2010 ENGINE

Engine Cooling - Camaro

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	Specification	
	Metric	English
Air Conditioning (A/C) Condenser Bolt	6.5 N.m	58 lb in
Air Conditioning (A/C) Line Clip to Fan Shroud Screw	1 N.m	9 lb in
Auxiliary Cooling Fan Bolt	6.5 N.m	58 lb in
Brake Master Cylinder Nut	25 N.m	18 lb ft
Clutch Master Cylinder Bolt	50 N.m	37 lb ft
Coolant Air Bleed Pipe Cover Bolt (LSA)	12 N.m	106 lb in
Coolant Air Bleed Stud (LSA)	12 N.m	106 lb in
Coolant Pipe to Cylinder Head Bolt (LLT)	50 N.m	37 lb ft
Coolant Pipe to Generator Bracket Bolt (LLT)	10 N.m	89 lb in
Coolant Pipe to Thermostat Housing Bolt (LLT)	10 N.m	89 lb in
Electric Cooling Fan Blade Nut	7 N.m	62 lb ft
Coolant Recovery Reservior Bolt	17 N.m	13 lb in
Electric Cooling Fan Motor Screw	5 N.m	44 lb in
Electric Cooling Fan Resistor Bolt	5.4 N.m	48 lb in
Electric Cooling Fan Shroud to Plenum Bolt	6.5 N.m	58 lb in
Electric Cooling Fan Shroud to Radiator Bolt	6.5 N.m	58 lb in
Engine Coolant Heater (LSA)	50 N.m	37 lb ft
Engine Coolant Heater Cord Fastener (LSA)	10 N.m	89 lb in
Engine Coolant Heater Ground Wire Bolt (LLT)	12 N.m	106 lb in
Oil Level Indicator Tube Bolt	20 N.m	15 lb ft
Radiator Support Bracket Bolt	9 N.m	80 lb in
Thermostat Bolt (LLT)	10 N.m	89 lb in
Thermostat Housing Bolt (LLT)	20 N.m	15 lb ft
Thermostat Housing Bolt (LSA)	15 N.m	11 lb ft
Water Outlet Housing Bolt (LLT)	10 N.m	89 lb in
Water Pump Bolt (LLT)	10 N.m	89 lb in
Water Pump Bolt (LSA)	30 N.m	22 lb ft
Water Pump Pulley Bolt (LLT)	12 N.m	106 lb in

SCHEMATIC AND ROUTING DIAGRAMS

ENGINE COOLING SCHEMATICS

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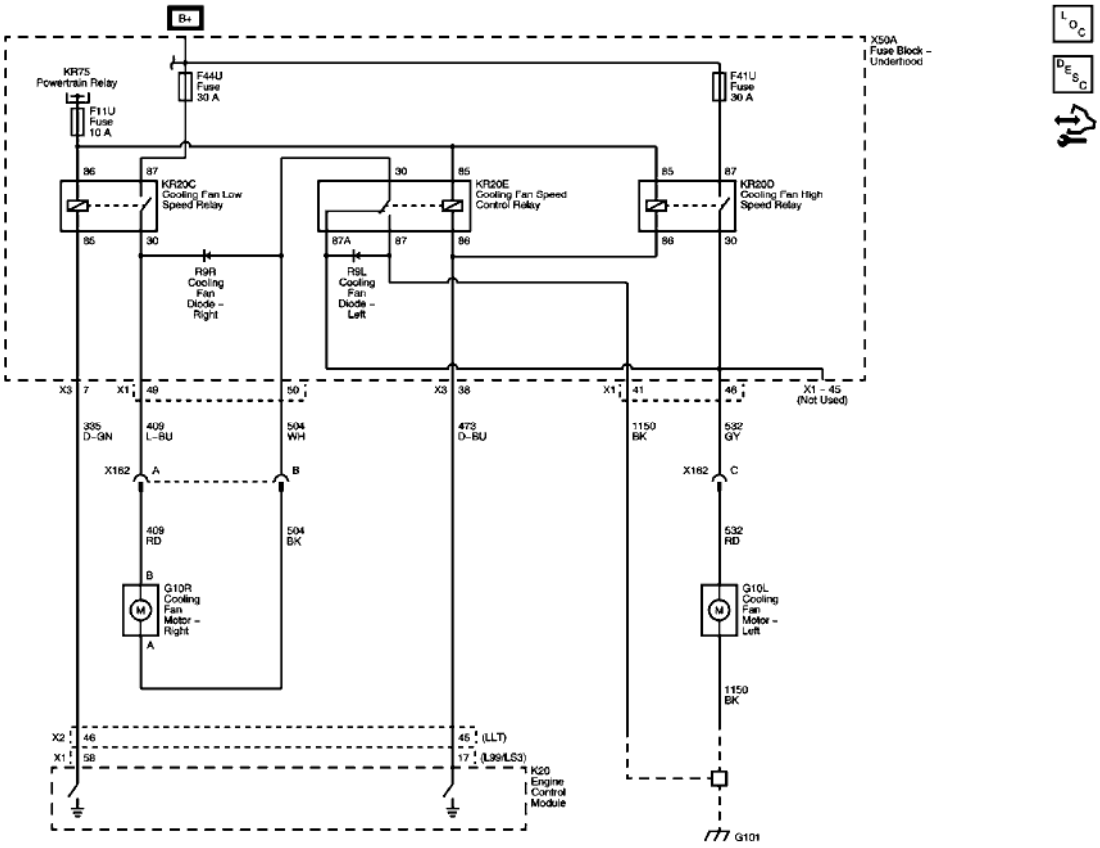


Fig. 1: Engine Cooling
Courtesy of GENERAL MOTORS CORP.

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC P0480 or P0481	P0480: Cooling Fan Relay 1 Control Circuit P0481: Cooling Fan Relays 2 and 3 Control Circuit
DTC P0480, P0481, P0691, P0692, P0693, or P0694 (w/V6-LLT)	P0480: Cooling Fan Relay 1 Control Circuit P0481: Cooling Fan Relay 2 Control Circuit P0691: Cooling Fan Relay 1 Control Circuit Low Voltage P0692: Cooling Fan Relay 1 Control Circuit High Voltage P0693: Cooling Fan Relay 2 Control Circuit Low Voltage P0694: Cooling Fan Relay 2 Control Circuit High Voltage
DTC P1258	P1258: Engine Coolant Overtemperature - Protection Mode Active

DTC P0480 OR P0481

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Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0480

Cooling Fan Relay 1 Control Circuit

DTC P0481

Cooling Fan Relays 2 and 3 Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition Circuit	P0480, P0481	P0480, P0481	-	-
Relay Switch Ignition Circuit	1	1	-	-
Low Speed Cooling Fan Relay Control	P0480	P0480	P0480	-
High Speed Cooling Fan Relay Control	P0481	P0481	P0481	-
Relay Controlled Output Circuit	1	1	2	-

1. Fans inoperative without a DTC.
2. Fans always ON without a DTC.

Typical Scan Tool Data

Cooling Fan Relay 1, and Cooling Fan Relays 2 and 3 Control Circuit Open, Low Voltage, and High Voltage Test Status with component OFF

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component Commanded OFF **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage test and Not Run for High Voltage test • Component ON - Not Run for Open/Low Voltage test and OK for High Voltage test			
Ignition Voltage	-	Malfunction	-
Low Speed Cooling Fan Relay Control	Malfunction	Malfunction	-
High Speed Cooling Fan Relay Control	Malfunction	Malfunction	Not Run

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Cooling Fan Relay 1, and Cooling Fan Relays 2 and 3 Control Circuit Open, Low Voltage, and High Voltage Test Status with component ON

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component Commanded ON **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage test and Not Run for High Voltage test • Component ON - Not Run for Open/Low Voltage test and OK for High Voltage test			
Ignition Voltage	Not Run	Not Run	-
Low Speed Cooling Fan Relay Control	Not Run	Not Run	Malfunction
High Speed Cooling Fan Relay Control	Not Run	Not Run	Malfunction

Circuit/System Description

The engine cooling fan system consists of a cooling fan assembly containing two electric cooling fans. The engine control module (ECM) uses two fan control circuits and a series of three relays to command the fans ON in either high speed or low speed, depending on cooling requirements. In low speed, both fans are turned ON at a reduced speed. High speed has both fans turned ON at full speed.

Conditions for Running the DTC

- The ignition voltage is between 11-18 volts.
- The engine speed is greater than 400 RPM.
- DTC P0480 and P0481 run continuously when the conditions above are met.

Conditions for Setting the DTC

P0480

The commanded state of the ECM driver and the actual state of the control circuit do not match for greater than 5 seconds.

P0481

The commanded state of the ECM driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the DTC Sets

DTCs P0480 and P0481 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0480 and P0481 are Type B DTCs.

Diagnostic Aids

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- The ECM has the capability of providing command to the fan relays even when a scan tool output control is being used. Always refer to the fan control command parameters on the scan tool to know which fans are being commanded ON by the ECM.
- The scan tool cooling fan output control operates as follows:
  - Cooling Fan Relay 1 operates both fans at a low speed
  - Cooling Fan Relay 2 and 3 operates the left fan at a high speed
  - Cooling Fan Relay 1, 2 and 3 operates both fans at a high speed
- KR20 cooling fan relay identification:
  - The KR20C cooling fan low speed relay is COOL FAN LOW Relay K613
  - The KR20E cooling fan speed control relay is COOL FAN CNTRL Relay K614
  - The KR20D cooling fan high speed relay is COOL FAN HI Relay K612
- When disconnecting or removing fuses and relays from a fuse block, always inspect the component electrical terminals for corrosion and the correct orientation in the fuse block. Test the mating electrical terminals for tightness.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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Circuit/System Verification

1. Engine operating, observe the DTC information with a scan tool. DTC P0480 or P0481 should not set.
2. Command the cooling fans ON and OFF at high speed while observing the scan tool circuit test status parameters listed below:
   - Cooling Fan Relay 1 Control Circuit Open, Low Voltage, and High Voltage Test Status
   - Cooling Fan Relays 2 and 3 Control Circuit Open, Low Voltage, and High Voltage Test Status

   The parameters should display OK or Not Run in each of the commanded states.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect all of the KR20 cooling fan relays.

NOTE: The following test must be performed on all three fan relay circuits.

2. Ignition ON, verify that a test lamp illuminates between ground and the relay coil ignition circuit terminal listed below:
   - KR20C Relay K613, terminal 86
   - KR20D Relay K612, terminal 85
   - KR20E Relay K614, terminal 85
   - If the test lamp does not illuminate, test the relay coil ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the relay coil ignition circuit fuse is open, test all components connected to the ignition circuit and replace as necessary.

NOTE: The following tests must be performed on all three fan relay control circuits.

3. Connect the red lead of the DMM to a control circuit terminal listed below. Connect the black lead to ground. Set the DMM on the diode setting. The DMM should display OL.
   - KR20C Relay K613, terminal 85
   - KR20D Relay K612, terminal 86
   - KR20E Relay K614, terminal 86
   - If less than the specified range, test the appropriate relay coil control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.

NOTE: The following test must be performed on all three fan relay circuits.

4. Command the cooling fan relay ON and OFF with a scan tool. The DMM should transition from OL when commanded OFF to less than 1 V when commanded ON.

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    - If the circuit voltage does not correspond to the specified values, test the control circuit for an open/high resistance or a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, test or replace the appropriate KR20 relay.

Component Testing

1. Ignition OFF, disconnect the KR20 cooling fan relay.
2. Test for 70-110 ohms between terminals 85 and 86.
    - If not within the specified range, replace the KR20 cooling fan relay.
3. Measure the resistance between the terminals listed below. The DMM should display OL.
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - If less than the specified range, replace the KR20 cooling fan relay.
4. Test the KR20E relay for less than 2 ohms between terminals 30 and 87A.
    - If greater than the specified range, replace the KR20E cooling fan relay.
5. Connect a 20 A fused jumper wire between relay terminal 85 and B+. Connect a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.
    - If greater than the specified range, replace the KR20 cooling fan relay.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0480, P0481, P0691, P0692, P0693, OR P0694 (W/V6-LLT)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0480

Cooling Fan Relay 1 Control Circuit

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DTC P0481

Cooling Fan Relay 2 Control Circuit

DTC P0691

Cooling Fan Relay 1 Control Circuit Low Voltage

DTC P0692

Cooling Fan Relay 1 Control Circuit High Voltage

DTC P0693

Cooling Fan Relay 2 Control Circuit Low Voltage

DTC P0694

Cooling Fan Relay 2 Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition	P0691, P0693	P0480, P0481	-	-
Relay Switch Ignition	1	1	-	-
Low Speed Cooling Fan Relay Control	P0691	P0480	P0692	-
High Speed Cooling Fan Relay Control	P0693	P0481	P0694	-
Relay Controlled Output	1	1	2	-

1. Fans inoperative without a DTC.
2. Fans always ON without a DTC.

Typical Scan Tool Data

Cooling Fan Relay 1, and Cooling Fan Relays 2 and 3 Control Circuit Open, Low Voltage, and High Voltage Test Status with component OFF

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component Commanded OFF **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage test and Not Run for High Voltage test • Component ON - Not Run for Open/Low Voltage test and OK for High Voltage test			

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Ignition Voltage	-	Malfunction	-
Low Speed Cooling Fan Relay Control	Malfunction	Malfunction	-
High Speed Cooling Fan Relay Control	Malfunction	Malfunction	Not Run

Cooling Fan Relay 1, and Cooling Fan Relays 2 and 3 Control Circuit Open, Low Voltage, and High Voltage Test Status with component ON

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component Commanded ON **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Low Voltage test and Not Run for High Voltage test • Component ON - Not Run for Open/Low Voltage test and OK for High Voltage test			
Ignition Voltage	Not Run	Not Run	-
Low Speed Cooling Fan Relay Control	Not Run	Not Run	Malfunction
High Speed Cooling Fan Relay Control	Not Run	Not Run	Malfunction

Circuit/System Description

The engine cooling fan system consists of a cooling fan assembly containing two electric cooling fans. The engine control module (ECM) uses two fan control circuits and a series of three relays to command the fans ON in either high speed or low speed, depending on cooling requirements. In low speed, both fans are turned ON at a reduced speed. High speed has both fans turned ON at full speed.

Conditions for Running the DTC

- The ignition voltage is between 10-18 volts.
- The engine speed is greater than 80 RPM.
- DTC P0480, P0481, P0691, P0692, P0693, and P0694 run continuously when the conditions above are met.

Conditions for Setting the DTC

P0480

The ECM detects an open on the low speed cooling fan relay control circuit for greater than 500 mS.

P0481

The ECM detects an open circuit on the high speed cooling fan relay control circuit for greater than 500 mS.

P0691

The ECM detects a short to ground on the low speed cooling fan relay control circuit for greater than 500 mS.

P0692

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The ECM detects a short to voltage on the low speed cooling fan relay control circuit for greater than 500 mS.

P0693

The ECM detects a short to ground on the high speed cooling fan relay control circuit for greater than 500 mS.

P0694

The ECM detects a short to voltage on the high speed cooling fan relay control circuit for greater than 500 mS.

Action Taken When the DTC Sets

DTCs P0480, P0481, P0691, P0692, P0693, and P0694 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0480, P0481, P0691, P0692, P0693, and P0694 are Type B DTCs.

Diagnostic Aids

- The ECM has the capability of providing command to the fan relays even when a scan tool output control is being used. Always refer to the fan control command parameters on the scan tool to know which fans are being commanded ON by the ECM.
- The scan tool cooling fan output control operates as follows:
  - Cooling Fan Relay 1 operates both fans at a low speed
  - Cooling Fan Relay 2 and 3 operates the left fan at a high speed
  - Cooling Fan Relay 1, 2 and 3 operates both fans at a high speed
- KR20 cooling fan relay identification:
  - The KR20C cooling fan low speed relay is COOL FAN LOW Relay K613
  - The KR20E cooling fan speed control relay is COOL FAN CNTRL Relay K614
  - The KR20D cooling fan high speed relay is COOL FAN HI Relay K612
- When disconnecting or removing fuses and relays from a fuse block, always inspect the component electrical terminals for corrosion and the correct orientation in the fuse block. Test the mating electrical terminals for tightness.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

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Cooling Fan Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine operating, observe the DTC information with a scan tool. DTC P0480, P0481, P0691, P0692, P0693, or P0694 should not set.
2. Command the cooling fans ON and OFF at high speed while observing the scan tool circuit test status parameters listed below:
   - Cooling Fan Relay 1 Control Circuit Open, Low Voltage, and High Voltage Test Status
   - Cooling Fan Relays 2 and 3 Control Circuit Open, Low Voltage, and High Voltage Test Status

   The parameters should display OK or Not Run in each of the commanded states.
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect all of the KR20 cooling fan relays.

   NOTE: The following tests must be performed on all three fan relay circuits.

2. Ignition ON, verify that a test lamp illuminates between ground and the relay coil ignition circuit terminal listed below:
   - KR20C Relay K613, terminal 86
   - KR20D Relay K612, terminal 85
   - KR20E Relay K614, terminal 85
   - If the test lamp does not illuminate, test the relay coil ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the relay coil ignition circuit fuse is open, test

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all components connected to the ignition circuit and replace as necessary.

NOTE: The following tests must be performed on all three fan relay circuits.

3. Connect the red lead of the DMM to a control circuit terminal listed below. Connect the black lead to ground. Set the DMM on the diode setting. The DMM should display OL.
   - KR20C Relay K613, terminal 85
   - KR20D Relay K612, terminal 86
   - KR20E Relay K614, terminal 86
   - If less than the specified range, test the appropriate relay coil control circuit for a short to ground. If the circuit tests normal, replace the K20 ECM.

NOTE: The following tests must be performed on all three fan relay circuits.

4. Command the cooling fan relay ON and OFF with a scan tool. The DMM should transition from OL when commanded OFF to less than 1 V when commanded ON.
   - If the circuit voltage does not correspond to the specified values, test the control circuit for an open/high resistance or a short to voltage. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, test or replace the appropriate KR20 relay.

Component Testing

1. Ignition OFF, disconnect the KR20 cooling fan relay.
2. Test for 70-110 ohms between terminals 85 and 86.
   - If not within the specified range, replace the KR20 cooling fan relay.
3. Measure the resistance between the terminals listed below. The DMM should display O.L.
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87
   - If less than the specified range, replace the KR20 cooling fan relay.
4. Test the KR20E relay for less than 2 ohms between terminals 30 and 87A.
   - If greater than the specified range, replace the KR20E cooling fan relay.
5. Connect a 20 A fused jumper wire between relay terminal 85 and B+. Connect a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.
   - If greater than the specified range, replace the KR20 cooling fan relay.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical**

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Center)

- **Control Module References** for ECM replacement, setup, and programming

DTC P1258

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of the diagnostic category.

DTC Descriptor

DTC P1258

Engine Coolant Overtemperature - Protection Mode Active

Circuit/System Description

The engine control module (ECM) uses the engine coolant temperature (ECT) sensor to monitor the engine for an over-termperature condition. This condition occurs when the coolant temperature is above a calibrated value for a calibrated length of time. The ECM will disable half of the cylinders by turning OFF the fuel injectors. By disabling half of cylinders, the ECM is able to reduce the temperature of the coolant.

Conditions for Running the DTC

- The engine is operating for greater than 30 seconds.
- DTC P0116, P0117, P0118, or P0128 is not set.

Conditions for Setting the DTC

- The ECM detects that engine coolant temperature is greater than 136°C (277°F) for greater than 1 second or a cumulative time of 10 seconds, for V6 applications.
- The ECM detects that the engine coolant temperature is greater than 131°C (267.8°F) for greater than 7 seconds, for V8 applications.

Action Taken When the DTC Sets

- DTC P1258 is a Type A DTC.
- The engine will operate in the Overheated Engine Protection Operating Mode.
- The instrument panel (IP) will illuminate the coolant indicator lamp and the driver information center (DIC), if equipped, may display a message.

Conditions for Clearing the DTC

DTC P1258 is a Type A DTC.

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Reference Information

Description and Operation

Cooling System Description and Operation

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: If DTCs P0480, P0481, P0691, P0692, P0693, or P0694 is set, diagnose the DTC first.

1. Observe the engine coolant level. The engine coolant level should be within operating range. Refer to Capacities - Approximate Fluid, and Engine Coolant in the Owner's Manual.
2. Ensure that the vehicle has the correct engine coolant, with correct concentration, and is not old, contaminated or contains additives. Refer to Recommended Fluids and Lubricants in the Owner's Manual.
3. Inspect the cooling system for the following:
   - Cooling system leaks
   - Kinked or pinched hoses, especially at the radiator
   - Loose, missing, or damaged radiator air seals or deflectors
   - The radiator and A/C condenser for any air flow obstructions or bent fins-Refer to **Symptoms - Engine Cooling**.

NOTE: A small delay occurs before the ECM changes the cooling fan speed.

4. Command the cooling fans in both low and high speed.
   - If the cooling fans do not operate in both speeds, refer to **Cooling Fan Inoperative**.
5. Test the thermostat for correct operation. Refer to **Thermostat Diagnosis**.
6. Test the engine cooling system for overheating. Refer to **Engine Overheating**.
7. Inspect the water pump and coolant flow for correct operation. Refer to **Water Pump Replacement (LLT)** or **Water Pump Replacement (LS3/L99)**.
8. Inspect the engine mechanical for worn/leaking/cracked cylinder heads and engine block. Refer to **Coolant in Combustion Chamber** and **Coolant in Engine Oil** .

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

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SYMPTOMS - ENGINE COOLING

Important Preliminary Inspections Before Starting

Before using the Symptom diagnosis, perform the following:

- Perform **Diagnostic System Check - Vehicle** and verify all of the following items:
  - Ensure that the engine control module (ECM) and indicator lamp are operating correctly.
  - Ensure that there are no diagnostic trouble codes (DTCs) that are stored.
  - Scan tool data is within a normal operating range.
- Verify the customer concern.
- Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important, and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.
- Locate the correct symptom. Perform the tests and inspections associated with the symptom.

Review the entire cooling system operation in order to familiarize yourself with the system functions. Refer to **Cooling Fan Description and Operation** and **Cooling System Description and Operation**.

Visual/Physical Inspection

CAUTION: Use the connector test adapter kit J 35616-A for any test that requires probing the following items:

- **The control module harness connectors**
- **The electrical center fuse/relay cavities**
- **The component terminals**
- **The component harness connector**

Using this kit will prevent damage caused by the improper probing of connector terminals.

Several of the symptom procedures call for a careful visual and physical inspection. This can lead to correcting a condition without further tests and can save time. This inspection should include the following areas:

- Ensure that the control module grounds are clean, tight, and correctly located.
- Inspect cooling system hoses and pipes for splits, kinks, and proper connections. Inspect thoroughly for any type of a leak or a restriction.
- Inspect for a dirty or restricted radiator and HVAC condenser.
- Inspect for aftermarket devices which could affect the operation of the Cooling System.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect the surge tank reservoir for the proper coolant level.

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Identifying Intermittent Conditions

Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement, vibration or physical movement of a component. Refer to the following for a list to help isolate an intermittent condition:

- Moisture and water intrusion in connectors, terminals, and components
- Connector mating
- Terminal contact
- High circuit or component resistance-High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.
- Harness' that are routed too tight, or chaffed circuits
- High or low ambient temperature
- High or low engine coolant temperatures
- High underhood temperatures
- Heat build up in component or circuit due to circuit resistance, poor terminal contact, or high electrical load
- High or low system voltage
- High vehicle load conditions
- Rough road surface
- Electro-magnetic interference (EMI)/circuit interference from relays, solenoids or other electrical surge
- Incorrect installation of non-factory, aftermarket, and after factory add on accessories

If an intermittent is detected, refer to **Testing for Intermittent Conditions and Poor Connections** for specific strategies in diagnosing intermittent conditions.

Symptom List

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

- **Cooling Fan Always On**
- **Cooling Fan Inoperative**
- **Engine Overheating**
- **Loss of Coolant**
- **Thermostat Diagnosis**
- **Engine Fails To Reach Normal Operating Temperature**

COOLING FAN ALWAYS ON

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

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- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The engine cooling fan system consists of a cooling fan assembly containing two electric cooling fans. The engine control module (ECM) uses two fan control circuits and a series of three relays to command the fans ON in either high speed or low speed, depending on cooling requirements. In low speed, both fans are turned ON at a reduced speed. High speed has both fans turned ON at full speed.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC P0480, P0481, P0691, P0692, P0693 or P0694 is not set.
   - If any cooling system DTCs are set, repair the DTCs first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition ON, verify with a scan tool that the ECM is not commanding fan activation.
3. Ignition ON, observe that the fan is not activated.

Circuit/System Testing

NOTE: The following tests must be performed on each cooling fan relay.

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1. Ignition OFF, disconnect each KR20 cooling fan relay one at a time.
2. Ignition ON, observe that the cooling fans are not activated.
    - If the fans are activated, test for a short to voltage in the relay controlled output circuit.
    - If the fans are not activated, test or replace the appropriate KR20 cooling fan relay.

Component Testing

1. Ignition OFF, disconnect the KR20 cooling fan relay.
2. Test for 70-110 ohms between terminals 85 and 86.
    - If not within the specified range, replace the KR20 cooling fan relay.
3. Measure the resistance between the terminals listed below. The DMM should display OL.
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - If not the specified range, replace the KR20 cooling fan relay.
4. Test the KR20E relay for less than 2 ohms between terminals 30 and 87A.
    - If greater than the specified range, replace the KR20E cooling fan relay.
5. Install a 20 A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.
    - If greater than the specified range, replace the KR20 cooling fan relay.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Relay Replacement (Attached to Wire Harness) or **Relay Replacement (Within an Electrical Center)**

COOLING FAN INOPERATIVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The engine cooling fan system consists of a cooling fan assembly containing two electric cooling fans. The engine control module (ECM) uses two fan control circuits and a series of three relays to command the fans ON in either high speed or low speed, depending on cooling requirements. In low speed, both fans are turned ON at a reduced speed. High speed has both fans turned ON at full speed.

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Diagnostic Aids

- The ECM has the capability of providing command to the fan relays even when a scan tool output control is being used. Always refer to the fan control command parameters on the scan tool to know which fans are being commanded ON by the ECM.
- The scan tool cooling fan output control operates as follows:
  - Cooling Fan Relay 1 operates both fans at a low speed
  - Cooling Fan Relay 2 and 3 operates the left fan at a high speed
  - Cooling Fan Relay 1, 2 and 3 operates both fans at a high speed
- KR20 cooling fan relay identification:
  - The KR20C cooling fan low speed relay is COOL FAN LOW Relay K613
  - The KR20E cooling fan speed control relay is COOL FAN CNTRL Relay K614
  - The KR20D cooling fan high speed relay is COOL FAN HI Relay K612
- When disconnecting or removing fuses and relays from a fuse block, always inspect the component electrical terminals for corrosion and the correct orientation in the fuse block. Test the mating electrical terminals for tightness.

Reference Information

Schematic Reference

Engine Cooling Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC P0480, P0481, P0691, P0692, P0693 or P0694 is not set.

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- If a DTC is set, refer to **DTC P0480 or P0481** or **DTC P0480, P0481, P0691, P0692, P0693, or P0694 (w/V6-LLT)**.

2. Ignition ON, command the appropriate fan relay ON and OFF with a scan tool. Verify that the fans turn ON and OFF when changing between the commanded states.

Circuit/System Testing

1. Ignition OFF, disconnect the cooling fan relays.
2. Connect a 30 A fused jumper between the KR20E relay K614 switch circuit terminal 30 and the ground circuit terminal 87. This completes the right side fan ground circuit. Leave this jumper in place for the remainder of this procedure.

NOTE: The following test must be performed on both the high speed fan relay circuit and the low speed fan relay circuit.

3. Ignition ON, verify that a test lamp illuminates between ground and the relay switched ignition circuit terminal listed below:
   - KR20C Relay K613, terminal 87
   - KR20D Relay K612, terminal 87
   - If the test lamp does not illuminate, test the appropriate relay switch B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the relay switch B+ circuit fuse is open, test the relay controlled output circuit for a short to ground. If the circuit tests normal, test or replace the appropriate G10 cooling fan.

NOTE: The following test must be performed first on the high speed fan relay circuit and next on the low speed fan relay circuit. Leave the jumper connected to the low speed fan relay circuit for the next test.

4. Connect a 30 A fused jumper between the KR20 cooling fan relay circuit terminals listed below. Verify the appropriate fan is activated.
   - KR20D Relay K612, terminals 87 and 30
   - KR20C Relay K613, terminals 87 and 30
   - If the corresponding cooling fan does not activate, test the relay controlled output circuit and the cooling fan ground circuit for an open/high resistance. If the circuits tests normal, replace the appropriate G10 cooling fan.
   - If the corresponding cooling fan activates, replace the appropriate KR20 cooling fan relay.
5. Install the KR20E relay K614. Verify both fans activate at low speed.
   - If both fans do not activate, test the KR20E relay controlled output circuit terminal 87A, for a short to ground or an open/high resistance.
6. If all circuits test normal, test or replace the KR20E cooling fan speed control relay.

Component Testing

1. Ignition OFF, disconnect the KR20 cooling fan relay.

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2. Test for 70-110 ohms between terminals 85 and 86.
    - If not within the specified range, replace the KR20 cooling fan relay.
3. Measure the resistance between the terminals listed below. The DMM should display O.L.
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - If not the specified range, replace the KR20 cooling fan relay.
4. Test the KR20E relay for less than 2 ohms between terminals 30 and 87A.
    - If greater than the specified range, replace the KR20E cooling fan relay.
5. Install a 20 A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.
    - If greater than the specified range, replace the KR20 cooling fan relay.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Engine Coolant Fan Motor Replacement**

ENGINE OVERHEATING

Step	Action	Yes	No
DEFINITION: The engine temperature lamp comes on and stays on, or temperature gauge shows hot, or coolant overflows from the coolant recovery reservoir onto the ground while the engine is running. **Special Tools:** **J-26568:** Coolant and Battery Fluid Tester			
1	Check the condenser, radiator, and auxiliary coolers for any obstructions or bent fins that would prevent air flow through the radiator. Is there any airflow obstruction or bent fins?	Go to **Step 2**	Go to **Step 3**
2	1. Remove any debris that may cause an air flow obstruction. 2. Remove or relocate aftermarket add-on components that block air flow to the radiator. Does the engine still overheat?	Go to **Step 3**	System OK
3	Check for loose, missing, or damaged radiator air seals or deflectors. Are there any loose, missing, or damaged radiator air seals or deflectors?	Go to **Step 4**	Go to **Step 5**

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4	Repair or replace any loose, missing, or damaged radiator air seals or deflectors. Does the engine still overheat?	Go to **Step 5**	System OK
5	Check for an inoperative cooling fan. Refer to **Cooling Fan Inoperative**. Is the cooling fan inoperative?	Go to **Step 6**	Go to **Step 7**
6	Repair or replace the cooling fan(s) as necessary. Refer to **Engine Coolant Fan Motor Replacement**. Does the engine still overheat?	Go to **Step 7**	System OK
7	Check for a loss of coolant. Refer to **Loss of Coolant**. Does the engine still overheat?	Go to **Step 8**	System OK
8	Check for kinked or pinched cooling hoses. Does the engine still overheat?	Go to **Step 9**	Go to **Step 10**
9	1. Relieve any kinks by rerouting the hoses. 2. Replace the hoses, if necessary. Does the engine still overheat?	Go to **Step 10**	System OK
10	Using **J-26568:** Coolant and Battery Fluid Tester, check the coolant concentration. Does the coolant concentration test correctly?	Go to **Step 12**	Go to **Step 11**
11	Replace the coolant, if necessary. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**. Does the engine still overheat?	Go to **Step 12**	System OK
12	Check for any blocked cooling system passages. Are there blocked cooling system passages?	Go to **Step 13**	Go to **Step 14**
13	Remove any obstructions by flushing the cooling system. Refer to **Flushing**. Does the engine still overheat?	Go to **Step 14**	Go to **Step 19**
14	Inspect the accessory drive belt tensioner. Refer to **Drive Belt Tensioner Diagnosis** for the 3.6L engine and **Drive Belt Tensioner Diagnosis** for the 6.2L engine. Does the engine still overheat?	Go to **Step 15**	System OK
15	Check for a faulty thermostat. Refer to **Thermostat Diagnosis**. Does the engine still overheat?	Go to **Step 16**	System OK
16	Replace the radiator. Refer to **Radiator Replacement (LLT)** or **Radiator Replacement (LS3, L99)**. Does the engine still overheat?	Go to **Step 17**	System OK
17	Check for a faulty water pump. The impeller blades may be eroded or broken. Is the water pump faulty?	Go to **Step 18**	-

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18	Replace the water pump. Refer to **Water Pump Replacement (LLT)** or **Water Pump Replacement (LS3/L99)**. Does the engine still overheat?	Go to **Step 19**	-
19	Operate the system to verify the repair. Did you correct the condition?	System OK	-

LOSS OF COOLANT

Step	Action	Yes	No
DEFINITION: The cooling system is loosing coolant either internally or externally.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to **Step 2**	Go to **Symptoms - Engine Cooling**
2	Repair any present DTCs. Refer to **Diagnostic System Check - Vehicle** . Is the action complete?	Go to **Step 3**	-
3	Inspect the coolant level. Is the coolant at the proper level?	Go to **Step 5**	Go to **Step 4**
4	Fill the cooling system to the proper level. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**. Is the action complete?	Go to **Step 5**	-
5	If the engine is suspected to have a coolant leak into a cylinder, the coolant can hydraulically lock the engine. Does the engine crankshaft rotate?	Go to **Step 6**	Go to **Step 28**
6	Engine overheating can cause a loss of coolant. Is the engine overheating?	Go to **Step 29**	Go to **Step 7**
7	Extended operation with a low coolant level can cause engine internal component failure. Is the engine knocking?	Go to **Step 31**	Go to **Step 8**
8	1. Idle the engine at normal operating temperature. 2. Inspect for heavy white smoke coming out of the exhaust pipe. Is a heavy white smoke present from the exhaust pipe?	Go to **Step 9**	Go to **Step 10**
9	Coolant in the exhaust system creates a distinctive, burning coolant odor in the exhaust. Condensation in the exhaust system can cause an odorless white smoke during engine warm up. Does the white smoke have a burning coolant type odor?	Go to **Step 30**	Go to **Step 10**
	WARNING: **Refer to Moving Parts and Hot Surfaces Warning .**		

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10	With the engine idling, inspect the coolant recovery system.Does the coolant recovery system discharge coolant while the engine is idling?	Go to **Step 15**	Go to **Step 11**
11	Visually inspect the hoses, pipes and hose clamps at the following locations: • Coolant overflow tank • Water Pump • Heater core • Radiator Are any of the hoses, clamps or pipes leaking?	Go to **Step 22**	Go to **Step 12**
12	Visually inspect the following components: • Coolant pressure cap • Block heater • Core plugs • Cylinder head gaskets • Engine block • Intake manifold • Radiator • Thermostat housing • Water pump Are any of the listed components leaking?	Go to **Step 22**	Go to **Step 13**
13	1. Pressure test the cooling system. Refer to **Cooling System Leak Testing**. 2. With the cooling system pressurized, visually inspect the components listed in steps 11 and 12. Are any leaks present?	Go to **Step 22**	Go to **Step 14**
14	Pressure test the coolant pressure cap. Refer to **Pressure Cap Testing**. Does the coolant pressure cap hold pressure?	Go to **Step 16**	Go to **Step 23**
15	Pressure test the coolant pressure cap. Refer to **Pressure Cap Testing**. Does the coolant pressure cap hold pressure?	Go to **Step 32**	Go to **Step 23**
	Inspect for the following conditions: • A coolant smell inside of the vehicle		

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16	• Coolant in the HVAC module drain tube • Coolant on the vehicle floor covering near the HVAC module Is coolant present?	Go to **Step 24**	Go to **Step 17**
17	1. Add 30 ml (1 oz) of GM P/N 89022219 (Canadian P/N 89022220) Canada Extended Life Coolant Leak Detection Dye to the cooling system for each 15 L (4 gal) of coolant. Refer to **Approximate Fluid Capacities** . 2. Start the vehicle and allow the engine to reach normal operating temperature. 3. Shut the engine off. 4. Use the **J 42220:** Universal 12V Leak Detection Lamp to visually inspect the components listed in steps 11 and 12. Are any leaks present?	Go to **Step 22**	Go to **Step 18**
18	Use the **J 42220:** Universal 12V Leak Detection Lamp to inspect for the following conditions: • Coolant dye in the HVAC module drain tube • Coolant dye on the vehicle floor covering near the HVAC module Is coolant dye present?	Go to **Step 24**	Go to **Step 19**
19	Inspect the underside of the engine oil fill cap for a gray/white milky substance. Is a milky substance under the oil fill cap?	Go to **Step 20**	Go to **Step 21**
20	Inspect the engine oil fluid level indicator for a gray/white milky substance. Is a milky substance on the engine oil fluid level indicator?	Go to **Step 30**	Go to **Step 21**
21	Inspect the automatic transmission oil fluid level indicator, if equipped, for a gray/white milky substance. Is there a milky substance on the automatic transmission fluid level indicator?	Go to **Step 25**	Go to **Step 33**
22	Repair or replace the leaking component. Refer to the appropriate repair. Is the repair complete?	Go to **Step 33**	-
23	Replace the coolant pressure cap. Is the repair complete?	Go to **Step 33**	-

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24	Replace the heater core. Refer to **Heater Core Replacement** . Is the repair complete?	Go to **Step 33**	-
25	1. Remove the transmission oil cooler lines from the radiator. 2. Pressure test the cooling system. Refer to **Cooling System Leak Testing**. 3. Inspect the transmission oil cooler for coolant. Is coolant present?	Go to **Step 26**	Go to **Step 27**
26	1. Replace the radiator. Refer to **Radiator Replacement (LLT)** or **Radiator Replacement (LS3, L99)**. 2. Service the automatic transmission. Refer to **Engine Coolant/Water in Transmission** . Is the repair complete?	Go to **Step 33**	-
27	Install the cooler lines to the radiator. Is the action complete?	Go to **Step 33**	-
28	Repair the engine no crank condition. Refer to **Engine Will Not Crank - Crankshaft Will Not Rotate** for 3.6L or **Engine Will Not Crank - Crankshaft Will Not Rotate** for 6.2L engine. Is the repair complete?	Go to **Step 33**	-
29	Repair the engine overheating condition. Refer to **Engine Overheating**. Is the repair complete?	Go to **Step 33**	-
30	Repair the engine internal coolant leak. Refer to **Coolant in Combustion Chamber** for 3.6L or **Coolant in Combustion Chamber** for 6.2L engine. Is the repair complete?	Go to **Step 33**	-
31	Repair the engine knock. Refer to **Lower Engine Noise, Regardless of Engine Speed** for 3.6L or **Lower Engine Noise, Regardless of Engine Speed** for 6.2L engine. Is the repair complete?	Go to **Step 33**	-
32	Repair the combustion pressure in the cooling system problem. Refer to **Coolant in Combustion Chamber** for 3.6L or **Coolant in Combustion Chamber** for 6.2L engine. Is the repair complete?	Go to **Step 33**	-
33	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to **Step 2**

THERMOSTAT DIAGNOSIS

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Special Tools

J 24731: Tempil Stick

Use one of the following procedures in testing for a malfunctioning thermostat.

Thermostat Test Procedure Using Tempil Sticks

The coolant thermostat can be tested using a temperature (tempil) stick. The temperature stick is a pencil like device. It has a wax material containing certain chemicals which melt at a given temperature. Take a 87°C (188° F) tempil stick or a 97°C (206°F) tempil stick and rub it on the thermostat housing. Temperature sticks can be used to determine a thermostat's operating range.

1. Use a **J 24731:** Tempil Stick in order to find the opening and the closing temperatures of the coolant thermostat.
    - The 188 tempil stick melts at 87°C (188°F). The thermostat should begin to open.
    - The 206 tempil stick melts at 97°C (206°F). The thermostat should be fully open.
2. Replace the coolant thermostat if it does not operate properly between this temperature range.

Thermostat Test Procedure Using Glycol

Inspect the operation of the thermostat by hanging the thermostat on a hook in a 50/50 percent solution of DEX-COOL® and clean drinkable water.

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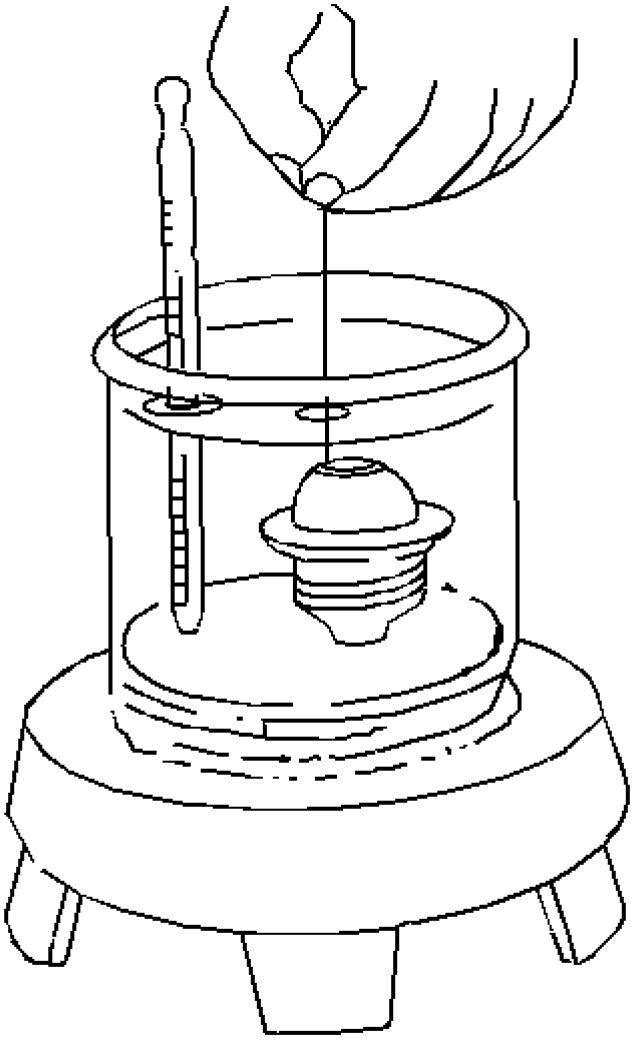


Fig. 2: View Of Thermostat Test
Courtesy of GENERAL MOTORS CORP.

In order to inspect if the thermostat valve is opening properly, perform the following test:

1. Completely submerge the thermostat in the glycol solution. The solution should be 11°C (22°F) above the temperature indicated on the thermostat valve.
2. Thoroughly agitate the solution. Under these conditions, the thermostat valve should open.

In order to inspect if the thermostat valve is closing properly, perform the following test:

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1. Completely submerge the thermostat in a glycol solution. The solution should be 6°C (10°F) below the temperature indicated on the thermostat valve.
2. Thoroughly agitate the solution. Under these conditions, the thermostat valve should close completely.

COOLANT HEATER INOPERATIVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The optional coolant heater operates using 110-volt AC external power and is designed to warm the coolant in the engine block area for improved starting in very cold weather. There is an internal thermal switch in the power cord that prevents operation above -18°C (0°F). The coolant heater helps reduce fuel consumption when a cold engine is warming up. The unit is equipped with a detachable AC power cord. A weather shield on the cord is provided to protect the plug when not in use.

Reference Information

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Testing

NOTE: The power supply cord will read open due to an internal thermal switch if the ambient temperature is above -18°C (0°F).

1. Test the engine coolant heater for an open or short to ground.
    - If open or shorted, replace the heater.
2. If the heater tests normal, replace the coolant heater power cord.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Coolant Heater Replacement (V6)**
- **Engine Coolant Heater Cord Replacement (V6)**

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ENGINE FAILS TO REACH NORMAL OPERATING TEMPERATURE

Step	Action	Yes	No
1	1. Ensure that the cooling system is full. 2. Allow the engine to cool. 3. Start the engine. 4. Turn the air conditioning system off. 5. Inspect the engine cooling fan(s). Is the electric cooling fan on?	Go to **Step 2**	Go to **Step 3**
2	1. Diagnose and repair the cooling fan system. Refer to **Cooling Fan Always On**. 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to **Step 3**	System OK
3	Install the Scan Tool to the DLC. Compare the Scan Tool coolant temperature reading to the I/P cluster coolant temperature. Is the I/P cluster coolant temperature close to the reading on the Scan Tool?	Go to **Step 5**	Go to **Step 4**
4	1. Diagnose and repair the coolant temperature gauge system. 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to **Step 5**	System OK
5	Inspect the thermostat for correct operation. Refer to **Thermostat Diagnosis**. Is the thermostat operating correctly?	System OK	Go to **Step 6**
6	1. Replace the thermostat. Refer to **Engine Coolant Thermostat Replacement (LLT)** or **Engine Coolant Thermostat Replacement (L99/LS3)**. 2. Verify the customer complaint. Does the engine still fail to reach normal operating temperature?	Go to **Step 1**	System OK

PRESSURE CAP TESTING

Special Tools

- **J 24460-01:** Cooling System Pressure Tester

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- **J 42401-1:** Radiator Cap / Surge Tank Test Adapter

Pressure Cap Testing

WARNING: To avoid being burned, do not remove the radiator cap or surge tank cap while the engine is hot. The cooling system will release scalding fluid and steam under pressure if radiator cap or surge tank cap is removed while the engine and radiator are still hot.

1. Remove the pressure cap.
2. Wash the pressure cap sealing surface with water.

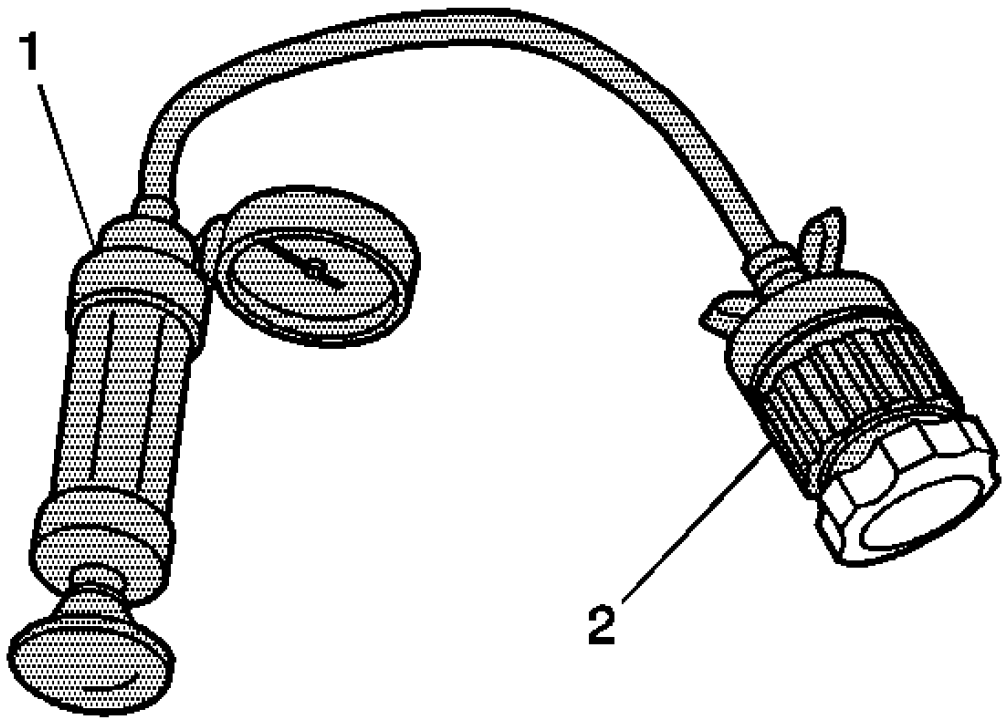


Fig. 3: Testing Pressure Cap
Courtesy of GENERAL MOTORS CORP.

NOTE: Lubricate J-42401-1 and pressure cap o-rings with coolant and press cap to seat o-ring on J-42401-1 before turning to engage threads.

3. Use the **J 24460-01:** Cooling System Pressure Tester (1) with **J 42401-1:** Radiator Cap / Surge Tank Test

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Adapter (2) in order to test the pressure cap.

4. Test the pressure cap for the following conditions:
   - Pressure release when the J 24460-01: Cooling System Pressure Tester exceeds the pressure rating of the pressure cap.
   - Maintain the rated pressure for at least 10 seconds.

     Note the rate of pressure loss.

5. Replace the pressure cap under the following conditions:
   - The pressure cap does not release pressure which exceeds the rated pressure of the cap.
   - The pressure cap does not hold the rated pressure.

COOLING SYSTEM LEAK TESTING

Special Tools

- **J 24460-01:** Cooling System Pressure Tester
- **J 42401-3:** Radiator Cap / Surge Tank Test Adapter

Cooling System Leak Testing

WARNING: Under pressure, the temperature of the solution in the radiator can be considerably higher, without boiling. Removing the radiator cap while the engine is hot (pressure is high), will cause the solution to boil instantaneously, with explosive force. The solution will spew out over the engine, fenders, and the person removing the cap. Serious bodily injury may result. Flammable antifreeze, such as alcohol, is not recommended for use at any time. Flammable antifreeze could cause a serious fire.

WARNING: In order to help avoid being burned, do not remove the radiator cap while the engine and the radiator are hot. Scalding fluid and steam can be blown out under pressure if the cap is removed too soon.

1. Remove the pressure cap.
2. Test the operation of the pressure cap. Refer to **Pressure Cap Testing**.
3. Wash the pressure cap mating surface with water.

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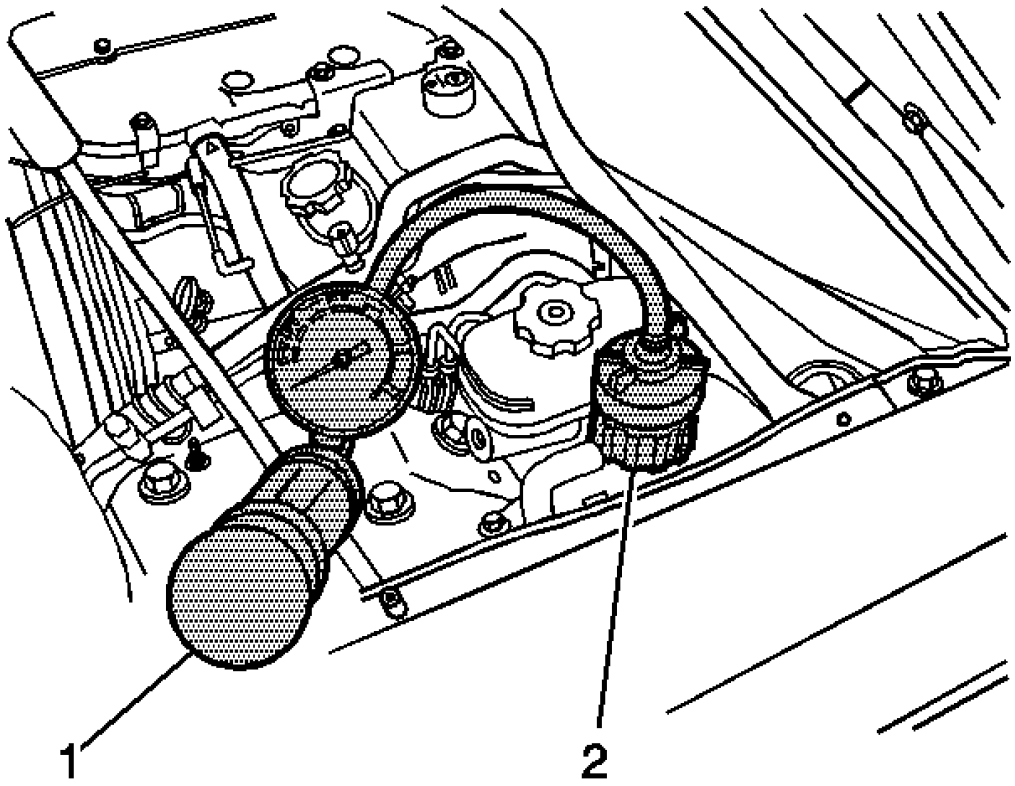


Fig. 4: Applying Pressure To Cooling System
Courtesy of GENERAL MOTORS CORP.

4. Use the J 24460-01: Cooling System Pressure Tester (1) with **J 42401-3:** Radiator Cap / Surge Tank Test Adapter (2) in order to apply pressure to the cooling system.

   Do not exceed the pressure cap rating.

5. The cooling system should hold the rated pressure for at least 2 minutes.

   Observe the gauge for any pressure loss.

6. Repair any leaks as required.

REPAIR INSTRUCTIONS

COOLING SYSTEM DRAINING AND FILLING (LS3, L99 STATIC FILL)

Special Tools

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J 26568: Coolant and Battery Fluid Tester

Draining Procedure

WARNING: To avoid being burned, do not remove the radiator cap or surge tank cap while the engine is hot. The cooling system will release scalding fluid and steam under pressure if radiator cap or surge tank cap is removed while the engine and radiator are still hot.

1. Remove the coolant pressure cap from the radiator.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Place a clean drain pan under the radiator drain cock.
4. Loosen the radiator drain cock.
5. Drain the cooling system.
6. Lower the vehicle.
7. Inspect the coolant.
8. Follow the appropriate procedure based on the condition of the coolant.
   - Normal in appearance-Follow the filling procedure.
   - Discolored-Follow the flush procedure. Refer to **Flushing**.
9. Tighten the radiator drain cock.
10. Lower the vehicle.

Filling Procedure

CAUTION: The procedure below must be followed. Improper coolant level could result in a low or high coolant level condition, causing engine damage.

NOTE: Use a 50/50 mixture of DEX-COOL antifreeze and clean drinkable water.

1. Slowly fill the radiator with a 50/50 coolant mixture until the coolant level is just below the radiator fill neck. Refer to **Approximate Fluid Capacities** .
2. Allow 30 seconds for the coolant level to stabilize and continue to fill the radiator until the level stabilizes for at least 2 minutes.
3. Start the engine and allow to the engine to idle.
4. Slowly fill the coolant mixture until the level stabilizes at the just below the top of radiator fill neck for at least 2 minutes.
5. Install the coolant pressure cap.
6. Allow the engine to idle until the engine reaches normal operating temperature.
7. Shut the engine OFF.
8. Allow the engine to cool.
9. Remove the coolant pressure cap and top off the engine coolant in the radiator.

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10. Inspect the concentration of the engine coolant using the **J 26568:** Coolant and Battery Fluid Tester.
11. Install coolant pressure cap.
12. Inspect and if necessary, fill the coolant reservoir bottle.
13. Rinse away any excess coolant from the engine and the engine compartment
14. Inspect the cooling system for leaks.
15. Top off the coolant reservoir if necessary.

COOLING SYSTEM DRAINING AND FILLING (LLT STATIC FILL)

Special Tools

J 26568: Coolant and Battery Fluid Tester

Draining Procedure

WARNING: To avoid being burned, do not remove the radiator cap or surge tank cap while the engine is hot. The cooling system will release scalding fluid and steam under pressure if radiator cap or surge tank cap is removed while the engine and radiator are still hot.

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
2. Remove the coolant pressure cap from the coolant filler neck.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Place a clean drain pan under the radiator drain cock.
5. Loosen the radiator drain cock.
6. Drain the cooling system.
7. Lower the vehicle.
8. Inspect the coolant.
9. Follow the appropriate procedure based on the condition of the coolant.
    - Normal in appearance-Follow the filling procedure.
    - Discolored-Follow the flush procedure. Refer to **Flushing**.
10. Tighten the radiator drain cock.
11. Lower the vehicle.

Filling Procedure

CAUTION: The procedure below must be followed. Improper coolant level could result in a low or high coolant level condition, causing engine damage.

NOTE: Use a 50/50 mixture of DEX-COOL antifreeze and clean drinkable water.

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1. Slowly fill the coolant filler neck with a 50/50 coolant mixture until the coolant level is just below the top of the coolant filler neck. Refer to **Approximate Fluid Capacities** .
2. Allow 30 seconds for the coolant level to stabilize and continue to fill the coolant filler neck until the level stabilizes for at least 2 minutes.
3. Start the engine and allow to the engine to idle in PARK or NEUTRAL with the parking brake engaged.
4. Slowly fill the coolant mixture until the level stabilizes just below the top of the coolant filler neck.
5. Install the coolant pressure cap.
6. Raise the engine RPM to 2500 rpm for 30-40 seconds.
7. Shut the engine OFF.
8. Allow the engine to cool, remove coolant pressure cap and repeat steps 4-10 until the coolant level has completely stabilized within the coolant fill neck.
9. Start the engine and allow the engine to idle until it reaches normal operating temperature.
10. Shut off the engine and allow the engine to cool.
11. Remove the coolant pressure cap.
12. Inspect the concentration of the engine coolant using the **J 26568:** Coolant and Battery Fluid Tester
13. Install the coolant pressure cap.
14. Inspect and if necessary, fill the coolant reservoir bottle as necessary.
15. Rinse away any excess coolant from the engine and the engine compartment
16. Inspect the cooling system for leaks.
17. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .

COOLING SYSTEM DRAINING AND FILLING (GE 47716)

Special Tools

- **J 26568:** Coolant and Battery Fluid Tester
- **J 42401:** Radiator Cap and Surge Tank Test Adapter
- **GE-47716:** Vac-N-Fill Coolant Refill Tool

Draining Procedure

WARNING: With a pressurized cooling system, the coolant temperature in the radiator can be considerably higher than the boiling point of the solution at atmospheric pressure. Removal of the surge tank cap, while the cooling system is hot and under high pressure, causes the solution to boil instantaneously with explosive force. This will cause the solution to spew out over the engine, the fenders, and the person removing the cap. Serious bodily injury may result.

1. Remove the coolant pressure cap.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Place a drain pan under the drain cock.

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4. Remove the radiator drain cock.
5. Drain the cooling system.
6. Lower the vehicle.
7. Inspect the coolant.
8. Follow the appropriate procedure based on the condition of the coolant.
    - Normal in appearance-Follow the filling procedure.
    - Discolored-Follow the flush procedure. Refer to **Flushing** .

Vac-N-Fill Procedure

1. Install the **J 42401:** Radiator Cap and Surge Tank Test Adapter onto the coolant surge tank.

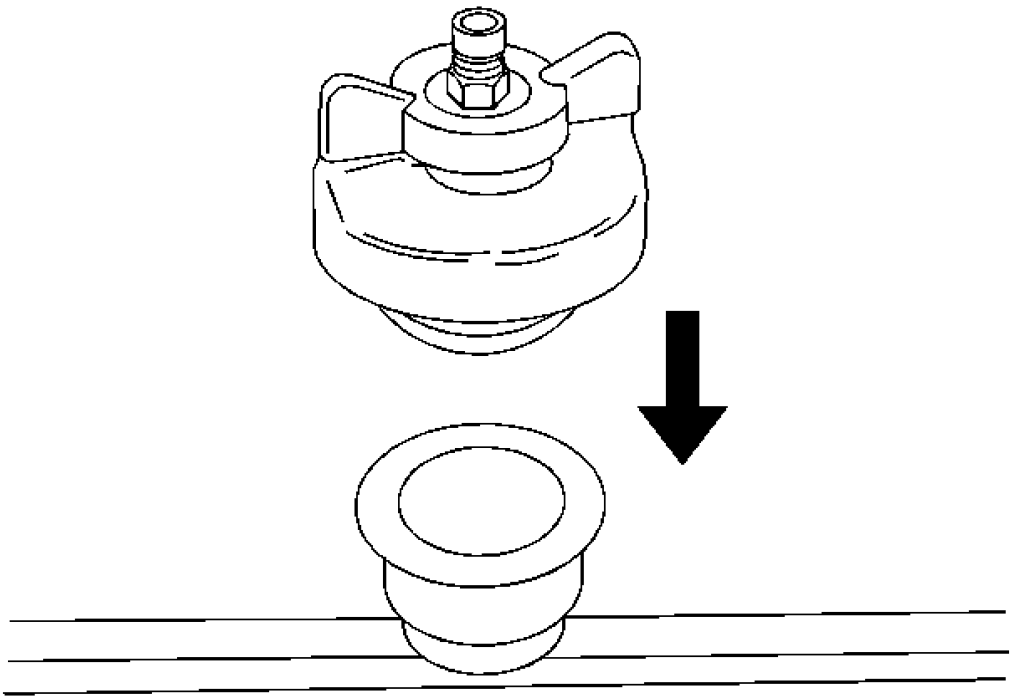


Fig. 5: Identifying Vac-N-Fill Cap
Courtesy of GENERAL MOTORS CORP.

WARNING: To avoid being burned, do not remove the radiator cap or surge tank cap while the engine is hot. The cooling system will release scalding fluid and steam under pressure if radiator cap or surge tank cap is removed while the engine and radiator are still hot.

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2. Attach the Vac-N-Fill cap to the **J 42401:** Radiator Cap and Surge Tank Test Adapter.

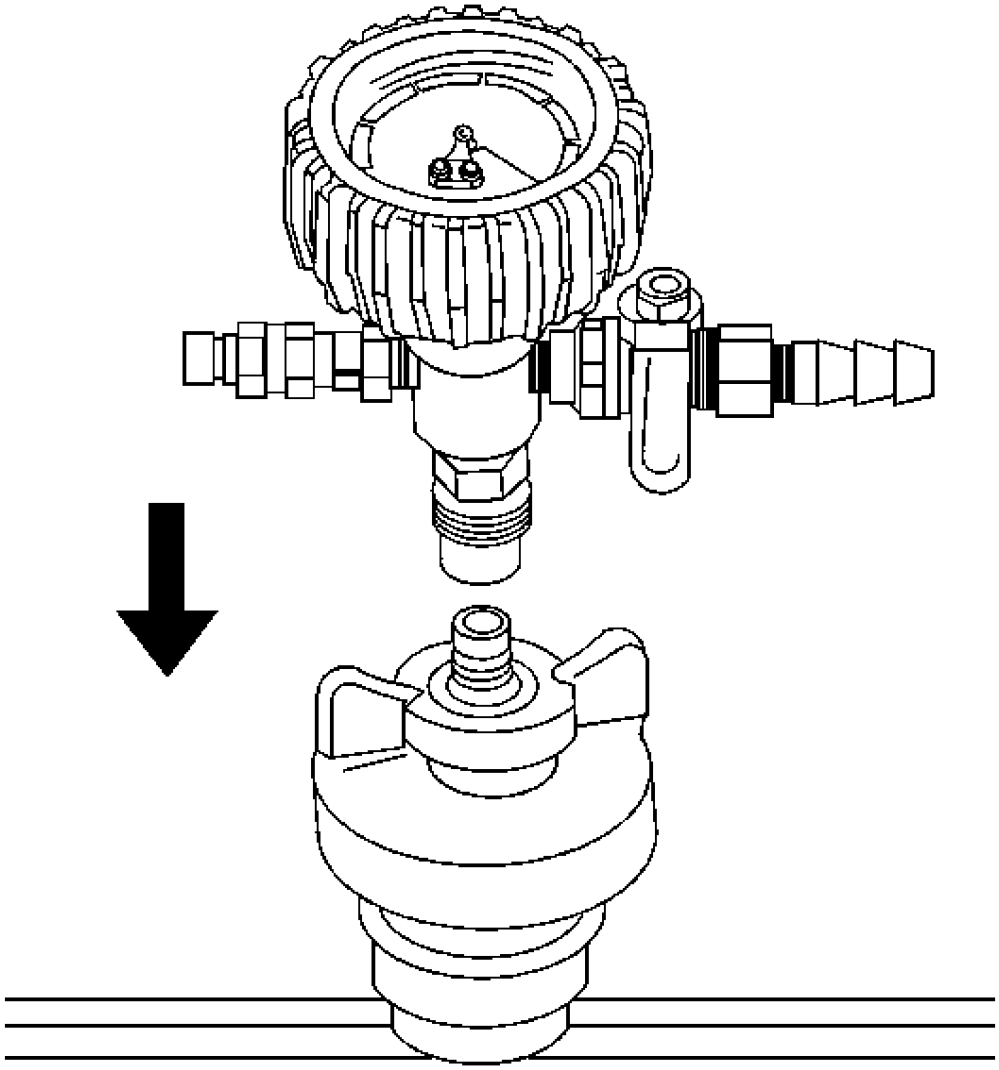


Fig. 6: Attaching Vacuum Gauge Assembly To Vac N Fill Cap
Courtesy of GENERAL MOTORS CORP.

3. Attach the vacuum gauge assembly to the Vac-N-Fill cap.

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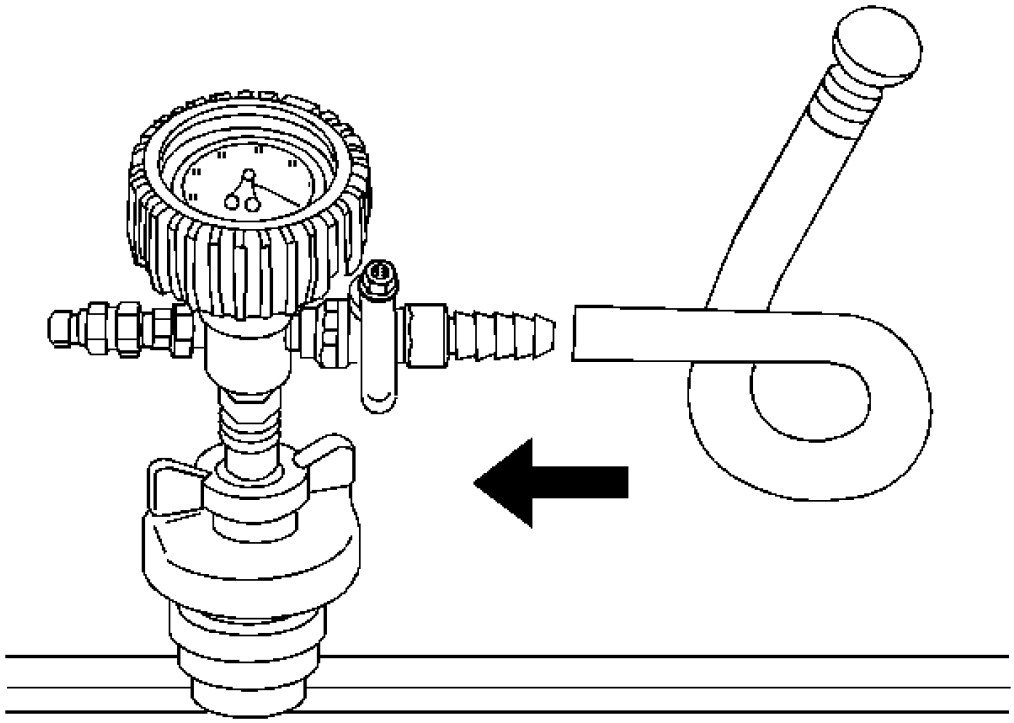


Fig. 7: Attaching Fill Hose To Barb Fitting On Vacuum Gage Assembly
Courtesy of GENERAL MOTORS CORP.

4. Attach the fill hose to the barb fitting on the vacuum gauge assembly.

   Ensure that the valve is closed.

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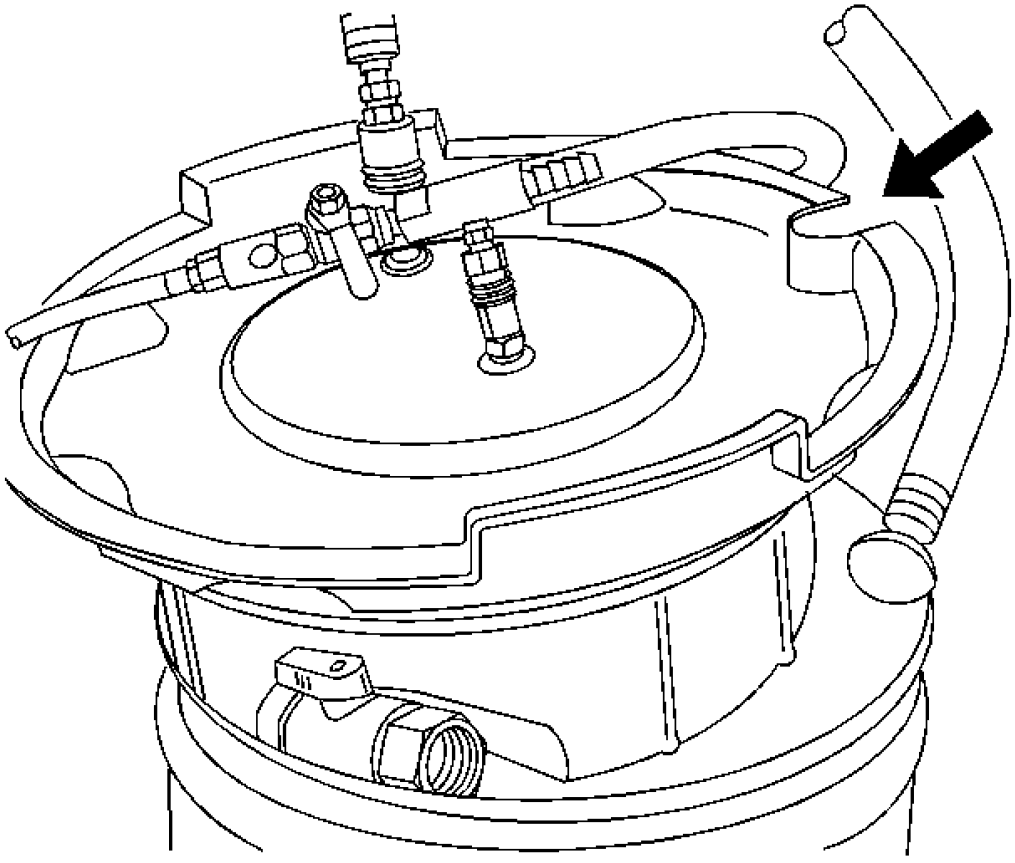


Fig. 8: View Of Graduated Reservoir & Hose
Courtesy of GENERAL MOTORS CORP.

NOTE: Use a 50/50 mixture of DEX-COOL antifreeze and clean, drinkable water. Always use more coolant than necessary. This will eliminate air from being drawn into the cooling system.

5. Pour the coolant mixture into the graduated reservoir.
6. Place the fill hose in the graduated reservoir.

NOTE: Prior to installing the vacuum tank onto the graduated reservoir, ensure that the drain valve located on the bottom of the tank is closed.

7. Install the vacuum tank on the graduated reservoir with the fill hose routed through the cut-out area in the vacuum tank.

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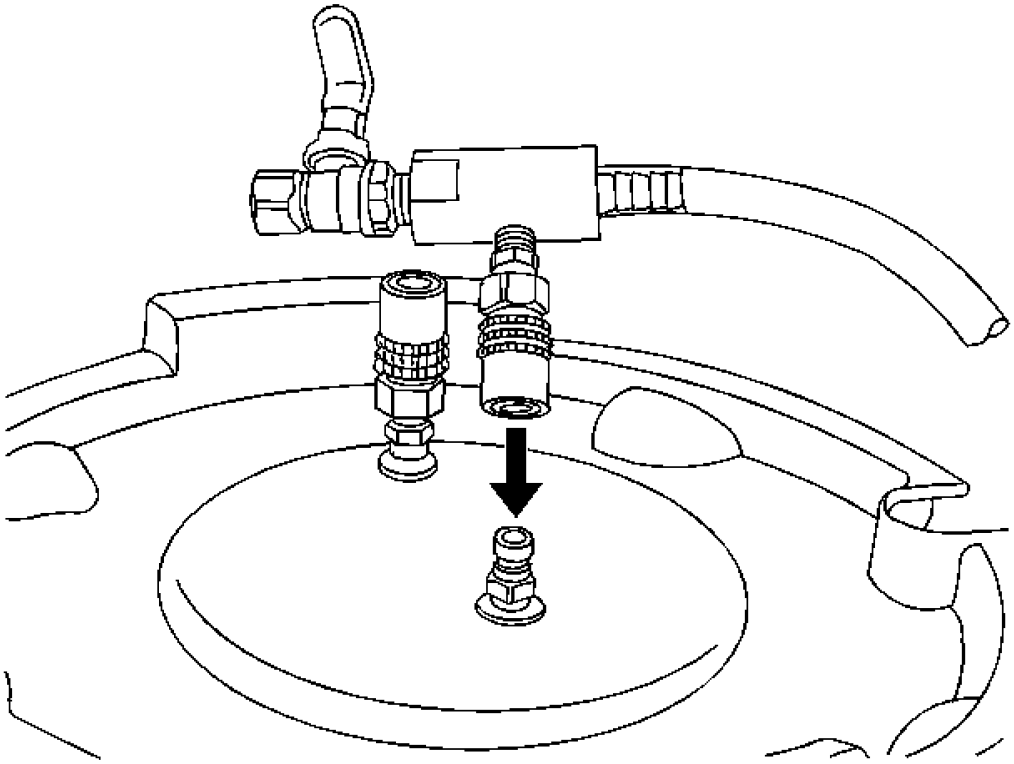


Fig. 9: Connecting Venturi Assembly To Vacuum Tank
Courtesy of GENERAL MOTORS CORP.

8. Attach the venturi assembly to the vacuum tank.

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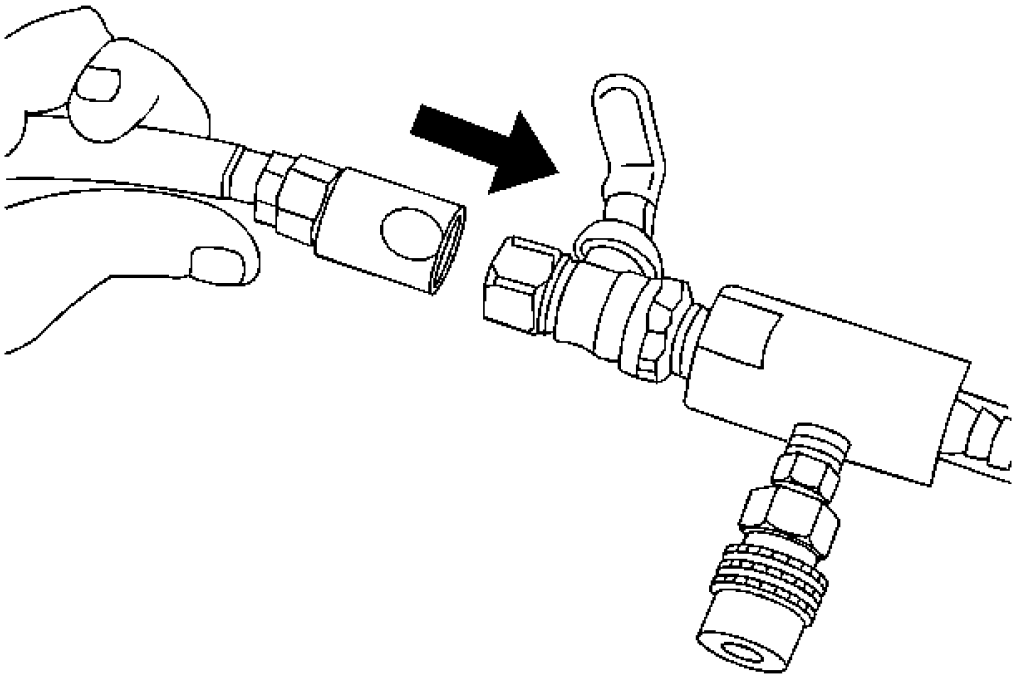


Fig. 10: Attaching Shop Air Hose To Venturi Assembly
Courtesy of GENERAL MOTORS CORP.

9. Attach a shop air hose to the venturi assembly.

   Ensure the valve on the venturi assembly is closed.

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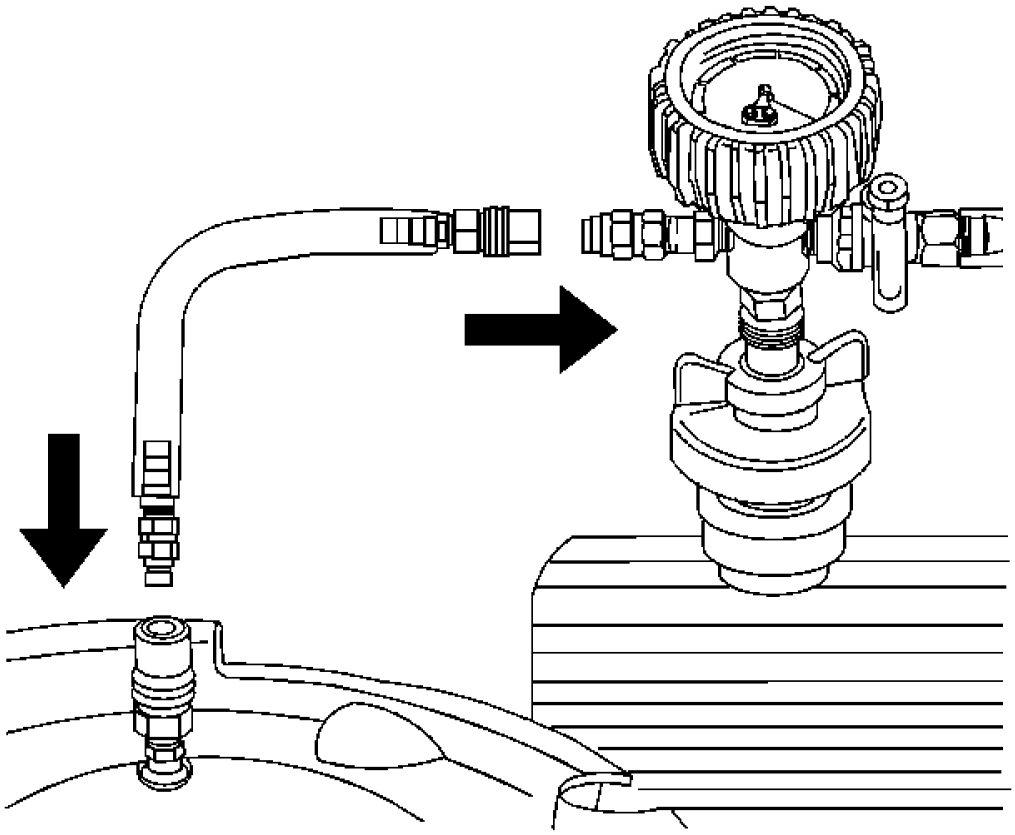


Fig. 11: Attaching Vacuum Hose To Vacuum Gauge Assembly & Vacuum Tank
Courtesy of GENERAL MOTORS CORP.

10. Attach the vacuum hose to the vacuum gauge assembly and the vacuum tank.

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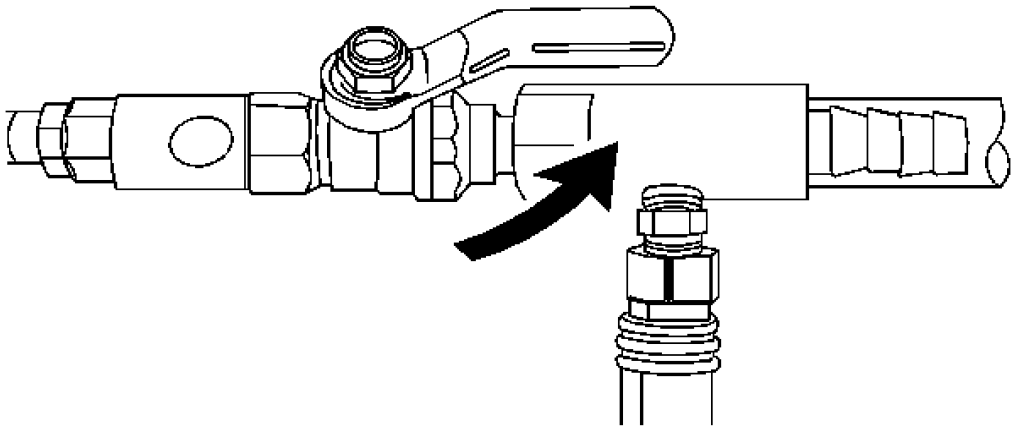


Fig. 12: Identifying Valve On Venturi Assembly
Courtesy of GENERAL MOTORS CORP.

11. Open the valve on the venturi assembly. The vacuum gauge will begin to rise and a hissing noise will be present.

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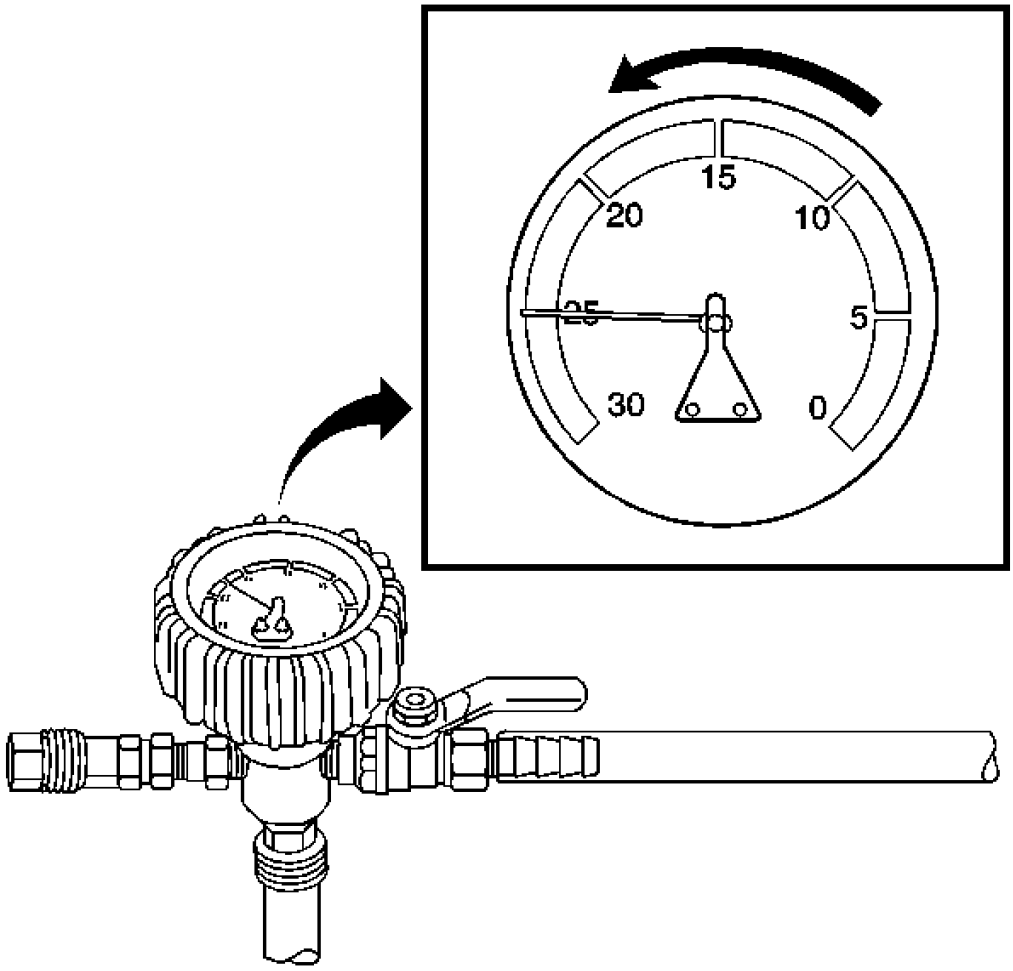


Fig. 13: View Of Vacuum Gauge
Courtesy of GENERAL MOTORS CORP.

12. Continue to draw vacuum until the needle stops rising. This should be 610-660 mm Hg (24-26 in Hg).

    Cooling hoses may start to collapse. This is normal due to vacuum draw.

13. To aid in the fill process, position the graduated reservoir above the coolant fill port.

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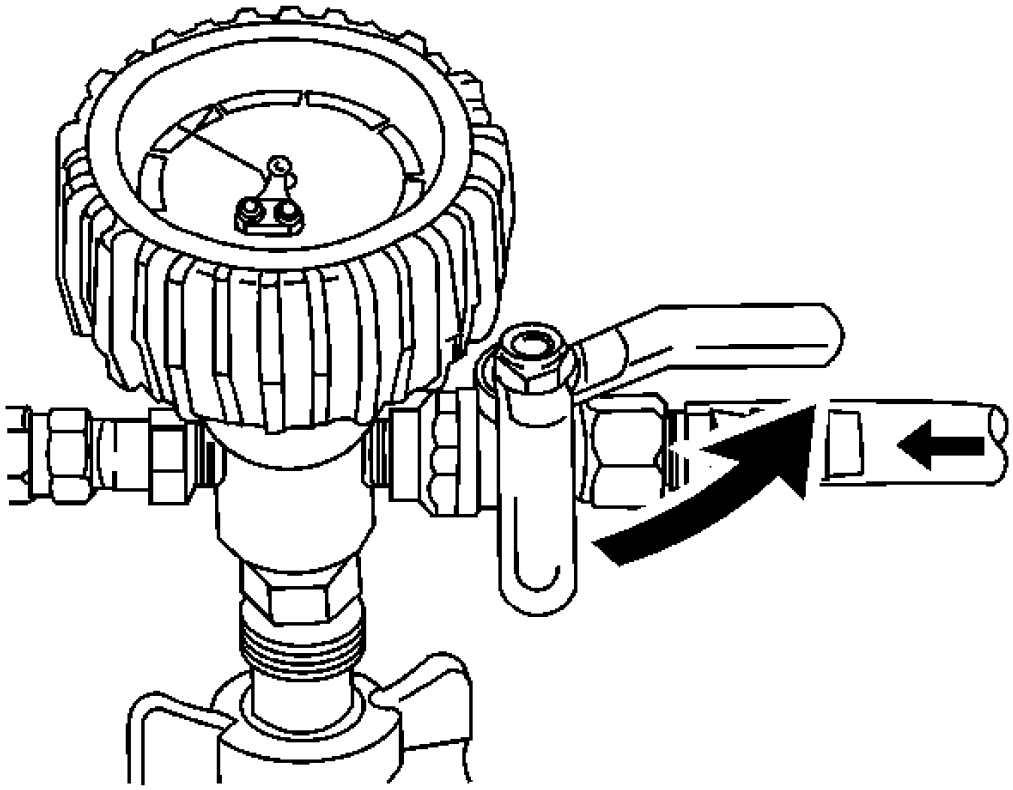


Fig. 14: Identifying Valve On Vacuum Gage Assembly
Courtesy of GENERAL MOTORS CORP.

14. Slowly open the valve on the vacuum gauge assembly. When the coolant reaches the top of the fill hose, close the valve. This will eliminate air from the fill hose.
15. Close the valve on the venturi assembly.
16. If there is a suspected leak in the cooling system, allow the system to stabilize under vacuum and monitor for vacuum loss.

    If vacuum loss is observed, refer to **Loss of Coolant**.

17. Open the valve on the vacuum gauge assembly. The vacuum gauge will drop as coolant is drawn into the system.

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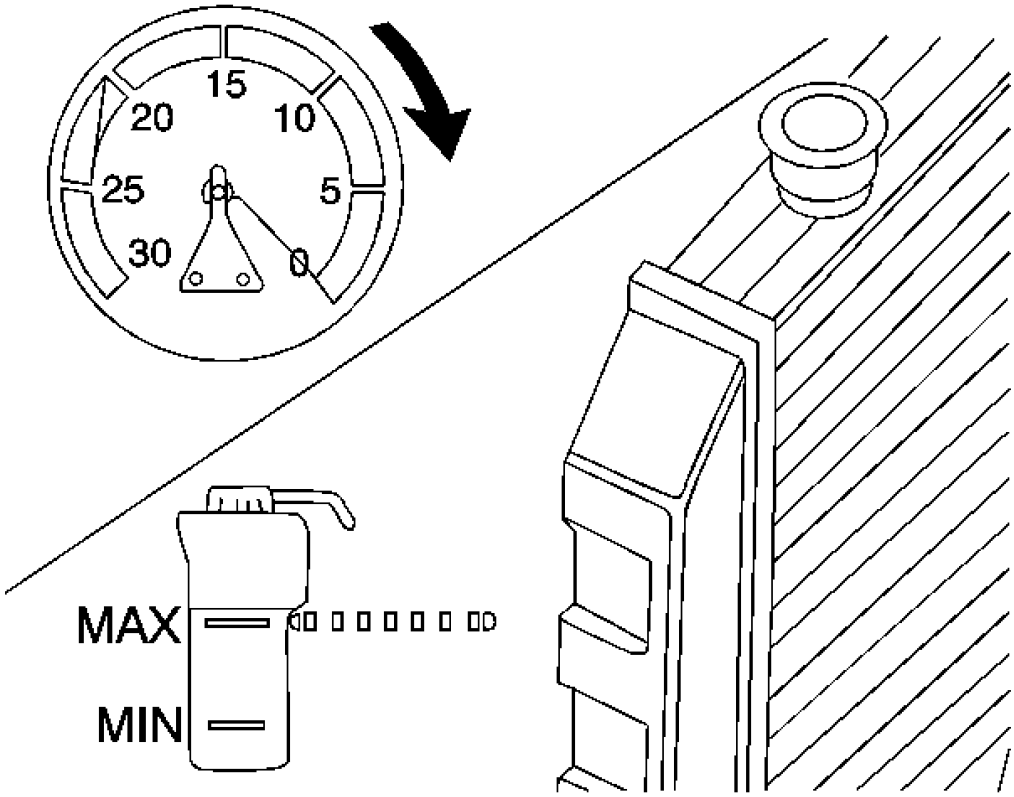


Fig. 15: View Of Vacuum Gauge & Radiator
Courtesy of GENERAL MOTORS CORP.

18. Once the vacuum gauge reaches zero, close the valve on the vacuum gauge assembly and repeat steps 11-17.
19. Detach the Vac-N-Fill cap from the **J 42401:** Radiator Cap and Surge Tank Test Adapter.
20. Remove the **J 42401:** Radiator Cap and Surge Tank Test Adapter from the coolant surge tank.
21. Add coolant to the system as necessary.
22. Inspect the concentration of the coolant mixture using **J 26568:** Coolant and Battery Fluid Tester.

NOTE: After filling the cooling system, the extraction hose can be used to remove excess coolant to achieve the proper coolant level.

23. Detach the vacuum hose from the vacuum gauge assembly.

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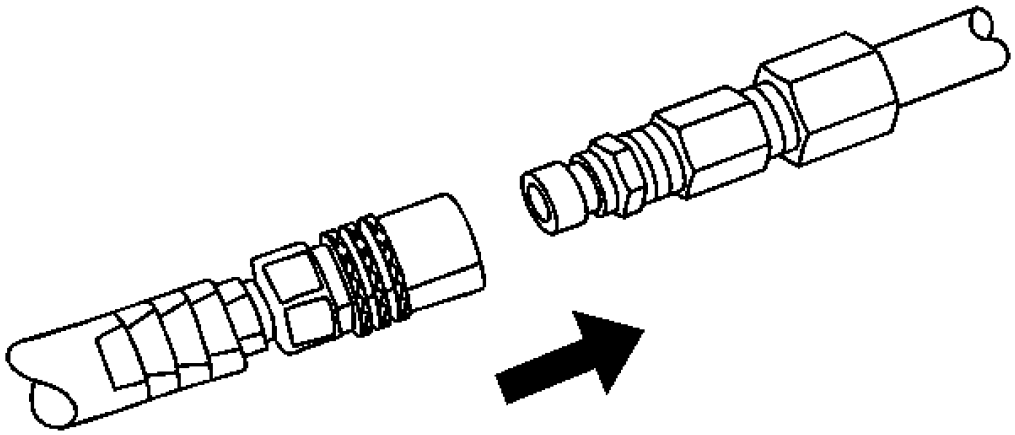


Fig. 16: Attaching Extraction Hose To Vacuum Hose
Courtesy of GENERAL MOTORS CORP.

24. Attach the extraction hose to the vacuum hose.

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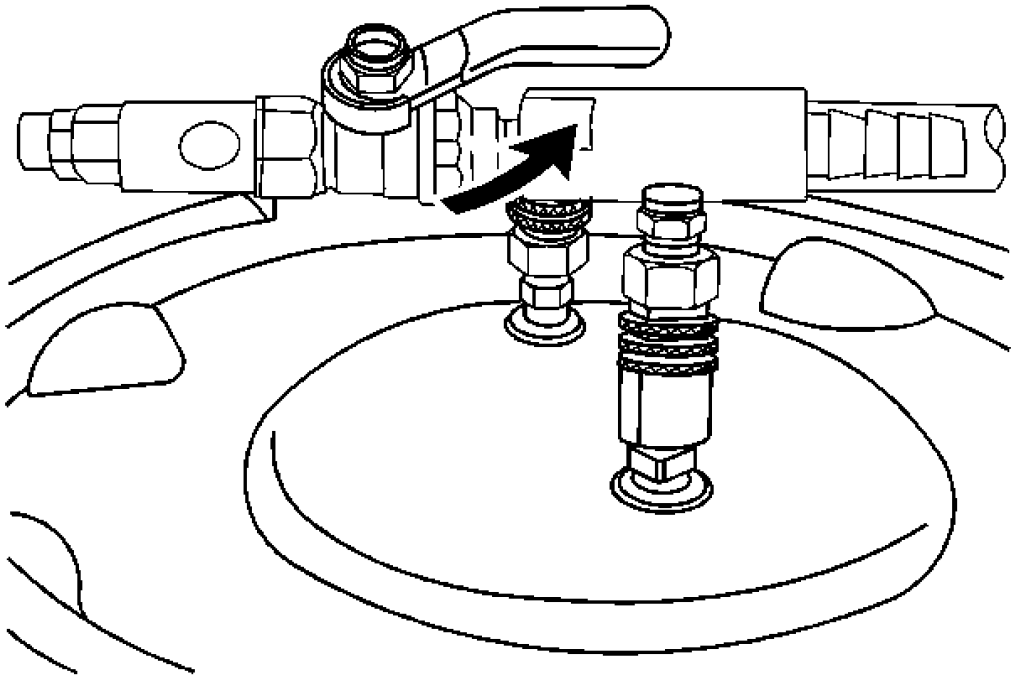


Fig. 17: Identifying Valve On Venturi Assembly
Courtesy of GENERAL MOTORS CORP.

25. Open the valve on the venturi assembly to start a vacuum draw.

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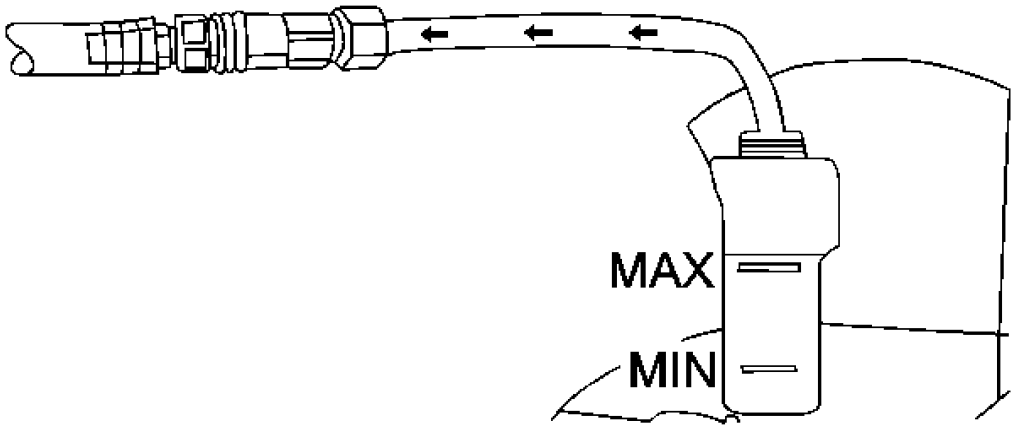


Fig. 18: Using Extraction Hose To Draw Out Coolant
Courtesy of GENERAL MOTORS CORP.

26. Use the extraction hose to draw out coolant to the proper level.
27. The vacuum tank has a drain valve on the bottom of the tank. Open the valve to drain coolant from the vacuum tank into a suitable container for disposal.
28. Install the surge tank cap.

FLUSHING

NOTE: Do not use a chemical flush. Store used coolant in the proper manner, such as in a used engine coolant holding tank. Do not pour used coolant down a drain. Ethylene glycol antifreeze is a very toxic chemical. Do not dispose of coolant into the sewer system or ground water. This is illegal and ecologically unsound. Various methods and equipment can be used to flush the cooling system. If special equipment is used, such as a back flusher, follow the manufacturer's instruction. Always remove the thermostat before flushing the cooling system.

When the cooling system becomes contaminated, the cooling system should be flushed thoroughly to remove the contaminants before the engine is seriously damaged.

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Remove the coolant recovery reservoir. Refer to **Coolant Recovery Reservoir Replacement**.
3. Clean and flush the coolant recovery reservoir with clean, drinkable water.
4. Install the coolant recovery reservoir. Refer to **Coolant Recovery Reservoir Replacement**.

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5. Follow the drain and fill procedure using only clean, drinkable water. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
6. Run the engine for 20 minutes.
7. Stop the engine.
8. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**
9. Repeat the procedure if necessary, until the fluid is nearly colorless.
10. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.

COOLANT RECOVERY RESERVOIR REPLACEMENT

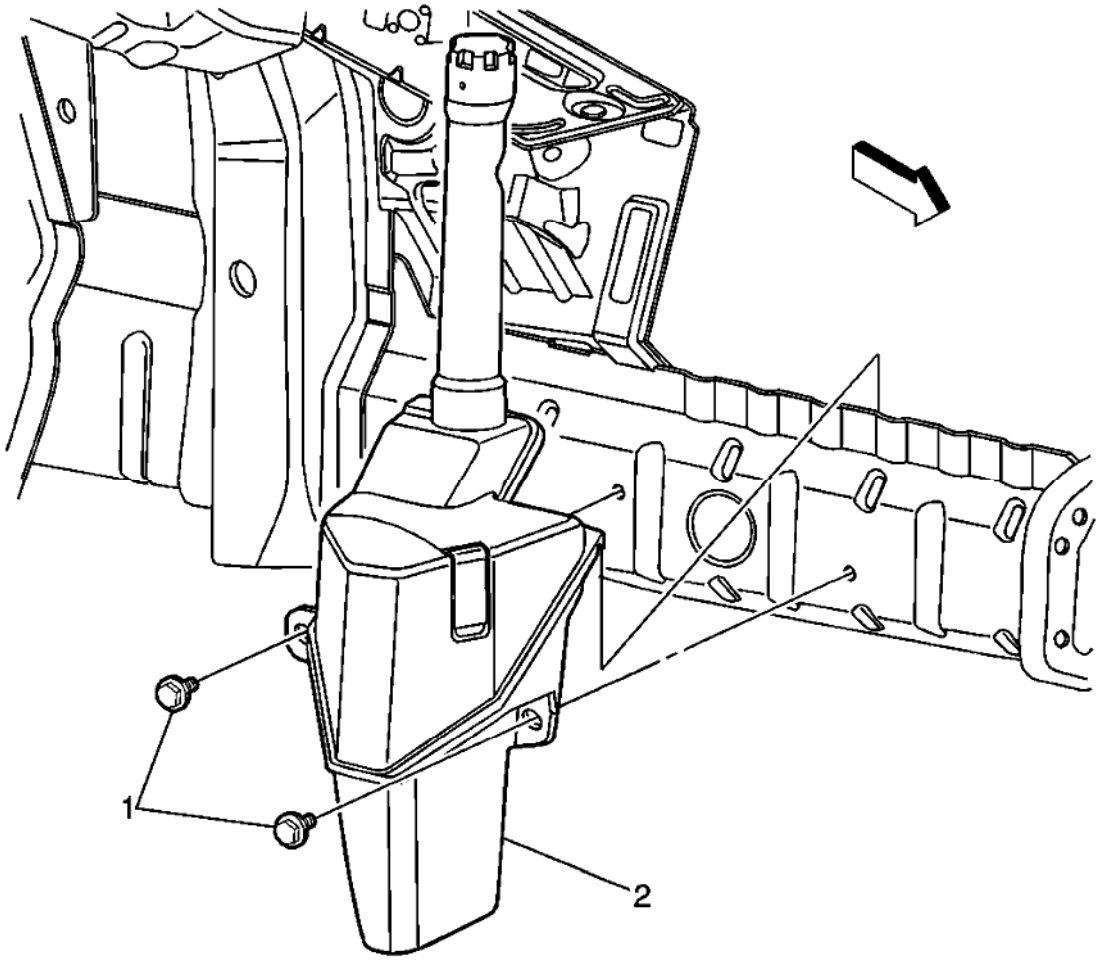


Fig. 19: Coolant Recovery Reservoir
Courtesy of GENERAL MOTORS CORP.

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Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 3. Remove the radiator overflow hose. Refer to **Radiator Overflow Hose Replacement (LLT)** or **Radiator Overflow Hose Replacement (LS3, L99)**.	
1	Coolant Recovery Reservoir Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 17 N.m (13 lb ft)
2	Coolant Recovery Reservoir

RADIATOR INLET HOSE REPLACEMENT (LLT)

Special Tools

J 38185: Hose Clamp Pliers

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Remove front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
3. Remove air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .

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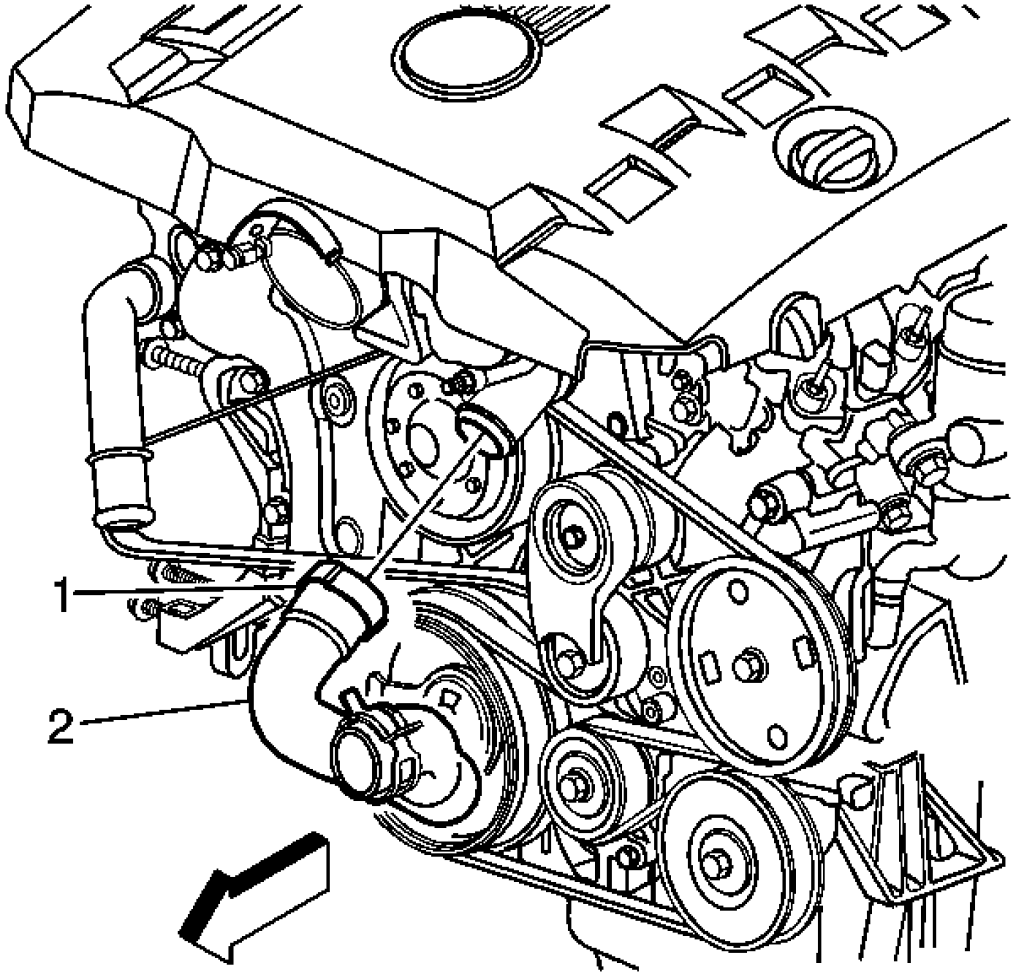


Fig. 20: Radiator Inlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

4. Disengage tension on the radiator inlet hose clamp (1) at the engine using **J 38185:** Hose Clamp Pliers.
5. Remove the radiator inlet hose (2) from the engine.

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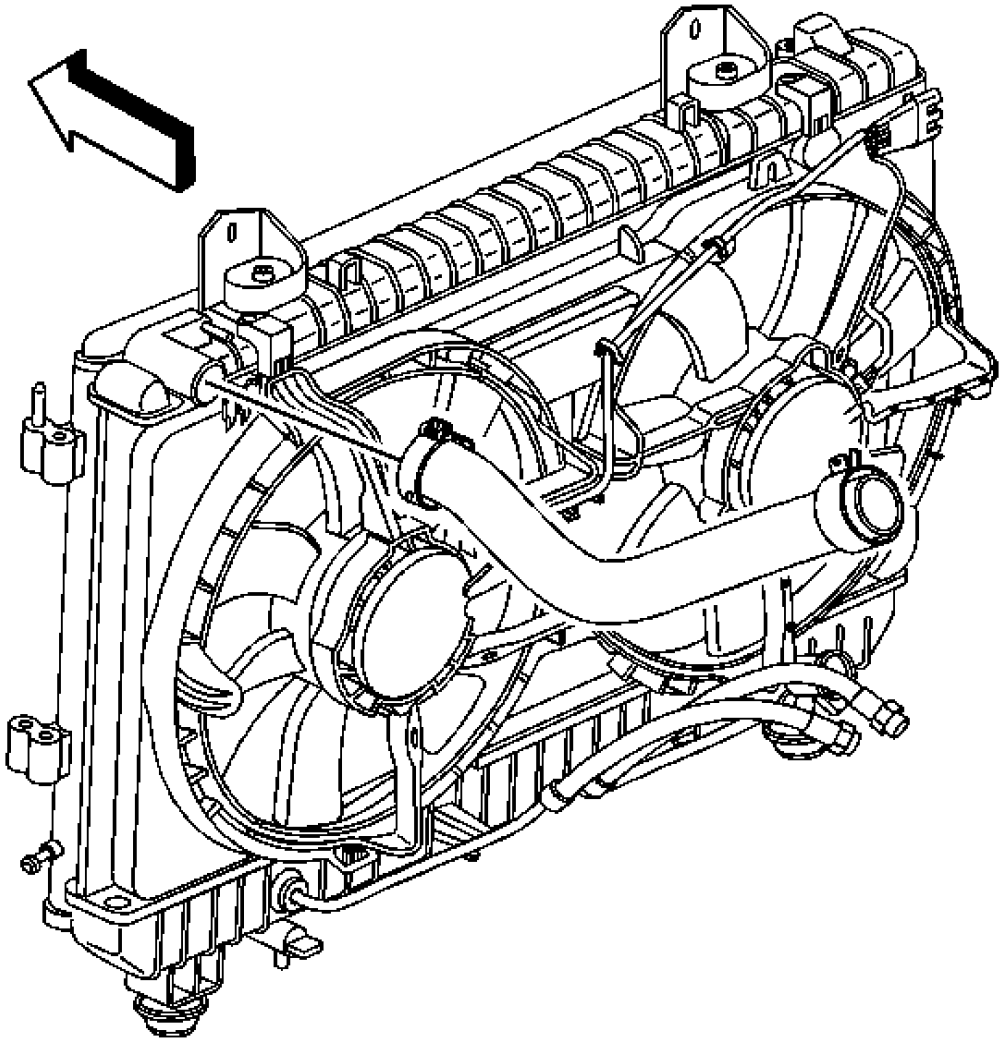


Fig. 21: Radiator Inlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

6. Disengage tension on the radiator inlet hose clamp (1) at the radiator using **J 38185:** Hose Clamp Pliers.
7. Remove the radiator inlet hose (2) from the radiator.
8. Remove the radiator inlet hose from the vehicle (2).

Installation Procedure

1. Install radiator inlet hose to the vehicle.

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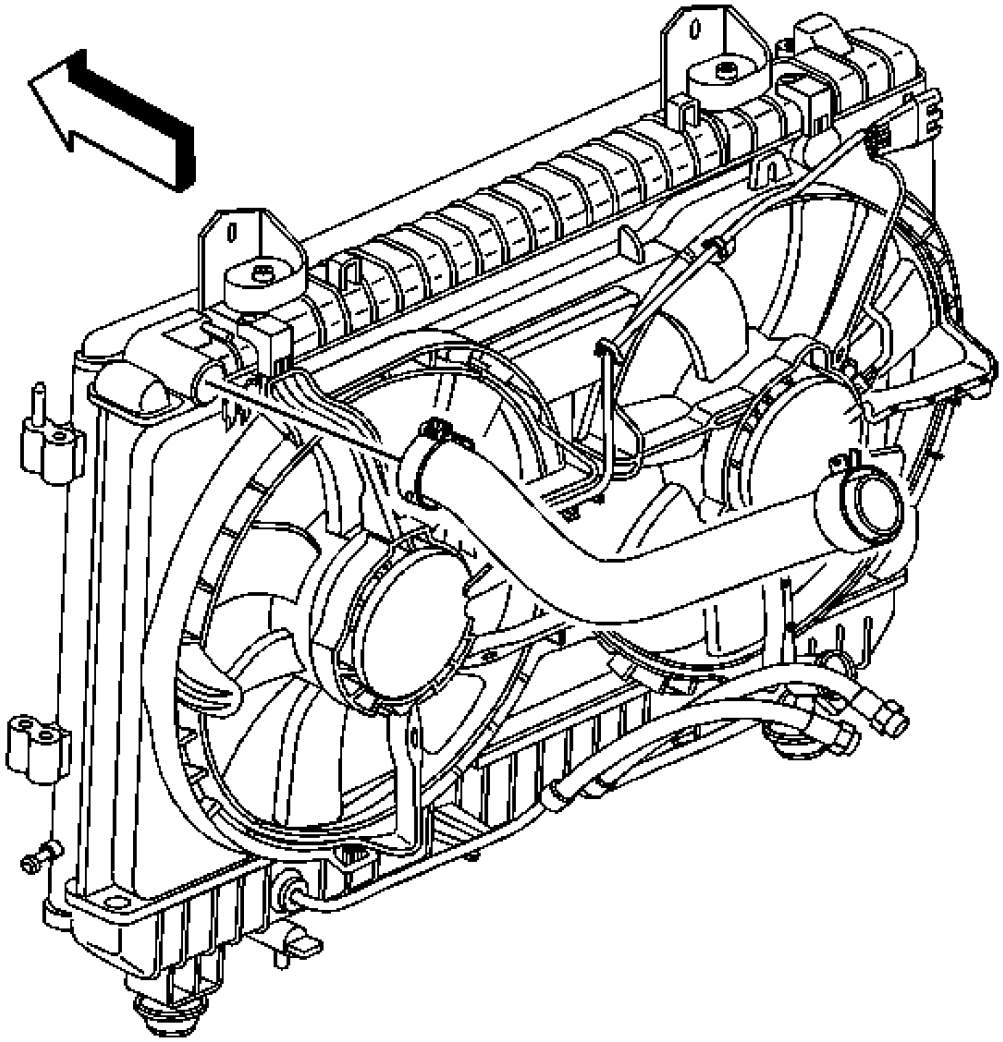


Fig. 22: Radiator Inlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

CAUTION: Make sure the reference marks on the hoses and the radiator are lined up. A twist on the hose would place strain on the radiator fitting which could cause the fitting to crack or break.

NOTE: Lubricate the inside diameters of the hose with clean coolant prior to installation.

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2. Install the radiator inlet hose (2) to the radiator.
3. Engage tension on the radiator inlet hose clamp (1) at the radiator using **J 38185:** Hose Clamp Pliers.

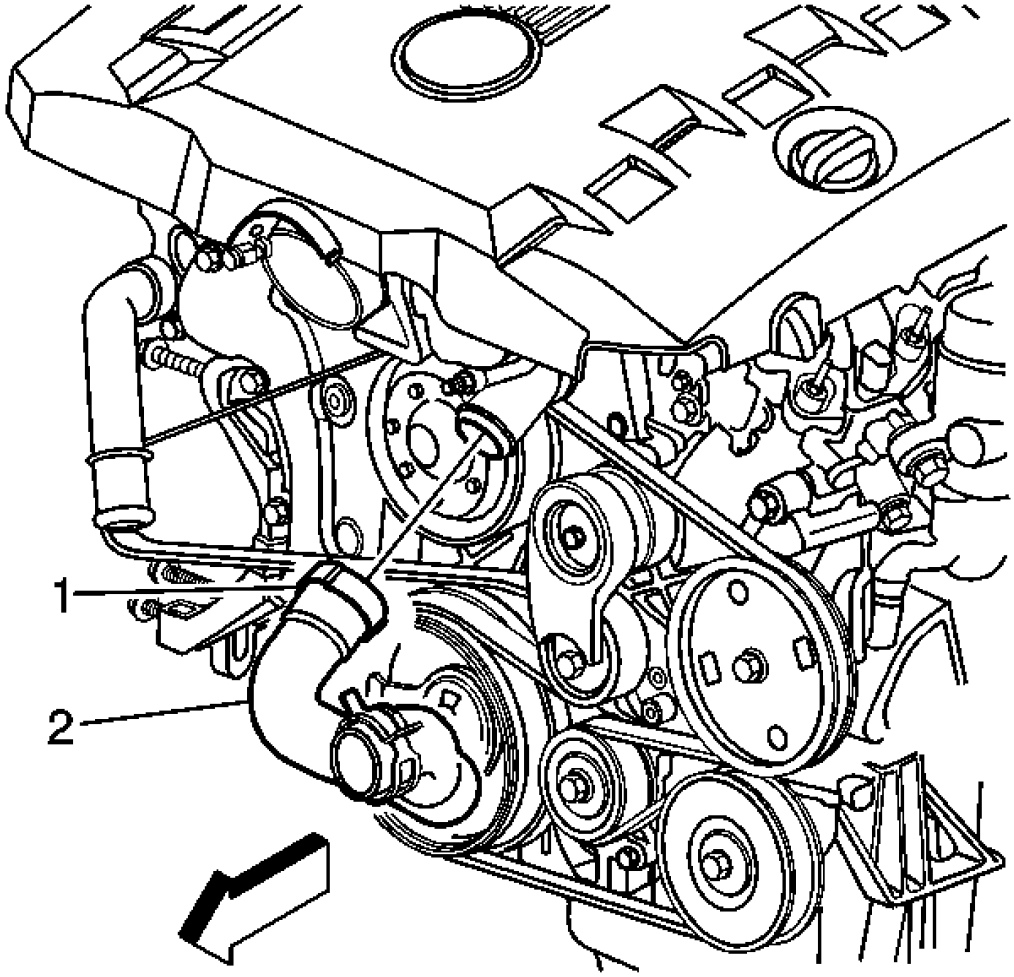


Fig. 23: Radiator Inlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

4. Install the radiator inlet hose (2) to the engine.
5. Engage tension on the radiator inlet hose clamp (1) at the engine using **J 38185:** Hose Clamp Pliers.
6. Install air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
7. Install the front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** .
8. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE**

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47716).

RADIATOR INLET HOSE REPLACEMENT (L99)

Special Tools

J 38185: Hose Clamp Pliers

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Remove the engine cover. Refer to **Engine Cover Replacement** .
3. Remove the air cleaner resonator and outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** .

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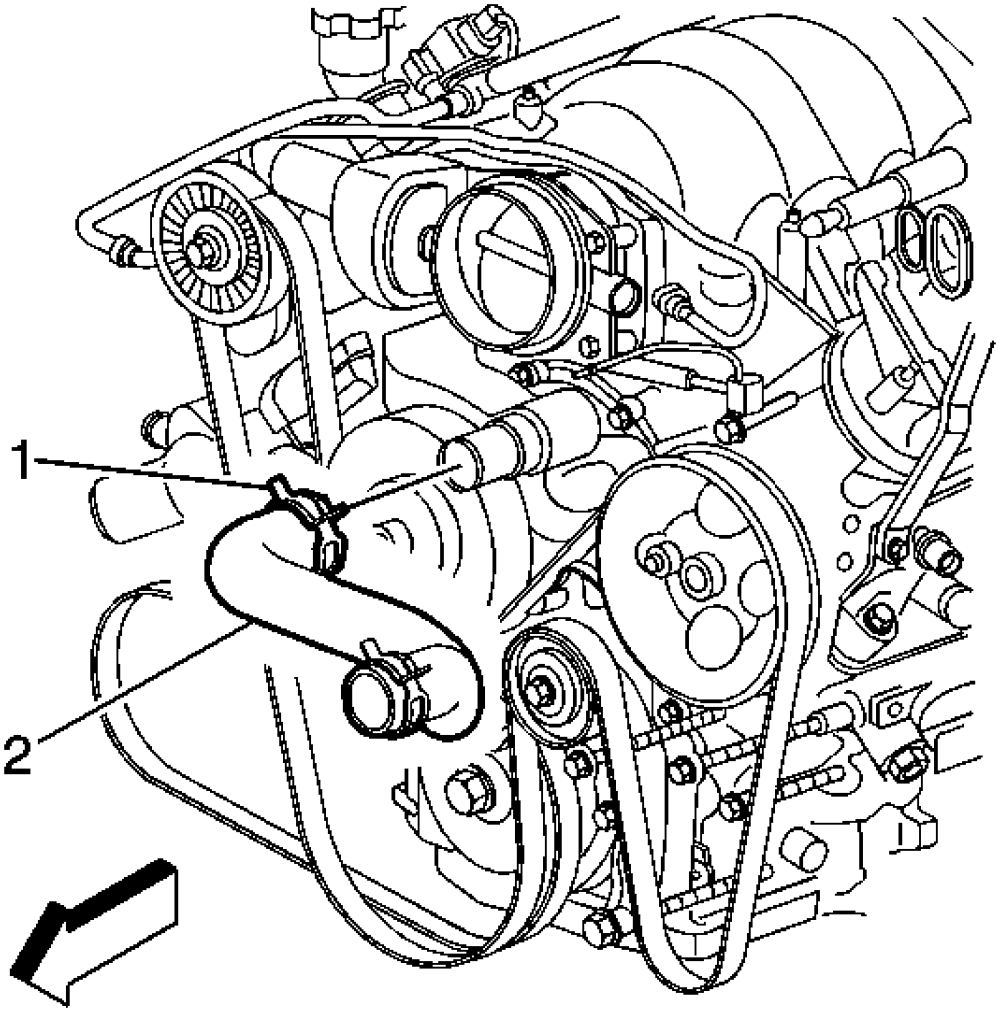


Fig. 24: Radiator Inlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

4. Disengage tension on the radiator inlet hose clamp (1) at the engine using **J 38185:** Hose Clamp Pliers.
5. Remove the radiator inlet hose (2) from the engine.

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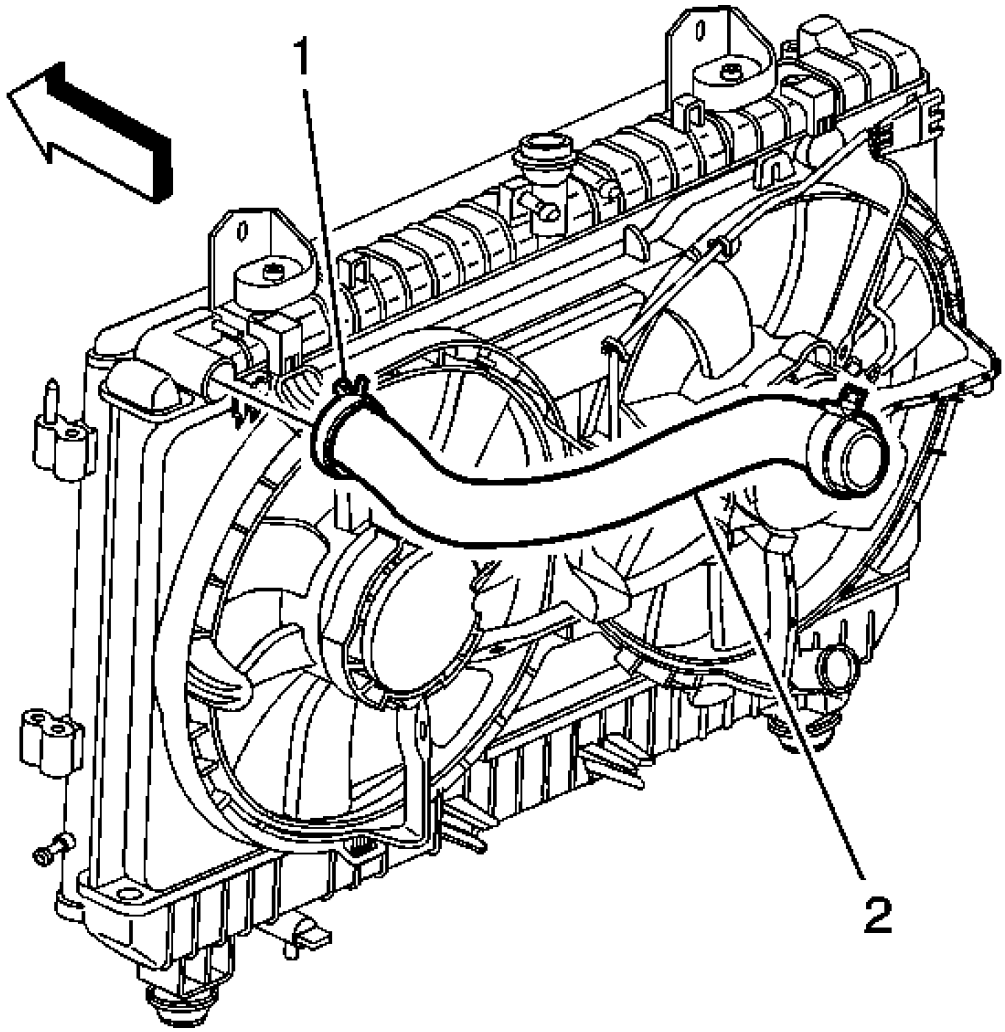


Fig. 25: Radiator Inlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

6. Disengage tension on the radiator inlet hose clamp (1) at the radiator using **J 38185:** Hose Clamp Pliers.
7. Remove the radiator inlet hose (2) from the radiator.
8. Remove the radiator inlet hose from the vehicle (2).

Installation Procedure

1. Install radiator inlet hose to the vehicle.

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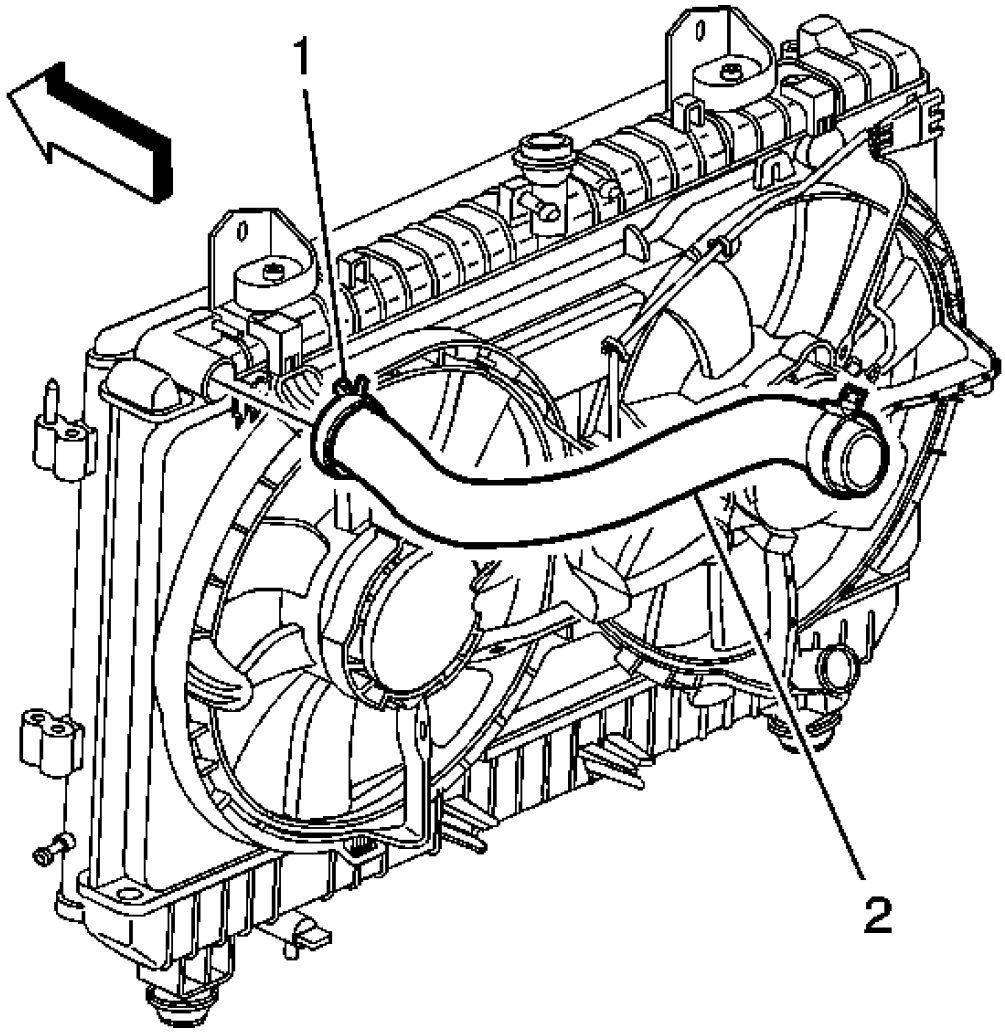


Fig. 26: Radiator Inlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

CAUTION: Make sure the reference marks on the hoses and the radiator are lined up. A twist on the hose would place strain on the radiator fitting which could cause the fitting to crack or break.

NOTE: Lubricate the inside diameters of the hose with clean coolant prior to installation.

2. Install the radiator inlet hose (2) to the radiator.

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3. Engage tension on the radiator inlet hose clamp (1) at the radiator using **J 38185:** Hose Clamp Pliers.

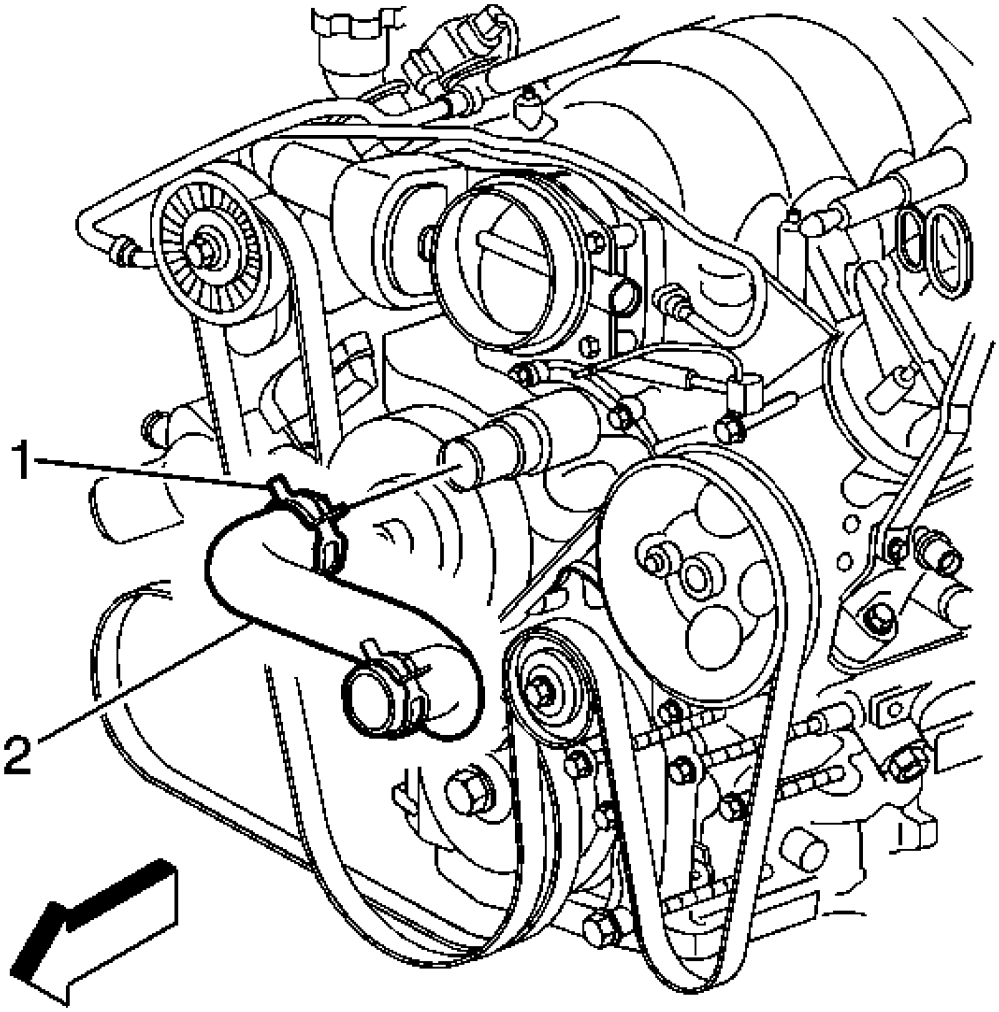


Fig. 27: Radiator Inlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

4. Install the radiator inlet hose (2) to the engine.
5. Engage tension on the radiator inlet hose clamp (1) at the engine using **J 38185:** Hose Clamp Pliers.
6. Install the air cleaner resonator and outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** .
7. Install the engine cover. Refer to **Engine Cover Replacement** .

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8. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.

RADIATOR INLET HOSE REPLACEMENT (LS3)

Special Tools

J 38185: Hose Clamp Pliers

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Remove the engine cover. Refer to **Engine Cover Replacement** .
3. Remove the air cleaner resonator and outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** .

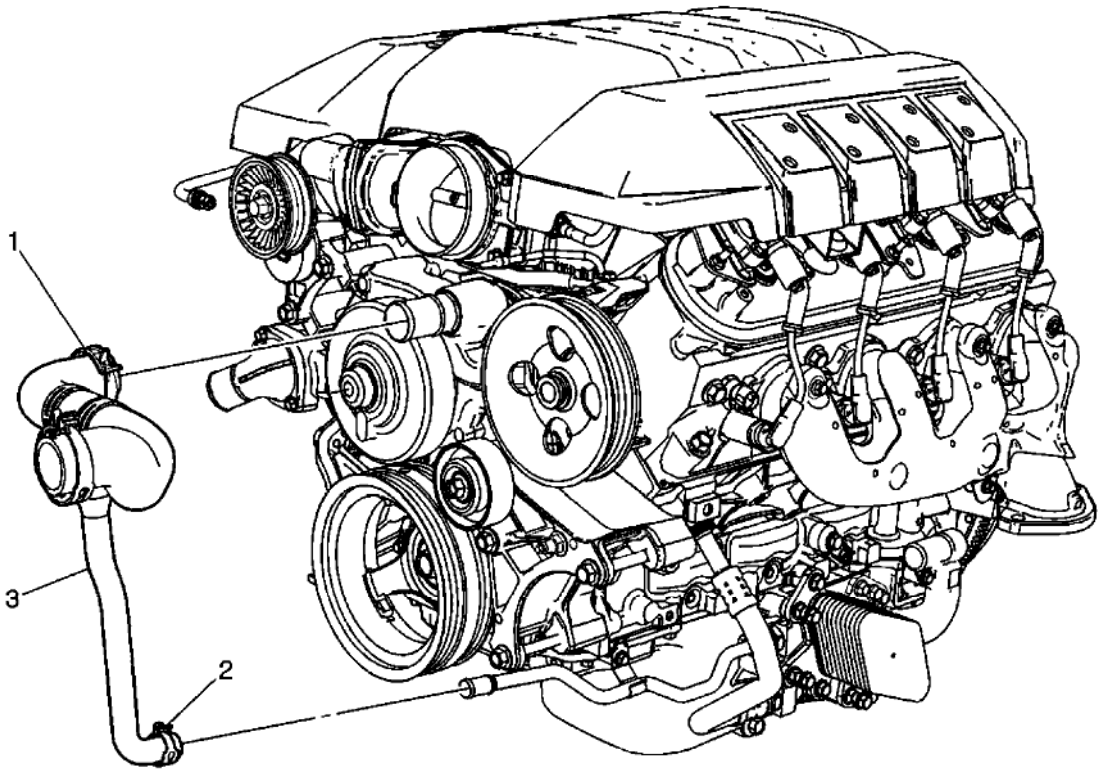


Fig. 28: Radiator Inlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

4. Disengage tension on the radiator inlet hose clamp (1) at the engine using **J 38185:** Hose Clamp Pliers.

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5. Remove the radiator inlet hose (3) from the engine.
6. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
7. Disengage tension on the radiator inlet hose clamp (2) at the engine oil cooler pipe using **J 38185:** Hose Clamp Pliers.
8. Remove the radiator inlet hose (3) from the engine oil cooler pipe.

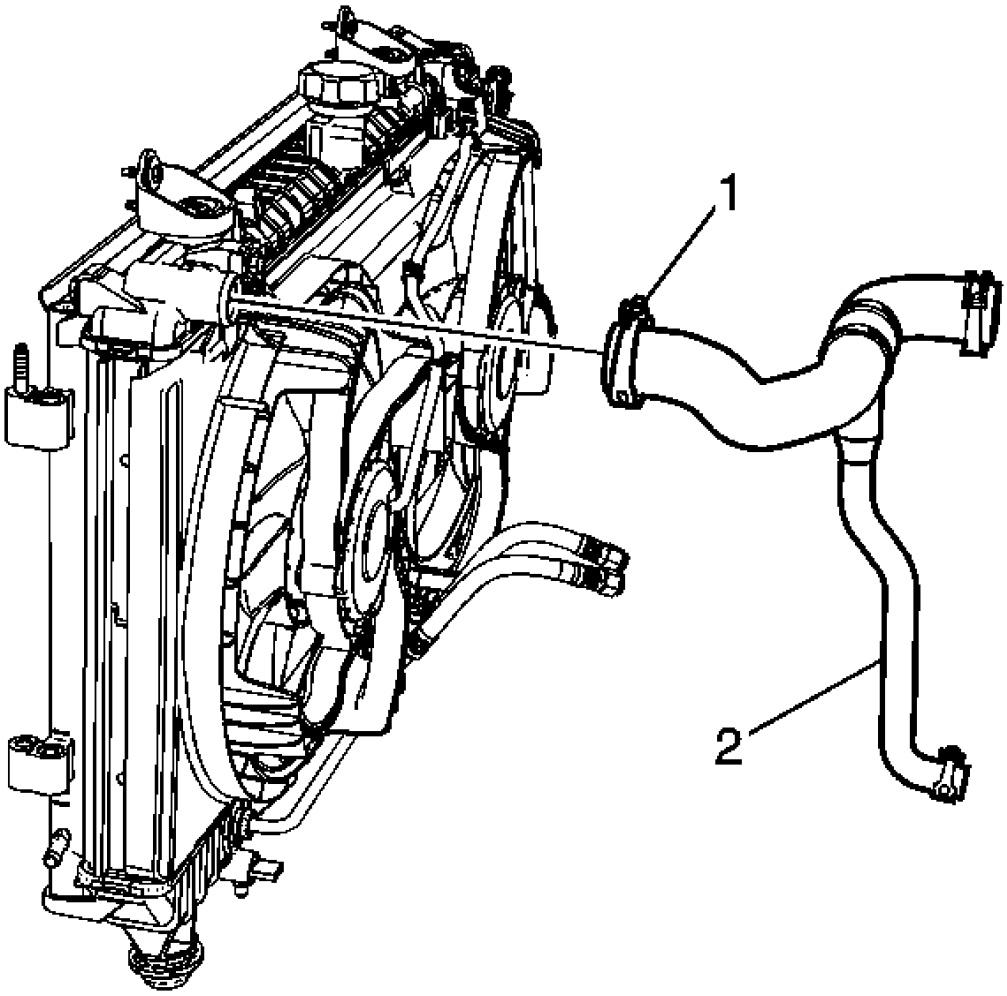


Fig. 29: Radiator Inlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

9. Disengage tension on the radiator inlet hose clamp (1) at the radiator using **J 38185:** Hose Clamp Pliers.
10. Remove the radiator inlet hose (2) from the radiator.

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11. Remove the radiator inlet hose from the vehicle (2).

Installation Procedure

1. Install radiator inlet hose to the vehicle.

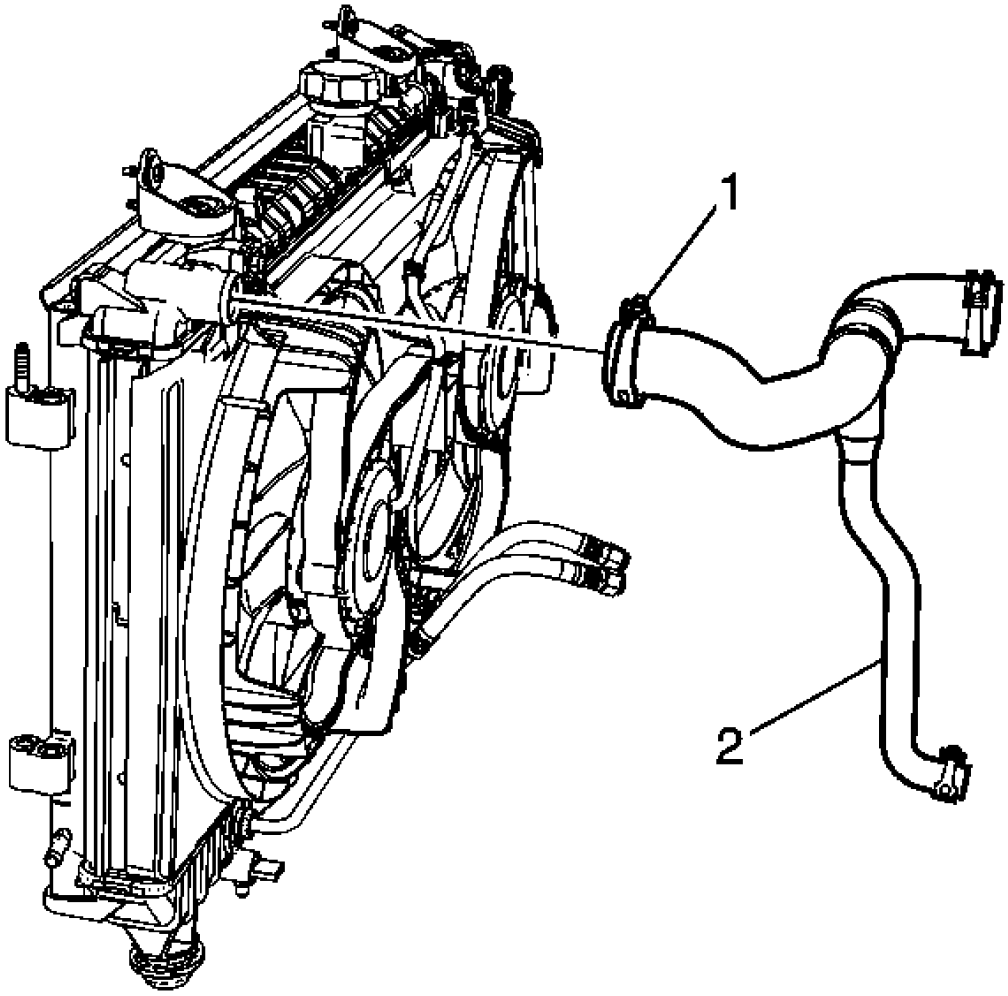


Fig. 30: Radiator Inlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

CAUTION: Make sure the reference marks on the hoses and the radiator are lined up. A twist on the hose would place strain on the radiator fitting which could cause the fitting to crack or break.

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NOTE: Lubricate the inside diameters of the hose with clean coolant prior to installation.

2. Install the radiator inlet hose (2) to the radiator.
3. Engage tension on the radiator inlet hose clamp (1) at the radiator using **J 38185:** Hose Clamp Pliers.

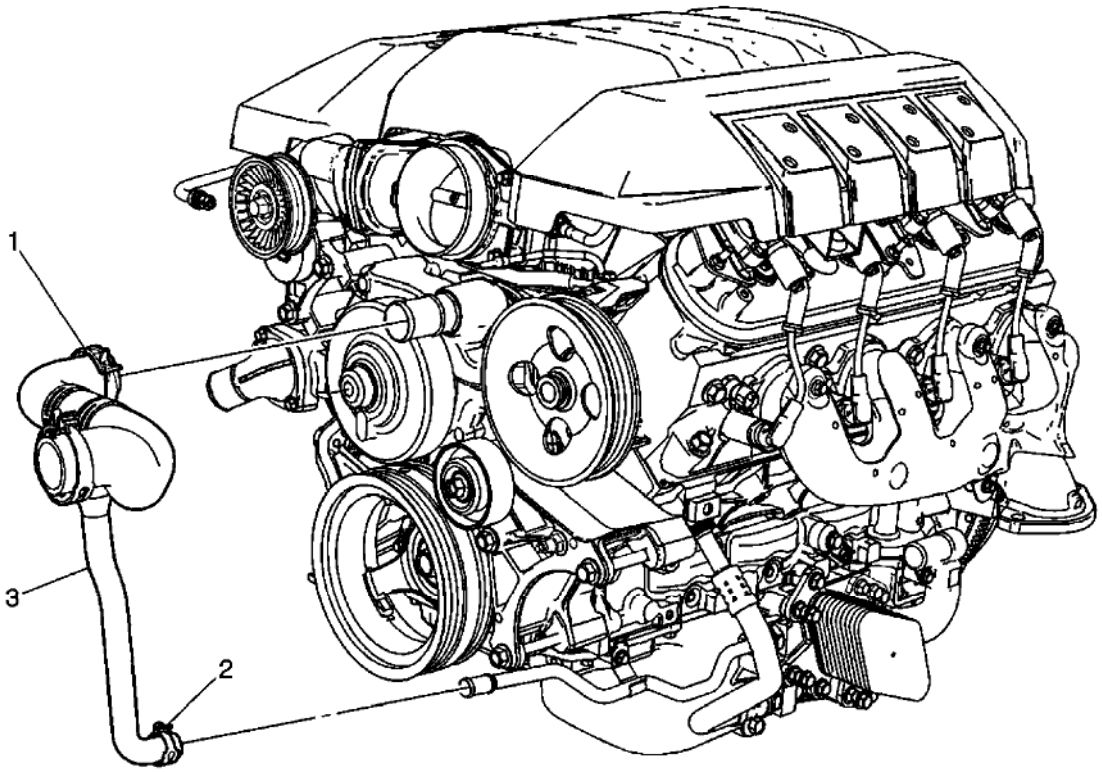


Fig. 31: Radiator Inlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

4. Install the radiator inlet hose (3) to the engine.
5. Engage tension on the radiator inlet hose clamp (1) at the engine using **J 38185:** Hose Clamp Pliers.
6. Install the radiator inlet hose (3) to the engine oil cooler pipe.
7. Engage tension on the radiator inlet hose clamp (2) at the engine oil cooler pipe using **J 38185:** Hose Clamp Pliers.
8. Lower the vehicle
9. Install the air cleaner resonator and outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** .
10. Install the engine cover. Refer to **Engine Cover Replacement** .
11. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.

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RADIATOR OUTLET HOSE REPLACEMENT (LLT)

Special Tools

J 38185: Hose Clamp Pliers

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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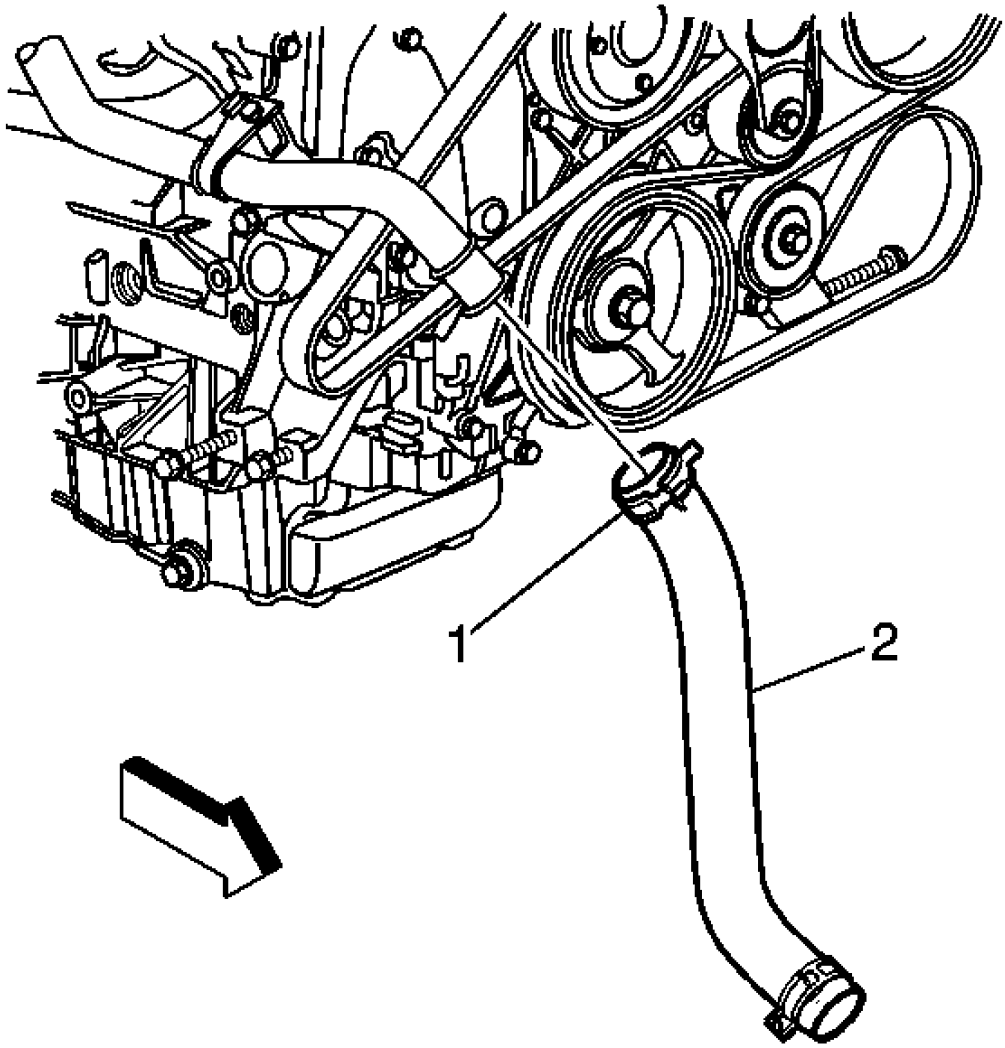


Fig. 32: Radiator Outlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

3. Disengage tension on the radiator outlet hose clamp (1) at the engine using **J 38185:** Hose Clamp Pliers.
4. Remove the radiator outlet hose (2) from the engine.

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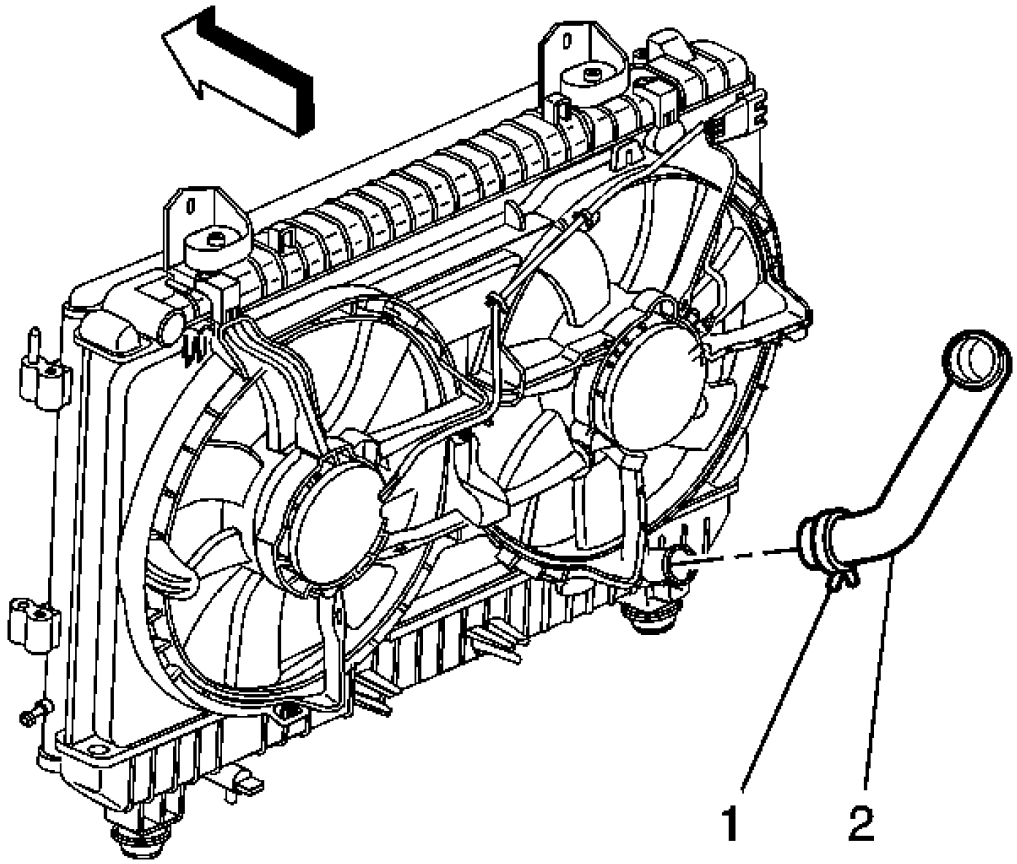


Fig. 33: Radiator Outlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

5. Disengage tension on the radiator outlet hose clamp (1) at the radiator using **J 38185:** Hose Clamp Pliers.
6. Remove the radiator outlet hose (2) from the radiator.
7. Remove the radiator outlet hose from the vehicle (2).

Installation Procedure

1. Install radiator outlet hose to the vehicle.

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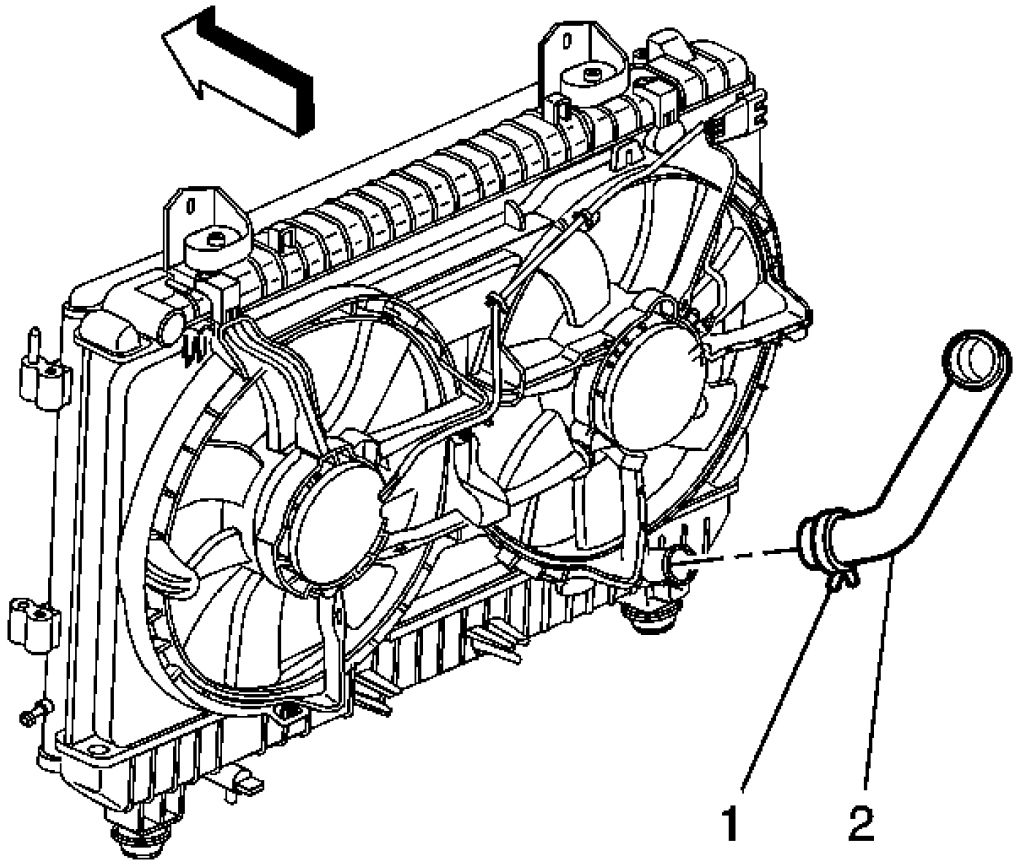


Fig. 34: Radiator Outlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

CAUTION: Make sure the reference marks on the hoses and the radiator are lined up. A twist on the hose would place strain on the radiator fitting which could cause the fitting to crack or break.

NOTE: Lubricate the inside diameters of the hose with clean coolant prior to installation.

2. Install the radiator outlet hose (2) to the radiator.
3. Engage tension on the radiator outlet hose clamp (1) at the radiator using **J 38185:** Hose Clamp Pliers.

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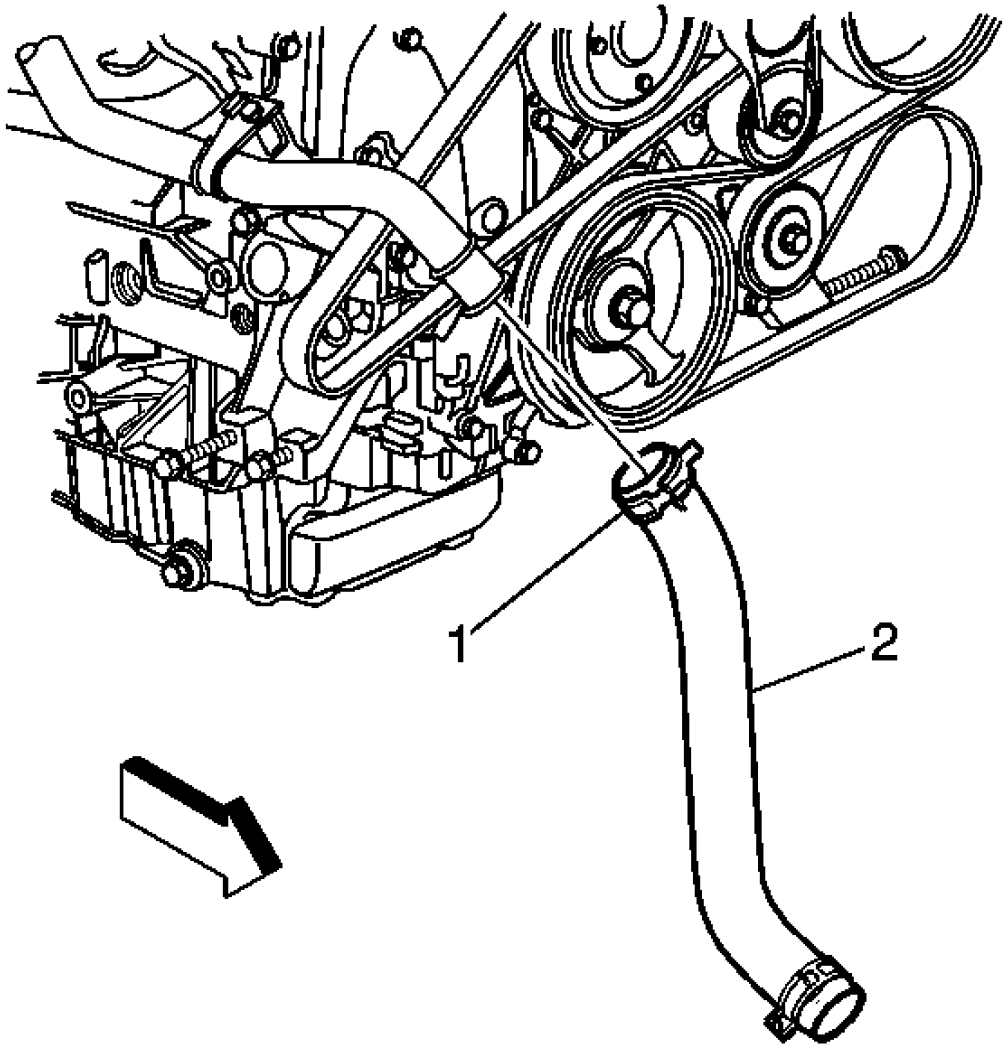


Fig. 35: Radiator Outlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

4. Install the radiator outlet hose (2) to the engine.
5. Engage tension on the radiator outlet hose clamp (1) at the engine using **J 38185:** Hose Clamp Pliers.
6. Lower the vehicle.
7. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.

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RADIATOR OUTLET HOSE REPLACEMENT (LS3, L99)

Special Tools

J 38185: Hose Clamp Pliers

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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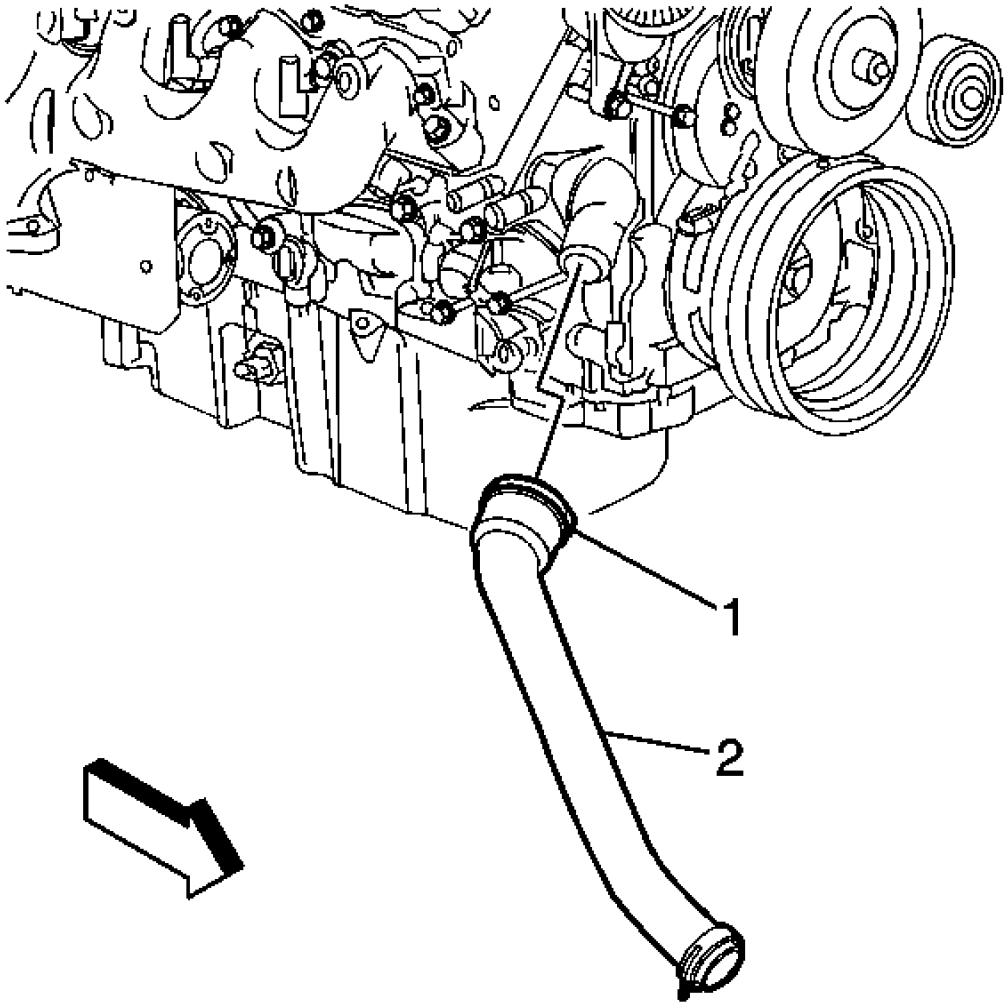


Fig. 36: Radiator Outlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

3. Disengage tension on the radiator outlet hose clamp (1) at the engine using **J 38185:** Hose Clamp Pliers.
4. Remove the radiator outlet hose (2) from the engine.

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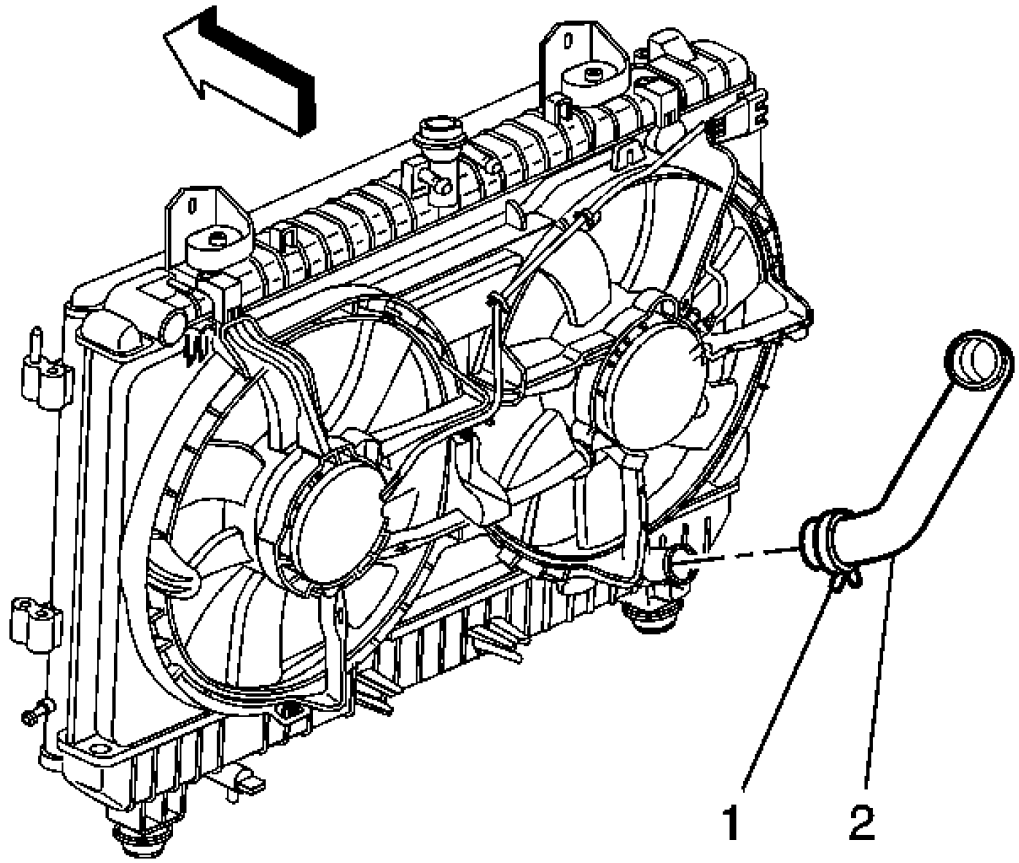


Fig. 37: Radiator Outlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

5. Disengage tension on the radiator outlet hose clamp (1) at the radiator using **J 38185:** Hose Clamp Pliers.
6. Remove the radiator outlet hose (2) from the radiator.
7. Remove the radiator outlet hose from the vehicle (2).

Installation Procedure

1. Install radiator outlet hose to the vehicle.

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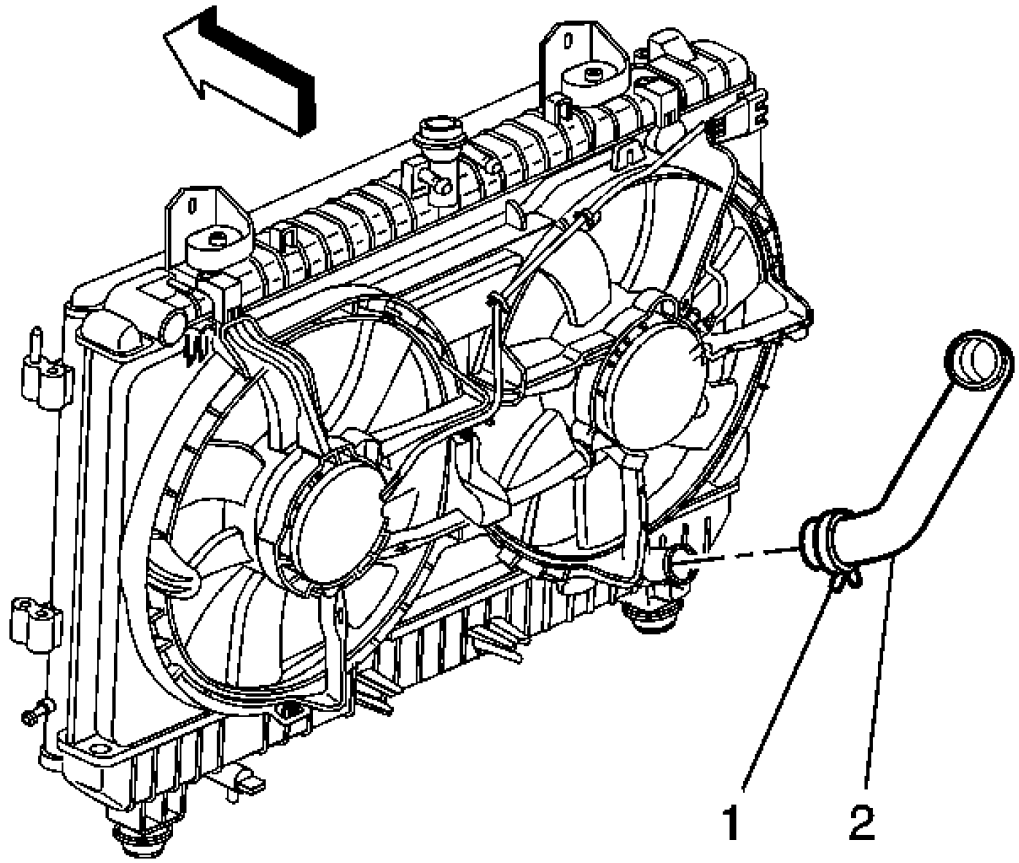


Fig. 38: Radiator Outlet Hose & Clamp At Radiator
Courtesy of GENERAL MOTORS CORP.

CAUTION: Make sure the reference marks on the hoses and the radiator are lined up. A twist on the hose would place strain on the radiator fitting which could cause the fitting to crack or break.

NOTE: Lubricate the inside diameters of the hose with clean coolant prior to installation.

2. Install the radiator outlet hose (2) to the radiator.
3. Engage tension on the radiator outlet hose clamp (1) at the radiator using **J 38185:** Hose Clamp Pliers.

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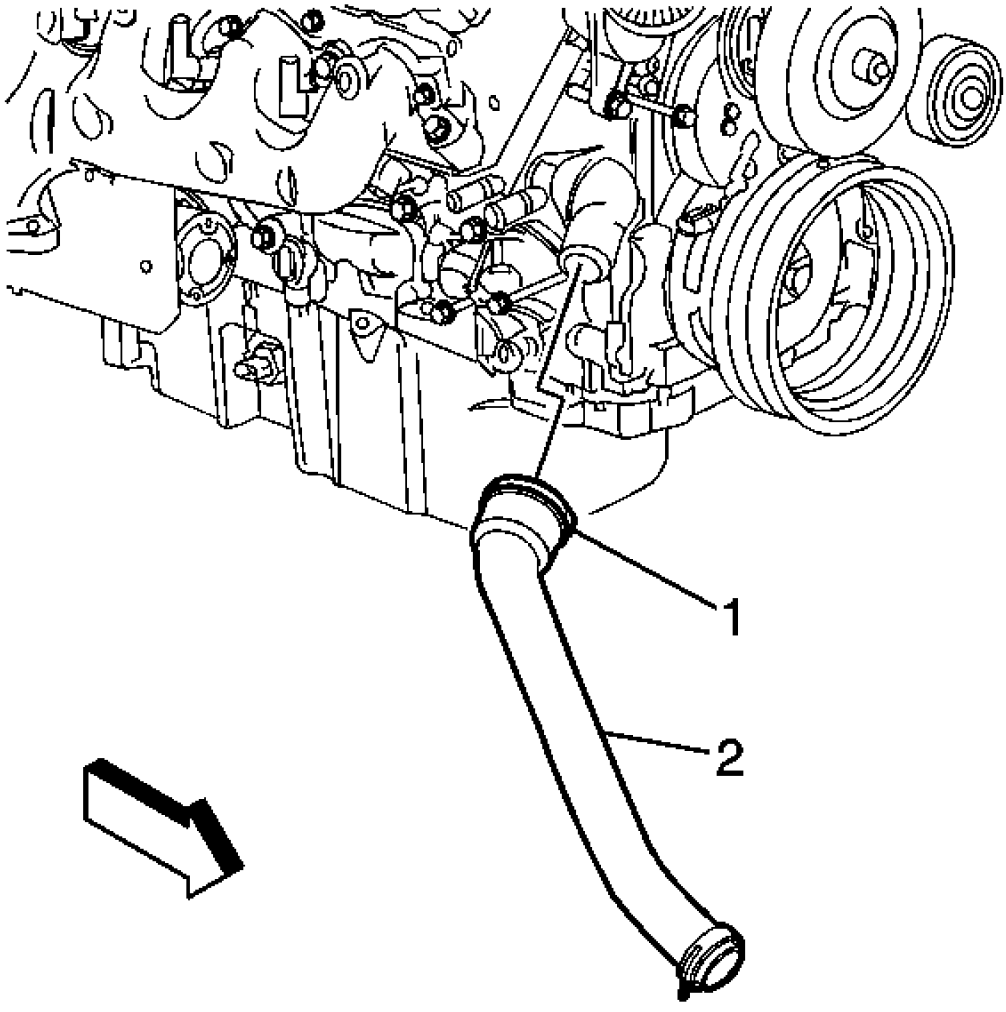


Fig. 39: Radiator Outlet Hose & Clamp At Engine
Courtesy of GENERAL MOTORS CORP.

4. Install the radiator outlet hose (2) to the engine.
5. Engage tension on the radiator outlet hose clamp (1) at the engine using **J 38185:** Hose Clamp Pliers.
6. Lower the vehicle.
7. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.

RADIATOR OUTLET PIPE REPLACEMENT (LLT)

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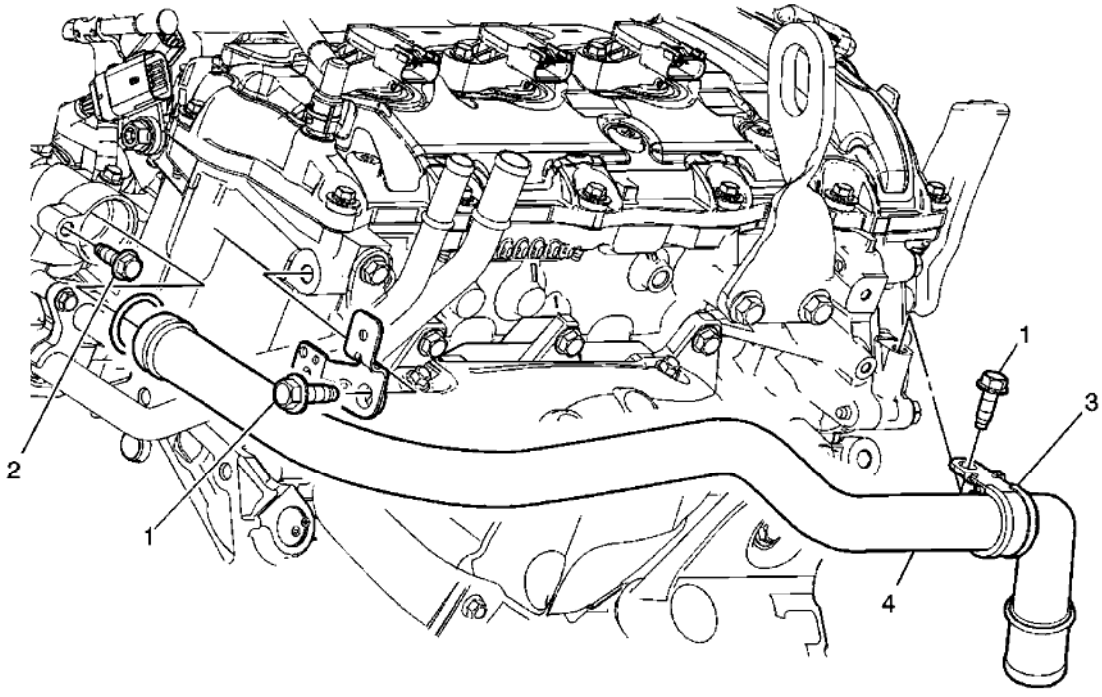


Fig. 40: Radiator Outlet Pipe (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Partially drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**. 2. Remove the intake manifold cover. 3. Disconnect the heater hoses from the heater pipes and set aside. 4. Disconnect the radiator outlet hose and set aside.	
1	Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 58 N.m (42 lb ft)
2	Bolt **Tighten:** 58 N.m (42 lb ft)
3	Radiator Outlet Pipe Clip
4	Radiator Outlet Pipe **Procedure:**

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	Discard and install a NEW Seal.

RADIATOR OVERFLOW HOSE REPLACEMENT (LLT)

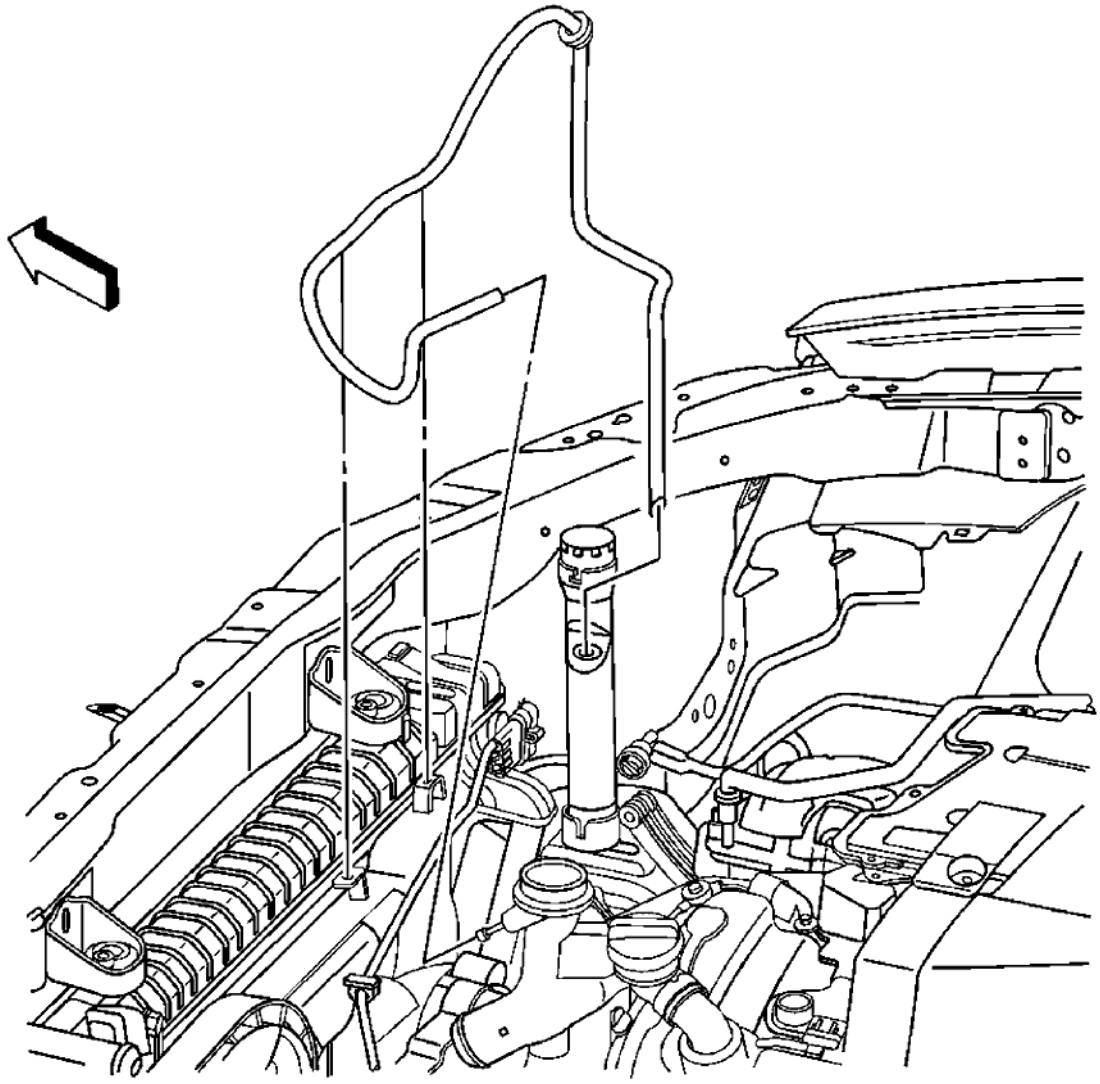


Fig. 41: Radiator Overflow Hose (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Drain the coolant from the radiator overflow hose. 2. Remove front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** 3. Remove air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**	
1	Radiator Overflow Hose

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RADIATOR OVERFLOW HOSE REPLACEMENT (LS3, L99)

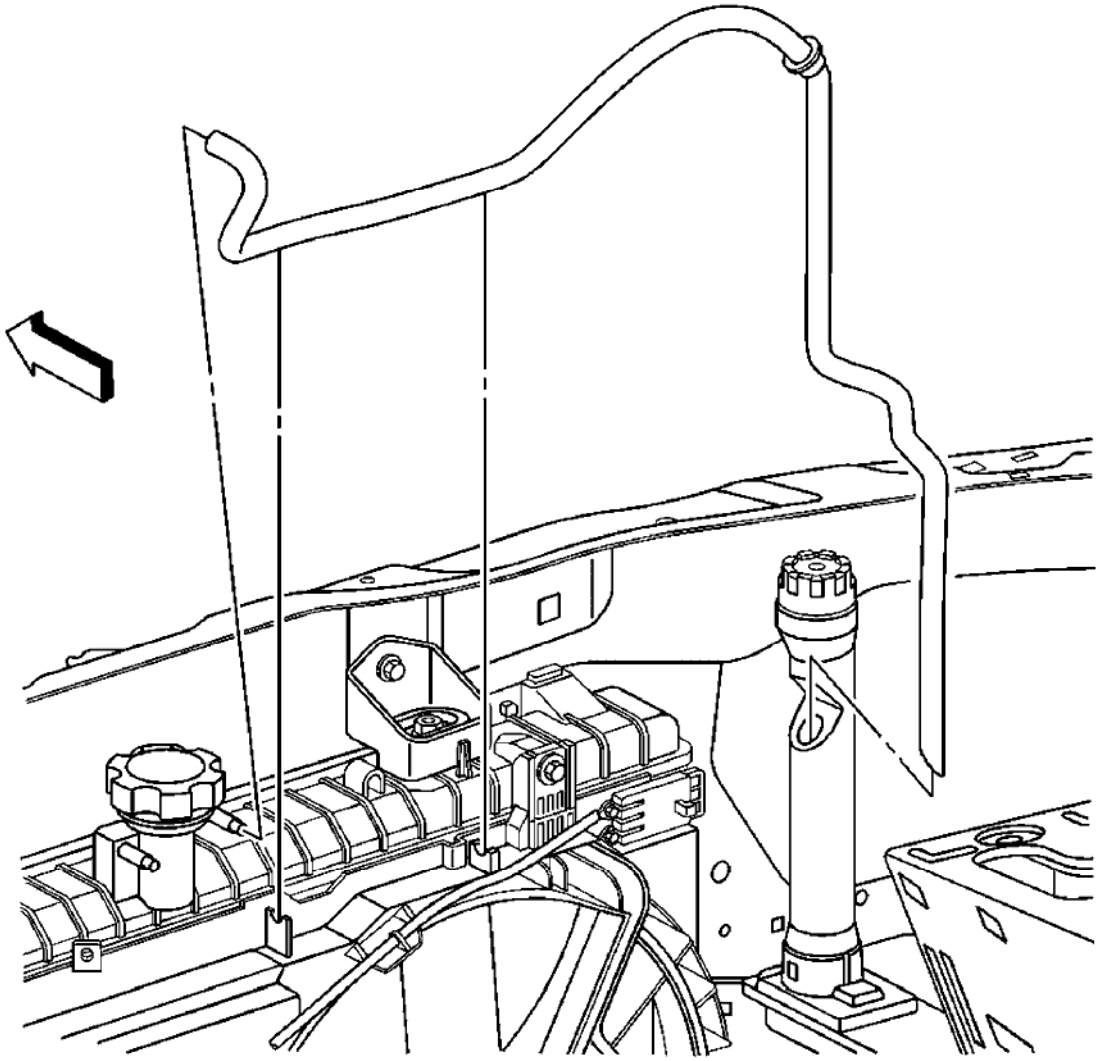


Fig. 42: Radiator Overflow Hose (LS3, L99)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Drain the coolant from the radiator overflow hose.	
1	Radiator Overflow Hose

ENGINE OIL COOLER REPLACEMENT

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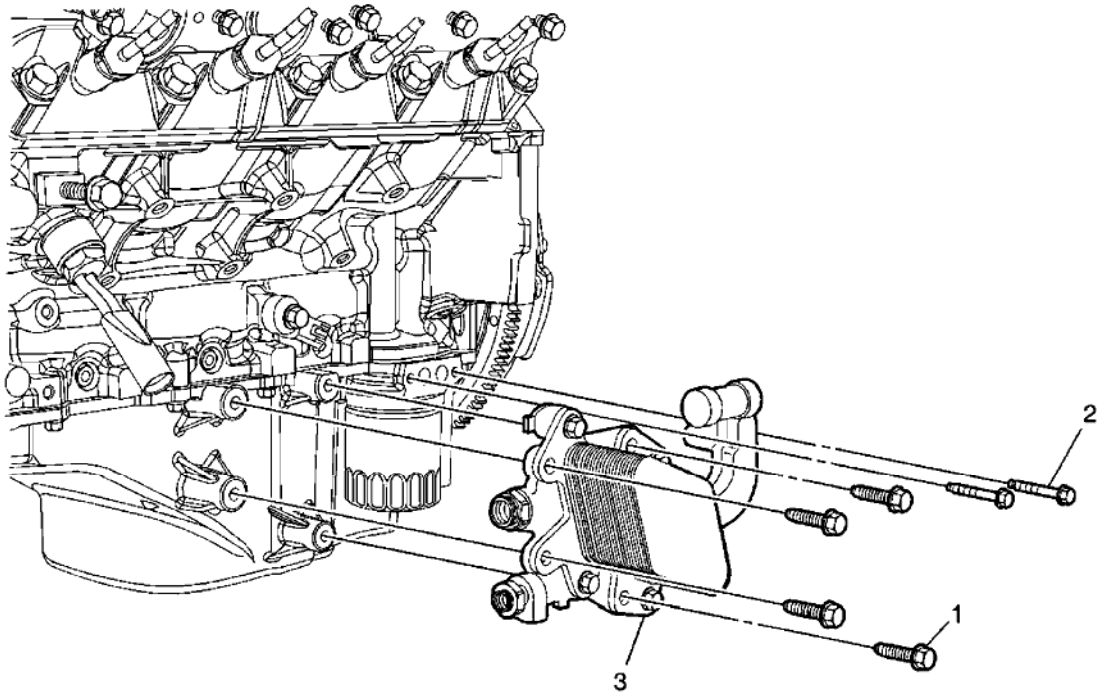


Fig. 43: Engine Oil Cooler
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove engine oil cooler coolant inlet hose. Refer to **Engine Oil Cooler Coolant Inlet Hose Replacement (LS3)**. 2. Remove engine oil cooler pipe. Refer to **Engine Oil Cooler Pipe Replacement (LS3)**.	
1	Engine Oil Cooler Fastener (Qty: 2) **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Tighten:** 10 N.m (89 lb in)
2	Engine Oil Cooler Fastener (Qty: 5) **Tighten:** 25 N.m (18 lb ft)
3	Engine Oil Cooler **Procedure** 1. Transfer components as necessary. 2. Ensure the full oil level after installation.

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ENGINE OIL COOLER HOSE/PIPE QUICK-CONNECT FITTING DISCONNECTION AND CONNECTION

Special Tools

- **J 41623-B:** 3/8 Inch Cooler Quick Connect Tool
- **DT 47731:** 1/2 Inch Quick Connect Release Tool

Removal Procedure

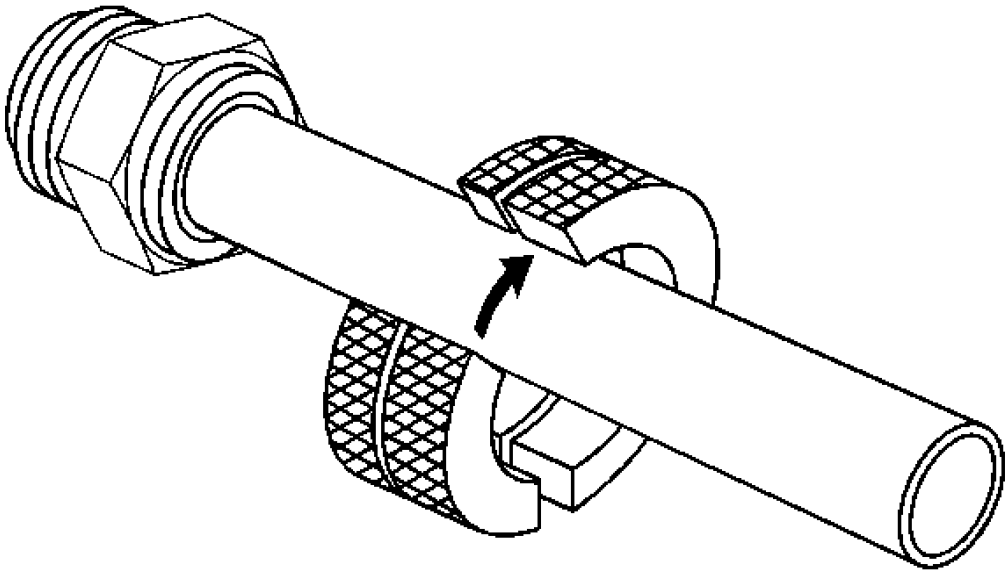


Fig. 44: Installing J 41623-B Onto Generator Cooling Inlet Pipe
Courtesy of GENERAL MOTORS CORP.

1. Install the **J 41623-B:** 3/8 Inch Cooler Quick Connect Tool or DT 47731: 1/2 Inch Quick Connect Release Tool onto the engine oil cooler (EOC) pipe.

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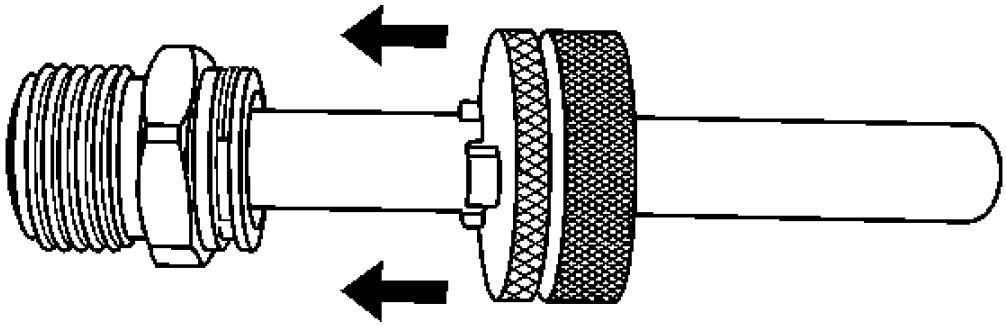


Fig. 45: Sliding J 41623-B Toward Generator Cooling Inlet Pipe Fitting
Courtesy of GENERAL MOTORS CORP.

2. Slide the **J 41623-B:** 3/8 Inch Cooler Quick Connect Tool or DT 47731: 1/2 Inch Quick Connect Release Tool toward the EOC pipe fitting.

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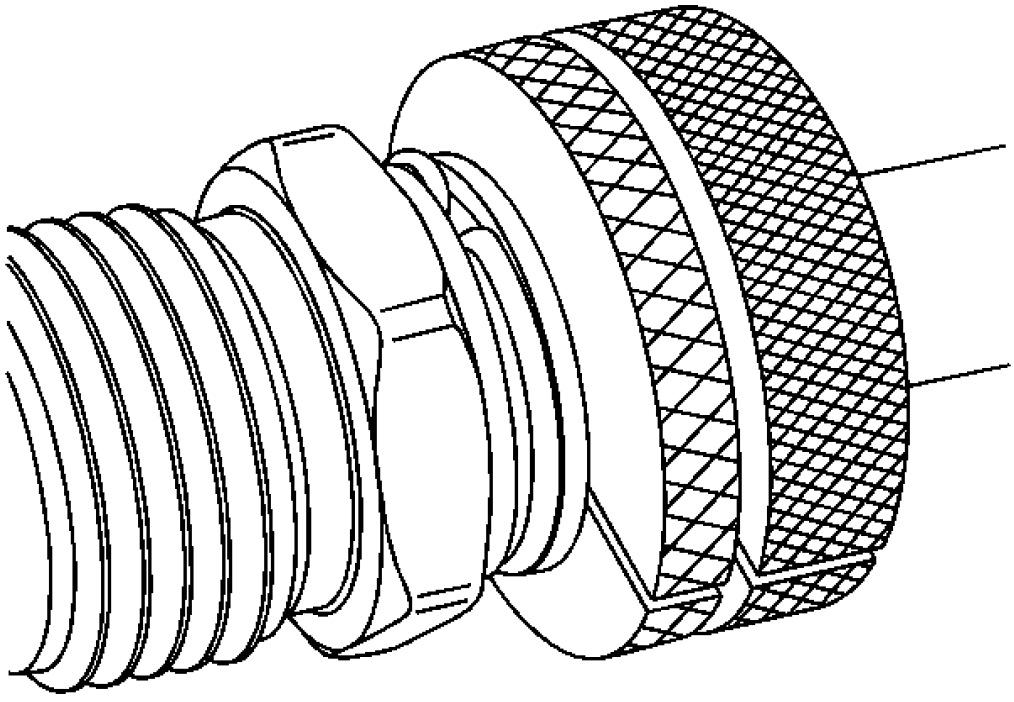


Fig. 46: Rotating J 41623-B On Coolant Pipe
Courtesy of GENERAL MOTORS CORP.

NOTE: **Rotate the J 41623-B: 3/8 Inch Cooler Quick Connect Tool or DT 47731: 1/2 Inch Quick Connect Release Tool to engage the EOC pipe fitting's retainer slots.**
The J 41623-B: 3/8 Inch Cooler Quick Connect Tool or DT 47731: 1/2 Inch Quick Connect Release Tool should be nearly flush with the fitting.

3. Connect the **J 41623-B:** 3/8 Inch Cooler Quick Connect Tool or DT 47731: 1/2 Inch Quick Connect Release Tool onto the EOC pipe fitting.

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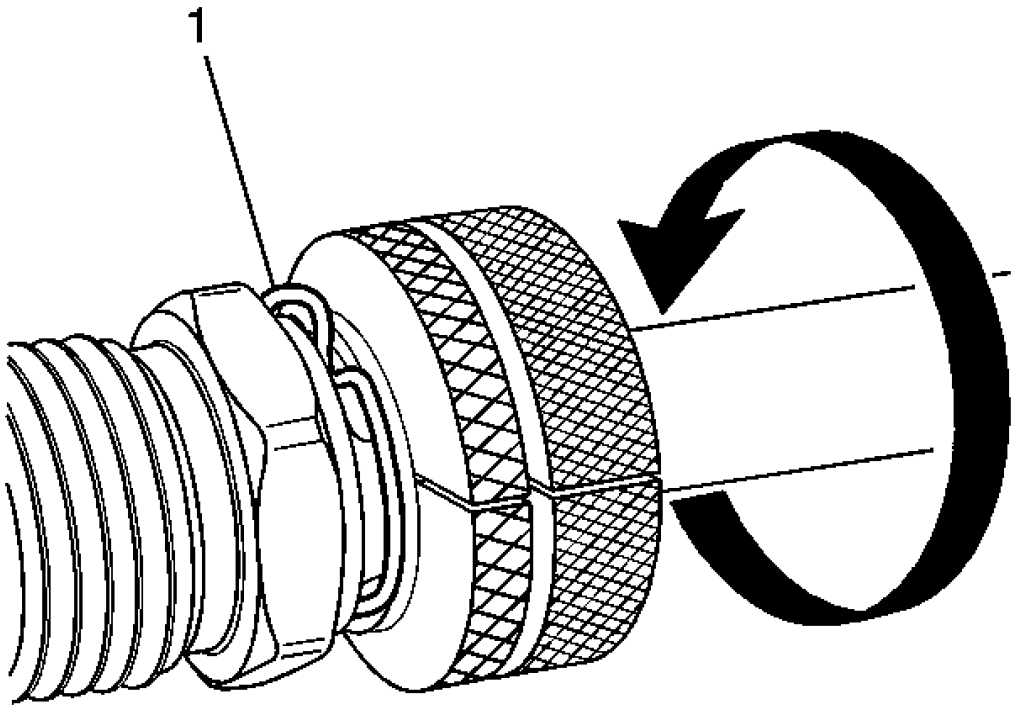


Fig. 47: Identifying Retainer Clip
Courtesy of GENERAL MOTORS CORP.

4. Rotate the **J 41623-B:** 3/8 Inch Cooler Quick Connect Tool or DT 47731: 1/2 Inch Quick Connect Release Tool until the retainer clip (1) rises above the fitting retainer seat.

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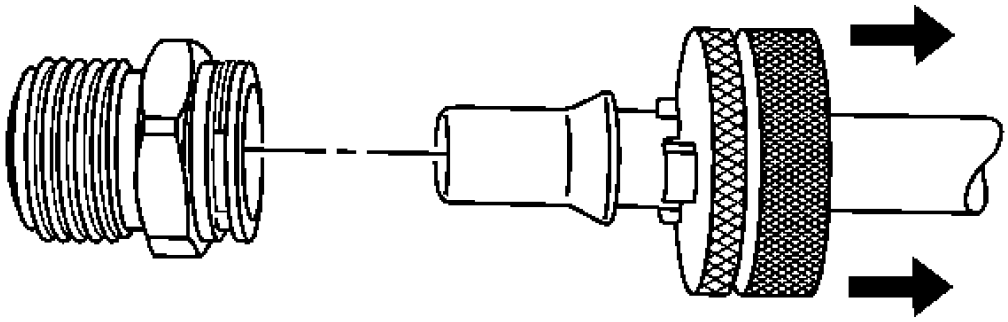


Fig. 48: Disengaging Pipe From EOC Pipe Fitting
Courtesy of GENERAL MOTORS CORP.

5. Pull back on the EOC pipe to disengage the pipe from the EOC pipe fitting.
6. Remove the **J 41623-B:** 3/8 Inch Cooler Quick Connect Tool or DT 47731: 1/2 Inch Quick Connect Release Tool from the EOC pipe.

Installation Procedure

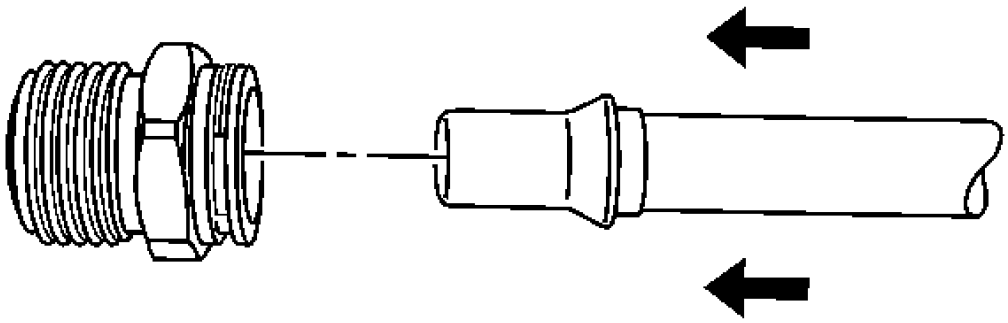


Fig. 49: Installing EOC Pipe Into EOC Pipe Fitting
Courtesy of GENERAL MOTORS CORP.

NOTE: Inspect the EOC pipe fitting and retaining clip for signs of wear or damage. Replace the components if necessary.

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1. Install the EOC pipe into the EOC pipe fitting.

   A distinct snap should be heard or felt when assembling the EOC pipe to the fitting.

2. To ensure the cooler line is properly installed, give the cooler pipe a gentle pull.

ENGINE OIL COOLER COOLANT INLET HOSE REPLACEMENT (LS3)

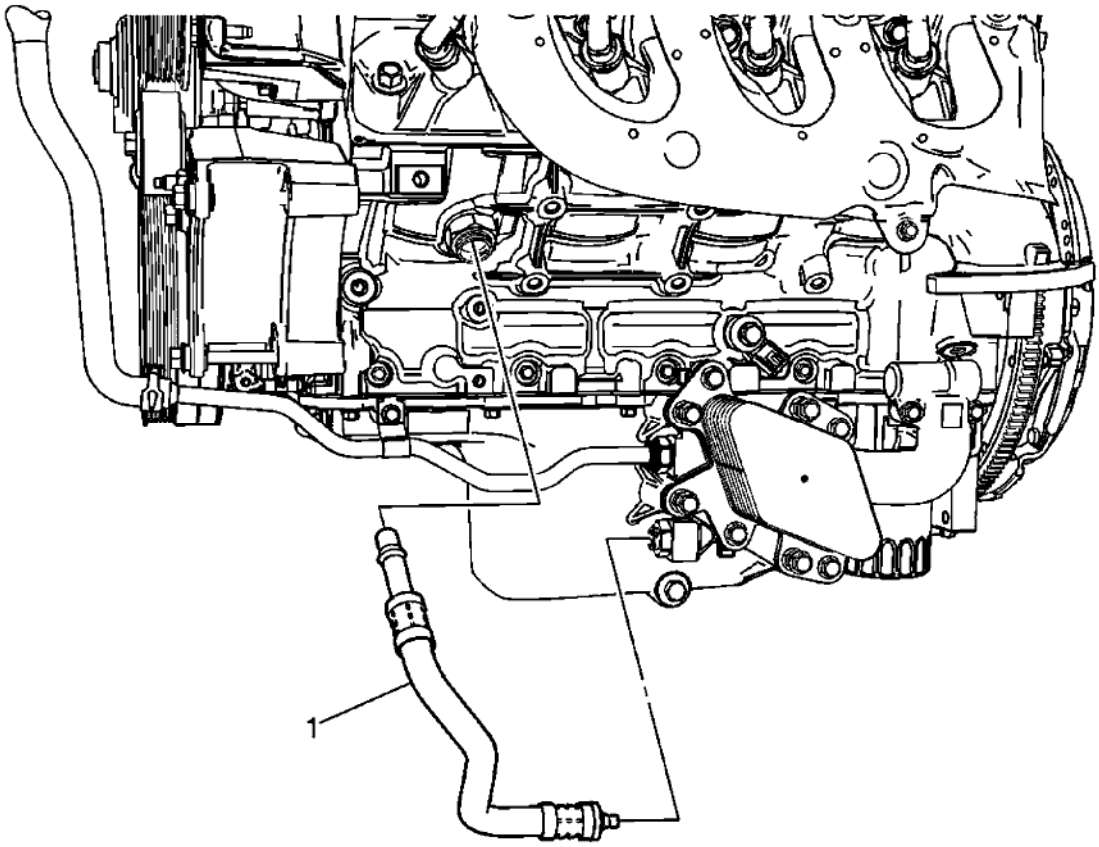


Fig. 50: Engine Oil Cooler Coolant Inlet Hose (LS3)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Install oil drain pan under the vehicle. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**	
1	Engine Oil Cooler Coolant Inlet Hose **Procedure:** Disconnect the engine oil cooler coolant inlet hose from the engine and cooler. Refer to **Engine Oil Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection**

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ENGINE OIL COOLER PIPE REPLACEMENT (LS3)

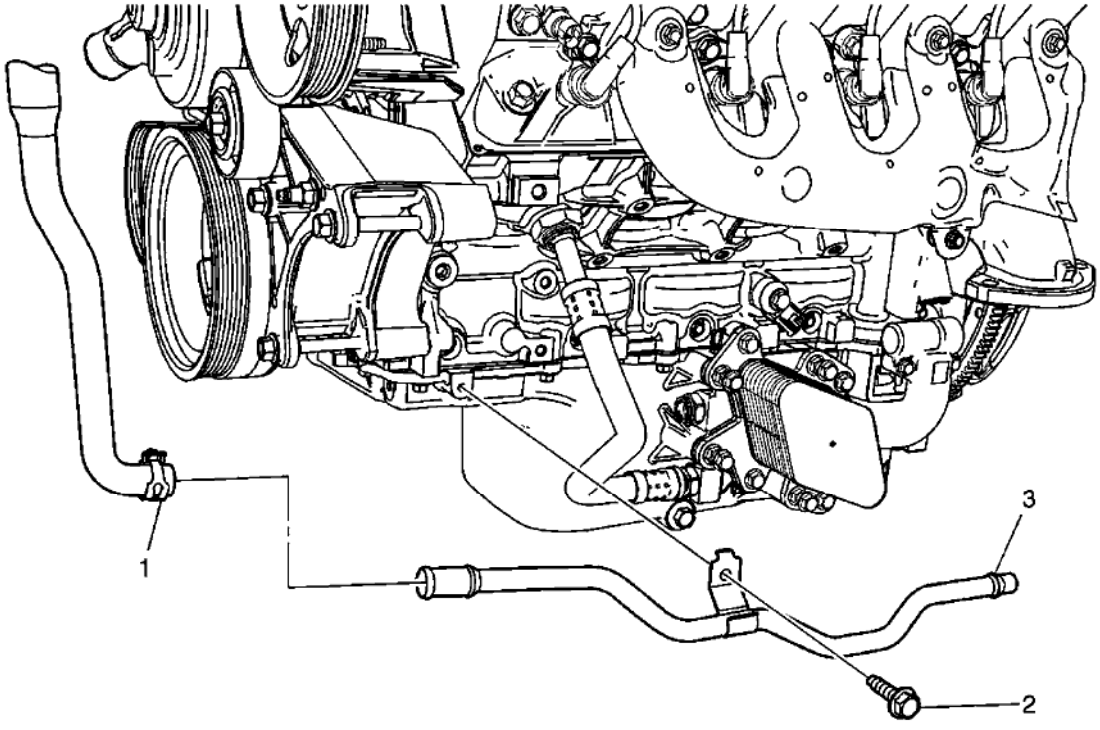


Fig. 51: Engine Oil Cooler Pipe (LS3)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Install oil drain pan under the vehicle. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**	
1	Radiator Inlet Hose Clamp **Procedure:** Using J 38185: Hose Clamp Pliers reposition the radiator inlet hose clamps. **Special Tools:** **J 38185:** Hose Clamp Pliers
2	Engine Oil Cooler Pipe Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 N.m (89 lb in)
3	Engine Oil Cooler Pipe **Procedure:** Disconnect the engine oil cooler pipe from the engine oil cooler. Refer to **Engine Oil**

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	Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection

ENGINE COOLANT FAN REPLACEMENT

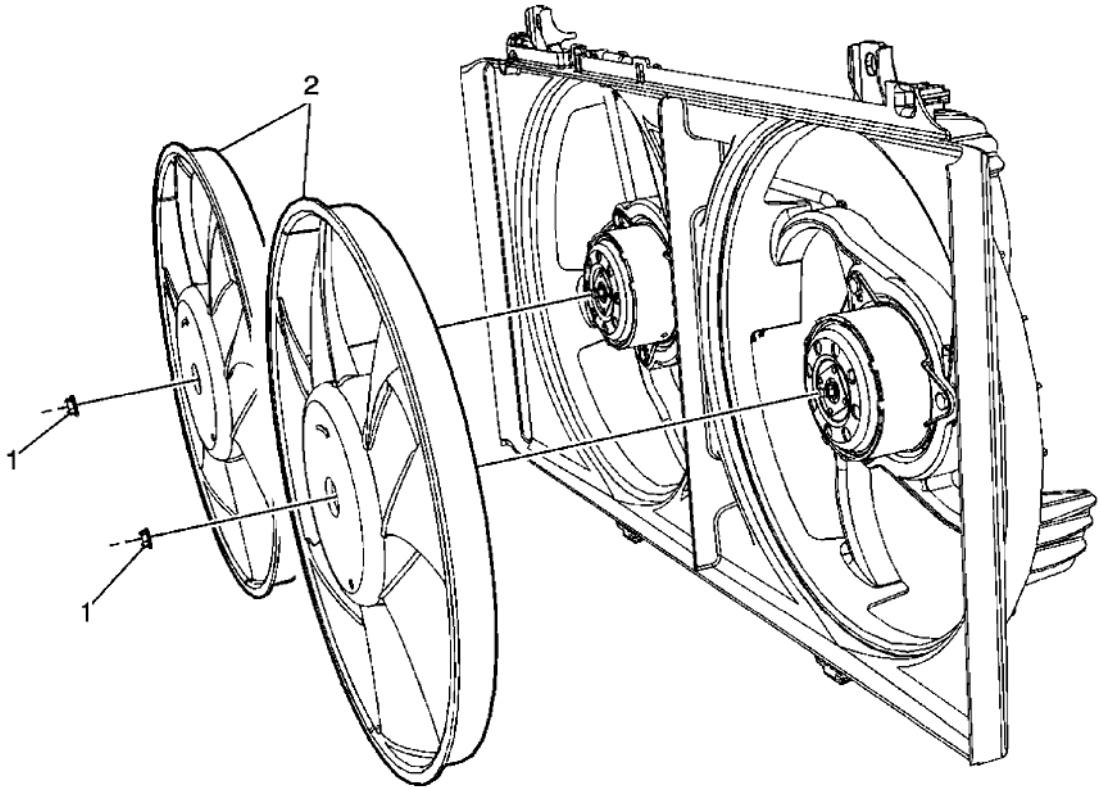


Fig. 52: Engine Coolant Fan
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Remove engine coolant fan and shroud. Refer to **Engine Coolant Fan Shroud Replacement (LLT)** or **Engine Coolant Fan Shroud Replacement (LS3, L99)**	
1	Engine Coolant Fan Nuts (Qty 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 6 N.m (53 lb in)
2	Engine Coolant Fan

ENGINE COOLANT FAN MOTOR REPLACEMENT

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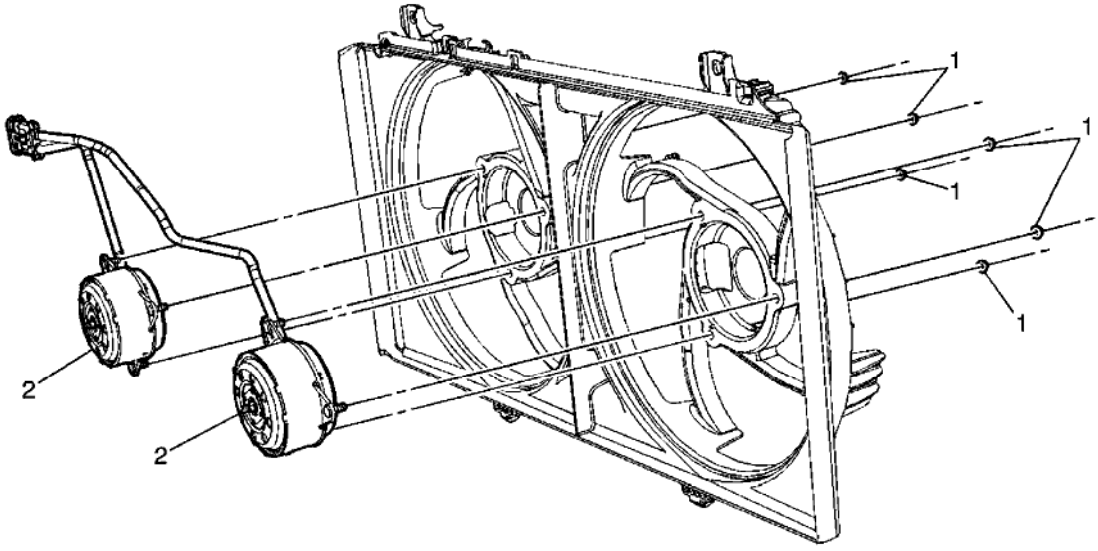


Fig. 53: Engine Coolant Fan Motor
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures: Remove engine coolant fan. Refer to **Engine Coolant Fan Replacement**	
1	Engine Coolant Fan Motor Nuts (Qty 6) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 6 N.m (53 lb in)
2	Engine Coolant Fan Motor

ENGINE COOLANT THERMOSTAT LOWER HOUSING REPLACEMENT (LLT)

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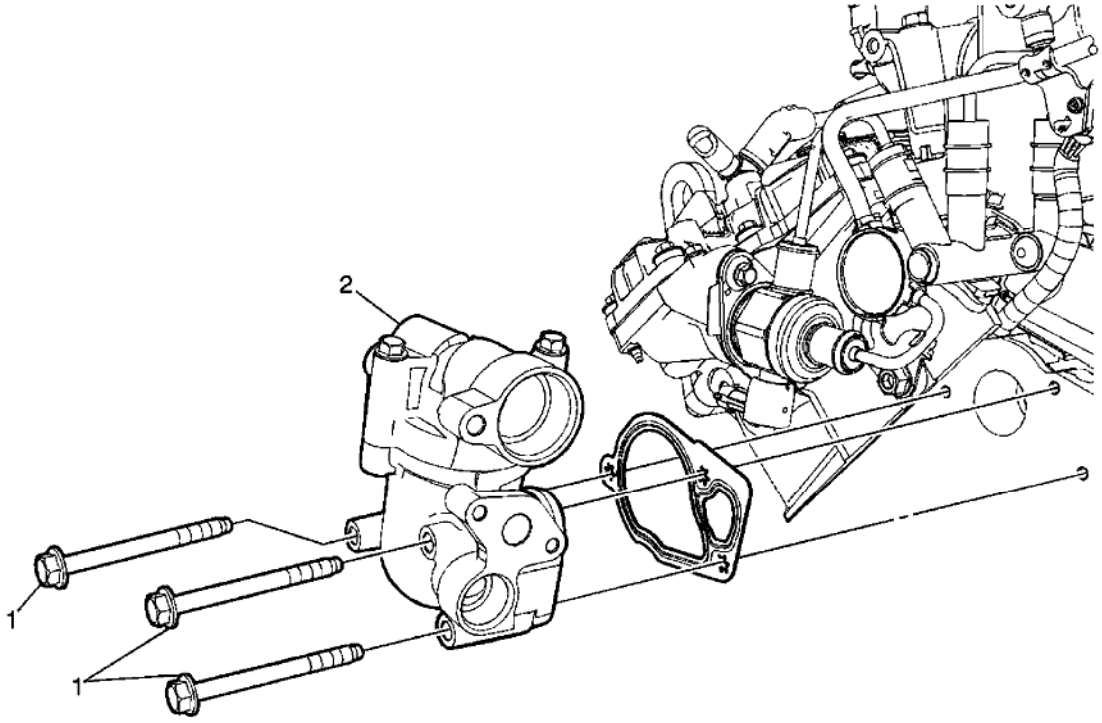


Fig. 54: Engine Coolant Thermostat Lower Housing (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Partially drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**. 2. Remove the rear intake manifold cover.Refer to **Intake Manifold Cover Replacement - Rear** 3. Remove the radiator outlet pipe. Refer to **Radiator Outlet Pipe Replacement (LLT)**. 4. Remove the inlet and outlet Heater pipes. Refer to **Heater Inlet And Outlet Pipe Replacement (LLT)**. 5. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement** .	
1	Lower Thermostat Housing Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 N.m (89 lb in)
2	Upper and Lower Thermostat Housing **Procedure:** Install NEW lower thermostat housing seals.

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ENGINE COOLANT THERMOSTAT REPLACEMENT (LLT)

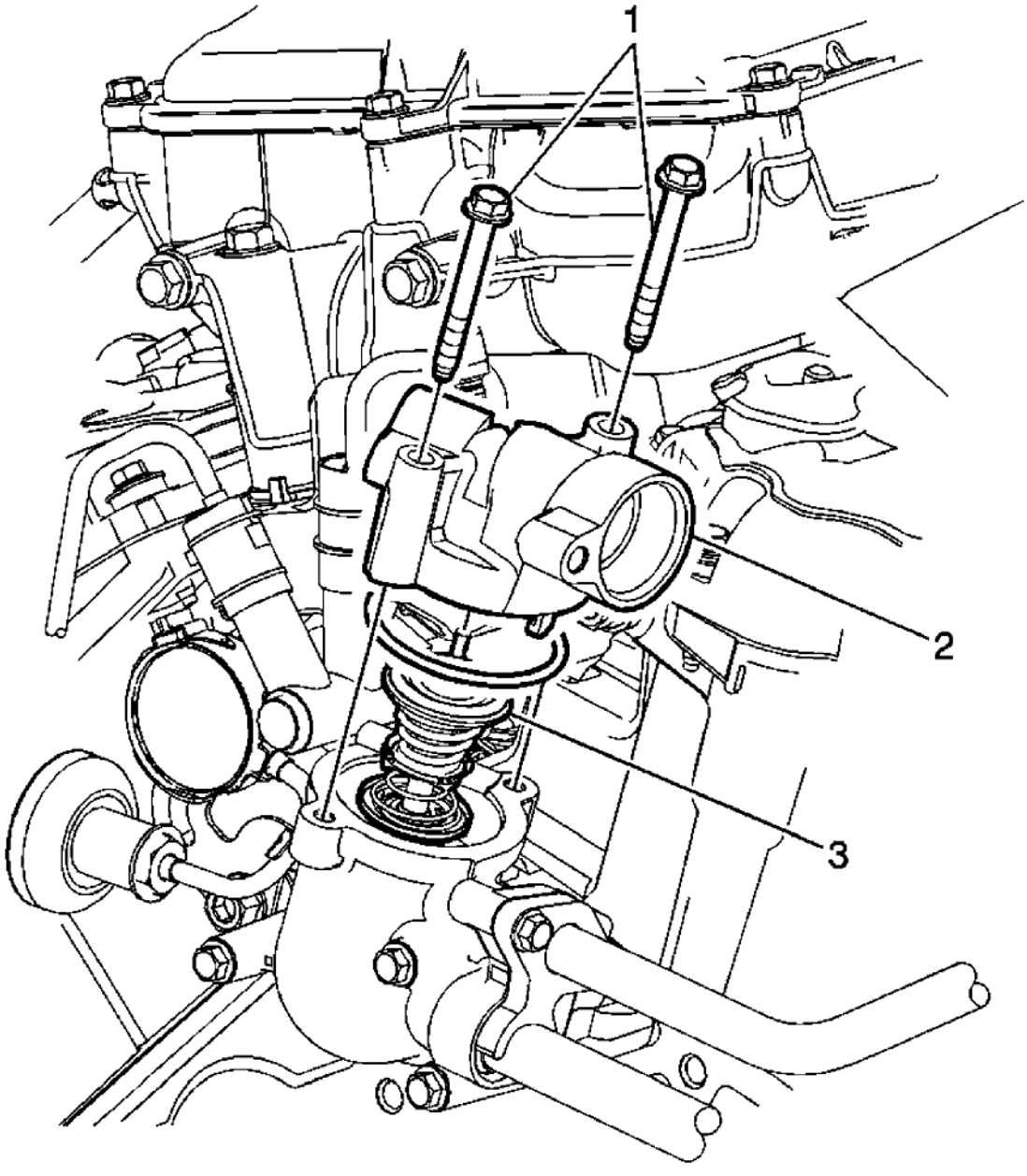


Fig. 55: Engine Coolant Thermostat (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures	
1. Partially drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System**	

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Draining and Filling (GE 47716).

2. Remove the radiator outlet pipe. Refer to **Radiator Outlet Pipe Replacement (LLT)**.
3. Remove the rear intake manifold cover.Refer to **Intake Manifold Cover Replacement - Rear**

1	Engine Coolant Thermostat Housing Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 N.m (89 lb in)
2	Upper Engine Coolant Thermostat Housing
3	Thermostat **Procedure:** Install a New thermostat housing seal.

ENGINE COOLANT THERMOSTAT REPLACEMENT (L99/LS3)

Removal Procedure

NOTE: The engine cooling system thermostat and water pump will not function correctly if oil is present in the cooling system.
The cooling system MUST be flushed, the water pump and thermostat replaced if oil is found in the cooling system.

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Reposition the outlet hose clamp at the water pump inlet.
3. Remove the outlet hose from the water pump inlet.

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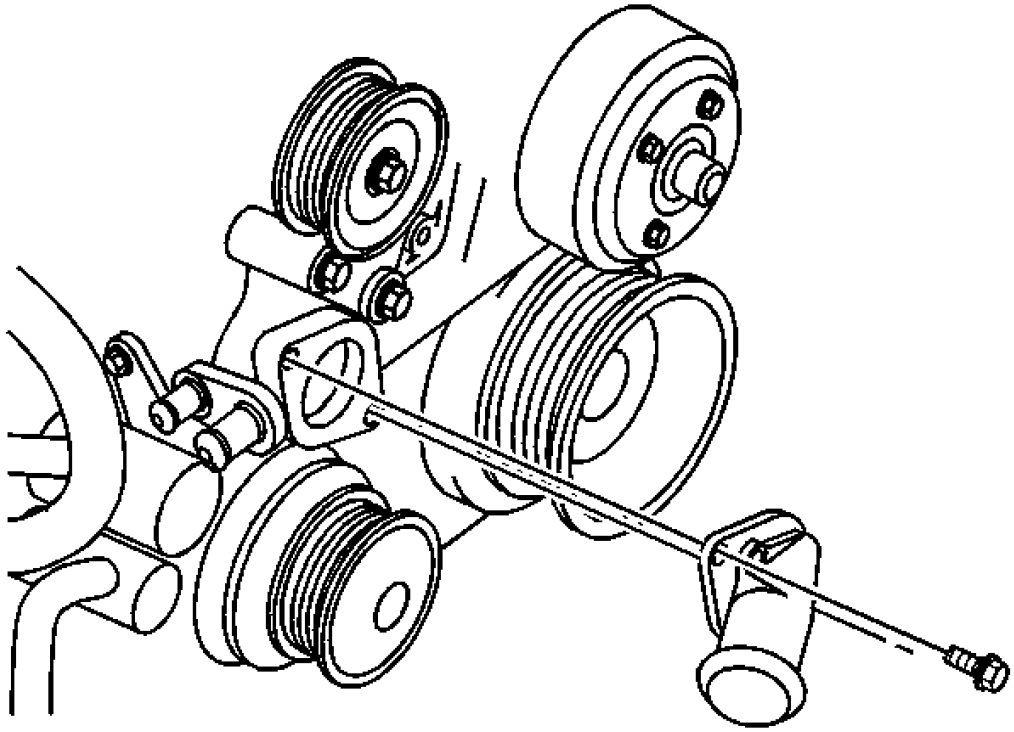


Fig. 56: View Of Water Pump Inlet
Courtesy of GENERAL MOTORS CORP.

4. Remove the water pump inlet bolts.
5. Remove the water pump inlet.
6. The O-ring seal is integral to the thermostat housing.
7. Remove the thermostat housing.

Installation Procedure

1. Install the thermostat housing.
2. Ensure the thermostat housing has an O-ring seal and is in the groove correctly.

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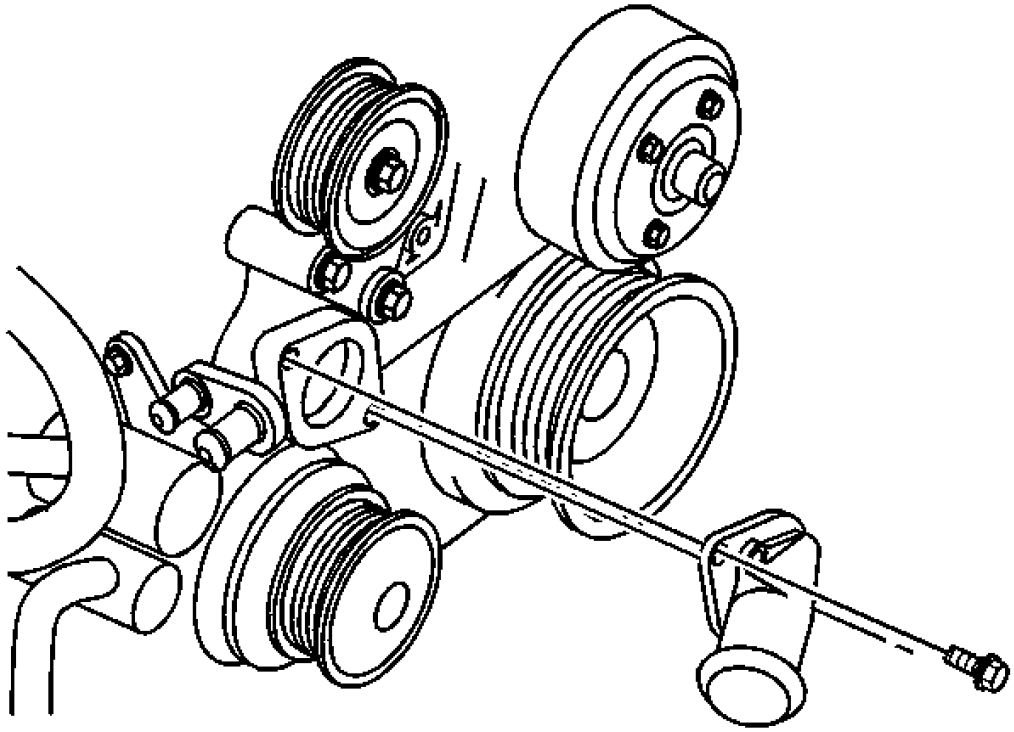


Fig. 57: View Of Water Pump Inlet
Courtesy of GENERAL MOTORS CORP.

3. Install the water pump inlet (with thermostat).

CAUTION: Refer to Fastener Caution .

4. Install the water pump inlet bolts.

   Tighten: Tighten the water pump inlet bolts to 15 N.m (11 lb ft).

5. Install the outlet hose to the water pump inlet.
6. Position the outlet hose clamp at the water outlet.
7. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.

ENGINE COOLANT AIR BLEED HOSE REPLACEMENT (LLT)

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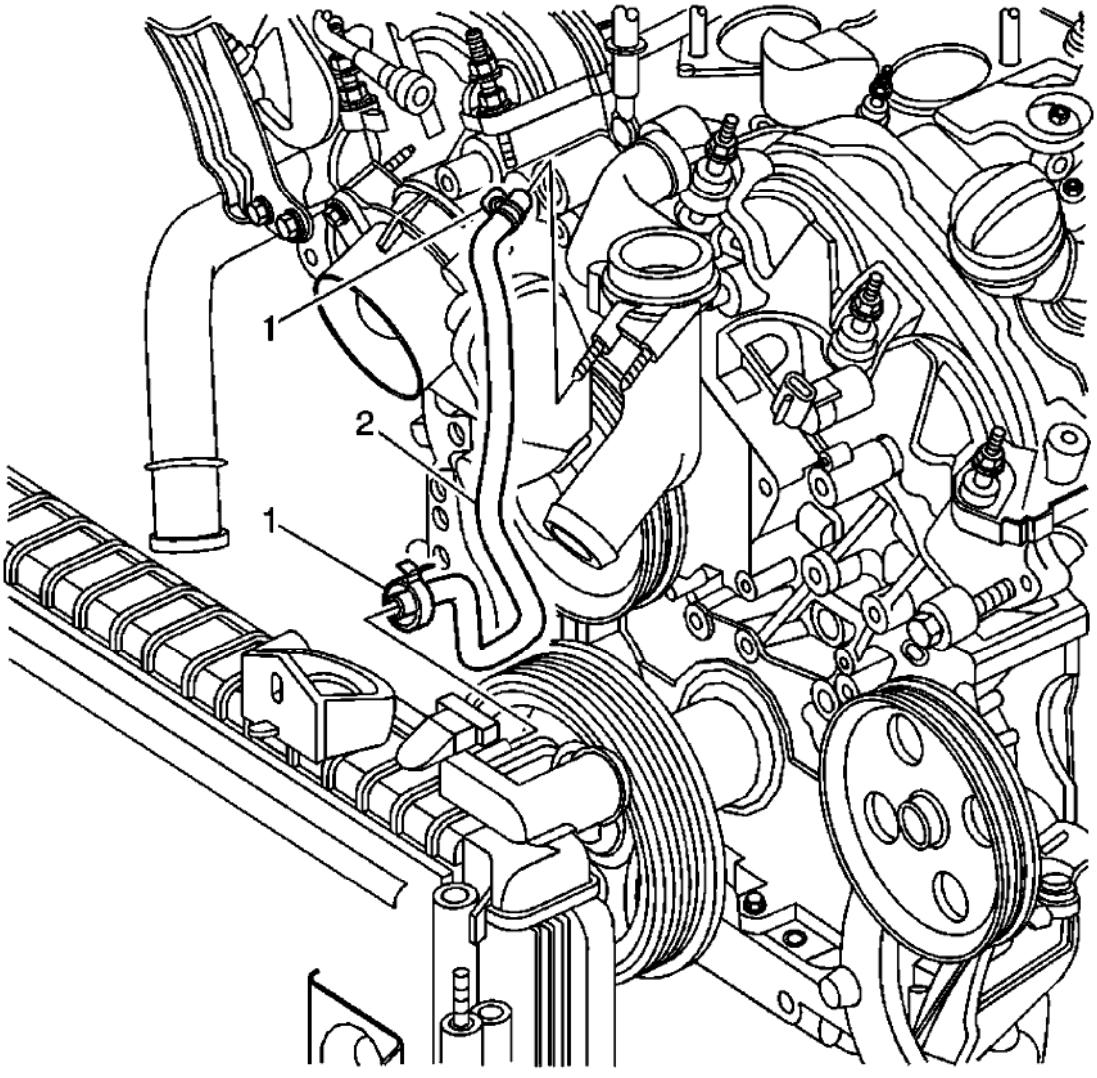


Fig. 58: Engine Coolant Air Bleed Hose (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Drain the coolant. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** 2. Remove front intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front** 3. Remove air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**	
1	Engine Coolant Air Bleed Hose Clamps **Procedure:** Reposition engine coolant air bleed hose clamp using **J 38185:** Hose Clamp Pliers.

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	Special Tools: **J 38185:** Hose Clamp Pliers
2	Engine Coolant Air Bleed Hose

ENGINE COOLANT AIR BLEED HOSE REPLACEMENT (LS3, L99)

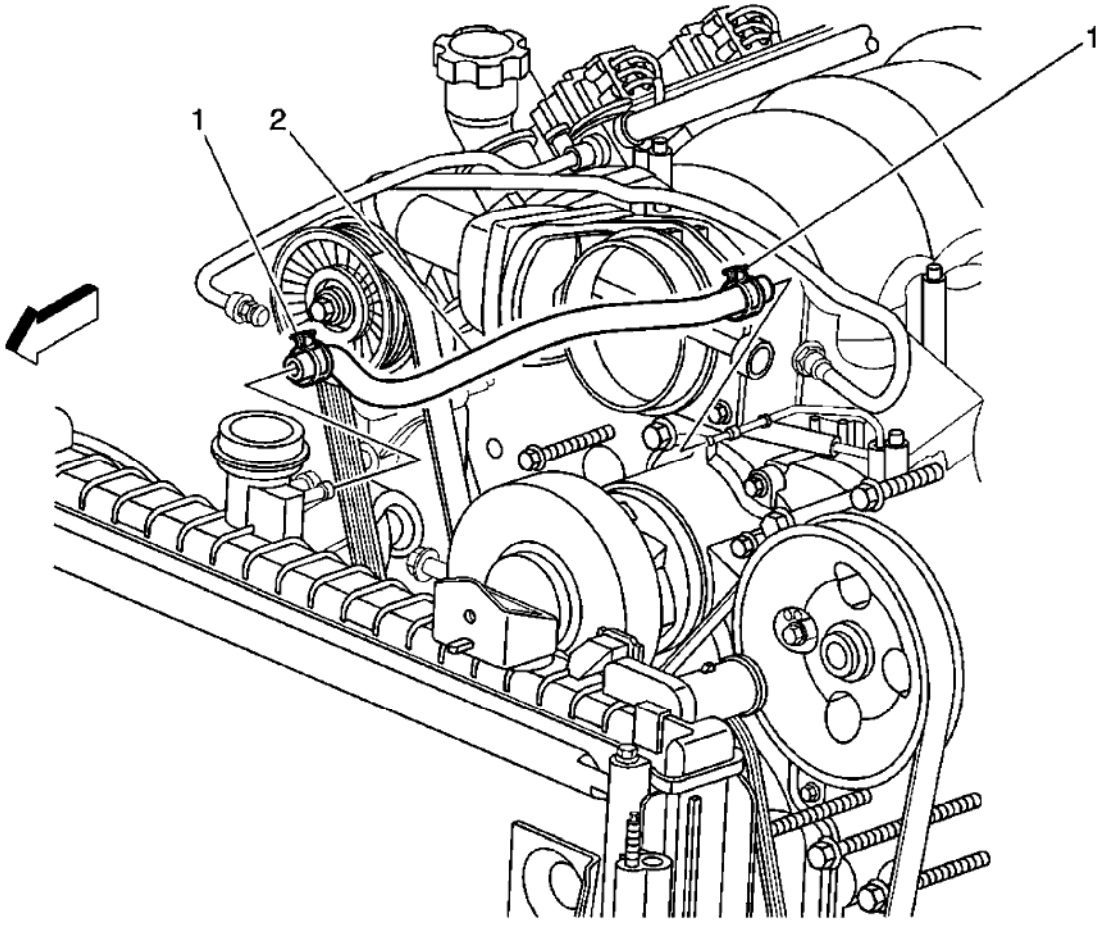


Fig. 59: Engine Coolant Air Bleed Hose (LS3, L99)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Drain the coolant. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** 2. Remove engine cover. Refer to **Engine Cover Replacement** 3. Remove air cleaner outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement**	
	Engine Coolant Air Bleed Hose Clamps

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1	**Procedure:** Reposition engine coolant air bleed hose clamp using **J 38185:** Hose Clamp Pliers. **Special Tools:** **J 38185:** Hose Clamp Pliers
2	Engine Coolant Air Bleed Hose

WATER OUTLET REPLACEMENT (LLT)

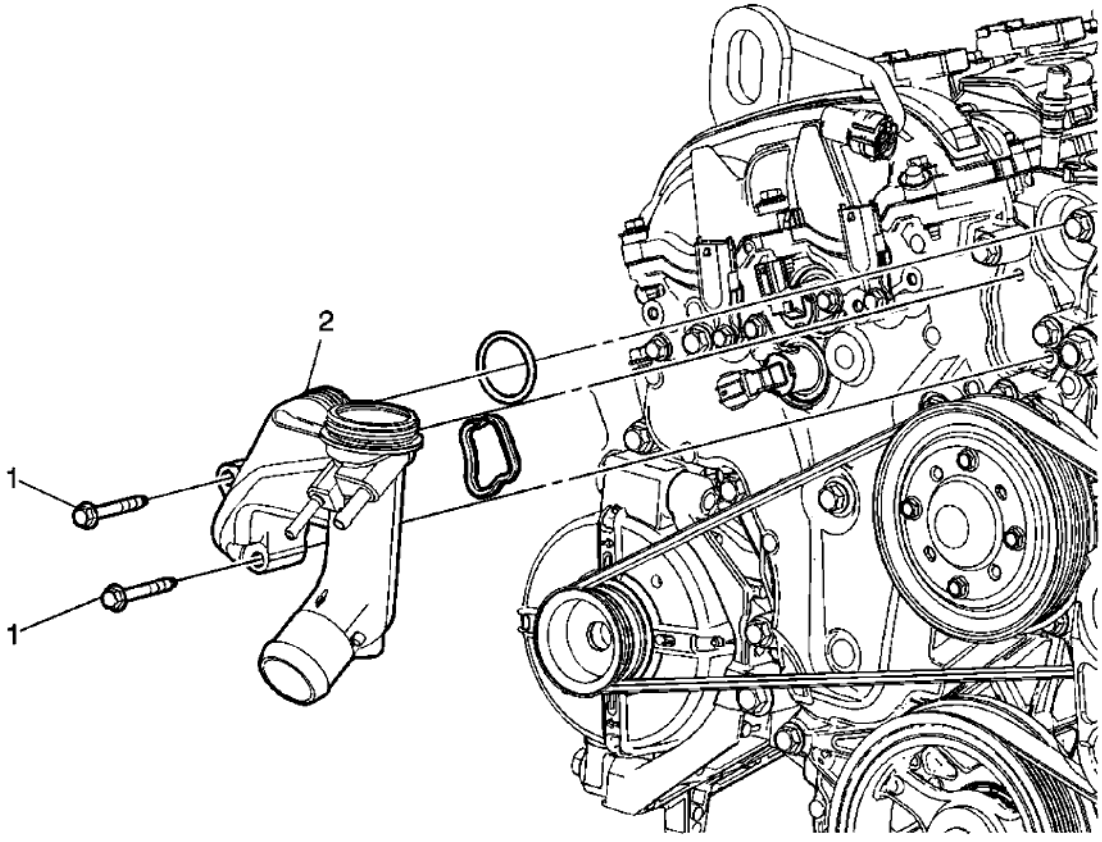


Fig. 60: Water Outlet (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**. 2. Remove the intake manifold. Refer to **Intake Manifold Replacement**	
	Bolt, Coolant Outlet Pipe (Qty: 2)

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1	**CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 N.m (89 lb in)
2	Coolant Outlet Pipe **Procedure** 1. Disconnect the outlet radiator hose from the water outlet pipe 2. Disconnect the engine coolant air bleed hoses from the water outlet. 3. Install NEW water outlet seals.

HEATER INLET AND OUTLET PIPE REPLACEMENT (LLT)

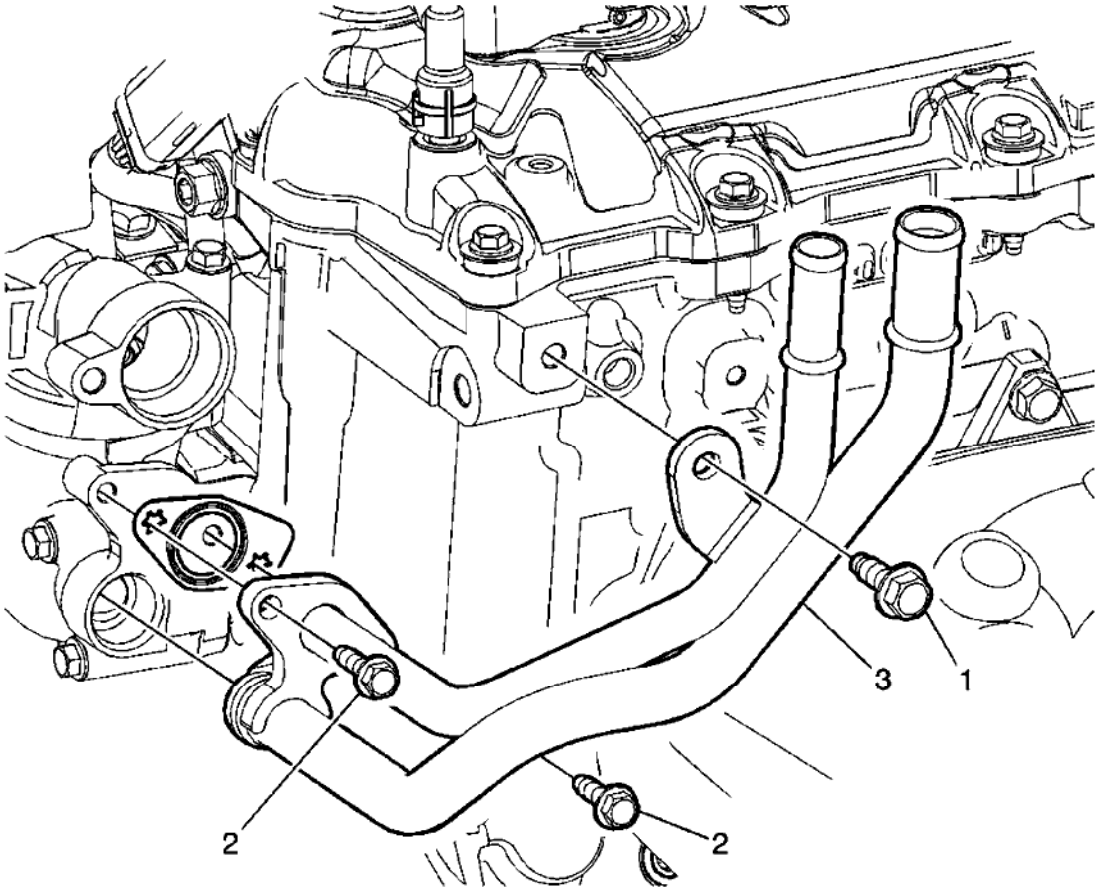


Fig. 61: Heater Inlet & Outlet Pipe (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure	

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1. Partially drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Remove the rear intake manifold cover.Refer to **Intake Manifold Cover Replacement - Rear**
3. Remove the radiator outlet pipe. Refer to **Radiator Outlet Pipe Replacement (LLT)**.
4. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement** .
5. Disconnect the Heater inlet and outer hoses from the heater inlet and outlet pipe.

1	Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 22 N.m (16 lb ft)
2	Bolt (Qty: 2) **Tighten:** 22 N.m (16 lb ft)
3	Heater Inlet and Outlet Pipe **Procedure:** Install a NEW gasket and seal.

WATER PUMP REPLACEMENT (LLT)

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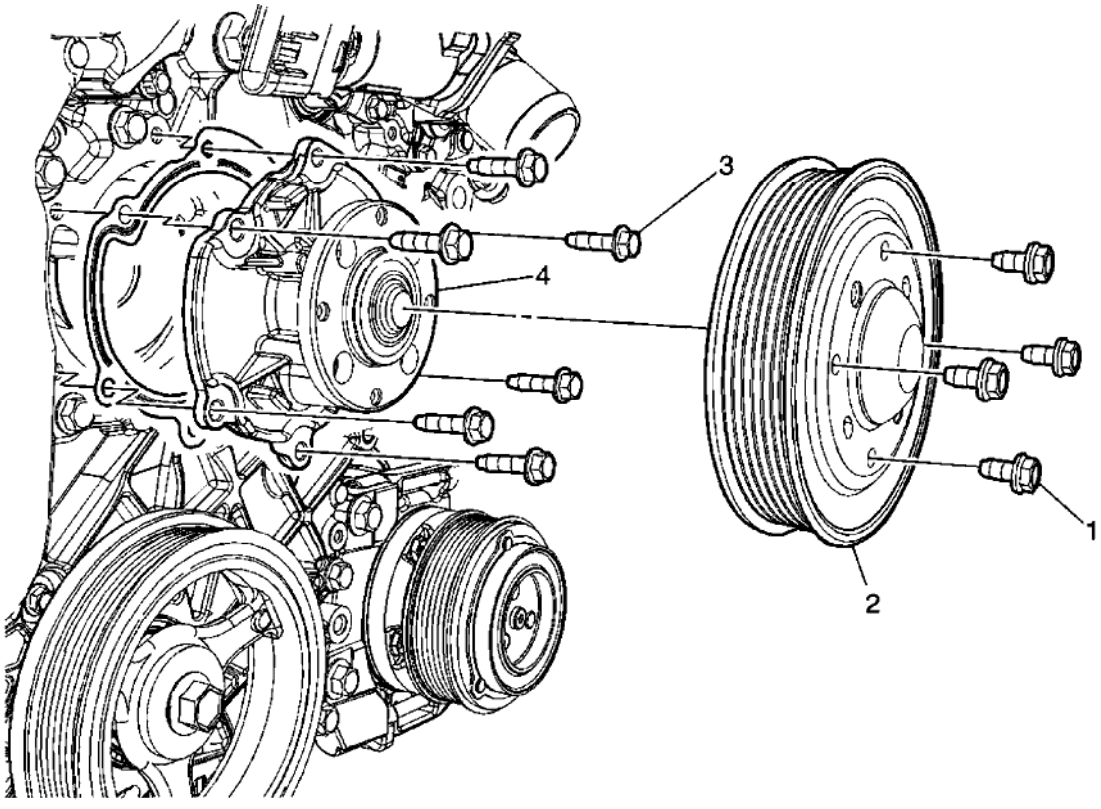


Fig. 62: Water Pump (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**. 2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** . 3. Remove the water pump drive belt. Refer to **Drive Belt Replacement**	
1	Bolt, Water Pump Pulley **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 N.m(89 lb in)
2	Water Pump Pulley
3	Bolt, Water Pump

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	Tighten: 10 N.m(89 lb in)
4	Water Pump **Procedure** • Clean the water pump mating surfaces. • Install a NEW water pump gasket.

WATER PUMP REPLACEMENT (LS3/L99)

Removal Procedure

1. Remove the air cleaner resonator and outlet duct assembly. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** .
2. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
3. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement - Accessory** .
4. Remove the drive belt idler pulley. Refer to **Drive Belt Idler Pulley Replacement** .
5. Disconnect the radiator inlet hose from the water pump. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose Replacement (L99)** or **Radiator Inlet Hose Replacement (LS3)**.
6. Disconnect the radiator outlet hose from the water pump. Refer to **Radiator Outlet Hose Replacement (LLT)** or **Radiator Outlet Hose Replacement (LS3, L99)**.
7. Disconnect the heater inlet and outlet hose from the water pump. Refer to **Heater Inlet and Outlet Hose Replacement (LS3, L99)** .

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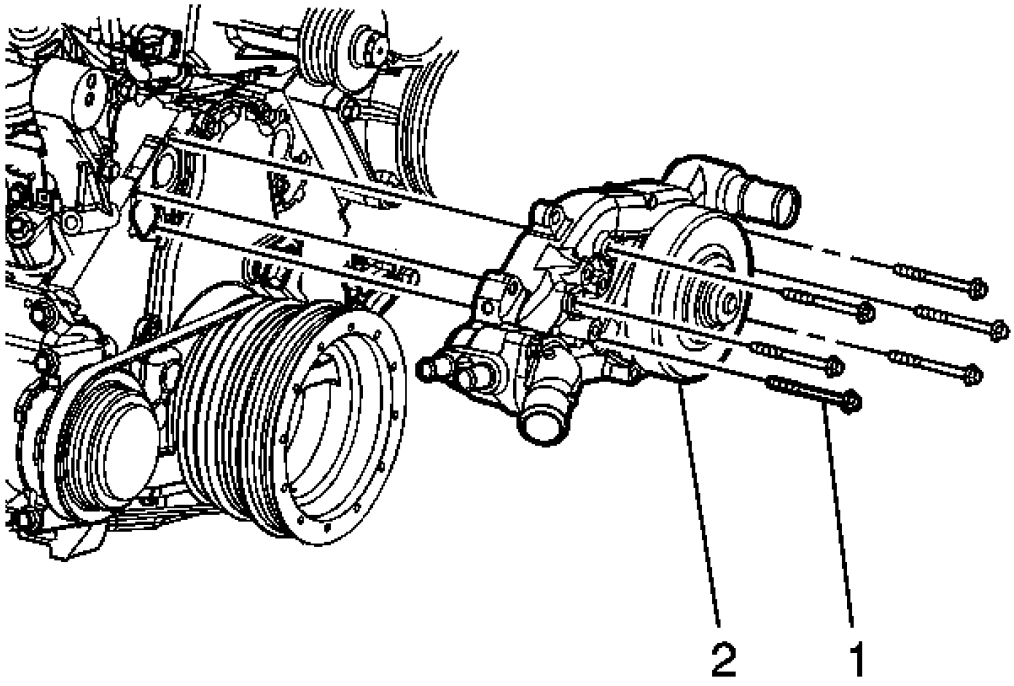


Fig. 63: Identifying Water Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the water pump to block bolts (1).

NOTE: Always clean the water pump and engine block mating surfaces and discard the gaskets.

9. Remove the water pump (2).

Installation Procedure

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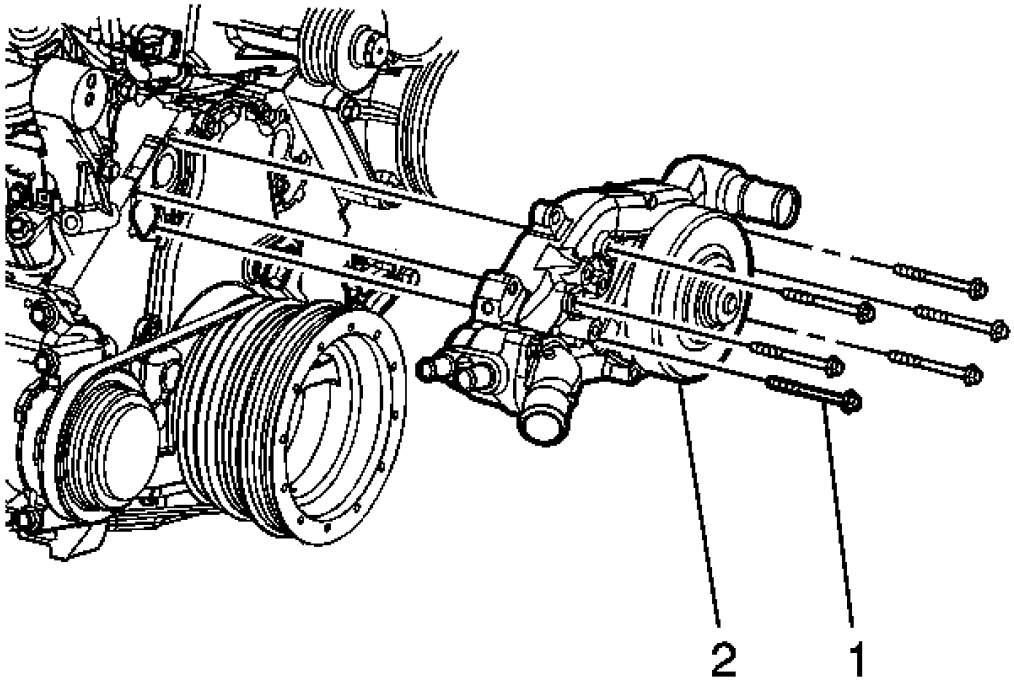


Fig. 64: Identifying Water Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: Always install a NEW water pump gasket.

1. Install the water pump (2) to the engine block and tighten the bolts (1) to 30 N.m (22 lb ft).
2. Connect the heater inlet and outlet hose to the water pump. Refer to **Heater Inlet And Outlet Pipe Replacement (LLT)**.
3. Connect the radiator outlet hose to the water pump. Refer to **Radiator Outlet Hose Replacement (LLT)** or **Radiator Outlet Hose Replacement (LS3, L99)**.
4. Connect the radiator inlet hose to the water pump. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose Replacement (L99)** or **Radiator Inlet Hose Replacement (LS3)**.
5. Install the drive belt idler pulley. Refer to **Drive Belt Idler Pulley Replacement** .
6. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement - Accessory** .
7. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE**

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47716).

8. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .

RADIATOR DRAIN COCK REPLACEMENT

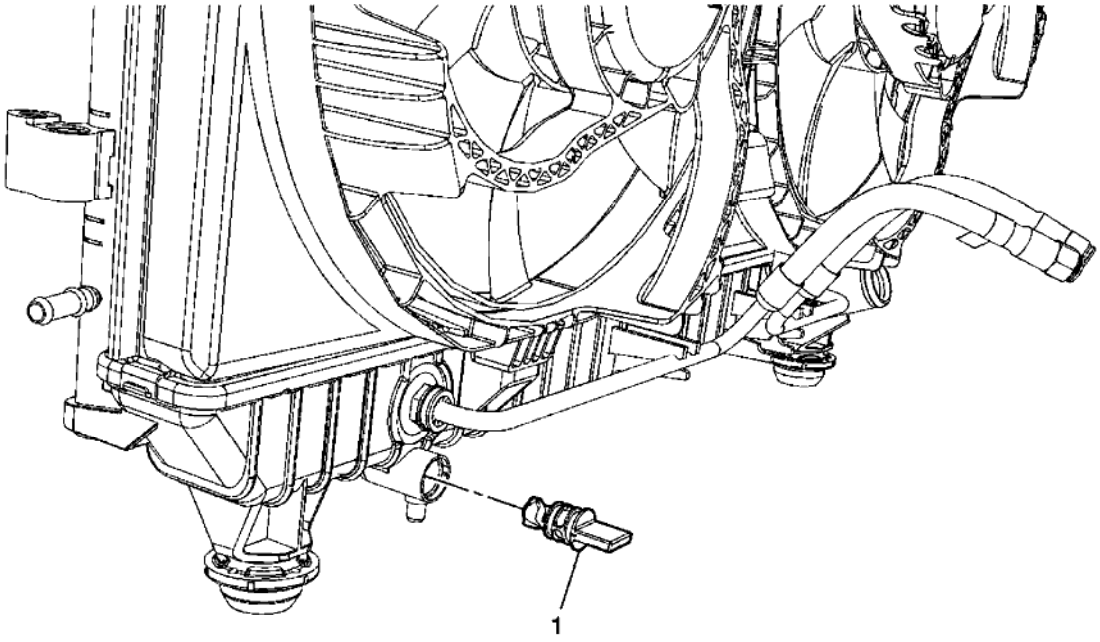


Fig. 65: Radiator Drain Cock
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** 2. Place a drain pan under the left side lower radiator mount.	
1	Radiator Drain Cock

ENGINE COOLANT FAN SHROUD REPLACEMENT (LLT)

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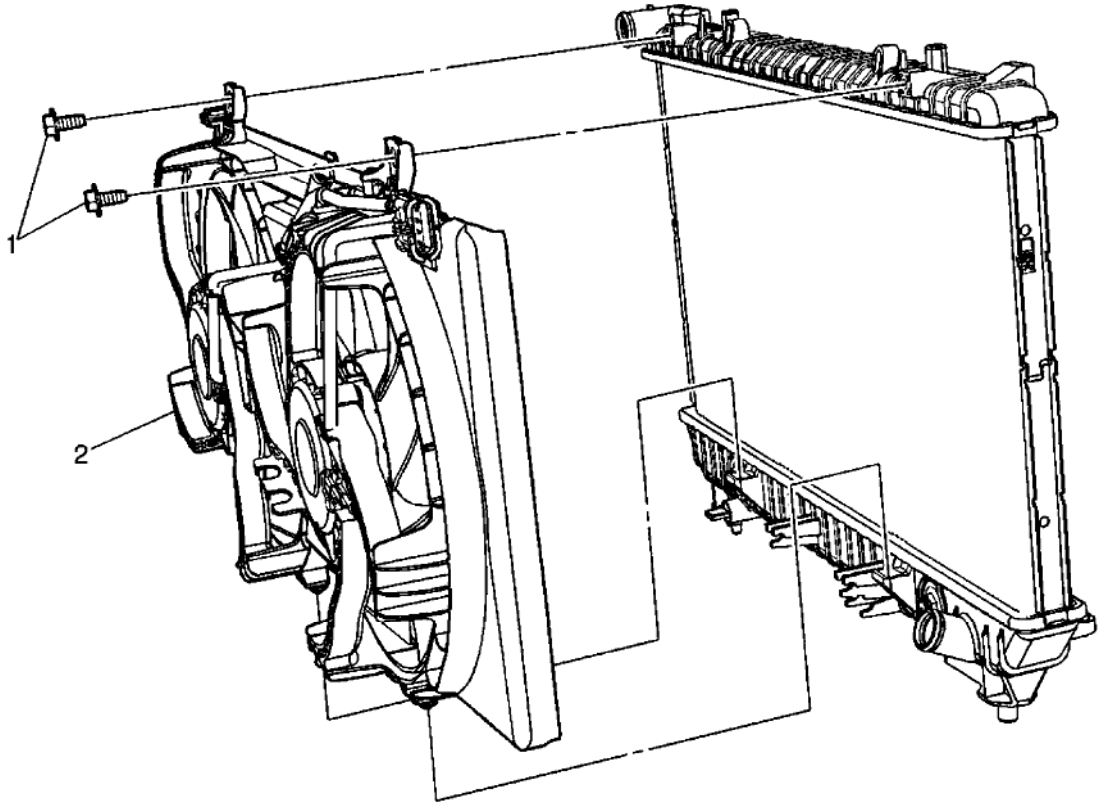


Fig. 66: Engine Coolant Fan Shroud (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove air cleaner resonator and outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** . 2. Reposition radiator overflow hose. Refer to **Radiator Overflow Hose Replacement (LLT)** or **Radiator Overflow Hose Replacement (LS3, L99)**. 3. Remove engine coolant air bleed hose. Refer to **Engine Coolant Air Bleed Hose Replacement (LLT)** or **Engine Coolant Air Bleed Hose Replacement (LS3, L99)**. 4. Remove radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose Replacement (L99)** or **Radiator Inlet Hose Replacement (LS3)**. 5. Reposition transmission cooler lines. 6. Disconnect the engine coolant fan motor connector.	
1	Engine Coolant Fan Shroud Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 8 N.m (6 lb in)

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2	Engine Coolant Fan Shroud

ENGINE COOLANT FAN SHROUD REPLACEMENT (LS3, L99)

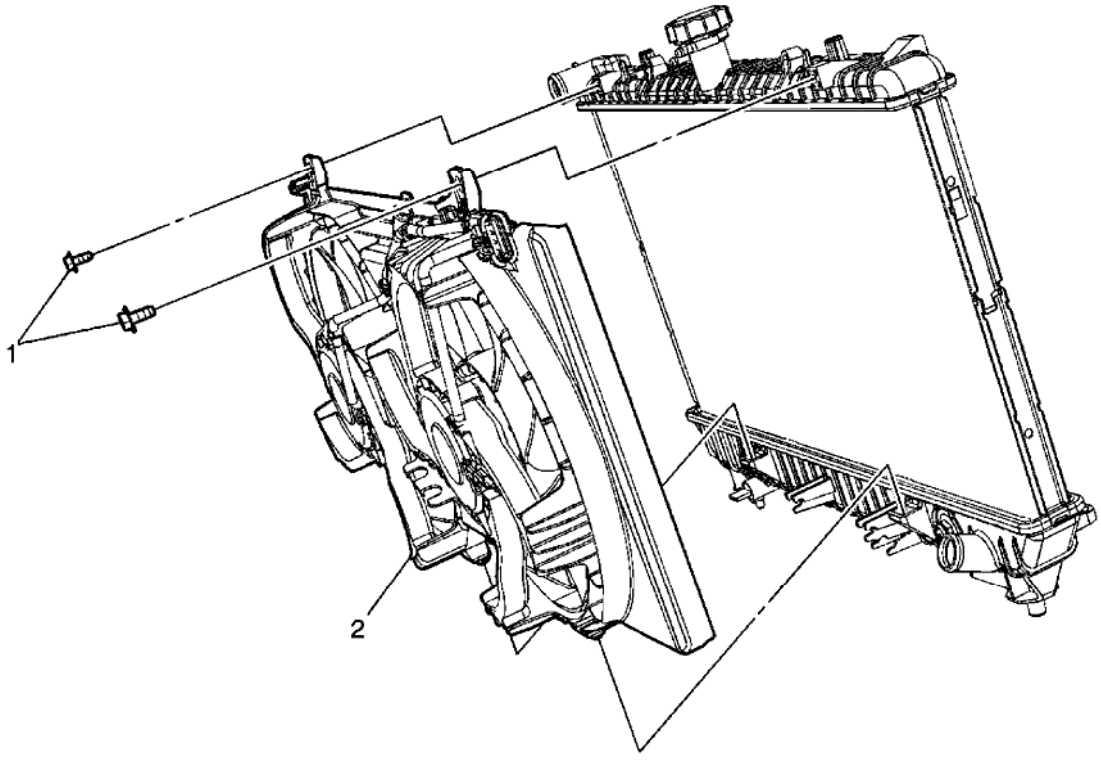


Fig. 67: Engine Coolant Fan Shroud (LS3, L99)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove air cleaner resonator and outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** . 2. Reposition radiator overflow hose. Refer to **Radiator Overflow Hose Replacement (LLT)** or **Radiator Overflow Hose Replacement (LS3, L99)**. 3. Remove engine coolant air bleed hose. Refer to **Engine Coolant Air Bleed Hose Replacement (LLT)** or **Engine Coolant Air Bleed Hose Replacement (LS3, L99)**. 4. Remove radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose Replacement (L99)** or **Radiator Inlet Hose Replacement (LS3)**. 5. Reposition transmission cooler lines. 6. Disconnect the engine coolant fan motor connector.	
	Engine Coolant Fan Shroud Bolt (Qty: 2)

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1	**CAUTION:** **Refer to Fastener Caution .** **Tighten:** 8 N.m (6 lb in)
2	Engine Coolant Fan Shroud

RADIATOR REPLACEMENT (LLT)

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Remove the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose Replacement (L99)** or **Radiator Inlet Hose Replacement (LS3)**.
3. Remove the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LLT)** or **Radiator Outlet Hose Replacement (LS3, L99)**.
4. Remove the engine coolant air bleed hose. Refer to **Engine Coolant Air Bleed Hose Replacement (LLT)** or **Engine Coolant Air Bleed Hose Replacement (LS3, L99)**.
5. Remove the radiator overflow hose. Refer to **Radiator Overflow Hose Replacement (LLT)** or **Radiator Overflow Hose Replacement (LS3, L99)**.
6. Remove the engine coolant fan shroud. Refer to **Engine Coolant Fan Shroud Replacement (LLT)** or **Engine Coolant Fan Shroud Replacement (LS3, L99)**.
7. Reposition the air conditioning condenser. Refer to **Air Conditioning Condenser Replacement (LLT)** or **Air Conditioning Condenser Replacement (LS3, L99)** .
8. Remove transmission oil cooler lines.

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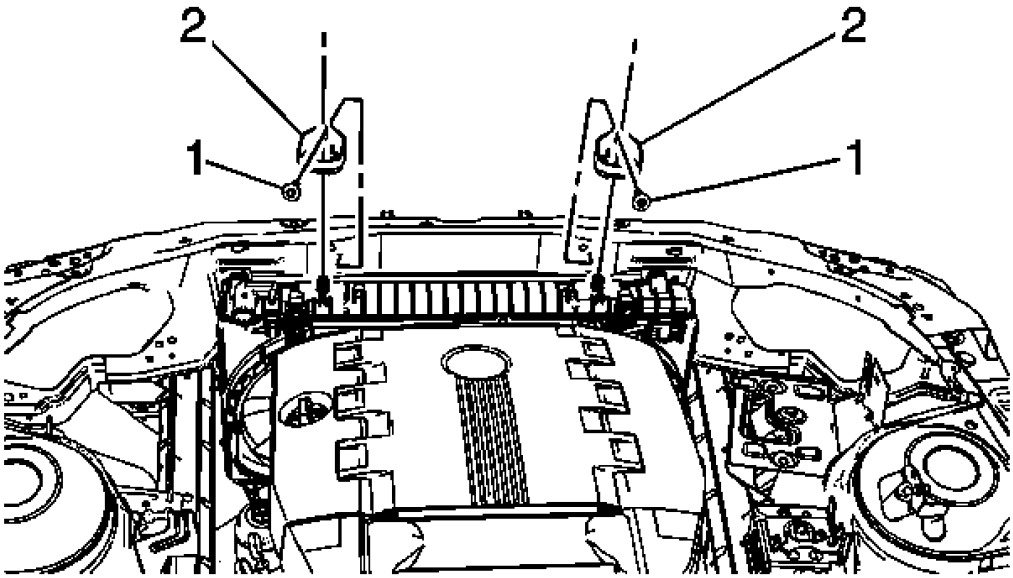


Fig. 68: Radiator Upper Support & Bolt
Courtesy of GENERAL MOTORS CORP.

9. Remove radiator upper support bolt (1).
10. Remove radiator upper support (2).

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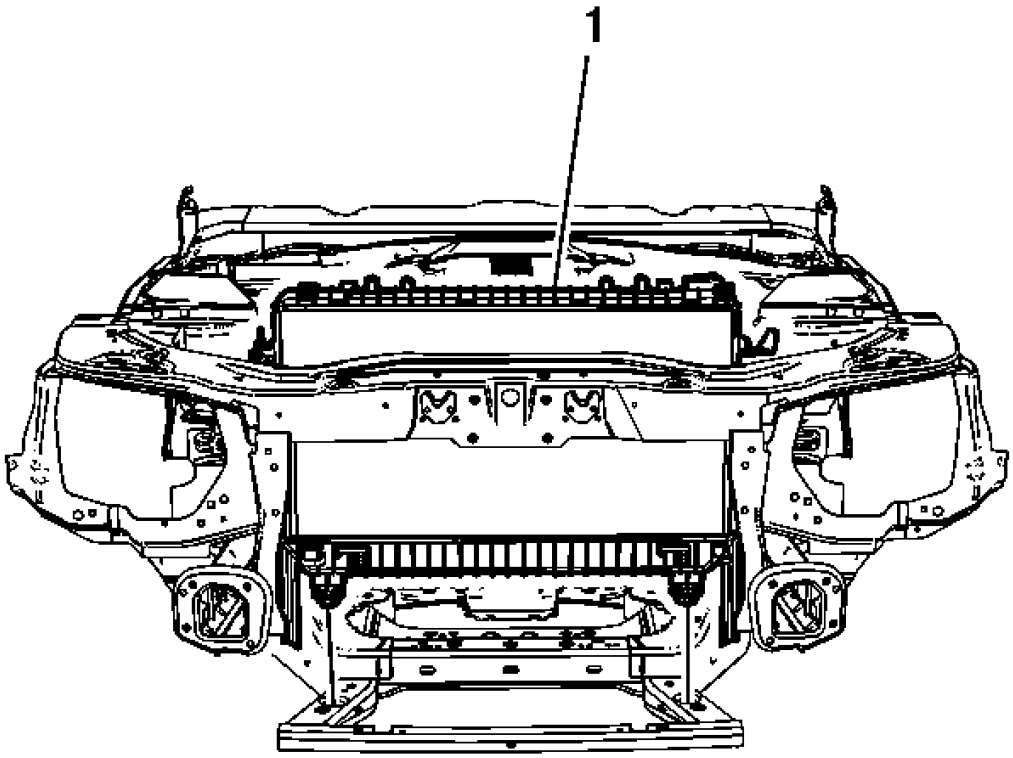


Fig. 69: Radiator
Courtesy of GENERAL MOTORS CORP.

11. Remove radiator (1) from vehicle.

Installation Procedure

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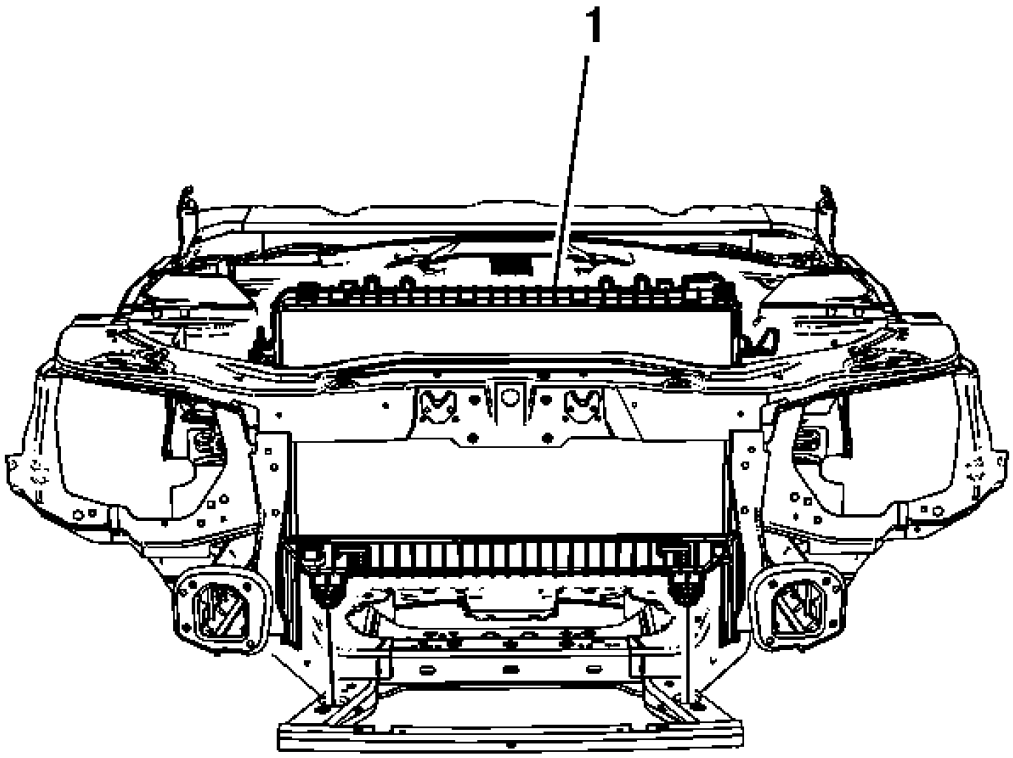


Fig. 70: Radiator
Courtesy of GENERAL MOTORS CORP.

1. Install radiator (1) to vehicle.

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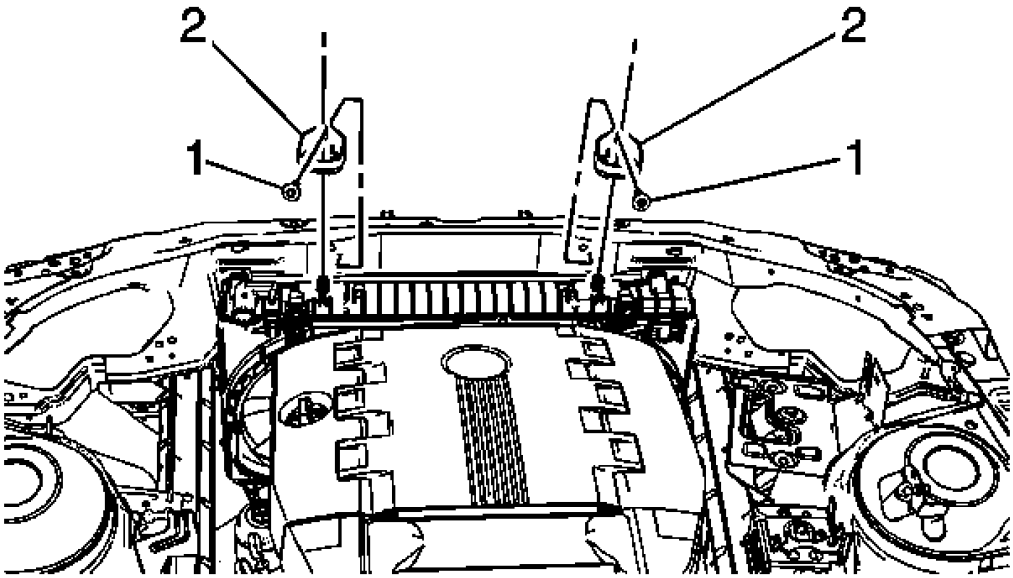


Fig. 71: Radiator Upper Support & Bolt
Courtesy of GENERAL MOTORS CORP.

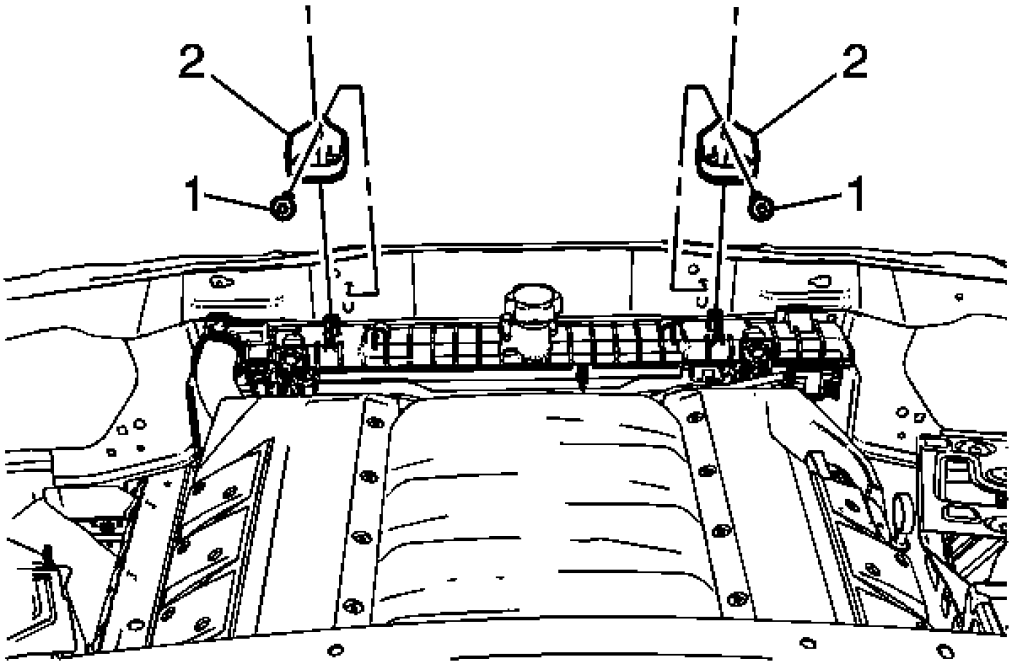
2. Install radiator upper support (2).
3. Install radiator upper support bolt (1) and tighten to 9N.m (80 lb in).
4. Install transmission oil cooler lines.
5. Install the air conditioning condenser. Refer to **Air Conditioning Condenser Replacement (LLT)** or **Air Conditioning Condenser Replacement (LS3, L99)** .
6. Install the engine coolant fan shroud. Refer to **Engine Coolant Fan Shroud Replacement (LLT)** or **Engine Coolant Fan Shroud Replacement (LS3, L99)**.
7. Install the radiator overflow hose. Refer to **Radiator Overflow Hose Replacement (LLT)** or **Radiator Overflow Hose Replacement (LS3, L99)**.
8. Install the engine coolant air bleed hose. Refer to **Engine Coolant Air Bleed Hose Replacement (LLT)** or **Engine Coolant Air Bleed Hose Replacement (LS3, L99)**.
9. Install the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LLT)** or **Radiator Outlet Hose Replacement (LS3, L99)**.
10. Install the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose Replacement (L99)** or **Radiator Inlet Hose Replacement (LS3)**.
11. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.

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RADIATOR REPLACEMENT (LS3, L99)

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)**.
2. Remove the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose Replacement (L99)** or **Radiator Inlet Hose Replacement (LS3)**.
3. Remove the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LLT)** or **Radiator Outlet Hose Replacement (LS3, L99)**.
4. Remove the engine coolant air bleed hose. Refer to **Engine Coolant Air Bleed Hose Replacement (LLT)** or **Engine Coolant Air Bleed Hose Replacement (LS3, L99)**.
5. Remove the radiator overflow hose. Refer to **Radiator Overflow Hose Replacement (LLT)** or **Radiator Overflow Hose Replacement (LS3, L99)**.
6. Remove the engine coolant fan shroud. Refer to **Engine Coolant Fan Shroud Replacement (LLT)** or **Engine Coolant Fan Shroud Replacement (LS3, L99)**.
7. Reposition the air conditioning condenser. Refer to **Air Conditioning Condenser Replacement (LLT)** or **Air Conditioning Condenser Replacement (LS3, L99)** .
8. Remove transmission oil cooler lines.



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Fig. 72: Radiator Upper Support & Bolt
Courtesy of GENERAL MOTORS CORP.

9. Remove radiator upper support bolt (1).
10. Remove radiator upper support (2).

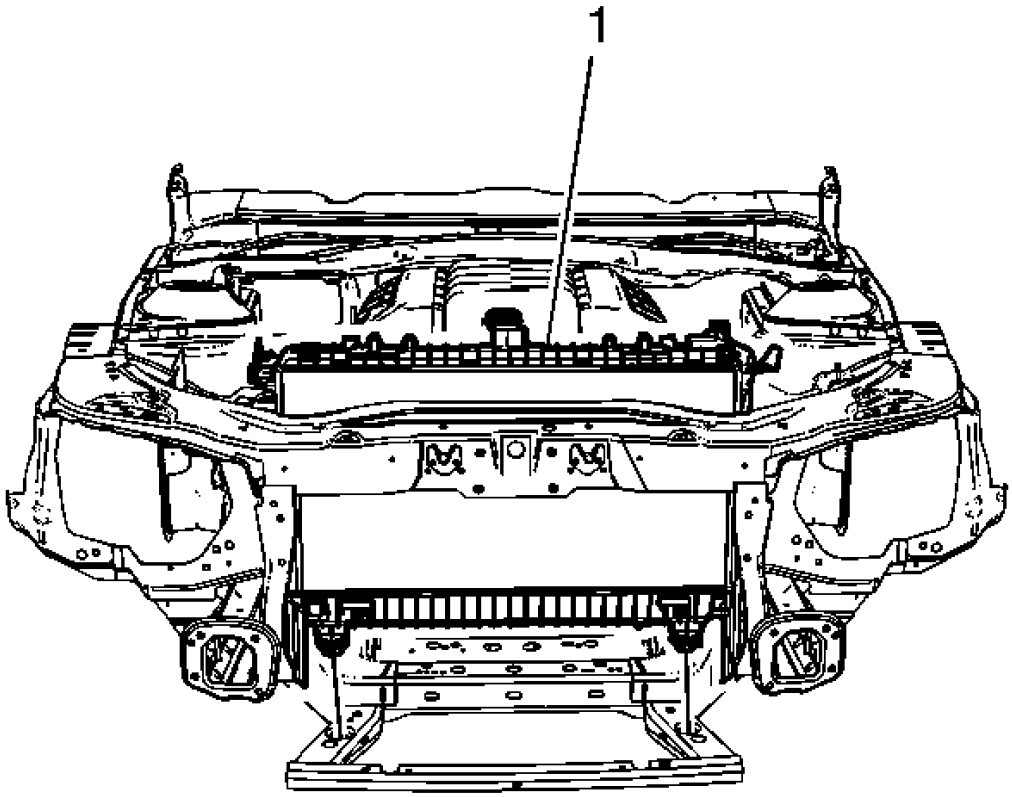


Fig. 73: Radiator
Courtesy of GENERAL MOTORS CORP.

11. Remove radiator (1) from vehicle.

Installation Procedure

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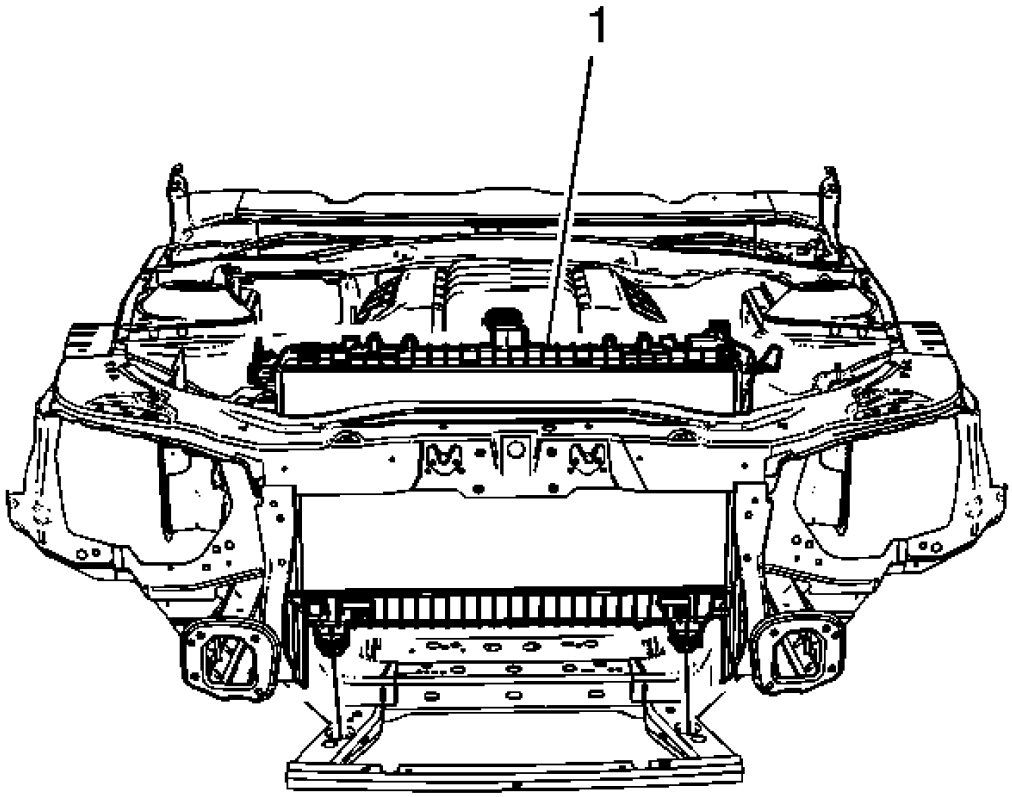


Fig. 74: Radiator
Courtesy of GENERAL MOTORS CORP.

1. Install radiator (1) to vehicle.

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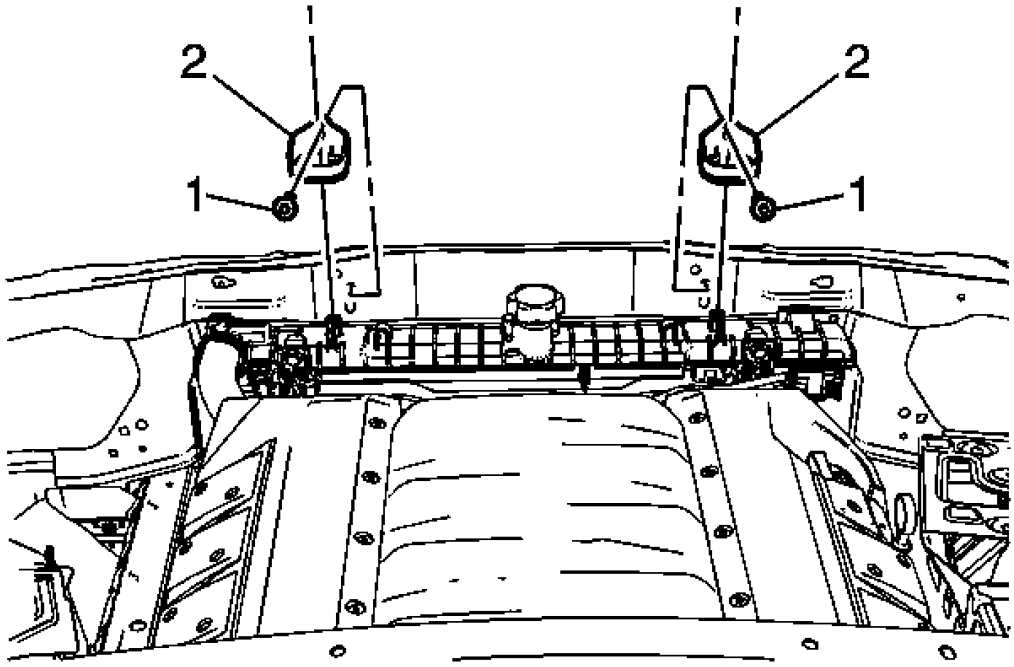


Fig. 75: Radiator Upper Support & Bolt
Courtesy of GENERAL MOTORS CORP.

2. Install radiator upper support (2).
3. Install radiator upper support bolt (1) and tighten to 9N.m (80 lb in).
4. Install transmission oil cooler lines.
5. Install the air conditioning condenser. Refer to **Air Conditioning Condenser Replacement (LLT)** or **Air Conditioning Condenser Replacement (LS3, L99)** .
6. Install the engine coolant fan shroud. Refer to **Engine Coolant Fan Shroud Replacement (LLT)** or **Engine Coolant Fan Shroud Replacement (LS3, L99)**.
7. Install the radiator overflow hose. Refer to **Radiator Overflow Hose Replacement (LLT)** or **Radiator Overflow Hose Replacement (LS3, L99)**.
8. Install the engine coolant air bleed hose. Refer to **Engine Coolant Air Bleed Hose Replacement (LLT)** or **Engine Coolant Air Bleed Hose Replacement (LS3, L99)**.
9. Install the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LLT)** or **Radiator Outlet Hose Replacement (LS3, L99)**.
10. Install the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose Replacement (L99)** or **Radiator Inlet Hose Replacement (LS3)**.
11. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE**

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47716).

RADIATOR AIR SIDE BAFFLE AND DEFLECTOR REPLACEMENT (LEFT)

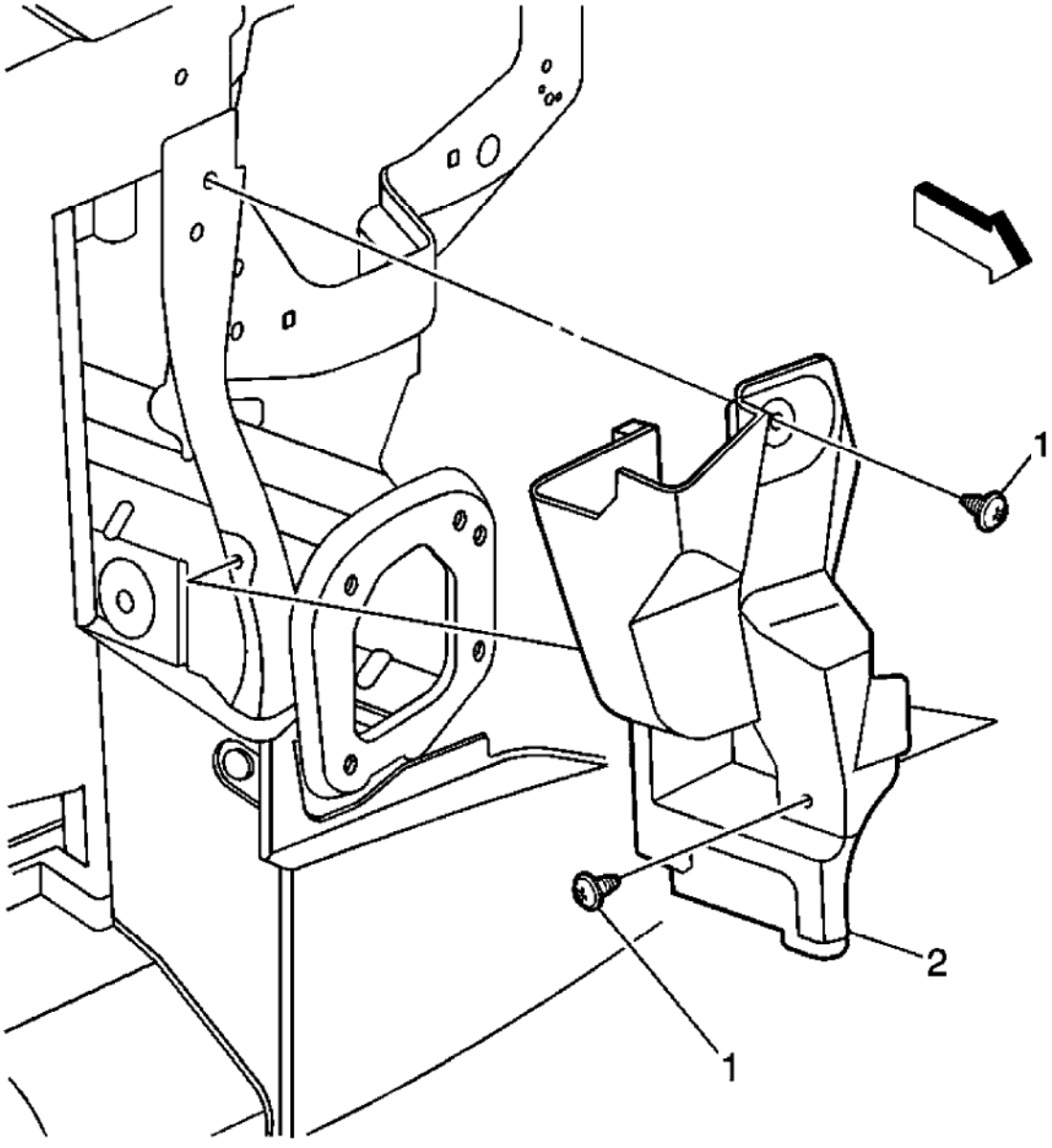


Fig. 76: Radiator Air Side Baffle & Deflector Replacement (Left)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove front bumper fascia. Refer to **Front Bumper Fascia Replacement** .	
1	Radiator Air Side Baffel and Deflector Left Retainer (Qty: 2)

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2	Radiator Air Side Baffel and Deflector Left

RADIATOR AIR SIDE BAFFLE AND DEFLECTOR REPLACEMENT (RIGHT)

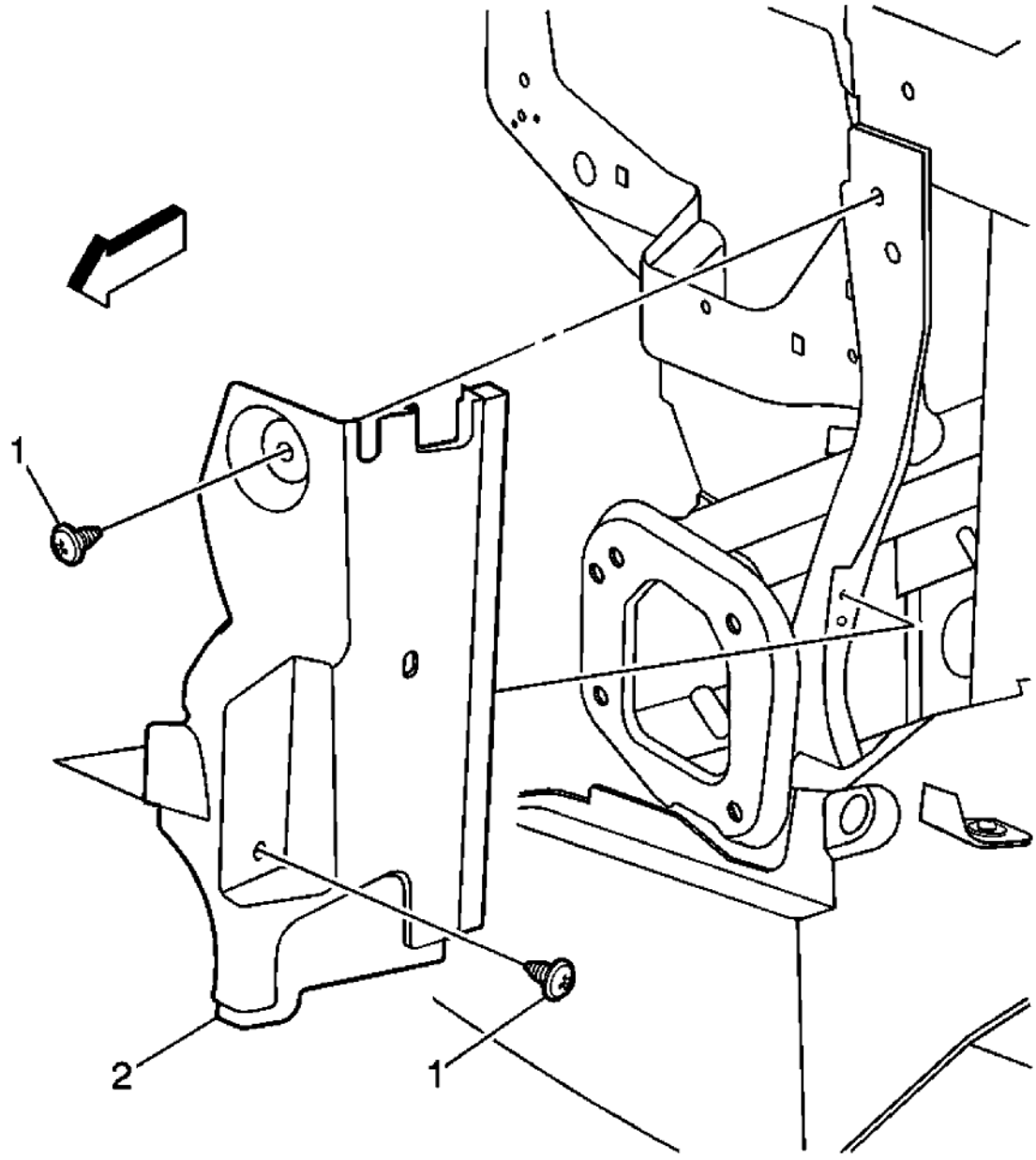


Fig. 77: Radiator Air Side Baffle & Deflector Replacement (Right)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove front bumper fascia. Refer to **Front Bumper Fascia Replacement** .	

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1	Radiator Air Side Baffel and Deflector Right Retainer (Qty: 2)
2	Radiator Air Side Baffel and Deflector Right

RADIATOR AIR INLET DUCT REPLACEMENT

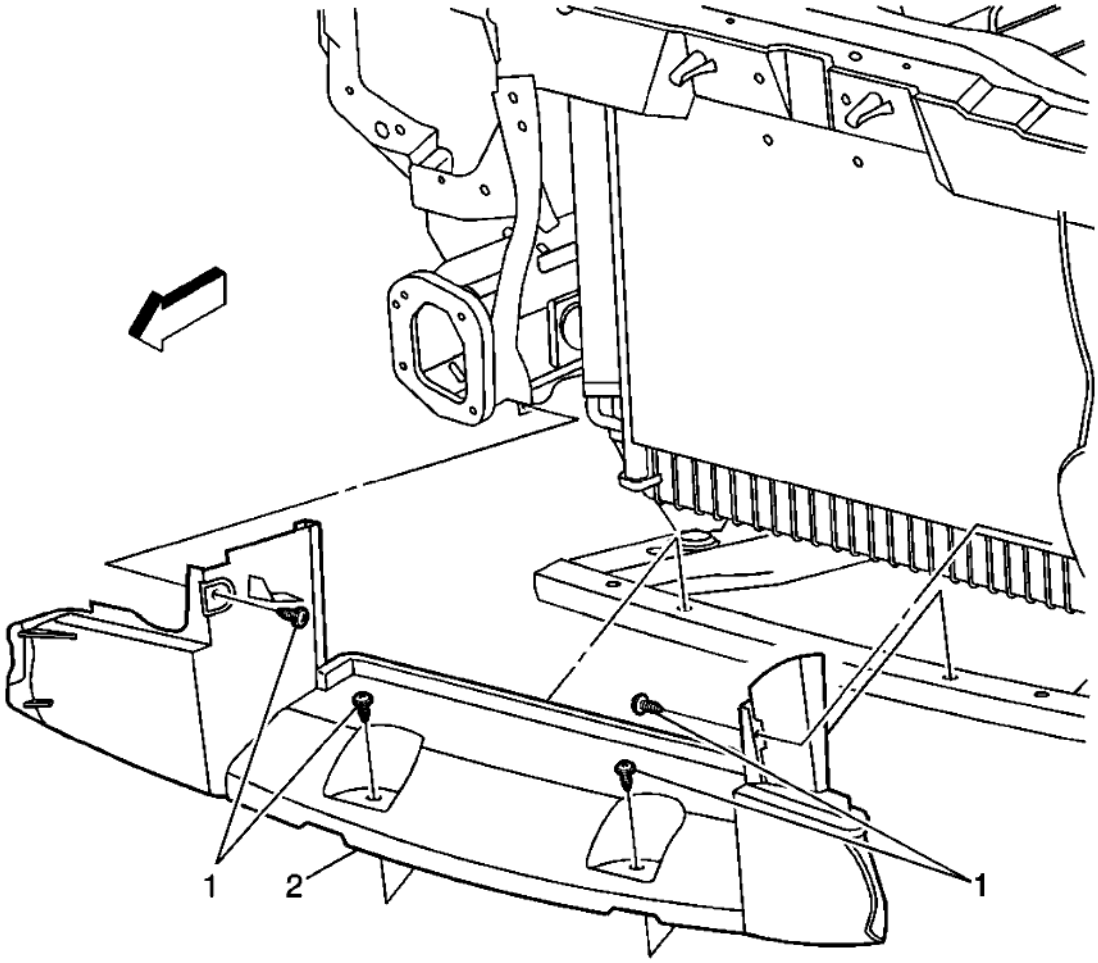


Fig. 78: Radiator Air Inlet Duct
Courtesy of GENERAL MOTORS CORP.

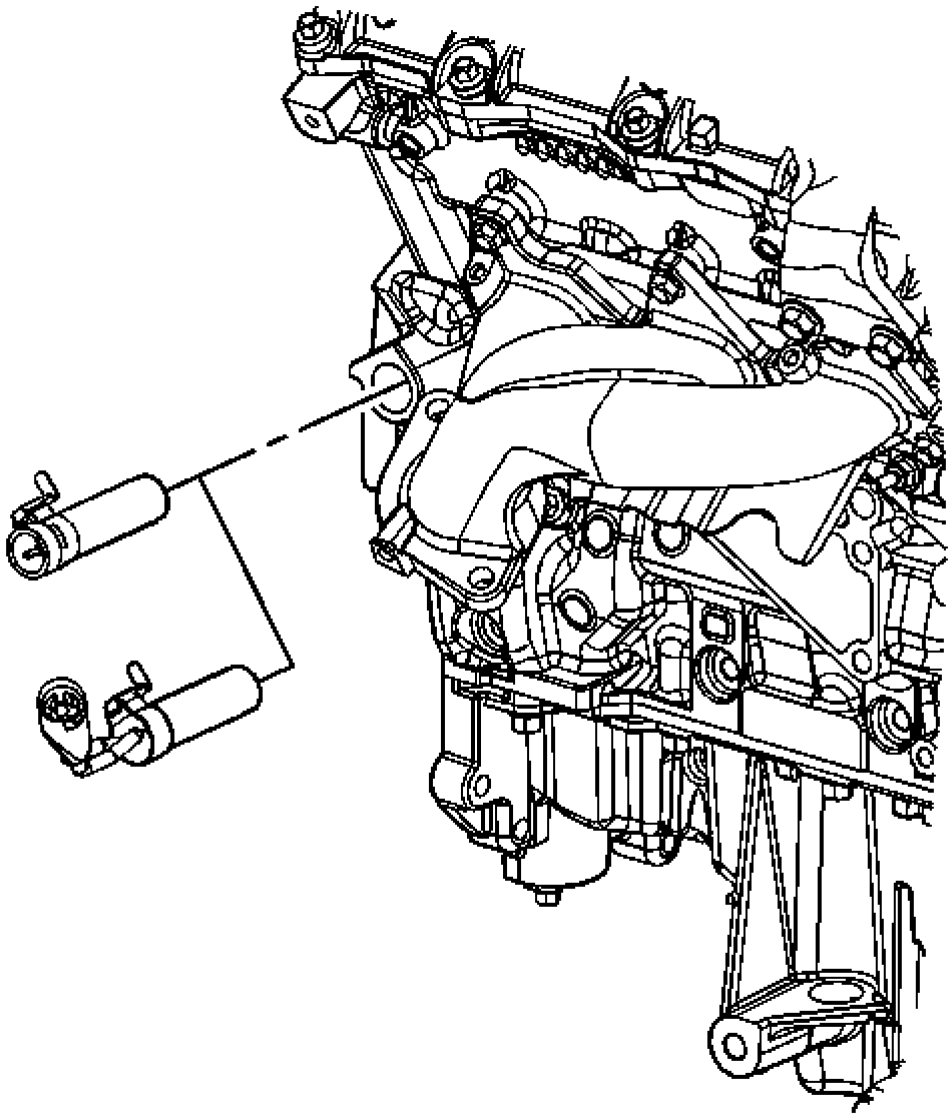
Callout	Component Name
Preliminary Procedures 1. Remove front bumper fascia. Refer to **Front Bumper Fascia Replacement** . 2. Remove the ambient air temperature sensor. Refer to **Ambient Air Temperature Sensor Replacement** .	
1	Radiator Air Inlet Duct Retainer (Qty: 4)
2	Radiator Air Inlet Duct

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ENGINE COOLANT HEATER REPLACEMENT (V6)

Removal Procedure

1. Turn the ignition OFF.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Disconnect the coolant heater cord from the coolant heater.



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Fig. 79: View Of Coolant Heater (V6)
Courtesy of GENERAL MOTORS CORP.

4. Remove the coolant heater.

Installation Procedure

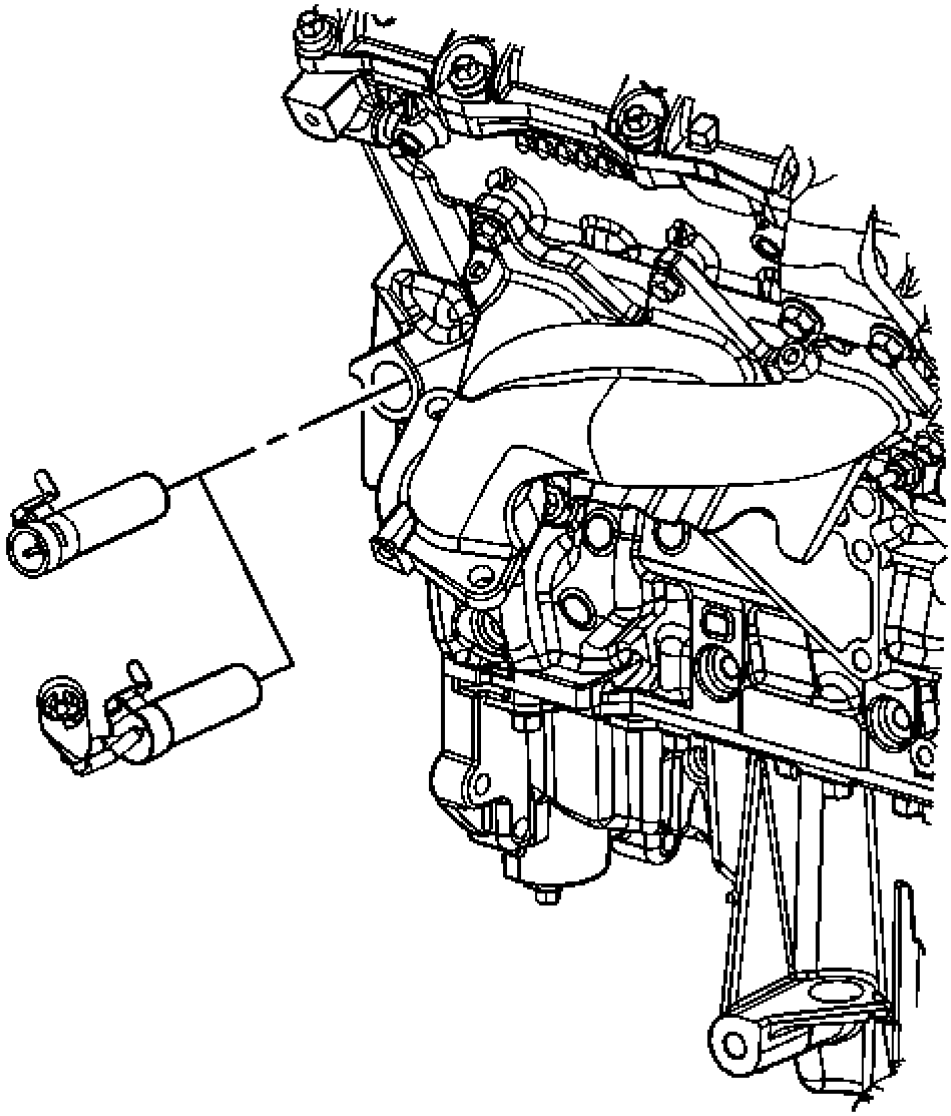


Fig. 80: View Of Coolant Heater (V6)

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Courtesy of GENERAL MOTORS CORP.

1. Install the coolant heater.
2. Connect the coolant heater cord to the coolant heater.
3. Lower the vehicle.

ENGINE COOLANT HEATER CORD REPLACEMENT (V6)

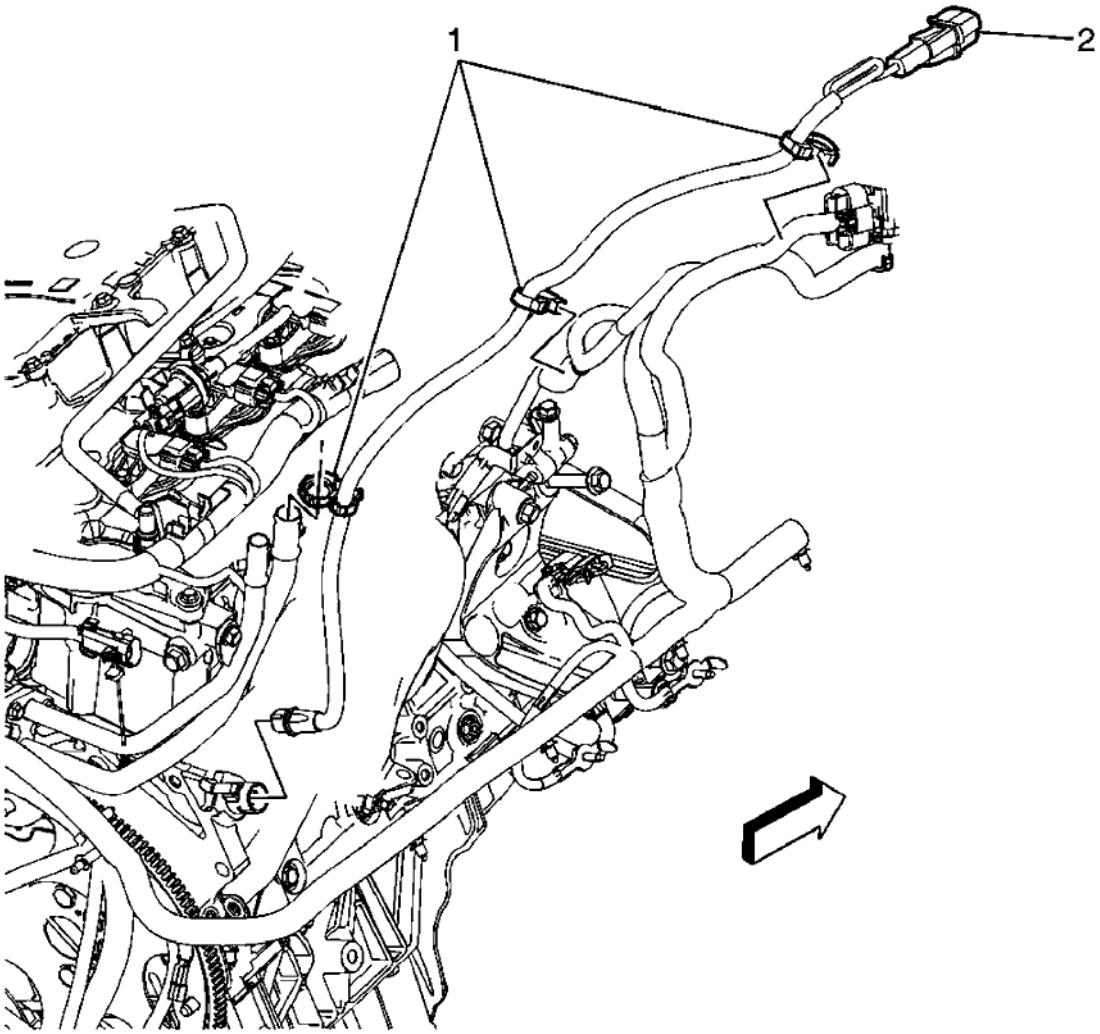


Fig. 81: Engine Coolant Heater Cord (V6)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Coolant Heater Cord Retainers. **Procedure:** Disconnect the coolant heater connector at the engine block and the retainers on the engine coolant heater cord harness.

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2	Engine Coolant Heater Cord.

DESCRIPTION AND OPERATION

COOLING FAN DESCRIPTION AND OPERATION

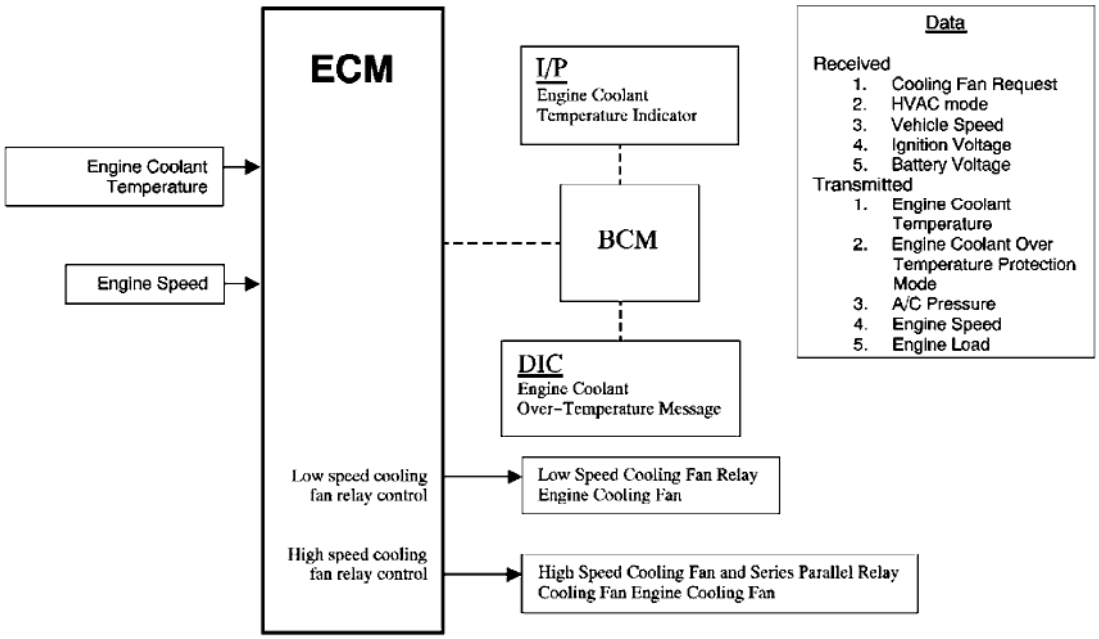


Fig. 82: Cooling Fan Operation
Courtesy of GENERAL MOTORS CORP.

The engine cooling fan system consists of 2 electric cooling fans and 3 fan relays. The relays are arranged in a series/parallel (S/P) configuration that allows the engine control module (ECM) to operate both fans together at low or high speeds. The cooling fans receive positive voltage from the cooling fan relays which receive battery positive voltage from the underhood fuse block.

In low speed operation, the ECM applies ground to the coil side of the cooling fan low speed relay. This energizes the coil and applies voltage directly to the right cooling fan through the switch side of the low speed relay. The right cooling fan is connected in series to the left cooling fan through the de-energized series/parallel (S/P) cooling fan speed control relay. The series circuit operates both fans at low speed.

In high speed operation, the ECM applies a ground to the coil side of the cooling fan low speed relay, the S/P cooling fan speed control relay, and the cooling fan high speed relay. When energized, the high speed fan relay applies voltage directly to the left cooling fan through the switch side of the relay. Simultaneously, the low speed fan relay and the S/P speed control relay provide ignition voltage and a direct path to ground for the right cooling fan. During high speed fan operation, both engine cooling fans have their own ground path. The result is a parallel circuit with both fans running at high speed.

COOLING SYSTEM DESCRIPTION AND OPERATION

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Cooling System

The cooling system's function is to maintain an efficient engine operating temperature during all engine speeds and operating conditions. The cooling system is designed to remove approximately one-third of the heat produced by the burning of the air-fuel mixture. When the engine is cold, the system cools slowly or not at all. This allows the engine to warm quickly.

Cooling Cycle

Coolant is drawn from the radiator outlet and into the water pump inlet by the water pump. Some coolant will then be pumped from the water pump, to the heater core, then back to the water pump. This provides the passenger compartment with heat and defrost.

Coolant is also pumped through the water pump outlet and into the engine block. In the engine block, the coolant circulates through the water jackets surrounding the cylinders where it absorbs heat.

The coolant is then forced through the cylinder head gasket openings and into the cylinder heads. In the cylinder heads, the coolant flows through the water jackets surrounding the combustion chambers and valve seats, where it absorbs additional heat.

From the cylinder heads, the coolant is then forced to the thermostat. The flow of coolant will either be stopped at the thermostat until the engine is warmed, or it will flow through the thermostat and into the radiator where it is cooled and the coolant cycle is completed.

Operation of the cooling system requires proper functioning of all cooling system components. The cooling system consists of the following components:

Coolant

The engine coolant is a solution made up of a 50-50 mixture of DEX-COOL and clean drinkable water. The coolant solution carries excess heat away from the engine to the radiator, where the heat is dissipated to the atmosphere.

Radiator

The radiator is a heat exchanger. It consists of a core and two tanks. The aluminum core is a downflow tube and fin design. This is a brazed tube with convoluted louvered fin design. Separate tubes and fins are stacked together with a manifold at each end. The entire assembly is then brazed forming a homogeneous unified structure. The fins allow for efficient heat transfer from the coolant to the atmosphere. The inlet and outlet tanks are molded with a high temperature, glass reinforced nylon plastic. The tank and gasket is supplied as an assembly with silicone gasket attached to the tank. The tanks are clamped to the core with clinch tabs. The tabs are part of the aluminum header at each end of the core. The radiator also has a drain cock which is located in the bottom left of the lower tank. The drain cock includes the drain cock and drain cock seal.

The radiator removes heat from the coolant passing through it. The fins on the core absorb heat from the coolant passing through the tubes. As air passes between the fins, it absorbs heat and cools the coolant.

During vehicle use, the coolant heats and expands. The coolant that is displaced by this expansion flows into the

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overflow tank. As the coolant circulates, air is allowed to exit. Coolant without bubbles absorbs heat much better than coolant with bubbles.

Pressure Cap

The pressure cap is a cap that seals and pressurizes the cooling system. It contains a blow off or pressure valve and a vacuum or atmospheric valve. The pressure valve is held against its seat by a spring and protects the radiator by relieving pressure if it exceeds 20 psi. The vacuum valve is held against its seat by a spring, which permits opening of the valve to relieve vacuum created in the cooling system as it cools off. The vacuum, if not relieved, could cause the radiator hoses to collapse.

The pressure cap allows pressure in the cooling system to build up. As the pressure builds, the boiling point of the coolant goes up as well. Therefore, the coolant can be safely run at a temperature higher than the boiling point of the coolant at atmospheric pressure. The hotter the coolant is, the faster the heat moves from the radiator to the cooler passing air. However, if the pressure exceeds the strength of the spring, the pressure valve rises so that the excess pressure can escape. When the engine cools down, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum causes the vacuum valve to open, allowing outside air into the cooling system. This equalizes the pressure in the cooling system with atmospheric pressure, thus preventing the radiator hoses from collapsing.

Coolant Recovery System

The coolant recovery system consists of a plastic coolant recovery reservoir and overflow tube. The recovery reservoir is also called a recovery tank or expansion tank. It is partially filled with coolant and is connected to the radiator fill neck with the overflow tube. Coolant can flow back and forth between the radiator and the reservoir.

In effect, a cooling system with a coolant recovery reservoir is a closed system. When the pressure in the cooling system gets too high, it will open the pressure valve in the pressure cap. This allows the coolant, which has expanded due to being heated, to flow through the overflow tube and into the recovery reservoir. As the engine cools down, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum opens the vacuum valve in the pressure cap, allowing some of the coolant in the reservoir to be siphoned back into the radiator. Under normal operating conditions, no coolant is lost. Although the coolant level in the recovery reservoir goes up and down, the radiator and cooling system are kept full. An advantage to using a coolant recovery reservoir is that it eliminates almost all air bubbles from the cooling system. Coolant without bubbles absorbs heat much better than coolant with bubbles.

Air Baffles and Seals

The cooling system uses deflectors, air baffles and air seals to increase system cooling. Deflectors are installed under the vehicle to redirect airflow beneath the vehicle to flow through the radiator and increase cooling. Air baffles are also used to direct airflow into the radiator and increase cooling. Air seals prevent air from bypassing the radiator and A/C condenser. Air seals also prevent recirculation of the air for better hot weather cooling and A/C condenser performance.

Transmission Oil Cooler

The transmission oil cooler is a heat exchanger. It is located inside the lower tank of the radiator. The

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transmission fluid temperature is regulated by the temperature of the engine coolant that surrounds the oil cooler as the transmission fluid passes through the cooler.

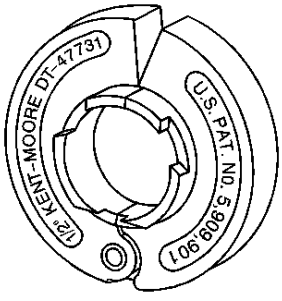
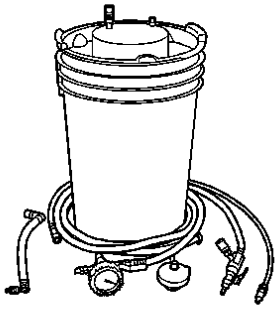
The transmission oil pump, pumps the fluid through the transmission oil cooler feed line to the oil cooler. The fluid then flows through the cooler while the engine coolant absorbs heat from the fluid. The fluid is then pumped through the transmission oil cooler return line, to the transmission.

Auxiliary Transmission Oil Cooler

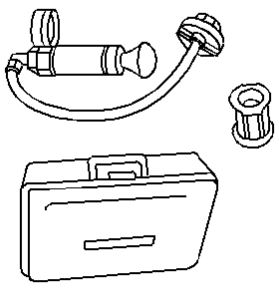
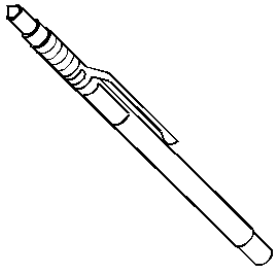
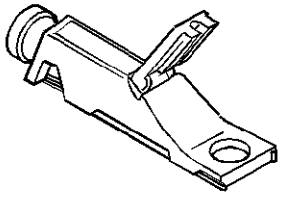
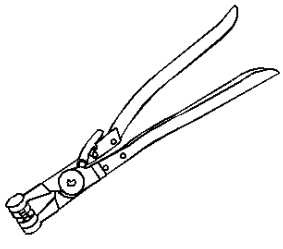
The auxiliary transmission oil cooler used on the L99 automatic transmission, is an oil-to-air heat exchanger located in front of the A/C condenser. The transmission oil temperature is regulated by the airflow passing over this heat exchanger. The oil out of the transmission is plumbed through the TOC lines to the cooler then directed back to the transmission. This cooler helps provided additional cooling for performance driving conditions.

SPECIAL TOOLS AND EQUIPMENT

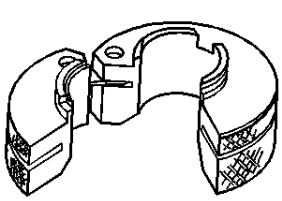
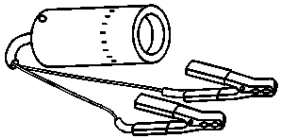
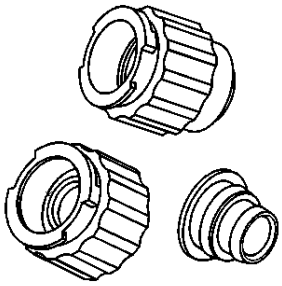
SPECIAL TOOLS

Illustration	Tool Number/ Description
	DT 47731 1/2 Inch Quick Connect Release Tool
	GE 47716 Vac N Fill Coolant Refill Tool

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	J 24460-01 Cooling System Pressure Tester
	J 24731 Tempil Stick
	J 26568 Coolant and Battery Fluid Tester
	J 38185 Hose Clamp Pliers
	J 39400-A

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	Halogen Leak Detector
	3/8 Inch Cooler Quick Connect Tool
	J 42220 Universal 12V Leak Detection Lamp
	J 42401 Radiator Cap and Surge Tank Test Adapter

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2010 ELECTRICAL

Engine Electrical - Camaro

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	Specification	
	Metric	English
Battery Hold Down Retainer Bolt	22 N.m	16 lb ft
Battery Negative Cable Bolt (at rear compartment floor)	25 N.m	18 lb ft
Battery Negative Cable Terminal Nut	15 N.m	11 lb ft
Battery Positive Cable Nut (at the fuse block)	15 N.m	11 lb ft
Battery Positive Cable Nut (at the junction block)	15 N.m	11 lb ft
Battery Positive Cable Nut (at the starter)	13 N.m	115 lb in
Battery Positive Cable Terminal Nut	5 N.m	44 lb in
Engine Harness and Battery Positive Cable Harness Retainers	12 N.m	9 lb ft
Generator BAT Terminal Nut	15 N.m	11 lb ft
Generator Bolt	58 N.m	43 lb ft
Generator Bracket Bolt (at the front of the bracket)	50 N.m	37 lb ft
Generator Bracket Nut (at the front of the bracket)	50 N.m	37 lb ft
Starter	58 N.m	43 lb ft
Starter Motor Mounting Bolt	58 N.m	43 lb ft
Starter Shield Bolt	5 N.m	44 lb in

BATTERY USAGE

Application	Specification
Cold Cranking Amperage (CCA)	720 A
Amp Hours	80 A/H

GENERATOR USAGE

Application	Specification
Alternator Model	FG15
Rated Output	150 Amps
Load Test Output	108 Amps

SCHEMATIC AND ROUTING DIAGRAMS

STARTING AND CHARGING SCHEMATICS

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Fig. 1: Starting
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Fig. 2: Charging
Courtesy of GENERAL MOTORS CORP.

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC B1325	B1325 03: Device Power Circuit Voltage Below Threshold B1325 07: Device Power Circuit Voltage Above Threshold
DTC B1420	B1420 00: Device Voltage Circuit
DTC B1516	B1516 08: Battery Current Sensor Signal Invalid B1516 66: Battery Current Sensor Wrong Mounting Position
DTC B1517	B1517 03: Battery Voltage Below Threshold B1517 07: Battery Voltage Above Threshold B1517 5A: Battery Voltage Plausibility Failure
DTC B151A	B151A 58: Low Battery Capacity Detected
DTC B1527	B1527 00: High Parasitic Load Detected
DTC C0800	C0800 03: Device Power 1 Circuit Voltage Below Threshold

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	C0800 07: Device Power 1 Circuit Voltage Above Threshold
DTC P0562	P0562: System Voltage Low
DTC P0563	P0563: System Voltage High
DTC P0615, P0616, or P0617	P0615: Starter Relay Control Circuit P0616: Starter Relay Control Circuit Low Voltage P0617: Starter relay Control Circuit High Voltage
DTC P0621	P0621: Generator L-Terminal Circuit
DTC P0622	P0622: Generator F-Terminal Circuit
DTC P0625 or P0626	P0625: Generator F-Terminal Circuit Low Voltage P0626: Generator F-Terminal Circuit High Voltage

DTC B1325

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1325 03

Device Power Circuit Voltage Below Threshold

DTC B1325 07

Device Power Circuit Voltage Above Threshold

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	B1325 03	B1325 03	-	-
Ground	-	B1325 03	-	-

Circuit/System Description

The following control modules monitor the system voltage through the battery positive (B+) voltage circuits:

- Instrument cluster
- Passenger presence detection module
- Inflatable restraint sensing and diagnostic module
- Multimedia player interface module

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- Radio
- Parking assist control module

Conditions for Running the DTC

- The voltages supplied to the control modules are in the range of 7-26 V.
- The ignition is ON.

Conditions for Setting the DTC

B1325 03

The control module detects a system voltage less than 9 V for 5 seconds.

B1325 07

The control module detects a system voltage greater than 18 V for 5 seconds.

Action Taken When the DTC Sets

- The control module immediately disables all outputs when an out of range voltage condition has been detected, with the exception of serial data, which is disabled after a 3 minute delay.
- The setting of other DTCs is inhibited.

Conditions for Clearing the DTC

The DTC passes when the malfunction is no longer present.

Diagnostic Aids

- A high or low voltage value in multiple modules indicates a concern in the charging system.
- Overcharging with a battery charger or jump starting can cause this DTC to set.

Reference Information

Schematic Reference

- **Instrument Cluster Schematics**
- **Object Detection Schematics**
- **Radio/Navigation System Schematics**
- **SIR Schematics**

Connector End View Reference

Component Connector End Views

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Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, accessories OFF, measure and record the battery voltage at the C1 battery terminals. The voltage should be between 12.6 and 15.0 V.
    - If the battery voltage is not within the specified range, refer to **Charging System Test**.
2. Observe the appropriate module scan tool Battery Voltage parameters. Verify that the scan tool displays a value that is within 2 V of the C1 battery terminal voltage.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connectors of the appropriate control module.
2. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 ohms between the ground circuit terminals listed below and ground:
    - Terminal 10, P16 Instrument cluster
    - Terminal A2, K85 Passenger presence detection module
    - Terminal 19 X1, K86 Inflatable restraint sensing and diagnostic module
    - Terminal 11 X1, T11 Multimedia player interface module
    - Terminal 38 X1, A11 Radio
    - Terminal 7 X1, K41 Parking assist control module
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Verify that a test lamp illuminates between the B+ circuit terminals listed below and ground:
    - Terminal 20, P16 Instrument cluster
    - Terminal A1, K85 Passenger presence detection module
    - Terminal 9 X1, K36 Inflatable restraint sensing and diagnostic module
    - Terminal 1 X1, T11 Multimedia player interface module
    - Terminal 44 X1, A11 Radio
    - Terminal 1 X1, K41 Parking assist control module

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- If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.

4. If the circuits test normal, replace the appropriate control module.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for the appropriate control module replacement, setup, and programming

DTC B1420

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1420 00

Device Voltage Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	B1420 00	B1420 00	-	-
Ground	-	B1420 00	-	-

Circuit/System Description

The auxiliary gauge module monitors the battery voltage through the battery voltage signal circuit. Damage to components, and incorrect data may occur when the voltage is out of range.

Conditions for Running the DTC

- The voltage supplied to the auxiliary gauge module is in the range of 7-26 V.
- The ignition is ON.
- The engine is running.

Conditions for Setting the DTC

- The auxiliary gauge module senses a battery voltage above or below the specified range of 9-16 V.
- The above condition lasts for 1 second.

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Action Taken When the DTC Sets

- The auxiliary gauge module will disable all its outputs when a high voltage condition is detected.
- The setting of this DTC inhibits the setting of other DTCs.

Conditions for Clearing the DTC

The DTC clears when the system voltage returns to a normal range.

Diagnostic Aids

- A high or low voltage DTC set or voltage value in multiple modules indicates a concern in the charging system.
- A possible cause of this DTC could be overcharging with a battery charger or jump starting.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running measure and record the voltage at the C1 battery terminals. Verify that the battery voltage is 12.6-15.0 V.
    - If the battery voltage is not within the specified range, refer to **Charging System Test**.
2. Engine running, observe the scan tool P26 auxiliary gauge module Battery Positive Voltage parameter.

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Verify that the scan tool displays a value that is within 2 V of the battery terminal voltage.

Circuit/System Testing

1. Ignition OFF. Disconnect the harness connectors at the P26 auxiliary gauge module.
2. Ignition OFF, test for less than 5.0 ohms between the ground circuit terminal 2 and ground.
   - If greater than the specified value, test the ground circuits for an open/high resistance.
3. Ignition ON, verify a test lamp between the B+ circuit terminal 1 and ground.
   - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. If all the circuits test normal, replace the P26 auxiliary gauge module.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for multifunction auxiliary gauge module replacement, setup, and programming

DTC B1516

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1516 08

Battery Current Sensor Signal Invalid

DTC B1516 66

Battery Current Sensor Wrong Mounting Position

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	B1516 08	B1516 08	-	-
Signal	B1516 08	B1516 08	B1516 08	B1516 08, B1516 66
Low Reference	-	B1516 08	-	-

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Circuit/System Description

The battery current sensor is a 3-wire hall effect current sensor. The body control module (BCM) supplies 5 V and ground tot he battery current sensor. the battery current sensor measures the amount of current flowing to or from the battery and supplies a pulse width modulation (PWM) signal to the BCM.

Conditions for Running the DTC

B1516 08

The BCM is awake.

B1516 66

- The BCM is awake.
- The engine is OFF.

Conditions for Setting the DTC

B1516 08

The battery current signal is less than 4 percent or greater than 96 percent duty cycle for 2 minutes.

B1516 66

The battery current polarity is positive for 2 minutes.

Action Taken When the DTC Sets

The regulated voltage control (RVC) is disabled.

Conditions for Clearing the DTC

The DTC passes when the battery current returns to the normal range for 15 seconds.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation

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Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

B1516 08

1. Ignition OFF, disconnect the harness connector at the B18 battery current sensor.
2. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 10 minutes. Test for less than 10 ohms between the low reference circuit terminal B and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the K9 BCM.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal A and ground.
    - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K9 BCM.
    - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit tests normal, replace the K9 BCM.
4. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal C and ground.
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K9 BCM.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the K9 BCM.
5. If all circuits test normal, replace the B18 battery current sensor.

B1516 66

1. Verify that the B18 battery current sensor is installed securely around the negative battery cable, with the tape tab pointing away from the negative terminal on the C1 battery.
    - If the B18 battery current sensor is not installed correctly, remove and reinstall the sensor properly.
2. Replace the B18 battery current sensor.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Battery Negative Cable Replacement**

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- **Control Module References** for BCM replacement, setup, and programming

DTC B1517

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1517 03

Battery Voltage Below Threshold

DTC B1517 07

Battery Voltage Above Threshold

DTC B1517 5A

Battery Voltage Plausibility Failure

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	B1517 03*, B1517 5A*	B1517 03*, B1517 5A*	-	-
Ground	-	B1517 03*, B1517 5A*	-	-
* All B+ and Ground terminals can set these DTCs				

Circuit/System Description

The body control module (BCM) has designated circuits for monitoring vehicle system voltage. The BCM monitors the system voltage to ensure that the voltage stays within the proper range. Damage to components, and incorrect data may occur when the system voltage is out of range. The BCM monitors the system voltage over an extended length of time.

Conditions for Running the DTC

- The BCM has power and ground.
- The ignition is not in the START position.

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Conditions for Setting the DTC

B1517 03

- The battery voltage is less than 11 V.
- The engine speed is greater than 1,100 RPM.
- The above conditions are met for 15 seconds.

B1517 07

- The battery voltage is greater than 16 V.
- The engine speed is greater than 1,100 RPM.
- The above conditions are met for 15 seconds.

B1517 5A

The battery voltage differs by 2 V on the BCM battery sense circuits for 10 seconds.

Action Taken When the DTC Sets

- The instrument panel cluster illuminates the charge indicator.
- The driver information center displays the SERVICE BATTERY CHARGING SYSTEM warning message.

Conditions for Clearing the DTC

- The DTC will clear current status when fault is no longer present.
- The history DTC will clear after 50 consecutive ignition cycles have occurred without a malfunction.

Diagnostic Aids

- A high or low voltage DTC set in multiple modules indicates a concern in the charging system. Refer to **Charging System Test**.
- This DTC may be set by overcharging with a battery charger, or by jump starting.
- Inspect the ground connection, and ensure that it is clean and tight.

Reference Information

Schematic Reference

Body Control System Schematics

Connector End View Reference

Component Connector End Views

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Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, accessories OFF, measure and record the voltage at the battery voltage at the battery terminals. The voltage should be between 12.6 and 15.0 V.
    - If not within the specified range, refer to **Charging System Test**.
2. Observe the scan tool BCM Battery Voltage parameter. The reading should be between 12.6 and 15.0 V.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connectors X1, X2, X4, X5, and X6 at the K9 BCM.
2. Ignition OFF, test for less than 3.0 ohms between the ground circuit terminals listed below and ground:
    - Terminal 1 X1
    - Terminal 2 X2
    - Terminal 3 X6
    - Terminal 26 X4
    - If not within the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify a test lamp illuminates between the B+ circuit terminals listed below and ground:
    - Terminal 2 X1
    - Terminal 3 X1
    - Terminal 4 X1
    - Terminal 1 X2
    - Terminal 3 X2
    - Terminal 4 X2
    - Terminal 20 X4
    - Terminal 3 X5
    - Terminal 4 X5
    - If the test lamp does not illuminate, test the B+ circuits for a short to ground or an open/high

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resistance.

4. If all the circuits test normal, test or replace the K9 BCM.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for BCM replacement, setup, and programming

DTC B151A

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B151A 58

Low Battery Capacity Detected

Circuit/System Description

The body control module (BCM) monitors the battery voltage level during an engine crank event to detect a low battery voltage condition.

Conditions for Running the DTC

The ignition must be in the crank position for this code to set.

Conditions for Setting the DTC

A minimum crank battery voltage is less than the minimum crank battery voltage threshold for 16 consecutive crank events.

Action Taken When the DTC Sets

A driver information center (DIC) message is displayed.

Conditions for Clearing the DTC

The DTC will clear if the minimum crank voltage is greater than the minimum crank voltage threshold during a crank event.

Reference Information

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Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Before replacing the C1 battery perform the **Battery Inspection/Test**.

DTC B1527

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1527 00

High Parasitic Load Detected

Circuit/System Description

The body control module (BCM) monitors the state of charge of the electrical system. If the BCM senses that the state of charge at ignition On is 30 percent lower than what it was when the engine was running.

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Conditions for Running the DTC

The ignition must be in Accessory or Run mode for this code to set.

Conditions for Setting the DTC

The state of charge at ignition ON is 30 percent lower than when the engine was running and battery drain is more than 2 A.

Action Taken When the DTC Sets

There is no battery telltale illuminated or DIC message displayed.

Conditions for Clearing the DTC

- The DTC will clear if the fault does not return after 50 consecutive ignition cycles.
- The DTC will clear when run state of charge is greater than or equal to 80 percent.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Refer to **Battery Electrical Drain/Parasitic Load Test**.

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DTC C0800

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0800 03

Device Power 1 Circuit Voltage Below Threshold

DTC C0800 07

Device Power 1 Circuit Voltage Above Threshold

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	C0800 03	C0800 03	-	-
Ground	-	C0800 03	-	-

Circuit/System Description

The following module/sensors monitor the system voltage circuit to determine if the voltage is within the normal operating range:

- Electronic brake control module
- Steering wheel angle sensor
- Multi-axis acceleration sensor

Conditions for Running the DTC

- Ignition is ON.
- Engine ON.

Conditions for Setting the DTC

C0800 03

- The module/sensor detects that the system voltage is less than 9.2 V.
- The above condition is present for 7 seconds.

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C0800 07

- The module/sensor detects that the system voltage is greater than 16 V.
- The above condition is present for 7 seconds.

Action Taken When the DTC Sets

A DIC message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

The system voltage returns to normal operating range.

Diagnostic Aids

- A high or low voltage DTC set in multiple sensors indicates a concern in the charging system.
- A possible cause of this DTC could be overcharging with a battery charger or jump starting.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, measure and record the voltage at the C1 battery terminals.
2. Verify that the battery voltage is 12.6-15.0 V.
    - If the battery voltage is not within the specified range, refer to **Charging System Test**.
3. Observe the appropriate module scan tool Battery Voltage parameters. Verify that the scan tool displays a value that is within 2 V of the C1 battery terminal voltage.

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Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate module/sensor.
2. Ignition OFF, test for less than 3 ohms between the ground circuit terminals listed below and ground:
   - Terminal 13, K17 Electronic brake control module
   - Terminal 38, K17 Electronic brake control module
   - Terminal 6, B99 Steering wheel angle sensor
   - Terminal 6, B119 Multi-Axis acceleration sensor
   - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify a test lamp illuminates between the B+/ignition circuits listed below and ground:
   - Terminal 1, K17 Electronic brake control module
   - Terminal 25, K17 Electronic brake control module
   - Terminal 35, K17 Electronic brake control module
   - Terminal 5, B99 Steering wheel angle sensor
   - Terminal 5, B119 Multi-Axis acceleration sensor
   - If the test lamp does not illuminate, test the circuit for an open/high resistance.
4. If all circuits test normal, replace the appropriate module/sensor.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Vehicle Yaw Sensor Replacement**
- **Steering Angle Sensor Replacement**
- **Control Module References** for electronic brake control module replacement, setup, and programming

DTC P0562

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0562

System Voltage Low

Diagnostic Fault Information

	Short to	Open/High	Short to	Signal

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Circuit	Ground	Resistance	Voltage	Performance
B+	P0562	P0562	-	-
Ground	-	P0562	-	-

Circuit/System Description

The following control modules monitor the system voltage to ensure that the voltage stays within the proper range:

- Engine control module
- Fuel pump control module

Damage to components, and incorrect data may occur when the voltage is out of range.

Conditions for Running the DTC

Engine Control Module

- The system voltage is between 9.5-18 V.
- The engine is running.

Fuel Pump Control Module

The engine is running.

Conditions for Setting the DTC

Engine Control Module

The engine control module detects a system voltage below 10 V for 5 seconds.

Fuel Pump Control Module

The fuel pump control module detects that battery voltage is less than 9 V.

Action Taken When the DTC Sets

DTC P0562 is a C type DTC.

Conditions for Clearing the DTC

DTC P0562 is a C type DTC.

Reference Information

Schematic Reference

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- **Engine Controls Schematics** for the 3.6L (LLT) engine
- **Engine Controls Schematics** for the 6.2L (L99) and (LS3) engine

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, accessories OFF, measure and record the battery voltage at the C1 battery terminals. The voltage should be between 12.6 and 15.0 V.
    - If not within the specified range, refer to **Charging System Test**.
2. Observe the scan tool of the appropriate control module battery voltage parameter. The reading should be between 12.6 and 15.0 V. Verify that the scan tool displays a value that is within 2 V of the battery terminal voltage.

Circuit/System Testing

Engine Control Module

1. Ignition OFF, disconnect the harness connectors at the K20 ECM.
2. Ignition OFF, and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 ohms between the ground circuit terminals listed below and ground:
    - Terminal 1 X2 (LLT)
    - Terminal 2 X2 (LLT)
    - Terminal 4 X2 (LLT)

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- Terminal 73 X1 (L99, LS3)
  - If greater than the specified range, test the ground circuit for an open/high resistance.

3. Connect a 15 A fused jumper wire between B+ and the KR75 powertrain relay switch control terminal 87. Ignition ON, verify that a test lamp illuminates between the IGN/B+ circuit terminals listed below and ground:
   - Terminal 56 X2 (LLT)
   - Terminal 54 X2 (LLT)
   - Terminal 3 X2 (LLT)
   - Terminal 5 X2 (LLT)
   - Terminal 6 X2 (LLT)
   - Terminal 41 X2 (LLT)
   - Terminal 20 X1 (L99, LS3)
   - Terminal 19 X1 (L99, LS3)
   - Terminal 47 X1 (L99, LS3)
   - Terminal 18 X1 (L99, LS3)
     - If the test lamp does not illuminate, test the IGN/B+ circuit for a short to ground or an open/high resistance.
4. If all circuits test normal, replace the K20 ECM.

Fuel Pump Control Module

1. Ignition OFF, disconnect the harness connectors at the K27 fuel pump control module.
2. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 ohms between the ground circuit terminal 25 and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Verify that a test lamp illuminates between the IGN/B+ circuit terminals listed below and ground:
   - Terminal 21
   - Terminal 1
   - Terminal 8
     - If the test lamp does not illuminate, test the IGN/B+ circuit for a short to ground or an open/high resistance.
4. If all circuits test normal, replace the K27 fuel pump control module.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for the appropriate control module replacement, setup, and programming

DTC P0563

Diagnostic Instructions

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- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0563

System Voltage High

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	P0562	P0562	-	-
Ground	-	P0562	-	-

Circuit/System Description

The following control modules monitor the system voltage to ensure that the voltage stays within the proper range:

- Engine control module
- Fuel pump control module

Damage to components, and incorrect data may occur when the voltage is out of range.

Conditions for Running the DTC

Engine Control Module

- The vehicle speed is above 8 km/h (5 mph).
- The system voltage is between 9.5-18 V.

Fuel Pump Control Module

The ignition is ON.

Conditions for Setting the DTC

Engine Control Module

The engine control module detects a system voltage above 16 V for less than 1 second.

Fuel Pump Control Module

The fuel pump control module detects that the system voltage is greater than 18 V.

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Action Taken When the DTC Sets

DTC P0563 is a C type DTC.

Conditions for Clearing the DTC

DTC P0563 is a C type DTC.

Diagnostic Aids

- A possible cause of this DTC could be overcharging with a battery charger or jump starting.
- A high voltage value in multiple modules indicates a concern in the charging system.

Reference Information

Schematic Reference

- **Engine Controls Schematics** for the 3.6L (LLT) engine
- **Engine Controls Schematics** for the 6.2L (L99) and (LS3) engine

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, accessories OFF, measure and record the battery voltage at the battery terminals. The

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voltage should be between 12.6 and 15.0 V.

- If not within the specified range, refer to **Charging System Test**.

2. Engine running, observe the scan tool of the appropriate control module Ignition 1 signal parameter. The voltage should be between 12.6 and 15.0 V.
   - If not within the specified range, replace the appropriate control module.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for ECM replacement, setup, and programming

DTC P0615, P0616, OR P0617

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0615

Starter Relay Control Circuit

DTC P0616

Starter Relay Control Circuit Low Voltage

DTC P0617

Starter relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	1	1	-	-
Signal	2	1	-	-
Control Terminal 85	P0615*, P0616**	P0615, 1	3	-
Control Terminal 87	1	1	3	-
Ground	-	P0615, 1	-	-

1. Starter Solenoid Does Not Click

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2. Cranks In Any Gear
3. Cranks All The Time
* L99, LS3
** LLT

Circuit/System Description

When the ignition switch is placed in the START position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the START position. The BCM then sends a message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the clutch pedal is depressed or the transmission is in Park/Neutral. If it is, the ECM then supplies 12 V to the control circuit of the starter relay. When this occurs, battery voltage is supplied through the switch of the starter relay to the starter solenoid.

Conditions for Running the DTC

- The ignition is in the START position.
- The system voltage is between 9.5-18 V.

Conditions for Setting the DTC

The ECM detects improper voltage on the control circuit of the starter relay.

Action Taken When the DTC Sets

DTC P0615, P0616, and P0617 are C type DTCs.

Conditions for Clearing the DTC

DTC P0615, P0616, and P0617 are C type DTCs.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Starting System Description and Operation

Electrical Information Reference

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- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the KR27 starter relay.
2. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5.0 ohms between the relay ground circuit terminal 86 and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, test the control circuit terminal 87 for a short to ground.
4. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 87 and ground.
    - If the test lamp illuminates, test the control circuit for a short to voltage.
5. Parking brake applied and the transmission is in NEUTRAL or PARK. Momentarily install a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87. Verify the starter is activated.
    - If the starter does not activate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the starter.
6. Ignition OFF, connect a test lamp between the control circuit terminal 85 and the ground circuit terminal 86.
7. Transmission in park or neutral, cycle the ignition between the ON and CRANK position. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for short to voltage. If the circuit tests normal, replace the K20 ECM.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
8. If all circuits tests normal, replace the KR27 starter relay.

Component Testing

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Relay Test

1. Ignition OFF, disconnect the STRTR relay.
2. Test for 60-180 ohms between terminals 85 and 86.
   - If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87
   - If not the specified value, replace the relay.
4. Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.
   - If greater than specified range, replace the relay.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0621

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0621

Generator L-Terminal Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	P0622*, P0625**	P0621	-	-
Control	P0621	P0621	P0621	-

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Signal	P0622*, P0625**	P0622*, P0625**	P0622*, P0626**	P0622*, P0625**
* L99 or LS3 ** LLT				

Circuit/System Description

The engine control module (ECM) uses the generator turn ON control circuit to control the load of the generator on the engine. A high side driver in the ECM applies a voltage to the voltage regulator. This controls the voltage regulator to turn the field circuit ON and OFF. The ECM monitors the state of the generator turn ON control circuit. The ECM should detect low voltage on generator turn on control circuit when the ignition is ON and the engine is OFF, or when the charging system malfunctions. With the engine running, the ECM should detect high voltage on the generator turn on control circuit.

Conditions for Running the DTC

- The ignition ON, engine OFF for ignition on test.
- The engine is running for the run test.

Conditions for Setting the DTC

- During the ignition on test, the ECM detects voltage on the generator turn on control circuit for 5 seconds.
- During the run test, the ECM detects low voltage on the generator turn on control circuit for 15 seconds.

Action Taken When the DTC Sets

DTC P0621 is a C type DTC.

Conditions for Clearing the DTC

DTC P0621 is a C type DTC.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

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- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

LLT Engine

1. Verify that a test lamp illuminates between the G13 generator B+ output circuit A X2 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
2. Ignition OFF, disconnect the X1 harness connector at the G13 generator.
3. Ignition ON, test for less than 1 V between the control circuit terminal 1 and ground.
    - If greater than the specified range, test the control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Engine running, test for greater than 3.5 V between the control circuit terminal 1 and ground.
    - If less than the specified range, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. If the circuit tests normal, replace the G13 generator.

L99 or LS3 Engine

1. Verify that a test lamp illuminates between the G13 generator B+ terminal A X2 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
2. Ignition OFF, disconnect the X1 harness connector at the G13 generator.
3. Ignition ON, test for 4.5-5.5 V between the control circuit terminal 1 and ground.
    - If greater than the specified range, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
    - If less than the specified range, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal replace the ECM.
4. If the circuits test normal, replace the G13 generator.

Repair Procedures

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Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Generator Replacement (LLT)** or **Generator Replacement (LS3/L99)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0622

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0622

Generator F-Terminal Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	-	P0621	-	-
Control	P0621	P0621	P0621	-
Signal	P0622	P0622	P0622	P0622

Circuit/System Description

The engine control module (ECM) uses the generator field duty cycle signal circuit, or F-terminal circuit, to monitor the duty cycle of the generator. The generator field duty cycle signal circuit connects to high side of the field windings in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field windings ON and OFF. The ECM uses the PWM signal input to determine the generator load on the engine. This allows the ECM to adjust the idle speed to compensate for high electrical loads. The ECM monitors the status of the generator field duty cycle signal circuit. When the ignition is ON and the engine is OFF, the ECM should detect a duty cycle near 0 percent. When the engine is running, the duty cycle should be between 5-99 percent.

Conditions for Running the DTC

- Ignition ON engine OFF, for the Ignition ON test.
- Engine running, engine speed less than 3,000 RPM for the RUN test.

Conditions for Setting the DTC

- DTC P0621 is not set.

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- Ignition ON engine OFF, the ECM detects a PWM signal that is greater than 65 percent for 5 seconds.
- Engine running, the ECM detects a PWM signal that is less than 5 percent for 15 seconds.

Action Taken When the DTC Sets

DTC P0622 is a C type DTC.

Conditions for Clearing the DTC

DTC P0622 is a C type DTC.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Engine running, observe the scan tool GEN-F Terminal Signal Circuit parameter. The GEN-F Terminal Signal Circuit parameter should display between 5-99 percent.

Circuit/System Testing

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1. Verify that a test lamp illuminates between the G13 generator B+ terminal A X2 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
2. Ignition OFF, disconnect the X1 harness connector at the G13 generator.
3. Ignition ON, verify the scan tool ECM GEN-F Terminal Signal parameter displays less than 5 percent.
    - If greater than the specified range, test the signal circuit terminal 2 for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Install a 3 A fused jumper wire between B+ and the signal circuit terminal 2.
5. Verify the scan tool ECM GEN-F Terminal Signal parameter displays greater than 95 percent.
    - If less than the specified range, test the signal circuit terminal 2 for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
6. If the circuit tests normal replace the G13 generator.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Generator Replacement (LLT)** or **Generator Replacement (LS3/L99)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P0625 OR P0626

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0625

Generator F-Terminal Circuit Low Voltage

DTC P0626

Generator F-Terminal Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	P0625	P0621	-	-
Signal	P0625	P0625	-	-

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Control	P0621	P0621	P0621	-

Circuit/System Description

The engine control module (ECM) uses the generator field duty cycle signal circuit, or F-terminal circuit, to monitor the duty cycle of the generator. The generator field duty cycle signal circuit connects to high side of the field windings in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field windings ON and OFF. The ECM uses the PWM signal input to determine the generator load on the engine. This allows the ECM to adjust the idle speed to compensate for high electrical loads. The ECM monitors the status of the generator field duty cycle signal circuit. When the ignition is ON and the engine is OFF, the ECM should detect a duty cycle near 0 percent. When the engine is running, the duty cycle should be between 5-99 percent.

Conditions for Running the DTC

P0625

- The engine is running.
- The engine speed is 3100 RPM +/- 15%.

P0626

- The engine is not running.
- The ignition is in the ON position.

Conditions for Setting the DTC

P0625

The ECM detects a pulse width modulated (PWM) signal less than 5 percent for 15 seconds.

P0626

The ECM detects a pulse width modulated (PWM) signal greater than 65 percent for 15 seconds.

Action Taken When the DTC Sets

DTC P0625 and P0626 are a C type DTCs.

Conditions for Clearing the DTC

DTC P0625 and P0626 are a C type DTCs.

Reference Information

Schematic Reference

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Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Engine running, observe the scan tool GEN-F Terminal Signal parameter. The GEN-F Terminal Signal parameter should display between 5-99 percent.

Circuit/System Testing

1. Verify that a test lamp illuminates between the G13 generator B+ output circuit terminal A X2 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
2. Ignition OFF, disconnect the X1 harness connector at the G13 generator.
3. Ignition ON, verify the scan tool ECM GEN-F Terminal Signal parameter displays less than 5 percent.
    - If greater than the specified range, test the signal circuit terminal 2 for a short to voltage. If the circuit tests normal, replace the K20 ECM.
4. Install a 3 A fused jumper wire between B+ and the signal circuit terminal 2.
5. Verify the scan tool ECM GEN-F Terminal Signal parameter displays greater than 95 percent.
    - If less than the specified range, test the signal circuit terminal 2 for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
6. If the circuit tests normal replace the G13 generator.

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Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Generator Replacement (LLT)** or **Generator Replacement (LS3/L99)**
- **Control Module References** for ECM replacement, setup, and programming

SYMPTOMS - ENGINE ELECTRICAL

NOTE: The following steps must be completed before using the symptom tables.

- Perform **Diagnostic System Check - Vehicle** before using the Symptom Tables in order to verify that all of the following are true:
  - There are no DTCs set.
  - The control modules can communicate via the serial data link.
- Review the system descriptions and operations in order to familiarize yourself with the system functions. Refer to one of the following system operations:
  - **Battery Description and Operation**
  - **Charging System Description and Operation**
  - **Electrical Power Management Description and Operation**
  - **Starting System Description and Operation**
  - **Load Shed System Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the starting and charging systems. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

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

- **Battery Inspection/Test**
- **Battery Electrical Drain/Parasitic Load Test**
- **Charging System Test**
- **Generator Noise Diagnosis**
- **Starter Solenoid Does Not Click**

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- **Starter Solenoid Clicks, Engine Does Not Crank**
- **Engine Cranks Slowly**
- **Starter Noise Diagnosis**

BATTERY INSPECTION/TEST

Diagnostic Aids

WARNING: Refer to Battery Disconnect Warning .

NOTE:

- **The battery test using the EL 42000: Battery Tester requires correct connections to the battery terminals. A failure to obtain the correct connections during the test may result in a failed test on a good battery.**
- **Use the Out of Vehicle test for each battery when testing a vehicle with dual batteries.**

Follow these instructions in order to avoid an incorrect diagnosis because of connections:

- If testing the vehicle with the battery cables still connected, wiggle the EL 42000 clips on the terminal bolt. This may cut through any coating or through any oxidation that may be present on the bolt.

  Even new bolts contain a protective coating that may insulate or cause a resistance in the test circuit.

- If correct connections to the battery terminal bolts in the vehicle are in doubt, perform the following steps:
  1. Disconnect the negative battery cable.
  2. Disconnect the positive battery cable.
  3. Install the test adapters on the terminals.
  4. Follow the instructions for testing a removed battery.
- If the tester displays a REPLACE BATTERY or BAD CELL-REPLACE result for a battery tested in the vehicle with the battery cables connected, perform the following steps:
  1. Disconnect the negative battery cable.
  2. Disconnect the positive battery cable.
  3. Install the tester adapters.

NOTE: Always write the test code displayed by the tester on the repair order for any warranty purposes. The number is a unique code that describes the test data for a particular battery at a particular time. The test code may occasionally repeat when you retest the same battery. More often, each test will result in a different code. Use the test code from the second, or Out of Vehicle test.

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4. Follow the instructions for testing a removed battery.
5. Replace the battery only if the second test shows a REPLACE BATTERY or BAD CELL-REPLACE result.

   Use the test code from the second test for any warranty purposes.

- Use the correct terminal adapters.

  Do not use any common bolts or a combination of bolts, of nuts, and of washers as adapters when testing the battery.

  Use the test adapters that are provided with the EL 42000 or GM P/N 12303040 terminal adapters. If the adapters that are provided with the EL 42000 require replacement, use GM P/N 12303040. Any other adapter may not contact the correct areas of the battery terminal, causing a resistance that may result in an invalid battery test result.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 42000: Battery Tester

For equivalent regional tools, refer to **Special Tools**.

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Circuit/System Testing

WARNING: Unless directed otherwise, the ignition and start switch must be in the OFF or LOCK position, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.
For Vehicles equipped with OnStar® (UE1) with Back Up Battery:
The Back Up Battery is a redundant power supply to allow limited OnStar® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStar®module). Do not disconnect the main vehicle battery or remove the OnStar® fuse with the ignition key in any position other than OFF. Retained accessory power (RAP) should be allowed to time out or be disabled (simply opening the driver door should disable RAP) before disconnecting power. Disconnecting power to the OnStar® module in any way while the ignition is On or with RAP activated may cause activation of the OnStar® Back-Up Battery (BUB) system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The BUB is not rechargeable and once activated the BUB must be replaced.

1. Inspect the C1 battery for a cracked, broken, or damaged case, which may be indicated by battery acid leakage.
    - If there is any apparent damage, replace the C1 battery.
2. Verify the cold cranking amperage and amp hour rating of the C1 battery to the original C1 battery or original equipment (OE) specification. Refer to **Battery Usage**.
    - If the C1 battery does not meet or exceed specifications, replace the C1 battery.
3. Verify that the C1 battery cables are clean and tight. The C1 battery terminal bolts should be torqued as specified in **Fastener Tightening Specifications**.
    - If the C1 battery cables need to be cleaned, clean as required and tighten as specified.
    - If the C1 battery cables are damaged, replace then tighten as specified.
4. Install the EL 42000 and follow directions supplied by the tester.
    - If the tester calls for charging the C1 battery, refer to **Battery Charging**.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Battery Positive Cable Replacement**
- **Battery Negative Cable Replacement**
- **Battery Replacement**

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BATTERY CHARGING

Special Tools

EL 42000: Battery Tester

For equivalent regional tools, refer to **Special Tools**.

Diagnostic Aids

- For best results, use an automatic taper-rate battery charger with a voltage capability of 16 V.
- The charging area should be well ventilated.
- Do not charge a battery that appears to be frozen. Allow the battery to warm to room temperature and test it using the EL 42000 before charging.

Battery State of Charge

NOTE: Using voltage to determine the batteries state of charge is only accurate after the battery has been at rest for 24 hours. This is enough time for the acid in each cell to equalize. If the battery has been charged or discharged in the past 24 hours, the battery state of charge will only be an estimate.

The maintenance-free batteries state of charge is estimated by reading the voltage of the battery across the battery terminals. Because the voltage is affected by current flow into or out of the battery, the engine must be stopped and all electrical loads turned OFF, including parasitic loads, when checking the voltage. The voltage can also be affected if the battery has just been charged or discharged, so it is important to consider what has happened to the battery in the time just before testing. Use the following procedure to determine the batteries state of charge:

1. Be sure all electrical loads are turned OFF.
2. Determine whether the battery has been used in a vehicle or charged within the past 12 hours.
   - If the answer is no, the terminal voltage will be stabilized and no action is necessary before reading the voltage. Skip to step 3.
   - If the answer is yes, terminal voltage will not be stabilized and you should wait 12 hours since the last time the battery was used.
3. Estimate the battery temperature by determining the average temperature to which the battery has been exposed for the past 12 hours.

   NOTE: The table is accurate to 10 percent only after the battery has been at rest for 12 hours.

4. Measure the battery voltage at the battery terminals. Refer to the following table to determine the state of charge according to the estimated battery temperature:

Battery Voltage	% Charge at 0°C (32°F)	% Charge at 25°C (75°F)

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12.75 V	100%	100%
12.7 V	100%	90%
12.6 V	90%	75%
12.45 V	75%	65%
12.2 V	65%	45%
12.0 V	40%	20%

Use the state of charge information as follows:

- A battery with a state of charge that is below 65 percent must always be recharged before returning it to service or continuing storage.
- A battery with a state of charge that is 65 percent or greater is generally considered to be charged enough in order to be returned to normal service or in order to continue storage. However, if the battery is being used in slow traffic or with short drive times, or if the temperature is very hot or very cold, the battery should be fully charged, to at least 90 percent, before returning it to service or continuing storage.

Charging Time Required

The time required to charge a battery will vary depending upon the following factors:

- The battery charger capacity-The higher the charger amperage, the less time it will take to charge the battery.
- The state of charge of the battery-A completely discharged battery requires more than twice as much charging time as a half charged battery. In a discharged battery with a voltage below 11 V, the battery has a very high internal resistance and may only accept a very low current at first. Later, as the charging current causes the acid content to increase in the electrolyte, the charging current will increase. Extremely discharged batteries may not activate the reversed voltage protection in some chargers. Refer to the manufacturer's instructions for operating this circuitry.
- The temperature of the battery-The colder the battery is, the more time it takes to recharge the battery. The charging current accepted by a cold battery is very low at first. As the battery warms, the charging current will increase.

Charging Procedure

CAUTION: Turn OFF the ignition when connecting or disconnecting the battery cables, the battery charger or the jumper cables. Failure to do so may damage the ECM/PCM or other electronic components.

CAUTION: Refer to Fastener Caution .

When charging side-terminal batteries with the battery cables connected, connect the charger to the positive cable bolt and to a ground located away from the battery. When charging side-terminal batteries with the battery cables disconnected, install the battery side terminal adapters and connect the charger to the adapters.

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Tighten: Tighten the battery side terminal adapters to 15 N.m (11 lb ft).

Use the following procedure to charge the battery:

1. Turn OFF the charger.
2. Ensure that all of the battery terminal connections are clean and tight.
3. Connect the charger positive lead to the battery positive terminal on the battery or the remote jumper stud underhood.

CAUTION: Do not connect the negative charger lead to the housings of other vehicle electrical accessories or equipment. The action of the battery charger may damage such equipment.

4. Connect the negative charger lead to a solid engine ground or to a ground stud in the engine compartment that is connected directly to the battery negative terminal, but away from the battery. If the negative battery cable is disconnected and a terminal adapter is being used, connect directly to the adapter.
5. Turn ON the charger and set to the highest setting for normal charging.
6. Inspect the battery every half hour after starting the battery charger.
   - Charge the battery until the taper-rate charger indicates that the battery is fully charged.
   - Estimate the battery temperature by feeling the side of the battery. If it feels hot to the touch or its temperature is over 45°C (125°F), discontinue charging and allow the battery to cool before resuming charging.
7. After charging, test the battery. Refer to **Battery Inspection/Test**.

BATTERY ELECTRICAL DRAIN/PARASITIC LOAD TEST

12 V Battery

The following procedure is for the 12 V battery only.

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

Components most likely to cause a parasitic draw on the vehicle's battery are switches, relays, and control modules. After the ignition is turned OFF the control modules will begin to go to sleep (shut OFF). All control modules do not go to sleep at the same time, some may take up to 30 minutes or longer after turning the ignition off before going to sleep, like the HVAC and body control modules. Others such as the ON Star and keyless entry control modules may periodically wake up then go back to sleep. These are all normal conditions.

Diagnostic Aids

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- Rule out any possible aftermarket equipment causing an unacceptable parasitic current drain. Aftermarket accessories installed into the courtesy lamp circuit can cause the inadvertent power timer in the body control module (BCM) to keep resetting. This would cause the BCM to remain awake and cause a current drain on the battery.
- Rule out customer driving habits such as regular short trips that do not allow enough time to properly charge the battery. Refer to **Battery Description and Operation**.
- Verify that the battery and charging system are in proper working order. Refer to **Battery Charging** and **Charging System Test**.
- A battery discharging for no apparent reason while the vehicle is parked can be caused by an intermittent draw, such as a module waking up, or a continuous draw, such as a dome light or stuck relay.
- Some systems and modules such as OnStar®, and regulated voltage control (RVC), if equipped, are designed to wake-up, perform a task, and go back asleep at regular intervals. Refer to **Body Control System Description and Operation** for the system or modules description and operation.
- An engine off natural vacuum evaporative test can occur if the engine control module (ECM) determines the drive cycle has met the appropriate criteria immediately after key off. The ECM will stay awake and the vent solenoid will stay energized for as long as 45 minutes. The typical current draw for this is about 1 A.
- Digital OnStar gen 6 and later VCIMs do not "wake up" every 10 minutes for the first 48 hours as the gen 5 and prior. Gen 6 and later VCIM current draw is very low, less than 40 mA, so the OnStar system is left in that state for up to the first 48 hours. Parasitic draw of up to 40 mA with an occasional spike as high as 80 mA through the VCIM for the first 48 hours is normal.
- Some automatic climate control systems can remain in a semi-awake state for up to three hours, actual draw amounts vary by vehicle platform but are typically not greater than 50 mA.
- An extremely low mA current level is consumed by the RKE receiver for monitoring purposes, actual system wake up only occurs when the fobs for the vehicle are used. When other devices on the same RKE operating frequency are activated, such as the 4 tire pressure monitoring sensors and other vehicle FOB's in the vicinity, the RKE receiver will have a 100 mA spike. These spikes are normal and occur too briefly to have a significant effect on battery drain. Competing signals may cause RKE performance issues such as jamming but should not cause excessive battery draw.
- If an excessive current draw is not present during initial testing, continue periodic testing over a 1-2 hour period to see if the current draw increases and stays above an unacceptable level.

NOTE: The battery specification listed below is a generic specification. Refer to Battery Usage when testing the battery.

- The battery run down time will vary depending on the batteries reserve capacity. If the reserve capacity is higher, then the battery run down time would be longer. If the reserve capacity is lower, then the battery run down time would be shorter. The graph below indicates roughly how many days a 690 cold cranking amp battery with a 110 min. reserve capacity starting at 80 percent state of charge will last with a constant current draw until it reaches 50 percent state of charge. Differences in battery reserve capacity and temperature will affect the results.

Current Drain	Days
25 mA	33

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50 mA	16.5
75 mA	11
100 mA	8.25
250 mA	3.3
500 mA	1.65
750 mA	1
1 A	0.8
2 A	0.4

Reference Information

Schematic Reference

Control Module References

Connector End View Reference

Component Connector End Views

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Connector Repairs**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 38758: Parasitic Draw Test Switch

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

NOTE:

- **Most vehicle systems will go to sleep within 30 minutes but it can take up to 2 hours before all systems power down allowing the parasitic draw test to pass. An occasional increase in the parasitic draw is normal as long as it returns within 1 second.**
- **Closing the door latches/ajar switch while leaving the doors open is recommended, this allows the vehicle systems to perform in a "doors**

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closed" mode while allowing vehicle interior access that may be needed to complete the diagnostic steps.

- **Locking doors will arm the vehicle content theft deterrent system if equipped. Failure to arm the system may cause a theft system fault to not be present during testing.**
- **There are many things that can prevent the vehicle from completely going to sleep and passing the parasitic draw test. Make sure all the conditions listed below are met before performing the parasitic current draw test.**
  - **Ignition OFF**
  - **Key out of the ignition switch - when not equipped with keyless access and start**
  - **Retained Accessory Power RAP OFF - open and close the driver door after ignition OFF**
  - **Scan tool not communicating with a vehicle control module - in some cases it may need to be disconnected from the DLC**
  - **All access doors closed**
  - **Headlamps OFF - auto headlamps disabled**
  - **Any delay lighting OFF**
  - **If equipped with an under hood lamp disable it**
  - **HVAC after blow OFF**
  - **Any accessory that can work with ignition OFF inactive or OFF**
  - **Wait up to 2 minutes or longer, after all other listed conditions are met**

Using an Inductive Pickup Probe

1. Connect an inductive pickup probe to the negative battery cable that can read down to 1 mA.
2. Ignition OFF, as the vehicle systems shut down test for less than 30 mA of parasitic current drain.
   - If greater than the specified range, refer to Circuit/System Testing.

Using the EL 38758 Parasitic Draw Test Switch

WARNING: Refer to Battery Disconnect Warning .

CAUTION: When a fused jumper wire or digital multimeter is connected to the test switch terminals, always turn the test switch ON before opening any access door, turning the ignition on, or turning any accessory on. This is to prevent damaging the jumper wire or digital multimeter fuse.

NOTE: The switch knob on the EL 38758: switch is marked ON and OFF. When the

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switch knob is in the ON position, the circuit is closed and electrical current will pass through the switch. When the switch knob is in the OFF position, the circuit is open and electrical current will not pass through the switch.

1. Ignition OFF, disconnect the battery negative cable from the battery. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Turn the **EL 38758:** switch knob to the OFF position.
3. Install the male end of the **EL 38758:** switch to the battery ground terminal.
4. Install the battery negative cable to the female end of the **EL 38758:** switch.
5. Turn the **EL 38758:** switch knob to the ON position.
6. Road test the vehicle and activate all of the accessories such as the radio and air conditioning.
7. Ignition OFF, connect a 10 A fused jumper wire to the test switch tool terminals.
8. Turn the **EL 38758:** switch knob to the OFF position. The current now flows through the jumper wire.
9. Check the fuse in the jumper wire. The fuse should be OK.
    - If the jumper wire fuse is blown, refer to Circuit/System Testing.
10. Turn the **EL 38758:** switch knob to the ON position. Remove the fused jumper wire.
11. Connect a DMM set to the 10 A DC scale between the test switch tool terminals.
12. Turn the **EL 38758:** switch knob to the OFF position. The current now flows through the DMM.
13. As the vehicle systems shut down test for less than 30 mA of parasitic current drain.
    - If greater than the specified range, refer to Circuit/System Testing.

Circuit/System Testing

NOTE:

- **Removing or installing a fuse, relay, or connector, to determine the area causing high parasitic draw may wake up control modules. You must wait for the control modules to go back to sleep before retesting. It is best to install any removed or disconnected components after the diagnosis is completed.**
- **Fuses for power mode master components such as the BCM should be removed last to avoid misdiagnosis.**
- **If a scan tool is connected to the DLC, either disconnect it or subtract the scan tool current draw from the DMM reading to get the actual vehicle parasitic current draw.**

If the vehicle has an unacceptable amount of parasitic current draw, remove each fuse one at a time until the current draw falls to an acceptable level. A drop of more than 10-20 mA, when disabling a single system or circuit, is an indication of an overly high current draw that could be causing the battery drain. Refer to **Power Distribution Schematics** to diagnose exactly which circuit of the suspect system is causing the high parasitic drain. The follow is a list of common components that could cause a high current draw:

- Stuck switch

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- Stuck relay
- Control module

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for control module replacement, programming and setup

CHARGING SYSTEM TEST

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

Engine running, observe the charge indicator on the instrument cluster or message in the driver information center display. The charge indicator on the instrument cluster should be turned OFF and the driver information center display should not display any charging system message.

Circuit/System Testing

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1. Ignition ON, verify that no G13 Generator or B18 battery current sensor DTCs are set that would cause a charging system concern.
    - If DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition OFF, measure the voltage across the battery terminals. The voltage should read 12.0 V or greater at room temperature.
    - If not within the specified value, refer to **Battery Inspection/Test**.

NOTE: Ensure vehicle accessories are OFF for the next step.

3. Engine ON, increase engine speed to 2,500 RPM. Verify the battery voltage is between 12.6-15.0 V.
    - If not within specified range, replace the G13 generator.
4. Engine ON, increase engine speed to 2,500 RPM. Turn ON all vehicle accessories. Verify the battery voltage is between 12.6-15.0 V.
    - If not within specified range, replace the G13 generator.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Generator Replacement (LLT) or **Generator Replacement (LS3/L99)**

GENERATOR NOISE DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Aids

Noise from a generator may be due to electrical or mechanical noise. Electrical noise or magnetic whine usually varies with the electrical load placed on the generator and is a normal operating characteristic of all generators. When diagnosing a noisy generator, it is important to remember that loose or misaligned components around the generator may transmit the noise into the passenger compartment and that replacing the generator may not solve the problem.

Circuit/System Testing

1. Start the engine, verify the noise can be heard. Compare the concern to a similar vehicle.
2. Inspect the generator, generator mounting, wiring harness, heater hoses, A/C lines or other accessory equipment that may be misrouted or be the cause of noise being transmitted into the passenger compartment.
3. Ignition OFF, remove the engine drive belt. Verify the generator, idler pulley and tensioner pulley spin freely.

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- If any of the pulleys do not spin freely, replace the affected component.

4. Loosen all generator mounting bolts and ensure the generator is properly aligned. Tighten mounting bolts to specification, refer to **Generator Replacement (LLT)** or **Generator Replacement (LS3/L99)**.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Drive Belt Replacement** for the 2.8L, 3.0L, 3.2L, or 3.6L engines
- **Drive Belt Replacement - Accessory** for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engines
- **Drive Belt Tensioner Replacement - Accessory** for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engines
- **Drive Belt Tensioner Replacement** for the 2.8L, 3.0L, 3.2L, or 3.6L engines
- **Generator Replacement (LLT)** or **Generator Replacement (LS3/L99)**

STARTER SOLENOID DOES NOT CLICK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	1	1	-	-
Signal	2	1	-	-
Control Terminal 85	-	1	3	-
Control Terminal 87	1	1	3	-
Ground	-	1	-	-
1. Starter Solenoid Does Not Click 2. Cranks In Any Gear 3. Cranks All The Time				

Circuit/System Description

When the ignition mode switch is placed in the START position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the START position. The BCM then sends a serial data message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the clutch is fully depressed or the automatic transmission is in Park/Neutral. If it is, the ECM then supplies 12 V to the control circuit of the starter relay. When this occurs, battery voltage is supplied through the switch of the starter relay to the starter solenoid.

Reference Information

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Schematic Reference

- **Starting and Charging Schematics**
- **Automatic Transmission Controls Schematics**

Connector End View Reference

Component Connector End Views

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Automatic Transmission

1. Ignition ON, verify that no ignition, starter relay, brake pedal position sensor, theft deterrent, or automatic transmission DTCs are set that would cause the ECM to disable engine starting.
   - If DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition ON, observe the scan tool BCM 5 V Ignition Switch parameter. Place the ignition switch in the crank position, the parameter should display Crank Request.
   - If not the specified value, refer to **Power Mode Mismatch** .
3. Transmission in park, verify the scan tool TCM Internal Mode Switch parameter displays Park.
   - If the TCM Internal Mode Switch parameter does not indicate Park. Refer to **Transmission Internal Mode Switch Logic** .
4. Transmission range selector in park or neutral attempt to start the vehicle. The crank relay should click and the engine should begin cranking.
   - If the starter relay does not click or the engine does not crank, refer to Circuit/System Testing.

Manual Transmission

1. Ignition ON, verify that no ignition, starter relay, clutch pedal position sensor, brake pedal position sensor, or theft deterrent DTCs are set that would cause the ECM to disable engine starting.

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- If DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

2. Ignition ON, observe the scan tool BCM 5 V ignition switch. Place the ignition switch in the crank position, the parameter should display Crank Request.
   - If not the specified value, refer to **Power Mode Description and Operation** .
3. Ignition ON, observe the scan tool ECM clutch pedal starter inhibit switch, verify the scan tool parameter displays Off/On while depressing and releasing the clutch pedal.
   - If the clutch pedal starter inhibit parameter does not change. Refer to **Clutch Pedal Position Sensor Learn** for MG9 transmission and **Clutch Pedal Position Sensor Learn** for MV7 transmission.
4. Clutch pedal fully depressed, attempt to start the vehicle. The crank relay should click and the engine should begin cranking.
   - If the starter relay does not click or the engine does not crank, refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition ON, with a scan tool verify the ECM Ignition 1 Signal parameter is greater than 10 V.
   - If less than the specified range, test the ECM ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.
2. Ignition OFF, disconnect the starter relay.
3. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5.0 ohms between the relay ground circuit terminal 86 and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.
4. Ignition ON, verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
   - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, test the control circuit terminal 87 for a short to ground.
5. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 87 and ground.
   - If the test lamp illuminates, test the control circuit for a short to voltage.
6. Ensure the parking brake is applied and the transmission is in NEUTRAL on manual transmission or PARK on automatic transmissions. Momentarily install a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87. Verify the starter is activated.
   - If the starter does not activate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the starter.
7. Connect a test lamp between the control circuit terminal 85 and the ground circuit terminal 86.
8. With the transmission range selector in park/neutral, or the clutch pedal fully applied, place the ignition switch between the OFF and CRANK position. The test lamp should turn ON and OFF when changing between the commanded states.
   - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the K20 ECM.
   - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the K20 ECM.

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9. If all circuits test normal, test or replace the starter relay.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Manual Shift Shaft Position Switch Replacement**
- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for ECM replacement, setup, and programming

STARTER SOLENOID CLICKS, ENGINE DOES NOT CRANK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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1. Ignition OFF, measure and record the battery voltage at the battery terminals. The voltage should be between 12.0-15.0 V.
    - If not within the specified range, refer to **Battery Charging**.
2. Remove the drive belts. Refer to **Drive Belt Tensioner Replacement** , **Drive Belt Replacement** for the LLT engine, **Drive Belt Tensioner Replacement - Accessory** or **Drive Belt Replacement - Accessory** for the L99/LS3 engines.
3. Place the S39 ignition switch to the CRANK position.
    - If the engine cranks, inspect the engine and belt drive system for mechanical binding, seized engine, or seized generator, etc.
    - If the engine does not crank, refer to **Engine Will Not Crank - Crankshaft Will Not Rotate** for the LLT engine or **Engine Will Not Crank - Crankshaft Will Not Rotate** for the LS3 engine.
4. Test for less than 0.5 V between the positive battery cable and terminal A X2 at the M64 starter motor as the ignition switch is placed to the START position.
    - If greater than the specified value, replace the positive battery cable.
5. Test for less than 0.5 V between the negative battery cable and the starter motor case as the ignition switch is placed to the START position.
    - If greater than the specified value, replace the negative battery cable.
6. If all circuits test normal, replace the M64 starter motor.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Battery Positive Cable Replacement**
- **Battery Negative Cable Replacement**
- **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)**

ENGINE CRANKS SLOWLY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

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Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition OFF, measure and record the battery voltage at the battery terminals. The voltage should be between 12.0-15.0 V.
    - If not within the specified range, refer to **Battery Charging**.
2. Remove the drive belts. Refer to **Drive Belt Tensioner Replacement** , **Drive Belt Replacement** for the LLT engine, **Drive Belt Tensioner Replacement - Accessory** or **Drive Belt Replacement - Accessory** for the L99/L53 engines.
3. Place the S39 ignition switch to the CRANK position.
    - If the engine cranks normal, inspect the engine and belt drive system for mechanical binding, seized engine, or seized generator, etc.
4. Test for less than 0.5 V between the positive battery cable and terminal A X2 at the M64 starter motor as the S39 ignition switch is placed to the CRANK position.
    - If greater than the specified value, replace the positive battery cable.
5. Test for less than 0.5 V between the negative battery cable and the starter motor case as the S39 ignition switch is placed to the CRANK position.
    - If greater than the specified value, replace the negative battery cable.
6. If all circuits test normal, replace the M64 starter motor.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Battery Positive Cable Replacement**
- **Battery Negative Cable Replacement**
- **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)**

STARTER NOISE DIAGNOSIS

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Circuit/System Testing

1. Remove the flywheel inspection cover.
2. Inspect the flywheel for the following:
    - Loose flywheel bolts
    - Chipped gear teeth
    - Missing gear teeth
    - Bent flywheel

- If not within specifications, secure the flywheel bolts or replace the flywheel.
- If all inspections were within specification, replace the starter motor.

Repair Procedures

- **Fastener Tightening Specifications** for the 2.8L, 3.0L, 3.2L, or 3.6L engines
- **Fastener Tightening Specifications (6.2L LS3)** or **Fastener Tightening Specifications (6.2L L99)** for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engines
- **Engine Flywheel Removal** for the 2.8L, 3.0L, 3.2L, or 3.6L engines
- **Engine Flywheel Replacement** for the 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L engines
- **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)**

REPAIR INSTRUCTIONS

BATTERY NEGATIVE CABLE DISCONNECTION AND

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Fig. 3: Battery Negative Cable Connection
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
WARNING: **Unless directed otherwise, the ignition and start switch must be in the OFF or LOCK position, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.** **For Vehicles equipped with OnStar® (UE1) with Back Up Battery:** **The Back Up Battery is a redundant power supply to allow limited OnStar® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStar®module). Do not disconnect the main vehicle battery or remove the OnStar® fuse with the ignition key in any position other than OFF. Retained accessory power (RAP) should be allowed to time out or be disabled (simply opening the driver door should disable RAP) before disconnecting power. Disconnecting power to the OnStar® module in any way while the ignition is On or with RAP activated may cause activation of the OnStar® Back-Up Battery (BUB) system and will discharge and permanently damage the back-up**	

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battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The BUB is not rechargeable and once activated the BUB must be replaced.

Preliminary Procedure

1. Turn all lamps and accessories OFF.
2. Turn the Ignition to the OFF position.
3. Remove the spare tire and air compressor (P43),if equipped.

1	Negative Terminal Nut **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 15 N.m (11 lb ft)
2	Negative Battery Cable

BATTERY NEGATIVE CABLE REPLACEMENT

Fig. 4: Battery Negative Cable
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
WARNING:	

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Unless directed otherwise, the ignition and start switch must be in the OFF or LOCK position, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.
For Vehicles equipped with OnStar® (UE1) with Back Up Battery:
The Back Up Battery is a redundant power supply to allow limited OnStar® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStar®module). Do not disconnect the main vehicle battery or remove the OnStar® fuse with the ignition key in any position other than OFF. Retained accessory power (RAP) should be allowed to time out or be disabled (simply opening the driver door should disable RAP) before disconnecting power. Disconnecting power to the OnStar® module in any way while the ignition is On or with RAP activated may cause activation of the OnStar® Back-Up Battery (BUB) system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The BUB is not rechargeable and once activated the BUB must be replaced.

Preliminary Procedures

1. Turn all lamps and accessories OFF.
2. Turn the Ignition to the OFF position.
3. Remove the spare tire and air compressor (P43),if equipped.
4. Disconnect the negative battery terminal. Refer to **Battery Negative Cable Disconnection and Connection**.

1	Negative Terminal Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 25 N.m (18 lb ft)
2	Negative Battery Cable

BATTERY POSITIVE CABLE REPLACEMENT

Removal Procedure

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

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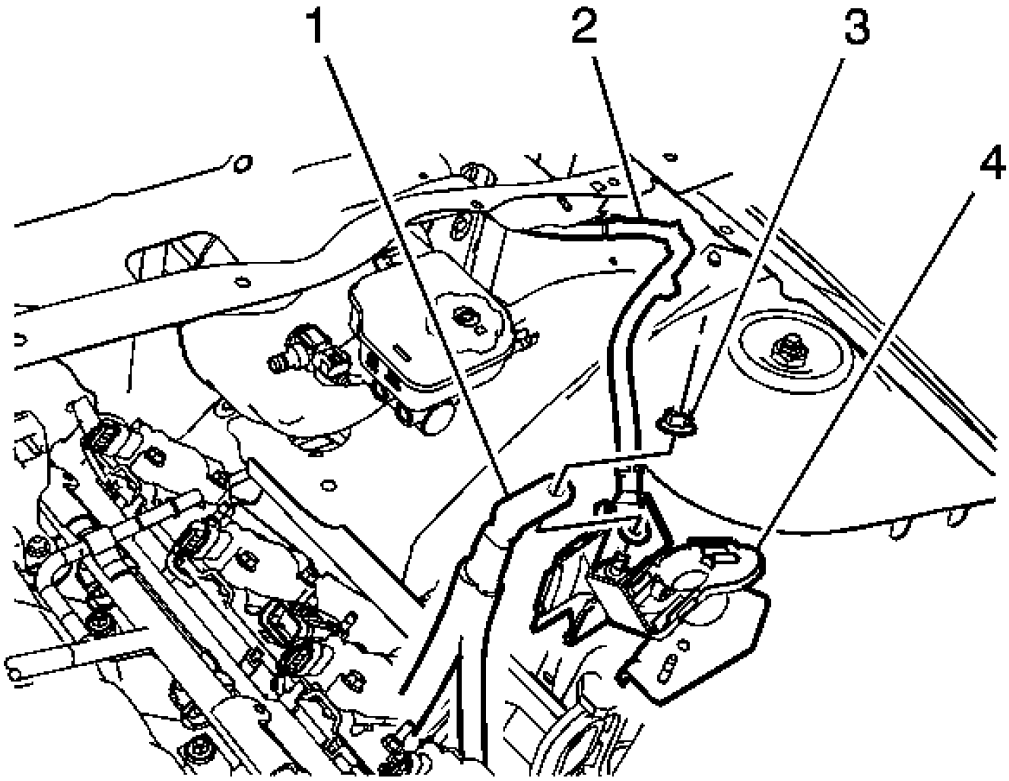


Fig. 5: Battery Positive Cable Components
Courtesy of GENERAL MOTORS CORP.

2. Remove the junction block cover (4).
3. Remove the junction block nut (3).
4. Remove the positive battery to starter cable from the junction block terminal (1).
5. Remove the positive battery cable (2).
6. Disengage all remaining cable retainers under the hood.
7. Remove the floor console. Refer to **Front Floor Console Replacement** .
8. Remove rear seat lower cushion. Refer to **Rear Seat Cushion Replacement** .
9. Remove left side quarter trim panel. Refer to **Quarter Trim Panel Replacement** .
10. Reposition rear compartment side trim panel as required.

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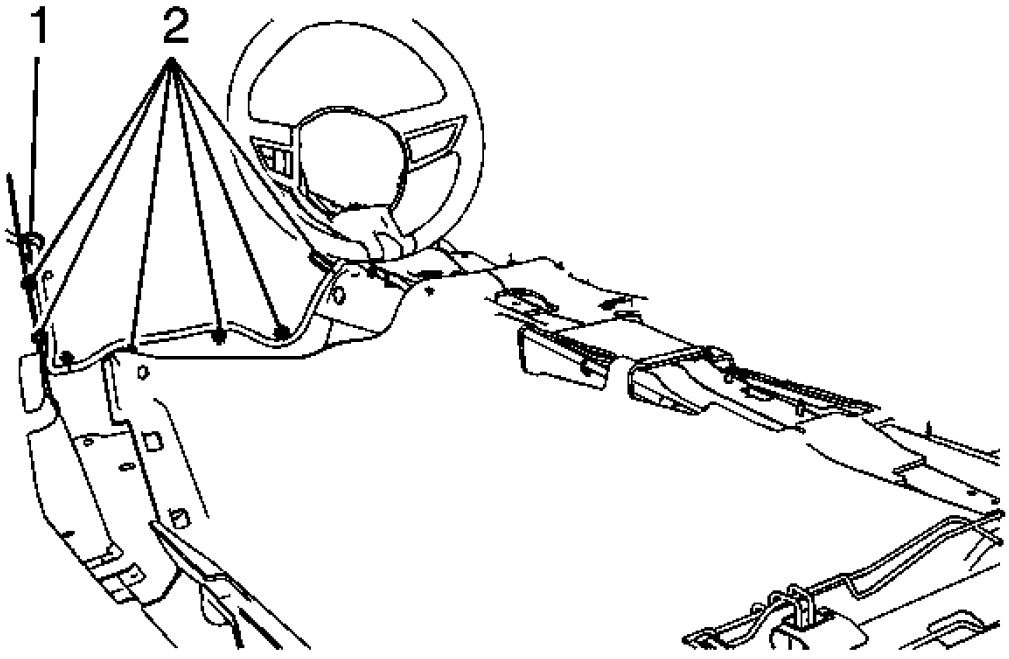


Fig. 6: Pass-Through Grommet & Cable Retainers
Courtesy of GENERAL MOTORS CORP.

11. Disconnect the pass-through grommet (1) from the floor plenum.
12. Disconnect cable retainers (2) from the floor plenum.

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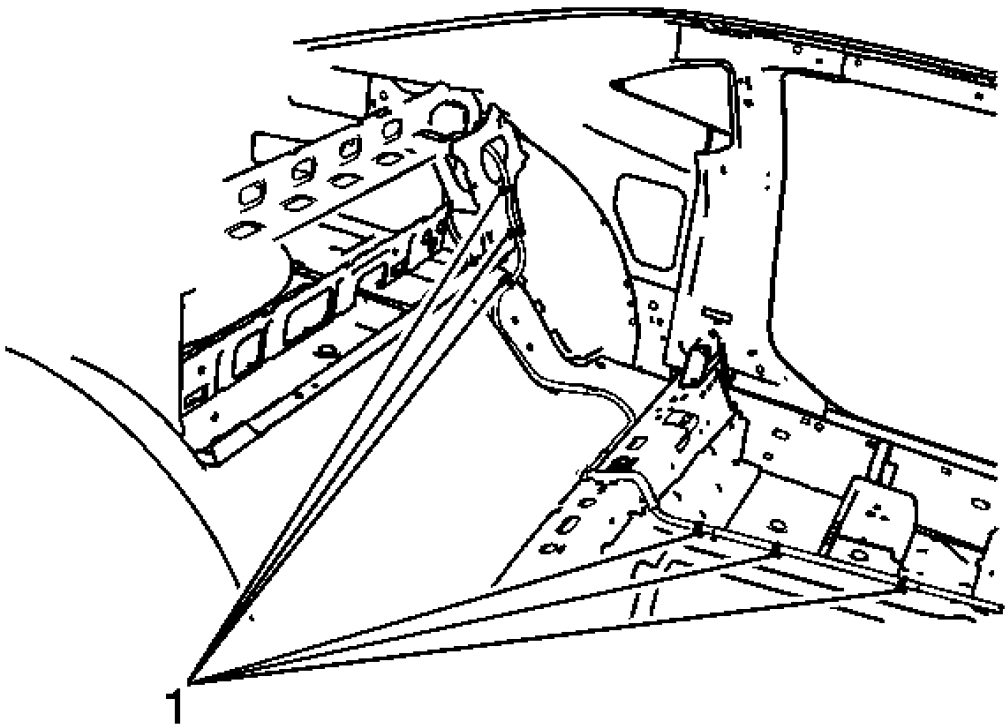


Fig. 7: Retainers
Courtesy of GENERAL MOTORS CORP.

13. Working through the openings in the floor carpet, disconnect all remaining retainers (1).
14. Pull the battery positive cable through the carpet. Note the cable routing for installation purposes.

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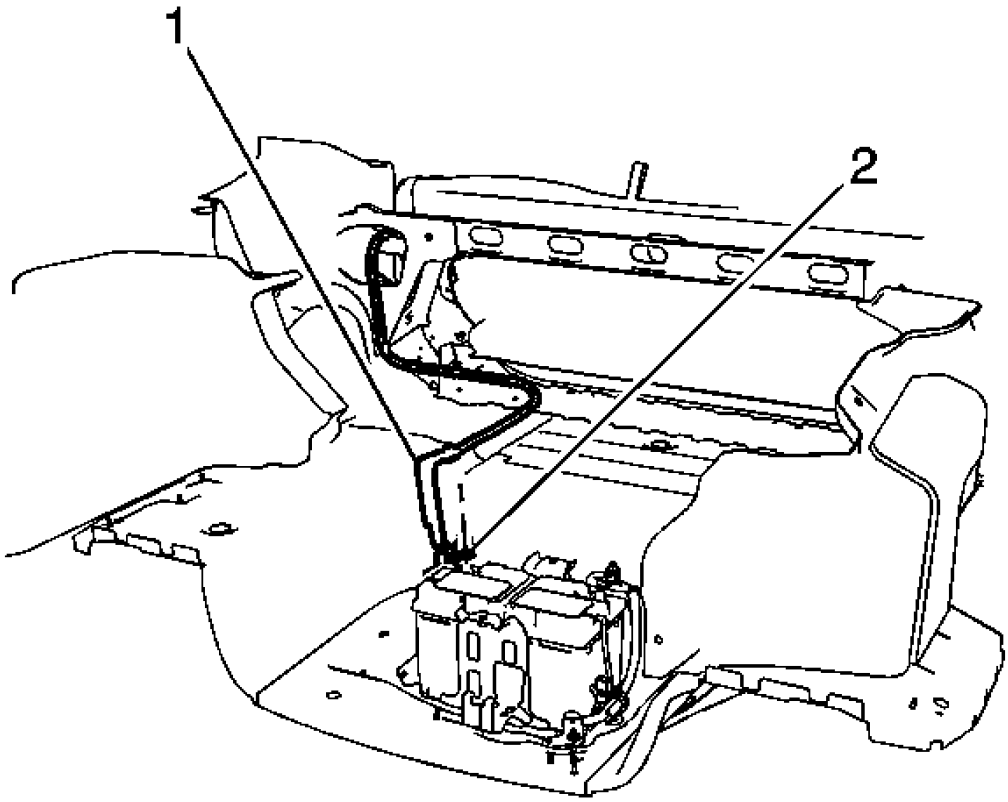


Fig. 8: Battery Positive Cable & Terminal Nut
Courtesy of GENERAL MOTORS CORP.

15. Loosen the battery terminal nut (2).
16. Open the positive battery cable terminal cover.
17. Remove the battery positive terminal.
18. Pull the positive battery cable (1) from the passenger compartment into the trunk area.

Installation Procedure

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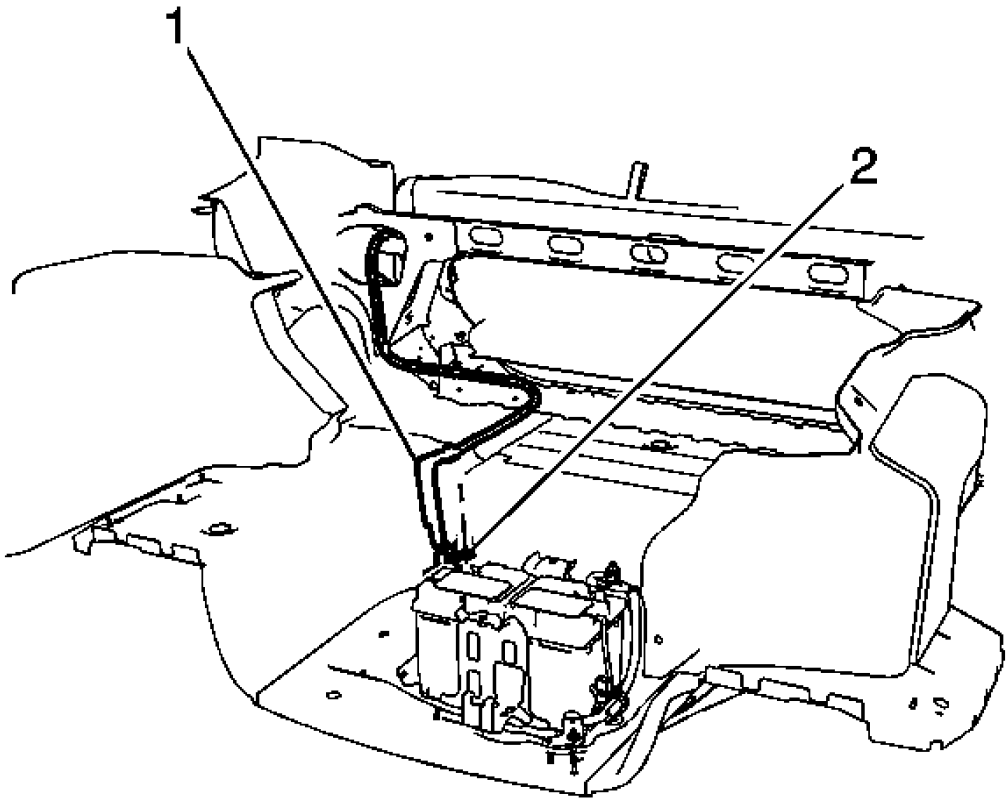


Fig. 9: Battery Positive Cable & Terminal Nut
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the battery positive cable (1) to the battery post and tighten battery positive cable nut (2) to 5.5 N.m (4 lb ft).
2. Attach battery positive cable retainers to rear compartment and route cable through rear seat back body panel into rear passenger compartment.
3. Attach battery positive cable retainers along left rear quarter trim area and in front of rear seat.

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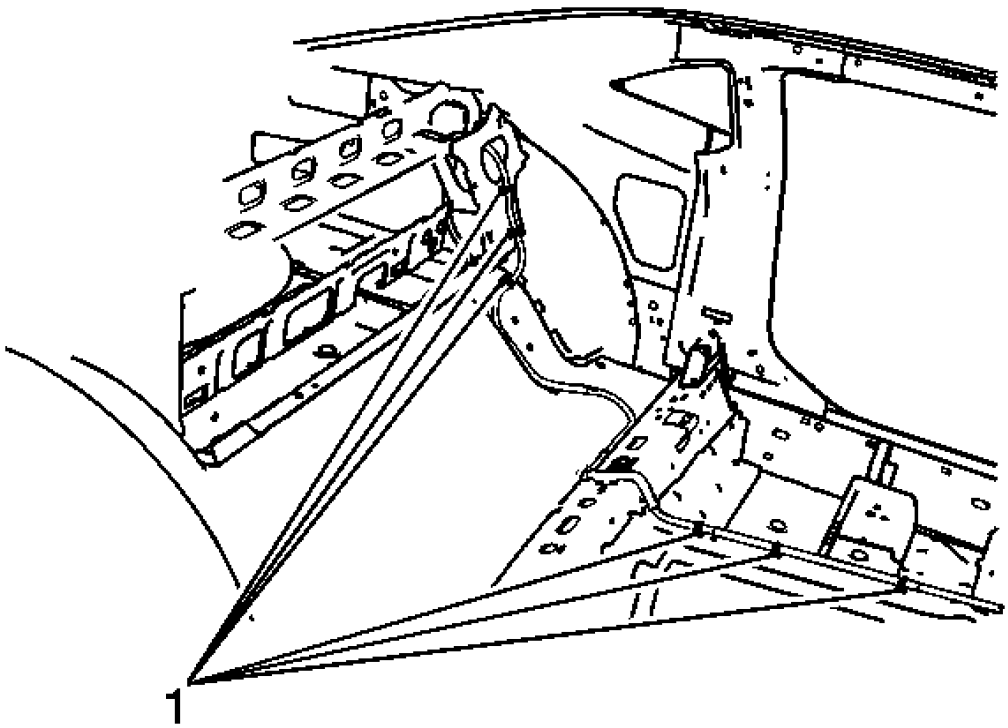


Fig. 10: Retainers
Courtesy of GENERAL MOTORS CORP.

4. Route battery positive cable under floor carpet and attach retainers along the left side of floor console (1).
5. Install the pass-through grommet and fasten battery positive cable retainers to lower floor plenum.
6. Install left side quarter trim panel. Refer to **Quarter Trim Panel Replacement** .
7. Install rear seat lower cushion. Refer to **Rear Seat Cushion Replacement** .
8. Install the floor console. Refer to **Front Floor Console Replacement** .

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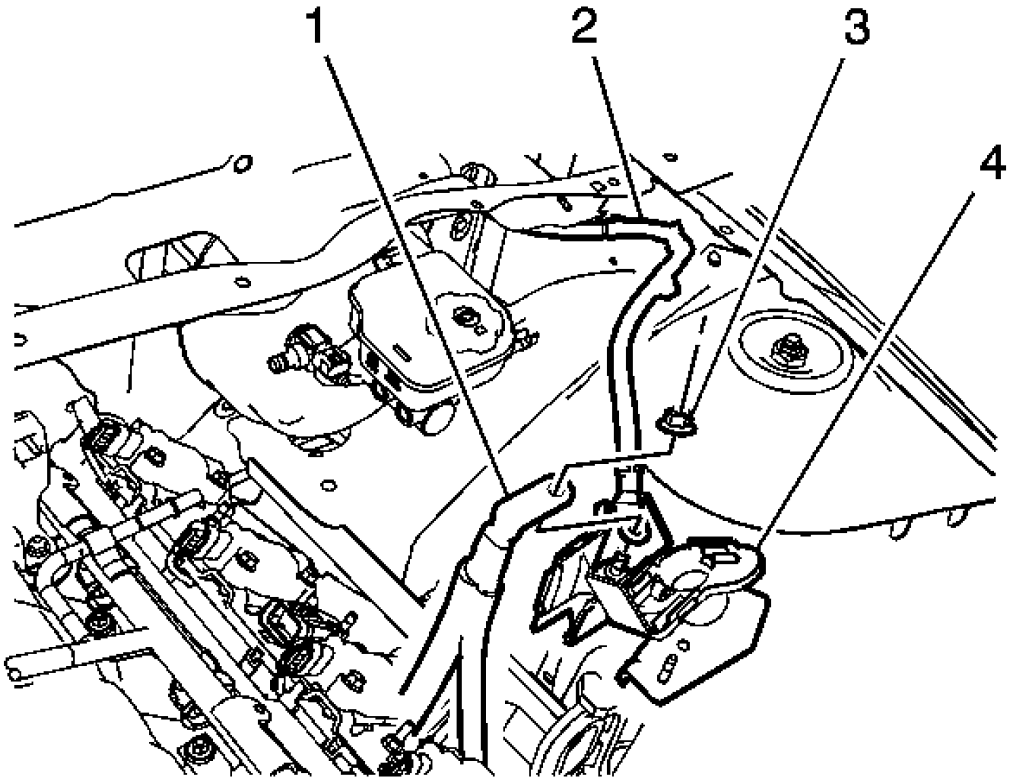


Fig. 11: Battery Positive Cable Components
Courtesy of GENERAL MOTORS CORP.

9. Route battery positive cable (2) along engine compartment and attach remaining fasteners.
10. Install battery positive cable to the junction block terminal.
11. Install the battery positive starter cable (1) to the junction block terminal and tighten nut (3) to 15 N.m (11 lb ft).
12. Attach the positive battery cable terminal cover (4).
13. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

ENGINE WIRING AND BATTERY POSITIVE CABLE HARNESS REPLACEMENT (L99,LS3)

Removal Procedure

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

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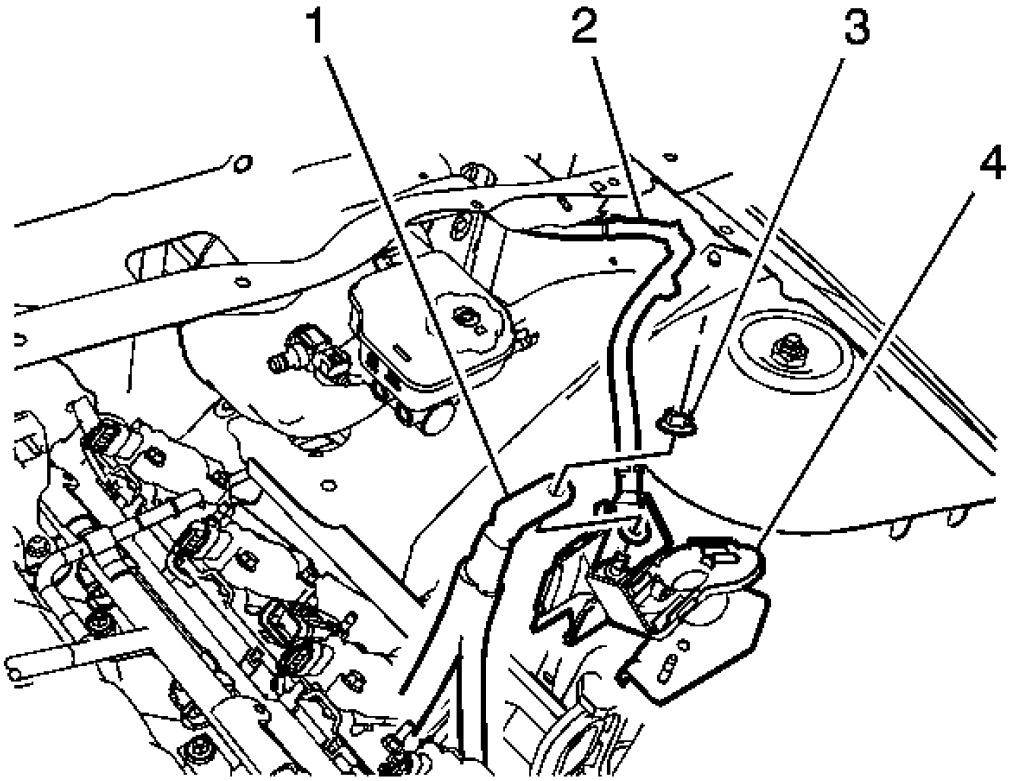


Fig. 12: Battery Positive Cable Components
Courtesy of GENERAL MOTORS CORP.

2. Remove the junction block cover (4).
3. Remove the junction block nut (3).
4. Remove the engine harness and the battery positive cable terminal from the junction block terminal (1).
5. Remove the engine harness and the battery positive cable (2).

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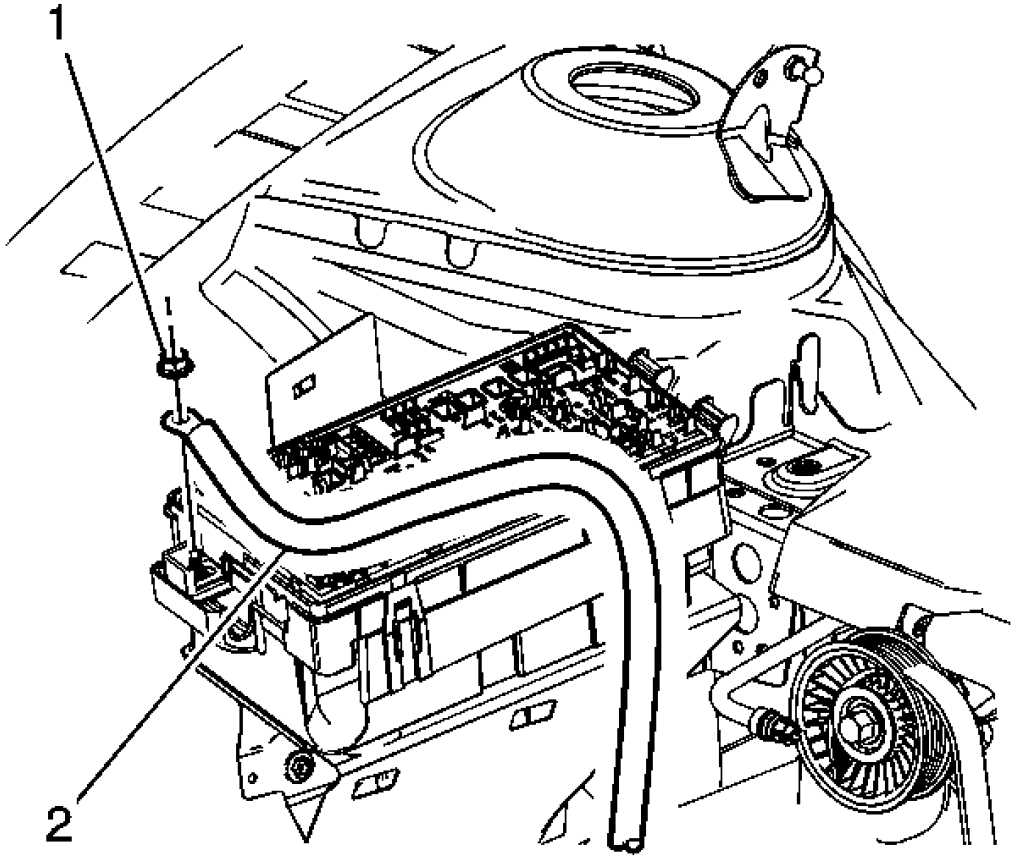


Fig. 13: Battery Positive Cable Terminal & Junction Nut
Courtesy of GENERAL MOTORS CORP.

6. Remove the battery positive cable terminal (2) and the junction nut (1), from the fuse block.

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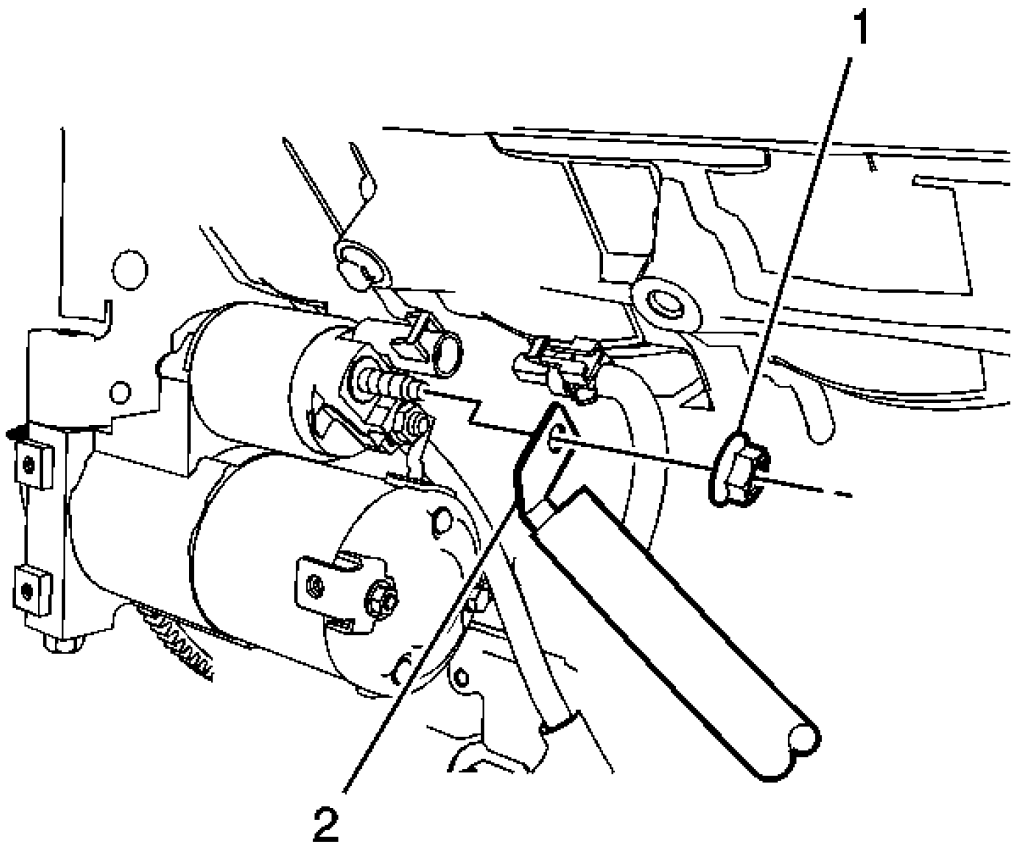


Fig. 14: Battery Positive Cable Nut & Terminal
Courtesy of GENERAL MOTORS CORP.

7. Remove the starter heat shield. Refer to **Starter Shield Replacement (LLT)** or **Starter Shield Replacement (LS3/L99)**.
8. Remove the battery positive cable nut (1) and the battery positive cable terminal (2), from the starter.

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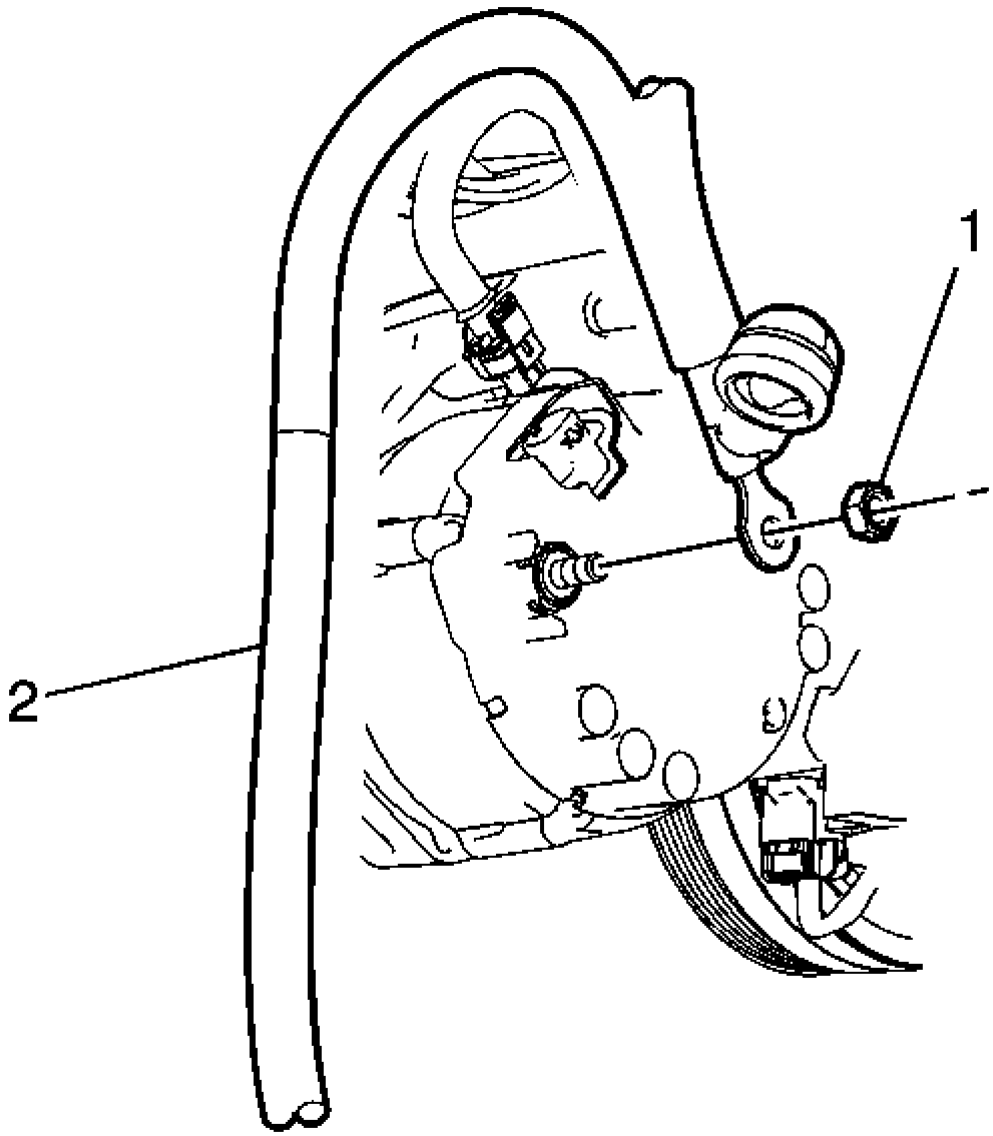


Fig. 15: Battery Positive Cable Generator Nut & Terminal
Courtesy of GENERAL MOTORS CORP.

9. Remove the battery positive cable generator nut (1) and the battery positive cable terminal (2), from the generator.

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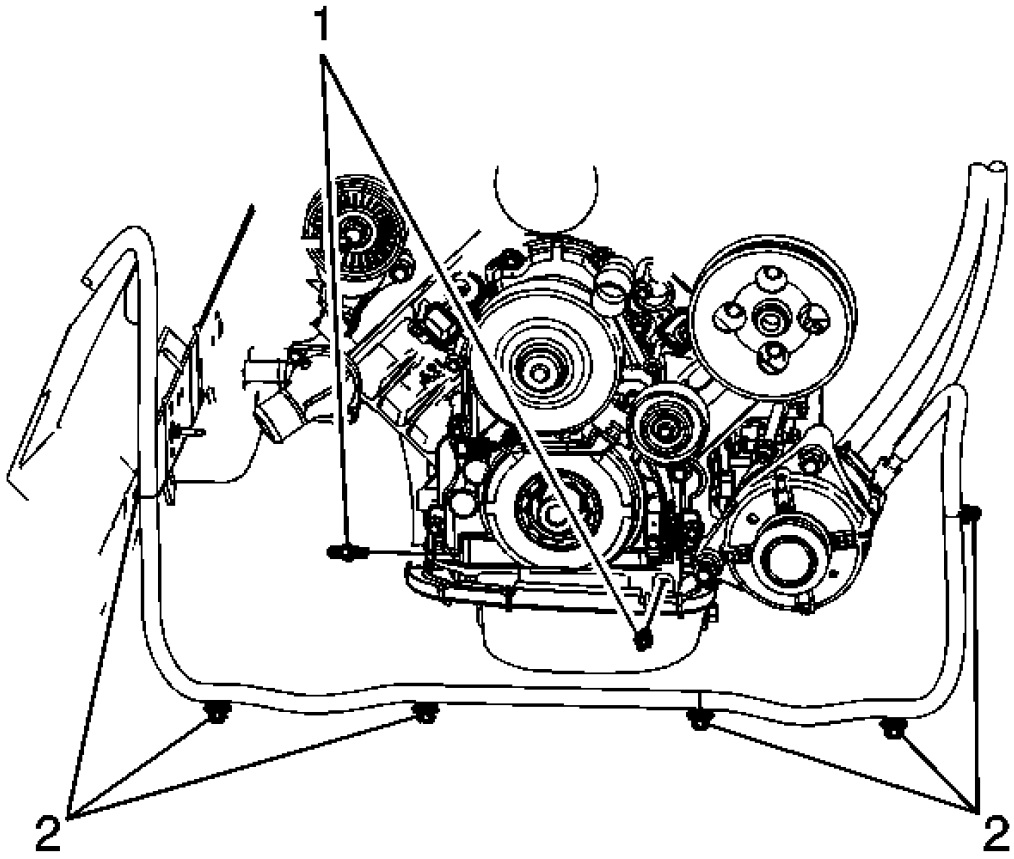


Fig. 16: Engine Harness Fasteners & Retainers
Courtesy of GENERAL MOTORS CORP.

10. Remove the nuts (1) retaining the engine harness to the oil pan.
11. Disconnect the remaining fasteners (2) that hold the harness to the frame.

NOTE: Visualize how the harness was routed within the engine compartment.

12. Remove the engine and battery positive cable harness from the engine compartment.

Installation Procedure

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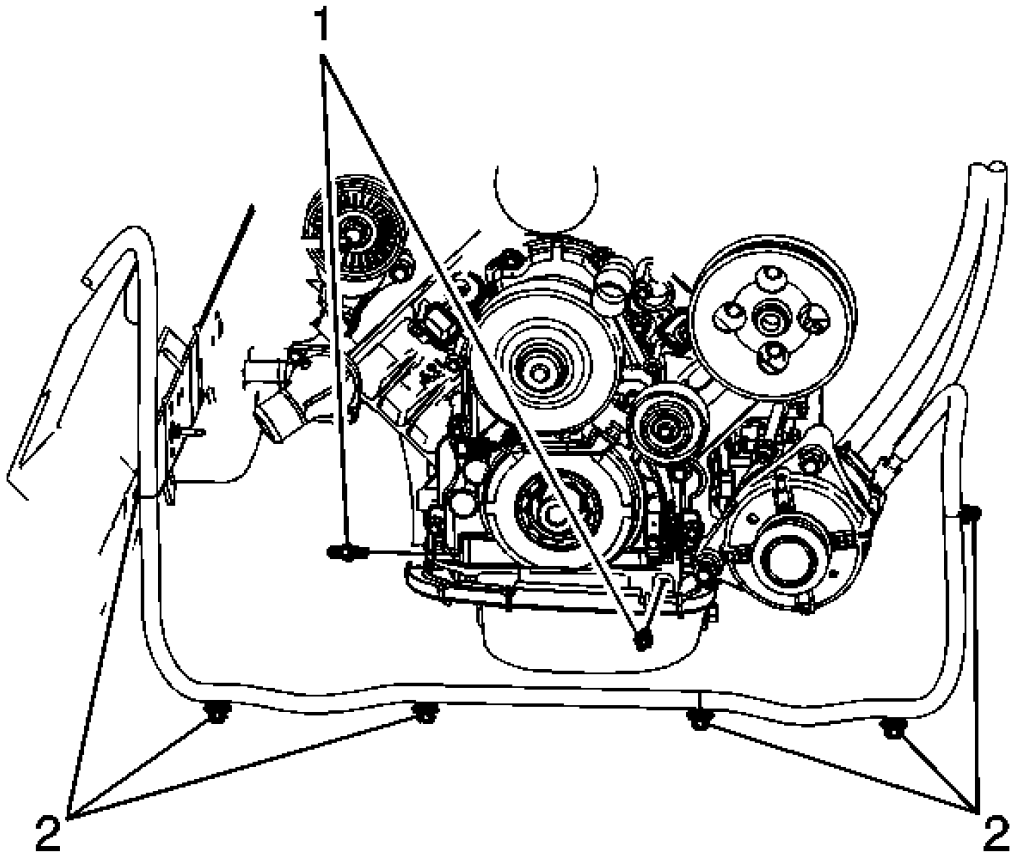


Fig. 17: Engine Harness Fasteners & Retainers
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Fasten the engine harness and the battery positive cable to the engine compartment and tighten the harness retainers (1) to 12 N.m (9 lb ft).

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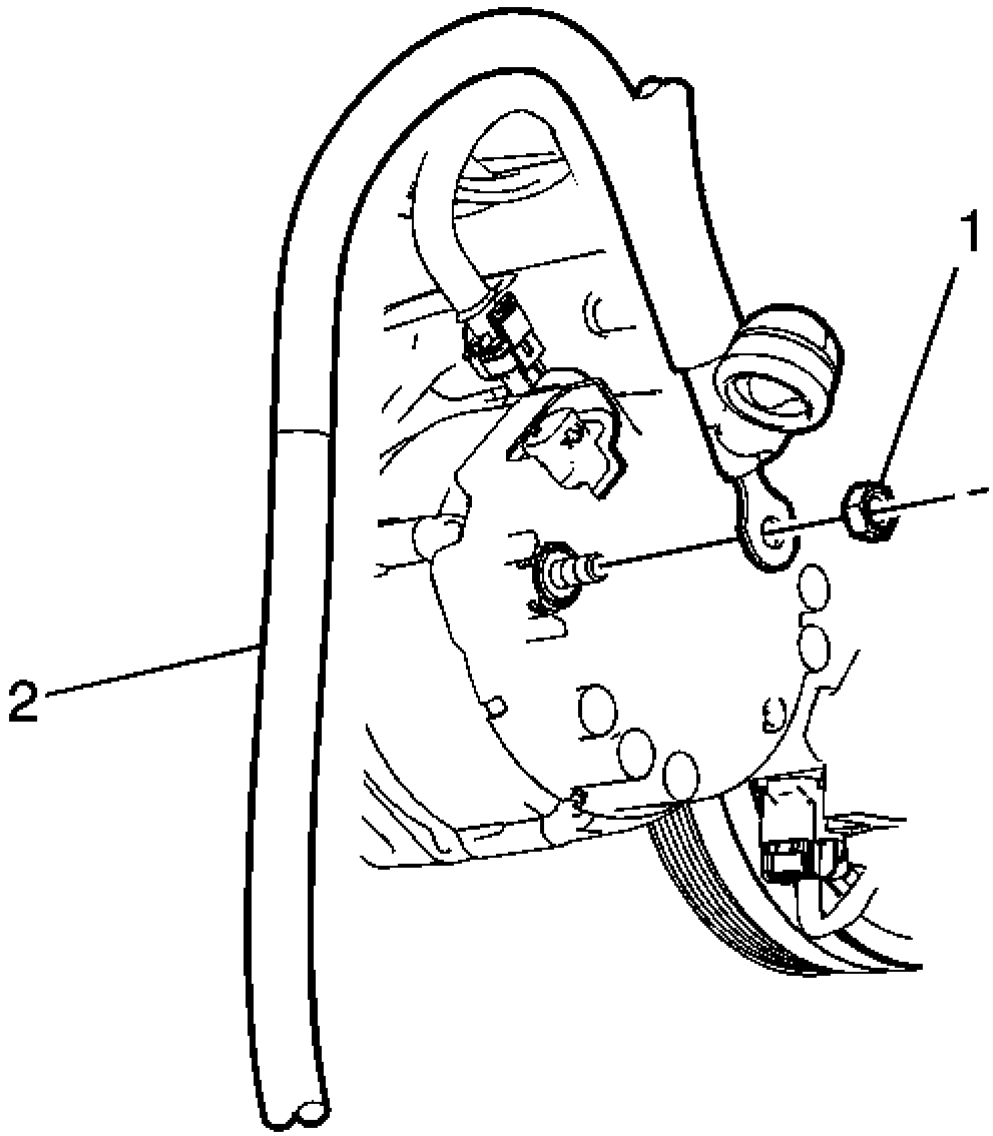


Fig. 18: Battery Positive Cable Generator Nut & Terminal
Courtesy of GENERAL MOTORS CORP.

2. Install the battery positive cable terminal (2) and the generator nut (1). Tighten to 15 N.m (11 lb ft).

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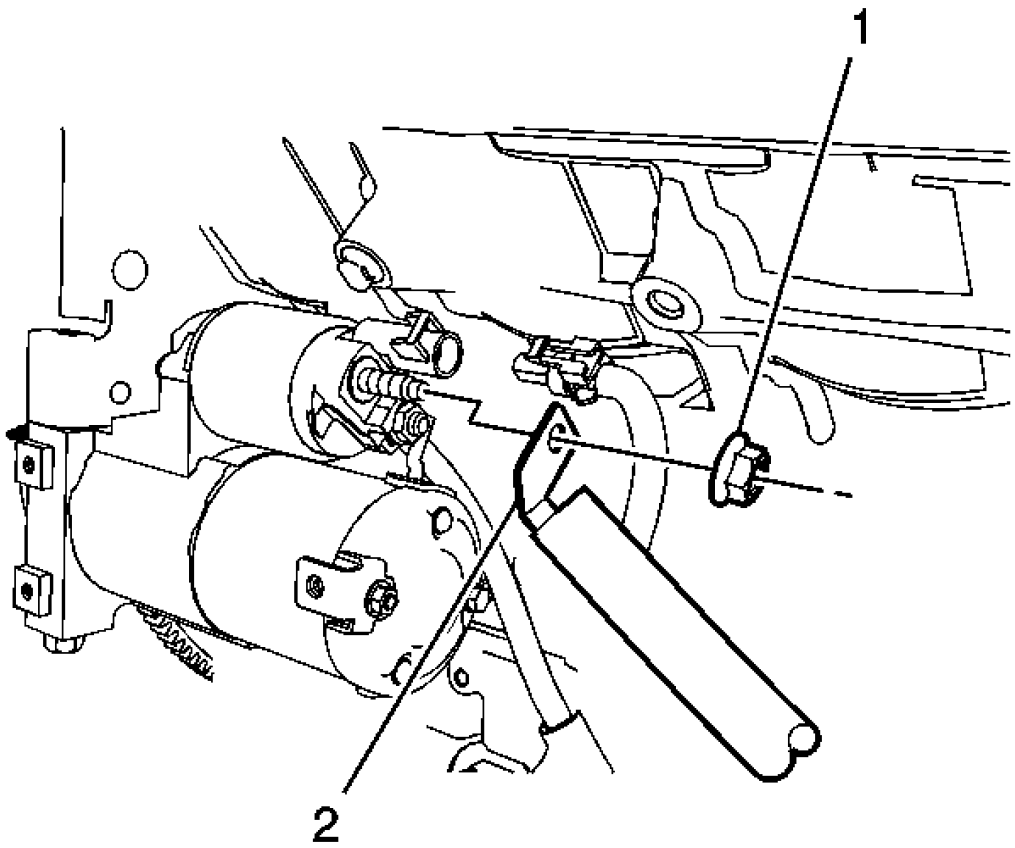


Fig. 19: Battery Positive Cable Nut & Terminal
Courtesy of GENERAL MOTORS CORP.

3. Install the battery positive cable terminal (2) and nut (1) to the starter. Tighten to 13 N.m (10 lb ft).

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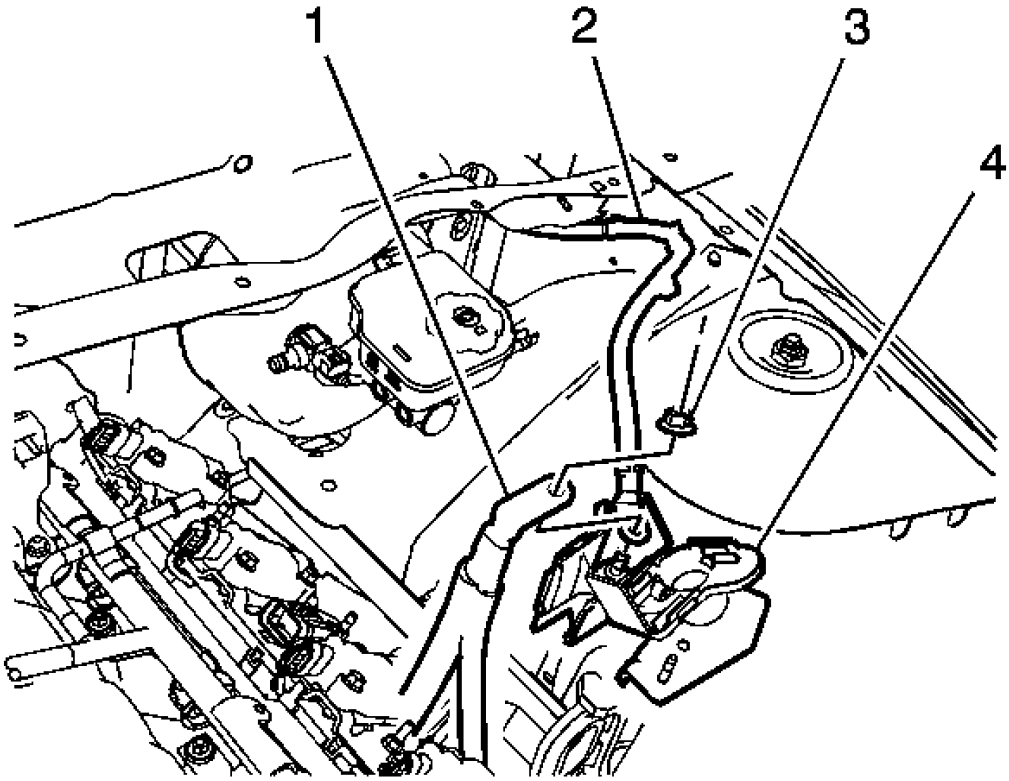


Fig. 20: Battery Positive Cable Components
Courtesy of GENERAL MOTORS CORP.

4. Install the engine harness and the battery positive cable terminal (1) to the junction block. Tighten the junction block nut (3) to 15 N.m (11 lb ft).

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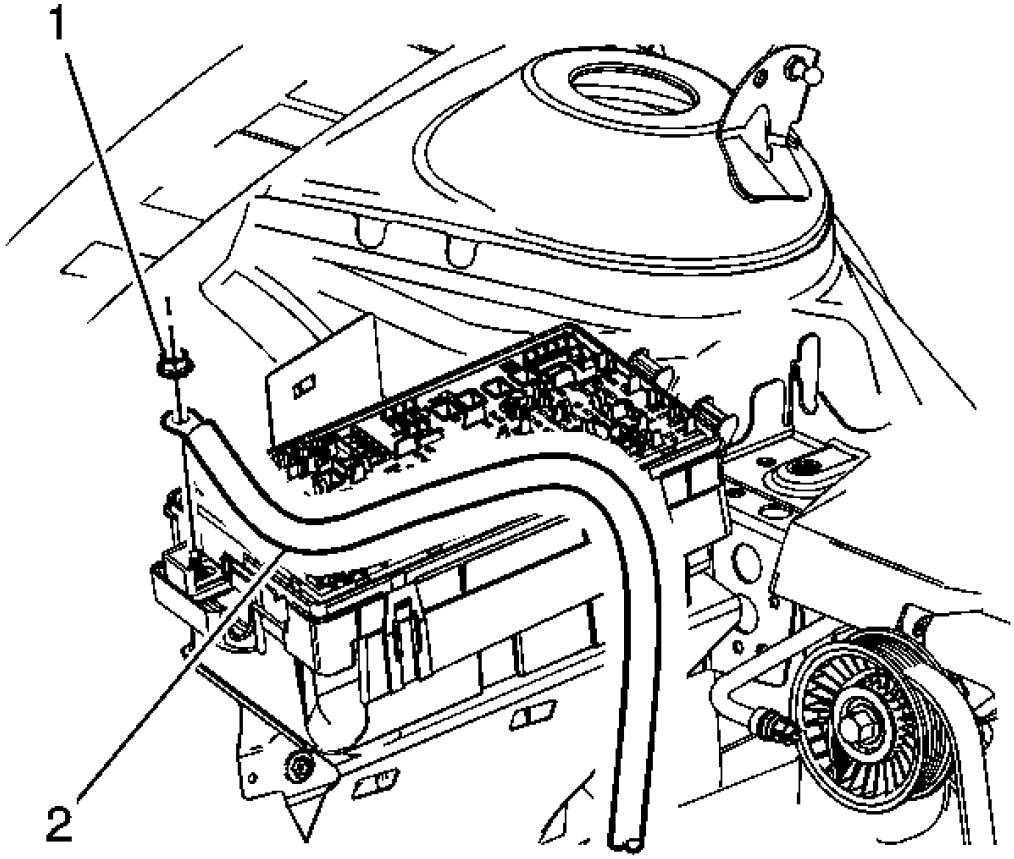


Fig. 21: Battery Positive Cable Terminal & Junction Nut
Courtesy of GENERAL MOTORS CORP.

5. Install the battery positive cable terminal (2) to the fuse block. Tighten the fuse block nut (1) to 15 N.m (11 lb ft).
6. Install the fuse block cover.
7. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

ENGINE WIRING AND BATTERY POSITIVE CABLE HARNESS REPLACEMENT (LLT)

Removal Procedure

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

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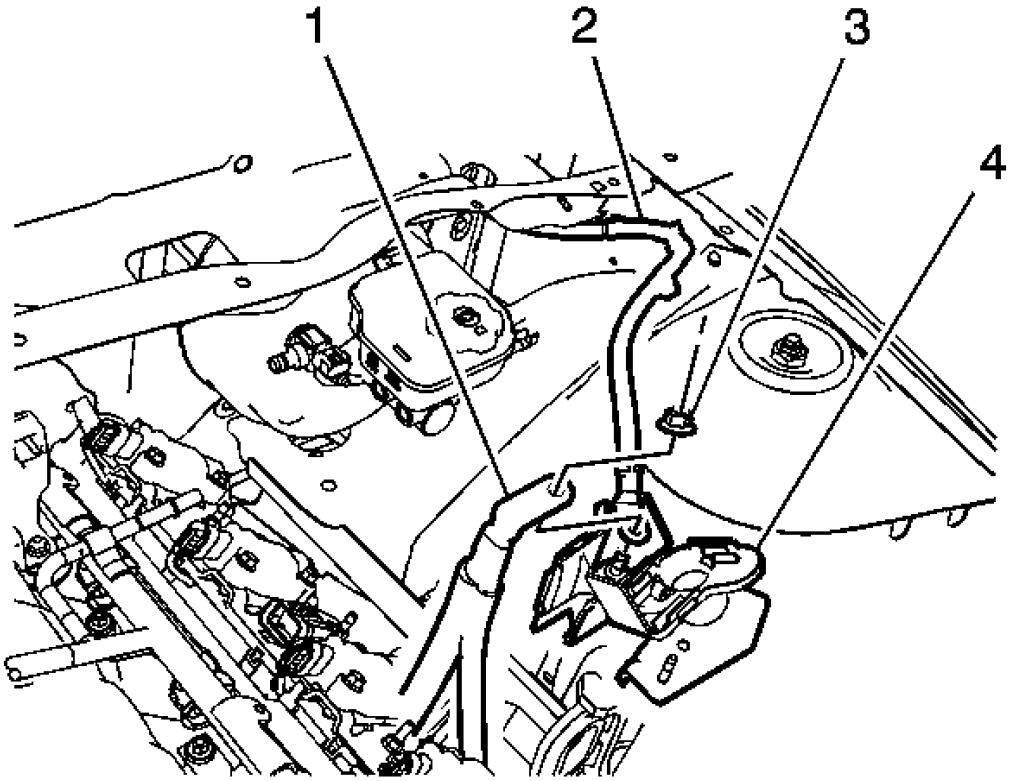


Fig. 22: Battery Positive Cable Components
Courtesy of GENERAL MOTORS CORP.

2. Remove the junction block cover (4).
3. Remove the junction block nut (3).
4. Remove the engine harness and the battery positive cable terminal from the junction block terminal (1).
5. Remove the engine harness and the battery positive cable (2).

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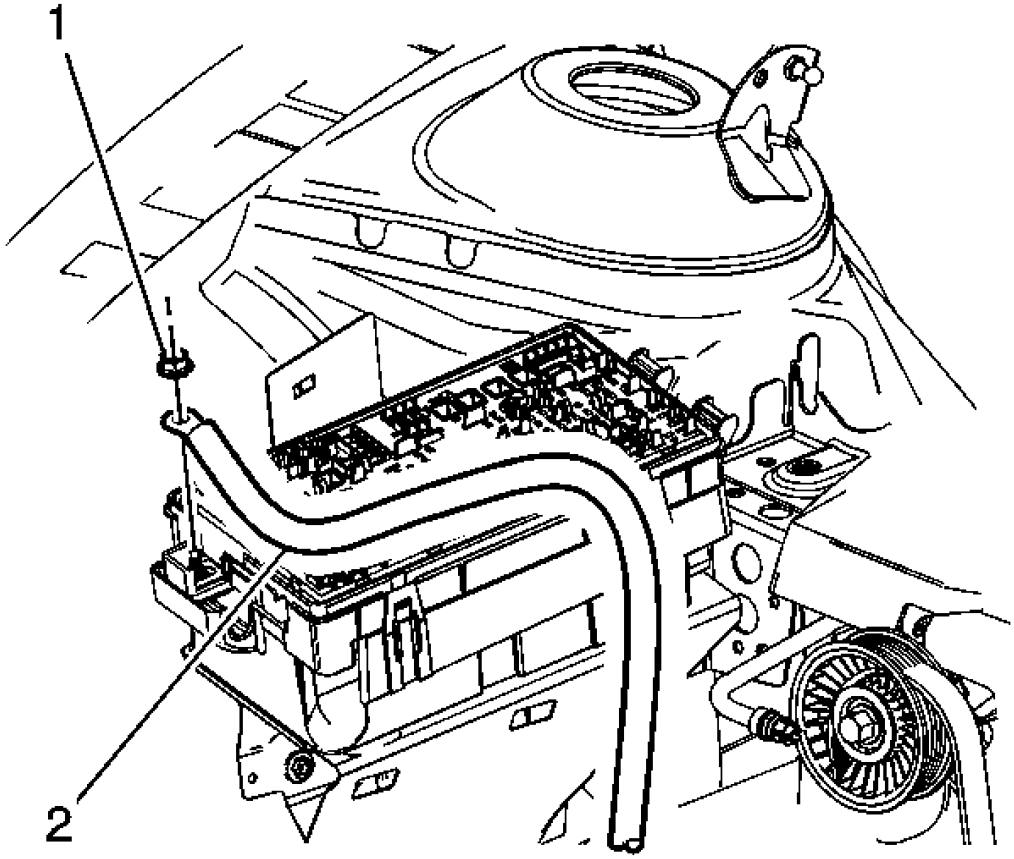


Fig. 23: Battery Positive Cable Terminal & Junction Nut
Courtesy of GENERAL MOTORS CORP.

6. Remove the battery positive cable terminal (2) and the junction nut (1), from the fuse block.

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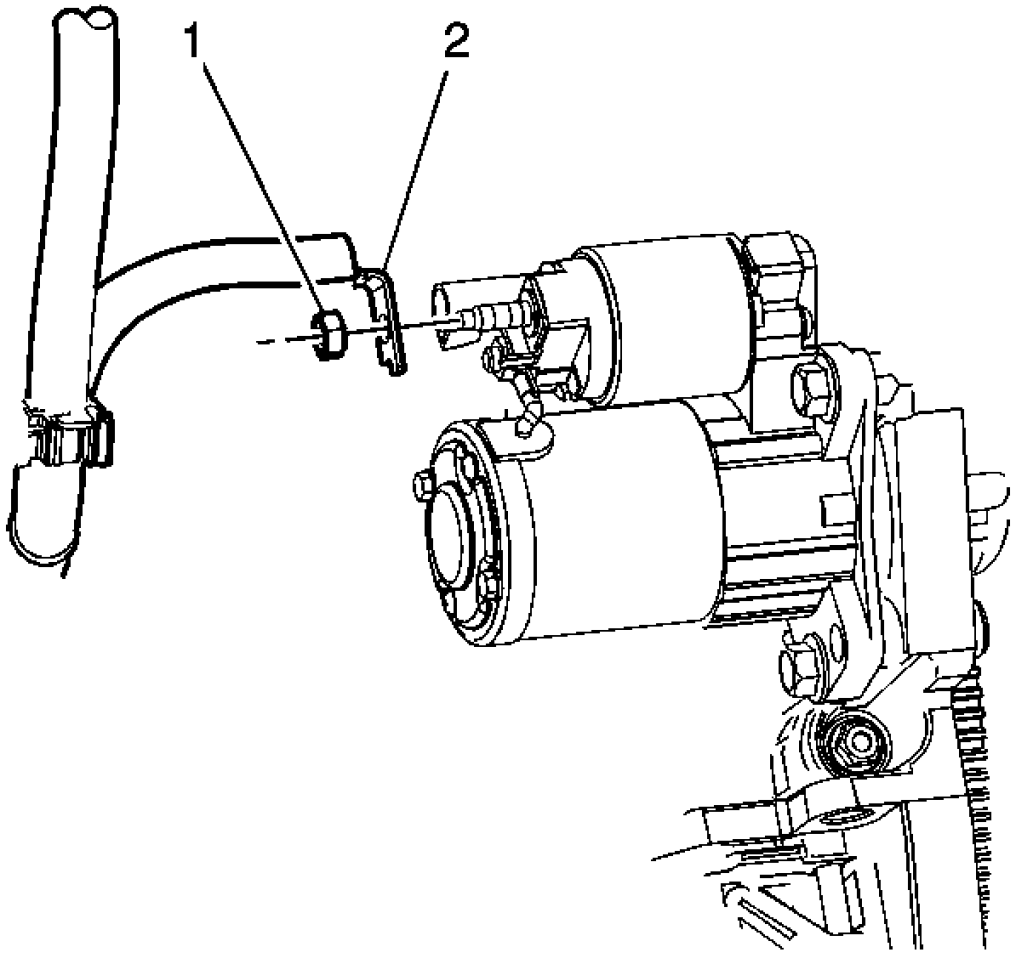


Fig. 24: Battery Positive Cable Nut & Terminal On Starter
Courtesy of GENERAL MOTORS CORP.

7. Remove the starter heat shield. Refer to **Starter Shield Replacement (LLT)** or **Starter Shield Replacement (LS3/L99)**.
8. Remove the battery positive cable nut (1) and the battery positive cable terminal (2), from the starter.

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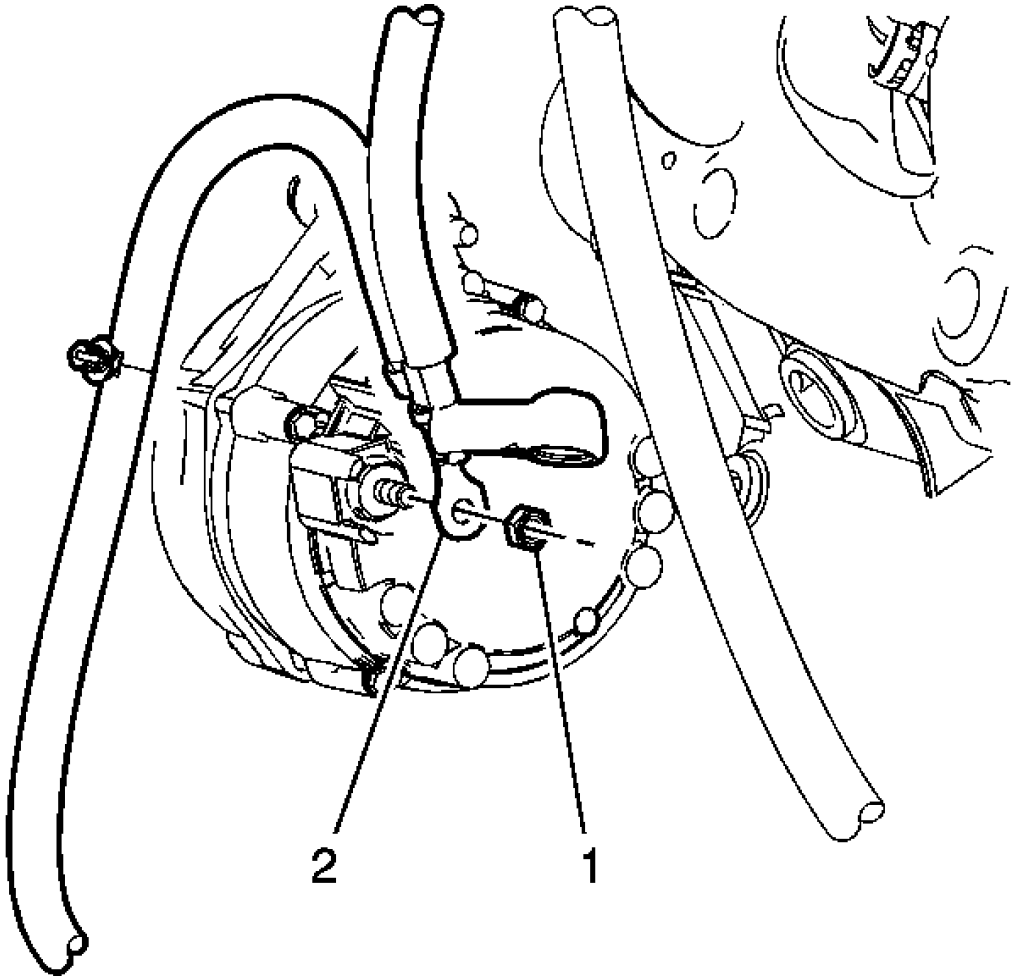


Fig. 25: Battery Positive Cable Generator Nut & Terminal On Generator
Courtesy of GENERAL MOTORS CORP.

9. Remove the battery positive cable generator nut (1) and the battery positive cable terminal (2), from the generator.

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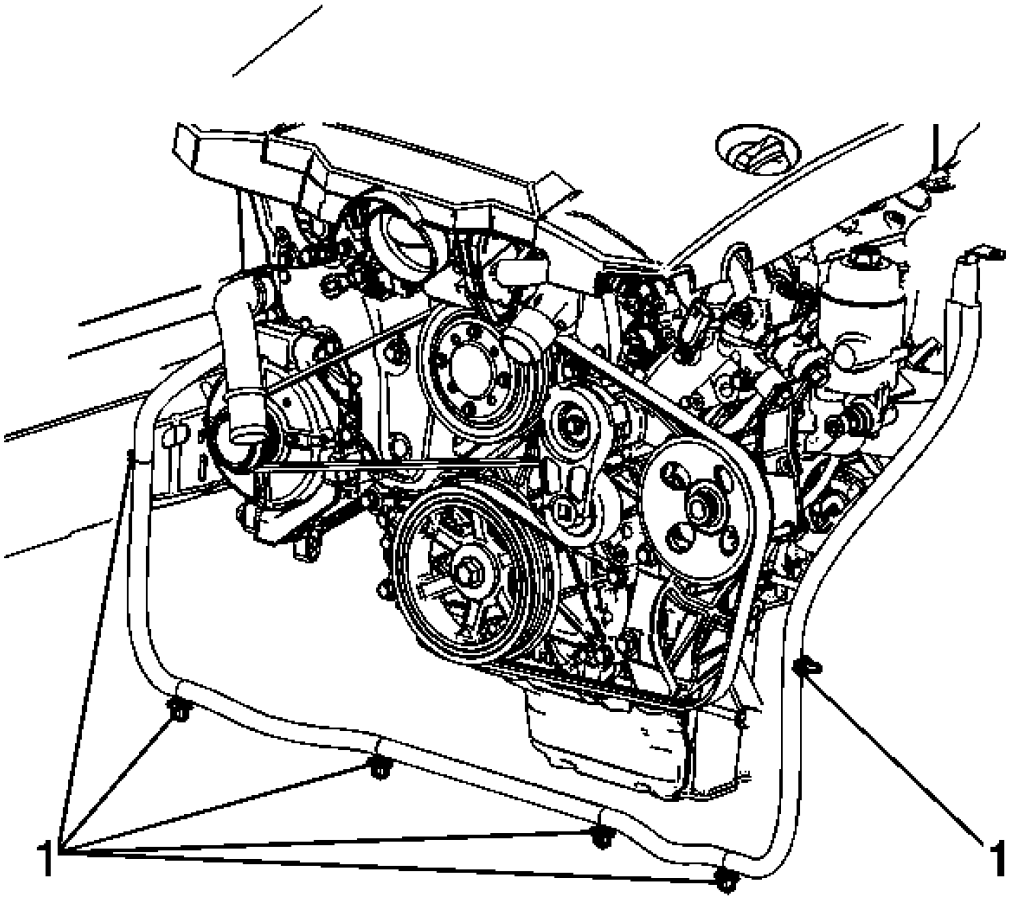


Fig. 26: Harness Fasteners On Frame
Courtesy of GENERAL MOTORS CORP.

10. Disconnect the fasteners (1) that hold the harness to the frame.

NOTE: Visualize how the harness was routed within the engine compartment.

11. Remove the engine and battery positive cable harness from the engine compartment.

Installation Procedure

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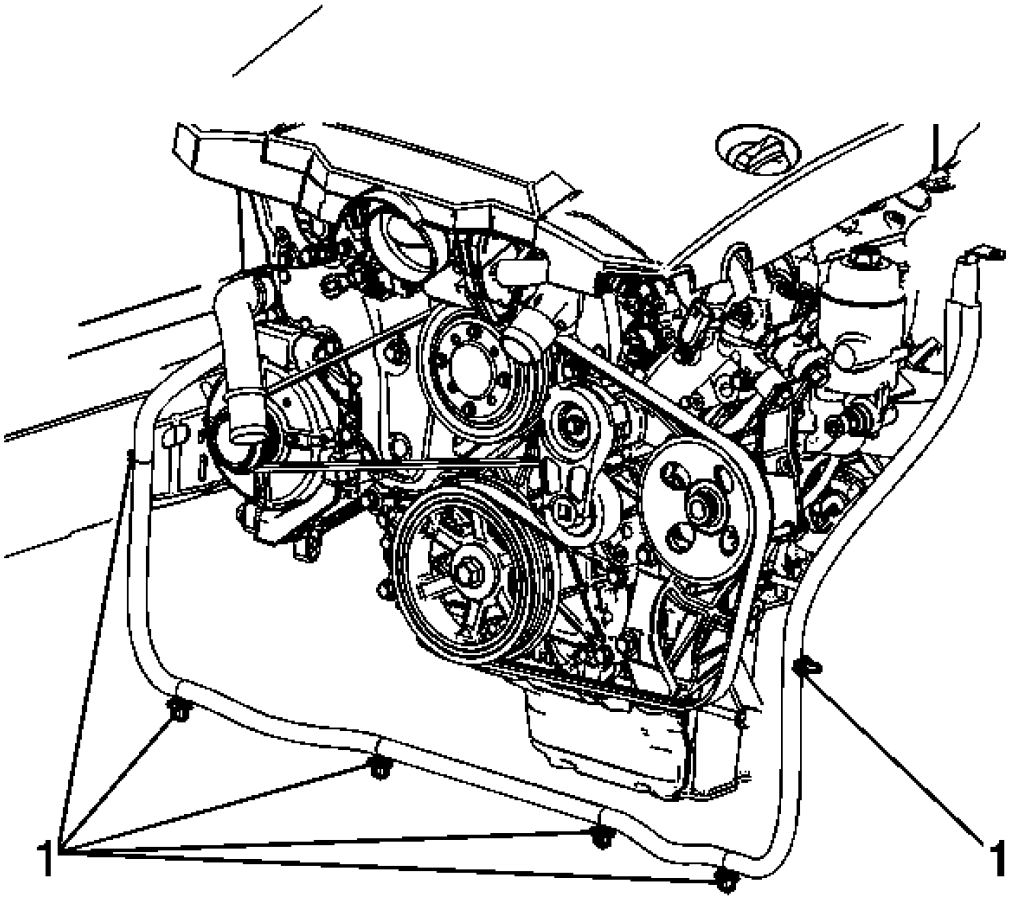


Fig. 27: Harness Fasteners On Frame
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Fasten the engine harness and the battery positive cable to the engine compartment with the harness retainers (1).

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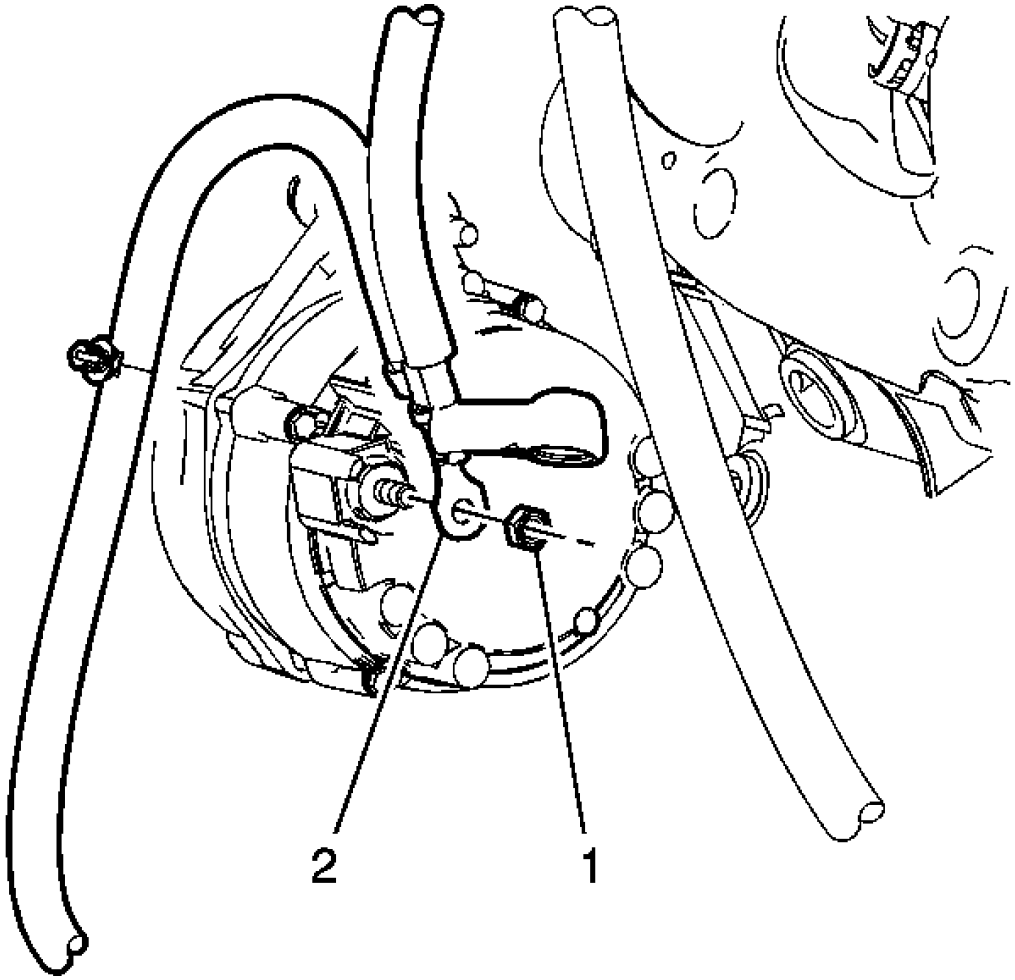


Fig. 28: Battery Positive Cable Generator Nut & Terminal On Generator
Courtesy of GENERAL MOTORS CORP.

2. Install the battery positive cable terminal (2) and the generator nut (1). Tighten to 15 N.m (11 lb ft).

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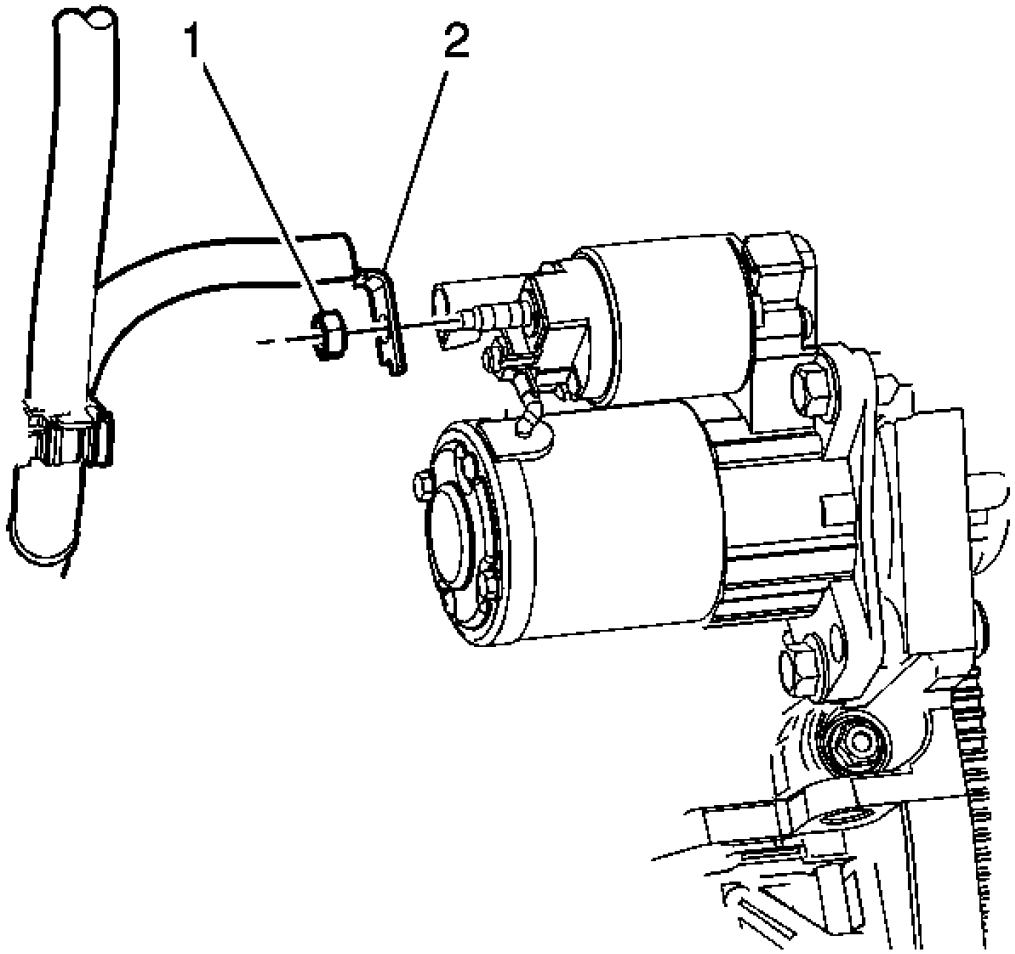


Fig. 29: Battery Positive Cable Nut & Terminal On Starter
Courtesy of GENERAL MOTORS CORP.

3. Install the battery positive cable terminal (2) and nut (1) to the starter. Tighten to 13 N.m (10 lb ft).

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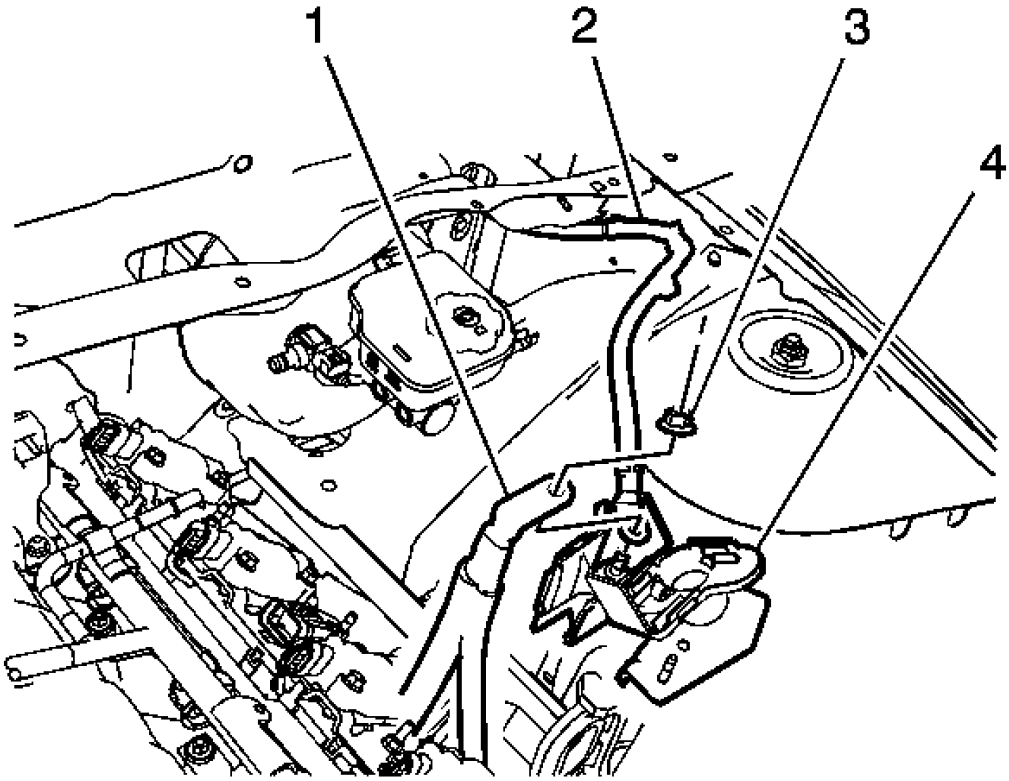


Fig. 30: Battery Positive Cable Components
Courtesy of GENERAL MOTORS CORP.

4. Install the engine harness and the battery positive cable terminal (1) to the junction block. Tighten the junction block nut (3) to 15 N.m (11 lb ft).

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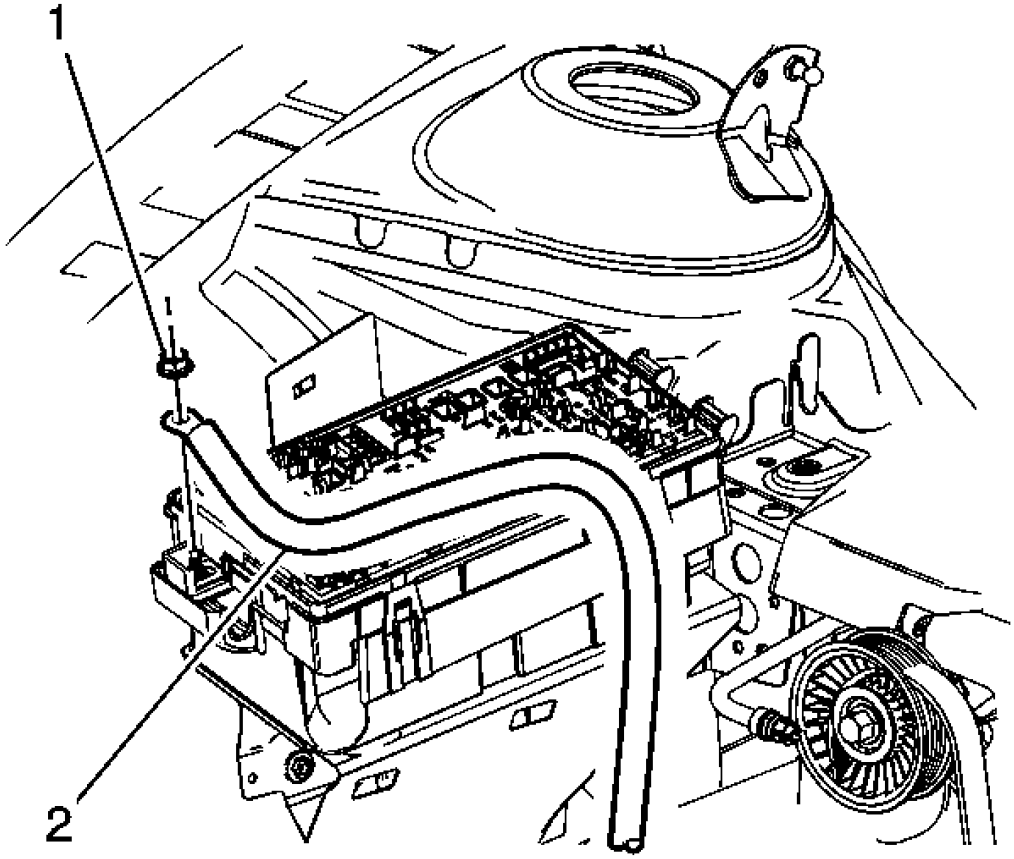


Fig. 31: Battery Positive Cable Terminal & Junction Nut
Courtesy of GENERAL MOTORS CORP.

5. Install the battery positive cable terminal (2) to the fuse block. Tighten the fuse block nut (1) to 15 N.m (11 lb ft).
6. Install the fuse block cover.
7. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

BATTERY REPLACEMENT

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Fig. 32: Battery
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**. 2. Disconnect the positive battery cable from the battery. Refer to **Battery Positive Cable Replacement**	
1	Battery Cover
2	Battery Support Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 22 N.m(16 lb ft)

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3	Battery Retainer Bolt
4	Battery Vent Tube
5	Battery

ENGINE GROUND CABLE REPLACEMENT

Fig. 33: Engine Ground Cable
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Ground Cable Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 25 N.m (18 lb ft)
2	Engine Ground Cable Stud **Tighten:** 48 N.m (35 lb ft)
3	Engine Ground Cable

STARTER REPLACEMENT (LLT)

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Fig. 34: Starter (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 3. Remove the starter heat shield. Refer to **Starter Shield Replacement (LLT)** or **Starter Shield Replacement (LS3/L99)**.	
1	Nut **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 13 N.m (115 lb in)
2	Bolt (Qty: 2) **Tighten:** 58 N.m (43 lb ft)
3	Starter **Procedure:** Disconnect the engine harness starter connector.

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STARTER REPLACEMENT (LS3/L99)

Fig. 35: Starter (LS3/L99)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 3. Remove the starter heat shield. Refer to **Starter Shield Replacement (LLT)** or **Starter Shield Replacement (LS3/L99)**.	
1	Nut **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 13 N.m (115 lb in)
2	Battery Positive Cable
3	Bolt (Qty: 2) **Tighten:** 58 N.m (43 lb ft)

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4	Starter **Procedure:** Disconnect the engine harness starter connector.

STARTER SHIELD REPLACEMENT (LLT)

Fig. 36: Starter Shield (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure:	

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Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Shield **Tip:** The shield is held to the exhaust manifold gasket with three retainers.

STARTER SHIELD REPLACEMENT (LS3/L99)

Fig. 37: Starter Shield (LS3/L99)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Bolt (Qty: 3) **Tighten:** 5 N.m (44 lb in)
2	Starter Heat Shield

GENERATOR BRACKET REPLACEMENT (LS3/L99)

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Fig. 38: Generator Bracket (LS3/L99)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**. 2. Remove the generator. Refer to **Generator Replacement (LLT)** or **Generator Replacement (LS3/L99)**.	
1	Nut **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 50 N.m (37 lb ft)
2	Bolt (Qty: 2) **Tighten:** 50 N.m (37 lb ft)
3	Generator **Procedure**

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	1. Disconnect the engine harness generator connector. 2. Transfer the drive belt idler pulley, if necessary.

GENERATOR REPLACEMENT (LLT)



Fig. 39: Generator (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**. 2. Remove the engine manifold cover. Refer to **Intake Manifold Cover Replacement - Front** . 3. Remove the radiator outlet pipe. Refer to **Radiator Outlet Pipe Replacement (LLT)** . 4. Remove the generator drive belt. Refer to **Drive Belt Replacement** .	
1	Nut **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 15 N.m (11 lb ft)
	Bolt (Qty: 2)

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2	**Tighten:** 58 N.m (43 lb ft)
3	Bolt (Qty: 1) **Tighten:** 58 N.m (43 lb ft)
4	Generator **Procedure:** Disconnect the engine harness generator connector.

GENERATOR REPLACEMENT (LS3/L99)



Fig. 40: Generator (LS3/L99)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**. 2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** . 3. Remove the generator drive belt. Refer to **Drive Belt Replacement - Accessory** .	
	Nut

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1	**CAUTION:** **Refer to Fastener Caution .** **Tighten:** 15 N.m (11 lb ft)
2	Generator battery positive cable
3	Bolt (Qty: 2) **Tighten:** 58 N.m (43 lb ft)
4	Generator **Procedure:** Disconnect the engine harness generator connector.

DESCRIPTION AND OPERATION

BATTERY DESCRIPTION AND OPERATION

WARNING: Batteries produce explosive gases, contain corrosive acid, and supply levels of electrical current high enough to cause burns. Therefore, to reduce the risk of personal injury when working near a battery:

- **Always shield your eyes and avoid leaning over the battery whenever possible.**
- **Do not expose the battery to open flames or sparks.**
- **Do not allow the battery electrolyte to contact the eyes or the skin. Flush immediately and thoroughly any contacted areas with water and get medical help.**
- **Follow each step of the jump starting procedure in order.**
- **Treat both the booster and the discharged batteries carefully when using the jumper cables.**

NOTE: Because of the materials used in the manufacture of automotive lead-acid batteries, dealers and service shops that handle them are subject to various regulations issued by OSHA, EPA, DOT, and various state or local agencies. Other regulations may also apply in other locations. Always know and follow these regulations when handling batteries.

Batteries that are no longer wanted must be disposed of by an approved battery recycler and must never be thrown in the trash or sent to a landfill.

Batteries that are not part of the vehicle itself, not the battery under the hood, must only be transported on public streets for business purposes via approved hazardous material transportation procedures.

Battery storage, charging and testing facilities in repair shops must meet various requirements for ventilation, safety equipment, material segregation, etc.

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The maintenance free battery is standard. There are no vent plugs in the cover. The battery is completely sealed except for 2 small vent holes in the side. These vent holes allow the small amount of gas that is produced in the battery to escape.

The battery has 3 functions as a major source of energy:

- Engine cranking
- Voltage stabilizer
- Alternate source of energy with generator overload

Battery Low Start Vehicle Message

When the vehicles battery is severely discharged, this message will display and four chimes may sound. Start the vehicle immediately. If the vehicle is not started and the battery continues to discharge, the climate controls, heated seats, and audio systems will shut off and the vehicle may require a jump start. These systems will function again after the vehicle is started.

Battery Ratings

A battery has 2 ratings:

- Cold cranking amperage
- Amp hours

When a battery is replaced use a battery with similar ratings. Refer to the battery specification label on the original battery or refer to **Battery Usage**.

Amp Hours

The amp hour rating tells you how much amperage is available when discharged evenly over a 20 hour period. The amp hour rating is cumulative, so in order to know how many constant amps the battery will output for 20 hours, you have to divide the amp hour rating by 20. Example: If a battery has an amp hour rating of 74, dividing by 20 = 3.75. Such a battery can carry a 3.75 A load for 20 hours before dropping to 10.5 V. (10.5 V is the fully discharged level, at which point the battery needs to be recharged.) A battery with an amp hour rating of 55 will carry a 2.75 A load for 20 hours before dropping to 10.5 V.

Cold Cranking Amperage

The cold cranking amperage is an indication of the ability of the battery to crank the engine at cold temperatures. The cold cranking amperage rating is the minimum amperage the battery must maintain for 30 seconds at -18°C (0°F) while maintaining at least 7.2 V. Refer to **Battery Usage** for the cold cranking amperage rating for this vehicle.

CHARGING SYSTEM DESCRIPTION AND OPERATION

Electrical Power Management Overview

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The electrical power management system is designed to monitor and control the charging system and send diagnostic messages to alert the driver of possible problems with the battery and generator. This electrical power management system primarily utilizes existing on-board computer capability to maximize the effectiveness of the generator, to manage the load, improve battery state-of-charge and life, and minimize the system's impact on fuel economy. The electrical power management system performs 3 functions:

- It monitors the battery voltage and estimates the battery condition.
- It takes corrective actions by boosting idle speeds, and adjusting the regulated voltage.
- It performs diagnostics and driver notification.

The battery condition is estimated during ignition-off and during ignition-on. During ignition-off the state-of-charge of the battery is determined by measuring the open-circuit voltage. The state-of-charge is a function of the acid concentration and the internal resistance of the battery, and is estimated by reading the battery open circuit voltage when the battery has been at rest for several hours.

The state-of-charge can be used as a diagnostic tool to tell the customer or the dealer the condition of the battery. Throughout ignition-on, the algorithm continuously estimates state-of-charge based on adjusted net amp hours, battery capacity, initial state-of-charge, and temperature.

While running, the battery degree of discharge is primarily determined by a battery current sensor, which is integrated to obtain net amp hours.

In addition, the electrical power management function is designed to perform regulated voltage control to improve battery state-of-charge, battery life, and fuel economy. This is accomplished by using knowledge of the battery state-of-charge and temperature to set the charging voltage to an optimum battery voltage level for recharging without detriment to battery life.

The Charging System Description and Operation is divided into 3 sections. The first section describes the charging system components and their integration into the electrical power management. The second section describes charging system operation. The third section describes the instrument panel cluster operation of the charge indicator, driver information center messages, and voltmeter operation.

Charging System Components

Generator

The generator is a serviceable component. If there is a diagnosed failure of the generator it must be replaced as an assembly. The engine drive belt drives the generator. When the rotor is spun it induces an alternating current (AC) into the stator windings. The AC voltage is then sent through a series of diodes for rectification. The rectified voltage has been converted into a direct current (DC) for use by the vehicles electrical system to maintain electrical loads and the battery charge. The voltage regulator integral to the generator controls the output of the generator. It is not serviceable. The voltage regulator controls the amount of current provided to the rotor. If the generator has field control circuit failure, the generator defaults to an output voltage of 13.8 V.

Body Control Module (BCM)

The body control module (BCM) is a GMLAN device. It communicates with the engine control module (ECM) and the instrument panel cluster for electrical power management (electrical power management) operation. The

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BCM determines the output of the generator and sends the information to the ECM for control of the generator turn on signal circuit. It monitors the generator field duty cycle signal circuit information sent from the ECM for control of the generator. It monitors a battery current sensor, the battery positive voltage circuit, and estimated battery temperature to determine battery state of charge. The BCM performs idle boost.

Battery Current Sensor

The battery current sensor is a serviceable component that is connected to the negative battery cable at the battery. The battery current sensor is a 3-wire hall effect current sensor. The battery current sensor monitors the battery current. It directly inputs to the BCM. It creates a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes.

Engine Control Module (ECM)

When the engine is running, the generator turn-on signal is sent to the generator from the ECM, turning on the regulator. The generator's voltage regulator controls current to the rotor, thereby controlling the output voltage. The rotor current is proportional to the electrical pulse width supplied by the regulator. When the engine is started, the regulator senses generator rotation by detecting AC voltage at the stator through an internal wire. Once the engine is running, the regulator varies the field current by controlling the pulse width. This regulates the generator output voltage for proper battery charging and electrical system operation. The generator field duty terminal is connected internally to the voltage regulator and externally to the ECM. When the voltage regulator detects a charging system problem, it grounds this circuit to signal the ECM that a problem exists. The ECM monitors the generator field duty cycle signal circuit, and receives control decisions based on information from the BCM.

Instrument Panel Cluster

The instrument panel cluster provides the customer notification in case a concern with the charging system. There are 2 means of notification, a charge indicator and a driver information center message of SERVICE BATTERY CHARGING SYSTEM if equipped.

Charging System Operation

The purpose of the charging system is to maintain the battery charge and vehicle loads. There are 6 modes of operation and they include:

- Battery Sulfation Mode
- Charge Mode
- Fuel Economy Mode
- Headlamp Mode
- Start Up Mode
- Voltage Reduction Mode

The engine control module (ECM) controls the generator through the generator turn ON signal circuit. The ECM monitors the generator performance though the generator field duty cycle signal circuit. The signal is a pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is

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between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes. The following table shows the commanded duty cycle and output voltage of the generator:

Commanded Duty Cycle	Generator Output Voltage
10%	11 V
20%	11.56 V
30%	12.12 V
40%	12.68 V
50%	13.25 V
60%	13.81 V
70%	14.37 V
80%	14.94 V
90%	15.5 V

The generator provides a feedback signal of the generator voltage output through the generator field duty cycle signal circuit to the ECM. This information is sent to the body control module (BCM). The signal is PWM signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-99 percent. Between 0-5 percent and 100 percent are for diagnostic purposes.

Battery Sulfation Mode

The BCM will enter this mode when the interpreted generator output voltage is less than 13.2 V for 45 minutes. When this condition exists the BCM will enter Charge Mode for 2-3 minutes. The BCM will then determine which mode to enter depending on voltage requirements.

Charge Mode

The BCM will enter Charge Mode when ever one of the following conditions are met.

- The wipers are ON for than 3 seconds.
- GMLAN (Climate Control Voltage Boost Mode Request) is true, as sensed by the HVAC control head. High speed cooling fan, rear defogger and HVAC high speed blower operation can cause the BCM to enter the Charge Mode.
- The estimated battery temperature is less than 0°C (32°F).
- Battery State of Charge is less than 80 percent.
- Vehicle speed is greater than 145 km/h (90 mph)
- Current sensor fault exists.
- System voltage was determined to be below 12.56 V

When any one of these conditions is met, the system will set targeted generator output voltage to a charging voltage between 13.9-15.5 V, depending on the battery state of charge and estimated battery temperature.

Fuel Economy Mode

The BCM will enter Fuel Economy Mode when the estimated battery temperature is at least 0°C (32°F) but less

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than or equal to 80°C (176°F), the calculated battery current is less than 15 amperes and greater than -8 amperes, and the battery state-of-charge is greater than or equal to 80 percent. Its targeted generator output voltage is the open circuit voltage of the battery and can be between 12.5-13.1 V. The BCM will exit this mode and enter Charge Mode when any of the conditions described above are present.

Headlamp Mode

The BCM will enter Headlamp Mode when ever the headlamps are ON (high or low beams). Voltage will be regulated between 13.9-14.5 V.

Start Up Mode

When the engine is started the BCM sets a targeted generator output voltage of 14.5 V for 30 seconds.

Voltage Reduction Mode

The BCM will enter Voltage Reduction Mode when the calculated ambient air temperature is above 0°C (32°F). The calculated battery current is less than 1 ampere and greater than -7 amperes, and the generator field duty cycle is less than 99 percent. Its targeted generator output voltage is 12.9 V. The BCM will exit this mode once the criteria are met for Charge Mode.

Instrument Panel Cluster Operation

Charge Indicator Operation

The instrument panel cluster illuminates the charge indicator and displays a warning message in the driver information center if equipped, when the one or more of the following occurs:

- The engine control module (ECM) detects that the generator output is less than 11 V or greater than 16 V. The instrument panel cluster receives a GMLAN message from the ECM requesting illumination.
- The instrument panel cluster determines that the system voltage is less than 11 V or greater than 16 V for more than 30 seconds. The instrument panel cluster receives a GMLAN message from the body control module (BCM) indicating there is a system voltage range concern.
- The instrument panel cluster performs the displays test at the start of each ignition cycle. The indicator illuminates for approximately 3 seconds.

BATTERY NOT CHARGING SERVICE CHARGING SYSTEM

The BCM and the ECM will send a GMLAN message to the driver information center for the BATTERY NOT CHARGING SERVICE CHARGING SYSTEM message to be displayed. It is commanded ON when a charging system DTC is a current DTC. The message is turned OFF when the conditions for clearing the DTC have been met.

SERVICE BATTERY CHARGING SYSTEM

The BCM and the ECM will send a GMLAN message to the driver information center for the SERVICE BATTERY CHARGING SYSTEM message to be displayed. It is commanded ON when a charging system DTC is a current DTC. The message is turned OFF when the conditions for clearing the DTC have been met.

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ELECTRICAL POWER MANAGEMENT DESCRIPTION AND OPERATION

Electrical Power Management

The electrical power management is used to monitor and control the charging system and alert the driver of possible problems within the charging system. The electrical power management system makes the most efficient use of the generator output, improves the battery state of charge, extends battery life.

The idle boost operation is a means of improving generator performance during a low voltage or low battery state-of-charge condition.

Idle boost is activated in incremental steps, idle boost 1 must be active before idle boost 2 can be active. The criteria used by the body control module (BCM) to regulate electrical power management are outlined below:

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-hour Calculation	Action Taken
Idle Boost 1 Start	Less Than -15°C (5° F)	Less Than 13 V	-	First level Idle boost requested
Idle Boost 1 Start	-	-	Battery has a net loss greater than 0.6 AH	First level Idle boost requested
Idle Boost 1 Start	-	Less Than 11 V	-	First level Idle boost requested
Idle Boost 1 End	Greater Than -15°C (5°F)	Greater Than 12 V	Battery has a net loss less than 0.2 AH	First level Idle boost request cancelled
Idle Boost 2 Start	-	Less Than 11 V	-	Second level Idle boost requested
Idle Boost 2 End	-	Greater Than 12 V	Battery has a net loss less than 0.8 AH	Second level Idle boost request cancelled
Idle Boost 3 Start	-	-	Battery has a net loss of 10 AH	Third level Idle boost requested
Idle Boost 3 Start	-	Less Than 11 V	-	Third level Idle boost requested
Idle Boost 3 End	-	Greater Than 12 V	Battery has a net loss of less than 6 AH	Third level Idle boost request cancelled

LOAD SHED SYSTEM DESCRIPTION AND OPERATION

Electrical Power Management

The electrical power management is used to monitor and control the charging system and alert the driver of possible problems within the charging system. The electrical power management system makes the most

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efficient use of the generator output, improves the battery state-of-charge, extends battery life, and manages system electrical loads.

The load shed operation is a means of reducing electrical loads during a low voltage or low battery state-of-charge condition.

The idle boost operation is a means of improving generator performance during a low voltage or low battery state-of-charge condition.

Each electrical power management function, either idle boost or load shed, is discrete. No two functions are active at the same time. Idle boost is activated in incremental steps, idle boost 1 must be active before idle boost 2 can be active. The criteria used by the body control module (BCM) to regulate electrical power management are outlined below:

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Idle Boost 1 Start	Less Than -15°C (5° F)	Less Than 13 V	-	First level Idle boost requested
Idle Boost 1 Start	-	-	Battery has a net loss greater than 0.6 AH	First level Idle boost requested
Idle Boost 1 Start	-	Less Than 10.9 V	-	First level Idle boost requested
Idle Boost 1 End	Greater Than -15°C (5°F)	Greater Than -12 V	Battery has a net loss less than 0.2 AH	First level Idle boost request cancelled
Load Shed 1 Start	-	-	Battery has a net loss of 4 AH	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 20% of their cycle
Load Shed 1 Start	-	Less Than 10.9 V	-	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 20% of their cycle
Load Shed 1 End	-	Greater Than 12 V	Battery has a net loss of less than 2 AH	Clear Load Shed 1
Idle Boost 2 Start	-	-	Battery has a net loss greater than 1.6 AH	Second level Idle boost requested
Idle Boost 2 Start	-	Less Than 10.9 V	-	Second level Idle boost requested
			Battery has a net	Second level Idle

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Idle Boost 2 End	-	Greater Than 12 V	loss less than 0.8 AH	boost request cancelled
Idle Boost 3 Start	-	-	Battery has a net loss of 10.0 AH	Third level Idle boost requested
Idle Boost 3 Start	-	Less Than 10.9 V	-	Third level Idle boost requested
Idle Boost 3 End	-	Greater Than 12 V	Battery has a net loss of less than 6.0 AH	Third level Idle boost request cancelled
Load Shed 2 Start	-	Less Than 10.9 V	Battery has a net loss greater than 12 AH	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 Start	-	Less Than 10.9 V	-	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 End	-	Greater Than 12.6 V	Battery has a net loss of less than 10.5 AH	Clear Load Shed 2
Load Shed 3 Start	-	Less Than 11.9 V	Battery has a net loss greater than 20 AH	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 100% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 3 End	-	Greater Than 12.6 V	Battery has a net loss of less than 15 AH	Clear Load Shed 3

STARTING SYSTEM DESCRIPTION AND OPERATION

The starter motors on this vehicle are non-repairable starter motors. They have pole pieces that are arranged

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around the armature. Both solenoid windings are energized. The pull-in winding circuit is completed to the ground through the starter motor. The windings work together magnetically to pull and hold in the plunger. The plunger moves the shift lever. This action causes the starter drive assembly to rotate on the armature shaft spline as it engages with the flywheel ring gear on the engine. Moving at the same time, the plunger also closes the solenoid switch contacts in the starter solenoid. Full battery voltage is applied directly to the starter motor and it cranks the engine.

As soon as the solenoid switch contacts close, current stops flowing thorough the pull-in winding because battery voltage is applied to both ends of the windings. The hold-in winding remains energized; its magnetic field is strong enough to hold the plunger, shift lever, starter drive assembly, and solenoid switch contacts in place to continue cranking the engine. When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened.

When the ignition switch is released from the START position, the starter relay opens and battery voltage is removed from the starter solenoid. Current flows from the motor contacts through both windings to the ground at the end of the hold-in winding. However, the direction of the current flow through the pull-in winding is now opposite the direction of the current flow when the winding was first energized.

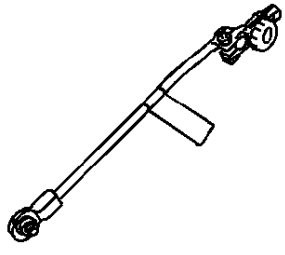
The magnetic fields of the pull-in and hold-in windings now oppose one another. This action of the windings, along with the help of the return spring, causes the starter drive assembly to disengage and the solenoid switch contacts to open simultaneously. As soon as the contacts open, the starter circuit is turned off.

Circuit Description

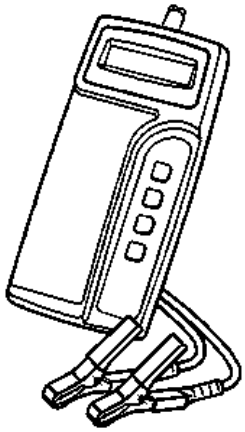
When the ignition switch is placed in the Start position a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the START position. The BCM then sends a message to the engine control module (ECM) notifying it that CRANK has been requested. The ECM verifies that the transmission is in Park / Neutral. If it is, the ECM then supplies 12 V to the control circuit of the starter relay. When this occurs battery positive voltage is supplied through the switch side of the starter relay to the starter solenoid.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/Description
	EL 38758 EL 50074 J 38758 Parasitic Draw Test Switch

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	EL 42000 EL 50076 J 42000 Battery Tester

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2010 ENGINE

Engine Exhaust - Camaro

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	Specification	
	Metric	English
Catalytic Converter to Exhaust Manifold Nut	48 N.m	35 lb ft
Exhaust Muffler Clamp	48 N.m	35 lb ft
Exhaust Muffler (H Pipe) Clamps	48 N.m	35 lb ft
Exhaust Manifold Heat Shield Bolt	10 N.m	89 lb in
Underbody Brace	58 N.m	43 lb ft

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - ENGINE EXHAUST

- Review the Exhaust System Description and Operation in order to familiarize yourself with the system functions. Refer to **Exhaust System Description**.
- All diagnostics on a vehicle should follow a logical process. Strategy Based Diagnostics is a uniform approach for repairing all systems. The diagnostic flow is the place to start when repairs are necessary and may always be used in order to resolve a system problem. For a detailed explanation, refer to **Strategy Based Diagnosis** .

Visual/Physical Inspection

- Inspect for aftermarket or non-OEM devices such as, but not including; tailpipe extensions, headers, and exhaust cutouts. This could affect the operation and proper performance of the exhaust system.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, engine temperature, engine load, and frequency of concern.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause any symptom.

Intermittent

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

Symptom List

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

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- Loss of power-Refer to **Restricted Exhaust**.
- Poor acceleration-Refer to **Restricted Exhaust**.
- Poor fuel economy-Refer to **Restricted Exhaust**.
- Excessive smoke-diesel-Refer to **Restricted Exhaust**.
- Exhaust hissing noise-Refer to **Exhaust Leakage**.
- Exhaust popping noise-Refer to **Exhaust Leakage**.
- Exhaust rattle noise-Refer to **Exhaust Noise**.
- Loud exhaust noise-Refer to **Exhaust Noise**
- Exhaust buzz, groan, hum noise-Refer to **Exhaust Noise**.

RESTRICTED EXHAUST

Special Tools

J 35314-A: Exhaust Back Pressure Gauge

Diagnostic Aids

> **WARNING:** **Refer to Hot Exhaust System Warning .**

For dual exhaust systems a quick check of exhaust flow will help determine which side of the exhaust system is restricted. The side that has less exhaust flow is the side that will be suspect, and diagnosis should begin there.

Test Description

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

4: The exhaust system has very low back pressure under normal conditions. If the exhaust system is restricted, a significant increase in the exhaust pressure is noticed on the **J 35314-A:** Exhaust Back Pressure Gauge .Removing the HO2S sensor may set a DTC. When finishing this diagnostic table, be sure to clear all codes.

5: This step will isolate the catalytic converter from the remainder of the exhaust system.

8: Confirming that the condition has been fixed is essential. If the symptom still exists and the vehicle has a dual exhaust system, proceed to step 2 and repeat diagnostic procedure on the opposite exhaust pipe.

Step	Action	Value(s)	Yes	No
1	Did you verify the customers complaint?	-	Go to **Step 2**	-
2	Did you review the exhaust symptoms diagnostic information and perform the necessary inspections?	-	Go to **Step 3**	Go to **Symptoms - Engine Exhaust**
3	Is the system equipped with dual exhaust?	-	Go to	

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			Diagnostic Aids	Go to **Step 4**
4	1. Remove the heated oxygen sensor (HO2S) that is in front of the catalytic converter. Refer **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1** or **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1** . 2. Install the **J 35314-A:** Exhaust Back Pressure Gauge in place of the HO2S sensor. 3. Start the engine. 4. Increase and monitor the engine speed at 2,500 RPM. 5. Observe the exhaust system back pressure reading on the gauge. Does the reading exceed the specified value?	9 kPa (1.25 psi)	Go to **Step 5**	Go to **Step 8**
5	1. Turn the engine off and place the ignition in the lock position. 2. Remove the **J 35314-A** . See **Special Tools**. 3. Re-install the HO2S sensor. Refer to **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1** or **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1** . 4. Remove the post-catalyst HO2S sensor. Refer to **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2** or **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2** . 5. Install the **J 35314-A** in place of the post HO2S sensor. See **Special Tools**. 6. Start the engine. 7. Increase and monitor the engine speed at 2,500 RPM. 8. Observe the exhaust system back pressure reading on the gauge. Does the reading exceed the specified value?	9 kPa (1.25 psi)	Go to **Step 6**	Go to **Step 7**
	Inspect the exhaust system for the following conditions: • Secondary catalyst restricted			

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6	• Damage in the exhaust pipe • Debris in the exhaust pipe • Muffler or resonator internal failure • Two-layer exhaust pipe separation Did you find and correct the condition?	-	Go to **Step 8**	-
7	Replace the catalytic converter. Refer to **Catalytic Converter Replacement - Left Side (LLT)** or **Catalytic Converter Replacement - Left Side (L99/LS3)** or **Catalytic Converter Replacement - Right Side (LLT)** or **Catalytic Converter Replacement - Right Side (L99/LS3)**. Did you find and correct the condition?	-	Go to **Step 8**	-
8	1. Remove the **J 35314-A** . See **Special Tools**. 2. Reinstall the applicable HO2S sensor. Refer to **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2** or **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2** . 3. Clear any codes. 4. Road test the vehicle in order to verify the repair. Did you correct the condition?	-	System OK	Go to **Step 2**

EXHAUST LEAKAGE

Condition	Action
WARNING: **Refer to Hot Exhaust System Warning .** DEFINITION: An exhaust leak may show stains at the area of the leak. The leak may be felt by holding a hand close to the suspected areas or using a smoke pencil. The leak may make a popping or hissing noise.Refer to **Symptoms - Engine Exhaust** prior to beginning this table.	
Misaligned or improperly installed exhaust system components	• Align and tighten the exhaust system components to the specifications. Refer to **Fastener Tightening Specifications**. • Ensure the exhaust hangers are in the proper locations and not loose. Refer to **Exhaust Muffler with Resonator, Exhaust, and Tail Pipe Replacement (H-Pipe)** or **Exhaust Muffler with Resonator, Exhaust, and Tail Pipe Replacement (Vehicle**

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	Service).
Exhaust leaks at the following connections: • Exhaust manifold to pipe • Flanges • Pipe clamps	Tighten the components to the specifications. Refer to **Fastener Tightening Specifications**.
Seals or gaskets leaking; • Exhaust manifold to cylinder head • Exhaust pipes to exhaust manifold • Catalytic converter connection	Replace the leaking seal or gasket. Refer to the affected components procedure for service.
Irregularities at the mating surfaces on the flange connections	Repair as required or replace the affected component. Refer to the affected components procedure for service.
Exhaust manifold cracked or broken	Replace the exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (LLT)** or **Exhaust Manifold Replacement - Left Side (L99/LS3)** or **Exhaust Manifold Replacement - Right Side (LLT)** or **Exhaust Manifold Replacement - Right Side (L99/LS3)**.
Exhaust system component connection welds leaking	Replace the leaking component. Refer to the affected component's procedure for service.
Muffler or resonator, if equipped, damaged or leaking at the seams	Replace the affected muffler or resonator, if equipped. Refer to **Exhaust Muffler Replacement - Left Side** .or **Exhaust Muffler Replacement - Right Side**

EXHAUST NOISE

Condition	Action
WARNING: **Refer to Hot Exhaust System Warning .** DEFINITION: An audible or physical noise due to a faulty component or damaged components causing a loose or misaligned exhaust system resulting in a rattle or vibration noise, i.e. buzz, groan, hum.Refer to **Symptoms - Engine Exhaust** prior to beginning this table.	
Popping or hissing noise	Exhaust leak-Refer to **Exhaust Leakage**.
Loud exhaust	1. Compare to a known good vehicle. 2. Inspect for a damaged or failed muffler or resonator, if equipped. 3. Replace the faulty muffler or resonator (if equipped). Refer to **Exhaust Muffler Replacement - Left Side** .or **Exhaust Muffler Replacement - Right Side**

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External rattle or vibration noise	1. Inspect for a bent or loose hanger, loose heat shield, or loose clamp. 2. Inspect for a exhaust pipe causing interference. 3. Repair or replace the affected component. Refer to the affected component's service procedure.
Internal rattle	1. Test the components by tapping with a rubber mallet to confirm a rattle. 2. Replace the faulty catalytic converter, resonator, if equipped, or muffler. Refer to **Exhaust Muffler Replacement - Left Side** or **Exhaust Muffler Replacement - Right Side**

REPAIR INSTRUCTIONS

EXHAUST MANIFOLD REPLACEMENT - LEFT SIDE (LLT)

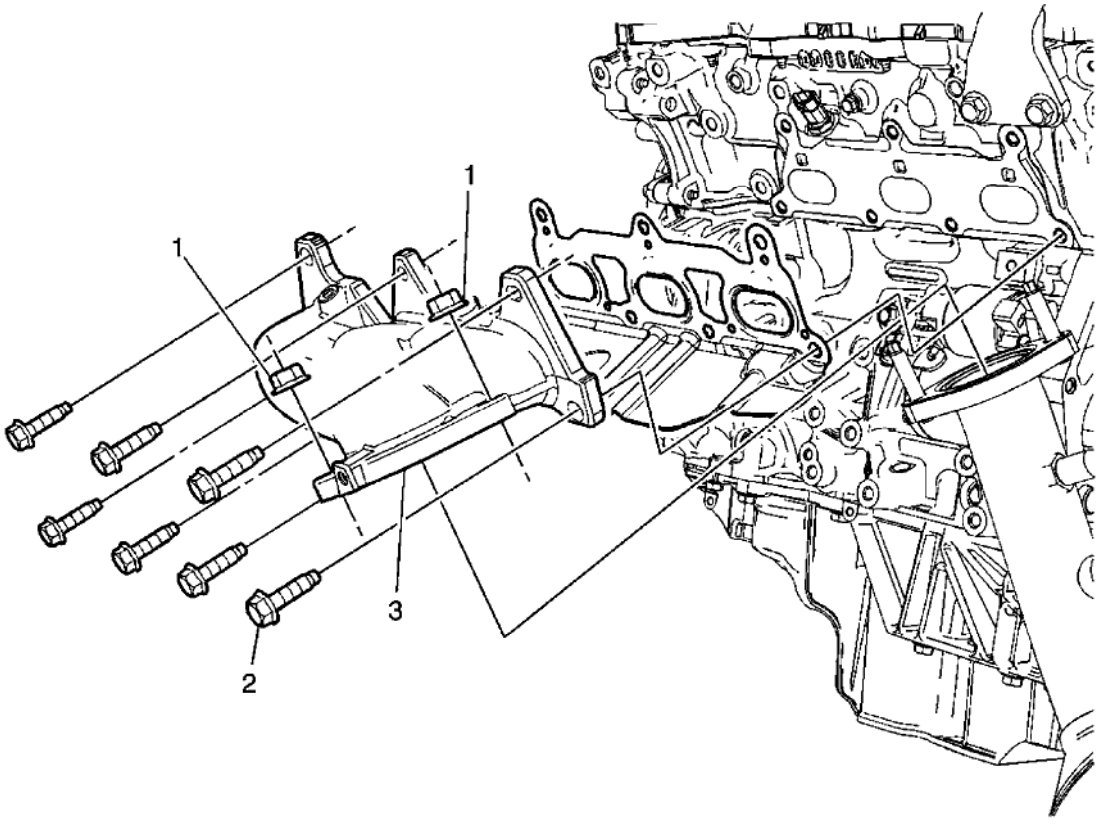


Fig. 1: Exhaust Manifold - Left Side (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure:	

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Remove the left exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement - Left Side (LLT)** or **Exhaust Manifold Heat Shield Replacement - Left Side (L99/LS3)**.	
1	Nut (Qty: 2) **WARNING:** **Refer to Hot Exhaust System Warning .** **CAUTION:** **Refer to Fastener Caution .** **Tip:** • Replace the gasket. • Clean the cylinder head surface. • Clean the exhaust manifold surface. **Tighten:** 48 N.m (35 lb ft)
2	Bolt (Qty: 7) **Tighten:** 20 N.m (15 lb ft)
3	Exhaust Manifold

EXHAUST MANIFOLD REPLACEMENT - LEFT SIDE (L99/LS3)

Removal Procedure

1. Remove the engine sight shield. Refer to **Engine Cover Replacement** .
2. Remove the left bank coil assembly. Refer to **Ignition Coil Replacement** .
3. Remove the left bank spark plugs. Refer to **Spark Plug Replacement** .
4. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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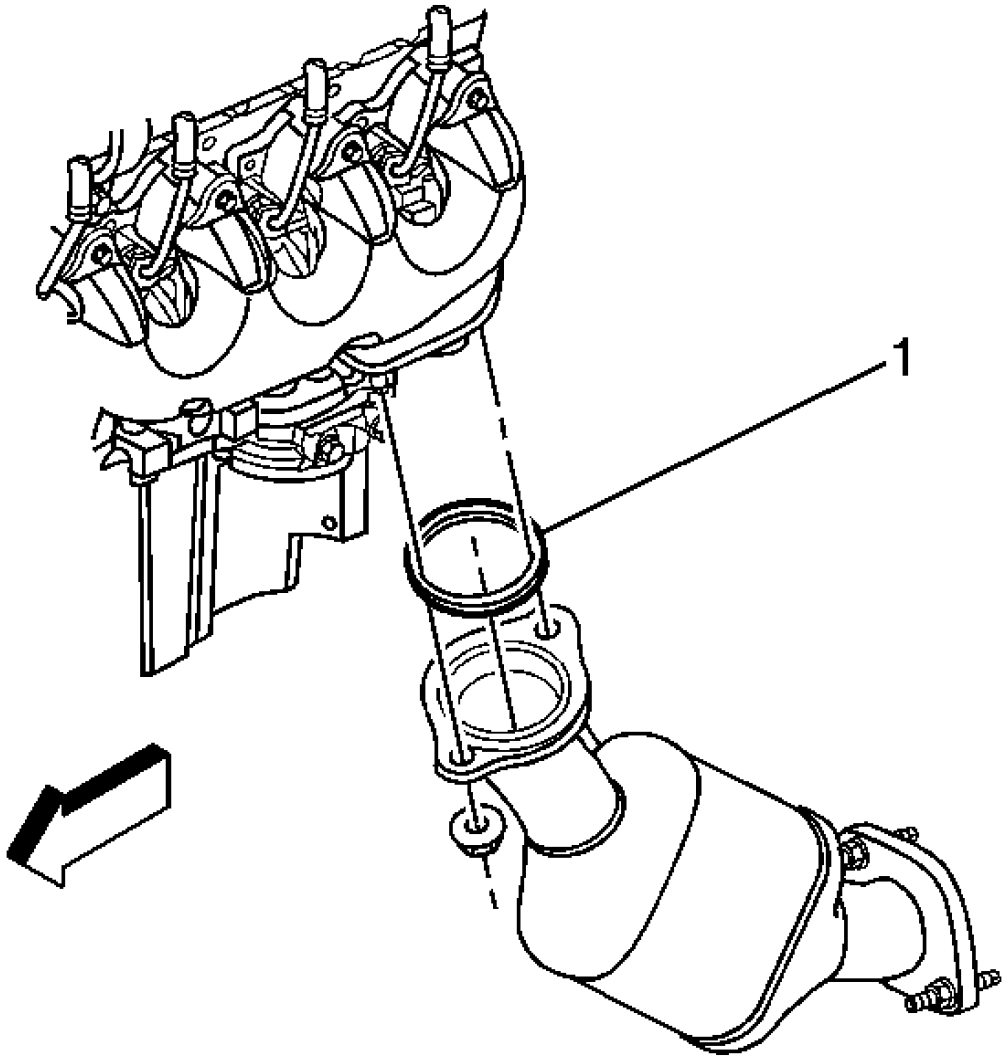


Fig. 2: Identifying Left Catalytic Converter Seal
Courtesy of GENERAL MOTORS CORP.

5. Remove the left catalytic converter and seal (1). Refer to **Catalytic Converter Replacement - Left Side (LLT)** or **Catalytic Converter Replacement - Left Side (L99/LS3)**.

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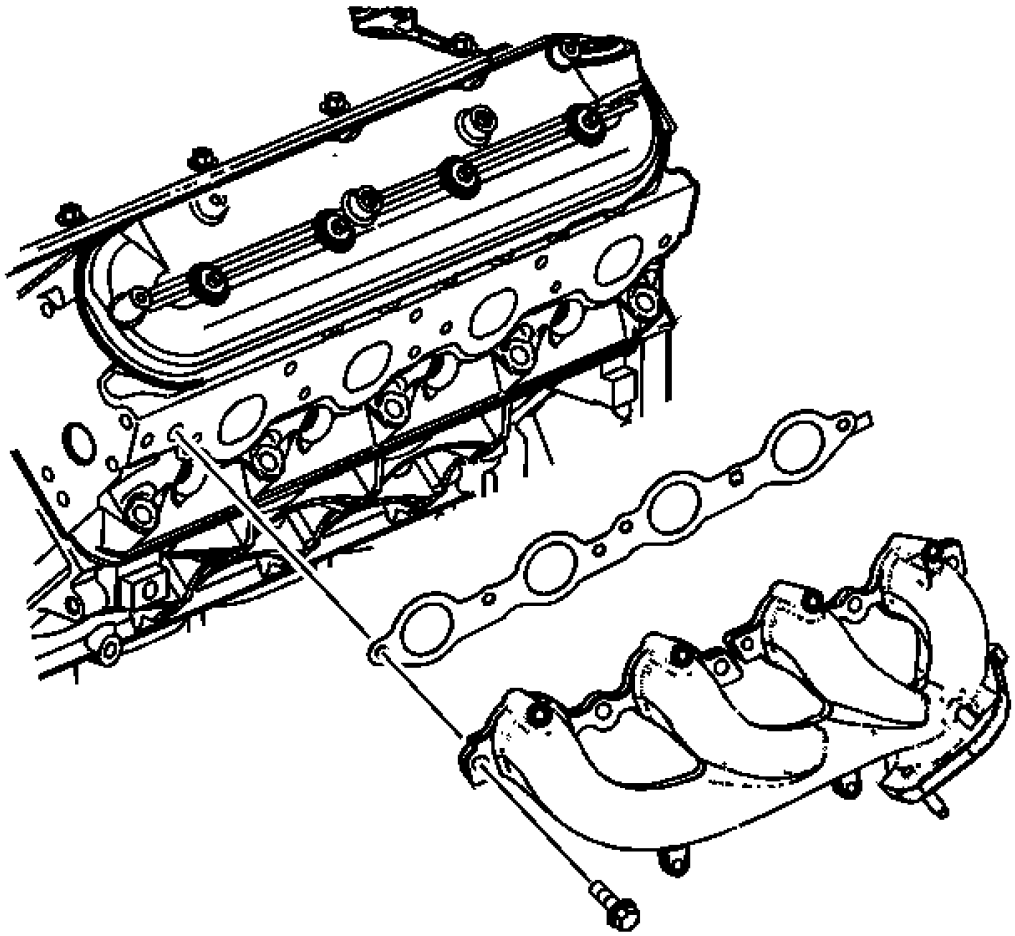


Fig. 3: View Of Left Exhaust Manifold, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the center steering shaft from the lower steering shaft. Separate the shafts and position aside to provide a removal envelope for the manifold. Refer to **Intermediate Steering Shaft Replacement** .
7. Lower the vehicle.
8. Remove the exhaust manifold bolts.
9. Remove the exhaust manifold, bolts, and gasket. Discard the gasket.
10. Remove the heat shield from the manifold, if required.
11. Clean and inspect the exhaust manifold. Refer to **Exhaust Manifold Cleaning and Inspection** .

Installation Procedure

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NOTE: Tighten the exhaust manifold bolts as specified in the service procedure. Improperly installed and/or leaking exhaust manifold gaskets may effect vehicle emissions and/or On-Board Diagnostics (OBD) II system performance.

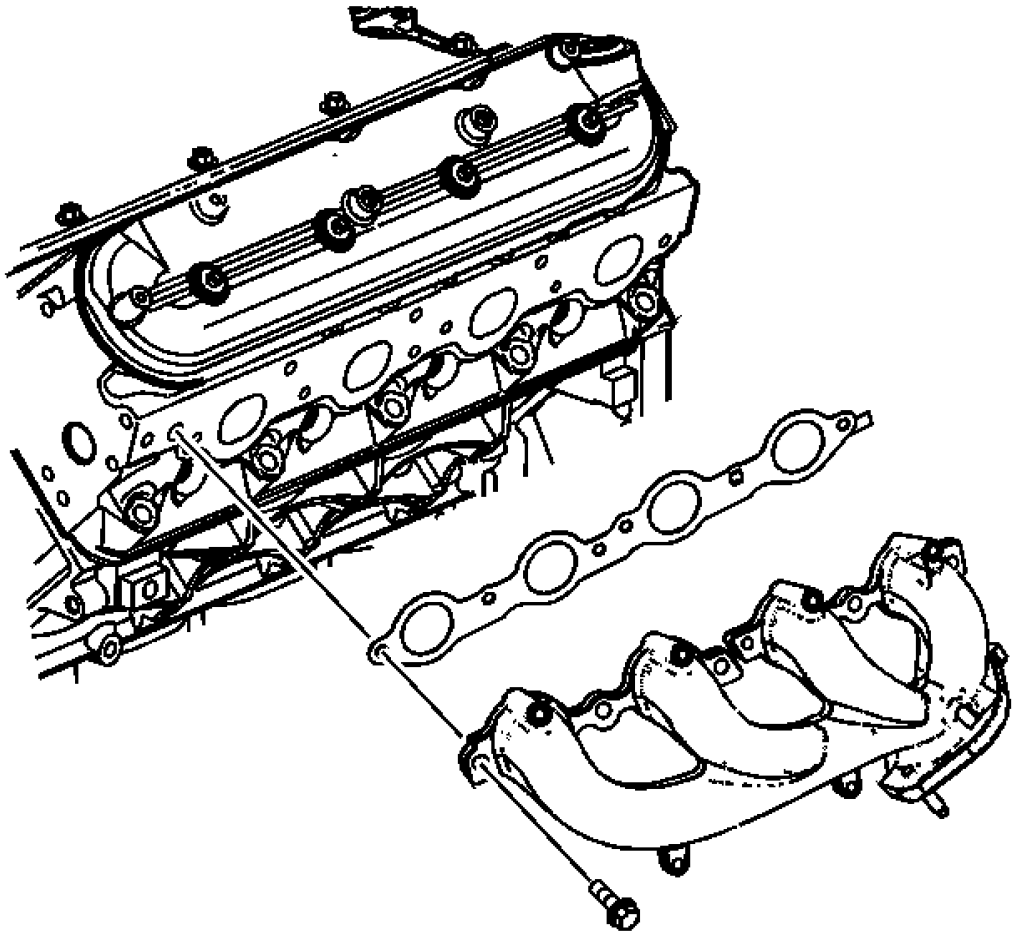


Fig. 4: View Of Left Exhaust Manifold, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. If necessary, install the exhaust manifold heat shield and bolts and tighten to 10 N.m (89 lb in).
2. Position the exhaust manifold and a NEW gasket into place.
3. Lower the vehicle.

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4. Install the exhaust manifold bolts. Refer to **Exhaust Manifold Installation - Left Side** .
5. Connect the center steering shaft to the lower steering shaft. Refer to **Intermediate Steering Shaft Replacement** .

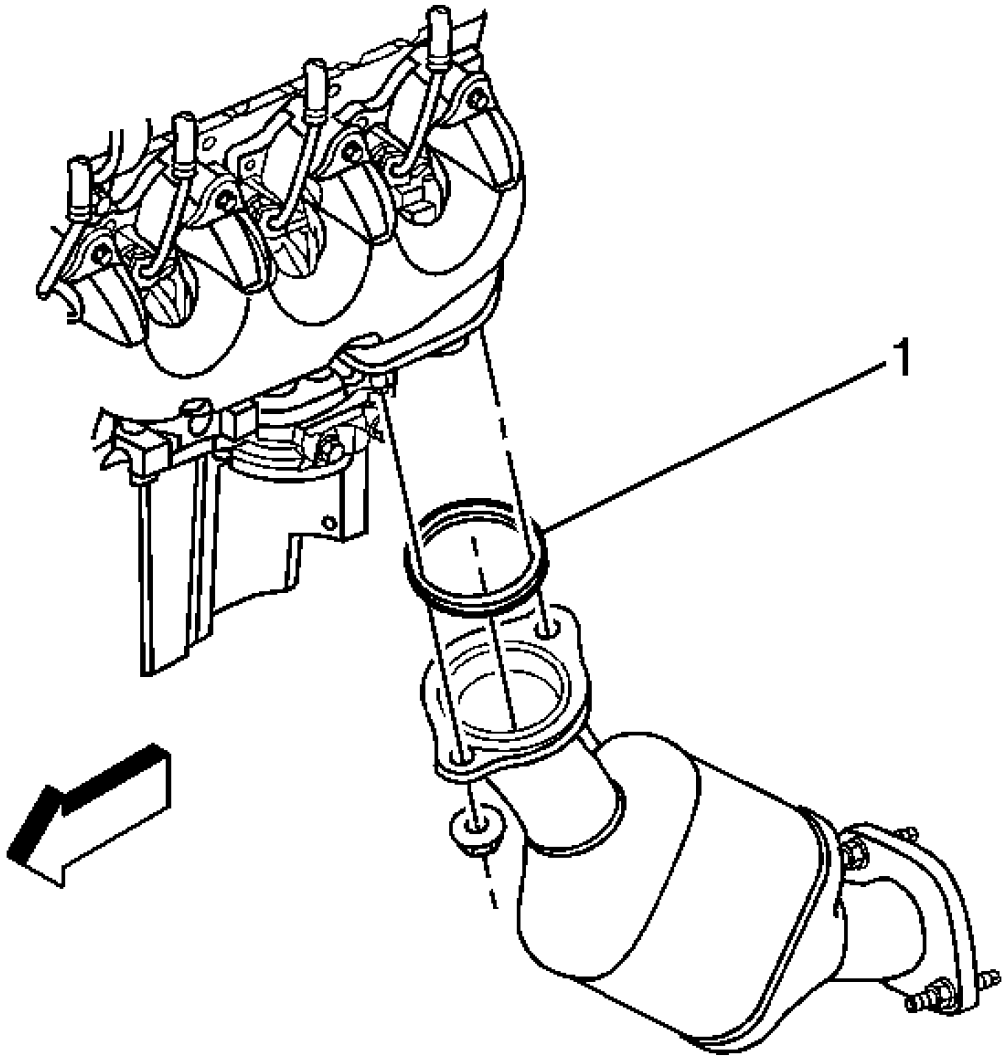


Fig. 5: Identifying Left Catalytic Converter Seal
Courtesy of GENERAL MOTORS CORP.

6. Install the left catalytic converter and seal (1). Refer to **Catalytic Converter Replacement - Left Side (LLT)** or **Catalytic Converter Replacement - Left Side (L99/LS3)**.
7. Lower the vehicle.

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8. Install the left bank spark plugs. Refer to **Spark Plug Replacement** .
9. Install the left bank coil assembly. Refer to **Ignition Coil Replacement** .
10. Install the engine sight shield. Refer to **Engine Cover Replacement** .

EXHAUST MANIFOLD REPLACEMENT - RIGHT SIDE (LLT)

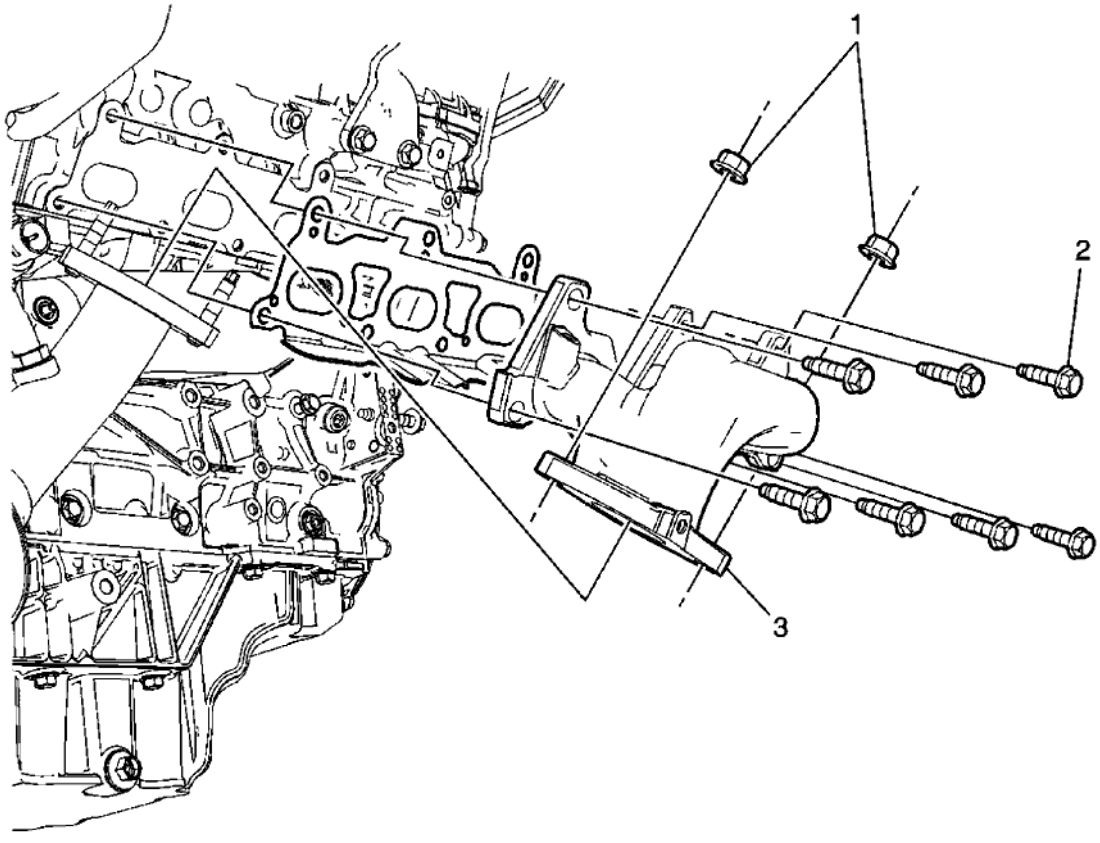


Fig. 6: Exhaust Manifold - Right Side (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the right exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement - Right Side (LLT)** or **Exhaust Manifold Heat Shield Replacement - Right Side (L99/LS3)**.	
	Nut (Qty: 2) **WARNING:** **Refer to Hot Exhaust System Warning .** **CAUTION:** **Refer to Fastener Caution .**

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1	**Tip:** • Replace the gasket. • Clean the cylinder head surface. • Clean the exhaust manifold surface. **Tighten:** 48 N.m.(35 lb ft)
2	Bolt (Qty: 7) **Tighten:** 20 N.m.(15 lb ft)
3	Exhaust Manifold

EXHAUST MANIFOLD REPLACEMENT - RIGHT SIDE (L99/LS3)

Removal Procedure

1. Remove the engine sight shield. Refer to **Engine Cover Replacement** .
2. Remove the right bank coil assembly. Refer to **Ignition Coil Replacement** .
3. Remove the right bank spark plugs. Refer to **Spark Plug Replacement** .
4. Remove the oil level dipstick tube. Refer to **Oil Level Indicator Tube Replacement** .
5. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
6. Remove the right catalytic converter. Refer to **Catalytic Converter Replacement - Right Side (LLT)** or **Catalytic Converter Replacement - Right Side (L99/LS3)**.

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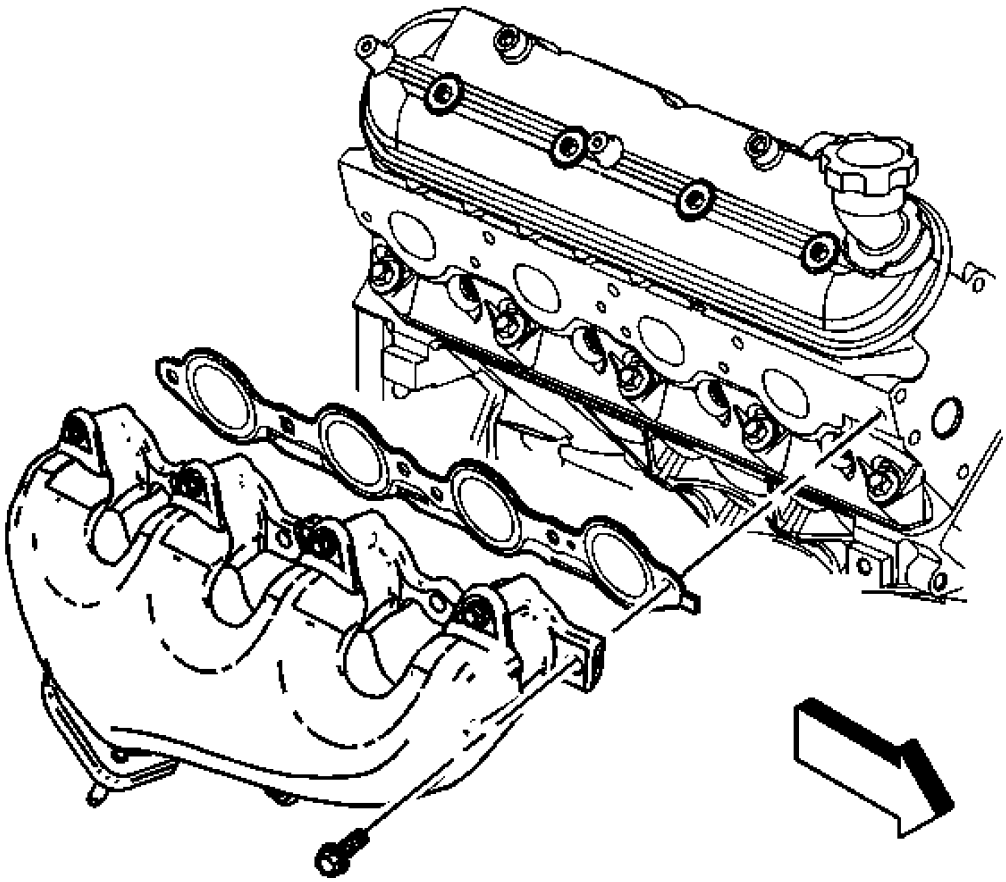


Fig. 7: Identifying Right Exhaust Manifold, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Remove the starter motor. Refer to **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)** .
8. Remove the exhaust manifold bolts.
9. Remove the exhaust manifold, bolts, and gasket. Discard the gasket.
10. Remove the heat shield from the manifold, if required.
11. Clean and inspect the exhaust manifold. Refer to **Exhaust Manifold Cleaning and Inspection** .

Installation Procedure

NOTE: Tighten the exhaust manifold bolts as specified in the service procedure. Improperly installed and/or leaking exhaust manifold gaskets may effect vehicle emissions and/or On-Board Diagnostics (OBD) II system performance.

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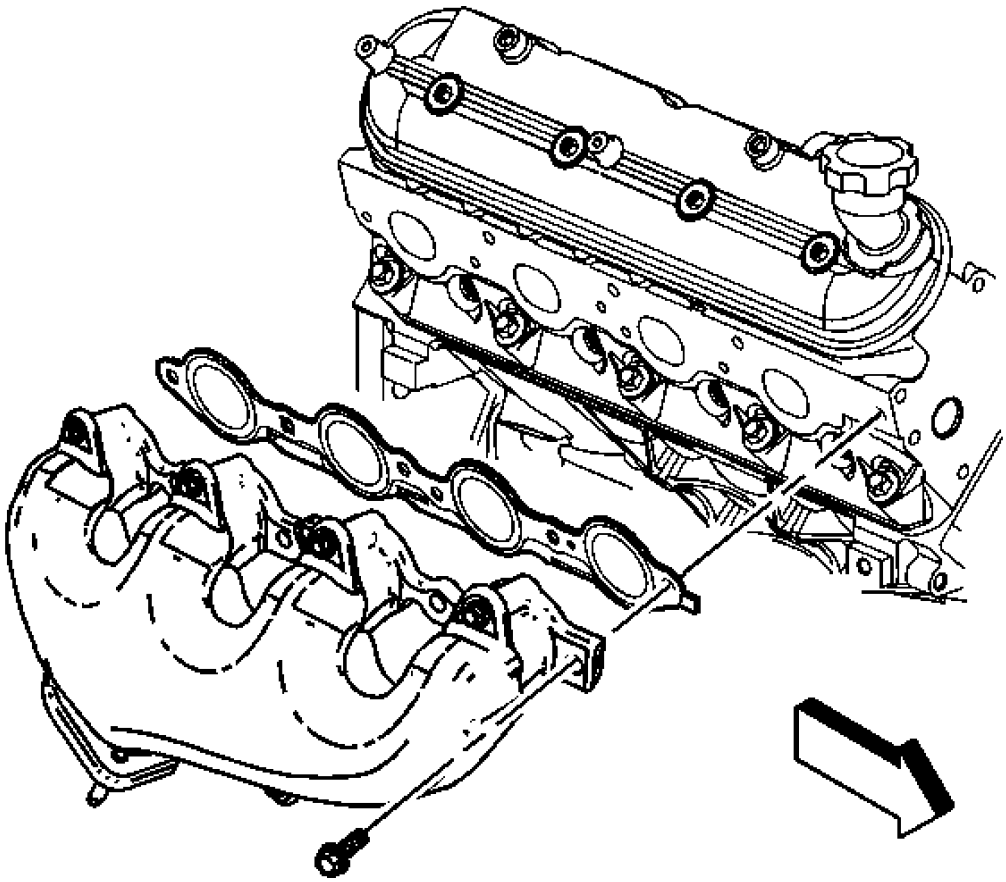


Fig. 8: Identifying Right Exhaust Manifold, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. If necessary, install the exhaust manifold heat shield and bolts and tighten to 9 N.m (80 lb in).
2. Position the exhaust manifold and a NEW gasket into place.
3. Install the exhaust manifold bolts. Refer to **Exhaust Manifold Installation - Right Side** .
4. Install the starter motor. Refer to **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)** .
5. Install the right catalytic converter. Refer to **Catalytic Converter Replacement - Right Side (LLT)** or **Catalytic Converter Replacement - Right Side (L99/LS3)**.
6. Lower the vehicle.

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7. Install the right bank spark plugs. Refer to **Spark Plug Replacement** .
8. Install the right bank coil assembly. Refer to **Ignition Coil Replacement** .
9. Install the oil level dipstick tube. Refer to **Oil Level Indicator Tube Replacement** .
10. Install the engine sight shield. Refer to **Engine Cover Replacement** .

CATALYTIC CONVERTER REPLACEMENT - LEFT SIDE (LLT)

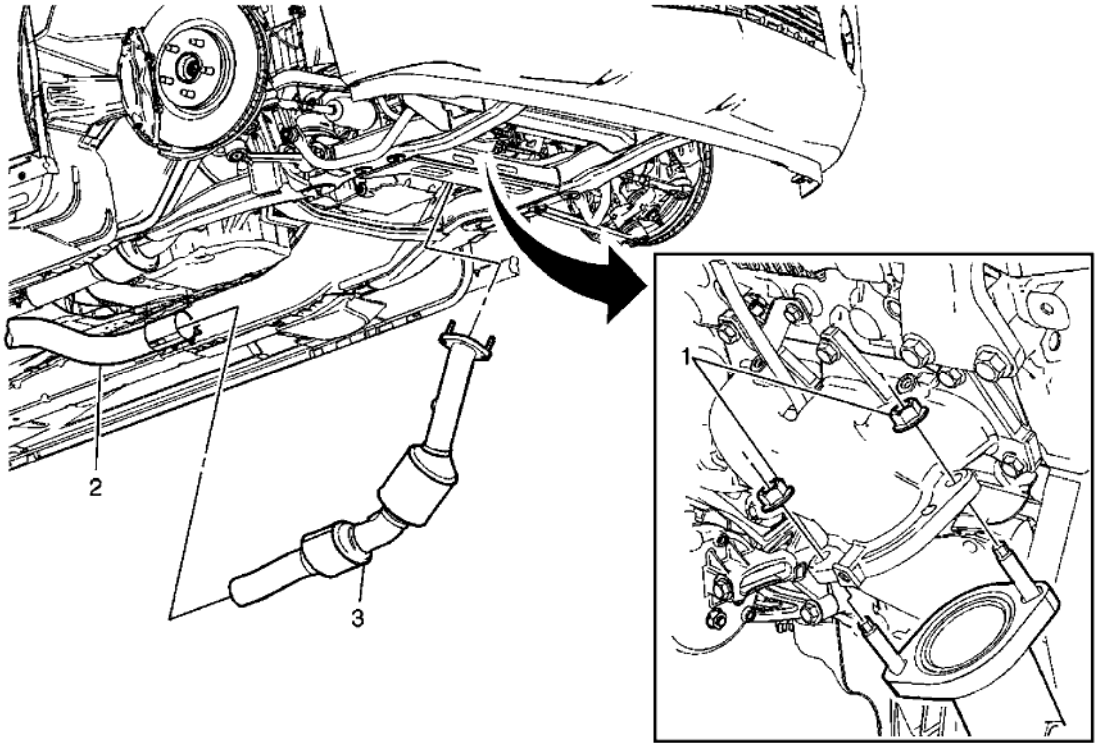


Fig. 9: Catalytic Converter - Left Side (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Remove the left exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement - Left Side (LLT)** or **Exhaust Manifold Heat Shield Replacement - Left Side (L99/LS3)**. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 3. Disconnect the oxygen sensors.	
	Nut (Qty: 2) **WARNING:** **Refer to Hot Exhaust System Warning .**

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1	**CAUTION:** **Refer to Fastener Caution .** **Tip:** • Replace the catalytic converter seal. • If replacing the catalytic converter, transfer oxygen sensor over to new converter. **Tighten:** 48 N.m (35 lb ft)
2	Clamp **Tighten:** 48 N.m (35 lb ft)
3	Three-Way Catalytic Converter

CATALYTIC CONVERTER REPLACEMENT - LEFT SIDE (L99/LS3)

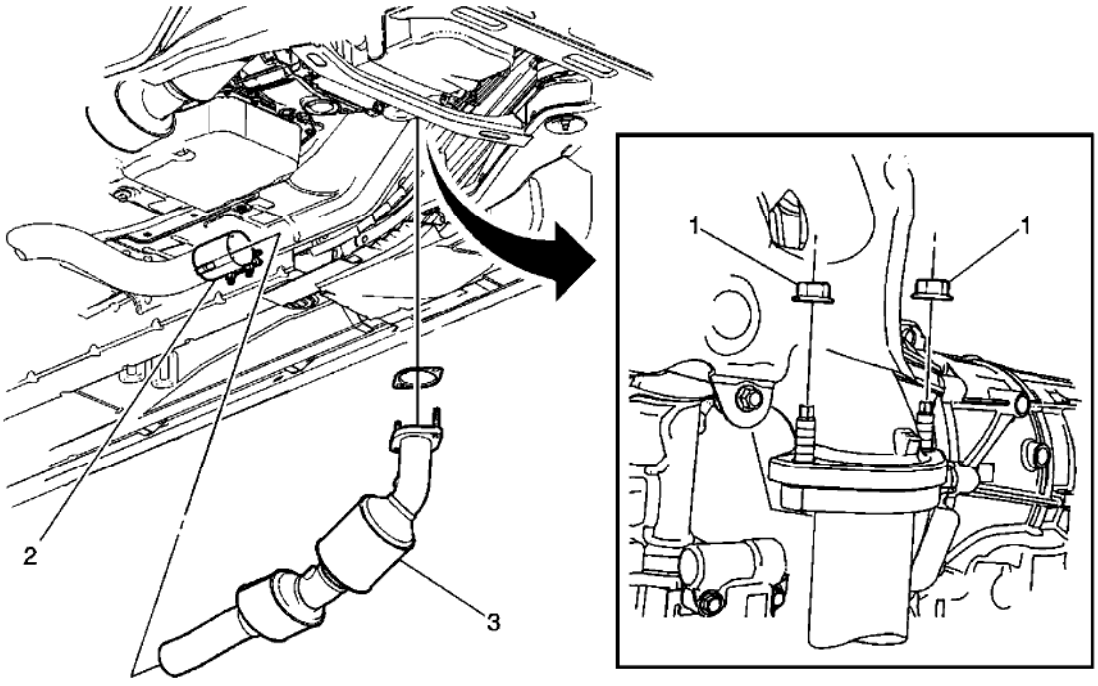


Fig. 10: Catalytic Converter - Left Side (L99/LS3)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure	
1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	

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2. Remove the oxygen sensors. Refer to **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1** and **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2** .

1	Nut (Qty: 2) **WARNING:** **Refer to Hot Exhaust System Warning .** **CAUTION:** **Refer to Fastener Caution .** **Tip:** • Remove the nuts from above the engine compartment. • If replacing the catalytic converter, transfer the oxygen sensors over to the new catalytic converter. **Tighten:** 48 N.m (35 lb ft)
2	Clamp **Tighten:** 48 N.m (35 lb ft)
3	Three-way Catalytic Converter

CATALYTIC CONVERTER REPLACEMENT - RIGHT SIDE (LLT)

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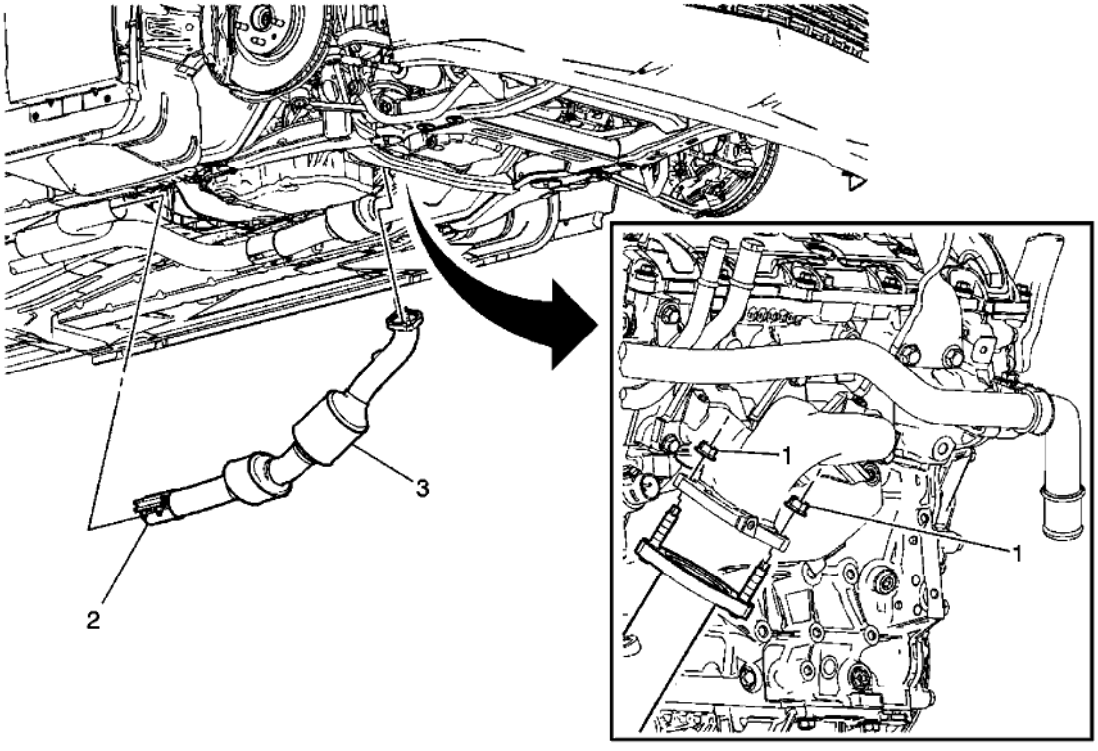


Fig. 11: Catalytic Converter - Right Side (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Remove the right exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement - Left Side (LLT)** or **Exhaust Manifold Heat Shield Replacement - Left Side (L99/LS3)**. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 3. Remove the oxygen sensors. Refer to **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1** and **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2** .	
1	Nut (Qty: 2) **WARNING:** **Refer to Hot Exhaust System Warning .** **CAUTION:** **Refer to Fastener Caution .** **Tip:**

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	• Replace the catalytic converter to exhaust manifold seal. • If replacing catalytic converter, transfer the oxygen sensors over to the new converter. **Tighten:** 48 N.m (35 lb ft)
2	Clamp **Tighten:** 48 N.m (35 lb ft)
3	Three-Way Catalytic Converter

CATALYTIC CONVERTER REPLACEMENT - RIGHT SIDE (L99/LS3)

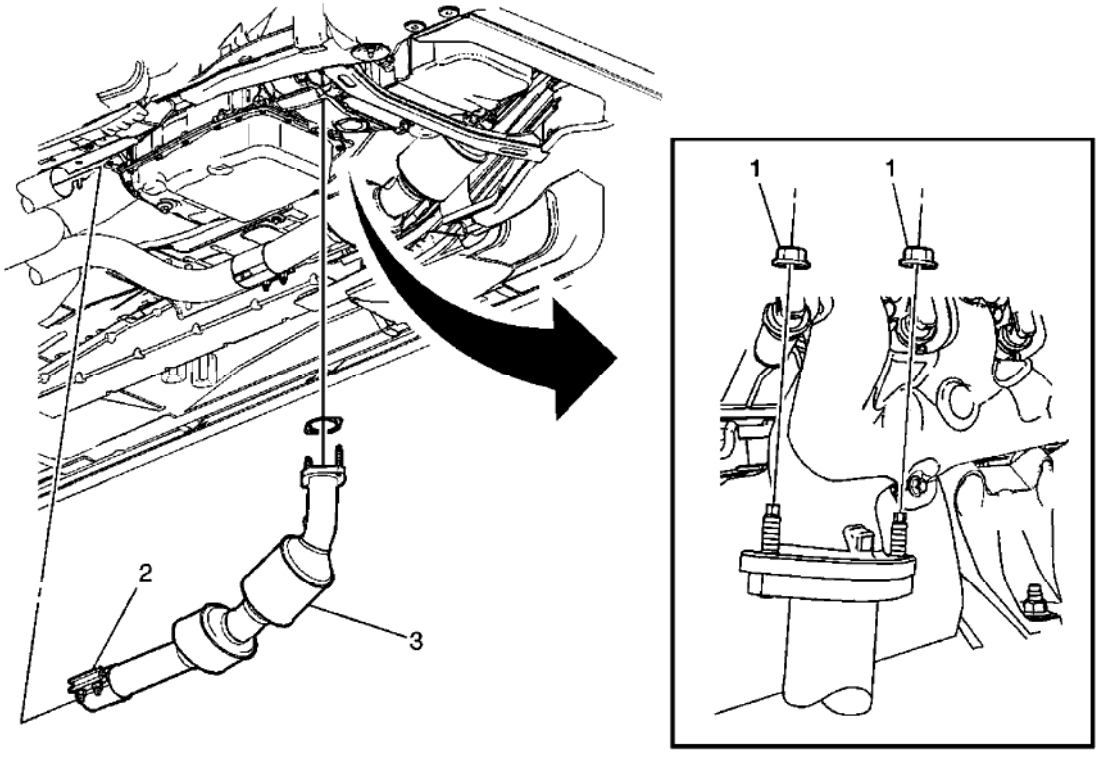


Fig. 12: Catalytic Converter - Right Side (L99/LS3)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Disconnect the oxygen sensors. Refer to **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1** and **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2** .	
	Nut (Qty: 2)

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1	**WARNING:** **Refer to Hot Exhaust System Warning .** **CAUTION:** **Refer to Fastener Caution .** **Tip:** • Remove the catalytic to the exhaust manifold nuts from above the engine compartment. • Replace the catalytic converter seal. • If replacing the catalytic converter, transfer the oxygen sensors over to the new converter. **Tighten:** 48 N.m (35 lb ft)
2	Clamp **Tighten:** 48 N.m (35 lb ft)
3	Three-way Catalytic Converter

UNDERBODY BRACE REPLACEMENT

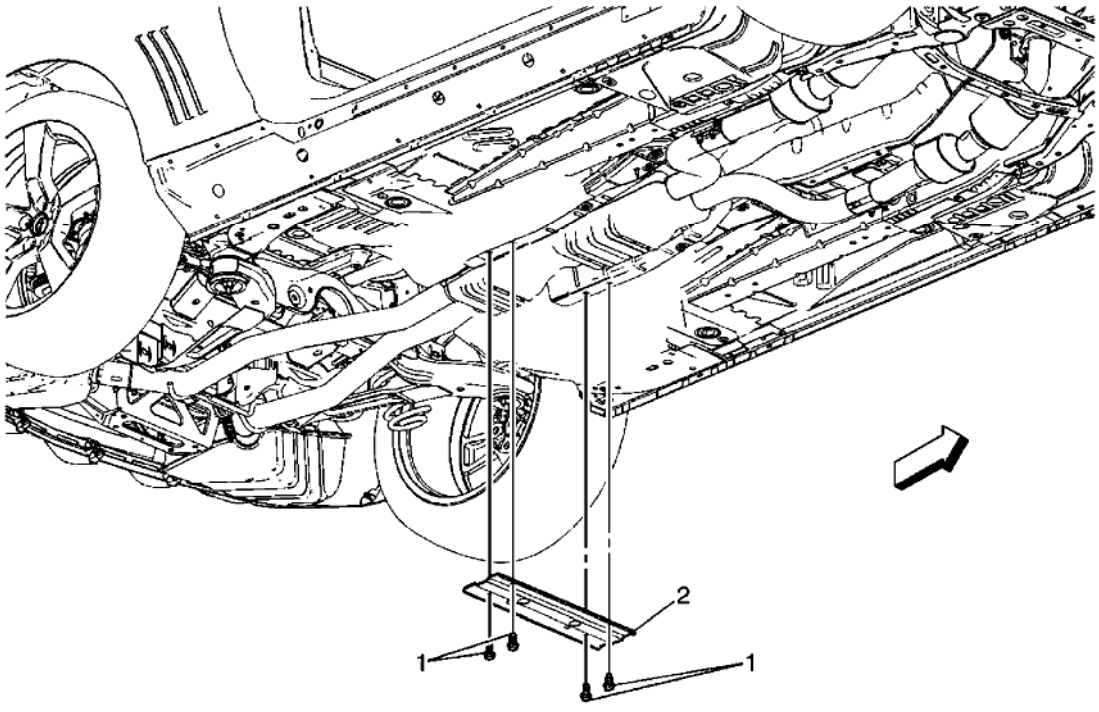


Fig. 13: Underbody Brace

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Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Underbody Brace Bolt (Qty: 4) **WARNING:** **Refer to Hot Exhaust System Warning .** **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 25 N.m (18 lb ft)
2	Underbody Brace

EXHAUST MUFFLER REPLACEMENT - LEFT SIDE

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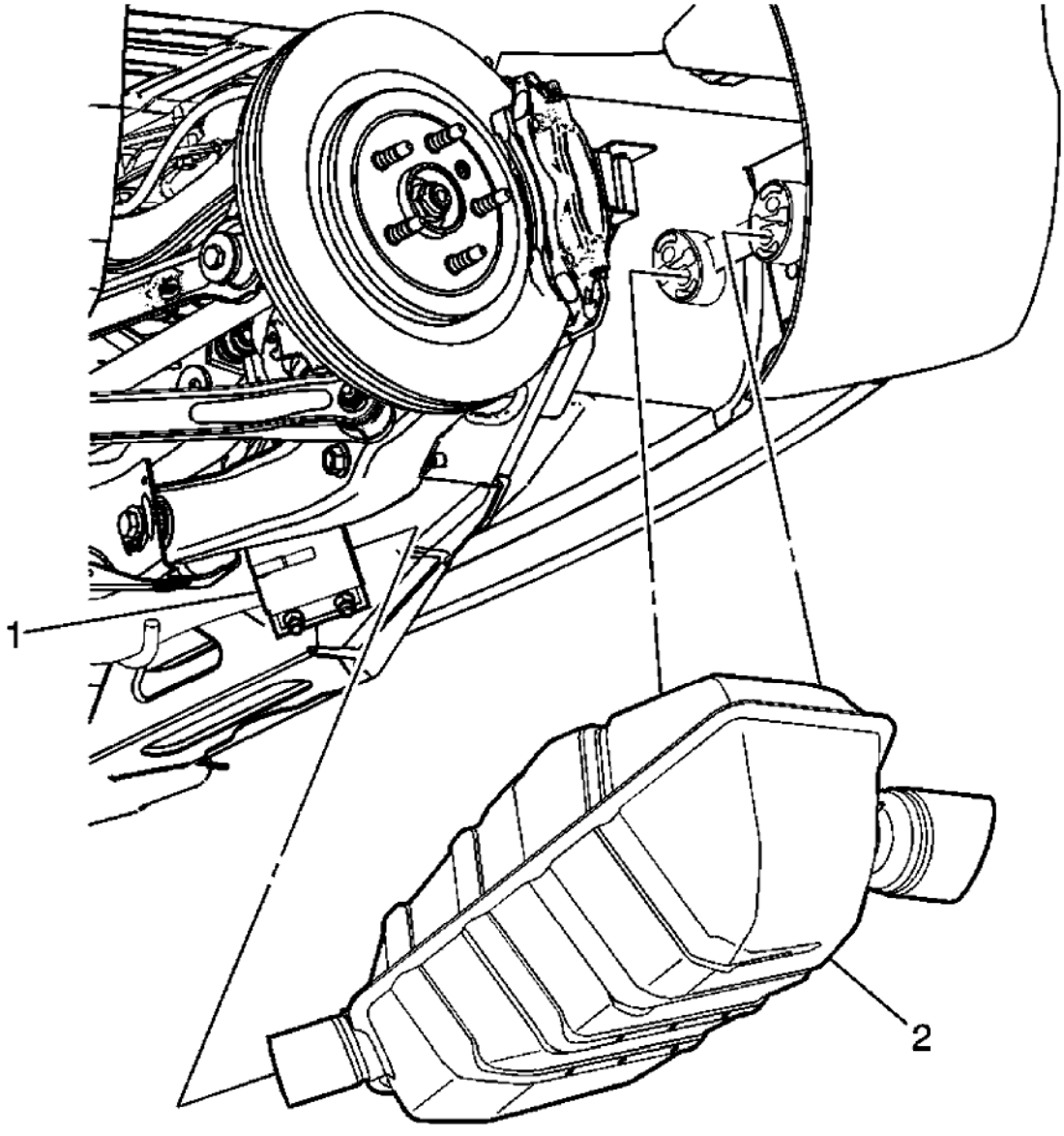


Fig. 14: Exhaust Muffler - Left Side
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Clamp **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 48 N.m (35 lb ft)

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	Muffler
2	**Procedure** 1. Cut off the original muffler. 2. Remove the rear muffler hangers. **Tip:** Cut 66 mm (2.5 in) forward of the muffler.

EXHAUST MUFFLER REPLACEMENT - RIGHT SIDE

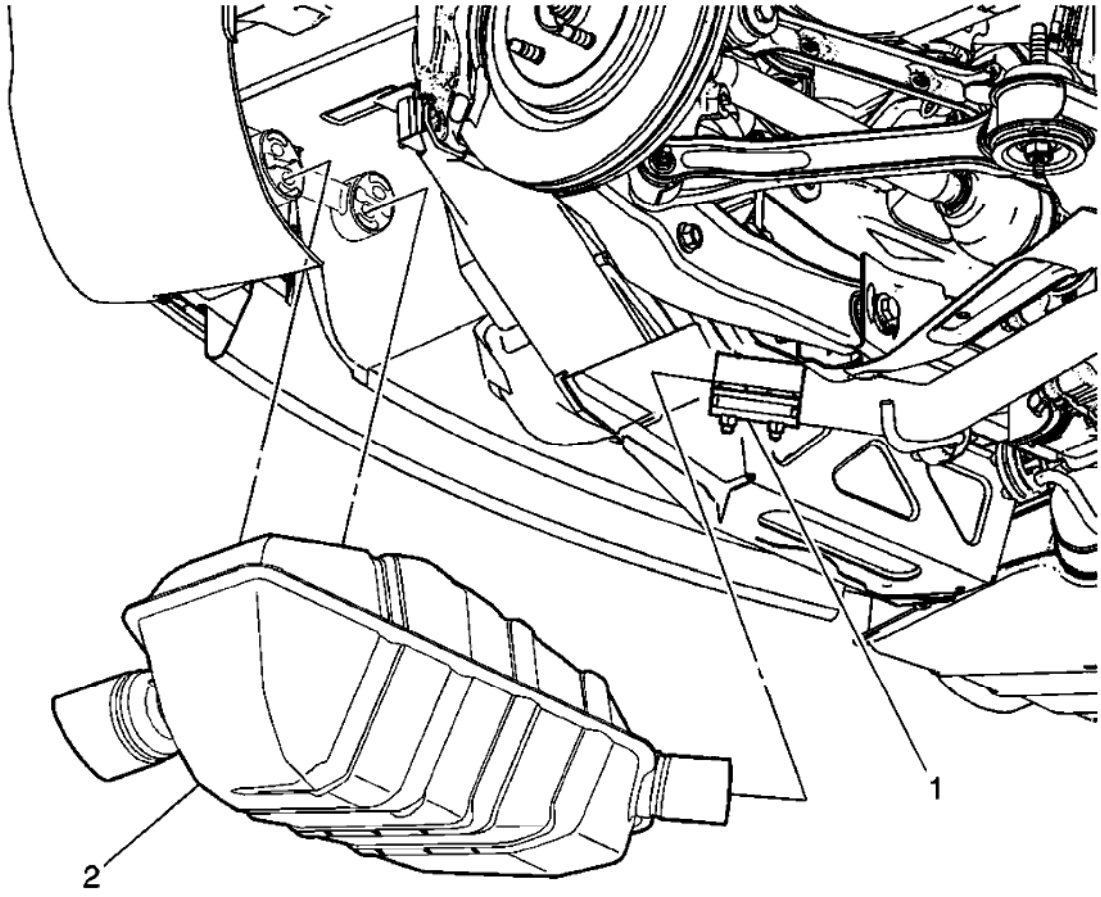


Fig. 15: Exhaust Muffler - Right Side
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
	Clamp

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1	**CAUTION:** **Refer to Fastener Caution .** **Tighten:** 48 N.m (35 lb ft)
2	Muffler **Procedure** 1. Cut off the original muffler. 2. Remove the rear muffler hangers. **Tip:** Cut 66 mm (2.5 in) forward of the muffler.

EXHAUST MUFFLER WITH RESONATOR, EXHAUST, AND TAIL PIPE REPLACEMENT (H-PIPE)

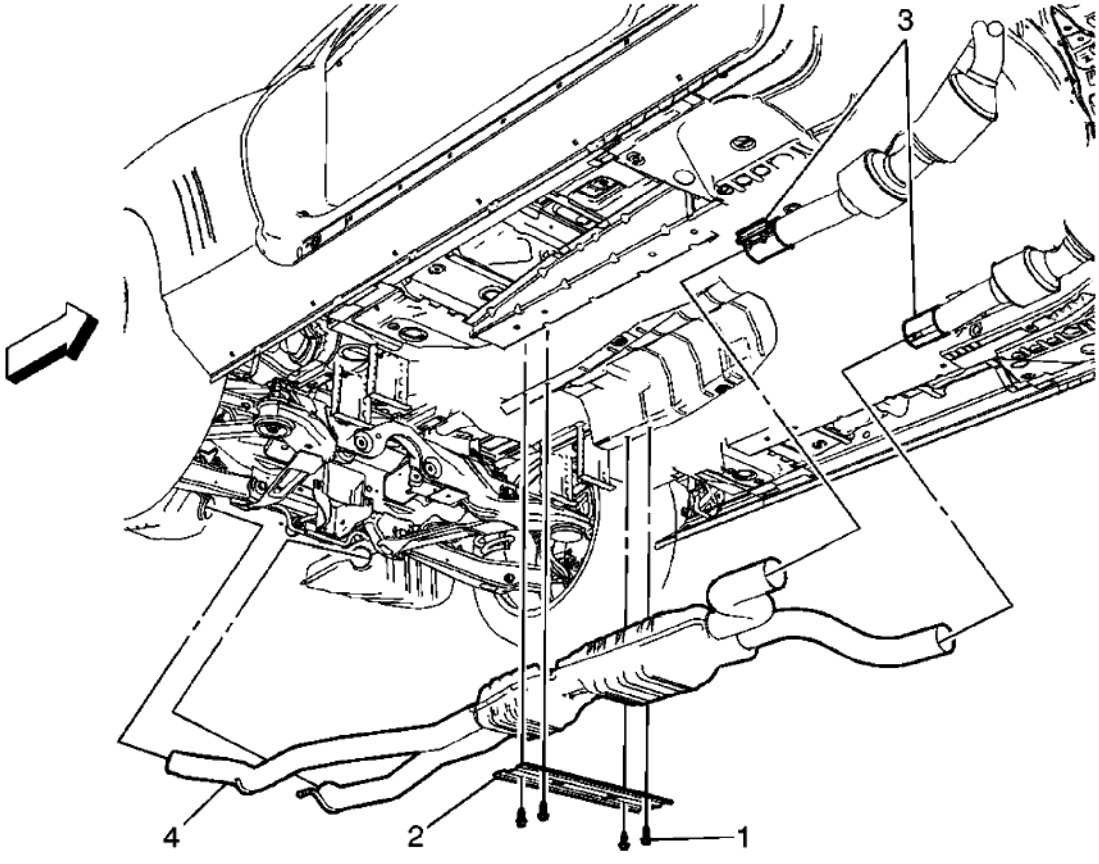


Fig. 16: Exhaust Muffler with Resonator, Exhaust & Tail Pipe (H-Pipe)
Courtesy of GENERAL MOTORS CORP.

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Callout	Component Name
Preliminary Procedure: Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Bolt (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 58 N.m (43 lb ft)
2	Underbody Brace
3	Clamp (Qty: 2) **Tighten:** 48 N.m (35 lb ft)
4	H-Pipe Assembly Without the Mufflers. **Procedure** 1. Cut off the original equipment muffler. 2. Remove the H-pipe from the exhaust hangers. **Tip:** Cut the H-Pipe 66 mm (2.5 in) forward of the muffler.

EXHAUST MUFFLER WITH RESONATOR, EXHAUST, AND TAIL PIPE REPLACEMENT (VEHICLE SERVICE)

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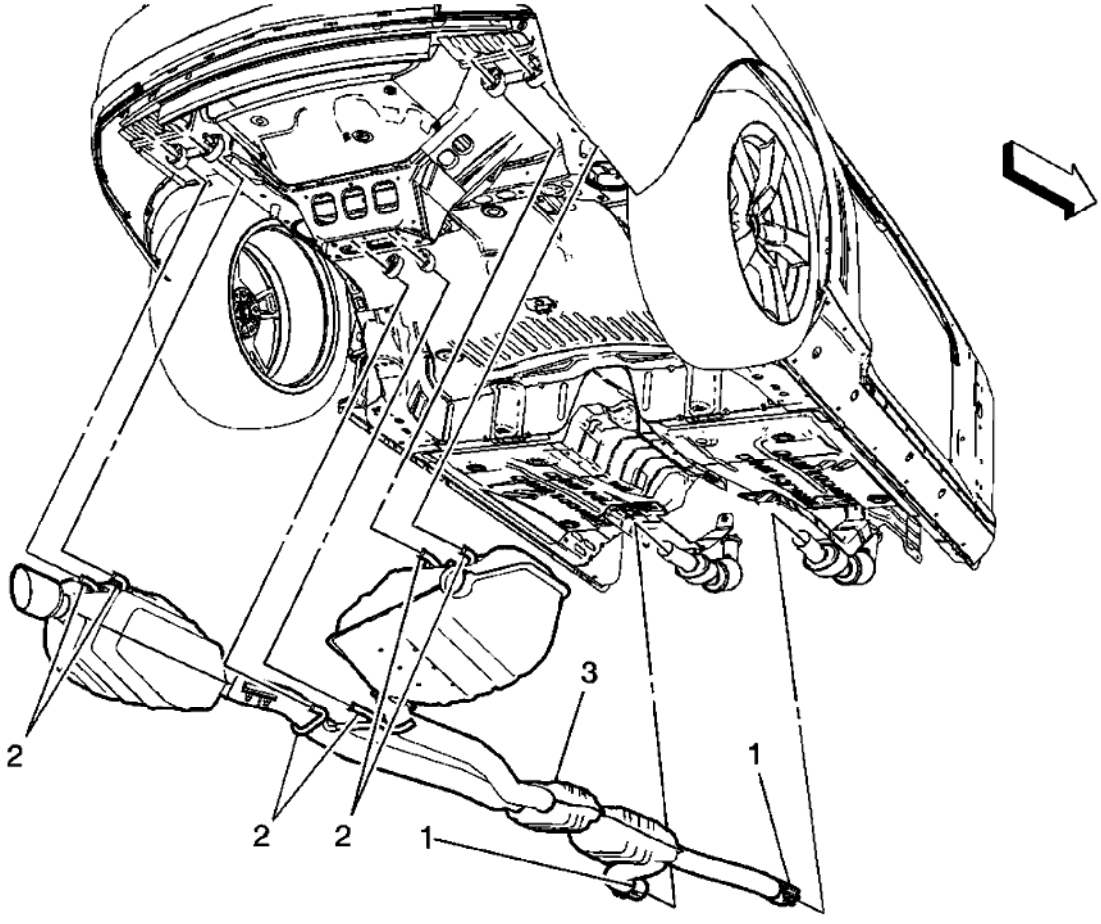


Fig. 17: Exhaust Muffler with Resonator, Exhaust & Tail Pipe (Vehicle Service)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the underbody brace.Refer to **Underbody Brace Replacement**	
1	Exhaust Clamp Bolt (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 48 N.m (35 lb ft)
2	Exhaust Hanger Rods
	Muffler Assembly. **Tip:** This exhaust system is not serviced as an assembly, but this procedure is for reference only.

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3	**Procedure** 1. Remove the exhaust clamps from each catalytic converter 2. With the aid of an assistant, remove the exhaust hanger rods from the exhaust isolators. **Tip:** Squeeze the rear muffler hanger rods through the isolators using a suitable tool. 3. Lubricate the exhaust hanger rods for ease of installation.

EXHAUST MUFFLER INTERMEDIATE HEAT SHIELD REPLACEMENT

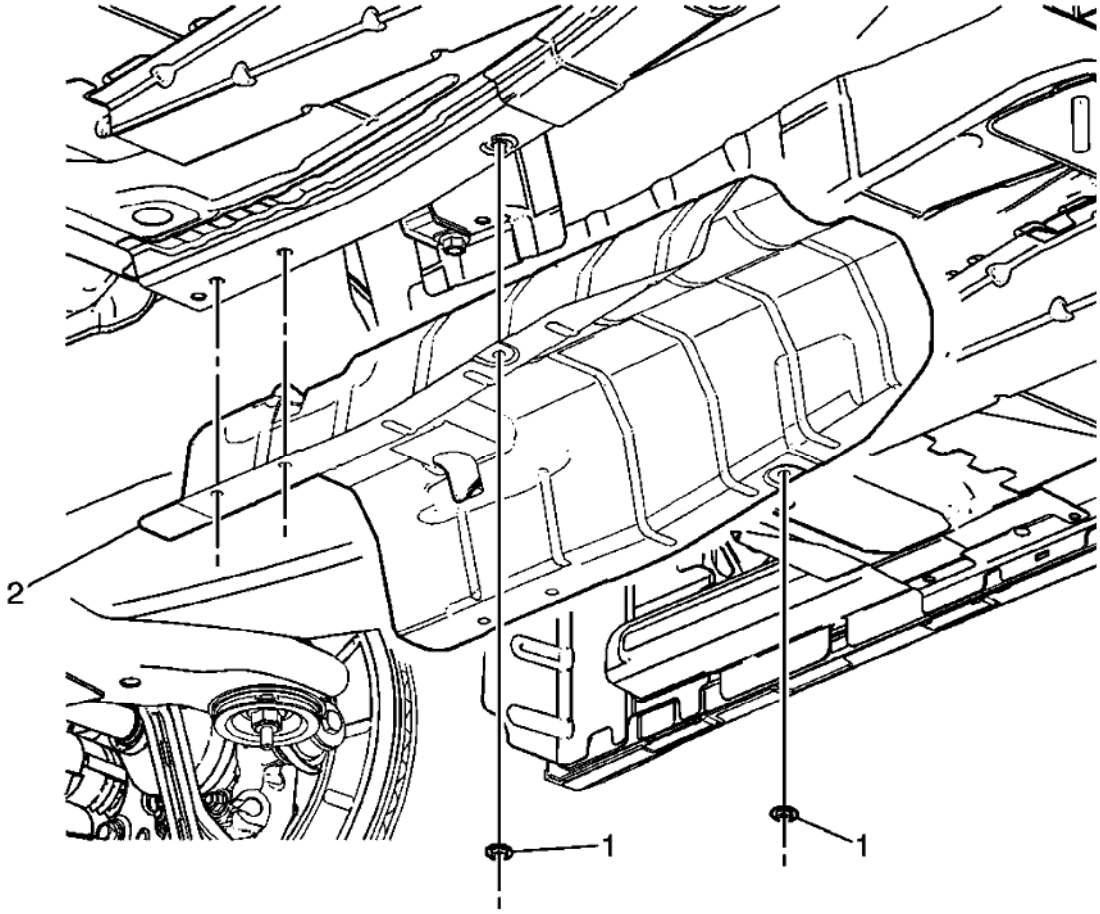


Fig. 18: Exhaust Muffler Intermediate Heat Shield
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure 1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	

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2. Partially lower and support the exhaust system. Refer to **Exhaust Muffler with Resonator, Exhaust, and Tail Pipe Replacement (H-Pipe)** or **Exhaust Muffler with Resonator, Exhaust, and Tail Pipe Replacement (Vehicle Service)**.	
1	Nut (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tip:** Tighten the nuts untill secure.
2	Exhaust Heat shield

EXHAUST MANIFOLD HEAT SHIELD REPLACEMENT - RIGHT SIDE (LLT)

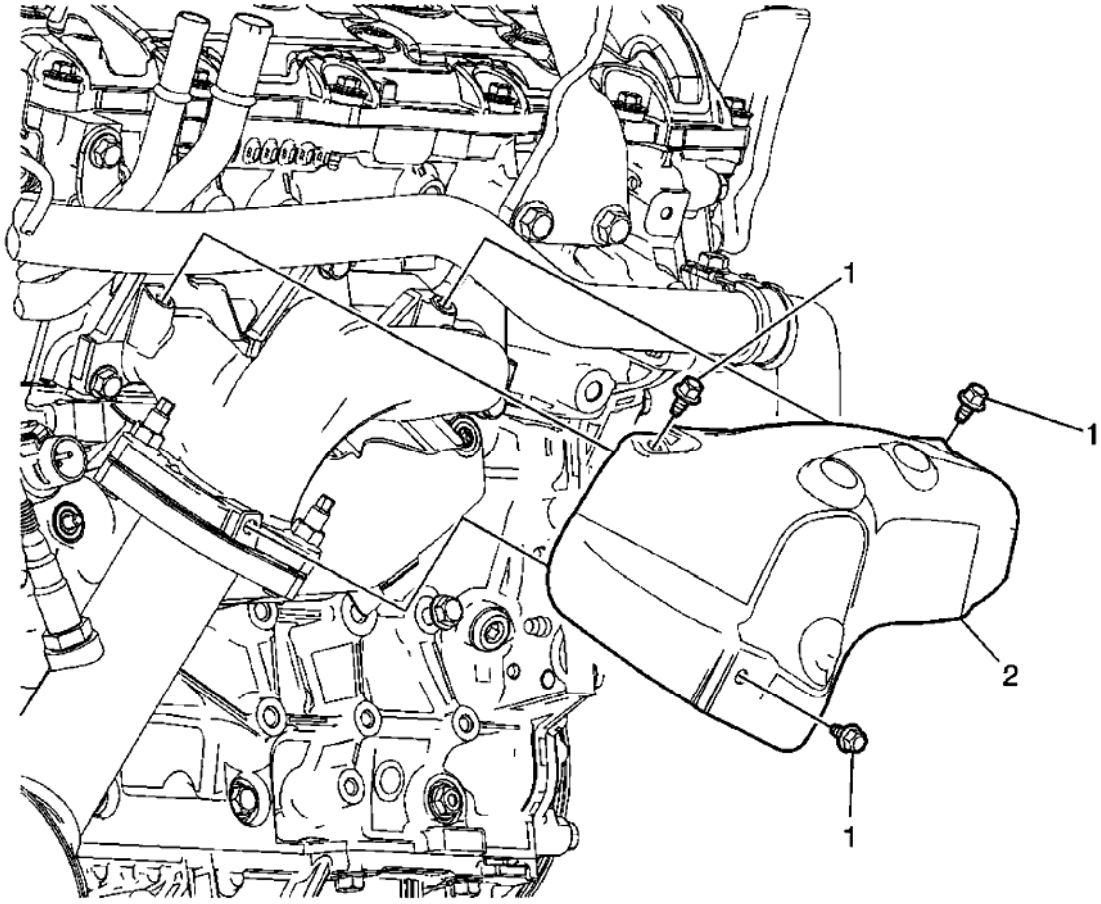


Fig. 19: Exhaust Manifold Heat Shield - Right Side (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name

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1	Bolt (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 N.m (89 lb in)
2	Exhaust Manifold Shield

EXHAUST MANIFOLD HEAT SHIELD REPLACEMENT - RIGHT SIDE (L99/LS3)

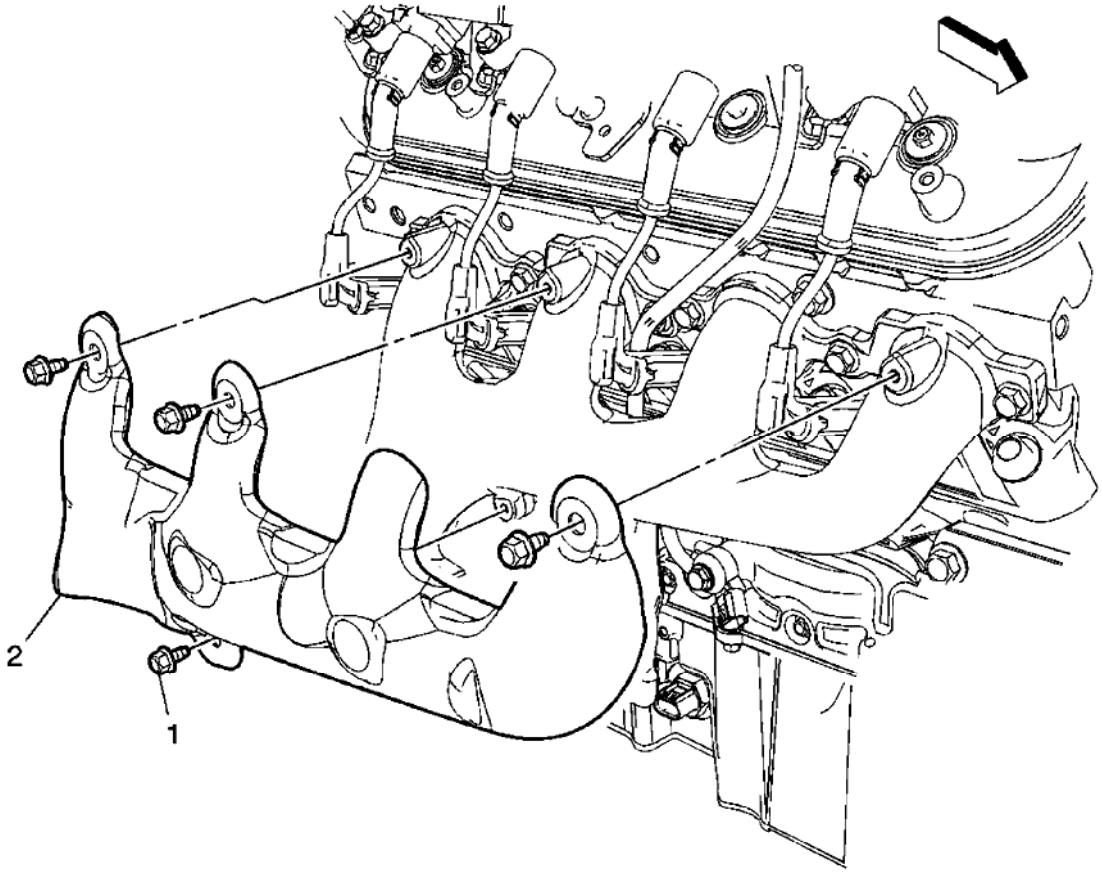


Fig. 20: Exhaust Manifold Heat Shield - Right Side (L99/LS3)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Bolt (Qty: 4) **CAUTION:** **Refer to Fastener Caution .**

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	Tighten: 10 N.m (89 lb in)
2	Exhaust Manifold Shield

EXHAUST MANIFOLD HEAT SHIELD REPLACEMENT - LEFT SIDE (LLT)

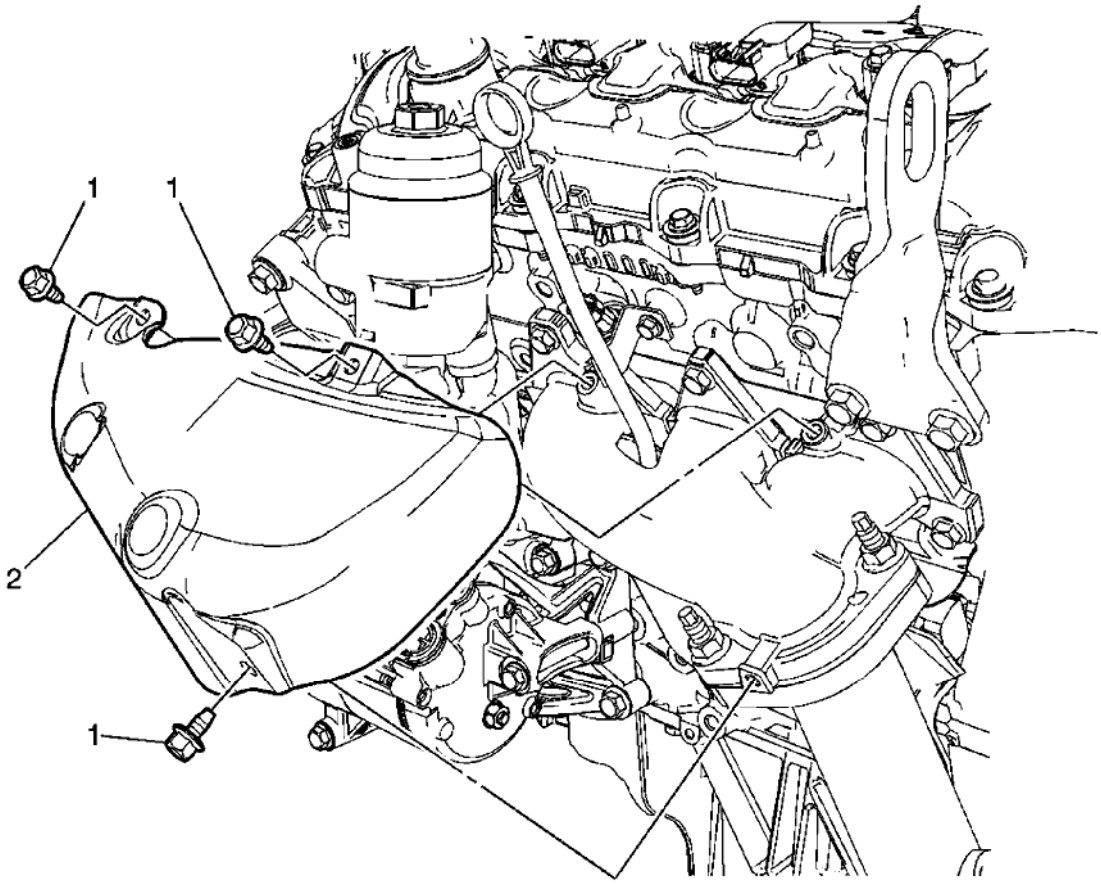


Fig. 21: Exhaust Manifold Heat Shield - Left Side (LLT)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Bolt (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 N.m (89 lb in)
2	Exhaust Manifold Shield

EXHAUST MANIFOLD HEAT SHIELD REPLACEMENT - LEFT SIDE (L99/LS3)

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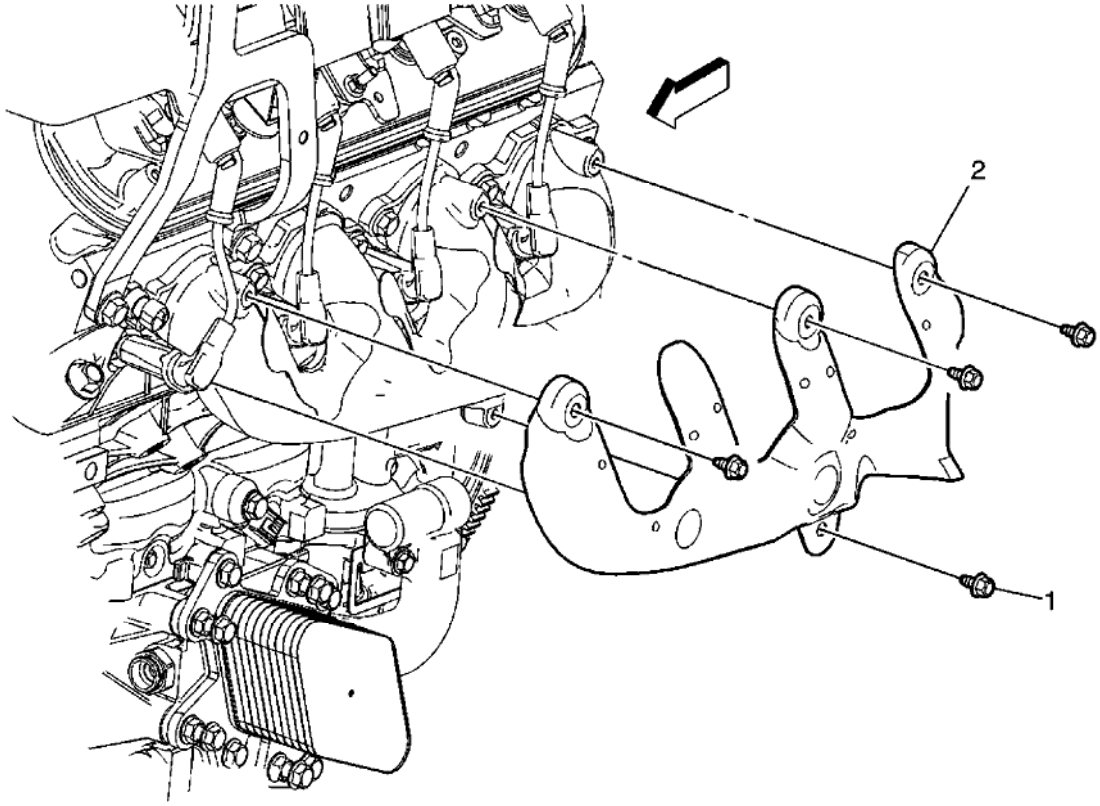


Fig. 22: Exhaust Manifold Heat Shield - Left Side (L99/LS3)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Bolt (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 10 N.m (89 lb in)
2	Exhaust Manifold Shield

DESCRIPTION AND OPERATION

EXHAUST SYSTEM DESCRIPTION

NOTE: Use of non-OEM parts may cause driveability concerns.

The exhaust system carries exhaust gases, treated by the catalytic converter, through a resonator, if applicable and into the exhaust muffler where exhaust noise is lessened.

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In order to secure the exhaust pipe to the exhaust manifold, a flange and seal-joint coupling is utilized. The exhaust system may utilize a slip-joint coupling design with a clamp and a U-bolt or a flange connection with a gasket.

Exhaust hangers and rubber insulators help to support the weight of the exhaust pipe along with insulating any exhaust system vibration, rattle, or noise.

Exhaust hangers also space the exhaust system away from the underbody of the vehicle and allows the exhaust system to expand as the exhaust system warms up.

Exhaust heat shields are used to protect the body and other components from damage due to the heat from the exhaust system.

The exhaust system may be comprised of the following components:

- Exhaust manifold
- Exhaust pipes
- Catalytic converters
- Exhaust muffler
- Exhaust resonator, if equipped
- Exhaust tail pipe, if equipped
- Exhaust hangers
- Exhaust heat shields

Resonator

Some exhaust systems are equipped with a resonator. The resonator, located either before or after the muffler, allows the use of mufflers with less back pressure. Resonators are used when vehicle characteristics require specific exhaust tuning.

Catalytic Converter

The catalytic converter is an emission control device added to the engine exhaust system in order to reduce hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx) pollutants from the exhaust gas.

The catalytic converter is comprised of a ceramic monolith substrate, supported in insulation and housed within a sheet metal shell. The substrate may be washcoated with 3 noble metals:

- Platium (Pt)
- Palladium (Pd)
- Rhodium (Rh)

The catalyst in the converter is not serviceable.

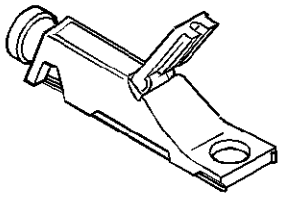
Muffler

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The exhaust muffler reduces the noise levels of the engine exhaust by the use of tuning tubes. The tuning tubes create channels inside the exhaust muffler that lower the sound levels created by the combustion of the engine.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description
	J 35314-A Exhaust Back Pressure Gauge

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2010 ENGINE

Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Camaro

DESCRIPTION AND OPERATION

CRANKCASE VENTILATION SYSTEM DESCRIPTION

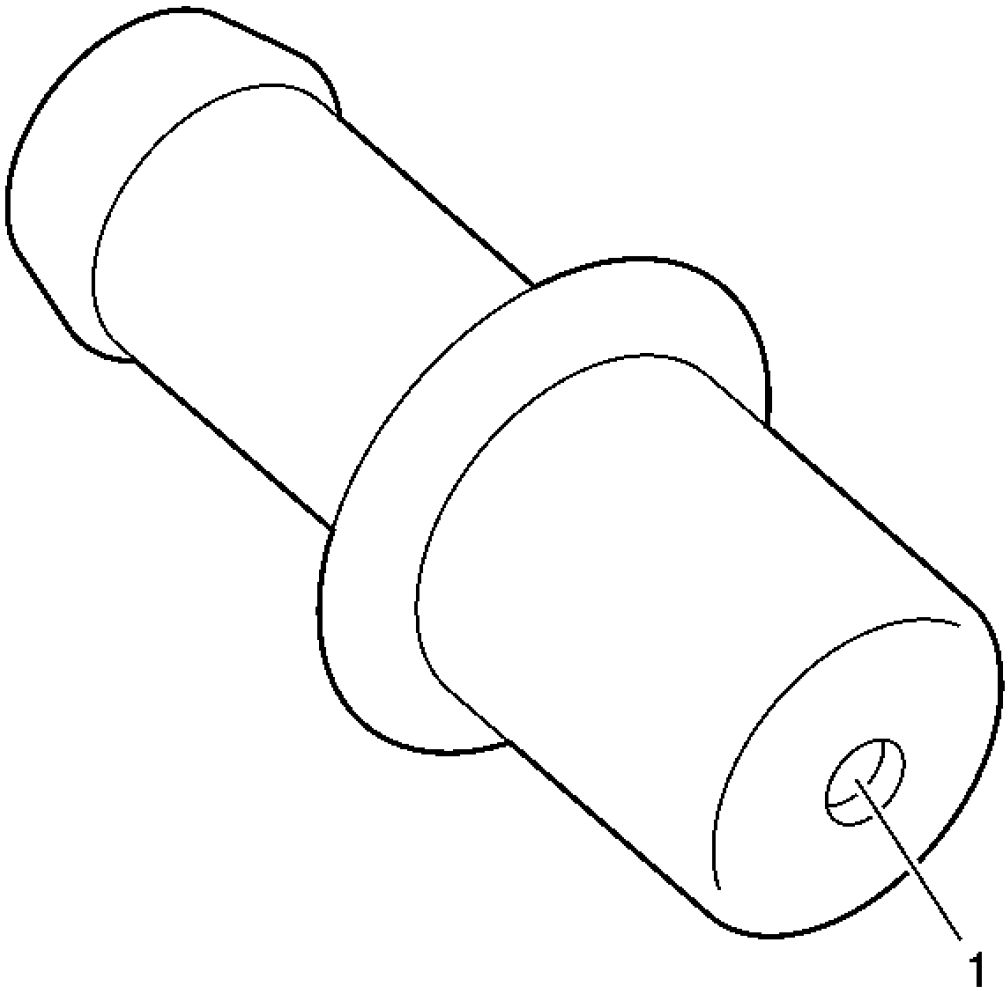


Fig. 1: Identifying PCV Orificed Tube Orifice
Courtesy of GENERAL MOTORS CORP.

A crankcase ventilation system is used to consume crankcase vapors created during the combustion process

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instead of venting them to the atmosphere.

Fresh air is supplied through a filter to the crankcase, the crankcase mixes the fresh air with the blow-by gases and then passed through a positive crankcase ventilation (PCV) orificed tube into the intake manifold.

The PCV orificed tube restricts the flow rate of the blow-by gases using an orifice (1) located at the end of the tube. If abnormal operating conditions arise, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase vent tube into the throttle body in order to be consumed by normal combustion.

DRIVE BELT SYSTEM DESCRIPTION

The drive belt system consists of the following components:

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

The drive belt system may use 1 belt or 2 belts. The drive belt is thin so that it can bend backwards and has several ribs to match the grooves in the pulleys. The drive belts are made of different types of rubbers, chloroprene or EPDM, and have different layers or plys containing either fiber cloth or cords for reinforcement.

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

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

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

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ENGINE COMPONENT DESCRIPTION (LLT)

The High Feature V6 (VIN Code Identifier "V" for cars, "D" for trucks) RPO LLT is a 3.6L VVT (Variable Valve Timing) engine with direct injection. The direct injection system places the high pressure injectors in the cylinder heads. This engine incorporates 2 intake and 2 exhaust valves per cylinder and is a dual overhead cam design with individual intake and exhaust camshafts. A camshaft position actuator is mounted on each camshaft. The cylinders are arranged in 2 banks of 3 with a 60 degree included angle. The right bank of cylinders are number 1-3-5 and the left bank of cylinders are 2-4-6, viewed from the flywheel end of the engine. The engine firing order is 1-2-3-4-5-6.

Crankcase

The cylinder block is constructed of aluminum alloy by precision sand-casting with cast in place iron cylinder liners. Each steel main bearing cap incorporates 6 bolts bolting the cap into the engine block. Along with 2 outer and 2 inner bolts, 2 side bolts are used in the deep skirt block. To prevent aeration, oil return from the valvetrain and cylinder heads is channeled away from the rotating and reciprocating components through oil drain back passages incorporated into the cylinder heads and engine block. Pressure-actuated piston oil cooling jets are mounted between opposing cylinders. A knock sensor is located on each side of the exterior of the engine block. The crankshaft position sensor is located on the right side of the exterior of the engine block.

Crankshaft

The crankshaft is a hardened, forged steel design with 4 main bearings. Crankshaft thrust is controlled by the upper portion of number 3 main bearing. The crankshaft position reluctor wheel is pressed onto the rear of the crankshaft in front of the rear main journal. A micro encapsulated adhesive is used on the reluctor wheel to aid retention. The crankshaft is internally balanced, and has an integral oil pump drive machined into the nose in front of the front main journal.

Connecting Rods and Pistons

The connecting rods are steel and have full floating piston pins. The piston pins are a slip fit in the bronze bushed connecting rod. Round wire retainers are used to retain the piston pin into the piston. The cast aluminum pistons incorporate a polymer-coated skirt to reduce friction. The piston uses two low tension compression rings and one multi-piece oil control ring. The top of the piston contains a dished portion for the direct injection system to aid in fuel-air charge mixture and even combustion.

Camshaft Drive System

The camshaft drive system consists of one primary timing drive chain driven by the crankshaft sprocket. The primary timing drive chain drives two intermediate drive shaft sprockets. Each intermediate drive shaft sprocket drives separate secondary timing drive chains. Each secondary timing drive chain drives the respective cylinder head's intake and exhaust camshaft position actuators.

The primary timing drive chain uses two stationary timing drive chain guides and a hydraulically-actuated tensioner with built-in shoe. The tensioner minimizes timing drive chain noise and provides accurate valve action by keeping slack out of the timing drive chains and continuously adjusting for timing drive chain wear. The tensioner incorporates a plunger that adjusts out with wear allowing only a minimal amount of backlash. The tensioner is equipped with an oiling jet to spray oil onto the timing components during engine operation.

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The secondary timing drive chains use a stationary timing drive chain guide and movable timing drive chain shoe. The secondary timing drive chain shoe is under tension from a hydraulically-actuated tensioner. All tensioners are sealed to the head or block using a rubber coated steel gasket. The gasket traps an adequate oil reserve to ensure quiet start-up.

Camshaft Position Actuator System

The engine incorporates a camshaft position actuator for each intake and exhaust camshaft. Camshaft phasing changes the inlet and exhaust valve timing as engine operating conditions vary. Dual camshaft phasing allows the further optimization of performance, fuel economy and emissions without compromising overall engine response and driveability. Variable valve timing also contributes to a reduction in exhaust emissions. It optimizes exhaust and inlet valve overlap and eliminates the need for an exhaust gas recirculation (EGR) system.

The camshaft position actuator is a hydraulic vane-type actuator that changes the camshaft lobe timing relative to the camshaft drive sprocket. Engine oil is directed by a camshaft position actuator oil control valve to the appropriate passages in the camshaft position actuator. Oil acting on the vane in the camshaft position actuator rotates the camshaft relative to the sprocket. At idle, both camshafts are at the default or "home" position. At this position, the exhaust camshaft is fully advanced and the intake is fully retarded to minimize valve overlap for smooth idle. An internal lock pin locks the inner rotor to the outer camshaft position actuator housing at idle and maintains this position during start-up conditions. Under other engine operating conditions, the camshaft position actuator is controlled by the engine control module (ECM) to deliver optimal intake and exhaust valve timing for performance, driveability and fuel economy. The camshaft position actuator incorporates an integral trigger wheel, which is sensed by the camshaft position sensor mounted in the front cover to accurately determine the position of each camshaft. Each camshaft position actuator has a specific timing drive mark for right or left bank application, as the camshaft position actuators are common bank to bank. The exhaust camshaft position actuator has a different internal configuration than the intake camshaft position actuator since the exhaust camshaft position actuator phases in the opposite direction relative to the inlet camshaft position actuator.

The camshaft position actuator oil control valve (OCV) directs oil from the oil feed in the head to the appropriate camshaft position actuator oil passages. There is one OCV for each camshaft position actuator. The OCV is sealed and mounted to the front cover. The ported end of the OCV is inserted into the cylinder head with a sliding fit. A filter screen protects each OCV oil port from any contamination in the oil supply.

The camshaft front journal has several drilled oil holes to allow camshaft position actuator control oil to transfer from the cylinder head to the camshaft position actuator. The center camshaft bolt hole is counterbored to allow oil to flow around the camshaft bolt and to the camshaft position actuator. Oil in this oil passage is used to move the camshaft position actuator to the default or home position. Radially outward from the center of the journal is a set of 4 drilled camshaft position actuator oil holes. Oil in this group of oil holes is used to move the camshaft from the default position to a specific set position as determined by the ECM. Seal rings are used at the front and rear of the front camshaft journal to prevent oil leakage from the camshaft position actuator hydraulic system. The seal is made from a plastic compound that resists wear and has a diagonal end gap to enhance sealing. The camshaft position actuator is mounted to the front end of the camshaft and the timing notch in the nose of the camshaft aligns with the dowel pin in the camshaft position actuator to ensure proper cam timing and camshaft position actuator oil hole alignment.

Cylinder Heads

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The cylinder heads are cast aluminum with powdered metal valve seat inserts and valve guides. Two intake valves and two exhaust valves are actuated by roller finger followers pivoting on a stationary hydraulic lash adjuster (SHLA). Separate exhaust and intake camshafts are supported by bearings machined into the cylinder head. The front camshaft bearing cap is used as a thrust control surface for each camshaft. In addition to the thrust bearing surfaces in the front camshaft bearing caps, there is a plastic thrust washer installed between the camshaft position actuator and the forward face of the cylinder head/camshaft thrust cap to supplement camshaft thrust control. Each spark plug is shielded by a tube that is pressed into the cylinder head. Each spark plug ignition coil is also mounted through the spark plug tube. The engine coolant temperature (ECT) sensor is threaded into the cylinder head. Longer intake ports are designed into the head for better airflow and eliminate the need for a separate lower intake manifold. With direct injection, the high pressure injectors are located in machined bores below the intake ports. A stainless steel, high pressure fuel rail is attached to the intake side of the head.

Induction System

A one piece, all-aluminum intake manifold is used to deliver a dry-air charge to the combustion chamber. Fuel is introduced directly to the cylinder during the intake stroke. As the piston approaches top-dead center, the air-fuel mixture is ignited by the spark plug. An electronically controlled throttle (ETC), through the ECM, coordinates the input from the driver with various control components.

Right and Left Bank Designation

Right hand (RH) and left hand (LH) designation through the engine mechanical section are viewed from the rear of the engine or from inside the vehicle.

NEW PRODUCT INFORMATION

The purpose of New Product Information is to highlight or indicate important changes from the previous model year.

Changes may include one or more of the following items:

- Torque values and/or fastener tightening strategies
- Changed engine specifications
- New sealants and/or adhesives
- Disassembly and assembly procedure revisions
- Engine mechanical diagnostic procedure revisions
- New special tools required
- A component comparison from the previous year

Torque Values and/or Fastener Tightening Strategies

Some torque specifications have changed for this model year. Refer to **Fastener Tightening Specifications** .

Changed Engine Specifications

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A variety of specifications have been revised for the LLT engine for this model year. Refer to **Engine Mechanical Specifications (LLT)** .

New Sealants and/or Adhesives

There are no changes to the sealants and/or adhesives used for this model year. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

Disassembly and Assembly Procedure Revisions

A variety of procedures have been revised based on the design of the LLT engine.

- Structural front engine cover has one additional bolt and two optional bolts that must be removed before the cover can be separated from the engine.
- Single belt accessory drive.
- Plastic thrust rings installed between cam position actuators and camshafts.

Engine Mechanical Diagnostic Procedure Revisions

Diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow should always be used in order to resolve a system condition. The diagnostic flow is the place to start when repairs are necessary. For a detailed explanation, refer to **Diagnostic Starting Point - Vehicle** .

New Special Tools Required

The Camaro and G8 applications require a different crankshaft balancer puller J-38416-B than other HFV6 applications. Many dealers already have this tool from previous applications; those who did not already have it will have it sent as part of this model year's Special Tool Package.

A Component Comparison from the Previous Year

- RWD LLT applications use a unique low pressure fuel feed line with integral check valve this model year.
- Some RWD LLT applications also use unique water outlets this model year.
- The Camaro and G8 LLT applications use a specific crankshaft balancer.
- All HFV6 engines use a new structural front engine cover for additional noise reduction.
- All FWD applications use a new oil pan.
- Spark plugs are changed to a different manufacturer for all applications.
- 5W-30 oil is recommended for all applications.

Refer to **Engine Component Description (LLT)** for additional information.

LUBRICATION DESCRIPTION

A structural diecast aluminum oil pan incorporates an oil suction tube and a windage tray. The oil suction tube

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is bolted into the oil pan and seals to the bottom of the block with O-ring gasket. The windage tray is bolted to the upper portion of the oil pan and reduces friction losses at high speed.

A crankshaft driven gerotor oil pump with internal pressure-relief valve is mounted to the front of the engine block and pulls oil from the oil suction tube through the lower passage in the engine block. The oil pump then directs the flow of pressurized oil back through the upper passage in the block to the left side of the engine block where the oil filter adapter is mounted.

An oil filter adapter is mounted with a gasket to the left side of the engine block.

RWD Applications : The oil filter adapter incorporates a top-access, cartridge style oil filter. The filter is accessed through a screw on cap with an O-ring gasket. The oil filter adapter cap has a built-in oil bypass valve. The oil filter adapter housing incorporates a drain back control valve and a threaded oil pressure sending unit. Oil flows through the lower passage in the oil filter adapter up to and through the oil filter cartridge. Filtered oil travels back through the upper passage of the oil filter adapter and back into the engine block.

FWD Applications : An oil filter adapter is mounted with a gasket to the left side of the engine block. The oil filter adapter incorporates a bottom-access, spin-on oil filter. The oil filter adapter housing incorporates a built-in oil bypass valve and a threaded oil pressure sending unit. Oil flows through the lower passage in the oil filter adapter to and through the oil filter. Filtered oil travels back through the upper passage of the oil filter adapter and back into the engine block.

Oil is directed up and across the engine block front through several drilled passages. These front passages feed oil to each cylinder head, oil to the passage for the main bearings and piston oil jets, oil to the right and left secondary idler sprockets, and oil to the primary timing drive chain tensioner.

Each cylinder head passage directs oil into the cylinder head where it is directed to oiling circuits for the stationary hydraulic lifter assemblies (SHLAs) and the camshaft bearing journals. Oil is also directed through 2 passages each with a spring-loaded check-ball valve to the 2 chambers where the camshaft position actuator oil control solenoid valves are mounted. Each chamber contains a camshaft position actuator oil control solenoid valve with built-in oil filter screen. One camshaft position actuator oil control solenoid valve is used to control the exhaust camshaft position actuator and 1 camshaft position actuator oil control solenoid valve is used to control the intake camshaft position actuator. The engine control module (ECM) electrically controls each camshaft position actuator oil control solenoid valve. When energized by the ECM the camshaft position actuator oil control solenoid valve directs oil to pass up through the cylinder head front camshaft bearing cap. Oil passes through the camshaft bearing cap passage into oil holes drilled into the side of the front camshaft journal and onto the front of the camshaft mounting surface. Oil passes through to matching passages in the camshaft position actuator. Oil is directed by the camshaft position actuator oil control solenoid valve to the appropriate passage in the system to pressurize oil on the vanes on the inside of the of the camshaft position actuator. Oil acting on the vanes rotates the camshaft mounted to the inner camshaft position actuator rotor relative to the sprocket mounted to the outer camshaft position actuator housing. An internal lock pin locks the inner rotor to the outer camshaft position actuator housing at idle and maintains the camshaft position actuator in the home or default position during start-up conditions. Oil pressure directed by the camshaft position actuator oil control solenoid valve unlocks the pin and allows the camshaft position actuator to function. An additional passage in the cylinder head also directs oil to the secondary timing drive chain tensioner mounted to each cylinder head.

The oil passage that supplies oil to the main bearings also supplies oil to pressure-actuated piston-cooling oil

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jets. Each oil jet is mounted between opposing cylinder bores and directs oil to the 2 bores to provide extra cooling and control piston temperatures.

Oil is directed from the front passages to the front of the block where the right and left secondary idler sprockets and the primary timing drive chain tensioner are mounted. Each camshaft timing drive chain tensioner relies on a gasket in order to maintain an oil reserve after the engine is turned OFF. All camshaft timing drive chain tensioners incorporate a small oil jet to supply an oil spray onto the camshaft timing drive chain components.

Oil returns to the oil pan sump either through the camshaft timing drive chain area or through the cast oil drain back passages on the outboard walls of the cylinder heads and engine block.

CLEANLINESS AND CARE

An automobile engine is a combination of many of the following surfaces:

- Machined
- Honed
- Polished
- Lapped

The tolerances of these surfaces are measured in the ten-thousandths of an inch. When you service any internal engine part, cleanliness and care are important. Apply a liberal coating of engine oil to the friction areas during assembly in order to protect and lubricate the surfaces on initial operation. Throughout this section, practice proper cleaning and protection procedures to the machined surfaces and to the friction areas.

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

Whenever you remove the valve train components, keep the components in order. Follow this procedure in order to install the components in the same locations and with the same mating surfaces as when removed.

WARNING: Refer to Battery Disconnect Warning .

Disconnect the negative battery cables before you perform any major work on the engine.

SEPARATING PARTS

In addition to the room temperature vulcanizing (RTV) sealant's sealing capabilities, the RTV sealants may form an adhesive bond between the components. This may make the components difficult to remove or to separate. Pry points have been provided in the components that utilize RTV as the sealing system. Pry points are positioned so they can be used without damaging other vital engine components.

REPLACING ENGINE GASKETS

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Gasket Reuse and Applying Sealant

- Do not reuse any gasket unless specified.
- Gaskets that can be reused will be identified in the service procedure.
- Do not apply sealant to any gasket or sealing surface unless specified in the service procedure.

Separating Components

- Use incorporated pry points to separate components using an RTV sealing system.
- Do not try to separate RTV sealed components by prying against other engine components.
- Pry points are positioned so no other vital engine components are damaged when they are used.

Cleaning Gasket Surfaces

- Use care to avoid gouging or scraping the sealing surfaces.
- Use a plastic or wood scraper in order to remove all the sealant from the components.

  Do not use any other method or technique to remove the sealant or the gasket material from a part.

- Do not use abrasive pads, sand paper, or power tools to clean the gasket surfaces.
  - These methods of cleaning can cause damage to the component sealing surfaces.
  - Abrasive pads also produce a fine grit that the oil filter cannot remove from the engine oil.

    This fine grit is an abrasive and can cause internal engine damage.

Assembling Components

- Assemble components using only the sealant, or equivalent, that is specified in the service procedure.
- Sealing surfaces must be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
- Components requiring lubrication will be identified in the service procedure.
- Apply only the amount of sealant specified in the service procedure to a component.
- Do not allow the sealant to enter into any blind threaded holes, as the sealant may prevent the fastener from clamping properly or cause component damage when tightened.

IMPORTANT: Do not overtighten the fasteners.

- Tighten the fasteners to the proper specifications.

USE OF ROOM TEMPERATURE VULCANIZING (RTV) AND ANAEROBIC SEALANT

Sealant Types

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NOTE: The correct sealant and amount of sealant must be used in the proper location to prevent oil leaks, coolant leaks, or the loosening of the fasteners. DO NOT interchange the sealants. Use only the sealant, or equivalent, as specified in the service procedure.

The following 2 major types of sealant are commonly used in engines:

- Anaerobic sealant room temperature vulcanizing (RTV)
- Anaerobic sealant, which include the following:
  - Gasket eliminator
  - Pipe
  - Threadlock

Anaerobic Type Room Temperature Vulcanizing (RTV) Sealant

Anaerobic type room temperature vulcanizing (RTV) sealant cures in the absence of air. This type of sealant is used where 2 components, such as the intake manifold and the engine block, are assembled together.

Use the following information when using RTV sealant:

- Do not use RTV sealant in areas where extreme temperatures are expected. These areas include:
  - The exhaust manifold
  - The head gasket
  - Any other surfaces where a different type of sealant is specified in the service procedure
- Always follow all the safety recommendations and the directions that are on the RTV sealant container.
- Use a plastic or wood scraper in order to remove all the RTV sealant from the components.

CAUTION: Do not allow the RTV sealant to enter any blind threaded hole. RTV sealant that is allowed to enter a blind threaded hole can cause hydraulic lock of the fastener when the fastener is tightened. Hydraulic lock of a fastener can lead to damage to the fastener and/or the components. Hydraulic lock of a fastener can also prevent the proper clamping loads to be obtained when the fastener is tightened. Improper clamping loads can prevent proper sealing of the components allowing leakage to occur. Preventing proper fastener tightening can allow the components to loosen or separate leading to extensive engine damage.

- The surfaces to be sealed must be clean and dry.
- Use a RTV sealant bead size as specified in the service procedure.
- Apply the RTV sealant bead to the inside of any bolt holes areas.

NOTE: Do not wait for the RTV sealant to skin over.

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- Assemble the components while the RTV sealant is still wet to the touch, within 3 minutes.

NOTE: Do not overtighten the fasteners.

- Tighten the fasteners in sequence, if specified, and to the proper torque specifications.

Anaerobic Type Gasket Eliminator Sealant

Anaerobic type gasket eliminator sealant cures in the absence of air. This type of sealant is used where 2 rigid parts, such as castings, are assembled together. When 2 rigid parts are disassembled and no sealant or gasket is readily noticeable, then the 2 parts were probably assembled using an anaerobic type gasket eliminator sealant.

Use the following information when using gasket eliminator sealant:

- Always follow all the safety recommendations and directions that are on the gasket eliminator sealant container.
- Apply a continuous bead of gasket eliminator sealant to one flange.

The surfaces to be sealed must be clean and dry.

CAUTION: Do not allow the sealant to enter a blind hole. The sealant may prevent the fastener from achieving proper clamp load, cause component damage when the fastener is tightened, or lead to component failure.

NOTE:

- **Gasket eliminator sealed joint fasteners that are partially torqued and the gasket eliminator sealant allowed to cure more than 5 minutes, may result in incorrect shimming and sealing of the joint.**
- **Do not overtighten the fasteners.**
  - **Apply the gasket eliminator sealant evenly to get a uniform thickness of the gasket eliminator sealant on the sealing surface.**
  - **Tighten the fasteners in sequence, if specified, and to the proper torque specifications.**
  - **After properly tightening the fasteners, remove the excess gasket eliminator sealant from the outside of the joint.**

Anaerobic Type Threadlock Sealant

Anaerobic type threadlock sealant cures in the absence of air. This type of sealant is used for threadlocking and sealing of bolts, fittings, nuts, and studs. This type of sealant cures only when confined between 2 close fitting metal surfaces.

Use the following information when using threadlock sealant:

- Always follow all safety recommendations and directions that are on the threadlock sealant container.

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- The threaded surfaces to be sealed must be clean and dry.
- Apply the threadlock sealant as specified on the threadlock sealant container.

NOTE:
- **Fasteners that are partially torqued and then the threadlock sealant allowed to cure more than 5 minutes, may result in incorrect clamp load of assembled components.**
- **Do not overtighten the fasteners.**

- Tighten the fasteners in sequence, if specified, and to the proper torque specifications.

Anaerobic Type Pipe Sealant

Anaerobic type pipe sealant cures in the absence of air and remains pliable when cured. This type of sealant is used where 2 parts are assembled together and require a leak proof joint.

Use the following information when using pipe sealant:

- Do not use pipe sealant in areas where extreme temperatures are expected. These areas include:
  - The exhaust manifold
  - The head gasket
  - Surfaces where a different sealant is specified
- Always follow all the safety recommendations and the directions that are on the pipe sealant container.
- The surfaces to be sealed must be clean and dry.
- Use a pipe sealant bead of the size or quantity as specified in the service procedure.

CAUTION: Do not allow the sealant to enter a blind hole. The sealant may prevent the fastener from achieving proper clamp load, cause component damage when the fastener is tightened, or lead to component failure.

- Apply the pipe sealant bead to the inside of any bolt hole areas.
- Apply a continuous bead of pipe sealant to one sealing surface.

NOTE: Do not overtighten the fasteners.

- Tighten the fasteners in sequence, if specified, and to the proper torque specifications.

TOOLS AND EQUIPMENT

- Special tools are listed and illustrated throughout this section, with a complete listing at the end of the section. These tools, or their equivalents, are designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the proper tightening of various fasteners.

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- To properly service the engine assembly, the following items should be readily available:
  - Approved eye protection and safety gloves
  - A clean, well-lit, work area
  - A suitable component cleaning tank
  - A compressed air supply
  - Trays or storage containers to keep components and fasteners organized
  - An adequate set of hand tools
  - Approved engine repair stand
  - An approved engine lifting device that adequately supports the weight of the components

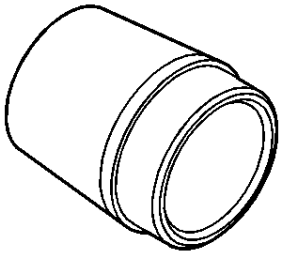
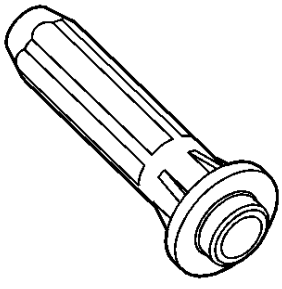
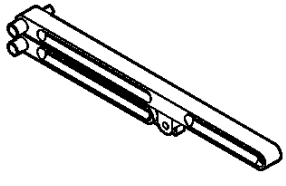
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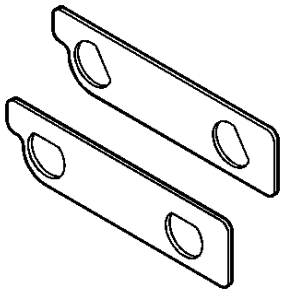
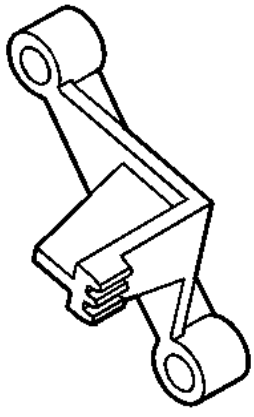
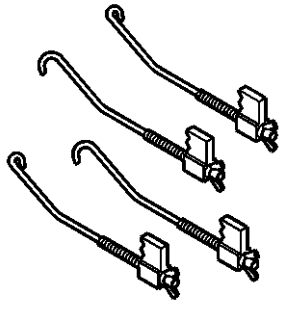
Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Camaro

SPECIAL TOOLS AND EQUIPMENT

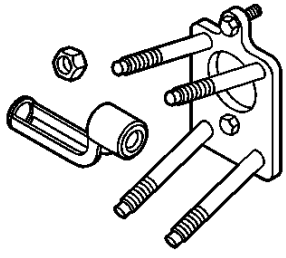
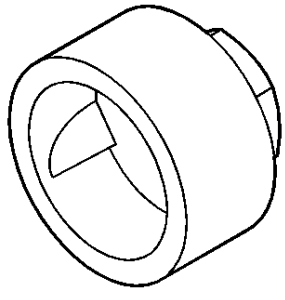
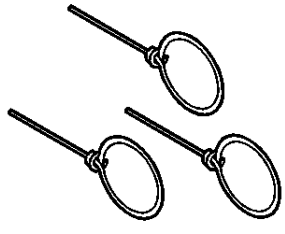
SPECIAL TOOLS

Illustration	Tool Number/Description
	EN 46101 Spark Plug Tube Seal Guide
	EN 46103 Camshaft Actuator Valve Seal Installer
	EN 46104 Water Pump Pulley Holding Tool
	EN 46105 Camshaft Locking Tool

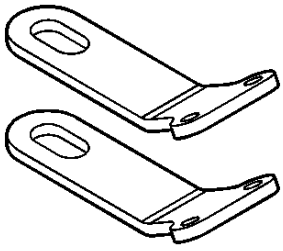
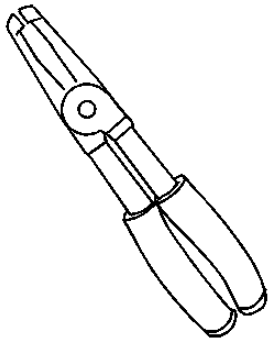
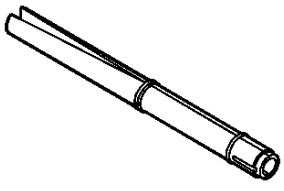
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	EN 46106 Flywheel Holding Tool
	EN 46108 Timing Chain Retention Tool
	EN 46109

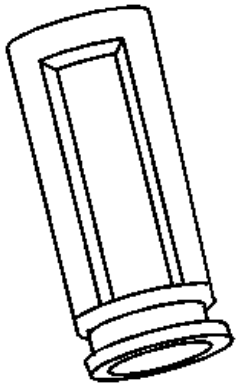
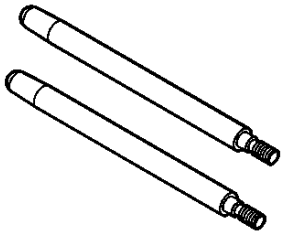
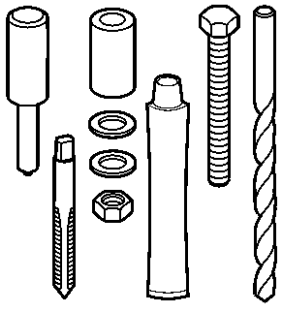
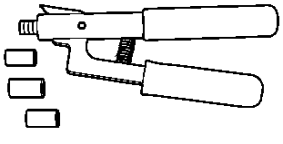
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	Guide Pins
	EN 46110 On-Vehicle Valve Spring Compressor
	EN 46111 Crankshaft Rotation Socket
	EN 46112 Tensioner Retraction Pins

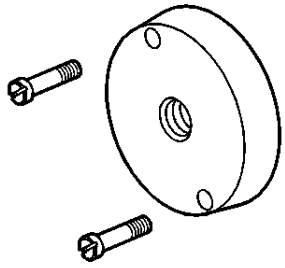
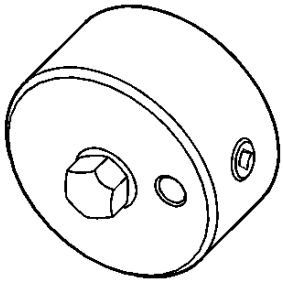
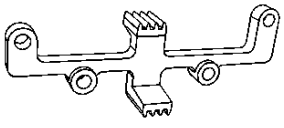
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	EN 46114 Engine Lift Brackets
	EN 46116 Valve Stem Seal Remover/Installer
	EN 46117 Valve Stem Key Remover/Installer
	EN 46119 Off-Vehicle Valve Spring Compressor Adapter

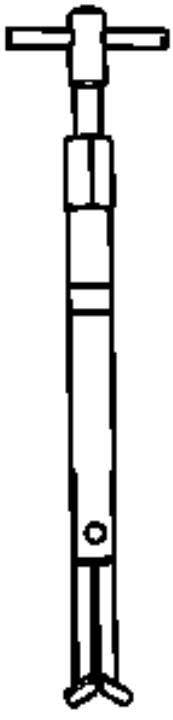
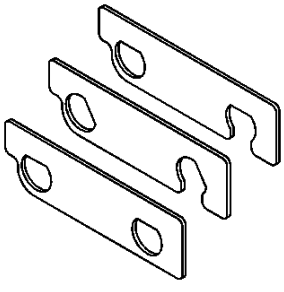
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	EN 46121 Connecting Rod Guide Pin Set
	EN 46122 Camshaft Position Actuator Check-Ball Valve Remover/Installer
	EN 46745 Piston Pin Clip Remover/Installer

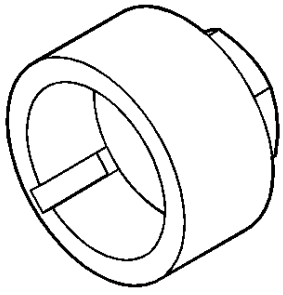
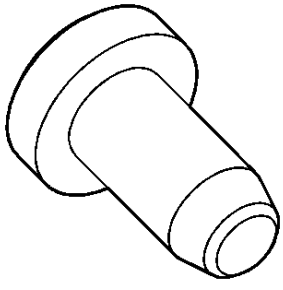
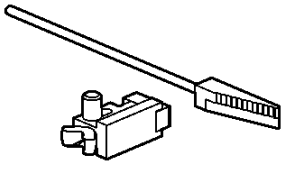
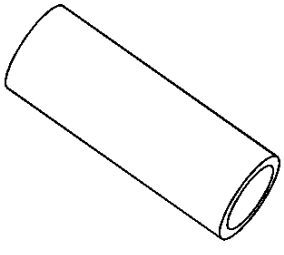
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	EN 47839 Crankshaft Rear Oil Seal Installation Tool
	EN 47971 Oil Pressure Gauge Adapter
	EN 48018 Flywheel Holding Tool
	EN 48313 Timing Chain Retention Tool

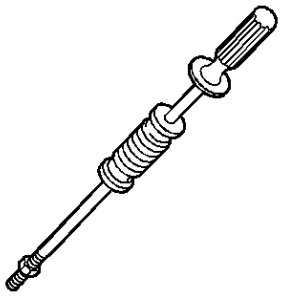
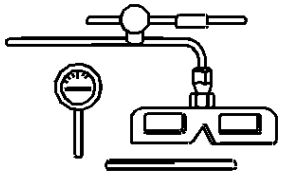
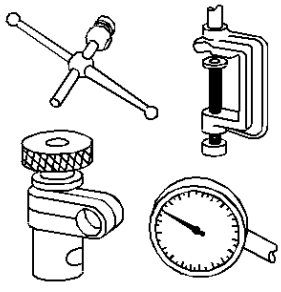
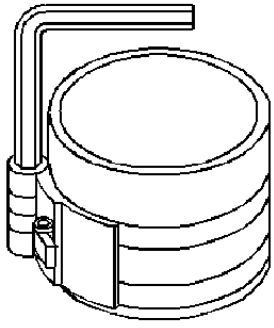
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	EN 48383 Camshaft Retaining Tool
	EN 48589

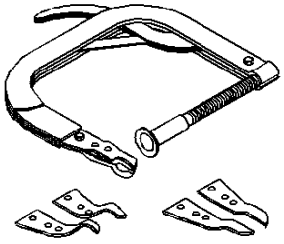
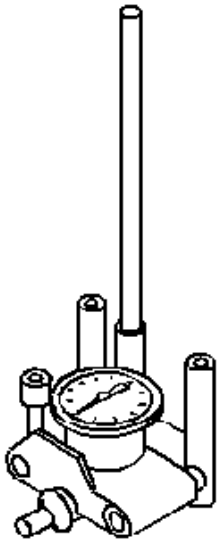
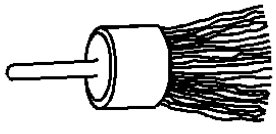
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	Crankshaft Rotation Socket
	
	EN 48896 HP Fuel Pump Installation Alignment Gauge
	EN 49882 Timing Chain Retainer
	J 5590 Bearing and Seal Driver

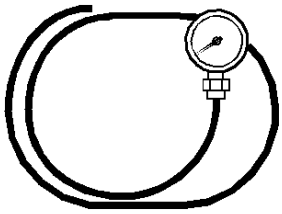
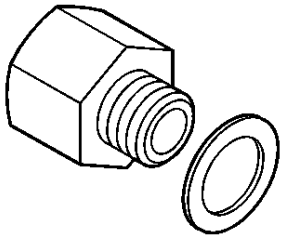
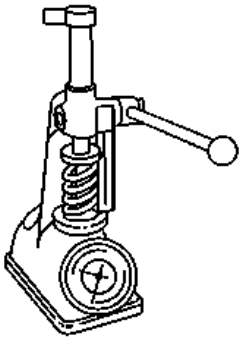
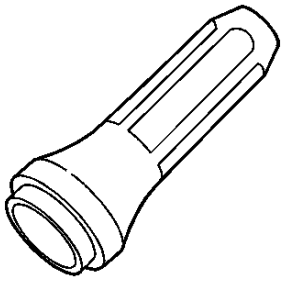
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	J 6125-1B Slide Hammer Adapter
	J 7872 Magnetic Base Dial Indicator
	J 8001 Dial Indicator Set
	J 8037 Ring Compressor

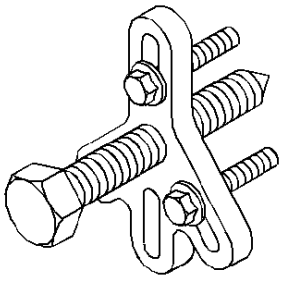
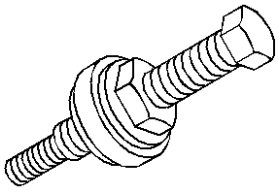
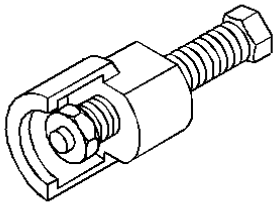
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	J 8062 Valve Spring Compressor - Head Off
	J 8087 Cylinder Bore Gauge
	J 8358 Carbon Removal Brush
	J 21867 Pressure Gauge

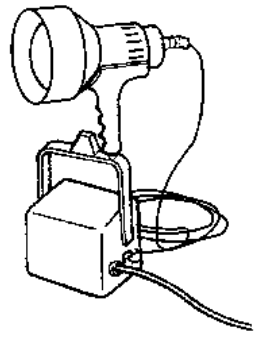
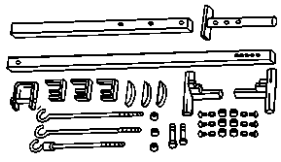
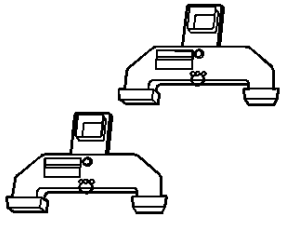
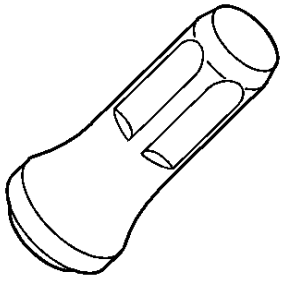
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	J 21867-6 Oil Pressure Adapter Fitting
	J 22738-B Valve Spring Tester
	J 24254 Oil Seal Installer

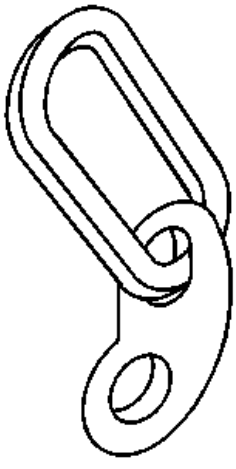
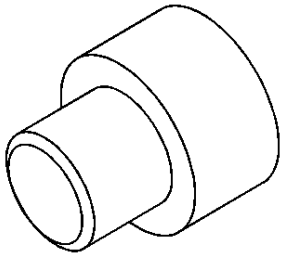
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	J 24420-C Harmonic Balancer Puller
	J 25033-C Pulley Installer
	J 25034-C Pulley Remover
	J 28410 Gasket Remover
	J 28428-E High Intensity Black Light Kit

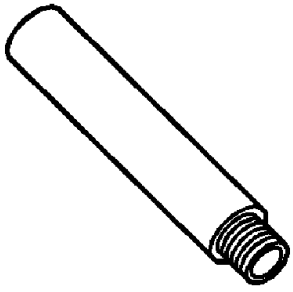
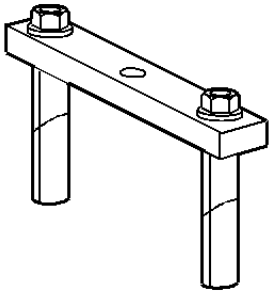
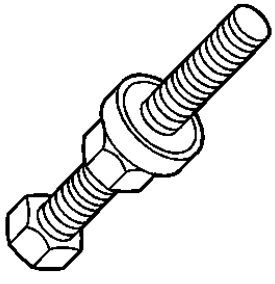
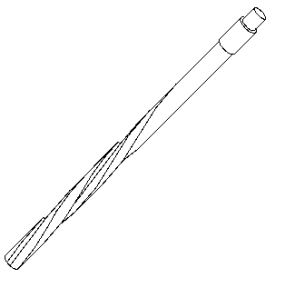
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	J 28467-B Universal Engine Support Fixture
	J 28467-501 Engine Support Fixture Adapters
	J 29184 Oil Seal Installer

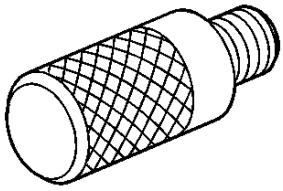
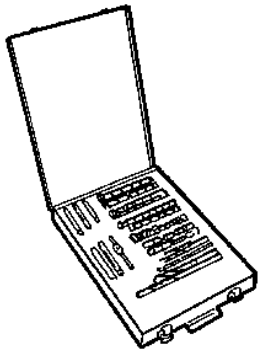
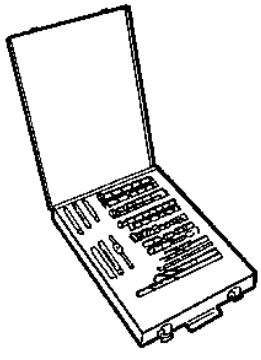
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	J 35667-A Cylinder Head Leakdown Tester
	J 36857 Engine Lift Bracket
	J 38416-2 Crankshaft Button

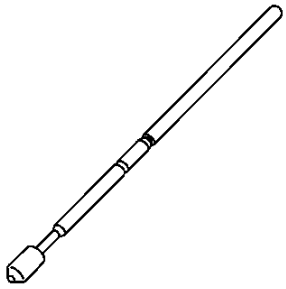
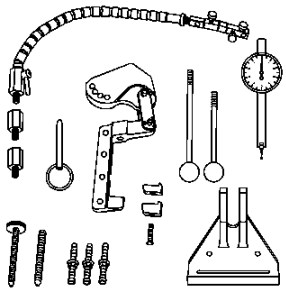
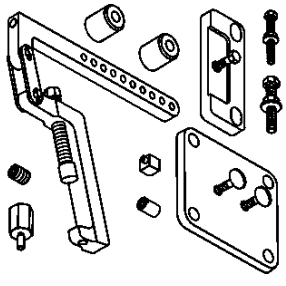
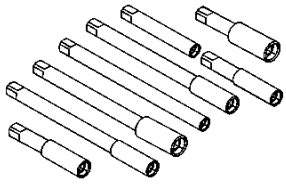
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	J 39313 Spark Plug Port Adapter
	J 41818 Crankshaft Bearing Cap Remover
	J 41998-B Crankshaft Balancer Installer
	J 42096 Valve Guide Reamer

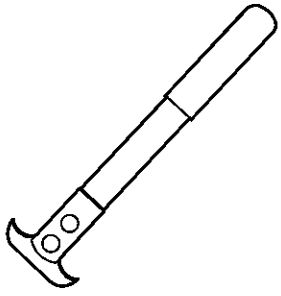
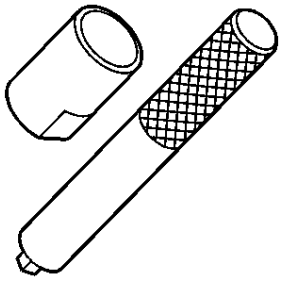
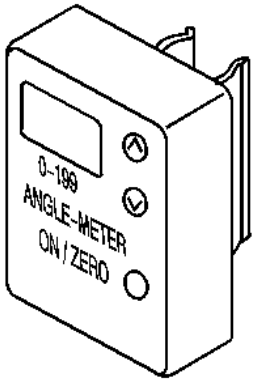
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	J 42183 Handle
	J 42385-700 High Feature Thread Repair Kit
	J 42385-2000 Thread Insert Kit
	J 42640 Steering Column Anti-Rotation Pin

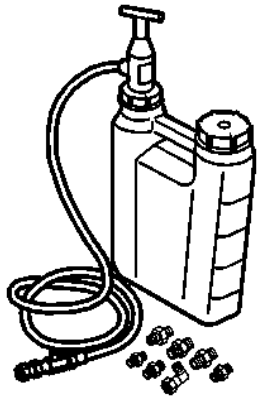
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	J 43690 Rod Bearing Clearance Checking Tool
	J 43690-100 Rod Bearing Clearance Checking Tool - Adapter Kit
	J 43965 Thread Repair Extension Kit

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	J 45000 Seal Remover
	J 45027 Tensioner Tool
	J 45059 Angle Meter
	J 45299

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2010 ENGINE

Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Camaro

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	Specification	
	Metric	English
A/C		
• Compressor Bolt - Rear - CTS Only	45 N.m	33 lb ft
• Compressor Bolt - Rear - All Except CTS	58 N.m	43 lb ft
• Compressor Bolt - Front	22 N.m	17 lb ft
• Compressor Bracket Bolt - Front	50 N.m	37 lb ft
• Compressor Hose Assembly Bolt	9 N.m	80 lb in
Camshaft Cap Bolt	10 N.m	89 lb in
Camshaft Cover Bolt	10 N.m	89 lb in
Camshaft Intermediate Drive Sprocket Bolt - Idler Sprocket	58 N.m	43 lb ft
Camshaft Position Actuator		
• Camshaft Bolt	58 N.m	43 lb ft
• Oil Control Valve Bolt	10 N.m	89 lb in
Camshaft Position Sensor Bolt	10 N.m	89 lb in
Catalytic Converter		
• Exhaust Manifold Nut	50 N.m	37 lb ft
Close Out Cover Bolt	10 N.m	89 lb in
Clutch Pressure Plate Bolts	30 N.m	22 lb ft
Connecting Rod Bolt		
• First Pass	30 N.m	22 lb ft
• Second Pass - Counterclockwise	Back Off to Zero	
• Third Pass	25 N.m	18 lb ft
• Final Pass	110 Degrees	
Coolant Outlet Bolt	10 N.m	89 lb in
Crankshaft Balancer Bolt		
• First Pass	100 N.m	74 lb ft
• Final Pass	150 Degrees	
Crankshaft Main Bearing Bolt - Inner		
• First Pass	20 N.m	15 lb ft

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• Final Pass	80 degrees	
Crankshaft Main Bearing Bolt - Outer		
• First Pass	15 N.m	11 lb ft
• Final Pass	110 Degrees	
Crankshaft Main Bearing Bolt - Side		
• First Pass	30 N.m	22 lb ft
• Final Pass	60 Degrees	
Crankshaft Position Sensor Bolt	10 N.m	89 lb in
Crankshaft Rear Oil Seal Housing Bolt	10 N.m	89 lb in
Cylinder Head Bolt - M8		
• First Pass	15 N.m	11 lb ft
• Final Pass	75 Degrees	
Cylinder Head Bolt - M11		
• First Pass	30 N.m	22 lb ft
• Final Pass	150 degrees	
Cylinder Head Core Hole Plug	31 N.m	23 lb ft
Drive Belt		
• Idler Pulley Bolt	58 N.m	43 lb ft
• Tensioner Bolt	58 N.m	43 lb ft
ECM		
• Bolt	10 N.m	89 lb in
• Bracket Bolt - Front	23 N.m	17 lb ft
• Bracket Bolt - Side	10 N.m	89 lb in
• Grounding Bolt	4.5 N.m	40 lb in
ECT Sensor	30 N.m	22 lb ft
Engine Flex Plate, Auto Trans, Bolt		
• First Pass	30 N.m	22 lb ft
• Final Pass	45 Degrees	
Engine Flywheel, Manual Trans, Bolt	67 N.m	49 lb ft
Engine Front Cover Studs	15 N.m	11 lb ft
Engine Front Cover Bolt - M6	15 N.m	11 lb ft
Engine Front Cover Bolt - M8		
• First Pass	20 N.m	14 lb ft
• Second Pass	20 N.m	14 lb ft
• Final Pass	60 Degrees	
Engine Front Cover Bolt - M12	65 N.m	48 lb ft

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Engine Mount		
• Bracket Bolt to Engine Block - M8 (AWD)	38 N.m	28 lb ft
• Bracket Bolt to Engine Block - M8 (RWD)	22 N.m	16 lb ft
• Bracket Bolt to Engine Block - M10	60 N.m	45 lb ft
• Nut to Engine Mount Bracket	80 N.m	59 lb ft
• Nut to Frame	80 N.m	59 lb ft
Engine Wiring Harness Bracket		
• Bolt - Cylinder Head Rear	40 N.m	30 lb ft
• Bolt - ECM Bracket Side	23 N.m	17 lb ft
• Bolt - ECM Bracket Top	10 N.m	89 lb in
• Bolt - Left Side Oil Filter Adapter	10 N.m	89 lb in
• Bolt - Left Side Oil Pan	10 N.m	89 lb in
• Bolt - Near Crankshaft Position Sensor	50 N.m	37 lb ft
• Bolt - Right Side Block Front	23 N.m	17 lb ft
• Bolt - Right Side Head Front	10 N.m	89 lb in
Engine Wiring Harness Ground		
• Bolt - ECM Bracket Top	10 N.m	89 lb in
• Bolt - Left Cylinder Head Side	10 N.m	89 lb in
• Bolt - Right Cylinder Head Rear	10 N.m	89 lb in
EVAP Purge Valve Bolt	10 N.m	89 lb in
Exhaust Manifold		
• Bolt	20 N.m	15 lb ft
• Heat Shield Bolt	10 N.m	89 lb in
• Lower Heat Shield, Knock Sensor Shield, Bolt	58 N.m	43 lb ft
Fuel Injection Fuel Rail Fuel Pressure Sensor	33 N.m	25 lb ft
Fuel Line Pressure Fuel Line Fitting Nuts	30 N.m	22 lb ft
Fuel Pump Bolts - High Pressure	15 N.m	11 lb ft
Fuel Rail Bolt	10 N.m	89 lb in
Generator		
• Bolt	50 N.m	37 lb ft
• Bracket Bolt - Front	50 N.m	37 lb ft
• Bracket Bolt - Side	22 N.m	16 lb ft
• Cable Nut	13 N.m	115 lb in
Ground Cable Bolt	50 N.m	37 lb ft
Heater Inlet/Outlet Pipe Assembly Bolt	10 N.m	89 lb in
Ignition Coil Bolt	10 N.m	89 lb in

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Intake Manifold		
• Brace Bolt - Engine Front Cover M12	65 N.m	48 lb ft
• Brace Bolt/Ball Stud - Intake Manifold M6	10 N.m	89 lb in
• Ball Stud to Cam Cover M6	5 N.m	44 lb in
• Sight Shield Ball Stud	10 N.m	89 lb in
• Tuning Valve Bolt	10 N.m	89 lb in
• Upper-to-Cylinder Head Bolt - Long	25 N.m	18 lb ft
• Upper-to-Cylinder Head Bolt - Short	25 N.m	18 lb ft
• Upper-to-Lower Intake Manifold Bolt	25 N.m	18 lb ft
Knock Sensor Bolt	25 N.m	18 lb ft
MAP Sensor Bolt	10 N.m	89 lb in
Oil Drain Plug	25 N.m	18 lb ft
Oil Filter Cap	25 N.m	18 lb ft
Oil Filter Housing Adapter		
• Bolt - Cylinder Head M10	58 N.m	43 lb ft
• Bolt - Engine Block M8	25 N.m	18 lb ft
Oil Gallery Plug	31 N.m	23 lb ft
Oil Level Indicator Tube Bolt	10 N.m	89 lb in
Oil Pan		
• Bolt - Block M8	25 N.m	18 lb ft
• Bolt - Crankshaft Rear Oil Seal Housing M6	10 N.m	89 lb in
• Windage Tray Bolt	10 N.m	89 lb in
Oil Pressure Sender	20 N.m	15 lb ft
Oil Pump		
• Bolt	25 N.m	18 lb ft
• Cover Bolt	13 N.m	115 lb in
Oxygen Sensor		
• Pump Converter Pipe	40 N.m	30 lb ft
PCV Tube Bracket Bolt	10 N.m	89 lb in
Piston Oil Cooling Nozzle Bolt	10 N.m	89 lb in
Power Steering Pump		
• Bracket to Engine Bolt Acadia/Enclave/Outlook/Traverse; Equinox/Terrain; Vue	50 N.m	37 lb ft
• Bracket to Engine Bolt	58 N.m	43 lb ft

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All Except: Acadia/Enclave/Outlook/Traverse; Equinox/Terrain; Vue		
• Pump to Bracket Bolt	22 N.m	16 lb ft
• Reservoir Bolt - Lower	25 N.m	18 lb ft
• Reservoir Bolt - Upper	9 N.m	80 lb in
Primary Camshaft Drive Chain		
• Left Lower Guide Bolt - Oil Pump - Second Design	25 N.m	18 lb ft
• Tensioner Bolt	25 N.m	18 lb ft
• Upper Guide Bolt	25 N.m	18 lb ft
Radiator Outlet Pipe		
• Bolt - Generator Bracket	25 N.m	18 lb ft
• Bolt - Right Cylinder Head Rear	58 N.m	43 lb ft
• Bolt - Thermostat Housing	25 N.m	18 lb ft
Secondary Camshaft Drive Chain		
• Guide Bolt	25 N.m	18 lb ft
• Shoe Bolt	25 N.m	18 lb ft
• Tensioner Bolt	25 N.m	18 lb ft
Spark Plug	18 N.m	13 lb ft
Starter Motor		
• Bolt	58 N.m	43 lb ft
• Cable Nut	13 N.m	115 lb in
Suction Tube Bolt	10 N.m	89 lb in
Suction Screen Bolt	10 N.m	89 lb in
Thermostat Housing Bolt	10 N.m	89 lb in
Throttle Body Bolt	10 N.m	89 lb in
Torque Converter Bolt	60 N.m	44 lb ft
Transmission		
• Mount Bolt to Transmission - RPO M82	60 N.m	45 lb ft
• Range Selector Lever Nut	9.5 N.m	84 lb in
• To Engine Bolt	50 N.m	37 lb ft
Water Pump		
• Bolt	10 N.m	89 lb in
• Pulley Bolt	10 N.m	89 lb in

ENGINE MECHANICAL SPECIFICATIONS (LLT)

	Specification	

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Application	Metric	English
General		
• Engine Type	V-6	
• Displacement	3.6 Liter	217 cu in
• RPO	LLT	
• VIN	V-cars/D-trucks	
• Bore	94 mm	3.7008 in
• Stroke	85.6 mm	3.37 in
• Compression Ratio	11.4:1	
• Firing Order	1-2-3-4-5-6	
• Spark Plug Gap	1.1 mm	0.0433 in
Block		
• Crankshaft Main Bearing Bore Diameter	72.867-72.881 mm	2.8688-2.8693 in
• Cylinder Bore Diameter	93.992-94.008 mm	3.7005-3.7011 in
• Cylinder Bore Out-of-Round - Production Max.	0.013 mm	0.0005 in
Camshaft		
• Camshaft Bearing Inside Diameter - Front Number 1	35.000-35.020 mm	1.3779-1.3787 in
• Camshaft Bearing Inside Diameter - Middle and Rear Number 2-4	27.000-27.020 mm	1.0630-1.0638 in
• Camshaft End Play	0.045-0.215 mm	0.0018-0.0085 in
• Camshaft Journal Diameter - Front Number 1	34.936-34.960 mm	1.3754-1.3764 in
• Camshaft Journal Diameter - Middle and Rear Number 2-4	26.936-26.960 mm	1.0605-1.0614 in
• Camshaft Journal Out-of-Round	0.006 mm	0.0002 in
• Camshaft Journal to Bore Clearance	0.040-0.084 mm	0.0016-0.0033 in
• Camshaft Lobe Lift - Exhaust	42.425-42.725 mm	1.6703-1.6821 in
• Camshaft Lobe Lift - Intake	42.385-42.685 mm	1.6687-1.6805 in
• Camshaft Runout - Front and Rear Number 1 and 4	0.025 mm	0.0010 in
• Camshaft Runout - Middle 2 and 3	0.050 mm	0.0020 in
• Valve Lift - Exhaust	10.8 mm	0.4252 in
• Valve Lift - Intake	10.8 mm	0.4252 in
Connecting Rod		
• Connecting Rod Bearing Clearance	0.010-0.070 mm	0.0004-0.0028 in
• Connecting Rod Bore Diameter - Bearing End	59.620-59.636 mm	2.3472-2.3479 in
• Connecting Rod Bore Diameter - Pin End -		

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Production	24.009-24.019 mm	0.9452-0.9456 in
• Connecting Rod Bore Diameter - Pin End - Service Maximum	24.021 mm	0.9457 in
• Connecting Rod Length - Center to Center	152.400 mm	6.0000 in
• Connecting Rod Side Clearance	0.095-0.355 mm	0.0374-0.0140 in
• Connecting Rod Width - Bearing End		
• Production	21.775 mm	0.8573 in
• Service	21.725-21.825 mm	0.8553-0.8593 in
• Connecting Rod Width - Pin End		
• Production	21.775 mm	0.8573 in
• Service	21.725-21.825 mm	0.8553-0.8593 in
Crankshaft		
• Connecting Rod Journal Diameter	55.992-56.008 mm	2.2044-2.2050 in
• Connecting Rod Journal Out-of-Round	0.005 mm	0.0002 in
• Connecting Rod Journal Taper	0.005 mm	0.0002 in
• Connecting Rod Journal Width		
• Production	22.000 mm	0.8661 in
• Service	21.920-22.080 mm	0.8630-0.8693 in
• Crankshaft End Play	0.100-0.330 mm	0.0039-0.0130 in
• Crankshaft Main Bearing Clearance	0.010-0.060 mm	0.0004-0.0024 in
• Crankshaft Main Journal Diameter	67.992-68.008 mm	2.6768-2.6775 in
• Crankshaft Main Journal Out-of-Round	0.005 mm	0.0002 in
• Crankshaft Main Journal Taper	0.005 mm	0.0002 in
• Crankshaft Main Journal Thrust Wall		
• Runout	0.000-0.040 mm	0.0000-0.0016 in
• Square	0.000-0.010 mm	0.0000-0.0004 in
• Crankshaft Main Journal Width, #2, 4		
• Production	24.000 mm	0.9449 in
• Service	23.900-24.100 mm	0.9409-0.9488 in
• Crankshaft Main Journal Width, #3		
• Production	24.400 mm	0.9606 in
• Service	24.360-24.440 mm	0.9591-0.9622 in
• Crankshaft Pilot Bearing Bore Diameter	20.965-20.995 mm	0.8254-0.8266 in
• Crankshaft Rear Flange Runout	0.025 mm	0.0010 in

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• Crankshaft Reluctor Ring Runout - Maximum	1.500 mm	0.0591 in
• Crankshaft Runout	0.030 mm	0.0012 in
• Crankshaft Thrust Bearing Clearance	0.076-0.305 mm	0.0030-0.0120 in
• Crankshaft Thrust Surface - Height Diameter	95.000 mm	3.7401 in
• Crankshaft Thrust Surface Runout	0.040 mm	0.0016 in
Cylinder Head		
• Valve Guide Bore - Exhaust	6.000-6.020 mm	0.2362-0.2370 in
• Valve Guide Bore - Intake	6.000-6.020 mm	0.2362-0.2370 in
• Valve Guide Installed Height	14.050-14.550 mm	0.5531-0.5728 in
• Valve Lifter Bore Diameter	12.008-12.030 mm	0.4728-0.4736 in
Lubrication System		
• Oil Capacity - with Filter	5.68 Liters	6 Quarts
• Oil Capacity - without Filter	5.20 Liters	5.5 Quarts
• Oil Pressure - Minimum @ Idle	69 kPa	10 psi
• Oil Pressure - Minimum @ 2,000 RPM	138 kPa	20 psi
• Piston Cooling Jet Valve Opening Pressure	1.7-2.3 bar	25-33 psi
Piston Rings		
• Piston Ring End Gap		
• First Compression Ring - Nominal	0.150-0.300 mm	0.0059-0.0118 in
• First Compression Ring - Maximum, Ring in Bore	0.390 mm	0.1535 in
• Second Compression Ring - Nominal	0.280-0.480 mm	0.0110-0.0189 in
• Second Compression Ring - Maximum, Ring in Bore	0.560 mm	0.0220 in
• Oil Control Ring	0.150-0.600 mm	0.0059-0.0236 in
• Piston Ring to Groove Clearance		
• First Compression Ring	0.030-0.065 mm	0.0012-0.0026 in
• Second Compression Ring	0.015-0.060 mm	0.0006-0.0024 in
• Oil Control Ring	0.030-0.170 mm	0.0012-0.0067 in
• Piston Ring Thickness		
• First Compression Ring	1.175-1.190 mm	0.0463-0.0469 in
• Second Compression Ring	1.470-1.495 mm	0.0579-0.0589 in
• Oil Control Ring	2.360-2.480 mm	0.0929-0.0976 in
Pistons and Pins		
• Piston		
• Piston Diameter - Measured Over Skirt Coating	93.976-94.014 mm	3.6998-3.7013 in

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• Piston Diameter - Service Limit Minimum w/more than 10K miles	93.926 mm	3.6979 in
• Piston Pin Bore Diameter	24.004-24.009 mm	0.9450-0.9452 in
• Piston Ring Groove Width - First Compression Ring	1.220-1.240 mm	0.0480-0.0488 in
• Piston Ring Groove Width - Second Compression Ring	1.510-1.530 mm	0.0595-0.0602 in
• Piston Ring Groove Width - Oil Control Ring	2.510-2.530 mm	0.0988-0.0996 in
• Piston to Bore Clearance - Production; Measured at Skirt Coating	0.022-0.032 mm	0.0008-0.0013 in
• Piston to Bore Clearance - Service Limit Maximum, w/more than 10k miles	0.650 mm	0.0256 in
• Pin		
• Piston Pin Clearance to Connecting Rod Bore - Production	0.007-0.024 mm	0.0003-0.0010 in
• Piston Pin Clearance to Connecting Rod Bore - Service Maximum	0.030 mm	0.0012 in
• Piston Pin Clearance to Piston Pin Bore - Production	0.004-0.012 mm	0.0002-0.0005 in
• Piston Pin Clearance to Piston Pin Bore - Service Maximum	0.015 mm	0.0006 in
• Piston Pin Diameter	23.997-24.000 mm	0.9448-0.9449 in
• Piston Pin Length	60.600-61.100 mm	2.3858-2.4055 in
Valve System		
• Valves		
• Valve Face Angle	44.25 degrees	
• Valve Face Runout	0.038 mm	0.0015 in
• Valve Face Width - Exhaust	2.750 mm	0.1083 in
• Valve Face Width - Intake	2.180 mm	0.0858 in
• Valve Head Diameter - Exhaust	30.470-30.730 mm	1.1996-1.2098 in
• Valve Head Diameter - Intake	36.830-37.090 mm	1.4500-1.4602 in
• Valve Installed Height	35.23-36.69 mm	1.3870-1.4445 in
• Valve Length - Exhaust	97.110 mm	3.8232 in
• Valve Length - Intake	101.230 mm	3.9854 in
• Valve Seat Angle - Seating Surface	45 degrees	
• Valve Seat Angle - Relief Surface	30 degrees	
• Valve Seat Angle - Undercut Surface	60 degrees	

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• Valve Seat Roundness- Maximum	0.025 mm	0.0010 in
• Valve Seat Runout - Maximum	0.080 mm	0.0032 in
• Valve Seat Width - Exhaust Seating Surface	1.400-1.800 mm	0.0551-0.0709 in
• Valve Seat Width - Exhaust Relief Surface	0.700-0.900 mm	0.0276-0.0354 in
• Valve Seat Width - Intake Seating Surface	1.000-1.400 mm	0.0394-0.0551 in
• Valve Seat Width - Intake Relief Surface	0.500-0.700 mm	0.0197-0.0276 in
• Valve Stem Diameter - Exhaust	5.945-5.965 mm	0.2341-0.2348 in
• Valve Stem Diameter - Intake	5.955-5.975 mm	0.2344-0.2352 in
• Valve Stem-to-Guide Clearance - Exhaust	0.035-0.075 mm	0.0014-0.0030 in
• Valve Stem-to-Guide Clearance - Intake	0.025-0.065 mm	0.0010-0.0026 in
• Valve Lifters - Stationary Hydraulic Lash Adjuster (SHLA)		
• Valve Lifter (SHLA) Diameter	11.989-12.000 mm	0.4720-0.4724 in
• Valve Lifter (SHLA)-to-Bore Clearance	0.008-0.041 mm	0.0003-0.0016 in
• Rocker Arms		
• Valve Rocker Arm Ratio	1.68 to 1	
• Valve Rocker Arm Roller Diameter	17.750-17.800 mm	0.6988-0.7008 in
• Valve Springs		
• Valve Spring Coil Thickness	3.250 x 3.900 mm	0.1280 x 0.1535 in
• Valve Spring Diameter - Inside Top	12.200-12.700 mm	0.4803-0.4999 in
• Valve Spring Diameter - Outside Top	20.250 mm	0.7972 in
• Valve Spring Diameter - Inside Bottom	17.950-18.450 mm	0.7067-0.7264 in
• Valve Spring Diameter - Outside Bottom	26.000 mm	1.0236 in
• Valve Spring Free Length	42.500-45.500 mm	1.6732-1.7913 in
• Valve Spring Installed Height - Closed	35.000 mm	1.3779 in
• Valve Spring Installed Height - Open	24.000 mm	0.9449 in
• Valve Spring Load - Closed	247-273 N	56-61 lb
• Valve Spring Load - Open	598-662 N	134-149 lb

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	
		United States	Canada
Block Pan Rail	Sealant	12378521	88901148
Camshaft Prelube	Lubricant	88862586	88862827
Coolant Drain Threaded Plug	Sealant	12346004	10953480

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Coolant Expansion Plugs	Sealant	12378521	88901148
Coolant and Oil Plug Threads	Sealant	12346004	10953480
Crankshaft Bearing Surfaces - Upper/Lower	Lubricant	1052367	992869
	Lubricant	12345501	992704
Crankshaft Connecting Rod Bearing Journal	Lubricant	1052367	992869
	Lubricant	12345501	992704
Crankshaft Prelube	Lubricant	1052367	992869
Crankshaft Rear Oil Seal Housing	Sealant	12378521	88901148
Engine Front Cover/Split Lines	Sealant	12378521	88901148
Engine Oil	5W-30 Mineral Oil	12345610	00799389
Fuel Injection Fuel Rail Fuel Pressure Sensor Sealing Cone/Threads	Lubricant	12345610	993193
Fuel Rail Sealing Cone/Threads	Lubricant	12345610	993193
GM Fuel System Treatment Plus	Cleaner	88861011	-
Oil Gallery Threaded Plug	Sealant	12346004	10953480
Oil Pan, Engine Front Cover, Crankshaft Rear Oil Seal Housing, Expansion Plugs	Sealant	12378521 (150g cartridge)	88901148
		88861417 (75 gram squeeze tube)	88861418
Piston Pin Bores	Lubricant	1052367	992869
Positive Crankcase Ventilation (PCV) Orifice	Sealant	12378521	88901148
Stationary Hydraulic Lash Adjuster (SHLA)	Engine Oil	12345610	993193
SHLA Bores in Cylinder Head	Engine Oil	12345610	993193
SHLA Pivot Spheres	Lubricant	12345501	992704
Thread Repair	Cutting Fluid	1052864	992881
	Cleaner	12346139 or 12377981	10953463
	Sealant	12345493	10953488
Valve Stem/Guide ID	Lubricant	12345501	992704

THREAD REPAIR SPECIFICATIONS

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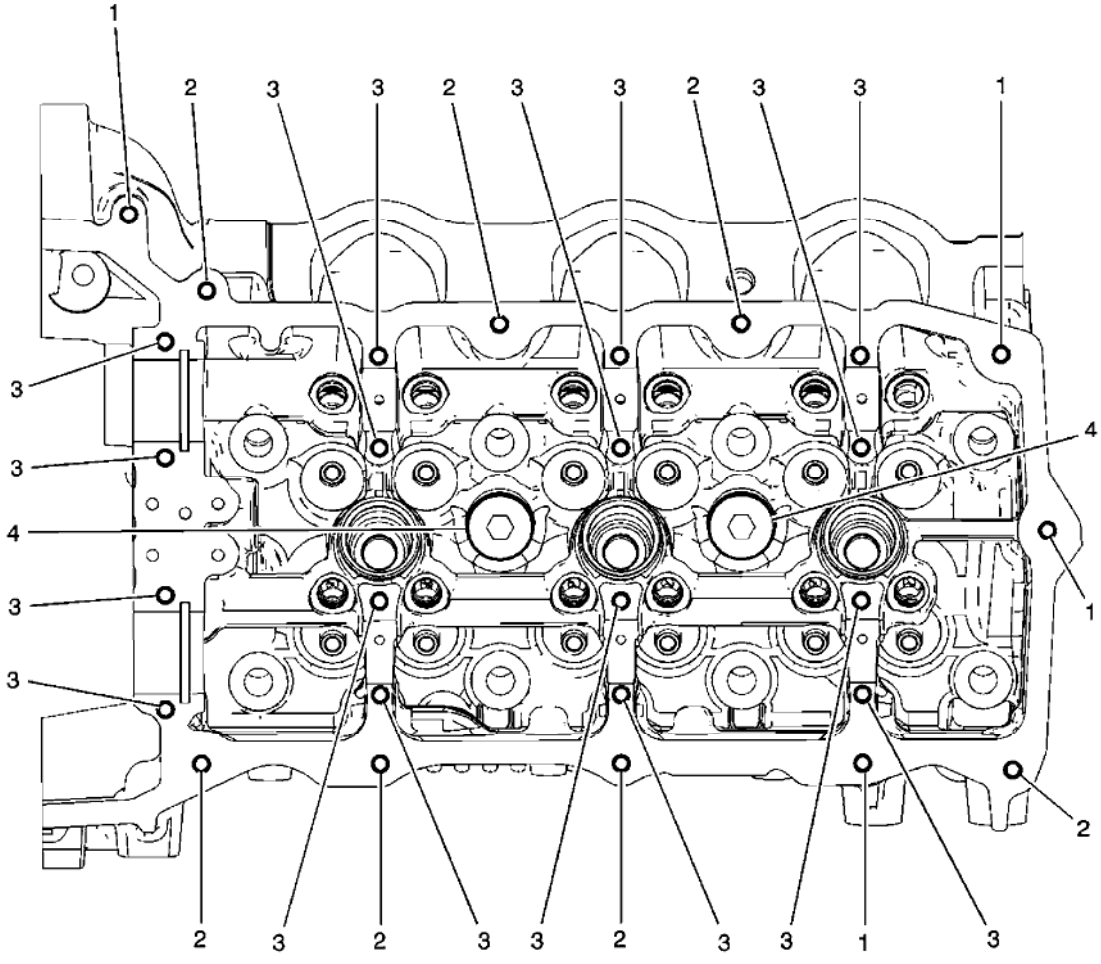


Fig. 1: Left Cylinder Head Camshaft Cover Face
Courtesy of GENERAL MOTORS CORP.

Left Cylinder Head Camshaft Cover Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.7087
2	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
3	M6 x 1.0	701	N/A	N/A	203	204	205	28.5	1.1220	24.0	0.9449
4	M20 x 1.5	715	716	N/A	717	718	719	25.0	0.9842	17.0	0.6693

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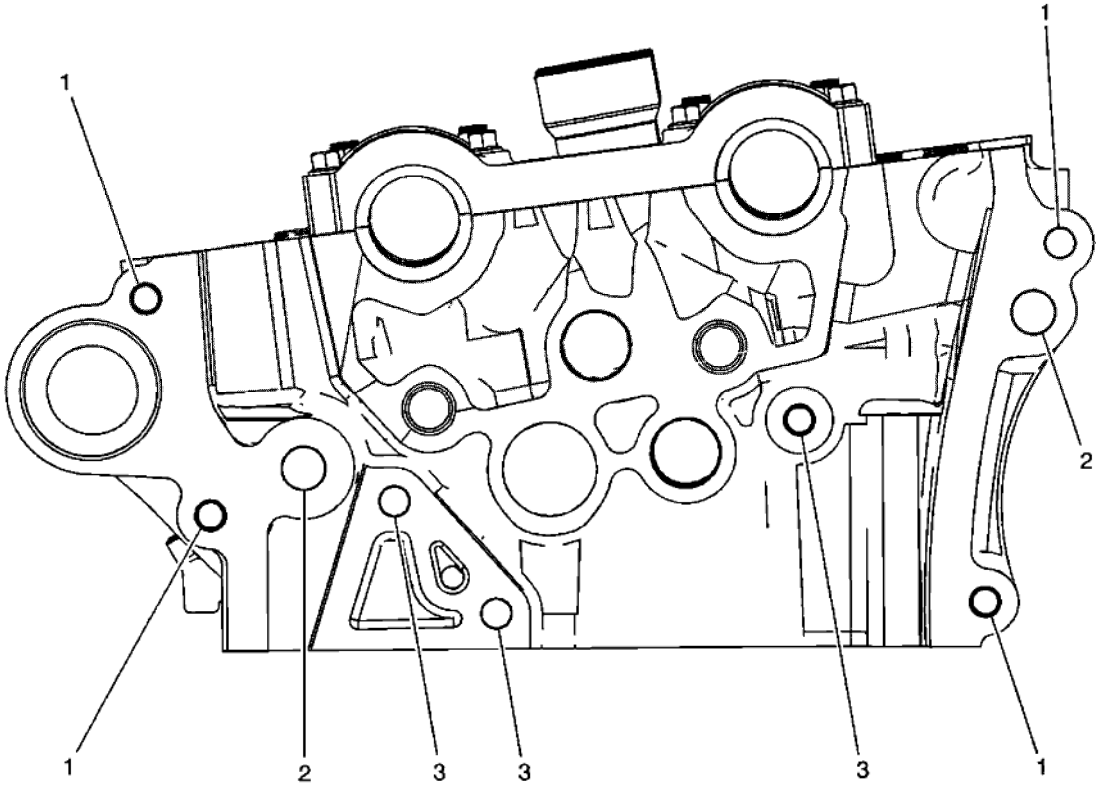


Fig. 2: Left Cylinder Head Front Face
Courtesy of GENERAL MOTORS CORP.

Left Cylinder Head Front Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	THRU		THRU	
2	M12 x 1.75	856	857	N/A	858	859	416	40.0	1.5748	32.5	1.2795
3	M8 x 1.25	206	207	N/A	208	209	210	18.0	0.7087	22.5	0.8858

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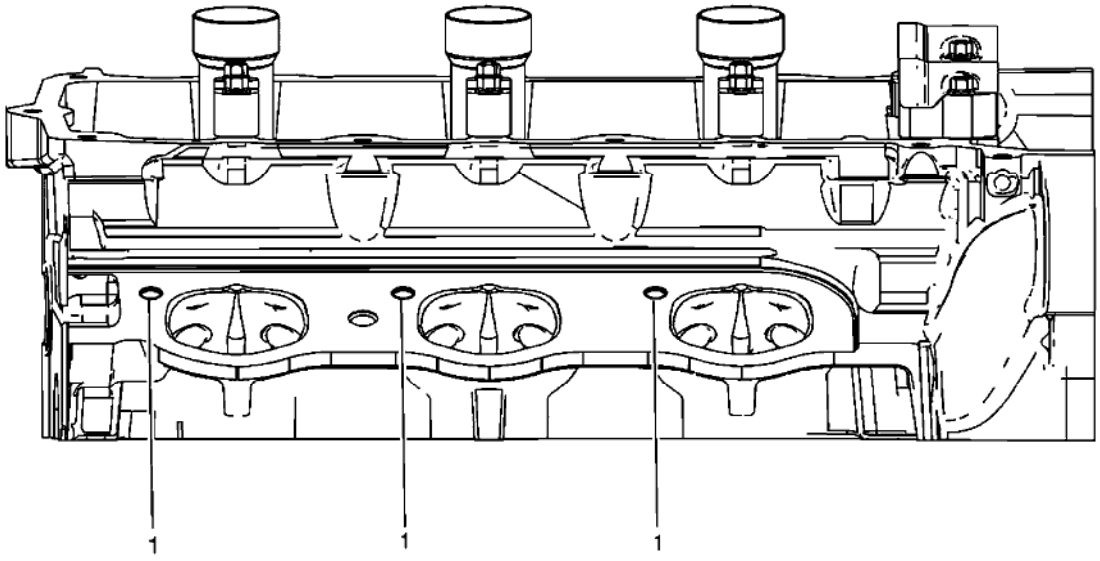


Fig. 3: Left Cylinder Head Intake Face
Courtesy of GENERAL MOTORS CORP.

Left Cylinder Head Intake Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

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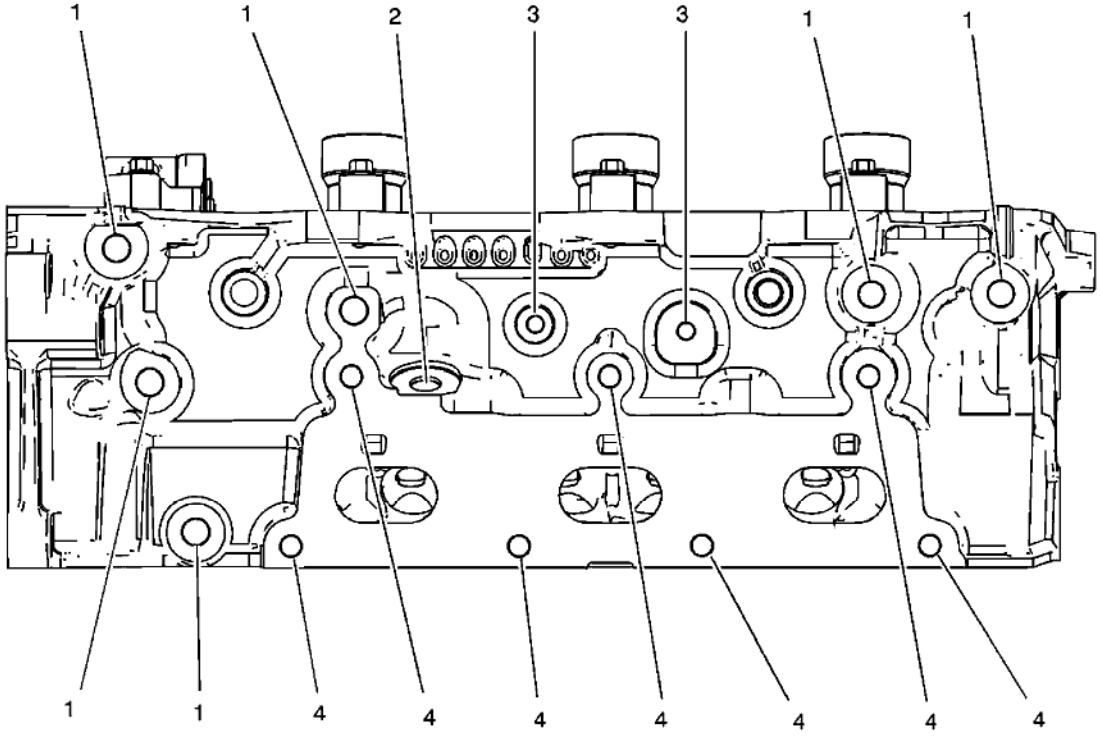


Fig. 4: Left Cylinder Head Exhaust Face
Courtesy of GENERAL MOTORS CORP.

Left Cylinder Head Exhaust Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630
2	M12 x 1.5	705	706	N/A	707	708	709	27.5	1.0827	13.0	0.5118
3	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.0000
4	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

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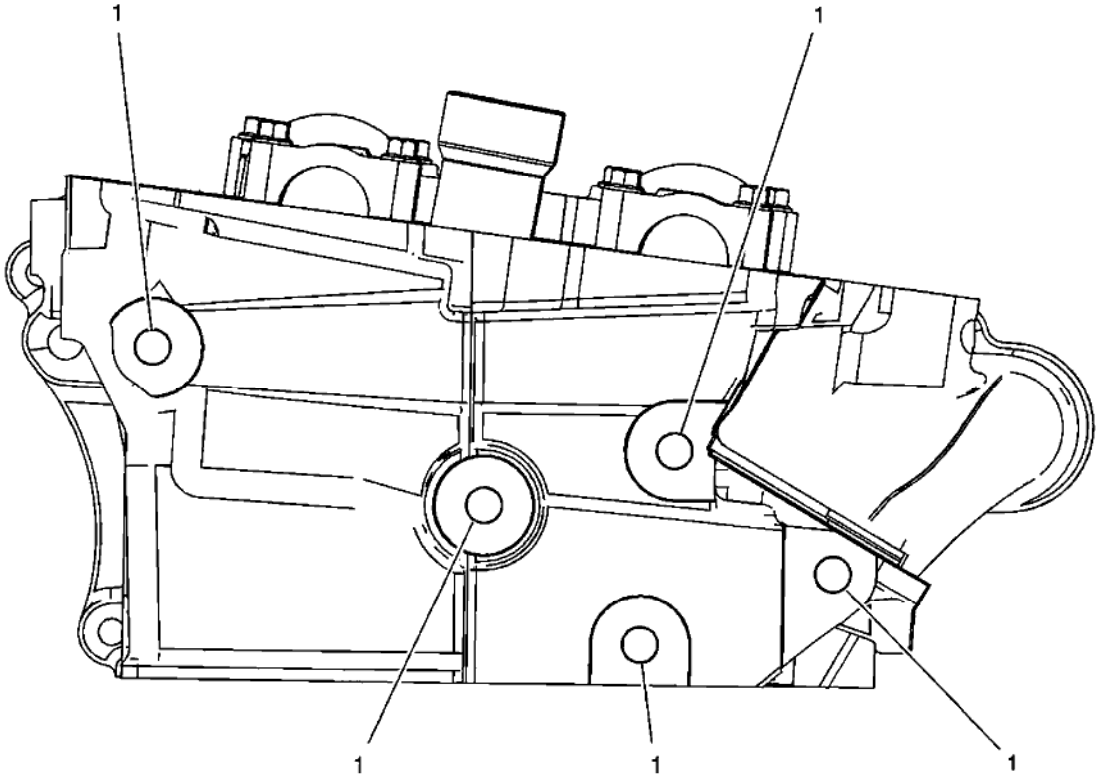


Fig. 5: Left Cylinder Head Rear Face
Courtesy of GENERAL MOTORS CORP.

Left Cylinder Head Rear Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630

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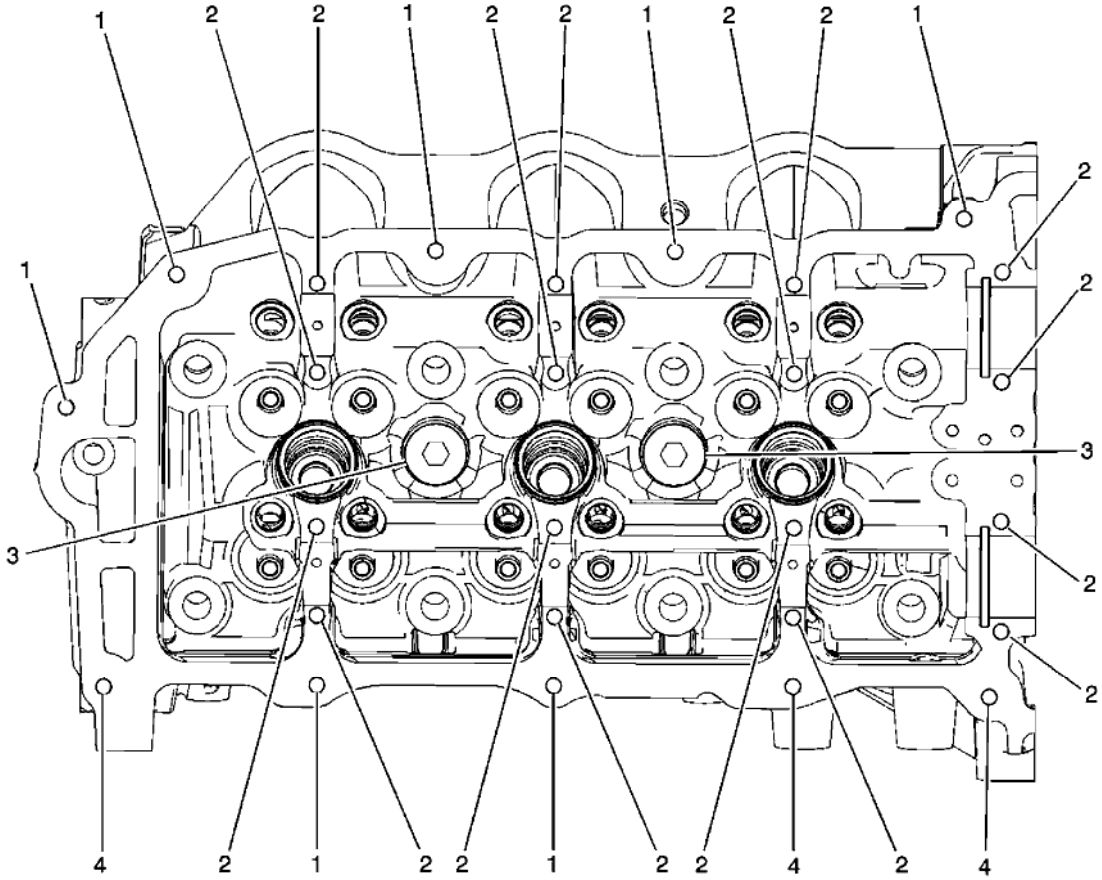


Fig. 6: Right Cylinder Head Camshaft Cover Face
Courtesy of GENERAL MOTORS CORP.

Right Cylinder Head Camshaft Cover Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
2	M6 x 1.0	701	N/A	N/A	203	204	205	28.5	1.1220	24.0	0.9449
3	M20 x 1.5	715	716	N/A	717	718	719	25.0	0.9842	17.0	0.6693
4	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.7087

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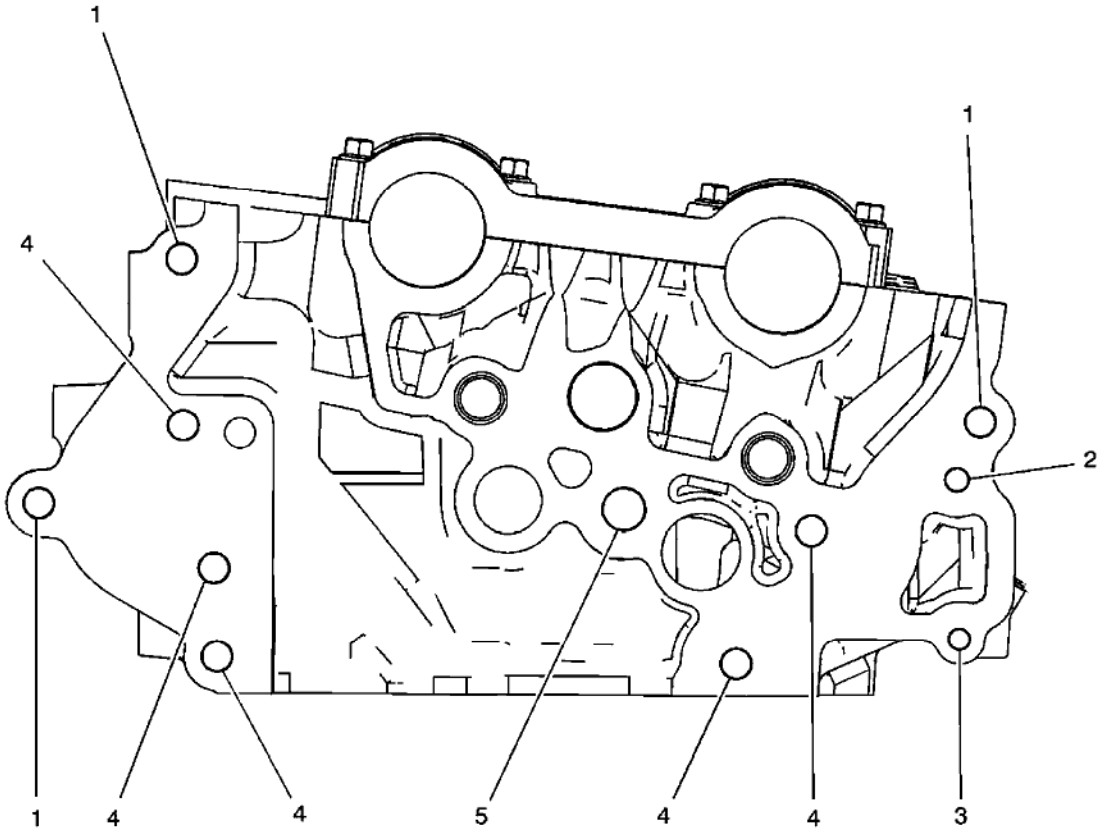


Fig. 7: Right Cylinder Head Front Face
Courtesy of GENERAL MOTORS CORP.

Right Cylinder Head Front Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	THRU		THRU	
2	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8880	18.0	0.7087
3	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
4	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
5	M12 x 1.75	856	857	N/A	858	859	416	40.0	1.5748	32.5	1.2795

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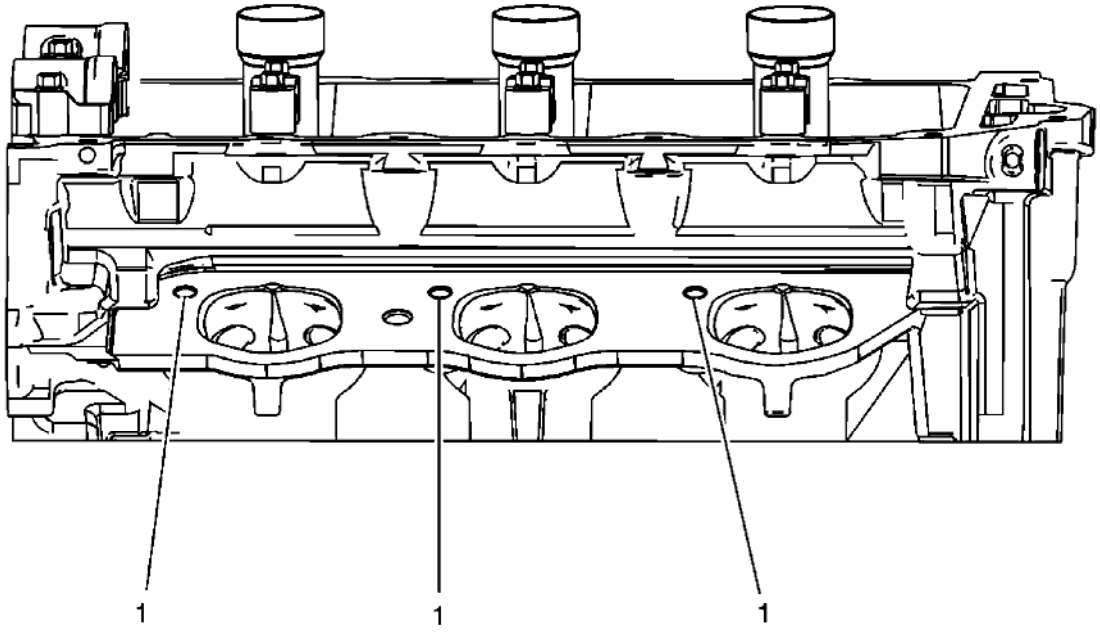


Fig. 8: Right Cylinder Head Intake Face
Courtesy of GENERAL MOTORS CORP.

Right Cylinder Head Intake Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

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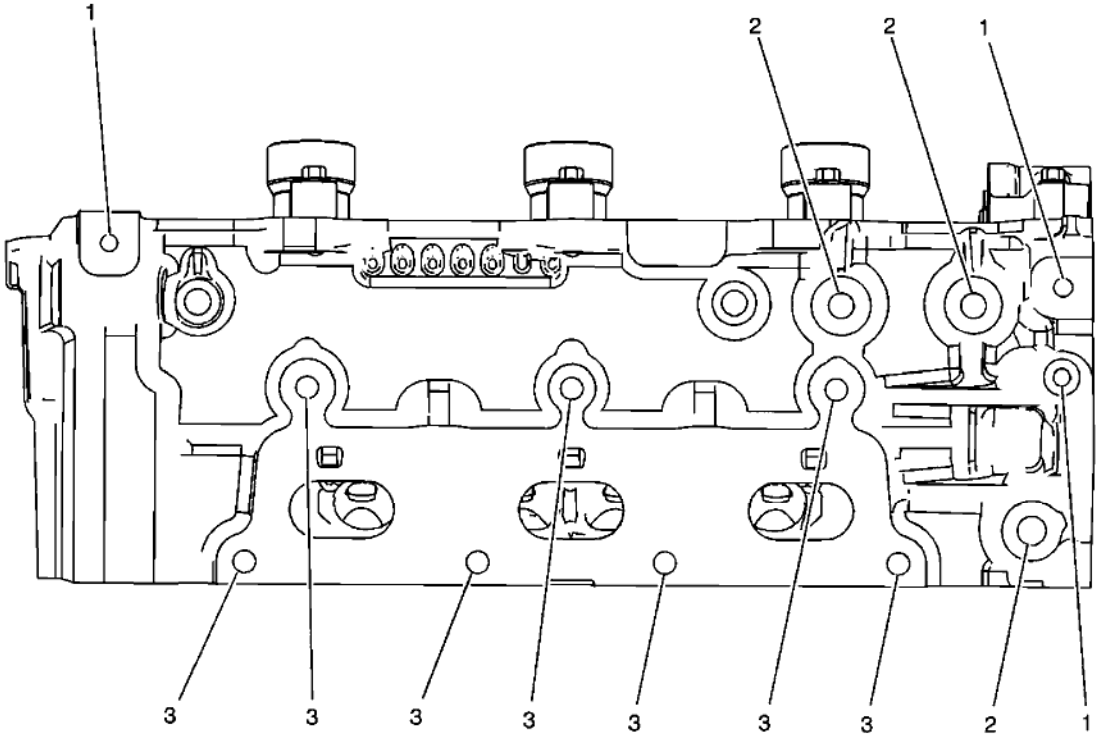


Fig. 9: Right Cylinder Head Exhaust Face
Courtesy of GENERAL MOTORS CORP.

Right Cylinder Head Exhaust Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.0000
2	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630
3	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

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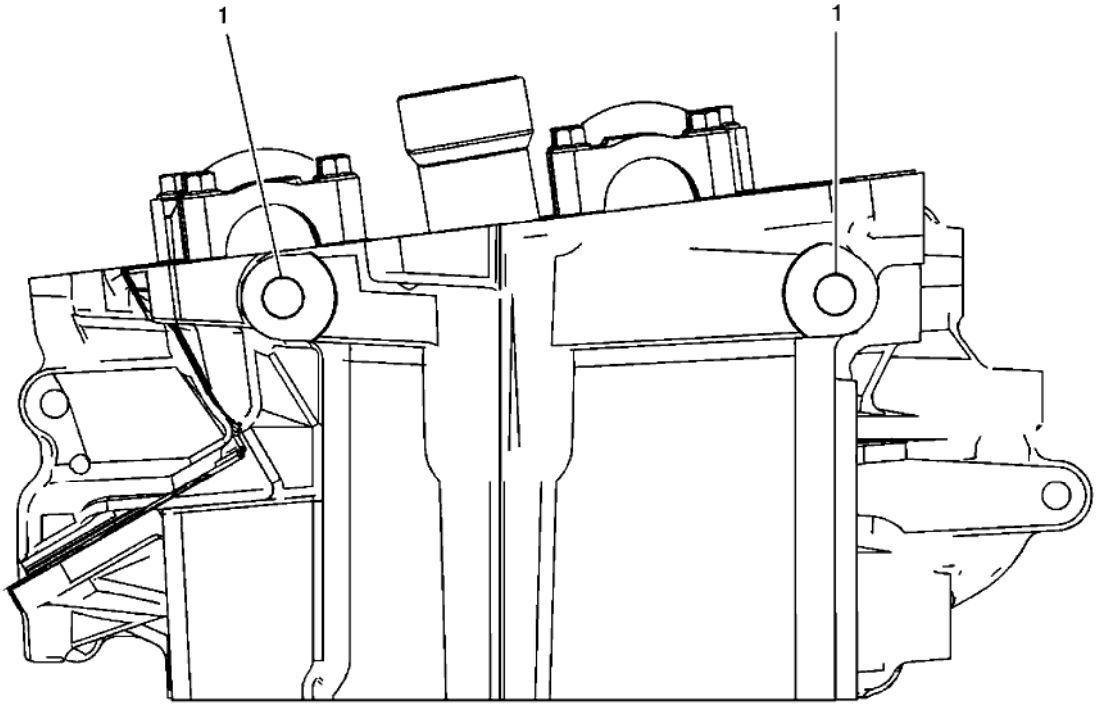


Fig. 10: Right Cylinder Head Rear Face
Courtesy of GENERAL MOTORS CORP.

Right Cylinder Head Rear Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630

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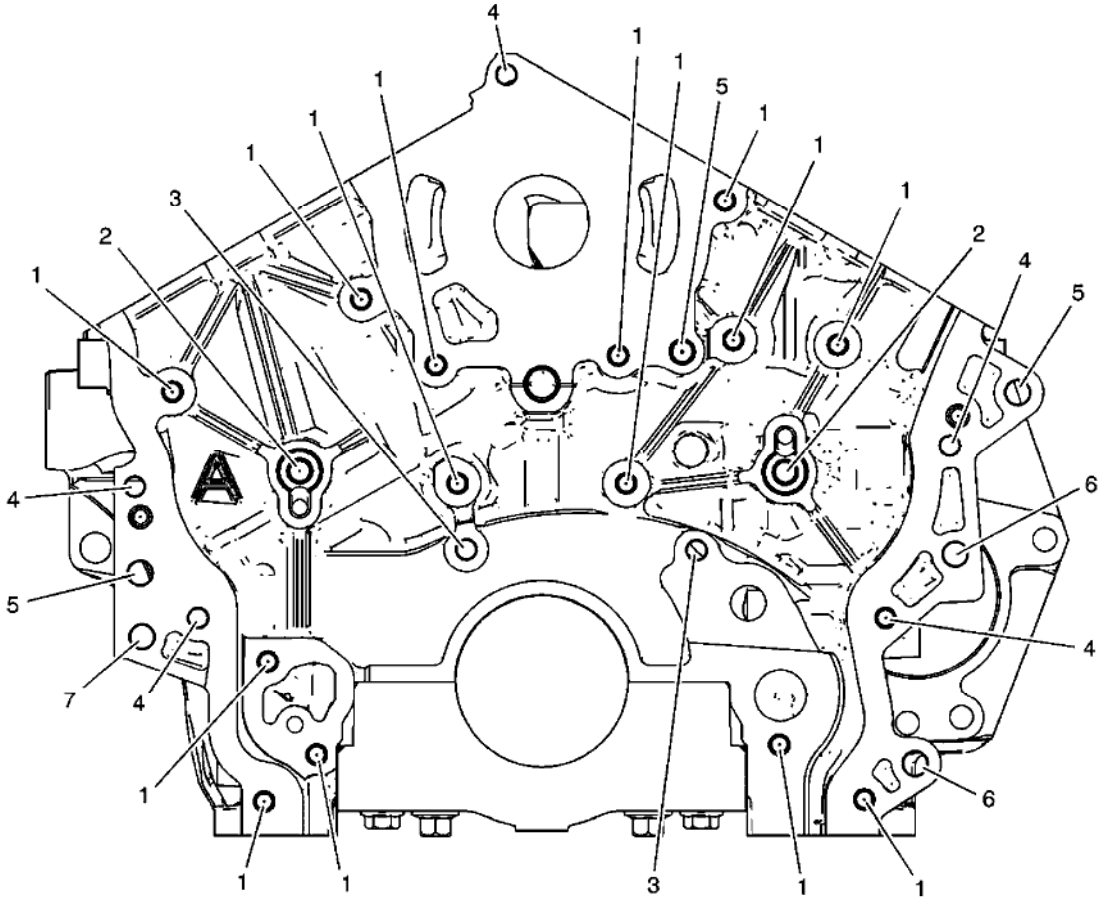


Fig. 11: Engine Block Front
Courtesy of GENERAL MOTORS CORP.

Engine Block Front

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
2	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630
3	M8 x 1.25	206	207	N/A	208	209	210	THRU		23.0	0.9055
4	M8 x 1.25	206	207	N/A	208	209	210	THRU		THRU	
5	M10 x 1.5	211	212	N/A	213	214	215	28.0	1.1024	28.0	1.1024
6	M10 x	211	212	N/A	213	214	215	THRU		20.0	0.7874

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	1.5									
7	M10 x 1.5	211	212	N/A	213	214	215	THRU	28.0	1.1024

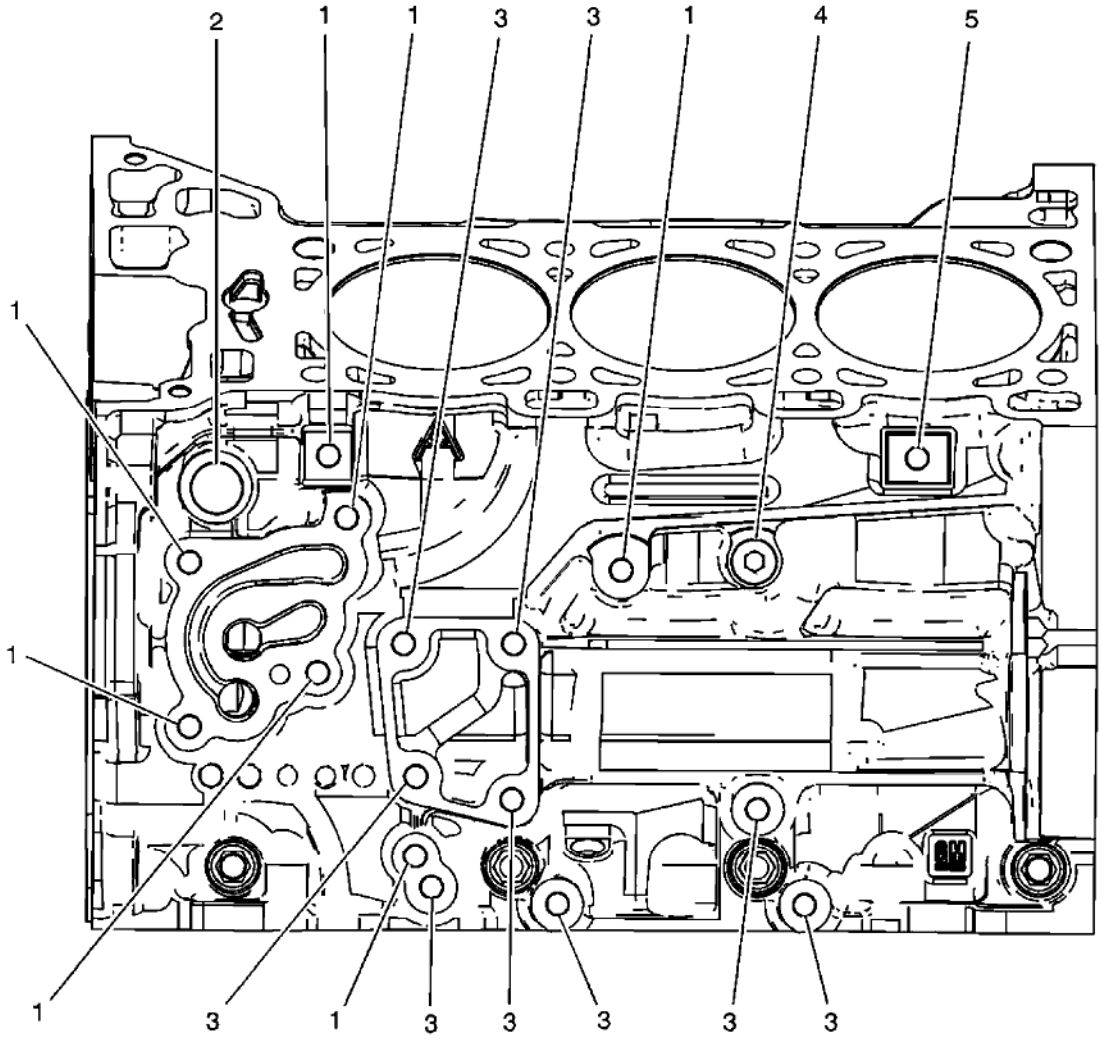


Fig. 12: Engine Block Left Side
Courtesy of GENERAL MOTORS CORP.

Engine Block Left Side

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
2	M20 x	715	716	N/A	717	718	719	30.0	1.1810	20.0	0.7874

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	1.5										
3	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3190	27.0	1.0630
4	M14 x 1.5	409	410	N/A	411	412	735	THRU		15.0	0.5905
5	M8 x 1.25	206	207	N/A	208	209	415	16.5	0.6496	11.0	0.4331

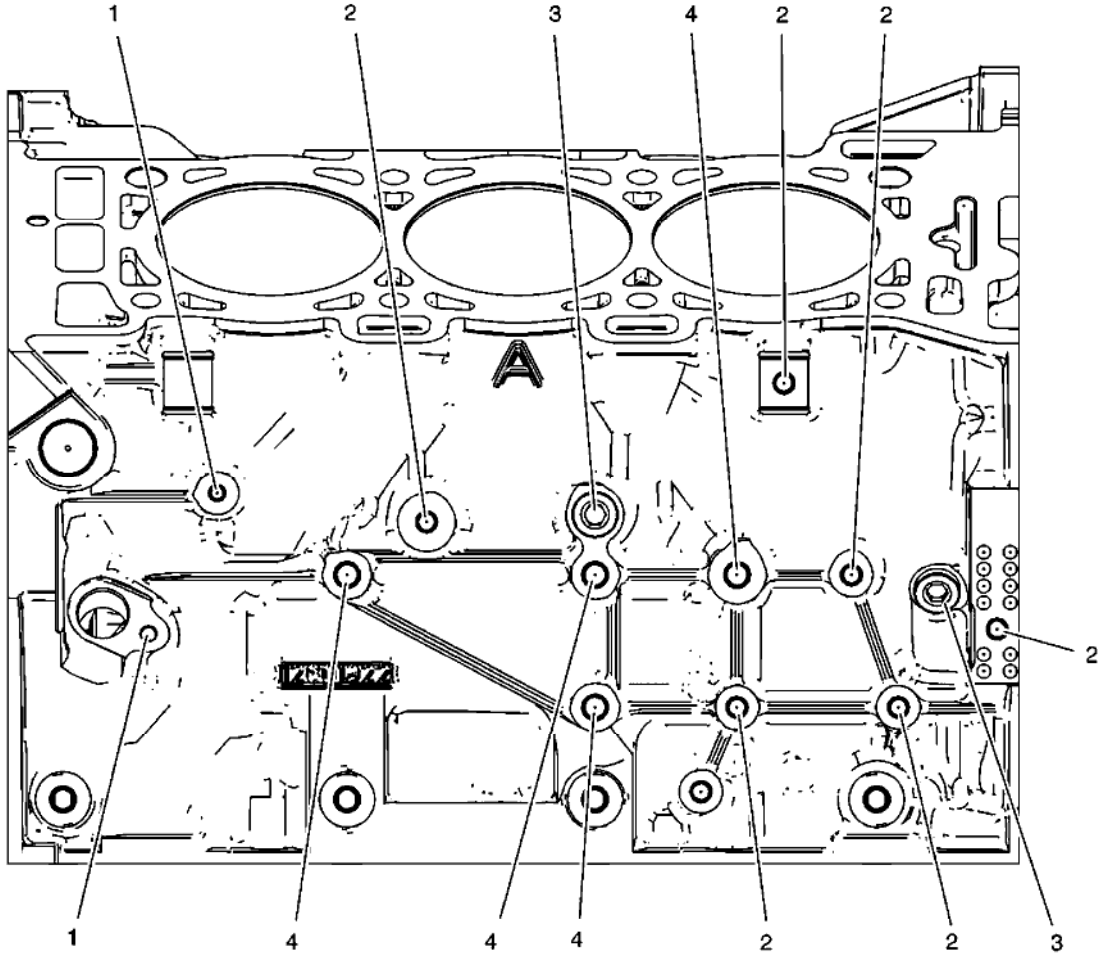


Fig. 13: Engine Block Right Side
Courtesy of GENERAL MOTORS CORP.

Engine Block Right Side

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.7087

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2	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
3	M14 x 1.5	409	410	N/A	411	412	735	THRU		15.0	0.5905
4	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3190	27.0	1.0630

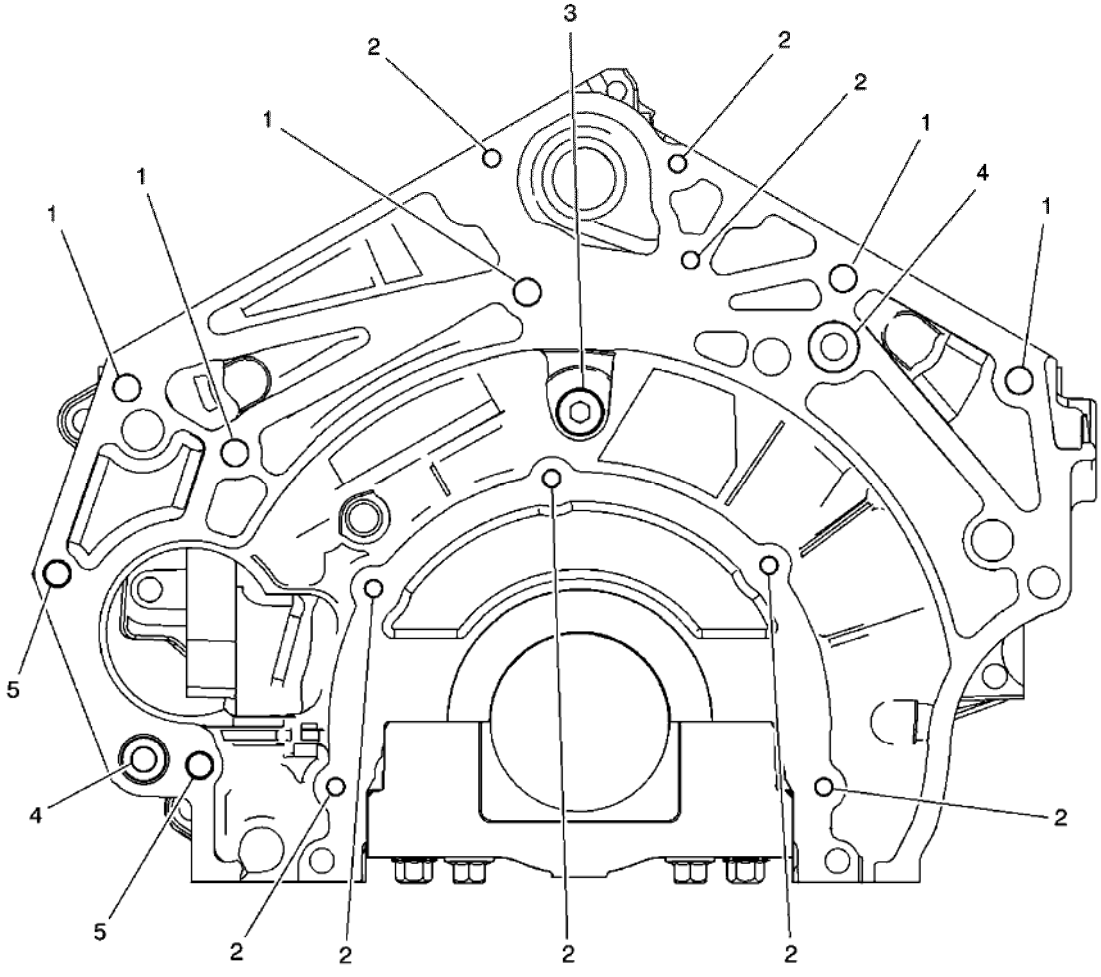


Fig. 14: Engine Block Rear
Courtesy of GENERAL MOTORS CORP.

Engine Block Rear

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	420	33.5	1.3190	27.0	1.0630

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2	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.7087
3	M14 x 1.5	409	410	N/A	411	412	735	THRU		15.0	0.5905
4	M10 x 1.5	211	212	N/A	213	214	216	39.5	1.5551	33.0	1.2992
5	M10 x 1.5	211	212	N/A	213	214	420	THRU		THRU	

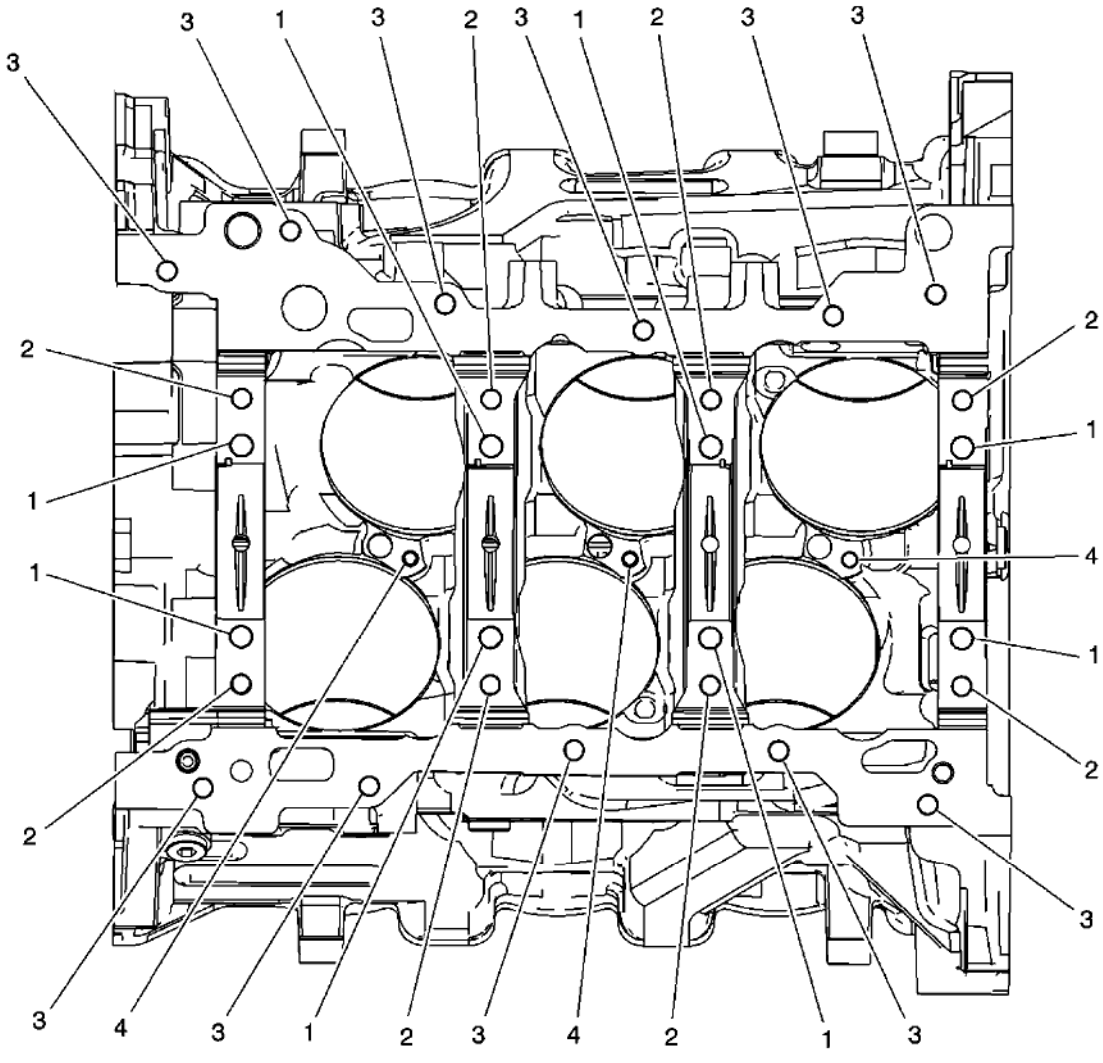


Fig. 15: Engine Block Bottom
Courtesy of GENERAL MOTORS CORP.

Engine Block Bottom

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	

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-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 2.0	720	N/A	N/A	721	722	104	56.0	2.2047	49.0	1.9291
2	M8 x 1.25	702	N/A	N/A	703	704	620	46.0	1.8110	40.5	1.5945
3	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
4	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	

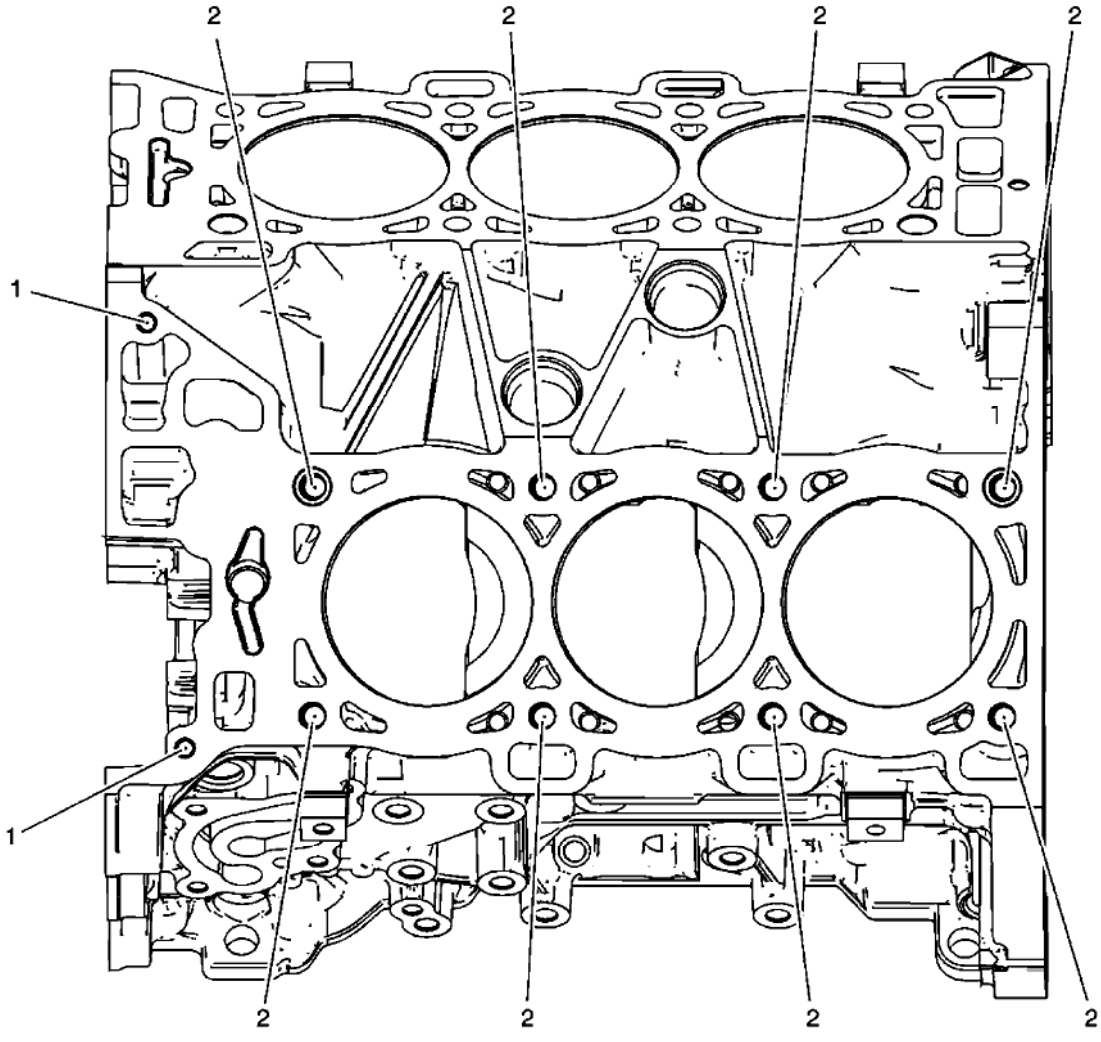


Fig. 16: Engine Block Left Deck Face
Courtesy of GENERAL MOTORS CORP.

Engine Block Left Deck Face

Hole	Thread		Counter Bore	Stop				Drill Depth	Tap Depth

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Location	Size	Drill	Tool	Collar	Tap	Driver	Insert	(Maximum)		(Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
2	M11 x 2.0	723	N/A	N/A	724	725	108	102.5	4.0354	94.0	3.7008

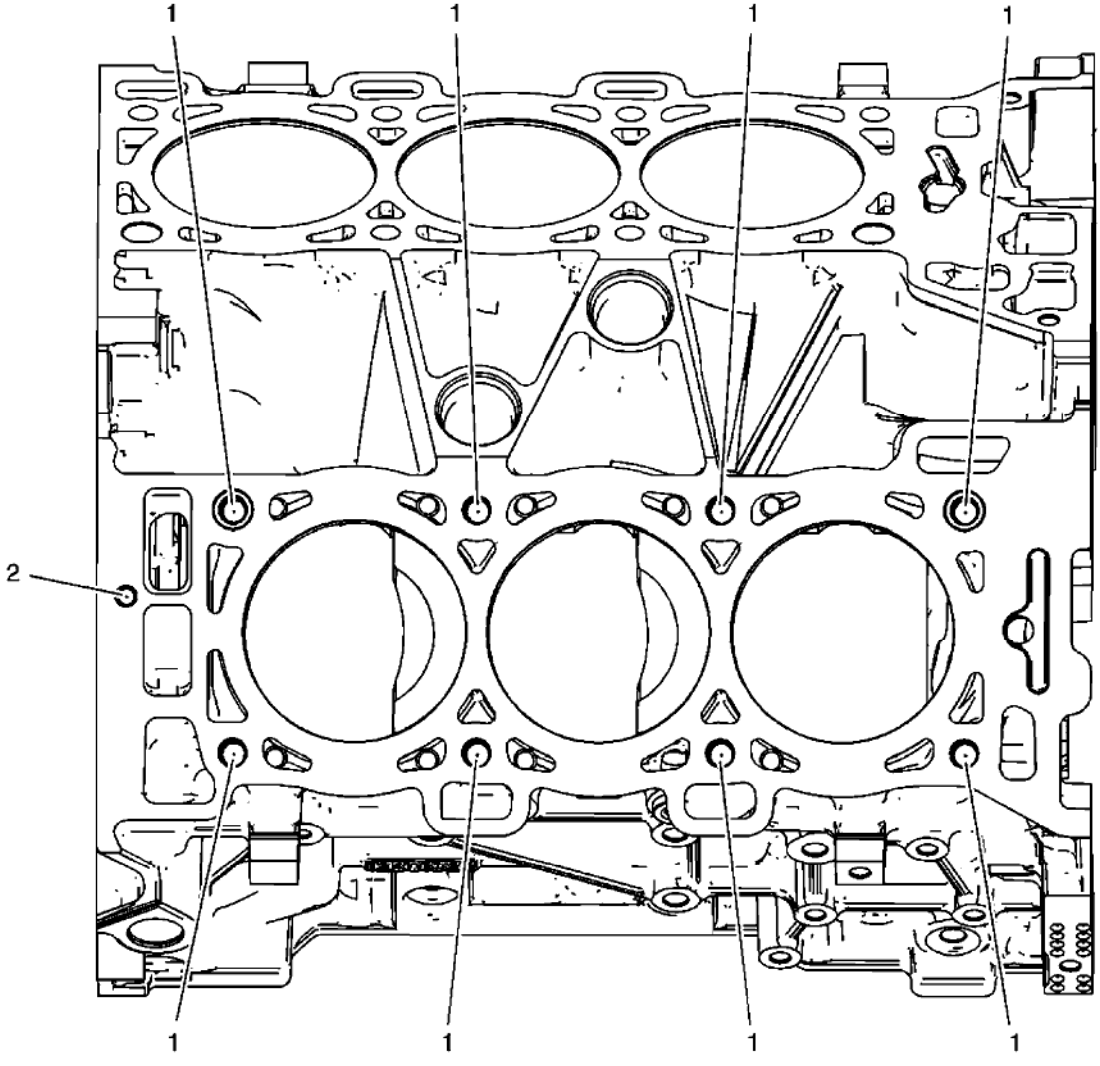


Fig. 17: Engine Block Right Deck Face
Courtesy of GENERAL MOTORS CORP.

Engine Block Right Deck Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)

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1	M11 x 2.0	723	N/A	N/A	724	725	108	102.5	4.0354	94.0	3.7008
2	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

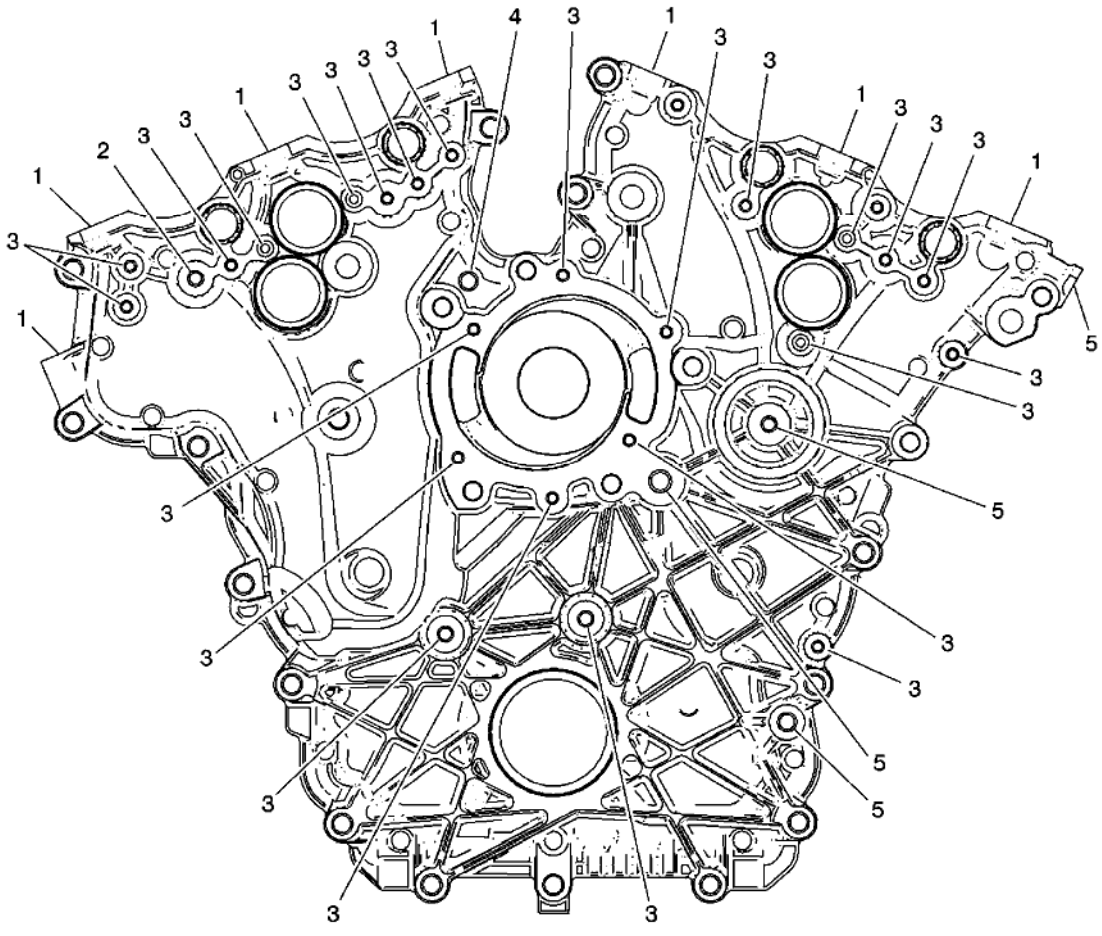


Fig. 18: Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

Engine Front Cover

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
2	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
3	M6 x 1.0	201	202	N/A	203	204	205	21.5	0.8465	18.0	0.7087
4	M10 x	211	212	N/A	213	214	215	THRU		THRU	

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	1.5										
5	M10 x 1.5	211	212	N/A	213	214	420	32.5	1.2795	27.0	1.0630

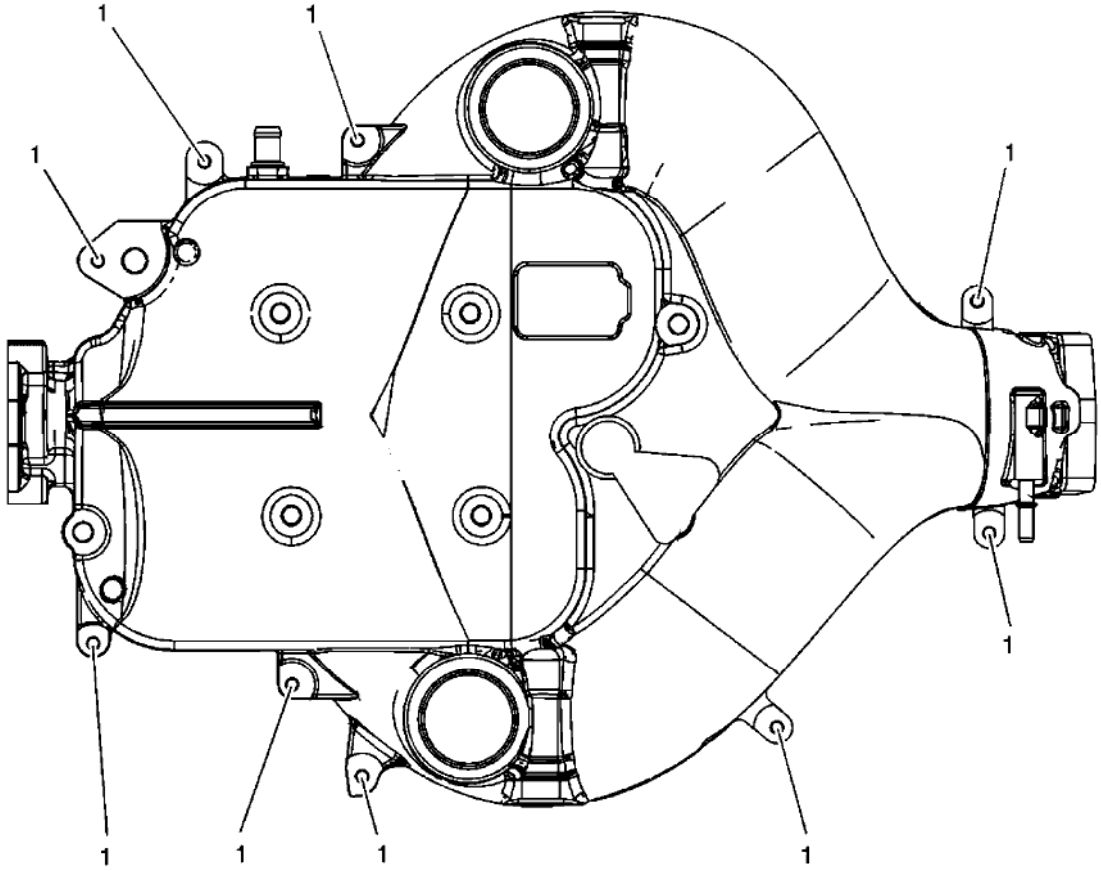


Fig. 19: Upper Intake Manifold - Top
Courtesy of GENERAL MOTORS CORP.

Upper Intake Manifold - Top

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	

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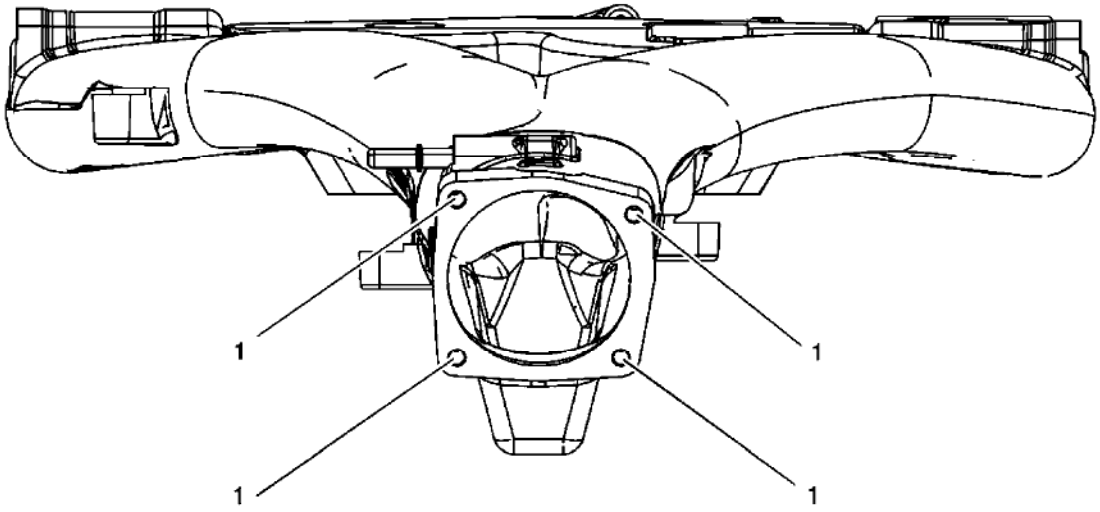


Fig. 20: Upper Intake Manifold - Front
Courtesy of GENERAL MOTORS CORP.

Upper Intake Manifold - Front

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	

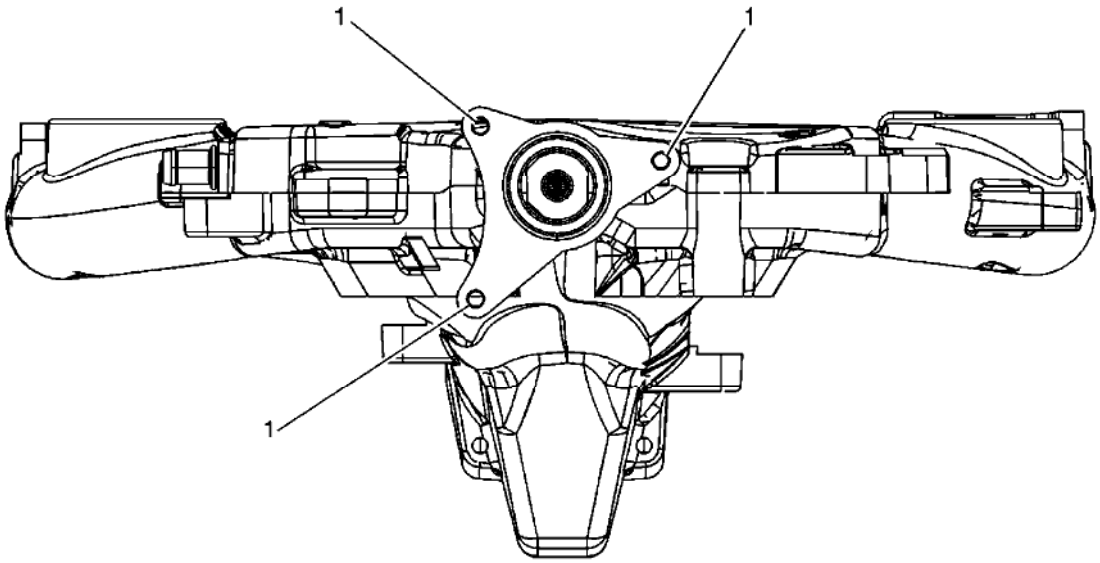


Fig. 21: Upper Intake Manifold - Rear
Courtesy of GENERAL MOTORS CORP.

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Upper Intake Manifold - Rear

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	

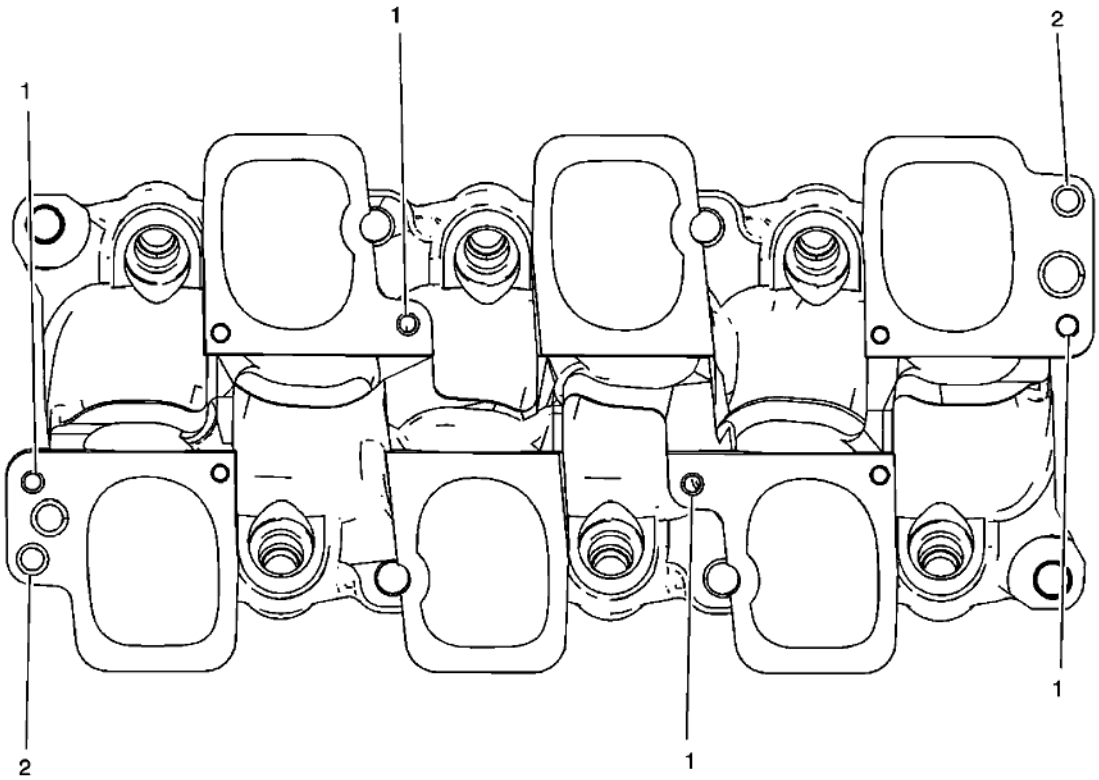


Fig. 22: Lower Intake Manifold - Top
Courtesy of GENERAL MOTORS CORP.

Lower Intake Manifold - Top

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
2	M8 x 1.25	206	207	N/A	208	209	210	THRU		THRU	

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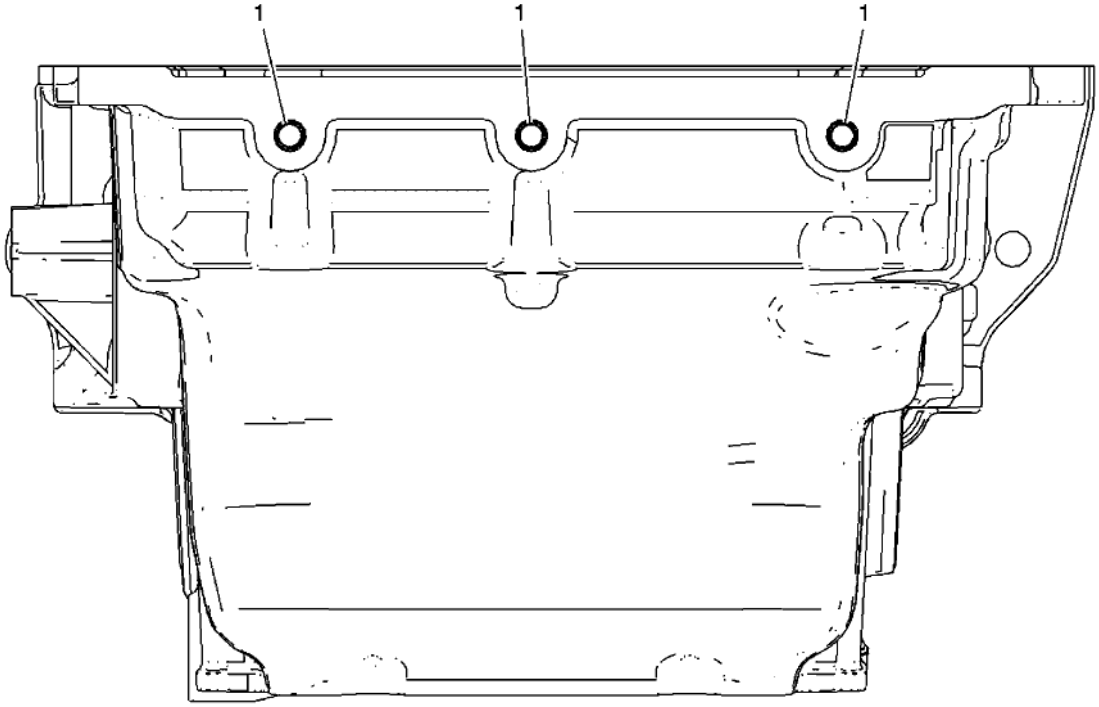


Fig. 23: Oil Pan Front
Courtesy of GENERAL MOTORS CORP.

Oil Pan Front

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

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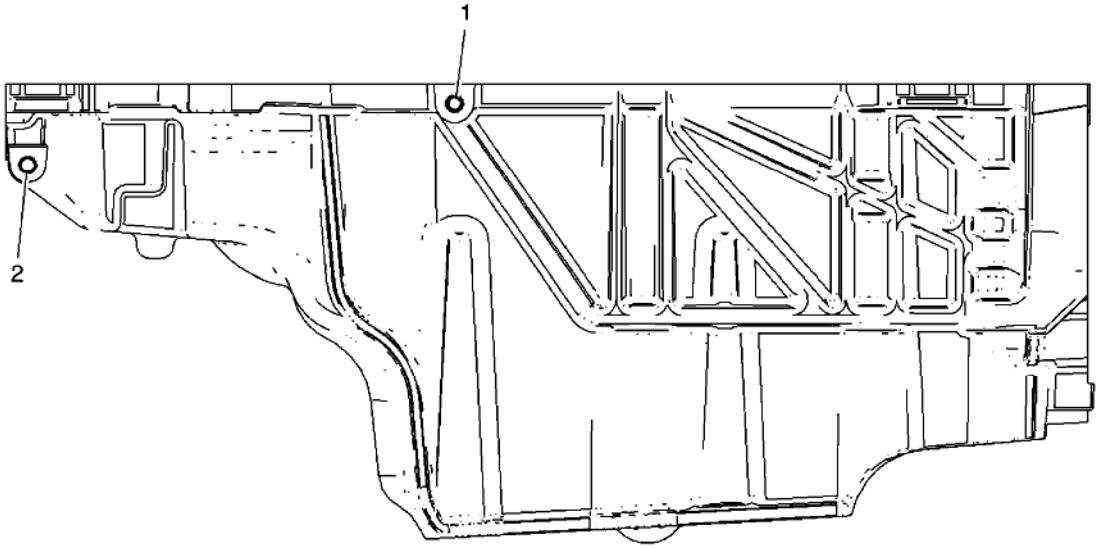


Fig. 24: Oil Pan Left Side
Courtesy of GENERAL MOTORS CORP.

Oil Pan Left Side

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	420	33.5	1.3189	27.0	1.0630
2	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

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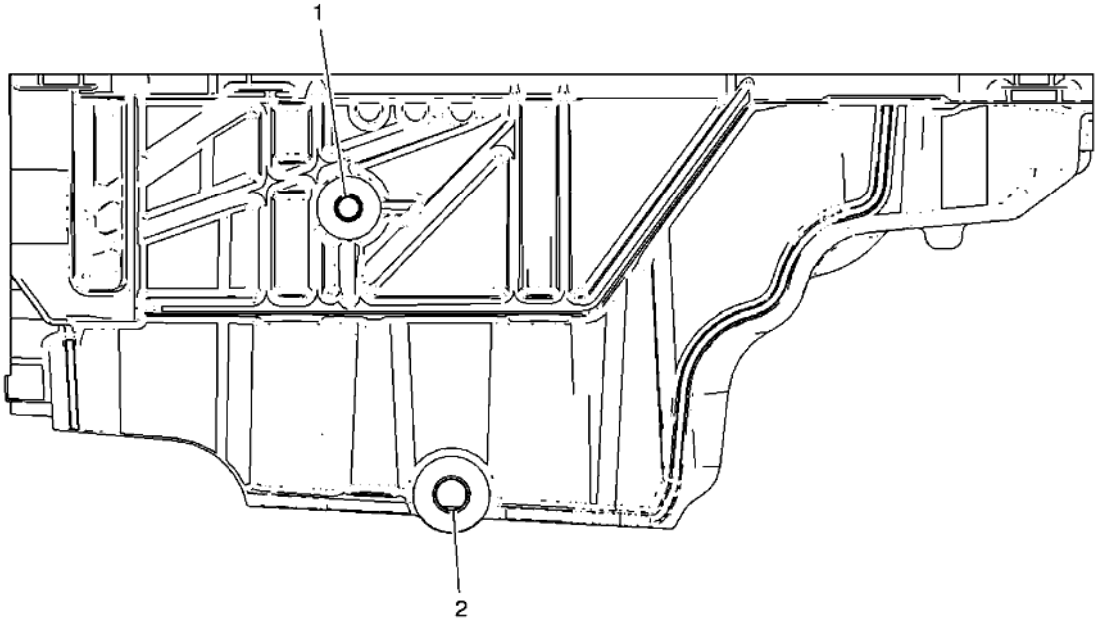


Fig. 25: Oil Pan Right Side
Courtesy of GENERAL MOTORS CORP.

Oil Pan Right Side

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M12 x 1.75	856	857	N/A	858	859	855	39.5	1.5551	32.0	1.2598
2	M12 x 1.75	856	N/A	N/A	858	859	855	39.5	1.5551	32.0	1.2598

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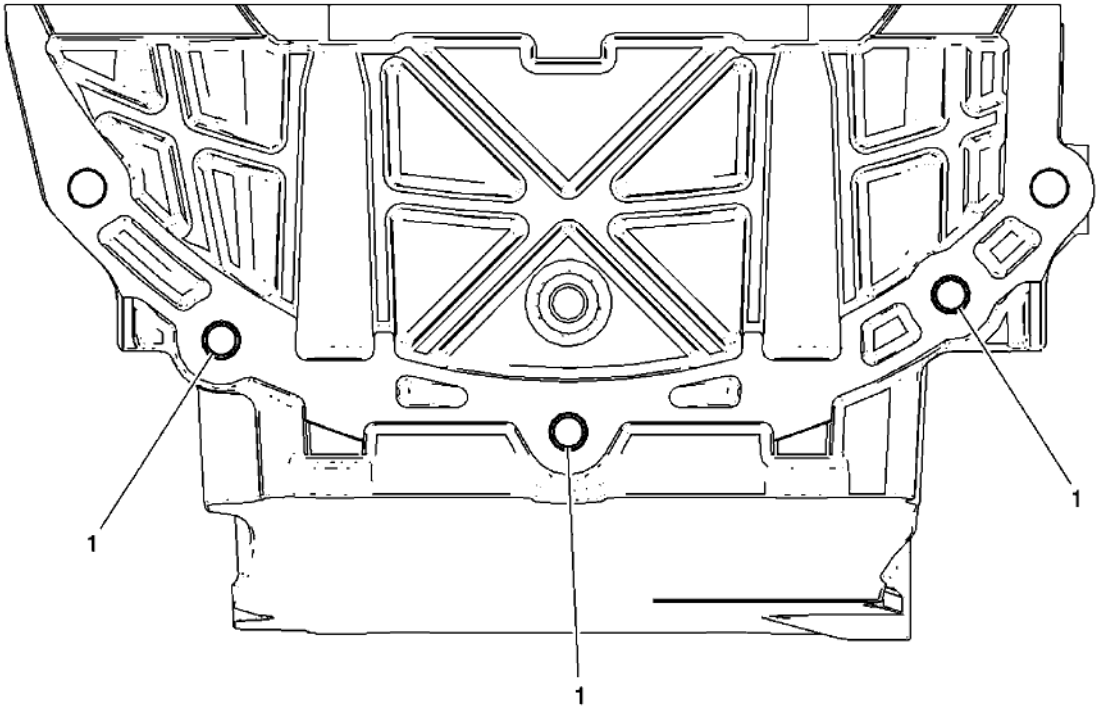


Fig. 26: Oil Pan Rear
Courtesy of GENERAL MOTORS CORP.

Oil Pan Rear

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	420	33.5	1.3189	27.0	1.0630

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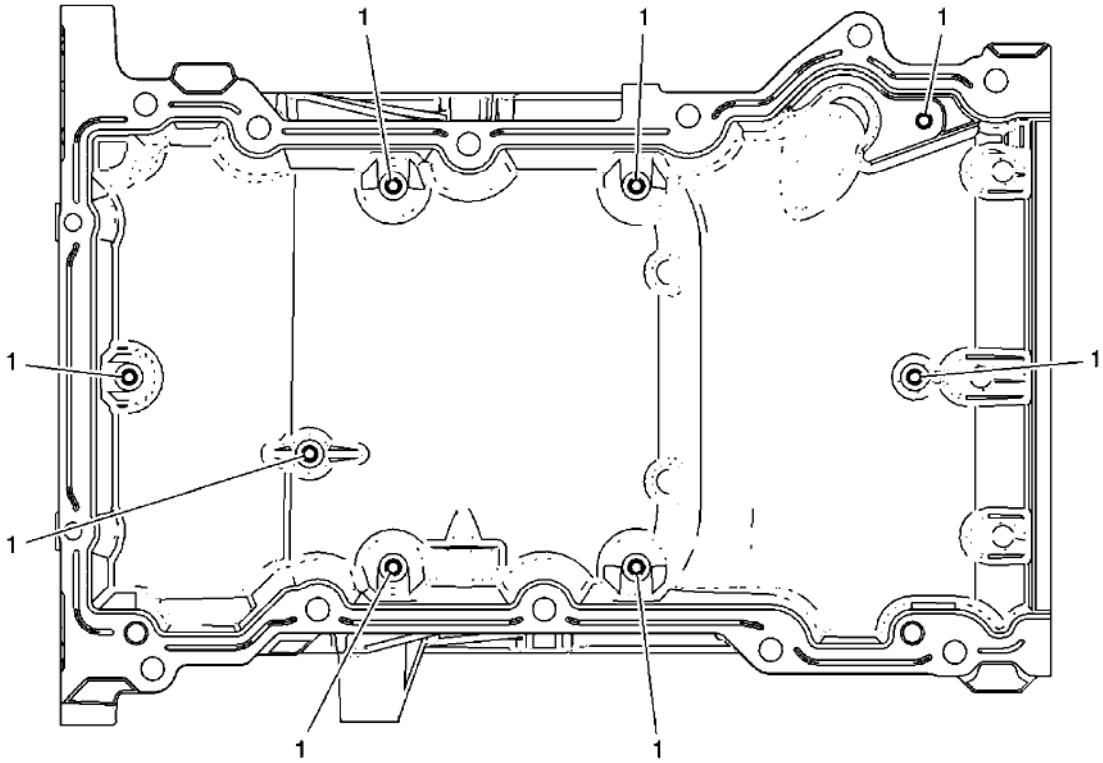


Fig. 27: Oil Pan Top
Courtesy of GENERAL MOTORS CORP.

Oil Pan Top

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	701	N/A	N/A	203	204	205	28.0	1.1024	23.5	0.9252

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2010 ENGINE

Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Camaro

COMPONENT LOCATOR

DISASSEMBLED VIEWS (6.2L LS3)

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Fig. 1: Intake Manifold/Upper Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name

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1	Evaporative Emission (EVAP) Canister Purge Tube
2	EVAP Canister Purge Solenoid Valve
3	EVAP Tube Clip
4	EVAP Canister Purge Tube
5	EVAP Purge Valve Bracket
6	Bolt
7	Bolt
8	Fuel Rail Ground Strap
9	Fuel Rail with Injectors
10	Bolt
11	Fuel Injection Fuel Rail Stop Bracket
12	Intake Manifold
13	Seal
14	Intake Manifold Gasket
15	Engine Coolant Air Bleed Plug
16	Oil Pressure Sensor
17	Washer
18	Bolt
19	Valley Cover
20	Valley Cover Gasket
21	Engine Block
22	Seal
23	Positive Crankcase Ventilation (PCV) Hose - Dirty Air
24	Seal
25	Engine Coolant Air Bleed Pipe
26	Bolt
27	Bolt
28	Throttle Body
29	Throttle Body Gasket
30	Seal
31	Manifold Absolute Pressure (MAP) Sensor
32	MAP Sensor Bolt

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Fig. 2: Cylinder Head/Upper Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
100	Engine Block
209	Valve Lifter
210	Valve Lifter Guide
211	Bolt
212	Pushrod
213	Valve Rocker Arm
214	Bolt
215	Valve Rocker Arm Pivot Support
216	Core Hole Plug
217	Cylinder Head Gasket
218	Cylinder Head

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220	Cylinder Head Bolt - M11
221	Cylinder Head Bolt - M8
222	Valve Stem Oil Seal
223	Valve Spring
224	Valve Spring Cap
225	Valve Stem Key
226	Core Hole Plug
227	Intake Valve
228	Exhaust Valve
229	Cylinder Head Plug
230	Cylinder Head Locating Pin
422	O-ring
423	Oil Fill Tube
424	Oil Fill Cap
450	O-ring
504	Valve Rocker Arm Cover Gasket
504	Valve Rocker Arm Cover Gasket
505	Valve Rocker Arm Cover
505	Valve Rocker Arm Cover
515	Bolt Grommet
516	Bolt
558	Plug
600	Exhaust Manifold
601	Exhaust Manifold Gasket
602	Bolt
603	Exhaust Manifold Heat Shield
604	Bolt
605	Stud
700	Positive Crankcase Ventilation (PCV) Hose - Fresh Air
719	Ignition Coil Bracket
720	Stud
721	Ignition Coil Wire Harness Assembly
722	Ignition Coil
723	Bolt
724	Spark Plug Wire
725	Coolant Temperature Sensor (CTS)
726	Spark Plug

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Fig. 3: Front Of Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Bolt
2	Water Inlet Housing
3	O-ring
4	Thermostat
5	Bolt
6	Water Pump
7	Water Pump Gasket
8	Oil Level Indicator
9	O-ring
10	Bolt
11	Oil Level Indicator Tube
12	O-ring
13	Engine Block
14	Camshaft Bearings

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15	Camshaft
16	Camshaft Sprocket Locating Pin
17	Crankshaft Sprocket
18	Crankshaft Balancer Washer
19	Camshaft Retainer
20	Bolt
21	Camshaft Sprocket
22	Bolt
23	Timing Chain
24	Timing Chain Tensioner
25	Bolt
26	Engine Front Cover Gasket
27	Engine Front Cover
28	Bolt
29	Crankshaft Front Oil Seal
30	Crankshaft Balancer
31	Bolt
32	Bolt
33	Camshaft Position (CMP) Sensor
34	O-ring
35	Bolt
36	CMP Sensor Wire Harness
37	Bolt
38	Oil Pump
39	Bolt
40	Oil Pump Housing Cover
41	Oil Pump Drive Gear
42	Oil Pump Driven Gear
43	Oil Pump Housing Plug
44	Oil Pump Pressure Relief Valve Spring
45	Oil Pump Pressure Relief Valve

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Fig. 4: Rear Of Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Block
2	Crankshaft Rear Oil Seal Housing Gasket
3	Crankshaft Rear Oil Seal Housing
4	Crankshaft Rear Oil Seal Housing Bolt
5	Crankshaft Rear Oil Seal
6	Flex Plate - Automatic Transmission (L99)
7	Flex Plate Bolt - Automatic Transmission (L99)
8	Clutch Pressure Plate Bolt - Manual Transmission (LS3)
9	Clutch Pressure Plate - Manual Transmission (LS3)
10	Clutch Driven Plate - Manual Transmission (LS3)
11	Clutch Pressure Plate Locating Pin - Manual Transmission (LS3)
12	Flywheel - Manual Transmission (LS3)
13	Transmission Pilot Bearing - Manual Transmission (LS3)

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Fig. 5: Lower Engine Assembly
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Block
2	Piston Pin
3	Piston Pin Retainer
4	Piston Rings
5	Piston
6	Connecting Rod
7	Connecting Rod Bearings
8	Connecting Rod Cap

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9	Connecting Rod Bolt
10	Crankshaft Main Bearing
10	Crankshaft Main Bearing
11	Crankshaft Thrust Bearing
11	Crankshaft Thrust Bearing
12	Crankshaft Sprocket Key
13	Crankshaft
14	Transmission Pilot Bearing - Manual Transmission
15	Crankshaft Bearing Cap
16	Crankshaft Bearing Cap Bolt - M8
17	Crankshaft Bearing Cap Stud - M10
18	Crankshaft Bearing Cap Bolt - M10
19	Crankshaft Oil Deflector
20	Oil Pan Gasket
21	Crankshaft Oil Deflector Nut
22	Oil Pump Screen
23	Oil Pump Screen Nut
24	Oil Pump Screen O-ring
25	Oil Pump Screen Bolt
26	Engine Closeout Cover Bolt
27	Engine Closeout Cover - Right
28	Oil Pan Baffle Bolt
29	Oil Pan Baffle
30	Oil Level Sensor
31	Oil Level Sensor O-ring
32	Oil Pan
33	Oil Pan Bolt - M8
34	Oil Pan Drain Plug O-ring Seal
35	Oil Pan Drain Plug
36	Oil Filter
37	Oil Filter Fitting
38	Oil Pan Bolt - M6
39	Washer
40	Active Fuel Management Oil Pressure Relief Valve
41	Engine Oil Cooler Coolant Fitting
42	Engine Oil Cooler-to-Oil Pan Bolt - M8
43	Engine Oil Cooler Core
44	Engine Oil Cooler Core-to-Housing Bolt
45	Engine Oil Cooler Housing
46	Engine Oil Cooler Gasket
47	Engine Oil Cooler-to-Oil Pan Bolt - M6
48	

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	Engine Oil Cooler Core Seal
49	Oil Pan Cover - Left
50	Oil Pan Cover Bolt

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Fig. 6: Engine Block Plugs/Sensors
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
100	Engine Block
100	Engine Block
101	Oil Gallery Plug - Front
110	O-Ring
111	Oil Gallery Plug - Rear
112	Oil Gallery Plug - Side
113	Washer
114	Engine Coolant Heater

115	Washer
116	Oil Gallery Plug - Side
117	Washer
130	Transmission Housing Locating Pin
145	Washer
146	Engine Block Coolant Drain Hole Plug
701	Crankshaft Position (CKP) Sensor
702	O-Ring
718	Knock Sensor
718	Knock Sensor
739	Bolt
739	Bolt
750	CKP Sensor Bolt

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Fig. 7: Oil Pump Assembly
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
408	Bolt
409	Oil Pump Housing Cover
410	Oil Pump Drive Gear
412	Oil Pump Driven Gear

413	Oil Pump
414	Oil Pump Pressure Relief Valve
415	Oil Pump Pressure Relief Valve Spring
416	Oil Pump Housing Plug

DISASSEMBLED VIEWS (6.2L L99)

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Fig. 8: Intake Manifold/Upper Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Positive Crankcase Ventilation (PCV) Tube - Dirty Air
2	Evaporative Emission (EVAP) Canister Purge Tube
3	EVAP Canister Purge Solenoid Valve
4	EVAP Canister Purge Tube
5	EVAP Purge Valve Bracket
6	Bolt
7	Fuel Rail Ground Strap
8	Bolt
9	Fuel Rail with Injectors
10	Manifold Absolute Pressure (MAP) Sensor Bolt
11	Manifold Absolute Pressure (MAP) Sensor
12	Seal
13	Bolt
14	Throttle Body
15	Throttle Body Gasket
16	Intake Manifold
17	Bolt
18	Fuel Injection Fuel Rail Stop Bracket
19	Seal
20	Intake Manifold Gasket
21	Engine Coolant Air Bleed Plug
22	Oil Pressure Sensor
23	Washer
24	Bolt
25	Filter
26	O-ring
27	Valve Lifter Oil Manifold
28	Valve Lifter Oil Manifold Gasket
29	Engine Block
30	Seal
31	Engine Coolant Air Bleed Pipe
32	Bolt

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Fig. 9: Cylinder Head/Upper Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Positive Crankcase Ventilation (PCV) Hose - Fresh Air
2	Oil Fill Cap
3	O-ring
4	Oil Fill Tube
5	O-ring
6	Valve Rocker Arm Cover
6	Valve Rocker Arm Cover
7	Valve Rocker Arm Cover Gasket
7	Valve Rocker Arm Cover Gasket
8	Ignition Coil Wire Harness Assembly
9	Bolt
10	Spark Plug Wire
11	Ignition Coil
12	Bolt

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13	Ignition Coil Bracket
14	Bolt
15	Bolt Grommet
16	Valve Stem Key
17	Valve Spring Cap
18	Valve Spring
19	Valve Stem Oil Seal
20	Core Hole Plug
21	Spark Plug
22	Cylinder Head Bolt - M11
23	Cylinder Head Bolt - M8
24	Cylinder Head
25	Cylinder Head Gasket
26	Core Hole Plug
27	Cylinder Head Locating Pin
28	Cylinder Head Plug
29	Coolant Temperature Sensor (CTS)
30	Exhaust Valve
31	Intake Valve
32	Exhaust Manifold Gasket
33	Exhaust Manifold
34	Exhaust Manifold Heat Shield
35	Bolt
36	Stud
37	Bolt
38	Engine Block
39	Valve Lifter - Active Fuel Management
40	Valve Lifter - Non-Active Fuel Management
41	Valve Lifter Guide
42	Bolt
43	Pushrod
44	Valve Rocker Arm Pivot Support
45	Valve Rocker Arm
46	Bolt

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Fig. 10: Front Of Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Water Pump Inlet Bolt
2	Water Pump Inlet
3	Engine Coolant Thermostat
4	Water Pump Bolt
5	Water Pump
6	Water Pump Gasket
7	Oil Level Indicator O-ring Seal
8	Oil Level Indicator
9	Oil Level Indicator Tube Bolt
10	Oil Level Indicator Tube
11	O-ring
12	Engine Block
13	Camshaft Bearing

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14	Camshaft
15	Camshaft Sprocket Locating Pin
16	Camshaft Retainer
17	Camshaft Retainer Bolt
18	CMP Actuator
19	Camshaft Position (CMP) Actuator Solenoid Valve
20	Crankshaft Sprocket
21	Crankshaft Balancer Washer
22	Timing Chain
23	Timing Chain Tensioner
24	Timing Chain Tensioner Bolt
25	Engine Front Cover Gasket
26	Engine Front Cover
27	Engine Front Cover Bolt
28	CMP Actuator Magnet Gasket
29	CMP Actuator Magnet
30	CMP Actuator Hub Cover Bolt
31	CMP Sensor Bolt
32	CMP Sensor O-ring Seal
33	CMP Sensor
34	CMP Sensor Wire Harness Assembly
35	CMP Sensor Wire Harness Assembly Bolt
36	Crankshaft Front Oil Seal
37	Crankshaft Balancer
38	Crankshaft Balancer Bolt
39	Oil Pump Bolt
40	Oil Pump Cover Bolt
41	Oil Pump Cover
42	Oil Pump Drive Gear
43	Oil Pump Driven Gear
44	Oil Pump
45	Oil Pressure Relief Valve
46	Oil Pressure Relief Valve Spring
47	Oil Pressure Relief Valve Bore Plug

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Fig. 11: Rear Of Engine
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Block
2	Crankshaft Rear Oil Seal Housing Gasket
3	Crankshaft Rear Oil Seal Housing
4	Crankshaft Rear Oil Seal Housing Bolt
5	Crankshaft Rear Oil Seal
6	Flex Plate - Automatic Transmission (L99)
7	Flex Plate Bolt - Automatic Transmission (L99)
8	Clutch Pressure Plate Bolt - Manual Transmission (LS3)
9	Clutch Pressure Plate - Manual Transmission (LS3)
10	Clutch Driven Plate - Manual Transmission (LS3)
11	Clutch Pressure Plate Locating Pin - Manual Transmission (LS3)
12	Flywheel - Manual Transmission (LS3)
13	Transmission Pilot Bearing - Manual Transmission (LS3)

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Fig. 12: Lower Engine Assembly
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Block
2	Piston Pin
3	Piston Pin Retainer
4	Piston Rings
5	Piston
6	Connecting Rod
7	Connecting Rod Bearings
8	Connecting Rod Cap

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9	Connecting Rod Bolt
10	Crankshaft Main Bearing
10	Crankshaft Main Bearing
11	Crankshaft Thrust Bearing
11	Crankshaft Thrust Bearing
12	Crankshaft Sprocket Key
13	Crankshaft
14	Transmission Pilot Bearing - Manual Transmission
15	Crankshaft Bearing Cap
16	Crankshaft Bearing Cap Bolt - M8
17	Crankshaft Bearing Cap Stud - M10
18	Crankshaft Bearing Cap Bolt - M10
19	Crankshaft Oil Deflector
20	Oil Pan Gasket
21	Crankshaft Oil Deflector Nut
22	Oil Pump Screen
23	Oil Pump Screen Nut
24	Oil Pump Screen O-ring
25	Oil Pump Screen Bolt
26	Engine Closeout Cover Bolt
27	Engine Closeout Cover - Right
28	Oil Pan Baffle Bolt
29	Oil Pan Baffle
30	Oil Level Sensor
31	Oil Level Sensor O-ring
32	Oil Pan
33	Oil Pan Bolt - M8
34	Oil Pan Drain Plug O-ring Seal
35	Oil Pan Drain Plug
36	Oil Filter
37	Oil Filter Fitting
38	Oil Pan Bolt - M6
39	Washer
40	Active Fuel Management Oil Pressure Relief Valve
41	Engine Oil Cooler Coolant Fitting
42	Engine Oil Cooler-to-Oil Pan Bolt - M8
43	Engine Oil Cooler Core
44	Engine Oil Cooler Core-to-Housing Bolt
45	Engine Oil Cooler Housing
46	Engine Oil Cooler Gasket
47	Engine Oil Cooler-to-Oil Pan Bolt - M6
48	

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	Engine Oil Cooler Core Seal
49	Oil Pan Cover - Left
50	Oil Pan Cover Bolt



Fig. 13: Engine Block Plugs/Sensors
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
100	Engine Block
100	Engine Block
101	Oil Gallery Plug - Front
110	O-Ring
111	Oil Gallery Plug - Rear
112	Oil Gallery Plug - Side
113	Washer
114	Engine Coolant Heater

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115	Washer
116	Oil Gallery Plug - Side
117	Washer
130	Transmission Housing Locating Pin
145	Washer
146	Engine Block Coolant Drain Hole Plug
701	Crankshaft Position (CKP) Sensor
702	O-Ring
718	Knock Sensor
718	Knock Sensor
739	Bolt
739	Bolt
750	CKP Sensor Bolt

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Fig. 14: Oil Pump Assembly
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
408	Bolt
409	Oil Pump Housing Cover
410	Oil Pump Drive Gear
412	Oil Pump Driven Gear

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413	Oil Pump
414	Oil Pump Pressure Relief Valve
415	Oil Pump Pressure Relief Valve Spring
416	Oil Pump Housing Plug

ENGINE IDENTIFICATION

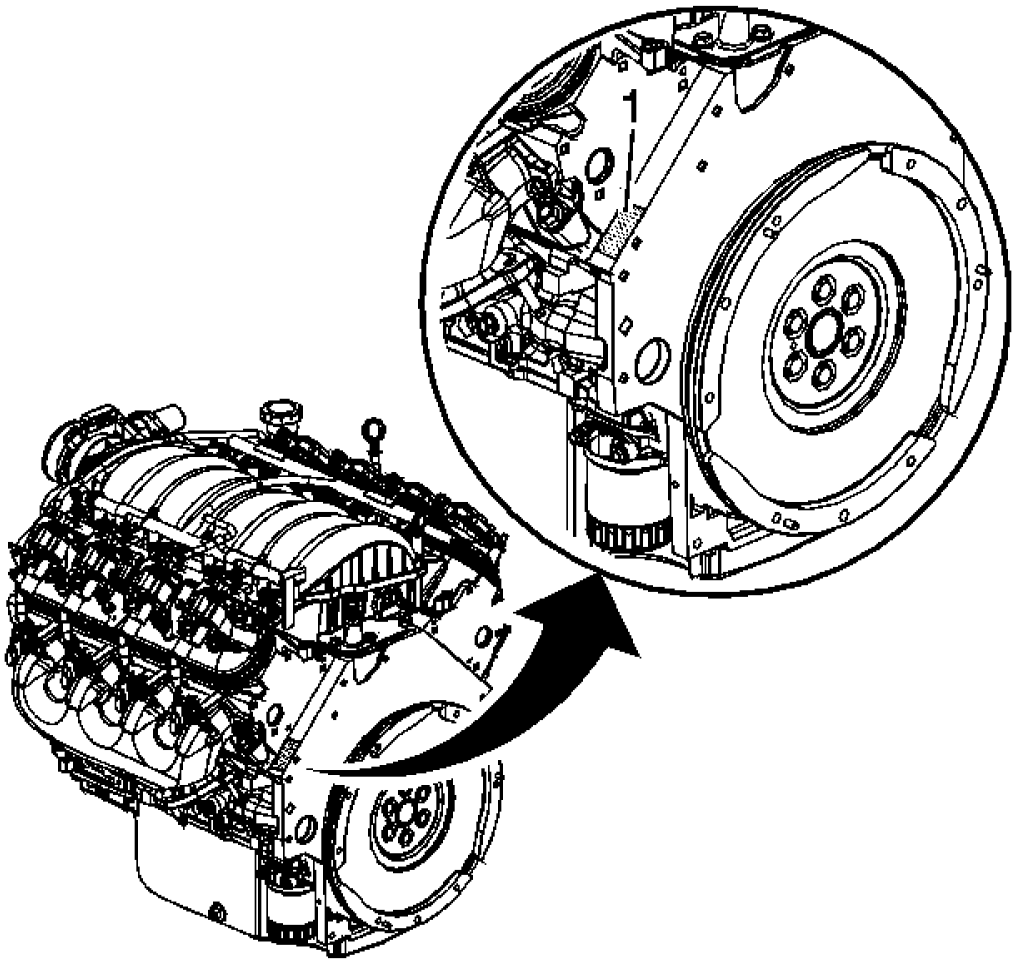


Fig. 15: Locating Vehicle Identification Number
Courtesy of GENERAL MOTORS CORP.

The vehicle identification number (VIN) (1) is located on the left side rear of the engine block and is typically a 9 digit number stamped or laser-etched onto the engine at the vehicle assembly plant.

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- The first digit identifies the division.
- The second digit identifies the model year.
- The third digit identifies the assembly plant.
- The fourth through ninth digits are the last 6 digits of the VIN.

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2010 ENGINE

Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Camaro

DESCRIPTION AND OPERATION

CRANKCASE VENTILATION SYSTEM DESCRIPTION

A closed crankcase ventilation system is used in order to provide a more complete scavenging of the crankcase vapors. Fresh air from the throttle body is supplied to the crankcase, mixed with blow-by gases, and then passed through a crankcase ventilation valve into the intake manifold.

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

Filtered fresh air is routed from up-stream of the throttle blade to the front of the right rocker arm cover via a formed rubber hose. To reduce the potential of oil pullover into the throttle bore area due to back flow of the ventilation system, the fitting in the right rocker arm cover is shielded from the rocker arms. From there fresh air and gases are routed through the crankcase and up to the opposite rocker arm cover where the positive crankcase ventilation (PCV) valve is located. Gases are then routed through a hose to the intake manifold.

DRIVE BELT SYSTEM DESCRIPTION

The drive belt system consists of the following components:

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

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

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chloroprene or EPDM, and have different layers or plys containing either fiber cloth or cords for reinforcement.

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

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

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

ENGINE COMPONENT DESCRIPTION (6.2L LS3)

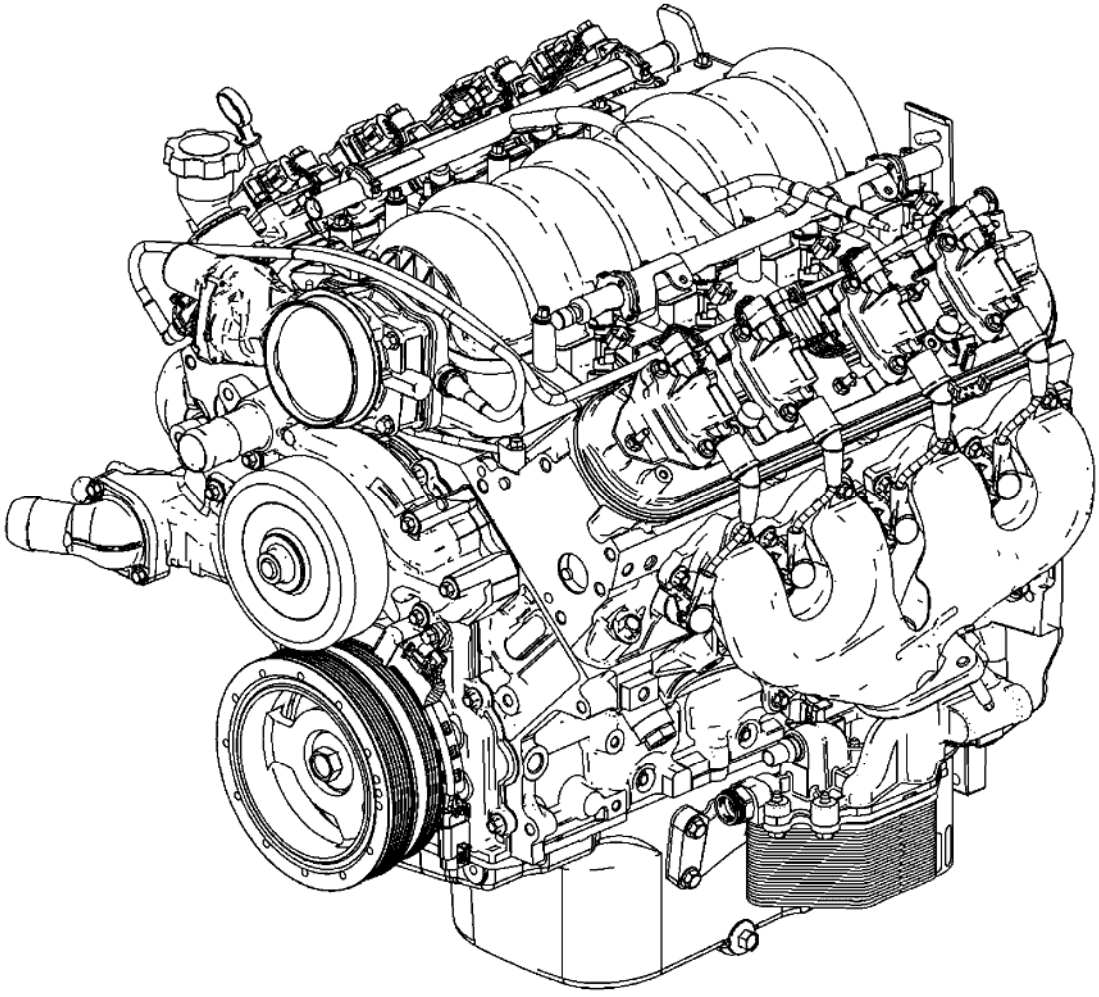


Fig. 1: 6.2 Liter V8 Engine (LS3)
Courtesy of GENERAL MOTORS CORP.

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The 6.2 Liter V8 engine is identified as RPO LS3 VIN W.

Camshaft and Drive System

A hollow billet steel 1 piece camshaft is supported by 5 bearings pressed into the engine block. The camshaft timing sprocket is mounted to the front of the camshaft and is driven by the crankshaft sprocket through the camshaft timing chain. The camshaft position (CMP) sensor lobes are incorporated into the front face of the camshaft sprocket with the CMP sensor mounted in the engine front cover. A timing chain tensioner is mounted to the front of the engine block above the crankshaft sprocket. The externally splined crankshaft sprocket is positioned to the crankshaft by a key and keyway. The crankshaft sprocket external splines drive the oil pump drive gear. A retaining plate mounted to the front of the engine block maintains camshaft location.

Crankshaft

The crankshaft is cast iron. The crankshaft is supported by 5 crankshaft bearings. The bearings are retained by crankshaft bearing caps which are machined with the engine block for proper alignment and clearance. The crankshaft journals are undercut and rolled. The center main journal is the thrust journal. A crankshaft position (CKP) reluctor ring is press fit mounted at the rear of the crankshaft. The reluctor ring is not serviceable separately.

Cylinder Heads

The cylinder heads are cast aluminum and have pressed in place powdered metal valve guides and valve seats. Passages for the engine coolant air bleed system are at the front of each cylinder head. The valve rocker arm covers are retained to the cylinder heads by 4 center mounted rocker arm cover bolts. High-flow cylinder heads with modified intake and exhaust ports are used to increase flow.

Engine Block

The engine block is a cam-in-block deep skirt 90 degree V configuration with 5 crankshaft bearing caps. The engine block is cast aluminum. The 5 crankshaft bearing caps each have 4 vertical M10 and 2 horizontal M8 mounting bolts. The camshaft is supported by 5 camshaft bearings pressed into the block.

Exhaust Manifolds

The exhaust manifolds are a 1 piece cast iron design. The exhaust manifolds direct exhaust gasses from the combustion chambers to the exhaust system. Each manifold also has an externally mounted heat shield that is retained by bolts.

Intake Manifold

The intake manifold is a 1 piece composite design that incorporates brass threaded inserts for mounting the fuel rail, throttle body, and wire harness studs. A non-serviceable cap with acoustic foam has been added to the top of the manifold to reduce engine noise. Each side of the intake manifold is sealed to the cylinder head by a non-reusable push-in-place silicone sealing gasket. The electronically actuated throttle body bolts to the front of the intake manifold. The throttle body is sealed by a 1 piece push-in-place silicone gasket. The fuel rail assembly, with 8 separate fuel injectors, is retained to the intake by 4 bolts. The injectors are seated into their individual manifold bores with O-ring seals to provide sealing. A fuel rail stop bracket is retained to the rear left of the

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intake manifold by mounting bolts. The manifold absolute pressure (MAP) sensor is installed and retained to the top front of the intake manifold and sealed by an O-ring seal. The evaporative emission (EVAP) canister purge solenoid valve is mounted to the front of the right cylinder head. There are no coolant passages within the intake manifold.

Oil Pan

The structural rear-sump oil pan is cast aluminum. Incorporated into the design are the oil filter mounting boss, drain plug opening, baffle, oil level sensor, oil pressure relief valve, and oil level indicator tube opening. The oil filter bypass valve is now internal to the oil filter. An external engine oil cooler assembly is mounted directly to the left side of the oil pan. The alignment of the structural oil pan to the rear of the engine block and transmission housing is critical.

Piston and Connecting Rod Assembly

The pistons are cast aluminum. The pistons use 2 compression rings and 1 oil control ring assembly. The piston is a low friction, lightweight design with a flat or recessed top and barrel shaped skirt. The piston pins are chromium steel and are a full-floating design. The connecting rods are powdered metal. The connecting rods are fractured at the connecting rod journal and then machined for the proper clearance. All applications use a piston with a graphite coated skirt. The piston and pin are to be serviced as an assembly.

Valve Rocker Arm Cover Assemblies

The valve rocker arm covers are cast aluminum and use a pre-molded silicon gasket for sealing. Mounted to each rocker cover are the coil and bracket assemblies. Incorporated into the right cover is the oil fill tube and the positive crankcase ventilation (PCV) fresh air passage.

Valve Train

Motion is transmitted from the camshaft through the hydraulic roller valve lifters and tubular pushrods to the roller type rocker arms. The nylon valve lifter guides position and retain the valve lifters. The valve rocker arms for each bank of cylinders are mounted on pivot supports. Each rocker arm is retained on the pivot support and cylinder head by a bolt. The inlet rocker arms are offset 6 mm (0.24 in) to enable more direct intake flow. Valve lash is net build.

ENGINE COMPONENT DESCRIPTION (6.2L L99)

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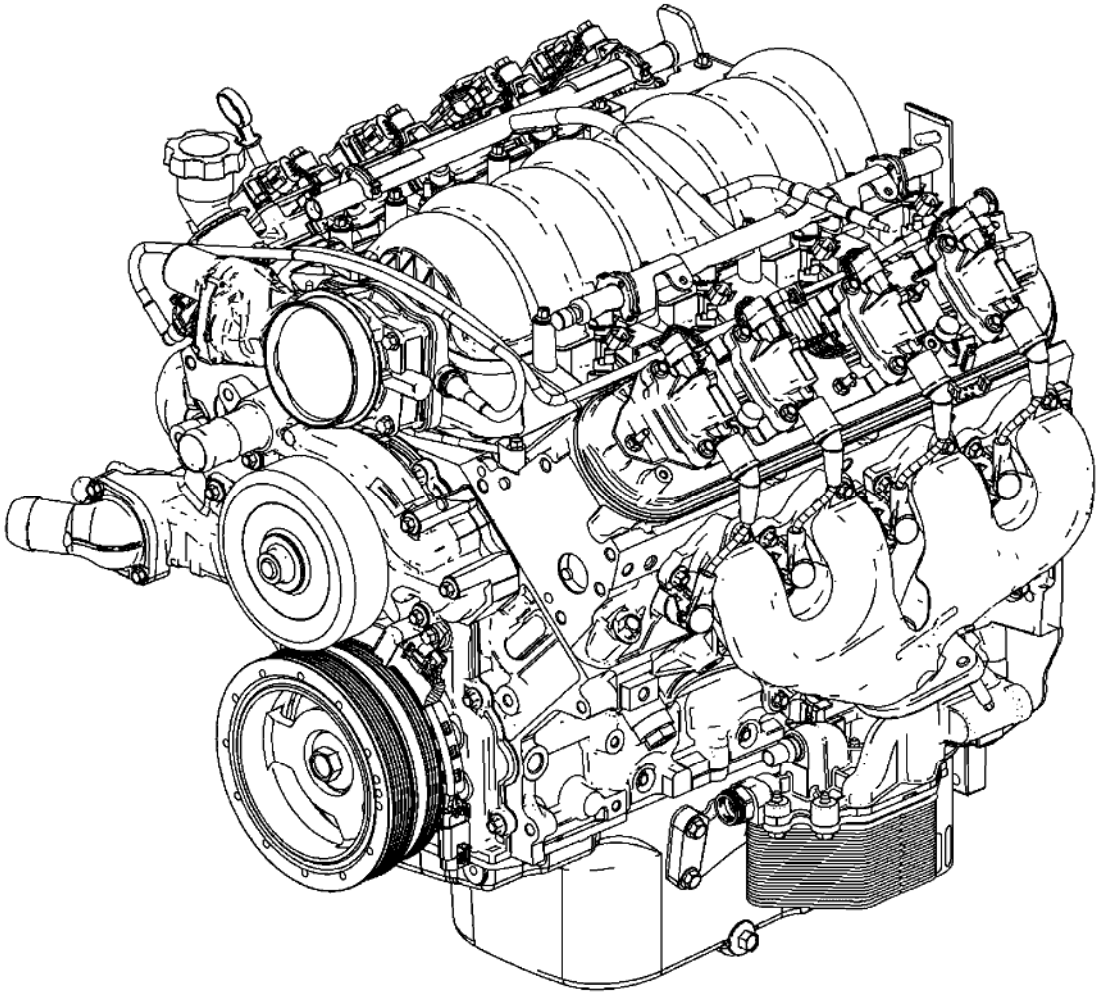


Fig. 2: 6.2 Liter V8 Engine (L99)
Courtesy of GENERAL MOTORS CORP.

The 6.2 Liter V8 engine is identified as RPO L99 VIN J.

Camshaft and Drive System

A billet steel 1-piece camshaft is supported by 5 bearings pressed into the engine block. The camshaft position (CMP) actuator is mounted to the front of the camshaft and retained by the CMP solenoid valve. The CMP actuator is driven by the crankshaft sprocket through the camshaft timing chain. The CMP sensor wheel is incorporated into the front face of the CMP actuator with the CMP sensor and CMP actuator magnet mounted in the engine front cover. A timing chain tensioner is mounted to the front of the engine block above the crankshaft sprocket. The externally splined crankshaft sprocket is positioned to the crankshaft by a key and keyway. The crankshaft sprocket external splines drive the oil pump drive gear. A retaining plate mounted to the front of the engine block maintains camshaft location. Refer to **Camshaft Position Actuator and Solenoid Valve Description**.

Crankshaft

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The crankshaft is cast iron. The crankshaft is supported by 5 crankshaft bearings. The bearings are retained by crankshaft bearing caps which are machined with the engine block for proper alignment and clearance. The crankshaft journals are undercut and rolled. The center main journal is the thrust journal. A crankshaft position (CKP) reluctor ring is press fit mounted at the rear of the crankshaft. The reluctor ring is not serviceable separately.

Cylinder Heads

The cylinder heads are cast aluminum and have pressed in place powdered metal valve guides and valve seats. Passages for the engine coolant air bleed system are at the front of each cylinder head. The valve rocker arm covers are retained to the cylinder heads by 4 center mounted rocker arm cover bolts. High-flow cylinder heads with modified intake and exhaust ports are used to increase flow.

Engine Block

The engine block is a cam-in-block deep skirt 90 degree V configuration with 5 crankshaft bearing caps. The engine block is cast aluminum. The 5 crankshaft bearing caps each have 4 vertical M10 and 2 horizontal M8 mounting bolts. The camshaft is supported by 5 camshaft bearings pressed into the block.

Exhaust Manifolds

The exhaust manifolds are a 1 piece cast iron design. The exhaust manifolds direct exhaust gasses from the combustion chambers to the exhaust system. Each manifold also has an externally mounted heat shield that is retained by bolts.

Intake Manifold

The intake manifold is a 1 piece composite design that incorporates brass threaded inserts for mounting the fuel rail, throttle body, and wire harness studs. A non-serviceable cap with acoustic foam has been added to the top of the manifold to reduce engine noise. Each side of the intake manifold is sealed to the cylinder head by a non-reusable push-in-place silicone sealing gasket. The electronically actuated throttle body bolts to the front of the intake manifold. The throttle body is sealed by a 1 piece push-in-place silicone gasket. The fuel rail assembly, with 8 separate fuel injectors, is retained to the intake by 4 bolts. The injectors are seated into their individual manifold bores with O-ring seals to provide sealing. A fuel rail stop bracket is retained to the rear left of the intake manifold by mounting bolts. The manifold absolute pressure (MAP) sensor is installed and retained to the top front of the intake manifold and sealed by an O-ring seal. The evaporative emission (EVAP) canister purge solenoid valve is mounted to the front of the right cylinder head. There are no coolant passages within the intake manifold.

Oil Pan

The structural rear-sump oil pan is cast aluminum. Incorporated into the design are the oil filter mounting boss, drain plug opening, baffle, oil level sensor, oil pressure relief valve, and oil level indicator tube opening. The oil filter bypass valve is now internal to the oil filter. An external engine oil cooler assembly is mounted directly to the left side of the oil pan. Alignment of the structural oil pan to the rear of the engine block and transmission housing is critical.

Piston and Connecting Rod Assembly

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The pistons are cast aluminum. The pistons use 2 compression rings and 1 oil control ring assembly. The piston is a low friction, lightweight design with a flat or recessed top and barrel shaped skirt. The piston pins are chromium steel and are a full-floating design. The connecting rods are powdered metal. The connecting rods are fractured at the connecting rod journal and then machined for the proper clearance. All applications use a piston with a graphite coated skirt. The piston and pin are to be serviced as an assembly.

Valve Rocker Arm Cover Assemblies

The valve rocker arm covers are cast aluminum and use a pre-molded silicon gasket for sealing. Mounted to each rocker cover are the coil and bracket assemblies. Incorporated into the right cover is the oil fill tube and the positive crankcase ventilation (PCV) fresh air passage.

Valve Train

Motion is transmitted from the camshaft through the hydraulic roller valve lifters and tubular pushrods to the roller type rocker arms. The nylon valve lifter guides position and retain the valve lifters. The valve rocker arms for each bank of cylinders are mounted on pedestals or pivot supports. Each rocker arm is retained on the pivot support and cylinder head by a bolt. Valve lash is net build. Cylinders 1, 4, 6, and 7 are active fuel management. Refer to **Cylinder Deactivation (Active Fuel Management) System Description**.

CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) SYSTEM DESCRIPTION

System Operation

General Motors Active Fuel Management engine control system has the ability, under certain light load driving conditions, to provide maximum fuel economy by deactivating 4 of the engines 8 cylinders. The engine will normally operate on 8 cylinders in V8 mode during starting, idling, and medium or heavy throttle conditions. When commanded ON, the engine control module (ECM) will direct the active fuel management system and deactivate cylinders 1 and 7 on the left bank and cylinders 4 and 6 on the right bank, forcing V4 mode. Refer to **Lubrication Description (6.2L LS3)** or **Lubrication Description (6.2L L99)** and **Cylinder Deactivation (Active Fuel Management) System Description** .

Valve Lifter Oil Manifold Assembly

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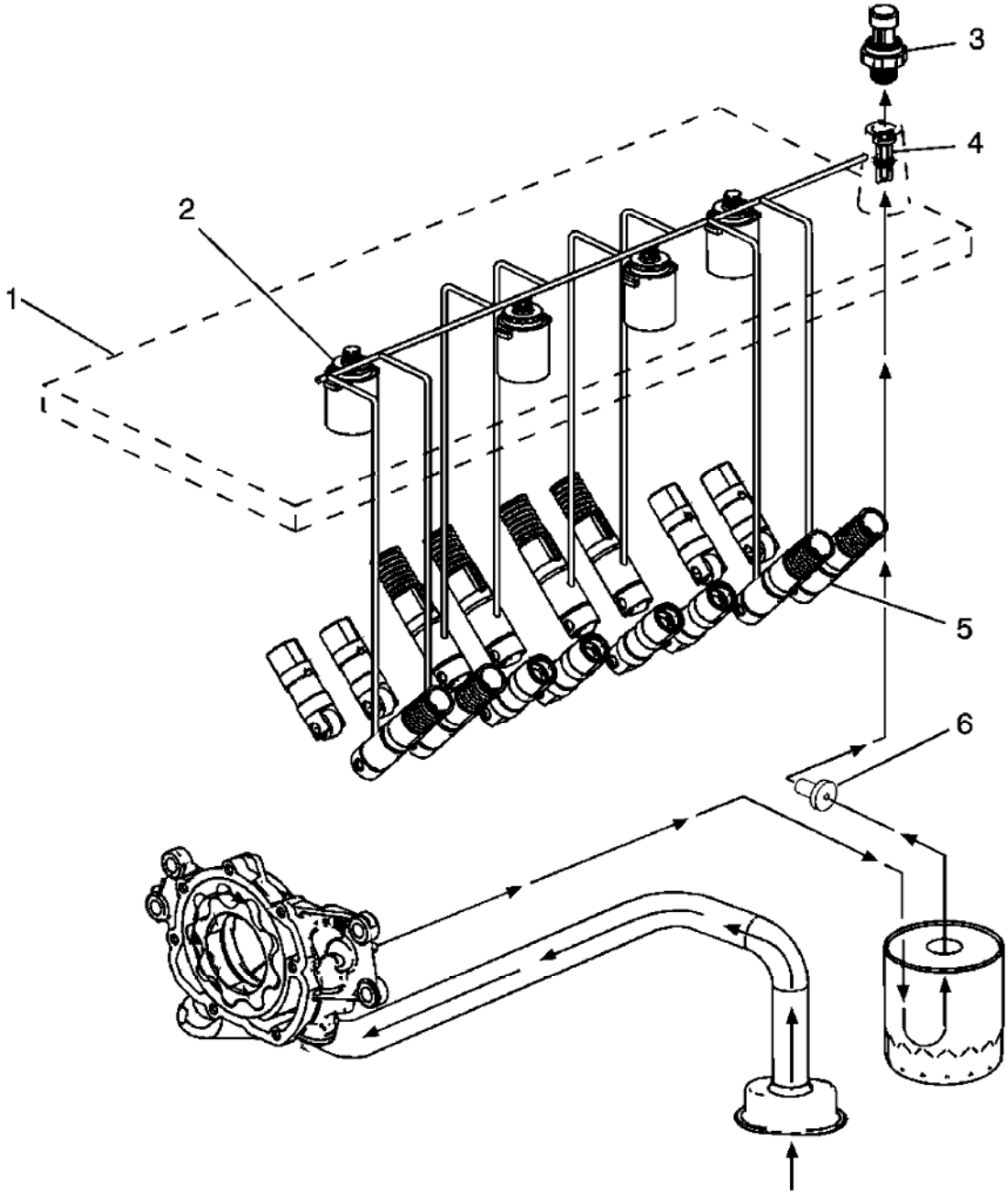


Fig. 3: View Of Engine Oil Flow
Courtesy of GENERAL MOTORS CORP.

The valve lifter oil manifold assembly (1) is bolted to the top of the engine block beneath the intake manifold assembly. The oil manifold consists of 4 electrically operated and normally-closed solenoids (2). Each solenoid directs the flow of pressurized engine oil to the active fuel management intake and exhaust valve lifters (5). The active fuel management oil pressure relief valve (6), located in the oil pan, regulates engine oil pressure to the lubrication system and the oil manifold.

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When enabling conditions are met for active fuel management operation, the ECM will ground each solenoid control circuit in firing order sequence, allowing current to flow through the solenoid windings. With the windings energized, the solenoid valves open and direct pressurized engine oil through the valve lifter oil manifold into 8 vertical passages in the engine block lifter valley. The 8 vertical passages, 2 per cylinder, direct pressurized oil to the valve lifter bores of the cylinders to be deactivated. When vehicle operating conditions require a return to V8 mode, the ECM will turn OFF the ground circuit for the solenoids, allowing the solenoid valves to close. When the solenoid valves are closed, remaining oil pressure is exhausted through the bleed passages of the valve lifter oil manifold into the engine block lifter valley. The housing of the oil manifold incorporates several oil bleed passages that continually purge trapped air from the manifold and engine block.

To help control contamination within the active fuel management hydraulic system, a small replaceable oil filter (4) is located in the valve lifter oil manifold oil inlet passage. The oil pressure sensor (3) monitors engine oil pressure and provides information to the ECM.

Active Fuel Management Valve Lifters

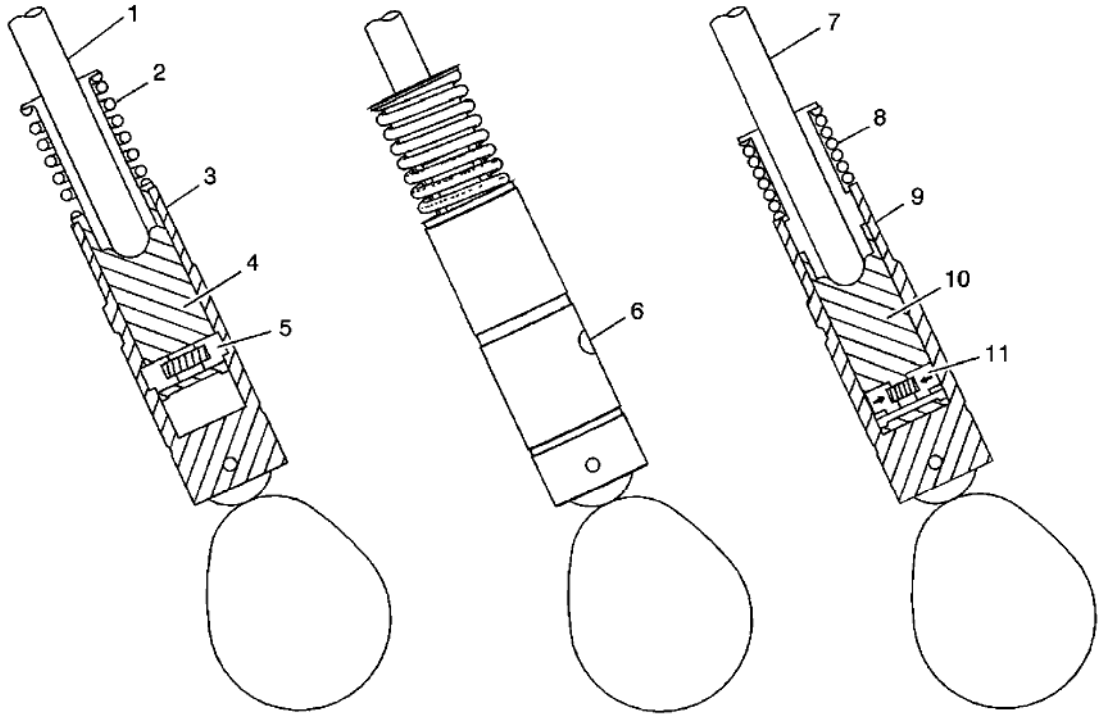


Fig. 4: Displacement On Demand Valve Lifters
Courtesy of GENERAL MOTORS CORP.

When operating in V8 mode, the active fuel management valve lifters function similar to the non-active fuel management valve lifters. The active fuel management oil manifold solenoids are in the closed position, with no pressurized oil directed to the valve lifters. The pushrod (1) travels upward and downward to actuate the rocker arm and valve. The spring loaded locking pins (5) of the lifter are extended outward and mechanically lock the pin housing (4) to the outer body of the valve lifter (3).

When the active fuel management system is commanded ON, the ECM will direct the solenoids of the oil

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manifold to open and direct pressurized oil to the valve lifters. Oil travels through the valve lifter oil manifold and engine block oil galleries and enters the inlet port (6) of the valve lifter.

When operating in V4 mode, pressurized oil forces the locking pins (11) inward. The pushrod (7) remains in a constant position and does not travel upward and downward. The outer body of the lifter (9) moves upward and downward independently from the pin housing (10). The valve lifter spring (8) retains tension on the valve train components to eliminate valve train noise.

When the active fuel management system is commanded OFF, the ECM directs the solenoids of the oil manifold to close, stopping the flow of pressurized oil to the valve lifters. The oil pressure within the lifter will decrease and the locking pins will move outward to mechanically lock the pin housing and outer body.

Engine Block

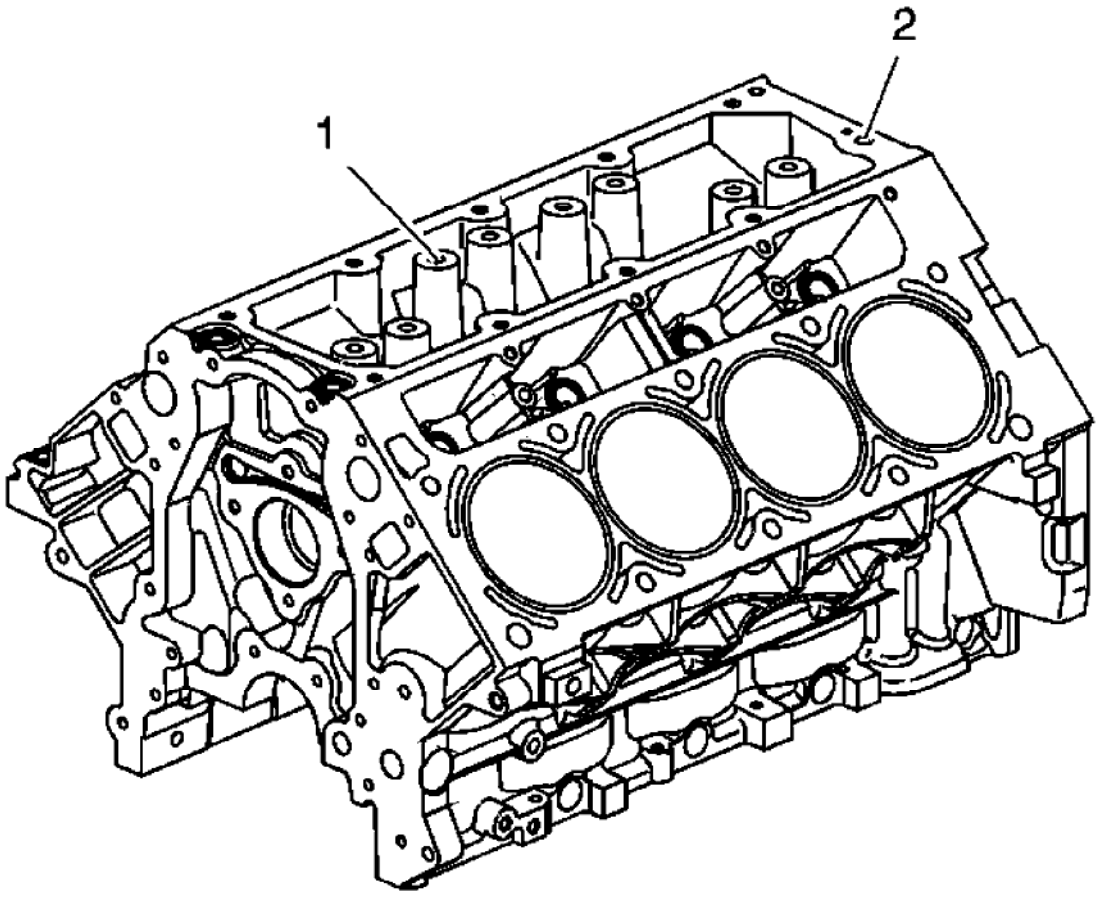


Fig. 5: Active Fuel Management Engine Block
Courtesy of GENERAL MOTORS CORP.

The active fuel management engine block incorporates additional features to support active fuel management system operation. Engine oil pressure is routed to the valve lifter oil manifold assembly from an oil gallery (2) in the rear of the cylinder block. Cylinders 1, 4, 6, and 7 each have 2 vertical, cast-in-block oil passages (1). The vertical oil passages permit oil flow from the manifold assembly to the valve lifter bores.

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Engine Control Module (ECM)

Refer to **Cylinder Deactivation (Active Fuel Management) System Description** .

CAMSHAFT POSITION ACTUATOR AND SOLENOID VALVE DESCRIPTION

Camshaft

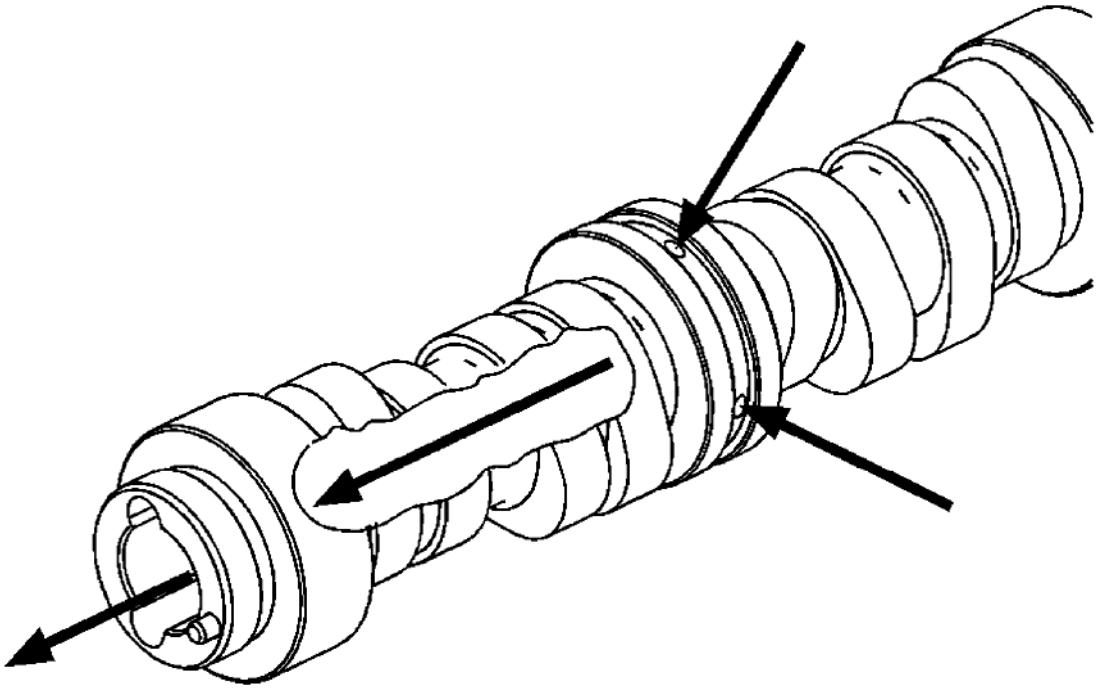


Fig. 6: Camshaft Lubrication Path
Courtesy of GENERAL MOTORS CORP.

The camshaft is designed to provide a lubrication path for pressurized engine oil to flow to the camshaft position (CMP) actuator. Pressurized engine oil enters the camshaft at bearing journal location number 2. Oil travels through the camshaft, out the front, and into the CMP actuator solenoid valve.

CMP Actuator Solenoid Valve

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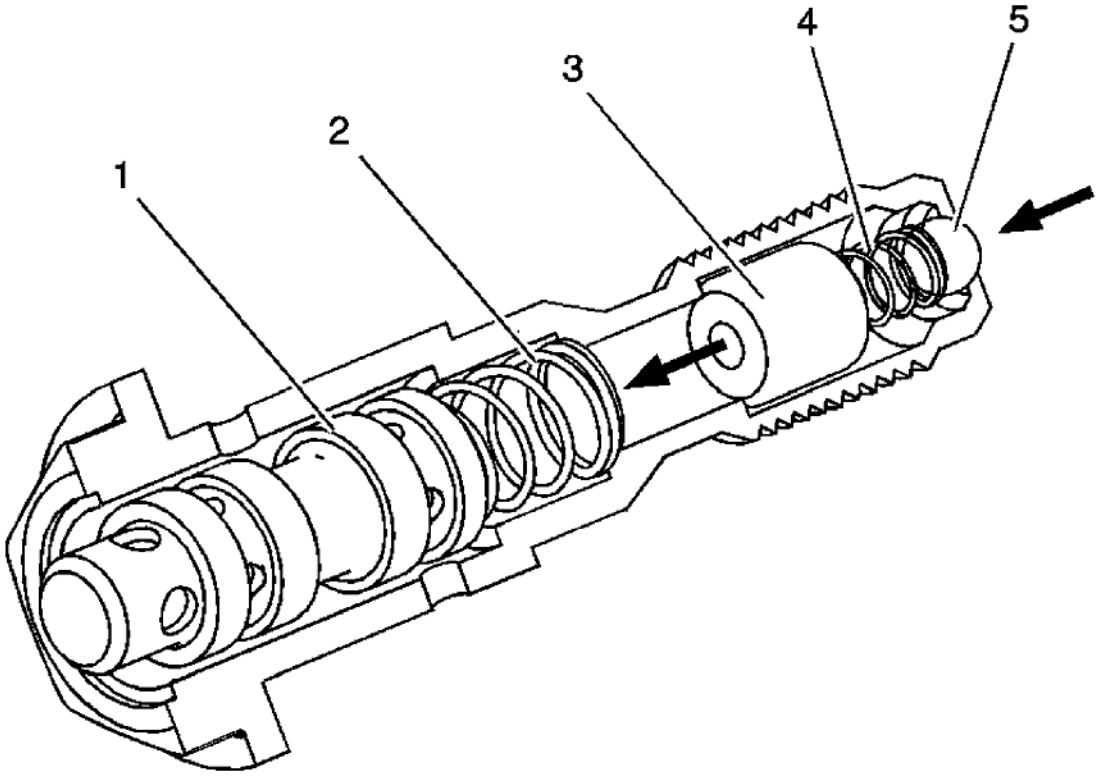


Fig. 7: CMP Actuator Solenoid Valve Components
Courtesy of GENERAL MOTORS CORP.

The CMP actuator solenoid valve consists of a housing, spool valve (1), spool return spring (2), oil filter (3), inlet check ball return spring (4), and inlet check ball (5). Pressurized engine oil enters the valve and travels through the filter to the spool. Spool position is controlled by the CMP magnet and engine control module (ECM). When the spool is moved to the proper position, oil flow is directed through the valve and into the CMP actuator assembly. The CMP solenoid valve is a torque-to-yield design and should be replaced each time it is removed.

CMP Actuator Magnet

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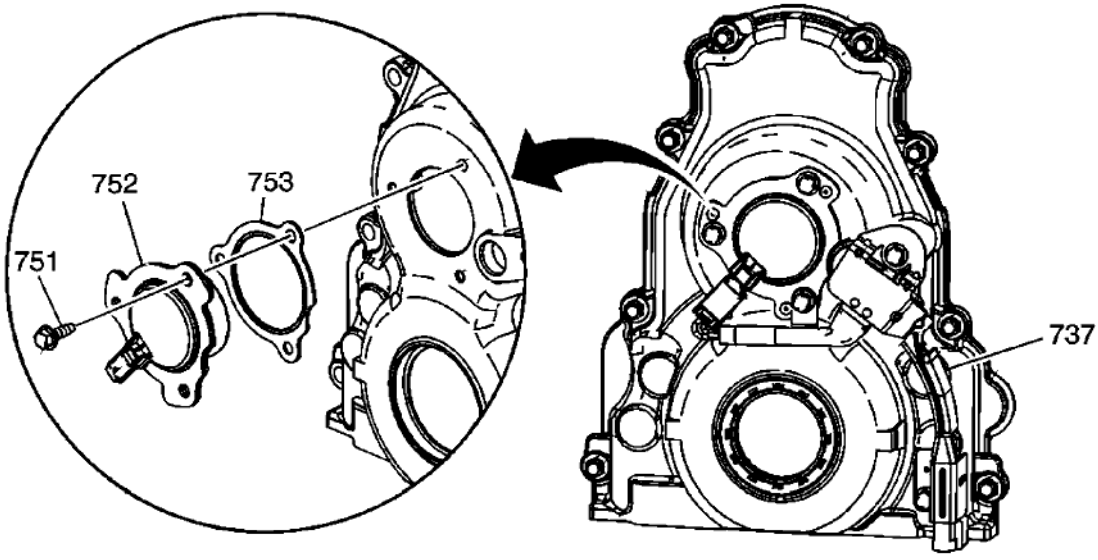


Fig. 8: View Of CMP Actuator Magnet & Components
Courtesy of GENERAL MOTORS CORP.

The CMP actuator magnet (752) is located in the engine front cover and is sealed by a gasket (753). The CMP actuator magnet is controlled by a 12-volt 150 Hz pulse width 0-100 percent duty cycle signal from the ECM. When energized, the solenoid uses electromagnetic force on the magnet pintle to position the spool valve of the CMP solenoid valve.

CMP Actuator

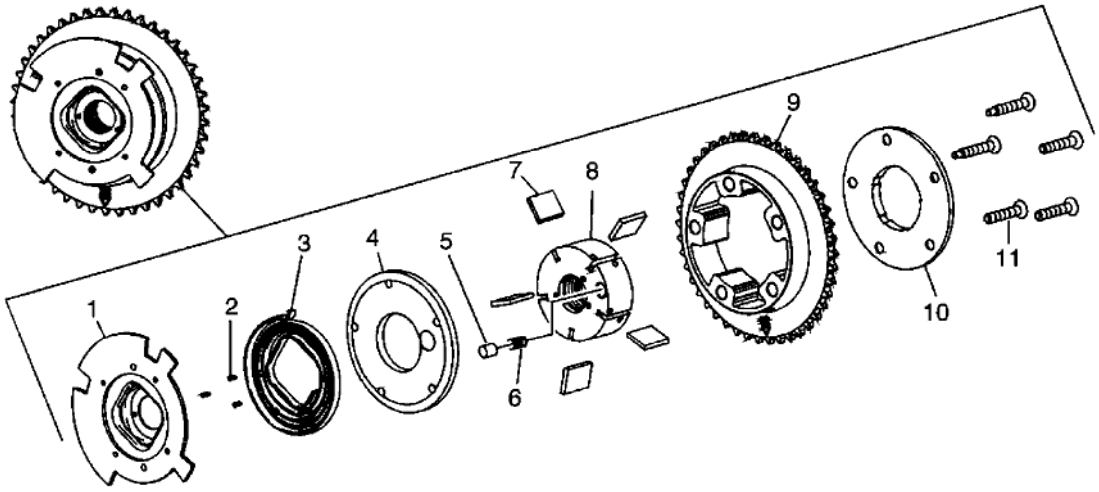


Fig. 9: View Of CMP Actuator Components
Courtesy of GENERAL MOTORS CORP.

The CMP actuator is a vane type design that hydraulically changes angle or timing of the camshaft relative to

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crankshaft position. The CMP actuator allows earlier or later intake and exhaust valve opening during the 4-stroke engine cycle. The CMP actuator cannot vary the duration of valve opening or valve lift. The CMP actuator is to be serviced as an assembly. For system operation, refer to **Camshaft Actuator System Description** .

The CMP actuator consists of the CMP reluctor wheel (1), wheel retaining pins (2), return spring (3), front cover (4), park position pin (5), park position pin spring (6), vanes and vane springs (7), rotor (8), housing with chain sprocket (9), sealing cover/thrust plate (10), and bolts (11).

CMP System Operation

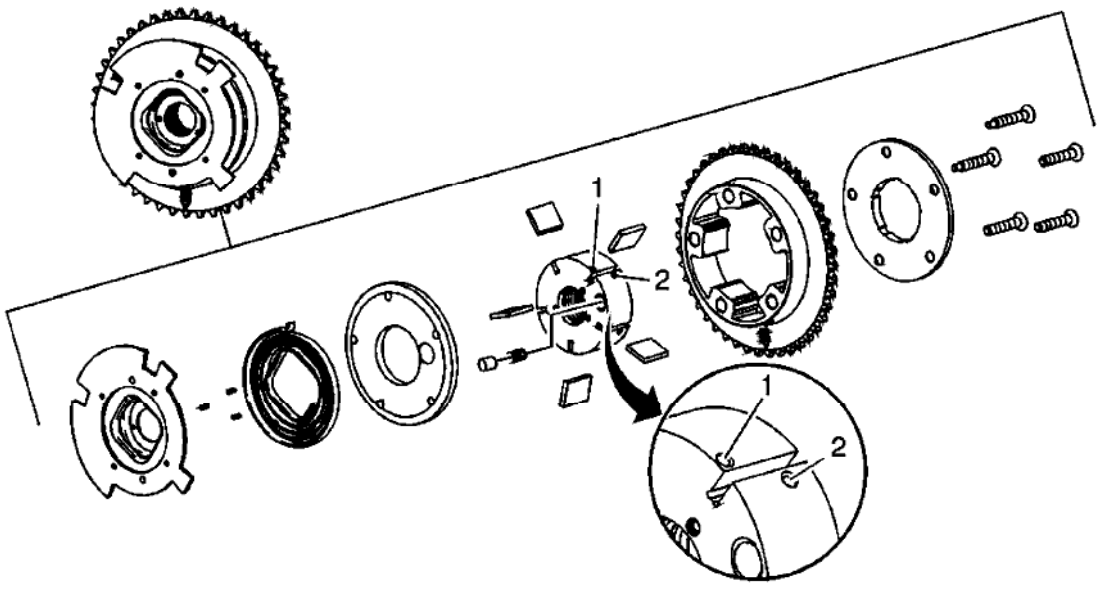


Fig. 10: CMP Actuator
Courtesy of GENERAL MOTORS CORP.

A CMP actuator dynamically changes valve timing events relative to piston timing by controlling camshaft position. This is sometimes referred to as variable valve timing or camshaft phasing. Variable valve timing or camshaft phasing does not change duration or lift.

- By advancing camshaft timing, an improvement in low end torque can be achieved.
- By retarding camshaft timing slightly, an improvement in high end power can be achieved.
- By retarding camshaft timing significantly, an improvement in light load fuel economy can be achieved.

There are 5 cavities divided by vanes within the CMP actuator.

- When oil is directed to the advance cavities (1), the camshaft timing is advanced.
- When oil is directed to the retard cavities (2), the camshaft timing is retarded.
- When oil is directed to both cavities, the camshaft is held stationary.

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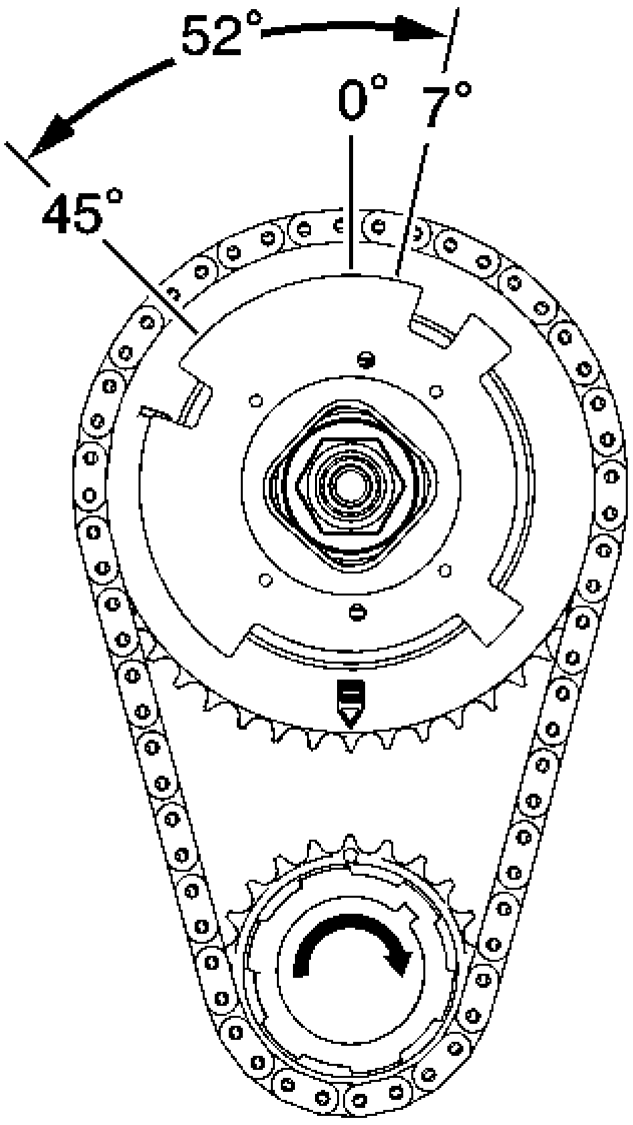


Fig. 11: Timing Camshaft - 52 Degree Range Of Authority
Courtesy of GENERAL MOTORS CORP.

The CMP actuator has a 52 degree range of authority. With the engine not running and no engine oil pressure to the CMP actuator, the high tension spring positions camshaft timing at the 7 degree advanced park position. During normal engine operation, and based on performance requirements, the ECM may adjust camshaft timing, as required, within a range from 7 degrees advanced to 45 degrees retard.

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CMP System Lubrication Flow and Actuator Operation

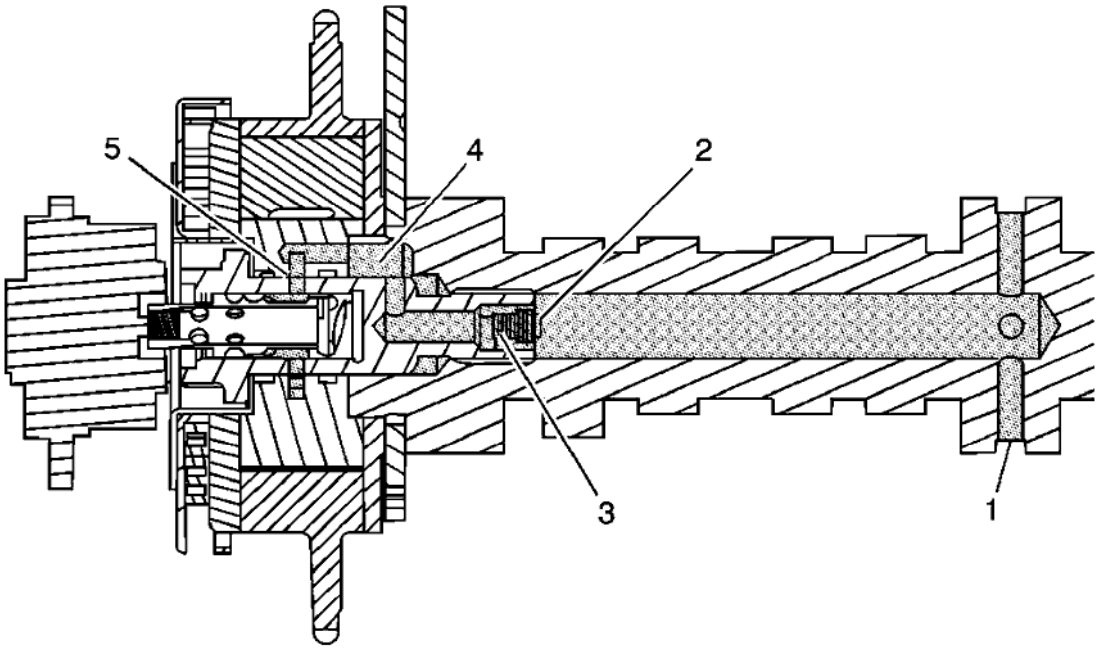


Fig. 12: Cutaway View Of Actuator
Courtesy of GENERAL MOTORS CORP.

1. Oil enters the camshaft at the second main bearing journal (1).
2. Oil travels through the camshaft into the CMP actuator valve check ball (2) and filter (3).
3. Oil exits the valve and travels through the internal passages of the camshaft (4).
4. Oil exits the camshaft and enters the actuator oil entry ports.
5. Oil travels through the actuator and is directed back into the valve (5).
6. Valve spool position directs oil to the advance or retard passages of the actuator.

The valve may also, under certain conditions, be positioned in a neutral position with no flow to either the advance or retard passages of the actuator.

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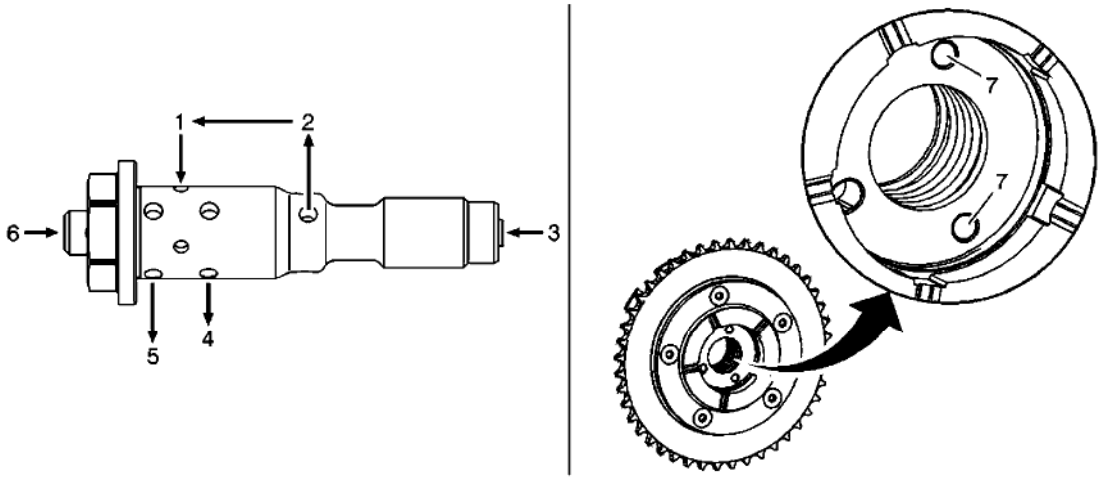


Fig. 13: Identifying Actuator Passages
Courtesy of GENERAL MOTORS CORP.

1. Oil flows from the camshaft into the valve inlet (3) through the internal check ball and filter.
2. Oil exits the valve (2) and travels within the internal passages of the camshaft into the entry ports (7) of the actuator.
3. The center oil groove of the actuator is pressurized and oil reenters the valve (1).
4. Valve spool position directs oil out of the valve advance (5) or retard (4) ports to the actuator.

The valve may also, under certain conditions, be positioned in a neutral position with no flow to either the advance or retard passages of the actuator.

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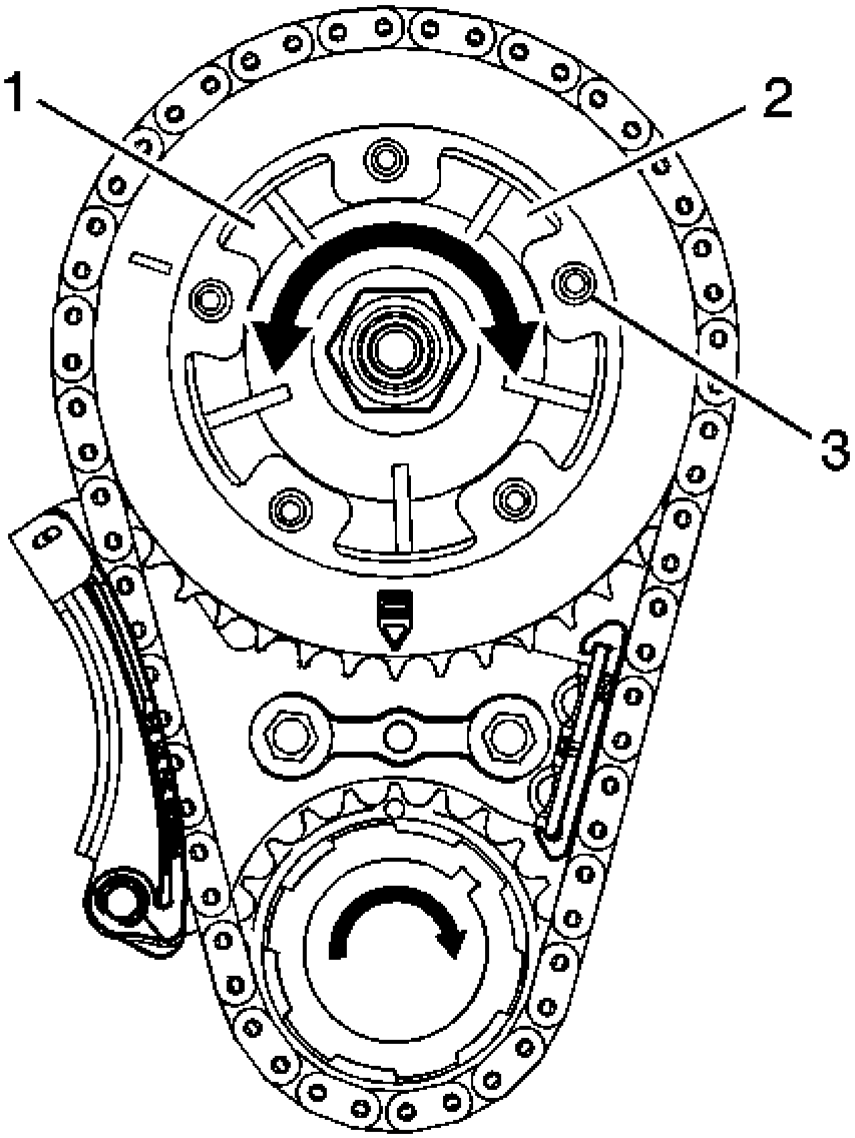


Fig. 14: Advance & Retard Cavities
Courtesy of GENERAL MOTORS CORP.

1. Pressurized oil enters the retard cavities (2) of the actuator and moves the park pin (3) from the locked position.
2. As pressure increases within the retard cavities (2), the rotor and camshaft rotate counter clockwise retarding valve timing.

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3. As the duty cycle decreases, the spool is repositioned and oil is sent to the advance cavities (1), rotating the rotor and camshaft clockwise, advancing valve timing.
    - With a 0 percent duty cycle signal to the magnet, the spool is positioned in the fully extended position and there is full flow to the advance cavities of the actuator. As duty cycle increases to near 50 percent, flow to the advance cavities is decreased.
    - With a 50 percent duty cycle, the spool is positioned neutral, with no flow to either the advance and retard cavities.
    - With a 51-100 percent duty cycle, the spool is positioned to provide oil flow to retard cavities. As the duty cycle increases, the flow to retard cavities increases.
    - With a 100 percent duty cycle, there is full flow to the retard cavities of the actuator.
    - The above duty cycle percentage values are only a guideline, as the actual duty cycle values may vary based on engine oil temperature, solenoid magnet coil temperature, magnet coil resistance, and other specifics.

CMP Actuator Park Position Verification

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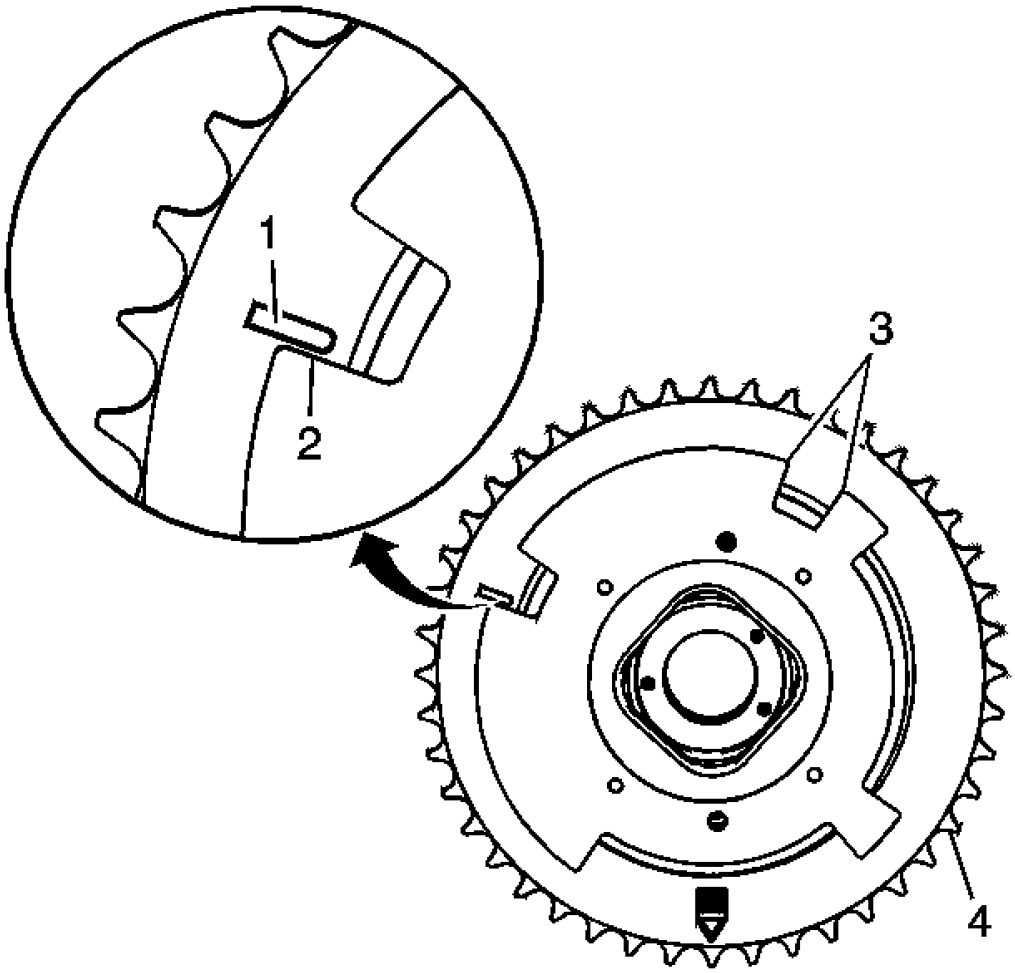


Fig. 15: CMP Actuator Park Position Verification
Courtesy of GENERAL MOTORS CORP.

The CMP actuator can be visually inspected to determine if the tension spring has returned the reluctor wheel and rotor to the park position.

With the reluctor wheel returned to the proper parked position, the edge of the notched area of the wheel (2) aligns with the marking (1) on the camshaft sprocket.

CMP Actuator Handling Safety

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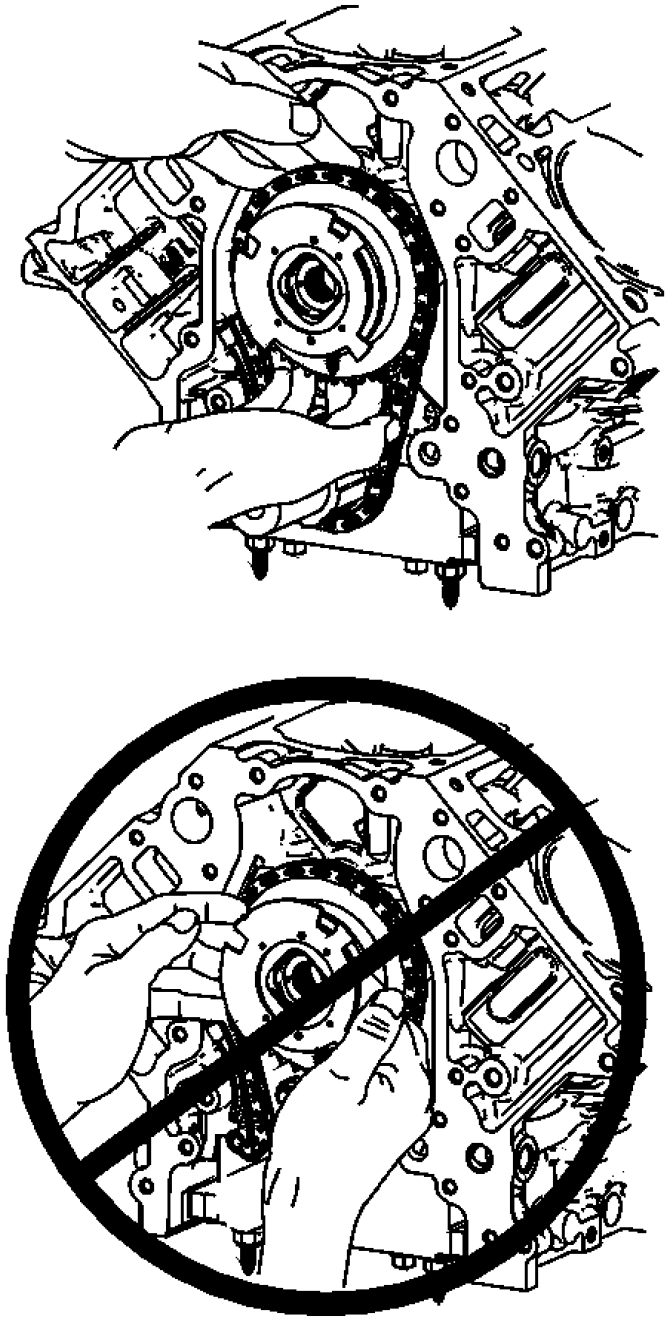


Fig. 16: View Of Proper CMP Actuator Removal
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Camshaft Position Actuator Removal and Installation Warning .

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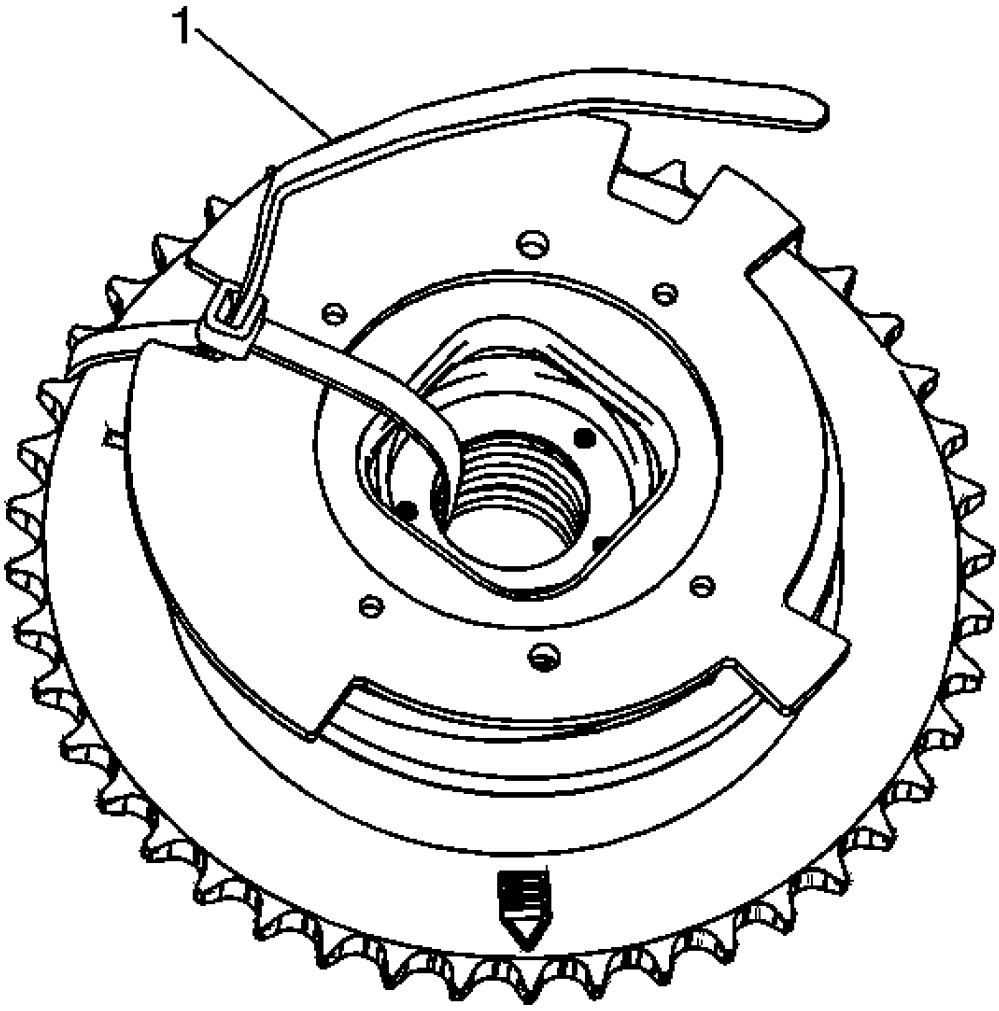


Fig. 17: Retaining Reluctor Wheel To Sprocket
Courtesy of GENERAL MOTORS CORP.

Install tie wrap (1) to retain the reluctor wheel to the sprocket. The reluctor wheel is mounted to the actuator body with 3 roll pins.

NEW PRODUCT INFORMATION (6.2L LS3)

The purpose of New Product Information is to highlight, or indicate, important product changes from the previous model year.

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Changes may include 1 or more of the following items:

- Torque values and/or fastener tightening strategies
- Changed engine specifications
- New sealants and/or adhesives
- Disassembly and assembly procedure revisions
- Engine mechanical diagnostic procedure revisions
- New special tools required
- A component comparison from the previous year

Torque Values and/or Fastener Tightening Strategies

- All fasteners and threaded holes on the LS3 engine utilize metric threads.
- Certain fasteners should not be used again. Bolts, studs, or other fasteners that must be replaced, will be called out in the specific service procedure.
- Refer to **Fastener Tightening Specifications (6.2L LS3)** or **Fastener Tightening Specifications (6.2L L99)** .

New Sealants and/or Adhesives

Sealers and adhesives, as required, are identified within the specific service procedures. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

Disassembly and Assembly Procedure Revisions

Disassembly and assembly repair procedures are provided for the LS3 application.

Engine Mechanical Diagnostic Procedure Revisions

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 condition. The diagnostic flow is the place to start when repairs are necessary. For a detailed explanation, refer to **Diagnostic System Check - Vehicle** .

New Special Tools Required

Special tools, as required for the LS3 application, are identified within the repair procedures. Refer to **Special Tools** .

NEW PRODUCT INFORMATION (6.2L L99)

The purpose of New Product Information is to highlight, or indicate, important product changes from the previous model year.

Changes may include 1 or more of the following items:

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- Torque values and/or fastener tightening strategies
- Changed engine specifications
- New sealants and/or adhesives
- Disassembly and assembly procedure revisions
- Engine mechanical diagnostic procedure revisions
- New special tools required
- A component comparison from the previous year

Torque Values and/or Fastener Tightening Strategies

- All fasteners and threaded holes on the L99 engine utilize metric threads.
- Certain fasteners should not be used again. Bolts, studs, or other fasteners that must be replaced, will be called out in the specific service procedure.
- Refer to **Fastener Tightening Specifications (6.2L LS3)** or **Fastener Tightening Specifications (6.2L L99)** .

New Sealants and/or Adhesives

Sealers and adhesives, as required, are identified within the specific service procedures. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

Disassembly and Assembly Procedure Revisions

Disassembly and assembly repair procedures are provided for the L99 application.

Engine Mechanical Diagnostic Procedure Revisions

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 condition. The diagnostic flow is the place to start when repairs are necessary. For a detailed explanation, refer to **Diagnostic System Check - Vehicle** .

New Special Tools Required

Special tools, as required for the L99 application, are identified within the repair procedures. Refer to **Special Tools** .

LUBRICATION DESCRIPTION (6.2L LS3)

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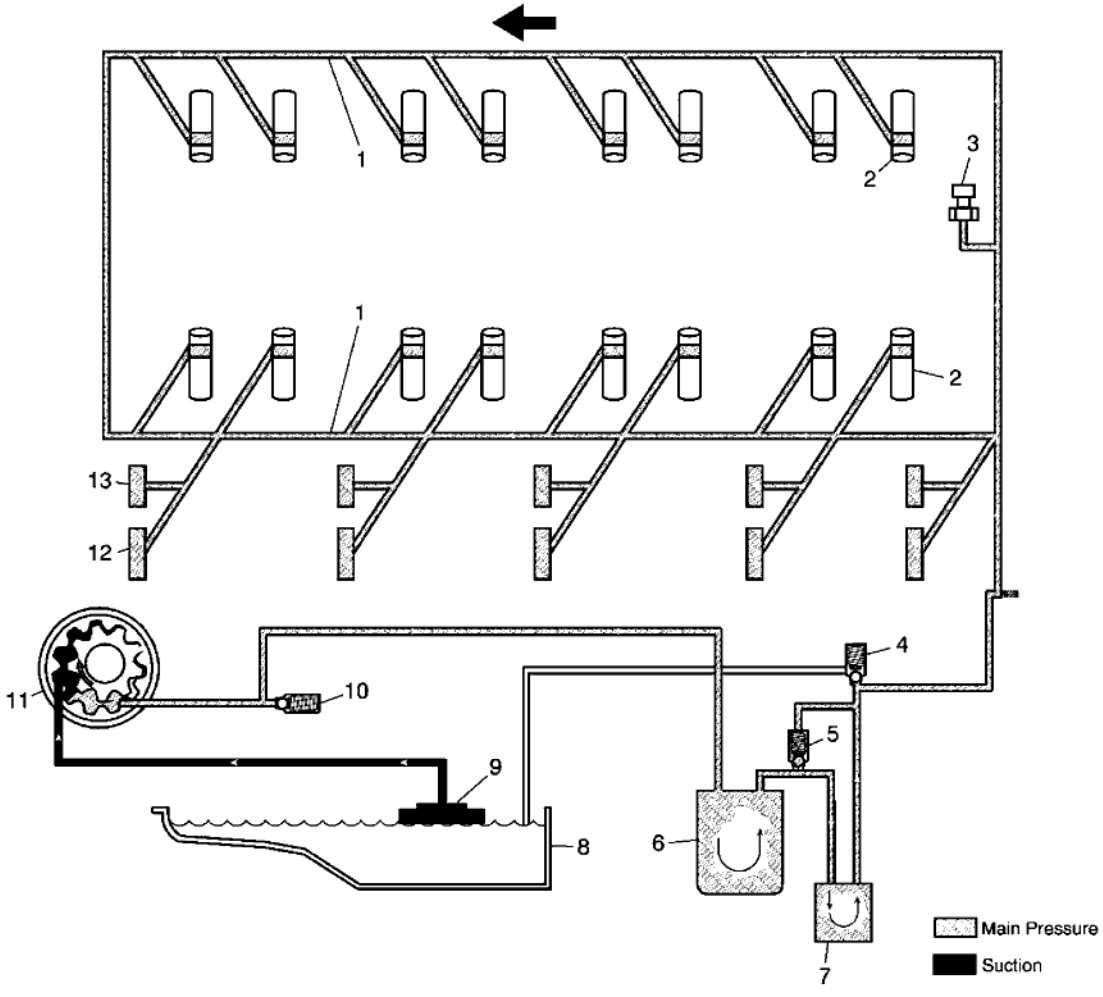


Fig. 18: Engine Lubrication Flow
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Upper Main Oil Galleries
2	Valve Lifters
3	Oil Pressure Sensor
4	Oil Pressure Relief Valve
5	Bypass Valve - Oil Cooler
6	Oil Filter
7	Engine Oil Cooler
8	Oil Pan Sump
9	Oil Pump Screen
10	Pressure Relief Valve - Oil Pump
11	Oil Pump
12	Crankshaft Bearings

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13	Camshaft Bearings

Engine lubrication is supplied by a gerotor type oil pump assembly (11). The pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump (8) through a pick-up screen and pipe (9). The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly is a pressure relief valve (10) that maintains oil pressure within a specified range.

Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter (6) where harmful contaminants are removed. Oil exits the oil filter and is then directed to the external oil cooler (7). A bypass valve (5) is incorporated into the oil cooler assembly in the event oil flow within the cooler is restricted. A second valve, the active fuel management oil pressure relief valve (4) is incorporated into the oil pan. The active fuel management oil pressure relief valve limits oil pressure to 379-517 kPa (55-75 psi) maximum.

Oil returns from the oil cooler and is directed to the upper main oil galleries (1). Oil from the left upper oil gallery is directed to the crankshaft bearings (12) and camshaft bearings (13). Oil that has entered both the upper main oil galleries also pressurizes the valve lifter assemblies (2) and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor (3) is located at the top rear of the engine.

LUBRICATION DESCRIPTION (6.2L L99)

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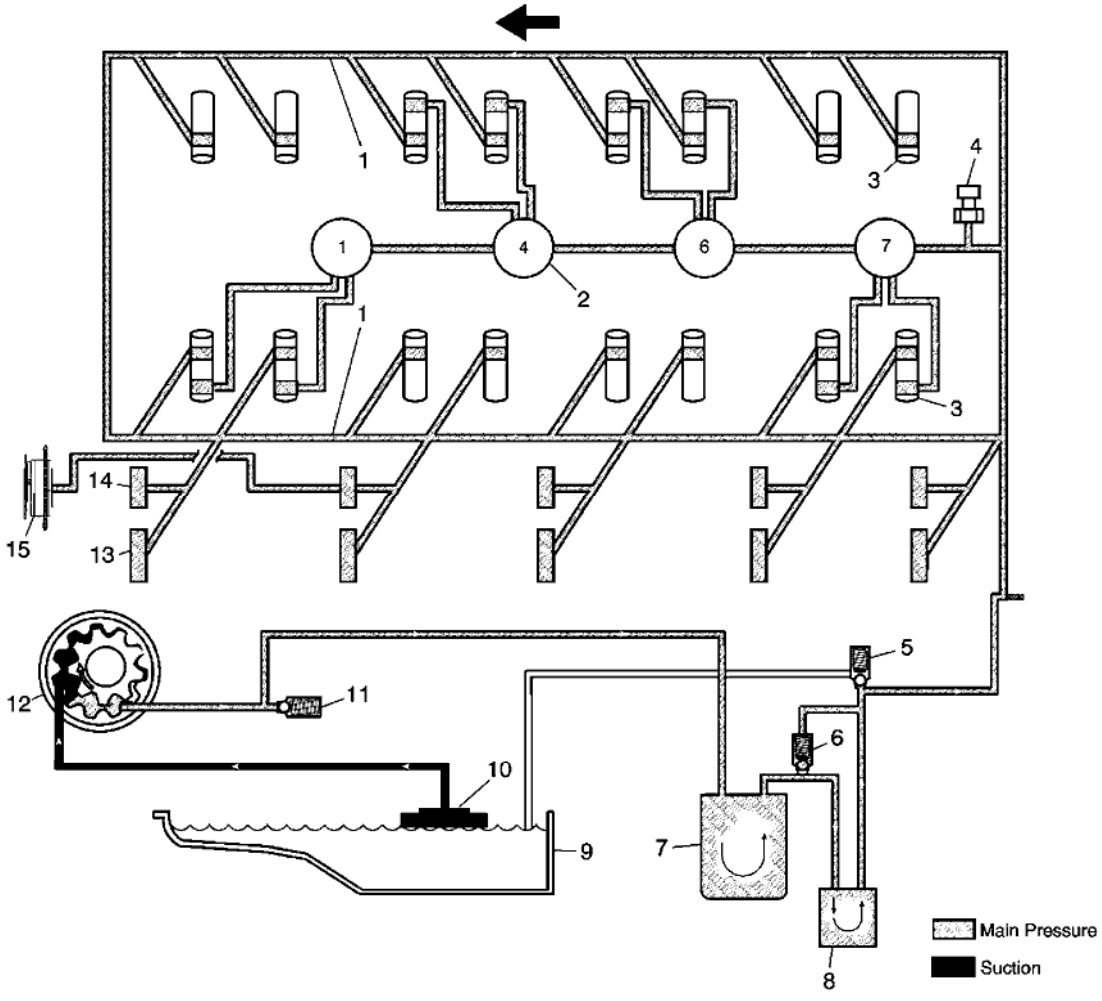


Fig. 19: Engine Lubrication Flow
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Upper Main Oil Galleries
2	Valve Lifter Oil Manifold
3	Valve Lifters
4	Oil Pressure Sensor
5	Bypass Valve - Oil Cooler
6	Oil Filter
7	Engine Oil Cooler
8	Oil Pan Sump
9	Oil Pump Screen
10	Pressure Relief Valve - Oil Pump
11	Oil Pump
12	Crankshaft Bearings

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13	Camshaft Bearings
14	Camshaft
15	Camshaft Position Actuator

Engine lubrication is supplied by a gerotor type oil pump assembly (12). The pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump (9) through a pick-up screen and pipe (10). The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly is a pressure relief valve (11) that maintains oil pressure within a specified range. Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter (7) where harmful contaminants are removed. Oil exits the oil filter and is then directed to the external oil cooler (8). A bypass valve (6) is incorporated into the oil cooler assembly in the event oil flow within the cooler is restricted. A second valve, the active fuel management oil pressure relief valve (5) is incorporated into the oil pan. The active fuel management oil pressure relief valve limits oil pressure directed to the upper oil galleries and valve lifter oil manifold assembly to 379-517 kPa (55-75 psi) maximum.

Oil exits the cooler (8) and is then directed to the upper main oil galleries and the valve lifter oil manifold assembly (2). Oil from the left upper oil gallery is directed to the crankshaft (13) and camshaft (14) bearings. Oil that has entered both the upper main oil galleries also pressurizes the valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems.

An oil passage at camshaft bearing location 2 permits oil flow into the center of the camshaft. Oil enters the camshaft exiting at the front and into the camshaft position (CMP) actuator solenoid valve. The CMP actuator solenoid valve spool position is controlled by the engine control module (ECM) and CMP magnet. When commanded by the ECM, the CMP magnet repositions the CMP actuator solenoid valve spool directing pressurized oil into the CMP actuator (15) to control valve timing. Refer to **Camshaft Actuator System Description** and **Camshaft Position Actuator and Solenoid Valve Description**.

With active fuel management activated, the ECM commands the 4 solenoids to open, directing oil through the engine block oil galleries to the intake and exhaust valve lifters for cylinders 1, 4, 6, and 7. Refer to **Cylinder Deactivation (Active Fuel Management) System Description**.

Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor (4) is located at the top rear of the engine.

LUBRICATION DESCRIPTION - MAIN PRESSURE BELOW 55 PSI WITH CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) OFF

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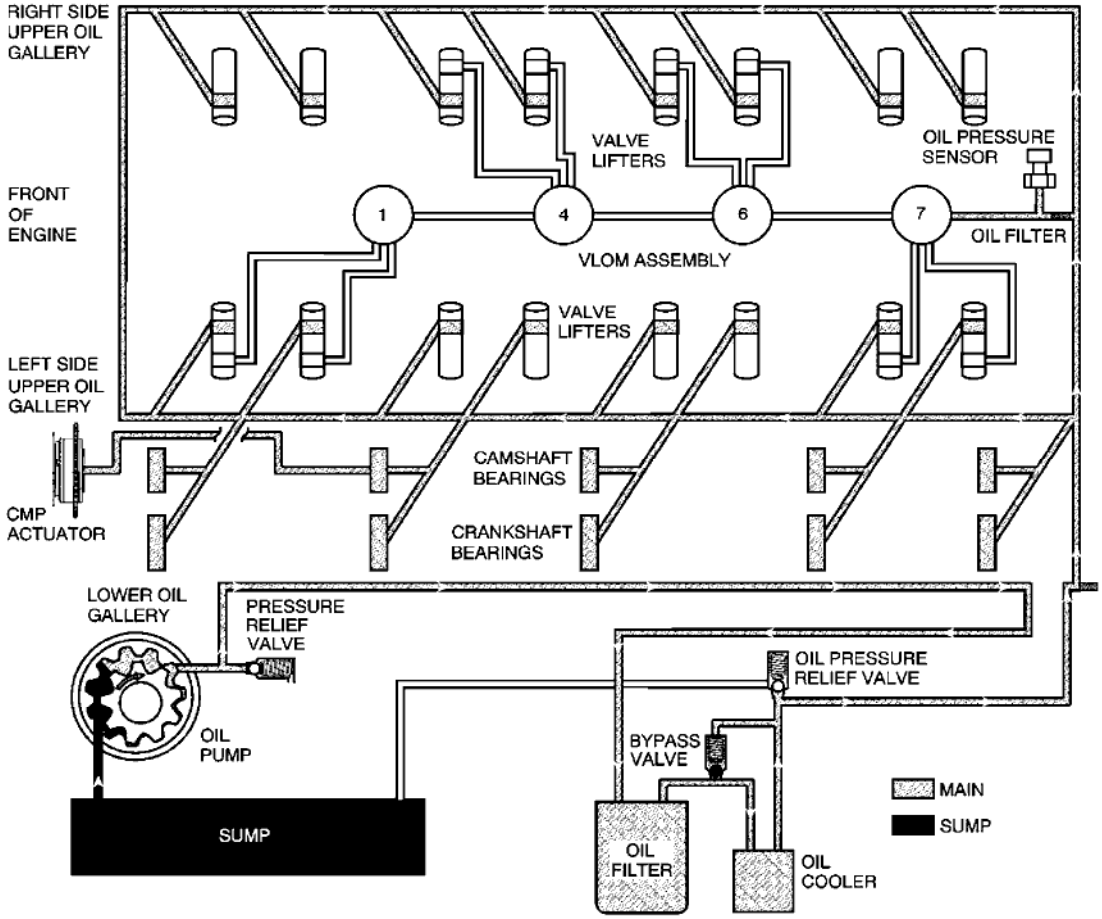


Fig. 20: Oil Flow
Courtesy of GENERAL MOTORS CORP.

Engine lubrication is supplied by a gerotor type oil pump assembly. The oil pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range.

Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter where harmful contaminants are removed. A bypass valve is incorporated into the oil filter, which permits oil flow in the event the filter becomes restricted. A second valve, the active fuel management oil pressure relief valve is incorporated into the oil pan. The active fuel management oil pressure relief valve limits oil pressure directed to the upper oil galleries and valve lifter oil manifold assembly to 379-517 kPa (55-75 psi) maximum. When main oil pressure exceeds 379 kPa (55 psi), the oil pressure relief valve exhausts excess oil to the sump.

Oil exits the oil filter and into and through the external oil cooler. A bypass valve is incorporated into the oil cooler in the event oil flow within the cooler is restricted. Oil exits the cooler and is directed to the upper main oil galleries and the valve lifter oil manifold assembly. Oil from the left upper oil gallery is directed to the crankshaft and camshaft bearings. Oil that has entered both the upper main oil galleries also pressurizes the

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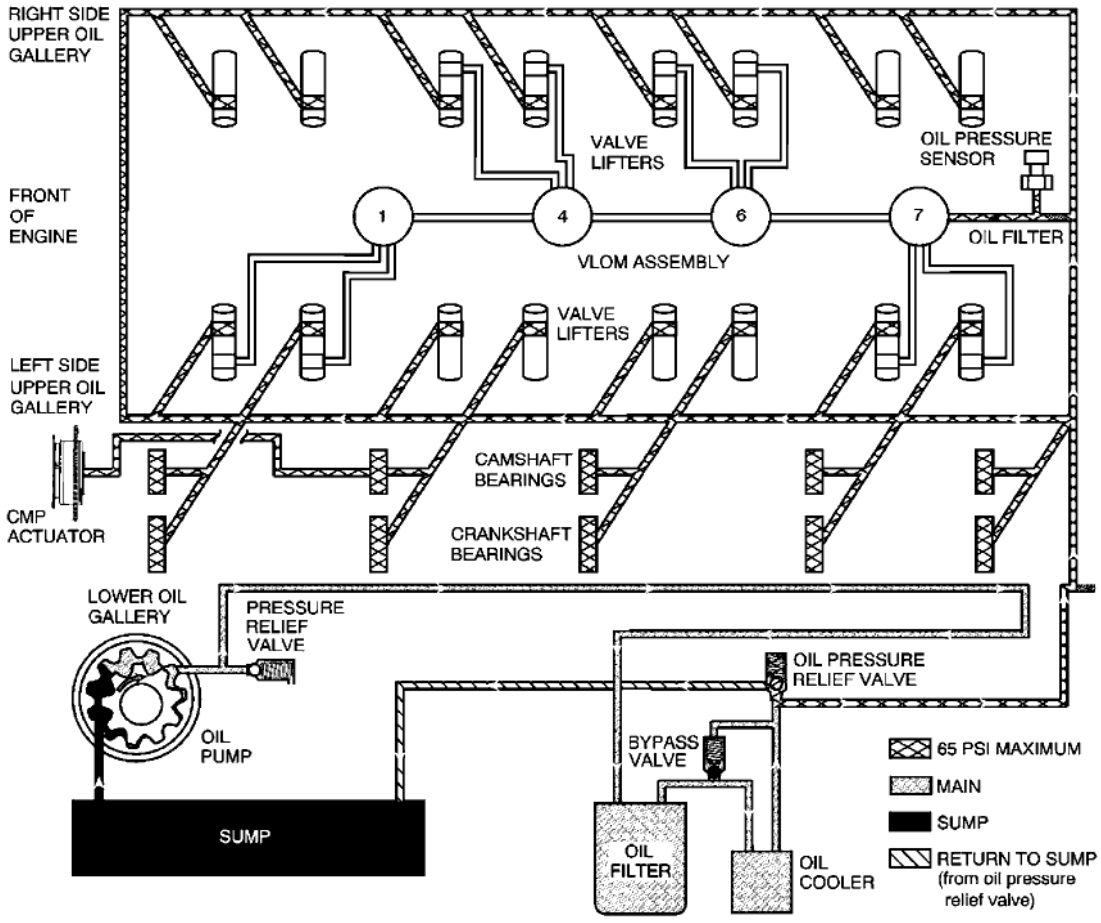
valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems.

An oil passage at camshaft bearing location 2 permits oil flow into the center of the camshaft. Oil enters the camshaft exiting at the front and into the camshaft position (CMP) actuator solenoid valve. The CMP valve spool position is controlled by the engine control module (ECM) and CMP magnet. When commanded by the ECM, the CMP magnet repositions the CMP actuator solenoid valve spool directing pressurized oil into the CMP actuator to control valve timing. Refer to **Camshaft Actuator System Description** and **Camshaft Position Actuator and Solenoid Valve Description**.

Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor is located at the top rear of the engine.

With active fuel management deactivated, the ECM commands the 4 valve lifter oil manifold solenoids to closed position to restrict oil flow to the intake and exhaust valve lifters for cylinders 1, 4, 6, and 7. Refer to **Cylinder Deactivation (Active Fuel Management) System Description**.

LUBRICATION DESCRIPTION - MAIN PRESSURE ABOVE 55 PSI WITH CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) OFF



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Fig. 21: Oil Flow
Courtesy of GENERAL MOTORS CORP.

Engine lubrication is supplied by a gerotor type oil pump assembly. The oil pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range.

Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter where harmful contaminants are removed. A bypass valve is incorporated into the oil filter, which permits oil flow in the event the filter becomes restricted. A second valve, the active fuel management oil pressure relief valve is incorporated into the oil pan. The active fuel management oil pressure relief valve limits oil pressure directed to the upper oil galleries and valve lifter oil manifold assembly to 379-517 kPa (55-75 psi) maximum. When main oil pressure exceeds 379 kPa (55 psi), the oil pressure relief valve exhausts excess oil to the sump.

Oil exits the oil filter and into and through the external oil cooler. A bypass valve is incorporated into the oil cooler in the event oil flow within the cooler is restricted. Oil exits the cooler and is directed to the upper main oil galleries and the valve lifter oil manifold assembly. Oil from the left upper oil gallery is directed to the crankshaft and camshaft bearings. Oil that has entered both the upper main oil galleries also pressurizes the valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems.

An oil passage at camshaft bearing location 2 permits oil flow into the center of the camshaft. Oil enters the camshaft exiting at the front and into the camshaft position (CMP) actuator solenoid valve. The CMP valve spool position is controlled by the engine control module (ECM) and CMP magnet. When commanded by the ECM, the CMP magnet repositions the CMP actuator solenoid valve spool directing pressurized oil into the CMP actuator to control valve timing. Refer to **Camshaft Actuator System Description** and **Camshaft Position Actuator and Solenoid Valve Description**.

Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor is located at the top rear of the engine.

With active fuel management deactivated, the ECM commands the 4 valve lifter oil manifold solenoids to closed position to restrict oil flow to the intake and exhaust valve lifters for cylinders 1, 4, 6, and 7. Refer to **Cylinder Deactivation (Active Fuel Management) System Description**.

LUBRICATION DESCRIPTION - MAIN PRESSURE BELOW 55 PSI WITH CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) ON

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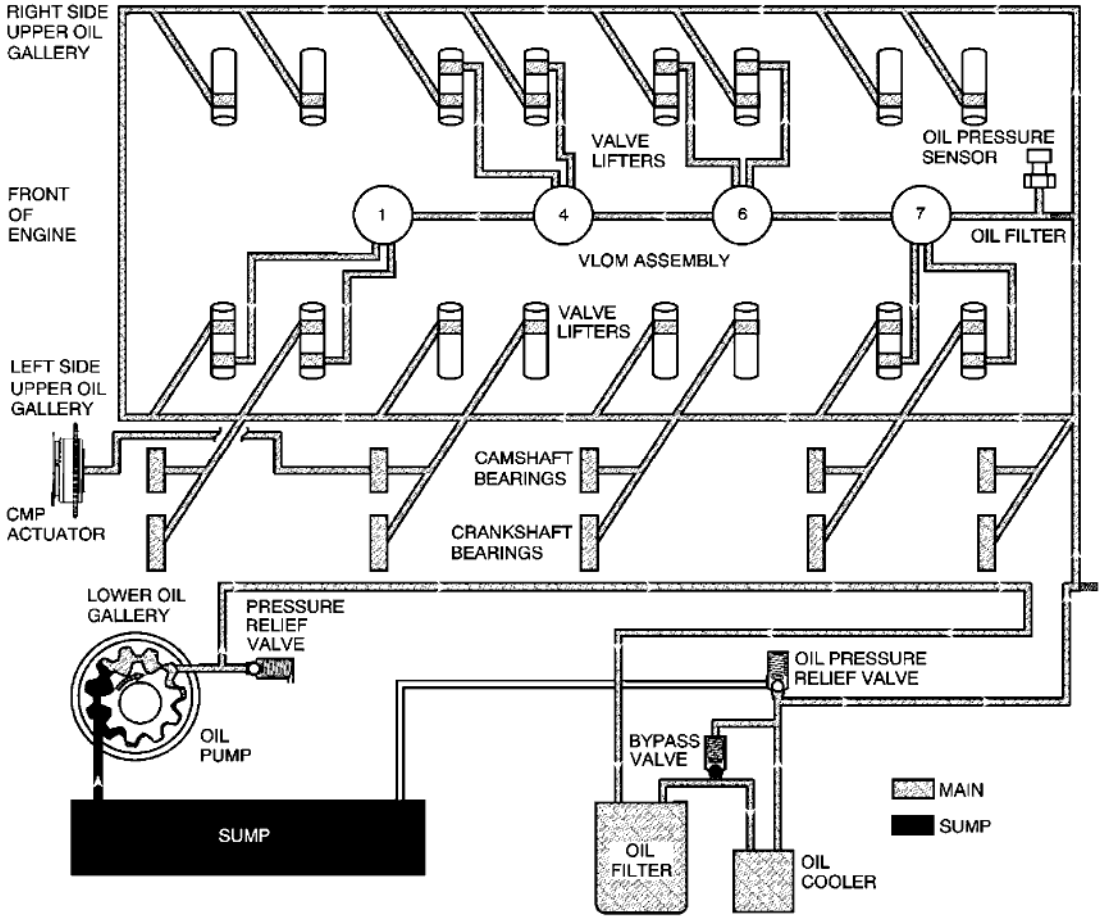


Fig. 22: Oil Flow
Courtesy of GENERAL MOTORS CORP.

Engine lubrication is supplied by a gerotor type oil pump assembly. The oil pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range.

Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter where harmful contaminants are removed. A bypass valve is incorporated into the oil filter, which permits oil flow in the event the filter becomes restricted. A second valve, the active fuel management oil pressure relief valve is incorporated into the oil pan. The active fuel management oil pressure relief valve limits oil pressure directed to the upper oil galleries and valve lifter oil manifold assembly to 379-517 kPa (55-75 psi) maximum. When main oil pressure exceeds 379 kPa (55 psi), the oil pressure relief valve exhausts excess oil to the sump.

Oil exits the oil filter and into and through the external oil cooler. A bypass valve is incorporated into the oil cooler in the event oil flow within the cooler is restricted. Oil exits the cooler and is directed to the upper main oil galleries and the valve lifter oil manifold assembly. Oil from the left upper oil gallery is directed to the crankshaft and camshaft bearings. Oil that has entered both the upper main oil galleries also pressurizes the

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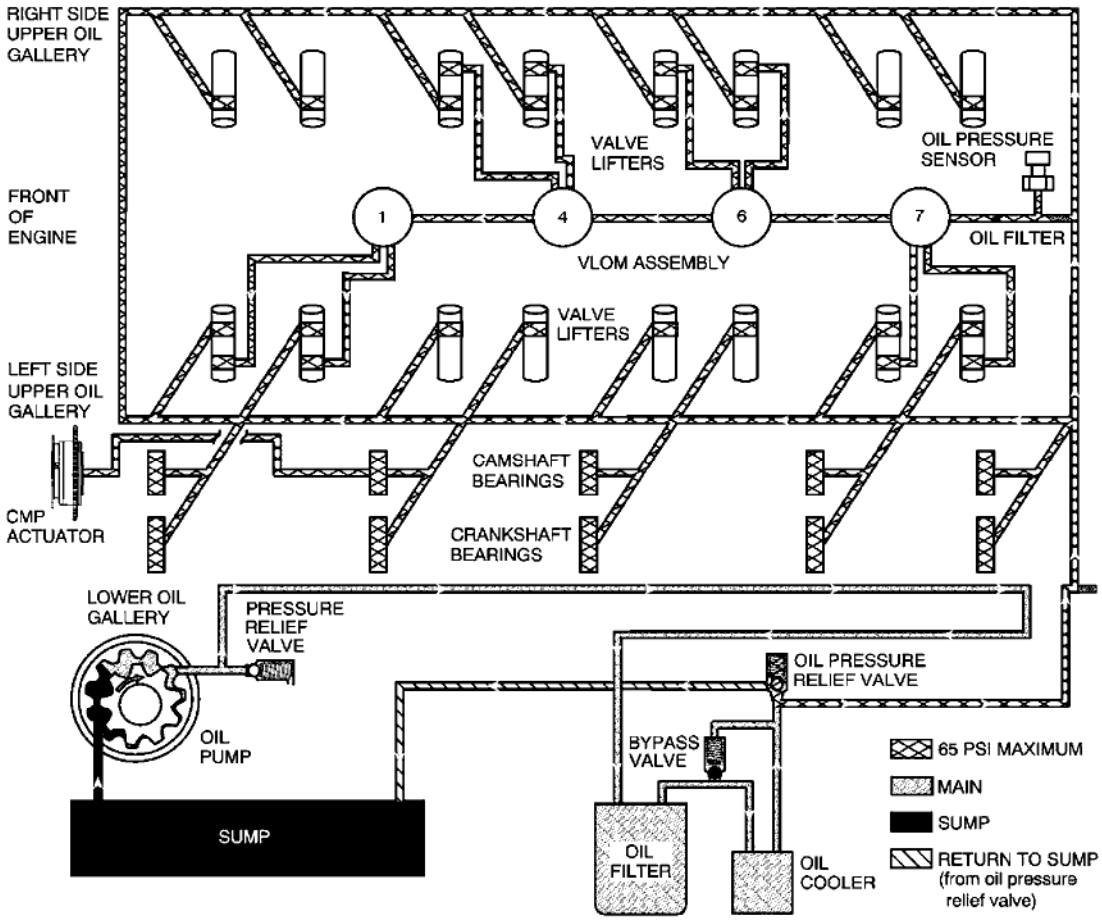
valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems.

An oil passage at camshaft bearing location 2 permits oil flow into the center of the camshaft. Oil enters the camshaft exiting at the front and into the camshaft position (CMP) actuator solenoid valve. The CMP valve spool position is controlled by the engine control module (ECM) and CMP magnet. When commanded by the ECM, the CMP magnet repositions the CMP actuator solenoid valve spool directing pressurized oil into the CMP actuator to control valve timing. Refer to **Camshaft Actuator System Description** and **Camshaft Position Actuator and Solenoid Valve Description**.

Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor is located at the top rear of the engine.

With active fuel management activated, the ECM commands the 4 valve lifter oil manifold solenoids to open directing oil through the engine block oil galleries to the intake and exhaust valve lifters for cylinders 1, 4, 6, and 7. Refer to **Cylinder Deactivation (Active Fuel Management) System Description**.

LUBRICATION DESCRIPTION - MAIN PRESSURE ABOVE 55 PSI WITH CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) ON



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Fig. 23: Oil Flow
Courtesy of GENERAL MOTORS CORP.

Engine lubrication is supplied by a gerotor type oil pump assembly. The oil pump is mounted on the front of the engine block and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump through a pick-up screen and pipe. The oil is pressurized as it passes through the pump and is sent through the engine block lower oil gallery. Contained within the oil pump assembly is a pressure relief valve that maintains oil pressure within a specified range.

Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter where harmful contaminants are removed. A bypass valve is incorporated into the oil filter, which permits oil flow in the event the filter becomes restricted. A second valve, the active fuel management oil pressure relief valve is incorporated into the oil pan. The active fuel management oil pressure relief valve limits oil pressure directed to the upper oil galleries and valve lifter oil assembly to 379-517 kPa (55-75 psi) maximum. When main oil pressure exceeds 379 kPa (55 psi), the oil pressure relief valve exhausts excess oil to the sump.

Oil exits the oil filter and into and through the external oil cooler. A bypass valve is incorporated into the oil cooler in the event oil flow within the cooler is restricted. Oil exits the cooler and is directed to the upper main oil galleries and the valve lifter oil manifold assembly. Oil from the left upper oil gallery is directed to the crankshaft and camshaft bearings. Oil that has entered both the upper main oil galleries also pressurizes the valve lifter assemblies and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems.

An oil passage at camshaft bearing location 2 permits oil flow into the center of the camshaft. Oil enters the camshaft exiting at the front and into the camshaft position (CMP) actuator solenoid valve. The CMP valve spool position is controlled by the engine control module (ECM) and CMP magnet. When commanded by the ECM, the CMP magnet repositions the CMP actuator solenoid valve spool directing pressurized oil into the CMP actuator to control valve timing. Refer to **Camshaft Actuator System Description** and **Camshaft Position Actuator and Solenoid Valve Description**.

Oil returning to the pan is directed by the crankshaft oil deflector. The oil pressure sensor is located at the top rear of the engine.

With active fuel management activated, the ECM commands the 4 valve lifter oil manifold solenoids to open, directing oil through the engine block oil galleries to the intake and exhaust valve lifters for cylinders 1, 4, 6, and 7. Refer to **Cylinder Deactivation (Active Fuel Management) System Description**.

CLEANLINESS AND CARE

- Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice even if not specifically stated.
- When any internal engine parts are serviced, care and cleanliness is important.
- When components are removed for service, they should be marked, organized or retained in a specific order for assembly. Refer to **Separating Parts**.
- At the time of installation, components should be installed in the same location and with the same mating surface as when removed.

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- An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in millimeters or thousandths of an inch. These surfaces should be covered or protected to avoid component damage.
- A liberal coating of clean engine oil should be applied to friction areas during assembly.
- Proper lubrication will protect and lubricate friction surfaces during initial operation.

SEPARATING PARTS

IMPORTANT:

- **Many internal engine components will develop specific wear patterns on their friction surfaces.**
- **When disassembling the engine, internal components MUST be separated, marked, or organized in a way to ensure installation to their original location and position.**

Separate, mark, or organize the following components:

- Piston and the piston pin
- Piston to the specific cylinder bore
- Piston rings to the piston
- Connecting rod location and orientation to the crankshaft journal
- Connecting rod to the bearing cap

  A paint stick or etching/engraving type tool are recommended. Stamping the connecting rod or cap near the bearing bore may affect component geometry.

- Crankshaft main and connecting rod bearings
- Camshaft and valve lifters
- Valve lifters, lifter guides, pushrods and rocker arm assemblies
- Valve to the valve guide
- Valve spring to the cylinder head location
- Engine block main bearing cap location and direction
- Oil pump drive and driven gears

REPLACING ENGINE GASKETS

Special Tools

J 28410: Gasket Remover

For equivalent regional tools, refer to **Special Tools**

Gasket Use and Applying Sealants

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- Do not use any gasket again unless specified.
- Gaskets that can be used again will be identified in the service procedure.
- Do not apply sealant to any gasket or sealing surface unless called out in the service information.

Separating Components

- Use a rubber mallet to separate components.
- Bump the part sideways to loosen the components.
- Bumping should be done at bends or reinforced areas to prevent distortion of parts.

Cleaning Gasket Surfaces

- Remove all gasket and sealing material from the part using the **J 28410:** remover or equivalent.
- Care must be used to avoid gouging or scraping the sealing surfaces.
- Do not use any other method or technique to remove sealant or gasket material from a part.
- Do not use abrasive pads, sand paper, or power tools to clean the gasket surfaces.
    - These methods of cleaning can cause damage to the component sealing surfaces.
    - Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil.
    - This grit is abrasive and has been known to cause internal engine damage.

Assembling Components

CAUTION: Refer to Sealant Caution .

- When assembling components, use only the sealant specified or equivalent in the service procedure.
- Sealing surfaces should be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
- Components requiring lubrication will be identified in the service procedure.
- When applying sealant to a component, apply the amount specified in the service procedure.
- Tighten bolts to specifications. Do not overtighten.

USE OF ROOM TEMPERATURE VULCANIZING (RTV) AND ANAEROBIC SEALANT

Pipe Joint Compound

NOTE: Three types of sealer are commonly used in engines. These are room temperature vulcanizing (RTV) sealer, anaerobic gasket eliminator sealer, and pipe joint compound. The correct sealer and amount must be used in the proper location to prevent oil leaks. DO NOT interchange the 3 types of sealers. Use only the specific sealer or the equivalent as recommended in the service procedure.

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- Pipe joint compound is a pliable sealer that does not completely harden. This type of sealer is used where 2 non-rigid parts, such as the oil pan and the engine block, are assembled together.
- Do not use pipe joint compound in areas where extreme temperatures are expected. These areas include: exhaust manifold, head gasket, or other surfaces where gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container.

To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets**.

CAUTION: Refer to Sealant Caution .

- Apply the pipe joint compound to a clean surface. Use a bead size or quantity as specified in the procedure. Run the bead to the inside of any bolt holes.
- Apply a continuous bead of pipe joint compound to one sealing surface. Sealing surfaces to be resealed must be clean and dry.
- Tighten the bolts to specifications. Do not overtighten.

RTV Sealer

- RTV sealant hardens when exposed to air. This type of sealer is used where 2 non-rigid parts, such as the intake manifold and the engine block, are assembled together.
- Do not use RTV sealant in areas where extreme temperatures are expected. These areas include: exhaust manifold, head gasket, or other surfaces where a gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container.

To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets**.

CAUTION: Refer to Sealant Caution .

- Apply RTV sealant to a clean surface. Use a bead size as specified in the procedure. Run the bead to the inside of any bolt holes.
- Assemble components while the RTV sealant is still wet, within 3 minutes. Do not wait for the RTV sealant to skin over.
- Tighten bolts to specifications. Do not overtighten.

Anaerobic Sealer

- Anaerobic gasket eliminator hardens in the absence of air. This type of sealer is used where 2 rigid parts, such as castings, are assembled together. When 2 rigid parts are disassembled and no sealer or gasket is readily noticeable, the parts were probably assembled using a gasket eliminator.
- Follow all safety recommendations and directions that are on the container.

To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets**.

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- Apply a continuous bead of gasket eliminator to one flange. Surfaces to be sealed must be clean and dry.

CAUTION: Refer to Sealant Caution .

- Spread the sealer evenly with your finger to get a uniform coating on the sealing surface.

NOTE: Anaerobic sealed joints that are partially torqued and allowed to cure more than 5 minutes may result in incorrect shimming and sealing of the joint.

- Tighten bolts to specifications. Do not overtighten.
- After properly tightening the fasteners, remove the excess sealer from the outside of the joint.

TOOLS AND EQUIPMENT

Special tools are listed and illustrated throughout this section, with a complete listing at the end of the section. These tools, or their equivalents, are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the proper tightening of various fasteners.

To properly service the engine assembly, the following items should be readily available:

- Approved eye protection and safety gloves
- A clean, well lit, work area
- A suitable parts cleaning tank
- A compressed air supply
- Trays or storage containers to keep parts and fasteners organized
- An adequate set of hand tools
- Approved engine repair stand
- An approved engine lifting device that will adequately support the weight of the components

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2010 ENGINE

Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Camaro

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - ENGINE MECHANICAL

Strategy Based Diagnostics

1. Perform the **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 (6.2L LS3)** or **Disassembled Views (6.2L L99)** , **Engine Component Description (6.2L LS3)** or **Engine Component Description (6.2L L99)** , **Lubrication Description (6.2L LS3)** or **Lubrication Description (6.2L L99)** , **Drive Belt System Description** , **Camshaft Position Actuator and Solenoid Valve Description** and **Cylinder Deactivation (Active Fuel Management) System Description** .

All diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system condition. 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.
- Inspect for the correct oil level, proper oil viscosity, and correct oil filter.
- 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**

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- **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**
- **Coolant in Combustion Chamber**
- **Coolant in Engine Oil**
- **Cylinder Deactivation (Active Fuel Management) System Diagnosis**
- **Engine Compression Test**
- **Cylinder Deactivation (Active Fuel Management) System Compression Test**
- **Cylinder Leakage Test**
- **Oil Consumption Diagnosis**
- **Oil Pressure Diagnosis and Testing**
- **Cylinder Deactivation (Active Fuel Management) Oil Pressure Relief Valve Diagnosis and Testing**
- **Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing**
- **Camshaft Position Actuator and Solenoid Valve Diagnosis and Testing**
- **Engine Oil Level Sensor Diagnosis**
- **Oil Leak Diagnosis**
- **Crankcase Ventilation System Inspection/Diagnosis**
- **Drive Belt Chirping, Squeal, and Whine Diagnosis**
- **Drive Belt Rumbling and Vibration Diagnosis**
- **Drive Belt Falls Off and Excessive Wear Diagnosis**
- **Drive Belt Tensioner Diagnosis**

BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

Cause	Correction
Fuel injector harness connectors are connected to the incorrect fuel injectors/cylinders	Relocate the fuel injector harness connectors, as necessary.
Abnormalities, such as severe cracking, bumps, or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations and lead to a misfire diagnostic trouble code (DTC). A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to **Drive Belt Replacement - Accessory** .
Worn, damaged, or mis-aligned accessory drive	Inspect the components and repair or replace, as

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components or excessive pulley runout May lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	required.
Loose or improperly installed engine flex plate or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flex plate and/or balancer, as required. Refer to **Automatic Transmission Flex Plate Replacement** , or **Crankshaft Balancer Replacement (L99 and LS3)** .
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.
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.
Worn or bent pushrods	• Replace the pushrods. • Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
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 lifters.
Excessive oil pressure A lubrication system with excessive oil pressure may lead to excessive valve lifter pump-up and loss of compression.	1. Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. 2. 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.	1. Inspect for spark plugs saturated by coolant. Refer to **Spark Plug Inspection** . 2. Inspect the cylinder heads, engine block, and/or head gaskets. Refer to **Coolant in Combustion Chamber**. 3. Repair or replace, as required.
Worn piston rings	1. Inspect the spark plugs for oil deposits. Refer

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Oil consumption may or may not cause the engine to misfire.	to **Spark Plug Inspection** . 2. Inspect the cylinders for a loss of compression. Refer to **Engine Compression Test**. 3. Perform cylinder leak down and compression testing to identify the cause. Refer to **Cylinder Leakage Test**. 4. 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 sync the crankshaft position. • Systems with electronic communication, DIS or coil per cylinder, and slight reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a P0300 DTC may be set. • Systems with mechanical communications, high voltage switch, and severe reluctor ring damage may cause additional pulses and effect fuel and spark delivery to the point of generating a P0300 DTC or P0336.	Replace the sensor and/or crankshaft, as required.
Improper operation of the active fuel management system	Repair, as required. Refer to **Cylinder Deactivation (Active Fuel Management) System Diagnosis**.
Improper operation of the camshaft position (CMP) actuator and/or control system	Repair, as required. Refer to **Camshaft Position Actuator and Solenoid Valve Diagnosis and Testing**.

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

Cause	Correction
Abnormalities, such as severe cracking, bumps or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.	Replace the drive belt.
Worn, damaged, or mis-aligned accessory drive	Inspect the components and repair or replace, as

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components or excessive pulley runout A misfire code may be present without an actual misfire condition.	required.
Loose or improperly installed engine flex plate or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flex plate and/or balancer, as required. Refer to **Automatic Transmission Flex Plate Removal** and **Automatic Transmission Flex Plate Installation** , or**Crankshaft Balancer Removal** and **Crankshaft Balancer Installation** .
Worn piston rings Oil consumption may or may not cause the engine to misfire.	1. Inspect the spark plugs for oil deposits. Refer to **Spark Plug Inspection** . 2. Inspect the cylinders for a loss of compression. Refer to **Engine Compression Test**. 3. Perform cylinder leak down and compression testing to determine the cause. Refer to **Cylinder Leakage Test**. 4. Repair or replace, as required.
Worn crankshaft thrust bearings Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit fore and aft movement of the crankshaft and create a DTC without an actual misfire condition.	Replace the crankshaft and bearings, as required.

BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

Cause	Correction
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact within the rocker arm assembly.	Replace the valve rocker arms, as required.
Worn or bent pushrods	• Replace the pushrods. • Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
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 lifters.
Sticking lifters	Replace, as required.
Cut or damaged oil pump screen O-ring seal which may cause aeration of the engine oil	Repair, as required. Refer to **Oil Pressure Diagnosis and Testing**.
Improper operation of the active fuel management	Repair, as required. Refer to **Cylinder Deactivation (Active Fuel Management) Oil Pressure Relief**

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oil pressure relief valve	**Valve Diagnosis and Testing**.
Improper operation of the active fuel management system	Repair, as required. Refer to **Cylinder Deactivation (Active Fuel Management) System Diagnosis**.
Improper operation of the camshaft position (CMP) actuator and/or control system	Repair, as required. Refer to **Camshaft Position Actuator and Solenoid Valve Diagnosis and Testing**.

BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

Cause	Correction
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages Coolant consumption may or may not cause the engine to overheat.	1. Inspect for spark plugs saturated by coolant. Refer to **Spark Plug Inspection** . 2. Perform a cylinder leak down test. Refer to **Cylinder Leakage Test**. 3. Inspect the cylinder heads and engine block for damage to the coolant passages and/or a faulty head gasket. Refer to **Coolant in Combustion Chamber**. 4. Repair or replace, as required.

BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION

Cause	Correction
Worn valves, valve guides and/or valve stem oil seals	1. Inspect the spark plugs for oil deposits. Refer to **Spark Plug Inspection** . 2. Repair or replace, as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	1. Inspect the spark plugs for oil deposits. Refer to **Spark Plug Inspection** . 2. Inspect the cylinders for a loss of compression. Refer to **Engine Compression Test**. 3. Perform cylinder leak down and compression testing to determine the cause. Refer to **Cylinder Leakage Test**. 4. Repair or replace, as required.

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

Cause	Correction
Incorrect oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	1. Drain the oil. 2. Install the correct viscosity oil.

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High valve lifter leak down rate	Replace the lifters, as required.
Worn crankshaft thrust bearing	1. Inspect the crankshaft end play. 2. Inspect the thrust bearing and crankshaft. 3. Repair or replace, as required.
Damaged or faulty oil filter bypass valve The bypass valve is now internal to the oil filter.	1. Inspect the oil filter bypass valve for proper operation. 2. Repair or replace, as required.

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Low oil pressure	1. Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. 2. Repair or replace, as required.
Loose and/or worn valve rocker arm attachments	1. Inspect the valve rocker arm, bolt, and pedestal. 2. Repair or replace, as required.
Worn or damaged valve rocker arm	1. Inspect the rocker arm for wear or missing needle bearings 2. Replace the valve rocker arms, as required.
Bent or damaged push rod	Inspect the following components and replace, as required: • The valve rocker arm • The valve push rod • The valve lifter • The valve lifter guide • The piston Inspect the top of the pistons for valve contact. If the top of the piston shows valve contact, replace the piston and pin assembly.
Improper lubrication to the valve rocker arms	Inspect the following components and repair or replace, as required: • The valve rocker arm • The valve push rod • The valve lifter • The oil filter bypass valve • The oil pump and pump screen

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	• Improper operation of the active fuel management oil pressure relief valve • The engine block oil galleries
Broken valve spring	Replace the valve spring and spring shim.
Worn or dirty valve lifters	Replace the valve lifters, as required.
Active fuel management valve lifter with a broken spring	Replace the valve lifters, as required.
Improper operation of the active fuel management oil pressure relief valve	Repair, as required. Refer to **Cylinder Deactivation (Active Fuel Management) Oil Pressure Relief Valve Diagnosis and Testing**.
Improper operation of the camshaft position (CMP) actuator and/or control system	Repair, as required. Refer to **Camshaft Position Actuator and Solenoid Valve Diagnosis and Testing**.
Stretched or broken timing chain and/or damaged sprocket teeth	Replace the timing chain and sprockets.
Worn engine camshaft lobes	1. Inspect the engine camshaft lobes. 2. 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
Cut or damaged oil pump screen O-ring seal which may cause aeration of the engine oil	Repair, as required. Refer to **Oil Pressure Diagnosis and Testing**.

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Low oil pressure	1. Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. 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.

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	2. Repair or replace, as required.
Detonation or spark knock	Verify the correct operation of the ignition controls system. Refer to **Symptoms - Engine Controls** .
Loose torque converter bolts	1. Inspect the torque converter bolts and flex plate. 2. Repair or replace, as required.
Loose or damaged flywheel or flex plate	Repair or replace the flywheel or flex plate.
Oil pump screen loose, damaged, or restricted	1. Inspect the oil pump screen. 2. Repair or replace, as required.
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, pin, and connecting rod. 2. Replace the piston and pin as an assembly, 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. Refer to **Piston, Connecting Rod, and Bearing Installation** . 2. Repair, as required.

ENGINE NOISE UNDER LOAD

Cause	Correction
Low oil pressure	1. Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. 2. Repair or replace, as required.
Detonation or spark knock	Verify the correct operation of the ignition controls. Refer to **Symptoms - Engine Controls** .

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Loose torque converter bolts	1. Inspect the torque converter bolts and flex plate. 2. Repair, as required.
Cracked flex plate - automatic transmission	1. Inspect the flex plate bolts and flex plate. 2. Repair, as required.
Excessive connecting rod bearing clearance	Inspect the following components and repair, as required: • The connecting rod bearings • The connecting rods • The crankshaft
Excessive crankshaft bearing clearance	Inspect the following components and repair, as required: • The crankshaft bearings • The crankshaft journals • The cylinder block crankshaft bearing bore

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Cause	Correction
Seized accessory drive system component	1. Remove the accessory drive belts. 2. Confirm that the engine will rotate. Rotate the crankshaft by hand at the crankshaft balancer or flex plate location. 3. Repair or replace the components, as required.
Seized automatic transmission torque converter	1. Remove the torque converter-to-flex plate bolts. 2. Confirm that the engine will rotate. Rotate the crankshaft by hand at the crankshaft balancer or flex plate location. 3. Repair or replace the components, as required.
Broken timing chain	1. Inspect the timing chain and sprockets. 2. Repair or replace the components, as required.
Seized timing chain or timing sprockets	1. Inspect the timing chain and sprockets for foreign material or a seized chain. 2. Repair or replace the components, as required.

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Seized or broken camshaft	1. Inspect the camshaft and the camshaft bearings. 2. Repair or replace the components, as required.
Bent valve in the cylinder head	1. Inspect the valves and the cylinder heads. 2. Repair or replace the components, as required.
Seized oil pump	1. Inspect the oil pump assembly. 2. Repair or replace, as required.
Hydraulically locked cylinder • Coolant/antifreeze in the cylinder • Oil in the cylinder • Fuel in the cylinder	1. Remove the spark plugs and inspect for fluid in the cylinder. When rotating the engine with the spark plugs removed, the piston, on compression stroke, will push fluid from the combustion chamber. Refer to **Coolant in Combustion Chamber**. 2. Inspect for failed/broken head gaskets. 3. Inspect for a cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector. 5. Repair or replace the components, as required.
Material in the cylinder • Broken valve • Broken piston rings • Piston material • Foreign material	1. Inspect the cylinder for damaged components and/or foreign materials. 2. Repair or replace the components, as required.
Seized crankshaft or connecting rod bearings	1. Inspect crankshaft and connecting rod bearings. 2. Repair or replace the components, as required.
Bent or broken connecting rod	1. Inspect the connecting rods. 2. Replace the piston and pin as an assembly, as required.
Broken crankshaft	1. Inspect the crankshaft. 2. Repair or replace the components, as required.

COOLANT IN COMBUSTION CHAMBER

Cause	Correction

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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 **Engine Will Not Crank - Crankshaft Will Not Rotate**. 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. 4. 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 **Engine Compression Test**.	
Faulty cylinder head gasket	Replace the head gasket and components, as required. Refer to **Cylinder Head Cleaning and Inspection** and **Cylinder Head Removal - Left Side** and **Cylinder Head Installation - Left Side** , or **Cylinder Head Removal - Right Side** and **Cylinder Head Installation - Right Side** .
Warped cylinder head	Machine the cylinder head to the proper flatness, if applicable and replace the cylinder head gasket. Refer to **Cylinder Head Cleaning and Inspection** .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components, as required.
Cylinder head or engine 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 **Lower Engine Noise, Regardless of Engine Speed**. 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 **Engine Compression Test**.	
Faulty external engine oil cooler	Replace the components, as required.
Faulty cylinder head gasket	Replace the head gasket and components, as required. Refer to **Cylinder Head Cleaning and**

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	Inspection and **Cylinder Head Removal - Left Side** and **Cylinder Head Installation - Left Side** , or **Cylinder Head Removal - Right Side** and **Cylinder Head Installation - Right Side** .
Warped cylinder head	Machine the cylinder head to proper flatness, if applicable, and replace the cylinder head gasket. Refer to **Cylinder Head Cleaning and Inspection** .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components, as required.
Cylinder head, block, or manifold porosity	Replace the components, as required.

CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) SYSTEM DIAGNOSIS

NOTE: Cylinder Deactivation (Active Fuel Management) System Diagnosis is applicable for RPO L99.

1. Measure the engine oil level. Fill, as required.
2. Using the scan tool, inspect for diagnostic codes within the engine control module (ECM). Refer to **Diagnostic System Check - Vehicle** . Repair, as required.
3. Verify proper engine oil pressure and operation of the active fuel management oil pressure relief valve. Refer to **Oil Pressure Diagnosis and Testing**.
4. Verify proper operation of the active fuel management system components. Refer to **Cylinder Deactivation (Active Fuel Management) System Compression Test**.
5. Remove the valve lifter oil manifold. Refer to **Valve Lifter Oil Manifold Replacement** .
6. Verify proper operation of the valve lifter oil manifold. Refer to **Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing**.
7. Replace the active fuel management valve lifters, as required. Both intake and exhaust lifters should be replaced in pairs. Refer to **Valve Lifter Replacement (Without AFM)** or **Valve Lifter Replacement (With AFM)** .

ENGINE COMPRESSION TEST

1. Charge the battery if the battery is not fully charged.
2. Disable the ignition system.
3. Disable the fuel injection system.
4. Remove all spark plugs.
5. Turn the ignition to the ON position.
6. Depress the accelerator pedal to position the throttle plate wide open.
7. Start with the compression gauge at zero and crank the engine through 4 compression strokes, 4 puffs.
8. Measure the compression for each cylinder. Record the readings.
9. If a cylinder has low compression, inject approximately 15 ml (1 tablespoon) of engine oil into the combustion chamber through the spark plug hole. Measure the compression again and record the reading.

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10. The minimum compression in any 1 cylinder should not be less than 70 percent of the highest cylinder. No cylinder should read less than 690 kPa (100 psi). For example, if the highest pressure in any 1 cylinder is 1 035 kPa (150 psi), the lowest allowable pressure for any other cylinder would be 725 kPa (105 psi). (1 035 x 70% = 725) (150 x 70% = 105).
    - Normal - Compression builds up quickly and evenly to the specified compression for each cylinder.
    - Piston Rings Leaking - Compression is low on the first stroke. Compression builds up with the following strokes, but does not reach normal. Compression improves considerably when you add oil.
    - Valves Leaking - Compression is low on the first stroke. Compression usually does not build up on the following strokes. Compression does not improve much when you add oil.
    - If 2 adjacent cylinders have lower than normal compression, and injecting oil into the cylinders does not increase the compression, the cause may be a head gasket leaking between the cylinders.

CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) SYSTEM COMPRESSION TEST

NOTE: Cylinder Deactivation (Active Fuel Management) System Compression Test is applicable for RPO L99.

The Cylinder Deactivation (Active Fuel Management) System Compression Test is a functional test of the valve lifter oil manifold and valve lifters. Using a compression gauge, the technician can monitor the specific cylinders ability to go into and out of active fuel management as commanded by the scan tool. The actual pressure values on the compression gauge are not as critical as is observing the on-off switching action of the solenoid and valve lifters.

1. Measure the engine oil level. Fill, as required.
2. Perform the Diagnostic System Check - Vehicle. Refer to **Diagnostic System Check - Vehicle** .
3. Disable the ignition system for the cylinder to be tested, by disconnecting the electrical wire harness to the ignition coil.
4. Disable the fuel injection system for the cylinder to be tested, by disconnecting the electrical wire harness to the fuel injector.
5. Remove the spark plug and wire for the cylinder to be tested.
6. Install a 0-1 378 kPa (0-200 psi) compression gauge.
7. Start the engine.
8. Using the scan tool output controls, command the solenoid ON, for the cylinder to be deactivated.
9. Depress the Schrader valve on the compression gauge, in order to release the pressure and zero the gauge. With the engine running and the cylinder in active fuel management mode, the compression reading should be less than 172 kPa (25 psi).
10. Using the scan tool, de-energize the solenoid while observing the reading on the compression gauge. With the engine running and the cylinder NOT in active fuel management mode, the compression gauge reading should increase quickly to greater than 345 kPa (50 psi).

NOTE: Only 1 cylinder can be tested at a time. When testing has been completed on a specific cylinder, the wire harness electrical connectors, spark plug,

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and spark plug wire must be installed prior to testing of each additional cylinder.

11. Test each of the 4 active fuel management cylinders, 1 at a time. If the readings are not within specifications, remove, and test the valve lifter oil manifold, as required. Refer to **Valve Lifter Oil Manifold Replacement** and **Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing**.
12. If the compression test has been performed and all active fuel management cylinders are operating within specifications, the active fuel management system is performing as designed and no repairs are required.
13. Clear the diagnostic trouble codes (DTCs) with a scan tool.

CYLINDER LEAKAGE TEST

Special Tools

J 35667-A Cylinder Head Leakdown Tester, or equivalent

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

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

WARNING: Refer to Battery Disconnect Warning .

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

NOTE: It may be necessary to hold the crankshaft balancer bolt to prevent the

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crankshaft from rotating.

5. Apply shop air pressure to the **J 35667-A** and adjust according to the manufacturers instructions.
6. Record the cylinder leakage value. Cylinder leakage that exceeds 25 percent is considered excessive and may require component service. In excessive leakage situations, inspect for the following conditions:
   - Air leakage noise at the throttle body or air inlet hose that may indicate a worn or burnt intake valve or a broken valve spring.
   - Air leakage noise at the exhaust system tailpipe that may indicate a worn or burnt exhaust valve or a broken valve spring.
   - Air leakage noise from the crankcase, oil level indicator tube, or oil fill tube that may indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged engine block or a damaged cylinder head.
   - Air bubbles in the cooling system may indicate a damaged cylinder head or a damaged cylinder head gasket.
7. Perform the leakage test on the remaining cylinders and record the values.

OIL CONSUMPTION DIAGNOSIS

Checks	Causes
Excessive oil consumption, not due to leaks, is the use of 1 L (1 qt) or more of engine oil within 3 200 kilometers (2,000 miles).	
Preliminary	The causes of excessive oil consumption may include the following conditions: • External oil leaks Refer to **Oil Leak Diagnosis**. • Incorrect oil level or improper reading of the oil level indicator With the vehicle on a level surface, run the engine for a few minutes. Allow adequate drain down time, 2-3 minutes, and inspect for the correct engine oil level. • Improper oil viscosity Refer to the vehicle owners manual and use the recommended SAE grade and viscosity for the prevailing temperatures. • Continuous high speed driving and/or severe usage • Crankcase ventilation system restrictions or malfunctioning components Refer to **Crankcase Ventilation System Inspection/Diagnosis**.

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	• Worn valve guides and/or valve stems • Worn or improperly installed valve stem oil seals Refer to **Spark Plug Inspection** . • Piston rings broken, worn, or not seated properly Allow adequate time for the rings to seat. Replace worn piston rings, as necessary. Refer to **Cylinder Leakage Test**. • Piston and rings improperly installed or not fitted to the cylinder bore Refer to **Lower Engine Noise, Regardless of Engine Speed**.

OIL PRESSURE DIAGNOSIS AND TESTING

Special Tools

- **EN-47971:** Oil Pressure Gauge Adapter
- **J 21867:** Pressure Gauge

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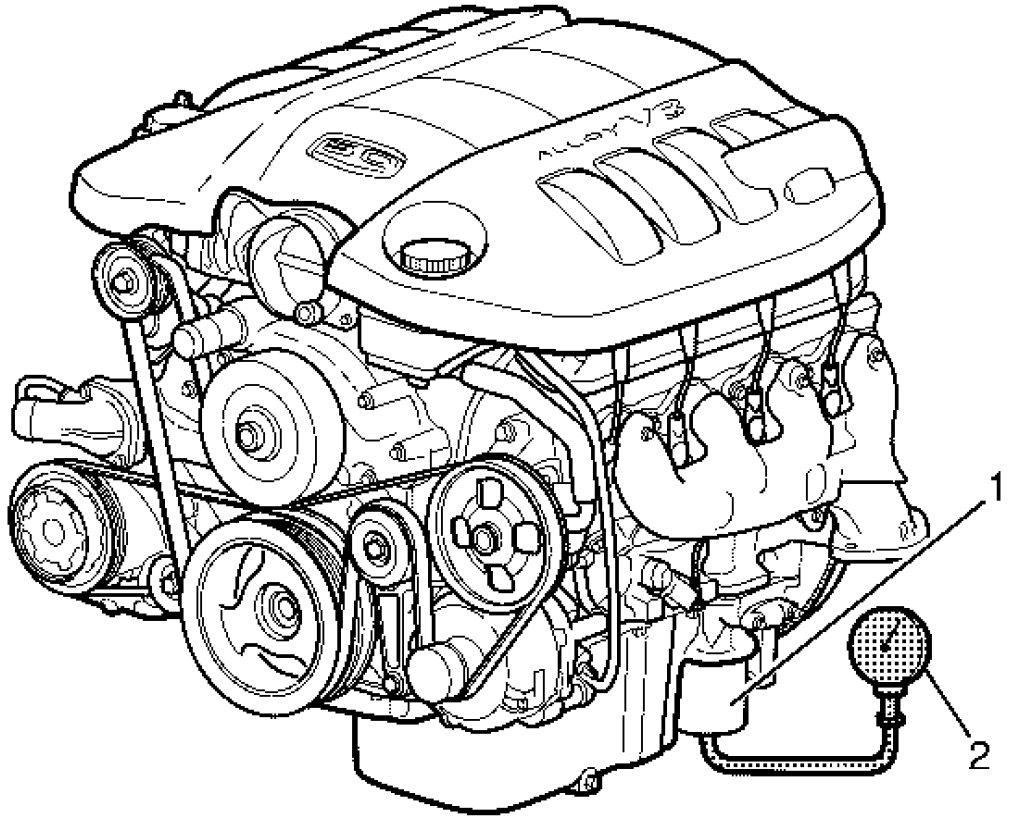


Fig. 1: Locating EN-47971 & J 21867
Courtesy of GENERAL MOTORS CORP.

1. With the vehicle on a level surface, run the vehicle for a few minutes. Allow adequate drain down time, 2-3 minutes, and measure the oil level.
2. If required, add the recommended grade engine oil and fill the crankcase until the oil level measures full on the oil level indicator.
3. Run the engine briefly, 10-15 seconds, and verify low or no oil pressure on the vehicle gauge or light.
4. Listen for a noisy valve train or a knocking noise.
5. Inspect for the following conditions:
   - Oil diluted by water or glycol antifreeze

     Refer to **Coolant in Engine Oil** .

   - Foamy oil, which may be caused by a cut or damaged oil pump screen O-ring seal
6. Remove the oil filter and install the **EN-47971** (1).

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7. Install the **J 21867** (2), or equivalent to the **EN-47971** (1).
8. Run the engine and measure the engine oil pressure.
9. Compare the readings to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .
10. If the engine oil pressure is below specifications, inspect the engine for 1 or more of the following conditions:
    - Oil pump worn or dirty

      Refer to **Oil Pump Cleaning and Inspection** .

    - Oil pump-to-engine block bolts loose

      Refer to **Oil Pump, Screen and Crankshaft Oil Deflector Installation** .

    - Oil pump screen loose, plugged, or damaged
    - Oil pump screen O-ring seal missing or damaged
    - Malfunctioning oil pump pressure relief valve
    - Excessive bearing clearance
    - Cracked, porous, or restricted oil galleries
    - Oil gallery plugs missing or incorrectly installed

      Refer to **Engine Block Plug Installation** .

    - Improper operation of the active fuel management oil pressure relief valve

      Refer to **Cylinder Deactivation (Active Fuel Management) Oil Pressure Relief Valve Diagnosis and Testing** .

    - Restriction within the engine oil cooler.

OIL PRESSURE RELIEF VALVE DIAGNOSIS AND TESTING

Special Tools

- **EN-47971** Oil Pressure Gauge Adapter
- **J 21867** Pressure Gauge
- **J-21867-16** Oil Pressure Adapter. See **Special Tools** .

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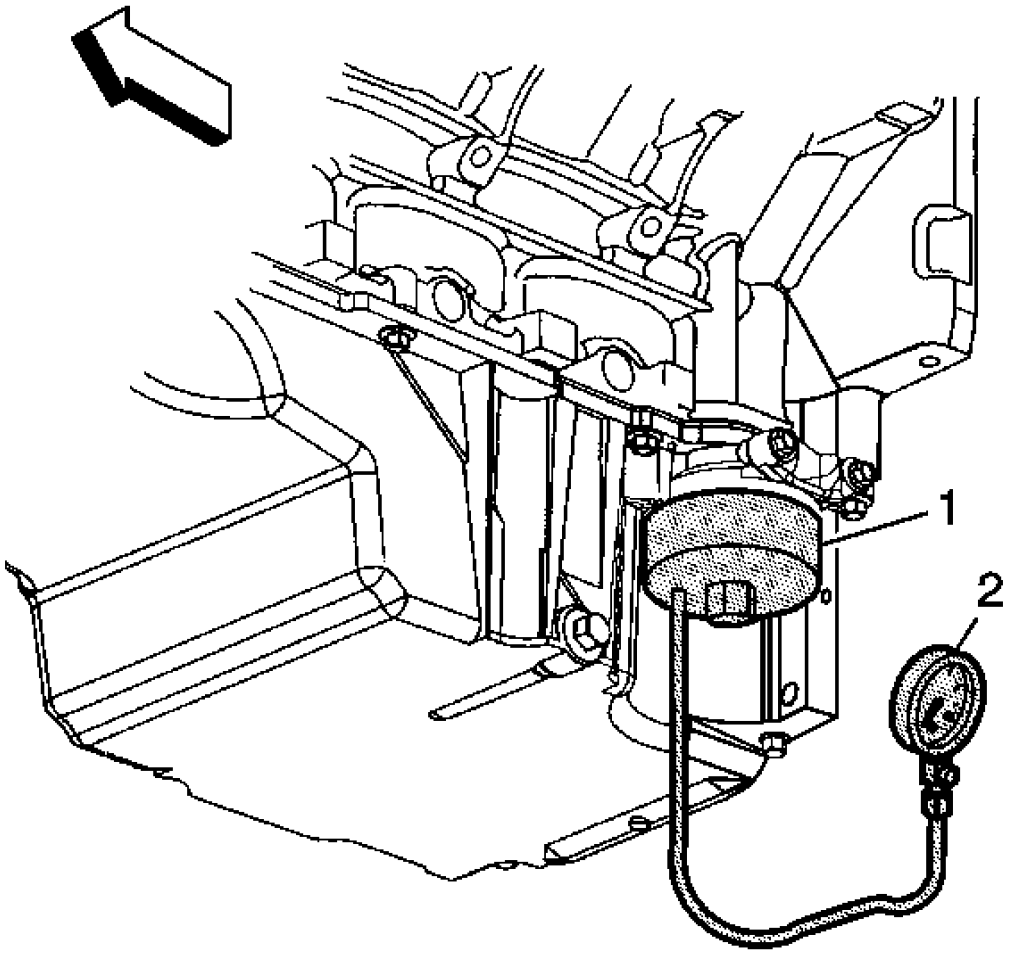


Fig. 2: Using Special Tools EN-47971 & J 21867 To Check Oil Pressure
Courtesy of GENERAL MOTORS CORP.

NOTE: **This test is performed to verify the operation of the active fuel management oil pressure relief valve located in the oil pan. Refer to Lubrication Description (6.2L LS3) or Lubrication Description (6.2L L99) .**

1. Remove the oil filter and install the **EN-47971** (1).
2. Install the **J 21867** (2), or equivalent, to the **EN-47971** (1).

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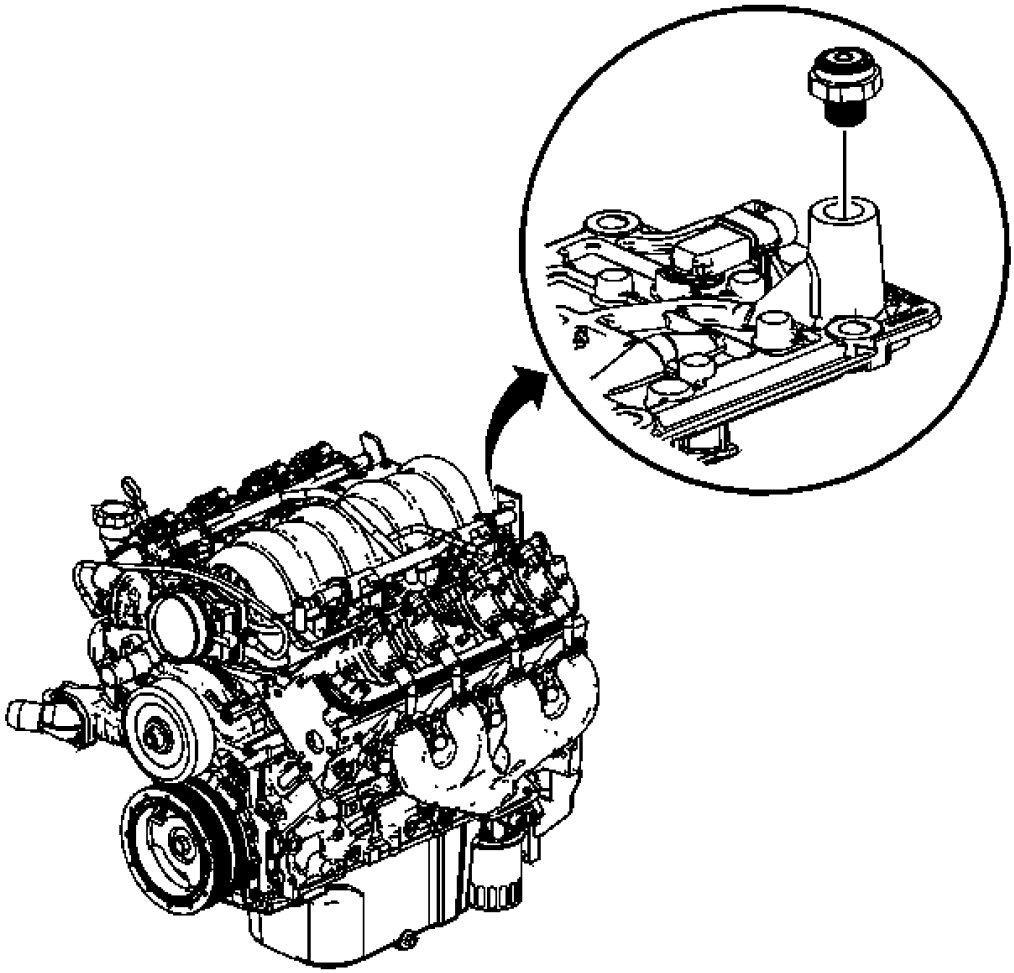


Fig. 3: Locating Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pressure sensor and install the **J-21867-16** . See **Special Tools** .

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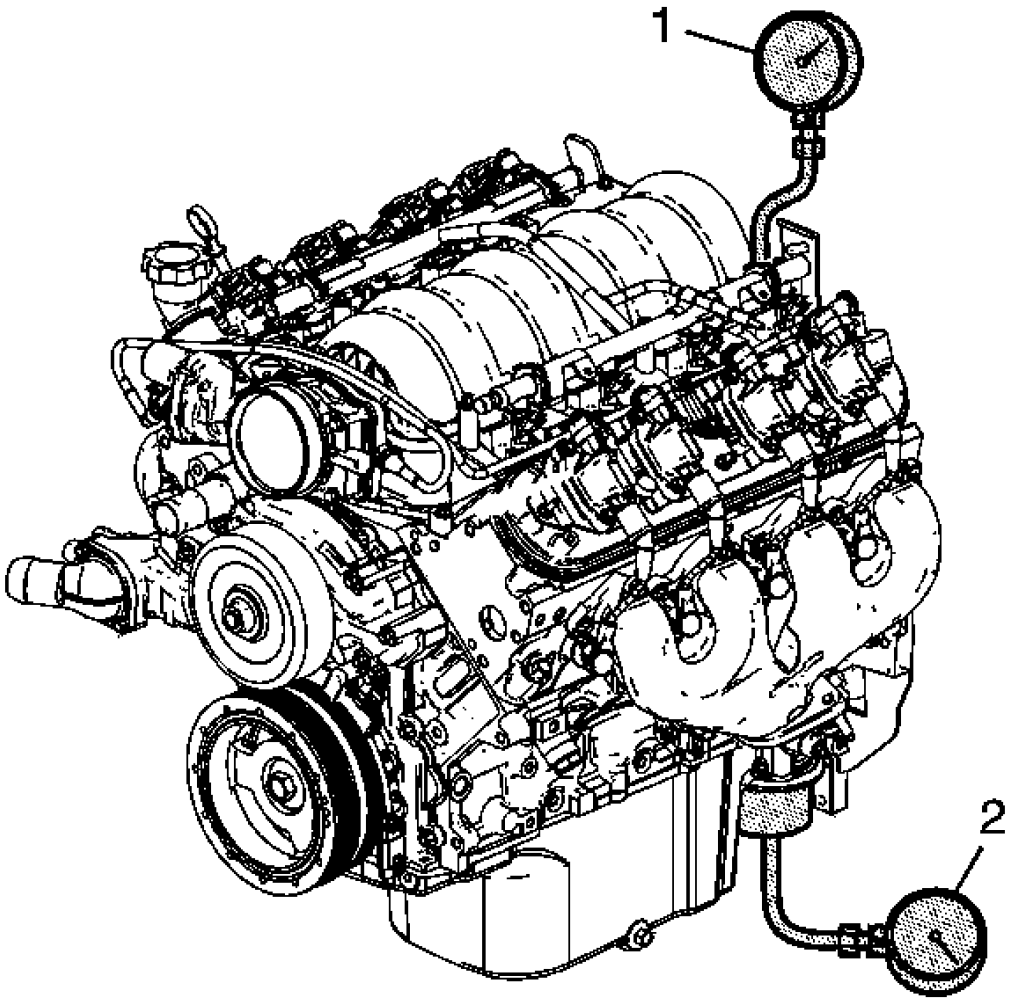


Fig. 4: Testing Oil Pressure
Courtesy of GENERAL MOTORS CORP.

4. Install the **J 21867** (1), or equivalent, to the **J-21867-16** (2). See **Special Tools** .
5. Run the engine and measure the engine oil pressure while observing both gauges.

   Operate the throttle, as required, to increase and decrease the engine oil pressure.

   - With the engine running and the lower pressure gauge (2) measuring below 379 kPa (55 psi), both gauges should display the same pressure reading. If the readings are not the same and the lower gauge (2) has a higher reading, the active fuel management oil pressure relief valve is stuck in the open position or the valve lifter oil manifold filter is plugged.

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- With the engine running and the lower pressure gauge (2) measuring above 379 kPa (55 psi), the upper gauge (1) should display no greater than 379-517 kPa (55-75 psi). If the reading on the upper gauge (1) is greater than 517 kPa (75 psi), the active fuel management oil pressure relief valve is stuck in the closed position.

6. Repair, as required.

CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) OIL PRESSURE RELIEF VALVE DIAGNOSIS AND TESTING

Special Tools

- **EN-47971** Oil Pressure Gauge Adapter
- **J 21867** Pressure Gauge
- **J-21867-16** Oil Pressure Adapter. See **Special Tools** .

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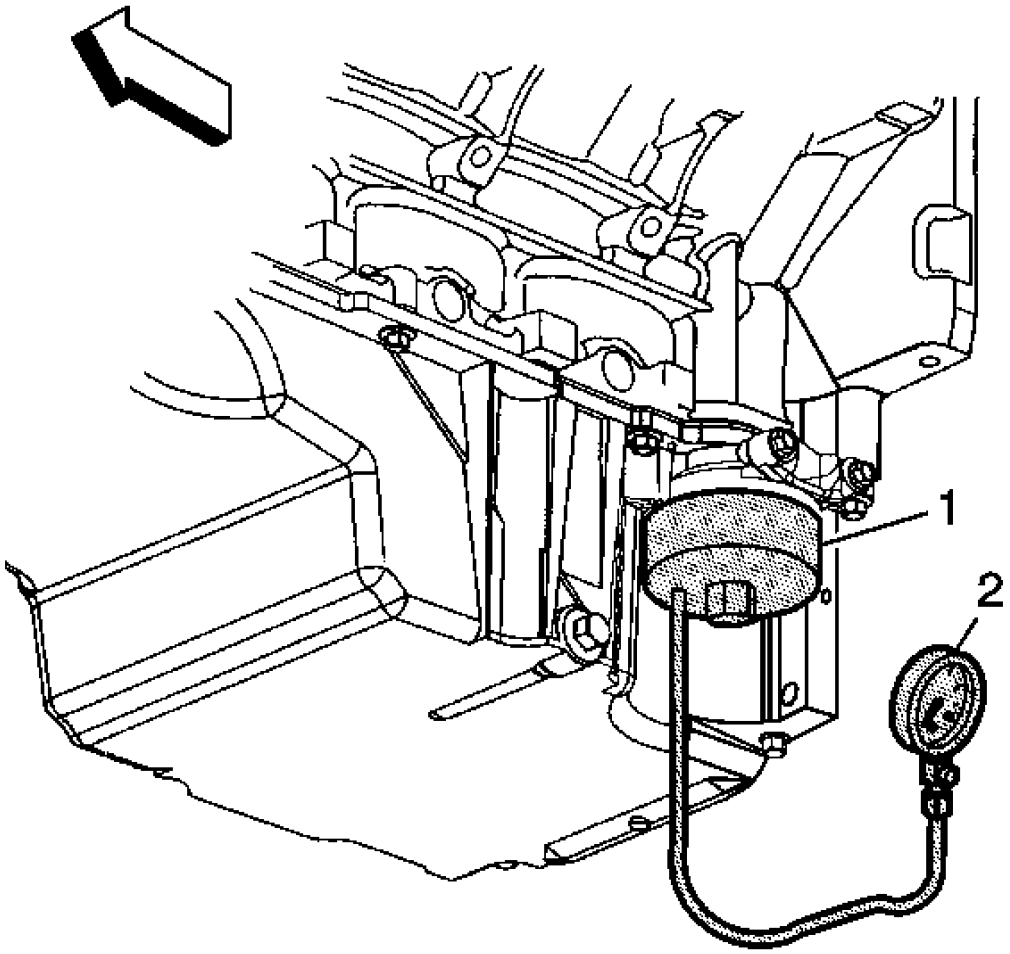


Fig. 5: Using Special Tools EN-47971 & J 21867 To Check Oil Pressure
Courtesy of GENERAL MOTORS CORP.

NOTE: **This test is performed to verify the operation of the active fuel management oil pressure relief valve located in the oil pan. Refer to Lubrication Description (6.2L LS3) or Lubrication Description (6.2L L99) .**

1. Remove the oil filter and install the **EN-47971** (1).
2. Install the **J 21867** (2), or equivalent, to the **EN-47971** (1).

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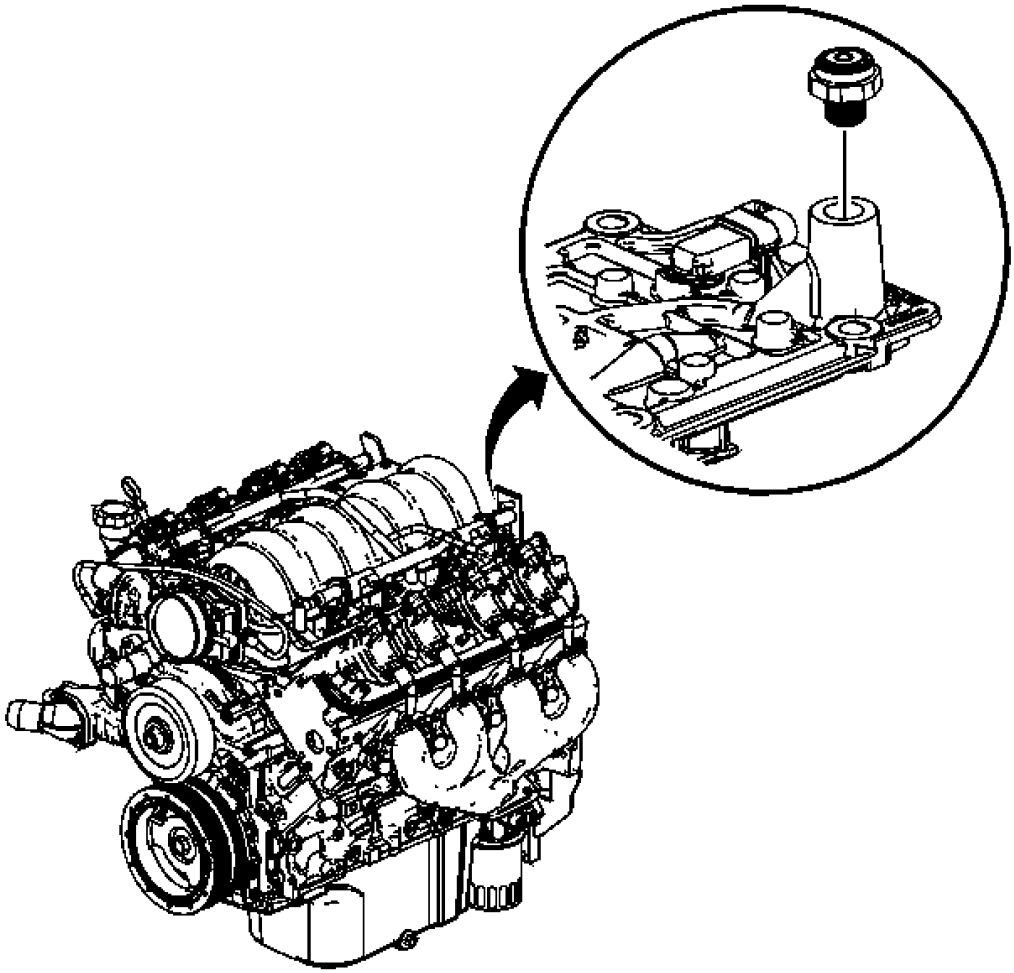


Fig. 6: Locating Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pressure sensor and install the **J-21867-16** . See **Special Tools** .

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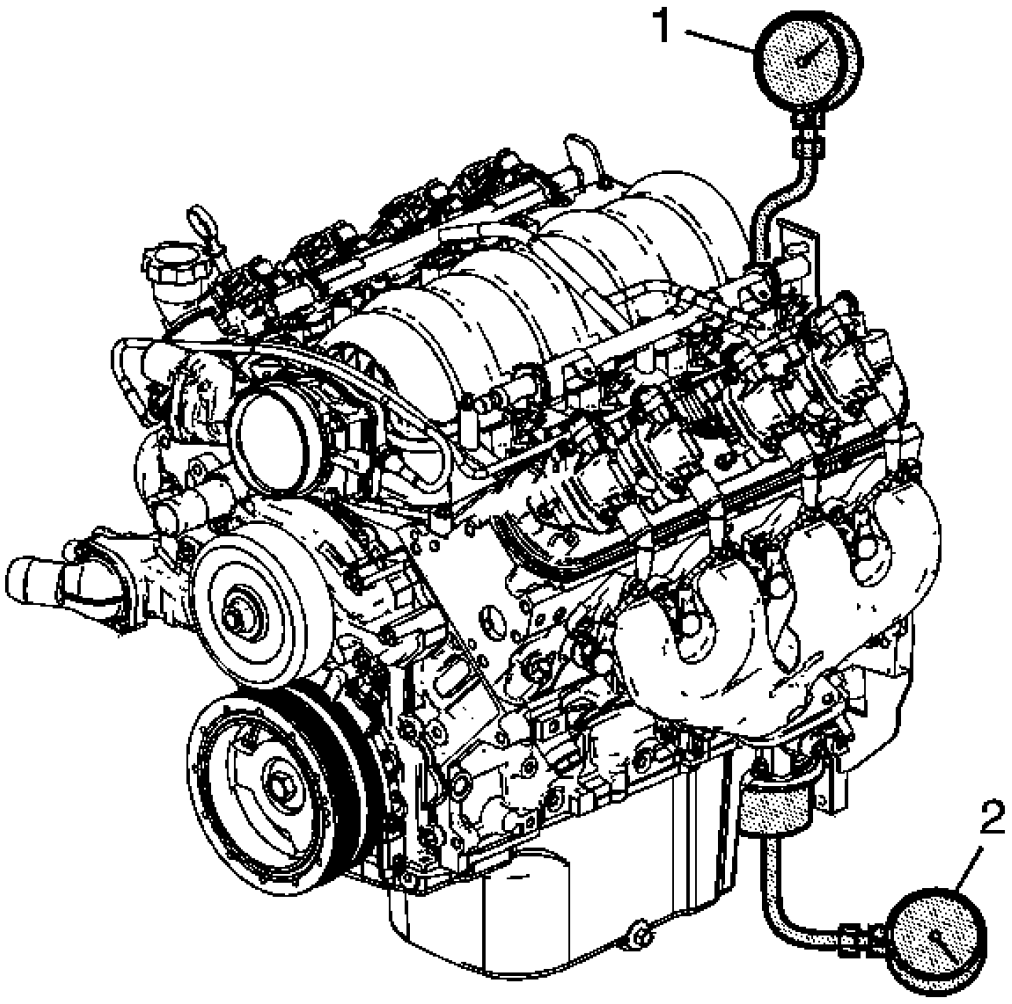


Fig. 7: Testing Oil Pressure
Courtesy of GENERAL MOTORS CORP.

4. Install the **J 21867** (1), or equivalent, to the **J-21867-16** (2). See **Special Tools** .
5. Run the engine and measure the engine oil pressure while observing both gauges.

   Operate the throttle, as required, to increase and decrease the engine oil pressure.

   - With the engine running and the lower pressure gauge (2) measuring below 379 kPa (55 psi), both gauges should display the same pressure reading. If the readings are not the same and the lower gauge (2) has a higher reading, the active fuel management oil pressure relief valve is stuck in the open position or the valve lifter oil manifold filter is plugged.

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- With the engine running and the lower pressure gauge (2) measuring above 379 kPa (55 psi), the upper gauge (1) should display no greater than 379-517 kPa (55-75 psi). If the reading on the upper gauge (1) is greater than 517 kPa (75 psi), the active fuel management oil pressure relief valve is stuck in the closed position.

6. Repair, as required.

CYLINDER DEACTIVATION (ACTIVE FUEL MANAGEMENT) VALVE LIFTER OIL MANIFOLD DIAGNOSIS AND TESTING

Special Tools

- **EN-46999:** Active Fuel Management Tester
- **EN-46999-1:** Active Fuel Management Tester Air Adapter
- **EN-46999-5:** Active Fuel Management Tester Harness - Small Block V8

For equivalent regional tools, refer to **Special Tools** .

NOTE:

- **Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing is applicable for RPO L76.**
- **A minimum shop air source of 206 kPa (30 psi) is required for manifold testing.**
- **A water bleed is located on the side of the EN-46999: tester. Occasionally, depress the valve in order to remove excess water from the tool.**

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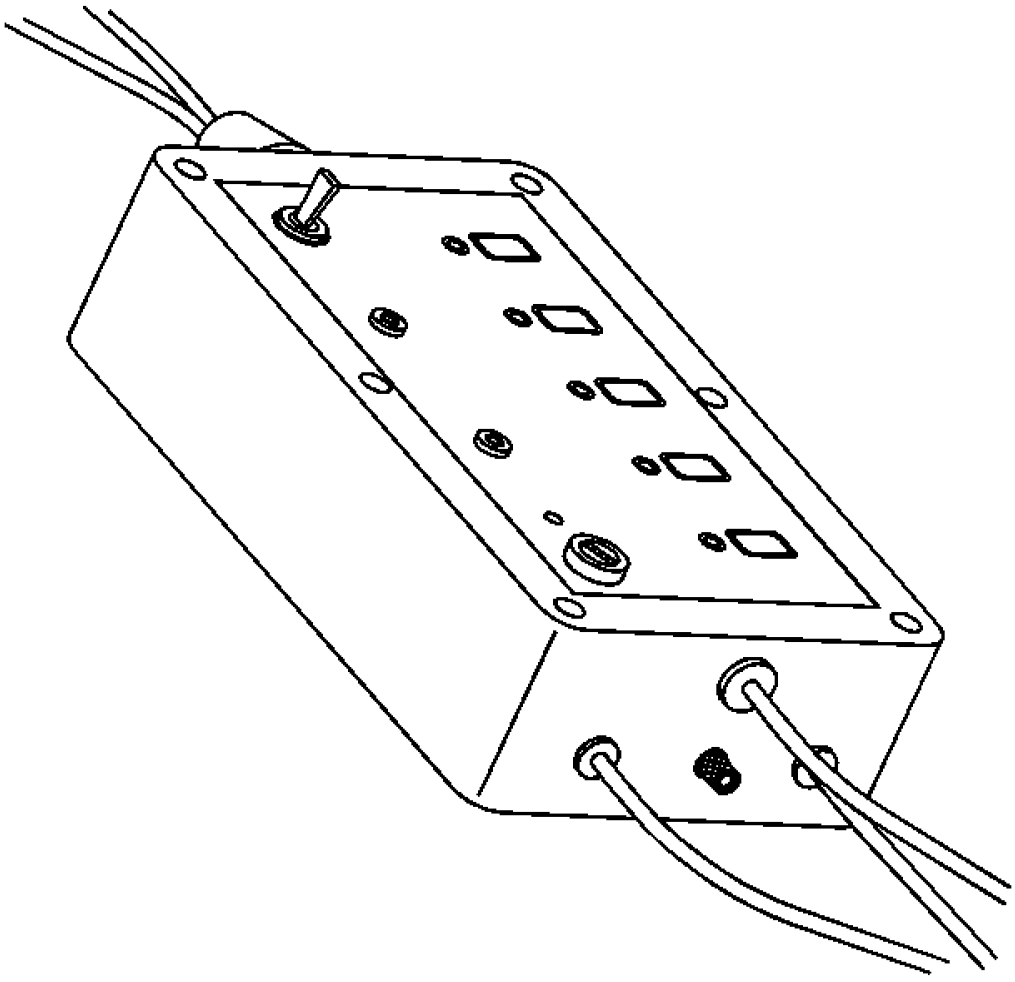


Fig. 8: Manifold Bench Test
Courtesy of GENERAL MOTORS CORP.

The manifold bench test provides a maximum 206 kPa (30 psi) of filtered shop air to the manifold and will test each solenoid/valve for the following conditions:

- Proper operation
- A stuck open condition - constant air flow
- A stuck closed condition - no air flow
- A flow restriction within the manifold

1. Individually depress each of the buttons 1-4 on the **EN-46999:** tester in order to activate each of the solenoid/valves. When activating each solenoid/valve, a loud click should be heard from the solenoid and

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an increased amount of air will exit the outlet ports.

- Button 1 will energize the solenoid/valve 1 for engine cylinder number 1.
- Button 2 will energize the solenoid/valve 2 for engine cylinder number 4.
- Button 3 will energize the solenoid/valve 3 for engine cylinder number 6.
- Button 4 will energize the solenoid/valve 4 for engine cylinder number 7.

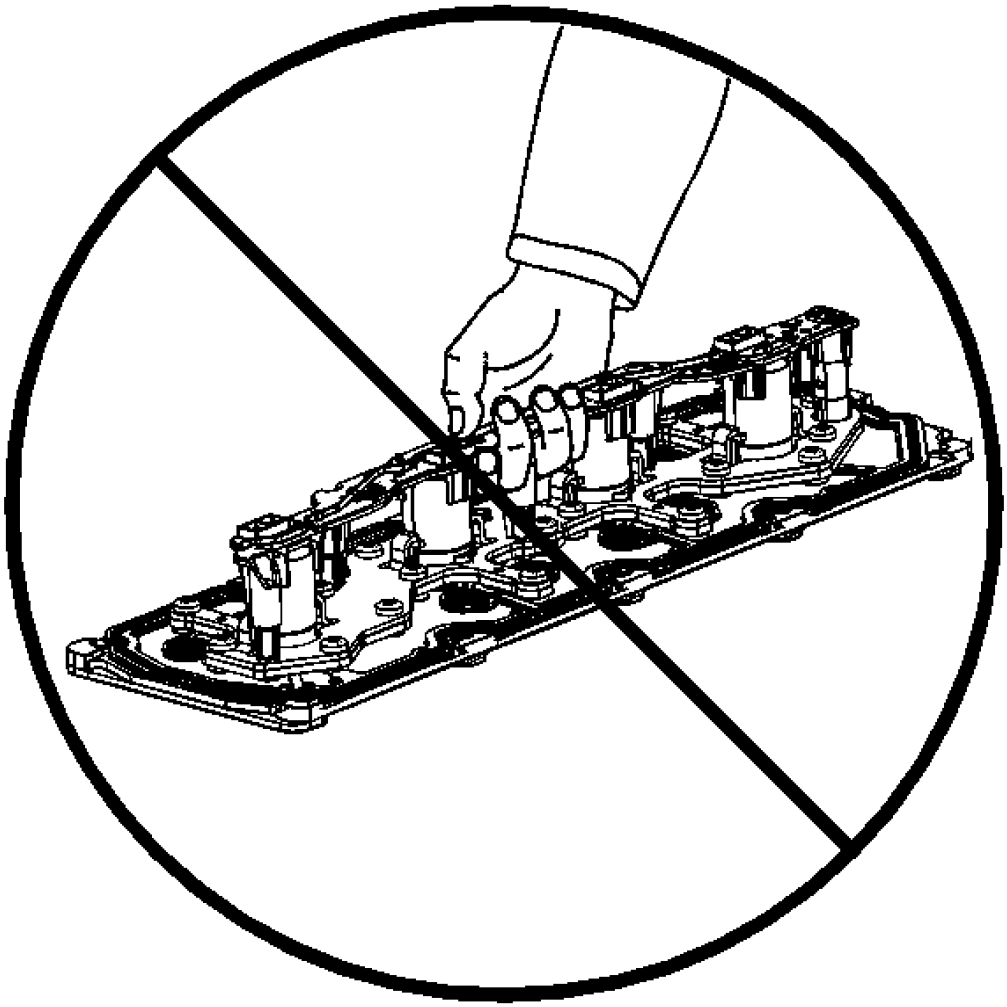


Fig. 9: Valve Lifter Oil Manifold Handling Precaution
Courtesy of GENERAL MOTORS CORP.

2. Do not lift the manifold assembly by the electrical lead frame.

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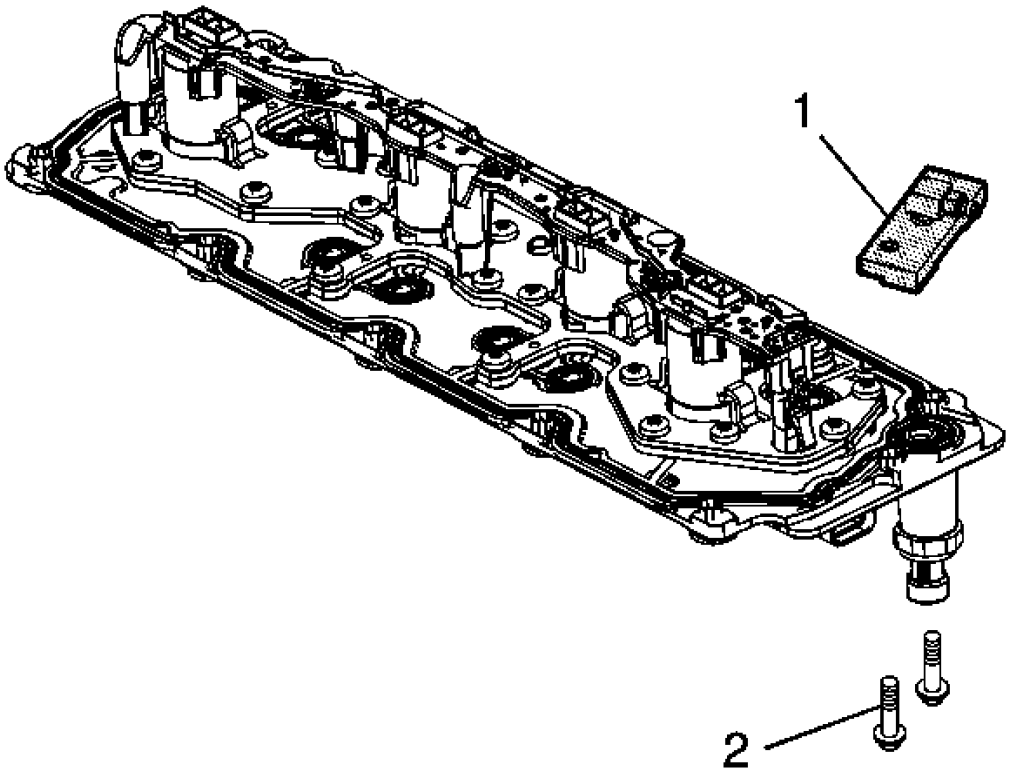


Fig. 10: Displacement-On-Demand Tester Air Adapter
Courtesy of GENERAL MOTORS CORP.

3. Install the **EN-46999-1:** tester air adapter (1) to the manifold.

CAUTION: Refer to Fastener Caution .

4. Install 2 of the manifold bolts (2) to the **EN-46999-1:** tester air adapter. Tighten the bolts to 25 N.m (18 lb ft).

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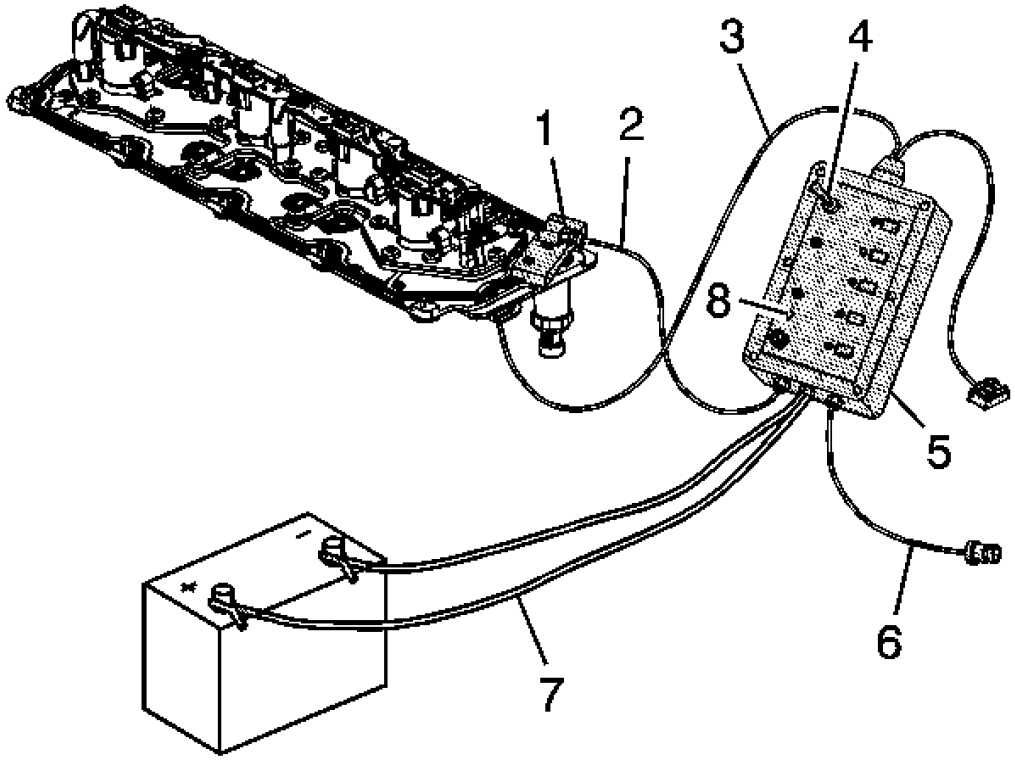


Fig. 11: Connecting Tester
Courtesy of GENERAL MOTORS CORP.

5. Connect the air out hose (2) of the **EN-46999:** AFM tester (5) to the **EN-46999-1:** tester air adapter (1). Verify the air supply switch (4) is in the off position.
6. Connect the air in hose (6) of the **EN-46999:** AFM tester (5) to a shop air source.
7. Connect the 12-volt power supply connectors (7) of the **EN-46999:** AFM tester (5) to a 12-volt power supply. Verify the Power light (8) on the tool is illuminated. If the light on the tool is not illuminated when connected to a 12-volt power supply, test and/or replace the 3 amp fuse.
8. Connect the **EN-46999-5:** tester harness power cable (3) to the electrical connector of the manifold.

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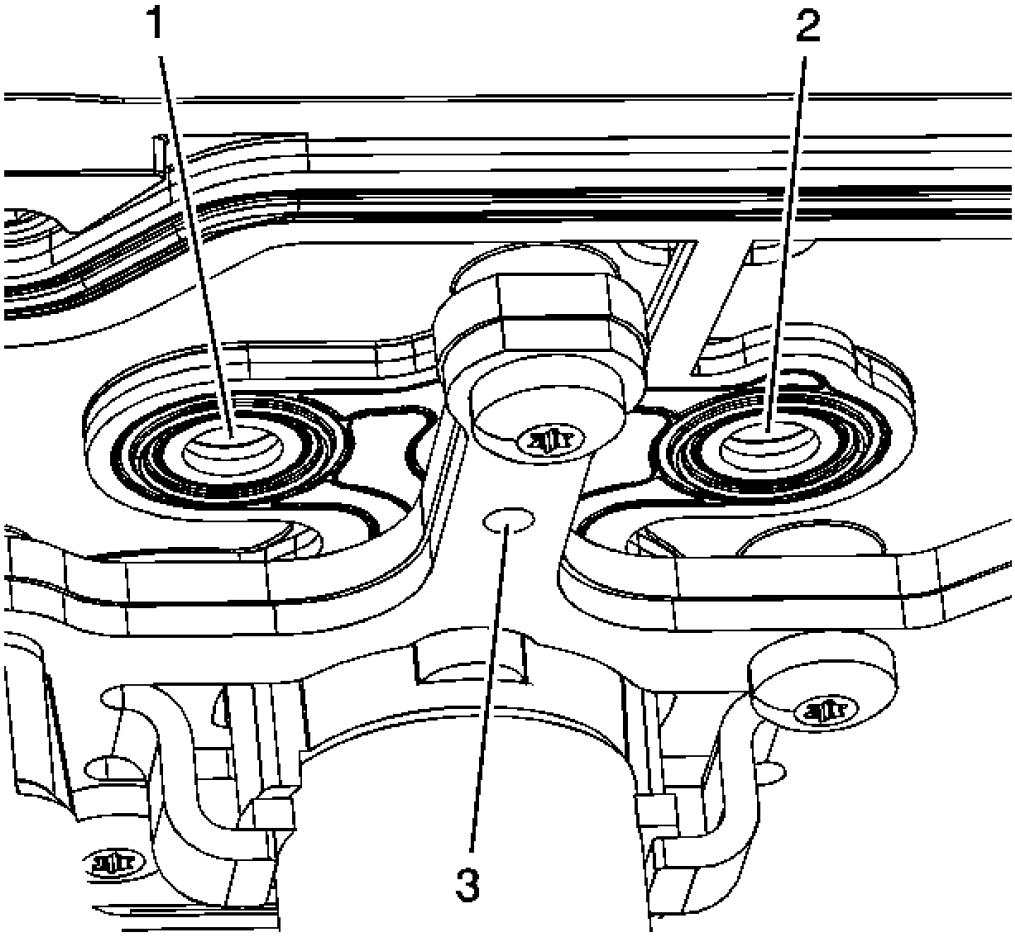


Fig. 12: Bleed Holes & Outlet Ports
Courtesy of GENERAL MOTORS CORP.

9. Turn the air supply switch of the **EN-46999:** AFM tester to the ON position. With the air supply connected to the manifold assembly and the solenoid/valves in the closed position, a limited amount of air will exit each of the bleed holes (3) and outlet ports (1, 2) of the manifold.

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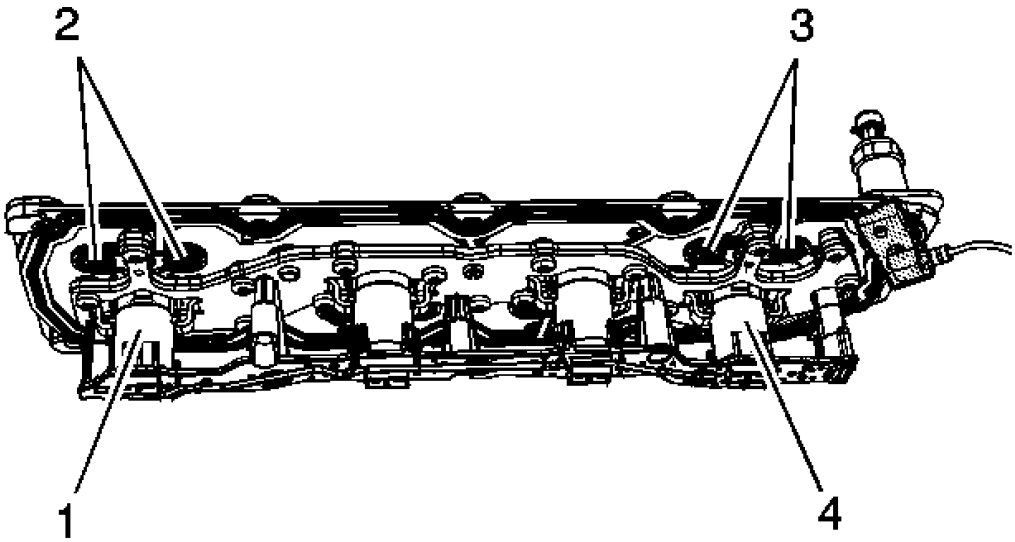


Fig. 13: Testing Solenoid/Valves
Courtesy of GENERAL MOTORS CORP.

NOTE: The manifold must be tested in the proper position to ensure the solenoid/valves operate as designed.

10. Position the manifold assembly onto a bench at a 45 degree angle in order to test solenoid/valves 1 and 4.
11. Depress button number 1 on the tool to activate solenoid/valve 1. With button 1 depressed, the solenoid/valve (1) should open, allowing an increased amount of air to exit the outlet ports (2) of the manifold.
12. Depress button number 4 on the tool to activate solenoid/valve 4. With button 4 depressed, the solenoid/valve (4) should open, allowing an increased amount of air to exit the outlet ports (3) of the manifold.

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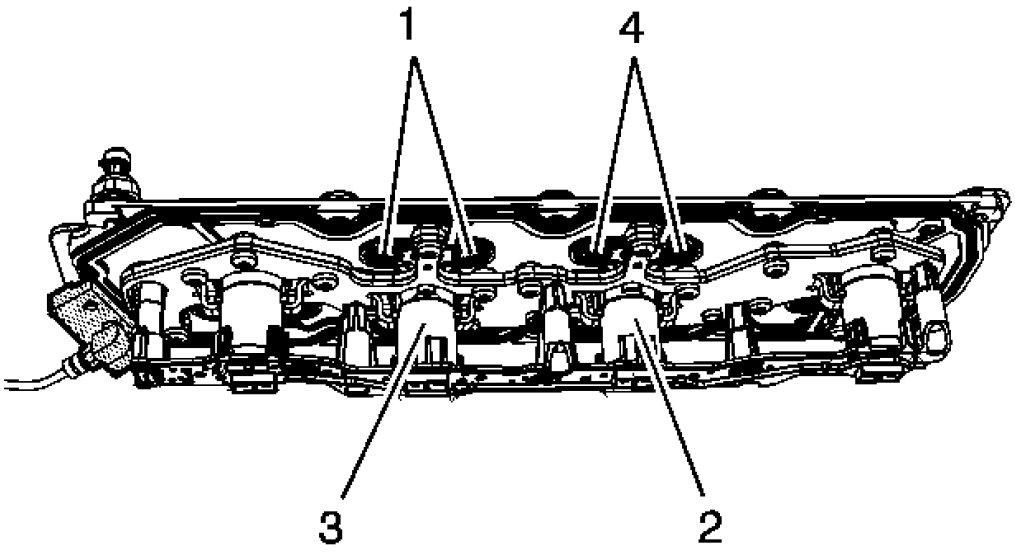


Fig. 14: View Of Solenoid/Valves 2 & 3
Courtesy of GENERAL MOTORS CORP.

13. Reposition the manifold assembly onto a bench at a 45 degree angle in order to test solenoid/valves 2 and 3.
14. Depress button number 2 on the tool to activate solenoid/valve 2. With button 2 depressed, the solenoid/valve (2) should open, allowing an increased amount of air to exit the outlet ports (4) of the manifold.
15. Depress button number 3 on the tool to activate solenoid/valve 3. With button 3 depressed, the solenoid/valve (3) should open, allowing an increased amount of air to exit the outlet ports (1) of the manifold.
16. When the test is completed, turn the air source switch on the **EN-46999:** AFM tester to the off position and disconnect the tool from the 12-volt power supply, shop air source and manifold assembly.
17. If after testing, it has been determined that one or more of the solenoid/valves is not functioning properly, replace the manifold as an assembly.
18. If after testing, it has been determined that the solenoid/valves are functioning properly, replace the valve lifters as required. Both intake and exhaust lifters should be replaced in pairs.

CAMSHAFT POSITION ACTUATOR AND SOLENOID VALVE DIAGNOSIS AND TESTING

NOTE: Camshaft Position (CMP) Actuator and Solenoid Valve Diagnosis and Testing is applicable for RPO L99.

1. Measure the engine oil level. Fill, as required.

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2. Using the scan tool, inspect for diagnostic codes within the engine control module (ECM). Refer to **Diagnostic System Check - Vehicle** . Repair, as required.
3. Verify proper engine oil pressure and operation of the active fuel management oil pressure relief valve. Refer to **Oil Pressure Diagnosis and Testing**.
4. Inspect the CMP actuator solenoid valve for proper operation. Refer to **Camshaft Position Actuator Solenoid Valve Inspection (Off-Vehicle)** or **Camshaft Position Actuator Solenoid Valve Inspection (On-Vehicle)** .
    - If valve inspection confirms proper movement of the spool, replace the CMP actuator and CMP valve.
    - If valve inspection confirms improper movement of the spool, replace only the CMP valve.
5. Verify proper operation of the CMP actuator control system. Refer to **Diagnostic System Check - Vehicle** .

ENGINE OIL LEVEL SENSOR DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Engine Oil Level Sensor Signal	2	1	-	1
Engine Oil Level Sensor Ground	-	1	-	-
1. DIC message Engine Oil Level Low Always ON 2. DIC message Engine Oil Level Low Always OFF				

Typical Scan Tool Data

Engine Oil Level Switch

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON **Parameter Normal Range:** OK			
Engine Oil Level Sensor/Switch Signal	OK	Low	OK
Engine Oil Level Ground	-	Low	-

Circuit/System Description

The engine oil level sensor/switch is a normally-closed with proper engine oil level. The switch opens when the engine oil level drops below a calibrated level. The engine control module (ECM) monitors the engine oil level signal circuit when the ignition is ON, and the engine is OFF. With the switch in the closed position, the ECM

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detects a low voltage signal circuit. With the switch in the open position, the ECM detects a high voltage on the signal circuit. When high voltage is detected on the signal circuit, the ECM will send a serial data message to the instrument panel cluster and a message is displayed on the driver information center.

The following information determines the message sent form the ECM to the instrument cluster. The Engine Oil Level Low message is displayed only after the ECM detects a high voltage on the signal circuit for three consecutive ignition cycles, followed by an ignition OFF event from 15 min to greater than 50 min, depending on the engine oil temperature.

The Engine Oil Level Low message is turned OFF when the ECM detects a low voltage on the signal circuit after an ignition OFF event for greater than 90 s, then followed by the ignition ON for less than 1 s.

Reference Information

Schematic Reference

- **Engine Mechanical Schematics**
- **Instrument Cluster Schematics**

Connector End View Reference

Component Connector End Views

Description and Operation

- **Instrument Cluster Description and Operation**
- **Indicator/Warning Message Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

1. Verify proper engine oil level. Add oil as necessary.
2. Ignition ON, observe the scan tool Engine Oil Level parameter. The reading should be OK and change to Low when the oil level sensor/switch harness connector is disconnected.

Circuit/System Testing

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NOTE: Verify proper engine oil level before continuing with diagnosis.

1. Ignition OFF, disconnect the harness connector at the B35C engine oil level sensor.
2. Ignition OFF for 90 s, test for less than 2 ohms between the ground circuit terminal C and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Engine Oil Level Warning parameter reads Low.
   - If the Oil Level Warning parameter reads OK, test the signal circuit terminal A for a short to ground. If the circuit tests normal, replace the ECM.

NOTE: If a short to voltage is found on the signal circuit, the fuse in the 3 A jumper wire will open.

4. Ignition ON, install a 3 A fused jumper wire between the signal circuit terminal A and the ground circuit terminal C. Verify the scan tool Engine Oil Level Warning parameter reads OK.
   - If the Engine Oil Level parameter reads Low, test the signal circuit terminal A for an open/high resistance. If the circuit tests normal, replace the K20 ECM.
5. If all circuits test normal, test or replace the B35C engine oil level temperature sensor.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Oil Level Sensor and/or Switch Replacement**
- **Engine Control Module Replacement**
- **Control Module References** for the ECM replacement, setup, and programming

OIL LEAK DIAGNOSIS

Step	Action	Yes	No
IMPORTANT: **You can repair most fluid leaks by first visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the cause of the leak as well as the leak itself.**			
1	1. Operate the vehicle until it reaches normal operating temperature. 2. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 3. Wait 15 minutes. 4. Inspect for drippings. Are drippings present?	Go to **Step 2**	System OK
2	Can you identify the type of fluid and the approximate location of the leak?	Go to **Step 10**	Go to **Step 3**

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

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	Can you identify the type of fluid and the approximate location of the leak?	Go to **Step 10**	Go to **Step 7**
7	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to **Step 10**	Go to **Step 8**
8	Use the **J 28428-E** high-intensity black light kit in order to identify the type of fluid, and the approximate location of the leak. Refer to the manufacturer's instructions when using the tool. Can you identify the type of fluid and the approximate location of the leak?	Go to **Step 10**	Go to **Step 9**
9	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Inspect for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to **Step 10**	System OK
10	1. Inspect the engine for mechanical damage. Special attention should be shown to the following areas: • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves • Plugged or malfunctioning engine ventilation system • Improperly tightened or damaged fasteners • Cracked or porous components • Improper sealants or gaskets, where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals		

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	• Damaged or worn sealing surfaces 2. Inspect the engine for customer modifications. Is there mechanical damage, or customer modifications to the engine?	Go to **Step 11**	System OK
11	Repair or replace all damaged or modified components. Does the engine still leak oil?	Go to **Step 1**	System OK

CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS

Symptom	Correction
External oil leak	Inspect for any of the following conditions: • Restricted or kinked PCV hose or engine vent hose • Damaged, incorrect, or incorrectly installed PCV hose • Excessive crankcase pressure
Rough Idle	Inspect for any of the following conditions: • Restricted or kinked PCV hose or engine vent hose • Leaking (damaged) PCV hose • Vacuum hoses worn or not properly installed
Stalling or slow idle speed	Inspect for any of the following conditions: • Restricted or kinked engine vent hose • Leaking (damaged) PCV hose
High idle speed	Inspect for a leaking (damaged) PCV hose
Sludge in the engine	Inspect for restricted or kinked PCV hose or engine vent hose

DRIVE BELT CHIRPING, SQUEAL, AND WHINE DIAGNOSIS

Diagnostic Aids

- A chirping or squealing noise may be intermittent due to moisture on the drive belt(s) or the pulley(s). It may be necessary to spray a small amount of water on the drive belt(s) in order to duplicate the customers concern. If spraying water on the drive belt duplicates the symptom, cleaning the belt pulley(s) 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 incorrect 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.

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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 diagnostic trouble codes (DTCs) may set when the engine is operating with the drive belt(s) 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 Belt Dressing Caution .** DEFINITION: The following items are indications of chirping:			

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- A high pitched noise that is heard once per revolution of the drive belt or pulley.
- Chirping may occur on cold damp start-ups and will subside once the vehicle reaches normal operating temperature.

DEFINITION: The following items are indications of drive belt squealing:

- 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 whining:

- A high pitched continuous noise.
- The noise may be caused by an accessory drive component failed bearing.

1	Did you review the Symptoms-Engine Mechanical operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Engine Mechanical**
2	Verify that there is a chirping, squealing or whining noise. Does the engine make the chirping, squealing or whining noise?	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 chirping, squealing or whining 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 squealing or whining noise, proceed to step 13. Does the belt grooves have pilling?	Go to **Step 5**	Go to **Step 6**
5	Clean the drive belt pulleys with a suitable wire brush. Did you complete the repair?	Go to **Step 20**	Go to **Step 6**
6	Inspect for misalignment of the pulleys. Are any of the pulleys misaligned?	Go to **Step 7**	Go to **Step 8**
	Replace or repair any misaligned pulleys.		

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7	Did you complete the repair?	Go to **Step 20**	Go to **Step 8**
8	Inspect for bent or cracked accessory brackets. Did you find any bent or cracked brackets?	Go to **Step 9**	Go to **Step 10**
9	Replace any bent or cracked accessory brackets. Did you complete the repair?	Go to **Step 20**	Go to **Step 10**
10	Inspect for incorrect, loose, or missing fasteners. Did you find the condition?	Go to **Step 11**	Go to **Step 12**
11	**CAUTION:** **Refer to Fastener Caution .** 1. Tighten any loose fasteners. Refer to **Fastener Tightening Specifications (6.2L LS3)** or **Fastener Tightening Specifications (6.2L L99)** . 2. Replace any incorrect 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. If diagnosing a whining noise and the condition still exists, proceed to Diagnostic Aids. Did you find and correct the condition?	Go to **Step 20**	Go to **Step 14**
14	Test the drive belt tensioner for correct operation. Refer to **Drive Belt Tensioner Diagnosis**. Did you find and correct the condition?	Go to **Step 20**	Go to **Step 15**
15	Inspect for the correct drive belt length. Did you find and correct the condition?	Go to **Step 20**	Go to **Step 16**
16	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to **Step 20**	Go to **Step 17**
17	Inspect for the correct pulley size. Did you find and correct the condition?	Go to **Step 20**	Go to Diagnostic Aids
18	Replace the bent pulley. Did you complete the repair?	Go to **Step 20**	Go to **Step 19**
19	Replace the drive belt(s). 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

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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 being over charged, the power steering system being restricted or the incorrect fluid being used, 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, diagnostic trouble codes (DTCs) may set when the engine is operating with the drive belt(s) 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 our felt as a lump in the belt.

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

9: Inspection of the fasteners can eliminate the possibility that the incorrect 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 Belt Dressing Caution .** 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:			

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- Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove
- The separation of the drive belt
- A damaged drive belt

DEFINITION: The following items are indications of drive belt vibration:

- The vibration is engine-speed related.
- The vibration may be sensitive to accessory load.

1	Did you review the Symptoms-Engine Mechanical operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Engine Mechanical**
2	Verify that there is a rumbling noise 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(s). 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?	• For rumbling diagnosis, go to **Symptoms - Engine Mechanical** • For vibration diagnosis, go to **Vibration Analysis - Engine**	Go to **Step 4**
4	Inspect the drive belt(s) for wear, damage, separation, sections of missing ribs, and/or debris build-up. Did you find any of these conditions?	Go to **Step 7**	Go to **Step 5**
5	Inspect for severe pilling of more than 1/3 of the drive belt pulley grooves. Did you find severe pilling?	Go to **Step 6**	Go to **Step 7**
6	1. Clean the drive belt pulleys using a suitable wire brush. 2. Reinstall the drive belts. Did you correct the condition?	Go to **Step 8**	Go to **Step 7**
7	Install a new drive belt. Did you complete the replacement?	Go to **Step 8**	-
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 9**
9	Inspect for improper, loose or missing fasteners. Did you find any of these conditions?	Go to **Step 10**	Go to **Step 11**

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10	**CAUTION:** **Refer to Fastener Caution .** 1. Tighten any loose fasteners. Refer to **Fastener Tightening Specifications (6.2L LS3)** or **Fastener Tightening Specifications (6.2L L99)** . 2. Replace any improper or missing fasteners. Did you complete the repair?	Go to **Step 13**	-
11	Inspect for a bent water pump shaft. Did you find and correct the condition?	Go to **Step 13**	Go to **Step 12**
12	Inspect for bent or cracked accessory 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 a result of pulley misalignment.

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

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

Excessive wear on a drive belt is usually caused by an incorrect installation or the incorrect 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 have occurred to the drive belt when the drive belt fell off. The drive belt may be 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

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component, incorrect installation of the accessory drive component pulley, or the pulley being bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across 2 or 3 pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper repair 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 may allow the drive belt to fall off.

7: Inspecting of the fasteners can eliminate the possibility that a incorrect bolt, nut, spacer, or washer was installed. Missing, loose, or an incorrect fastener 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 component 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 Belt Dressing Caution .** DEFINITION: • The drive belt falls off the pulleys or may not sit correctly on the pulleys. • Wear at the outside ribs of the drive belt may be due to an incorrectly installed drive belt.			
1	Did you review the Symptoms-Engine Mechanical operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Engine Mechanical**
2	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. Does the drive belt continue to fall off?	Go to **Step 4**	System OK
4	Inspect for pulley misalignment. 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 accessory bracket. Did you find and repair the condition?	Go to **Step 12**	Go to **Step 7**
7	Inspect for improper, loose or missing fasteners.		

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	Did you find loose or missing fasteners?	Go to **Step 8**	Go to **Step 9**
8	**CAUTION:** **Refer to Fastener Caution .** 1. Tighten any loose fasteners. Refer to **Fastener Tightening Specifications (6.2L LS3)** or **Fastener Tightening Specifications (6.2L L99)** . 2. Replace any improper or missing fasteners. Does the drive belt continue to fall off?	Go to **Step 9**	System OK
9	Inspect the drive belt tensioner for proper operation. Refer to **Drive Belt Tensioner Diagnosis**. Does the drive belt tensioner operate properly?	Go to **Step 11**	Go to **Step 10**
10	Replace the drive belt tensioner. Does the drive belt continue to fall off?	Go to **Step 11**	System OK
11	Inspect for failed drive belt idler and/or drive belt tensioner pulley bearings. Did you find and repair the condition?	Go to **Step 12**	Go to Diagnostic Aids
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 2**
13	Inspect the drive belt for the proper installation. Did you find this condition?	Go to **Step 16**	Go to **Step 14**
14	Inspect for the proper drive belt. Did you find this condition?	Go to **Step 16**	Go to **Step 15**
15	Inspect the drive belt for contact 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 belts. Did you complete the replacement?	Go to **Step 17**	-
17	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

DRIVE BELT TENSIONER DIAGNOSIS

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

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

1. Remove the drive belt. Refer to **Drive Belt Replacement - Accessory** .
2. Position a hex-head socket on the belt tensioner pulley bolt.
3. Move the belt tensioner through its full travel.

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- The movement should feel smooth.
- There should be no binding.
- The belt tensioner should return freely.

4. If any binding is observed, replace the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement - Accessory**
5. Install the drive belt. Refer to **Drive Belt Replacement - Accessory** .

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2010 ENGINE

Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Repair Instructions - Off Vehicle - Camaro

DRAINING FLUIDS AND OIL FILTER REMOVAL

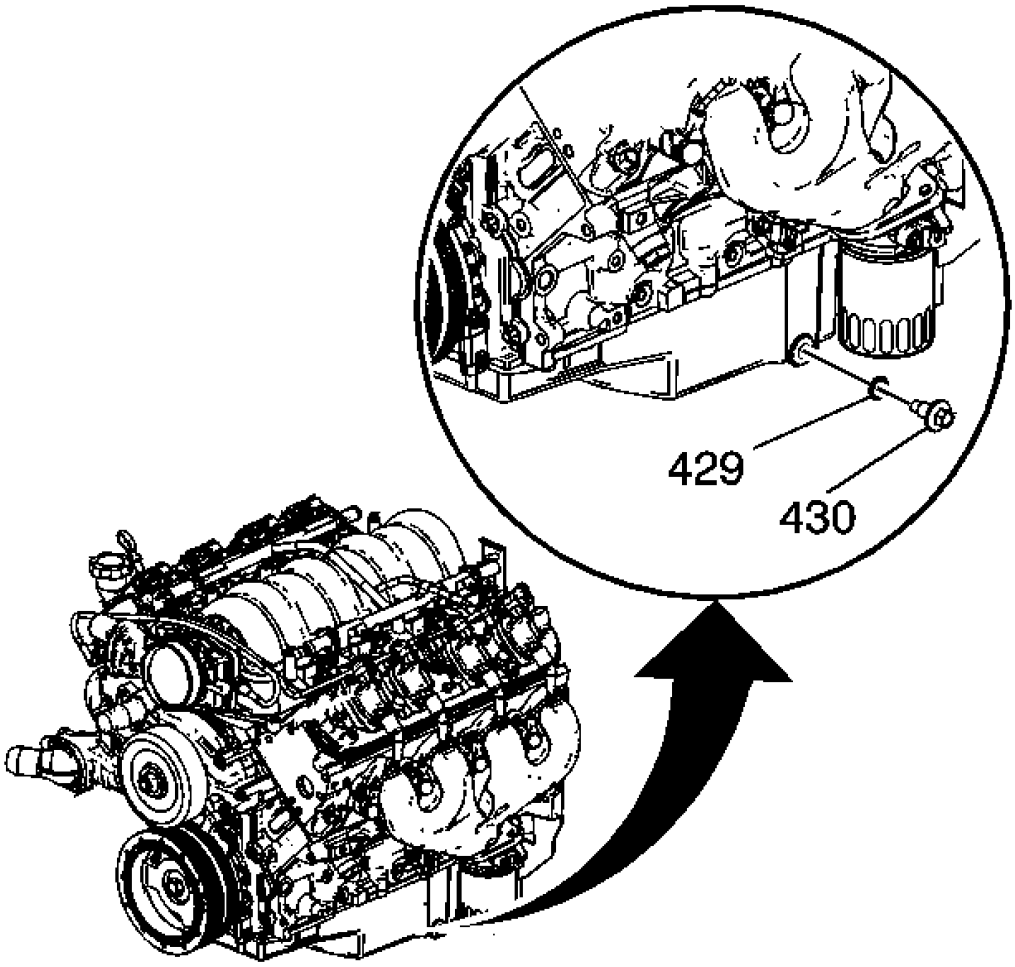


Fig. 1: Oil Pan Drain Plug & O-Ring
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pan drain plug (430) with O-ring (429).

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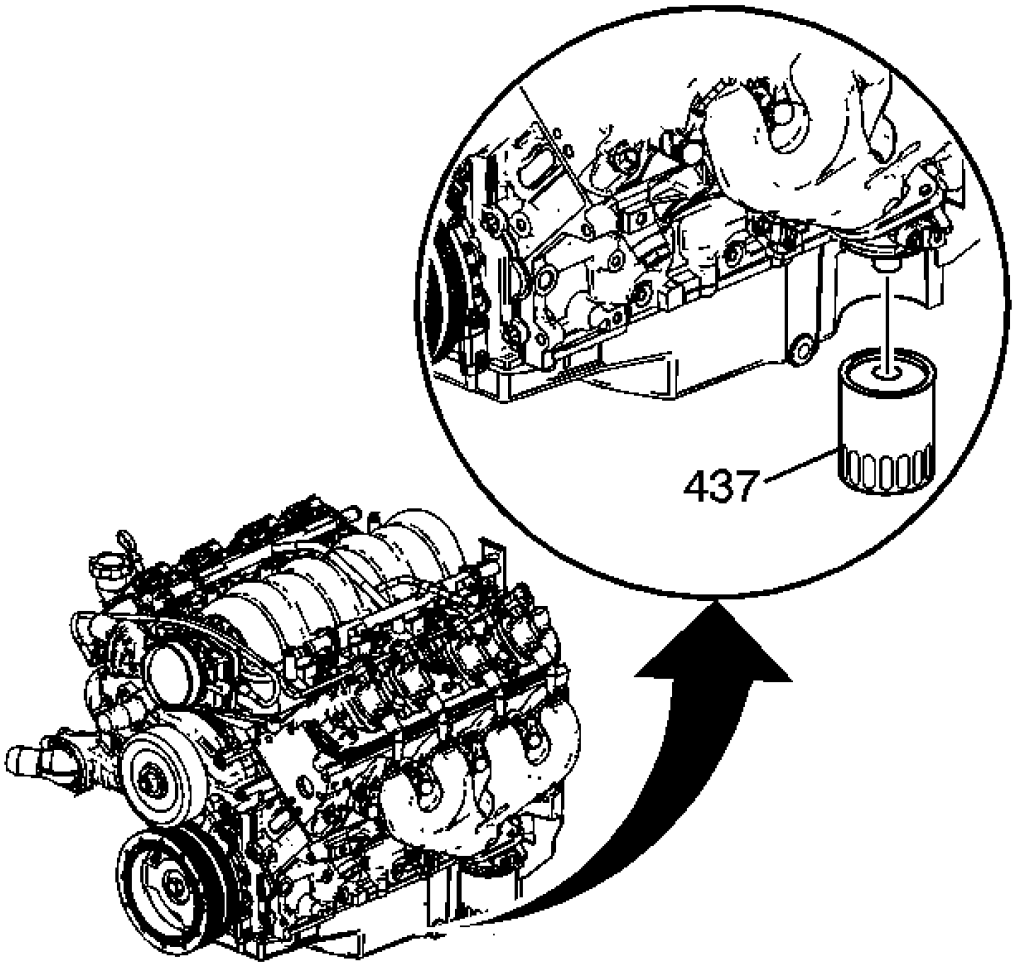


Fig. 2: Engine Oil Filter
Courtesy of GENERAL MOTORS CORP.

2. Remove the engine oil filter (437).

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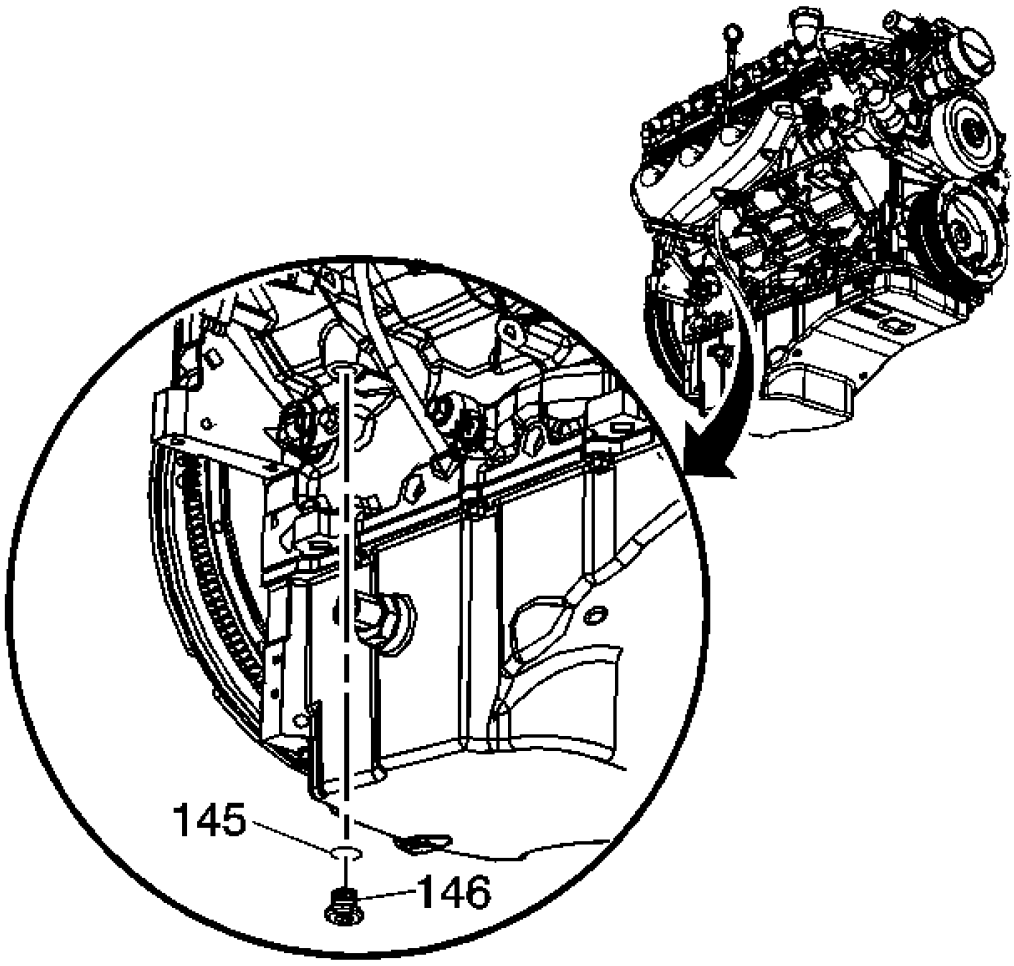


Fig. 3: Engine Block Coolant Drain Plug
Courtesy of GENERAL MOTORS CORP.

3. Remove the right side rear engine block coolant drain hole plug (146) with washer (145).

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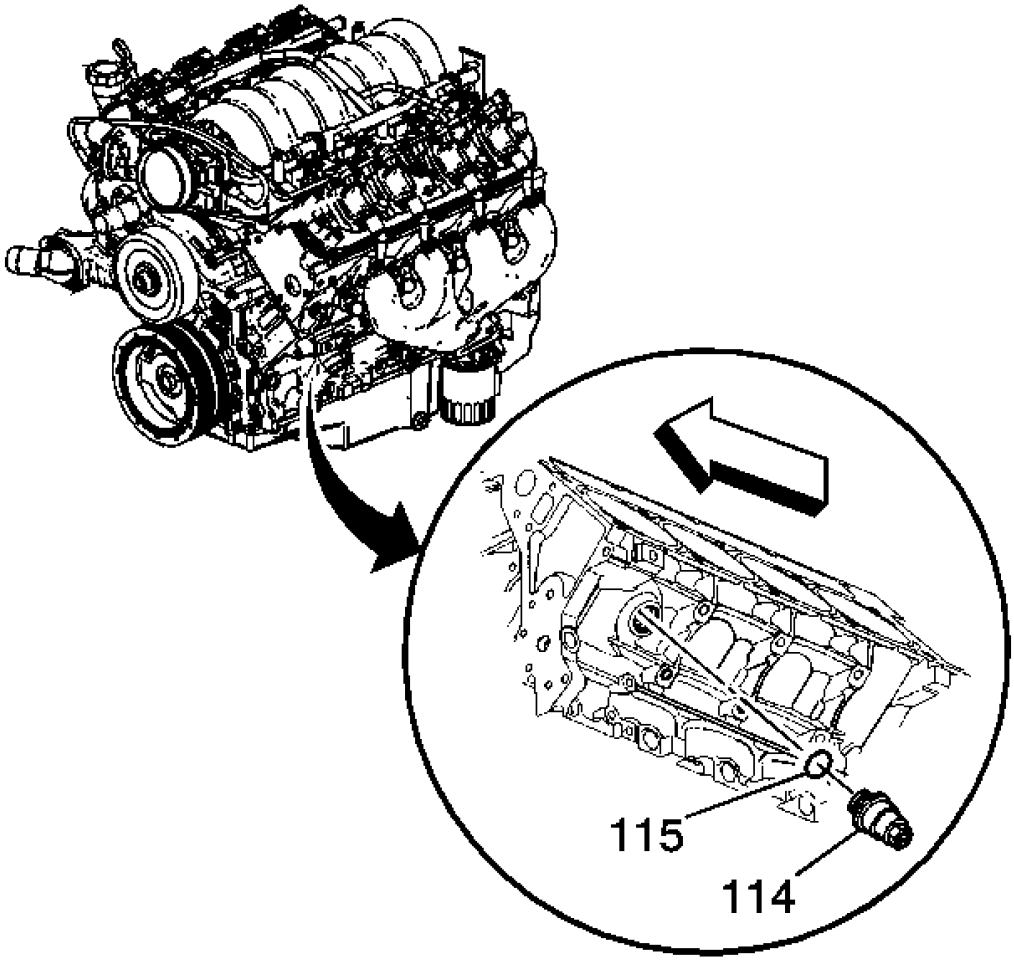


Fig. 4: Engine Block Coolant Heater & Washer
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine block coolant heater (114) with washer (115).

CRANKSHAFT BALANCER REMOVAL

Special Tools

- **J 41816:** Crankshaft Balancer Remover
- **J 41816-2:** Crankshaft End Protector
- **J 42386-A:** Flywheel Holding Tool

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For equivalent regional tools, refer to **Special Tools** .

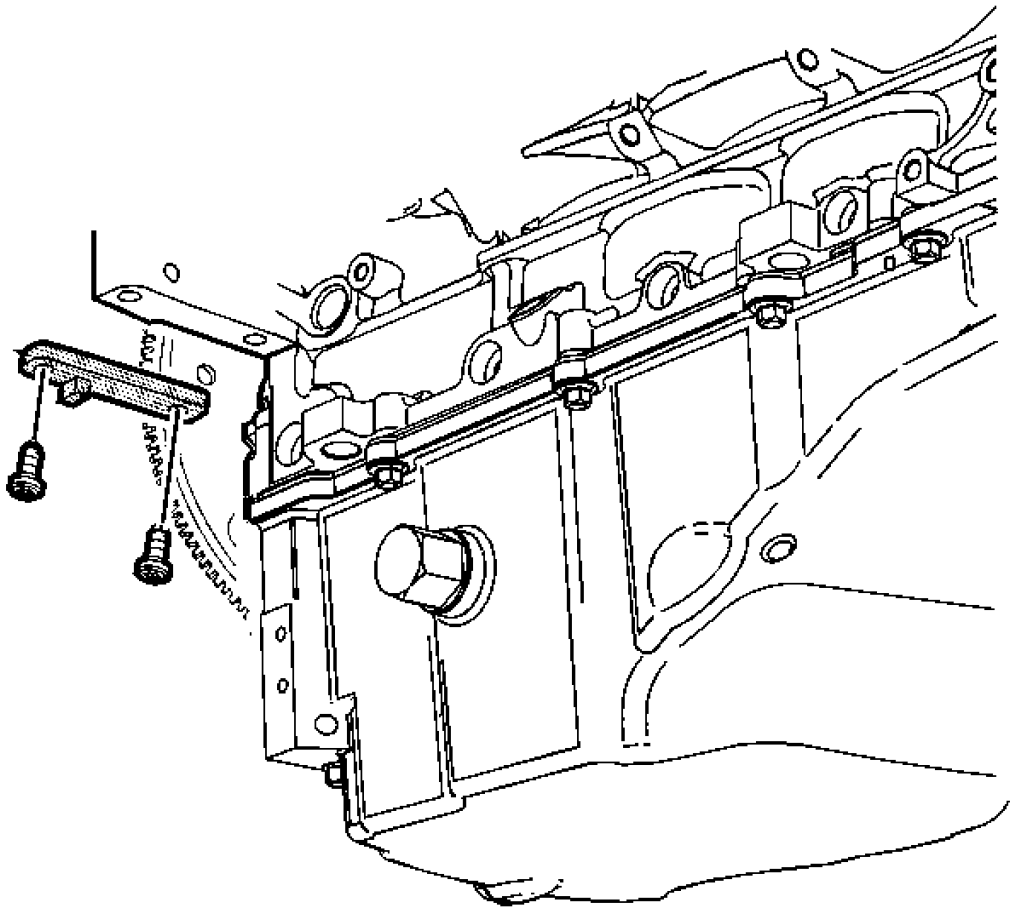


Fig. 5: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: Do not use the crankshaft balancer bolt again. Install a NEW crankshaft balancer bolt during final assembly.

1. Install the **J 42386-A:** holding tool and bolts.

   Use one M10 - 1.5 x 120 mm and one M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the **J**

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42386-A: holding tool bolts to 50 N.m (37 lb ft).

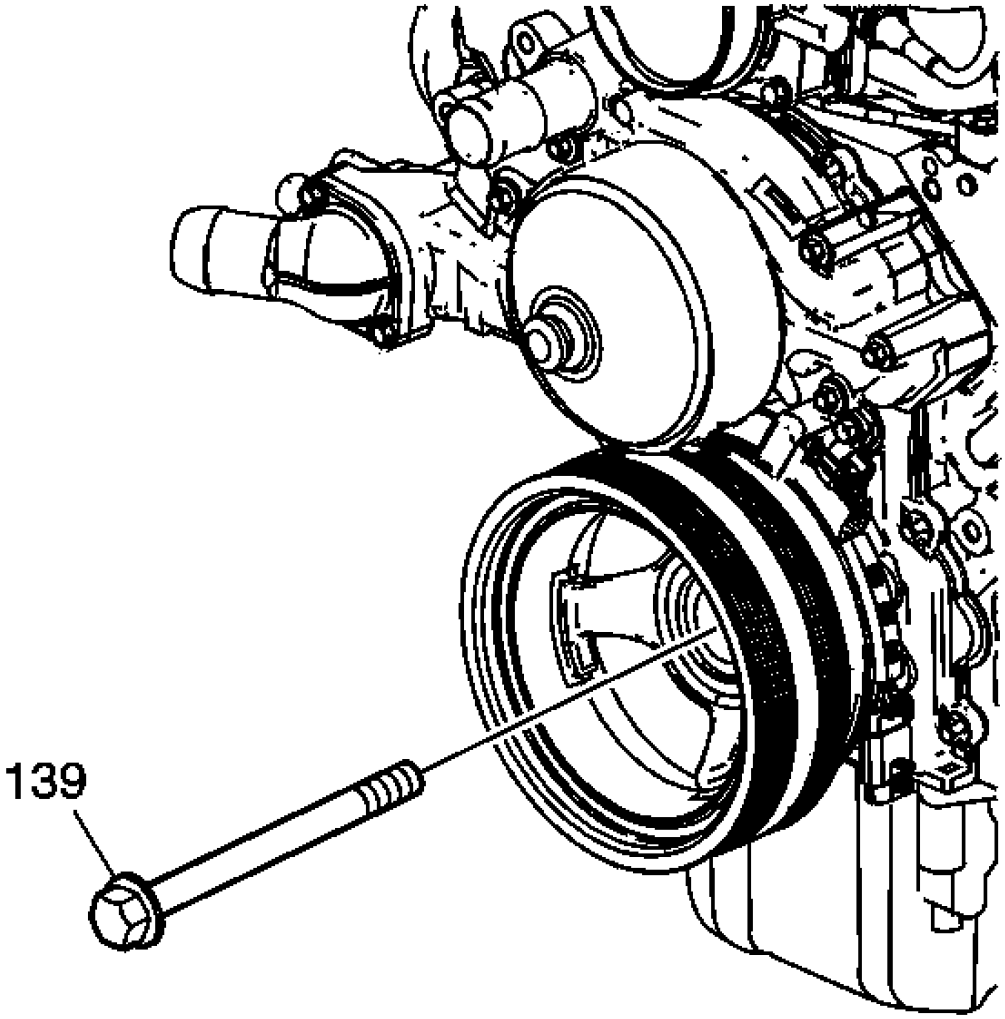


Fig. 6: Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

2. Remove the crankshaft balancer bolt (139). Do not discard the crankshaft balancer bolt. The balancer bolt will be used during the balancer installation procedure.

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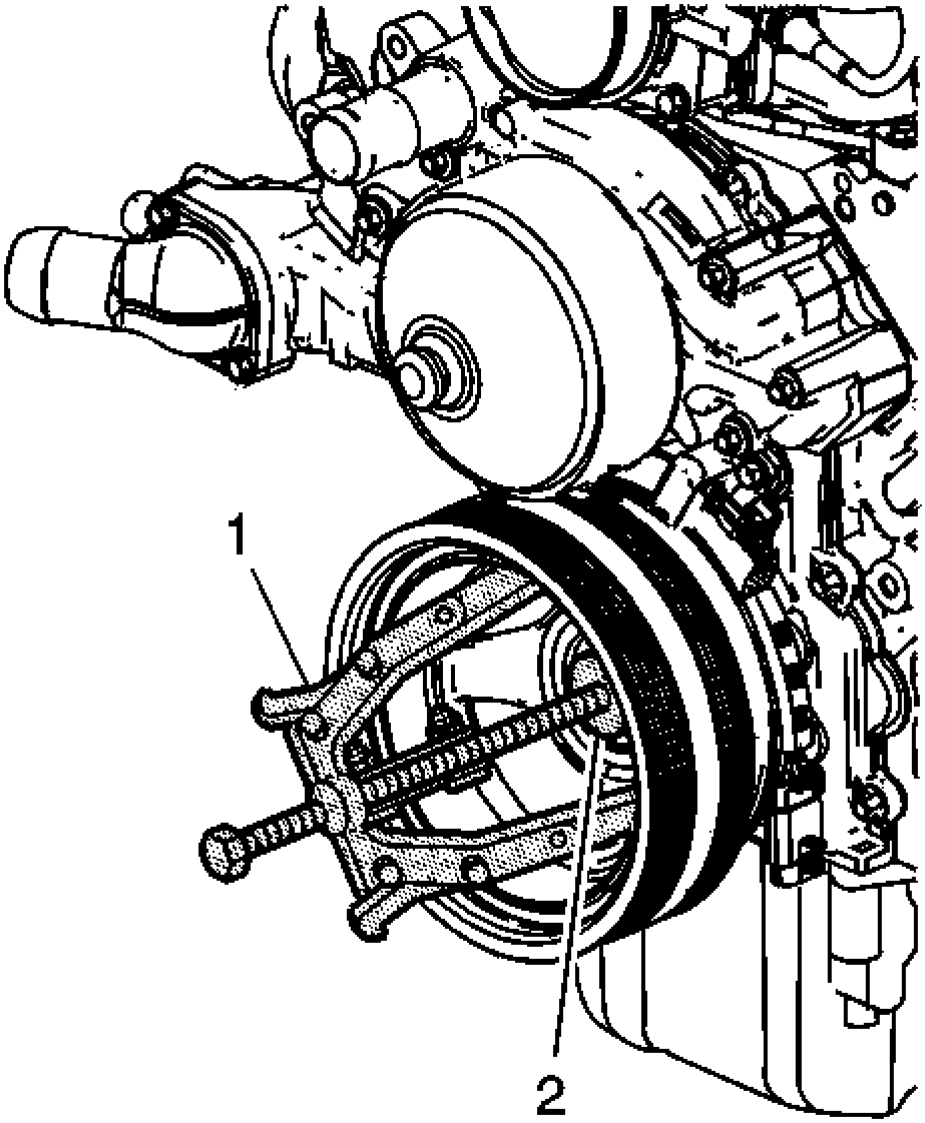


Fig. 7: Removing Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

3. Use the **J 41816:** remover (1) and the **J 41816-2:** protector (2) in order to remove the crankshaft balancer.

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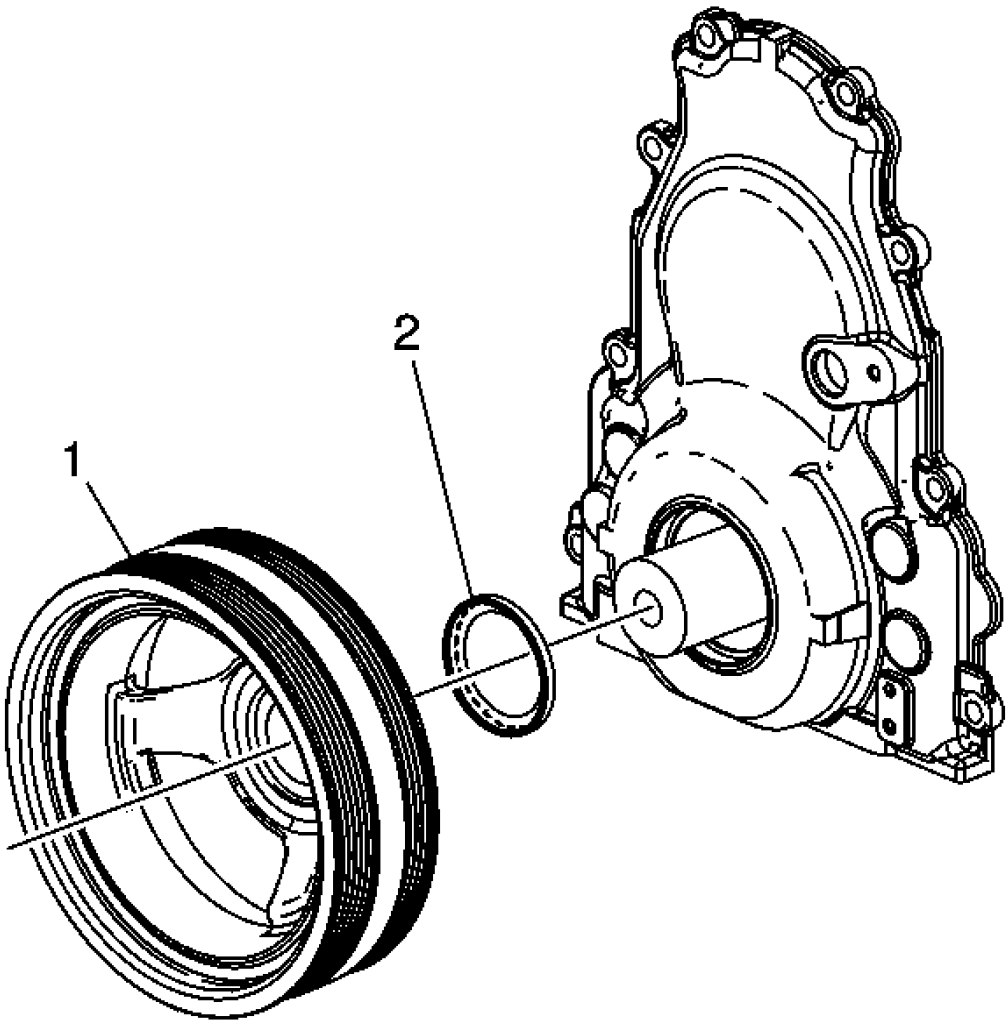


Fig. 8: Crankshaft Balancer & Washer
Courtesy of GENERAL MOTORS CORP.

4. Remove the crankshaft balancer (1) and the crankshaft balancer washer (2).
5. Remove the **J 42386-A:** holding tool and bolts.

ENGINE FLYWHEEL REMOVAL

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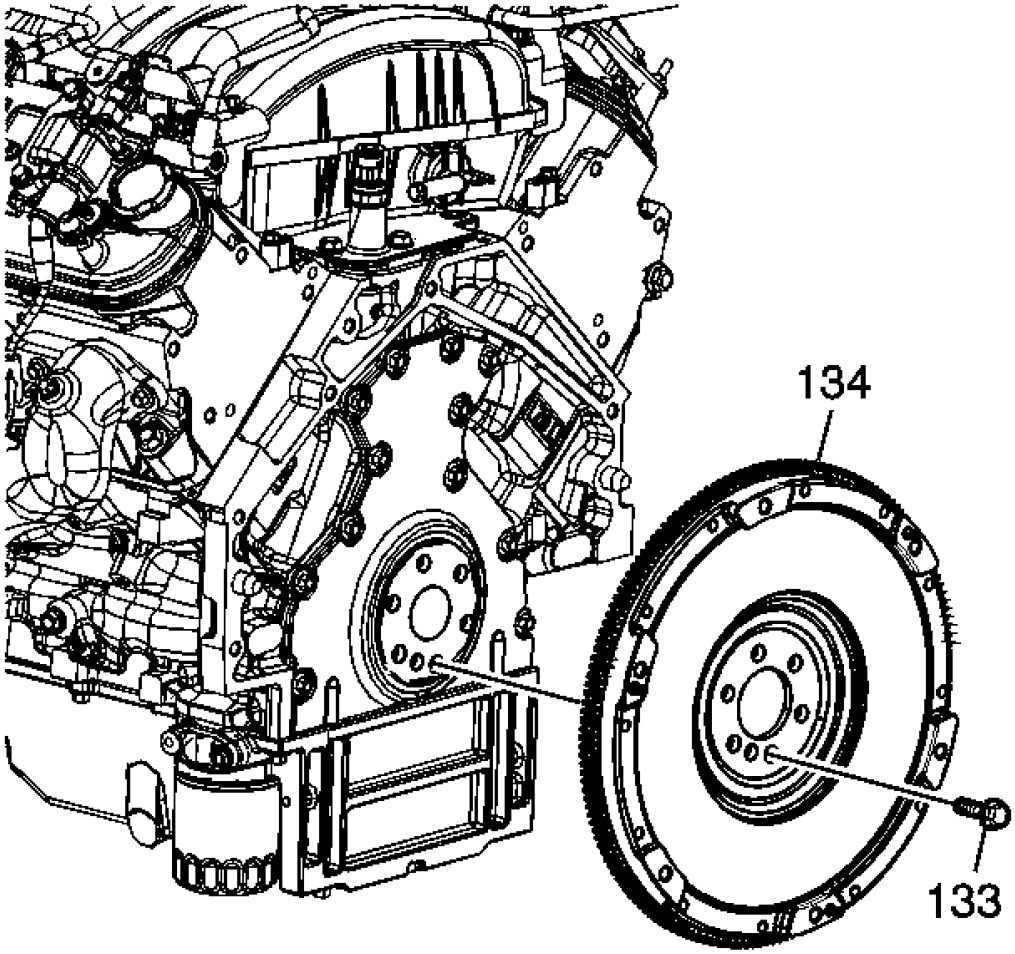


Fig. 9: Manual Transmission Flywheel & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the flywheel bolts (133).
2. Remove the manual transmission flywheel (134).

AUTOMATIC TRANSMISSION FLEX PLATE REMOVAL

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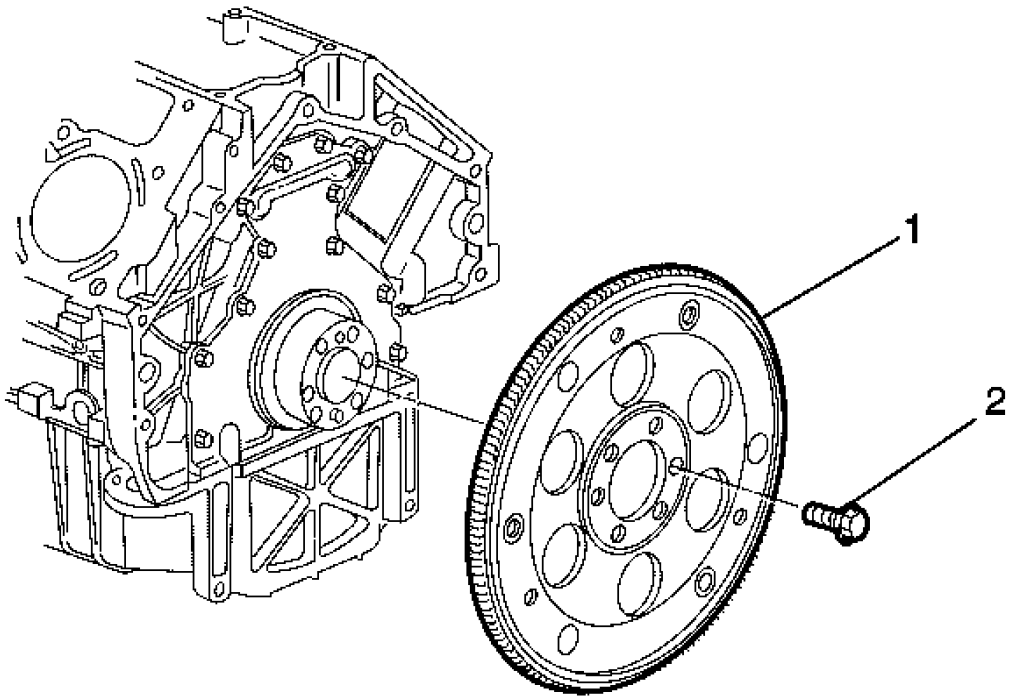


Fig. 10: Identifying Flexplate To Crankshaft Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Note the position and direction of the flex plate (1) before removal. The flex plate (1) does not use a locating pin for alignment. Mark or scribe the end of the crankshaft and the flex plate (1) before component removal.

1. Remove the flex plate to crankshaft retaining bolts (2).
2. Remove the flex plate (1).

CLUTCH PILOT BEARING REMOVAL

Special Tools

- **J 2619-01:** Slide Hammer
- **J 23907:** Slide Hammer with Bearing Adapter
- **J 23907-1:** Slide Hammer

For equivalent regional tools, refer to **Special Tools** .

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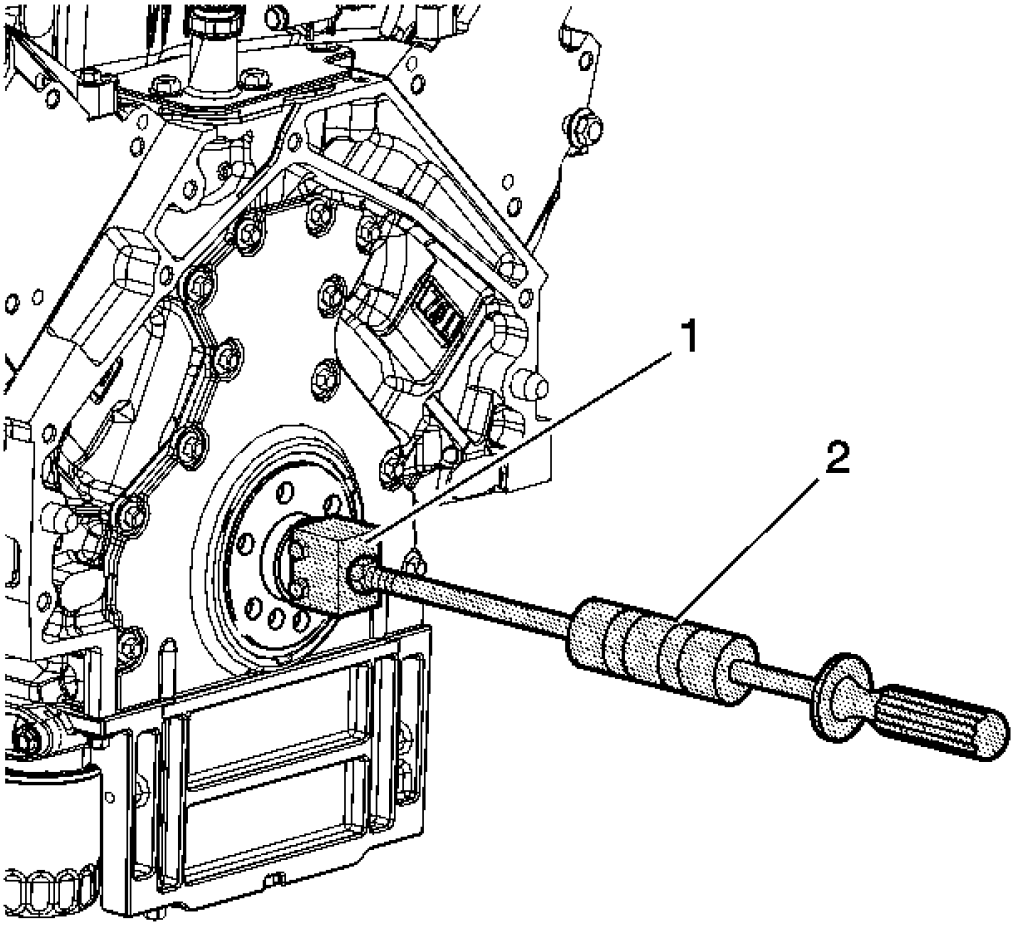


Fig. 11: Removing Clutch Pilot Bearing
Courtesy of GENERAL MOTORS CORP.

NOTE: J 23907-1: slide hammer was part of the J 23907: slide hammer with bearing adapter set. The adapter is still available as J 23907: adapter.

1. Remove the clutch pilot bearing using the **J 23907:** adapter (1) and **J 23907-1:** slide hammer (2).
    1. Install the legs of the **J 23907:** adapter (1) into the clutch pilot bearing.
    2. Rotate the shaft of the tool until the legs of the tool are snug and contacting the I.D. surface of the bearing.
    3. Install the **J 23907-1:** slide hammer (2) to the **J 23907:** adapter (1).
    4. Remove the bearing from the rear of the crankshaft.
    5. Remove the special tools from the bearing.

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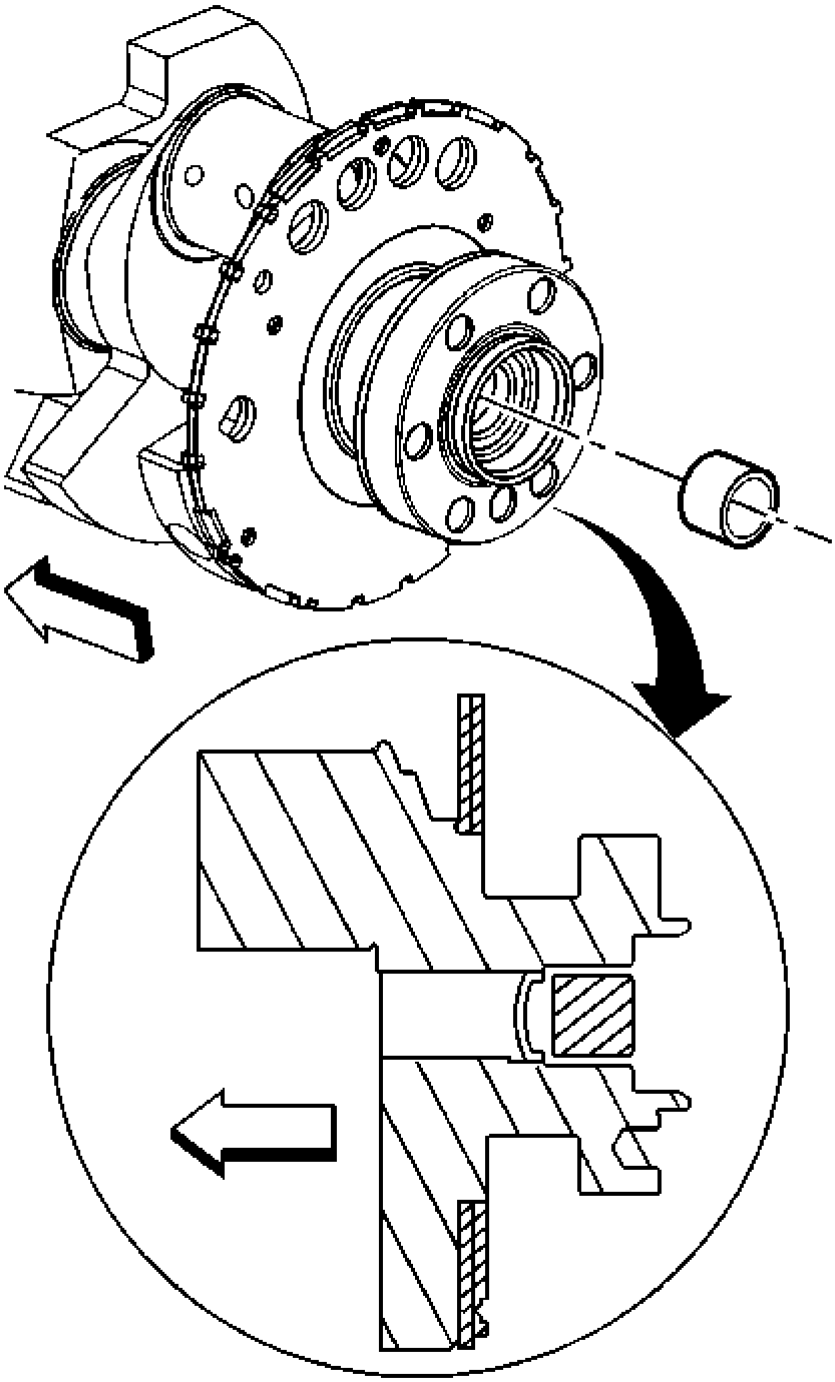


Fig. 12: Pilot Bearing

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Courtesy of GENERAL MOTORS CORP.

2. Discard the bearing.

OIL LEVEL INDICATOR AND TUBE REMOVAL

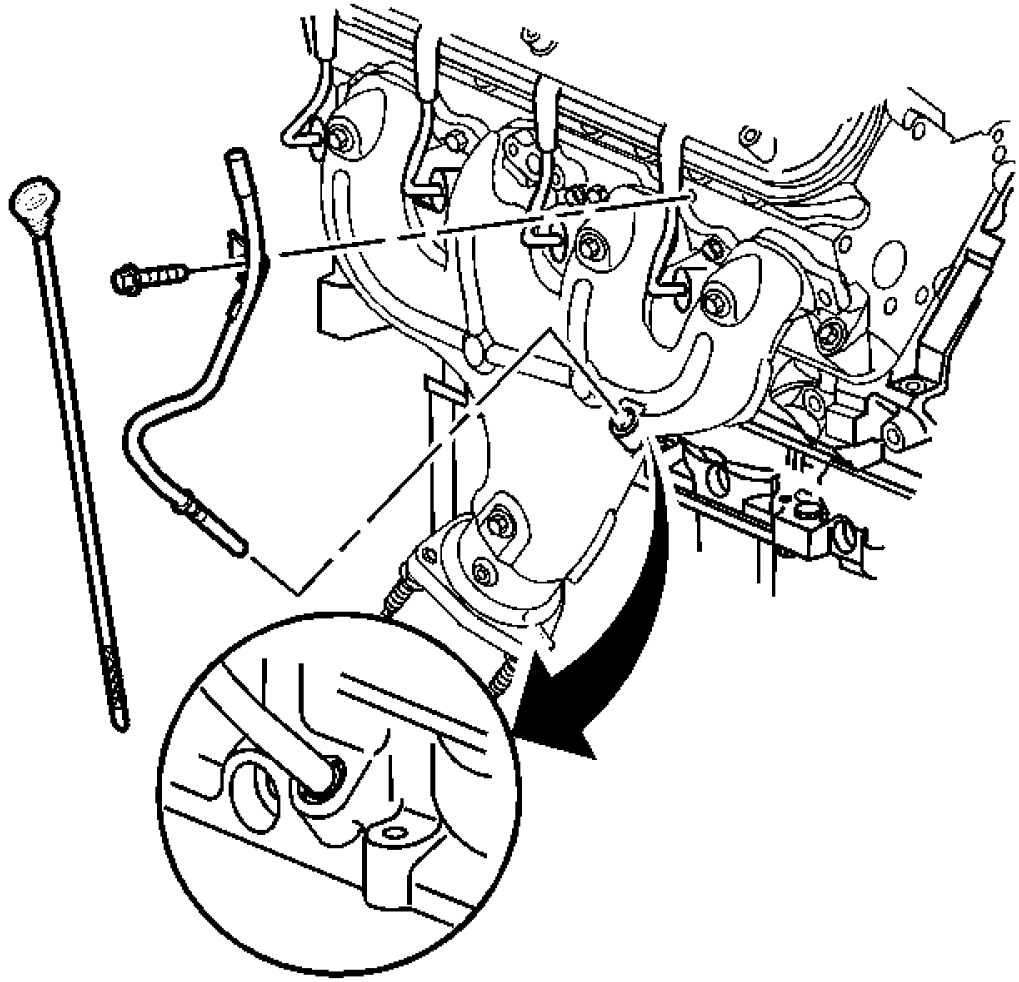


Fig. 13: Oil Level Indicator & Tube
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil level indicator from the tube.
2. Remove the oil level indicator tube bolt.
3. Remove the oil level indicator tube from the engine block.

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NOTE: Inspect the O-ring for cuts or damage. The O-ring may be used again if it is not cut or damaged.

4. Remove the O-ring from the tube, as required.

EXHAUST MANIFOLD REMOVAL - LEFT SIDE

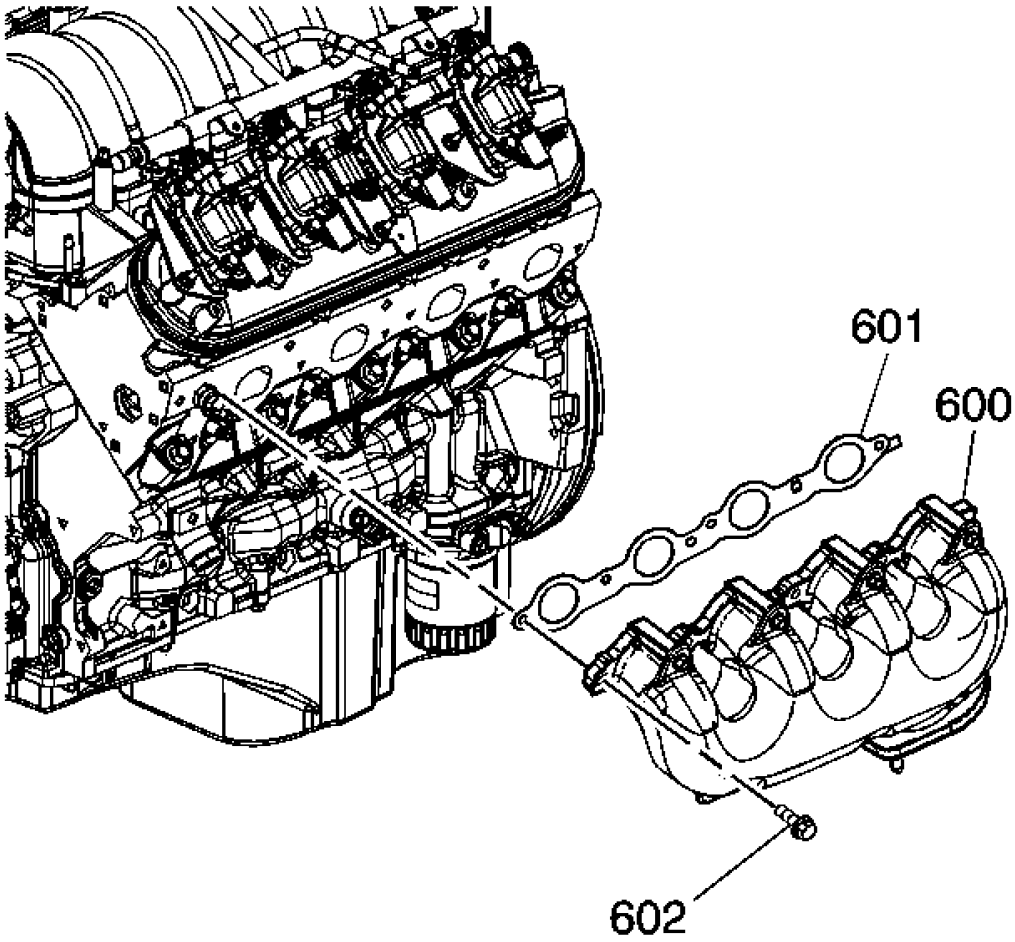


Fig. 14: Exhaust Manifold, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the spark plug wires from the spark plugs.
2. Remove the exhaust manifold (600), bolts (602), and gasket (601).
3. Discard the gasket.

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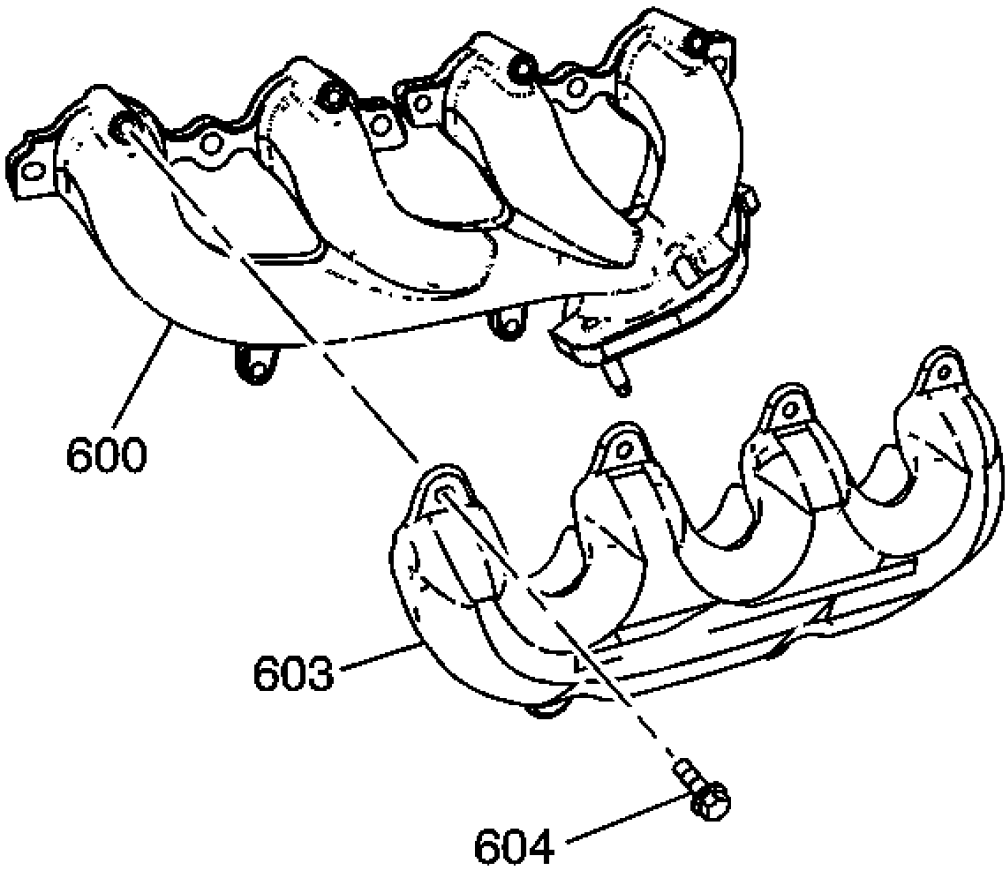


Fig. 15: View Of Exhaust Manifold, Heat Shield & Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the heat shield (603) and bolts (604) from the manifold (600), as required.

EXHAUST MANIFOLD REMOVAL - RIGHT SIDE

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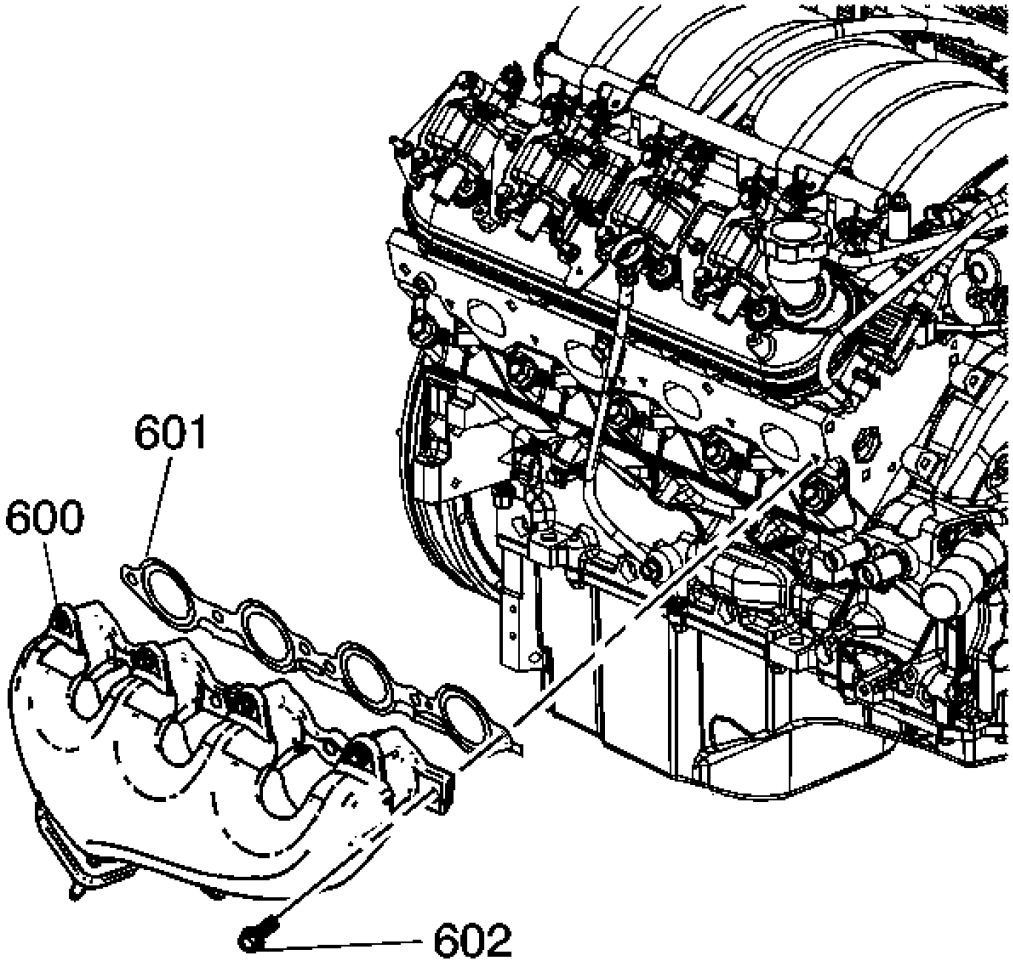


Fig. 16: Exhaust Manifold, Bolts & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Remove the spark plug wires from the spark plugs.
2. Remove the exhaust manifold (600), bolts (602), and gasket (601).
3. Discard the gasket.

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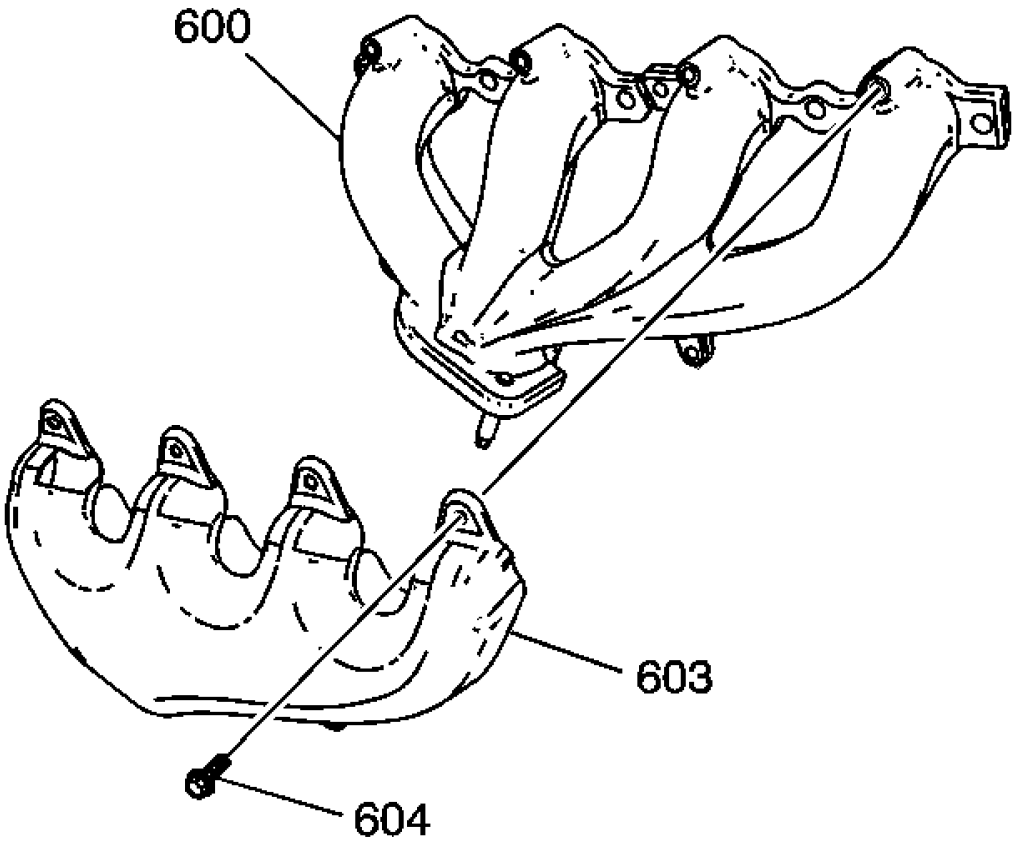


Fig. 17: View Of Heat Shield & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the heat shield (603) and bolts (604) from the manifold (600), as required.

WATER PUMP REMOVAL

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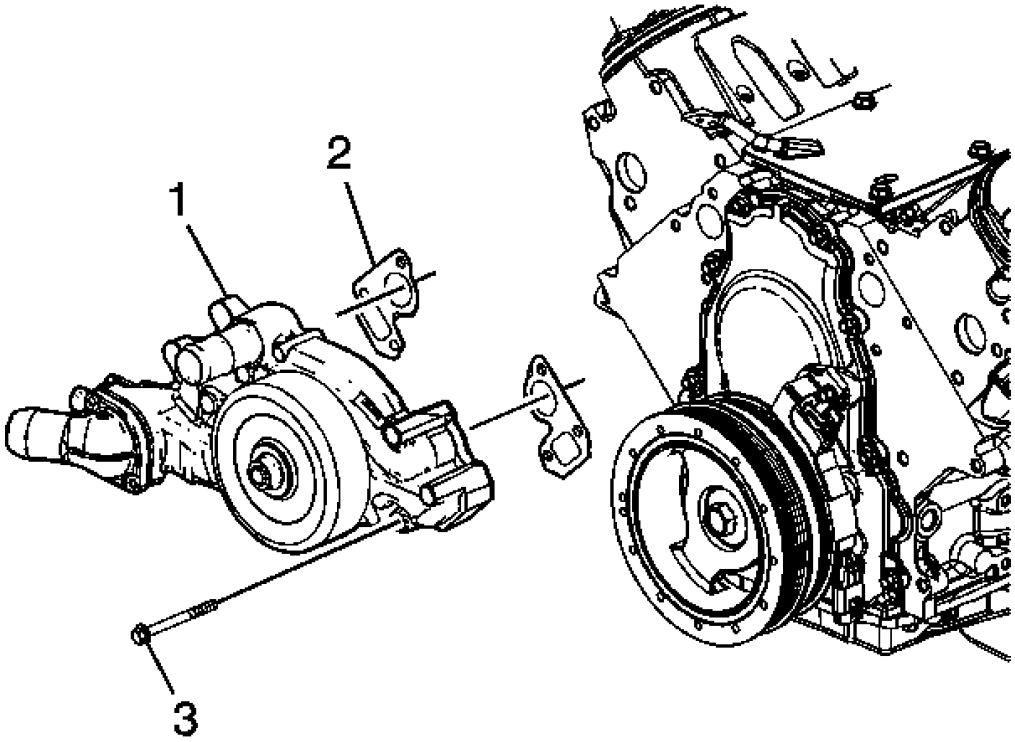


Fig. 18: Water Pump & Gaskets
Courtesy of GENERAL MOTORS CORP.

1. Remove the water pump bolts (3).
2. Remove the water pump (1) and gaskets (2).
3. Discard the water pump gaskets.

THROTTLE BODY ASSEMBLY REMOVAL

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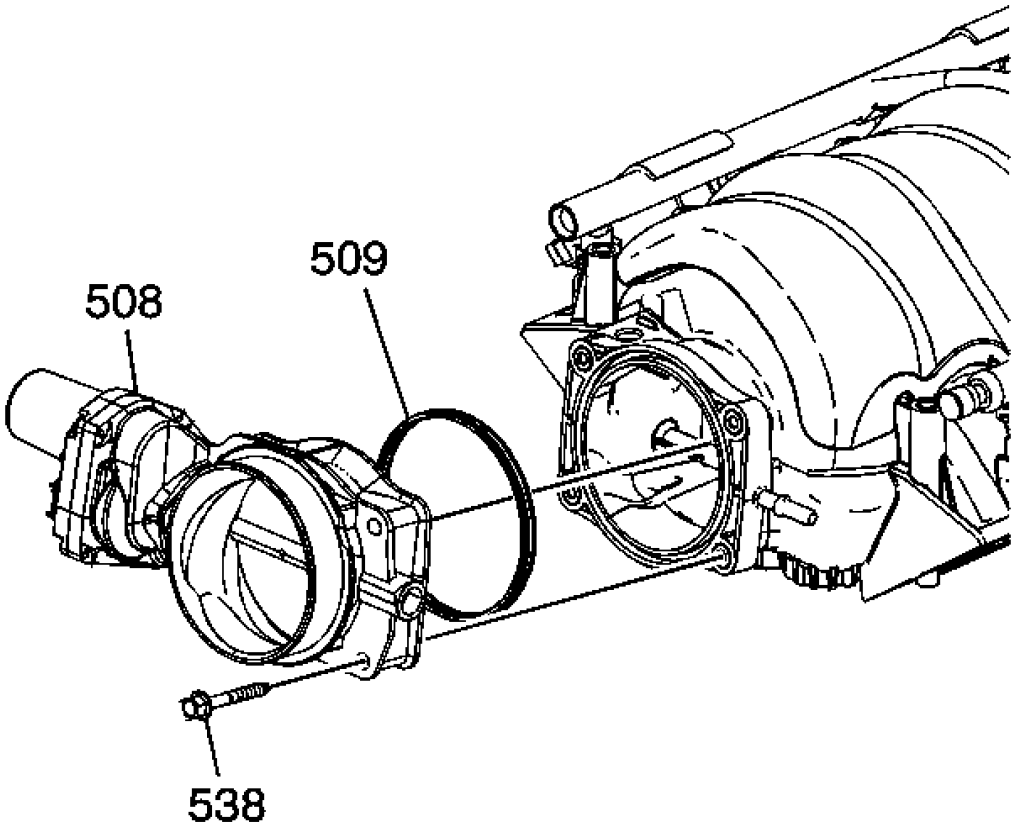


Fig. 19: Removing/Installing Throttle Body
Courtesy of GENERAL MOTORS CORP.

CAUTION: Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.

NOTE: The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

1. Remove the throttle body bolts (538).
2. Remove the throttle body (508).
3. Remove the throttle body gasket (509).

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4. Discard the gasket.

FUEL RAIL AND INJECTORS REMOVAL

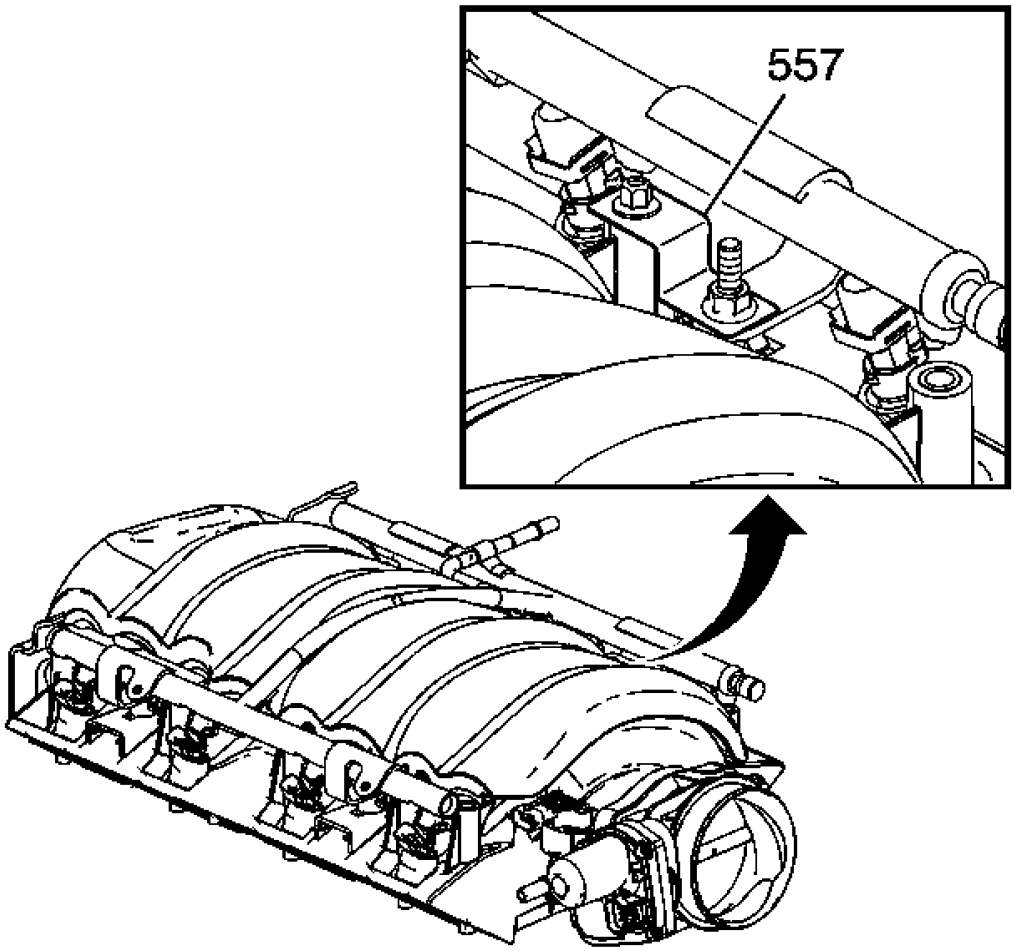


Fig. 20: Exploded View Of Fuel Rail & Injectors
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Fuel Rail Stop Bracket Installation Warning .

NOTE:

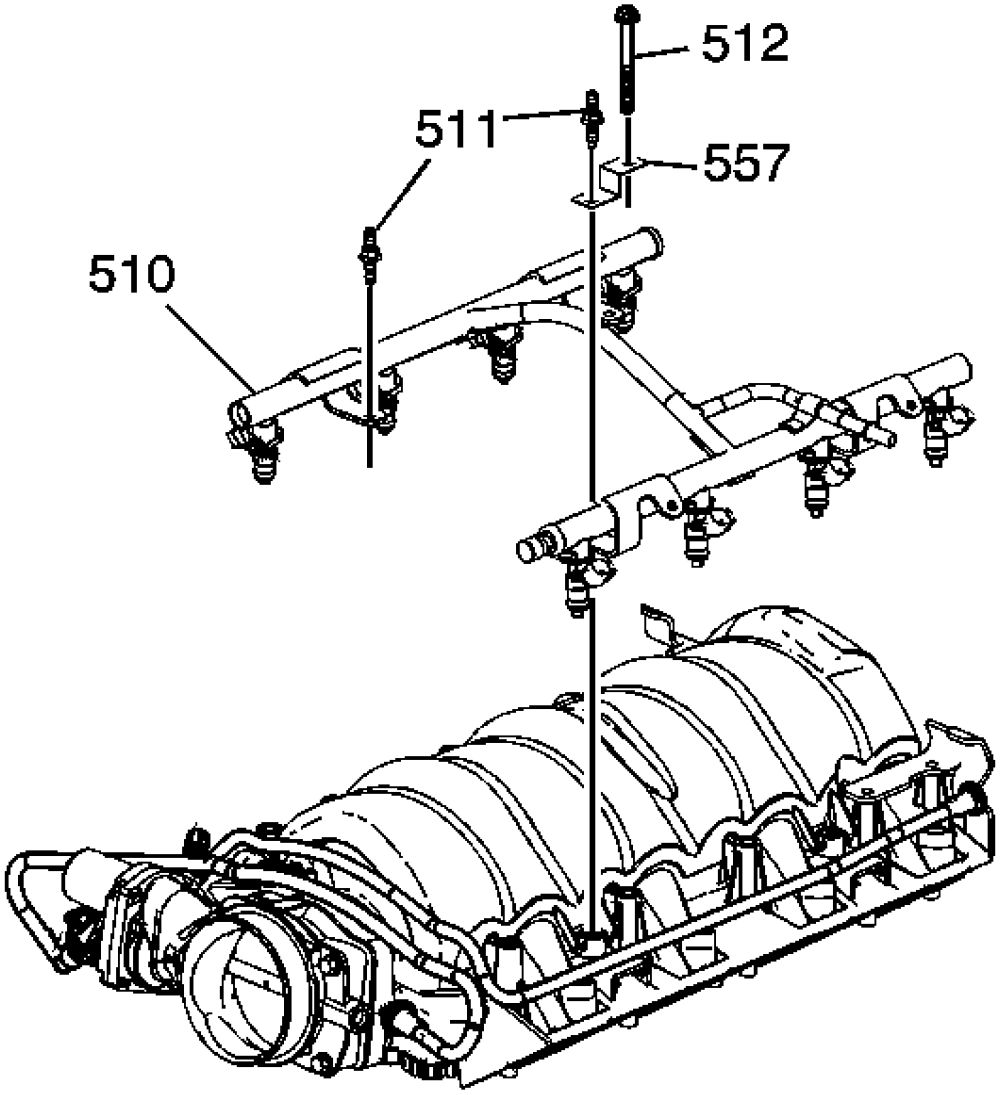
- **The intake manifold, throttle body, fuel injection rail and fuel injectors may be removed as an assembly. If not servicing the individual**

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components, remove the intake manifold as a complete assembly.

- **Do not separate the fuel injectors from the fuel rail unless component service is required.**
- **Use cleanliness and care when handling the fuel system components. Do not allow dirt or debris to enter the fuel injectors or fuel rail components. Cap ends as necessary.**

1. Note the location of the fuel rail ground strap (557).



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Fig. 21: Removing/Installing Bolts, Ground Strap, Fuel Rail & Injectors
Courtesy of GENERAL MOTORS CORP.

2. Remove the bolts (511 and 512), ground strap (557), and fuel rail with injectors (510). Lift evenly on both sides of the fuel rail until all injectors have left their bores.

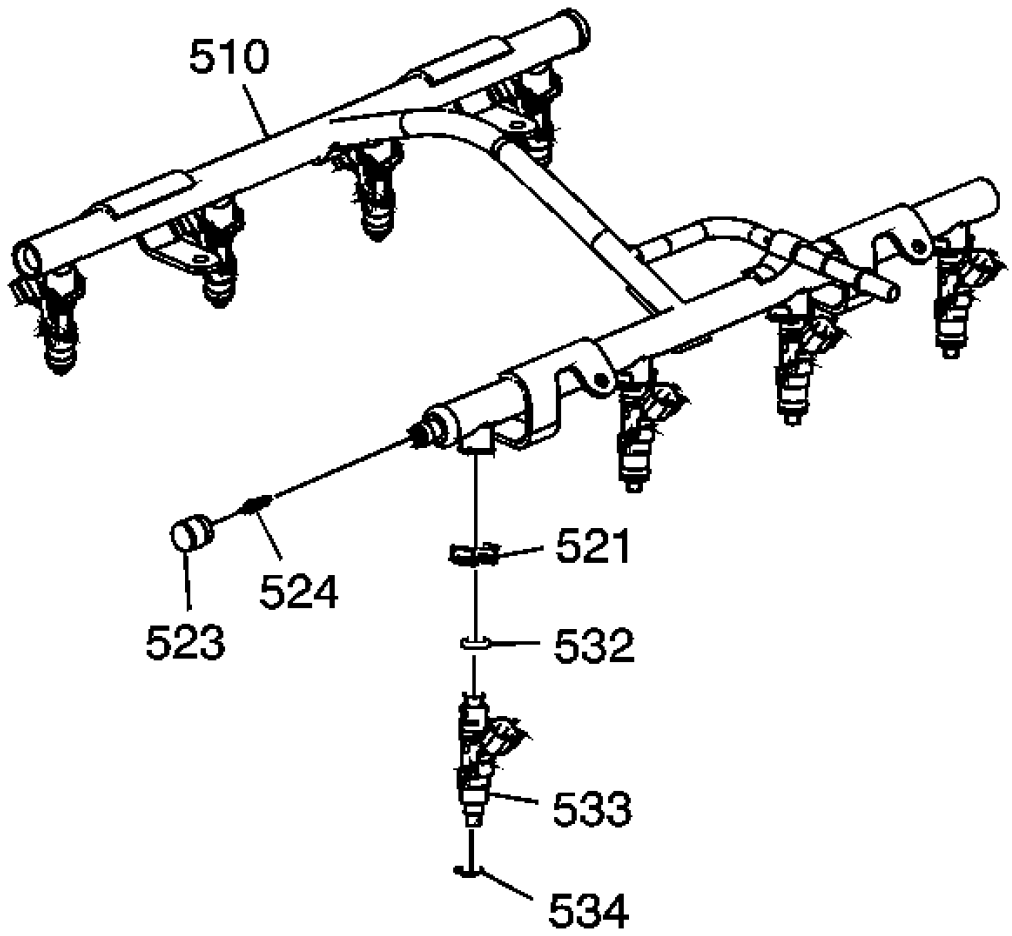


Fig. 22: Fuel Injectors & Retainers
Courtesy of GENERAL MOTORS CORP.

3. Remove the fuel injectors (533) and retainers (521).
4. Remove the O-rings (532 and 534), as required.
5. Remove the cap (523) and service valve (524), as required.

INTAKE MANIFOLD REMOVAL

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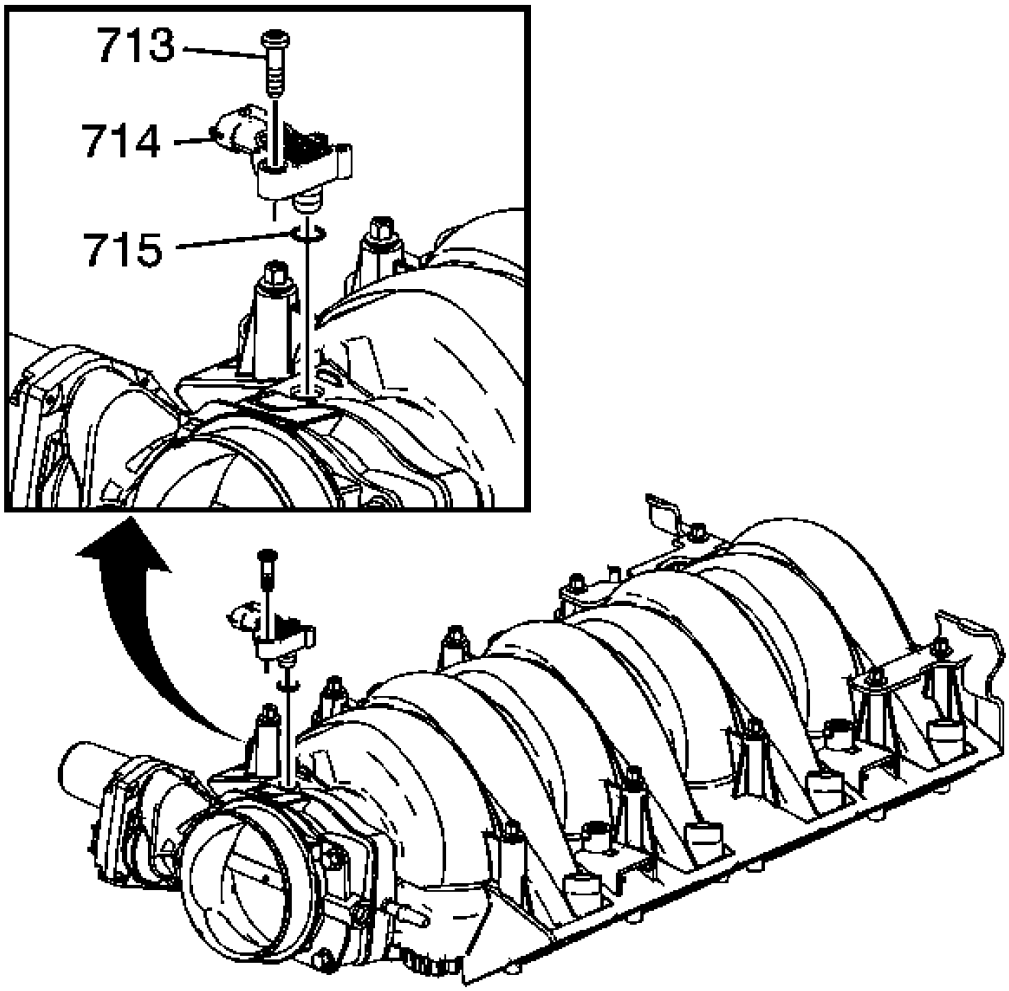


Fig. 23: Identifying Sensor Grommet, MAP Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, remove the manifold as a complete assembly.

1. Remove the manifold absolute pressure (MAP) sensor bolt (713).
2. Remove the MAP sensor (714).
3. Remove the seal (715) from the sensor, as required.

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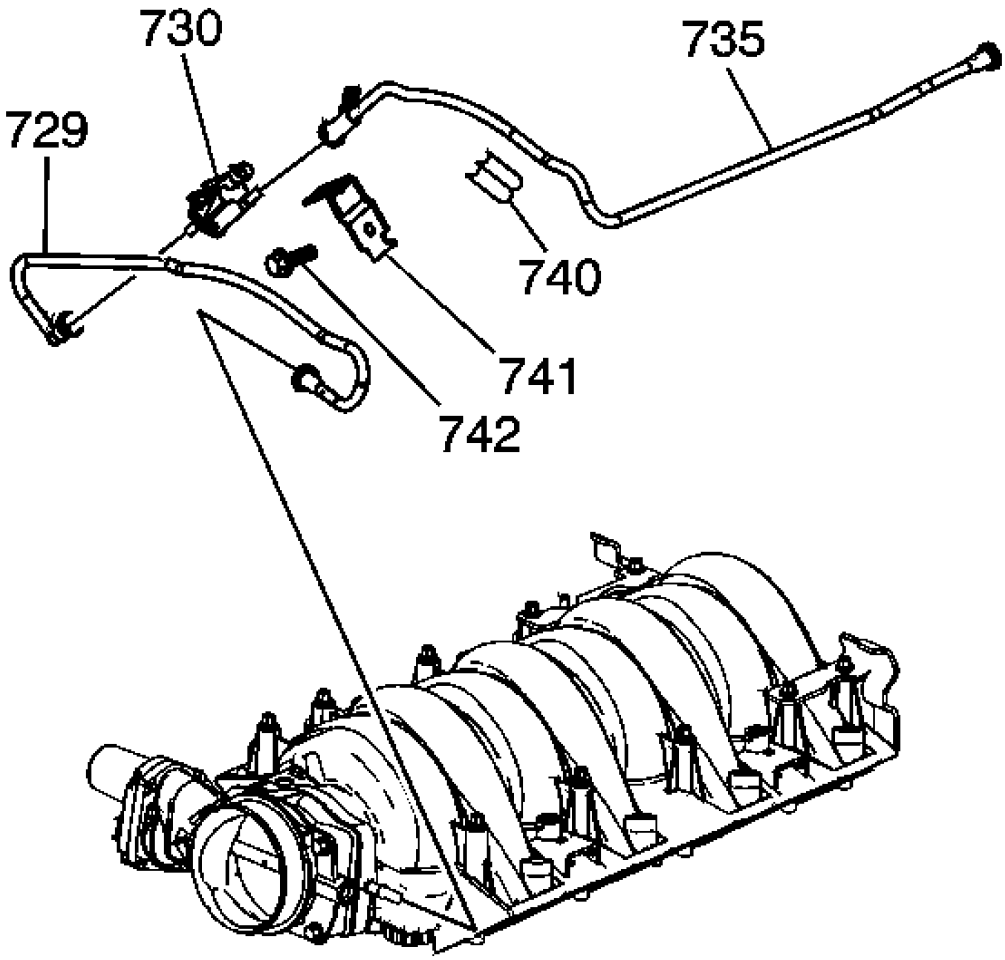


Fig. 24: Identifying Evaporative Emission Components
Courtesy of GENERAL MOTORS CORP.

4. Remove the evaporative emission (EVAP) clip (740), bolt (742), bracket (741), canister purge solenoid valve (730), and tubes (729 and 735).

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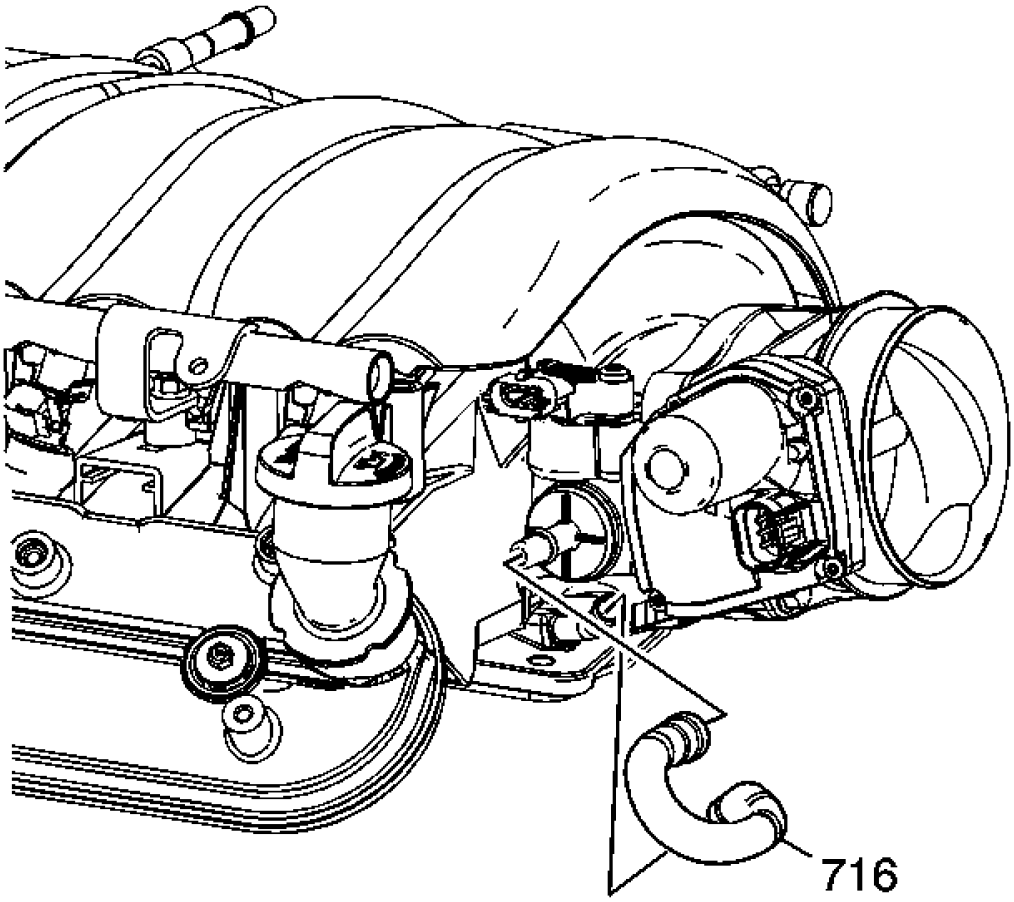


Fig. 25: Removing/Installing Positive Crankcase Ventilation (PCV) Hose
Courtesy of GENERAL MOTORS CORP.

5. Remove the positive crankcase ventilation (PCV) hose - dirty air (716).

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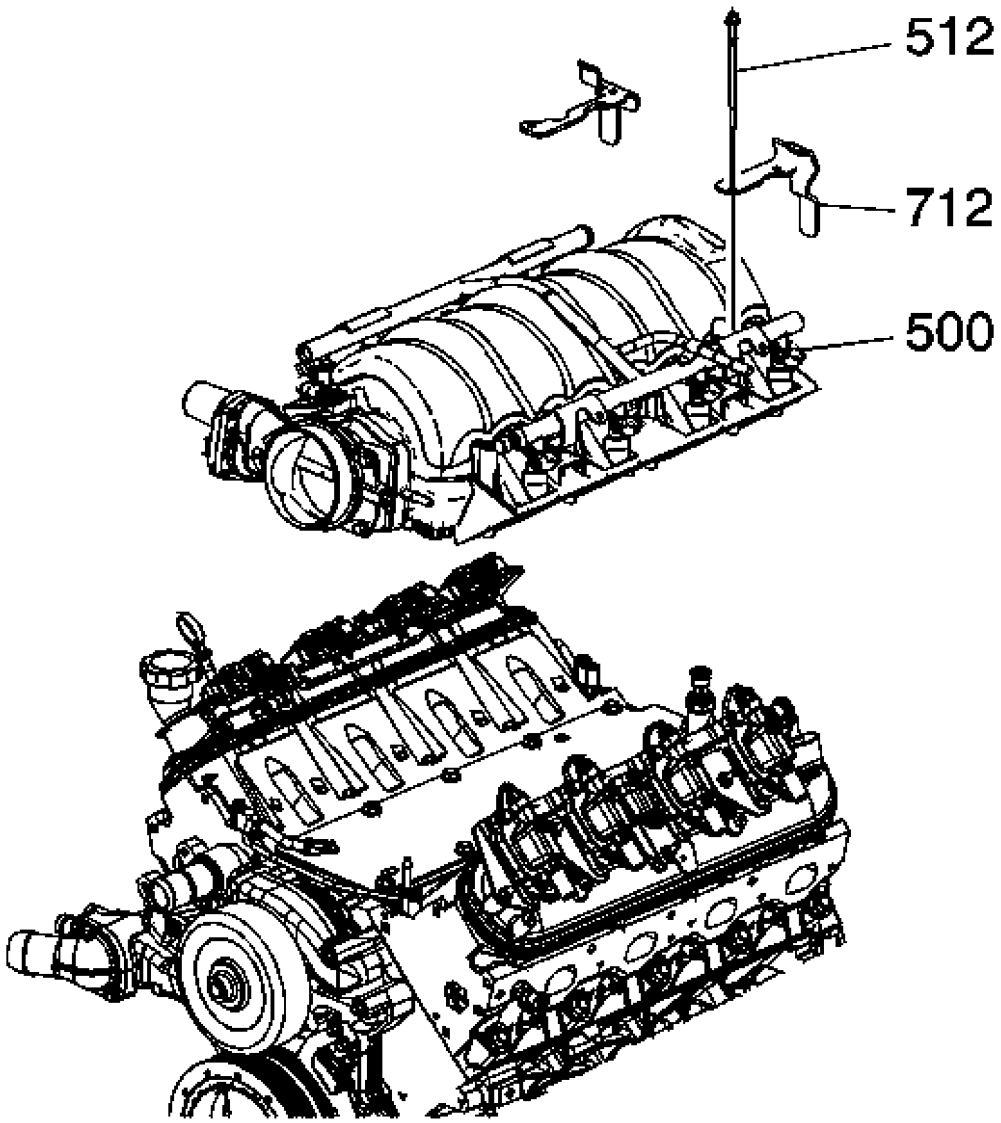


Fig. 26: Identifying Intake Manifold, Bolts & Fuel Rail Stop Brackets
Courtesy of GENERAL MOTORS CORP.

6. Remove the intake manifold bolts (512) and fuel rail stop brackets (712).
7. Remove the intake manifold (500).

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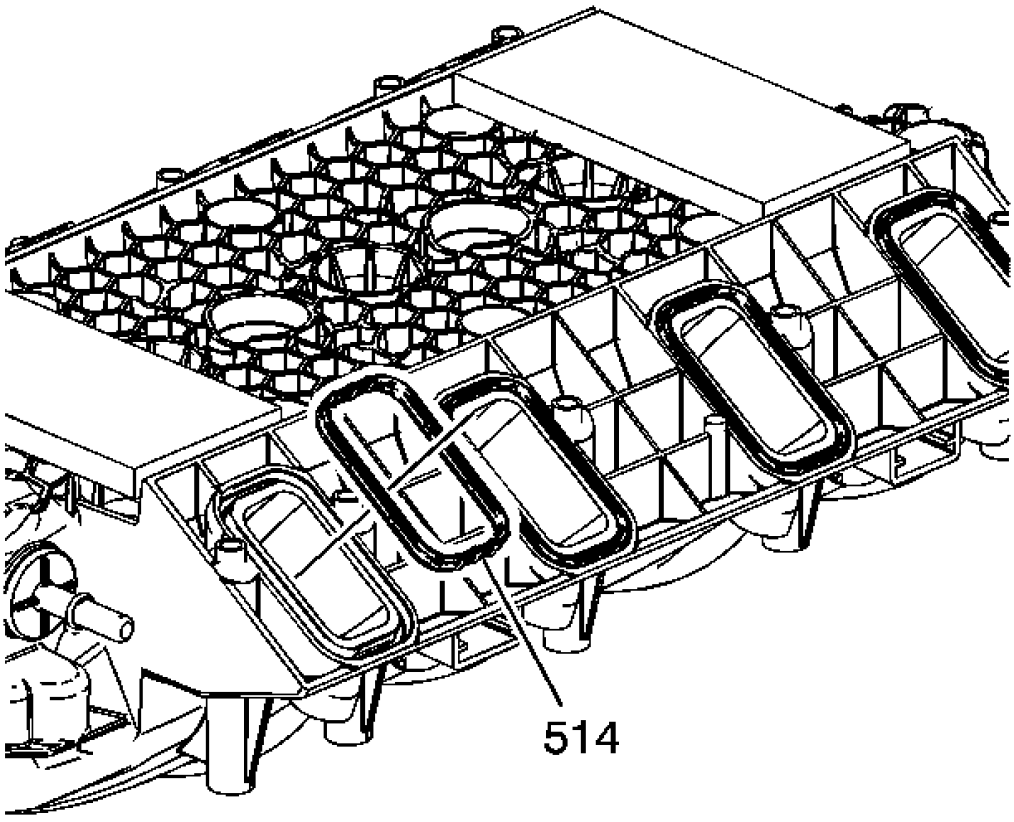


Fig. 27: View Of Intake Manifold-To-Cylinder Head Gaskets
Courtesy of GENERAL MOTORS CORP.

8. Remove the intake manifold gaskets (514).
9. Discard the intake manifold gaskets.

ENGINE COOLANT AIR BLEED PIPE AND HOLE COVER REMOVAL

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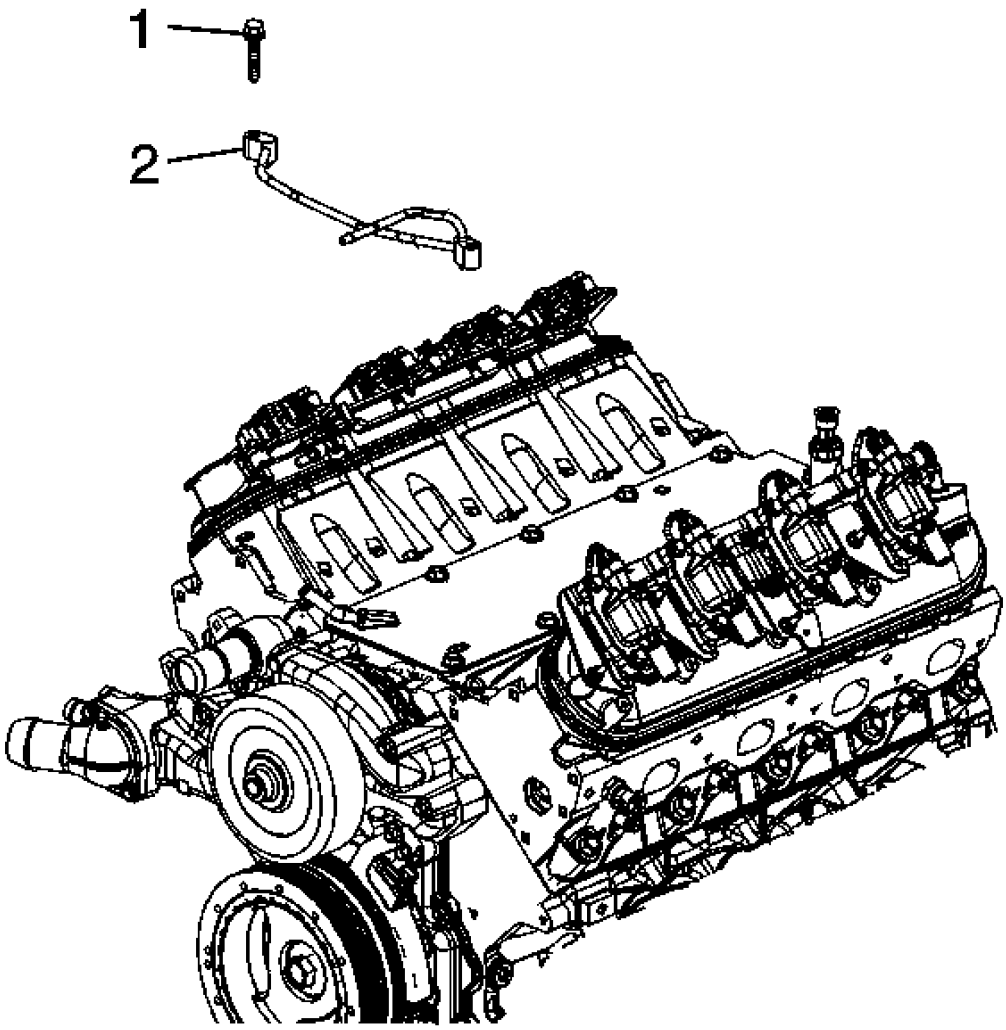


Fig. 28: Engine Coolant Air Bleed Pipe & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine coolant air bleed pipe bolts (1).
2. Remove the pipe (2).

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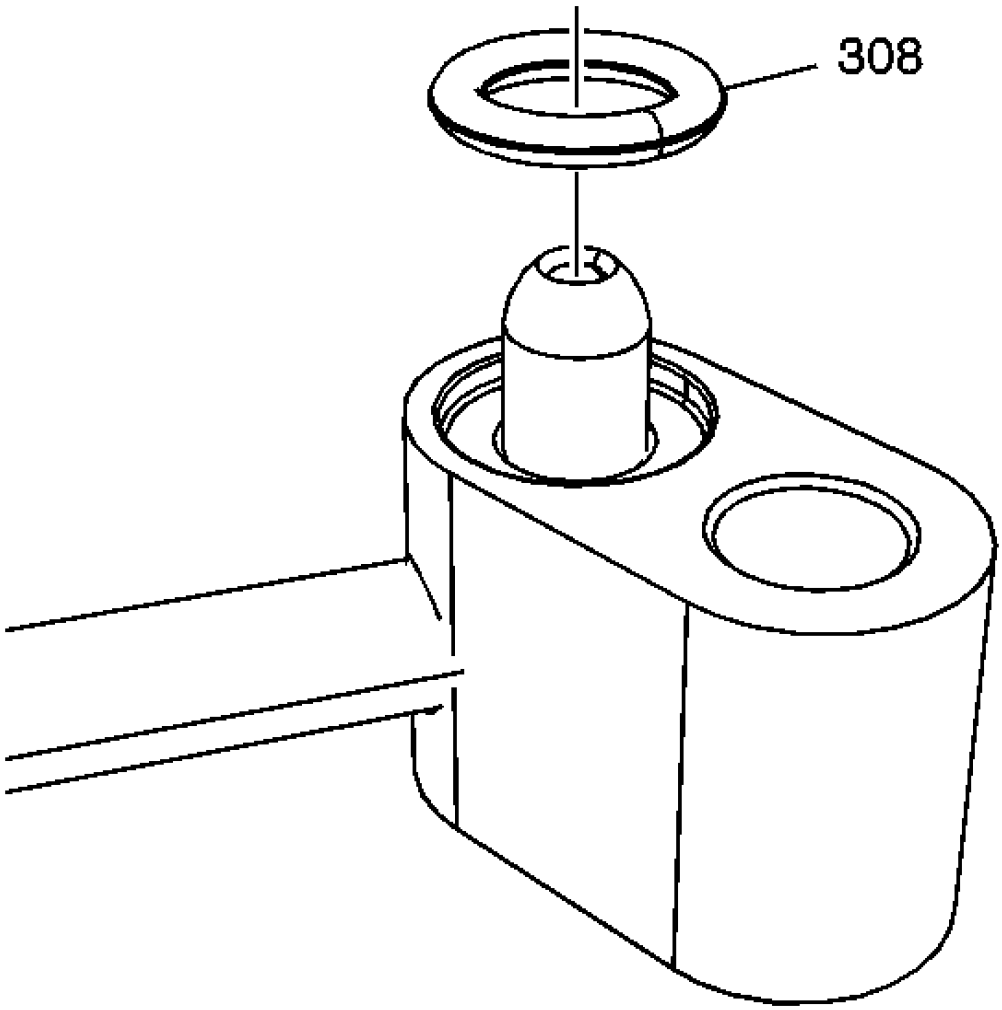


Fig. 29: View Of Coolant Air Bleed Pipe Seal
Courtesy of GENERAL MOTORS CORP.

3. Remove the seals (308) from the pipe.
4. Discard the seals.

ENGINE BLOCK VALLEY COVER REMOVAL (6.2L LS3)

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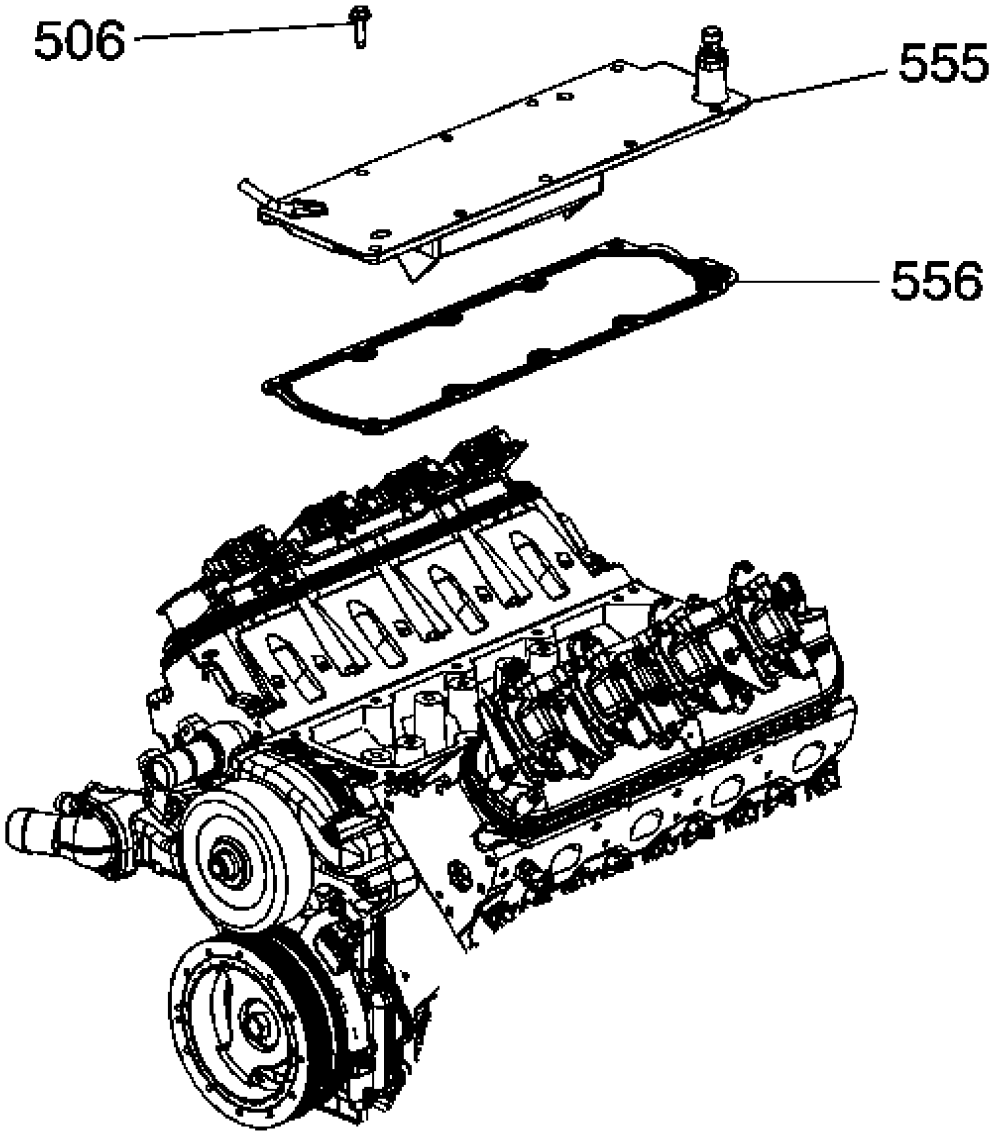


Fig. 30: View Of Engine Valley Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine block valley cover bolts (506).
2. Remove the valley cover (555) and gasket (556).

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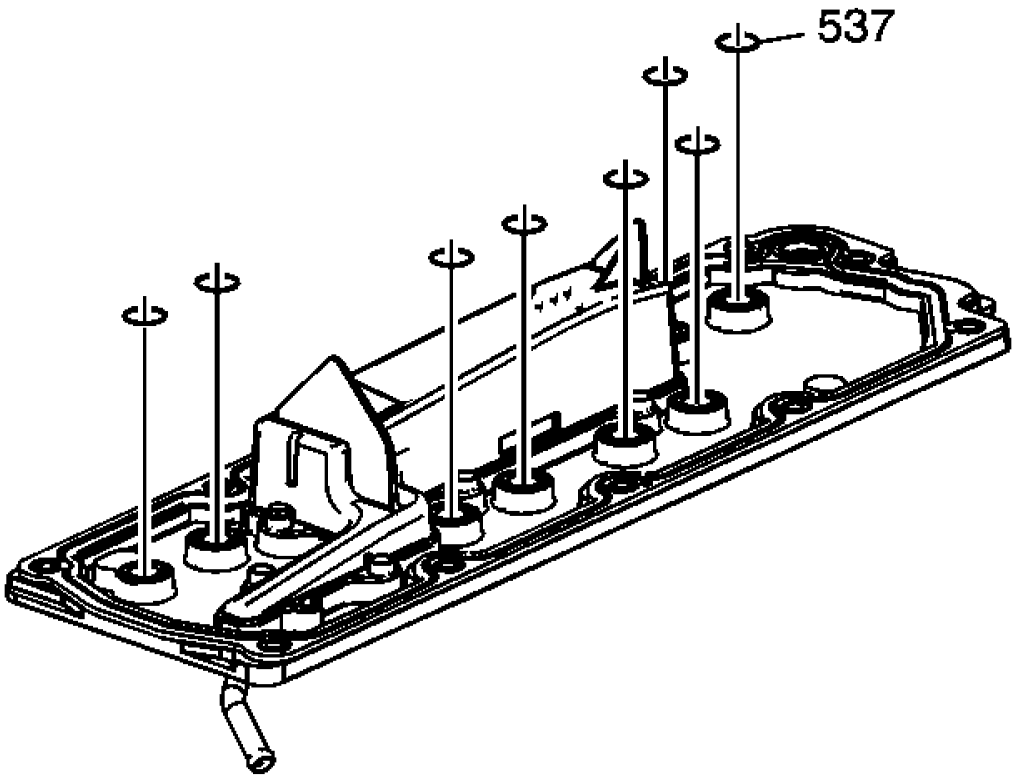


Fig. 31: Valley Cover Seals
Courtesy of GENERAL MOTORS CORP.

3. Remove the seals (537) from the cover.

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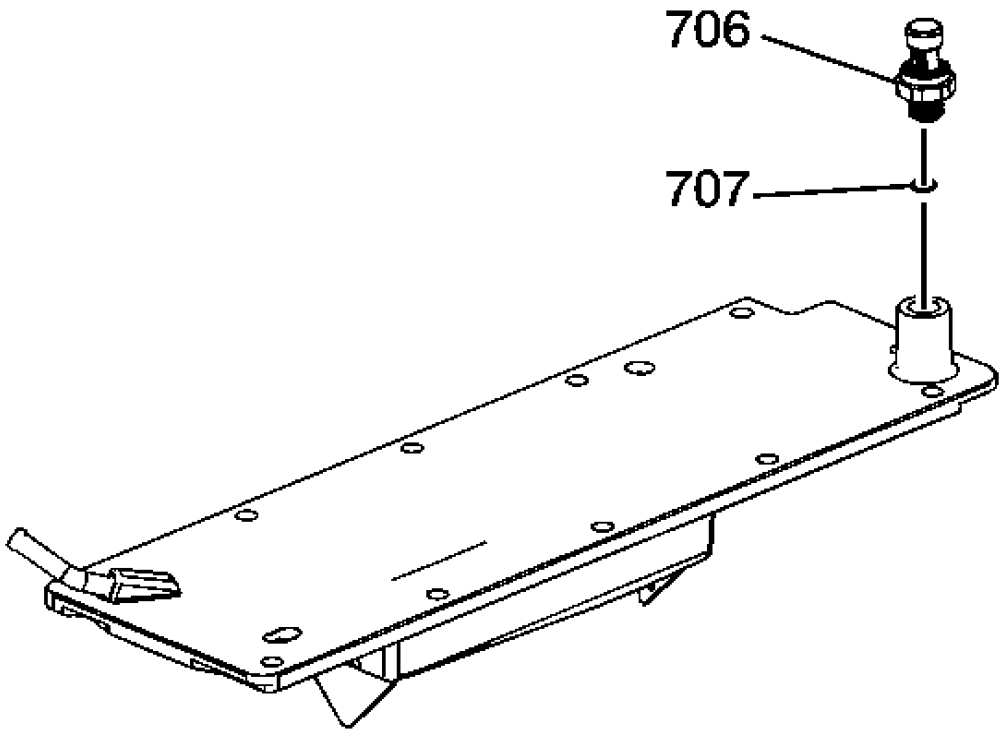


Fig. 32: Oil Pressure Sensor & Seal
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine oil pressure sensor (706) and seal (707), as required.

VALVE LIFTER OIL MANIFOLD REMOVAL

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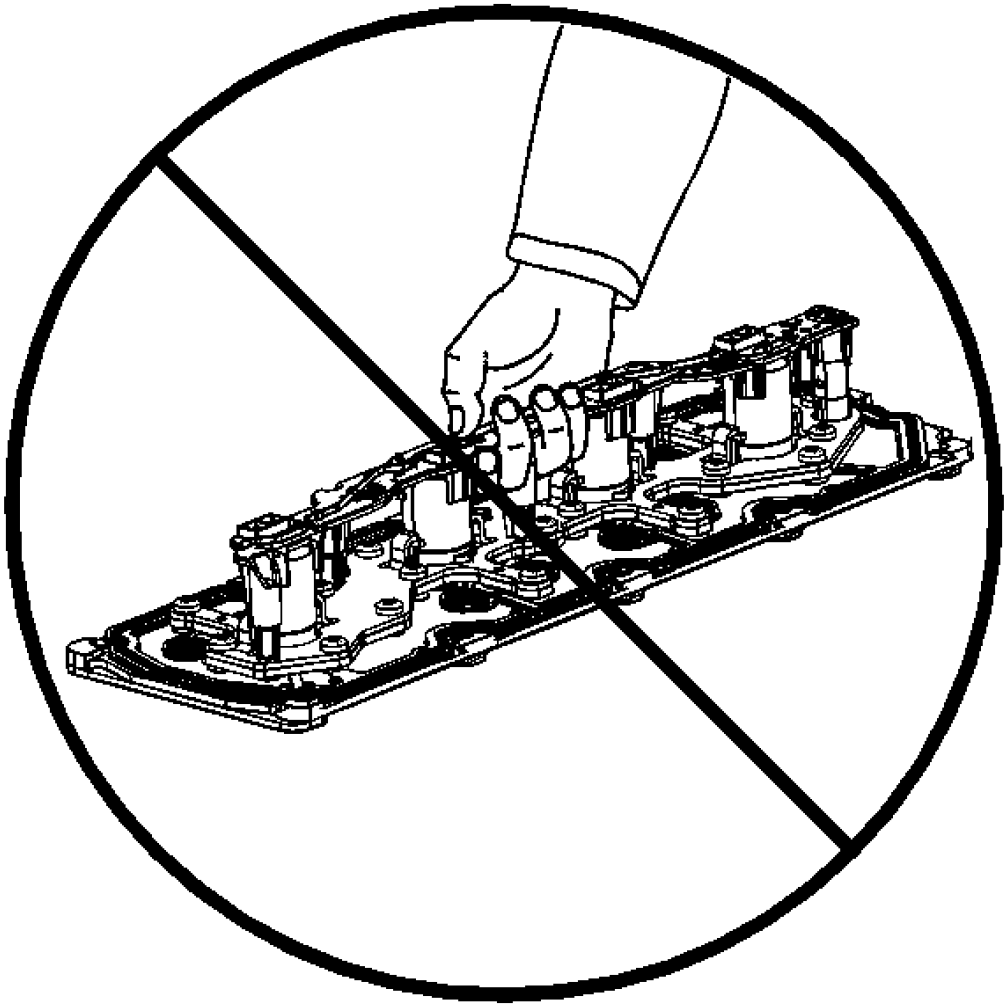


Fig. 33: Valve Lifter Oil Manifold Handling Precaution
Courtesy of GENERAL MOTORS CORP.

1. Do not lift the manifold by the electrical lead frame.

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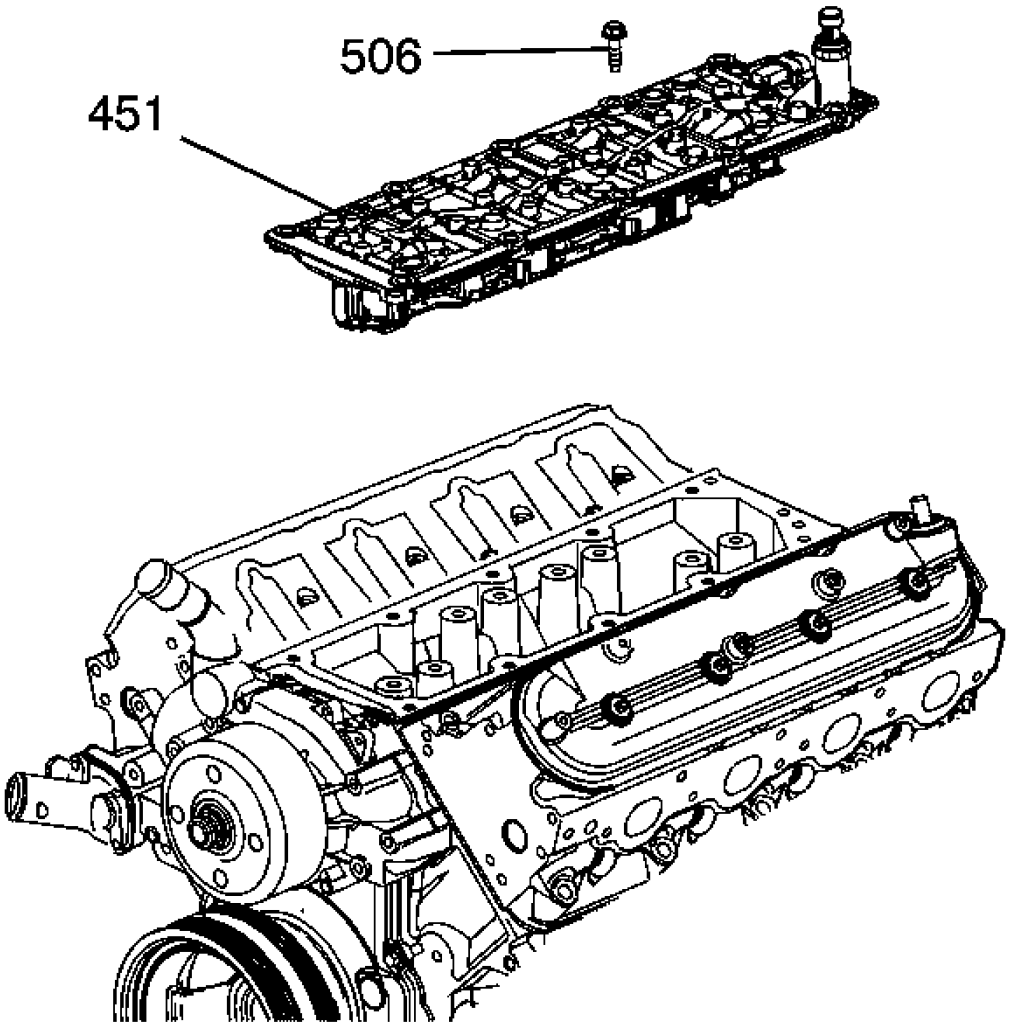


Fig. 34: View Of Valve Lifter Oil Manifold
Courtesy of GENERAL MOTORS CORP.

2. Remove the valve lifter oil manifold bolts (506).

IMPORTANT: Do not allow dirt or debris to enter the oil passages of the manifold. Plug, as required.

3. Remove the valve lifter oil manifold (451).

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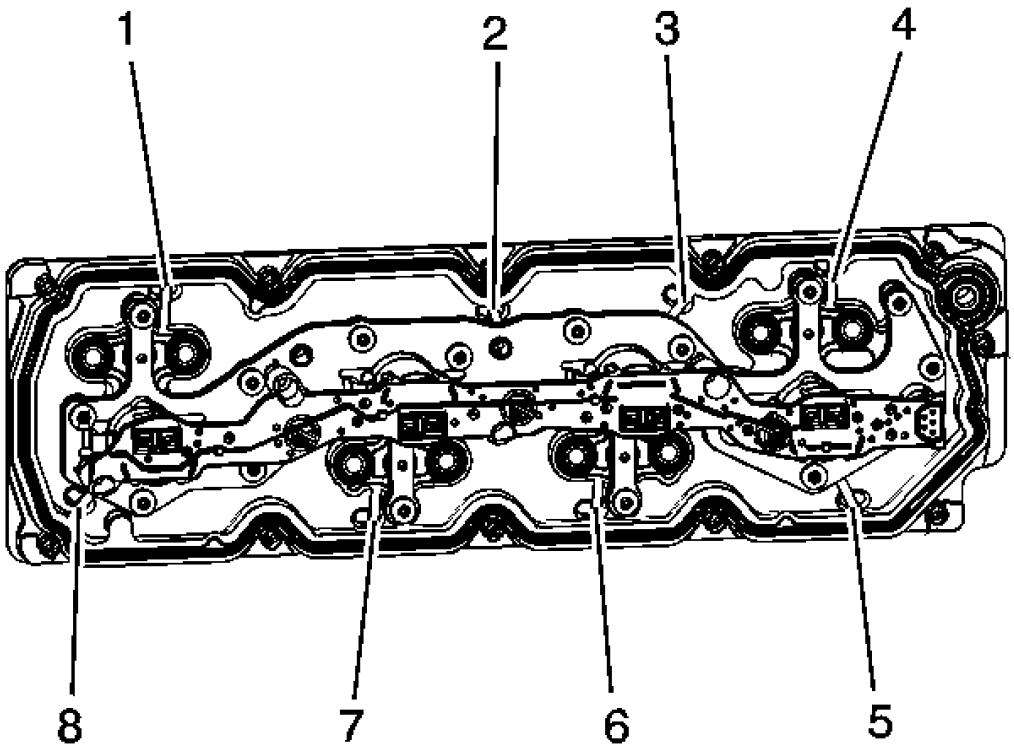


Fig. 35: Gasket Retaining Strap Locations
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Remove only the outer gasket from the manifold. Do not disassemble any of the internal components of the manifold in an attempt to remove the 8 inner sealing gaskets. If the inner gaskets are cut or damaged, replace the manifold as an assembly. Only use a wire-cutter type tool in order to minimize the amount of debris. Do not use a rotary-type cutting tool on the retaining straps.

4. Identify the 8 gasket retaining strap locations (1-8).

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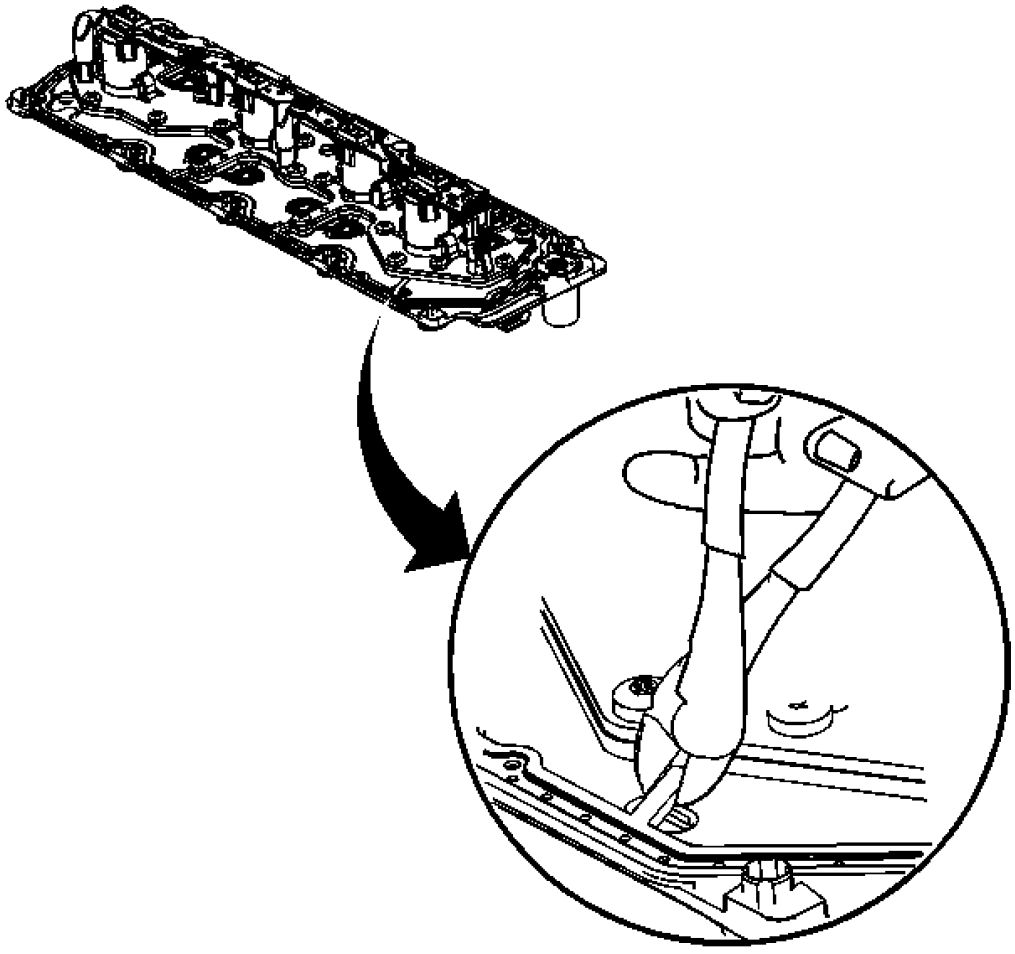


Fig. 36: Cutting Retaining Strap
Courtesy of GENERAL MOTORS CORP.

5. Using a wire-cutter type tool, cut the 8 retaining straps.

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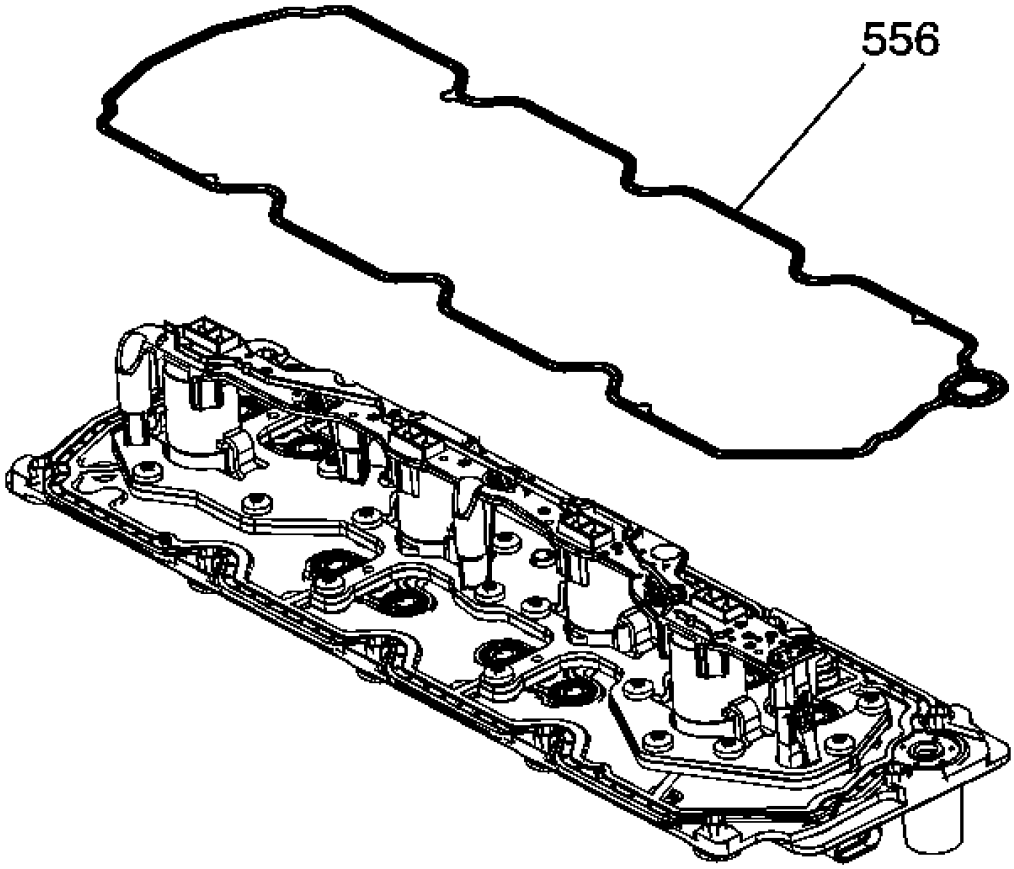


Fig. 37: Outer Gasket
Courtesy of GENERAL MOTORS CORP.

6. Remove the outer gasket (556) from the manifold.

VALVE LIFTER OIL FILTER REMOVAL

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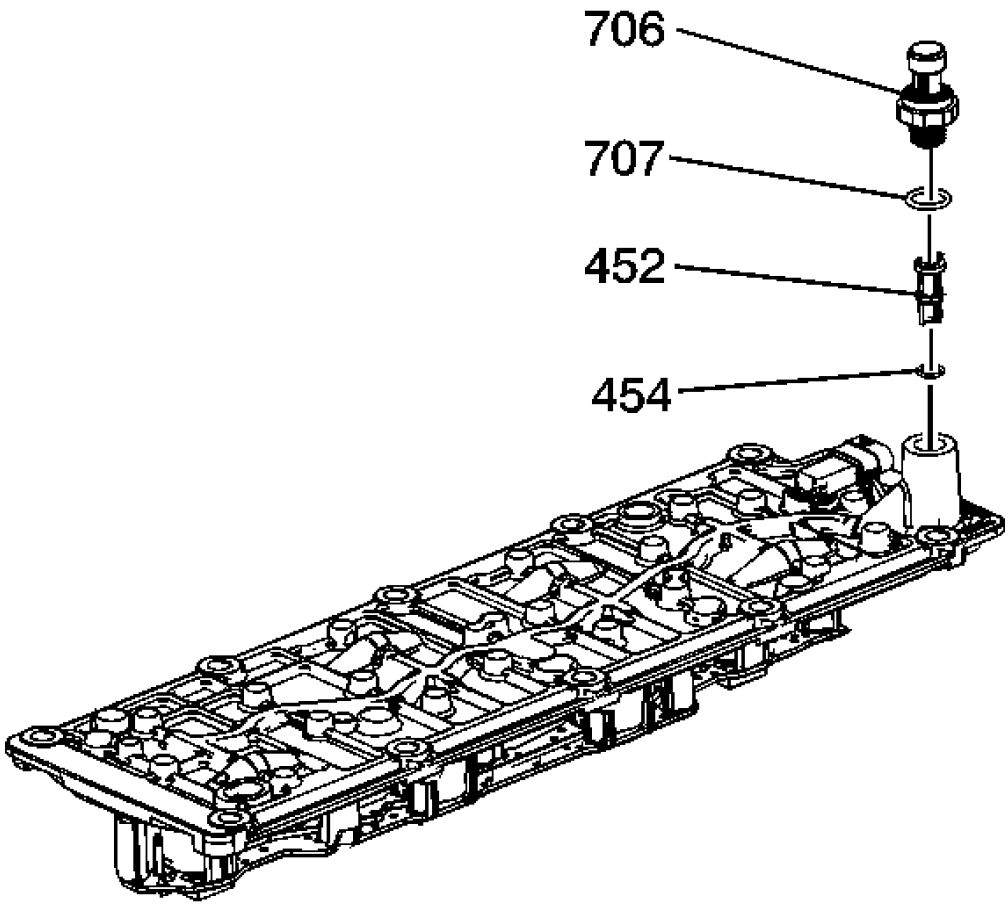


Fig. 38: Valve Lifter Oil Filter
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not allow dirt or debris to enter the oil passages of the manifold. Plug, as required.

1. Remove the oil pressure sensor (706) and washer (707).
2. Remove the oil filter (452).
3. Inspect the O-ring (454) for cuts or damage. If the filter is plugged or the O-ring is cut or damaged, replace the filter and O-ring as an assembly.

VALVE ROCKER ARM COVER REMOVAL - LEFT SIDE

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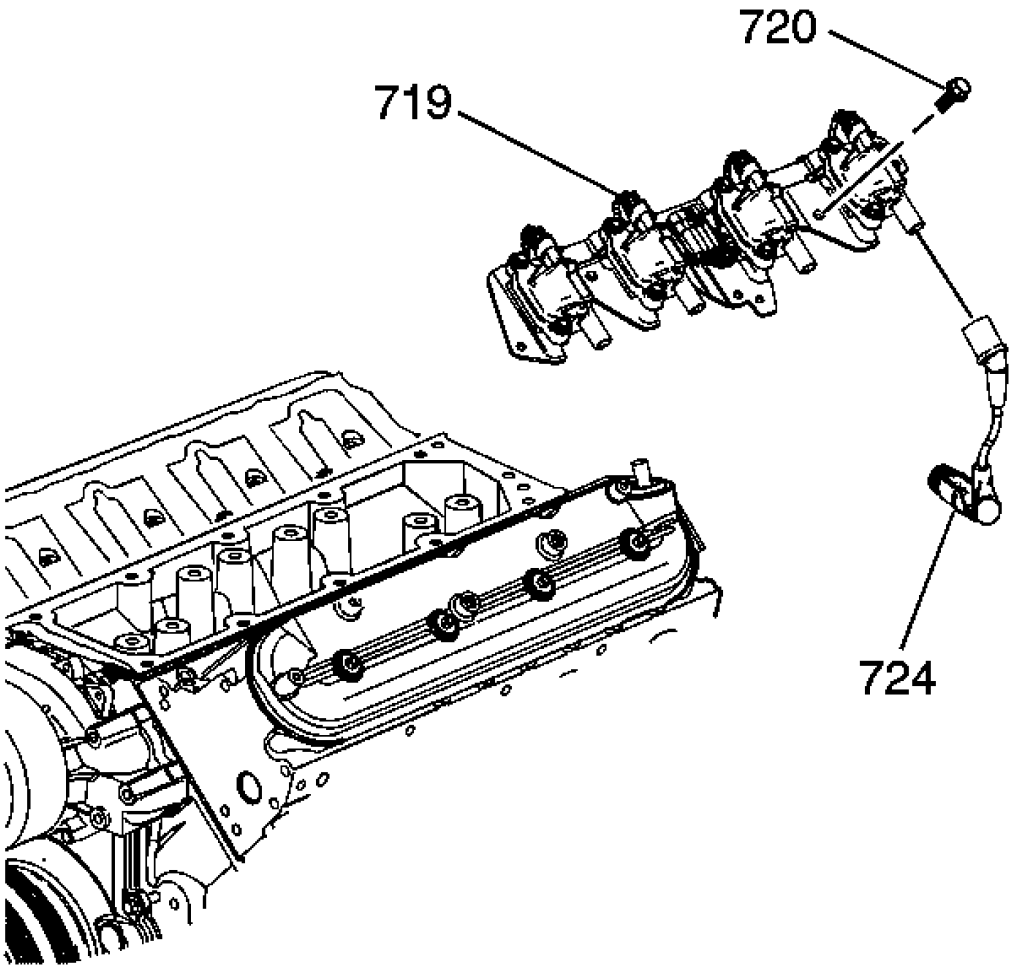


Fig. 39: Ignition Coils & Bracket
Courtesy of GENERAL MOTORS CORP.

1. Remove the spark plug wires (724).
2. Remove the ignition coil bracket studs (720).
3. Remove the ignition coil and bracket assembly (719).

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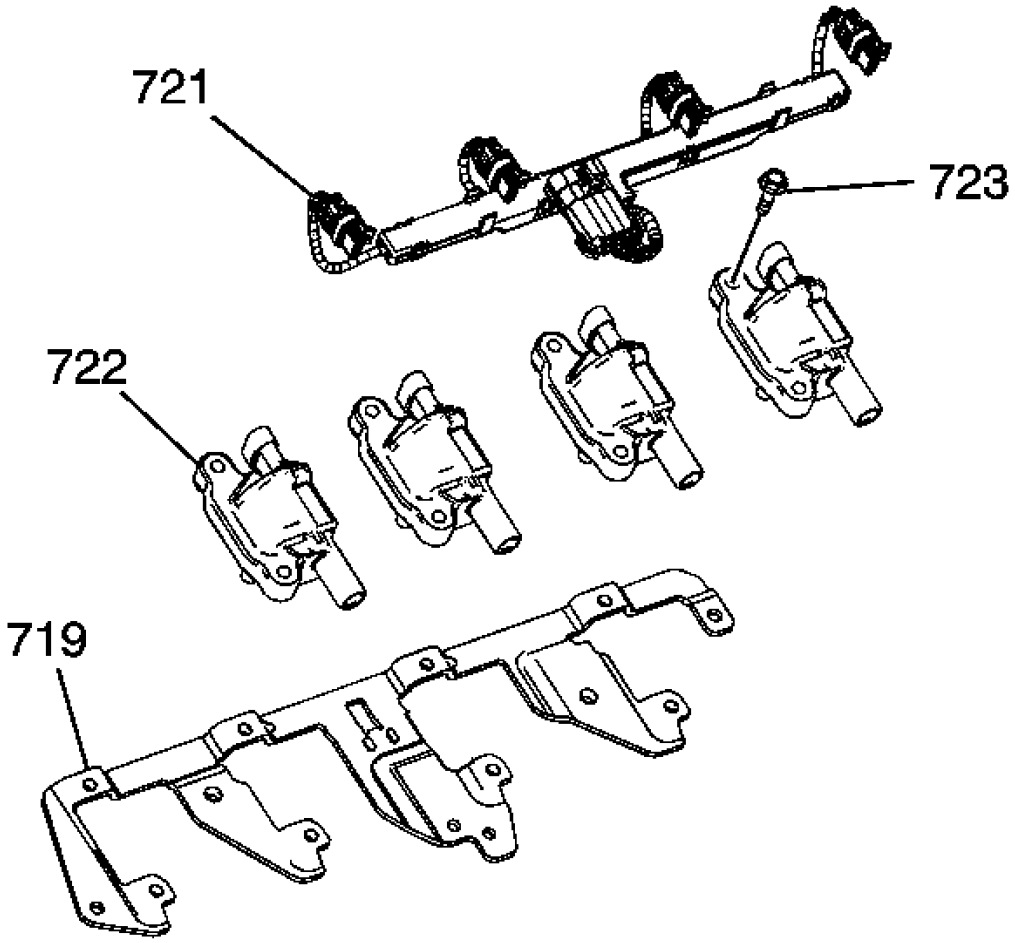


Fig. 40: View Of Bracket, Bolts, Coils & Wire Harness
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the ignition coil electrical connectors.
5. Remove the bolts (723), coils (722), and wire harness (721) from the bracket (719), as required.

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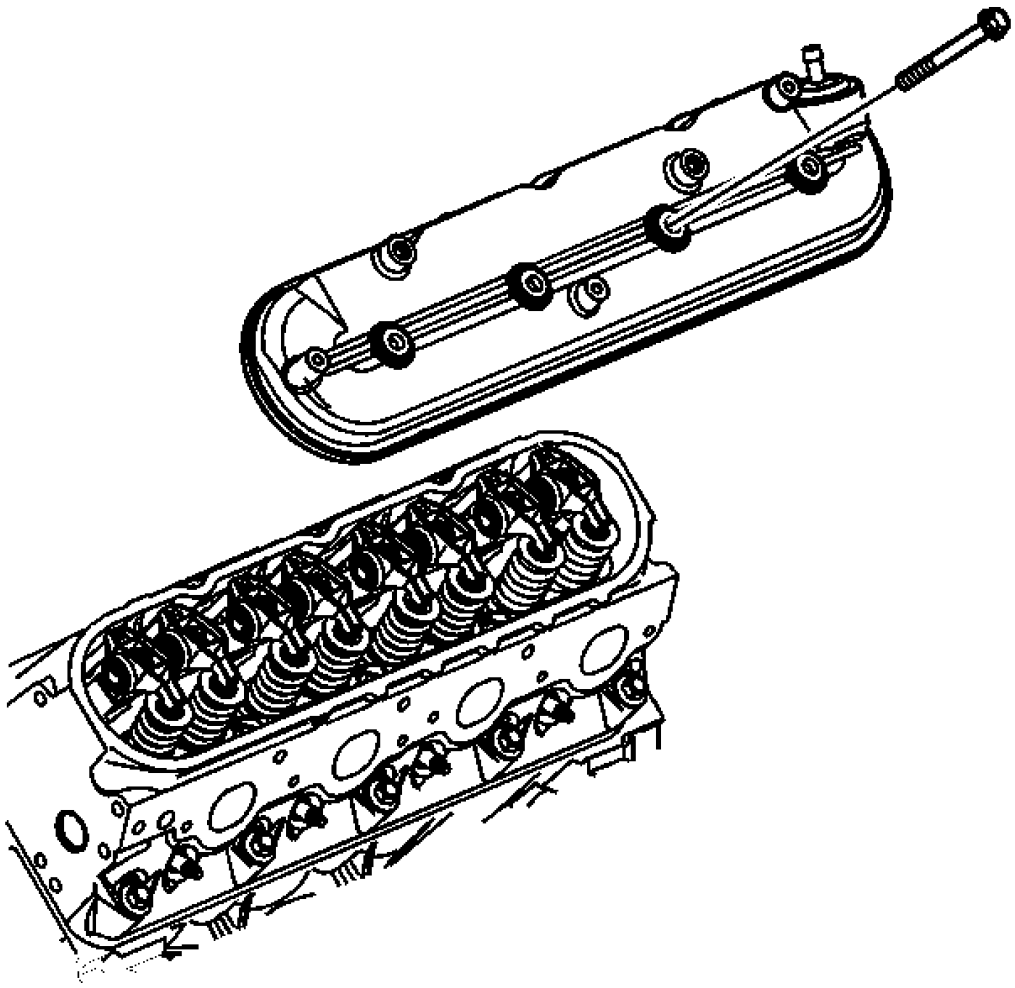


Fig. 41: View Of Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

6. Remove the valve rocker arm cover bolts and cover.
7. If the valve rocker arm cover grommets are cracked or damaged, replace the valve rocker arm cover bolts. The grommet is serviced with the rocker arm cover bolt.

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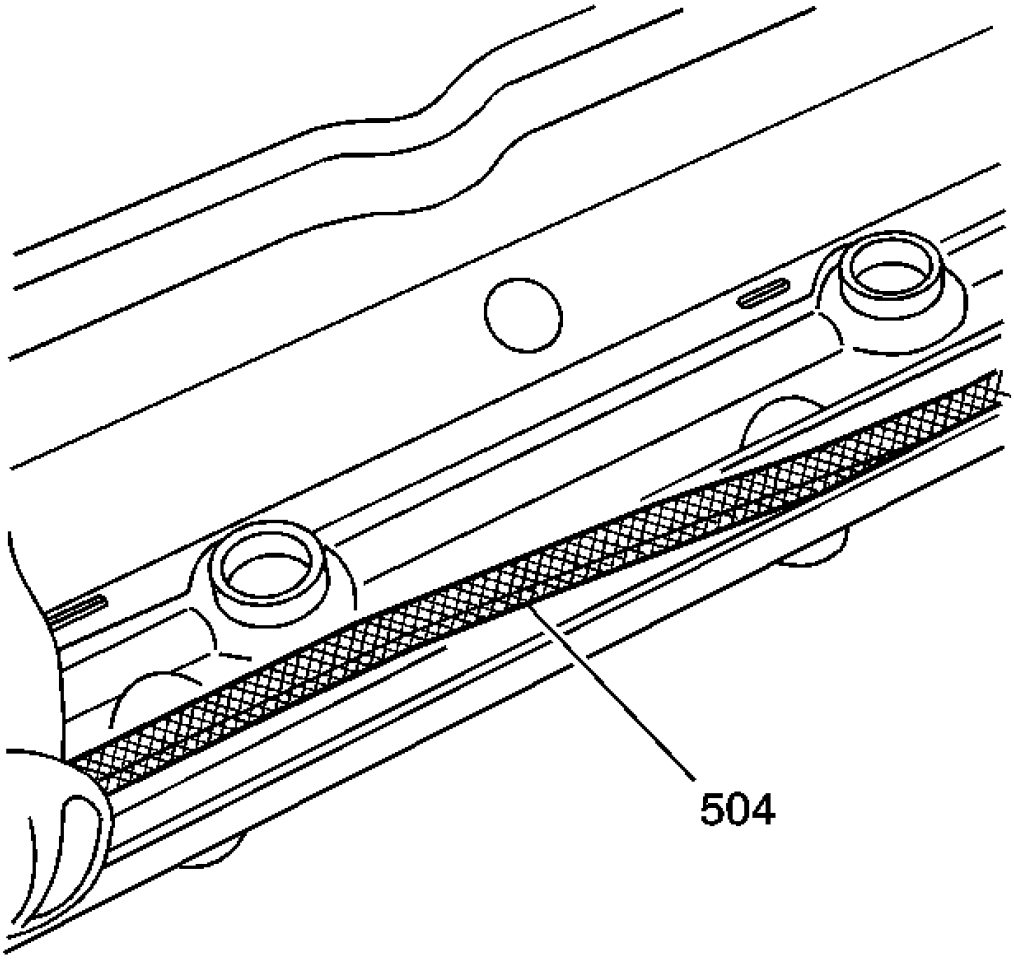


Fig. 42: View Of Valve Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

8. Remove and discard the valve rocker arm cover gasket (504) from the cover.

VALVE ROCKER ARM COVER REMOVAL - RIGHT SIDE

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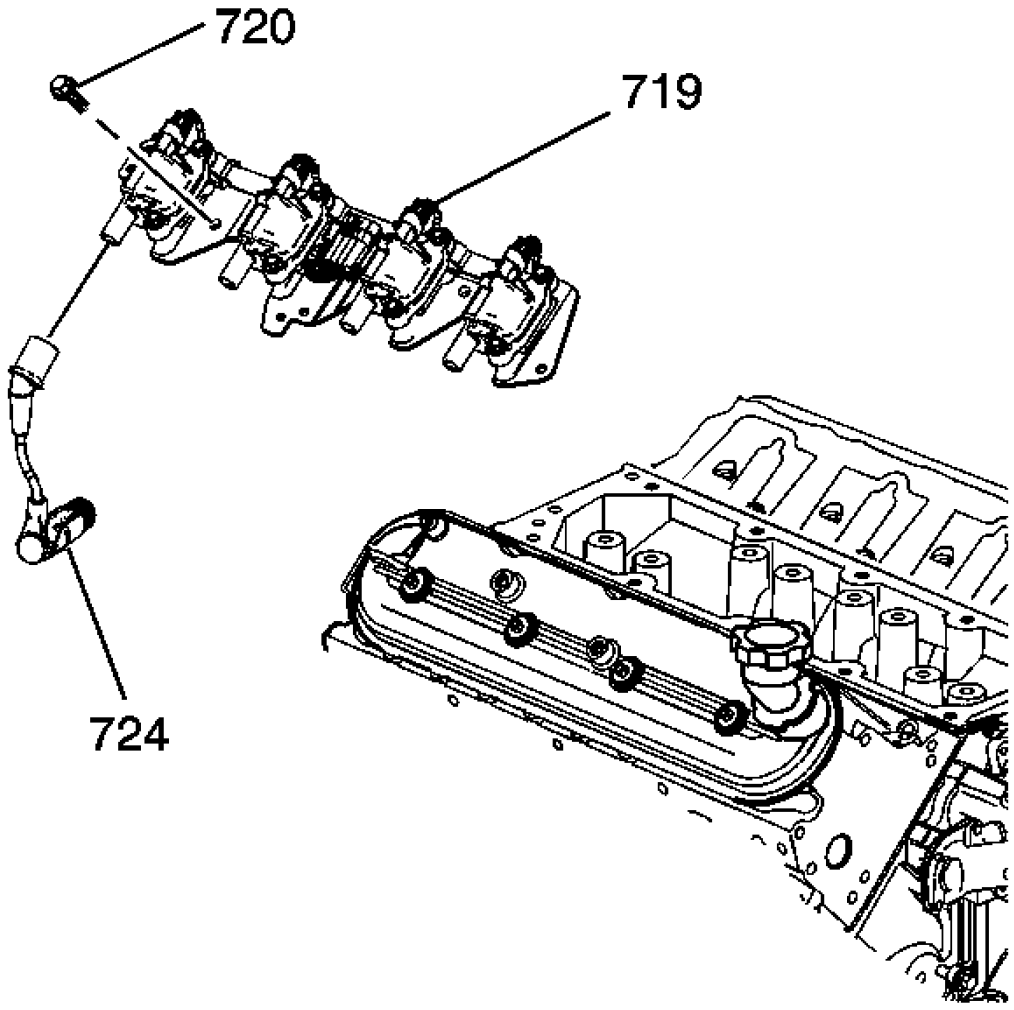


Fig. 43: Ignition Coils & Bracket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not remove the oil fill tube from the cover, unless service is required. If the oil fill tube has been removed from the cover, install a NEW tube during assembly.

1. Remove the spark plug wires (724).
2. Remove the ignition coil bracket studs (720).
3. Remove the ignition coil and bracket assembly (719).

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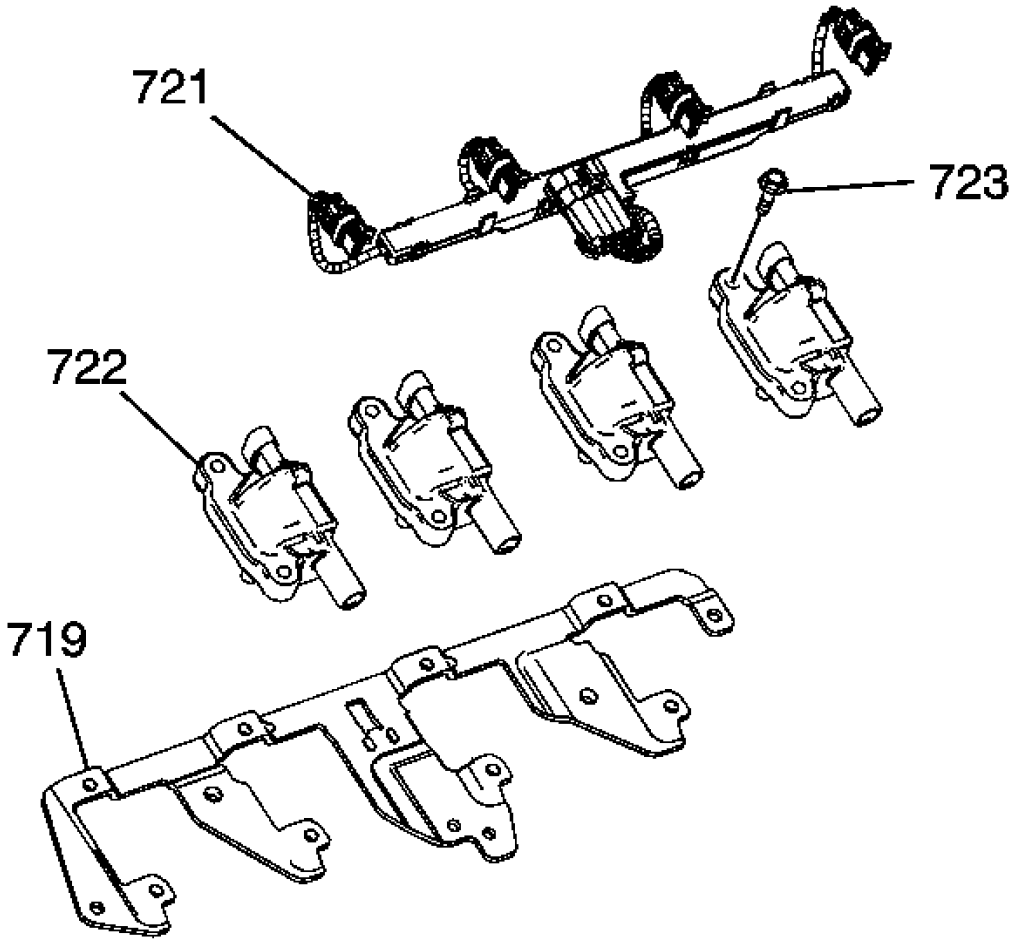


Fig. 44: View Of Bracket, Bolts, Coils & Wire Harness
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the ignition coil electrical connectors.
5. Remove the bolts (723), coils (722), and wire harness (721) from the bracket (719), as required.

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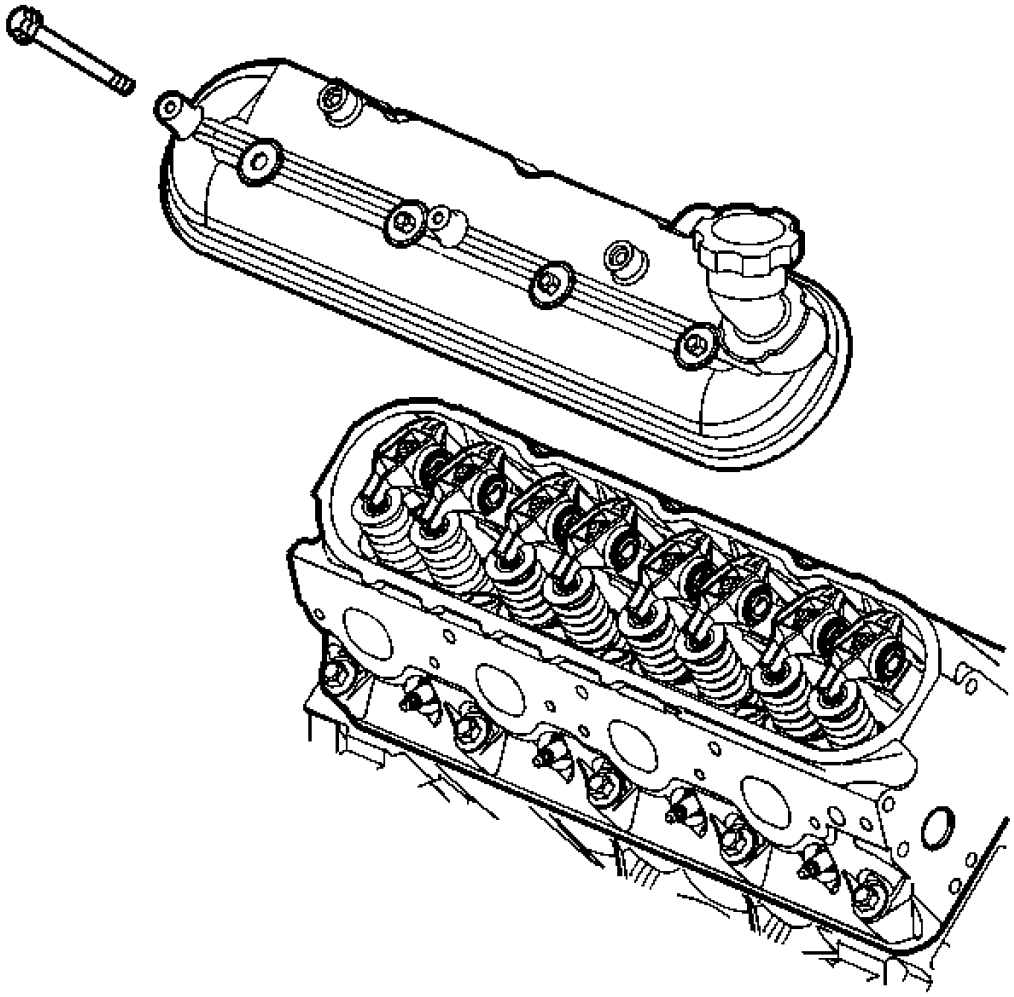


Fig. 45: View Of Valve Rocker Arm Cover & Bolts (Right)
Courtesy of GENERAL MOTORS CORP.

6. Remove the valve rocker arm cover bolts and cover.
7. If the valve rocker arm cover grommets are cracked or damaged, replace the valve rocker arm cover bolts. The grommet is serviced with the rocker arm cover bolt.

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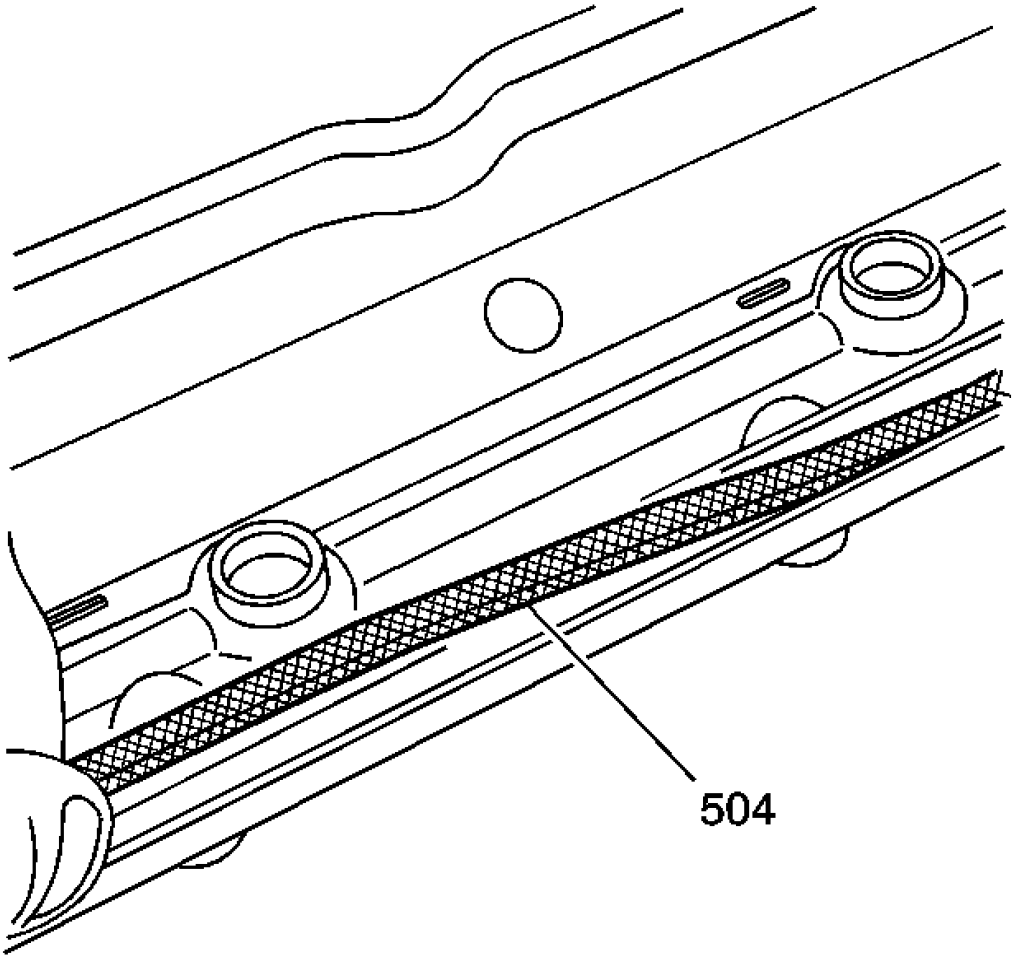


Fig. 46: View Of Valve Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

8. Remove and discard the valve rocker arm cover gasket (504) from the cover.

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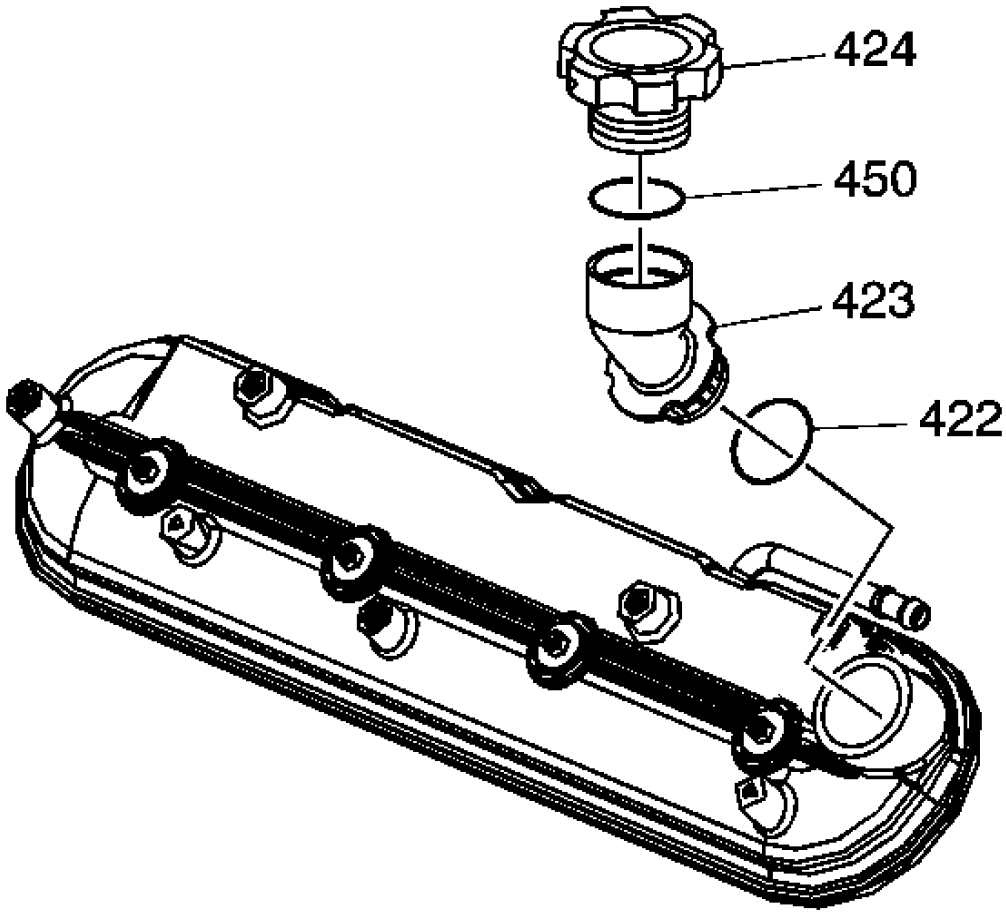


Fig. 47: Oil Fill Cap & Oil Fill Tube
Courtesy of GENERAL MOTORS CORP.

9. Remove the oil fill cap (424) from the oil fill tube (423).
10. Remove the oil fill tube, as required.
11. Discard the oil fill tube.

VALVE ROCKER ARM AND PUSH ROD REMOVAL

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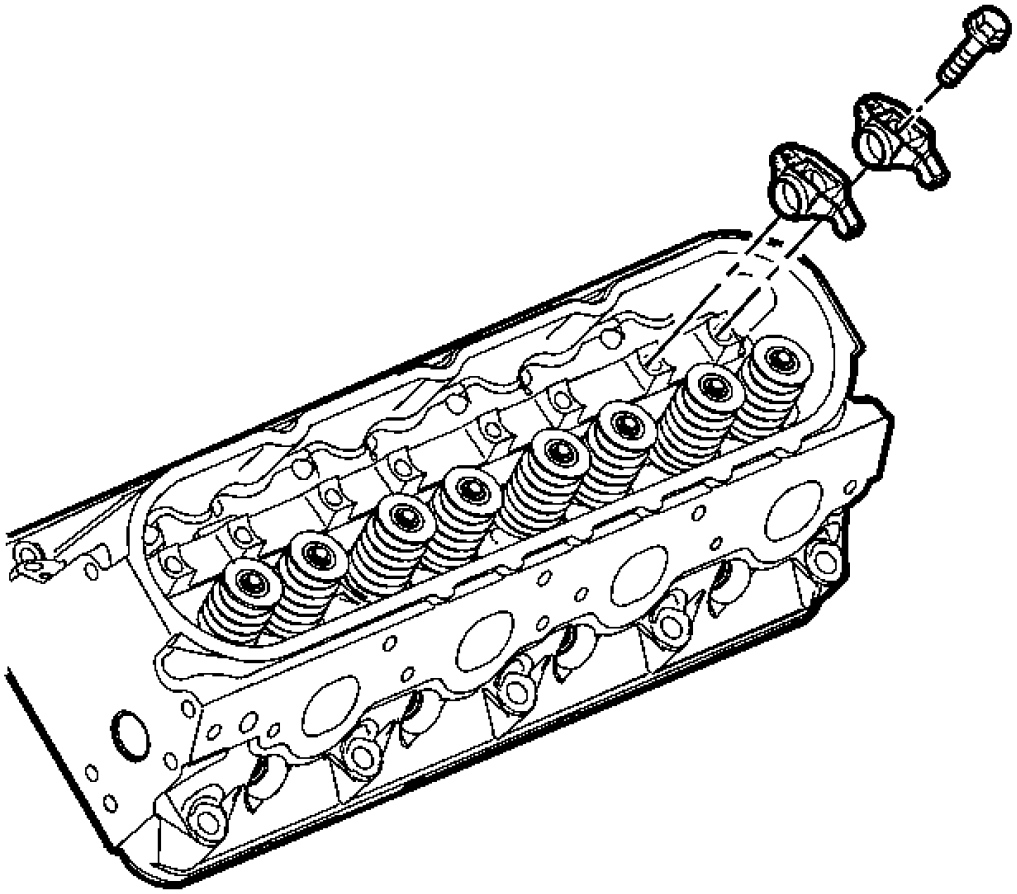


Fig. 48: View Of Rocker Arms & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Place the valve rocker arms, valve pushrods, and pivot support in a rack so they can be installed in the same location from which they were removed.

1. Remove the valve rocker arm bolts.
2. Remove the valve rocker arms.

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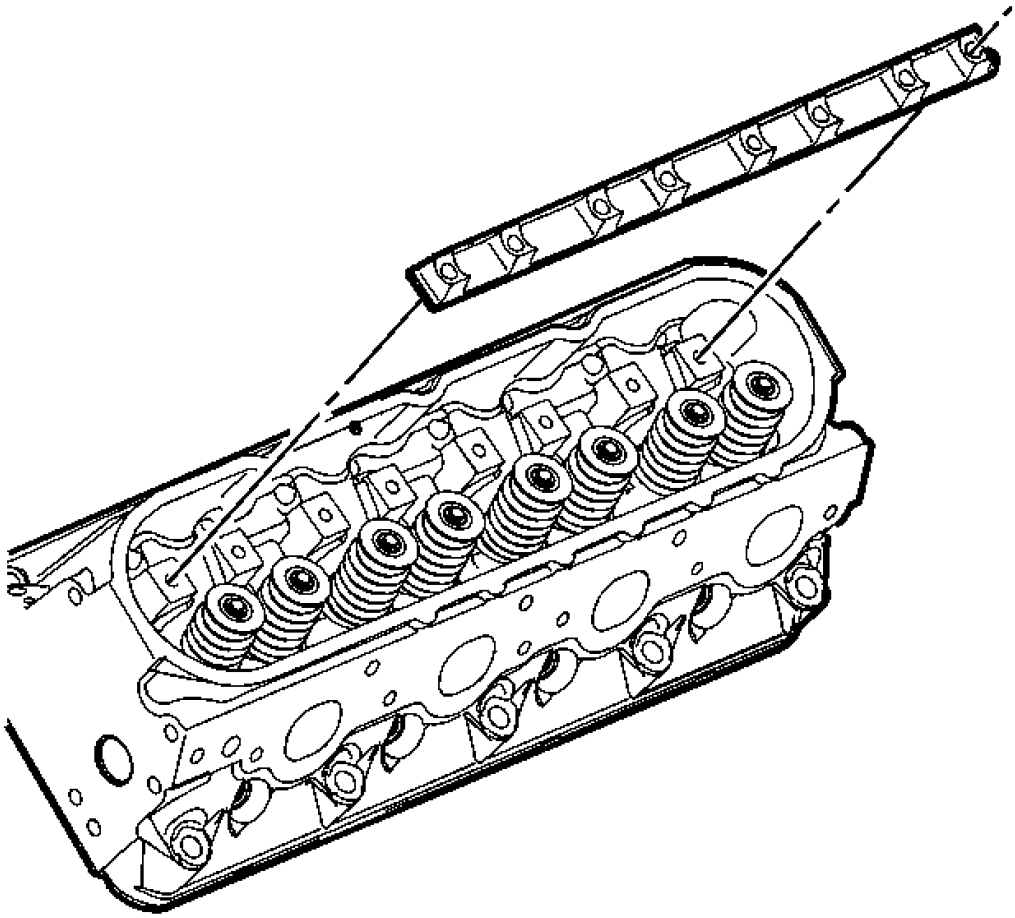


Fig. 49: View Of Valve Rocker Arm Pivot Support
Courtesy of GENERAL MOTORS CORP.

3. Remove the valve rocker arm pivot support.

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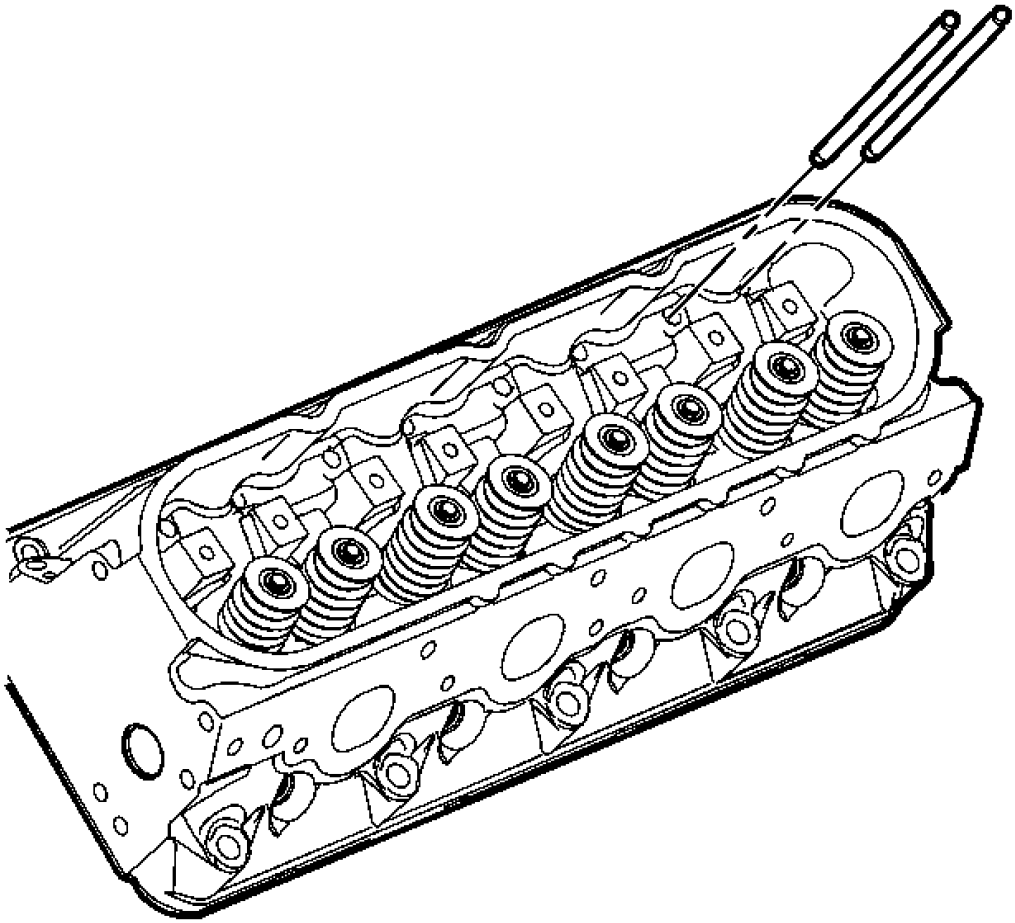


Fig. 50: View Of Pushrods
Courtesy of GENERAL MOTORS CORP.

4. Remove the pushrods.

CYLINDER HEAD REMOVAL - LEFT SIDE

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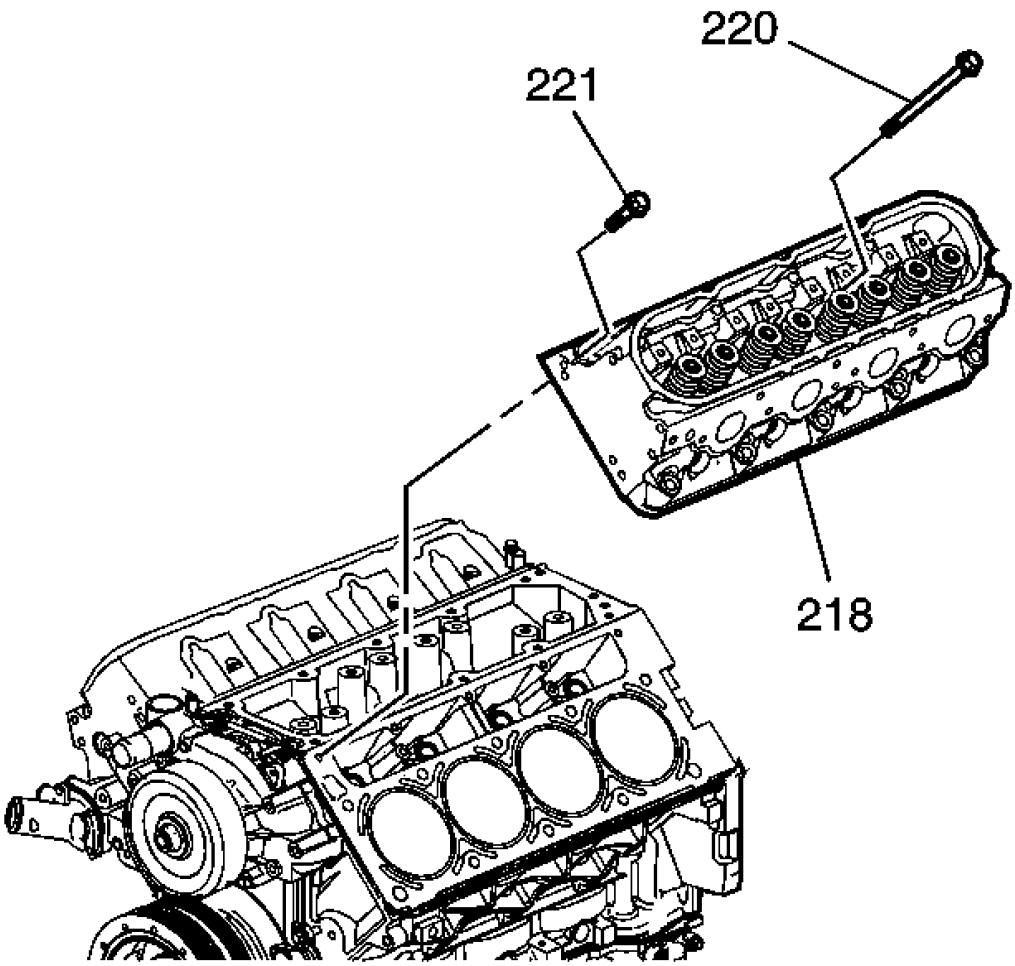


Fig. 51: Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: The cylinder head bolts are of a torque-to-yield design and are NOT to be used again. Install NEW cylinder head bolts during assembly.

1. Remove the cylinder head bolts (220, 221).

CAUTION: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

2. Remove the cylinder head (218).

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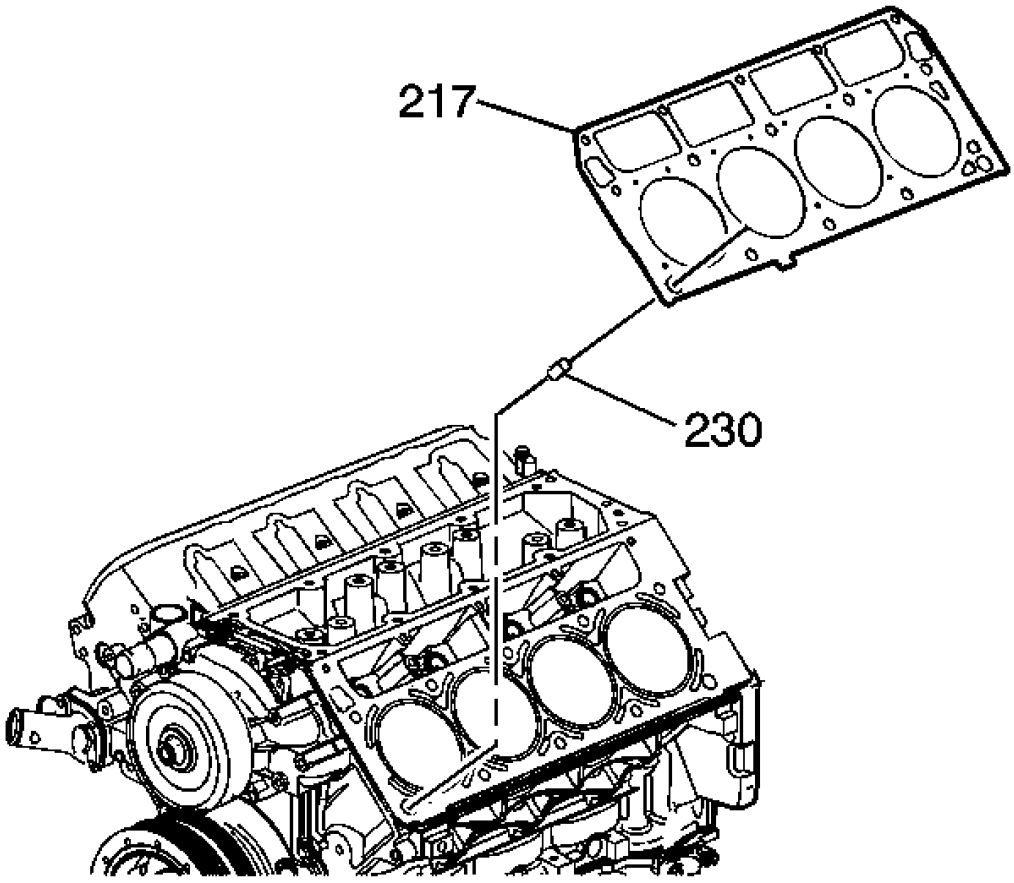


Fig. 52: View Of Cylinder Head Gasket & Locating Pin - Left
Courtesy of GENERAL MOTORS CORP.

3. Remove the gasket (217) and locating pins (230).
4. Discard the gasket and cylinder head bolts.

CYLINDER HEAD REMOVAL - RIGHT SIDE

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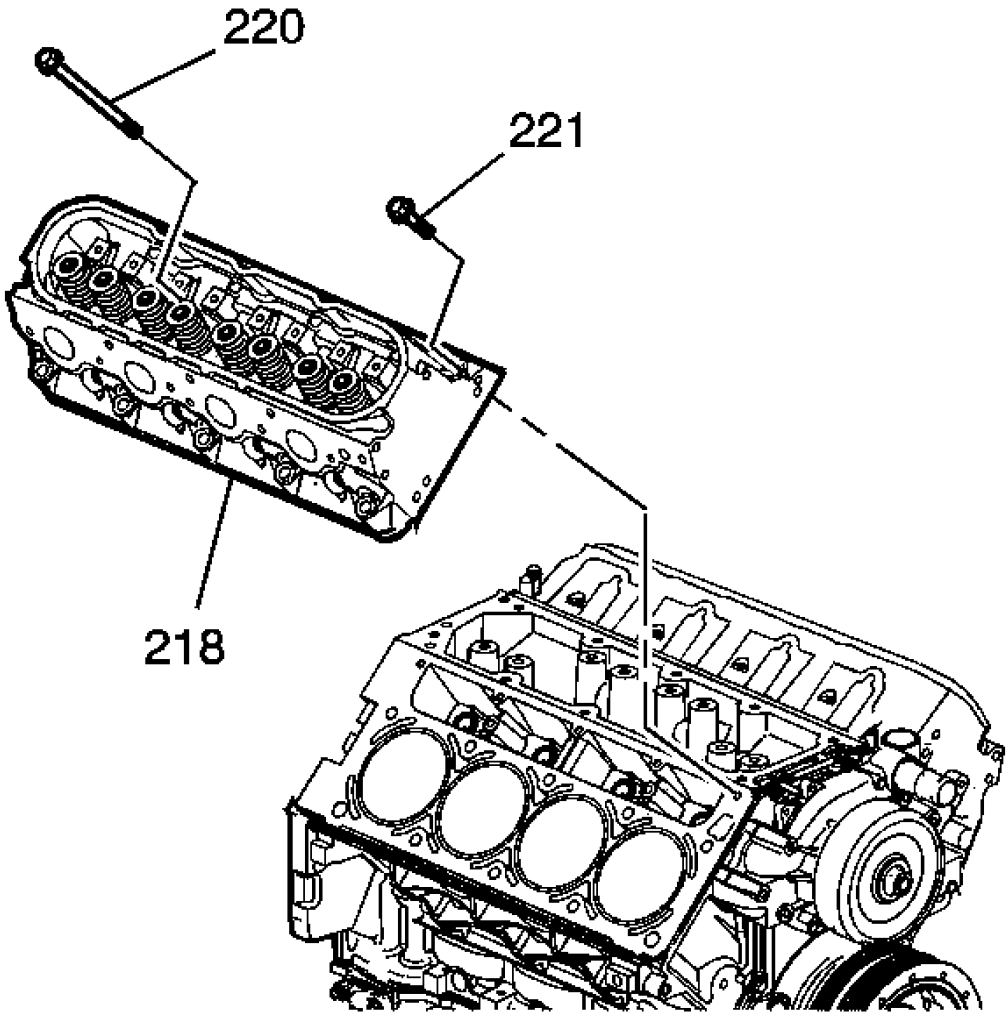


Fig. 53: Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: The cylinder head bolts are of a torque-to-yield design and are NOT to be used again. Install NEW cylinder head bolts during assembly.

1. Remove the cylinder head bolts (220, 221).

CAUTION: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

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2. Remove the cylinder head (218).

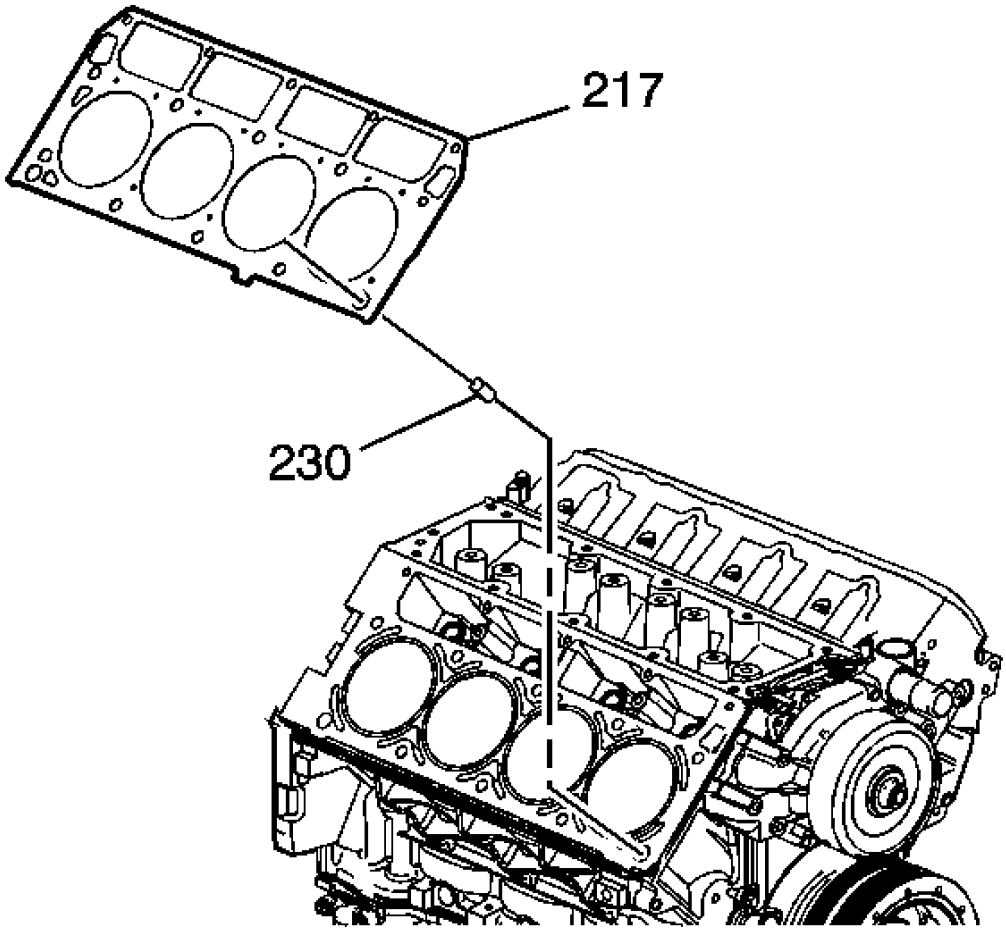


Fig. 54: Cylinder Head Gasket & Locating Pins - Right
Courtesy of GENERAL MOTORS CORP.

3. Remove the gasket (217) and locating pins (230).
4. Discard the gasket and cylinder head bolts.

VALVE LIFTER REMOVAL (LS3)

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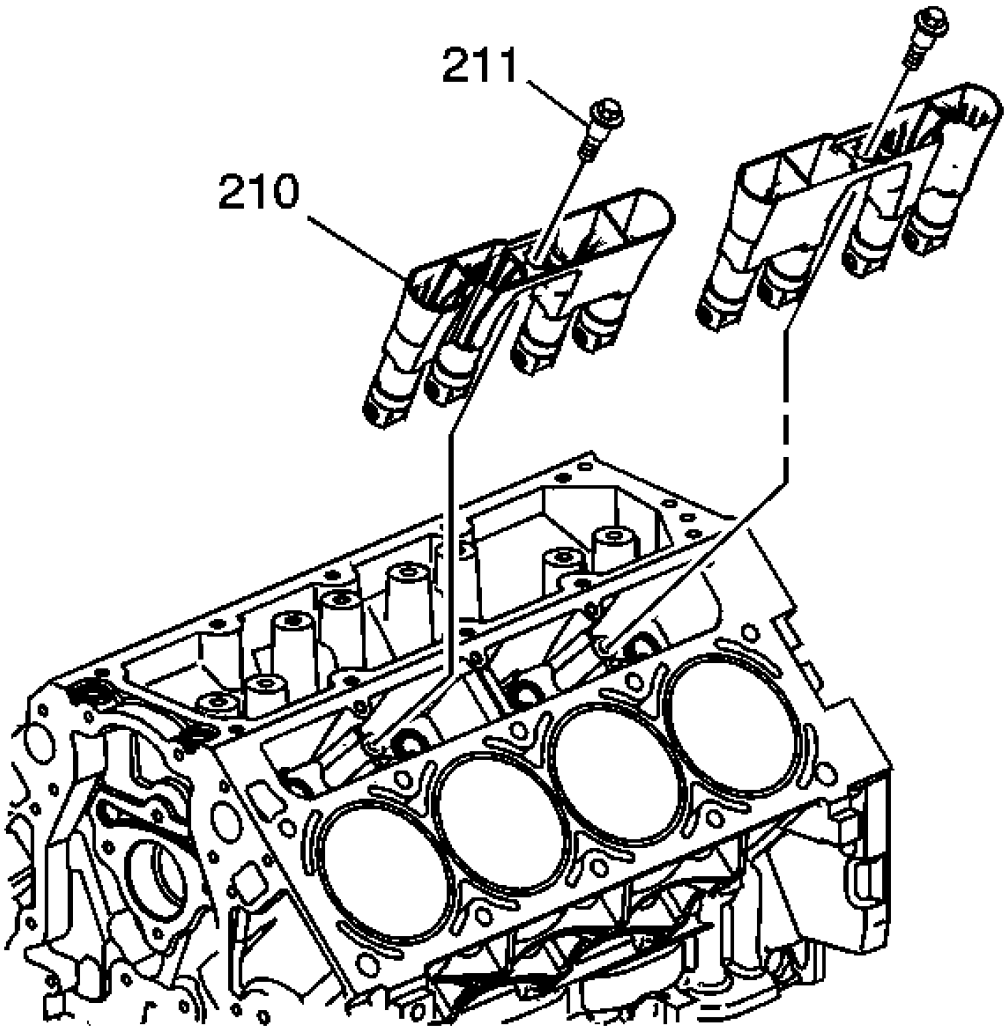


Fig. 55: Valve Lifter Guides, Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the guide bolts (211).
2. Remove the guides (210) with lifters.

Note the installed position of the guides. The notched area of the guide is to align with the locating tab on the block.

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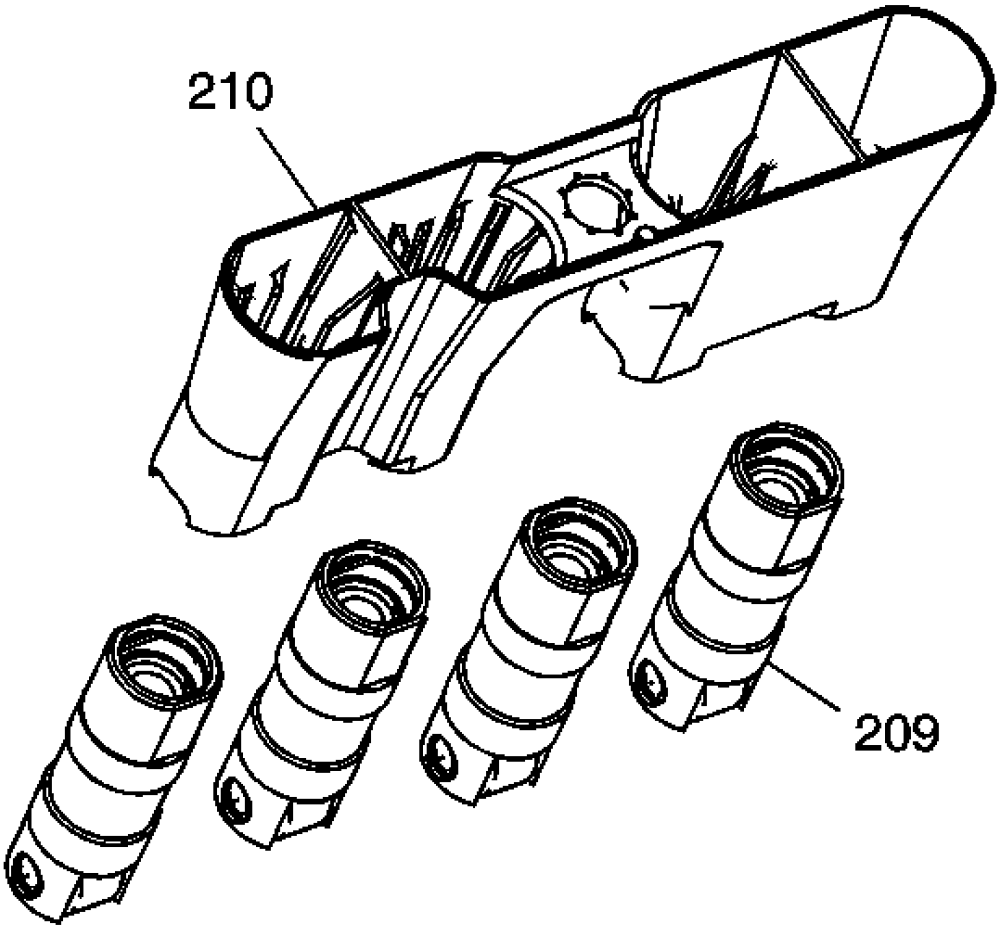


Fig. 56: Valve Lifters & Guides
Courtesy of GENERAL MOTORS CORP.

3. Remove the valve lifters (209) from the guide (210).
4. Organize or mark the components so they can be installed in the same location from which they were removed. Refer to **Separating Parts** .

VALVE LIFTER REMOVAL (L99)

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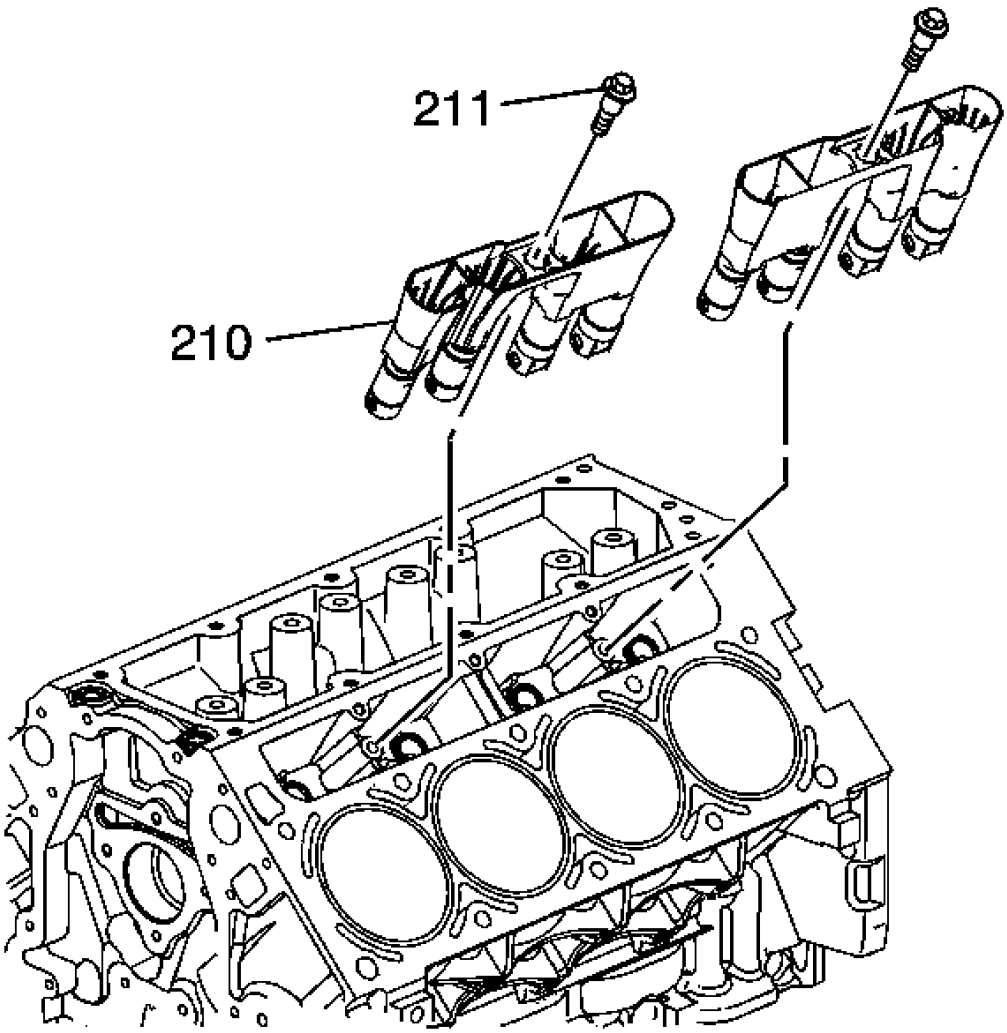


Fig. 57: View Of Lifter Guides & Lifters
Courtesy of GENERAL MOTORS CORP.

1. Remove the bolts (211).
2. Remove the guides (210) with lifters.

Note the installed position of the guides. The notched area of the guide is to align with the locating tab of the block.

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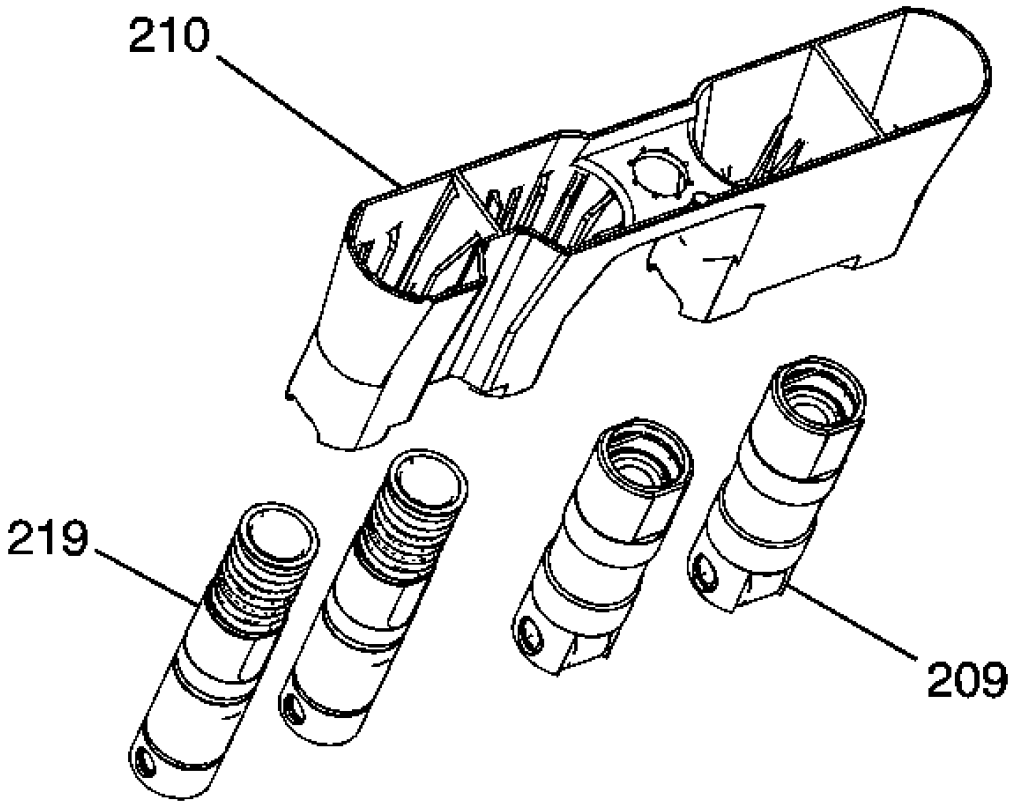


Fig. 58: Lifter Guide & Lifters
Courtesy of GENERAL MOTORS CORP.

3. Remove the valve lifters (209, 219) from the guide (210).

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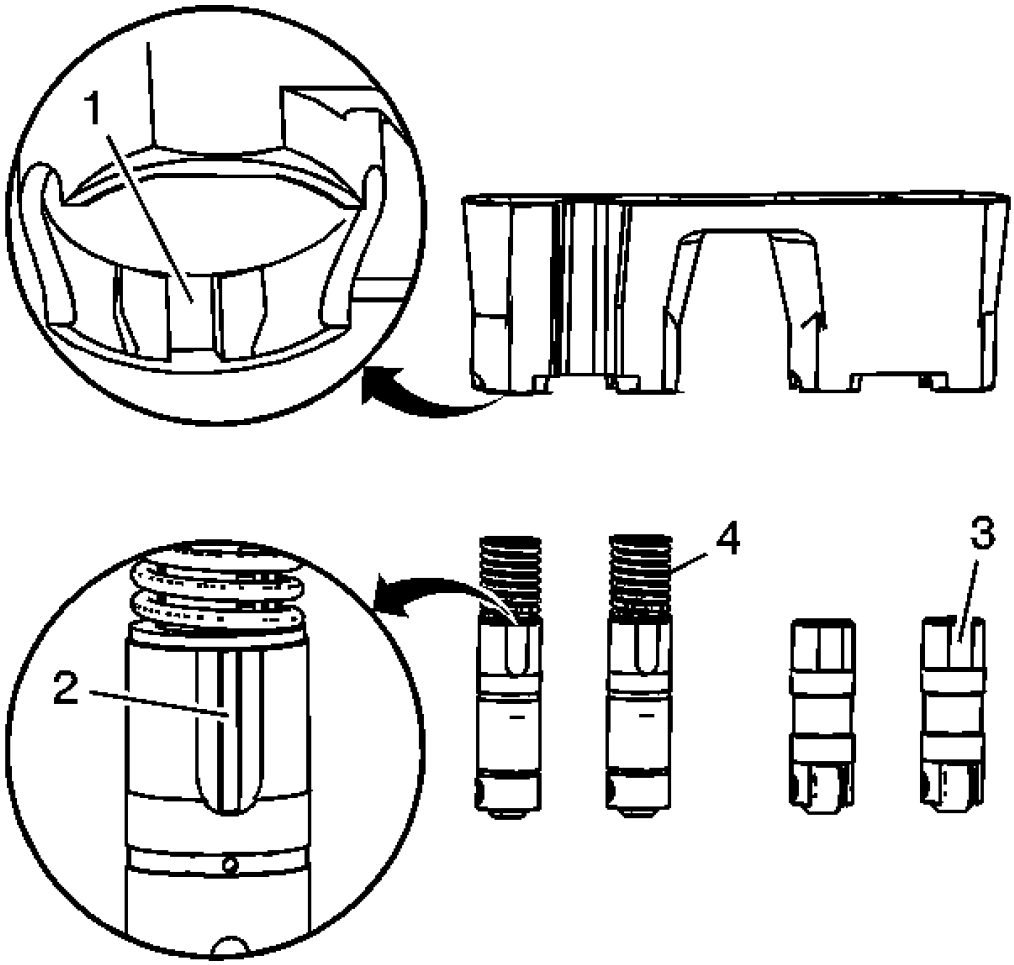


Fig. 59: Inserting Valve Lifters Into Lifter Guides
Courtesy of GENERAL MOTORS CORP.

4. Organize or mark the components so they can be installed in the same location from which they were removed. The active fuel management lifters (4) are installed into the guide by aligning the notched area of the guide (1) with the raised surface on the side of the lifter (2). Refer to **Separating Parts** .

ENGINE OIL COOLER REMOVAL

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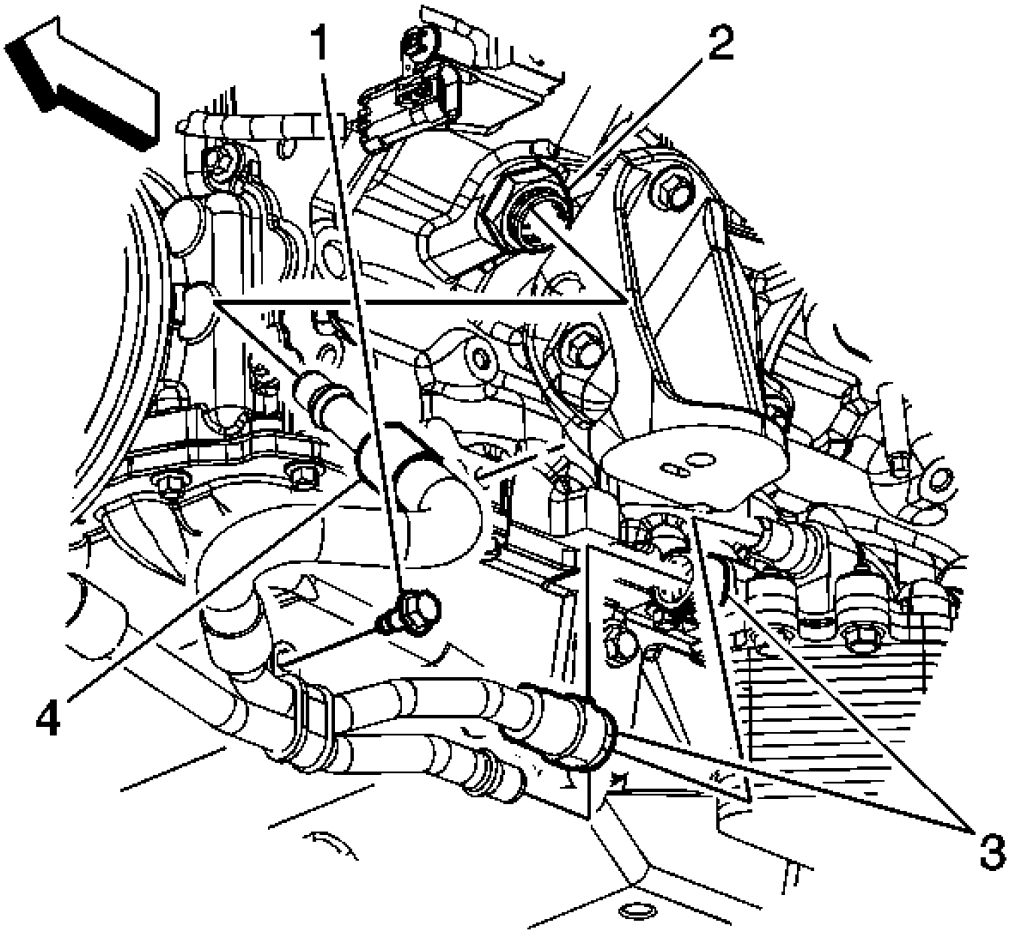


Fig. 60: Identifying Engine Oil Cooler Hose/Pipe
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine oil cooler coolant hose/pipe bolt (1).
2. Disconnect the hose/pipe (4) from the engine block coolant fitting (2) and oil cooler (3).
3. Remove the hose/pipe.

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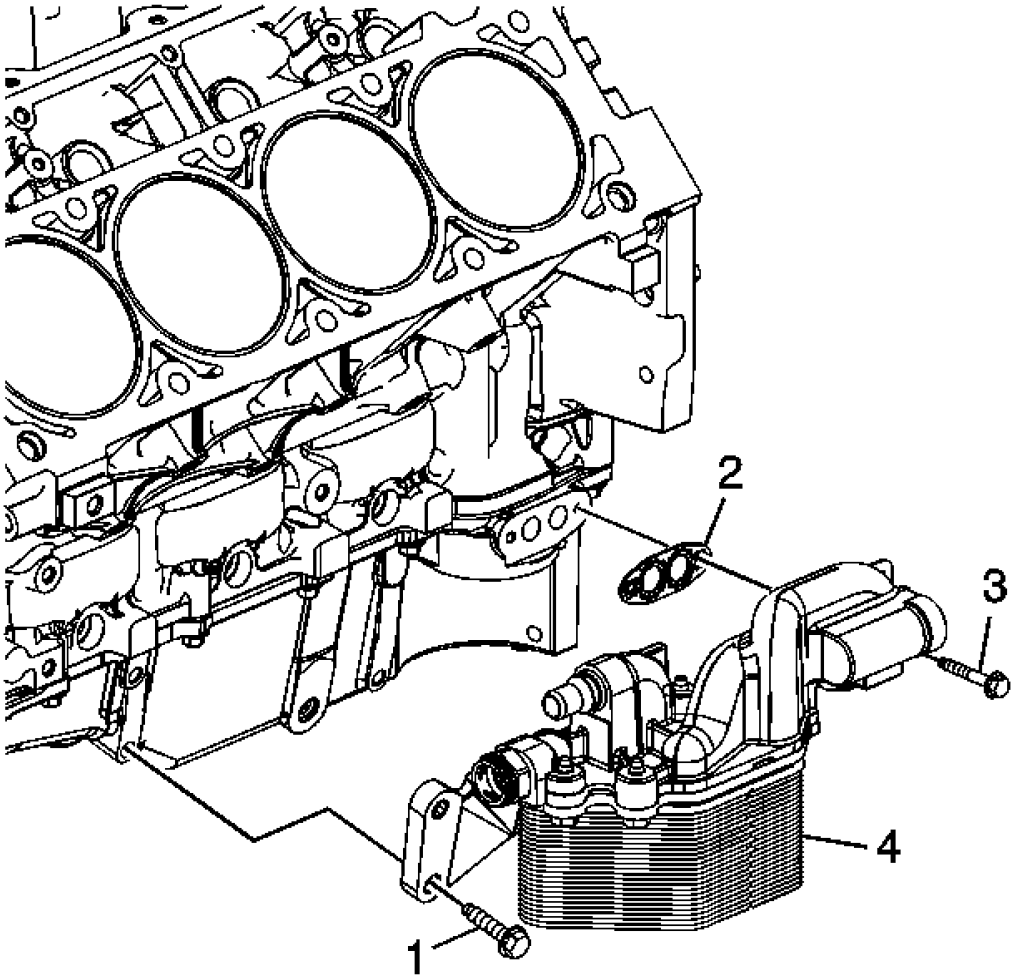


Fig. 61: Identifying Oil Cooler Components
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil cooler M8 (1) and M6 (3) bolts.
5. Remove the oil cooler (4).
6. Remove the oil cooler gasket (2).

OIL FILTER REMOVAL

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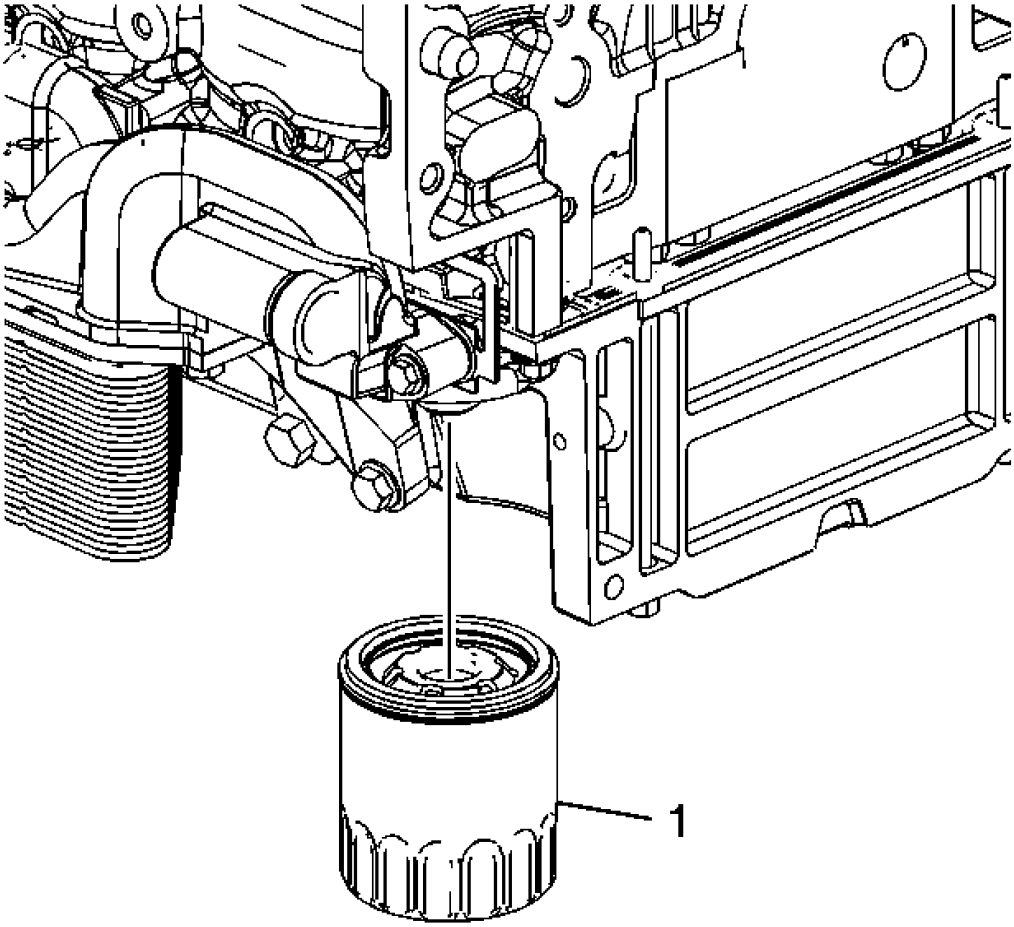


Fig. 62: Identifying Oil Filter
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil filter (1).

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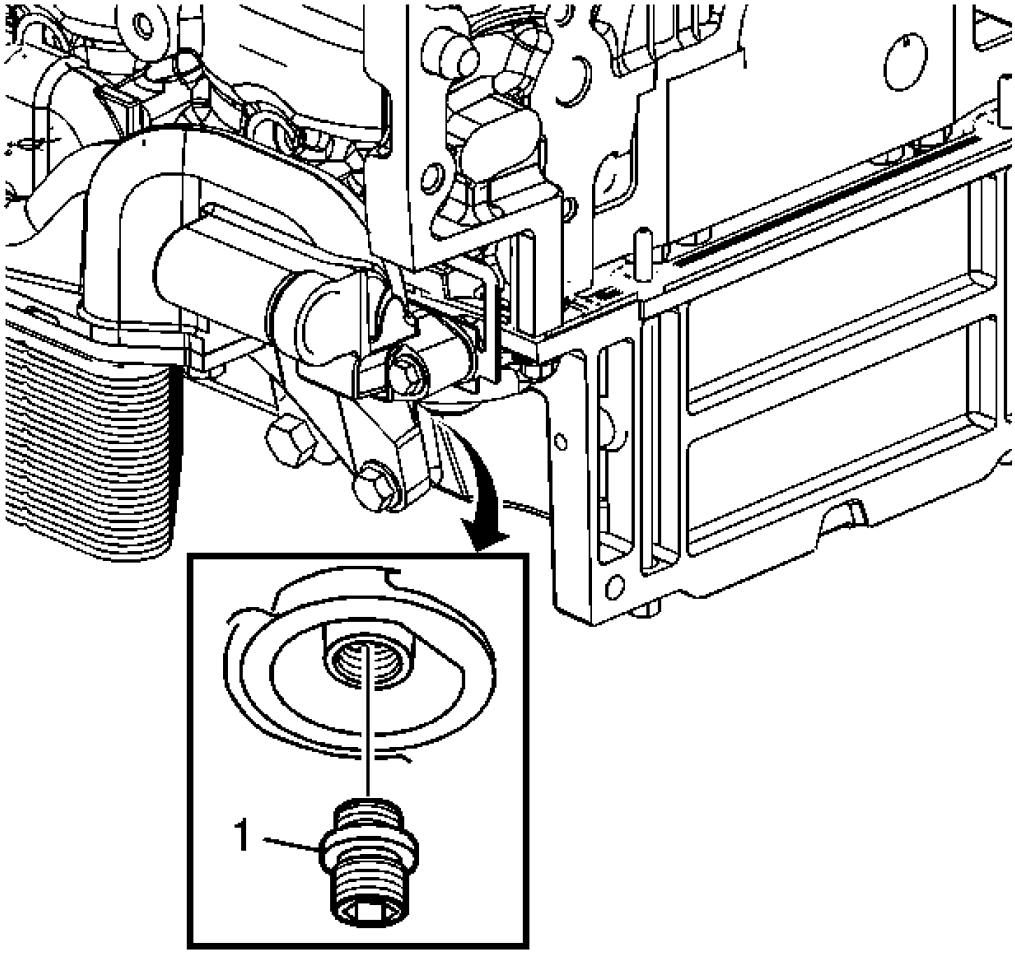


Fig. 63: Identifying Oil Filter Fitting
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil filter fitting (1), as required.

OIL PAN REMOVAL

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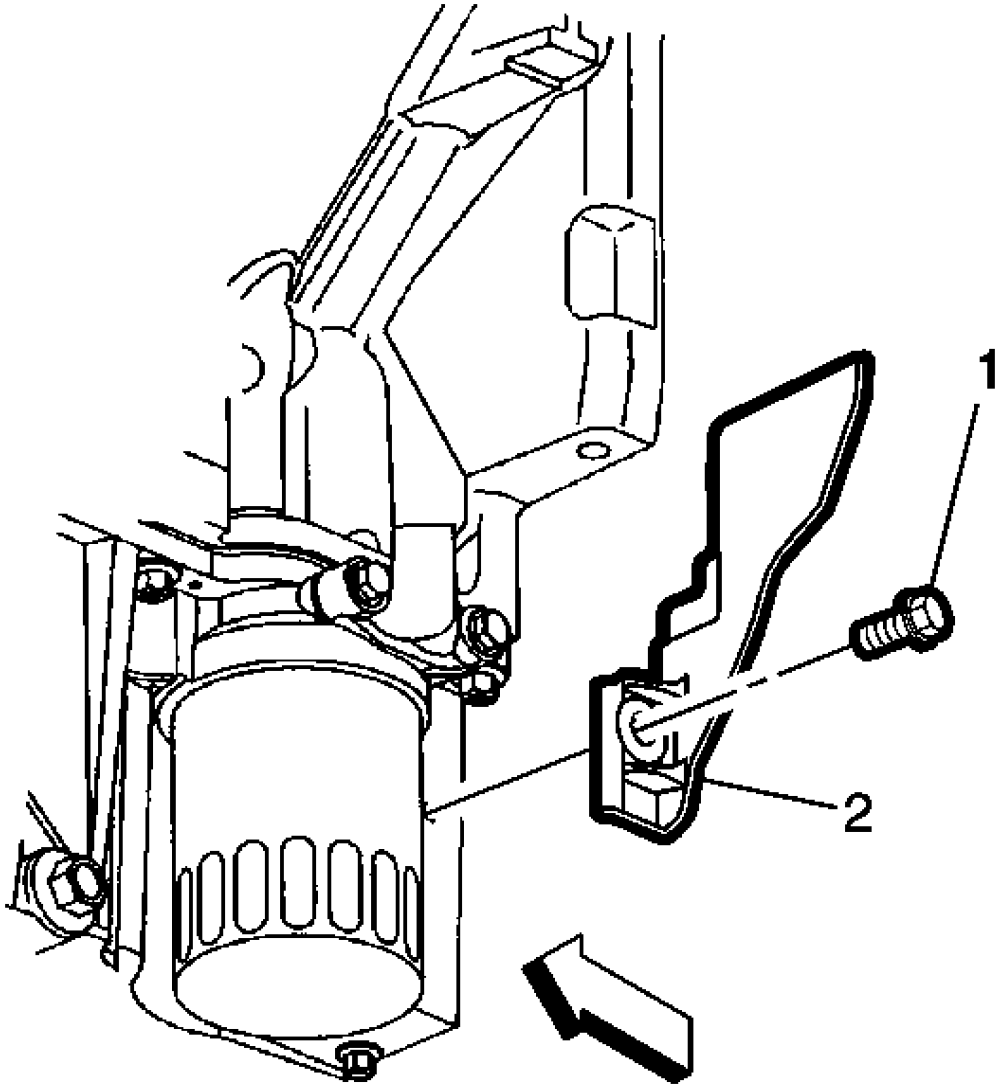


Fig. 64: View Of Left Closeout Cover & Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **The original oil pan gasket is retained and aligned to the oil pan by rivets. When installing a new gasket, it is not necessary to install new oil pan gasket rivets.**
- **DO NOT use the oil pan gasket again. When installing the oil pan, install a NEW oil pan gasket.**

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1. Remove the left close out cover and bolt.

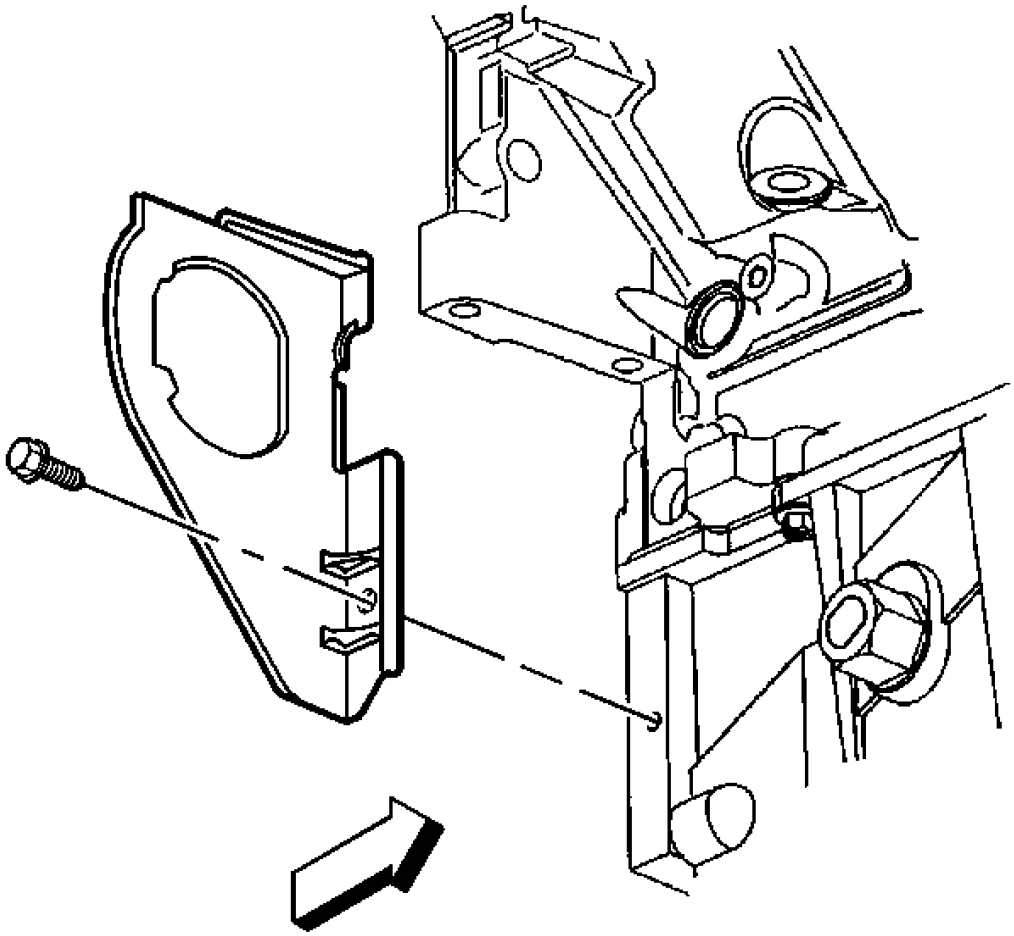


Fig. 65: View Of Right Closeout Cover & Bolt
Courtesy of GENERAL MOTORS CORP.

2. Remove the right closeout cover and bolt.

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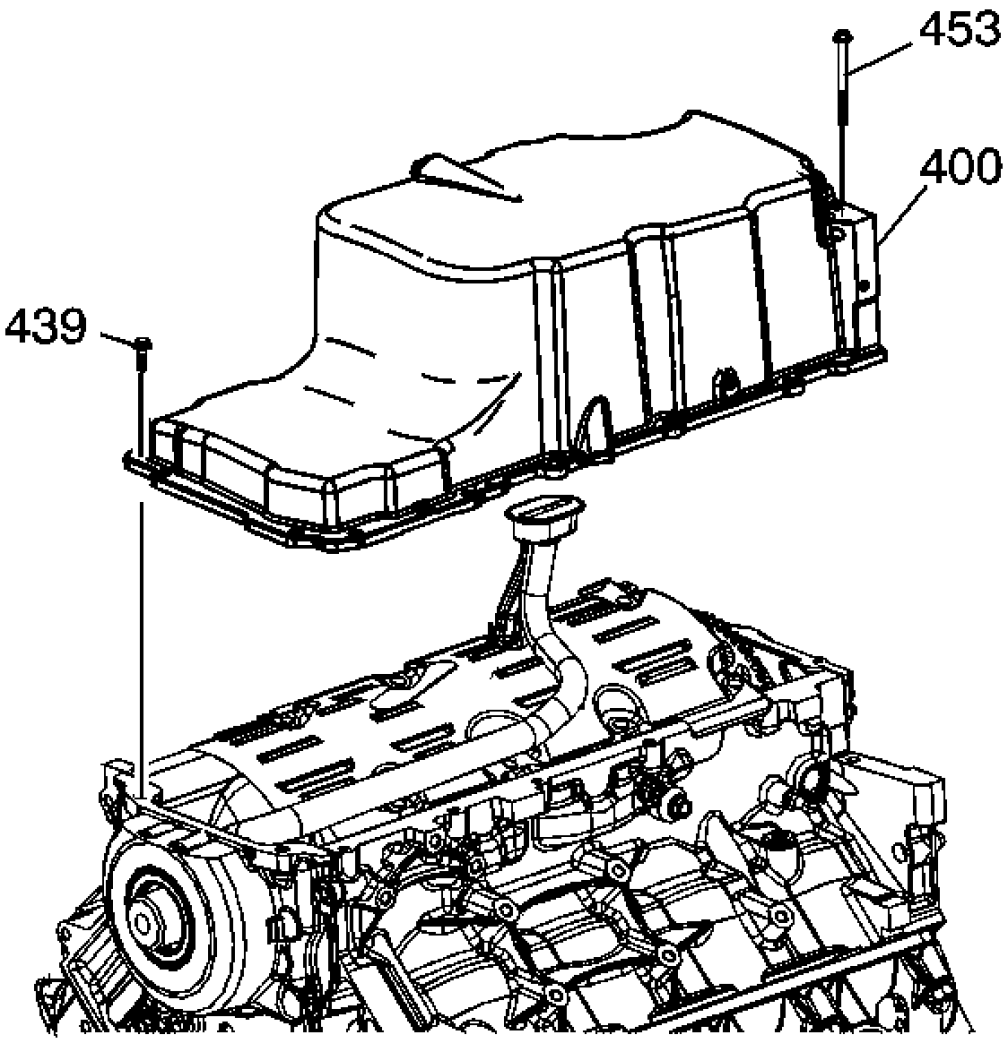


Fig. 66: Oil Pan & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pan bolts (439 and 453).
4. Remove the oil pan (400).

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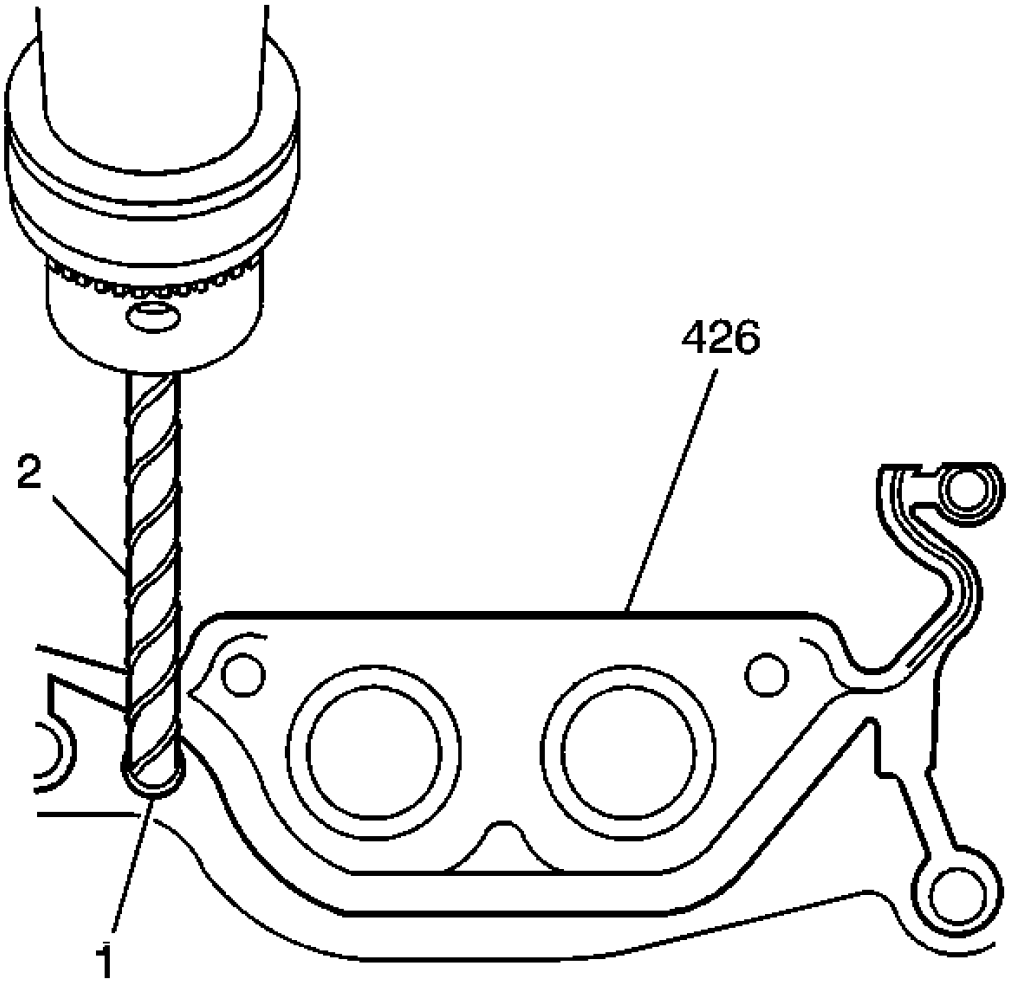


Fig. 67: Drilling Out Oil Pan Gasket Retaining Rivets
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **DO NOT allow foreign material to enter the oil passages of the oil pan. Cap or cover the openings, as required.**
- **Use care not to gouge, score, or damage the oil pan sealing surface.**

5. Drill (2) out the oil pan gasket retaining rivets (1), if required.
6. Remove the gasket (426) from the pan.
7. Discard the gasket (426) and rivets.
8. Remove the oil level sensor, baffle and other internal components, as required. Refer to **Oil Pan**

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Cleaning and Inspection .

ENGINE FRONT COVER REMOVAL (LS3)

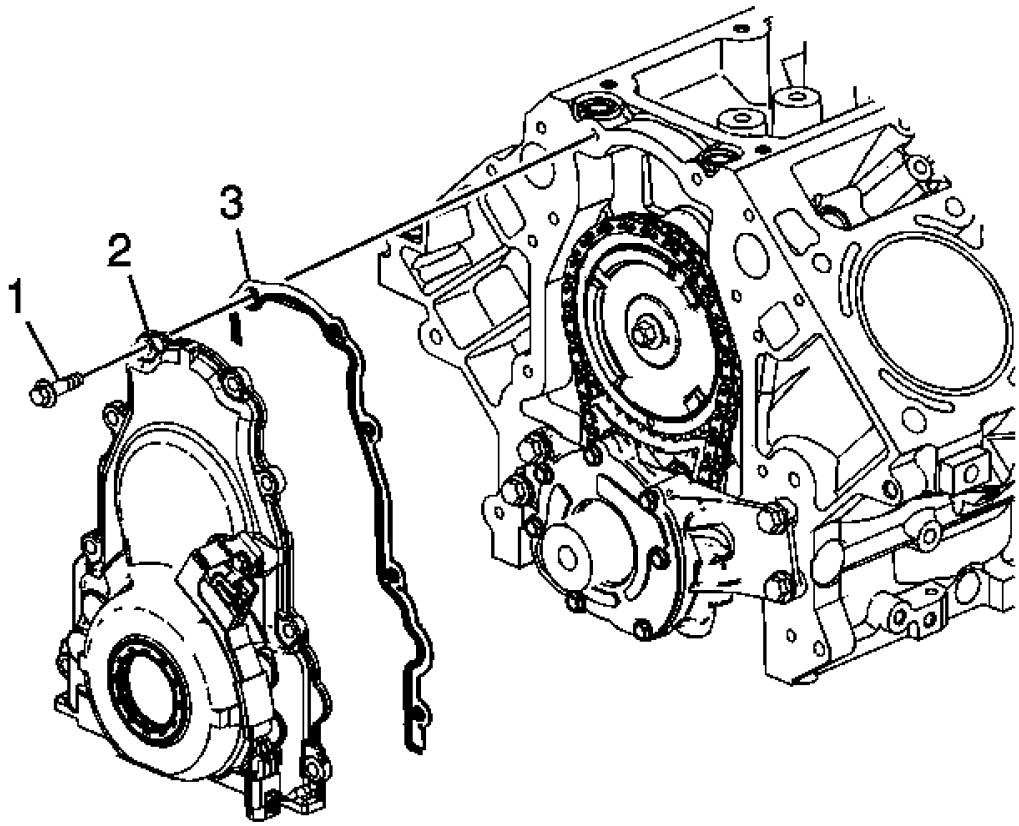


Fig. 68: View Of Front Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Remove the front cover bolts (1).
2. Remove the front cover (2) and gasket (3).
3. Discard the front cover gasket.

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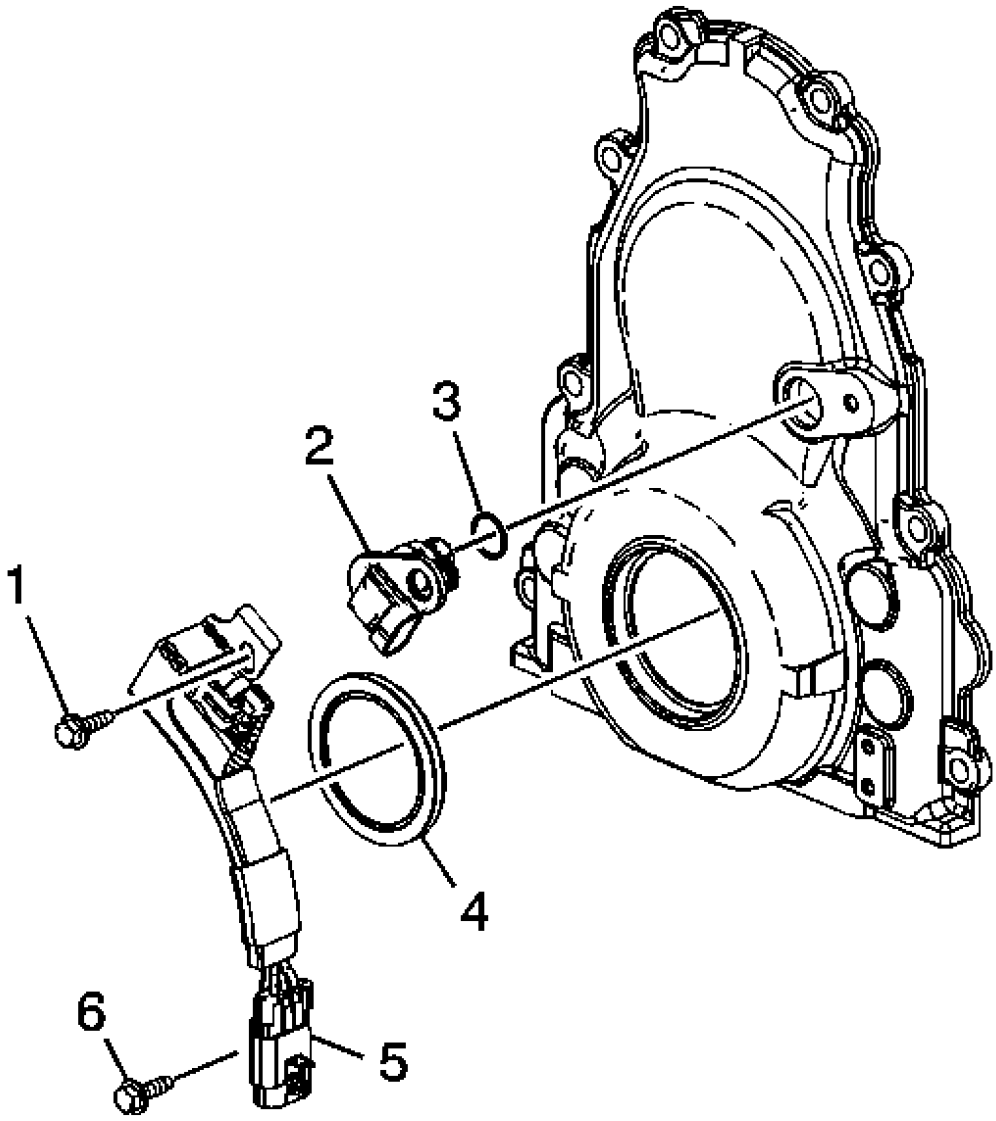


Fig. 69: View Of Front Cover, Oil Seal, Camshaft Position Sensor, Bracket & O Ring
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil seal (4).
5. Remove the bolts (1, 6), camshaft position (CMP) sensor (2), and wire harness (5).
6. Remove the O-ring (3) from the sensor, as required.

ENGINE FRONT COVER REMOVAL (L99)

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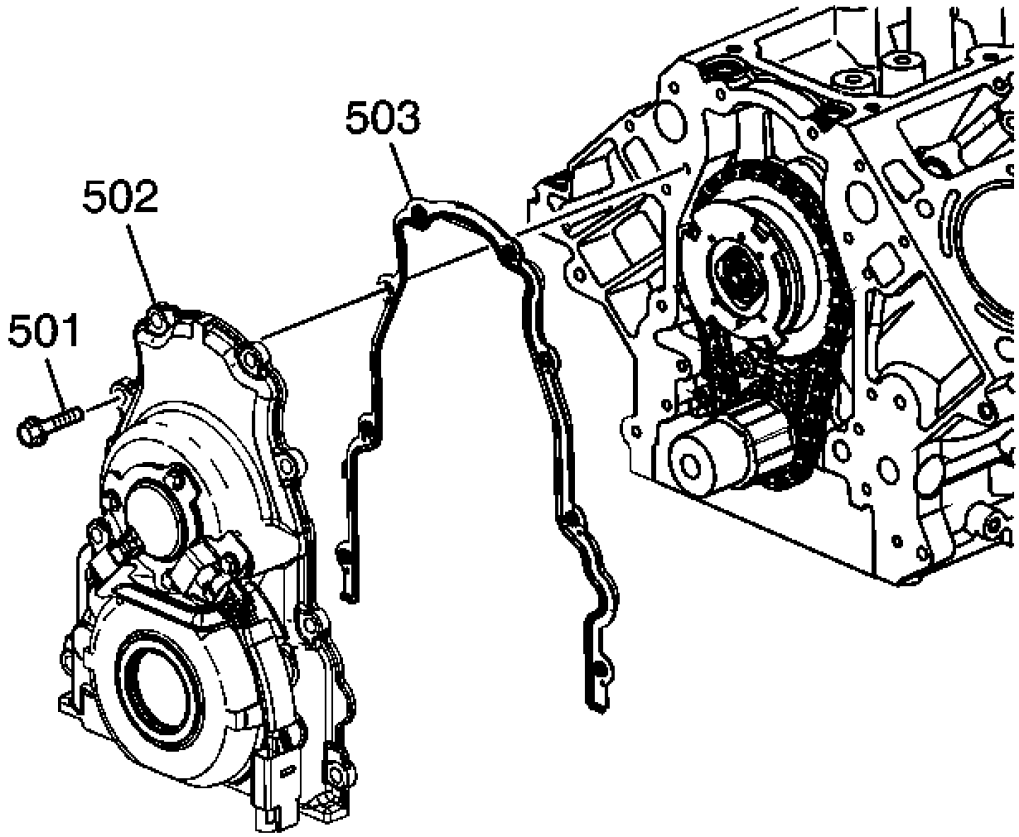


Fig. 70: View Of Front Cover, Bolts & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Remove the front cover bolts (501).
2. Remove the front cover (502) and gasket (503).
3. Discard the front cover gasket.

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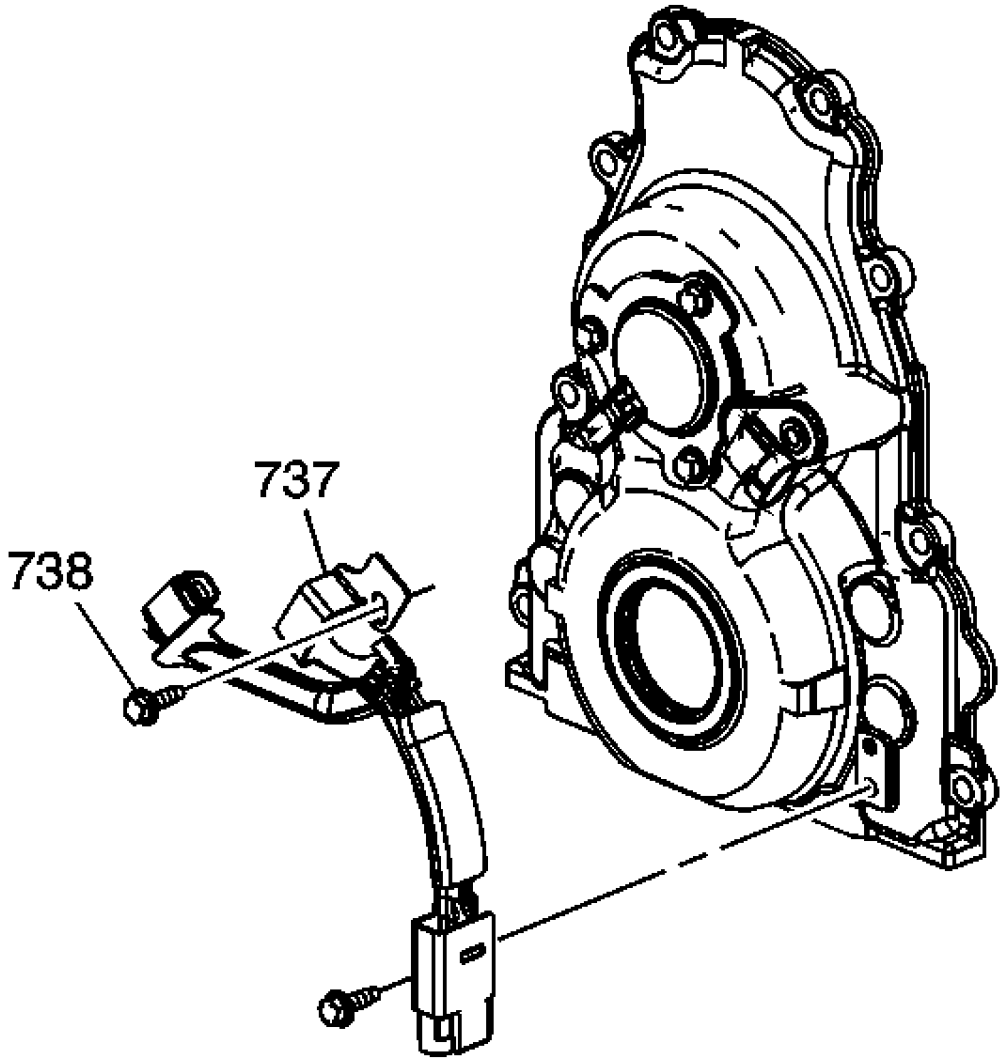


Fig. 71: View Of CMP Sensor Wire Harness & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the camshaft position (CMP) sensor wire harness (737) and bolts (738).

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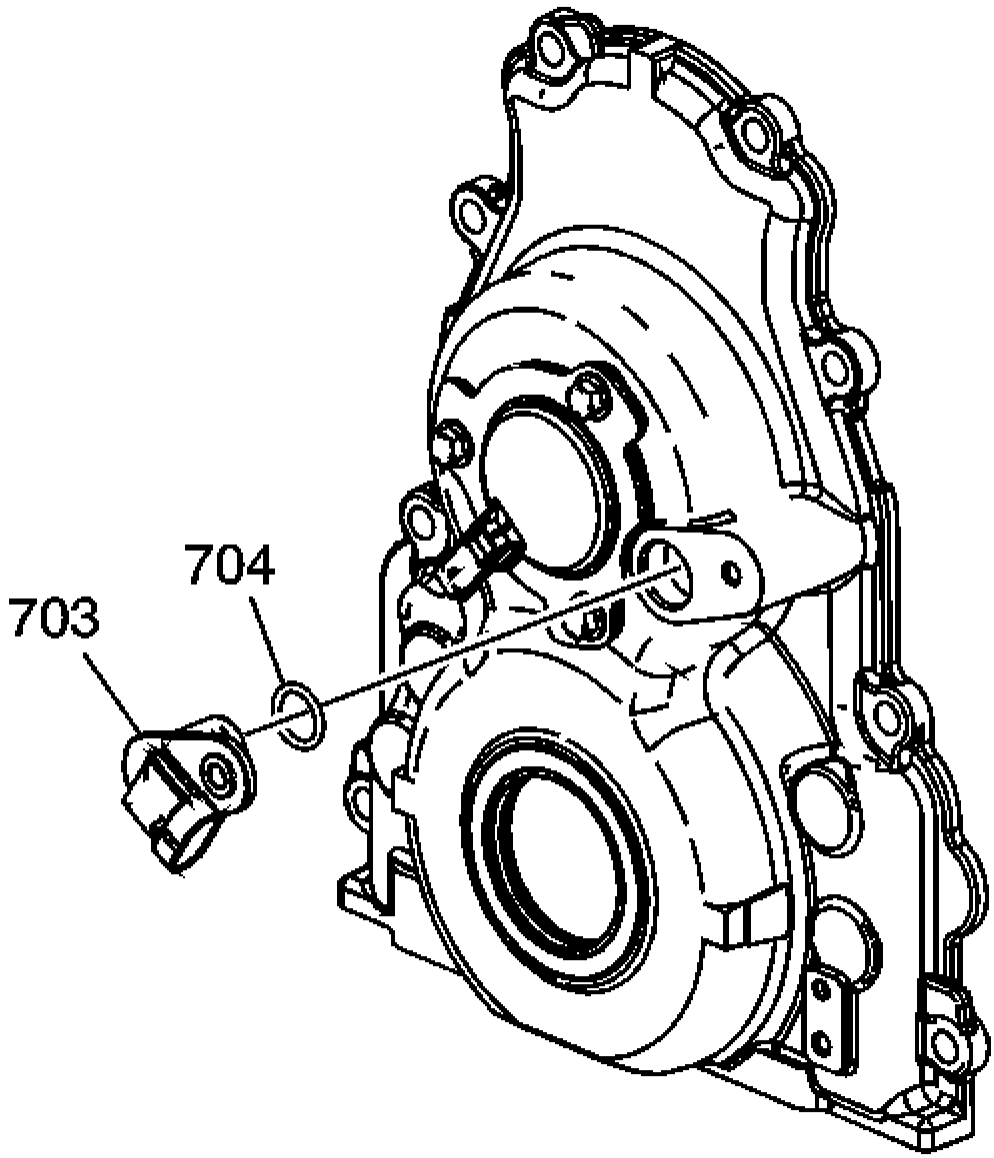


Fig. 72: View Of CMP Sensor & O-Ring
Courtesy of GENERAL MOTORS CORP.

5. Remove the CMP sensor (703).
6. Remove the O-ring (704) from the sensor, as required.

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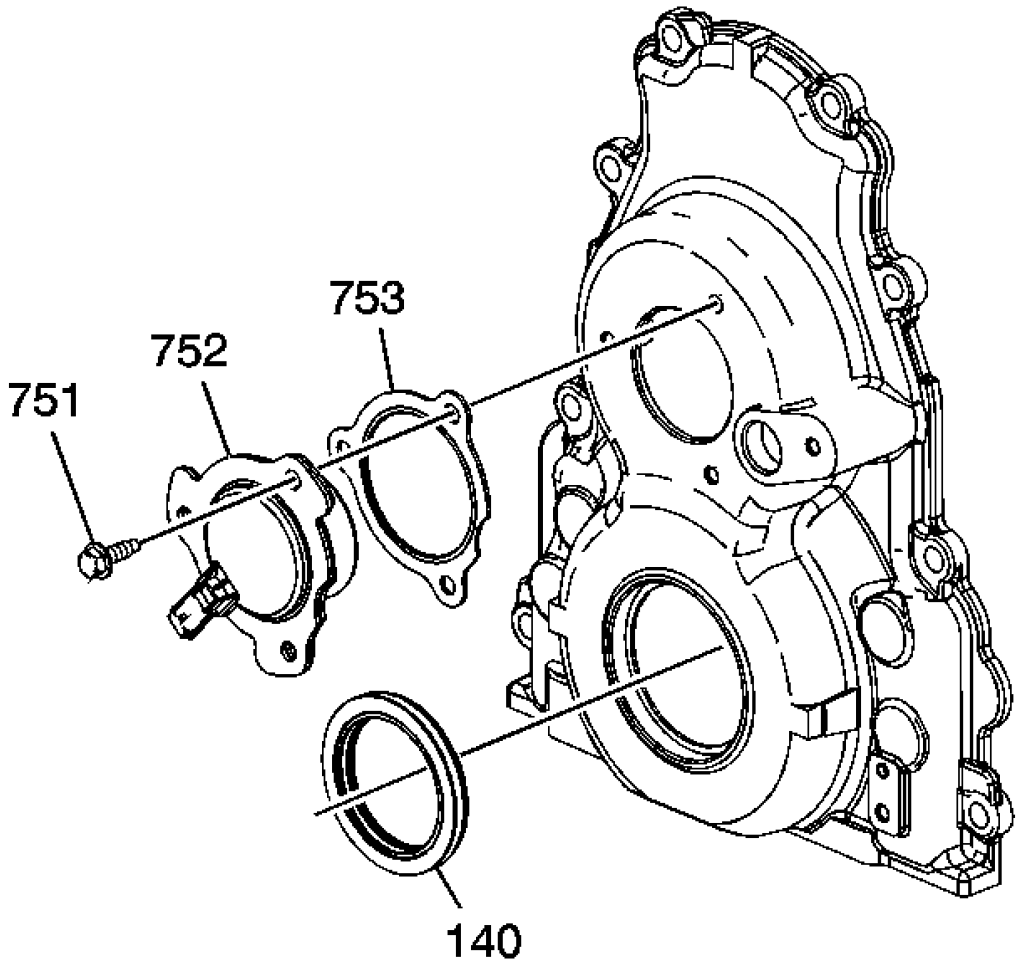


Fig. 73: View Of CMP Actuator Magnet, Bolts, Gasket & Oil Seal
Courtesy of GENERAL MOTORS CORP.

7. Remove the CMP actuator magnet (752), bolts (751), and gasket (753).
8. Remove the oil seal (140).

CRANKSHAFT REAR OIL SEAL HOUSING REMOVAL

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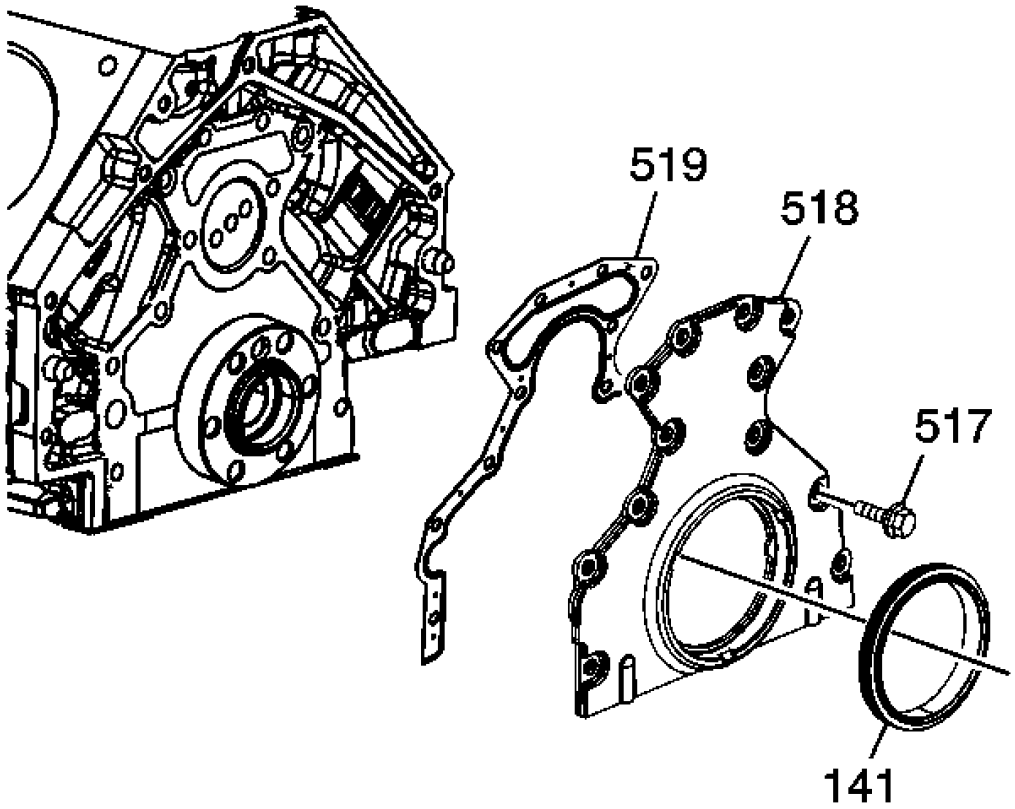


Fig. 74: View of Rear Housing, Gasket & Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the rear oil seal housing bolts (517).
2. Remove the housing (518) and gasket (519).
3. Remove the rear oil seal (141).

OIL PUMP, SCREEN AND CRANKSHAFT OIL DEFLECTOR REMOVAL

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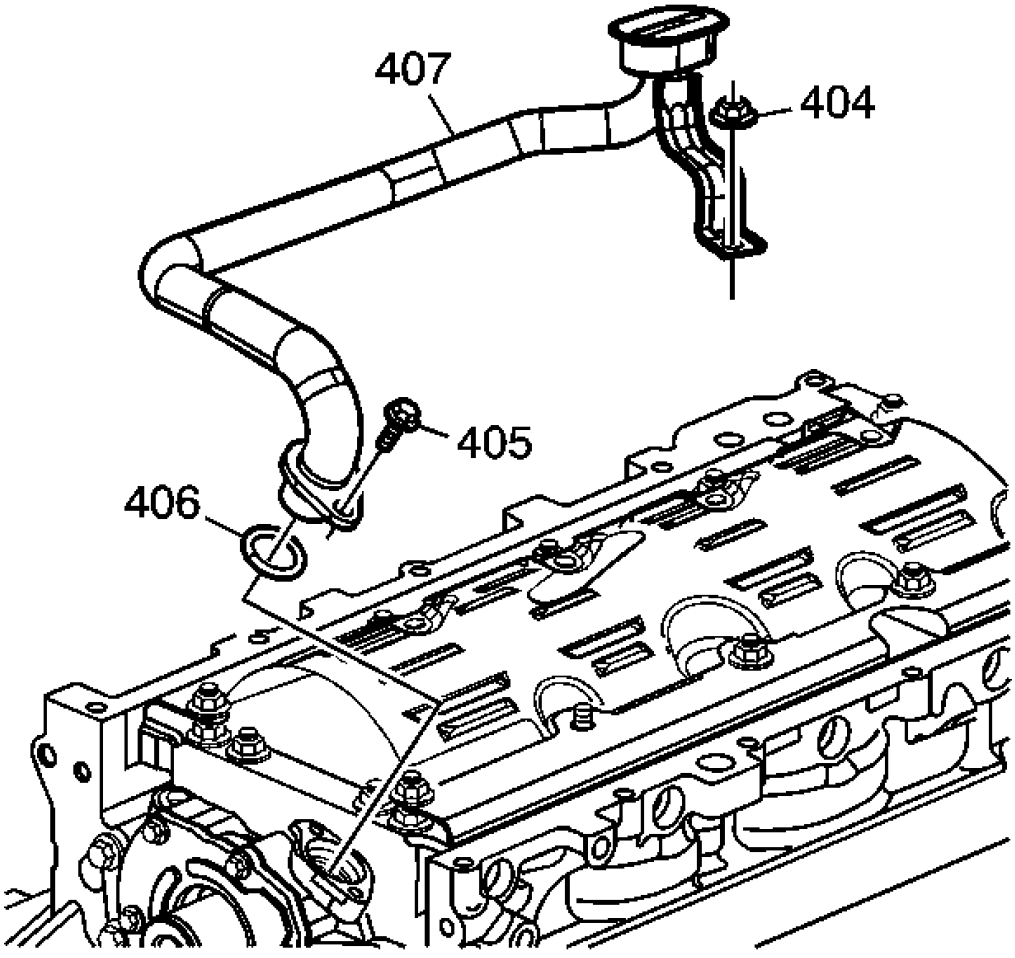


Fig. 75: Oil Pump Screen Bolt, Nut & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pump screen bolt (405) and nut (404).
2. Remove the oil pump screen (407) with O-ring seal.
3. Remove the O-ring seal (406) from the pump screen.
4. Discard the O-ring seal.

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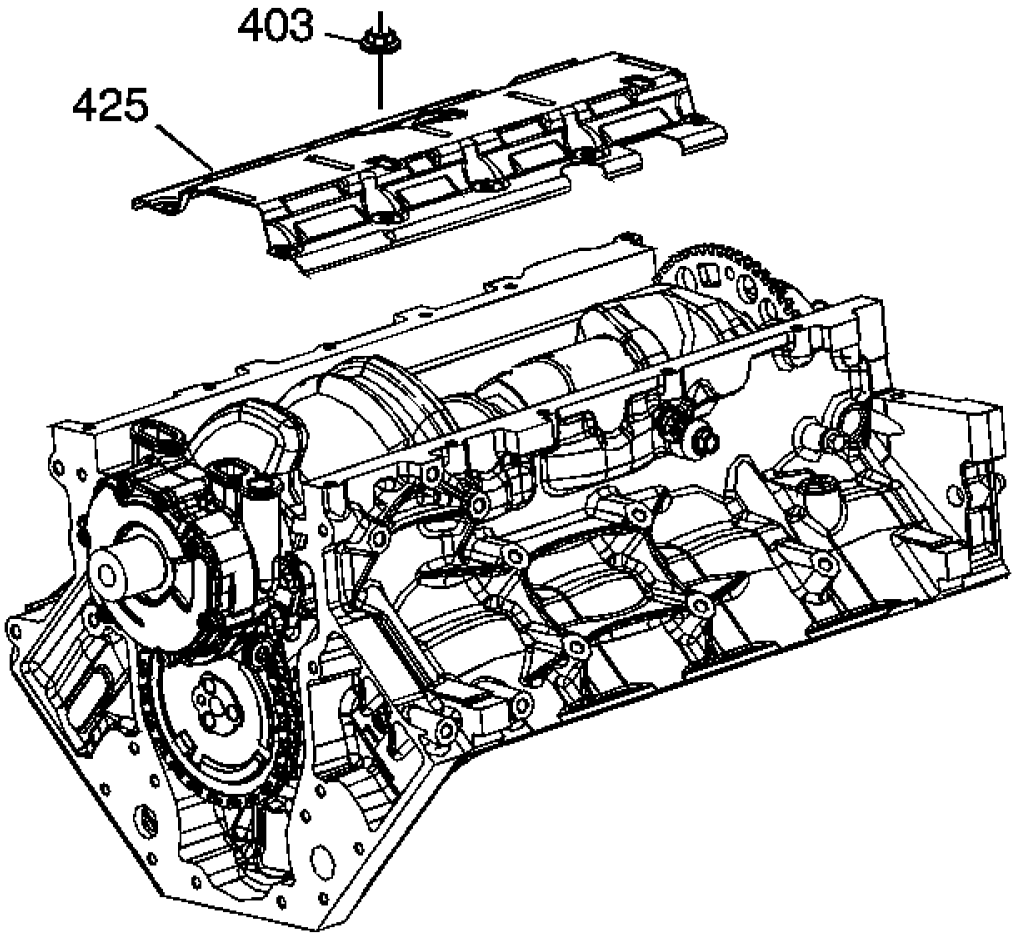


Fig. 76: Crankshaft Oil Deflector & Nuts
Courtesy of GENERAL MOTORS CORP.

5. Remove the crankshaft oil deflector nuts (403).
6. Remove the crankshaft oil deflector (425).

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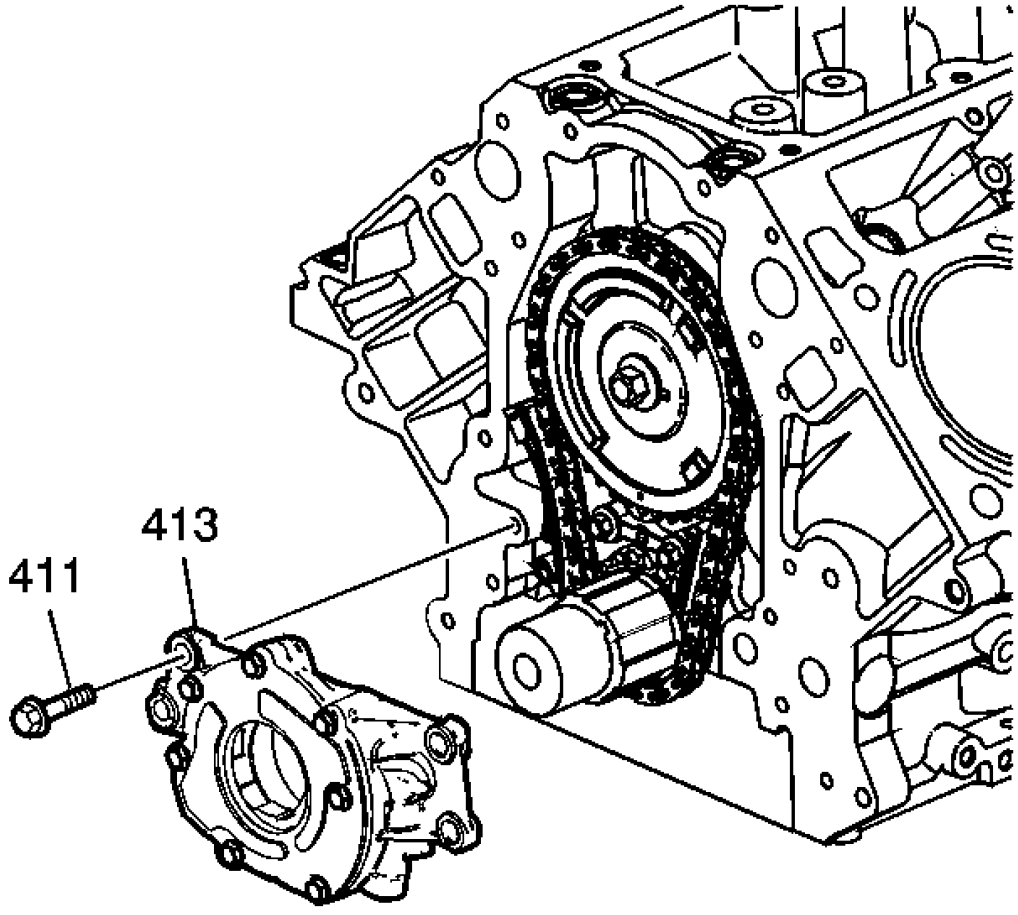


Fig. 77: View Of Oil Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Remove the oil pump bolts (411).

NOTE: Do not allow dirt or debris to enter the oil pump assembly. Cap ends, as necessary.

8. Remove the oil pump (413).

TIMING CHAIN AND SPROCKET REMOVAL

Special Tools

- **J 8433:** Two Jaw Puller

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- **J 41558:** Crankshaft Sprocket Remover
- **J 41816-2:** Crankshaft End Protector
- **J 42386-A:** Flywheel Holding Tool

For equivalent regional tools, refer to **Special Tools** .

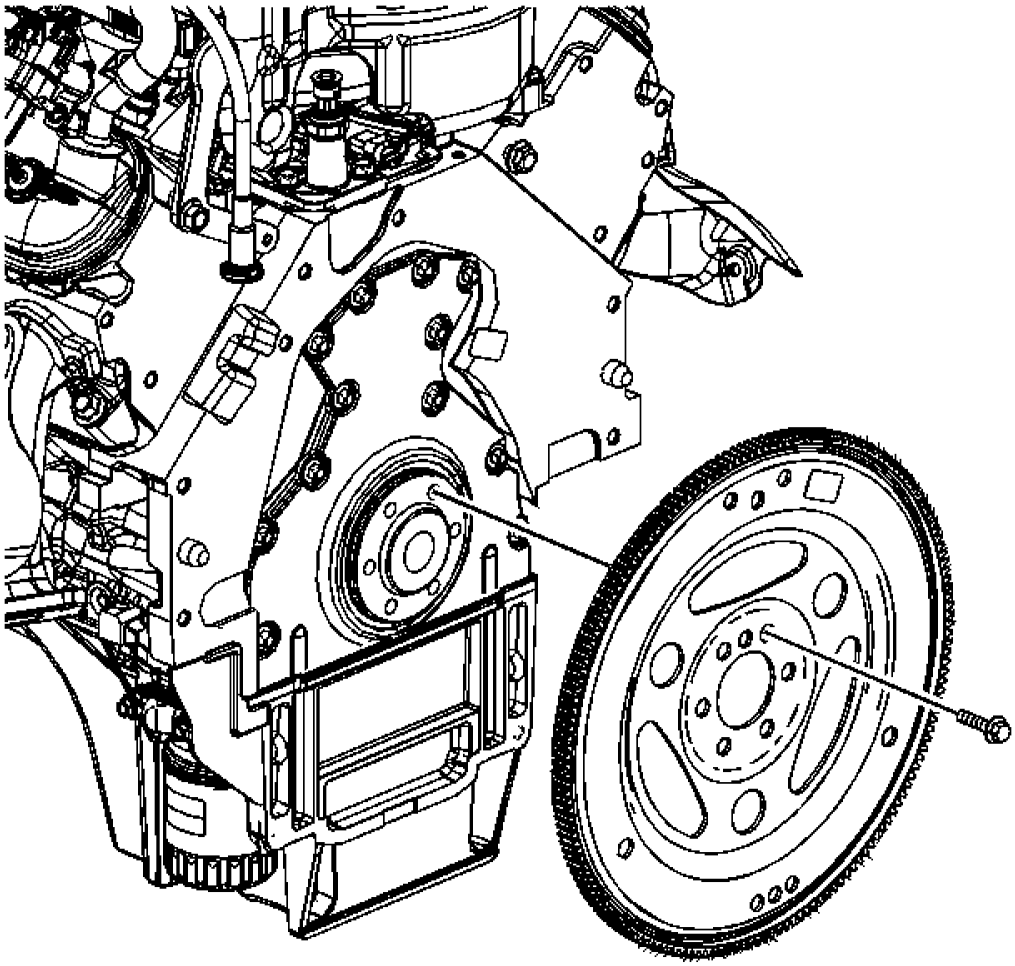


Fig. 78: View Of Flex Plate & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not apply threadlock to the flex plate bolts at this time.

1. Temporarily install the automatic transmission flex plate and bolts. Refer to **Automatic Transmission Flex Plate Installation** .

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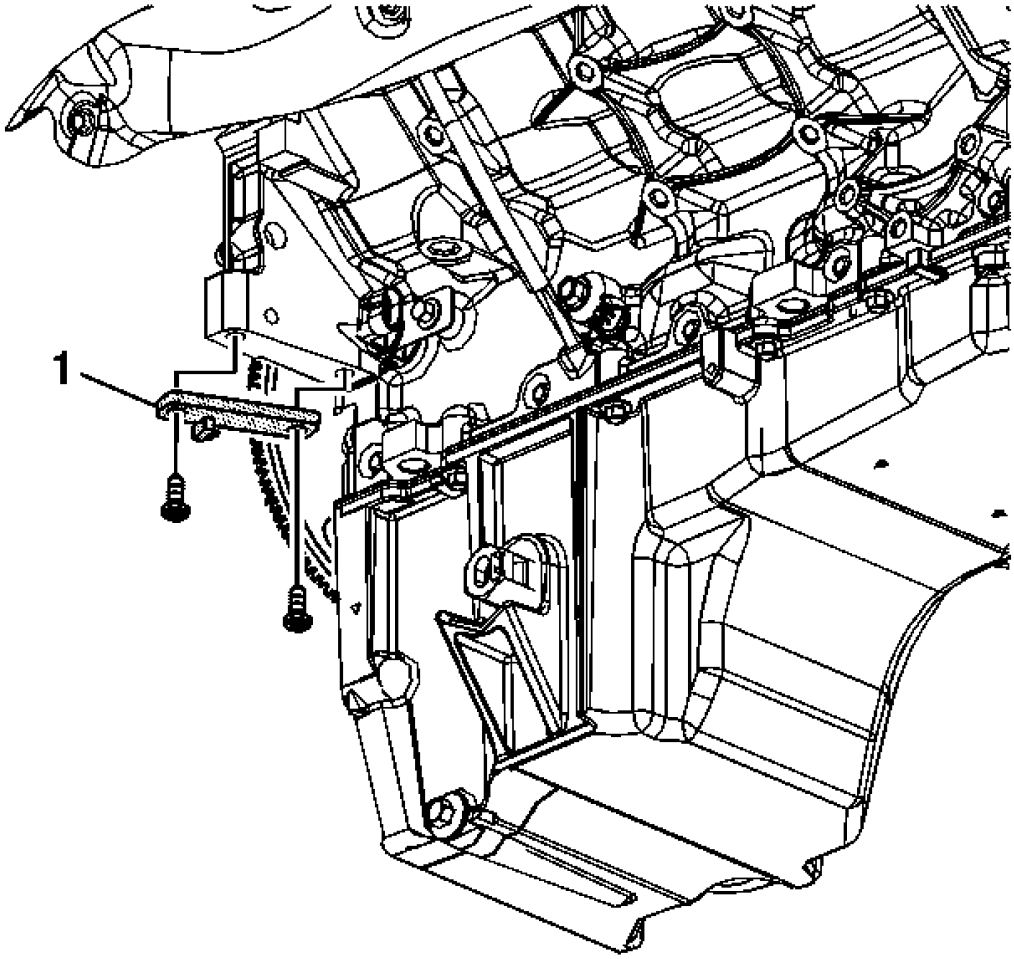


Fig. 79: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Install the **J 42386-A:** tool (1) and bolts. Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the **J 42386-A:** tool bolts to 50 N.m (37 lb ft).

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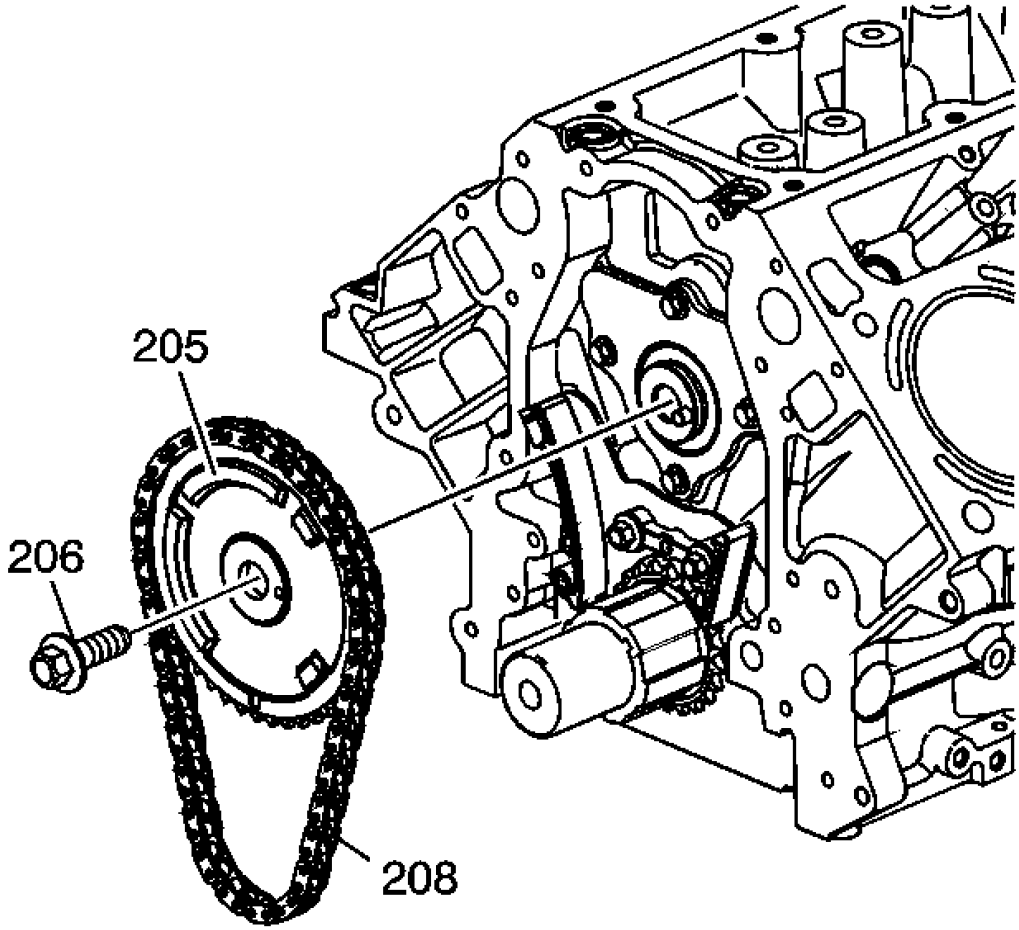


Fig. 80: View Of Camshaft Sprocket, Sprocket Bolt & Timing Chain
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

3. Remove and discard the camshaft sprocket bolt (206).
4. Remove the camshaft sprocket (205) and timing chain (208).

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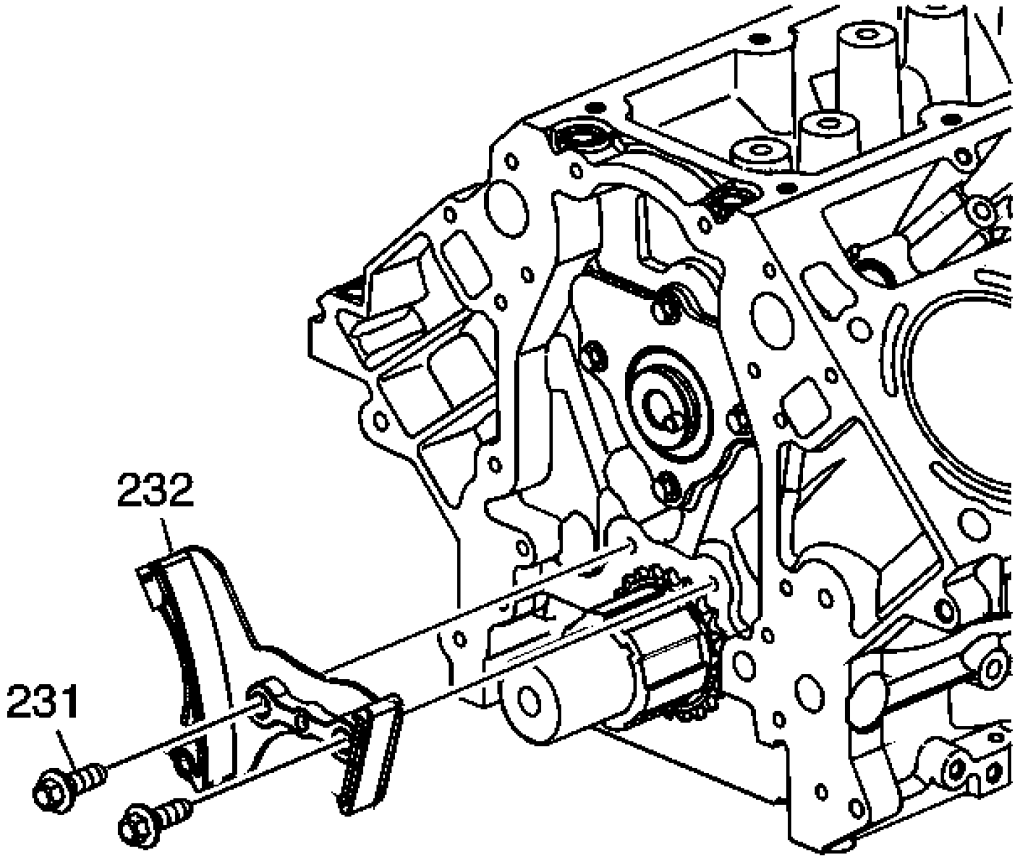


Fig. 81: View Of Timing Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the bolts (231) and timing chain tensioner (232).

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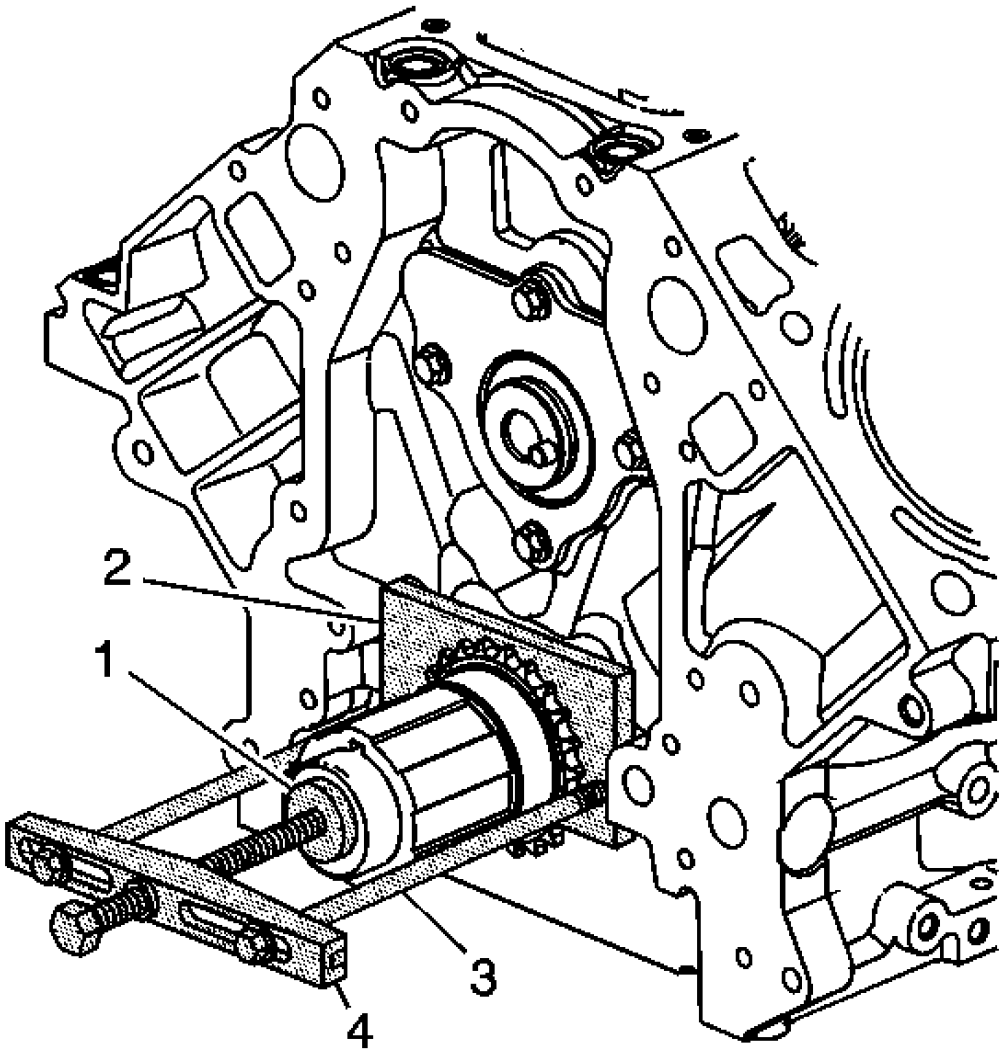


Fig. 82: View Of Crankshaft Sprocket Special Tools
Courtesy of GENERAL MOTORS CORP.

6. Use the **J 41816-2:** protector (1), the **J 41558:** remover (2), bolts (3), and the **J 8433:** puller (4) in order to remove the crankshaft sprocket.

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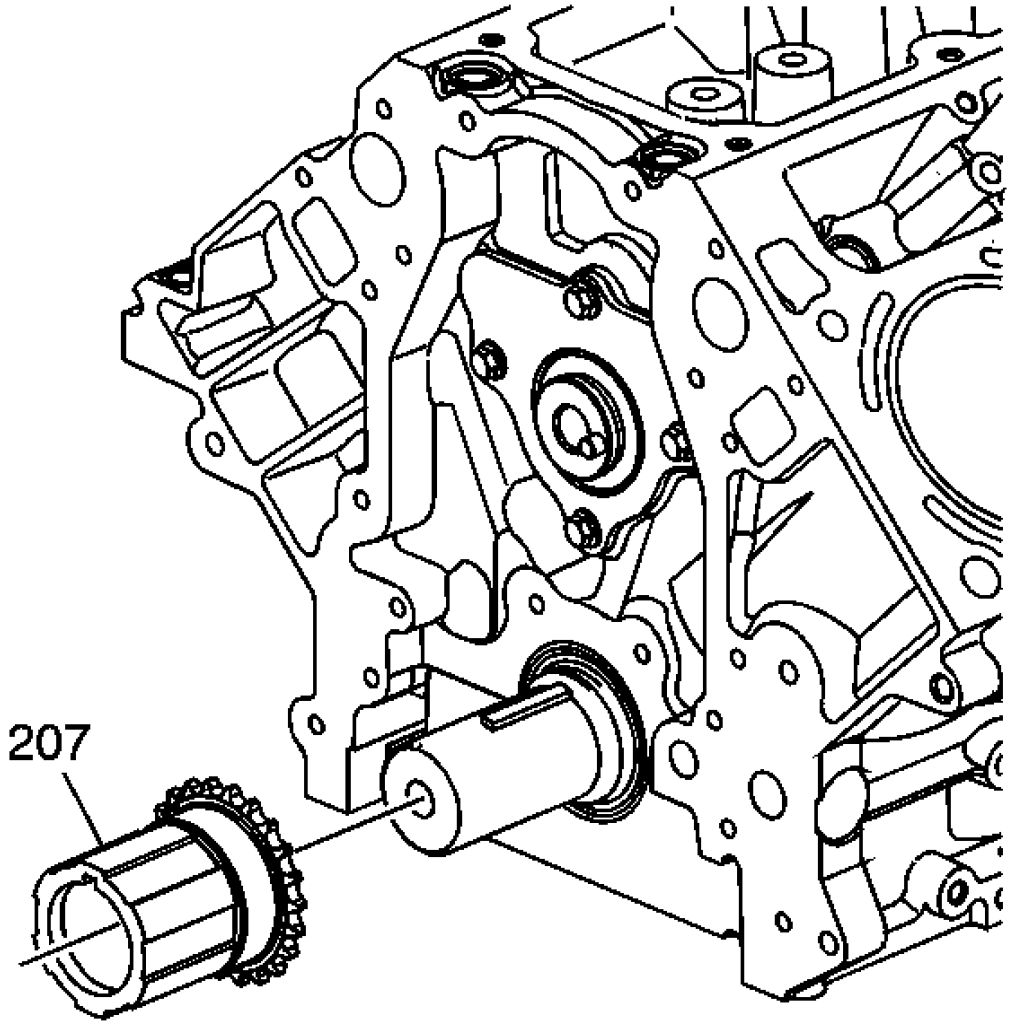


Fig. 83: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

7. Remove the crankshaft sprocket (207).

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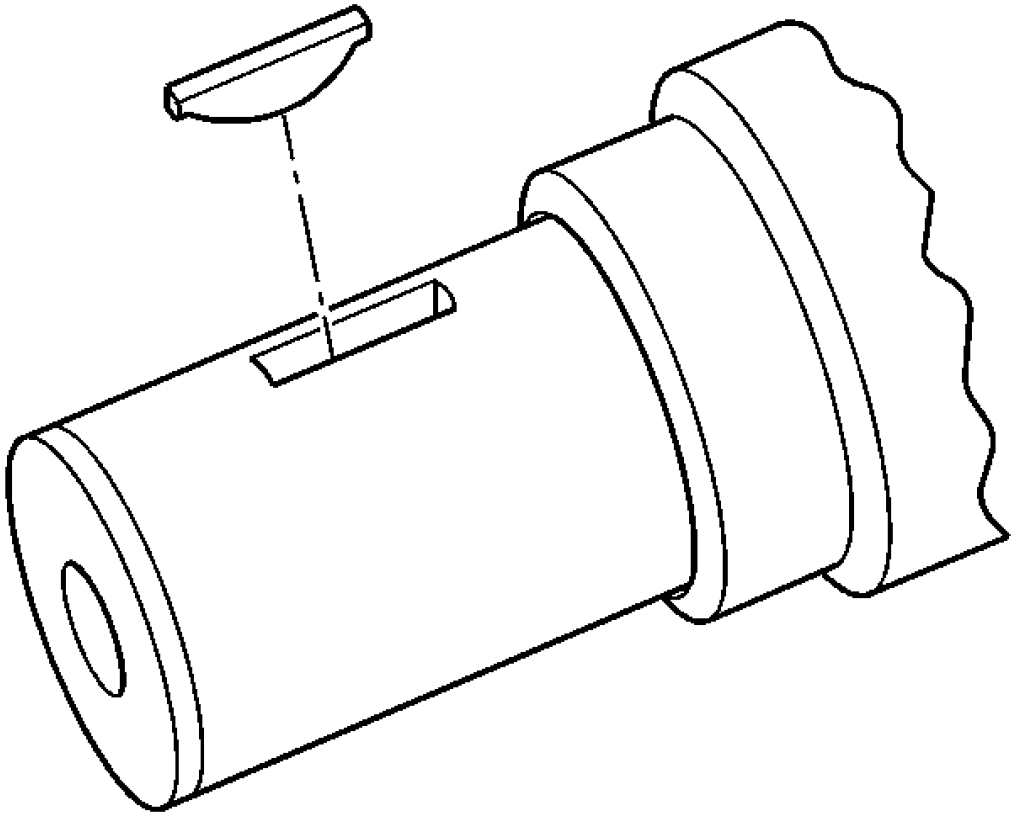


Fig. 84: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS CORP.

8. Remove the crankshaft sprocket key, as required.
9. Remove the automatic transmission flex plate and bolts. Refer to **Automatic Transmission Flex Plate Removal**.
10. Remove the **J 42386-A:** tool and bolts.

TIMING CHAIN, CRANKSHAFT SPROCKET, CAMSHAFT POSITION ACTUATOR, AND SOLENOID VALVE REMOVAL

Special Tools

- **J 8433:** Two Jaw Puller
- **J 41558:** Crankshaft Sprocket Remover
- **J 41816-2:** Crankshaft End Protector

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- **J 42386-A:** Flywheel Holding Tool

For equivalent regional tools, refer to **Special Tools**

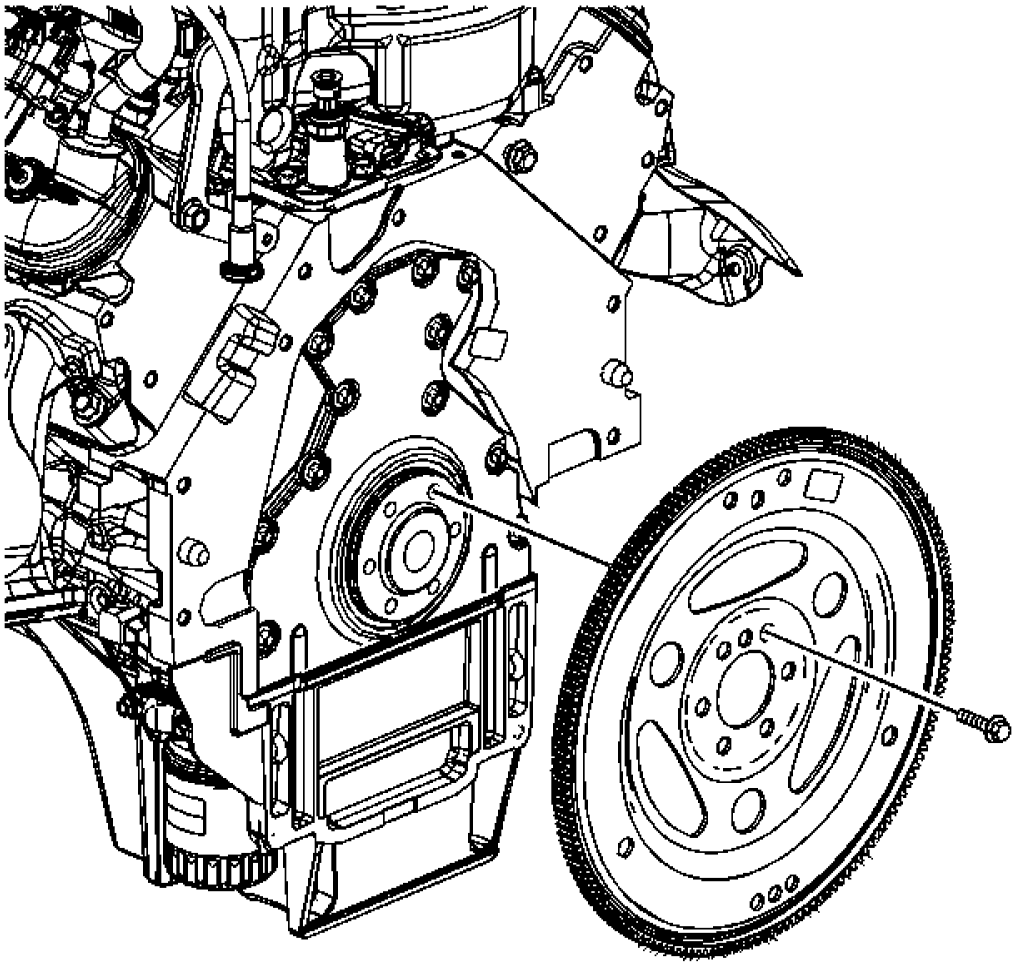


Fig. 85: View Of Flex Plate & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Do not use the camshaft position (CMP) actuator solenoid valve again. Upon installation of the CMP actuator and timing chain, install a NEW valve.**
- **Do not apply threadlock to the flex plate bolts at this time.**

1. Temporarily install the automatic transmission flex plate and bolts. Refer to **Automatic Transmission**

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Flex Plate Installation .

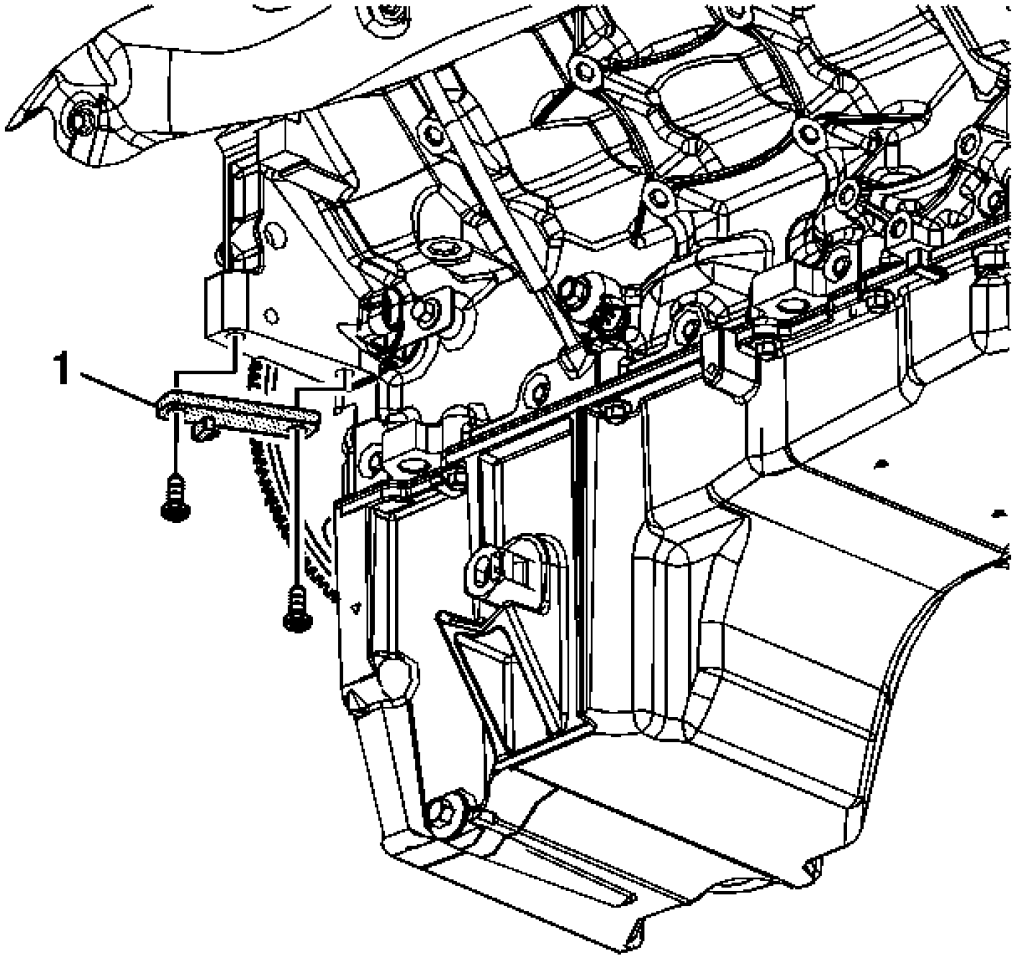


Fig. 86: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Install the **J 42386-A:** tool (1) and bolts. Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the **J 42386-A:** tool bolts to 50 N.m (37 lb ft).

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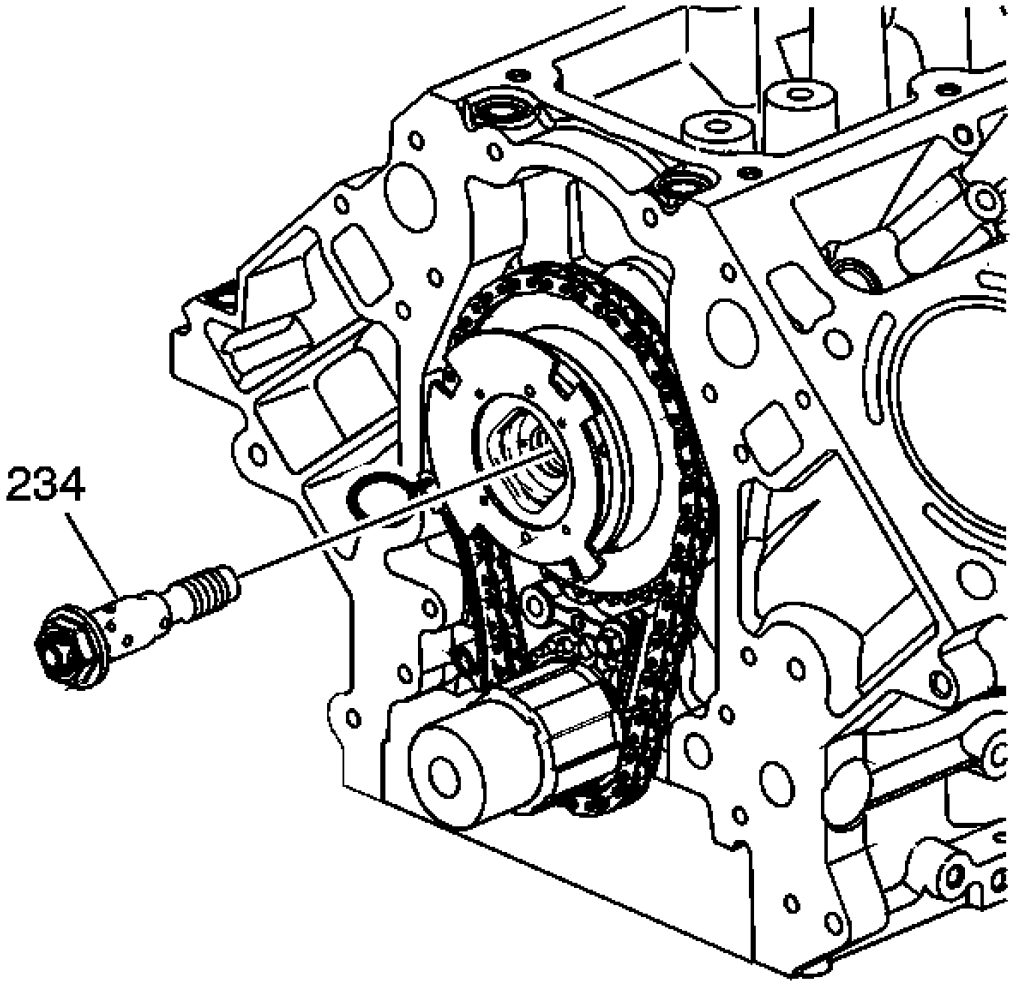


Fig. 87: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

3. Remove the CMP actuator solenoid valve (234).
4. Discard the solenoid valve.

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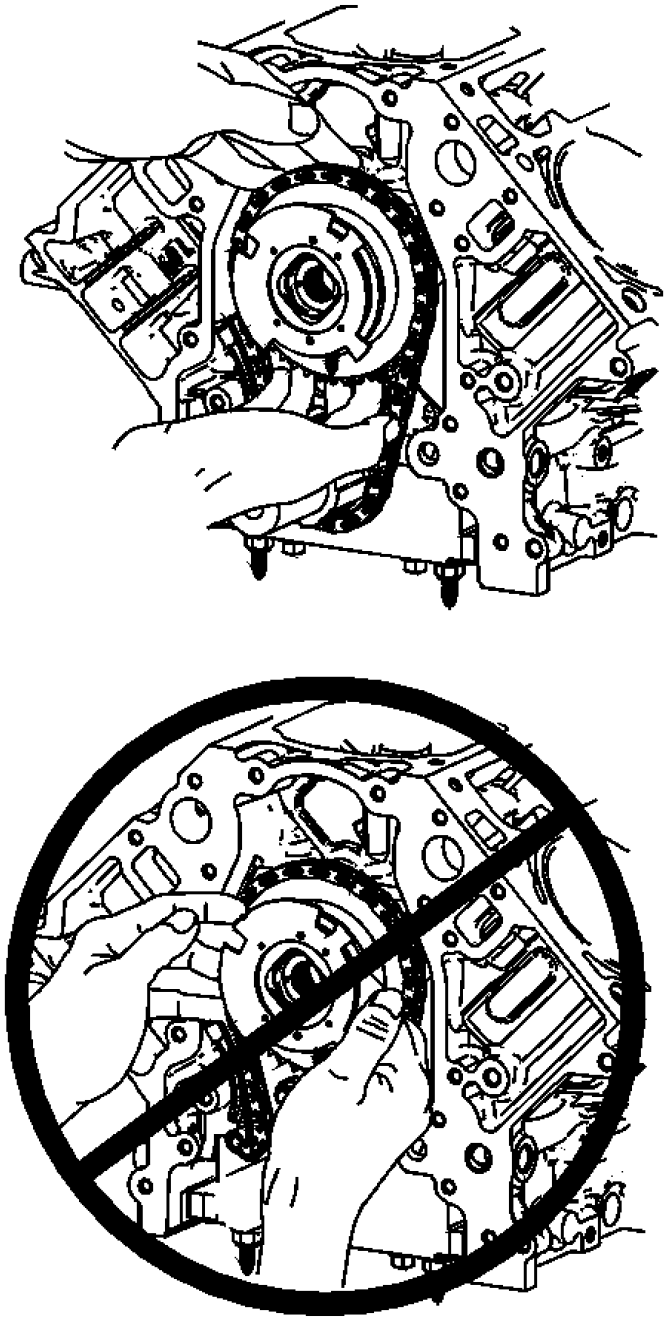


Fig. 88: View Of Proper CMP Actuator Removal
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Camshaft Position Actuator Removal and Installation

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Warning .

5. Loosen and separate the CMP actuator and timing chain from the camshaft. Position fingers behind the actuator sprocket and pull the actuator away from the front of the camshaft. Never pull on the reluctor wheel when attempting to remove the actuator.

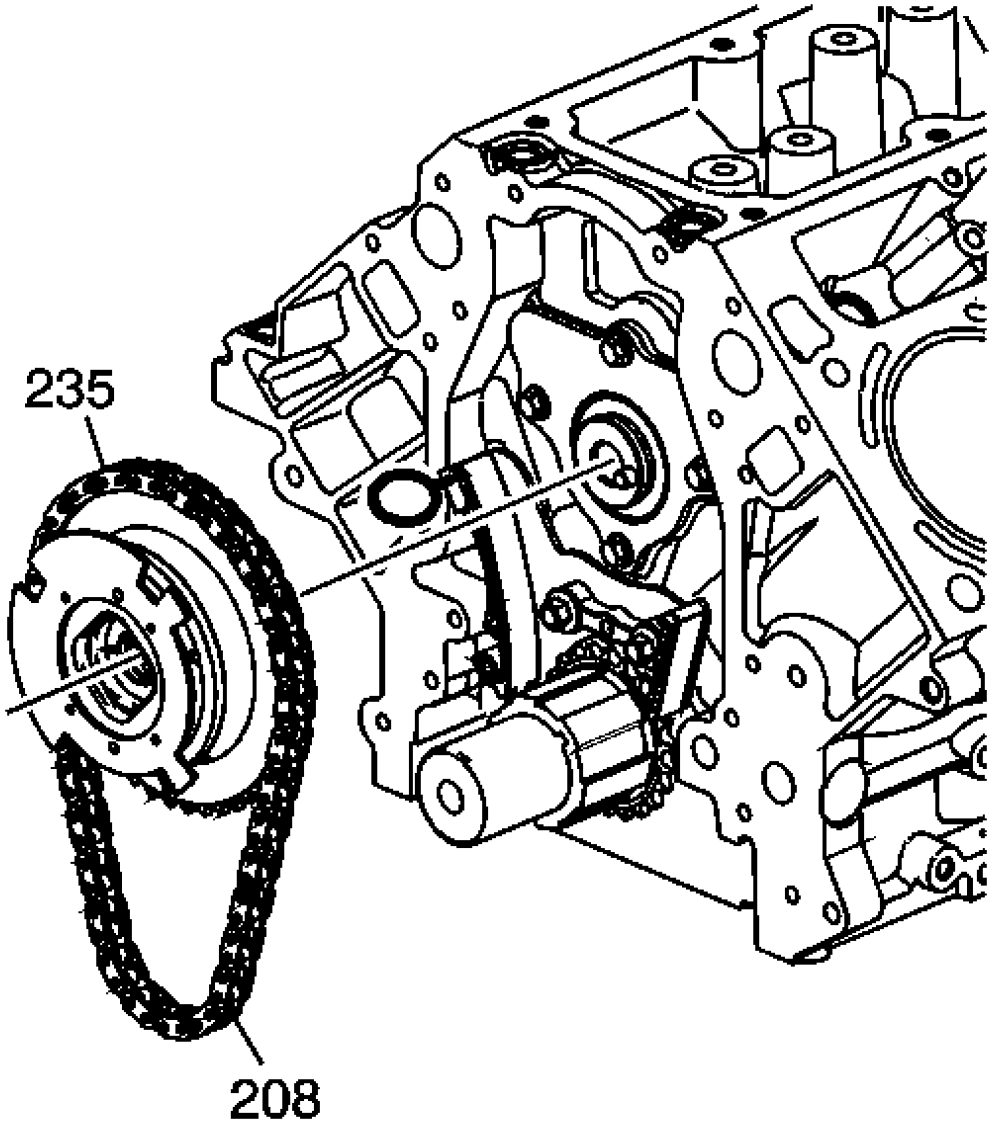


Fig. 89: View Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS CORP.

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6. Remove the CMP actuator (235) and timing chain (208).

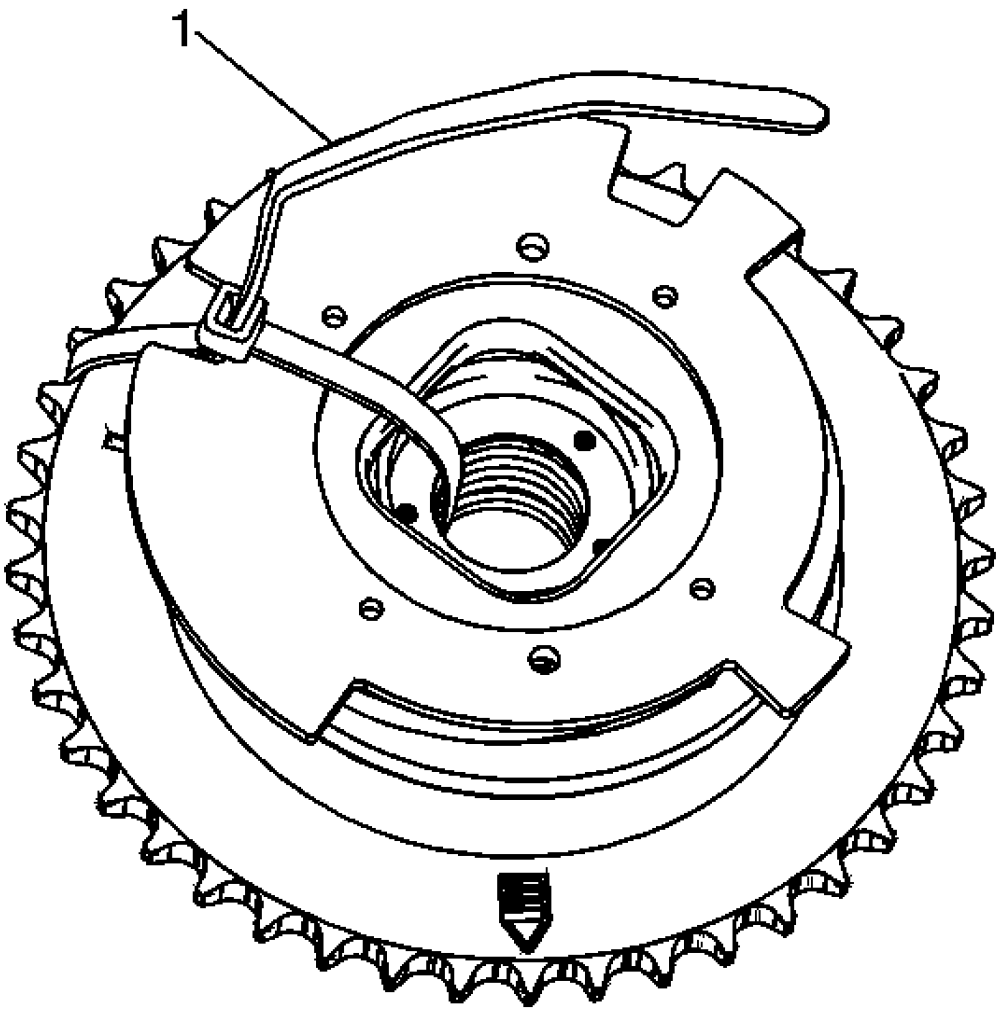


Fig. 90: View Of Tie Strap Through Center Of Actuator
Courtesy of GENERAL MOTORS CORP.

7. Insert a tie strap (1) through the center of the actuator and over the reluctor wheel.

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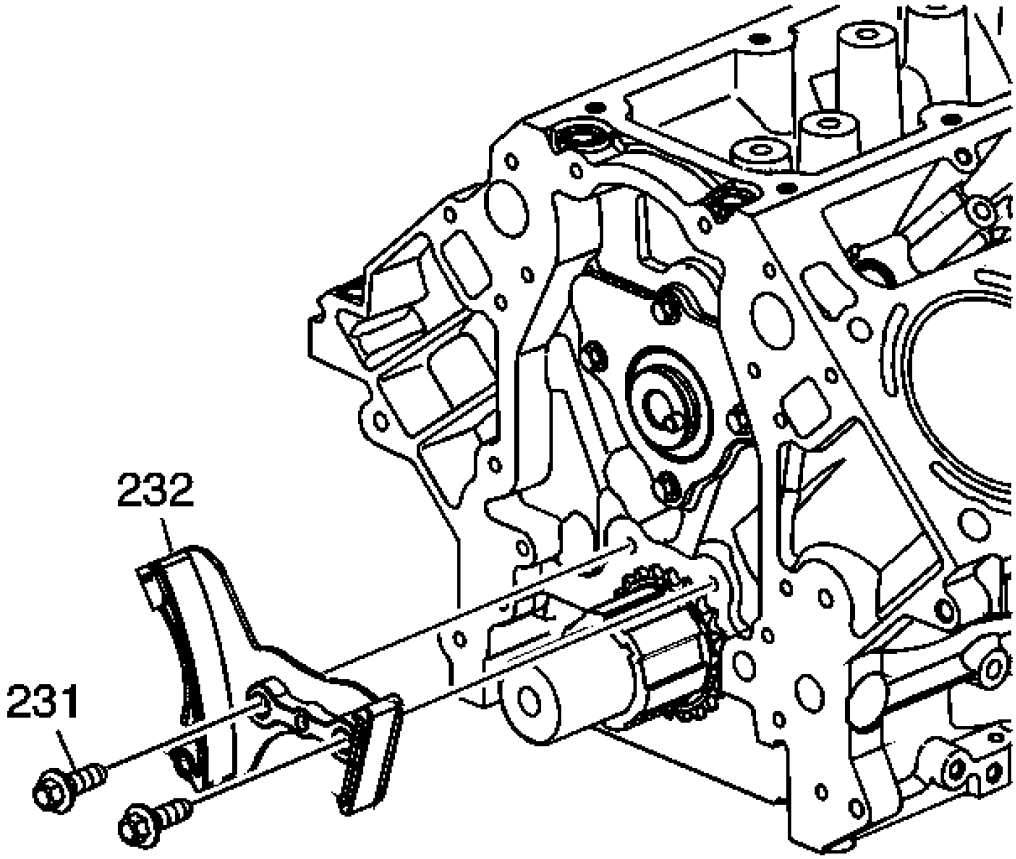


Fig. 91: View Of Timing Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the bolts (231) and timing chain tensioner (232).

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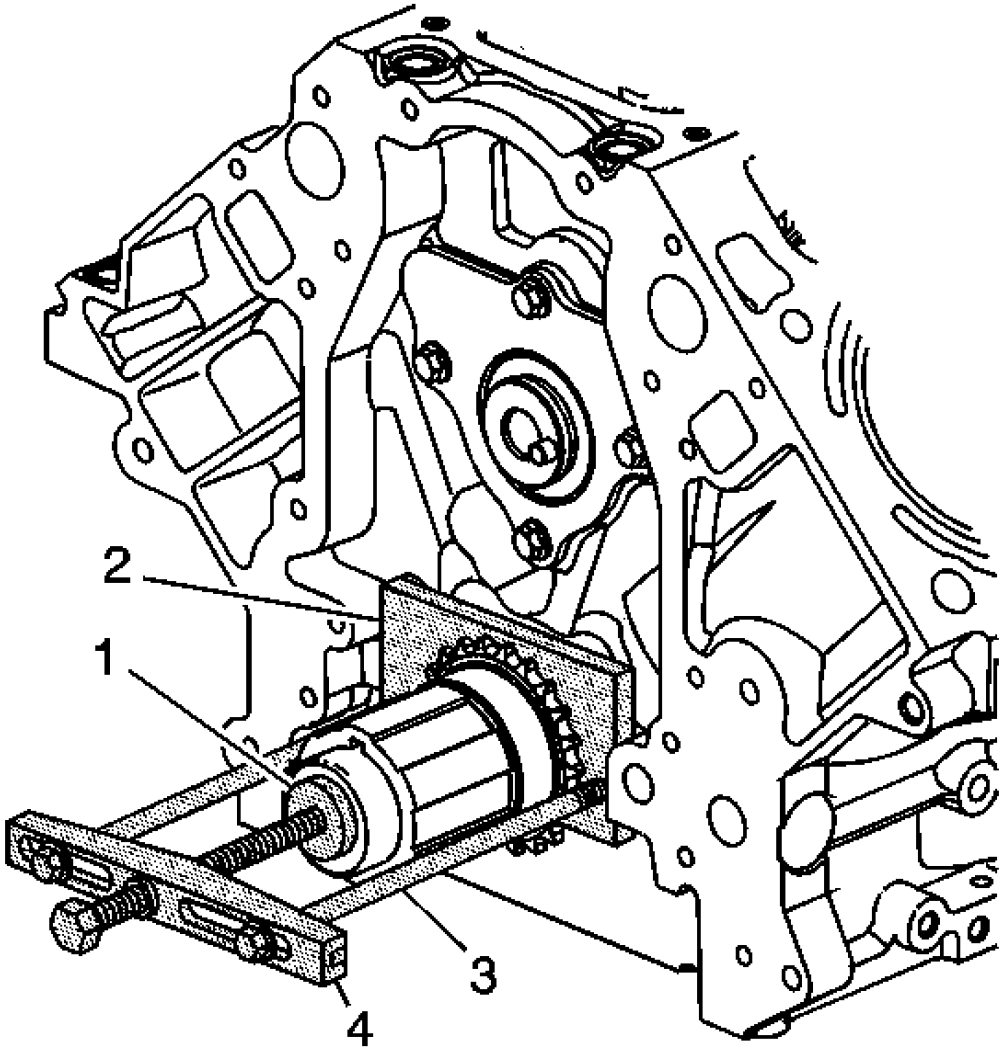


Fig. 92: View Of Crankshaft Sprocket Special Tools
Courtesy of GENERAL MOTORS CORP.

9. Use the **J 41816-2:** protector (1), the **J 41558:** remover (2), bolts (3), and the **J 8433:** puller (4) in order to remove the crankshaft sprocket.

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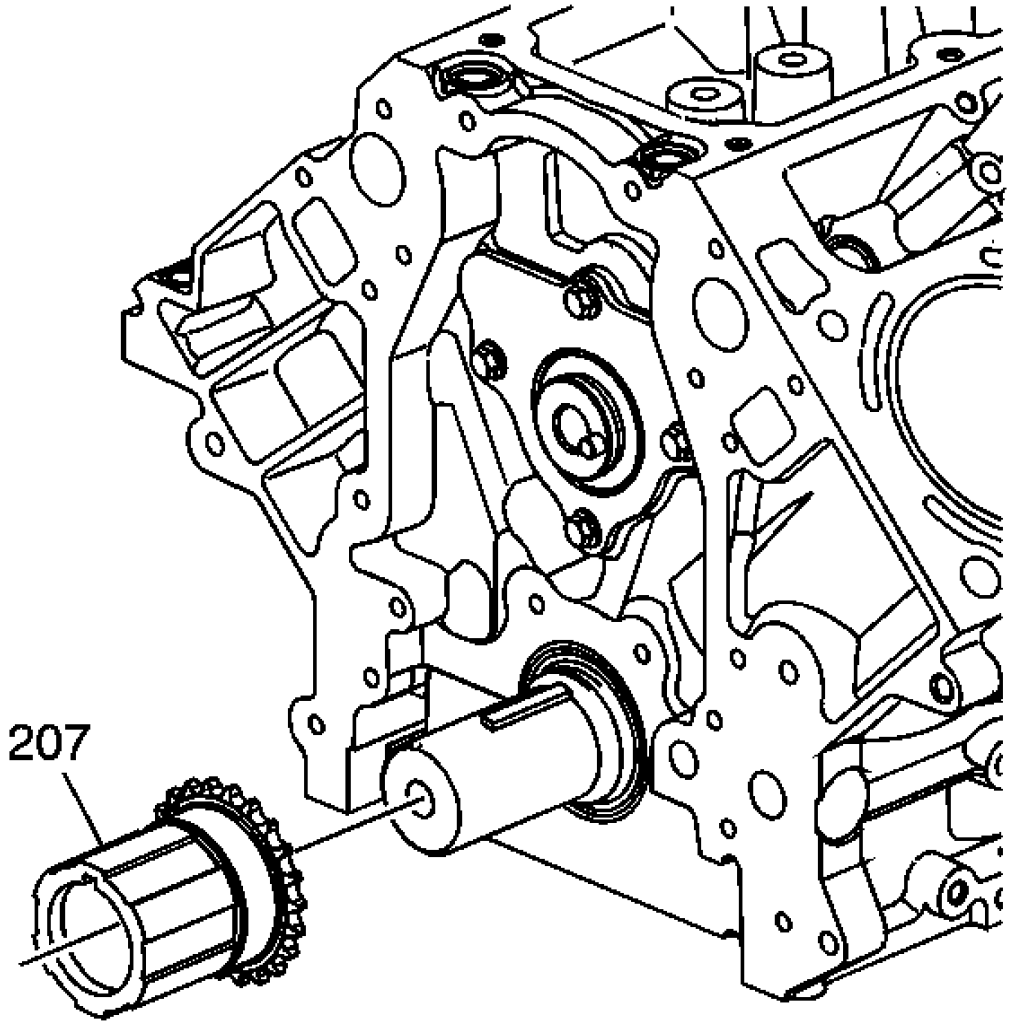


Fig. 93: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

10. Remove the crankshaft sprocket (207).

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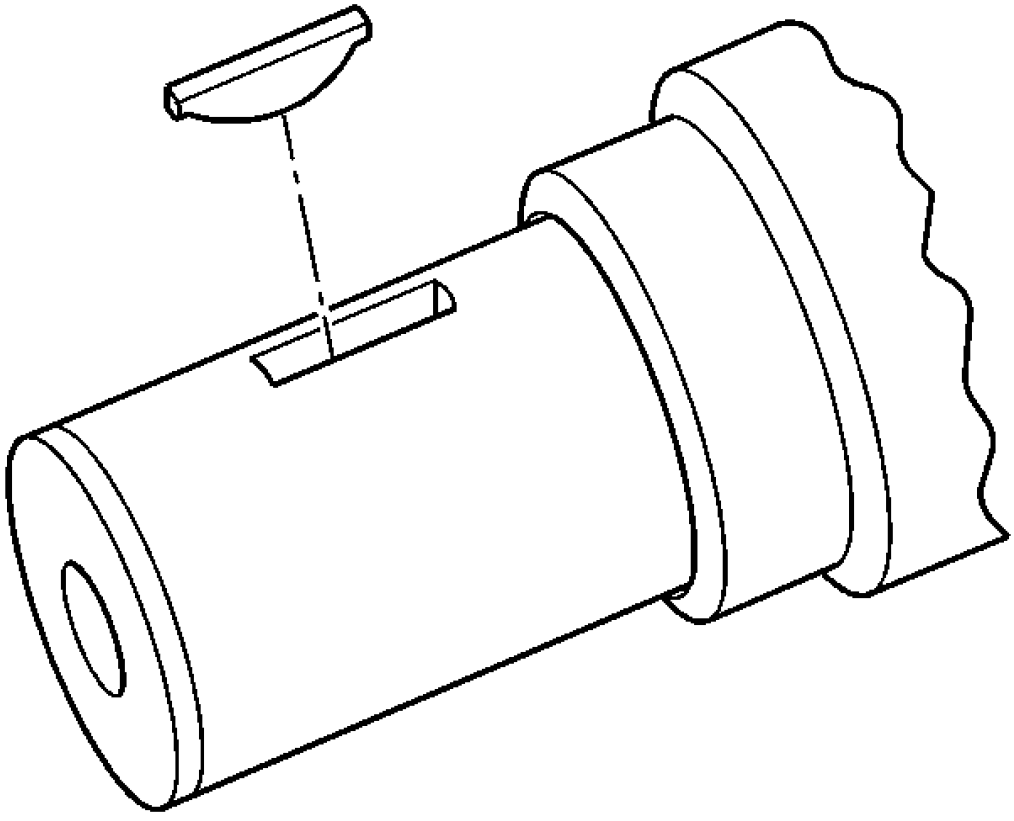


Fig. 94: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS CORP.

11. Remove the crankshaft sprocket key, as required.
12. Remove the flex plate and bolts. Refer to **Automatic Transmission Flex Plate Removal**.
13. Remove the **J 42386-A:** tool and bolts.

CAMSHAFT REMOVAL

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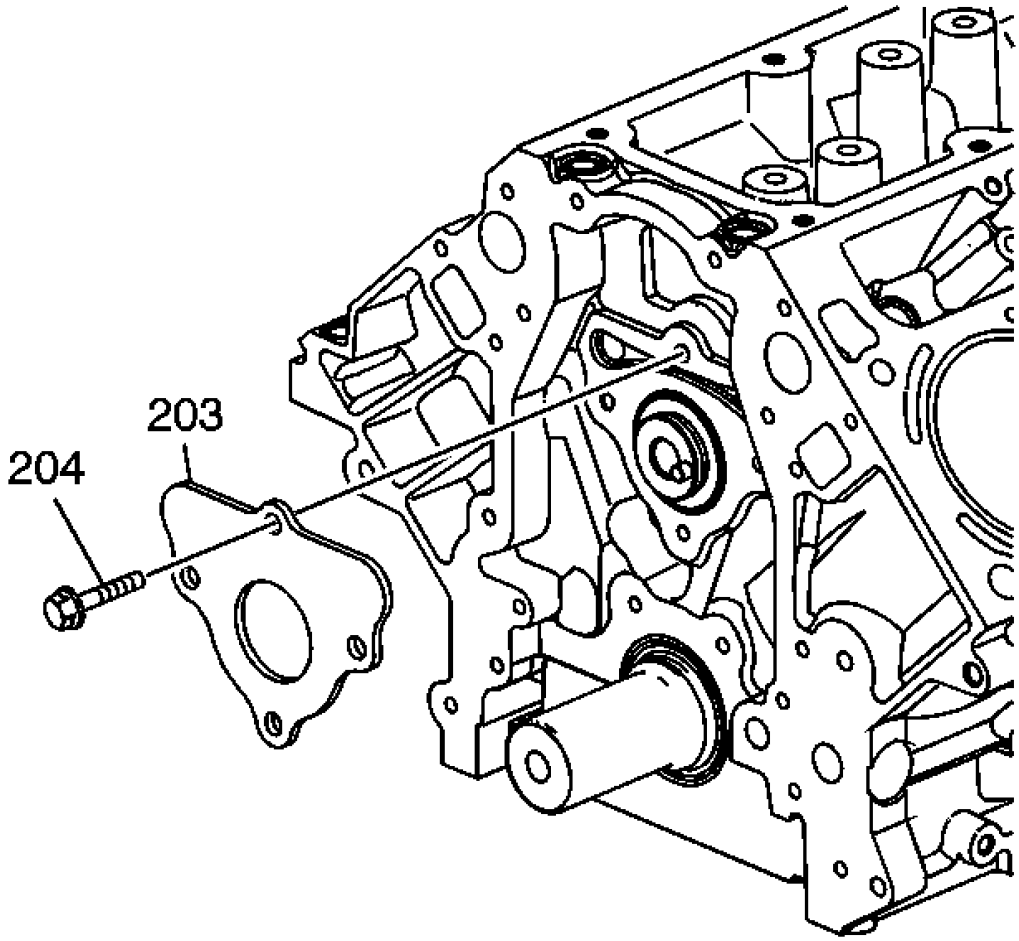


Fig. 95: View Of Camshaft Retainer & Retainer Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the camshaft retainer bolts (204) and retainer (203).

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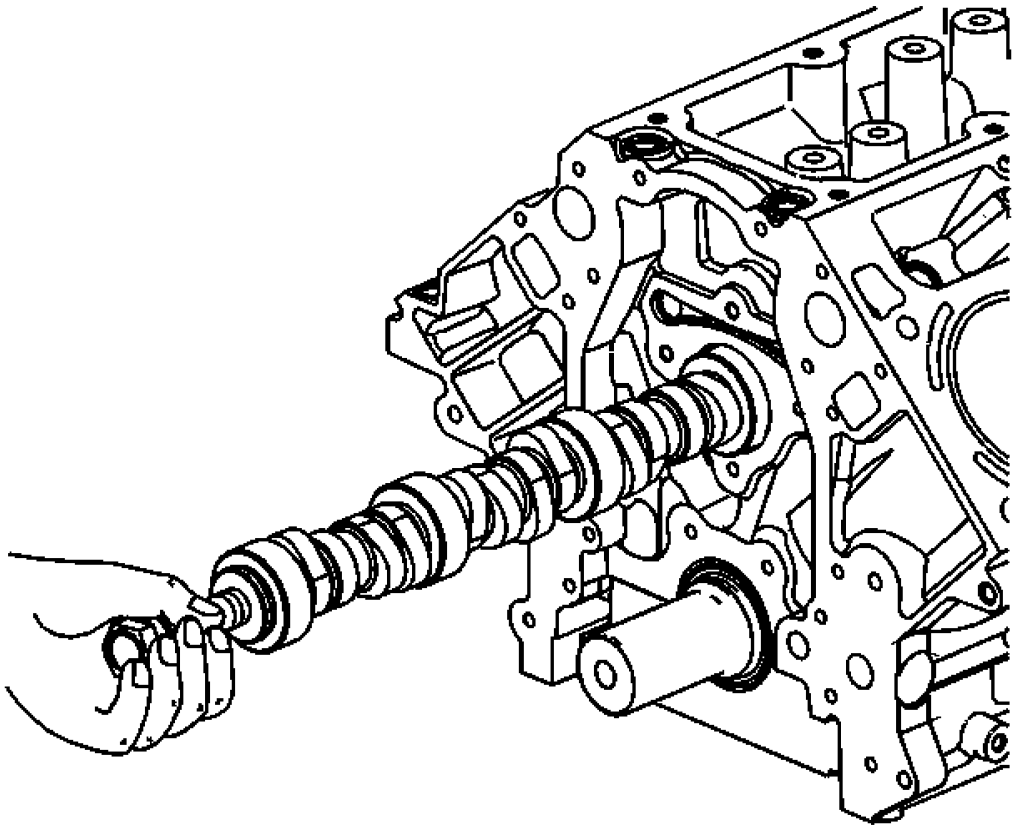


Fig. 96: View Of Camshaft
Courtesy of GENERAL MOTORS CORP.

CAUTION: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

2. Remove the camshaft.
    1. Install the camshaft sprocket bolt or solenoid valve into the camshaft front bolt hole.
    2. Using the bolt or solenoid valve as a handle, carefully rotate and pull the camshaft out of the engine block.
    3. Remove the bolt or solenoid valve from the front of the camshaft.

PISTON, CONNECTING ROD, AND BEARING REMOVAL

Tools Required

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- **J 24270** Cylinder Bore Ridge Reamer. See **Special Tools** .
- **J 41556** Connecting Rod Guide. See **Special Tools** .

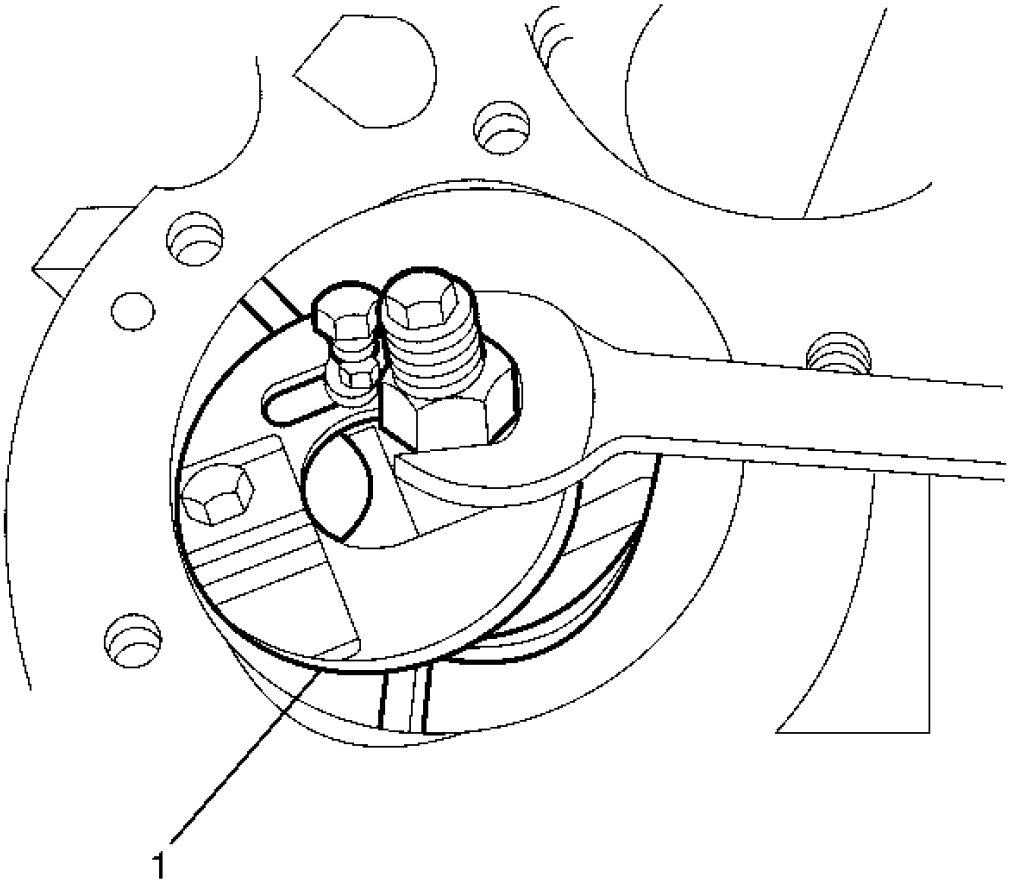


Fig. 97: Removing Cylinder Bore Ring Ridge
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Follow the manufacturer's operating instructions for the ridge remover being used.

1. Use the **J 24270** or equivalent (1) in order to remove the cylinder bore ring ridge, if required. See **Special Tools** .
    1. Turn the crankshaft until the piston is at the bottom of the stroke.
    2. Place a cloth on top of the piston.
    3. Use the **J 24270** or equivalent (1), in order to remove a cylinder ring ridge. See **Special Tools** .

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4. Turn the crankshaft so the piston is at the top of the stroke.
5. Remove the cloth.
6. Remove the cutting debris from the cylinder and piston.

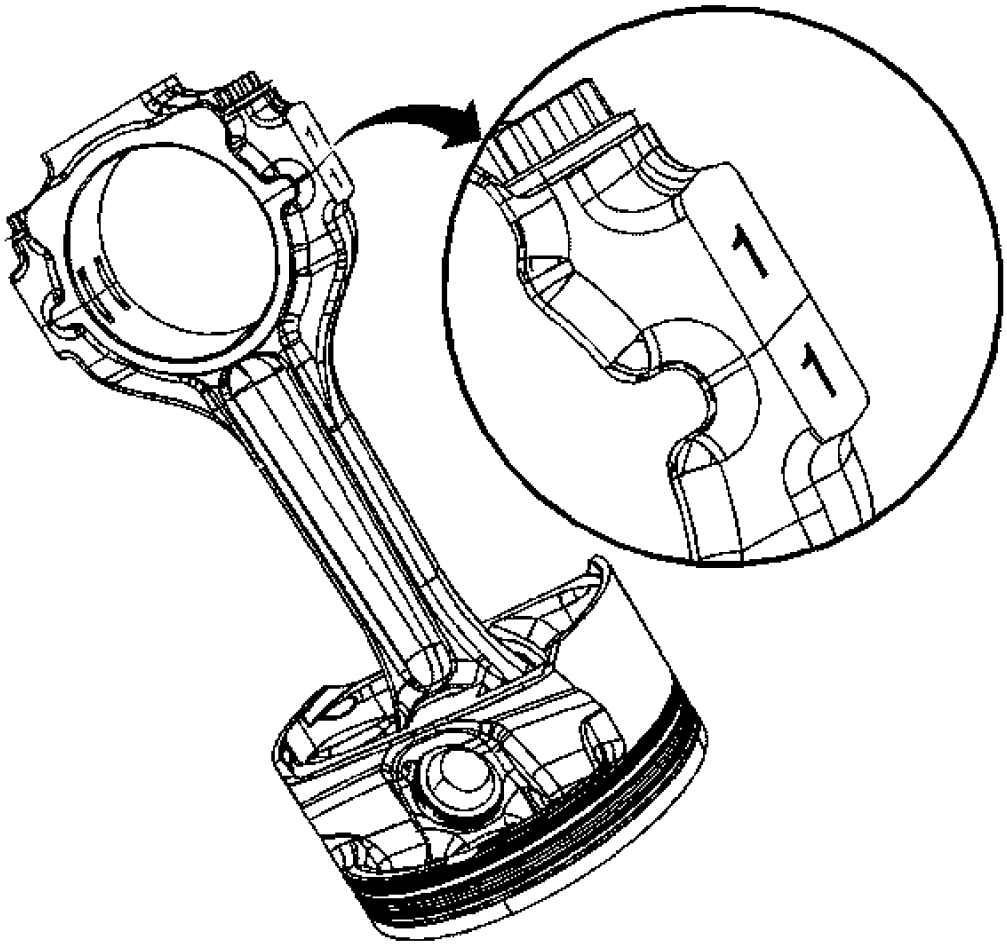


Fig. 98: Identifying Connecting Rod & Piston Assembly
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not apply a stamping mark to any part of the connecting rod and piston assembly, A stamping mark on the side of the connecting rod, at the crankshaft journal, may affect component geometry.

2. Using a paint stick or etching tool, place match marks or numbers on the connecting rods and the connecting rod caps. The connecting rods and caps MUST be assembled to their original position and

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direction.

3. Mark the top of the piston to the specific cylinder bore.

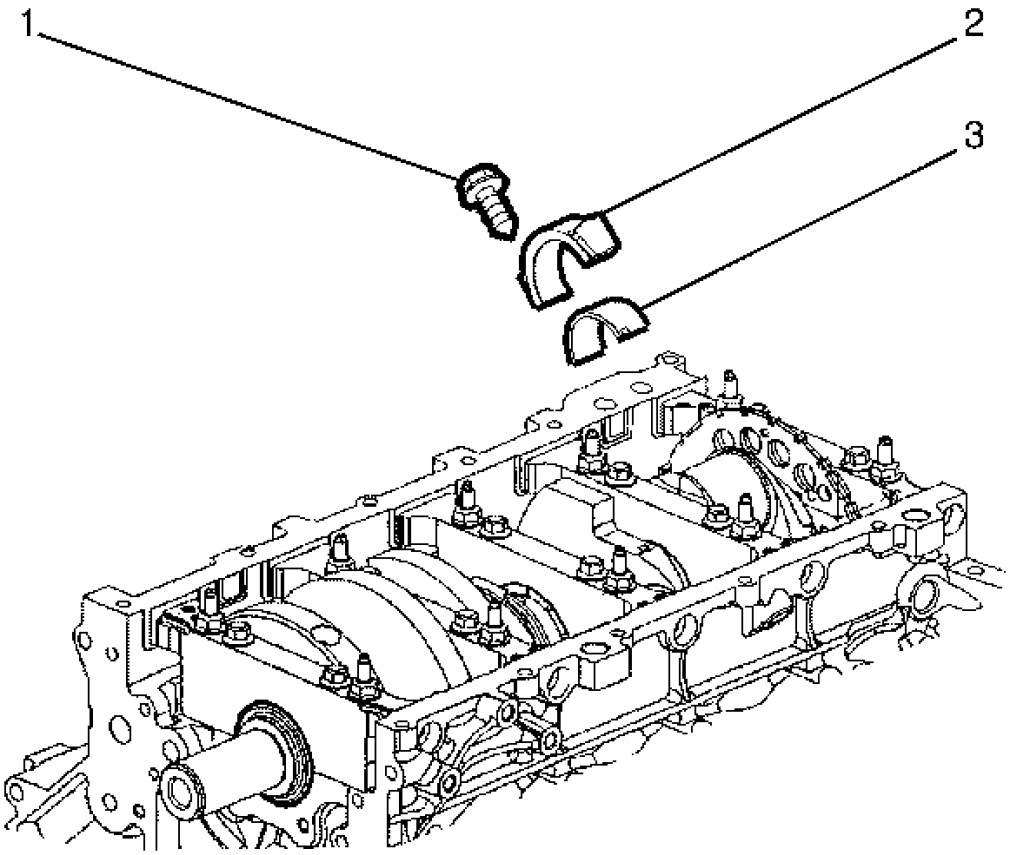


Fig. 99: Identifying Connecting Rod Bolts, Bearing & Cap
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Mark, sort, or organise the connecting rod bearings so they may be installed to their original position and location. The connecting rods and the bearing caps are NOT interchangeable. Refer to Separating Parts .

4. Remove the connecting rod bolts (1).
5. Remove the connecting rod bearing cap (2).
6. Remove the connecting rod bearing (3).

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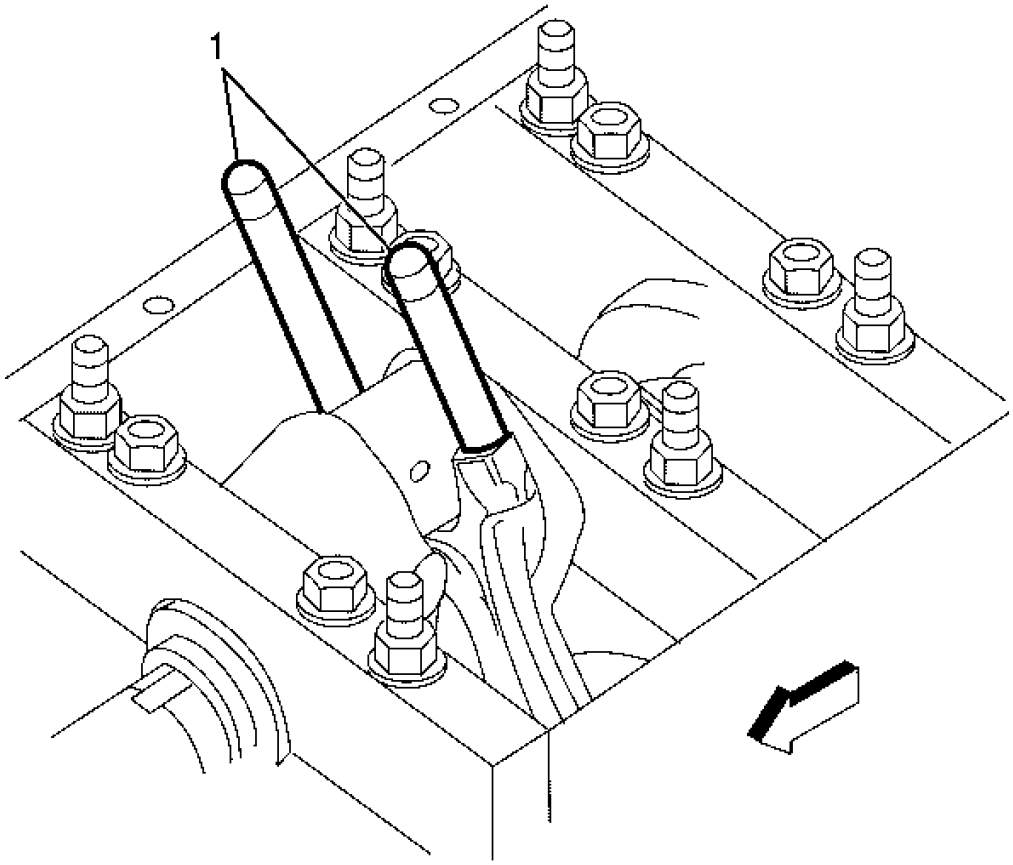


Fig. 100: Identifying J 41556
Courtesy of GENERAL MOTORS CORP.

7. Install the **J 41556** (1) to the connecting rod. See **Special Tools** .
8. Using a soft hammer, tap lightly on the end of the **J 41556** (1) in order to remove the piston and connecting rod assembly from the cylinder bore. See **Special Tools** .

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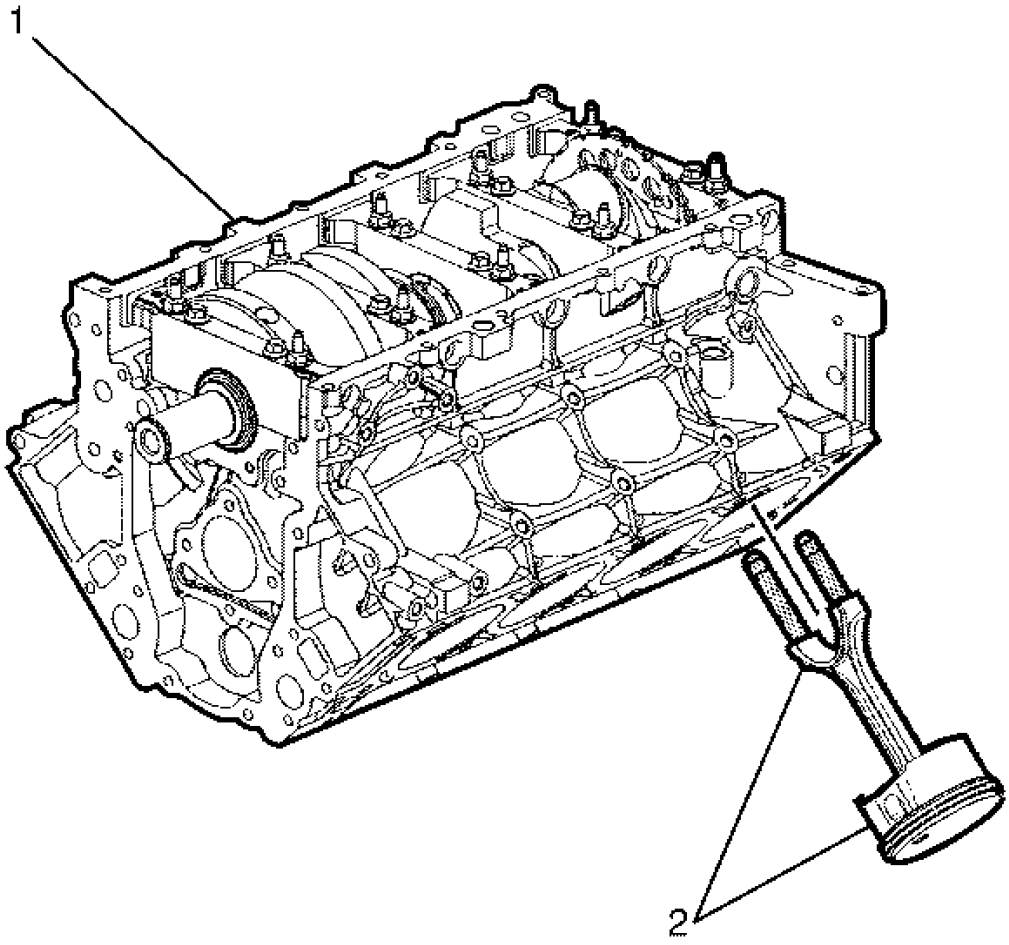


Fig. 101: Identifying Piston & Connecting Rod Assembly With Cylinder Block
Courtesy of GENERAL MOTORS CORP.

9. Remove the piston and connecting rod assembly (2) from the cylinder block (1).
10. Upon removal of the piston and connecting rod assembly, assemble the connecting rod cap and bolt onto the matching connecting rod.

CRANKSHAFT AND BEARING REMOVAL

Special Tools

- **J 6125-1B:** Slide Hammer
- **J 41818:** Crankshaft Bearing Cap Remover

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For equivalent regional tools, refer to **Special Tools**

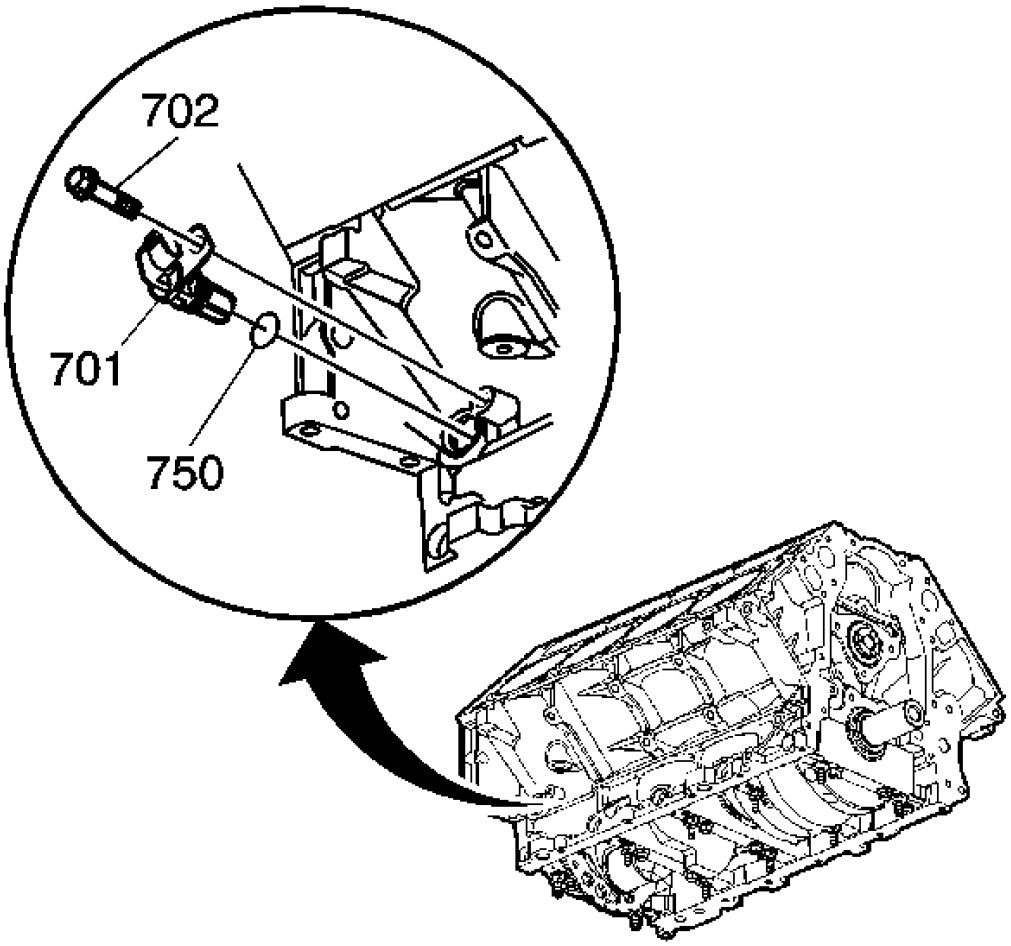


Fig. 102: CKP Sensor, Bolt & O-Ring
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **The crankshaft bearing caps are machined with the engine block, for the proper clearances. Mark or identify each crankshaft bearing cap location and direction before removal. The crankshaft bearing caps MUST be installed to their original position and direction.**
- **All M8, and M10 bolts are to be discarded and replaced with NEW.**

1. Remove the crankshaft position (CKP) sensor bolt (702).
2. Remove the CKP sensor (701).

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3. Remove the O-ring (750) from the sensor, as required.

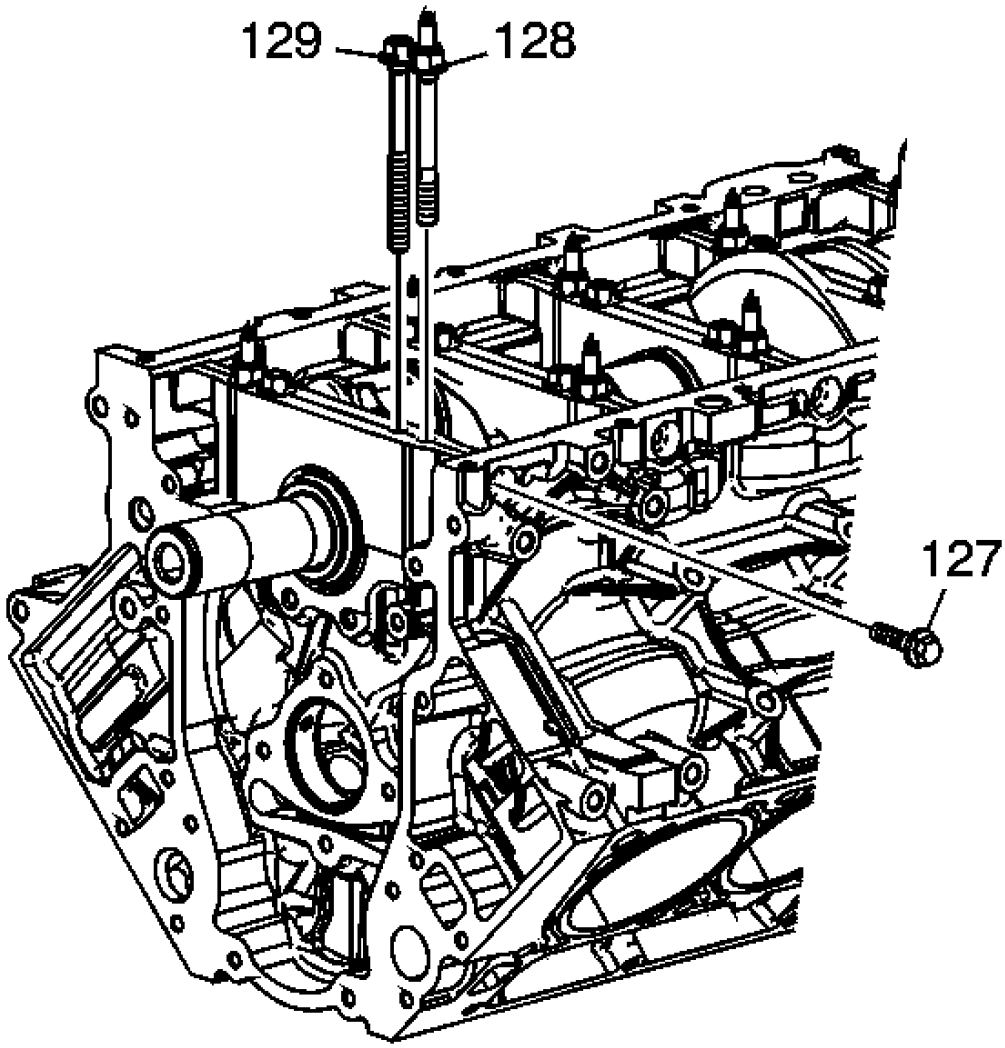


Fig. 103: Identifying Bearing Cap Bolts & Studs
Courtesy of GENERAL MOTORS CORP.

4. Remove and discard the crankshaft bearing cap M8 bolts (127).
5. Remove and discard the bearing cap M10 bolts (129) and studs (128).

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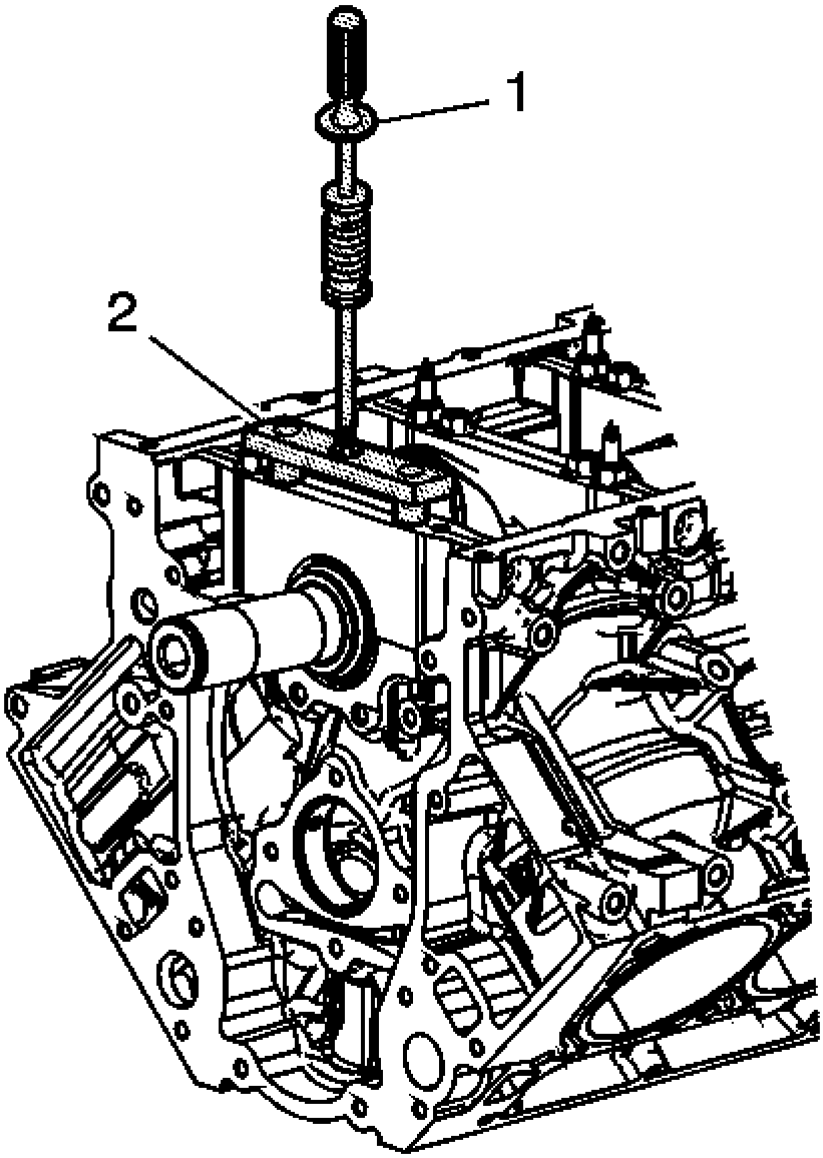


Fig. 104: Removing Crankshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

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6. Install the **J 41818:** remover (2) and tighten to 11 N.m (100 lb in).
7. Install the **J 6125-1B:** hammer (1) to the **J 41818:** remover (2) in order to remove the crankshaft bearing caps.

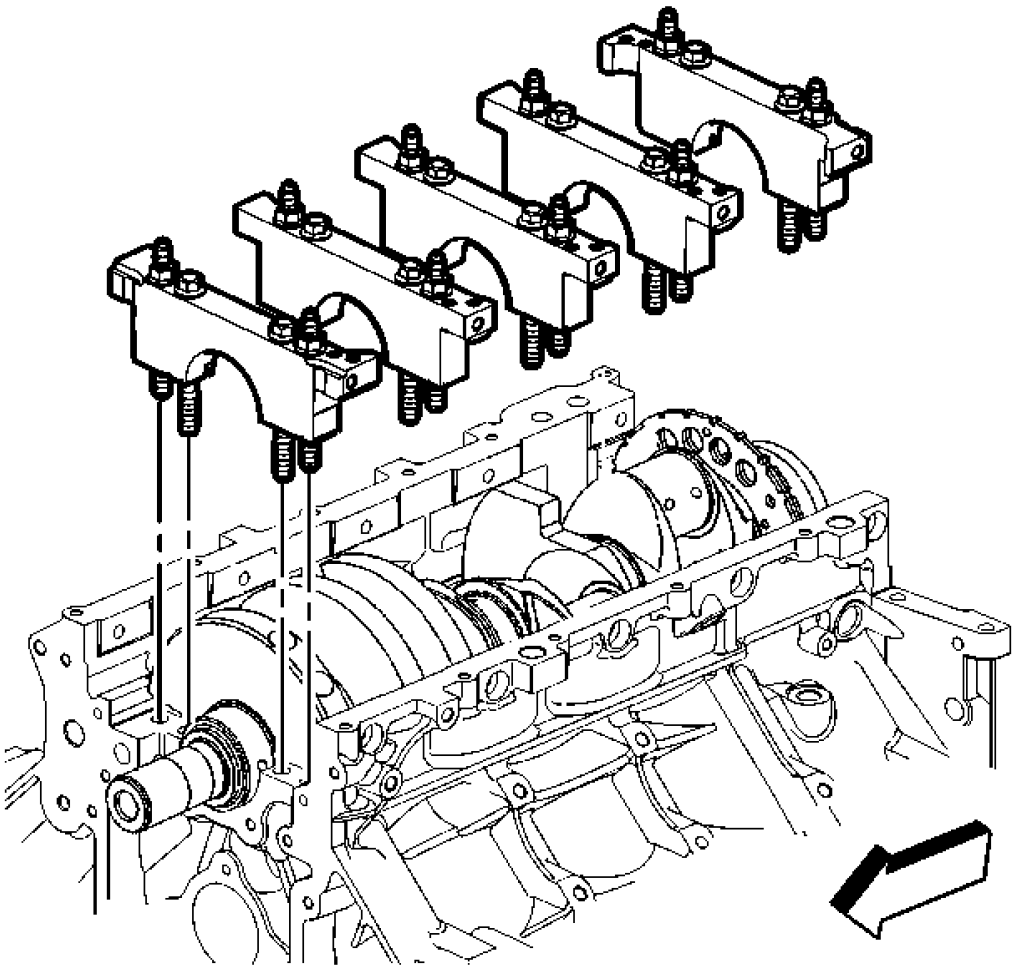


Fig. 105: View Of Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS CORP.

8. Remove the bearing caps.

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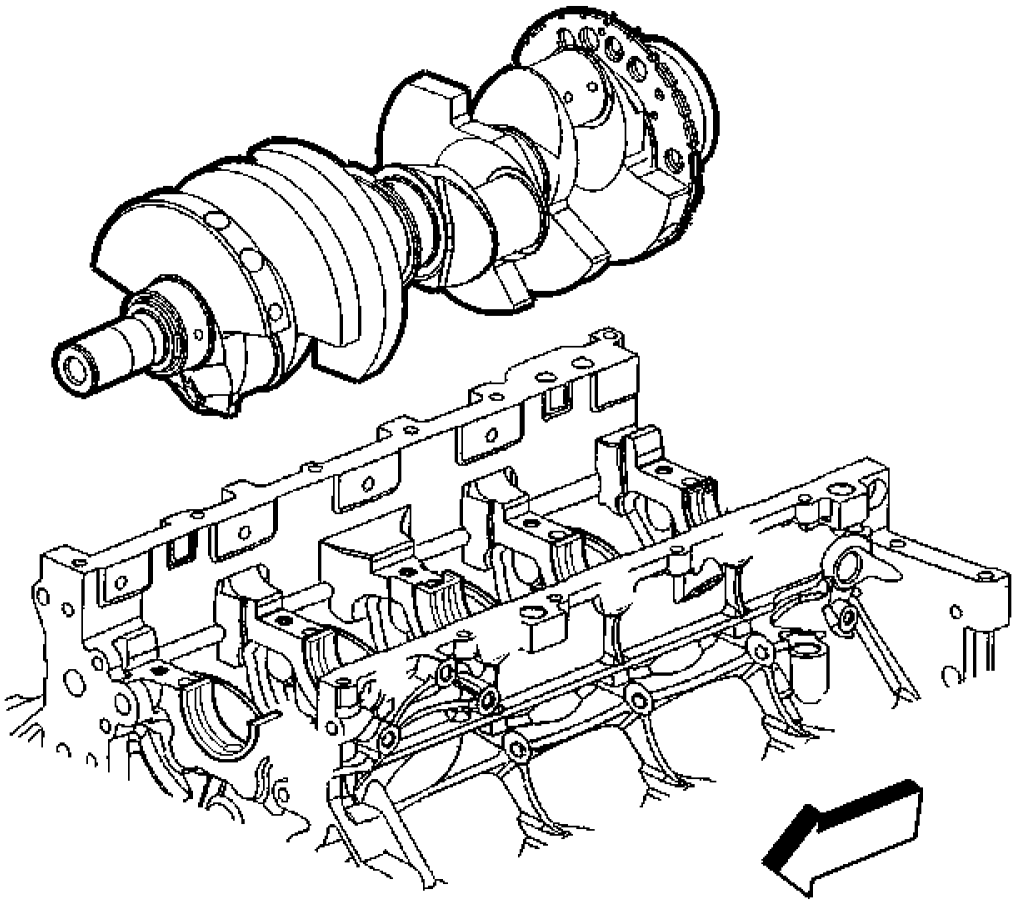


Fig. 106: View Of Crankshaft & Engine Block
Courtesy of GENERAL MOTORS CORP.

9. Remove the crankshaft.

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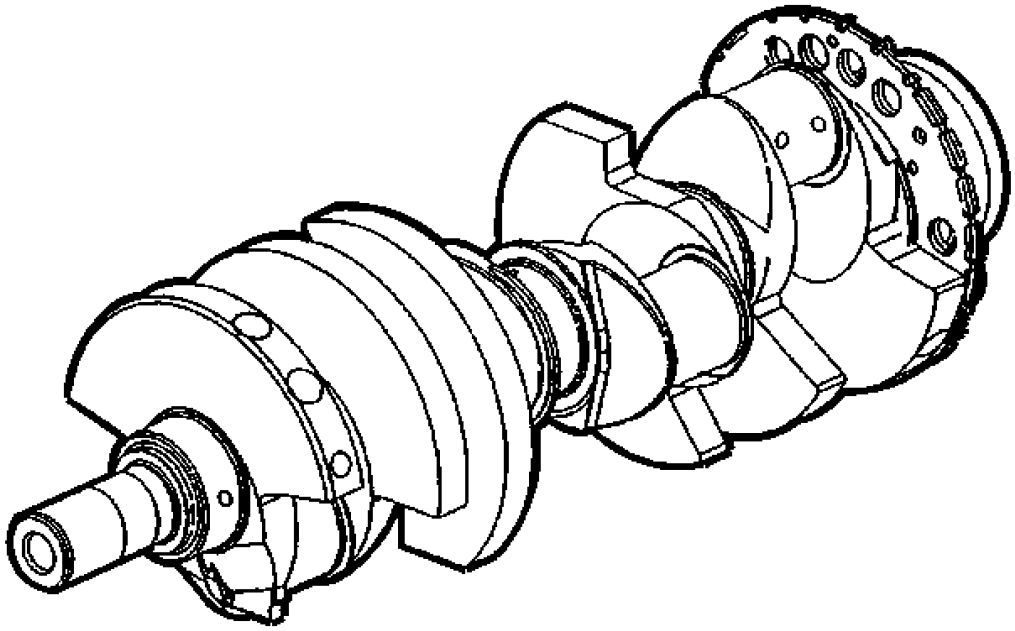


Fig. 107: View Of Crankshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: Use care when handling the crankshaft. Avoid damage to the CKP sensor reluctor ring teeth. Nicks, burrs or other damage to the teeth may affect on-board diagnostics (OBD) II system performance.

10. Lay the crankshaft onto 2 wooden V-blocks or other protective surface.

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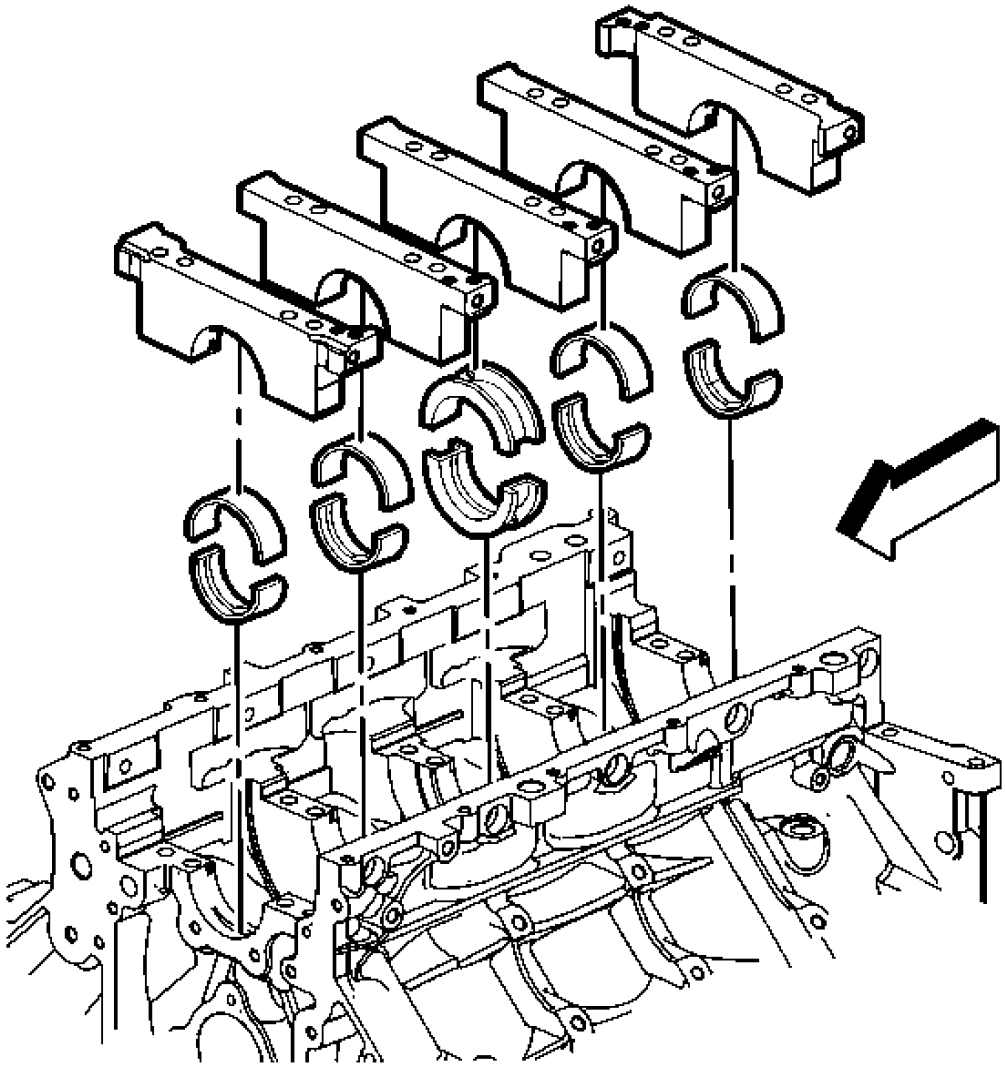


Fig. 108: View Of Crankshaft Bearings & Bearing Caps
Courtesy of GENERAL MOTORS CORP.

11. Remove the crankshaft bearings from the bearing caps and the engine block.
12. Mark, sort, or organize the crankshaft bearings so they may be installed to their original position and location. Refer to **Separating Parts** .

ENGINE BLOCK PLUG REMOVAL

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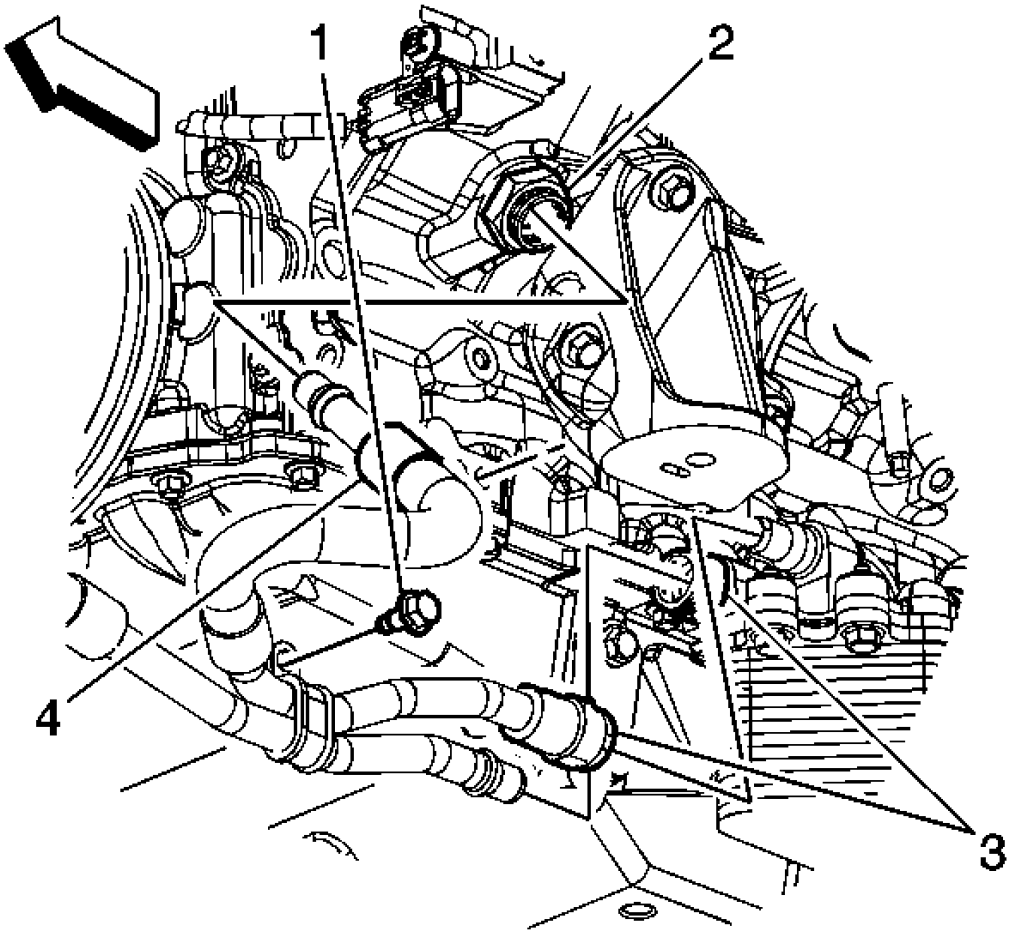


Fig. 109: Identifying Engine Oil Cooler Coolant Fitting
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine oil cooler coolant fitting (2).

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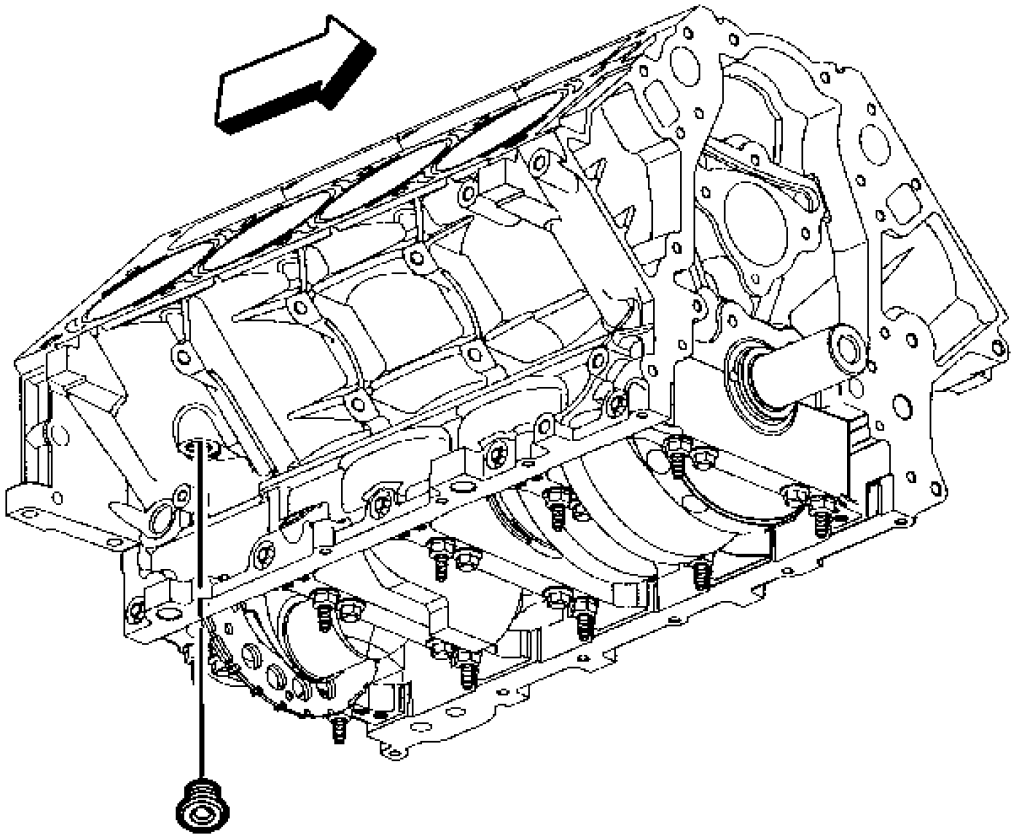


Fig. 110: View Of Engine Block Right Rear Coolant Drain Hole Plug
Courtesy of GENERAL MOTORS CORP.

2. Remove the engine block right rear coolant drain hole plug and seal.

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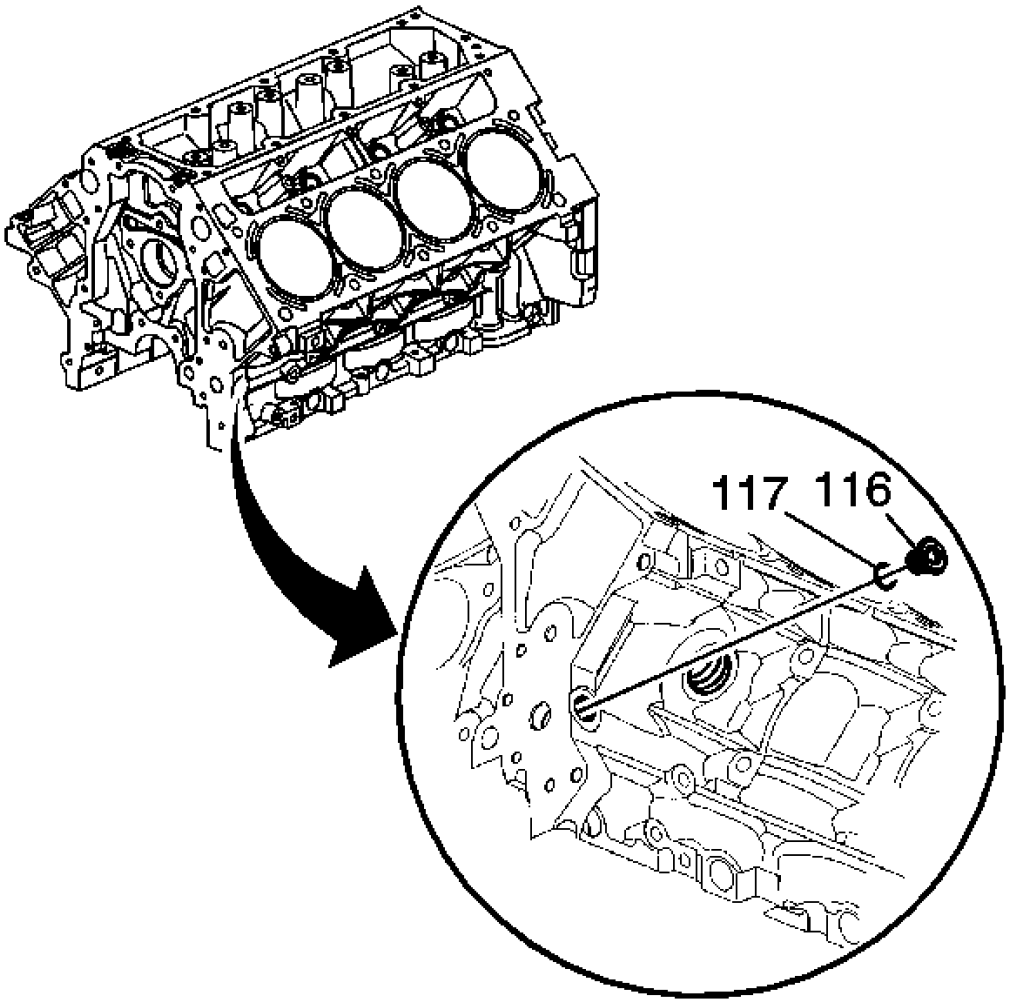


Fig. 111: Locating Engine Block Left Front Oil Gallery Plug & Seal
Courtesy of GENERAL MOTORS CORP.

3. Remove the engine block left front oil gallery plug (116) and seal (117).

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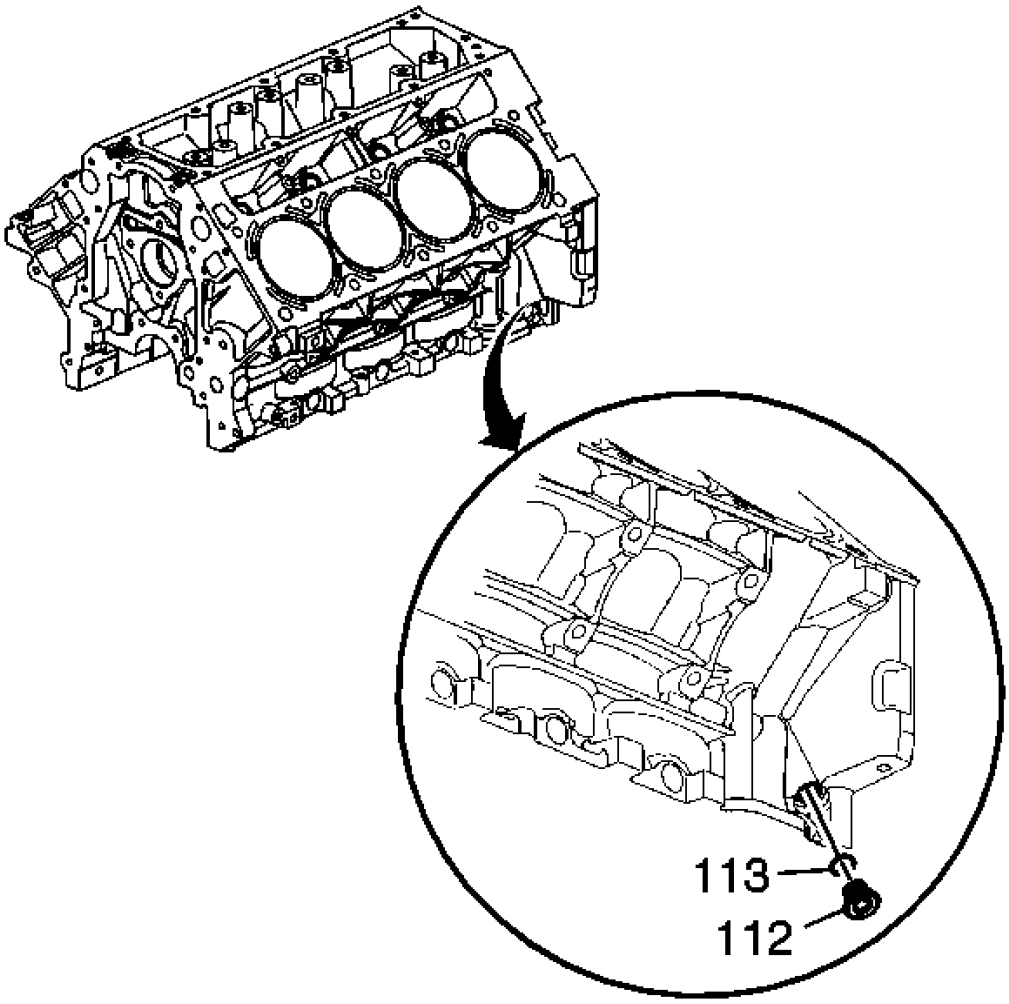


Fig. 112: Locating Engine Block Left Rear Oil Gallery Plug & Seal
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine block left rear oil gallery plug (112) and seal (113).

   If the block plug and coolant heater sealing washers are not damaged, they may be used during assembly.

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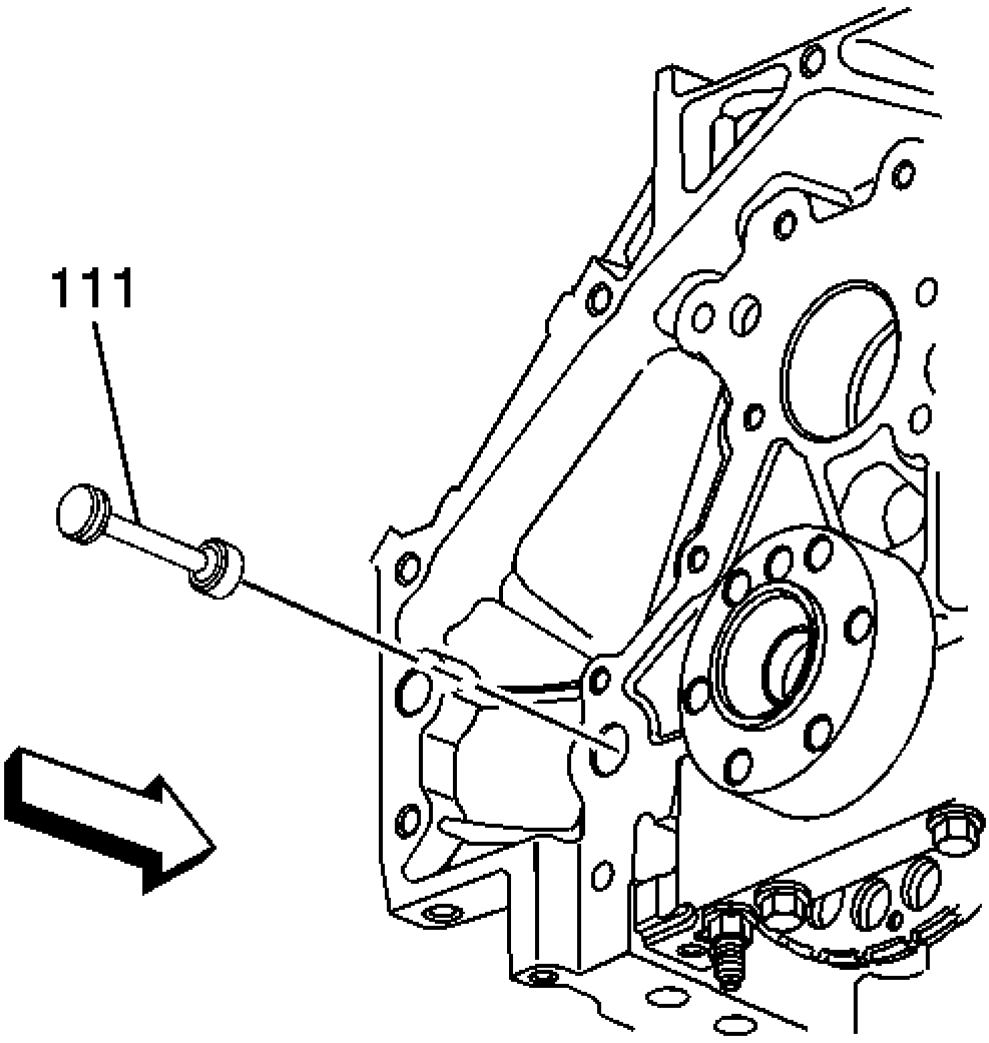


Fig. 113: Identifying Engine Block Rear Oil Gallery Plug & Seal
Courtesy of GENERAL MOTORS CORP.

5. Remove the engine block rear oil gallery plug (111) and seal.
6. Inspect the O-ring seal of the rear oil gallery plug.

   If the O-ring seal is not cut or damaged, the plug and O-ring seal may be used during assembly.

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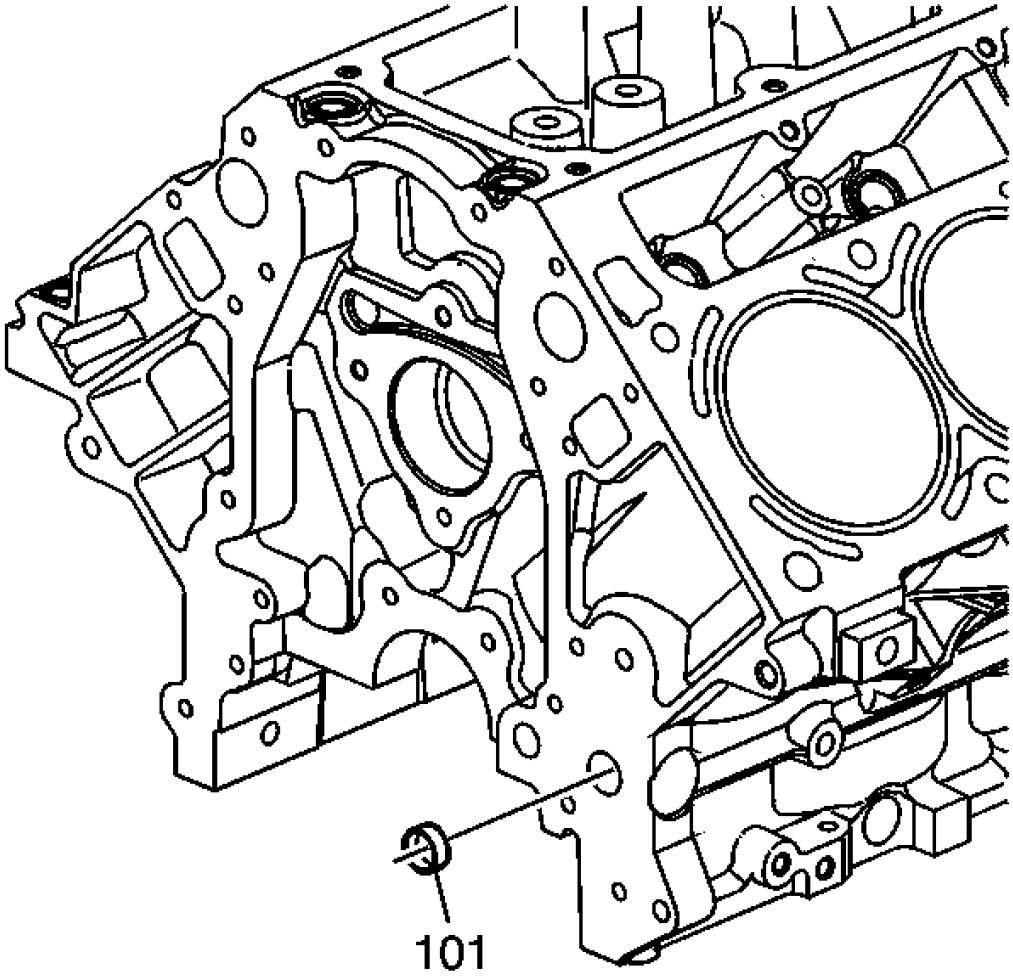


Fig. 114: View Of Engine Block Front Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

NOTE: Remove the front oil gallery plug, only if service is required. If the front oil gallery plug is removed, a NEW oil gallery plug must be installed.

7. Remove the engine block front oil gallery plug (101).

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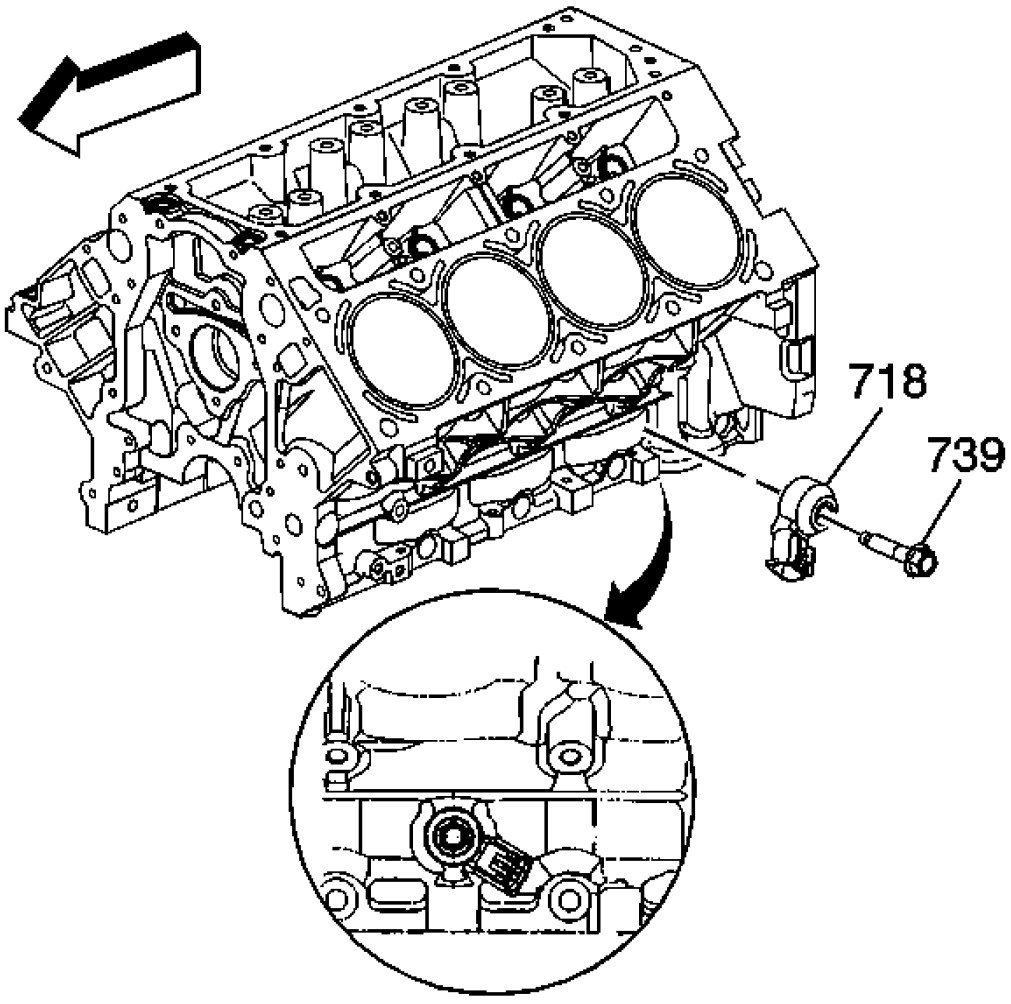


Fig. 115: Knock Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

8. Remove the left and right side knock sensor (718) and bolt (739).

ENGINE BLOCK CLEANING AND INSPECTION

Special Tools

- **J 8087:** Cylinder Bore Gauge
- **J 42385-100:** Head/Main Bolt Thread Repair Kit

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For equivalent regional tools, refer to **Special Tools**

CLEANING PROCEDURE

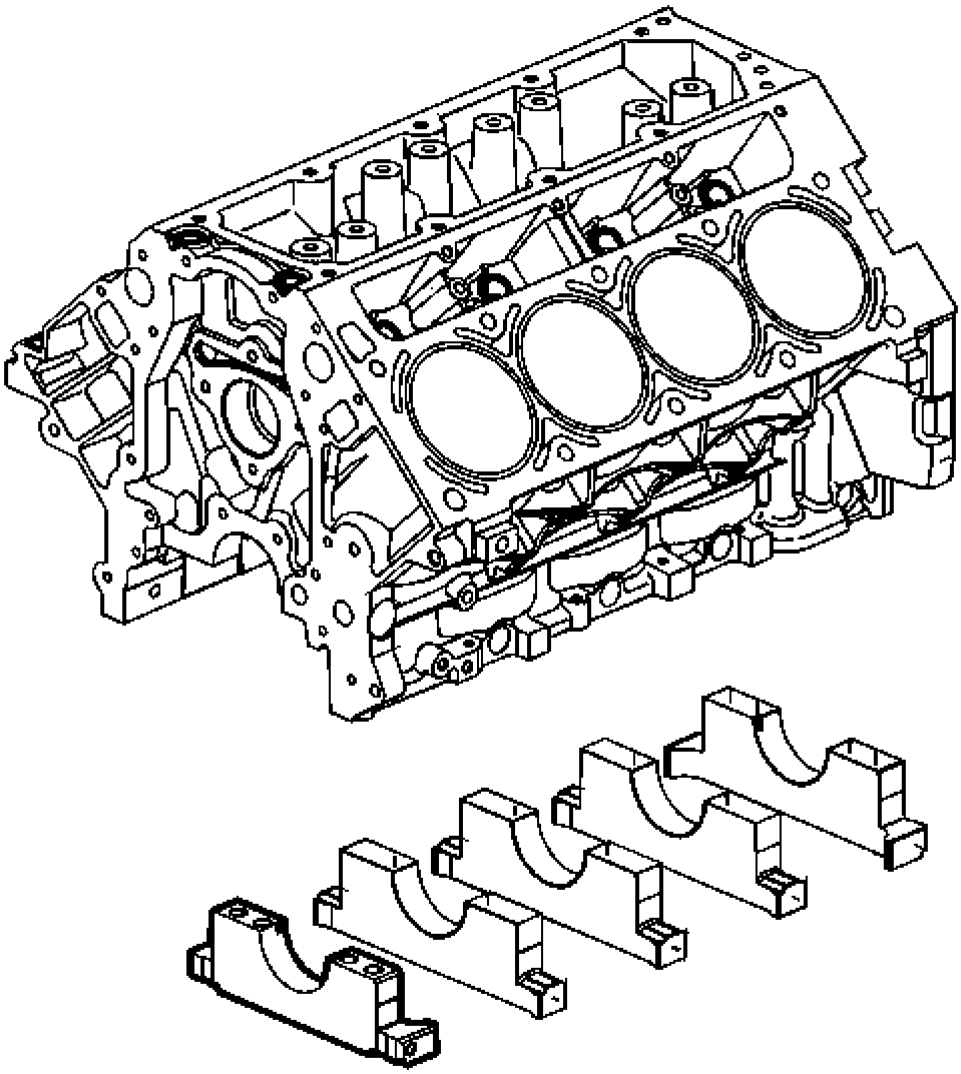


Fig. 116: Main Bearing Caps
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not use a caustic solution to clean the aluminum engine block.

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NOTE: When cleaning the engine block in a thermal type oven, do not exceed 232°C (450°F).

Clean the following components:

- Remove all sludge, dirt, or debris using a cleaning solvent or thermal type oven. Refer to **Cleanliness and Care** .
- Gasket surfaces

  Refer to **Replacing Engine Gaskets** .

- Coolant passages
- Oil galleries
- Main bearing caps
- Cylinder head bolt holes to remove threadlocking material

  Thread repair tool J 42385-107 may be used to clean the threads of any residual threadlocking material.

INSPECTION PROCEDURE

1. Inspect the following components:
   - Cylinder walls for excessive scratches, gouging, or ring ridge
   - Cylinder bores for excessive ring ridge at the top of the cylinder
   - Coolant jacket for cracks
   - Valve lifter bores for excessive scoring or wear
   - Crankshaft bearing webs for cracks
   - Gasket sealing surfaces for excessive scratches or gouging

     Refer to **Replacing Engine Gaskets** .

   - Oil galleries for restrictions
   - Threaded bolt holes for damaged threads
   - Cylinder bores for excessive ring ridge at the top of the cylinder
2. Measure the cylinder bores for an oversize condition:

MEASURING THE CYLINDER FOR OVERSIZE

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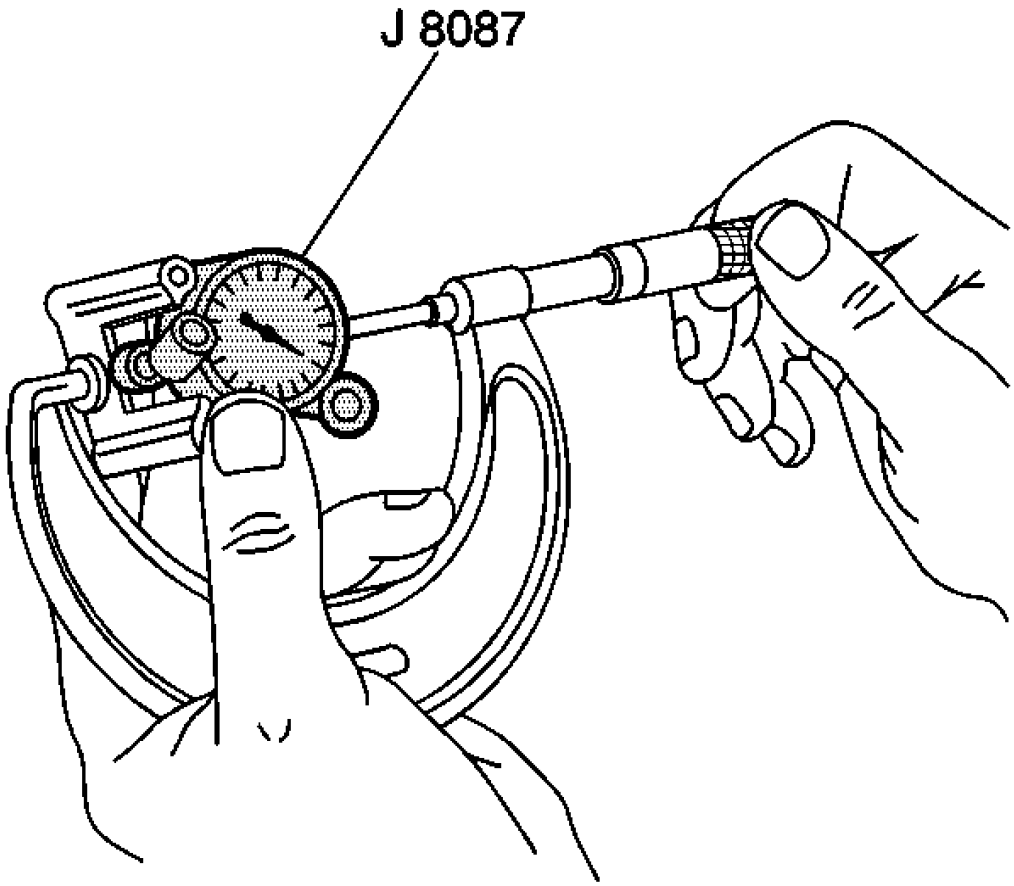


Fig. 117: Zeroing Bore Gauge Dial
Courtesy of GENERAL MOTORS CORP.

1. Adjust the micrometer to a dimension slightly smaller than the bore size. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .
2. Insert the **J 8087:** gauge into the micrometer and zero the bore gauge dial.

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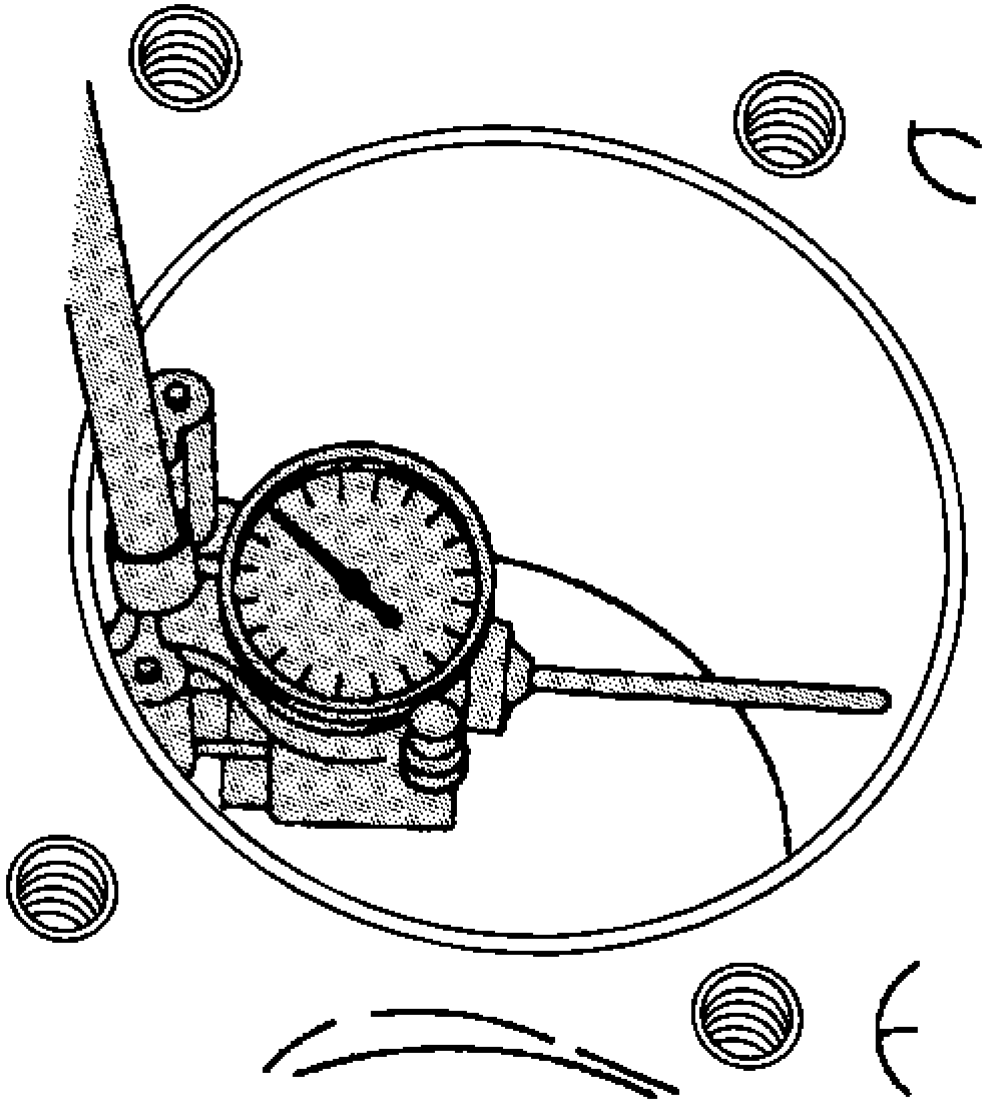


Fig. 118: Measuring Cylinder Bore
Courtesy of GENERAL MOTORS CORP.

3. Using the **J 8087:** gauge, measure the cylinder bore for oversize.

   Slide the bore gauge up and down throughout the length of the cylinder bore. Measure the bore, both parallel and perpendicular to the centerline of the crankshaft, at the top, center, and bottom of the bore. A cylinder bore that exceeds the maximum diameter must be serviced with an oversized piston. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

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CYLINDER BORING AND HONING

BORING PROCEDURE

NOTE: A 0.5 mm (0.02 in) oversize service piston and a piston ring set are available.

1. Measure all pistons with a micrometer to determine the cylinder bore diameter.
2. Before you use any type of boring bar, use a fine file and clean the top of the cylinder block, removing any dirt or burrs. If you do not check the cylinder block, the boring bar may be improperly positioned or tilted and the cylinder bore could be bored at an incorrect angle.
3. Carefully follow the instructions furnished by the manufacturer regarding use of the equipment.
4. When you bore the cylinders, ensure all the crankshaft bearing caps are in place. Tighten the crankshaft bearing caps to the proper torque in order to avoid distortion of the cylinder bores during final assembly.
5. When you take the final cut with a boring bar, leave 0.03 mm (0.001 in) on the cylinder bore diameter for the finish honing and fit of the piston.

HONING PROCEDURE

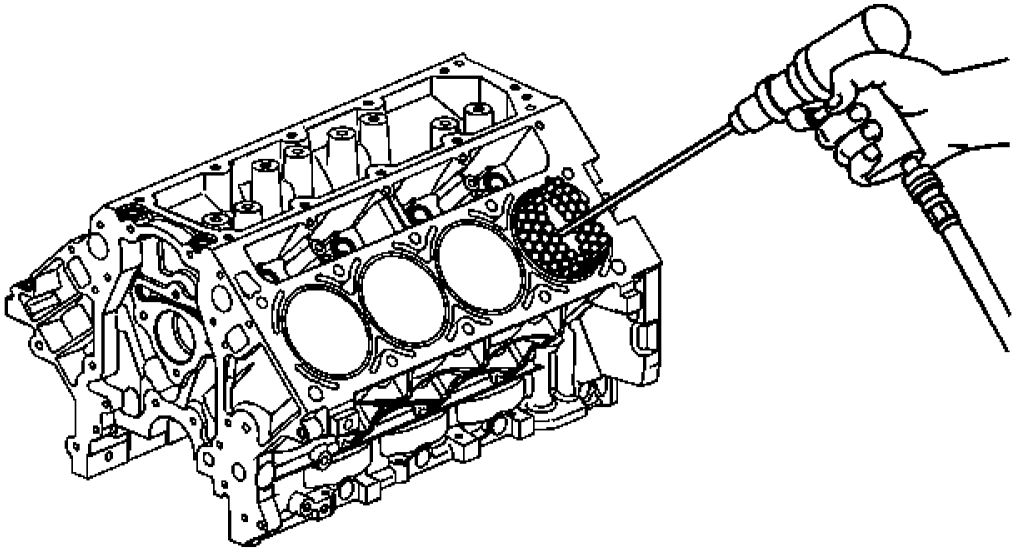


Fig. 119: Honing Cylinder
Courtesy of GENERAL MOTORS CORP.

1. When honing the cylinders, follow the manufacturer's recommendations for equipment use, cleaning, and lubrication. Use only clean, sharp stones of the proper grade for the amount of material you remove. Dull,

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dirty stones cut unevenly and generate excessive heat. Do not hone to final clearance with a coarse or medium-grade stone. Leave sufficient metal so that all stone marks may be removed with fine-grade stones. Perform final honing with a fine-grade stone, honing the cylinder to the proper clearance.

2. During the honing operation, thoroughly clean the cylinder bore. Repeatedly check the cylinder bore for fit with the selected piston.

   All measurements of the piston or the cylinder bore should be made with the components at normal room temperature.

3. When honing a cylinder for fit to an oversize piston, first perform the preliminary honing with a 100-grit stone.
4. Perform final cylinder honing with a 240-grit stone and obtain a 45 degree cross hatch pattern.

   A 240-grit stone is preferred for final honing. If a 240-grit stone is not available, a 220-grit stone may be used as a substitute.

5. The finish marks should be clean but not sharp. The finish marks should also be free from imbedded particles and torn or folded metal.
6. By measuring the selected piston at the sizing point and by adding the average of the clearance specification, you can determine the final cylinder honing dimension required.
7. After final honing and before the piston is checked for fit, clean the cylinder bores with hot water and detergent. Scrub the bores with a stiff bristle brush and rinse the bores thoroughly with hot water. Do not allow any abrasive material to remain in the cylinder bores. This abrasive material may cause premature wear of the new piston rings and the cylinder bores. Abrasive material will also contaminate the engine oil and may cause premature wear of the bearings. After washing the cylinder bore, dry the bore with a clean rag.
8. Perform final measurements of the piston and the cylinder bore.
9. Permanently mark the top of the piston for the specific cylinder to which it has been fitted.
10. Apply clean engine oil to each cylinder bore in order to prevent rusting.

DEGLAZING PROCEDURE

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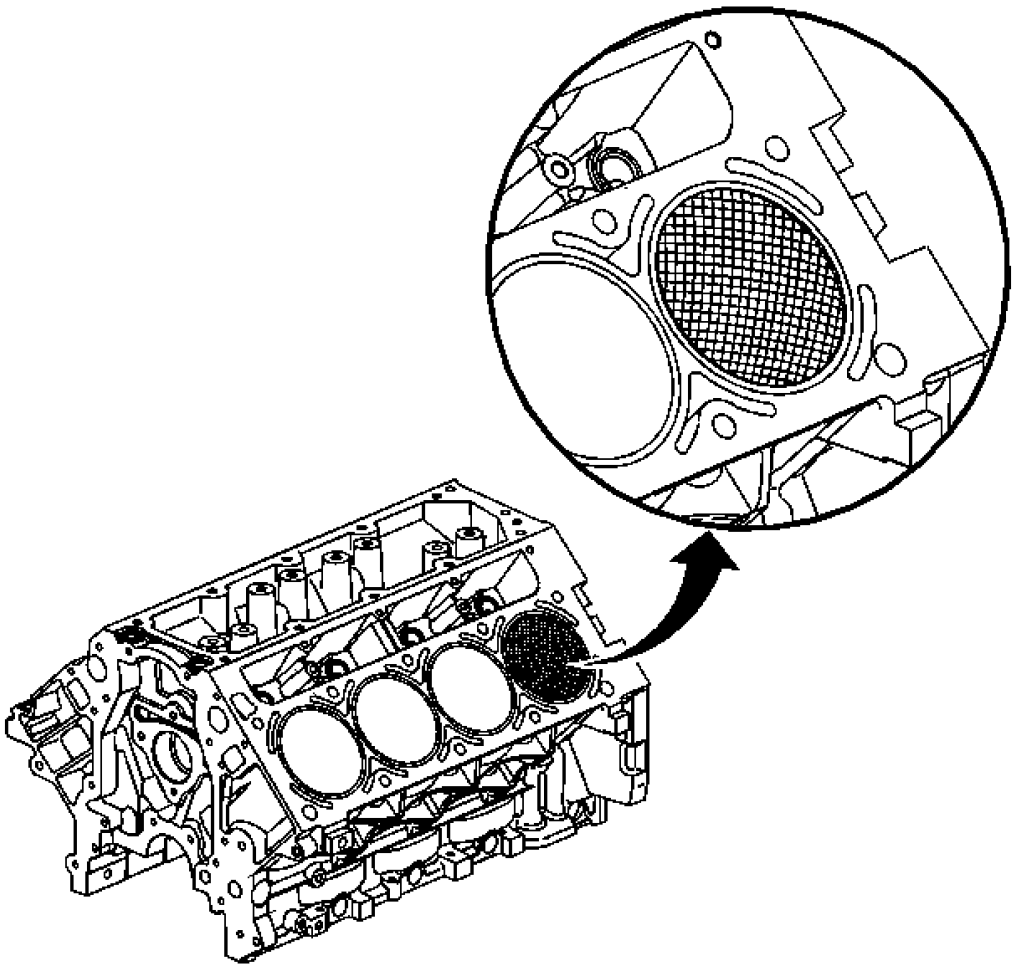


Fig. 120: Deglazing Cylinder Bore
Courtesy of GENERAL MOTORS CORP.

Using a ball type or self centering honing tool, deglaze the cylinder bore lightly. Deglazing should be done only to remove any deposits that may have formed. Use a 240-grit stone of silicone carbide, or equivalent, material when preforming the deglazing procedure.

A 240-grit stone is preferred for final honing. If a 240-grit stone is not available, a 220-grit stone may be used as a substitute.

CRANKSHAFT AND BEARING CLEANING AND INSPECTION

Special Tools

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- **J 7872:** Magnetic Base Dial Indicator Set
- **J 43690:** Rod Bearing Checking Tool
- **J 43690-100:** Rod Bearing Checking Tool - Adapter Kit

For equivalent regional tools, refer to **Special Tools**

CLEANING PROCEDURE

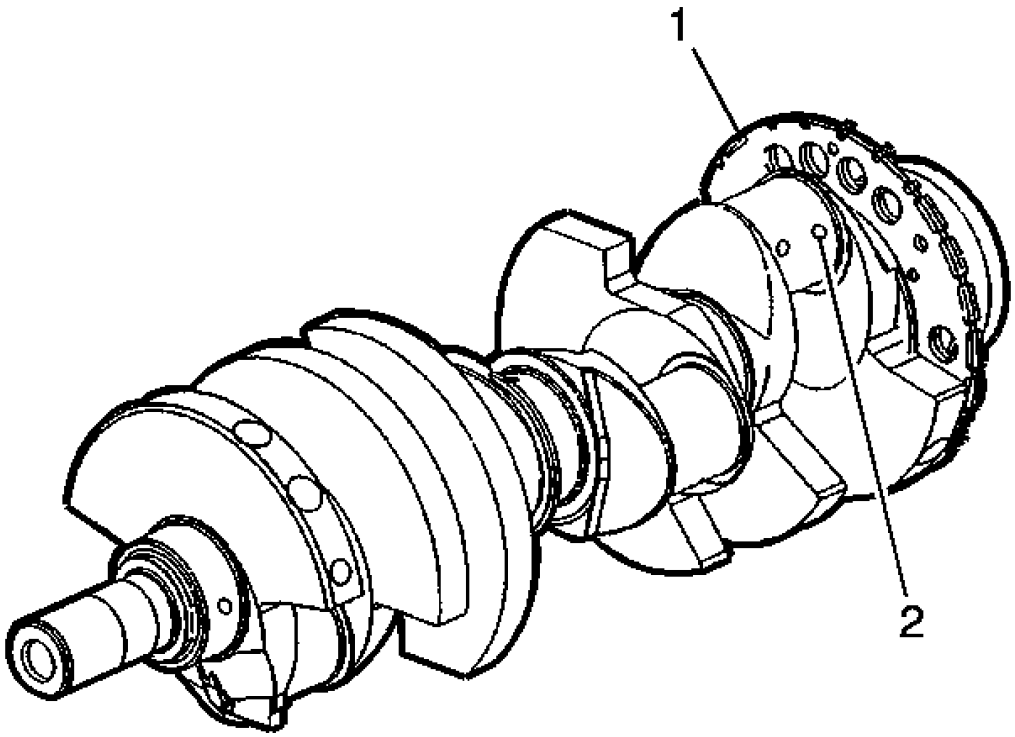


Fig. 121: Oil Passages & CKP Reluctor Ring Teeth
Courtesy of GENERAL MOTORS CORP.

NOTE: Use care when handling the crankshaft. Avoid damage to the bearing surfaces or the teeth of the crankshaft position (CKP) reluctor ring. Damage to the teeth of the CKP reluctor ring may affect on-board diagnostics (OBD) II system performance.

1. Clean the crankshaft with solvent.
2. Thoroughly clean all oil passages (2) and inspect for restrictions or burrs.

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WARNING: Refer to Safety Glasses Warning .

3. Dry the crankshaft with compressed air.

INSPECTION PROCEDURE

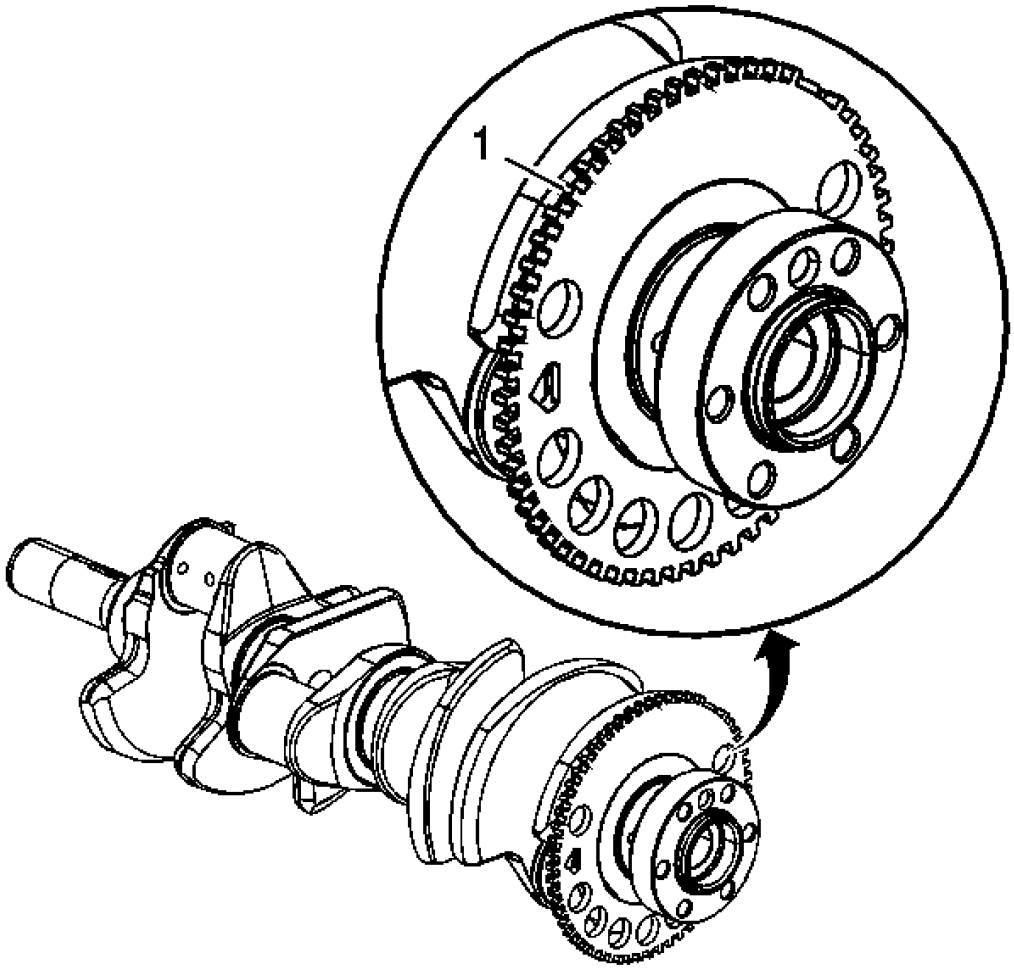


Fig. 122: View Of Reluctor Ring Teeth
Courtesy of GENERAL MOTORS CORP.

NOTE: The reluctor ring teeth should not have imperfections on the rising or falling edges. Imperfections of the reluctor ring teeth may affect OBD II

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system performance.

1. Inspect the CKP reluctor ring teeth (1) for damage.

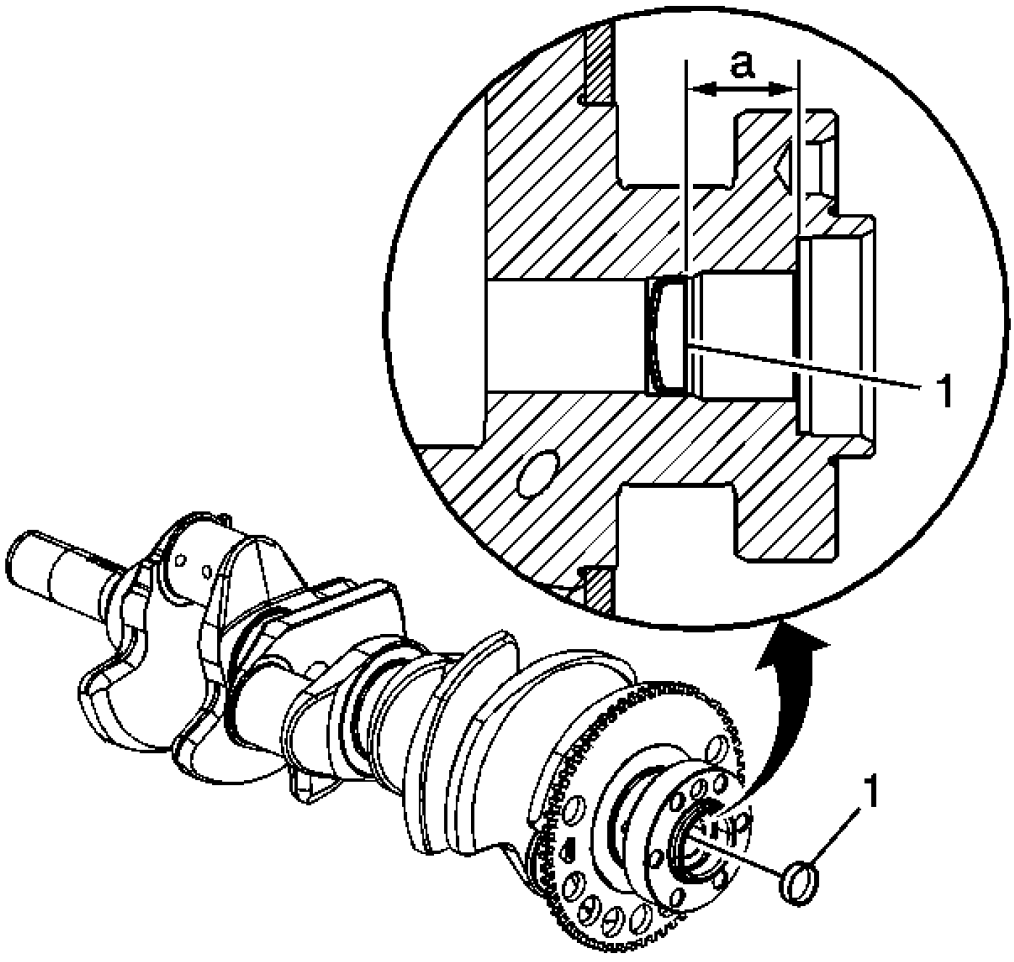


Fig. 123: Identifying Rear Cup Plug
Courtesy of GENERAL MOTORS CORP.

2. Inspect the rear cup plug (1) for leakage, if applicable.

NOTE: If a new plug is required, apply sealant GM P/N 89021297 (Canadian P/N 10953488) to the side of the plug prior to installation.

3. Install the rear cup plug (1) to a depth of 24.4 mm (0.96 in) (a).

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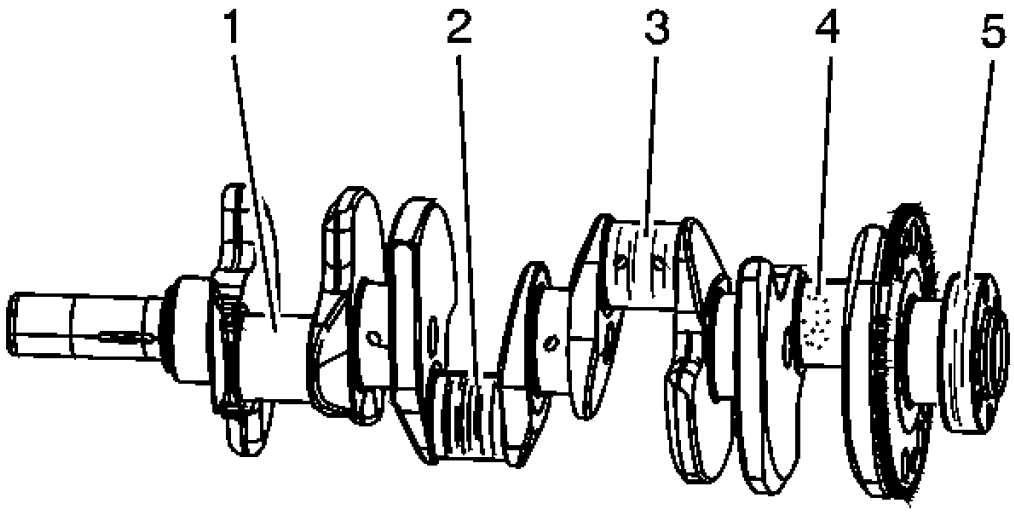


Fig. 124: View Of Crankshaft Journals
Courtesy of GENERAL MOTORS CORP.

4. Inspect the crankshaft journals for wear.

   Journals should be smooth (1) with no signs of scoring, wear, or damage.

5. Inspect the crankshaft journals for grooves or scoring (2).
6. Inspect the crankshaft journals for scratches or wear (3).
7. Inspect the crankshaft journals for pitting or imbedded bearing material (4).
8. Inspect the crankshaft rear oil seal surface (5) for grooves or scoring.

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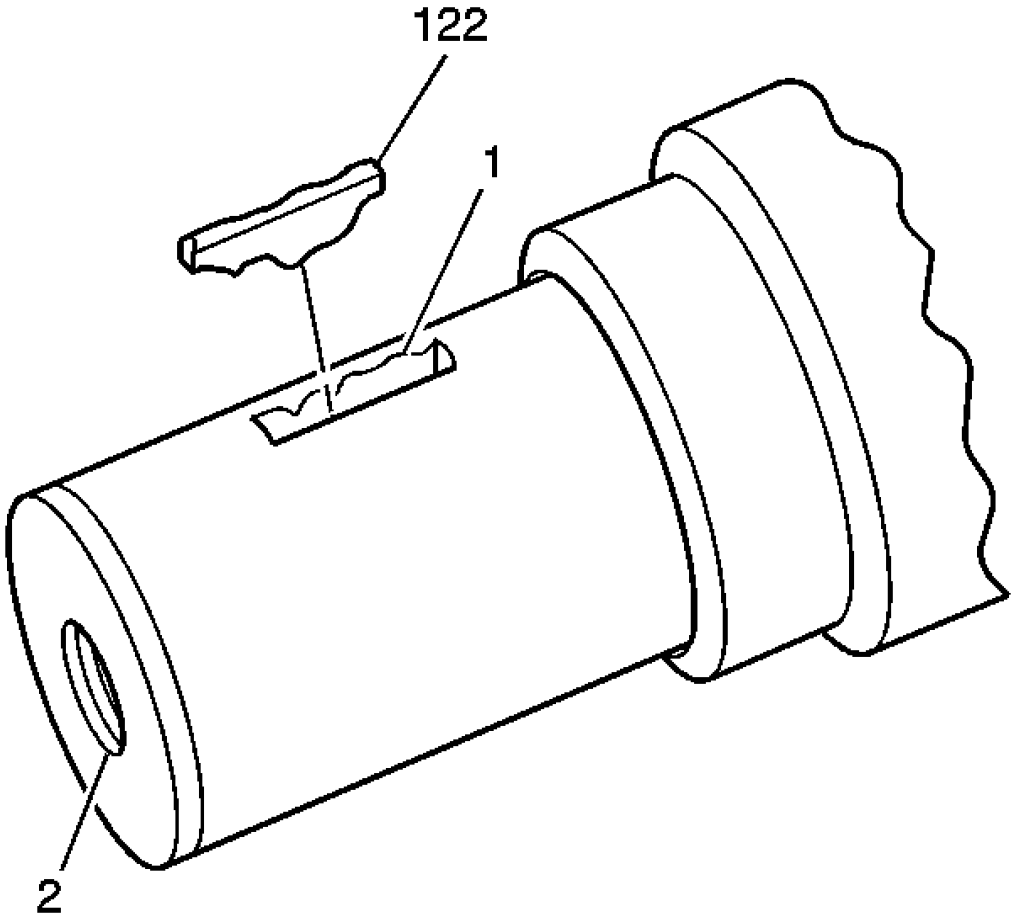


Fig. 125: View Of Crankshaft Key, Keyway & Threaded Hole
Courtesy of GENERAL MOTORS CORP.

9. Inspect the crankshaft key (122), keyway (1), and threaded hole (2) for damage.

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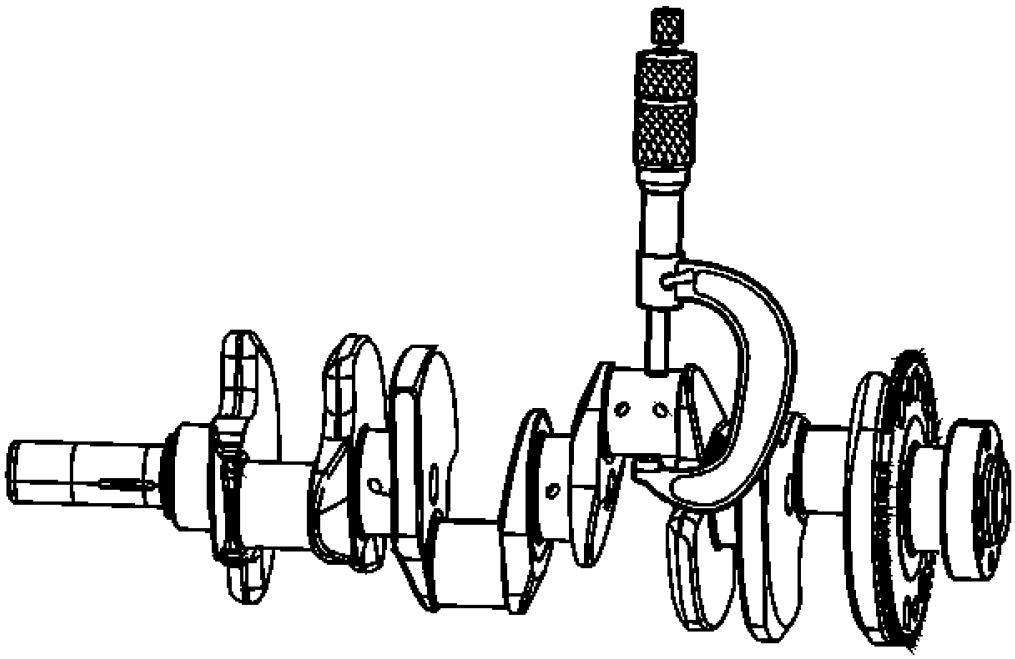


Fig. 126: Measuring Connecting Rod Journals For Out-Of-Round & Taper
Courtesy of GENERAL MOTORS CORP.

10. Measure the main and connecting rod journals for out-of-round and taper. Replace the crankshaft if all journals are not within specification for diameter, out-of-round, and taper. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

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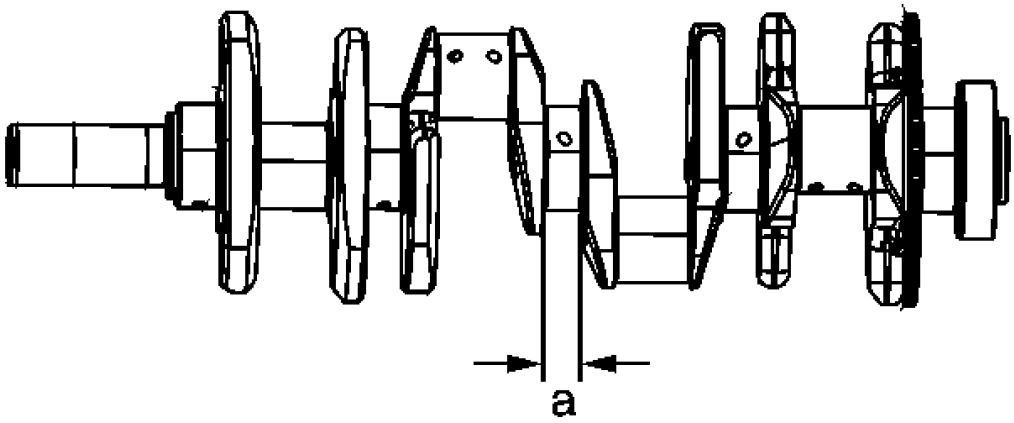


Fig. 127: Measuring Crankshaft Thrust Wall Width
Courtesy of GENERAL MOTORS CORP.

11. Measure the crankshaft thrust wall width.

    A crankshaft with a thrust wall width in excess of 26.22 mm (1.0322 in) (a) must be replaced.

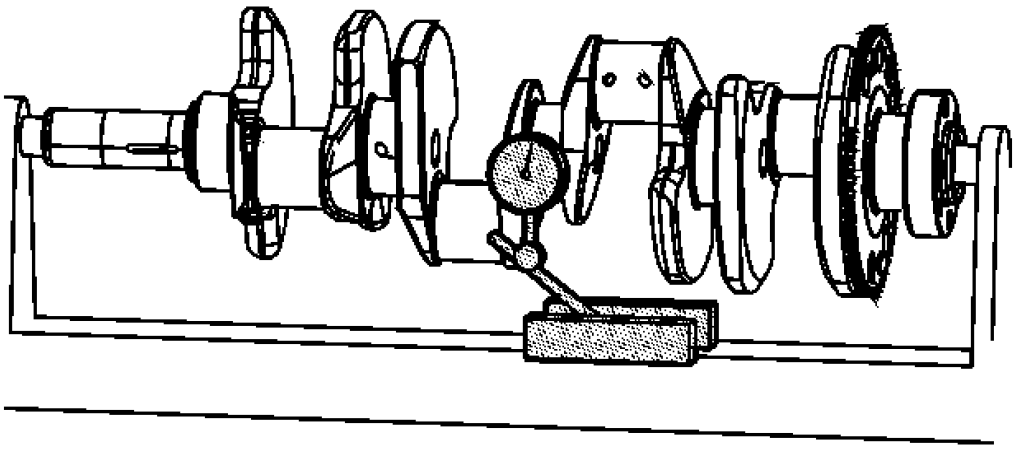


Fig. 128: Measuring Crankshaft Runout
Courtesy of GENERAL MOTORS CORP.

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12. Measure the crankshaft runout. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

    Use wooden V-blocks or a fixture to support the crankshaft on the front and rear journals.

13. Use the **J 7872:** dial indicator in order to measure the crankshaft runout at the number 3 main journal and the adjacent front and rear intermediate journals.
14. Use the **J 7872:** dial indicator in order to measure the runout of the crankshaft rear flange.
15. Use the **J 7872:** dial indicator in order to measure the runout of the crankshaft position reluctor ring. Reluctor ring runout should be measured 1.0 mm (0.04 in) below the ring teeth.

    If the reluctor ring has runout in excess of 0.7 mm (0.028 in), replace the crankshaft.

    If runout is not within specification for main journals or rear flange, replace the crankshaft.

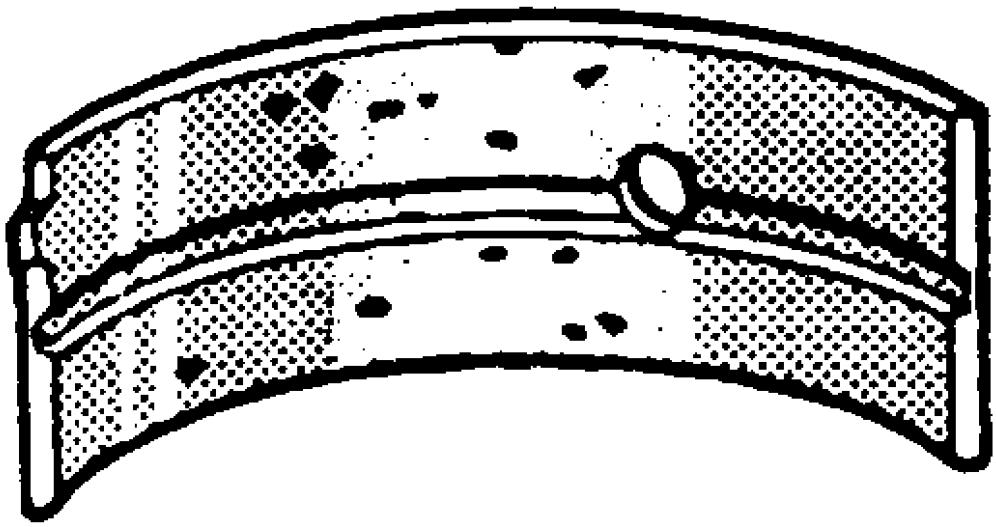


Fig. 129: Identifying Crankshaft Bearing Craters Or Pockets
Courtesy of GENERAL MOTORS CORP.

16. Inspect crankshaft bearings for craters or pockets. Flattened sections on the bearing halves also indicate fatigue.

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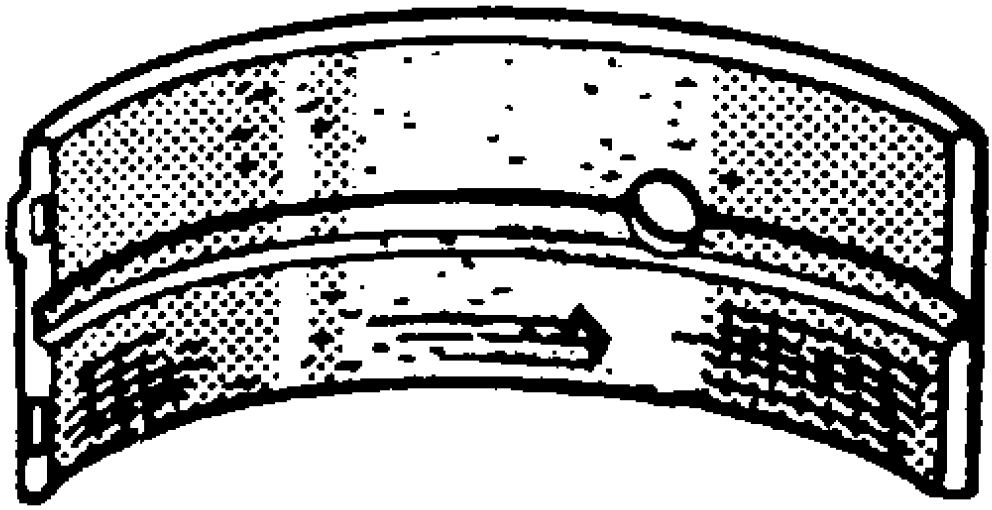


Fig. 130: Identifying Connecting Rod Bearing Scoring Or Discoloration
Courtesy of GENERAL MOTORS CORP.

17. Inspect the crankshaft bearings for excessive scoring or discoloration.
18. Inspect the crankshaft bearings for dirt or debris imbedded into the bearing material.

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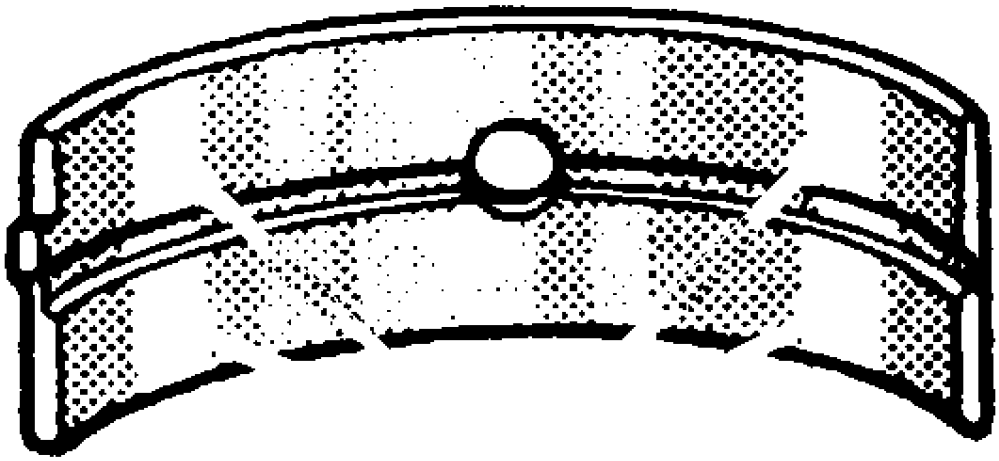


Fig. 131: View Of Improper Seating
Courtesy of GENERAL MOTORS CORP.

19. Inspect the crankshaft bearings for improper seating, indicated by bright, polished sections of the bearing.

    If the lower half of the bearing is worn or damaged, both upper and lower halves should be replaced.

    Generally, if the lower half is suitable for use, the upper half should also be suitable for use.

MEASURING MAIN BEARING CLEARANCE - GAGING PLASTIC METHOD

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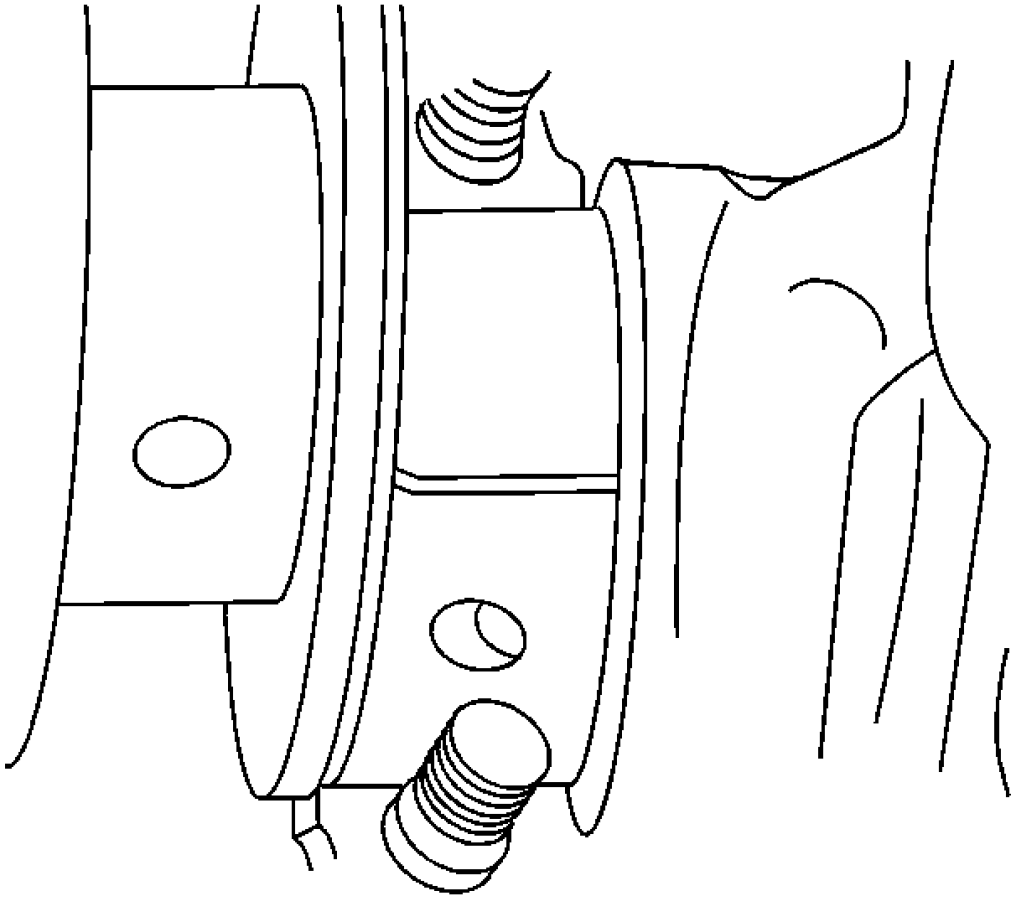


Fig. 132: View Of Bearing Cap Side Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **The crankshaft main bearings are a precision insert type. Main bearing caps are machined with the engine block, for proper clearance, and cannot be shimmed or filed for bearing fit. If the clearances are found to be excessive, new bearings and/or engine block and cap repair or replacement may be required.**
- **Do not rotate the crankshaft while gaging plastic is between the crankshaft journal and the bearing surface.**
- **The crankshaft bearing clearances are critical. Excessive bearing clearance may affect crankshaft position sensor signals and may affect on-board diagnostics (OBD) II system operation.**
- **Remove the bearing cap side bolts prior to cap removal.**

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1. Remove the bearing caps, bearing half, and bolts. Refer to **Crankshaft and Bearing Removal**.
2. Install gaging plastic onto the crankshaft journal. Install the gaging plastic the full width of the crankshaft bearing journal.
3. Install the bearing caps, bearing half, and bolts. Refer to **Crankshaft and Bearing Installation** .
4. Remove the bearing caps, bearing half, and bolts. Refer to **Crankshaft and Bearing Removal**.

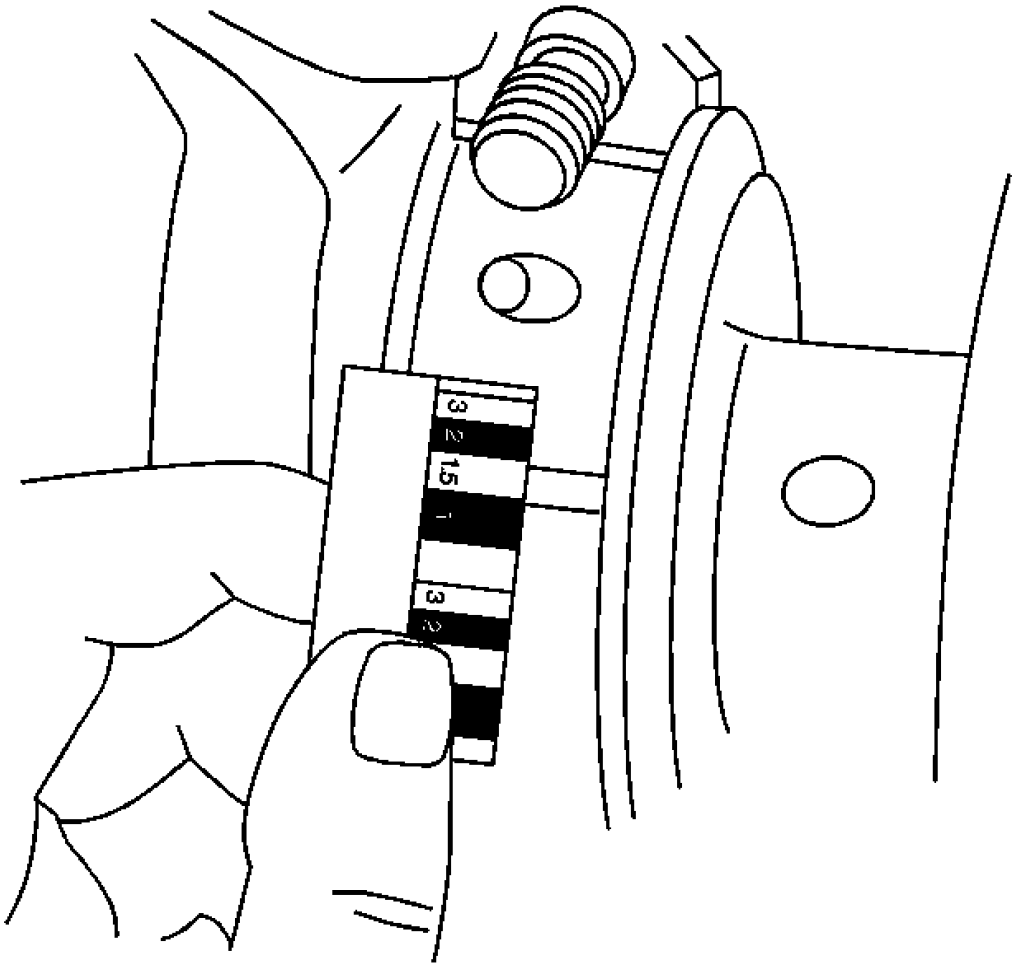


Fig. 133: Measuring Gaging Plastic
Courtesy of GENERAL MOTORS CORP.

5. Using the scale supplied with the plastic gaging kit, measure the gaging plastic at its widest area.
   - If the gaging plastic shows irregularity in the journal, exceeding 0.025 mm (0.001 in), remove the crankshaft and measure the journal with a micrometer.

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- If clearance cannot be brought to specifications, replace the crankshaft or engine block as required. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

MEASURING CONNECTING ROD BEARING CLEARANCE - GAGING PLASTIC METHOD

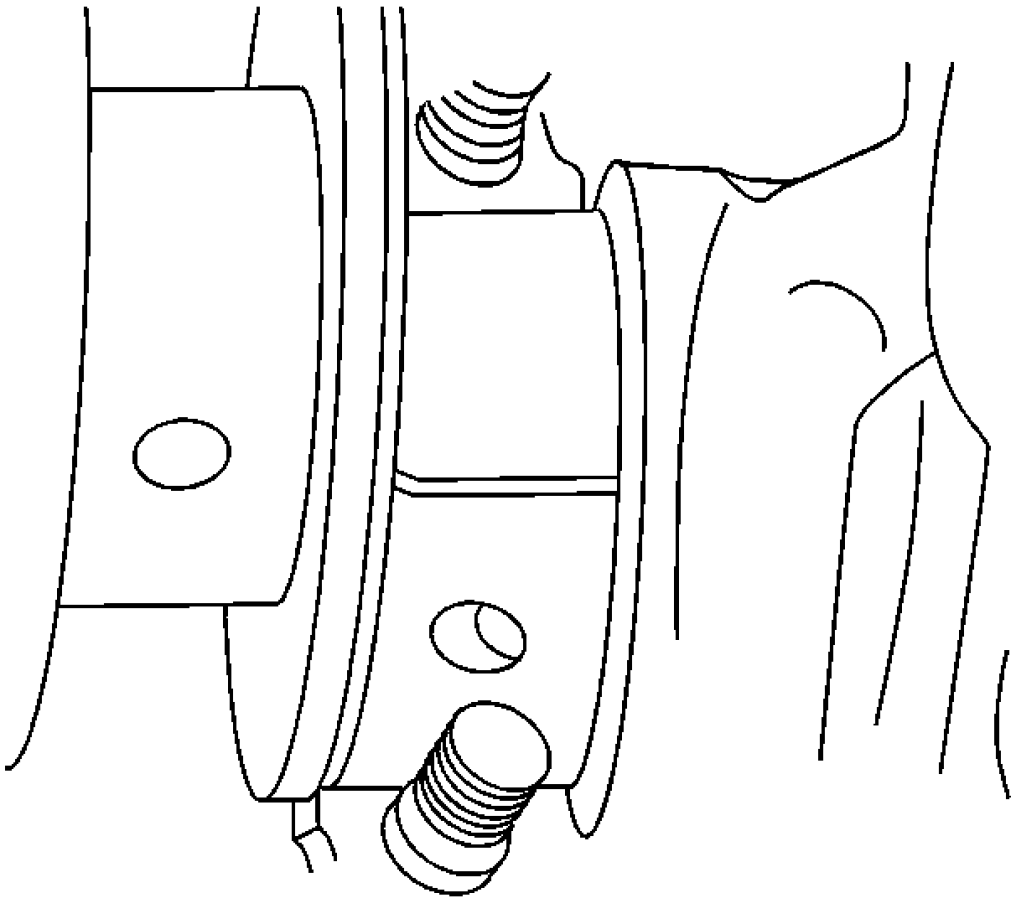


Fig. 134: View Of Bearing Cap Side Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Connecting rod bearings are a precision insert type. Connecting rods are of a powdered metal design and cannot be shimmed or filed for bearing fit. If clearances are found to be excessive, a new bearing and/or connecting rod is required.**
- **Do not rotate the crankshaft while gaging plastic is between the**

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crankshaft journal and the bearing surface.

1. Remove the bearing cap, bearing half, and bolts. Refer to **Piston, Connecting Rod, and Bearing Removal**.
2. Install the gaging plastic onto the connecting rod bearing journal. Install the gaging plastic the full width of the journal.
3. Install the bearing cap, bearing half, and bolts. Refer to **Piston, Connecting Rod, and Bearing Installation** .
4. Remove the bearing cap, bearing half, and bolts. Refer to **Piston, Connecting Rod, and Bearing Removal**.

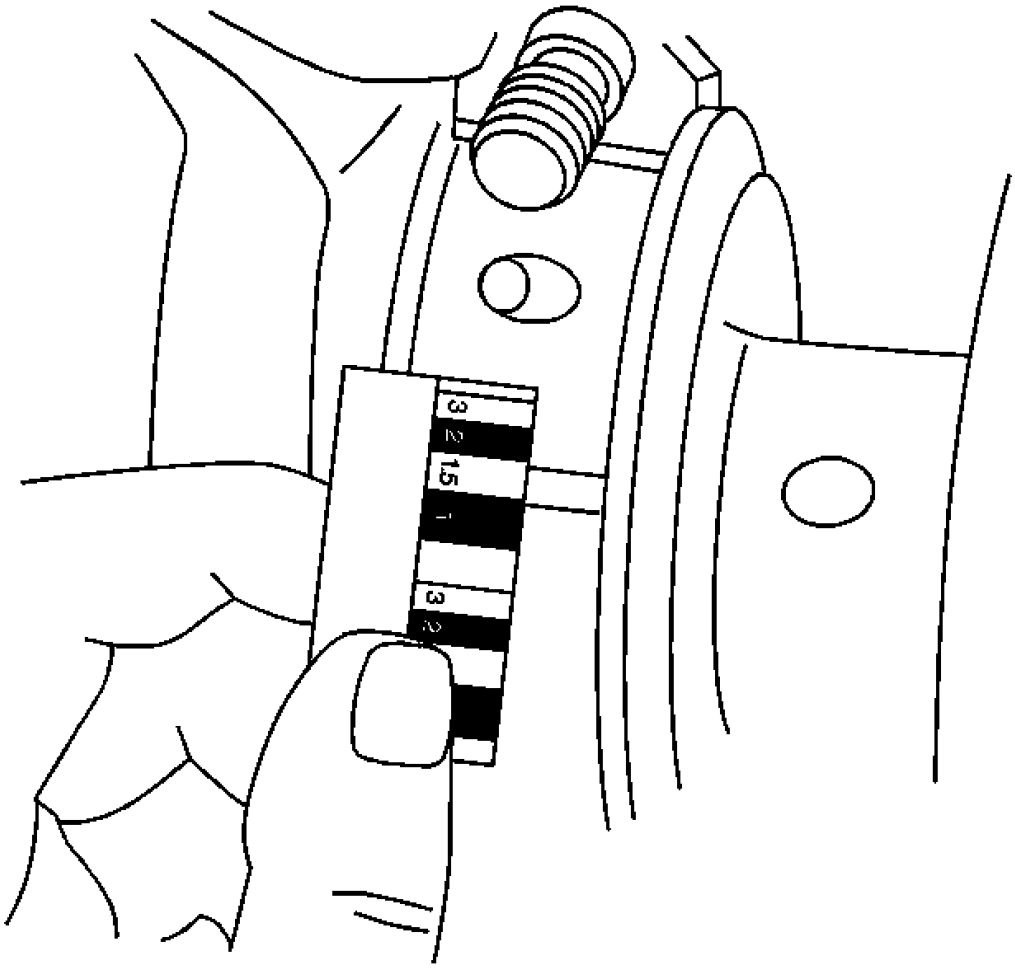


Fig. 135: Measuring Gaging Plastic
Courtesy of GENERAL MOTORS CORP.

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5. Using the scale supplied with the plastic gaging kit, measure the gaging plastic at its widest area. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

MEASURING CONNECTING ROD BEARING CLEARANCE - USING J 43690/J 43690-100

J 43690: checking tool and **J 43690-100:** adapter kit have been developed as a more accurate method to measure connecting rod bearing clearances. The instructions below provide an overview of tool set-up and usage. For more detailed information, refer to the tool instruction sheets supplied by the tool manufacturer.

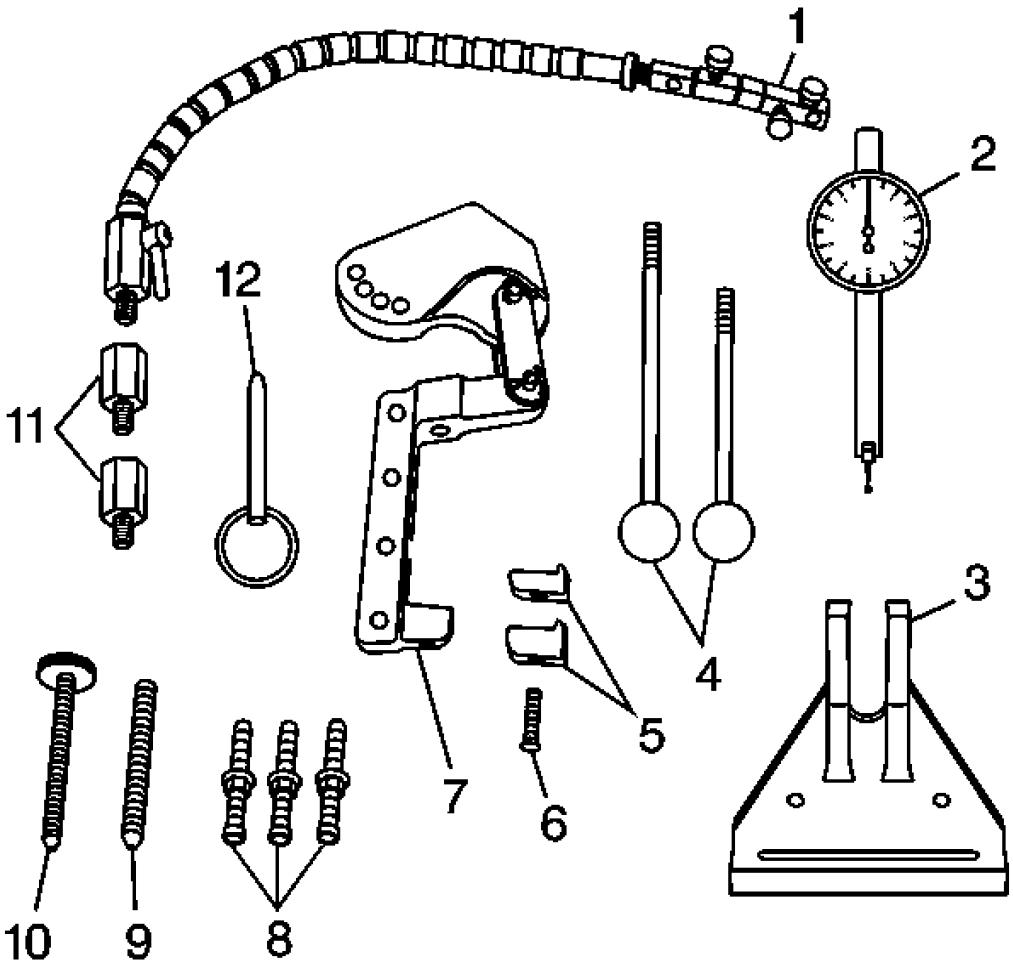


Fig. 136: Identifying Rod Bearing Clearance Checking Tool
Courtesy of GENERAL MOTORS CORP.

J 43690 Rod Bearing Checking Tool

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- J 43690-20 Swivel Base (1)
- J 43690-19 Dial Indicator (2)
- J 43690-2 Base (3)
- J 43690-5, J 43690-6 Handle (4)
- J 43690-10, J 43690-11 Foot (5)
- 280307 Screw (6)
- J 43690-1 Pivot Arm Assembly (7)
- J 43690-3, J 43690-7, J 43690-8 Screws (8)
- 280319 Screw (9)
- 280311 Screw (10)
- J 43690-17, J 43690-18 Adapter (11)
- 280310 Pin (12)

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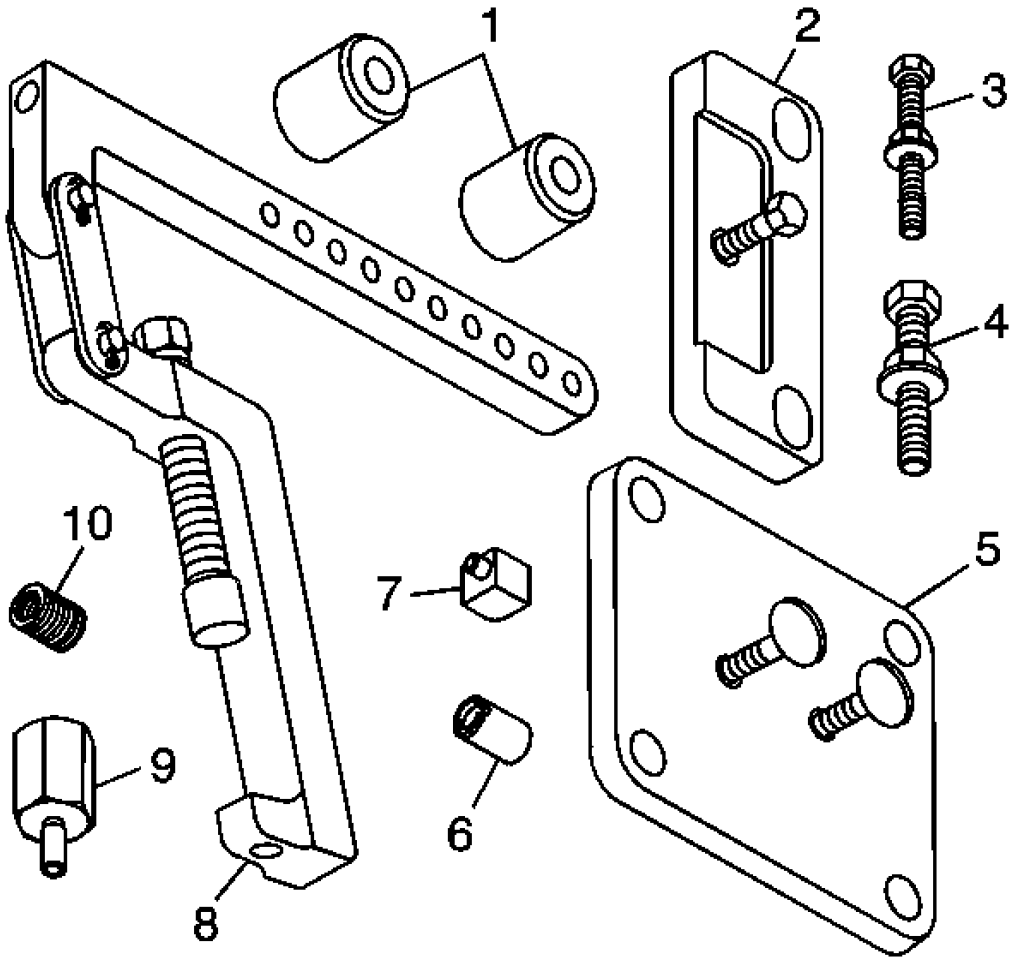


Fig. 137: Identifying Rod Bearing Clearance Tool - Adapter Kit
Courtesy of GENERAL MOTORS CORP.

J 43690-100 Rod Bearing Checking Tool - Adapter Kit

- J 43690-104 Spacer (1)
- J 43690-105 Retainer Plate (2)
- 505478 Bolt (3)
- 511341 Bolt (4)
- J 43690-106 Retainer Plate (5)
- J 43690-107 Cap (6)
- J 43690-102 Foot (7)

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- J 43690-101 Pivot Arm Assembly (8)
- J 43690-103 Adapter (9)
- 505439 Adapter (10)

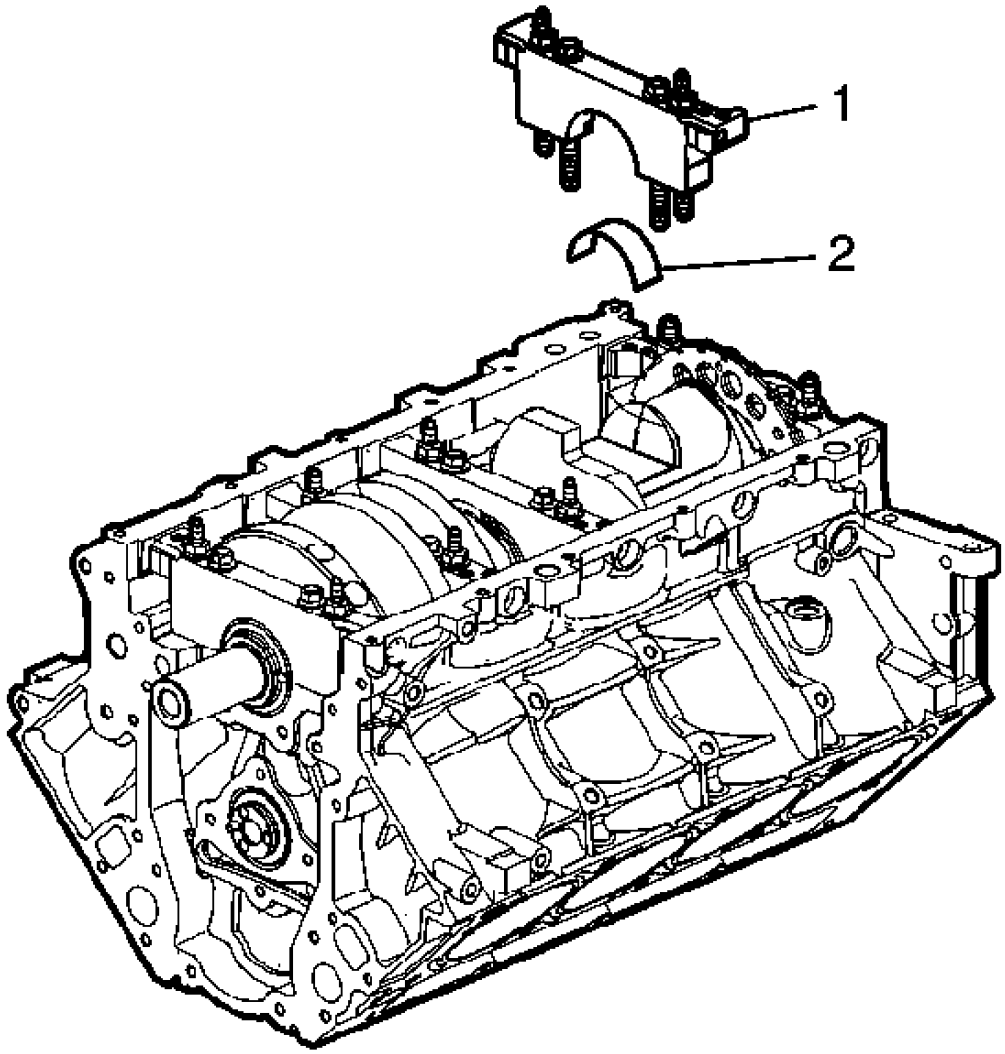


Fig. 138: View Of Bearing Cap, Bolt & Bearing Half
Courtesy of GENERAL MOTORS CORP.

NOTE: **The crankshaft must be secure, with no movement or rotation, in order to obtain an accurate reading.**

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1. Rotate the crankshaft until the journal/connecting rod to be measured is in the 12 o'clock position.
2. Remove a bearing cap and bolts (1).
3. Remove the bearing half (2).
4. Insert a piece of paper card stock onto the crankshaft journal.
5. Install the bearing half (2) and cap and bolts (1). Refer to **Fastener Tightening Specifications (6.2L LS3)** or **Fastener Tightening Specifications (6.2L L99)** .

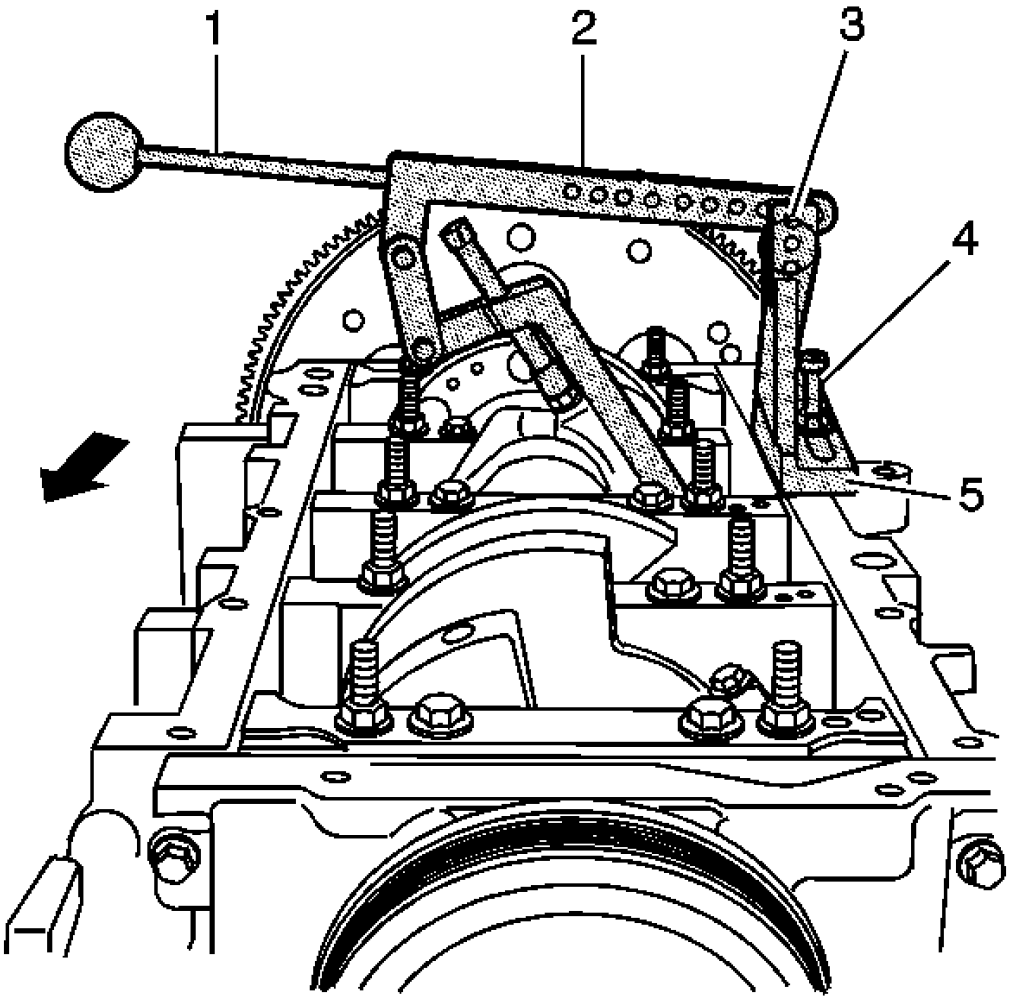


Fig. 139: View Of Special Tool Installed On Engine Block
Courtesy of GENERAL MOTORS CORP.

6. Install the following:

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1. J 43690-2 (5)
2. J 43690-3 (4)
3. J 43690-101 (2)
4. 280310 (3)
5. J 43690-5 (1)

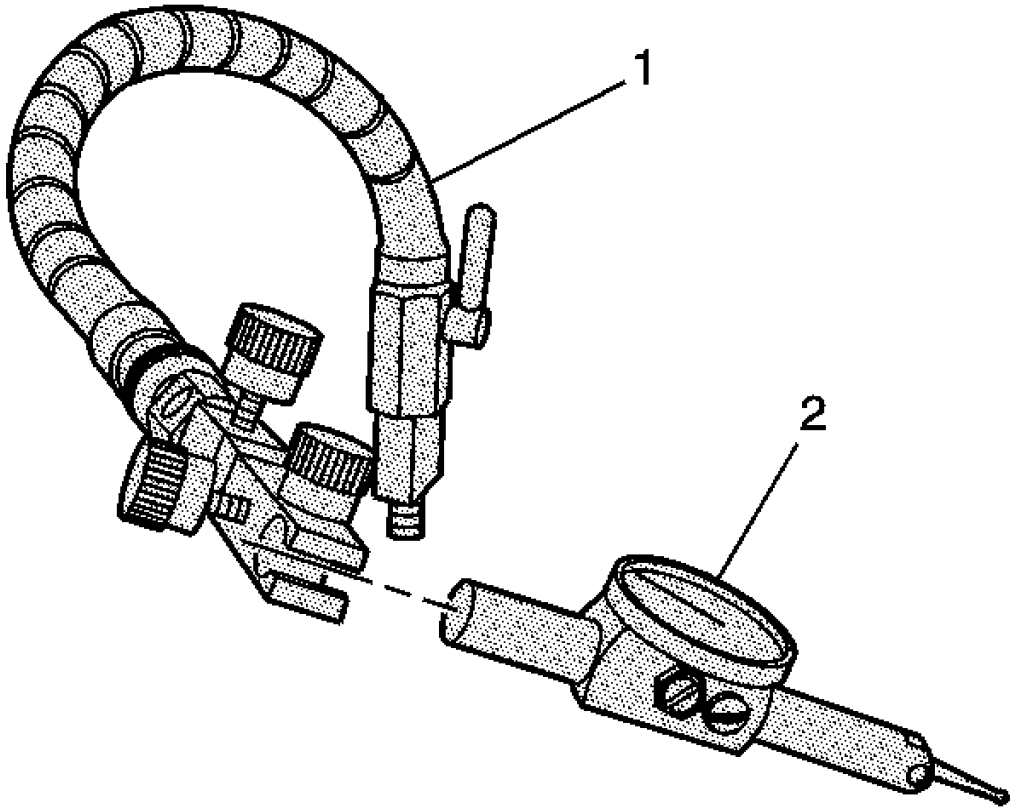


Fig. 140: View Of Swivel Base & Dial Indicator
Courtesy of GENERAL MOTORS CORP.

7. Install the swivel base (1) and dial indicator (2).
8. Adjust per the manufacturers instructions and measure the connecting rod bearing clearance.

   The connecting rod side clearance must be within specification. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** . Service components, as required.

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CRANKSHAFT BALANCER CLEANING AND INSPECTION

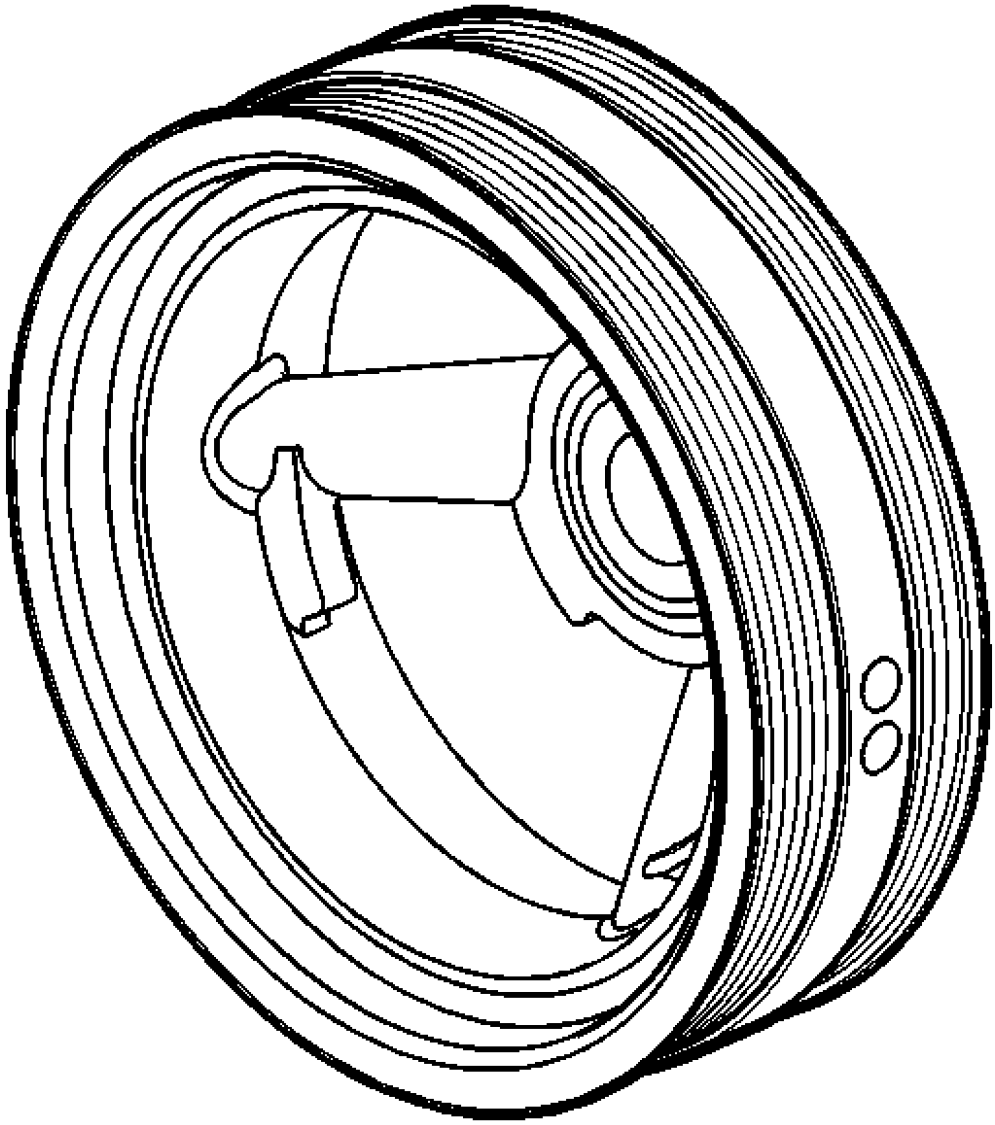


Fig. 141: View Of Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

1. Clean the crankshaft balancer in solvent.
2. Clean the belt grooves of all dirt or debris with a wire brush.

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3. Dry the crankshaft balancer with compressed air.
4. Inspect the crankshaft balancer for the following conditions:
    - Worn, grooved, or damaged hub seal surface

      A crankshaft balancer hub seal surface with excessive scoring, grooves, rust or other damage must be replaced.

      Minor imperfections on the hub seal surface may be removed with polishing compound or fine grade emery cloth.

      NOTE: In order for the belt to track properly, the belt grooves should be free of all dirt or debris.

    - Dirty or damaged belt grooves

      The balancer belt grooves should be free of any nicks, gouges, or other damage that may not allow the belt to track properly.

      Minor imperfections may be removed with a fine file.

    - Worn, chunking, or deteriorated rubber between the hub and pulley

ENGINE FLYWHEEL CLEANING AND INSPECTION

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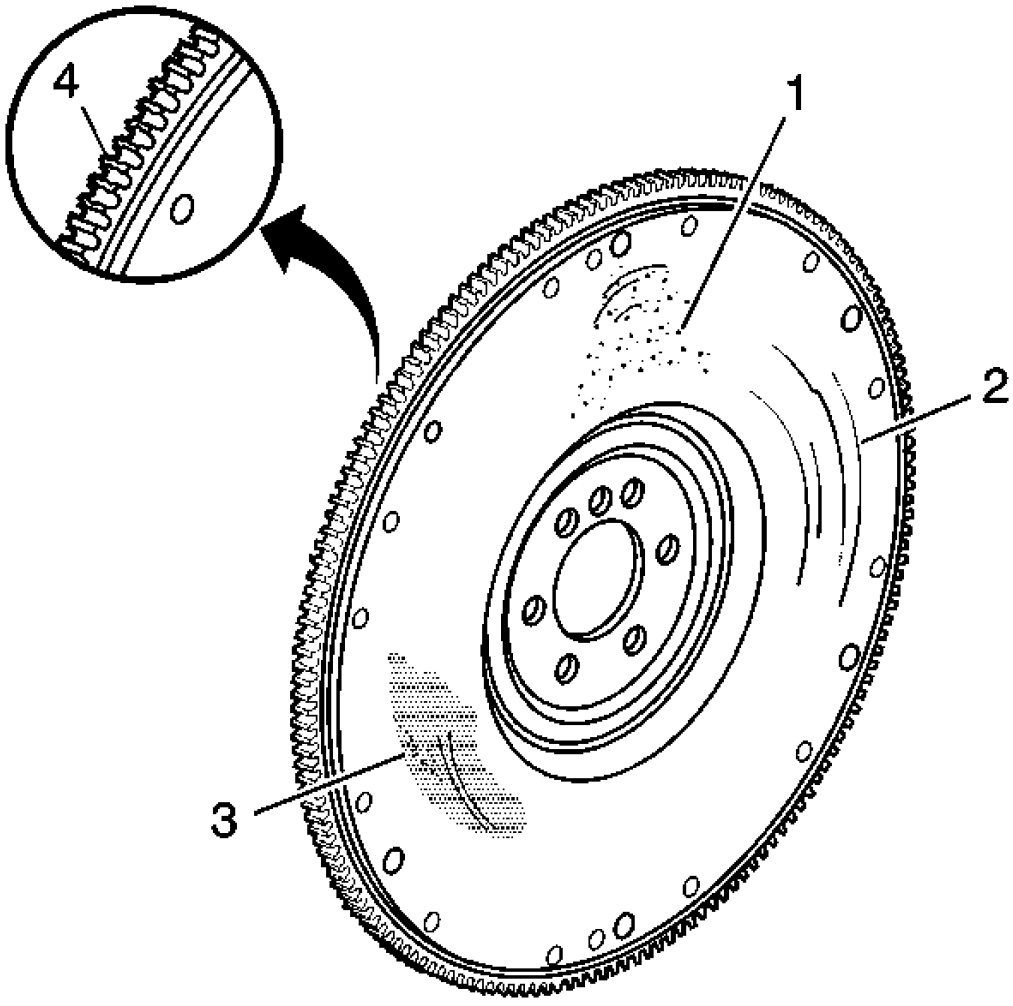


Fig. 142: Flywheel Inspection Areas (Manual Transmission)
Courtesy of GENERAL MOTORS CORP.

NOTE: In order to maintain the proper component balance, contact surface taper, and heat transfer, manual transmission flywheels are NOT to be machined.

Inspect the manual transmission flywheel for the following conditions:

- Pitted surface (1)
- Grooved or scored surface (2)
- Rusted surface (3)

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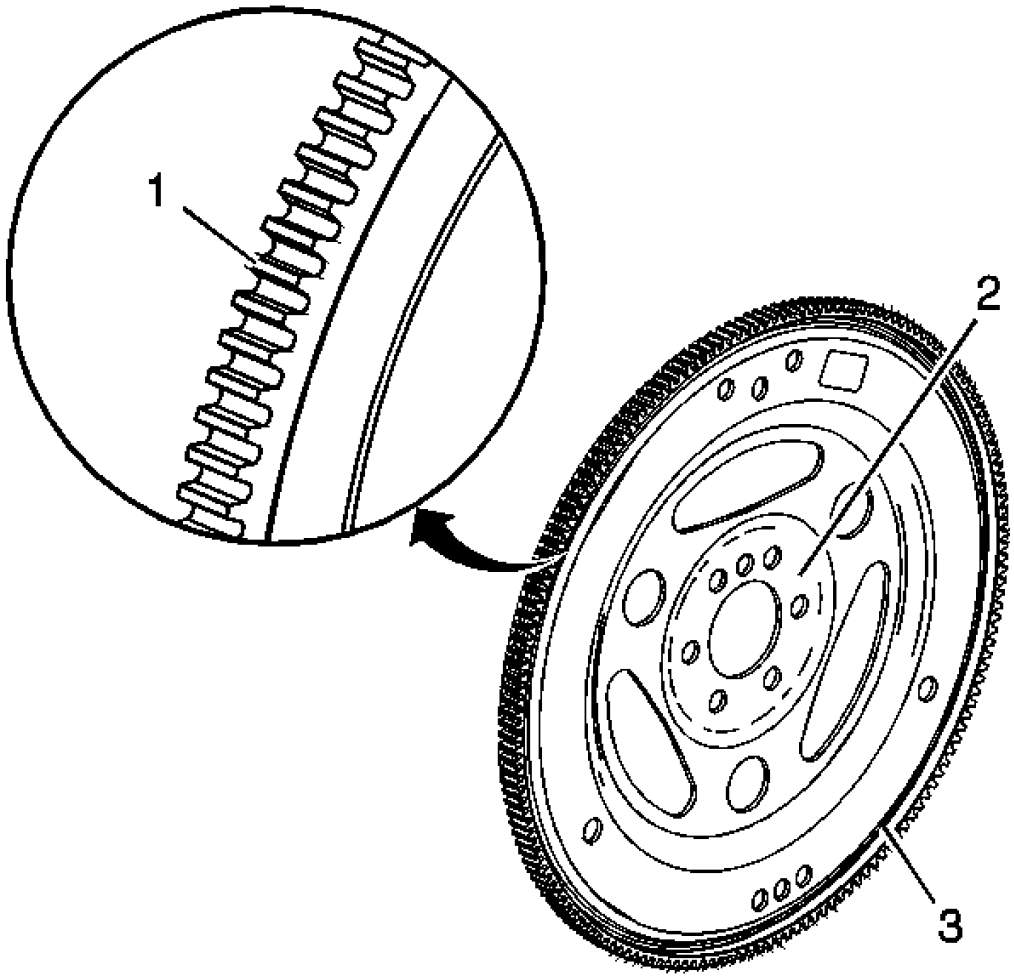
- Damaged ring gear teeth (4)
- Loose or improperly positioned ring gear

  The ring gear has an interference fit onto the flywheel and should be positioned completely against the flange of the flywheel.

- Missing, bent or damaged pressure plate locating pins

  The 2 locating pins are installed into the flywheel and spaced 170 degrees apart to ensure proper orientation of the clutch pressure plate to the engine flywheel during assembly.

AUTOMATIC TRANSMISSION FLEX PLATE CLEANING AND INSPECTION



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Fig. 143: View Of Ring Gear Teeth
Courtesy of GENERAL MOTORS CORP.

1. Clean the flex plate in solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Dry the flex plate with compressed air.
3. Inspect the flex plate for the following conditions:
   - Damaged ring gear teeth (1)
   - Stress cracks around the flex plate-to-crankshaft bolt hole locations (2)

NOTE: Do not attempt to repair the welded areas that retain the ring gear to the flex plate. Install a new flex plate.

   - Welded areas (3) that retain the ring gear onto the flex plate for cracking

PISTON AND CONNECTING ROD DISASSEMBLE

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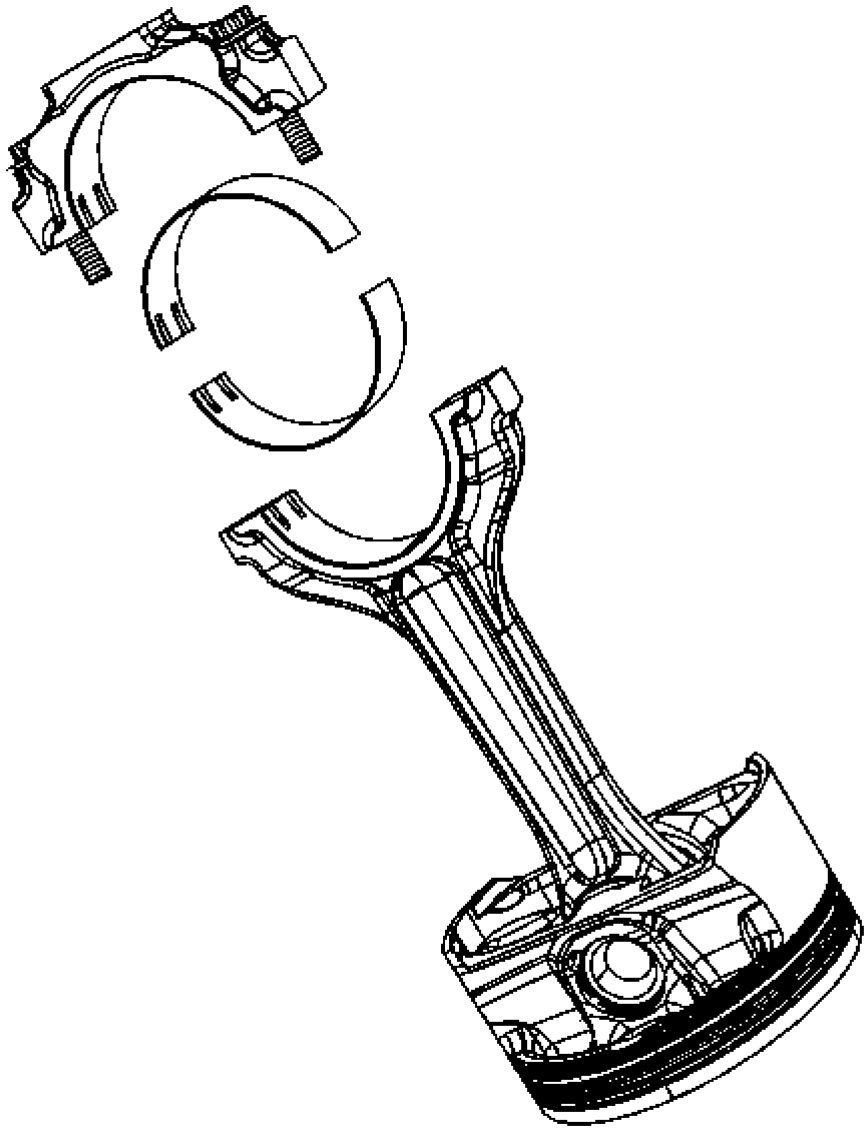


Fig. 144: View Of Piston, Connecting Rod & Bearing Assembly
Courtesy of GENERAL MOTORS CORP.

1. Remove the connecting rod bearings from the rod and cap.

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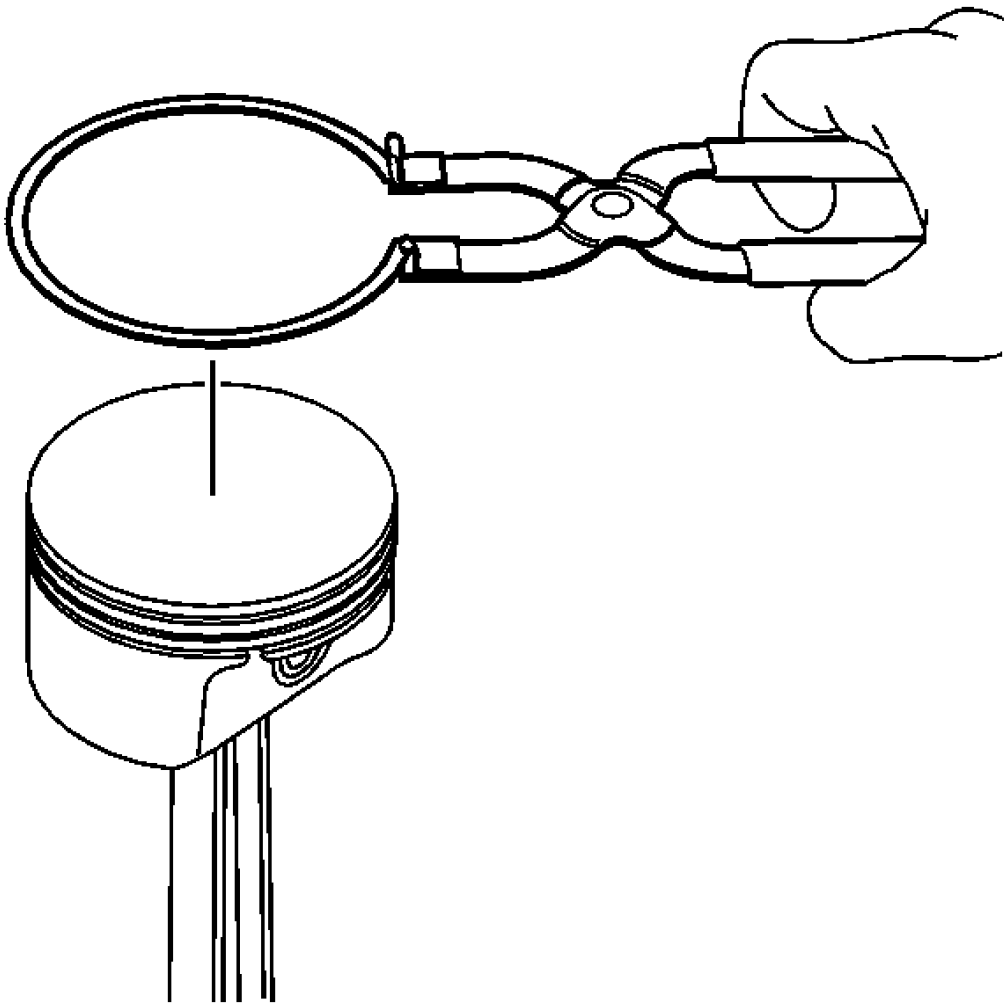


Fig. 145: Removing/Installing Piston Rings
Courtesy of GENERAL MOTORS CORP.

2. Using piston ring pliers, remove the piston rings from the piston.

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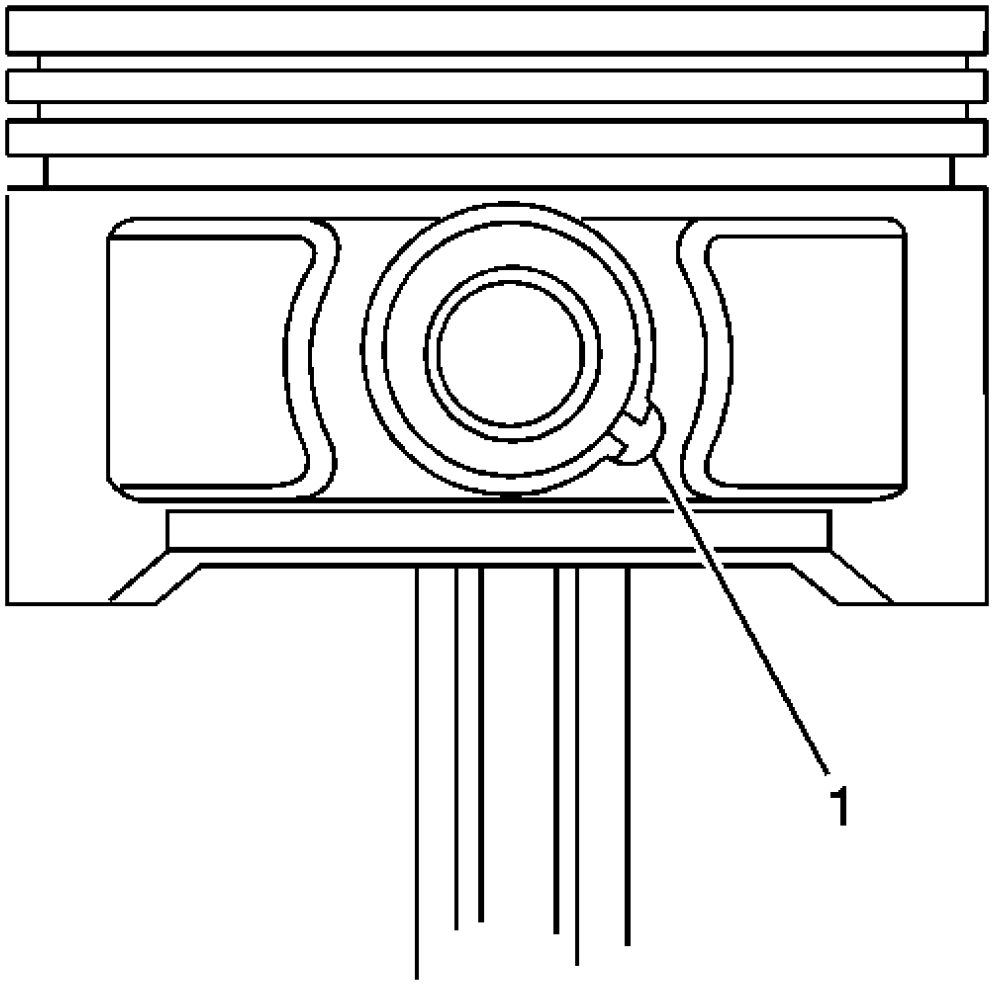


Fig. 146: View Of Piston Pin Retaining Clip & Cutout Area Of Pin Bore
Courtesy of GENERAL MOTORS CORP.

3. Rotate the piston pin retainers until the ring end gaps are positioned in the cutout area (1) of the pin bore.

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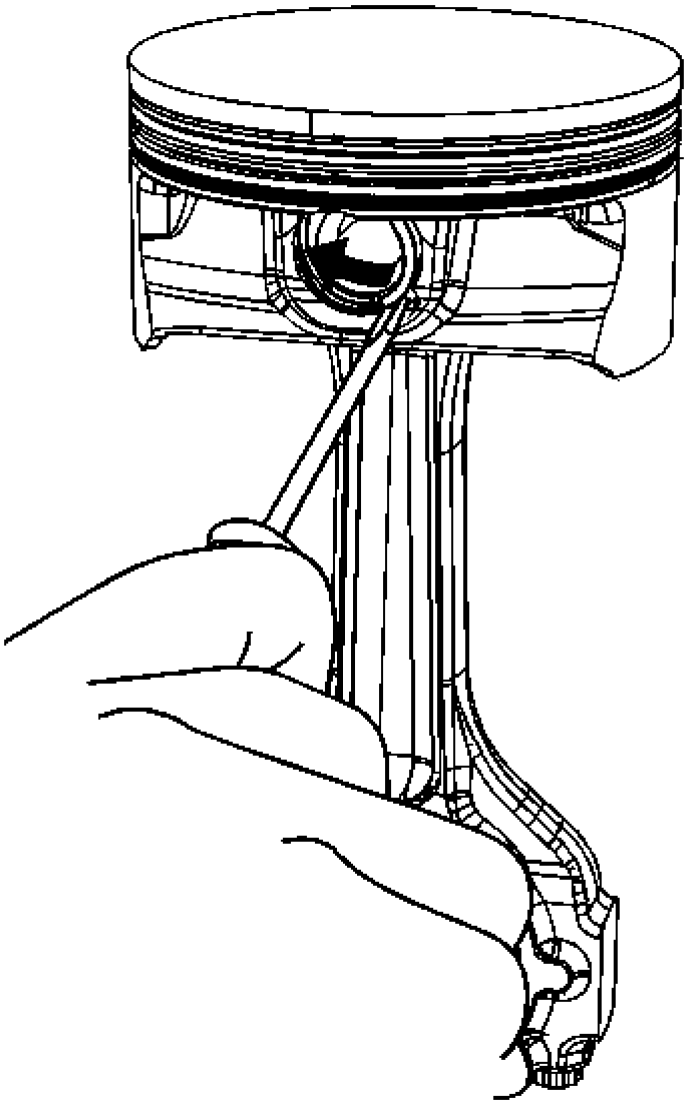


Fig. 147: Piston Pin Retainer
Courtesy of GENERAL MOTORS CORP.

4. Remove the retainers starting in the cutout area of the pin bore.

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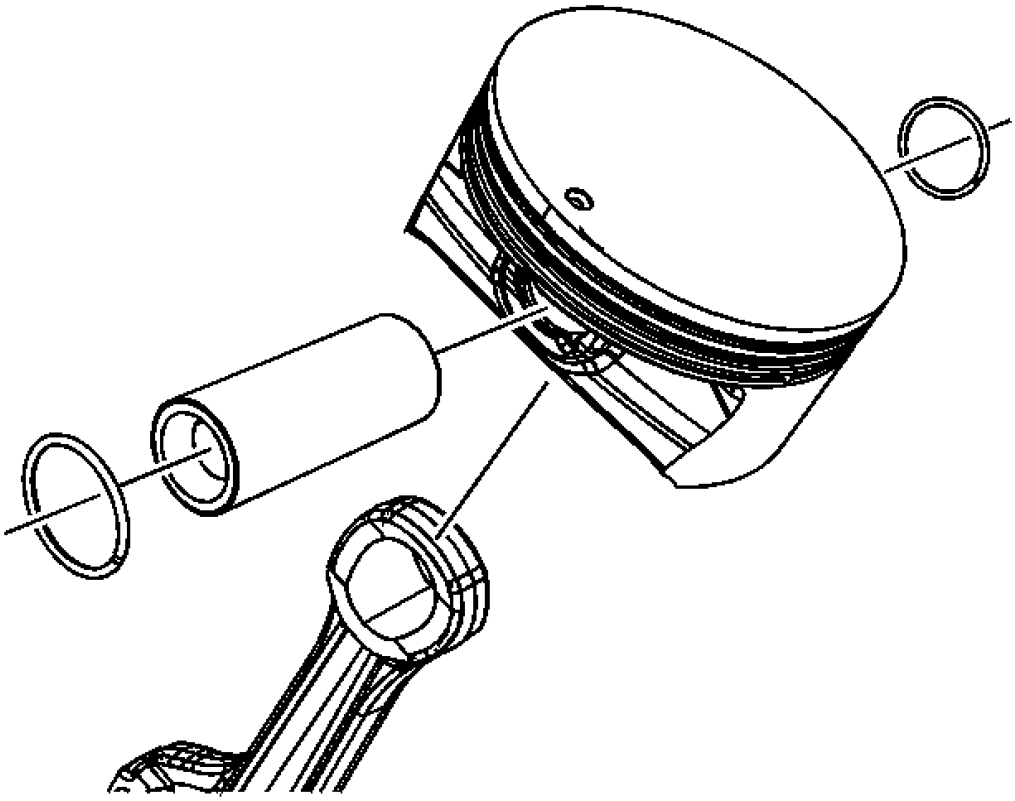


Fig. 148: Piston Pin, Piston & Connecting Rod
Courtesy of GENERAL MOTORS CORP.

5. Remove the pin from the piston and connecting rod.
6. The piston and pin are a matched set and are not to be serviced separately.

   Mark, sort, or organize the piston and the matching piston pin.

PISTON, CONNECTING ROD, AND BEARING CLEANING AND INSPECTION

PISTON, PIN, AND PISTON RINGS

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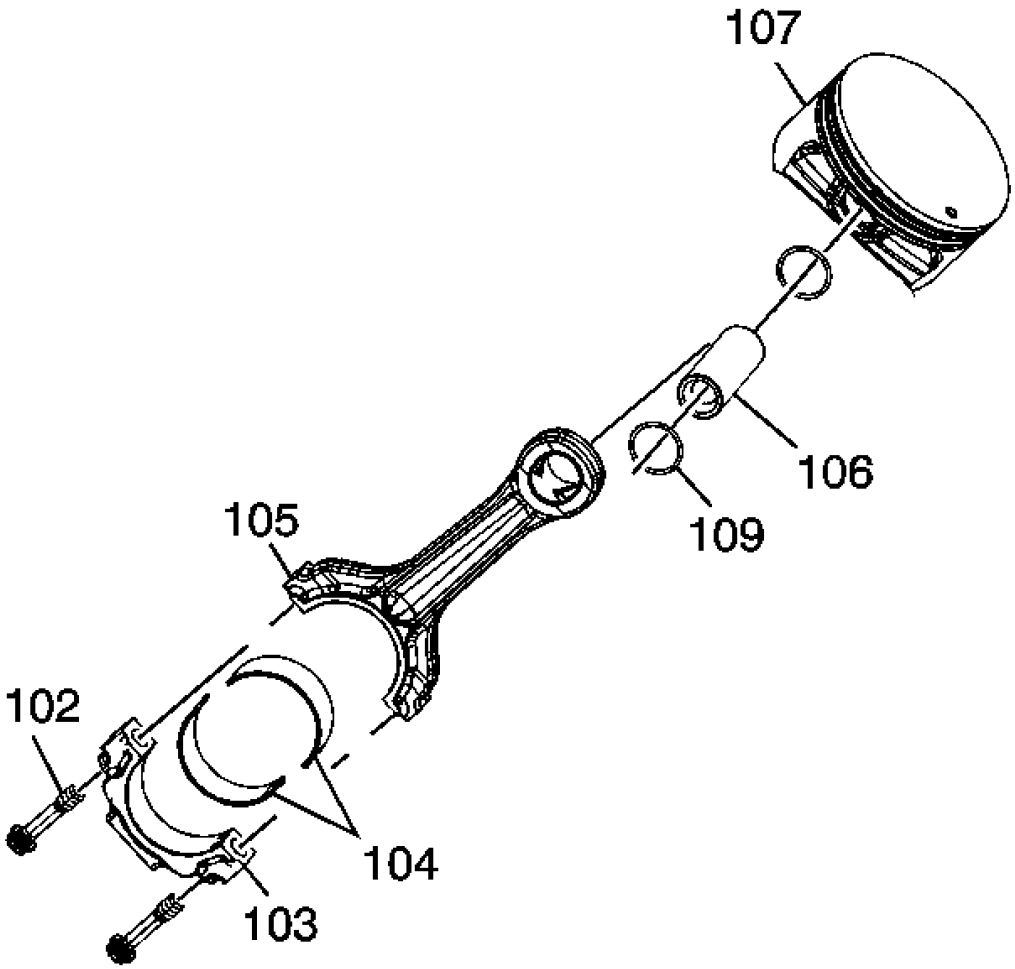


Fig. 149: View Of Piston, Pin & Piston Rings
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Replace pistons, pins, and connecting rods that are damaged or show signs of excessive wear.**
- **The piston and pin are to be serviced as an assembly.**
- **Do not wire brush any part of the piston.**
- **Measurement of the components should be taken with the components at normal room temperature.**

1. Clean the varnish and carbon from the piston (107) using cleaning solvent.

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WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Dry the components with compressed air.

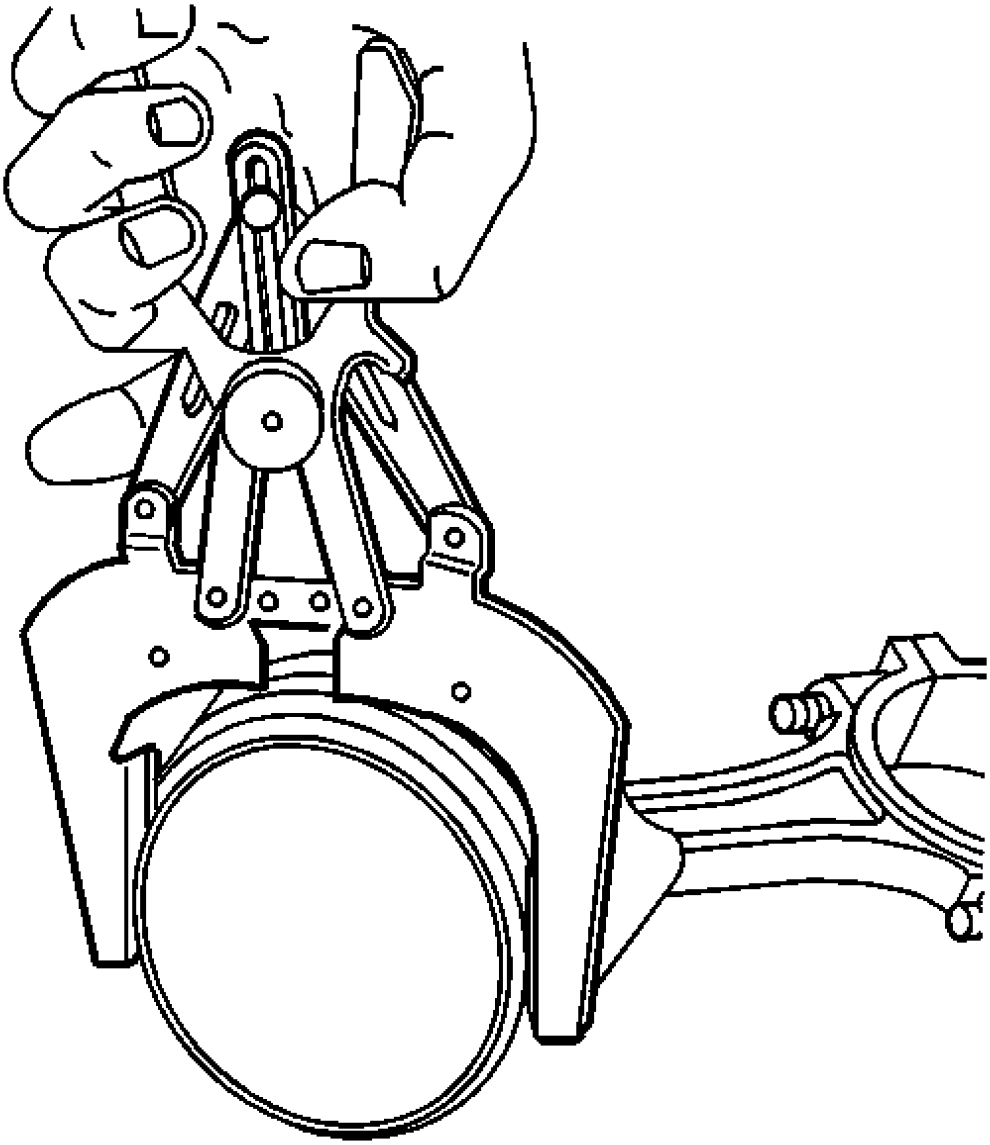


Fig. 150: Cleaning Piston Ring Grooves
Courtesy of GENERAL MOTORS CORP.

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3. Clean the piston ring grooves with a suitable ring groove cleaning tool.
4. Clean the oil lubrication holes and slots.

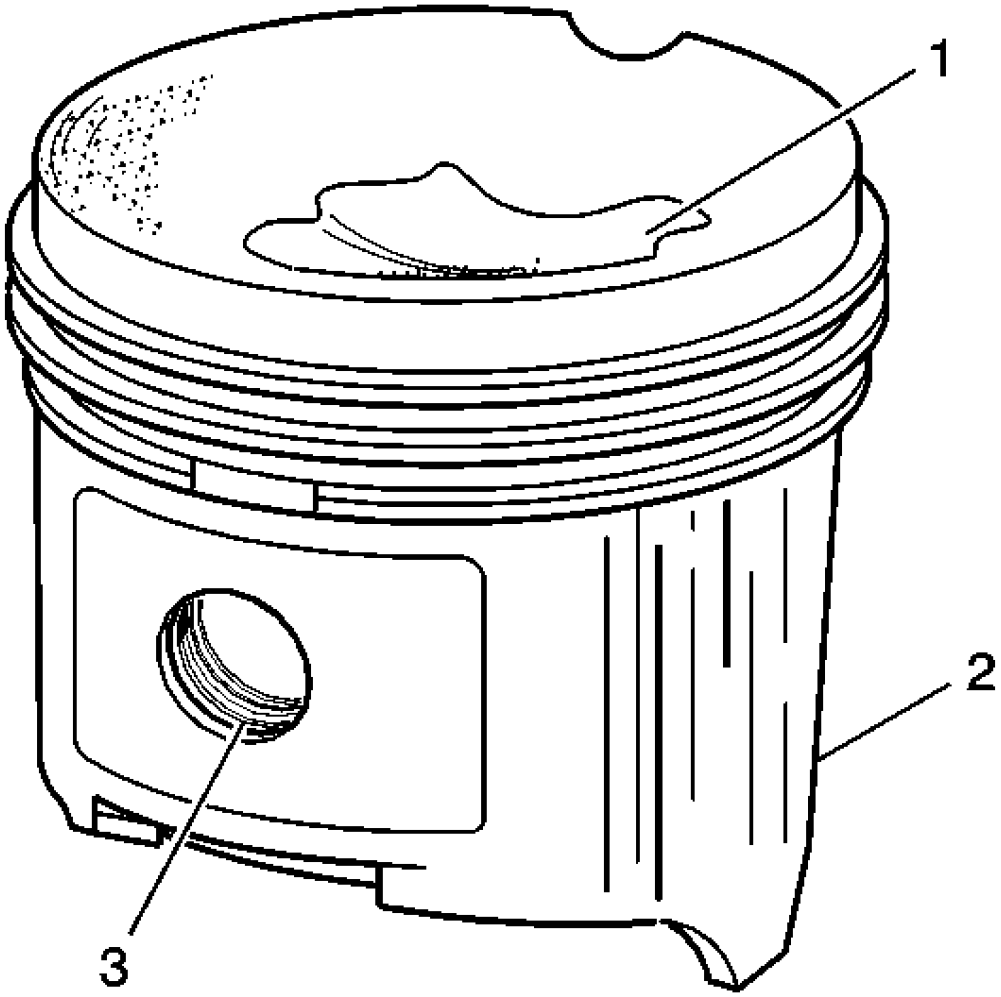


Fig. 151: Identifying Piston Damage
Courtesy of GENERAL MOTORS CORP.

5. Inspect the piston for the following conditions:
   - Cracks in the piston ring lands, the piston skirt, or pin bosses
   - Piston ring grooves for nicks, burrs, or warpage which may cause the piston ring to bind

   MINOR imperfections may be removed from the piston with a fine file.

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- Eroded areas at the top of the piston (1)
- Scuffed or damaged skirts (2)
- Scoring to the piston pin bore (3) or piston pin

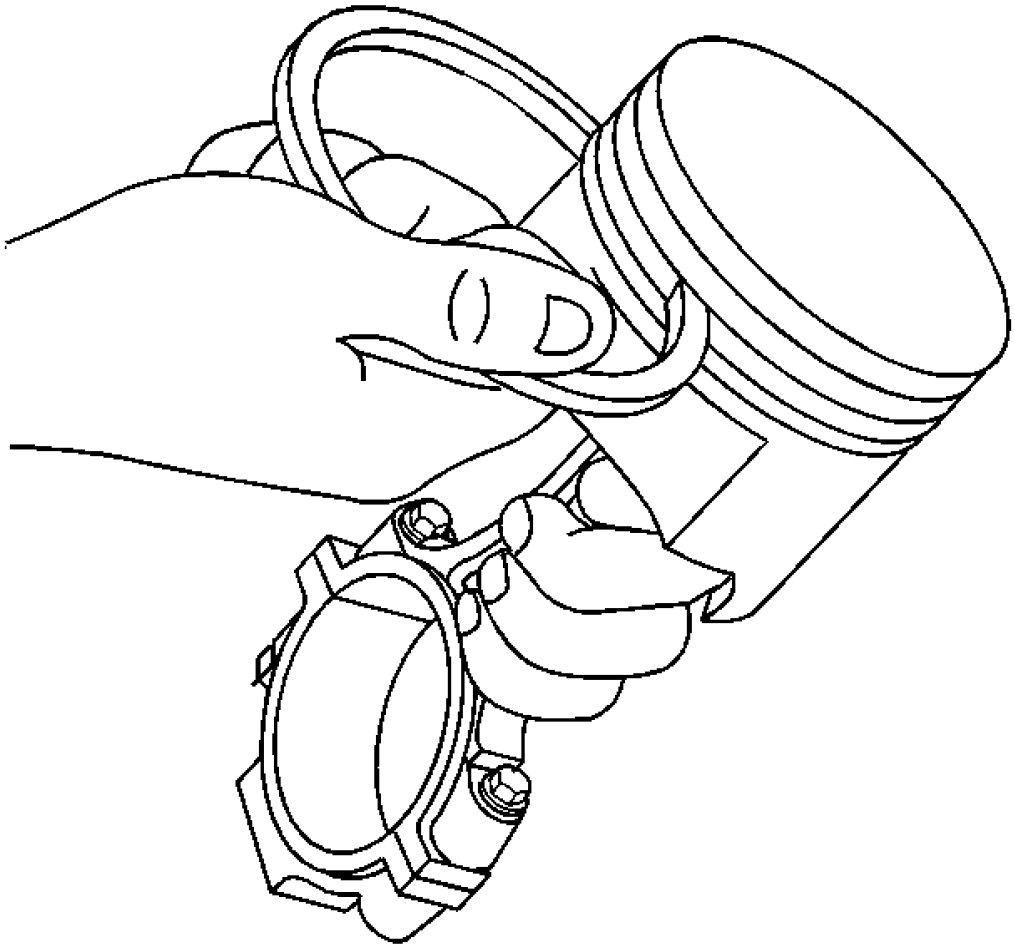


Fig. 152: Inserting Piston Ring Into Ring Groove
Courtesy of GENERAL MOTORS CORP.

6. Insert the edge of the piston ring into the piston ring groove.

   Roll the piston ring completely around the piston. If binding is caused by a distorted ring groove, MINOR imperfections may be removed with a fine file. If binding is caused by a distorted piston ring, replace the rings, as required.

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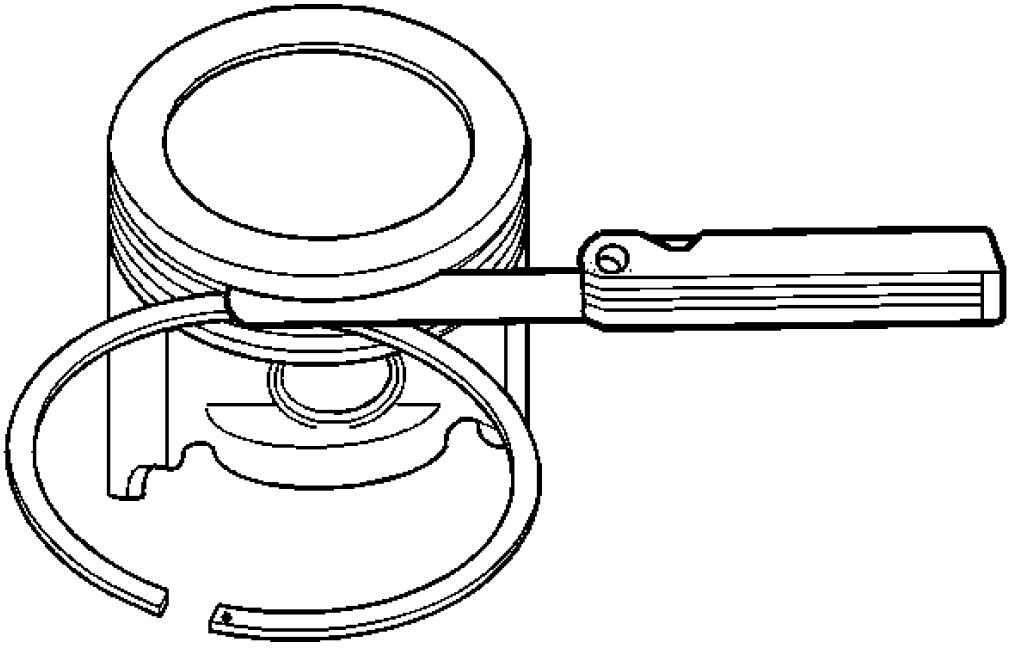


Fig. 153: Measuring Piston Ring Side Clearance
Courtesy of GENERAL MOTORS CORP.

7. Measure the piston ring side clearance with a feeler gauge. If side clearance is not within specifications, try another piston ring. If the proper ring-to-groove clearance cannot be obtained, replace the piston and pin as an assembly. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

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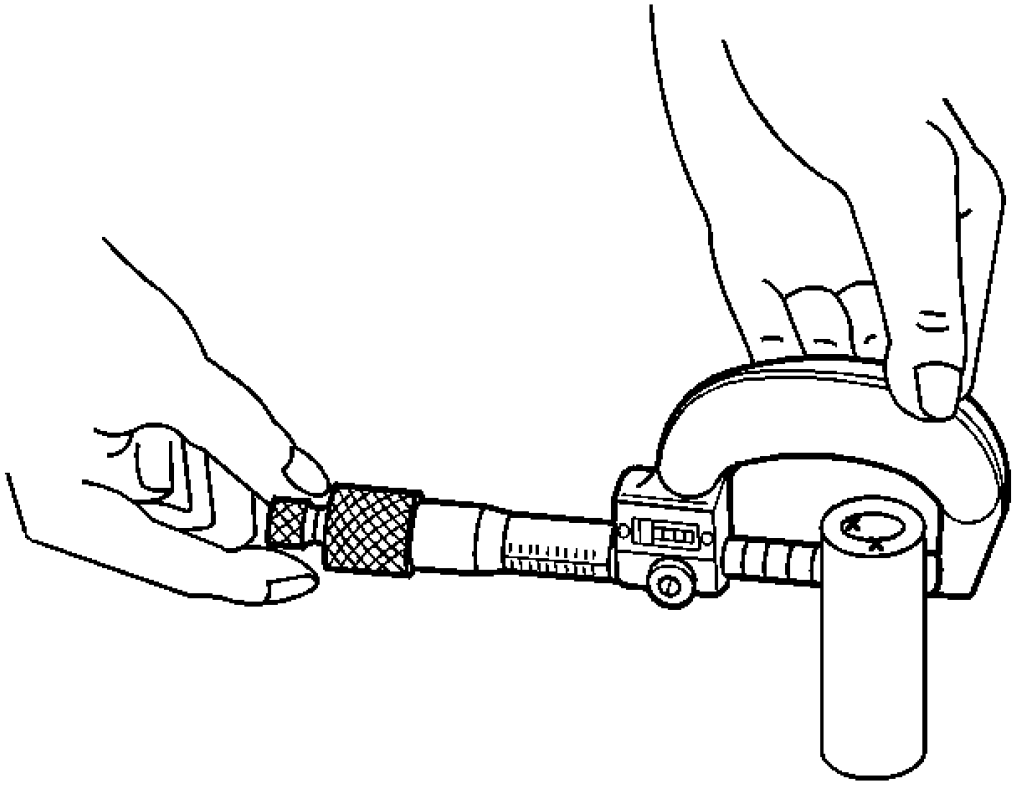


Fig. 154: Measuring Piston Pin Diameter
Courtesy of GENERAL MOTORS CORP.

8. To determine piston pin-to-bore clearance, use a micrometer and measure the piston pin outside diameter (OD).

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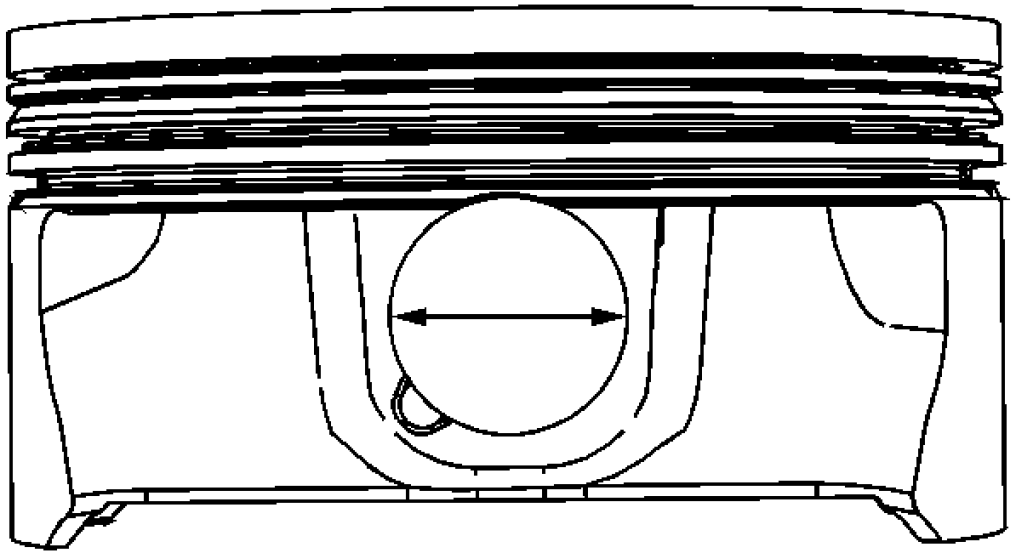


Fig. 155: Measuring Piston Pin-To-Bore Clearance
Courtesy of GENERAL MOTORS CORP.

9. To determine the piston pin-to-bore clearance, use an inside micrometer and measure the piston pin bore inside diameter (ID).
10. Subtract the piston pin OD measurement from the piston pin bore ID measurement to determine pin-to-bore clearance. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

MEASURING PISTON RING END GAP

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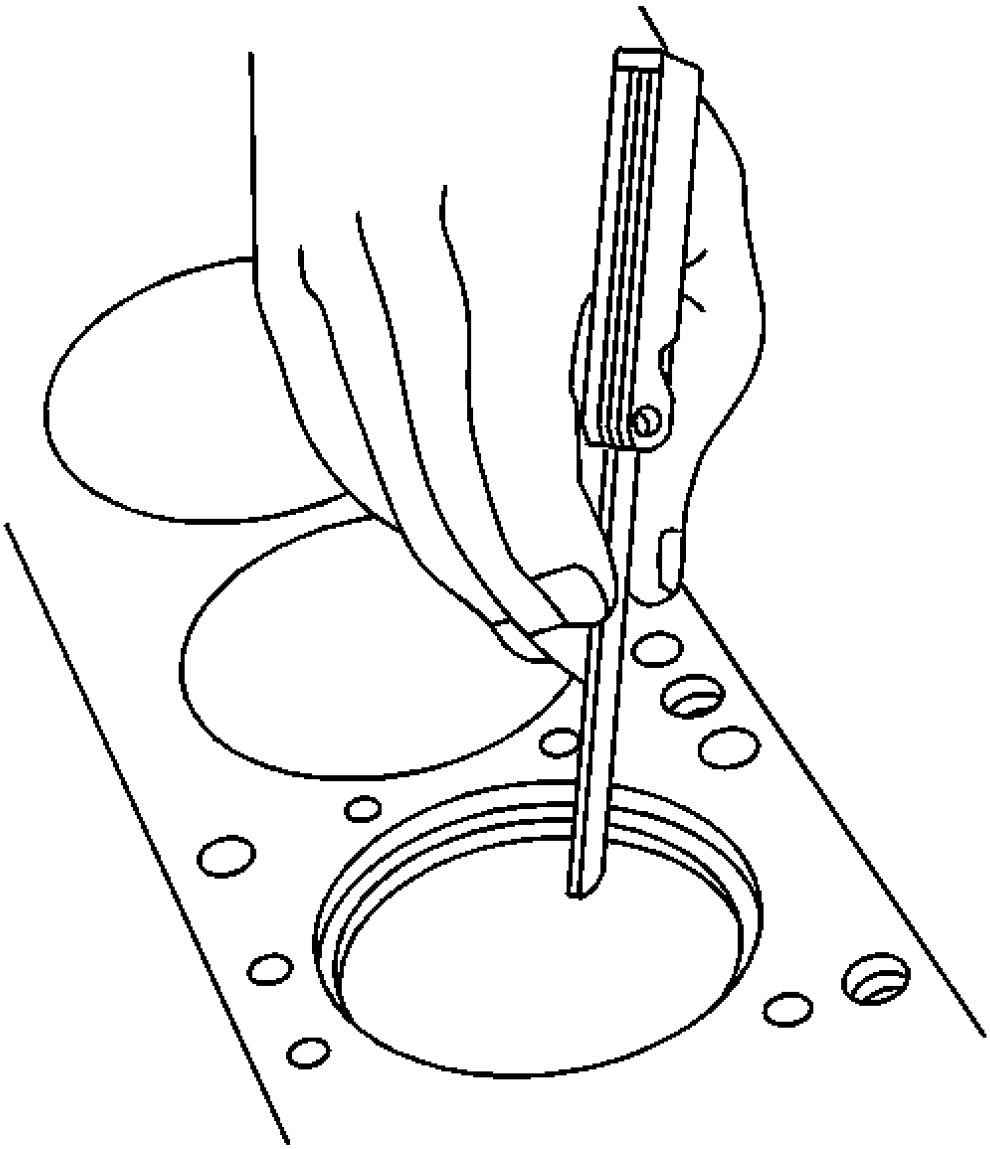


Fig. 156: Measuring Piston Ring End Gap
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Do not attempt to file the end of the piston ring to achieve the proper end gap clearance.**
- **Measure the piston ring in the cylinder in which it will be used.**

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1. Place the piston ring into the cylinder bore 6.5 mm (0.25 in) below the top of the ring travel area. Both rings should be installed with the orientation marks facing the top of the piston.
2. Insert a feeler gauge and measure the piston ring end gap. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

CONNECTING ROD AND BEARINGS

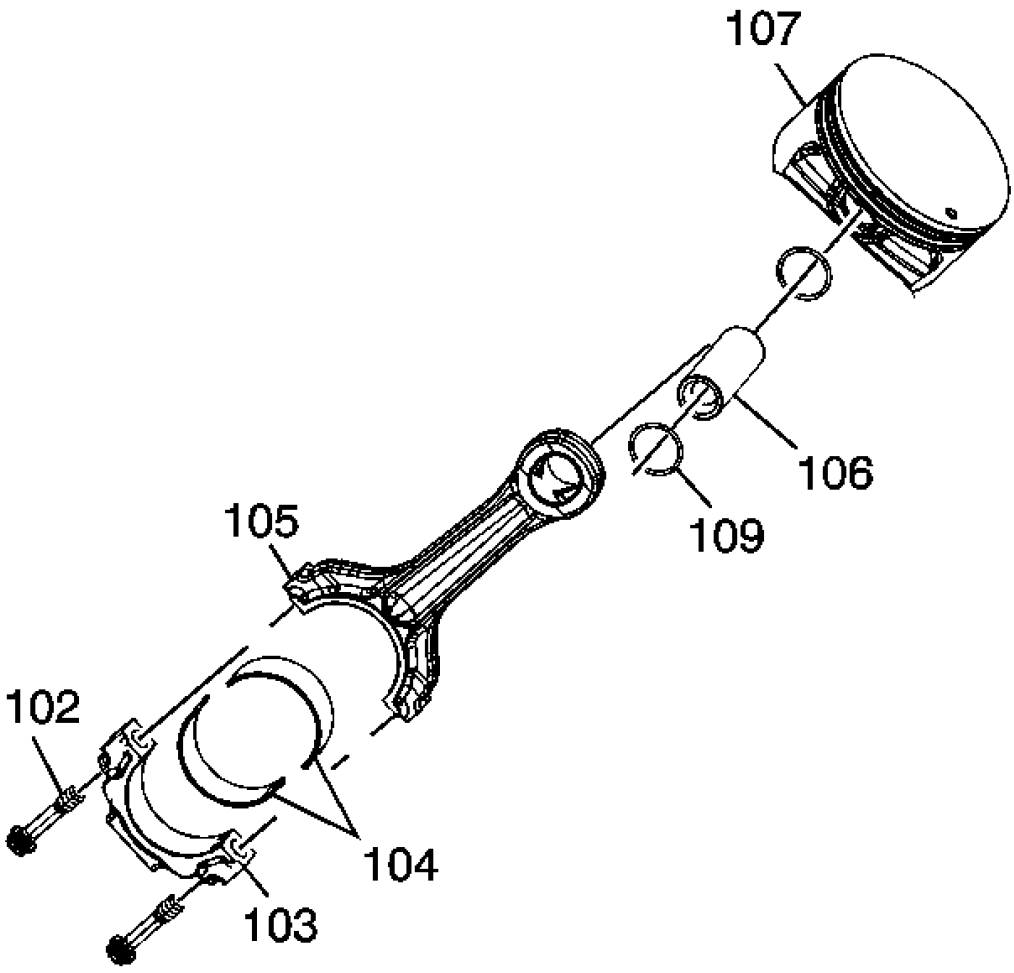


Fig. 157: View Of Piston, Pin & Piston Rings
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **The powdered metal connecting rod and cap are machined for proper clearances. The connecting rod and cap must be used as an assembly with no repair or modifications to either mating surface. Do**

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not attempt to repair the rod or cap. If service is required, replace the rod and cap as an assembly.

- **Do not attempt to repair the bolt hole threads of the connecting rod.**

1. Clean the connecting rod (105) and cap (103) in solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Dry the components with compressed air.

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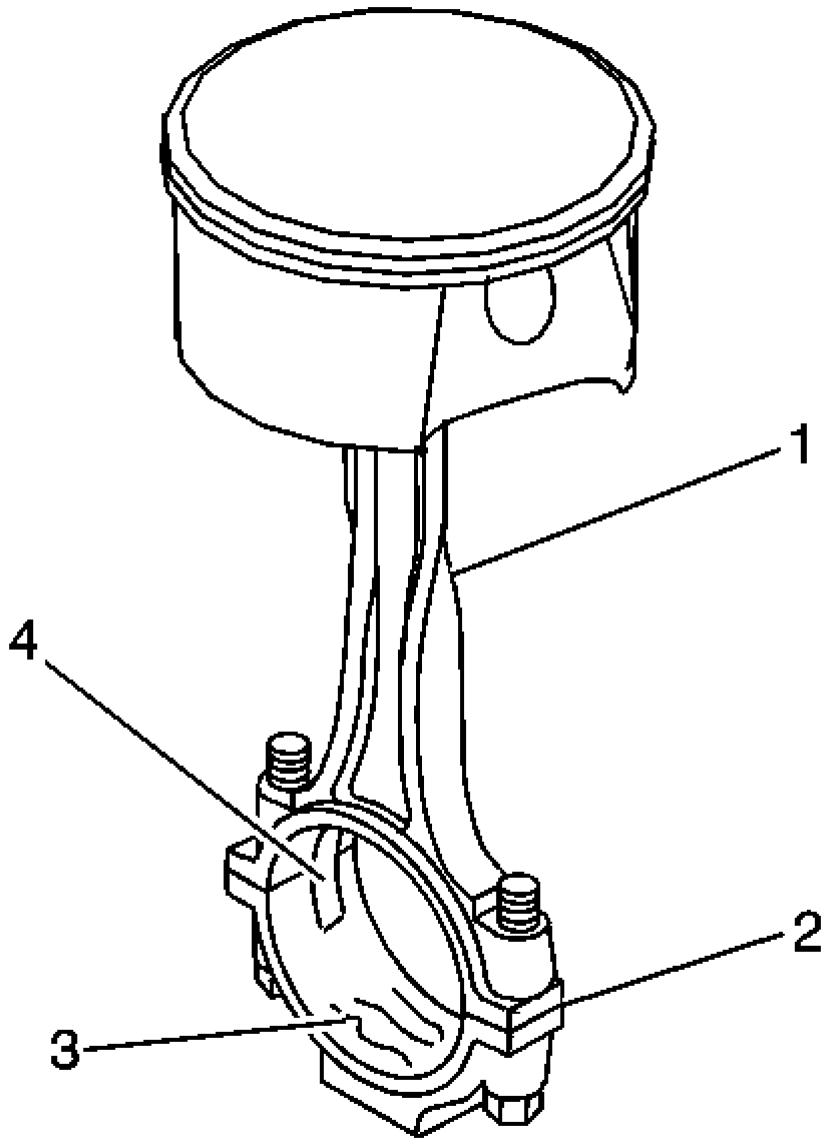


Fig. 158: Identifying Connecting Rod Inspection Areas
Courtesy of GENERAL MOTORS CORP.

3. Inspect the connecting rod for the following conditions:
    - Twisting (1)
    - Proper fit of the connecting rod and cap mating surfaces (2)
    - Nicks or gouges in the bearing bore (3)

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- Damage to the bearing locating slots (4)

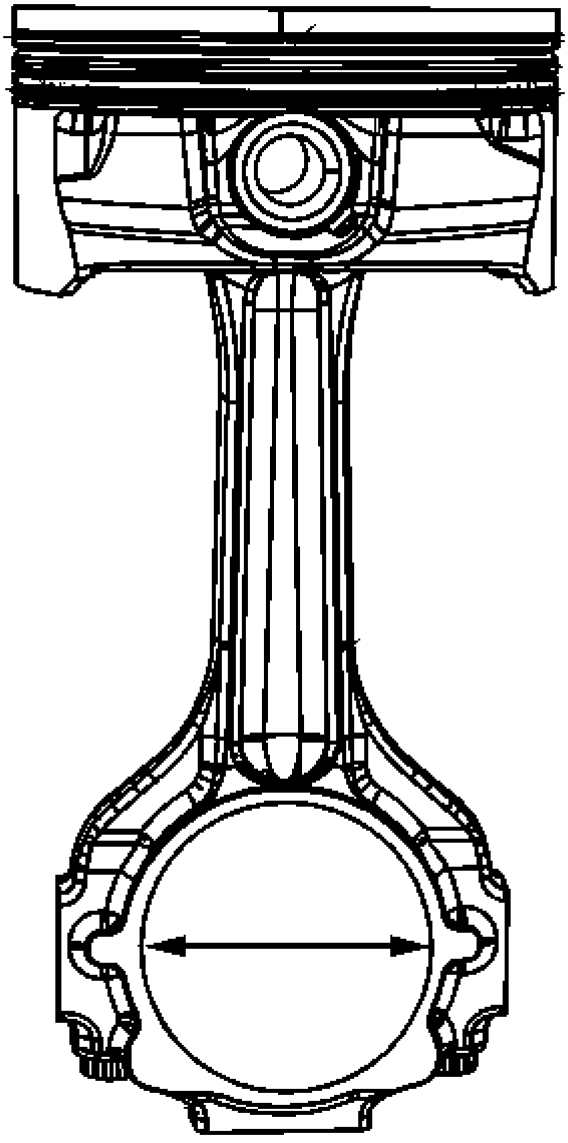


Fig. 159: Identifying Connecting Rod Bearing Bore
Courtesy of GENERAL MOTORS CORP.

4. Measure the connecting rod bearing bore for an out-of-round condition. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

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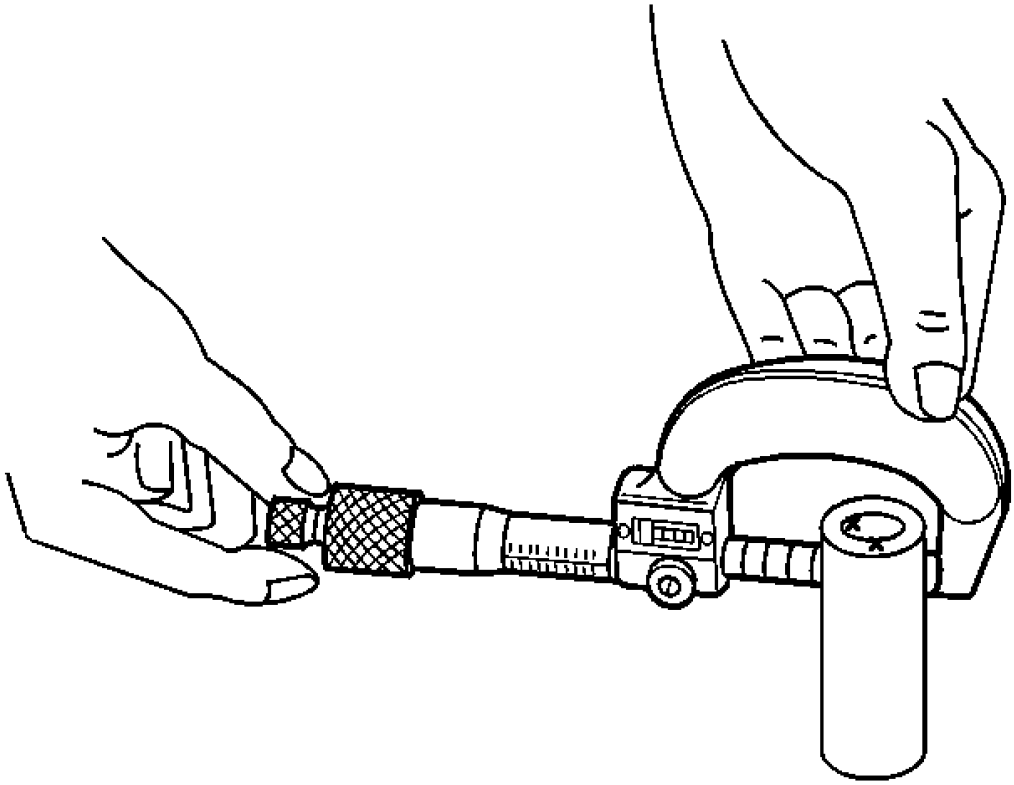


Fig. 160: Measuring Piston Pin Diameter
Courtesy of GENERAL MOTORS CORP.

5. To determine piston pin-to-connecting rod bore clearance, use a micrometer and measure the piston pin OD.

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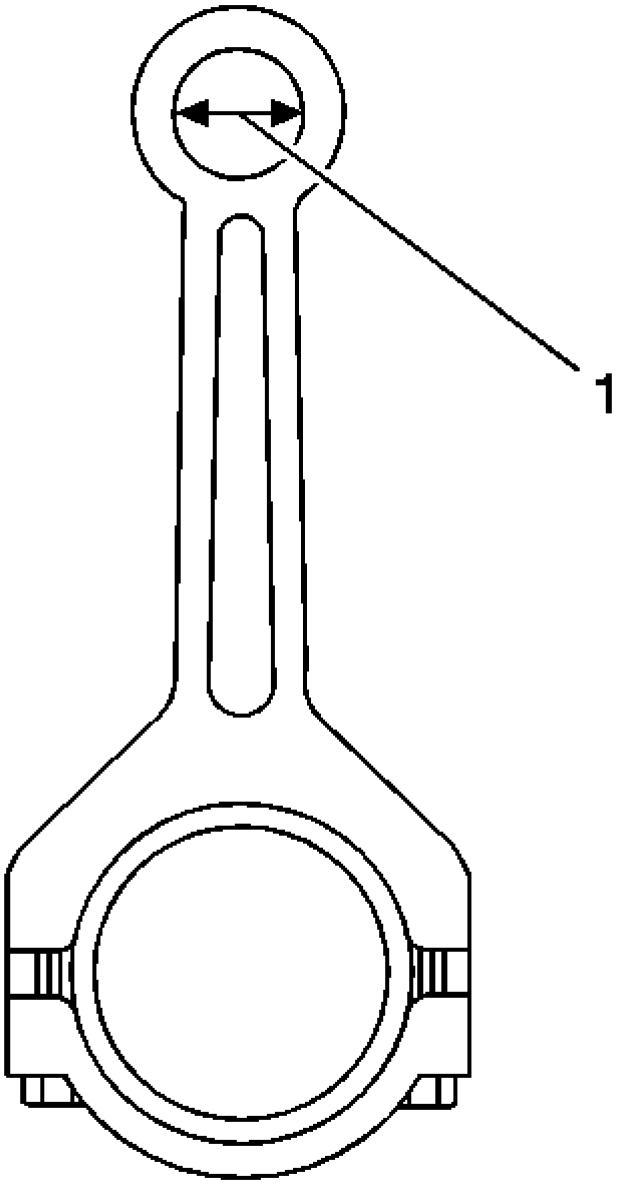


Fig. 161: Measuring Connecting Rod Pin Bore Inside Diameter
Courtesy of GENERAL MOTORS CORP.

6. To determine the piston pin-to-connecting rod bore clearance, use a micrometer and measure the connecting rod pin bore (1) ID.
7. Subtract the piston pin OD measurement from the connecting rod pin bore ID measurement to determine

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pin-to-bore clearance. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

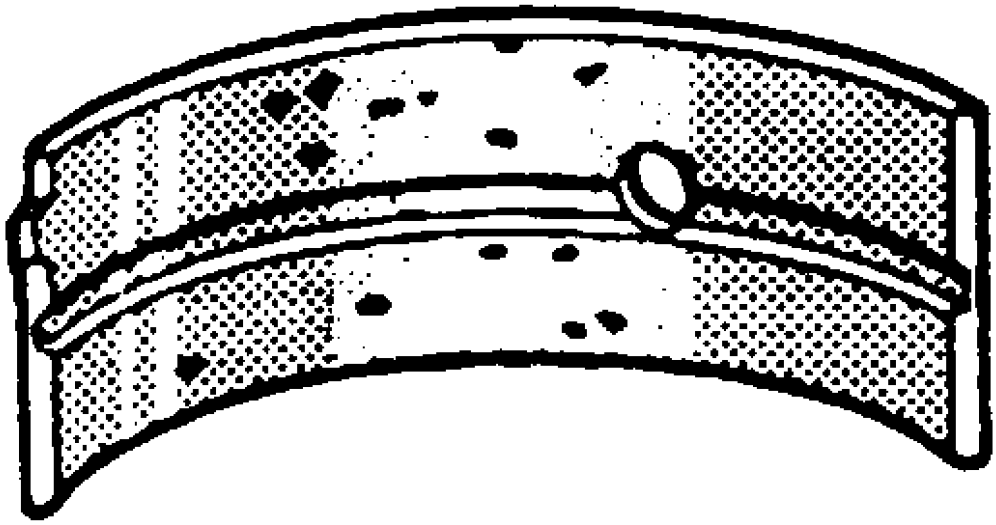


Fig. 162: Identifying Crankshaft Bearing Craters Or Pockets
Courtesy of GENERAL MOTORS CORP.

8. Inspect the connecting rod bearings for craters or pockets. Flattened sections on the bearing halves indicate fatigue.

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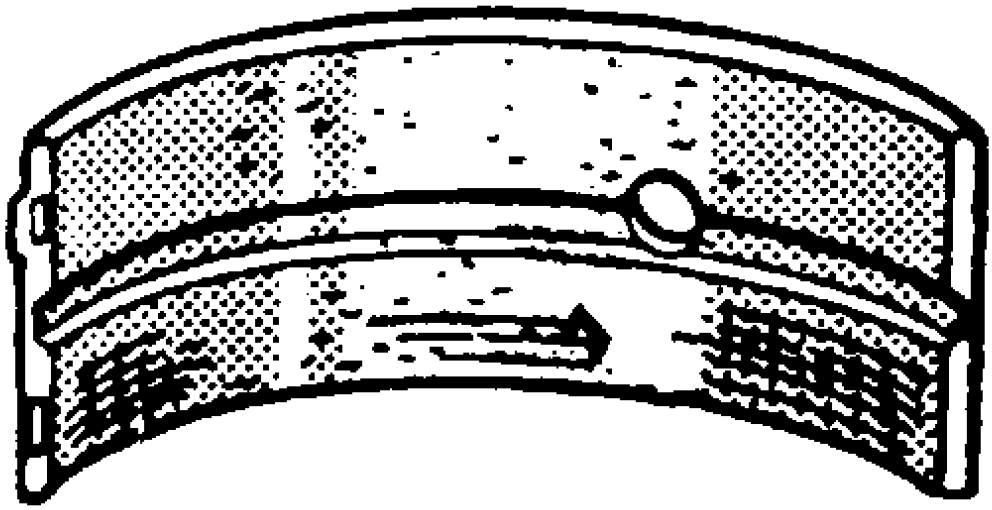


Fig. 163: Identifying Connecting Rod Bearing Scoring Or Discoloration
Courtesy of GENERAL MOTORS CORP.

9. Inspect the connecting rod bearings for excessive scoring or discoloration.
10. Inspect the connecting rod bearings for dirt or debris imbedded into the bearing material.

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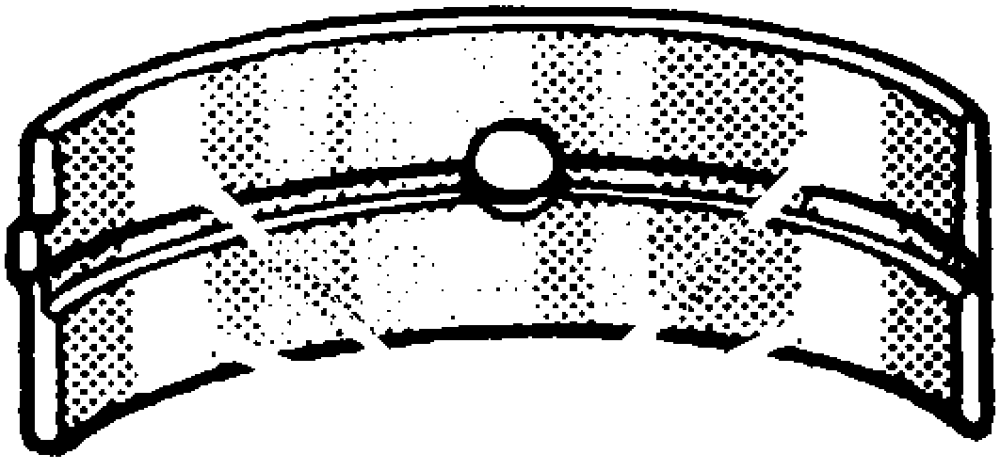


Fig. 164: View Of Improper Seating
Courtesy of GENERAL MOTORS CORP.

11. Inspect the connecting rod bearings for improper seating indicated by bright, polished sections of the bearing surface.
12. To determine the piston pin-to-bore clearance, use an inside micrometer and measure the piston pin bore ID.
13. Subtract the piston pin OD measurement from the piston pin bore ID measurement to determine pin-to-bore clearance. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

PISTON AND CONNECTING ROD ASSEMBLE

SPECIAL TOOLS

J 41556: Connecting Rod Guide Set

For equivalent regional tools, refer to **Special Tools** Special Tools.

PISTON AND PISTON PIN INSTALLATION PROCEDURE

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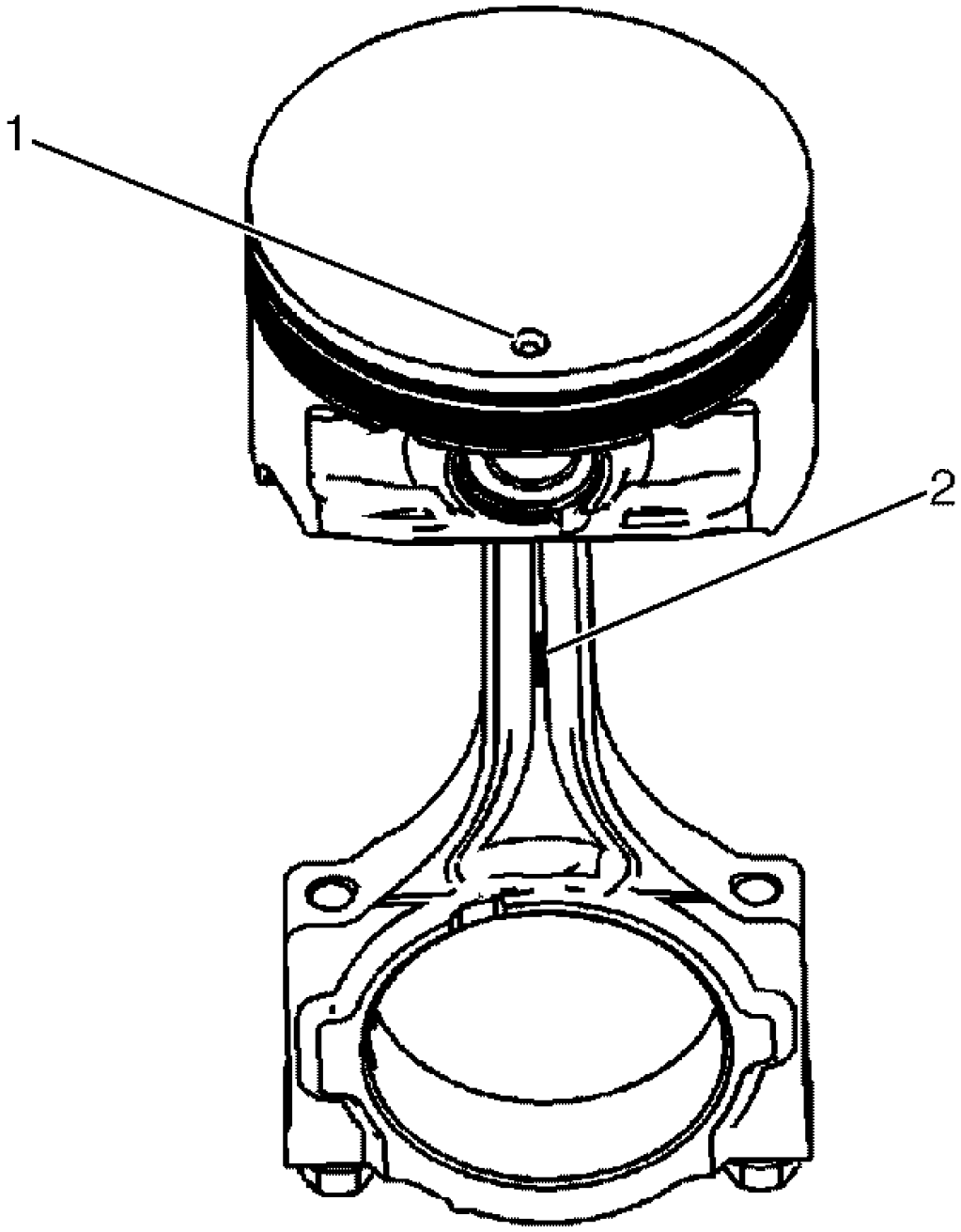


Fig. 165: Identifying Piston Notch & Connecting Rod Painted Mark
Courtesy of GENERAL MOTORS CORP.

1. Assemble the piston and connecting rod with the notch (1) on the piston and the painted mark (2) on the

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connecting rod facing the front of the engine.

When installing the piston and connecting rod assembly, the mark on the top of the piston (1) and the painted mark (2) on the connecting rod should face the front of the engine.

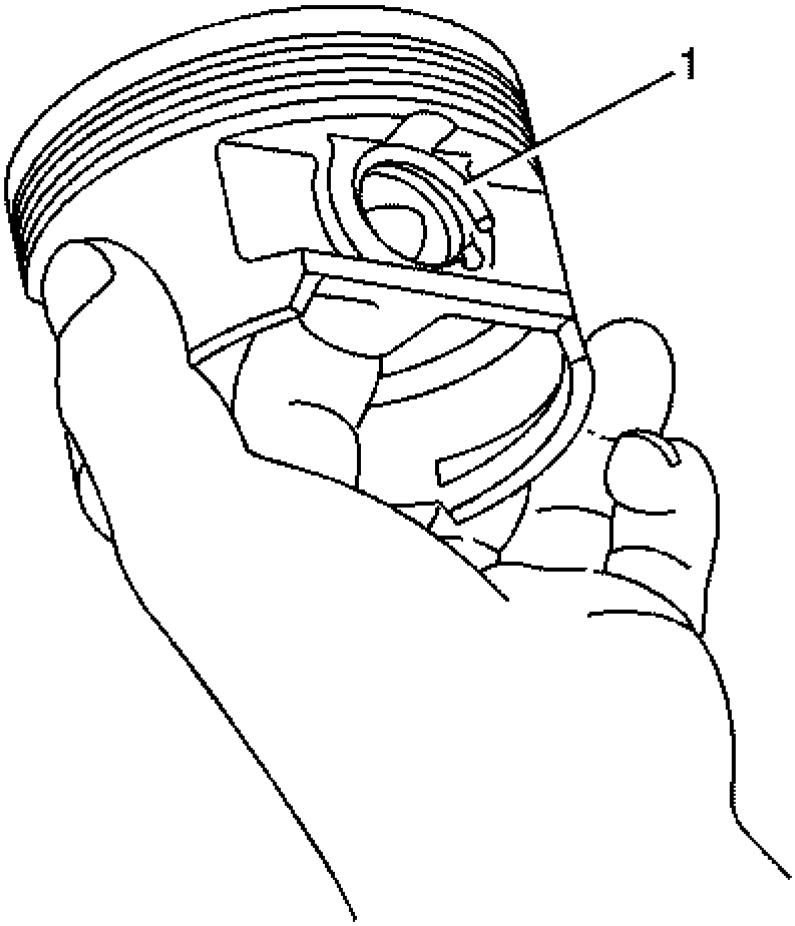


Fig. 166: View Of Retainer
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure the retainer (1) is seated in the groove.

2. Install the retainer (1).

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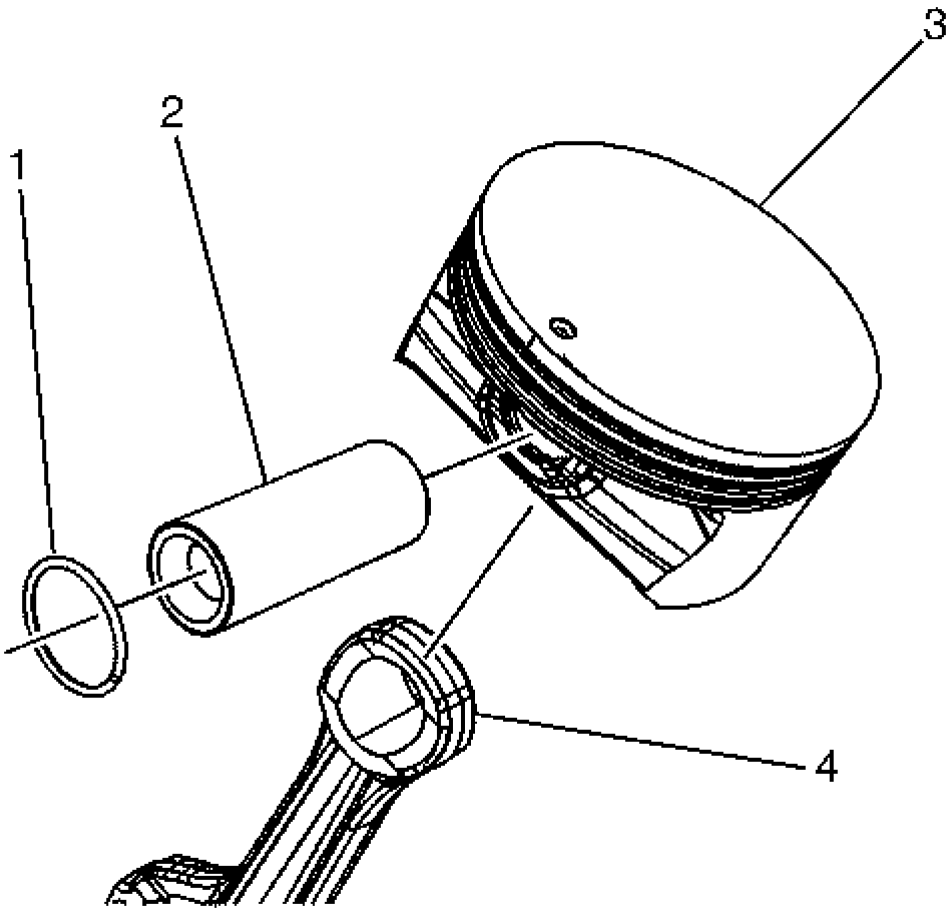


Fig. 167: View Of Retainer, Piston Pin, Piston & Connecting Rod
Courtesy of GENERAL MOTORS CORP.

3. Install the piston pin (2) to the piston (3) and connecting rod (4).

NOTE: Ensure the retainer (1) is seated in the groove.

4. Install the retainer (1).

PISTON RING INSTALLATION PROCEDURE

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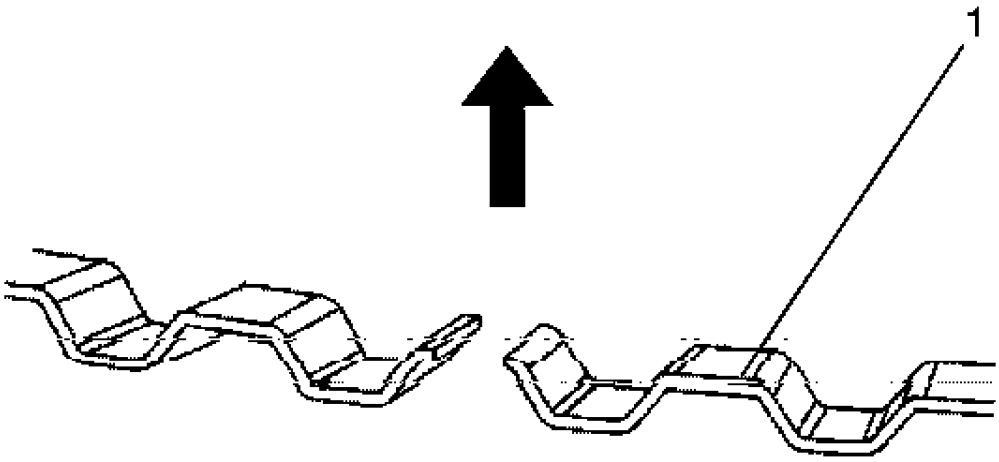


Fig. 168: Identifying Oil Control Ring Expander
Courtesy of GENERAL MOTORS CORP.

1. Correctly orient the oil control ring expander (1) as shown before installation. The ends of the oil control ring expander (1) must be facing toward the top of the piston.

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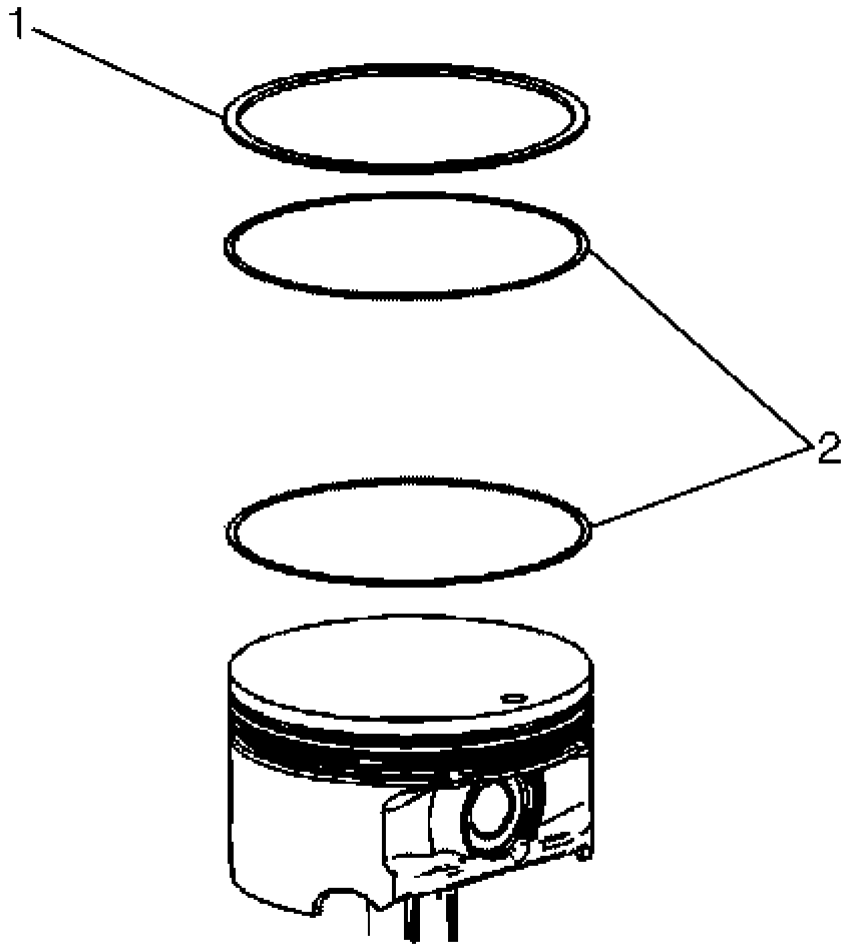


Fig. 169: Identifying Expander & Oil Scraper Rings
Courtesy of GENERAL MOTORS CORP.

NOTE: Install the 2 oil scraper rings (1). Expand the rings only enough to clear the piston diameter.

2. Using a piston ring expander, install the oil control ring assembly using the following procedure:
3. Install the expander ring (2).

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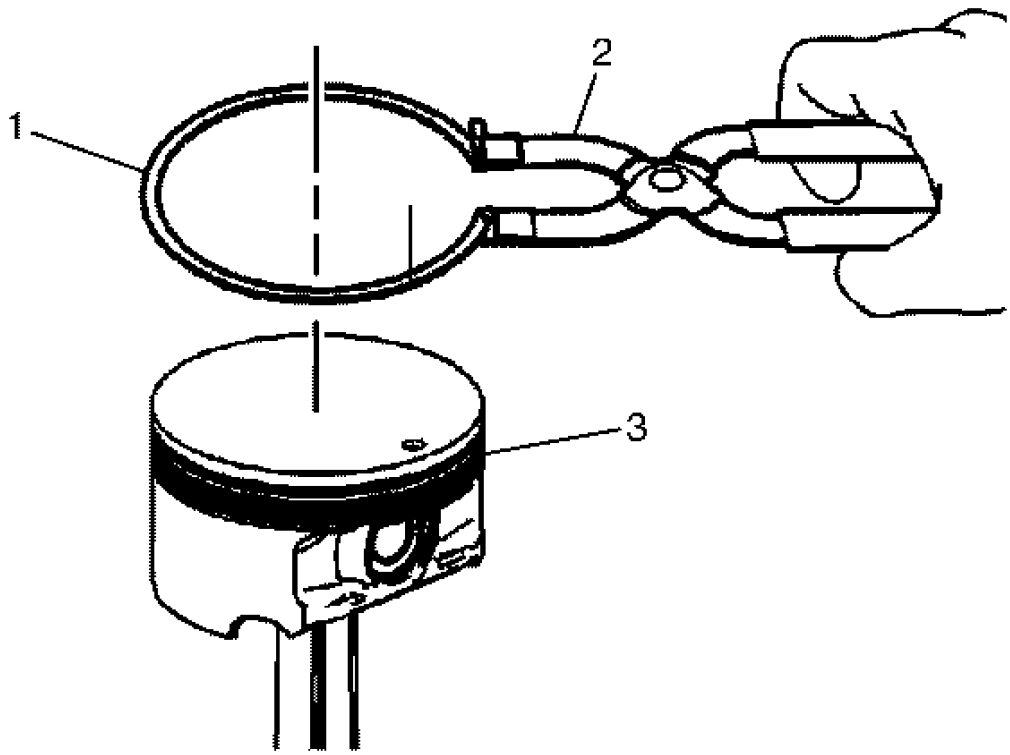


Fig. 170: View Of Ring Expander, Second Piston Ring & Piston
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Ensure you do not over expand the piston ring. Over expanding the piston rings will distort or crack the rings.**
- **Install the second piston ring (2) onto the piston (3) using the ring expander (1).**

4. Install the second piston ring (2) onto the piston (3).

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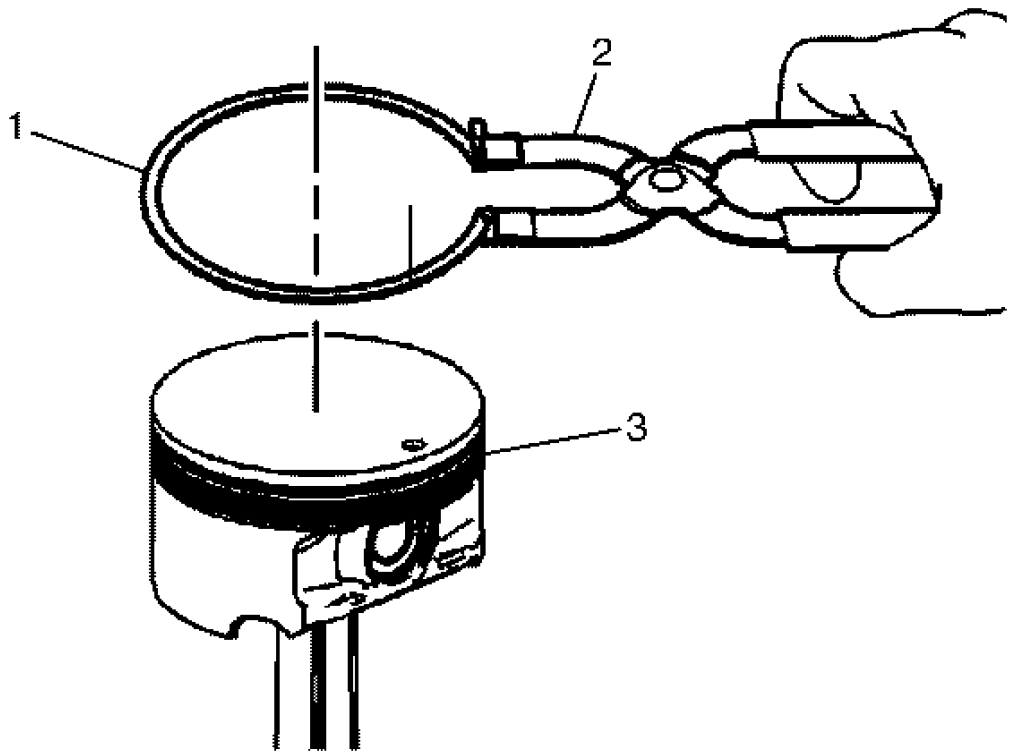


Fig. 171: View Of Ring Expander, Second Piston Ring & Piston
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Ensure you do not over expand the piston ring. Over expanding the piston rings will distort or crack the rings.**
- **Install the top piston ring (2) onto the piston (3) using the ring expander (1).**

5. Install the top piston ring (2) onto the piston (3).

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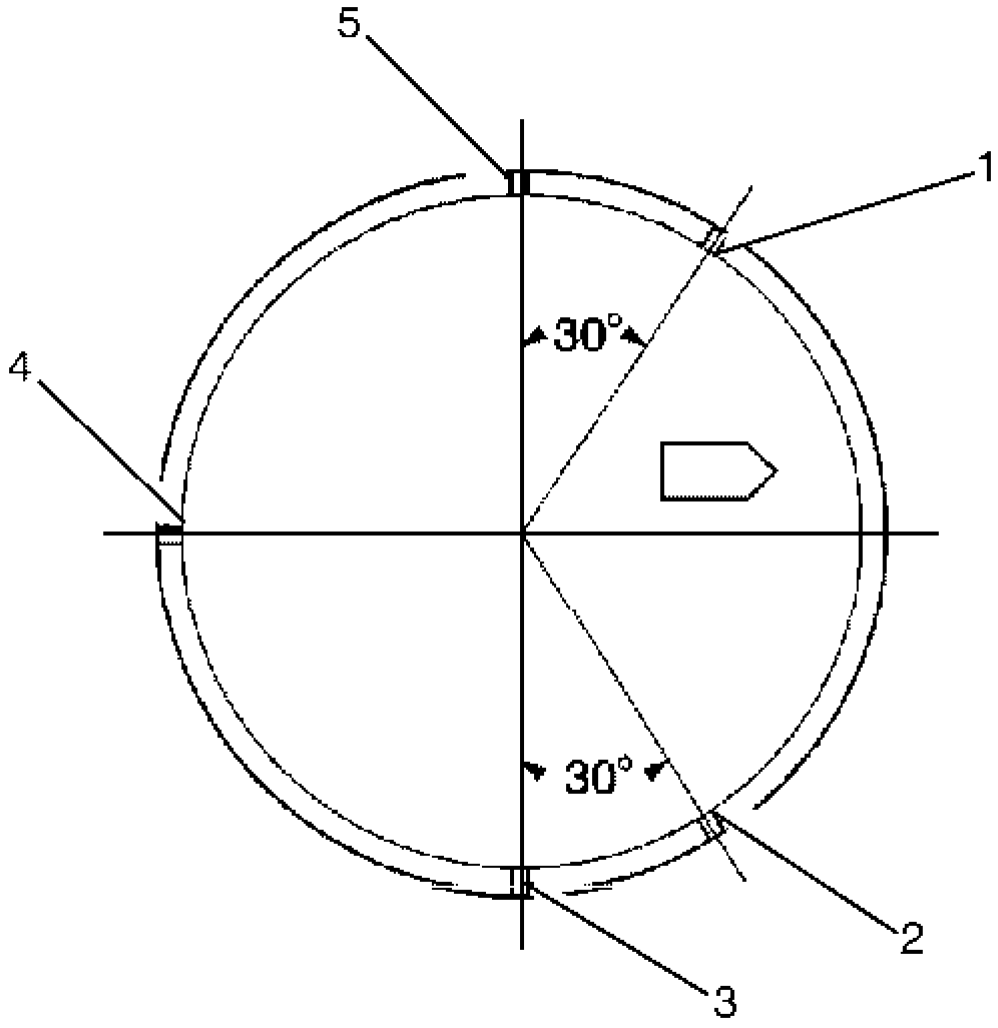


Fig. 172: Identifying Ring Positions
Courtesy of GENERAL MOTORS CORP.

6. Once the rings are installed, set the ring gaps for the oil control, second and top ring as follows. Use the piston location arrow for reference.
    1. Lower oil control ring - position (1).
    2. Upper oil control ring - position (2).
    3. Top Ring - position (3).
    4. Oil control ring expander - position (4).
    5. Second ring - position (5).

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CONNECTING ROD BEARING INSTALLATION PROCEDURE

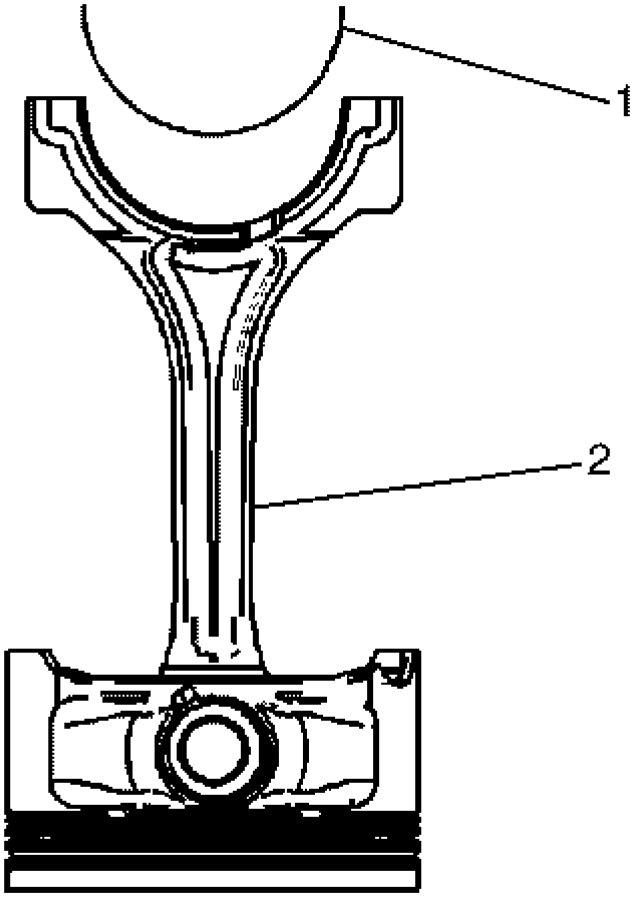


Fig. 173: Identifying Connecting Rod & Bearings
Courtesy of GENERAL MOTORS CORP.

NOTE: If the connecting rod bearings (1) have been used in a running engine, you must replace them with NEW connecting rod bearings (1) for reassembly.

1. Clean the connecting rod (2) and the connecting rod cap bearing bore with a lint-free cloth.
2. Clean all the oil from behind the connecting rod bearing (1) halves.
3. Install new upper connecting rod bearings (1) into position. Roll the connecting rod bearings (1) into position so that the lock tang engages the alignment slot. The connecting rod bearings (1) must fit flush in the connecting rod (2).

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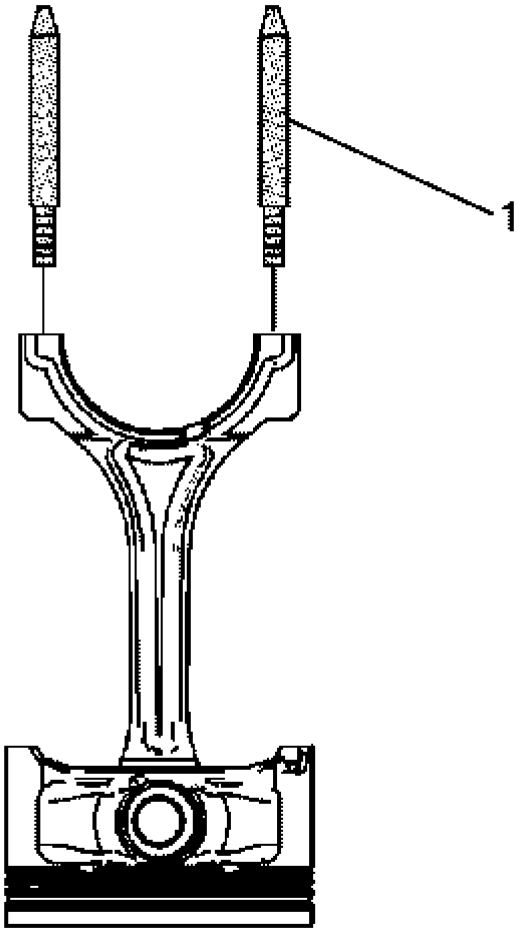


Fig. 174: View Guide Set
Courtesy of GENERAL MOTORS CORP.

4. Install the **J 41556:** guide set (1) into the connecting rod bolt holes.

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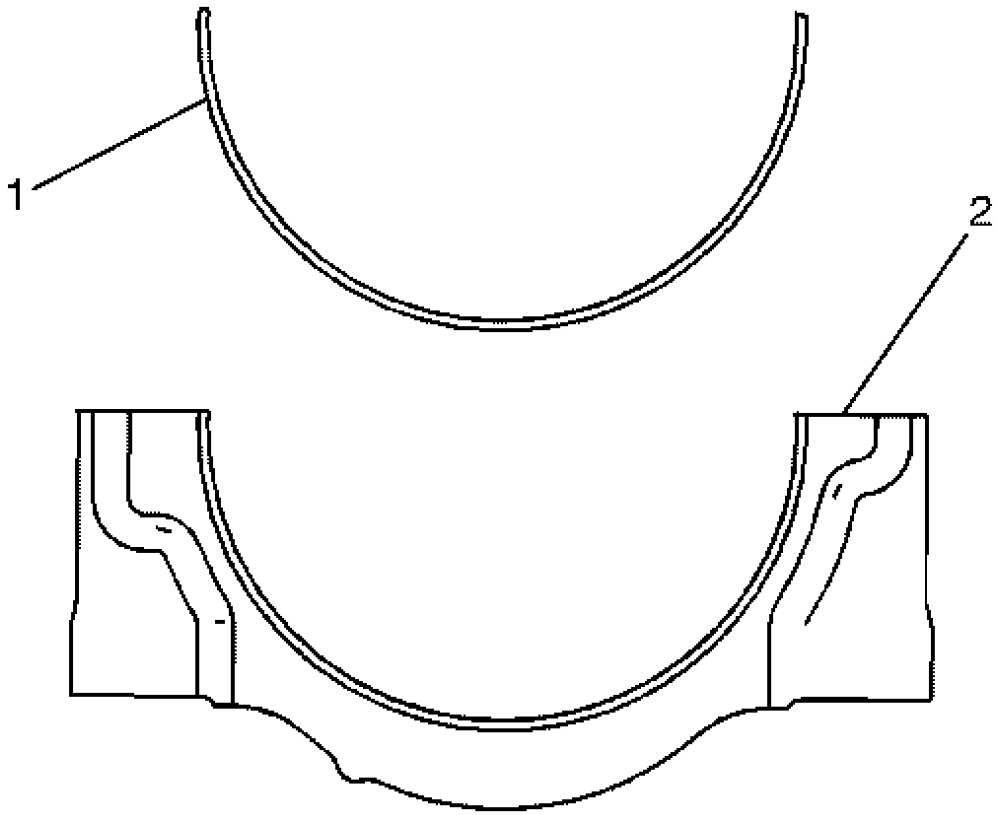


Fig. 175: Identifying Lower Connecting Rod Bearings & Connecting Rod Cap
Courtesy of GENERAL MOTORS CORP.

5. Install new lower connecting rod bearings (1) into position in the connecting rod cap (2). Roll the connecting rod bearings (1) into position so that the lock tang engages the alignment slot. The bearings must fit flush with the connecting rod cap (2).

CAMSHAFT BEARING REMOVAL

Special Tools

J 33049: Camshaft Bearing Service Set

For equivalent regional tools, refer to **Special Tools** .

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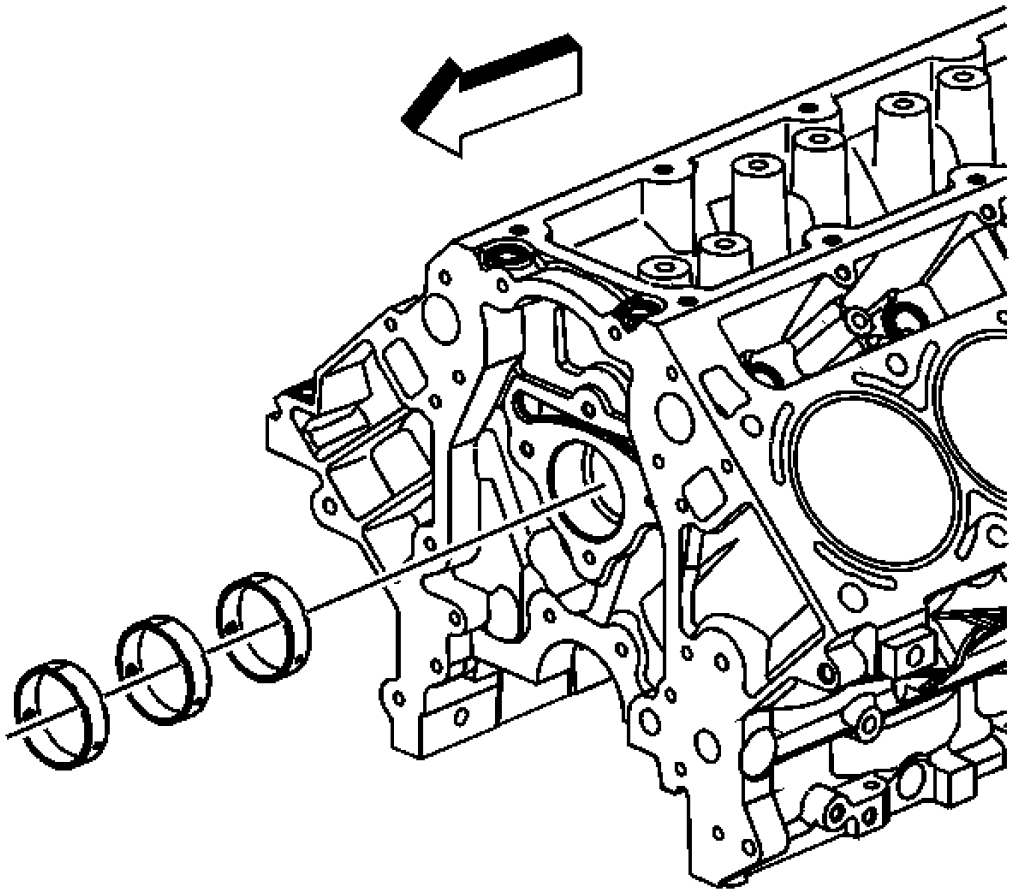


Fig. 176: Camshaft Bearings
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: A loose camshaft bearing may be caused by an enlarged, out of round, or damaged engine block bearing bore.

1. Prior to bearing removal, inspect the camshaft bearings for loose fit in the engine block bearing bores. Refer to **Camshaft and Bearings Cleaning and Inspection (without variable valve timing)** or **Camshaft and Bearings Cleaning and Inspection (with variable valve timing)**.
2. Repair or replace the components, as required.

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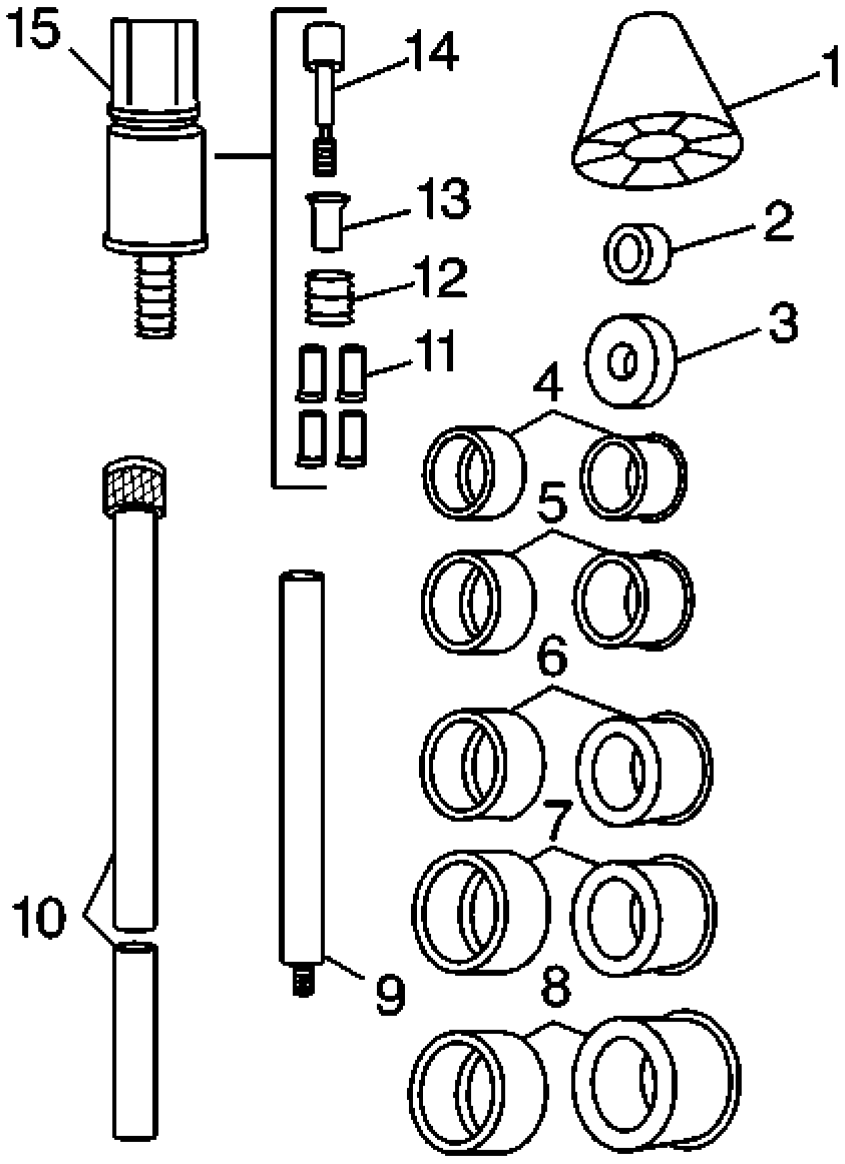


Fig. 177: View Of J 33049 Camshaft Bearing Service Kit Components
Courtesy of GENERAL MOTORS CORP.

3. Select the expanding driver (4-8) and washer (2 or 3) from the **J 33049:** service set.
4. Assemble the tool.
5. Insert the tool through the front of the engine block and into the bearing.

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6. Tighten the expander assembly (15) nut until snug.
7. Push the guide cone (1) into the front camshaft bearing in order to align the tool.

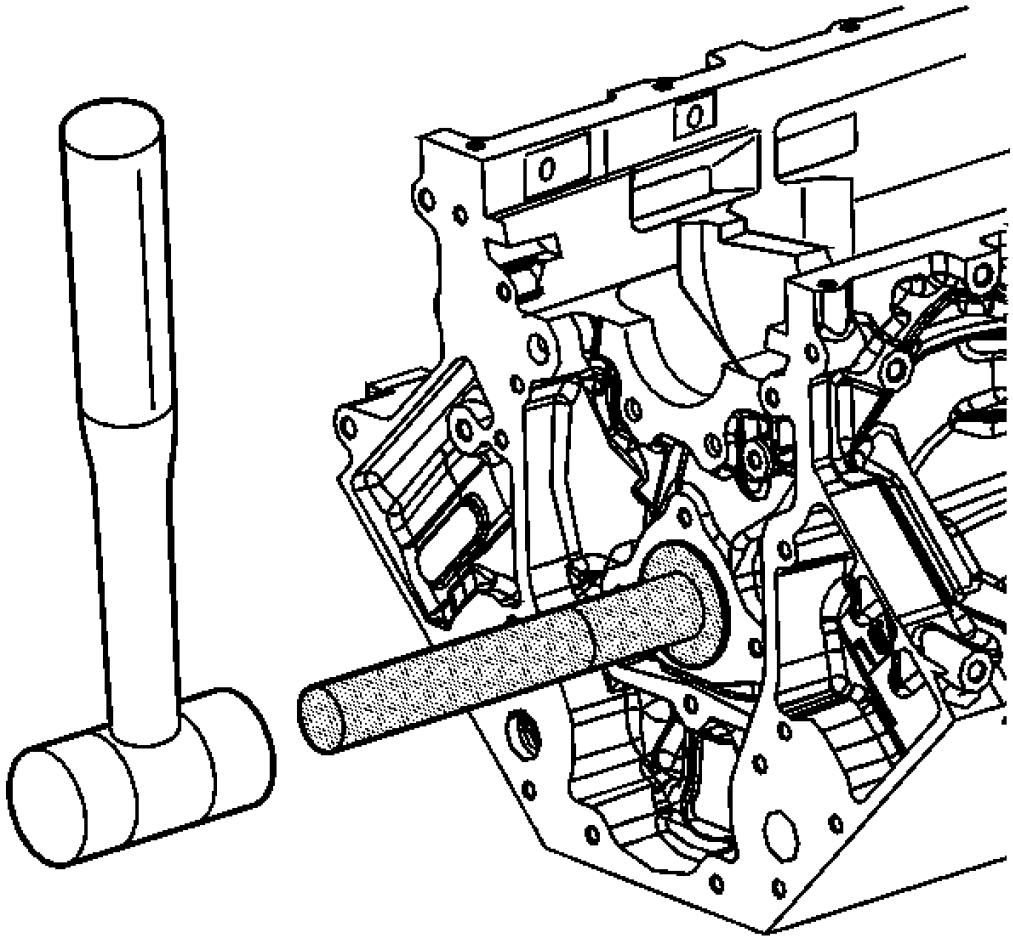


Fig. 178: Driving Bearing Out Of Or Into Engine Block
Courtesy of GENERAL MOTORS CORP.

8. Drive the bearing from the block bore.

IMPORTANT: In order to remove the inner camshaft bearings, operate the tool from either end of the block, using the driver bar extension and the guide cone in the front or rear camshaft bearing bore.

9. Repeat the above procedures in order to remove the remaining bearings.

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TOOL USAGE INFORMATION

Bearing, Expander, and Expander Driver Information

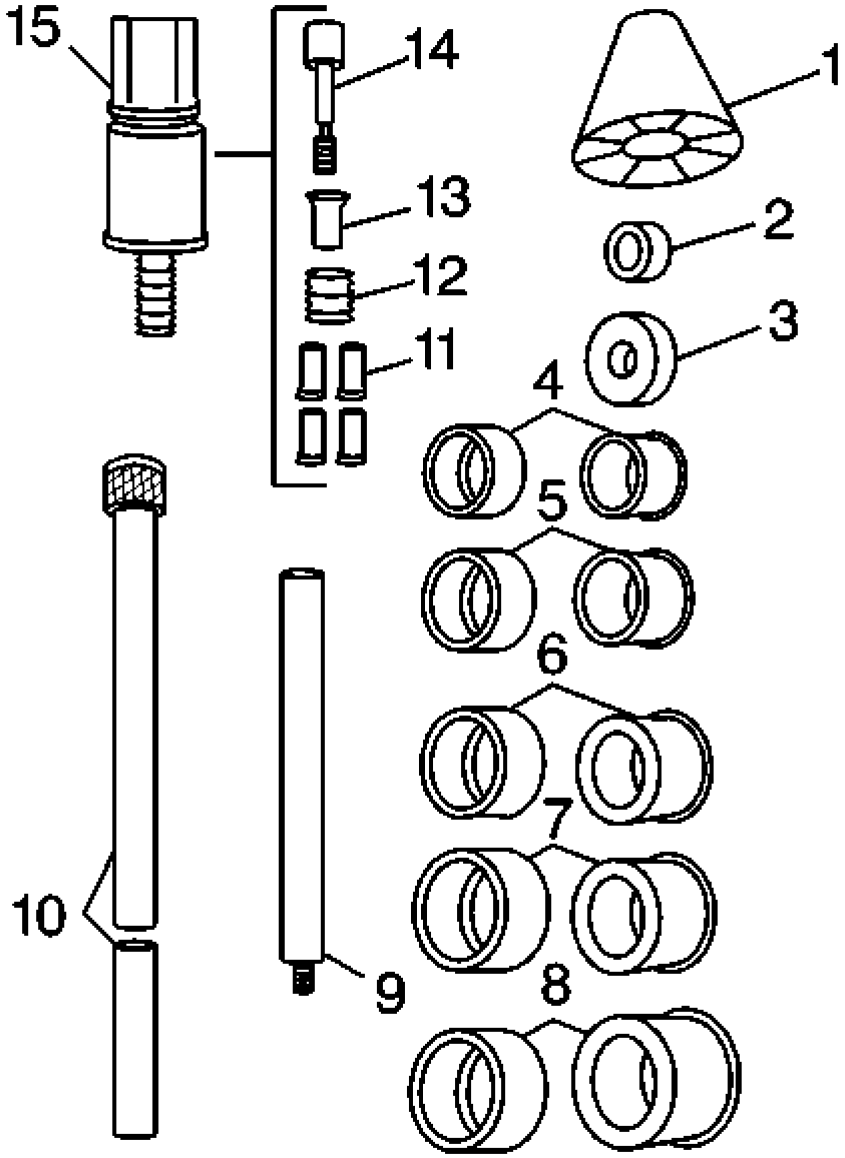


Fig. 179: View Of J 33049 Camshaft Bearing Service Kit Components
Courtesy of GENERAL MOTORS CORP.

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- The tool consists of a guide cone (1), driving washers (2 or 3), expander bearing drivers (4-8), driver bars (9 or 10), expander jaws (11), expander sleeve (12), expander cone (13), expander shaft (14), and expander assembly (15).

NOTE: The expander bearing drivers (4-8) in the J 33049: service set are stamped with a number (1-5) to assist in identifying the appropriate diameter driver.

- Expander assembly (15) is used as a driver for the bearing when inside diameter is 28.575-37.465 mm (1.125-1.475 in) and is used with the small washer.
- Expander bearing driver number 1 inside diameter is 37.465-43.18 mm (1.475-1.7 in) and is used with the expander assembly (15) and the small washer.
- Expander bearing driver number 2 inside diameter is 43.18-48.895 mm (1.7-1.925 in) and is used with the expander assembly (15) and the large washer.
- Expander bearing driver number 3 inside diameter is 48.895-54.61 mm (1.925-2.15 in) and is used with the expander assembly (15) and the large washer.
- Expander bearing driver number 4 inside diameter is 54.61-60.325 mm (2.150-2.375 in) and is used with expander assembly (15) and the large washer.
- Expander bearing driver number 5 inside diameter is 60.325-68.326 mm (2.375-2.69 in) and is used with expander assembly (15) and the large washer.

Tool Assembly and Operation

1. Select the proper expanding driver and washer from the expanding driver and washer information.

IMPORTANT: To install or remove the expanding driver, always push on or pull from the ends.
Pressure on the outside diameter may cause a bind against the rubber expanding sleeve.

2. Place the expanding driver onto the expander assembly.
3. Ensure the separation lines between the segments of the expanding driver align with the separation lines of the expander assembly.
4. With the small end of the cone facing the driver assembly, place the guide cone over the driving bar.
5. Place the driving washer over the threaded portion of the expander assembly.
6. Screw the expander assembly, with driving washer, onto the driving bar.

For removal of the inner bearings, it may be necessary to install the driver bar extension.

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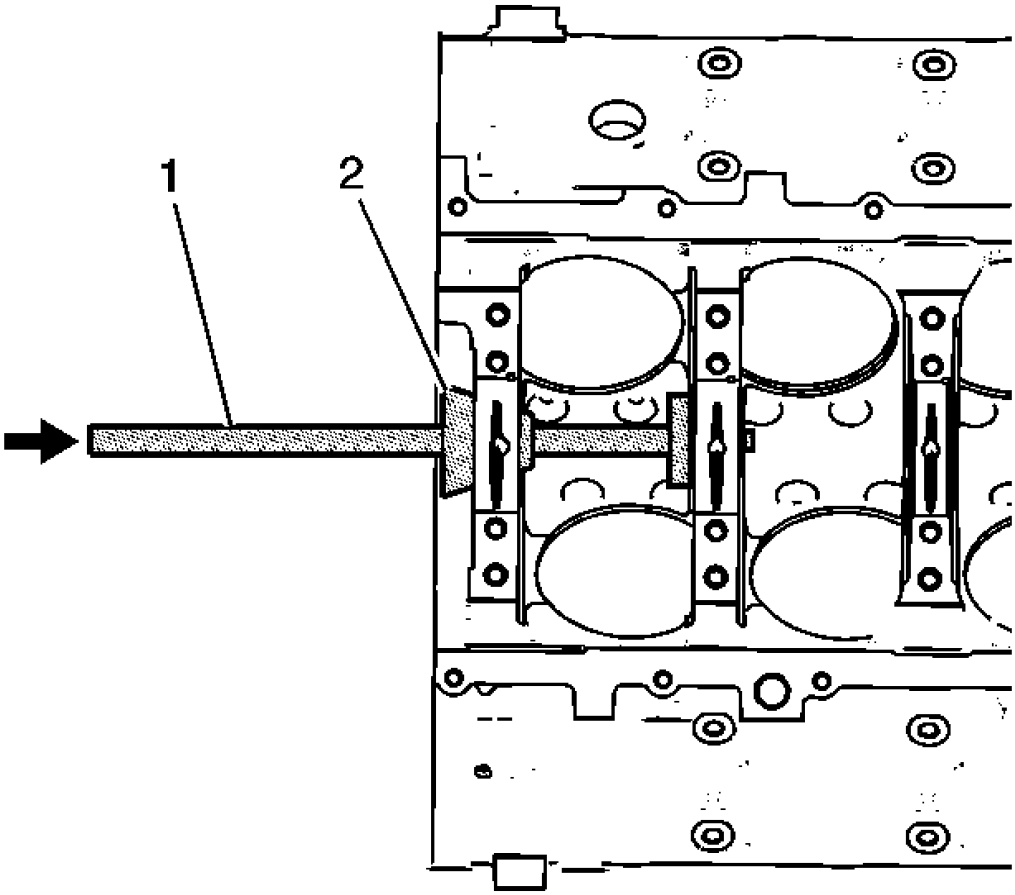


Fig. 180: Driving Bearing Out Of Or Into Engine Block
Courtesy of GENERAL MOTORS CORP.

7. Insert the tool (1) into an inner camshaft bearing and tighten until snug.

   Operate the tool from the front or rear of the engine block.

   On some engine blocks, the nut on the expander assembly is inaccessible, except from either end. In this case, you must use a socket and extension to enlarge and reduce the expander assembly.

8. Slide the nylon cone (2) into the front or rear camshaft bearing. This will properly align the tool.
9. Drive the bearing out of or into the engine block.
10. Repeat the procedure for the additional inner bearings.

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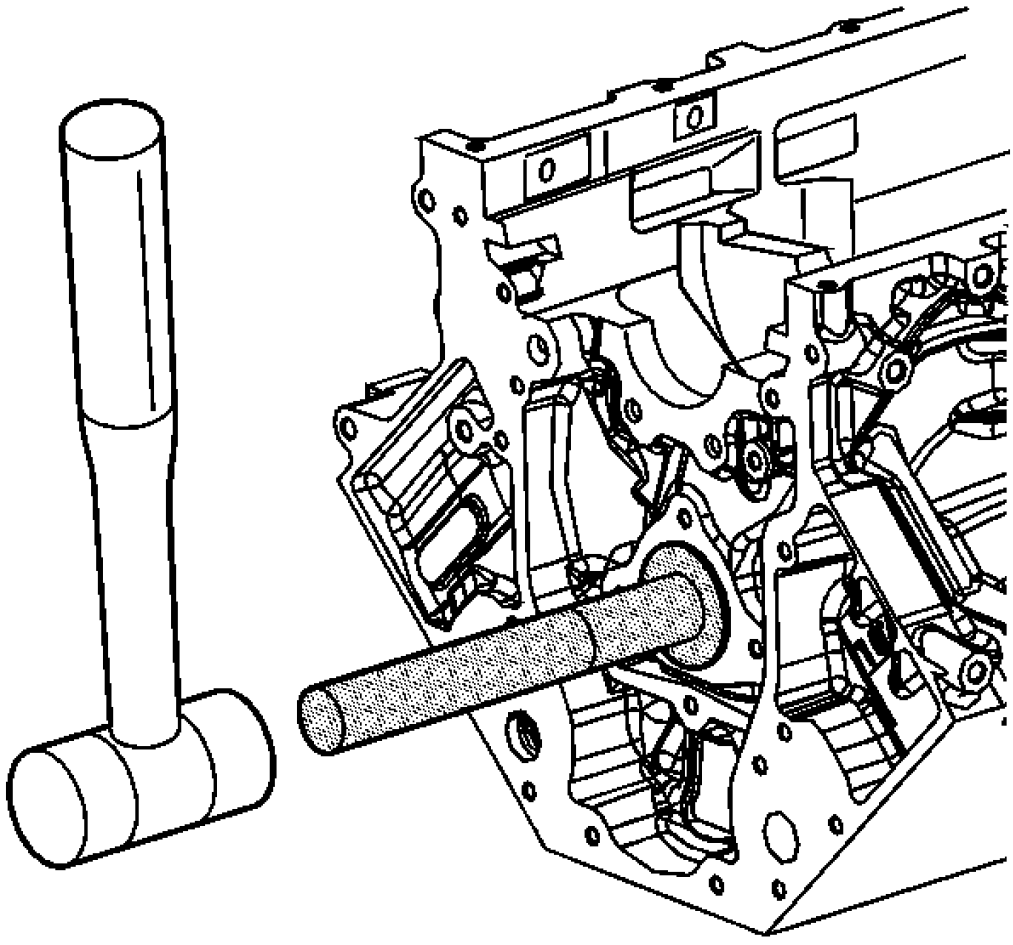


Fig. 181: Driving Bearing Out Of Or Into Engine Block
Courtesy of GENERAL MOTORS CORP.

11. For the end bearings, front, position number 1, and the rear, position number 5, remove the nylon cone and driver bar extension.
12. Drive the bearings out of or into the engine block.

CAMSHAFT AND BEARINGS CLEANING AND INSPECTION (WITHOUT VARIABLE VALVE TIMING)

Special Tools

- **J 7872:** Magnetic Base Dial Indicator Set

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- **J 8520:** Camshaft Lobe Lift Indicator

For equivalent regional tools, refer to **Special Tools** .

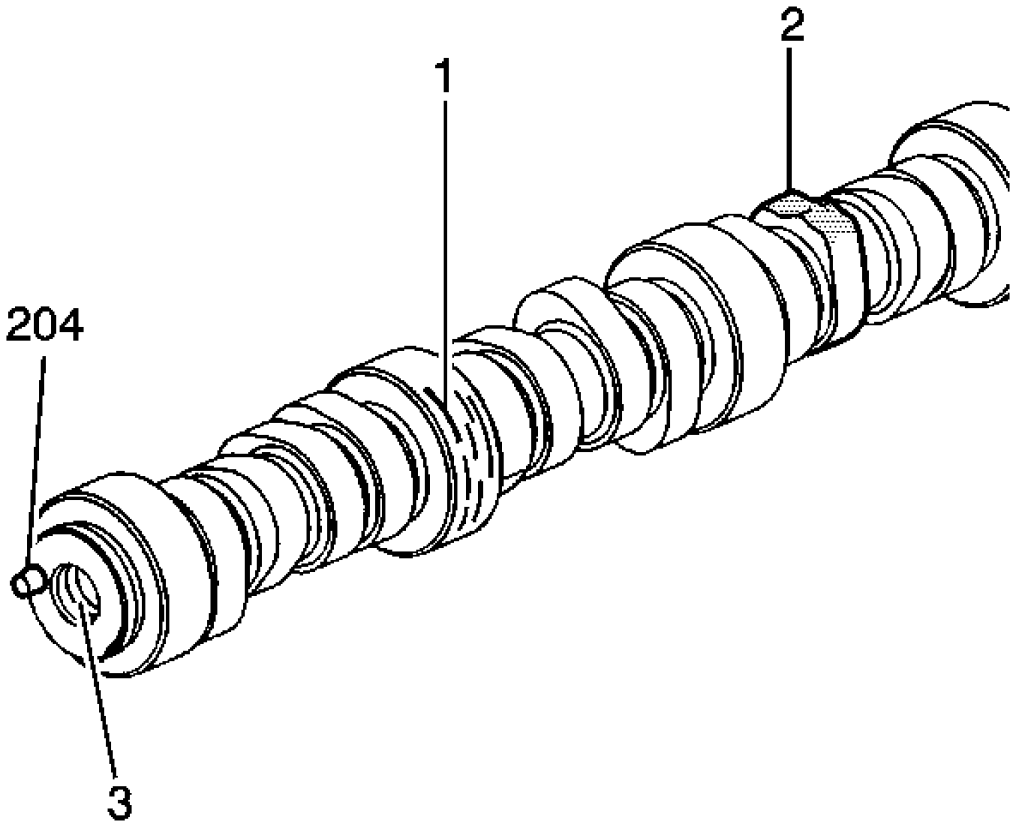


Fig. 182: Identifying Camshaft Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Clean the components in solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the components with compressed air.
3. Inspect the camshaft bearing journals (1) for scoring or excessive wear.
4. Inspect the camshaft valve lifter lobes (2) for scoring or excessive wear.
5. Inspect the threaded bolt hole (3) in the front of the camshaft for damaged threads or debris.

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6. Inspect the camshaft sprocket pin (204) for damage.
7. Inspect the camshaft retainer plate for wear or a damaged sealing gasket.

   If the camshaft retainer plate sealing gasket is not cut or damaged, it may be used again.

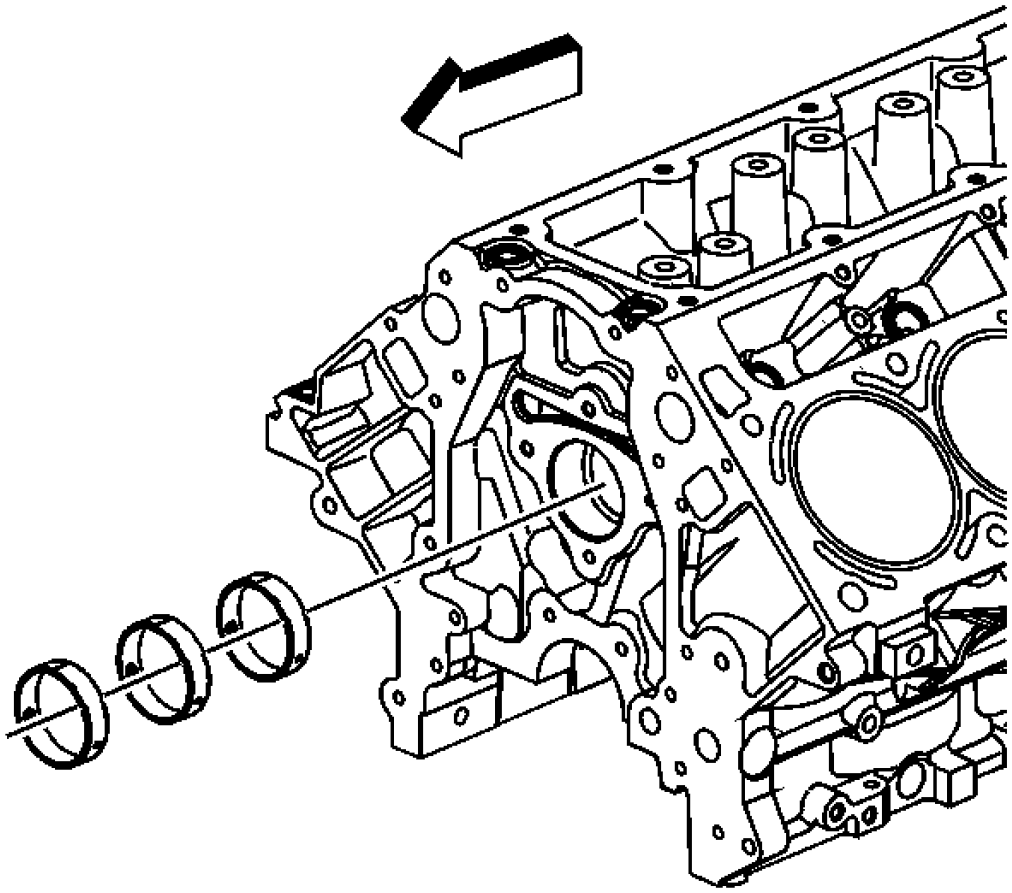


Fig. 183: Camshaft Bearings
Courtesy of GENERAL MOTORS CORP.

8. Inspect the camshaft bearings for the following conditions:
   - Excessive wear, evidence of galling, pitting, scoring, or embedded debris. The appearance of the bearing material being different shades of gray are considered normal, and are not a guideline for bearing replacement. Measure the bearing inside diameter (ID) as required for an over-sized condition. Refer to **Engine Mechanical Specifications (6.2L LS3)** **Engine Mechanical Specifications (6.2L L99)** .
   - Proper fit in the engine block. Camshaft bearings have an interference fit to the engine block and

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should not be loose in the engine block bearing bores.

- The oil lubrication feed hole in the bearing must be in alignment with the drilled oil passage in the block.
- The oil lubrication feed hole is not plugged by debris.
- Bearings with excessive wear, galling, pitting, scoring, or embedded debris must be replaced.

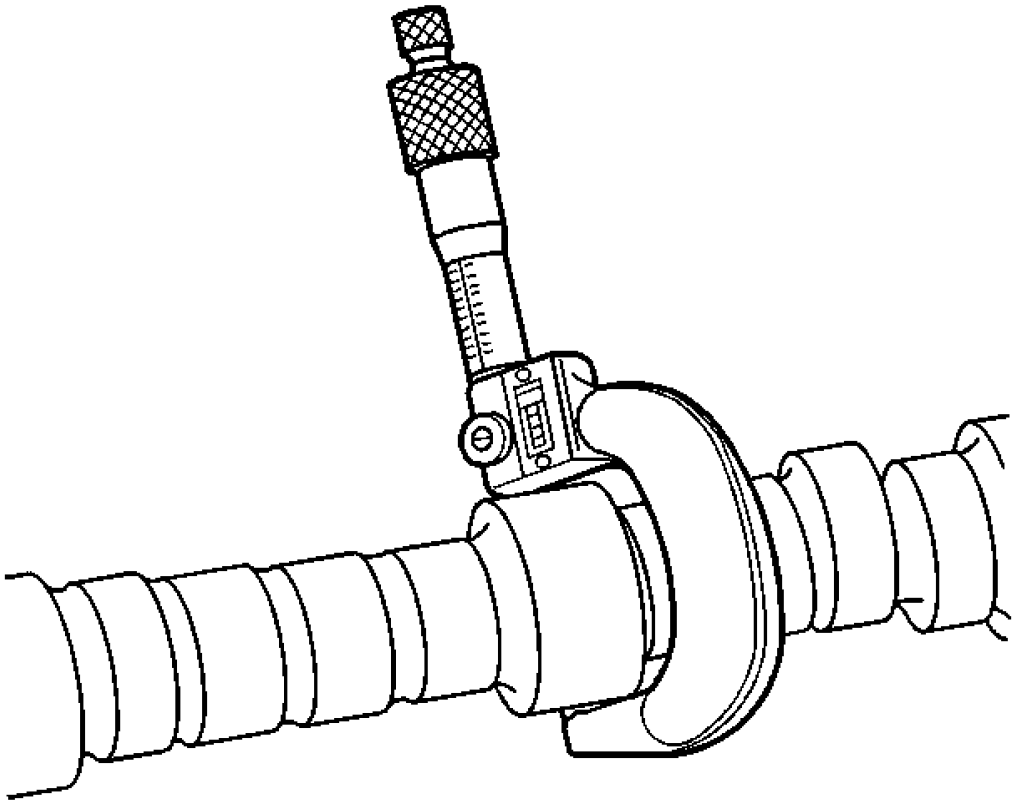


Fig. 184: Measuring Camshaft Journals
Courtesy of GENERAL MOTORS CORP.

9. Using a micrometer, measure the camshaft journals for wear and out-of-round. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .
   - If the camshaft bearing journals are out-of-round, replace the camshaft.
   - If the camshaft bearing journal diameter is not within specification, replace the camshaft.

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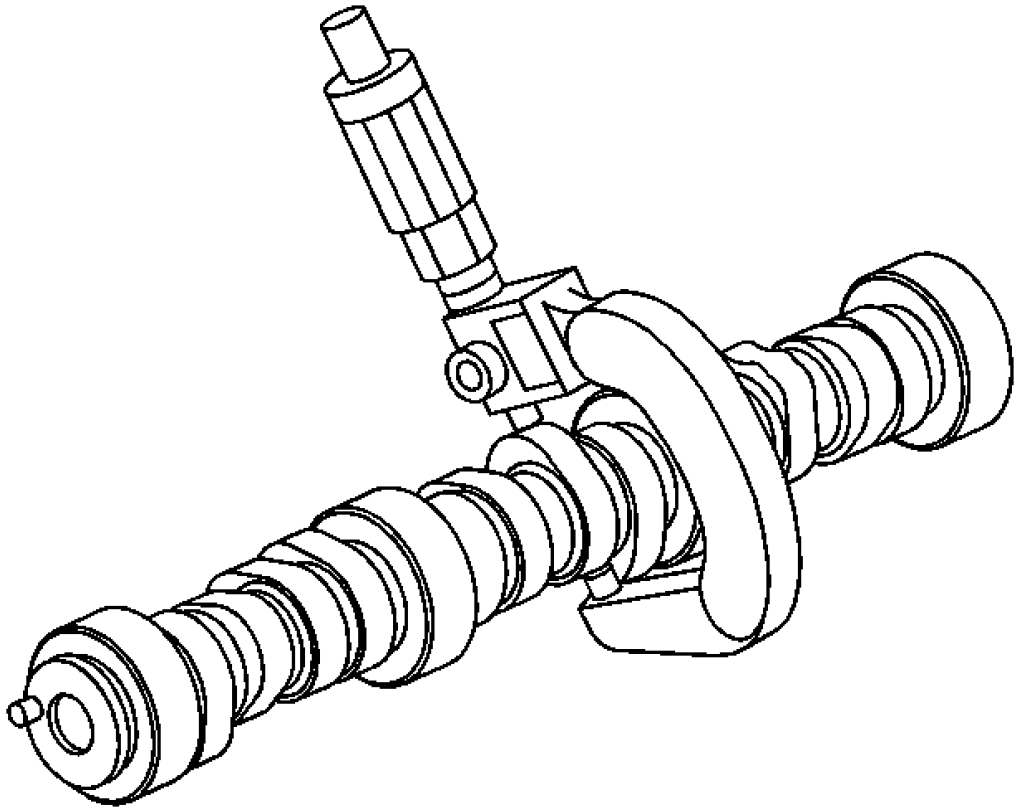


Fig. 185: Measuring Camshaft Lobes
Courtesy of GENERAL MOTORS CORP.

10. Using a micrometer, measure the camshaft lobes for wear. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

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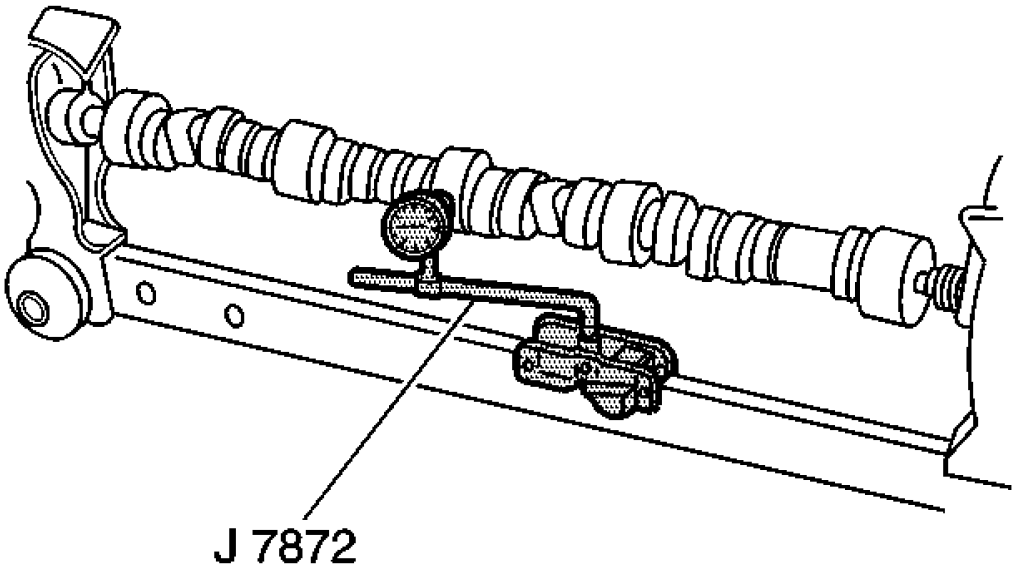
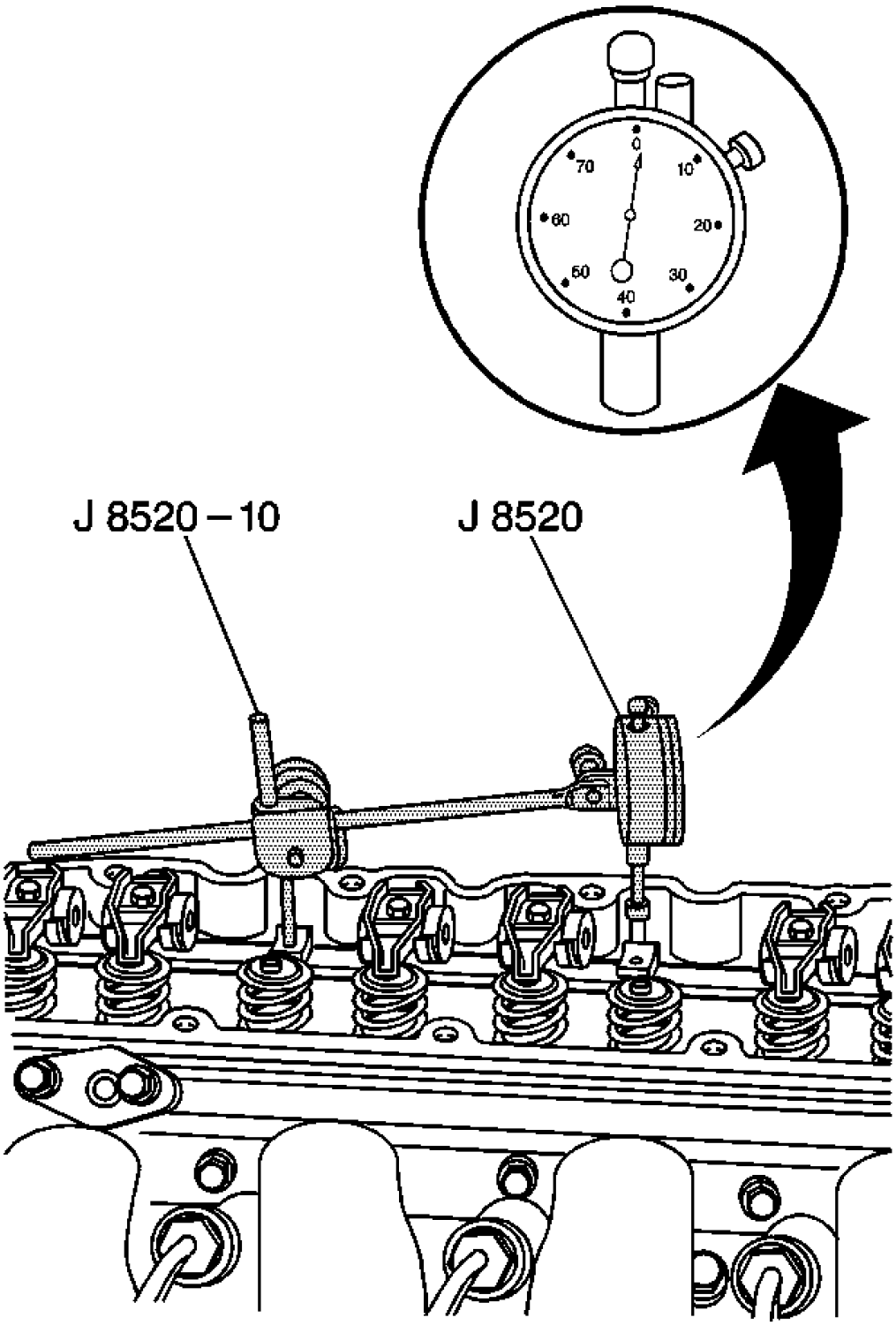


Fig. 186: Measuring Camshaft Runout
Courtesy of GENERAL MOTORS CORP.

11. Measure the camshaft runout.
    1. Mount the camshaft in wooden V-blocks or between centers on a fixture.
    2. Using the **J 7872:** indicator , measure the runout of the intermediate camshaft bearing journals.
    3. If camshaft runout is not within specification, the camshaft is bent and should be replaced. Refer to **Engine Mechanical Specifications (6.2L LS3)** **Engine Mechanical Specifications (6.2L L99)** .

MEASURING CAMSHAFT LOBE LIFT

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Fig. 187: Measuring Camshaft Lobe Lift
Courtesy of GENERAL MOTORS CORP.

NOTE: Measuring camshaft lobe lift is a procedure used to determine if the camshaft lobes have worn. This test is to be performed prior to engine disassembly and with the camshaft and valve train components installed in the engine.

1. Using the **J 8520** , measure camshaft lobe lift. See **Special Tools** .
2. Remove the valve rocker arms and bolts.
3. Install the dial indicator mounting stud into the valve rocker arm bolt hole.
4. Assemble the components of the **J 8520:** indicator and position onto the stud.
5. Position the shaft of the dial indicator onto the end of the pushrod.
6. Rotate the face of the dial indicator to zero.
7. Slowly rotate the crankshaft clockwise, until the dial indicator obtains its highest and lowest readings.
8. Compare the total to specifications. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** . The total lobe lift is the difference between the highest and lowest reading.

CAMSHAFT AND BEARINGS CLEANING AND INSPECTION (WITH VARIABLE VALVE TIMING)

Special Tools

- **J 7872:** Magnetic Base Dial Indicator Set
- **J 8520:** Camshaft Lobe Lift Indicator

For equivalent regional tools, refer to **Special Tools**

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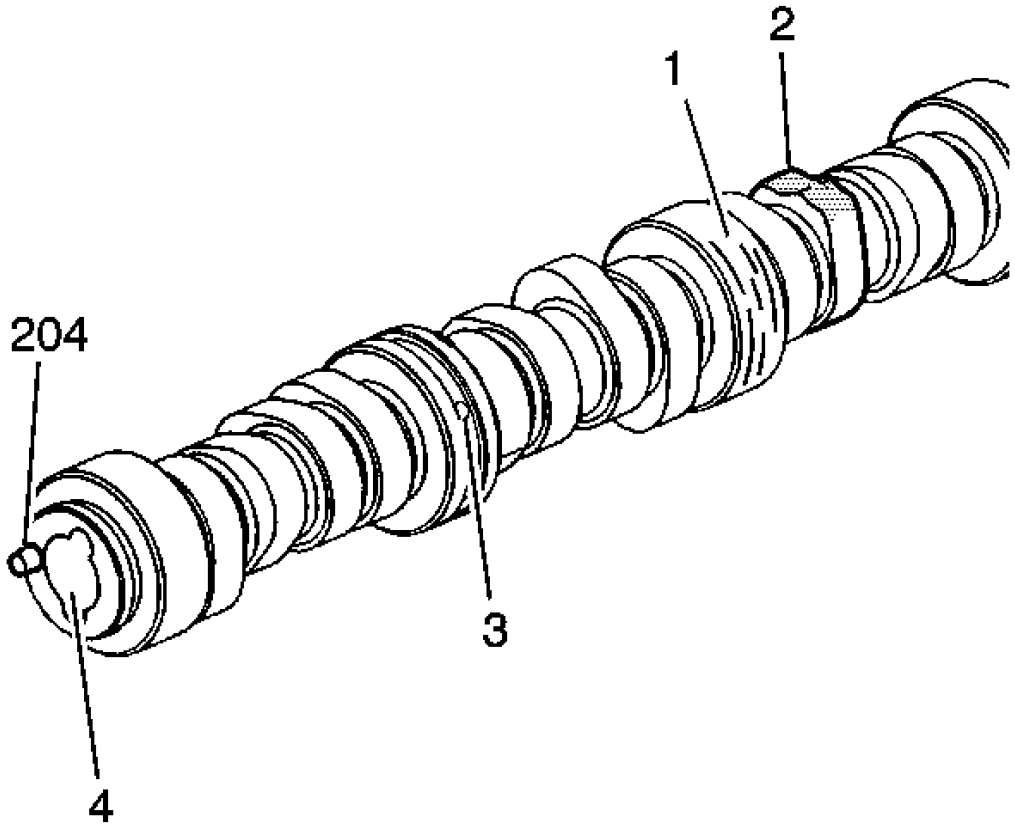


Fig. 188: View Of Camshaft Inspection Points
Courtesy of GENERAL MOTORS CORP.

1. Clean the components in solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning

2. Dry the components with compressed air.
3. Inspect the camshaft bearing journals (1) for scoring or excessive wear.
4. Inspect the camshaft valve lifter lobes (2) for scoring or excessive wear.
5. Inspect the camshaft position (CMP) actuator oil passages (3) for restrictions.
6. Inspect the threaded bolt hole (4) in the front of the camshaft for damaged threads or debris.
7. Inspect the camshaft sprocket pin (204) for damage.
8. Inspect the camshaft retainer plate for wear or a damaged sealing gasket.

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If the camshaft retainer plate sealing gasket is not cut or damaged, it may be used again.

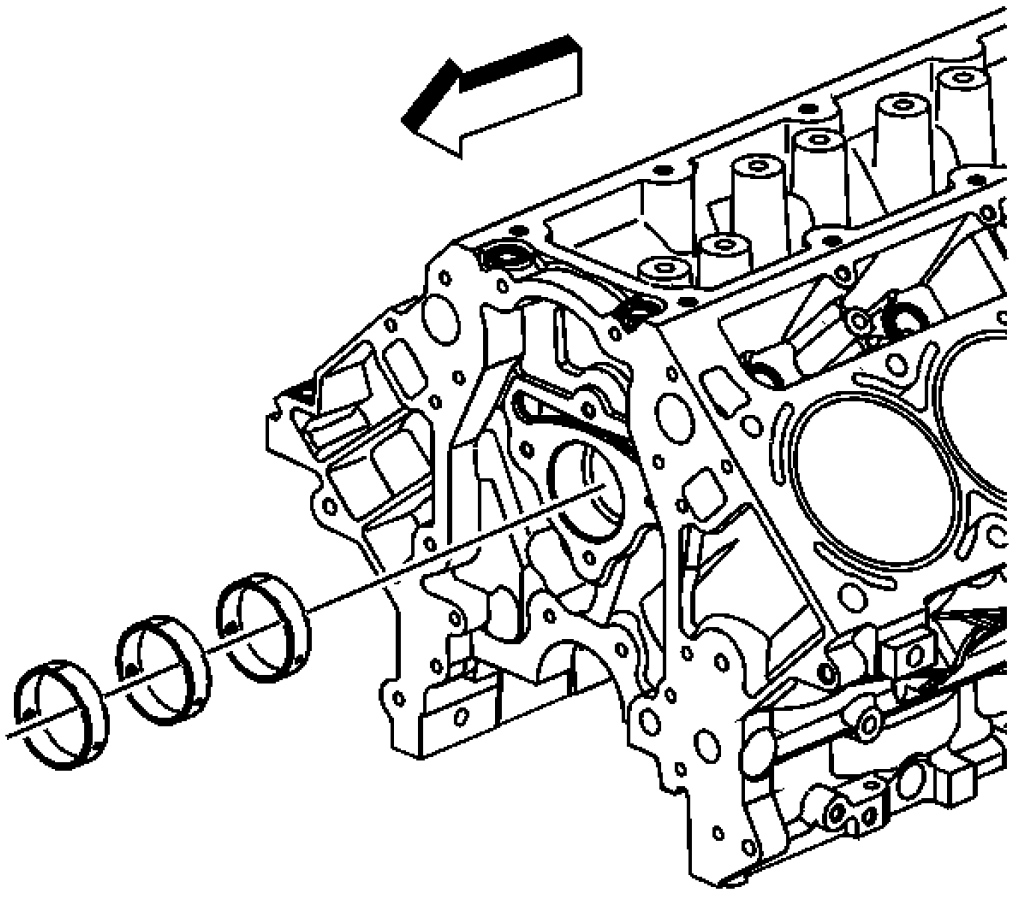


Fig. 189: Camshaft Bearings
Courtesy of GENERAL MOTORS CORP.

9. Inspect the camshaft bearings for the following:
   - Excessive wear, evidence of galling, pitting, scoring, or embedded debris. The appearance of the bearing material being different shades of gray are considered normal, and are not guideline for bearing replacement. Measure the bearing inside diameter (ID) as required for an over-sized condition. Refer to **Engine Mechanical Specifications (6.2L LS3)** **Engine Mechanical Specifications (6.2L L99)** .
   - Proper fit in the engine block. Camshaft bearings have an interference fit to the engine block and should not be loose in the engine block bearing bores.
   - The oil lubrication feed hole in the bearing must be in alignment with the drilled out passage in the block.

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- The oil lubrication feed hole is not plugged by debris.
- Bearings with excessive wear or scoring must be replaced.
- Bearings with excessive wear, galling, pitting, scoring, or embedded debris must be replaced.

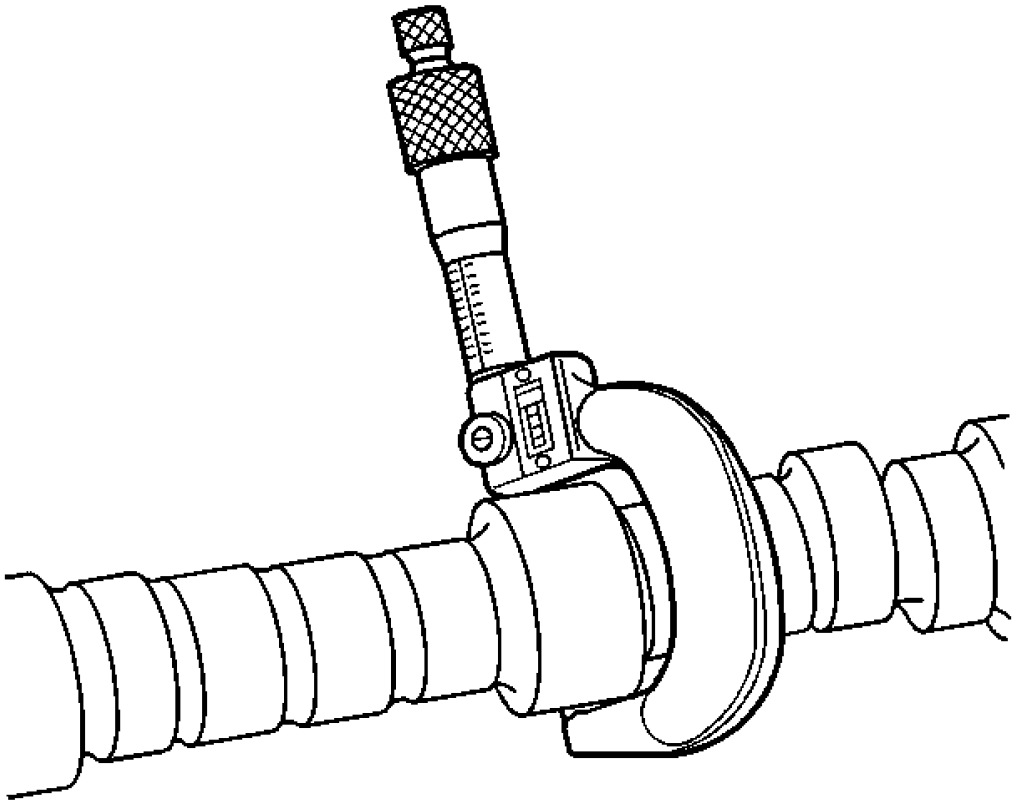


Fig. 190: Measuring Camshaft Journals
Courtesy of GENERAL MOTORS CORP.

10. Using a micrometer, measure the camshaft journals for wear and out-of-round. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .
    - If the camshaft bearing journals are out-of-round, replace the camshaft.
    - If the camshaft bearing journal diameter is not within specification, replace the camshaft.

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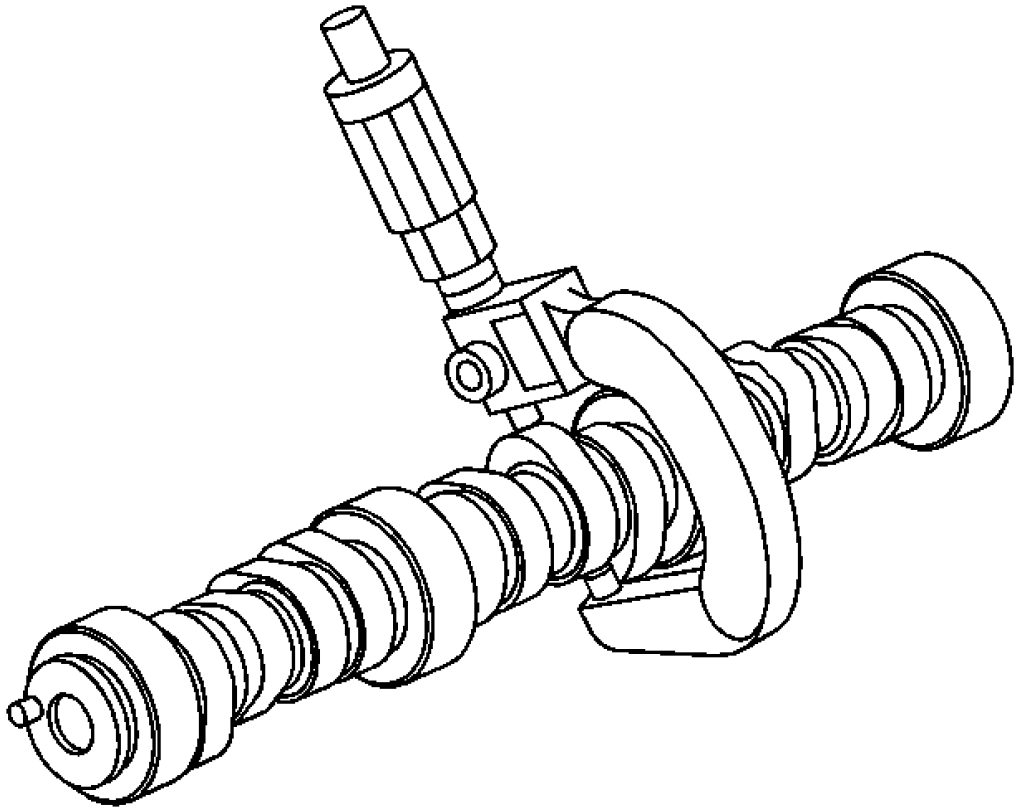


Fig. 191: Measuring Camshaft Lobes
Courtesy of GENERAL MOTORS CORP.

11. Using a micrometer, measure the camshaft lobes for wear. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

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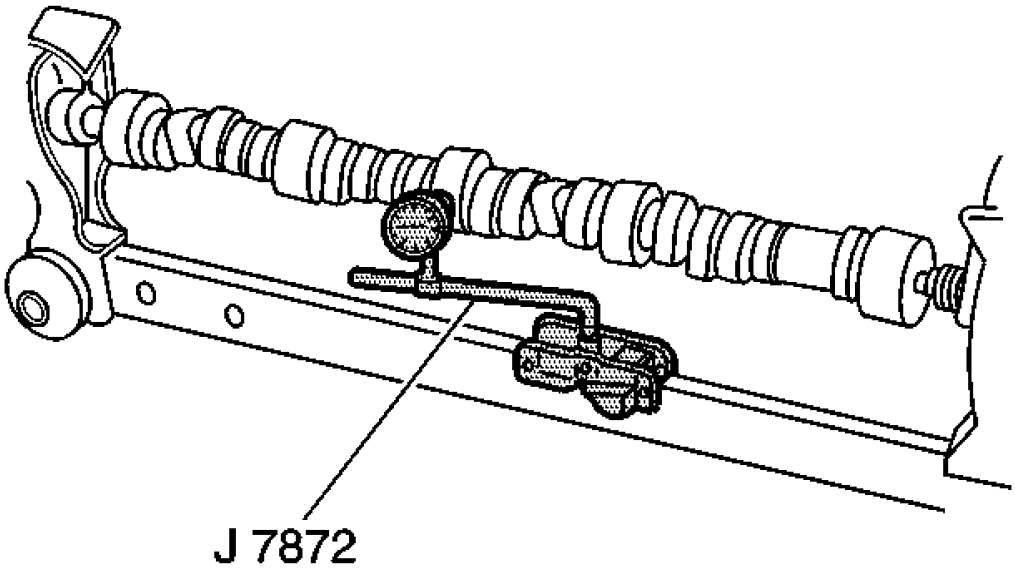
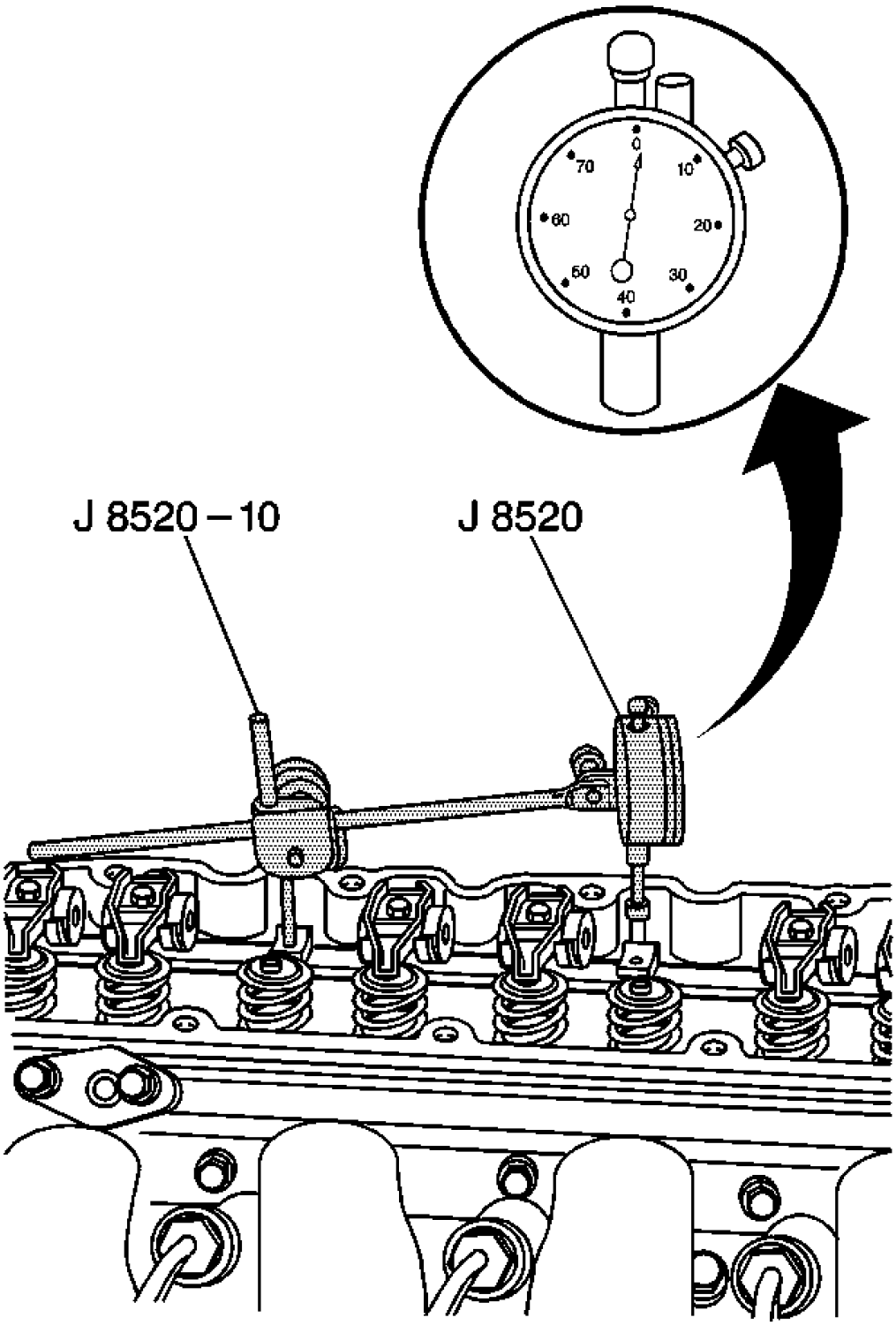


Fig. 192: Measuring Camshaft Runout
Courtesy of GENERAL MOTORS CORP.

12. Measure the camshaft runout.
    1. Mount the camshaft in wooden V-blocks or between centers on a fixture.
    2. Using the **J 7872:** set , measure the runout of the intermediate camshaft bearing journals.
    3. If camshaft runout is not within specification, the camshaft is bent and should be replaced. Refer to **Engine Mechanical Specifications (6.2L LS3)** **Engine Mechanical Specifications (6.2L L99)** .

MEASURING CAMSHAFT LOBE LIFT

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Fig. 193: Measuring Camshaft Lobe Lift
Courtesy of GENERAL MOTORS CORP.

NOTE: Measuring camshaft lobe lift is a procedure used to determine if the camshaft lobes have worn. This test is to be performed prior to engine disassembly and with the camshaft and valve train components installed in the engine.

1. Using the **J 8520:** indicator, measure camshaft lobe lift.
2. Remove the valve rocker arms and bolts.
3. Install the dial indicator mounting stud into the valve rocker arm bolt hole.
4. Assemble the components of the **J 8520:** indicator and position onto the stud.
5. Position the shaft of the dial indicator onto the end of the pushrod.
6. Rotate the face of the dial indicator to zero.
7. Slowly rotate the crankshaft clockwise, until the dial indicator obtains its highest and lowest readings.
8. Compare the total to specifications. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** . The total lobe lift is the difference between the highest and lowest reading.

CAMSHAFT BEARING INSTALLATION

Special Tools

J 33049: Camshaft Bearing Service Set

For equivalent regional tools, refer to **Special Tools** .

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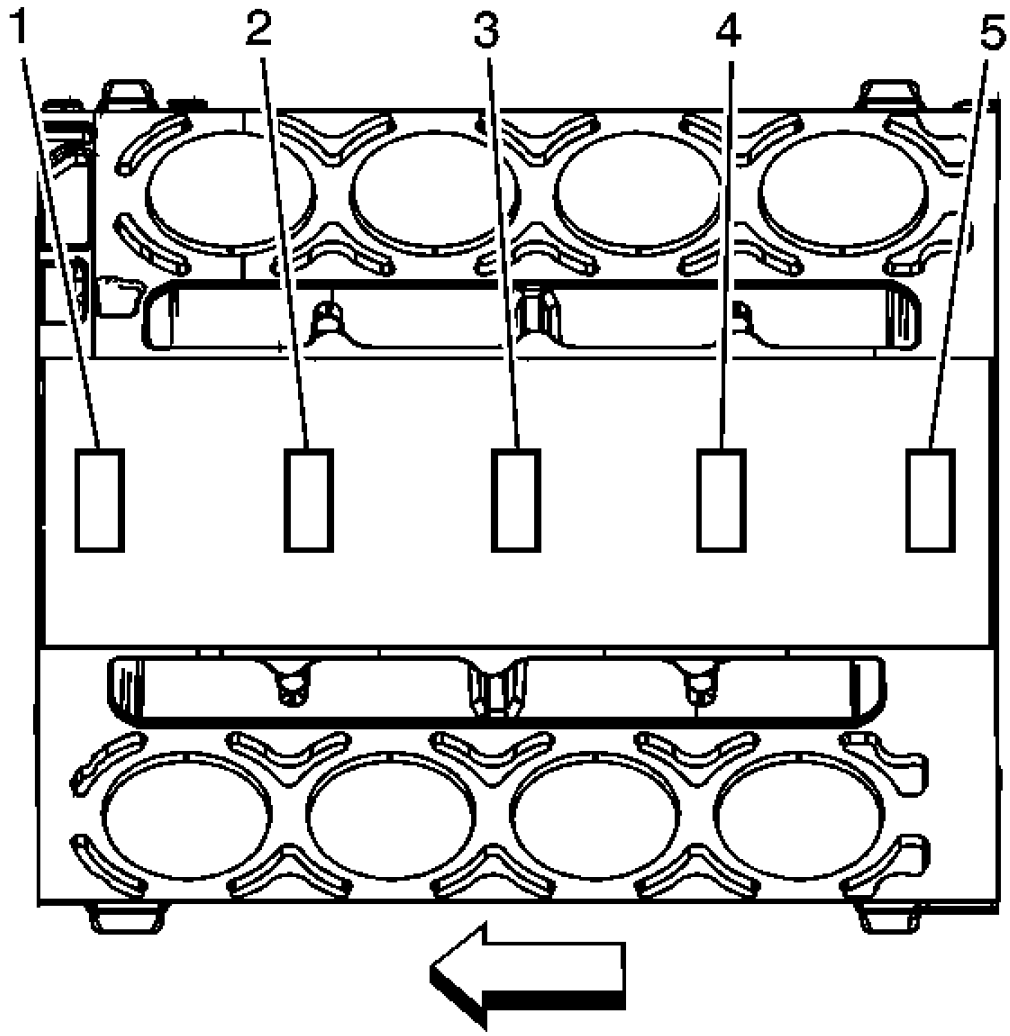


Fig. 194: Identifying Engine Block Camshaft Bearing Bores
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The engine block camshaft bearing bores are machined for 3 different outside diameter (OD) size bearings. Position 1 and 5 are the largest diameter bores. Position 3 is the smallest diameter bore. Position 2 and 4 are the intermediate size bores. The inside diameter (ID) for all camshaft bearings is the same size.

1. Measure the engine block camshaft bearing bores (1-5) in order to identify the correct OD size bearing for each position. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical**

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Specifications (6.2L L99) .

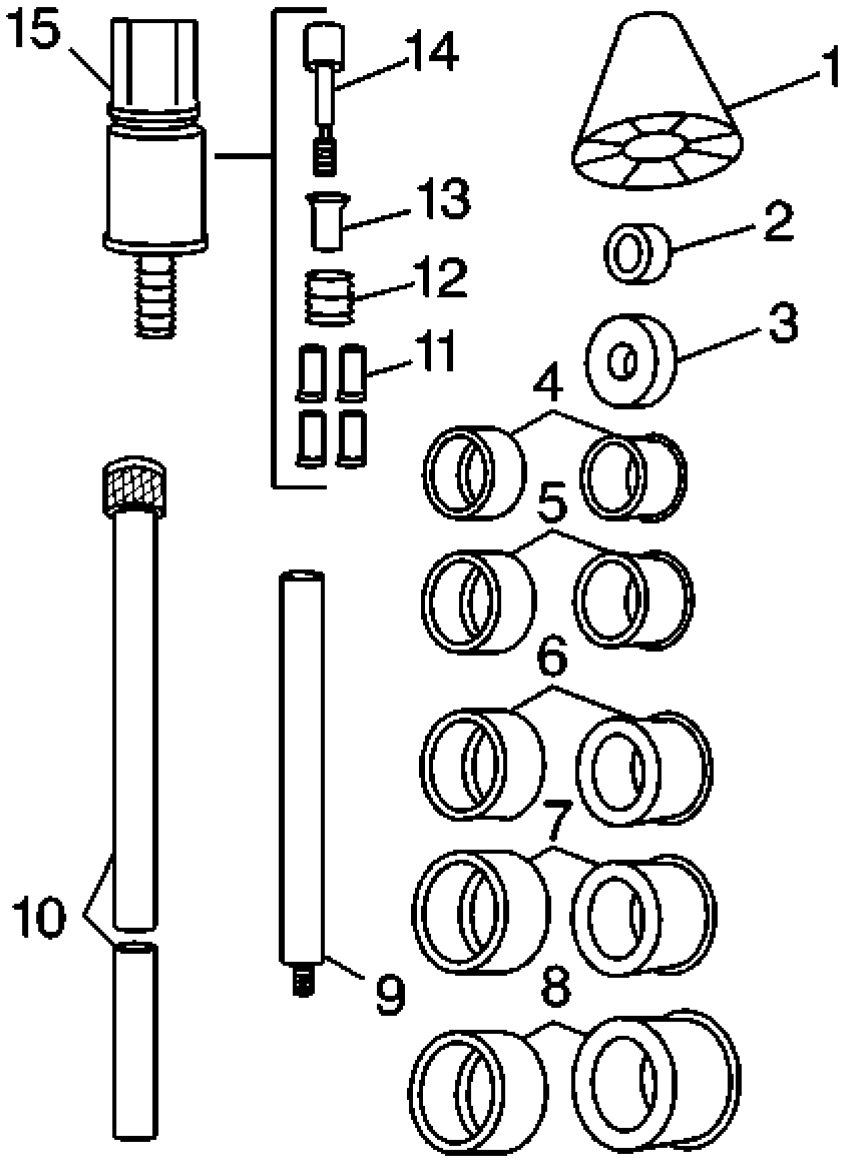


Fig. 195: View Of J 33049 Camshaft Bearing Service Kit Components
Courtesy of GENERAL MOTORS CORP.

2. Select the expanding driver (4-8) and washer (2 or 3) from the **J 33049:** service set. Refer to tool usage information in **Camshaft Bearing Removal**.

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3. Assemble the tool.

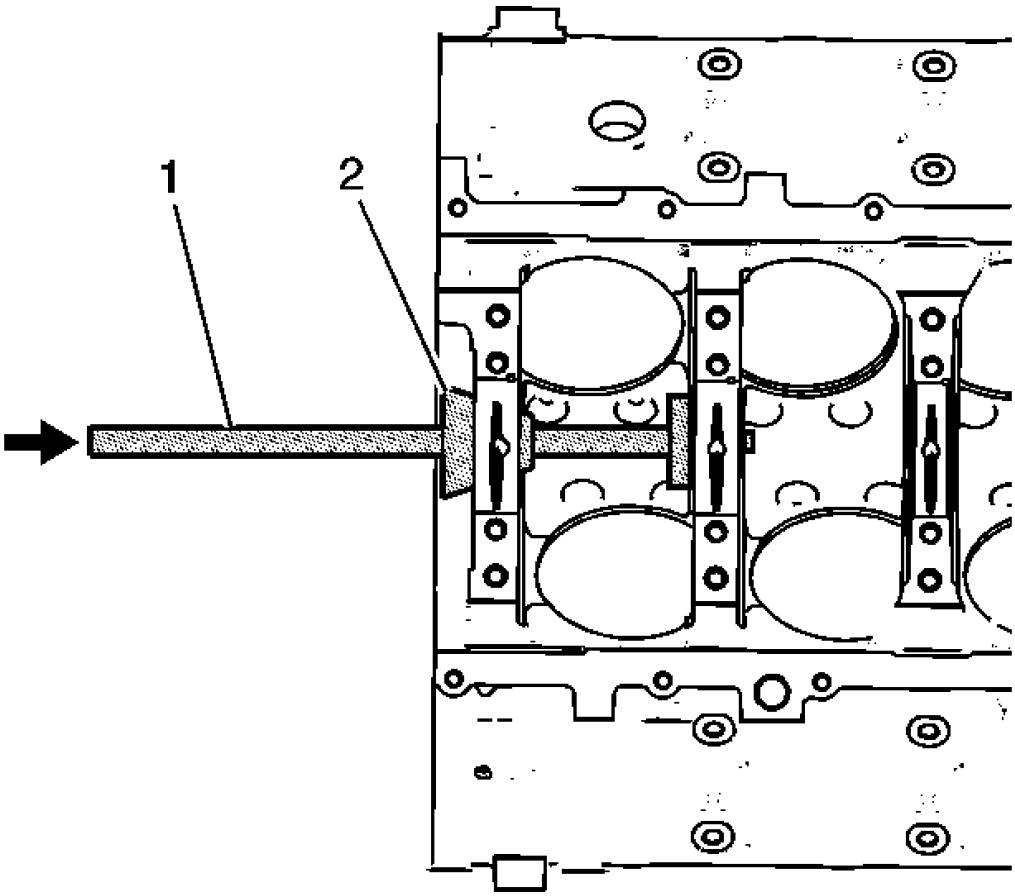


Fig. 196: Driving Bearing Out Of Or Into Engine Block
Courtesy of GENERAL MOTORS CORP.

4. Insert the tool (1) through the front or rear of the engine block and into the bearing. For installation of inner bearings, it may be necessary to install the driver bar extension.
5. Tighten the expander assembly nut until snug.
6. Push the guide cone (2) into the front camshaft bearing in order to align the tool.

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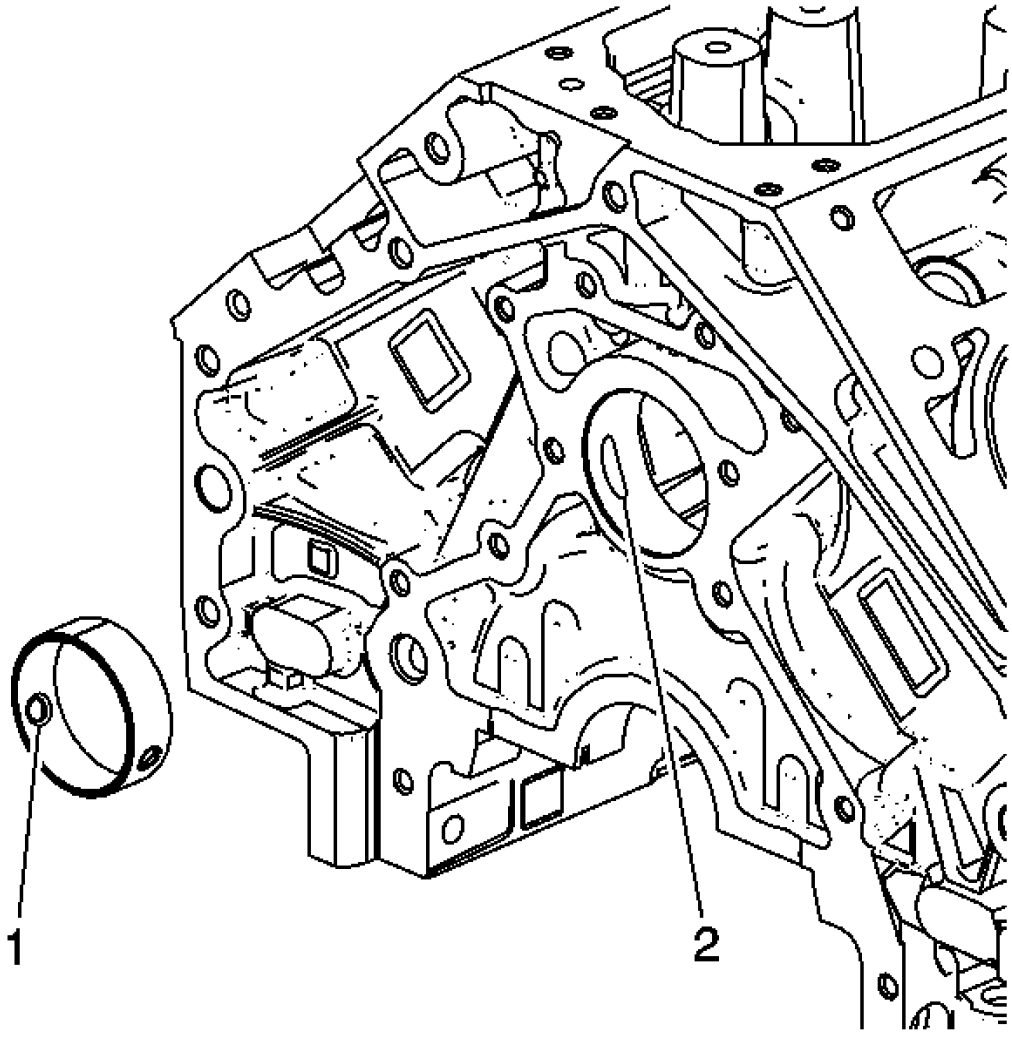


Fig. 197: Positioning Camshaft Bearing With Oil Feed Hole
Courtesy of GENERAL MOTORS CORP.

CAUTION: Camshaft bearings must be installed with bearing oil feed hole in alignment with the drilled oil passage in the block bore to ensure proper oil flow to the camshaft. The split seam in the bearing must be installed in the 12 o'clock position towards the top of the block. Improperly installed bearings may restrict oil flow causing engine damage.

7. Position the camshaft bearing with oil feed hole (1) in alignment with drilled oil passage in block bore

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(2).

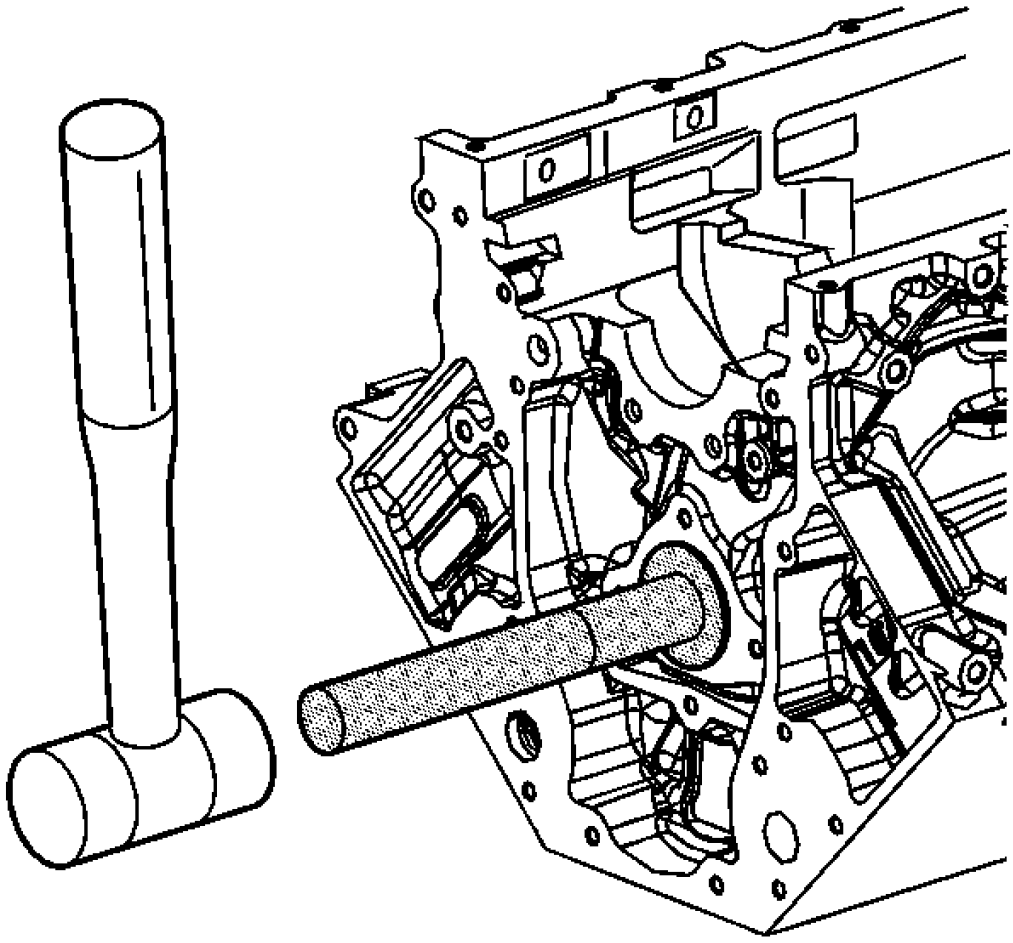


Fig. 198: Driving Bearing Out Of Or Into Engine Block
Courtesy of GENERAL MOTORS CORP.

8. Drive the bearing into the block bore. During installation, ensure the bearing is installed straight.
9. Remove **J 33049:** service set, inspect bearing to confirm the oil hole in the bearing is in alignment with the drilled oil passage in the block bore.
10. Repeat procedure to install the remaining bearings into the block.

CAMSHAFT TIMING CHAIN AND SPROCKET CLEANING AND INSPECTION

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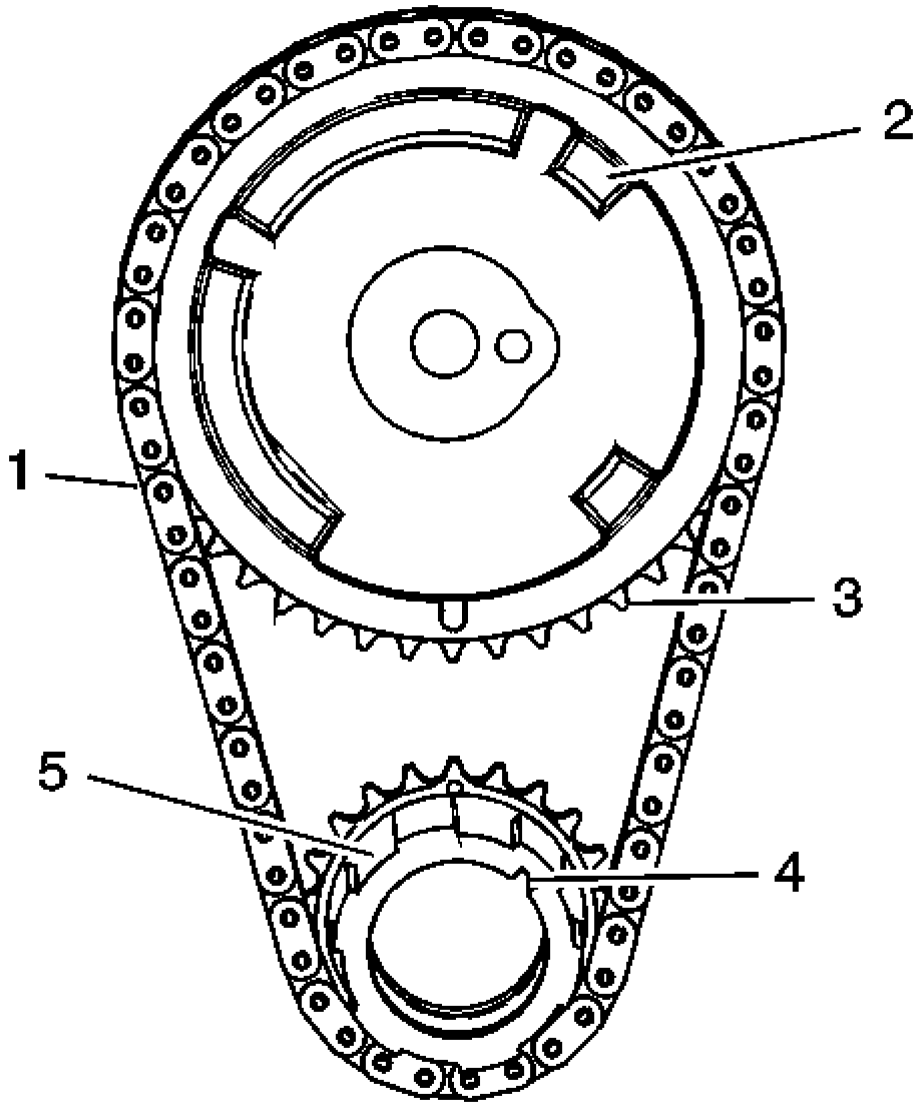


Fig. 199: Identifying Timing Chain & Sprockets Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Clean the components with cleaning solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

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2. Dry the components with compressed air.
3. Inspect the timing chain (1) for binding or wear.
4. Inspect the camshaft position (CMP) sensor raised areas (2) for nicks or damage.
5. Inspect for worn, damaged, or chipped teeth (3).
6. Inspect for a damaged keyway (4).
7. Inspect for worn oil pump drive splines (5).

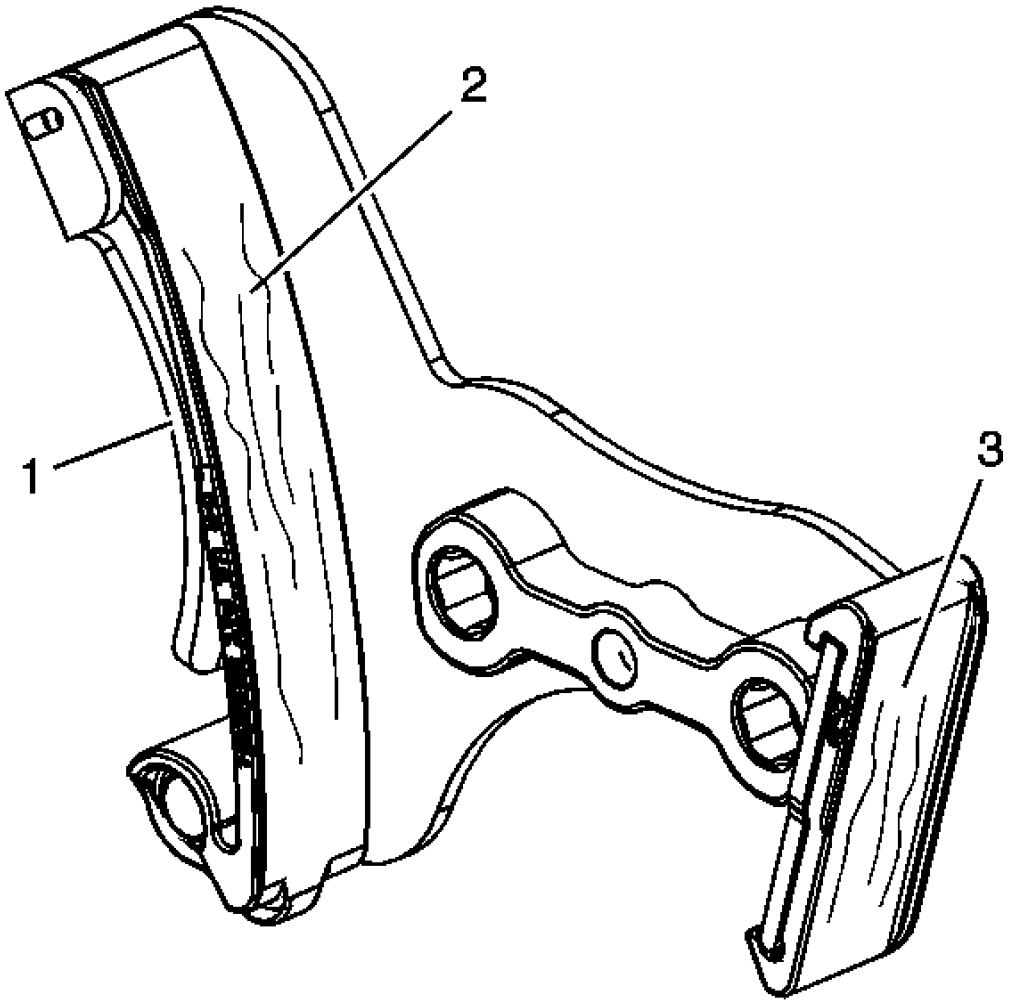


Fig. 200: View Of Timing Chain Tensioner Inspection Points
Courtesy of GENERAL MOTORS CORP.

8. Inspect the timing chain tensioner for the following conditions:

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- Damaged or broken tension spring (1)
- Excessive wear or scoring on the chain guide surfaces (2, 3)

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2010 ENGINE

Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Repair Instructions - Off Vehicle - Camaro

CAMSHAFT POSITION ACTUATOR CLEANING AND INSPECTION

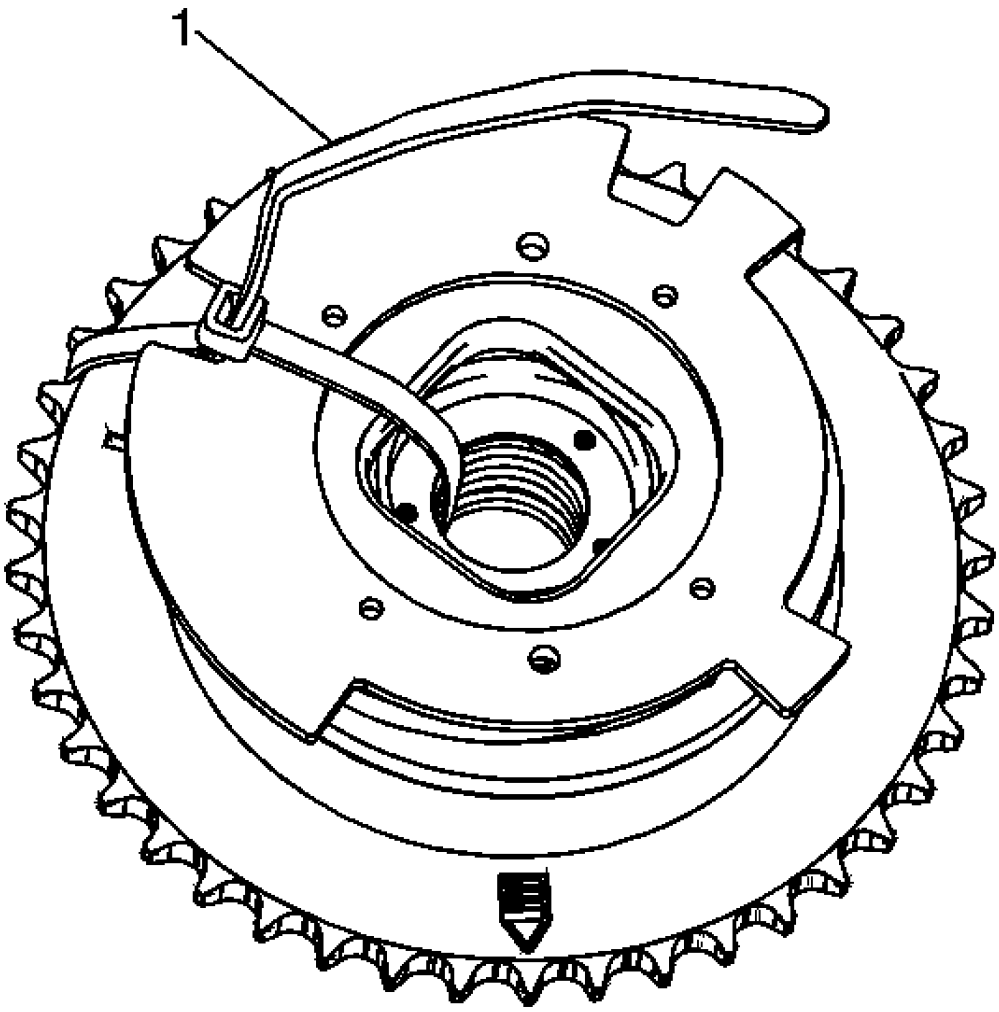


Fig. 1: View Of Tie Strap Through Center Of Actuator
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Camshaft Position Actuator Removal and Installation Warning .

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1. Insert a tie strap (1) through the center of the camshaft position (CMP) actuator and over the reluctor wheel.

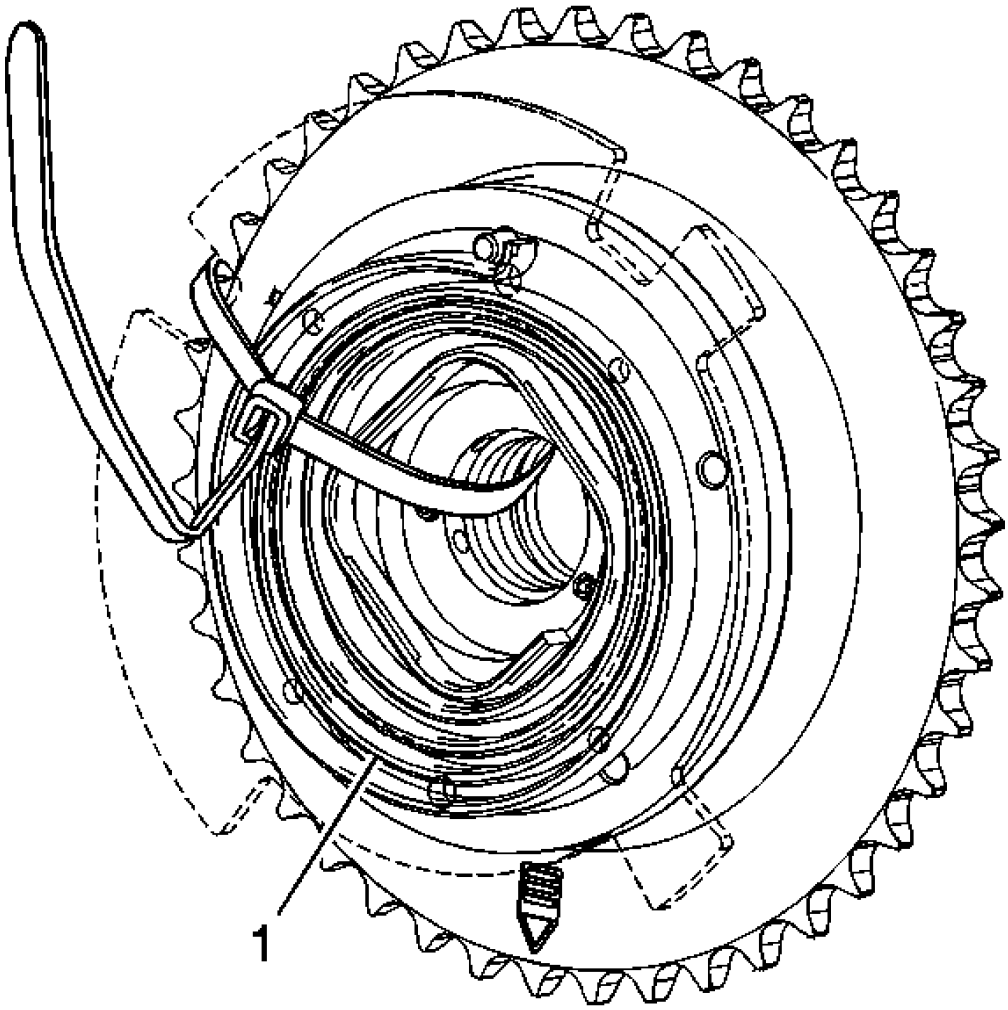


Fig. 2: Inspecting CMP Actuator For Broken Spring
Courtesy of GENERAL MOTORS CORP.

2. Clean the CMP actuator with cleaning solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

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3. Dry the components with compressed air.
4. Inspect the CMP actuator for a broken spring (1).

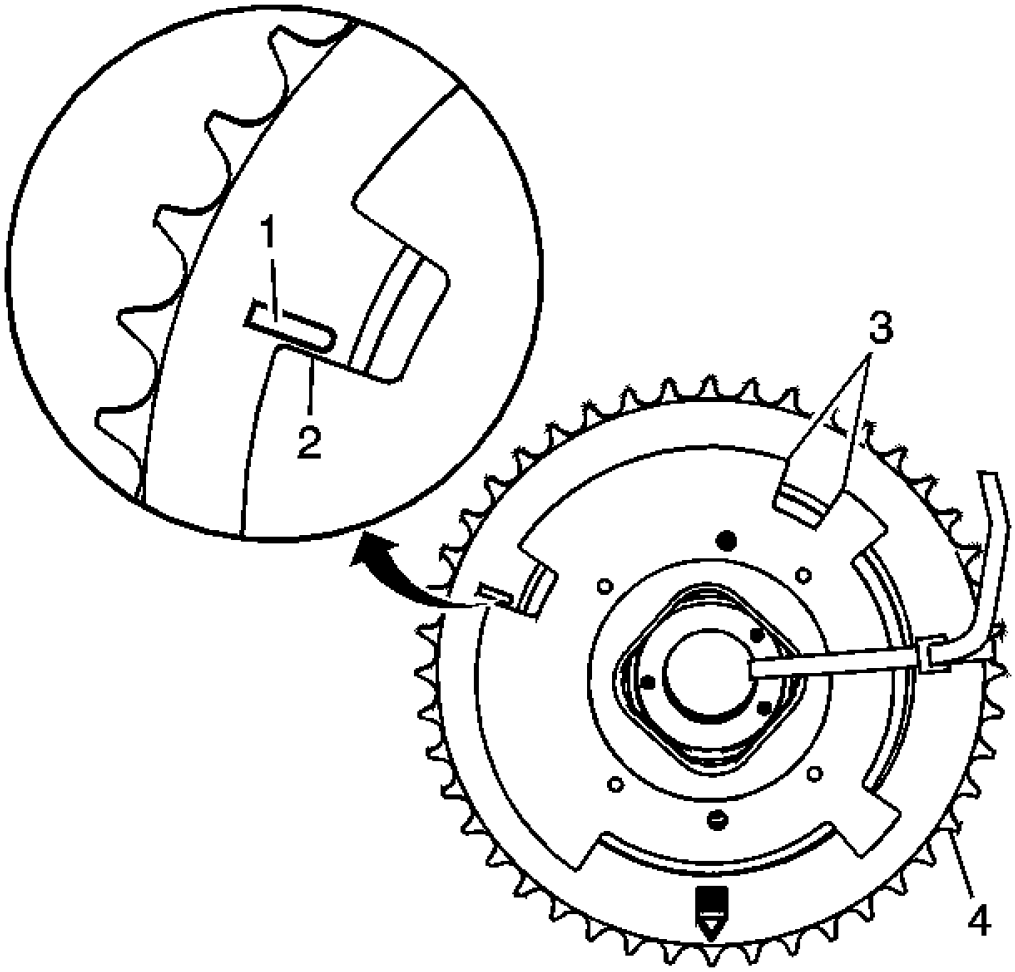


Fig. 3: CMP Actuator Inspection Points
Courtesy of GENERAL MOTORS CORP.

5. Inspect the CMP actuator for the following conditions:
   - Improper positioning of the CMP reluctor wheel. The actuator return spring should reposition the reluctor wheel to the PARK position. Inspect for proper alignment of the mark on the face of the sprocket (1) with the flat edge of the reluctor wheel (2). If the reluctor wheel is not properly positioned, the internal components of the actuator are sticking or the return spring is broken and the actuator should be replaced as an assembly.
   - Nicked or damaged edges (3) on the CMP reluctor wheel

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- Damaged timing sprocket teeth (4)

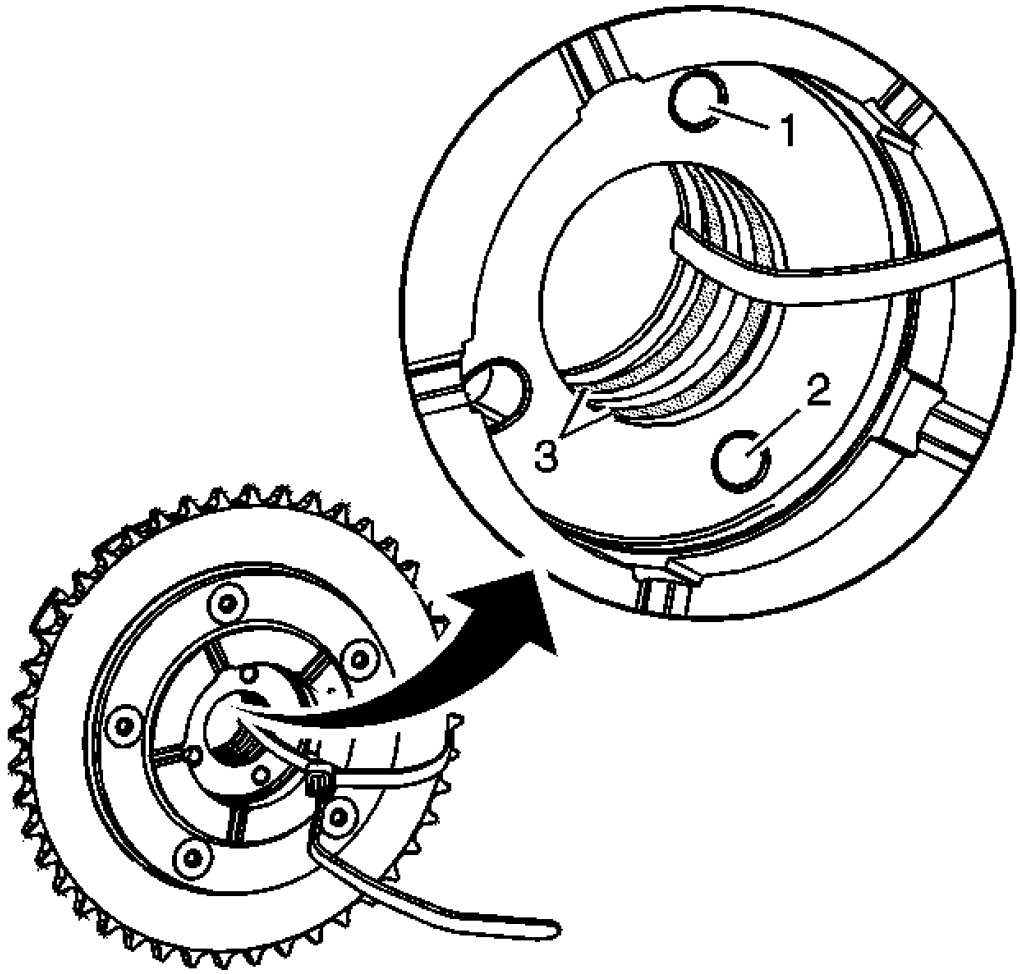


Fig. 4: View Of Oil Passages
Courtesy of GENERAL MOTORS CORP.

6. Inspect the CMP actuator for dirt, debris, or restrictions within the oil passages (1, 2, 3).

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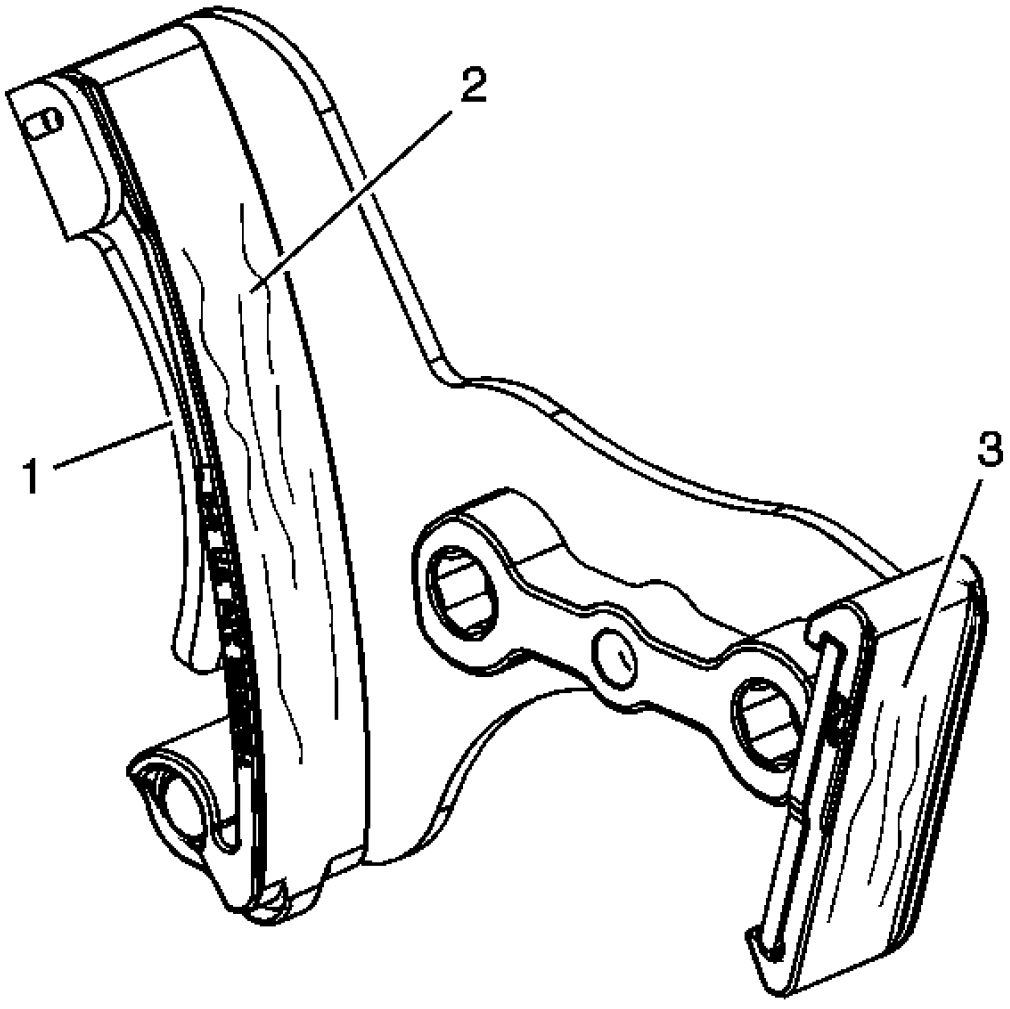


Fig. 5: View Of Timing Chain Tensioner Inspection Points
Courtesy of GENERAL MOTORS CORP.

7. Inspect the timing chain tensioner for the following conditions:
    - Damaged or broken tension spring (1)
    - Excessive wear or scoring on the chain guide surfaces (2, 3)

CAMSHAFT POSITION ACTUATOR MAGNET CLEANING AND INSPECTION

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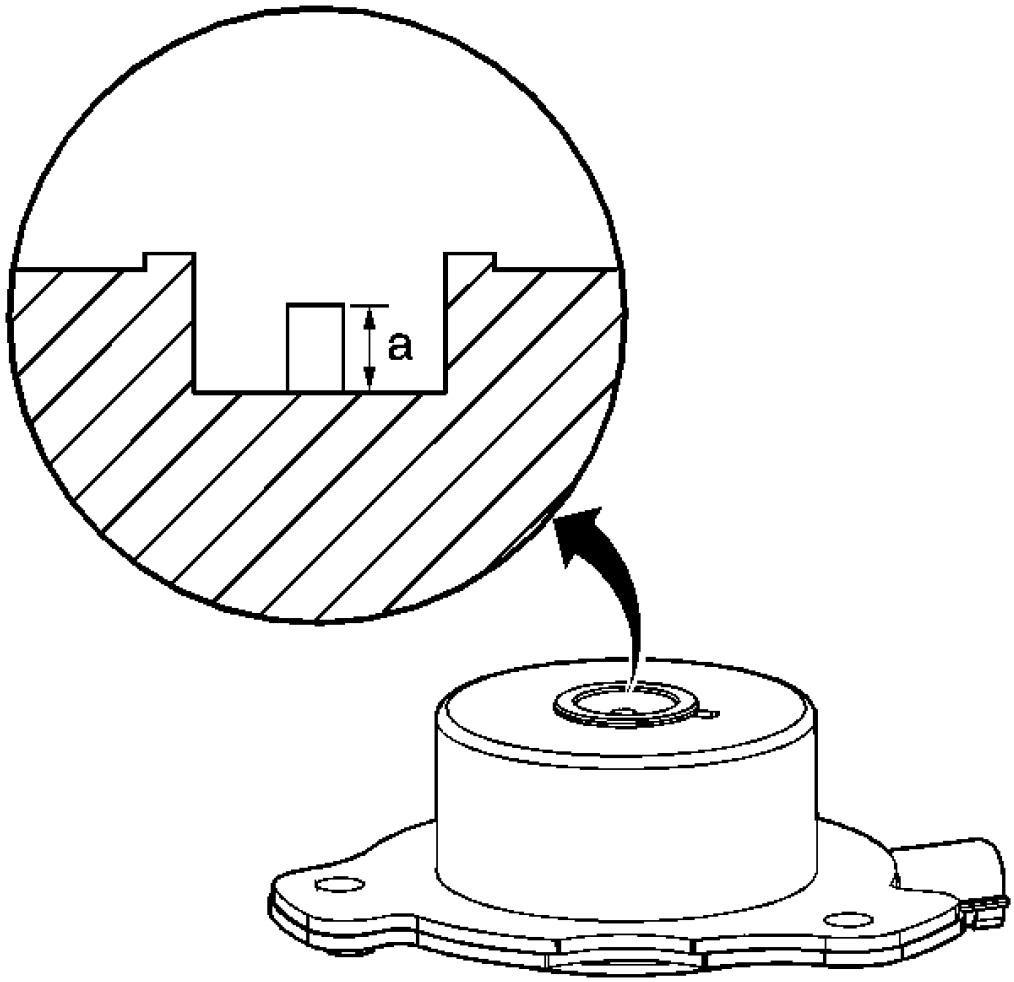


Fig. 6: Identifying Pintle Retracted Position
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not energize the camshaft position (CMP) magnet using a 12-volt power supply.

1. Inspect the CMP magnet for the following conditions:
   - A damaged electrical connector
   - An accumulation of dirt or debris in the recessed area around the pintle
   - A build-up of burnt engine oil on the shaft of the pintle which may cause the pintle to stick and not move freely within the proper range of travel
2. Holding the CMP magnet with the pintle facing upward, measure the pintle retracted position (a). Record

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the dimension.

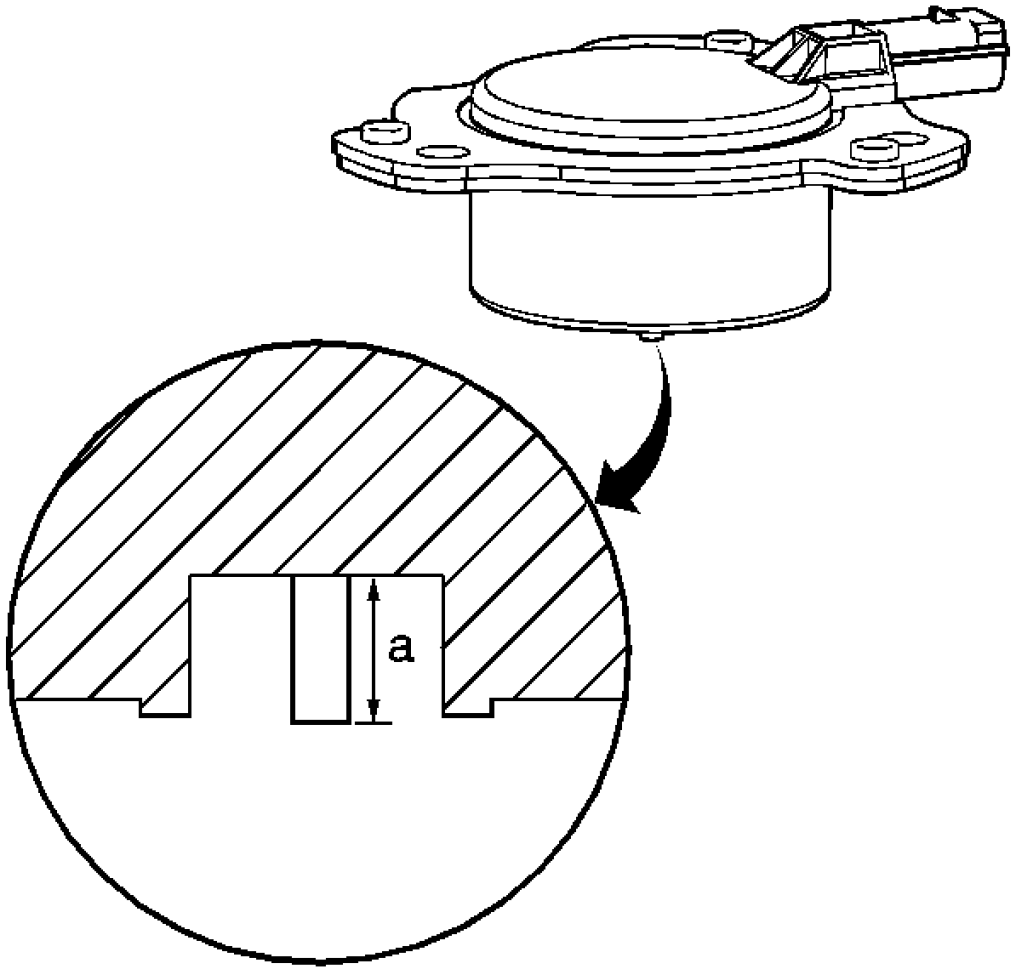


Fig. 7: Measuring Pintle Extended Position
Courtesy of GENERAL MOTORS CORP.

3. Holding the CMP magnet with the pintle facing downward, measure the pintle extended position (a). Record the dimension.
4. Subtract the retracted dimension from the extended dimension to determine pintle travel. A properly moving pintle will travel 3.0-5.5 mm (0.12-0.22 in).
5. If the pintle of the CMP magnet is binding or does not move within the proper range of travel, replace the CMP magnet as an assembly.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE INSPECTION (OFF-

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VEHICLE)

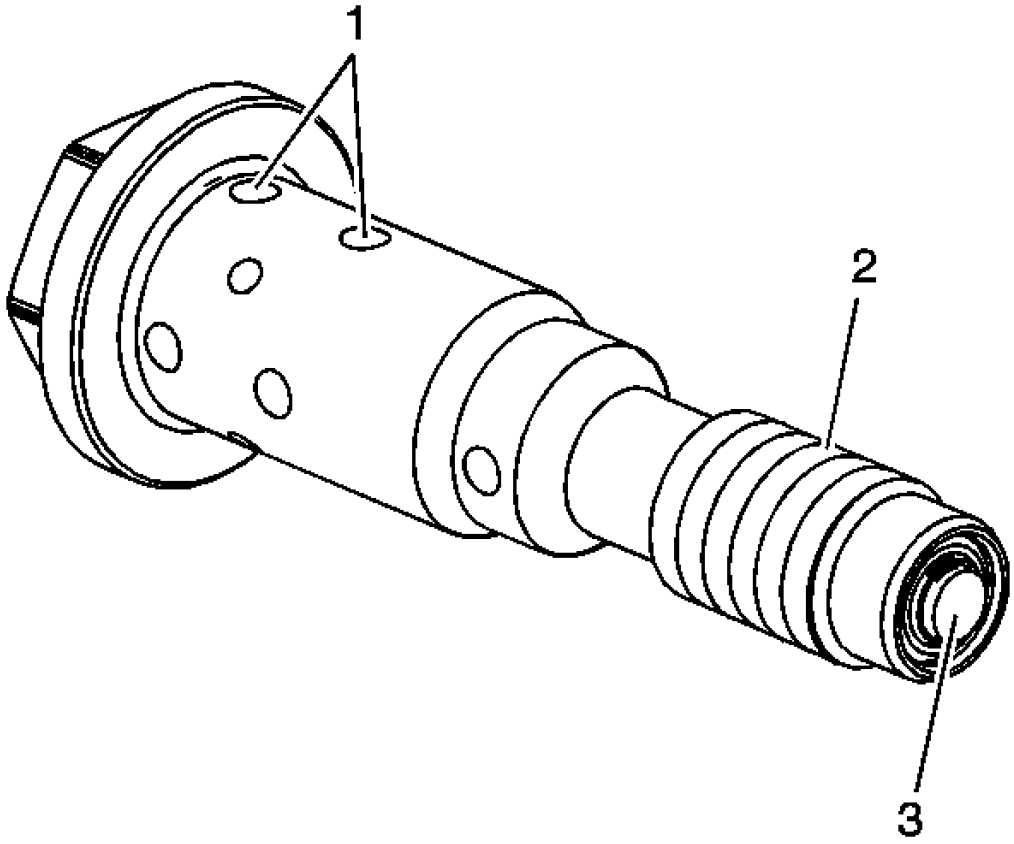


Fig. 8: View Of CMP Inspection Points
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not use the camshaft position (CMP) actuator solenoid valve again. Install a NEW valve during assembly. The inspection procedure below is provided for off-vehicle diagnostic purposes only.

1. Inspect the CMP valve for the following conditions:
   - Dirt, debris, or restrictions within the oil passages (1)
   - Damaged threads (2)

   If the threads of the valve are damaged, also inspect the threads in the front of the camshaft for damage.

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- Dirt, debris, or restrictions within the oil inlet check valve (3)

  If debris is detected, the engine assembly should be inspected to determine the source of contamination.

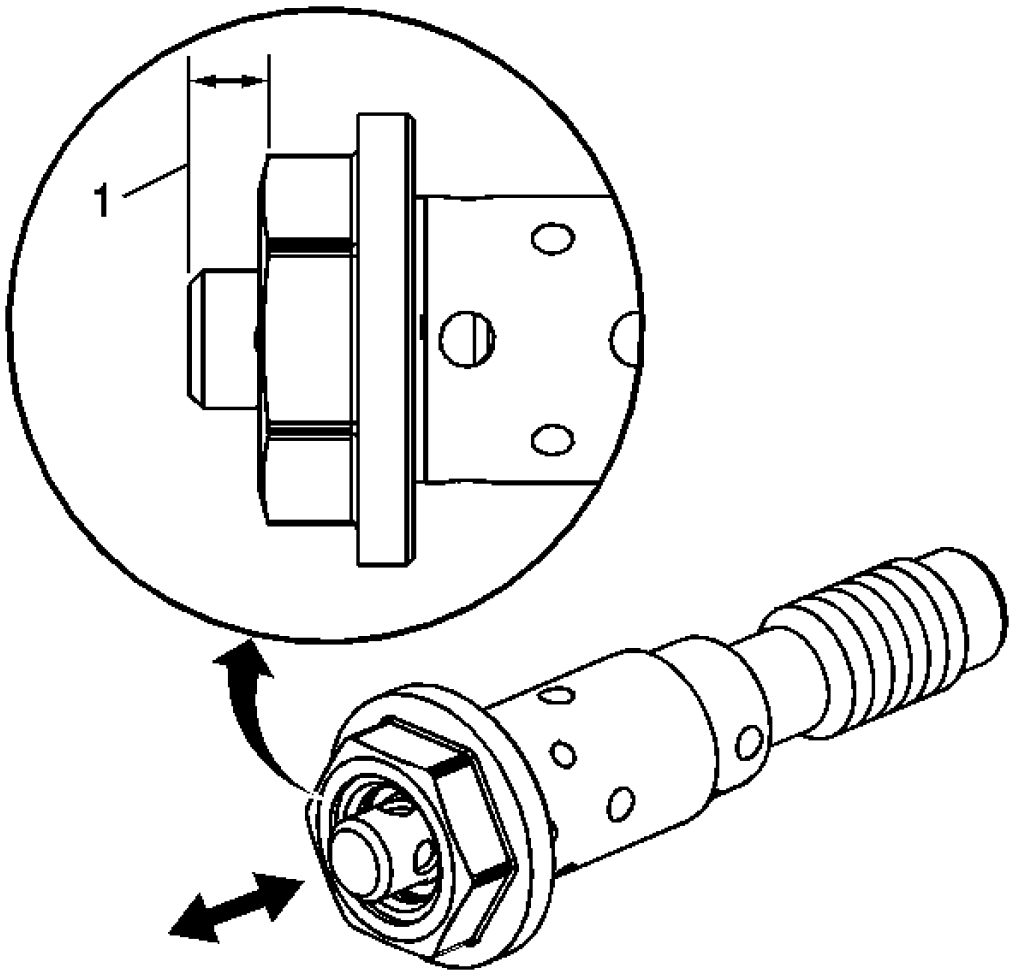


Fig. 9: View Of Proper Valve Spool Position
Courtesy of GENERAL MOTORS CORP.

2. Inspect for a sticking valve spool or broken valve spool spring.
3. Depress the valve spool into the housing. The valve should move freely with no binding or sticking and minimal resistance inward. When released, the valve spring should return the spool to the proper extended position (1) of 6.08-6.12 mm (0.239-0.241 in).

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CAMSHAFT POSITION ACTUATOR SOLENOID VALVE INSPECTION (ON-VEHICLE)

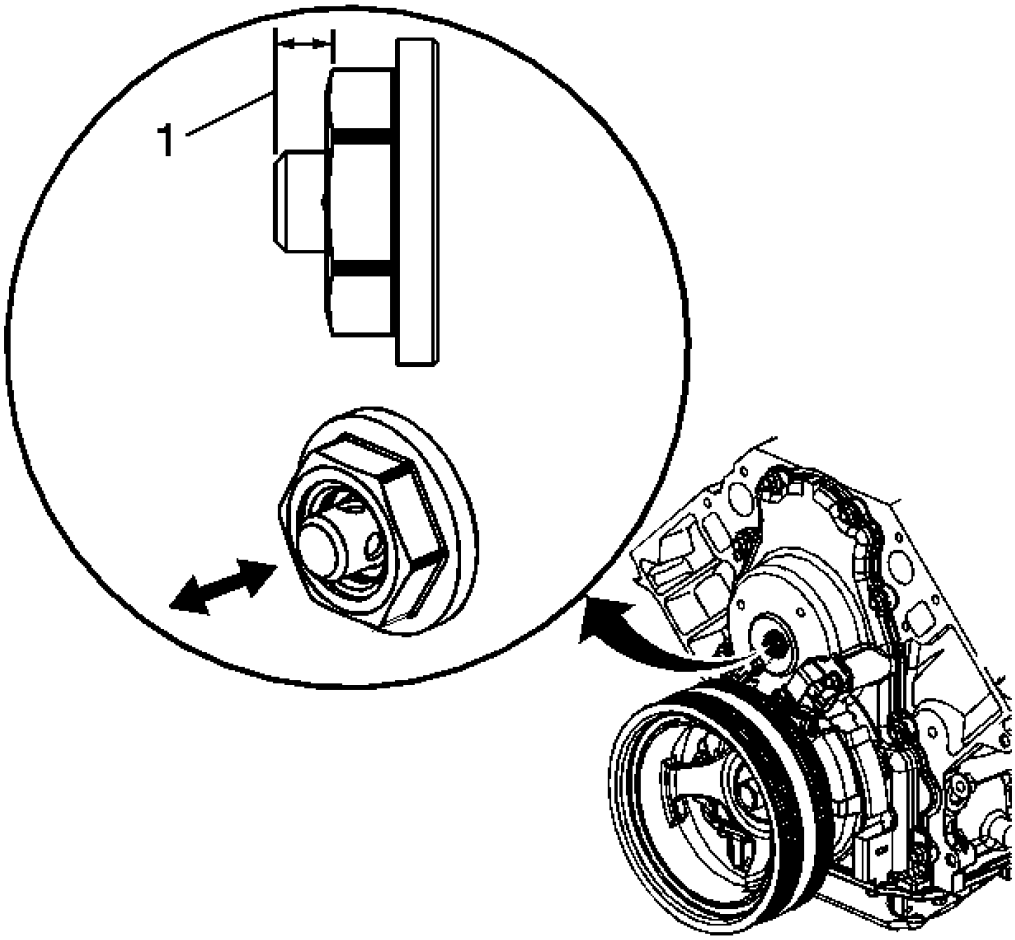


Fig. 10: View Of Proper Valve Spool Position
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not use the camshaft position (CMP) actuator solenoid valve again. Install a NEW valve during assembly. The inspection procedure below is provided for on-vehicle diagnostic purposes only.

1. With the CMP magnet removed, inspect for a sticking valve spool or broken valve spool spring.
2. Depress the valve spool into the housing. The valve should move freely with no binding or sticking and minimal resistance inward. When released, the valve spring should return the spool to the proper

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extended position (1) of 6.08-6.12 mm (0.239-0.241 in).

VALVE ROCKER ARM AND PUSH ROD CLEANING AND INSPECTION

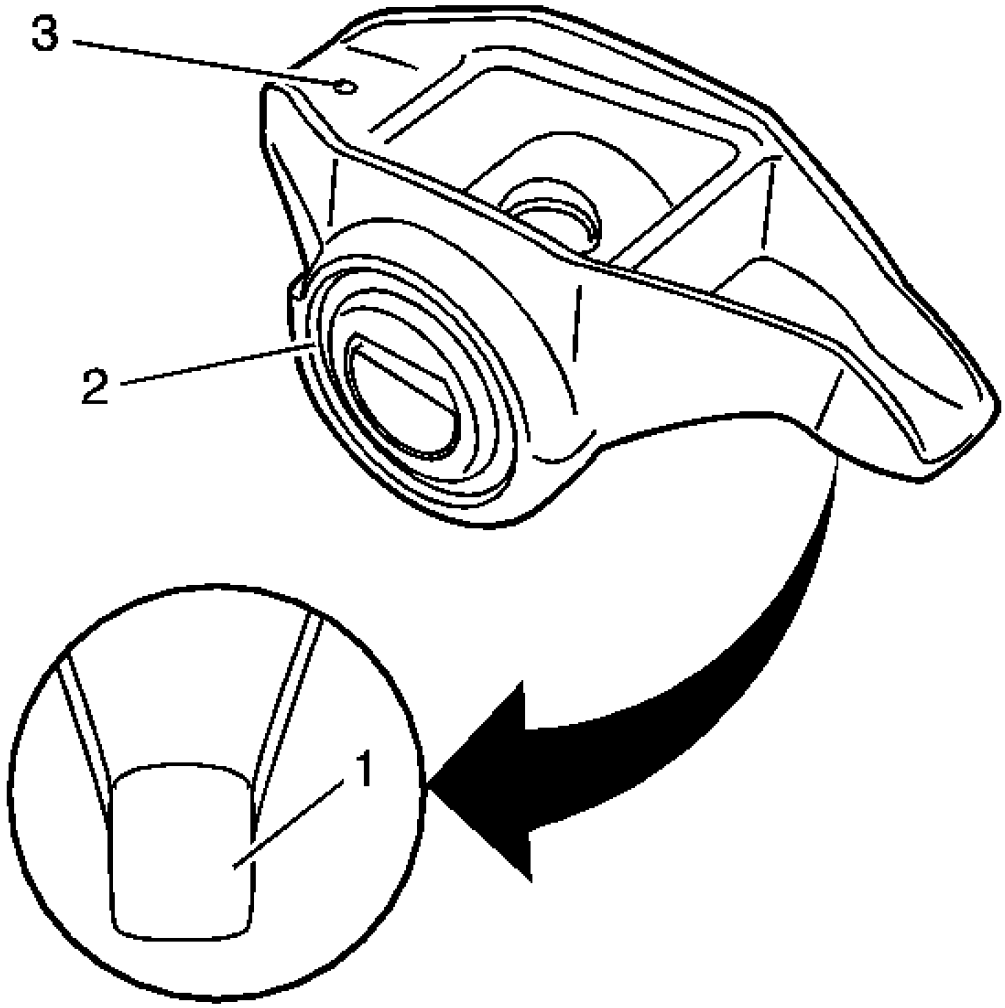


Fig. 11: Identifying Valve Rocker Arm Components
Courtesy of GENERAL MOTORS CORP.

NOTE: **Parts that are to be used again must be marked, sorted or organized for assembly.**

1. Mark, sort, or organize the components for assembly. Refer to **Separating Parts** .

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2. Clean the components with cleaning solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

3. Dry the components with compressed air.
4. Inspect the valve rocker arms bearings (2) for binding or roughness.
5. Inspect the valve rocker arm pushrod sockets (3) and valve stem mating surfaces (1). These surfaces should be smooth with no scoring or exceptional wear.
6. Inspect the pushrods for worn or scored ends. These surfaces should be smooth with no scoring or exceptional wear.
7. Inspect the pushrods for bends. Roll the pushrod on a flat surface to determine if the pushrod is bent.
8. Inspect the pushrod oil passages for restrictions.
9. Inspect the rocker arm pivot supports for cracks, wear, or other damage.

VALVE LIFTER AND GUIDE CLEANING AND INSPECTION

NON ACTIVE FUEL MANAGEMENT VALVE LIFTERS

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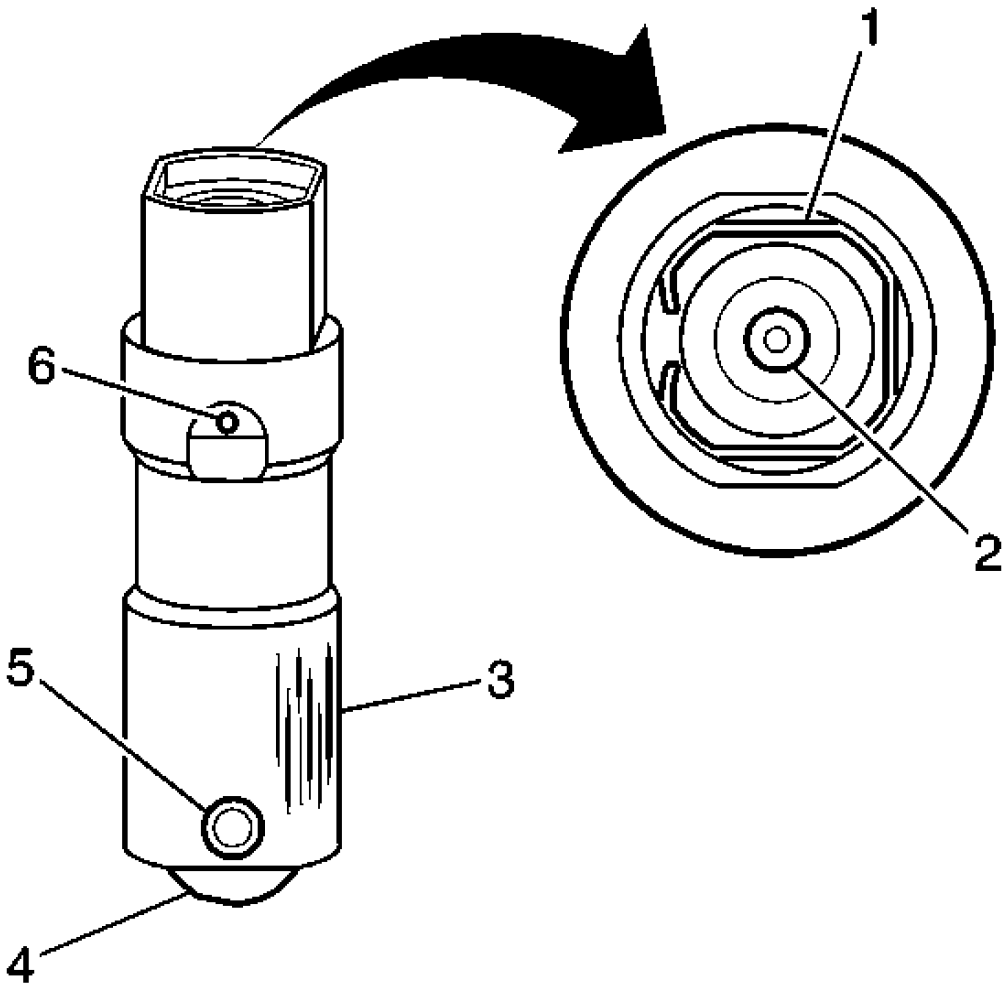


Fig. 12: Identifying Valve Lifter Inspection Areas
Courtesy of GENERAL MOTORS CORP.

NOTE: Components that are to be used again must be marked, sorted or organized for assembly.

1. Clean the components in cleaning solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

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2. Dry the components with compressed air.
3. Inspect the valve lifters for the following conditions:
    - Bent or broken clip (1)
    - Worn pushrod socket (2)
    - Scuffed or worn sides (3)

      If the valve lifter shows wear, inspect the engine block lifter bores for wear or damage.

    - Flat spots on the roller (4)
    - Loose or damaged pin (5)
    - Plugged oil hole (6)
    - Worn or damaged roller bearing

      The roller should rotate freely with no binding or roughness.

ACTIVE FUEL MANAGEMENT VALVE LIFTERS

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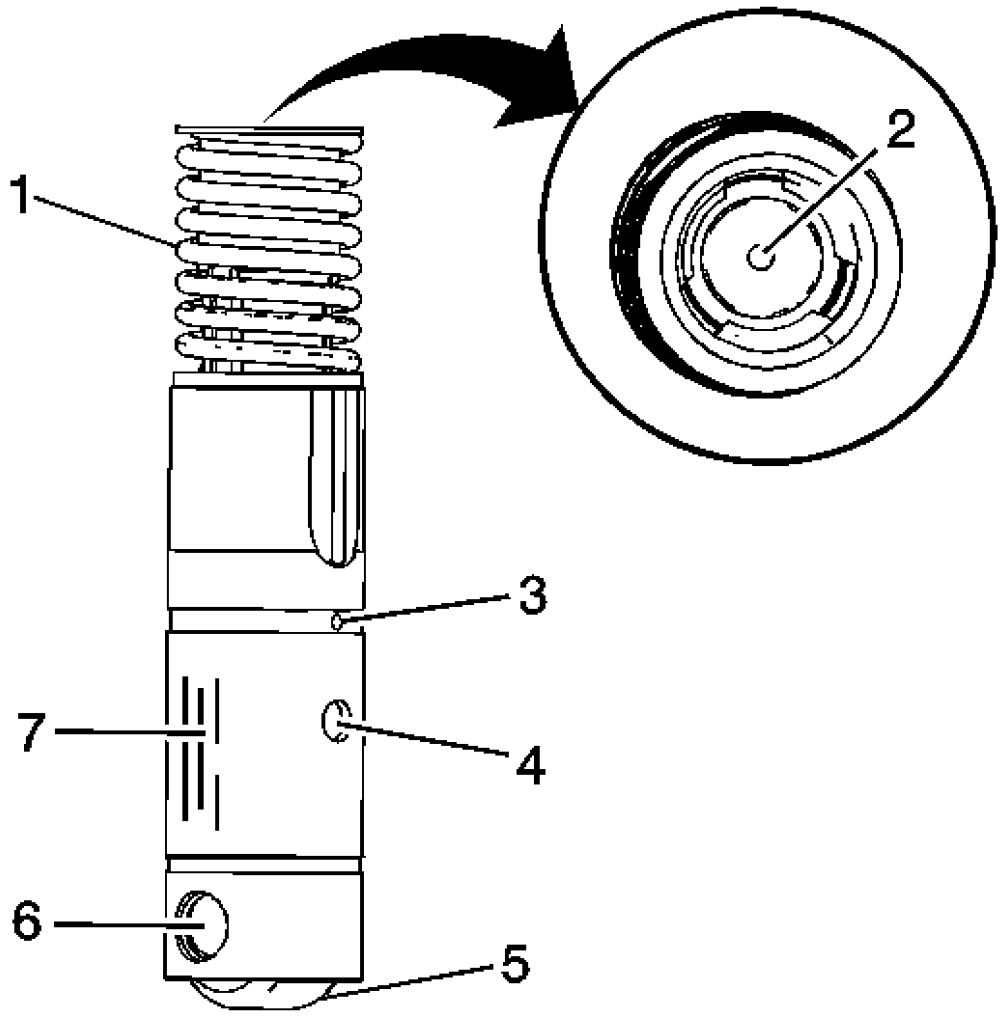


Fig. 13: Displacement On Demand Valve Lifters Assembly
Courtesy of GENERAL MOTORS CORP.

NOTE: Components that are to be used again must be marked, sorted or organized for assembly.

1. Clean the components in cleaning solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

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2. Dry the components with compressed air.
3. Inspect the valve lifters for the following conditions:
    - Broken or collapsed spring (1)
    - Worn pushrod socket (2)
    - Plugged lubrication hole (3)
    - Plugged lifter oil-switching hole (4)
    - Flat spots on the roller (5)
    - Worn or damaged roller bearing (6)

      The roller should rotate freely with no binding or roughness.

    - Scuffed or worn sides (7)

VALVE GUIDES

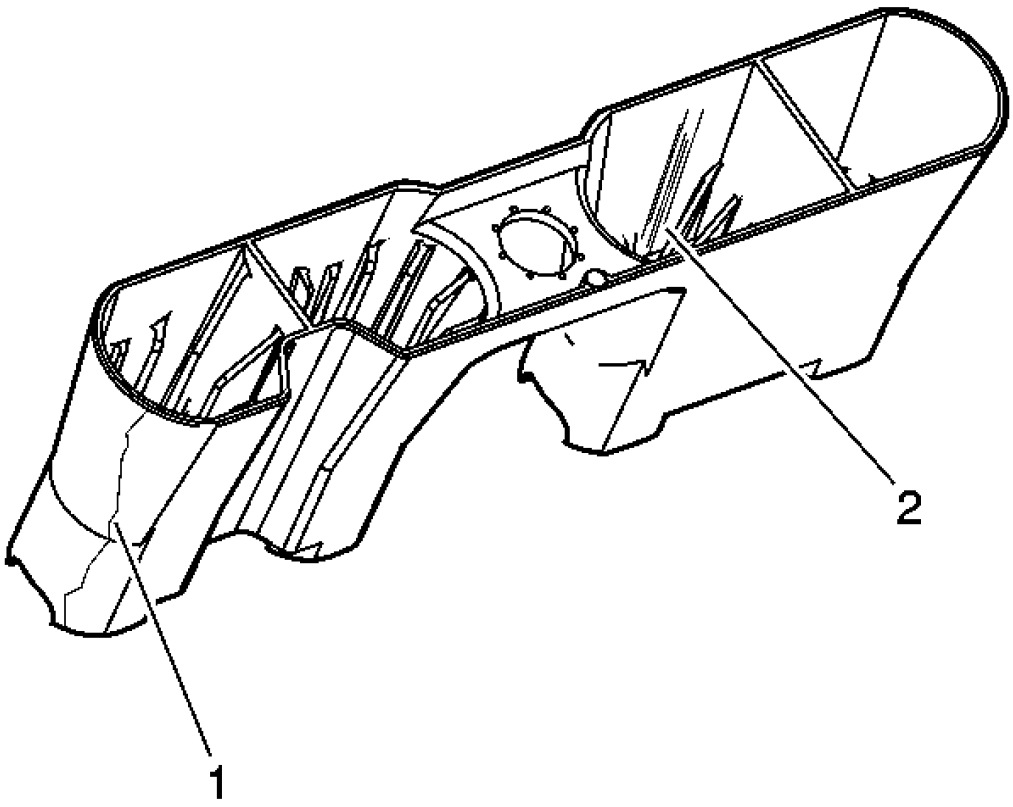


Fig. 14: Identifying Valve Guides Damage

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Courtesy of GENERAL MOTORS CORP.

Inspect the valve lifter guides for the following conditions:

- Cracks or damage (1)
- Excessive wear in the lifter mounting bores (2)

CYLINDER HEAD DISASSEMBLE

Special Tools

J 8062: Valve Spring Compressor - Head Off

For equivalent regional tools, refer to **Special Tools** .

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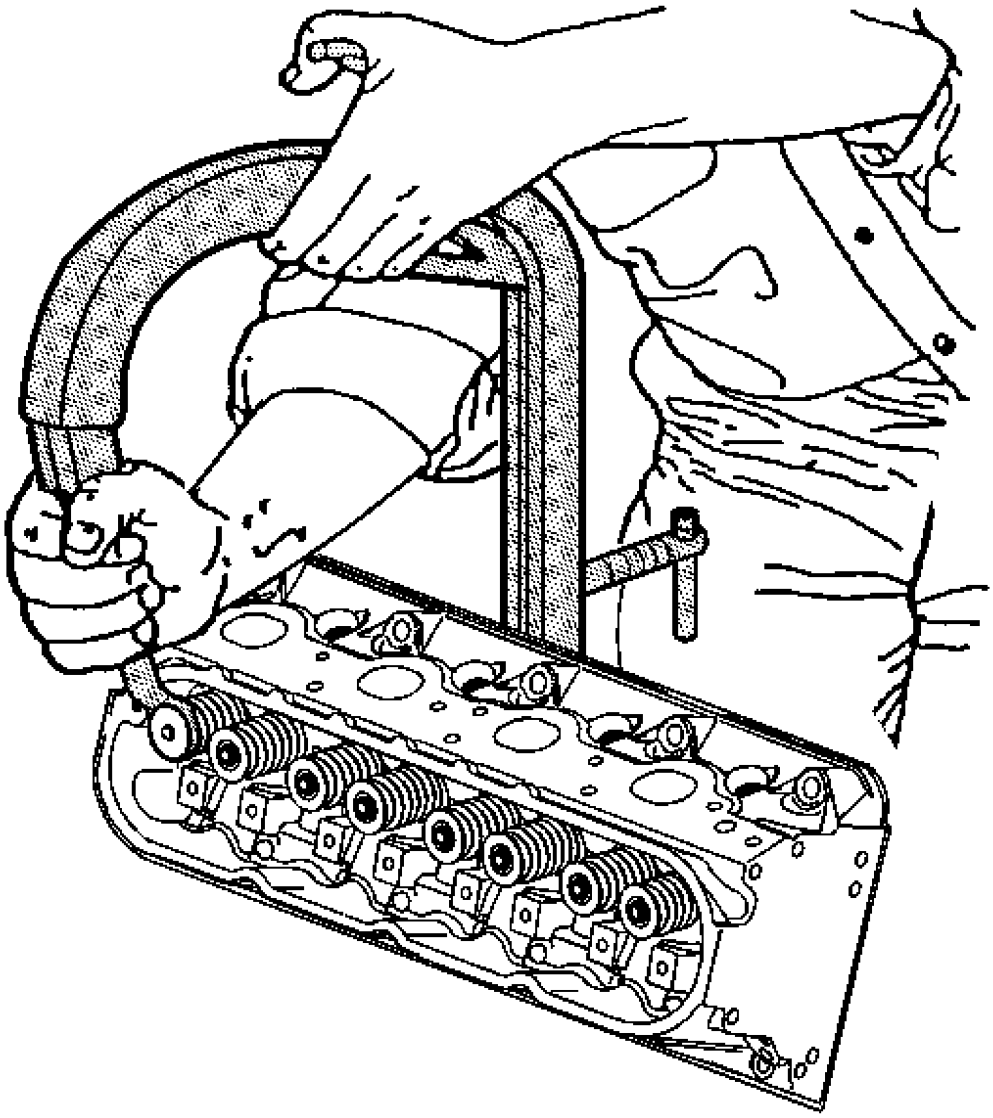


Fig. 15: Compressing Valve Spring
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **With the components at room temperature, remove the spark plugs from the cylinder head.**
- **Mark, organize, or sort the cylinder head components for assembly. Return the components to their original location during assembly.**

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1. Remove the spark plugs from the cylinder heads.
2. Use the **J 8062:** valve spring compressor in order to compress the valve spring.

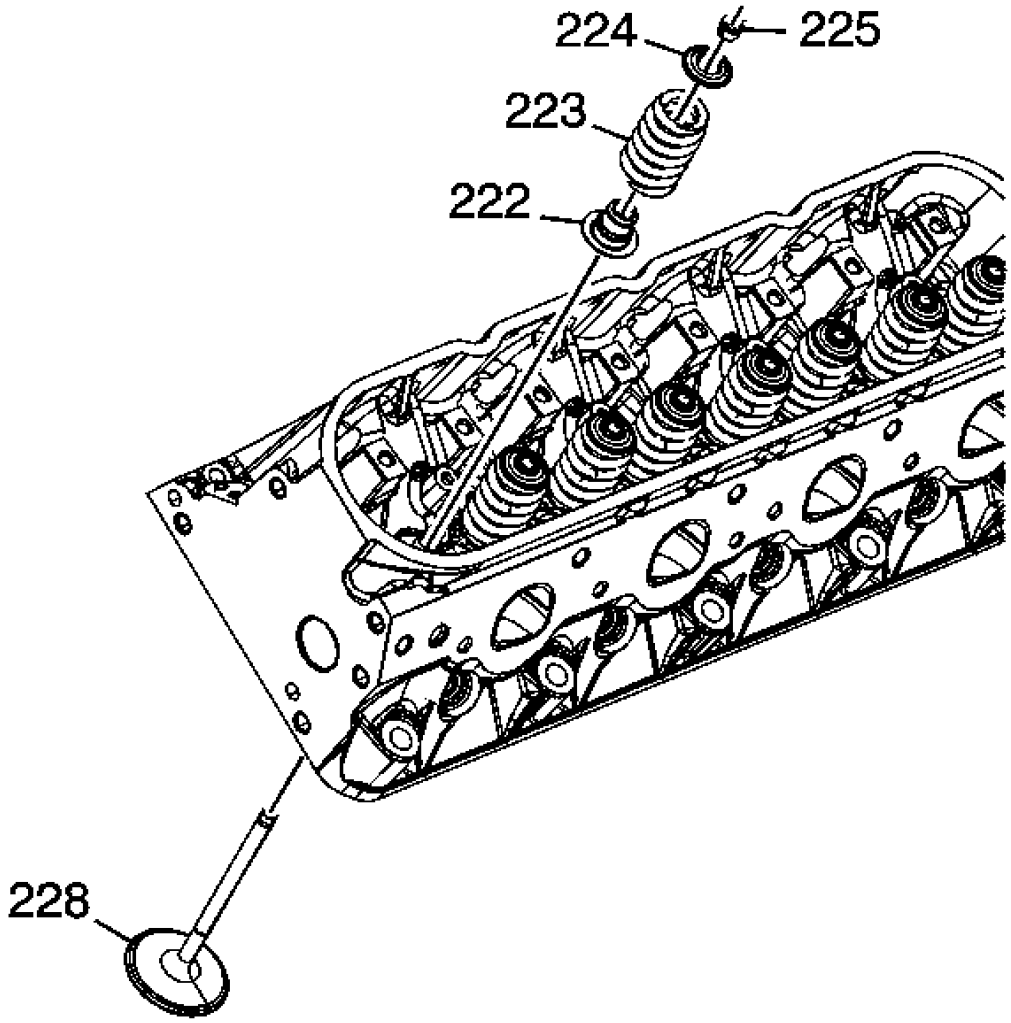


Fig. 16: Valve Components
Courtesy of GENERAL MOTORS CORP.

3. Remove the valve stem keys (225).
4. Remove the valve spring cap (224).
5. Remove the valve spring (223).
6. Remove the valves (228).

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7. Remove the valve stem oil seal (222). Refer to **Separating Parts** .

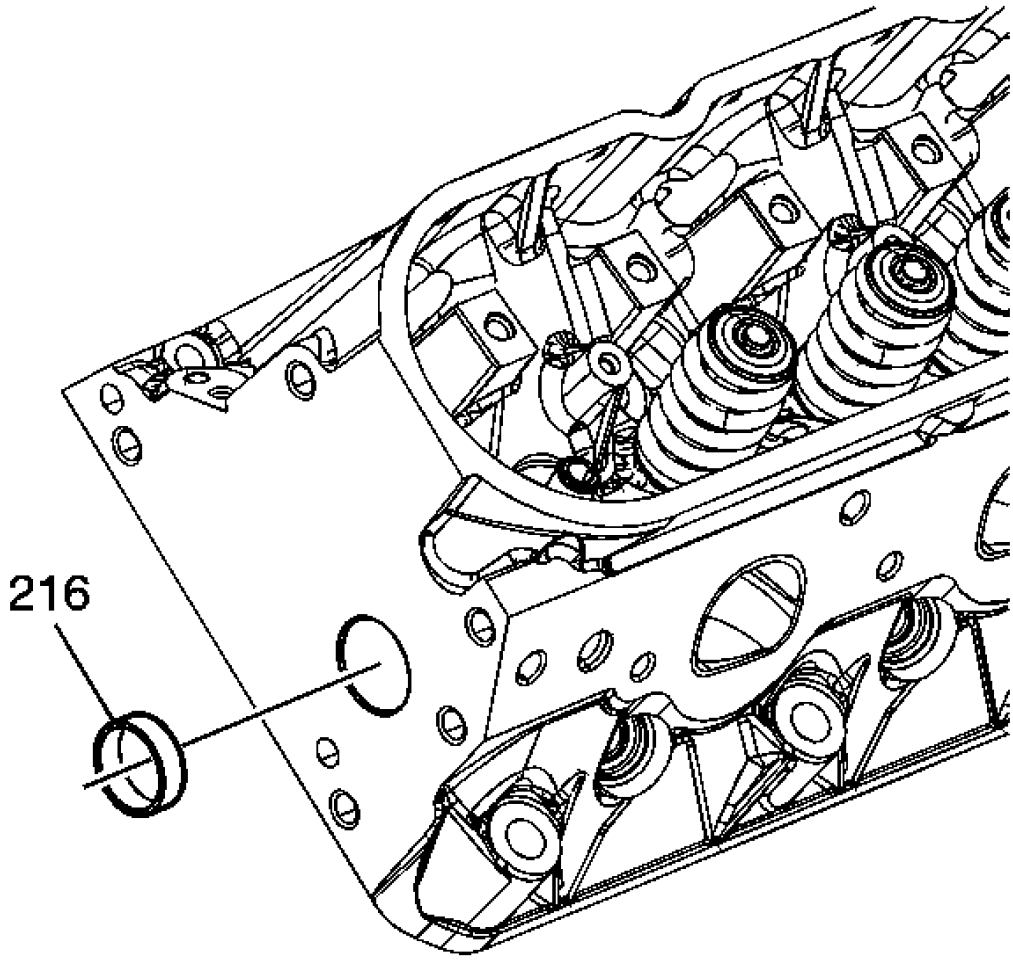


Fig. 17: Locating Cylinder Head Core Hole Plug
Courtesy of GENERAL MOTORS CORP.

8. Remove the cylinder head core hole plugs (216), as required.

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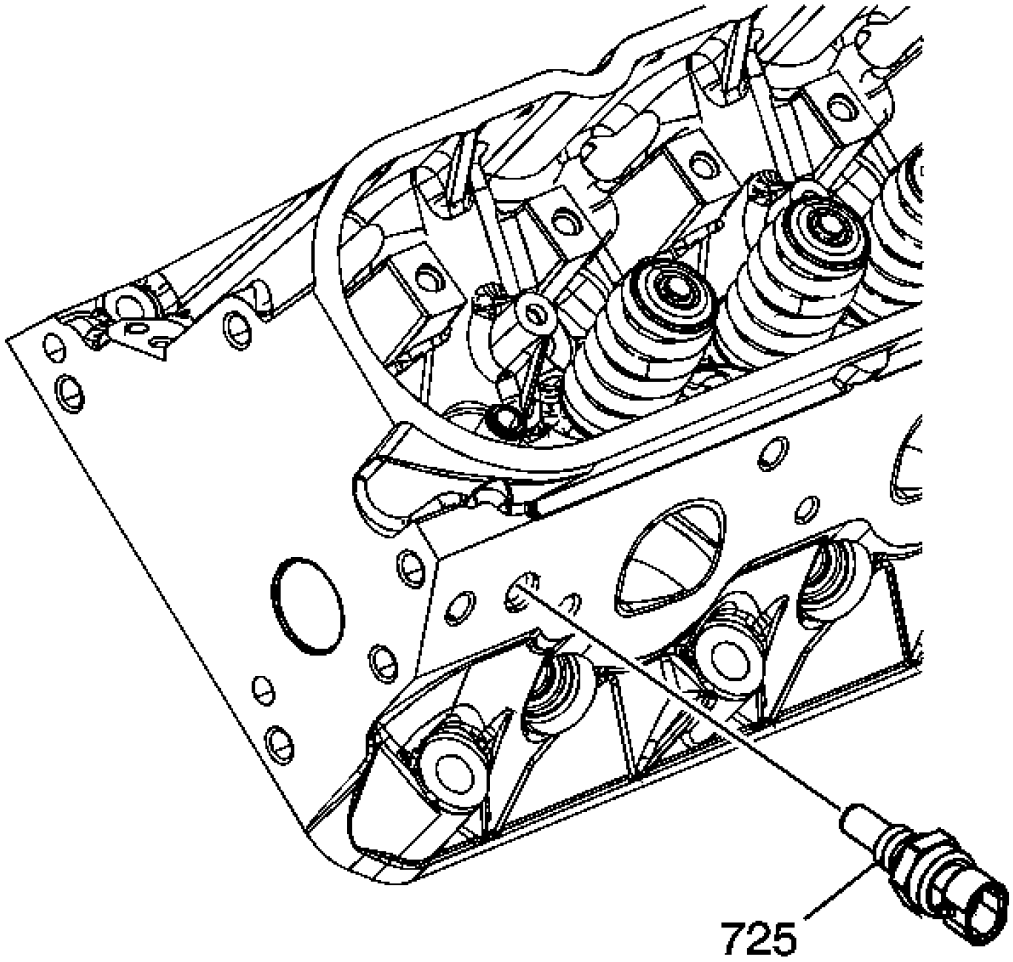


Fig. 18: Locating Coolant Temperature Sensor
Courtesy of GENERAL MOTORS CORP.

9. Remove the coolant temperature sensor (725) from the left cylinder head.

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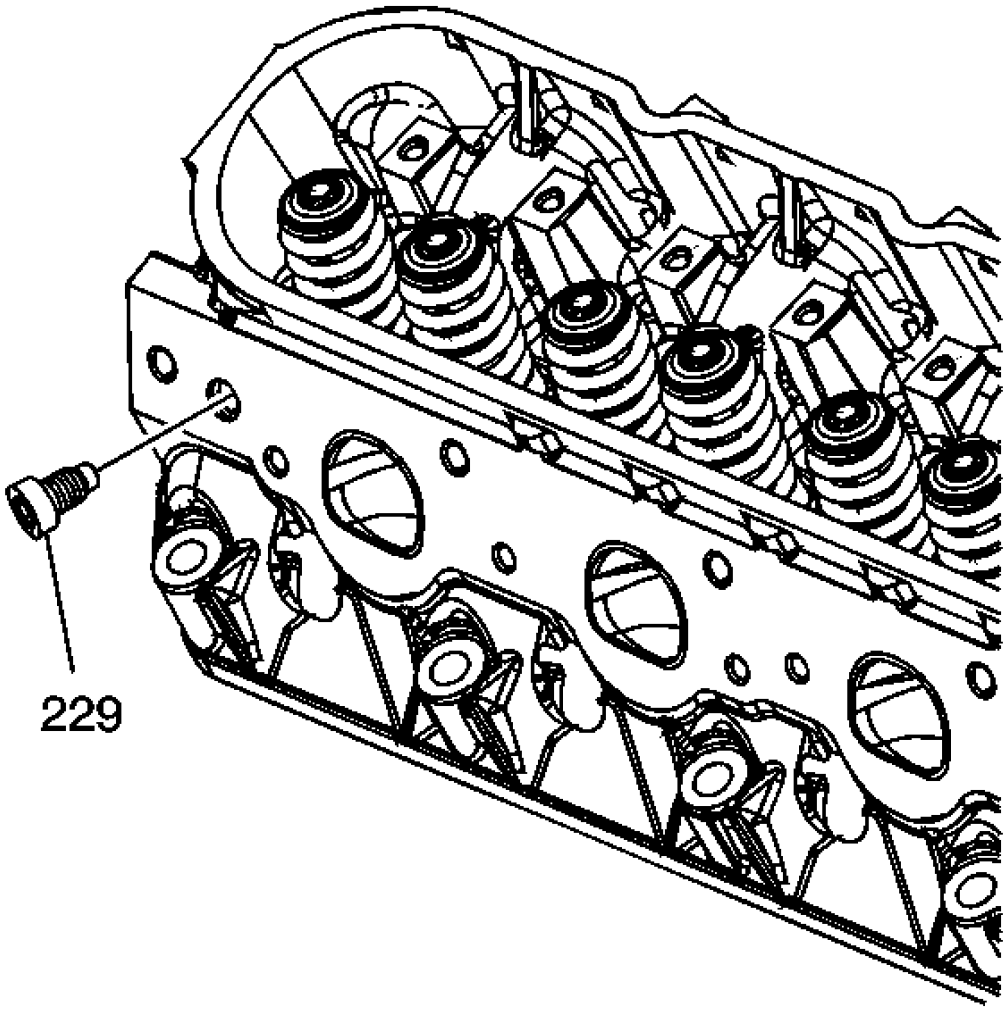


Fig. 19: Cylinder Head Plug
Courtesy of GENERAL MOTORS CORP.

10. Remove the cylinder head plug (229) from the right cylinder head.

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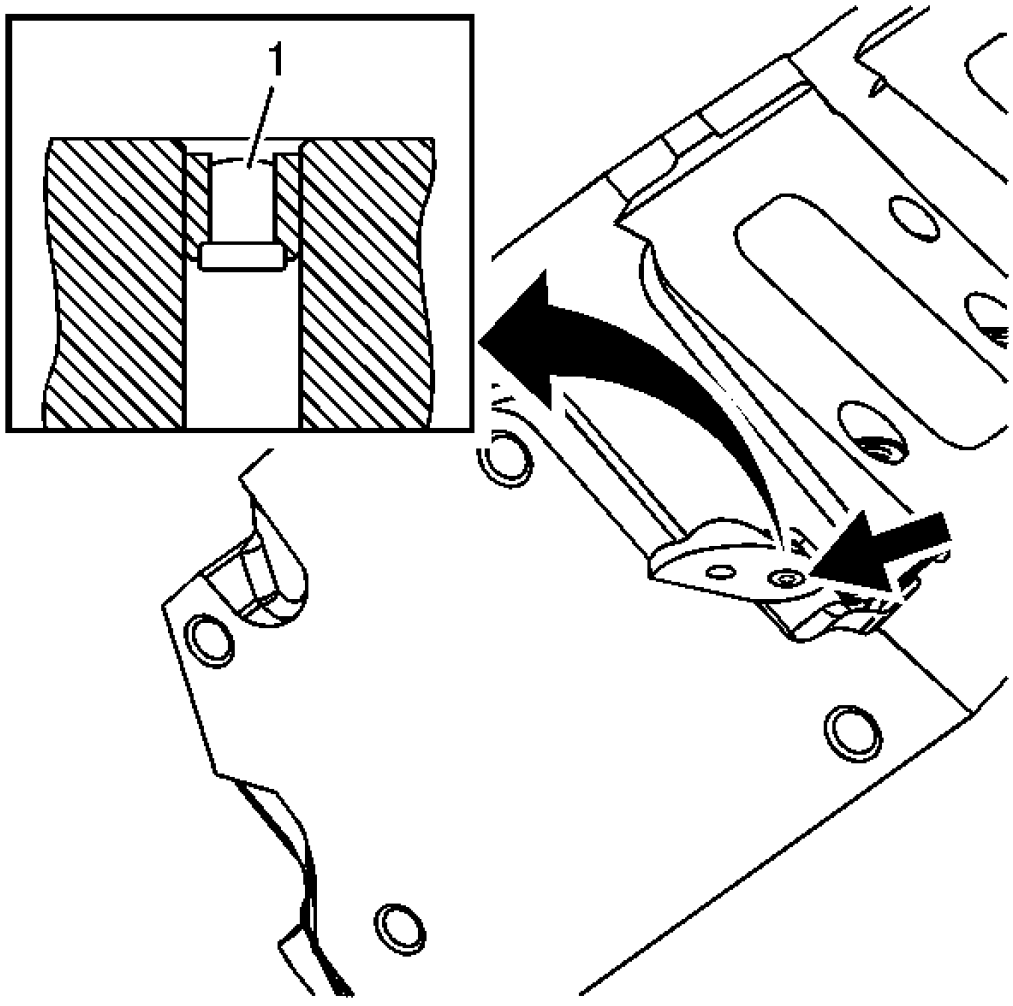


Fig. 20: Rivet-Type Plug
Courtesy of GENERAL MOTORS CORP.

11. Inspect for a leaking plug (1) at the top rear coolant passage of each cylinder head. If service of a leaking plug is required, it is necessary to remove the cylinder head from the engine to properly remove the plug.

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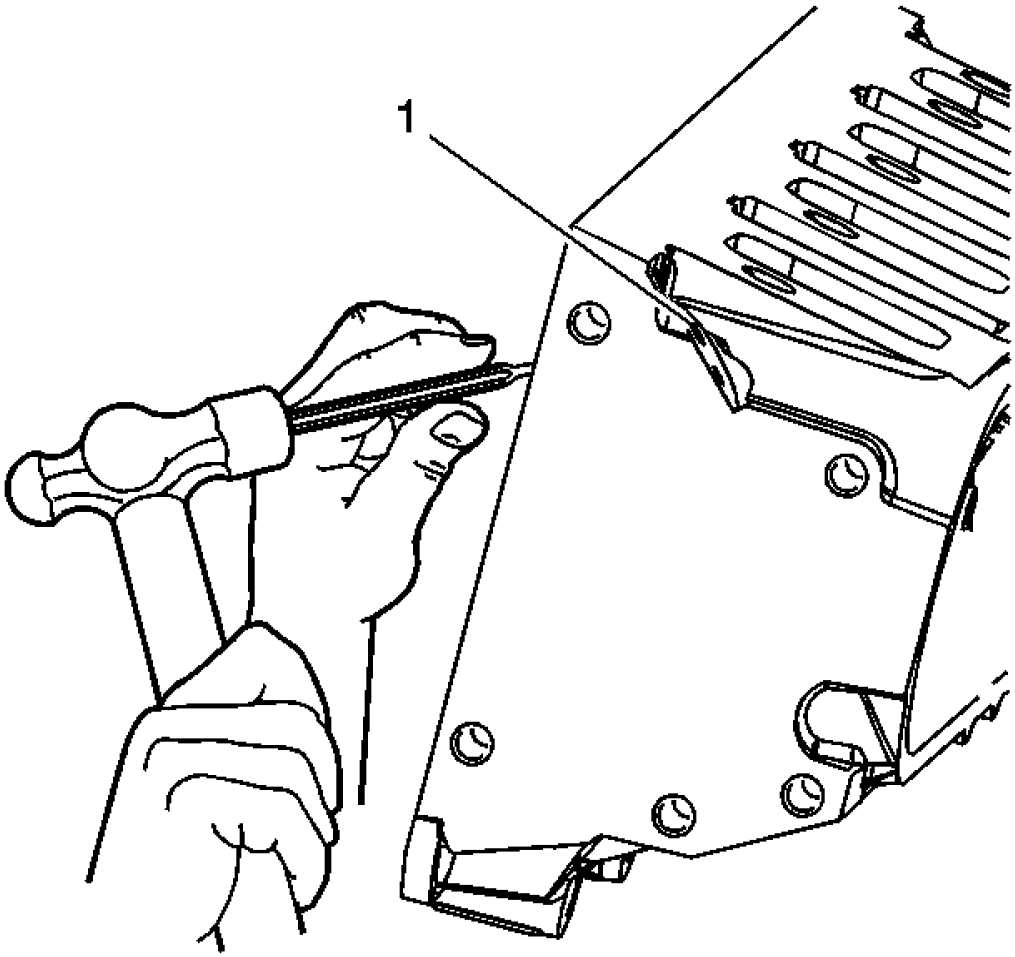


Fig. 21: Removing Plug Assembly
Courtesy of GENERAL MOTORS CORP.

12. Using a 6.43 mm (0.25 in) or smaller punch, remove the plug assembly (1) from the cylinder head.

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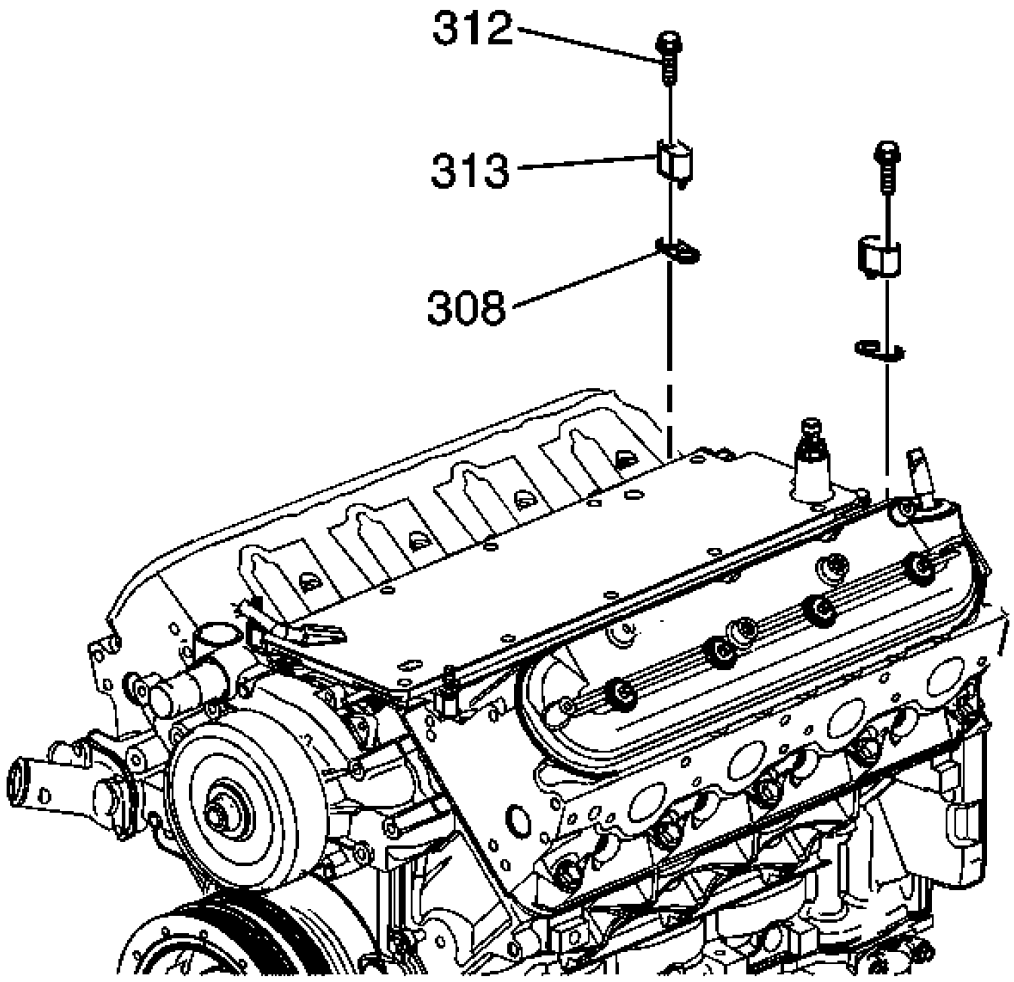


Fig. 22: Engine Coolant Air Bleed Cover, Bolts & Seals
Courtesy of GENERAL MOTORS CORP.

13. If plug removal is required, install either a new plug or a first design coolant air bleed cover (313), seal (308), and bolt (312) to complete the repair. Refer to **Cylinder Head Assemble**

CYLINDER HEAD CLEANING AND INSPECTION

Special Tools

- **J 8089:** Carbon Removal Brush
- **J 9666:** Valve Spring Tester

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For equivalent regional tools, refer to **Special Tools** .

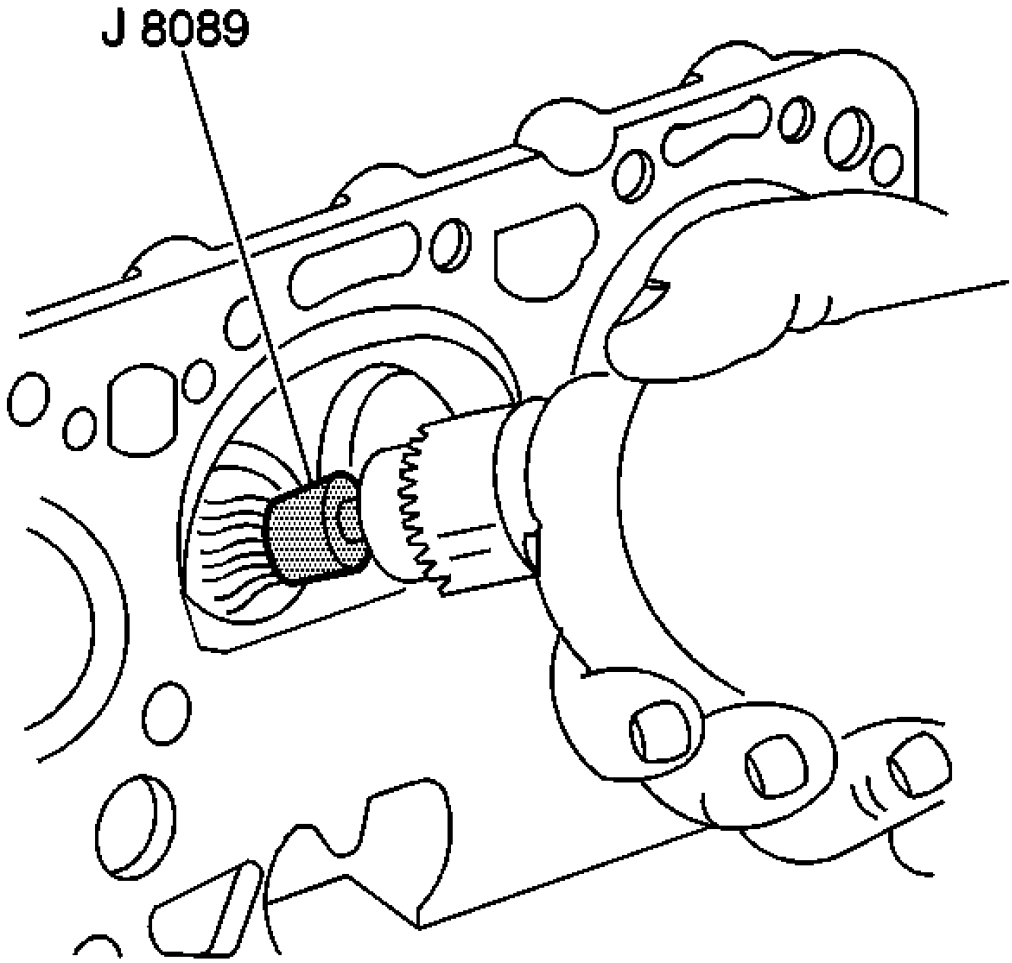


Fig. 23: Removing Carbon
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Safety Glasses Warning .

NOTE:

- **When cleaning a cylinder head in a thermal type oven, do not exceed 204°C (400°F).**
- **Be careful not to scuff the chamber.**

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1. Clean the following components:
   - Use the **J 8089:** brush in order to remove the carbon from the combustion chambers.
   - Gasket surfaces

     Refer to **Replacing Engine Gaskets** .

   - Valve stems and heads on a buffing wheel
   - Bolt hole threads

     Remove all dirt, debris, or threadlocking material from the bolt holes.

2. Inspect the cylinder head for the following conditions:
   1. Cracks in the exhaust ports and combustion chambers
   2. External cracks in the water chambers
   3. Gasket surfaces for excessive scratches or gouging

      Refer to **Replacing Engine Gaskets** .

   4. Bolt hole threads for debris or damaged threads

      Refer to **Thread Repair** or **Thread Repair Specifications** .

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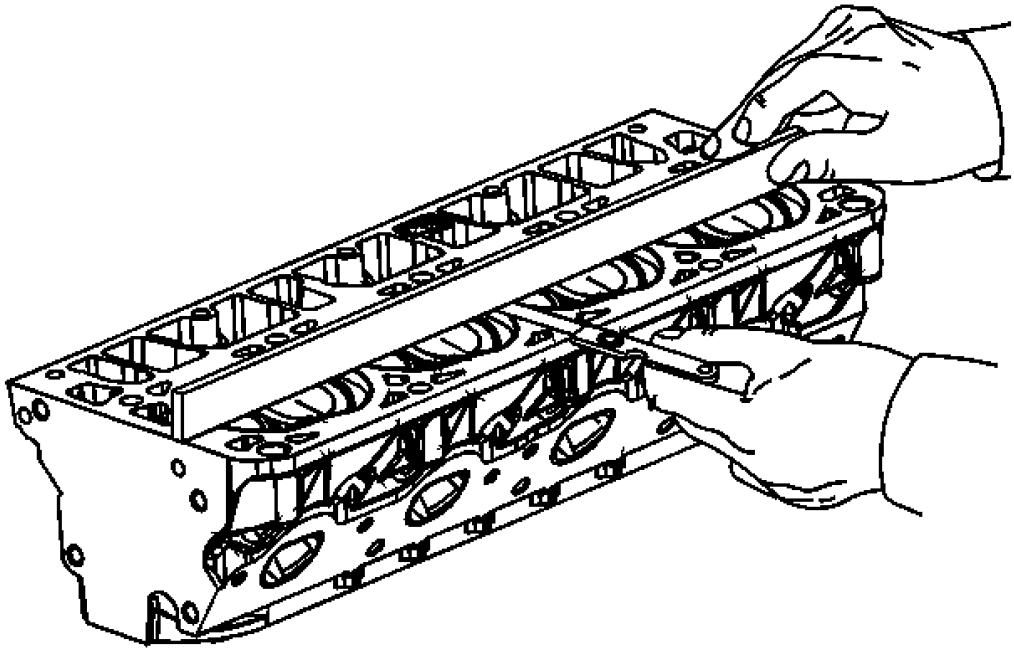


Fig. 24: Inspecting Cylinder Head For Warpage
Courtesy of GENERAL MOTORS CORP.

3. Inspect the cylinder head for warpage. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

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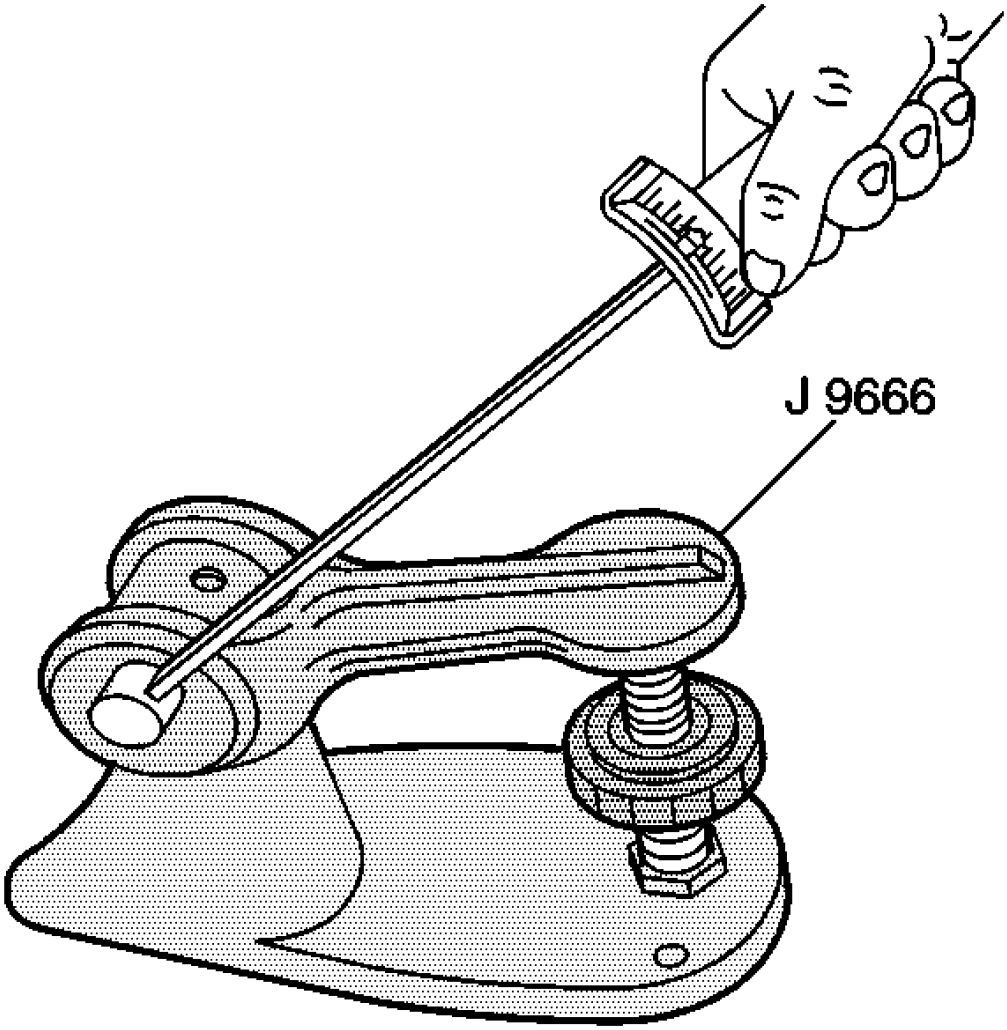


Fig. 25: Measuring Valve Spring Tension
Courtesy of GENERAL MOTORS CORP.

4. Use the **J 9666:** tester in order to measure the valve spring tension. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

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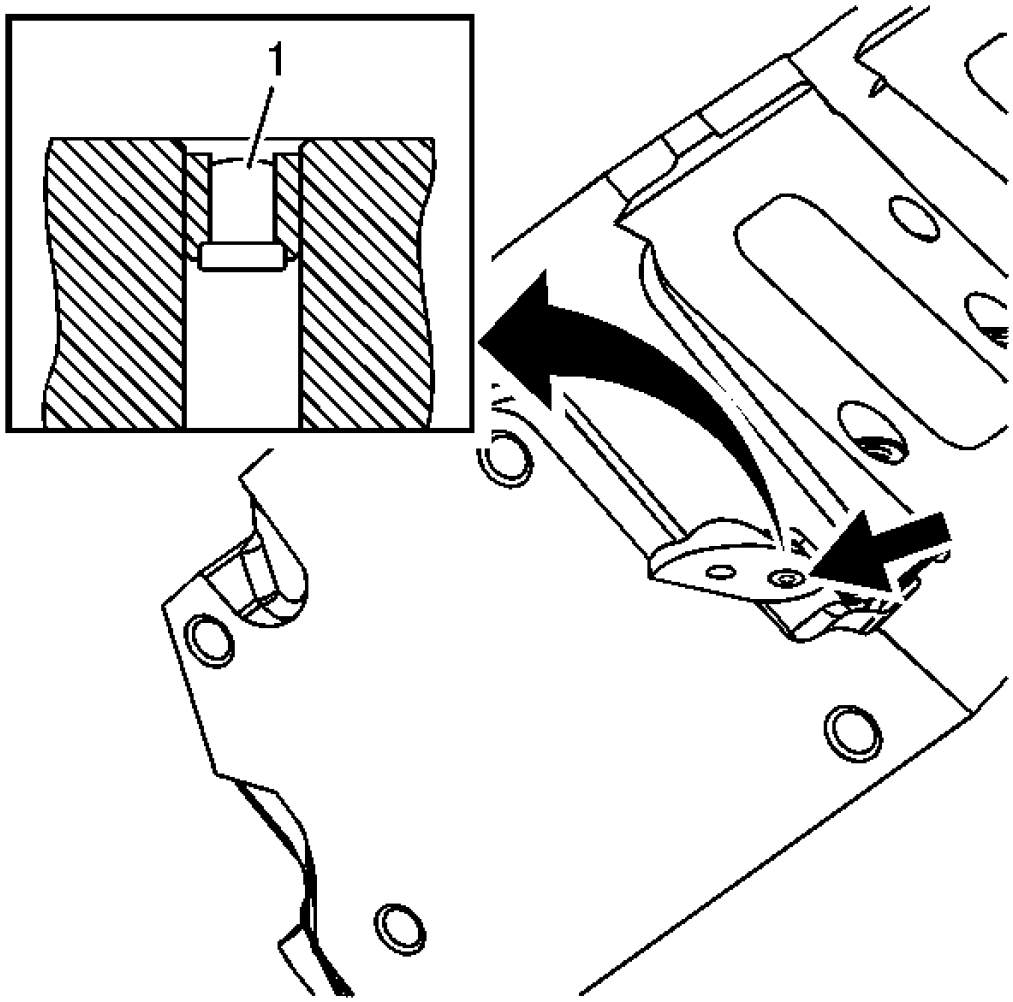


Fig. 26: Rivet-Type Plug
Courtesy of GENERAL MOTORS CORP.

5. Inspect for a leaking plug (1) at the top rear coolant passage of each cylinder head. If service of a leaking plug is required, it is necessary to remove the cylinder head from the engine to properly remove the plug. Refer to **Cylinder Head Disassemble**.

VALVE GUIDE REAMING, AND VALVE AND SEAT GRINDING

SPECIAL TOOLS

J 8001: Dial Indicator Set

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For equivalent regional tools, refer to **Special Tools** .

VALVE GUIDE REAMING

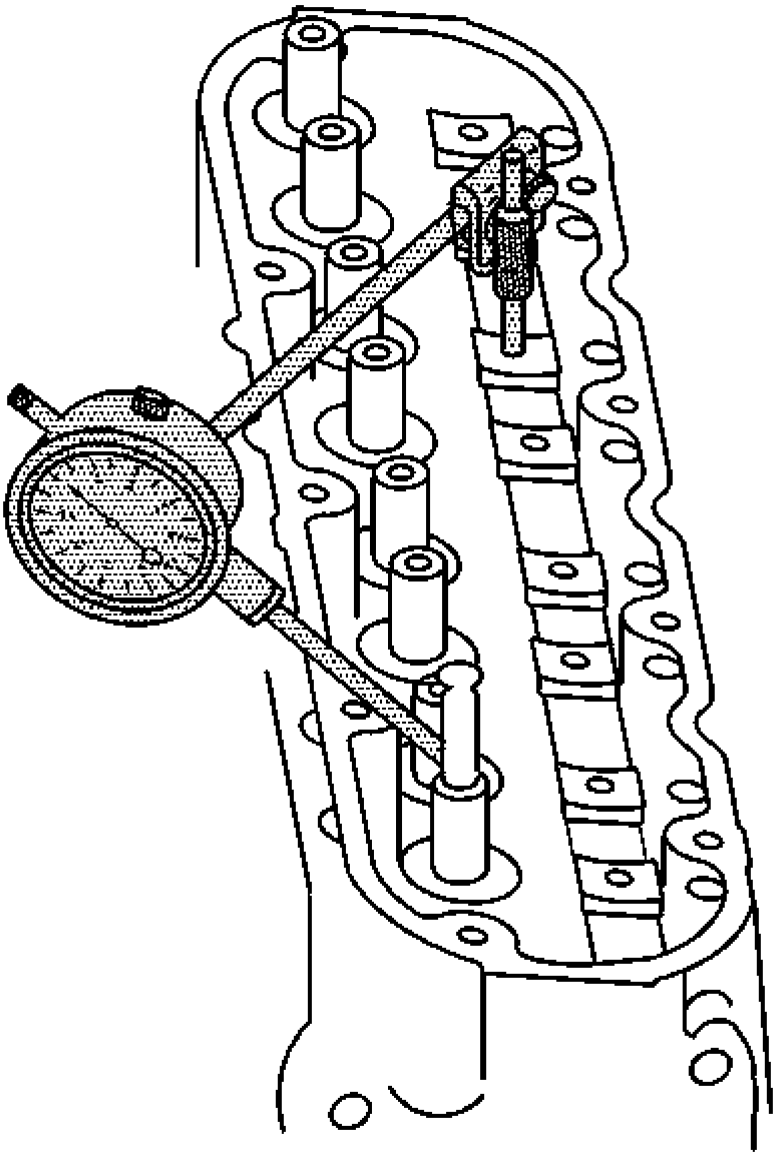


Fig. 27: Measuring Valve Stem-To-Guide Clearance
Courtesy of GENERAL MOTORS CORP.

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CAUTION: Excessive valve stem-to-guide clearance may cause a noisy valve train, premature valve stem oil seal wear, component damage, and/or excessive engine oil consumption.

CAUTION: Insufficient valve stem-to-guide clearance will result in noisy or sticking valves. Valves that are too tight may disturb engine smoothness or lead to component damage.

1. Using the **J 8001:** dial indicator, measure the valve stem-to-guide clearance. Position the tip of the dial indicator at the top of the valve guide.

   Valve stem-to-guide clearance may also be obtained by using a micrometer to measure the valve stem diameter and a ball type measuring gauge to measure the guide bore.

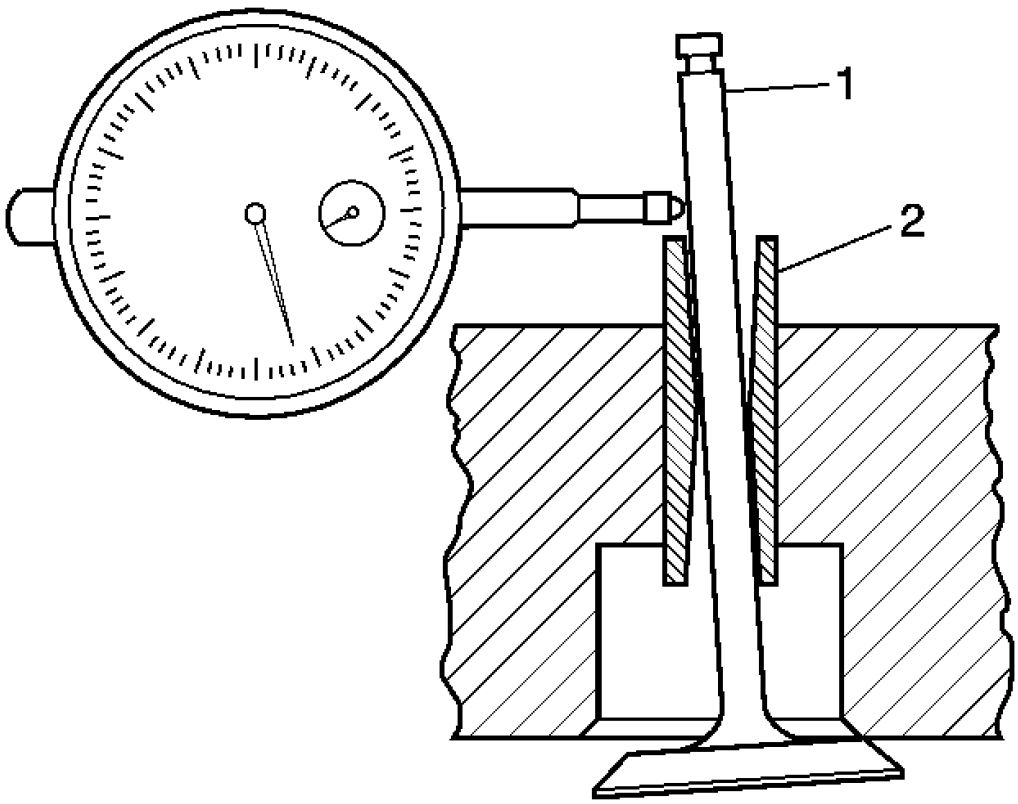


Fig. 28: Inspecting For Excessive Valve Stem To Guide Clearance
Courtesy of GENERAL MOTORS CORP.

2. If the clearance measurement between the valve stem (1) and guide (2) is not within specification, the

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valve and/or the cylinder head must be replaced. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

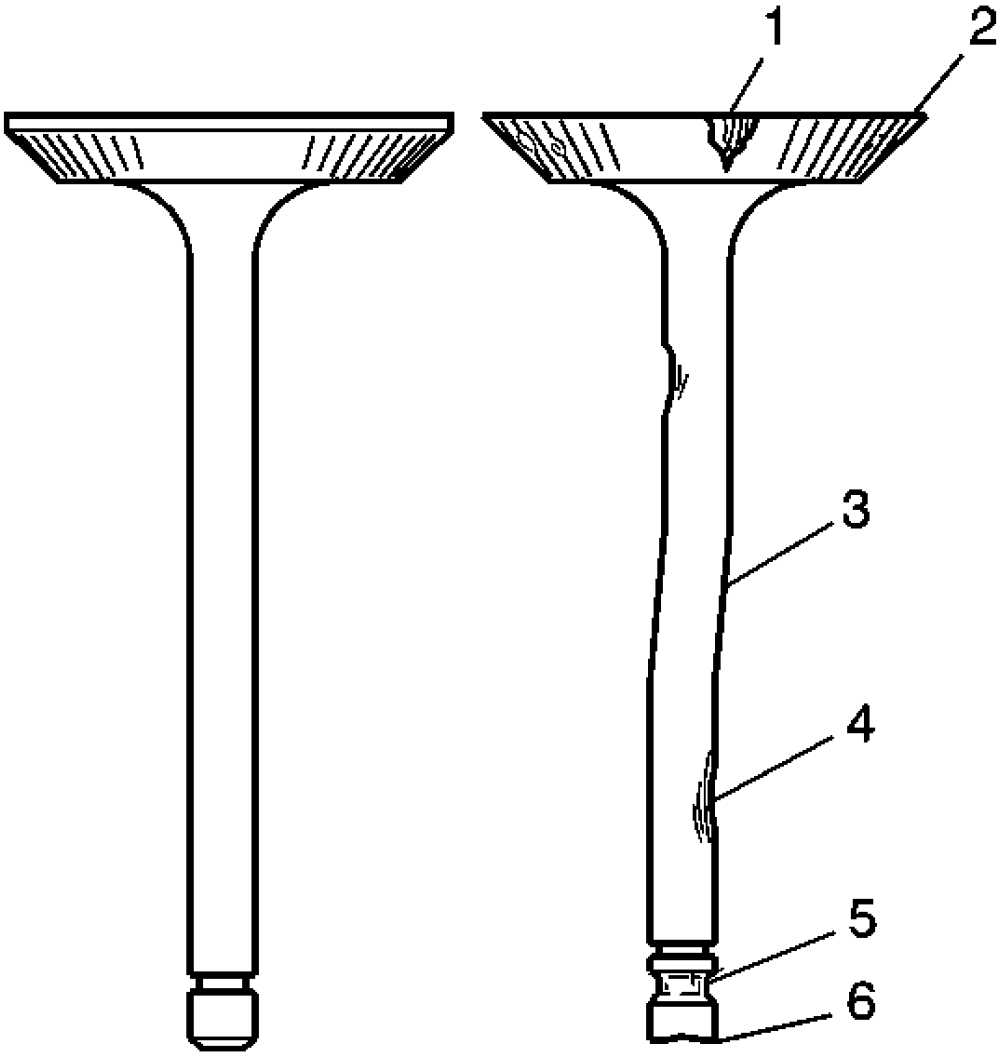


Fig. 29: Identifying Valve Damage
Courtesy of GENERAL MOTORS CORP.

3. Inspect the valve stems for excessive scoring, wear, or warpage.
   - A valve stem that has excessive scoring (3 or 4) or wear (4 or 6) must be replaced.
   - If a valve guide is worn or has excessive stem-to-guide clearance, the cylinder head should be replaced.

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4. Measure the valve stem diameter. If the valve stem diameter is not within specification, the valve must be replaced. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

   If the valve stem diameter is within specifications, and the stem-to-guide clearance is excessive, the cylinder head must be replaced.

VALVE AND SEAT GRINDING

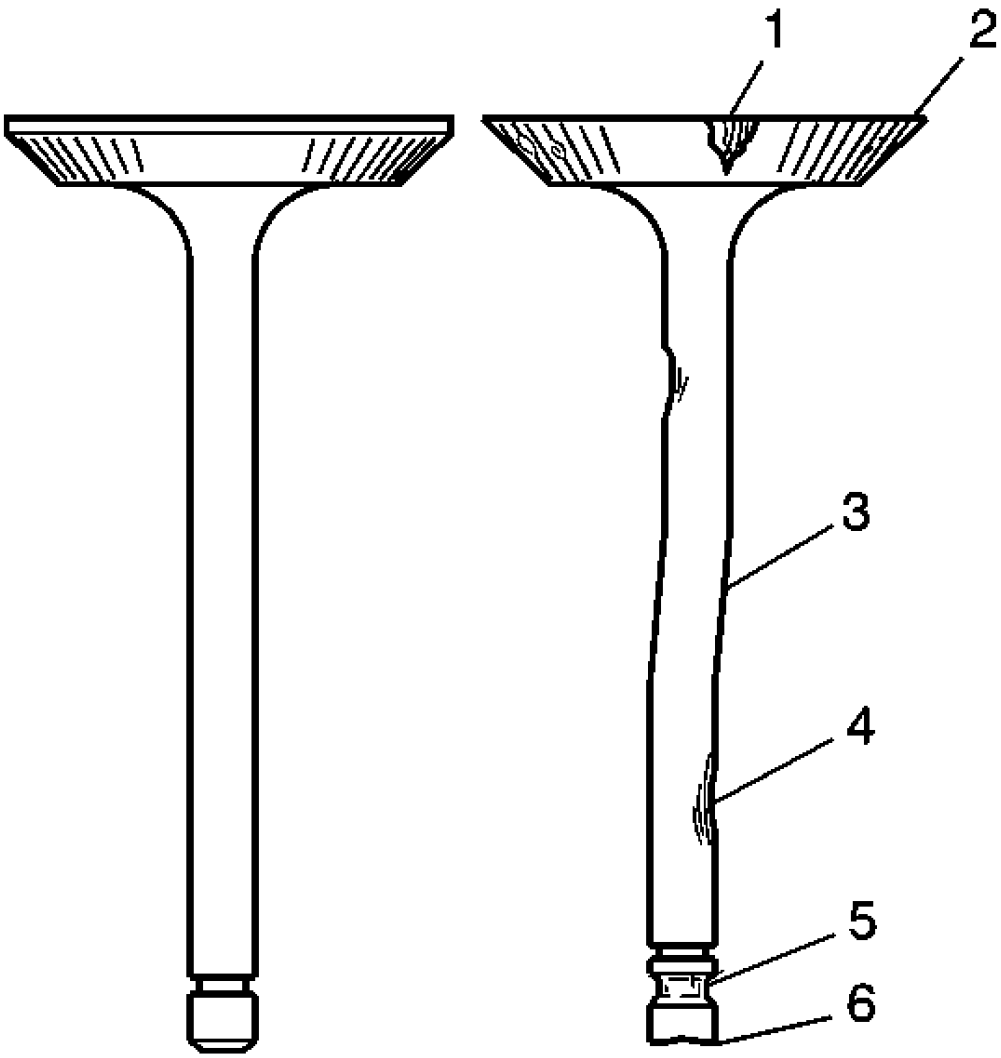


Fig. 30: Identifying Valve Damage

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Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Reconditioning the valve seats is very important. The seating of the valves must be perfect for the engine to deliver optimum power and performance. Several different types of equipment are available for grinding valve seats.**
- **Another important factor is the cooling of the valve head. Good contact between the valve and the seat will ensure that heat will be properly dissipated.**
- **The recommendations of the equipment manufacturer should be followed carefully to obtain the proper results. Regardless of the type of equipment used, it is essential that valve guide bores be free of carbon or dirt to ensure proper centering of the tool pilot in the guide.**
- **Valves that are pitted must be refaced to the proper angle. Valve stems that show excessive wear, or valves that are warped excessively must be replaced. When a valve head that is warped excessively is refaced, a knife edge may be ground on part or all of the valve head due to the amount of metal that must be removed. Knife edges lead to breakage, burning or pre-ignition due to heat localizing on this knife edge. If the edge of the valve head, margin, is not within specification after grinding, replace the valve.**
- **Several different types of equipment are available for refacing valves. The recommendation of the equipment manufacturer should be carefully followed to obtain the proper results.**
- **DO NOT reface intake valves. Intake valves with excessive wear or damage MUST be replaced.**

1. Inspect the valve for the following conditions:
   - Burnt or eroded areas (1)
   - A worn margin (2)
   - A bent stem (3)
   - A worn or scored stem (4)
   - A worn key groove (5)
   - A worn stem tip (6)

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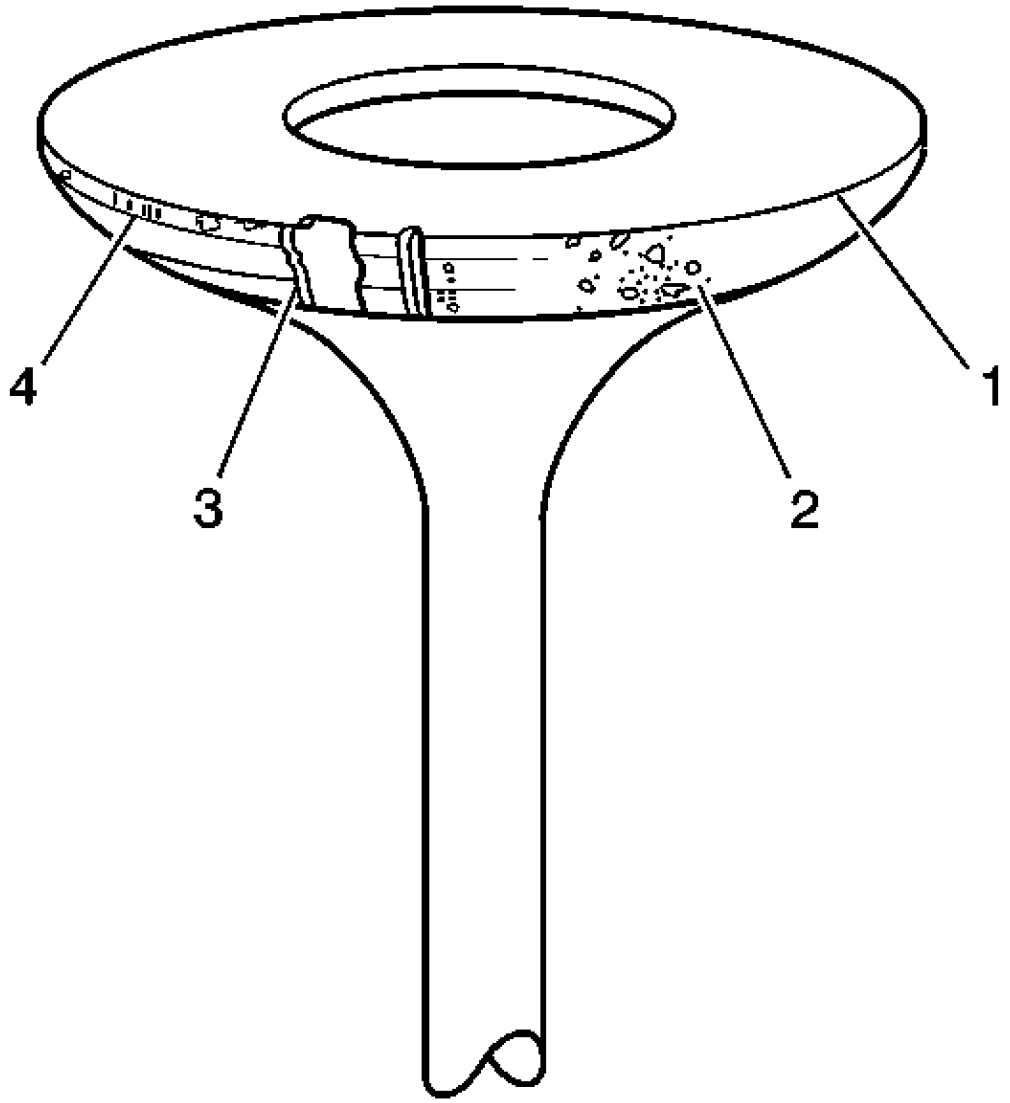


Fig. 31: Inspecting Valve Face For Burning, Pitting & Cracking
Courtesy of GENERAL MOTORS CORP.

2. Inspect the valve face for the following conditions:
   - Worn or no margin (1 or 4)
   - Pitted surfaces (2)
   - Burnt or eroded areas (3)

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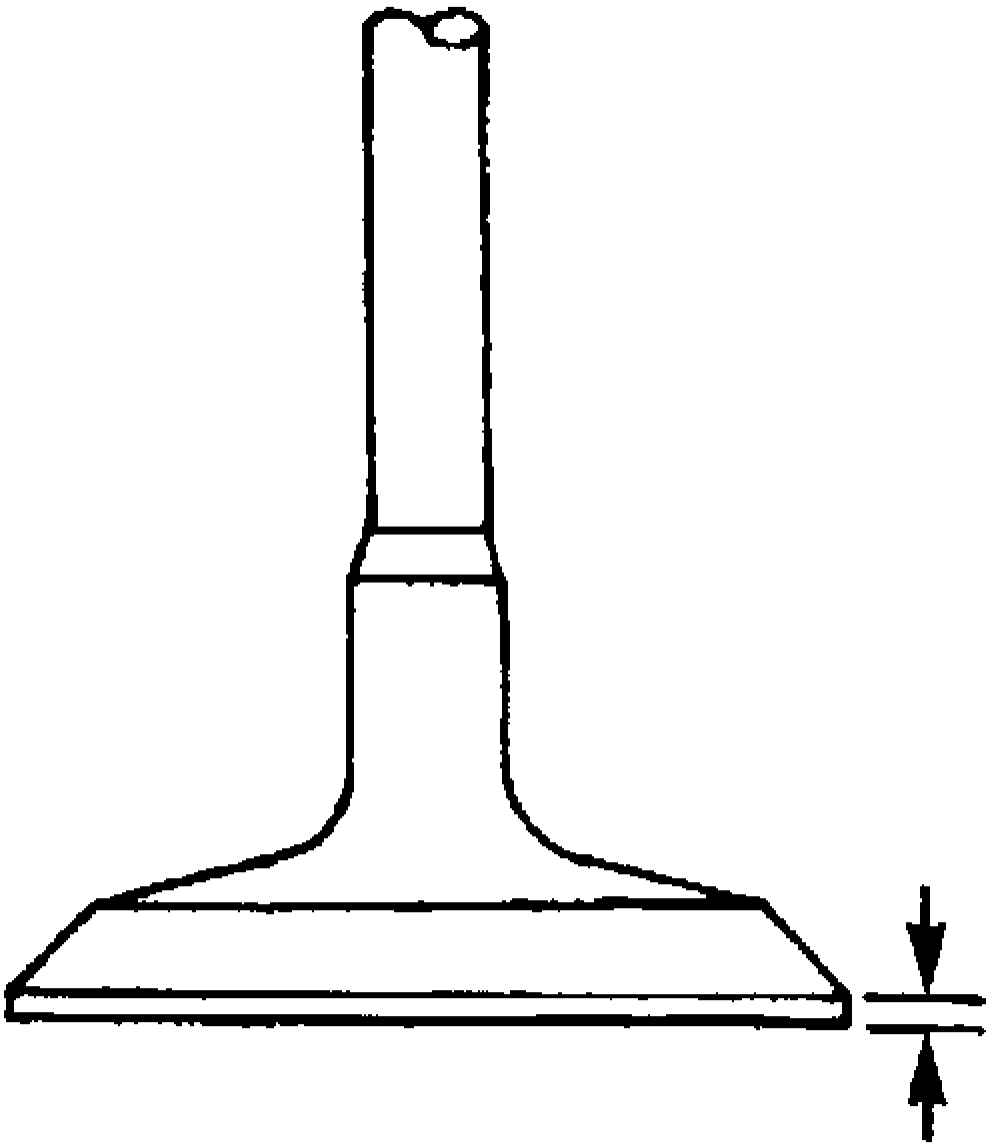


Fig. 32: Inspecting Valve Margin
Courtesy of GENERAL MOTORS CORP.

3. Inspect the valve margin.

   The exhaust valve may be refaced if the margin is within specification before grinding. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

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4. Reface pitted exhaust valves on a suitable valve refacing machine.
5. Replace the valve if the margin is not within specification after grinding. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .
6. If the valve face has been ground, measure the valve spring installed height after reassembly of the cylinder head. The valve, and/or cylinder head must be replaced if the valve spring installed height is not within specification. Refer to **Cylinder Head Assemble**.
7. Inspect for a loose valve seat in the cylinder head. The valve seat has an interference fit to the cylinder head.
8. Clean the valve guide bores with a suitable tool. Remove all carbon or dirt from the bores.

   The valve guide must be clean for the seat grinding tool to obtain proper results.

9. Grind the valve seat.

   The recommendations of the equipment manufacturer should be followed carefully to obtain the proper results. Regardless of the type of equipment used, it is essential that valve guide bores be free from carbon or dirt to ensure proper centering of the tool pilot in the guide.

10. Inspect the valve seats.
    - The valve seats should be concentric to the centerline of the guide, measure valve seat runout. The total indicator runout reading must be within specification. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .
    - If the valve seat has been ground, measure the valve spring installed height after reassembly of the cylinder head. The cylinder head, and/or valve must be replaced if the valve spring installed height is not within specification after seat grinding. Refer to **Cylinder Head Assemble**.

CYLINDER HEAD ASSEMBLE

Special Tools

J 8062: Valve Spring Compressor - Head Off

For equivalent regional tools, refer to **Special Tools**

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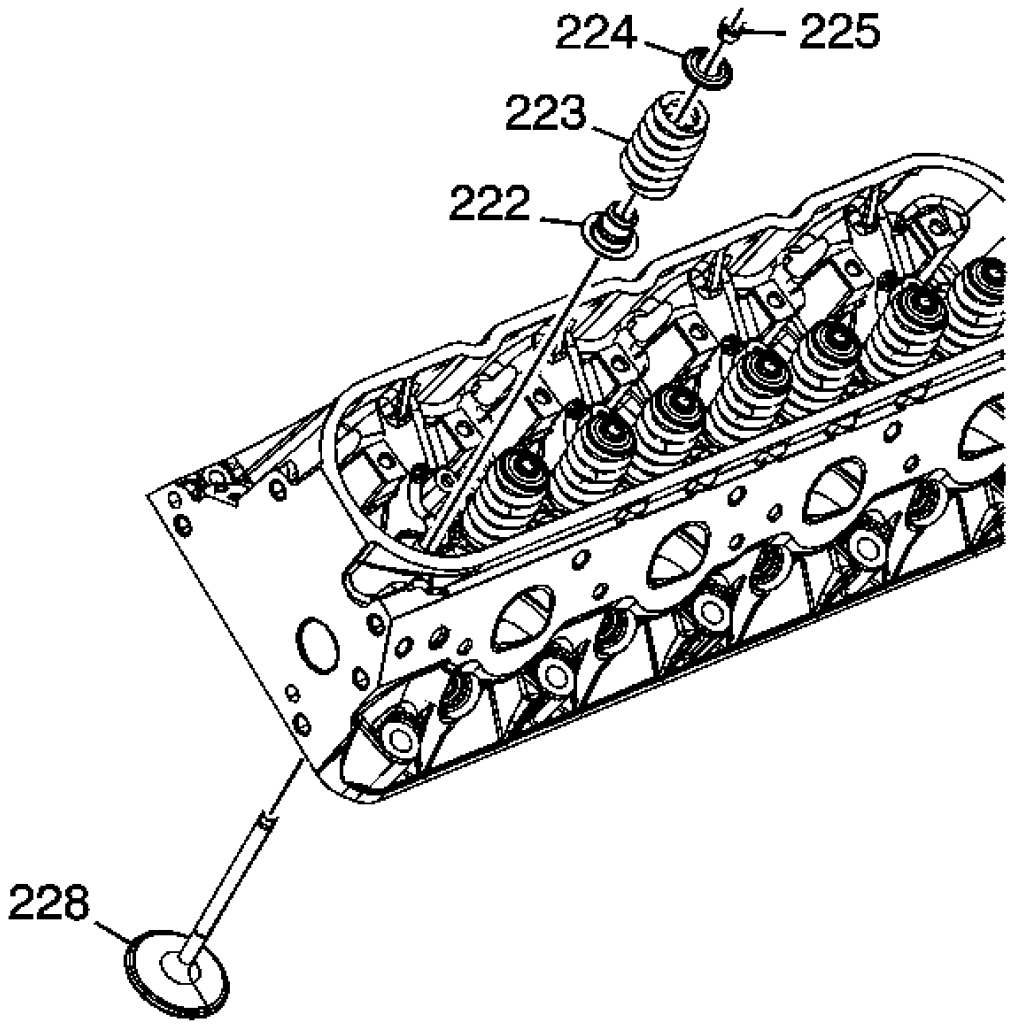


Fig. 33: Valve Components
Courtesy of GENERAL MOTORS CORP.

1. Clean the cylinder head valve spring shim area.

NOTE: When using the valves and related components again, install the parts to their original location.

2. Install the valves (228) into the proper port. Refer to **Separating Parts**
3. Install a NEW valve stem oil seal (222).
4. Install the valve spring (223).

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5. Install the valve spring cap (224).

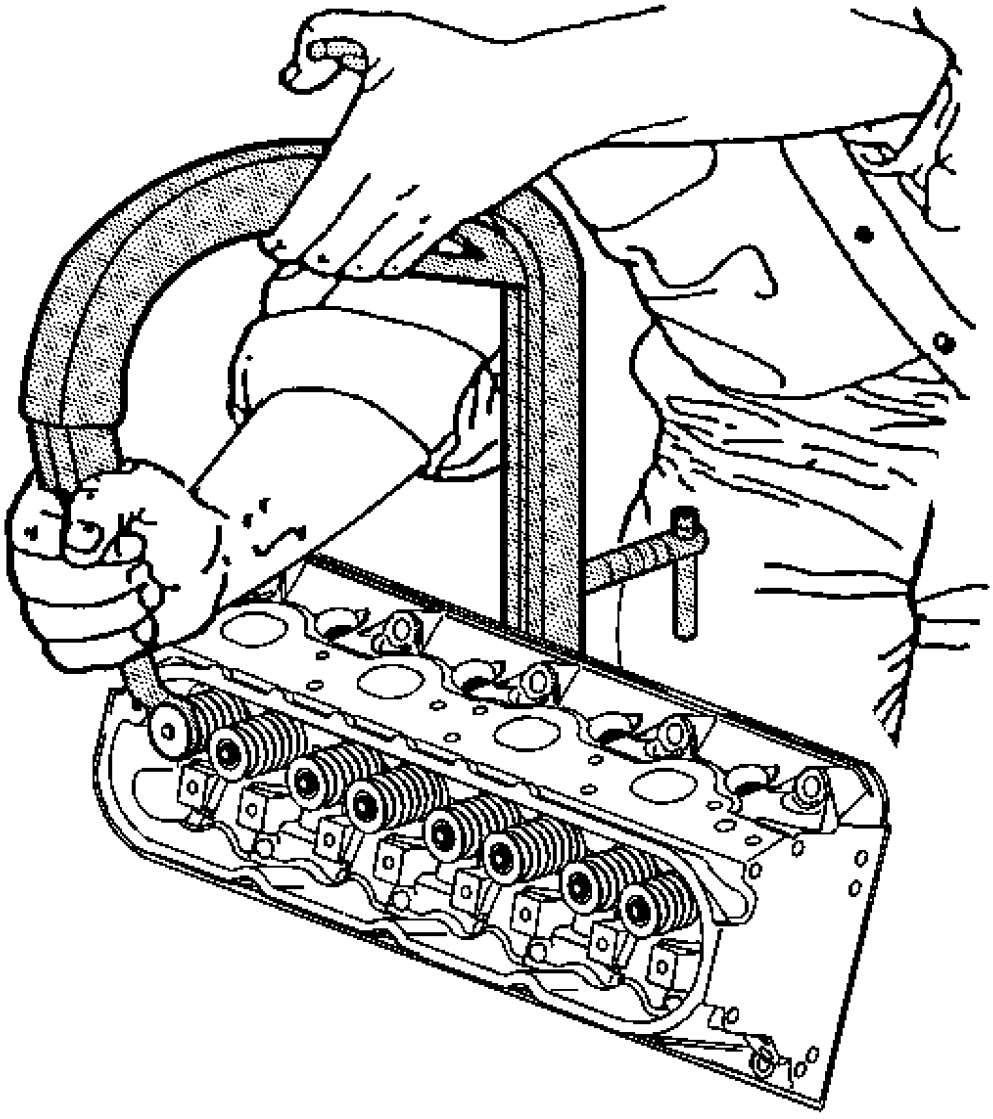


Fig. 34: Compressing Valve Spring
Courtesy of GENERAL MOTORS CORP.

6. Using the **J 8062:** spring compressor, compress the valve spring.
7. Install the valve stem keys.
    1. Use grease in order to hold the keys in place and remove the **J 8062:** spring compressor .

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2. Ensure the keys seat properly in the groove of the valve stem.
3. Tap the end of the valve stem with a plastic face hammer to seat the keys, if necessary.

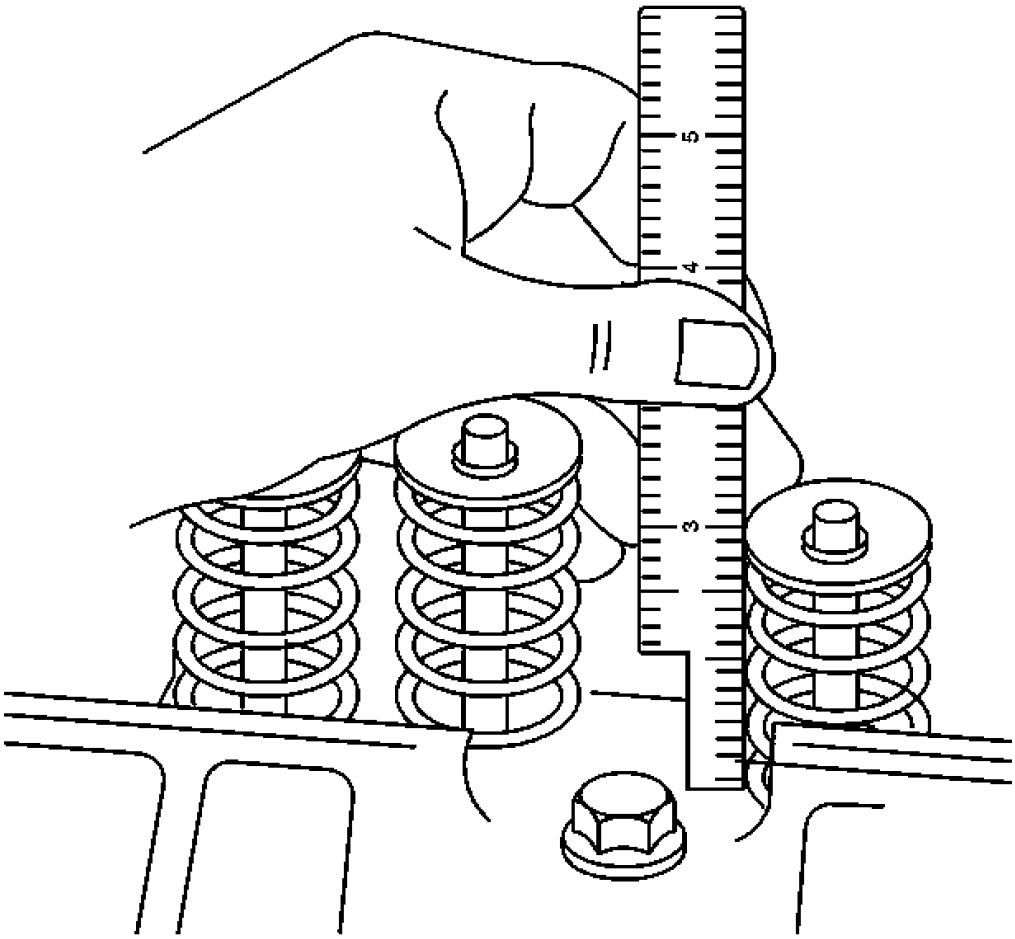


Fig. 35: Measuring Valve Spring Installed Height
Courtesy of GENERAL MOTORS CORP.

8. After installation, measure the valve spring installed height.

   Measure from the base of the valve spring to the top of the valve spring. If the spring installed height is not within specification, the valve and/or cylinder head must be replaced. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)**

9. Install the remaining valves, springs, and other components.

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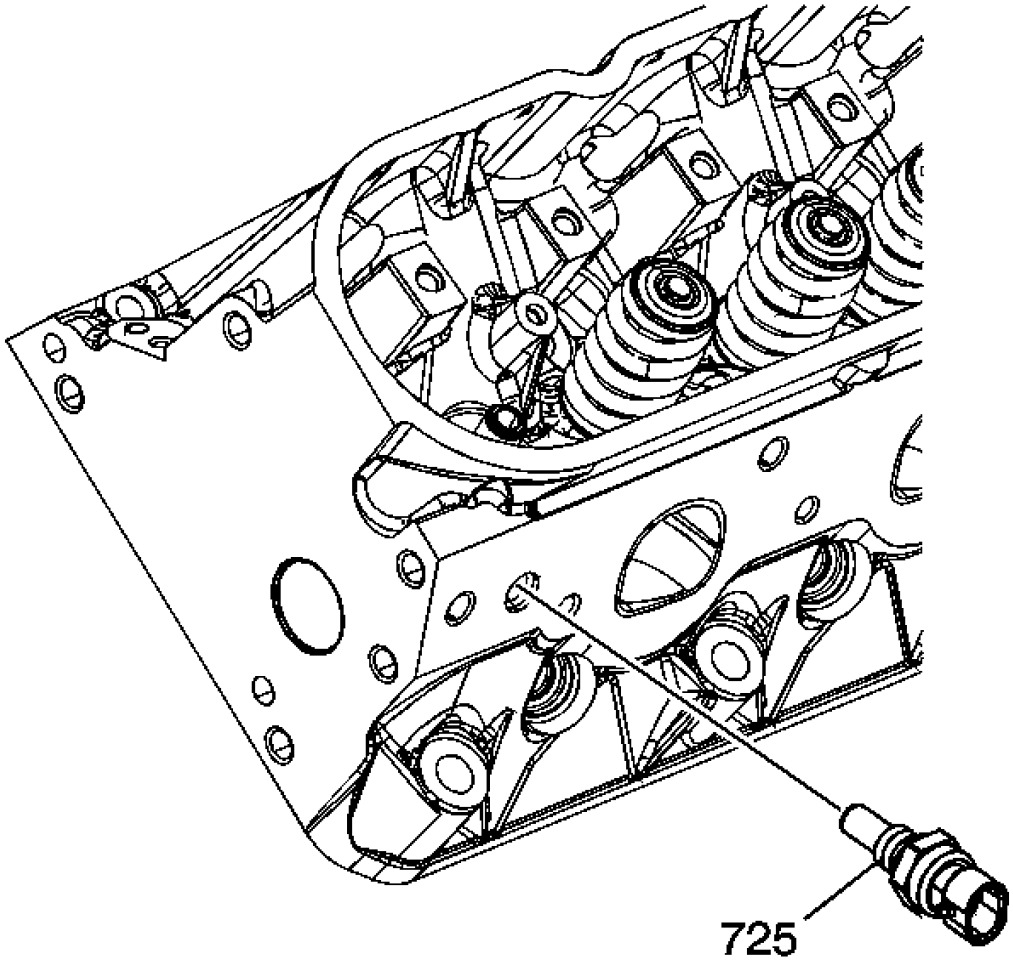


Fig. 36: Locating Coolant Temperature Sensor
Courtesy of GENERAL MOTORS CORP.

10. Install sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the coolant temperature sensor (725).

CAUTION: Refer to Fastener Caution

11. Install the coolant temperature sensor into the left cylinder head and tighten to 20 N.m (15 lb ft).

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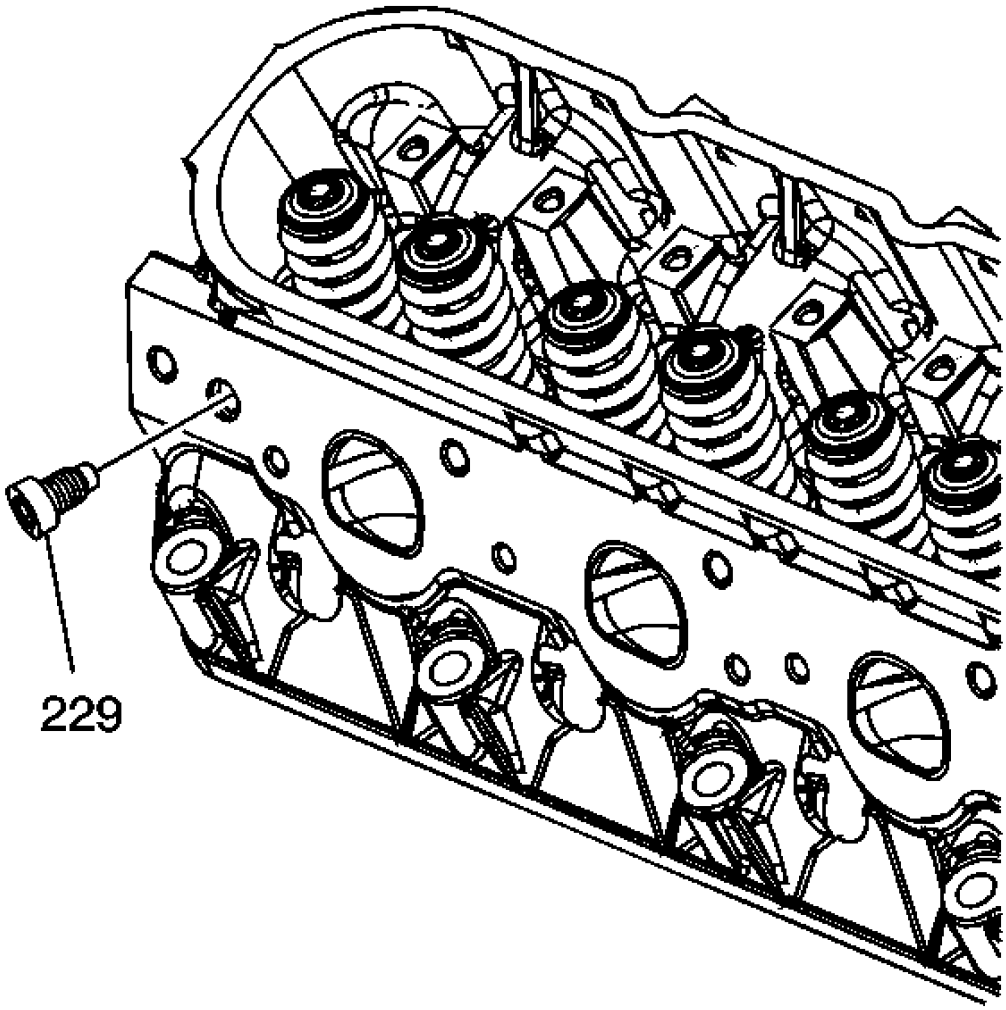


Fig. 37: Cylinder Head Plug
Courtesy of GENERAL MOTORS CORP.

12. Install sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the cylinder head plug (229).
13. Install the cylinder head plug to the right cylinder head and tighten to 20 N.m (15 lb ft).

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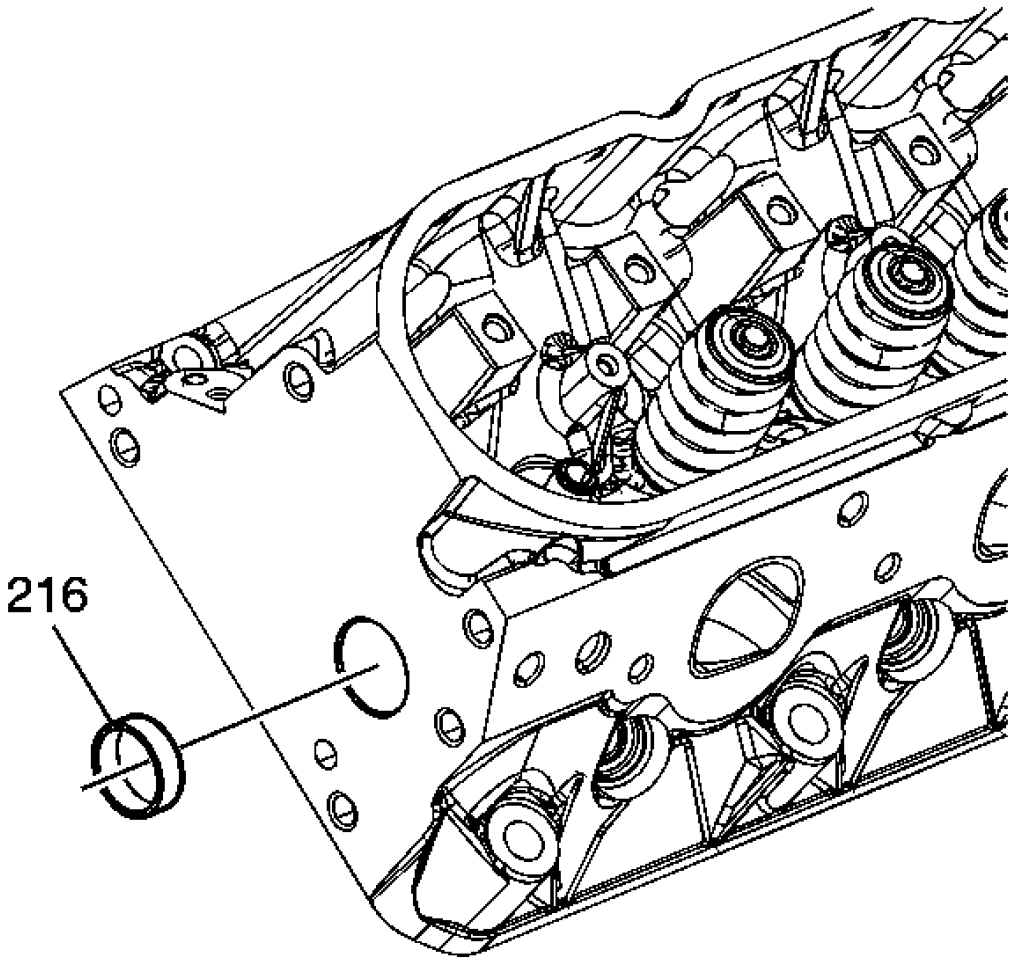


Fig. 38: Locating Cylinder Head Core Hole Plug
Courtesy of GENERAL MOTORS CORP.

14. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the sides of the cylinder head plugs (216).
15. Install the cylinder head plugs into the cylinder head.

    A properly installed plug should be installed 2.5 mm (0.1 in) below the end face of the head.

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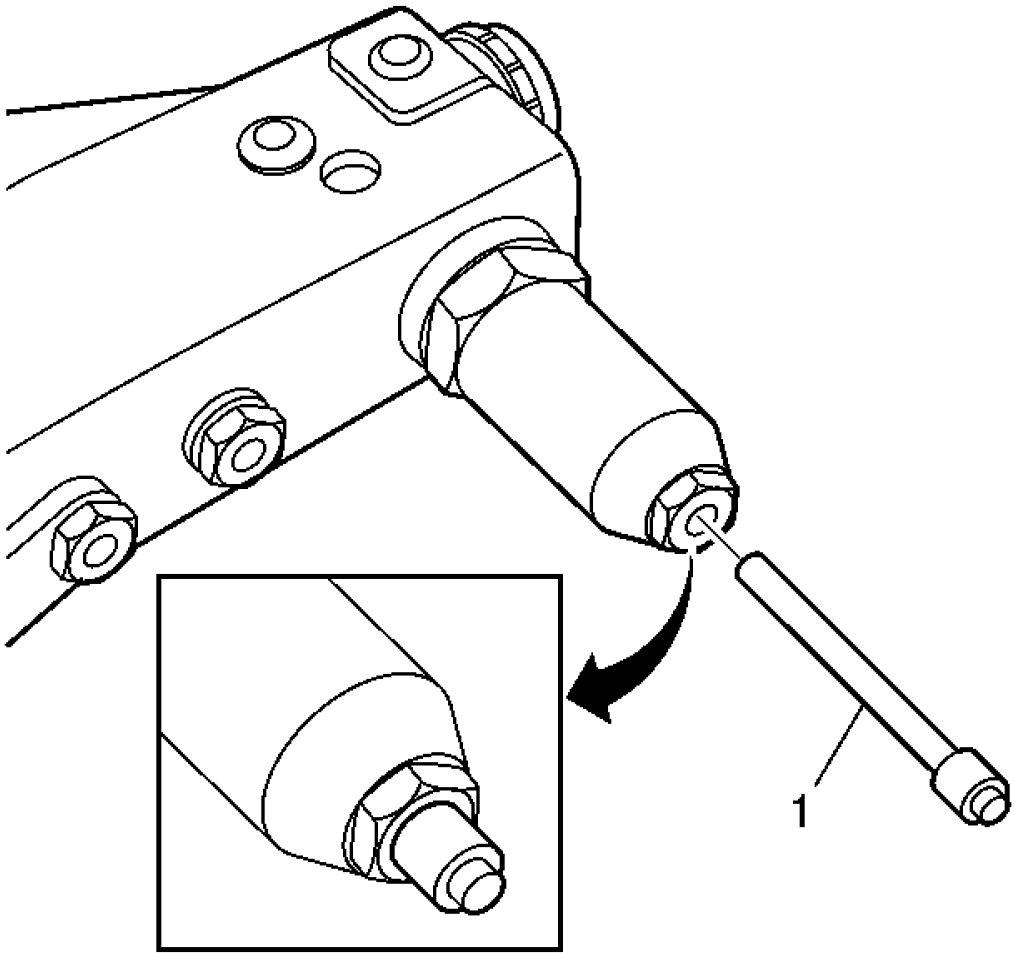


Fig. 39: Rivet Plug
Courtesy of GENERAL MOTORS CORP.

16. Install the rivet plug (1) into a rivet gun.

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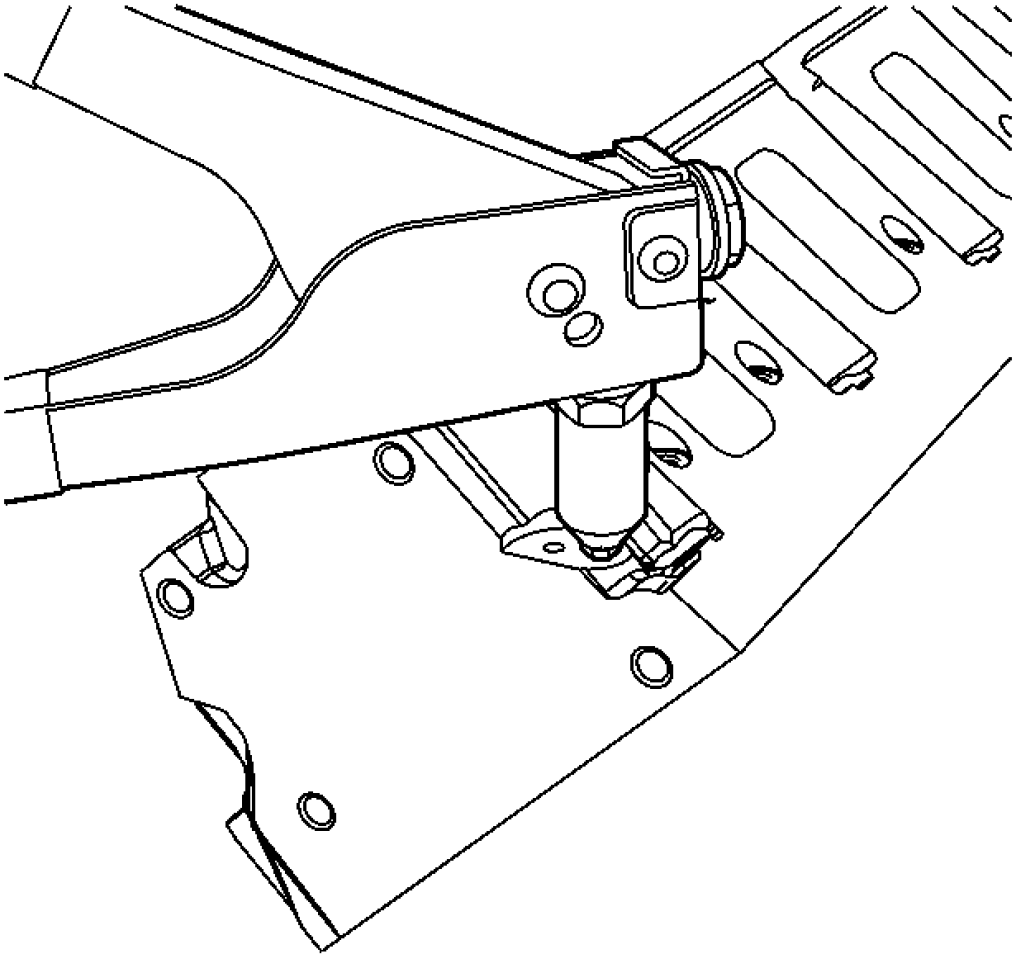


Fig. 40: Installing Rivet
Courtesy of GENERAL MOTORS CORP.

17. Insert the rivet into the coolant passage of the cylinder head.
18. Squeezing the handle of the tool, install the rivet.

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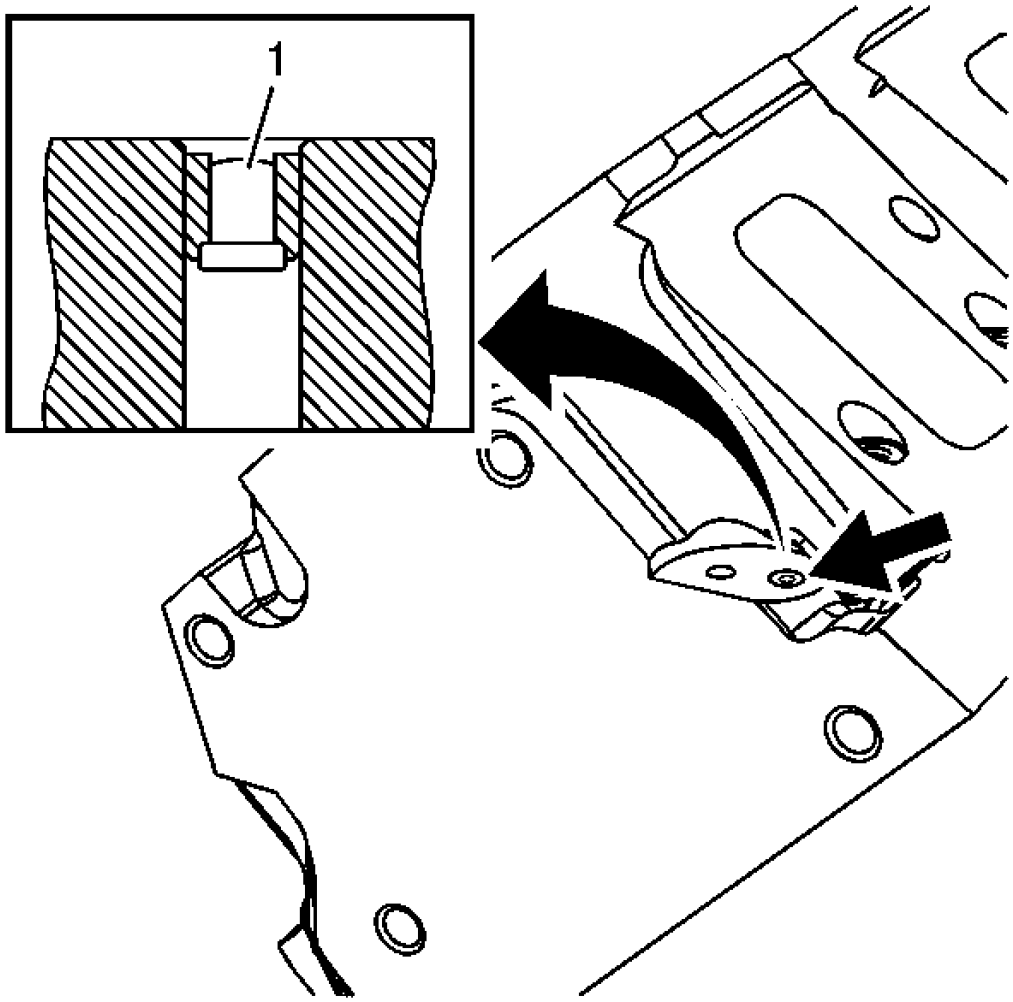


Fig. 41: Rivet-Type Plug
Courtesy of GENERAL MOTORS CORP.

19. Inspect for proper installation of the rivet (1).

    A properly installed plug should be installed flush with the surface of the head.

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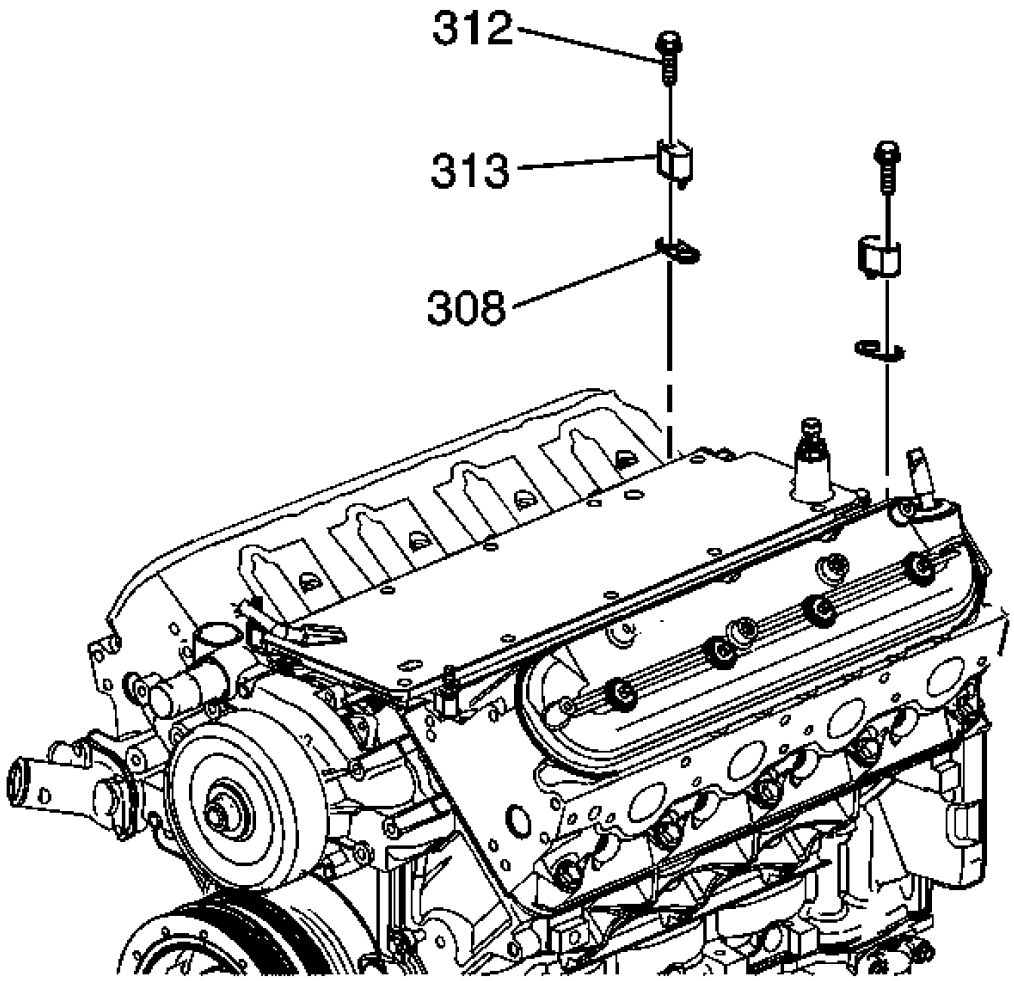


Fig. 42: Engine Coolant Air Bleed Cover, Bolts & Seals
Courtesy of GENERAL MOTORS CORP.

20. Installation of the first design coolant air bleed cover (313) and bolt (312) may be used instead of the rivet plug to complete the repair. Tighten the coolant air bleed bolts to 12 N.m (106 lb in).

OIL PUMP DISASSEMBLE

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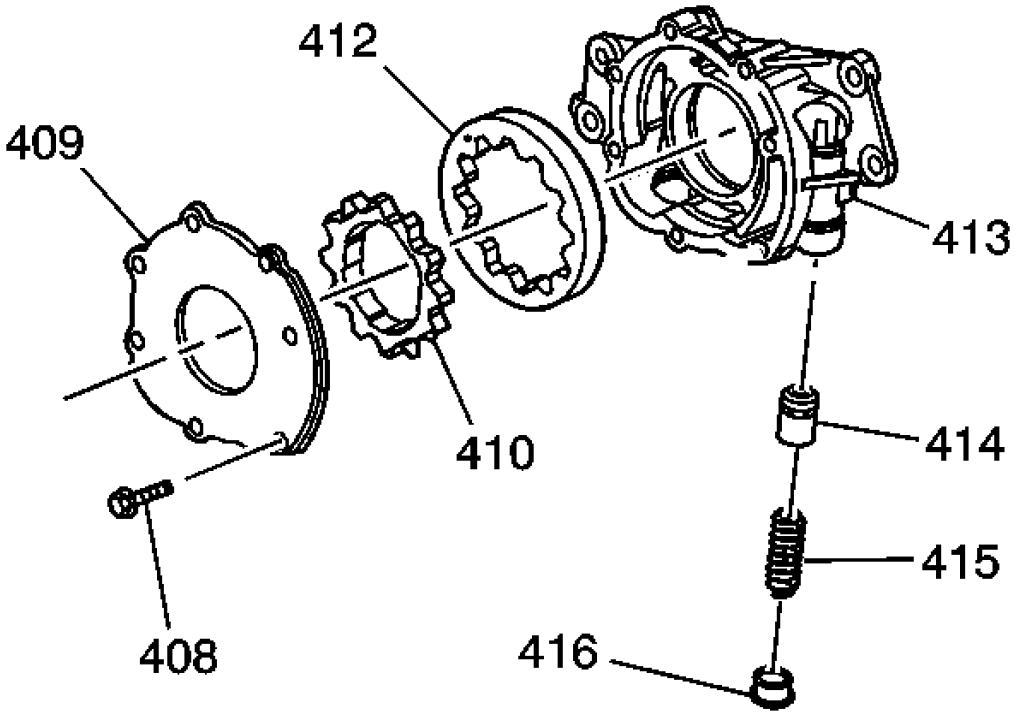


Fig. 43: Exploded View Of Oil Pump
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The internal parts of the oil pump assembly are not serviced separately, excluding the spring. If the oil pump components are worn or damaged, replace the oil pump as an assembly.

1. Remove the oil pump cover bolts (408).
2. Remove the oil pump cover (409).

IMPORTANT: Mark or identify the gears for assembly. Refer to Separating Parts .

3. Remove the drive gear (410).
4. Remove the driven gear (412).
5. Remove the pressure relief valve plug (416).
6. Remove the pressure relief valve spring (415).
7. Remove the pressure relief valve (414).
8. Inspect the oil pump components. Refer to **Oil Pump Cleaning and Inspection**.

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OIL PUMP CLEANING AND INSPECTION

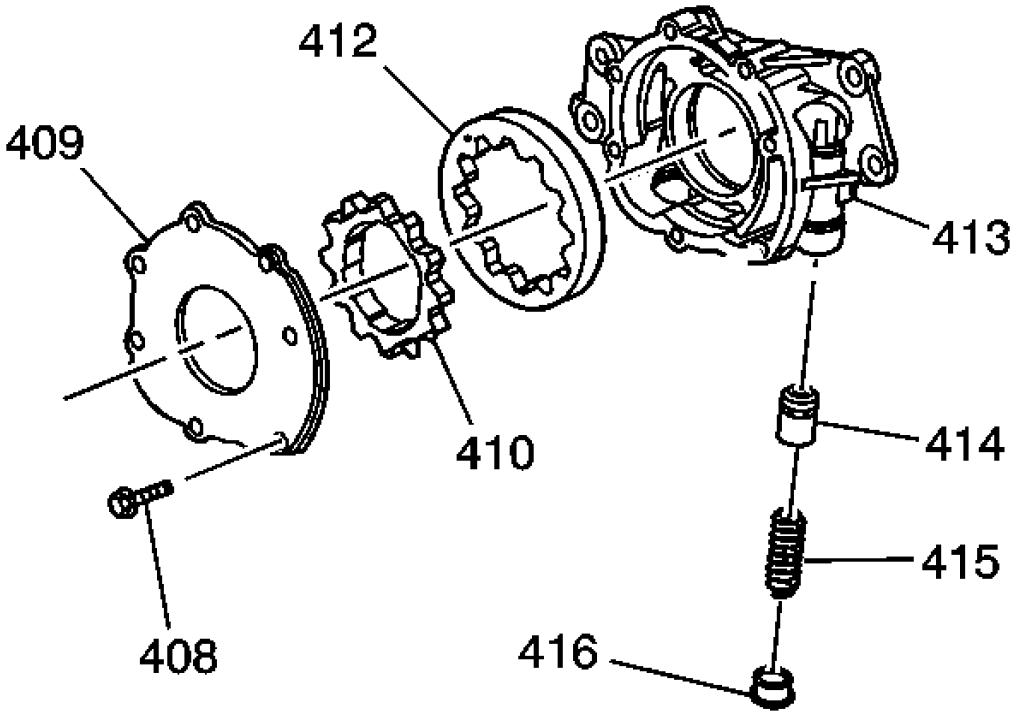


Fig. 44: Exploded View Of Oil Pump
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **The internal components of the oil pump assembly are not serviced separately, excluding the spring. If the oil pump components are worn or damaged, replace the oil pump as an assembly.**
- **The oil pump pipe and screen are to be serviced as an assembly. Do not attempt to repair the wire mesh portion of the pump and screen assembly.**

1. Clean the parts in solvent.

   WARNING: Refer to Safety Glasses Warning .

2. Dry the parts with compressed air.

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3. Inspect the oil pump housing (413) and the cover (409) for cracks, excessive wear, scoring, or casting imperfections.
4. Inspect the oil pump housing-to-engine block oil gallery surface for scratches or gouging.
5. Inspect the oil pump housing for damaged bolt hole threads.
6. Inspect the relief valve plug (416) and plug bore for damaged threads.
7. Inspect the oil pump internal oil passages for restrictions.
8. Inspect the drive gear (410) and driven gear (412) for chipping, galling, or wear.

   Minor burrs or imperfections on the gears may be removed with a fine oil stone.

9. Inspect the drive gear splines for excessive wear.
10. Inspect relief valve spring (415) for cracks, scratches, and wear to coils in spring.
11. Inspect the pressure relief valve (414) and bore for scoring or wear.

    The valve must move freely in the bore, with no restrictions.

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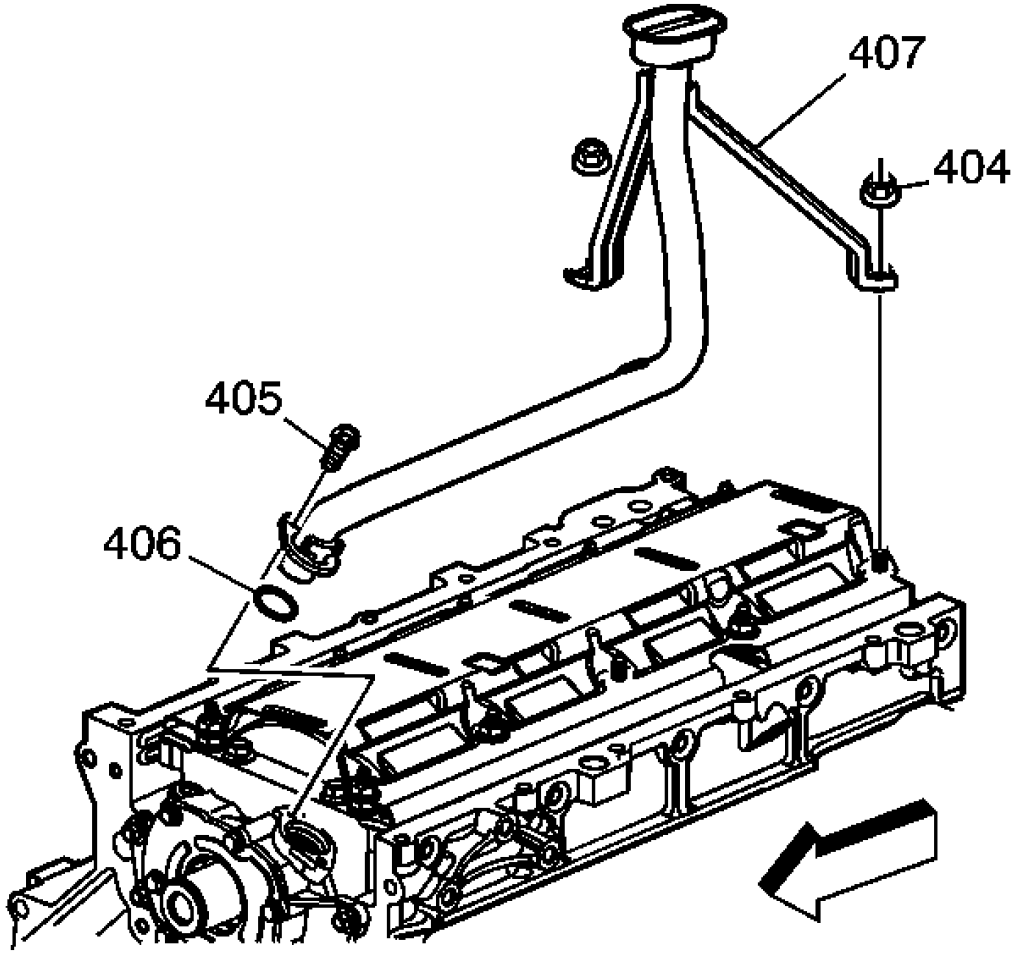


Fig. 45: View Of Oil Pump Screen, Bolt, Nuts, & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

12. Inspect the oil pump screen (407) for debris or restrictions.
13. Inspect the oil pump screen for broken or loose wire mesh.

OIL PUMP ASSEMBLE

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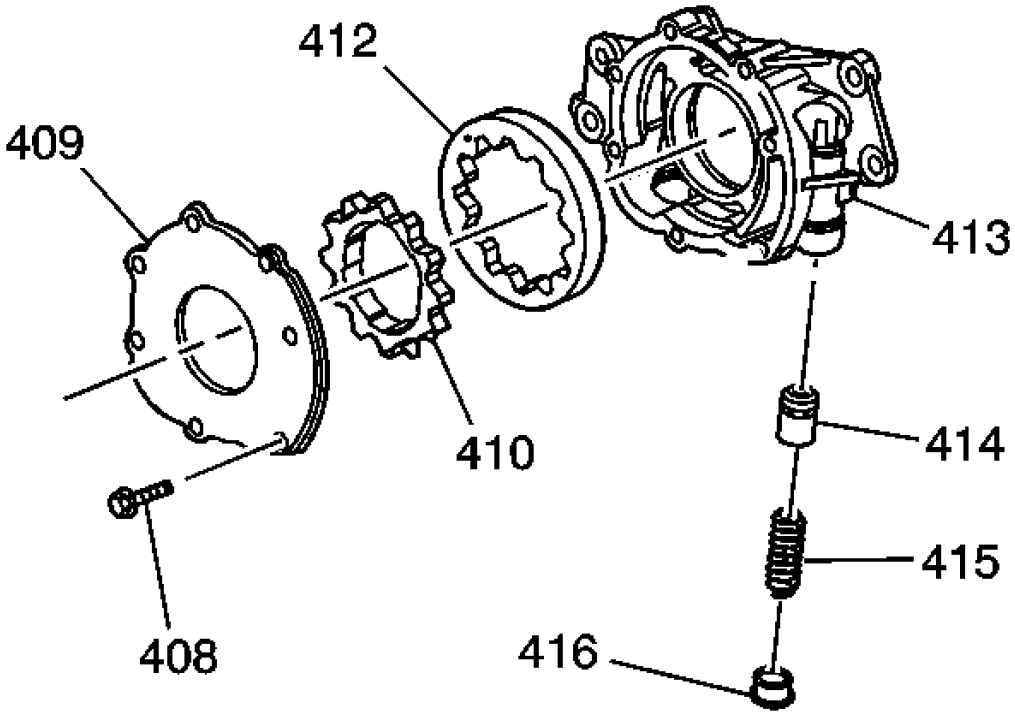


Fig. 46: Exploded View Of Oil Pump
Courtesy of GENERAL MOTORS CORP.

NOTE: Prior to assembling the oil pump, coat all wear or internal surfaces with clean engine oil.

1. Install the driven gear (412) into the pump housing (413).

   Install the driven gear with the orientation mark facing the pump cover.

2. Install the drive gear (410) into the pump housing.
3. Install the oil pump cover (409).

CAUTION: Refer to Fastener Caution .

4. Install the oil pump cover bolts (408) and tighten to 12 N.m (106 lb in).
5. Install the relief valve (414).
6. Install the relief valve spring (415).

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7. Install the relief valve plug (416) and tighten to 14 N.m (124 lb in).
8. Inspect the oil pump for smooth operation by rotating the drive gear.

ENGINE FRONT COVER CLEANING AND INSPECTION (6.2L LS3)

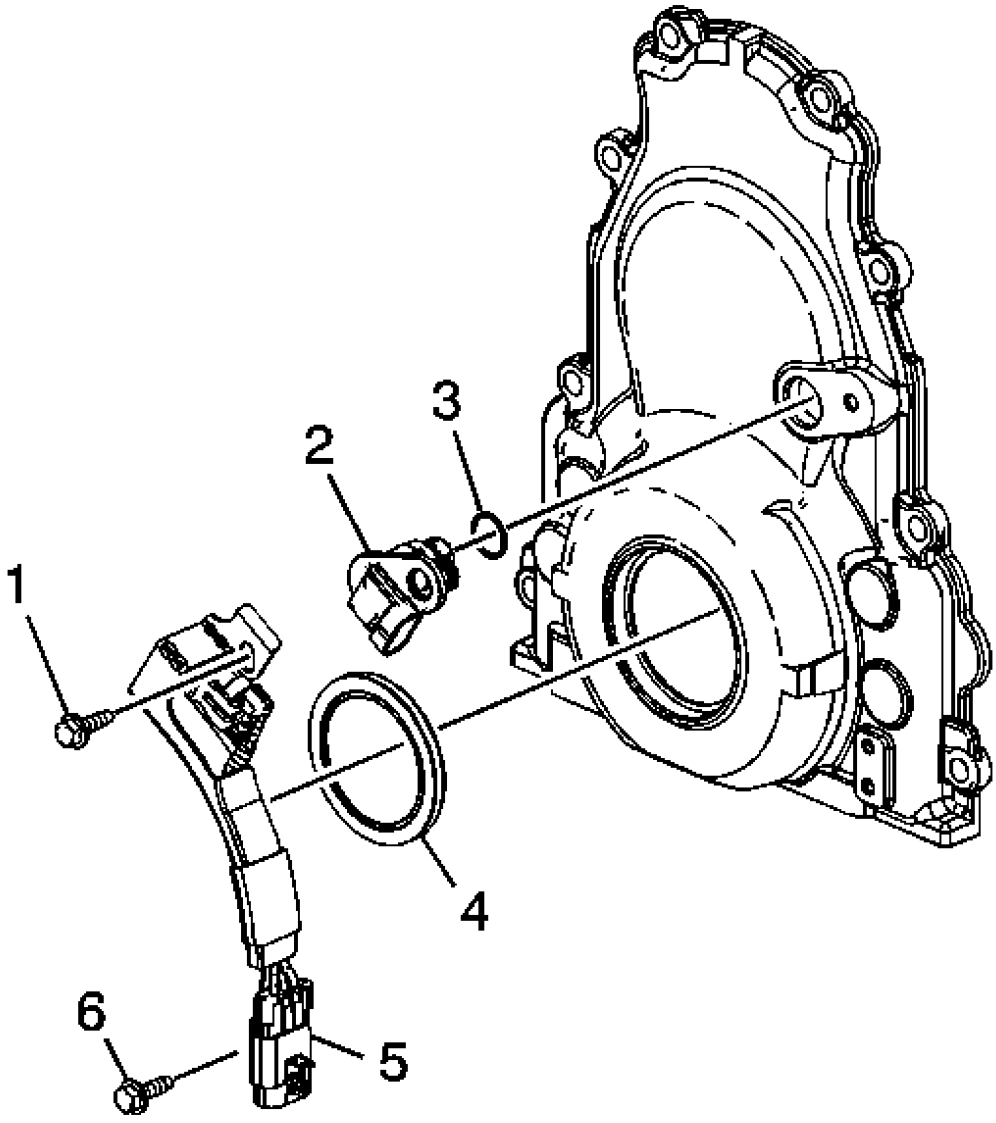


Fig. 47: View Of Front Cover, Oil Seal, Camshaft Position Sensor, Bracket & O Ring
Courtesy of GENERAL MOTORS CORP.

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NOTE:

- **Do not use the crankshaft oil seal again. Install a NEW crankshaft oil seal during assembly.**
- **Do not use the front cover-to-engine block gasket again. Install a NEW gasket during assembly.**

1. Remove the crankshaft oil seal (4) from the front cover.
2. Clean the cover in solvent. Remove the sealant from the cover oil pan surface. Refer to **Replacing Engine Gaskets** .

WARNING: Refer to Safety Glasses Warning .

3. Dry the cover with compressed air.
4. Inspect the gasket sealing surfaces for excessive scratches or gouging.
5. Inspect the threaded bolt holes for damaged threads or debris.
6. Inspect the crankshaft oil seal and camshaft position (CMP) sensor mounting bores for damage.

ENGINE FRONT COVER CLEANING AND INSPECTION (6.2L L99)

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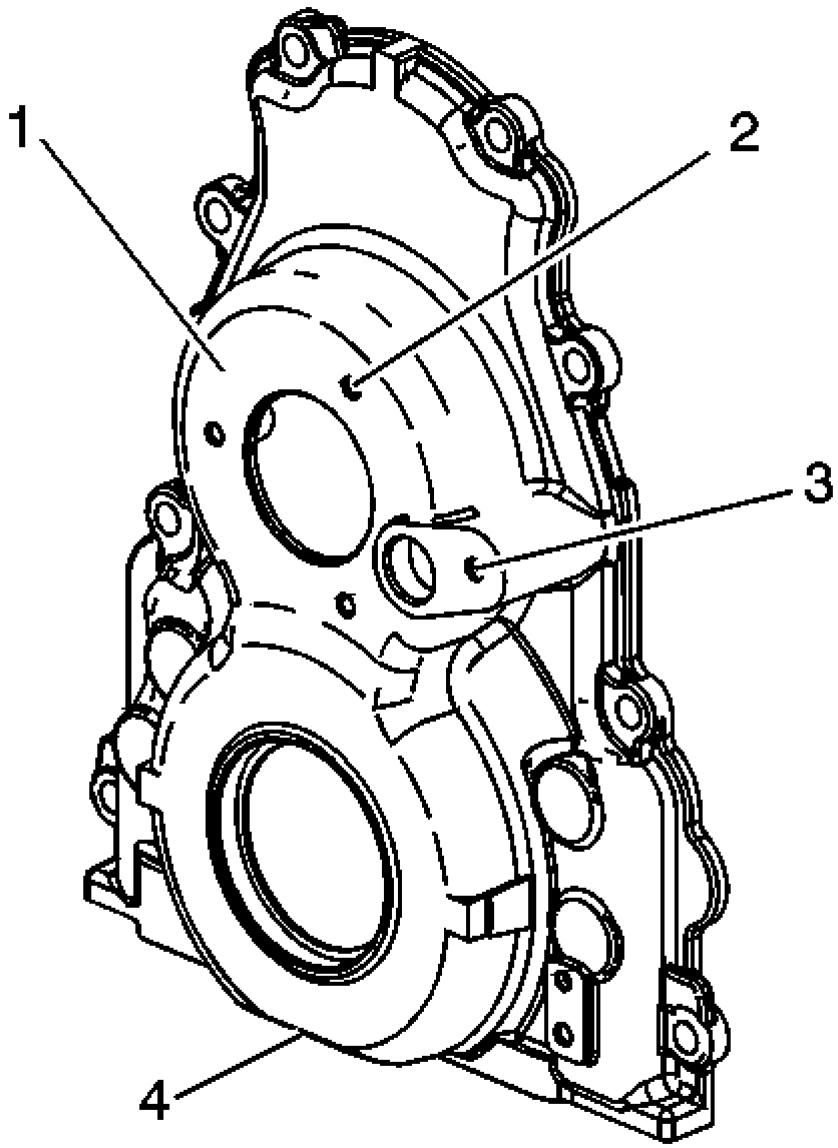


Fig. 48: Identifying Gasket Sealing Surfaces & Bolt Holes
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Do not use the crankshaft front oil seal again. Install a NEW crankshaft front oil seal during assembly.**
- **Do not use the front cover-to-engine block gasket again. Install a NEW gasket during assembly.**

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- **Do not use the camshaft position (CMP) actuator magnet gasket again. Install a NEW gasket during assembly.**

1. Clean the cover in solvent. Remove the sealant from the cover oil pan surface. Refer to **Replacing Engine Gaskets** .

WARNING: Refer to Safety Glasses and Compressed Air Warning

2. Dry the cover with compressed air.
3. Inspect the gasket sealing surfaces (1, 4) for excessive scratches or gouging.
4. Inspect the threaded bolt holes (2, 3) for damaged threads or debris.

CRANKSHAFT REAR OIL SEAL HOUSING CLEANING AND INSPECTION

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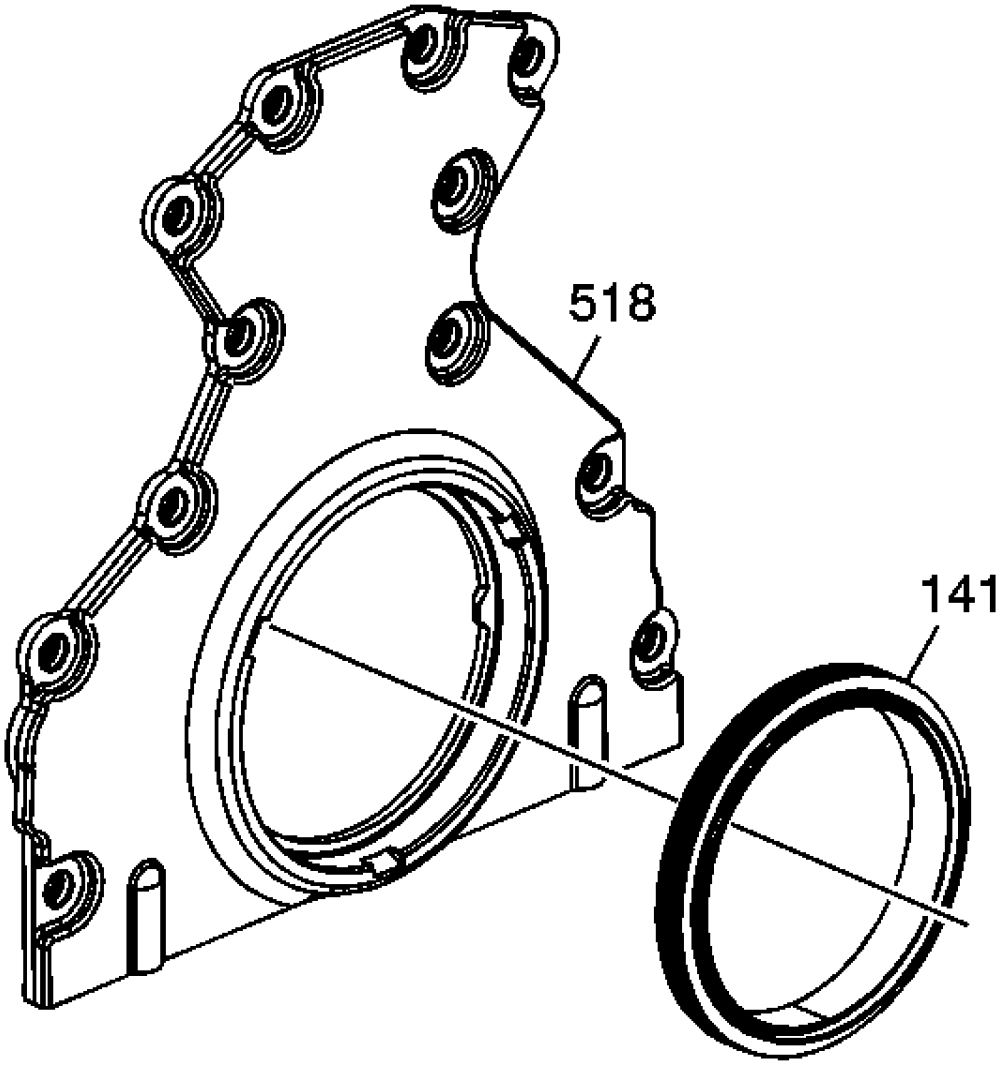


Fig. 49: Crankshaft Rear Oil Seal & Housing
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Do not use the crankshaft rear oil seal again. Install a NEW crankshaft oil seal during assembly.**
- **Do not use the rear housing-to-engine block gasket again. Install a NEW gasket during assembly.**

1. Remove the crankshaft oil seal (141) from the rear housing.

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2. Clean the housing in solvent. Remove the sealant from the housing oil pan surface. Refer to **Replacing Engine Gaskets** .

WARNING: Refer to Safety Glasses Warning .

3. Dry the housing with compressed air.
4. Inspect the gasket sealing surfaces for excessive scratches or gouging.
5. Inspect the housing-to-oil pan threaded bolt holes for damaged threads or debris.
6. Inspect the crankshaft oil seal mounting bore for damage.

ENGINE BLOCK VALLEY COVER CLEANING AND INSPECTION

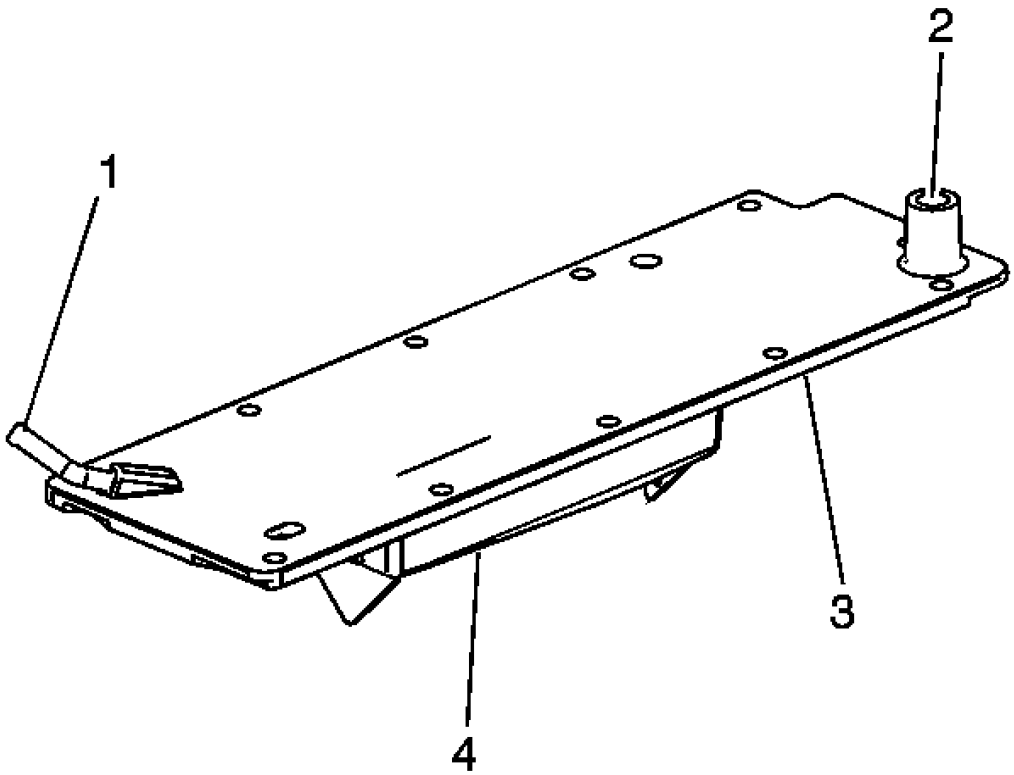


Fig. 50: PCV Passages, Damaged Threads & Damaged Sealing Surfaces
Courtesy of GENERAL MOTORS CORP.

1. Clean the valley cover in solvent.

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WARNING: **Refer to Safety Glasses Warning .**

2. Dry with compressed air.
3. Inspect for restrictions within the positive crankcase ventilation (PCV) passages (1, 4).
4. Inspect for damaged threads (2) and damaged sealing surfaces (3).

VALVE LIFTER OIL MANIFOLD CLEANING AND INSPECTION

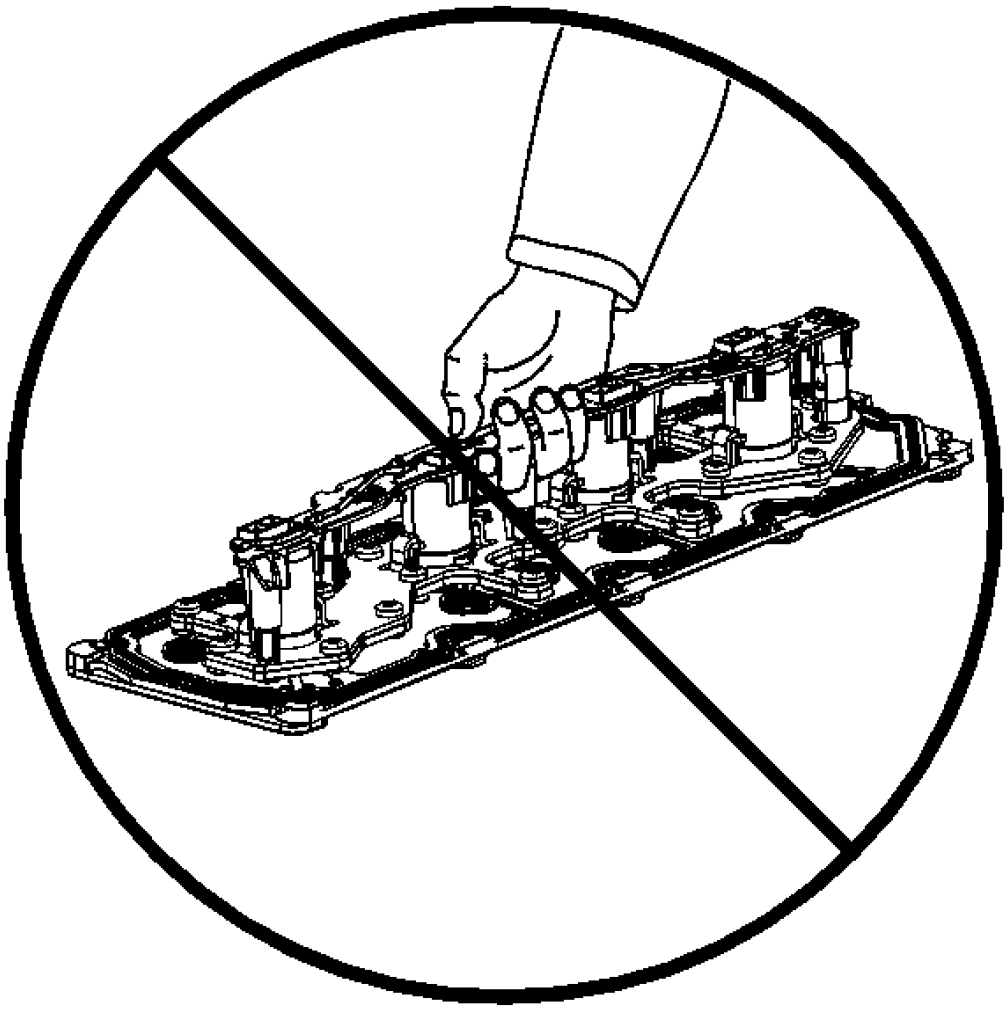


Fig. 51: Valve Lifter Oil Manifold Handling Precaution
Courtesy of GENERAL MOTORS CORP.

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NOTE:

- **Do not allow dirt or debris to enter the oil passages of the manifold. Plug, as required.**
- **Do not disassemble the electrical components from the manifold.**
- **Do not submerge the electrical components in cleaning solvent.**
- **Do not use the manifold exterior gasket again. Remove the exterior gasket and install a NEW service gasket during assembly.**

1. Do not lift the manifold assembly by the electrical lead frame.

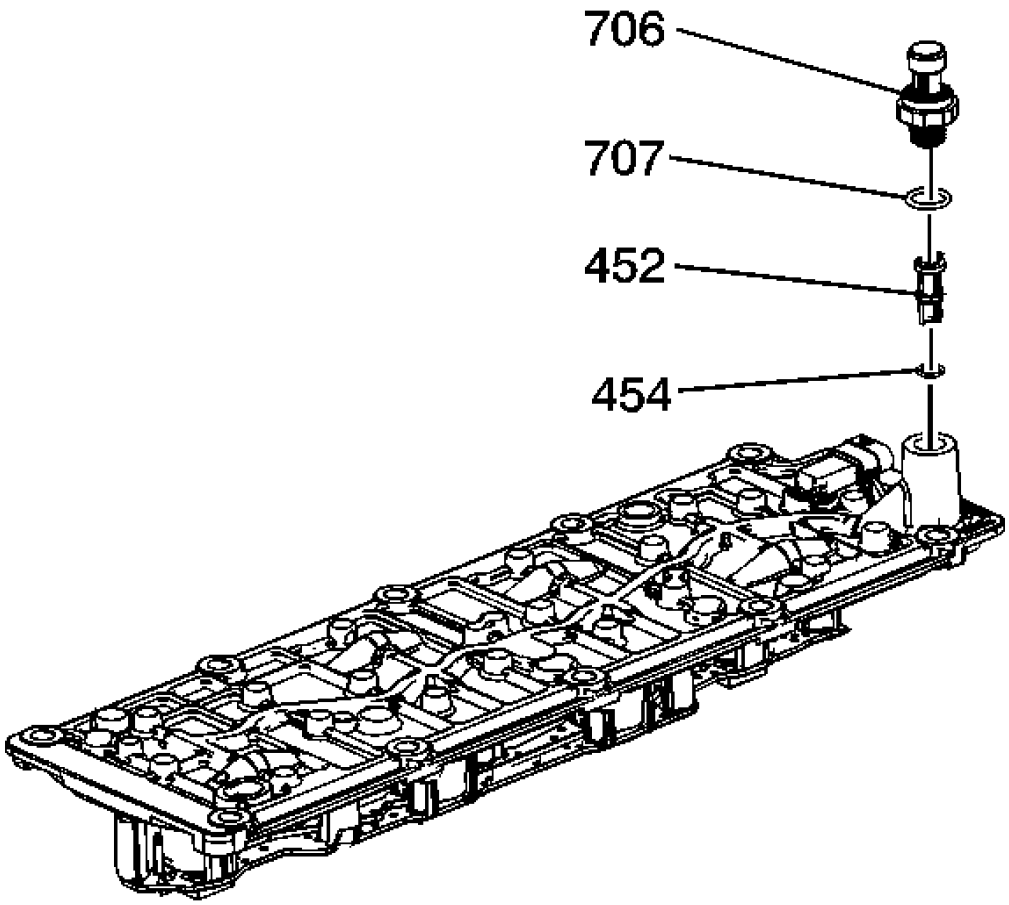


Fig. 52: View Of Oil Pressure Sensor, Washer & Valve Lifter Oil Filter
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil pressure sensor (706) and washer (707).
3. Remove the oil screen (452) with O-ring (454).

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WARNING: Refer to Safety Glasses and Compressed Air Warning .

4. Clean the manifold with compressed air.

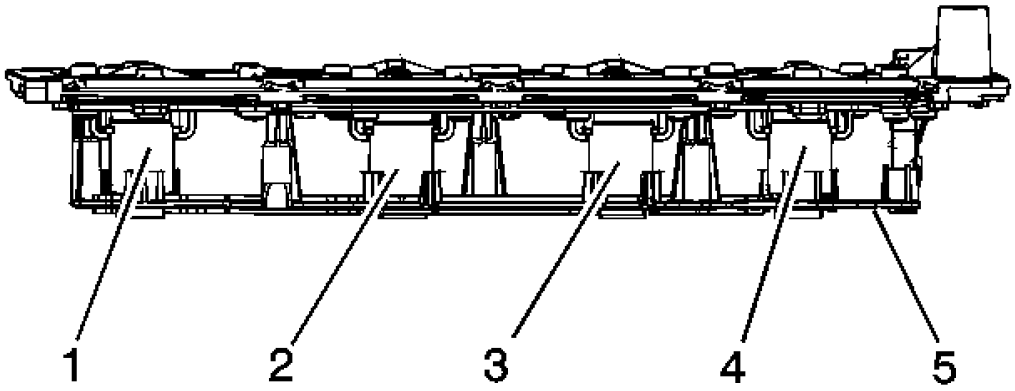


Fig. 53: Electrical Solenoids
Courtesy of GENERAL MOTORS CORP.

5. Inspect for loose electrical solenoids (1-4) or loose or missing bolts.
6. Inspect for damage to the electrical lead frame (5).
7. Inspect for a damaged electrical connector, for bent or corroded pins.

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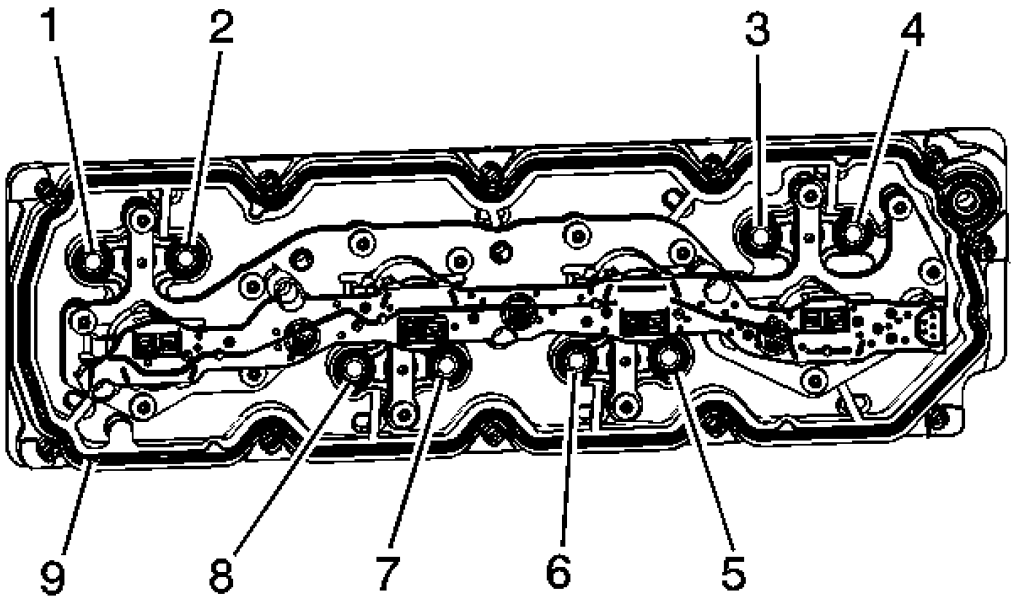


Fig. 54: Sealing Gaskets
Courtesy of GENERAL MOTORS CORP.

8. Inspect for damaged interior sealing gaskets (1-8). If the interior sealing gaskets are damaged, the manifold must be replaced as an assembly.
9. Inspect for a damaged exterior sealing gasket (9) or scored gasket surfaces.
10. Inspect for debris or restrictions within the oil passages of the manifold. Refer to **Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing** .

VALVE ROCKER ARM COVER CLEANING AND INSPECTION

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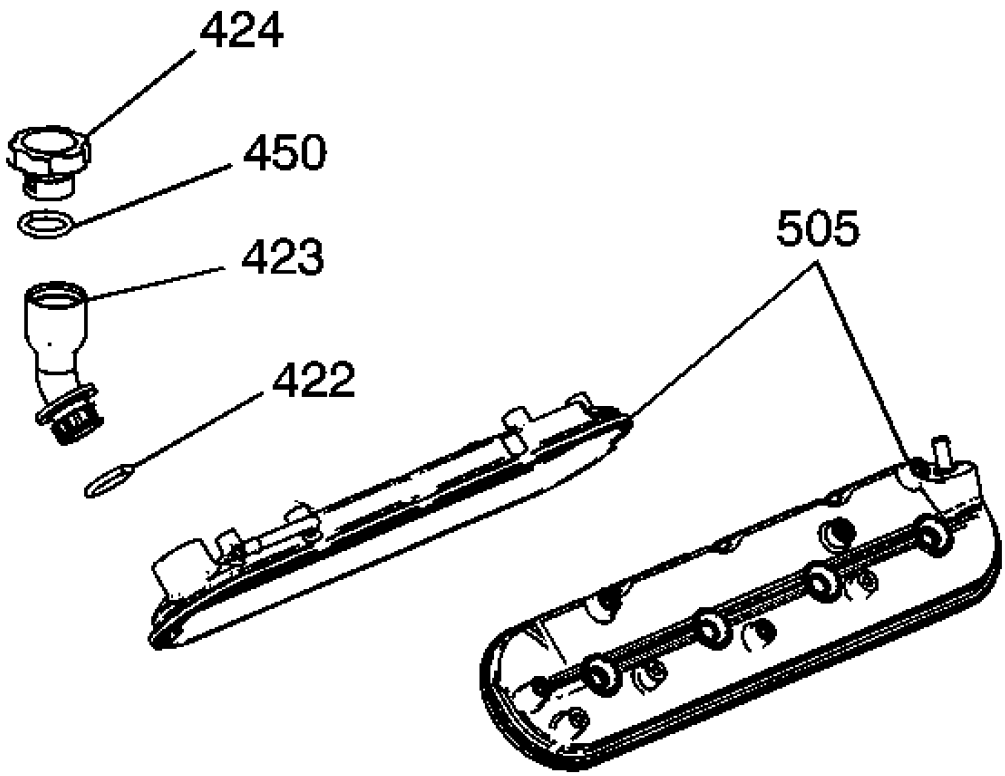


Fig. 55: View Of Valve Rocker Arm Covers
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **Do not use the valve rocker arm cover gasket again. Install a NEW gasket during assembly.**
- **Remove the ignition coils before cleaning the cover in solvent. Do not submerge the ignition coils in solvent.**
- **Do not remove the oil fill tube from the covers unless service is required. If the tube is removed from the cover, install a NEW tube (423) and seal (422) during assembly.**

1. Inspect the oil fill tube (423) for a loose fit or damage.
2. Inspect the covers (505) for the following conditions:
   - Scoring or damage to the gasket surfaces
   - Ventilation system passages for restrictions
   - Threaded bolt holes for damage or debris

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OIL PAN CLEANING AND INSPECTION

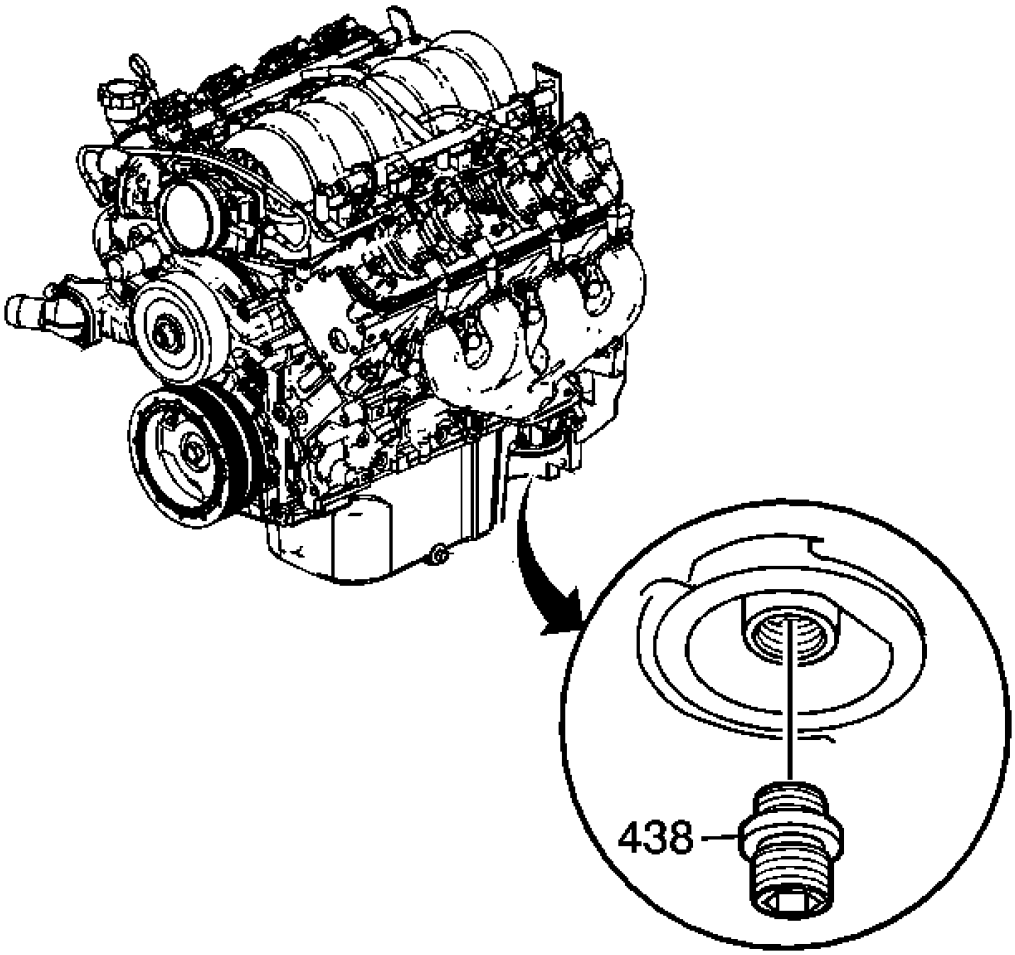


Fig. 56: Oil Filter Fitting
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil filter fitting (438) as required.

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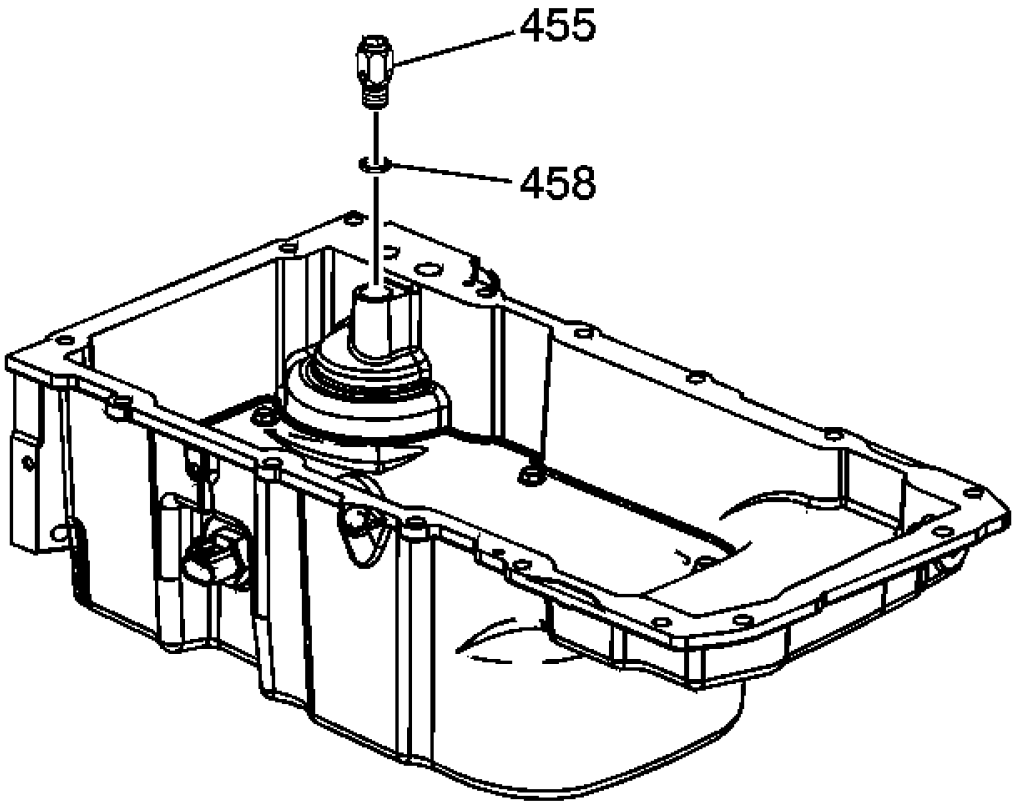


Fig. 57: Oil Pressure Relief Valve & Washer
Courtesy of GENERAL MOTORS CORP.

2. Remove the active fuel management oil pressure relief valve (455) and washer (458).

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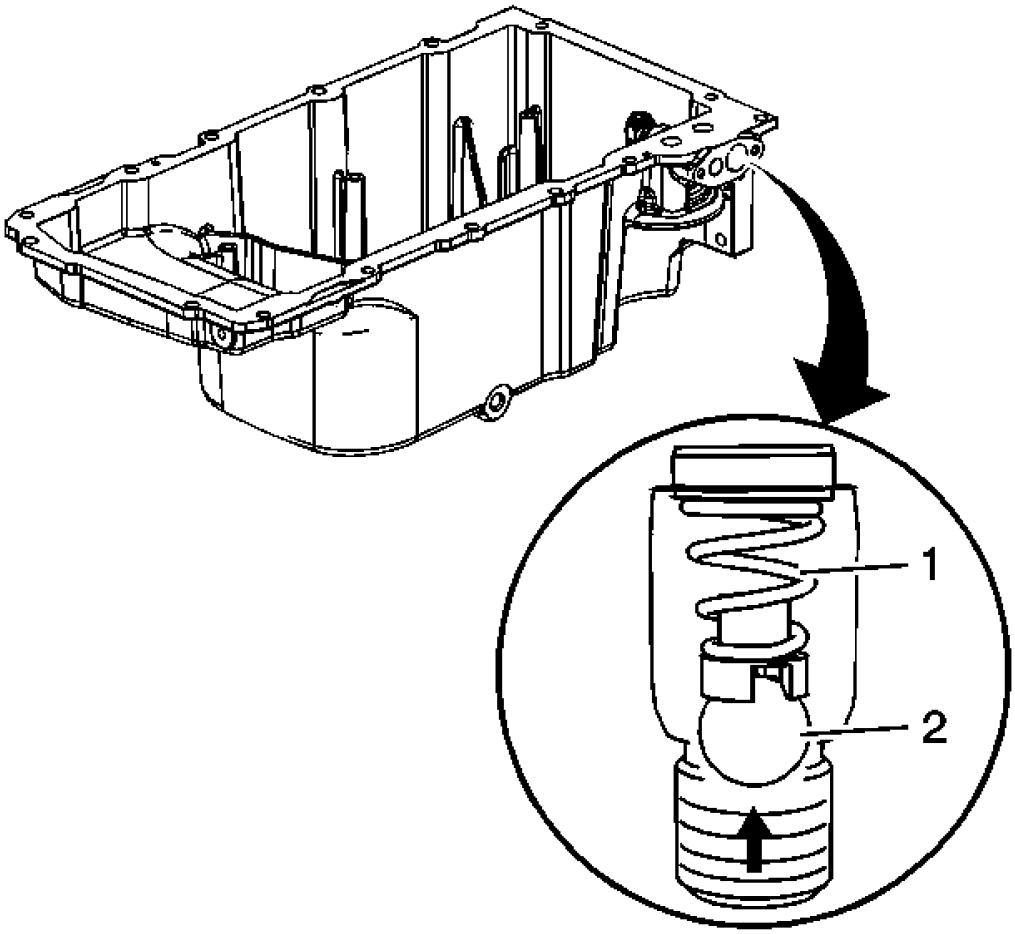


Fig. 58: Ball & Spring
Courtesy of GENERAL MOTORS CORP.

3. Inspect the active fuel management oil pressure relief valve for proper operation. Lightly depress the ball (2). The valve spring (1) should seat the ball to the proper closed position.

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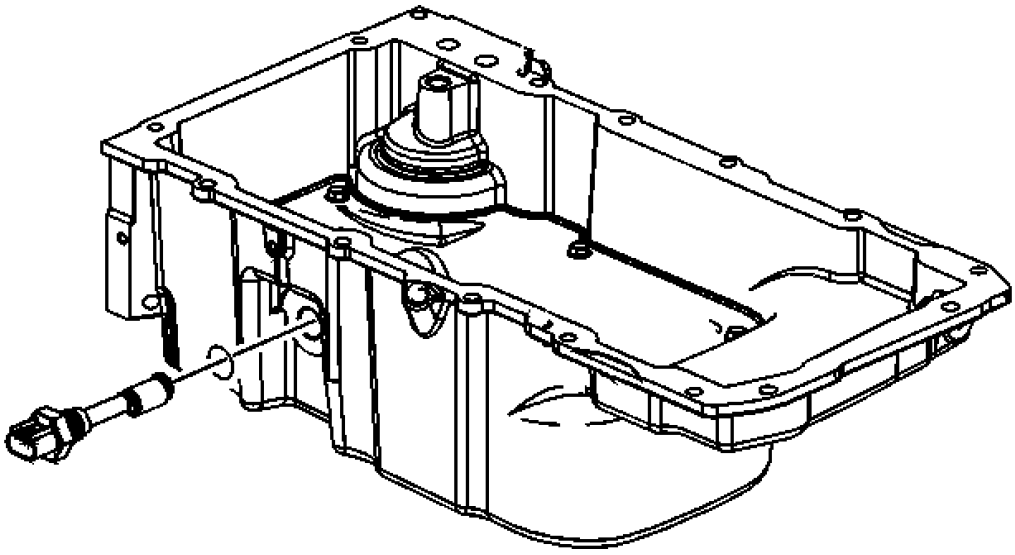


Fig. 59: Oil Level Sensor & O-Ring
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil level sensor and O-ring.

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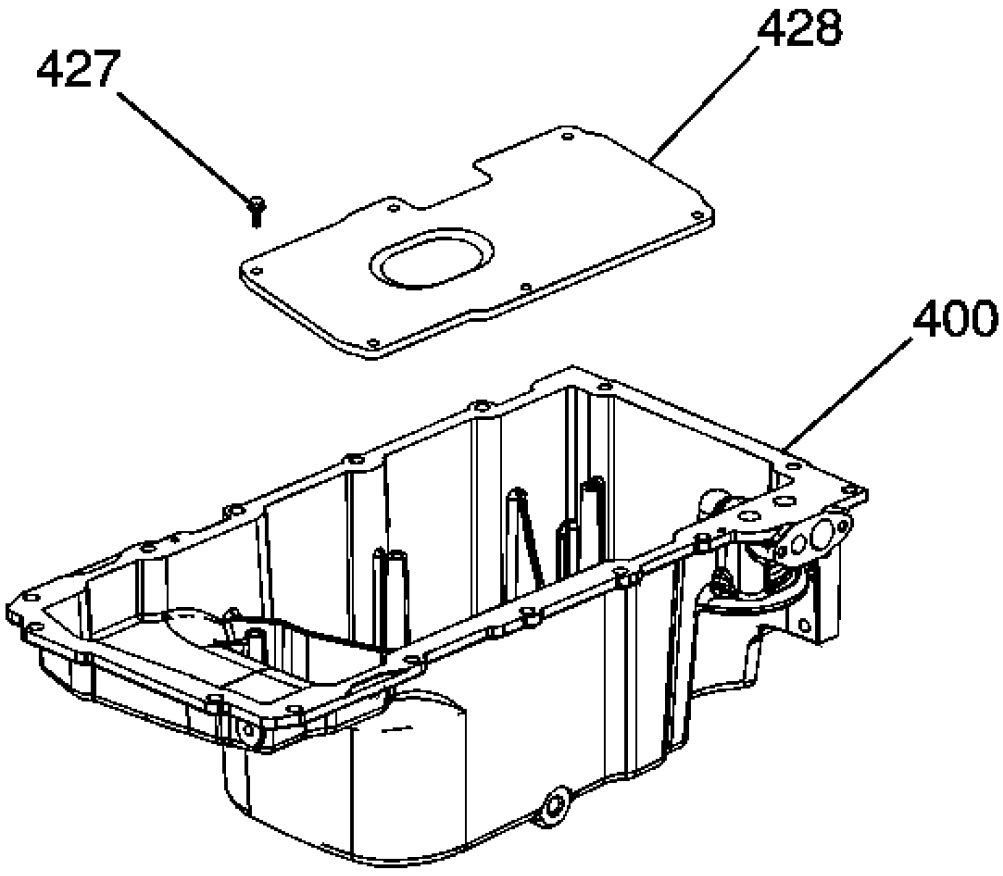


Fig. 60: Bolts & Baffle
Courtesy of GENERAL MOTORS CORP.

5. Remove the bolts (427) and baffle (428).
6. Clean the oil pan in solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

7. Dry the oil pan with compressed air.

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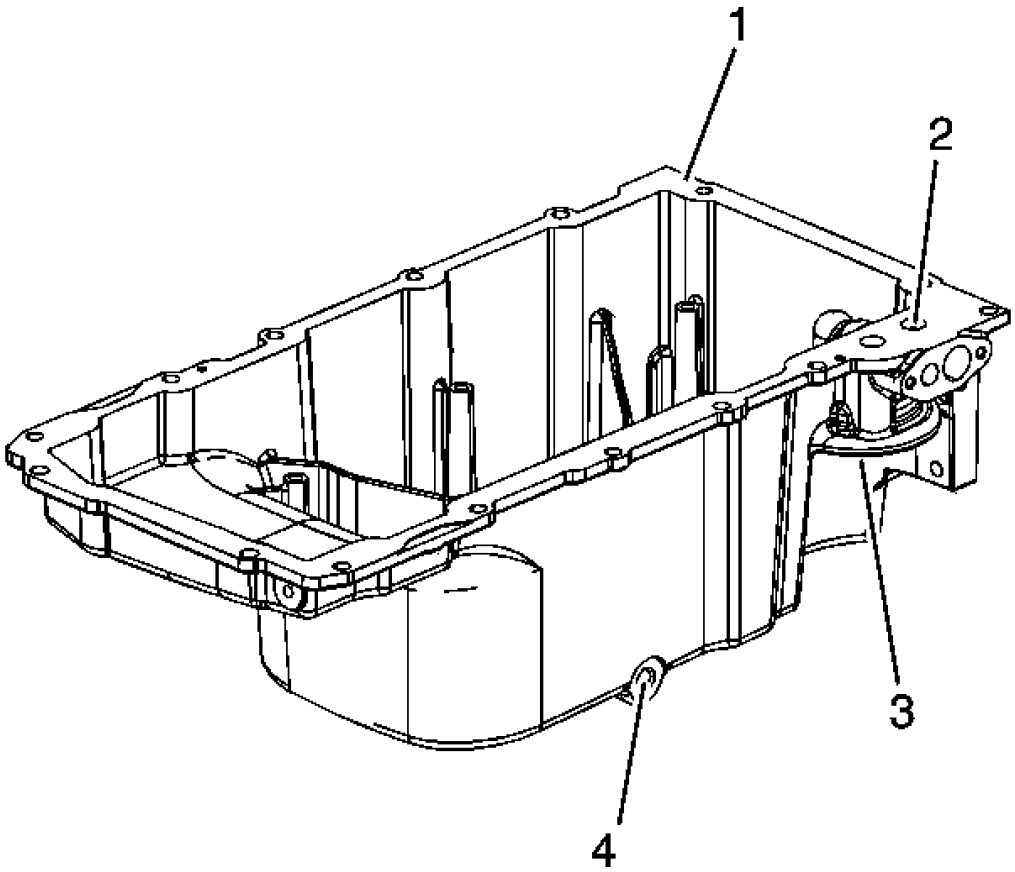


Fig. 61: Oil Pan Components
Courtesy of GENERAL MOTORS CORP.

8. Inspect the oil pan for the following conditions:
    - Damaged gasket surfaces (1)
    - Restrictions within the oil passages (2) of the pan
    - Damaged oil filter seal surface (3)
    - Threaded bolt holes (4) for damage

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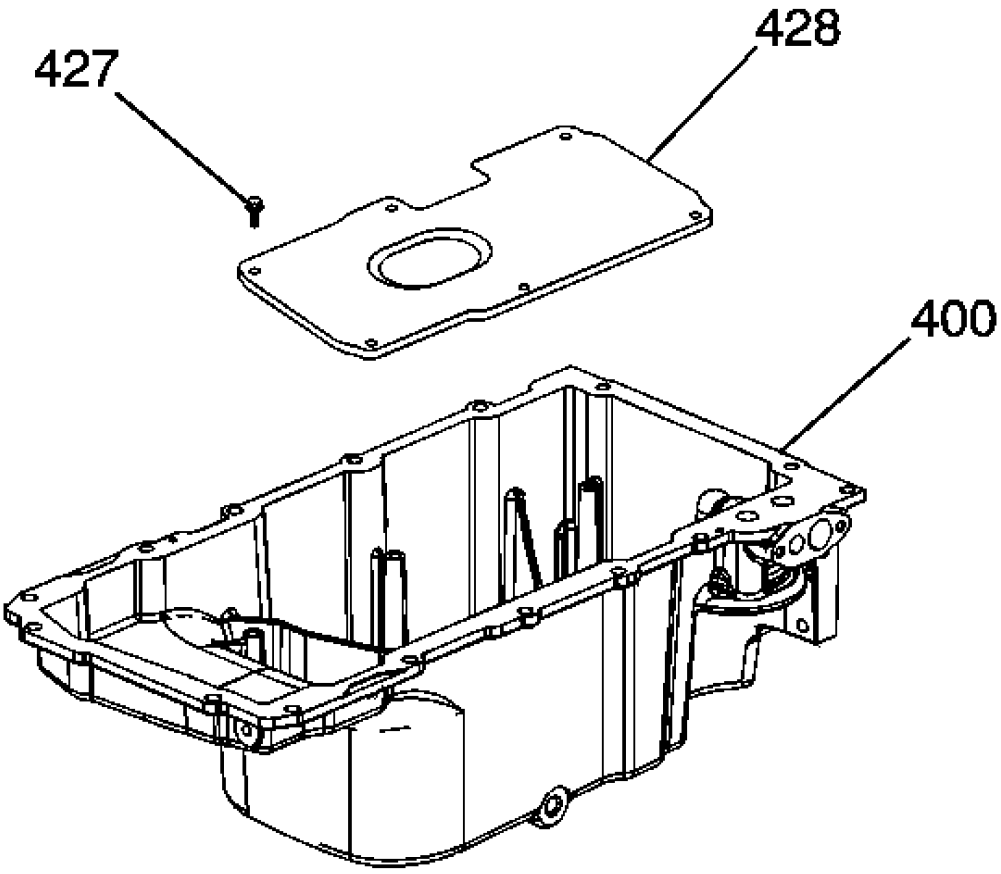


Fig. 62: Bolts & Baffle
Courtesy of GENERAL MOTORS CORP.

9. Install the baffle (428) and baffle bolts (427).

CAUTION: Refer to Fastener Caution .

10. Tighten the baffle bolts (427) to 12 N.m (106 lb in).

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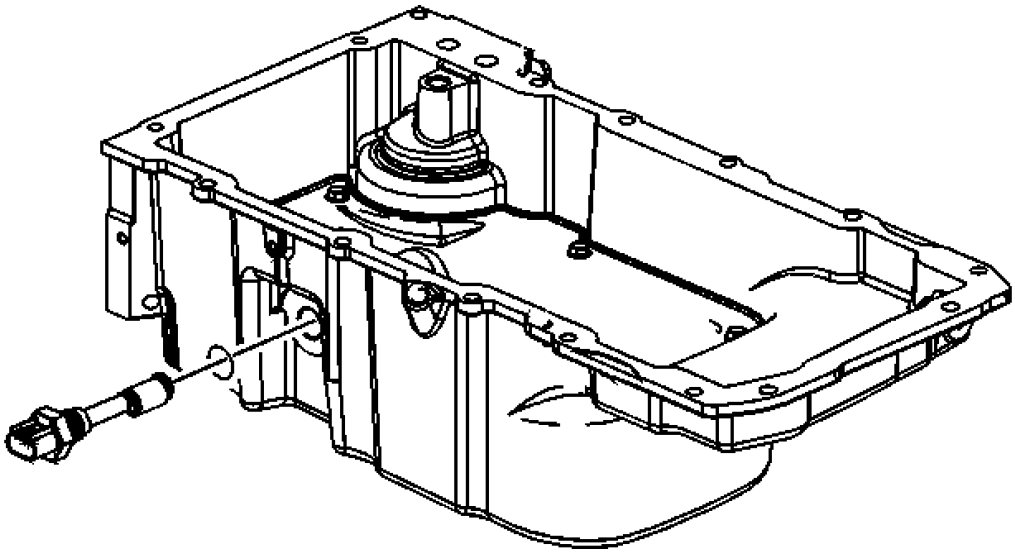


Fig. 63: Oil Level Sensor & O-Ring
Courtesy of GENERAL MOTORS CORP.

11. Install the oil level sensor O-ring seal.
12. Install the oil level sensor and tighten to 20 N.m (15 lb ft).

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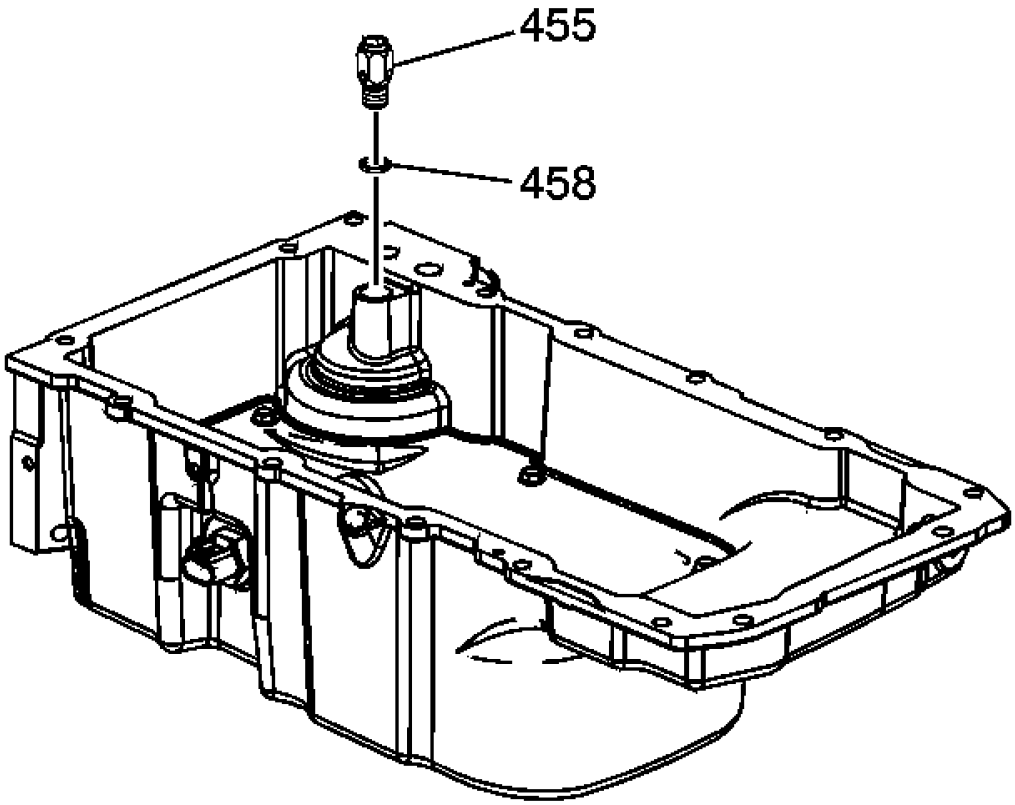


Fig. 64: Oil Pressure Relief Valve & Washer
Courtesy of GENERAL MOTORS CORP.

13. Install the active fuel management oil pressure relief valve (455) and washer (458).
14. Tighten the active fuel management oil pressure relief valve (455) to 27 N.m (20 lb ft).

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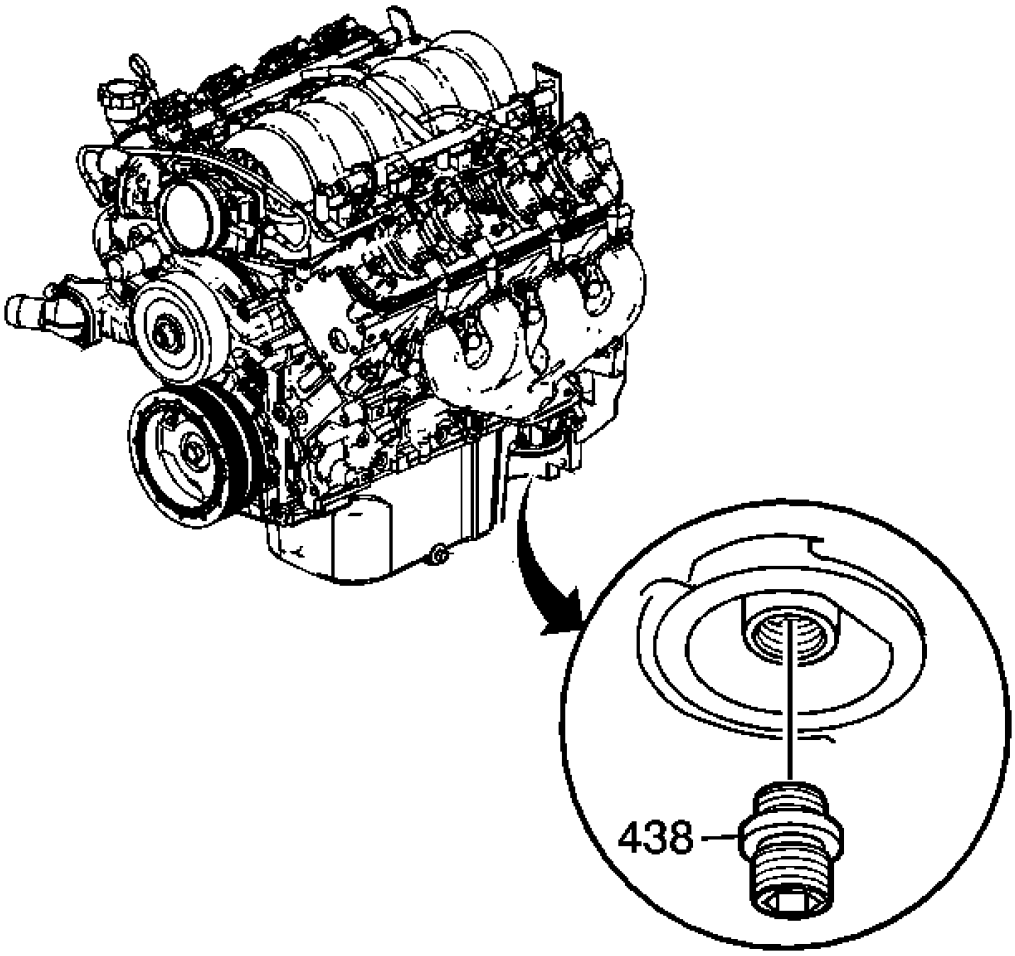


Fig. 65: Oil Filter Fitting
Courtesy of GENERAL MOTORS CORP.

15. Install the oil filter fitting (438) as required.
16. Tighten the oil filter fitting to 55 N.m (40 lb ft).

ENGINE OIL COOLER DISASSEMBLE

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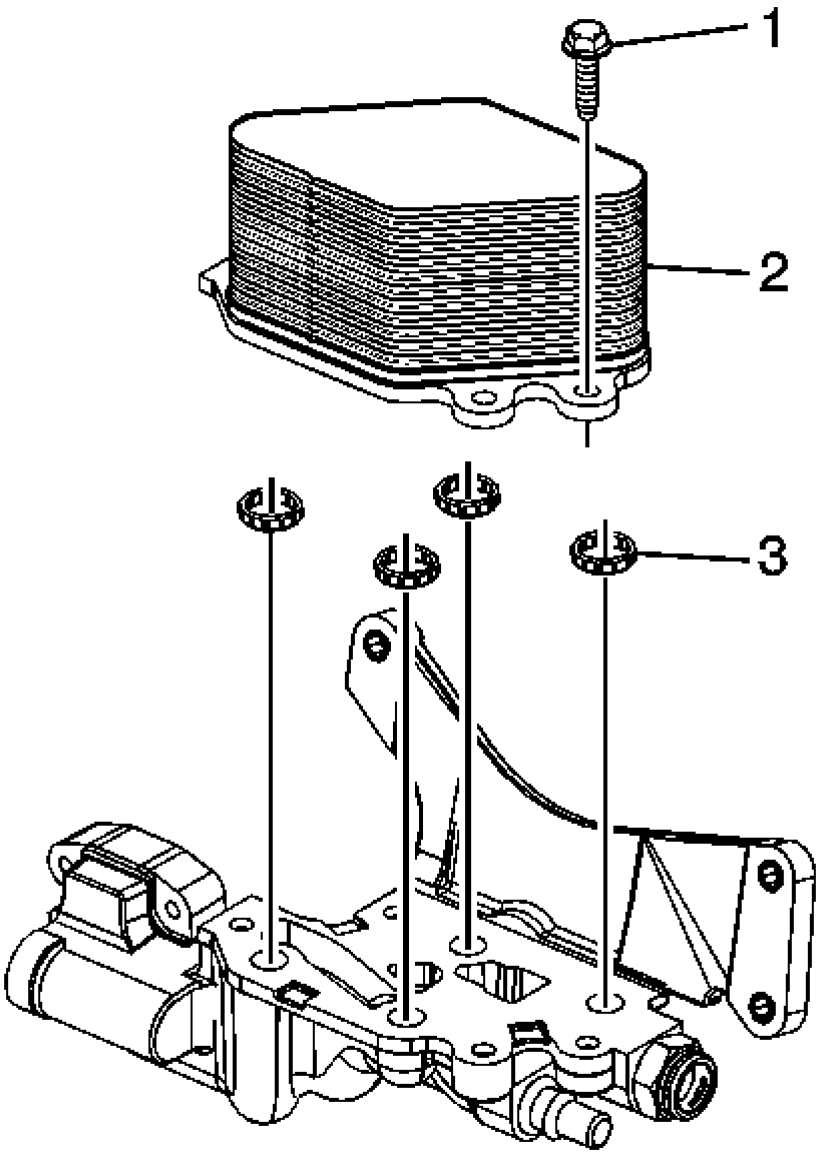


Fig. 66: Identifying Oil Cooler Core Components
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Engine Oil Cooler Debris Caution .

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1. Remove the oil cooler core bolts (1).
2. Remove the oil cooler core (2).
3. Remove the oil cooler core seals (3).

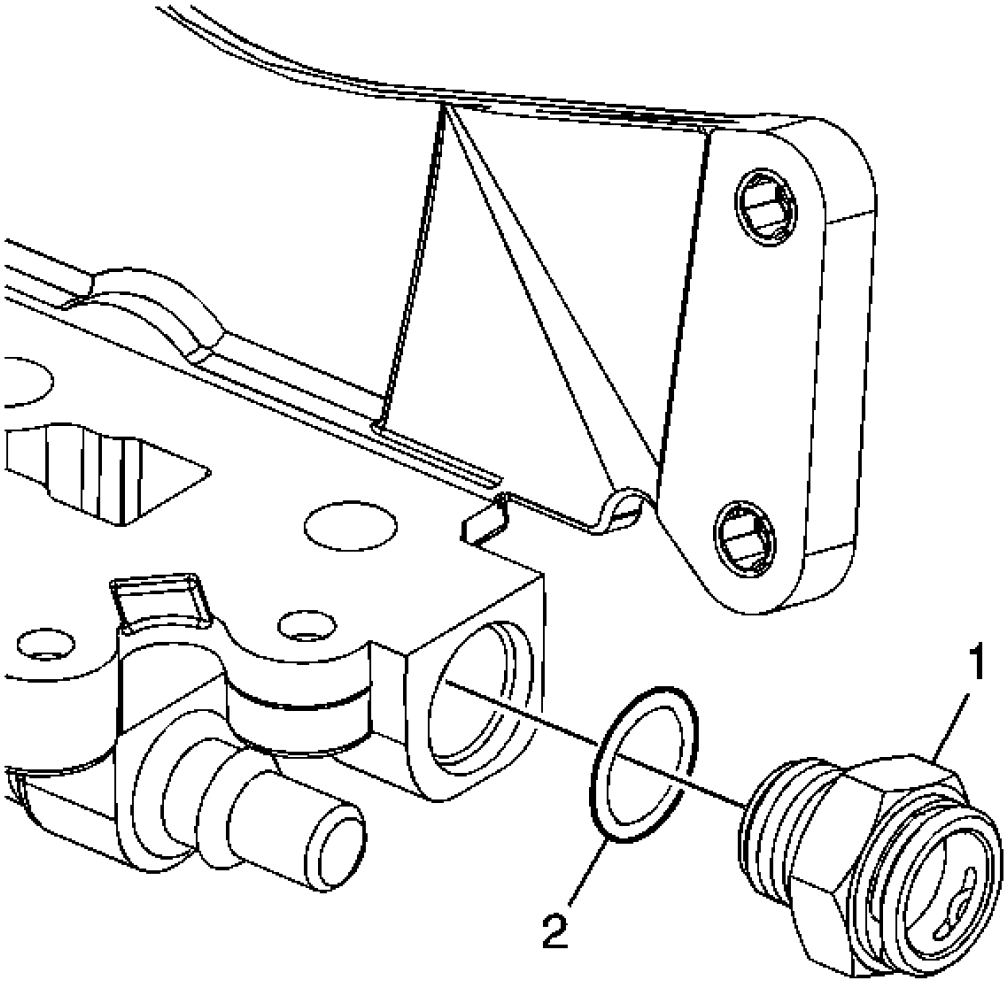


Fig. 67: Identifying Coolant Fitting & Seal
Courtesy of GENERAL MOTORS CORP.

4. Remove the coolant fitting (1), as required.
5. Remove the coolant fitting seal (2).
6. Discard the seal.

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ENGINE OIL COOLER CLEANING AND INSPECTION

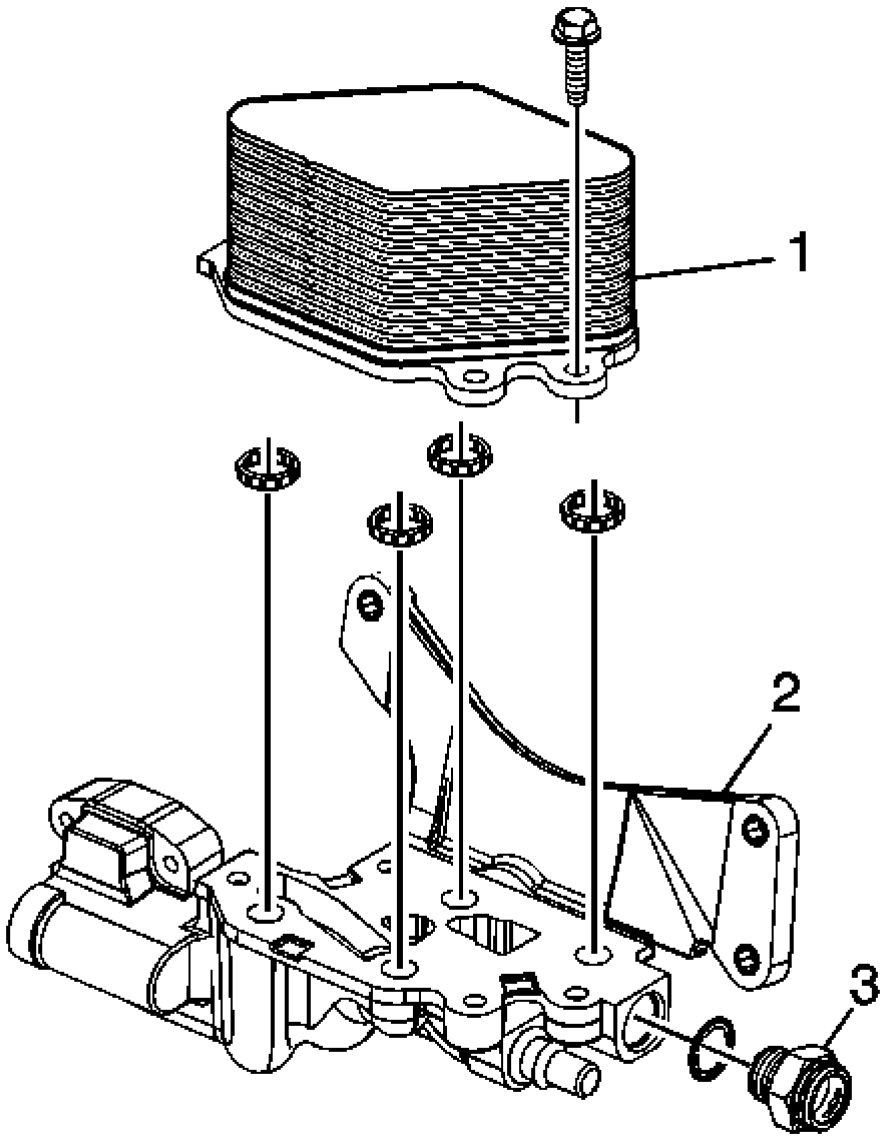


Fig. 68: Identifying Engine Oil Cooler Components
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Engine Oil Cooler Debris Caution .

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1. Inspect the oil cooler housing (2) and the oil cooler core (1) for cracks or casting imperfections.
2. Inspect the oil cooler housing for damaged bolt hole threads.
3. Inspect the oil cooler housing and core for damaged seal surfaces.
4. Inspect the oil cooler core for damaged or broken cooling fins.
5. Inspect for restrictions within the coolant passages of the core or housing.
6. Inspect for restrictions within the oil passages of the core or housing.
7. Inspect for a leaking coolant hose fitting (3).

ENGINE OIL COOLER ASSEMBLE

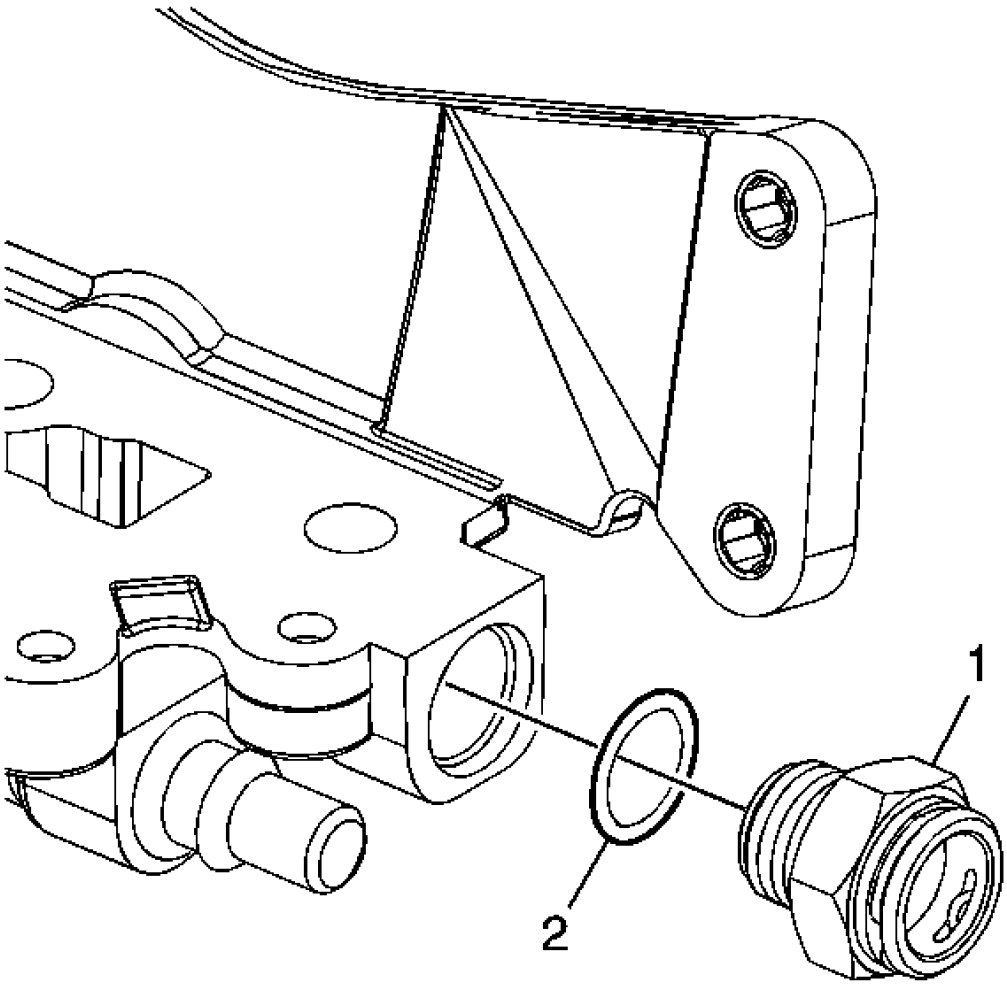


Fig. 69: Identifying Coolant Fitting & Seal

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Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Engine Oil Cooler Debris Caution .

1. Install a NEW coolant fitting seal (2).

CAUTION: Refer to Fastener Caution

2. Install the coolant fitting (1) and tighten to 35 N.m (26 lb ft).

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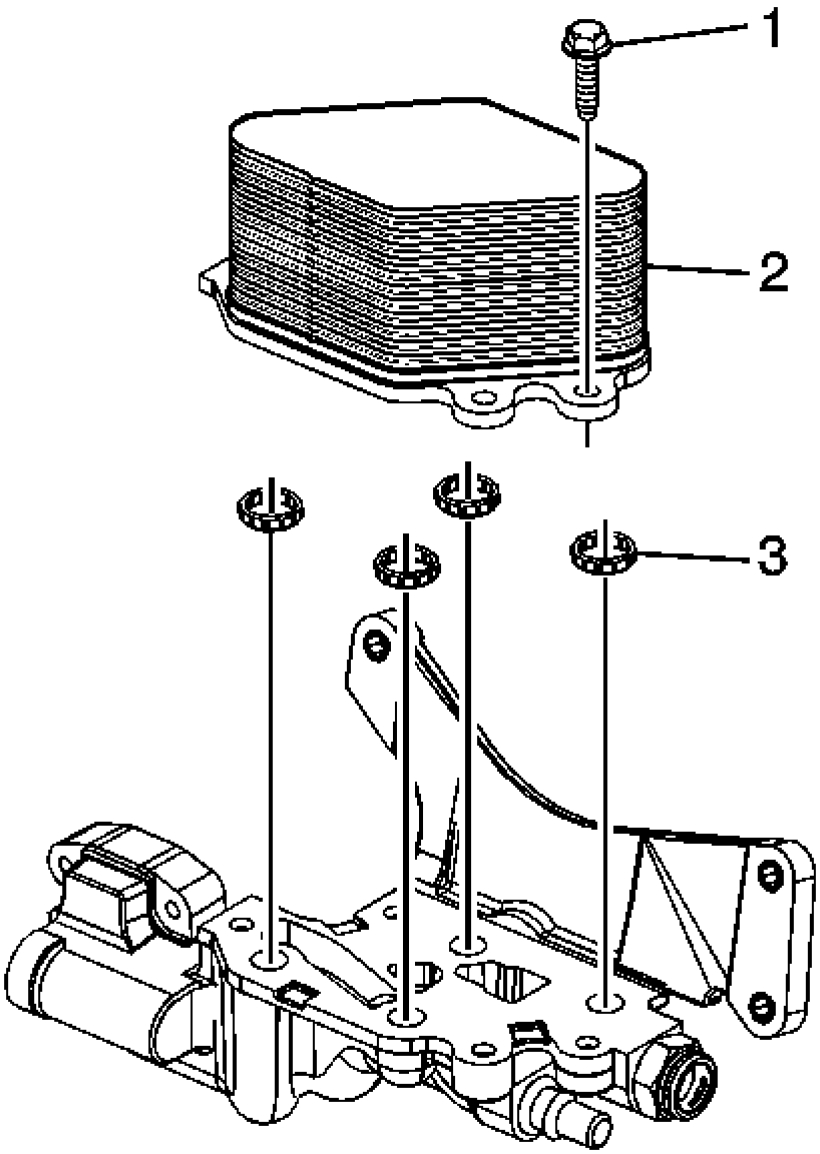


Fig. 70: Identifying Oil Cooler Core Components
Courtesy of GENERAL MOTORS CORP.

3. Install the NEW oil cooler core seals (3).
4. Install the oil cooler core (2).
5. Install the oil cooler core bolts (1) and tighten to 25 N.m (18 lb ft).

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INTAKE MANIFOLD CLEANING AND INSPECTION

CLEANING PROCEDURE

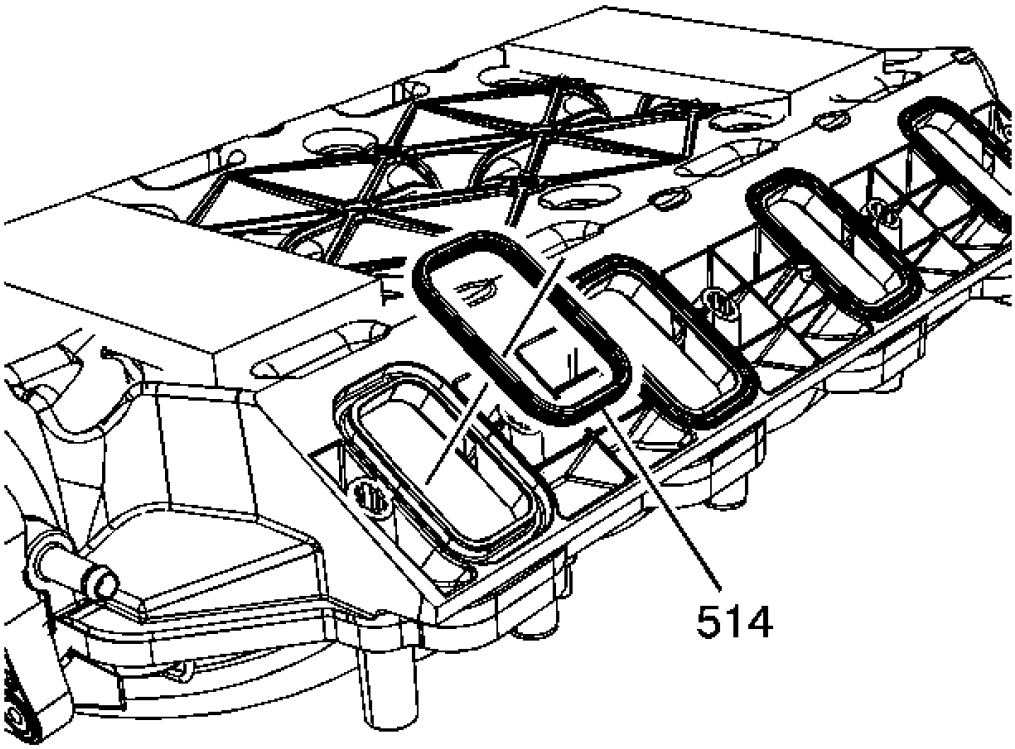


Fig. 71: Intake Manifold-To-Cylinder Head Gaskets
Courtesy of GENERAL MOTORS CORP.

1. Remove and discard the intake manifold-to-cylinder head gaskets (514).
2. Remove the manifold absolute pressure (MAP) sensor. Refer to **Intake Manifold Removal** .
3. Remove the evaporative emission (EVAP) canister purge solenoid valve, EVAP tubes, and fuel rail with injectors. Refer to **Fuel Rail and Injectors Removal** .
4. Remove the throttle body and gasket. Refer to **Throttle Body Assembly Removal** .
5. Clean the intake manifold in solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

6. Dry the intake manifold with compressed air.

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INSPECTION PROCEDURE

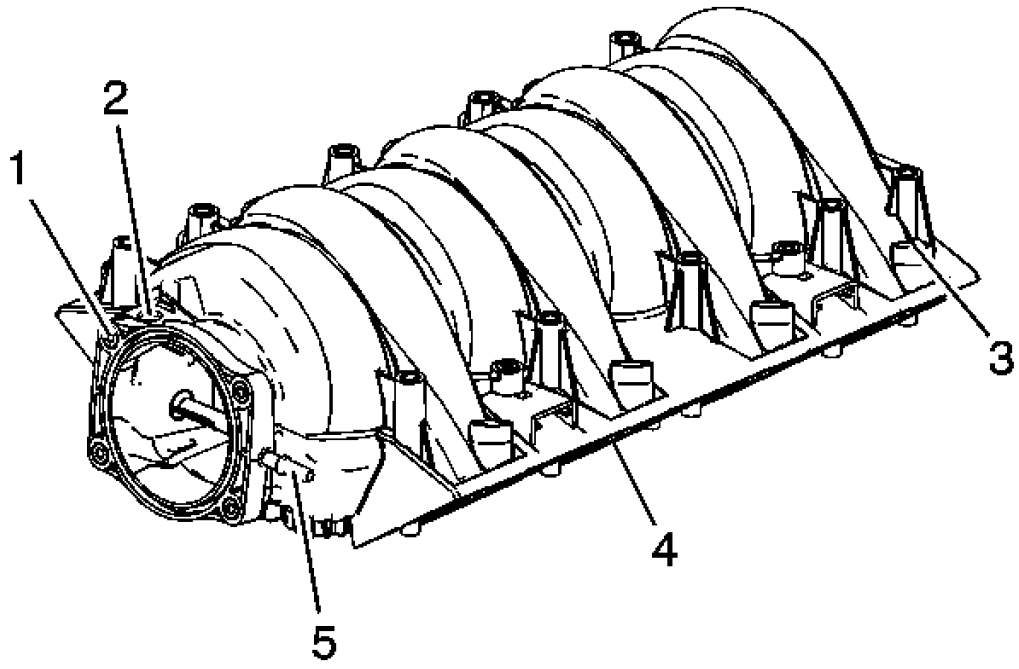


Fig. 72: View Of Manifold
Courtesy of GENERAL MOTORS CORP.

1. Inspect the manifold for the following conditions:
   - Loose threaded inserts (1)
   - Damaged MAP sensor bore (2)
   - Damaged fuel injector bore (3)
   - Damaged gasket or sealing surfaces (4)
   - Damaged or broken vacuum fittings (5)
   - Debris or restrictions within the passages of the manifold
   - Inspect the composite intake manifold assembly for cracks or other damage.
2. Inspect the intake manifold cylinder head deck for warpage.
   1. Locate a straight edge across the intake manifold cylinder head deck surface.

      Position the straight edge across a minimum of two runner port openings.

   2. Insert a feeler gauge between the intake manifold and the straight edge.

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An intake manifold with warpage in excess of 3 mm (0.118 in) over a 200 mm (7.87 in) area is warped and should be replaced.

EXHAUST MANIFOLD CLEANING AND INSPECTION

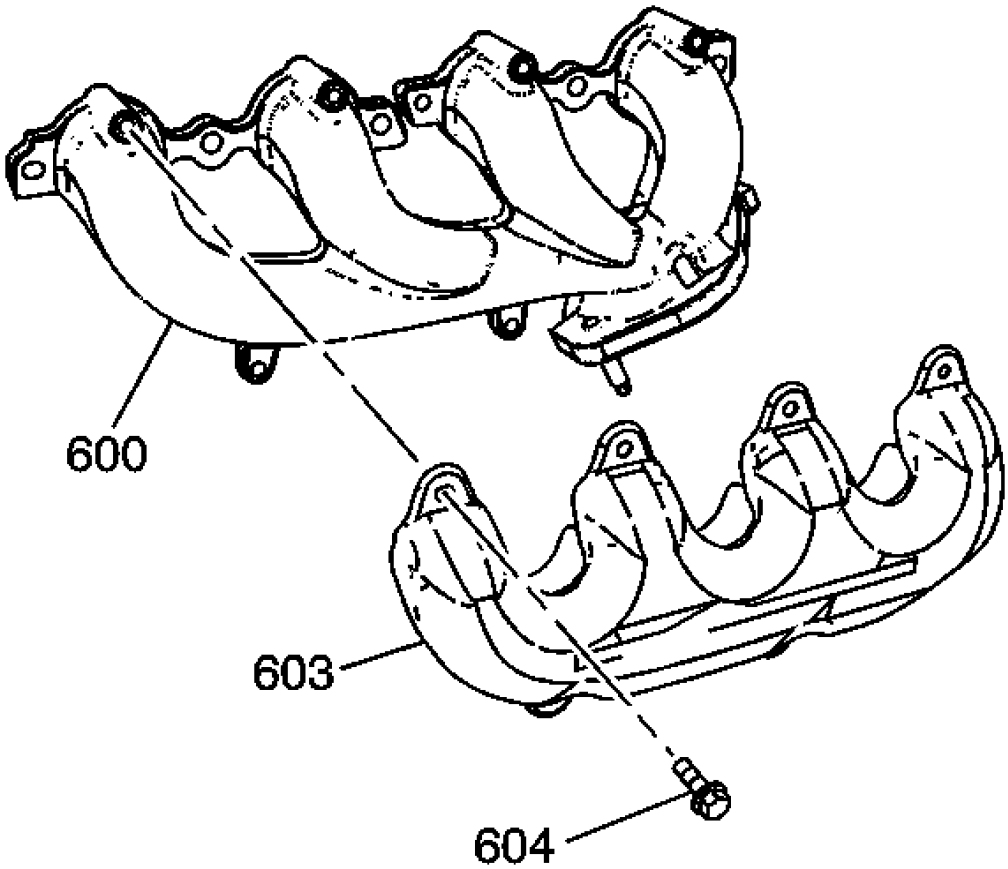


Fig. 73: View Of Exhaust Manifold, Heat Shield & Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not use the exhaust manifold-to-cylinder head gaskets again. Upon installation of the exhaust manifold, install a NEW gasket. An improperly installed gasket or leaking exhaust system may effect on-board diagnostics (OBD) II system performance.

1. Clean the exhaust manifold (600) and heat shield (603) in solvent.

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WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Dry the exhaust manifold with compressed air.
3. Inspect the exhaust manifold-to-cylinder head gasket surface for excessive scratches or gouging.
4. Inspect for a loose, damaged, or cracked heat shield (603), or missing bolts (604).
5. Inspect the exhaust pipe studs for damaged threads.

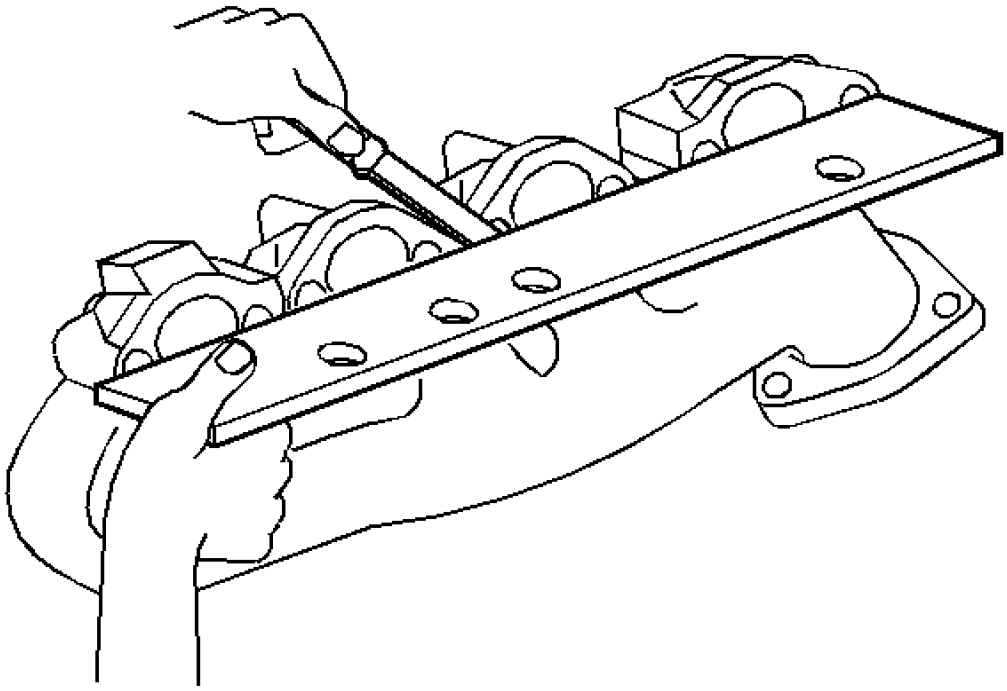


Fig. 74: Measuring Exhaust Manifold To Cylinder Head Surface For Warpage
Courtesy of GENERAL MOTORS CORP.

6. Use a straight edge and a feeler gauge and measure the exhaust manifold cylinder head deck for warpage.

   An exhaust manifold deck with warpage in excess of 0.25 mm (0.01 in) within the 2 front or 2 rear runners or 0.5 mm (0.02 in) overall, may cause an exhaust leak and may effect OBD II system performance. Exhaust manifolds not within specifications must be replaced.

ENGINE COOLANT AIR BLEED PIPE AND HOLE COVER CLEANING AND INSPECTION

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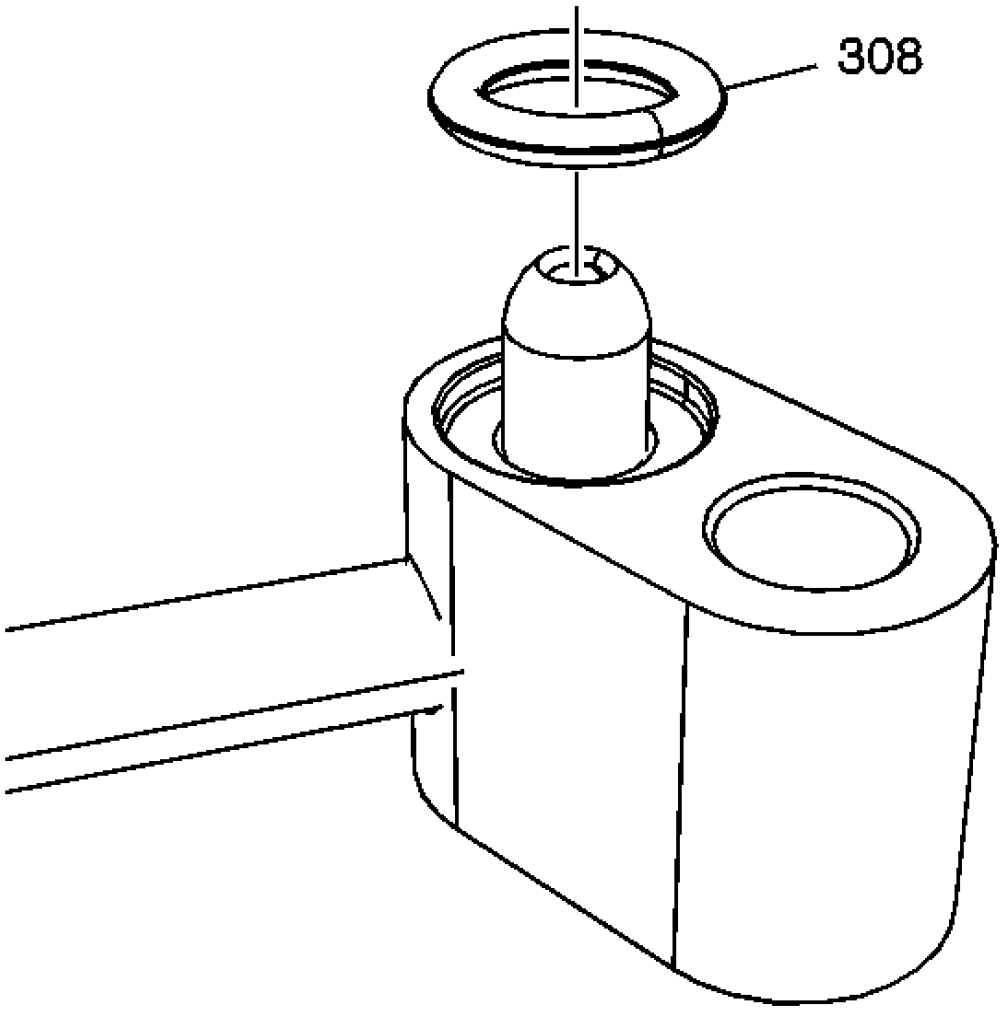


Fig. 75: View Of Coolant Air Bleed Pipe Seal
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not use the engine coolant air bleed pipe seals again. Upon installation of the pipe, install NEW seals.

1. Remove the seals (308) from the pipe.

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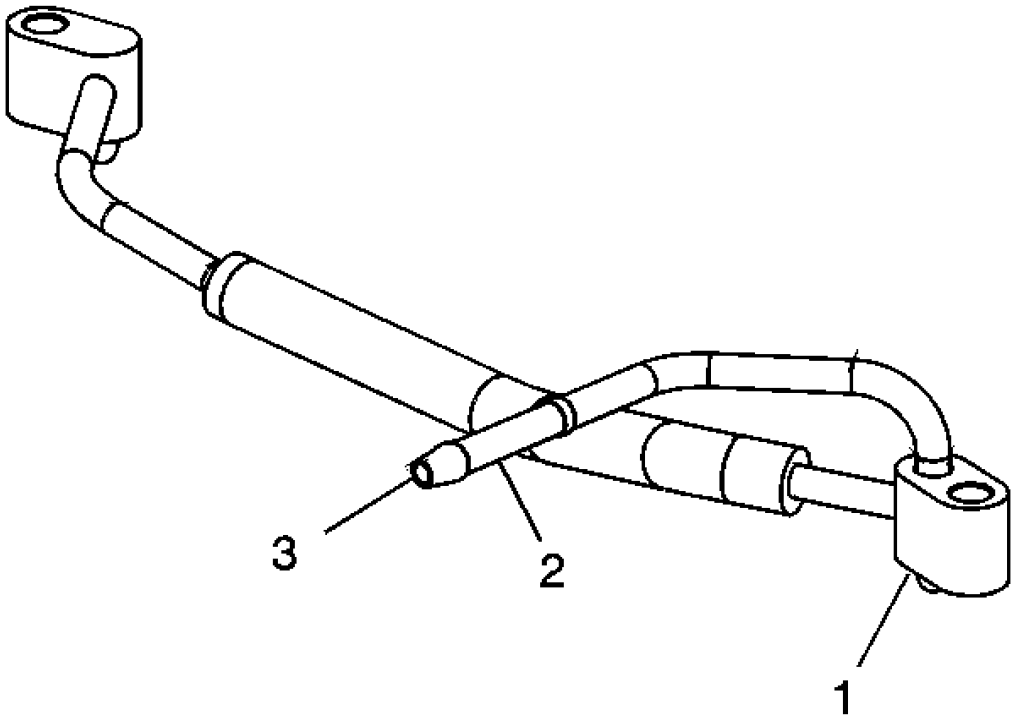


Fig. 76: Coolant Air Bleed Pipe
Courtesy of GENERAL MOTORS CORP.

2. Clean the pipe in solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

3. Dry the pipe with compressed air.
4. Inspect the pipe for damaged sealing surfaces (1, 2) or restrictions within the pipe (3).

WATER PUMP CLEANING AND INSPECTION

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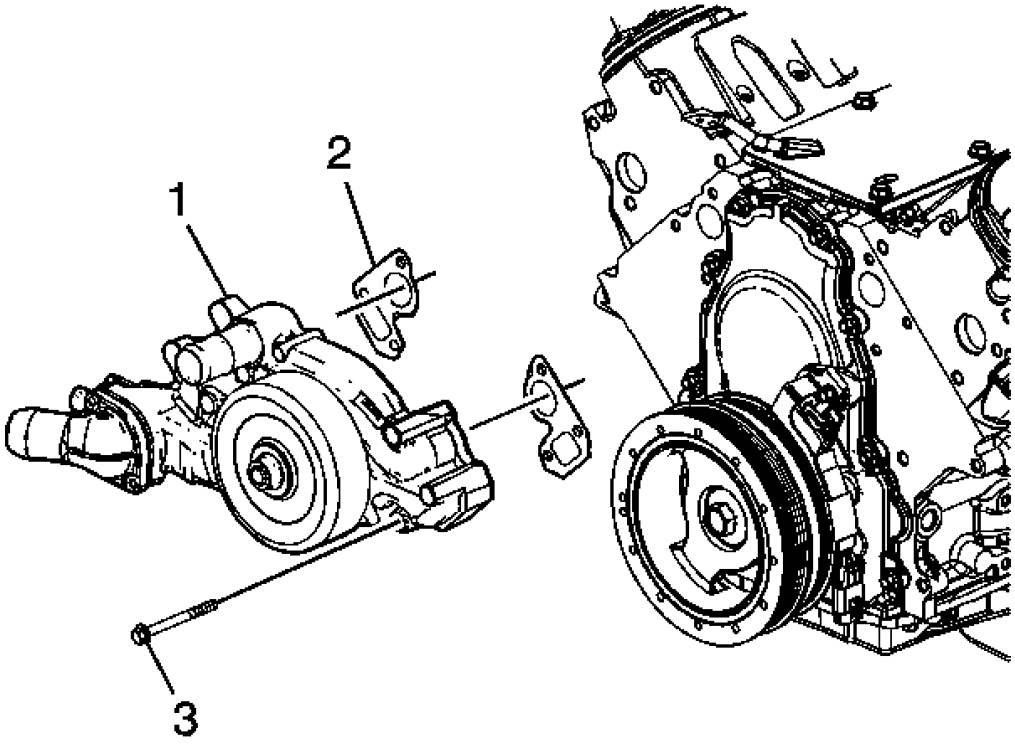


Fig. 77: Water Pump & Gaskets
Courtesy of GENERAL MOTORS CORP.

1. Remove the old gasket from the water pump sealing surfaces. Refer to **Replacing Engine Gaskets** .
2. Clean all excess dirt and debris from the water pump housing.
3. Inspect the water pump (1) for the following conditions:
   - Gasket and hose sealing surfaces for excessive scratches or gouging
   - Restrictions within the internal coolant passages
   - Excessive side-to-side play in the pulley shaft
   - Leakage at the water inlet housing or rear cover gasket
   - Leakage at the water pump vent hole

     A stain around the vent hole is acceptable. If leakage, dripping, occurs with the engine running and the cooling system pressurized, replace the water pump.

   - Wear or damage in the belt tracking area of the pulley

THREAD REPAIR

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Special Tools

- **J 42385-100:** Head/Main Bolt Thread Repair Kit
- **J 42385-300:** Fixtures and Hardware Kit

For equivalent regional tools, refer to **Special Tools**

GENERAL THREAD REPAIR

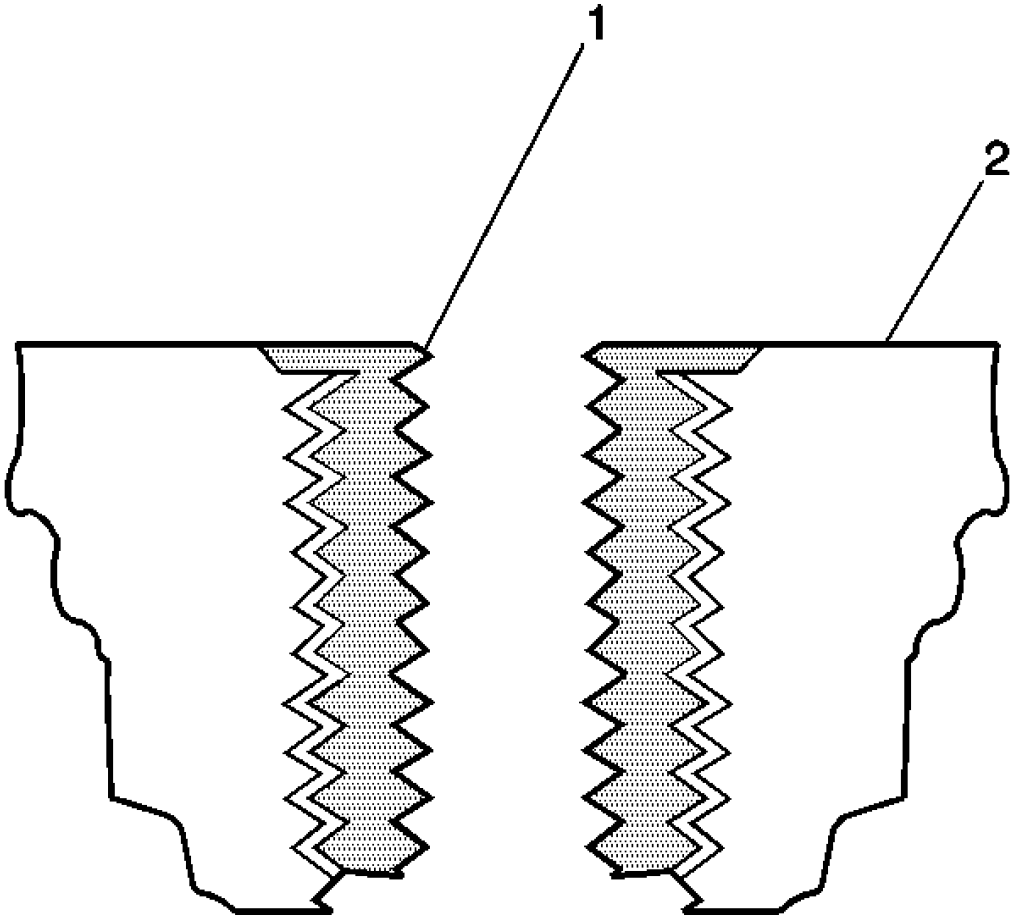


Fig. 78: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS CORP.

The thread repair process involves a solid, thin walled, self-locking, carbon steel, bushing type insert (1). During the bushing installation process, the driver tool expands the bottom external threads of the insert into the base material (2). This action mechanically locks the insert in place. Also, when installed to the proper depth,

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the flange of the insert will be seated against the counterbore of the repaired hole.

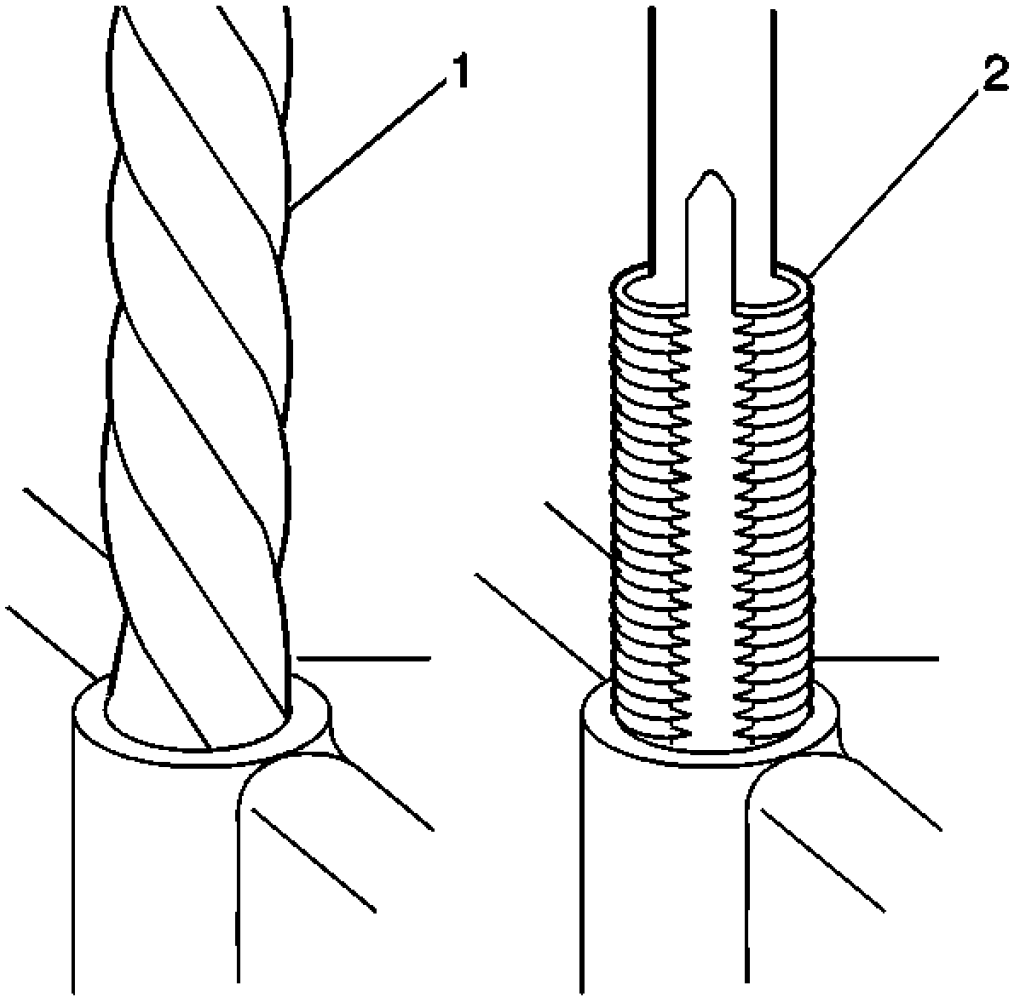


Fig. 79: Drilling & Tapping Threads
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Safety Glasses Warning .

NOTE:

- **The use of a cutting type fluid GM P/N 1052864 (Canadian P/N 992881), WD 40®, or equivalent, is recommended when performing the drilling, counterboring, and tapping procedures.**

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- **Driver oil MUST be used on the installer driver tool.**
- **The tool kits are designed for use with either a suitable tap wrench or drill motor.**

1. Drill out the threads of the damaged hole (1).
   - M6 inserts require a minimum drill depth of 15 mm (0.59 in).
   - M8 inserts require a minimum drill depth of 20 mm (0.79 in).
   - M10 inserts require a minimum drill depth of 23.5 mm (0.93 in).
2. Using compressed air, clean out any chips.

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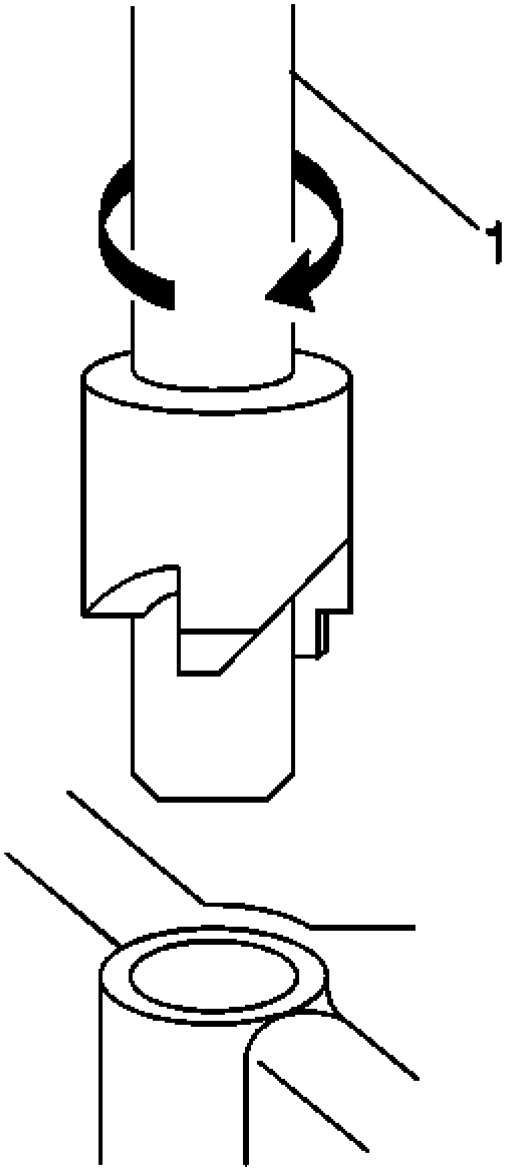


Fig. 80: Identifying Counterbore Drill
Courtesy of GENERAL MOTORS CORP.

3. Counterbore the hole to the full depth permitted by the tool (1).
4. Using compressed air, clean out any chips.

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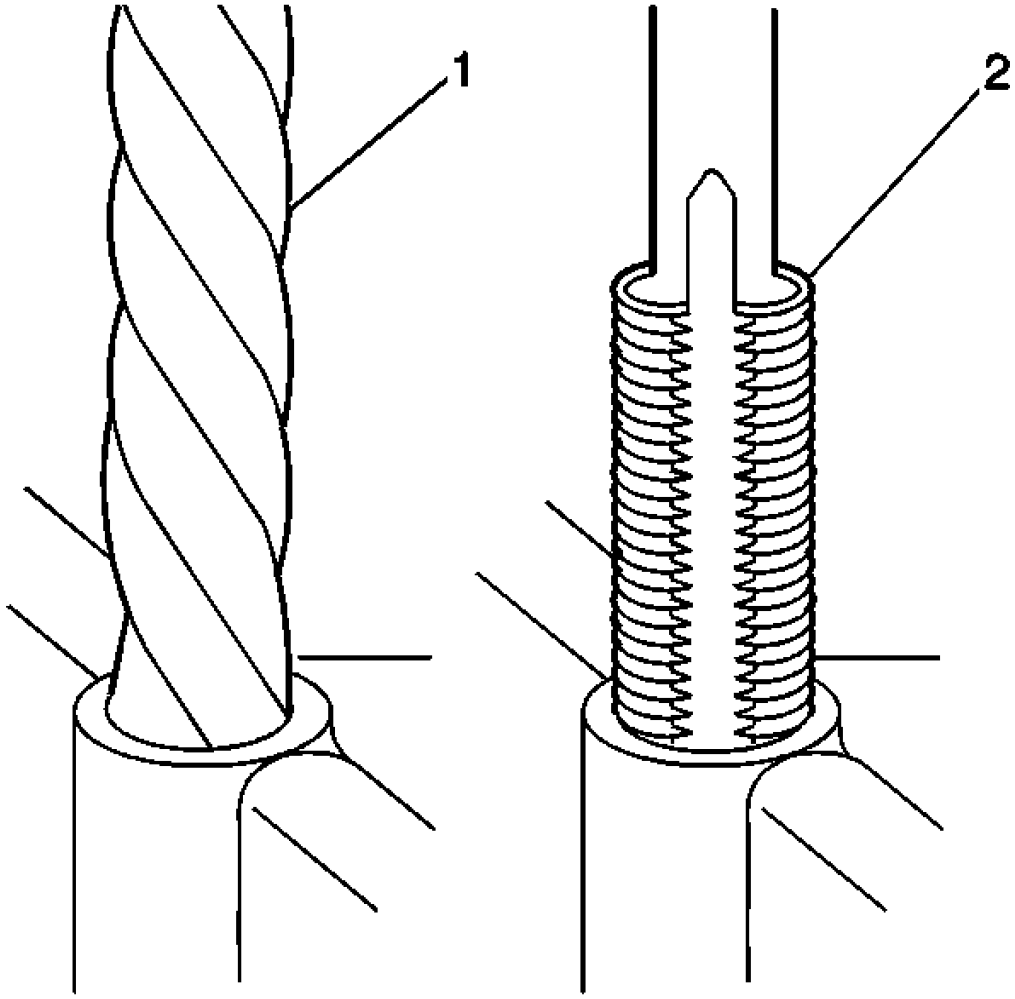


Fig. 81: Drilling & Tapping Threads
Courtesy of GENERAL MOTORS CORP.

5. Using a tap wrench (2), tap the threads of the drilled hole.
    - M6 inserts require a minimum tap depth of 15 mm (0.59 in).
    - M8 inserts require a minimum tap depth of 20 mm (0.79 in).
    - M10 inserts require a minimum tap depth of 23.5 mm (0.93 in).
6. Using compressed air, clean out any chips.
7. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.
8. Using compressed air, clean any cutting oil and chips out of the hole.

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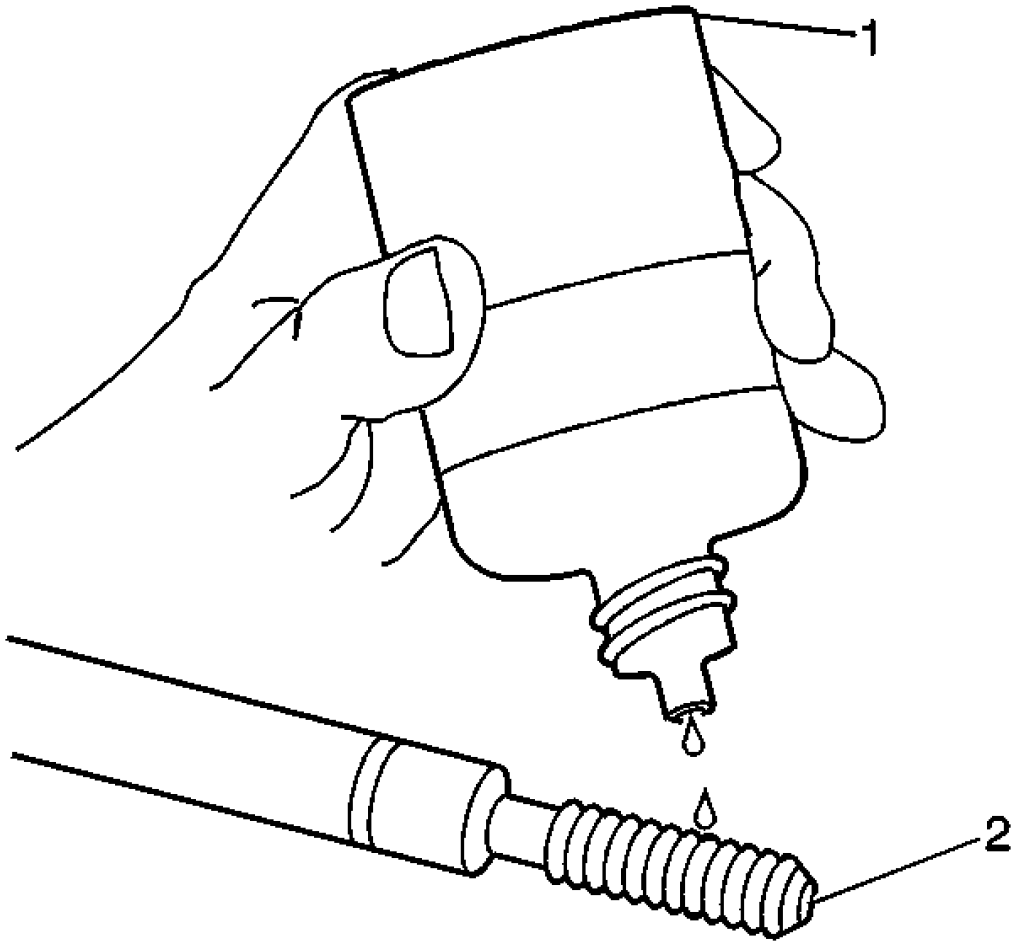


Fig. 82: Lubricating Installer Tool Threads
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

9. Lubricate the threads of the installer tool (2) with the driver oil (1).

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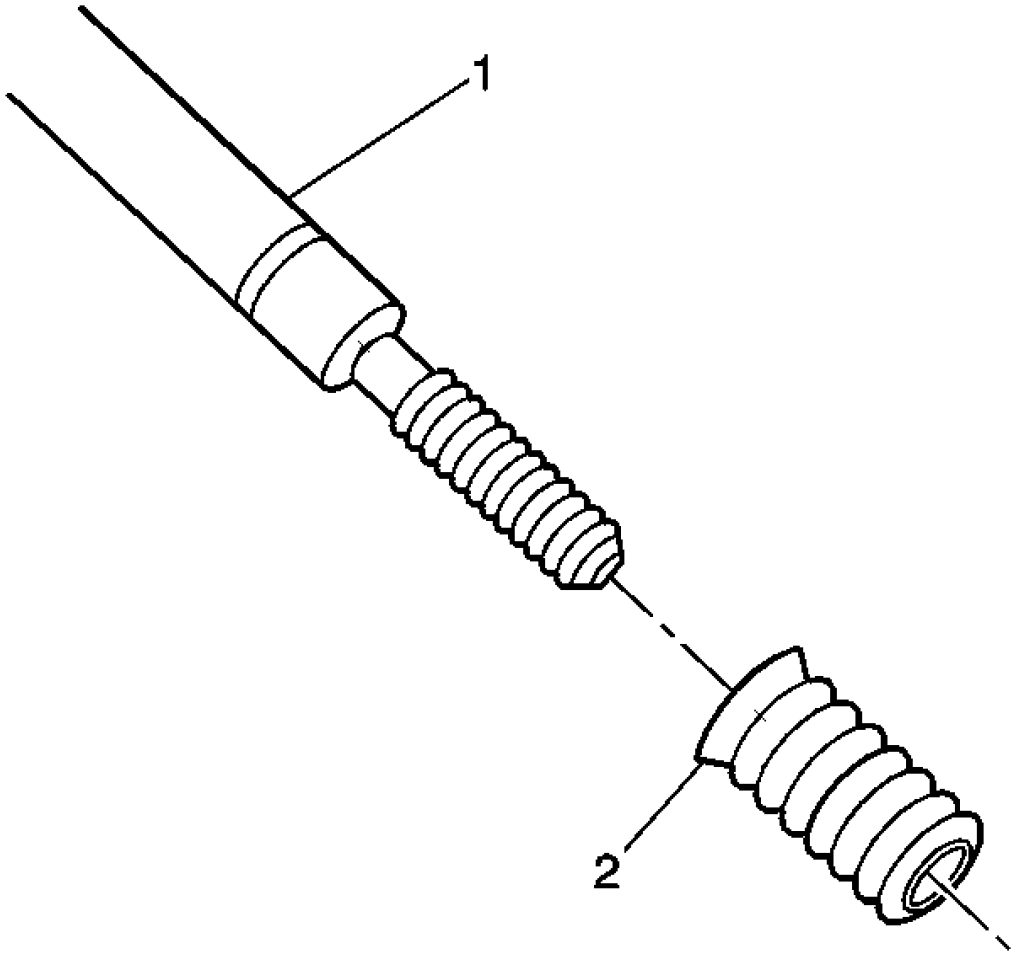


Fig. 83: Installing Insert Onto Driver Tool
Courtesy of GENERAL MOTORS CORP.

10. Install the insert (2) onto the driver tool (1).

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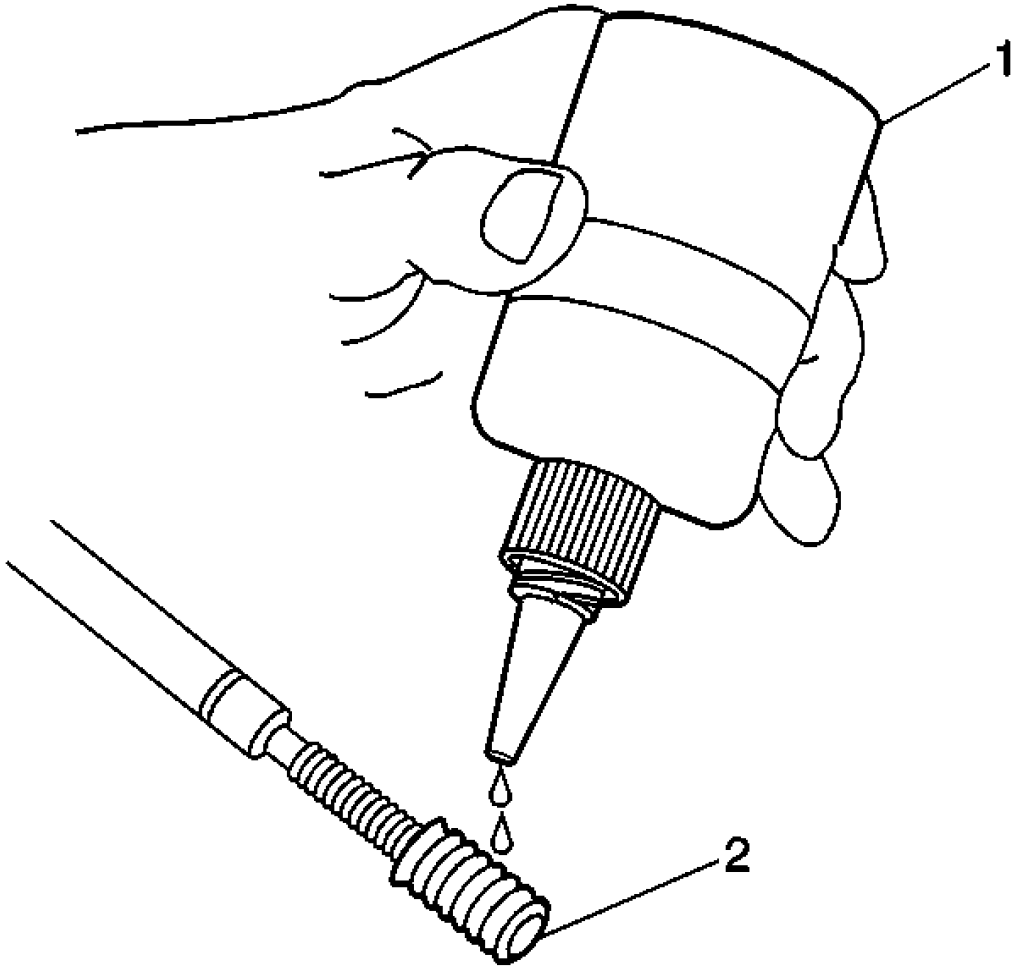


Fig. 84: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS CORP.

11. Apply threadlock LOCTITE™ 277, J 42385-109 (1), or equivalent, to the insert OD threads (2).

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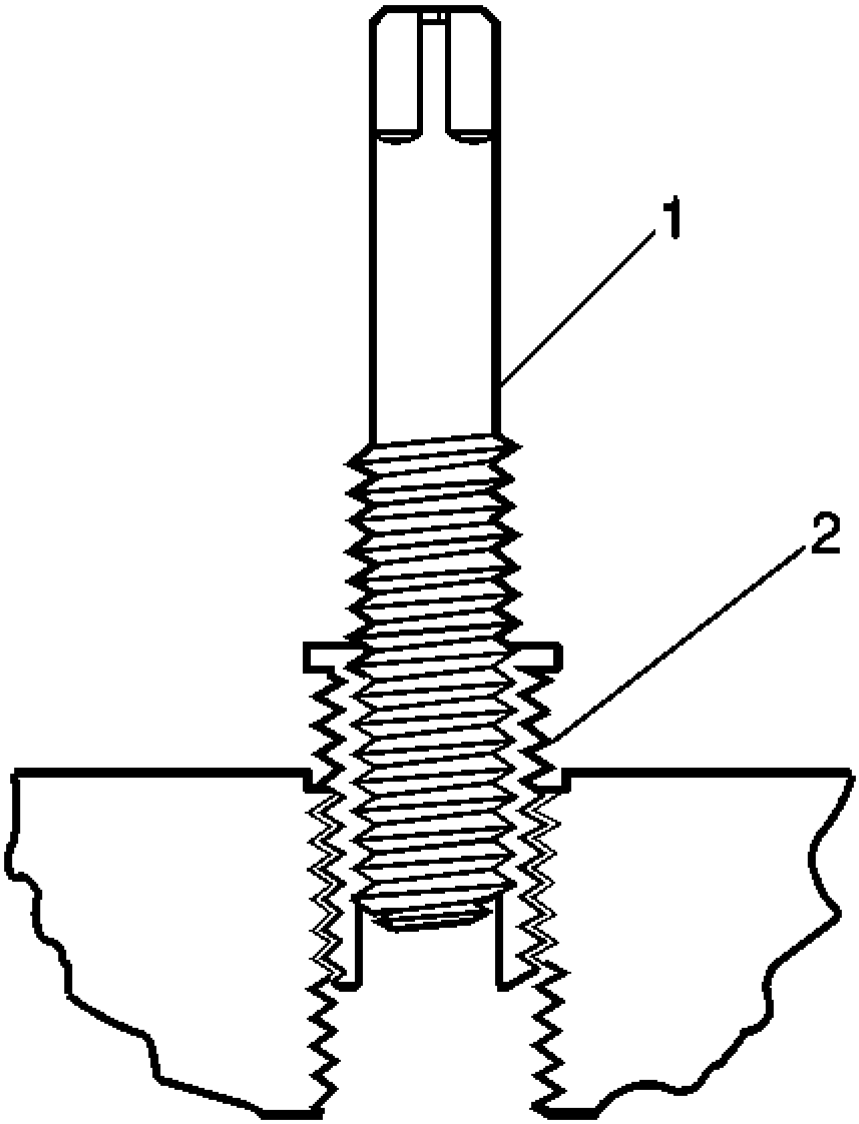


Fig. 85: Installing Insert Into Tapped Bolt Hole
Courtesy of GENERAL MOTORS CORP.

12. Install the insert (2) into the hole.

    Install the insert until the flange of the insert contacts the counterbored surface. Continue to rotate the installer tool (1) through the insert.

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The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

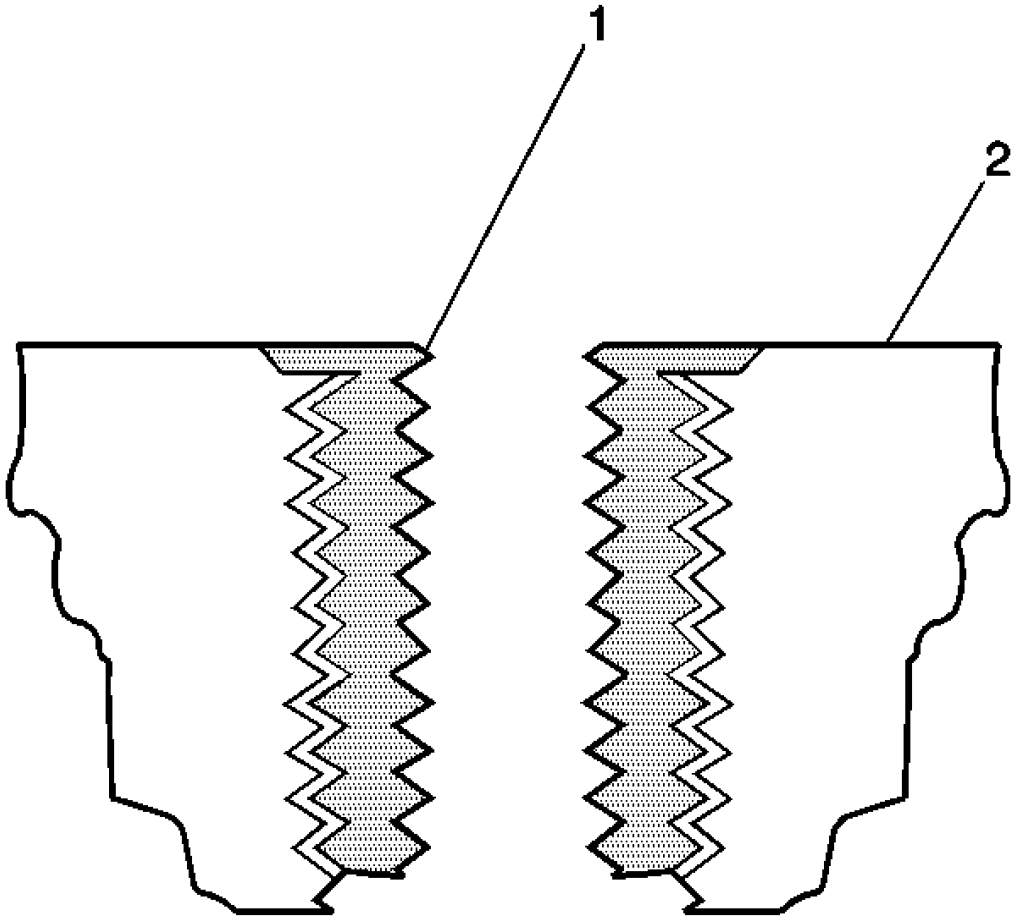


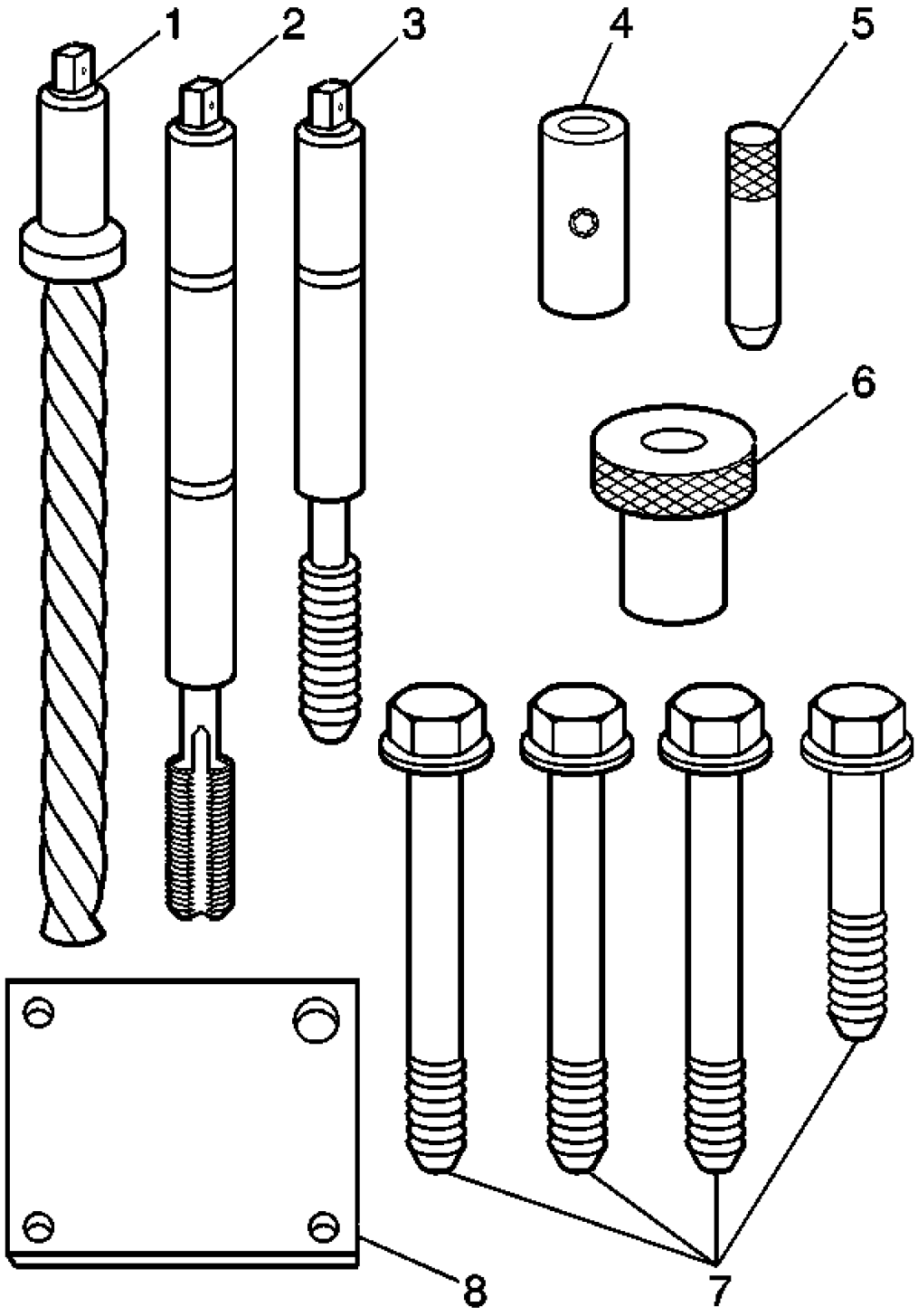
Fig. 86: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS CORP.

13. Inspect the insert for proper installation into the hole.

    A properly installed insert (1) will be either flush or slightly below flush with the surface of the base material (2).

CYLINDER HEAD BOLT HOLE THREAD REPAIR

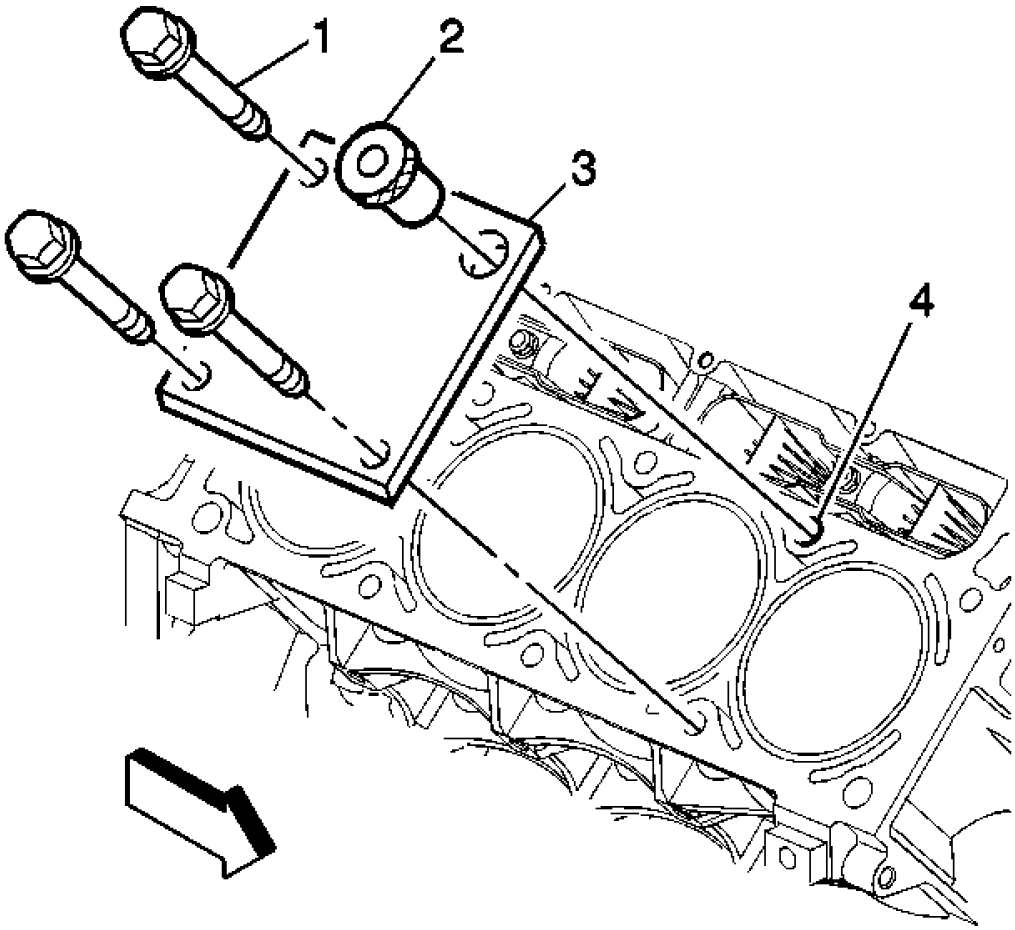
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Fig. 87: Identifying Thread Repair Kit Components
Courtesy of GENERAL MOTORS CORP.

1. The cylinder head bolt hole thread repair kit consists of the following items:
    - The drill (1)
    - The tap (2)
    - The installer (3)
    - The sleeve (4)
    - The alignment pin (5)
    - The bushing (6)
    - The bolts (7)
    - The fixture plate (8)



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Fig. 88: View Of Fixture Plate, Bolts, Bushing & Cylinder Hole
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Safety Glasses Warning .

NOTE:

- **The use of a cutting type fluid GM P/N 1052864 (Canadian P/N 992881), WD 40®, or equivalent, is recommended when performing the drilling and tapping procedures.**
- **Driver oil MUST be used on the installer driver tool.**
- **The tool kits are designed for use with either a suitable tap wrench or drill motor.**

2. Install the fixture plate (3), bolts (1), and bushing (2) onto the engine block deck.

   Position the fixture plate and bushing over the hole that is to be repaired (4).

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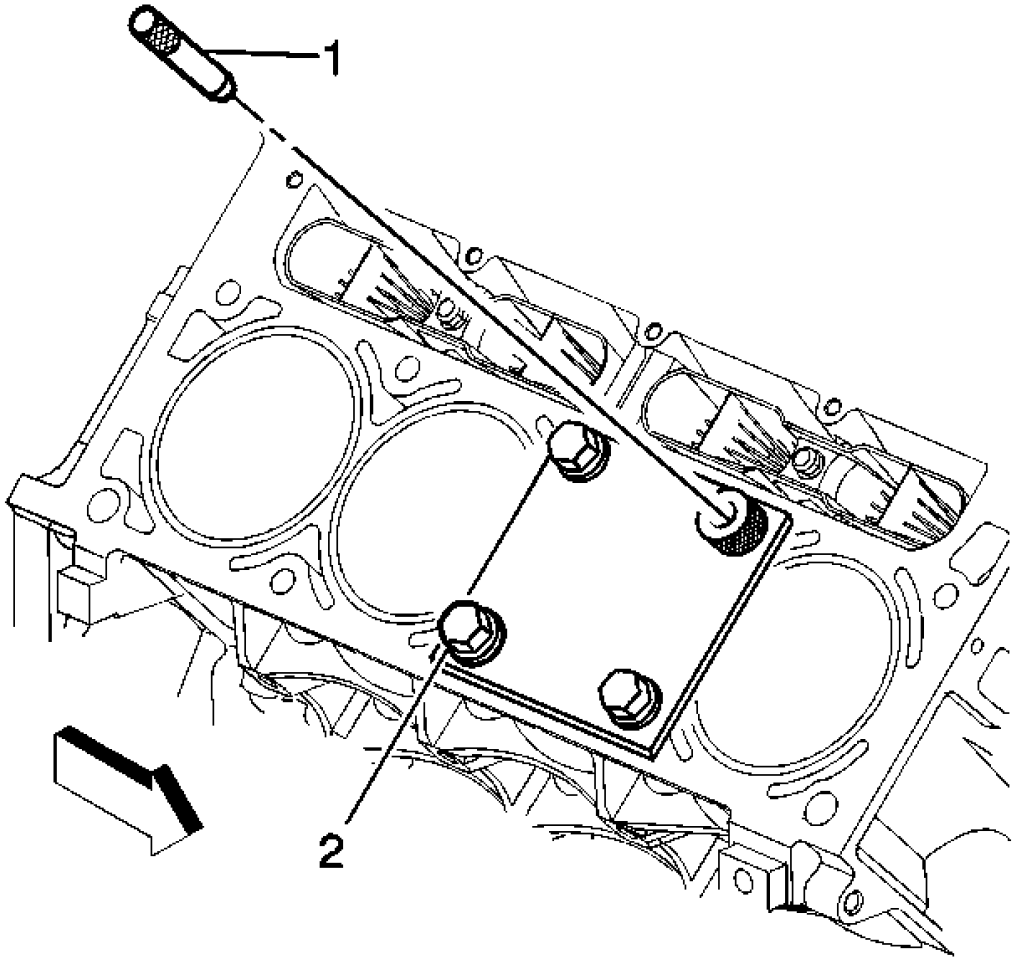


Fig. 89: View Of Alignment Pin & Fixture Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

3. Position the alignment pin (1) through the bushing and into the hole.
4. With the alignment pin in the desired hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin from the hole.

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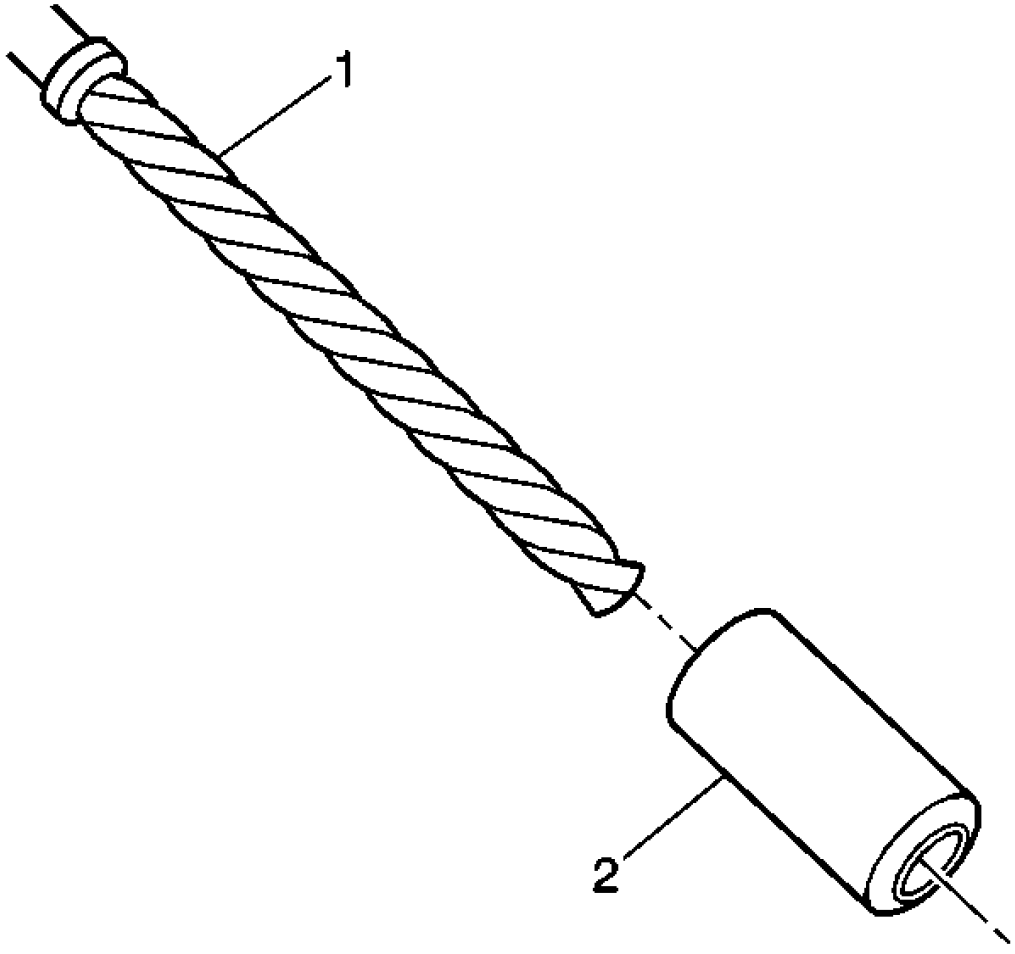


Fig. 90: Identifying Stop Collar & Counterbore Drill
Courtesy of GENERAL MOTORS CORP.

6. Install the sleeve (2) onto the drill (1).

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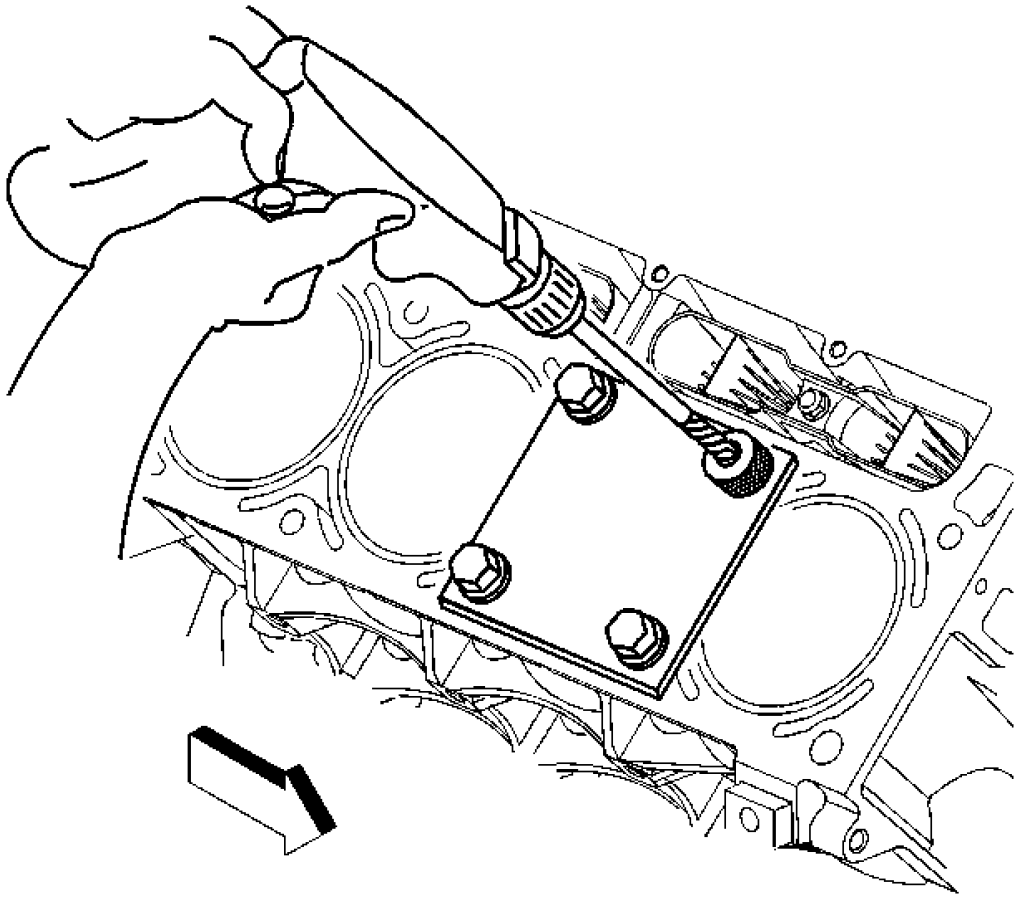


Fig. 91: Drilling Cylinder Head Bolt Hole
Courtesy of GENERAL MOTORS CORP.

NOTE: During the reaming process, it is necessary to repeatedly remove the drill and clean the chips from the hole.

7. Drill out the threads of the damaged hole.

   Drill the hole until the stop collar of the drill bit or the sleeve contacts the bushing.

8. Using compressed air, clean out any chips.

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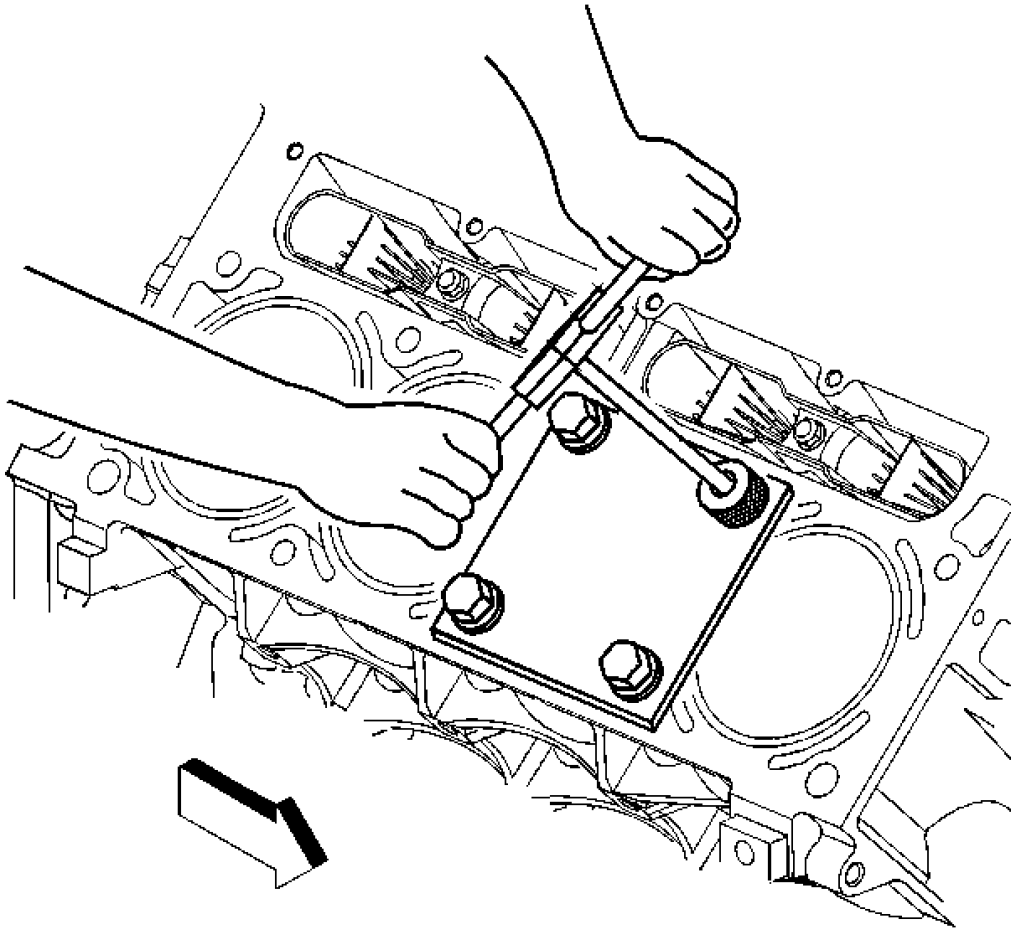


Fig. 92: Tapping Threads Of Drilled Hole
Courtesy of GENERAL MOTORS CORP.

9. Using a tap wrench, tap the threads of the drilled hole.

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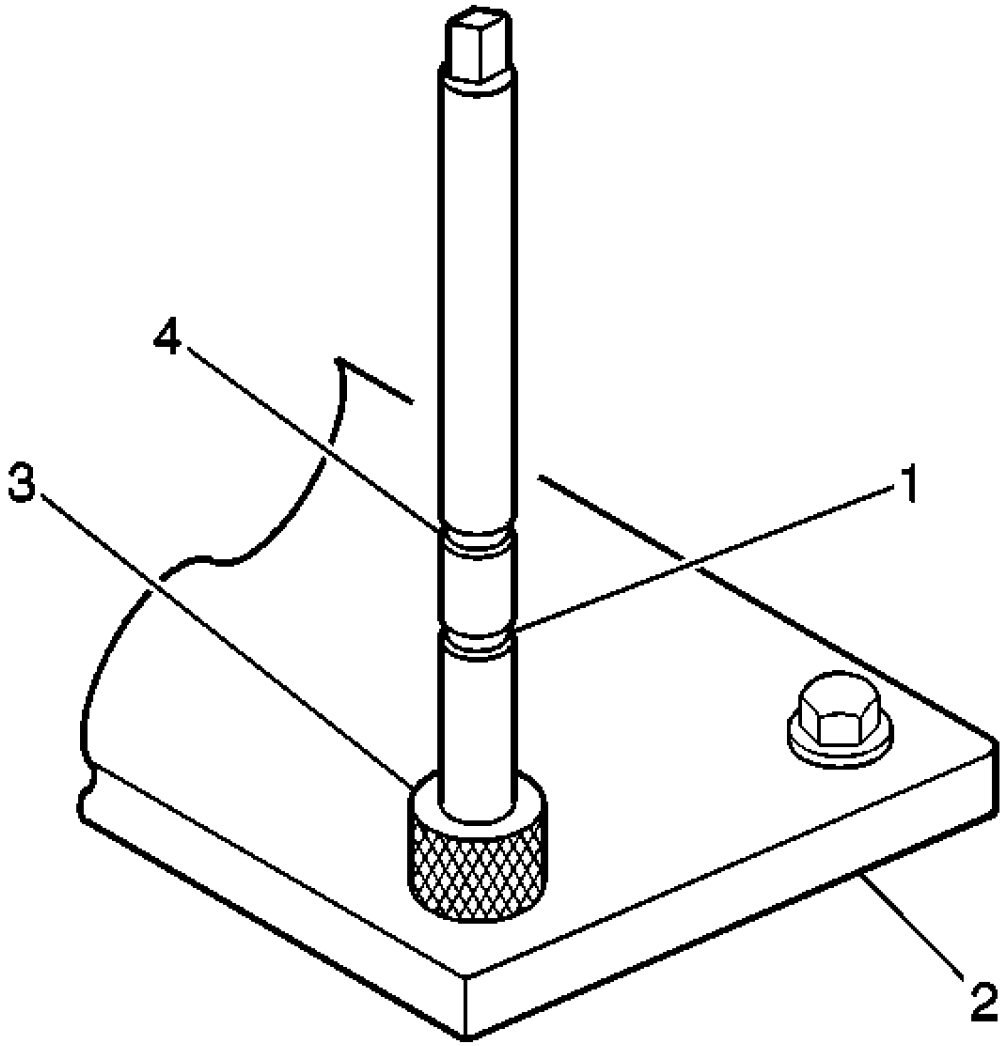


Fig. 93: View Of Tap Upper & Lower Marks, Fixture Plate & Bushing
Courtesy of GENERAL MOTORS CORP.

10. In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark (1) on the tap aligns with the top of the drill bushing (3).
11. Remove the fixture plate (2), bushing (3), and bolts.
12. Using compressed air, clean out any chips.
13. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.
14. Using compressed air, clean any cutting oil and chips out of the hole.

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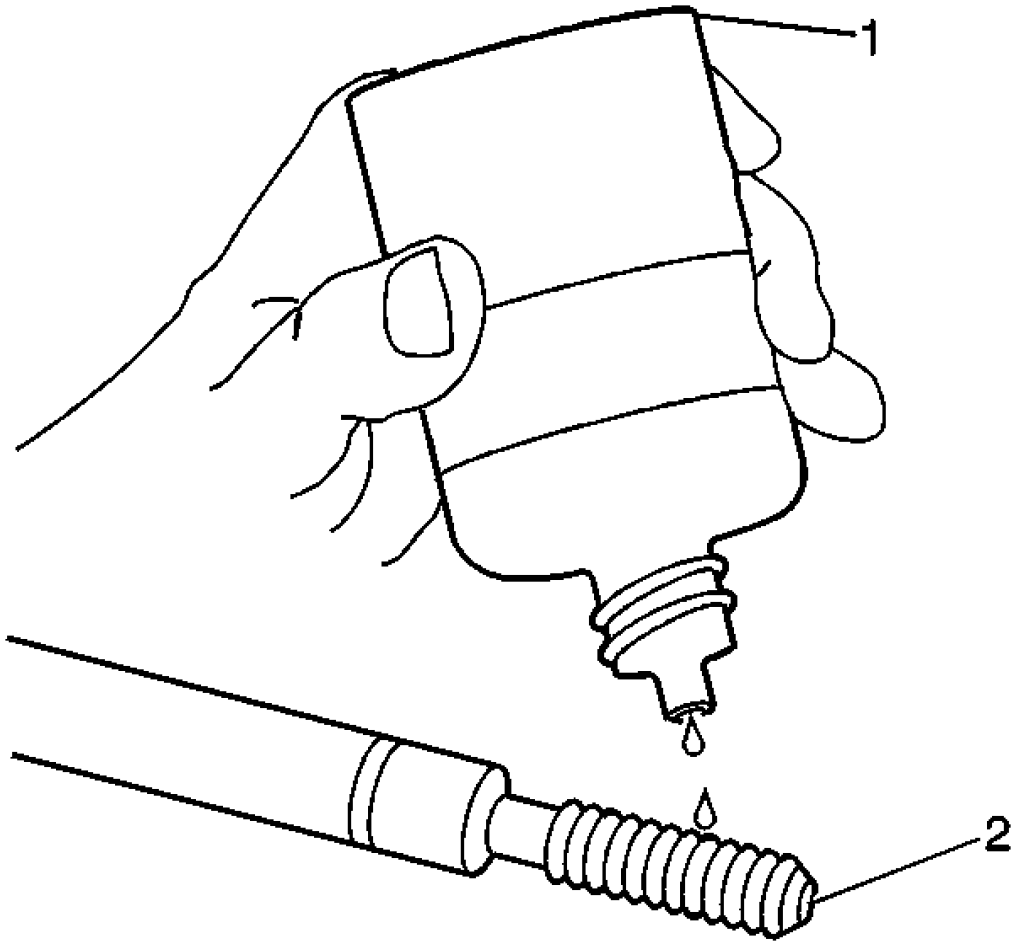


Fig. 94: Lubricating Installer Tool Threads
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not allow oil or foreign material to contact the OD of the insert.

15. Lubricate the threads of the installer tool (2) with the driver oil (1).

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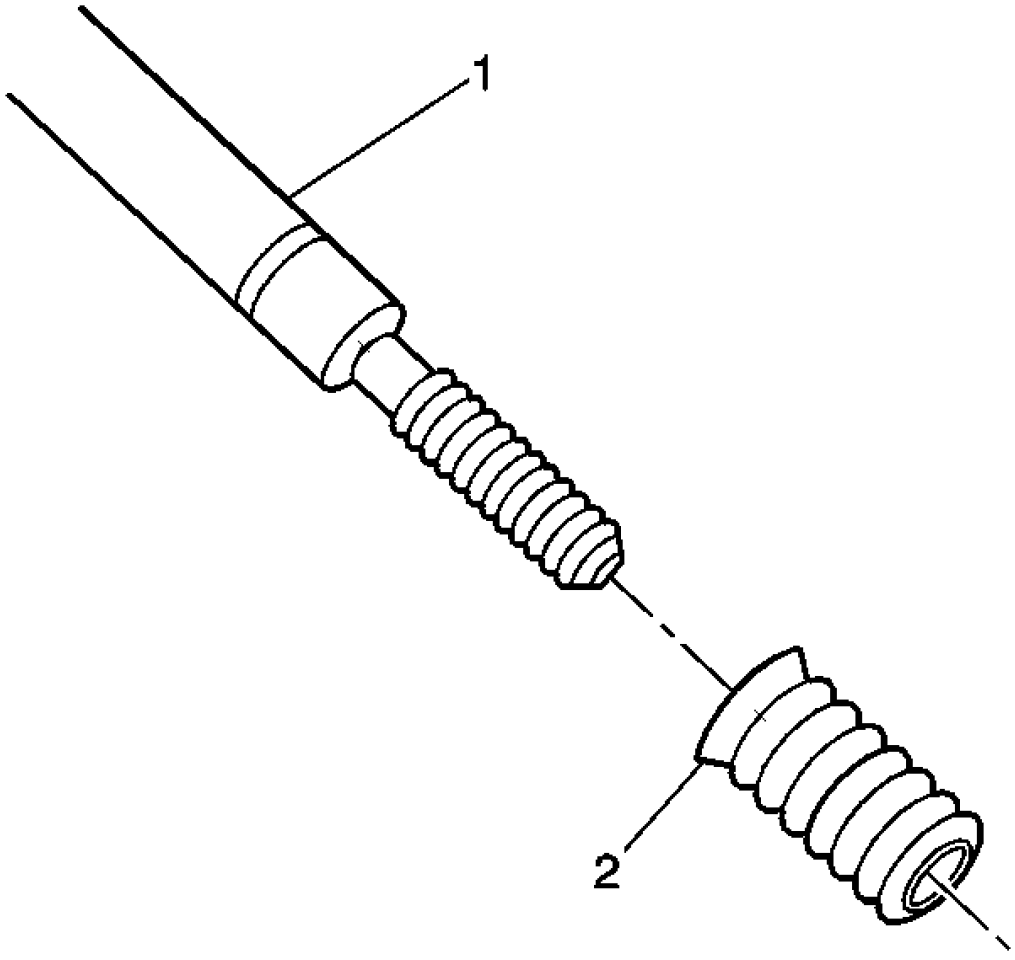


Fig. 95: Installing Insert Onto Driver Tool
Courtesy of GENERAL MOTORS CORP.

16. Install the insert (2) onto the driver tool (1).

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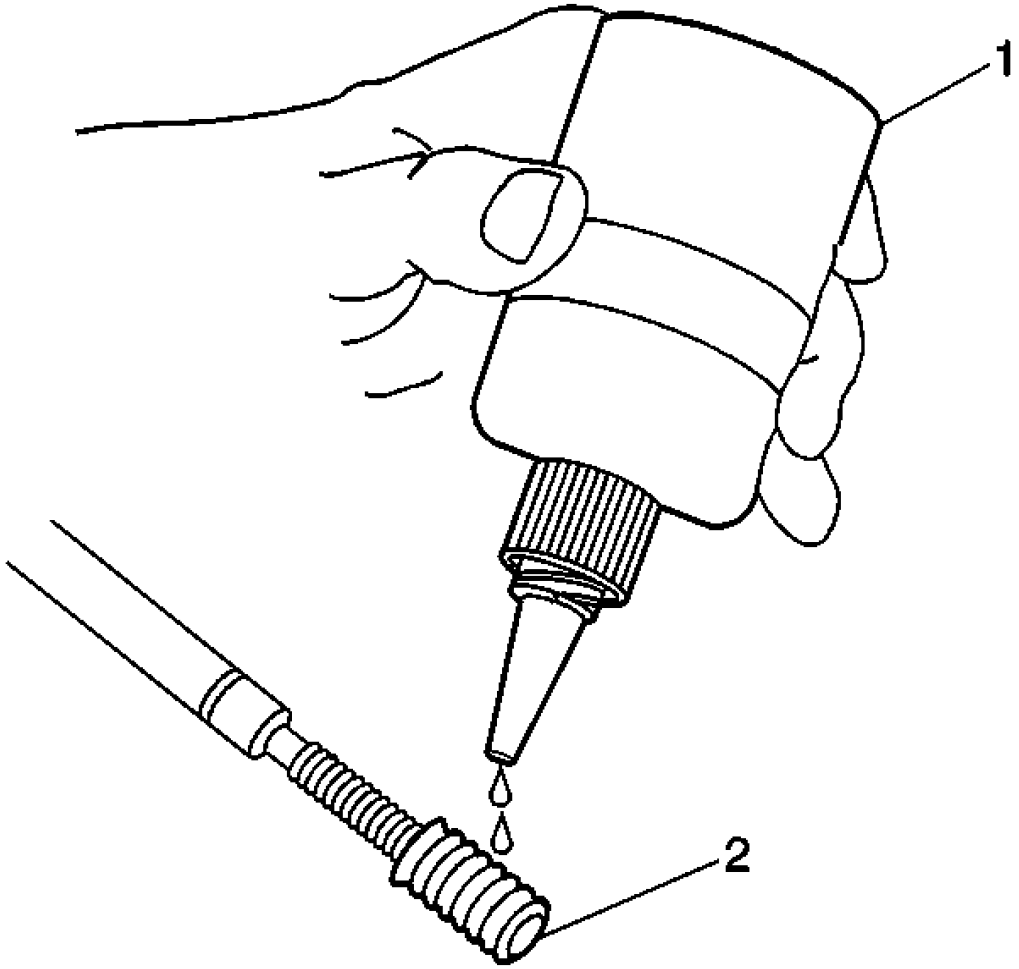


Fig. 96: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS CORP.

17. Apply threadlock LOCTITE™ 277, J 42385-109 (1), or equivalent, to the insert OD threads (2).

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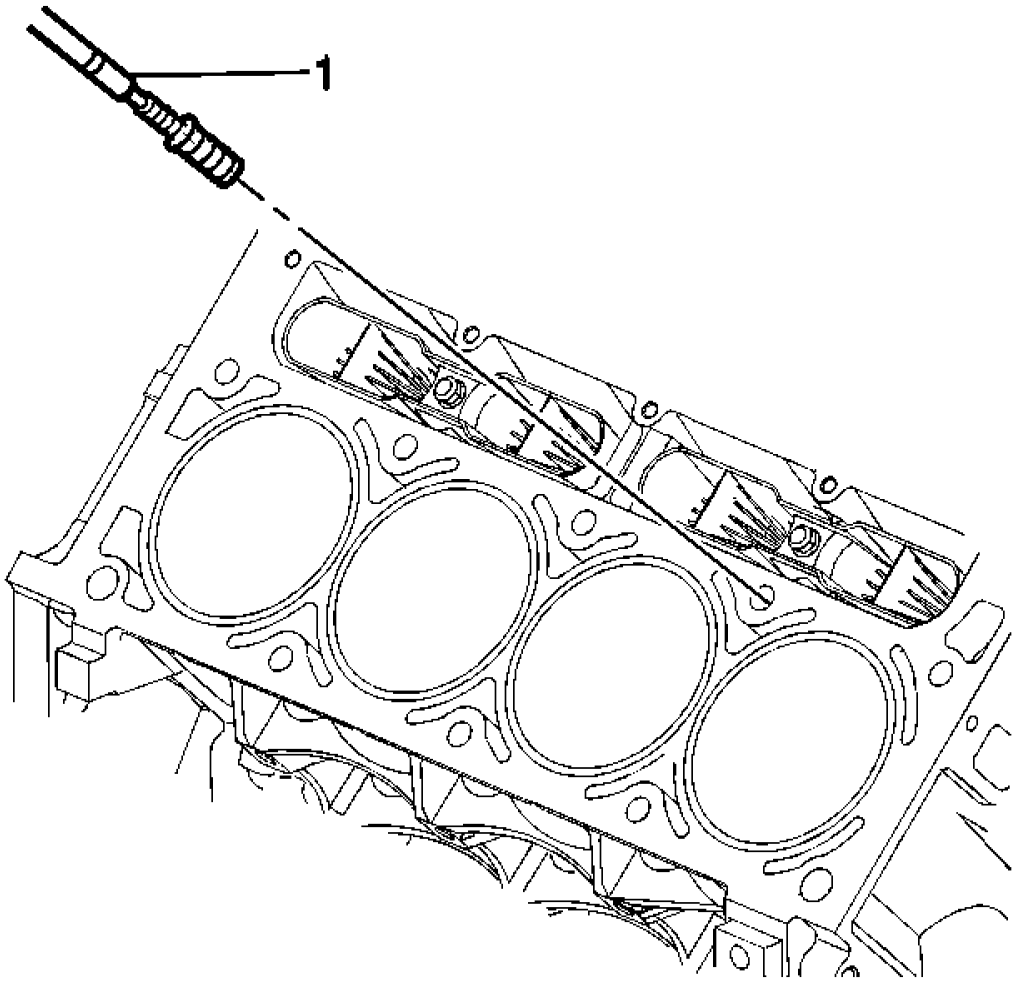


Fig. 97: Installing Insert & Driver Into Cylinder Bolt Hole
Courtesy of GENERAL MOTORS CORP.

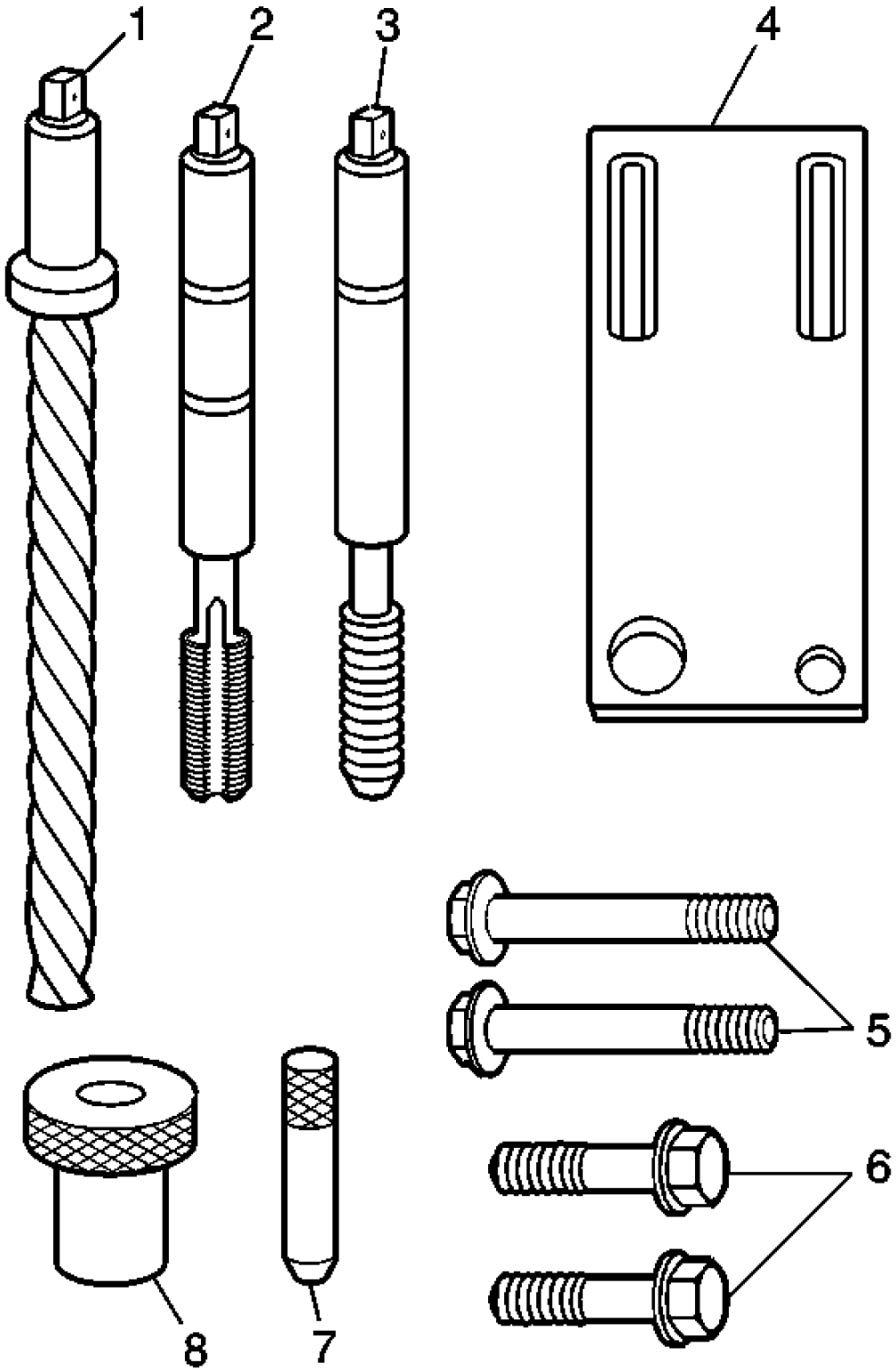
18. Install the insert and driver (1) into the hole.

    Rotate the driver tool until the mark on the tool aligns with the deck surface of the engine block.

    The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

MAIN CAP BOLT HOLE THREAD REPAIR

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Fig. 98: Identifying Thread Repair Kit Components
Courtesy of GENERAL MOTORS CORP.

1. The main cap bolt hole thread repair kit consists of the following items:
    - The drill (1)
    - The tap (2)
    - The installer (3)
    - The fixture plate (4)
    - The long bolts (5)
    - The short bolts (6)
    - The alignment pin (7)
    - The bushing (8)

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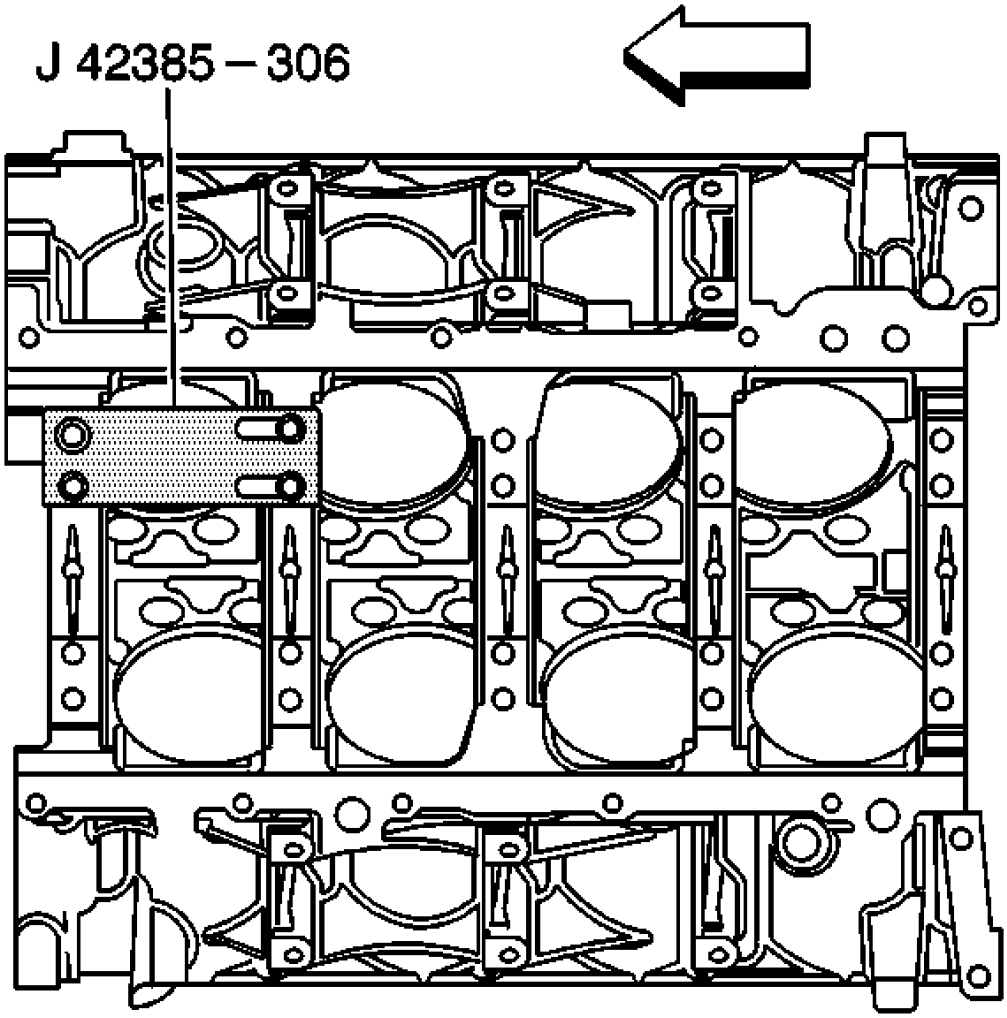


Fig. 99: View Of Fixture Plate, Bolt & Bushing
Courtesy of GENERAL MOTORS CORP.

2. Install the fixture plate, bolt, and bushing onto the engine block.

   Position the fixture plate and bushing over the hole that is to be repaired.

3. Position the alignment pin in the desired hole and tighten the fixture retaining bolts.

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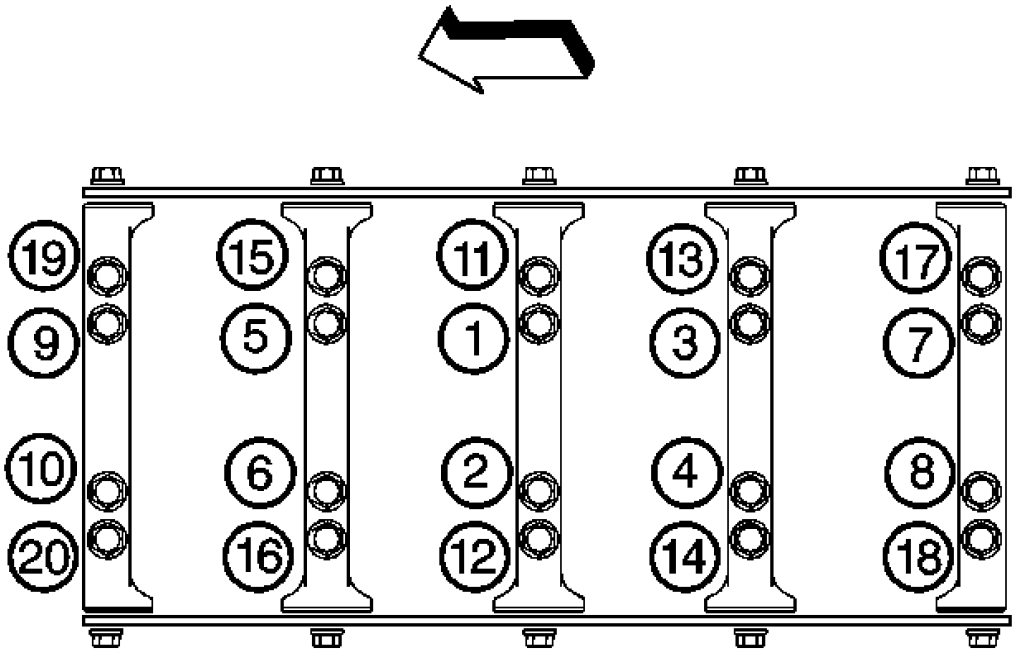


Fig. 100: Crankshaft Main Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

4. Drill out the damaged hole.

   The outer bolt hole locations 11-20 have the shallower counterbores. Use sleeve J 42385-316 with the drill.

   Drill until the stop collar of the drill bit or the sleeve contacts the bushing.

5. Using compressed air, clean out any chips.

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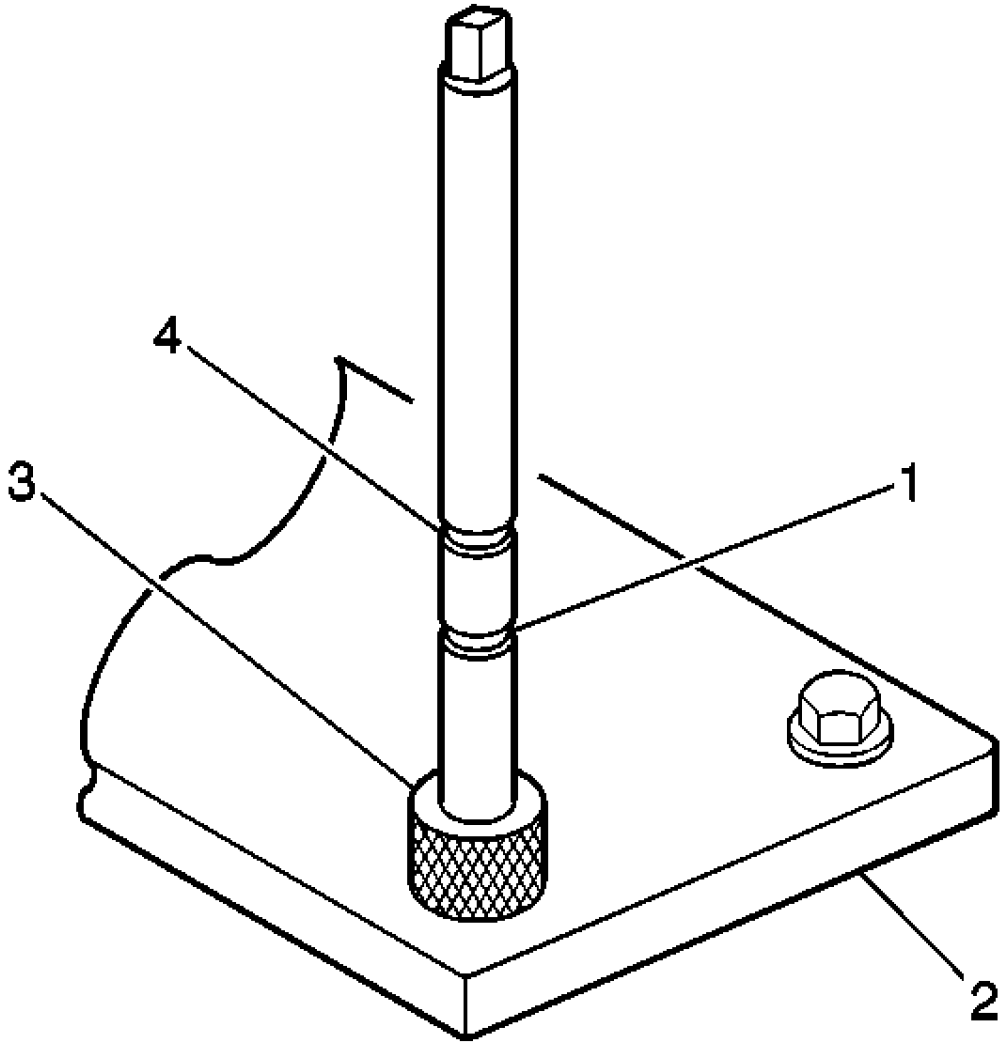


Fig. 101: View Of Tap Upper & Lower Marks, Fixture Plate & Bushing
Courtesy of GENERAL MOTORS CORP.

6. Using a tap wrench, tap the threads of the drilled hole.

   In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark on the tap aligns with the top of the bushing.

   For the deeper main cap holes 1-10, rotate the tap until the upper mark (4) on the tap aligns with the top of the bushing (3).

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For the shallower main cap holes 11-20, rotate the tap until the lower mark (1) on the tap aligns with top of the bushing (3).

7. Using compressed air, clean out any chips.
8. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463), or equivalent, into the hole.
9. Using compressed air, clean any cutting oil and chips out of the hole.

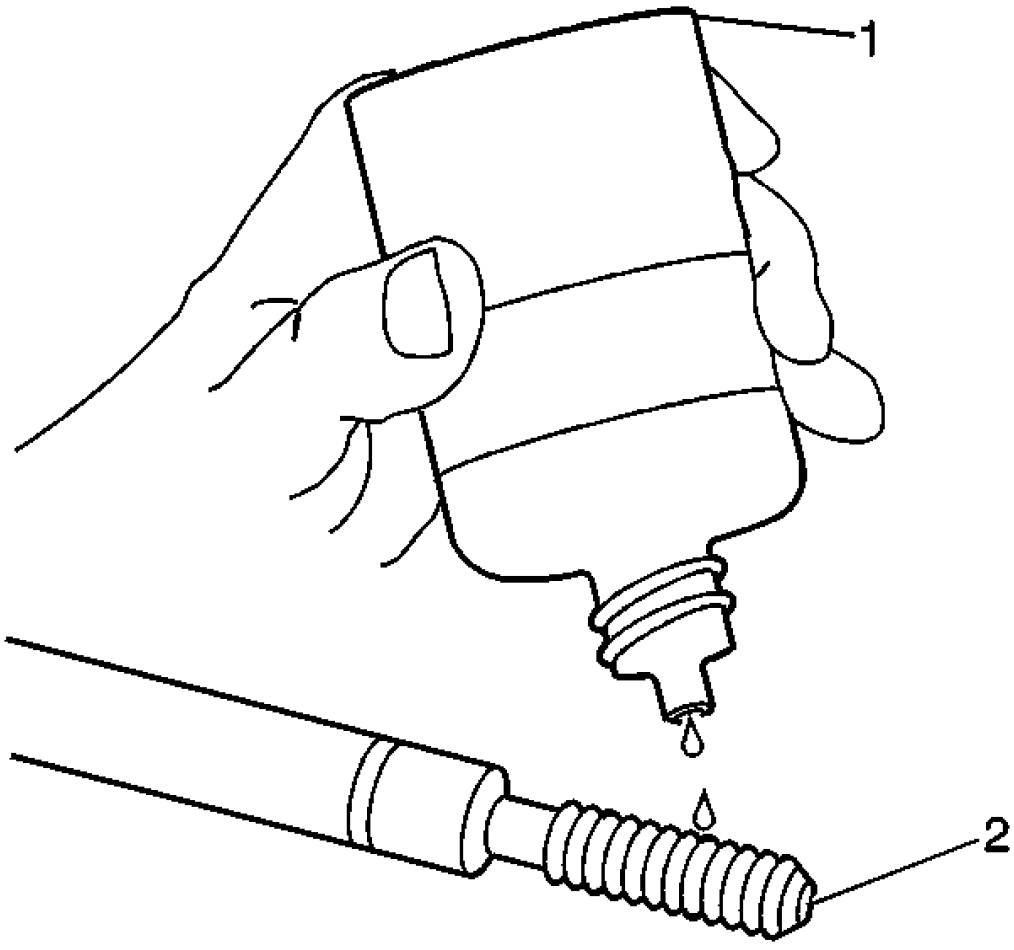


Fig. 102: Lubricating Installer Tool Threads
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not allow oil or foreign material to contact the OD of the insert.

10. Lubricate the threads of the installer tool (2) with the driver oil (1).

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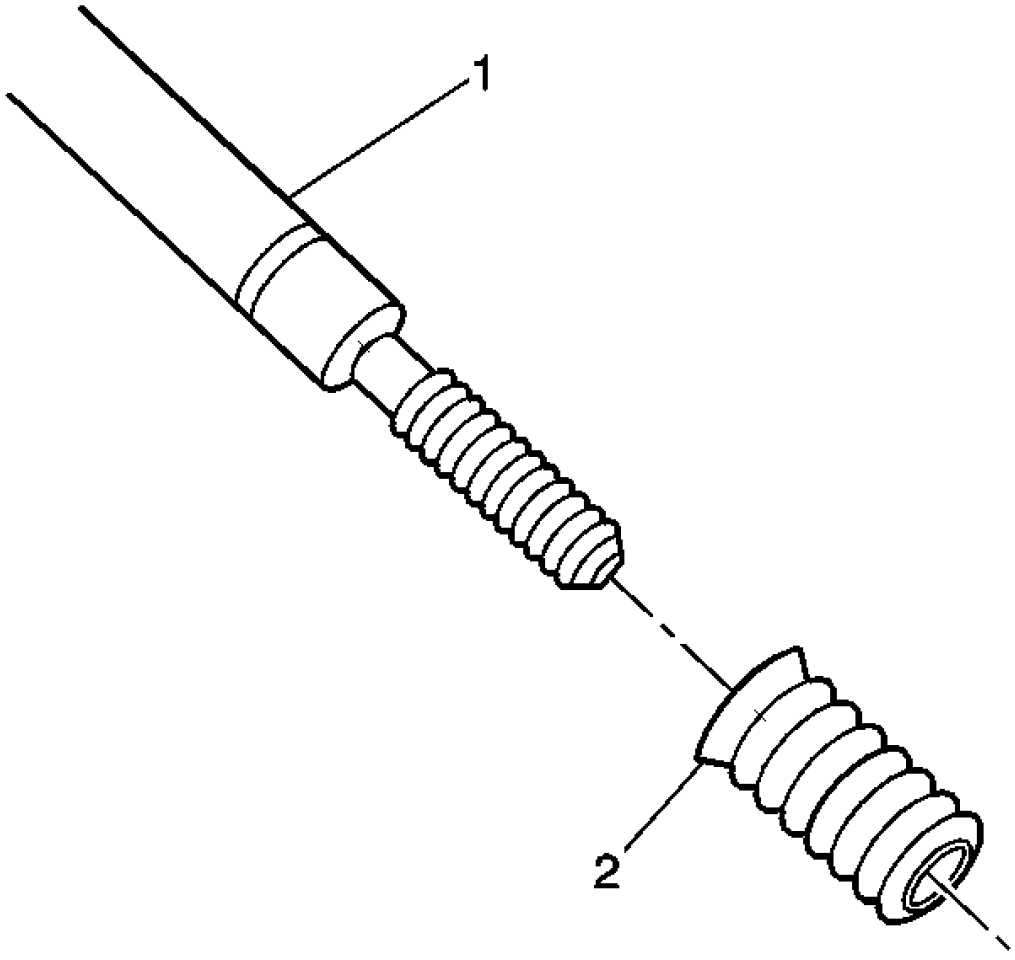


Fig. 103: Installing Insert Onto Driver Tool
Courtesy of GENERAL MOTORS CORP.

11. Install the insert (2) onto the driver tool (1).

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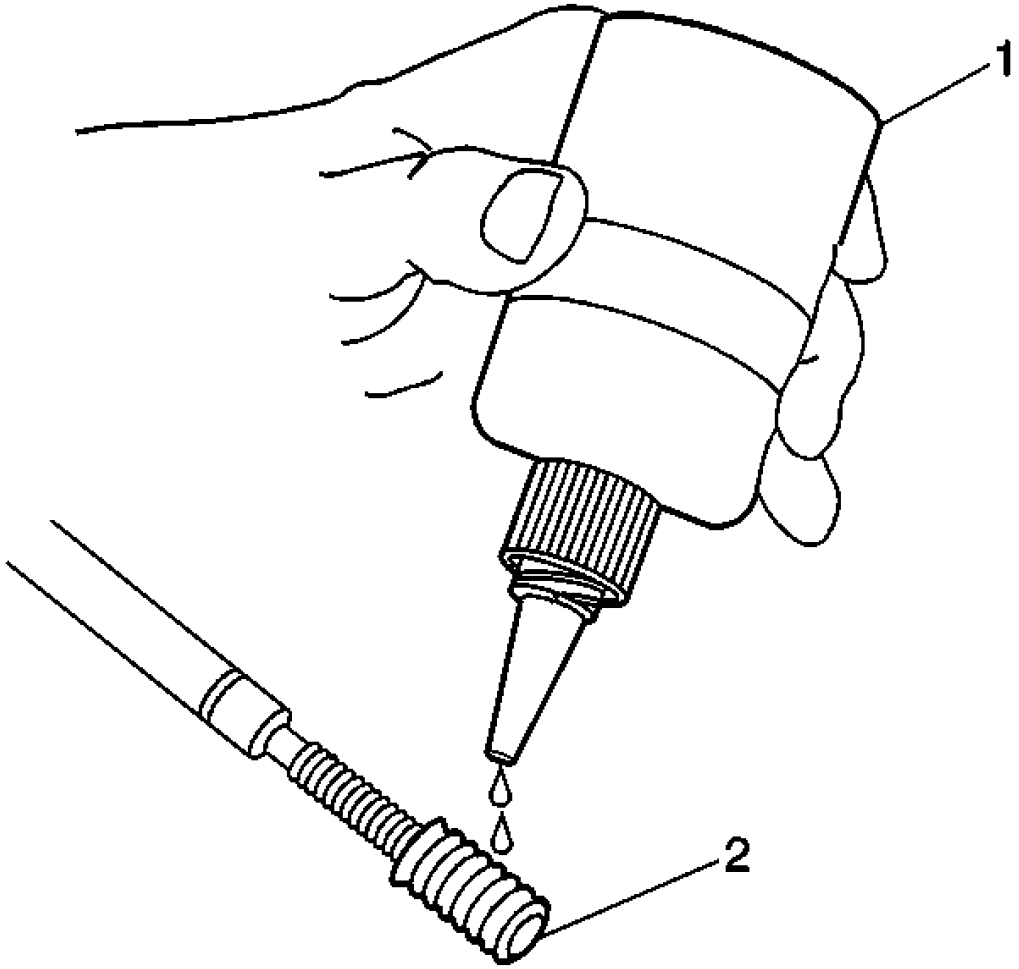


Fig. 104: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS CORP.

12. Apply threadlock LOCTITE™ 277, J 42385-109 (1), or equivalent, to the insert OD threads (2).

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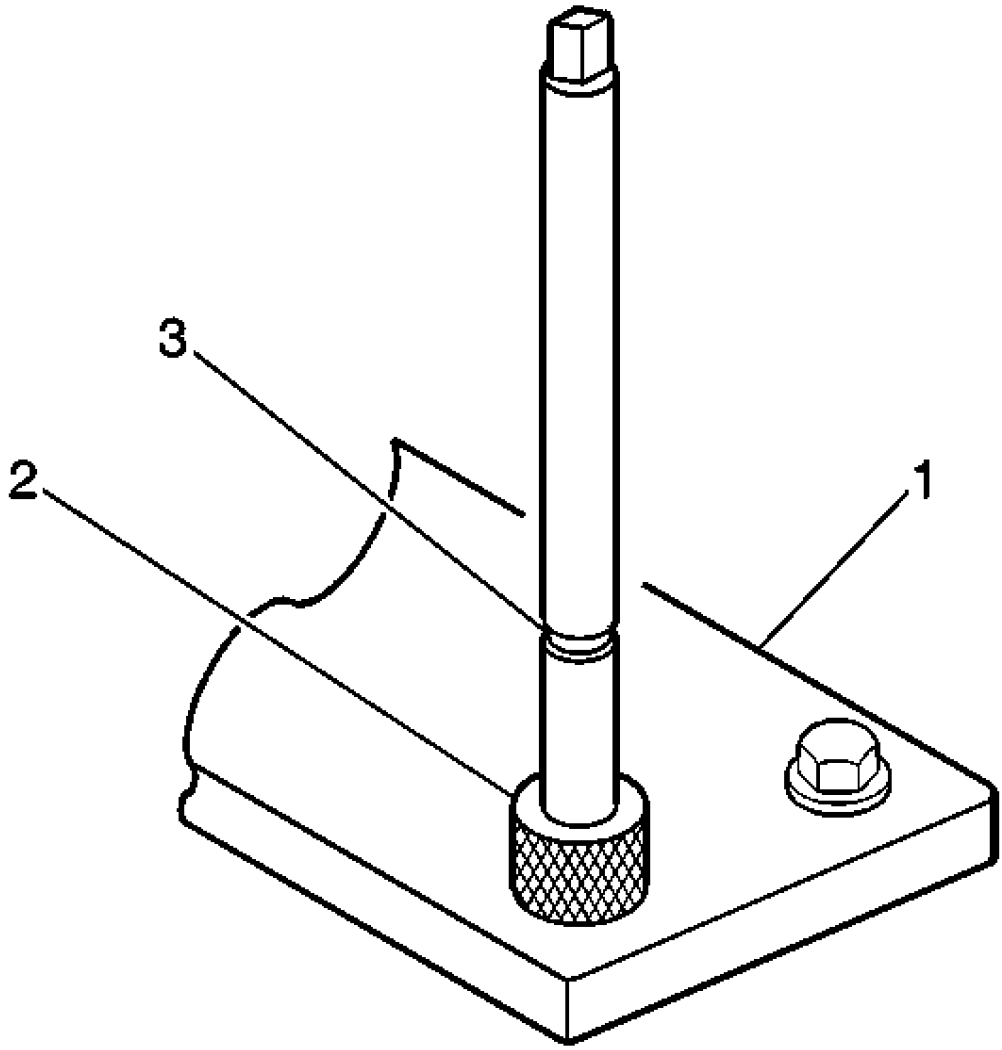


Fig. 105: View Of Driver, Bushing & Tool Marking
Courtesy of GENERAL MOTORS CORP.

NOTE: The fixture plate and bushing remains installed onto the engine block during the insert installation procedure.

13. Install the insert and driver (1) through the fixture plate and bushing and into the hole.

    Rotate the driver tool until the mark on the tool (3) aligns with the top of the bushing (2).

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The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

SERVICE PRIOR TO ASSEMBLY

- Dirt or debris causes premature wear of the rebuilt engine. Clean all components. Refer to **Cleanliness and Care** .
- Use the proper tools to measure components when inspecting for excessive wear. Components that are not within the manufacturers specifications must be repaired or replaced.
- When the components are installed into an engine, return the components to their original location, position and direction. Refer to **Separating Parts** .
- During assembly, lubricate all moving parts with clean engine oil. This provides initial lubrication when the engine is first started.

ENGINE BLOCK PLUG INSTALLATION

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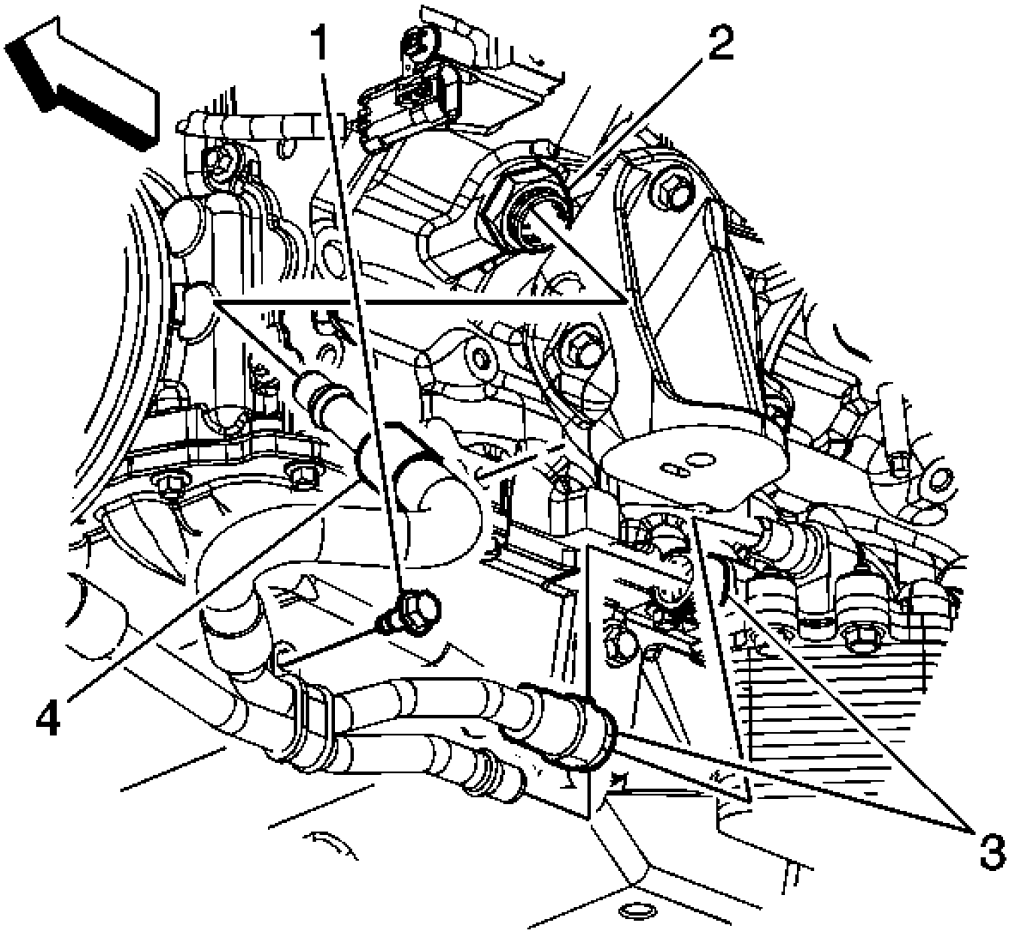


Fig. 106: Identifying Engine Oil Cooler Hose/Pipe
Courtesy of GENERAL MOTORS CORP.

NOTE: Engine block plug, oil gallery, and coolant sealing washers may be used again if not bent, scored or otherwise damaged.

1. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the threads of the engine oil cooler coolant fitting (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

CAUTION: Refer to Component Fastener Tightening Caution .

2. Install the engine oil cooler coolant fitting (2) and tighten to 50 N.m (37 lb ft).

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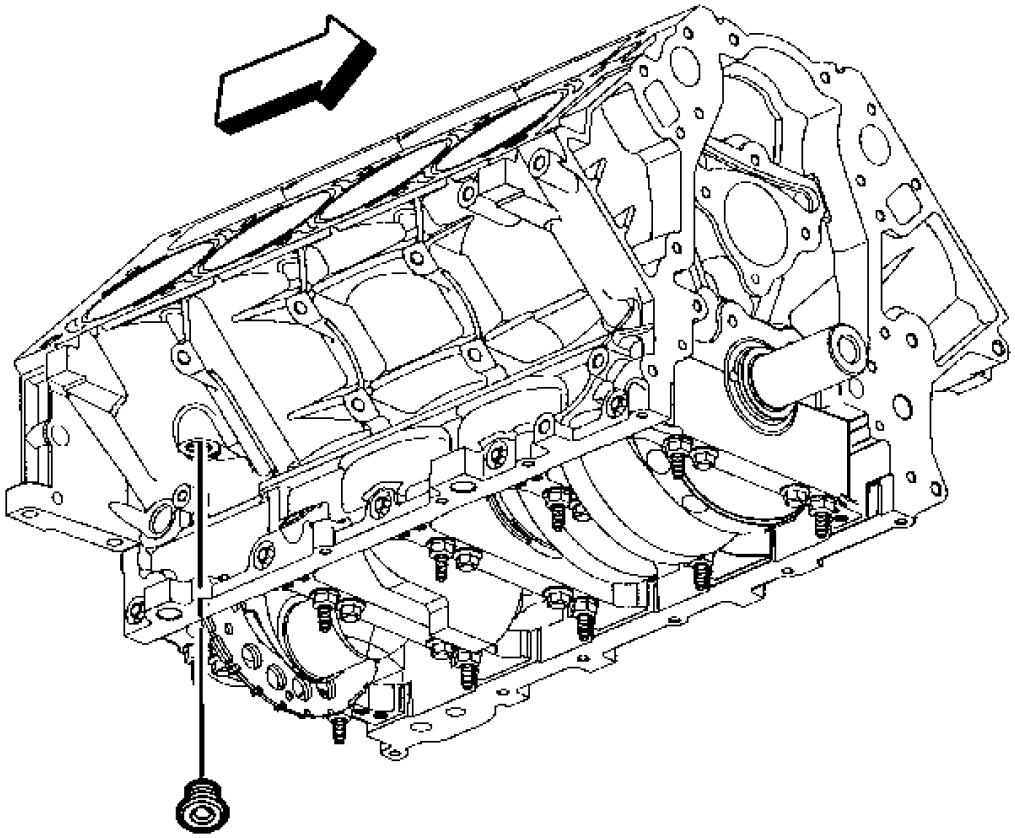


Fig. 107: Engine Block Right Rear Coolant Drain Hole Plug
Courtesy of GENERAL MOTORS CORP.

3. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block right rear coolant drain hole plug sealing washer.
4. Install the engine block right rear coolant drain hole plug and tighten to 60 N.m (44 lb ft).

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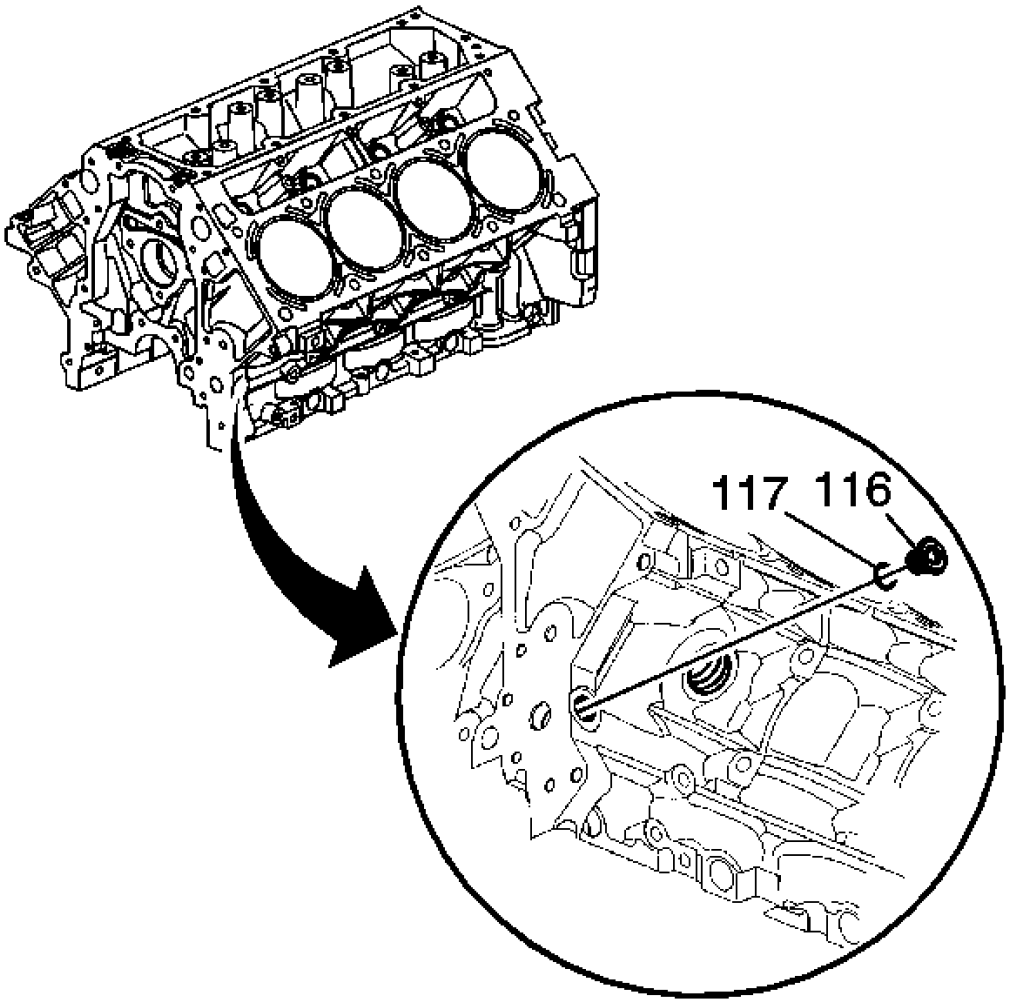


Fig. 108: Locating Engine Block Left Front Oil Gallery Plug & Washer
Courtesy of GENERAL MOTORS CORP.

5. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block left front oil gallery plug sealing washer (117).
6. Install the engine block left front oil gallery plug (116) and tighten to 60 N.m (44 lb ft).

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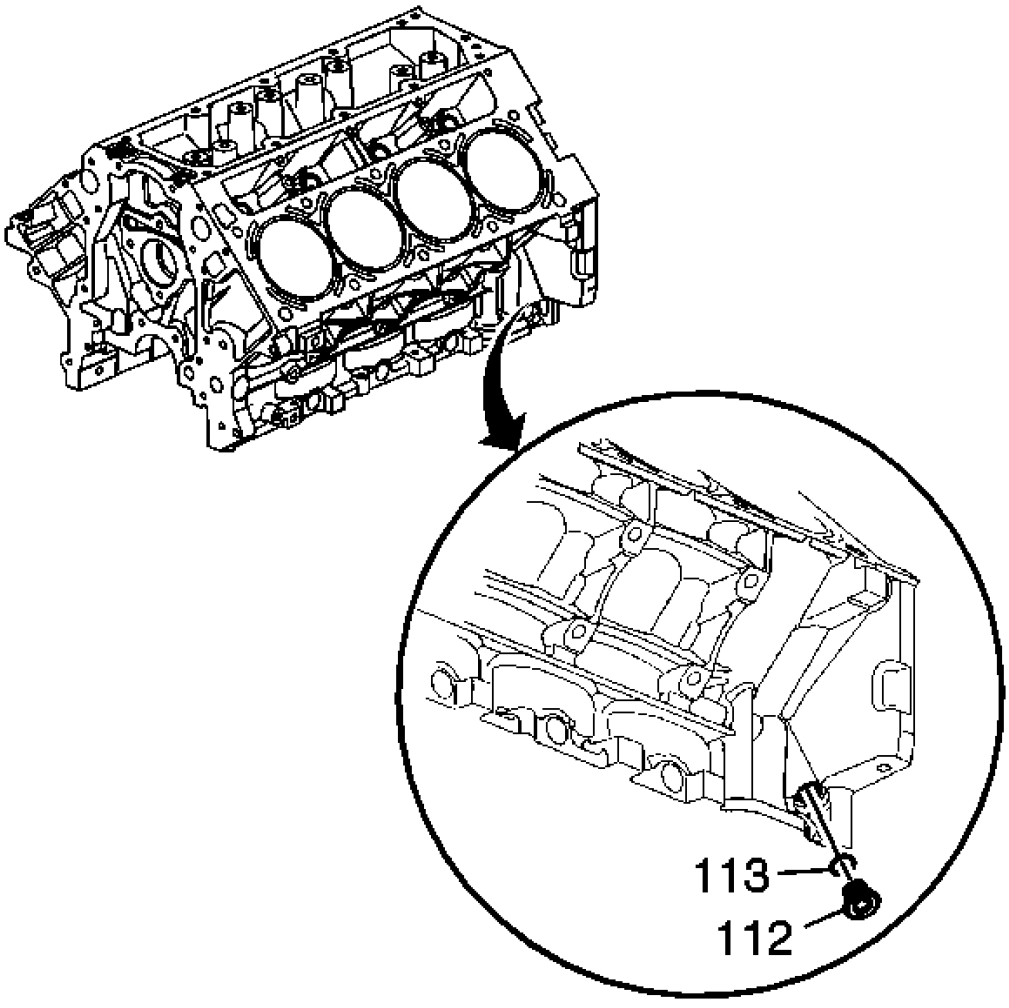
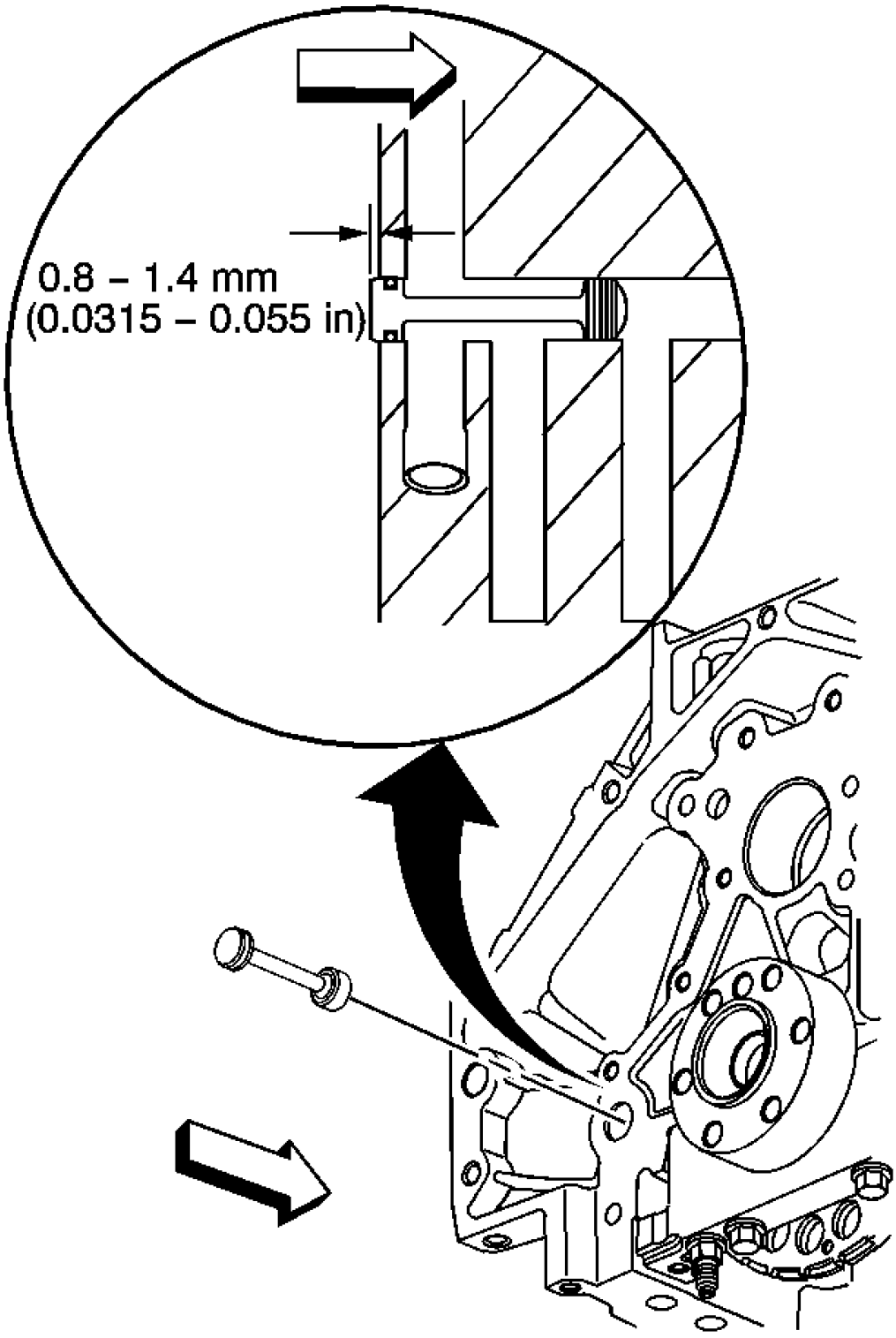


Fig. 109: Locating Engine Block Left Rear Oil Gallery Plug & Washer
Courtesy of GENERAL MOTORS CORP.

7. Apply a 3.175 mm (0.125 in) bead of sealant GM P/N 12346004 (Canadian P/N 10953480) to the engine block left rear oil gallery plug sealing washer (113).
8. Install the engine block left rear oil gallery plug (112) and tighten to 60 N.m (44 lb ft).

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Fig. 110: View Of Engine Block Rear Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

9. Inspect the engine block rear oil gallery plug and O-ring seal. If the O-ring seal on the plug is not cut or damaged, the rear oil gallery plug may be used again.
10. Lubricate the O-ring seal with clean engine oil.
11. Install the O-ring seal onto the plug.
12. Install the engine block rear oil gallery plug into the oil gallery bore. A properly installed block plug will protrude 0.8-1.4 mm (0.0315-0.055 in) beyond the rear face of the block.

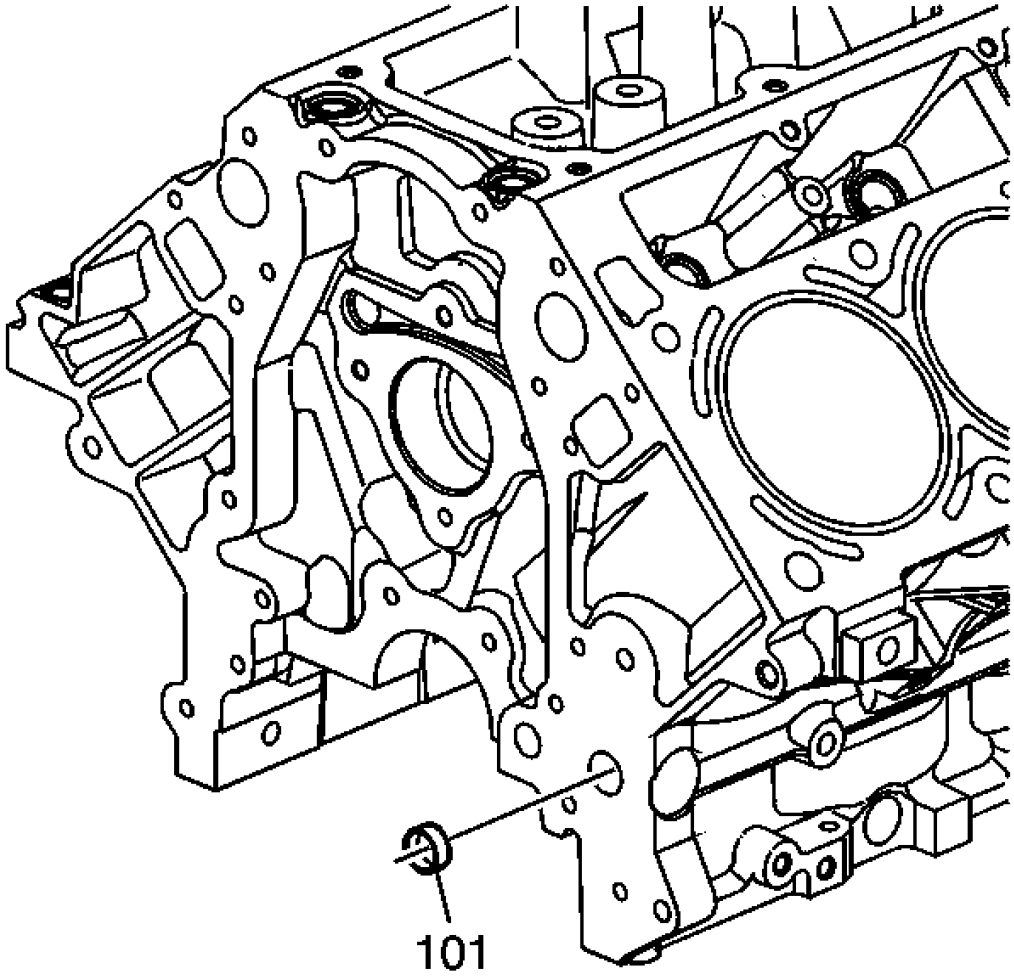


Fig. 111: View Of Engine Block Front Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

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13. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489) to the sides of the NEW front oil gallery plug (101).

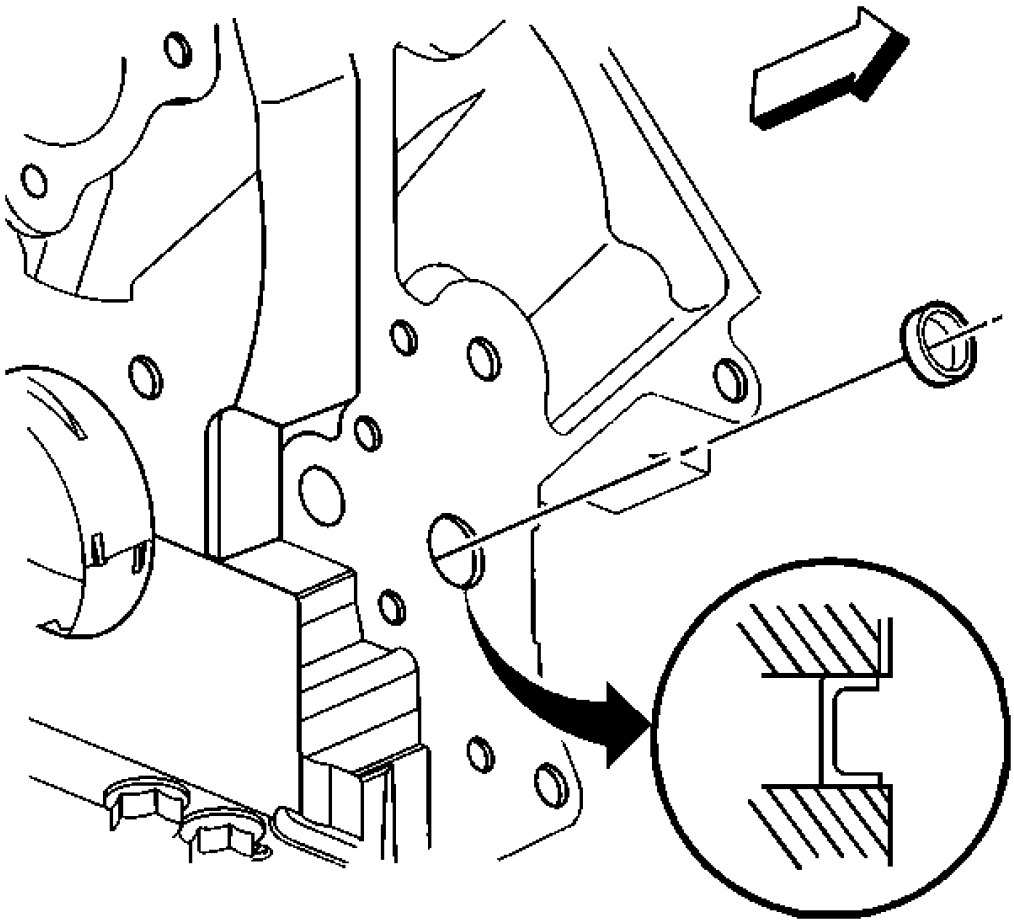


Fig. 112: Locating Engine Block Front Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

14. Install a NEW engine block front oil gallery plug. Install the plug into the oil gallery bore 2.2-2.8 mm (0.0086-0.011 in) below flush.

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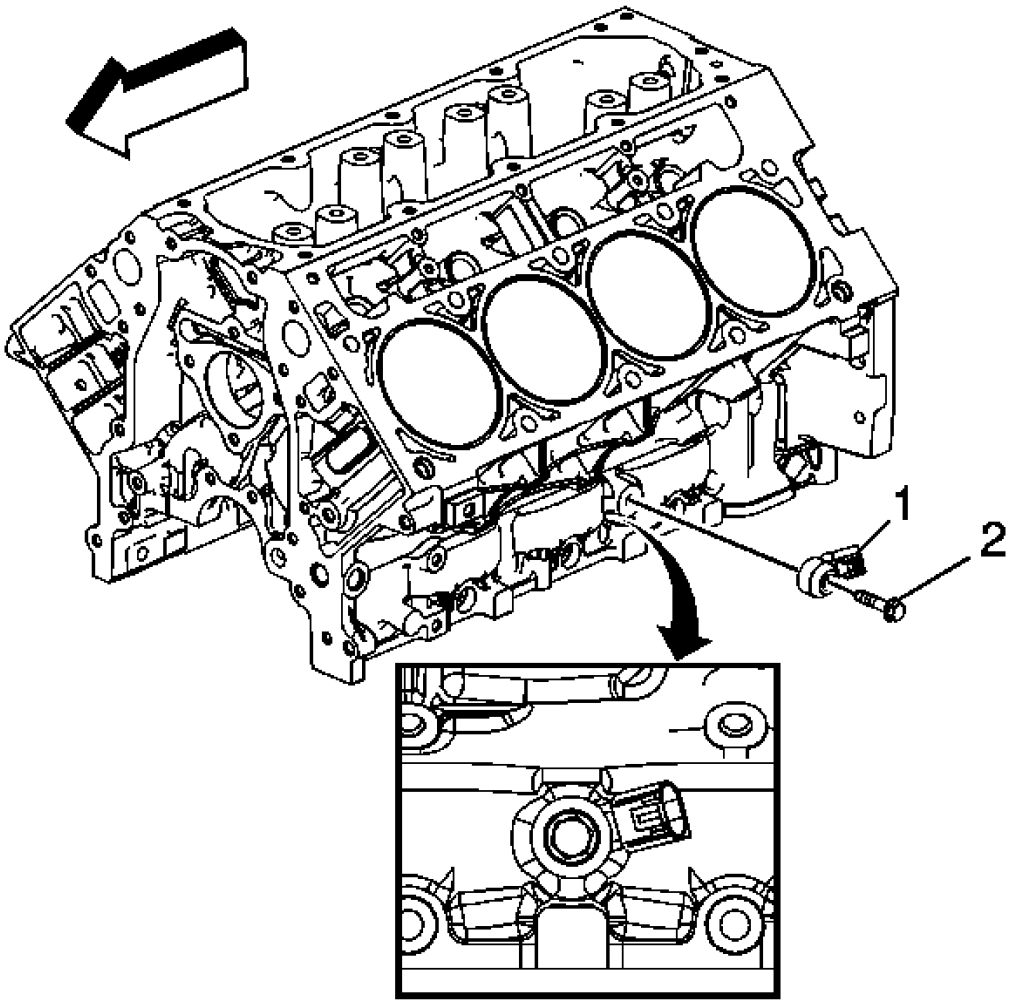


Fig. 113: Identifying Left Side Knock Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

15. Install the left side knock sensor (1) and bolt (2) and tighten to 25 N.m (18 lb ft).

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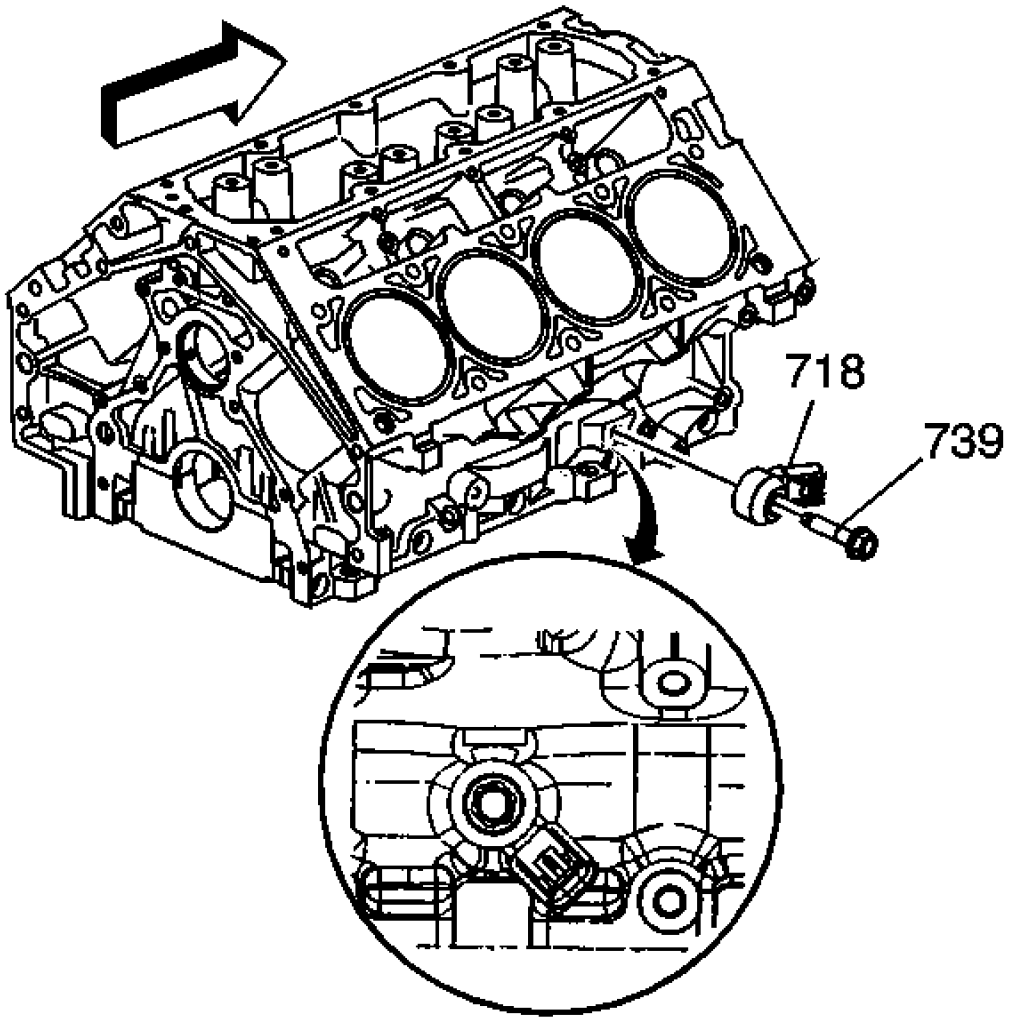


Fig. 114: Right Side Knock Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

16. Install the right side knock sensor (718) and bolt (739) and tighten to 25 N.m (18 lb ft).

CRANKSHAFT AND BEARING INSTALLATION

Special Tools

J 45059: Angle Meter

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For equivalent regional tools, refer to **Special Tools**

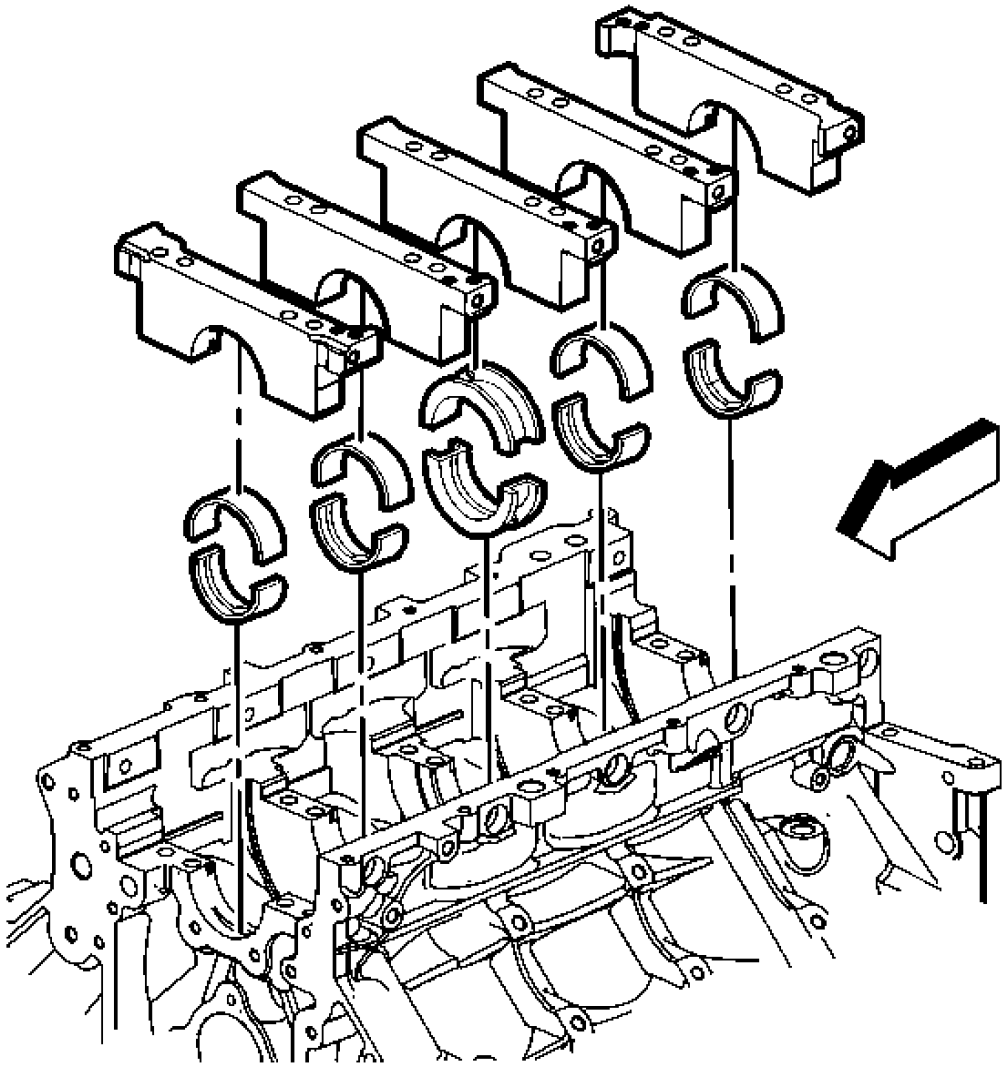


Fig. 115: View Of Crankshaft Bearings & Bearing Caps
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Crankshaft bearing clearances are critical. Excessive crankshaft bearing clearance may affect crankshaft position (CKP) sensor signals and/or on-board diagnostic (OBD) II system performance.**
- **Crankshaft bearing caps must be installed to the proper location and**

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direction.

- **When installing the crankshaft bearings, align the locating tabs on the bearings with the locating notches in the engine block journal bore and the bearing cap.**
- **Always install crankshaft bearings with their machined partner. Do not file bearings or mix bearing halves.**
- **In order to prevent engine block oil leakage, install NEW M8 crankshaft bearing cap side bolts.**

  The crankshaft bearing cap M8 side bolts have a pre-applied sealant patch applied to the bolt flange.

1. Install the crankshaft bearings to the engine block and bearing caps. The thrust bearings are to be installed into center journal.
2. Lubricate the bearing surfaces and crankshaft journals with clean engine oil.

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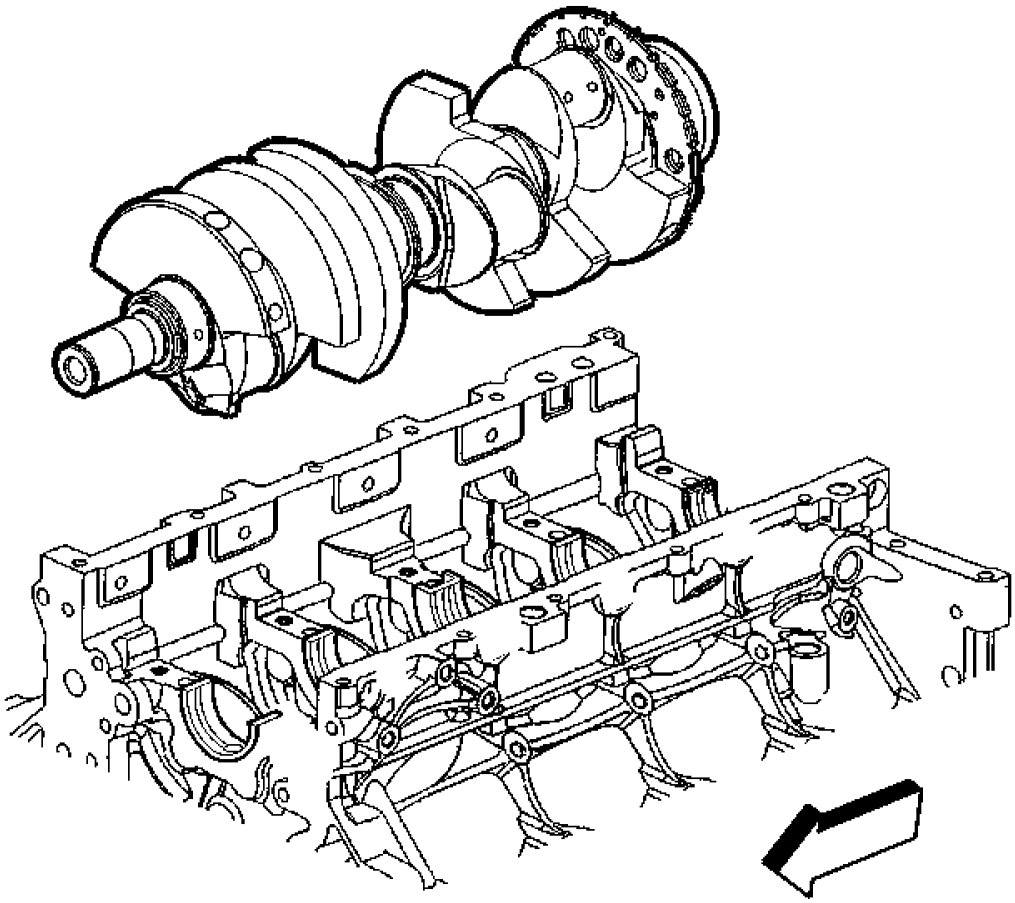


Fig. 116: View Of Crankshaft & Engine Block
Courtesy of GENERAL MOTORS CORP.

CAUTION: To maintain proper crankshaft end play, use extreme care during crankshaft installation. Avoid scoring or damaging the thrust bearing.

3. Install the crankshaft.

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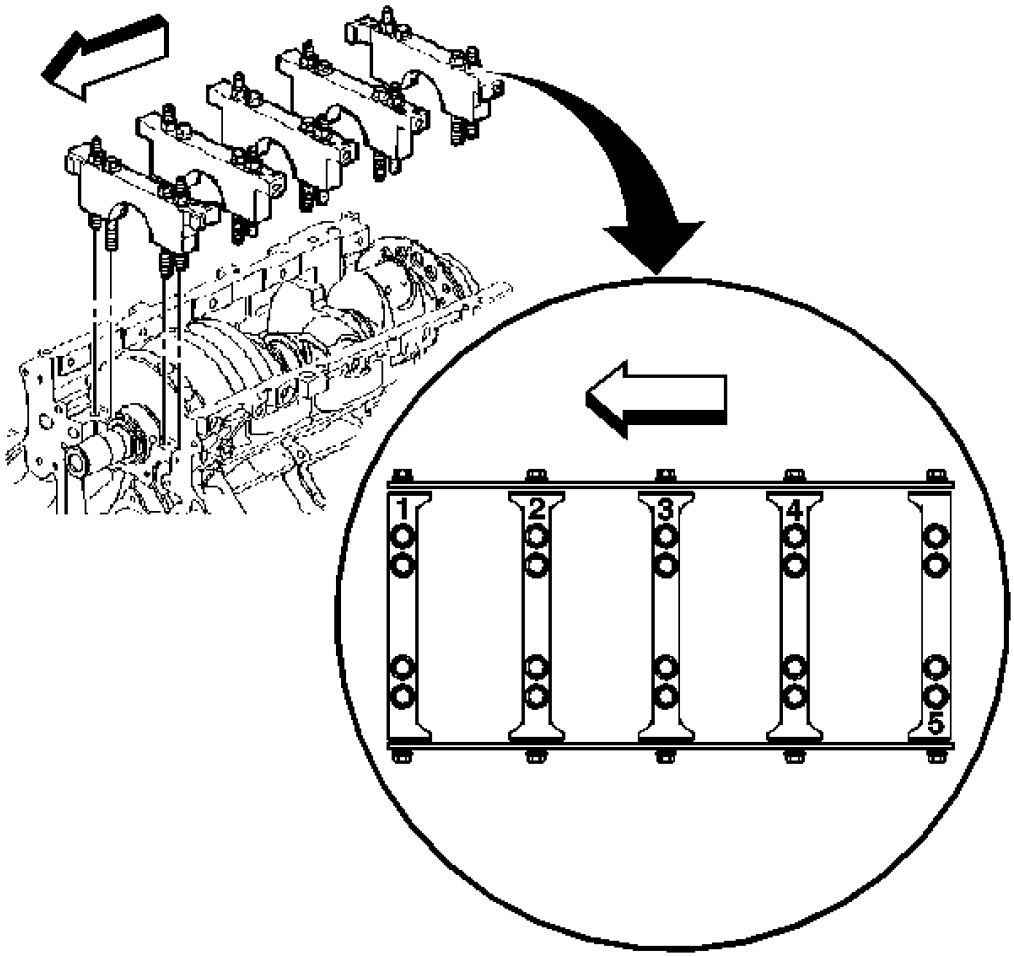


Fig. 117: View Of Proper Bearing Cap Installation
Courtesy of GENERAL MOTORS CORP.

NOTE: The bearing caps must be installed in the proper location and direction.

4. Install the crankshaft bearing caps, with bearings, into the engine block.

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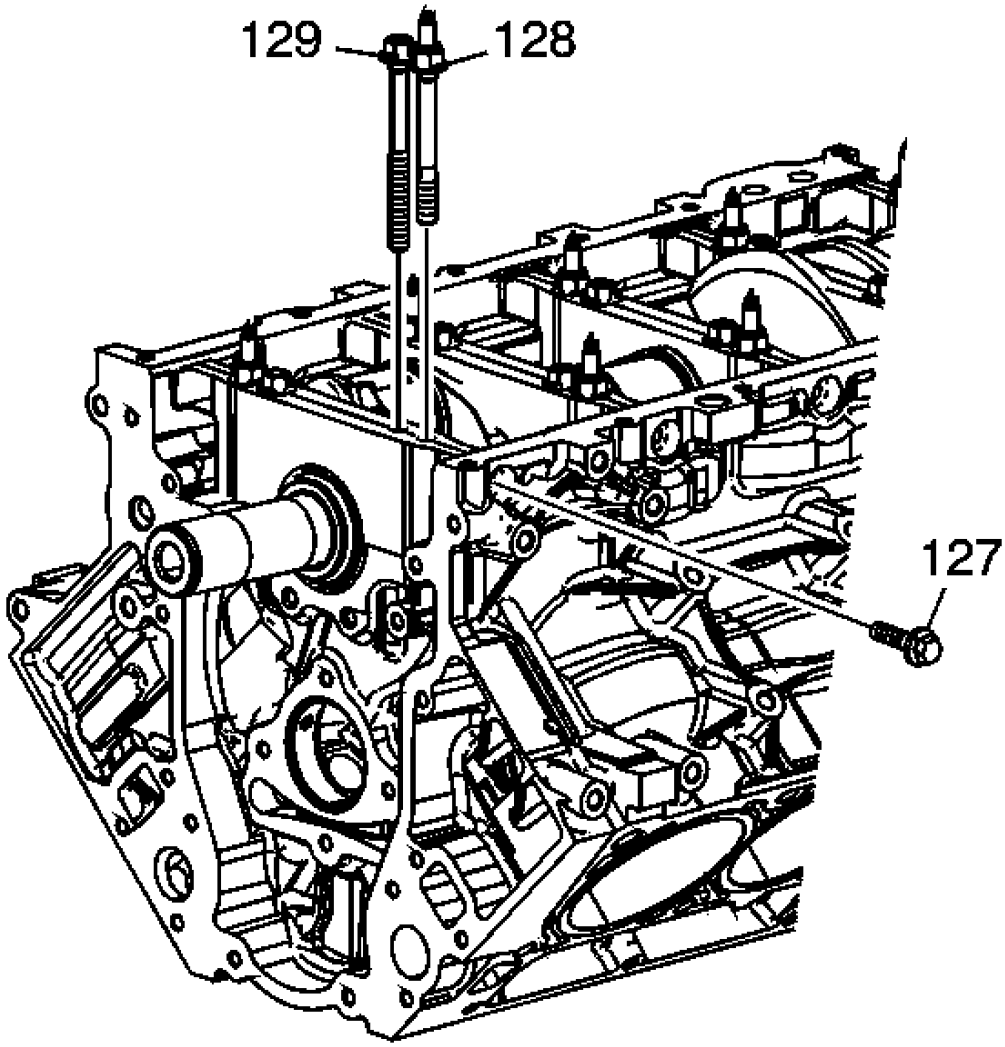


Fig. 118: Identifying Bearing Cap Bolts & Studs
Courtesy of GENERAL MOTORS CORP.

5. Install NEW M10 bolts (129) and NEW studs (128).
6. Using a plastic-face hammer, tap the bearing caps into place.
7. Install the NEW M8 bearing cap side bolts (127).

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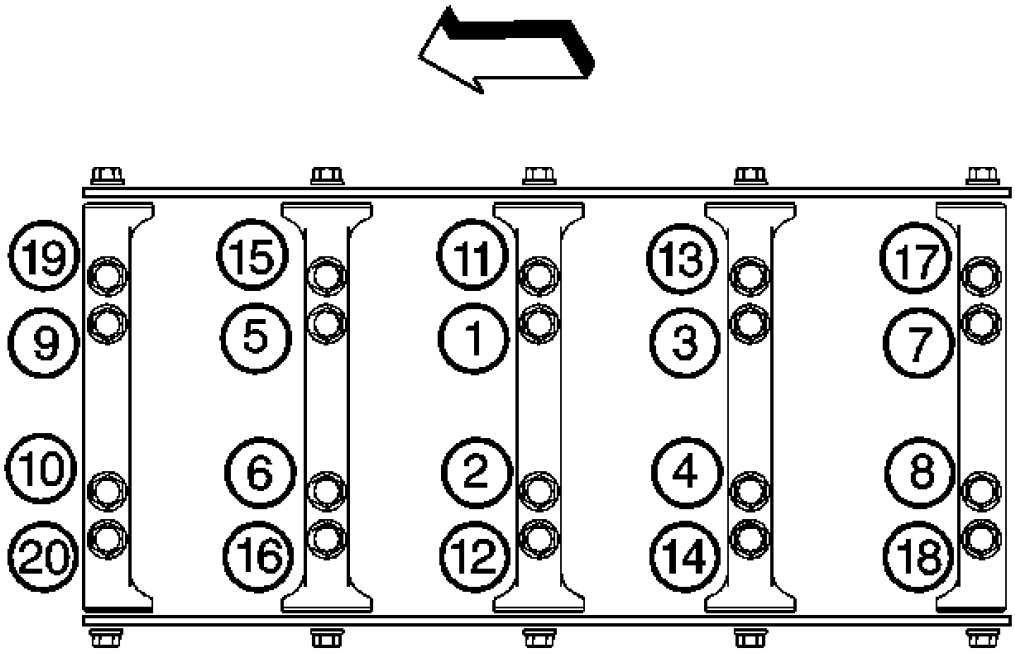


Fig. 119: Crankshaft Main Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

8. Tighten the M10 bearing cap bolts (1-10) a first pass in sequence to 20 N.m (15 lb ft).

NOTE: To properly align the crankshaft thrust bearings, the final thrust of the crankshaft MUST be in the forward direction.

9. Using a plastic-face hammer, tap the crankshaft rearward, then forward in order to align the thrust bearings.
   - Tighten the M10 bolts (1-10) a final pass in sequence 80 degrees using the **J 45059:** meter .
   - Tighten the M10 studs (11-20) a first pass in sequence to 20 N.m (15 lb ft) .
   - Tighten the M10 studs (11-20) a final pass in sequence 51 degrees using the **J 45059:** meter .

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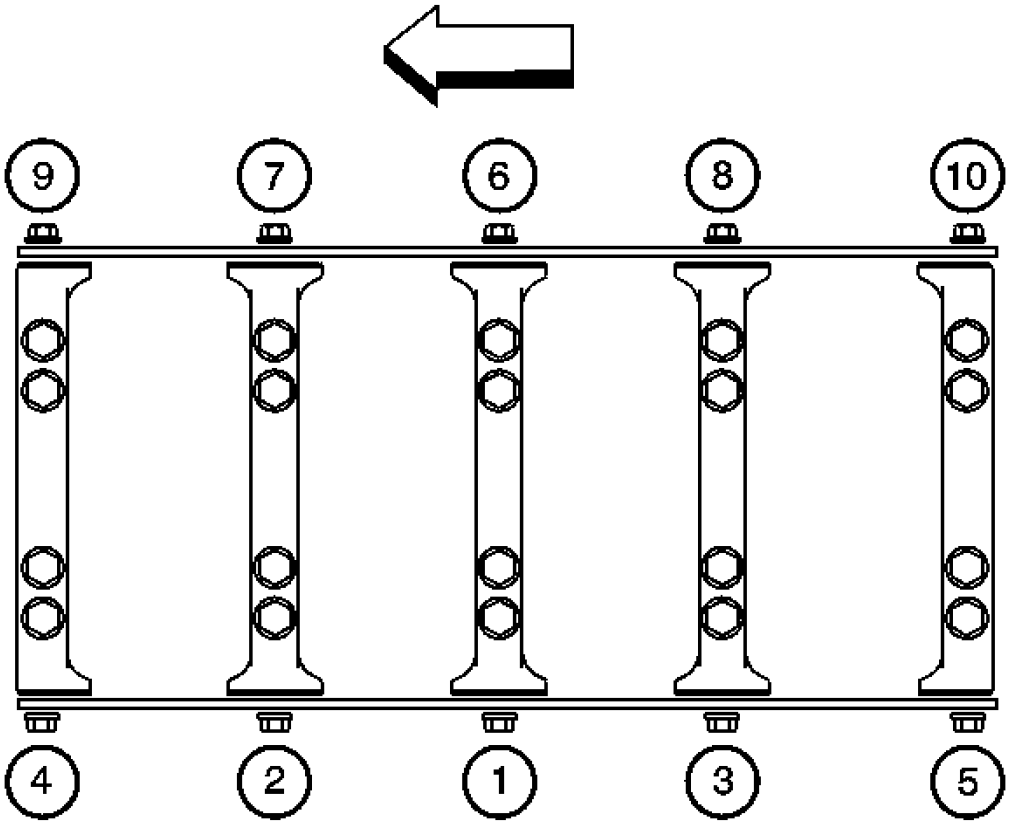


Fig. 120: Identifying M8 Main Bearing Cap Side Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

10. Tighten the M8 main bearing cap side bolts (1-10).
    - Tighten the M8 bolts (1-5) a first pass in sequence to 20 N.m (15 lb ft) .
    - Tighten the M8 bolts (1-5) a final pass in sequence to 30 N.m (22 lb ft) .
    - Tighten the M8 bolts (6-10) a first pass in sequence to 20 N.m (15 lb ft) .
    - Tighten the M8 bolts (6-10) a final pass in sequence to 30 N.m (22 lb ft) .

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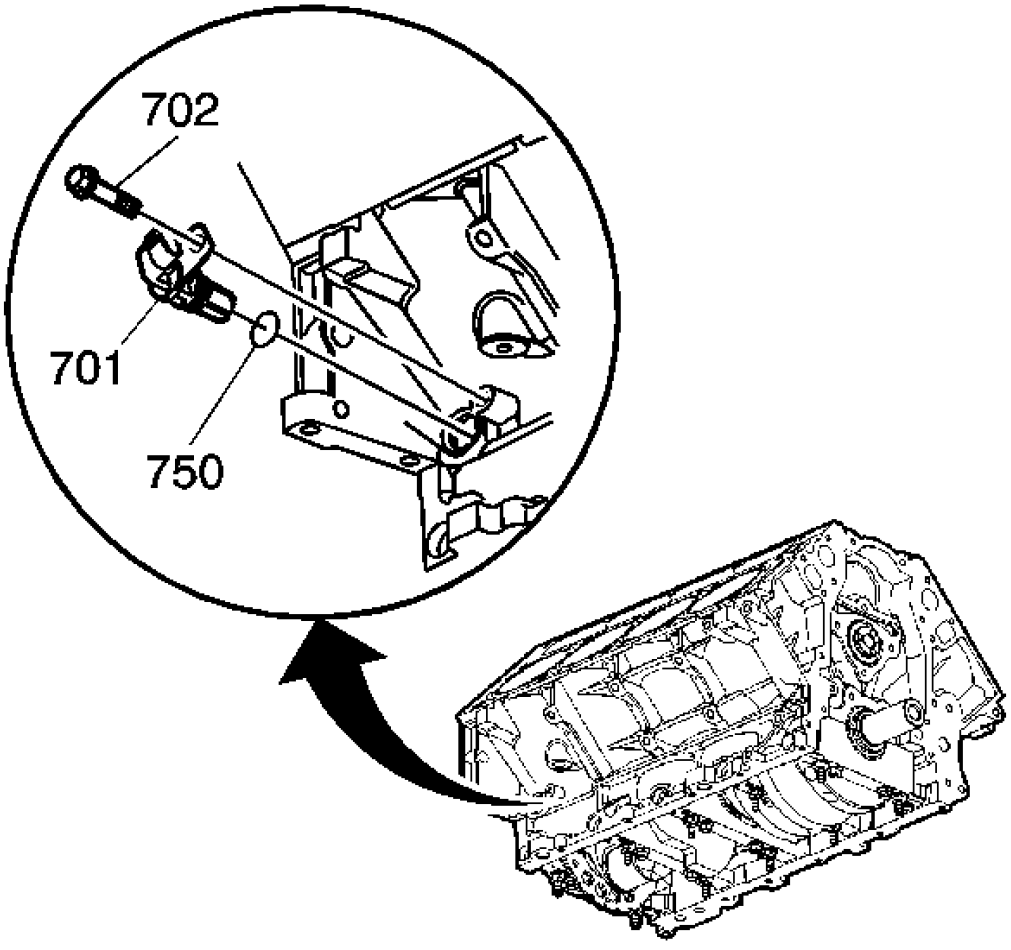


Fig. 121: CKP Sensor, Bolt & O-Ring
Courtesy of GENERAL MOTORS CORP.

11. Install the CKP sensor.
    1. Inspect the CKP sensor O-ring seal (750). If the O-ring seal is not cut or damaged, it may be used again.
    2. Coat the O-ring seal with clean engine oil.
    3. Install the O-ring onto the sensor.
    4. Install the sensor (701). Rotate the sensor until the locating hole in the bracket aligns with the bolt hole in the block.
    5. Install the sensor bolt (702) and tighten to 25 N.m (18 lb ft) .

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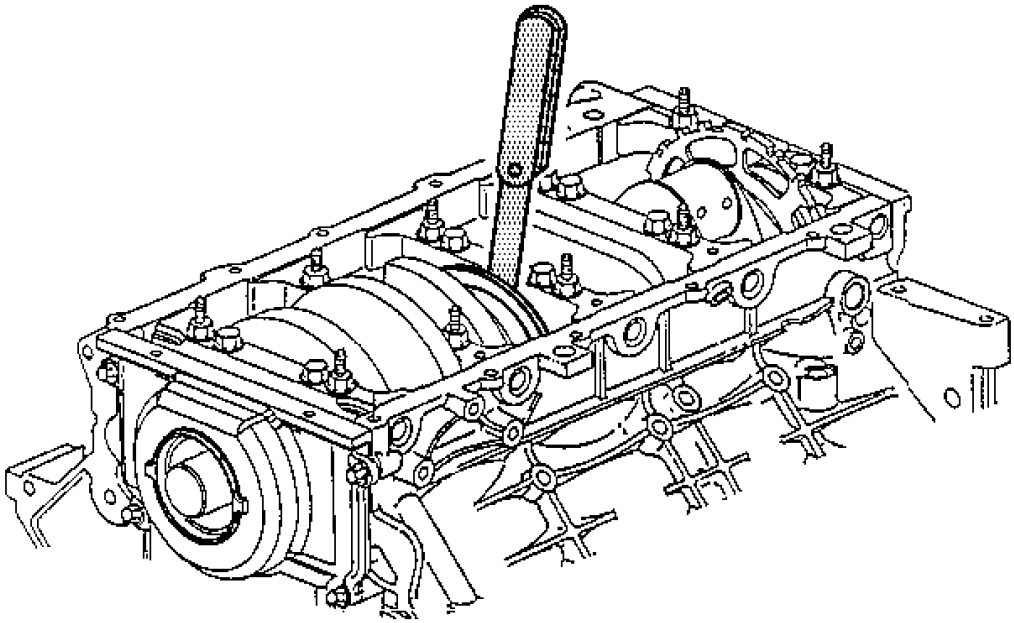


Fig. 122: Measuring Crankshaft End Play
Courtesy of GENERAL MOTORS CORP.

12. Measure the crankshaft end play.
    1. Thrust the crankshaft forward or rearward.
    2. Insert a feeler gauge between the center crankshaft bearing and the bearing surface of the crankshaft and measure the bearing clearance.

       The proper crankshaft end play clearance is 0.04-0.2 mm (0.0015-0.0078 in).

    3. If the bearing clearance is not within specifications, inspect the thrust surfaces for nicks, gouges or raised metal. Minor imperfections may be removed with a fine stone.

PISTON, CONNECTING ROD, AND BEARING INSTALLATION

Special Tools

- **J 8037:** Piston Ring Compressor
- **J 8087:** Cylinder Bore Gauge
- **J 41556:** Connecting Rod Guide
- **J 45059:** Angle Meter

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For equivalent regional tools, refer to **Special Tools** .

PISTON SELECTION

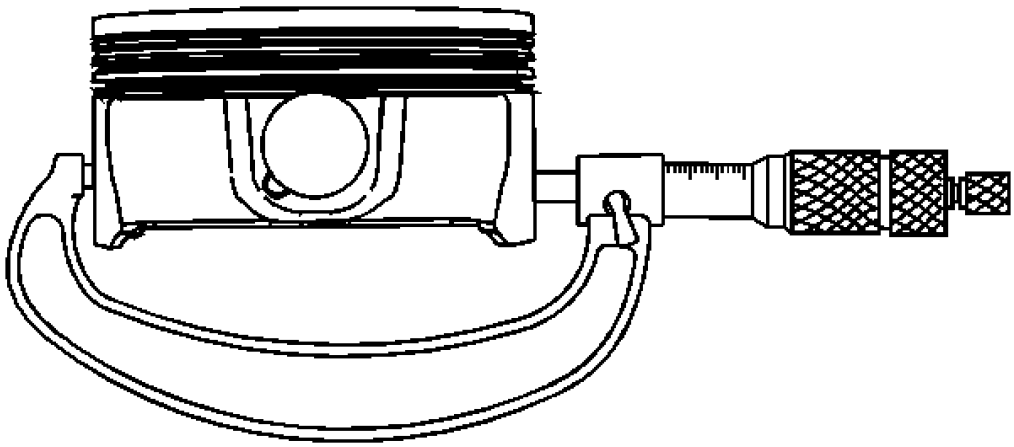


Fig. 123: Measuring Piston Outside Diameter
Courtesy of GENERAL MOTORS CORP.

NOTE: Measurements of all components should be taken with the components at normal room temperature. For proper piston fit, the engine block cylinder bores must not have excessive wear or taper. A used piston, pin, and connecting rod assembly may be installed if, after inspection is within specifications.

1. With a micrometer at a right angle, measure the piston outside diameter (OD). Measure the diameter 43 mm (1.69 in) from the top of the piston. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .
2. Record the piston OD.

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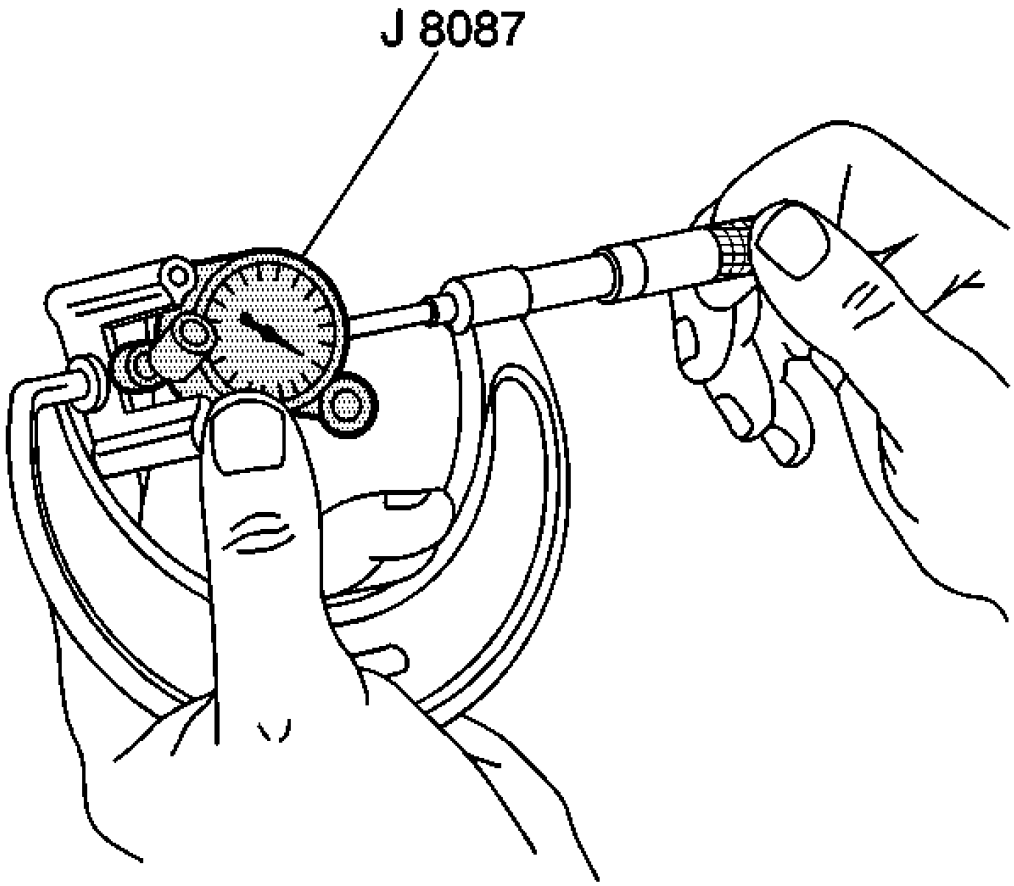


Fig. 124: Zeroing Bore Gauge Dial
Courtesy of GENERAL MOTORS CORP.

3. Adjust the micrometer to the recorded piston OD.
4. Insert the **J 8087:** bore gauge into the micrometer and zero the gauge dial.

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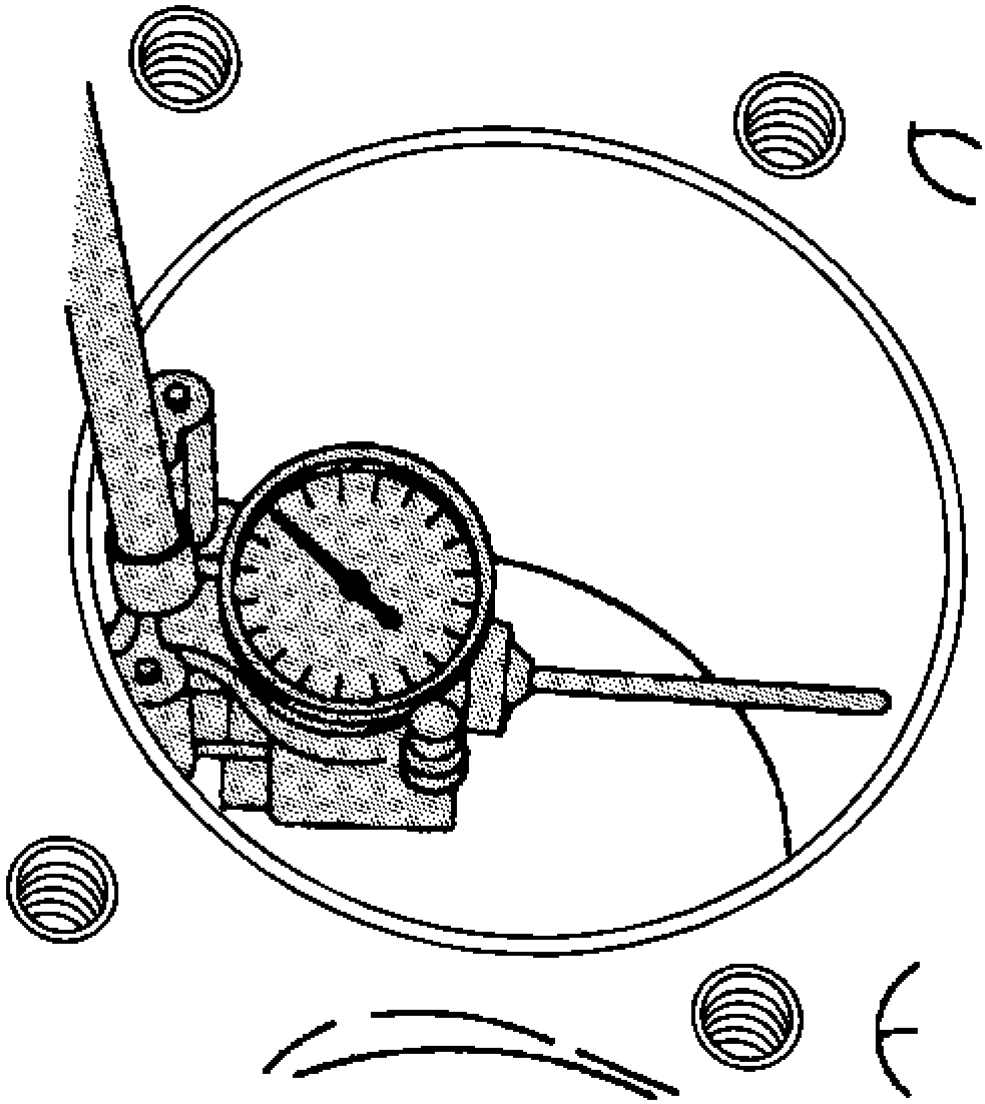


Fig. 125: Measuring Cylinder Bore
Courtesy of GENERAL MOTORS CORP.

5. Using the **J 8087:** bore gauge, measure the cylinder bore inside diameter (ID). Measure at a point 64 mm (2.5 in) from the top of the cylinder.
6. Record the cylinder bore ID.
7. Subtract the piston OD from the cylinder bore ID in order to determine the piston-to-bore clearance. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

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8. If the proper clearance cannot be obtained, select another piston and pin assembly and measure the clearances again. If the proper fit cannot be obtained, the cylinder bore may require honing for an oversize piston.

PISTON, PIN, AND CONNECTING ROD INSTALLATION

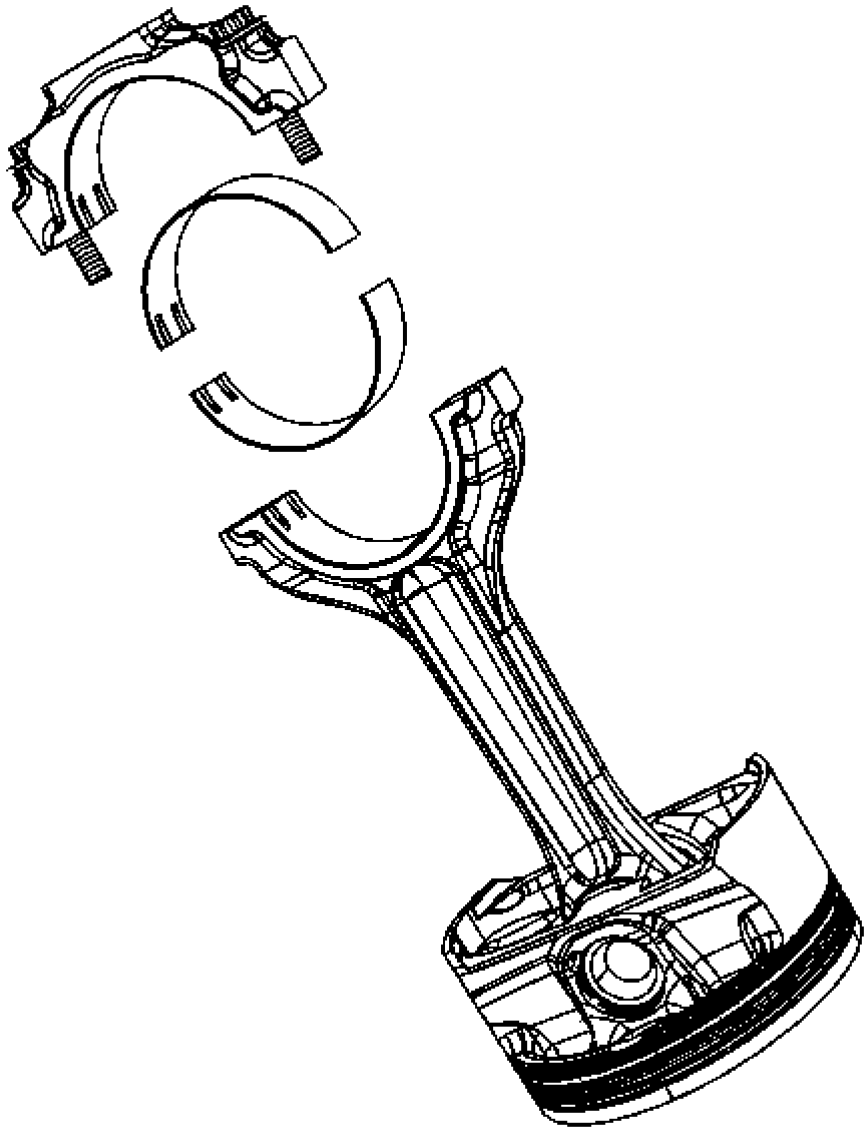


Fig. 126: View Of Piston, Connecting Rod & Bearing Assembly
Courtesy of GENERAL MOTORS CORP.

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1. Lubricate the following components with clean engine oil:
   - Piston
   - Piston rings
   - Cylinder bore
   - Bearings and bearing surfaces
2. Install the bearings to the connecting rod and cap.
3. Position the oil control ring end gaps a minimum of 25 mm (1.0 in) from each other.
4. Position the compression ring end gaps 180 degrees opposite each other.

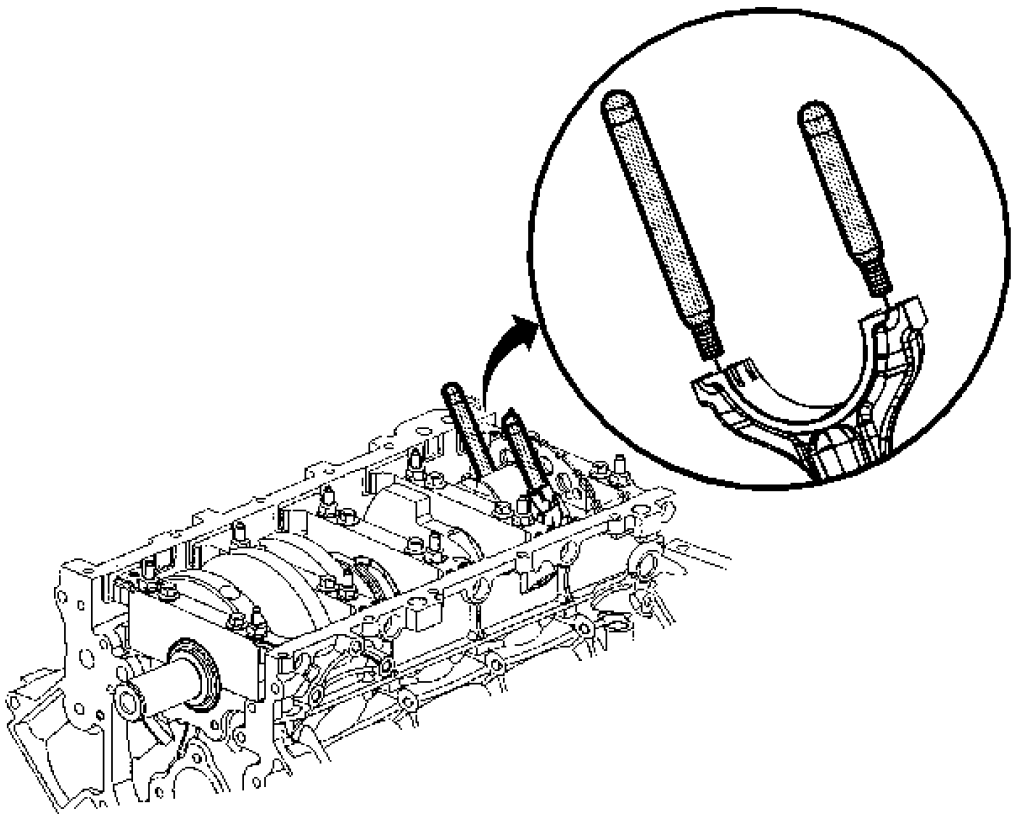


Fig. 127: Installing Special Tool To Connecting Rod
Courtesy of GENERAL MOTORS CORP.

5. Install the **J 41556:** bore guide to the connecting rod.

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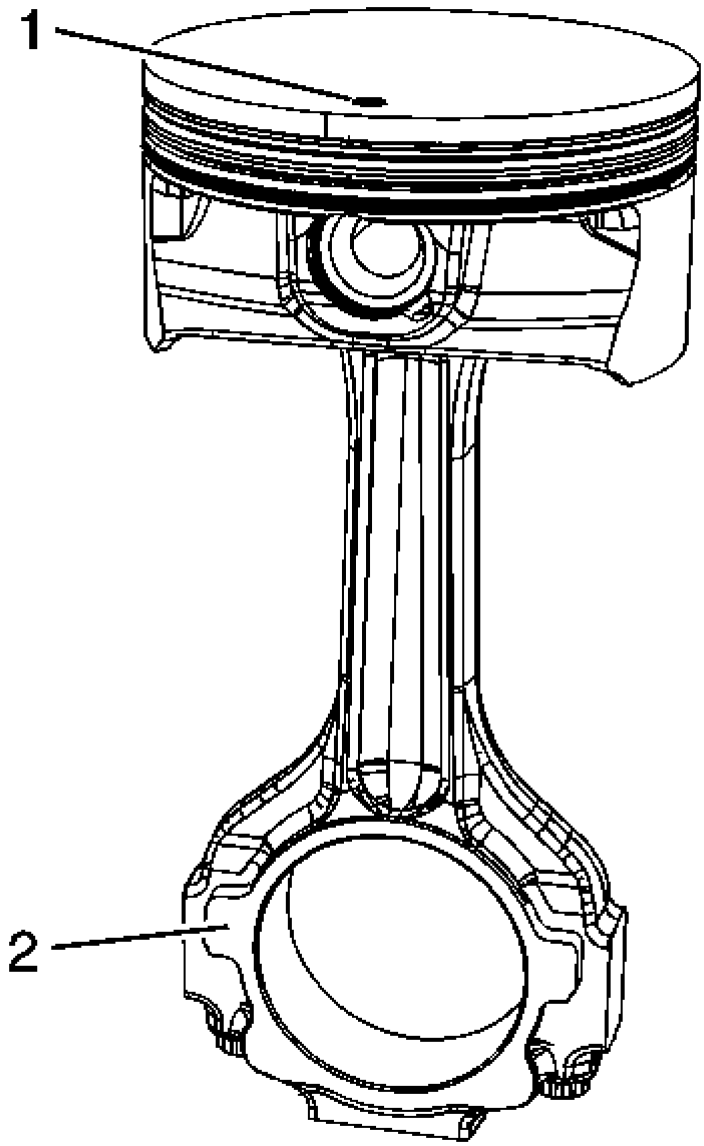


Fig. 128: View of Mark On Top Of Piston & Connecting Rod Tab
Courtesy of GENERAL MOTORS CORP.

6. Identify the proper installation direction of the piston and connecting rod assembly. When installing the piston and connecting rod assembly, the mark on the top of the piston (1) and the tab (2) on the side of the connecting rod should face the front of the engine.

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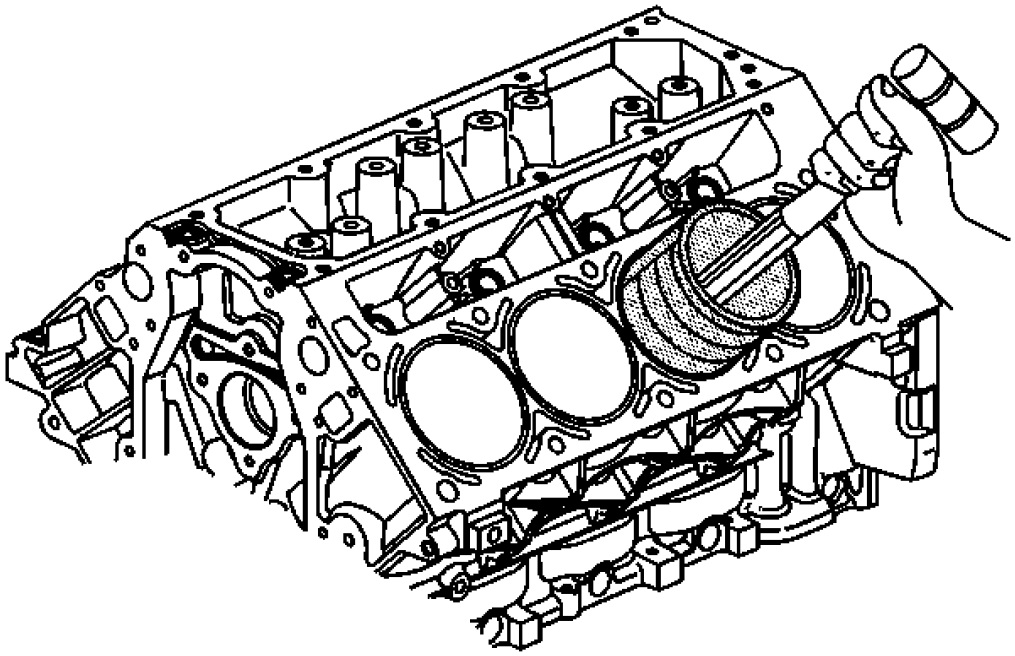


Fig. 129: Installing Piston
Courtesy of GENERAL MOTORS CORP.

7. Install the **J 8037:** ring compressor onto the piston and compress the piston rings.

NOTE: The piston alignment mark MUST face the front of the engine block.

8. Install the piston, pin, and connecting rod assembly into the cylinder bore. Hold the piston ring compressor firmly against the engine block. Using a wooden hammer handle, lightly tap the top of the piston until all piston rings have entered the cylinder bore.
9. Use the **J 41556:** rod guide to guide the connecting rod onto the crankshaft journal.
10. Remove the **J 41556:** rod guide from the connecting rod.

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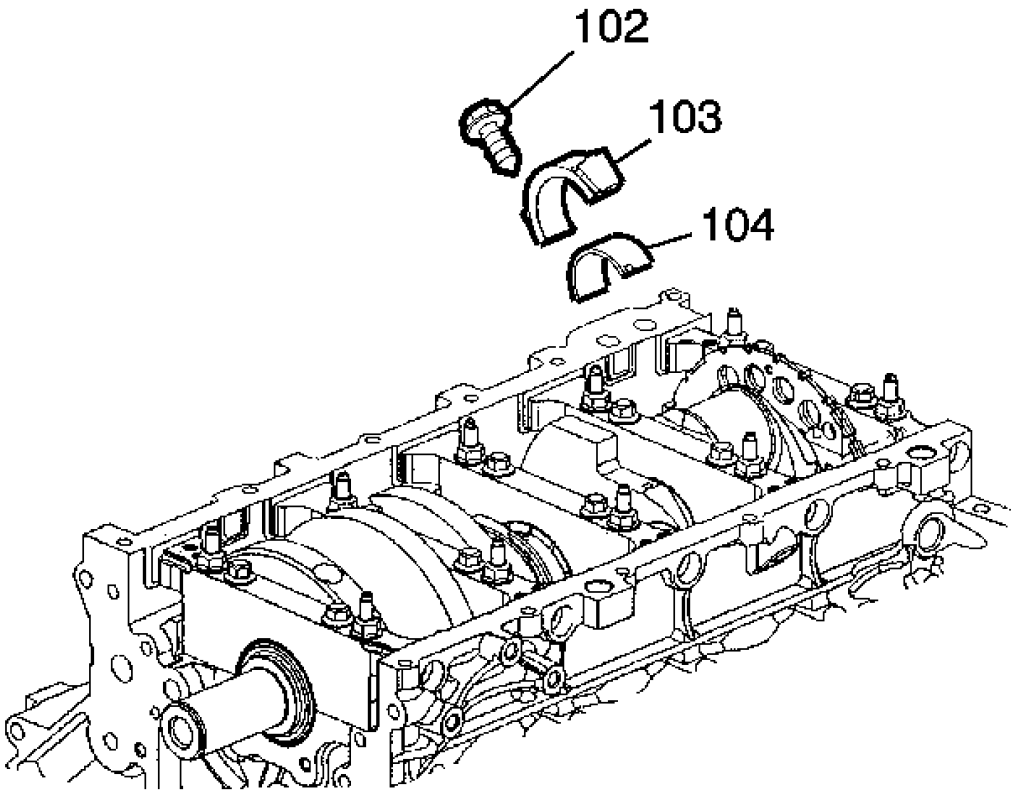


Fig. 130: Connecting Rod Bolt, Cap & Bearing
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE:

- **The connecting rod and cap must be assembled with the mating surfaces properly aligned.**
- **If re-using connecting rods, DO NOT re-use connecting rod fasteners. During an installation procedure, the new connecting rod bolts can be re-tightened a maximum of 3 times.**

11. Install the bearing cap (103), bearing (104), and bolts (102).
    1. Tighten the bolts a first pass to 20 N.m (15 lb ft).
    2. Tighten the bolts a final pass to 85 degrees using the **J 45059:** angle meter.

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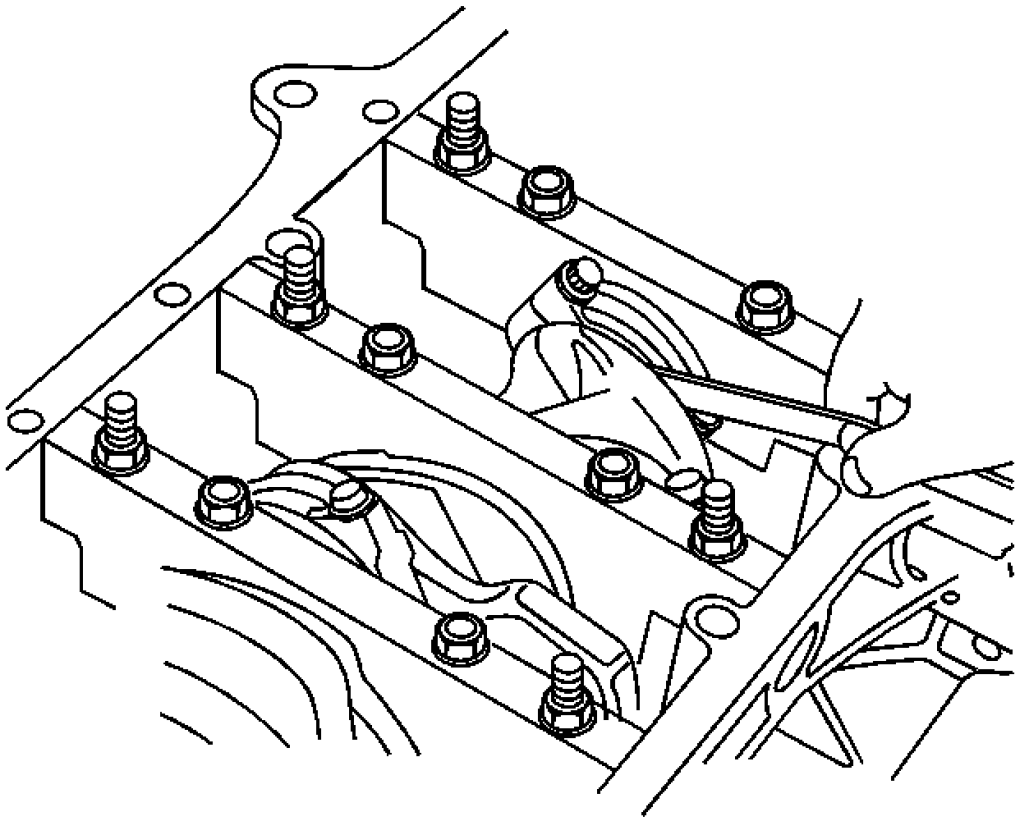


Fig. 131: Measuring Connecting Rod Side Clearance
Courtesy of GENERAL MOTORS CORP.

12. Measure the connecting rods for the proper side clearance. Refer to **Engine Mechanical Specifications (6.2L LS3)** or **Engine Mechanical Specifications (6.2L L99)** .

CAMSHAFT INSTALLATION

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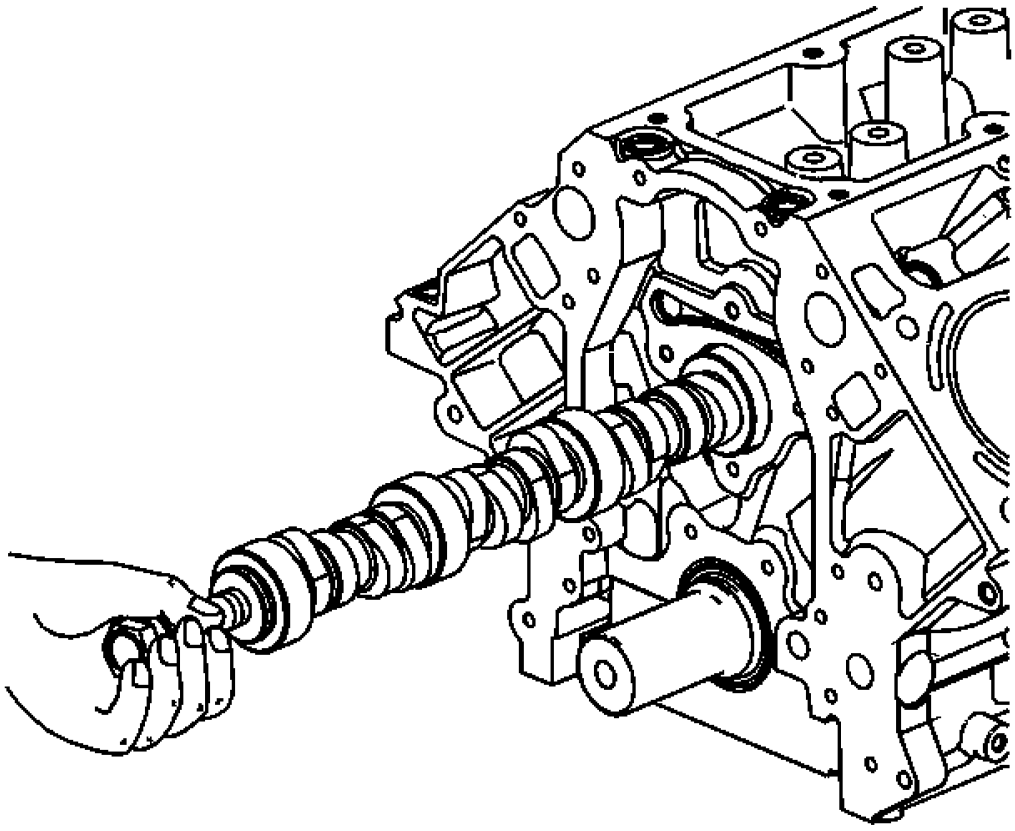


Fig. 132: View Of Camshaft
Courtesy of GENERAL MOTORS CORP.

NOTE: If camshaft replacement is required, the valve lifters must also be replaced.

1. Lubricate the camshaft journals and the bearings with clean engine oil.
2. Install the camshaft sprocket bolt or solenoid valve into the camshaft front bolt hole.

CAUTION: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

3. Using the bolt or solenoid valve as a handle, carefully install the camshaft into the engine block.
4. Remove the bolt or solenoid valve from the front of the camshaft.

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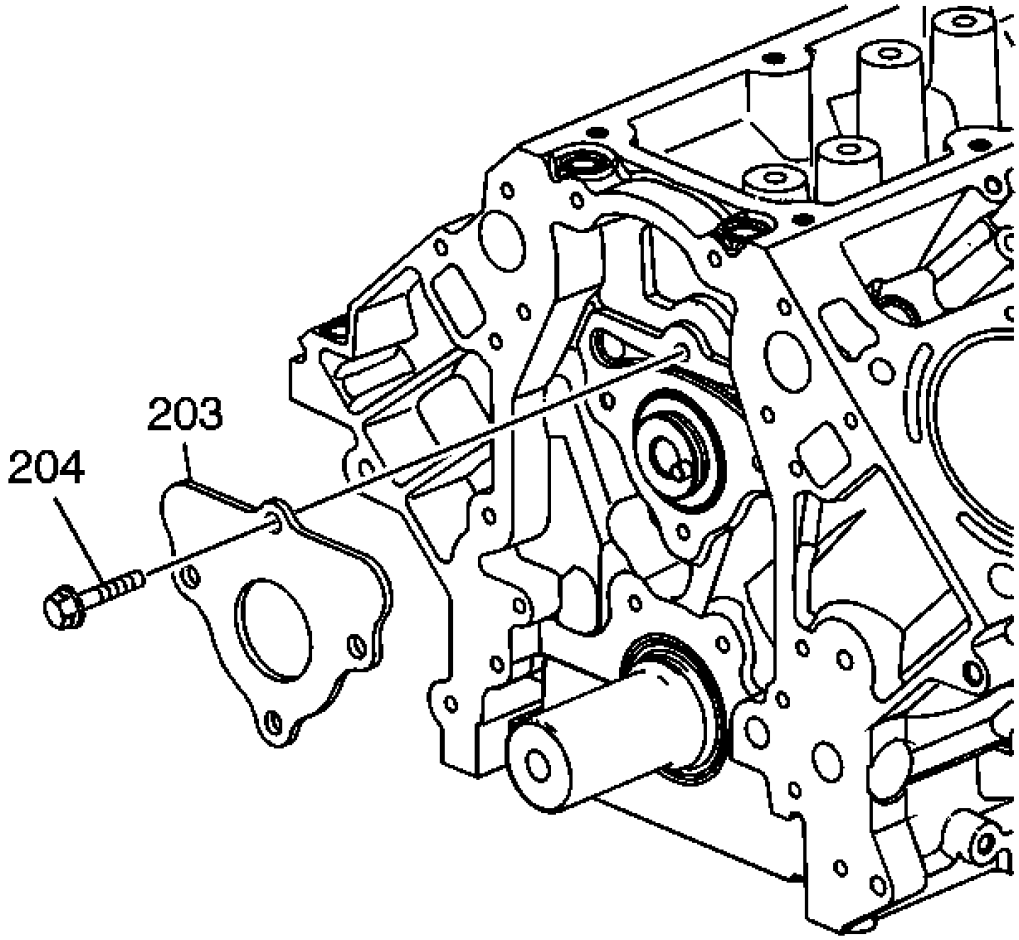


Fig. 133: View Of Camshaft Retainer & Retainer Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: The gasket surface on the engine block should be clean and free of dirt or debris.

5. Install the camshaft retainer (203) and the bolts (204). Install the retainer with the sealing gasket facing the front of the engine block.

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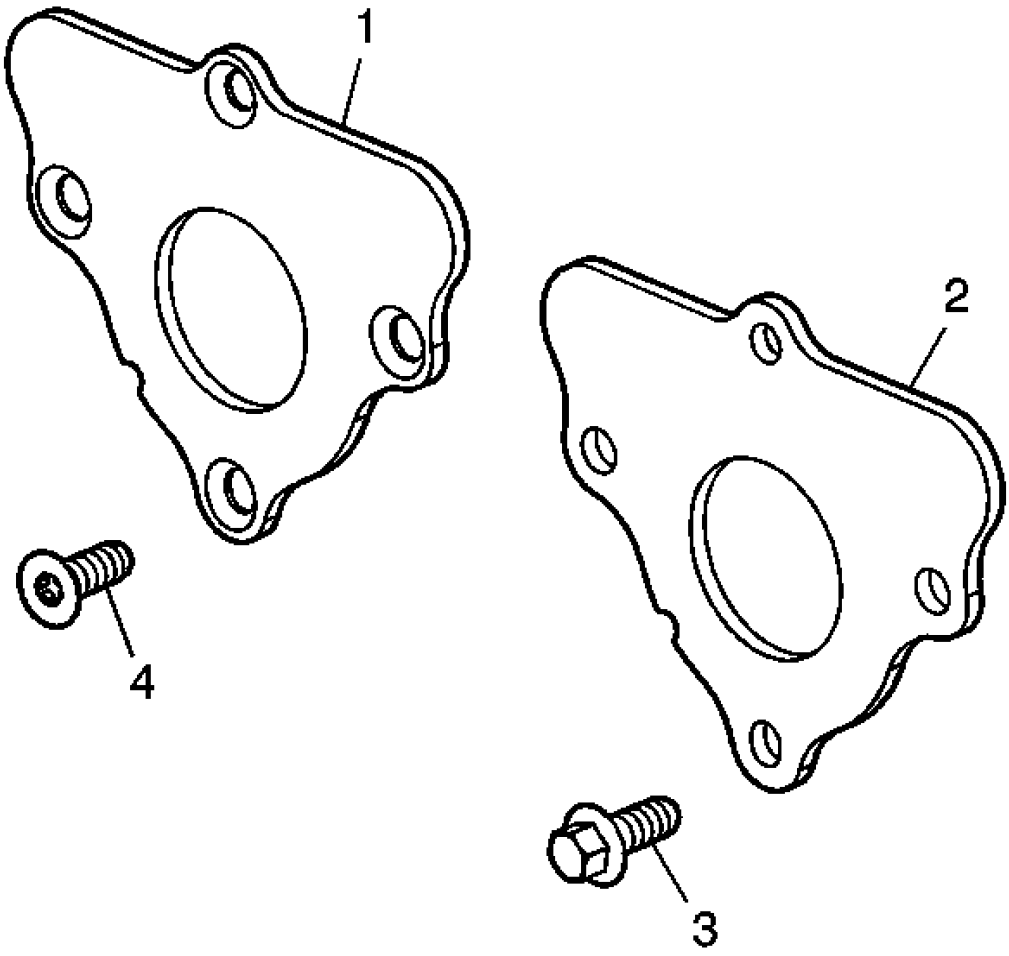


Fig. 134: Identifying Camshaft Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

6. Tighten the camshaft retainer bolts.
   - Tighten the first design hex head bolts (3) to 25 N.m (18 lb ft) .
   - Tighten the second design TORX® head bolts (4) to 15 N.m (11 lb ft) .

TIMING CHAIN, CRANKSHAFT SPROCKET, CAMSHAFT POSITION ACTUATOR, AND SOLENOID VALVE INSTALLATION

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Special Tools

- **EN 46330:** Timing Belt Tensioner Retaining Pin
- **J 41478:** Crankshaft Front Oil Seal Installer
- **J 41665:** Crankshaft Balancer and Sprocket Installer
- **J 42386-A:** Flywheel Holding Tool
- **J 45059:** Angle Meter

For equivalent regional tools, refer to **Special Tools** .

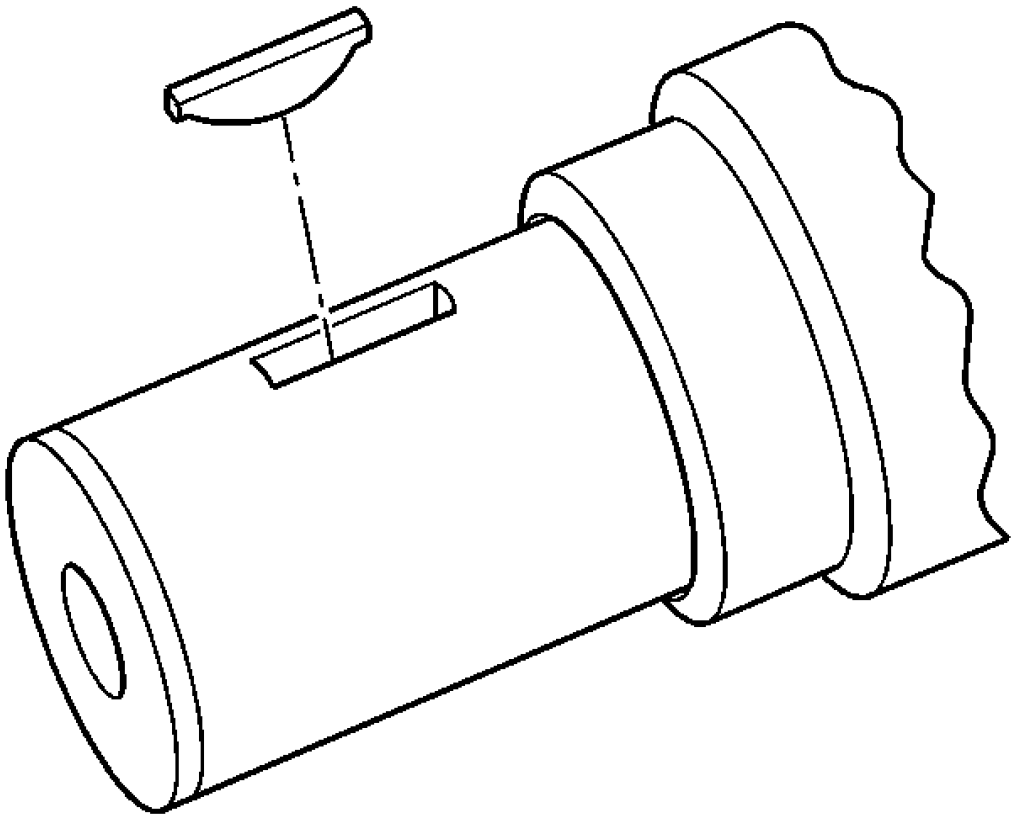


Fig. 135: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS CORP.

1. Install the key into the crankshaft keyway, if previously removed.

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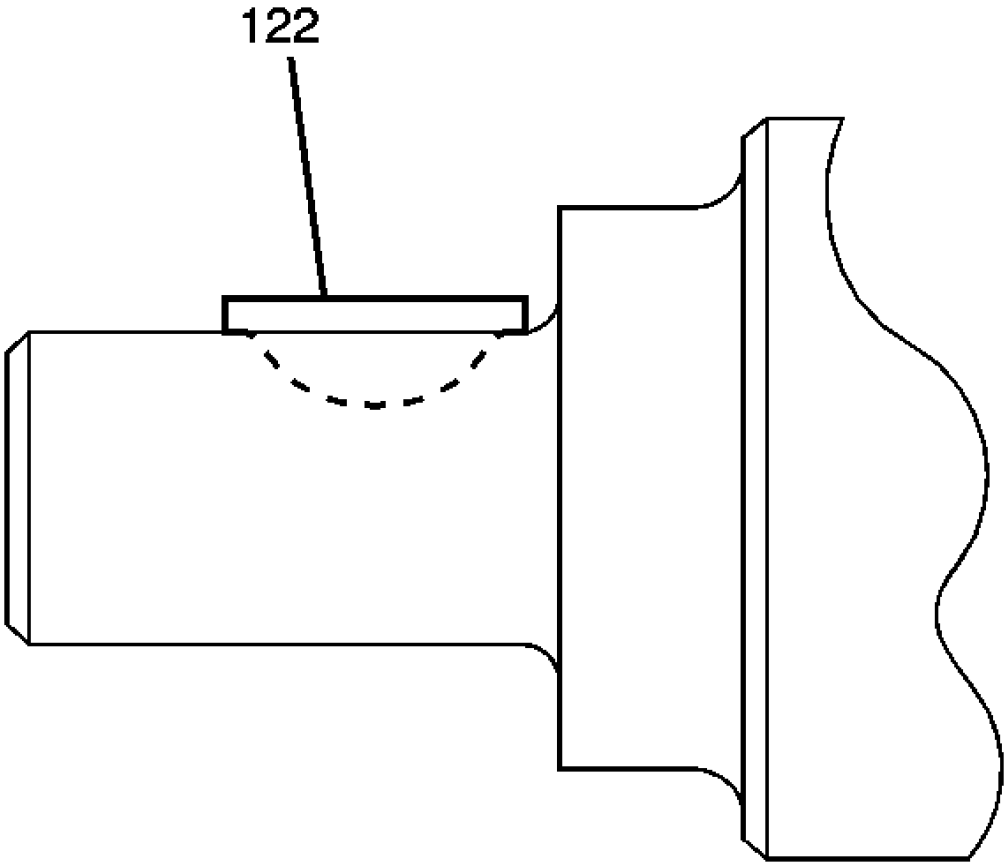


Fig. 136: View Of Installed Crankshaft Key
Courtesy of GENERAL MOTORS CORP.

2. Tap the key (122) into the keyway until both ends of the key bottom onto the crankshaft.

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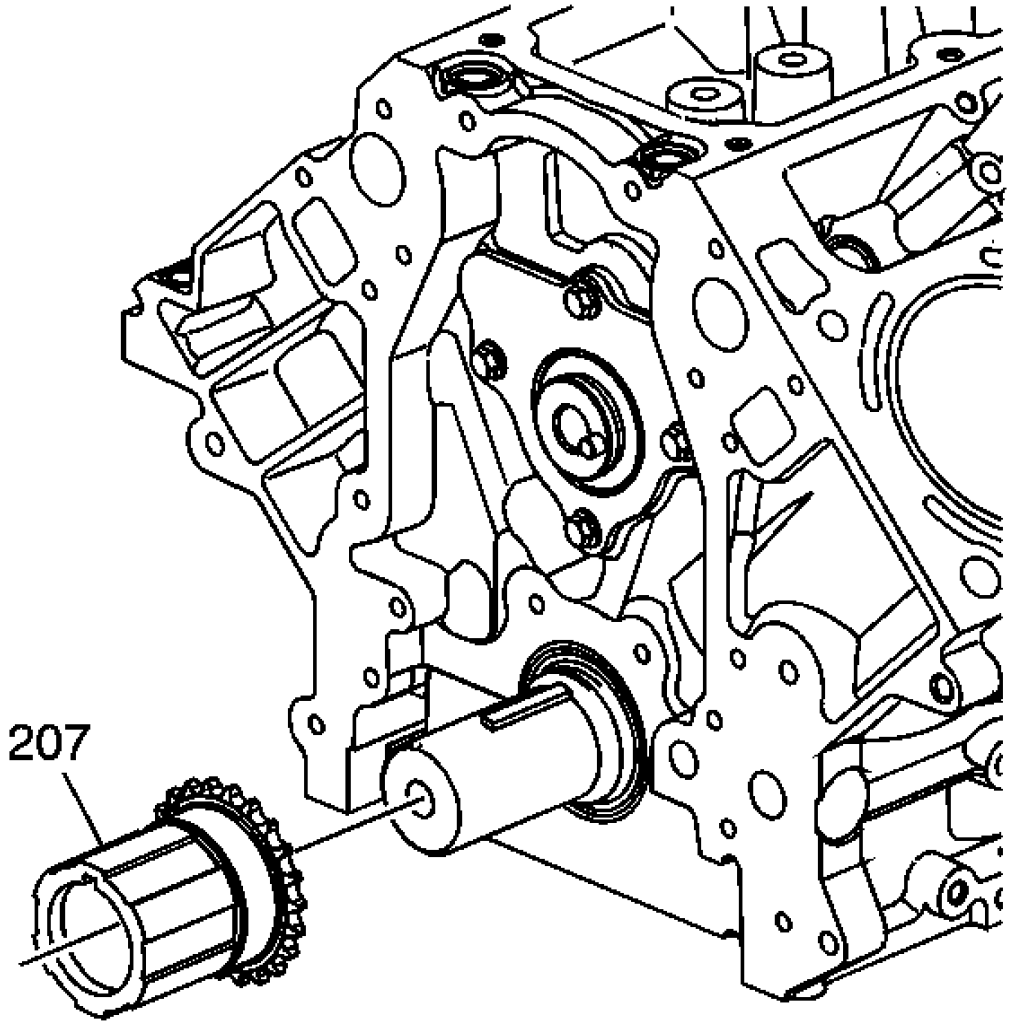


Fig. 137: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft sprocket (207) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.

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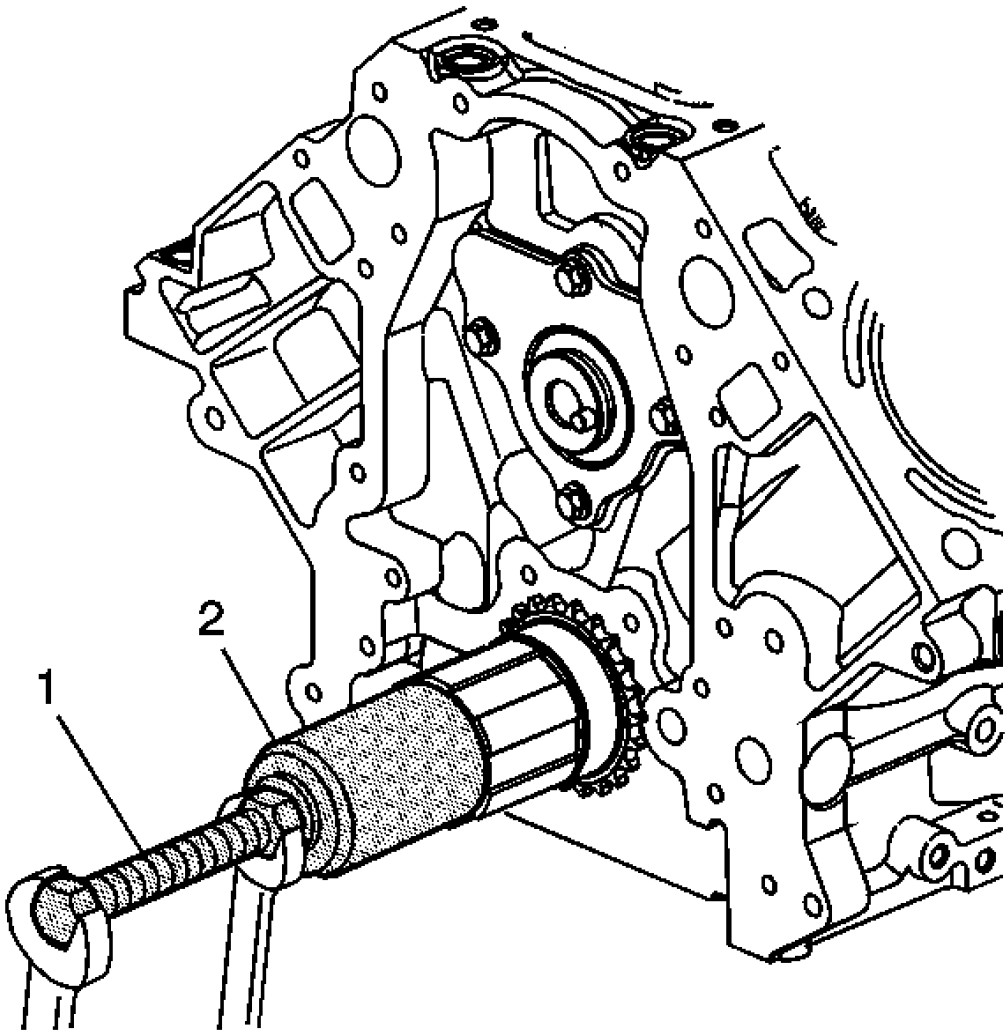


Fig. 138: View Of Crankshaft Sprocket & Installer
Courtesy of GENERAL MOTORS CORP.

4. Use the **J 41478:** installer (1) and the **J 41665:** installer (2) in order to install the crankshaft sprocket. Install the sprocket onto the crankshaft until fully seated against the crankshaft flange.
5. Rotate the crankshaft sprocket until the sprocket alignment mark is in the 12 o'clock position.

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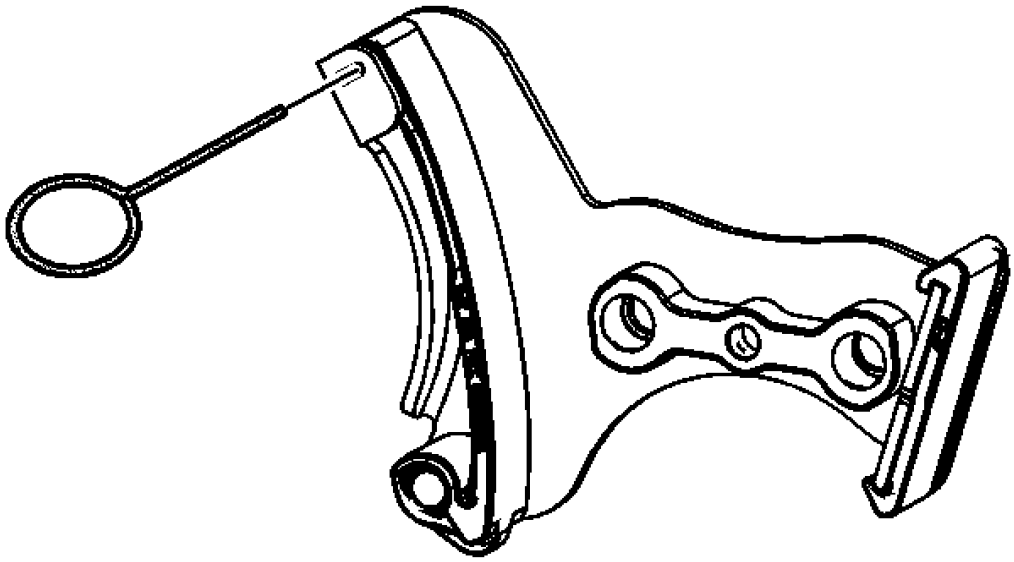


Fig. 139: View Of Compressed Tensioner
Courtesy of GENERAL MOTORS CORP.

6. Compress the timing chain tensioner guide and install the **EN 46330:** pin.

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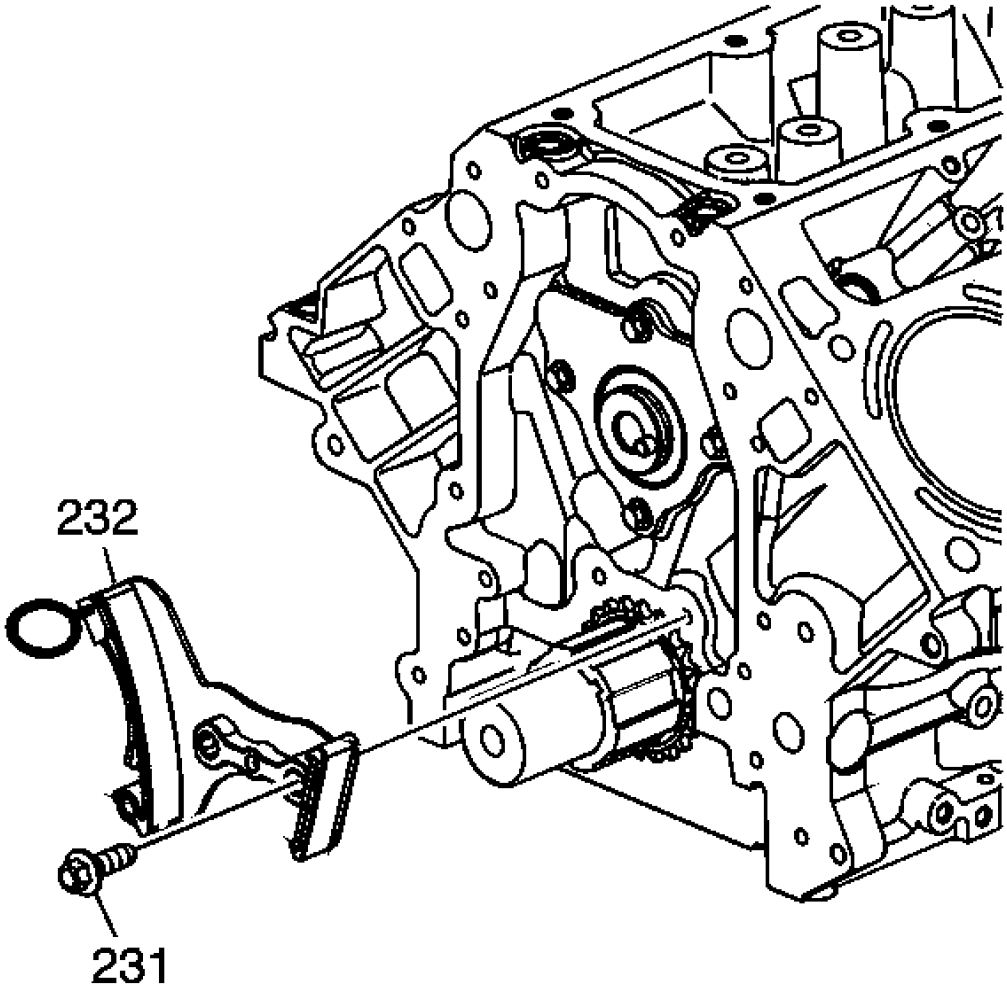


Fig. 140: View Of Timing Chain Tensioner & Left Side Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

7. Install the timing chain tensioner (232) and left side bolt (231). Do not install the right side bolt at this time. The right side bolt will be installed after the camshaft position (CMP) actuator and chain have been installed onto the engine.

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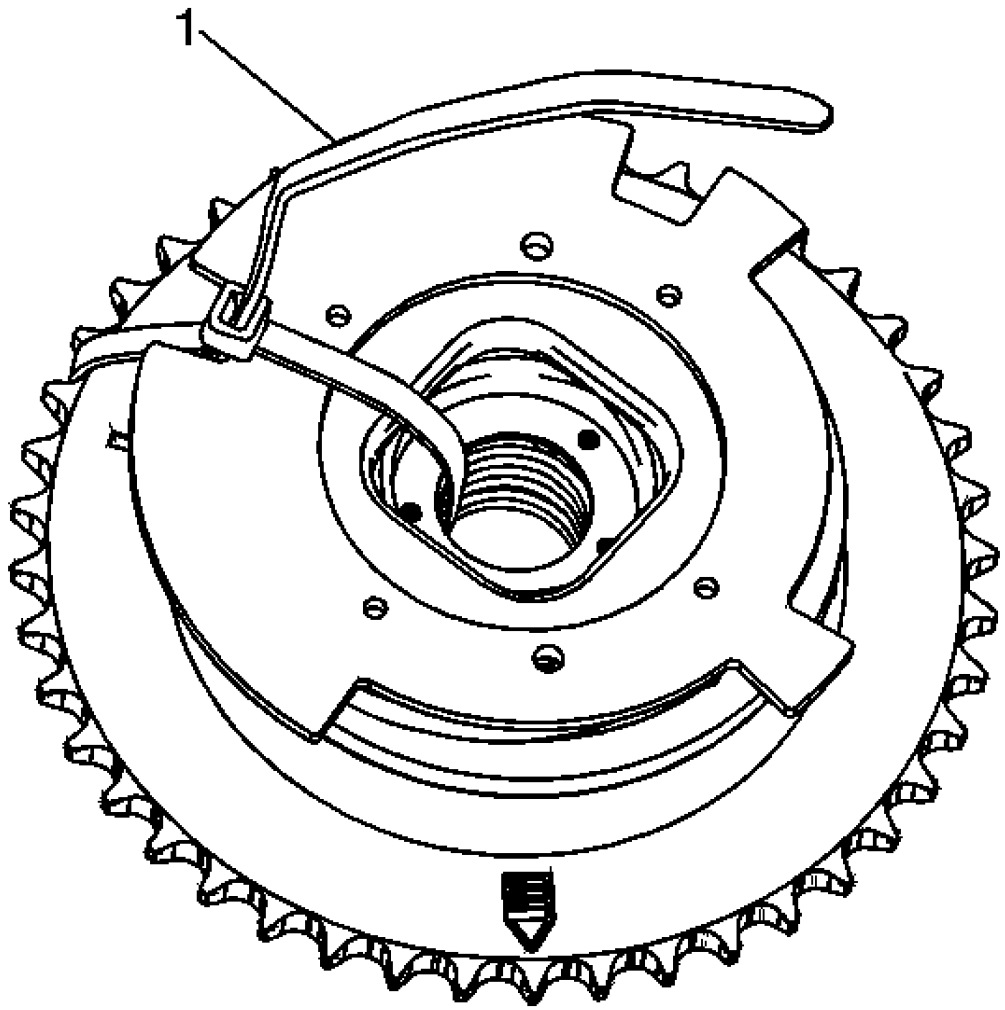


Fig. 141: View Of Tie Strap Through Center Of Actuator
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Camshaft Position Actuator Removal and Installation Warning .

8. Remove the tie strap (1) from the actuator.

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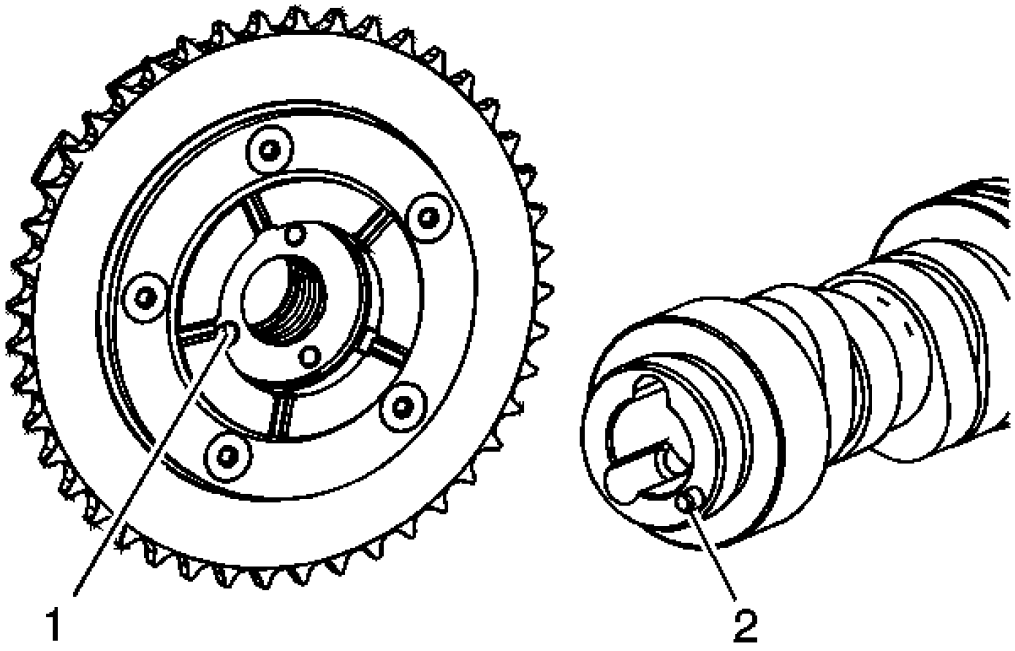


Fig. 142: Identifying Alignment Hole & Locating Pin
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Properly locate the CMP actuator onto the locating pin of the camshaft.**
- **The sprocket teeth and timing chain must mesh.**
- **The camshaft and the crankshaft sprocket alignment marks MUST be aligned properly.**
- **Do not use the CMP solenoid valve again. Install a NEW valve during assembly.**

9. Identify the alignment hole (1) in the rear face of the CMP actuator and the locating pin (2) on the front face of the camshaft.

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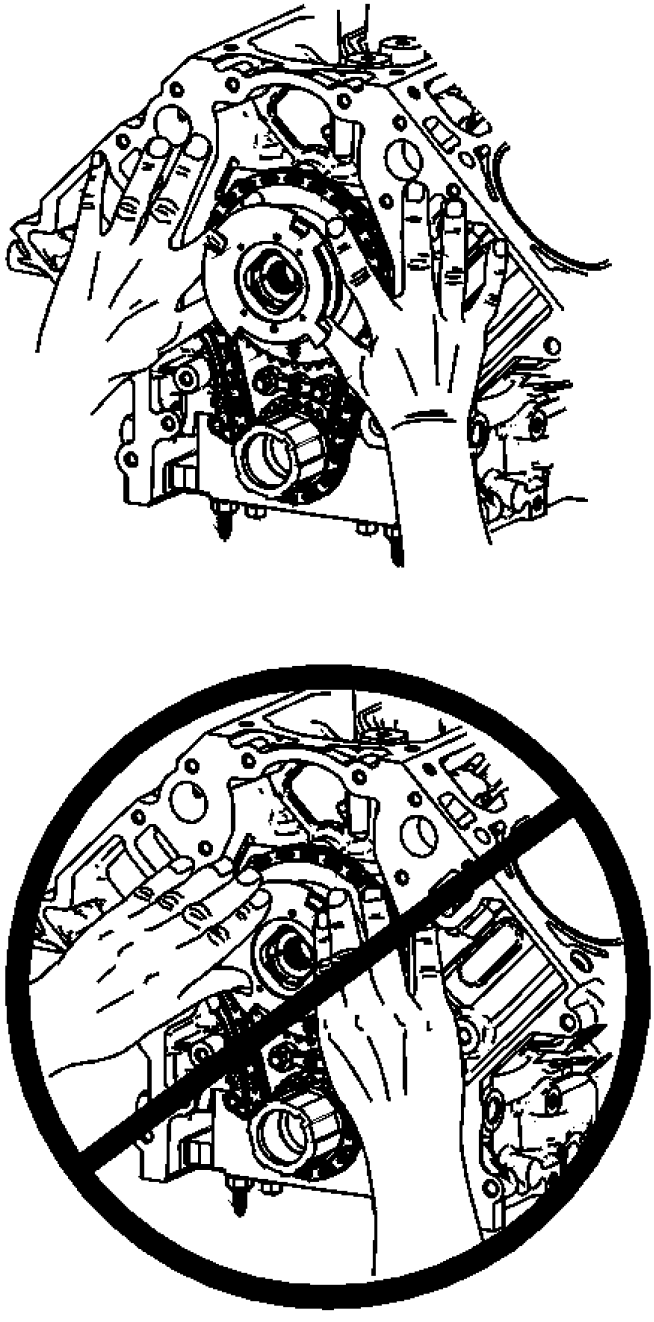


Fig. 143: Proper Installation Of CMP Actuator
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Camshaft Position Actuator Removal and Installation

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Warning .

10. Install the CMP actuator and timing chain. Align the hole in the rear face of the CMP actuator with the locating pin on the front face of the camshaft. If necessary, rotate the camshaft or crankshaft sprockets in order to align the timing marks. Use care to install the actuator completely onto the front of the camshaft. Position fingers onto the face of the actuator sprocket and push the actuator onto the front of the camshaft. Never push on the reluctor wheel when attempting to install the actuator.

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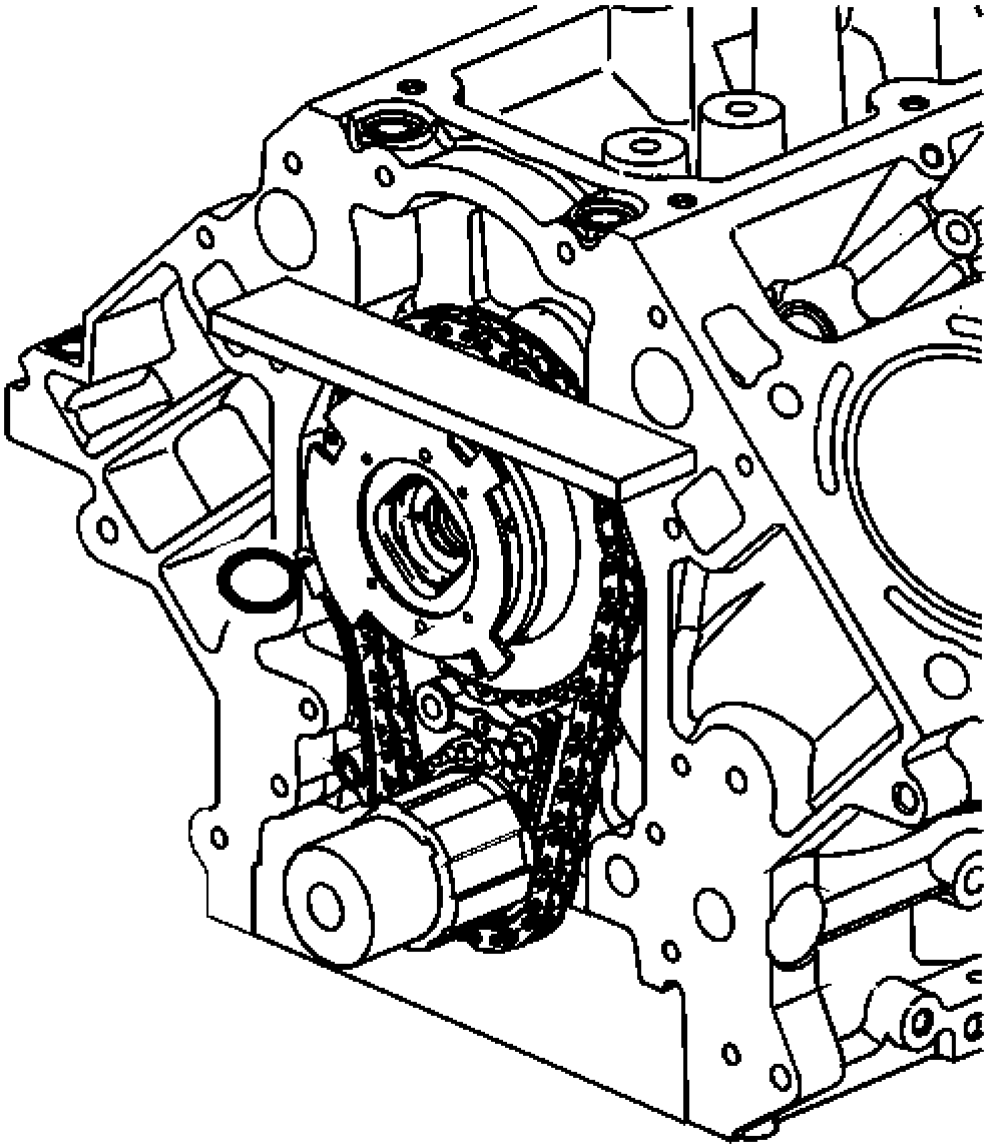


Fig. 144: Inspecting For Proper Installation Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS CORP.

11. Locate a straight edge across the front face of the engine block and inspect for proper installation of the CMP actuator and timing chain. With the CMP actuator properly and completely installed onto the front of camshaft, the timing chain will not protrude beyond the front face of engine block.

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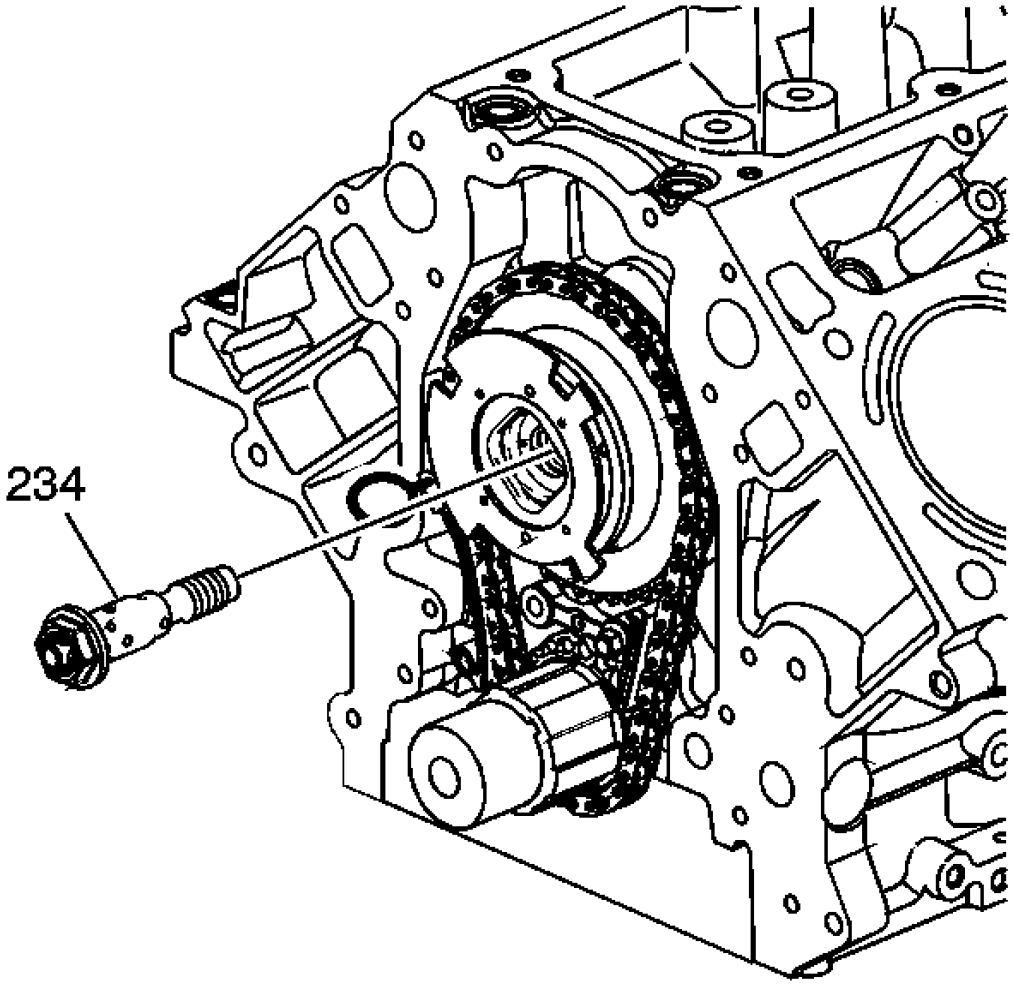


Fig. 145: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

12. Install a NEW CMP actuator solenoid valve (234). With the CMP actuator properly positioned onto the camshaft, the CMP actuator solenoid valve can be threaded completely into the camshaft using light hand pressure. Tighten by hand until snug.

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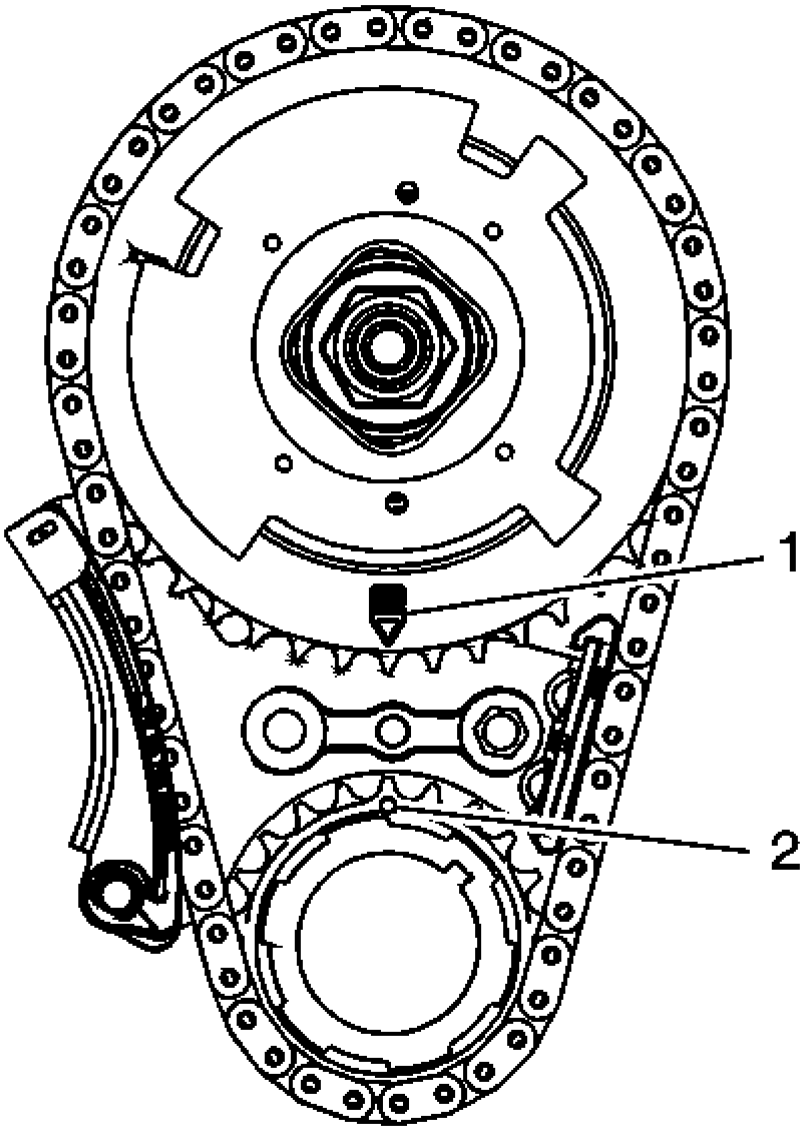


Fig. 146: View Of CMP Actuator Alignment Mark & Crankshaft Sprocket Alignment Mark
Courtesy of GENERAL MOTORS CORP.

13. Inspect the sprockets for proper alignment. The mark on the CMP actuator sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

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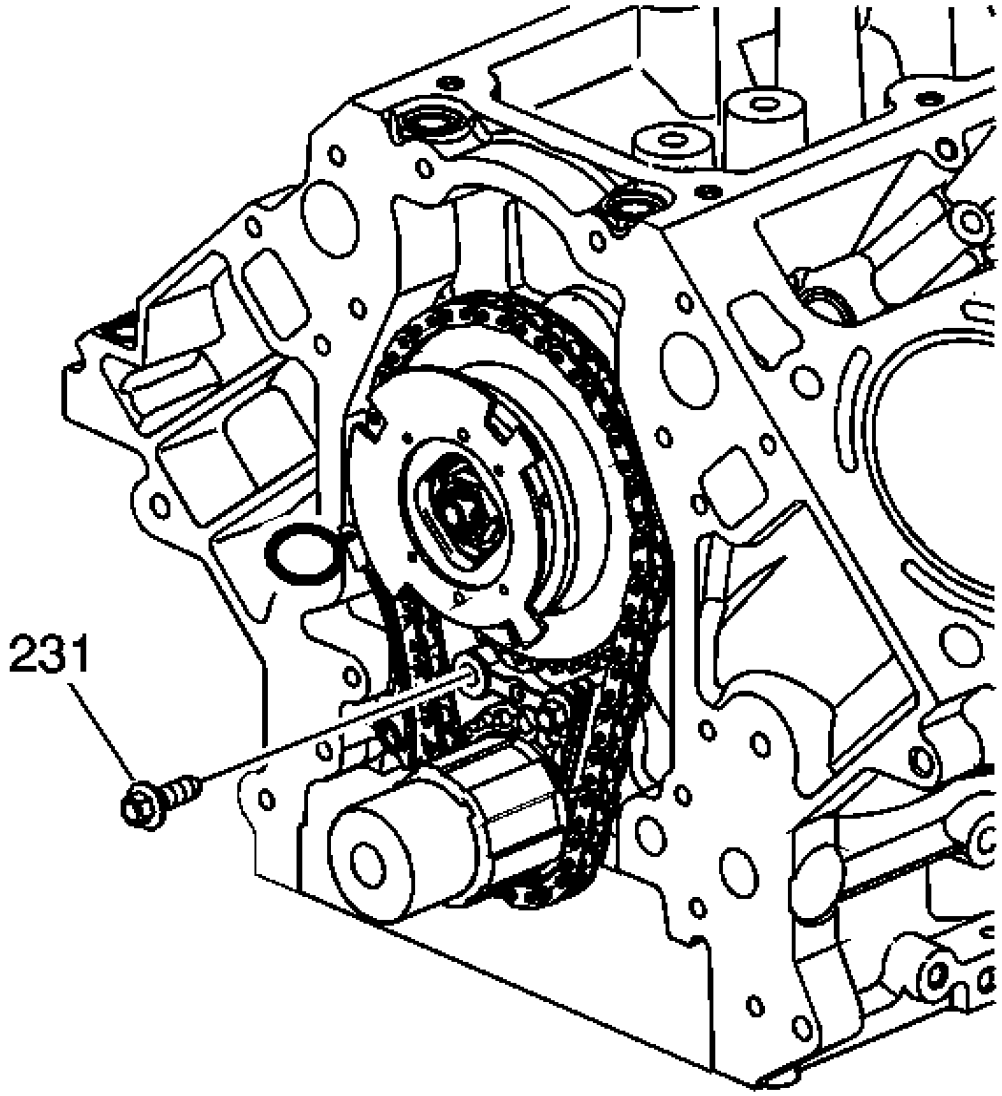


Fig. 147: View Of Timing Chain Tensioner Bolt
Courtesy of GENERAL MOTORS CORP.

14. Install the right side bolt (231) into the timing chain tensioner and tighten both bolts to 30 N.m (22 lb ft).

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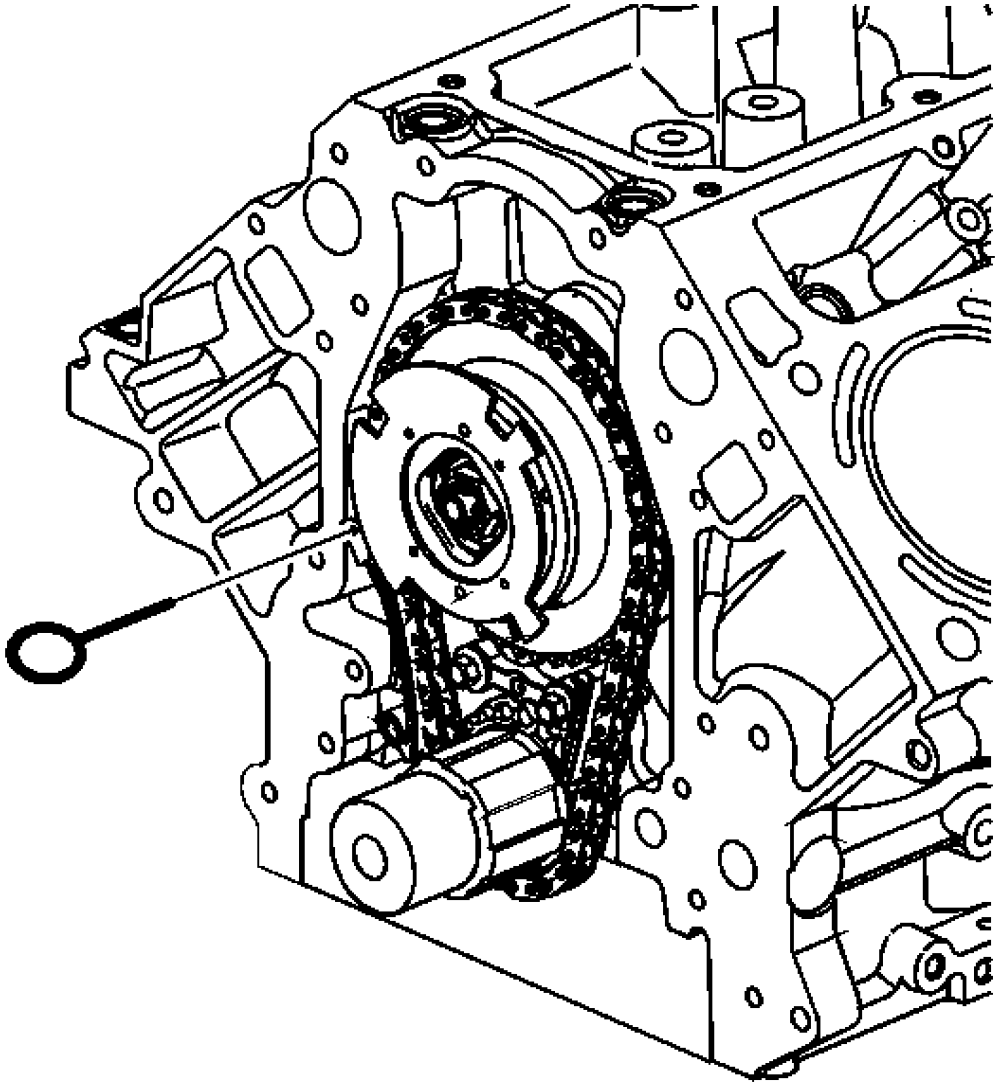


Fig. 148: View Of Special Tool EN 46330
Courtesy of GENERAL MOTORS CORP.

15. Remove the **EN 46330:** pin.

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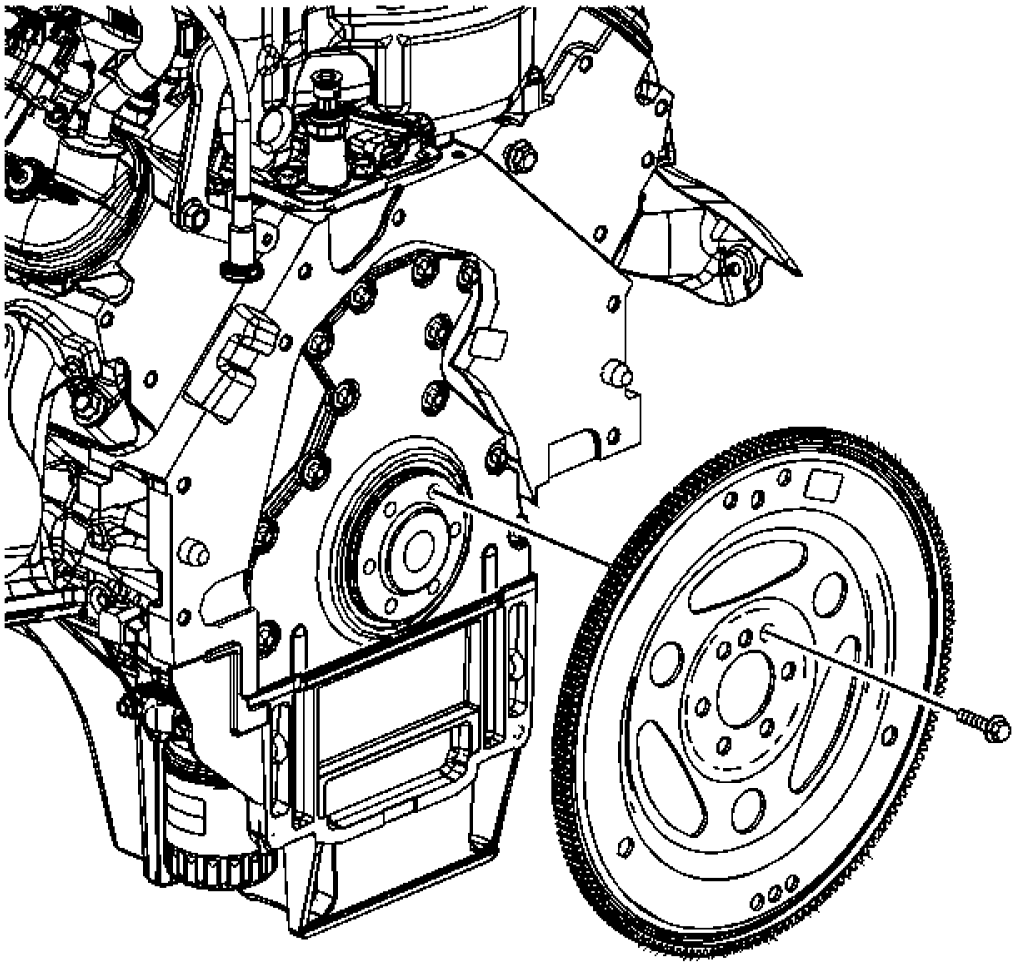


Fig. 149: View Of Flex Plate & Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not apply threadlock to the flex plate bolts at this time.

16. Temporarily install the automatic transmission flex plate and bolts. Refer to **Automatic Transmission Flex Plate Installation** .

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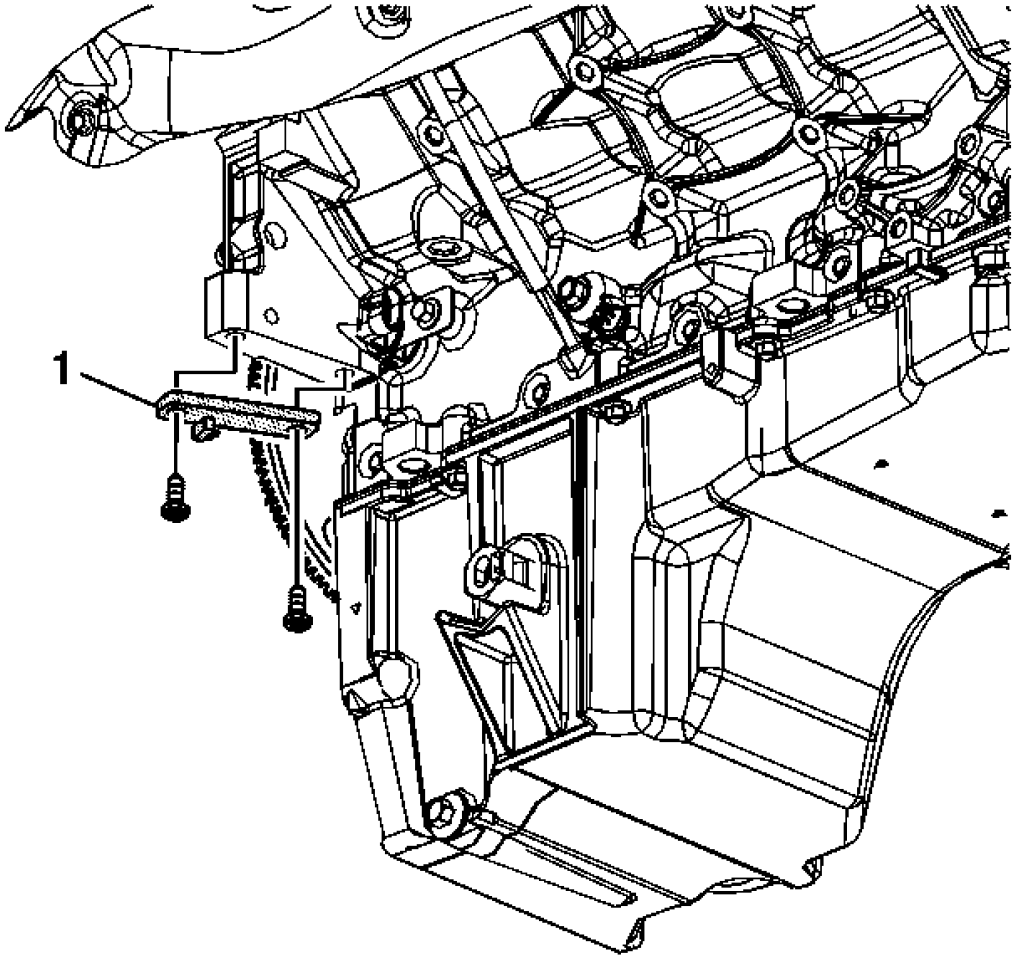


Fig. 150: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS CORP.

17. Install the **J 42386-A:** tool (1) and bolts. Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the **J 42386-A:** tool bolts to 50 N.m (37 lb ft).

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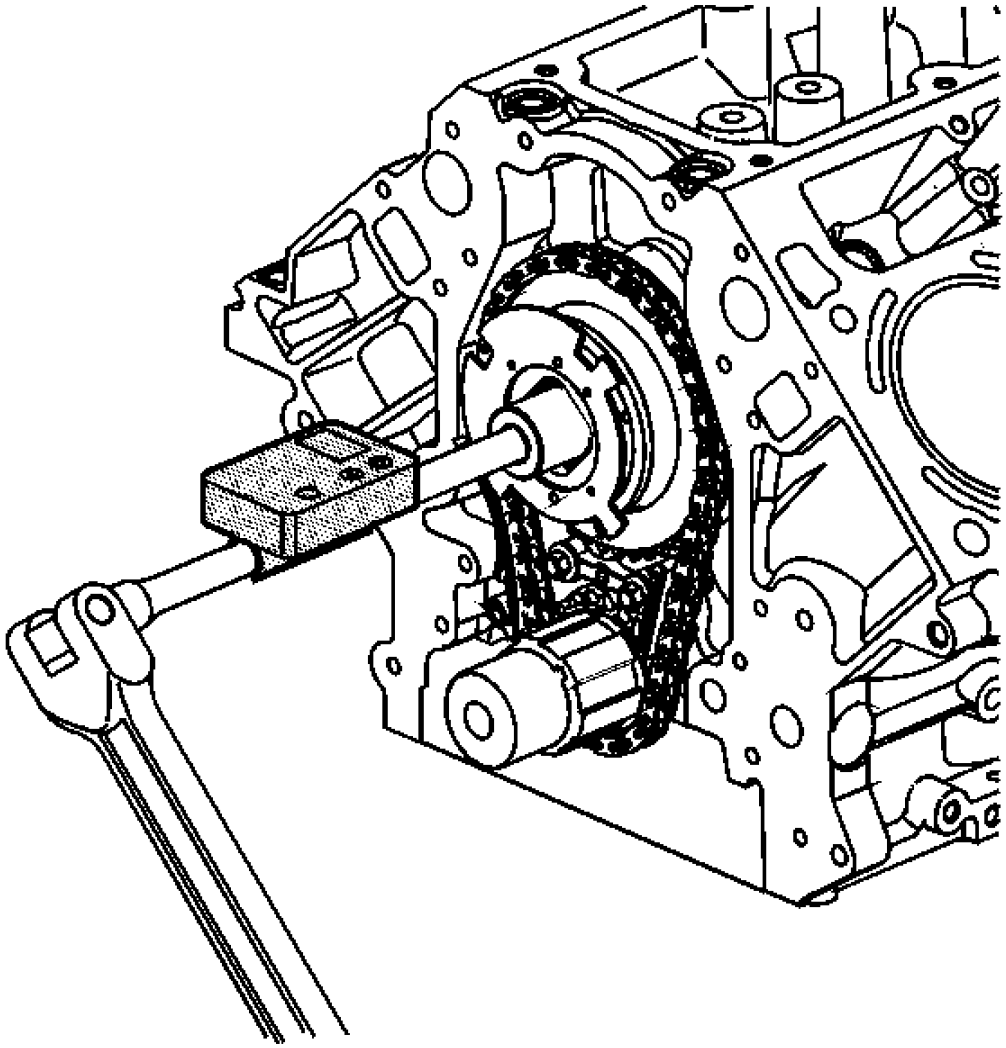


Fig. 151: Tightening CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

18. Tighten the CMP actuator solenoid valve.
    1. Tighten the CMP actuator solenoid valve a first pass to 65 N.m (48 lb ft) .
    2. Tighten the CMP actuator solenoid valve a final pass an additional 90 degrees using the **J 45059:** meter .
19. Remove the **J 42386-A:** tool and bolts.
20. Remove the automatic transmission flex plate and bolts. Refer to **Automatic Transmission Flex Plate Removal** .

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TIMING CHAIN AND SPROCKET INSTALLATION

Special Tools

- **EN 46330:** Timing Belt Tensioner Retaining Pin
- **J 41478:** Crankshaft Front Oil Seal Installer
- **J 41665:** Crankshaft Balancer and Sprocket Installer
- **J 42386-A:** Flywheel Holding Tool
- **J 45059:** Angle Meter

For equivalent regional tools, refer to **Special Tools**

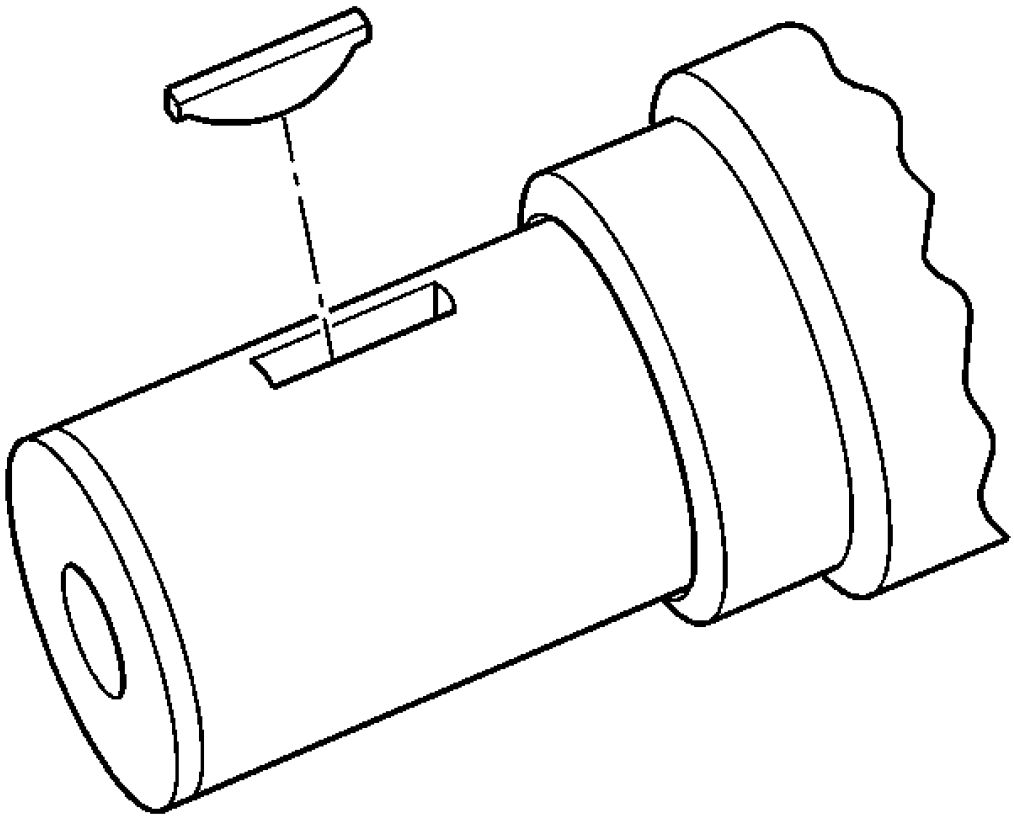


Fig. 152: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS CORP.

1. Install the key into the crankshaft keyway, if previously removed.

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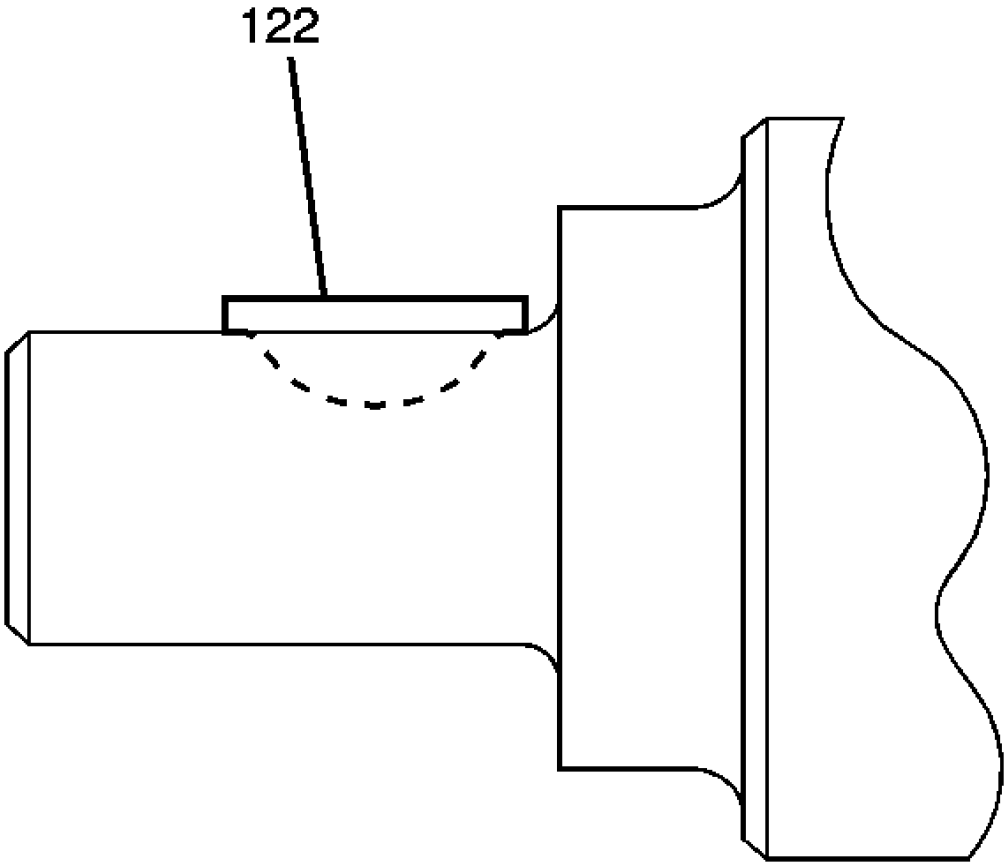


Fig. 153: View Of Installed Crankshaft Key
Courtesy of GENERAL MOTORS CORP.

2. Tap the key (122) into the keyway until both ends of the key bottom onto the crankshaft.

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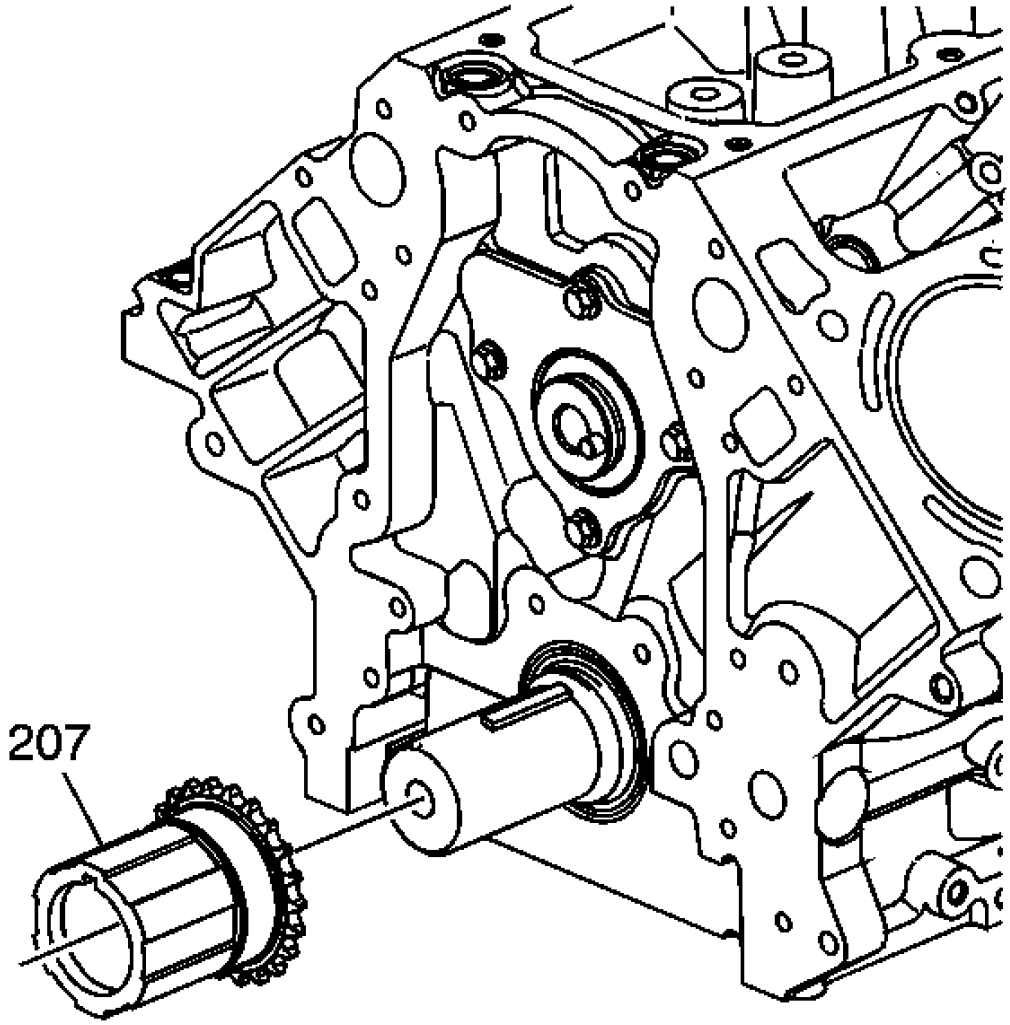


Fig. 154: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft sprocket (207) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.

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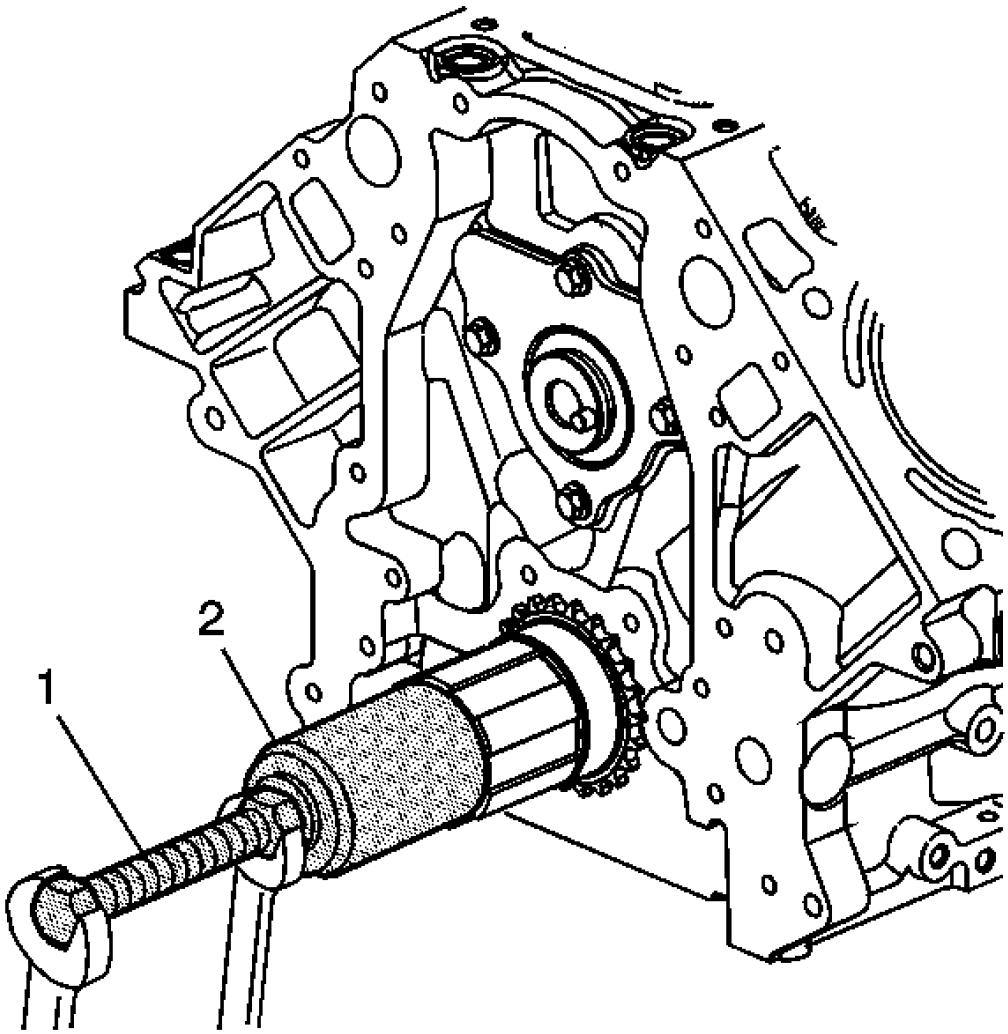


Fig. 155: View Of Crankshaft Sprocket & Installer
Courtesy of GENERAL MOTORS CORP.

4. Use the **J 41478:** installer (1) and the **J 41665:** installer (2) in order to install the crankshaft sprocket.

   Install the sprocket onto the crankshaft until fully seated against the crankshaft flange.

5. Rotate the crankshaft sprocket until the alignment mark is in the 12 o'clock position.

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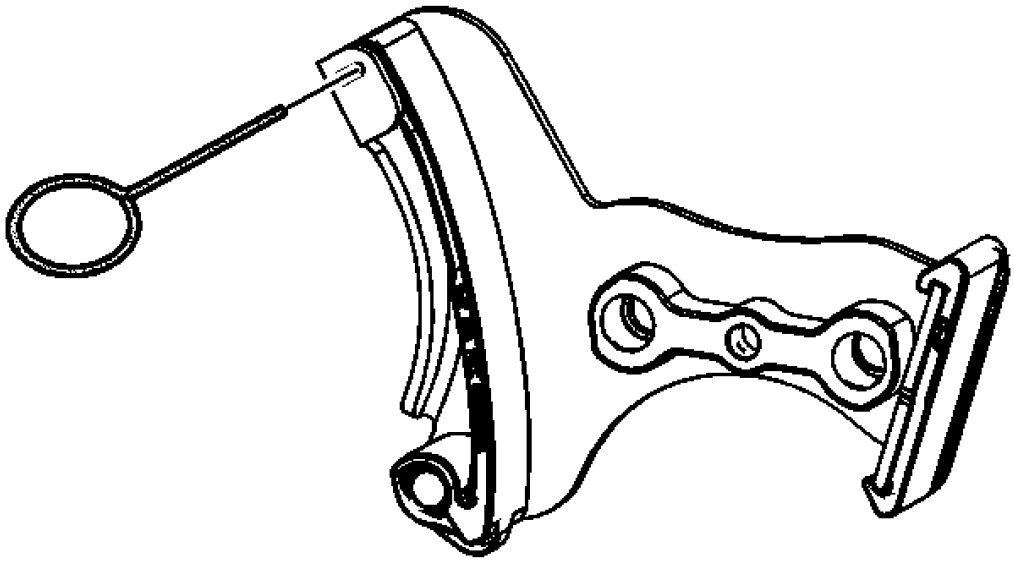


Fig. 156: View Of Compressed Tensioner
Courtesy of GENERAL MOTORS CORP.

6. Compress the timing chain tensioner guide and install the **EN 46330:** pin.

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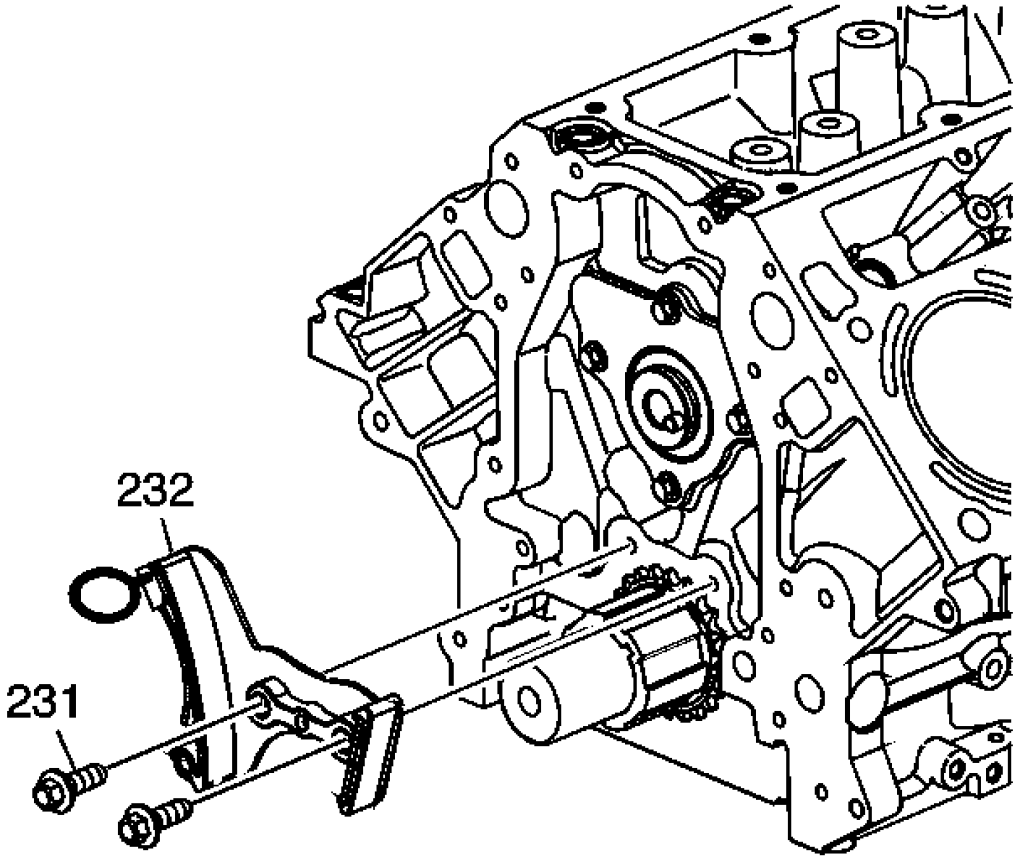


Fig. 157: View Of Timing Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

7. Install the timing chain tensioner (232) and bolts (231). Tighten the timing chain tensioner bolts to 30 N.m (22 lb ft).

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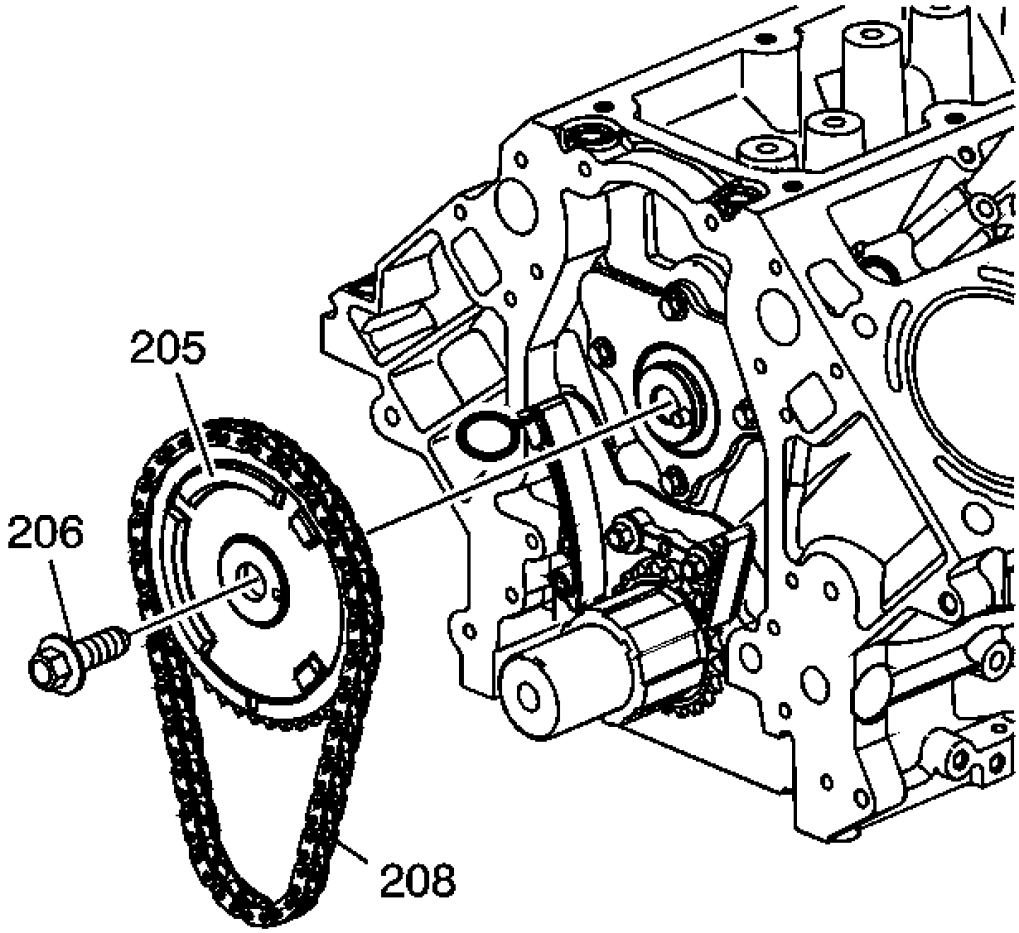


Fig. 158: View Of Camshaft Sprocket, Timing Chain & Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Do not use the camshaft sprocket bolt again. Install a NEW bolt during assembly.**
- **The sprocket teeth and timing chain must mesh.**
- **The camshaft and the crankshaft sprocket alignment marks MUST be aligned properly.**

8. Install the camshaft sprocket (205), timing chain (208), and NEW bolt (206).

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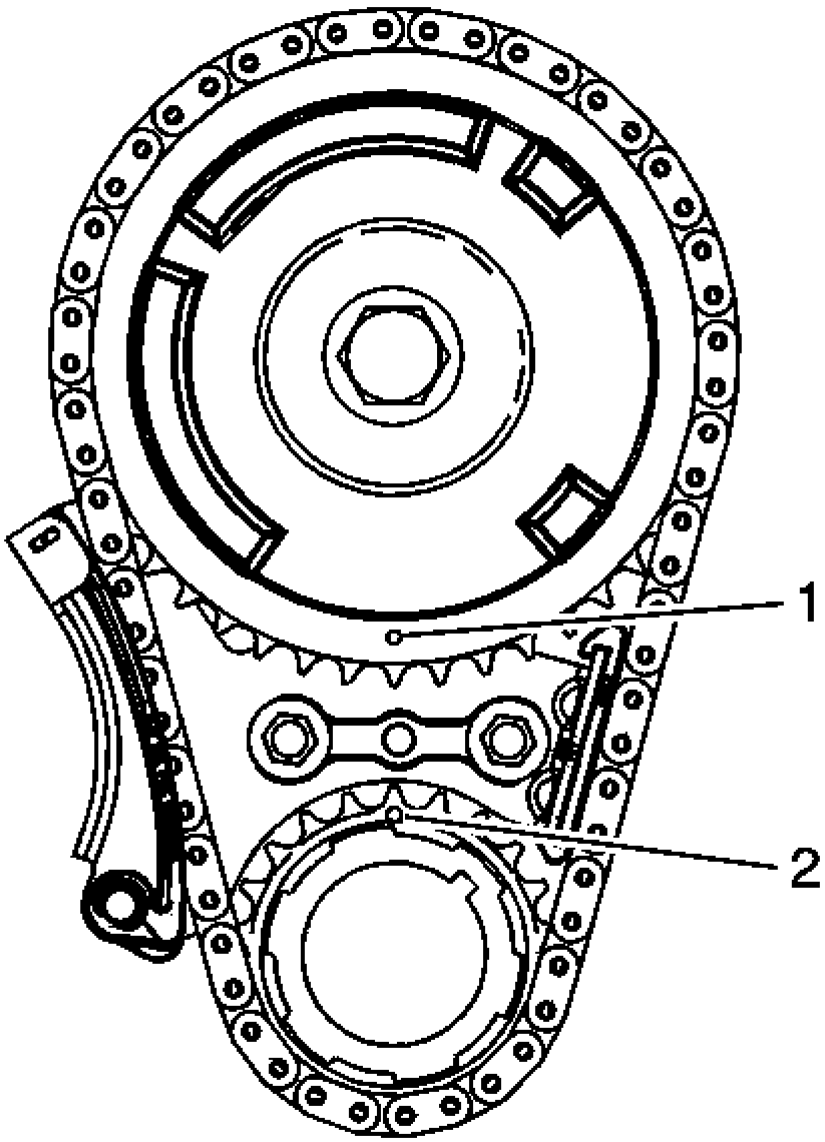


Fig. 159: Identifying Camshaft & Crankshaft Marks
Courtesy of GENERAL MOTORS CORP.

9. Inspect the sprockets for proper alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

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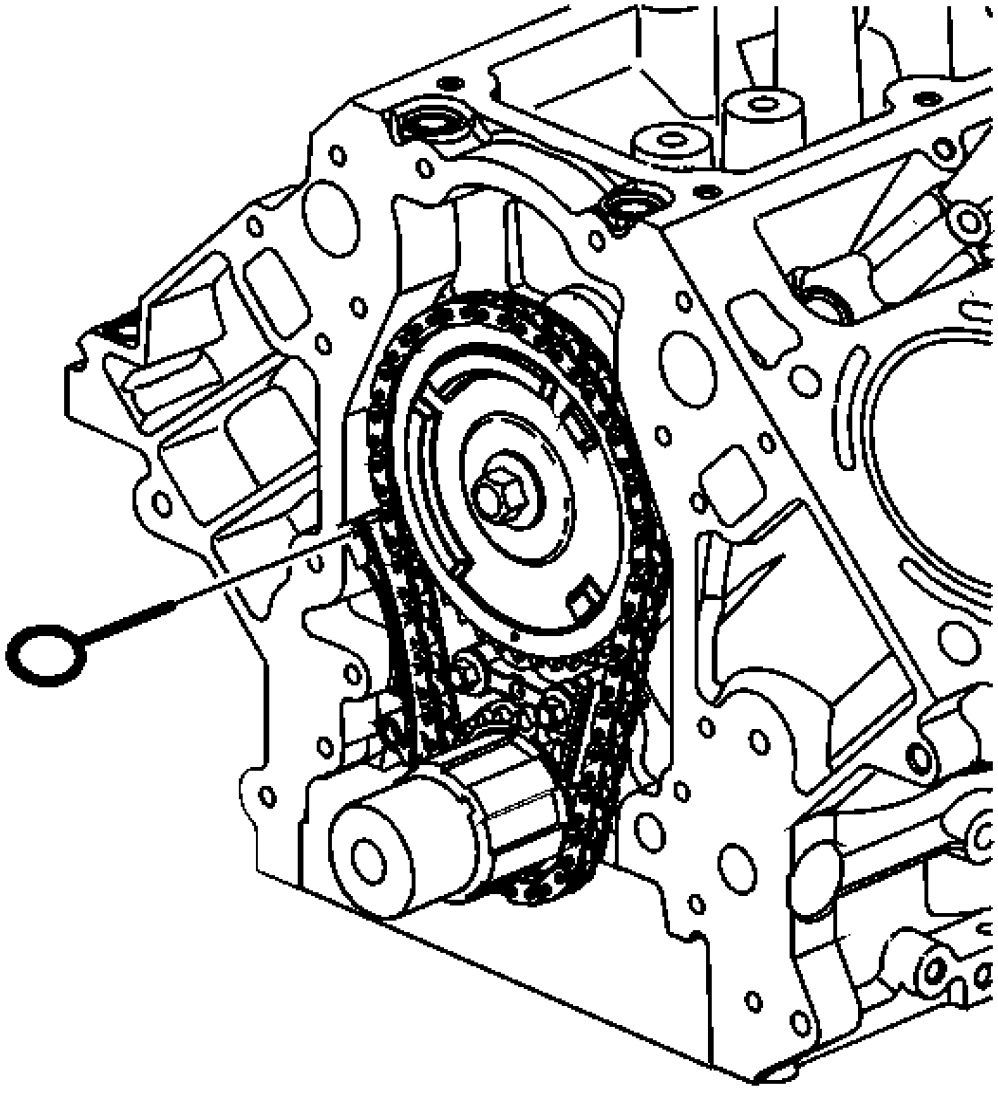


Fig. 160: Removing Tensioner Pin
Courtesy of GENERAL MOTORS CORP.

10. Remove the **EN 46330:** pin.

NOTE: Do not apply threadlock to the flex plate bolts at this time.

11. Temporarily install the automatic transmission flex plate and bolts. Refer to **Automatic Transmission Flex Plate Installation** .

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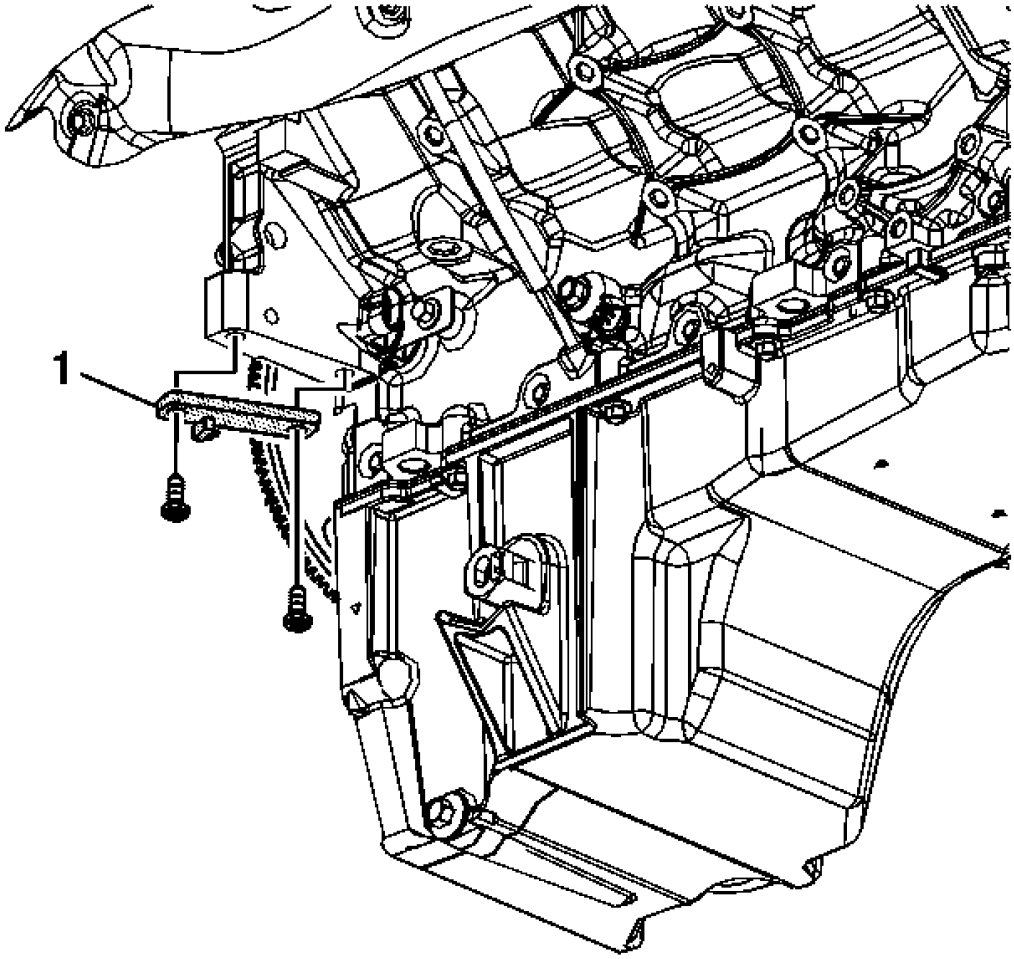


Fig. 161: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS CORP.

12. Install the **J 42386-A:** tool (1) and bolts. Use 1 M10-1.5 x 120 mm bolt and 1 M10-1.5 x 45 mm bolt for proper tool operation. Tighten the **J 42386-A:** tool bolts to 50 N.m (37 lb ft).

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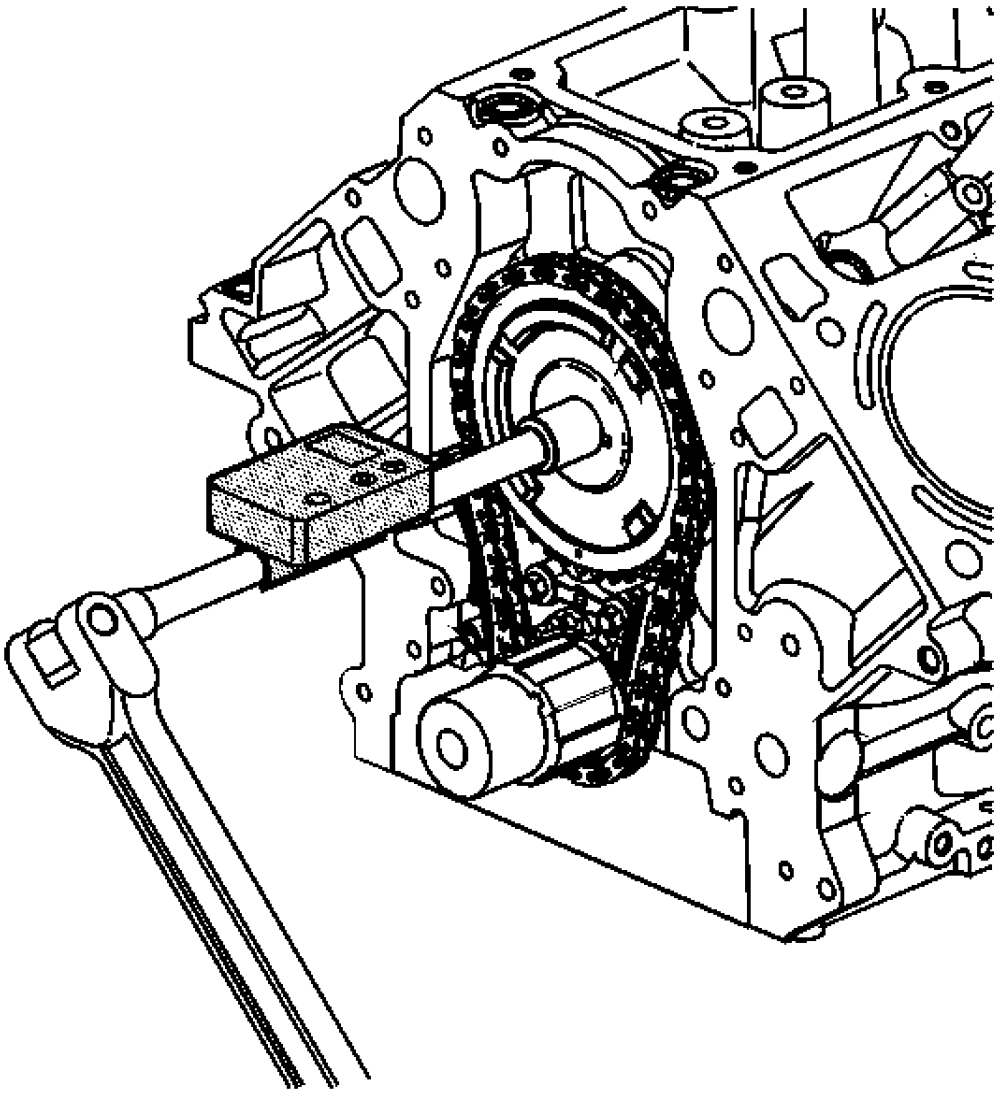


Fig. 162: Tightening Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

13. Tighten the camshaft sprocket bolt.
    1. Tighten the camshaft sprocket bolt a first pass to 75 N.m (55 lb ft) .
    2. Tighten the camshaft sprocket bolt a final pass an additional 50 degrees using the **J 45059:** meter .
14. Remove the **J 42386-A:** tool and bolts.
15. Remove the automatic transmission flex plate and bolt. Refer to **Automatic Transmission Flex Plate**

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Removal .

OIL PUMP, SCREEN AND CRANKSHAFT OIL DEFLECTOR INSTALLATION

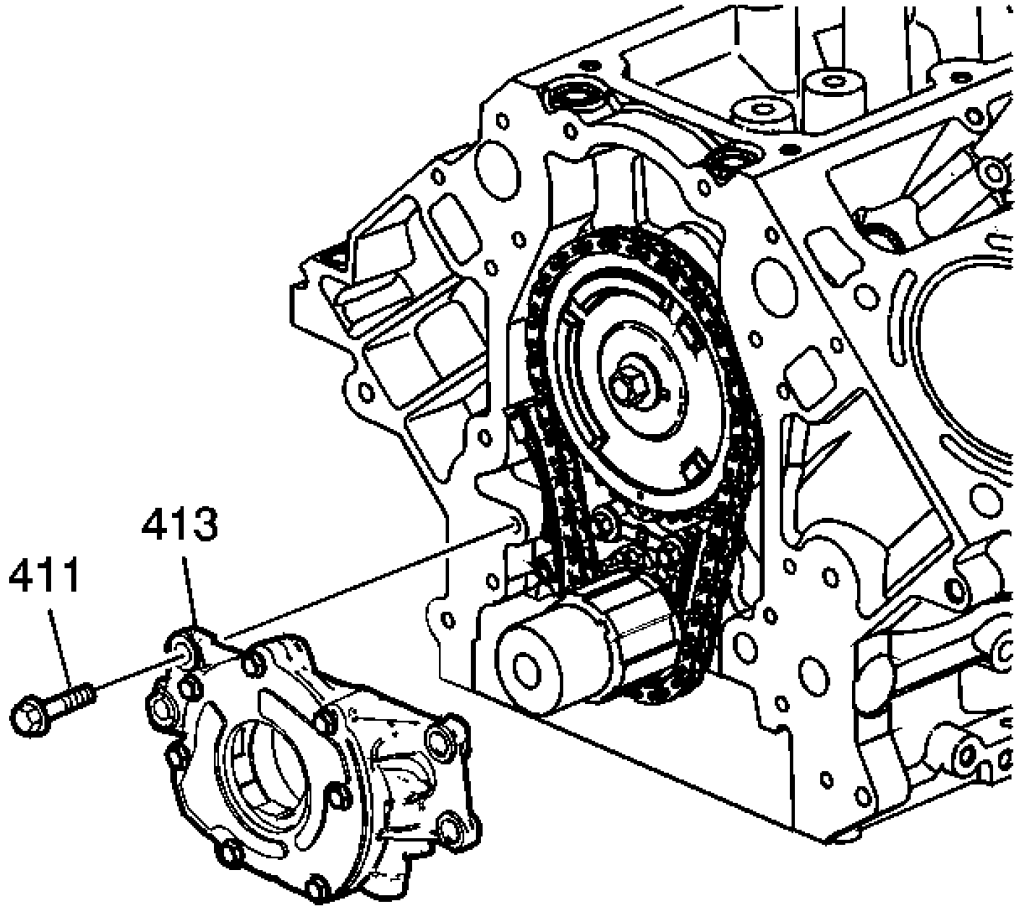


Fig. 163: View Of Oil Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Inspect the oil pump and engine block oil gallery passages. These surfaces must be clear and free of debris or restrictions.

1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump (413).
2. Install the oil pump onto the crankshaft sprocket until the pump housing contacts the face of the engine block.

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CAUTION: Refer to Fastener Caution .

3. Install the oil pump bolts (411) and tighten to 25 N.m (18 lb ft).

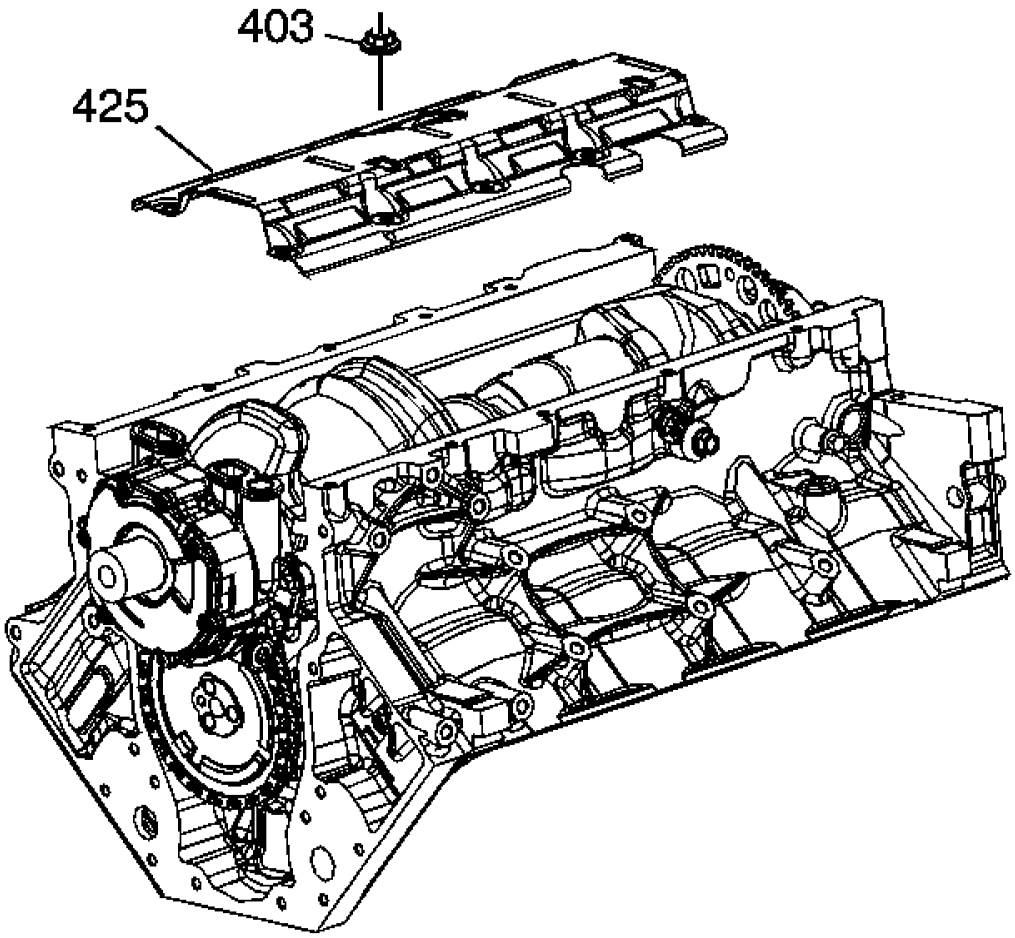


Fig. 164: Crankshaft Oil Deflector & Nuts
Courtesy of GENERAL MOTORS CORP.

4. Install the crankshaft oil deflector (425).

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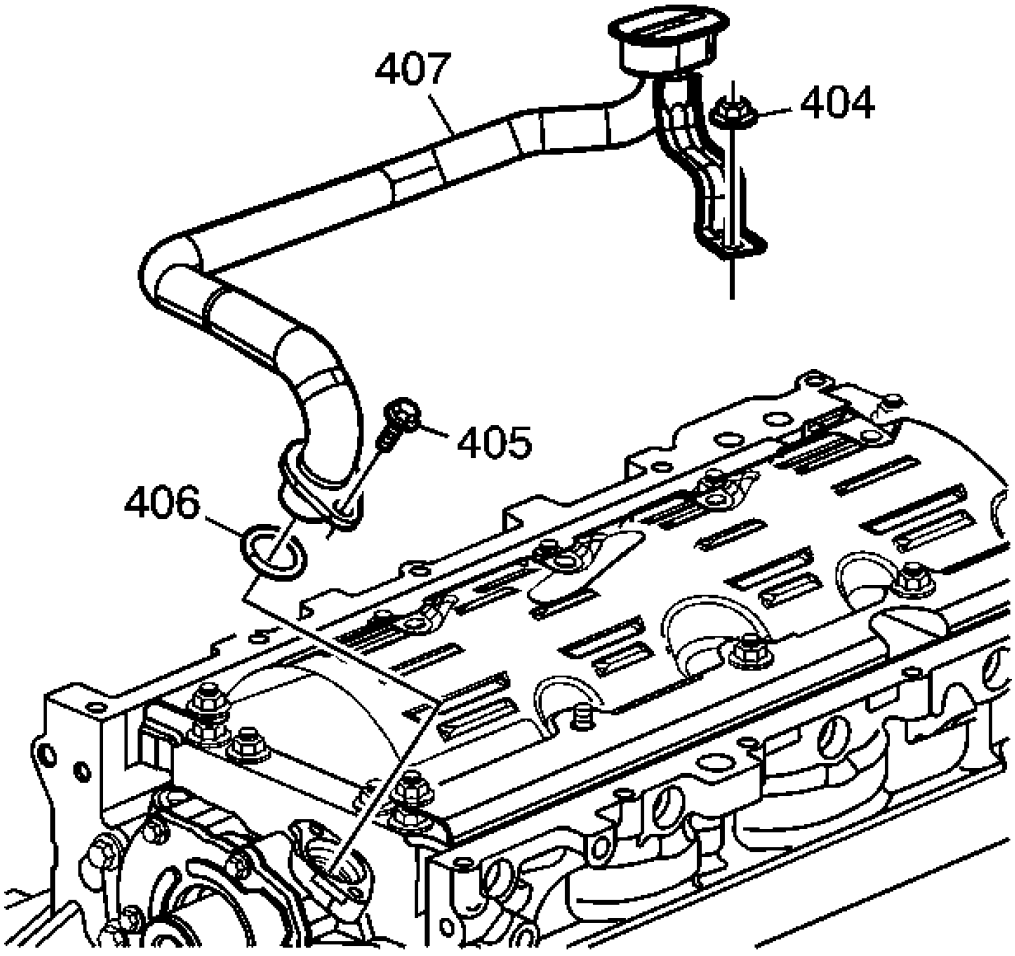


Fig. 165: Oil Pump Screen Bolt, Nut & O-Ring Seal
Courtesy of GENERAL MOTORS CORP.

5. Lubricate a NEW oil pump screen O-ring seal (406) with clean engine oil.
6. Install the NEW O-ring seal onto the oil pump screen.

NOTE:

- **Push the oil pump screen tube completely into the oil pump prior to tightening the bolt. Do not allow the bolt to pull the tube into the pump.**
- **Align the oil pump screen mounting brackets with the correct crankshaft bearing cap bolt/studs.**

7. Install the oil pump screen (407).

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8. Install the oil pump screen bolt (405) and the deflector nut (404).
    1. Tighten the oil pump screen bolt to 12 N.m (106 lb in) .
    2. Tighten the crankshaft oil deflector nut to 25 N.m (18 lb ft) .

CRANKSHAFT REAR OIL SEAL HOUSING INSTALLATION

Special Tools

- **J 41476:** Front and Rear Cover Alignment Tool
- **J 41479-2A:** Crankshaft Rear Oil Seal Installation Guide
- **J 41480:** Front and Rear Cover Alignment

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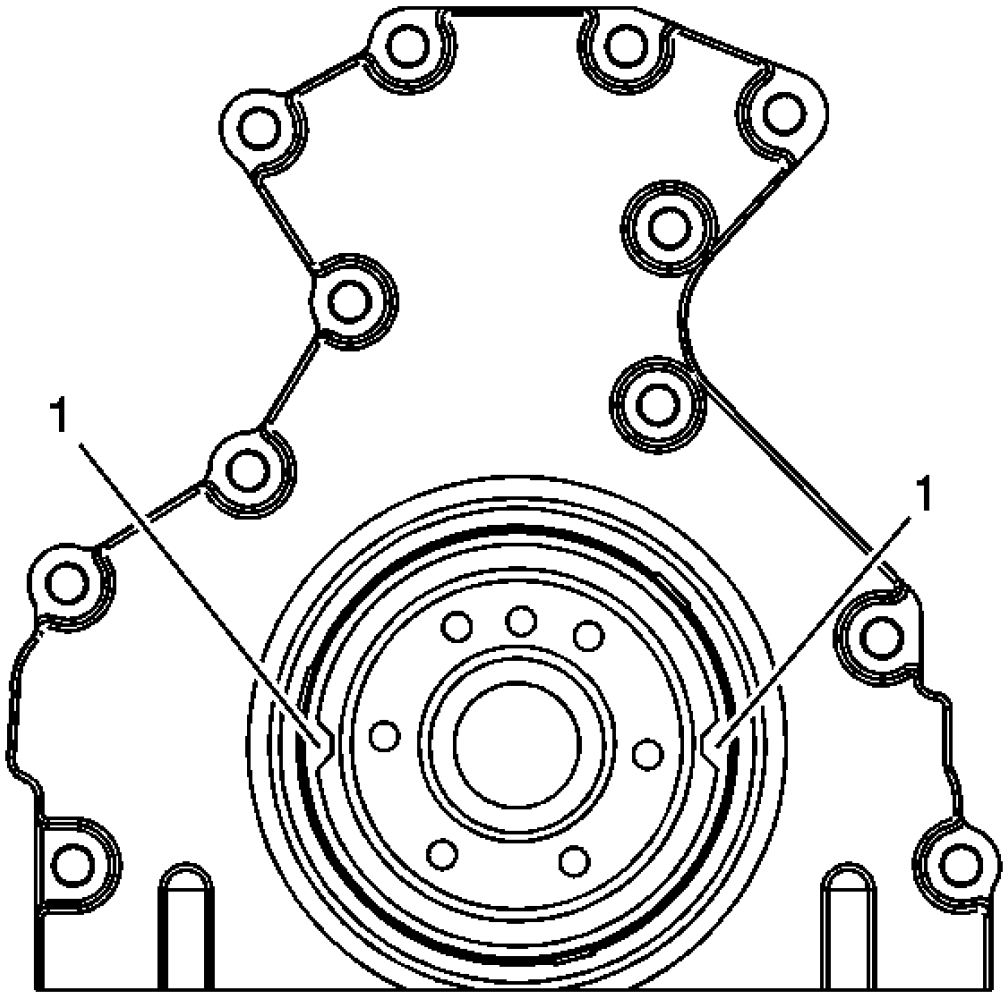


Fig. 166: Identifying Rear Housing Alignment Tabs
Courtesy of GENERAL MOTORS CORP.

NOTE:

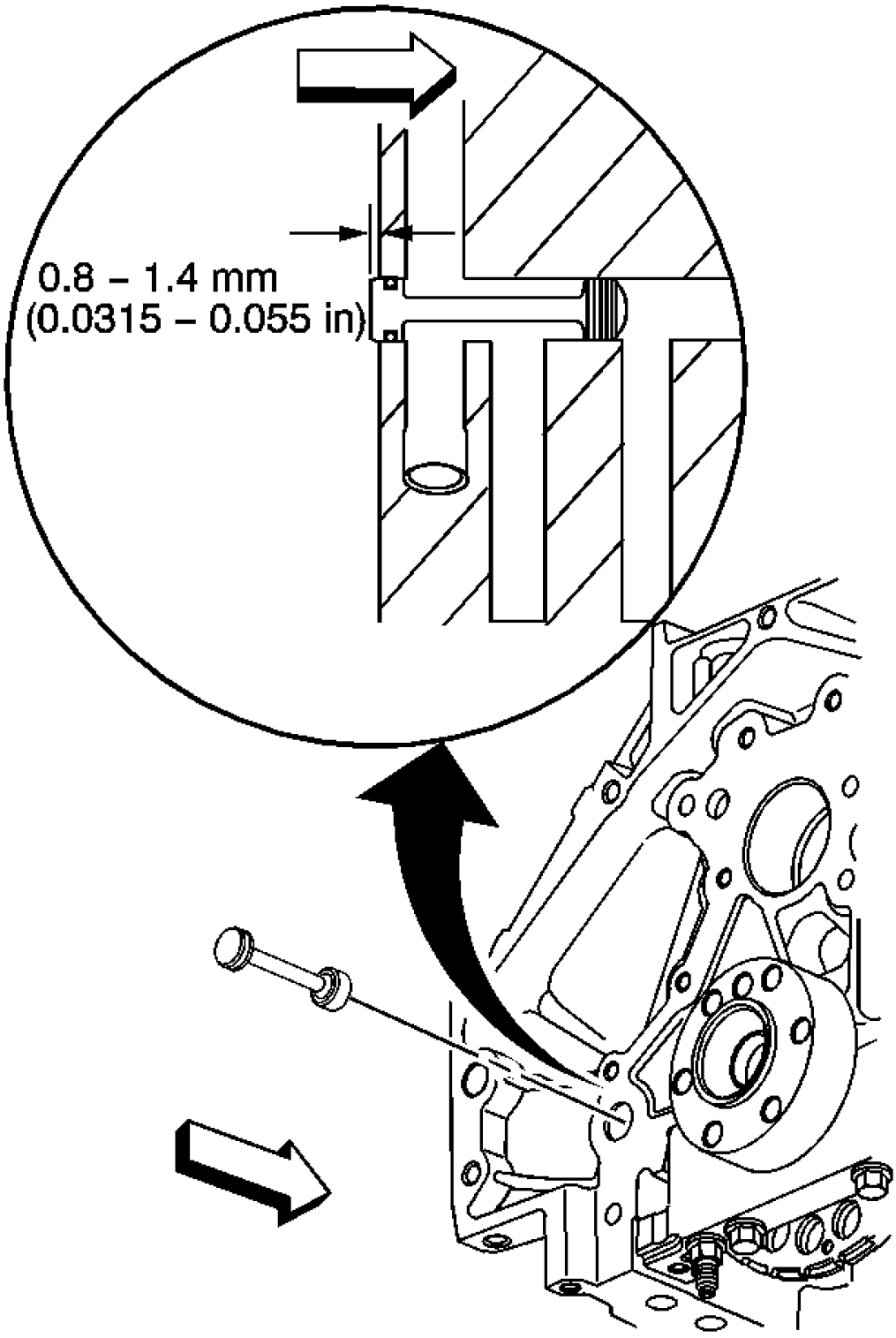
- **Do not use the crankshaft rear oil seal or the engine rear housing gasket again.**
- **Do not apply any type of sealant to the rear housing gasket, unless specified.**
- **The special tool in this procedure is used to properly align the engine rear housing at the oil pan surface.**
- **Current design rear housings have alignment tabs for horizontal alignment. J 41476: tool is not required for proper alignment of**

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current design rear housings. The housing may be installed and aligned with or without the seal already installed into the housing.

1. Inspect the rear housing to identify for alignment tabs (1).

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Fig. 167: View Of Engine Block Rear Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

2. Inspect the rear oil gallery plug for proper installation.

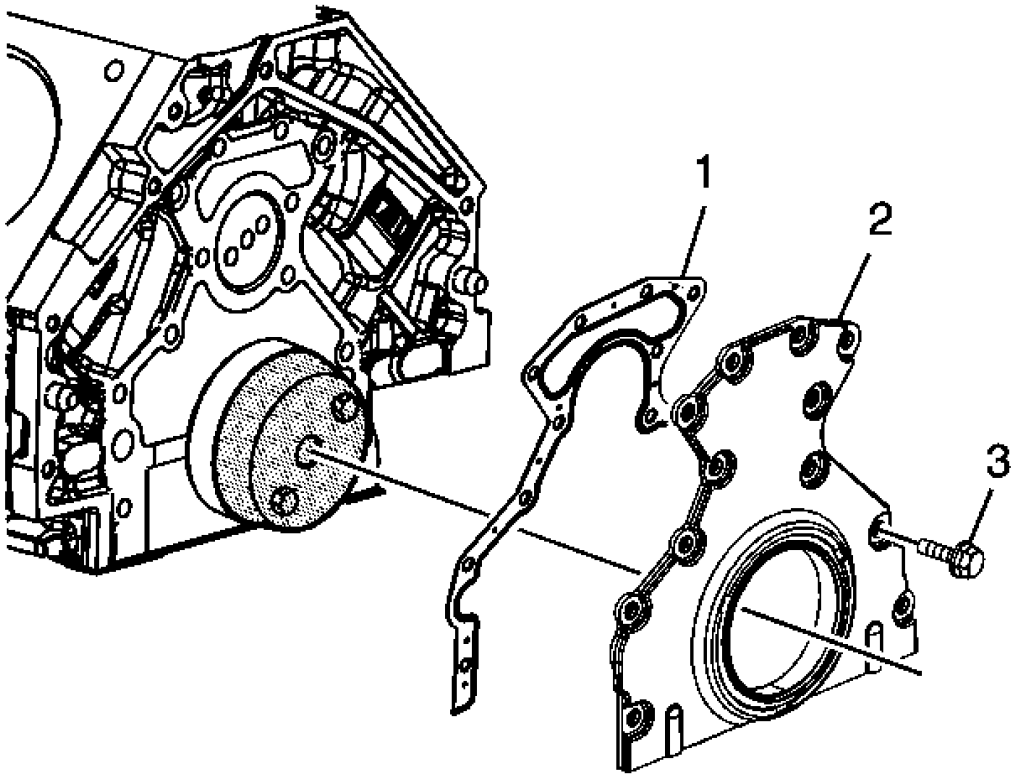


Fig. 168: View Of Rear Housing Gasket, Rear Housing With Seal & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: The J 41479-2A: guide is required when installing the rear housing with the rear oil seal. The J 41479-2A: guide is used to guide and protect the rear seal sealing surface as it is installed over the rear flange of the crankshaft. The J 41479-2A: guide is NOT required when installing the rear housing without rear oil seal.

3. Install the **J 41479-2A:** guide cone and bolts onto the rear of the crankshaft.
4. Tighten the bolts until snug. Do not overtighten.
5. Install the rear housing gasket (1), rear housing with seal (2), and bolts (3).
6. Tighten the bolts finger tight. Do not overtighten.

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7. Remove the **J 41479-2A:** guide and bolts.

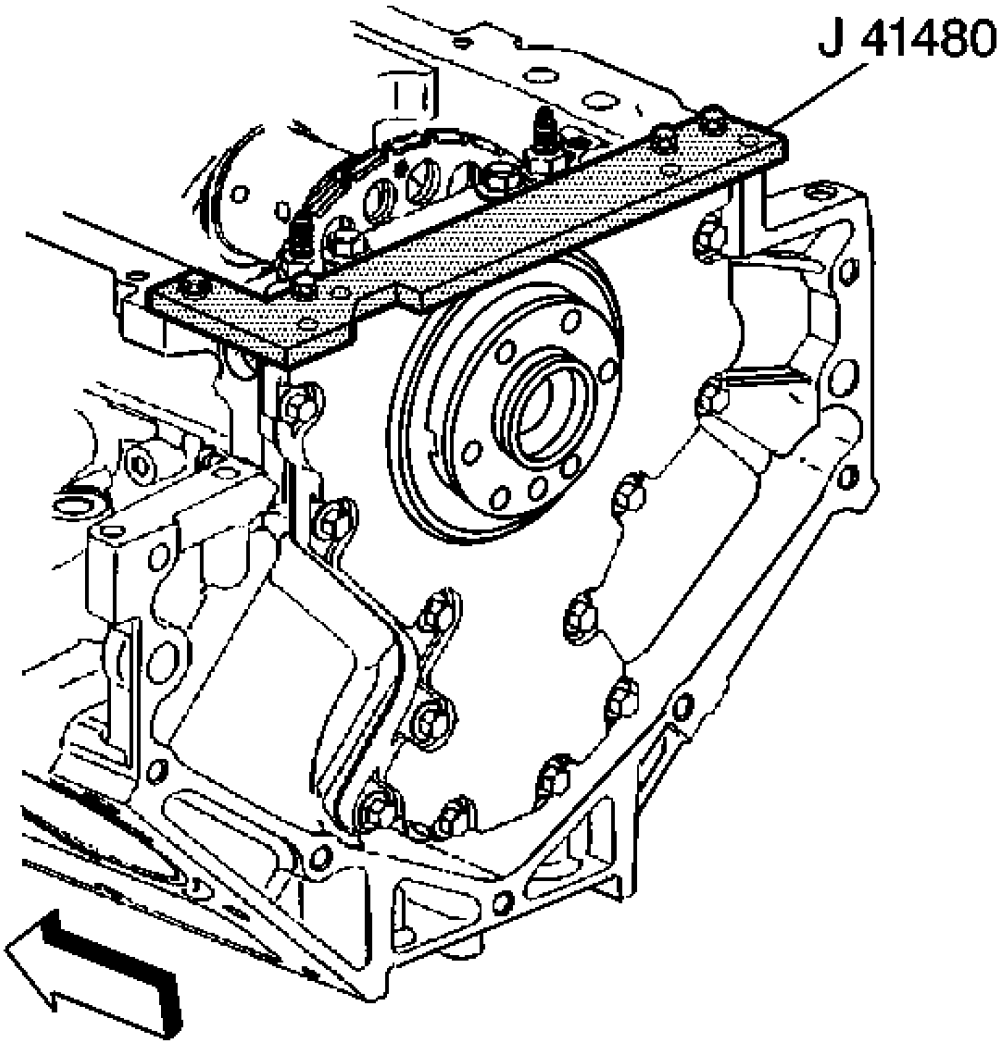


Fig. 169: View Of J 41480 Installed To Engine Block
Courtesy of GENERAL MOTORS CORP.

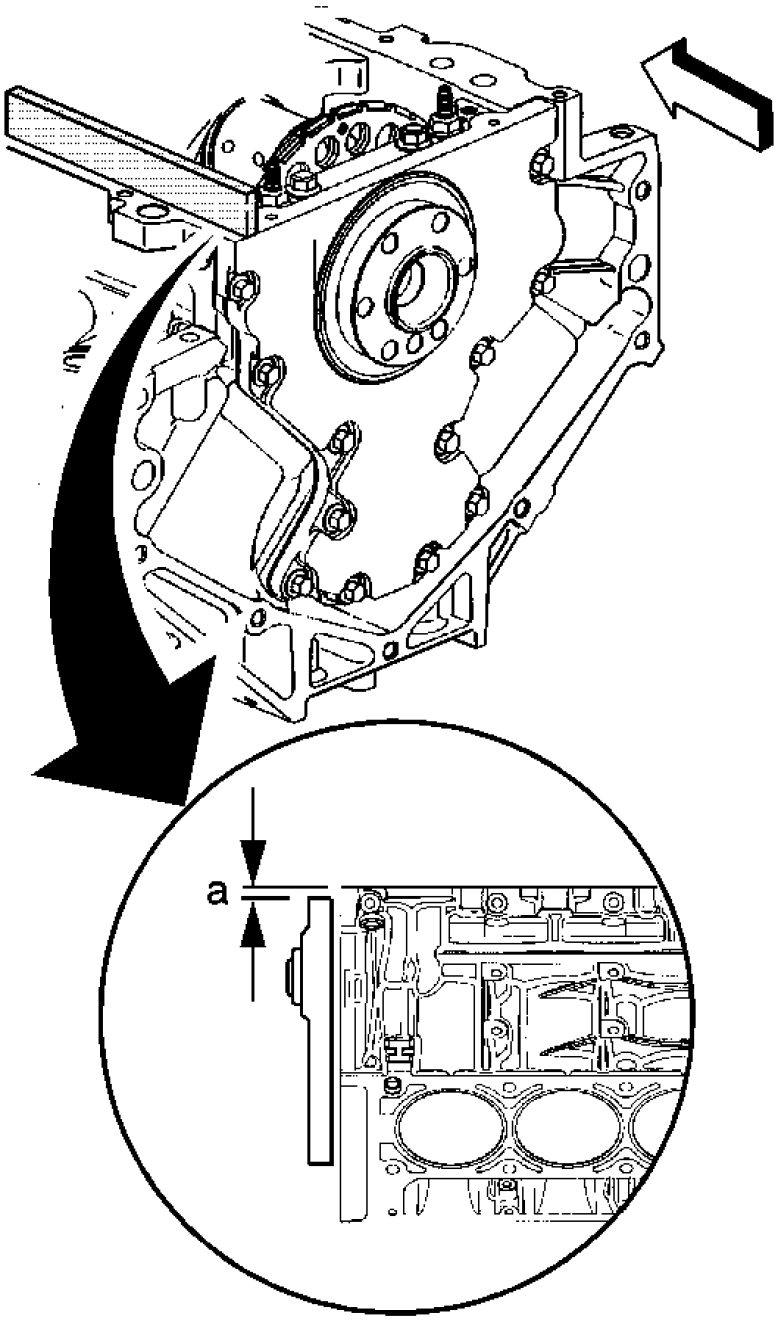
CAUTION: Refer to Fastener Caution .

8. Install the **J 41480:** cover alignment and bolts.
    1. Tighten the tool-to-engine block bolts to 25 N.m (18 lb ft) .

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2. Tighten the **J 41480:** cover alignment tool-to-rear housing bolts evenly to 12 N.m (106 lb in) .
3. Tighten the rear housing-to-engine block bolts to 30 N.m (22 lb ft) .

9. Remove the **J 41480:** cover alignment and bolts.



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Fig. 170: Checking Rear Cover-To-Engine Block For Proper Installation
Courtesy of GENERAL MOTORS CORP.

10. Measure the rear housing-to-engine block oil pan surface for flatness.
    1. Place a straight edge onto the engine block and rear housing oil pan sealing surfaces.

       Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

    2. Insert a feeler gauge between the rear housing and the straight edge. The housing must be flush with the oil pan or no greater than 0.3 mm (0.0118 in) below flush (a).
11. If the rear housing-to-engine block oil pan surface alignment is not within specifications, repeat the housing alignment procedure.
12. If the correct rear housing-to-engine block alignment at the oil pan surface cannot be obtained, replace the rear housing.

CRANKSHAFT REAR OIL SEAL INSTALLATION

Special Tools

- **J 41479:** Crankshaft Rear Oil Seal Installer
- **J 41479-2A:** Crankshaft Rear Oil Seal Installation Guide

For equivalent regional tools, refer to **Special Tools**

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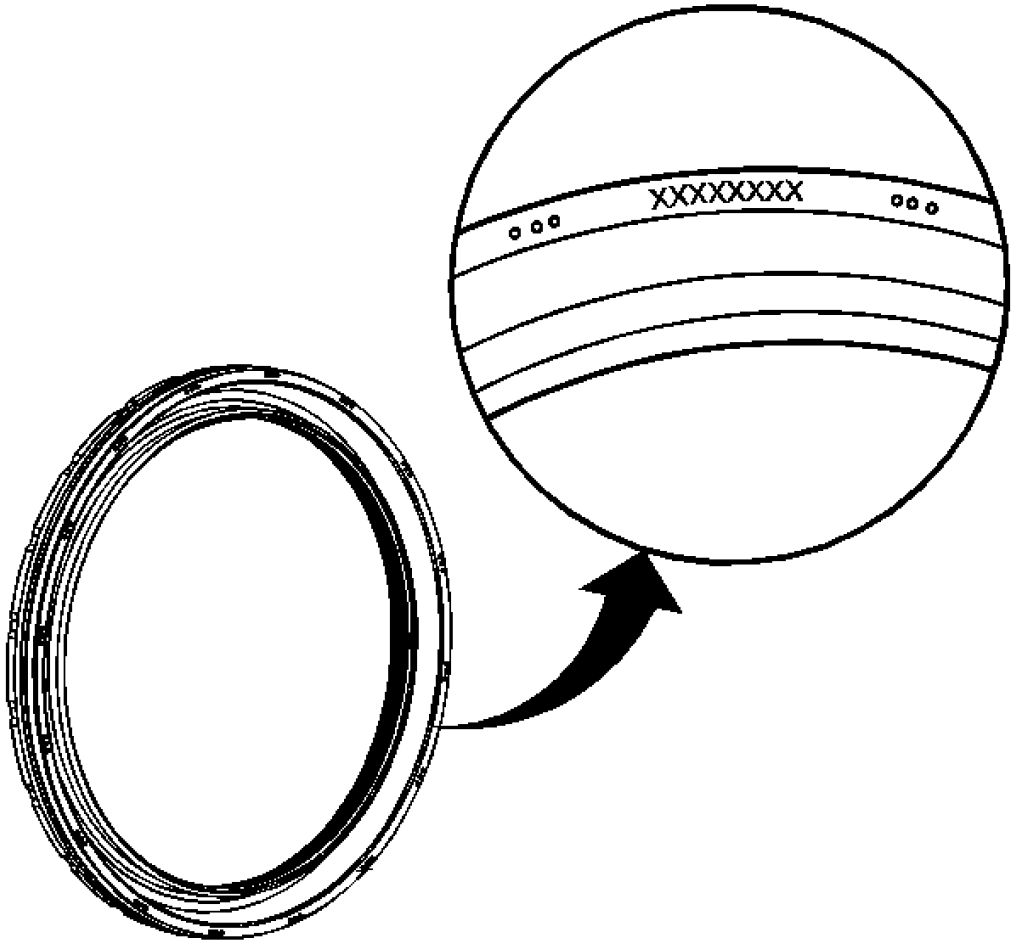


Fig. 171: Identifying Oil Seal
Courtesy of GENERAL MOTORS CORP.

NOTE: For proper orientation, note the installation direction of the oil seal. The oil seal is a reverse-lip design. The part number is applied to the outside face of the seal, as shown.

1. Inspect the seal and identify the part number markings for proper orientation.

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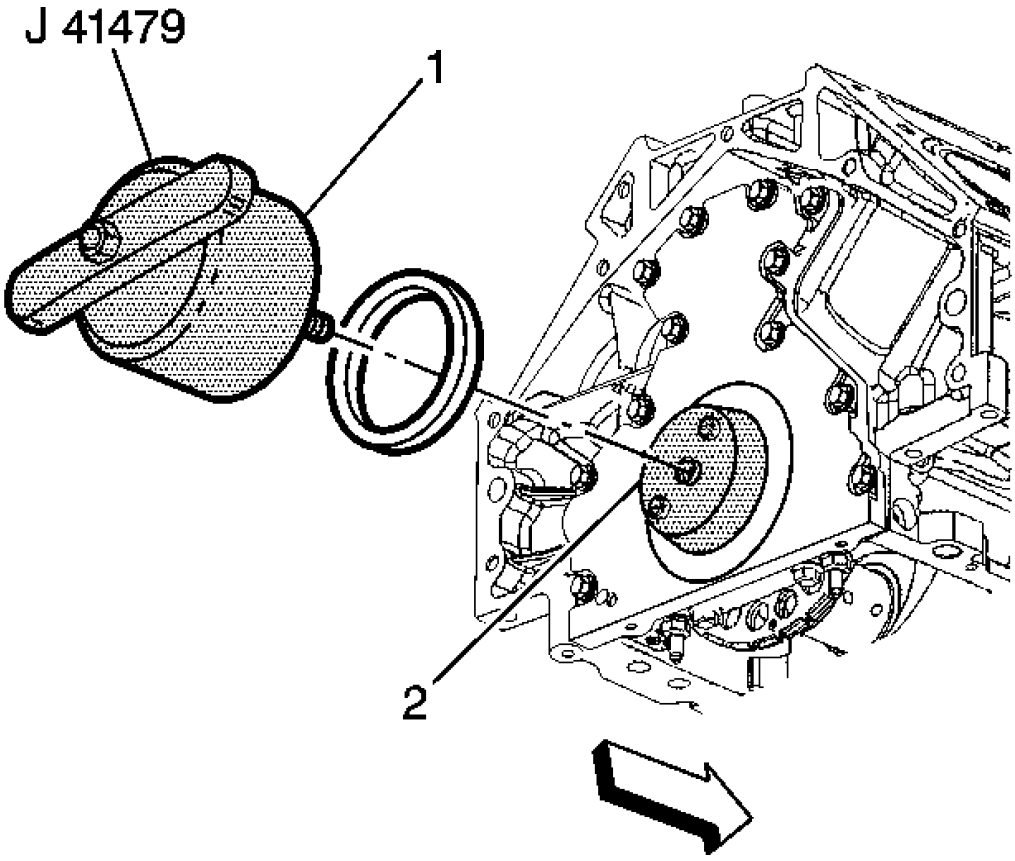


Fig. 172: Installing Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS CORP.

2. Install the **J 41479:** installer or the **J 41479-2A:** guide cone (2) and bolts onto the rear of the crankshaft. The **J 41479-2A:** guide may be required for manual transmission or 5.3L LS4 applications.
3. Tighten the bolts until snug. Do not overtighten.
4. Install the rear oil seal onto the tapered cone (2) and push the seal to the rear seal bore. Install the oil seal with the part number markings facing away from the engine.
5. Thread the **J 41479:** installer threaded rod into the tapered cone until the tool (1) contacts the oil seal.
6. Align the oil seal onto the tool (1).
7. Rotate the handle of the tool (1) clockwise until the seal enters the rear housing and bottoms into the seal bore.
8. Remove the tool.

ENGINE FRONT COVER INSTALLATION (WITHOUT CAMSHAFT POSITION

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ACTUATOR)

Special Tools

- **EN-48853:** Front Cover Alignment Tool
- **J 41480:** Front and Rear Cover Alignment

For equivalent regional tools, refer to **Special Tools** .

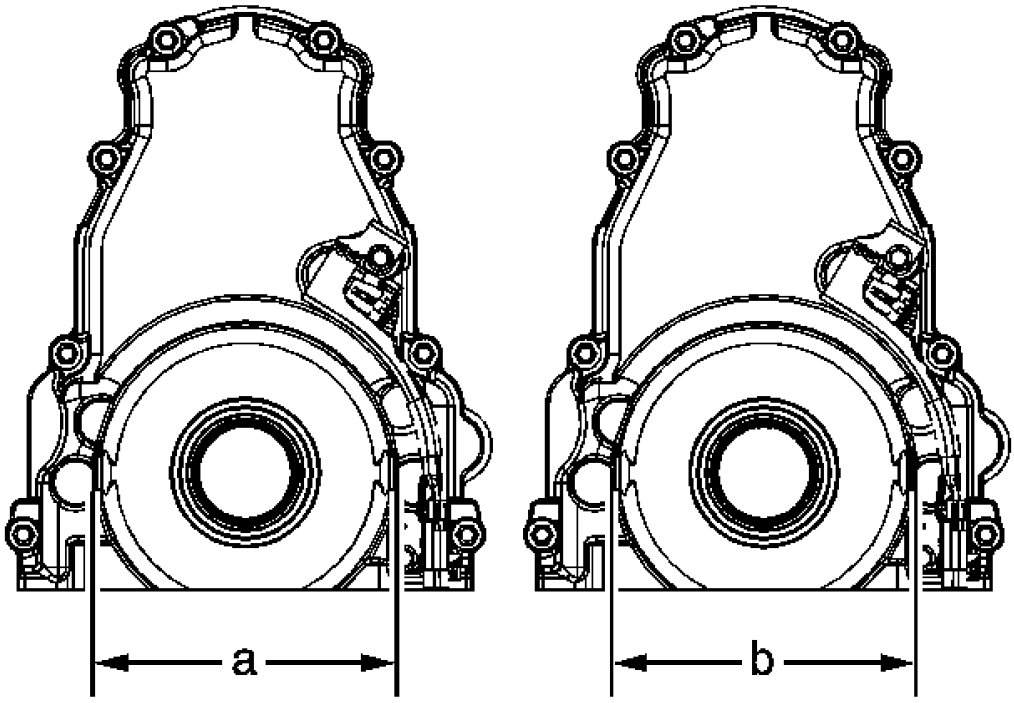


Fig. 173: Identifying Alignment Tab Distance On Front Cover
Courtesy of GENERAL MOTORS CORP.

1. Measure the alignment tab distance on the front cover.

   The engine front cover may have either a 141 mm (5.55 in) dimension (a) or 159 mm (6.26 in) dimension (b) alignment tab distance. Front cover alignment tool **EN-48853:** alignment tool is designed to properly align both front covers. For the 141 mm (5.55 in) cover, adapters EN-48853-2 must be used.

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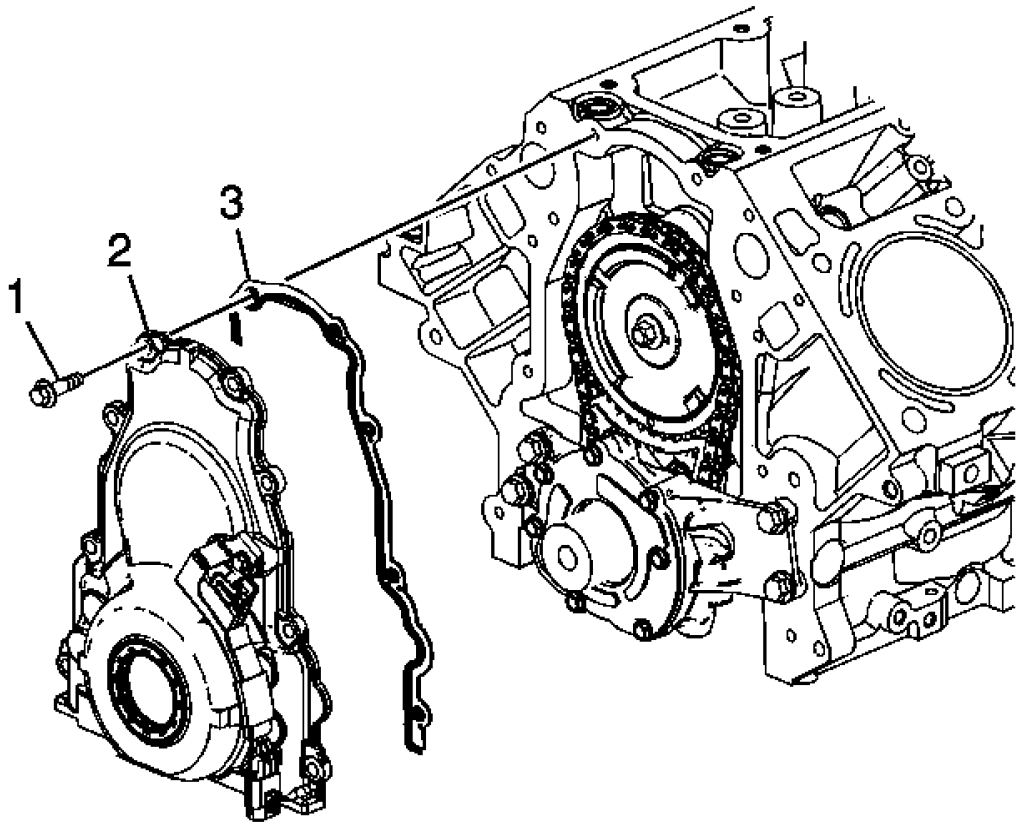


Fig. 174: View Of Front Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE:

- **Do not use the crankshaft oil seal or the engine front cover gasket again.**
- **Do not apply any type of sealant to the front cover gasket, unless specified.**
- **The special tools in this procedure are used to properly align the engine front cover at the oil pan surface and to center the crankshaft front oil seal.**
  - **All gasket surfaces should be free of oil or other foreign material during assembly.**

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The crankshaft front oil seal MUST be centered in relation to the crankshaft.

- **The oil pan sealing surface at the front cover and engine block MUST be aligned within specifications.**
- **An improperly aligned front cover may cause premature front oil seal wear and/or engine assembly oil leaks.**

2. Install the front cover gasket (3), front cover (2), and bolts (1).
3. Tighten the cover bolts finger tight. Do not overtighten.

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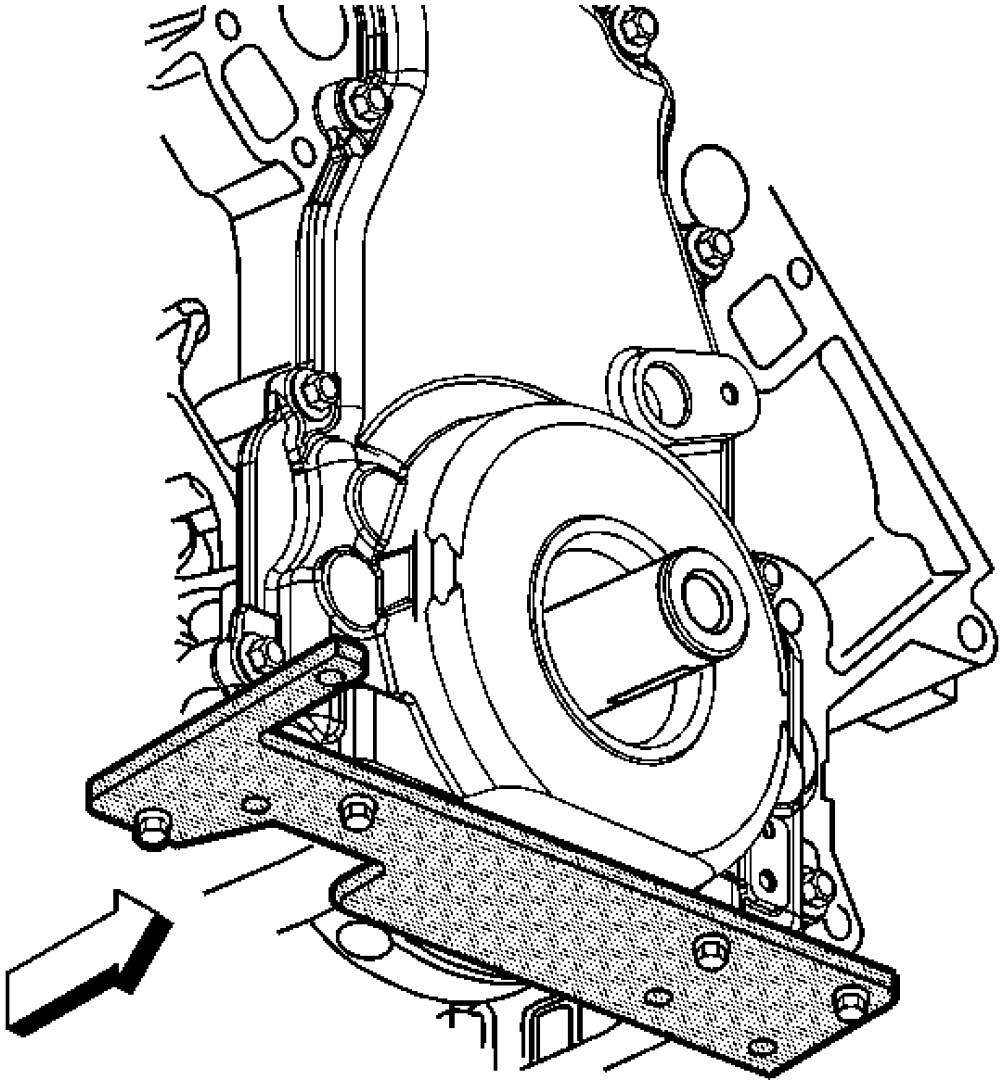


Fig. 175: Installing J 41480
Courtesy of GENERAL MOTORS CORP.

NOTE: Start the tool-to-front cover bolts. Do not tighten the bolts at this time.

4. Install the **J 41480:** cover alignment and tighten the tool-to-engine block bolts to 25 N.m (18 lb ft).

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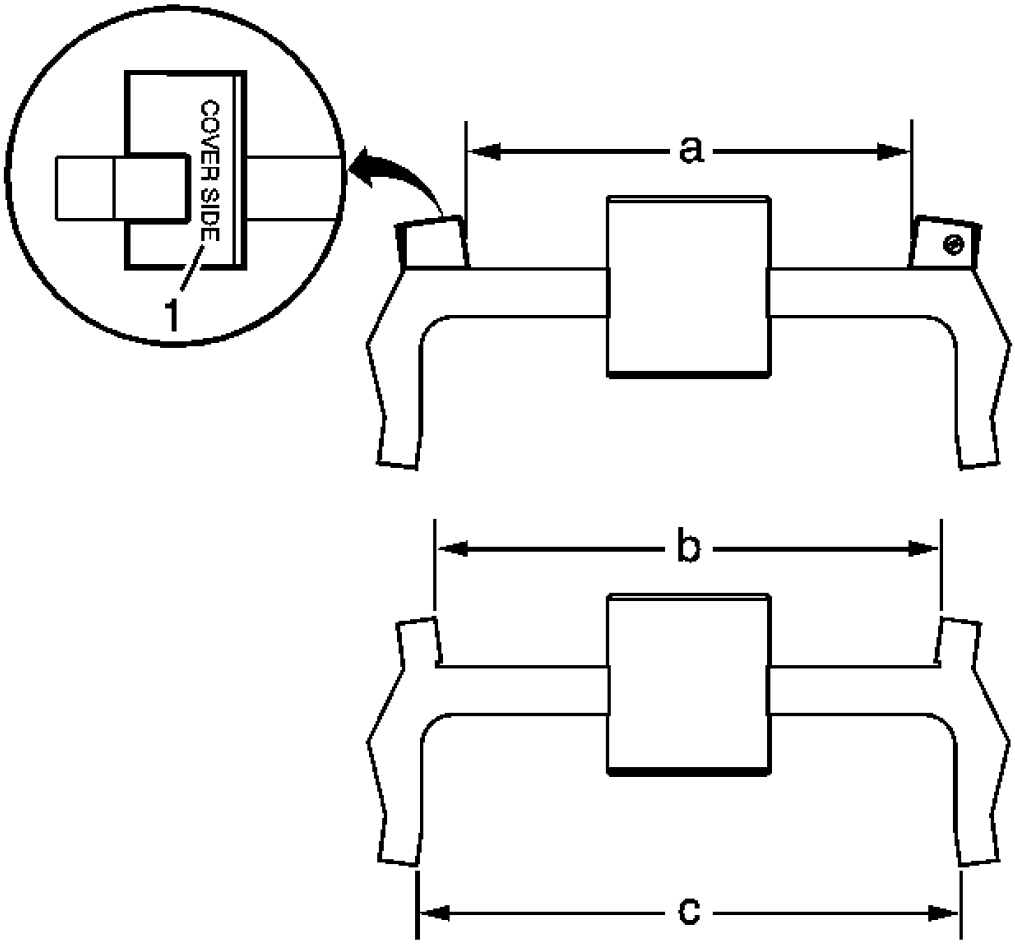


Fig. 176: Installing EN 48853-2 Adapters
Courtesy of GENERAL MOTORS CORP.

5. Install the EN-48853-2 adapters as required for usage on the 141 mm (5.55 in) dimension (a) front cover. Position the adapters against the legs of the **EN-48853:** tool with the words "cover side" (1) facing away from the tool.

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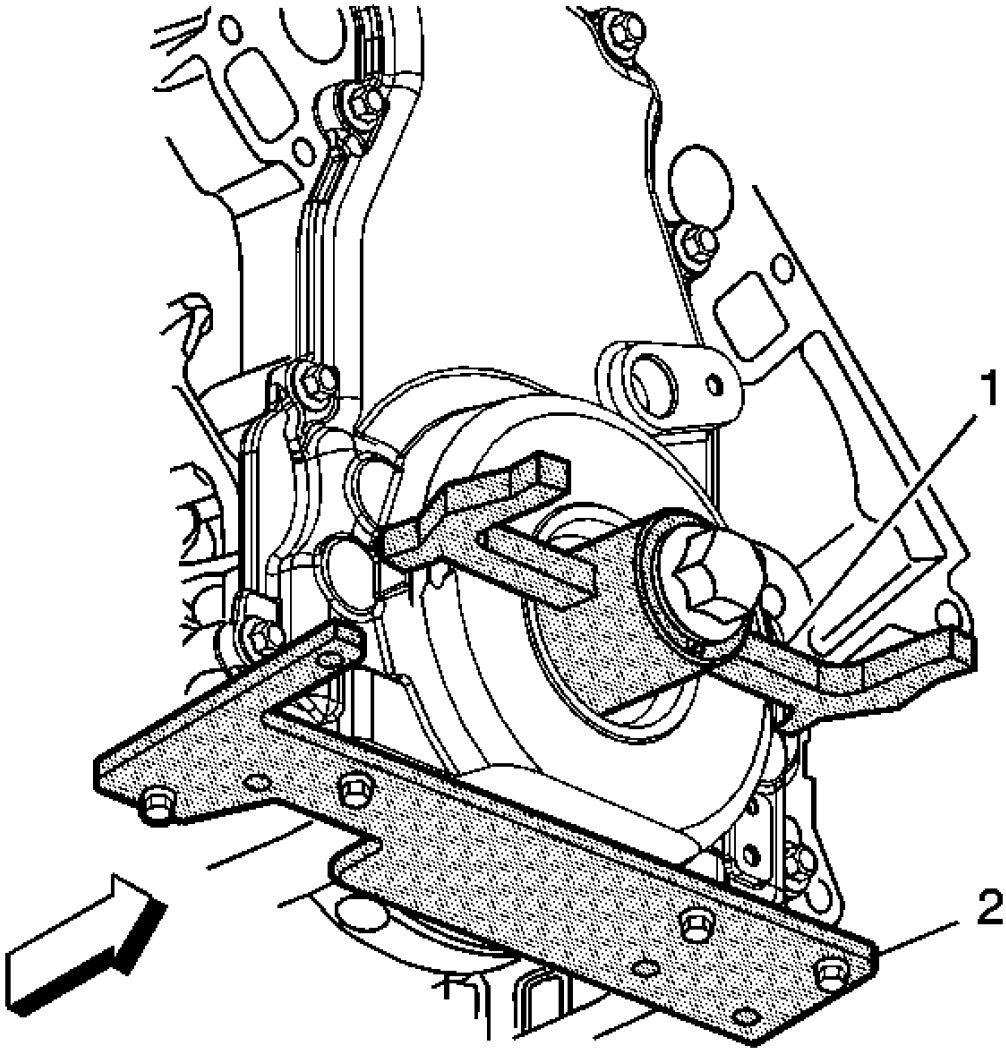


Fig. 177: View Of EN-48853 & J 41480
Courtesy of GENERAL MOTORS CORP.

NOTE: Align the tapered legs of the tool with the machined alignment surfaces on the front cover.

6. Install the **EN-48853:** alignment tool (1).
7. Install the crankshaft balancer bolt.
8. Tighten the crankshaft balancer bolt by hand until snug. Do not overtighten.
9. Tighten the **J 41480:** cover alignment (2).

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10. Tighten the engine front cover bolts to 25 N.m (18 lb ft).
11. Remove the tools.

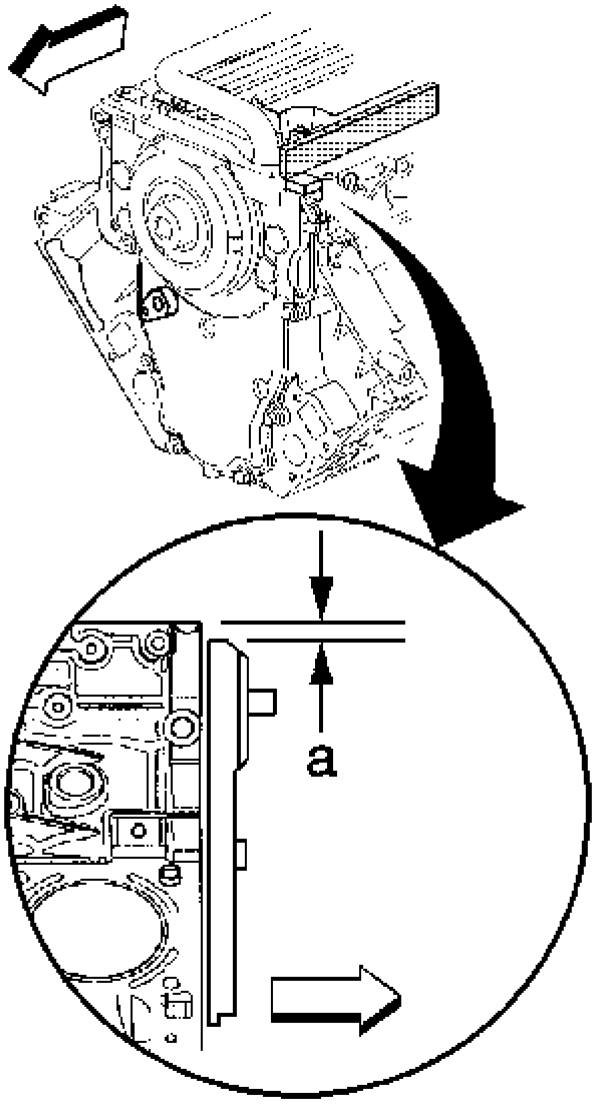


Fig. 178: Measuring Oil Pan Surface Flatness & Front Cover-To-Engine Block
Courtesy of GENERAL MOTORS CORP.

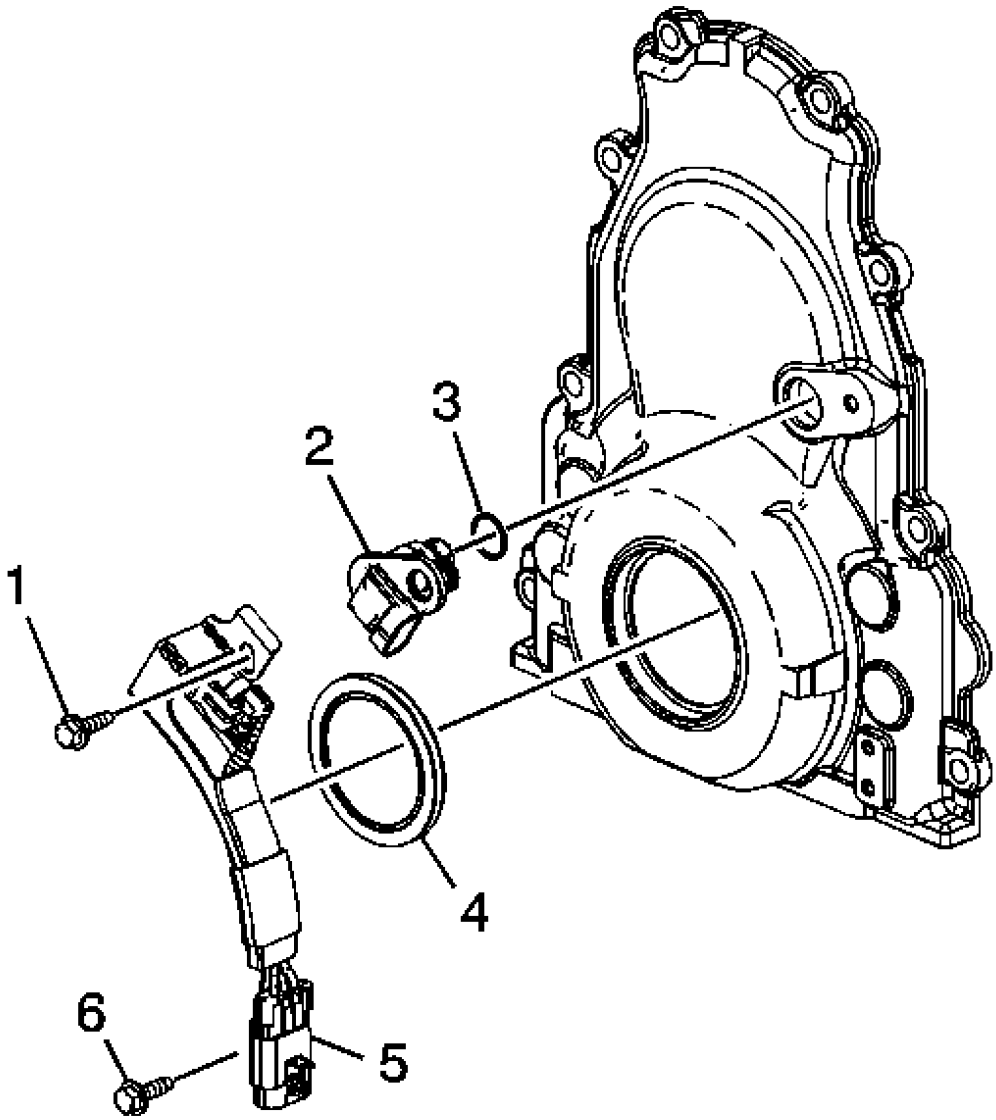
12. Measure the oil pan surface flatness, front cover-to-engine block.
    1. Place a straight edge across the engine block and front cover oil pan sealing surfaces.

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Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

2. Insert a feeler gauge between the front cover and the straight edge tool. The cover must be flush with the oil pan surface or no greater than 0.3 mm (0.0118 in) (a) below flush.

13. If the front cover-to-engine block oil pan surface alignment is not within specifications, repeat the cover alignment procedure.
14. If the correct front cover-to-engine block alignment cannot be obtained, replace the front cover.



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Fig. 179: View Of Front Cover, Oil Seal, Camshaft Position Sensor, Bracket & O Ring
Courtesy of GENERAL MOTORS CORP.

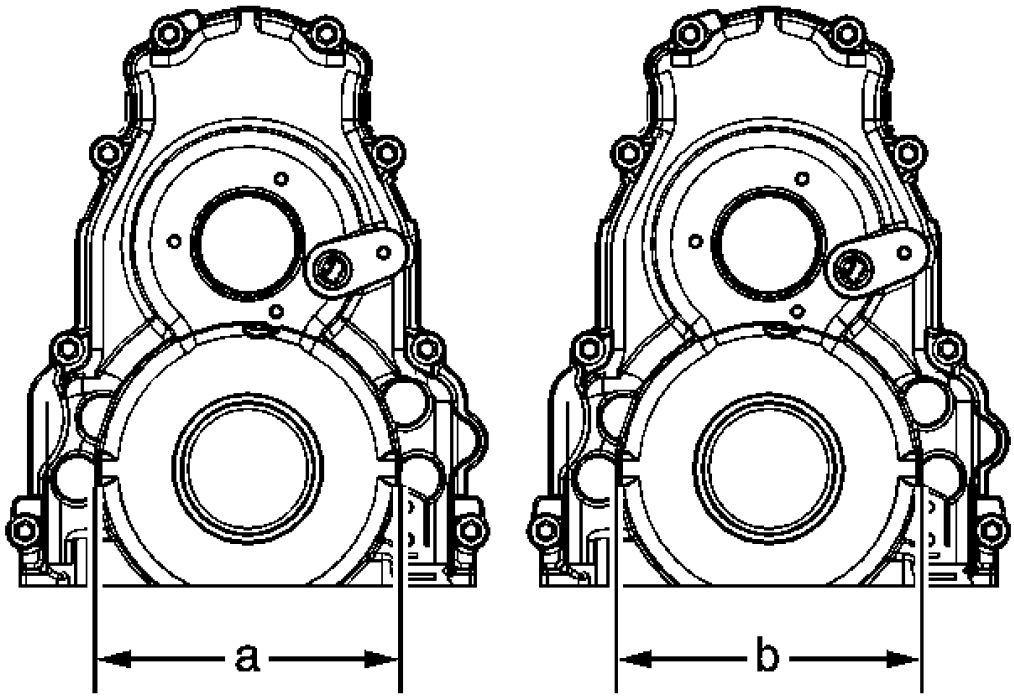
15. Inspect the camshaft position (CMP) sensor O-ring seal (3) for cuts or damage. If the seal is not cut or damaged, it may be used again.
16. Lubricate the O-ring seal with clean engine oil.
17. Install the O-ring seal onto the sensor (2).
18. Install the sensor to the cover.
19. Install the CMP sensor wire harness (5) and bolts (1, 6). Tighten the bolts to 12 N.m (106 lb in).

ENGINE FRONT COVER INSTALLATION (WITH CAMSHAFT POSTITION ACTUATOR)

Special Tools

- **EN-48853:** Front Cover Alignment Tool
- **J 41480:** Front and Rear Cover Alignment

For equivalent regional tools, refer to **Special Tools**



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Fig. 180: Identifying Alignment Tab Distance On Front Cover
Courtesy of GENERAL MOTORS CORP.

1. Measure the alignment tab distance on the front cover.

   The engine front cover may have either a 141 mm (5.55 in) dimension (a) or 159 mm (6.26 in) dimension (b) alignment tab distance. Front cover alignment tool **EN-48853:** tool is designed to properly align both design front covers. For the 141 mm (5.55 in) cover, adapters EN 48853-2 must be used.

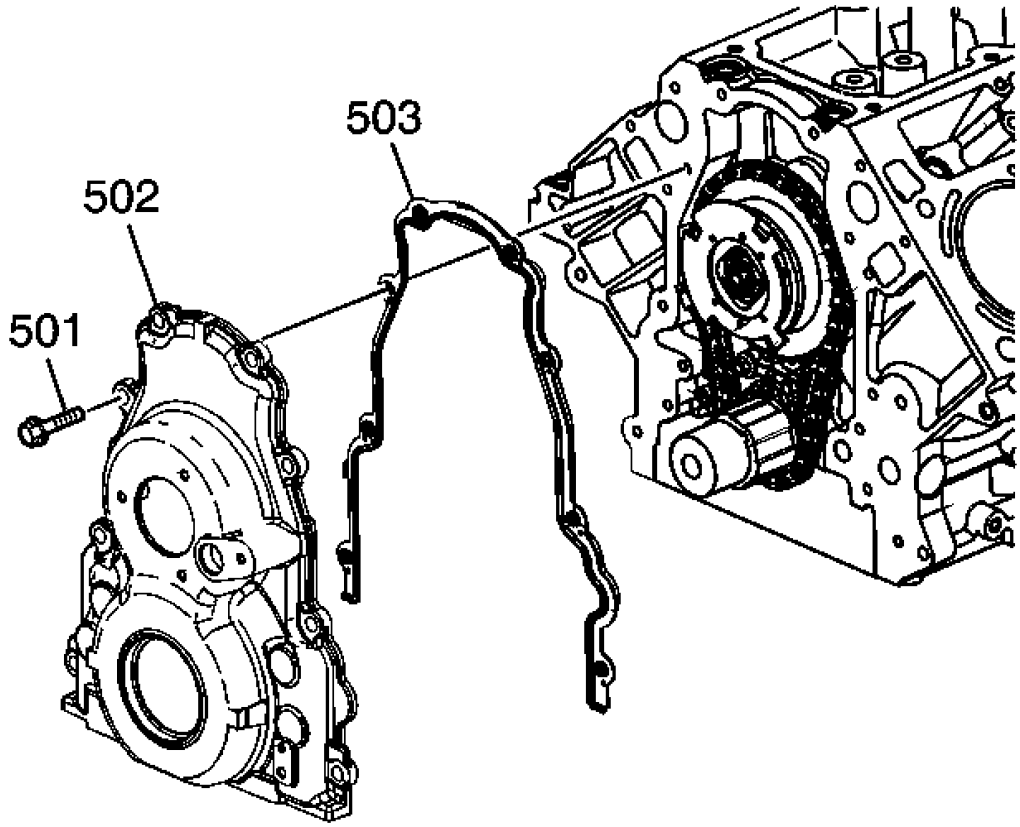


Fig. 181: Engine Front Cover Components
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE:

- **Do not use the crankshaft oil seal or the engine front cover gasket**

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again.

- **Do not apply any type of sealant to the front cover gasket, unless specified.**
- **The special tools in this procedure are used to properly align the engine front cover at the oil pan surface and to center the crankshaft front oil seal.**
  - **All gasket surfaces should be free of oil or other foreign material during assembly.**

    The crankshaft front oil seal MUST be centered in relation to the crankshaft.

  - **The oil pan sealing surface at the front cover and engine block MUST be aligned within specifications.**
  - **An improperly aligned front cover may cause premature front oil seal wear and/or engine assembly oil leaks.**

2. Install the front cover gasket (503), front cover (502), and bolts (501).
3. Tighten the cover bolts finger tight. Do not overtighten.

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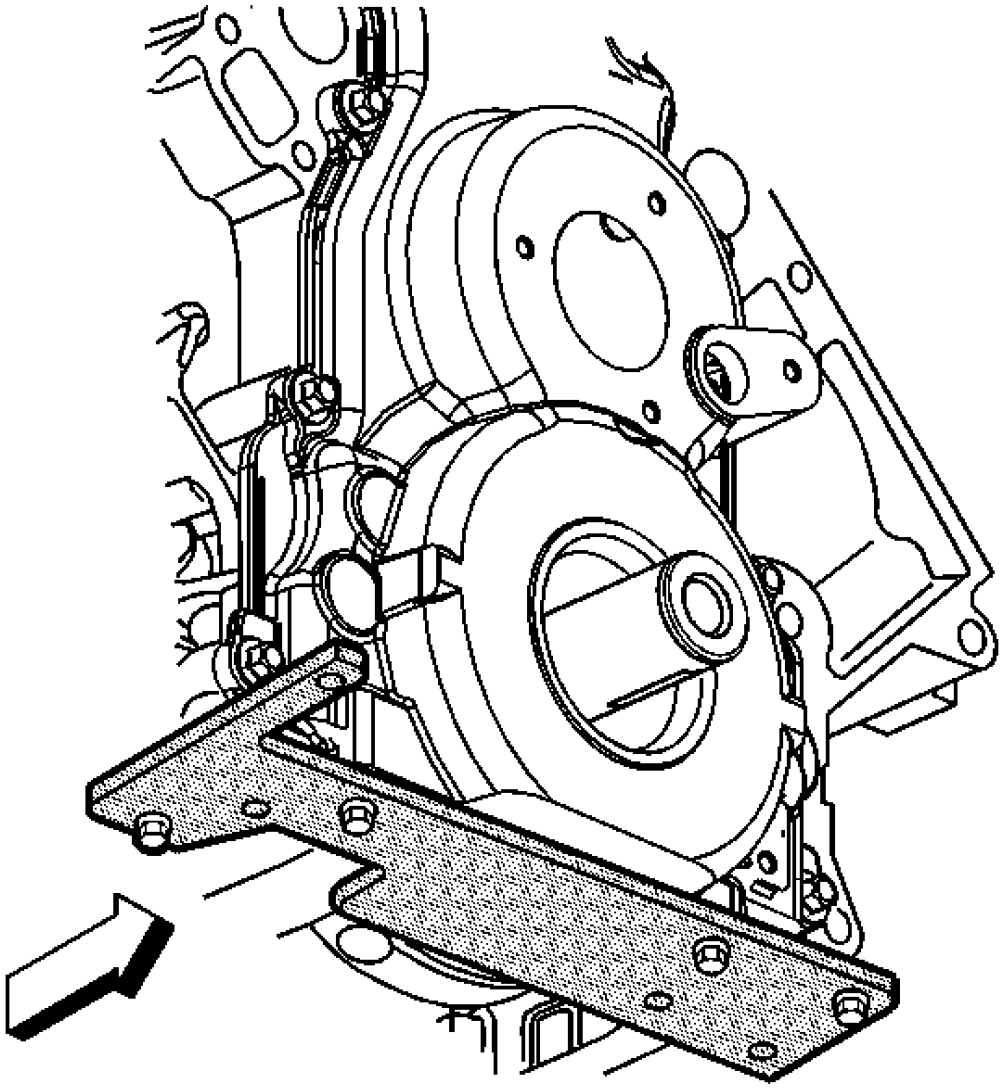


Fig. 182: Aligning Front Cover Using Special Tool J 41480
Courtesy of GENERAL MOTORS CORP.

NOTE: Start the tool-to-front cover bolts. Do not tighten the bolts at this time.

4. Install the **J 41480:** alignment and tighten to 25 N.m (18 lb ft).

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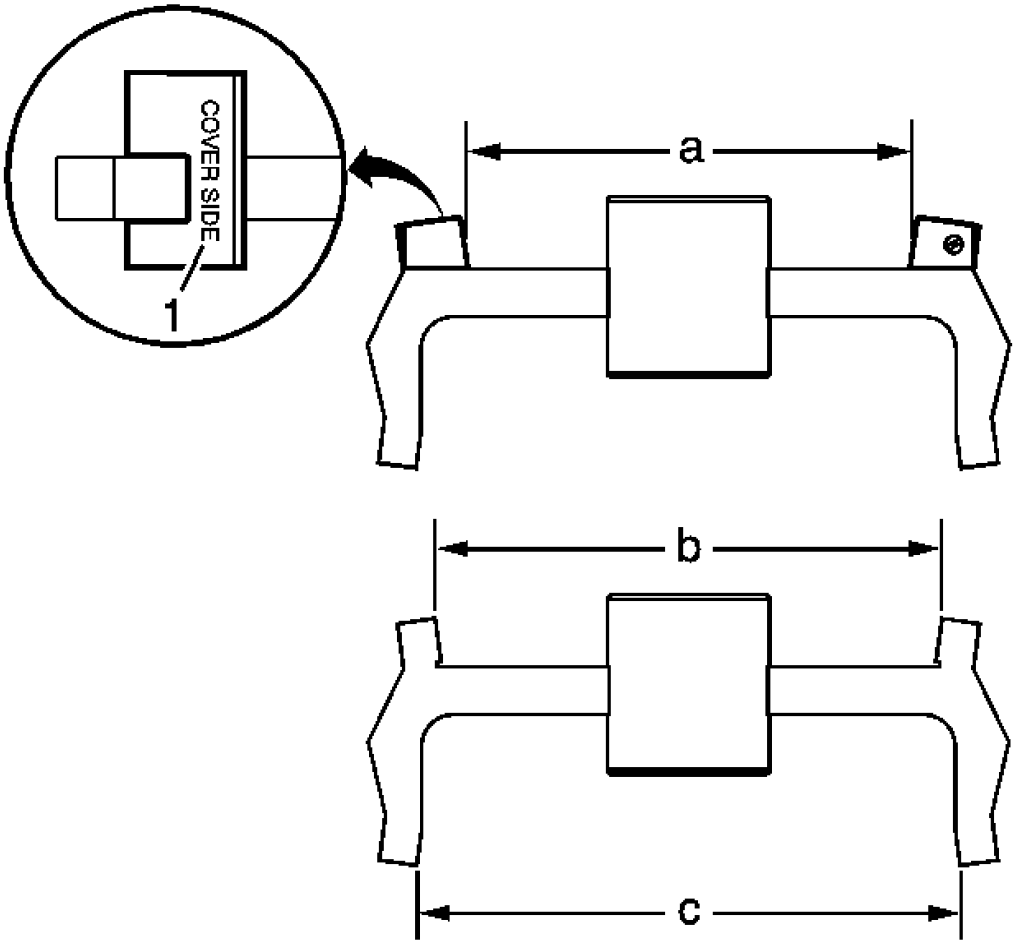


Fig. 183: Installing EN 48853-2 Adapters
Courtesy of GENERAL MOTORS CORP.

5. Install the EN 48853-2 adapters as required for usage on the 141 mm (5.55 in) dimension (a) front cover. Position the adapters against the legs of the **EN-48853:** tool with the words "cover side" (1) facing away from the tool.

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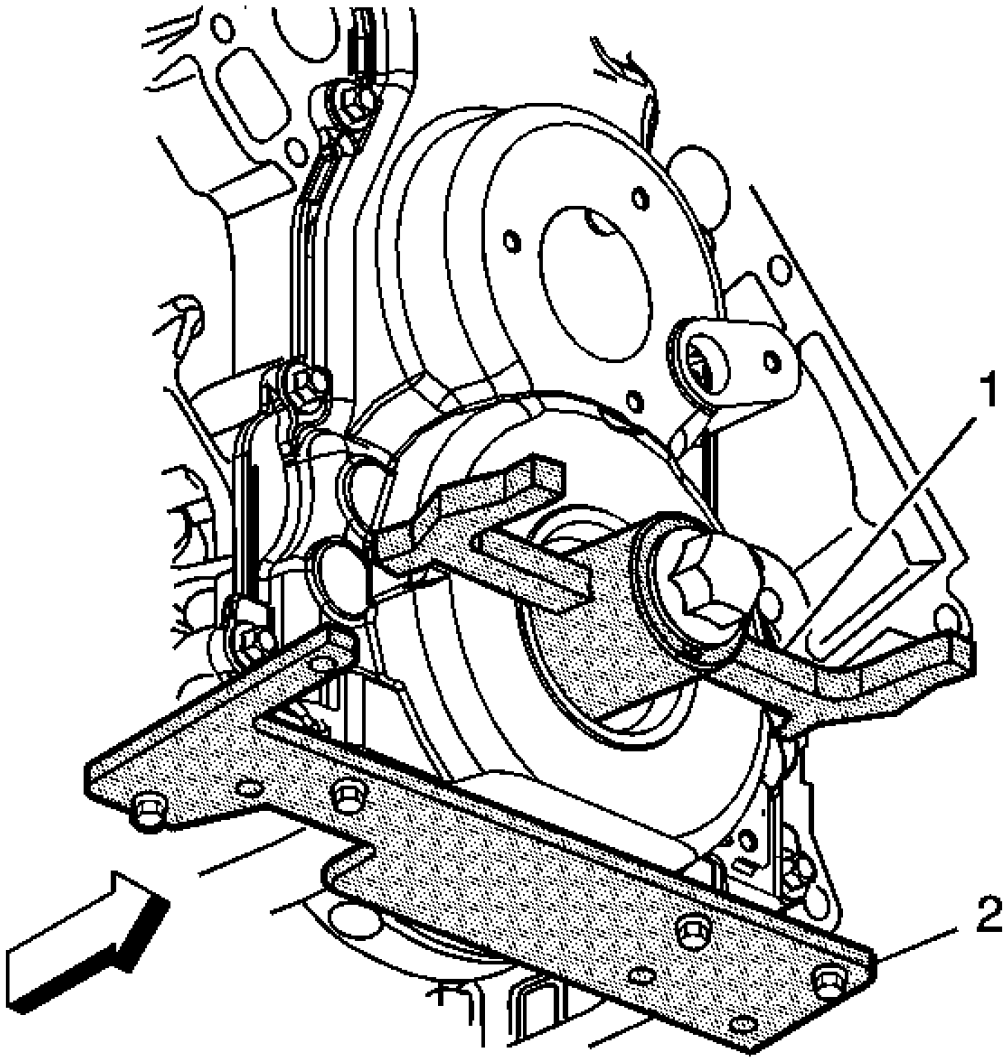


Fig. 184: View Of Special Tool EN-48853
Courtesy of GENERAL MOTORS CORP.

NOTE: Align the tapered legs of the tool with the machined alignment surfaces on the front cover.

6. Install the **EN-48853:** tool (1).
7. Install the crankshaft balancer bolt.
    1. Tighten the crankshaft balancer bolt by hand until snug. Do not overtighten.

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2. Tighten the **J 41480:** alignment (2) .
3. Tighten the engine front cover bolts to 25 N.m (18 lb ft) .

8. Remove the tools.

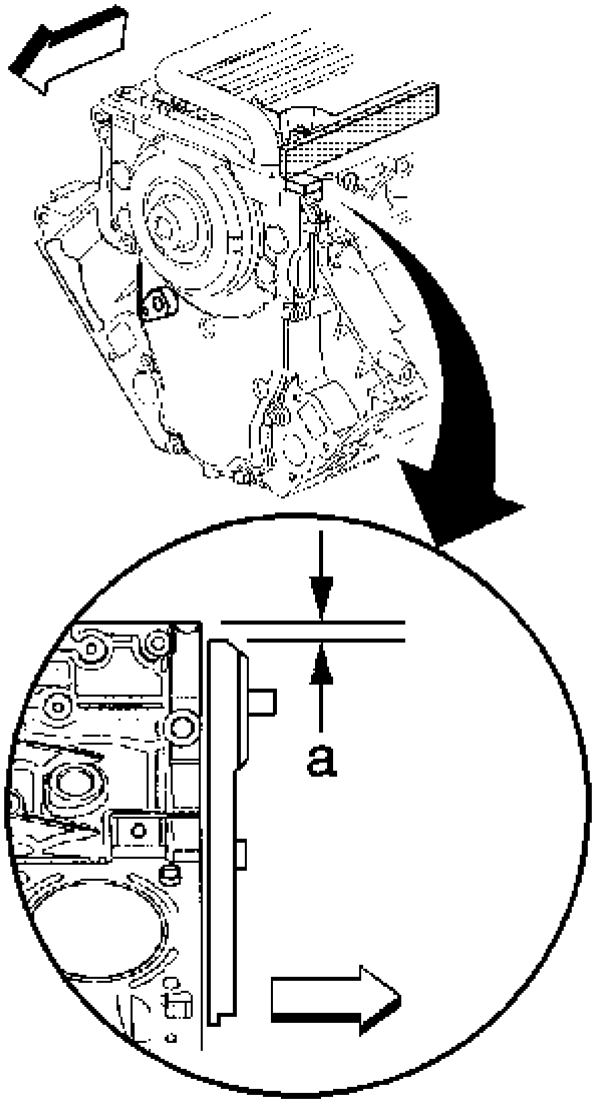


Fig. 185: Measuring Oil Pan Surface Flatness & Front Cover-To-Engine Block
Courtesy of GENERAL MOTORS CORP.

9. Measure the oil pan surface flatness, front cover-to-engine block.

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1. Place a straight edge across the engine block and front cover oil pan sealing surfaces.

   Avoid contact with the portion of the gasket that protrudes into the oil pan surface.

2. Insert a feeler gauge between the front cover and the straight edge tool. The cover must be flush with the oil pan surface or no greater than 0.3 mm (0.0118 in) (a) below flush.

10. If the front cover-to-engine block oil pan surface alignment is not within specifications, repeat the cover alignment procedure.
11. If the correct front cover-to-engine block alignment cannot be obtained, replace the front cover.

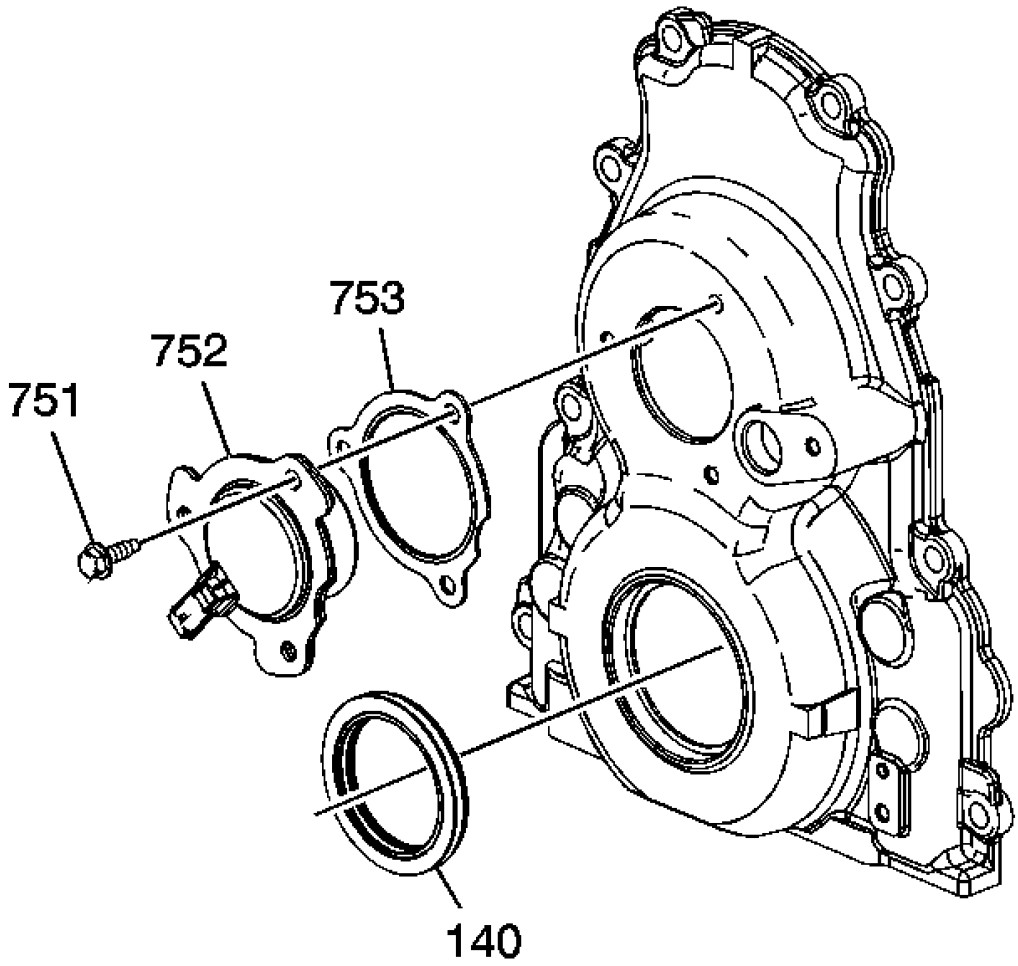


Fig. 186: View Of CMP Actuator Magnet, Bolts, Gasket & Oil Seal
Courtesy of GENERAL MOTORS CORP.

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12. Install the camshaft position (CMP) actuator magnet (752), gasket (753), and bolts (751). Tighten the bolts to 12 N.m (106 lb in).

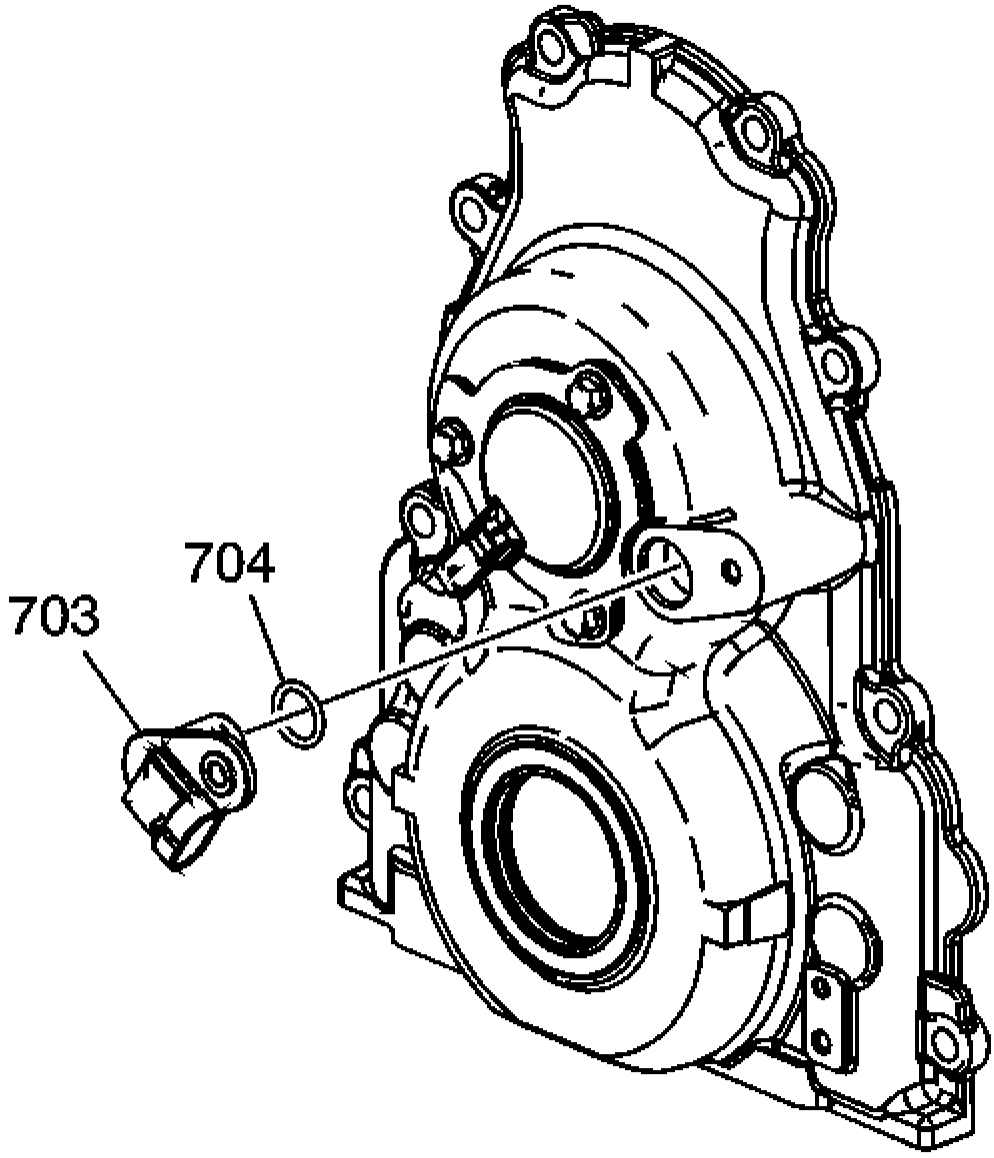


Fig. 187: View Of CMP Sensor & O-Ring
Courtesy of GENERAL MOTORS CORP.

13. Install the CMP sensor (703) and O-ring (704).

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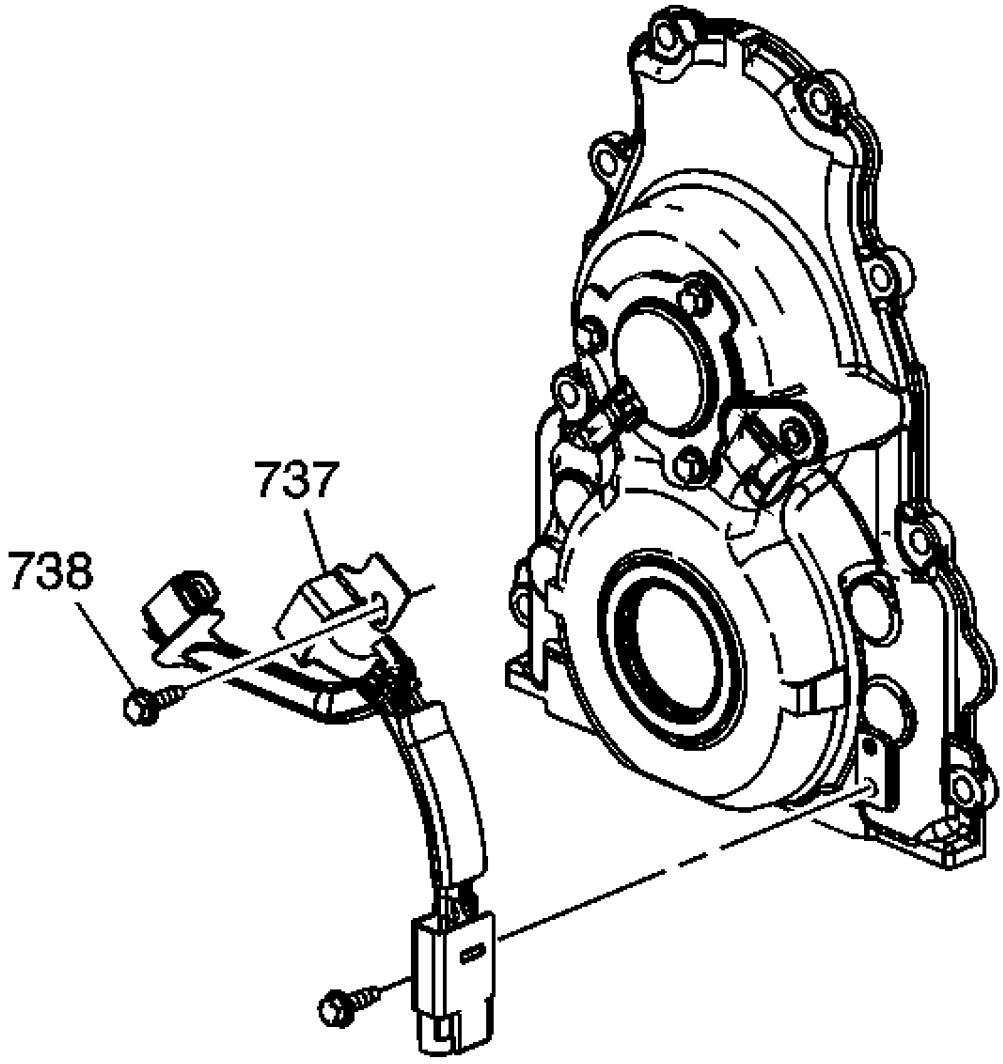


Fig. 188: View Of CMP Sensor Wire Harness & Bolts
Courtesy of GENERAL MOTORS CORP.

14. Install the CMP sensor wire harness (737) and bolts (738). Tighten the bolts to 12 N.m (106 lb in).

CRANKSHAFT FRONT OIL SEAL INSTALLATION

Special Tools

J 41478: Crankshaft Front Oil Seal Installer

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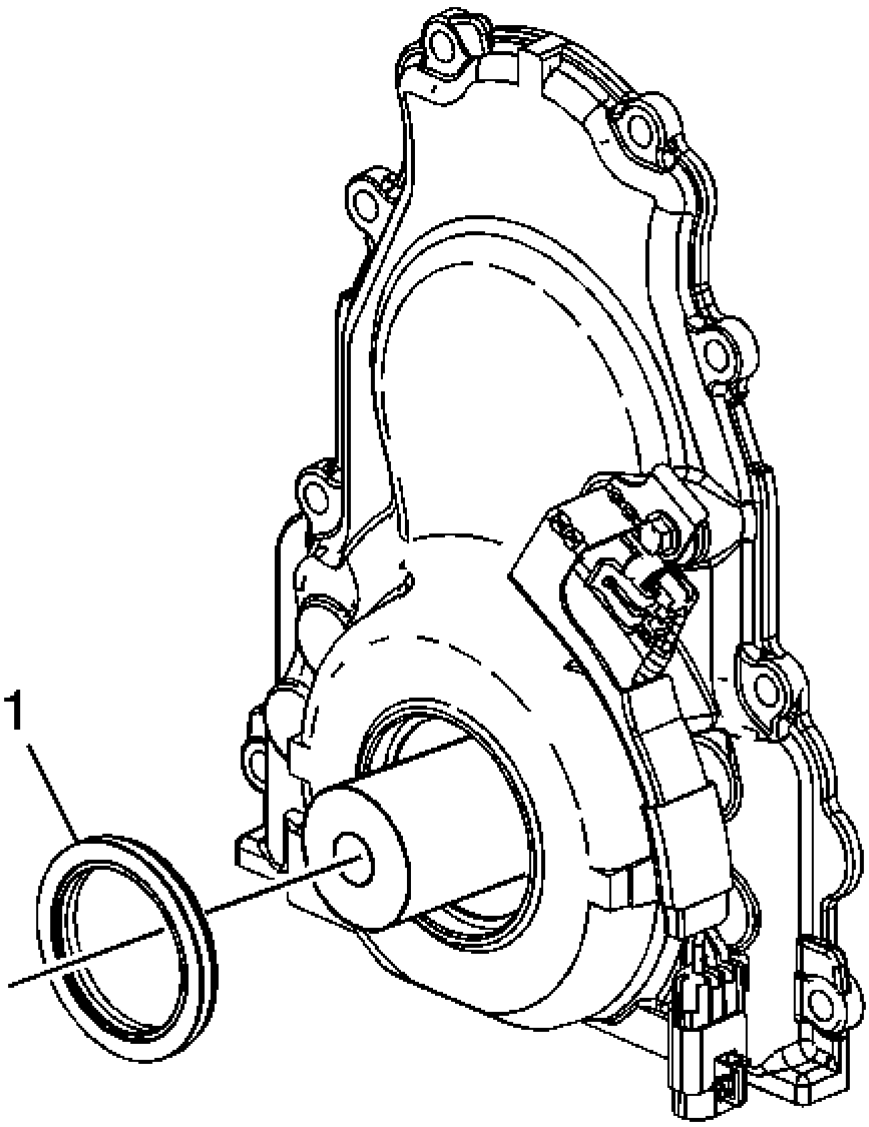


Fig. 189: View Of Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Do not lubricate the oil seal sealing surface.**
- **Do not use the crankshaft front oil seal again.**

1. Lubricate the outer edge of the oil seal (1) with clean engine oil.

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2. Lubricate the front cover oil seal bore with clean engine oil.

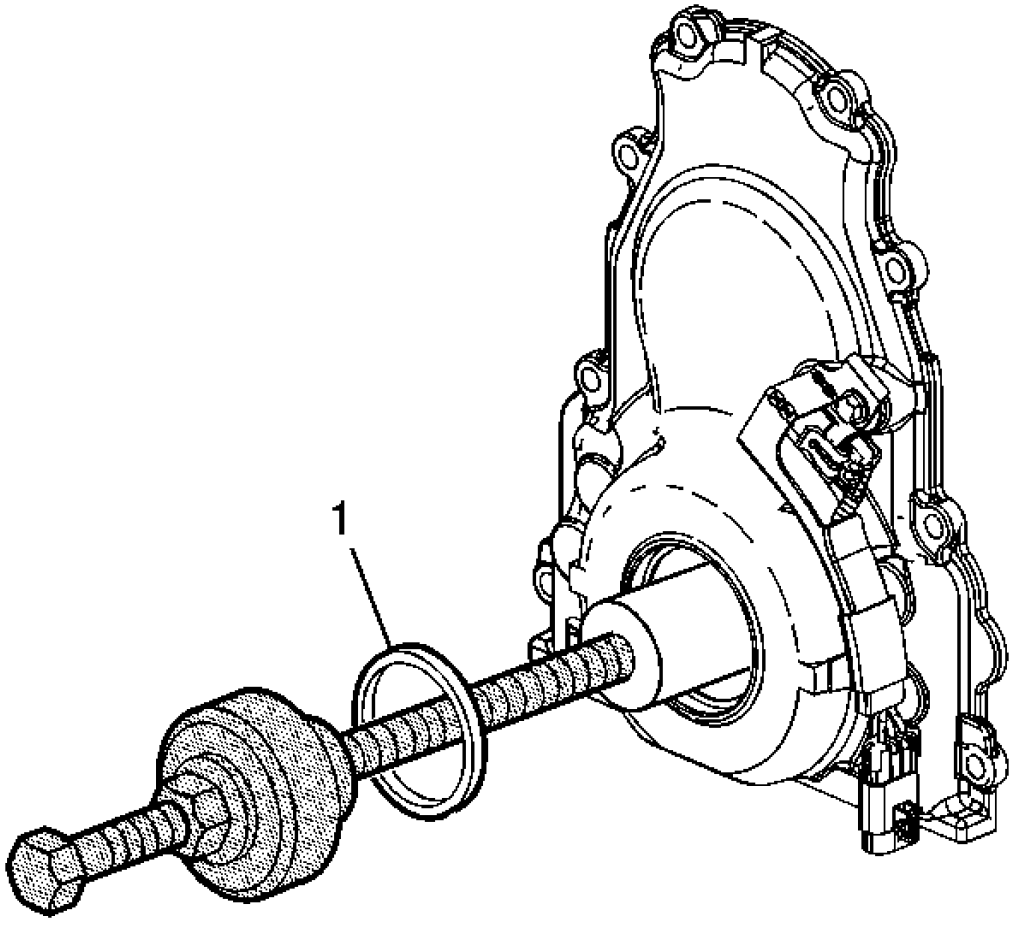


Fig. 190: View Of Crankshaft Front Oil Seal Installation
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft front oil seal (1) onto the **J 41478:** seal installer.
4. Install the **J 41478:** seal installer threaded rod, with nut, washer, guide, and oil seal, into the end of the crankshaft.
5. Use the **J 41478:** seal installer in order to install the oil seal into the cover bore.
    1. Use a wrench and hold the hex on the installer bolt.
    2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in the cover bore.
    3. Remove the tool.
    4. Inspect the oil seal for proper installation. The oil seal should be installed evenly and completely

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into the front cover bore.

OIL PAN INSTALLATION

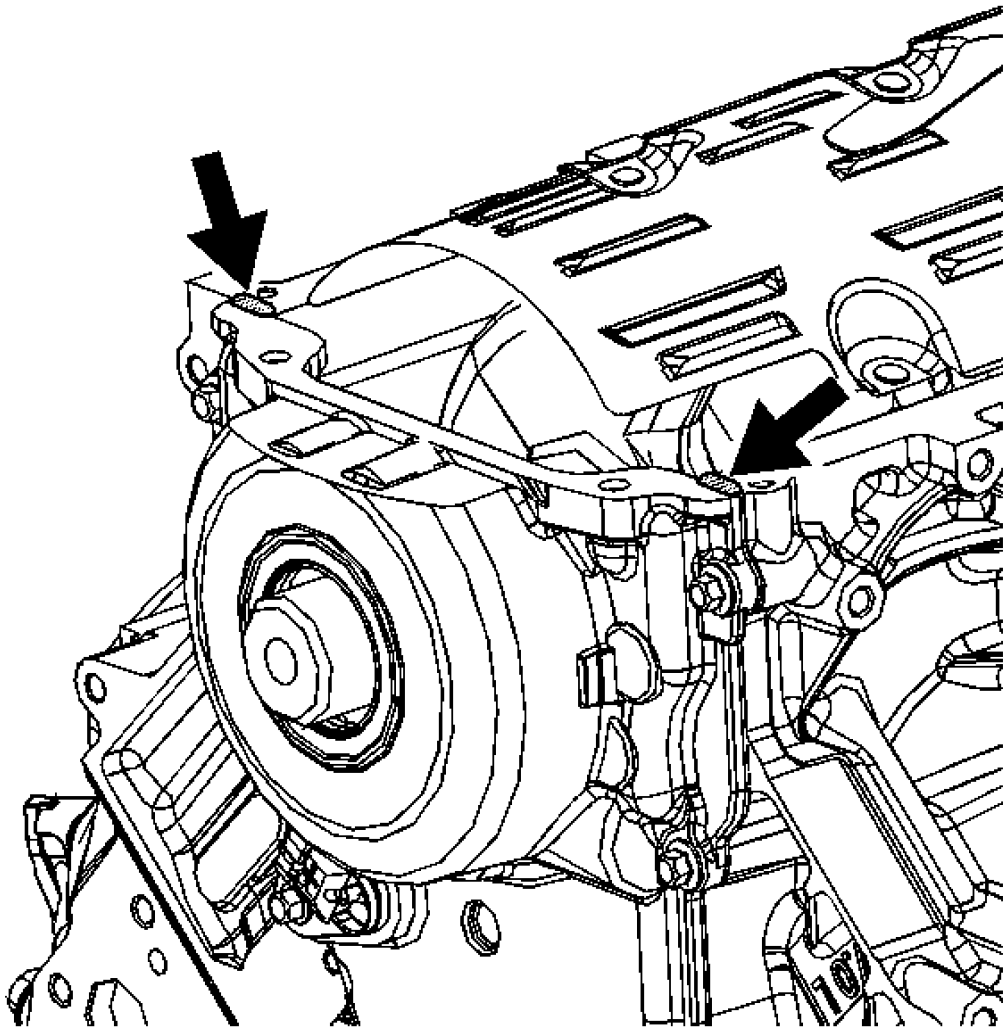


Fig. 191: Sealant Application Areas
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission housing. To ensure the rigidity of the powertrain and correct transmission alignment, it is important that the rear of the block and**

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the rear of the oil pan are flush, or even. The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing plane.

- **Do not use the oil pan gasket again.**
- **It is not necessary to rivet the NEW gasket to the oil pan.**

1. Install the baffle, as required. Refer to **Oil Pan Cleaning and Inspection**.
2. Apply a 5 mm (0.2 in) bead of sealant GM P/N 12378521 (Canadian P/N 88901148), or equivalent, 20 mm (0.8 in) long to the engine block. Apply the sealant directly onto the tabs of the front cover gasket that protrude into the oil pan surface. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

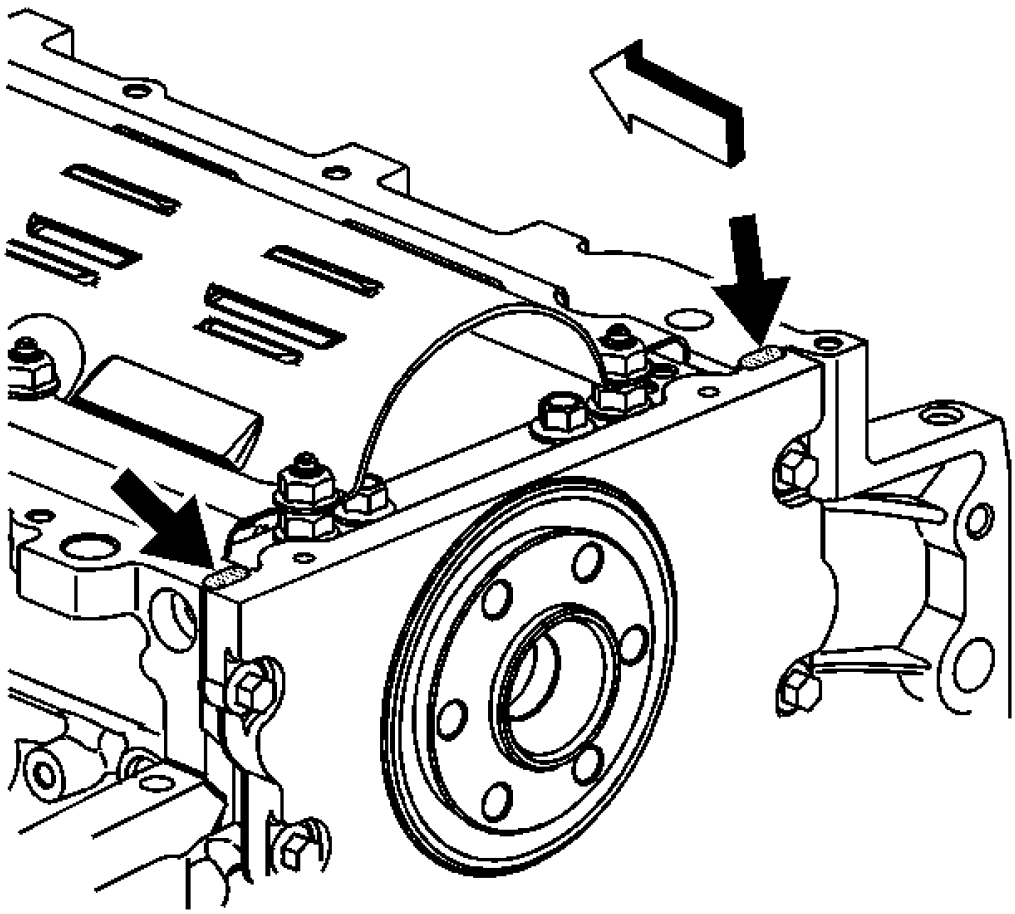


Fig. 192: View Of Sealant On Engine Rear Cover Gasket Tabs
Courtesy of GENERAL MOTORS CORP.

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3. Apply a 5 mm (0.2 in) bead of sealant GM P/N 12378521 (Canadian P/N 88901148), or equivalent, 20 mm (0.8 in) long to the engine block. Apply the sealant directly onto the tabs of the rear housing gasket that protrude into the oil pan surface.

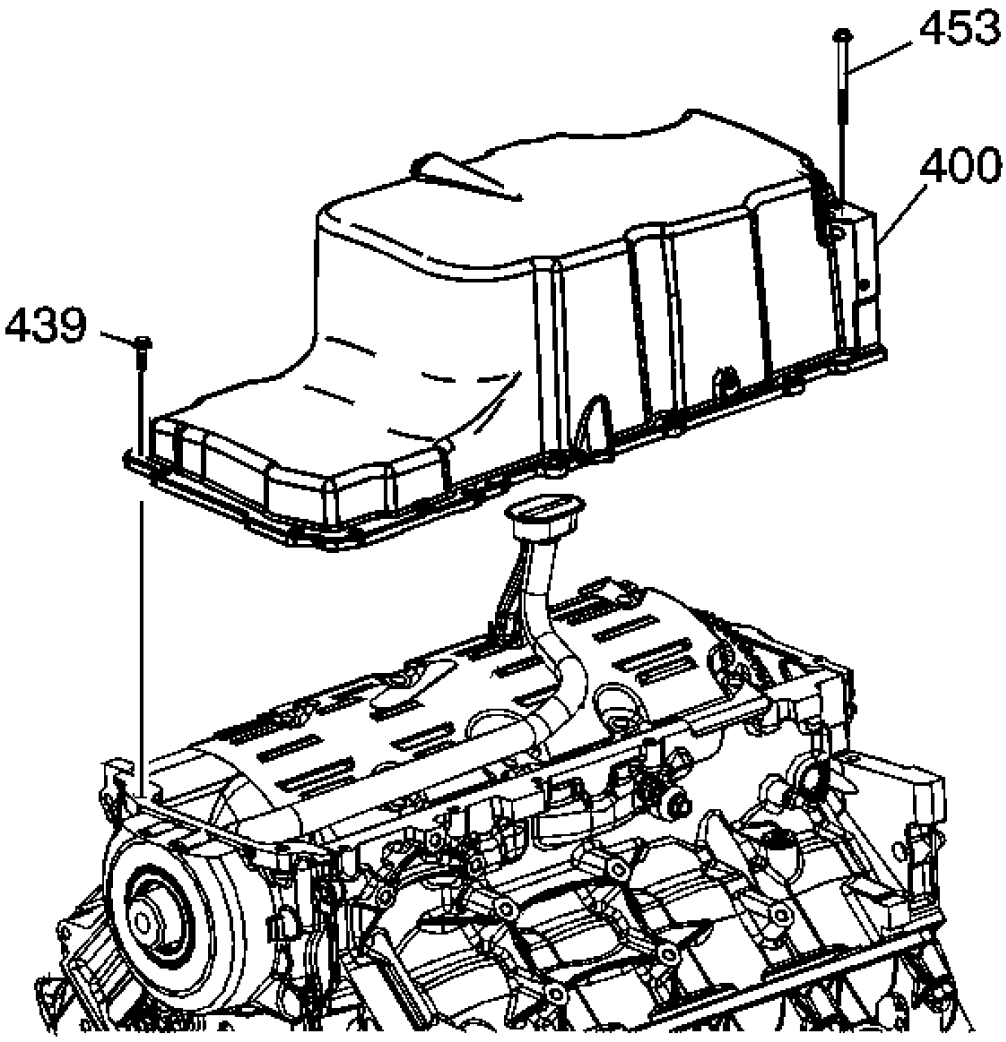


Fig. 193: Oil Pan & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure the oil gallery passages in the oil pan and engine block properly align with the oil pan gasket.

4. Pre-assemble the oil pan gasket to the pan.

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1. Install the gasket onto the oil pan.
2. Install the oil pan bolts to the pan and through the gasket.

5. Install the oil pan (400), gasket, and bolts (439 and 453) to the engine block.
6. Tighten the bolts finger tight. Do not overtighten.

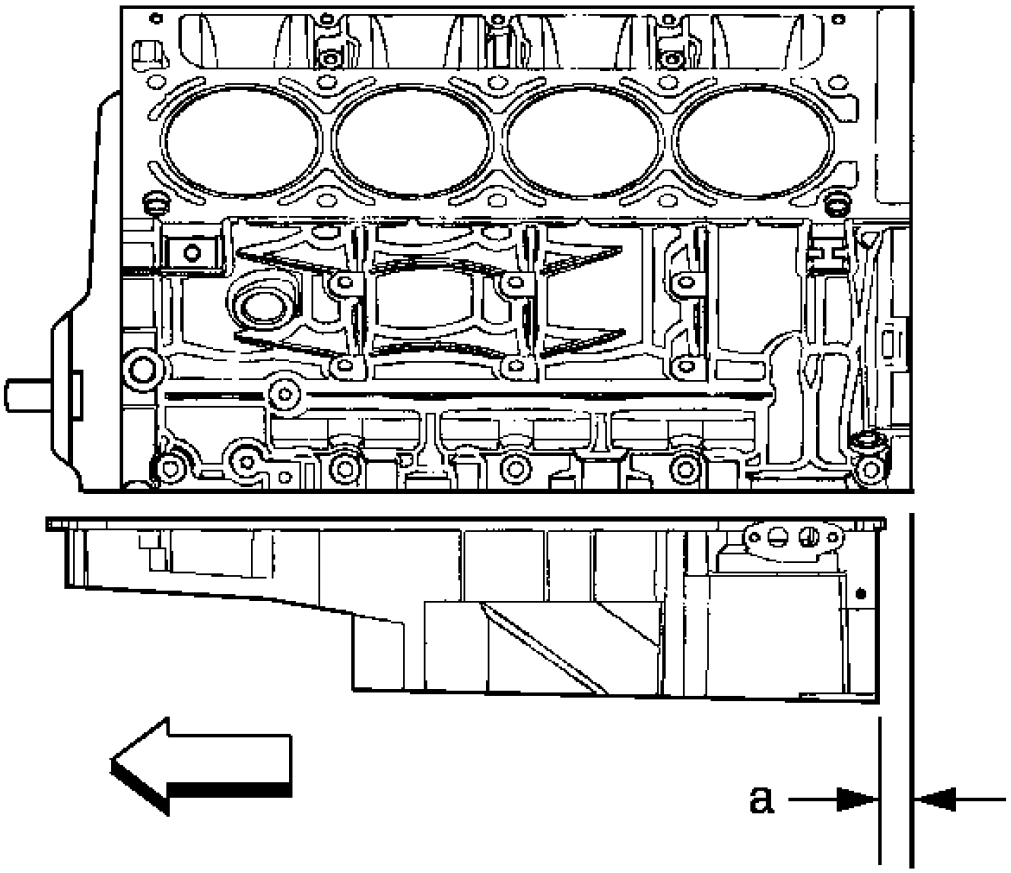


Fig. 194: Measuring Oil Pan-To-Engine Block
Courtesy of GENERAL MOTORS CORP.

7. Place a straight edge across the rear of the engine block and the rear of the oil pan at the transmission housing mounting surfaces.

CAUTION: Refer to Fastener Caution .

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8. Align the oil pan until the rear of engine block and rear of oil pan are flush or even.
    1. Tighten the oil pan-to-block and oil pan-to-front cover bolts to 25 N.m (18 lb ft) .
    2. Tighten the oil pan-to-rear housing bolts to 12 N.m (106 lb in) .
9. Measure the oil pan-to-engine block alignment (a).
    1. Place a straight edge across the rear of the engine block and rear of oil pan at the transmission housing mounting surfaces.

        NOTE: The rear of the oil pan must NEVER protrude beyond the engine block and transmission housing mounting surfaces.

    2. Insert a feeler gauge between the straight edge and the oil pan transmission housing mounting surface, and inspect to ensure there is no greater than a 0.1 mm (0.004 in) gap (a) between the pan and straight edge.
    3. If the oil pan alignment is not within specifications, remove the oil pan and repeat the above procedure.

ENGINE OIL COOLER INSTALLATION

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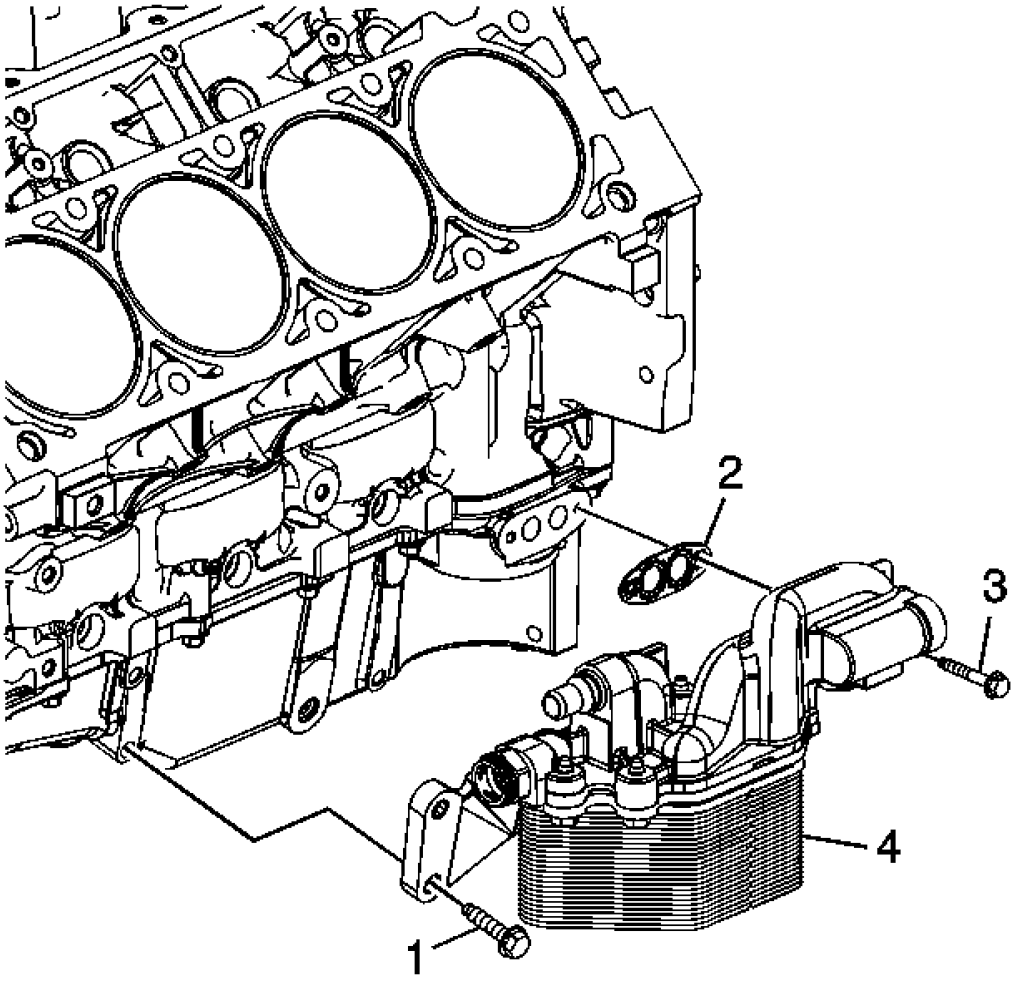


Fig. 195: Identifying Oil Cooler Components
Courtesy of GENERAL MOTORS CORP.

1. Install the oil cooler gasket (2).
2. Install the oil cooler (4).

CAUTION: Refer to Fastener Caution .

3. Install the oil cooler M8 (1) and M6 (3) bolts.
4. Tighten the M6 bolts to 10 N.m (89 lb in).
5. Tighten the M8 bolts to 25 N.m (18 lb ft).

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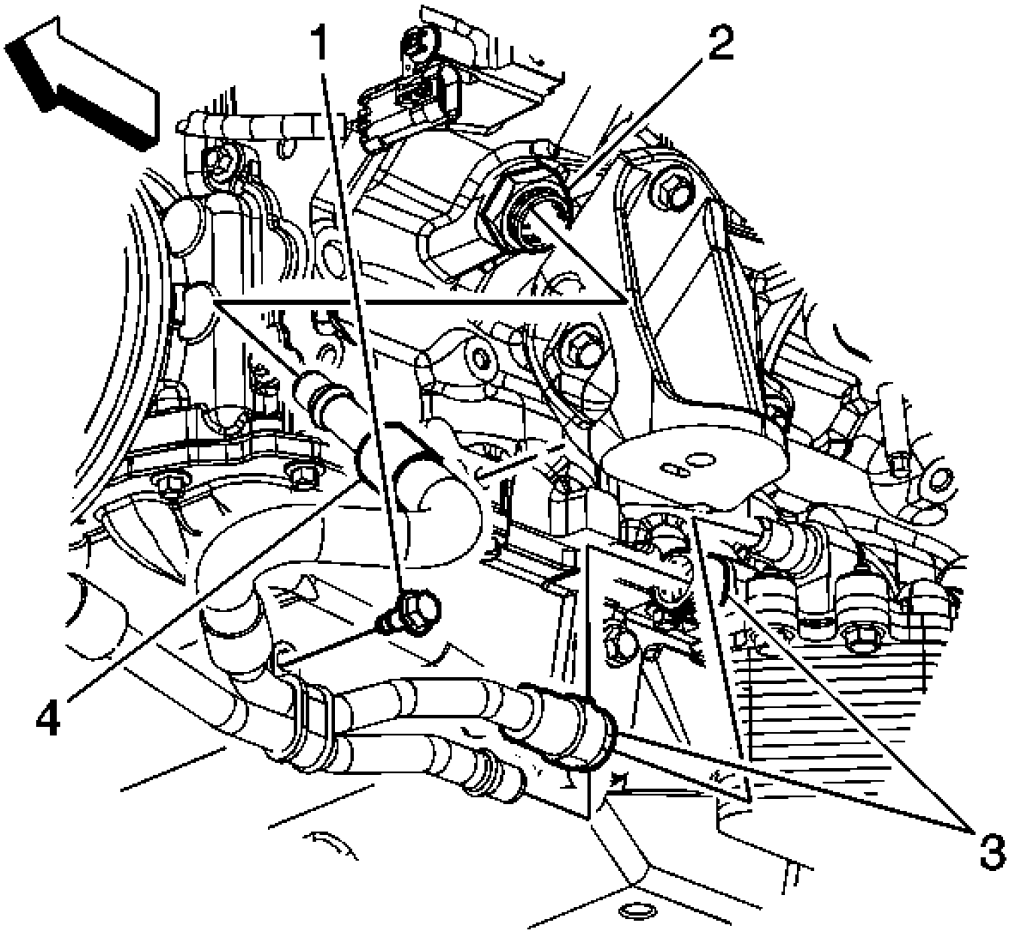


Fig. 196: Identifying Engine Oil Cooler Hose/Pipe
Courtesy of GENERAL MOTORS CORP.

6. Install the engine oil cooler coolant fitting (2) to the block, as required and tighten to 50 N.m (37 lb ft).
7. Install the hose/pipe (4) to the fitting (2) and cooler (3).
8. Install the bolt and tighten to 25 N.m (18 lb ft).

OIL FILTER INSTALLATION

Special Tools

J 35908: Oil Filter Wrench

For equivalent regional tools, refer to **Special Tools** .

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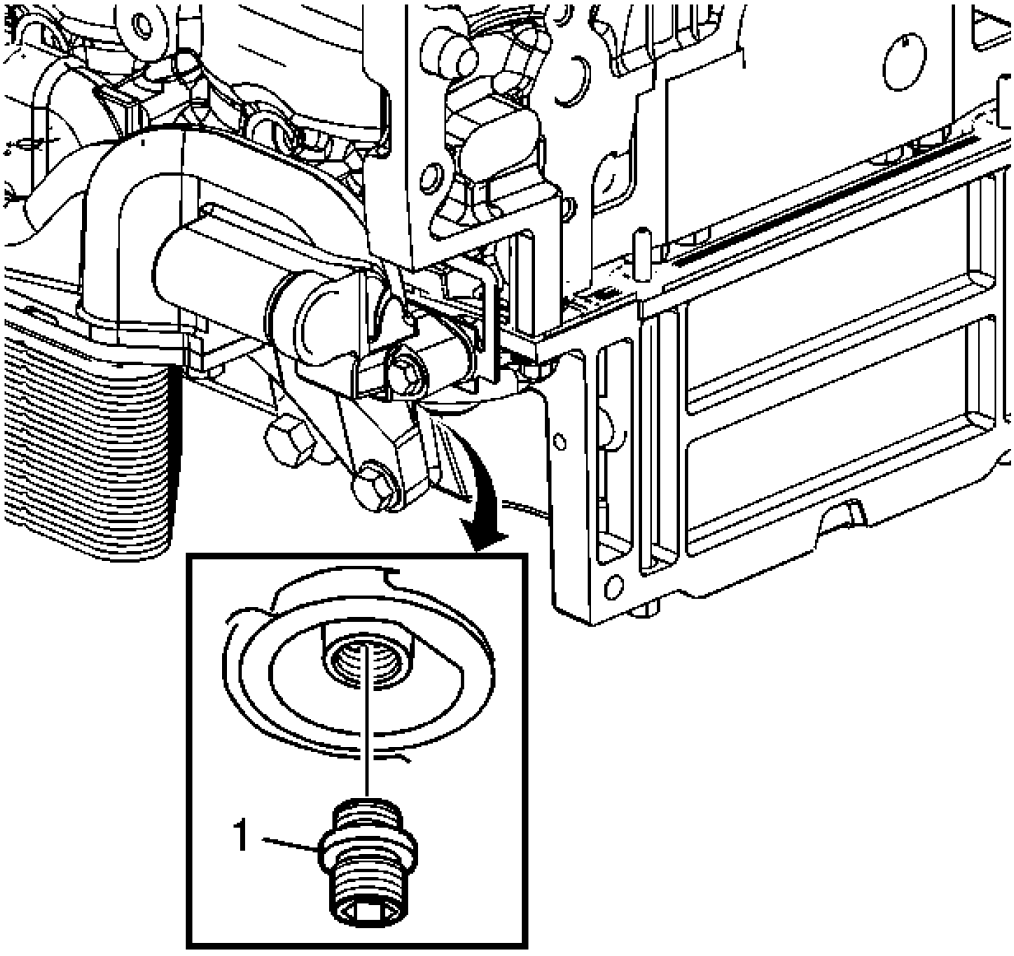


Fig. 197: Identifying Oil Filter Fitting
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the oil filter fitting (1) and tighten to 55 N.m (40 lb ft).

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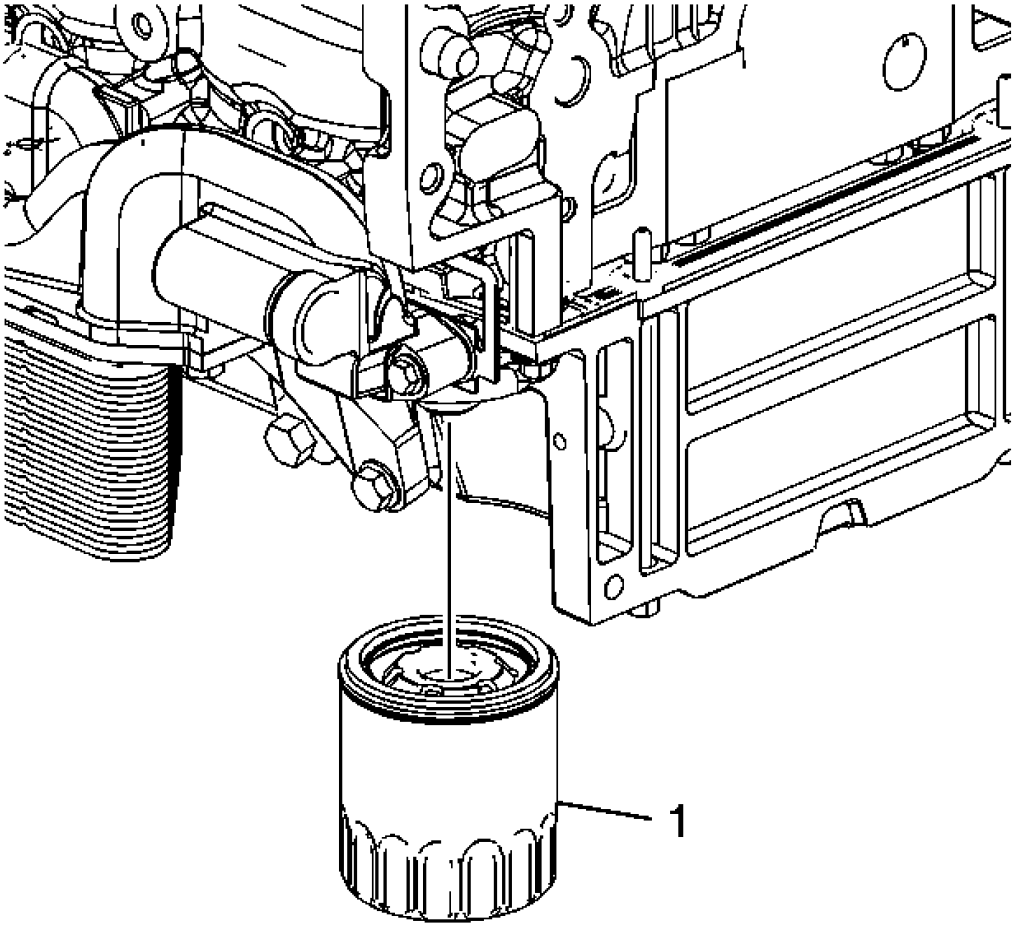


Fig. 198: Identifying Oil Filter
Courtesy of GENERAL MOTORS CORP.

2. Lubricate the oil filter seal with clean engine oil.
3. Install the oil filter (1) using the **J 35908:** wrench or equivalent and tighten to 30 N.m (22 lb ft).

VALVE LIFTER INSTALLATION (LS3)

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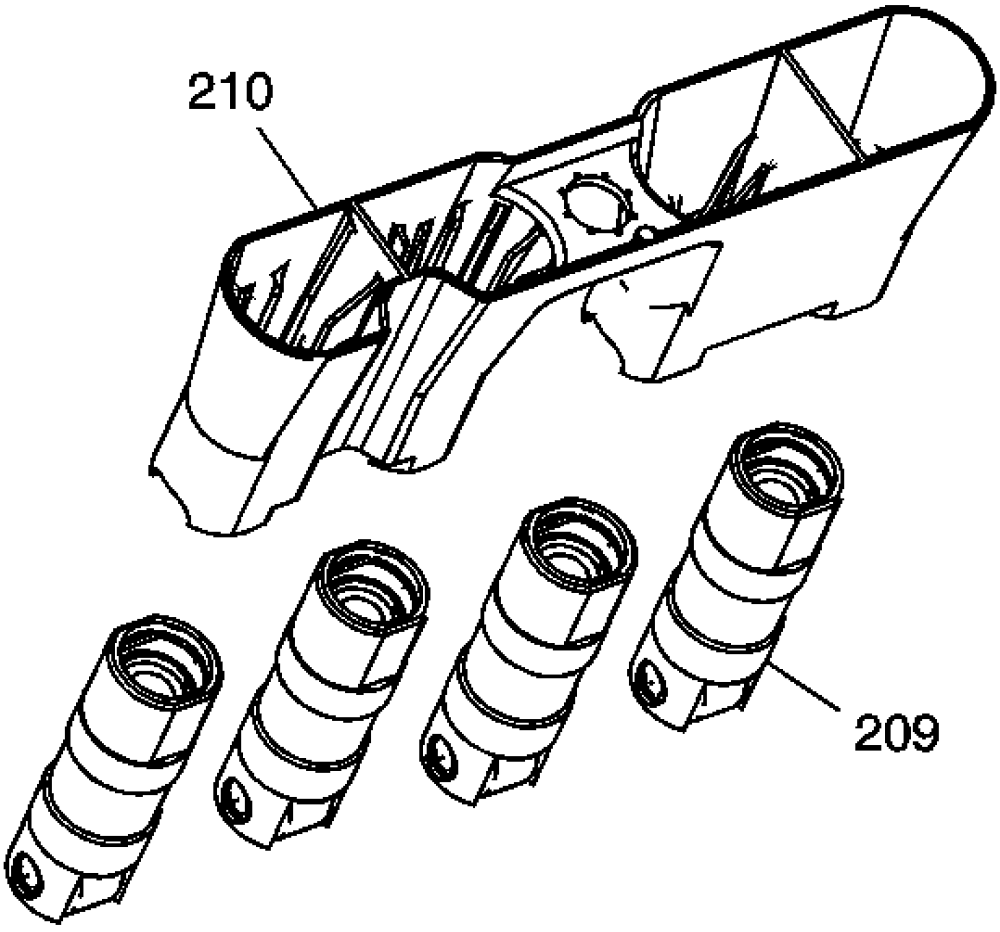


Fig. 199: Identifying Valve Lifters & Guide
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **When using the valve lifters again, install the lifters to their original locations.**
- **If camshaft replacement is required, the valve lifters must also be replaced.**

1. Lubricate the valve lifters (209) and engine block valve lifter bores with clean engine oil.
2. Insert the valve lifters into the lifter guides (210).

   Align the flat area on the top of the lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.

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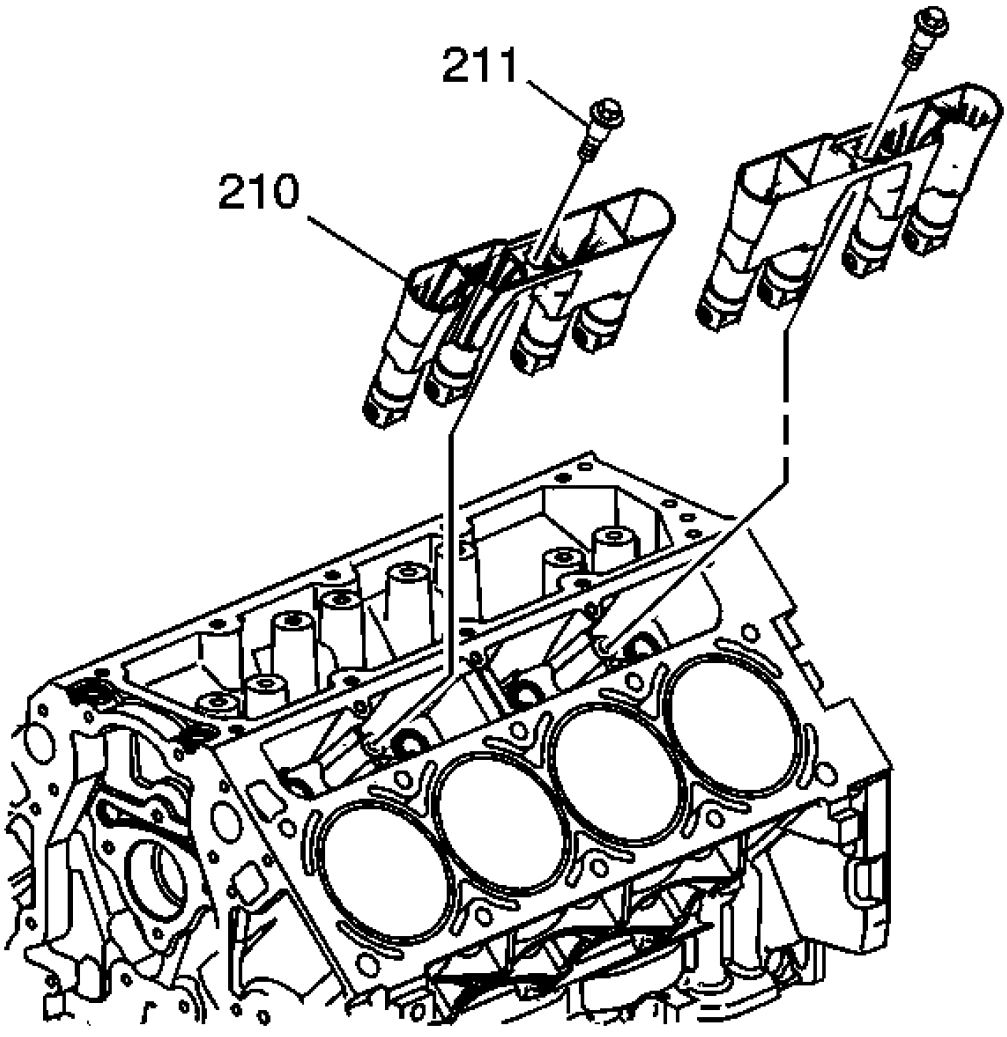


Fig. 200: Valve Lifter Guides, Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the valve lifters and guide assembly (210) to the engine block.

CAUTION: Refer to Fastener Caution .

4. Install the valve lifter guide bolts (211) and tighten to 12 N.m (106 lb in).

VALVE LIFTER INSTALLATION (L99)

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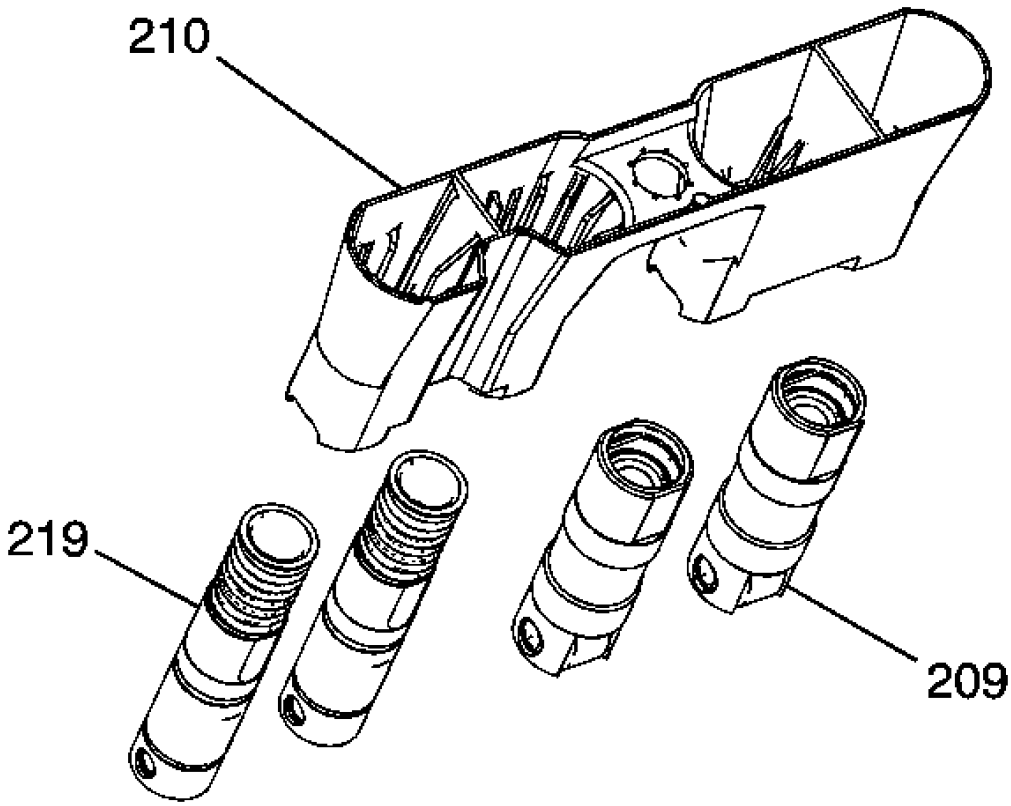


Fig. 201: Valve Lifters & Guide
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **When using the valve lifters again, install the lifters to their original locations.**
- **If camshaft replacement is required, the valve lifters must also be replaced.**
- **Each of the 4 valve guide assemblies will contain 2 active fuel management valve lifters and 2 non-active fuel management valve lifters.**
- **With the lifters and guides properly installed, cylinders 1, 4, 6, and 7 lifter bores will each contain 2 active fuel management valve lifters.**

1. Lubricate the valve lifters (209, 219) and engine block valve lifter bores with clean engine oil.

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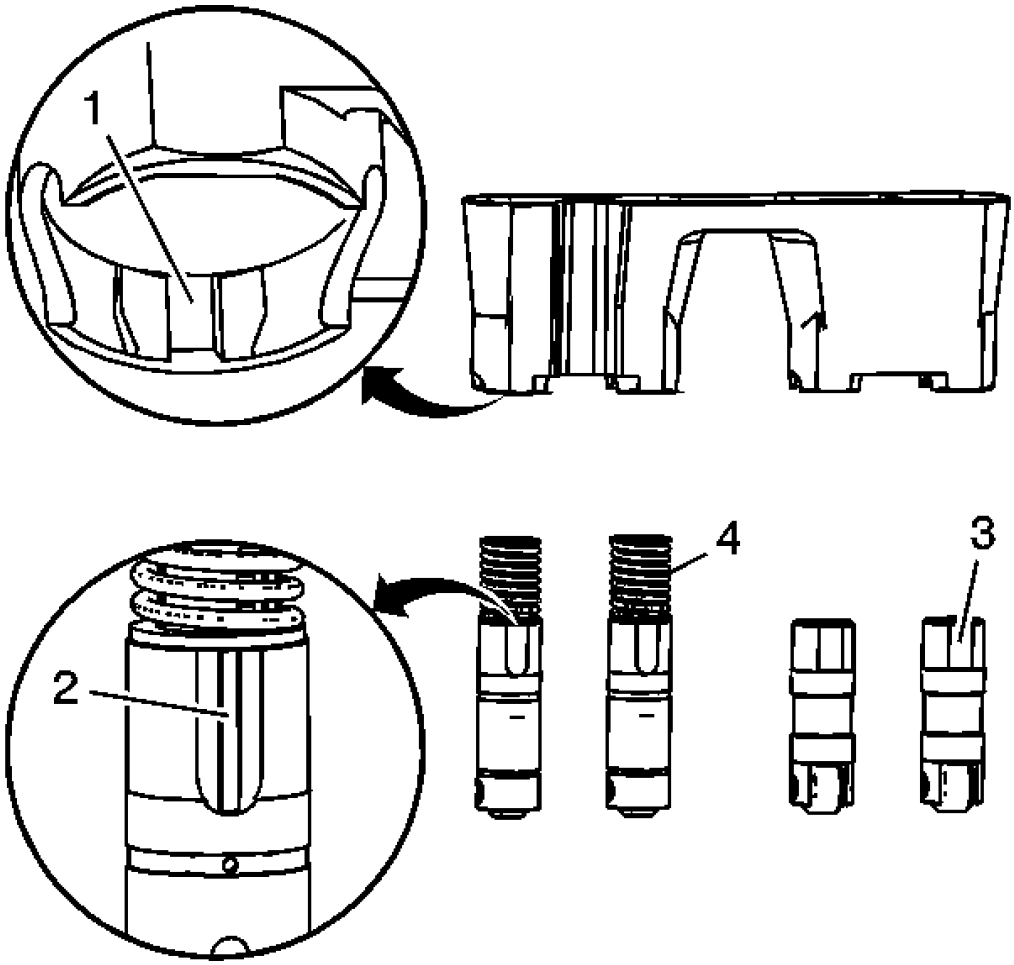


Fig. 202: Inserting Valve Lifters Into Lifter Guides
Courtesy of GENERAL MOTORS CORP.

2. Insert the valve lifters into the lifter guides.
   - Align the flat area (3) on the top of the non-active fuel management lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.
   - The active fuel management lifters (4) are to be installed into the guide, with the notch in the guide (1) aligned with the raised area (2) of the lifter.

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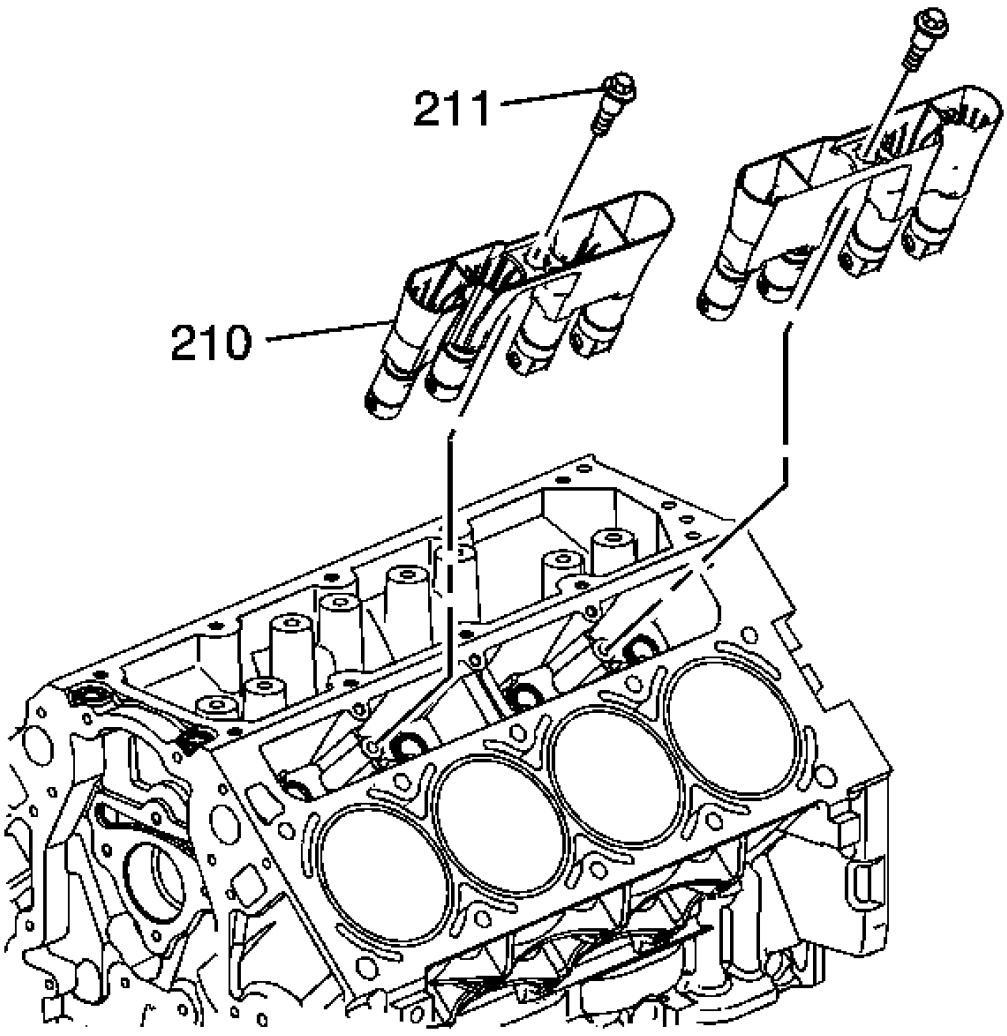


Fig. 203: View Of Lifter Guides & Lifters
Courtesy of GENERAL MOTORS CORP.

3. Install the valve lifters and guide assembly (210) to the engine block.

CAUTION: Refer to Fastener Caution .

4. Install the valve lifter guide bolts (211) and tighten to 12 N.m (106 lb in).

CYLINDER HEAD INSTALLATION - LEFT SIDE

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Special Tools

- **J 42385-100:** Thread Repair Kit
- **J 45059:** Angle Meter

For equivalent regional tools, refer to **Special Tools**

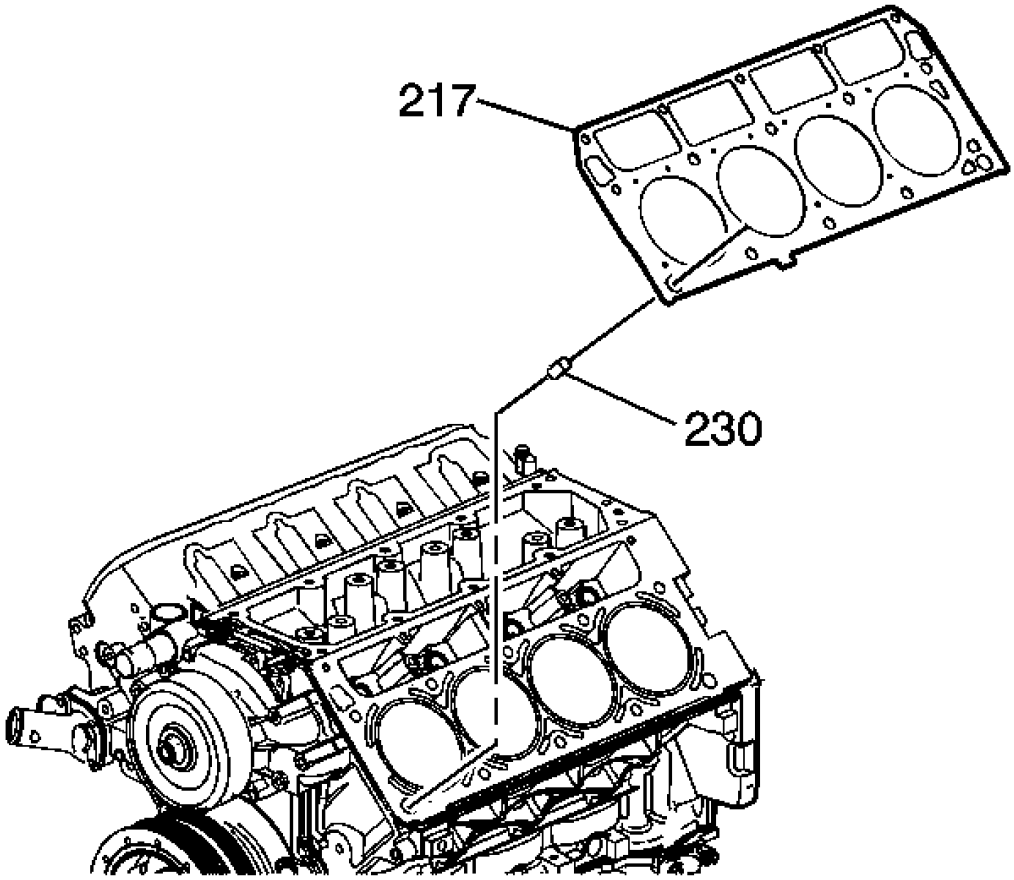


Fig. 204: View Of Cylinder Head Gasket & Locating Pin - Left
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Safety Glasses Warning .

CAUTION: Clean all dirt, debris, and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in

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damaged threads, improperly tightened fasteners or damage to components.

NOTE:

- **Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.**
- **Do not use any type of sealant on the cylinder head gasket, unless specified.**
- **The cylinder head gaskets must be installed in the proper direction and position.**

1. Clean the engine block cylinder head bolt holes, if required.

   Thread repair tool J 42385-107 may be used to clean the threads of old threadlocking material.

2. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463), GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.
3. Clean the cylinder head bolt holes with compressed air.
4. Install the cylinder head locating pins (230).

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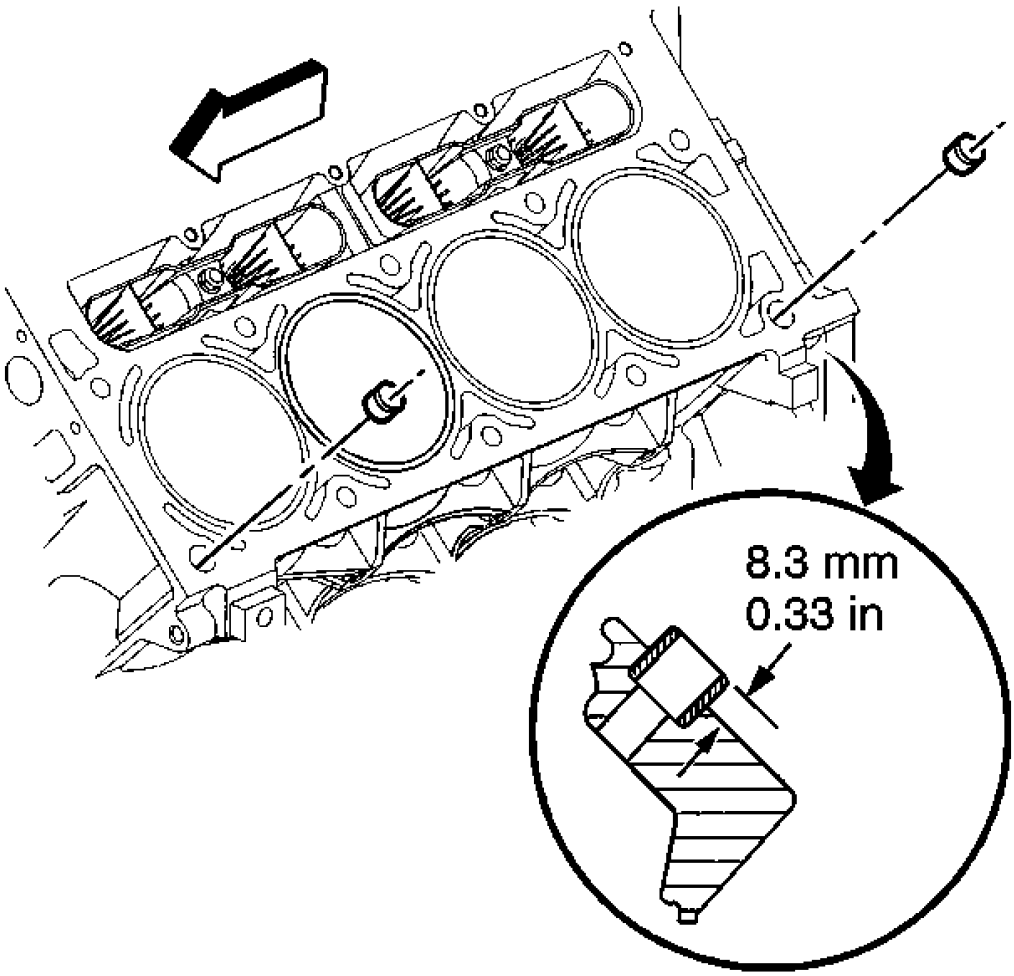


Fig. 205: Cylinder Head Locating Pins
Courtesy of GENERAL MOTORS CORP.

5. Inspect the locating pins for proper installation.

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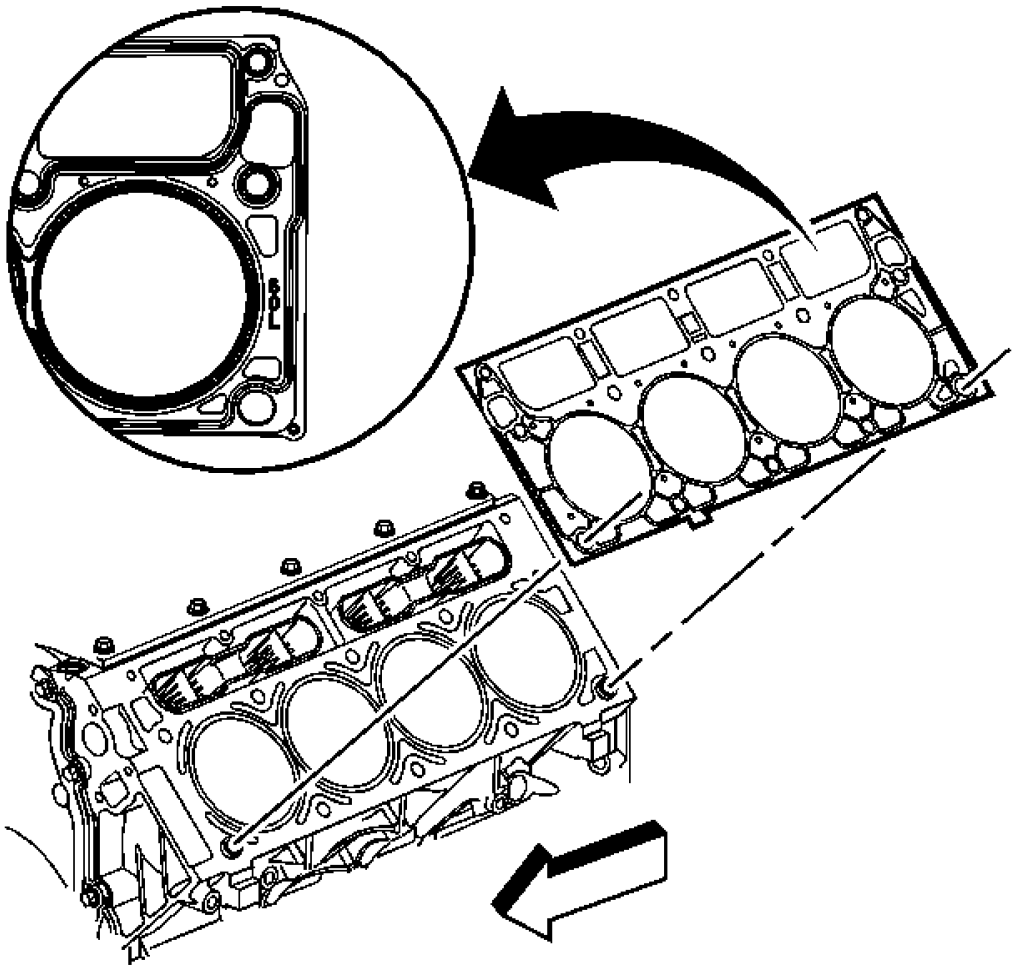


Fig. 206: Gasket Displacement Markings - Left
Courtesy of GENERAL MOTORS CORP.

6. Inspect the displacement markings on the gasket for proper usage.

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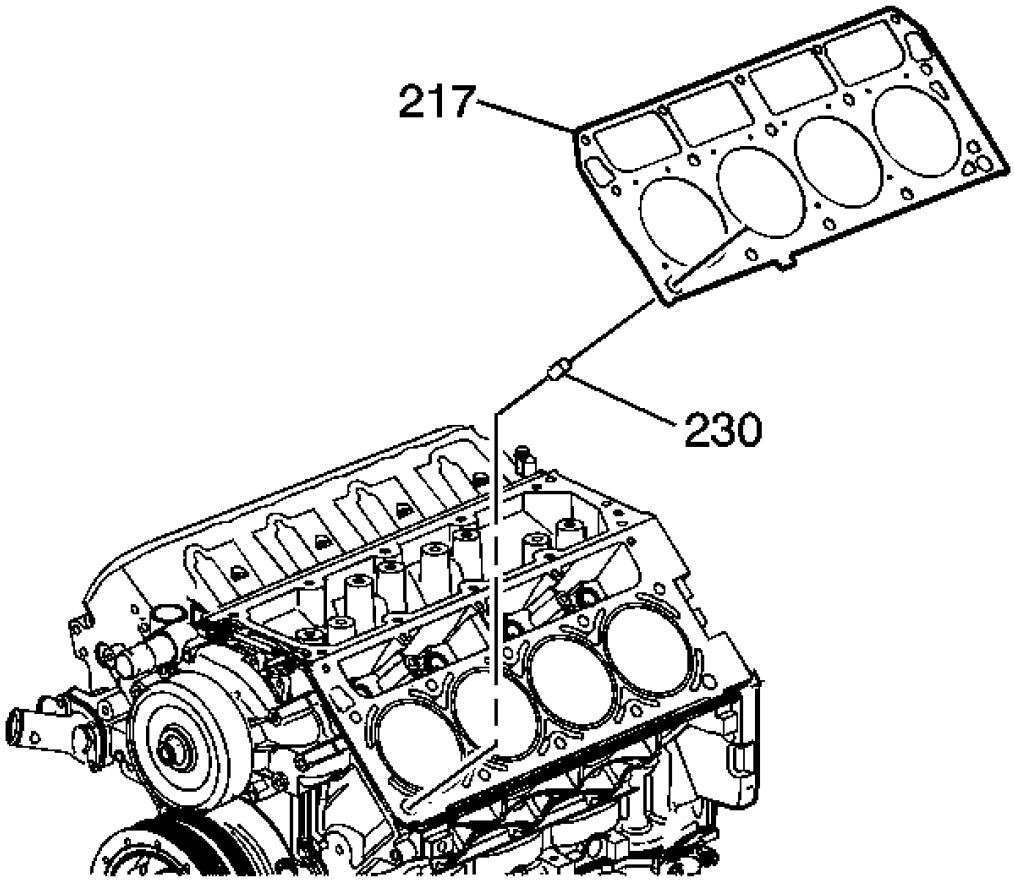


Fig. 207: View Of Cylinder Head Gasket & Locating Pin - Left
Courtesy of GENERAL MOTORS CORP.

7. Install the NEW cylinder head gasket (217) onto the locating pins.

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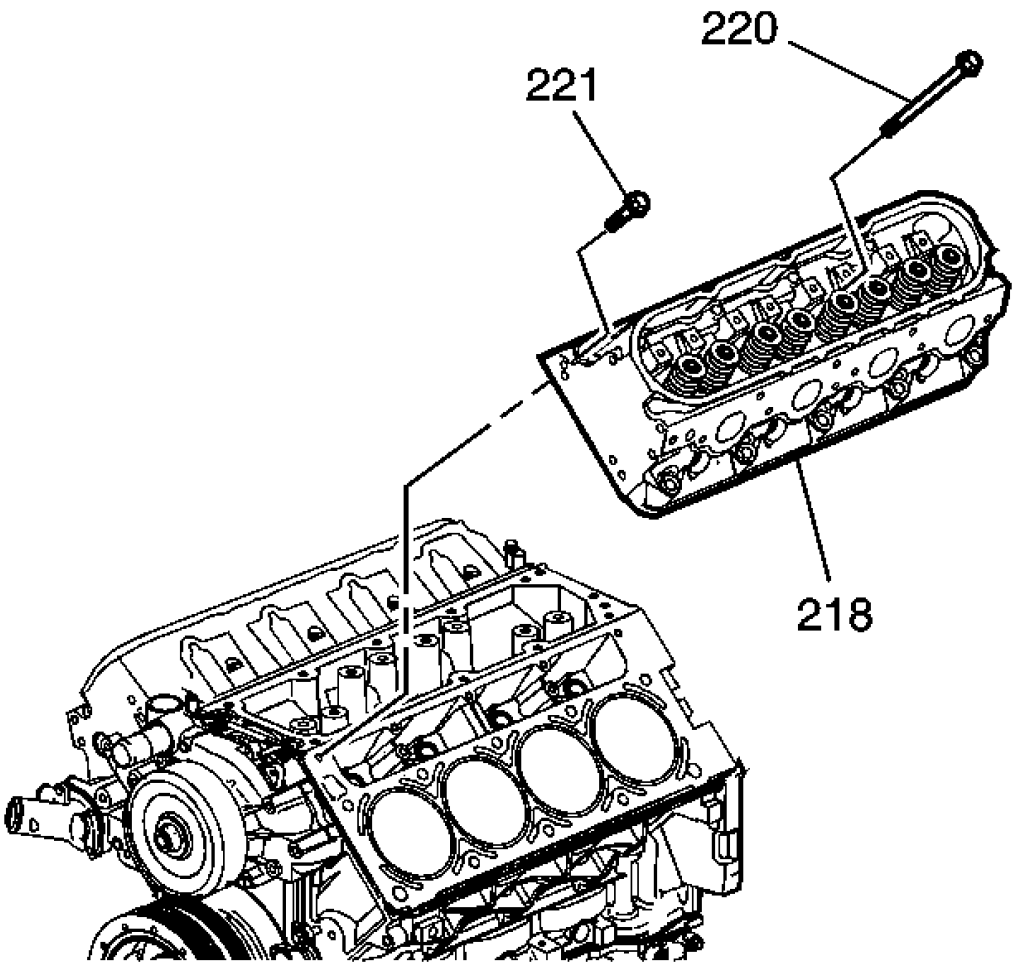


Fig. 208: Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Install the cylinder head (218) onto the locating pins and the gasket.
9. Install the NEW cylinder head bolts (220, 221).

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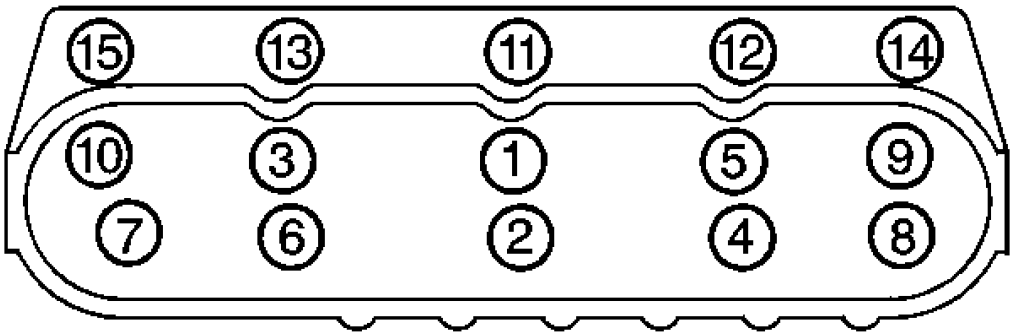


Fig. 209: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Safety Glasses Warning .

10. Tighten the cylinder head bolts:
    1. Tighten the M11 cylinder head bolts (1-10) a first pass in sequence to 30 N.m (22 lb ft) .
    2. Tighten the M11 cylinder head bolts (1-10) a second pass in sequence to 90 degrees using the **J 45059:** meter .
    3. Tighten the M11 cylinder head bolts (1-10) a final pass in sequence to 70 degrees using the **J 45059:** meter .
    4. Tighten the M8 cylinder head bolts (11-15) to 30 N.m (22 lb ft). Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

CYLINDER HEAD INSTALLATION - RIGHT SIDE

Special Tools

- **J 42385-100:** Thread Repair Kit
- **J 45059:** Angle Meter

For equivalent regional tools, refer to **Special Tools**

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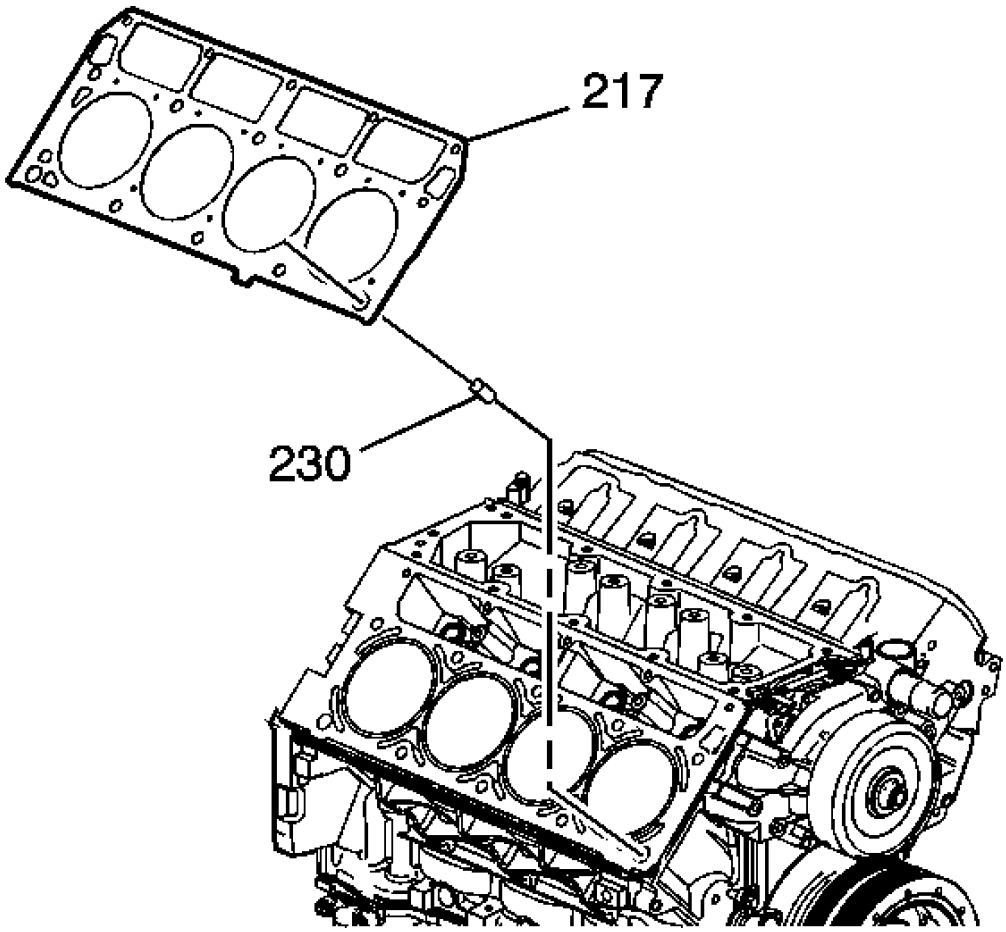


Fig. 210: Cylinder Head Gasket & Locating Pins - Right
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Safety Glasses Warning .

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

NOTE:

- **Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.**

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- **Do not use any type of sealant on the cylinder head gasket, unless specified.**
- **The cylinder head gaskets must be installed in the proper direction and position.**

1. Clean the engine block cylinder head bolt holes, if required.

   Thread repair tool J 42385-107 may be used to clean the threads of old threadlocking material.

2. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463), GM P/N 12377981 (Canadian P/N 10953463), or equivalent, into the hole.
3. Clean the cylinder head bolt holes with compressed air.
4. Install the cylinder head locating pins (230).

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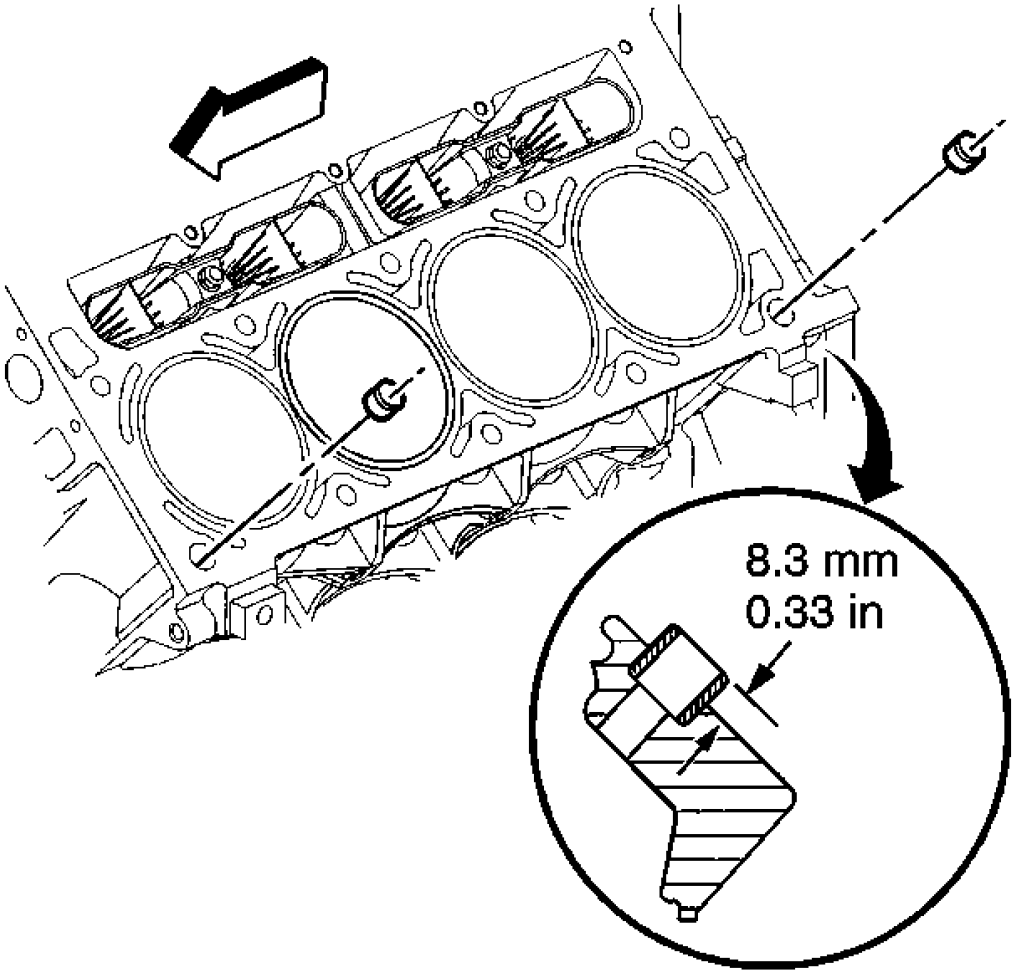


Fig. 211: Cylinder Head Locating Pins
Courtesy of GENERAL MOTORS CORP.

5. Inspect the locating pins for proper installation.

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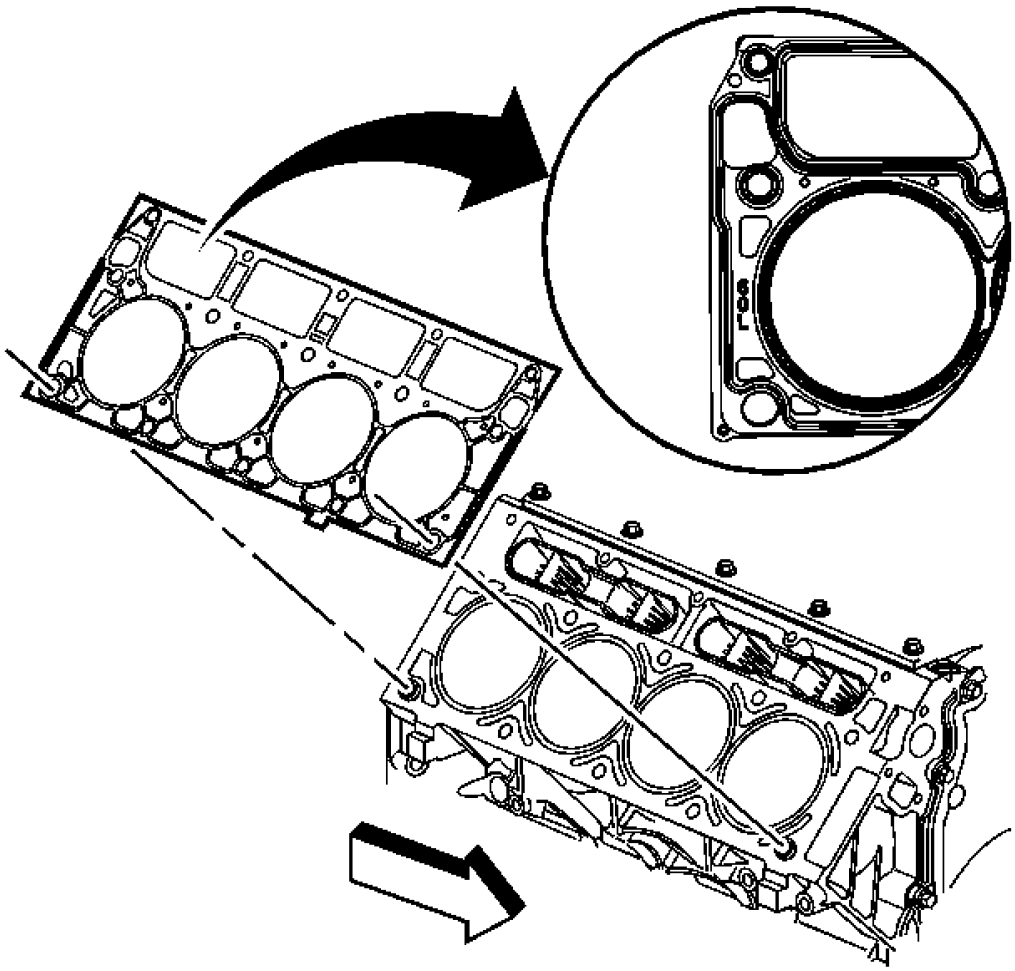


Fig. 212: Gasket Displacement Markings - Right
Courtesy of GENERAL MOTORS CORP.

6. Inspect the displacement markings on the gasket for proper usage.

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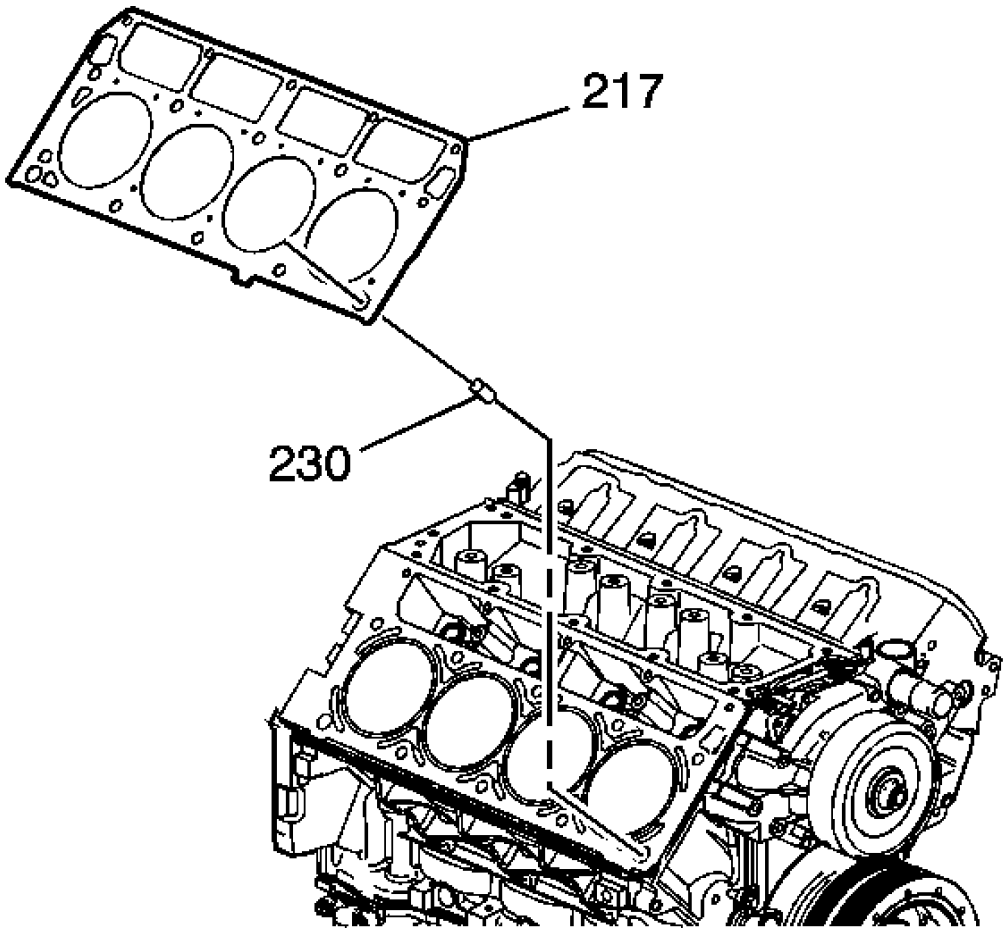


Fig. 213: Cylinder Head Gasket & Locating Pins - Right
Courtesy of GENERAL MOTORS CORP.

7. Install the NEW cylinder head gasket (217) onto the locating pins.

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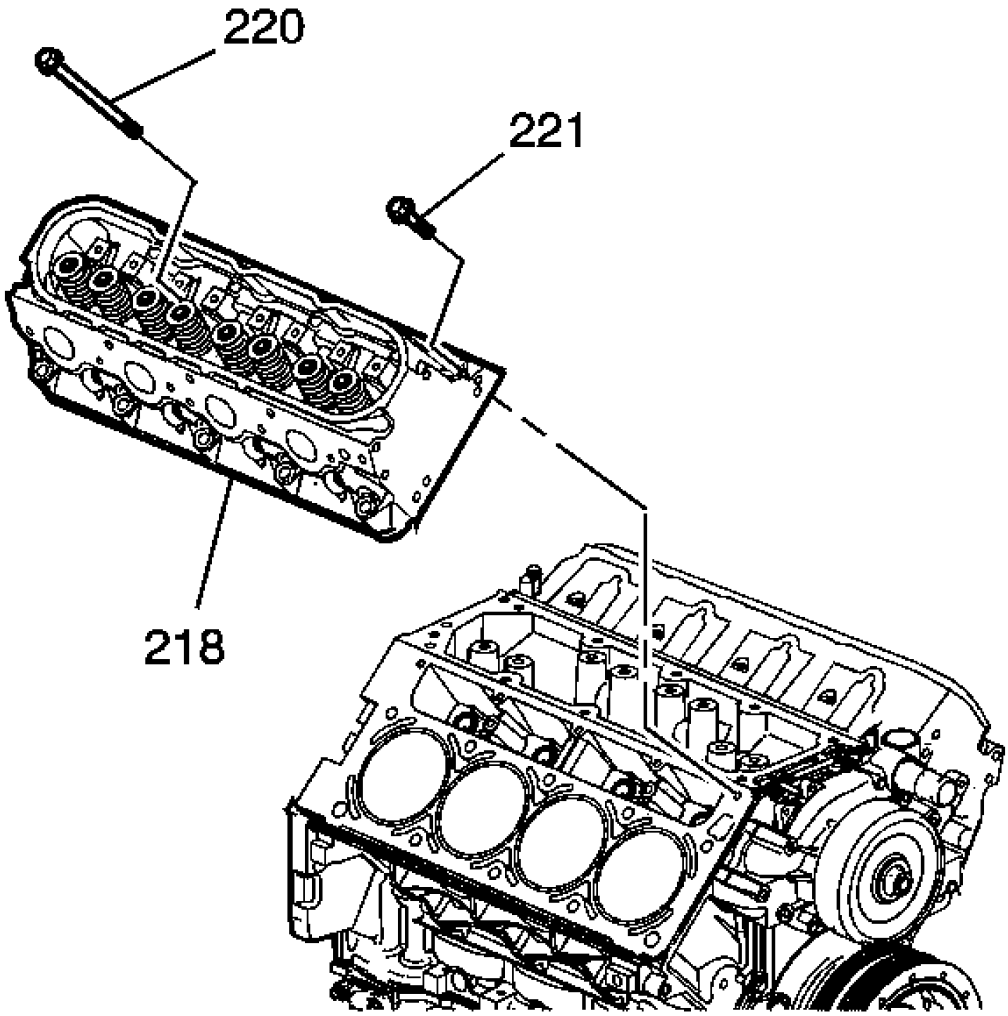


Fig. 214: Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Install the cylinder head (218) onto the locating pins and the gasket.
9. Install the NEW cylinder head bolts (220, 221).

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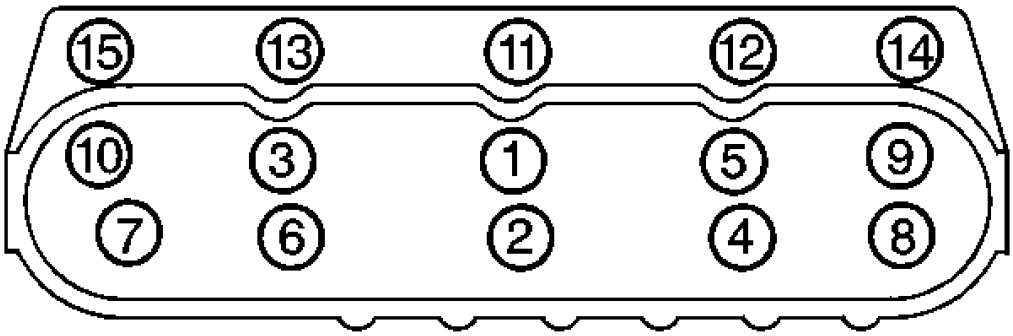


Fig. 215: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

10. Tighten the cylinder head bolts:
    1. Tighten the M11 cylinder head bolts (1-10) a first pass in sequence to 30 N.m (22 lb ft) .
    2. Tighten the M11 cylinder head bolts (1-10) a second pass in sequence to 90 degrees using the **J 45059:** meter .
    3. Tighten the M11 cylinder head bolts (1-10) a final pass in sequence to 70 degrees using the **J 45059:** meter .
    4. Tighten the M8 cylinder head bolts (11-15) to 30 N.m (22 lb ft). Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.

VALVE ROCKER ARM AND PUSH ROD INSTALLATION (6.2L LS3)

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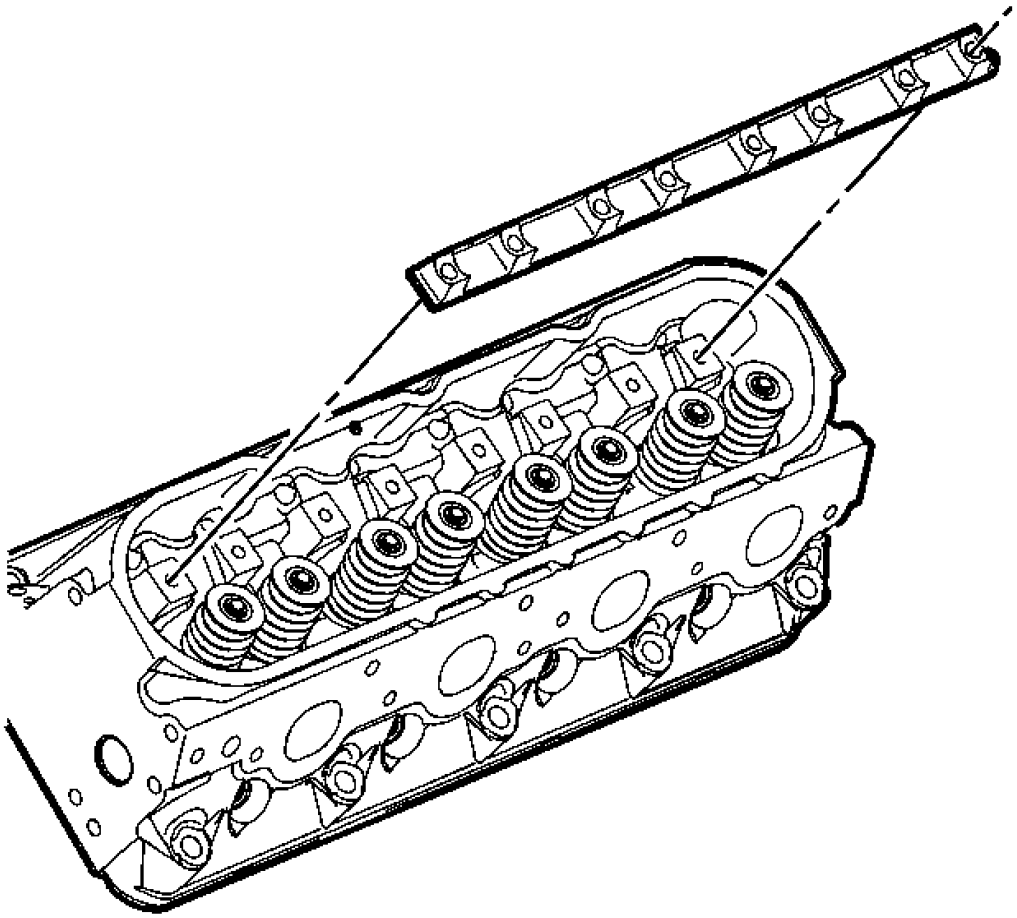


Fig. 216: View Of Valve Rocker Arm Pivot Support
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **When using the valve train components again, always install the components to the original location and position.**
- **Valve lash is net build. No valve adjustment is required.**

1. Lubricate the valve rocker arms and pushrods with clean engine oil.
2. Lubricate the flange of the valve rocker arm bolts with clean engine oil.
3. Install the valve rocker arm pivot support.

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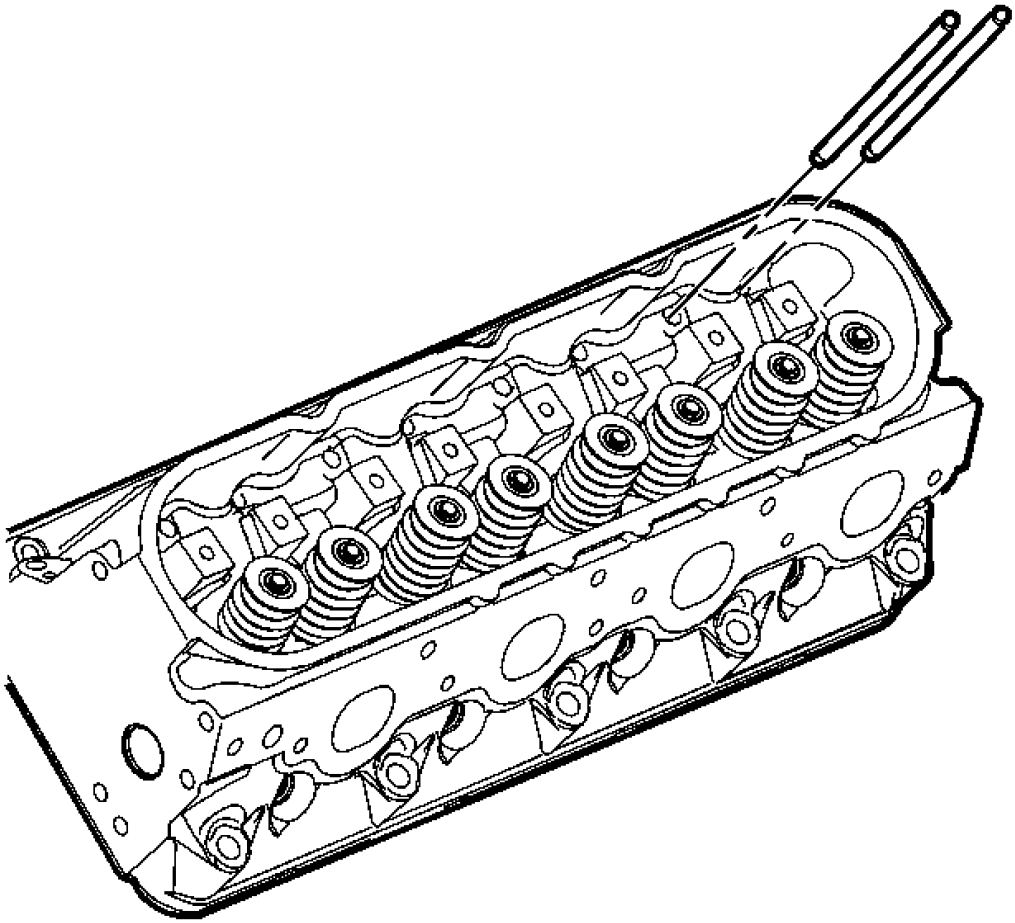


Fig. 217: View Of Pushrods
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure the pushrods seat properly to the valve lifter sockets.

4. Install the pushrods.

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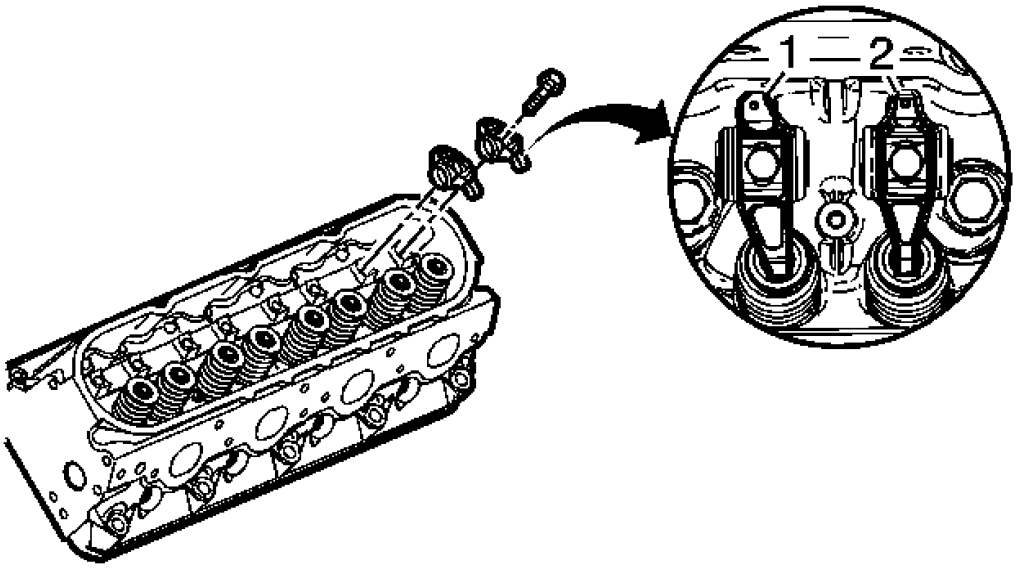


Fig. 218: View Of Offset Intake Rocker Arm & Intake Rocker Arm
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Ensure the pushrods seat properly to the ends of the rocker arms.**
- **DO NOT tighten the rocker arm bolts at this time.**

5. Install the rocker arms and bolts.

   The intake rocker arms (1) have an offset design.

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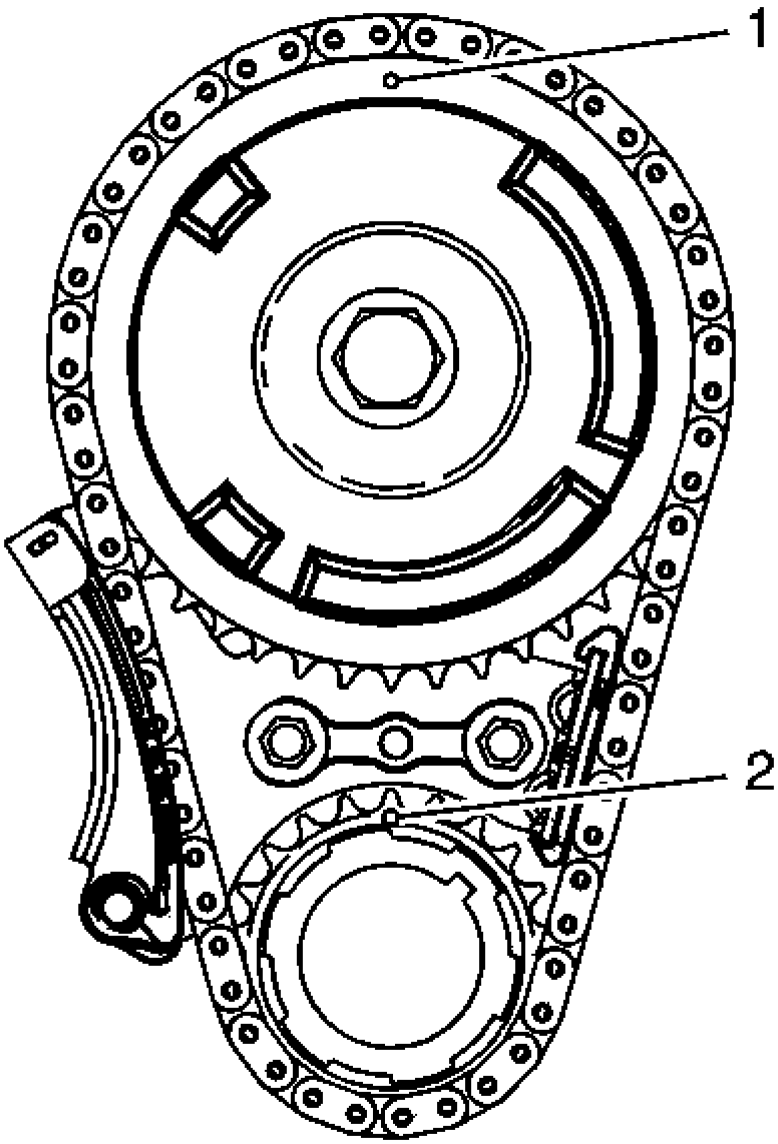


Fig. 219: View Of Camshaft & Crankshaft Sprocket Alignment Marks In 12 O'clock Position
Courtesy of GENERAL MOTORS CORP.

6. Rotate the crankshaft until number 1 piston is at top dead center of compression stroke.

   In this position, cylinder number 1 rocker arms will be off lobe lift, and the crankshaft sprocket key will be at the 1:30 position. The camshaft and crankshaft sprocket alignment marks (1, 2) will be in the 12 o'clock position. If viewing from the rear of the engine, the additional crankshaft pilot hole, non-threaded,

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will be in the 10:30 position.

The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3.

Cylinders 1, 3, 5 and 7 are left bank.

Cylinders 2, 4, 6, and 8 are right bank.

CAUTION: Refer to Fastener Caution .

7. With the engine in the number 1 firing position, tighten the following valve rocker arm bolts:
    1. Tighten the exhaust valve rocker arm bolts 1, 2, 7, and 8 to 30 N.m (22 lb ft) .
    2. Tighten the intake valve rocker arm bolts 1, 3, 4, and 5 to 30 N.m (22 lb ft) .
8. Rotate the crankshaft 360 degrees.
9. Tighten the following valve rocker arm bolts:
    1. Tighten the exhaust valve rocker arm bolts 3, 4, 5, and 6 to 30 N.m (22 lb ft) .
    2. Tighten the intake valve rocker arm bolts 2, 6, 7, and 8 to 30 N.m (22 lb ft) .

VALVE ROCKER ARM AND PUSH ROD INSTALLATION (6.2L L99)

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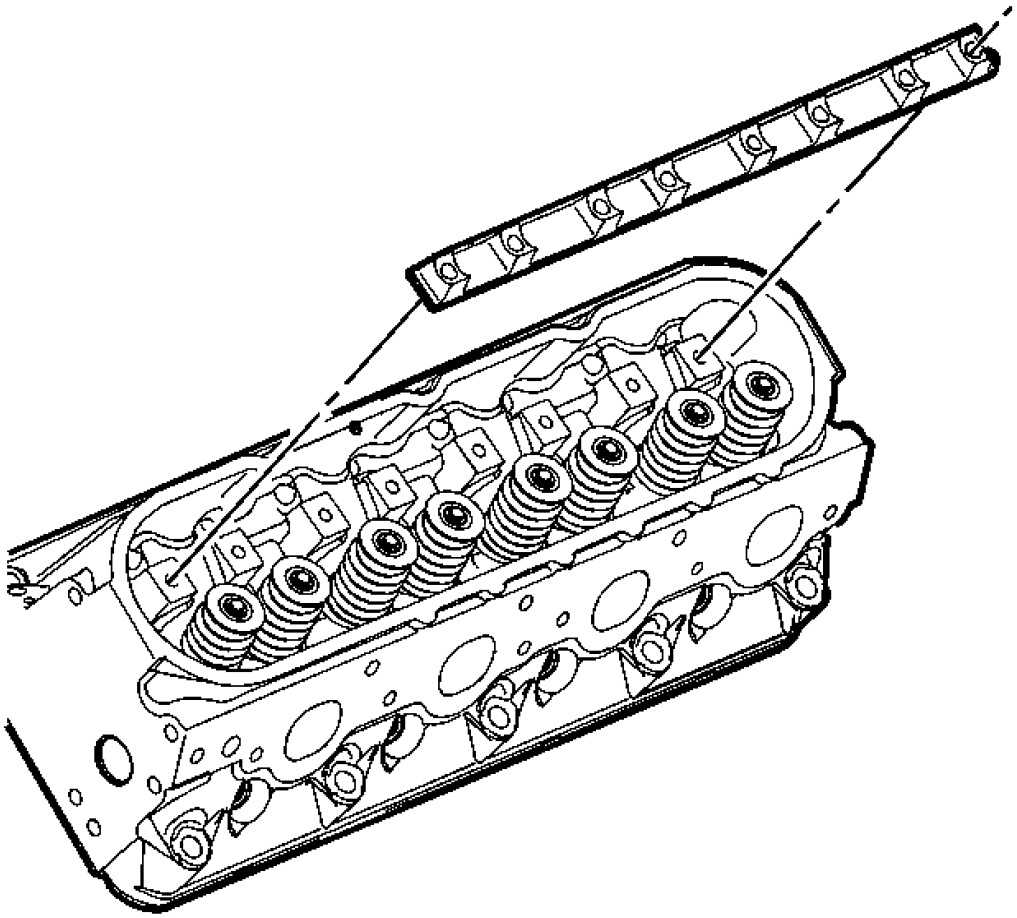


Fig. 220: View Of Valve Rocker Arm Pivot Support
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **When using the valve train components again, always install the components to the original location and position.**
- **Valve lash is net build. No valve adjustment is required.**

1. Lubricate the valve rocker arms and pushrods with clean engine oil.
2. Lubricate the flange of the valve rocker arm bolts with clean engine oil.
3. Install the valve rocker arm pivot support.

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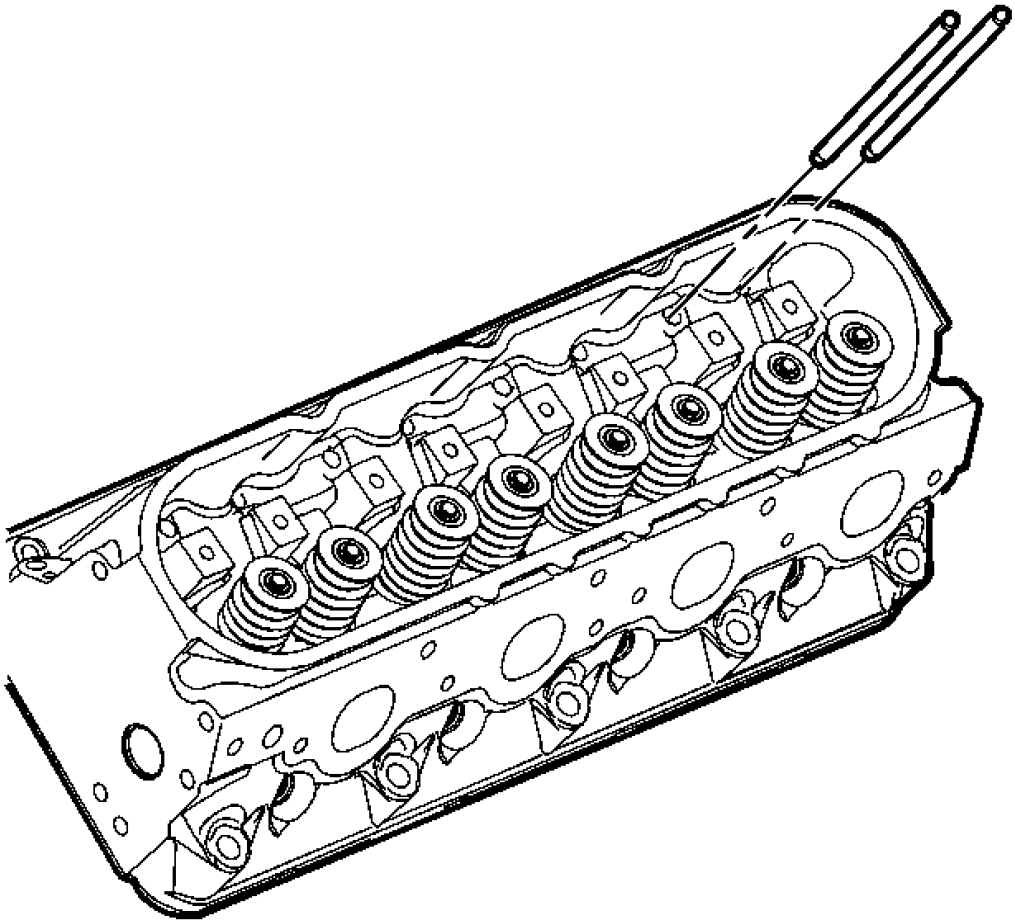


Fig. 221: View Of Pushrods
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure the pushrods seat properly to the valve lifter sockets.

4. Install the pushrods.

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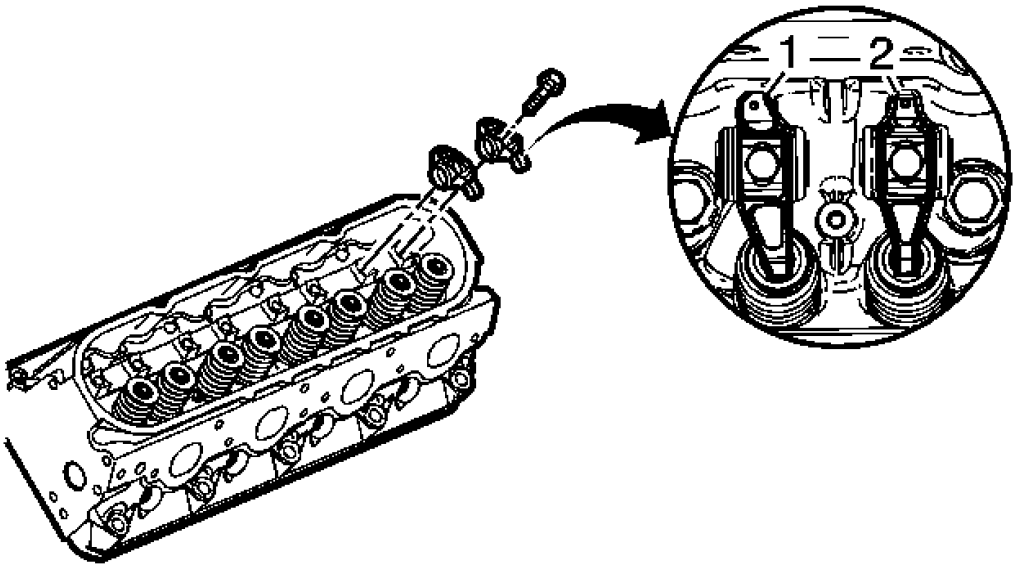


Fig. 222: View Of Offset Intake Rocker Arm & Intake Rocker Arm
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Ensure the pushrods seat properly to the ends of the rocker arms.**
- **DO NOT tighten the rocker arm bolts at this time.**

5. Install the rocker arms and bolts.

   The intake rocker arms (1) have an offset design.

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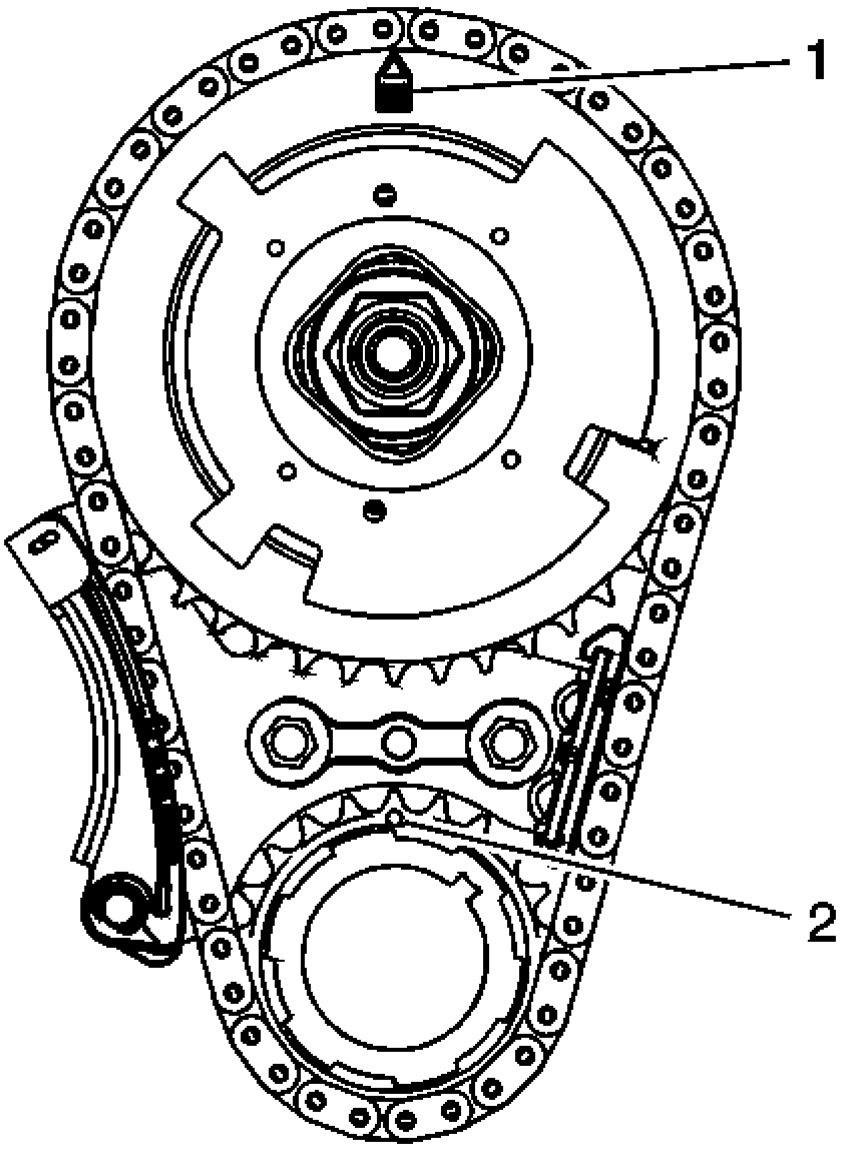


Fig. 223: View Of Camshaft & Crankshaft Sprocket Alignment Marks
Courtesy of GENERAL MOTORS CORP.

6. Rotate the crankshaft until number 1 piston is at top dead center of compression stroke.

   In this position, cylinder number 1 rocker arms will be off lobe lift, and the crankshaft sprocket key will be at the 1:30 position. The camshaft and crankshaft sprocket alignment marks (1, 2) will be in the 12

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o'clock position. If viewing from the rear of the engine, the additional crankshaft pilot hole, non-threaded, will be in the 10:30 position.

The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3.

Cylinders 1, 3, 5 and 7 are left bank.

Cylinders 2, 4, 6, and 8 are right bank.

CAUTION: Refer to Fastener Caution

7. With the engine in the number 1 firing position, tighten the following valve rocker arm bolts:
    1. Tighten the exhaust valve rocker arm bolts 1, 2, 7, and 8 to 30 N.m (22 lb ft) .
    2. Tighten the intake valve rocker arm bolts 1, 3, 4, and 5 to 30 N.m (22 lb ft) .
8. Rotate the crankshaft 360 degrees.
9. Tighten the following valve rocker arm bolts:
    - Tighten the exhaust valve rocker arm bolts 3, 4, 5, and 6 to 30 N.m (22 lb ft) .
    - Tighten the intake valve rocker arm bolts 2, 6, 7, and 8 to 30 N.m (22 lb ft) .

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2010 ENGINE

Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Repair Instructions - Off Vehicle - Camaro

VALVE ROCKER ARM COVER INSTALLATION - LEFT SIDE

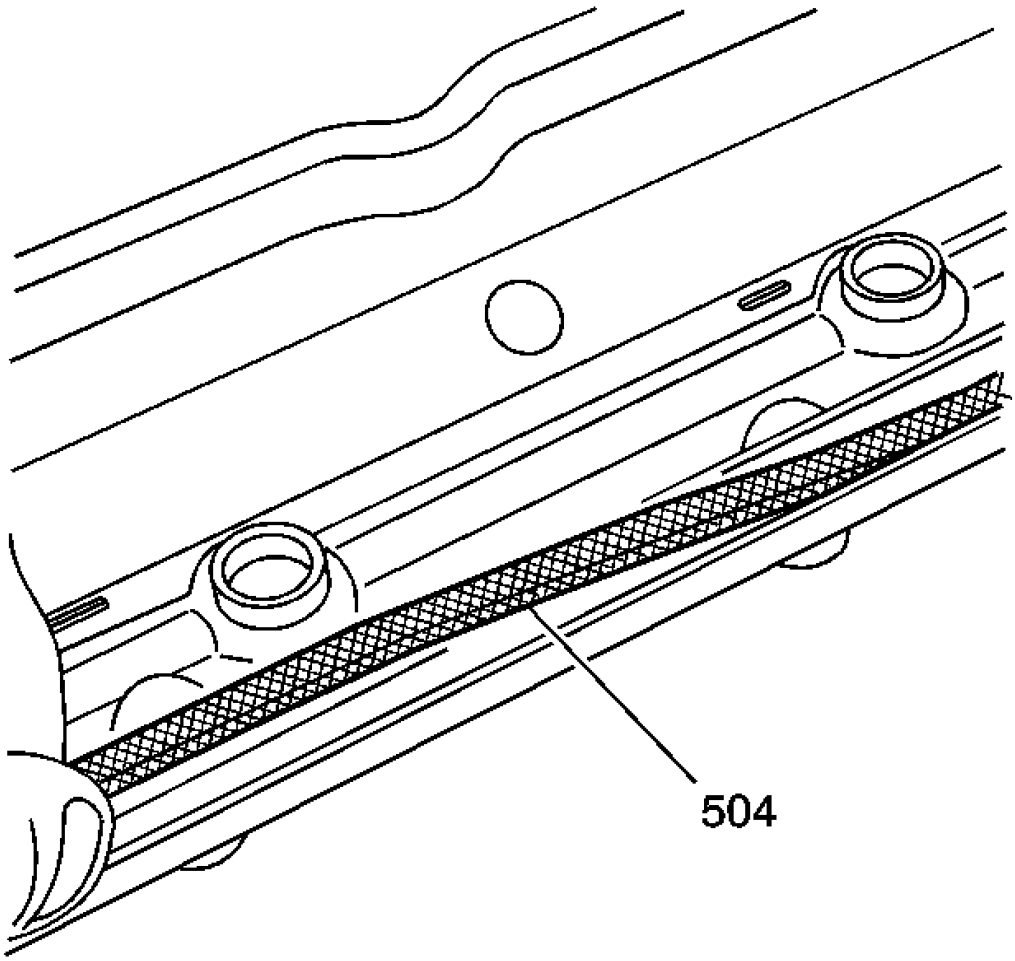


Fig. 1: View Of Valve Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **All gasket surfaces should be free of oil or other foreign material during assembly.**
- **DO NOT use the valve rocker arm cover gasket again.**

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1. Install NEW valve rocker arm cover grommets and use NEW valve rocker arm cover bolts if they are serviced with the grommet.
2. Install a NEW gasket (504) into the valve rocker arm cover.

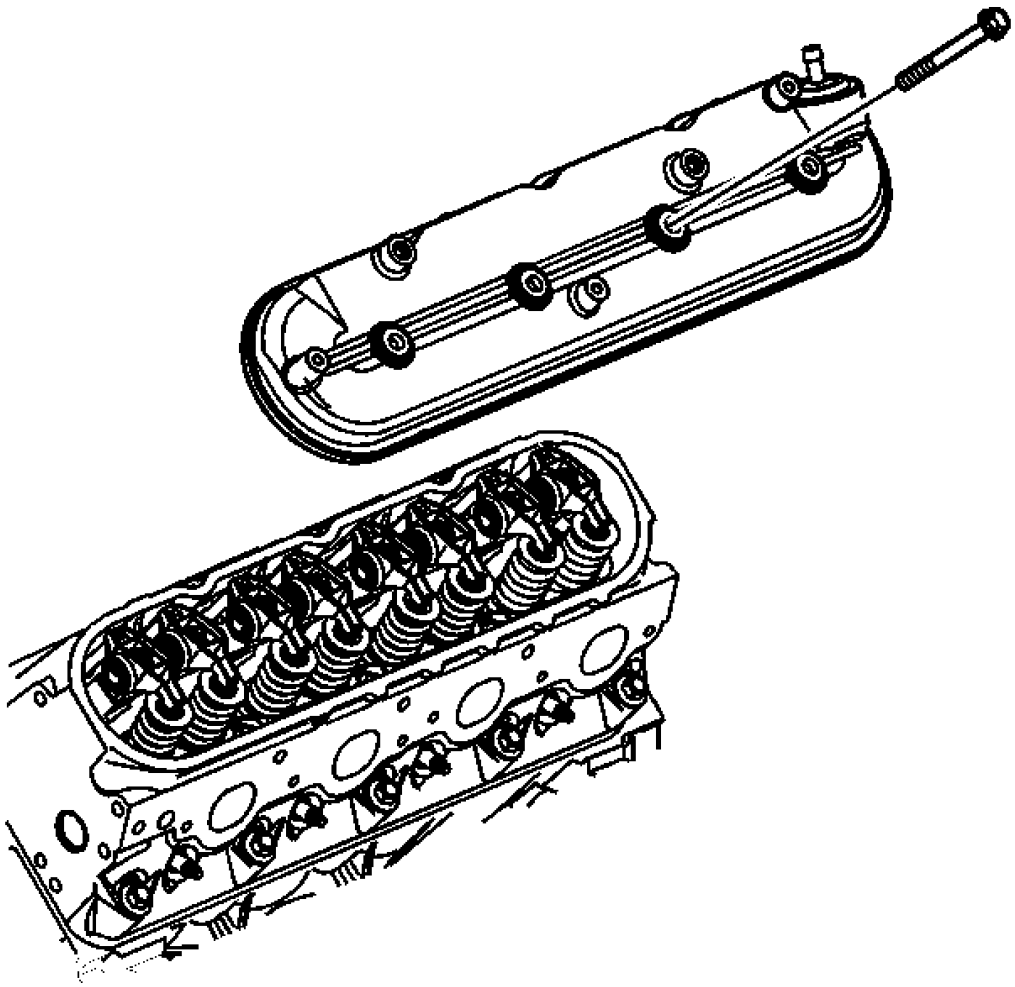


Fig. 2: View Of Valve Rocker Arm Cover
Courtesy of GENERAL MOTORS CORP.

3. Install the valve rocker arm cover onto the cylinder head.

CAUTION: Refer to Fastener Caution .

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4. Install the cover bolts with grommets and tighten to 12 N.m (106 lb in).

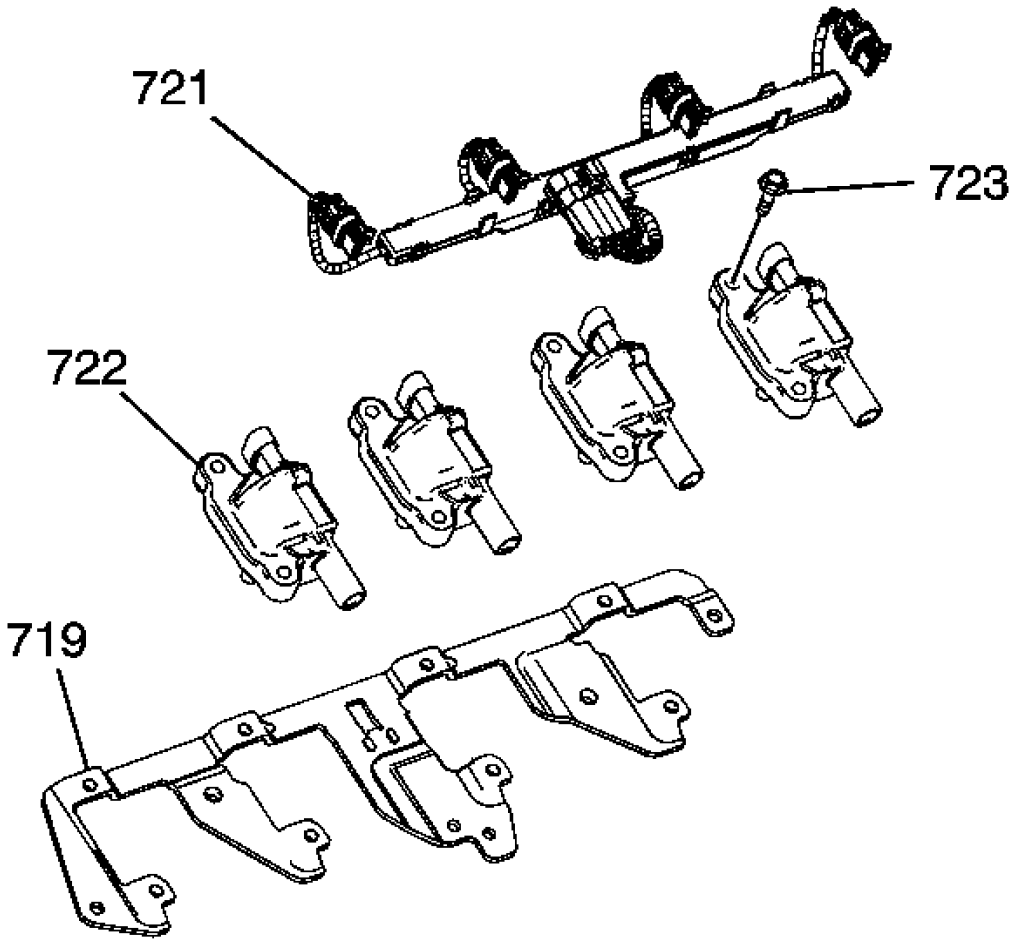


Fig. 3: View Of Bracket, Bolts, Coils & Wire Harness
Courtesy of GENERAL MOTORS CORP.

5. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the ignition coil bolts (723).
6. Install the ignition coils (722), wire harness (721), and bolts (723) to the bracket (719). Tighten the ignition coil bolts to 10 N.m (89 lb in).

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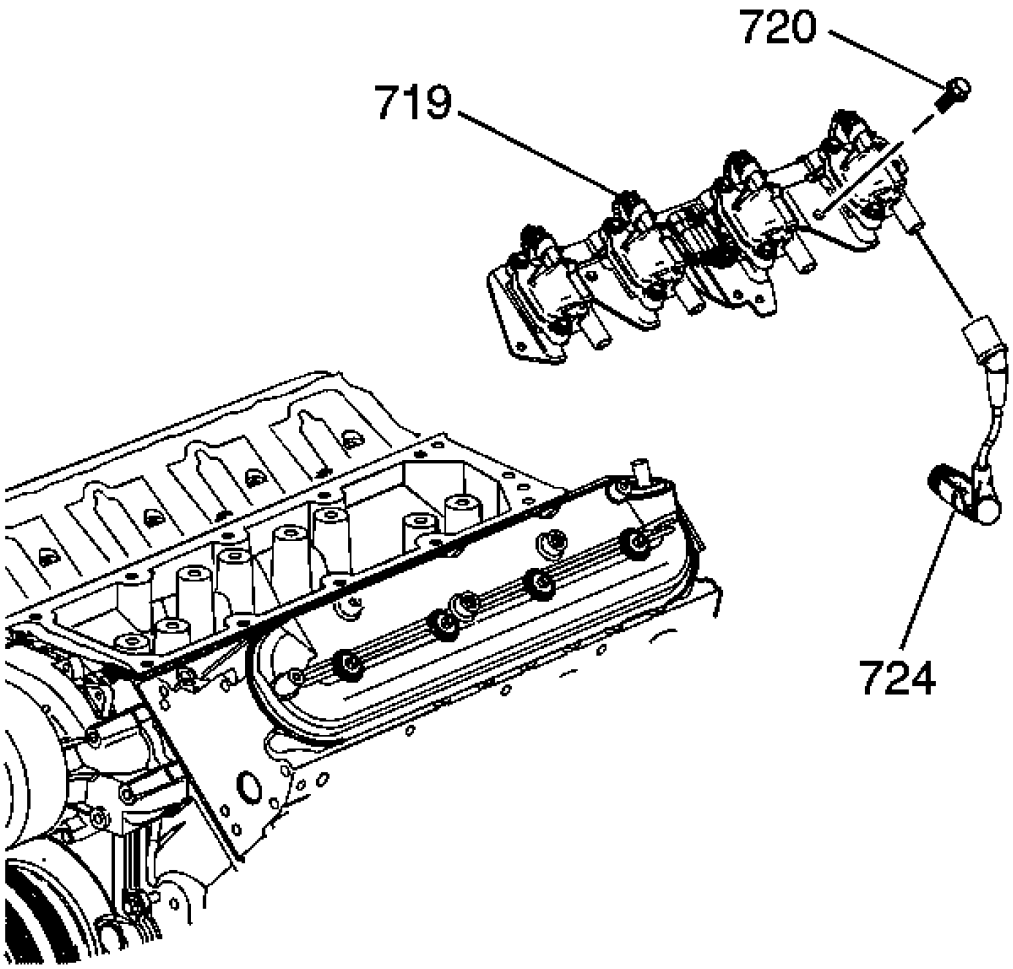


Fig. 4: Ignition Coils & Bracket
Courtesy of GENERAL MOTORS CORP.

7. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the ignition coil bracket studs (720).
8. Install the ignition coil and bracket assembly (719) and studs (720). Tighten the bracket studs to 12 N.m (106 lb in).

VALVE ROCKER ARM COVER INSTALLATION - RIGHT SIDE

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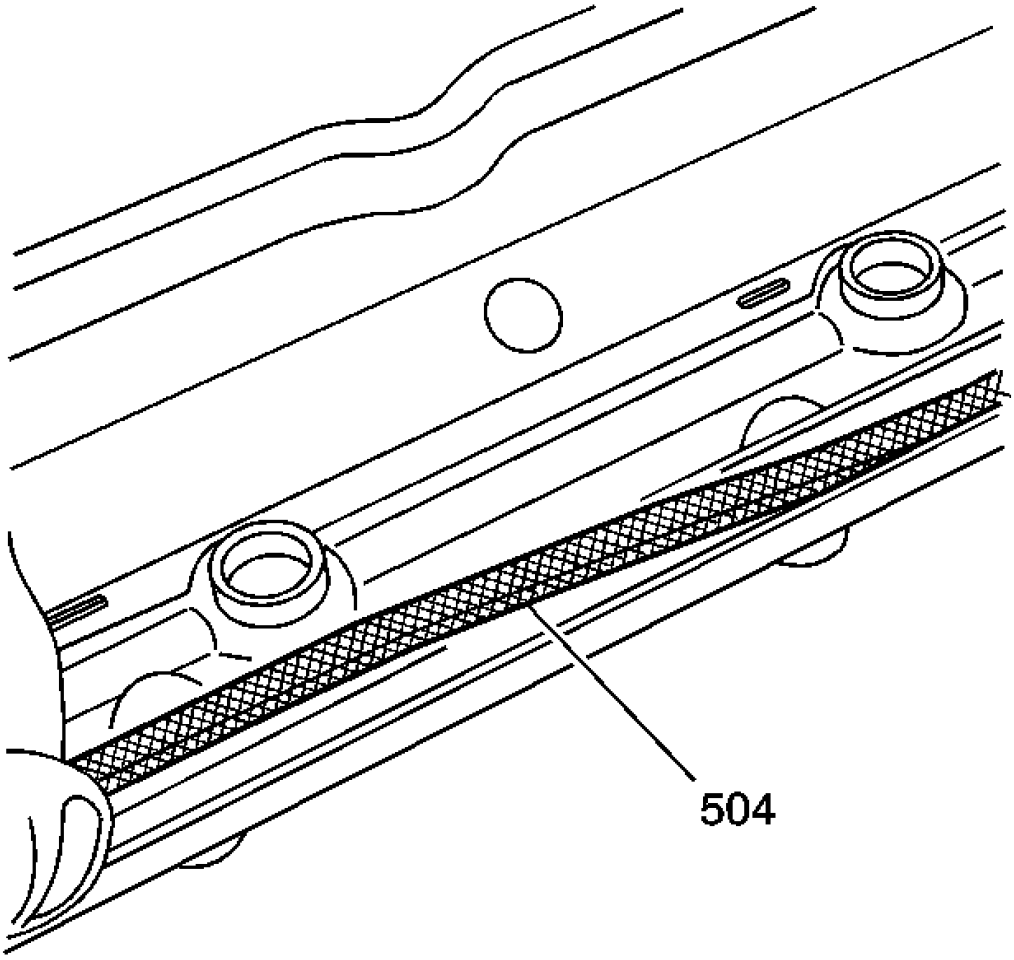


Fig. 5: View Of Valve Rocker Arm Cover Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **All gasket surfaces should be free of oil or other foreign material during assembly.**
- **DO NOT use the valve rocker arm cover gasket again.**

1. Install NEW valve rocker arm cover grommets and use NEW valve rocker arm cover bolts if they are serviced with the grommet.
2. Install a NEW gasket (504) into the valve rocker arm cover.

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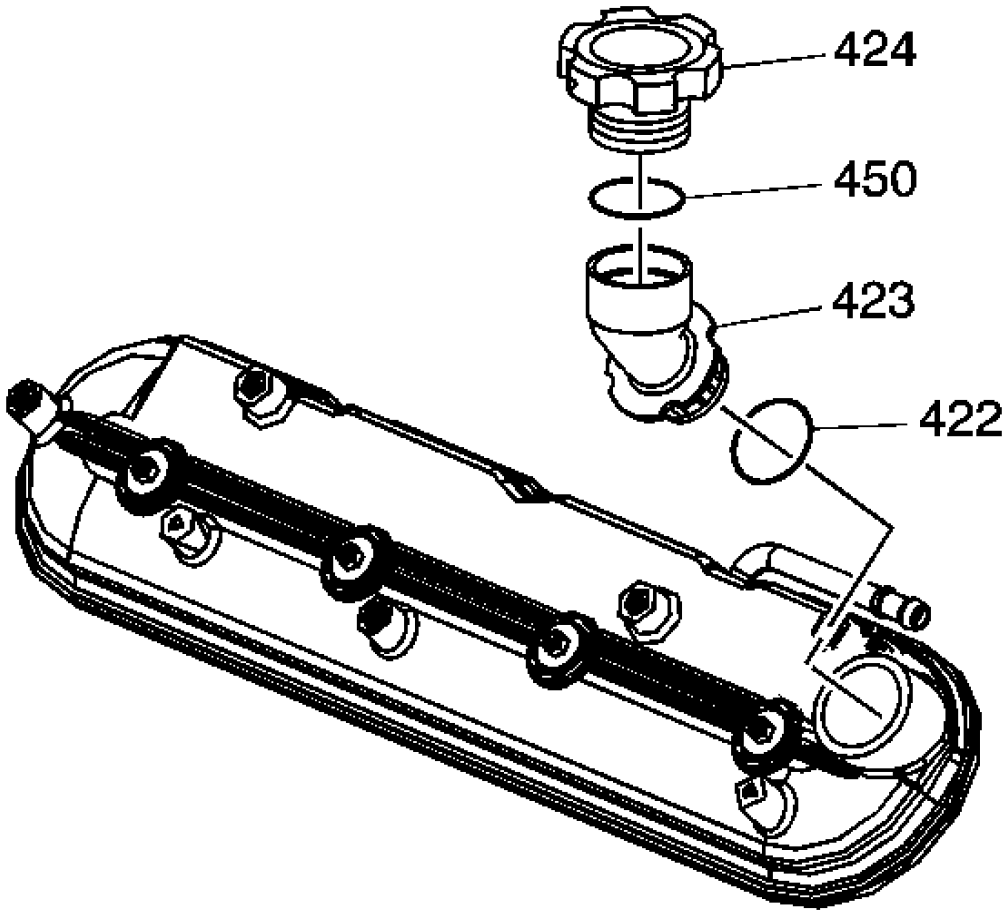


Fig. 6: Oil Fill Cap & Oil Fill Tube
Courtesy of GENERAL MOTORS CORP.

3. Install a NEW oil fill tube (423) to the valve rocker arm cover.
4. Install the oil fill cap (424).

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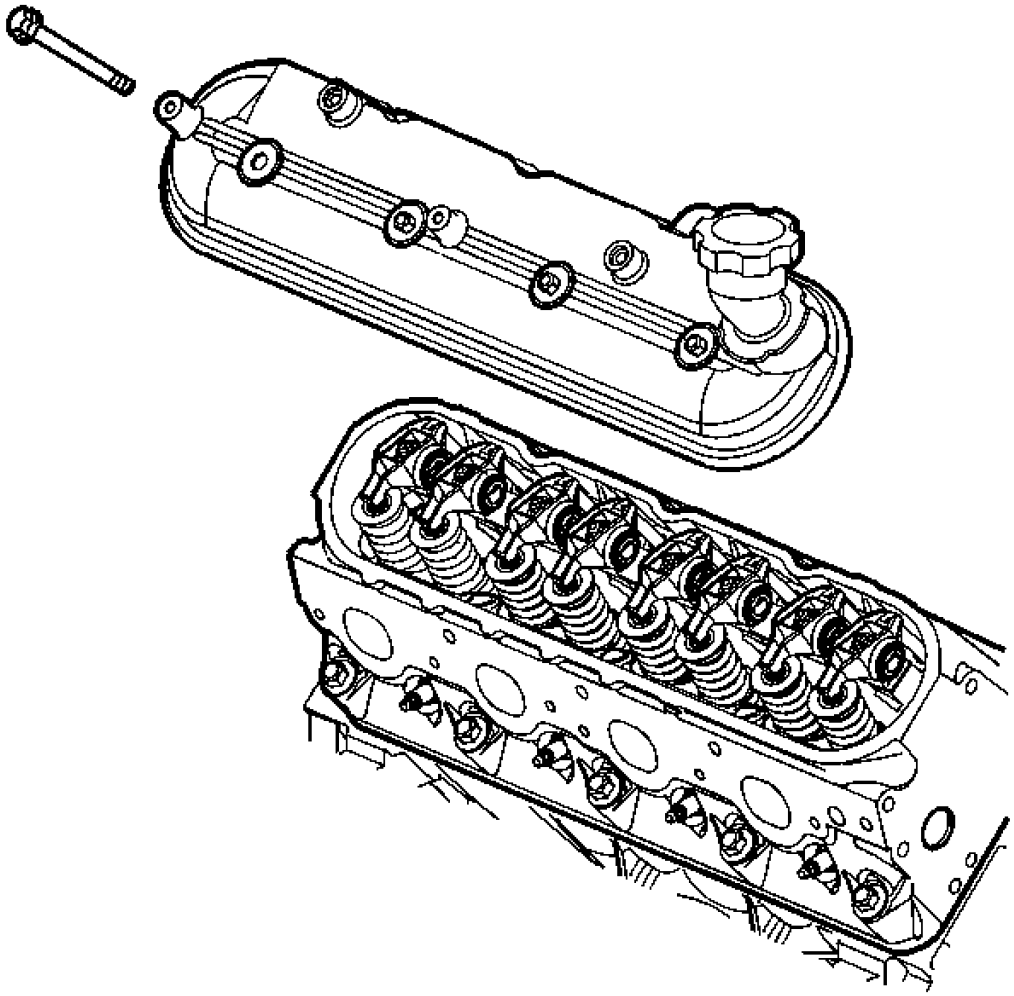


Fig. 7: View Of Valve Rocker Arm Cover & Bolts (Right)
Courtesy of GENERAL MOTORS CORP.

5. Install the valve rocker arm cover onto the cylinder head.

CAUTION: Refer to Fastener Caution .

6. Install the cover bolts with grommets and tighten to 12 N.m (106 lb in).

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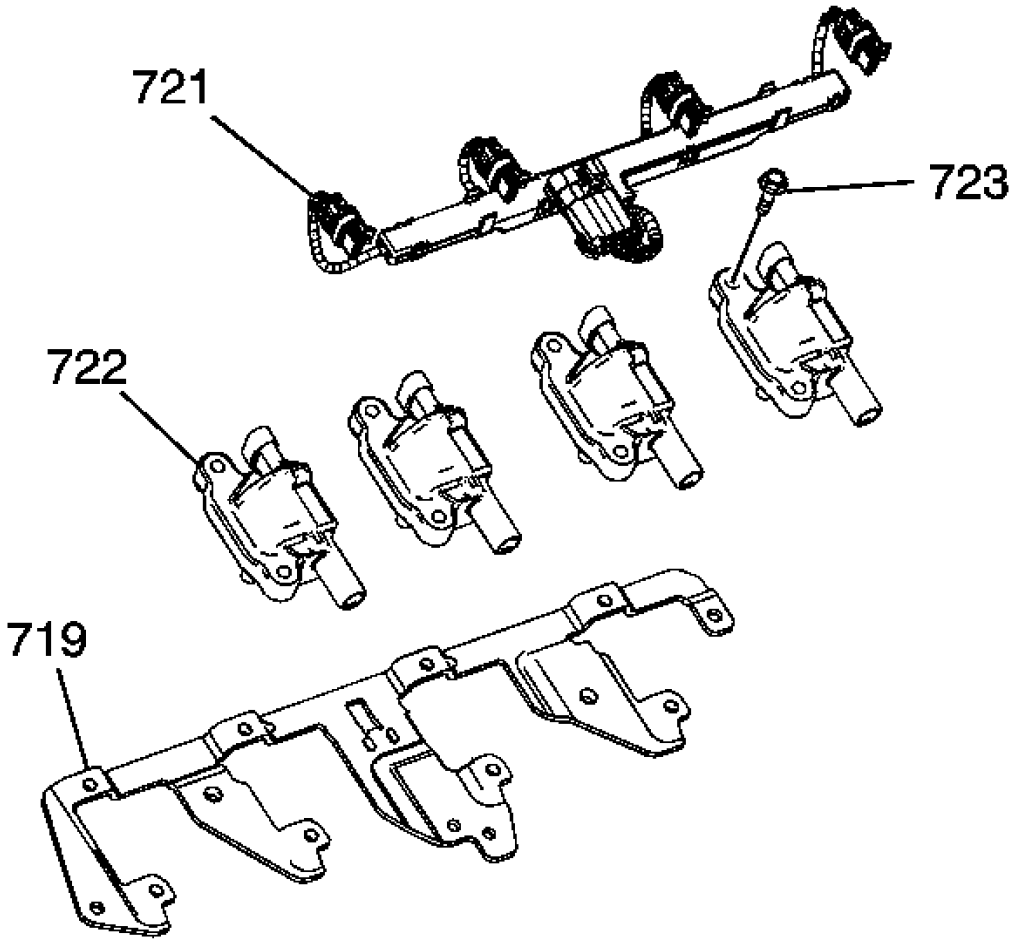


Fig. 8: View Of Bracket, Bolts, Coils & Wire Harness
Courtesy of GENERAL MOTORS CORP.

7. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the ignition coil bolts (723).
8. Install the ignition coils (722), wire harness (721), and bolts (723) to the bracket (719). Tighten the ignition coil bolts to 10 N.m (89 lb in).

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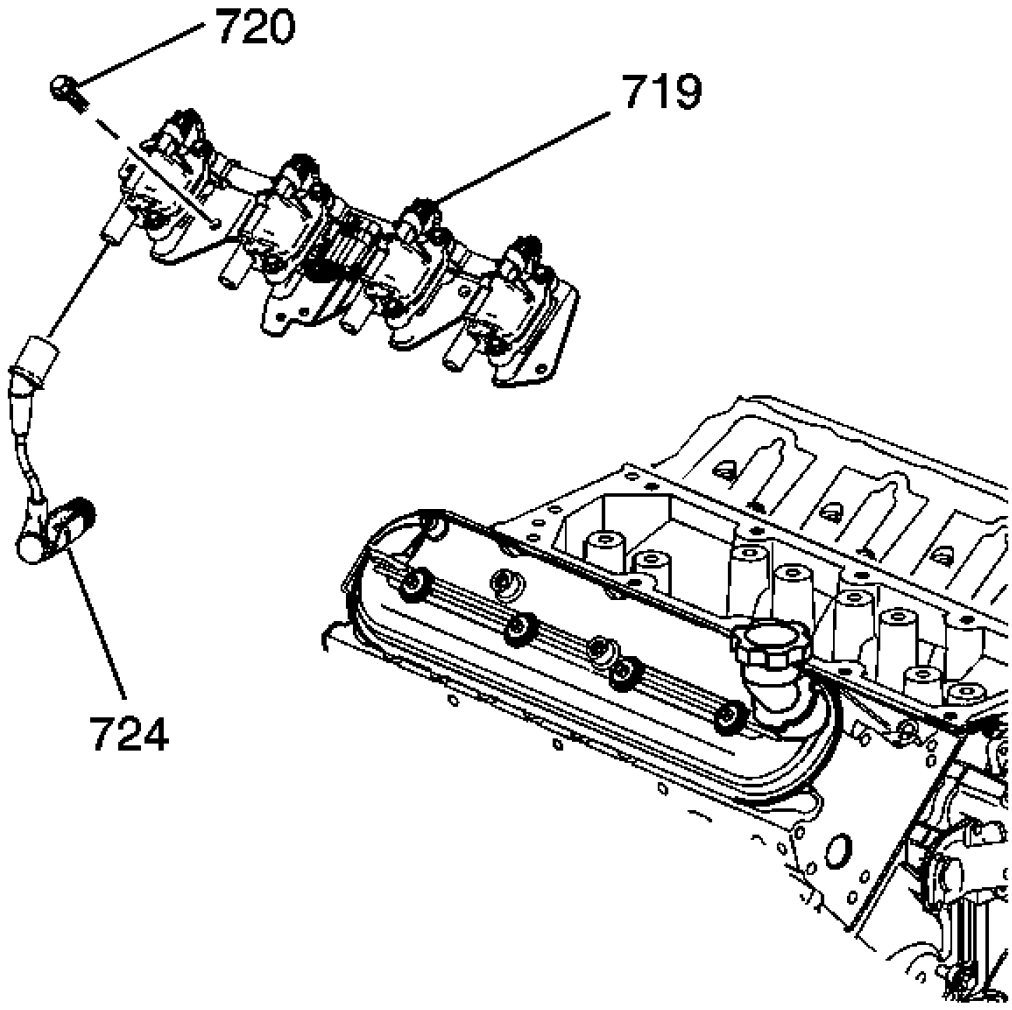


Fig. 9: Ignition Coils & Bracket
Courtesy of GENERAL MOTORS CORP.

9. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the ignition coil bracket studs (720).
10. Install the ignition coil and bracket assembly (719) and studs (720). Tighten the bracket studs to 12 N.m (106 lb in).

ENGINE BLOCK VALLEY COVER INSTALLATION (6.2L LS3)

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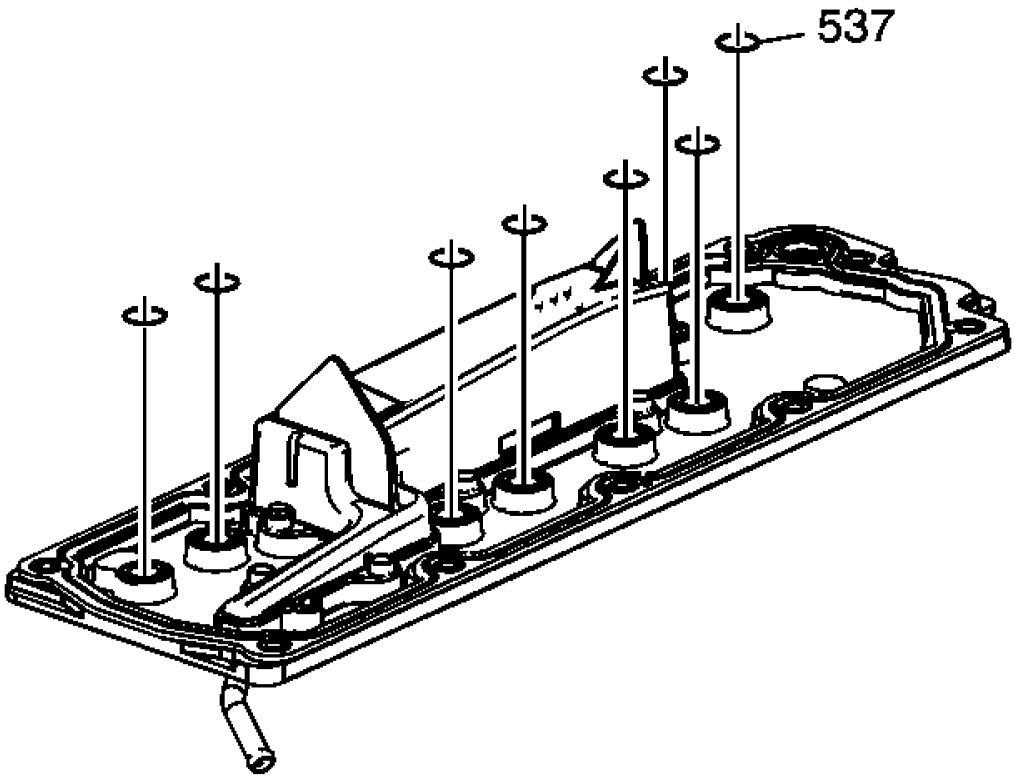


Fig. 10: Valley Cover Seals & Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE: All gasket surfaces should be free of oil or other foreign material during assembly.

1. Lubricate the O-ring seals (537) with clean engine oil.
2. Install the O-ring seals (537) to the cover.

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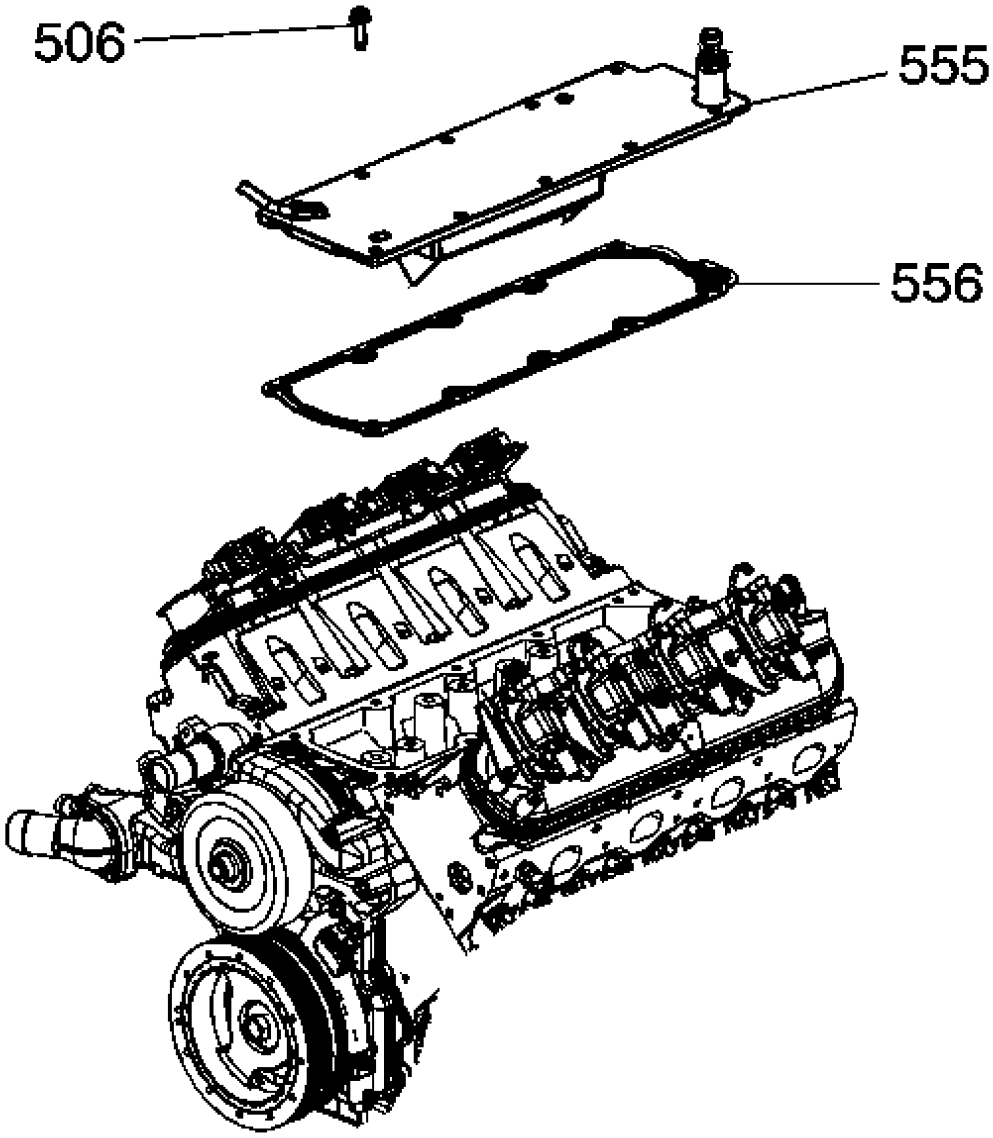


Fig. 11: View Of Cover, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install the cover (555), gasket (556), and bolts (506). Tighten the cover bolts to 25 N.m (18 lb ft).

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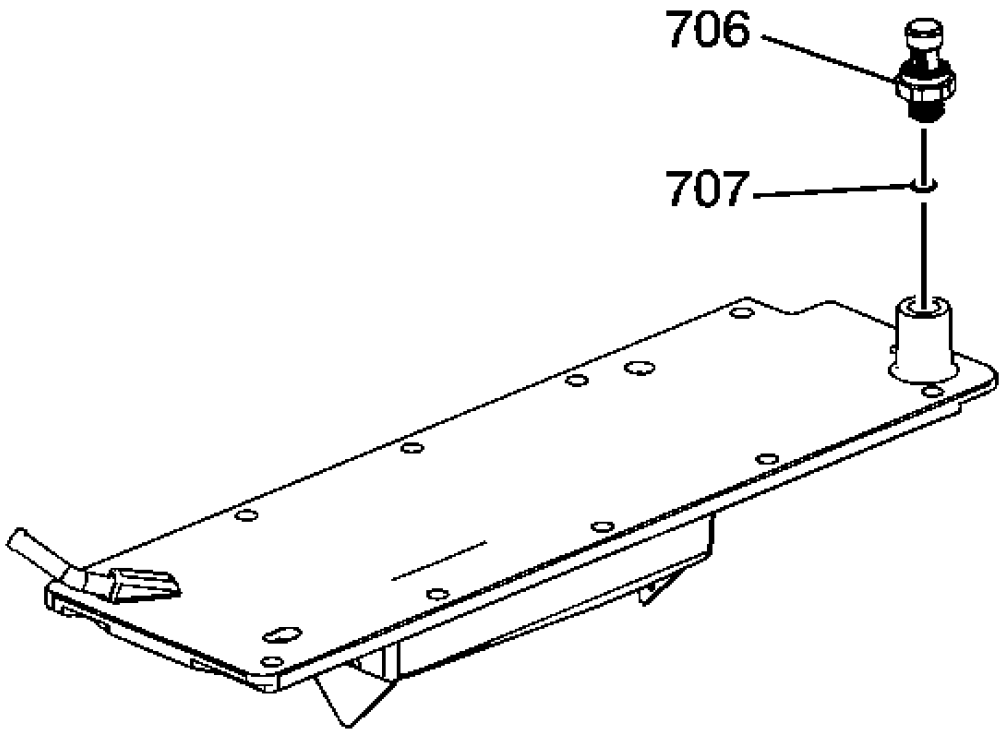


Fig. 12: Oil Pressure Sensor & Washer
Courtesy of GENERAL MOTORS CORP.

4. Apply sealant GM P/N 12346004 (Canadian P/N 10953480), or equivalent, to the threads of the sensor.
5. Install the oil pressure sensor (706) and sealing washer (707). Tighten the sensor to 35 N.m (26 lb ft).

VALVE LIFTER OIL FILTER INSTALLATION

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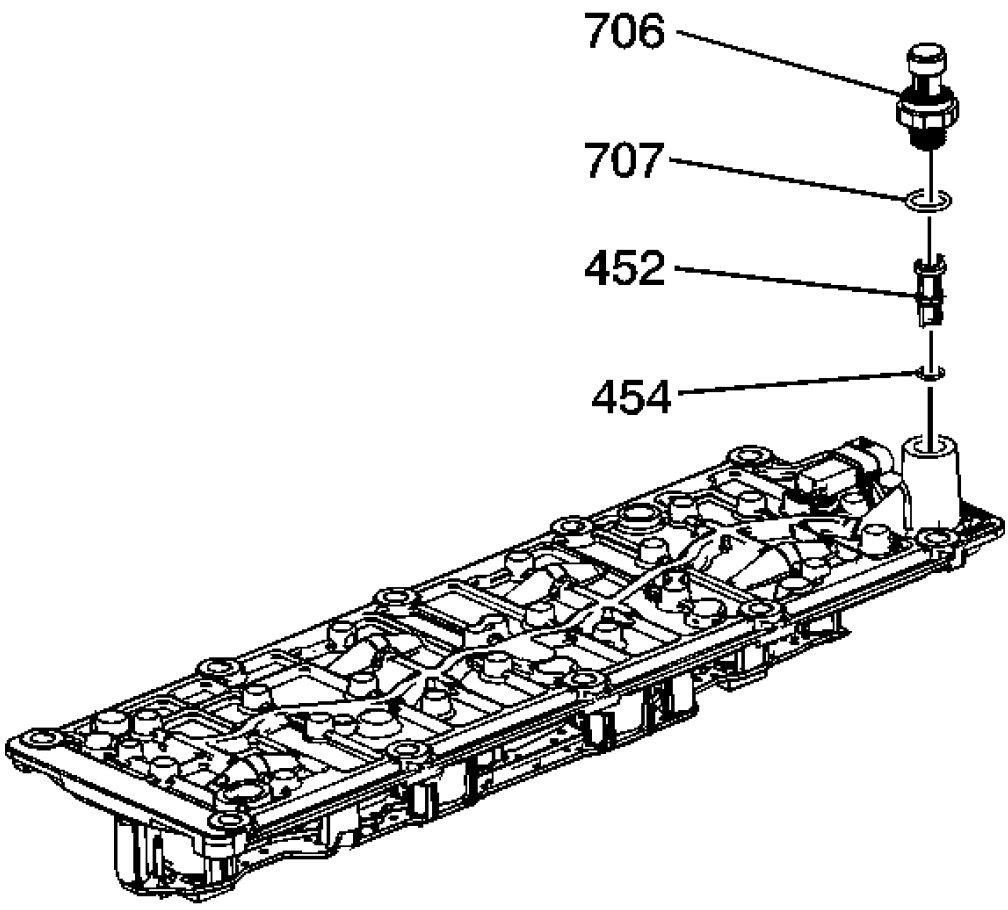


Fig. 13: View Of Oil Pressure Sensor, Washer & Valve Lifter Oil Filter
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not allow dirt or debris to enter the oil passages of the manifold. Plug, as required.

1. Install a NEW oil filter (452) and O-ring (454) assembly.
2. Apply sealant GM P/N 12346004 (Canadian P/N 10953480) to the threads of the sensor.

CAUTION: Refer to Fastener Caution .

3. Install the oil pressure sensor (706) and washer (707). Tighten the oil pressure sensor to 35 N.m (26 lb ft).

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VALVE LIFTER OIL MANIFOLD INSTALLATION

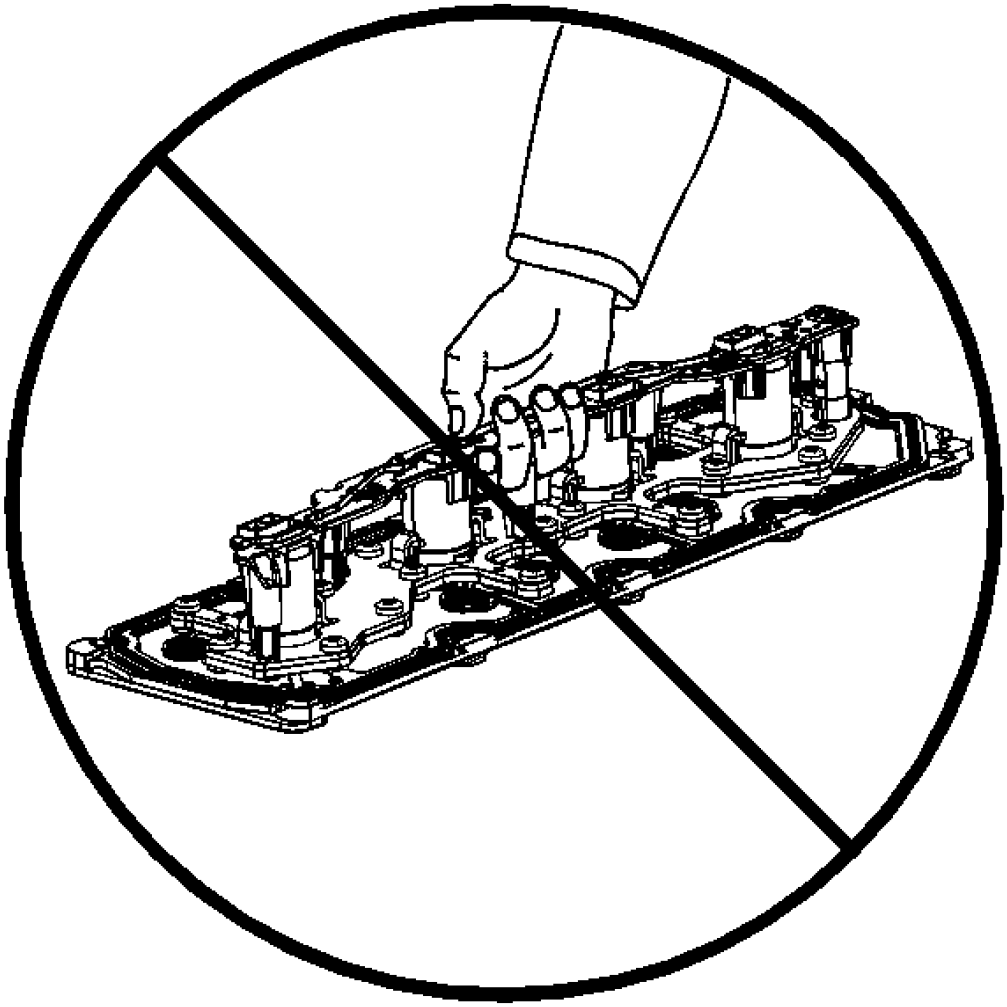


Fig. 14: Valve Lifter Oil Manifold Handling Precaution
Courtesy of GENERAL MOTORS CORP.

1. Do not lift the manifold assembly by the electrical lead frame.

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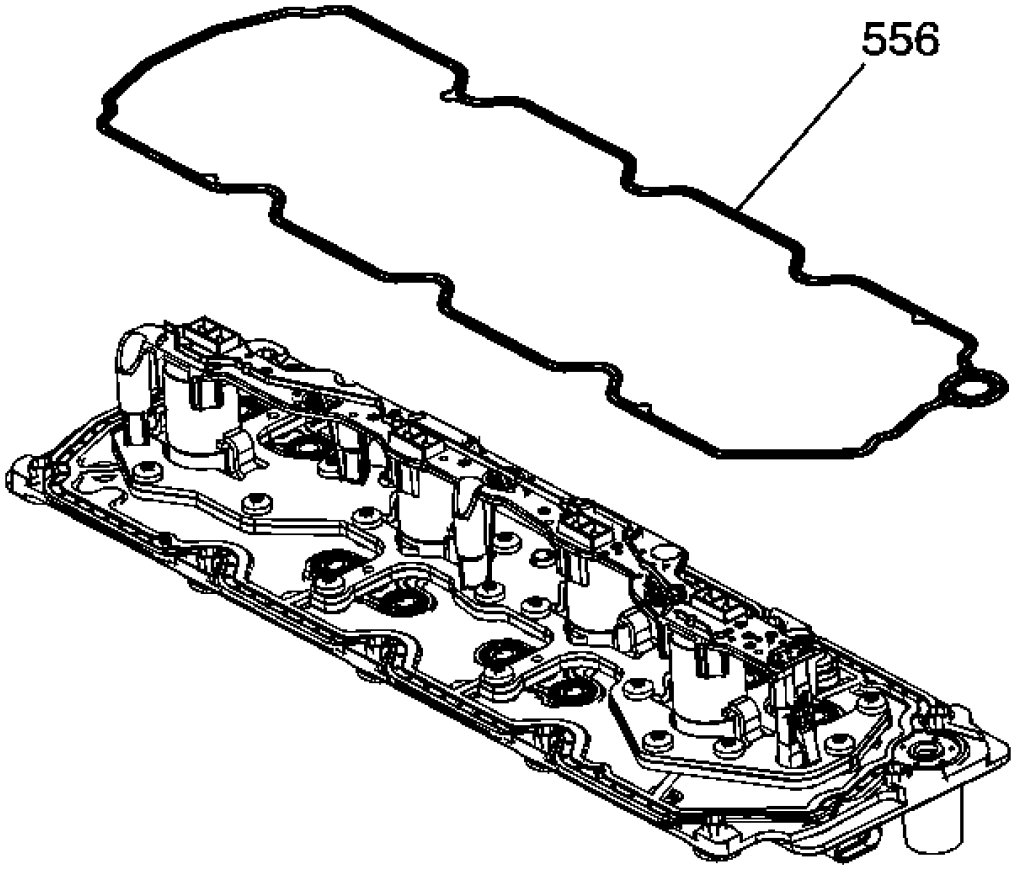


Fig. 15: View Of Outer Gasket
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **All gasket surfaces should be free of oil or other foreign material during assembly.**
- **Do not allow dirt or debris to enter the manifold. Plug, as required.**

2. Install the service gasket (556) onto the manifold.

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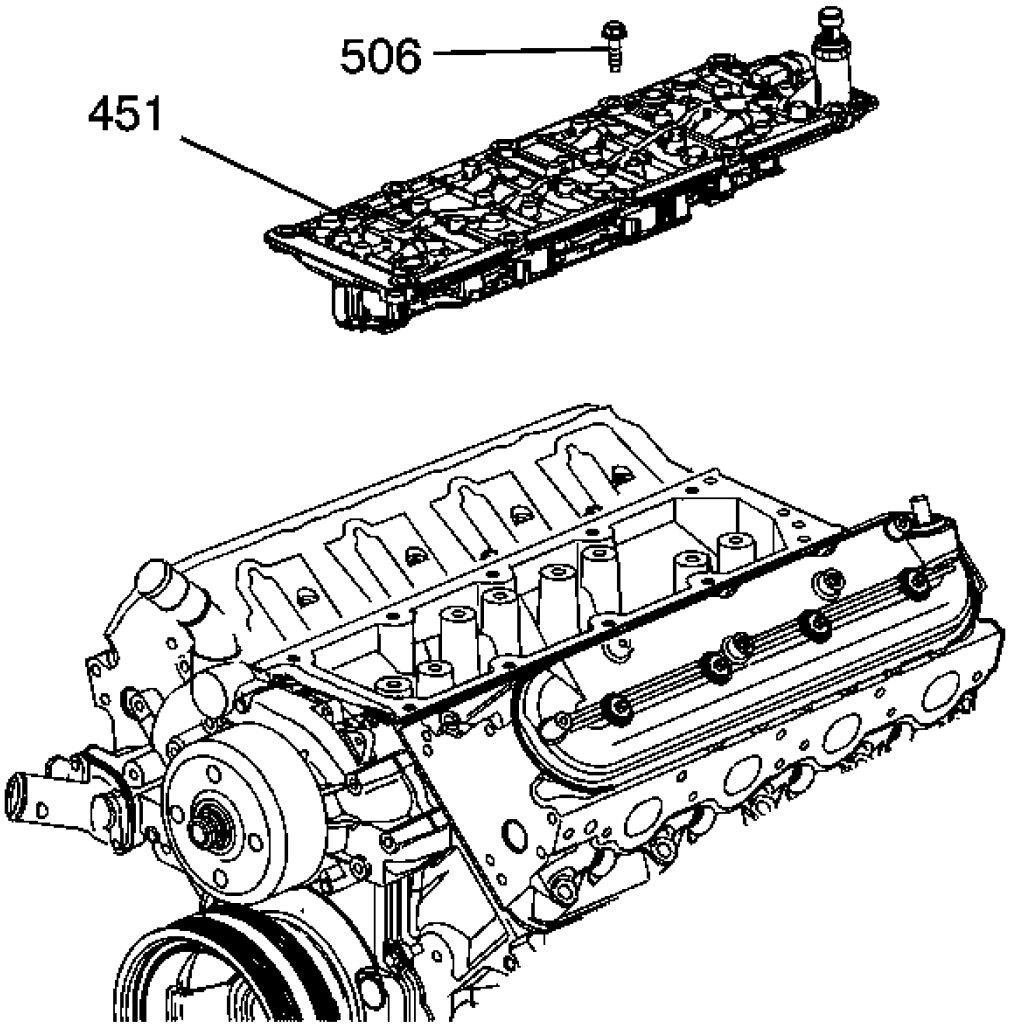


Fig. 16: View Of Valve Lifter Oil Manifold
Courtesy of GENERAL MOTORS CORP.

3. Install the manifold (451) with gasket.

CAUTION: Refer to Fastener Caution .

4. Install the manifold bolts (506) and tighten to 25 N.m (18 lb ft).

ENGINE COOLANT AIR BLEED PIPE AND HOLE COVER INSTALLATION

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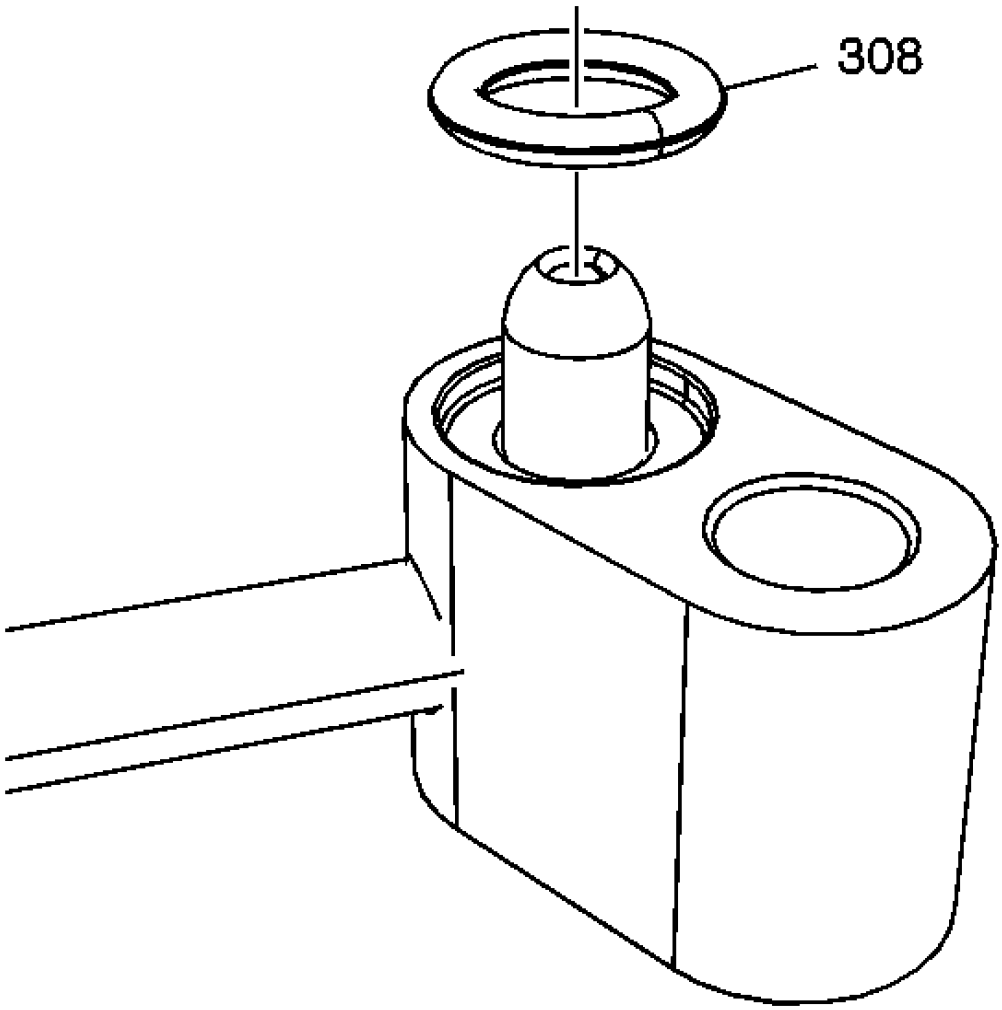


Fig. 17: View Of Coolant Air Bleed Pipe Seal
Courtesy of GENERAL MOTORS CORP.

NOTE: Position the gasket O-ring seal (308) onto the nipple portion of the pipe.

1. Install the seals onto the engine coolant air bleed pipe and covers.

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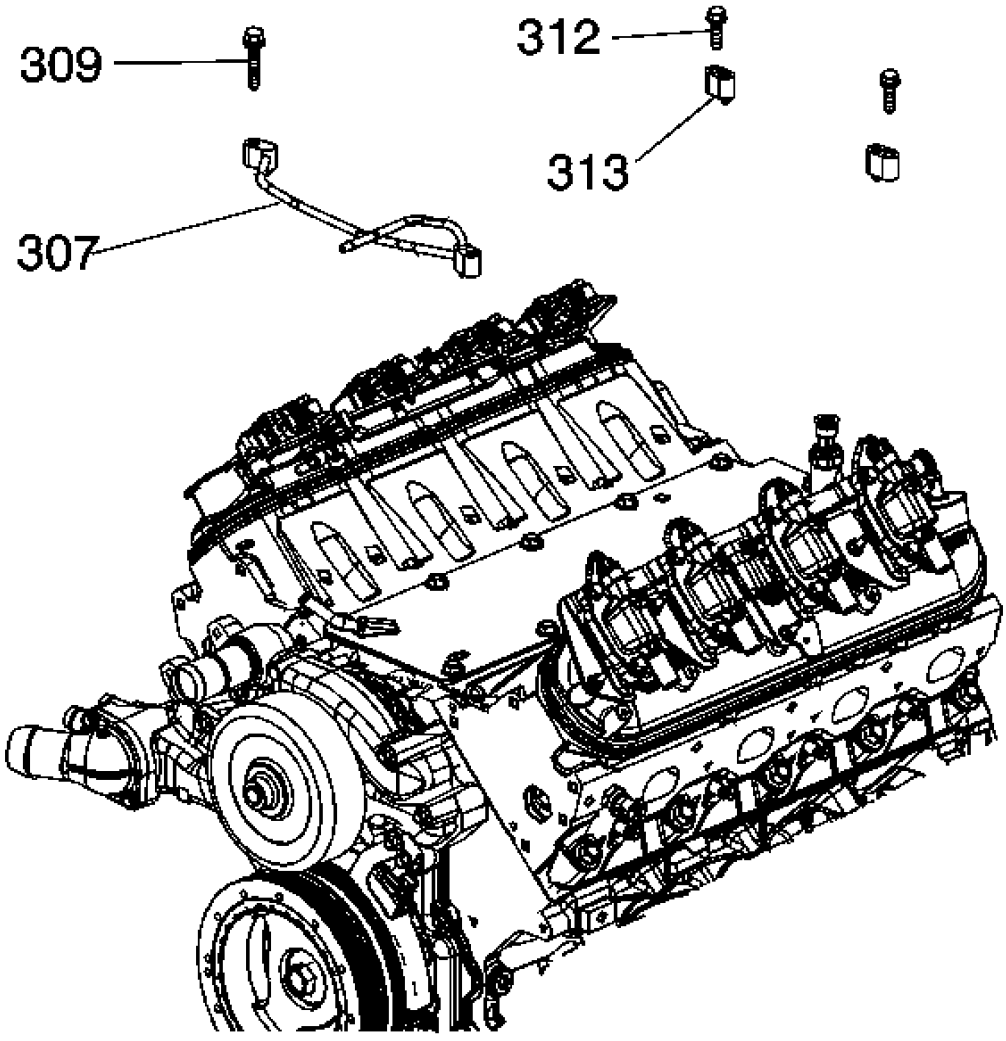


Fig. 18: Coolant Air Bleed Pipe, Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Install the pipe (307) and gaskets (308).

CAUTION: Refer to Fastener Caution .

3. Install the bolts (309) and tighten to 12 N.m (106 lb in).

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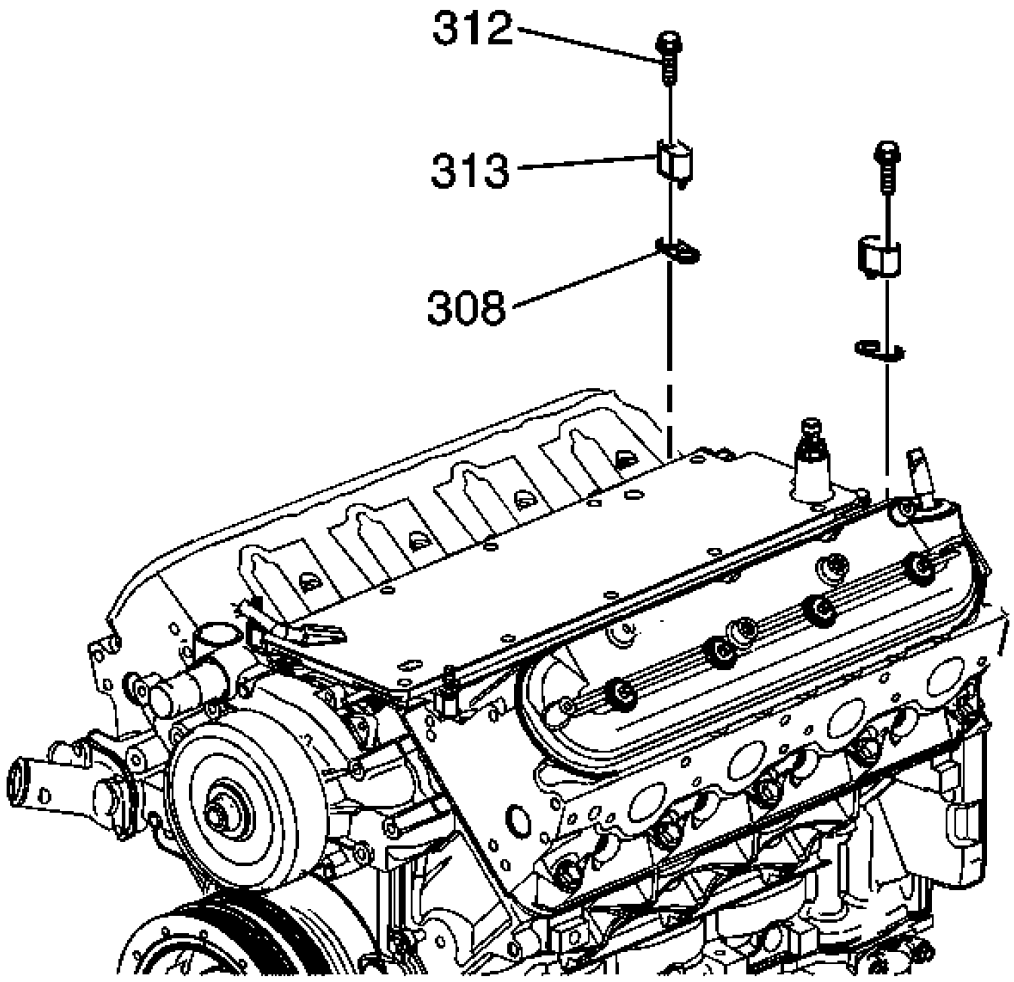


Fig. 19: Engine Coolant Air Bleed Cover, Bolts & Seals
Courtesy of GENERAL MOTORS CORP.

NOTE: Production engines use a rivet-type plug at the top rear coolant passage of each cylinder head. If service of a leaking plug is required, it is necessary to remove the cylinder head from the engine to properly remove the plug. Refer to Cylinder Head Disassemble .

4. As required, install either a new plug or the earlier design coolant air bleed covers (313) and gaskets (308). Refer to **Cylinder Head Assemble** .
5. Install the bolts (312).
6. Tighten the cover bolts to 12 N.m (106 lb in).

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INTAKE MANIFOLD INSTALLATION

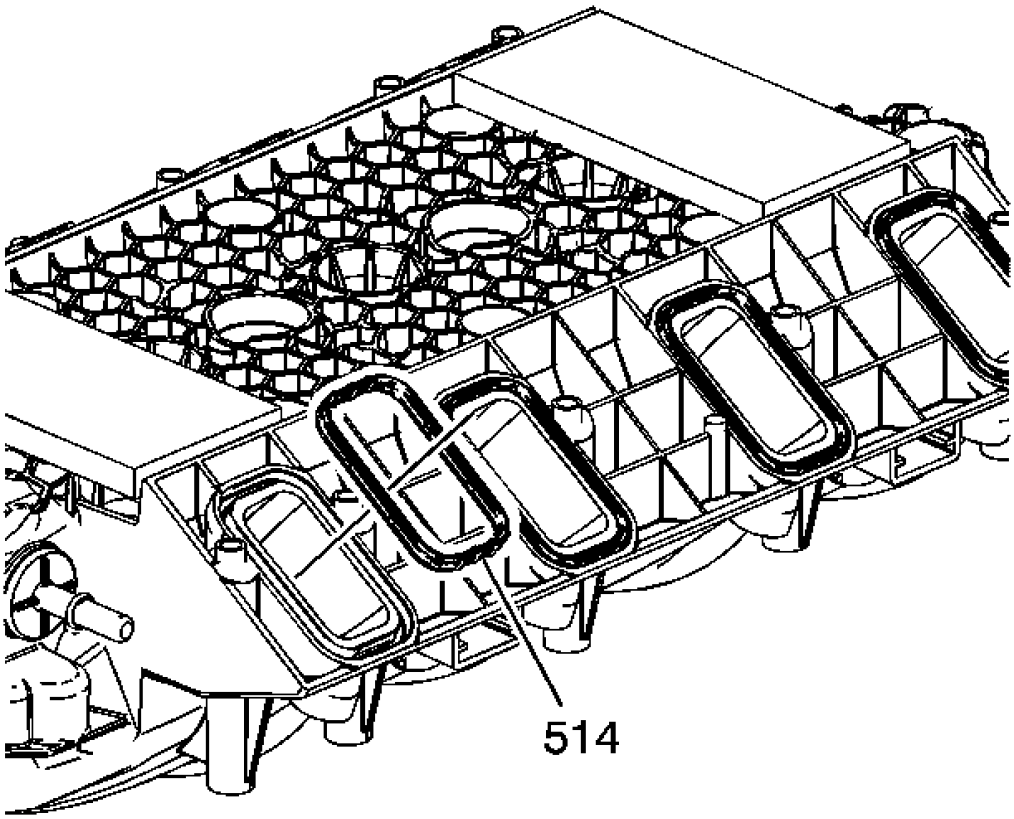


Fig. 20: View Of Intake Manifold-To-Cylinder Head Gaskets
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **The intake manifold, throttle body, fuel injection rail, and fuel injectors may be removed as an assembly. If not servicing the individual components, install the intake manifold as a complete assembly.**
- **DO NOT use the intake manifold gaskets again. Install NEW intake manifold-to-cylinder head gaskets.**

1. Install NEW intake manifold-to-cylinder head gaskets (514).

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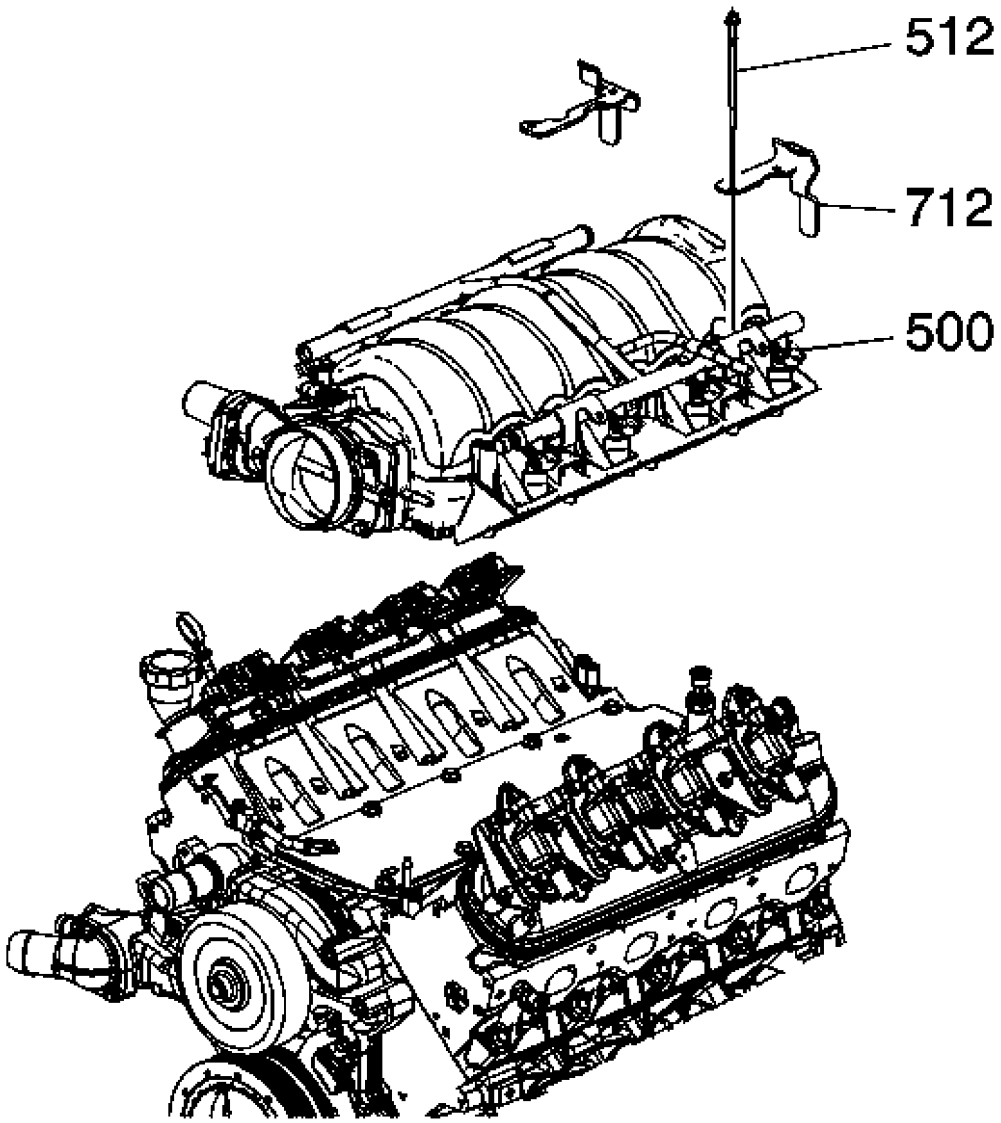


Fig. 21: Identifying Intake Manifold Bolts & Fuel Rail Stop Brackets
Courtesy of GENERAL MOTORS CORP.

2. Install the intake manifold (500).
3. Apply a 5 mm (0.20 in) band of threadlock GM P/N 12345382 (Canadian P/N 10953489) to the threads of the intake manifold bolts (512). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
4. Install the intake manifold bolts (512) and fuel rail stop brackets (712).

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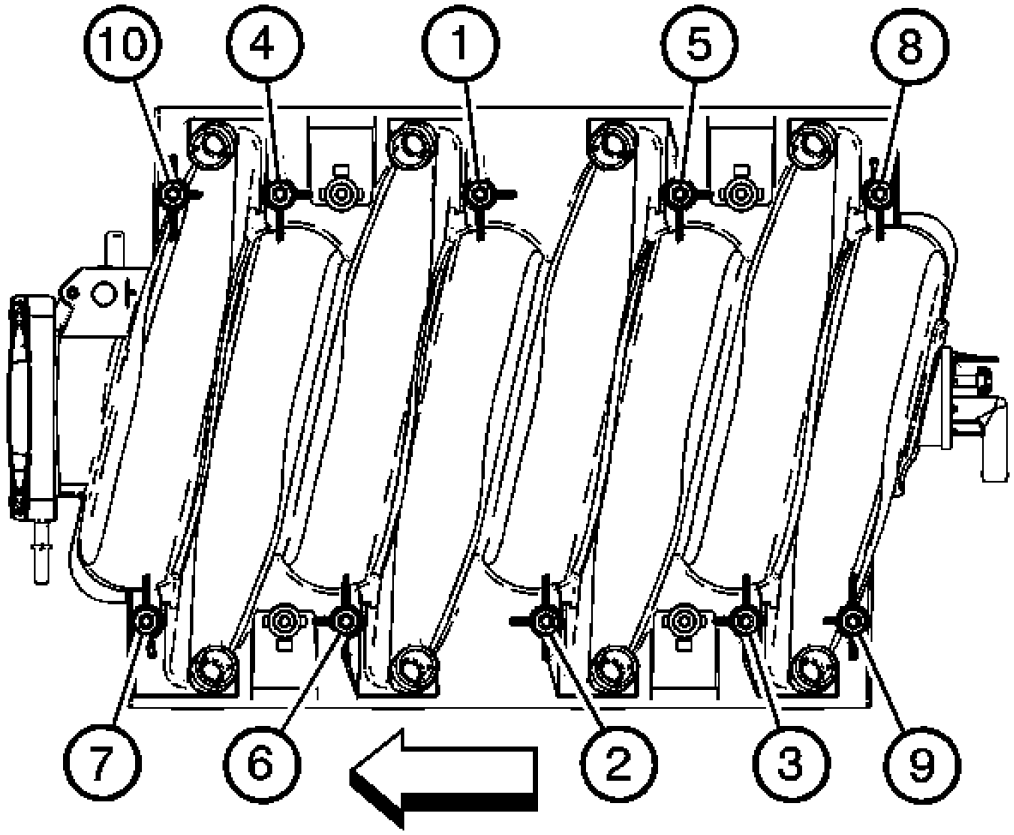


Fig. 22: Identifying Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

5. Tighten the intake manifold bolts:
    1. Tighten the intake manifold bolts (1-10) a first pass in sequence to 5 N.m (44 lb in) .
    2. Tighten the intake manifold bolts (1-10) a final pass in sequence to 10 N.m (89 lb in) .

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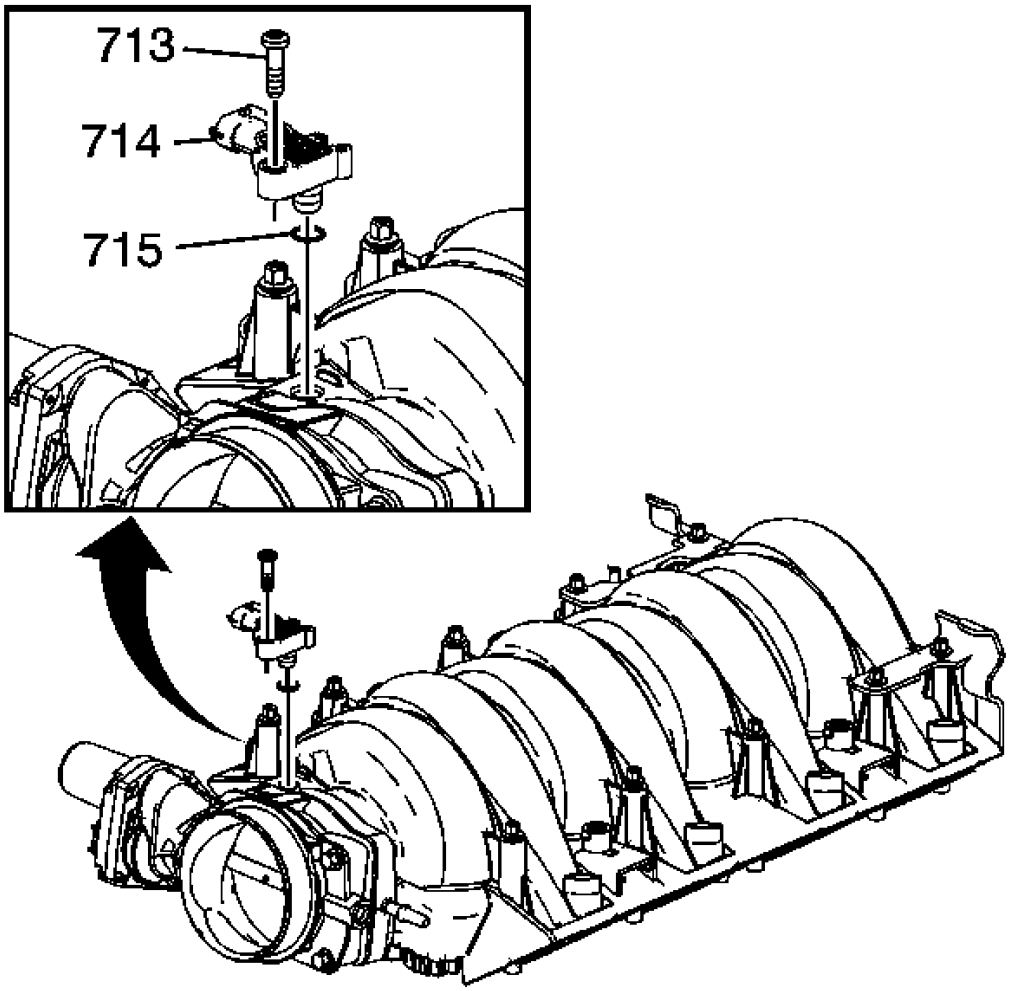


Fig. 23: Identifying Sensor Grommet, MAP Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

6. Lubricate the manifold absolute pressure (MAP) sensor grommet (715) with clean engine oil.
7. Install the MAP sensor (714) and grommet (715).
8. Install the MAP sensor bolt (713).

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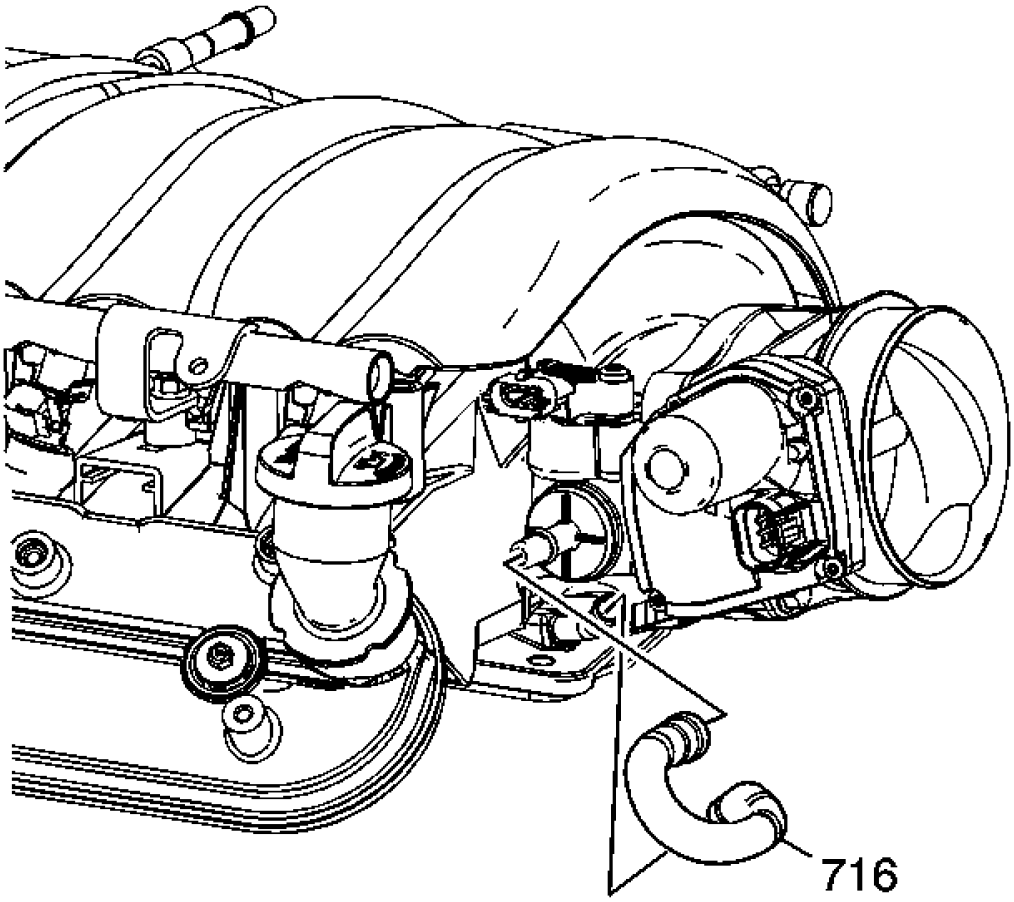


Fig. 24: Removing/Installing Positive Crankcase Ventilation Dirty Air Hose
Courtesy of GENERAL MOTORS CORP.

9. Install the positive crankcase ventilation (PCV) - dirty air hose (716).
10. Install the PCV - fresh air hose.

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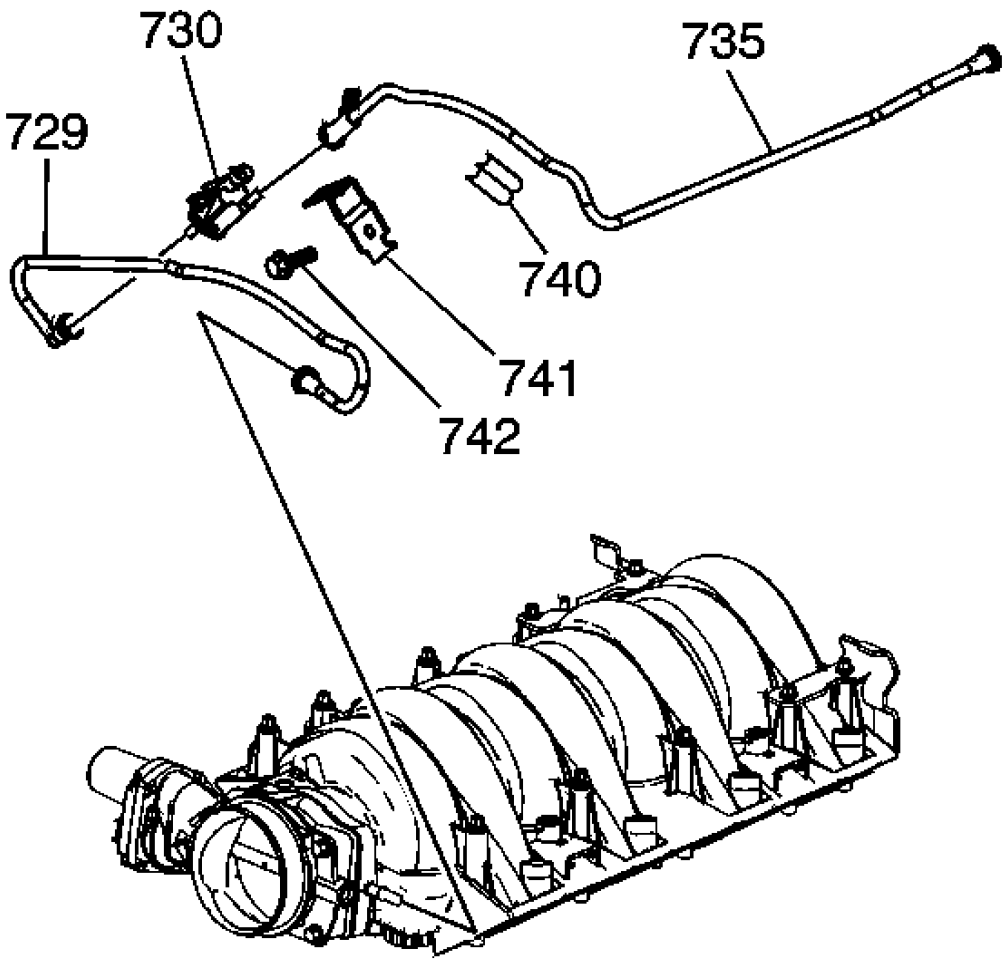


Fig. 25: Identifying Evaporative Emission Components
Courtesy of GENERAL MOTORS CORP.

11. Install the evaporative emission (EVAP) canister purge solenoid valve (730), bracket (741), and bolt (742). Tighten the bolt to 50 N.m (37 lb ft).
12. Install the EVAP tubes (729 and 735).
13. Install the fuel rail. Refer to **Fuel Rail and Injectors Installation**.

FUEL RAIL AND INJECTORS INSTALLATION

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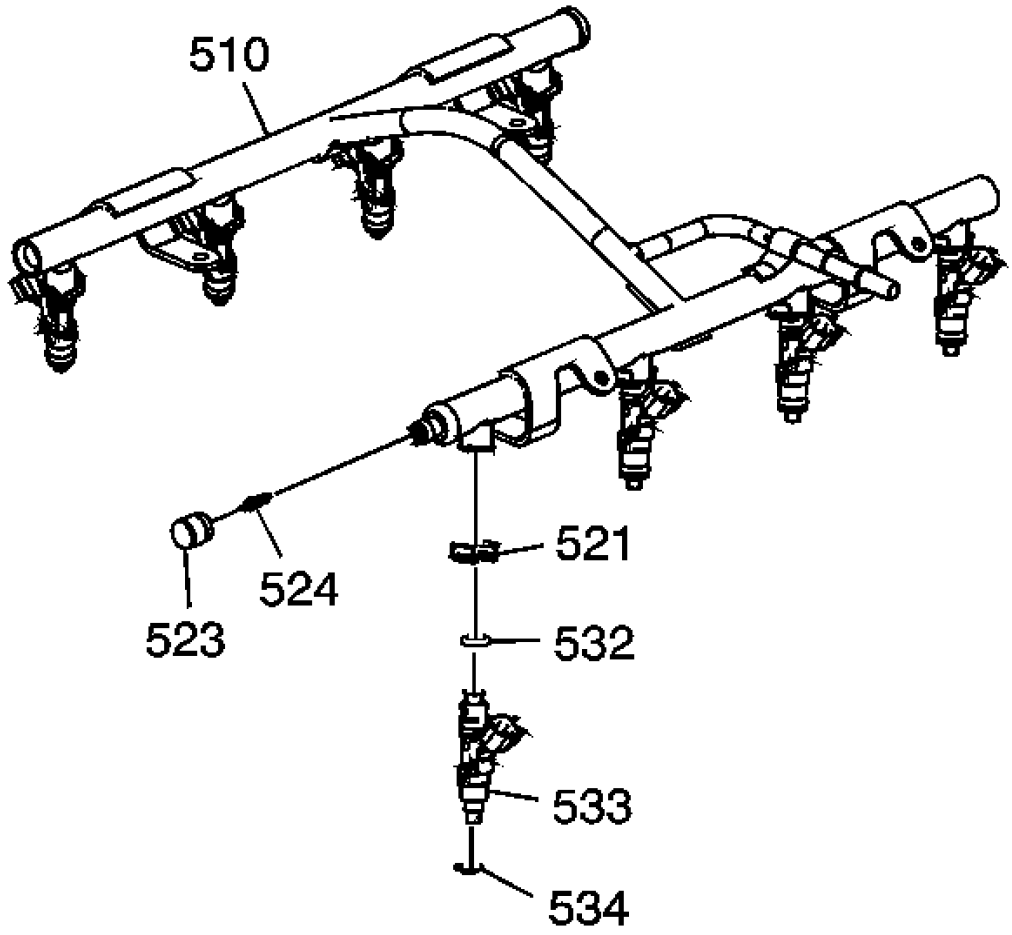


Fig. 26: Fuel Injectors & Retainers
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Fuel Rail Stop Bracket Installation Warning .

NOTE: DO NOT use the fuel injector O-ring seals again. Install NEW fuel injector O-ring seals during assembly.

1. Lubricate the NEW fuel injector O-ring seals (532 and 534) with clean engine oil.
2. Install the O-ring seals to the fuel injectors.
3. Install the fuel injectors (533) and retainers (521).

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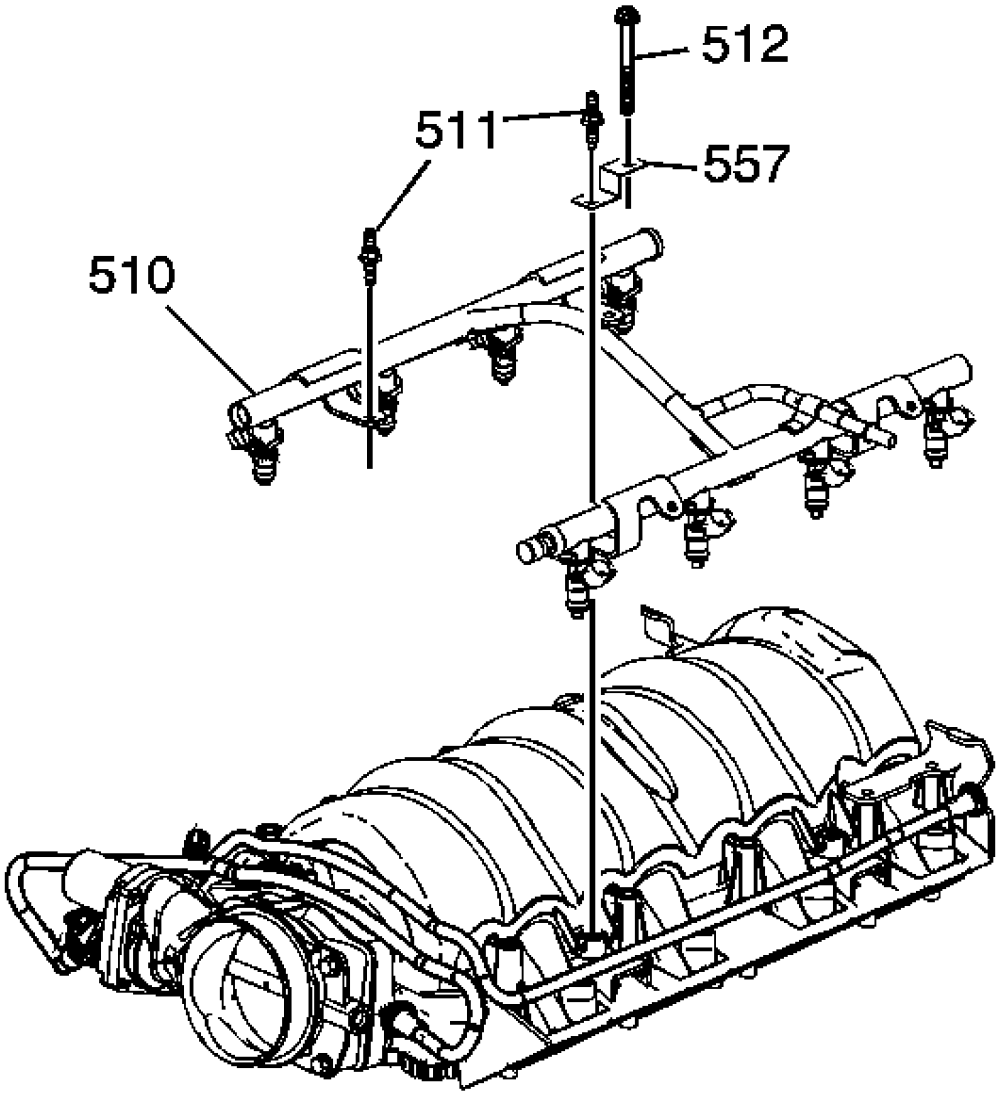


Fig. 27: Removing/Installing Bolts, Ground Strap, Fuel Rail & Injectors
Courtesy of GENERAL MOTORS CORP.

4. Install the fuel rail assembly (510) to the manifold. Push firmly on both sides of the rail until all injectors have entered their bores.
5. Apply a 5 mm (0.2 in) band of threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the fuel rail bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

CAUTION: Refer to Fastener Caution .

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6. Install the fuel rail bolts (511 and 512) and fuel rail ground strap (557). Tighten the fuel rail bolts to 10 N.m (89 lb in).

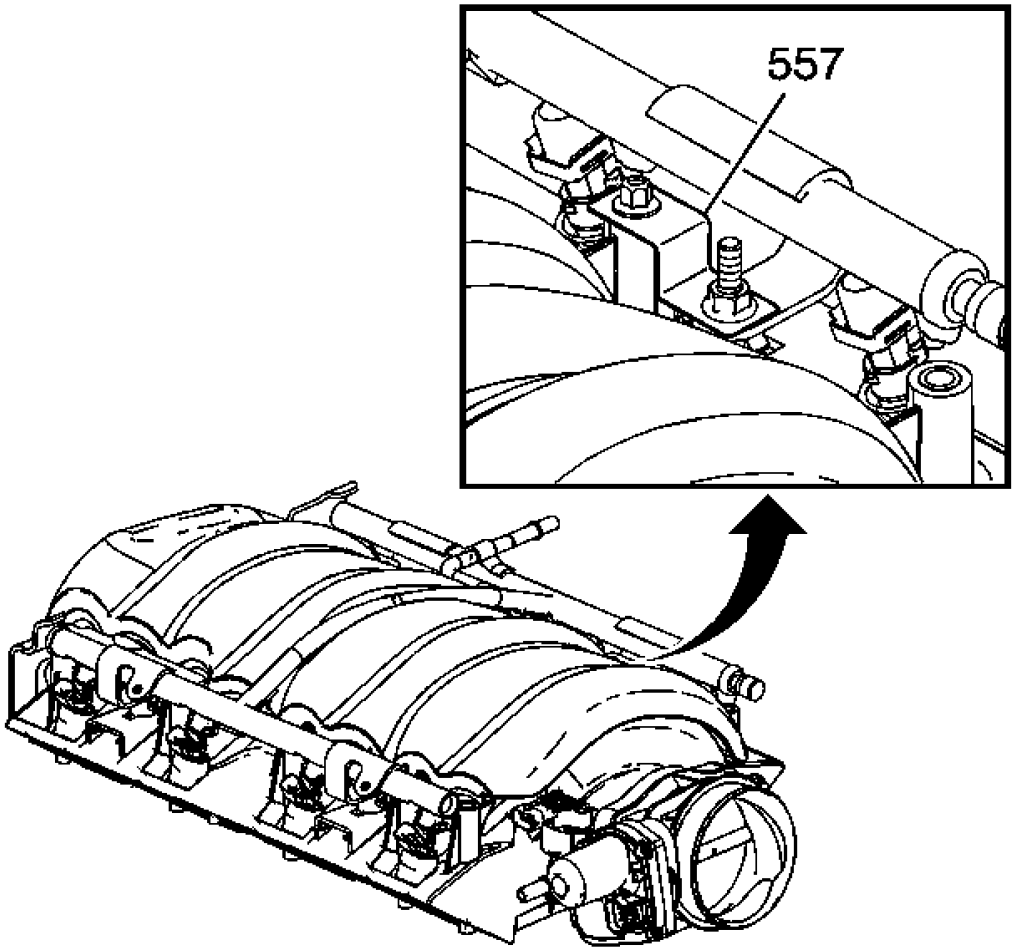


Fig. 28: Fuel Rail Ground Strap
Courtesy of GENERAL MOTORS CORP.

7. Inspect the fuel rail ground strap (557) for proper installation.

THROTTLE BODY ASSEMBLY INSTALLATION

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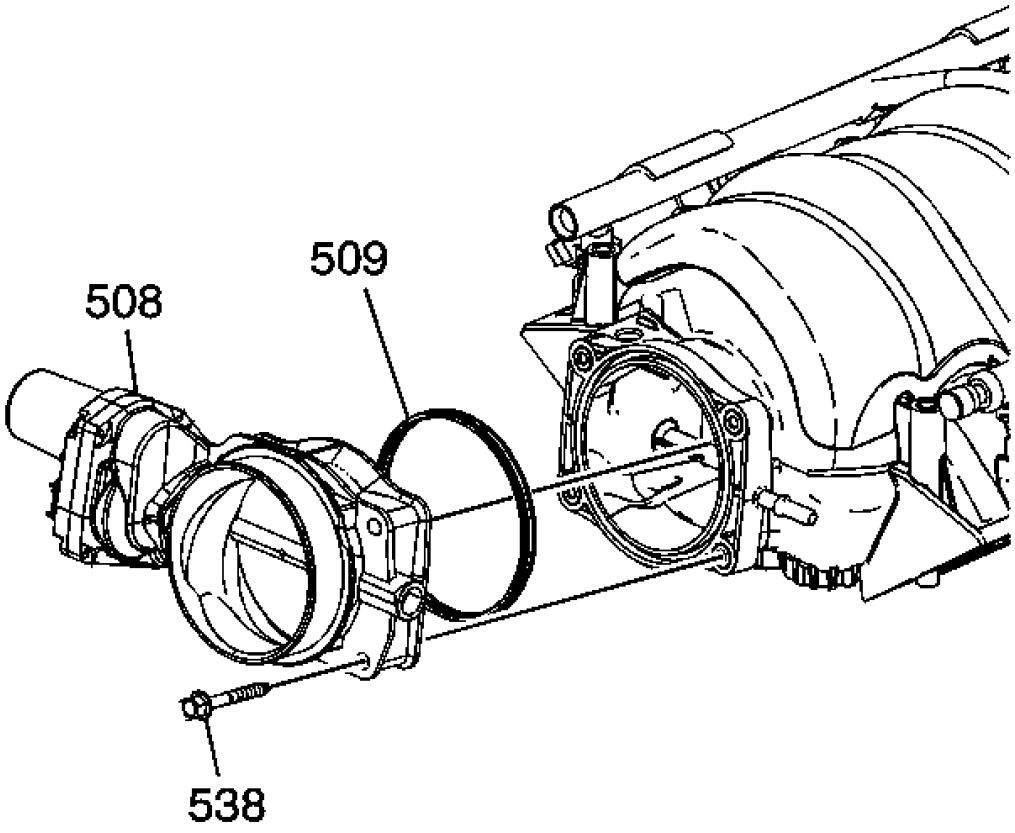


Fig. 29: Removing/Installing Throttle Body
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT use the throttle body gasket again. Install a NEW gasket during assembly.

1. Install the throttle body gasket (509) to the intake manifold. Align the locating tab of the gasket with the notch in the manifold.

CAUTION: Refer to Fastener Caution .

2. Install the throttle body (508) and bolts (538). Tighten the throttle body bolts to 10 N.m (89 lb in).

WATER PUMP INSTALLATION

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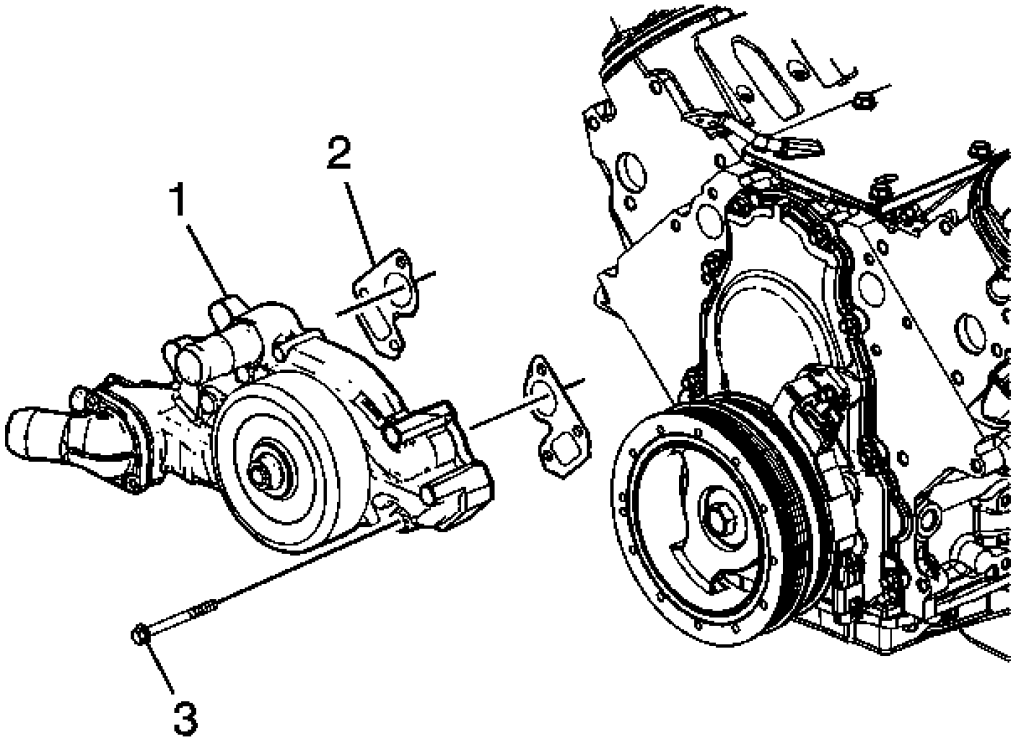


Fig. 30: Water Pump & Gaskets
Courtesy of GENERAL MOTORS CORP.

CAUTION: DO NOT use cooling system seal tabs, or similar compounds, unless otherwise instructed. The use of cooling system seal tabs, or similar compounds, may restrict coolant flow through the passages of the cooling system or the engine components. Restricted coolant flow may cause engine overheating and/or damage to the cooling system or the engine components/assembly.

NOTE: All gasket surfaces are to be free of oil or other foreign material during assembly.

1. Install the water pump (1) and NEW gaskets (2).

CAUTION: Refer to Fastener Caution .

2. Install the water pump bolts (3).

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1. Tighten the water pump bolts a first pass to 15 N.m (11 lb ft) .
2. Tighten the water pump bolts a final pass to 30 N.m (22 lb ft) .

EXHAUST MANIFOLD INSTALLATION - LEFT SIDE

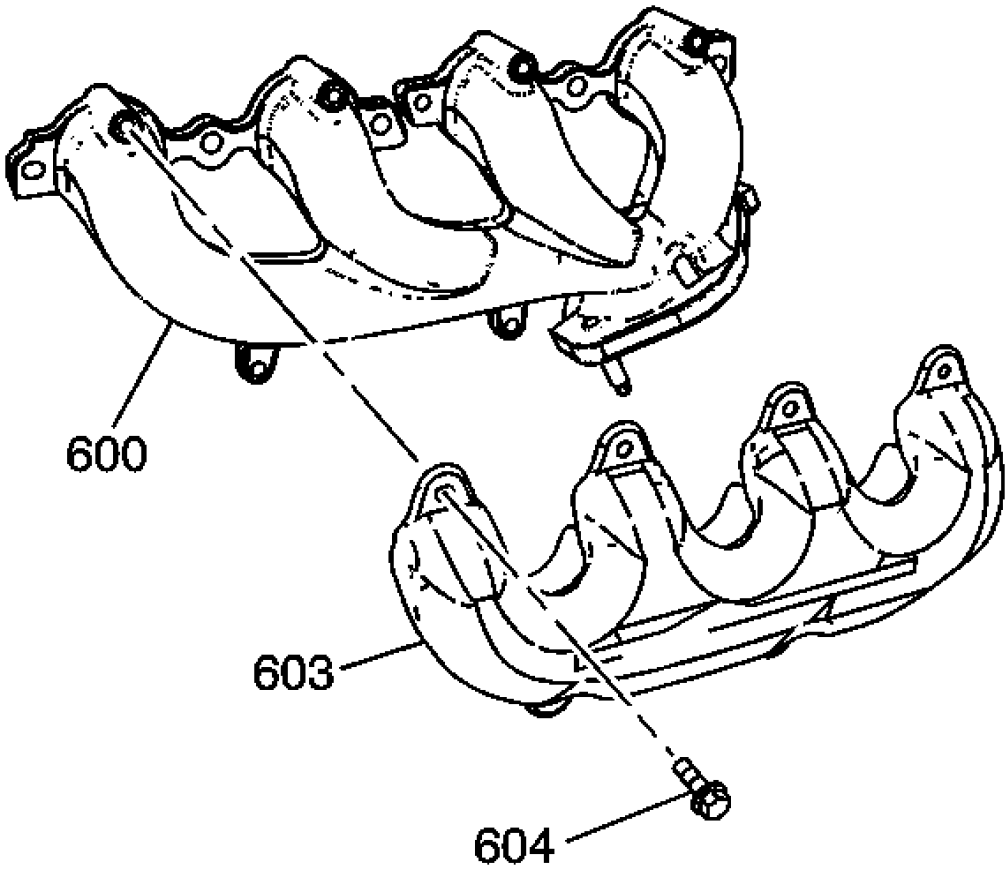


Fig. 31: View Of Exhaust Manifold, Heat Shield & Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE:

- **Tighten the exhaust manifold bolts as specified in the service procedure. Improperly installed and/or leaking exhaust manifold gaskets may affect vehicle emissions and/or on-board diagnostic**

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(OBD) II system performance.

- **The cylinder head exhaust manifold bolt hole threads must be clean and free of debris or threadlocking material.**
- **Do not apply sealant to the first 3 threads of the bolt.**

1. Install the heat shield (603) and bolts (604) and tighten to 9 N.m (80 lb in).
2. Install the exhaust pipe studs and tighten to 20 N.m (15 lb ft).

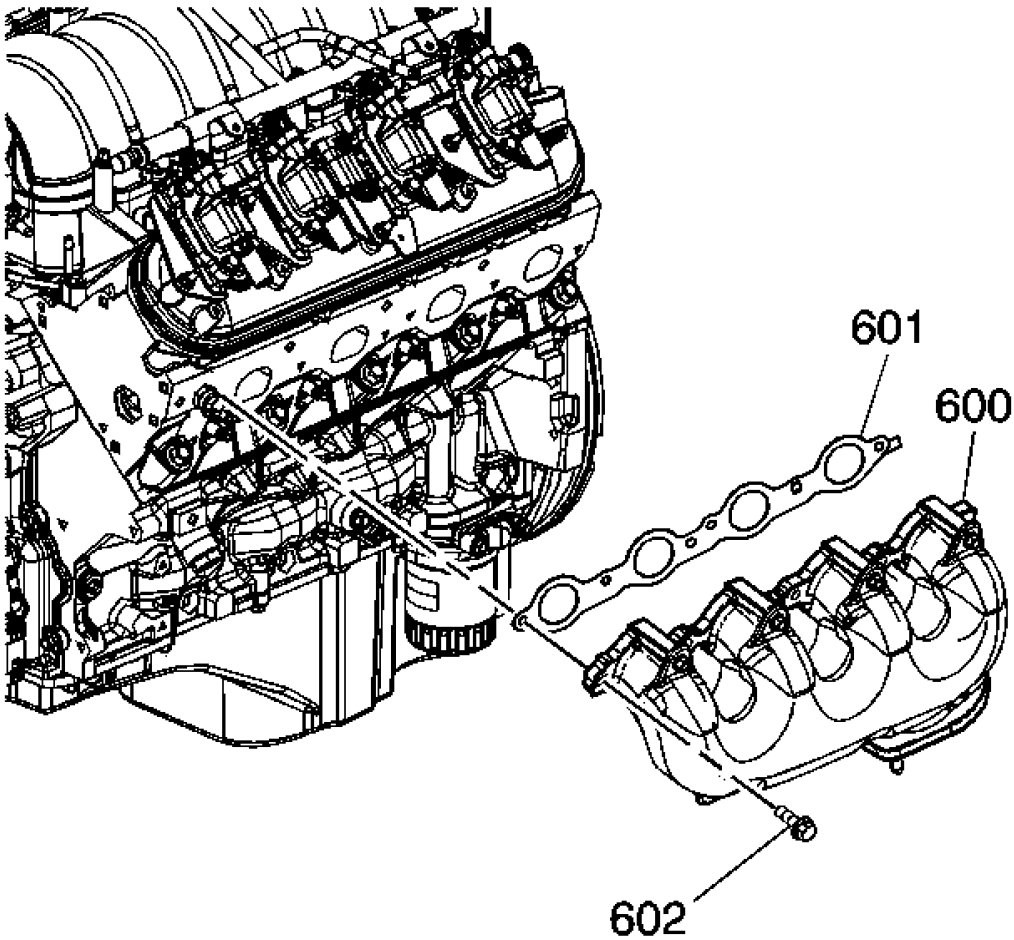


Fig. 32: Exhaust Manifold, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Apply a 5 mm (0.2 in) wide band of threadlock GM P/N 12345493 (Canadian P/N 10953488), or equivalent, to the threads of the exhaust manifold bolts (602). Refer to **Adhesives, Fluids, Lubricants,**

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and Sealers .

4. Install the exhaust manifold (600), NEW gasket (601), and bolts.
    1. Tighten the exhaust manifold bolts a first pass to 15 N.m (11 lb ft). Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
    2. Tighten the exhaust manifold bolts a final pass to 20 N.m (15 lb ft). Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
5. Using a flat punch, bend over the exposed edge of the exhaust manifold gasket at the rear of the left cylinder head.

EXHAUST MANIFOLD INSTALLATION - RIGHT SIDE

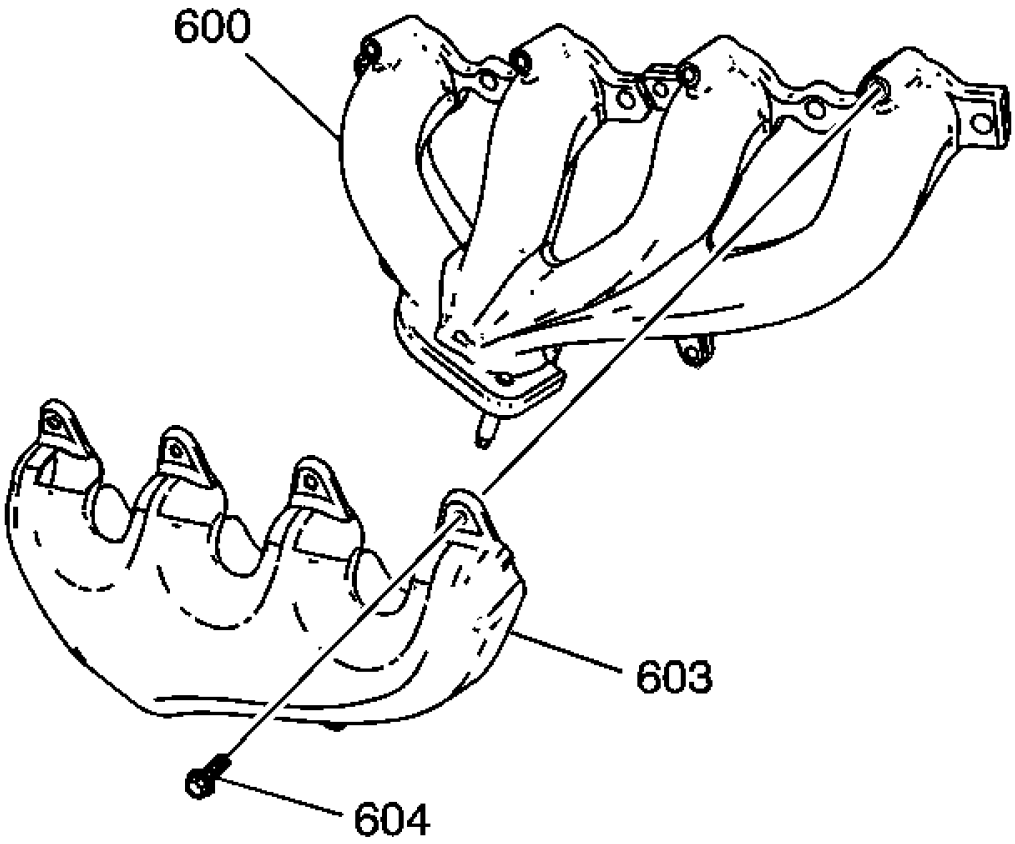


Fig. 33: View Of Heat Shield & Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

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CAUTION: Refer to Fastener Caution .

NOTE:

- **Tighten the exhaust manifold bolts as specified in the service procedure. Improperly installed and/or leaking exhaust manifold gaskets may affect vehicle emissions and/or on-board diagnostic (OBD) II system performance.**
- **The cylinder head exhaust manifold bolt hole threads must be clean and free of debris or threadlocking material.**
- **Do not apply sealant to the first 3 threads of the bolt.**

1. Install the heat shield (603) and bolts (604) and tighten to 9 N.m (80 lb in).
2. Install the exhaust pipe studs and tighten to 20 N.m (15 lb ft).

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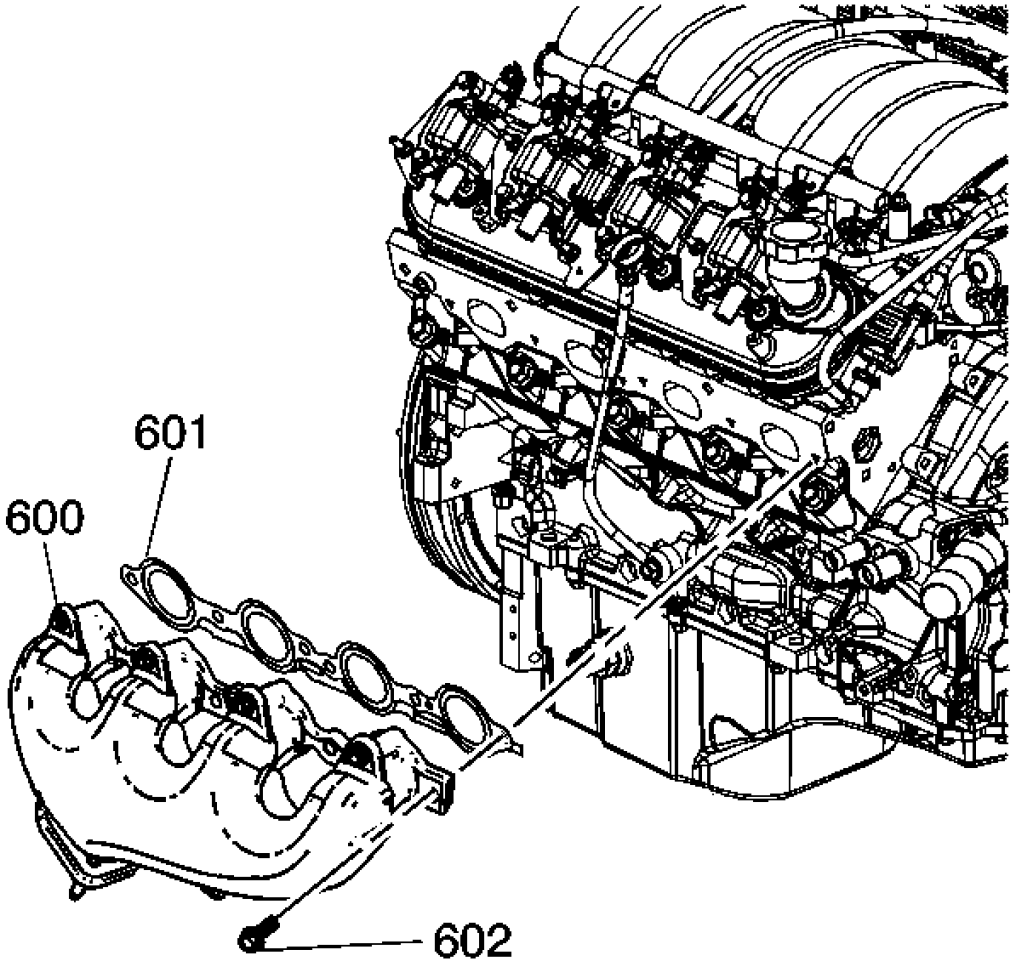


Fig. 34: Exhaust Manifold, Gasket & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Apply a 5 mm (0.2 in) wide band of threadlock GM P/N 12345493 (Canadian P/N 10953488), or equivalent, to the threads of the exhaust manifold bolts (602). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
4. Install the exhaust manifold (600), NEW gasket (601), and bolts.
    1. Tighten the exhaust manifold bolts a first pass to 15 N.m (11 lb ft). Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.
    2. Tighten the exhaust manifold bolts a final pass to 20 N.m (15 lb ft). Tighten the exhaust manifold bolts beginning with the center 2 bolts. Alternate from side-to-side, and work toward the outside bolts.

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5. Using a flat punch, bend over the exposed edge of the exhaust manifold gasket at the rear of the right cylinder head.

OIL LEVEL INDICATOR AND TUBE INSTALLATION

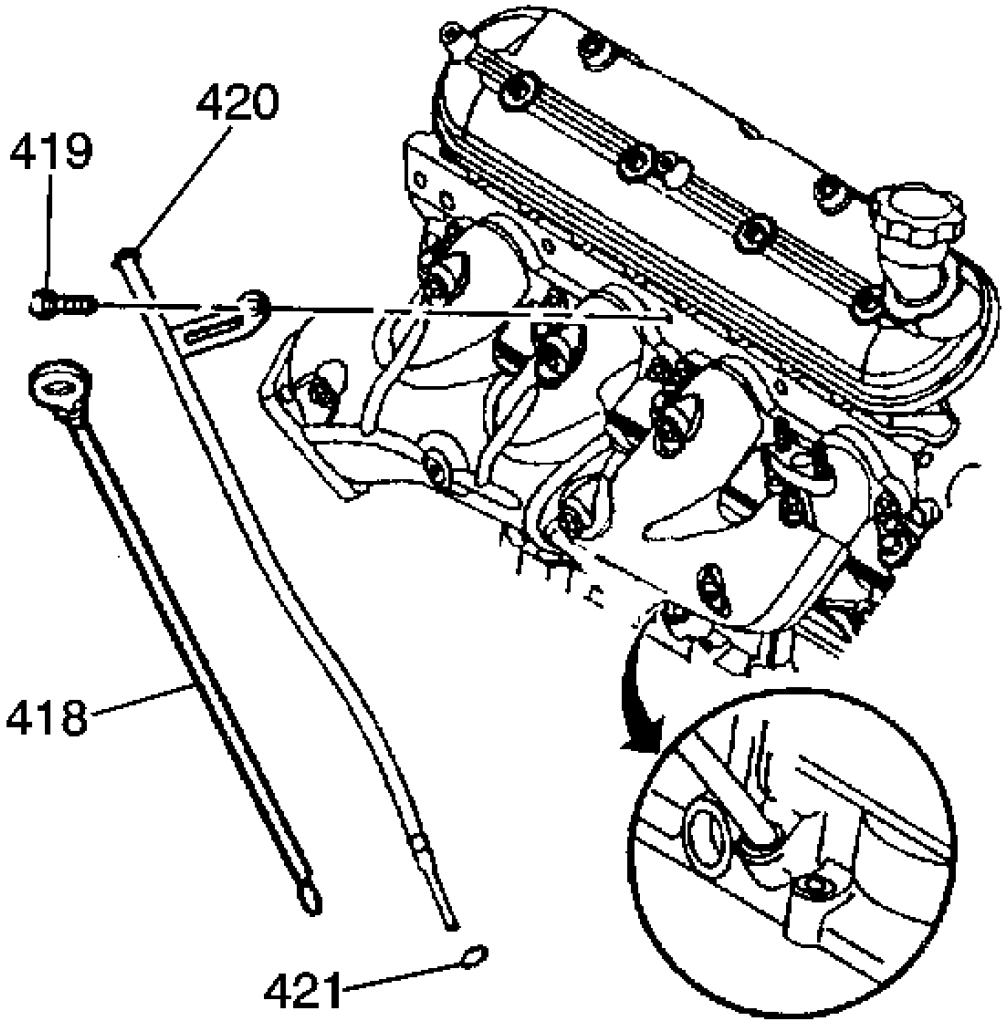


Fig. 35: Oil Level Indicator & Tube
Courtesy of GENERAL MOTORS CORP.

1. Inspect the O-ring seal (421) for cuts or damage. If the oil level indicator tube O-ring seal is not cut or damaged, it may be used again.
2. Lubricate the O-ring seal with clean engine oil.

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3. Install the O-ring seal onto the oil level indicator tube (420).
4. Install the oil level indicator tube into the engine block and rotate into proper position.

CAUTION: Refer to Fastener Caution .

5. Install the tube bolt (419) and tighten to 25 N.m (18 lb ft).
6. Install the oil level indicator (418) into the tube.

CLUTCH PILOT BEARING INSTALLATION (NON-LS9)

Special Tools

- **J 8433:** Two Jaw Puller
- **J 45949:** Pilot Bearing and Flywheel Locator Installer

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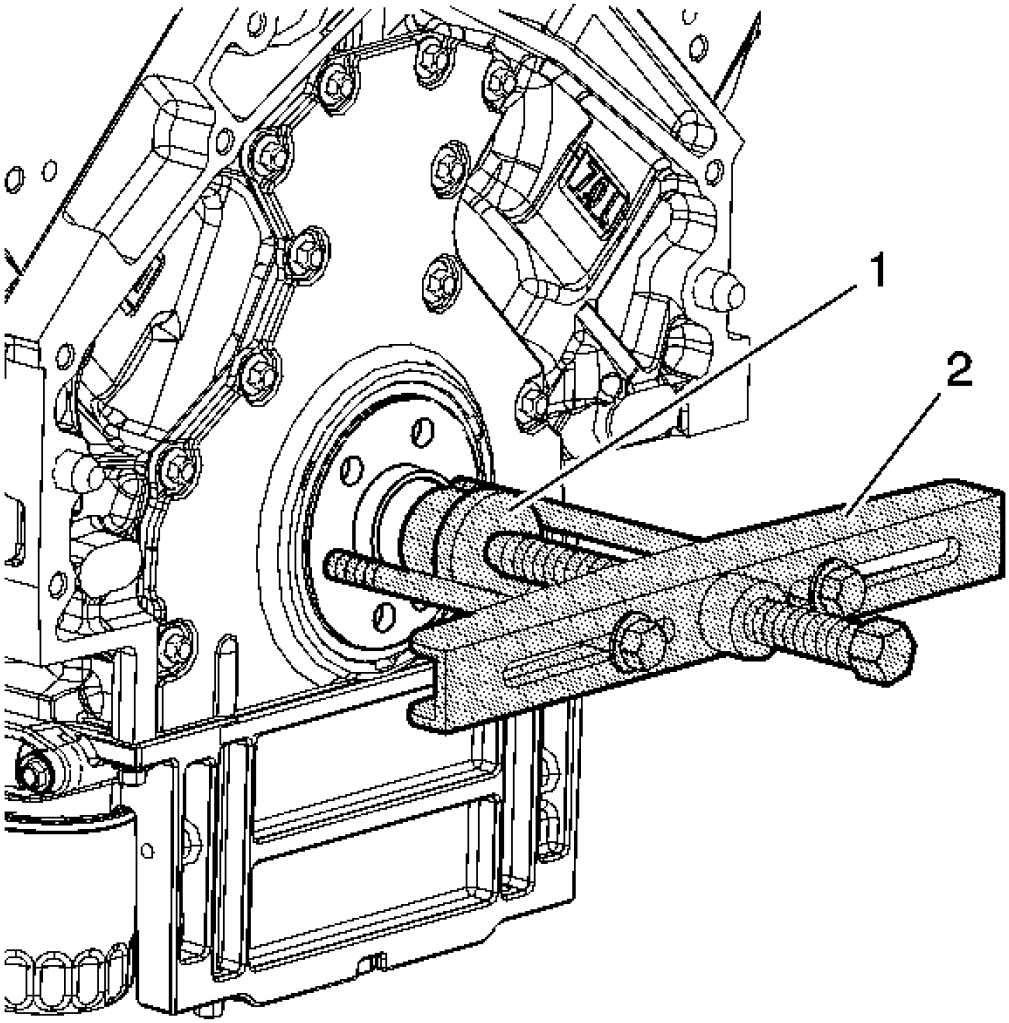


Fig. 36: Seating Bearing In Bore Of Crankshaft
Courtesy of GENERAL MOTORS CORP.

1. Position the bearing to the rear of the crankshaft.
2. Assemble the **J 8433:** two jaw puller (2), the **J 45949:** pilot bearing and flywheel locator installer (1) and bolts to the rear of the crankshaft.

   Tighten the bolts until snug.

3. Rotate the bolt of the **J 8433:** two jaw puller (2) until the bearing is seated in the bore of the crankshaft.
4. Remove the tools.

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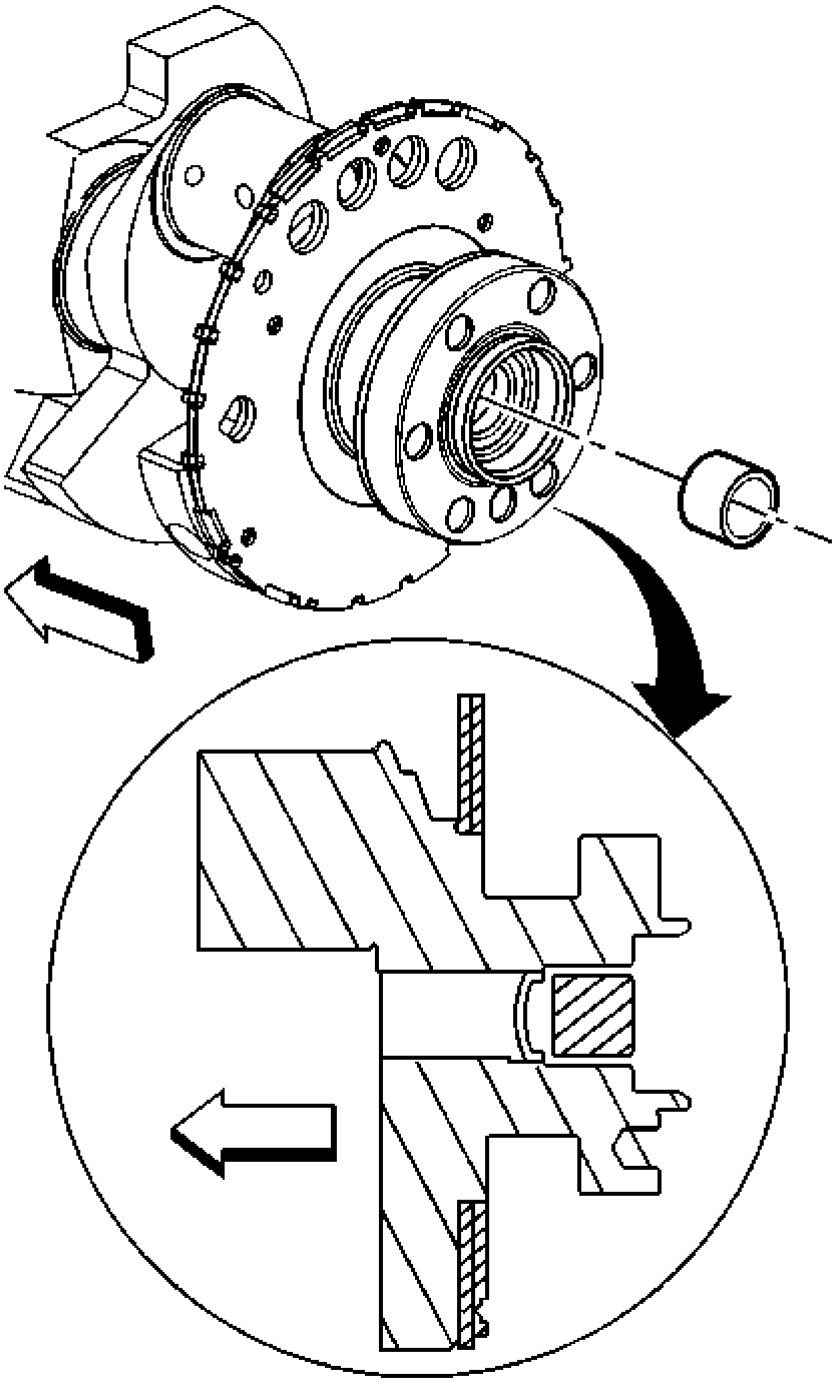


Fig. 37: Locating Clutch Pilot Bearing

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Courtesy of GENERAL MOTORS CORP.

5. Inspect the clutch pilot bearing for proper installation.

ENGINE FLYWHEEL INSTALLATION

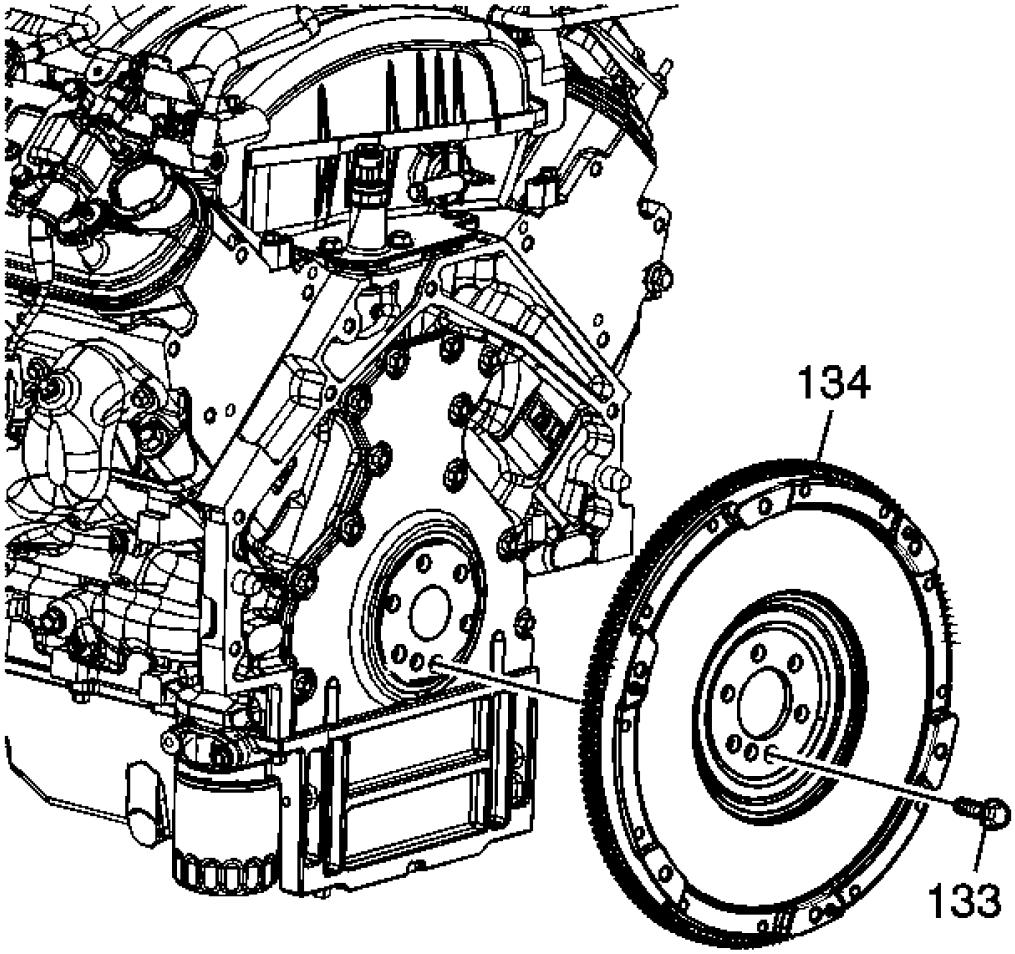


Fig. 38: Flywheel
Courtesy of GENERAL MOTORS CORP.

1. Install the flywheel (134) to the crankshaft.
2. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the flywheel bolts (133).

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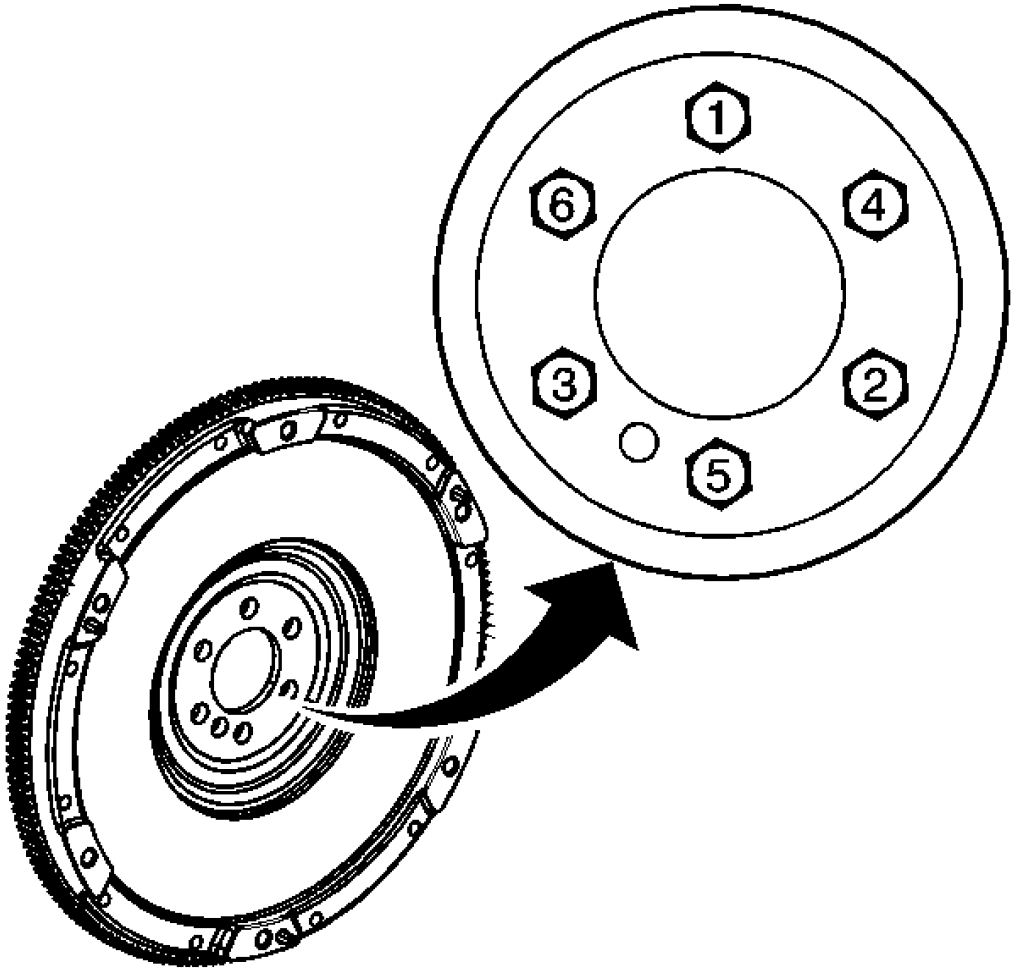


Fig. 39: Identifying Flywheel Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install the bolts.
    1. Tighten the bolts (1-6) a first pass in sequence to 20 N.m (15 lb ft) .
    2. Tighten the bolts (1-6) a second pass in sequence to 50 N.m (37 lb ft) .
    3. Tighten the bolts (1-6) a final pass in sequence to 100 N.m (74 lb ft) .

AUTOMATIC TRANSMISSION FLEX PLATE INSTALLATION

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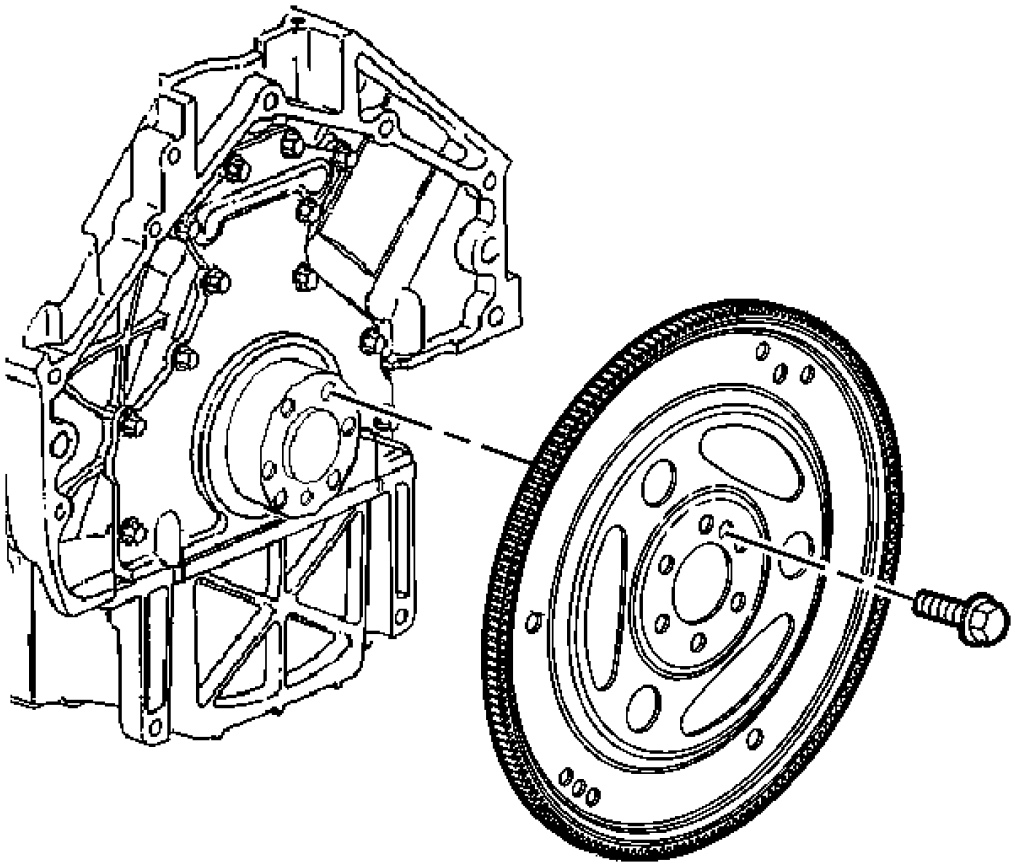


Fig. 40: View Of Engine Flex Plate
Courtesy of GENERAL MOTORS CORP.

NOTE: The flex plate does not use a locating pin for alignment and will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the engine flex plate bolts. This procedure requires a 3 stage tightening process.

1. Install the flex plate to the crankshaft.
2. Apply threadlock GM P/N 12345382 (Canadian P/N 10953489), or equivalent, to the threads of the flex plate bolts.

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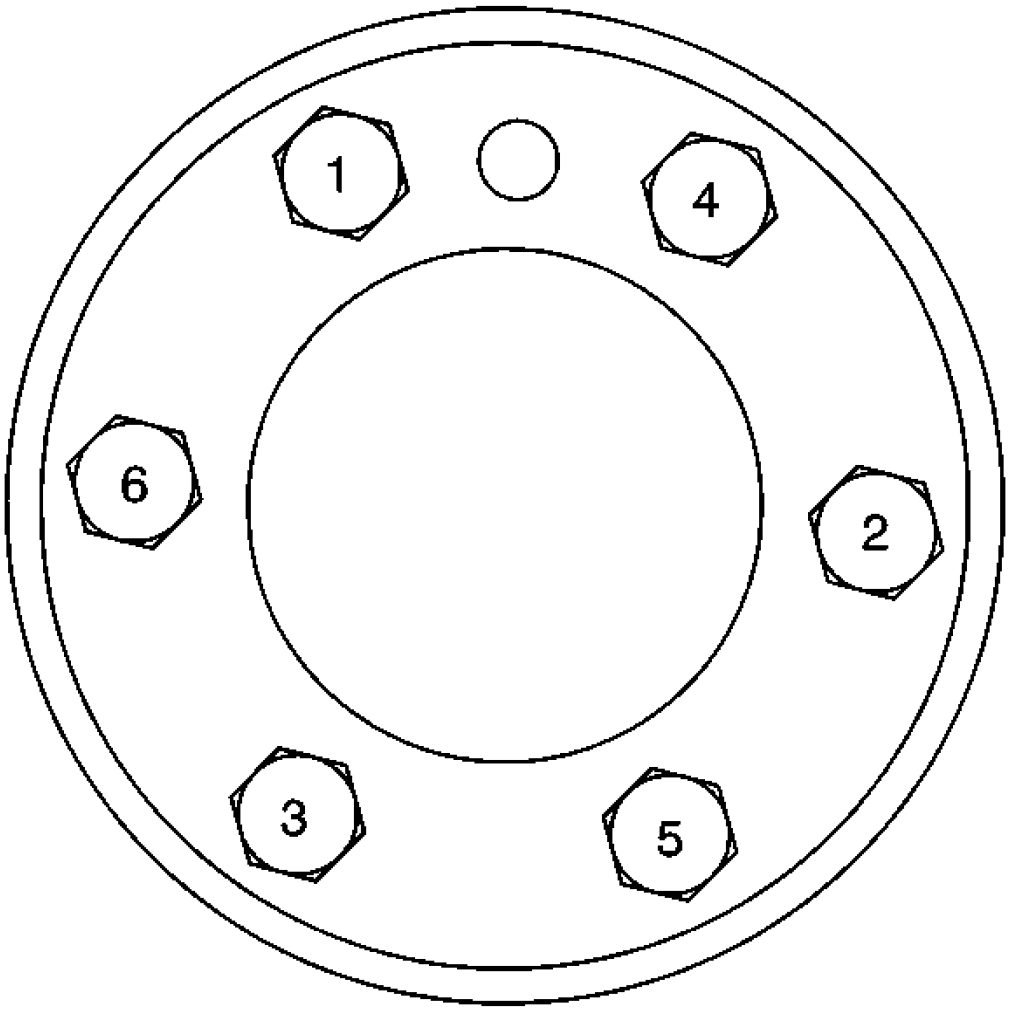


Fig. 41: Identifying Flex Plate Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

3. Install the engine flex plate bolts.
    1. Tighten the engine flex plate bolts (1-6) a first pass in sequence to 20 N.m (15 lb ft) .
    2. Tighten the engine flex plate bolts (1-6) a second pass in sequence to 50 N.m (37 lb ft) .
    3. Tighten the engine flex plate bolts (1-6) a final pass in sequence to 100 N.m (74 lb ft) .

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CRANKSHAFT BALANCER INSTALLATION

Special Tools

- **J 41478:** Crankshaft Front Oil Seal Installer
- **J 41665:** Crankshaft Balancer and Sprocket Installer
- **J 42386-A:** Flywheel Holding Tool
- **J 45059:** Angle Meter

For equivalent regional tools, refer to **Special Tools** .

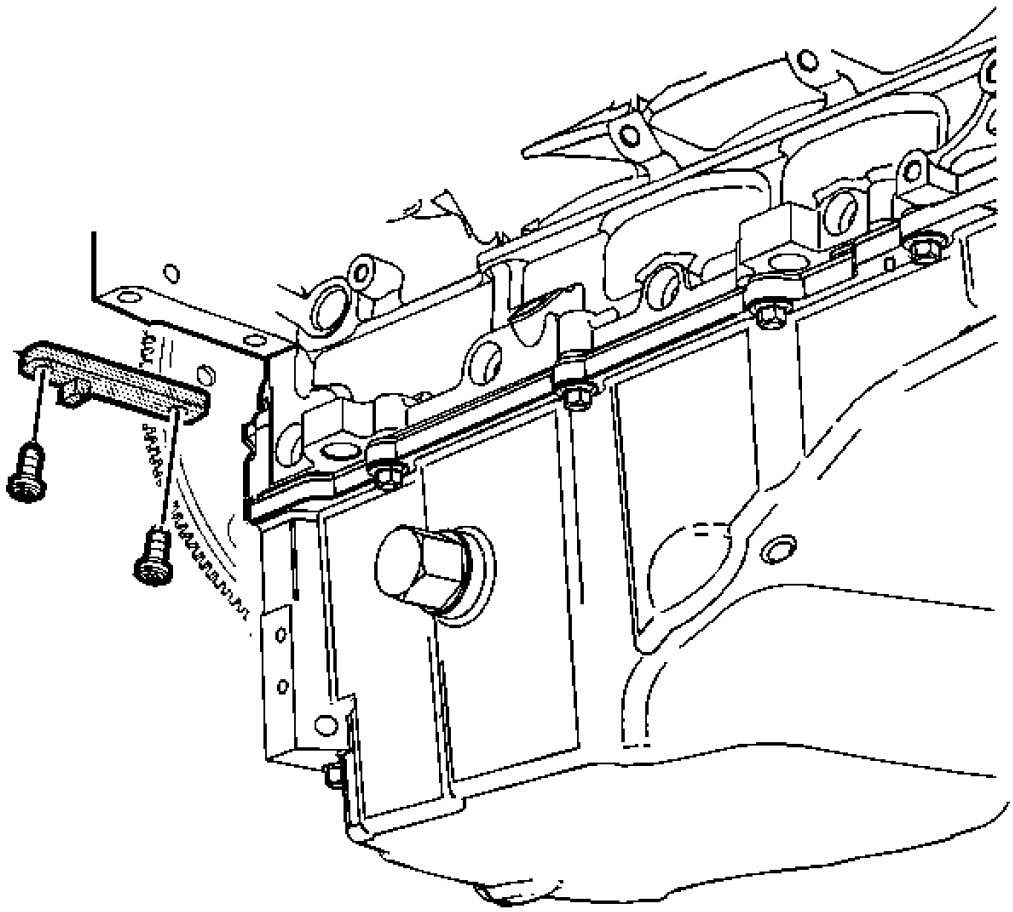


Fig. 42: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS CORP.

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CAUTION: Refer to Fastener Caution .

NOTE:

- **Ensure the teeth of the tool engage the engine flywheel teeth.**
- **The used crankshaft balancer bolt is used only during the installation procedure. Install a NEW crankshaft balancer bolt during final assembly.**

1. Install the **J 42386-A:** holding tool and bolts.

   Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the **J 42386-A:** holding tool bolts to 50 N.m (37 lb ft).

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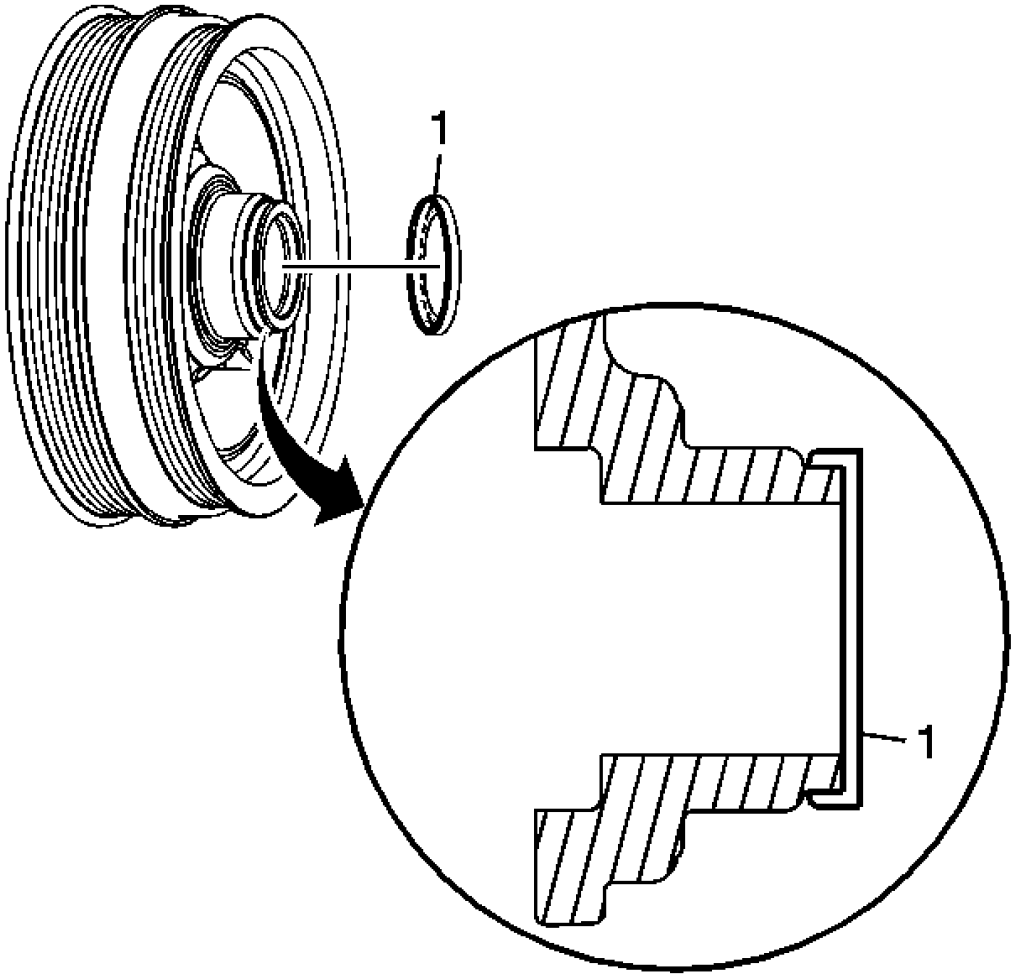


Fig. 43: Identifying Crankshaft Balancer Washer
Courtesy of GENERAL MOTORS CORP.

2. Install the crankshaft balancer washer (1) onto the crankshaft balancer.

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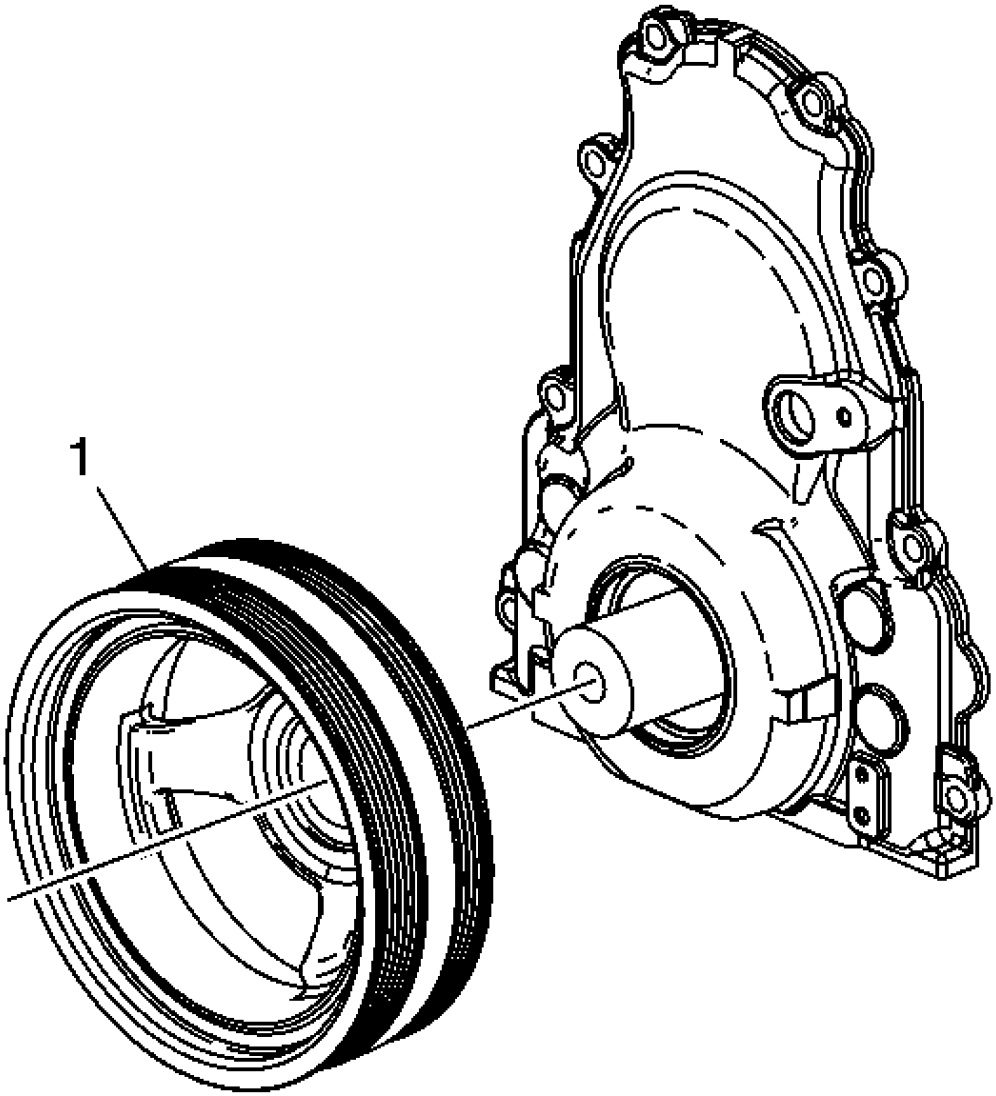


Fig. 44: Balancer
Courtesy of GENERAL MOTORS CORP.

NOTE: The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.

3. Position the balancer (1) and washer onto the end of the crankshaft.

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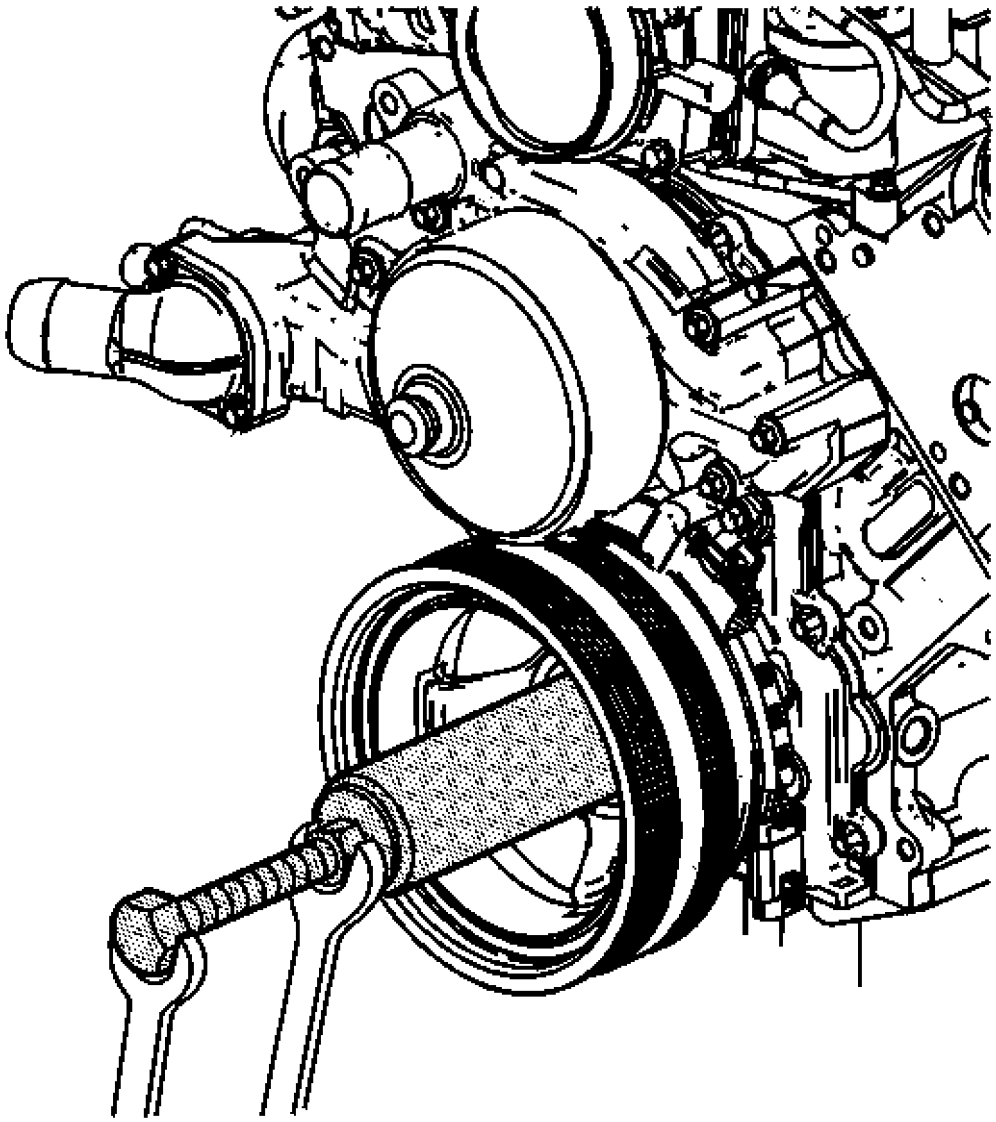


Fig. 45: Installing Balancer
Courtesy of GENERAL MOTORS CORP.

4. Use the **J 41665:** balancer and sprocket installer and the **J 41478:** oil seal installer in order to install the balancer.
    1. Assemble the **J 41478:** oil seal installer threaded rod, nut, washer and the **J 41665:** balancer and sprocket installer .

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Insert the smaller end of the installer into the front of the balancer.

2. Use a wrench and hold the hex end of the threaded rod.
3. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto the crankshaft.
4. Remove and reverse the installation tool.

Position the larger end of the installer against the front of the balancer.

5. Use a wrench and hold the hex end of the threaded rod.
6. Use a second wrench and rotate the installation tool nut clockwise until the balancer is installed onto the crankshaft.
7. Remove the balancer installation tools.

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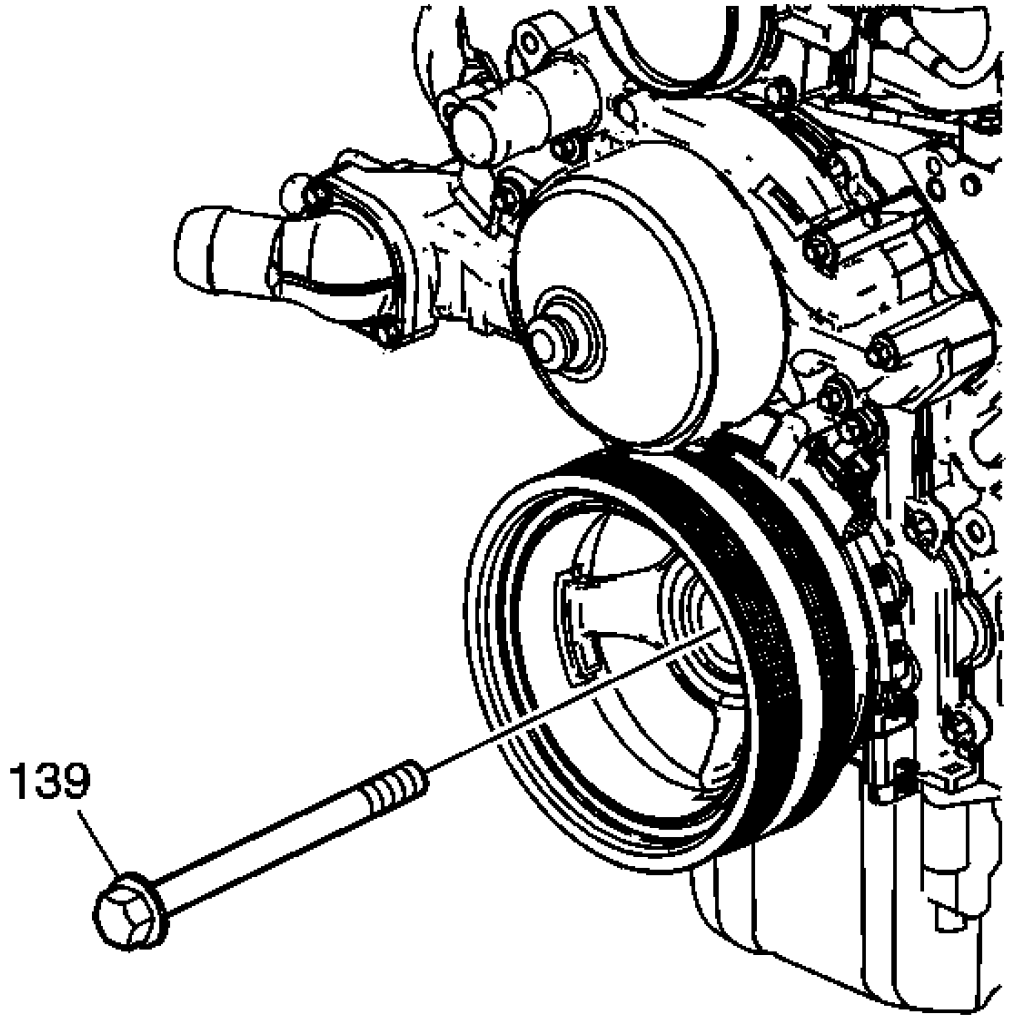


Fig. 46: Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

5. Install the used crankshaft balancer bolt (139) and tighten to 330 N.m (240 lb ft) to fully seat the balancer.
6. Remove the used crankshaft balancer bolt.

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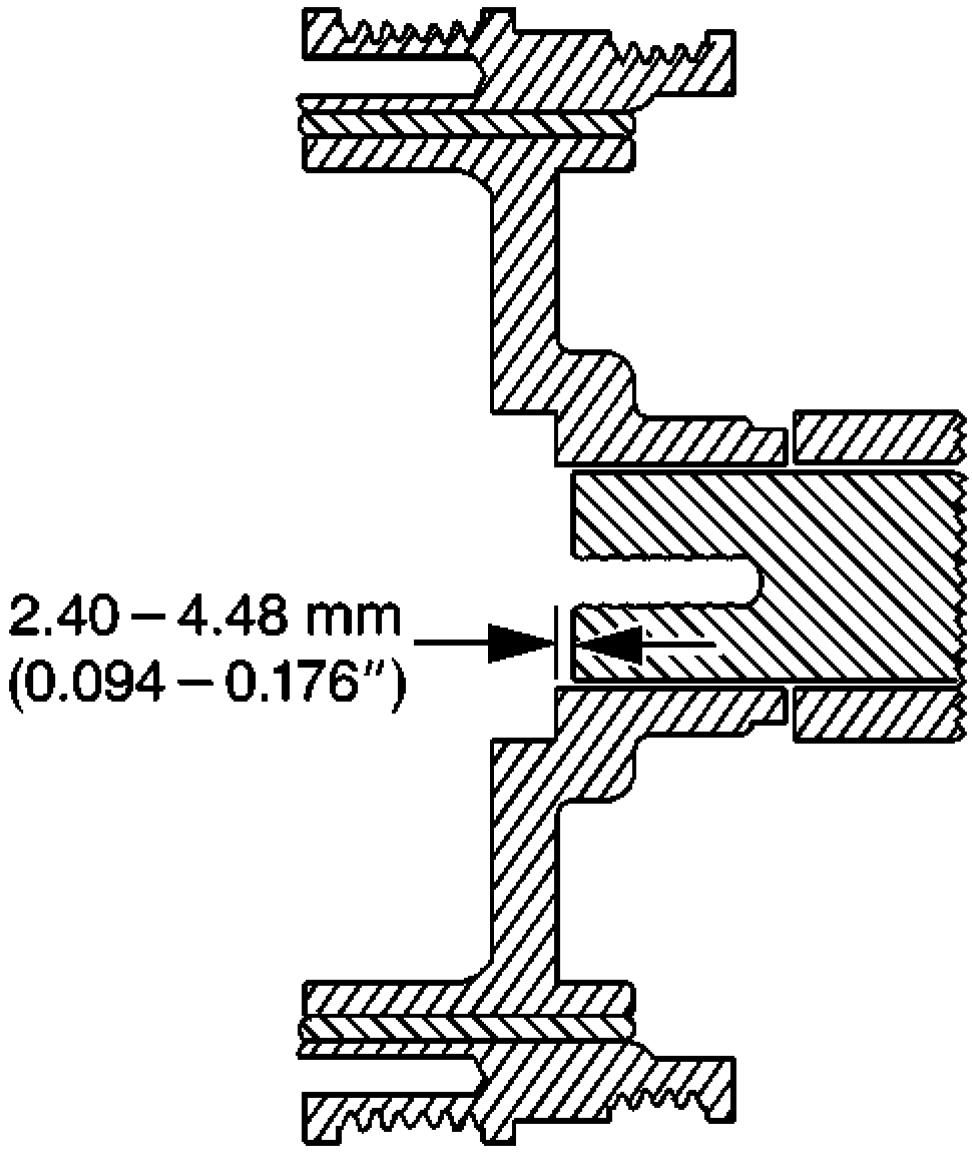


Fig. 47: Identifying Hub To Crankshaft Distance
Courtesy of GENERAL MOTORS CORP.

NOTE: The nose of the crankshaft should be recessed 2.4-4.48 mm (0.094-0.176 in) into the balancer bore.

7. Measure for a correctly installed balancer.

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If the balancer is not installed to the proper dimensions, install the **J 41665:** balancer and sprocket installer and repeat the installation procedure.

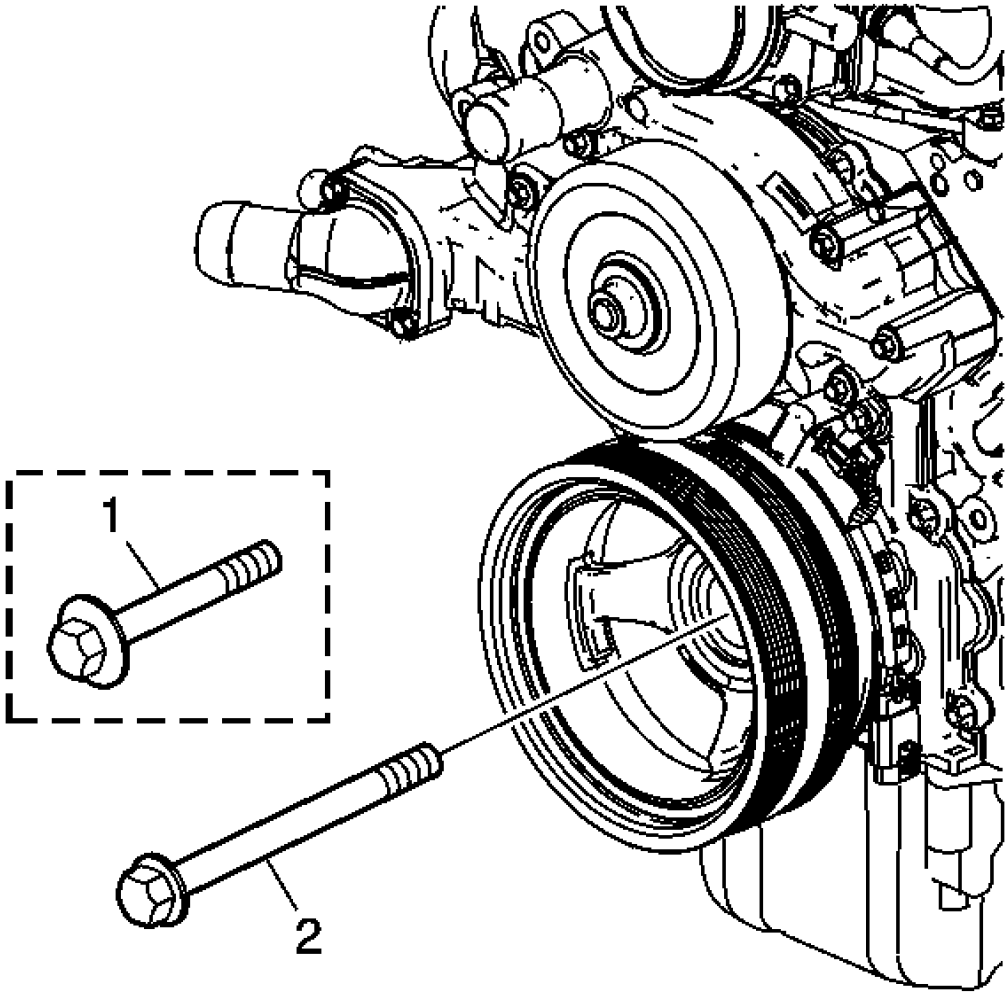


Fig. 48: Identifying Crankshaft Balancer Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: There are two crankshaft balancer bolt designs, one has a flanged head, no washer, and the other has a retained rotating washer. There are two different torque specifications for the final pass; the final torque angle is dependent on the bolt design.

8. Install the NEW crankshaft balancer bolt.

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1. Tighten the crankshaft balancer bolt to 150 N.m (110 lb ft) .
2. Loosen the crankshaft balancer bolt 360 degrees .
3. Tighten the crankshaft balancer bolt to 80 N.m (59 lb ft) .
4. Tighten the crankshaft balancer bolt a final pass
    - Balancer bolt with flanged head (1) tighten to 125 degrees using the **J 45059:** angle meter .
    - Balancer bolt with retained rotating washer (2) tighten to 200 degrees using the **J 45059:** angle meter .

9. Remove the **J 42386-A:** holding tool.

ENGINE PRELUBING

SPECIAL TOOLS

J 45299: Engine Preluber

For equivalent regional tools, refer to **Special Tools** .

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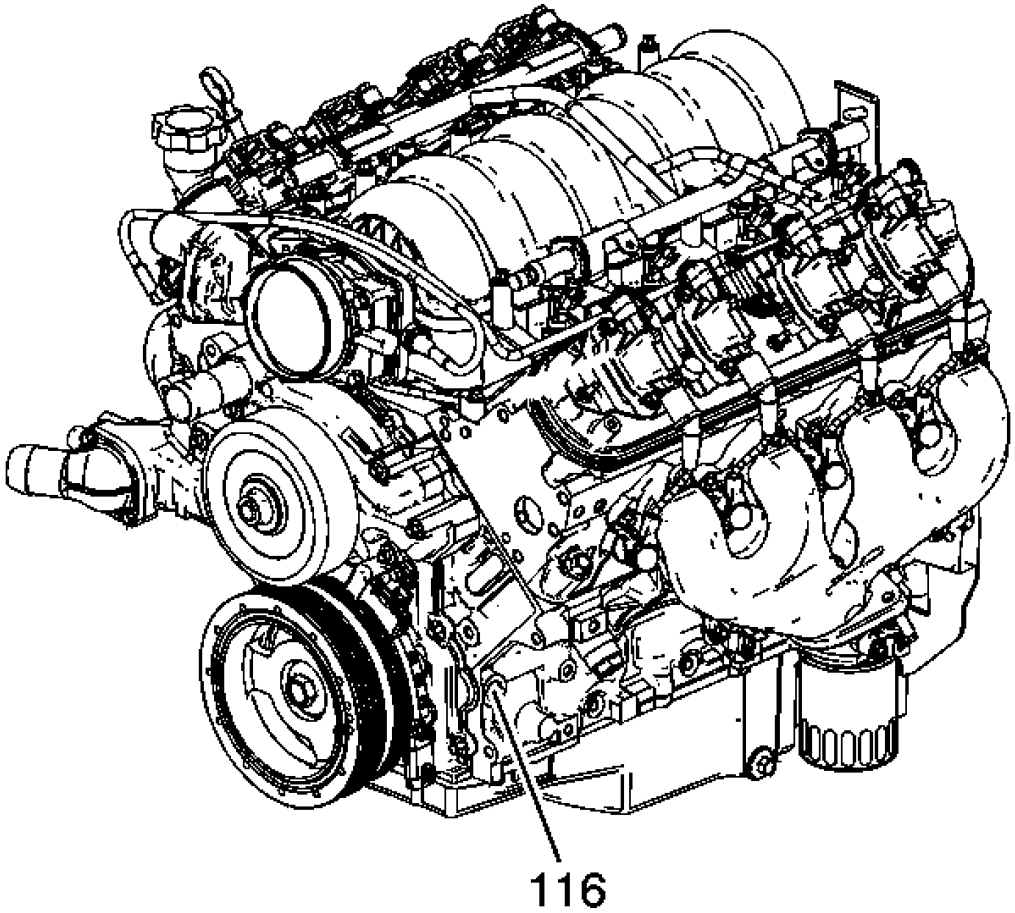


Fig. 49: Locating Engine Block Left Front Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

NOTE: A constant and continuous flow of clean engine oil is required in order to properly prime the engine. Be sure to use an approved engine oil as specified in the owners manual.

1. Remove the engine oil filter, and fill with clean engine oil.

CAUTION: Refer to Fastener Caution .

2. Install the oil filter and tighten to 30 N.m (22 lb ft).
3. Locate the engine block left front oil gallery plug (116).

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4. Install the M16 x 1.5 adapter P/N 509375.

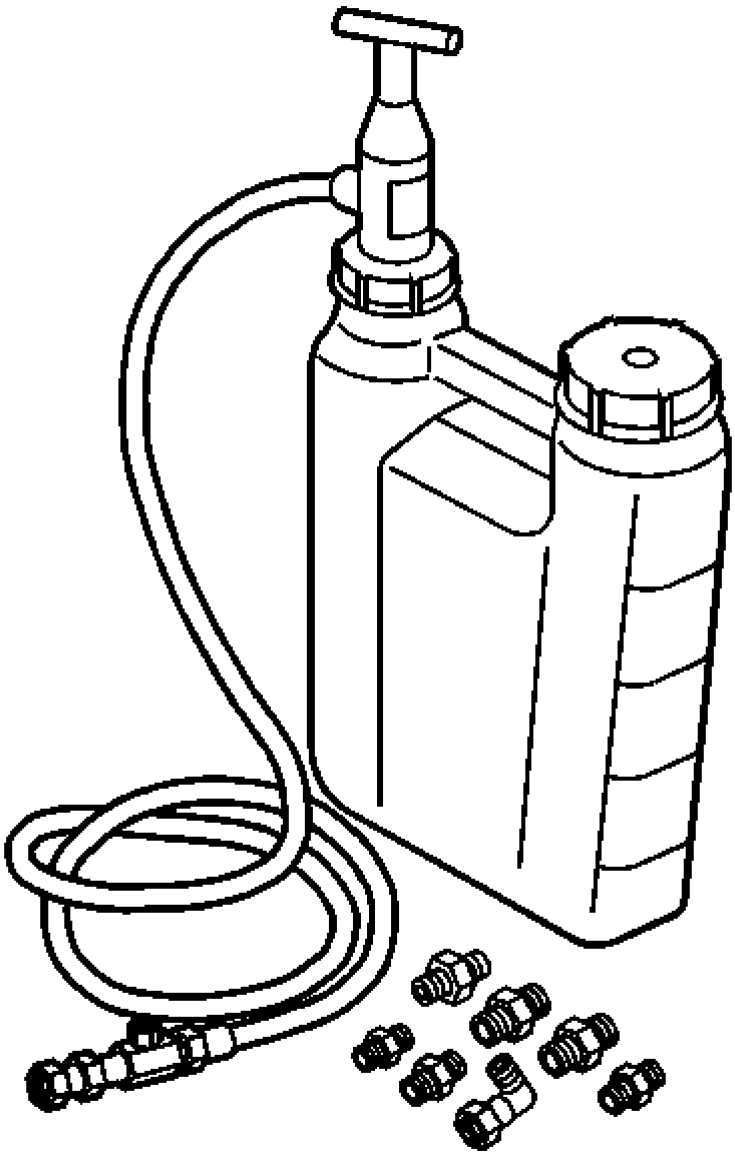


Fig. 50: Identifying Engine Preluber J 45299
Courtesy of GENERAL MOTORS CORP.

5. Install the flexible hose to the adapter and open the valve.
6. Pump the handle on the **J 45299:** preluber in order to flow a minimum of 1.0-1.9 liters (1-2 quarts) engine

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oil. Observe the flow of engine oil through the flexible hose and into the engine assembly.

7. Close the valve and remove the flexible hose and adapter from the engine.
8. Install the gallery plug to the engine and tighten to 60 N.m (44 lb ft).
9. Top-off the engine oil to the proper level.

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2010 ENGINE

Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Repair Instructions - On Vehicle - Camaro

DRIVE BELT REPLACEMENT - ACCESSORY

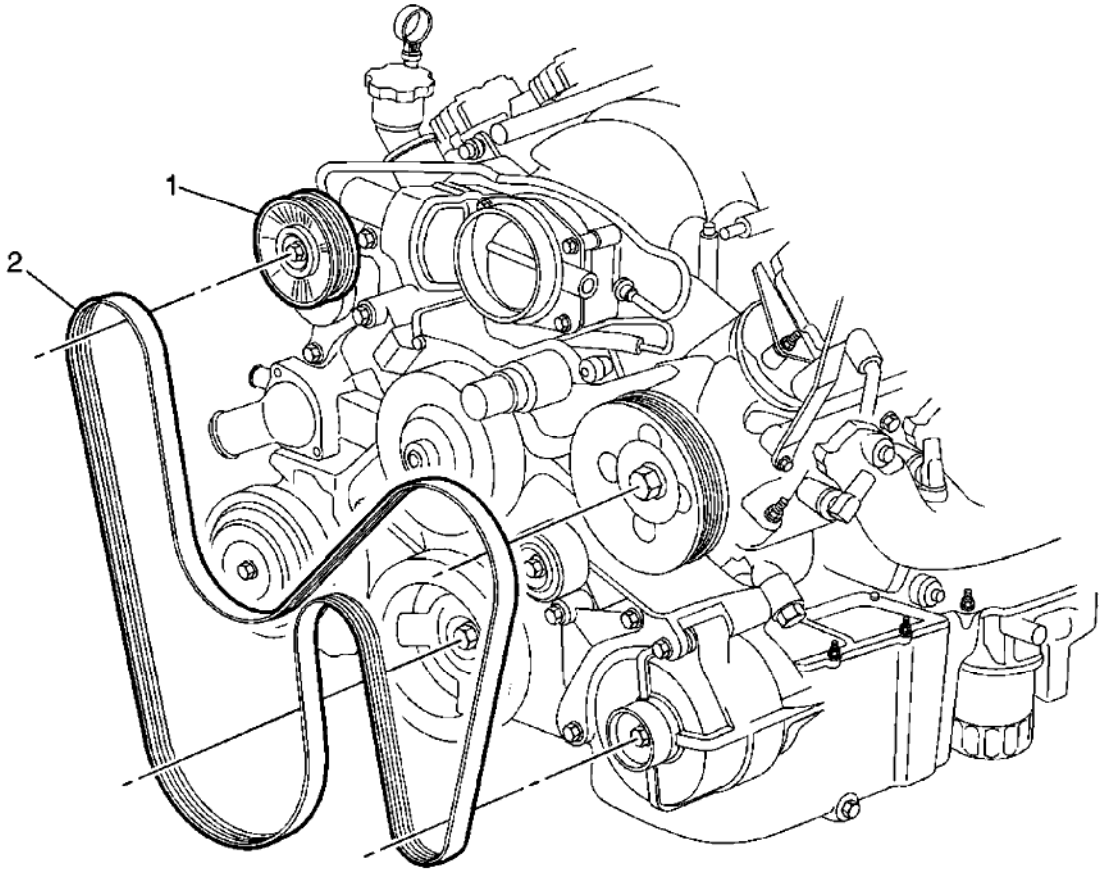


Fig. 1: Drive Belt - Accessory
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Drive Belt **Procedure** 1. Use the proper tool to rotate the drive belt tensioner. 2. Remove the drive belt from the pulleys and tensioner.
2	Drive Belt Tensioner **Procedure**

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1. Clean and inspect the drive belt surfaces of all the pulleys.
2. Inspect the drive belt for correct alignment.

AIR CONDITIONING COMPRESSOR BELT REPLACEMENT

REMOVAL PROCEDURE

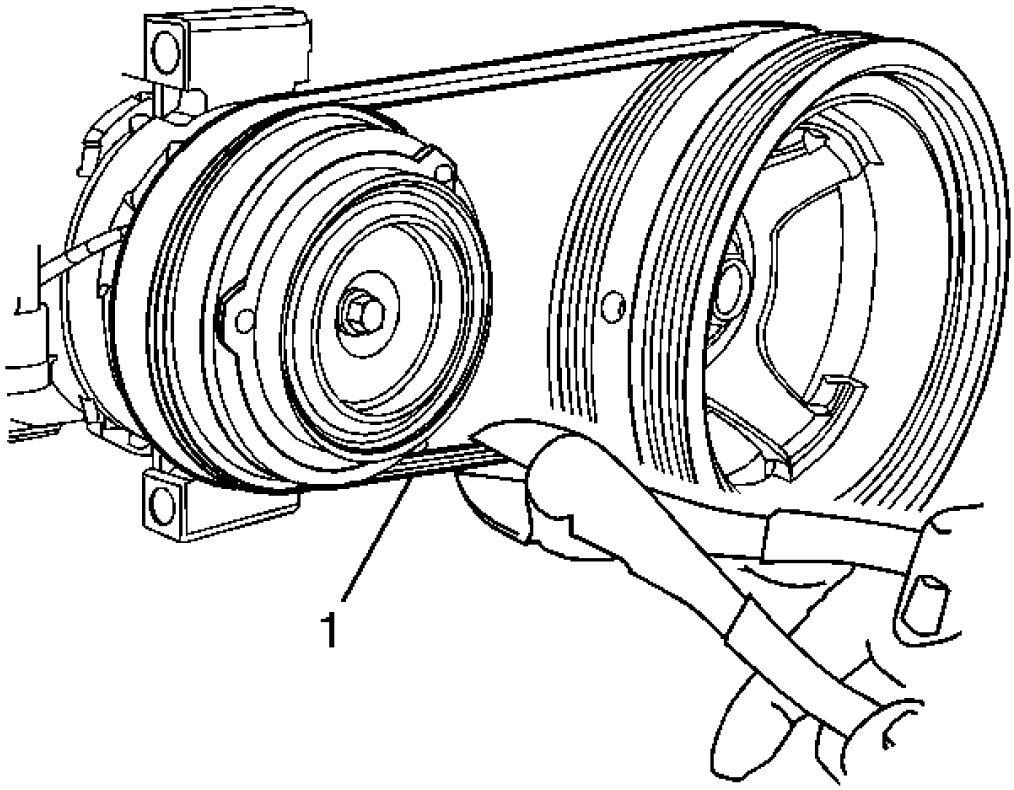


Fig. 2: Cutting Belt
Courtesy of GENERAL MOTORS CORP.

1. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.
2. Cut the belt (1) from air conditioning (A/C) and crankshaft pulleys.

INSTALLATION PROCEDURE

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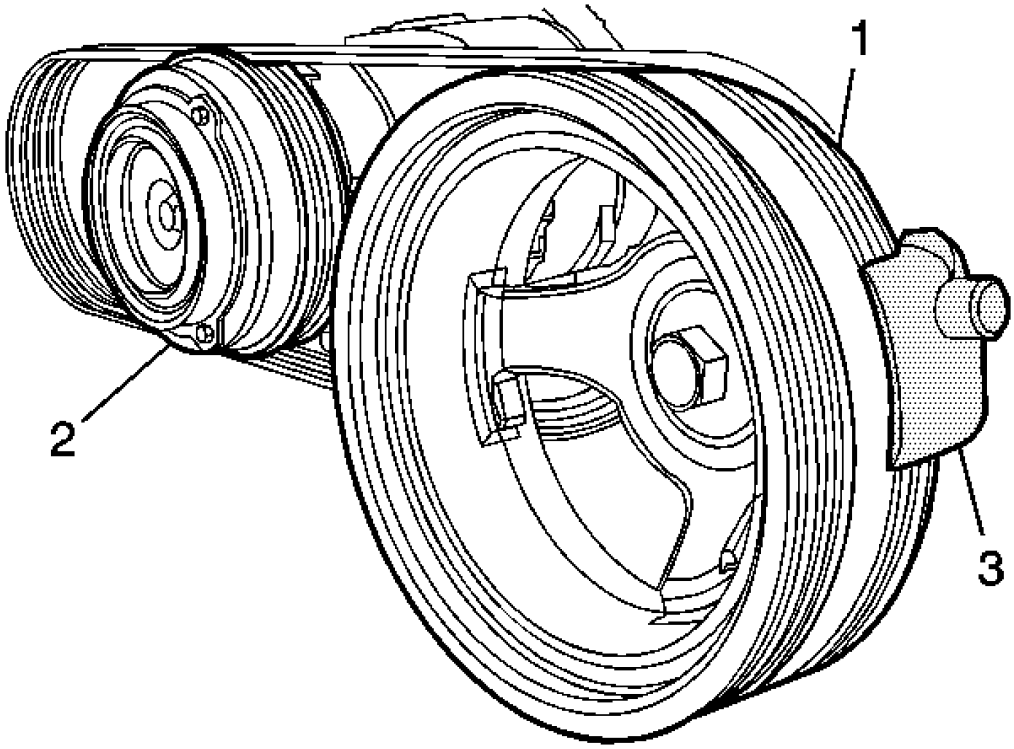


Fig. 3: Belt Installation Tool
Courtesy of GENERAL MOTORS CORP.

1. Position the belt behind the rear face of the balancer (1) and off of the A/C pulley (2).
2. Install the belt installation tool (3) onto the balancer.

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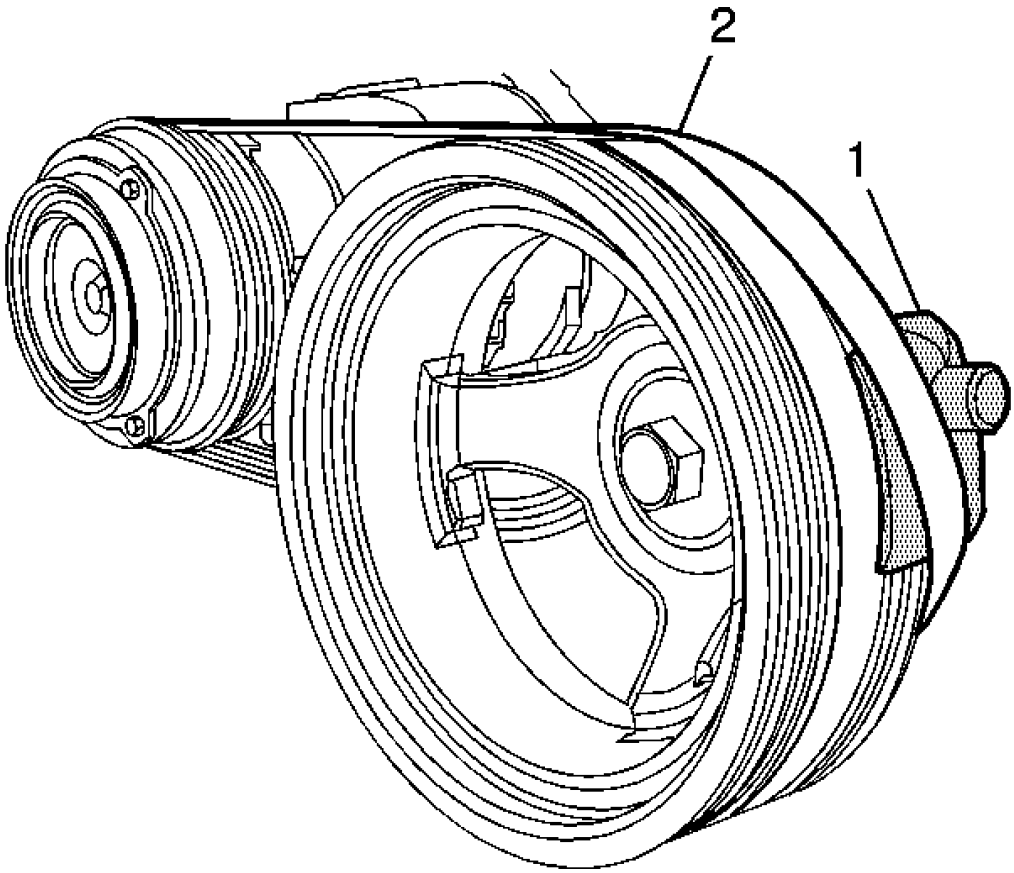


Fig. 4: InstallingBelt
Courtesy of GENERAL MOTORS CORP.

NOTE: For RPO L99 applications, it may be necessary to loosen and reposition or remove the camshaft position sensor/actuator wire harness bracket for belt installation.

3. Slide the belt installation tool (1) upward, installing the belt (2) onto the belt installation tool.

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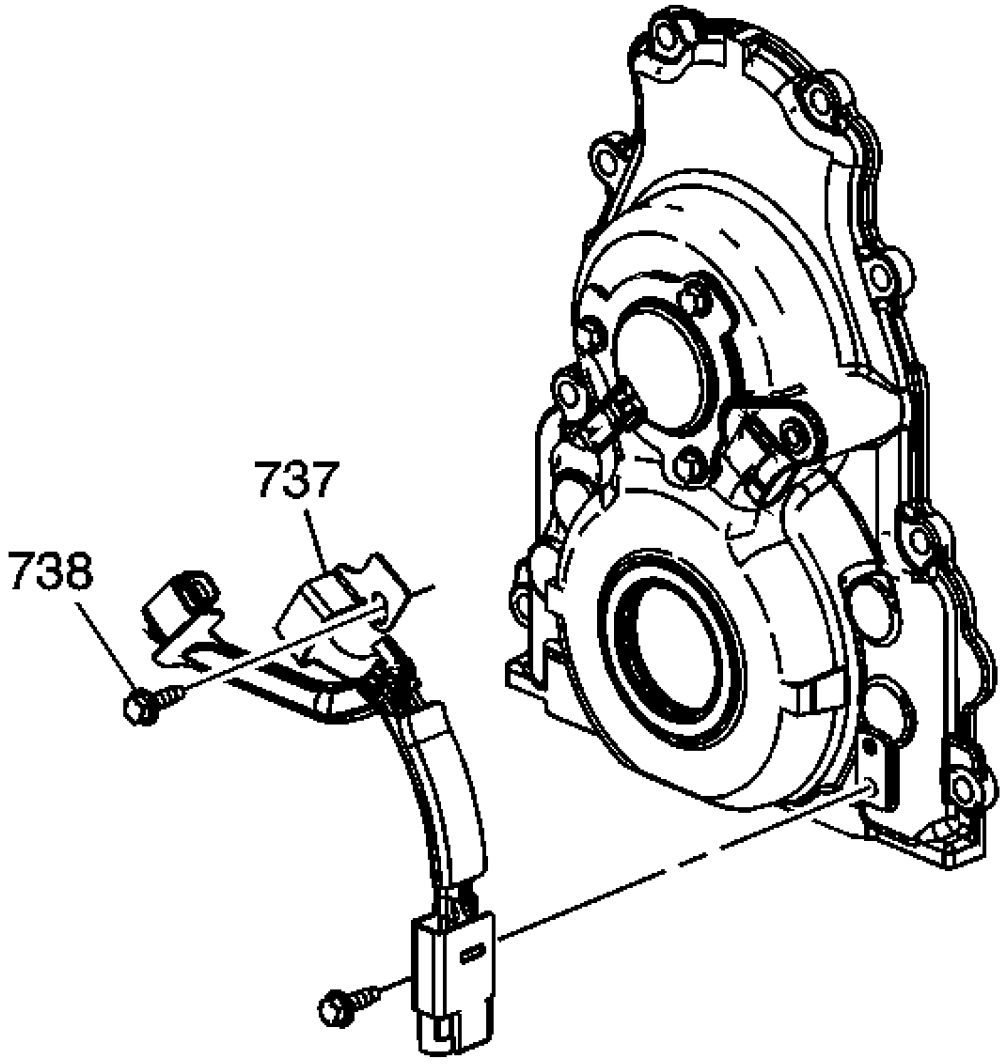


Fig. 5: View Of CMP Sensor Wire Harness & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Loosen the camshaft position sensor/actuator wire harness bracket bolts (738) and reposition or remove the bracket (737) as required.
5. Slide the belt installation tool downward, positioning the belt onto the A/C pulley, applying light tension to the belt.

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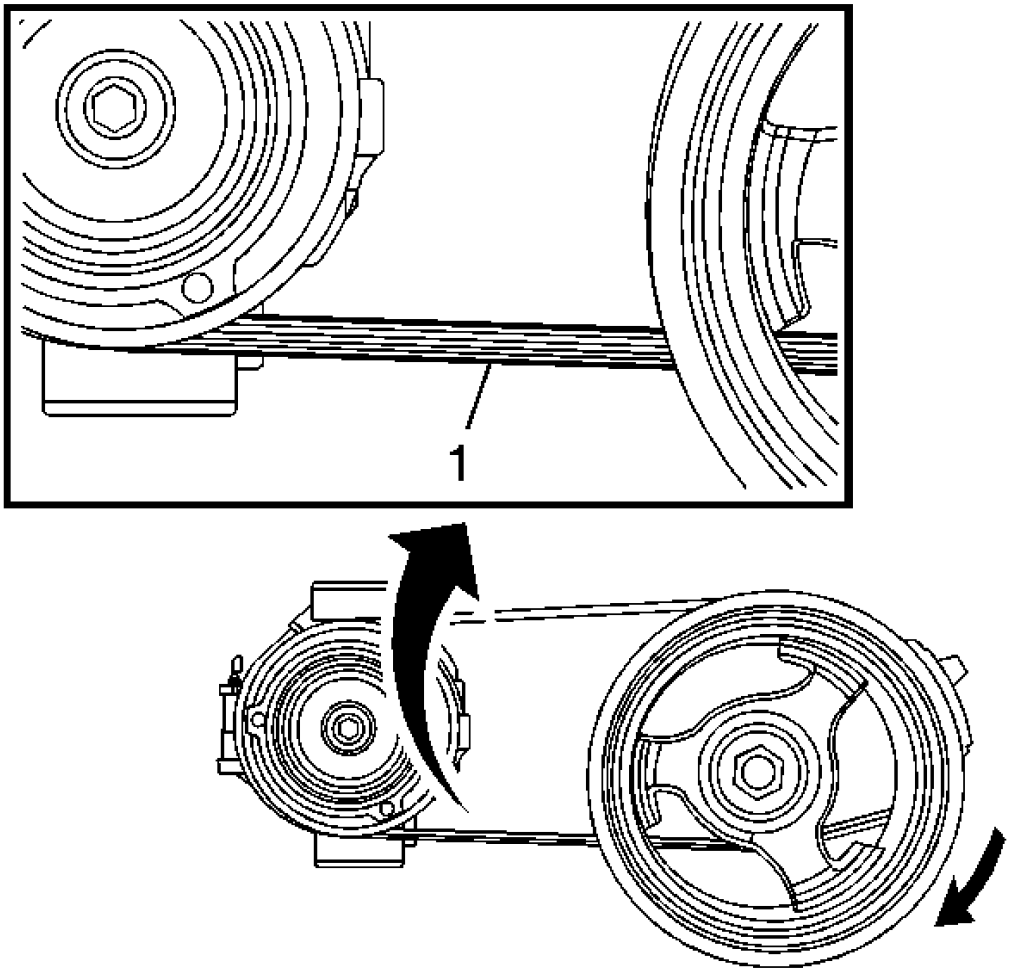


Fig. 6: Positioning Lower Portion Of Belt
Courtesy of GENERAL MOTORS CORP.

6. Position the lower portion of the belt (1) with the ribbed area facing forward.

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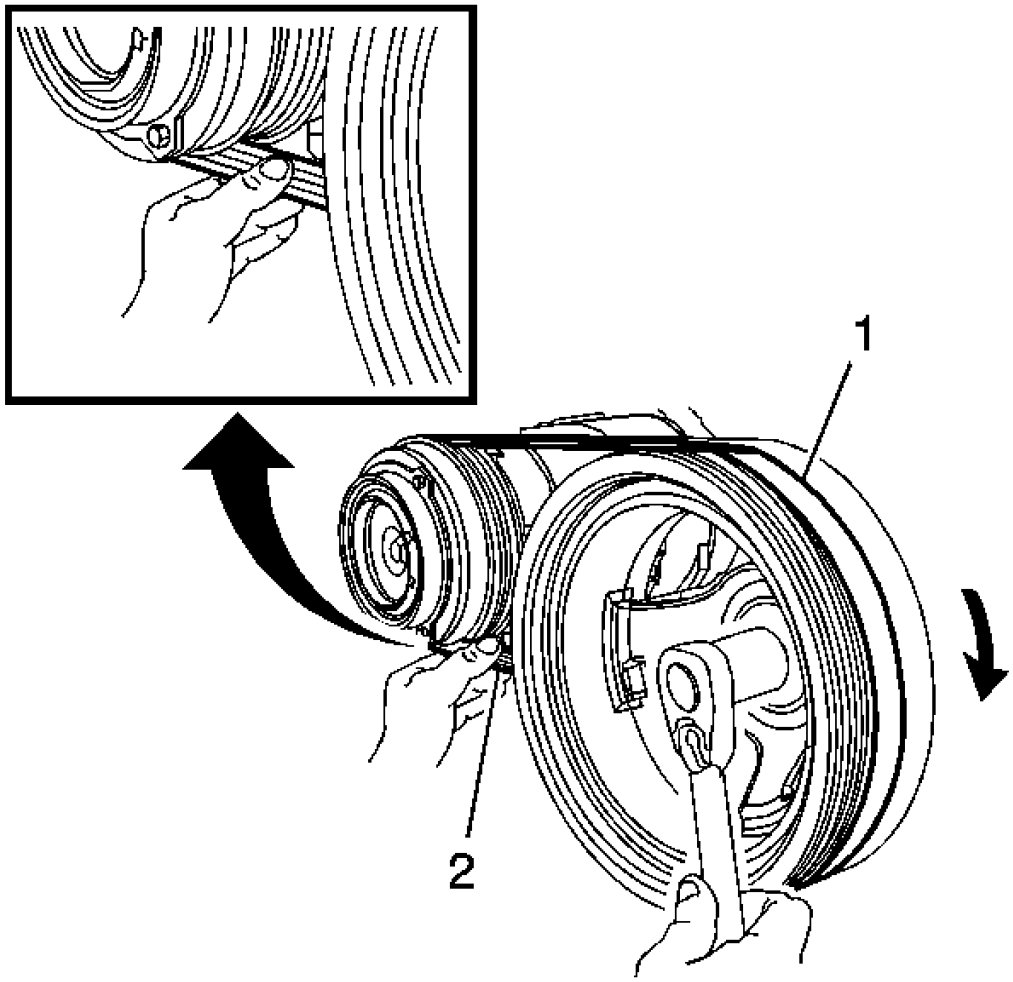


Fig. 7: Rotating Crankshaft Pulley
Courtesy of GENERAL MOTORS CORP.

7. Slowly rotate the crankshaft pulley (1) in a clockwise direction while using finger pressure to pull the belt (2) forward. Ensure that the ribbed area of the belt remains facing forward and the belt aligns properly to the A/C pulley.

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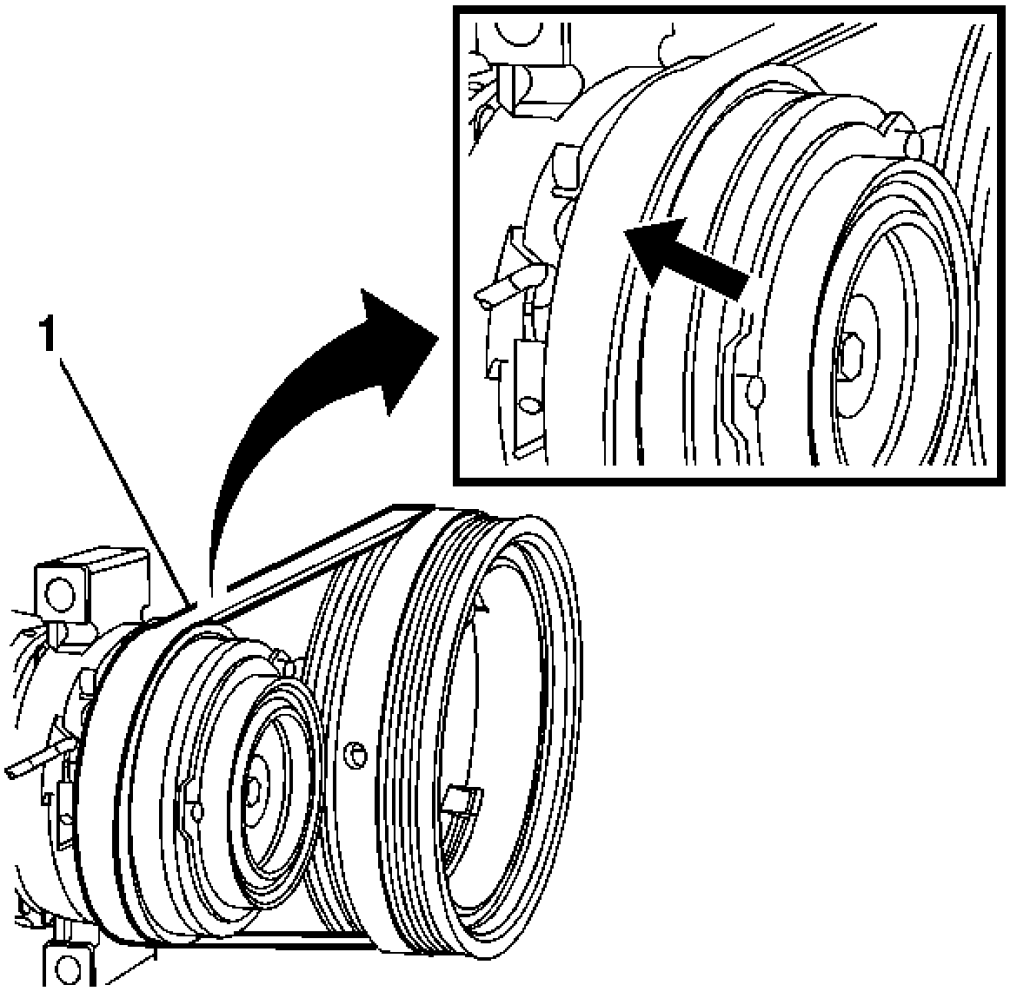


Fig. 8: Drive Belt Alignment
Courtesy of GENERAL MOTORS CORP.

8. Inspect the drive belt (1) for proper installation and alignment.

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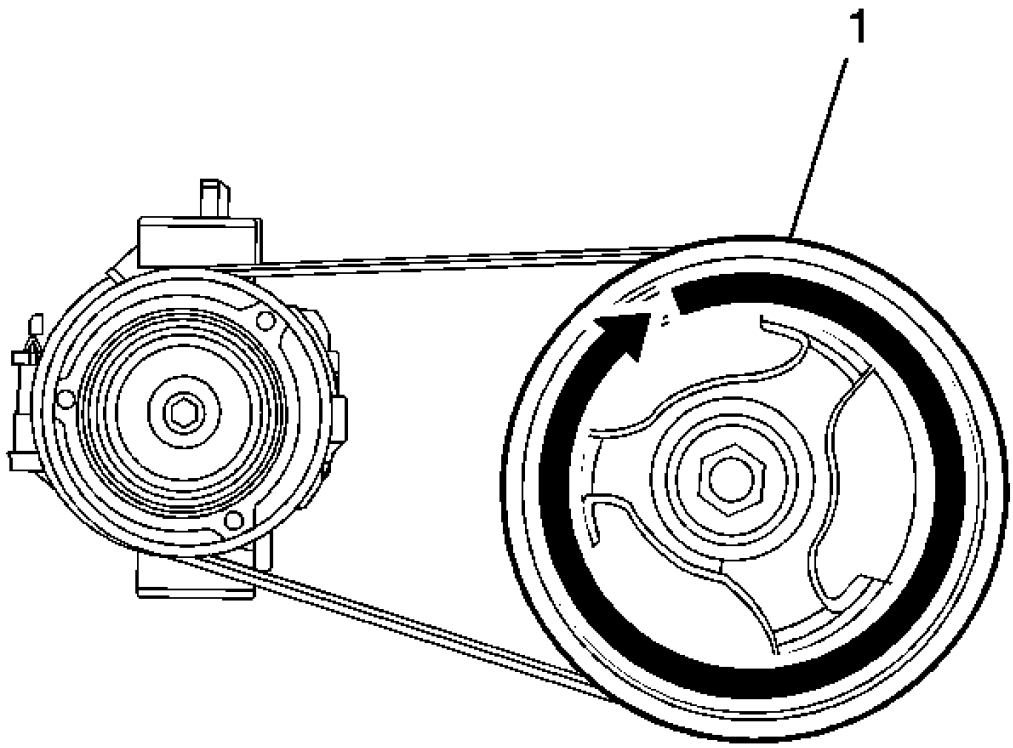


Fig. 9: Rotating Balancer
Courtesy of GENERAL MOTORS CORP.

9. Rotate the balancer (1) and additional 360 degrees to ensure proper belt installation.

CAUTION: Refer to Fastener Caution .

10. Reposition the camshaft position sensor/actuator wire harness bracket and tighten the bolts as required.

    Tighten the bolts to 12 N.m (106 lb in).

11. Install the accessory drive belt. Refer to **Drive Belt Replacement - Accessory**.

DRIVE BELT IDLER PULLEY REPLACEMENT

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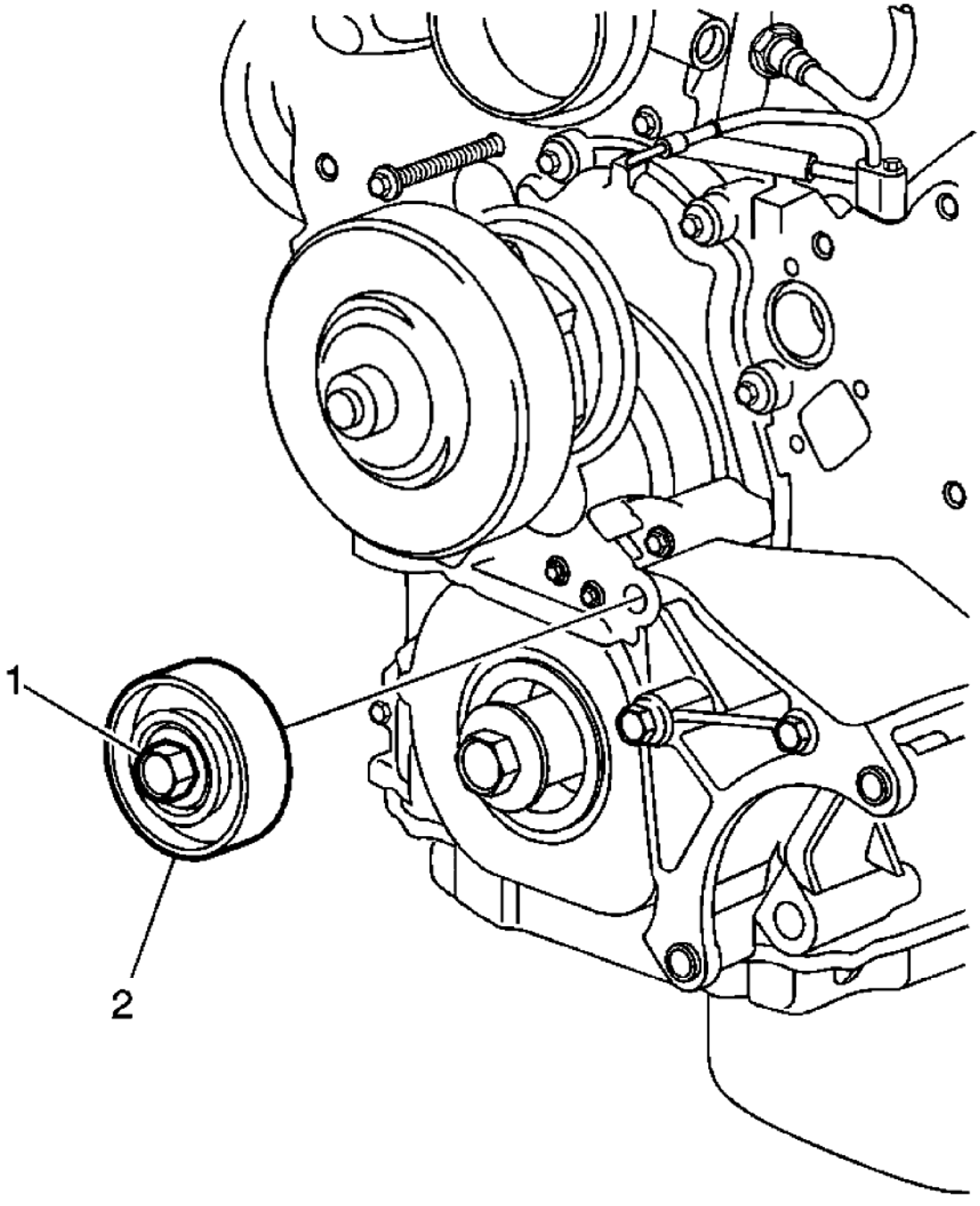


Fig. 10: Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the drive belt. Refer to **Drive Belt Replacement - Accessory**.	
	Drive Belt Idler Pulley Fastener

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1	**CAUTION:** **Refer to Component Fastener Tightening Caution .** **Tighten:** 50 N.m (59 lb ft)
2	Drive Belt Idler Pulley **Procedure:** Transfer components as necessary.

DRIVE BELT TENSIONER REPLACEMENT - ACCESSORY

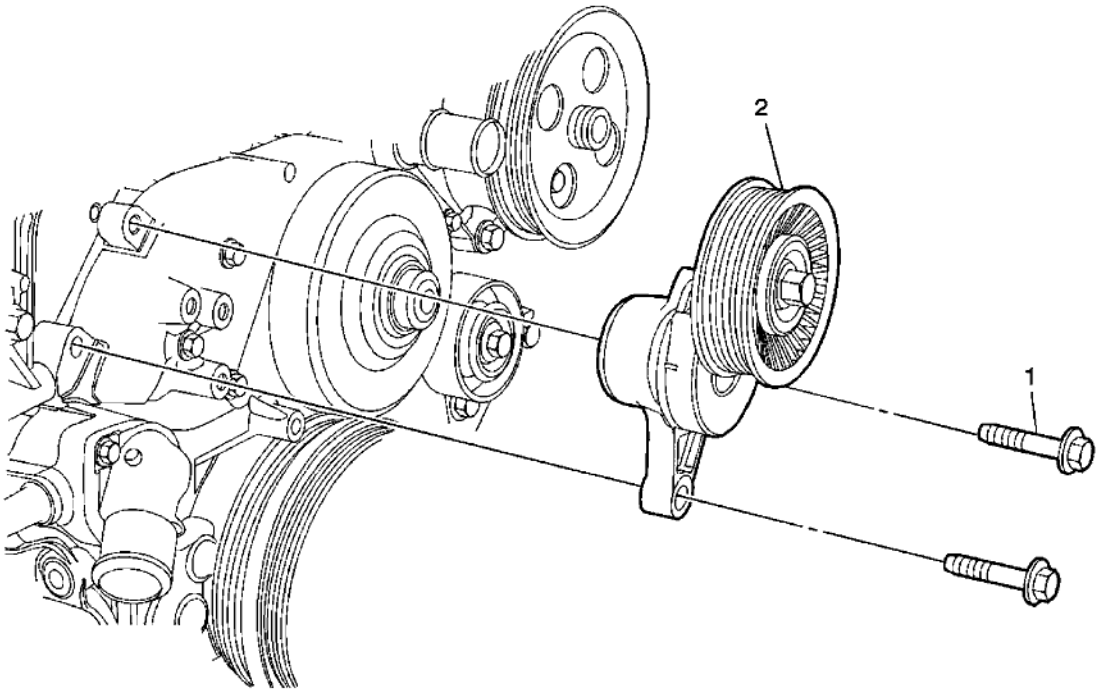


Fig. 11: Drive Belt Tensioner - Accessory
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the drive belt. Refer to **Drive Belt Replacement - Accessory**.	
1	Drive Belt Tensioner Fastener (Qty: 2) **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Tighten:** 50 N.m (59 lb ft)
2	Drive Belt Tensioner **Procedure:**

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	Transfer components as necessary.

ENGINE COVER REPLACEMENT

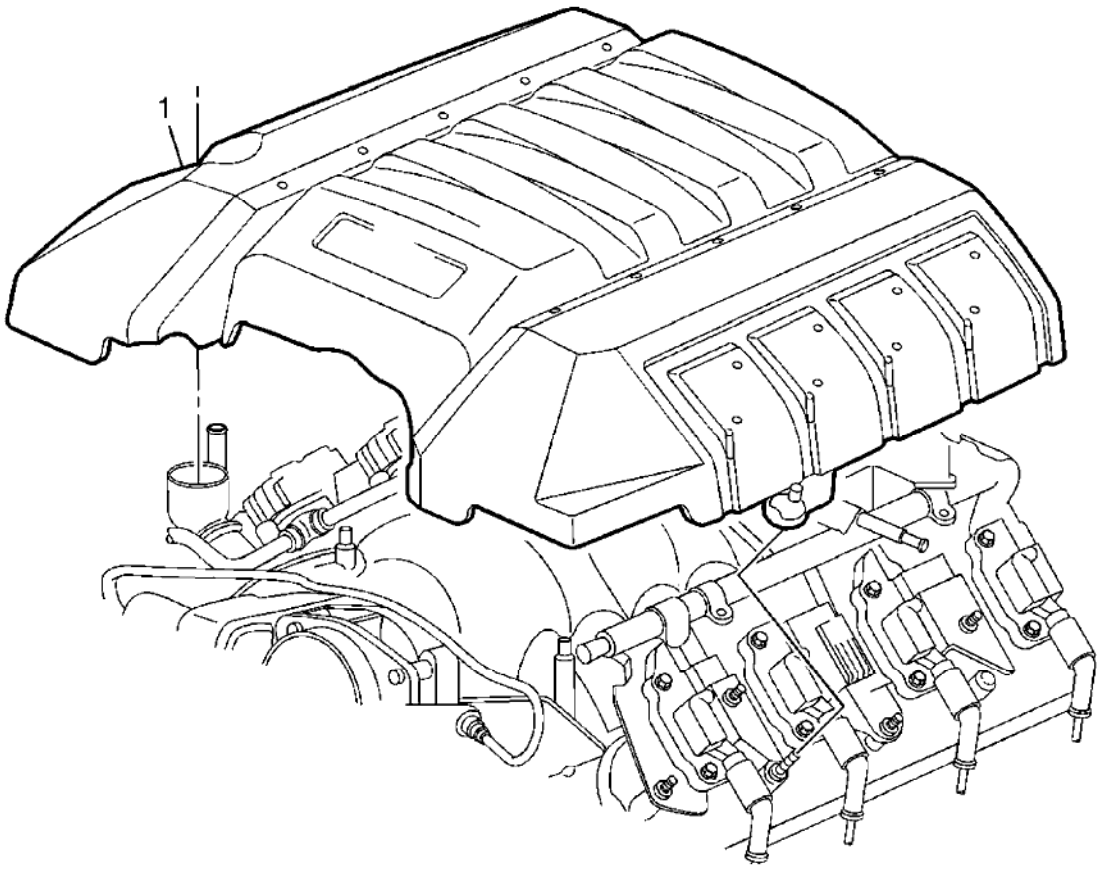


Fig. 12: Engine Cover
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Cover **Procedure** 1. Remove the oil cap before removing the cover. 2. Pull upward to remove the engine cover.

ENGINE SUPPORT FIXTURE

Special Tools

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- **J 28467-81:** Engine Support Fixture Kit
- **J 41798:** Engine Lift Bracket

INSTALLATION PROCEDURE

1. Remove the engine cover. Refer to **Engine Cover Replacement**.
2. Remove the two studs from the left valve cover ignition coil bracket.
3. Install **J 4179-2:** engine bracket to the left cylinder head.
4. Remove the #4 ignition coil from the right valve cover.
5. Remove the ground wire bolt from the right cylinder head.
6. Install **J 36857-1:** Lifting Hook at the ground wire location.
7. Support the hood and remove the hood support strut. Refer to **Hood Strut Replacement**

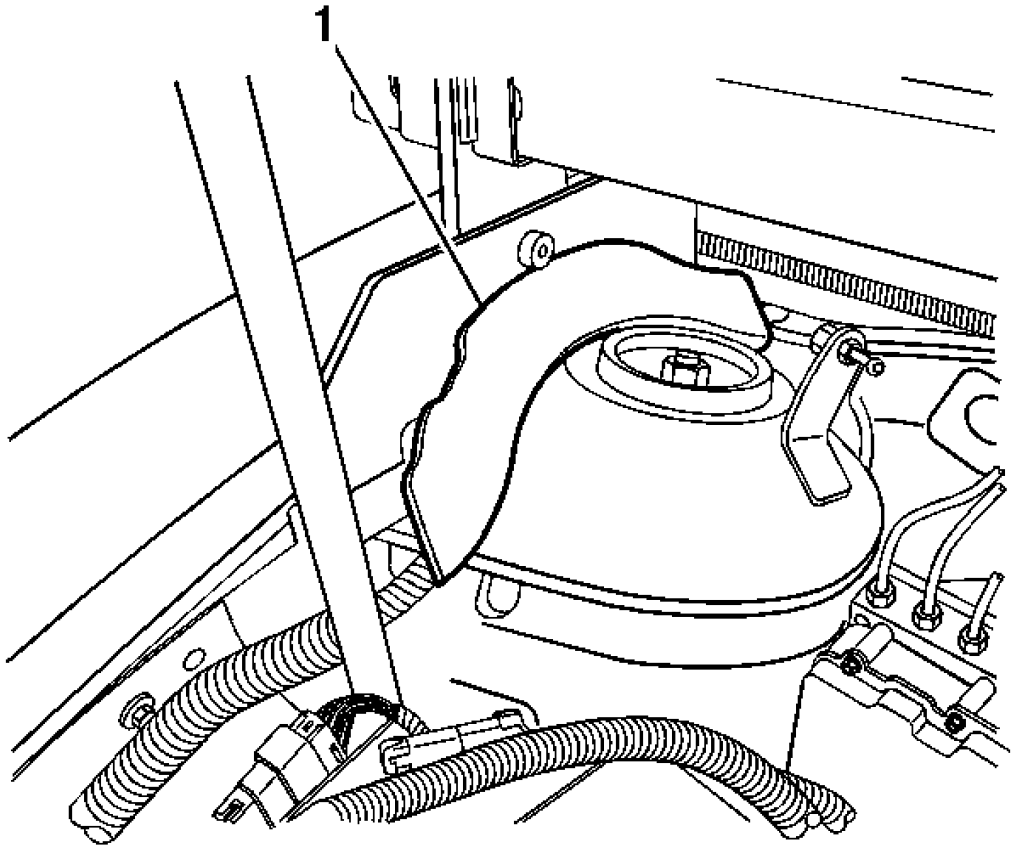


Fig. 13: Passenger Side Wire Harness
Courtesy of GENERAL MOTORS CORP.

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8. Reposition the passenger side wire harness (1) to provide clearance for support fixture leg.

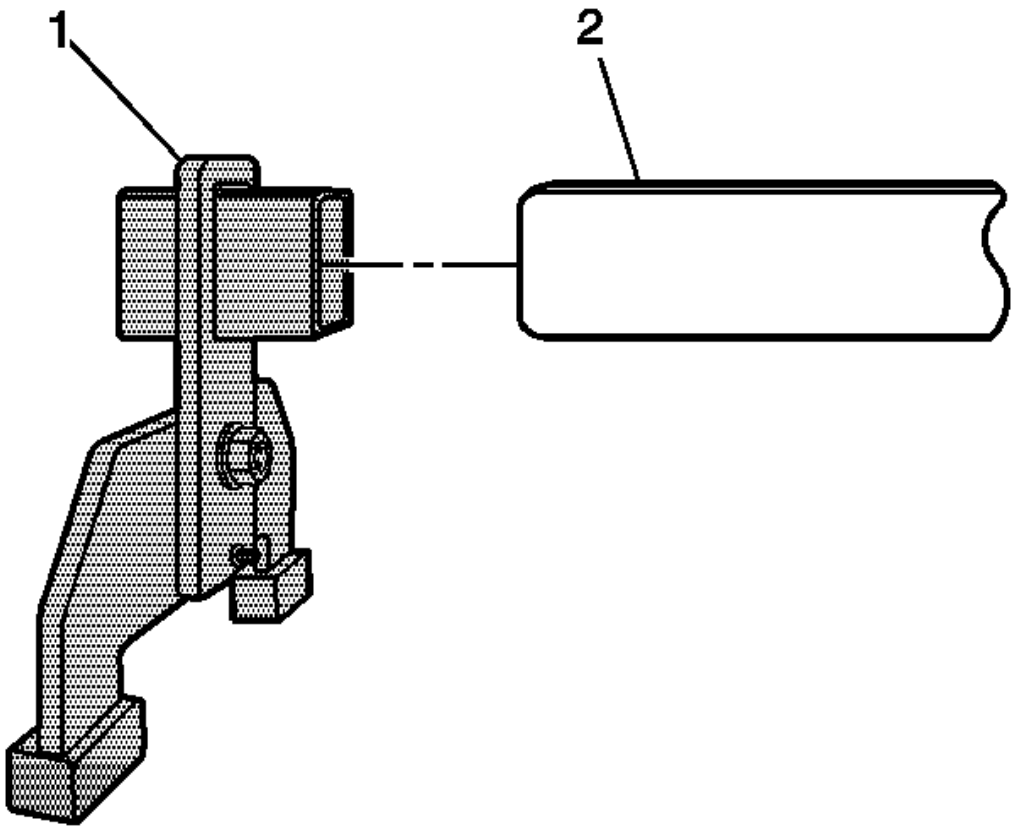


Fig. 14: Identifying Support Leg & Main Bar
Courtesy of GENERAL MOTORS CORP.

9. Assemble a **J 28467-501:** support leg (1) to each end of the **J 28467-518:** main bar (2).

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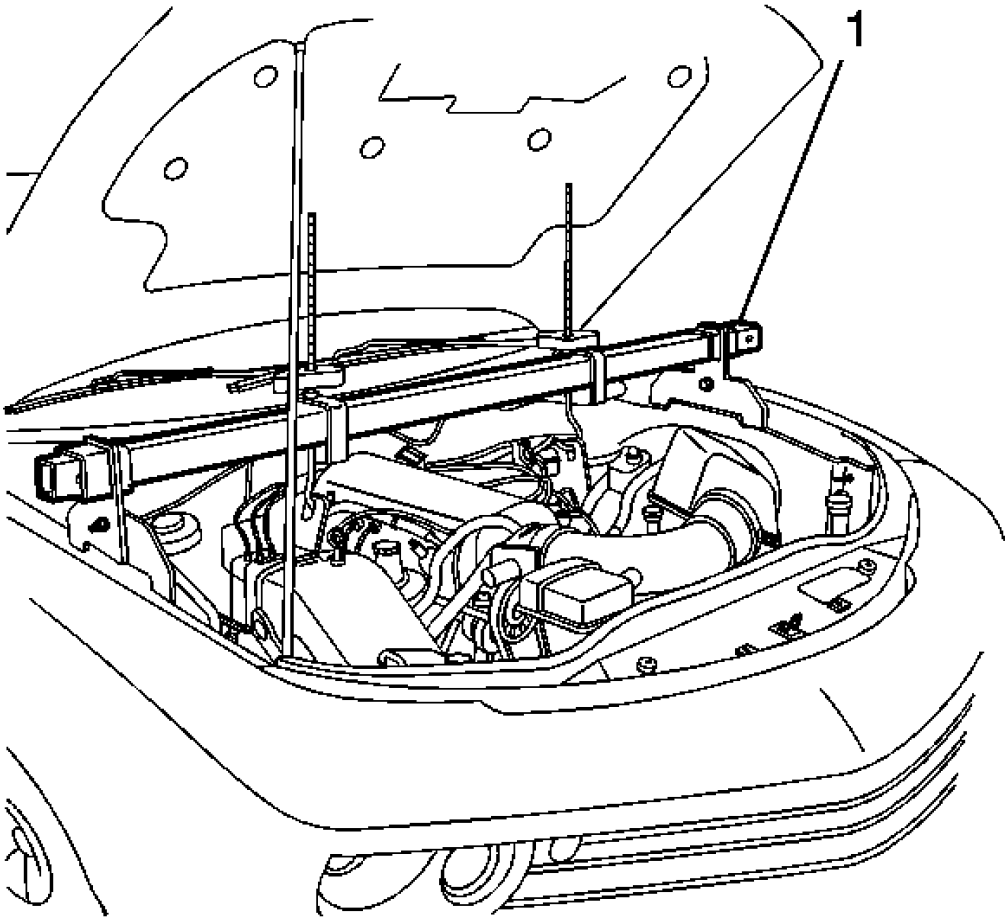


Fig. 15: Engine Support Kit
Courtesy of GENERAL MOTORS CORP.

10. Position the main bar (1) with the support legs over each shock tower. Ensure the rear support legs are located over the reinforced section of the shock tower.

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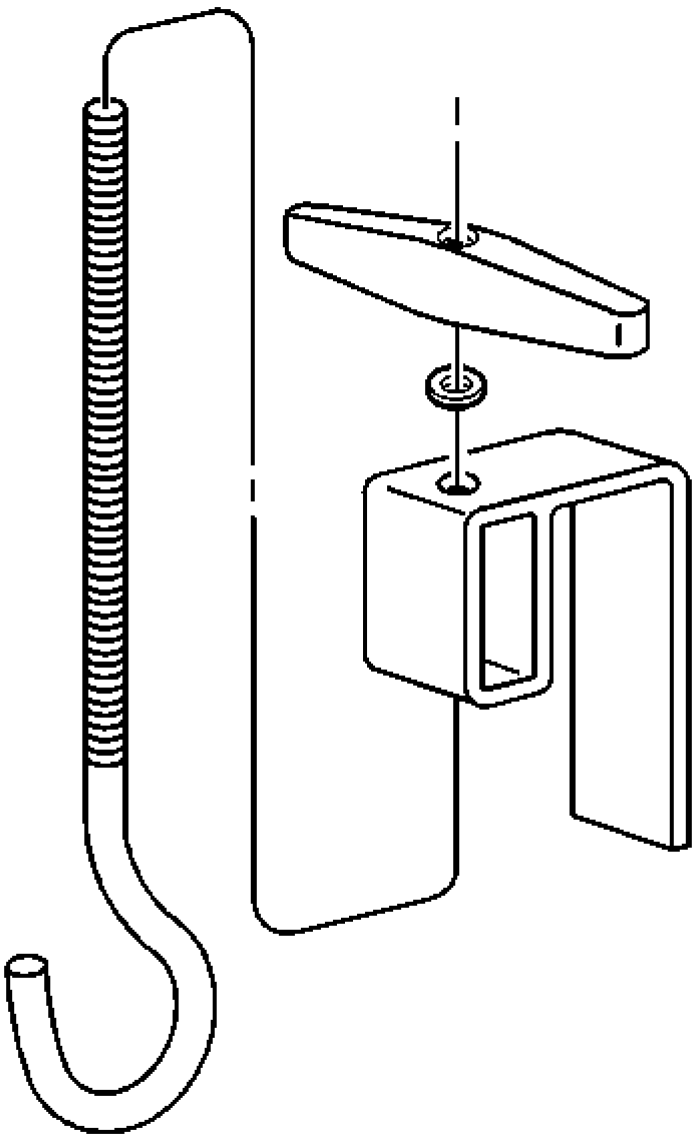


Fig. 16: View Of Lift Hook Assembly
Courtesy of GENERAL MOTORS CORP.

11. Install the **J 28467-7A:** lift hook through the **J 28467-6A:** lift hook bracket.
12. Install the 1/2 inch lift hook washer and the **J 28467-34:** handle onto the **J 28467-7A:** lift hook.

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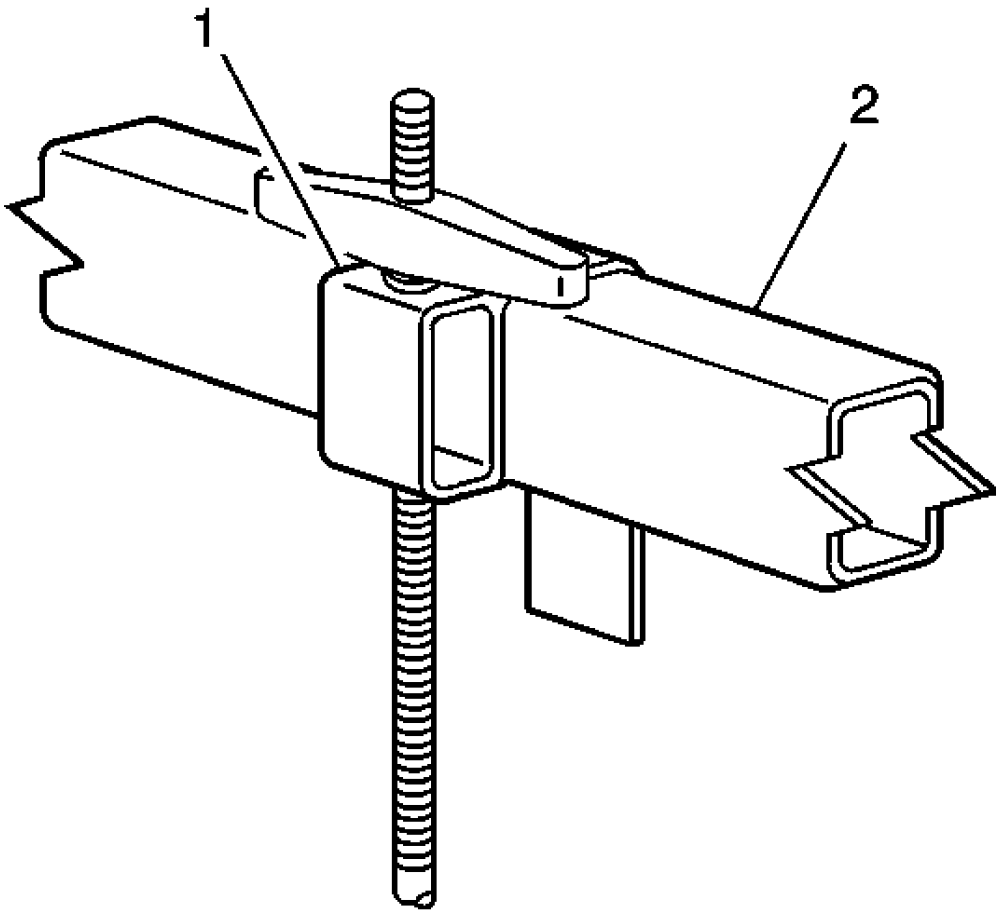


Fig. 17: View Of Lift Hook & Bracket Assembly At Longitudinal Mounted Cross Bar
Courtesy of GENERAL MOTORS CORP.

13. Install the **J 28467-6A:** assembled lift hook bracket (1) over the **J 28467-16:** main bar (2).
14. Adjust the **J 28467-6A:** assembled lift hook bracket (1) in order to align the hook with the **J 41798:** engine bracket.
15. Repeat steps 8-11 for the right lift hook.

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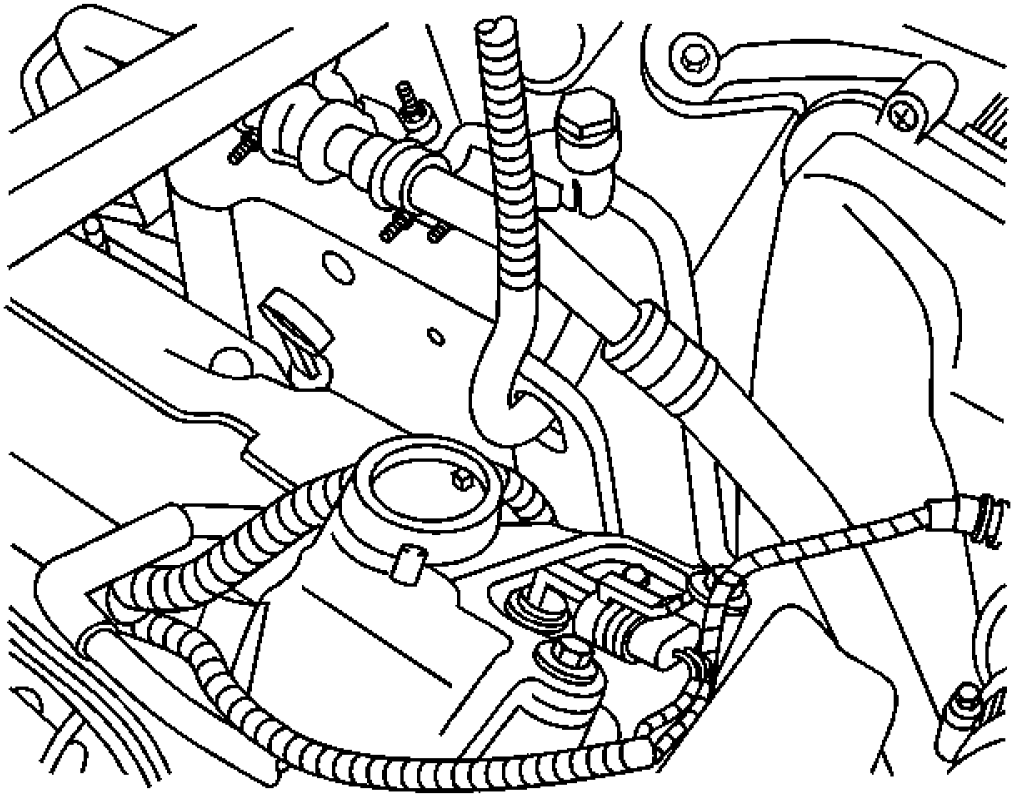


Fig. 18: Lift Hook Through Engine Lift Bracket
Courtesy of GENERAL MOTORS CORP.

16. Install each **J 28467-7A:** lift hook through each engine bracket. Ensure that the hooks do not damage the surrounding components.
17. Hand-tighten the lift hook wing nuts securely to remove all slack from the engine support fixture assembly.
18. The engine is now supported in the vehicle to perform repairs that require front frame removal.

REMOVAL PROCEDURE

1. Loosen and remove the **J 28467-7A:** lift hooks.

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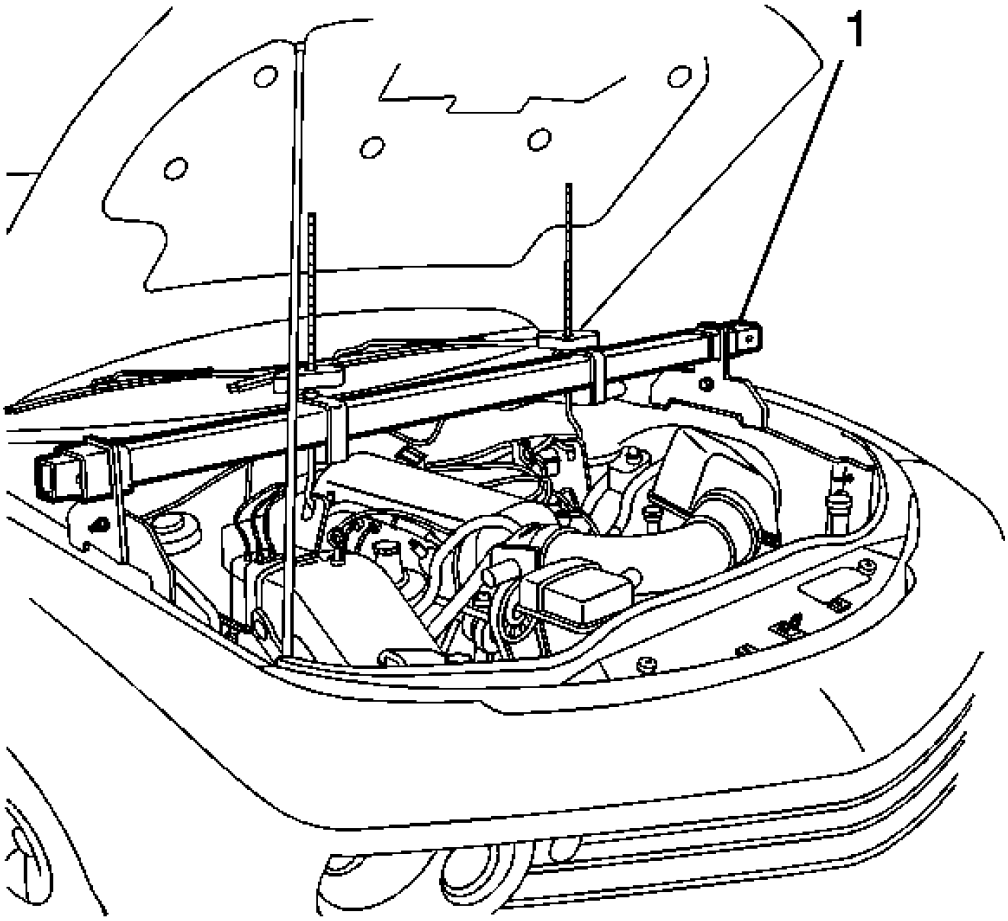


Fig. 19: Engine Support Kit
Courtesy of GENERAL MOTORS CORP.

2. Remove the **J 28467-81:** kit (1).
3. Remove **J 36857-1:** Lifting Hook from the right cylinder head.
4. Remove **J 4179-2:** engine bracket from the left cylinder head.
5. Install the #4 ignition coil to the right valve cover.
6. Install the ground wire bolt to the right cylinder head.
7. Install the two studs to the left valve cover ignition coil bracket.
8. Install the hood support strut. Refer to **Hood Strut Replacement** .
9. Install the engine cover. Refer to **Engine Cover Replacement**.

ENGINE MOUNT INSPECTION

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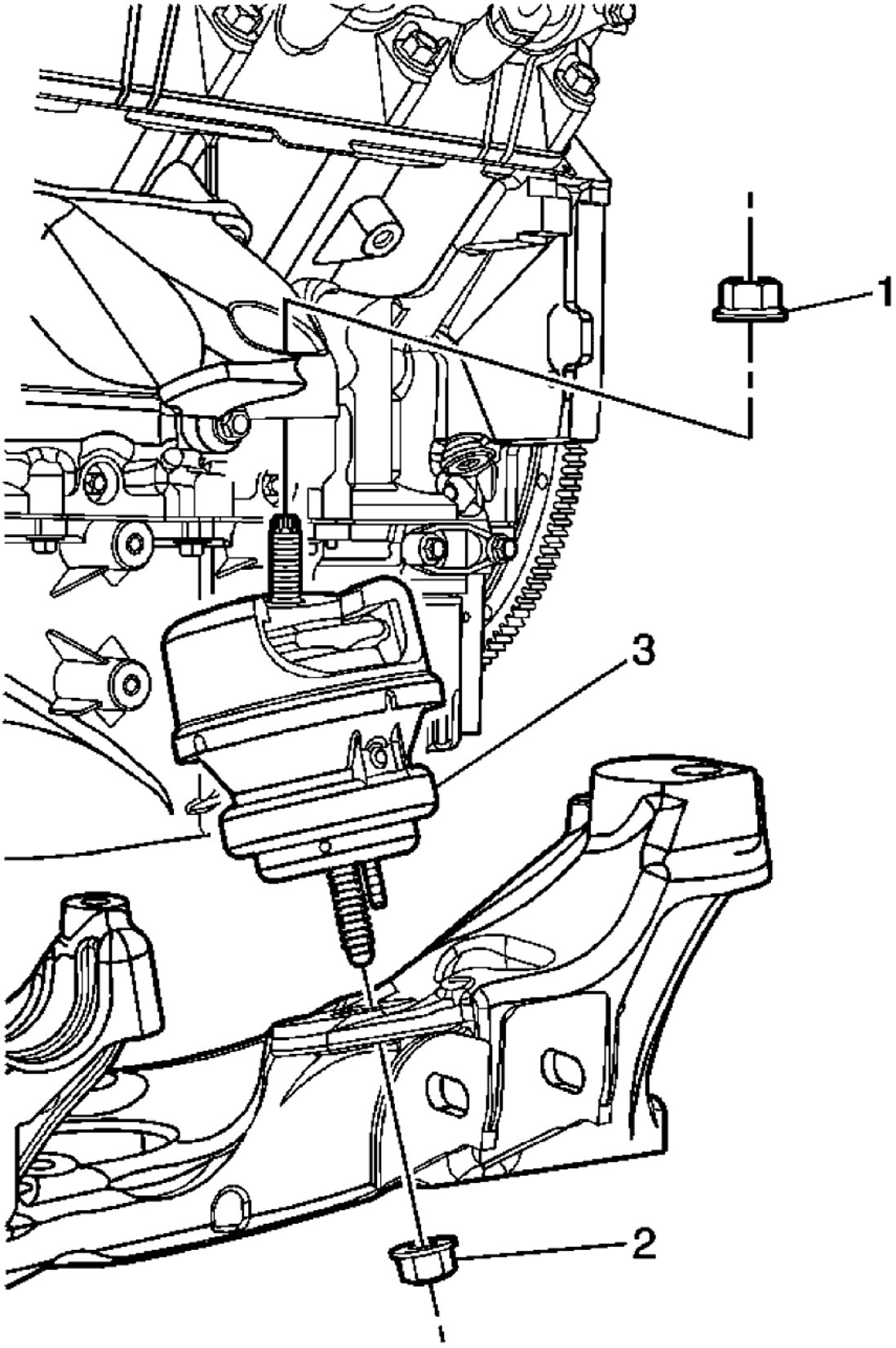
CAUTION: Broken or deteriorated mounts can cause misalignment and destruction of certain drive train components. When a single mount breaks, the remaining mounts are subjected to abnormally high stresses.

CAUTION: When raising or supporting the engine for any reason, do not use a jack under the oil pan, any sheet metal, or the crankshaft pulley. Due to the small clearance between the oil pan and the oil pump screen, jacking against the oil pan may cause the pan to be bent against the pump screen. This will result in a damaged oil pickup unit.

1. Measure the engine movement at the engine mount in order to check for damage to the rubber portions of the mount.
    1. Apply the park brake.
    2. Start the engine.
    3. Firmly apply and hold the primary brakes.
    4. Have an assistant stand to the side of the vehicle in order to observe for engine movement.
    5. Slightly load the engine shifting from drive to reverse a few times.
    6. If the engine moves more than 24 mm (0.945 in) from the at rest position, in either direction, check for loose engine mount or engine mount bracket attachments.
2. If the engine mount and engine mount bracket bolt torque is at specifications, check the condition of the engine mount.
3. Replace the engine mount if any of the following conditions exist:
    - Heat check cracks cover the rubber cushion surface.
    - The rubber cushion is separated from the metal plate of the mount.
    - There is a split through the rubber cushion.

ENGINE MOUNT REPLACEMENT - LEFT SIDE

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Fig. 20: Engine Mount - Left Side
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Mount Fastener **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Procedure** 1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Position a screw jack and a block of wood under the engine oil pan. **Tighten:** 80 N.m (59 lb ft)
2	Engine Mount Fastener **Procedure:** The engine mounts must be replaced once loosened or removed. **Tighten:** 80 N.m (59 lb ft)
3	Engine Mount **Procedure** 1. Using the screw jack, raise the engine enough to remove the engine mount. 2. Install the new right and left engine mount lower nut first.

ENGINE MOUNT BRACKET REPLACEMENT - LEFT SIDE

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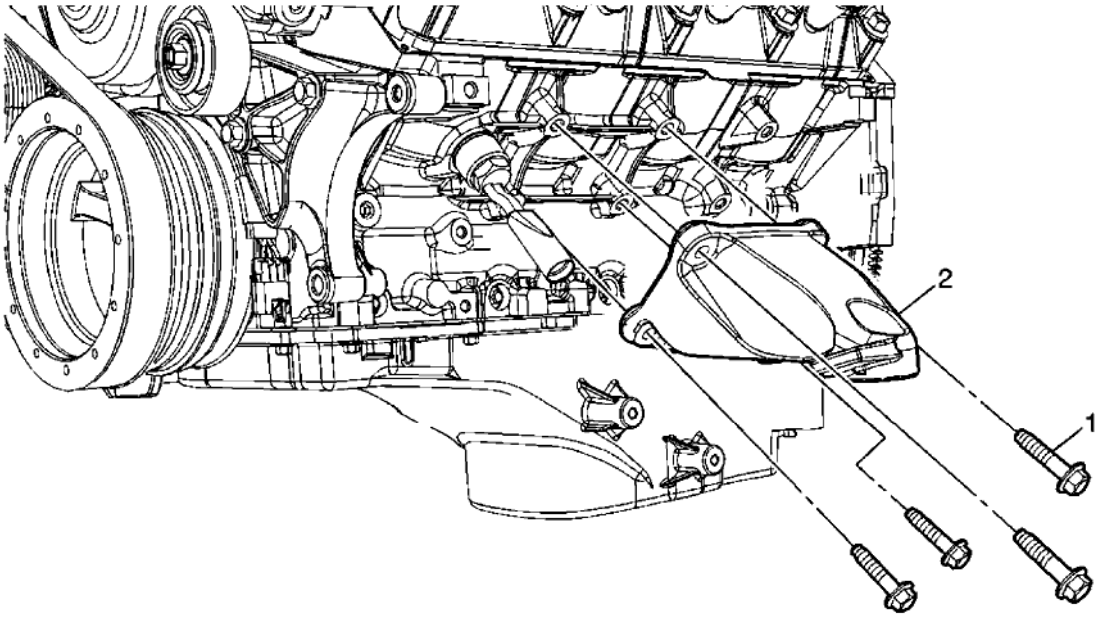


Fig. 21: Identifying Engine Mount Bracket - Left Side
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the engine mount. Refer to **Engine Mount Replacement - Left Side** .	
1	Engine Mount Bracket Fastener (Qty: 4) **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Tighten:** 60 N.m (44 lb ft)
2	Engine Mount Bracket **Procedure:** Transfer components as necessary.

ENGINE MOUNT REPLACEMENT - RIGHT SIDE

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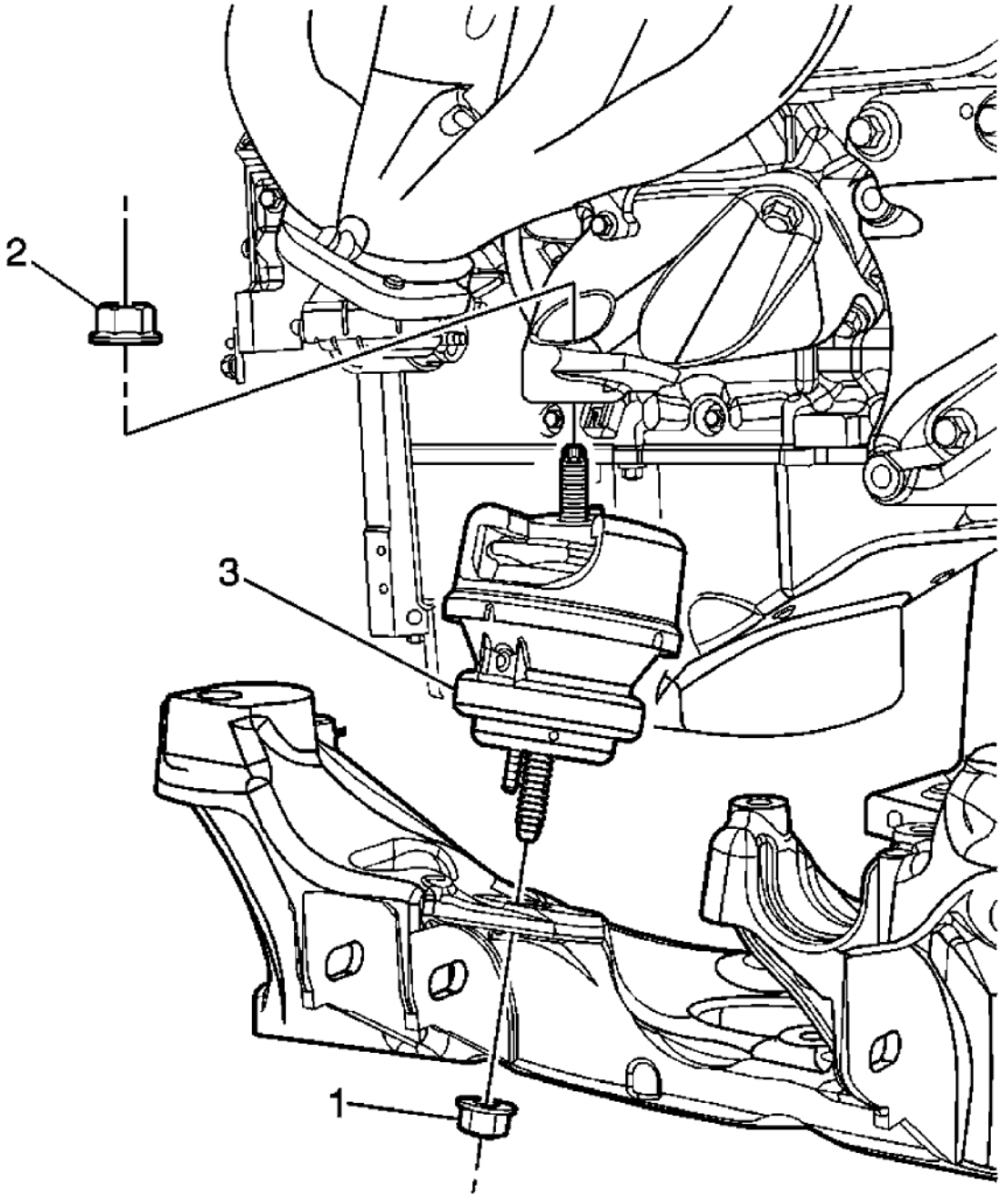


Fig. 22: Engine Mount - Right Side
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
	Engine Mount Fastener **CAUTION:** **Refer to Component Fastener Tightening Caution .**

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1	**Procedure** 1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Position a screw jack and a block of wood under the engine oil pan. **Tighten:** 80 N.m (59 lb ft)
2	Engine Mount Fastener **Procedure:** The engine mounts must be replaced once loosened or removed. **Tighten:** 80 N.m (59 lb ft)
3	Engine Mount **Procedure** 1. Using the screw jack, raise the engine enough to remove the engine mount. 2. Install the new right and left engine mount lower nut first.

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE

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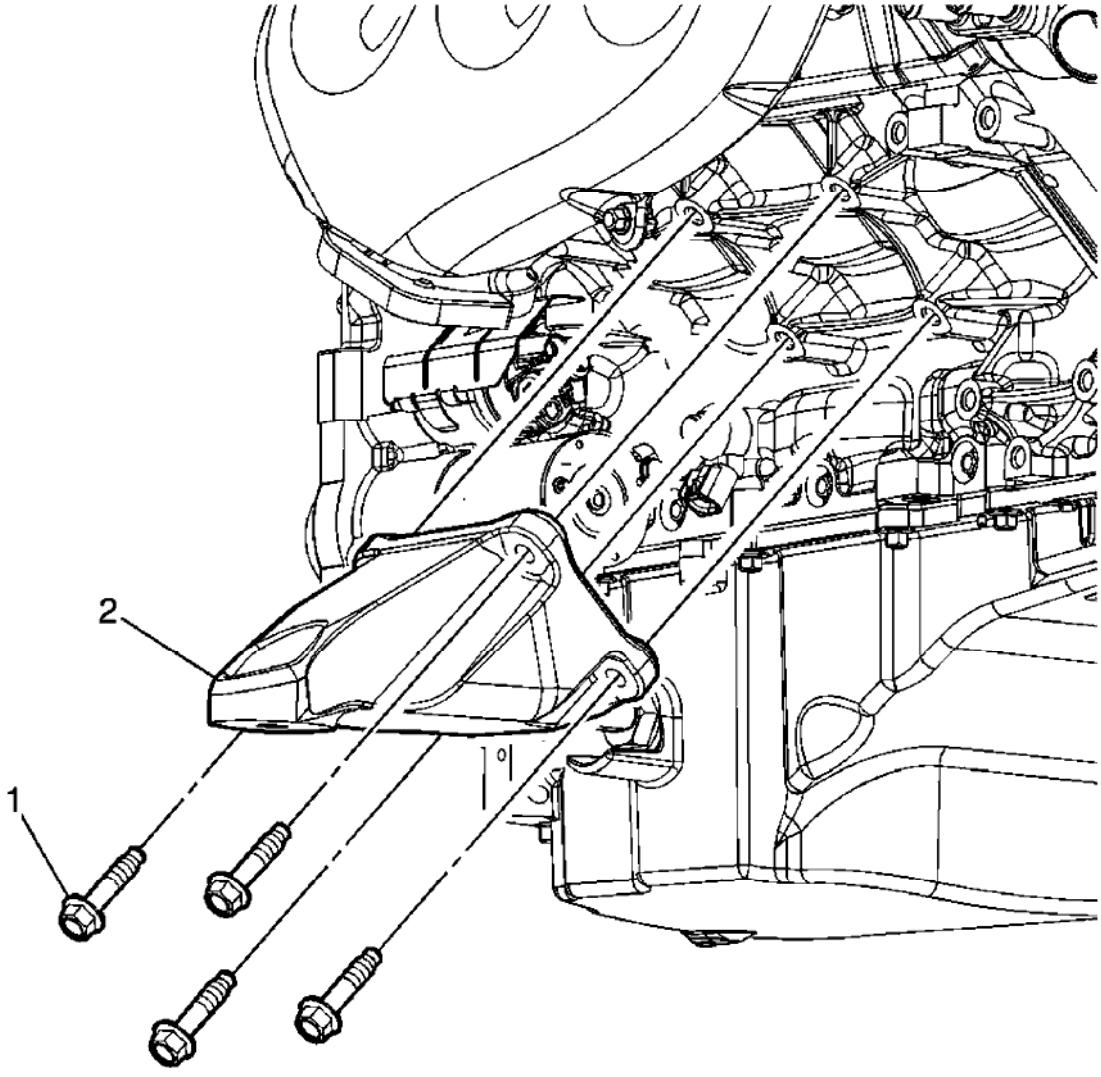


Fig. 23: Engine Mount Bracket - Right Side
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the engine mount. Refer to **Engine Mount Replacement - Right Side** .	
1	Engine Mount Bracket Fastener (Qty: 4) **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Tighten:** 60 N.m (44 lb ft)
2	Engine Mount Bracket **Procedure:**

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	Transfer components as necessary.

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT

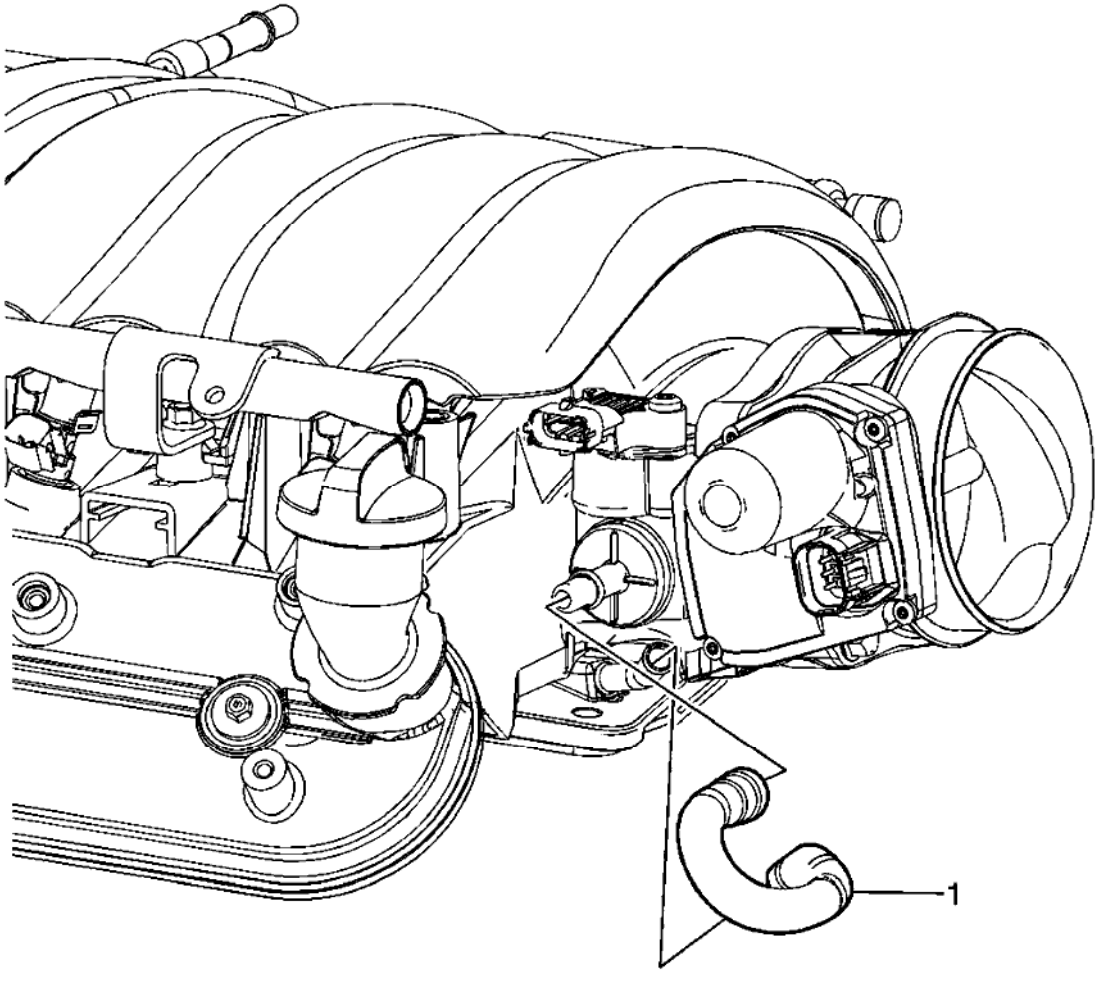


Fig. 24: Positive Crankcase Ventilation Hose/Pipe/Tube
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the engine cover. Refer to **Engine Cover Replacement**.	
1	Positive Crankcase Ventilation Hose/Pipe/Tube **Procedure** 1. Release the tabs on the end of the tube before removing. 2. Disconnect the electrical connectors, as needed.

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3. Transfer components as necessary.

INTAKE MANIFOLD REPLACEMENT

REMOVAL PROCEDURE

NOTE: The intake manifold, throttle body, fuel injection rail and injectors may be removed as an assembly. If not servicing the individual components, remove the intake manifold as a complete assembly.

1. Remove the engine covers. Refer to **Engine Cover Replacement**.
2. Remove the air cleaner resonator and outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement** .
3. Disconnect the electrical connector for the fuel injectors.
4. Disconnect the electrical connectors from the throttle body.
5. Disconnect the fuel feed for the fuel injectors. Refer to **Fuel Line Replacement - Engine** .
6. Remove positive crankcase ventilation hose/pipe/tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement**.

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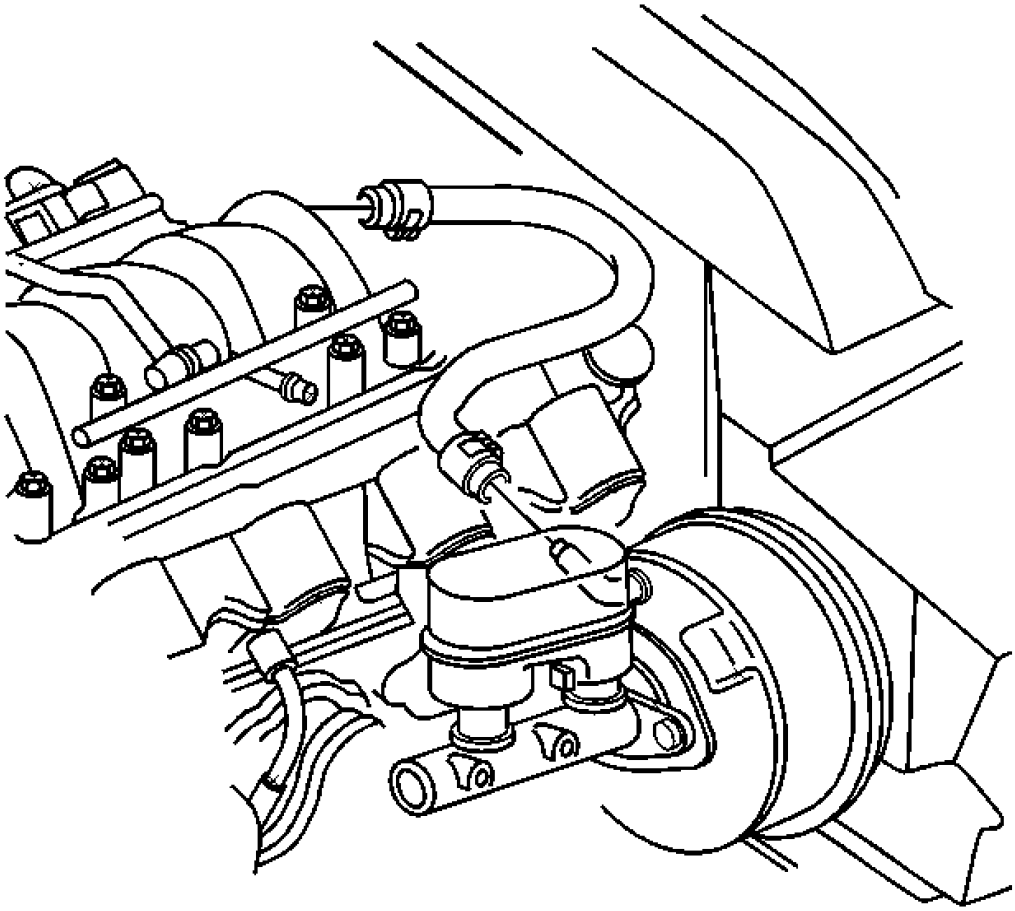


Fig. 25: View Of Vacuum Brake Booster Hose
Courtesy of GENERAL MOTORS CORP.

7. Remove the vacuum hose from the brake booster.
8. Disconnect the electrical connector from the manifold absolute pressure (MAP) sensor.

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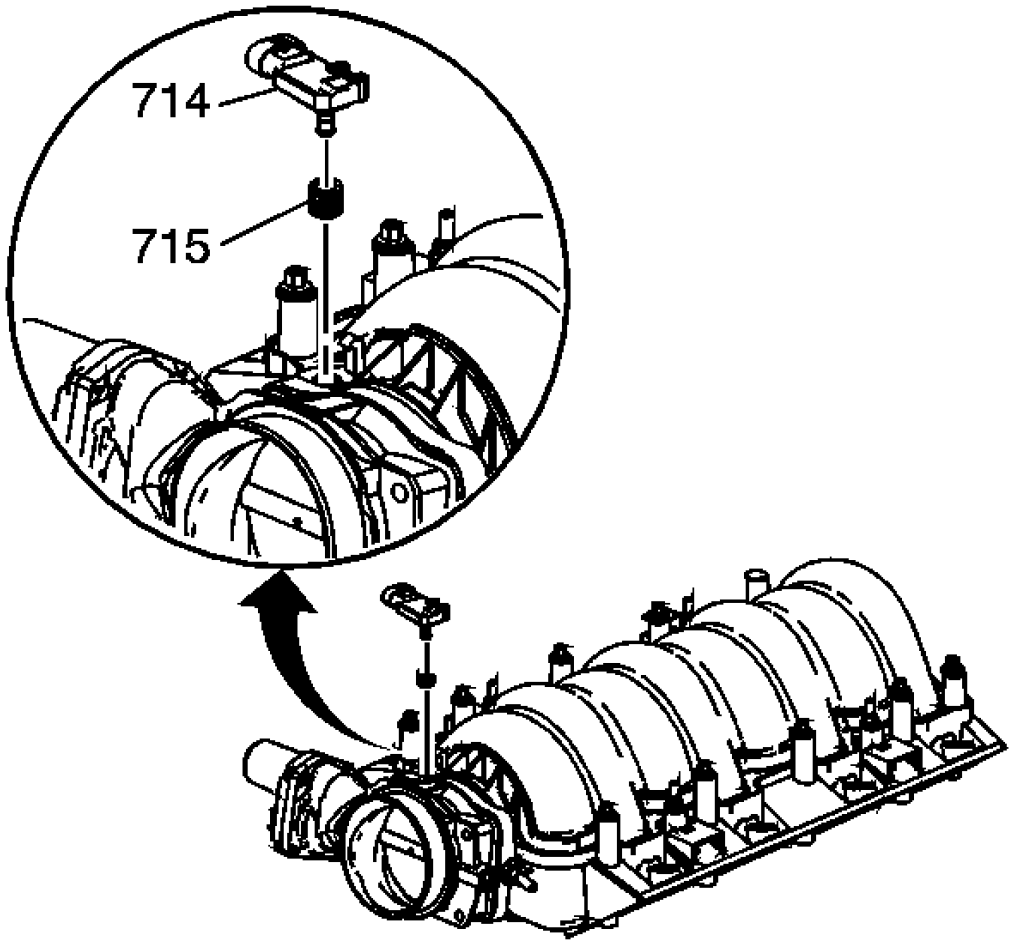


Fig. 26: MAP Sensor & Grommet
Courtesy of GENERAL MOTORS CORP.

9. Remove the MAP sensor (714).
10. Remove the grommet (715) from the sensor, as required.

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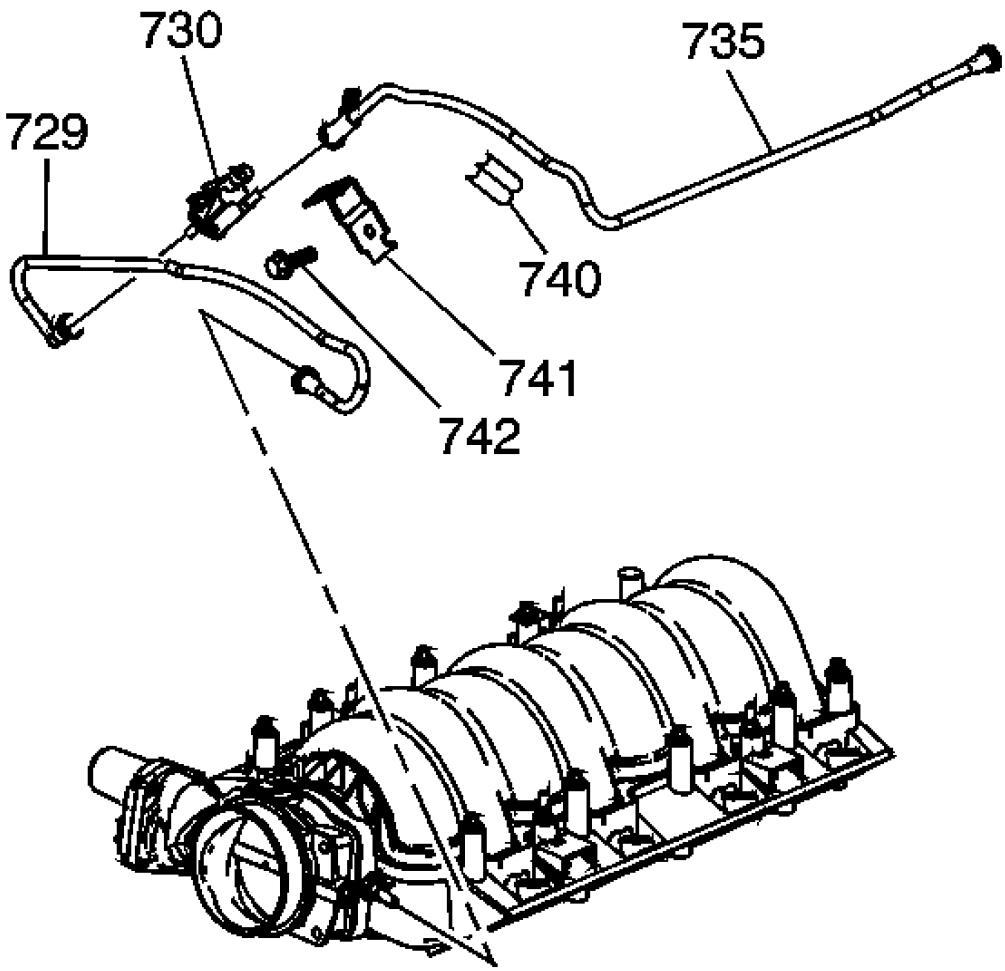


Fig. 27: EVAP Clip, Bolt, Bracket, Valve & Tubes
Courtesy of GENERAL MOTORS CORP.

11. Remove the evaporative emission (EVAP) clip (740), bolt (742), bracket (741), valve (730) and tubes (729, 735).

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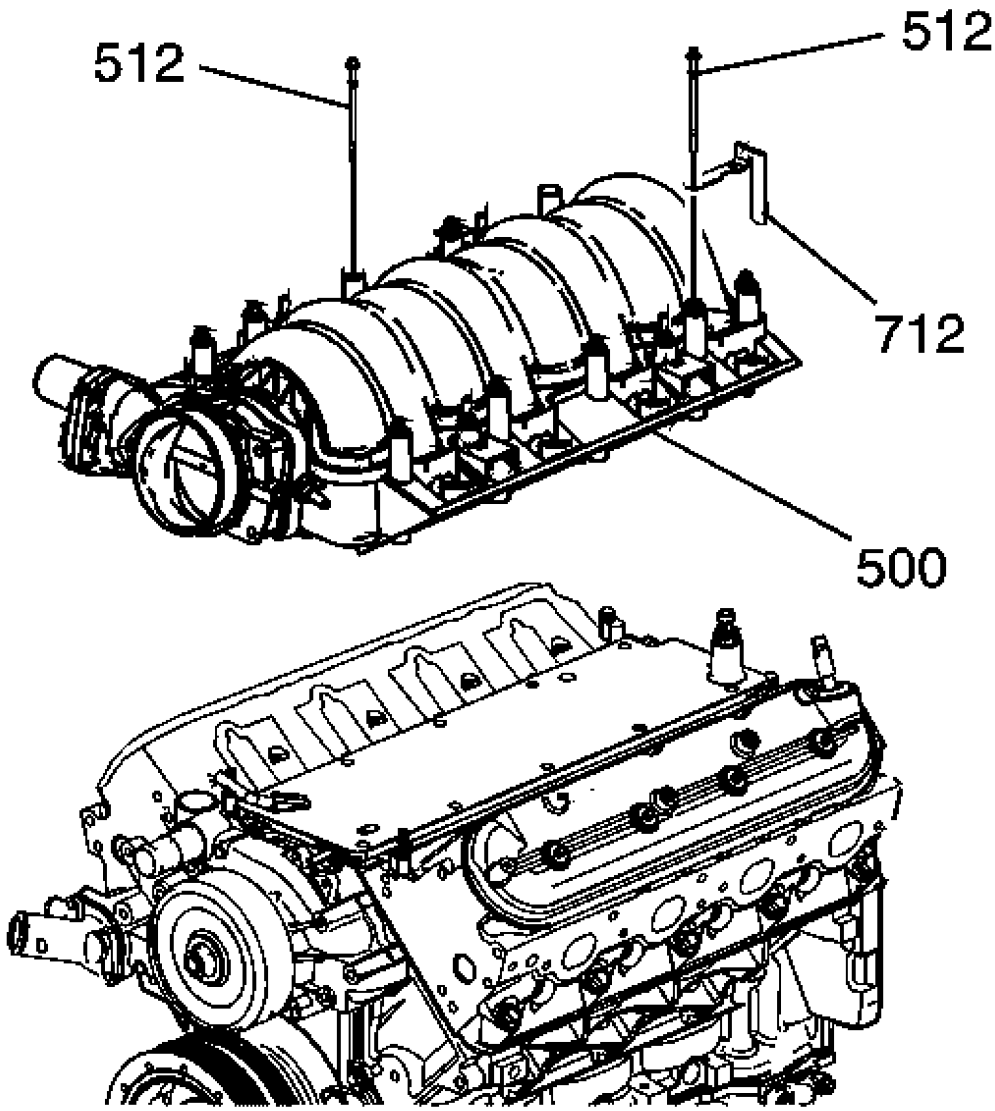


Fig. 28: Intake Manifold, Bolts & Fuel Rail Stop Bracket
Courtesy of GENERAL MOTORS CORP.

12. Remove the intake manifold bolts (512) and the fuel rail stop bracket (712).
13. Remove the intake manifold (500).

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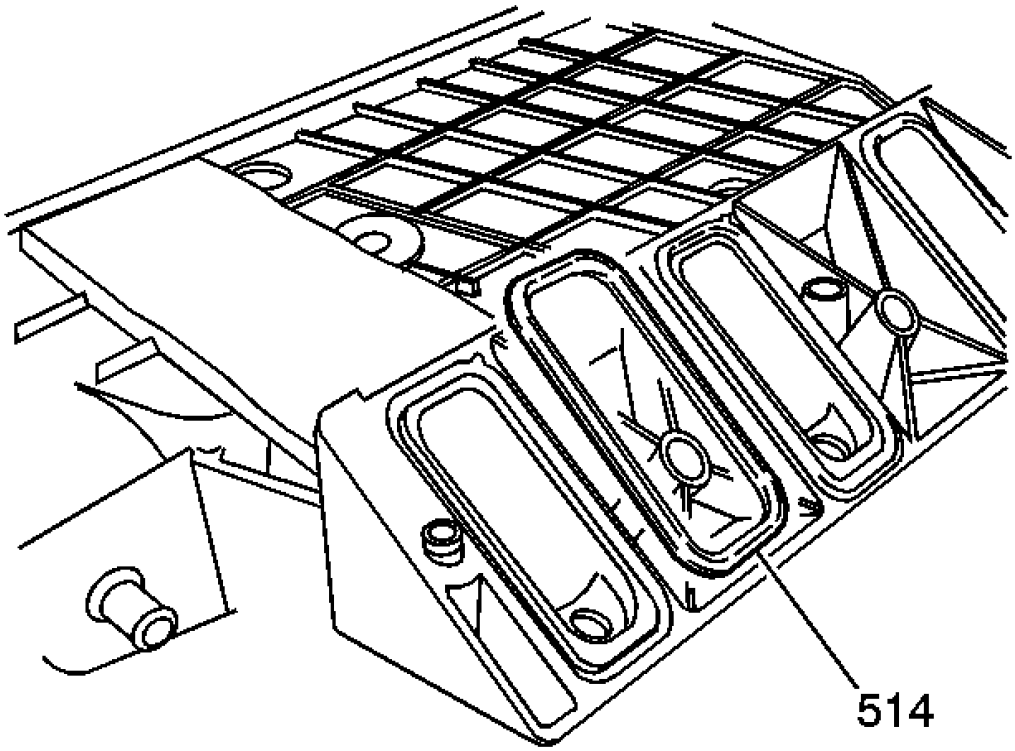


Fig. 29: View Of Intake Manifold-To-Cylinder Head Gaskets
Courtesy of GENERAL MOTORS CORP.

14. Remove the intake manifold gaskets (514).
15. Discard the intake manifold gaskets.
16. If necessary clean and inspect intake manifold. Refer to **Intake Manifold Cleaning and Inspection** .

INSTALLATION PROCEDURE

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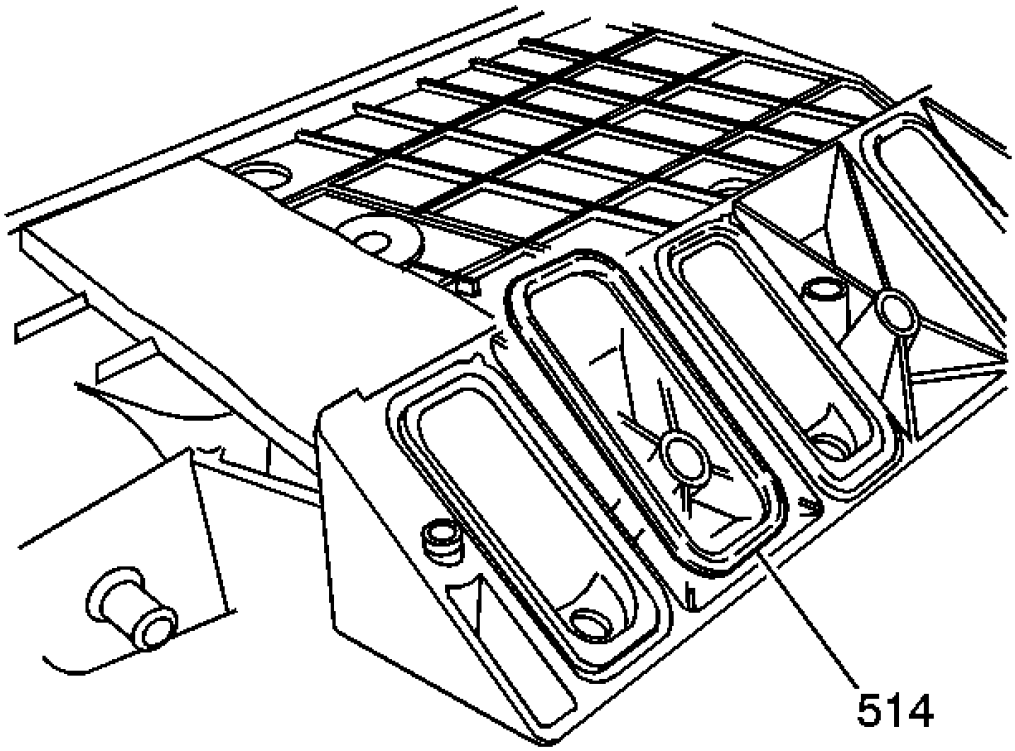


Fig. 30: View Of Intake Manifold-To-Cylinder Head Gaskets
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT reuse the intake manifold gaskets. Install NEW intake manifold gaskets.

NOTE:

- **The intake manifold, throttle body, fuel injection rail and injectors may be removed as an assembly. If not servicing the individual components, install the intake manifold as a complete assembly.**
- **DO NOT use the intake manifold gaskets again. Install NEW intake manifold-to-cylinder head gaskets.**

1. Install NEW intake manifold-to-cylinder head gaskets (514).

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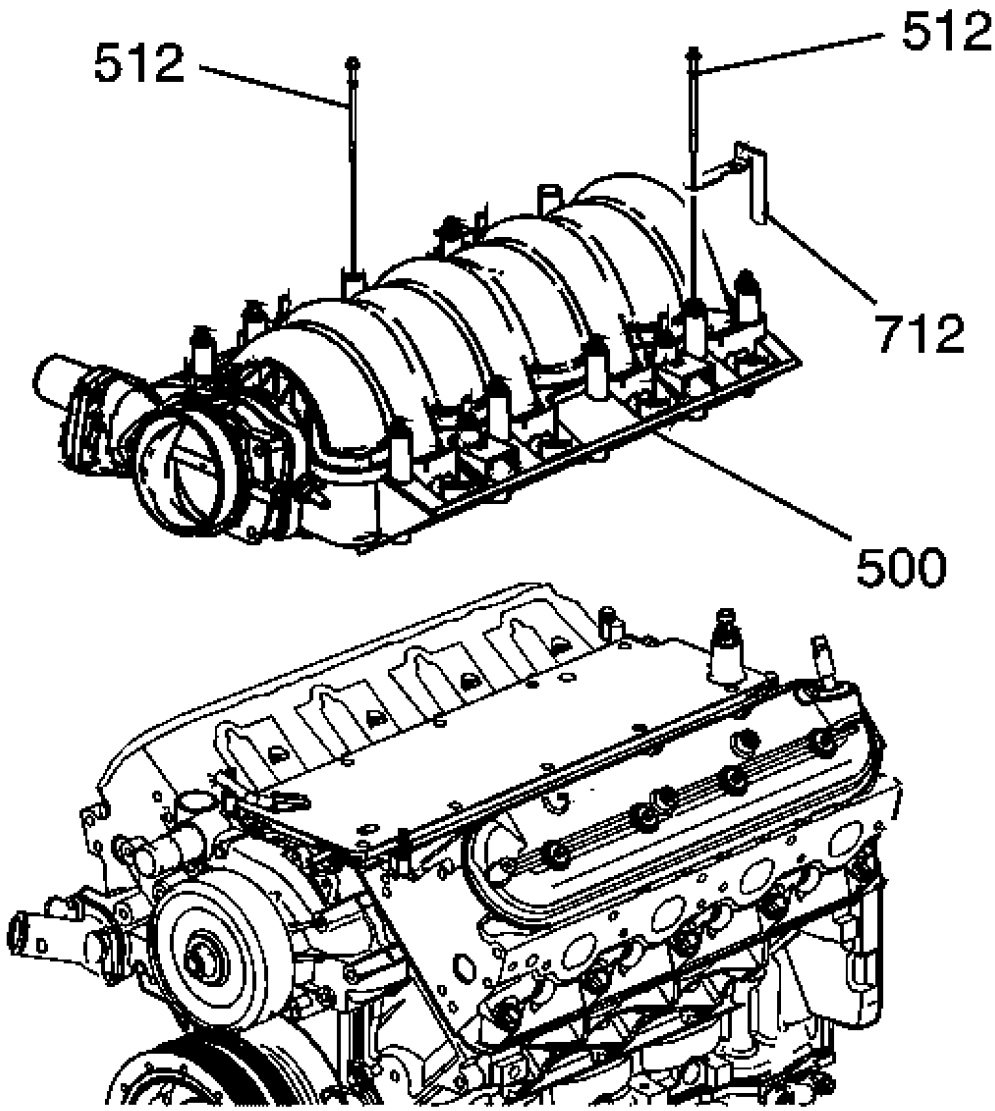


Fig. 31: Intake Manifold, Bolts & Fuel Rail Stop Bracket
Courtesy of GENERAL MOTORS CORP.

2. Install the intake manifold (500).
3. Apply a 5 mm (0.20 in) band of threadlocker to the threads of the intake manifold bolts (512). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
4. Install the fuel rail stop bracket (712).
5. Install the intake manifold bolts (512).

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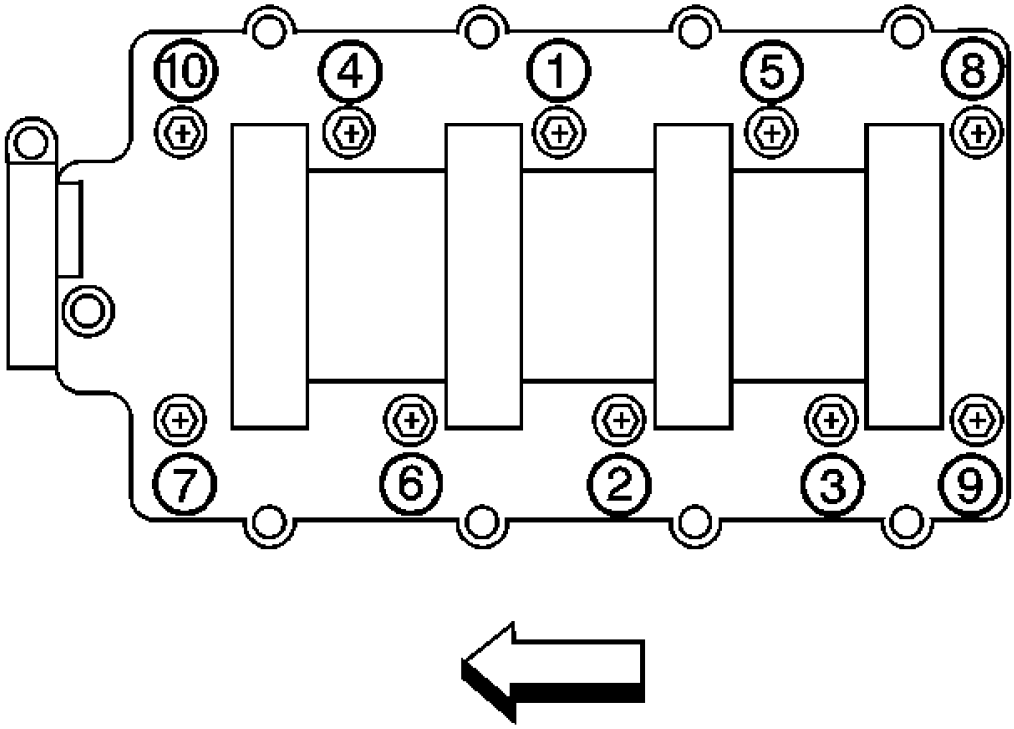


Fig. 32: Identifying Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

6. Tighten the intake manifold bolts to the sequence below:
   - First Pass: Tighten the intake manifold bolts in sequence to 5 N.m (44 lb in).
   - Second Pass: Tighten the intake manifold bolts in sequence to 10 N.m (89 lb in).

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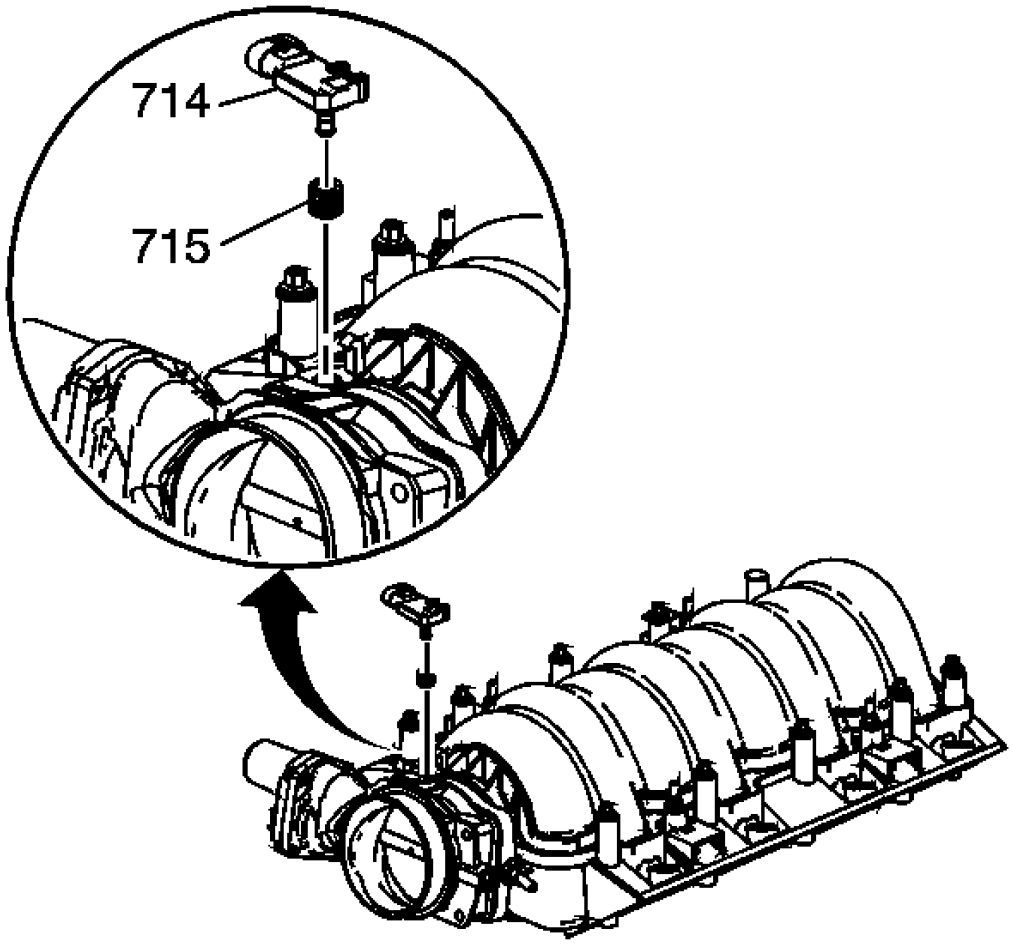


Fig. 33: MAP Sensor & Grommet
Courtesy of GENERAL MOTORS CORP.

7. Lubricate the MAP sensor grommet (715) with clan engine oil.
8. Install the MAP sensor (714) and grommet (715).

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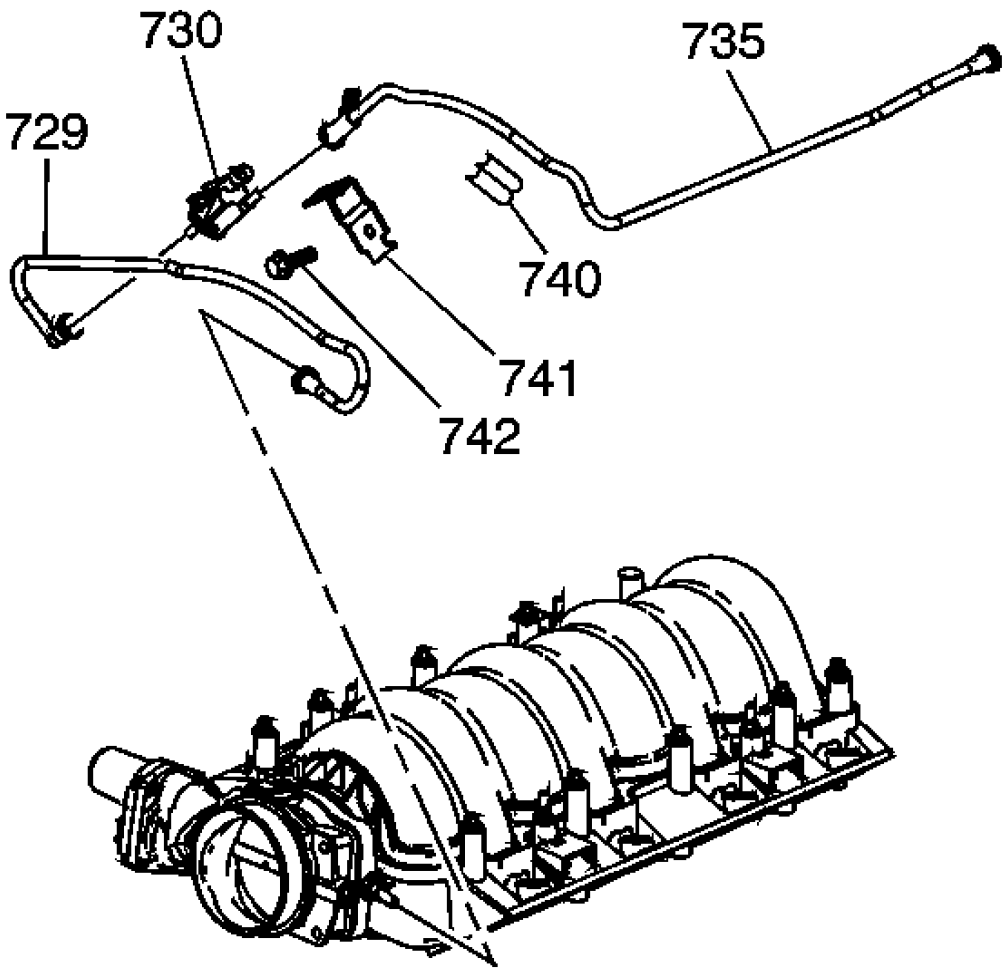


Fig. 34: EVAP Clip, Bolt, Bracket, Valve & Tubes
Courtesy of GENERAL MOTORS CORP.

9. Install the EVAP valve (730), bracket (741) and bolt (742).

   Tighten the bolt to 50 N.m (37 lb ft).

10. Install the EVAP tubes (729, 735).
11. Install the fuel rail. Refer to **Fuel Rail and Injectors Installation** .
12. Connect the electrical connector for the MAP sensor.

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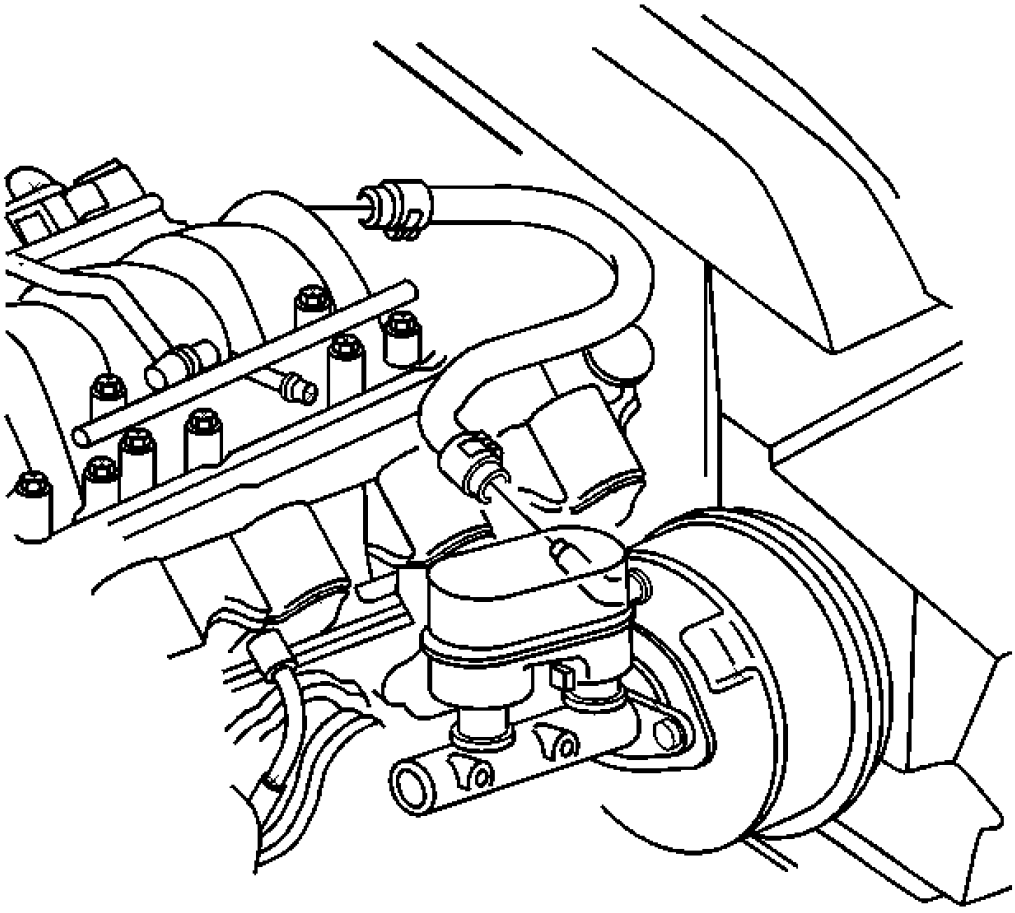


Fig. 35: View Of Vacuum Brake Booster Hose
Courtesy of GENERAL MOTORS CORP.

13. Install the vacuum hose for the brake booster.
14. Connect the electrical connectors (3) for the throttle body.
15. Connect the electrical connector (1) for the fuel injectors.
16. Refill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** .
17. Install the engine covers. Refer to **Engine Cover Replacement**.

VALVE LIFTER OIL MANIFOLD REPLACEMENT

REMOVAL PROCEDURE

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1. Remove the intake manifold. Refer to **Intake Manifold Replacement**
2. Disconnect the engine harness electrical connector from the oil pressure sensor and oil manifold..

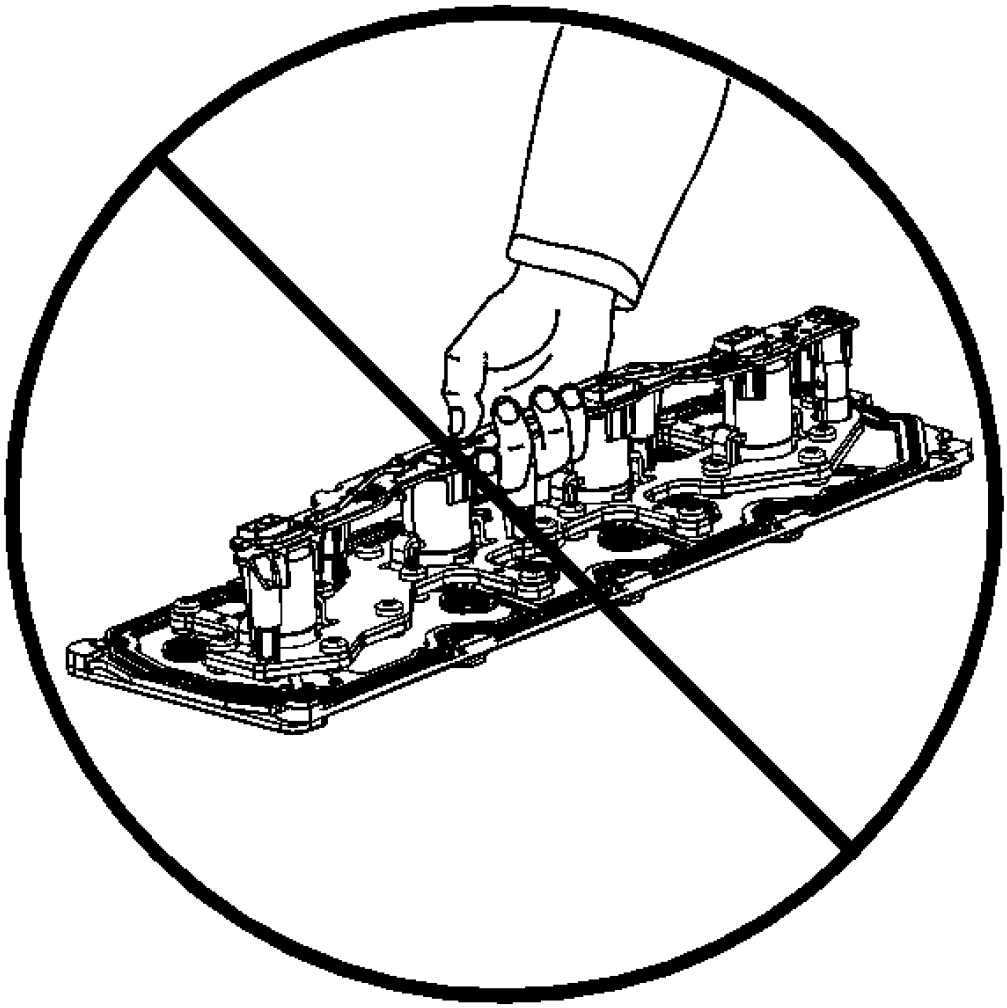


Fig. 36: Valve Lifter Oil Manifold Handling Precaution
Courtesy of GENERAL MOTORS CORP.

3. DO NOT lift the valve lifter oil manifold by the electrical lead frame.

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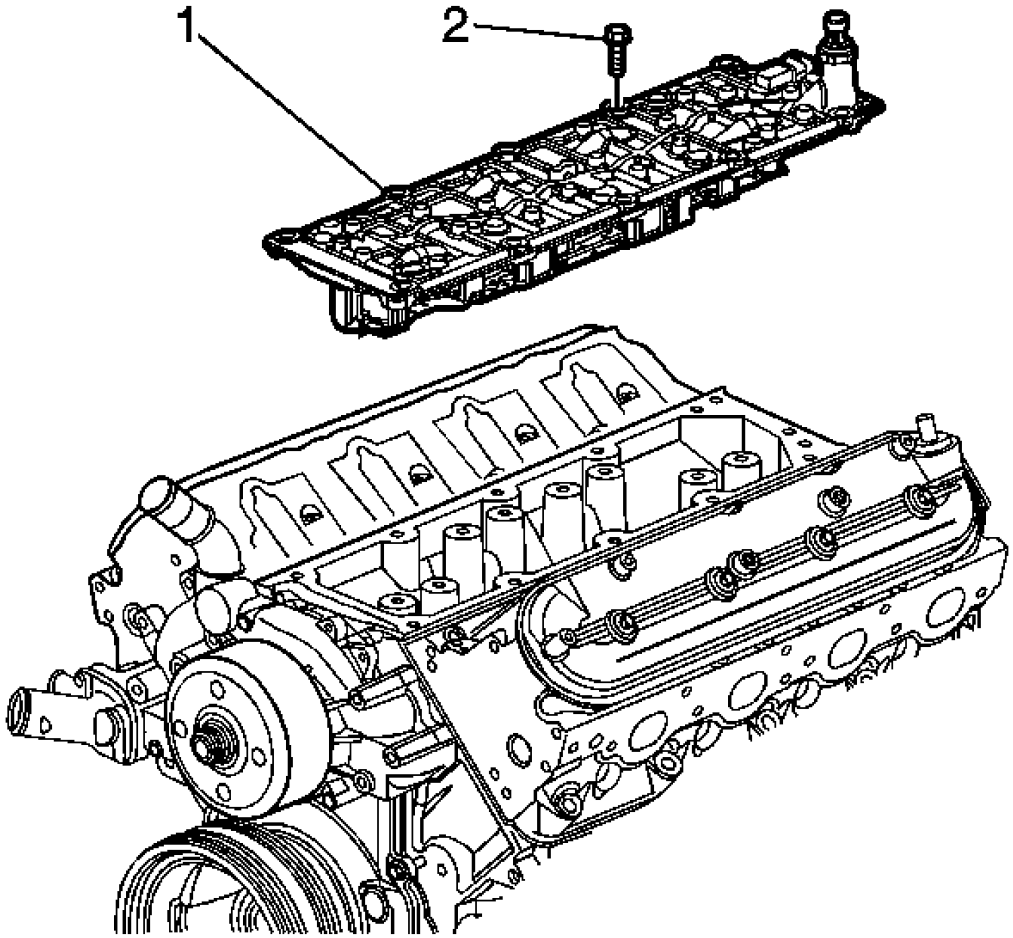


Fig. 37: Valve Lifter Oil Manifold
Courtesy of GENERAL MOTORS CORP.

4. Remove the valve lifter oil manifold bolts (2).
5. Remove the valve lifter oil manifold (1).

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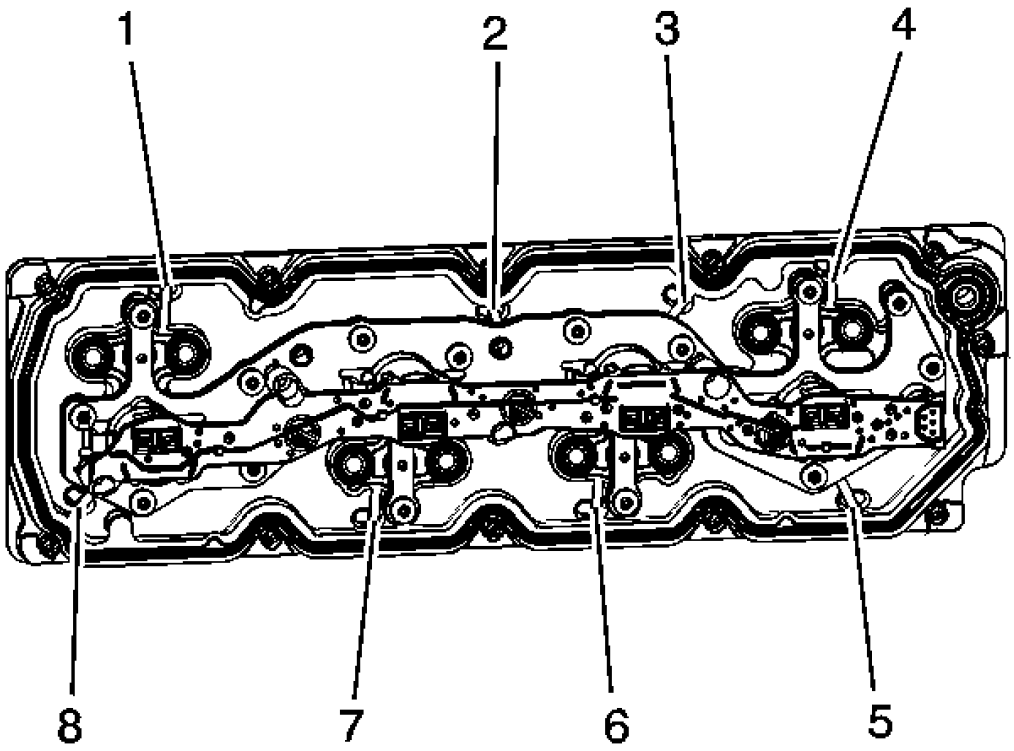


Fig. 38: Gasket Retaining Strap Locations
Courtesy of GENERAL MOTORS CORP.

NOTE: Remove only the outer gasket from the manifold. Do not disassemble any of the internal components of the manifold in an attempt to remove the 8 inner sealing gaskets. If the inner gaskets are cut or damaged, replace the manifold as an assembly. Only use a wire-cutter type tool in order to minimize the amount of debris. Do not use a rotary-type cutting tool on the retaining straps.

6. Identify the 8 gasket retaining strap locations (1-8).

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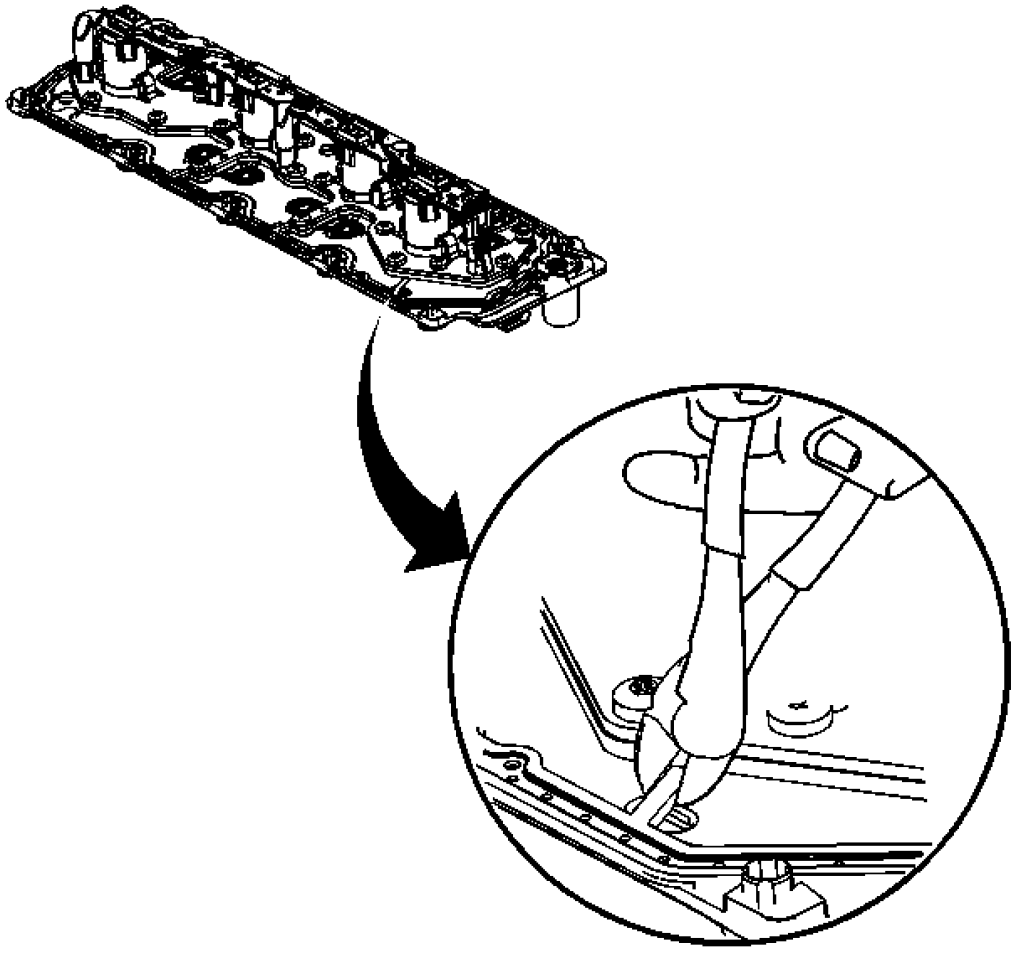


Fig. 39: Cutting Retaining Straps
Courtesy of GENERAL MOTORS CORP.

7. Using a cutter type tool, cut the 8 retaining straps.

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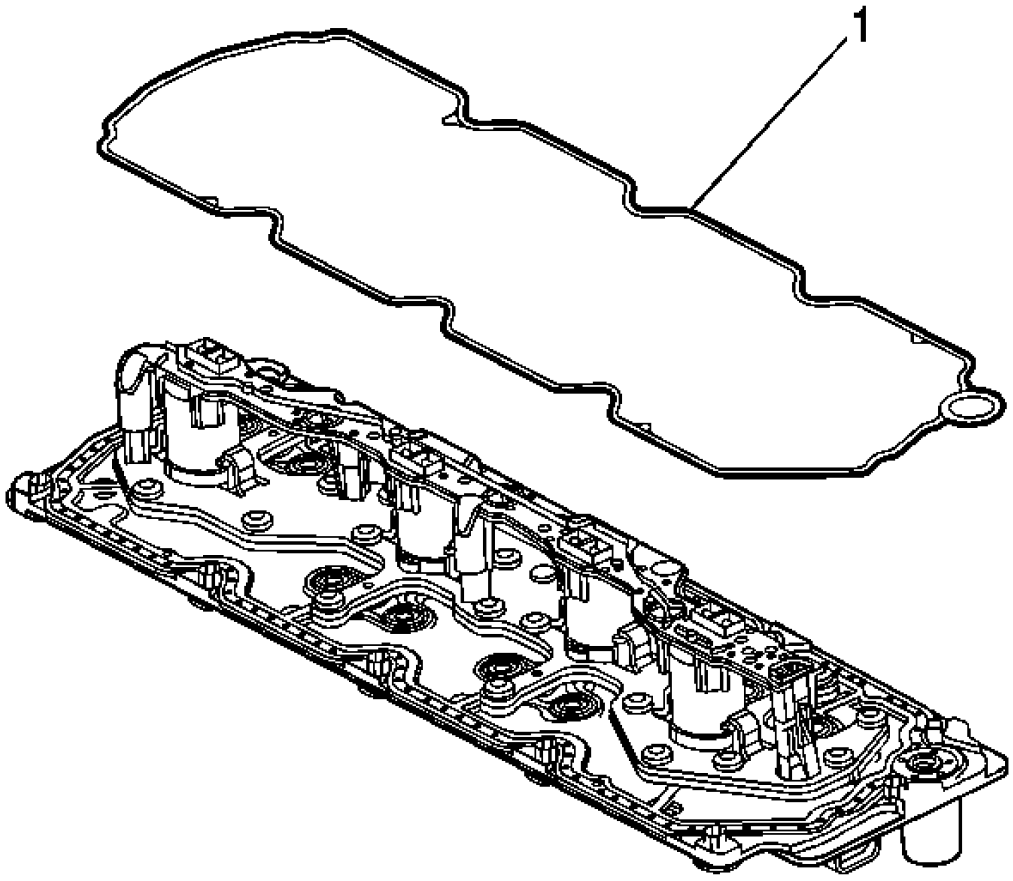


Fig. 40: Outer Gasket
Courtesy of GENERAL MOTORS CORP.

8. Remove the outer gasket (1) from the valve lifter oil manifold.

INSTALLATION PROCEDURE

NOTE: All gasket surfaces should be free of oil or other foreign material during assembly.

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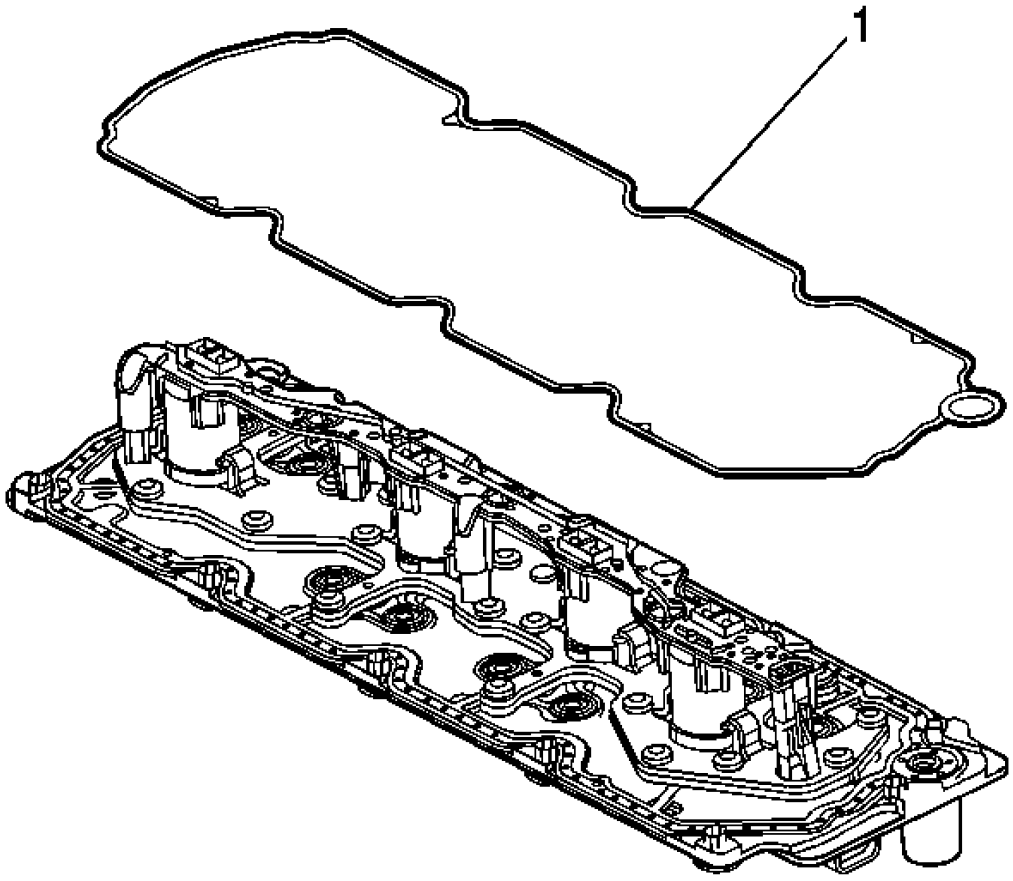


Fig. 41: Outer Gasket
Courtesy of GENERAL MOTORS CORP.

1. Place the service gasket (1) onto the valve lifter oil manifold.

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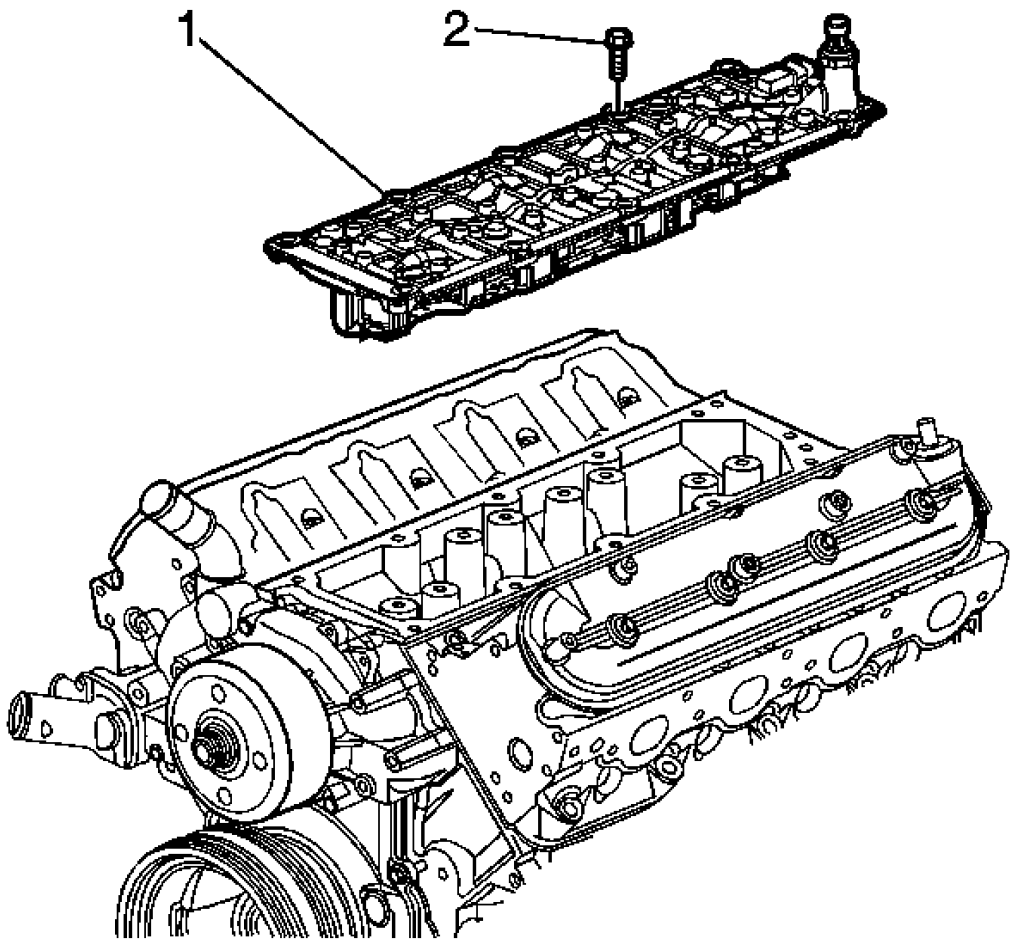


Fig. 42: Valve Lifter Oil Manifold
Courtesy of GENERAL MOTORS CORP.

2. Install the valve lifter oil manifold (1) to the engine.

CAUTION: Refer to Fastener Caution

3. Install the valve lifter oil manifold bolts (2) and tighten to 25 N.m (18 lb ft).
4. Connect the engine harness electrical connector (1) to the oil pressure sensor.
5. Install the intake manifold. Refer to **Intake Manifold Replacement**

VALVE LIFTER OIL FILTER REPLACEMENT

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REMOVAL PROCEDURE

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
2. Disconnect the engine harness electrical connector (1) from the oil pressure sensor.

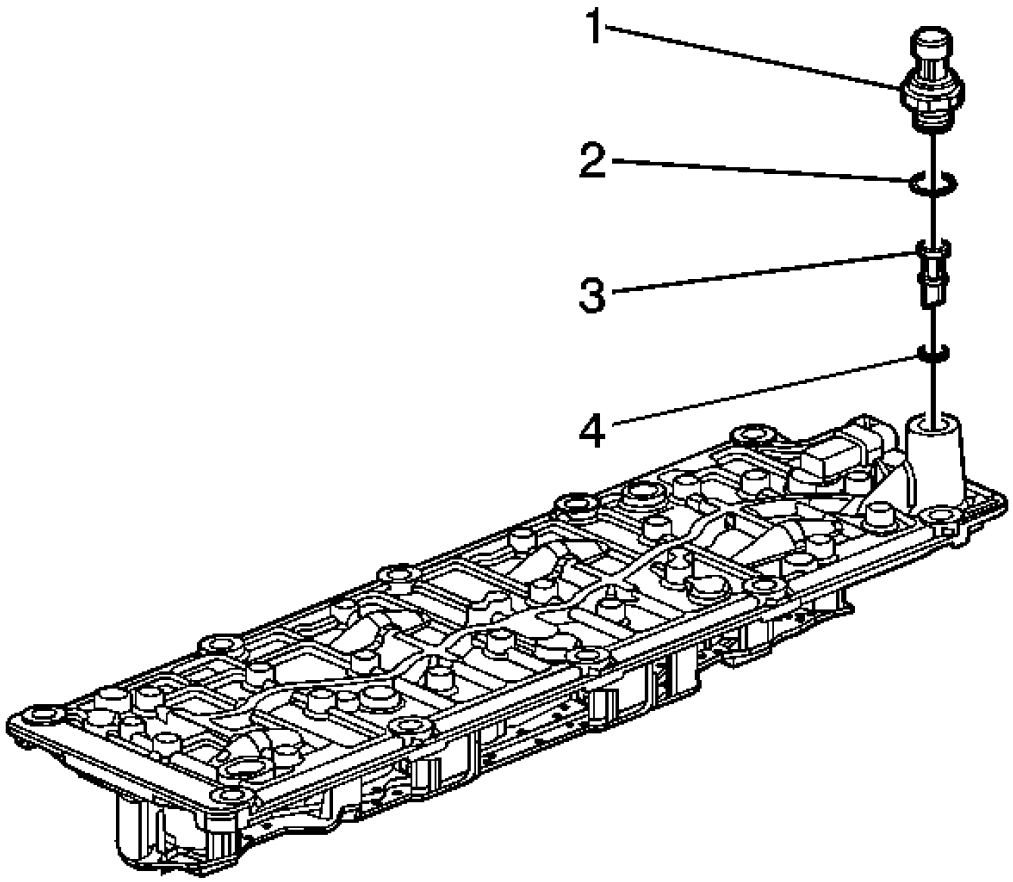


Fig. 43: Oil Pressure Sensor & Valve Lifter Oil Filter
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pressure sensor (1) and washer (2).
4. Remove and discard the valve lifter oil filter (3).
5. Remove and discard the valve lifter oil filter O-ring seal (4).

INSTALLATION PROCEDURE

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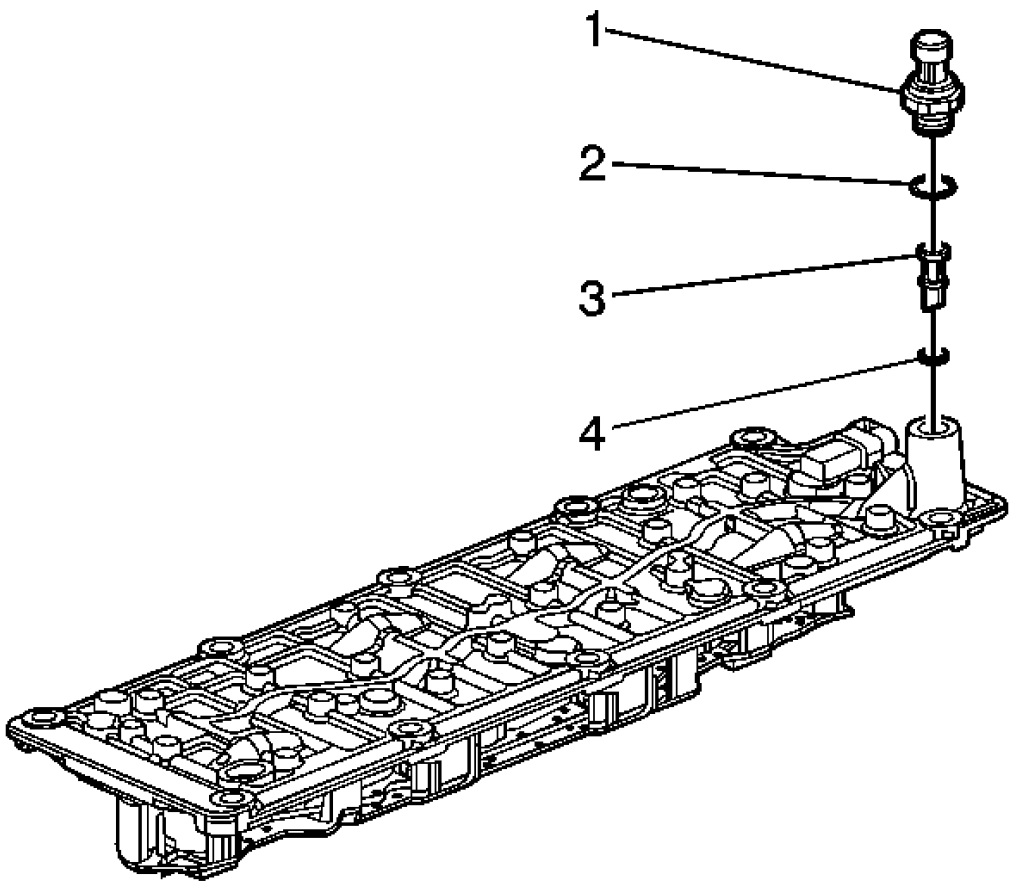


Fig. 44: Oil Pressure Sensor & Valve Lifter Oil Filter
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW valve lifter oil filter O-ring seal (4) into the valve lifter oil manifold.
2. Install the NEW valve lifter oil filter (3).
3. Apply sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent to the threads of the oil pressure sensor.

CAUTION: Refer to Fastener Caution .

4. Install the oil pressure sensor washer (2) and sensor (1) and tighten the sensor to 35 N.m (26 lb ft).
5. Connect the engine harness electrical connector (1) to the oil pressure sensor.
6. Install the intake manifold. Refer to **Intake Manifold Replacement**.

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VALVE ROCKER ARM COVER REPLACEMENT - LEFT SIDE

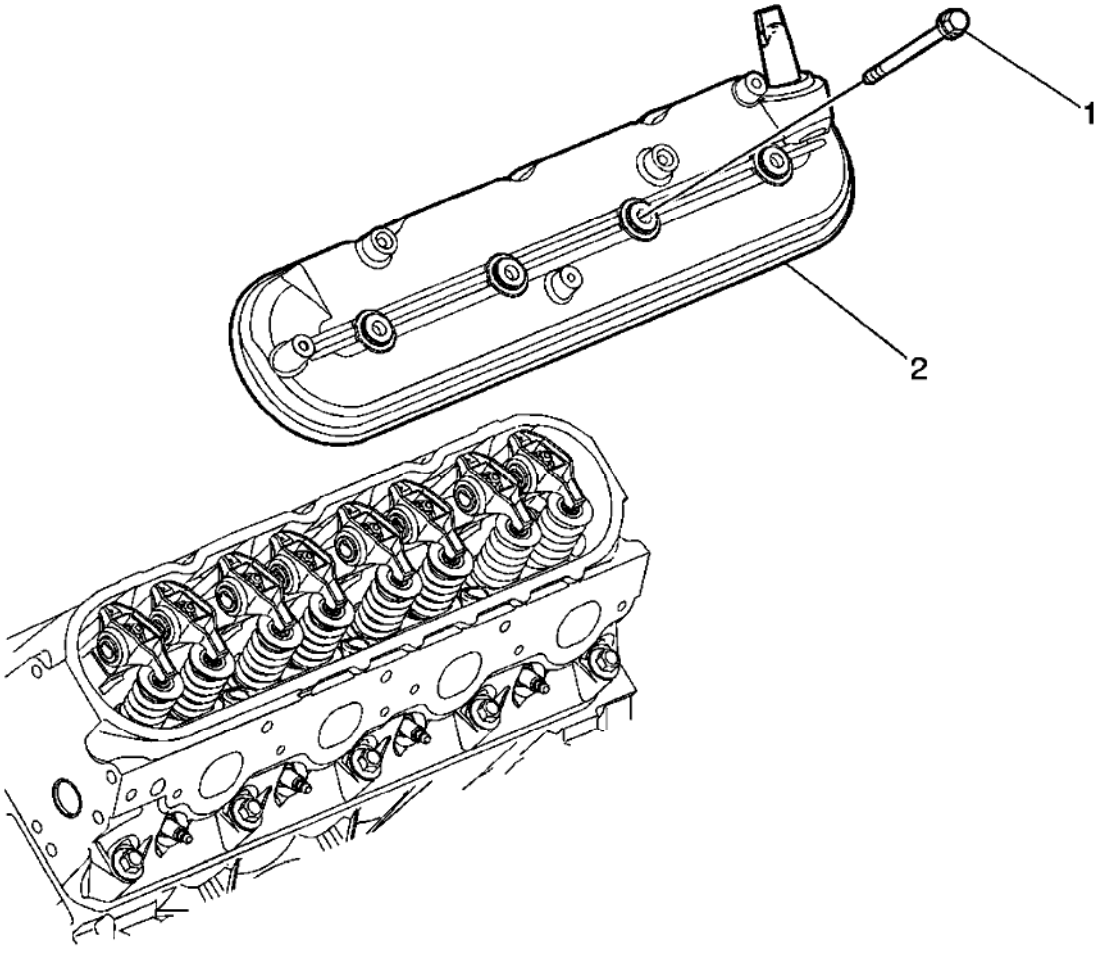


Fig. 45: Valve Rocker Arm Cover - Left Side
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove the crankcase ventilation hoses/pipes. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement**. 2. Remove the ignition coil. Refer to **Ignition Coil Replacement** .	
1	Valve Rocker Arm Cover Fastener (Qty: 4) **CAUTION:** **Refer to Component Fastener Tightening Caution .**

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	Procedure: If valve rocker arm cover grommets are cracked, or damaged, replace the valve rocker arm cover bolts. The grommet is serviced with the rocker arm cover bolt. **Tighten:** 12 N.m (106 lb in)
2	Valve Rocker Arm Cover **Procedure** 1. Disconnect any electrical connectors. 2. Transfer components as necessary.

VALVE ROCKER ARM COVER REPLACEMENT - RIGHT SIDE

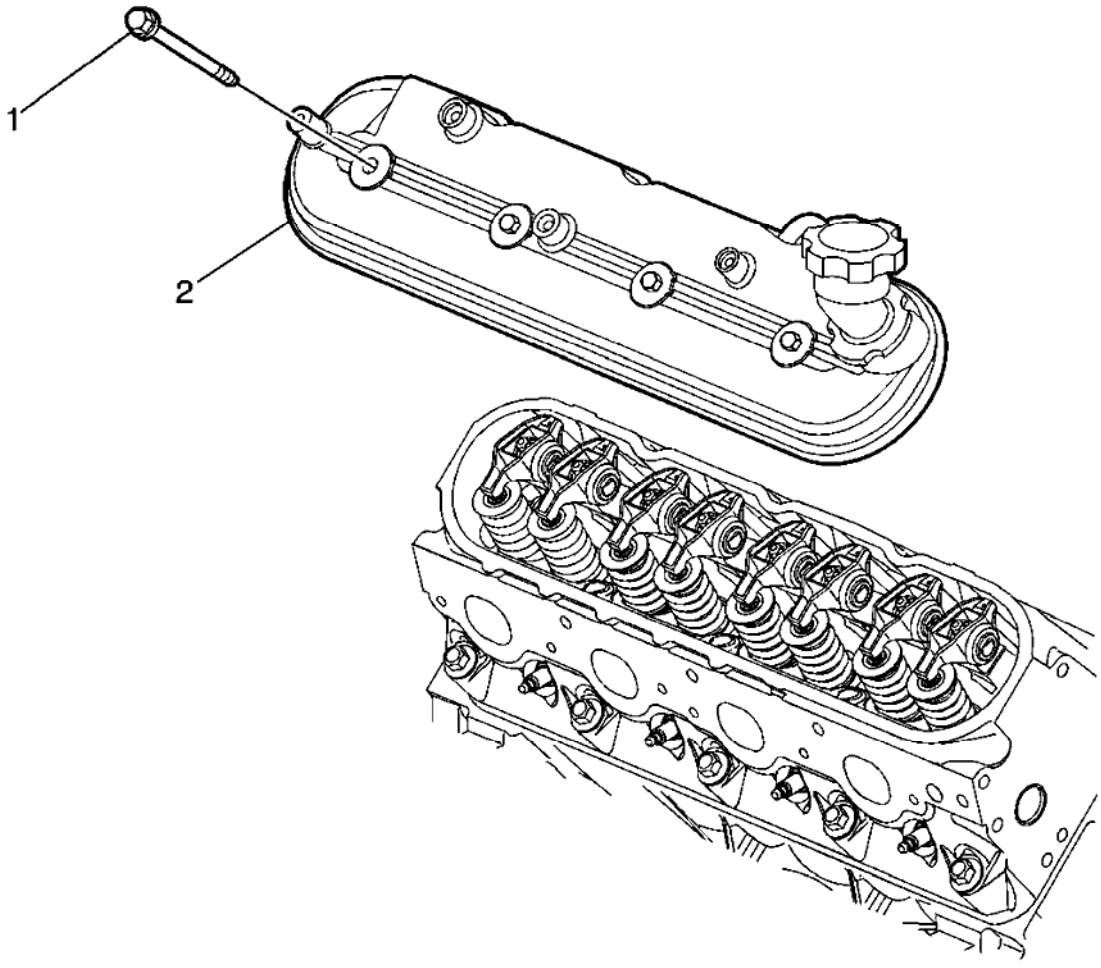


Fig. 46: Valve Rocker Arm Cover - Right Side
Courtesy of GENERAL MOTORS CORP.

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Callout	Component Name
Preliminary Procedures 1. Remove the crankcase ventilation hoses/pipes. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement**. 2. Remove the ignition coil. Refer to **Ignition Coil Replacement** .	
1	Valve Rocker Arm Cover Fastener (Qty: 4) **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Procedure:** If valve rocker arm cover grommets are cracked, or damaged, replace the valve rocker arm cover bolts. The grommet is serviced with the rocker arm cover bolt. **Tighten:** 12 N.m (106 lb in)
2	Valve Rocker Arm Cover **Procedure** 1. Disconnect any electrical connectors. 2. Transfer components as necessary.

VALVE ROCKER ARM AND PUSH ROD REPLACEMENT

REMOVAL PROCEDURE

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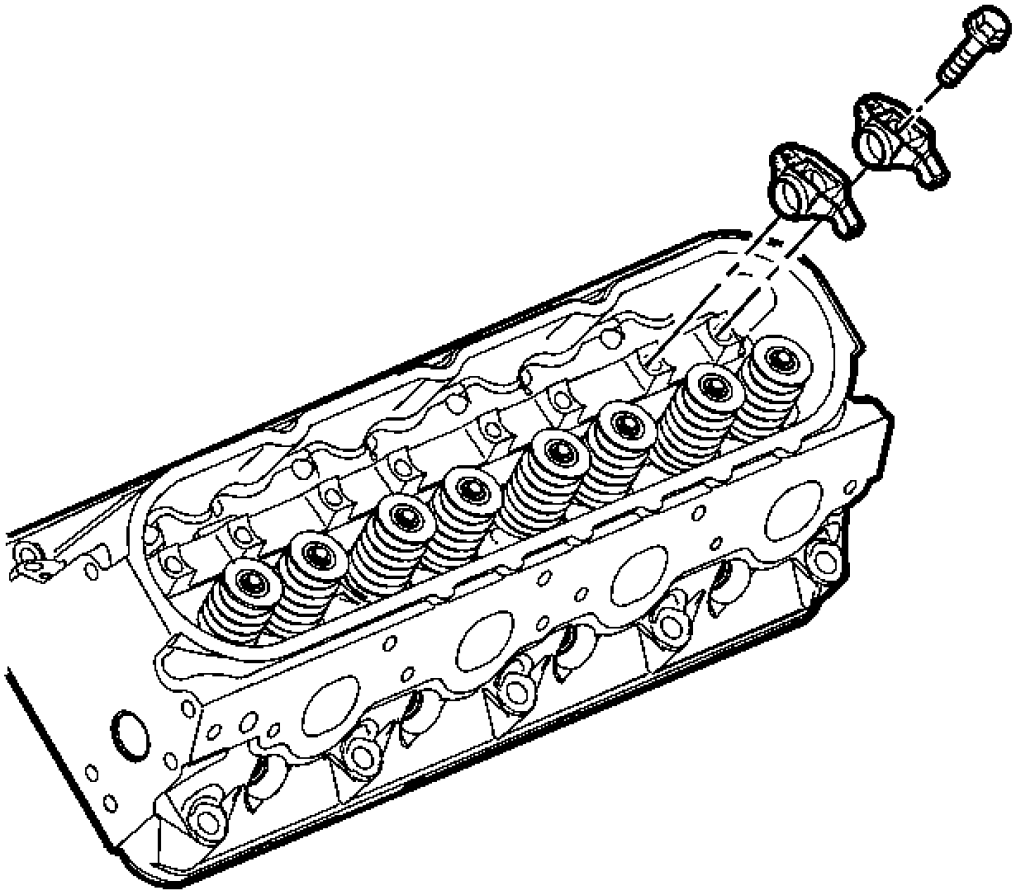


Fig. 47: View Of Rocker Arms & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Place the valve rocker arms, valve pushrods, and pivot support, in a rack so that they can be installed in the same location from which they were removed.

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

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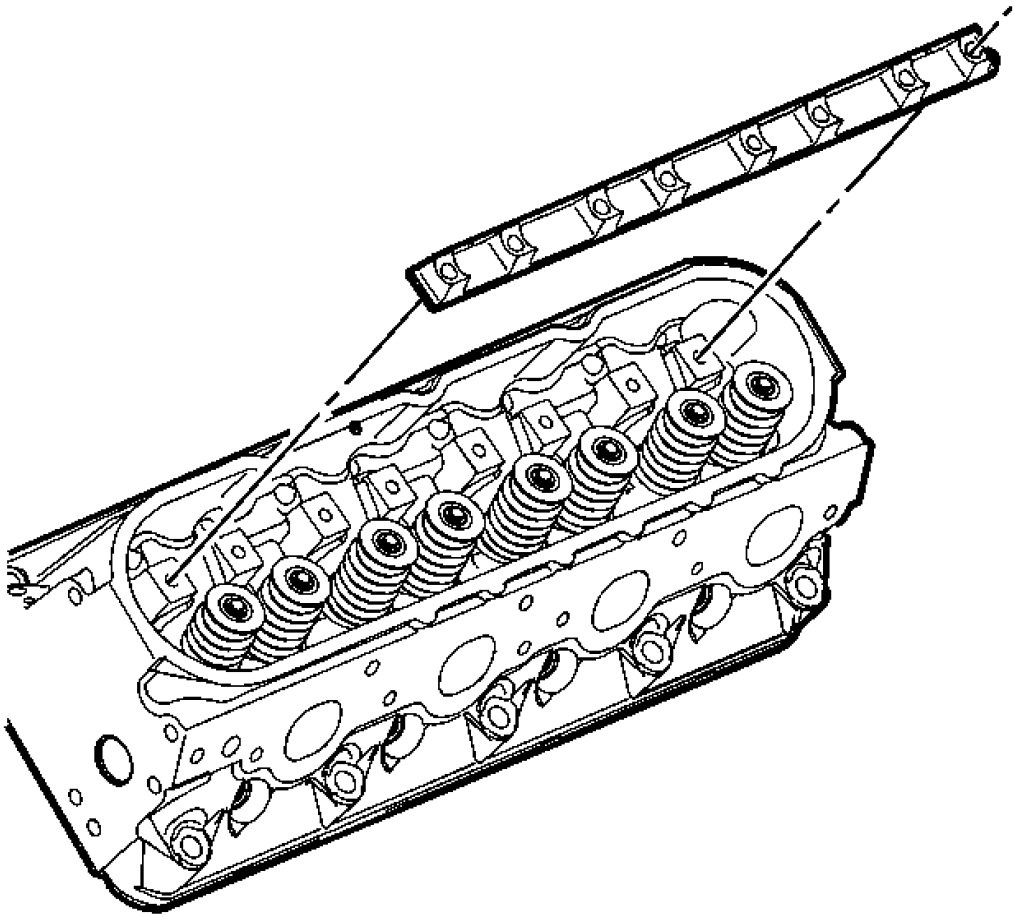


Fig. 48: View Of Valve Rocker Arm Pivot Support
Courtesy of GENERAL MOTORS CORP.

4. Remove the valve rocker arm pivot support.

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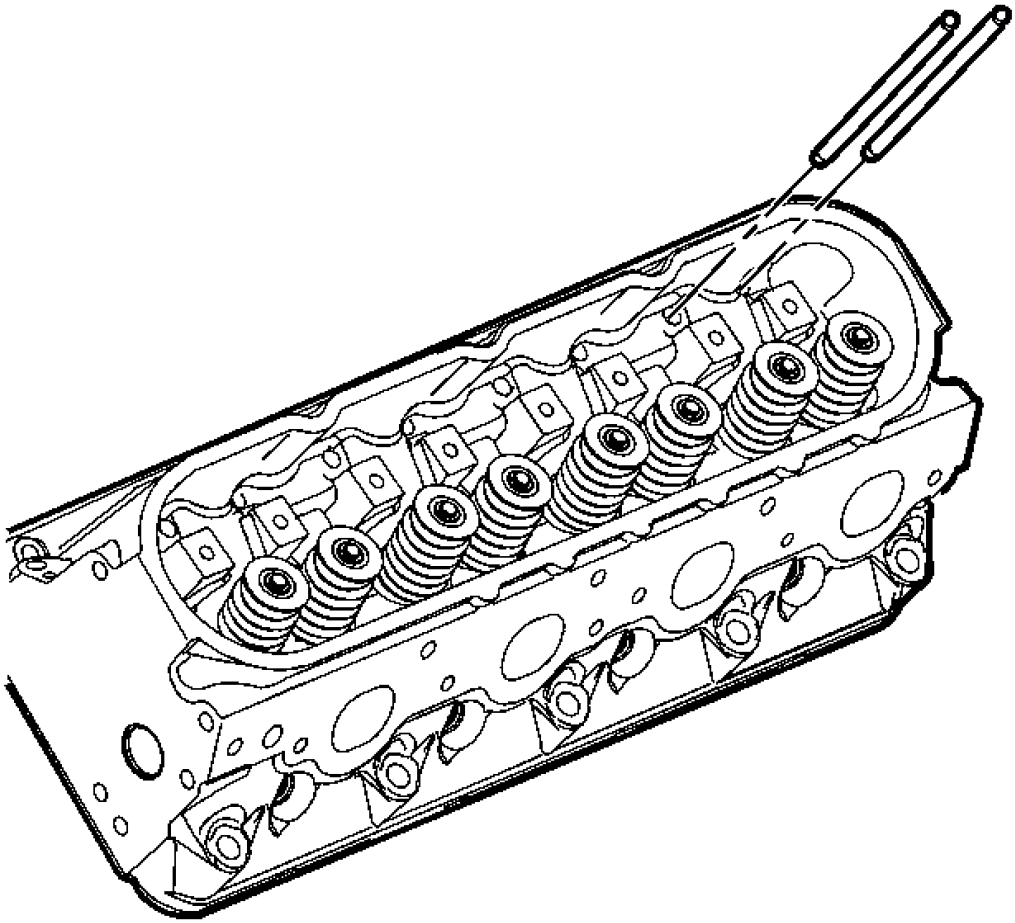


Fig. 49: View Of Pushrods
Courtesy of GENERAL MOTORS CORP.

5. Remove the pushrods.
6. Clean and inspect the valve rocker arms and pushrods. Refer to **Valve Rocker Arm and Push Rod Cleaning and Inspection** .

INSTALLATION PROCEDURE

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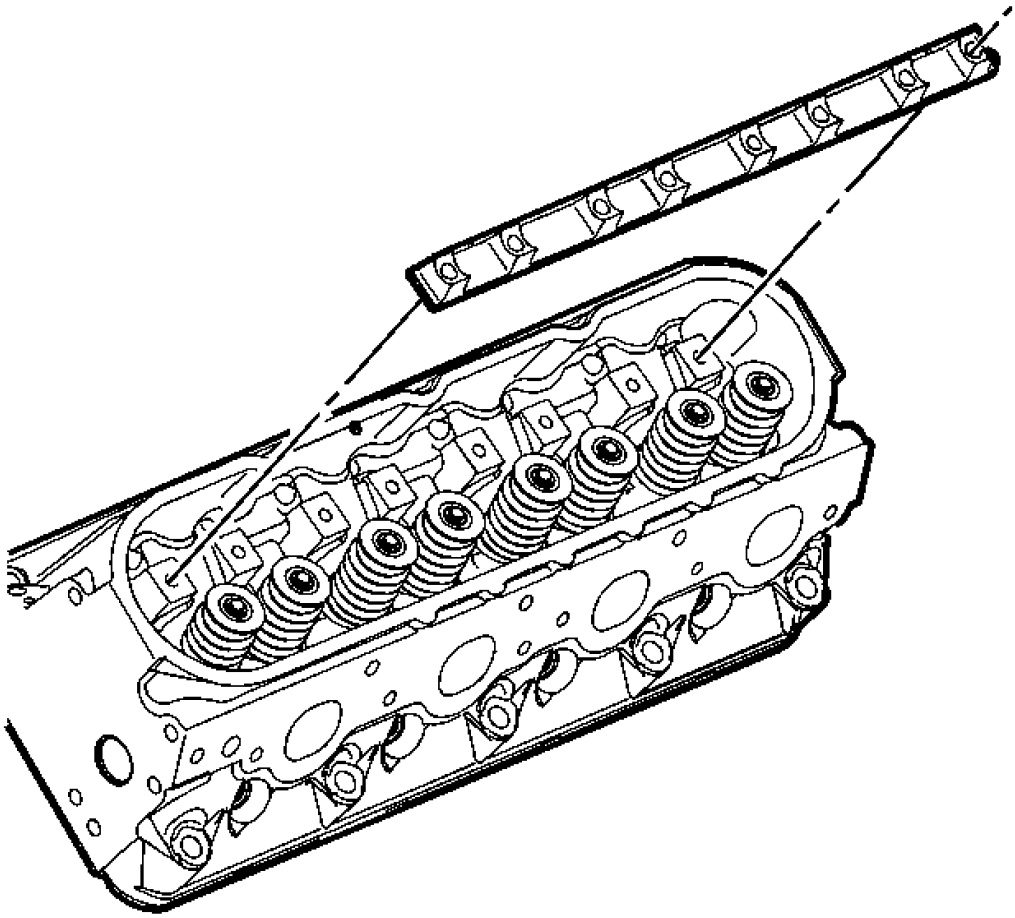


Fig. 50: View Of Valve Rocker Arm Pivot Support
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **When using the valve train components again, always install the components to the original location and position.**
- **Valve lash is net build, no valve adjustment is required.**

1. Lubricate the valve rocker arms and pushrods with clean engine oil.
2. Lubricate the flange of the valve rocker arm bolts with clean engine oil.
3. Install the valve rocker arm pivot support.

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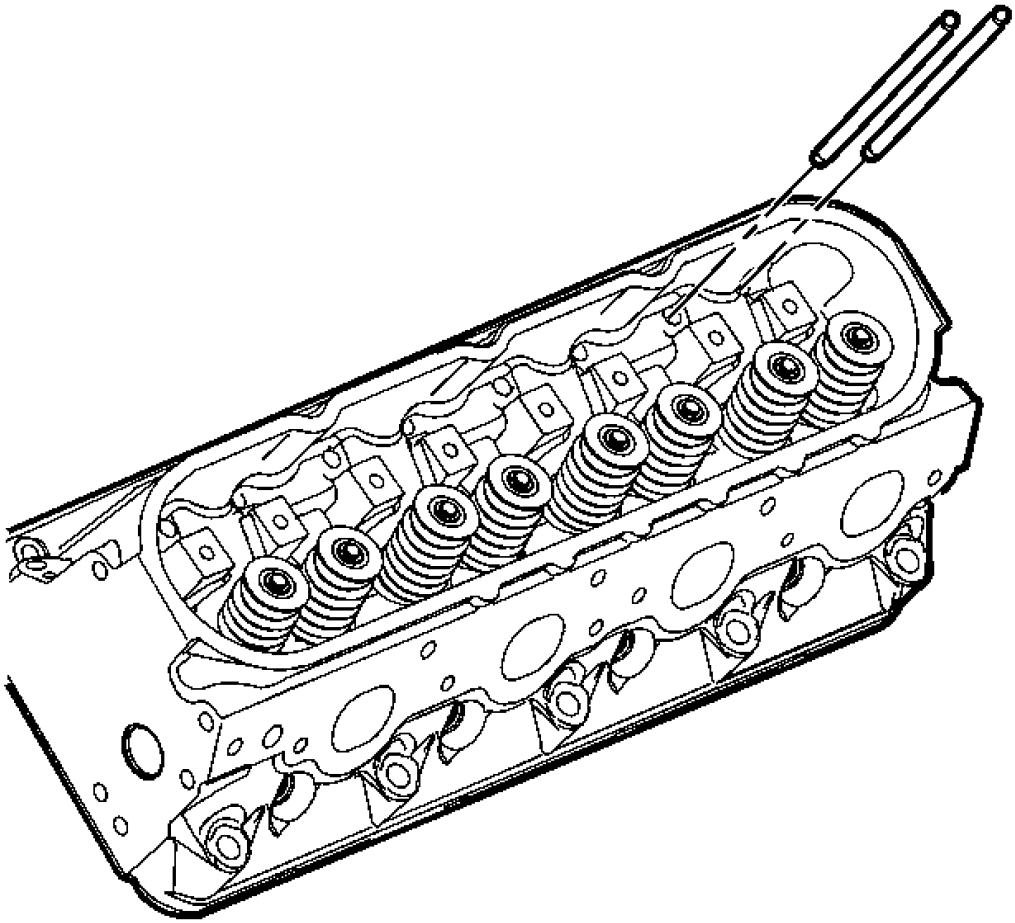


Fig. 51: View Of Pushrods
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure the pushrods seat properly to the valve lifter sockets.

4. Install the pushrods.

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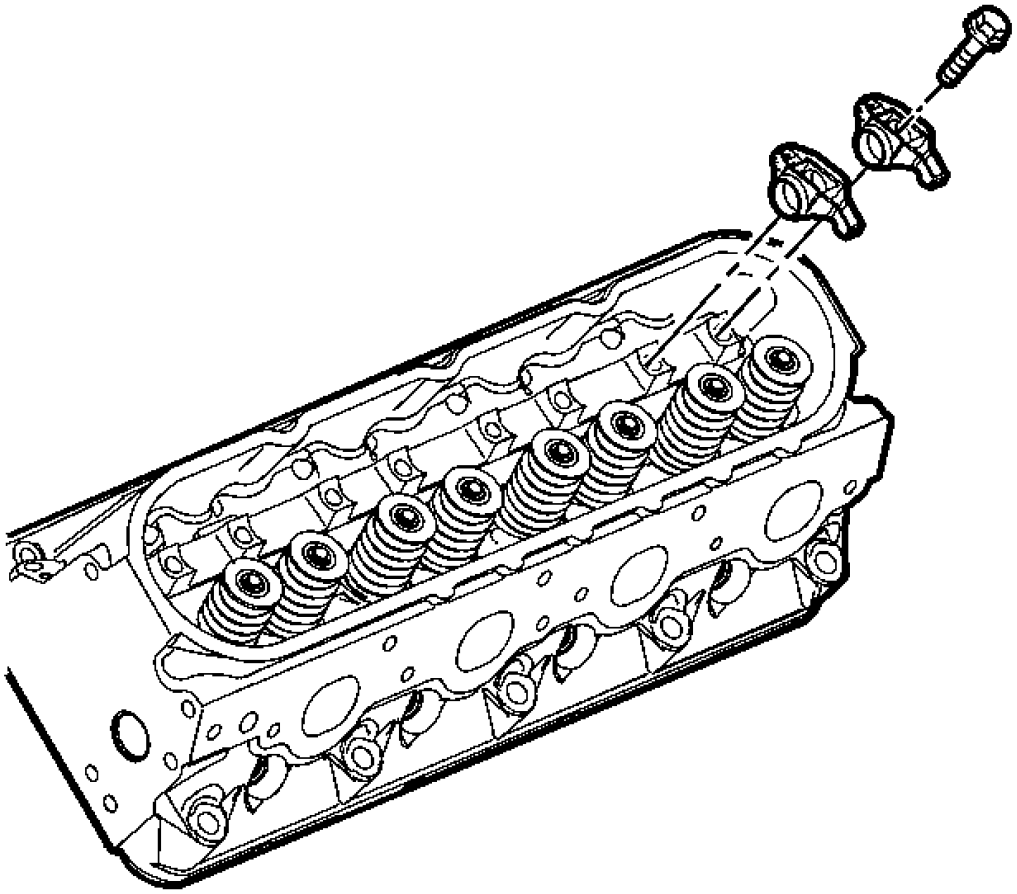


Fig. 52: View Of Rocker Arms & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Ensure the pushrods seat properly to the ends of the rocker arms.**
- **DO NOT tighten the rocker arm bolts at this time.**

5. Install the rocker arms and bolts.

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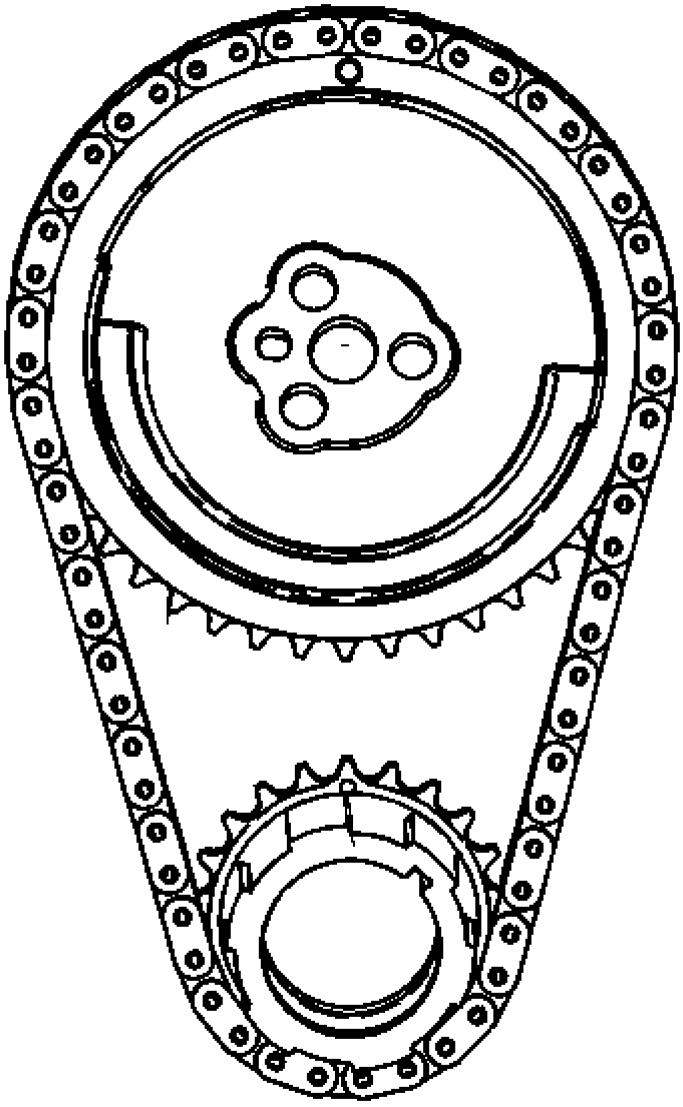


Fig. 53: Camshaft & Crankshaft Sprocket Alignment Marks
Courtesy of GENERAL MOTORS CORP.

6. Rotate the crankshaft until number one piston is at top dead center of compression stroke.

   In this position, cylinder number one rocker arms will be off lobe lift, and the crankshaft sprocket key will be at the 1:30 position. The camshaft and crankshaft sprocket alignment marks will be in the 12 o'clock positions. If viewing from the rear of the engine, the additional crankshaft pilot hole, non-threaded, will be in the 10:30 position.

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The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3.

Cylinders 1, 3, 5 and 7 are left bank.

Cylinders 2, 4, 6, and 8 are right bank.

CAUTION: Refer to Fastener Caution .

7. With the engine in the number one firing position, tighten the following valve rocker arm bolts:
   - Tighten exhaust valve rocker arm bolts 1, 2, 7, and 8 to 30 N.m (22 lb ft).
   - Tighten intake valve rocker arm bolts 1, 3, 4, and 5 to 30 N.m (22 lb ft).
8. Rotate the crankshaft 360 degrees.
9. Tighten the following valve rocker arm bolts:
   - Tighten exhaust valve rocker arm bolts 3, 4, 5, and 6 to 30 N.m (22 lb ft).
   - Tighten intake valve rocker arm bolts 2, 6, 7, and 8 to 30 N.m (22 lb ft).
10. Install the valve rocker arm covers. Refer to **Valve Rocker Arm Cover Replacement - Left Side** or **Valve Rocker Arm Cover Replacement - Right Side**.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

Special Tools

- **J 22794** Spark Plug Port Adapter. See **Special Tools** .
- **J 38606** Valve Spring Compressor (Head-on)

REMOVAL PROCEDURE

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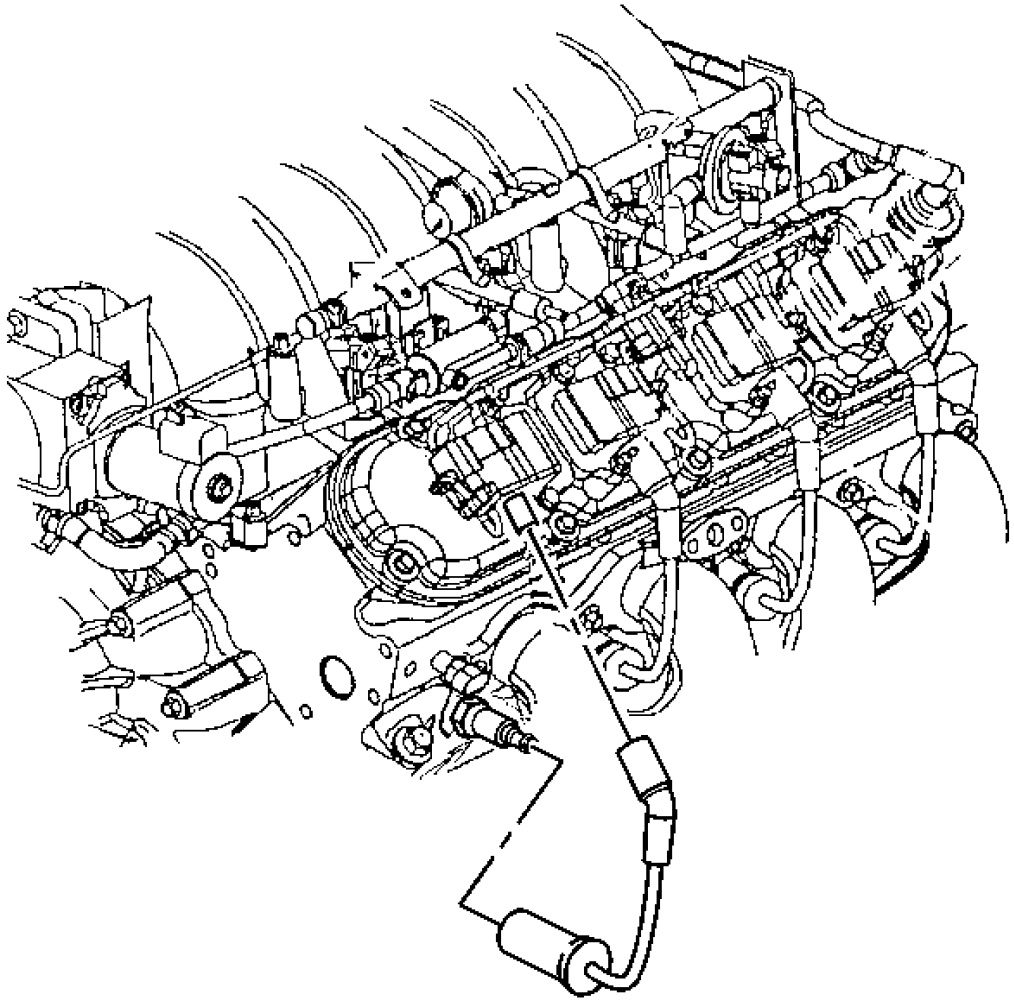


Fig. 54: Spark Plug & Wire
Courtesy of GENERAL MOTORS CORP.

1. Remove the valve rocker arms. Refer to **Valve Rocker Arm and Push Rod Replacement**.
2. Remove the spark plug. Refer to **Spark Plug Replacement** .

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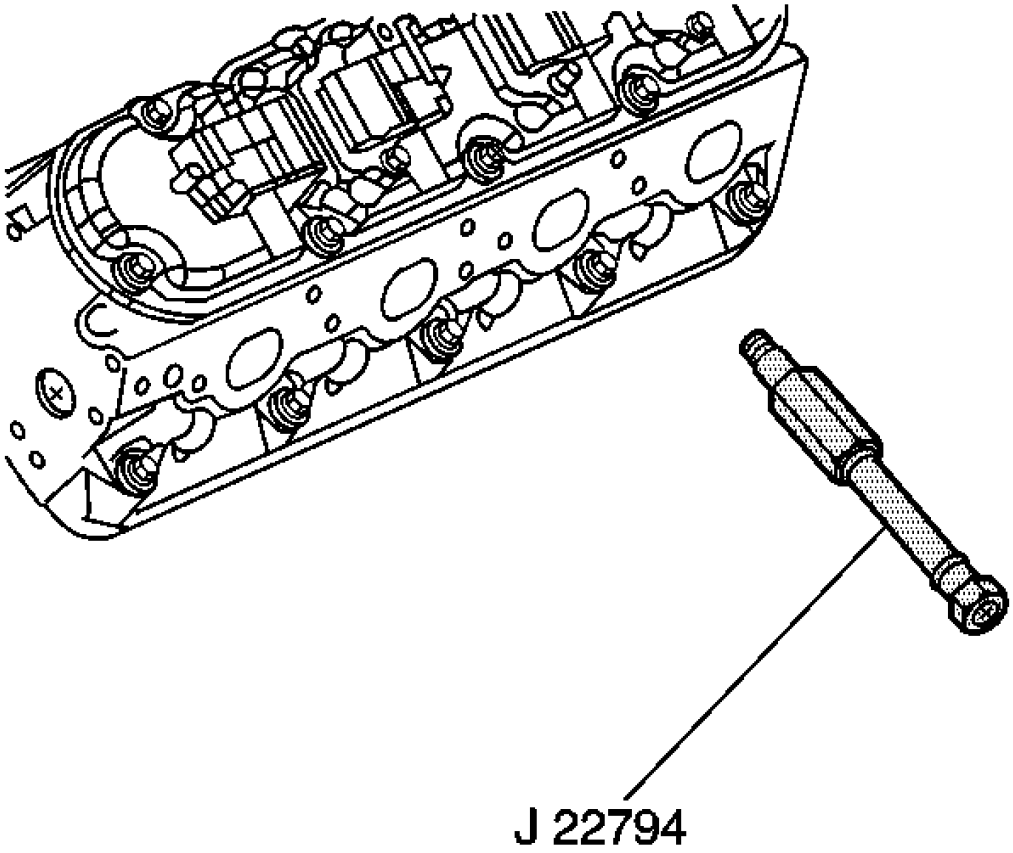


Fig. 55: Identifying J 22794
Courtesy of GENERAL MOTORS CORP.

3. Install the **J 22794** into the spark plug hole. See **Special Tools** .
4. Attach an air hose to **J 22794** . See **Special Tools** .
5. Tap the end of the valve stem with a plastic face hammer in order to loosen any varnish on the valve stem keys.

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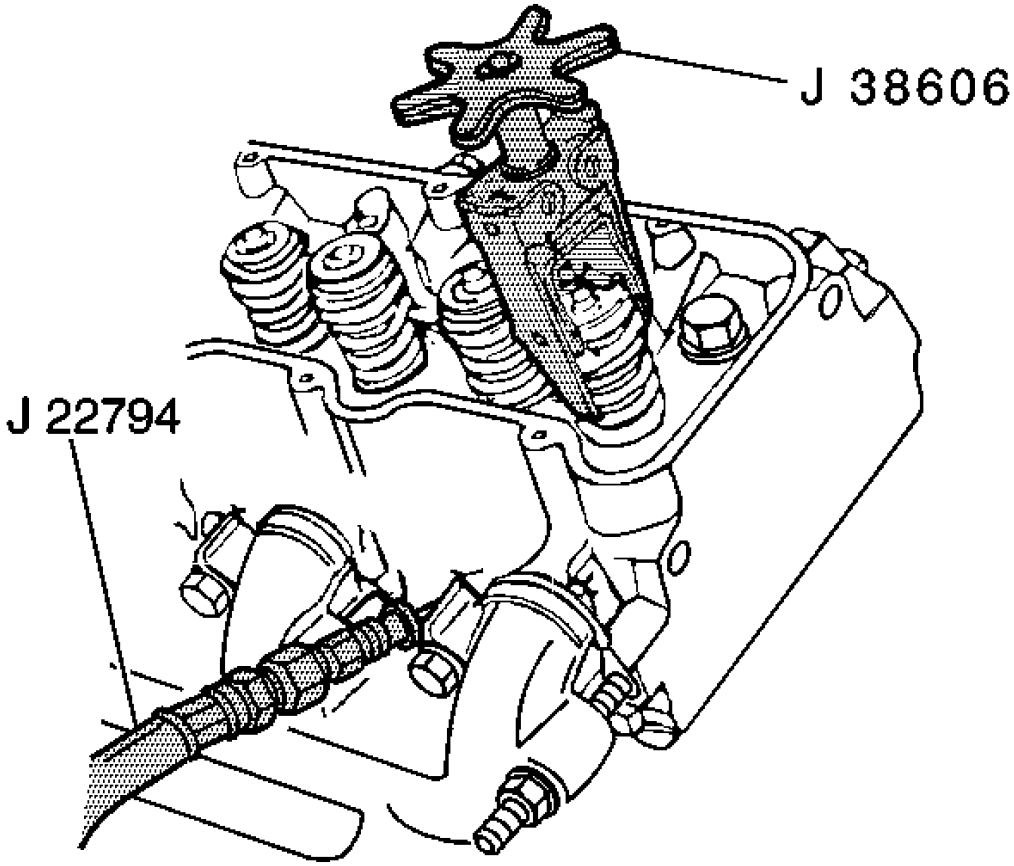


Fig. 56: Compressing Valve Spring
Courtesy of GENERAL MOTORS CORP.

6. Use the **J 38606** in order to compress the valve spring.

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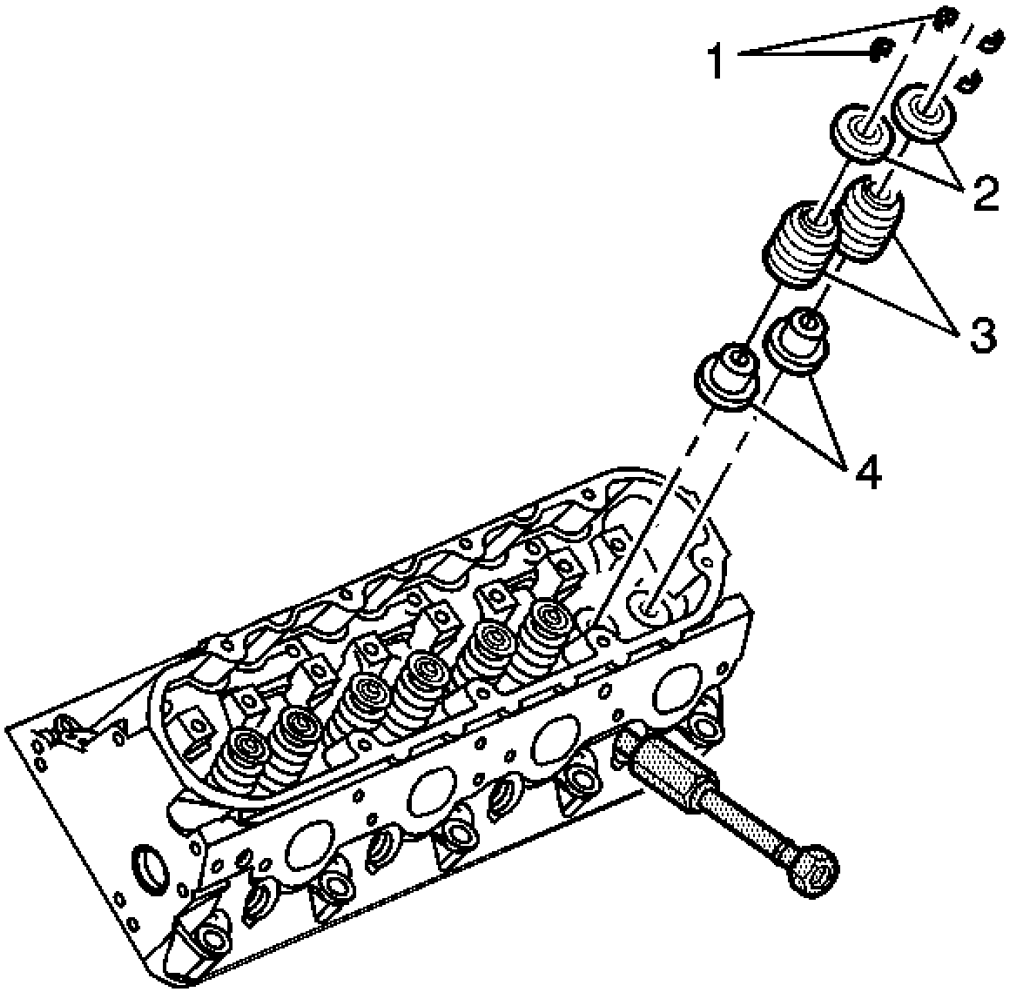


Fig. 57: Valve Stem Keys, Spring, Cap & Shim
Courtesy of GENERAL MOTORS CORP.

7. Remove the valve stem keys (1).
8. Carefully release the valve spring tension.
9. Remove the **J 38606** .
10. Remove the valve spring cap (2).
11. Remove the valve spring (3).
12. Remove the valve stem oil seal and shim (4).

INSTALLATION PROCEDURE

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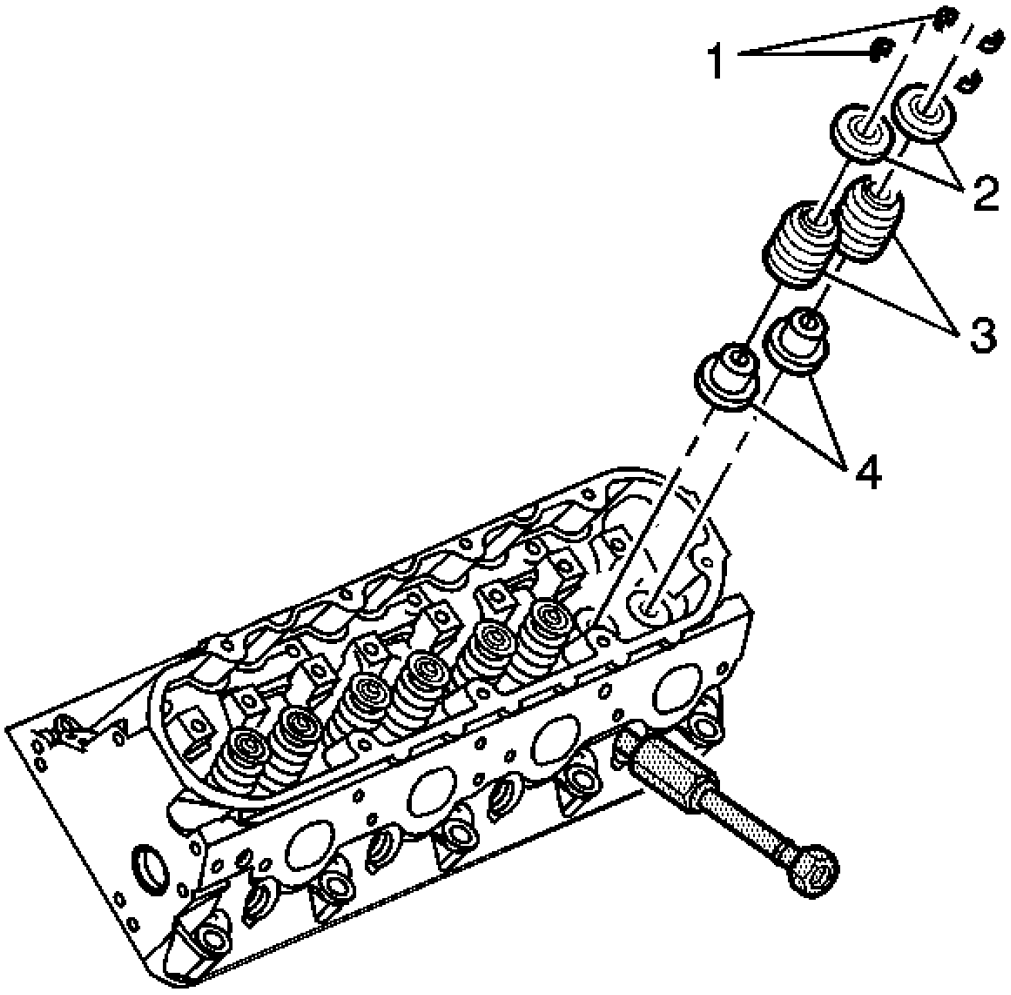


Fig. 58: Valve Stem Keys, Spring, Cap & Shim
Courtesy of GENERAL MOTORS CORP.

1. Clean the cylinder head valve spring seat and/or shim area.
2. Install the valve stem oil seal and shim (2).

IMPORTANT: The valve stem oil seal alignment and position on the valve guide is critical.
An improperly installed valve stem oil seal may lead to excessive oil consumption, and increased vehicle emissions.

3. Install the valve stem oil seal onto the guide.

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1. Lubricate the valve guide and valve stem oil seal with clean engine oil.
2. Install the valve stem oil seal onto the valve stem. Push the seal down until the seal contacts the valve guide.

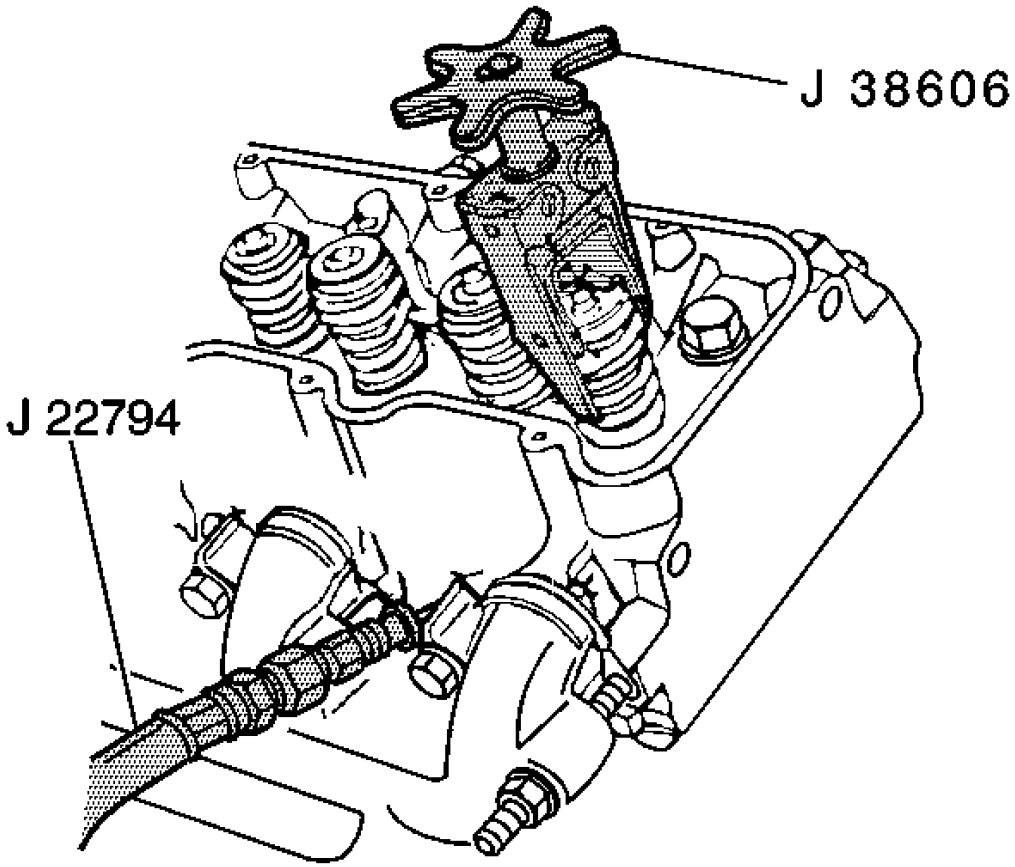


Fig. 59: Compressing Valve Spring
Courtesy of GENERAL MOTORS CORP.

4. Install the valve spring to the **J 38606** .
5. Compress the valve spring using the **J 38606** .
6. Install the valve spring to the cylinder head.

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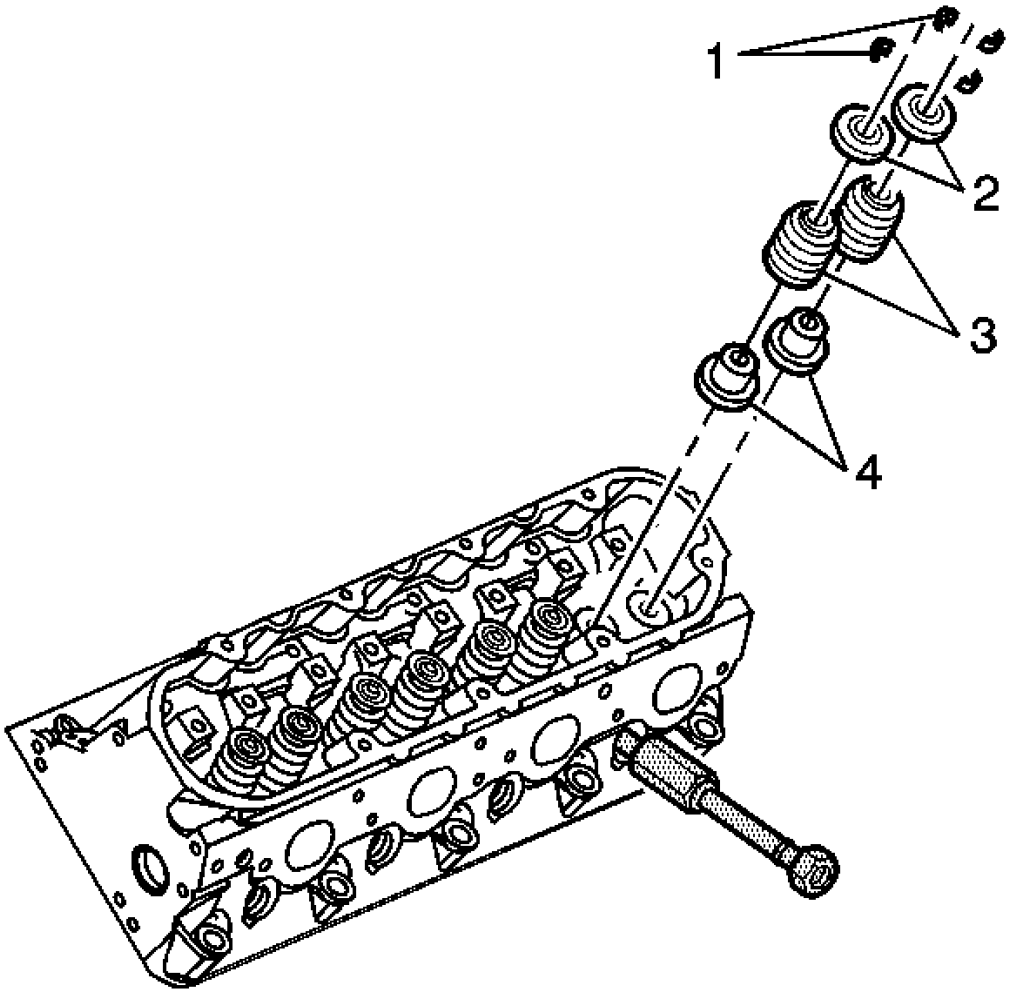


Fig. 60: Valve Stem Keys, Spring, Cap & Shim
Courtesy of GENERAL MOTORS CORP.

7. Install the valve spring cap (2).
8. Install the valve stem keys (1).
    1. Use grease to hold the keys (2) in place and remove **J 38606** .
    2. Make sure the keys (2) seat properly in the groove of the valve stem.
    3. Carefully release the valve spring pressure, making sure the valve keys stay in place.
    4. Remove the **J 38606** .
    5. Tap the end to the valve stem with a plastic faced hammer to seat the keys, if necessary.

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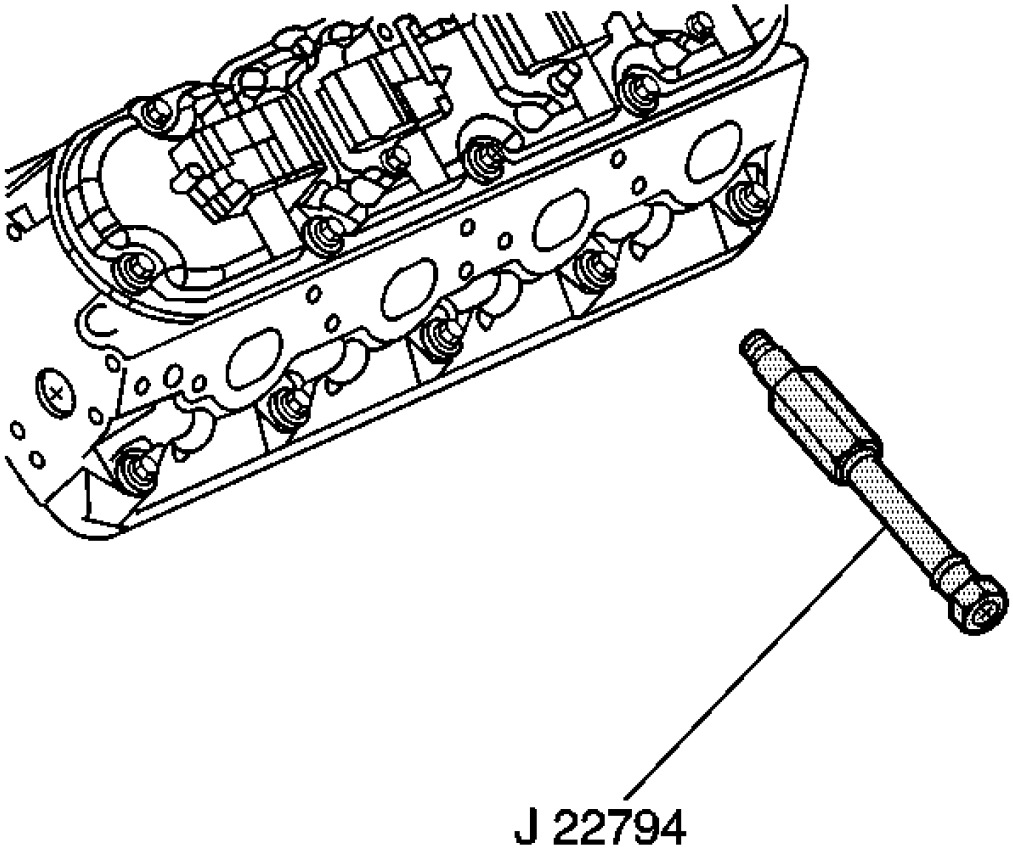


Fig. 61: Identifying J 22794
Courtesy of GENERAL MOTORS CORP.

9. Disconnect and remove the air supply from the **J 22794** . See **Special Tools** .
10. Remove the **J 22794** from the spark plug hole. See **Special Tools** .

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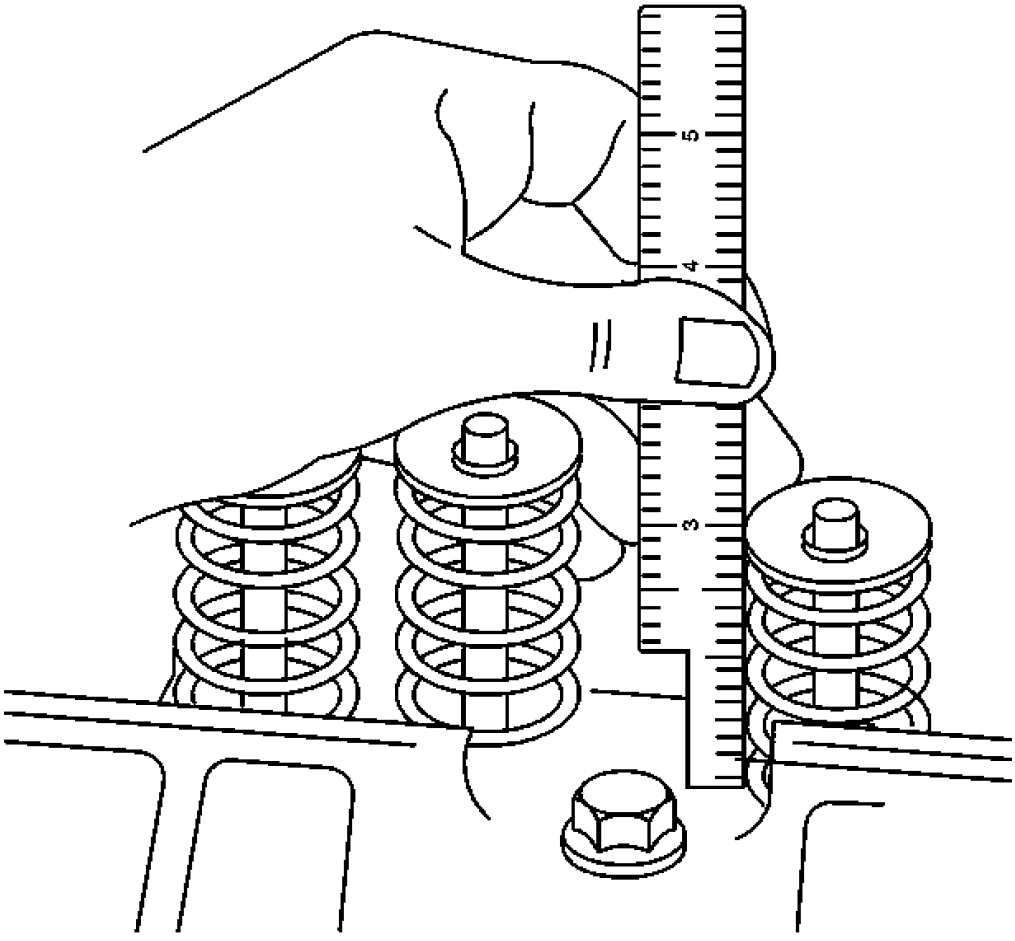


Fig. 62: Measuring Valve Spring Installed Height
Courtesy of GENERAL MOTORS CORP.

11. Measure the valve spring installed height using a ruler.

    Measure from the base of the valve spring to the top of the valve spring.

    - If the installed height exceeds 46.25 mm (1.82 in), install a valve spring shim of approximately 0.5 mm (0.02 in) thick.
    - Do not shim the valve spring to obtain less than the specified height.

      Do not assemble the components without a spring shim on the cylinder head.

12. Remove the air hose from the **J 22794** . See **Special Tools** .

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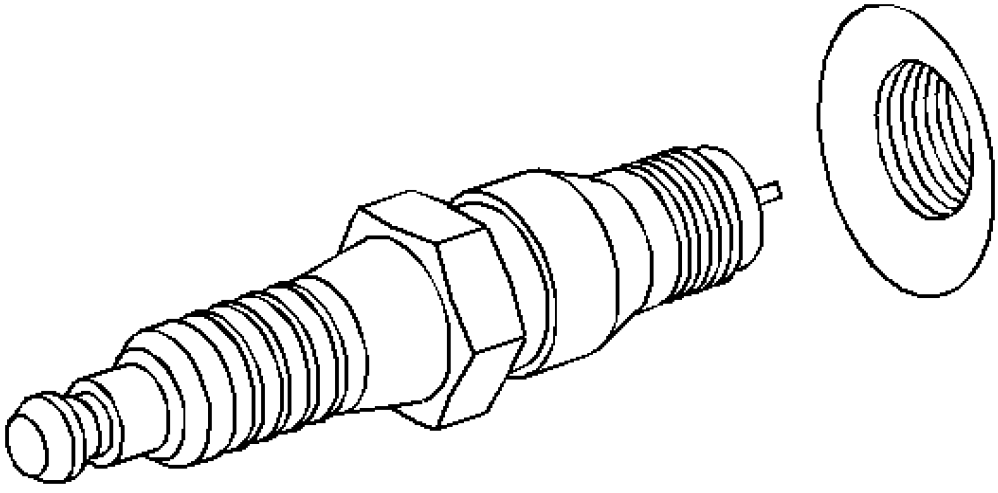


Fig. 63: View Of Spark Plug
Courtesy of GENERAL MOTORS CORP.

13. Install the spark plug. Refer to **Spark Plug Replacement** .
14. Install the valve rocker arms. Refer to **Valve Rocker Arm and Push Rod Replacement**.

OIL LEVEL INDICATOR TUBE REPLACEMENT

REMOVAL PROCEDURE

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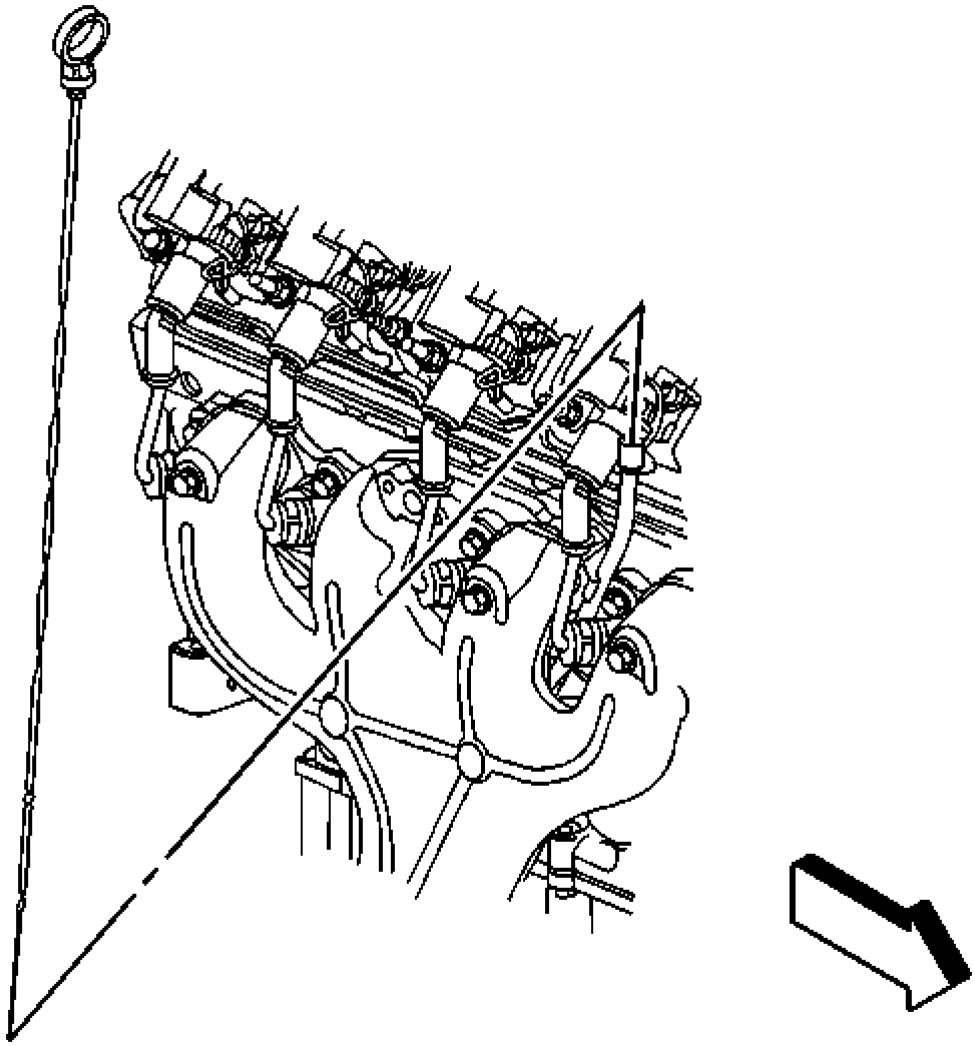


Fig. 64: Oil Level Indicator
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil level indicator.

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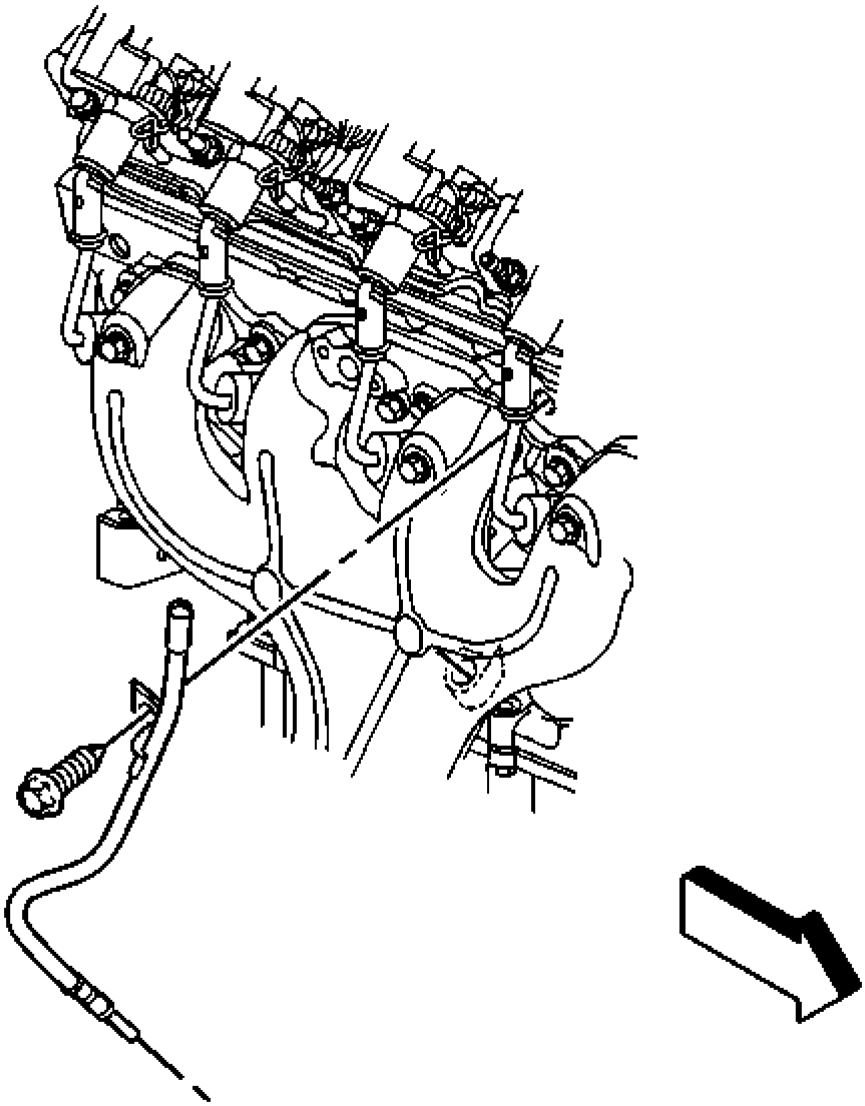


Fig. 65: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil level indicator tube bolt.
3. Remove the oil level indicator tube.

NOTE: Inspect the O-ring seal for cuts or damage. The O-ring seal may be reused if not cut or damaged.

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4. Remove the O-ring from the oil level indicator tube, if required.

INSTALLATION PROCEDURE

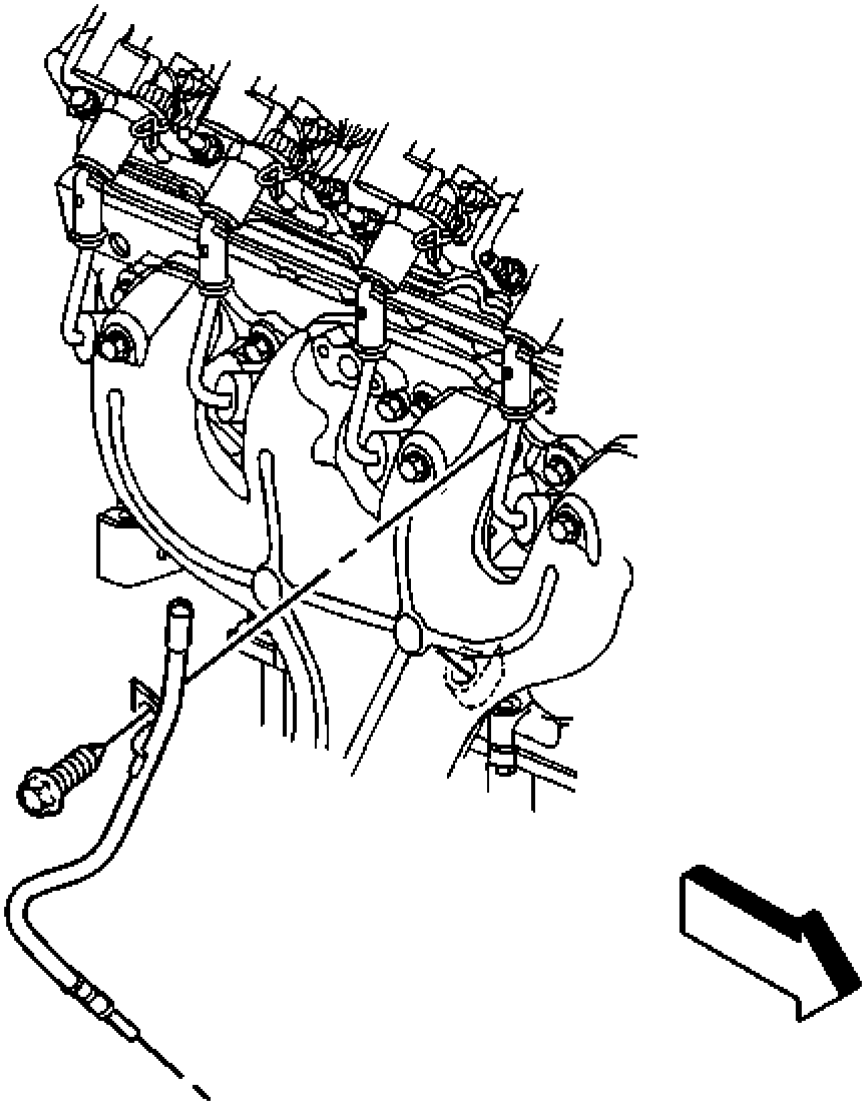


Fig. 66: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the O-ring seal with clean engine oil.

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2. Install the oil level indicator tube into position.
3. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Insert the oil level indicator tube into the engine block until the collar is flush with the block.
5. Lower the vehicle.

CAUTION: Refer to Fastener Caution .

6. Install the oil level indicator tube bolt and tighten to 25 N.m (18 lb ft).

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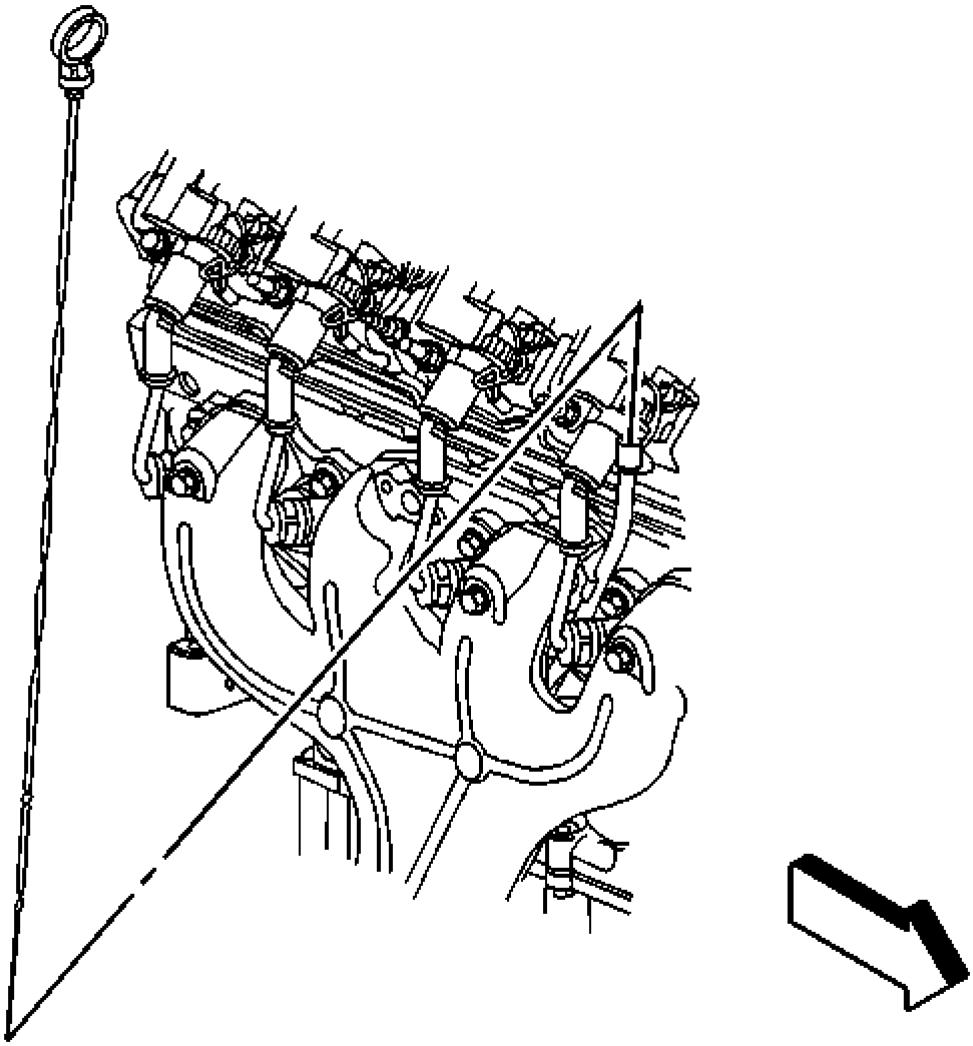


Fig. 67: Oil Level Indicator
Courtesy of GENERAL MOTORS CORP.

7. Install the oil level indicator.
8. Check the oil level and add if necessary.

CYLINDER HEAD REPLACEMENT - LEFT SIDE

Special Tools

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- **J 42385-100** Head/Main Bolt Thread Repair Kit. See **Special Tools** .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

1. Drain the coolant. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** .
2. Remove the valve rocker arms and pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
3. Remove the engine coolant air bleed hose.
4. Remove the power steering pump bracket. Refer to **Power Steering Pump Replacement (V6)** or **Power Steering Pump Replacement (V8)** .
5. Remove the exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (LLT)** or **Exhaust Manifold Replacement - Left Side (L99/LS3)** .
6. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
7. Remove the Engine Coolant Air Bleed Pipe and Hole Cover. Refer to **Engine Coolant Air Bleed Pipe and Hole Cover Removal** .
8. Remove the engine wiring harness ground bolt from the rear of the left cylinder head.
9. Reposition the engine wire harness ground strap away from the cylinder head.
10. Disconnect and unclip electrical as necessary.

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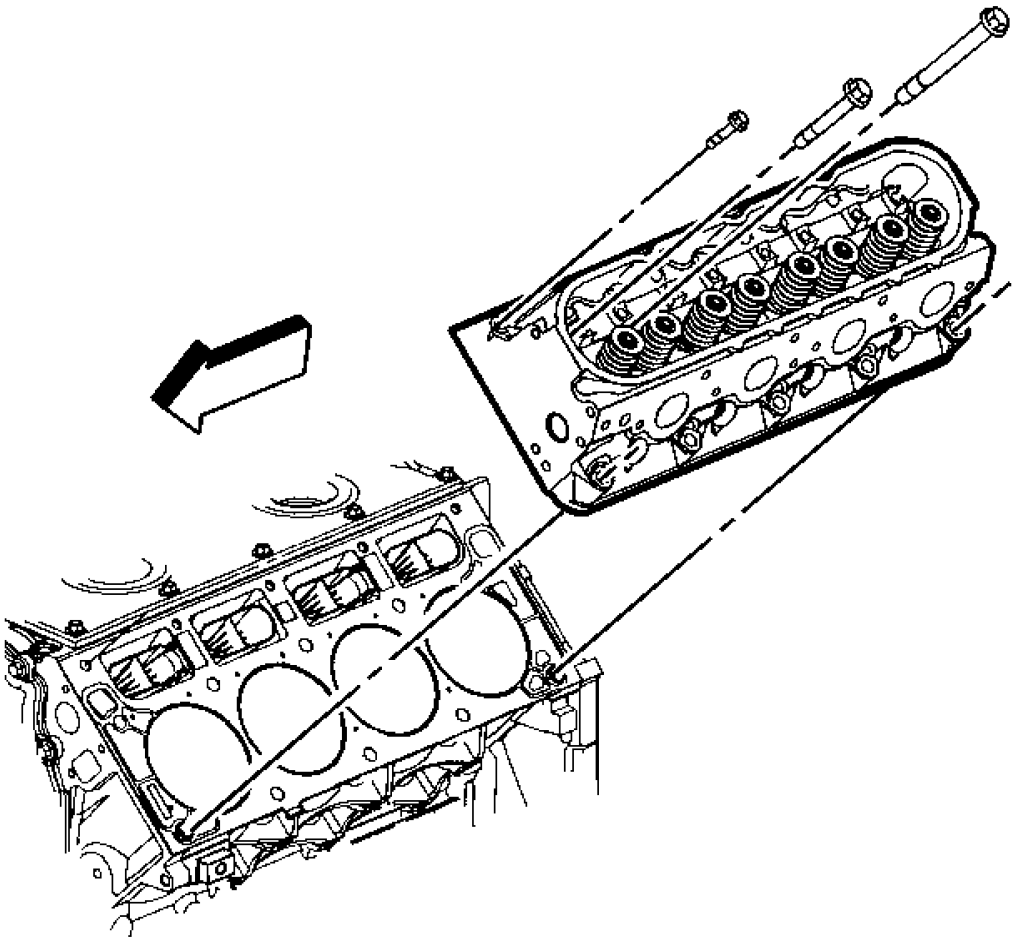


Fig. 68: View Of Cylinder Head & Bolts (Left)
Courtesy of GENERAL MOTORS CORP.

NOTE: The cylinder head bolts are NOT reusable.

CAUTION: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

11. Remove the cylinder head bolts.
12. Remove the cylinder head.

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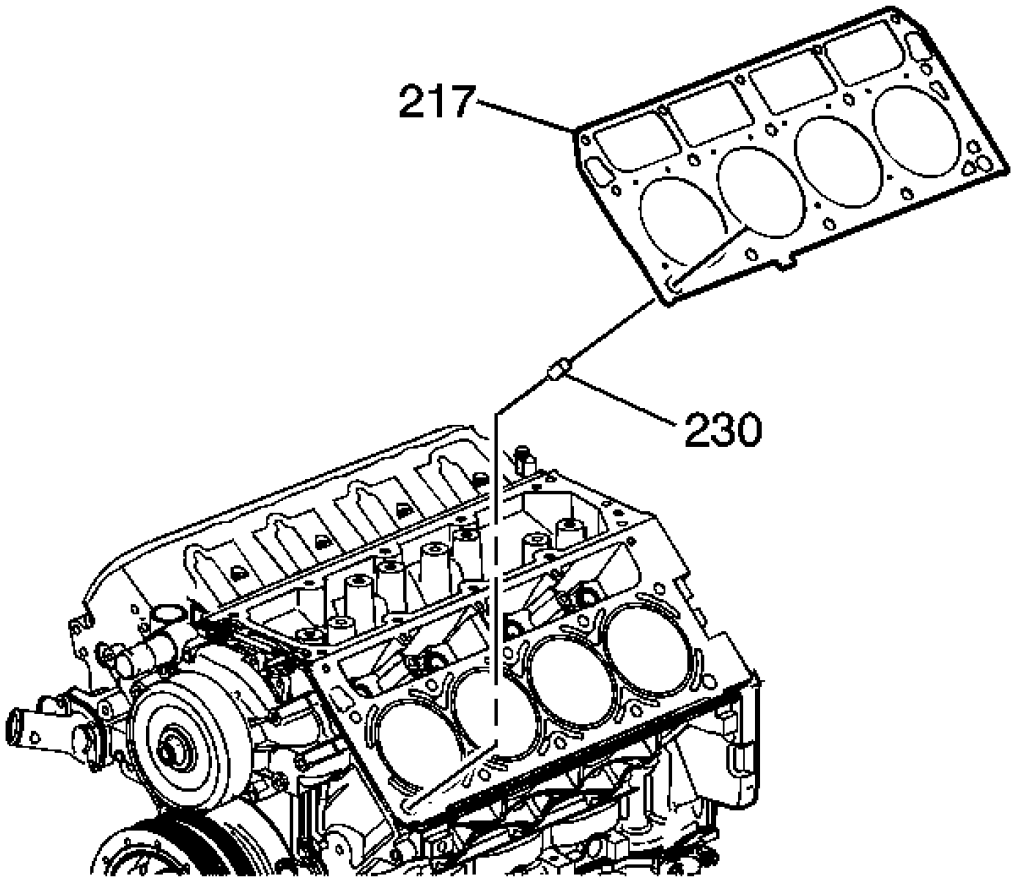


Fig. 69: View Of Cylinder Head Gasket & Locating Pin - Left
Courtesy of GENERAL MOTORS CORP.

13. Remove the cylinder head gasket (217).
14. Discard the gasket.
15. Discard all M8 and M11 cylinder head bolts.
16. Clean and inspect the cylinder head. Refer to **Cylinder Head Cleaning and Inspection** .

INSTALLATION PROCEDURE

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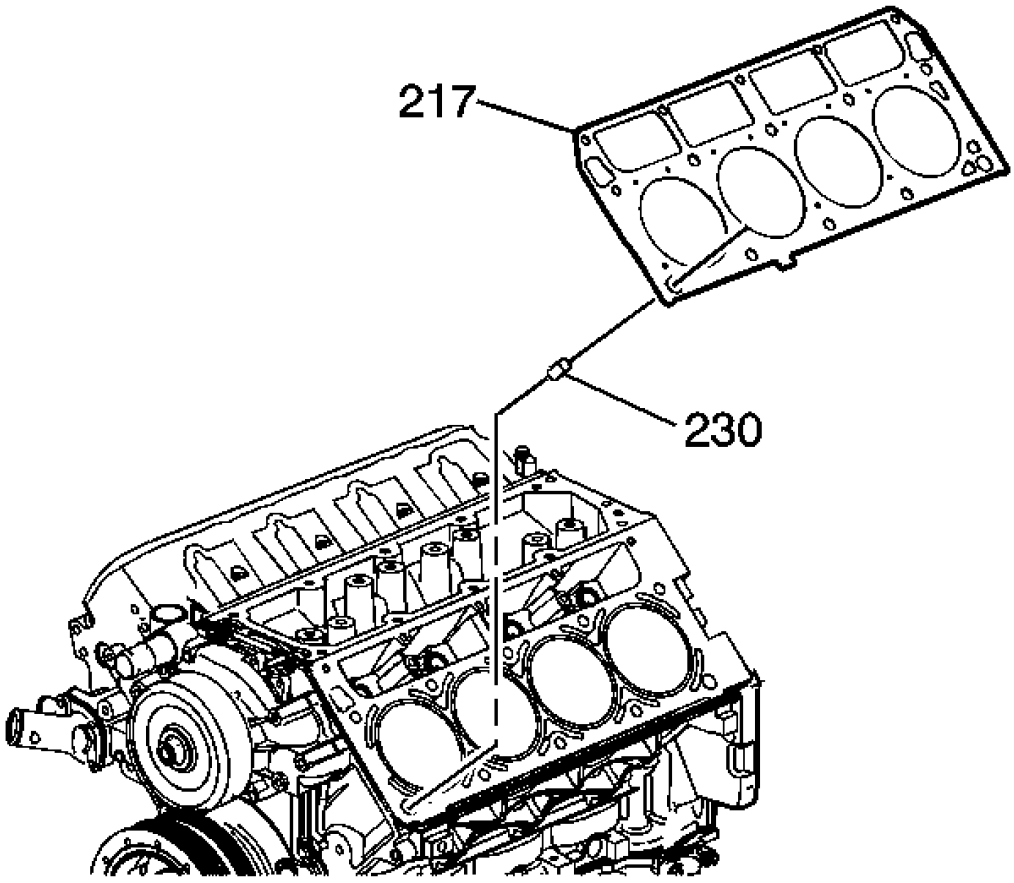


Fig. 70: View Of Cylinder Head Gasket & Locating Pin - Left
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Safety Glasses Warning .

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

NOTE: If installing a new cylinder head it is necessary to install a new engine coolant air bleed plug into the rear coolant passage of the cylinder head. Refer to Cylinder Head Assemble .

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NOTE:

- **Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.**
- **Do not use any type of sealant on the cylinder head gasket, unless specified.**
- **The cylinder head gaskets must be installed in the proper direction and position.**

1. Clean the engine block cylinder head bolt holes, if required.

   Thread repair tool J 42385-107 may be used to clean the threads of old threadlocking material.

2. Spray cleaner into the hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
3. Clean the cylinder head bolt holes with compressed air.
4. Install the cylinder head locating pins (230).

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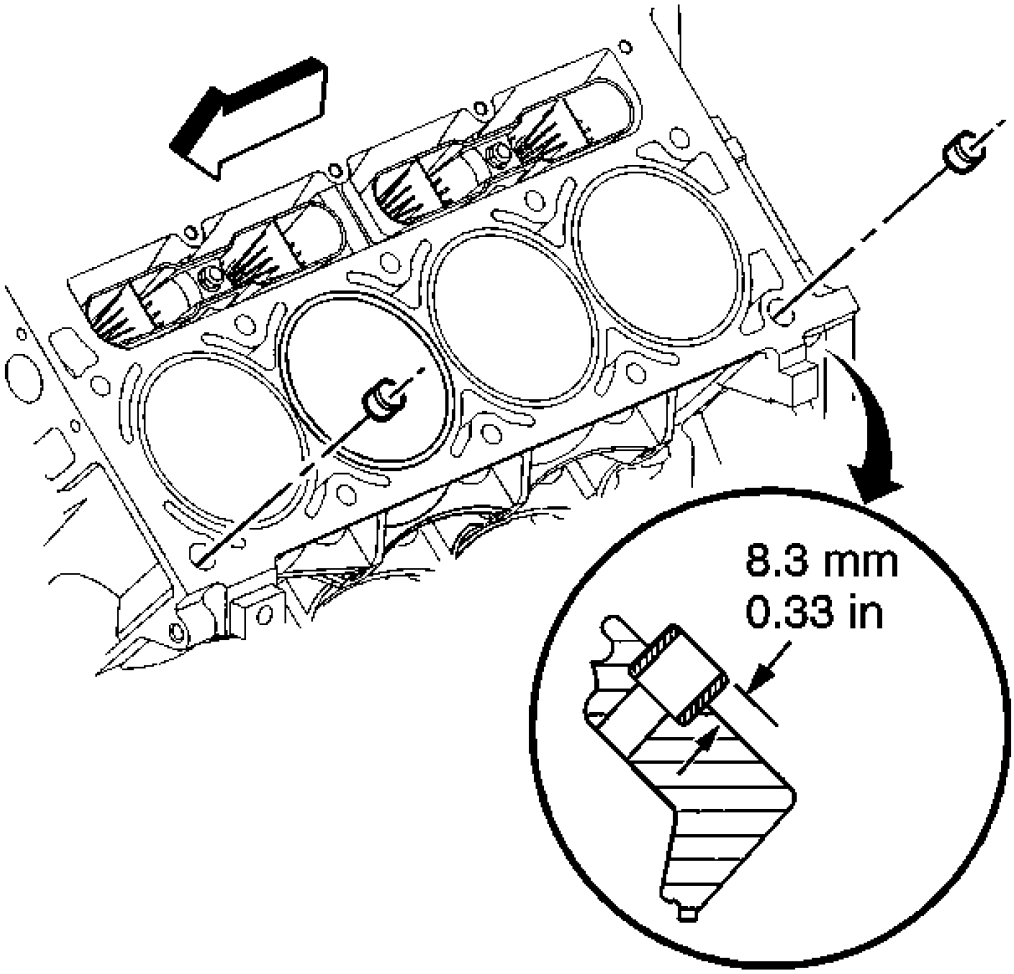


Fig. 71: Cylinder Head Locating Pins
Courtesy of GENERAL MOTORS CORP.

5. Inspect the locating pins for proper installation.

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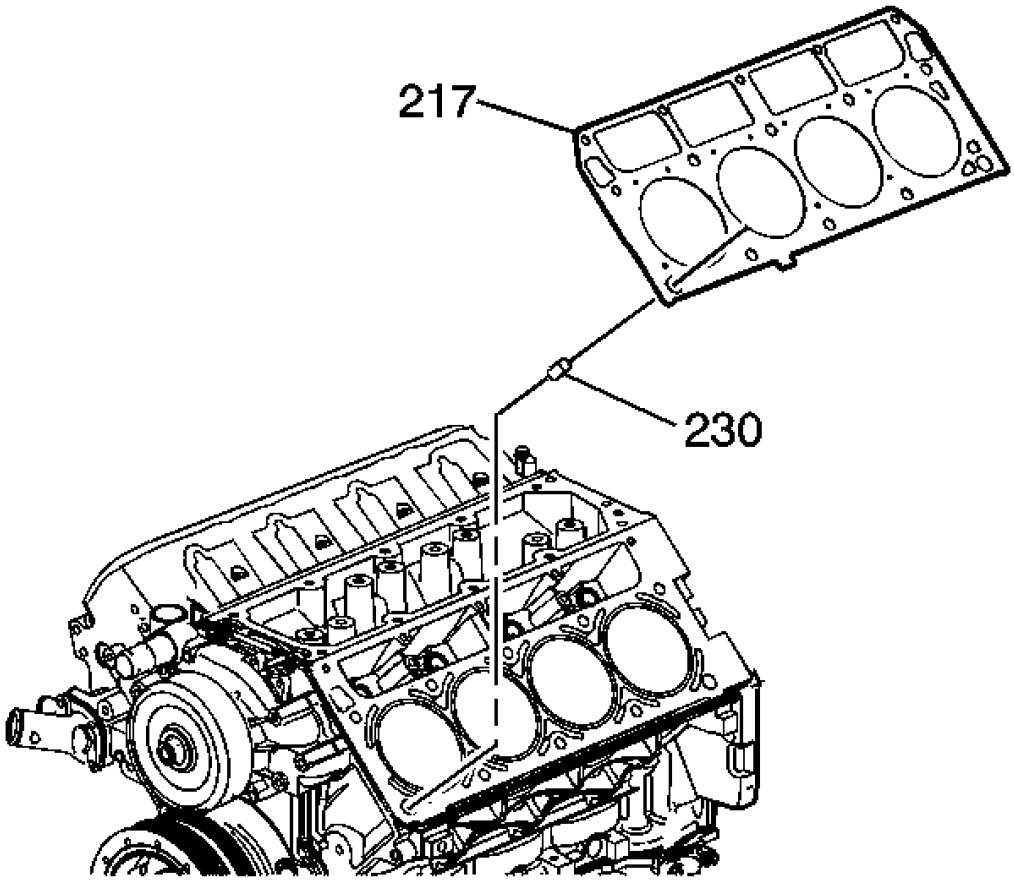


Fig. 72: View Of Cylinder Head Gasket & Locating Pin - Left
Courtesy of GENERAL MOTORS CORP.

6. Install the NEW cylinder head gasket (217) onto the locating pins.

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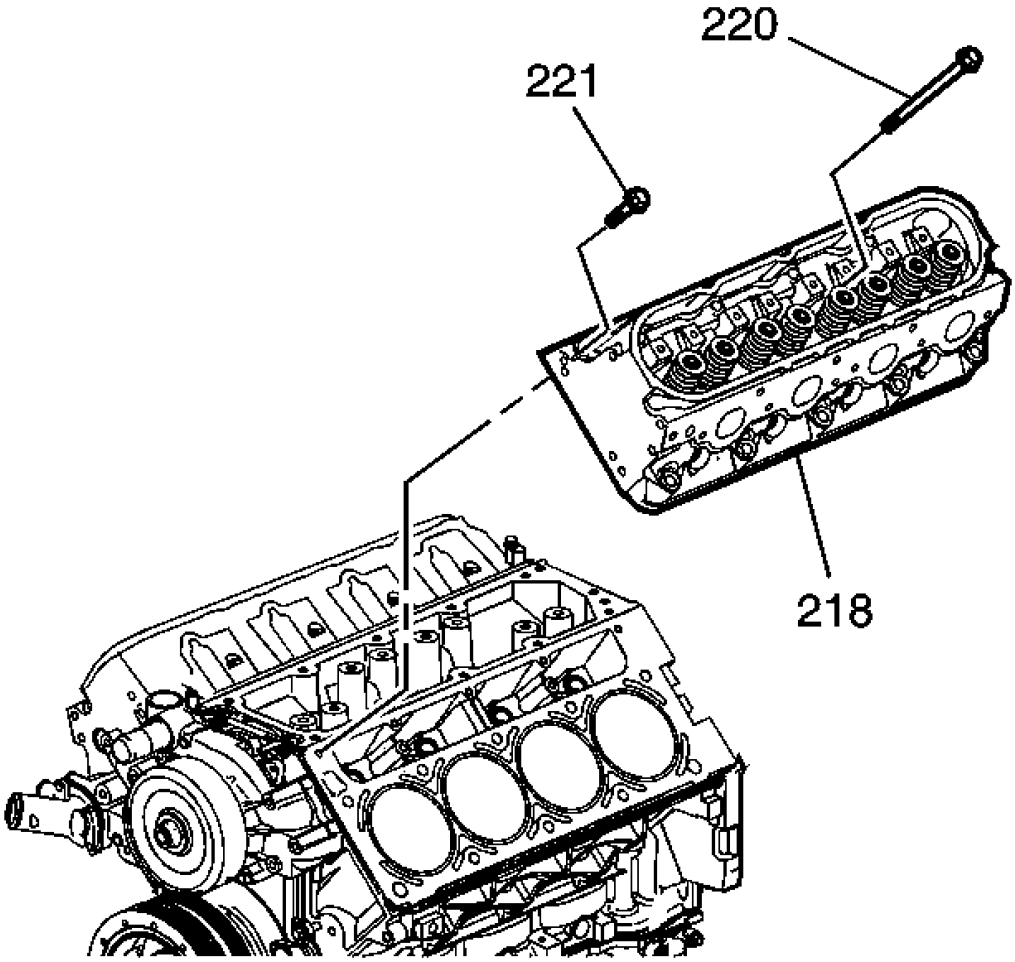


Fig. 73: Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the cylinder head (218) onto the locating pins and the gasket.
8. Install the NEW cylinder head bolts (200, 221).

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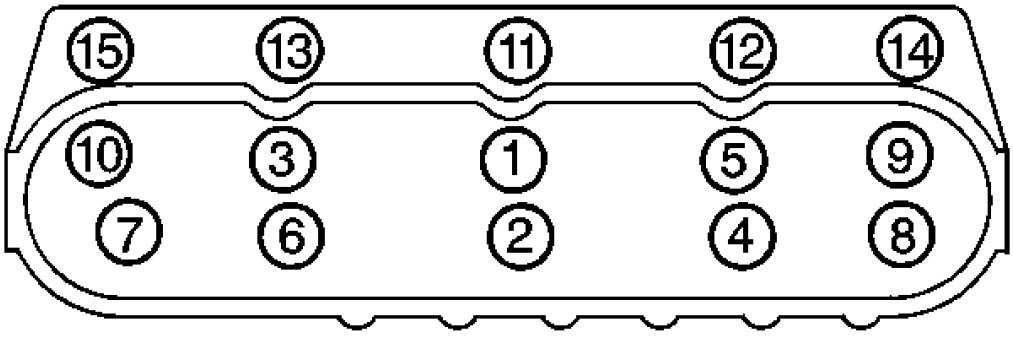


Fig. 74: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

9. Tighten the cylinder head bolts.
    1. Tighten the M11 cylinder head bolts (1-10) a first pass in sequence to 30 N.m (22 lb ft).
    2. Tighten the M11 cylinder head bolts (1-10) a second pass in sequence to 90 degrees using the **J 45059** .
    3. Tighten the M11 cylinder head bolts (1-10) a final pass in sequence to 70 degrees using the **J 45059** .
    4. Tighten the M8 cylinder head bolts (11-15) to 30 N.m (22 lb ft). Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.
10. Install the intake manifold. Refer to **Intake Manifold Replacement**.
11. Position the engine wire harness ground strap against the cylinder head.
12. Install the engine wiring harness ground bolt to the rear of the left cylinder head. Tighten the bolt to 32 N.m (24 lb ft).
13. Install Engine Coolant Air Bleed Pipe and Hole Cover. Refer to **Engine Coolant Air Bleed Pipe and Hole Cover Installation**
14. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement - Left Side (LLT)** or **Exhaust Manifold Replacement - Left Side (L99/LS3)** .
15. Install the power steering pump bracket. Refer to **Power Steering Pump Replacement (V6)** or **Power Steering Pump Replacement (V8)** .
16. Install the engine coolant air bleed hose.
17. Install the valve rocker arms and push rods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
18. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or

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Cooling System Draining and Filling (LLT Static Fill) or **Cooling System Draining and Filling (GE 47716)** .

CYLINDER HEAD REPLACEMENT - RIGHT SIDE

Special Tools

- **J 42385-100** Head/Main Bolt Thread Repair Kit. See **Special Tools** .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

1. Drain the coolant. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** .

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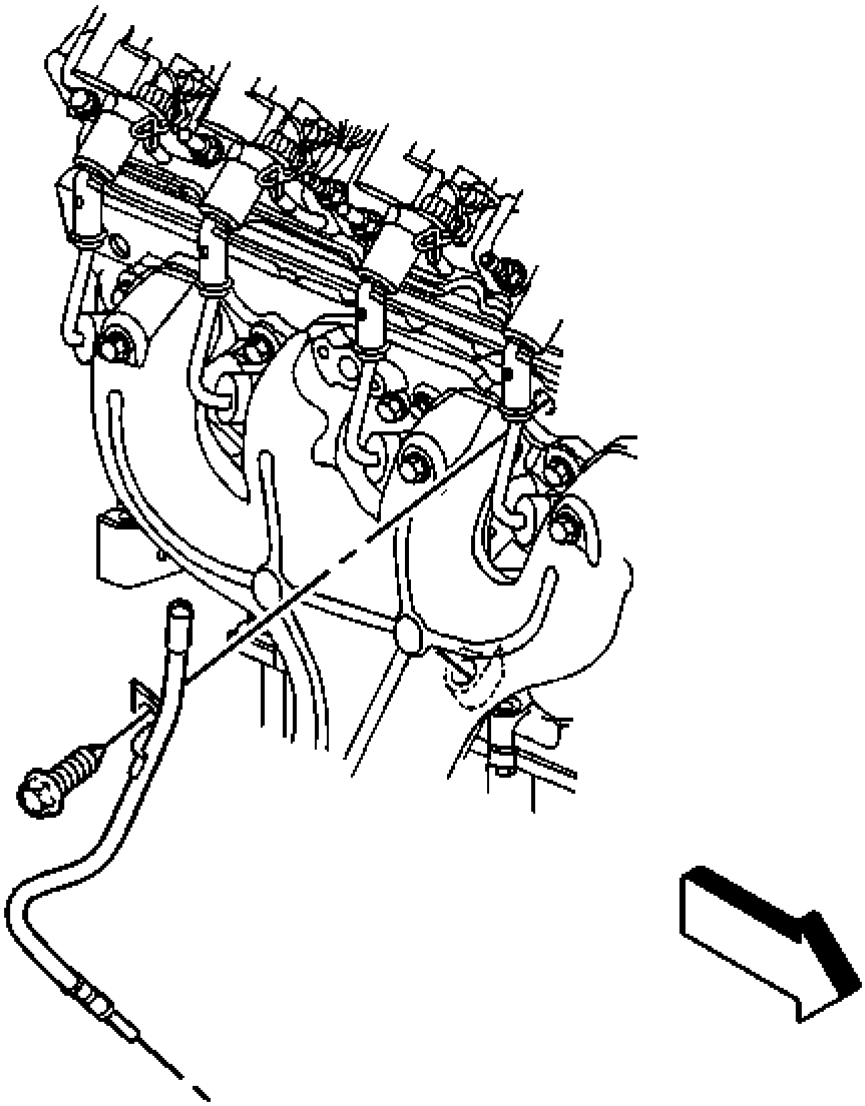


Fig. 75: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

2. Remove the valve rocker arms and pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
3. Remove the engine coolant air bleed hose.
4. Remove the exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (LLT)** or **Exhaust Manifold Replacement - Right Side (L99/LS3)** .
5. Remove the oil level indicator tube bolt.

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6. Reposition the oil level indicator tube, if necessary.
7. Remove the Engine Coolant Air Bleed Pipe and Hole Cover. Refer to **Engine Coolant Air Bleed Pipe and Hole Cover Removal**
8. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
9. Remove the wiring harness from the clip at the rear of the cylinder head.
10. Remove the ground wire bolts/studs from the rear, center, and front of the cylinder head.
11. Remove the canister purge solenoid. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement** .
12. Reposition the harnesses as necessary.

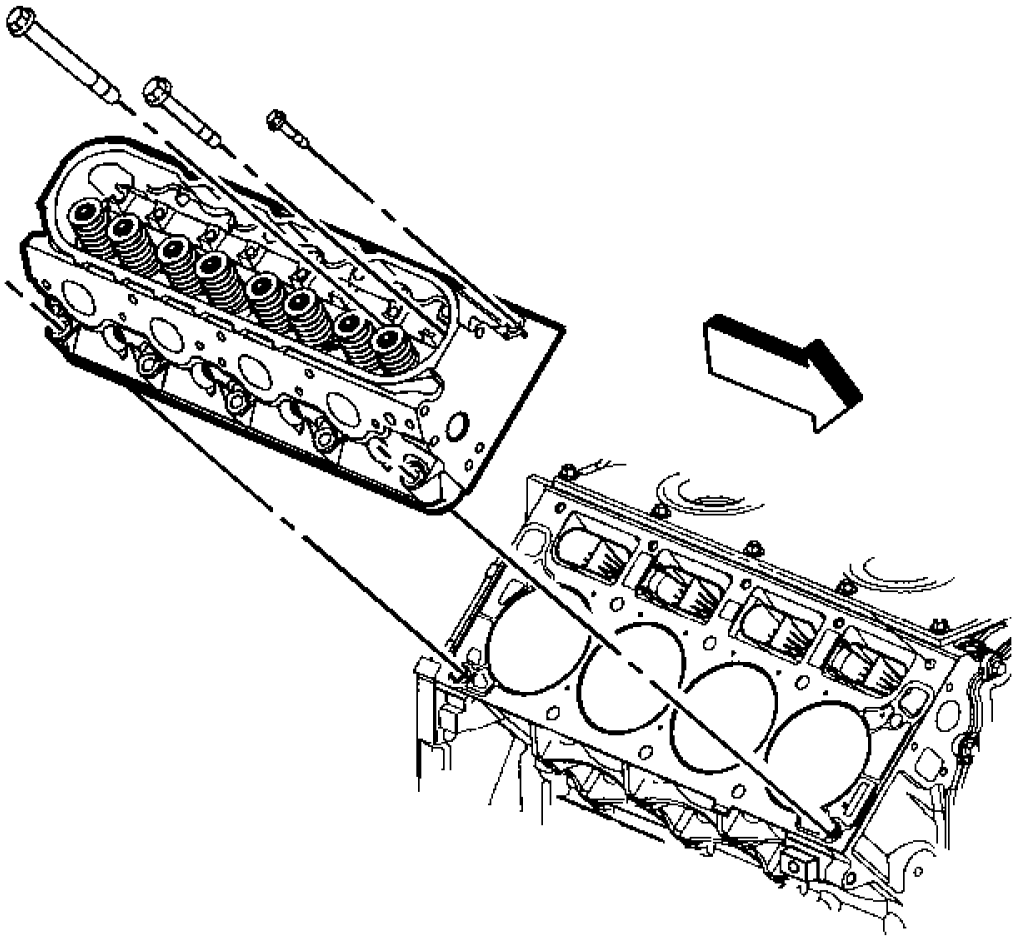


Fig. 76: View Of Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

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NOTE: The cylinder head bolts are NOT reusable.

CAUTION: After removal, place the cylinder head on 2 wood blocks in order to prevent damage to the sealing surfaces.

13. Remove the cylinder head bolts.
14. Remove the cylinder head.

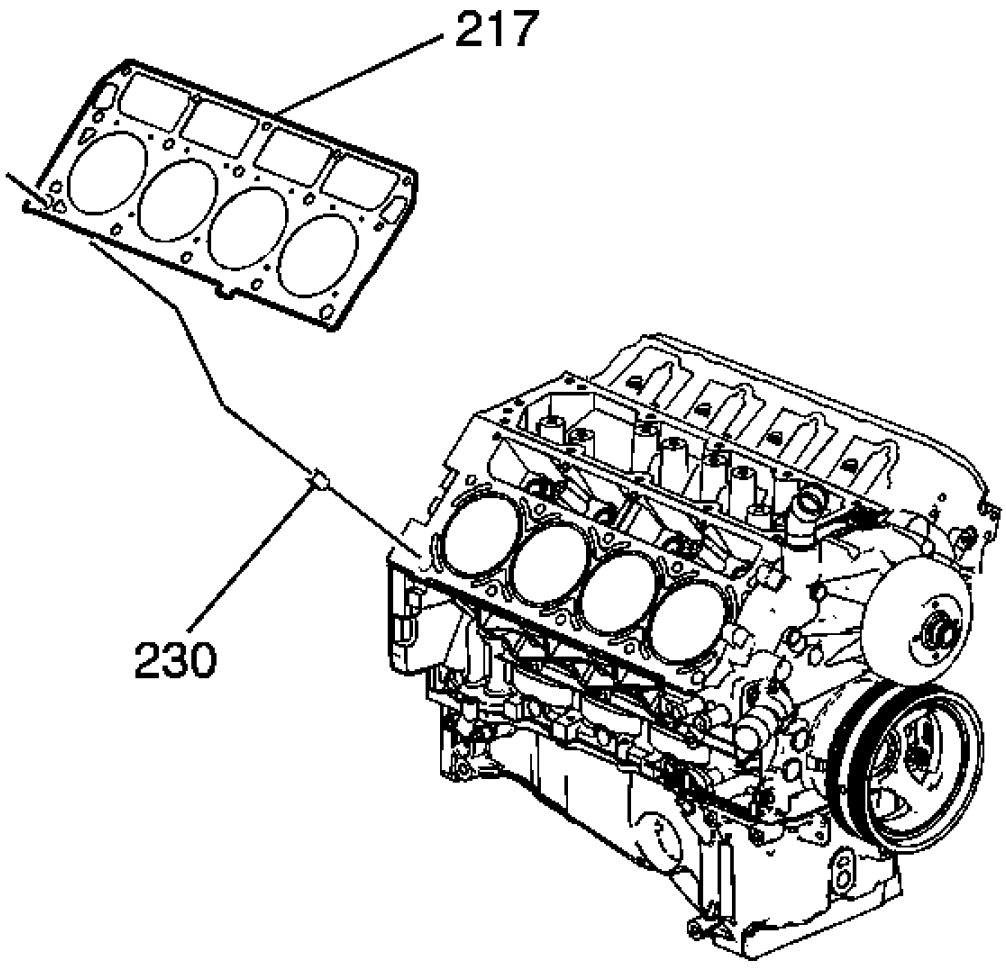


Fig. 77: Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

15. Remove the cylinder head gasket (217).

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16. Discard the gasket.
17. Discard the cylinder head bolts.
18. Clean and inspect the cylinder head. Refer to **Cylinder Head Cleaning and Inspection** .

INSTALLATION PROCEDURE

WARNING: Wear safety glasses in order to avoid eye damage.

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

NOTE: If installing a new cylinder head it is necessary to install a new engine coolant air bleed plug into the rear coolant passage of the cylinder head. Refer to Cylinder Head Assemble .

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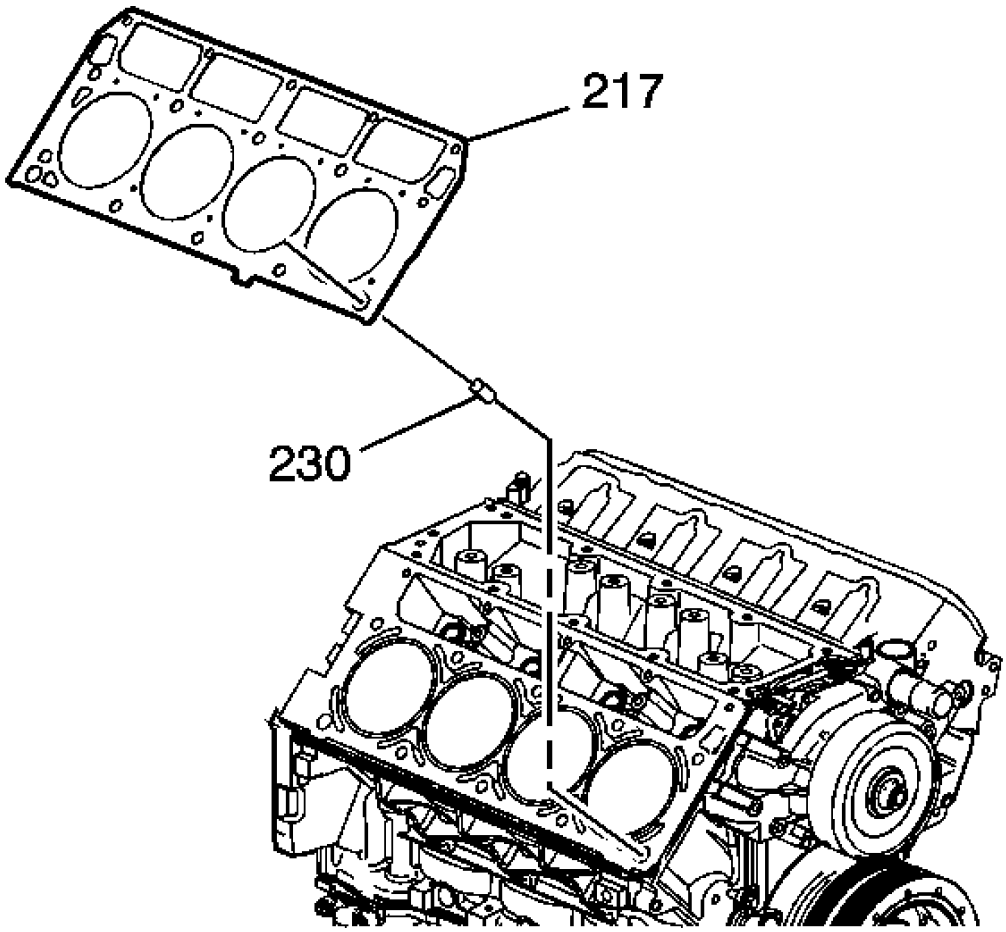


Fig. 78: Cylinder Head Gasket & Locating Pins - Right
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Do not use the cylinder head bolts again. Install NEW cylinder head bolts during assembly.**
- **Do not use any type of sealant on the cylinder head gasket, unless specified.**
- **The cylinder head gaskets (217) must be installed in the proper direction and position.**

1. Clean the engine block cylinder head bolt holes, if required.

   Thread repair tool J 42385-107 may be used to clean the threads of old threadlocking material.

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2. Spray cleaner into the hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.
3. Clean the cylinder head bolt holes with compressed air.
4. Install the cylinder head locating pins (230).

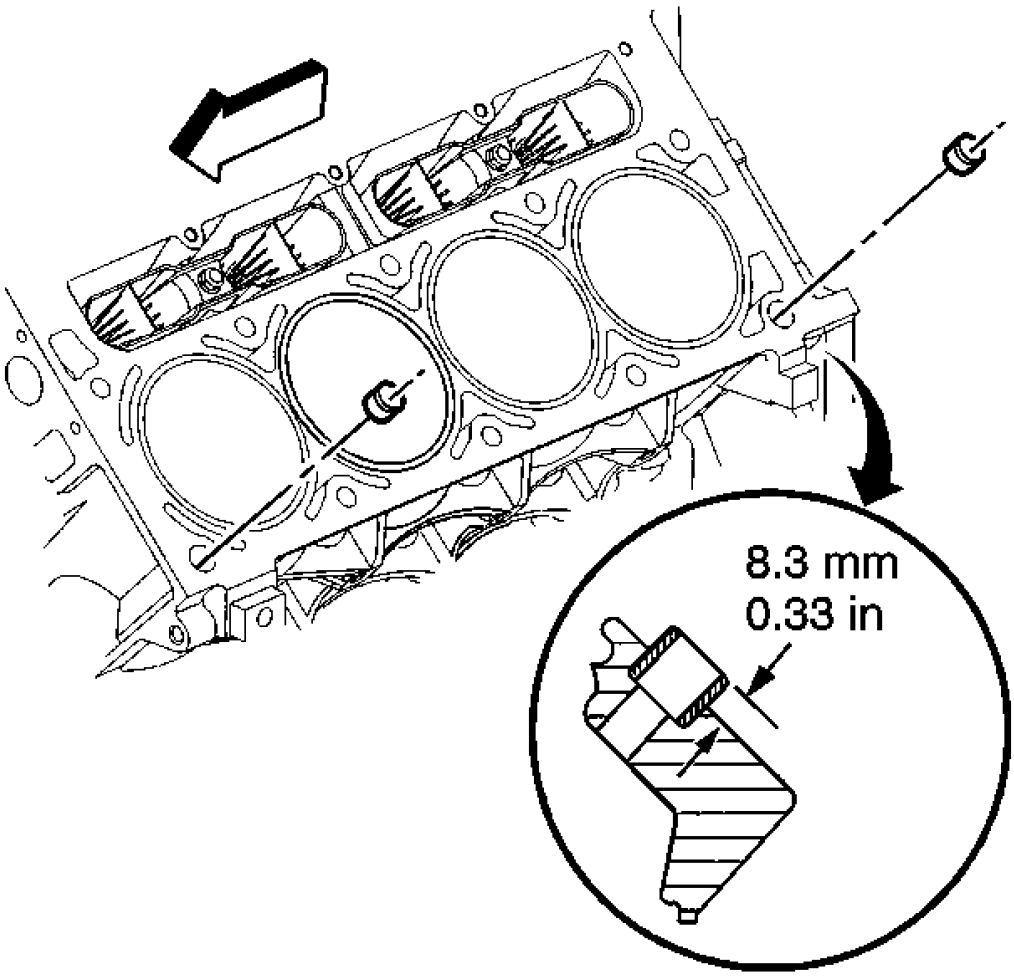


Fig. 79: Cylinder Head Locating Pins
Courtesy of GENERAL MOTORS CORP.

5. Inspect the locating pins for proper installation.

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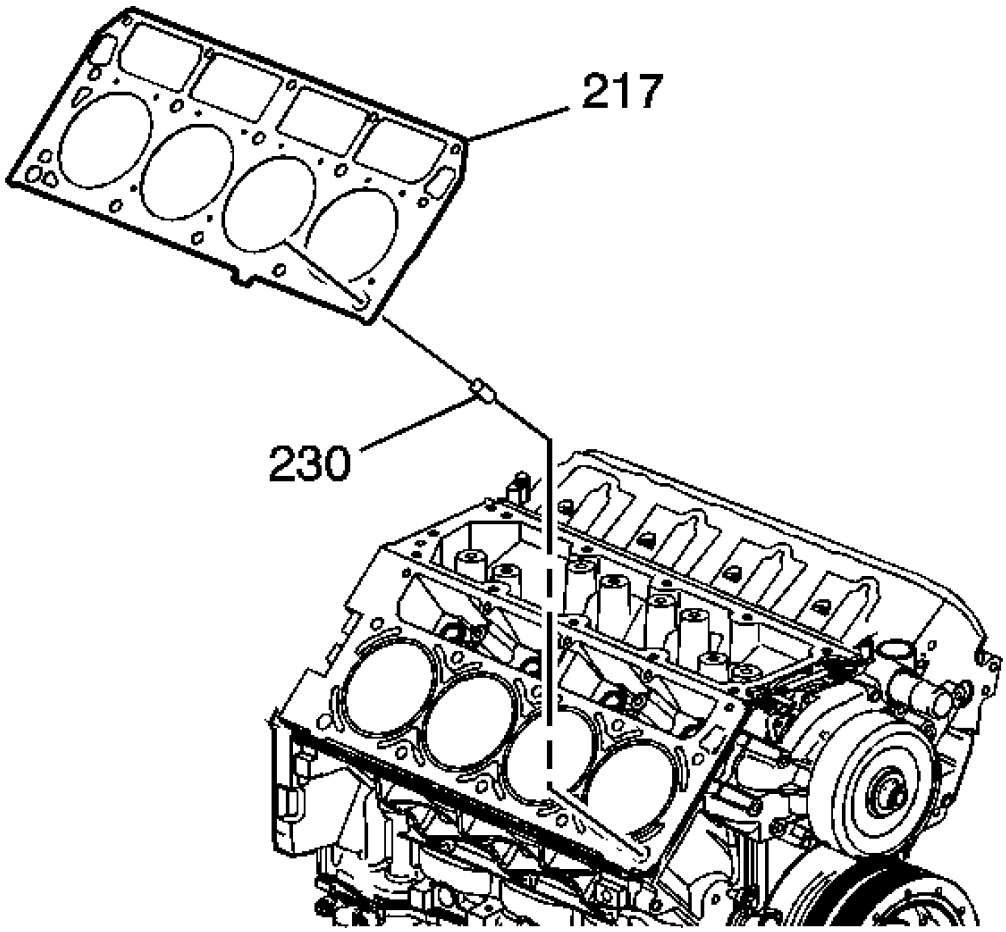


Fig. 80: Cylinder Head Gasket & Locating Pins - Right
Courtesy of GENERAL MOTORS CORP.

6. Install the NEW cylinder head gasket (217) onto the locating pins.

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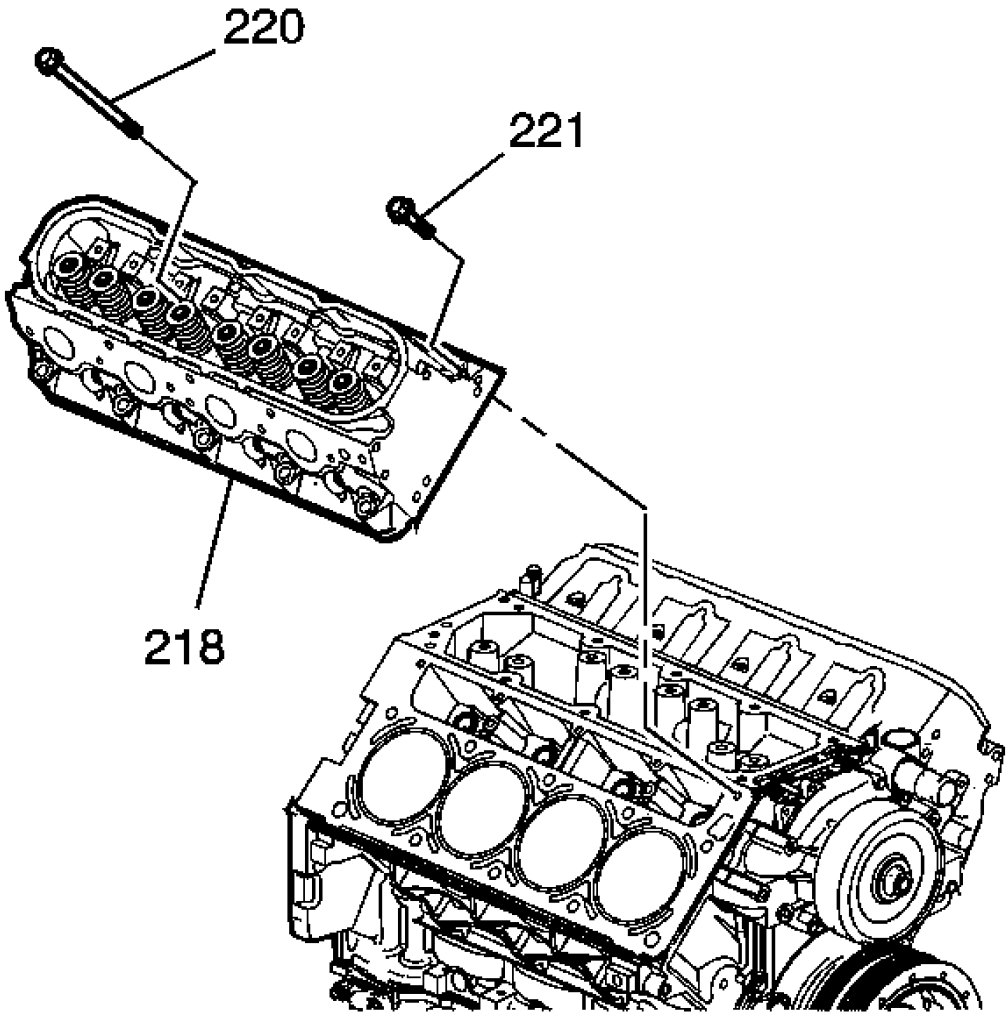


Fig. 81: Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the cylinder head (218) onto the locating pins and the gasket.
8. Install the NEW cylinder head bolts (220, 221).

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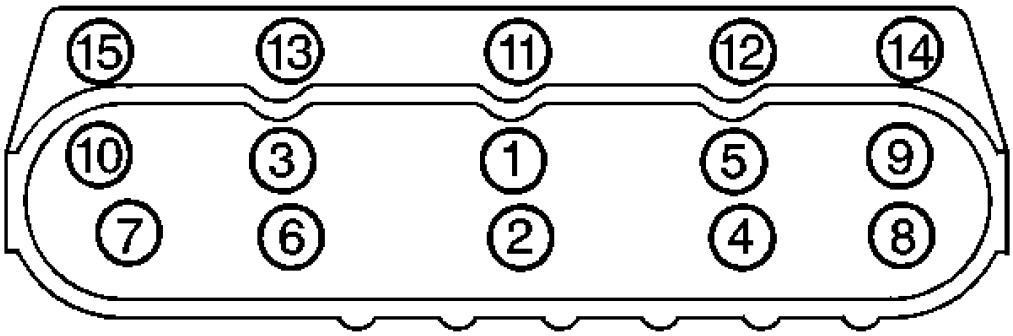


Fig. 82: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

9. Tighten the cylinder head bolts.
    1. Tighten the M11 cylinder head bolts (1-10) a first pass in sequence to 30 N.m (22 lb ft) .
    2. Tighten the M11 cylinder head bolts (1-10) a second pass in sequence to 90 degrees using the **J 45059** .
    3. Tighten the M11 cylinder head bolts (1-10) a final pass in sequence to 70 degrees using the **J 45059** .
    4. Tighten the M8 cylinder head bolts (11-15) to 30 N.m (22 lb ft). Begin with the center bolt (11) and alternating side-to-side, work outward tightening all of the bolts.
10. Install the wiring harness to the clip at the rear of the cylinder head.
11. Install the intake manifold. Refer to **Intake Manifold Replacement**.
12. Install the canister purge solenoid. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement** .

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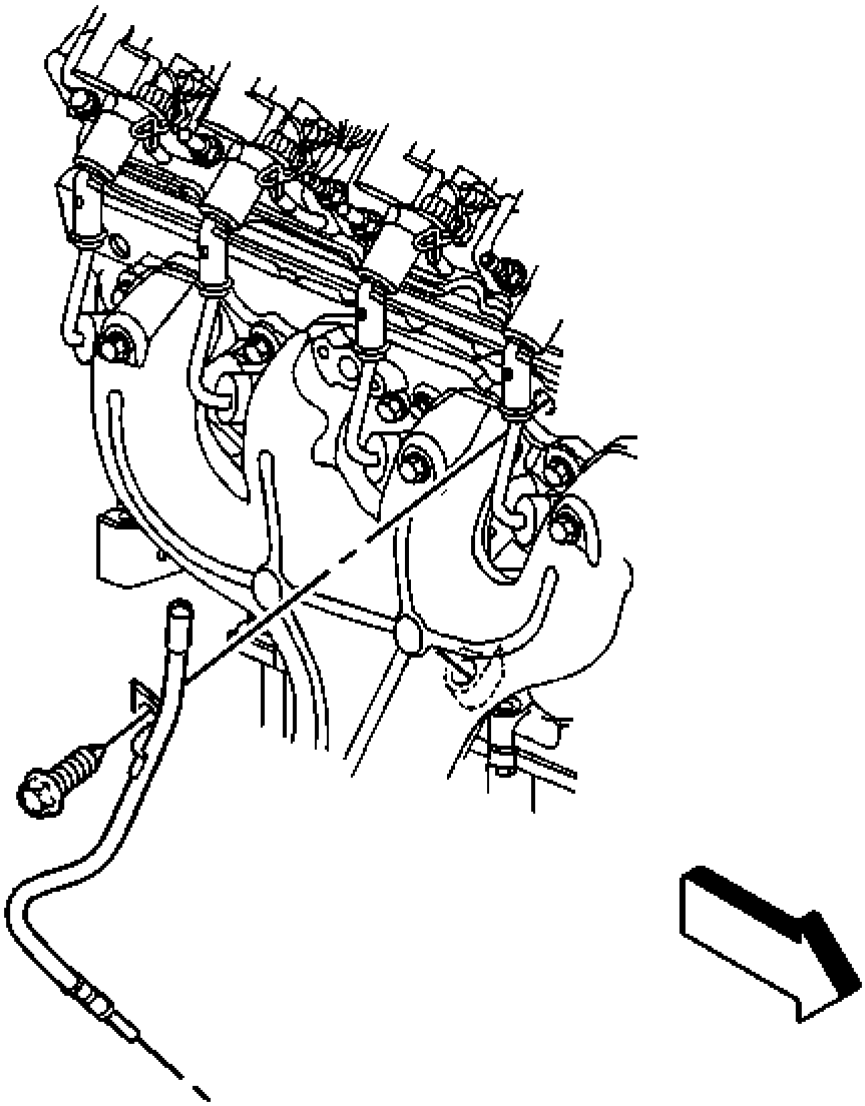


Fig. 83: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

13. Install the ground wire bolts/studs to the rear, center, and front of the cylinder head.
14. Install Engine Coolant Air Bleed Pipe and Hole Cover. Refer to **Engine Coolant Air Bleed Pipe and Hole Cover Installation**
15. Position the oil level indicator tube into place.
16. Install the oil level indicator tube bolt and tighten to 25 N.m (18 lb ft).

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17. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement - Right Side (LLT)** or **Exhaust Manifold Replacement - Right Side (L99/LS3)** .
18. Install the engine coolant air bleed hose.
19. Install the valve rocker arms and pushrods. Refer to **Valve Rocker Arm and Push Rod Replacement**.
20. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** .

VALVE LIFTER REPLACEMENT (WITHOUT AFM)

REMOVAL PROCEDURE

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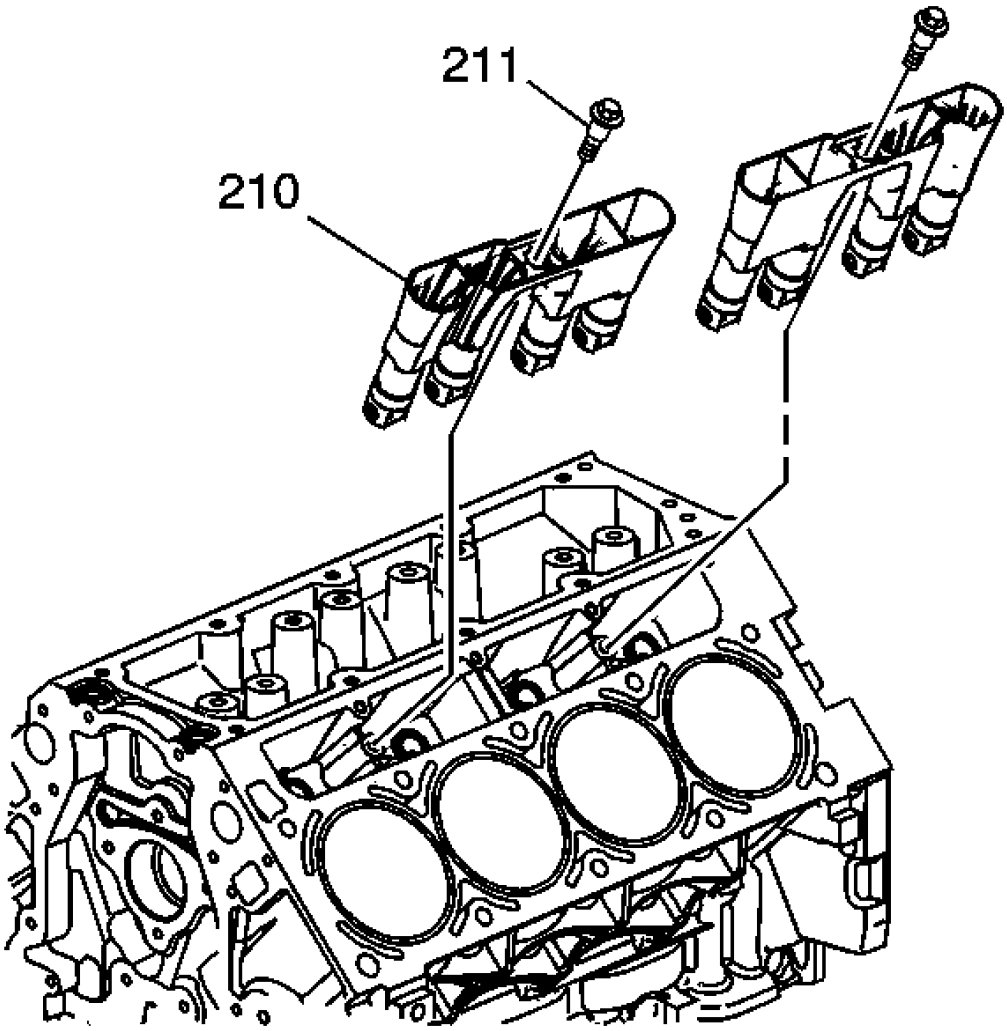


Fig. 84: Identifying Valve Lifter Guides & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the cylinder head and gasket. Refer to **Cylinder Head Replacement - Left Side** or **Cylinder Head Replacement - Right Side**.
2. Remove the valve lifter guide bolts (211).
3. Remove the valve lifter guides (210) with the lifters. Note the installed position of the guides. The notched area of the guides is to align with the locating tab on the engine block.

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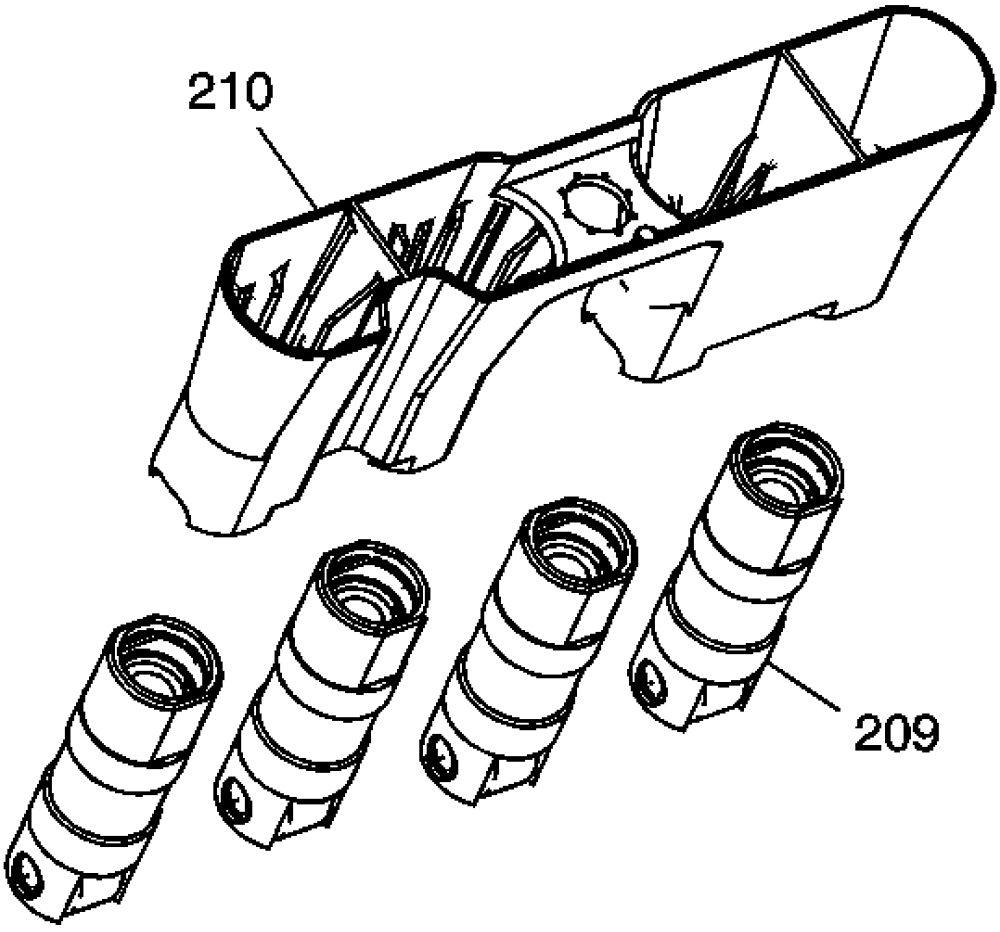


Fig. 85: Valve Lifters & Guides
Courtesy of GENERAL MOTORS CORP.

4. Remove the valve lifters (209) from the guide (210).
5. Organize or mark the components so that they can be installed in the same location from which they were removed, if required.
6. Clean and inspect the valve lifters, if required. Refer to **Valve Lifter and Guide Cleaning and Inspection** .

INSTALLATION PROCEDURE

Note:

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- If camshaft replacement is required, the valve lifters must also be replaced.
- When reusing valve lifters, install the lifters to their original locations

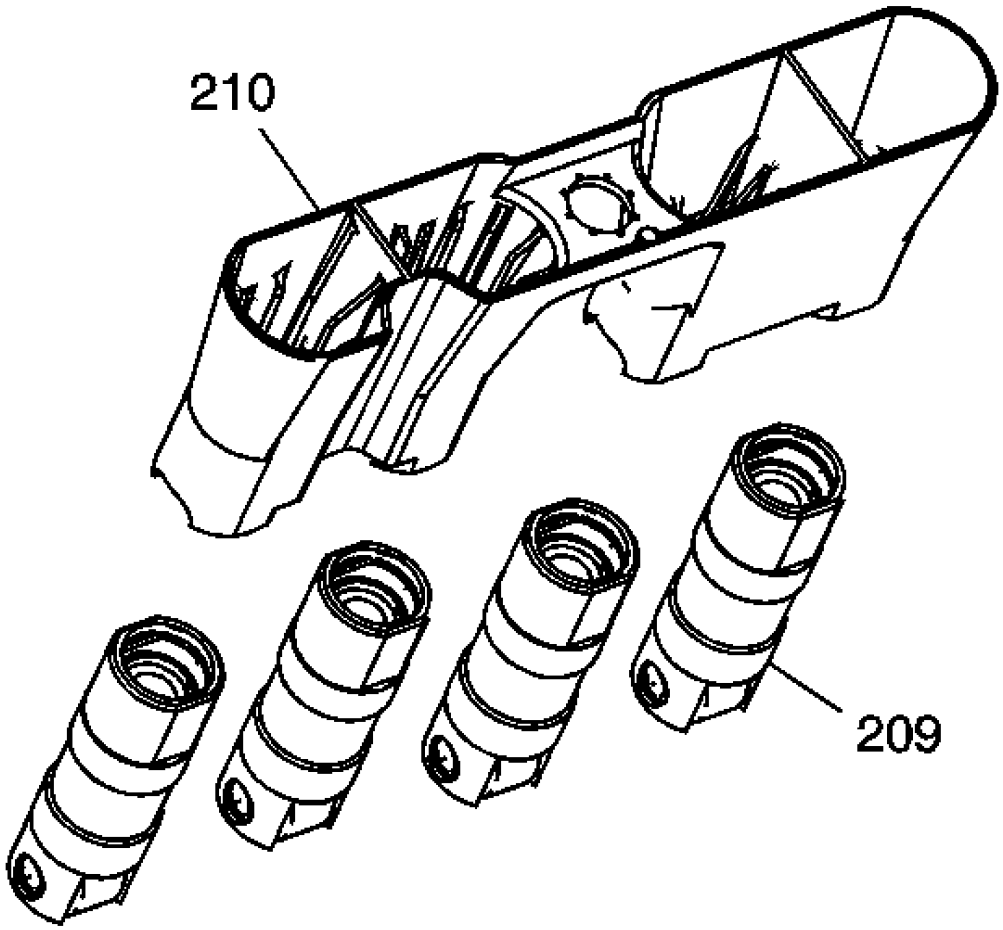


Fig. 86: Valve Lifters & Guides
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the valve lifters (209) and engine block valve lifter bores with clean engine oil.
2. Insert the valve lifters into the lifter guides (210). Align the flat area on the top of the lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.

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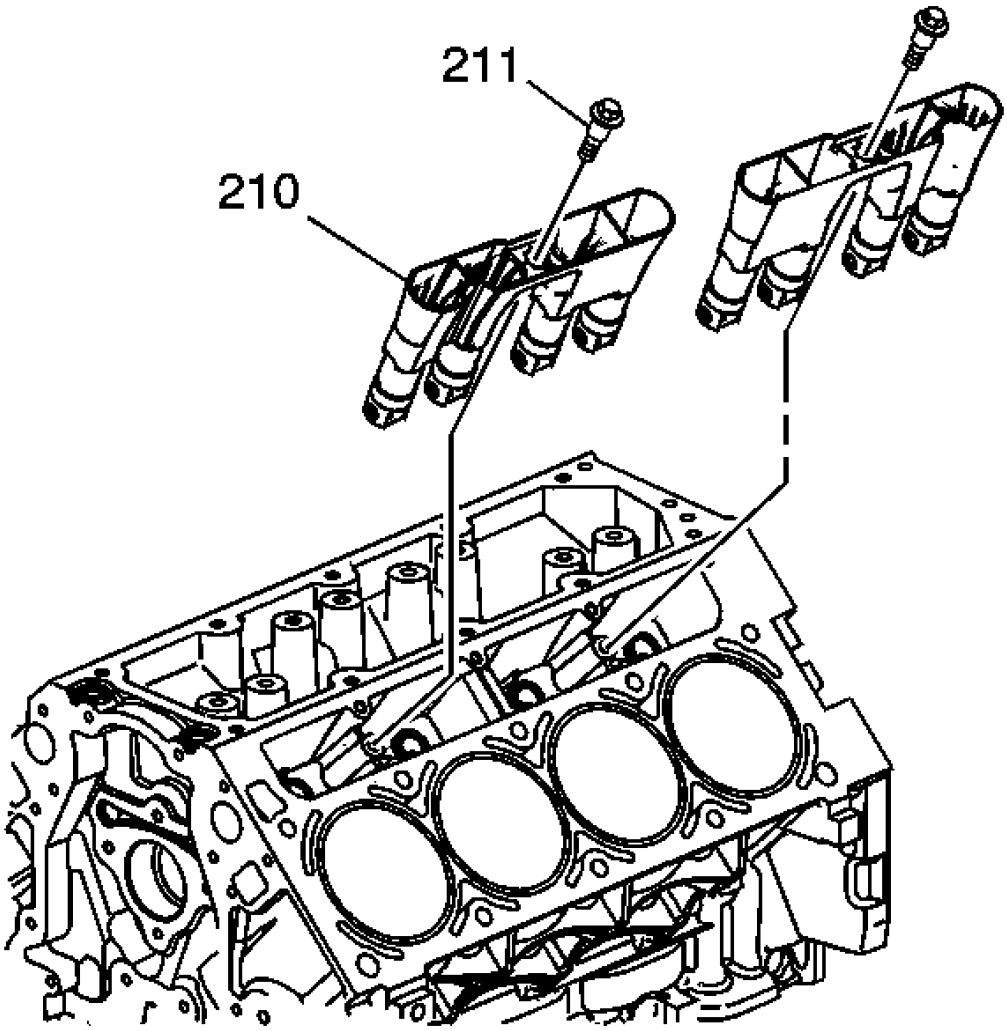


Fig. 87: Identifying Valve Lifter Guides & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the valve lifters and guide (210) to the engine block.

CAUTION: Refer to Fastener Caution .

4. Install the valve lifter guide bolts.

Tighten: Tighten the bolt to 12 N.m (106 lb in).

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5. Install the cylinder head and gasket. Refer to **Cylinder Head Replacement - Left Side** or **Cylinder Head Replacement - Right Side**.

VALVE LIFTER REPLACEMENT (WITH AFM)

REMOVAL PROCEDURE

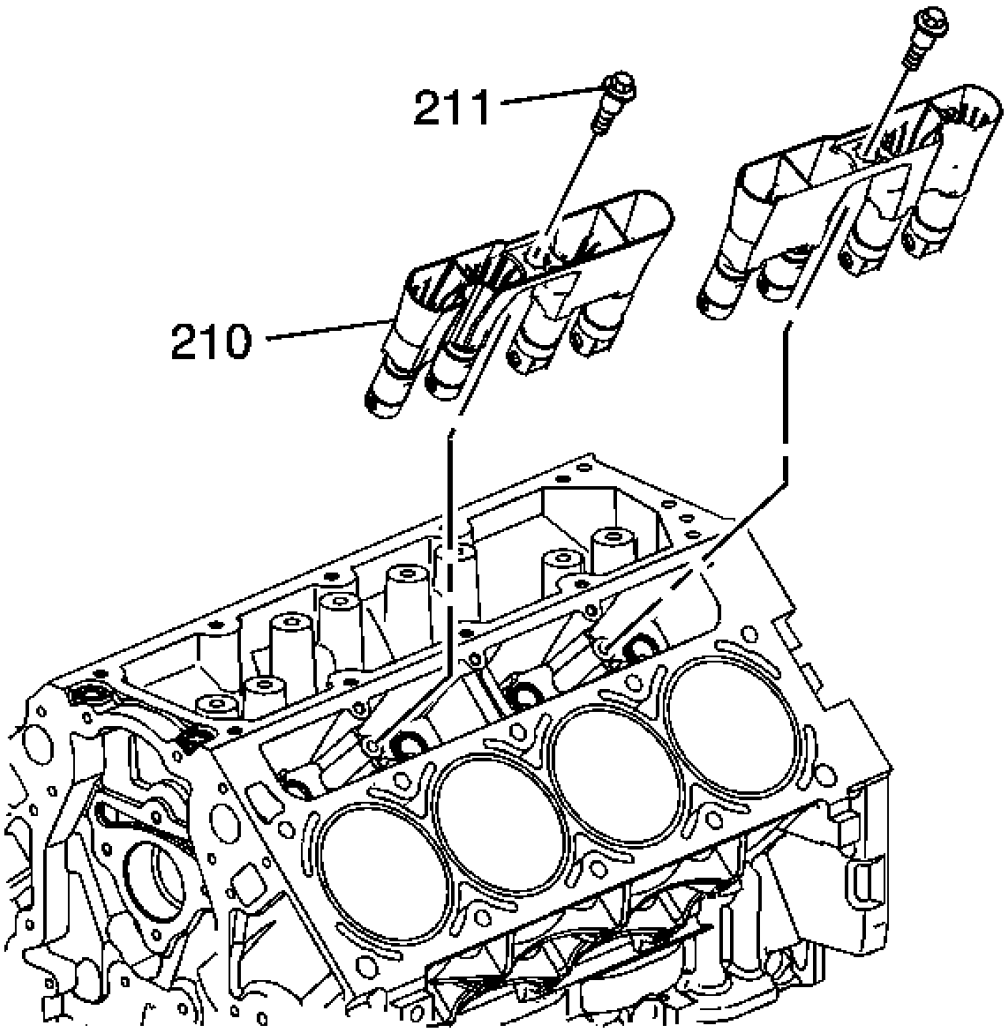


Fig. 88: Valve Lifter Guides & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the cylinder head and gasket. Refer to **Cylinder Head Replacement - Left Side**

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2. Remove the cylinder head and gasket. Refer to **Cylinder Head Replacement - Right Side**.
3. Remove the valve lifter guide bolts (211).
4. Remove the valve lifter guides (210) with the lifters. Note the installed position of the guides. The notched area of the guides is to align with the locating tab on the engine block.

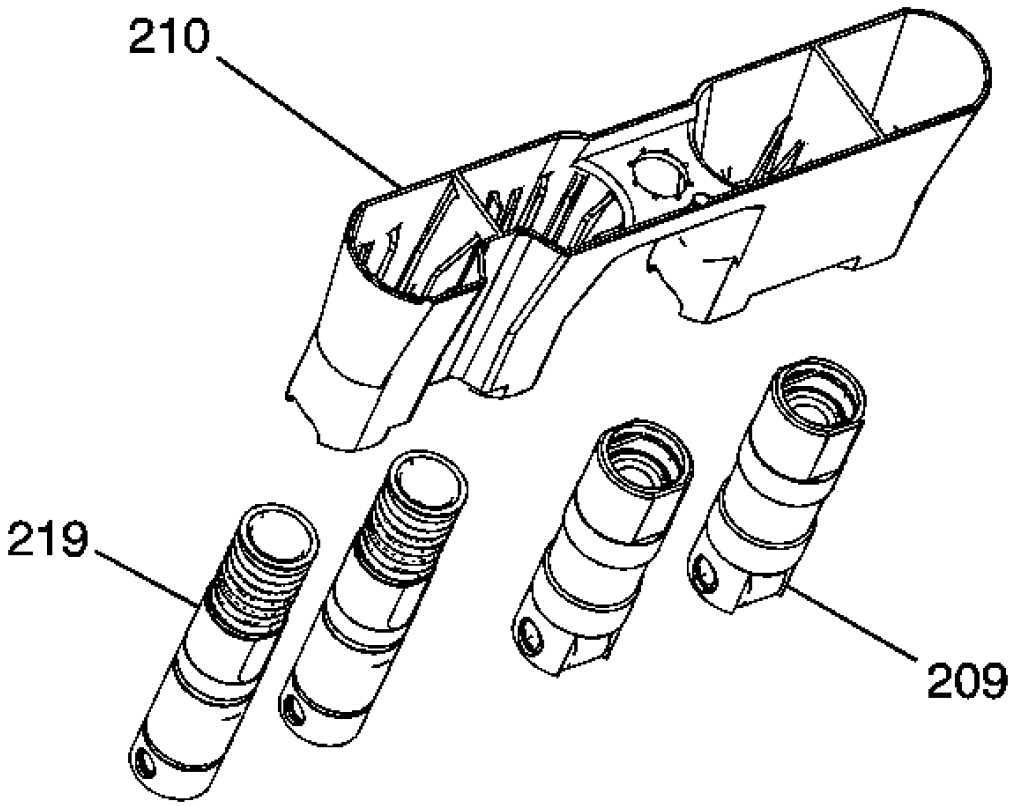


Fig. 89: Exploded View Of Lifter Guides & Lifters
Courtesy of GENERAL MOTORS CORP.

5. Remove the valve lifters (209, 219) from the guide (210).

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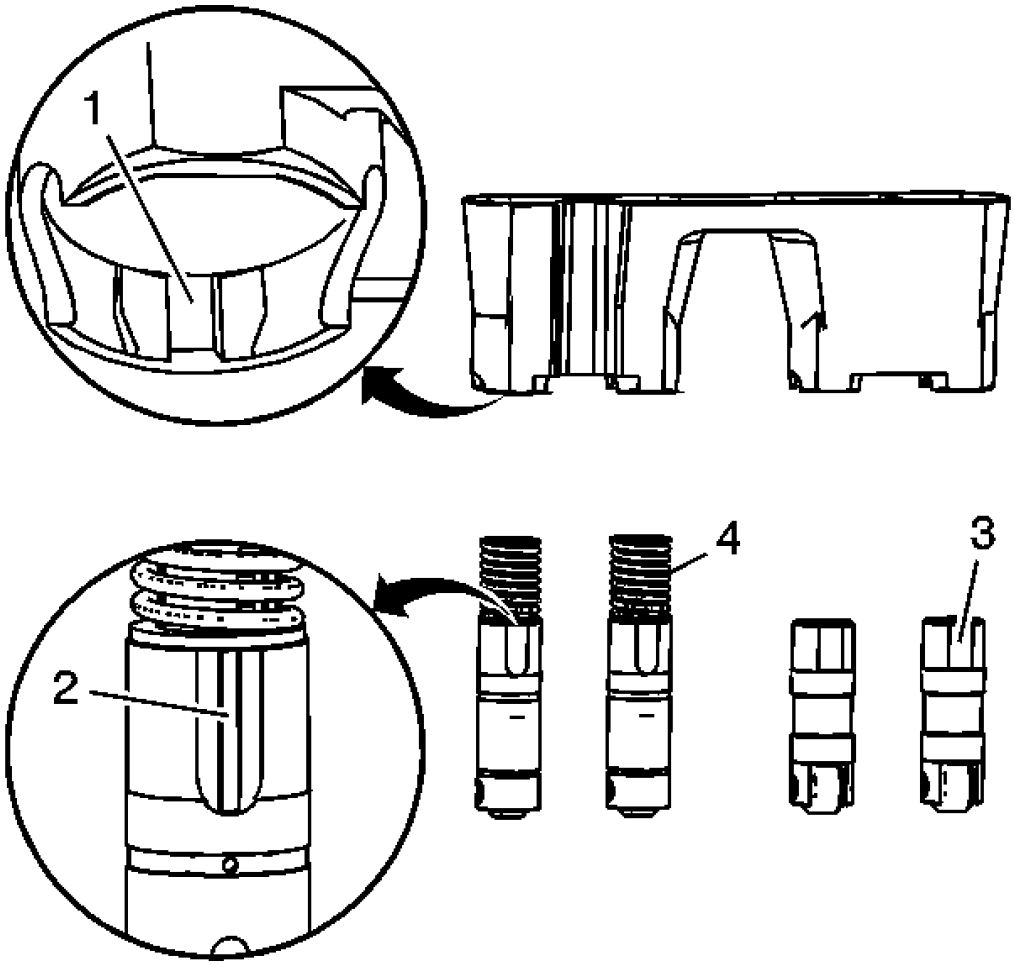


Fig. 90: Aligning Notched Area Of Guide With Raised Surface On Side Of Lifter
Courtesy of GENERAL MOTORS CORP.

NOTE: The active fuel management lifters are installed into the guide by aligning the notched area of the guide (1) with the raised surface on the side of the lifter (2).

6. Organize or mark the components so that they can be installed in the same location from which they were removed, if required.
7. Clean and inspect the valve lifters, if required. Refer to **Valve Lifter and Guide Cleaning and Inspection**

INSTALLATION PROCEDURE

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NOTE:

- **If camshaft replacement is required, the valve lifters must also be replaced.**
- **When reusing valve lifters, install the lifters to their original locations.**
- **Each of the 4 valve guide assemblies will contain 2 active fuel management valve lifters and 2 non active fuel management valve lifters.**
- **With the lifters and guides properly installed, cylinders 1, 4, 6, and 7 lifter bores will each contain 2 active fuel management valve lifters.**

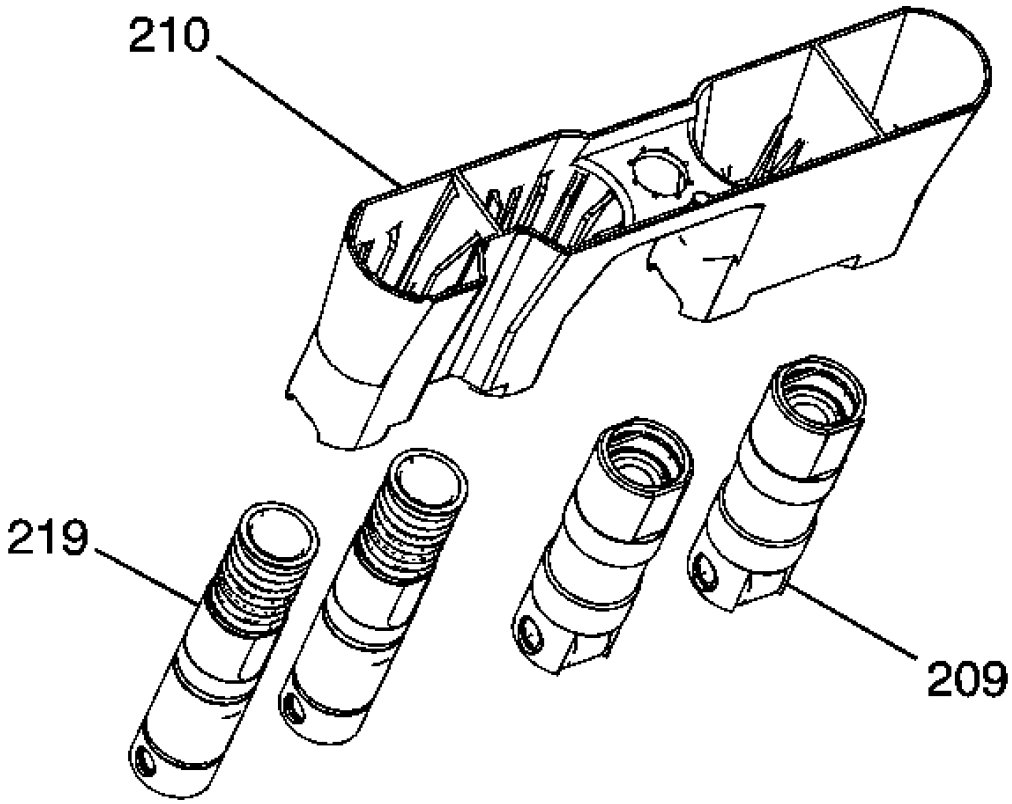


Fig. 91: Exploded View Of Lifter Guides & Lifters
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the valve lifters (209, 219) and engine block valve lifter bores with clean engine oil.

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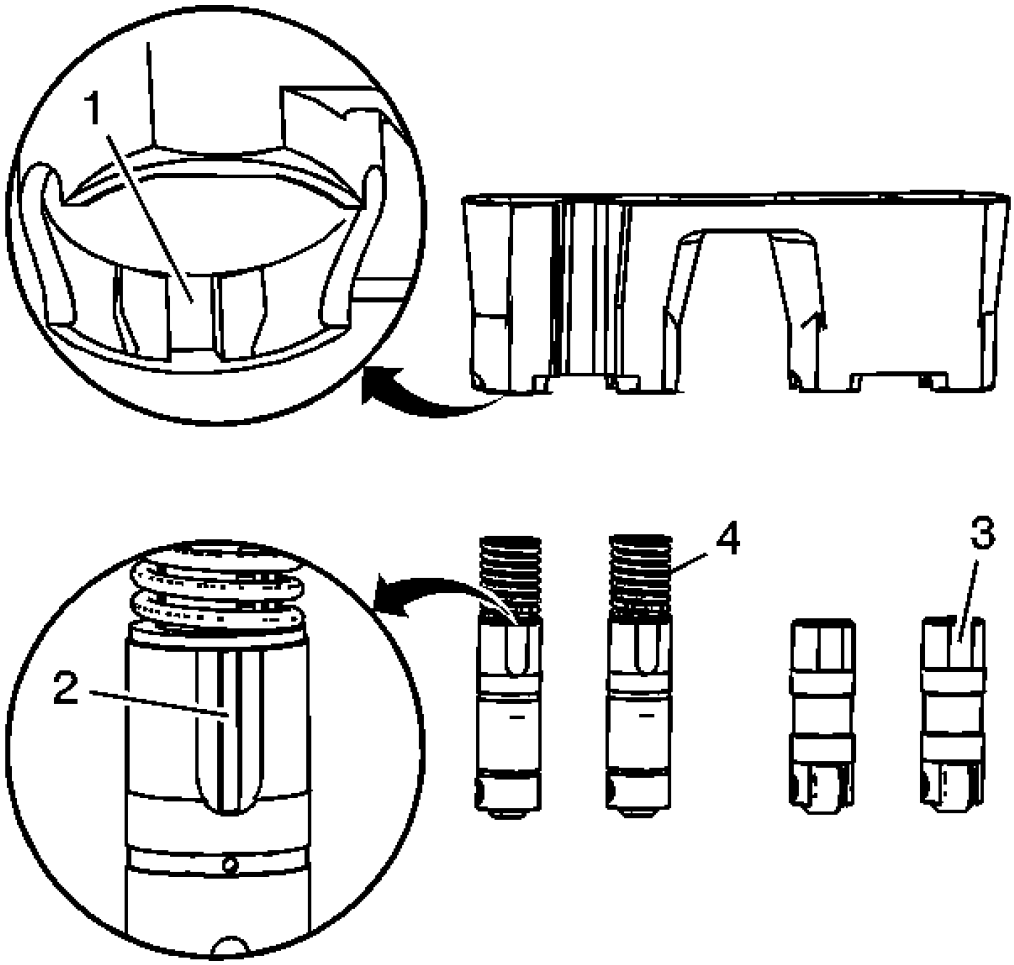


Fig. 92: Aligning Notched Area Of Guide With Raised Surface On Side Of Lifter
Courtesy of GENERAL MOTORS CORP.

2. Insert the valve lifters into the lifter guides.
   - Align the flat area (3) on the top of the non active fuel management lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.
   - The active fuel management lifters are to be installed into the guide, with the notch in the guide (1) aligned with the raised area (2) of the lifter.

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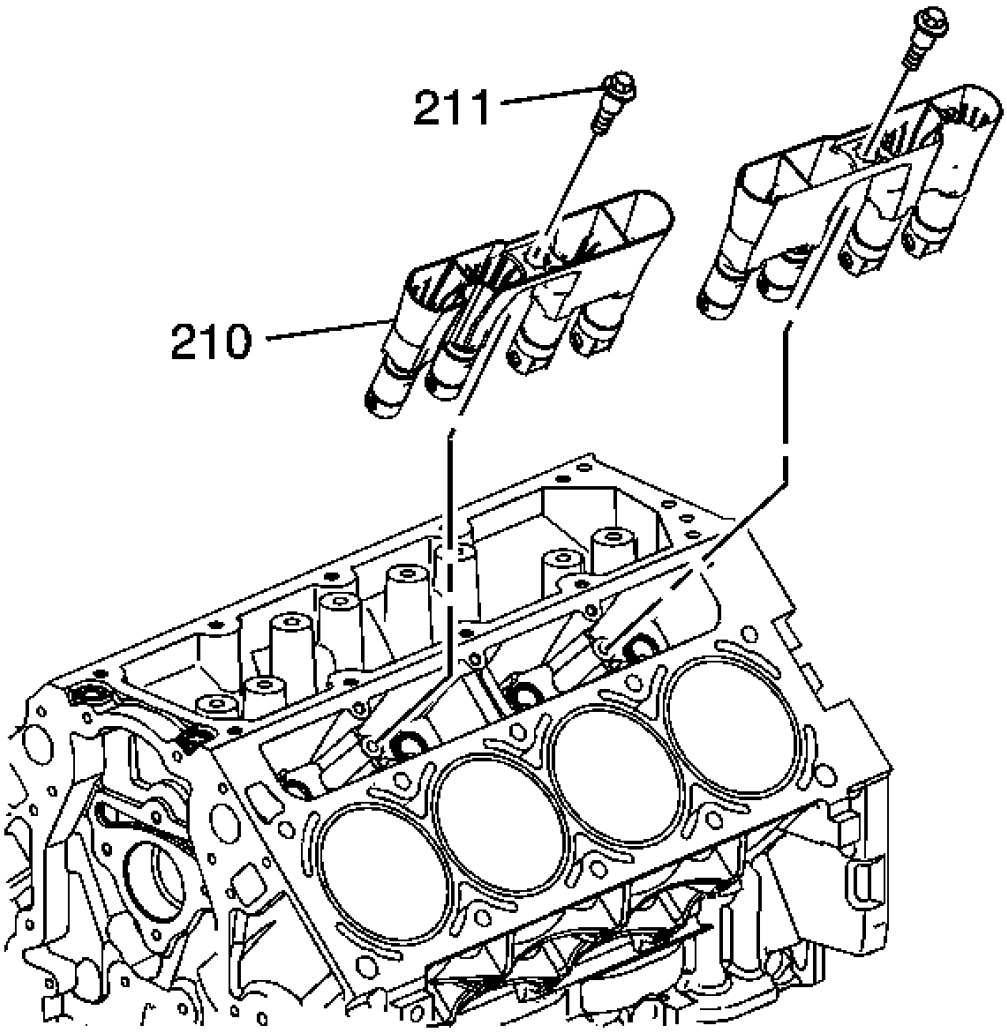


Fig. 93: Valve Lifter Guides & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the valve lifters and guide (210) to the engine block.

CAUTION: Refer to Fastener Caution

4. Install the valve lifter guide bolts (211).

Tighten: Tighten the bolt to 12 N.m (106 lb in).

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5. Install the cylinder head and gasket. Refer to **Cylinder Head Replacement - Left Side**
6. Install the cylinder head and gasket. Refer to **Cylinder Head Replacement - Right Side**

CRANKSHAFT BALANCER REPLACEMENT (L99 AND LS3)

Special Tools

- **J 41478** Crankshaft Front Oil Seal Installer. See **Special Tools** .
- **J 41665** Crankshaft Balancer and Sprocket Installer
- **J 41816-A** Crankshaft Balancer Remover. See **Special Tools** .
- **J 41816-2** Crankshaft End Protector. See **Special Tools** .
- **J 42386-A** Flywheel Holding Tool. See **Special Tools** .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

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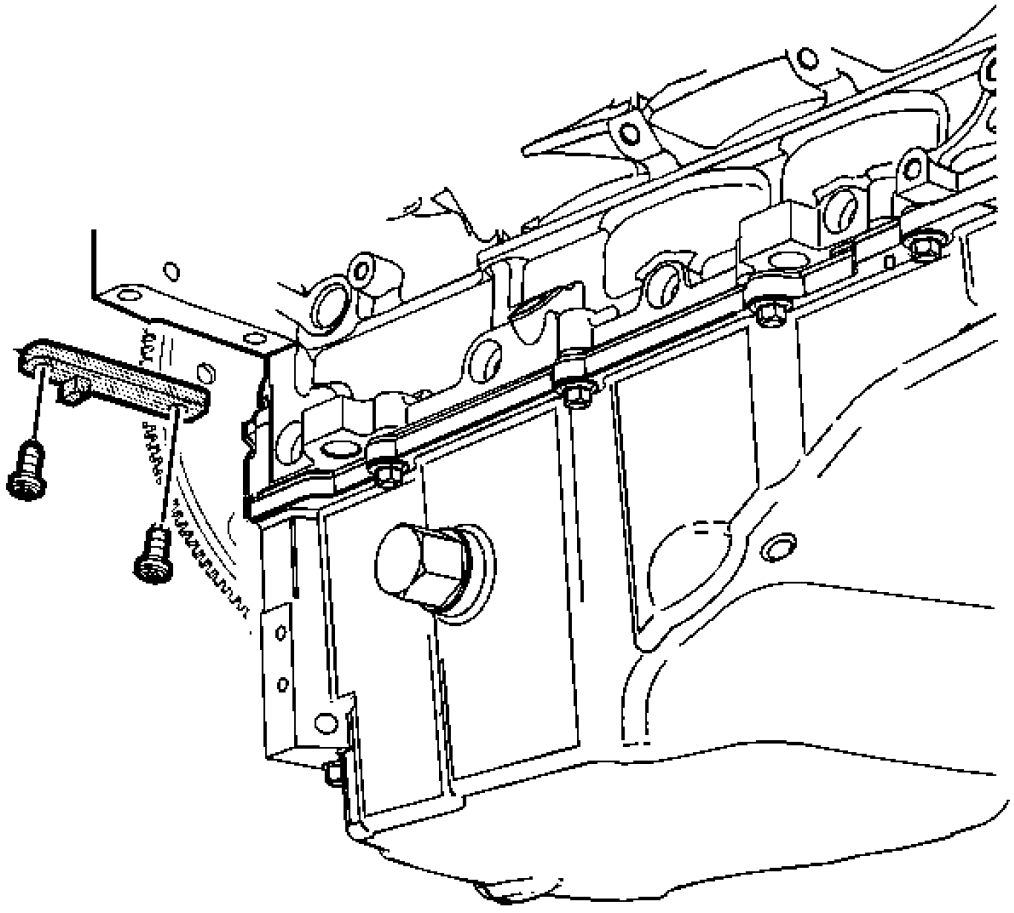


Fig. 94: Identifying J 42386-A
Courtesy of GENERAL MOTORS CORP.

1. Remove the air cleaner resonator outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement**
2. Remove the air conditioning (A/C) drive belt. Refer to **Air Conditioning Compressor Belt Replacement**.
3. Remove the starter motor. Refer to **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)** .

CAUTION: Refer to Fastener Caution .

NOTE: Ensure that the teeth of the J 42386-A mesh with the teeth of the engine flywheel. See Special Tools .

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4. Install the **J 42386-A** (1) and bolts. See **Special Tools** . Use one M10-1.5 x 120 mm and one M10-1.5 x 45 mm bolt for proper tool operation.

   Tighten: Tighten the **J 42386-A** bolts to 50 N. See **Special Tools** .m (37 lb ft).

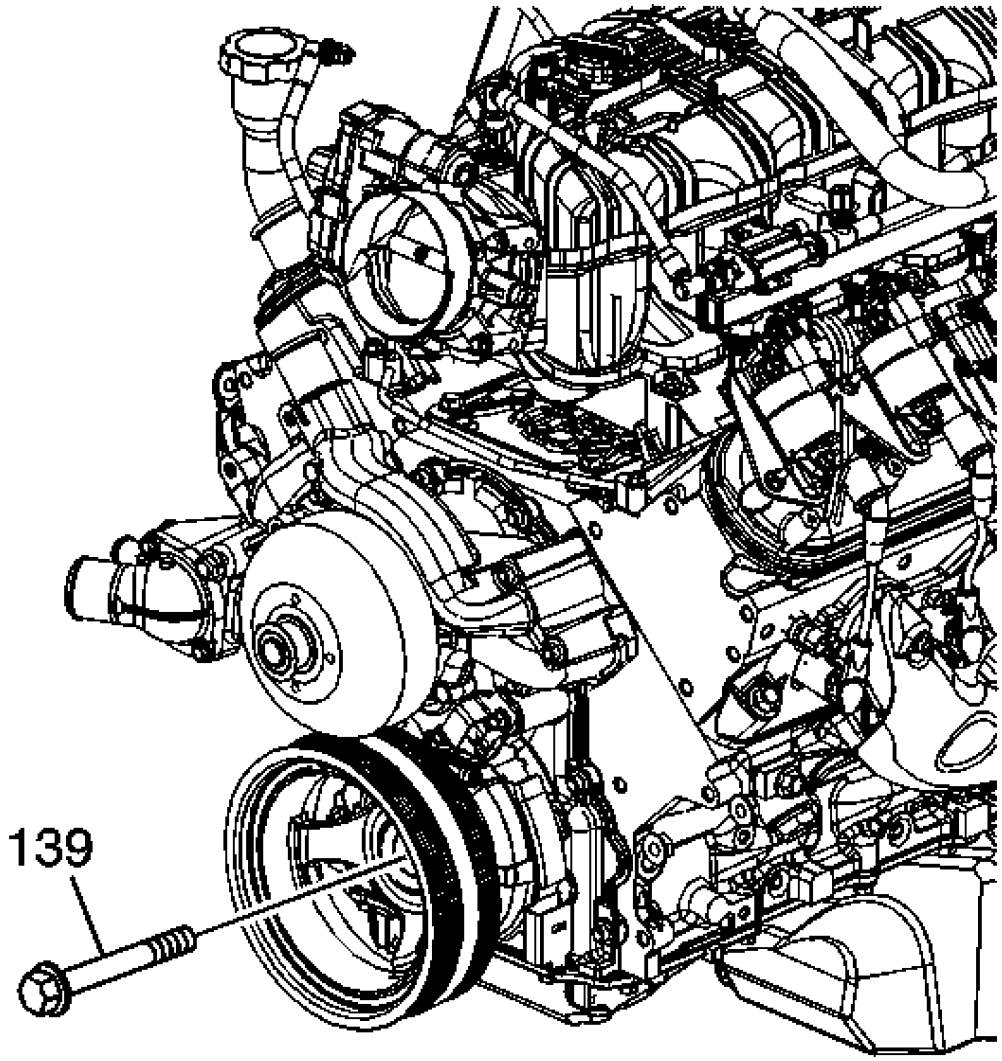


Fig. 95: View Of Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

5. Remove the crankshaft balancer bolt (139). Do not discard the crankshaft balancer bolt at this time. The old balancer bolt will be used during the balancer installation procedure.

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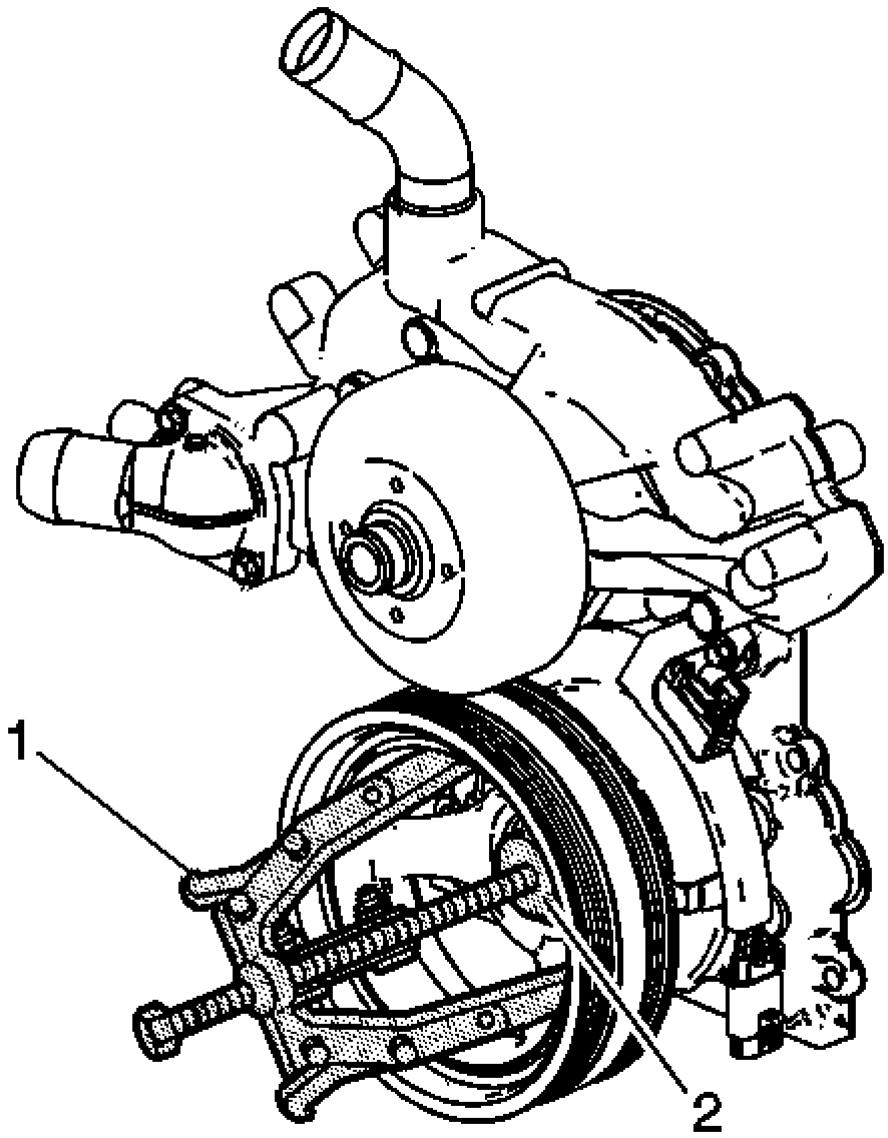


Fig. 96: Removing Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

6. Install the **J 41816** (1) and **J 41816-2** (2) to the crankshaft balancer. See **Special Tools** .

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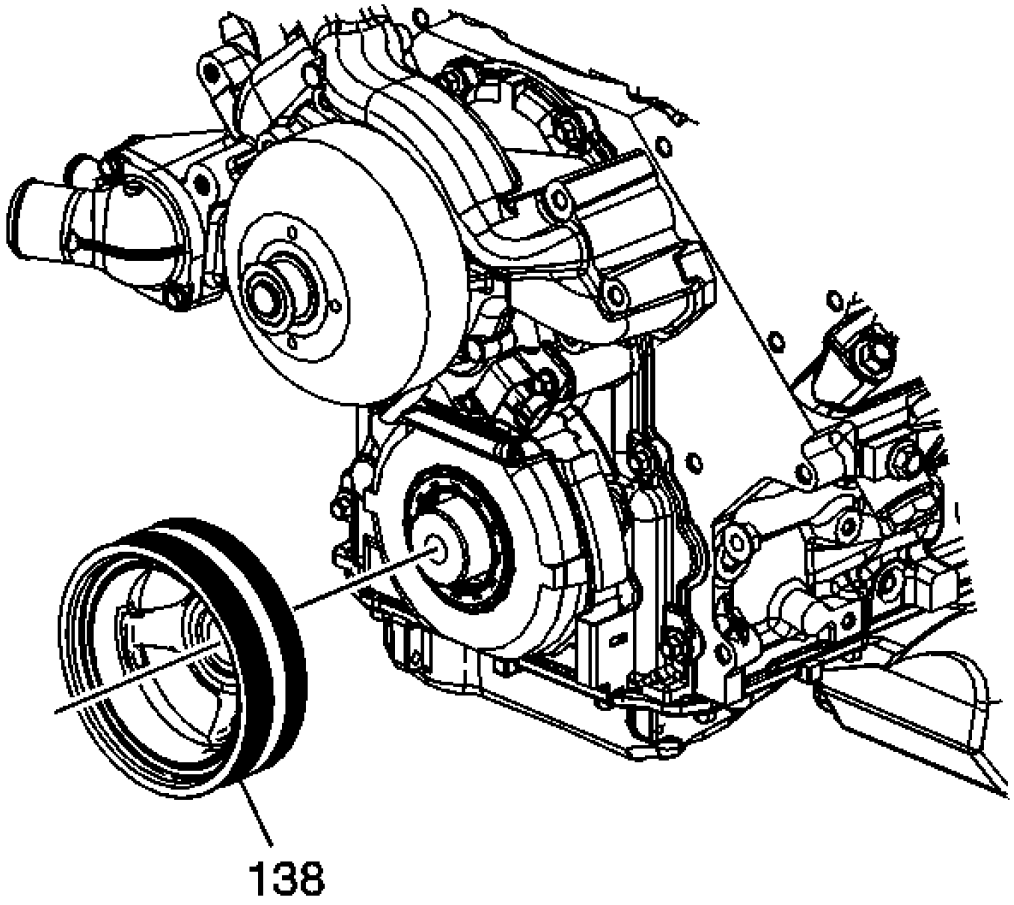


Fig. 97: View Of Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

NOTE: The crankshaft balancer is balanced as an individual component. It is not necessary to mark the balancer prior to removal.

7. Use the **J 41816** and the **J 41816-2** to remove the crankshaft balancer (138). See **Special Tools** .
8. Remove the **J 41816** and the **J 41816-2** from the crankshaft balancer. See **Special Tools** .

INSTALLATION PROCEDURE

NOTE:

- **The crankshaft balancer installation and bolt tightening involves a four stage tightening process. The first pass ensures that the balancer is installed completely onto the crankshaft. The second, third, and fourth**

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passes tighten the NEW bolt to the proper torque.

- **The used crankshaft balancer bolt will be used ONLY during the first pass of the balancer installation procedure. Install a NEW bolt and tighten as described in the second, third and fourth passes of the balancer bolt tightening procedure.**

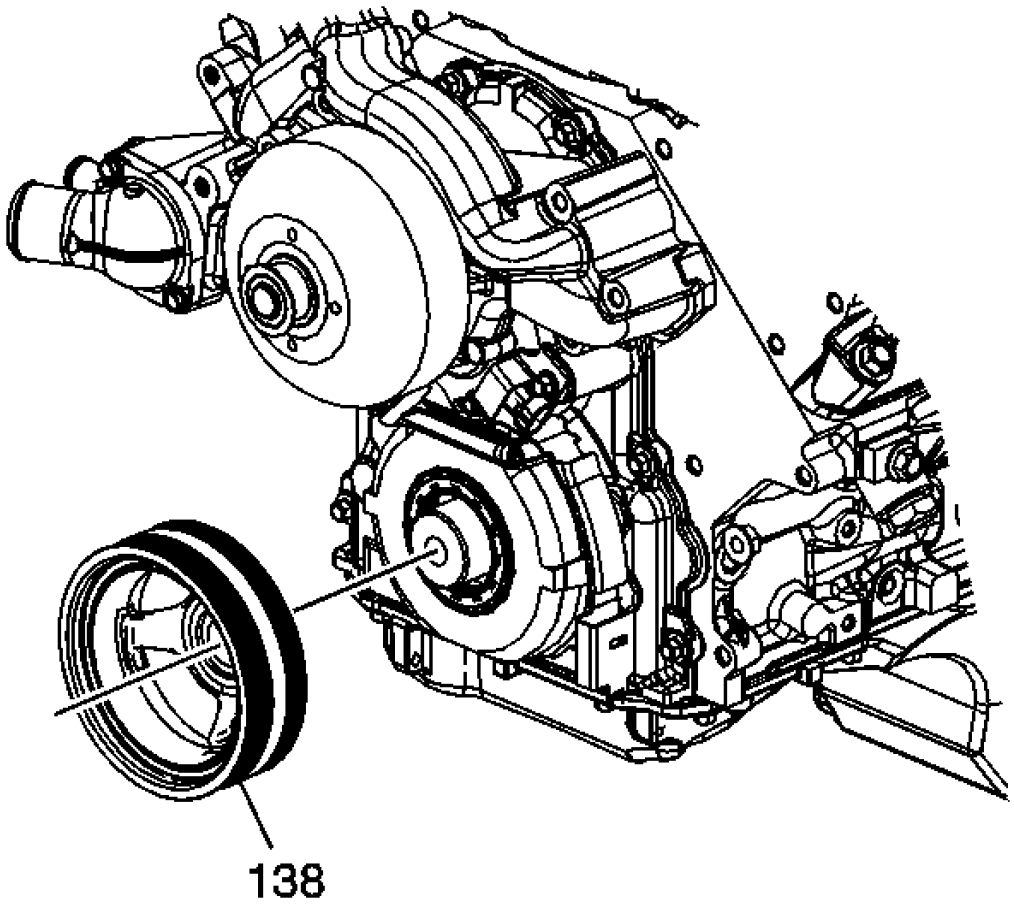


Fig. 98: View Of Crankshaft Balancer
Courtesy of GENERAL MOTORS CORP.

NOTE: The balancer should be positioned onto the end of the crankshaft as straight as possible prior to tool installation.

1. Position the crankshaft balancer (138) onto the end of the crankshaft.

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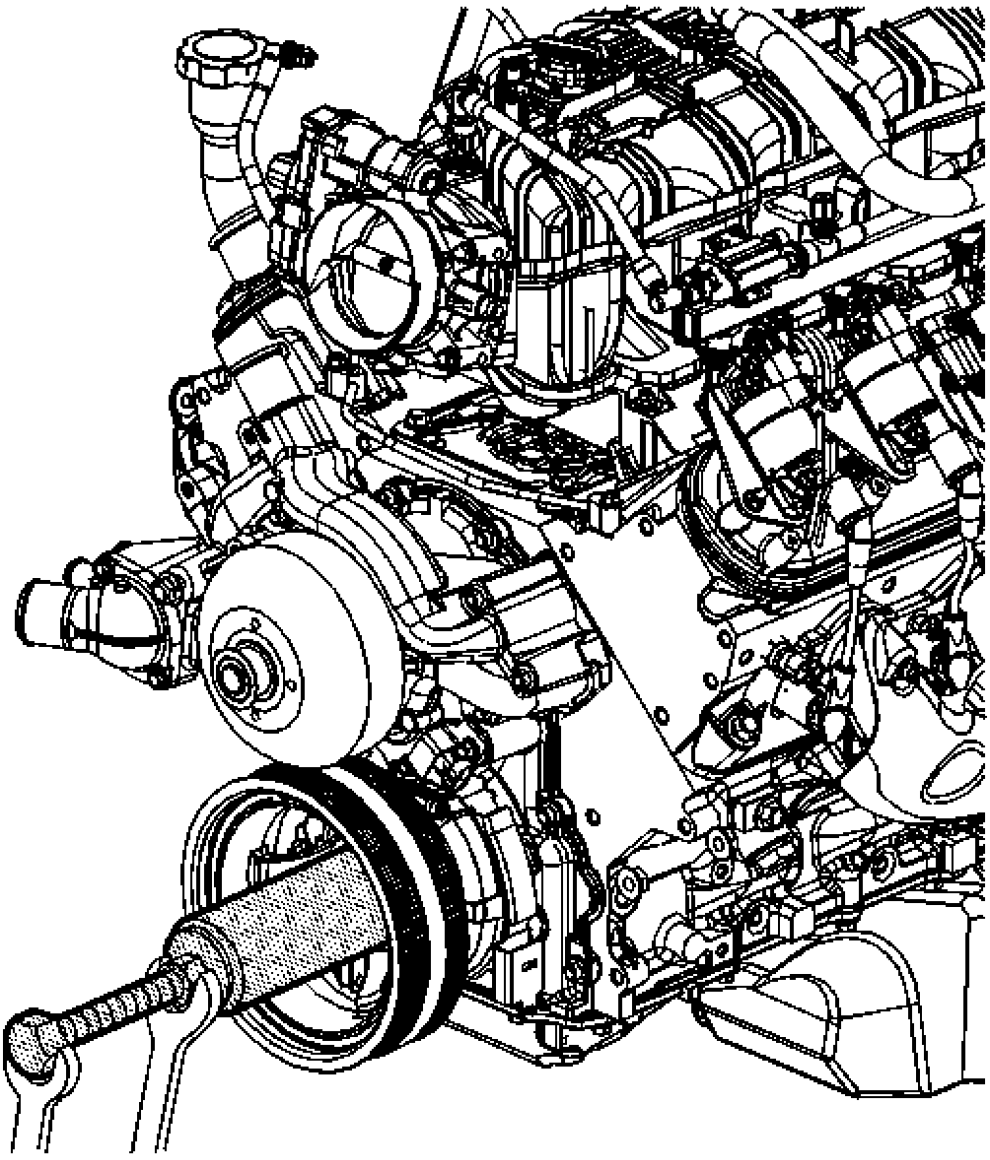


Fig. 99: Installing Balancer
Courtesy of GENERAL MOTORS CORP.

2. Install the **J 41665** and the threaded rod from the **J 41478** to crankshaft balancer and install the balancer. See **Special Tools** .
    1. Assemble the threaded rod, nut, washer and installer. Insert the smaller end of the installer into the front of the balancer.

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2. Use a wrench and hold the hex end of the threaded rod.
3. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto the crankshaft.
4. Remove the tool and reverse the installation tool.

   Position the larger end of the installer against the front of the balancer.

5. Use a wrench and hold the hex end of the threaded rod.
6. Use a second wrench and rotate the installation tool nut clockwise until the balancer is installed onto the crankshaft.
7. Remove the **J 41665** and the threaded rod.

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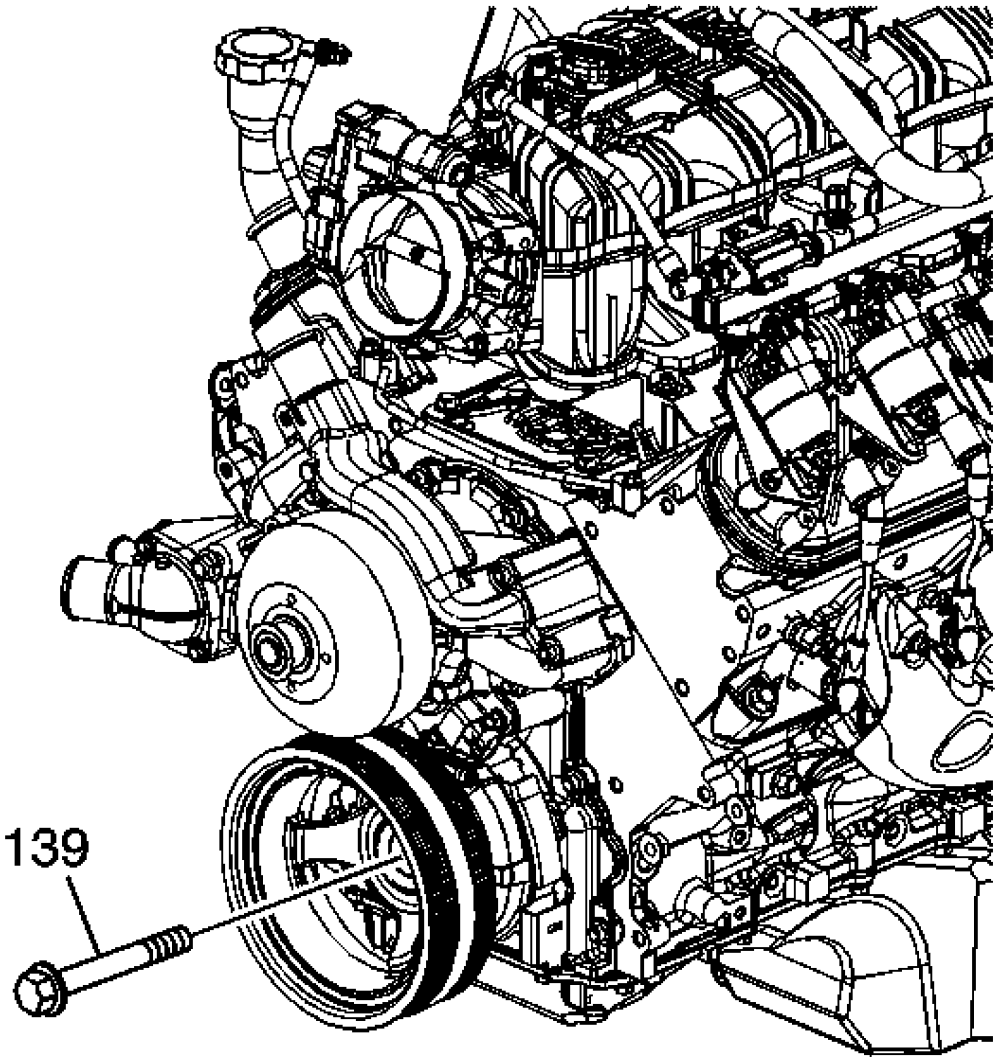


Fig. 100: View Of Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

3. Install the USED crankshaft balancer bolt (139).

   Tighten: Tighten the USED bolt to 330 N.m (240 lb ft).

4. Remove the USED crankshaft balancer bolt.

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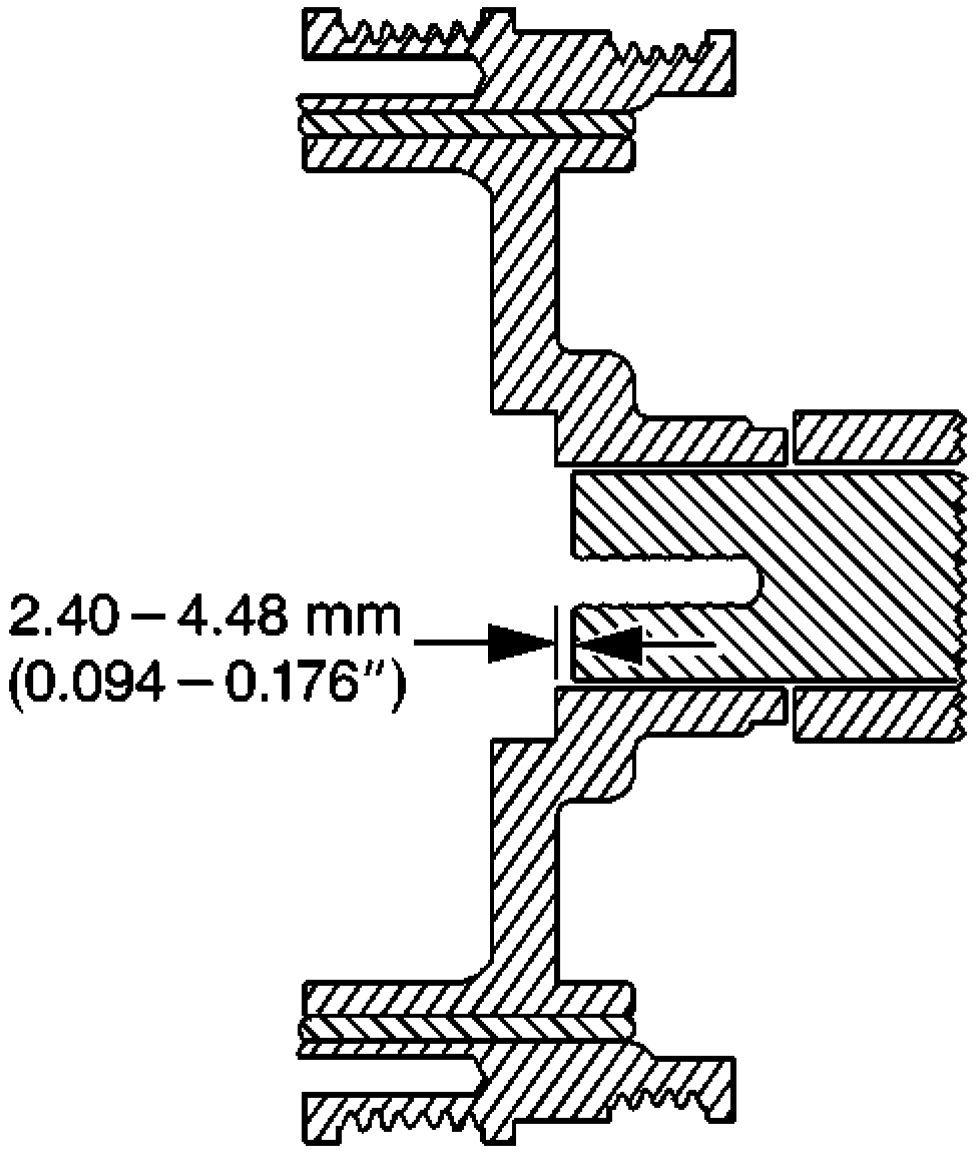


Fig. 101: Identifying Hub To Crankshaft Distance
Courtesy of GENERAL MOTORS CORP.

NOTE: The nose of the crankshaft should be recessed 2.4-4.48 mm (0.094-0.176 in) into the balancer bore.

5. Measure for a correctly installed balancer. If the balancer is not installed to the proper dimension, install

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the **J 41665** and repeat the installation procedure.

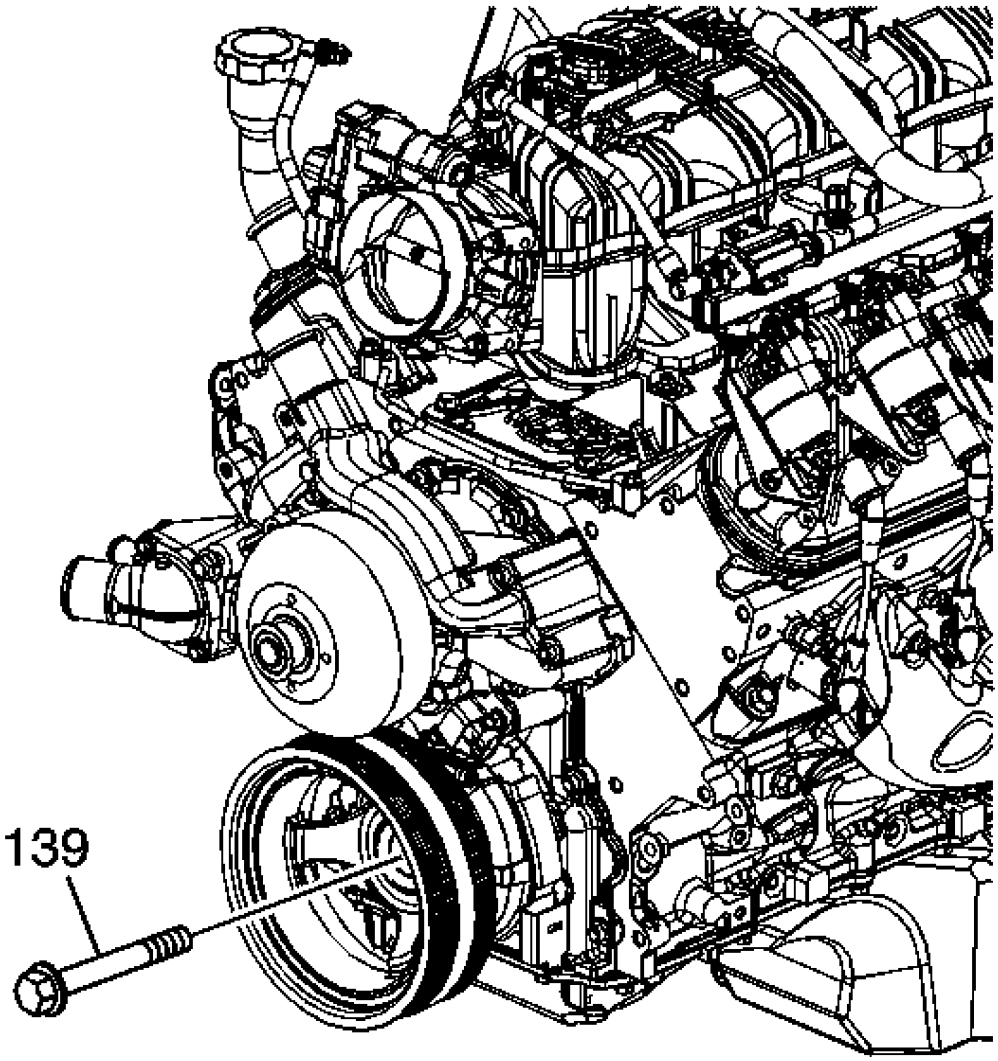


Fig. 102: View Of Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: **There are two crankshaft balancer bolt designs, one has a flanged head, no washer, and the other has a retained rotating washer. There are two different torque specifications for the final pass; the final torque angle is dependent on the bolt design.**

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6. Install the NEW crankshaft balancer bolt (139).

Tighten:

1. Tighten the crankshaft balancer bolt to 150 N.m (110 lb ft).
2. Loosen the crankshaft balancer bolt 360 degrees.
3. Tighten the crankshaft balancer bolt to 80 N.m (59 lb ft)
4. Tighten the crankshaft balancer bolt a final pass
5. If equipped with Balancer bolt with flanged head tighten to 125 degrees using the **J 45059** .
6. If equipped with Balancer bolt with retained rotating washer tighten to 200 degrees using the **J 45059** .

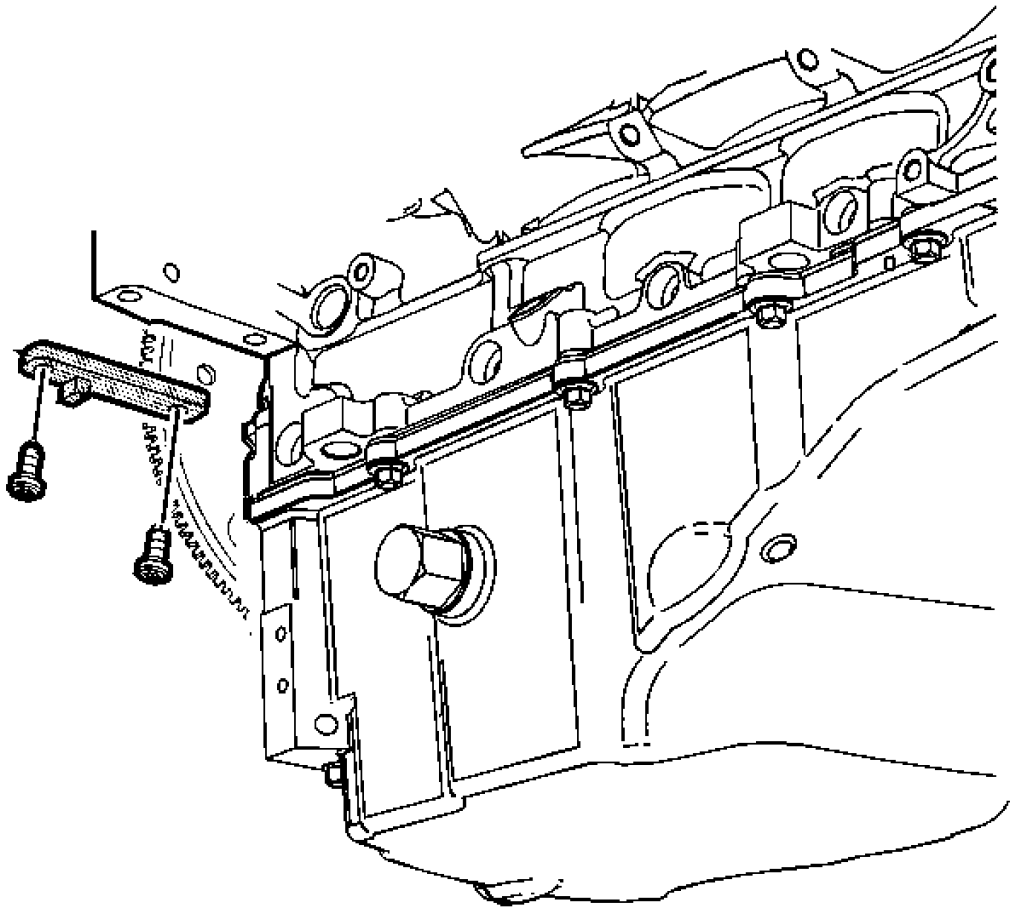


Fig. 103: Identifying J 42386-A
Courtesy of GENERAL MOTORS CORP.

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7. Remove the **J 42386-A** and bolts. See **Special Tools** .
8. Install the starter motor. Refer to **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)** .
9. Instal the air conditioning (A/C) drive belt. Refer to **Air Conditioning Compressor Belt Replacement**.
10. Install the air cleaner resonator outlet duct. Refer to **Air Cleaner Resonator and Outlet Duct Replacement**
11. Perform the crankshaft position (CKP) system variation learn procedure. Refer to **Crankshaft Position System Variation Learn** .

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

SPECIAL TOOLS

J 41478 Crankshaft Front Oil Seal Installer. See **Special Tools** .

REMOVAL PROCEDURE

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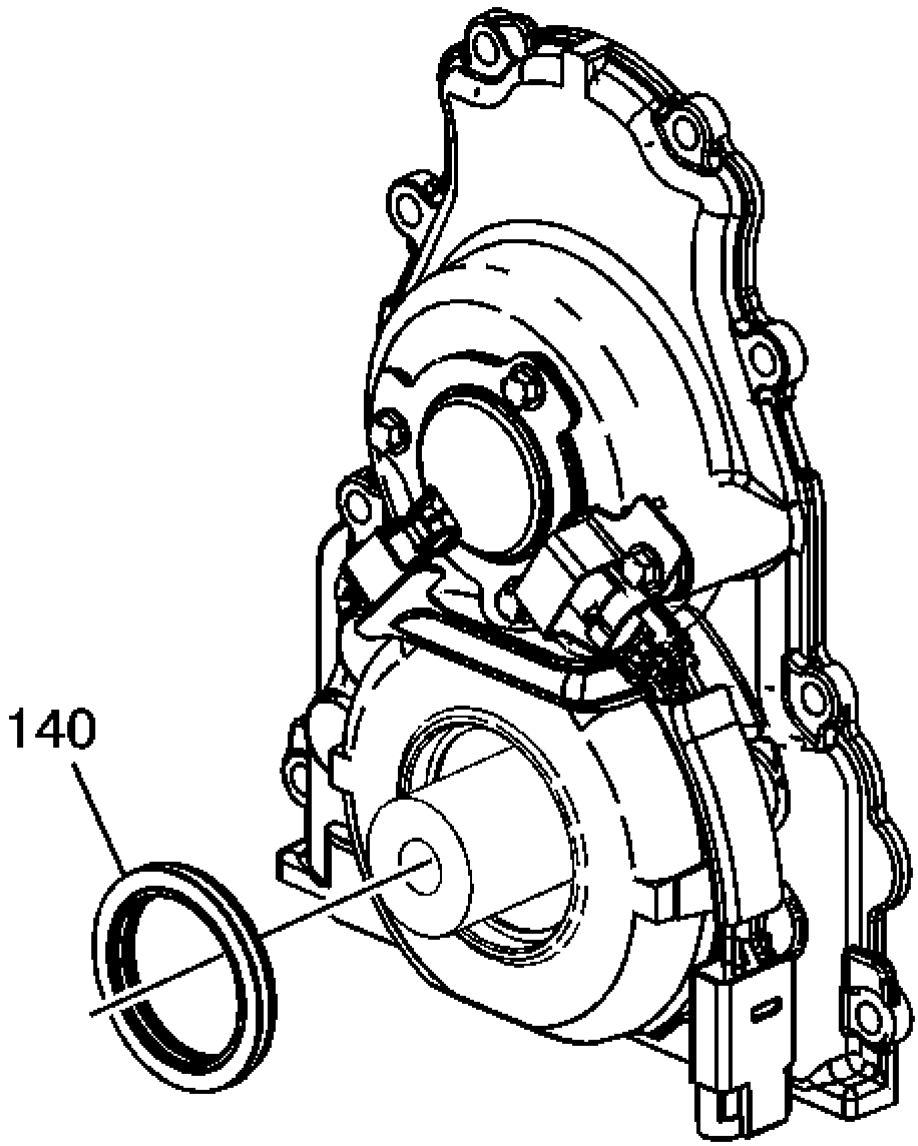


Fig. 104: Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement (L99 and LS3)**.
2. Remove the crankshaft front oil seal (140) from the front cover.

INSTALLATION PROCEDURE

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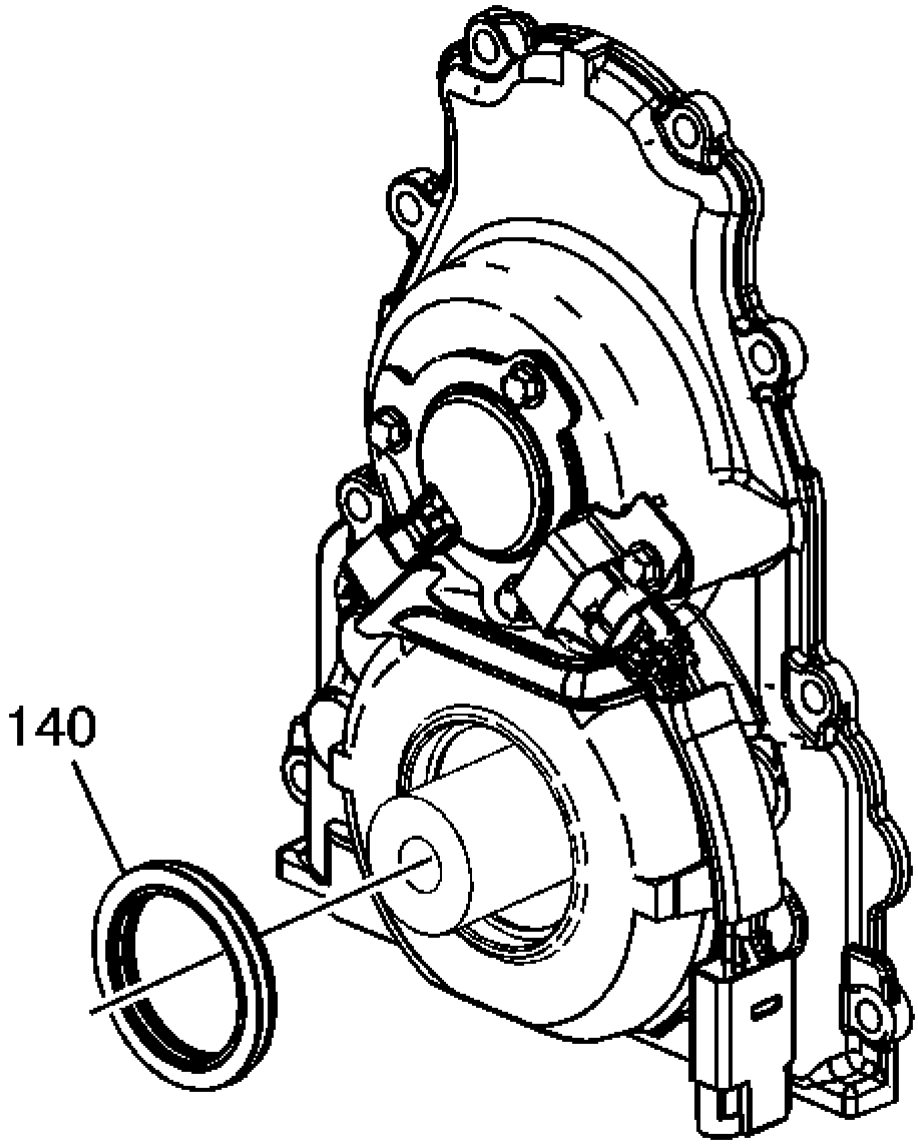


Fig. 105: Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Do not lubricate the oil seal sealing surface.**
- **Do not reuse the crankshaft front oil seal.**

1. Lubricate the outer edge of the oil seal (140) with clean engine oil.

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2. Lubricate the front cover oil seal bore with clean engine oil.

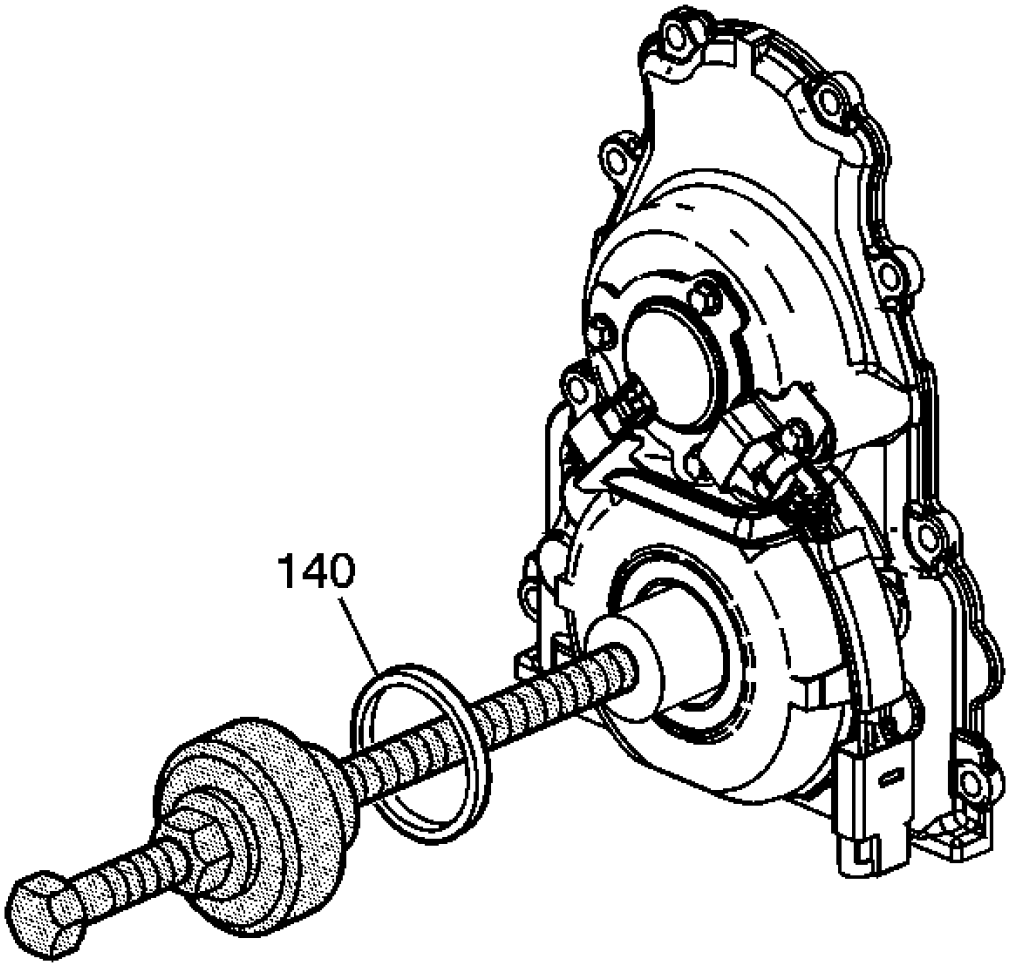


Fig. 106: View Of Front Oil Seal & Special Tool
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft front oil seal (140) onto the **J 41478** guide. See **Special Tools** .
4. Install the **J 41478** threaded rod (with nut, washer, guide, and oil seal) into the end of the crankshaft. See **Special Tools** .
5. Use the **J 41478** in order to install the oil seal into the cover bore. See **Special Tools** .
    1. Use a wrench and hold the hex on the installer bolt.
    2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in the cover bore.
    3. Remove the **J 41478** . See **Special Tools** .

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4. Inspect the oil seal for proper installation. The oil seal should be installed evenly and completely into the front cover bore.

6. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement (L99 and LS3)**.

CAMSHAFT POSITION ACTUATOR MAGNET REPLACEMENT

REMOVAL PROCEDURE

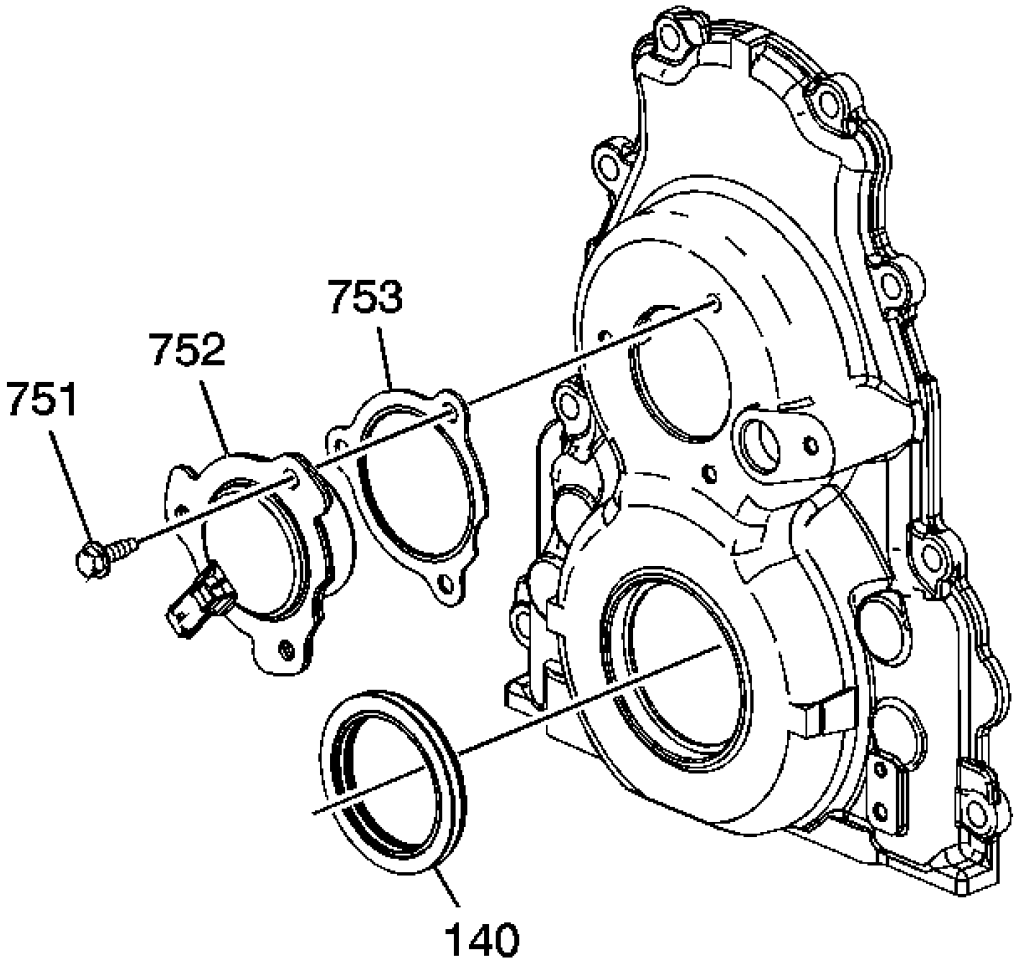


Fig. 107: View Of CMP Actuator Magnet, Bolts, Gasket & Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the water pump. Refer to **Water Pump Replacement (LLT)** or **Water Pump Replacement (LS3/L99)** .

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2. Disconnect the engine harness electrical connector from the camshaft position (CMP) actuator magnet.
3. Remove the CMP actuator magnet bolts (751) and magnet (752).
4. Remove and discard the CMP actuator magnet gasket (753).

INSTALLATION PROCEDURE

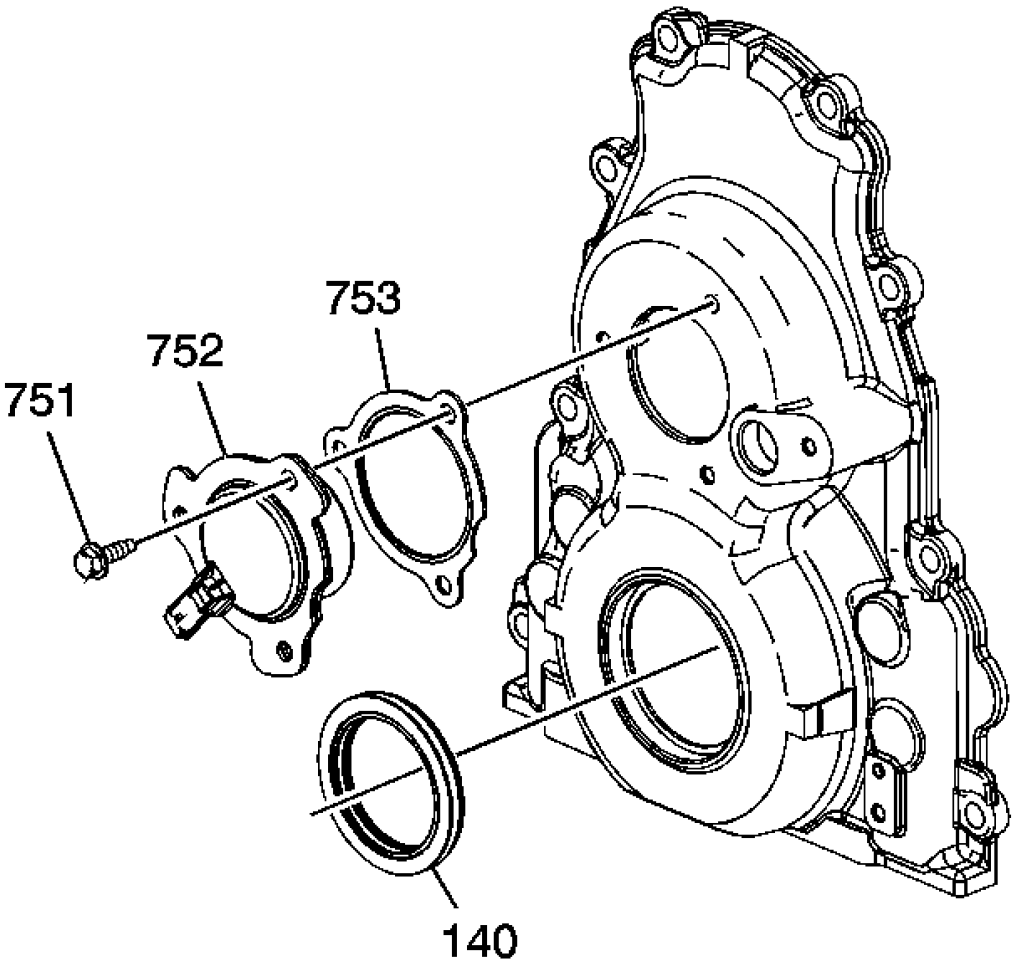


Fig. 108: View Of CMP Actuator Magnet, Bolts, Gasket & Oil Seal
Courtesy of GENERAL MOTORS CORP.

NOTE: The gasket surface should be free of oil or other foreign material during assembly.

1. Install a NEW CMP actuator magnet gasket (753) onto the CMP actuator magnet.

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2. Install the CMP actuator magnet (752) to the front cover.

CAUTION: Refer to Fastener Caution .

3. Install the CMP actuator magnet bolts (751) and tighten to 12 N.m (106 lb in).
4. Connect the engine harness electrical connector to the CMP actuator magnet.
5. Install the water pump. Refer to **Water Pump Replacement (LLT)** or **Water Pump Replacement (LS3/L99)** .

ENGINE FRONT COVER REPLACEMENT (L99)

SPECIAL TOOLS

J 41476 Front and Rear Cover Alignment Tool. See **Special Tools** .

REMOVAL PROCEDURE

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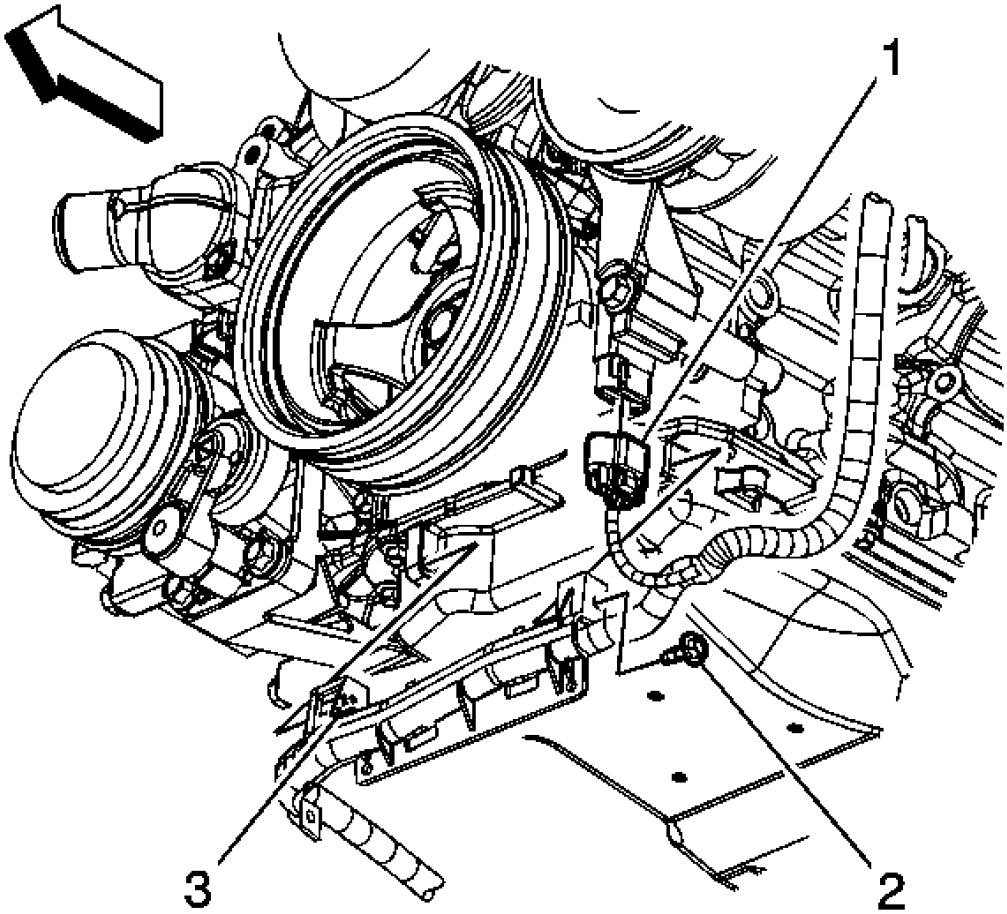


Fig. 109: View Of Electrical Connector, Cable Channel Bolt & Pin
Courtesy of GENERAL MOTORS CORP.

1. Remove the water pump. Refer to **Water Pump Replacement (LLT)** or **Water Pump Replacement (LS3/L99)** .
2. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement (L99 and LS3)**.
3. Disconnect the engine harness electrical connector (1) from the camshaft position (CMP) sensor wire harness electrical connector.

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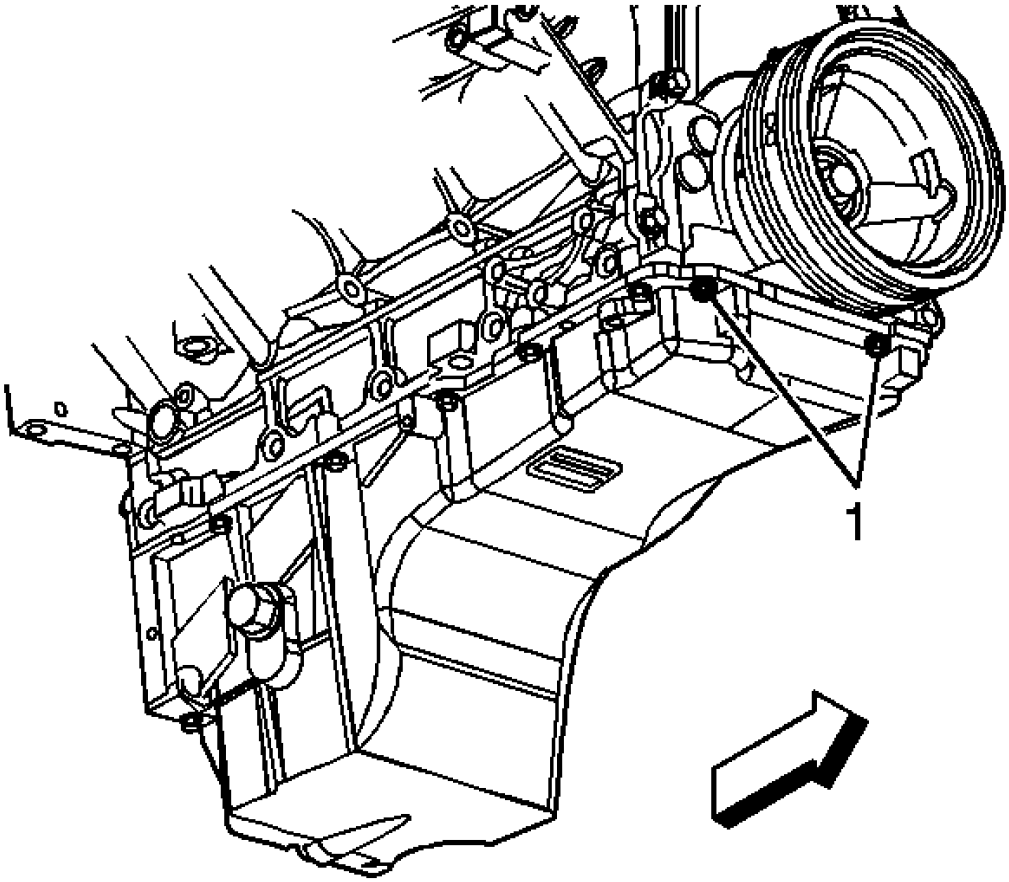


Fig. 110: View Of Oil Pan-To-Front Cover Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil pan-to-front cover bolts (1).

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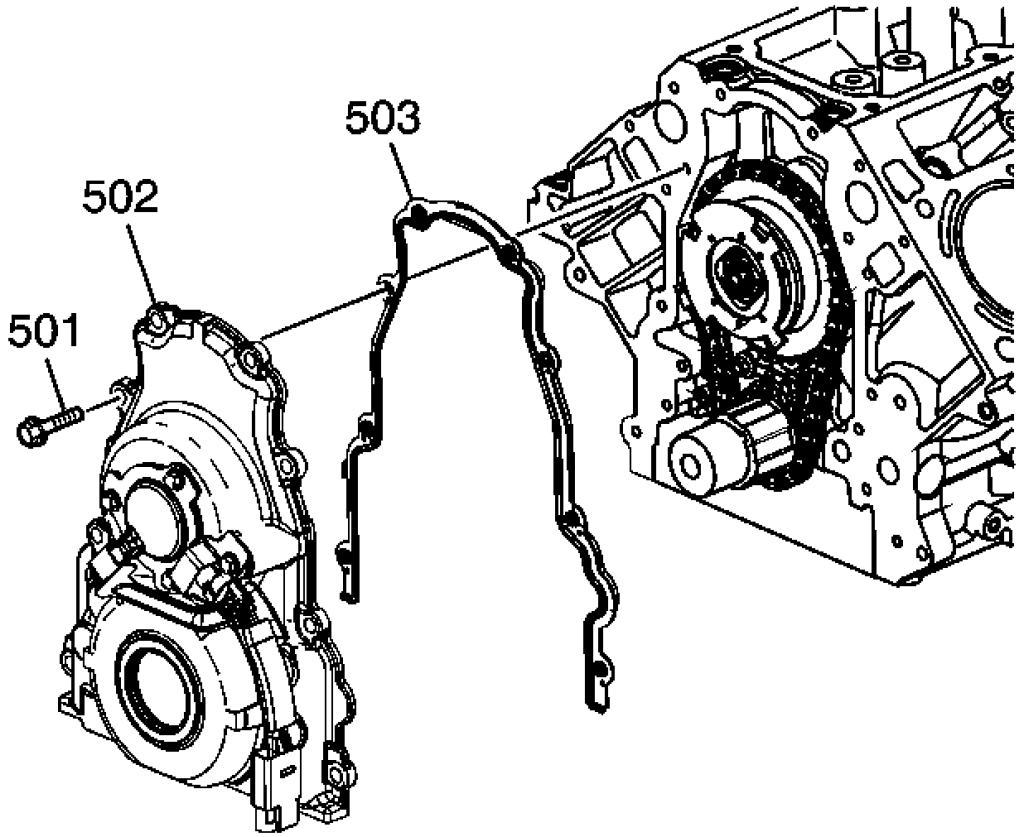


Fig. 111: View Of Front Cover, Bolts & Gasket
Courtesy of GENERAL MOTORS CORP.

5. Remove the front cover bolts (501).
6. Remove the front cover (502) and gasket (503).
7. Discard the front cover gasket.
8. Remove the crankshaft front oil seal.

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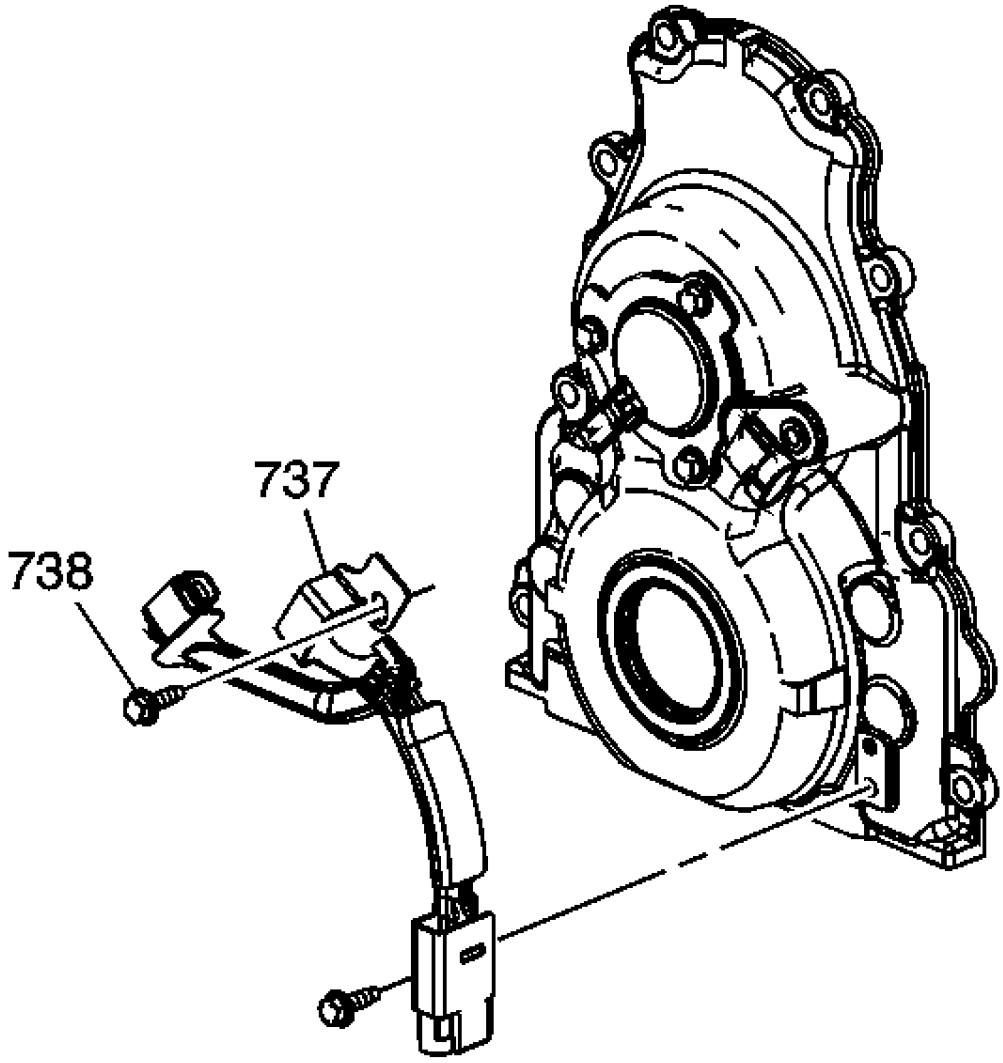


Fig. 112: View Of CMP Sensor Wire Harness & Bolts
Courtesy of GENERAL MOTORS CORP.

9. If replacing the engine front cover perform the following steps, otherwise proceed to step 10 of the installation procedure.
10. Remove the CMP sensor wire harness bolts (738).
11. Disconnect the CMP sensor wire harness from the CMP sensor.
12. Remove the CMP sensor wire harness (737).

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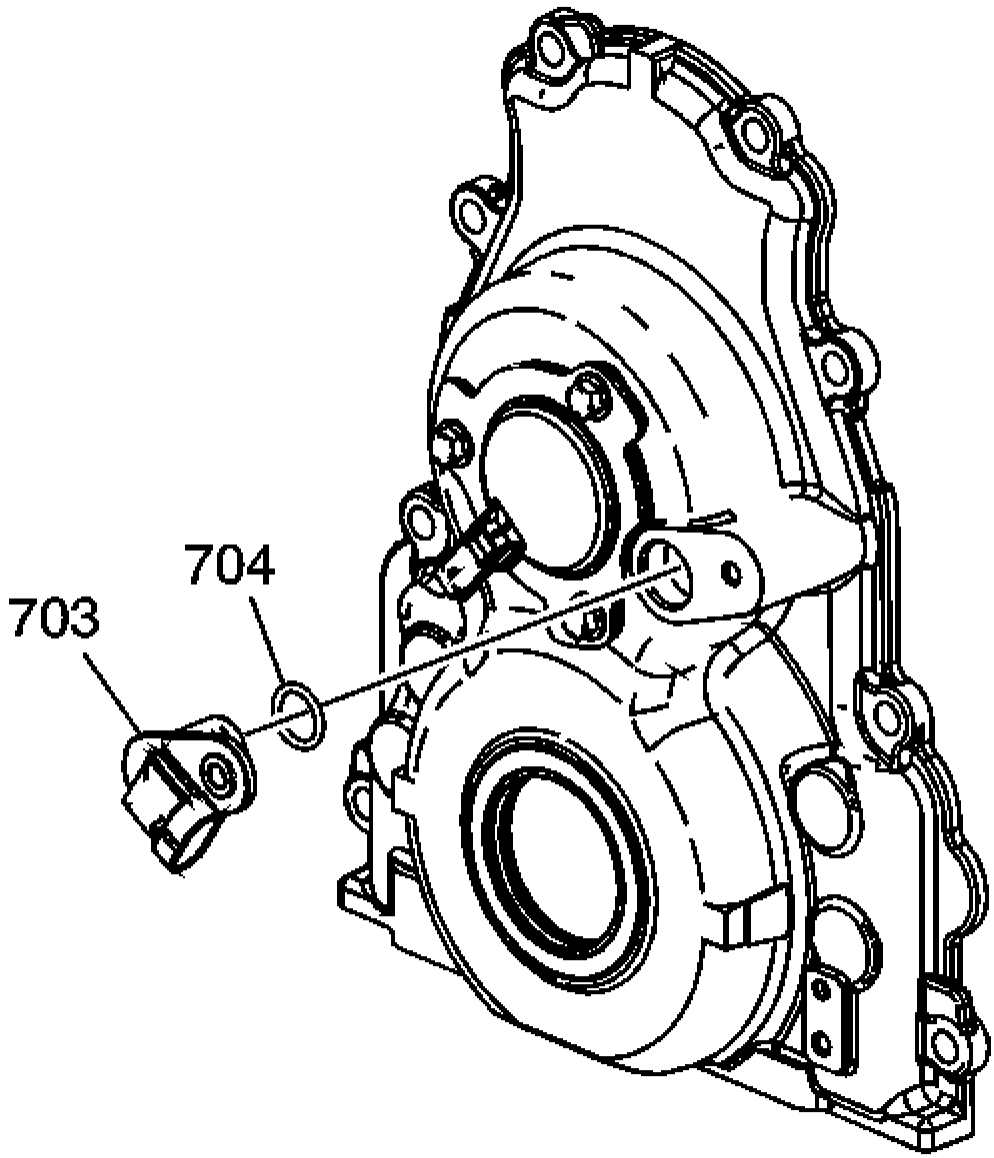


Fig. 113: View Of CMP Sensor & O-Ring
Courtesy of GENERAL MOTORS CORP.

13. Remove the CMP sensor (703).

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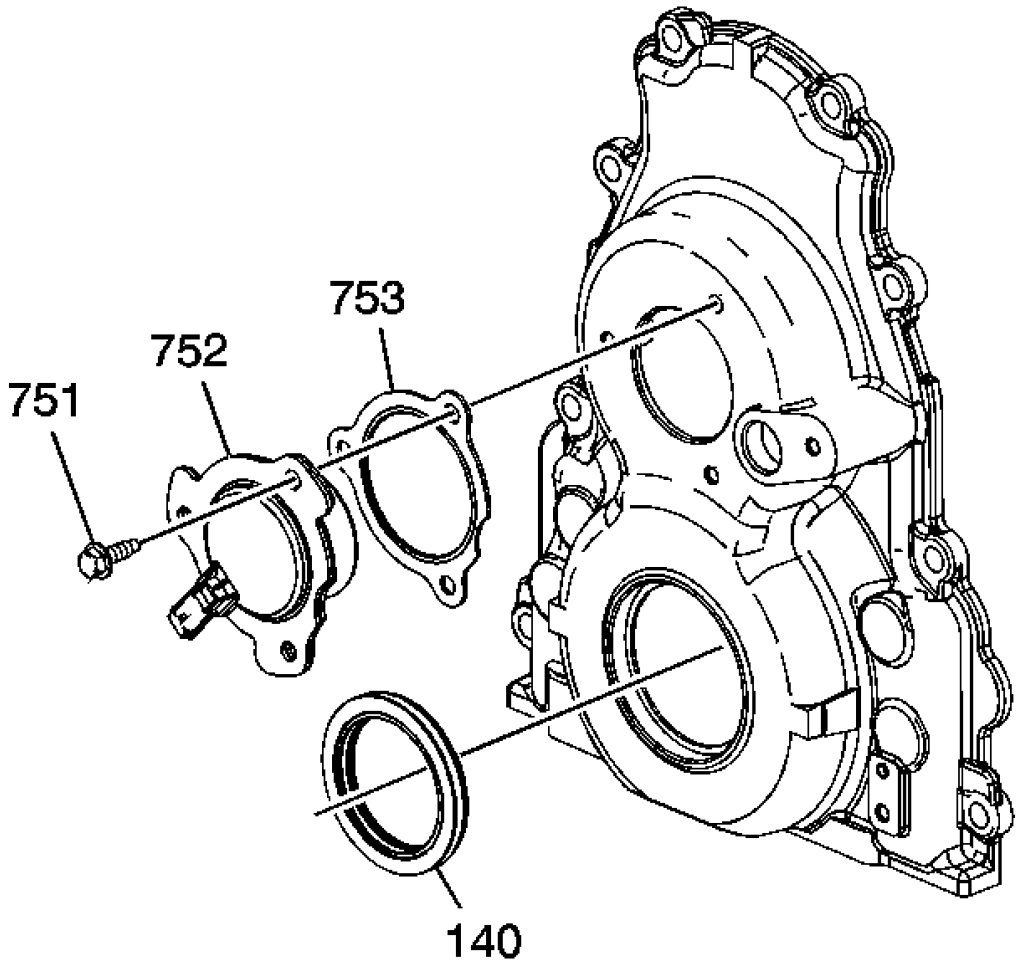


Fig. 114: View Of CMP Actuator Magnet, Bolts, Gasket & Oil Seal
Courtesy of GENERAL MOTORS CORP.

14. Remove the CMP actuator magnet bolts (751), and magnet (752).
15. Remove and discard the CMP actuator magnet gasket (753).

INSTALLATION PROCEDURE

NOTE:

- **Do not reuse the crankshaft oil seal or front cover gasket.**
- **Do not apply any type of sealant to the front cover gasket, unless specified.**
- **The special tool in this procedure is used to properly center the front**

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crankshaft front oil seal.

- **All gasket surfaces should be free of oil or other foreign material during assembly.**
- **The crankshaft front oil seal MUST be centered in relation to the crankshaft.**
- **An improperly aligned front cover may cause premature front oil seal wear and/or engine oil leaks.**

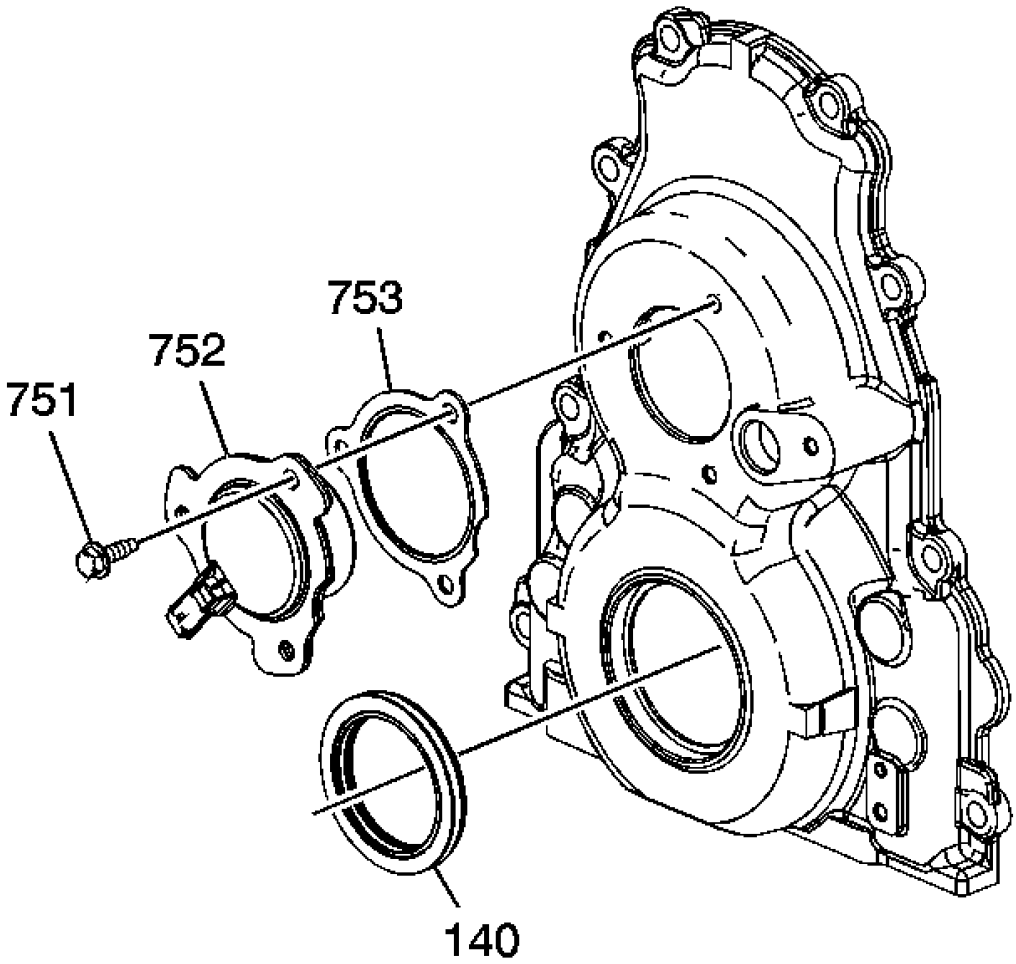


Fig. 115: View Of CMP Actuator Magnet, Bolts, Gasket & Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. If replacing the front cover perform the following steps, otherwise proceed to step 10.

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2. Install a NEW CMP actuator magnet gasket (753) onto the magnet.

CAUTION: Refer to Fastener Caution .

3. Install the CMP actuator magnet (752) and bolts (751) and tighten to 12 N.m (106 lb in).

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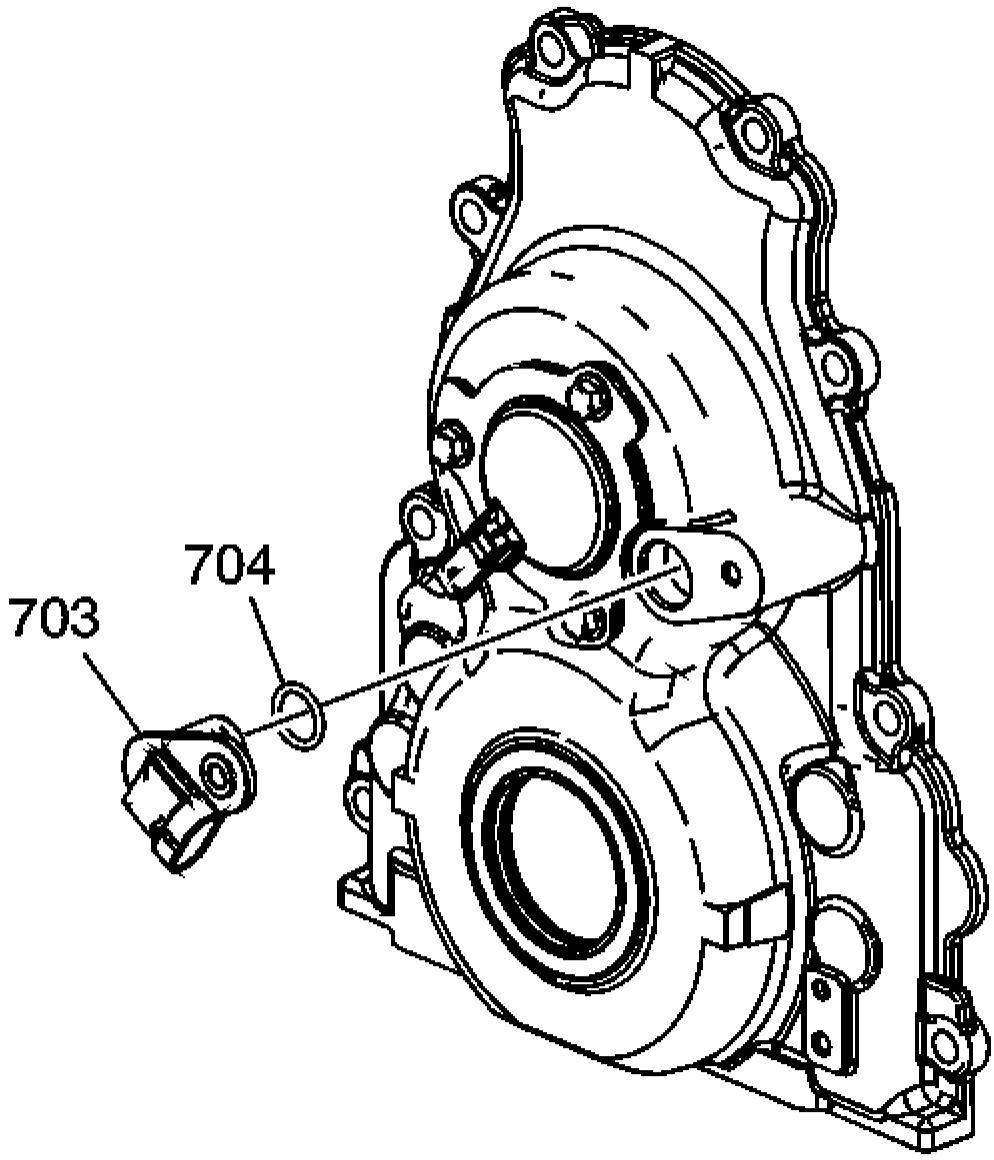


Fig. 116: View Of CMP Sensor & O-Ring
Courtesy of GENERAL MOTORS CORP.

4. Inspect the CMP sensor O-ring seal for cuts or damage. If the seal is not cut or damaged, it may be reused.
5. Lubricate the O-ring seal (704) with clean engine oil.
6. Install the CMP sensor (703).

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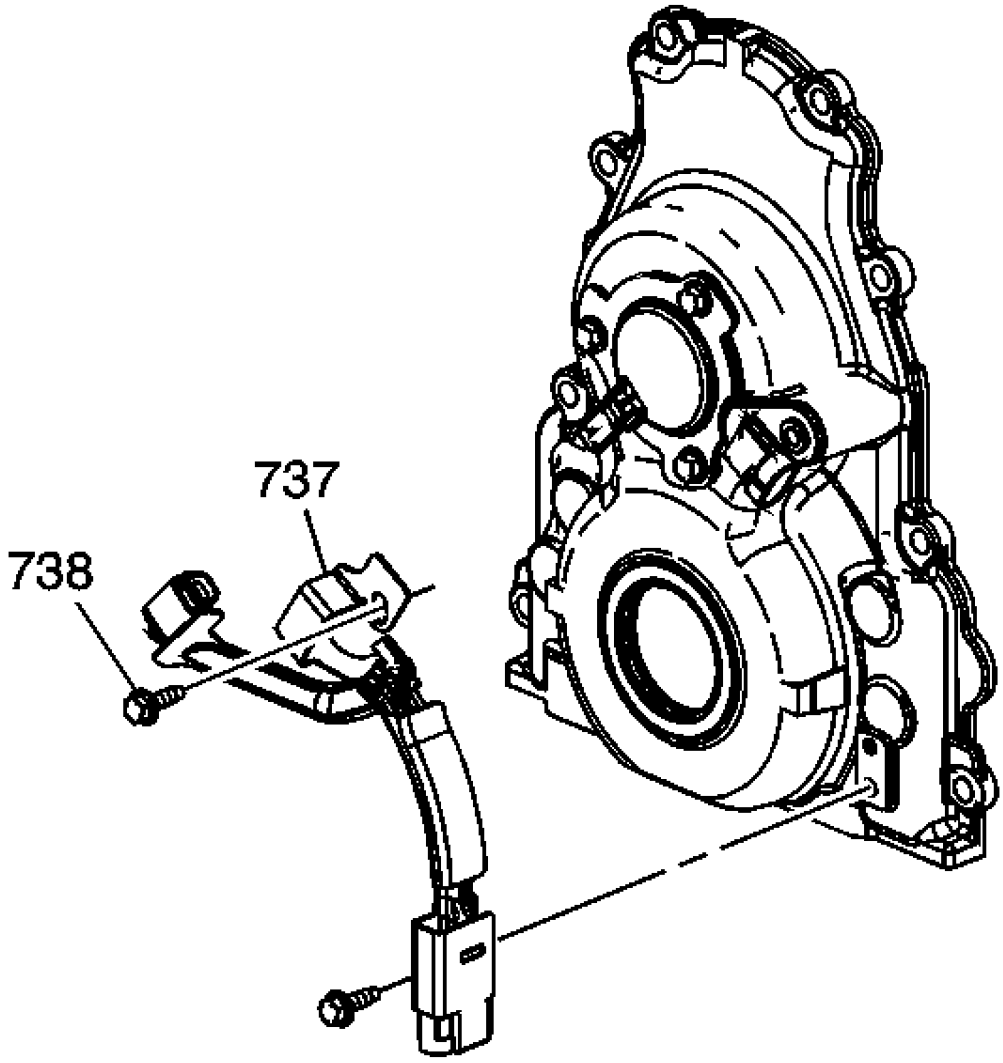


Fig. 117: View Of CMP Sensor Wire Harness & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Position the CMP sensor wire harness (737) to the front cover
8. Connect the CMP sensor wire harness to the CMP sensor.
9. Install the CMP sensor wire harness bolts (738) and tighten to 12 N.m (106 lb in).

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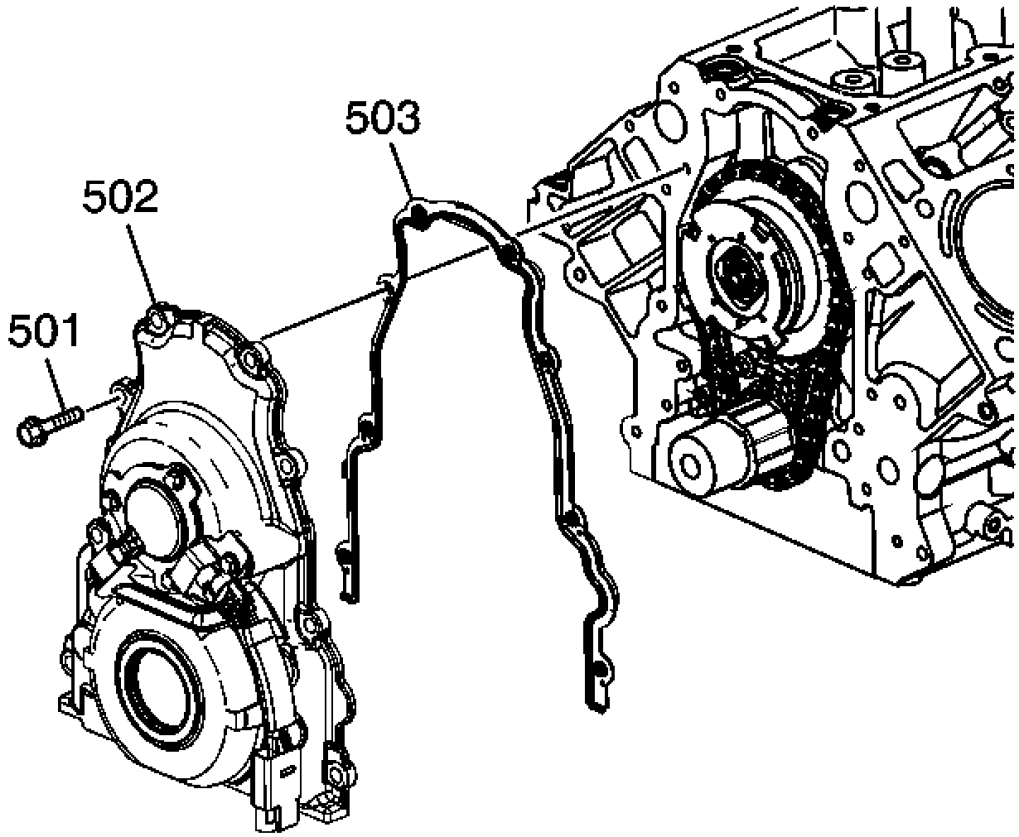


Fig. 118: View Of Front Cover, Bolts & Gasket
Courtesy of GENERAL MOTORS CORP.

10. Apply a 5 mm (0.20 in) bead of sealant, 20 mm (0.80 in) long to the oil pan to engine block junction. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
11. Position the NEW engine front cover gasket (503) and front cover (502) to the engine.
12. Install the front cover bolts (501) until snug. Do not overtighten.

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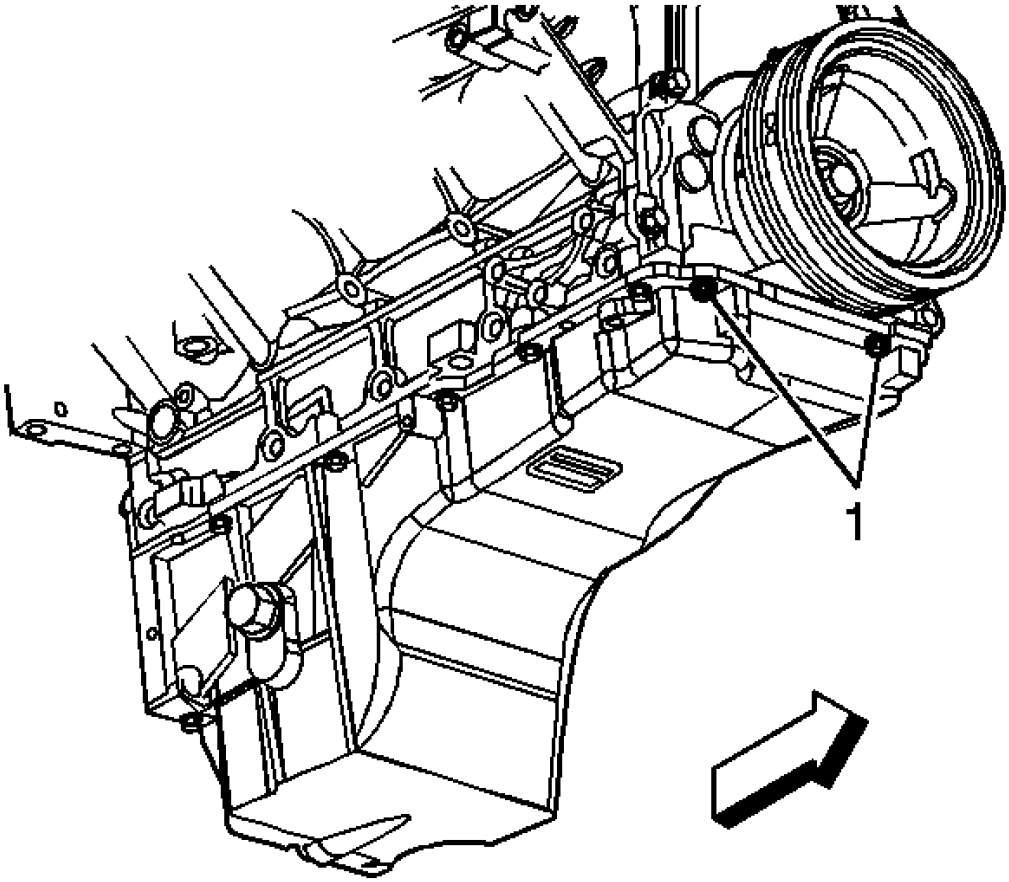


Fig. 119: View Of Oil Pan-To-Front Cover Bolts
Courtesy of GENERAL MOTORS CORP.

13. Install the oil pan-to-front cover bolts (1) until snug. Do not over tighten.

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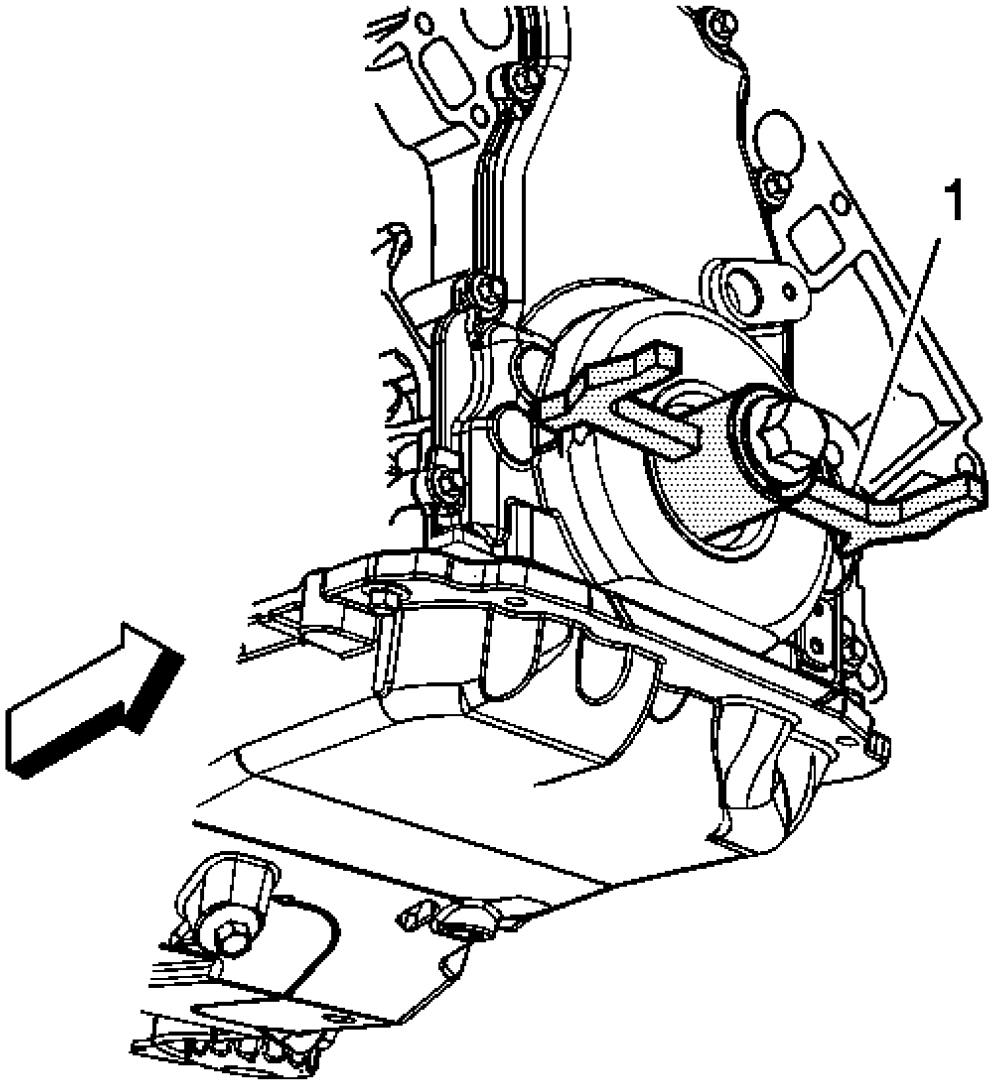


Fig. 120: View Of EN-48853 On Crankshaft
Courtesy of GENERAL MOTORS CORP.

14. Install **J 41476** to the crankshaft. See **Special Tools** .
15. Align the tapered legs of the **J 41476** with the machined alignment surfaces on the front cover. See **Special Tools** .
16. Install the crankshaft balancer bolt until snug. Do not overtighten.
    1. Tighten the oil pan to front cover bolts to 25 N.m (18 lb ft).

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2. Tighten the engine front cover bolts to 25 N.m (18 lb ft).

17. Remove the **J 41476** . See **Special Tools** .

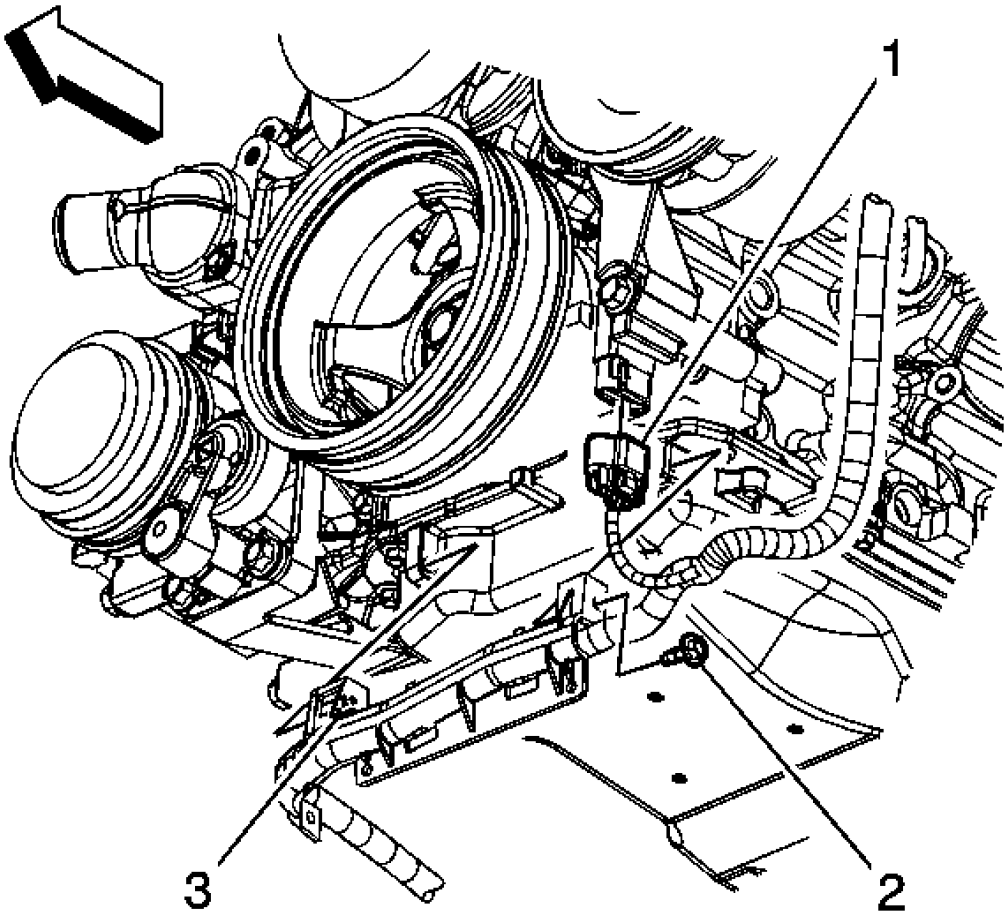


Fig. 121: View Of Electrical Connector, Cable Channel Bolt & Pin
Courtesy of GENERAL MOTORS CORP.

18. Connect the engine harness electrical connector (1) to the CMP sensor wire harness electrical connector.
19. Install a NEW crankshaft front oil seal. Refer to **Crankshaft Front Oil Seal Replacement**.
20. Install the water pump. Refer to **Water Pump Replacement (LLT)** or **Water Pump Replacement (LS3/L99)** .

ENGINE FRONT COVER REPLACEMENT (LS3)

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SPECIAL TOOLS

J 41476 Front and Rear Cover Alignment Tool. See **Special Tools** .

REMOVAL PROCEDURE

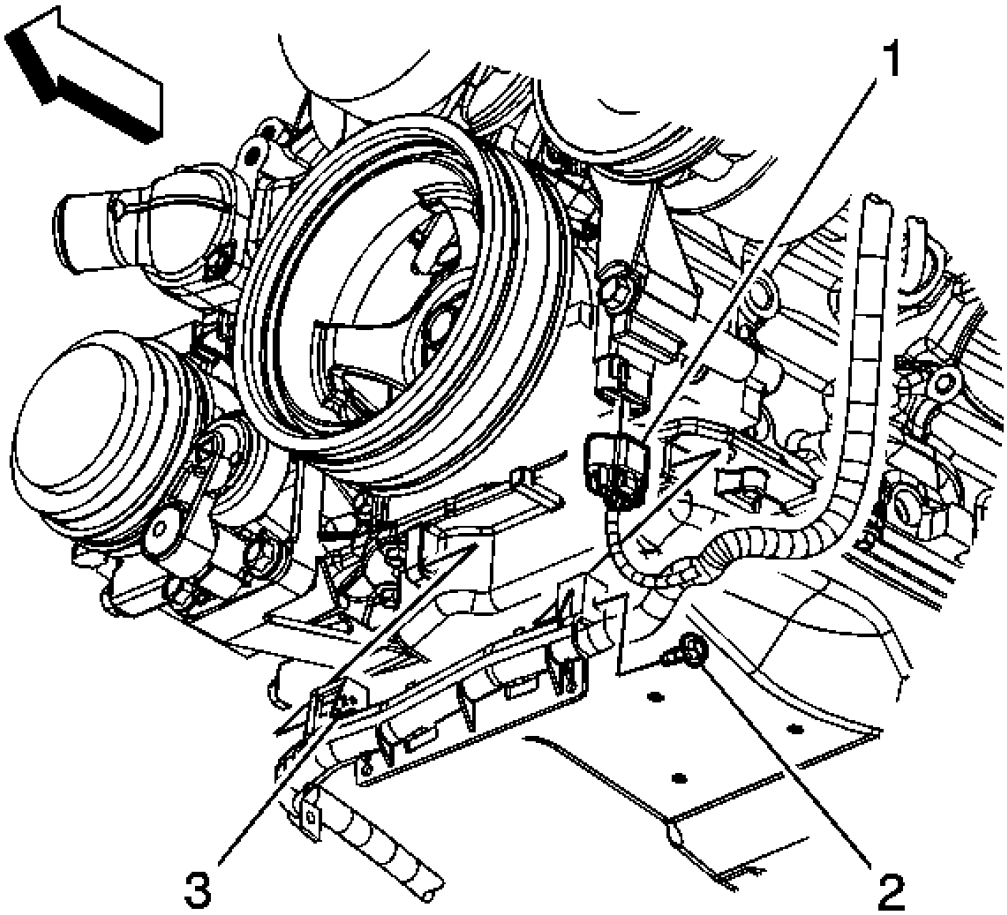


Fig. 122: View Of Electrical Connector, Cable Channel Bolt & Pin
Courtesy of GENERAL MOTORS CORP.

1. Remove the water pump. Refer to **Water Pump Replacement (LLT)** or **Water Pump Replacement (LS3/L99)** .
2. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement (L99 and LS3)**.
3. Disconnect the engine harness electrical connector (1) from the camshaft position (CMP) sensor wire harness electrical connector.

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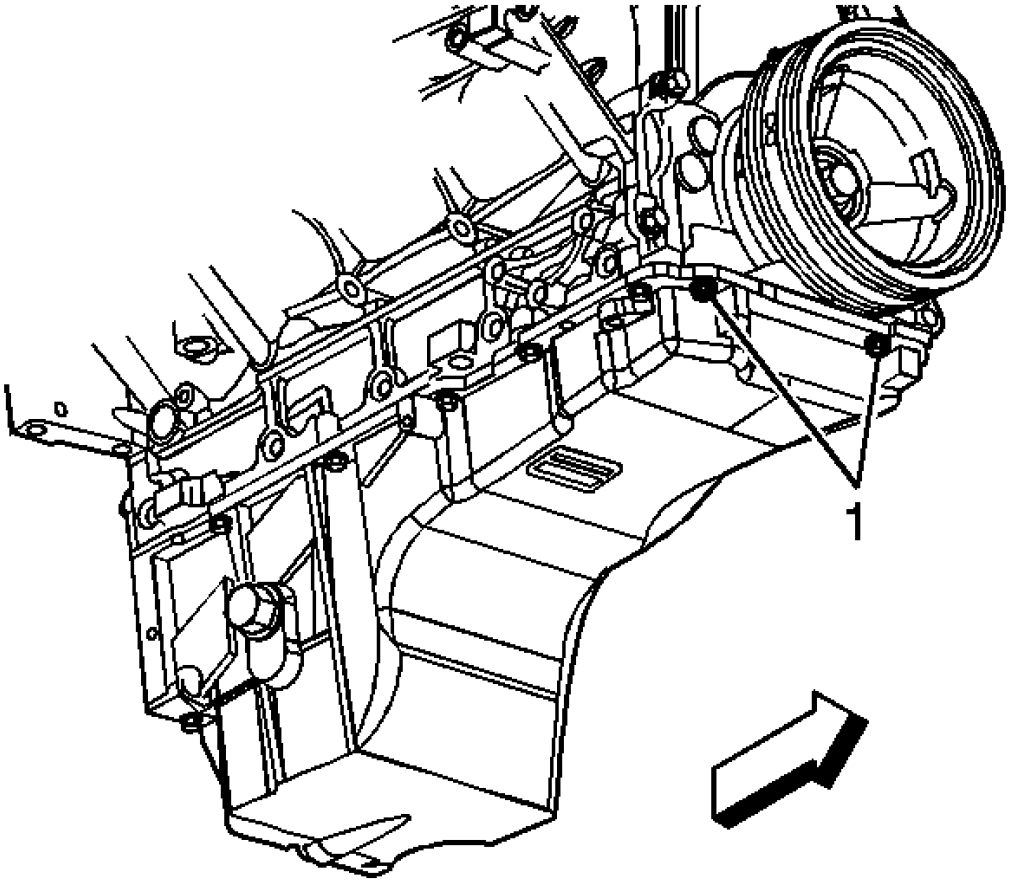


Fig. 123: View Of Oil Pan-To-Front Cover Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil pan-to-front cover bolts (1).

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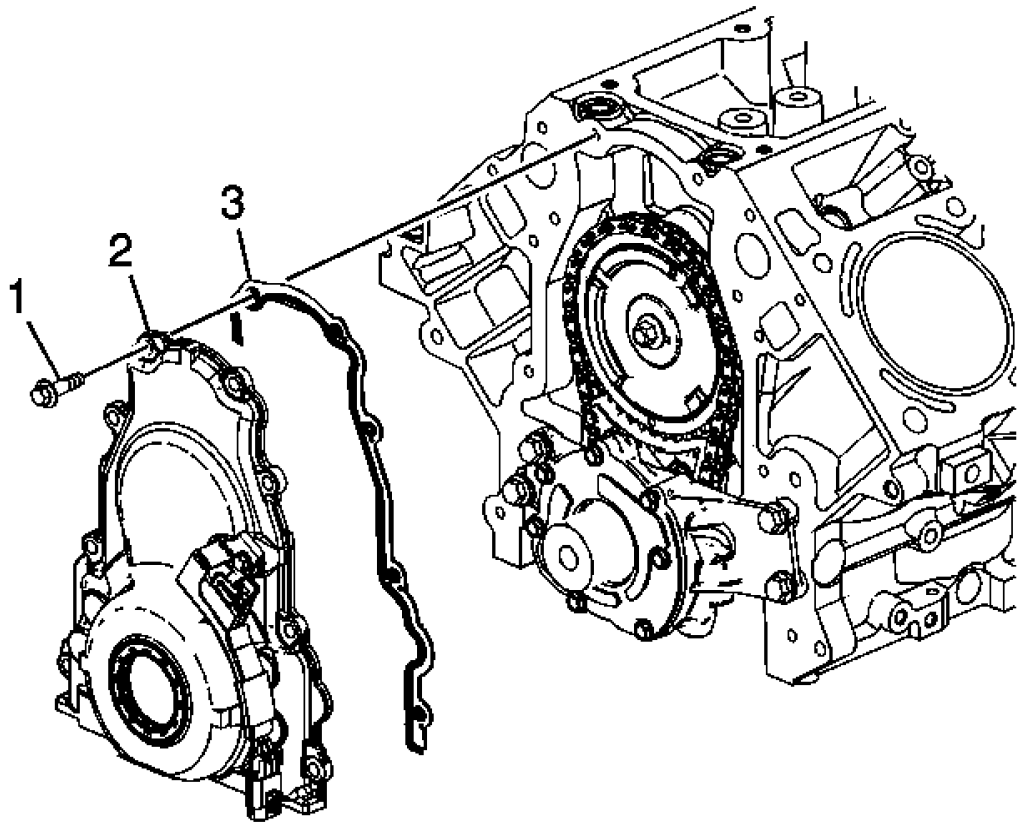


Fig. 124: View Of Front Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

5. Remove the front cover bolts (1).
6. Remove the front cover (2) and gasket (3).
7. Discard the front cover gasket.

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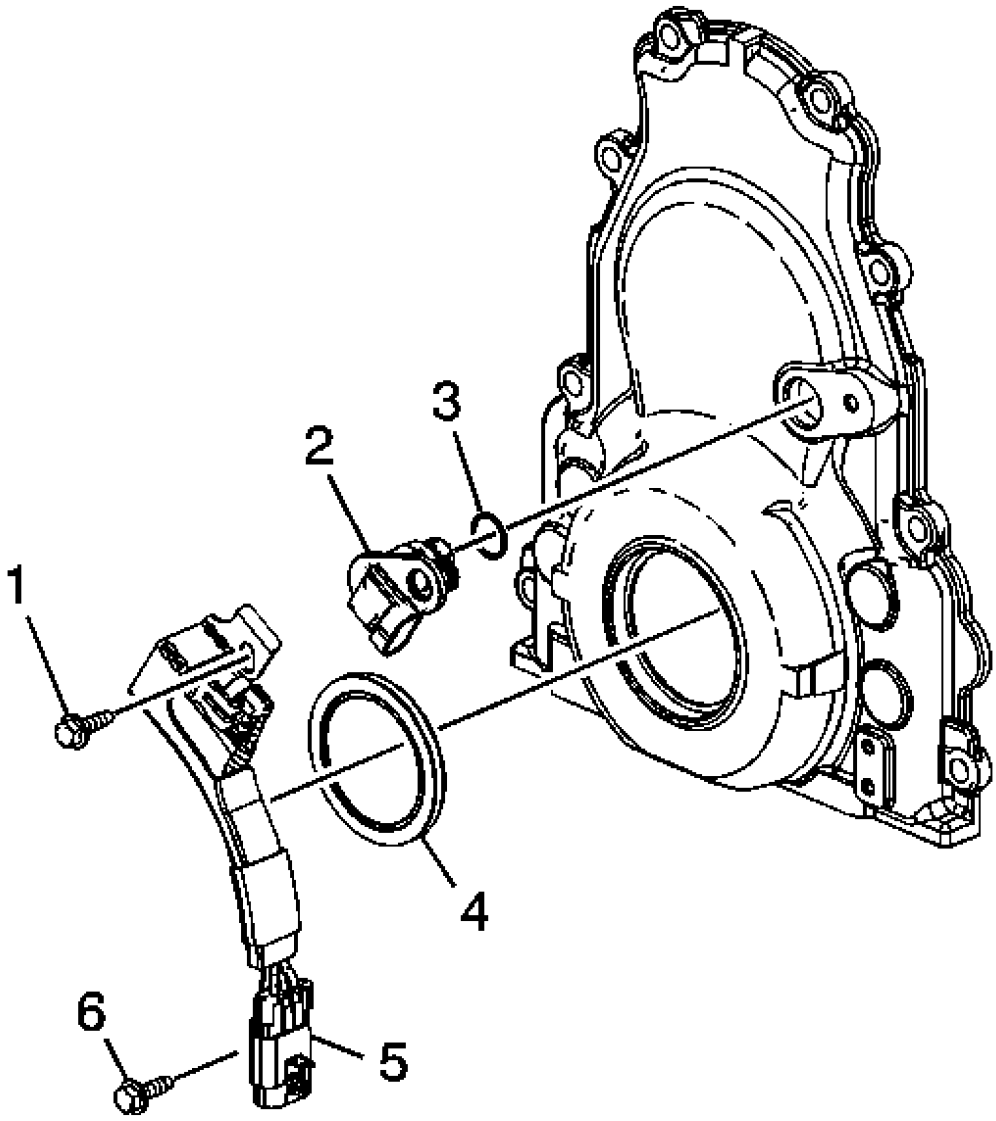


Fig. 125: View Of Front Cover, Oil Seal, Camshaft Position Sensor, Bracket & O Ring
Courtesy of GENERAL MOTORS CORP.

8. Remove the crankshaft front oil seal (4).
9. If replacing the engine front cover perform the following steps, otherwise proceed to step 8 of the installation procedure.
10. Remove the CMP sensor wire harness bolts (1 and 6).
11. Disconnect the CMP sensor wire harness from the CMP sensor.

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12. Remove the CMP sensor wire harness (5).
13. Remove the CMP sensor (2).

INSTALLATION PROCEDURE

NOTE:

- **Do not reuse the crankshaft oil seal or front cover gasket.**
- **Do not apply any type of sealant to the front cover gasket, unless specified.**
- **The special tool in this procedure is used to properly center the front crankshaft front oil seal.**
  - **All gasket surfaces should be free of oil or other foreign material during assembly.**
  - **The crankshaft front oil seal MUST be centered in relation to the crankshaft.**
  - **An improperly aligned front cover may cause premature front oil seal wear and/or engine oil leaks.**

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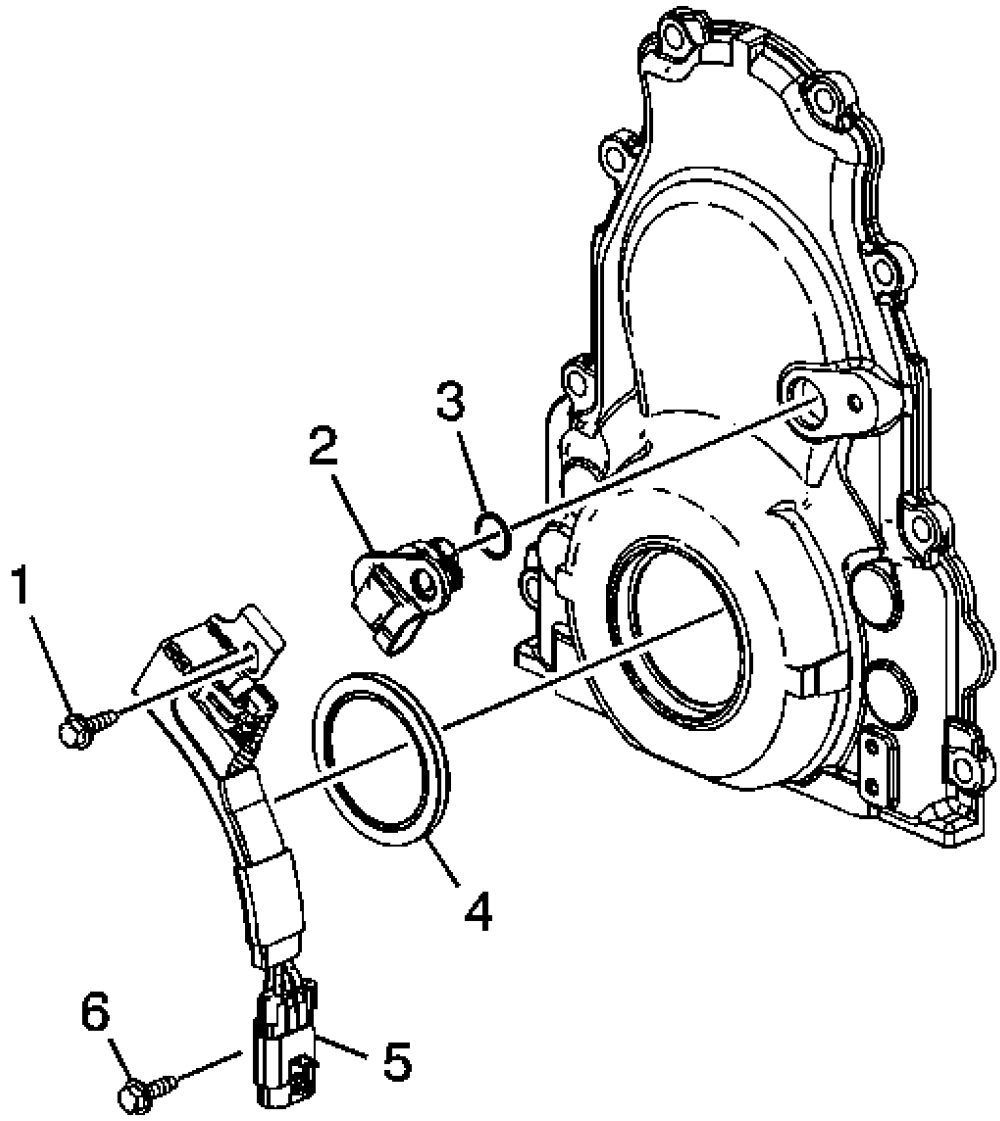


Fig. 126: View Of Front Cover, Oil Seal, Camshaft Position Sensor, Bracket & O Ring
Courtesy of GENERAL MOTORS CORP.

1. If replacing the front cover perform the following steps, otherwise proceed to step 8.
2. Inspect the CMP sensor O-ring seal for cuts or damage. If the seal is not cut or damaged, it may be reused.
3. Lubricate the O-ring seal (3) with clean engine oil.
4. Install the CMP sensor (2).

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5. Position the CMP sensor wire harness (5) to the front cover.
6. Connect the CMP sensor wire harness to the CMP sensor.

CAUTION: Refer to Fastener Caution .

7. Install the CMP sensor wire harness bolts (1 and 6).

   Tighten: Tighten the bolts to 12 N.m (106 lb in).

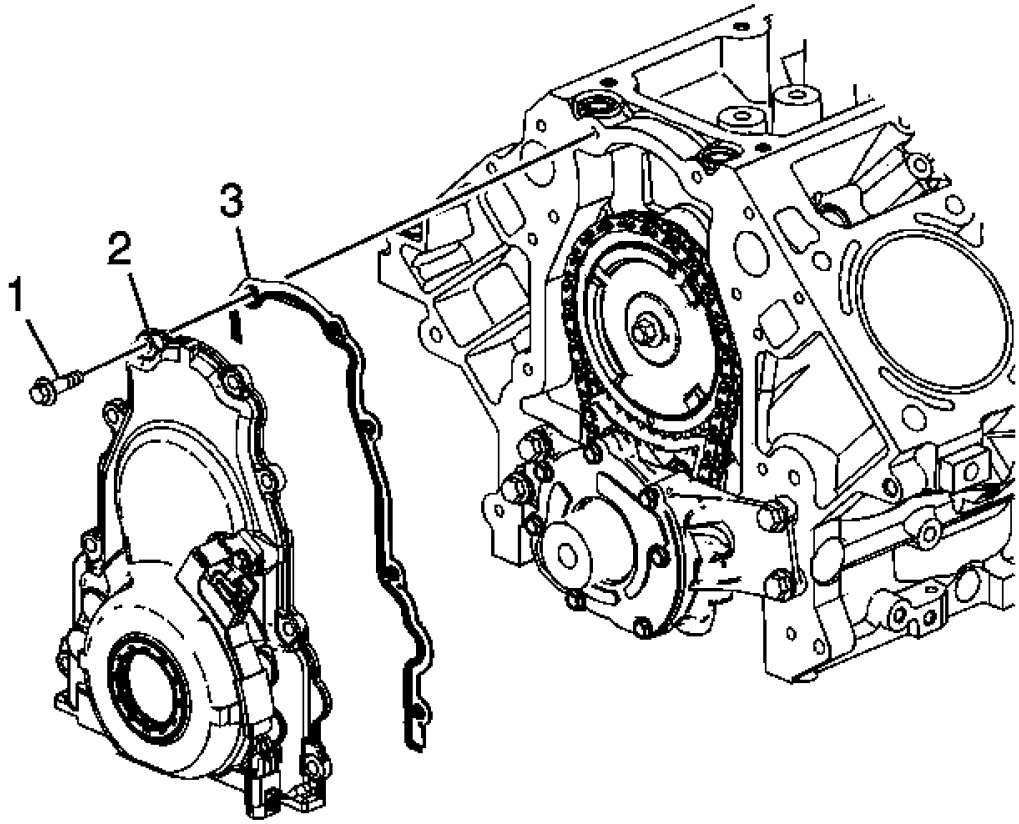


Fig. 127: View Of Front Cover & Gasket
Courtesy of GENERAL MOTORS CORP.

8. Apply a 5 mm (0.20 in) bead of sealant, 20 mm (0.80 in) long to the oil pan to engine block junction. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
9. Position the NEW engine front cover gasket (3) and front cover (2) to the engine.

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10. Install the front cover bolts (1) until snug. Do not overtighten.

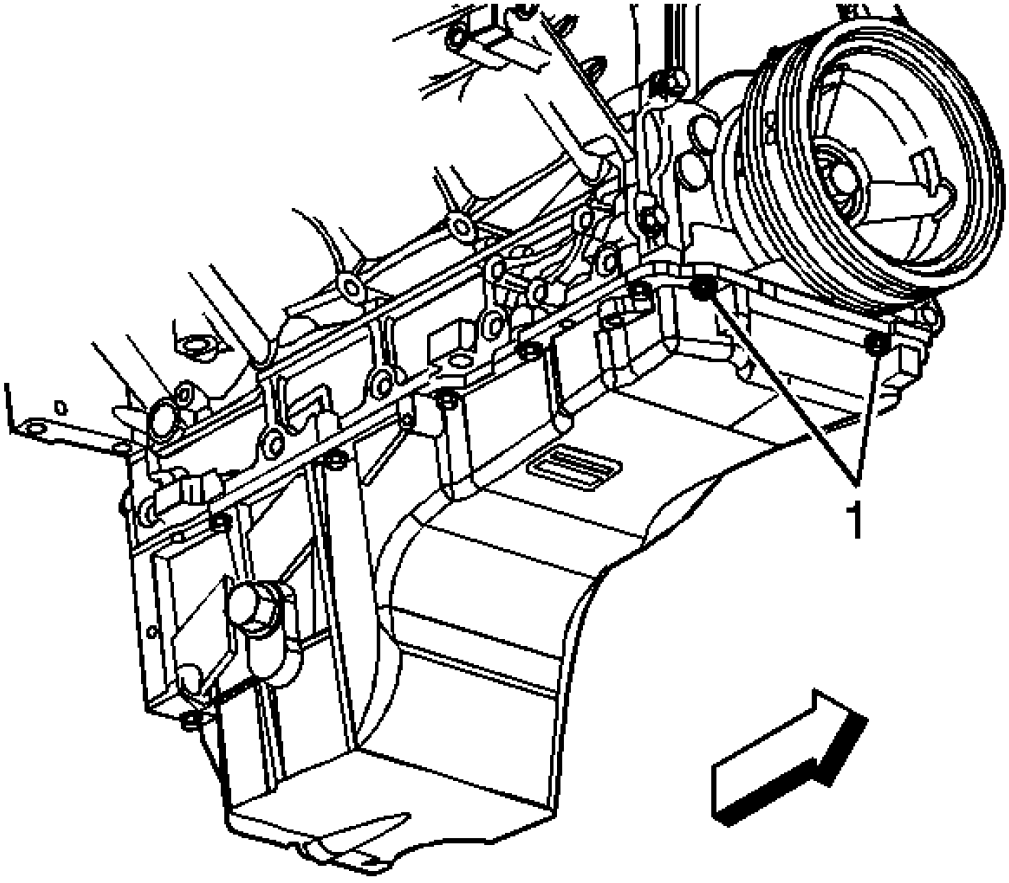


Fig. 128: View Of Oil Pan-To-Front Cover Bolts
Courtesy of GENERAL MOTORS CORP.

11. Install the oil pan-to-front cover bolts (1) until snug. Do not over tighten.

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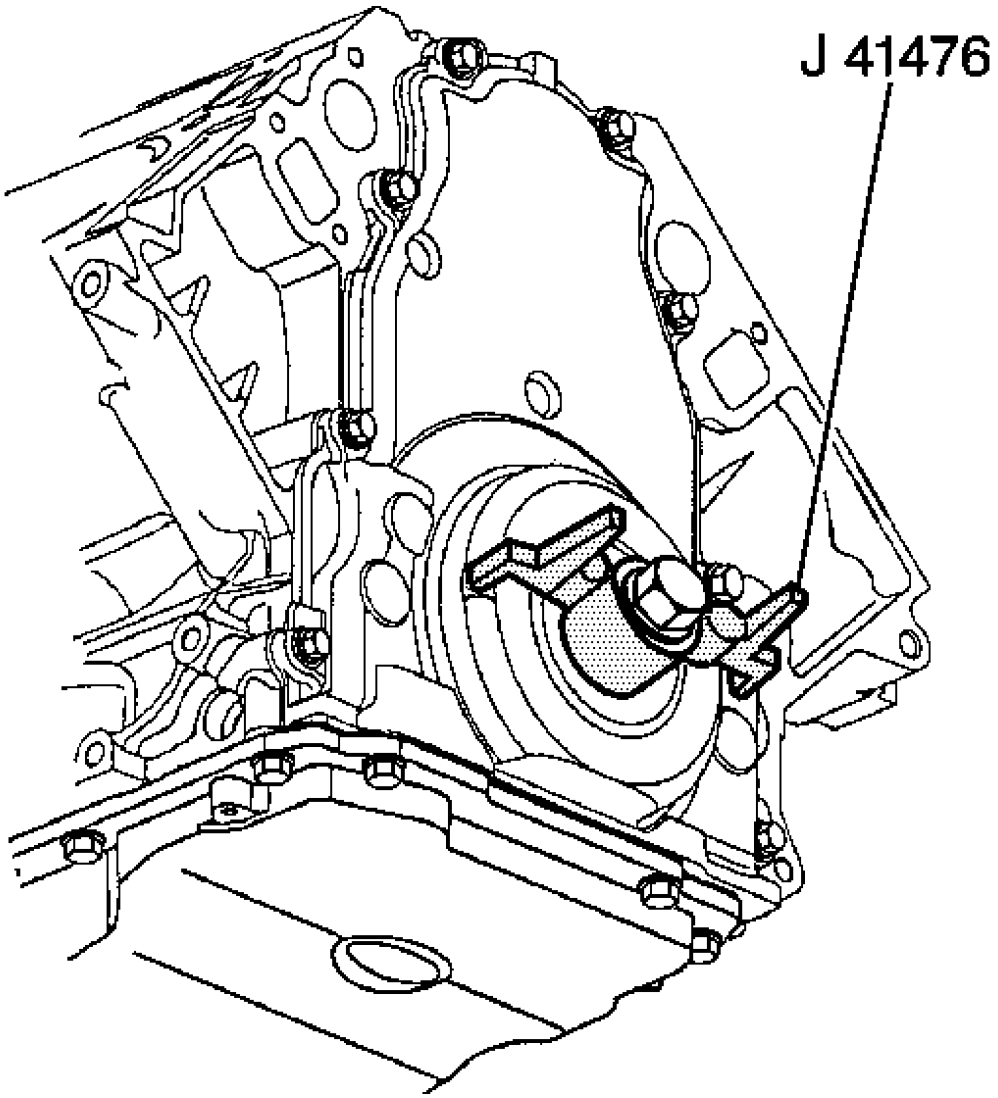


Fig. 129: View of J 41476 Installed To Front Cover
Courtesy of GENERAL MOTORS CORP.

12. Install **J 41476** to the front cover. See **Special Tools** .
13. Align the tapered legs of the **J 41476** with the machined alignment surfaces on the front cover. See **Special Tools** .
14. Install the crankshaft balancer bolt until snug. Do not overtighten.

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Tighten:

1. Tighten the oil pan to front cover bolts to 25 N.m (18 lb ft).
2. Tighten the engine front cover bolts to 25 N.m (18 lb ft).

15. Remove the **J 41476** . See **Special Tools** .

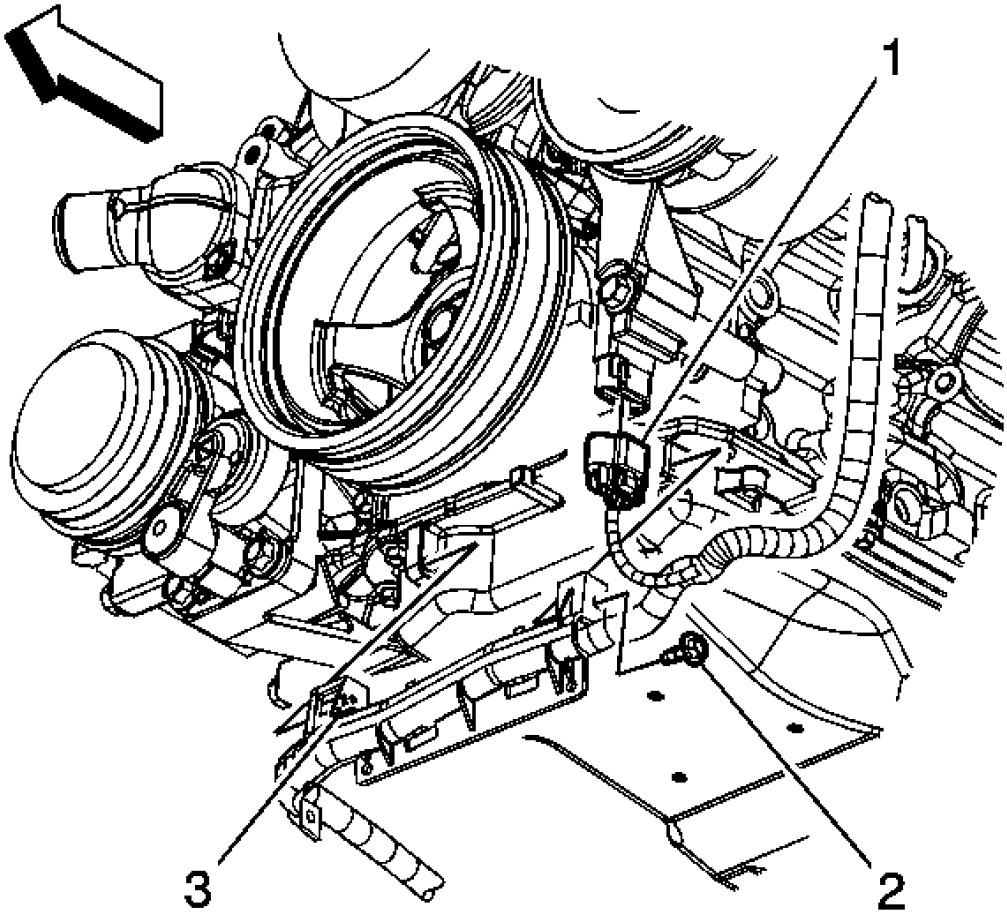


Fig. 130: View Of Electrical Connector, Cable Channel Bolt & Pin
Courtesy of GENERAL MOTORS CORP.

16. Connect the engine harness electrical connector (1) to the CMP sensor wire harness electrical connector.
17. Install a NEW crankshaft front oil seal. Refer to **Crankshaft Front Oil Seal Replacement**.
18. Install the water pump. Refer to **Water Pump Replacement (LLT)** or **Water Pump Replacement (LS3/L99)** .

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CAMSHAFT POSITION ACTUATOR SOLENOID VALVE REPLACEMENT

Special Tools

- **J 42386-A** Flywheel Holding Tool. See **Special Tools** .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

1. Remove the starter. Refer to **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)** .

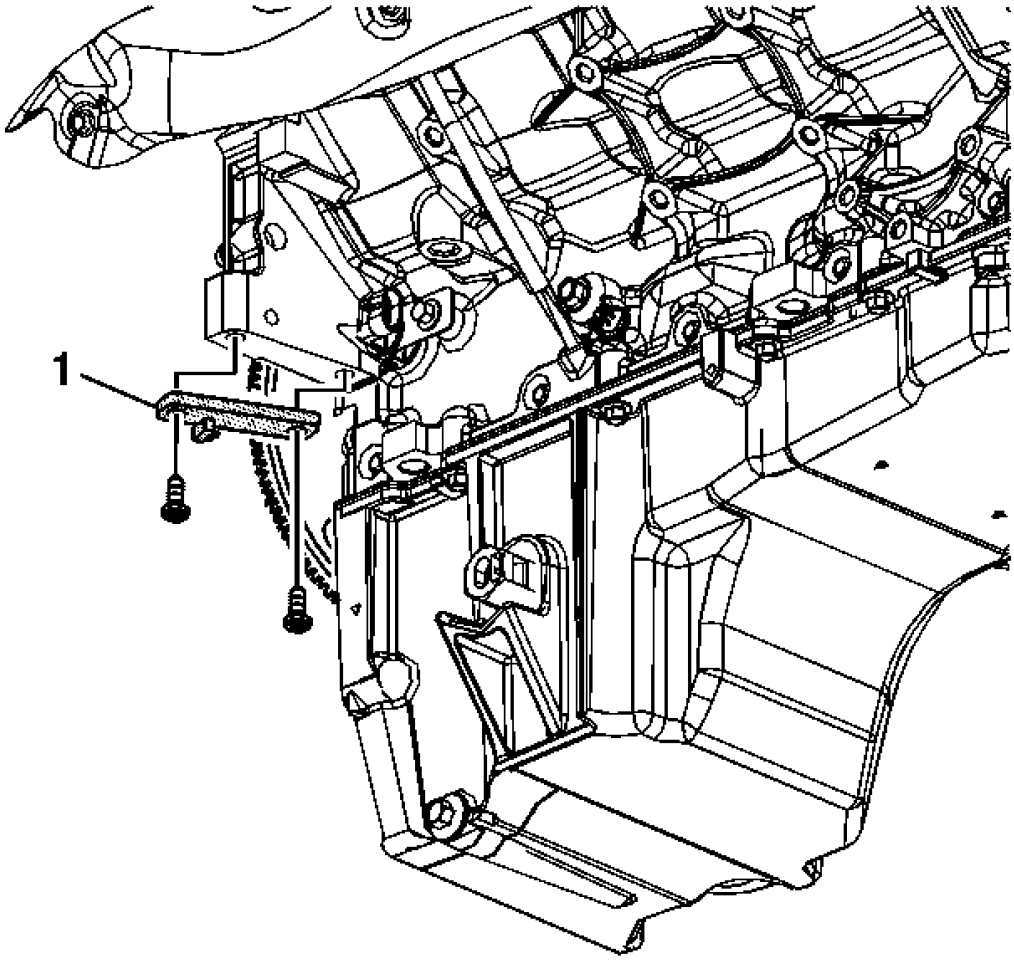


Fig. 131: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS CORP.

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CAUTION: Refer to Fastener Caution .

2. Install the **J 42386-A** (1) and bolts. See **Special Tools** . Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the **J 42386-A** bolts to 50 N. See **Special Tools** .m (37 lb ft).
3. Remove the camshaft position (CMP) actuator magnet. Refer to **Camshaft Position Actuator Magnet Replacement**.

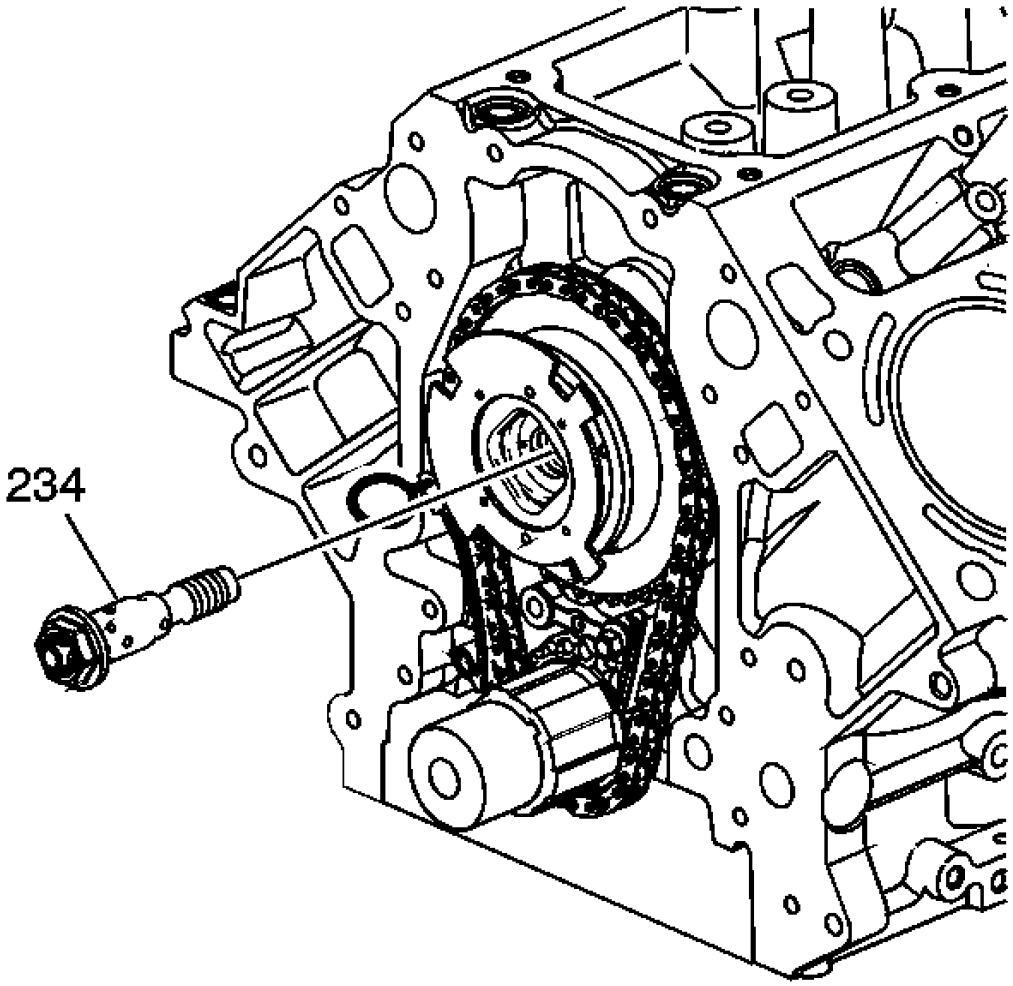


Fig. 132: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Camshaft Position Actuator Removal and Installation

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Warning .

4. Remove the CMP actuator solenoid valve (234).
5. Discard the solenoid valve.

INSTALLATION PROCEDURE

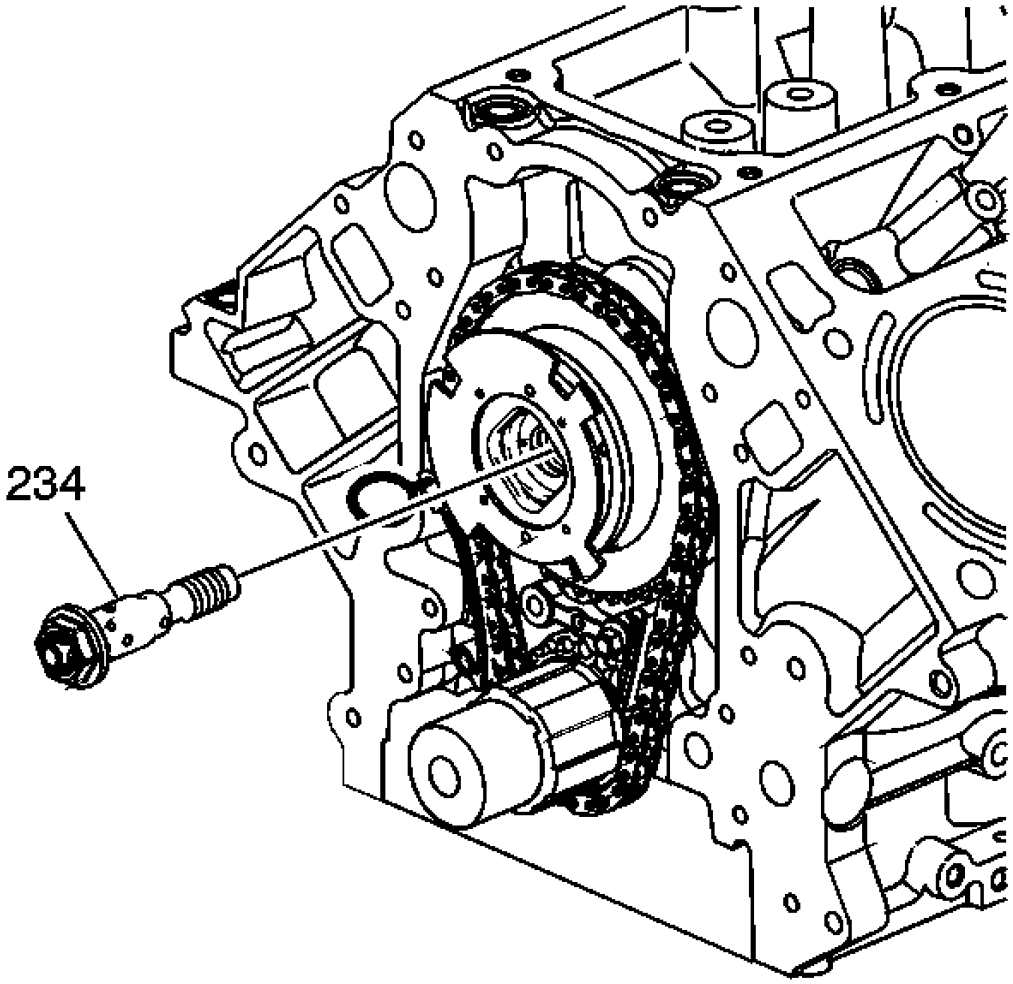


Fig. 133: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW CMP actuator solenoid valve (234).

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With the CMP actuator properly positioned onto the camshaft, the CMP actuator solenoid valve can be threaded completely into the camshaft using light hand pressure. Tighten by hand until snug.

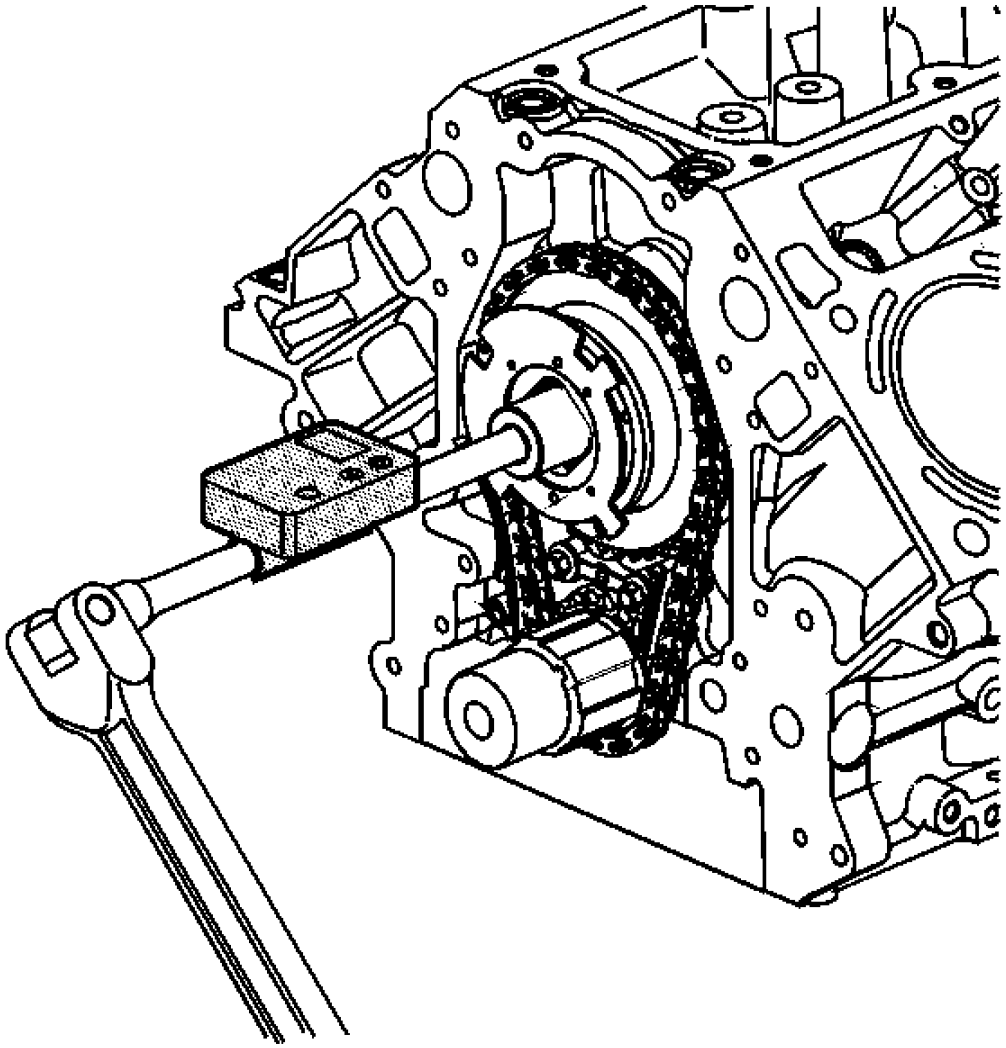


Fig. 134: Tightening CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Component Fastener Tightening Caution .

2. Tighten the CMP actuator solenoid valve.

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1. Tighten the CMP actuator solenoid valve a first pass to 65 N.m (48 lb ft).
2. Tighten the CMP actuator solenoid valve a final pass an additional 90 degrees using the **J 45059** .

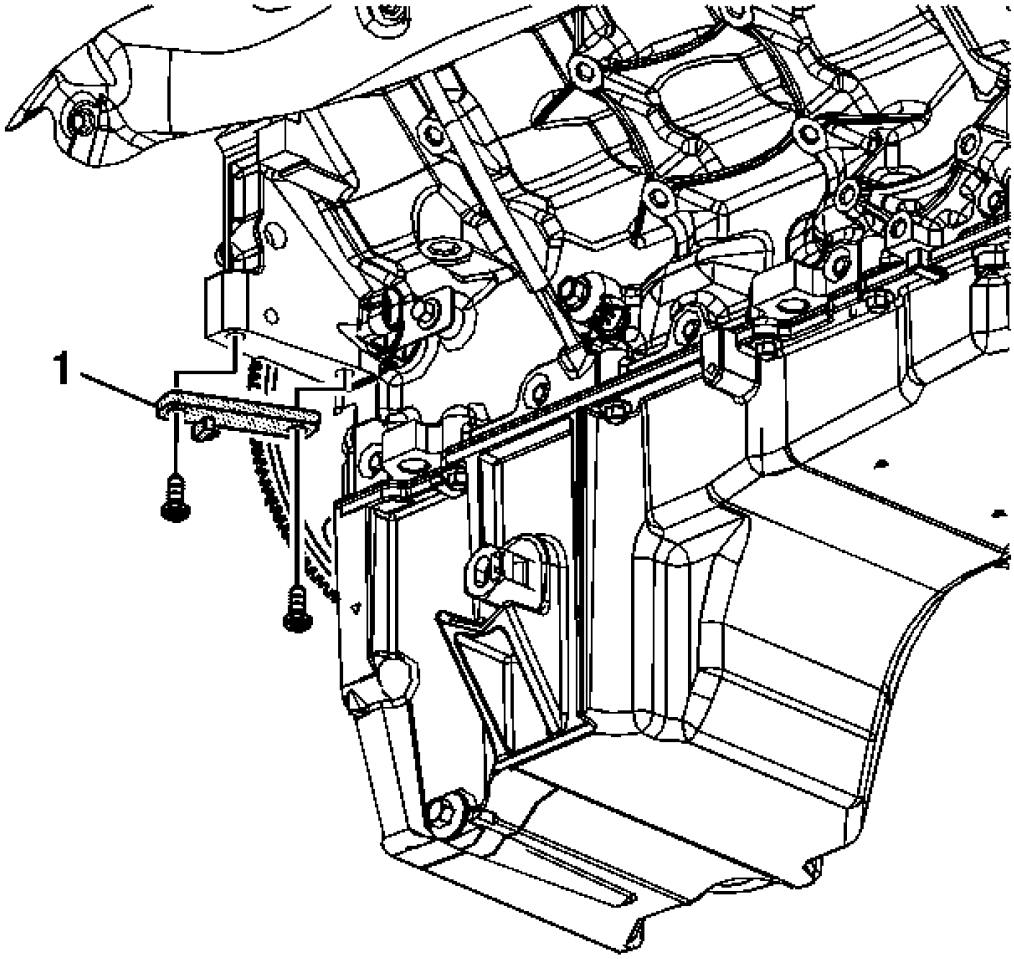


Fig. 135: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the **J 42386-A** (1). See **Special Tools** .
4. Install the CMP actuator magnet. Refer to **Camshaft Position Actuator Magnet Replacement**.
5. Install the starter. Refer to **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)** .

CAMSHAFT POSITION ACTUATOR REPLACEMENT

Special Tools

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- **EN 46330** Timing Belt Tensioner Retaining Pin. See **Special Tools** .
- **J 42386-A** Flywheel Holding Tool. See **Special Tools** .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

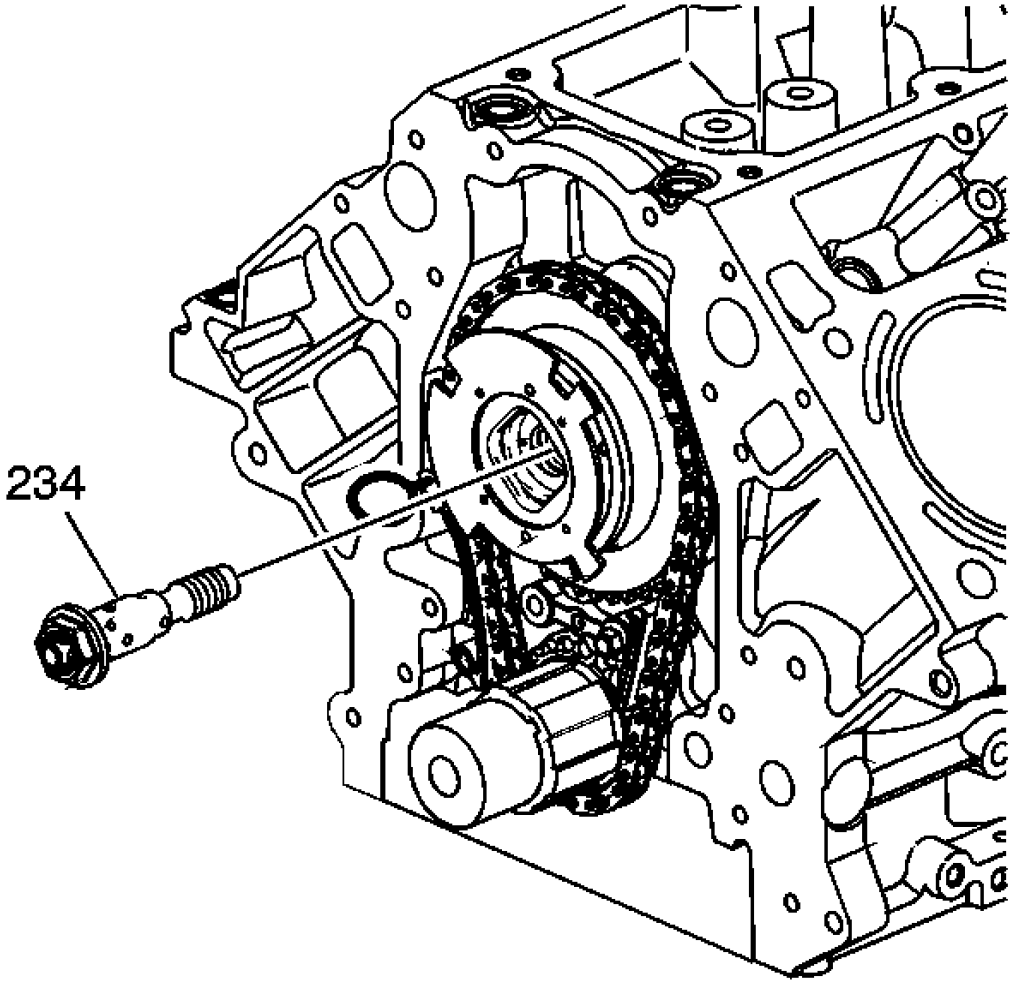


Fig. 136: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.
2. Align the timing marks.
3. Install the **J 42386-A** . See **Special Tools** .

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4. Remove and discard the camshaft position (CMP) actuator solenoid valve (234).

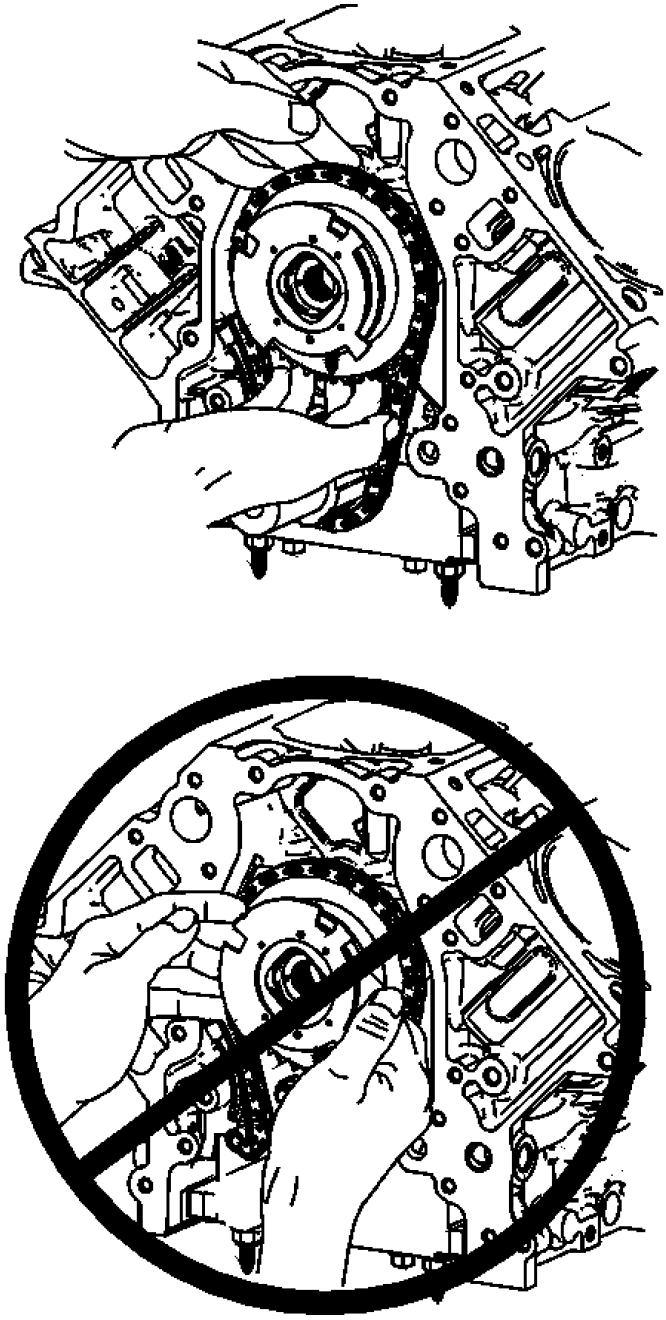


Fig. 137: View Of Proper CMP Actuator Removal
Courtesy of GENERAL MOTORS CORP.

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WARNING: Do not push or pull on the reluctor wheel of the camshaft position (CMP) actuator during removal or installation. The reluctor wheel is retained to the front of the CMP actuator by 3 roll pins. Pushing or pulling on the wheel may dislodge the wheel from the front of the actuator. The actuator return spring is under tension and may rotate the dislodged reluctor wheel, causing personal injury.

5. Loosen and separate the CMP actuator and timing chain from the camshaft. Position your fingers behind the actuator sprocket and pull the actuator away from the front of the camshaft. Never pull on the reluctor wheel when attempting to remove the actuator.

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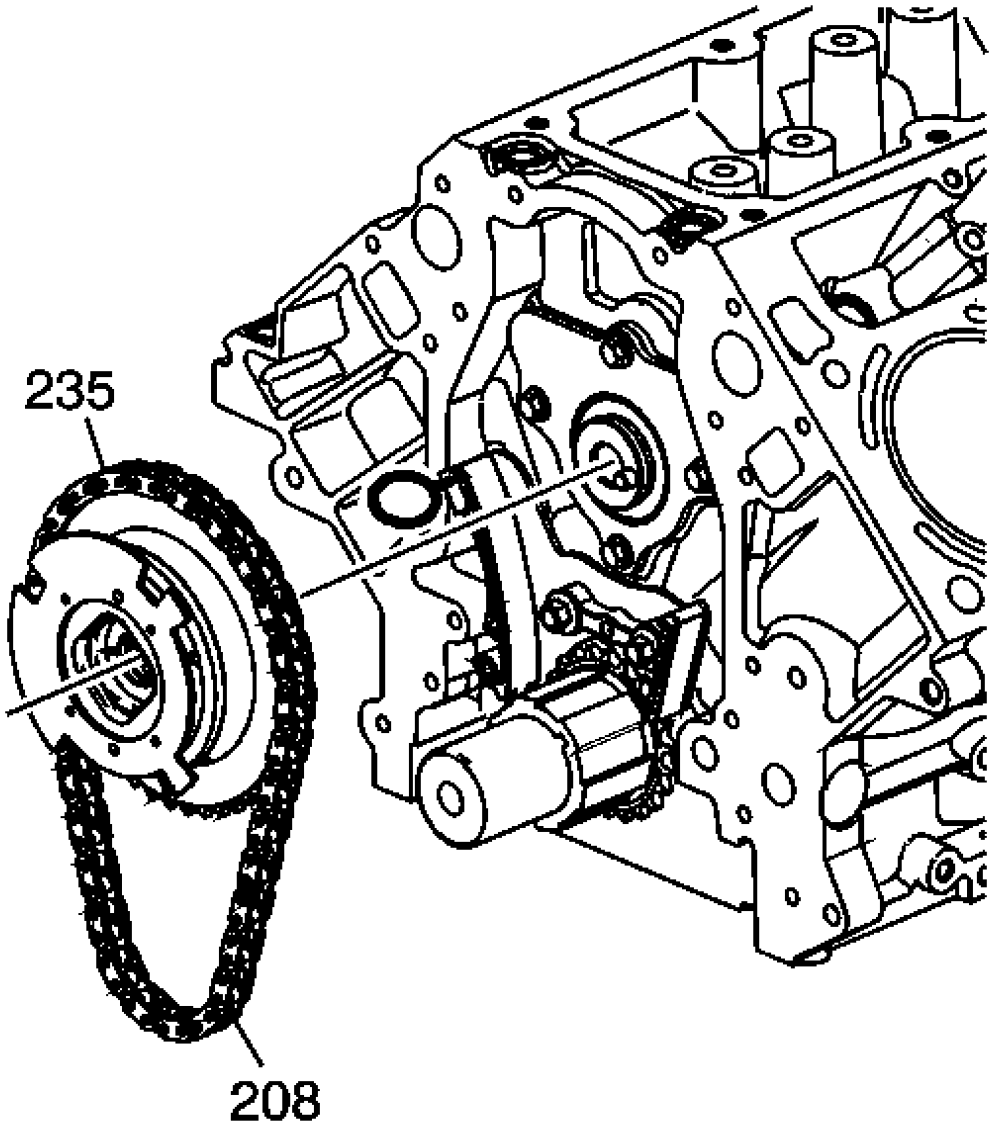


Fig. 138: View Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS CORP.

6. Remove the CMP actuator (235) and timing chain (208).

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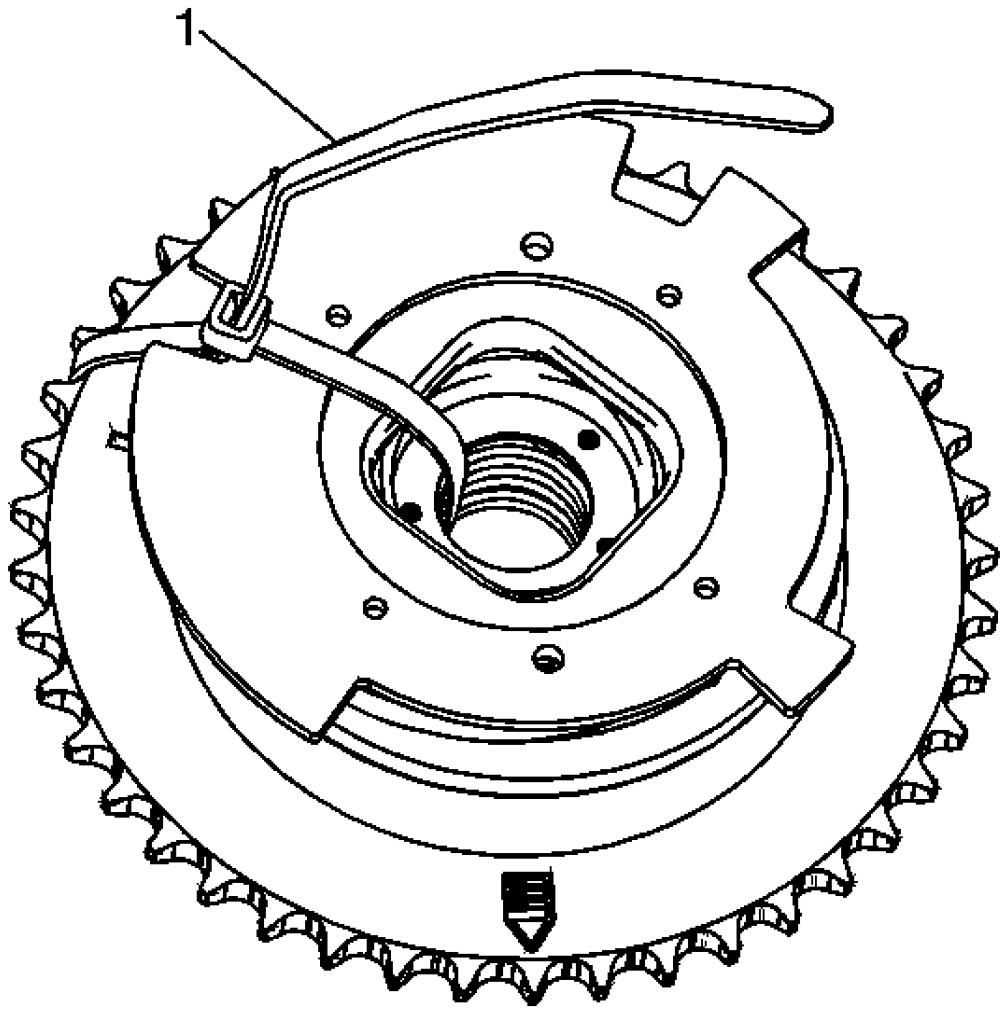


Fig. 139: View Of Tie Strap Through Center Of Actuator
Courtesy of GENERAL MOTORS CORP.

7. Insert and secure a tie strap (1) through the center of the actuator and over the reluctor wheel.

INSTALLATION PROCEDURE

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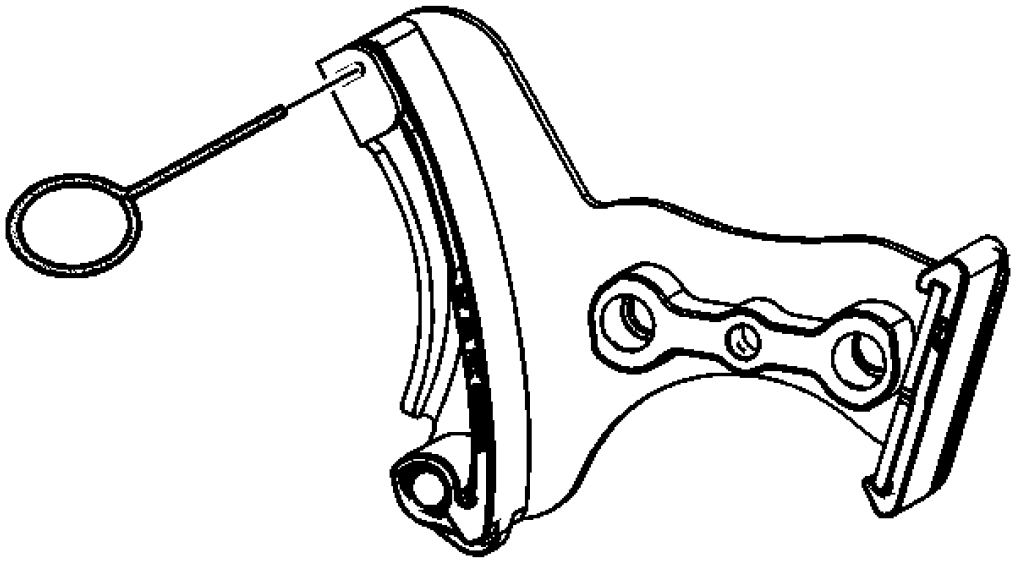


Fig. 140: View Of Compressed Tensioner & Pin
Courtesy of GENERAL MOTORS CORP.

1. Compress the timing chain tensioner guide and install the **EN 46330** . See **Special Tools** .

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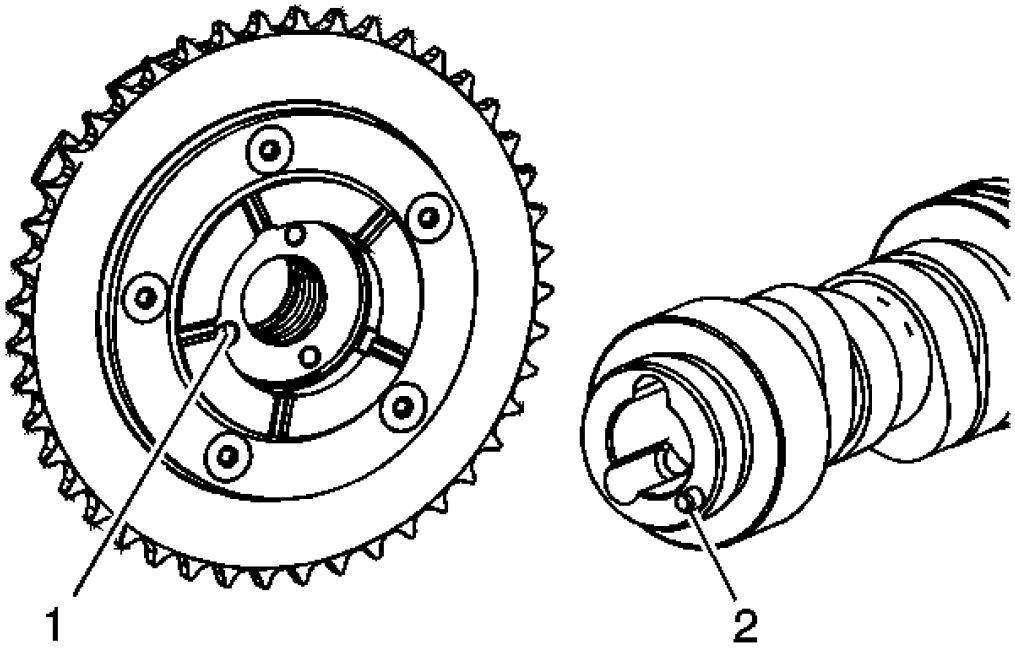


Fig. 141: Identifying Alignment Hole & Locating Pin
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Properly locate the CMP actuator on the locating pin of the camshaft.**
- **The sprocket teeth and timing chain must mesh.**
- **The camshaft and the crankshaft sprocket alignment marks MUST be aligned properly.**
- **DO NOT use the CMP solenoid valve again. Install a NEW valve during assembly.**

2. Identify the alignment hole (1) in the rear face of the CMP actuator and the locating pin (2) on the front face of the camshaft.

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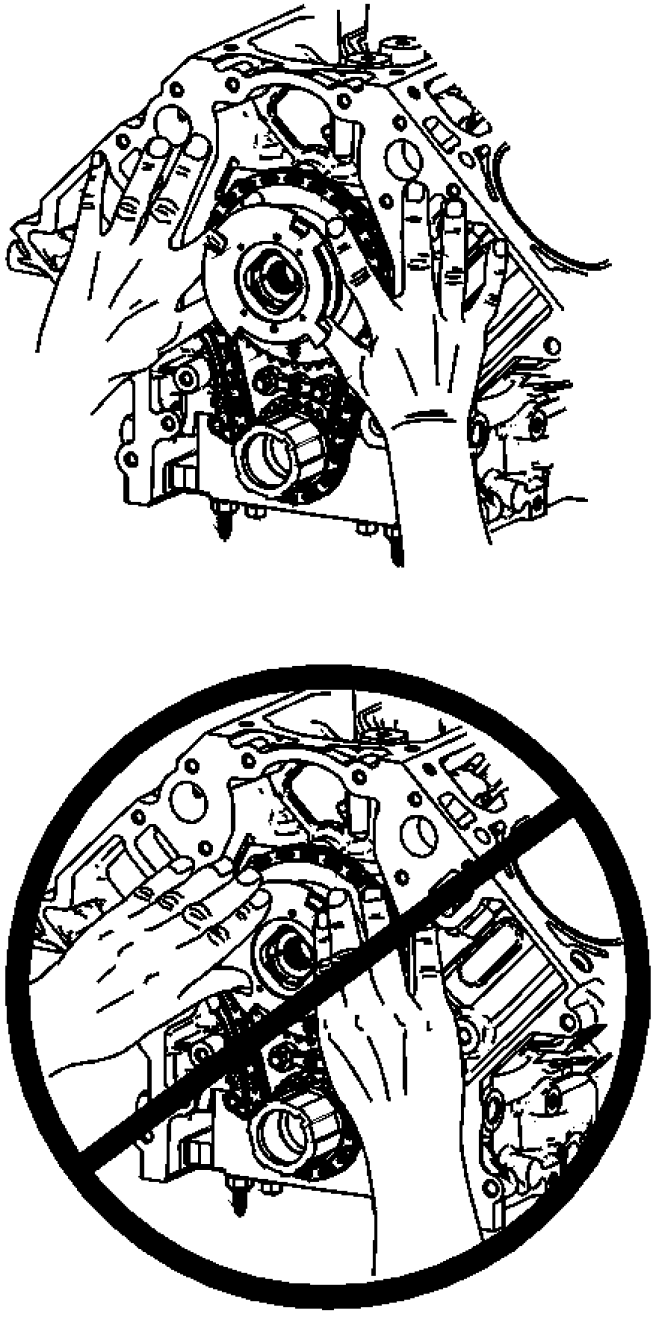


Fig. 142: Proper Installation Of CMP Actuator
Courtesy of GENERAL MOTORS CORP.

WARNING: Do not push or pull on the reluctor wheel of the camshaft position

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(CMP) actuator during removal or installation. The reluctor wheel is retained to the front of the CMP actuator by 3 roll pins. Pushing or pulling on the wheel may dislodge the wheel from the front of the actuator. The actuator return spring is under tension and may rotate the dislodged reluctor wheel, causing personal injury.

3. Install the CMP actuator and timing chain. Align the hole in the rear face of the CMP actuator with the locating pin on the front face of the camshaft. If necessary, rotate the camshaft or crankshaft sprockets in order to align the timing marks. Use care to install the actuator completely onto the front of the camshaft. Position your fingers onto the face of the actuator sprocket and push the actuator onto the front of the camshaft. Never push on the reluctor wheel when attempting to install the actuator.

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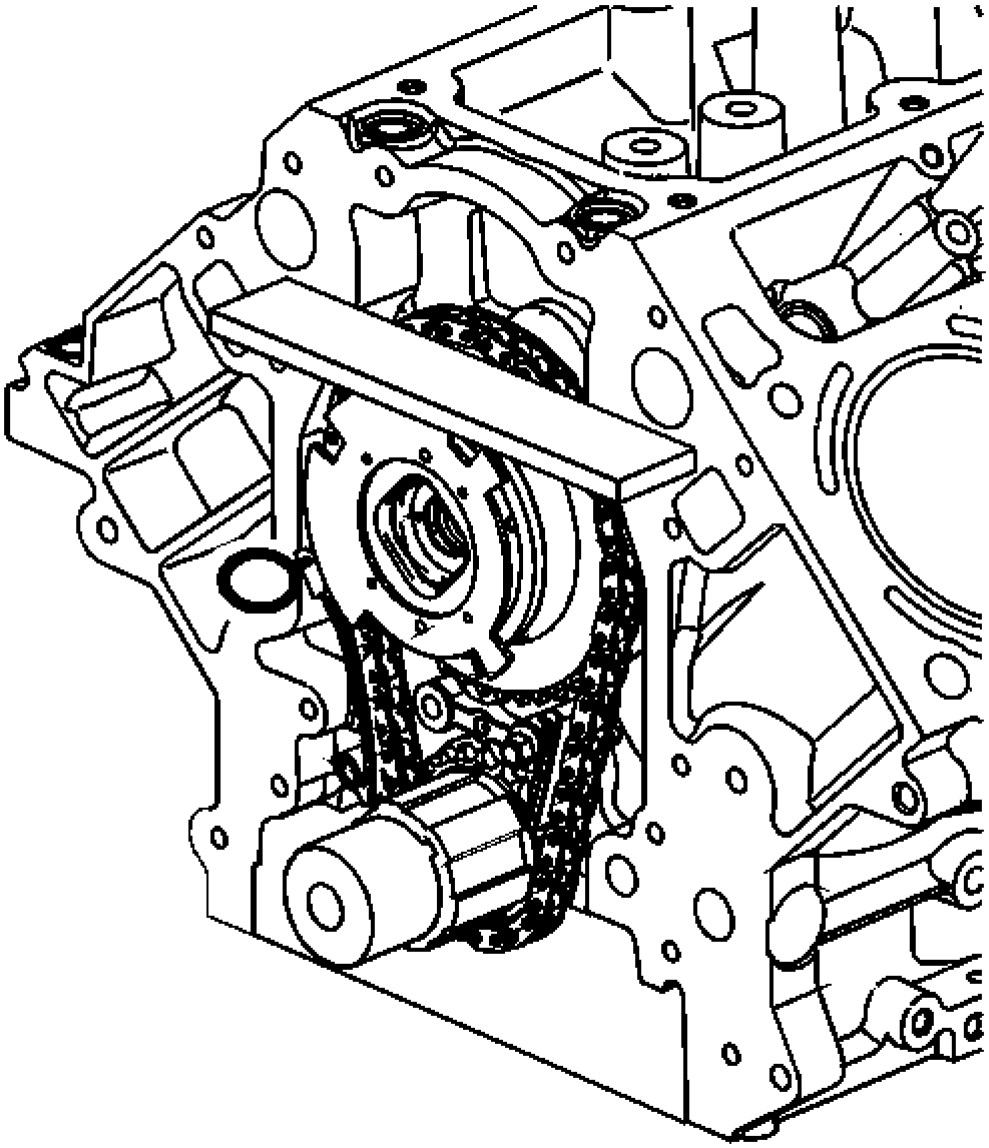


Fig. 143: Inspecting For Proper Installation Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS CORP.

4. Place a straight edge across the front face of the engine block and inspect for proper installation of the CMP actuator and timing chain. With the CMP actuator properly and completely installed onto the front of the camshaft, the timing chain will not protrude beyond the front face of the engine block.

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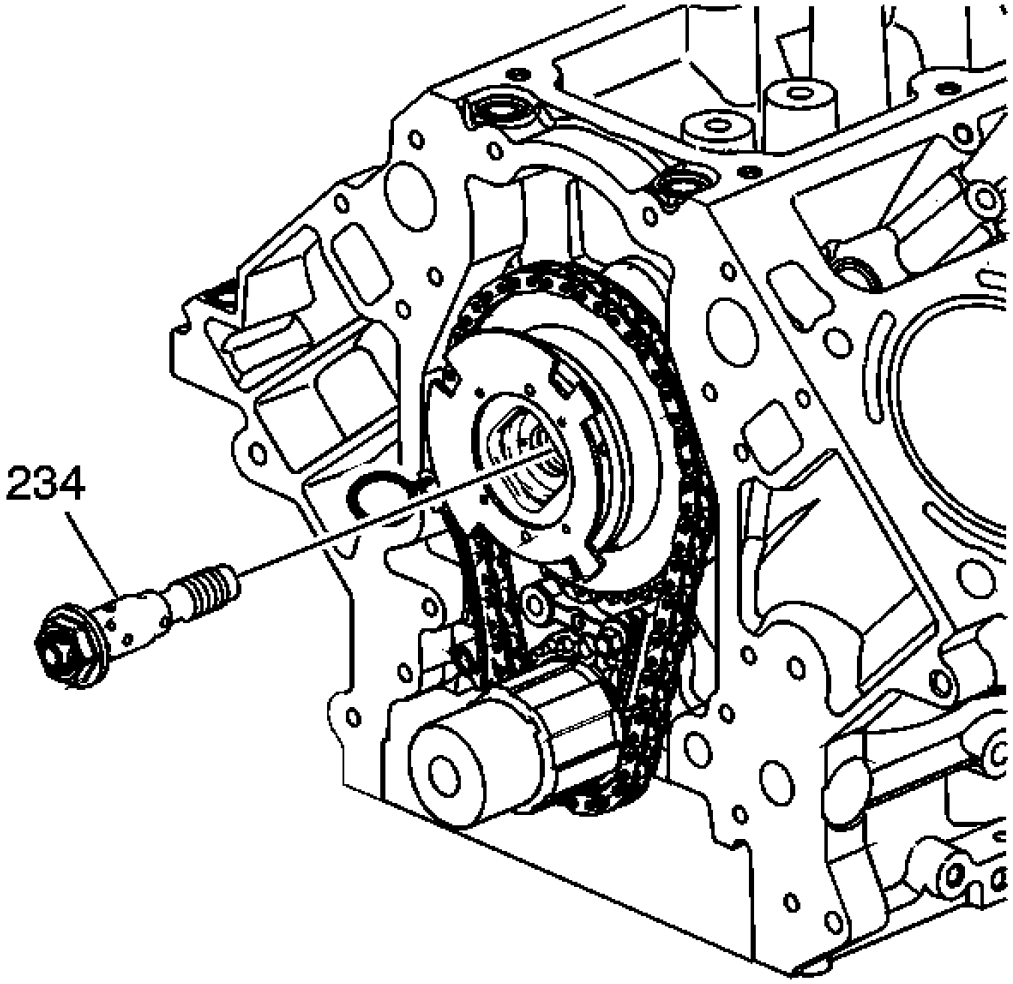


Fig. 144: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

5. Install a NEW CMP actuator solenoid valve (234). With the CMP actuator properly positioned onto the camshaft, the CMP actuator solenoid valve can be threaded completely into the camshaft using light hand pressure. Tighten by hand until snug.

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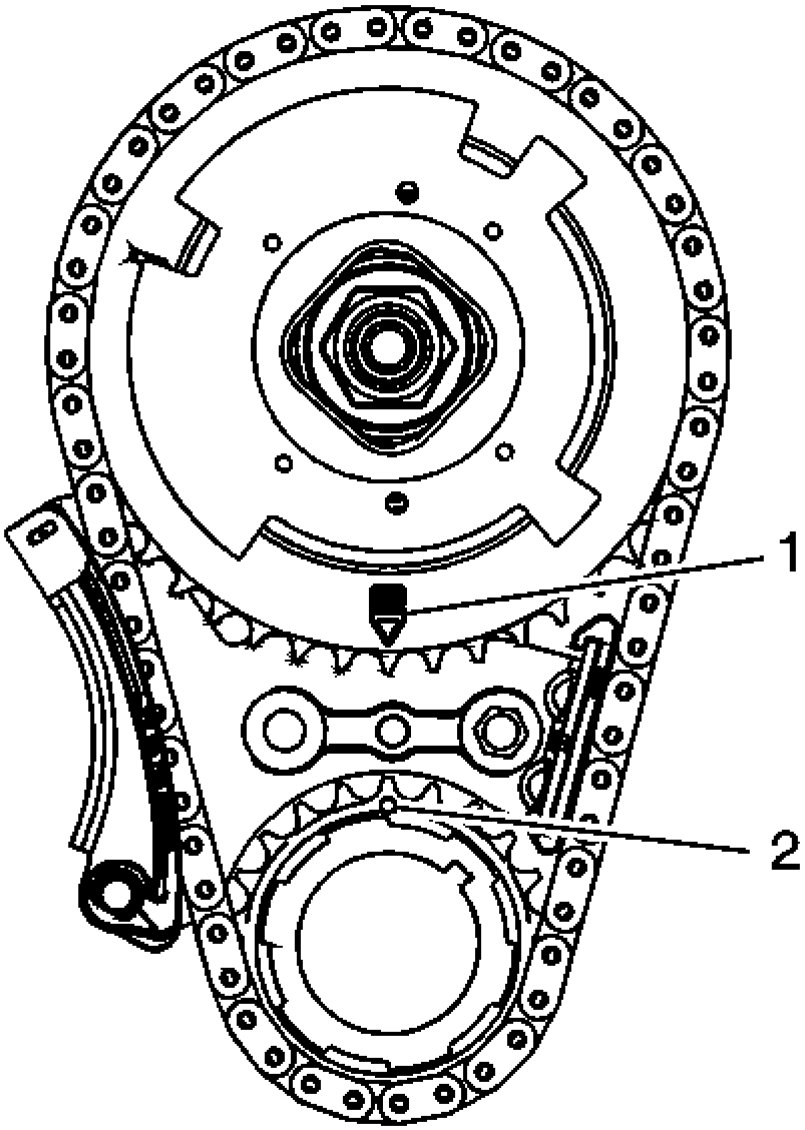


Fig. 145: View Of CMP Actuator Alignment Mark & Crankshaft Sprocket Alignment Mark
Courtesy of GENERAL MOTORS CORP.

6. Inspect the sprockets for proper alignment. The mark on the CMP actuator sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

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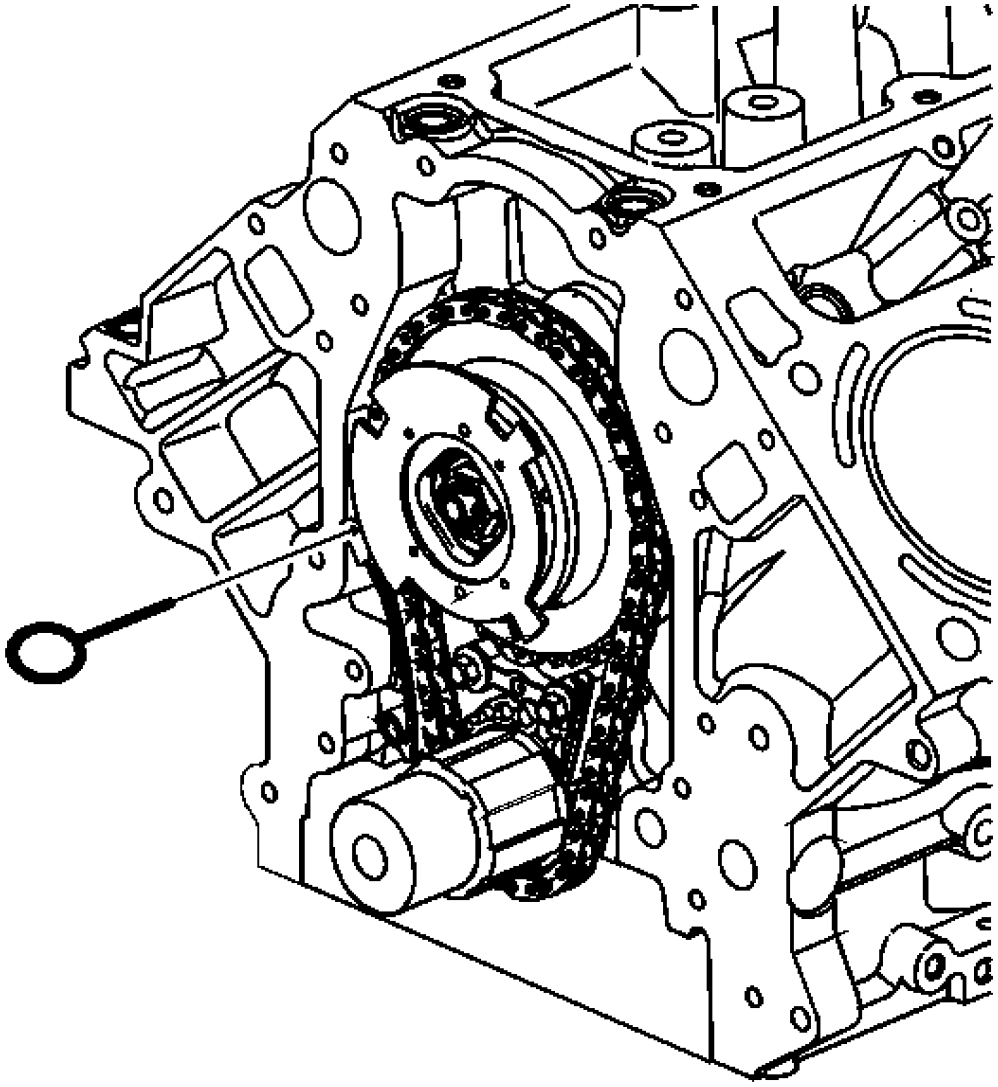


Fig. 146: View Of Special Tool EN 46330
Courtesy of GENERAL MOTORS CORP.

7. Remove the **EN 46330** . See **Special Tools** .

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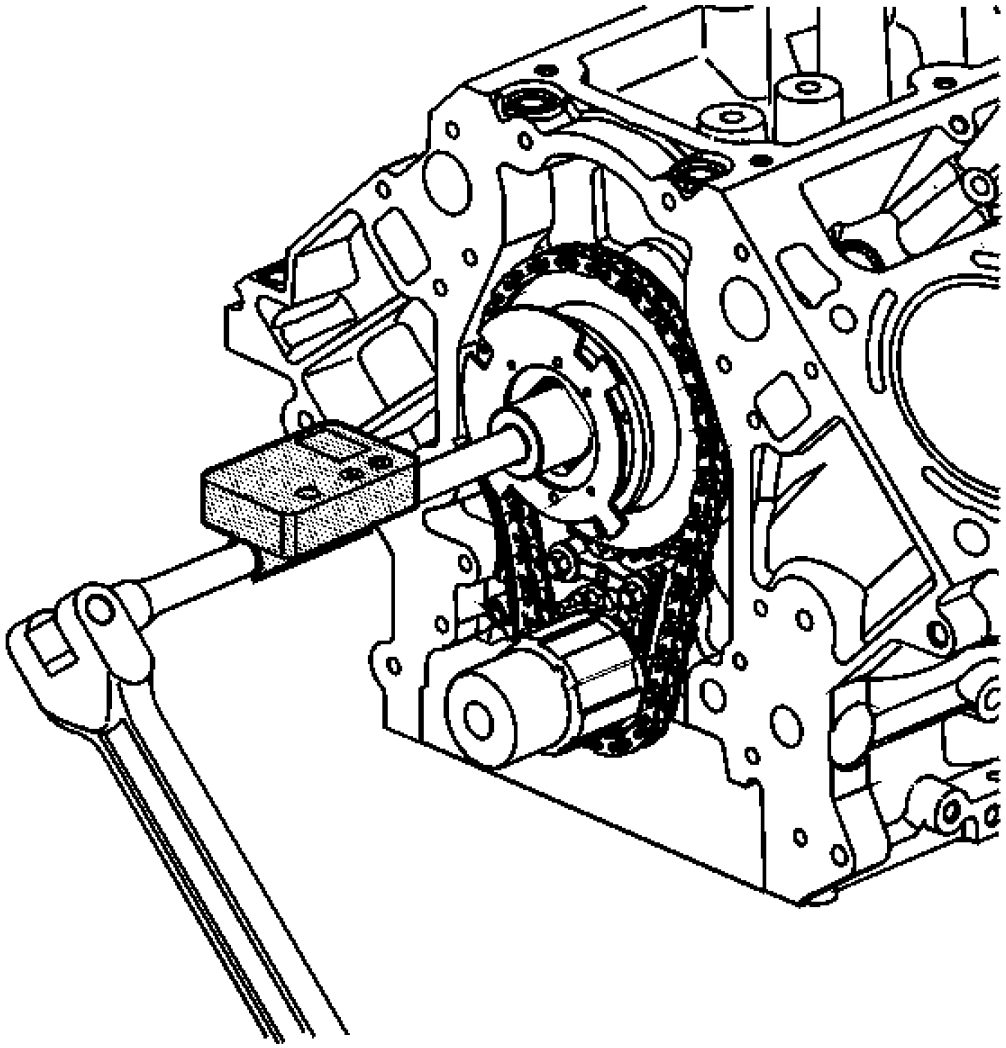


Fig. 147: Tightening CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

8. Tighten the CMP actuator solenoid valve.
    1. Tighten the valve a first pass to 65 N.m (48 lb ft).
    2. Tighten the valve a final pass and additional 90 degrees using **J 45059** .

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9. Remove the **J 42386-A** . See **Special Tools** .
10. Install the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.

CRANKSHAFT REAR OIL SEAL REPLACEMENT

SPECIAL TOOLS

J 41479 Crankshaft Rear Oil Seal Installer

REMOVAL PROCEDURE

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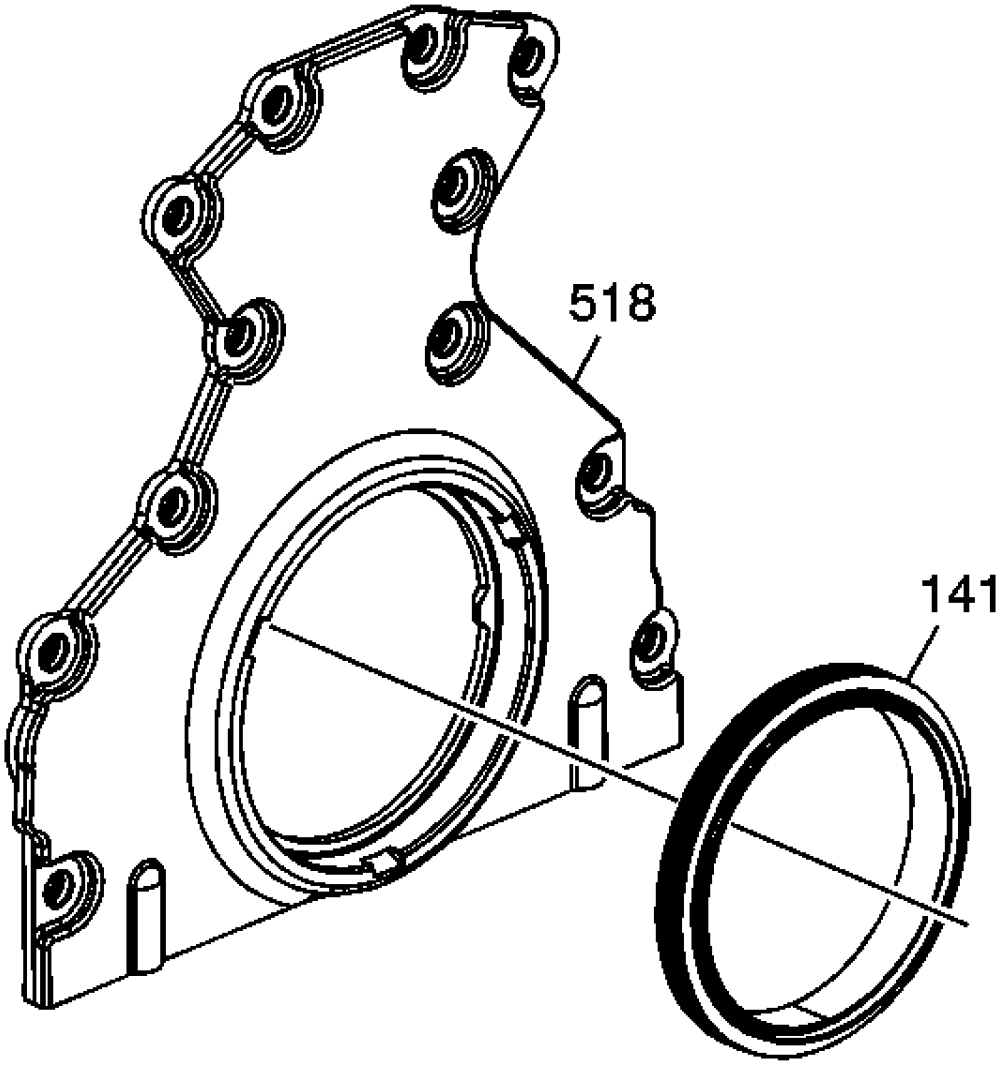


Fig. 148: Crankshaft Rear Oil Seal & Housing
Courtesy of GENERAL MOTORS CORP.

1. If equipped with manual transmission, remove the flywheel. Refer to **Engine Flywheel Replacement**.
2. If equipped with automatic transmission, remove the automatic transmission flexplate, refer to **Automatic Transmission Flex Plate Replacement** .
3. Remove and discard the crankshaft rear oil seal (141).

INSTALLATION PROCEDURE

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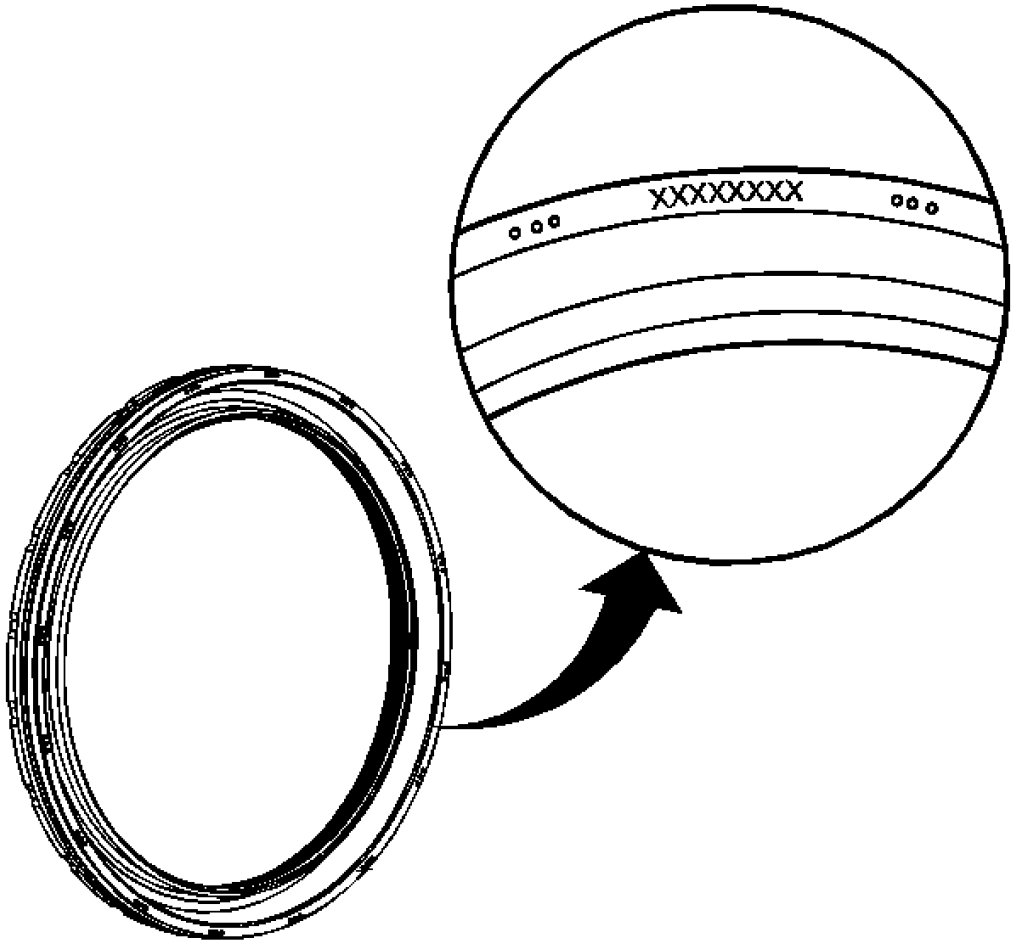


Fig. 149: Identifying Oil Seal
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: For proper orientation, note the installation direction of the oil seal. The oil seal is a reverse-lip design. The part number is applied to the outside face of the seal, as shown.

1. Inspect the seal and identify the part number markings for proper orientation.

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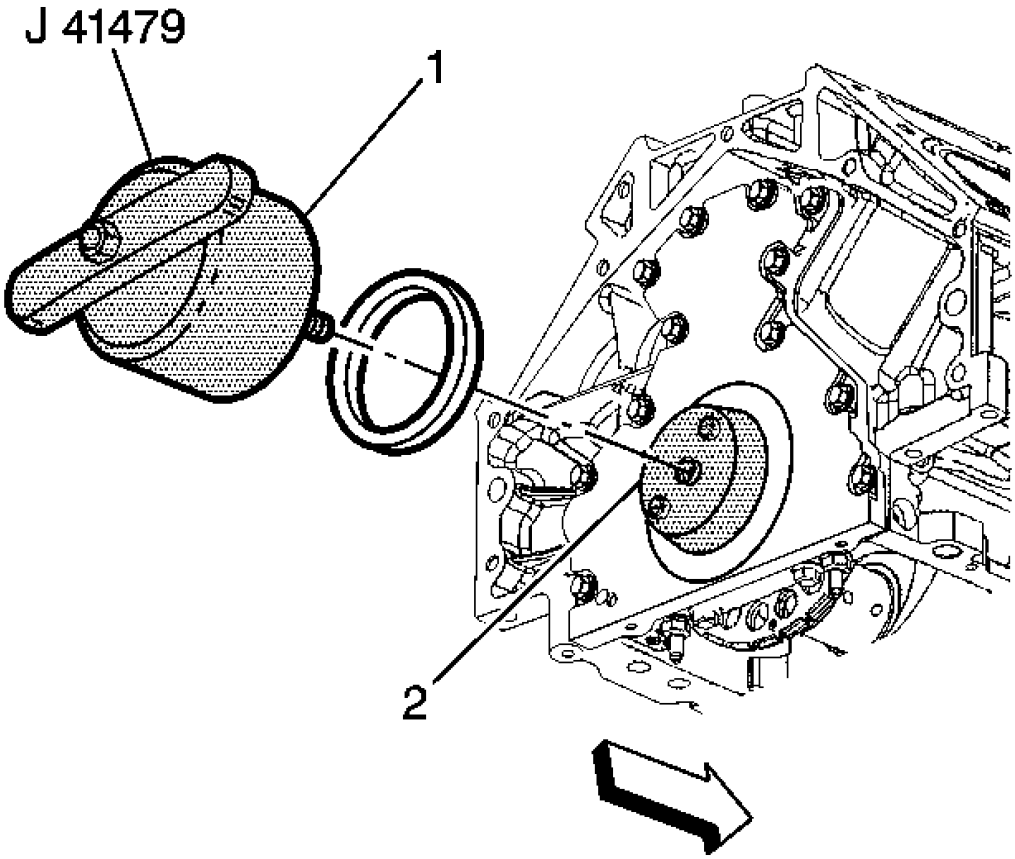


Fig. 150: Installing Crankshaft Rear Oil Seal Using J 41479
Courtesy of GENERAL MOTORS CORP.

2. Install the **J 41479** cone (2) and bolts onto the rear of the crankshaft.
3. Tighten the bolts until snug. Do not overtighten.
4. Install the rear oil seal onto the tapered cone (2) and push the seal to the rear seal bore. Install the oil seal with the part number markings facing away from the engine.
5. Thread the **J 41479** threaded rod into the tapered cone until the tool (1) contacts the oil seal.
6. Align the oil seal into the tool (1).
7. Rotate the handle of the tool (1) clockwise until the seal enters the rear cover and bottoms into the cover bore.
8. Remove the **J 41479** .
9. If equipped with automatic transmission, install the automatic transmission flexplate. refer to **Automatic Transmission Flex Plate Replacement** .
10. If equipped with manual transmission, install the flywheel. Refer to **Engine Flywheel Replacement**.

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CRANKSHAFT REAR OIL SEAL HOUSING REPLACEMENT

Special Tools

- **J 41476** Front and Rear Cover Alignment Tool. See **Special Tools** .
- **J 41479-2A** Crankshaft Rear Oil Seal Installation Guide. See **Special Tools** .

REMOVAL PROCEDURE

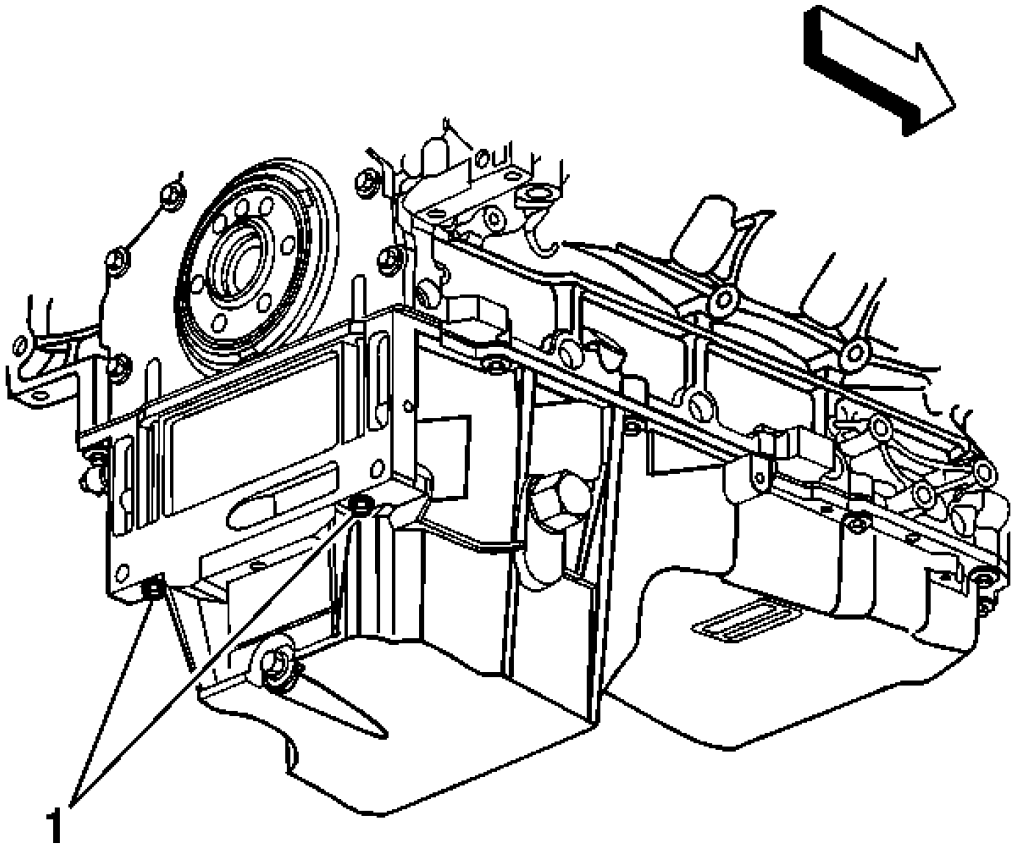


Fig. 151: View Of Oil Pan-To-Rear Cover Bolts
Courtesy of GENERAL MOTORS CORP.

1. If equipped with manual transmission, remove the flywheel. Refer to **Camshaft Replacement (LS3)** or **Camshaft Replacement (L99)**.
2. If equipped with automatic transmission, remove the automatic transmission flexplate, refer to **Automatic Transmission Flex Plate Replacement** .

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3. Remove the oil pan-to-rear oil seal housing bolts (1).

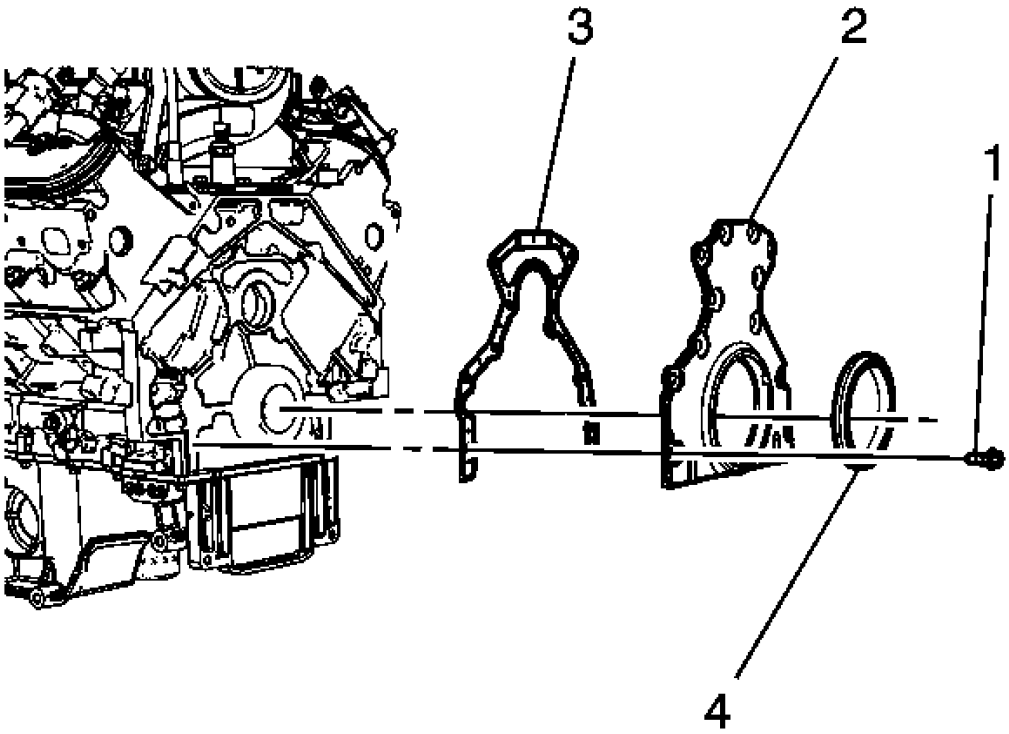


Fig. 152: Identifying Rear Oil Seal Housing Components
Courtesy of GENERAL MOTORS CORP.

4. Remove the rear oil seal housing bolts (1).
5. Remove the rear oil seal housing (2) and gasket (3). Discard the gasket.
6. Remove and discard the rear oil seal (4).

INSTALLATION PROCEDURE

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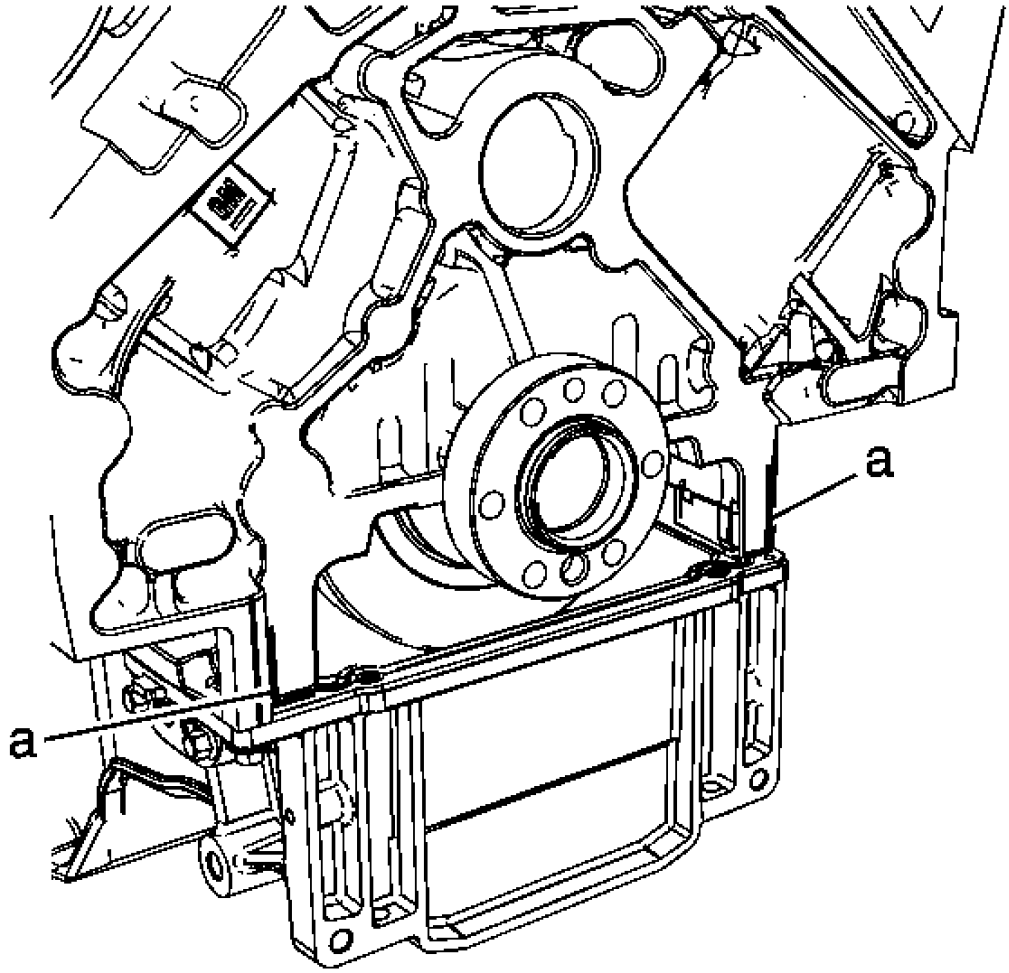


Fig. 153: Locating Joints At Rear Of Block/Pan
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Do not reuse the crankshaft oil seal or rear cover gasket.**
- **Do not apply any type of sealant to the rear cover gasket, unless specified.**
- **The special tool in this procedure is used to properly center the crankshaft rear oil seal.**
- **All gasket surfaces should be free of oil or other foreign material during assembly.**
- **The crankshaft rear oil seal MUST be centered in relation to the**

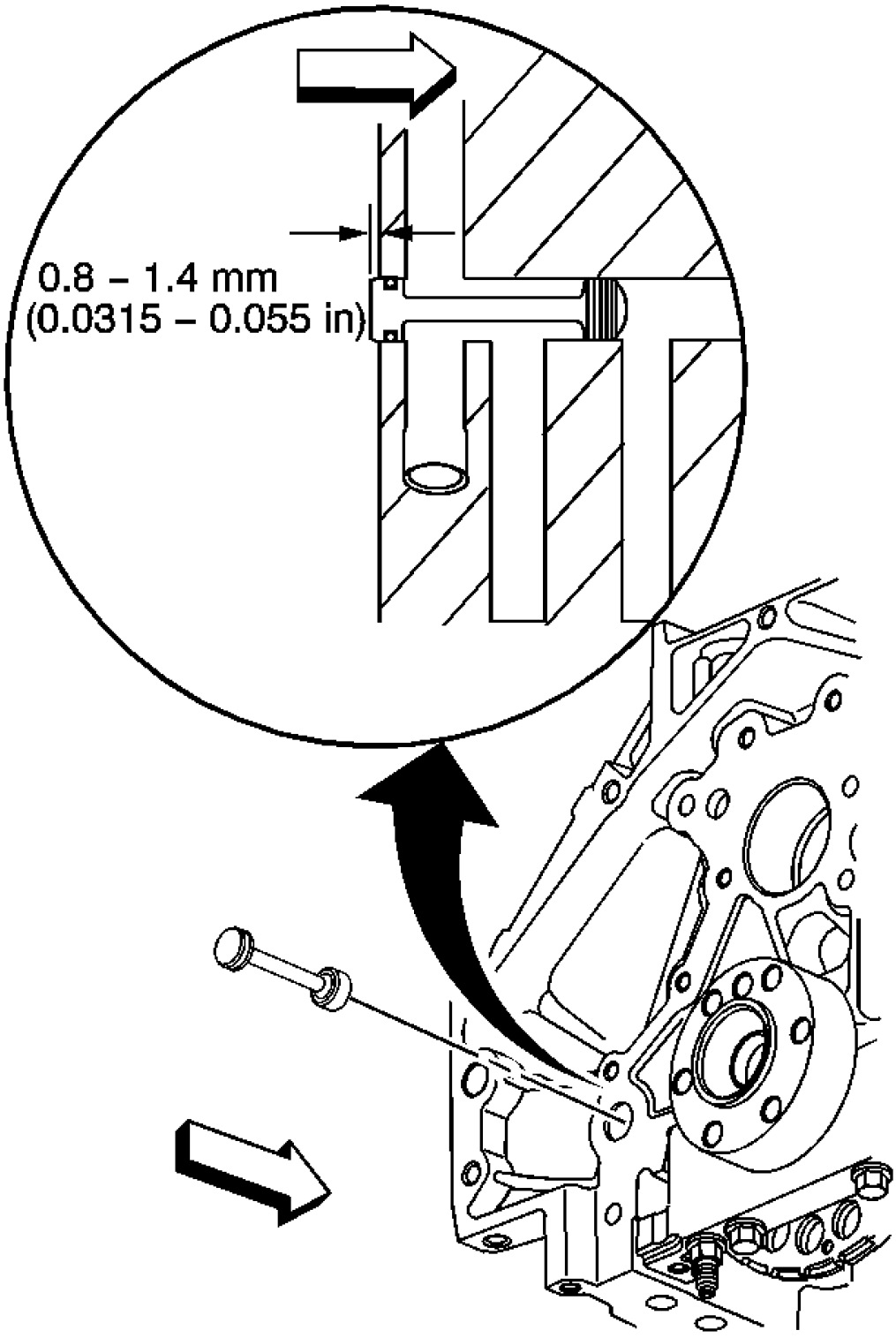
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crankshaft.

- **An improperly aligned rear cover may cause premature rear oil seal wear and/or engine assembly oil leaks.**

1. Apply a 5 mm (0.2 in) bead of sealant, 20 mm (0.8 in) to the 2 joints (a) at the rear of the block/pan. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

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Fig. 154: View Of Engine Block Rear Oil Gallery Plug
Courtesy of GENERAL MOTORS CORP.

2. Inspect the rear oil gallery plug for proper installation.

INSTALLATION PROCEDURE - COVER WITH SEAL

1. Install the **J 41479-2A** cone and bolts onto the rear of the crankshaft. See **Special Tools** .

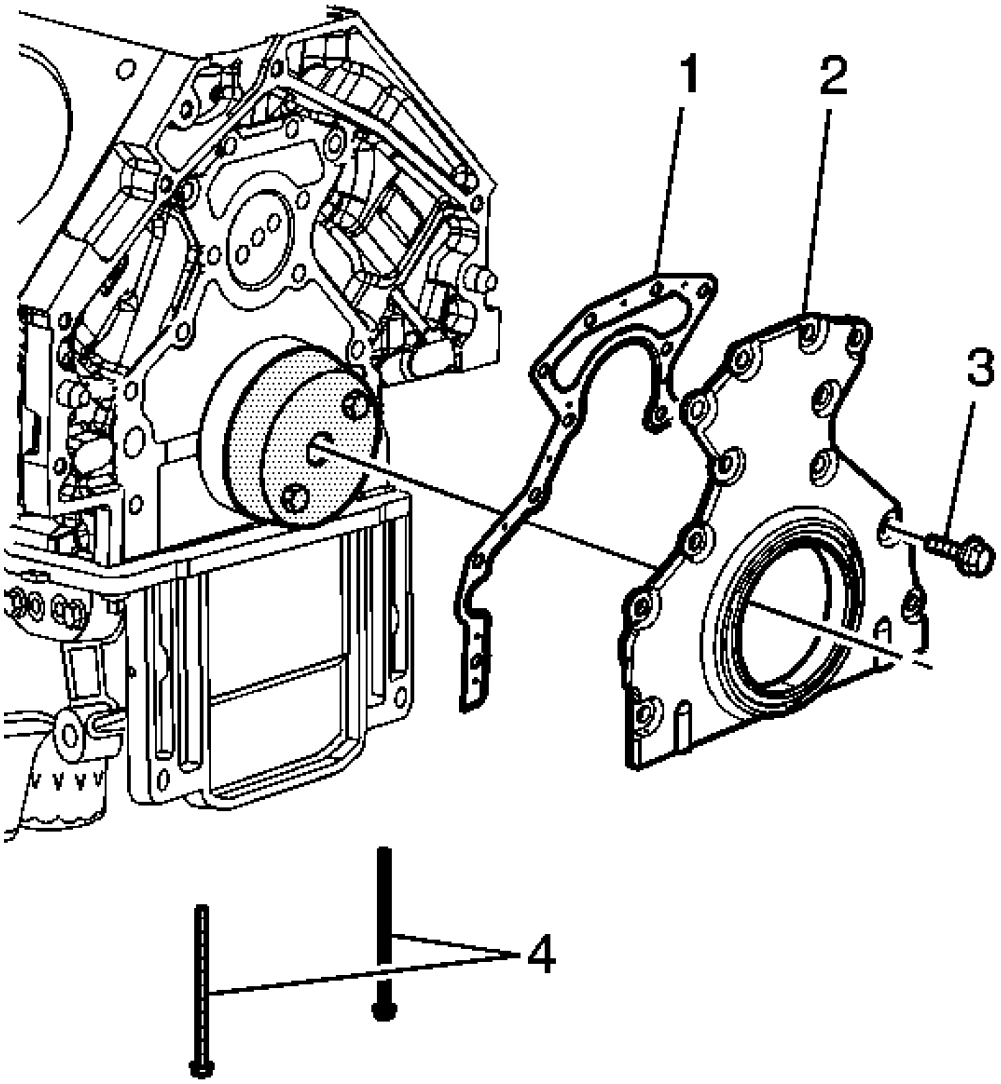


Fig. 155: Identifying Rear Housing Components

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Courtesy of GENERAL MOTORS CORP.

2. Install the NEW rear housing gasket (1), rear housing with seal (2), rear housing to engine bolts (3) and oil pan to rear housing bolts (4).

CAUTION: Refer to Fastener Caution .

3. Tighten the rear housing to engine bolts (3) until snug. Do not overtighten. Tighten the oil pan-to-rear housing bolts (4) to 12 N.m (106 lb in).
4. Tighten the rear housing to engine bolts (3) to 30 N.m (22 lb ft).
5. Remove the **J 41479-2A** . See **Special Tools** .
6. If equipped with automatic transmission, install the automatic transmission flexplate. refer to **Automatic Transmission Flex Plate Replacement** .
7. If equipped with manual transmission, install the flywheel. Refer to **Camshaft Replacement (LS3)** or **Camshaft Replacement (L99)**.

INSTALLATION PROCEDURE - COVER WITHOUT SEAL

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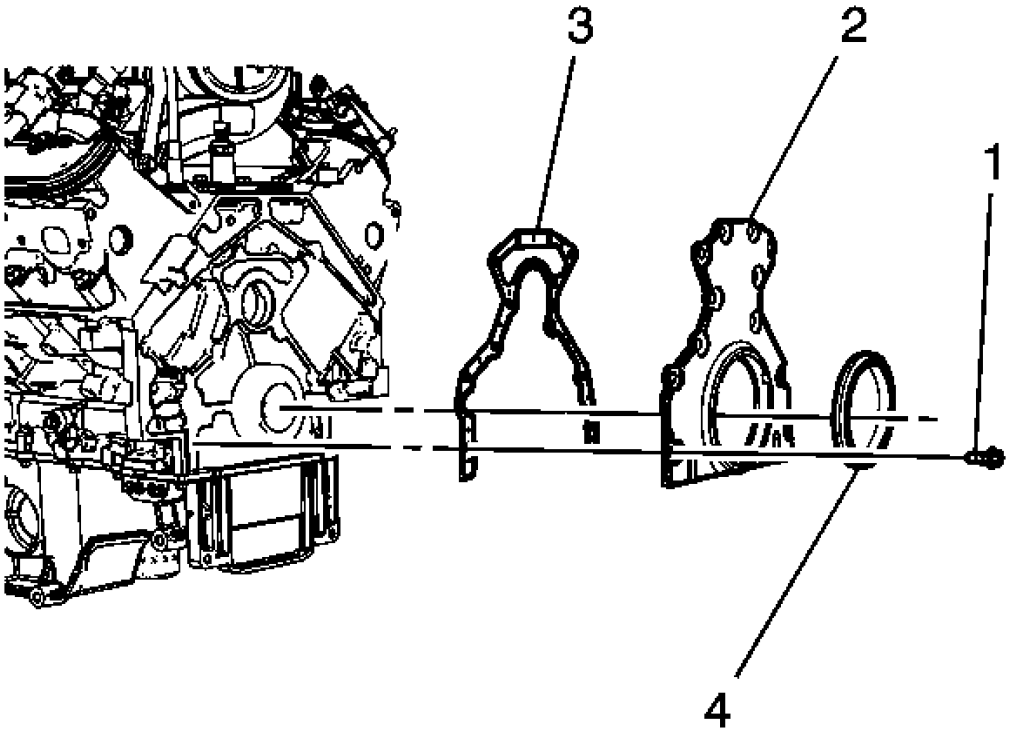


Fig. 156: Identifying Rear Oil Seal Housing Components
Courtesy of GENERAL MOTORS CORP.

1. Position a NEW rear oil seal housing gasket (3) and the housing (2) to the engine.
2. Install the rear oil seal housing bolts (1) until snug. Do not overtighten.
3. Rotate the crankshaft until 2 opposing flywheel bolts holes are parallel to the oil pan surface.

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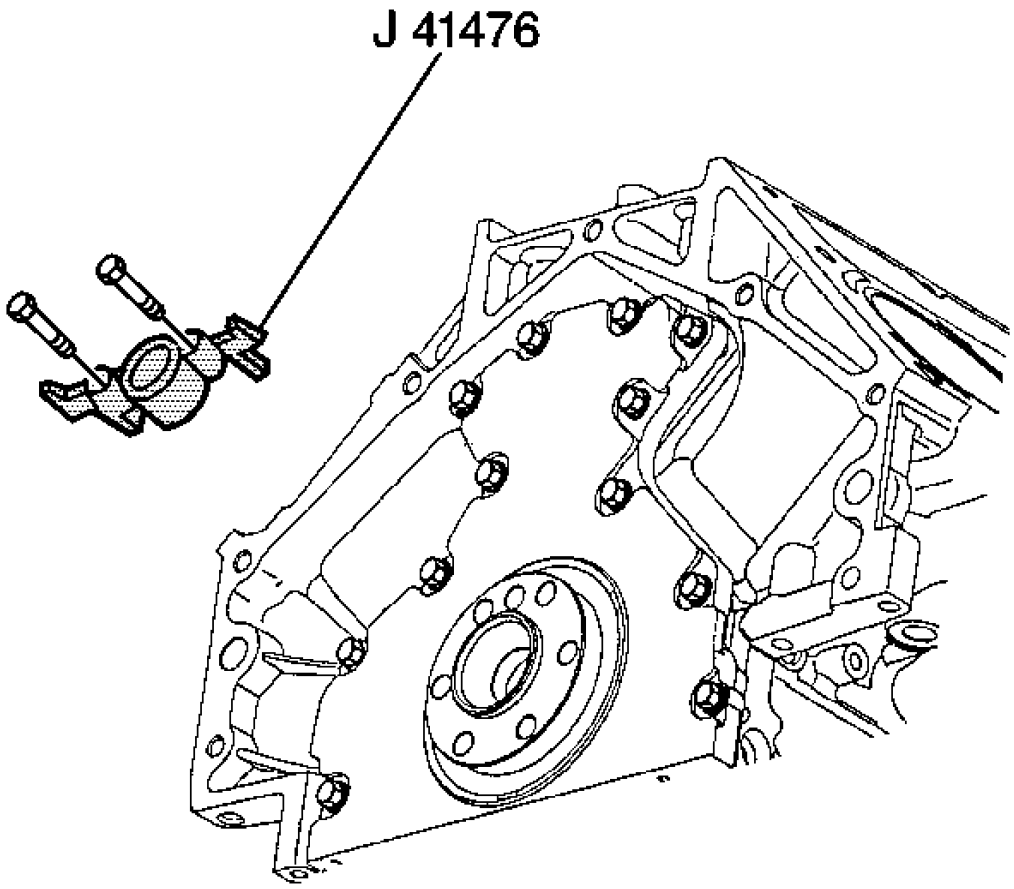


Fig. 157: View Of J 41476
Courtesy of GENERAL MOTORS CORP.

NOTE: The tapered legs of the alignment tool must enter the rear cover oil seal bore.

4. Install the **J 41476** and bolts onto the rear of the crankshaft. See **Special Tools** .
5. Tighten the **J 41476** bolts until snug. See **Special Tools** . Do not overtighten.

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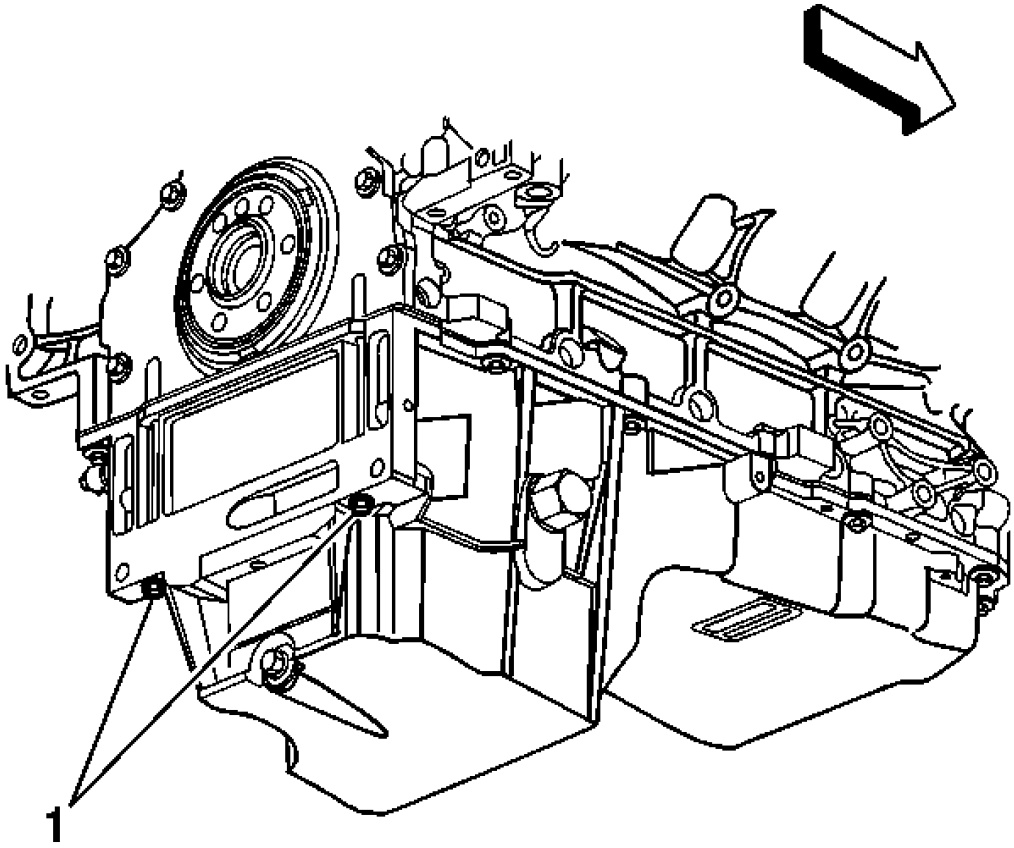


Fig. 158: View Of Oil Pan-To-Rear Cover Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install the oil pan to rear oil seal housing bolts (1).
    1. Tighten the oil pan to rear cover bolts to 12 N.m (106 lb in).
    2. Tighten the rear oil seal housing to engine bolts to 30 N.m (22 lb ft).
7. Remove the **J 41476** . See **Special Tools** .
8. Install a NEW crankshaft rear oil seal. Refer to **Crankshaft Rear Oil Seal Replacement**.
9. If equipped with automatic transmission, install the automatic transmission flexplate. refer to **Automatic Transmission Flex Plate Replacement** .
10. If equipped with manual transmission, install the flywheel. Refer to **Camshaft Replacement (LS3)** or **Camshaft Replacement (L99)**.

OIL FILTER ADAPTER REPLACEMENT

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REMOVAL PROCEDURE

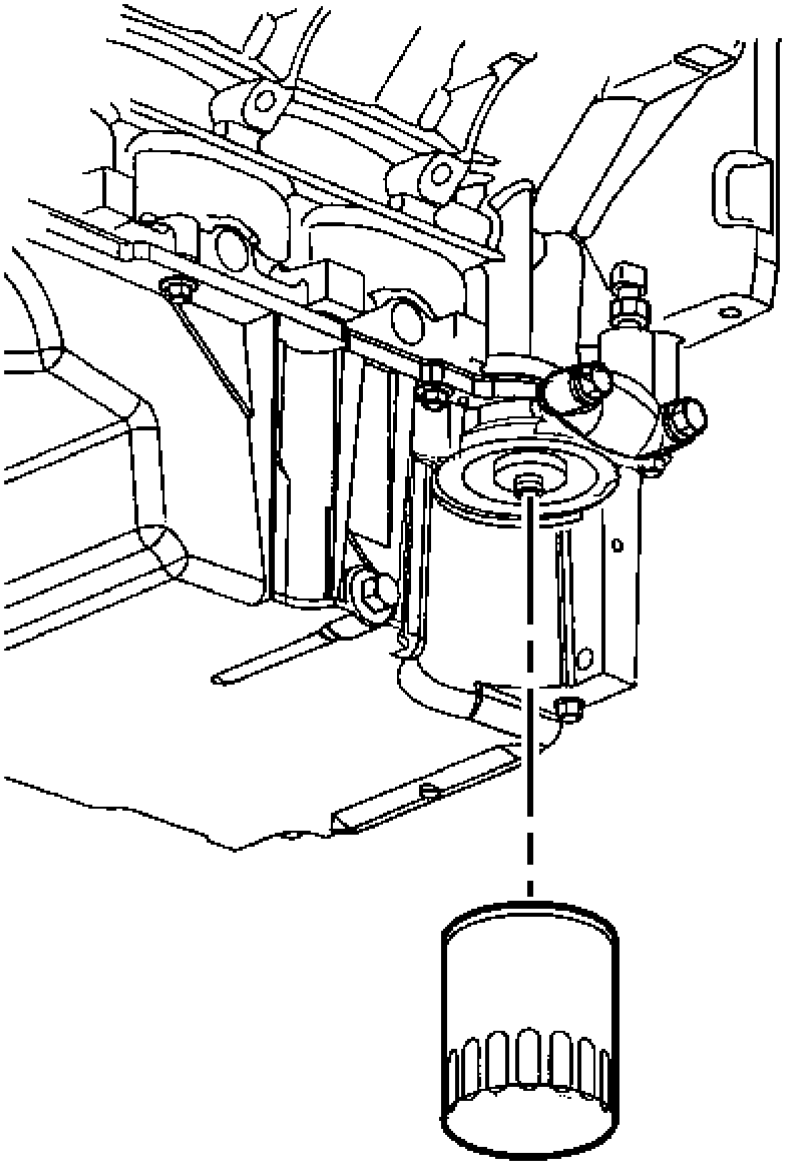


Fig. 159: Installing/Removing Oil Filter
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil filter.

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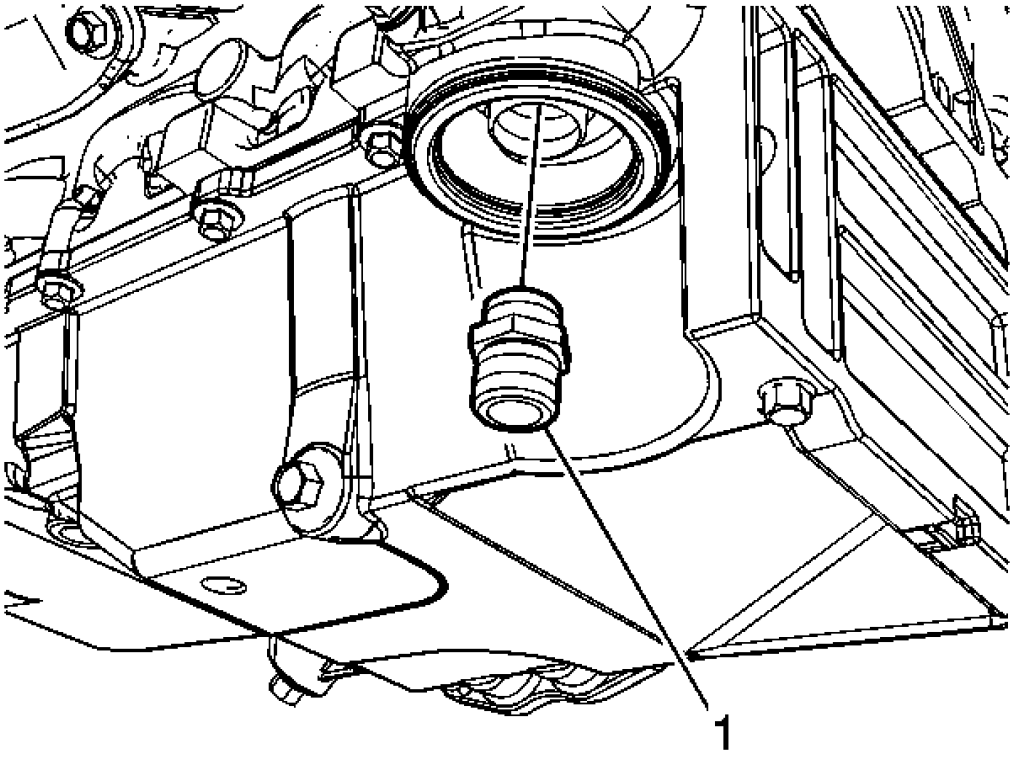


Fig. 160: Oil Filter Adapter
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil filter adapter (1).

INSTALLATION PROCEDURE

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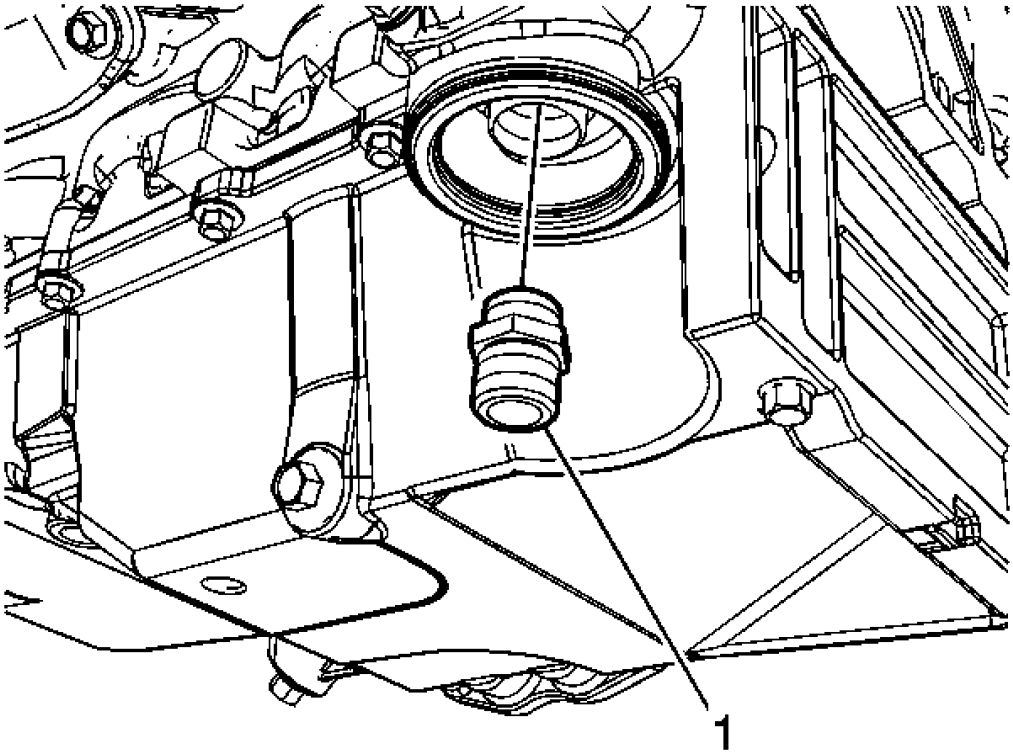


Fig. 161: Oil Filter Adapter
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the oil filter adapter (1).

   Tighten: Tighten the oil filter adapter to 55 N.m (40 lb ft).

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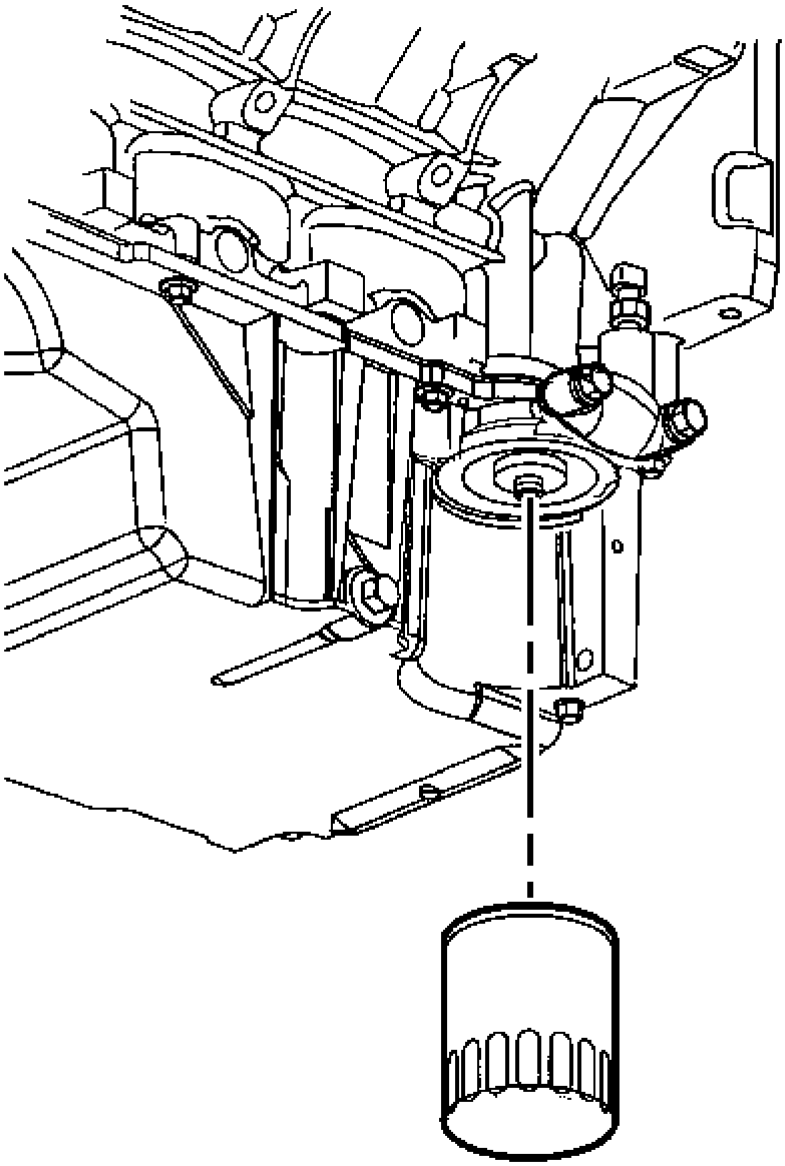


Fig. 162: Installing/Removing Oil Filter
Courtesy of GENERAL MOTORS CORP.

2. Install the oil filter.

Tighten: Tighten the oil filter to 30 N.m (22 lb ft).

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OIL PAN REPLACEMENT

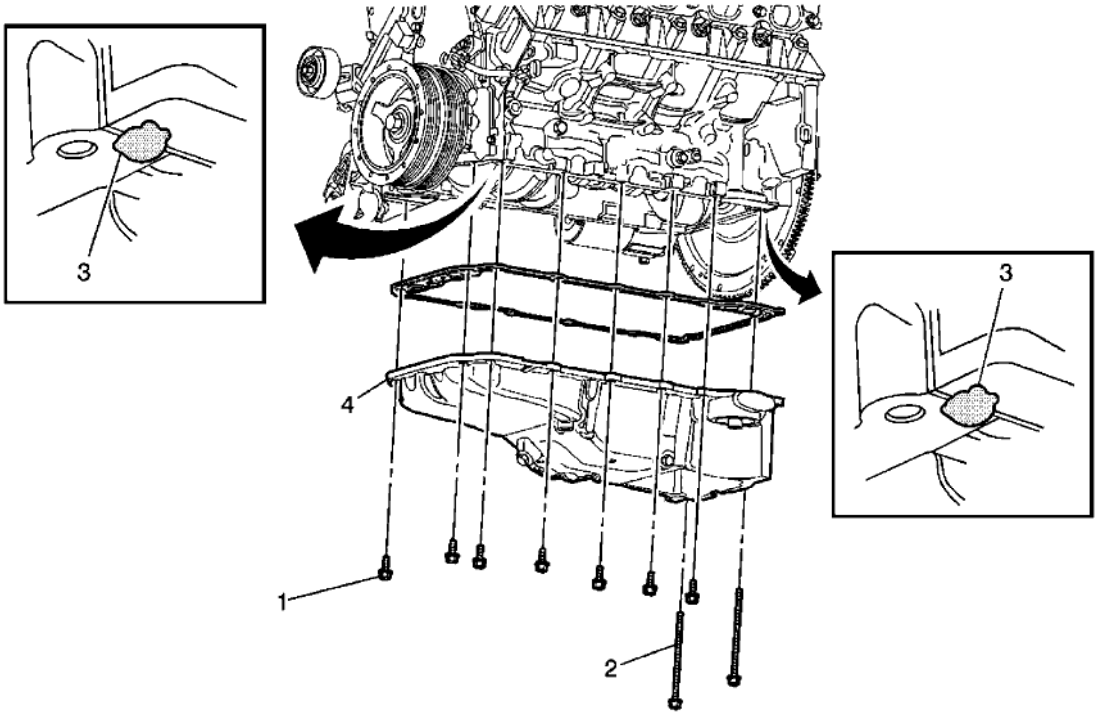


Fig. 163: Oil Pan
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove the front frame. Refer to **Drivetrain and Front Suspension Frame Replacement** . 2. Remove the oil filter. Refer to **Engine Oil and Oil Filter Replacement**. 3. Remove the starter assembly. Refer to **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)** . 4. Remove the engine oil cooler. Refer to **Engine Oil Cooler Replacement** . 5. Remove the A/C lines from the compressor and reposition to access the harness and bolts. Refer to **Air Conditioning Compressor Hose Replacement (LLT)** or **Air Conditioning Compressor Hose Replacement (LS3, L99)** . 6. Reposition the engine wiring harness. 7. Reposition the oil cooler lines as needed.	
1	Oil Pan Fastener (Qty: 12) **CAUTION:** **Refer to Fastener Caution .**

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	Tighten: 25 N.m (18 lb ft)
2	Oil Pan Fastener (Qty: 2) **Tighten:** 12 N.m (106 lb in)
3	Oil Pan Sealant **Procedure** 1. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the engine block. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . 2. Apply the sealant directly onto the tabs of the front cover gasket that protrude into the oil pan surface. **Tip:** • The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission housing. To ensure the rigidity of the powertrain and correct transmission alignment, it is important that the rear of the block and the rear of the oil pan are flush or even. The rear of the oil pan must NEVER protrude beyond the engine block and the transmission housing plane. • A new oil pan gasket should be used whenever the oil pan is removed from the engine assembly.
4	Oil Pan **Procedure** 1. Disconnect any electrical connectors. 2. Transfer components as necessary.

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT (L99/LS3)

SPECIAL TOOLS

J 41712 Oil Pressure Sensor Socket. See **Special Tools** .

REMOVAL PROCEDURE

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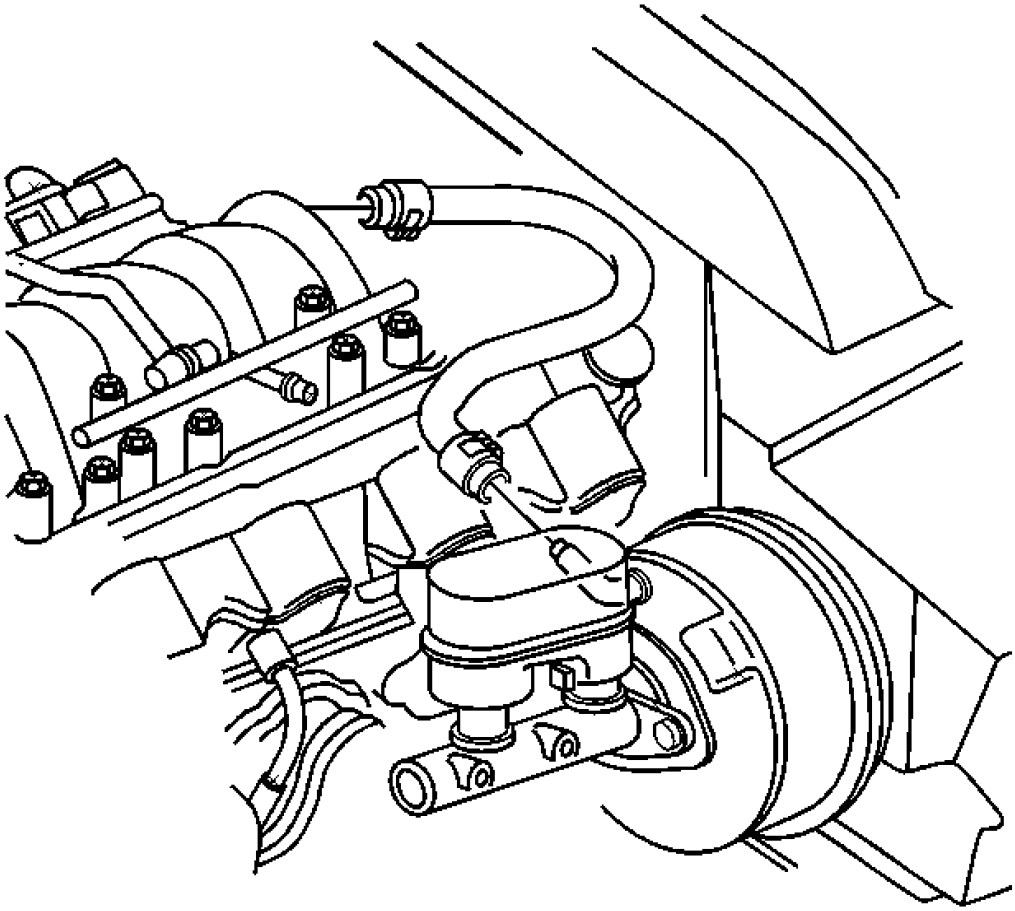


Fig. 164: View Of Vacuum Brake Booster Hose
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine cover. Refer to **Engine Cover Replacement**
2. Clean area around the oil sensor/switch before removing it.
3. Remove the positive crankcase ventilation hose/pipe/tube. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement**

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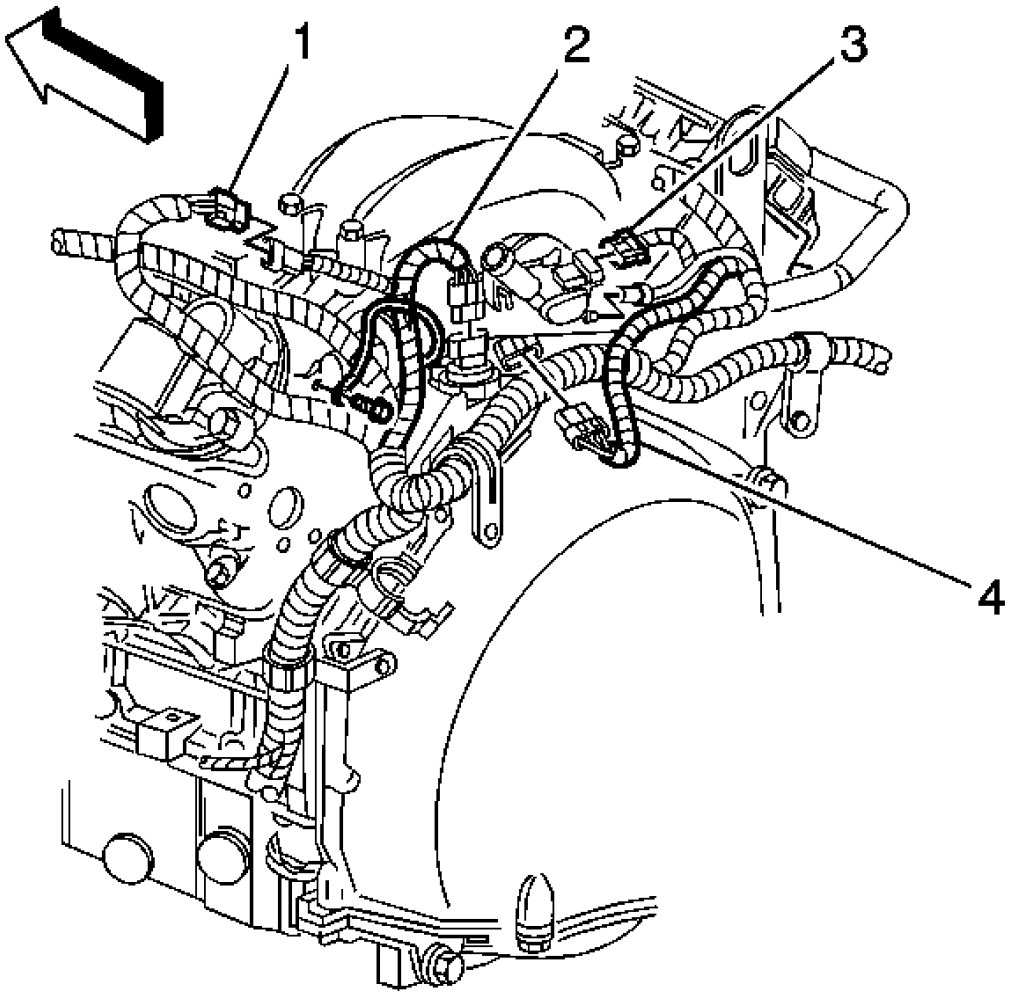


Fig. 165: Oil Pressure Sensor/Switch Electrical Connector
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the electrical connector for the oil pressure sensor/switch (2).

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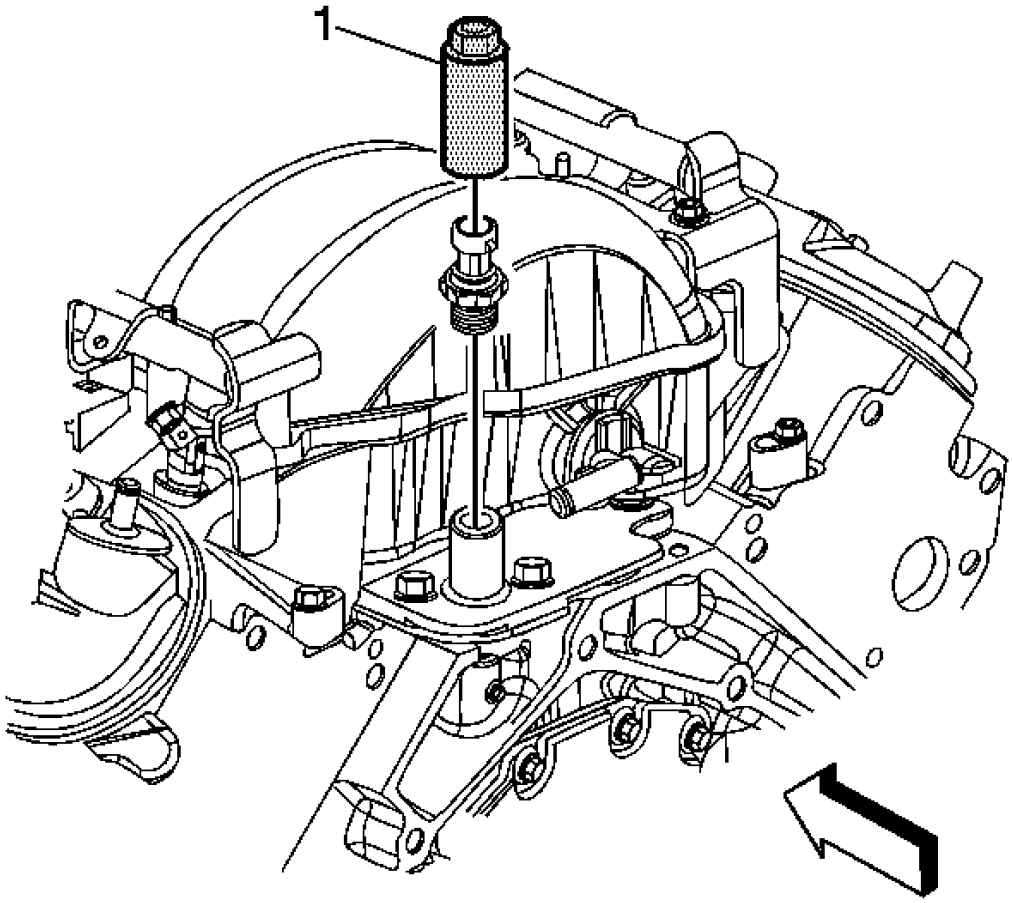


Fig. 166: J 41712 & Oil Pressure Sensor/Switch
Courtesy of GENERAL MOTORS CORP.

5. Using the **J 41712** (1), remove the oil pressure sensor/switch. See **Special Tools** .

INSTALLATION PROCEDURE

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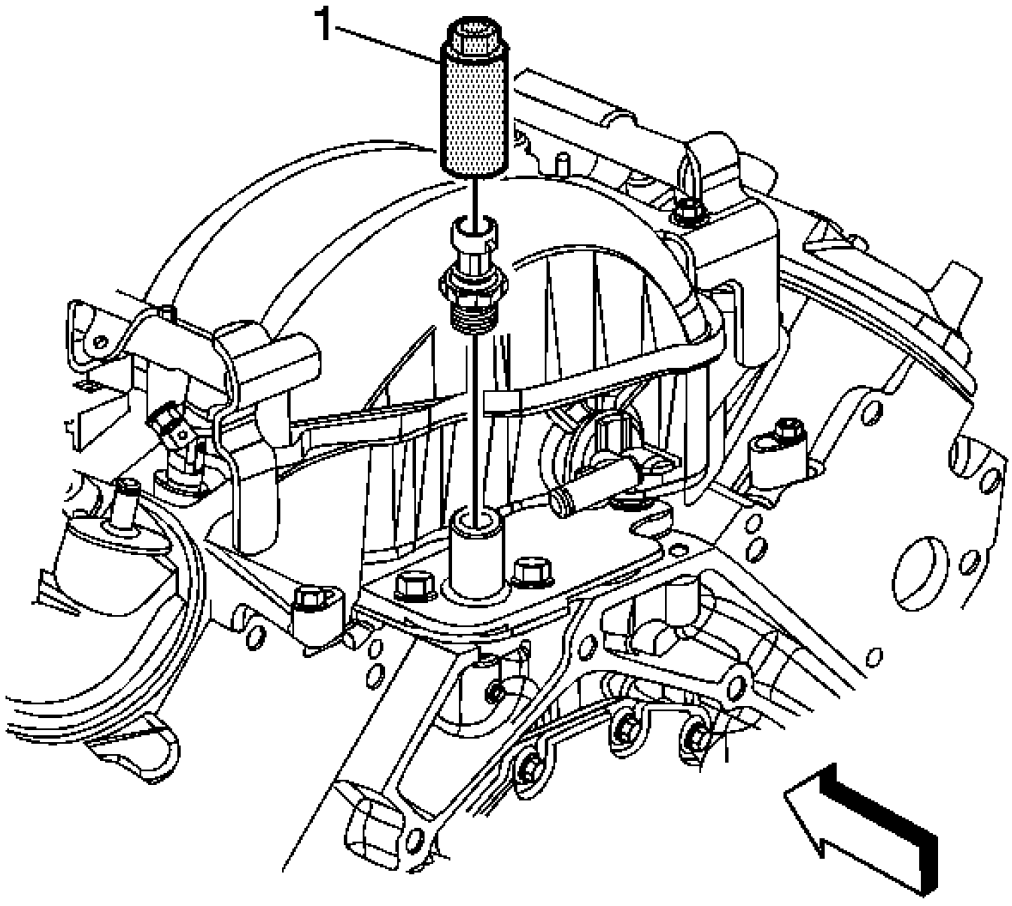


Fig. 167: J 41712 & Oil Pressure Sensor/Switch
Courtesy of GENERAL MOTORS CORP.

1. If installing the old sensor, apply threadlocker sealant. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

CAUTION: Refer to Fastener Caution .

2. Using the **J 41712** (1), install the oil pressure sensor/switch. See **Special Tools** . Tighten the engine oil pressure sensor to 20 N.m (15 lb ft).

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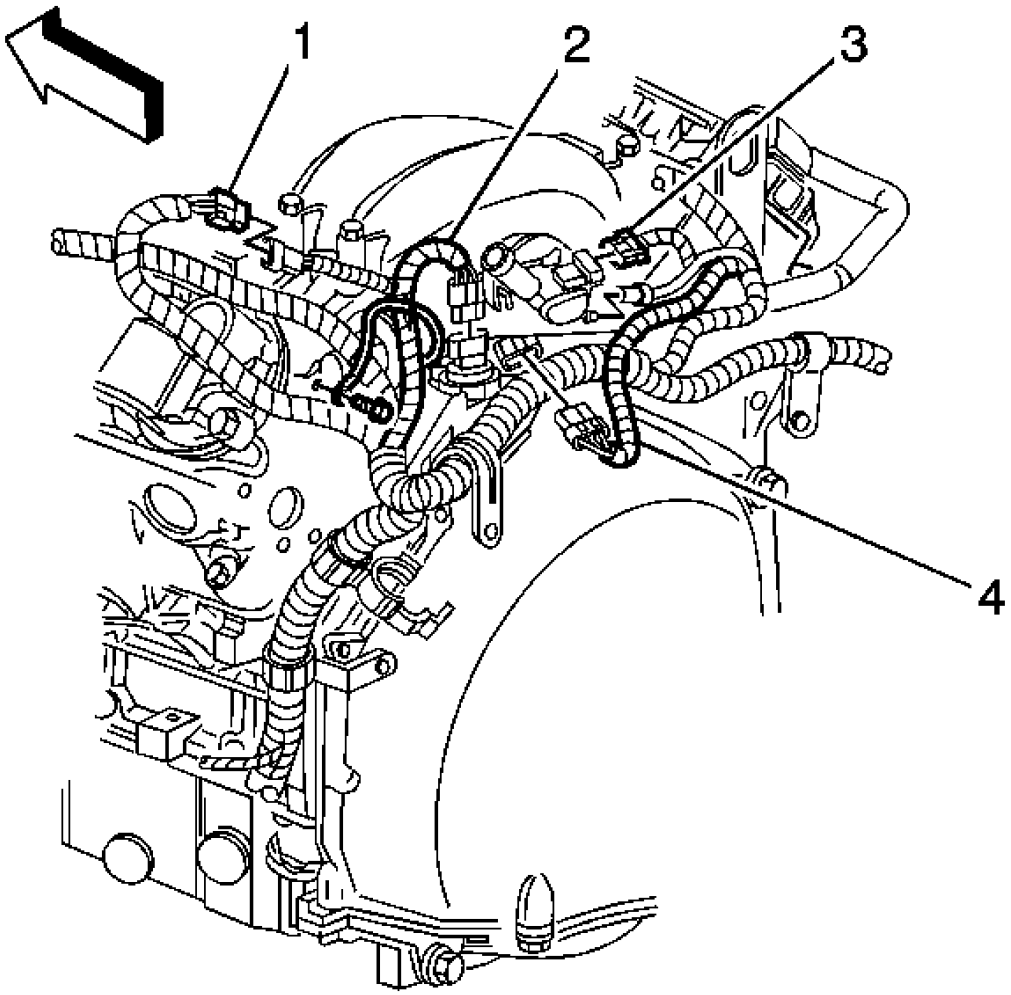


Fig. 168: Oil Pressure Sensor/Switch Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Reconnect the oil pressure sensor/switch electrical connector (2).

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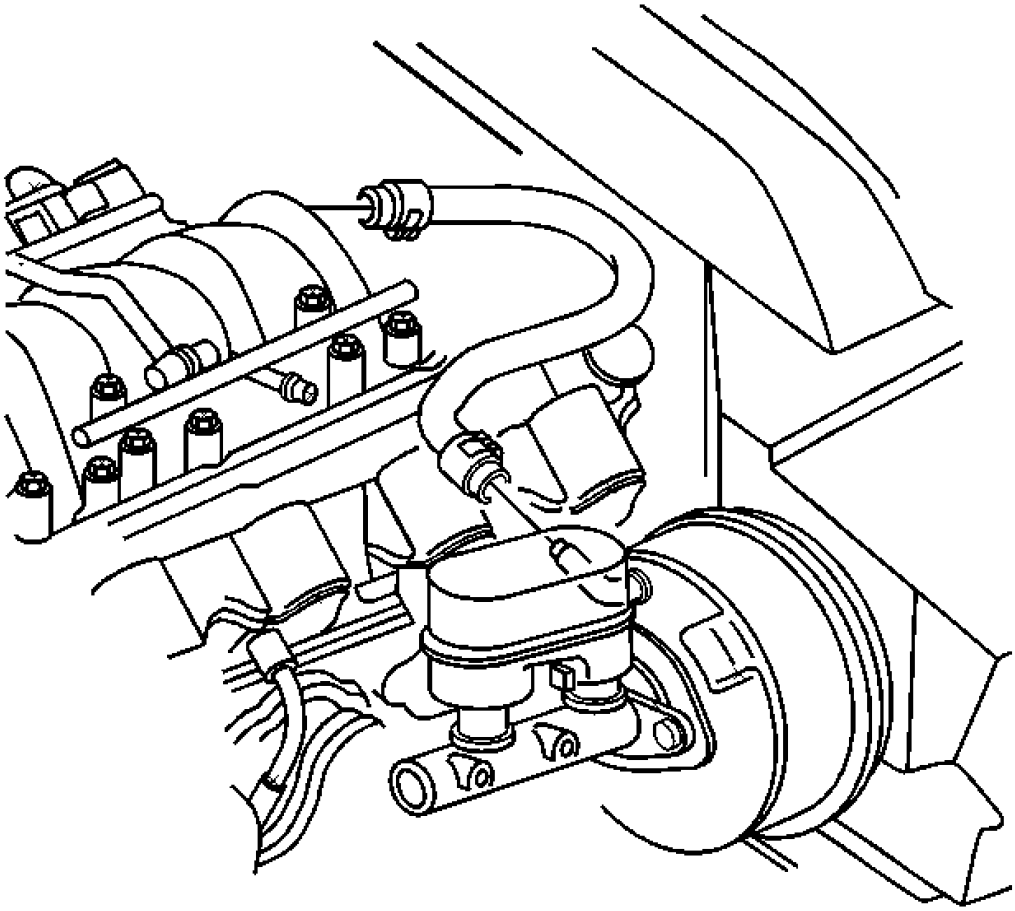


Fig. 169: View Of Vacuum Brake Booster Hose
Courtesy of GENERAL MOTORS CORP.

4. Install the vacuum hose for the power brake booster.
5. Install the left engine sight cover.

ENGINE OIL LEVEL SENSOR AND/OR SWITCH REPLACEMENT

REMOVAL PROCEDURE

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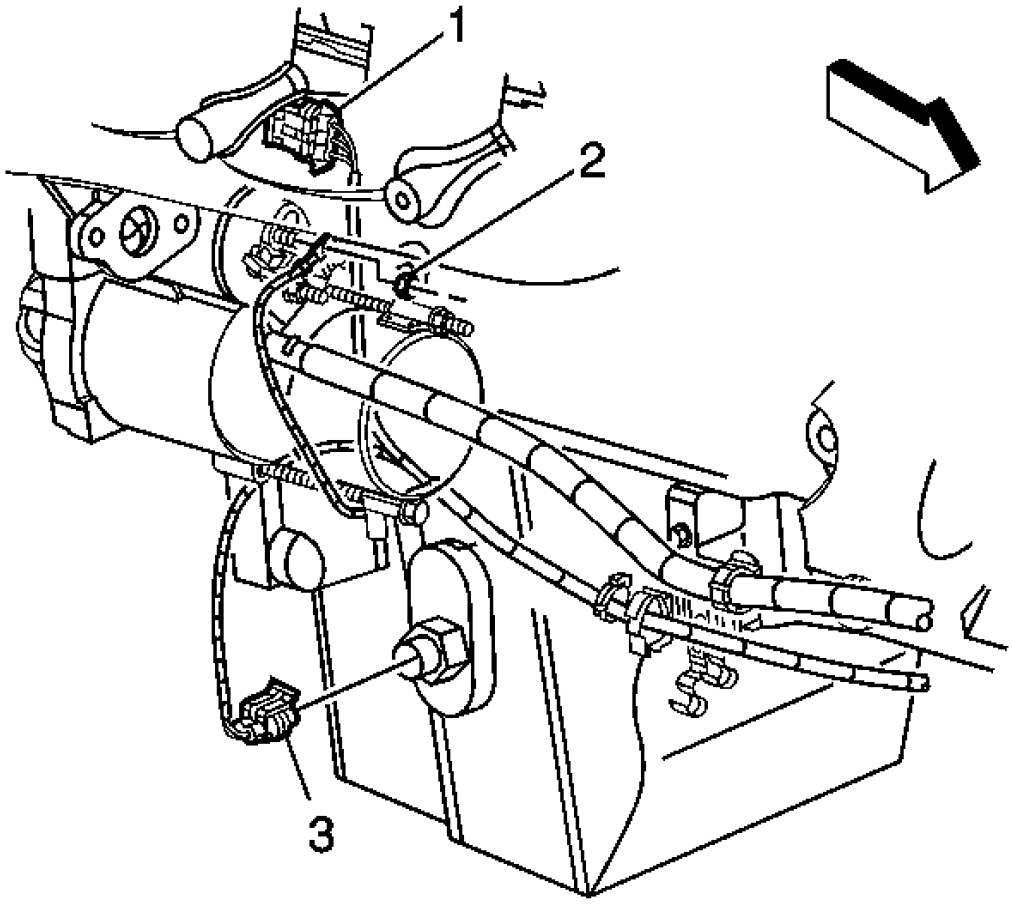


Fig. 170: View Of Oil Level Sensor & CKP Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Drain the engine of oil.
3. Disconnect the electrical connector (3).

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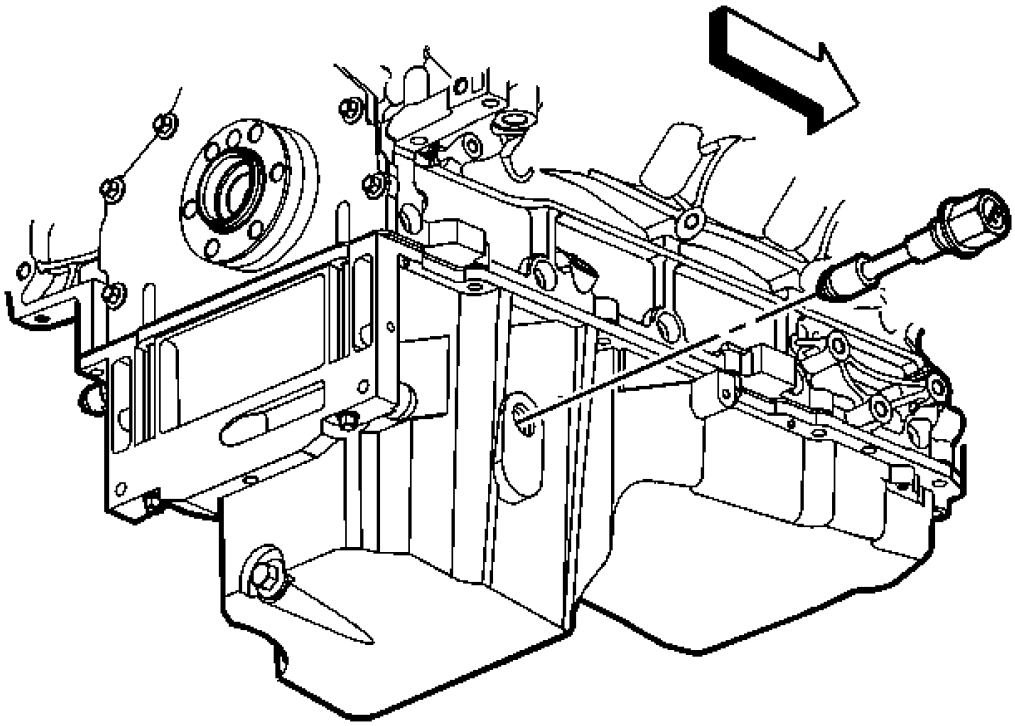


Fig. 171: View Of Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

4. Remove the engine oil lever sensor.

INSTALLATION PROCEDURE

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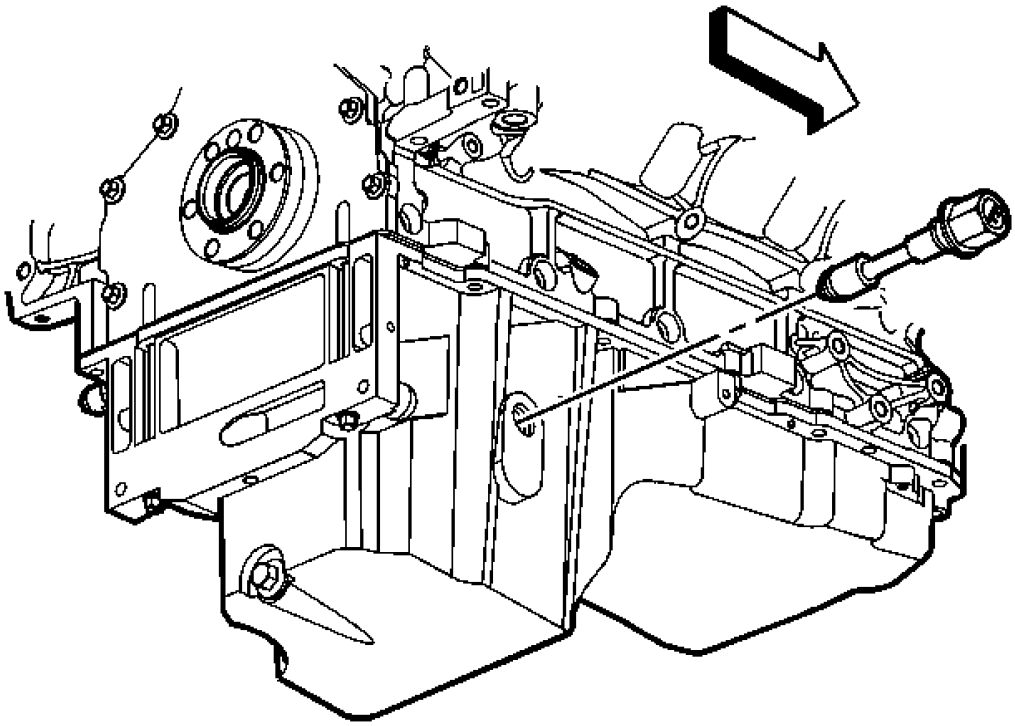


Fig. 172: View Of Oil Level Sensor
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the drain plug and tighten to 25 N.m (18 lb ft).
2. Install the engine oil level sensor. Tighten the sensor to 20 N.m (15 lb ft).

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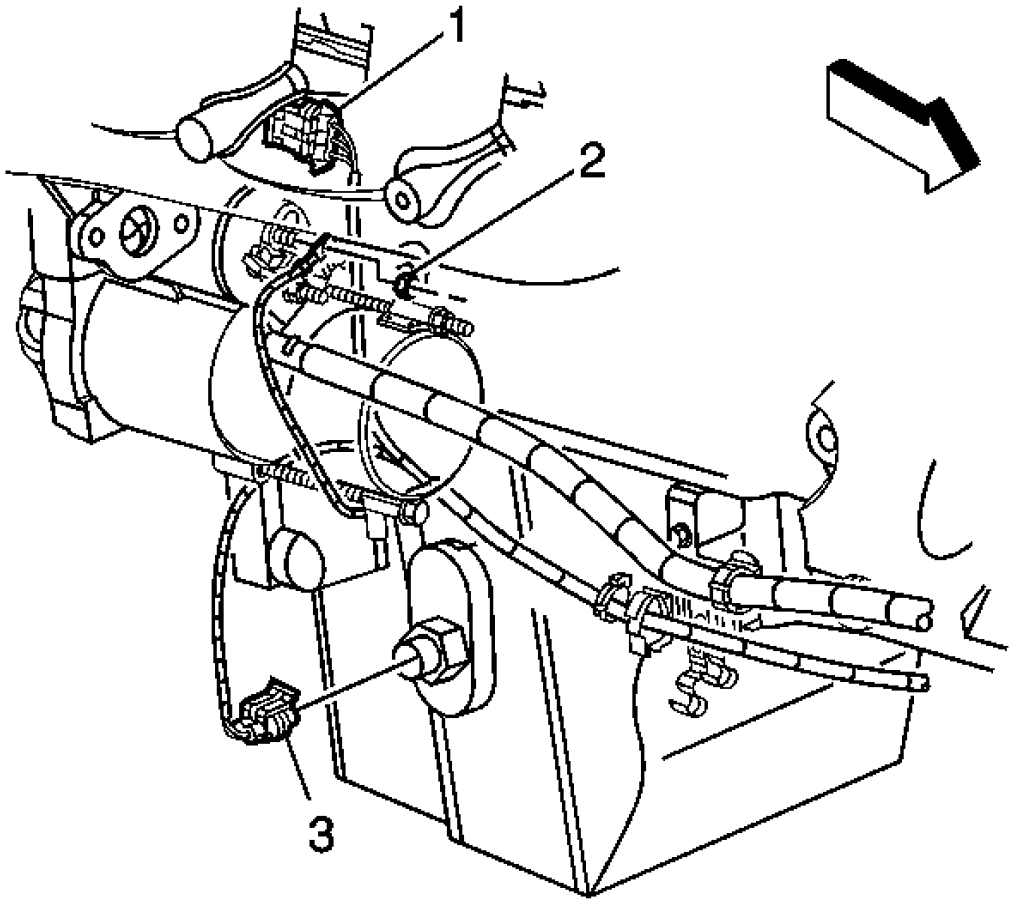


Fig. 173: View Of Oil Level Sensor & CKP Sensor Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Reconnect the electrical connector (3).
4. Lower the vehicle.
5. Refill the engine. Refer to **Approximate Fluid Capacities** .

OIL PUMP, SCREEN, AND CRANKSHAFT OIL DEFLECTOR REPLACEMENT

REMOVAL PROCEDURE

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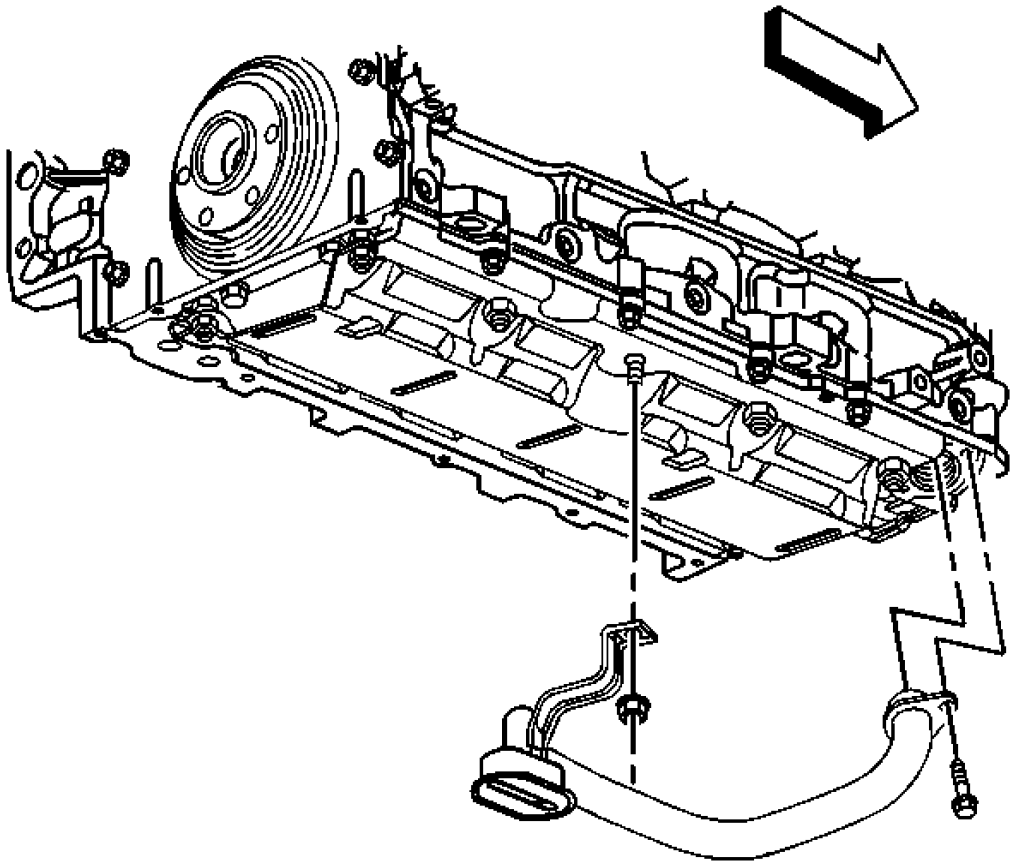


Fig. 174: O-Ring Seal, Oil Pump Screen & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement (L99)** or **Engine Front Cover Replacement (LS3)**.
2. Remove the engine oil pan. Refer to **Oil Pan Replacement**.
3. Remove the oil pump screen bolt and nut.
4. Remove the oil pump screen and O-ring seal.
5. Remove the O-ring seal from the pump screen.
6. Discard the O-ring seal.

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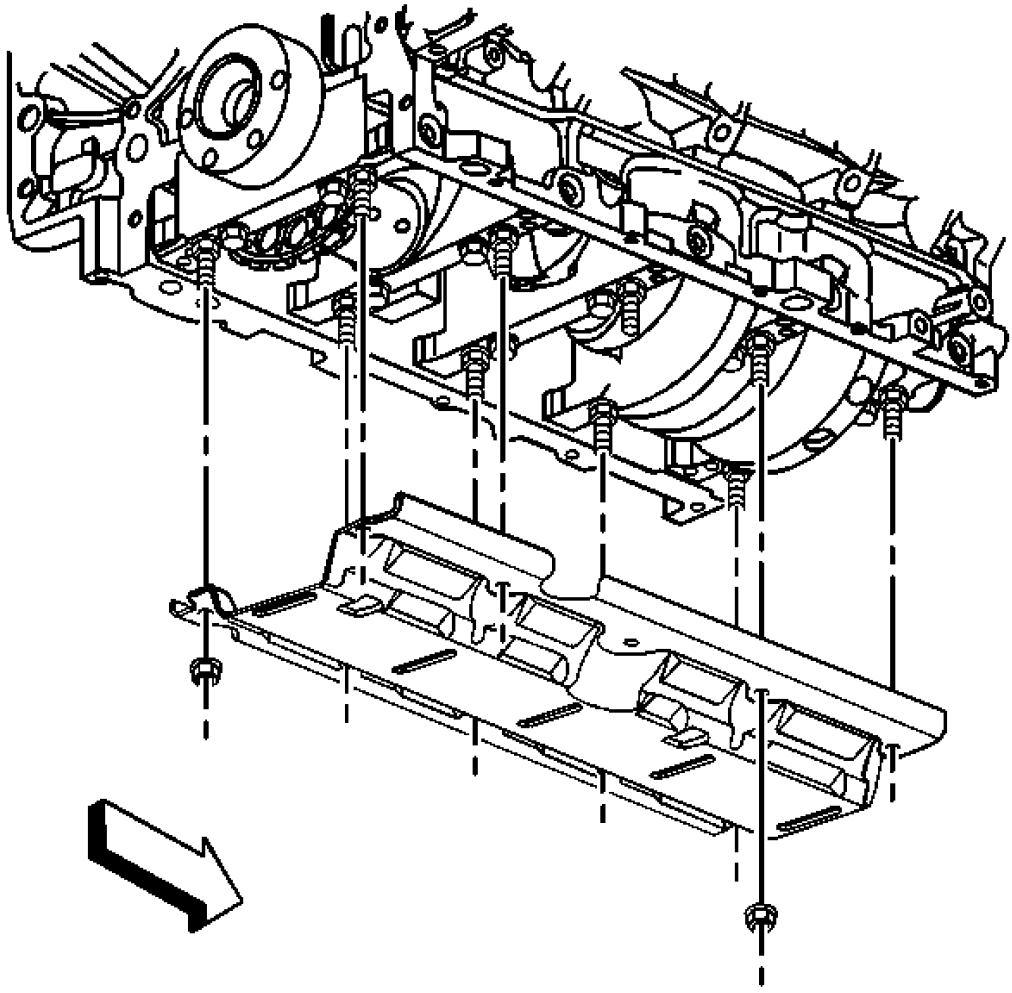


Fig. 175: View Of Crankshaft Oil Deflector & Nuts
Courtesy of GENERAL MOTORS CORP.

7. Remove the remaining crankshaft oil deflector nuts.
8. Remove the crankshaft oil deflector.

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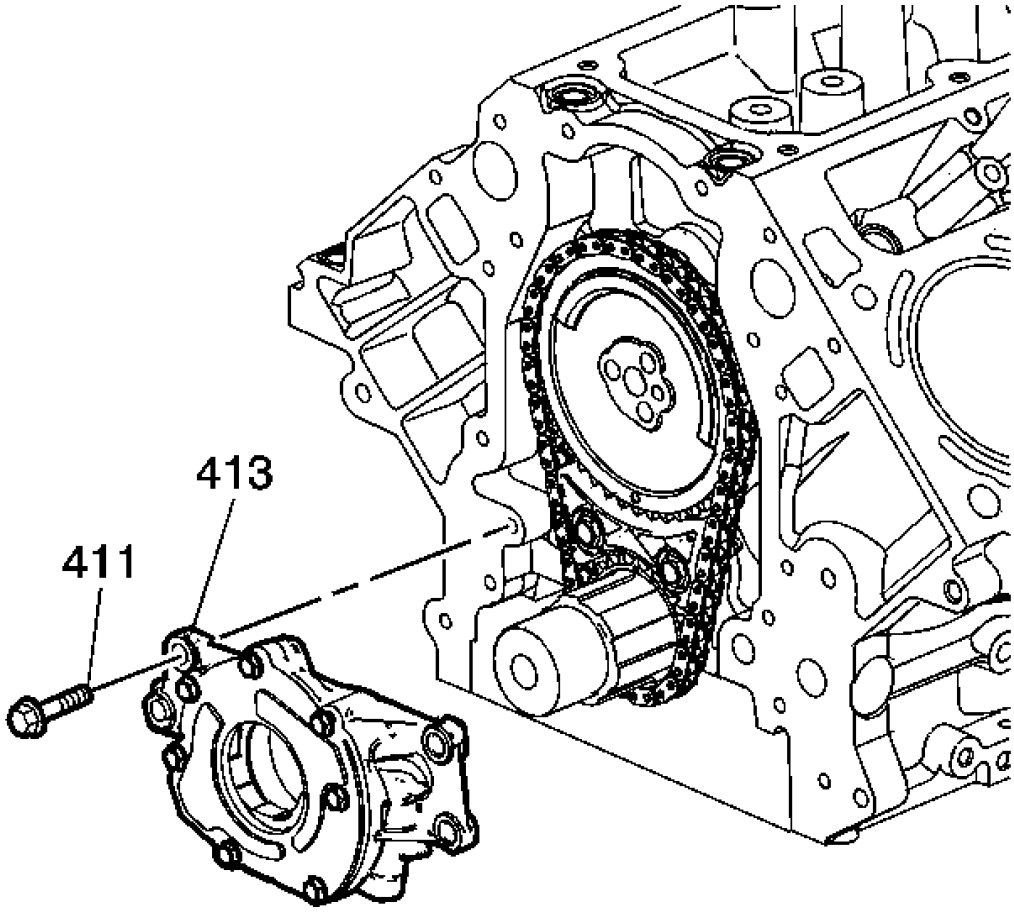


Fig. 176: View Of Oil Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not allow dirt or debris to enter the oil pump, cap the ends as necessary.

9. Remove the oil pump (413) and bolts (411).
10. Remove the oil pump.
11. Clean and inspect the oil pump. Refer to **Oil Pump Cleaning and Inspection** .

INSTALLATION PROCEDURE

NOTE: Inspect the engine block oil gallery passages. These surfaces must be clear and free of debris or restrictions.

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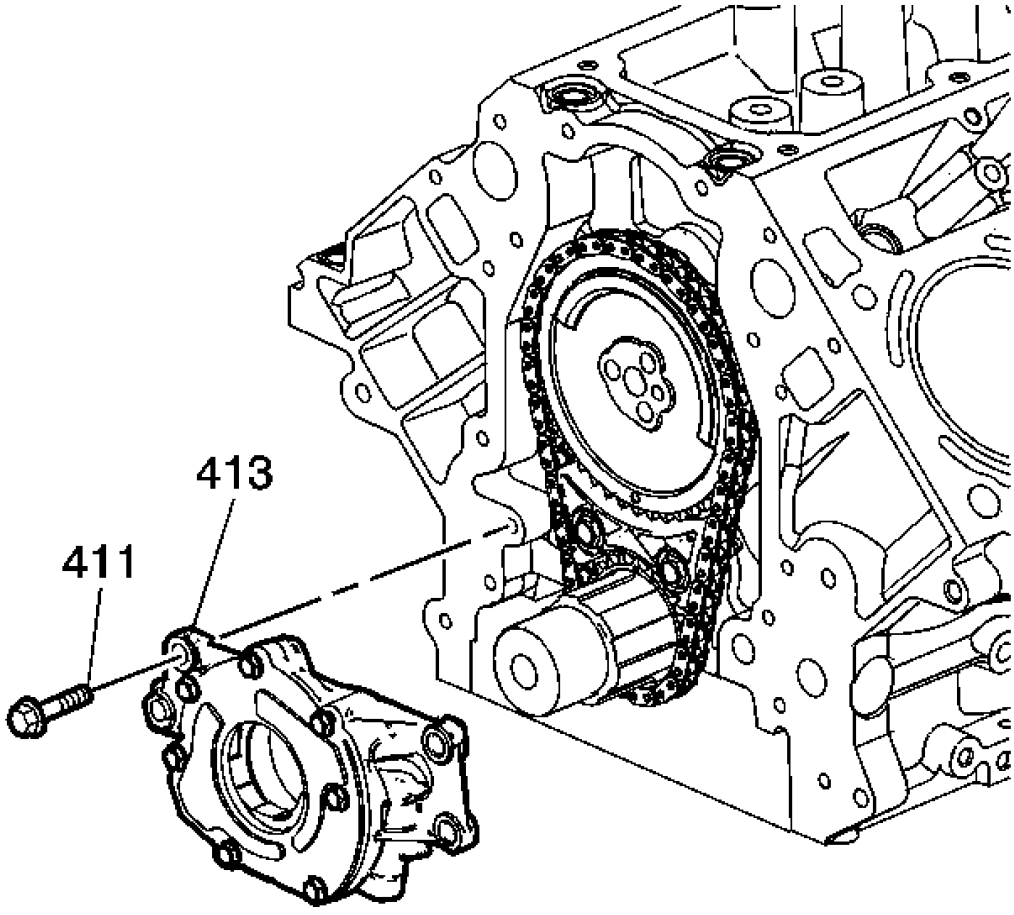


Fig. 177: View Of Oil Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Align the splined surfaces of the crankshaft sprocket and the oil pump drive gear and install the oil pump (413).
2. Install the oil pump (413) onto the crankshaft sprocket until the pump housing contacts the face of the engine block.

CAUTION: Refer to Fastener Caution .

3. Install the oil pump bolts (411).

Tighten: Tighten the oil pump bolts to 25 N.m (18 lb ft).

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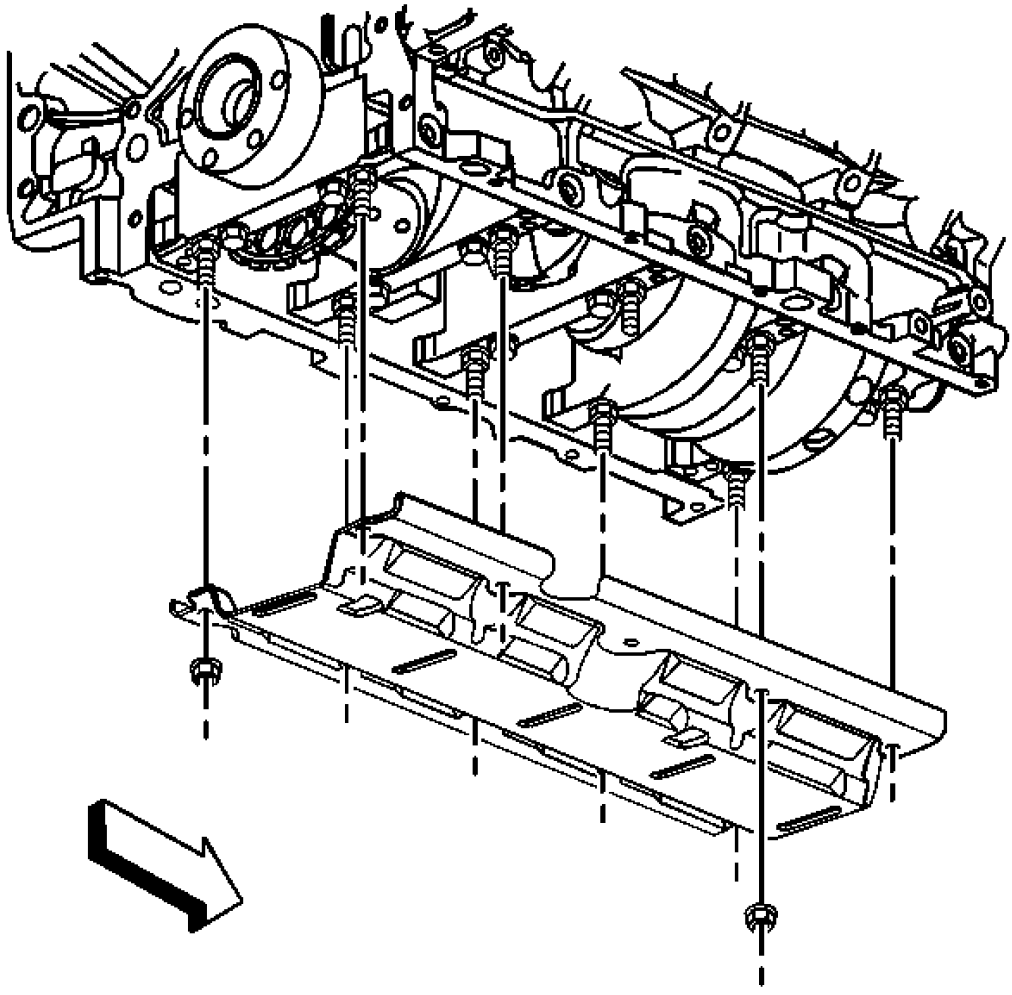


Fig. 178: View Of Crankshaft Oil Deflector & Nuts
Courtesy of GENERAL MOTORS CORP.

4. Install the crankshaft oil deflector.
5. Install the crankshaft oil deflector nuts.

Tighten: Tighten the crankshaft oil deflector nuts to 25 N.m (18 lb ft).

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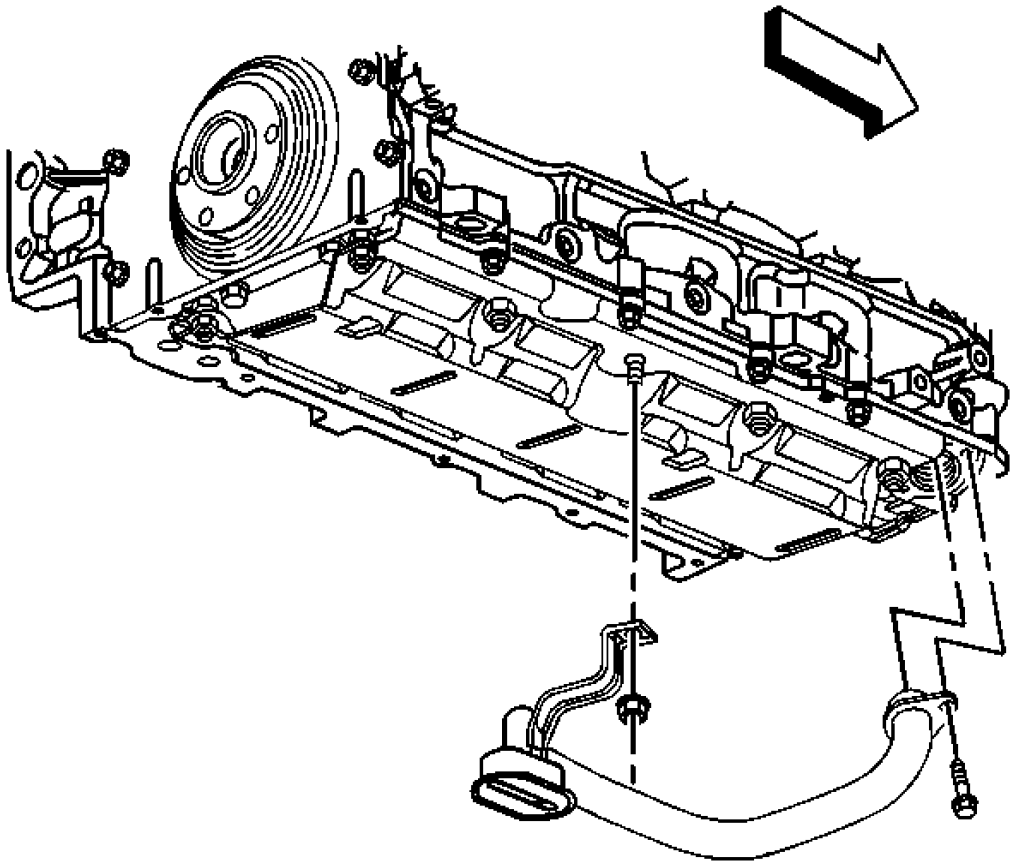


Fig. 179: O-Ring Seal, Oil Pump Screen & Bolt
Courtesy of GENERAL MOTORS CORP.

6. Lubricate a NEW oil pump screen O-ring seal with clean engine oil.
7. Install the NEW O-ring seal onto the oil pump screen.

NOTE: Push the oil pump screen tube completely into the oil pump prior to tightening the bolt. Do not allow the bolt to pull the tube into the pump. Align the oil pump screen brackets with the correct crankshaft bearing cap studs.

8. Install the oil pump screen.
9. Install the oil pump screen bolt and nut.

Tighten:

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- Tighten the oil pump screen bolt to 12 N.m (106 lb in).
- Tighten the oil pump screen nut to 25 N.m (18 lb ft).

10. Install the engine oil pan. Refer to **Oil Pan Replacement**.
11. Install the engine front cover. Refer to **Engine Front Cover Replacement (L99)** or **Engine Front Cover Replacement (LS3)**.

TIMING CHAIN, CRANKSHAFT SPROCKET, CAMSHAFT POSITION ACTUATOR, AND SOLENOID VALVE REPLACEMENT

Special Tools

- **EN 46330** . See **Special Tools** .
- **J 8433** . See **Special Tools** .
- **J 41478** . See **Special Tools** .
- **J 41558** . See **Special Tools** .
- **J 41665**
- **J 41816-2** . See **Special Tools** .
- **J 42386-A** . See **Special Tools** .
- **J 45059**

REMOVAL PROCEDURE

1. Remove the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**

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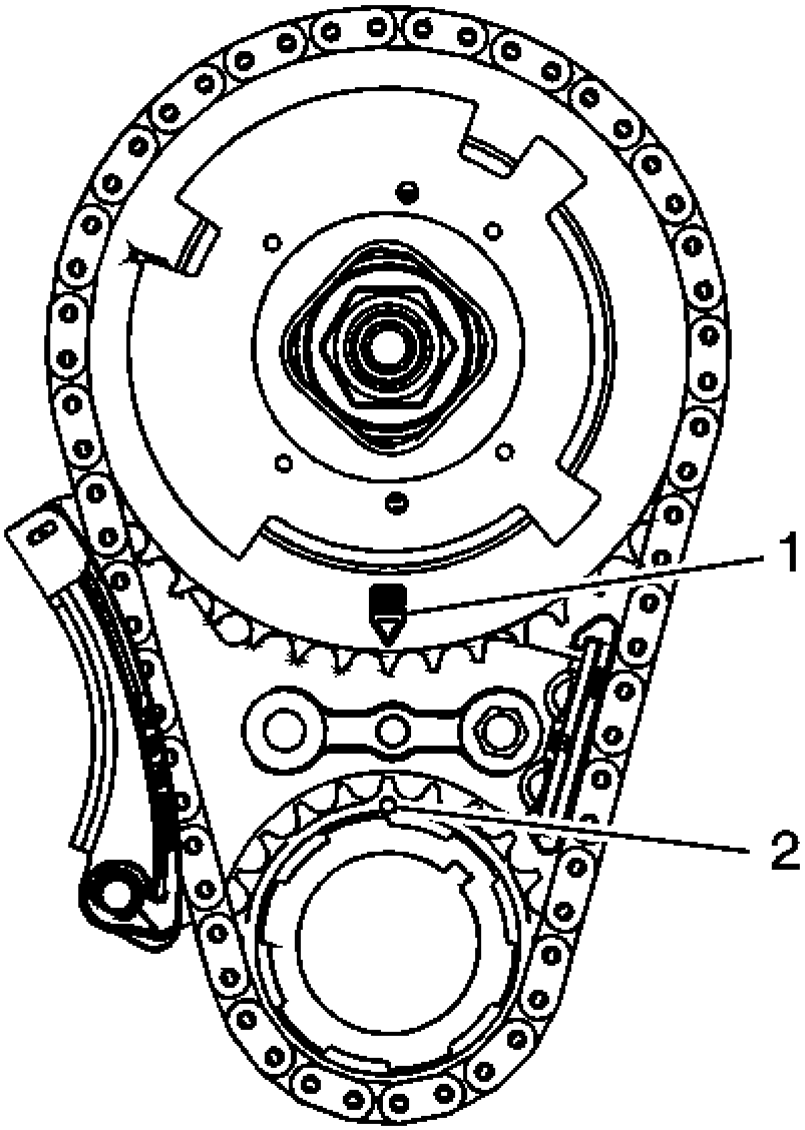


Fig. 180: View Of CMP Actuator Alignment Mark & Crankshaft Sprocket Alignment Mark
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution

NOTE: Ensure that the teeth of the J 42386-A . See Special Tools .

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2. Install the **J 42386-A** . See **Special Tools** .

   Tighten: Tighten the **J 42386-A** . See **Special Tools** .

3. Rotate the crankshaft sprocket until the camshaft position (CMP) actuator alignment mark (1) and the crankshaft sprocket alignment mark (2) are aligned

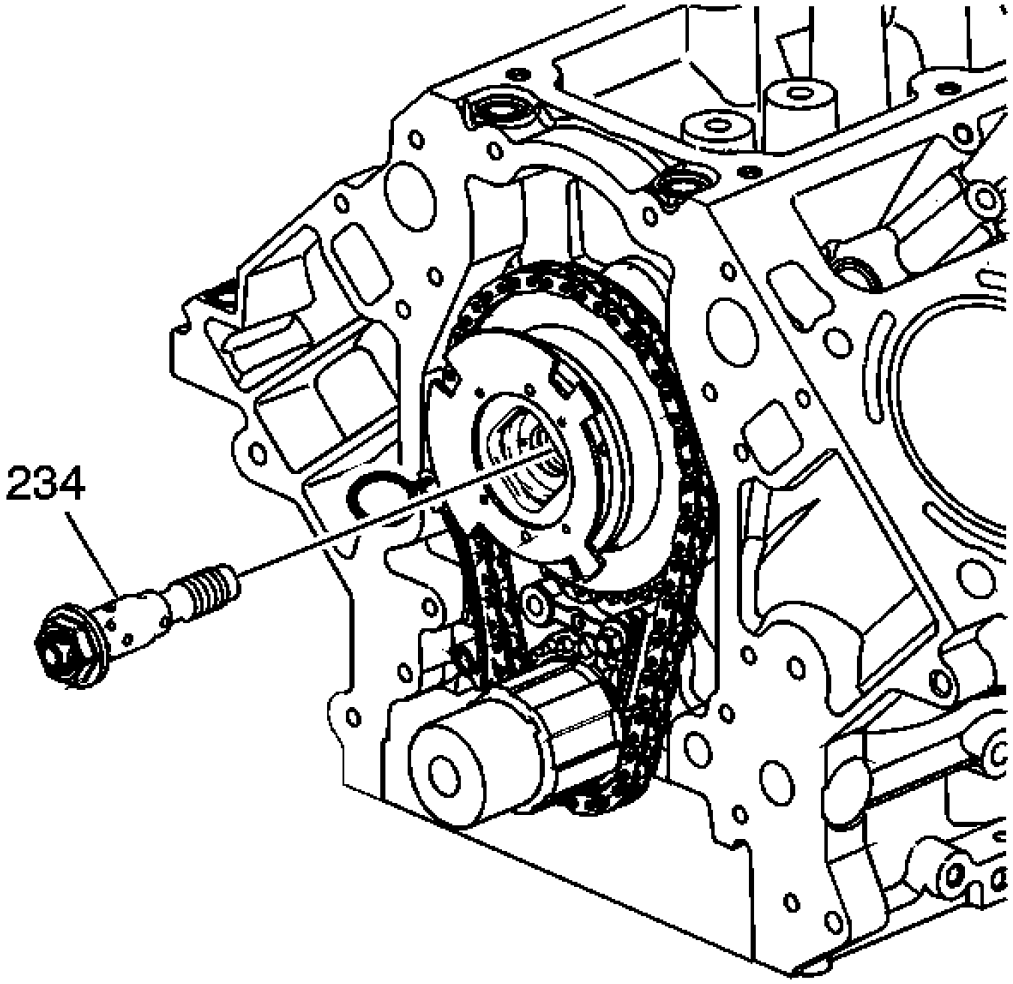


Fig. 181: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

4. Remove and discard the CMP actuator solenoid valve (234).

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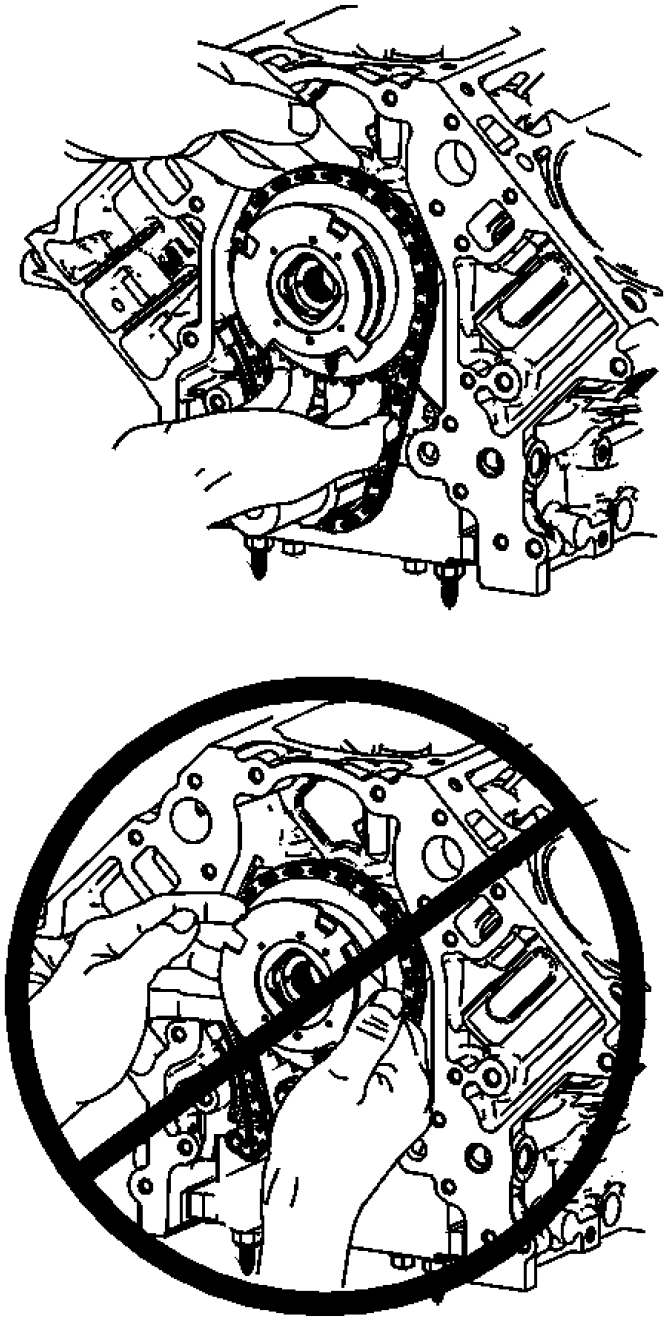


Fig. 182: View Of Proper CMP Actuator Removal
Courtesy of GENERAL MOTORS CORP.

5. Loosen and separate the CMP actuator and timing chain from the camshaft. Position your fingers behind the actuator sprocket and pull the actuator away from the front of the camshaft. Never pull on the reluctor

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wheel when attempting to remove the actuator

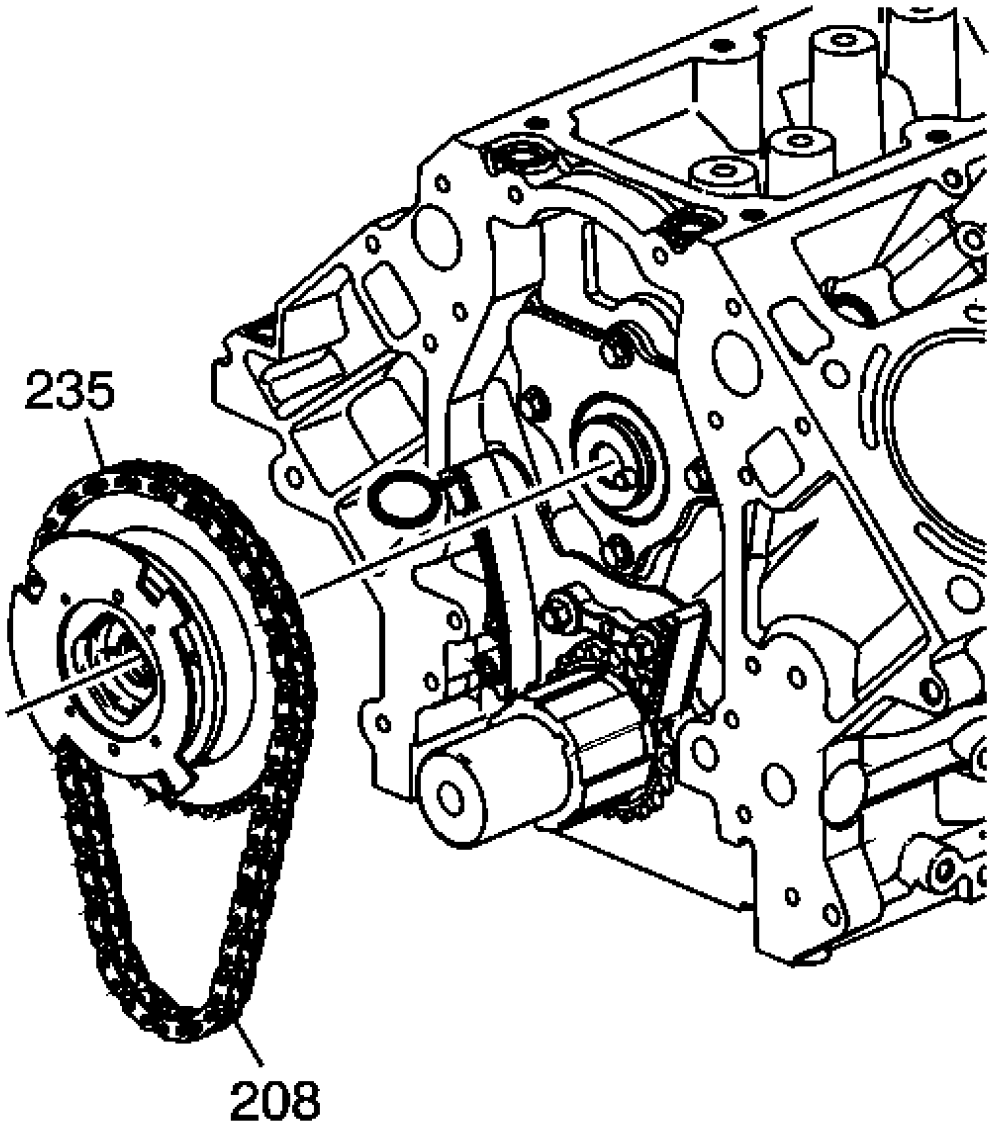


Fig. 183: View Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

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6. Remove the CMP actuator (235) and timing chain (208)

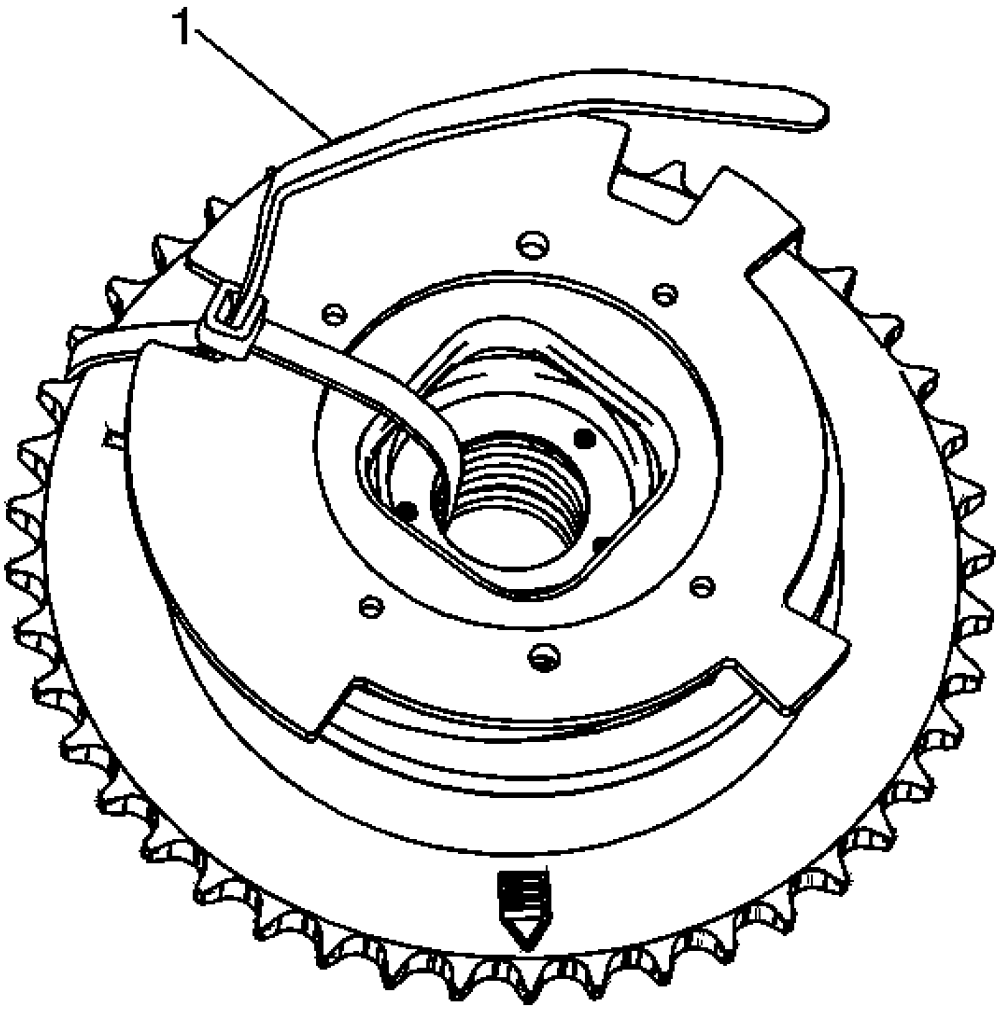


Fig. 184: View Of Tie Strap Through Center Of Actuator
Courtesy of GENERAL MOTORS CORP.

7. Insert and secure a tie strap (1) through the center of the actuator and over the reluctor wheel.

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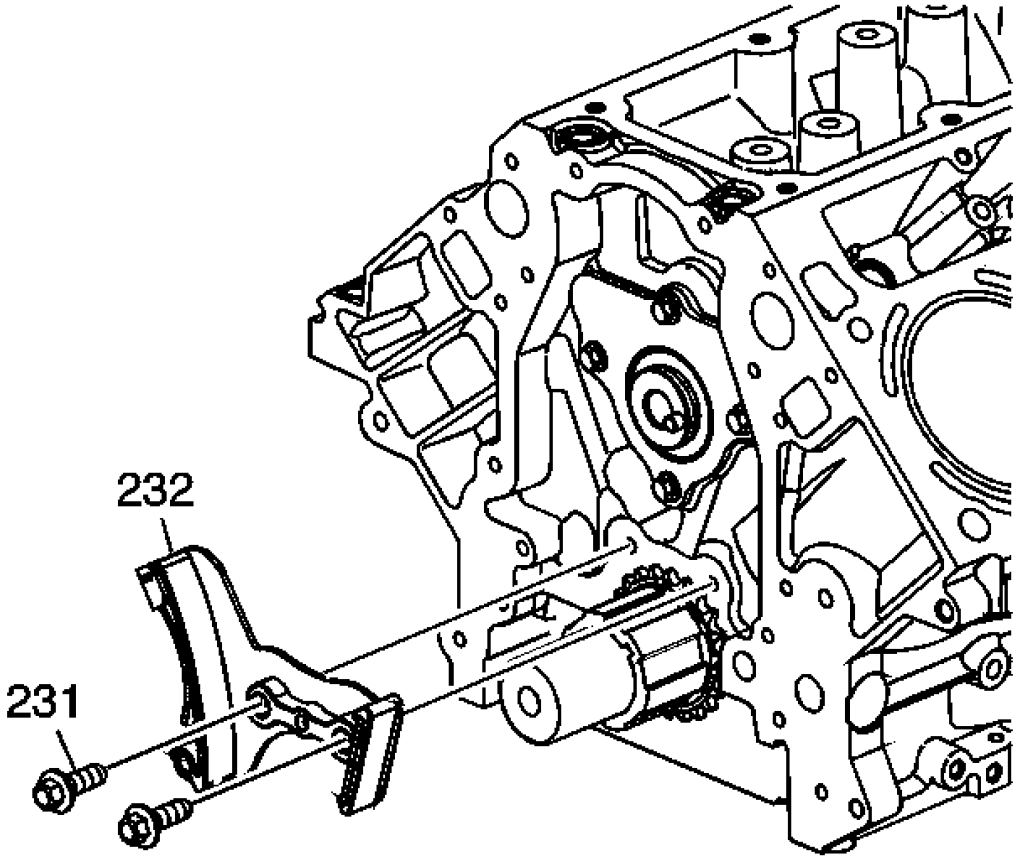


Fig. 185: View Of Timing Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the timing chain tension bolts (231) and tensioner (232).

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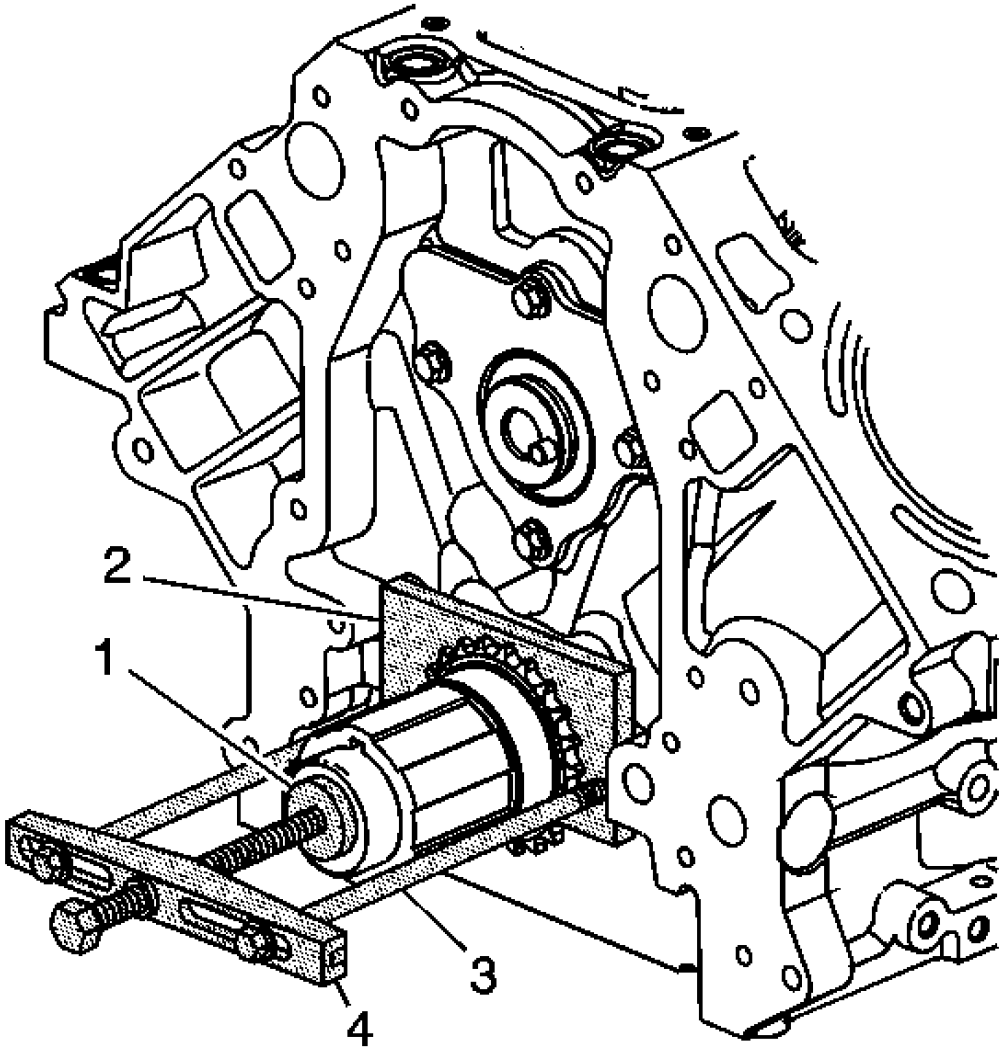


Fig. 186: View Of Crankshaft Sprocket Special Tools
Courtesy of GENERAL MOTORS CORP.

9. Using the J 41816-2 (1), the J 41558 (2), bolts (3) and the J 8433 (4) in order to remove the crankshaft sprocket.

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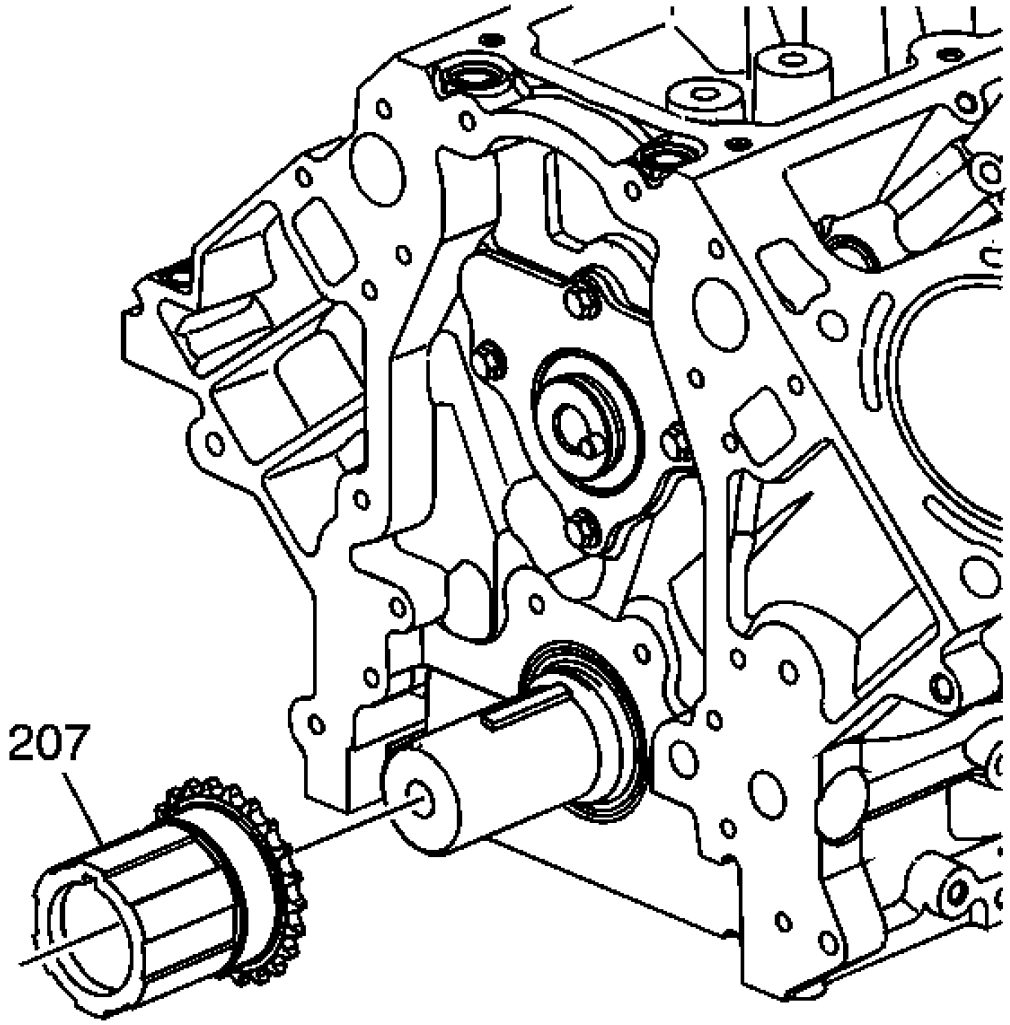


Fig. 187: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

10. Remove the crankshaft sprocket (207).

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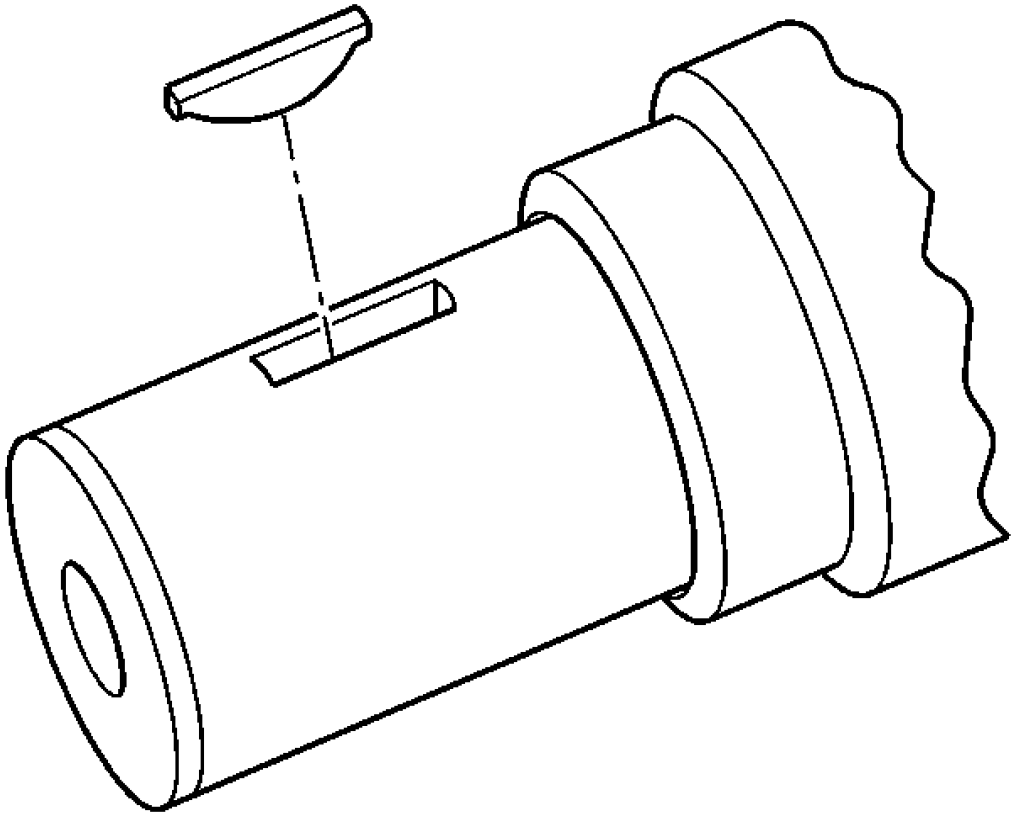


Fig. 188: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS CORP.

11. Remove the crankshaft sprocket key, if required.

INSTALLATION PROCEDURE

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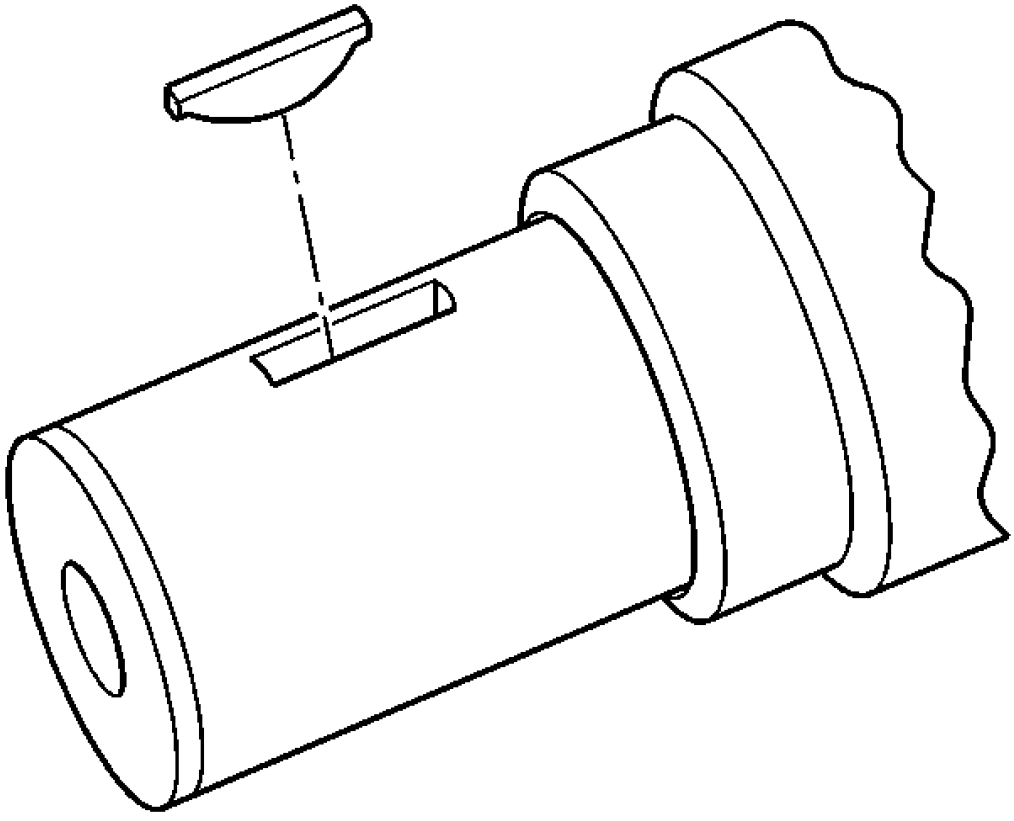


Fig. 189: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS CORP.

1. Install the key into the crankshaft keyway, if previously removed.

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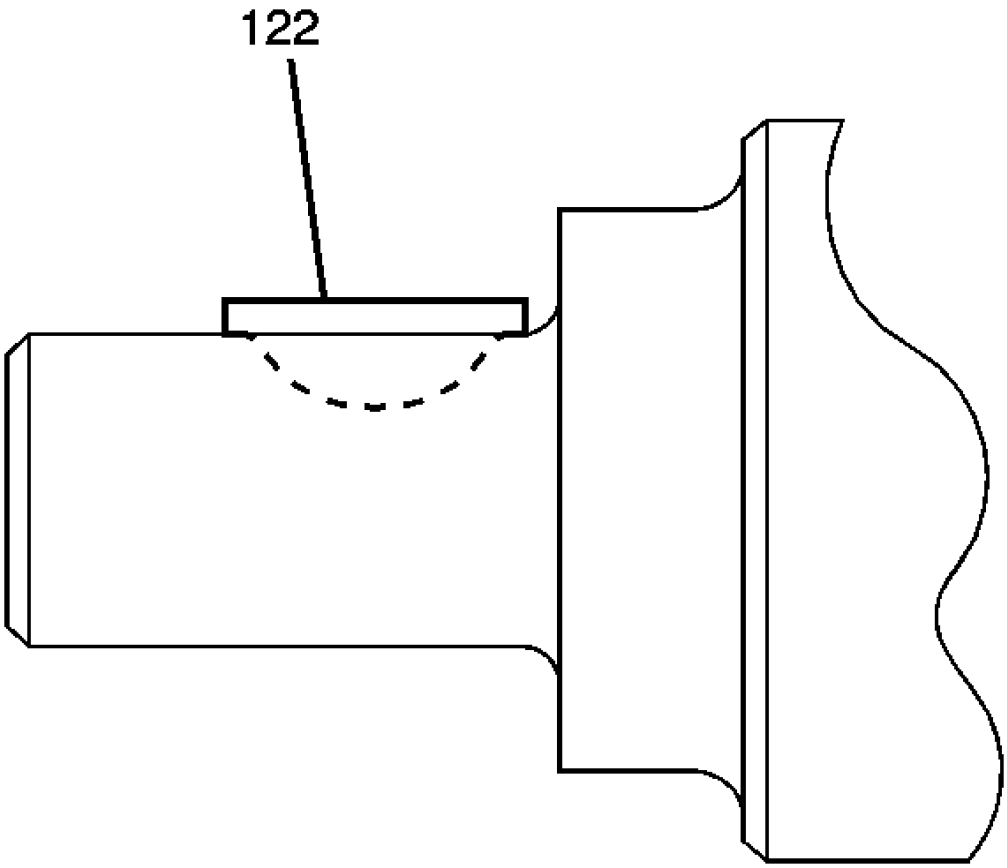


Fig. 190: View Of Installed Crankshaft Key
Courtesy of GENERAL MOTORS CORP.

2. Tap the key (122) into the keyway until both ends of the key bottom onto the crankshaft.

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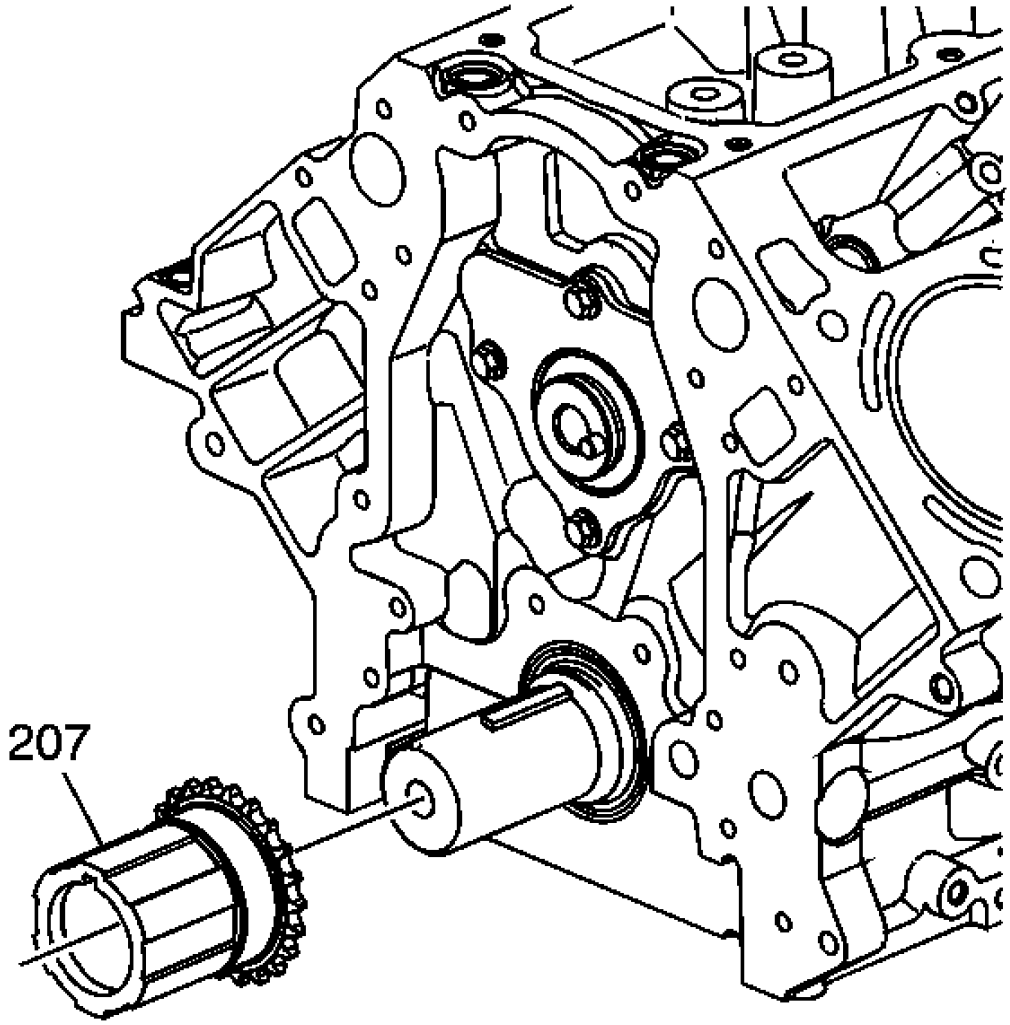


Fig. 191: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft sprocket (207) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.

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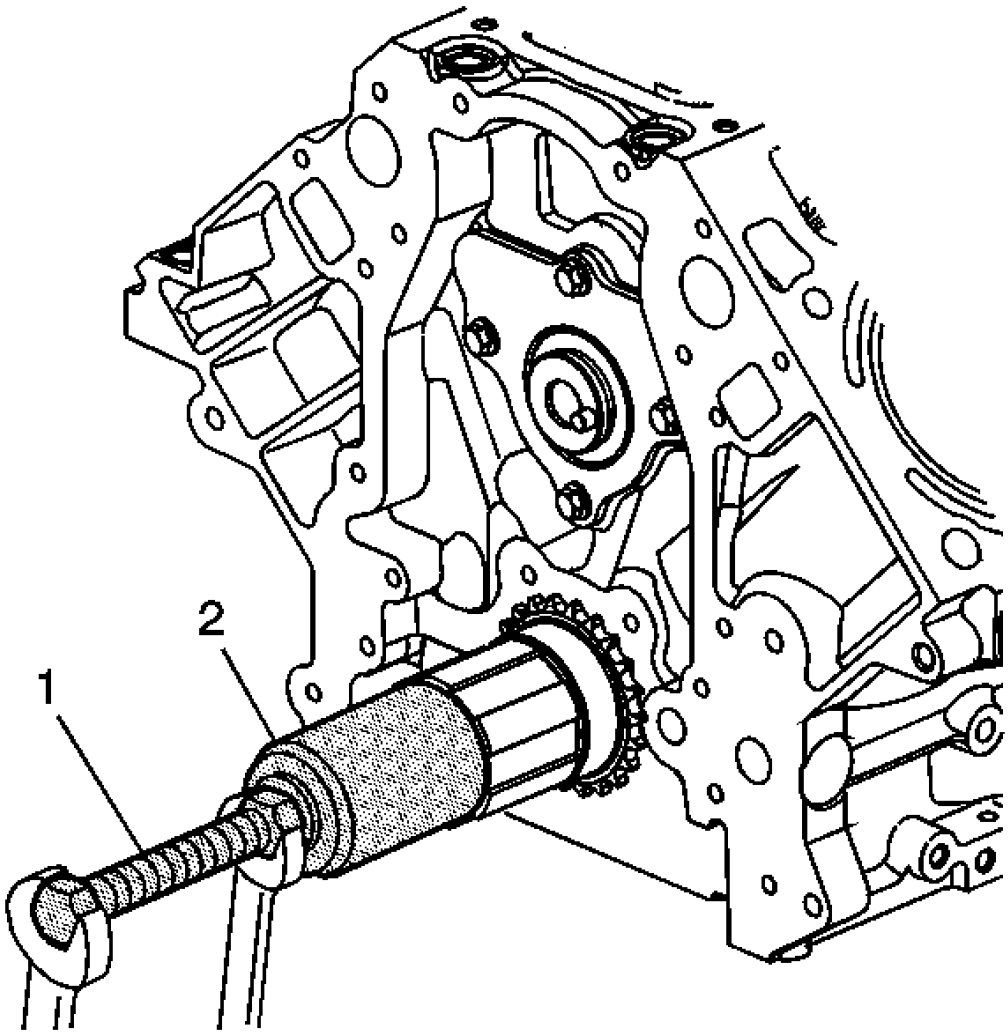


Fig. 192: View Of Crankshaft Sprocket & Installer
Courtesy of GENERAL MOTORS CORP.

4. Use the J 41478 (1) and the J 41665 (2) in order to install the crankshaft sprocket. Install the sprocket onto the crankshaft until fully seated against the crankshaft flange.

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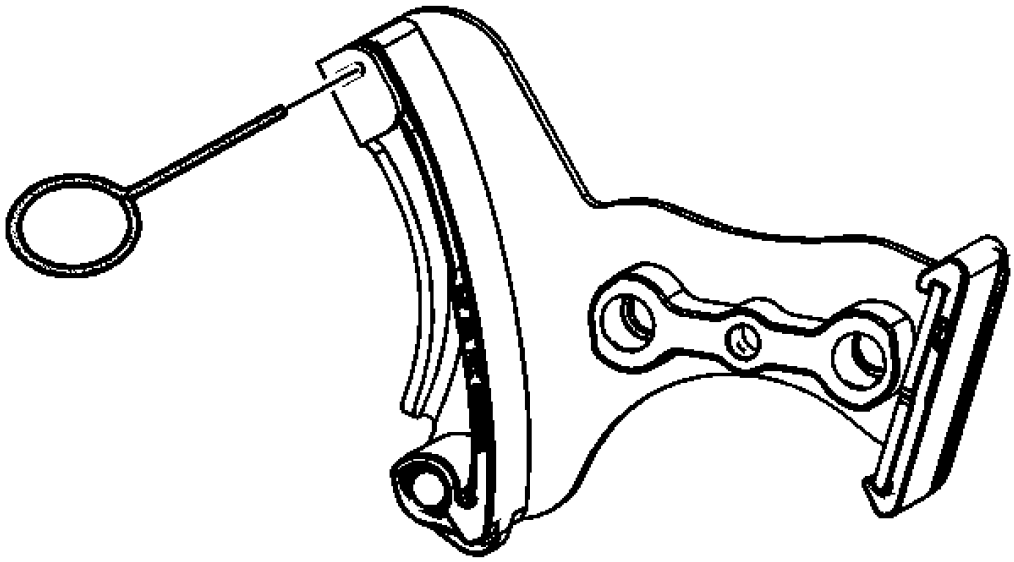


Fig. 193: View Of Compressed Tensioner & Pin
Courtesy of GENERAL MOTORS CORP.

5. Compress the timing chain tensioner guide and install the **EN 46330** . See **Special Tools** .

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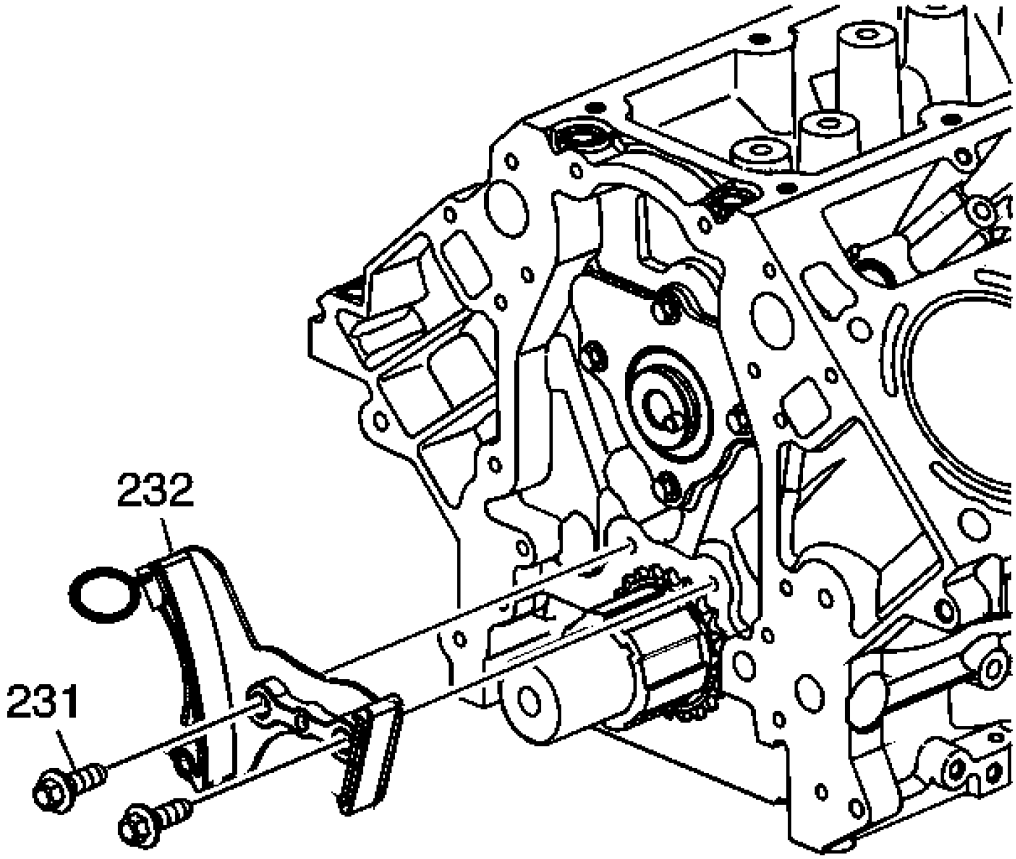


Fig. 194: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution

6. Install the timing chain tensioner (232) and bolts (231).

   Tighten: Tighten the bolts to 25 N.m (18 lb ft).

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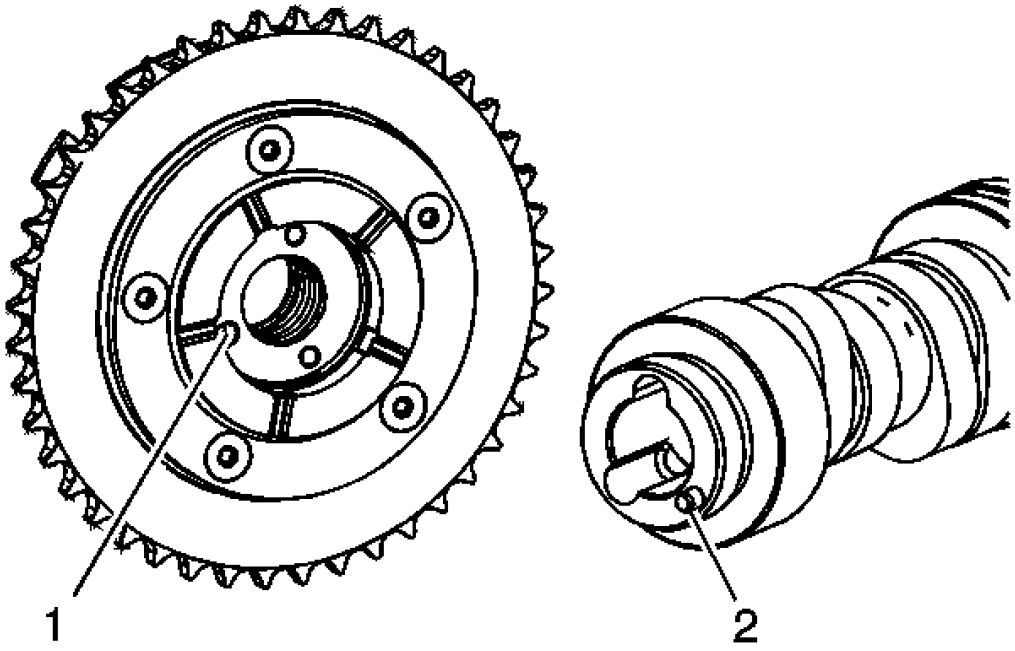


Fig. 195: Identifying Alignment Hole & Locating Pin
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Properly locate the CMP actuator onto the locating pin of the camshaft.**
- **The sprocket teeth and timing chain teeth must mesh.**
- **The camshaft and the crankshaft sprocket alignment MUST be aligned properly.**
- **Do not use the CMP solenoid valve again. Install a NEW CMP valve during assembly.**

7. Identify the alignment hole (1) in the rear face of the CMP actuator and the locating pin (2) on the front face of he camshaft.

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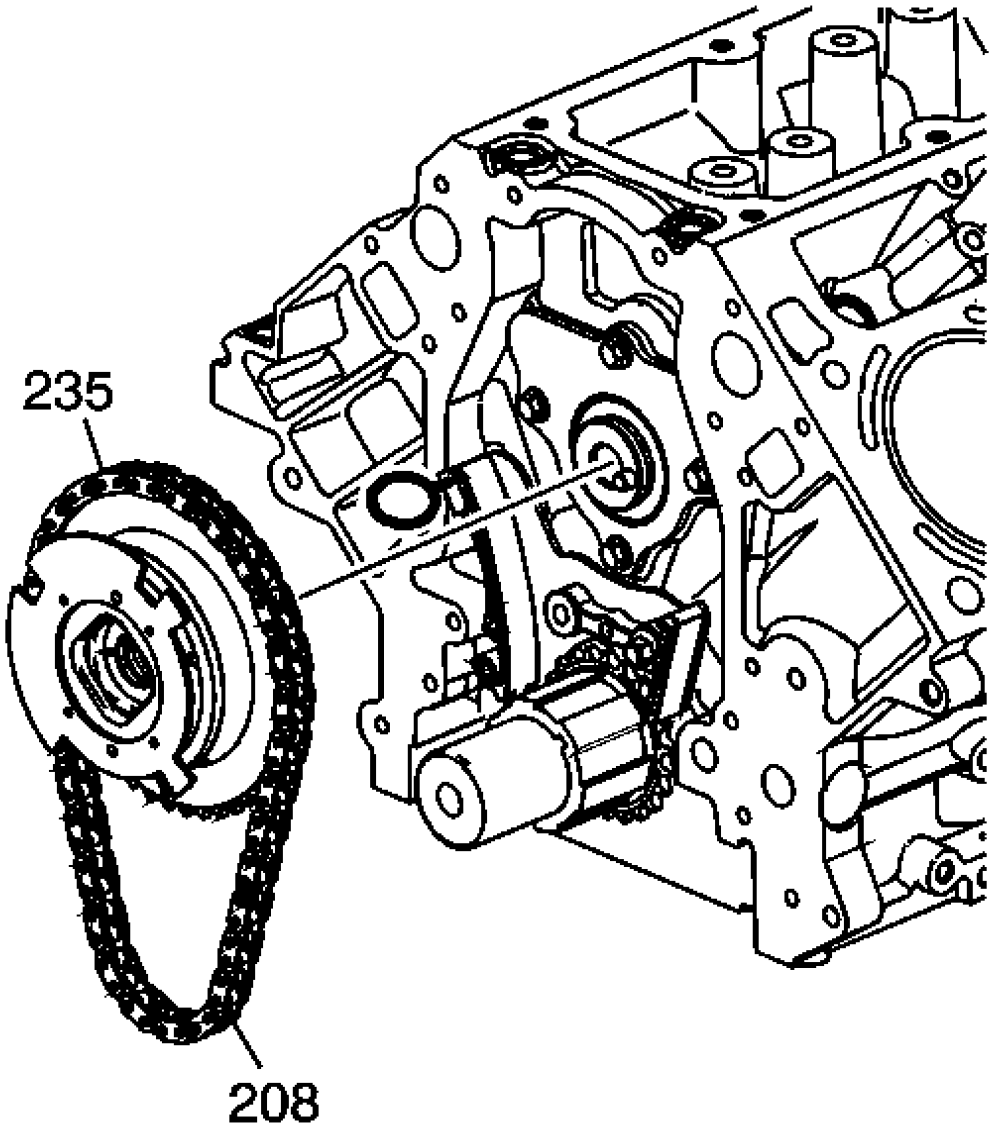


Fig. 196: View Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS CORP.

8. Align the CMP actuator so the timing mark is in the 6 o'clock position.
9. Install the CMP actuator (235) and timing chain (208). Align the hole in the face of the CMP actuator with the locating pin on the front face of the camshaft.

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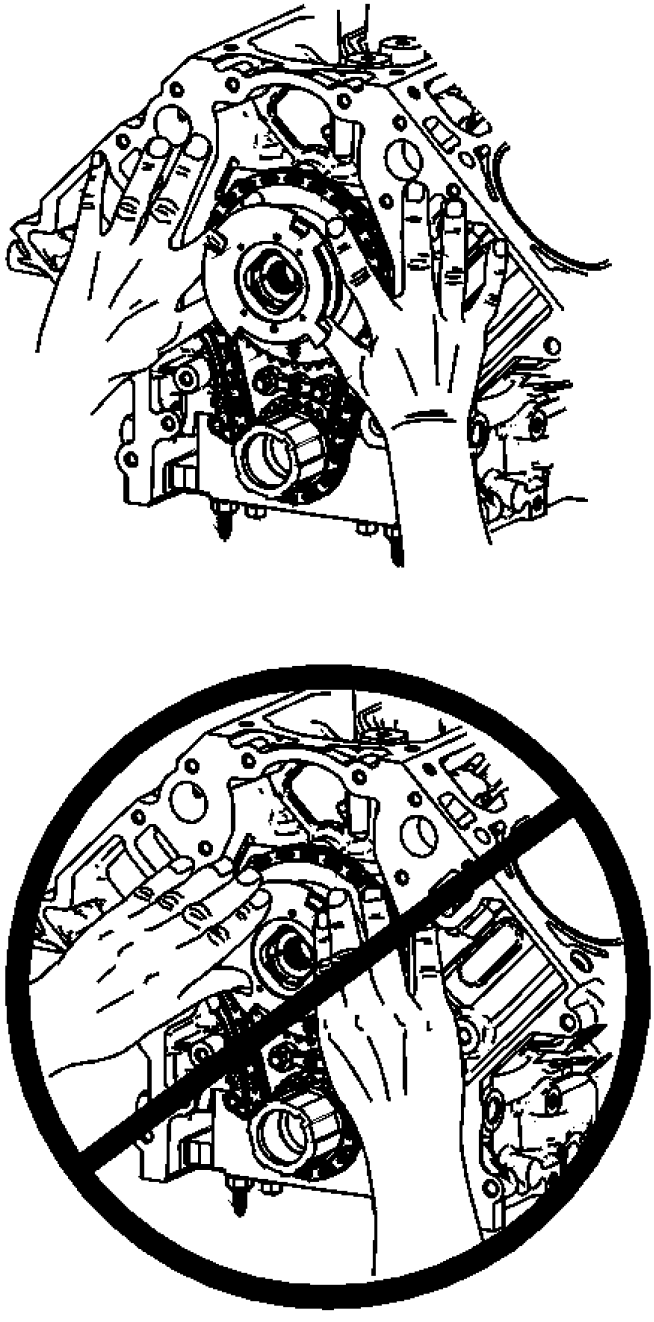


Fig. 197: Proper Installation Of CMP Actuator
Courtesy of GENERAL MOTORS CORP.

WARNING: Do not push or pull on the reluctor wheel of the camshaft position

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(CMP) actuator during removal or installation. The reluctor wheel is retained to the front of the CMP actuator by 3 roll pins. Pushing or pulling on the wheel may dislodge the wheel from the front of the actuator. The actuator return spring is under tension and may rotate the dislodged reluctor wheel, causing personal injury.

10. Use care to install the actuator completely onto the front of the camshaft. Position your fingers onto the face of the actuator sprocket and push the actuator onto the front of the camshaft. Never push on the reluctor wheel when attempting to install the actuator

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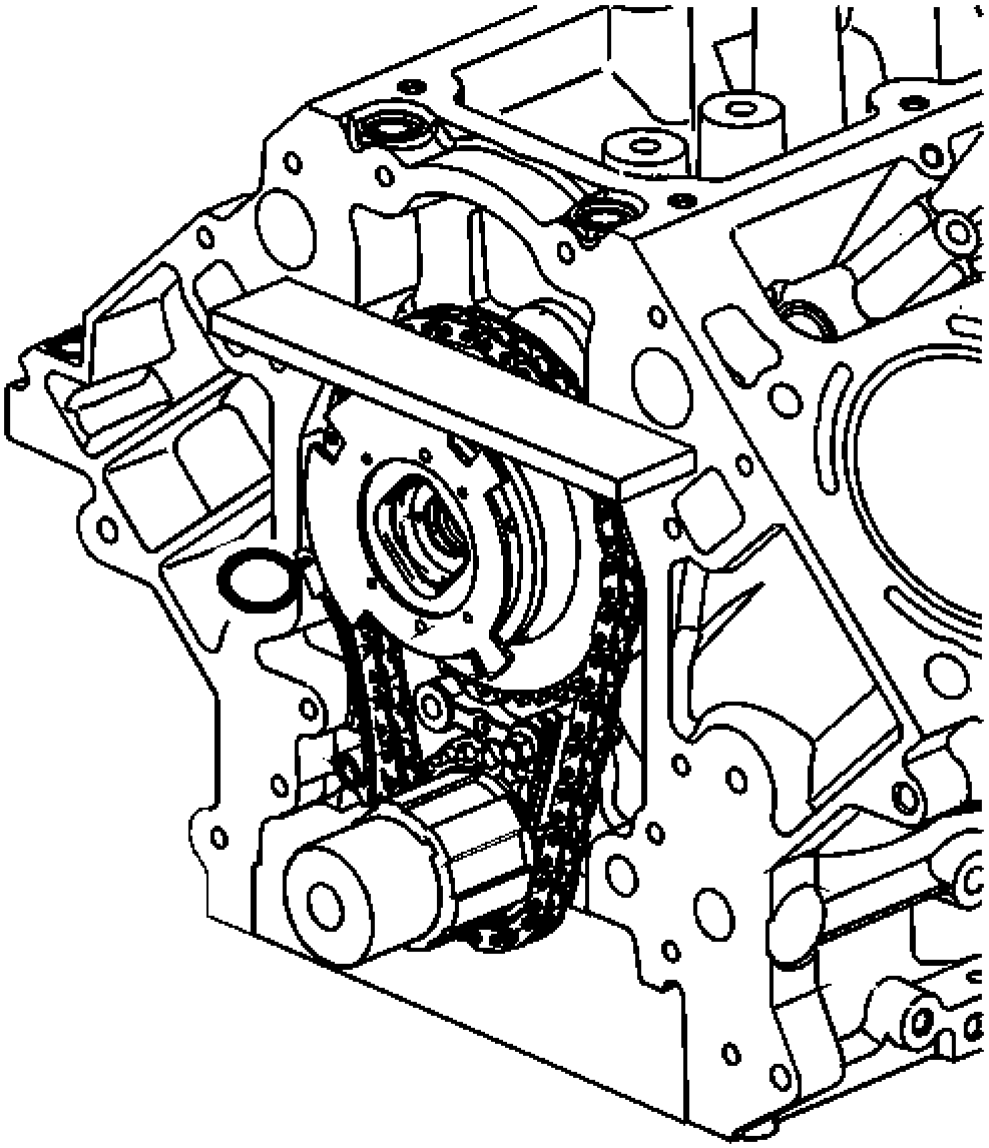


Fig. 198: Inspecting For Proper Installation Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS CORP.

11. Place a straight edge across the front face of the engine block and inspect for proper installation of the CMP actuator and timing chain. With the CMP actuator properly and completely installed onto the front of the camshaft, the timing chain will not protrude beyond the front face of the engine block.

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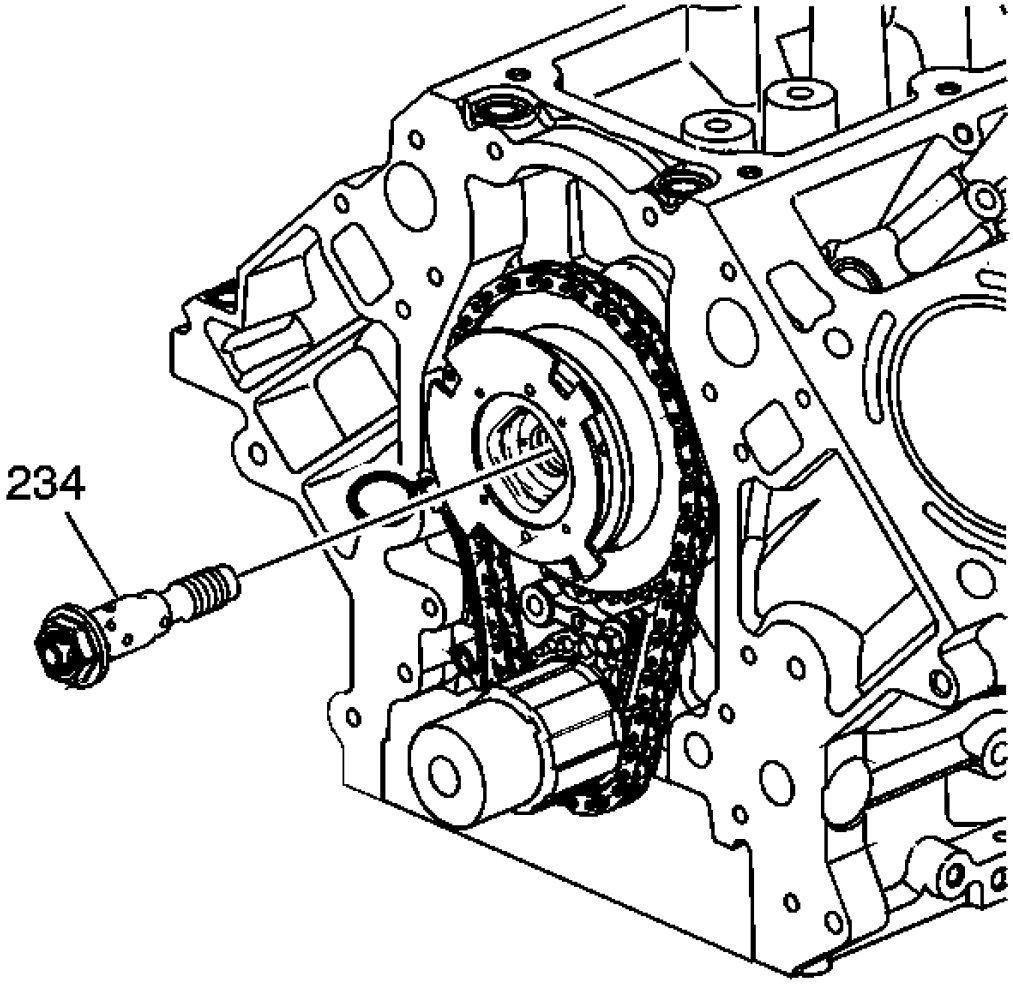


Fig. 199: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

12. Install a NEW CMP actuator valve (234). With the CMP actuator properly positioned onto the camshaft, the CMP actuator solenoid valve can be threaded completely into the camshaft using light hand pressure. Tighten by hand until snug.

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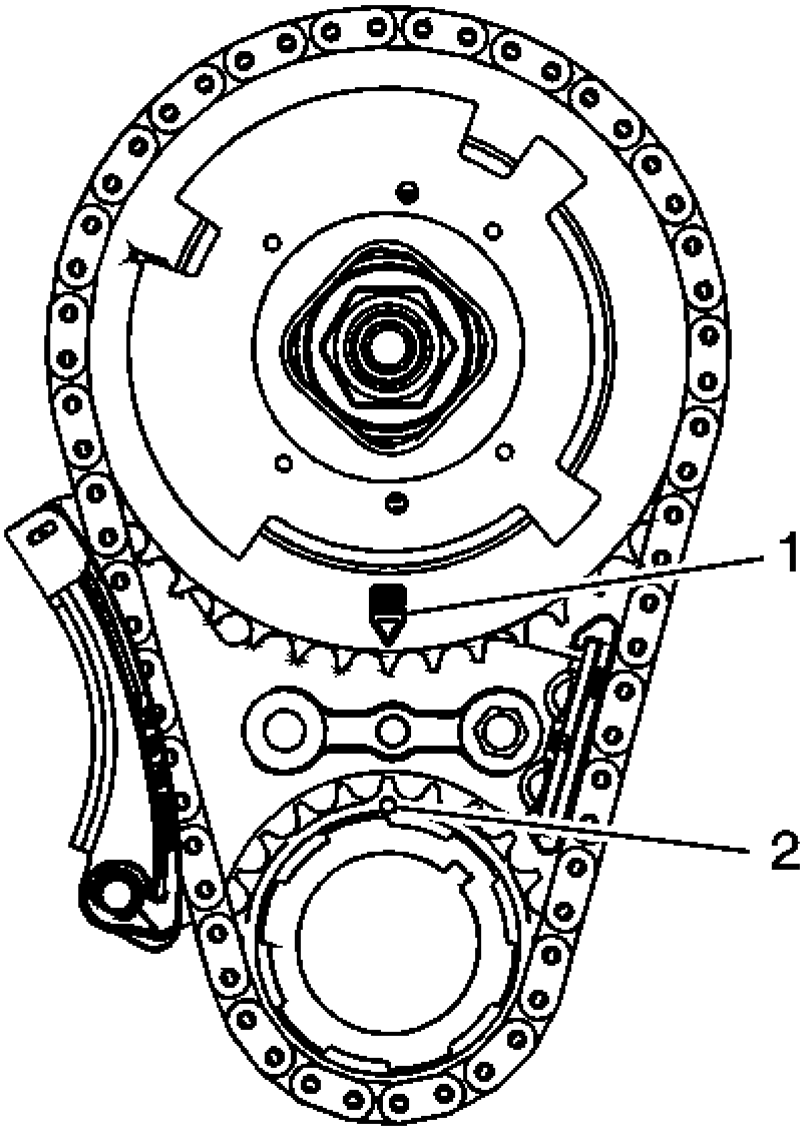


Fig. 200: View Of CMP Actuator Alignment Mark & Crankshaft Sprocket Alignment Mark
Courtesy of GENERAL MOTORS CORP.

13. Inspect the sprockets for proper alignment. The mark on the CMP (1) actuator sprocket should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

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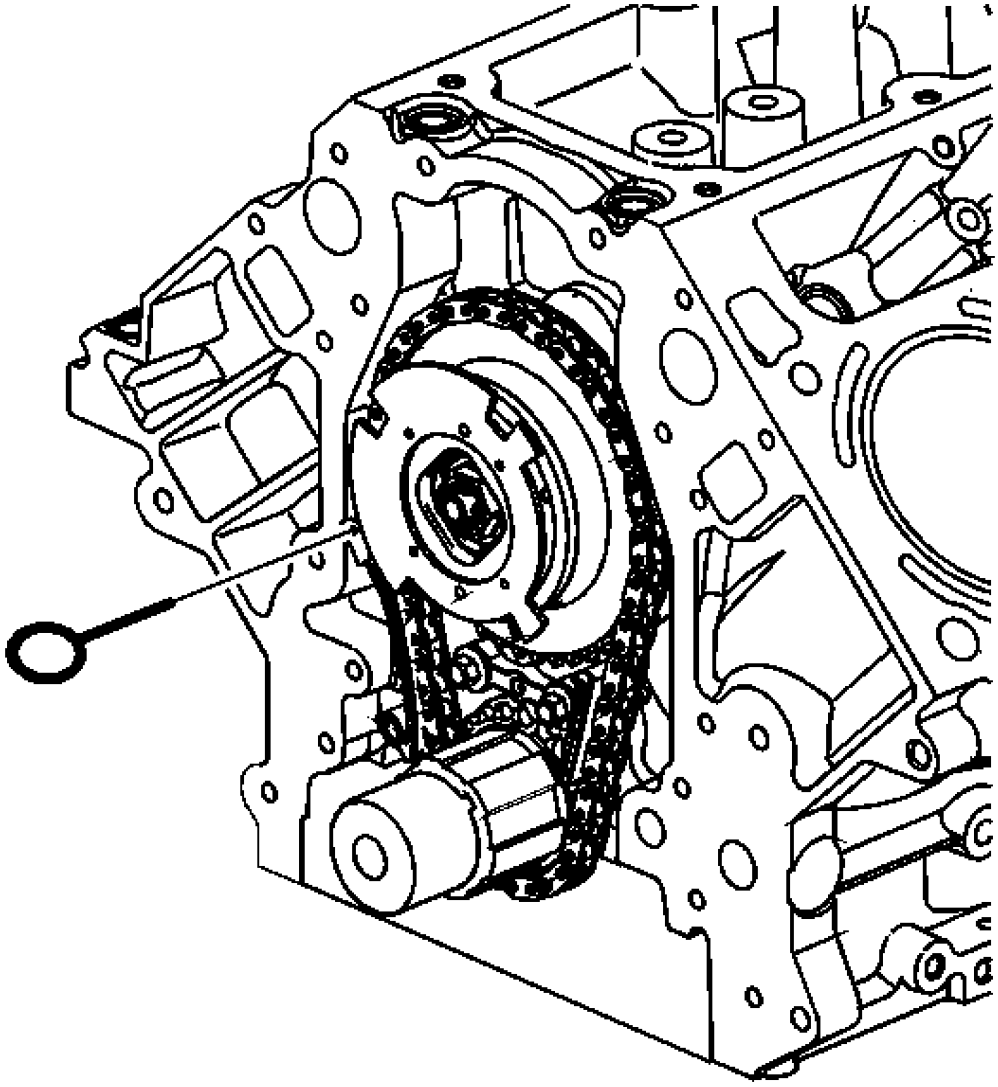


Fig. 201: View Of Special Tool EN 46330
Courtesy of GENERAL MOTORS CORP.

14. Remove the **EN 46330** . See **Special Tools** .

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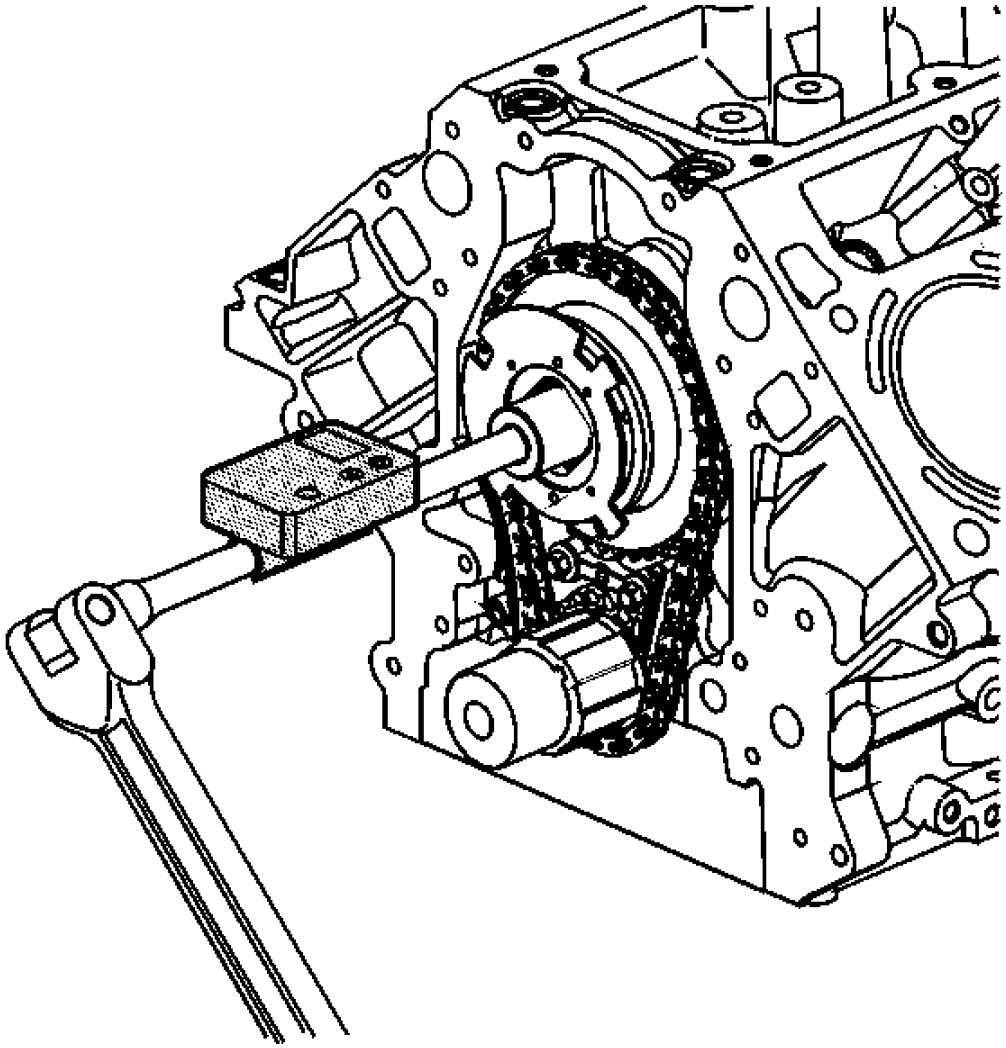


Fig. 202: Tightening CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

15. Tighten the CMP actuator bolt.

    Tighten:

    1. Tighten the bolt a first pass to 65 N.m (48 lb ft).
    2. Tighten the bolt a final pass an additional 90 degrees using **J 45059**

16. Remove the **J 42386-A** . See **Special Tools** .

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17. Install the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**

CAMSHAFT TIMING CHAIN AND SPROCKET REPLACEMENT (LS3)

Special Tools

- **EN 46330** Timing Chain Tensioner Retaining Pin. See **Special Tools** .
- **J 8433** Puller Bar. See **Special Tools** .
- **J 41478** Crankshaft Front Oil Seal Installer. See **Special Tools** .
- **J 41558** Crankshaft Sprocket Remover. See **Special Tools** .
- **J 41665** Crankshaft Balancer and Sprocket Installer
- **J 41816-2** Crankshaft End Protector. See **Special Tools** .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

1. Remove the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.

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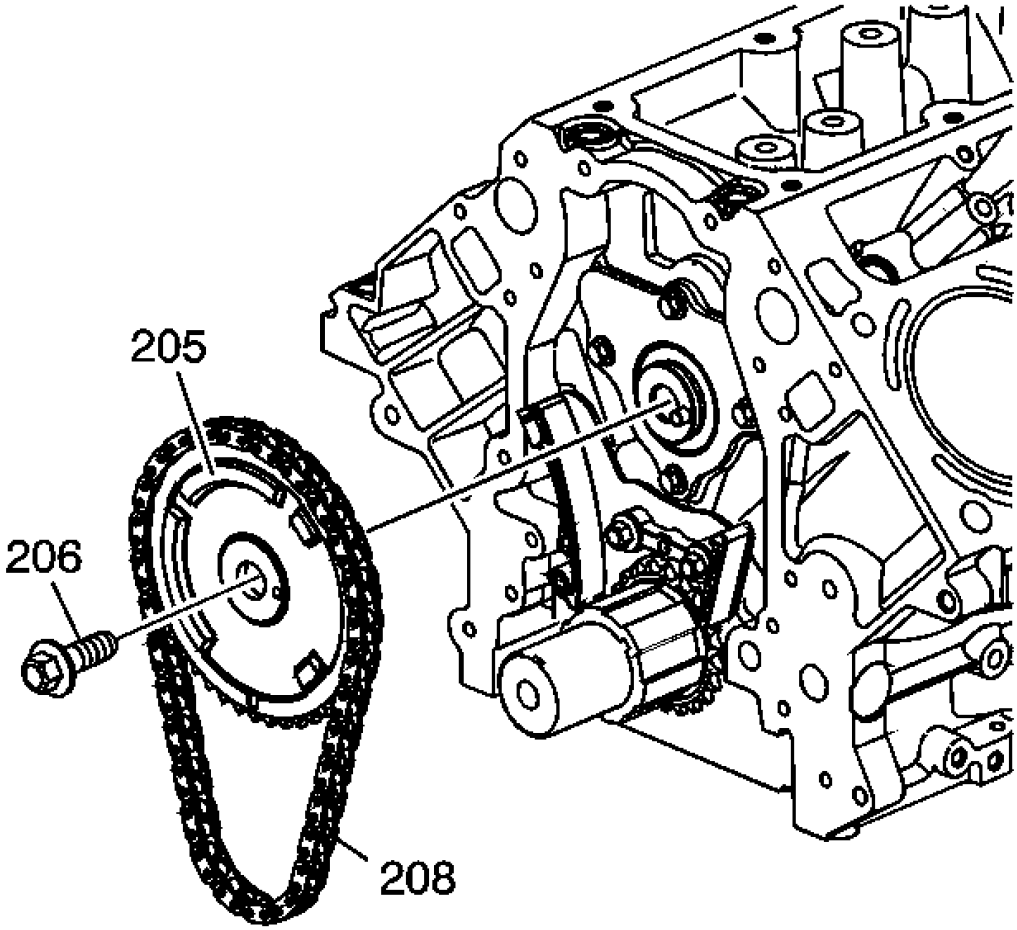


Fig. 203: View Of Camshaft Sprocket, Timing Chain & Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

2. Rotate the crankshaft until the timing marks on the crankshaft and the camshaft sprockets are aligned.
3. Remove the camshaft sprocket bolt (206) and discard sprocket bolt.
4. Remove the camshaft sprocket (205) and timing chain (208).

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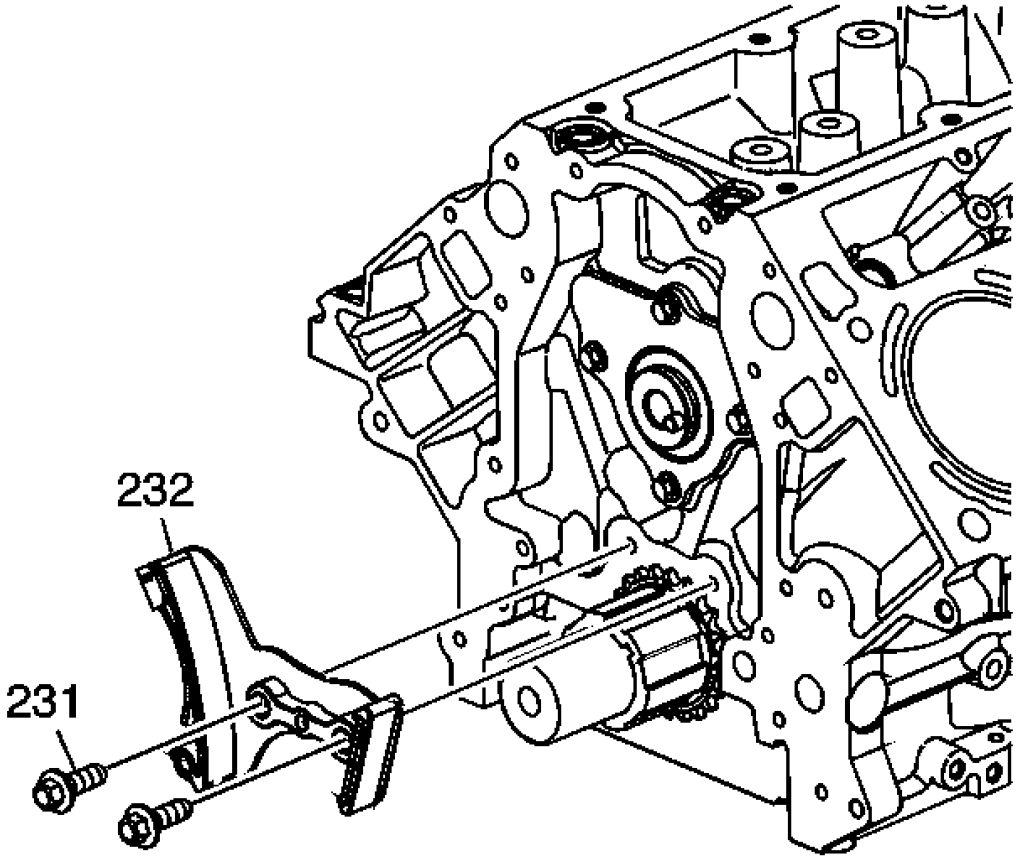


Fig. 204: View Of Timing Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Remove the timing chain tension bolts (231) and tensioner (232).

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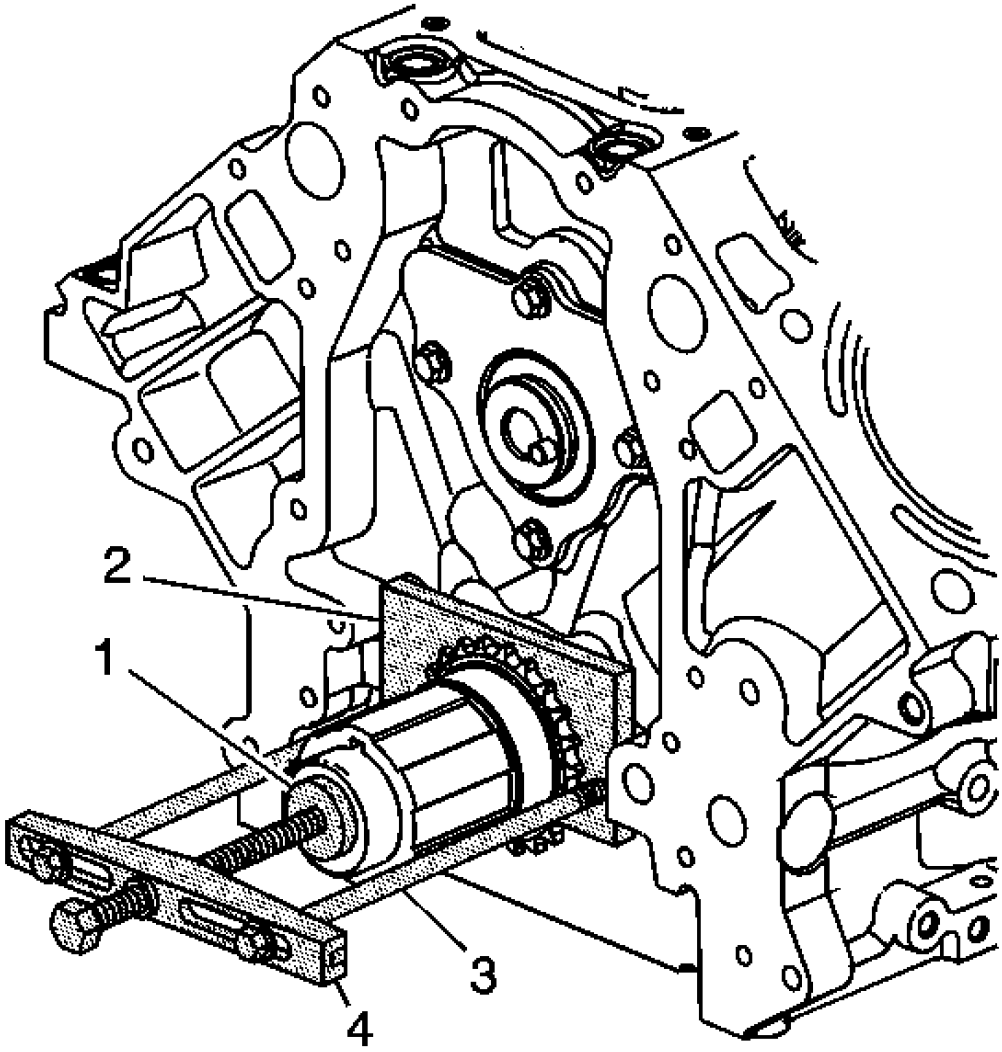


Fig. 205: View Of Crankshaft Sprocket Special Tools
Courtesy of GENERAL MOTORS CORP.

6. Using the **J 41816-2** (1), the **J 41558** (2), bolts (3) and the **J 8433** (4) in order to remove the crankshaft sprocket. See **Special Tools** .

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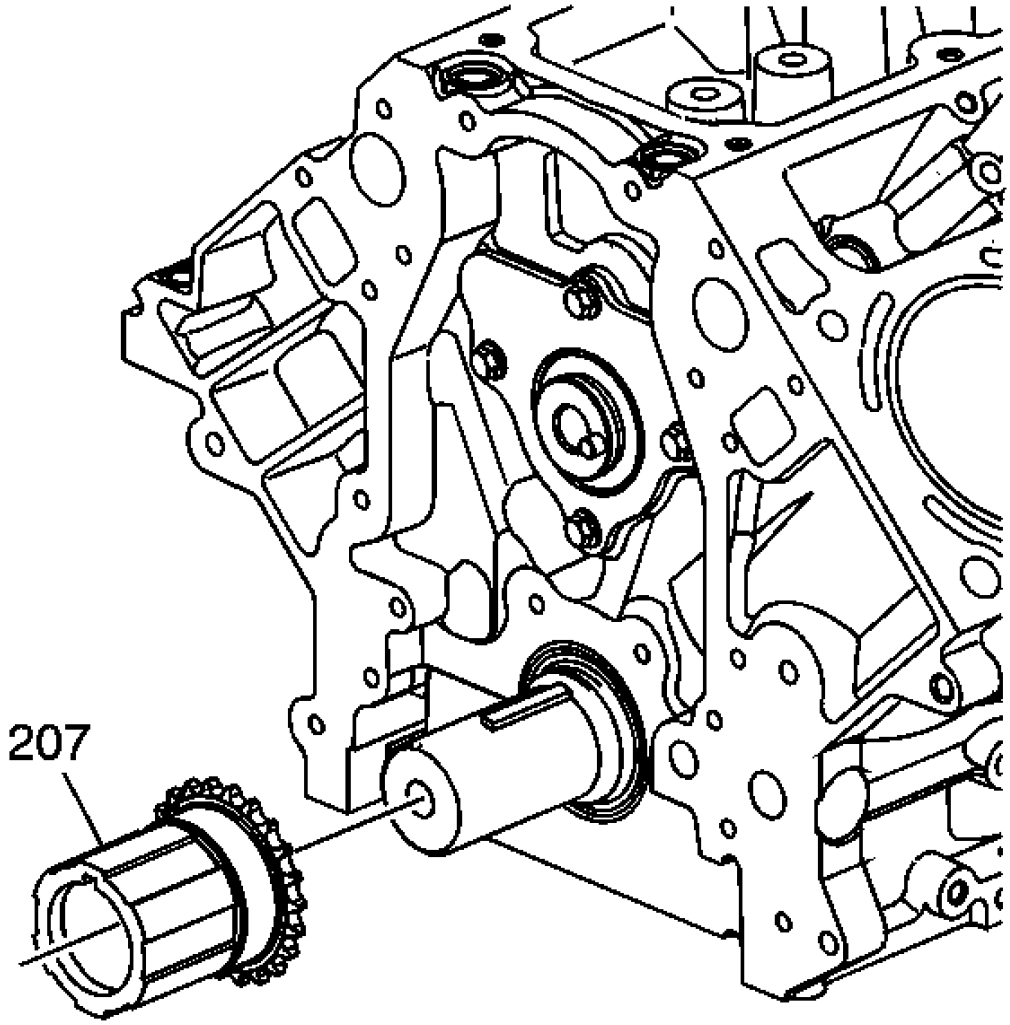


Fig. 206: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

7. Remove the crankshaft sprocket (207).

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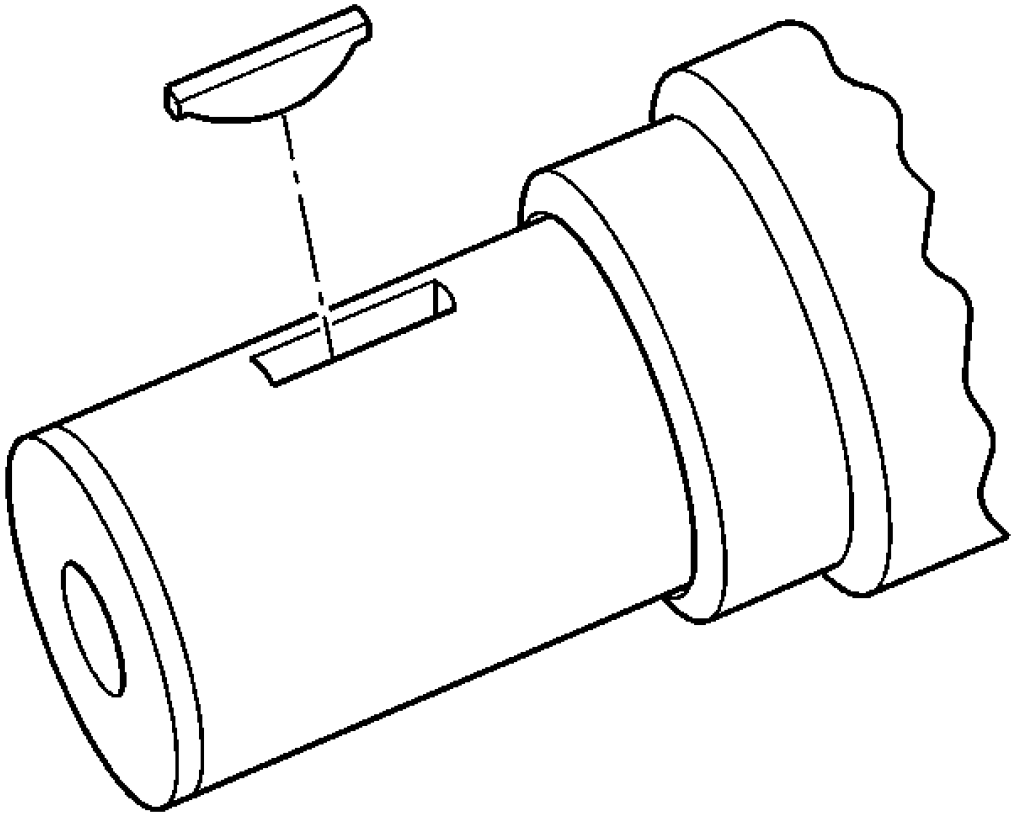


Fig. 207: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS CORP.

8. Remove the crankshaft sprocket key, if required.

INSTALLATION PROCEDURE

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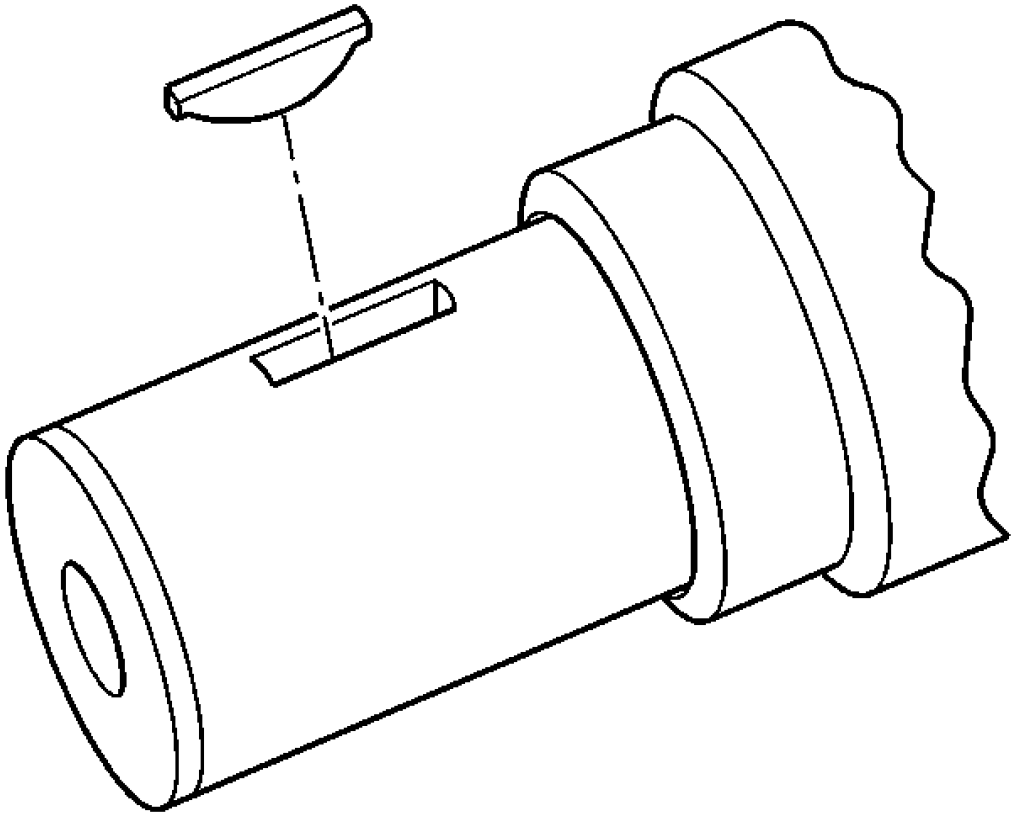


Fig. 208: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS CORP.

1. Install the key into the crankshaft keyway, if previously removed.

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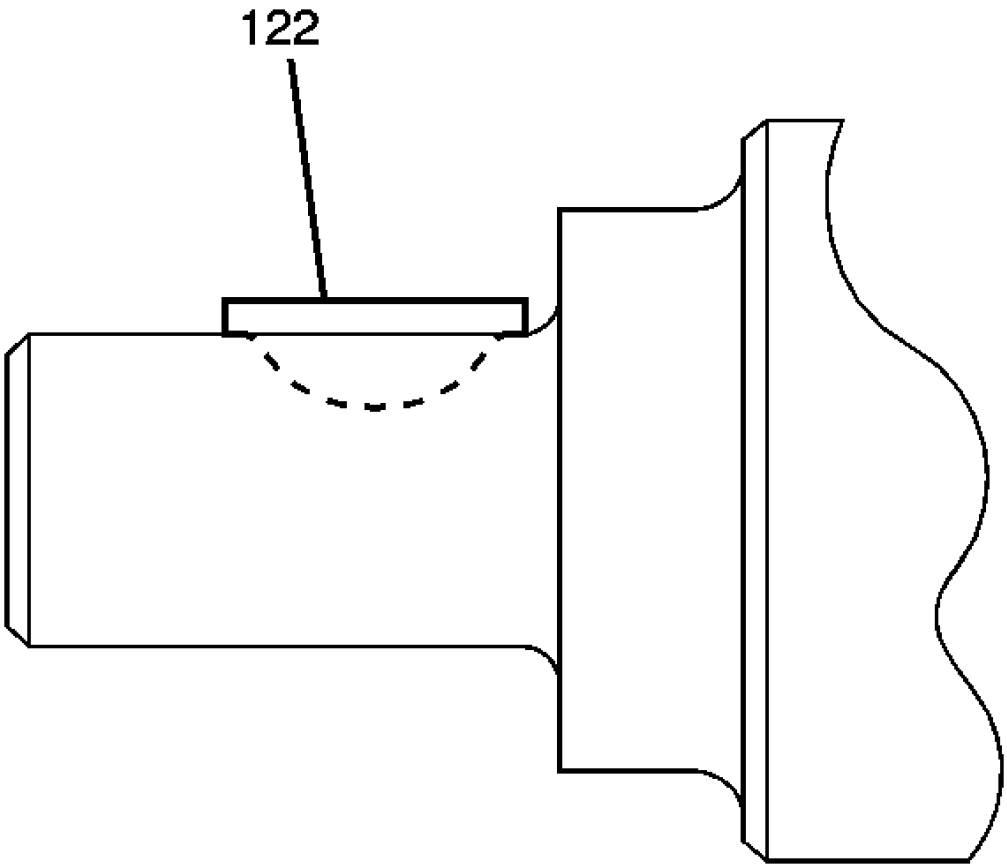


Fig. 209: View Of Installed Crankshaft Key
Courtesy of GENERAL MOTORS CORP.

2. Tap the key (122) into the keyway until both ends of the key bottom onto the crankshaft.

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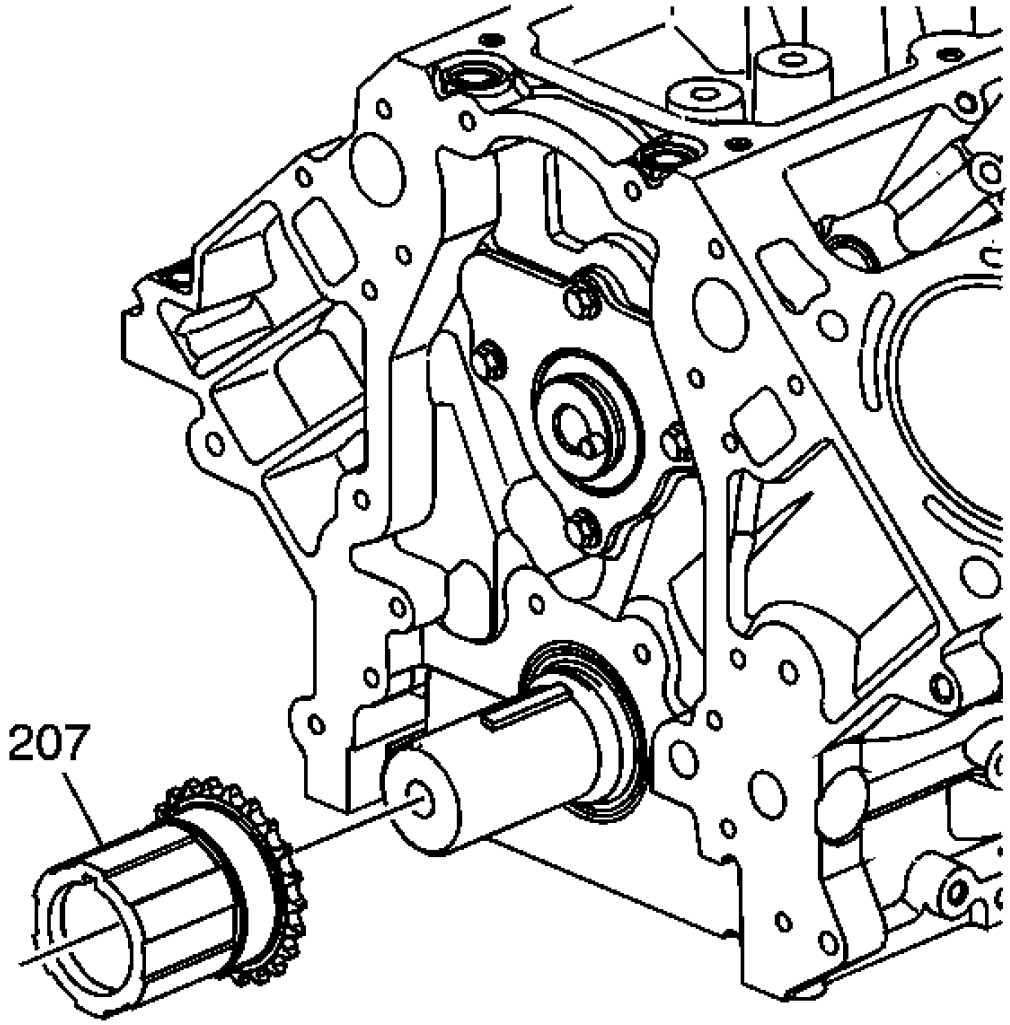


Fig. 210: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft sprocket (207) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.

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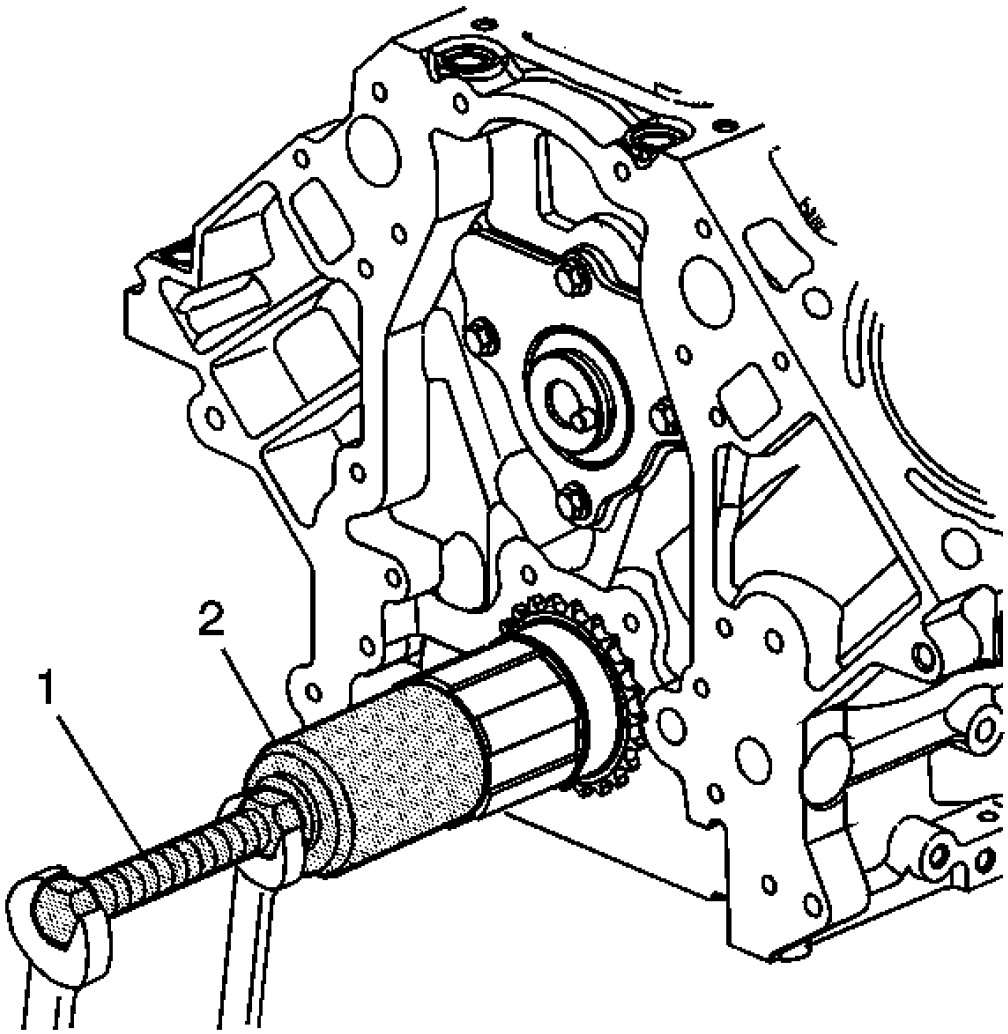


Fig. 211: View Of Crankshaft Sprocket & Installer
Courtesy of GENERAL MOTORS CORP.

4. Use the **J 41478** (1) and the **J 41665** (2) in order to install the crankshaft sprocket. Install the sprocket onto the crankshaft until fully seated against the crankshaft flange.

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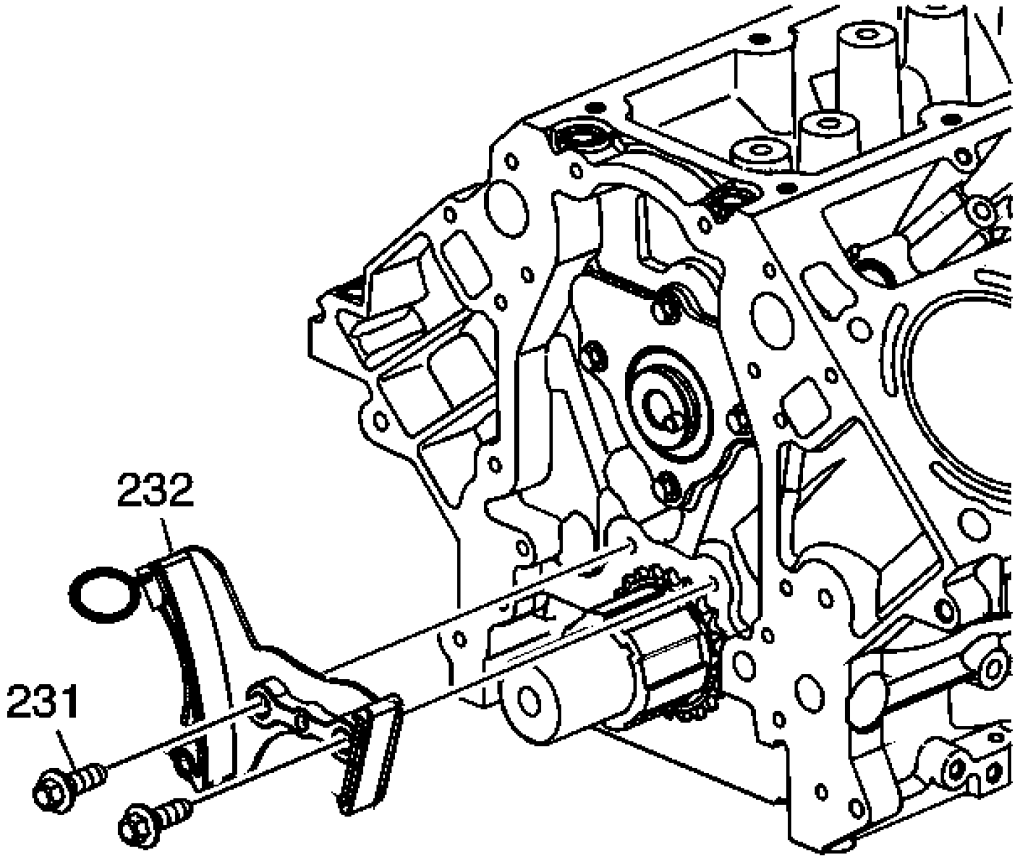


Fig. 212: View Of Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

5. Install the timing chain tensioner (232) and bolts (231).

   Tighten: Tighten the bolts to 30 N.m (22 lb ft).

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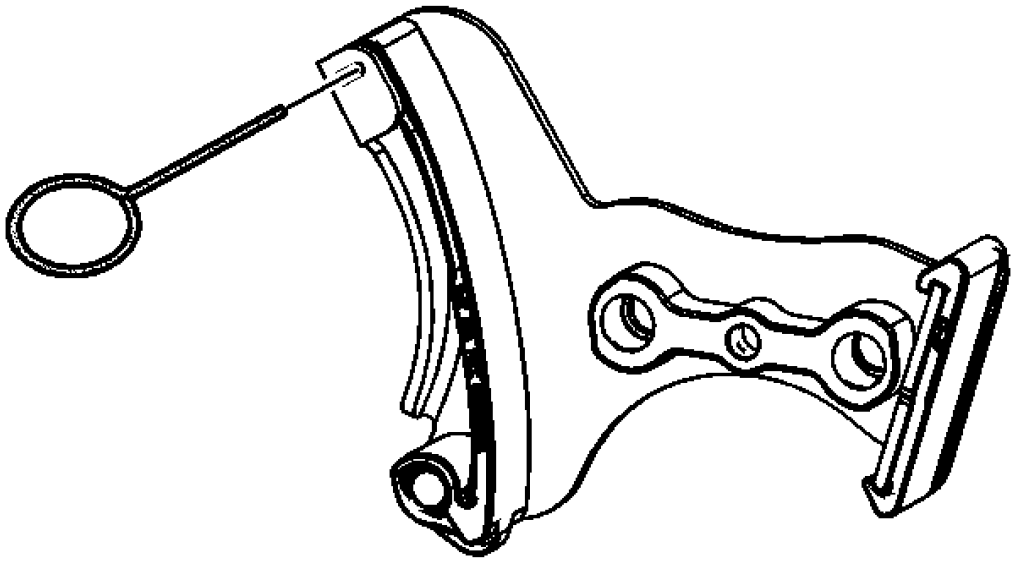


Fig. 213: View Of Compressed Tensioner & Pin
Courtesy of GENERAL MOTORS CORP.

6. Compress the timing chain tensioner guide and install the **EN 46330** . See **Special Tools** .

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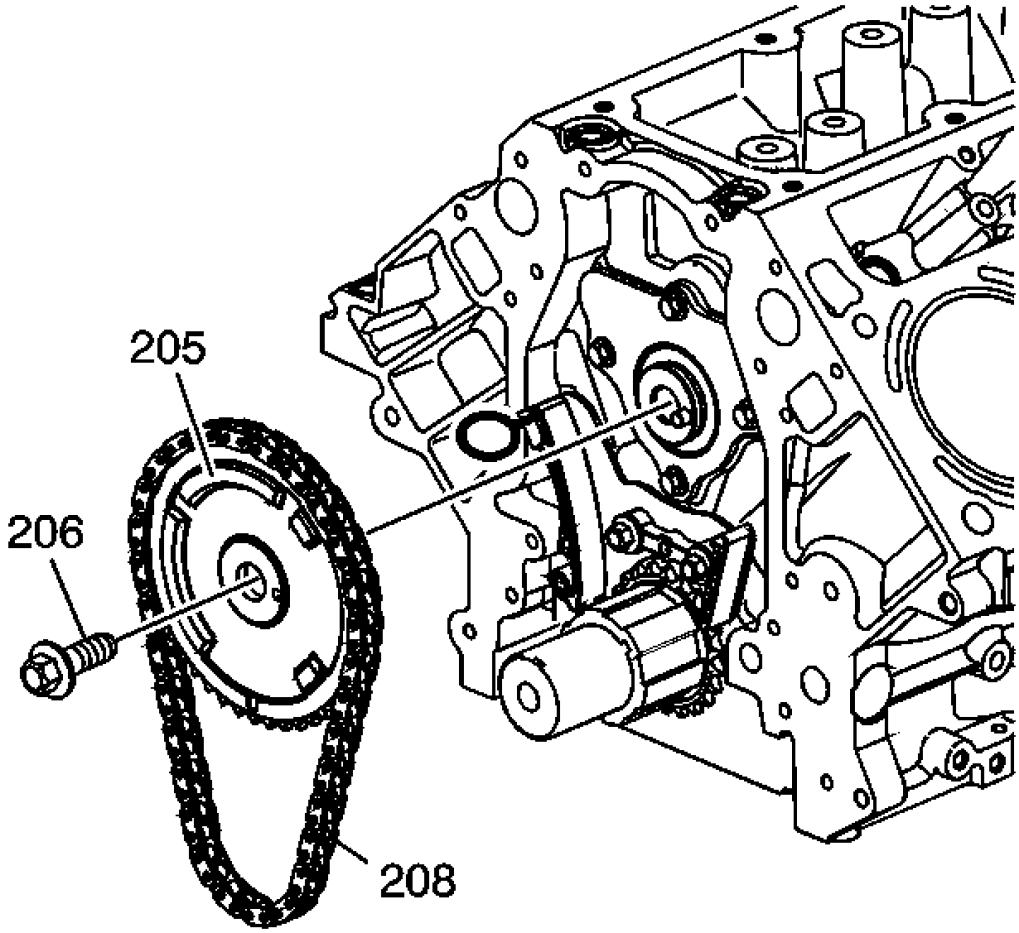


Fig. 214: View Of Camshaft Sprocket & Timing Chain
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **The sprocket teeth and timing chain must mesh.**
- **The camshaft and the crankshaft sprocket alignment marks MUST be aligned properly.**

7. Position the camshaft sprocket (205) so the timing mark is in the 6 o'clock position.
8. Install the camshaft sprocket (205), timing chain (208), and bolt (206).

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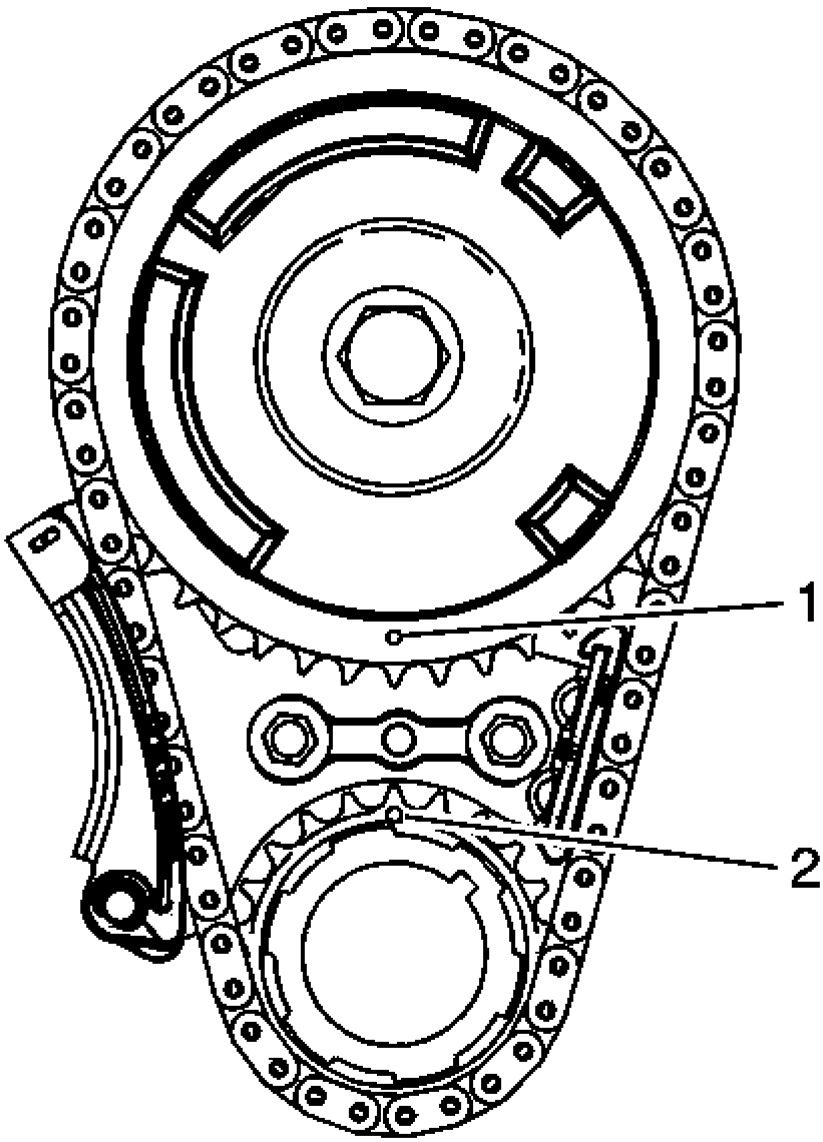


Fig. 215: Identifying Camshaft & Crankshaft Marks
Courtesy of GENERAL MOTORS CORP.

9. Inspect the sprockets for proper alignment. The mark on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

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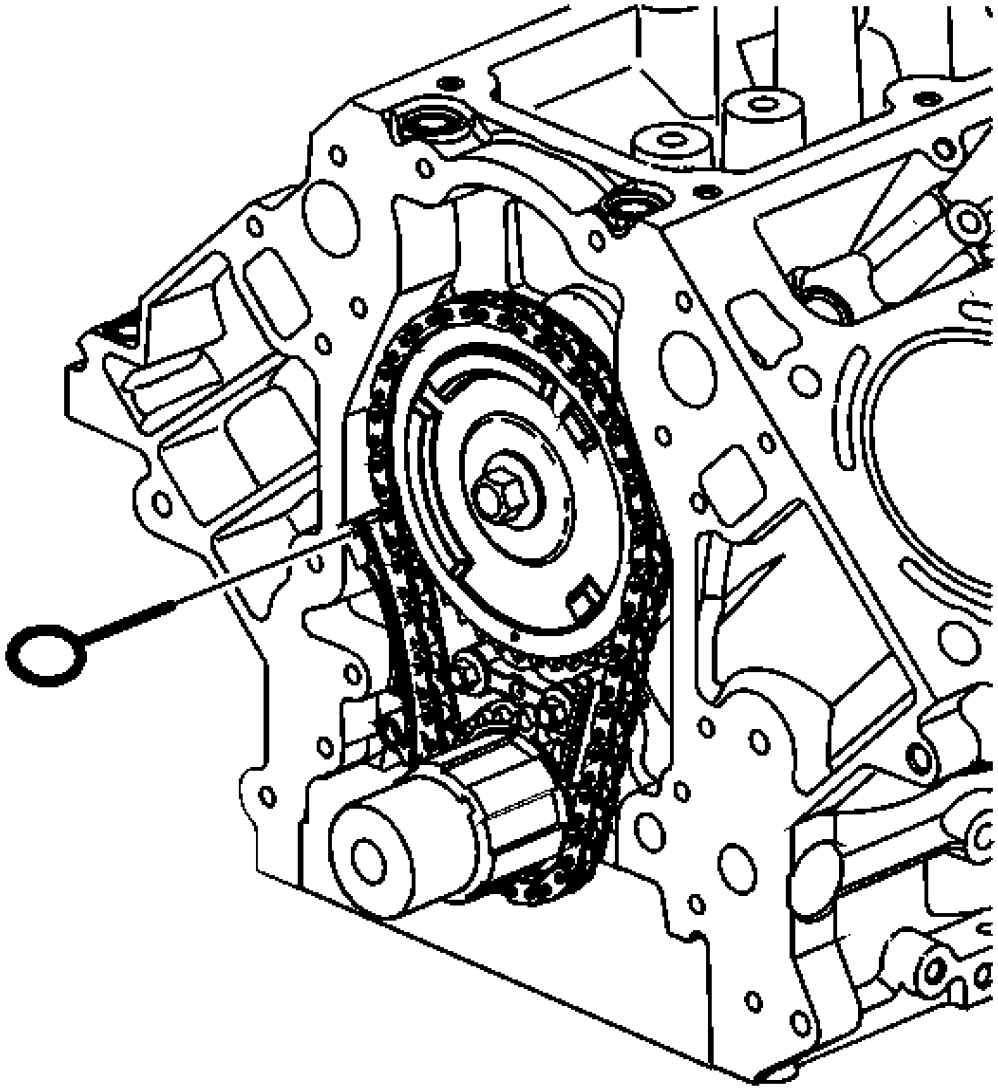


Fig. 216: Locating Tensioner Pin
Courtesy of GENERAL MOTORS CORP.

10. Remove the **EN 46330** . See **Special Tools** .

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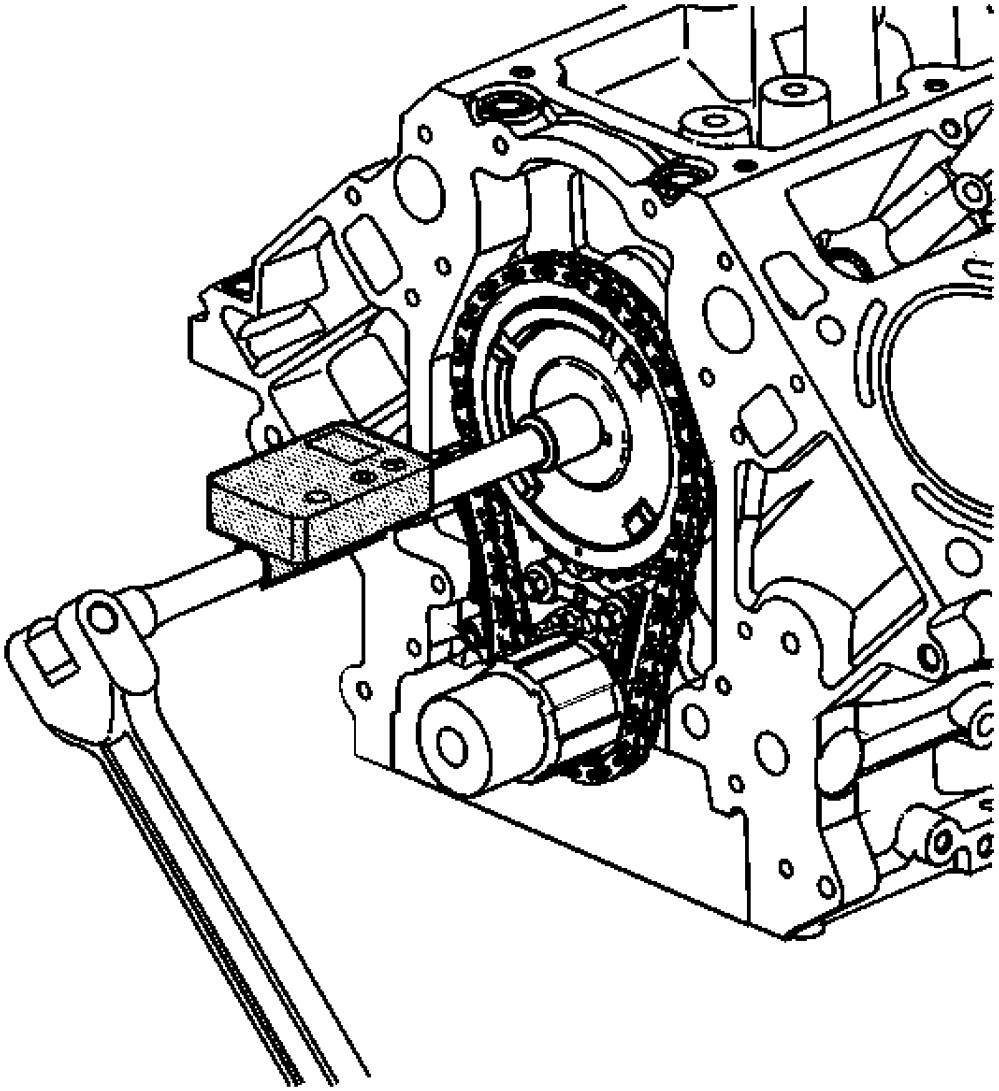


Fig. 217: Tightening Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Do Not re-use camshaft sprocket bolt. New sprocket bolt must be used.

11. Tighten the camshaft sprocket bolt

Tighten:

1. Tighten the bolt a first pass to 75 N.m (55 lb ft).

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2. Tighten the bolt a final pass an additional 50 degrees using **J 45059** .

12. Remove the **J 42386-A** (1) and bolts. See **Special Tools** .
13. Install the oil pump. Refer to **Oil Pump, Screen, and Crankshaft Oil Deflector Replacement**.

CAMSHAFT REPLACEMENT (LS3)

Special Tools

- **EN 46330** Timing Belt Tensioner Retaining Pin. See **Special Tools** .
- **J 42386-A** Flywheel Holding Tool. See **Special Tools** .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

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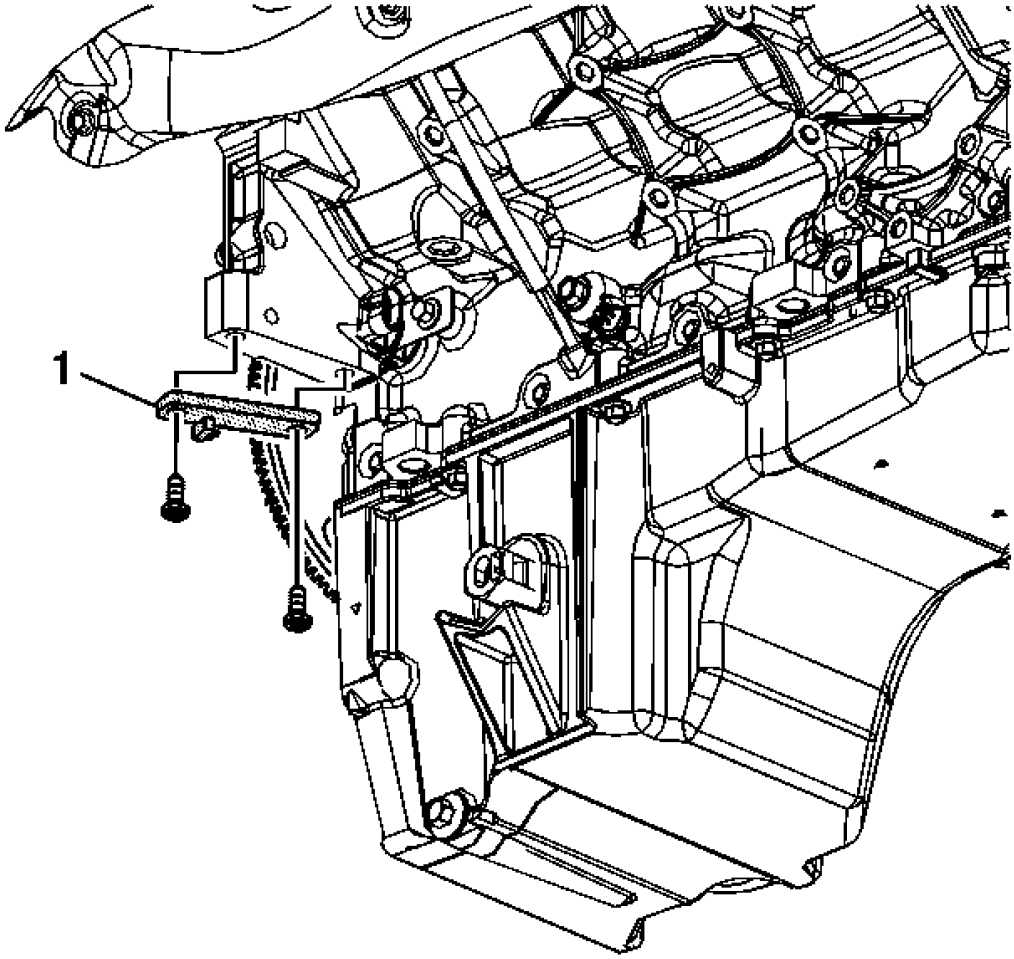


Fig. 218: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: If camshaft replacement is required, the valve lifters must also be replaced.

1. Remove the radiator support.
2. Remove the valve lifters. Refer to **Valve Lifter Replacement (Without AFM)** or **Valve Lifter Replacement (With AFM)**.
3. Remove the engine front cover. Refer to **Engine Front Cover Replacement (L99)** or **Engine Front Cover Replacement (LS3)**.
4. Remove the starter motor. Refer to **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)** .

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CAUTION: Refer to Fastener Caution .

NOTE: Ensure that the teeth of the J 42386-A mesh with the teeth of the engine flywheel. See Special Tools .

5. Install the **J 42386-A** (1) and bolts. See **Special Tools** . Use one M10 - 1.5 x 120 mm and one M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the **J 42386-A** bolts to 50 N. See **Special Tools** .m (37 lb ft).

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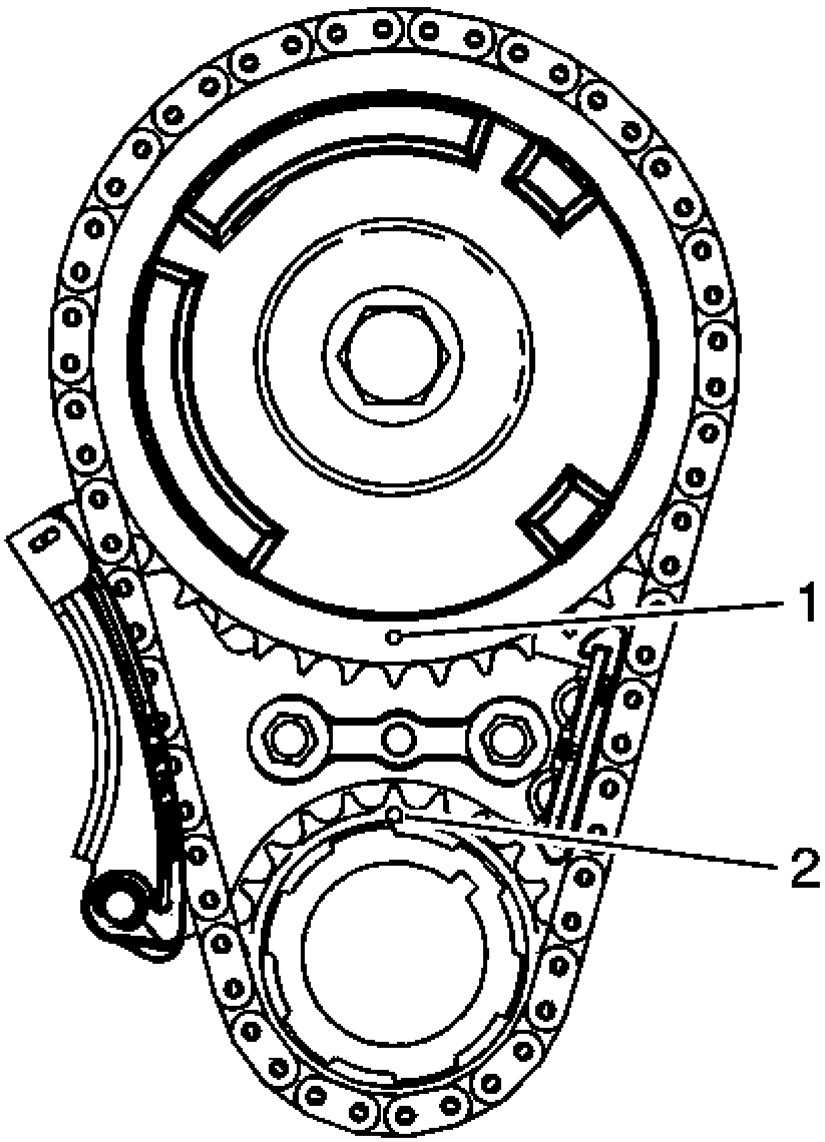


Fig. 219: Identifying Camshaft & Crankshaft Marks
Courtesy of GENERAL MOTORS CORP.

6. Rotate the crankshaft sprocket until the camshaft sprocket alignment mark (1) and the crankshaft sprocket alignment mark (2) are aligned.

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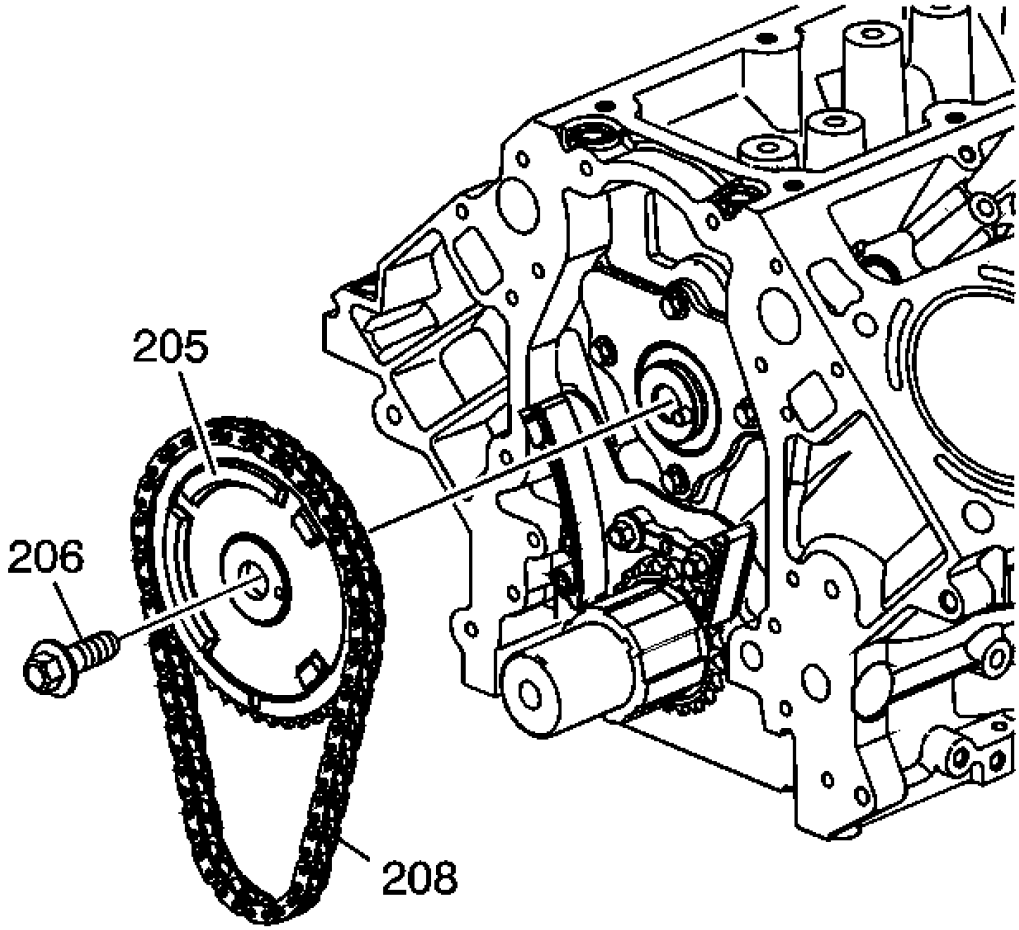


Fig. 220: View Of Camshaft Sprocket, Timing Chain & Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not turn the crankshaft assembly after the timing chain has been removed in order to prevent damage to the piston assemblies or the valves.

7. Remove the camshaft sprocket bolt (206).
8. Remove the camshaft sprocket (205) and timing chain (208).

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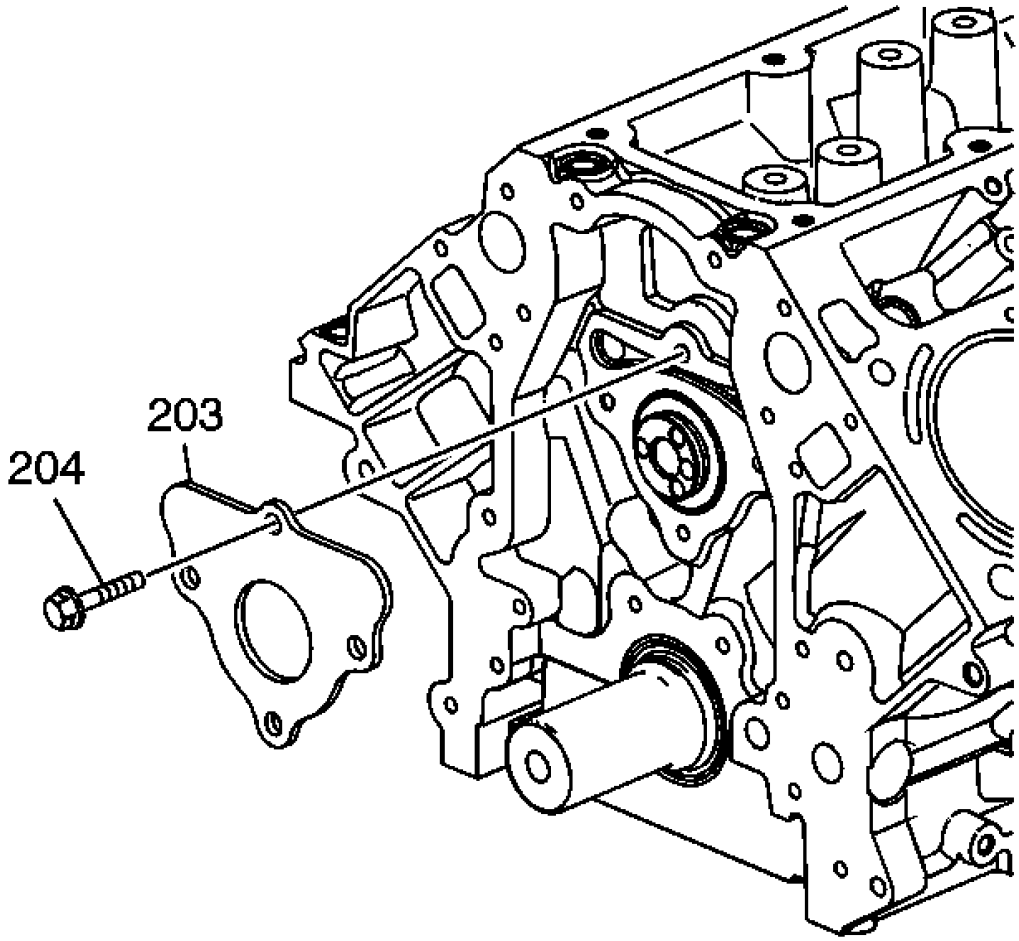


Fig. 221: Camshaft Retainer & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Remove the camshaft retainer bolts (204) and retainer (203).

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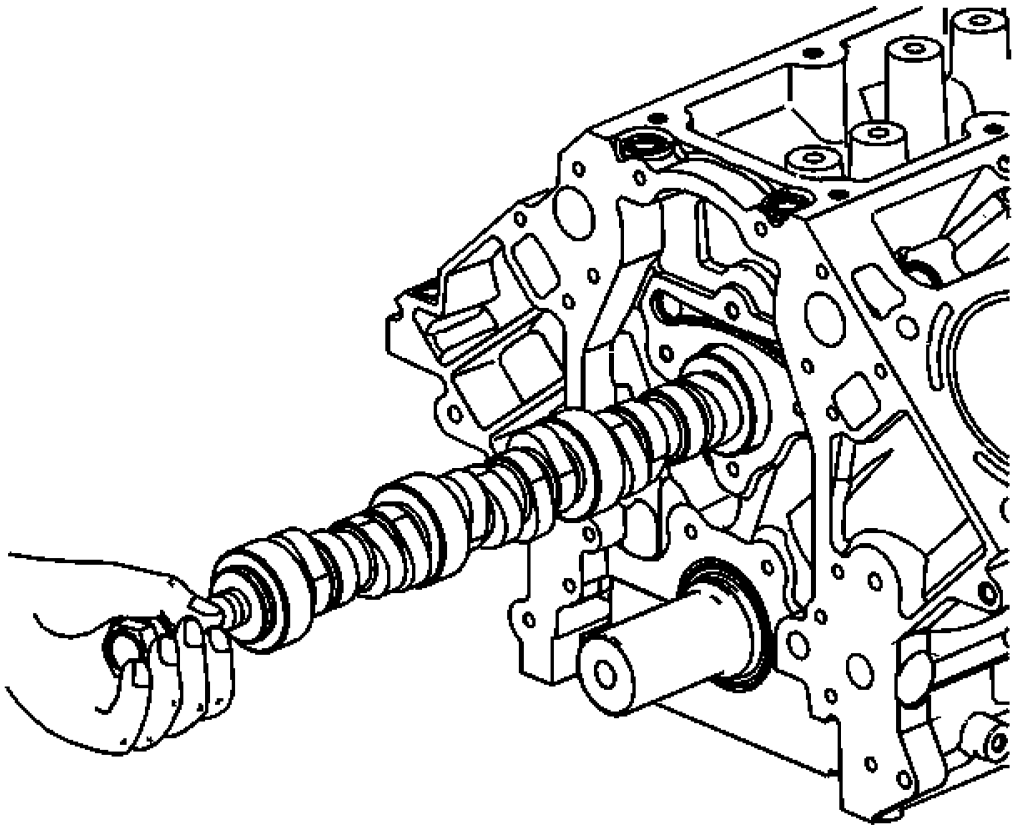


Fig. 222: View Of Camshaft
Courtesy of GENERAL MOTORS CORP.

CAUTION: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

10. Install the camshaft sprocket bolt into the camshaft front bolt hole.
11. Using the bolt as a handle, carefully rotate and remove the camshaft from the engine block.
12. Remove the bolt from the camshaft.

INSTALLATION PROCEDURE

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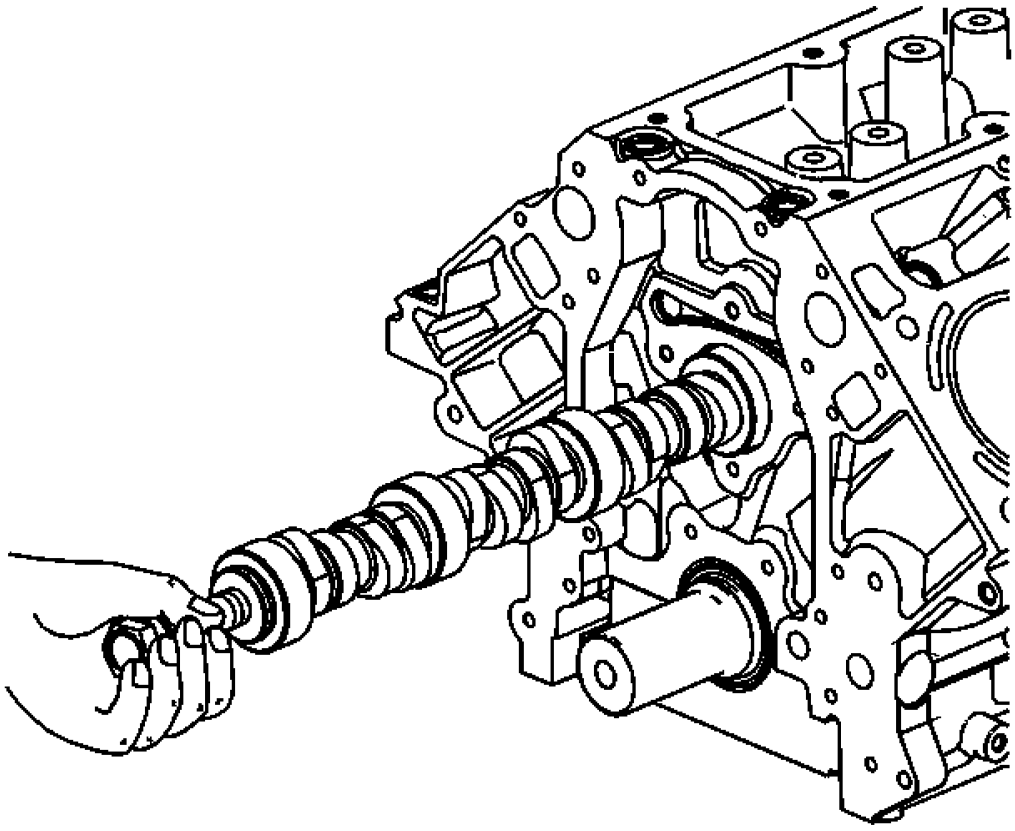


Fig. 223: View Of Camshaft
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the camshaft journals and the bearings with clean engine oil.
2. Install the camshaft sprocket bolt into the camshaft front bolt hole.

CAUTION: All camshaft journals are the same diameter, so care must be used in removing or installing the camshaft to avoid damage to the camshaft bearings.

3. Using the bolt as a handle, carefully install the camshaft into the engine block.
4. Remove the bolt from the front of the camshaft.

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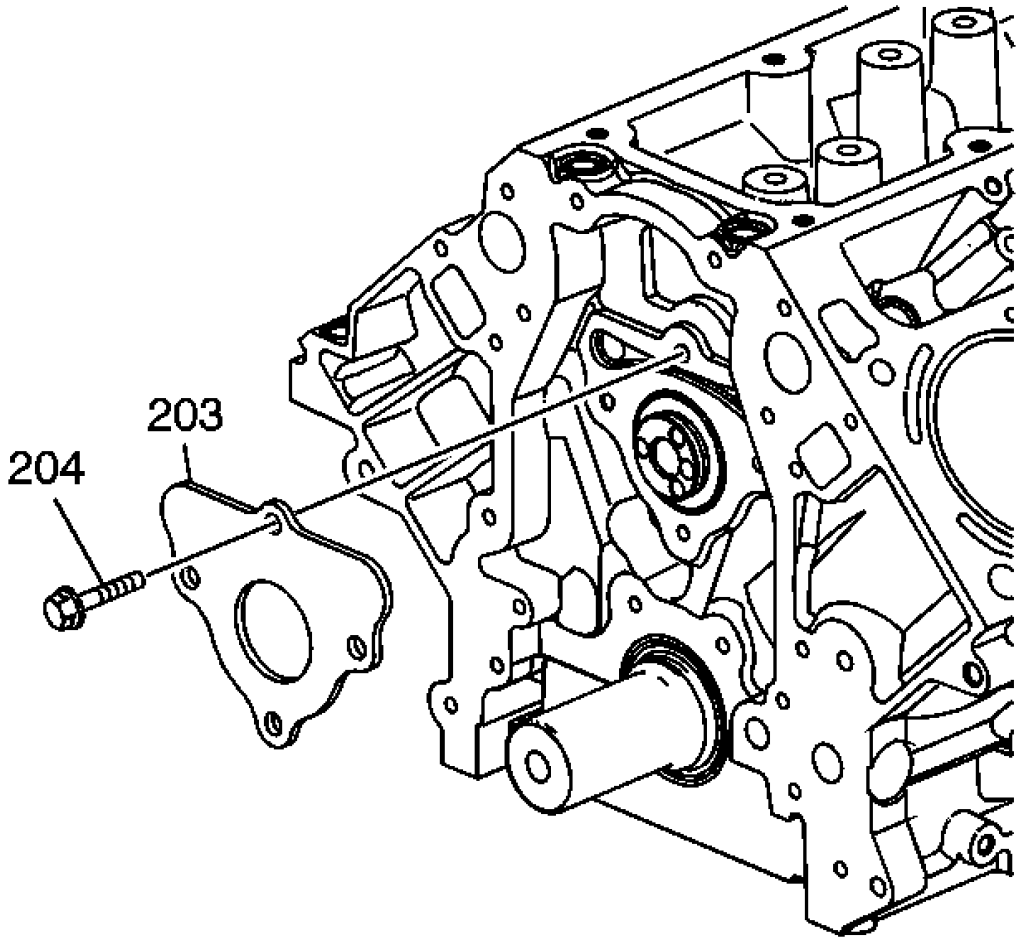


Fig. 224: Camshaft Retainer & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: The gasket surface on the engine block should be clean and free of dirt and/or debris.

5. Install the camshaft retainer (203) and bolts (204). Install the retainer with the sealing gasket facing the engine block.

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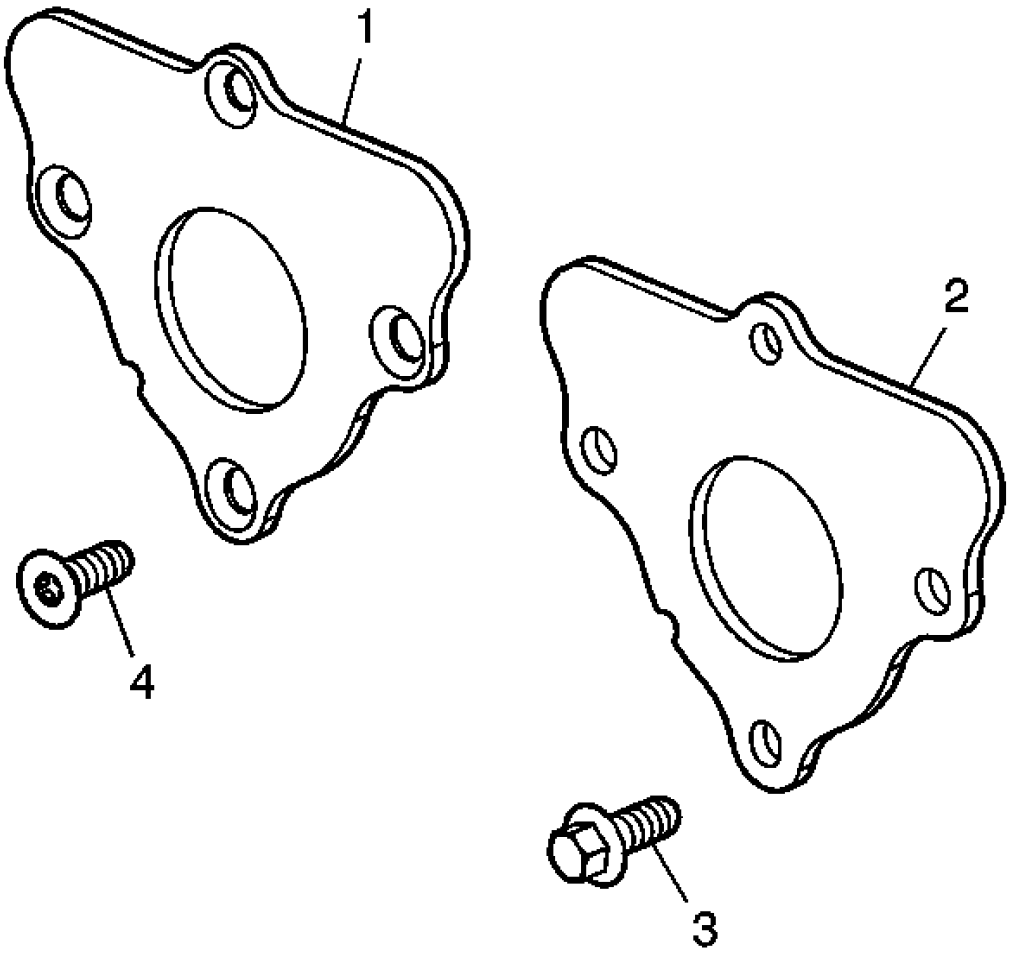


Fig. 225: Identifying Camshaft Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

6. Tighten the camshaft retainer bolts.
    - Tighten the first design hex head bolts (3) to 25 N.m (18 lb ft).
    - Tighten the second design TORX® head bolts (4) to 15 N.m (11 lb ft).

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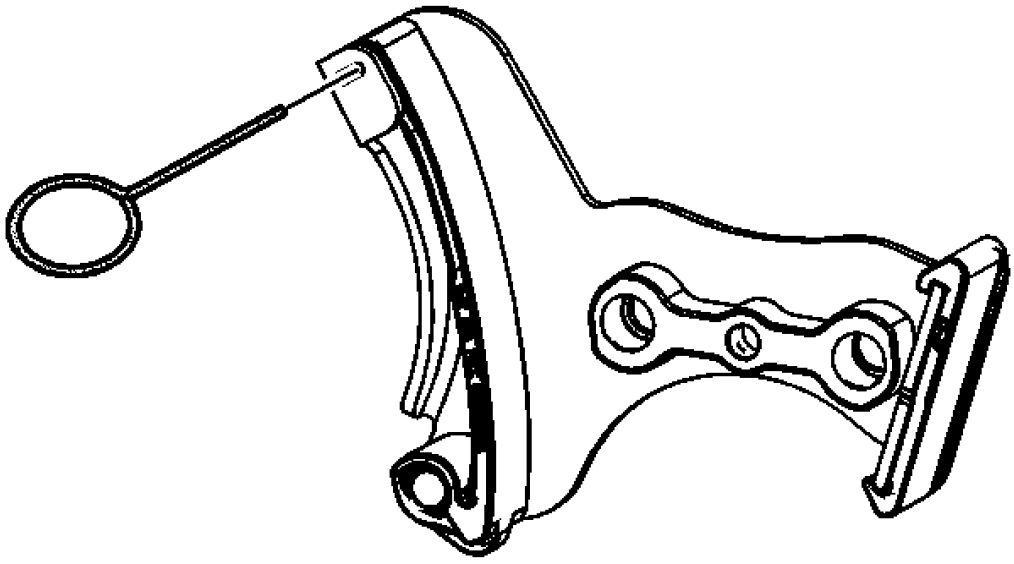


Fig. 226: View Of Compressed Tensioner & Pin
Courtesy of GENERAL MOTORS CORP.

7. Compress the timing chain tensioner guide and install the **EN 46330** . See **Special Tools** .

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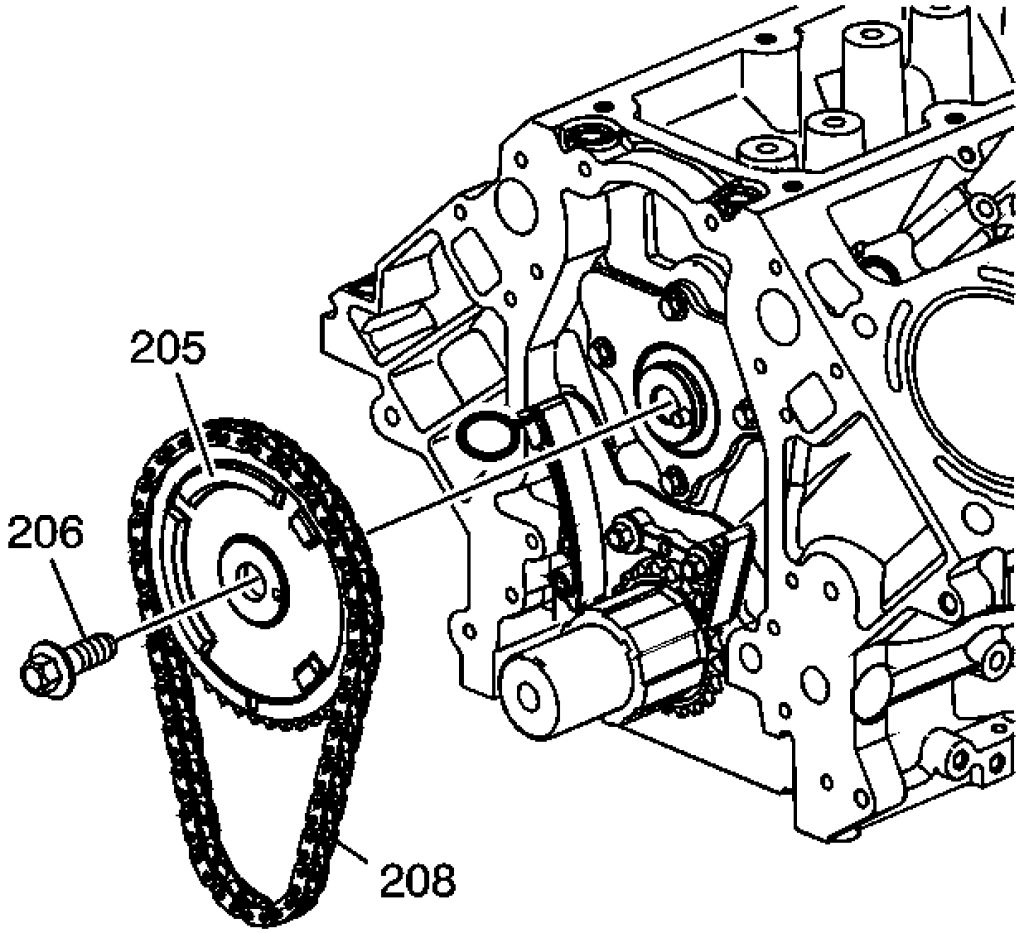


Fig. 227: View Of Camshaft Sprocket & Timing Chain
Courtesy of GENERAL MOTORS CORP.

8. Align the camshaft sprocket so the timing mark is in the 6 o'clock position.
9. Install the camshaft sprocket (205), timing chain (208), and bolt (206).

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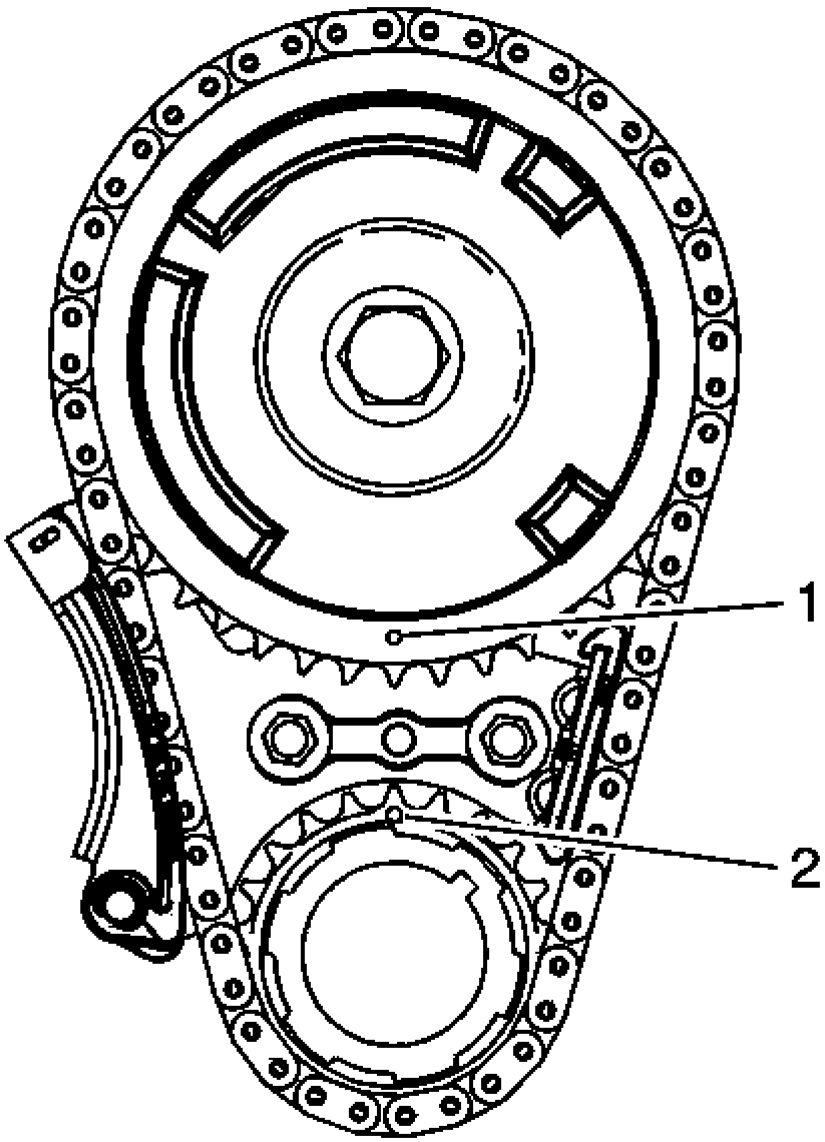


Fig. 228: Identifying Camshaft & Crankshaft Marks
Courtesy of GENERAL MOTORS CORP.

10. Inspect the sprockets for proper alignment. The marks on the camshaft sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

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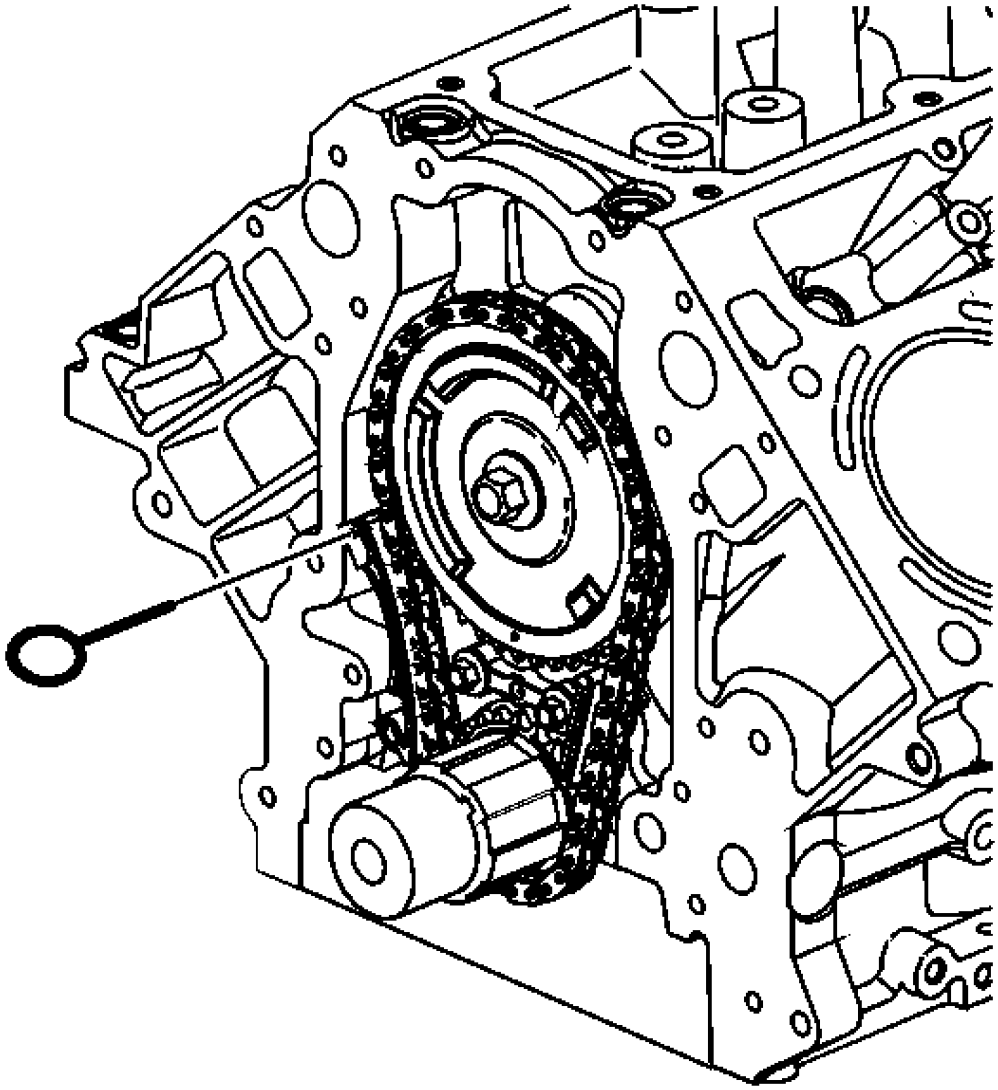


Fig. 229: Locating Tensioner Pin
Courtesy of GENERAL MOTORS CORP.

11. Remove the **EN 46330** . See **Special Tools** .

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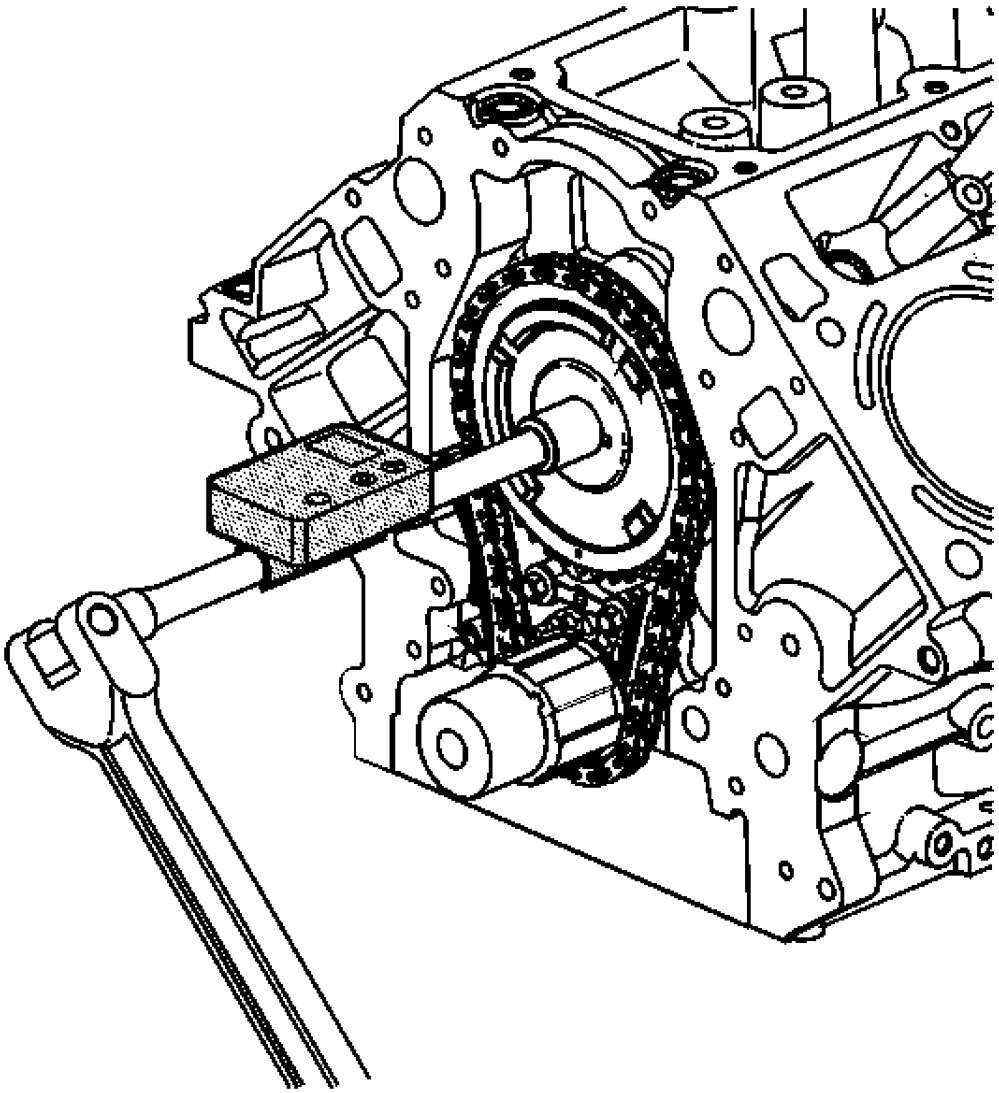


Fig. 230: Tightening Camshaft Sprocket Bolt
Courtesy of GENERAL MOTORS CORP.

12. Tighten the camshaft sprocket bolt.
    1. Tighten the bolt a first pass to 90 N.m (66 lb ft).
    2. Tighten the bolt a final pass to 40 degrees using **J 45059** .

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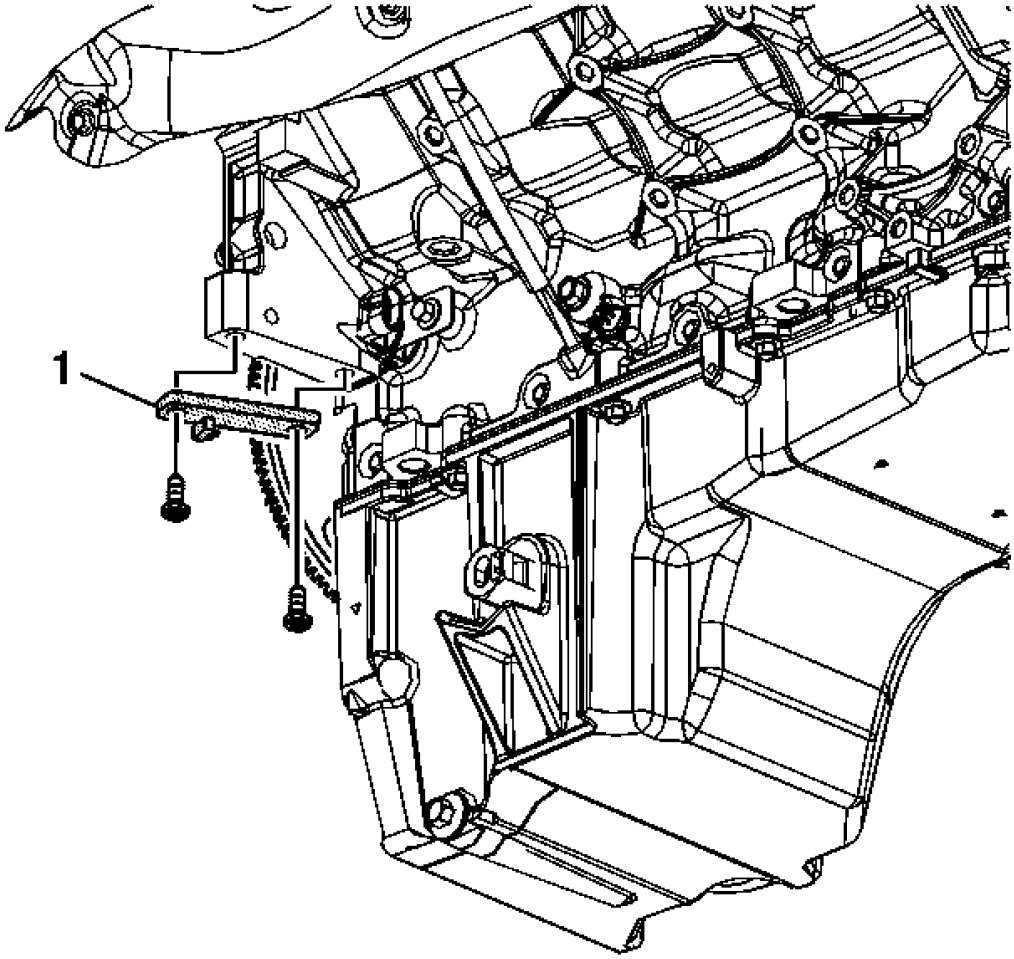


Fig. 231: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS CORP.

13. Remove the **J 42386-A** (1) and bolts. See **Special Tools** .
14. Install the starter motor. Refer to **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)** .
15. Install the engine front cover. Refer to **Engine Front Cover Replacement (L99)** or **Engine Front Cover Replacement (LS3)**.
16. Install the valve lifters. Refer to **Valve Lifter Replacement (Without AFM)** or **Valve Lifter Replacement (With AFM)**.
17. Install the radiator support.

CAMSHAFT REPLACEMENT (L99)

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Special Tools

- **EN 46330** Timing Belt Tensioner Retaining Pin. See **Special Tools** .
- **J 42386-A** Flywheel Holding Tool. See **Special Tools** .
- **J 45059** Angle Meter

REMOVAL PROCEDURE

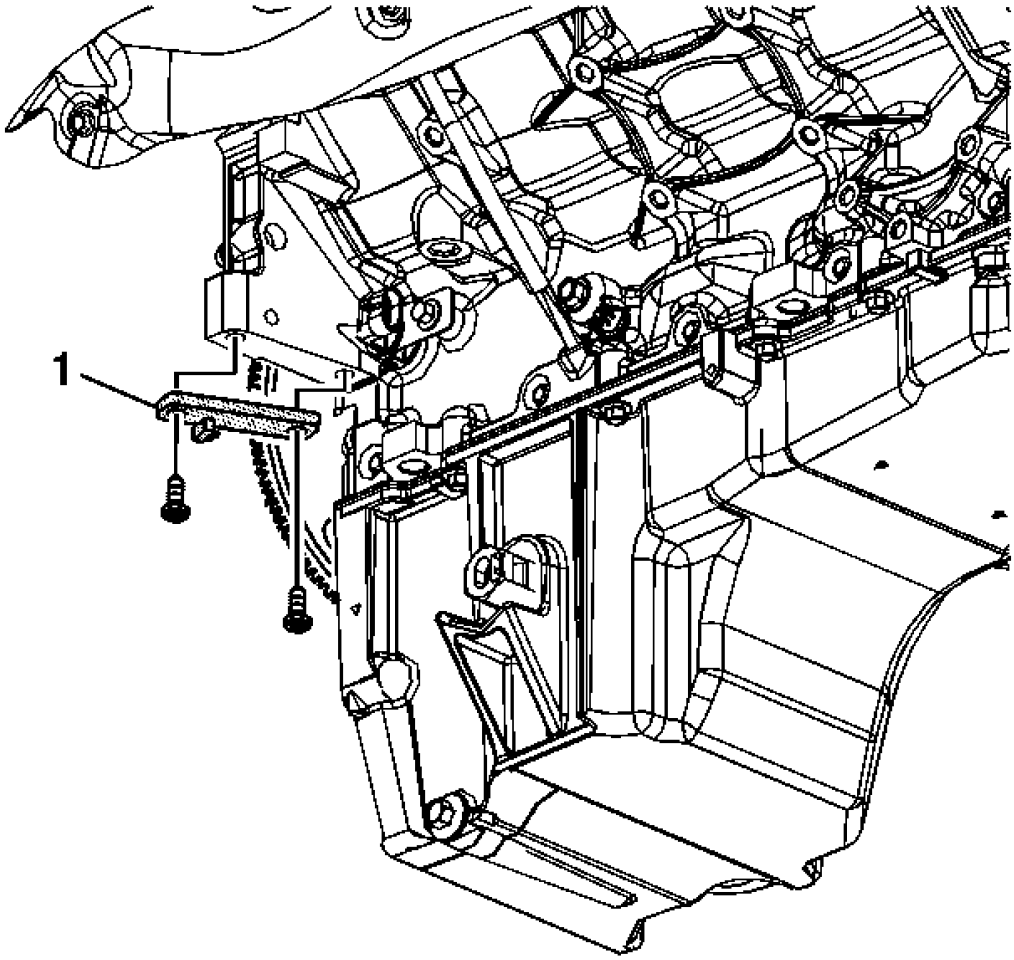


Fig. 232: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: **If camshaft replacement is required, the valve lifters must also be replaced.**

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1. Remove the radiator support. Refer to **Air Conditioning Condenser Replacement (LLT)** or **Air Conditioning Condenser Replacement (LS3, L99)** .
2. Remove the valve lifters. Refer to **Valve Lifter Replacement (Without AFM)** or **Valve Lifter Replacement (With AFM)**.
3. Remove the camshaft position actuator. Refer to **Camshaft Position Actuator Replacement**.

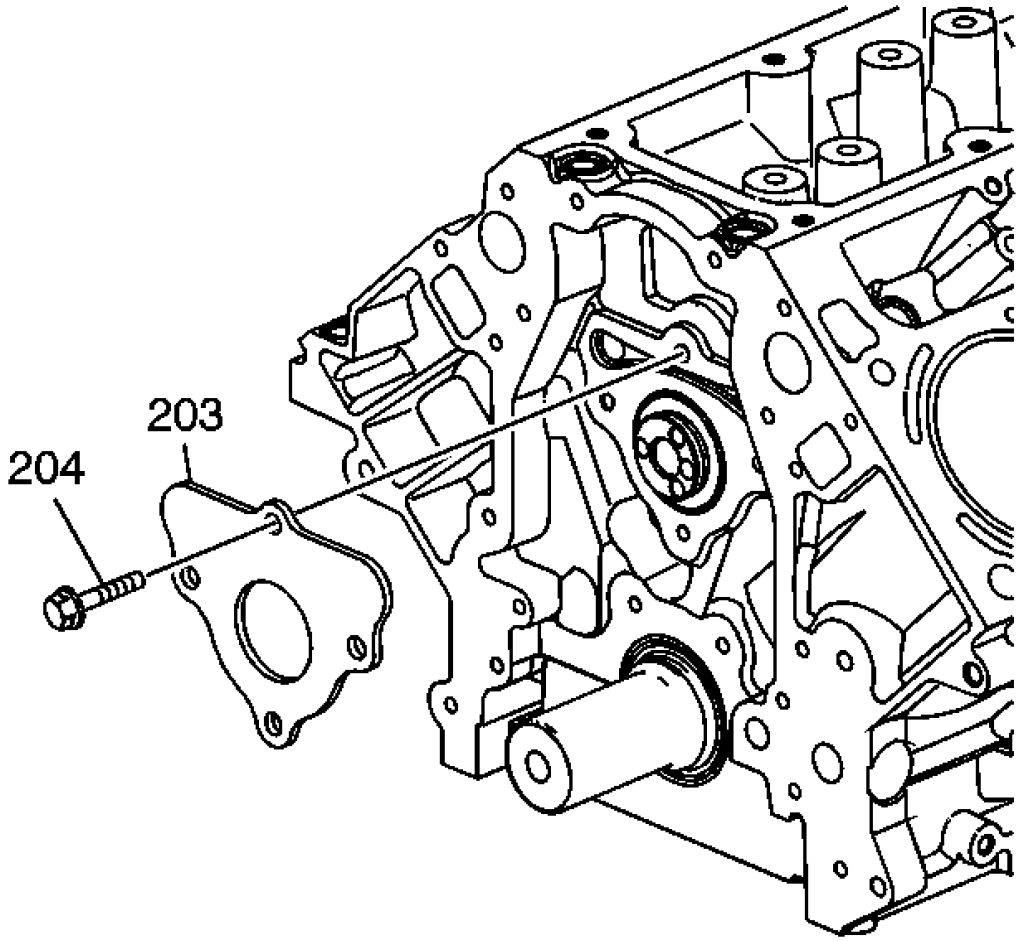


Fig. 233: Camshaft Retainer & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the camshaft retainer bolts (204) and retainer (203).
5. Install the camshaft sprocket bolt into the camshaft front bolt hole
6. Using the bolt as a handle, carefully rotate and remove the camshaft from the engine block.
7. Remove the bolt from the camshaft.

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INSTALLATION PROCEDURE

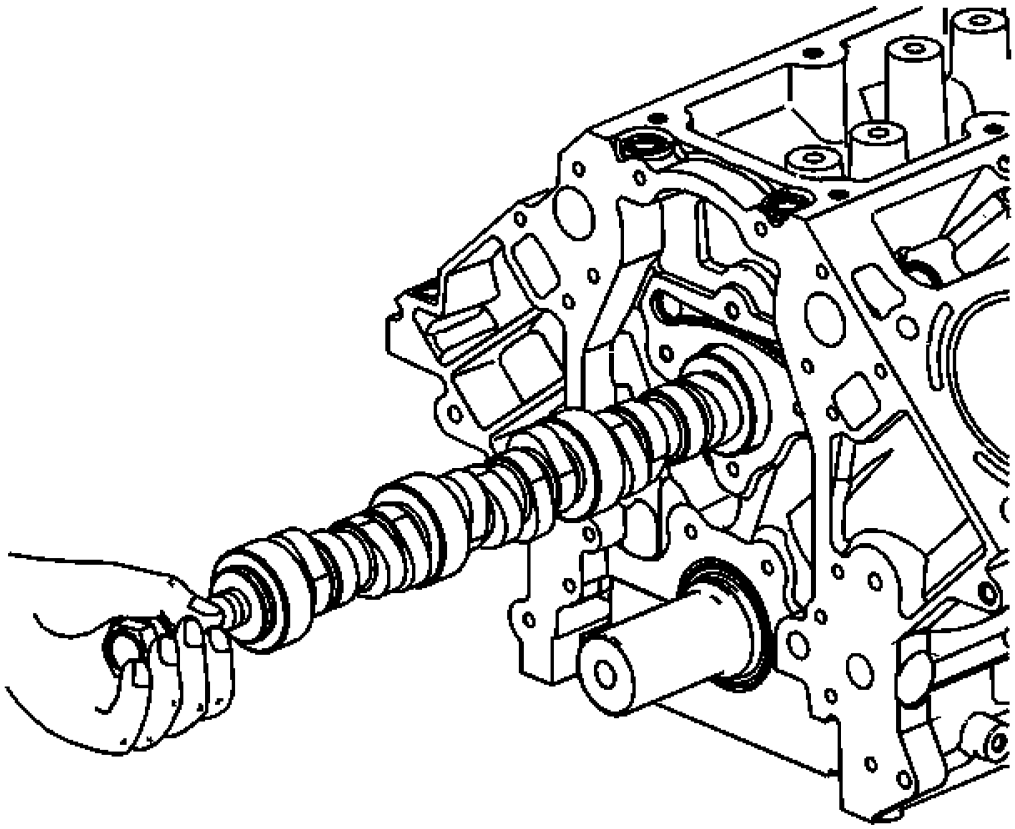


Fig. 234: View Of Camshaft
Courtesy of GENERAL MOTORS CORP.

1. Lubricate the camshaft journals and the bearings with clean engine oil.
2. Install the camshaft sprocket bolt into the camshaft front bolt hole.

NOTE: Using the bolt as a handle, carefully install the camshaft into the engine block.

3. Remove the bolt from the front of the camshaft.

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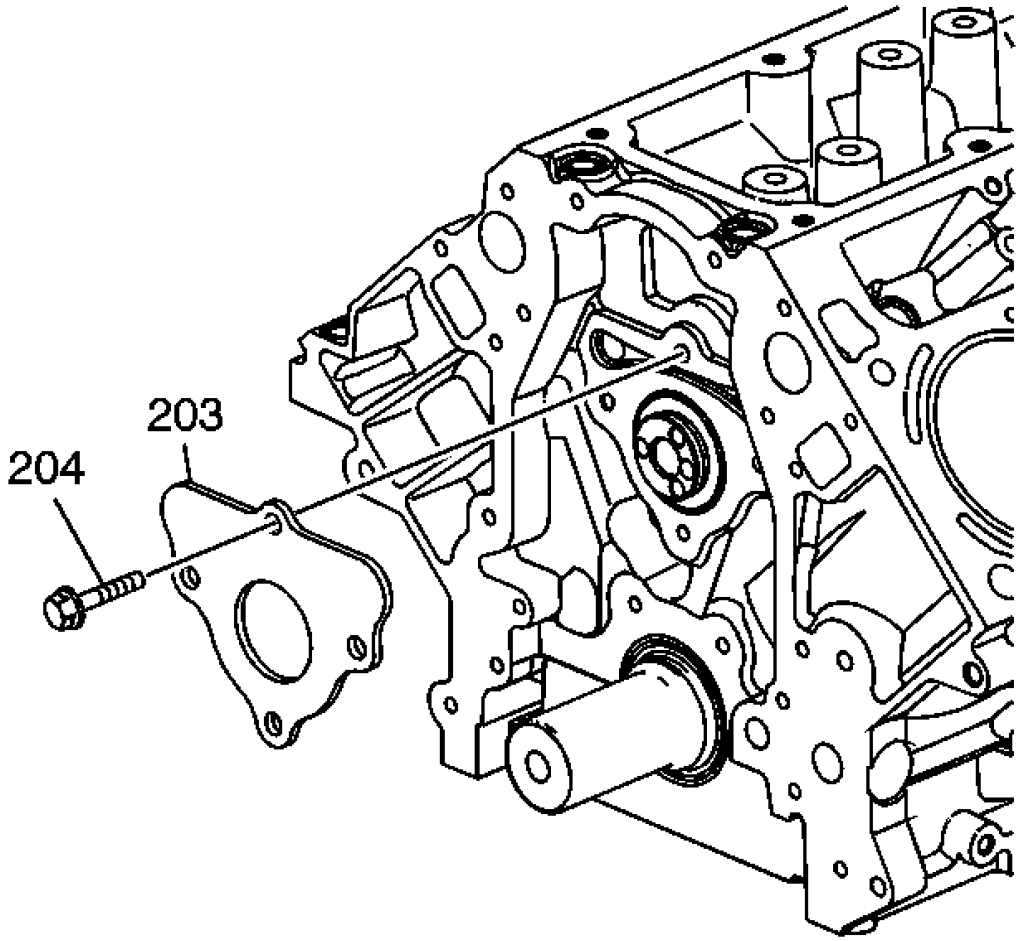


Fig. 235: Camshaft Retainer & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: The gasket surface on the engine block should be clean and free of dirt and/or debris.

4. Install the camshaft retainer (203) and bolts (204). Install the retainer with the sealing gasket facing the engine block.

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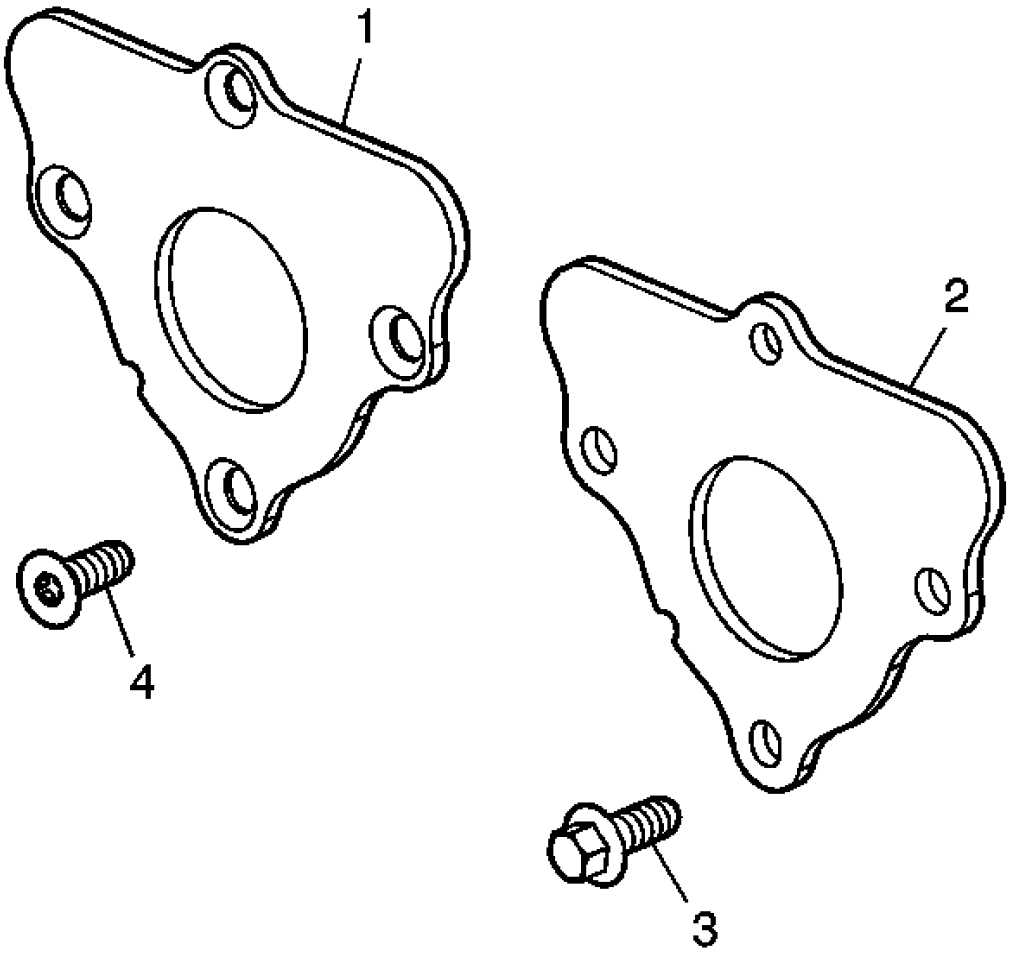


Fig. 236: Identifying Camshaft Retainer Bolts
Courtesy of GENERAL MOTORS CORP.

5. Tighten the camshaft retainer bolts.
    - Tighten the first design hex head bolts (3) to 25 N.m (18 lb ft).
    - Tighten the second design TORX® head bolts (4) to 15 N.m (11 lb ft).

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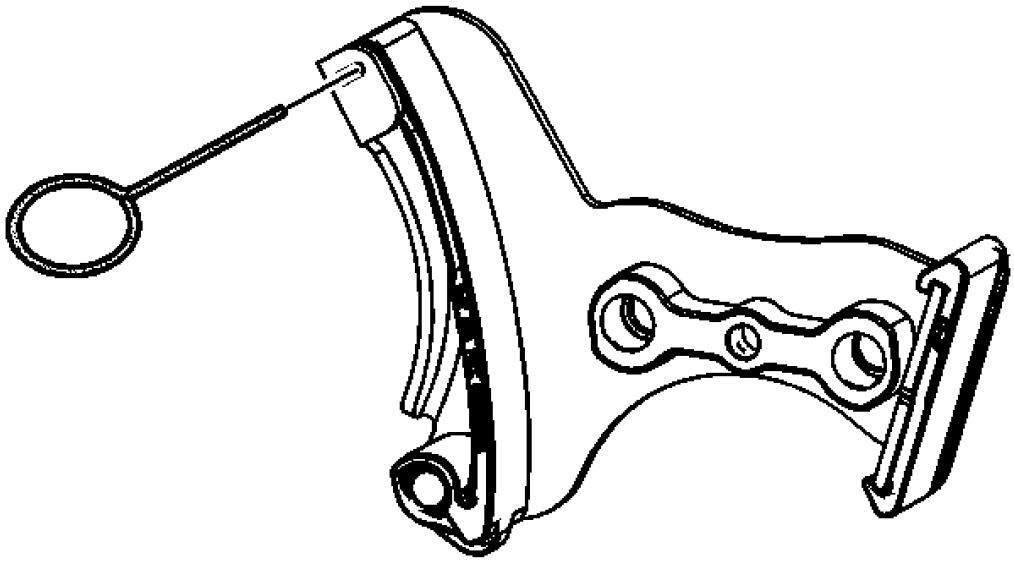


Fig. 237: View Of Compressed Tensioner & Pin
Courtesy of GENERAL MOTORS CORP.

6. Compress the timing chain tensioner guide and install the **EN 46330** . See **Special Tools** .

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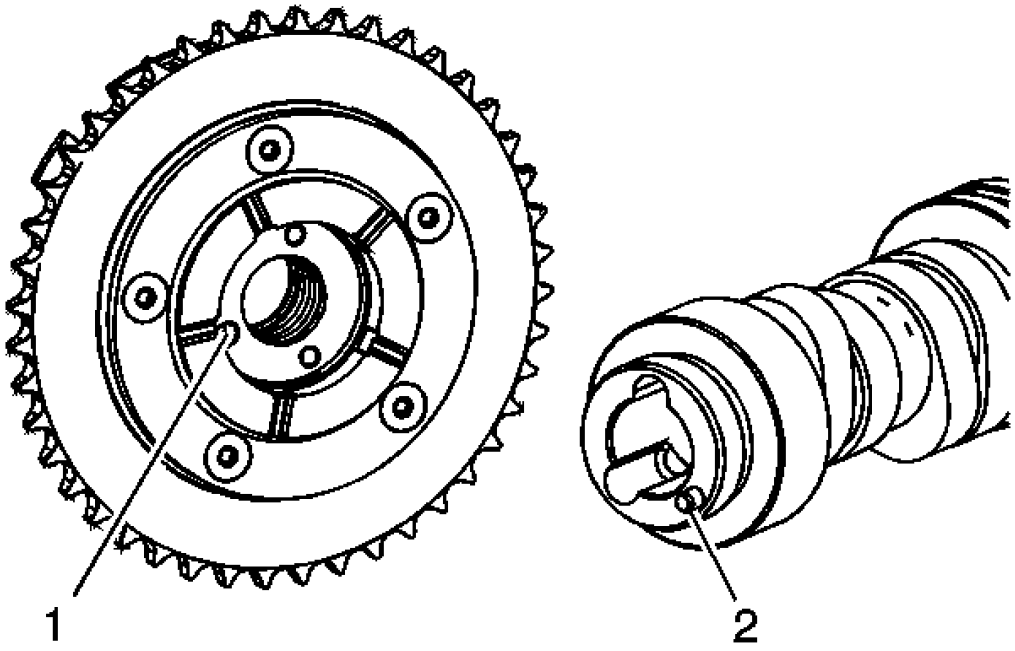


Fig. 238: Identifying Alignment Hole & Locating Pin
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Properly locate the CMP actuator onto the locating pin of the camshaft.**
- **The sprocket teeth and timing chain teeth must mesh.**
- **The camshaft and the crankshaft sprocket alignment mark MUST be aligned properly.**
- **Do not use the CMP solenoid valve again. Install a NEW valve during assembly.**

7. Identify the alignment hole (1) in the rear face of the CMP actuator and the locating pin (2) on the front face of the camshaft.

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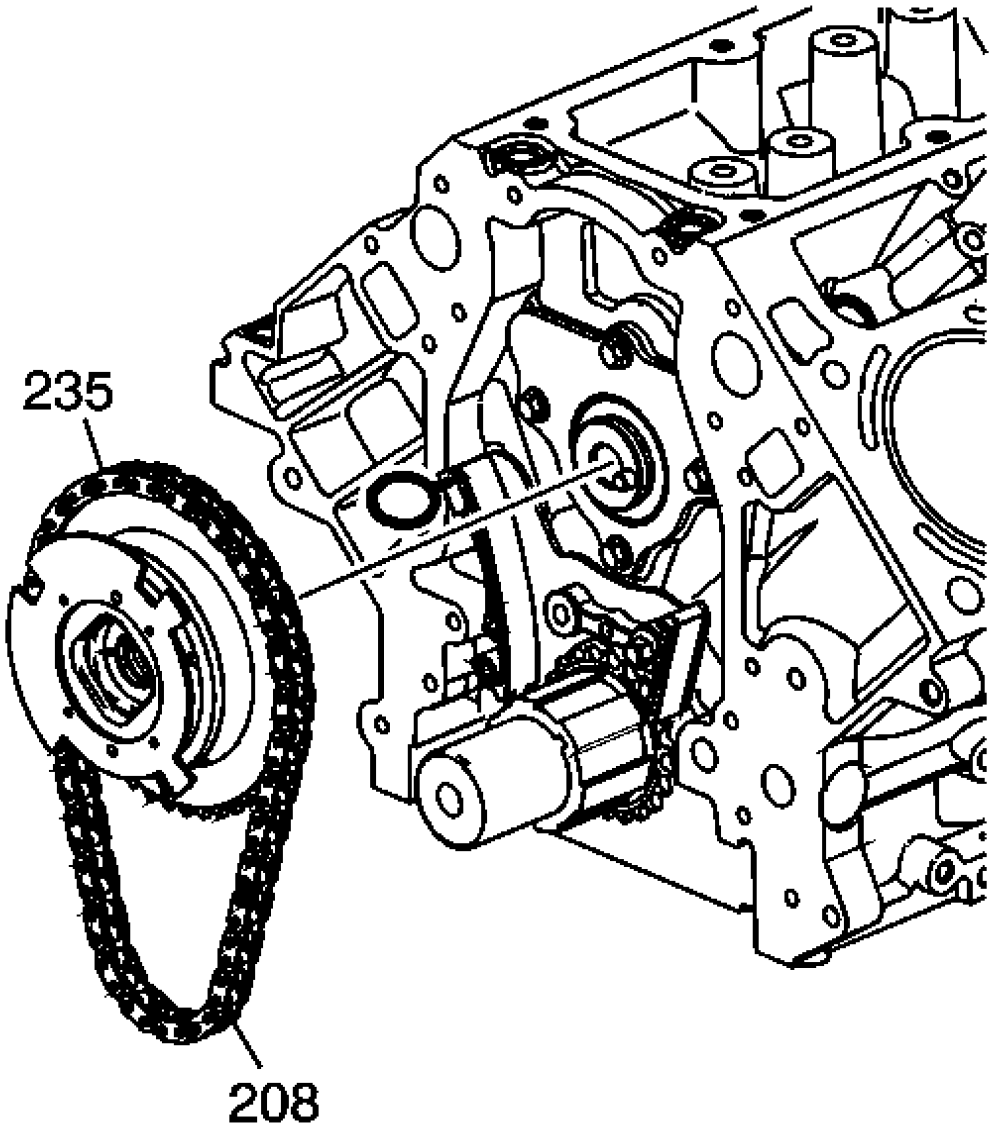


Fig. 239: View Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS CORP.

8. Align the CMP actuator so the timing mark is in the 6 o'clock position.
9. Install the CMP actuator (235) and timing chain (208). Align the hole in the face of the CMP actuator with the locating pin on the front face of the camshaft.

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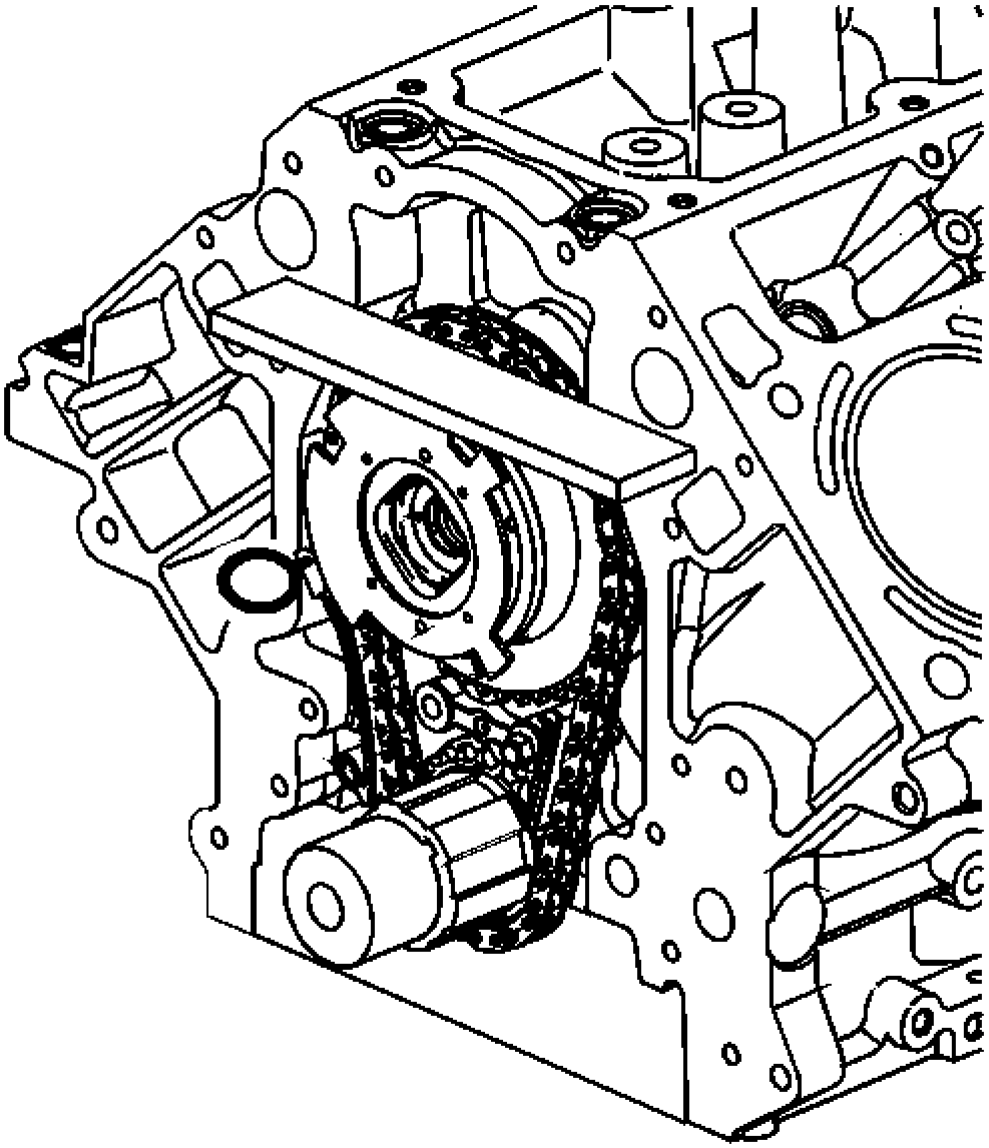


Fig. 240: Inspecting For Proper Installation Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS CORP.

10. Place a straight edge across the front face of the engine block and inspect for proper installation of the CMP actuator and timing chain. With the CMP actuator properly and completely installed onto the front of the camshaft, the timing chain will not protrude beyond the front face of the engine block.

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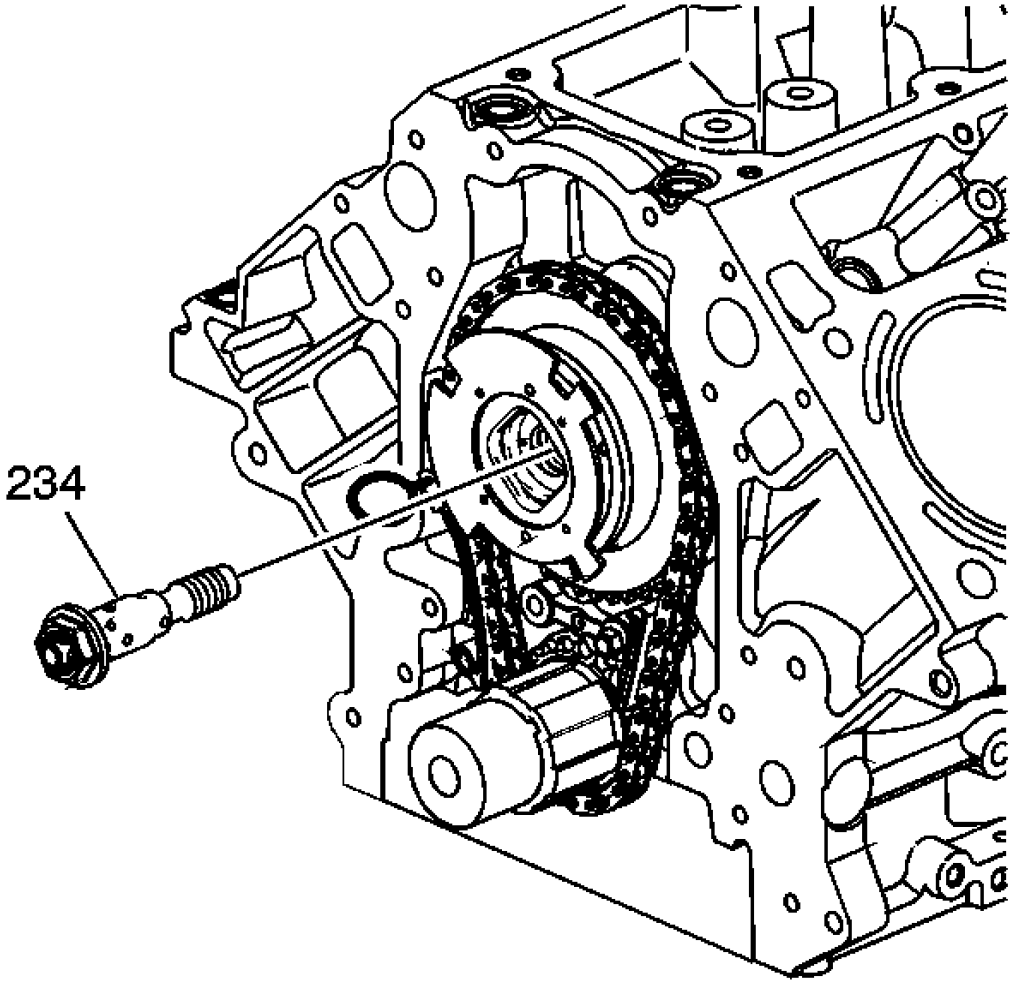


Fig. 241: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

11. Install a NEW CMP actuator solenoid valve (234). With the CMP actuator properly positioned onto the camshaft, the CMP actuator solenoid valve can be threaded completely into the camshaft using light hand pressure. Tighten by hand until snug.

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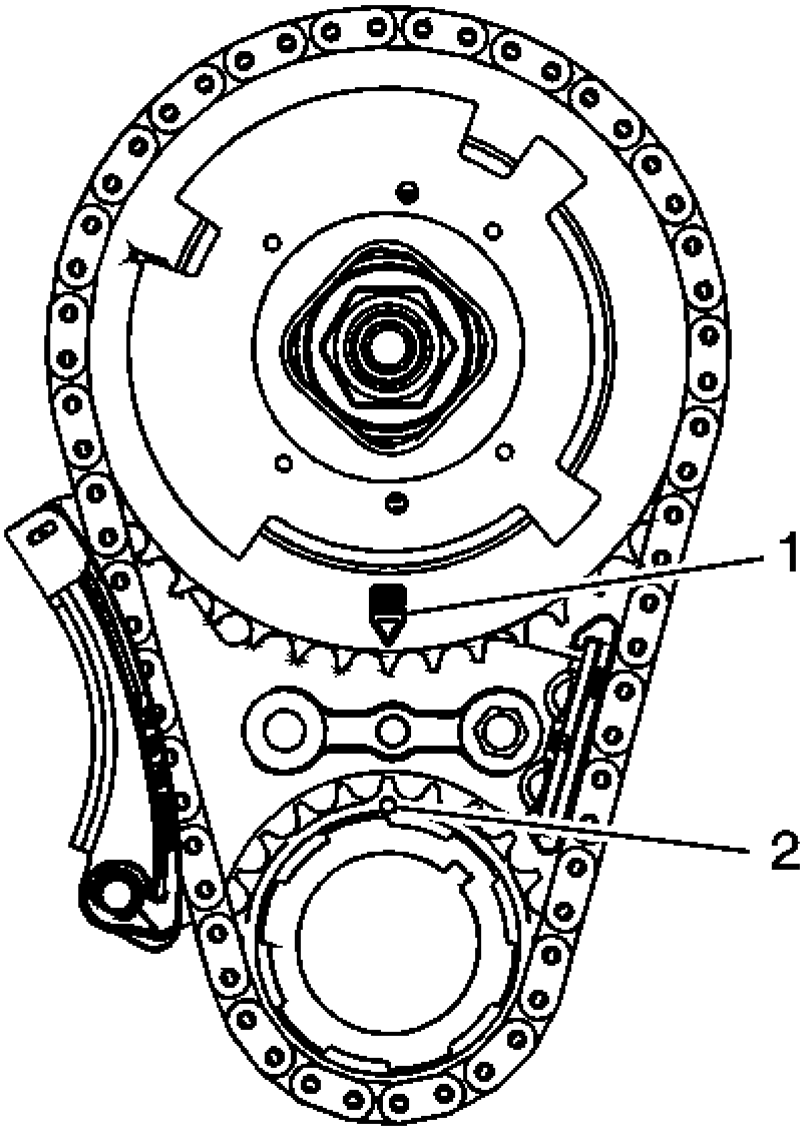


Fig. 242: View Of CMP Actuator Alignment Mark & Crankshaft Sprocket Alignment Mark
Courtesy of GENERAL MOTORS CORP.

12. Inspect the sprockets for proper alignment. The mark on the CMP actuator sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

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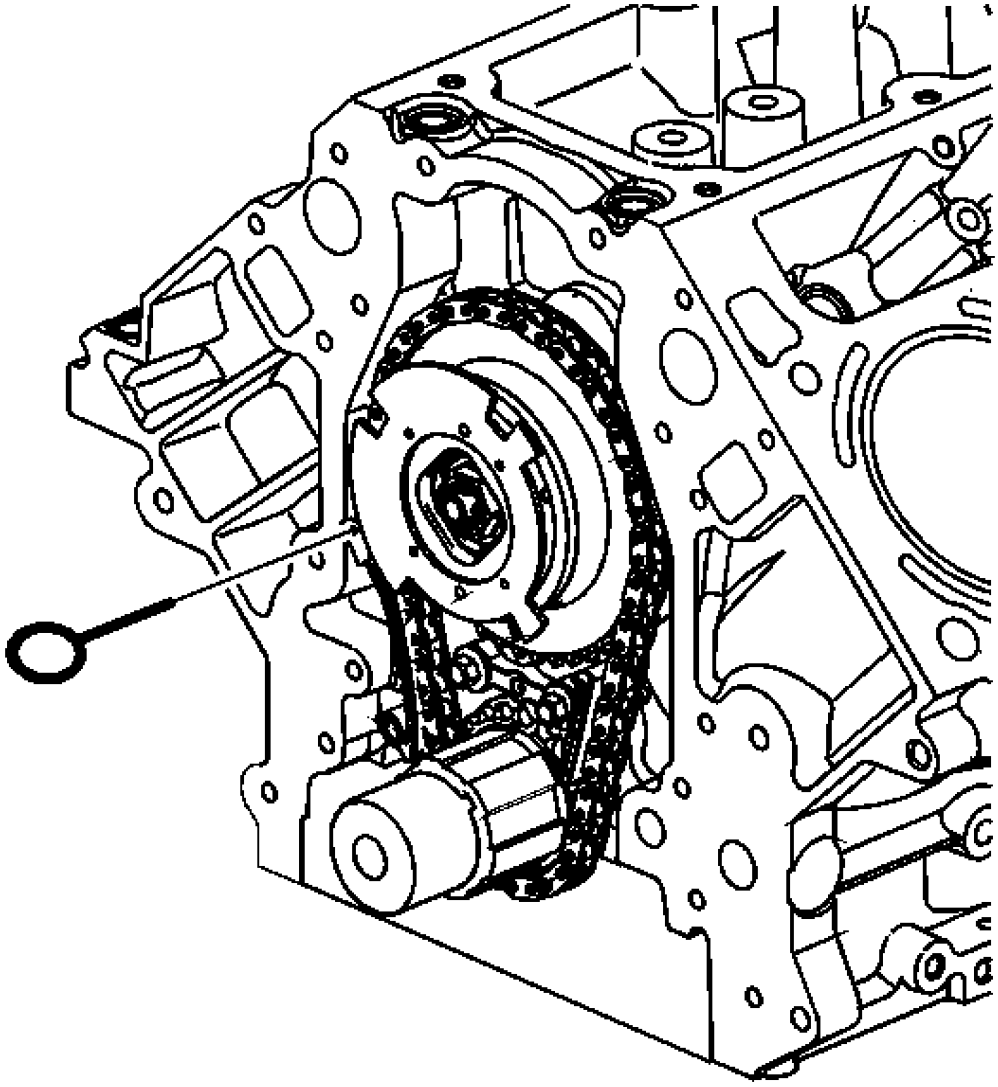


Fig. 243: View Of Special Tool EN 46330
Courtesy of GENERAL MOTORS CORP.

13. Remove the **EN 46330** . See **Special Tools** .

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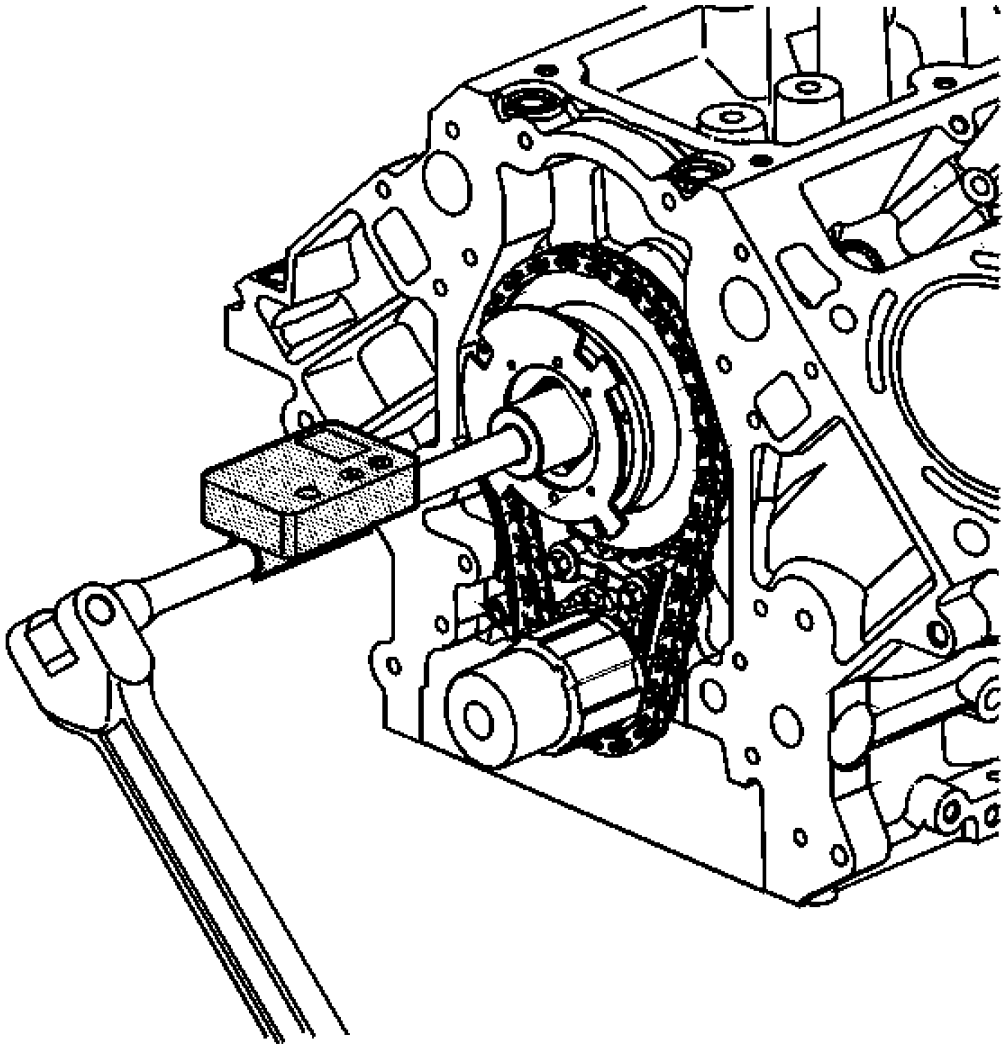


Fig. 244: Tightening CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS CORP.

14. Tighten the CMP actuator solenoid valve.
    1. Tighten the valve a first pass to 65 N.m (48 lb ft).
    2. Tighten the valve a final pass to 90 degrees using **J 45059** .

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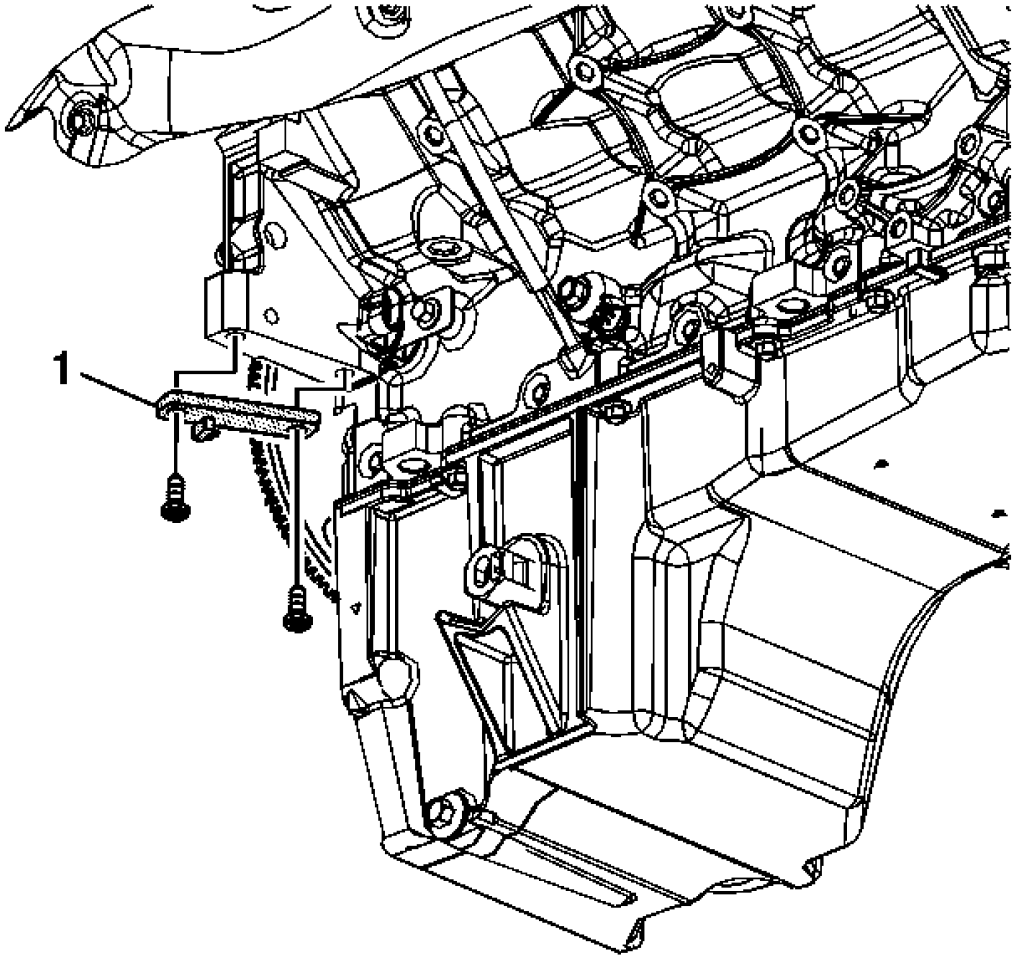


Fig. 245: View Of Special Tool & Bolts
Courtesy of GENERAL MOTORS CORP.

15. Remove the **J 42386-A** . See **Special Tools** .
16. Install the starter motor. Refer to **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)**
17. Install the engine front cover. Refer to **Engine Front Cover Replacement (L99)** or **Engine Front Cover Replacement (LS3)**.
18. Install the valve lifters. Refer to **Valve Lifter Replacement (Without AFM)** or **Valve Lifter Replacement (With AFM)**.
19. Install the radiator support.

ENGINE FLYWHEEL REPLACEMENT

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REMOVAL PROCEDURE

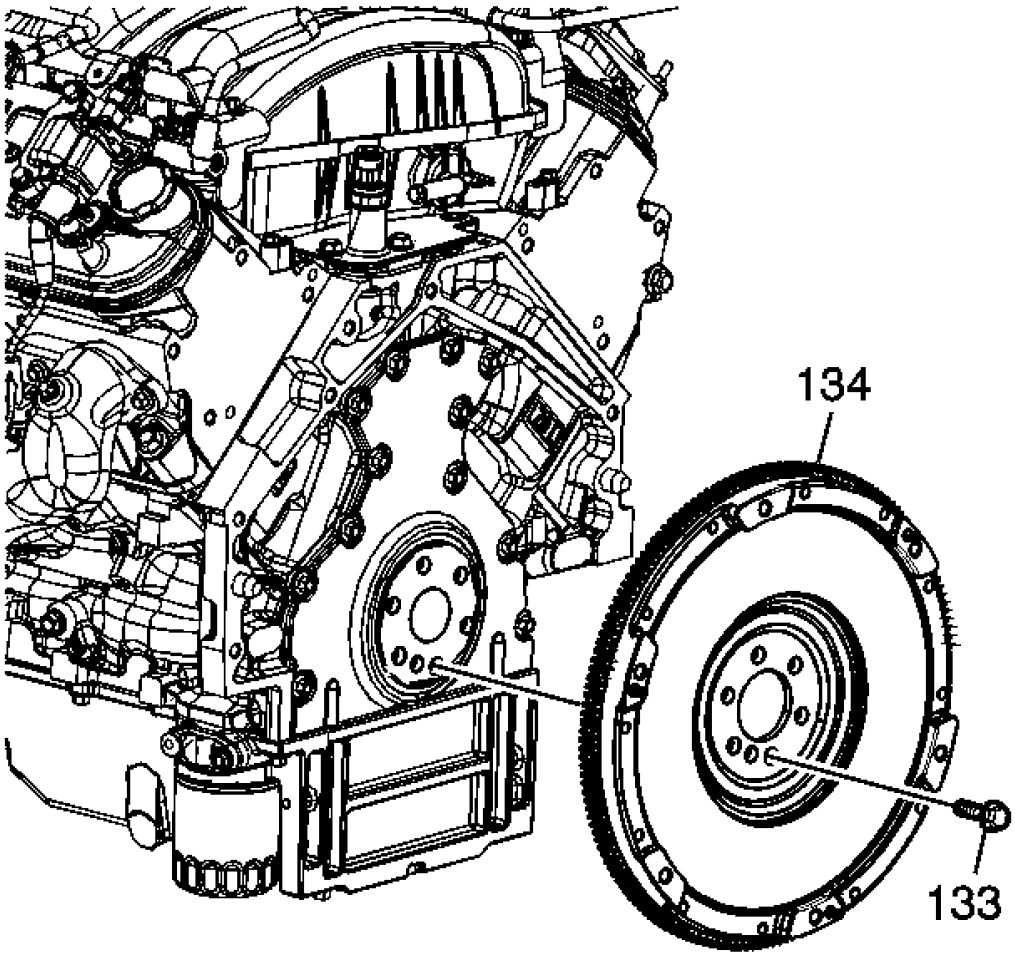


Fig. 246: Manual Transmission Flywheel & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the Clutch Assembly. Rere to **Clutch Assembly Replacement**
2. Remove the engine flywheel bolts (133) and the flywheel (134).
3. Clean and inspect the flywheel. Refer to **Engine Flywheel Cleaning and Inspection** . If the flywheel teeth are damaged, inspect the starter for proper operation. Replace the starter if you find excessive wear or damage to the starter drive. Refer to **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)** .

INSTALLATION PROCEDURE

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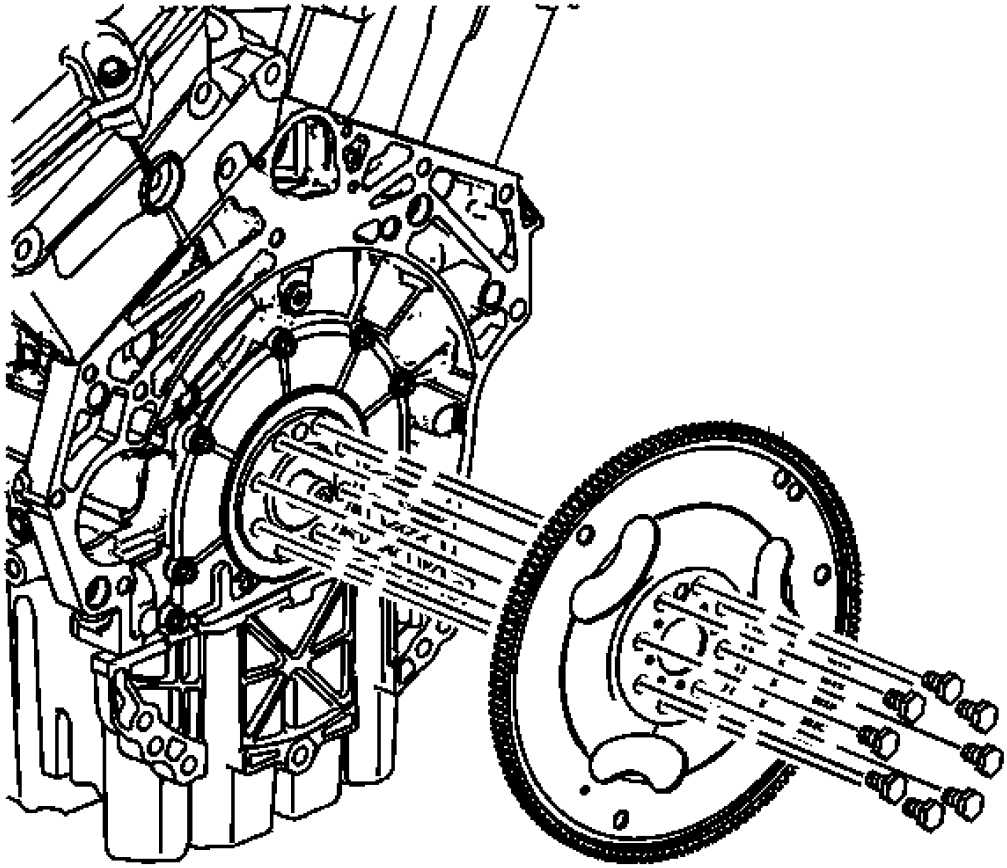


Fig. 247: View Of Engine Flywheel
Courtesy of GENERAL MOTORS CORP.

1. Install the engine flywheel bolts (133) and the flywheel (134). Refer to **Engine Flywheel Installation**
2. Install the Clutch Assembly. Rere to **Clutch Assembly Replacement** .

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

REMOVAL PROCEDURE

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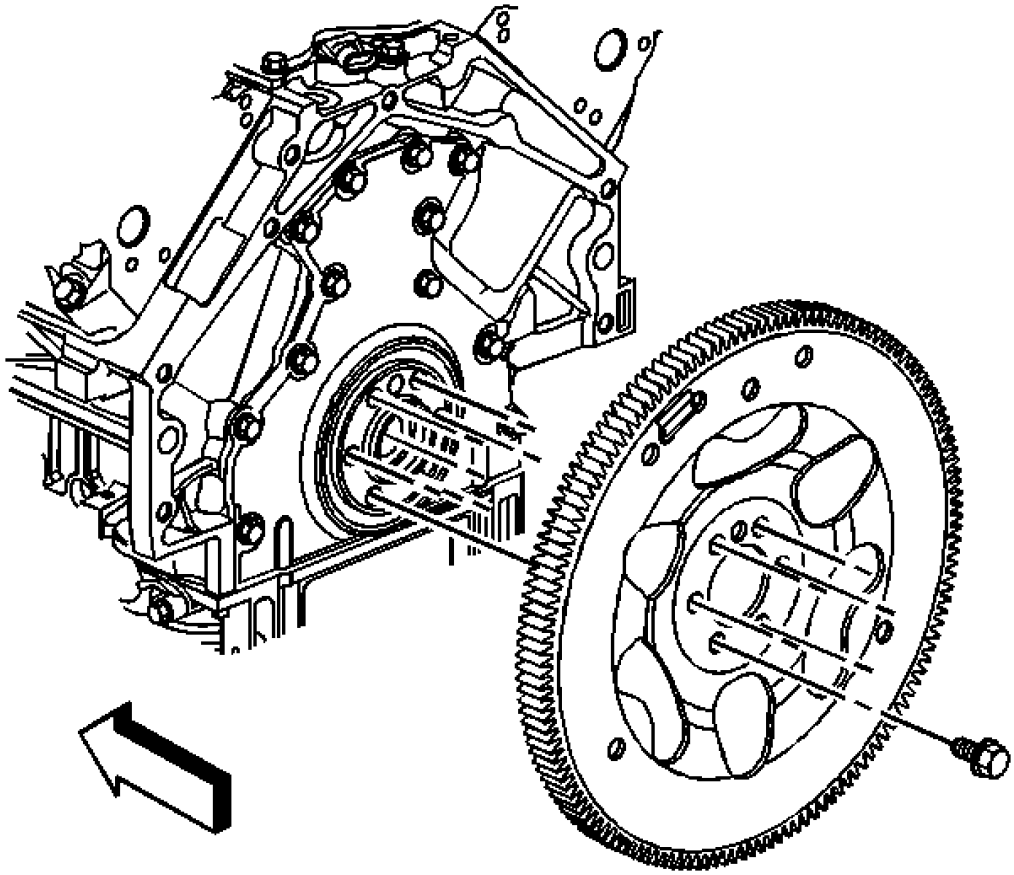


Fig. 248: Flex Plate & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the automatic transmission. Refer to **Transmission Replacement** .

NOTE: Note the position and direction of the engine flex plate before removal.

2. Remove the flex plate bolts.
3. Remove the flex plate.

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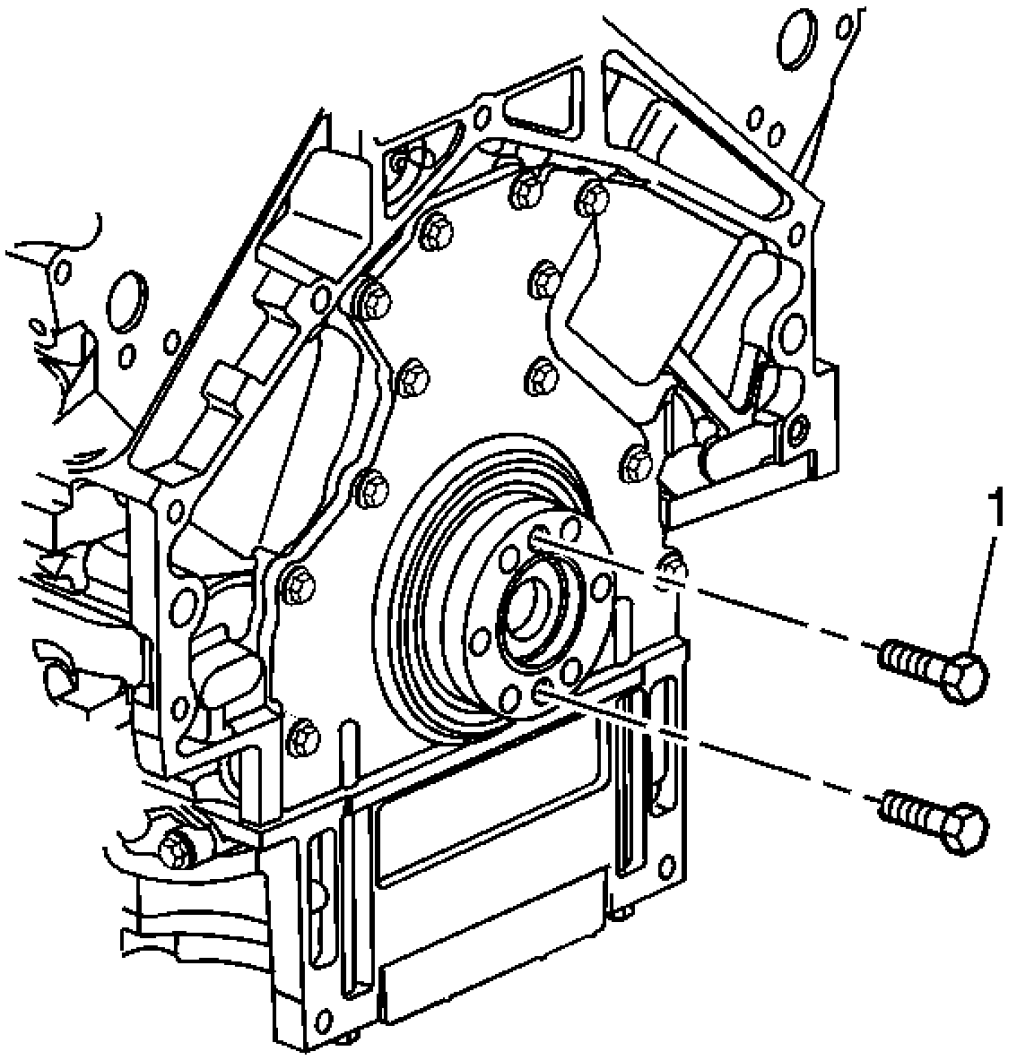


Fig. 249: View Of Bolts & Spacer
Courtesy of GENERAL MOTORS CORP.

4. Install two M11x1.5 mm bolts (1) to the threaded holes of the spacer, if applicable.
5. Rotate the bolts clockwise to remove the spacer.

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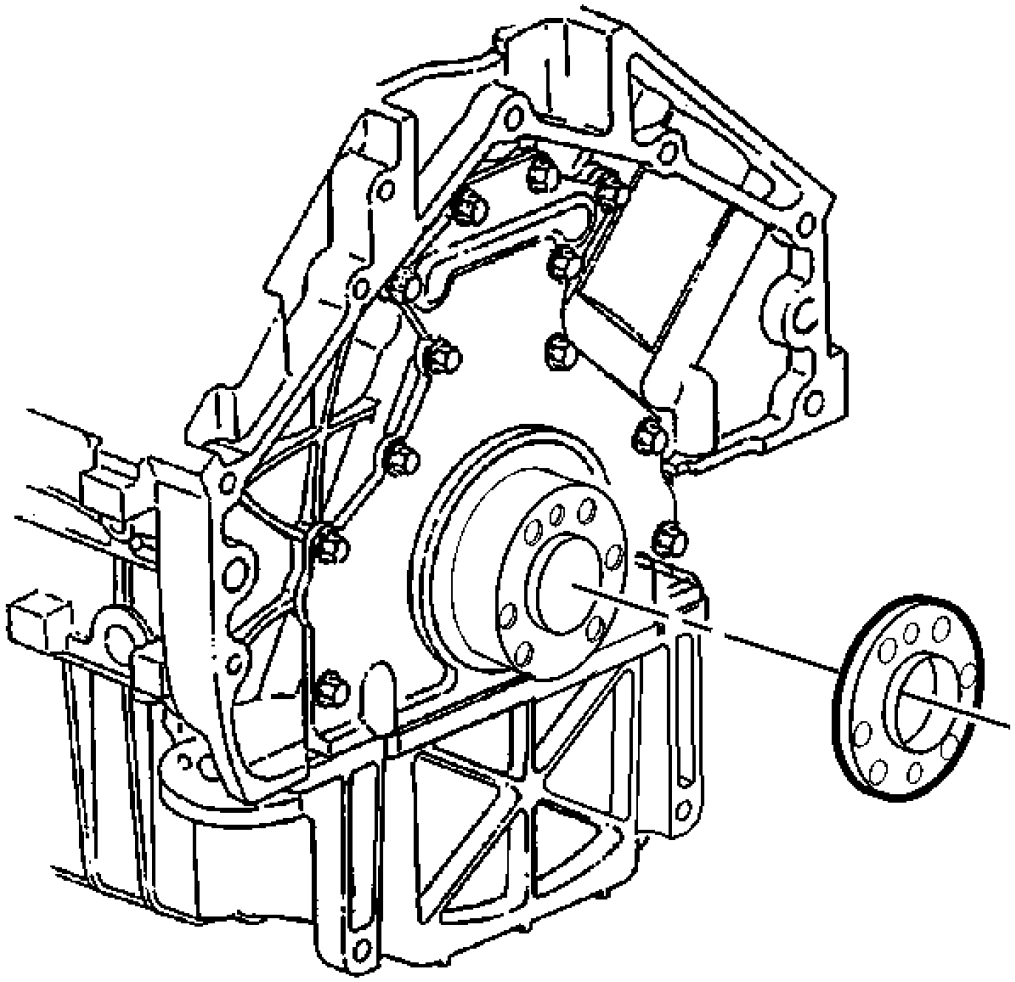


Fig. 250: View Of Rear Spacer
Courtesy of GENERAL MOTORS CORP.

6. Remove the spacer from the rear of the crankshaft, if applicable.

INSTALLATION PROCEDURE

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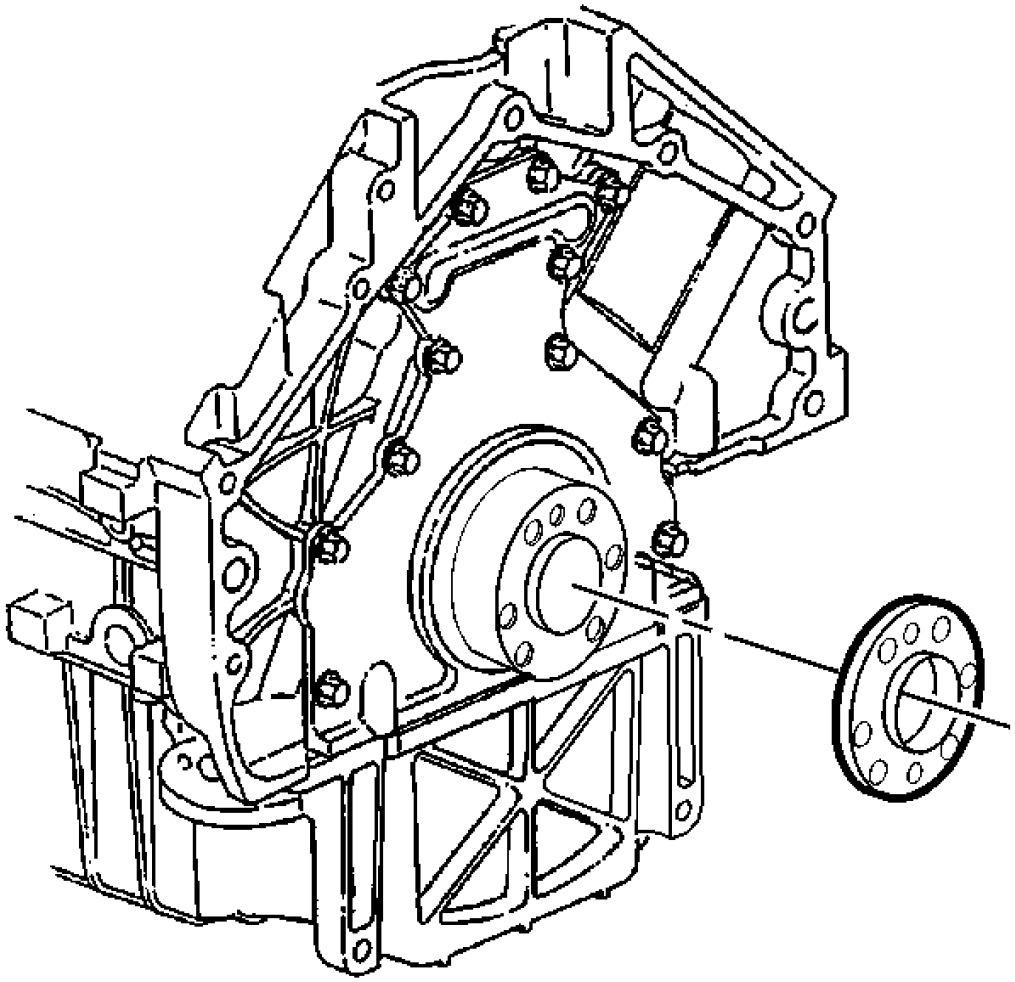


Fig. 251: View Of Rear Spacer
Courtesy of GENERAL MOTORS CORP.

NOTE: The flex plate does not use a locating pin for alignment and will not initially seat against the crankshaft flange or spacer, if applicable, but will be pulled onto the crankshaft by the engine flex plate bolts. This procedure requires a three stage tightening process.

1. Install the spacer, if applicable, onto the rear of the crankshaft.

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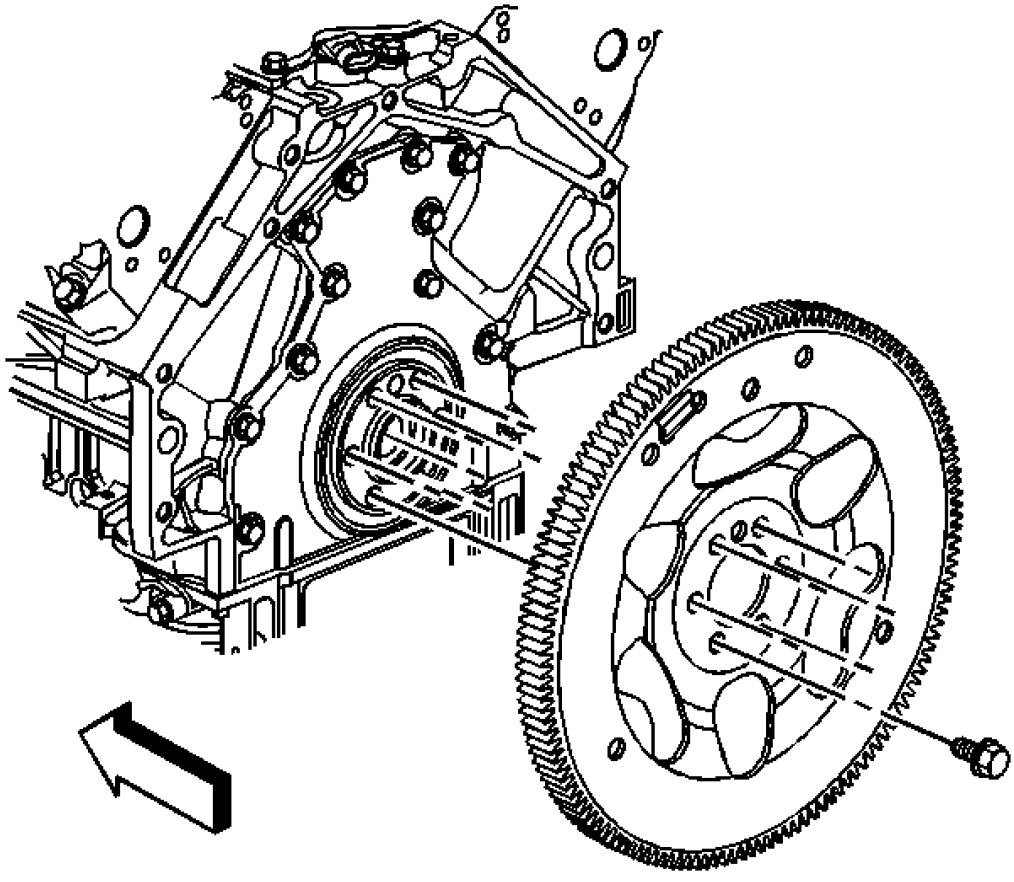


Fig. 252: Flex Plate & Bolt
Courtesy of GENERAL MOTORS CORP.

NOTE: Longer flex plate bolts must be used on applications using a flex plate spacer.

2. Install the flex plate and bolts to the crankshaft.
3. Apply threadlock to the threads of the flex plate bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

CAUTION: Refer to Fastener Caution .

4. Tighten the flex plate bolts.
    1. Tighten the bolts (1-6) a first pass in sequence to 20 N.m (15 lb ft).

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2. Tighten the bolts (1-6) a second pass in sequence to 50 N.m (37 lb ft).
3. Tighten the bolts (1-6) a final pass in sequence to 100 N.m (74 lb ft).

5. Install the automatic transmission. Refer to **Transmission Replacement** .

ENGINE REPLACEMENT

SPECIAL TOOLS

J 39580: Engine Support Table

REMOVAL PROCEDURE

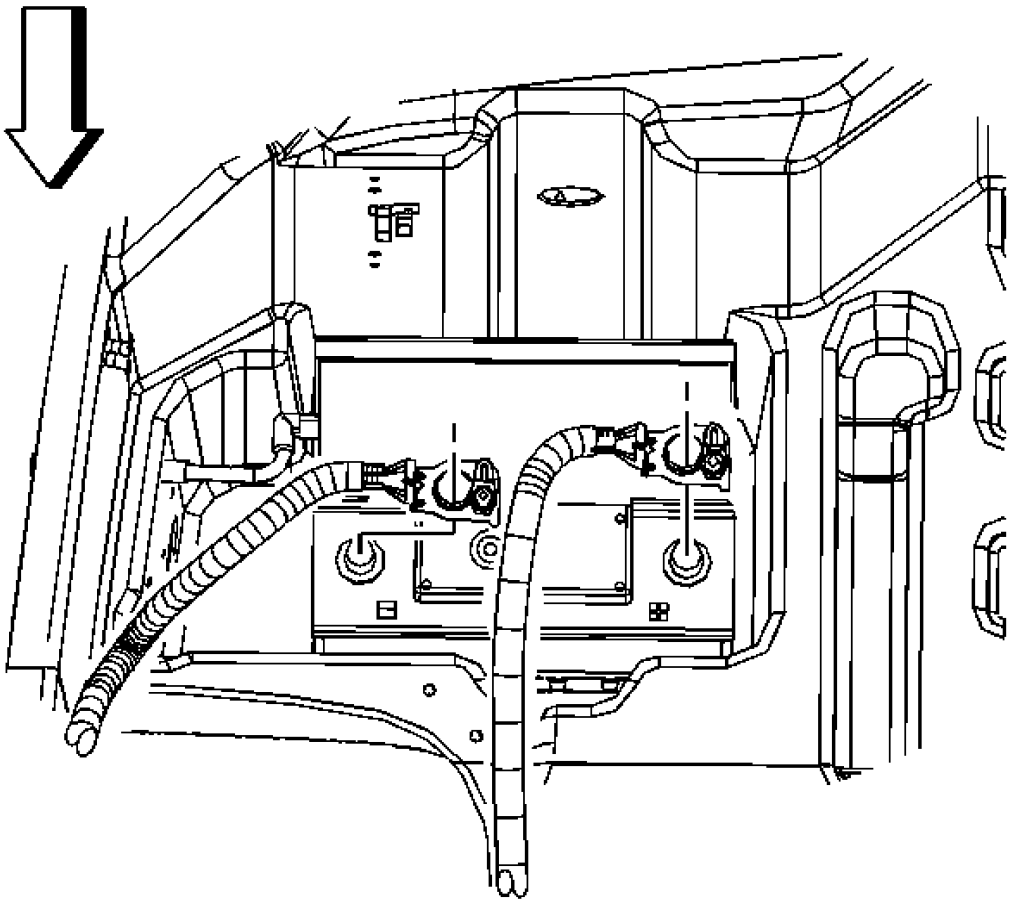


Fig. 253: Battery & Cables
Courtesy of GENERAL MOTORS CORP.

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1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the engine cover. Refer to **Engine Cover Replacement**.
3. Discharge the air conditioning (A/C) system. Refer to **Refrigerant Recovery and Recharging** .
4. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Remove the front tires. Refer to **Tire and Wheel Removal and Installation** .
6. Remove the transmission. Refer to **Transmission Replacement** .

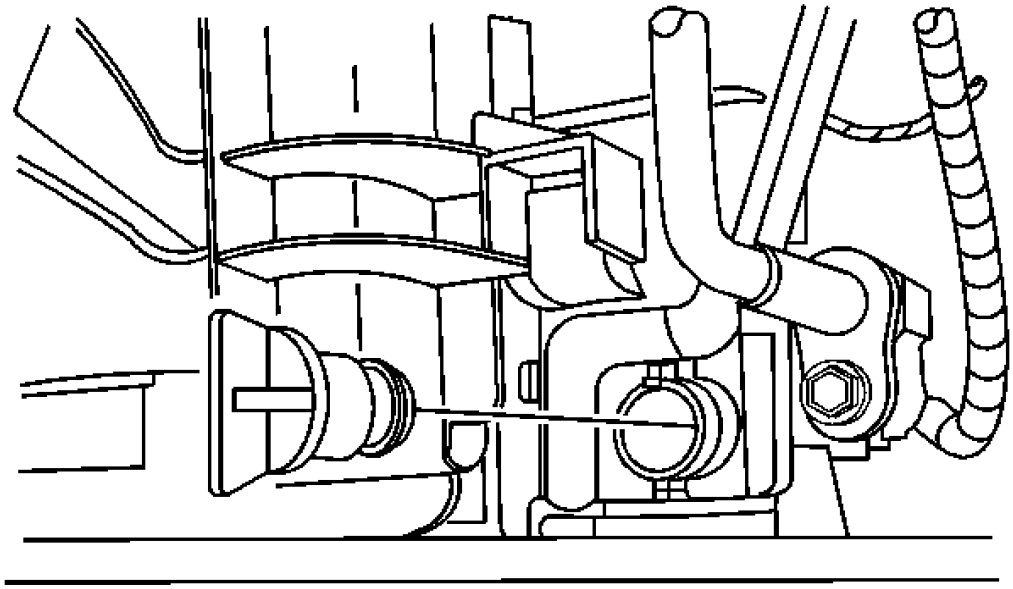


Fig. 254: View Of Radiator Drain Cock
Courtesy of GENERAL MOTORS CORP.

7. Drain the engine cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** .

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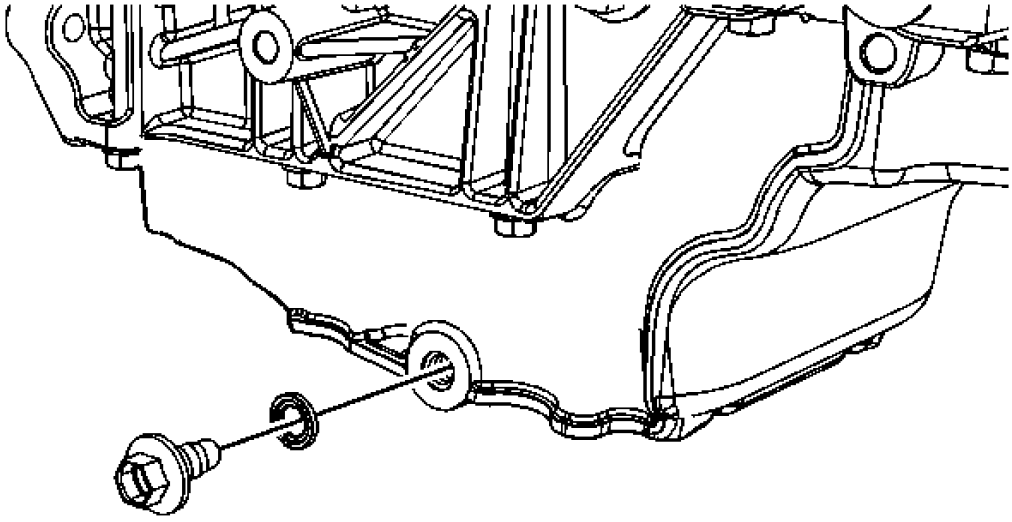


Fig. 255: Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

8. Drain the engine oil from the oil pan. Refer to **Engine Oil and Oil Filter Replacement (LLT)** .
9. Install the drain plugs to the oil pan and tighten.
10. Lower the vehicle.
11. Remove the air cleaner resonator outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
12. Disconnect the heater core hose from the quick disconnect fittings on the engine, then position out of the way.
13. Remove the positive cable from the jump start location.
14. Disconnect the engine to body ground wire from the engine assembly.
15. Disconnect the air conditioning suction line from the cowl.
16. Disconnect the cables and harnesses from the underhood electrical center.
17. Remove the powertrain control module from the PCM bracket, then position toward engine assembly.
18. Disconnect the fuel feed line from the engine assembly.
19. Disconnect the evaporator line from the engine assembly.
20. Disconnect the air conditioning liquid line from the condenser assembly.
21. Disconnect the intermediate shaft from the steering gear. Refer to **Intermediate Steering Shaft Replacement** .
22. Remove the front wheel and tire assemblies. Refer to **Tire and Wheel Removal and Installation** .
23. Remove the front fascia. Refer to **Intermediate Steering Shaft Replacement** .
24. Disconnect the outer tie rod ends from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod**

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Replacement .

25. Disconnect the front lower control arm ball joints from the steering knuckles. Refer to **Front Lower Control Rear Arm Replacement** .
26. Disconnect the rear lower control arm ball joints from the steering knuckles. Refer to **Front Lower Control Front Arm Replacement** .
27. Secure the front of the vehicle to the hoist.
28. Install **J 39580** under the frame.
29. Lower the vehicle to the frame support table.
30. Remove the six frame mounting bolts.
31. With the aid of an assistant, carefully raise the body from the frame.
32. Ensure when raising the body the following items are clear from the frame:
    - Steering knuckles
    - Electrical wiring harnesses
    - Power steering pipes
33. Remove the engine mount fasteners.
34. Disconnect all necessary hoses and electrical connectors from the engine assembly.
35. using a suitable engine lifting device, remove the engine from the frame.

INSTALLATION PROCEDURE

1. Install the engine to the frame.

CAUTION: Refer to Fastener Caution .

2. Install the engine mount lower retaining fasteners and tighten to 50 N.m (37 lb ft).
3. With the aid of an assistant, carefully lower the body to the frame.
4. Install the frame with the engine and radiator cooling module.
5. Install the front frame mountings bolts and tighten to 160 N.m (118 lb ft).
6. Install the rear frame mountings bolts and tighten to 240 N.m (177 lb ft).
7. Connect the front lower control arm ball joints to the steering knuckles. Refer to **Front Lower Control Rear Arm Replacement** .
8. Connect the rear lower control arm ball joints to the steering knuckles. Refer to **Front Lower Control Front Arm Replacement** .
9. Connect the outer tie rod ends to the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement** .
10. Connect the intermediate shaft to the steering gear. Refer to **Intermediate Steering Shaft Replacement** .
11. Raise the vehicle.
12. Remove the **J 39580** from under the vehicle.
13. Install the transmission. Refer to **Transmission Replacement** .

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14. Lower the vehicle.
15. Install the front wheel and tire assemblies. Refer to **Tire and Wheel Removal and Installation** .
16. Connect all necessary engine harness electrical connectors. Refer to **Powertrain Component Views** and **Harness Routing Views** .
17. Connect the fuel feed line to the engine assembly.
18. Connect the evaporator line to the engine assembly.
19. Connect the air conditioning liquid line to the condenser assembly.
20. Connect the heater core hose to the quick disconnect fittings on the engine.
21. Connect the cables and harnesses to the underhood electrical center.
22. Install the powertrain control module to the PCM bracket.
23. Connect the positive cable to the jump start location.
24. Install the front fascia. Refer to **Intermediate Steering Shaft Replacement** .
25. Connect the engine to body ground wire to the engine assembly.
26. Connect the air conditioning suction line to the cowl.
27. Connect the cables and harnesses to the underhood electrical center.
28. Install the air cleaner resonator outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
29. Add engine coolant to the system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** .
30. Charge the A/C system. Refer to **Refrigerant Recovery and Recharging** .
31. Install the engine cover. Refer to **Engine Cover Replacement**.
32. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
33. Road test the vehicle when done.

ENGINE OIL AND OIL FILTER REPLACEMENT

REMOVAL PROCEDURE

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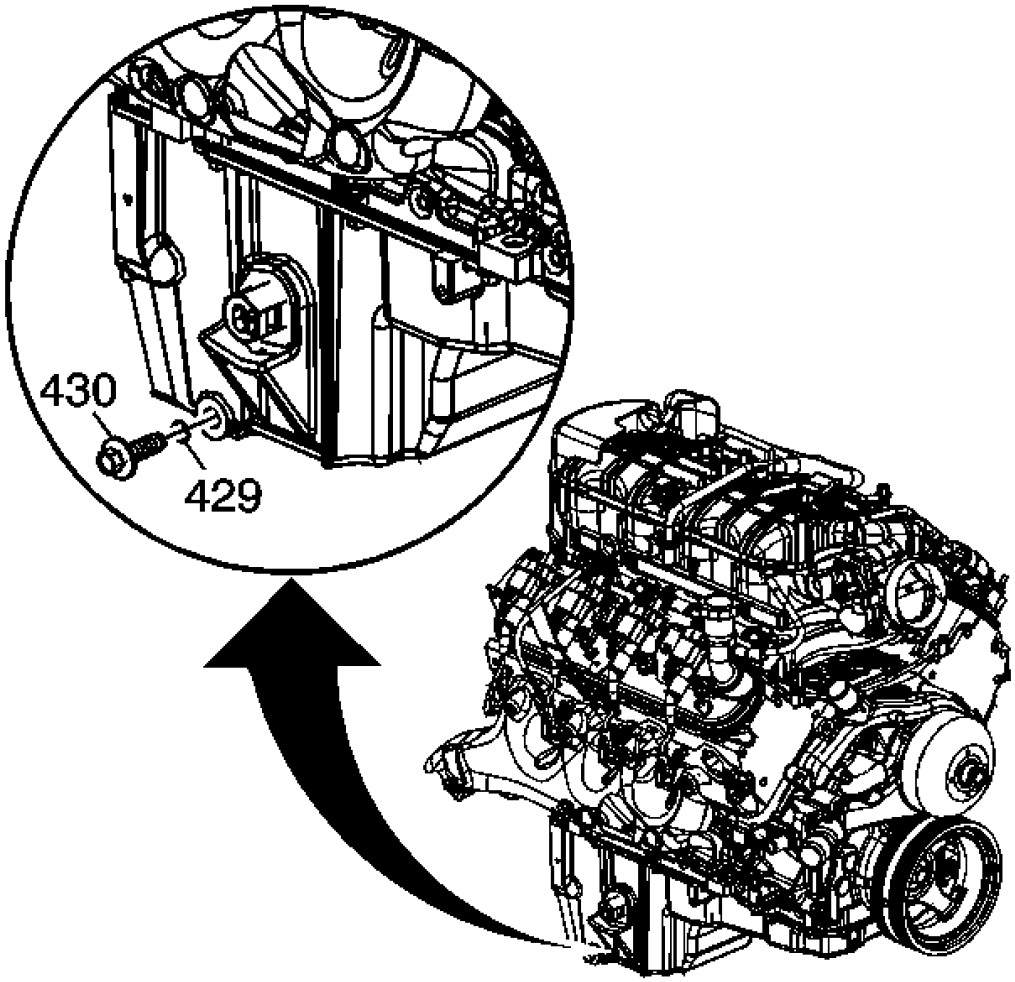


Fig. 256: View Of Oil Pan Drain Plug & Seal
Courtesy of GENERAL MOTORS CORP.

1. Open the hood.
2. Remove the oil fill cap.
3. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Place a oil drain pan under the oil pan drain plug.
5. Remove the oil pan drain plug (430).
6. Allow the oil to drain completely.
7. Clean and inspect the oil pan drain plug, replace if necessary.
8. Clean and inspect the oil pan sealing surface, replace the oil pan if necessary.

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9. Wipe any remaining oil from the drain plug hole and reinstall the oil pan drain plug until snug.

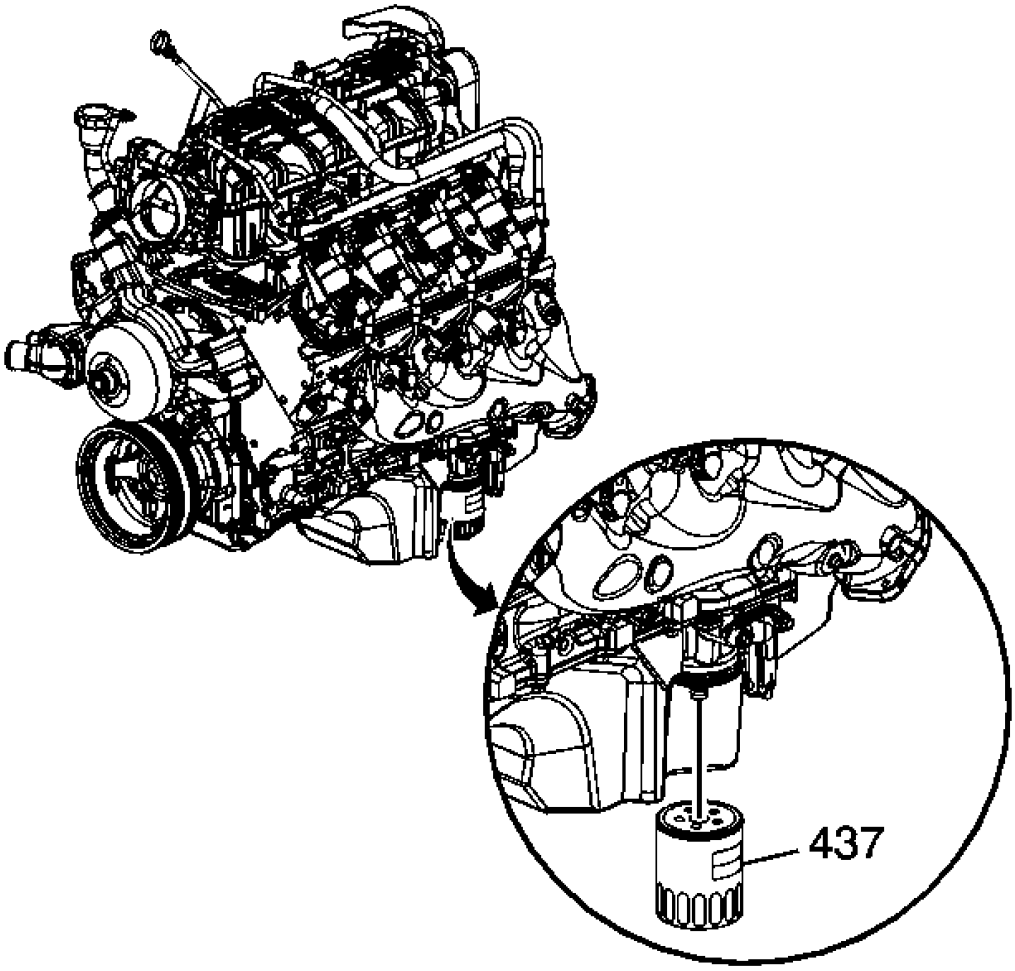


Fig. 257: View Of Engine Oil Filter
Courtesy of GENERAL MOTORS CORP.

10. Position the drain pan under the oil filter (437).
11. Remove the oil filter.
12. Ensure that the oil filter gasket is still on the old filter if not, remove the oil filter gasket from the oil pan.

INSTALLATION PROCEDURE

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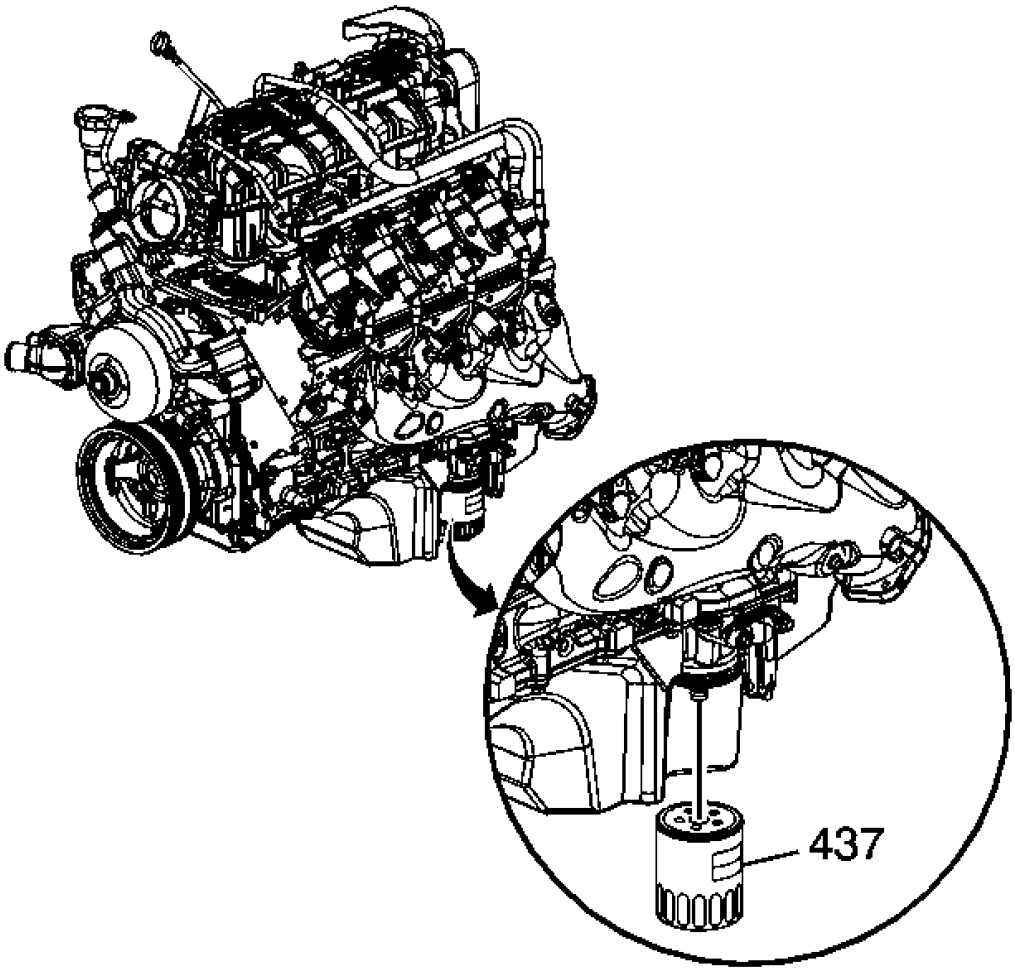


Fig. 258: View Of Engine Oil Filter
Courtesy of GENERAL MOTORS CORP.

1. Apply clean engine oil to the NEW oil filter seal.

CAUTION: Refer to Fastener Caution .

2. Install the NEW oil filter (437) and tighten to 30 N.m (22 lb ft).

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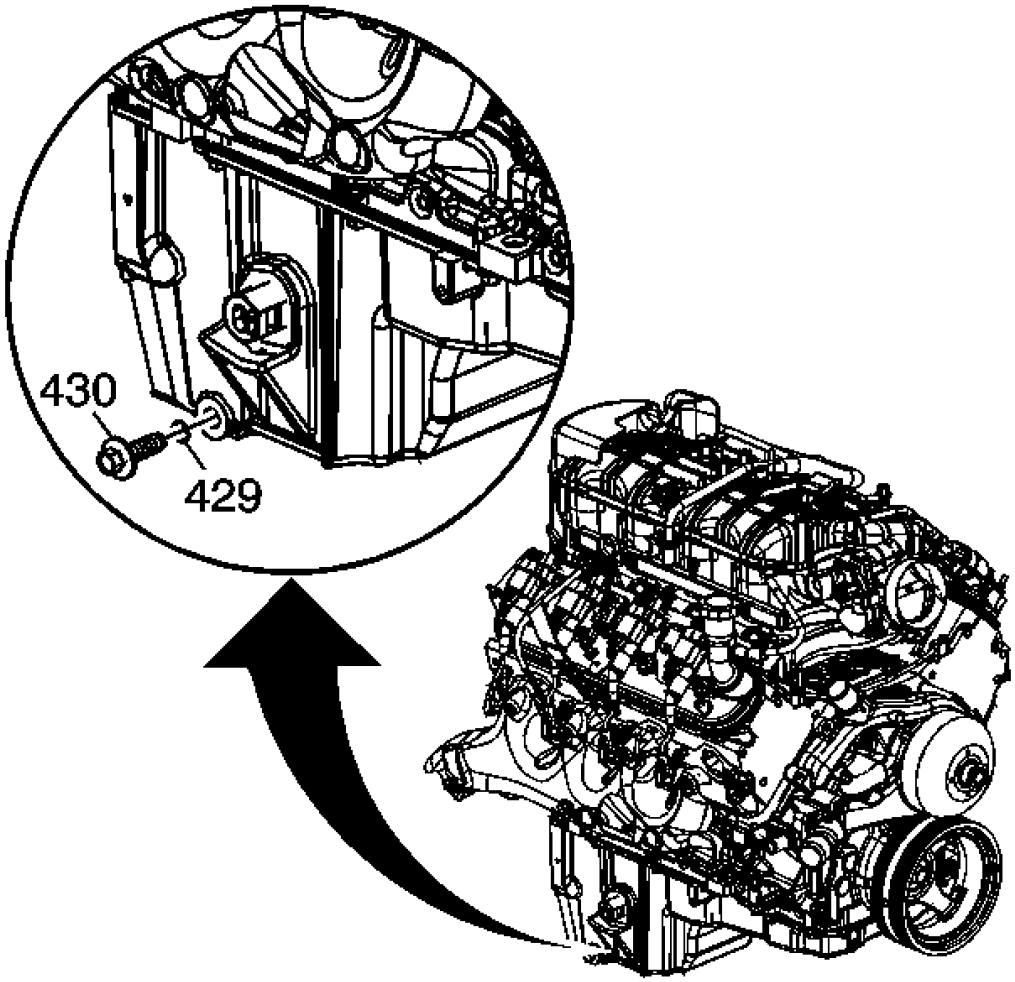


Fig. 259: View Of Oil Pan Drain Plug & Seal
Courtesy of GENERAL MOTORS CORP.

3. Tighten the oil pan drain plug (430) to 25 N.m (18 lb ft).
4. Remove the oil drain pan from under the vehicle.
5. Lower the vehicle.
6. Fill the engine with new engine oil. Refer to **Approximate Fluid Capacities** and **Fluid and Lubricant Recommendations (USA and Canada)** .
7. Start the engine.
8. Inspect for oil leaks after engine start up.
9. Turn off the engine and allow the oil a few minutes to drain back into the oil pan.

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

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2010 ENGINE

Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Camaro

SCHEMATIC AND ROUTING DIAGRAMS

ENGINE MECHANICAL SCHEMATICS

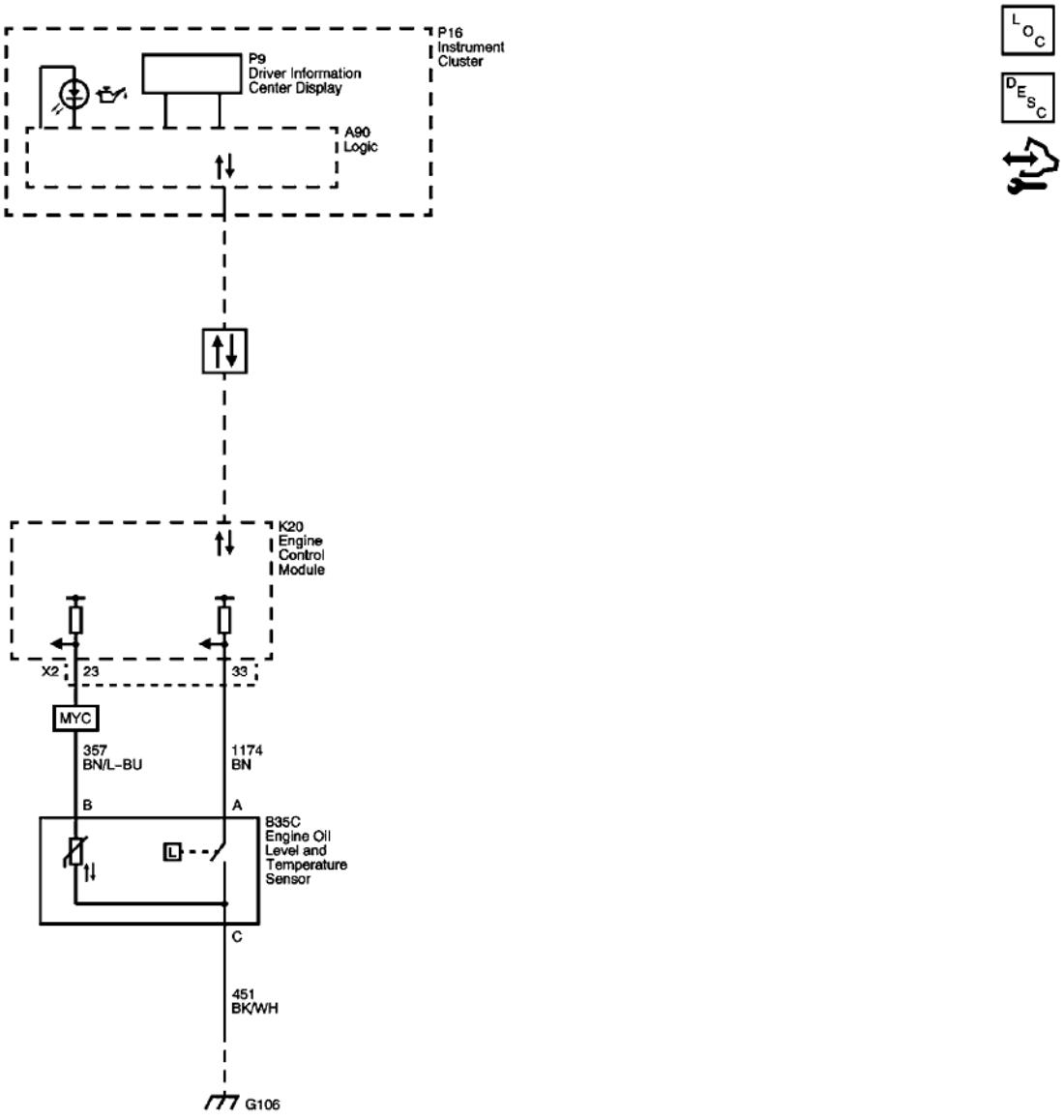


Fig. 1: Engine Mechanical
Courtesy of GENERAL MOTORS CORP.

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2010 ENGINE

Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Camaro

COMPONENT LOCATOR

DISASSEMBLED VIEWS

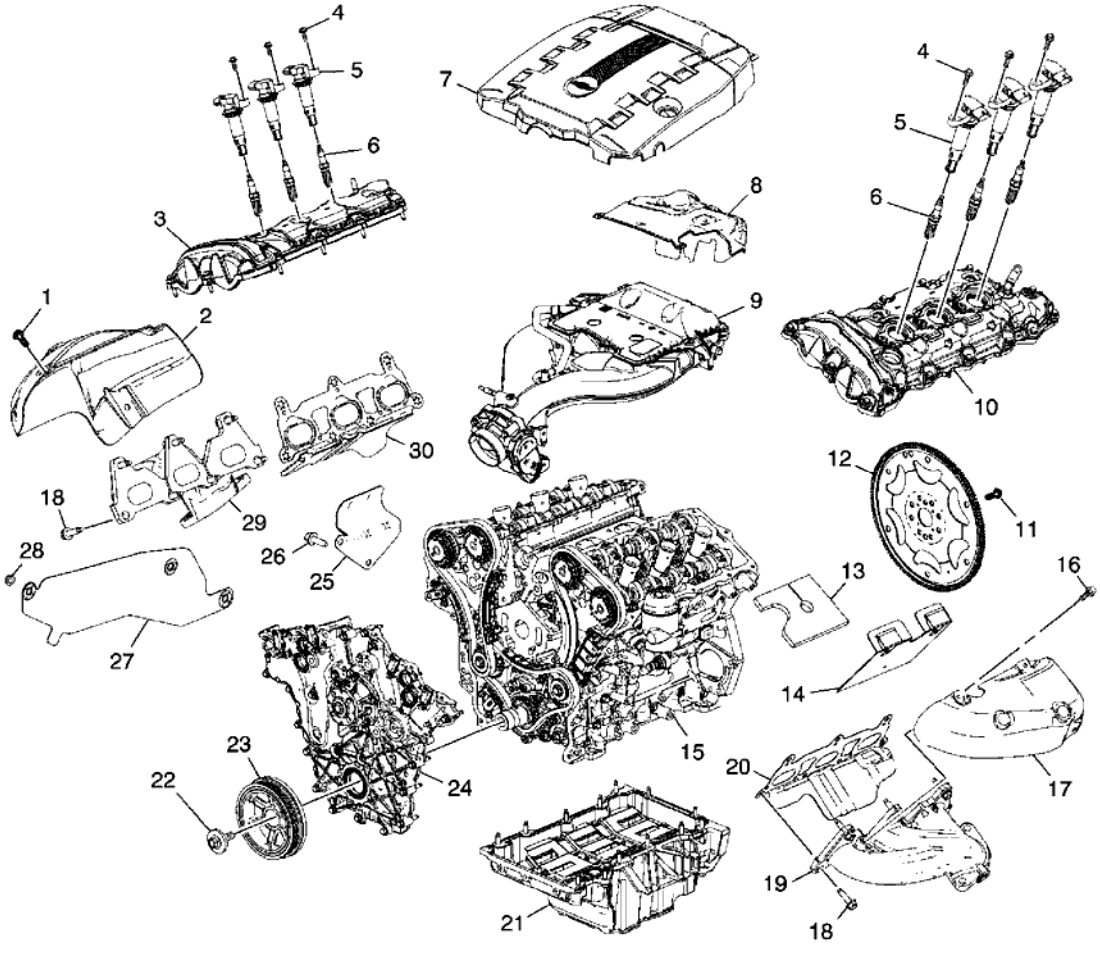


Fig. 1: Engine Component Assemblies (1 of 2)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Right Exhaust Manifold Heat Shield Bolt
2	Right Exhaust Manifold Heat Shield
3	Right Camshaft Cover Assembly
4	Ignition Coil Bolt
5	Ignition Coil

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6	Spark Plug
7	Fuel Injector Sight Shield Cover
8	Upper Intake Manifold Cover
9	Intake Manifold Assembly
10	Left Camshaft Cover Assembly
11	Engine Flywheel Bolt
12	Engine Flywheel
13	Left Exhaust Manifold Upper Heat Shield
14	Left Exhaust Manifold Lower Heat Shield
15	Engine Assembly
16	Left Exhaust Manifold Heat Shield Bolt
17	Left Exhaust Manifold Heat Shield
18	Cylinder Head Exhaust Manifold Bolt
19	Left Exhaust Manifold
20	Left Exhaust Manifold Gasket
21	Oil Pan Assembly
22	Crankshaft Balancer Bolt
23	Crankshaft Balancer
24	Engine Front Cover Assembly
25	Exhaust Manifold Lower Heat Shield
26	Exhaust Manifold Lower Heat Shield Bolt
27	Right Exhaust Manifold Lower Heat Shield
28	Right Exhaust Manifold Lower Heat Shield Retainers
29	Right Exhaust Manifold
30	Right Exhaust Manifold Gasket

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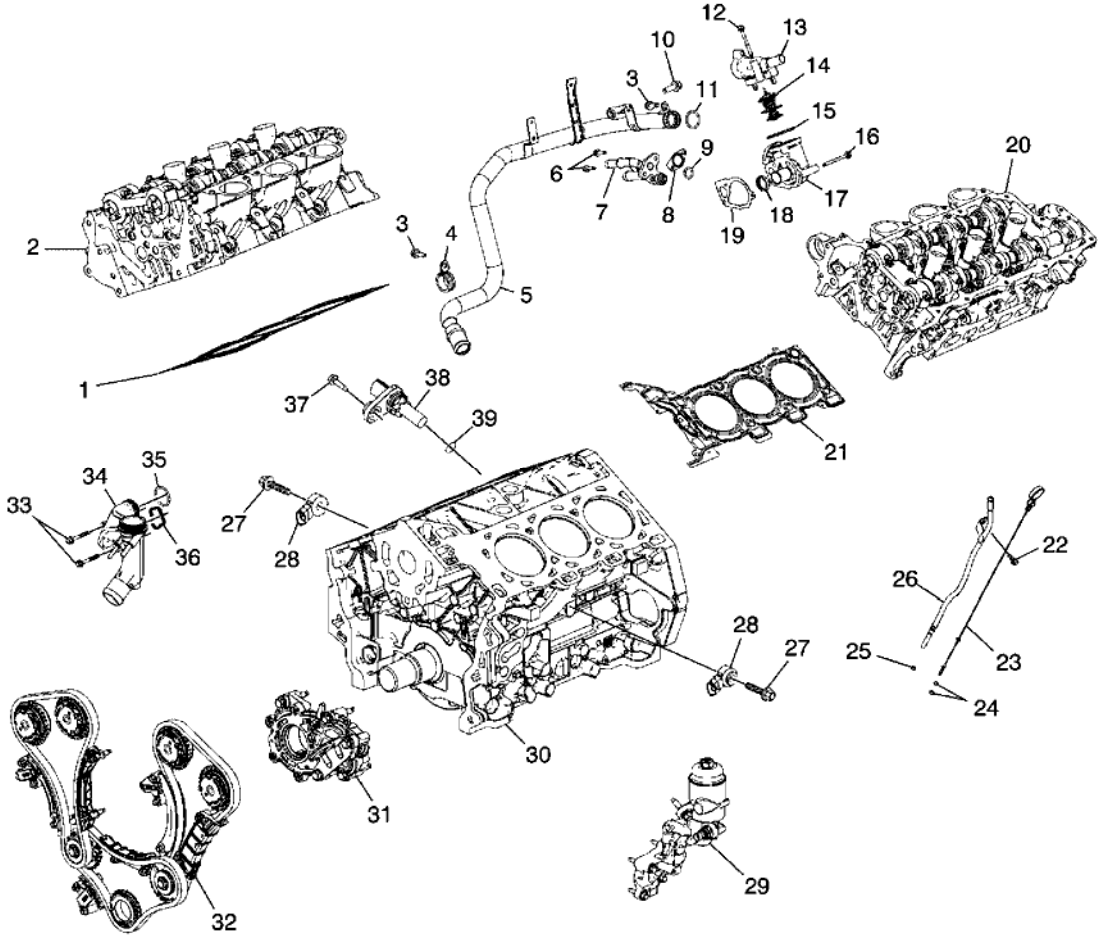


Fig. 2: Engine Component Assemblies (2 of 2)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Right Cylinder Head Gasket
2	Right Cylinder Head Assembly
3	Coolant Pipe Bracket Bolt - Small
4	Coolant Pipe Clamp
5	Coolant Pipe
6	Water Inlet/Outlet Pipe Bolts
7	Water Inlet/Outlet Pipe
8	Water Inlet/Outlet Pipe Gaskets
9	Water Inlet/Outlet Pipe O-ring
10	Coolant Pipe Bracket Bolt - Large
11	Coolant Pipe O-ring
12	Engine Cooling Thermostat Housing Bolt
13	Engine Cooling Thermostat Housing

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14	Engine Cooling Thermostat
15	Engine Cooling Thermostat Seal
16	Engine Cooling Thermostat Lower Housing Bolt
17	Engine Cooling Thermostat Lower Housing
18	Engine Cooling Thermostat Lower Housing Seal
19	Engine Cooling Thermostat Gasket
20	Left Cylinder Head Assembly
21	Left Cylinder Head Gasket
22	Oil Level Indicator Tube Bolt
23	Oil Level Indicator
24	Oil Level Indicator Handle O-ring
25	Oil Level Indicator Tube O-ring
26	Oil Level Indicator Tube
27	Knock Sensor Bolt
28	Knock Sensor
29	Oil Filter Adapter Assembly
30	Engine Short Block Assembly
31	Oil Pump Assembly
32	Timing Drive Assembly
33	Water Outlet Bolt
34	Water Outlet
35	Water Outlet O-ring
36	Water Outlet Seal
37	Crankshaft Position Sensor Bolt
38	Crankshaft Position Sensor
39	Crankshaft Position Sensor O-ring

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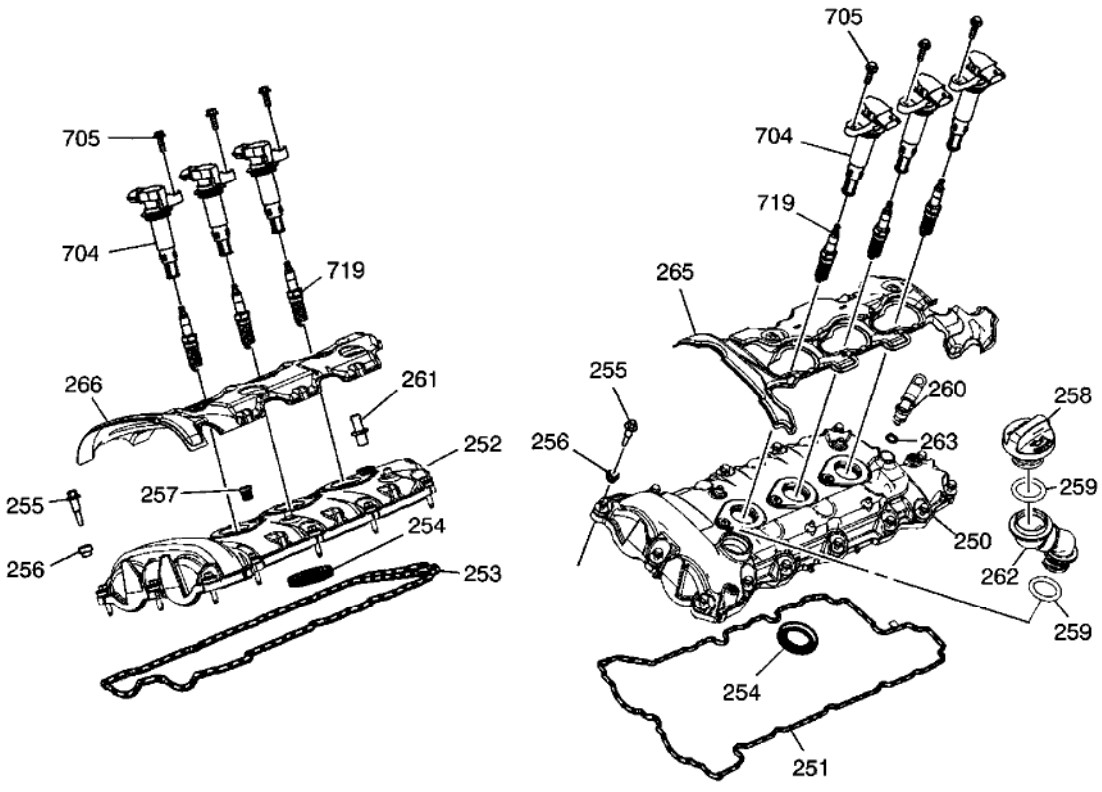


Fig. 3: Camshaft Cover Assembly
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
250	Left Camshaft Cover
251	Left Camshaft Cover Gasket
252	Right Camshaft Cover
253	Right Camshaft Cover Gasket
254	Camshaft Cover Spark Plug Port Seal
254	Camshaft Cover Spark Plug Port Seal
255	Camshaft Cover Bolt
255	Camshaft Cover Bolt
256	Camshaft Cover Bolt Insulator
256	Camshaft Cover Bolt Insulator
257	Ignition Coil Bolt Thread Insert
258	Oil Fill Cap
259	Oil Fill O-ring
259	Oil Fill O-ring
260	Left Camshaft Cover PCV Fitting
261	Right Camshaft Cover PCV Fitting Orifice
262	Oil Fill Tube

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263	Left Camshaft Cover PCV Fitting O-ring
265	Left Camshaft Housing Cover Insulator
266	Right Camshaft Housing Cover Insulator
704	Ignition Coil
704	Ignition Coil
705	Ignition Coil Bolt
705	Ignition Coil Bolt
719	Spark Plug
719	Spark Plug

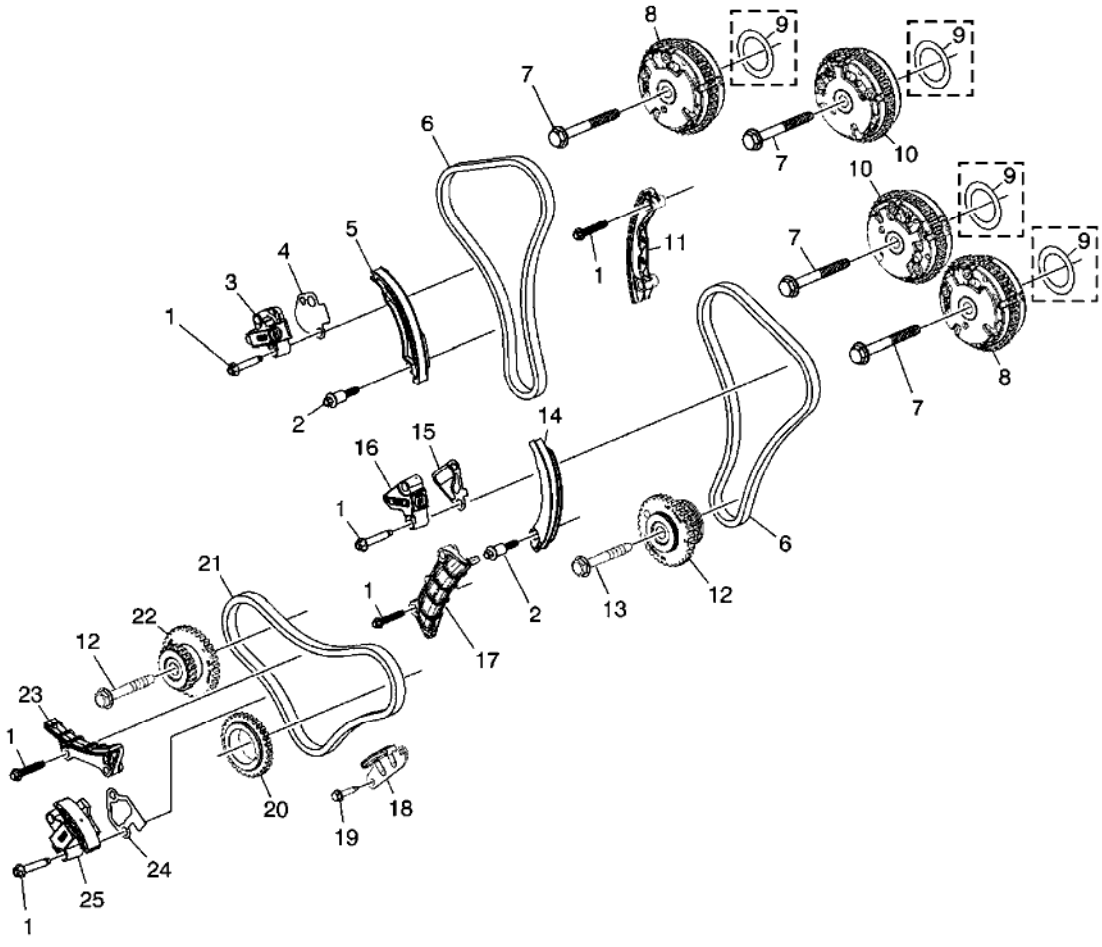


Fig. 4: Camshaft Timing Components
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Primary Timing Chain Tensioner Bolt
2	Left Secondary Timing Chain Shoe Bolt
3	Right Secondary Timing Chain Tensioner

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4	Right Secondary Timing Chain Tensioner Gasket
5	Right Secondary Timing Chain Shoe
6	Secondary Timing Chain
7	Camshaft Position Actuator Bolt
8	Exhaust Camshaft Position Actuator
9	Camshaft Position Actuator Thrust Washer
10	Intake Camshaft Position Actuator
11	Right Secondary Timing Chain Guide
12	Left Camshaft Intermediate Drive Shaft Sprocket
13	Camshaft Intermediate Drive Shaft Sprocket Bolt
14	Left Secondary Timing Chain Shoe
15	Left Secondary Timing Chain Tensioner Gasket
16	Left Secondary Timing Chain Tensioner
17	Left Secondary Timing Chain Guide
18	Lower Primary Timing Chain Guide
19	Lower Primary Timing Chain Guide Bolt
20	Crankshaft Sprocket
21	Primary Timing Chain
22	Right Camshaft Intermediate Drive Shaft Sprocket
23	Upper Primary Timing Chain Guide
24	Primary Timing Chain Tensioner Gasket
25	Primary Timing Chain Tensioner

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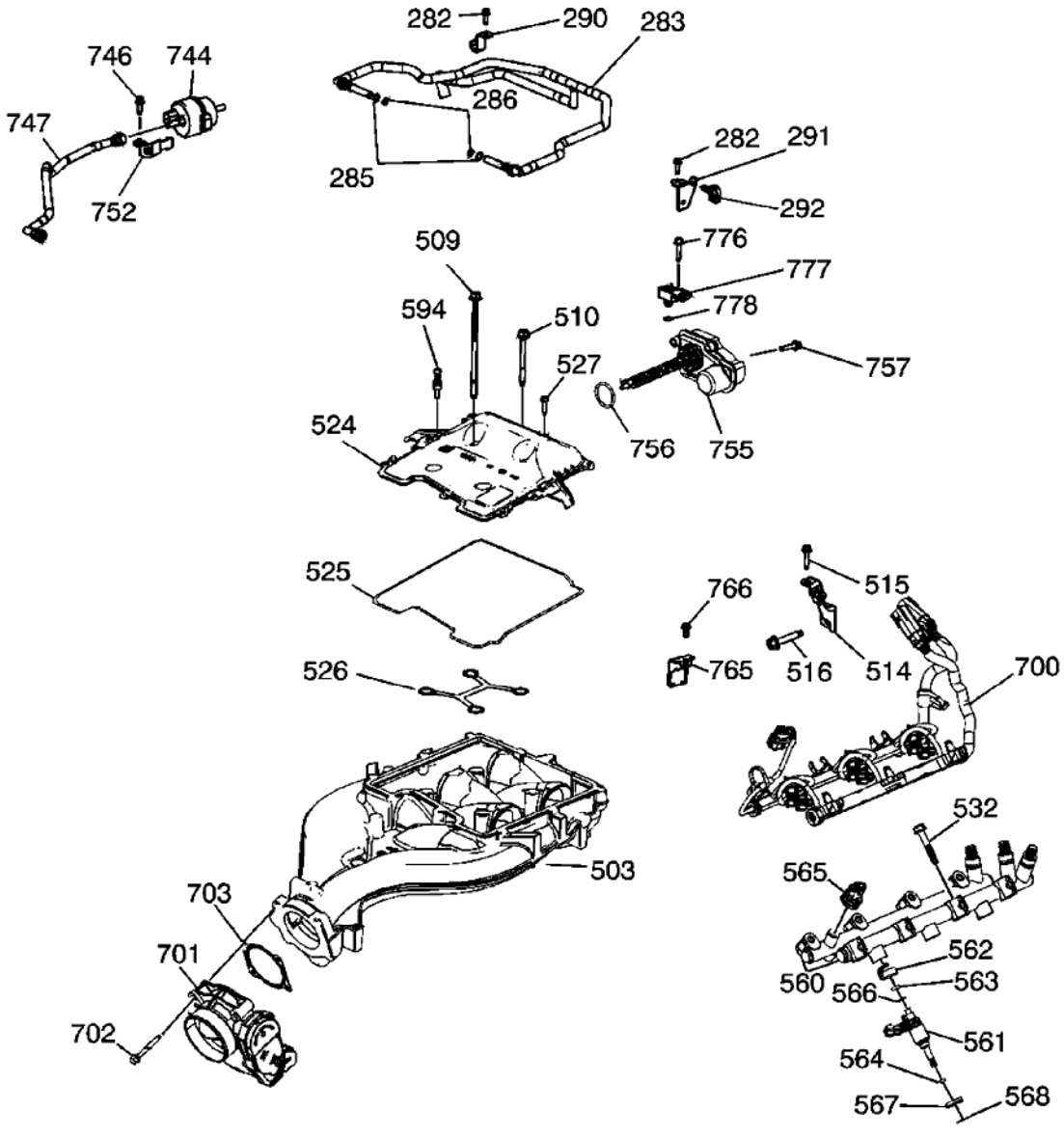


Fig. 5: Intake Manifold Components
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
282	PCV Hose Bolt
282	PCV Hose Bolt
283	Dirty PCV Hose
285	PCV Hose O-ring Outer/Larger
286	PCV Hose O-ring Inner/Smaller
290	PCV Hose Right Bracket
291	PCV Hose Left Bracket

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292	PCV Hose Clip
503	Upper Intake Manifold
509	Upper Intake Manifold Bolt - Long
510	Upper Intake Manifold Bolt - Short
514	Intake Manifold Brace
515	Intake Manifold Brace Small Bolt
516	Intake Manifold Brace Large Bolt
524	Intake Manifold Cover
525	Intake Manifold Cover Gasket
526	Intake Manifold Cover Lower Gasket
527	Intake Manifold Cover Bolt
532	Fuel Rail Bolt
560	Fuel Rail
561	Fuel Injector
562	Fuel Injector Retainer
563	Fuel Injector O-ring Seal
564	Fuel Injector Teflon Seal
565	Fuel Pressure Sensor
566	Fuel Injector Spacer
567	Fuel Injector Isolator Cup
568	Fuel Injector Isolator Cup Retaining Ring
594	Fuel Injector Sight Shield Cover Ball Stud
700	Fuel Injector Wiring Harness
701	Throttle Body
702	Throttle Body Bolt
703	Throttle Body Gasket
744	EVAP Purge Solenoid
746	EVAP Purge Solenoid Bolt
747	EVAP Purge Solenoid Tube
752	EVAP Purge Solenoid Bracket
755	Intake Manifold Tuning Valve
756	Intake Manifold Tuning Valve O-ring
757	Intake Manifold Tuning Valve Bolt
765	Fuel Injector Wiring Harness Bracket
766	Fuel Injector Wiring Harness Bracket Bolt
776	BARO Sensor Bolt
777	BARO Sensor
778	BARO Sensor O-ring

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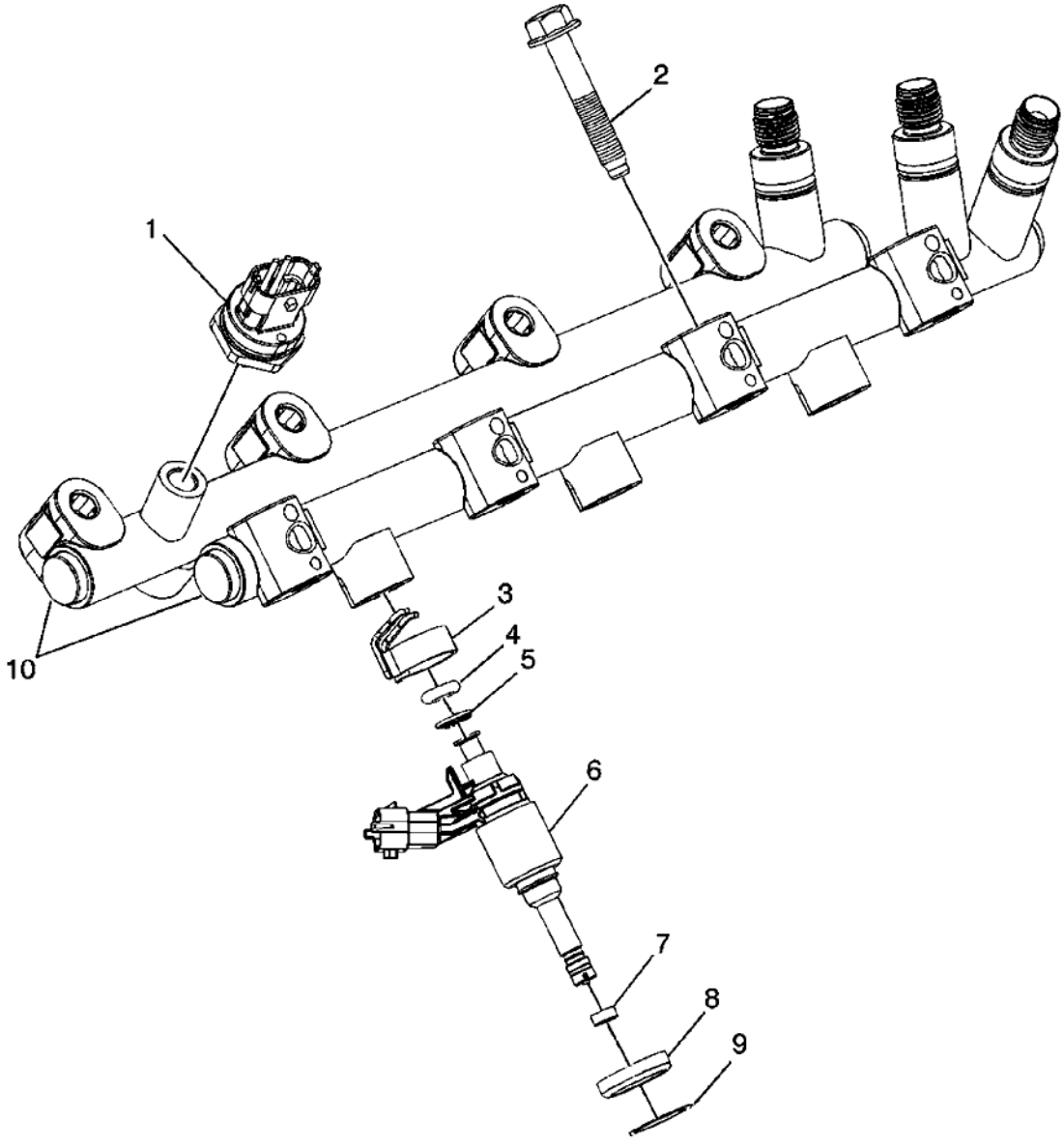


Fig. 6: Fuel Rail
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Fuel Pressure Sensor
2	Fuel Rail Bolt
3	Fuel Injector Retainer
4	Fuel Injector O-ring Seal
5	Fuel Injector Spacer
6	Fuel Injector
7	Fuel Injector Teflon Seal

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8	Fuel Injector Isolator Cup
9	Fuel Injector Isolator Cup Retaining Ring
10	Fuel Rail

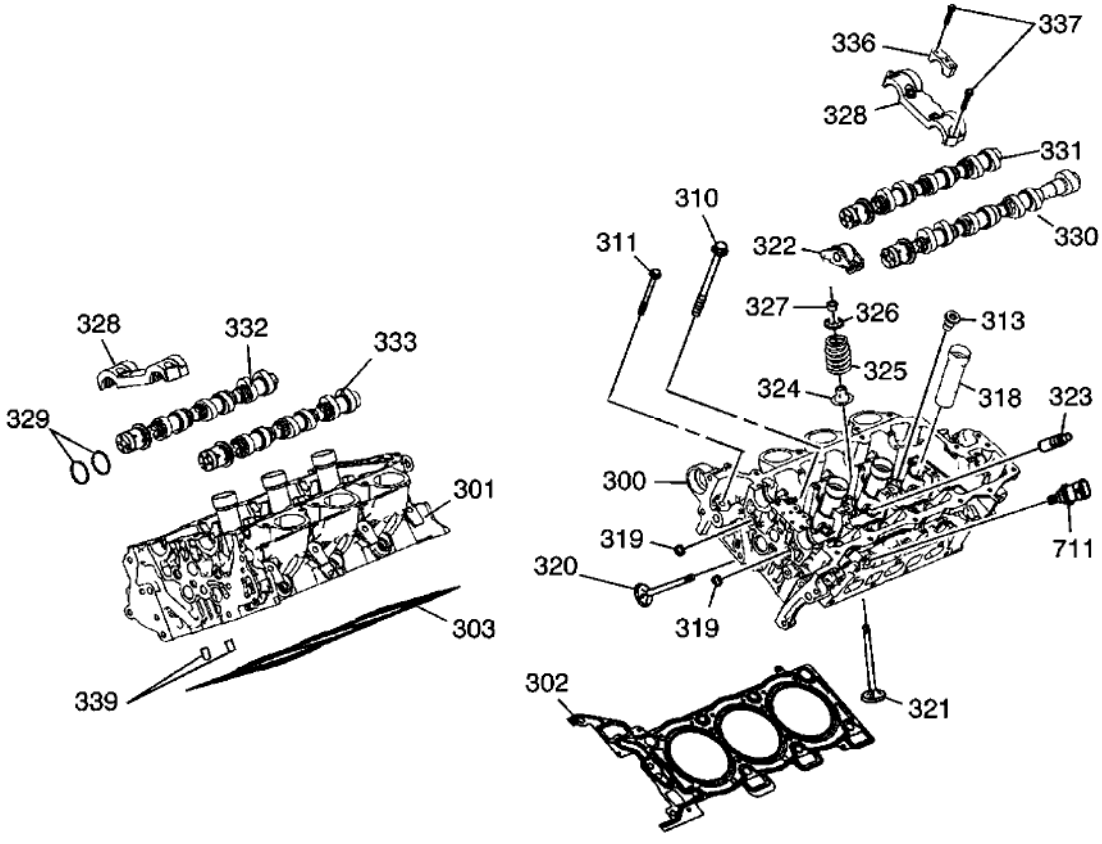


Fig. 7: Cylinder Head Assemblies
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
300	Left Cylinder Head
301	Right Cylinder Head
302	Left Cylinder Head Gasket
303	Right Cylinder Head Gasket
310	Cylinder Head Bolt
311	Cylinder Head Front Bolt
313	Cylinder Head Coolant Hole Threaded Plug
318	Spark Plug Sleeve
319	Cylinder Head Oil Gallery Expansion Plug - 14 mm
319	Cylinder Head Oil Gallery Expansion Plug - 14 mm
320	Exhaust Valve

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321	Intake Valve
322	Valve Rocker Arm Assembly
323	Hydraulic Valve Lash Adjuster Assembly
324	Valve Stem Oil Seal
325	Valve Spring
326	Valve Spring Cap
327	Valve Stem Key
328	Cylinder Head Camshaft Front Thrust Bearing Cap
328	Cylinder Head Camshaft Front Thrust Bearing Cap
329	Camshaft Oil Seal Ring
330	Left Exhaust Camshaft
331	Left Intake Camshaft
332	Right Intake Camshaft
333	Right Exhaust Camshaft
336	Cylinder Head Camshaft Cap - Intermediate
337	Cylinder Head Camshaft Cap Bolt
339	Cylinder Head Oil Gallery Check Valve
711	Engine Coolant Temperature Sensor

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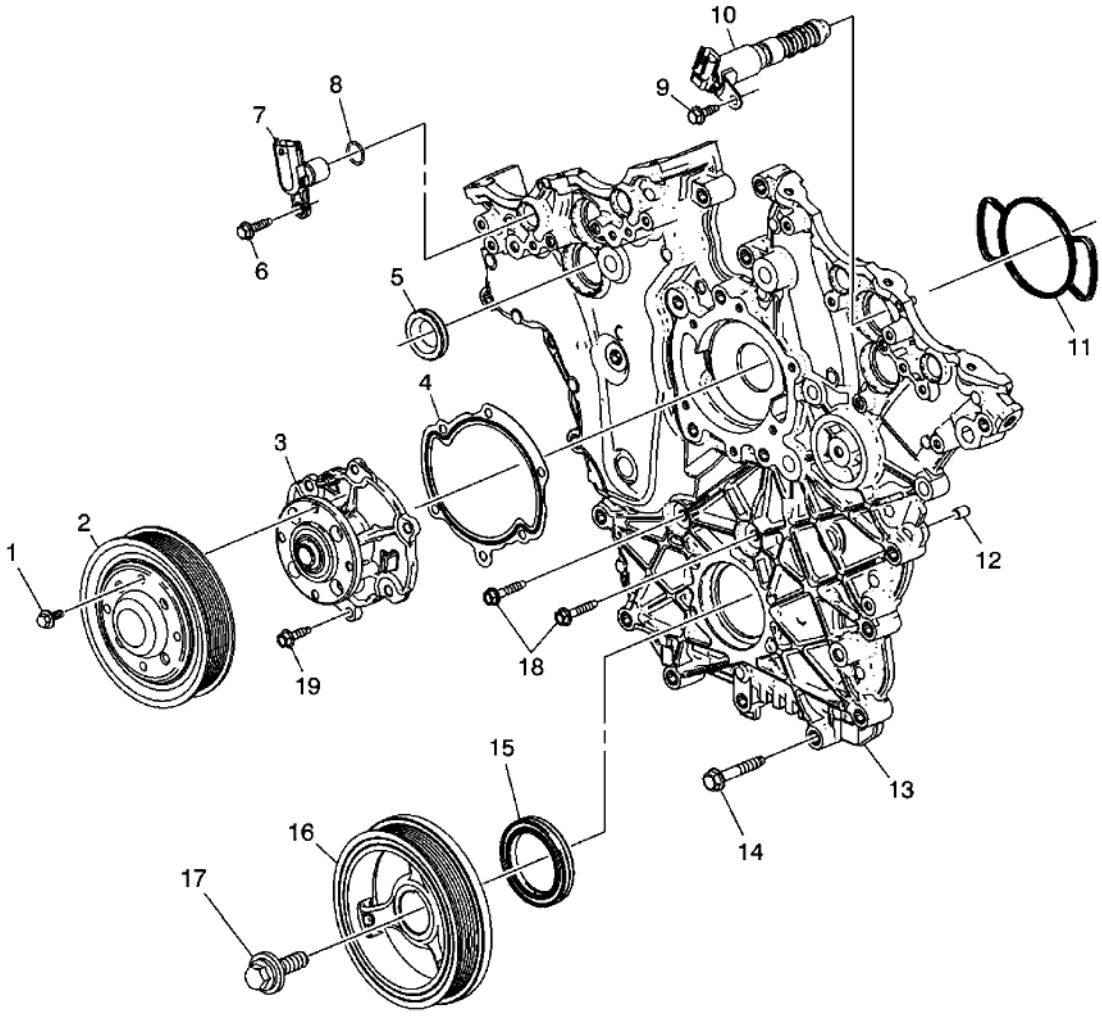


Fig. 8: Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Water Pump Pulley Bolt
2	Water Pump Pulley
3	Water Pump Assembly
4	Water Pump Pulley Gasket
5	Camshaft Position Actuator Solenoid Valve Seal
6	Camshaft Position Sensor Bolt
7	Camshaft Position Sensor
8	Camshaft Position Sensor O-ring Seal
9	Camshaft Position Actuator Solenoid Valve Bolt
10	Camshaft Position Actuator Solenoid Valve
11	Engine Front Cover Gasket

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12	Engine Front Cover Locating Pin
13	Engine Front Cover
14	Engine Front Cover Bolt
15	Engine Front Cover Seal
16	Crankshaft Balancer
17	Crankshaft Balancer Bolt
18	Engine Front Cover Bolt
19	Water Pump Bolt

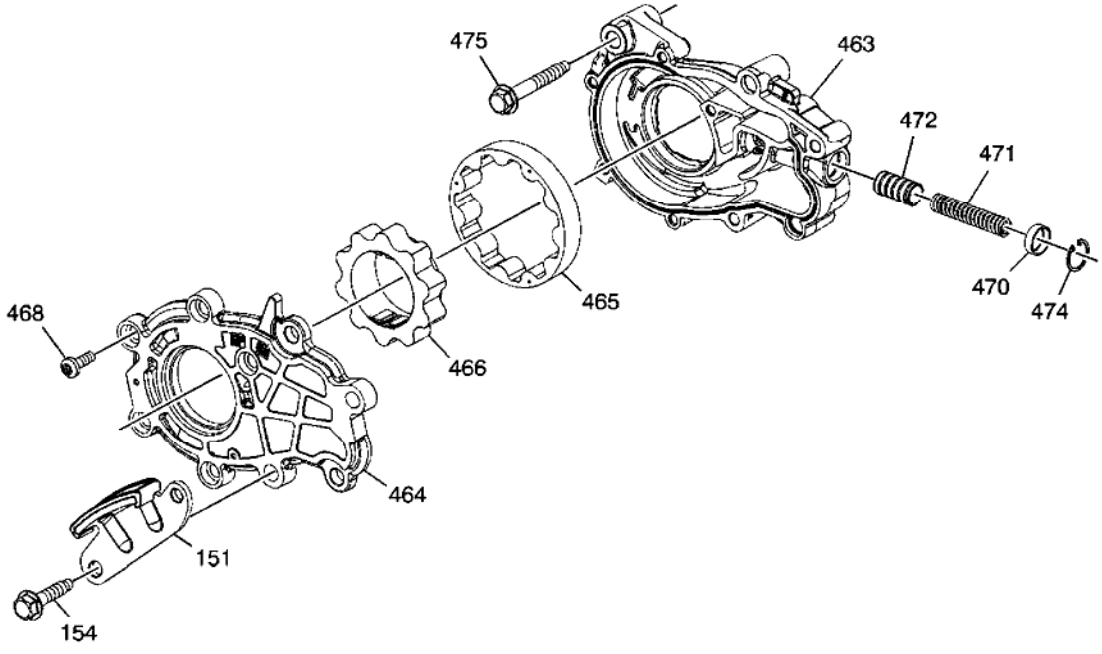


Fig. 9: Oil Pump - Second Design
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
151	Lower Primary Timing Chain Guide
154	Lower Primary Timing Chain Guide Bolt
463	Oil Pump Housing
464	Oil Pump Cover
465	Oil Pump Driven Gear
466	Oil Pump Drive Gear
468	Oil Pump Cover Bolt
470	Oil Pressure Relief Valve Bore Plug
471	Oil Pressure Relief Valve Spring
472	Oil Pressure Relief Valve
474	Oil Pressure Relief Valve Bore Plug Retainer Clip

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475	Oil Pump Bolt

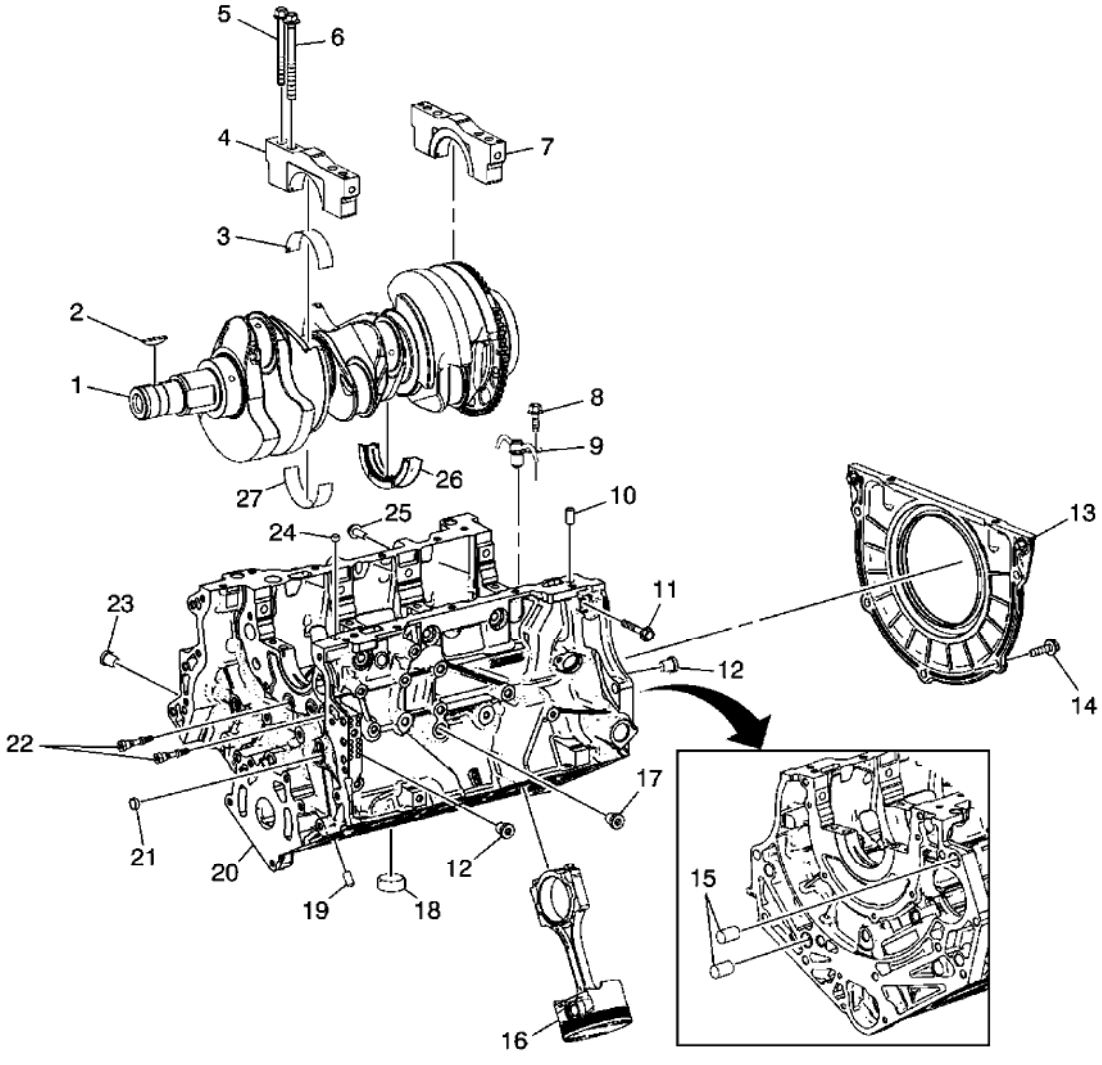


Fig. 10: Engine Block Assembly
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Crankshaft
2	Crankshaft Key
3	Crankshaft Lower Bearing
4	Crankshaft Bearing Cap
5	Crankshaft Bearing Cap Outboard Bolt
6	Crankshaft Bearing Cap Inboard Bolt
7	Crankshaft Bearing Thrust Cap
8	Piston Oil Nozzle Bolt

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9	Piston Oil Nozzle
10	Oil Pan Locating Pin
11	Crankshaft Bearing Cap Side Bolt - Long
12	Engine Block Oil Gallery Threaded Plug - 14 mm
13	Crankshaft Rear Oil Seal Housing Assembly
14	Crankshaft Rear Oil Seal Housing Assembly Bolt
15	Transaxle Locating Pin
16	Piston and Connecting Rod Assembly
17	Engine Block Coolant Drain Threaded Plug - 14 mm
18	Engine Block Core Coolant Expansion Plug - 34.3 mm
19	Cylinder Head Locating Pin
20	Engine Block
21	Engine Block Oil Gallery Expansion Plug - 14
22	Engine Front Cover Stud
23	Engine Block Oil Gallery Threaded Plug - 20 mm
24	Engine Block Oil Gallery Expansion Plug - 10 mm
25	Crankshaft Bearing Cap Side Bolt - Short
26	Crankshaft Upper Thrust Bearing #3
27	Crankshaft Upper Bearing

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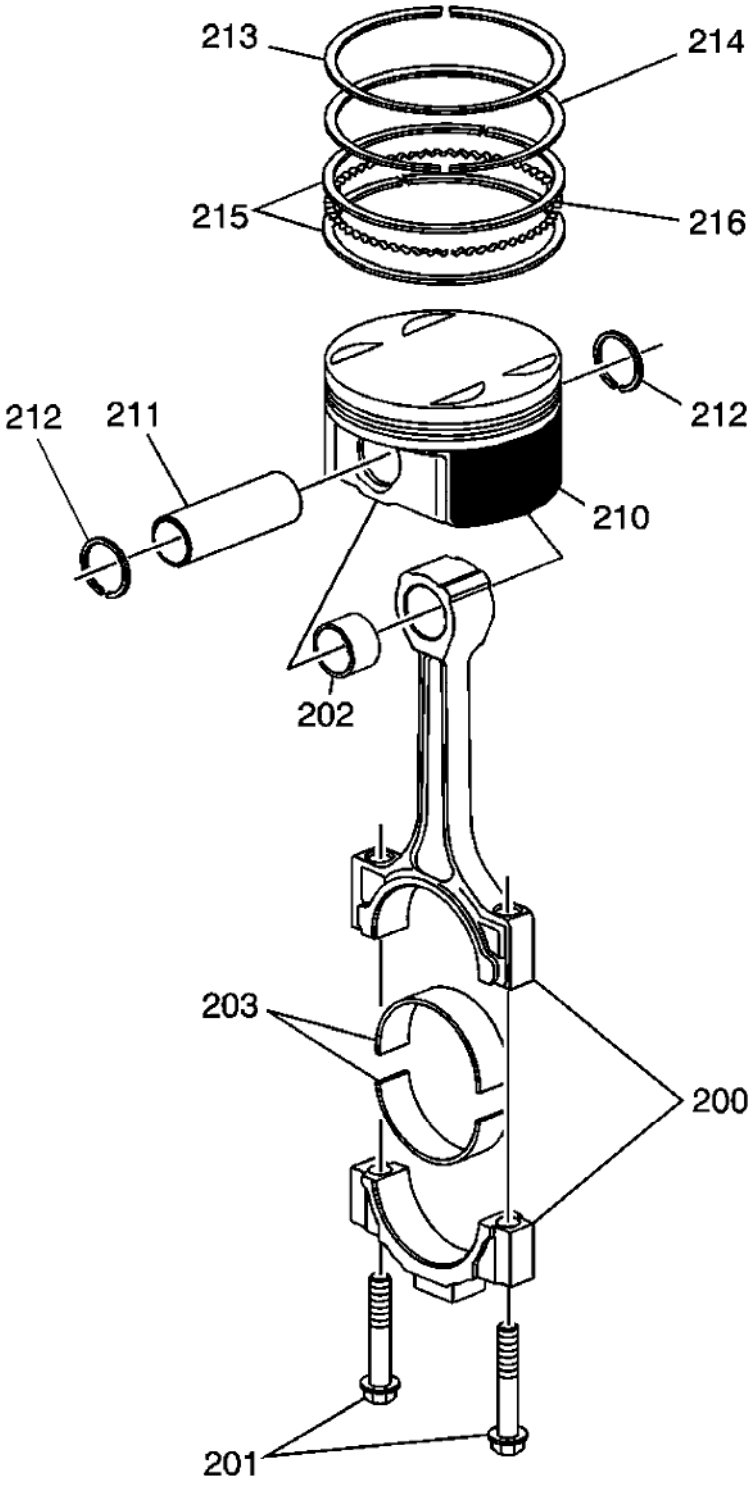


Fig. 11: Piston, Rings, Bearing & Connecting Rod
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name

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200	Connecting Rod
201	Connecting Rod Bolt
202	Connecting Rod Bushing
203	Connecting Rod Bearing
210	Piston
211	Piston Pin
212	Piston Pin Retainer
212	Piston Pin Retainer
213	Piston Upper Compression Ring
214	Piston Lower Compression Ring
215	Piston Oil Control Rail Ring
216	Piston Oil Control Ring Spacer

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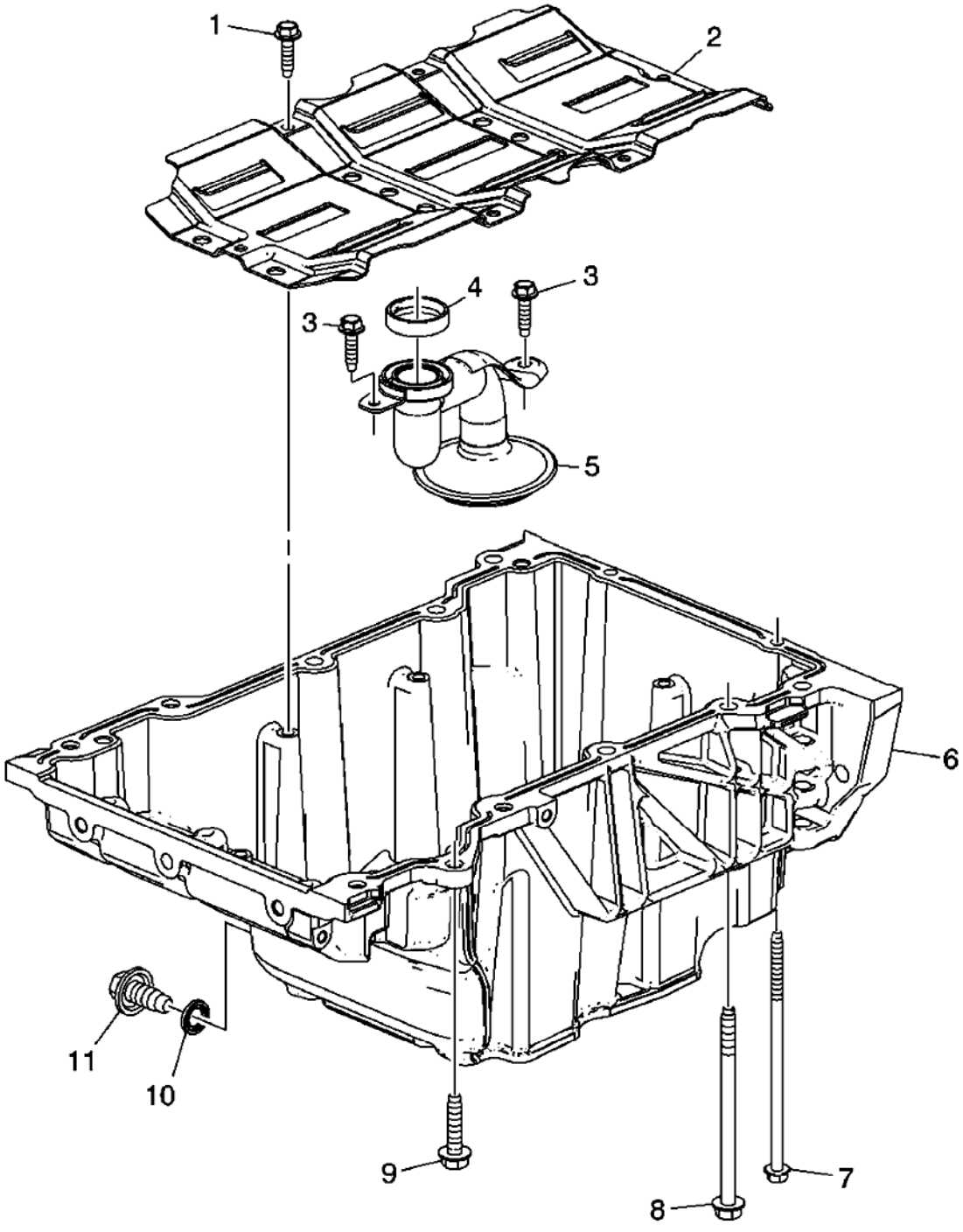


Fig. 12: Oil Pan Assembly
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Oil Pan Baffle Scraper Bolt
2	Oil Pan Baffle Scraper

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3	Oil Pump Suction Pipe Bolt
4	Oil Pump Suction Pipe Seal
5	Oil Pump Suction Pipe
6	Oil Pan
7	Oil Pan Bolt - Long
8	Oil Pan Bolt - Medium
9	Oil Pan Bolt - Short
10	Oil Pan Drain Plug Seal
11	Oil Pan Drain Plug

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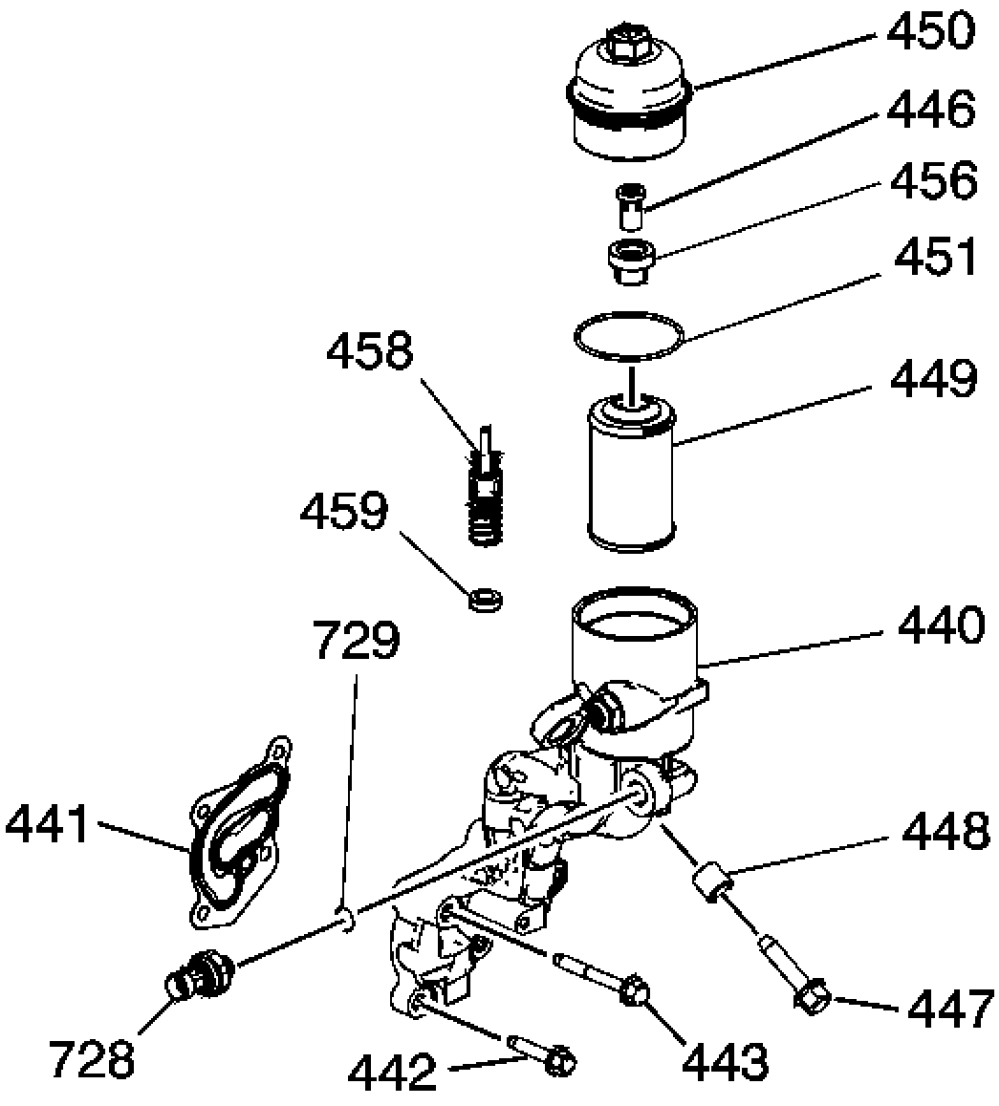


Fig. 13: Oil Filter Adapter
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
440	Oil Filter Adapter
441	Oil Filter Adapter Gasket
442	Oil Filter Adapter Bolt
443	Oil Filter Adapter Bolt - Long

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446	Oil Filter Bypass Valve
447	Oil Filter Adapter Bolt - Large
448	Oil Filter Adapter Bolt Sleeve
449	Oil Filter
450	Oil Filter Cap
451	Oil Filter Cap O-ring
456	Oil Filter Bypass Valve Body
458	Drain Valve Assembly
459	Drain Valve Assembly Seal
728	Engine Oil Pressure Sensor
729	Engine Oil Pressure Sensor O-ring

ENGINE IDENTIFICATION

Vehicle Identification Number

The Vehicle Identification Number (VIN) Derivative is located in two places on the engine and is a nine digit number stamped or laser etched onto the block at the vehicle assembly plant. If reading the identification number the following information can be obtained:

- The first digit identifies the vehicle division.
- The second digit is the model year.
- The third digit identifies the assembly plant.
- The fourth through ninth digits are the last six digits of the Vehicle Identification Number (VIN).

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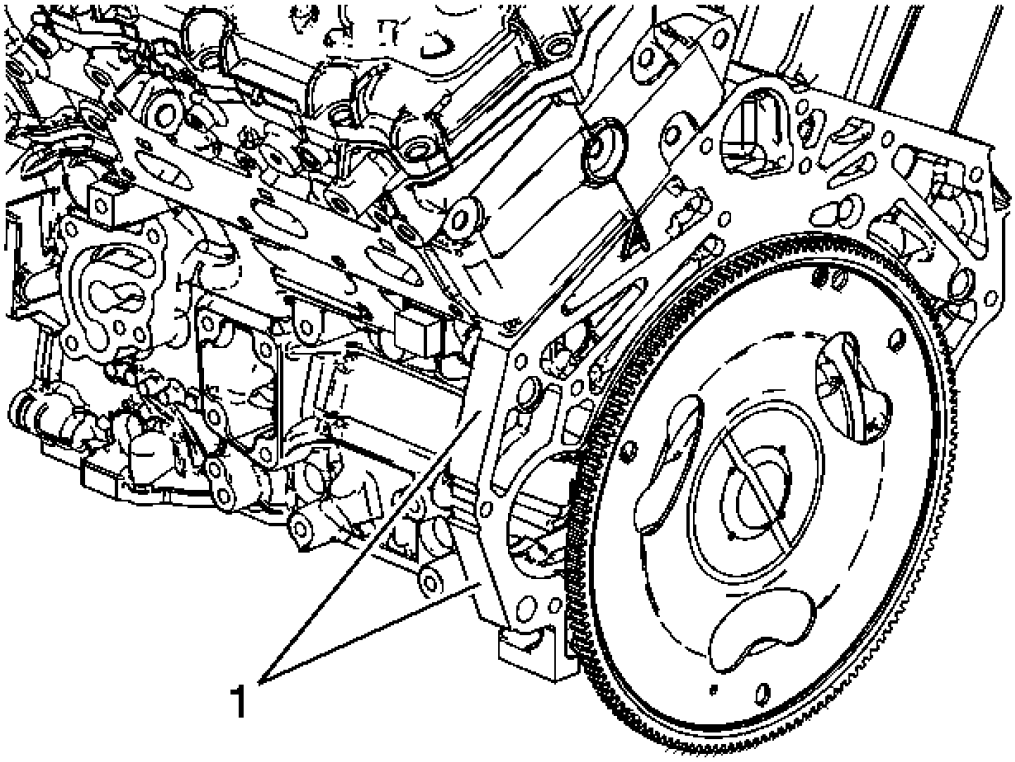


Fig. 14: Locating Engine VIN - Left Rear Side
Courtesy of GENERAL MOTORS CORP.

The engine block is marked with the VIN on a pad area on the left rear side (1).

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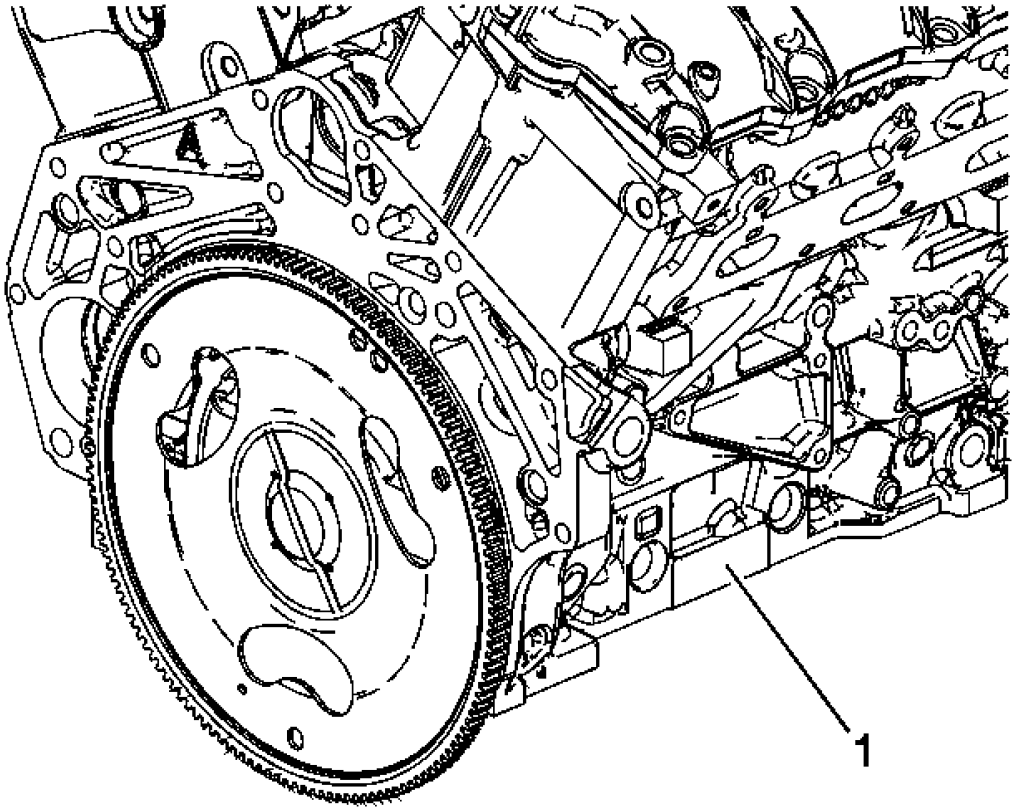


Fig. 15: Identifying Vehicle Identification Number (VIN)
Courtesy of GENERAL MOTORS CORP.

The engine block is marked with the VIN on a pad area on the center lower right side (1).

Engine Traceability Label

The engine traceability label is located in two places on the engine and consists of the broadcast code, bar code and sequence number.

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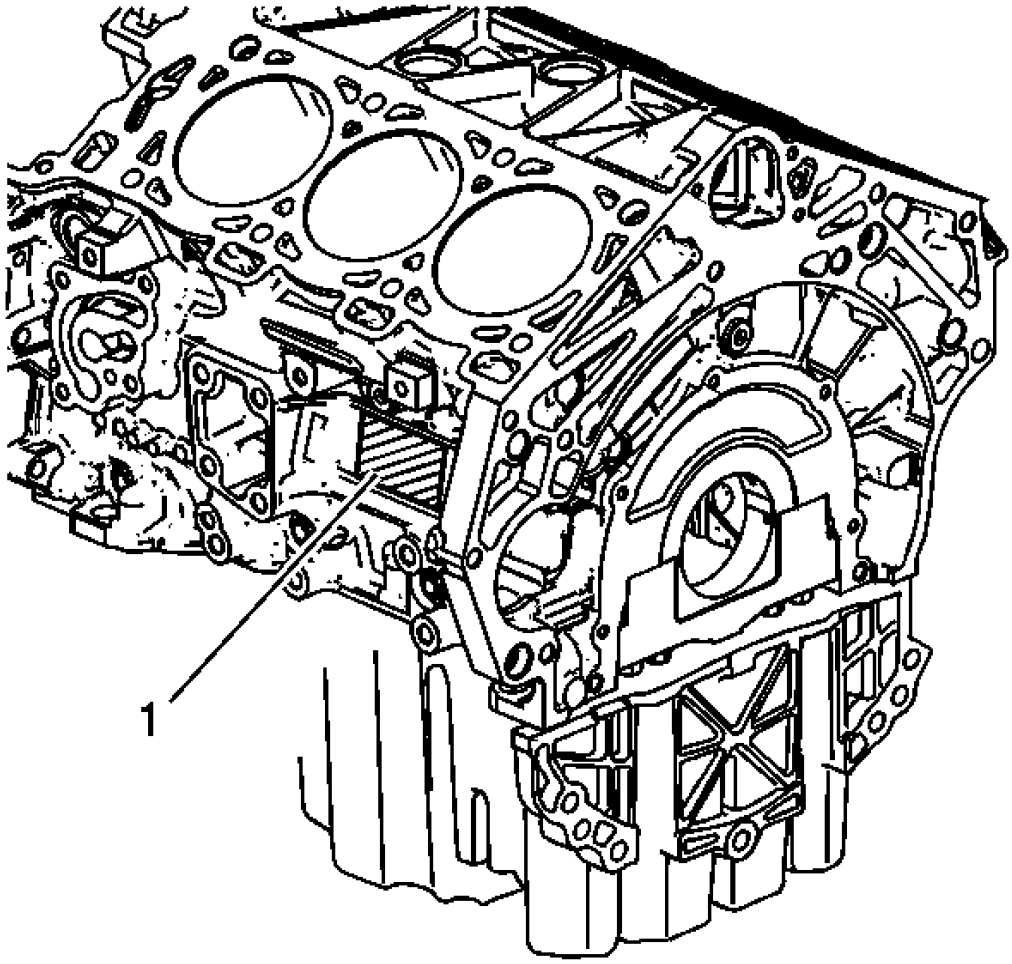


Fig. 16: Locating Left Rear Engine Traceability Label
Courtesy of GENERAL MOTORS CORP.

One engine traceability label (1) is located on the left rear side of the engine block.

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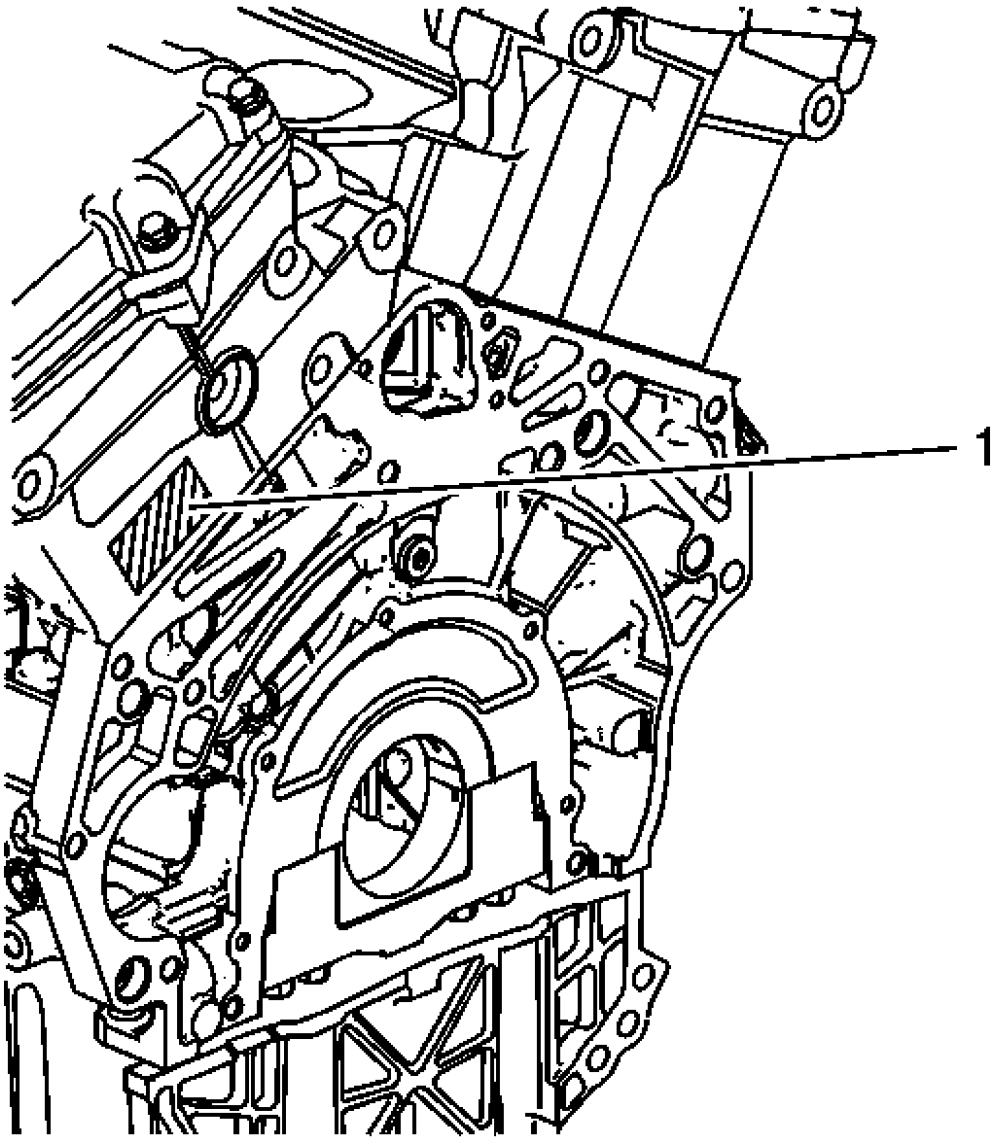


Fig. 17: View Of Engine Traceability Label On Left Cylinder Head
Courtesy of GENERAL MOTORS CORP.

Another engine traceability label (1) is located on the rear of the left cylinder head.

Engine Verification Label

The engine verification label is located in two places on the engine and consists of the broadcast code and bar

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code.

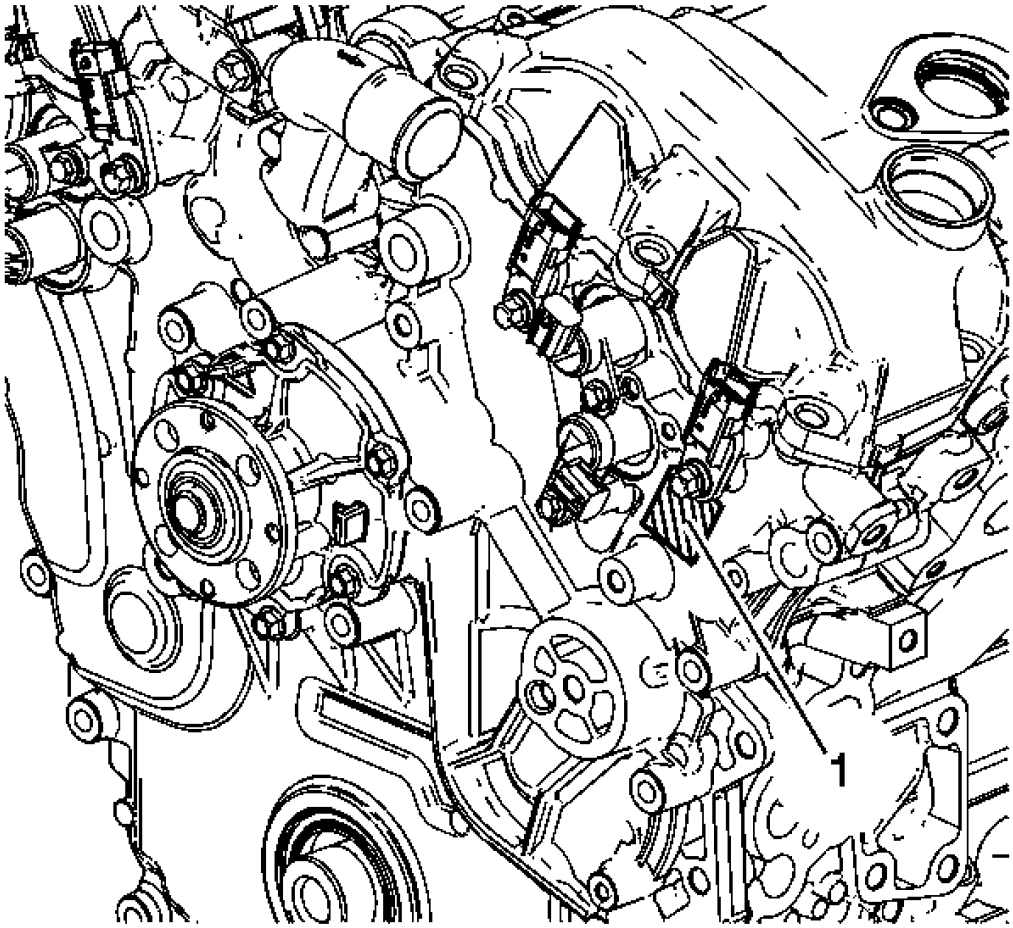


Fig. 18: Identifying Engine Verification Label
Courtesy of GENERAL MOTORS CORP.

One engine verification label (1) is located on the left side of the engine front cover below the exhaust camshaft position sensor.

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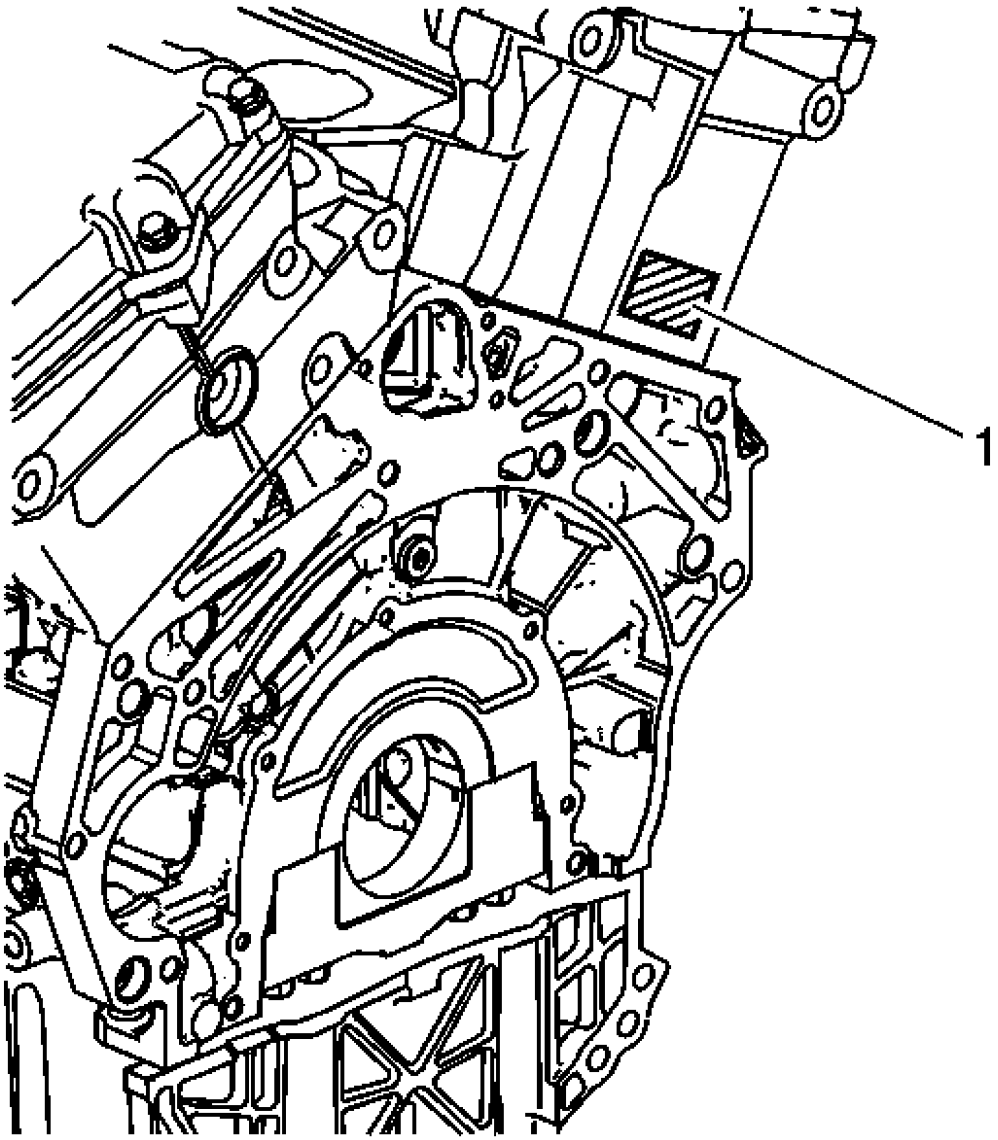


Fig. 19: Identifying Engine Verification Label On Rear Of Right Cylinder Head
Courtesy of GENERAL MOTORS CORP.

Another engine verification label (1) is located on the rear of the right cylinder head.

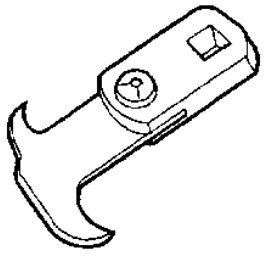
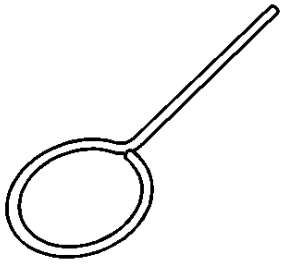
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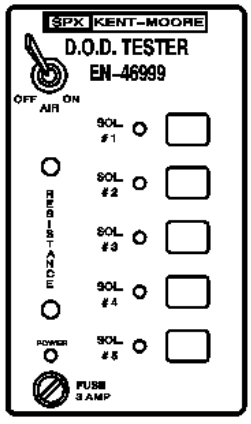
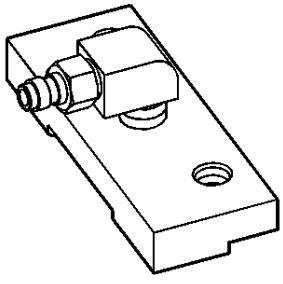
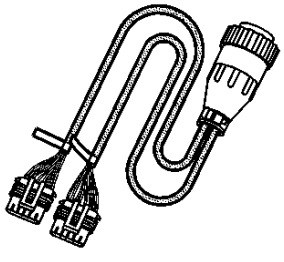
Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Camaro

SPECIAL TOOLS AND EQUIPMENT

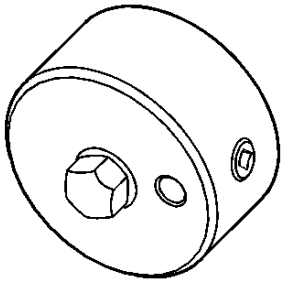
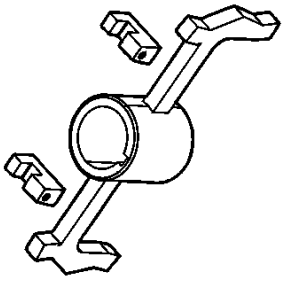
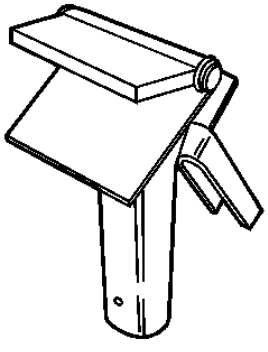
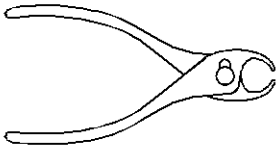
SPECIAL TOOLS

Illustration	Tool Number/Description
	E 308 Universal Seal Remover
	EN-46330 Timing Belt Tensioner Retaining Pin
	EN-46999 Active Fuel Management Tester

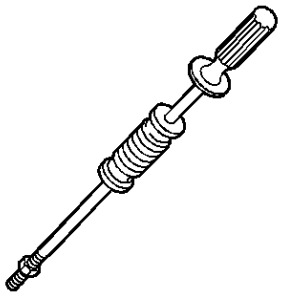
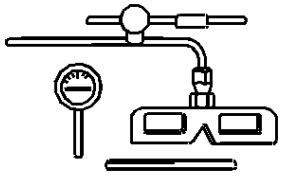
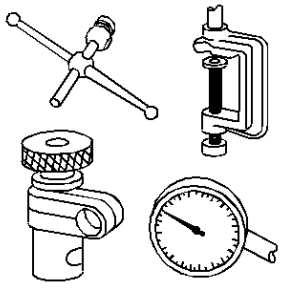
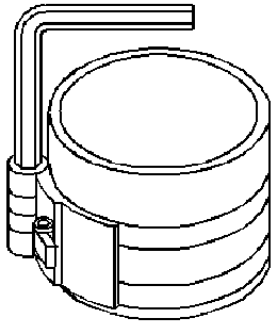
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	EN-46999-1 Active Fuel Management Tester Air Adapter
	EN-46999-5 Active Fuel Management Tester Harness - Small Block V8
	EN-47971 Oil Pressure Gauge Adapter

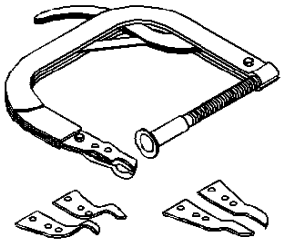
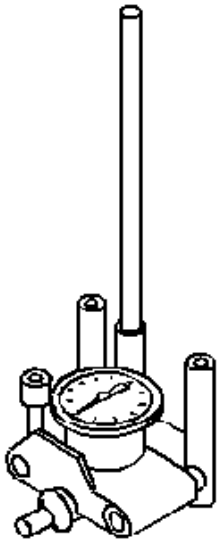
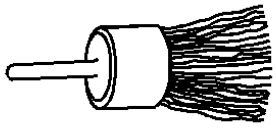
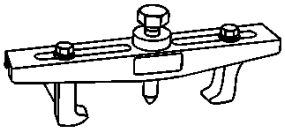
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	EN-48853 Front Cover Alignment Tool
	GE-48326 Sealant Dispenser
	J 3049-A Valve Lifter Remover

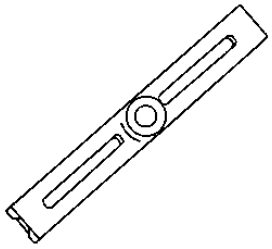
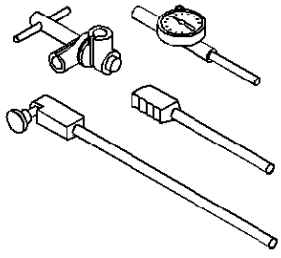
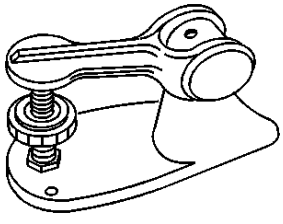
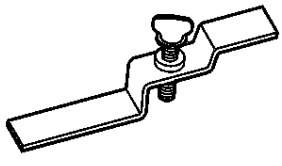
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	J 6125-1B Slide Hammer with Adapter
	J 7872 Magnetic Base Dial Indicator Set
	J 8001 Dial Indicator Set
	J 8037 Ring Compressor

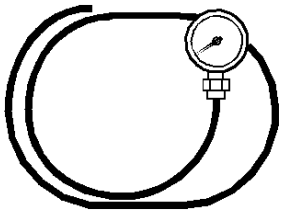
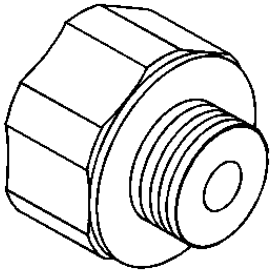
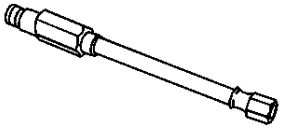
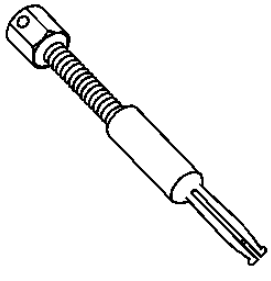
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	J 8062 Valve Spring Compressor - Head Off
	J 8087 Cylinder Bore Gauge
	J 8089 Carbon Removal Brush
	J 8433 Two Jaw Puller

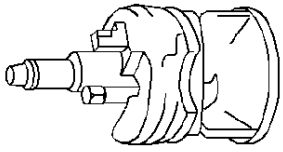
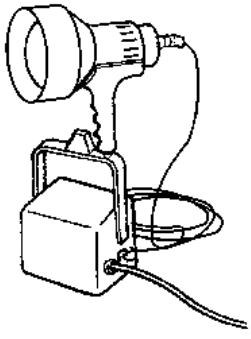
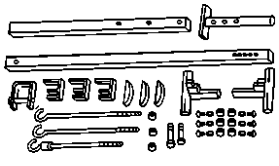
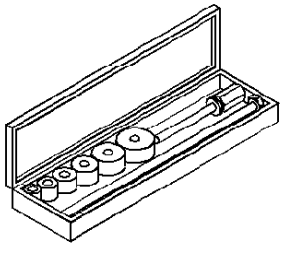
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	J 8433-1 Puller Bar
	J 8520 Cam Lobe Lift Indicator
	J 9666 Valve Spring Tester
	J 21366 Converter Holding Strap
	J 21867 Pressure Gauge

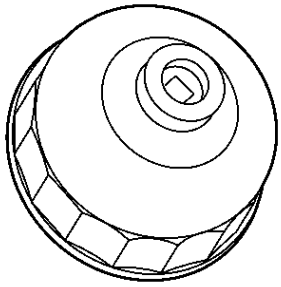
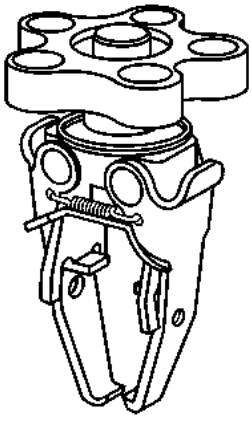
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	J 21867-16 Oil Pressure Adapter
	J 22794 Spark Plug Port Adapter
	J 23907 Slide Hammer
	J 24270 Cylinder Bore Ridge Reamer

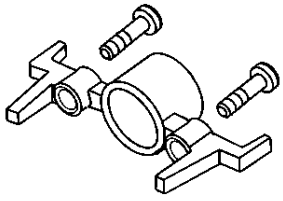
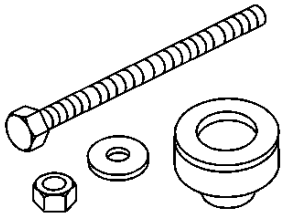
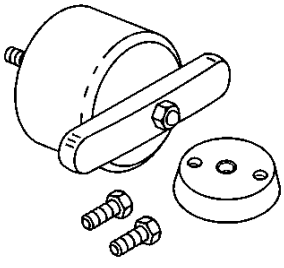
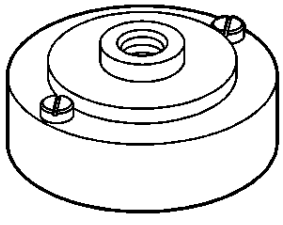
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	J 28410 Gasket Remover
	J 28428-E High-Intensity Black Light Kit
	J 28467-B Universal Engine Support Fixture
	J 33049 Camshaft Bearing Service Set

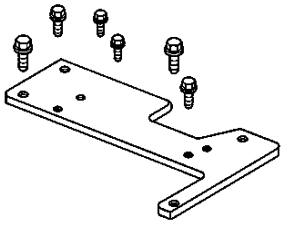
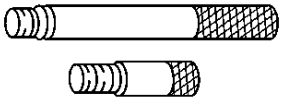
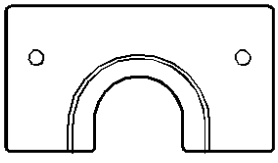
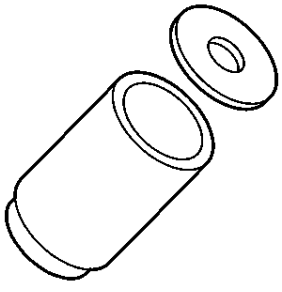
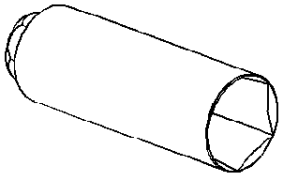
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	J 35667-A Cylinder Head Leakdown Tester
	J-35908 Oil Filter Wrench
	J 38606 Valve Spring Compressor

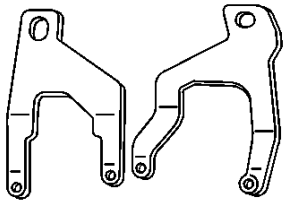
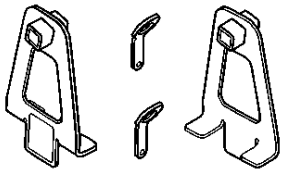
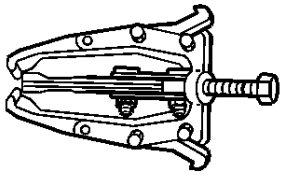
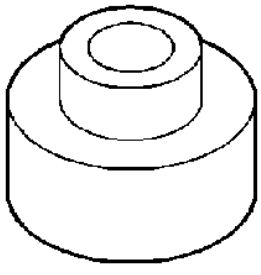
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	J 41415-40 Fuel Tank Cap Adaptor
	J 41476 Front and Rear Cover Alignment Tool
	J 41478 Crankshaft Front Oil Seal Installer
	J 41479-B Crankshaft Rear Oil Seal Installer
	J 41479-2A Crankshaft Rear Oil Seal Installation Guide

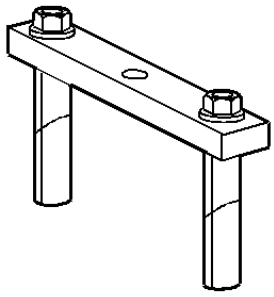
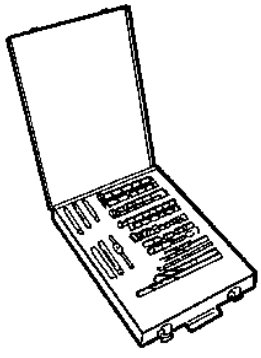
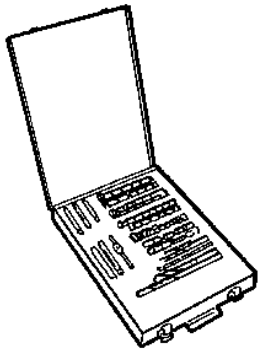
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	J 41480 Front and Rear Cover Alignment
	J 41556 Connecting Rod Guide
	J 41558 Crankshaft Sprocket Remover
	J 41665-A Crankshaft Balancer and Sprocket Installer
	J 41712 Oil Pressure Switch Socket

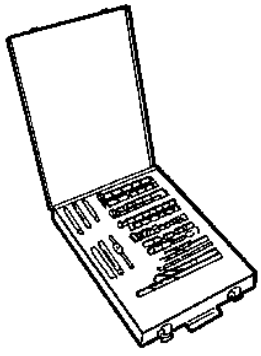
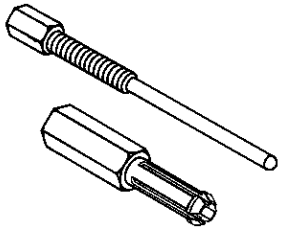
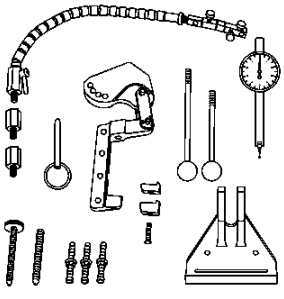
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	J 41798 Engine Lift Bracket
	J 41803 Engine Support Fixture
	J 41816-A Crankshaft Balancer Remover
	J 41816-2 Crankshaft End Protector
	J 41818 Crankshaft Bearing Cap Remover

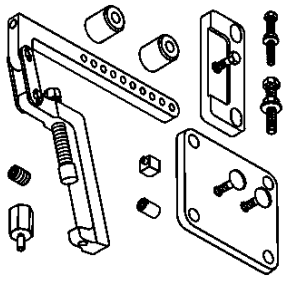
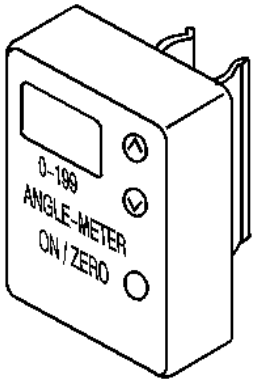
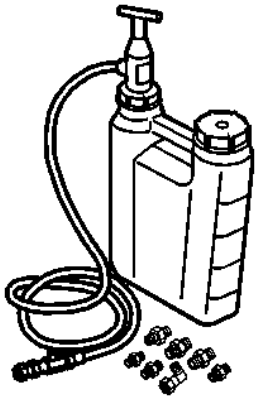
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	J 42385-100 Head/Main Bolt Thread Repair Kit
	J 42385-200 Common Thread Repair Kit

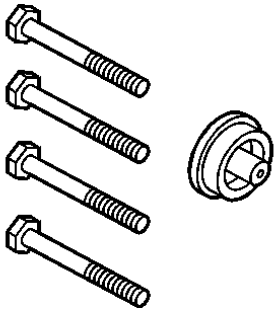
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	J 42385-300 Fixtures and Hardware Kit
	J 42386-A Flywheel Holding Tool
	J 43276 Clutch Pilot Bearing Remover
	J 43690 Rod Bearing Clearance Checking Tool

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	J 43690-100 Rod Bearing Clearance Checking Tool - Adapter Kit
	J 45059 Angle Meter
	J 45299 Engine Preluber

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	J 45949 Pilot Bearing and Flywheel Locator Installer

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2010 ENGINE

Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - Camaro

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS (6.2L LS3)

Application	Specification	
	Metric	English
Camshaft Position (CMP) Sensor Bolt	12 N.m	106 lb in
CMP Sensor Wire Harness Bolt	12 N.m	106 lb in
Camshaft Retainer Bolts - Hex Head Bolts	25 N.m	18 lb ft
Camshaft Retainer Bolts - TORX® Head Bolts	15 N.m	11 lb ft
Camshaft Sprocket Bolt - First Pass	75 N.m	55 lb ft
Camshaft Sprocket Bolt - Final Pass	50 degrees	
Clutch Pressure Plate Bolts	70 N.m	52 lb ft
Connecting Rod Bolts - First Pass	20 N.m	15 lb ft
Connecting Rod Bolts - Final Pass	85 degrees	
Coolant Air Bleed Pipe Bolts	12 N.m	106 lb in
Coolant Temperature Sensor	20 N.m	15 lb ft
Crankshaft Balancer Bolt - Step 1	150 N.m	111 lb ft
Crankshaft Balancer Bolt - Step 2	Loosen 360 degrees	
Crankshaft Balancer Bolt - Step 3	50 N.m	37 lb ft
Crankshaft Balancer Bolt - (with Flanged Head) Final Step	125 degrees	
Crankshaft Balancer Bolt - (with Retained Rotating Washer) Final Step	200 degrees	
Crankshaft Bearing Cap M10 Bolts - First Pass in Sequence	20 N.m	15 lb ft
Crankshaft Bearing Cap M10 Bolts - Final Pass in Sequence	80 degrees	
Crankshaft Bearing Cap M10 Studs - First Pass in Sequence	20 N.m	15 lb ft
Crankshaft Bearing Cap M10 Studs - Final Pass in Sequence	51 degrees	
Crankshaft Bearing Cap M8 Bolts (1-5) - First Pass	20 N.m	15 lb ft
Crankshaft Bearing Cap M8 Bolts (1-5) - Final Pass	30 N.m	22 lb ft
Crankshaft Bearing Cap M8 Bolts (6-10) - First Pass	20 N.m	15 lb ft
Crankshaft Bearing Cap M8 Bolts (6-10) - Final Pass	30 N.m	22 lb ft
Crankshaft Oil Deflector Nuts	25 N.m	18 lb ft
Crankshaft Position (CKP) Sensor Bolt	25 N.m	18 lb ft
Crankshaft Rear Oil Seal Housing Bolts	30 N.m	22 lb ft
Cylinder Head M11 Bolts - First Pass in Sequence	30 N.m	22 lb ft
Cylinder Head M11 Bolts - Second Pass in Sequence	90 degrees	
Cylinder Head M11 Bolts - Final Pass in Sequence	70 degrees	
Cylinder Head M8 Bolts - in Sequence	30 N.m	22 lb ft

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Cylinder Head Coolant Plug	20 N.m	15 lb ft
Engine Block Coolant Drain Hole Plug	60 N.m	44 lb ft
Engine Block Oil Gallery Plug	60 N.m	44 lb ft
Engine Oil Cooler Coolant Hose Bracket-to-Oil Pan	25 N.m	18 lb ft
Engine Oil Cooler Coolant Hose Connector-to-Cooler Housing	35 N.m	26 lb ft
Engine Oil Cooler Core-to-Housing Bolts	25 N.m	18 lb ft
Engine Oil Cooler-to-Oil Pan M6 Bolts	10 N.m	89 lb in
Engine Oil Cooler-to-Oil Pan M8 Bolts	25 N.m	18 lb ft
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Bolt	50 N.m	37 lb ft
Exhaust Manifold Bolts - First Pass	15 N.m	11 lb ft
Exhaust Manifold Bolts - Final Pass	20 N.m	15 lb ft
Exhaust Manifold Heat Shield Bolts	9 N.m	80 lb in
Exhaust Manifold Stud	20 N.m	15 lb ft
Flywheel Bolts - First Pass	20 N.m	15 lb ft
Flywheel Bolts - Second Pass	50 N.m	37 lb ft
Flywheel Bolts - Final Pass	100 N.m	74 lb ft
Front Cover Bolts	25 N.m	18 lb ft
Fuel Injection Fuel Rail Bolts	10 N.m	89 lb in
Ignition Coil Bracket-to-Valve Rocker Arm Cover Stud	12 N.m	106 lb in
Ignition Coil-to-Bracket Bolts	10 N.m	89 lb in
Intake Manifold Bolts - First Pass in Sequence	5 N.m	44 lb in
Intake Manifold Bolts - Final Pass in Sequence	10 N.m	89 lb in
J 41798 M8 Bolt	25 N.m	18 lb ft
J 41798 M10 Bolts	50 N.m	37 lb ft
Knock Sensor Bolts	25 N.m	18 lb ft
Motor Mount Bracket Bolts	50 N.m	37 lb ft
Oil Filter	30 N.m	22 lb ft
Oil Filter Fitting	55 N.m	40 lb ft
Oil Level Indicator Tube Bolt	25 N.m	18 lb ft
Oil Level Sensor	13 N.m	115 lb in
Oil Pan Closeout Cover Bolt - Left Side	9 N.m	80 lb in
Oil Pan Closeout Cover Bolt - Right Side	9 N.m	80 lb in
Oil Pan Drain Plug	25 N.m	18 lb ft
Oil Pan M6 Bolts - Oil Pan-to-Rear Oil Seal Housing	12 N.m	106 lb in
Oil Pan M8 Bolts - Oil Pan-to-Engine Block and Oil Pan-to-Front Cover	25 N.m	18 lb ft
Oil Pressure Relief Valve - In Oil Pan	27 N.m	20 lb ft
Oil Pressure Sensor	35 N.m	26 lb ft
Oil Pump Cover Bolts	12 N.m	106 lb in
Oil Pump Relief Valve Plug	12 N.m	106 lb in

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Oil Pump Screen Nuts	25 N.m	18 lb ft
Oil Pump Screen-to-Oil Pump Bolt	12 N.m	106 lb in
Oil Pump-to-Engine Block Bolts	25 N.m	18 lb ft
Spark Plugs	15 N.m	11 lb ft
Throttle Body Bolts	10 N.m	89 lb in
Timing Chain Tensioner Bolts	30 N.m	22 lb ft
Valley Cover Bolts	25 N.m	18 lb ft
Valve Lifter Guide Bolts	12 N.m	106 lb in
Valve Rocker Arm Bolts	30 N.m	22 lb ft
Valve Rocker Arm Cover Bolts	12 N.m	106 lb in
Water Inlet Housing Bolts	15 N.m	11 lb ft
Water Pump Bolts - First Pass	15 N.m	11 lb ft
Water Pump Bolts - Final Pass	30 N.m	22 lb ft

FASTENER TIGHTENING SPECIFICATIONS (6.2L L99)

Application	Specification	
	Metric	English
Active Fuel Management Oil Pressure Relief Valve	27 N.m	20 lb ft
Camshaft Position (CMP) Actuator Magnet Bolts	12 N.m	106 lb in
Camshaft Position (CMP) Actuator Solenoid Valve - First Pass	65 N.m	48 lb ft
Camshaft Position (CMP) Actuator Solenoid Valve - Final Pass	90 degrees	
Camshaft Position (CMP) Sensor Bolt	12 N.m	106 lb in
CMP Sensor Wire Harness Bolt	12 N.m	106 lb in
Camshaft Retainer Bolts - TORX® Head Bolts	15 N.m	11 lb ft
Connecting Rod Bolts - First Pass	20 N.m	15 lb ft
Connecting Rod Bolts - Final Pass	85 degrees	
Coolant Air Bleed Pipe Bolts	12 N.m	106 lb in
Coolant Temperature Sensor	20 N.m	15 lb ft
Crankshaft Balancer Bolt - Step 1	150 N.m	110 lb ft
Crankshaft Balancer Bolt - Step 2	Loosen 360 degrees	
Crankshaft Balancer Bolt - Step 3	50 N.m	37 lb ft
Crankshaft Balancer Bolt, with Flanged Head, - Final Step	125 degrees	
Crankshaft Balancer Bolt, with Retained Rotating Washer, - Final Step	200 degrees	
Crankshaft Bearing Cap M8 Bolts (1-5) - First Pass	20 N.m	15 lb ft
Crankshaft Bearing Cap M8 Bolts (1-5) - Final Pass	30 N.m	22 lb ft
Crankshaft Bearing Cap M8 Bolts (6-10) - First Pass	20 N.m	15 lb ft
Crankshaft Bearing Cap M8 Bolts (6-10) - Final Pass	30 N.m	22 lb ft
Crankshaft Bearing Cap M10 Bolts - First Pass in Sequence	20 N.m	15 lb ft

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Crankshaft Bearing Cap M10 Bolts - Final Pass in Sequence	80 degrees	
Crankshaft Bearing Cap M10 Studs - First Pass in Sequence	20 N.m	15 lb ft
Crankshaft Bearing Cap M10 Studs - Final Pass in Sequence	51 degrees	
Crankshaft Oil Deflector Nuts	25 N.m	18 lb ft
Crankshaft Position (CKP) Sensor Bolt	25 N.m	18 lb ft
Crankshaft Rear Oil Seal Housing Bolts	30 N.m	22 lb ft
Cylinder Head Coolant Plug	20 N.m	15 lb ft
Cylinder Head M8 Bolts - in Sequence	30 N.m	22 lb ft
Cylinder Head M11 Bolts - First Pass in Sequence	30 N.m	22 lb ft
Cylinder Head M11 Bolts - Second Pass in Sequence	90 degrees	
Cylinder Head M11 Bolts - Final Pass in Sequence	70 degrees	
Engine Block Coolant Drain Hole Plug	60 N.m	44 lb ft
Engine Block Oil Gallery Plug	60 N.m	44 lb ft
Engine Oil Cooler to Block	50 N.m	37 lb ft
Engine Oil Cooler Coolant Hose Bracket to Oil Pan	25 N.m	18 lb ft
Engine Oil Cooler Coolant Hose Connector to Cooler Housing	35 N.m	26 lb ft
Engine Oil Cooler Core-to-Housing Bolts	25 N.m	18 lb ft
Engine Oil Cooler-to-Oil Pan M6 Bolts	10 N.m	89 lb in
Engine Oil Cooler-to-Oil Pan M8 Bolts	25 N.m	18 lb ft
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Bolt	50 N.m	37 lb ft
Exhaust Manifold Bolts - First Pass	15 N.m	11 lb ft
Exhaust Manifold Bolts - Final Pass	20 N.m	15 lb ft
Exhaust Manifold Heat Shield Bolts	9 N.m	80 lb in
Exhaust Manifold Studs	20 N.m	15 lb ft
Flex Plate Bolts - First Pass	20 N.m	15 lb ft
Flex Plate Bolts - Second Pass	50 N.m	37 lb ft
Flex Plate Bolts - Final Pass	100 N.m	74 lb ft
Front Cover Bolts	25 N.m	18 lb ft
Fuel Injection Fuel Rail Bolts	10 N.m	89 lb in
Ignition Coil Bracket-to-Valve Rocker Arm Cover Studs	12 N.m	106 lb in
Ignition Coil-to-Bracket Bolts	10 N.m	89 lb in
Intake Manifold Bolts - First Pass in Sequence	5 N.m	44 lb in
Intake Manifold Bolts - Final Pass in Sequence	10 N.m	89 lb in
J 41798 M8 Bolt	25 N.m	18 lb ft
J 41798 M10 Bolts	50 N.m	37 lb ft
Knock Sensor Bolts	25 N.m	18 lb ft
Oil Filter	30 N.m	22 lb ft
Oil Filter Fitting	55 N.m	40 lb ft
Oil Level Indicator Tube Bolt	25 N.m	18 lb ft

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Oil Level Sensor	20 N.m	15 lb ft
Oil Pan Baffle Bolt	12 N.m	106 lb in
Oil Pan Closeout Cover Bolt - Left Side	9 N.m	80 lb in
Oil Pan Closeout Cover Bolt - Right Side	9 N.m	80 lb in
Oil Pan Drain Plug	25 N.m	18 lb ft
Oil Pan M6 Bolts - Oil Pan-to-Rear Oil Seal Housing	12 N.m	106 lb in
Oil Pan M8 Bolts - Oil Pan-to-Engine Block and Oil Pan-to-Front Cover	25 N.m	18 lb ft
Oil Pressure Sensor	35 N.m	26 lb ft
Oil Pump Cover Bolts	12 N.m	106 lb in
Oil Pump Relief Valve Plug	12 N.m	106 lb in
Oil Pump Screen-to-Oil Pump Bolt	12 N.m	106 lb in
Oil Pump-to-Engine Block Bolts	25 N.m	18 lb ft
Spark Plugs	15 N.m	11 lb ft
Throttle Body Bolts	10 N.m	89 lb in
Timing Chain Tensioner Bolts	30 N.m	22 lb ft
Valve Lifter Oil Manifold Bolts	25 N.m	18 lb ft
Valve Lifter Guide Bolts	12 N.m	106 lb in
Valve Rocker Arm Bolts	30 N.m	22 lb ft
Valve Rocker Arm Cover Bolts	12 N.m	106 lb in
Water Inlet Housing Bolts	15 N.m	11 lb ft
Water Pump Bolts - First Pass	15 N.m	11 lb ft
Water Pump Bolts - Final Pass	30 N.m	22 lb ft

ENGINE MECHANICAL SPECIFICATIONS (6.2L LS3)

Application	Specification	
	Metric	English
• Engine Type	V8	
• Displacement	6.2L	376 CID
• RPO	LS3	
• VIN	W	
• Bore	103.241-103.259 mm	4.0065-4.0065 in
• Stroke	92.0 mm	3.622 in
• Compression Ratio	10.7:1	
• Firing Order	1-8-7-2-6-5-4-3	
• Spark Plug Gap	1.02 mm	0.04 in
Block		
• Camshaft Bearing Bore 1 and 5 Diameter	59.58-59.63 mm	2.345-2.347 in

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• Camshaft Bearing Bore 2 and 4 Diameter	59.08-59.13 mm	2.325-2.327 in
• Camshaft Bearing Bore 3 Diameter	58.58-58.63 mm	2.306-2.308 in
• Crankshaft Main Bearing Bore Diameter	69.871-69.889 mm	2.75-2.751 in
• Crankshaft Main Bearing Bore Out-of-Round	0.006 mm	0.0002 in
• Cylinder Bore Diameter	103.241-103.259 mm	4.0646-4.0653 in
• Cylinder Head Deck Height - Measuring from the Centerline of Crankshaft to the Deck Face	234.57-234.82 mm	9.235-9.245 in
• Cylinder Head Deck Surface Flatness - Measured Within a 152.4 mm (6.0 in) Area	0.11 mm	0.004 in
• Cylinder Head Deck Surface Flatness - Measuring the Overall Length of the Block Deck	0.22 mm	0.008 in
• Valve Lifter Bore Diameter	21.417-21.443 mm	0.843-0.844 in
Camshaft		
• Camshaft End Play	0.025-0.305 mm	0.001-0.012 in
• Camshaft Journal Diameter	54.99-55.04 mm	2.164-2.166 in
• Camshaft Journal Out-of-Round	0.025 mm	0.001 in
• Camshaft Lobe Lift - Exhaust	7.77 mm	0.306 in
• Camshaft Lobe Lift - Intake	8.24 mm	0.324 in
• Camshaft Runout - Measured at the Intermediate Journals	0.05 mm	0.002 in
Connecting Rod		
• Connecting Rod Bearing Clearance - Production	0.023-0.065 mm	0.0009-0.0025 in
• Connecting Rod Bearing Clearance - Service	0.023-0.076 mm	0.0009-0.003 in
• Connecting Rod Bore Diameter - Bearing End	56.505-56.525 mm	2.224-2.225 in
• Connecting Rod Bore Out-of-Round - Bearing End - Production	0.004-0.008 mm	0.00015-0.0003 in
• Connecting Rod Bore Out-of-Round - Bearing End - Service	0.004-0.008 mm	0.00015-0.0003 in
• Connecting Rod Side Clearance	0.11-0.51 mm	0.00433-0.02 in
Crankshaft		
• Connecting Rod Journal Diameter - Production	53.318-53.338 mm	2.0991-2.0999 in
• Connecting Rod Journal Diameter - Service	53.308 mm	2.0987 in
• Connecting Rod Journal Out-of-Round - Production	0.005 mm	0.0002 in
• Connecting Rod Journal Out-of-Round - Service	0.01 mm	0.0004 in
• Connecting Rod Journal Taper - Maximum for 1/2 of Journal Length - Production	0.005 mm	0.0002 in

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• Connecting Rod Journal Taper - Maximum for 1/2 of Journal Length - Service	0.02 mm	0.00078 in
• Crankshaft End Play	0.04-0.2 mm	0.0015-0.0078 in
• Crankshaft Main Bearing Clearance - Production	0.02-0.052 mm	0.0008-0.0021 in
• Crankshaft Main Bearing Clearance - Service	0.02-0.065 mm	0.0008-0.0025 in
• Crankshaft Main Journal Diameter - Production	64.992-65.008 mm	2.558-2.559 in
• Crankshaft Main Journal Diameter - Service	64.992 mm	2.558 in
• Crankshaft Main Journal Out-of-Round - Production	0.003 mm	0.000118 in
• Crankshaft Main Journal Out-of-Round - Service	0.008 mm	0.0003 in
• Crankshaft Main Journal Taper - Production	0.01 mm	0.0004 in
• Crankshaft Main Journal Taper - Service	0.02 mm	0.00078 in
• Crankshaft Rear Flange Runout	0.05 mm	0.002 in
• Crankshaft Reluctor Ring Runout - Measured 1.0 mm (0.04 in) Below Tooth Diameter	0.7 mm	0.028 in
• Crankshaft Thrust Surface - Production	26.14-26.22 mm	1.029-1.0315 in
• Crankshaft Thrust Surface - Service	26.22 mm	1.0315 in
• Crankshaft Thrust Surface Runout	0.025 mm	0.001 in
Cylinder Head		
• Cylinder Head Height/Thickness - Measured from the Cylinder Head Deck to the Valve Rocker Arm Cover Seal Surface	120.2 mm	4.732 in
• Surface Flatness - Block Deck - Measured within a 152.4 mm (6.0 in) Area	0.08 mm	0.003 in
• Surface Flatness - Block Deck - Measuring the Overall Length of the Cylinder Head	0.1 mm	0.004 in
• Surface Flatness - Exhaust Manifold Deck	0.13 mm	0.005 in
• Surface Flatness - Intake Manifold Deck	0.08 mm	0.0031 in
• Valve Guide Installed Height - Measured from the Spring Seat Surface to the Top of the Guide	17.32 mm	0.682 in
Intake Manifold		
• Surface Flatness - Measured at Gasket Sealing Surfaces and Measured Within a 200 mm (7.87 in) Area that Includes 2 Runner Port Openings	0.3 mm	0.118 in
Lubrication System		
• Oil Capacity - with Filter	7.6 Liters	8.0 Quarts
• Oil Capacity - without Filter	7.1 Liters	7.5 Quarts
	41 kPa at 1,000	6 psig at 1,000 engine

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• Oil Pressure - Minimum - Hot	engine RPM 124 kPa at 2,000 engine RPM 165 kPa at 4,000 engine RPM	RPM 18 psig at 2,000 engine RPM 24 psig at 4,000 engine RPM
• Active Fuel Management Relief Valve Oil Pressure - as Measured at Oil Pressure Sensor Location	379-517 kPa Maximum	55-75 psi Maximum
Oil Pan		
• Front Cover Alignment - at Oil Pan Surface	0.0-0.5 mm	0.0-0.02 in
• Crankshaft Rear Oil Seal Housing Alignment - at Oil Pan Surface	0.0-0.5 mm	0.0-0.02 in
• Oil Pan Alignment - to Rear of Engine Block at Transmission Bell Housing Mounting Surface	0.0-0.1 mm	0.0-0.004 in
Piston Rings		
• Piston Ring End Gap - First Compression Ring - Measured in Cylinder Bore - Production	0.17-0.38 mm	0.0067-0.0150 in
• Piston Ring End Gap - First Compression Ring - Measured in Cylinder Bore - Service	0.17-0.44 mm	0.0067-0.0173 in
• Piston Ring End Gap - Second Compression Ring - Measured in Cylinder Bore - Production	0.32-0.63 mm	0.0126-0.0248 in
• Piston Ring End Gap - Second Compression Ring - Measured in Cylinder Bore - Service	0.32-0.69 mm	0.0126-0.0272 in
• Piston Ring End Gap - Oil Control Ring - Measured in Cylinder Bore - Production	0.22-0.79 mm	0.0086-0.031 in
• Piston Ring End Gap - Oil Control Ring - Measured in Cylinder Bore - Service	0.22-0.85 mm	0.0086-0.0335 in
• Piston Ring to Groove Clearance - First Compression Ring - Production	0.030-0.083 mm	0.0012-0.0033 in
• Piston Ring to Groove Clearance - First Compression Ring - Service	0.030-0.083 mm	0.0012-0.0033 in
• Piston Ring to Groove Clearance - Second Compression Ring - Production	0.040-0.083 mm	0.0016-0.0033 in
• Piston Ring to Groove Clearance - Second Compression Ring - Service	0.040-0.083 mm	0.0016-0.0033 in
• Piston Ring to Groove Clearance - Oil Control Ring - Production	0.013-0.201 mm	0.0005-0.0079 in
• Piston Ring to Groove Clearance - Oil Control Ring - Service	0.013-0.201 mm	0.0005 in-0.0079 in
Pistons and Pins		
• Pin - Piston Pin Clearance to Piston Pin Bore -		

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Production	0.002 mm-0.01 mm	0.0008 in-0.0004 in
• Pin - Piston Pin Clearance to Piston Pin Bore - Service	0.002 mm-0.015 mm	0.0008 in-0.0006 in
• Pin - Piston Pin Diameter	23.952 mm-23.955 mm	0.943 in-0.943 in
• Pin - Piston Pin Fit in Connecting Rod Bore - Production	0.007 mm-0.02 mm	0.00027 in-0.00078 in
• Pin - Piston Pin Fit in Connecting Rod Bore - Service	0.007 mm-0.022 mm	0.00027 in-0.00086 in
• Piston - Piston Diameter - Measured Over Skirt Coating	103.258 mm-103.289 mm	4.0653 in-4.0665 in
• Piston - Piston to Bore Clearance - Production	-0.048 mm to +0.001 mm	-0.0009 in to +0.000 in
• Piston - Piston to Bore Clearance - Service Limit with Skirt Coating Worn Off	0.055 mm	0.0022 in
Valve System		
• Valves - Valve Face Angle	45 degrees	
• Valves - Valve Face Width	1.25 mm	0.05 in
• Valves - Valve Lash	Net Lash - No Adjustment	
• Valve Lift - Exhaust	13.97 mm	0.55 in
• Valve Lift - Intake	13.22 mm	0.52 in
• Valves - Valve Seat Angle	46 degrees	
• Valves - Valve Seat Runout	0.05 mm	0.002 in
• Valves - Valve Seat Width - Exhaust	1.78 mm	0.07 in
• Valves - Valve Seat Width - Intake	1.02 mm	0.04 in
• Valves - Valve Stem Diameter - Production	7.955-7.976 mm	0.313-0.314 in
• Valves - Valve Stem Diameter - Service	7.95 mm	0.313 in
• Valves - Valve Stem-to-Guide Clearance - Production - Exhaust	0.025-0.066 mm	0.001-0.0026 in
• Valves - Valve Stem-to-Guide Clearance - Service - Exhaust	0.093 mm	0.0037 in
• Valves - Valve Stem-to-Guide Clearance - Production - Intake	0.025-0.066 mm	0.001-0.0026 in
• Valves - Valve Stem-to-Guide Clearance - Service - Intake	0.093 mm	0.0037 in
• Rocker Arms - Valve Rocker Arm Ratio	1.70:1	
• Valve Springs - Valve Spring Free Length	52.9 mm	2.08 in

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• Valve Springs - Valve Spring Installed Height	45.75 mm	1.8 in
• Valve Springs - Valve Spring Load - Closed	400 N at 45.75 mm	90 lb at 1.8 in
• Valve Springs - Valve Spring Load - Open	1310 N at 31.74 mm	295 lb at 1.25 in

ENGINE MECHANICAL SPECIFICATIONS (6.2L L99)

Application	Specification	
	Metric	English
• Engine Type	V8	
• Displacement	6.2L	376 CID
• RPO	L99	
• VIN	J	
• Bore	103.241-103.259 mm	4.0065-4.0065 in
• Stroke	92.0 mm	3.622 in
• Compression Ratio	10.41:1	
• Firing Order	1-8-7-2-6-5-4-3	
• Active Fuel Management Cylinders	1-4-6-7	
• Spark Plug Gap	1.02 mm	0.04 in
Block		
• Camshaft Bearing Bore 1 and 5 Diameter	59.58-59.63 mm	2.345-2.347 in
• Camshaft Bearing Bore 2 and 4 Diameter	59.08-59.13 mm	2.325-2.327 in
• Camshaft Bearing Bore 3 Diameter	58.58-58.63 mm	2.306-2.308 in
• Crankshaft Main Bearing Bore Diameter	69.871-69.889 mm	2.75-2.751 in
• Crankshaft Main Bearing Bore Out-of-Round	0.006 mm	0.0002 in
• Cylinder Bore Diameter	103.241-103.259 mm	4.0065-4.0065 in
• Cylinder Head Deck Height - Measuring from the Centerline of Crankshaft to the Deck Face	234.57-234.82 mm	9.235-9.245 in
• Cylinder Head Deck Surface Flatness - Measured Within a 152.4 mm (6.0 in) Area	0.11 mm	0.004 in
• Cylinder Head Deck Surface Flatness - Measuring the Overall Length of the Block Deck	0.22 mm	0.008 in
• Valve Lifter Bore Diameter	21.417-21.443 mm	0.843-0.844 in
Camshaft		
• Camshaft End Play	0.025-0.305 mm	0.001-0.012 in
• Camshaft Journal Diameter	54.99-55.04 mm	2.164-2.166 in
	0.025 mm	0.001 in

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• Camshaft Journal Out-of-Round		
• Camshaft Lobe Lift - Exhaust - Non Active Fuel Management Cylinders	7.36 mm	0.290 in
• Camshaft Lobe Lift - Exhaust - Active Fuel Management Cylinders	7.49 mm	0.295 in
• Camshaft Lobe Lift - Intake - Non Active Fuel Management Cylinders	7.48 mm	0.294 in
• Camshaft Lobe Lift - Intake - Active Fuel Management Cylinders	7.61 mm	0.299 in
• Camshaft Runout - Measured at the Intermediate Journals	0.05 mm	0.002 in
Camshaft Position Actuator		
• Range of Authority	52 degrees	
• Park Position	7 degrees Advanced	
Connecting Rod		
• Connecting Rod Bearing Clearance - Production	0.023-0.065 mm	0.0009-0.0025 in
• Connecting Rod Bearing Clearance - Service	0.023-0.076 mm	0.0009-0.003 in
• Connecting Rod Bore Diameter - Bearing End	56.505-56.525 mm	2.224-2.225 in
• Connecting Rod Bore Out-of-Round - Bearing End - Production	0.004-0.008 mm	0.00015-0.0003 in
• Connecting Rod Bore Out-of-Round - Bearing End - Service	0.004-0.008 mm	0.00015-0.0003 in
• Connecting Rod Side Clearance	0.11-0.51 mm	0.00433-0.02 in
Crankshaft		
• Connecting Rod Journal Diameter - Production	53.318-53.338 mm	2.0991-2.0999 in
• Connecting Rod Journal Diameter - Service	53.308 mm	2.0987 in
• Connecting Rod Journal Out-of-Round - Production	0.005 mm	0.0002 in
• Connecting Rod Journal Out-of-Round - Service	0.01 mm	0.0004 in
• Connecting Rod Journal Taper - Maximum for 1/2 of Journal Length - Production	0.005 mm	0.0002 in
• Connecting Rod Journal Taper - Maximum for 1/2 of Journal Length - Service	0.02 mm	0.00078 in
• Crankshaft End Play	0.04-0.2 mm	0.0015-0.0078 in
• Crankshaft Main Bearing Clearance - Production	0.02-0.052 mm	0.0008-0.0021 in
• Crankshaft Main Bearing Clearance - Service	0.02-0.065 mm	0.0008-0.0025 in
• Crankshaft Main Journal Diameter - Production	64.992-65.008 mm	2.558-2.559 in

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• Crankshaft Main Journal Diameter - Service	64.992 mm	2.558 in
• Crankshaft Main Journal Out-of-Round - Production	0.003 mm	0.000118 in
• Crankshaft Main Journal Out-of-Round - Service	0.008 mm	0.0003 in
• Crankshaft Main Journal Taper - Production	0.01 mm	0.0004 in
• Crankshaft Main Journal Taper - Service	0.02 mm	0.00078 in
• Crankshaft Rear Flange Runout	0.05 mm	0.002 in
• Crankshaft Reluctor Ring Runout - Measured 1.0 mm (0.04 in) Below Tooth Diameter	0.7 mm	0.028 in
• Crankshaft Thrust Surface - Production	26.14-26.22 mm	1.029-1.0315 in
• Crankshaft Thrust Surface - Service	26.22 mm	1.0315 in
• Crankshaft Thrust Surface Runout	0.025 mm	0.001 in
Cylinder Head		
• Cylinder Head Height/Thickness - Measured from the Cylinder Head Deck to the Valve Rocker Arm Cover Seal Surface	120.2 mm	4.732 in
• Surface Flatness - Block Deck - Measured within a 152.4 mm (6.0 in) Area	0.08 mm	0.003 in
• Surface Flatness - Block Deck - Measuring the Overall Length of the Cylinder Head	0.1 mm	0.004 in
• Surface Flatness - Exhaust Manifold Deck	0.13 mm	0.005 in
• Surface Flatness - Intake Manifold Deck	0.08 mm	0.0031 in
• Valve Guide Installed Height - Measured from the Spring Seat Surface to the Top of the Guide	17.32 mm	0.682 in
Intake Manifold		
• Surface Flatness - Measured at Gasket Sealing Surfaces and Measured Within a 200 mm (7.87 in) Area that Includes 2 Runner Port Openings	0.3 mm	0.118 in
Lubrication System		
• Oil Capacity - with Filter	7.6 Liters	8.0 Quarts
• Oil Capacity - without Filter	7.1 Liters	7.5 Quarts
• Oil Pressure - Minimum - Hot	41 kPa at 1,000 engine RPM 124 kPa at 2,000 engine RPM 165 kPa at 4,000 engine RPM	6 psig at 1,000 engine RPM 18 psig at 2,000 engine RPM 24 psig at 4,000 engine RPM
• Active Fuel Management Relief Valve Oil Pressure - as Measured at Oil Pressure Sensor Location	379-517 kPa Maximum	55-75 psi Maximum

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Oil Pan		
• Front Cover Alignment - at Oil Pan Surface	0.0-0.5 mm	0.0-0.02 in
• Crankshaft Rear Oil Seal Housing Alignment - at Oil Pan Surface	0.0-0.5 mm	0.0-0.02 in
• Oil Pan Alignment - to Rear of Engine Block at Transmission Bell Housing Mounting Surface	0.0-0.1 mm	0.0-0.004 in
Piston Rings		
• Piston Ring End Gap - First Compression Ring - Measured in Cylinder Bore - Production	0.17-0.38 mm	0.0067-0.0150 in
• Piston Ring End Gap - First Compression Ring - Measured in Cylinder Bore - Service	0.17-0.44 mm	0.0067-0.0173 in
• Piston Ring End Gap - Second Compression Ring - Measured in Cylinder Bore - Production	0.32-0.63 mm	0.0126-0.0248 in
• Piston Ring End Gap - Second Compression Ring - Measured in Cylinder Bore - Service	0.32 mm-0.69 mm	0.0126 in-0.0272 in
• Piston Ring End Gap - Oil Control Ring - Measured in Cylinder Bore - Production	0.22 mm-0.79 mm	0.0086 in-0.031 in
• Piston Ring End Gap - Oil Control Ring - Measured in Cylinder Bore - Service	0.22 mm-0.85 mm	0.0086 in-0.0335 in
• Piston Ring to Groove Clearance - First Compression Ring - Production	0.030 mm-0.083 mm	0.0012 in-0.0033 in
• Piston Ring to Groove Clearance - First Compression Ring - Service	0.030 mm-0.083 mm	0.0012 in-0.0033 in
• Piston Ring to Groove Clearance - Second Compression Ring - Production	0.040 mm-0.083 mm	0.0016 in-0.0033 in
• Piston Ring to Groove Clearance - Second Compression Ring - Service	0.040 mm-0.083 mm	0.0016 in-0.0033 in
• Piston Ring to Groove Clearance - Oil Control Ring - Production	0.013 mm-0.201 mm	0.0005 in-0.0079 in
• Piston Ring to Groove Clearance - Oil Control Ring - Service	0.013 mm-0.201 mm	0.0005 in-0.0079 in
Pistons and Pins		
• Pin - Piston Pin Clearance to Piston Pin Bore - Production	0.002 mm-0.01 mm	0.0008 in-0.0004 in
• Pin - Piston Pin Clearance to Piston Pin Bore - Service	0.002 mm-0.015 mm	0.0008 in-0.0006 in
• Pin - Piston Pin Diameter	23.952 mm-23.955 mm	0.943 in-0.943 in
• Pin - Piston Pin Fit in Connecting Rod Bore -	0.007 mm-0.02 mm	0.00027 in-0.00078

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Production		in
• Pin - Piston Pin Fit in Connecting Rod Bore - Service	0.007 mm-0.022 mm	0.00027 in-0.00086 in
• Piston - Piston Diameter - Measured Over Skirt Coating	103.258 mm-103.289 mm	4.0653 in-4.0665 in
• Piston - Piston to Bore Clearance - Production	-0.048 mm to +0.001 mm	-0.0009 in to +0.000 in
• Piston - Piston to Bore Clearance - Service Limit with Skirt Coating Worn Off	0.055 mm	0.0022 in
Valve System		
• Valves - Valve Face Angle	45°	
• Valves - Valve Face Width	1.25 mm	0.05 in
• Valves - Valve Lash	Net Lash - No Adjustment	
• Valve Lift - Exhaust - Non Active Fuel Management	12.52 mm	0.493 in
• Valve Lift - Exhaust - Active Fuel Management	12.74 mm	0.501 in
• Valve Lift - Intake - Non Active Fuel Management	12.69 mm	0.499 in
• Valve Lift - Intake - Active Fuel Management	12.91 mm	0.508 in
• Valves - Valve Seat Angle	46 degrees	
• Valves - Valve Seat Runout	0.05 mm	0.002 in
• Valves - Valve Seat Width - Exhaust	1.78 mm	0.07 in
• Valves - Valve Seat Width - Intake	1.02 mm	0.04 in
• Valves - Valve Stem Diameter - Production	7.955-7.976 mm	0.313-0.314 in
• Valves - Valve Stem Diameter - Service	7.95 mm	0.313 in
• Valves - Valve Stem-to-Guide Clearance - Production - Exhaust	0.025-0.066 mm	0.001-0.0026 in
• Valves - Valve Stem-to-Guide Clearance - Service - Exhaust	0.093 mm	0.0037 in
• Valves - Valve Stem-to-Guide Clearance - Production - Intake	0.025-0.066 mm	0.001-0.0026 in
• Valves - Valve Stem-to-Guide Clearance - Service - Intake	0.093 mm	0.0037 in
• Rocker Arms - Valve Rocker Arm Ratio	1.70:1	
• Valve Springs - Valve Spring Free Length	52.9 mm	2.08 in
• Valve Springs - Valve Spring Installed Height	45.75 mm	1.8 in
• Valve Springs - Valve Spring Load - Closed	400 N at 45.75 mm	90 lb at 1.8 in
• Valve Springs - Valve Spring Load - Open	1175 N at 33.05 mm	264 lb at 1.30 in

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ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	
		United States	Canada
Coolant Temperature Sensor Threads	Sealant	12346004	10953480
Cylinder Head Core Hole Plugs	Threadlock	12345382	10953489
Cylinder Head Plug	Threadlock	12345382	10953489
Engine Block Coolant Drain Hole Plug Washer	Sealant	12346004	10953480
Engine Block Oil Gallery Plug - Front	Threadlock	12345382	10953489
Engine Block Oil Gallery Plug Washers	Sealant	12346004	10953480
Engine Oil	5W-30 Oil	12345610	729389
Engine Oil Pressure Sensor Threads	Sealant	12346004	10953480
Engine Oil Supplement	Fluorescent Dye	12345795	10953470
Exhaust Manifold Bolts	Threadlock	12345493	10953488
Flexplate/Flywheel Bolts	Threadlock	12345382	10953489
Fuel Injection Fuel Rail Bolts	Threadlock	12345382	10953489
Ignition Coil Bracket-to-Valve Cover Studs	Threadlock	12345382	10953489
Ignition Coil-to-Bracket Bolts	Threadlock	12345382	10953489
Intake Manifold Bolts	Threadlock	12345382	10953489
Oil Pan Surface at Front Cover and Rear Housing	Sealant	12378521	88901148
Thread Repair Component Cleaner	Cleaner	12346139	10953463
Thread Repair Component Cleaner	Cleaner	12377981	10953463
Thread Repair Cutting Oil	Lubricant	1052864	992881

THREAD REPAIR SPECIFICATIONS

Engine Block - Front/Rear Views

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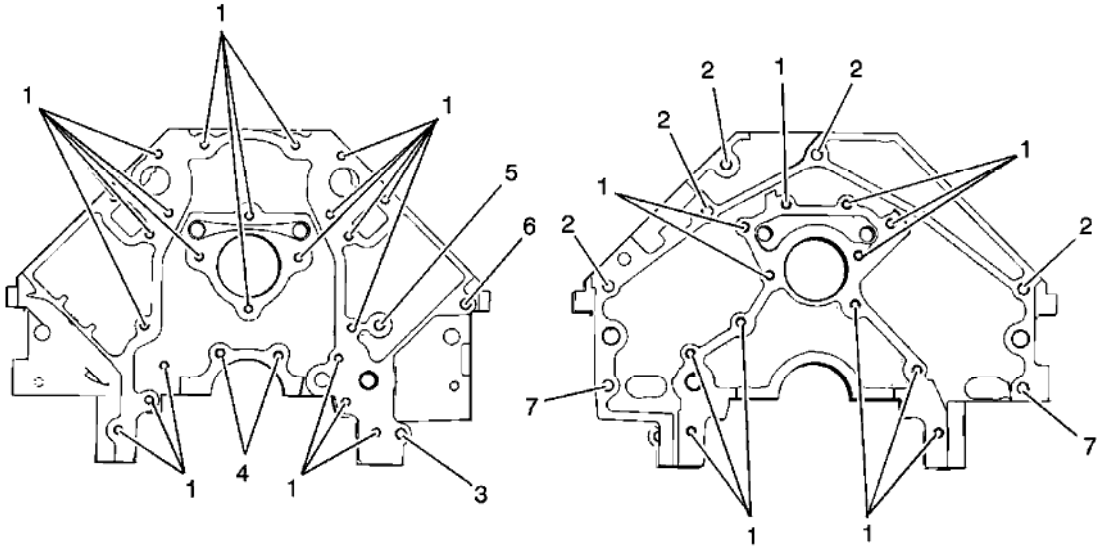


Fig. 1: Engine Block - Front/Rear Views
Courtesy of GENERAL MOTORS CORP.

Engine Block - Front/Rear Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	22.5	(0.885)	17.5	(0.688)
2	M10 x 1.5	211	212	N/A	213	214	215	27.5	(1.08)	22.0	(0.866)
3	M10 x 1.5	211	212	N/A	213	214	215	Through		Through	
4	M8 x 1.25	206	207	N/A	208	209	210	Through		Through	
5	M10 x 1.5	211	212	N/A	213	214	215	25.0	(0.984)	19.5	(0.767)
6	M10 x 1.5	211	212	N/A	213	214	215	32.5	(1.279)	25.0	(0.984)
7	M10 x 1.5	211	212	N/A	213	214	215	Through		Through	
Bolt hole 6 is drilled and tapped for aluminium block applications only.											

Engine Block - Left/Right Side Views

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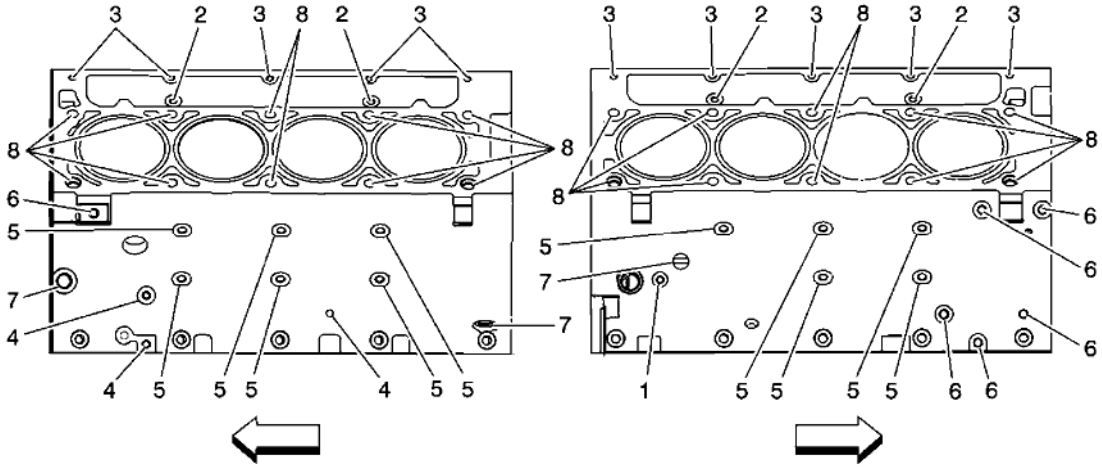


Fig. 2: Engine Block - Left/Right Side Views
Courtesy of GENERAL MOTORS CORP.

Engine Block - Left/Right Side Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	22.5	(0.885)	17.5	(0.688)
2	M8 x 1.25	206	207	N/A	208	209	210	28.5	(1.122)	23.0	(0.905)
3	M8 x 1.25	206	207	N/A	208	209	210	21.5	(0.846)	16.0	(0.629)
4	M10 x 1.25	211	212	N/A	213	214	215	29.0	(1.141)	23.0	(0.905)
5	M10 x 1.5	211	212	N/A	213	214	215	27.0	(1.062)	21.5	(0.846)
6	M16 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	
7	M11 x 2.0	105	N/A	N/A	106	107	108	69.0	(2.72)	60.0	(2.36)
8	M28 x 1.25	N/A	N/A	N/A	N/A	N/A	N/A	Through		Through	
Bolt hole 7 has a 30 mm (1.18 in) counterbore included in the 69.0 mm (2.72 in) drill depth. Use sleeve J 42385-315 with the drill and tap.											

Engine Block - Top/Bottom Views

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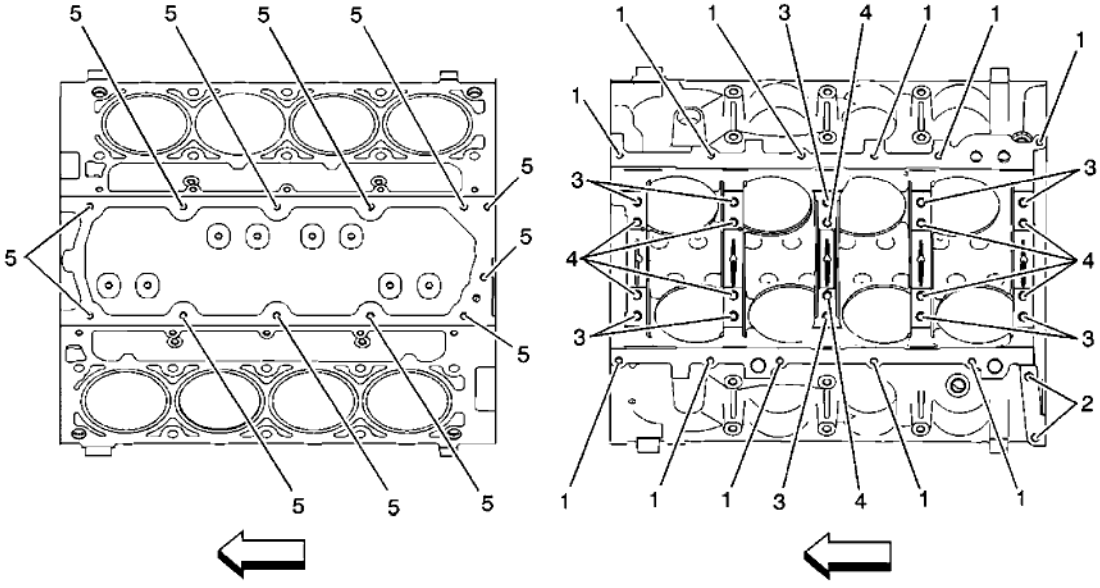


Fig. 3: Engine Block - Top/Bottom Views
Courtesy of GENERAL MOTORS CORP.

Engine Block - Top/Bottom Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	22.5	(0.885)	17.5	(0.688)
2	M10 x 1.5	211	212	N/A	213	214	215	42.5	(1.67)	37.0	(1.45)
3	M10 x 2.0	101	N/A	N/A	102	103	104	31.0	(1.22)	25.5	(1.0)
4	M10 x 2.0	101	N/A	N/A	102	103	104	53.5	(2.10)	44.0	(1.73)
5	M8 x 1.25	206	207	N/A	208	209	210	26.5	(1.043)	19.0	(0.748)

- Bolt hole 2 has an 11.5 mm (0.452 in) counterbore included in the 42.5 mm (1.67 in) drill depth. Use sleeve J 42385-311 with the drill and tap.
- Bolt hole 3 has a 1.5 mm (0.059 in) counterbore included in the 31.0 mm (1.22 in) drill depth. Use sleeve J 42385-316 with the drill and tap.
- Bolt hole 4 has a 20.5 mm (0.807 in) counterbore included in the 53.5 mm (2.10 in) drill depth.

Cylinder Head - Top/End Views

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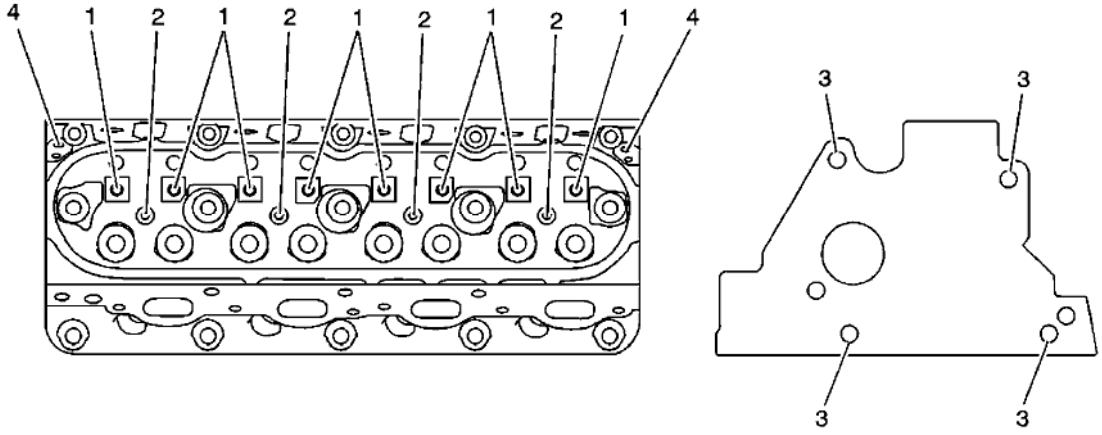


Fig. 4: Cylinder Head - Top/End Views
Courtesy of GENERAL MOTORS CORP.

Cylinder Head - Top/End Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	26.5	(1.04)	19.0	(0.784)
2	M6 x 1.0	201	202	N/A	203	204	205	20.05	(0.789)	16.05	(0.632)
3	M10 x 1.5	211	212	N/A	213	214	215	28.0	(1.10)	20.0	(0.787)
4	M6 x 1.0	201	202	N/A	203	204	205	22.5	(0.885)	15.0	(0.688)

Cylinder Head - Intake/Exhaust Side Views

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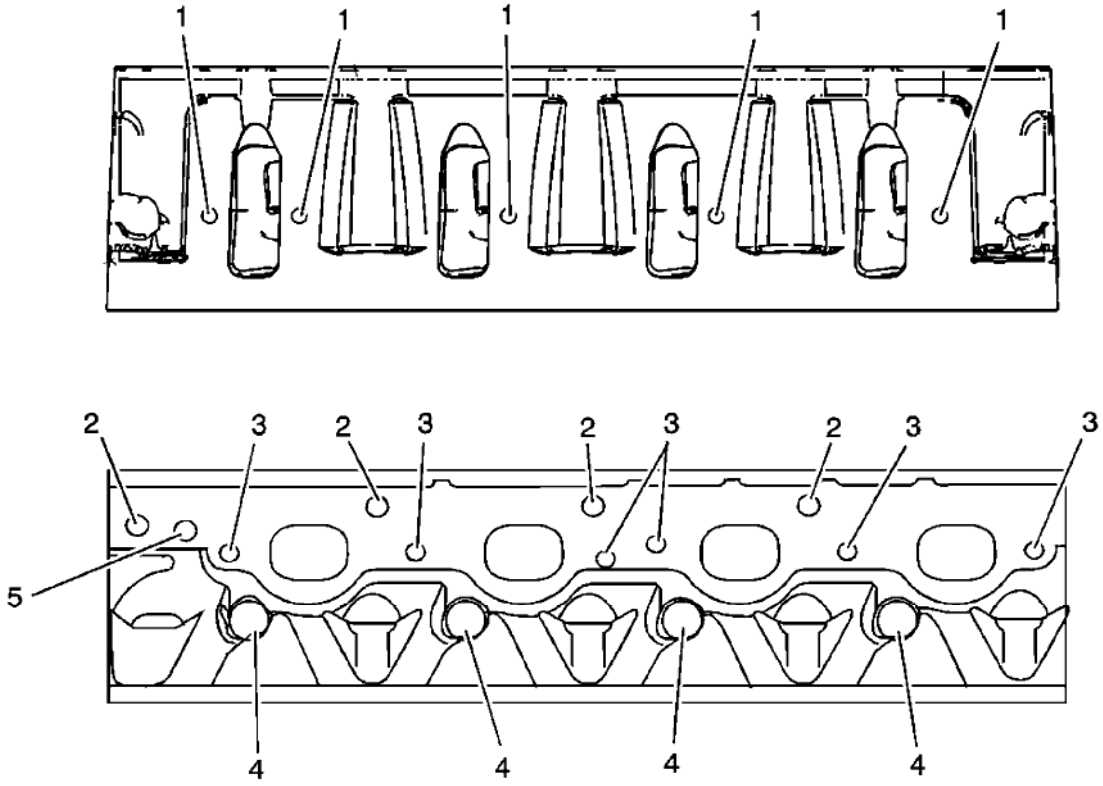


Fig. 5: Cylinder Head - Intake/Exhaust Side Views
Courtesy of GENERAL MOTORS CORP.

Cylinder Head - Intake/Exhaust Side Views

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	Through		Through	
2	M10 x 1.5	211	212	N/A	213	214	215	28.0	(1.10)	20.0	(0.787)
3	M8 x 1.25	206	207	N/A	208	209	210	21.0	(0.826)	16.0	(0.629)
4	M14 x 1.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	
5	M12 x 1.5	N/A	N/A	N/A	N/A	N/A	N/A	N/A		N/A	

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2010 ENGINE

Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Camaro

DIAGNOSTIC INFORMATION AND PROCEDURES

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 (LLT)** , **Drive Belt System Description** and **Lubrication 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**

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- **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 Consumption Diagnosis**
- **Oil Pressure Diagnosis and Testing**
- **Oil Leak Diagnosis**

BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

Cause	Correction
Abnormalities, severe cracking, bumps, or missing areas, in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations and lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to **Drive Belt Replacement** .
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, repair or replace as required.
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required. Refer to **Engine Flywheel Replacement (Manual)** or **Crankshaft Balancer Replacement** .
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, intake manifold and plenum duct, plenum duct and water crossover, water crossover and throttle body and/or pressure relief valve and intake manifold.	Replace the intake manifold, plenum duct, gaskets, cylinder heads, throttle body and/or pressure relief valve as required.
Improperly installed or damaged MAP sensor and/or seal The sealing grommet of the MAP sensor should not	Repair or replace the MAP sensor as required.

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be torn or damaged.	
Improperly installed or damaged EVAP purge solenoid and/or O-ring seal	Repair or replace the EVAP purge solenoid as required.
Worn or loose followers, valve rocker arms The follower, valve rocker arm, roller bearing should be intact and in the proper position	Replace the followers, valve rocker arms, as required.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chain or chains	Replace the timing chain or chains and sprockets as required.
Worn camshaft lobes	Replace the camshaft or camshafts and SHLAs, 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 **Oil Pressure Diagnosis and Testing**. • 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. Refer to **Diagnostic Starting Point - Vehicle** . Coolant consumption may or may not cause the engine to overheat.	• Inspect for spark plugs saturated by coolant. Refer to **Spark Plug Inspection** for the 3.6L engine. • 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. Refer to **Spark Plug Inspection** for the 3.6L engine. • Inspect the cylinders for a loss of compression. Refer to **Engine Compression Test**. • 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 SEVERE reluctor ring damage may exhibit periodic loss of crankshaft position, stop delivering a signal, and then re-sync the crankshaft position. • Systems with SLIGHT reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a P0300	Replace the crankshaft as required.

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DTC may be set.	

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

Cause	Correction
Abnormalities, severe cracking, bumps or missing areas, in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to **Drive Belt Replacement** .
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 engine flywheel and/or crankshaft balancer as required. Refer to **Engine Flywheel Replacement (Manual)** or **Crankshaft Balancer Replacement** .
Worn or broken piston rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. Refer to **Spark Plug Inspection** . • Inspect the cylinders for a loss of compression. Refer to **Engine Compression Test**. • Perform cylinder leak down and compression testing to determine the cause. • Repair or replace as required.
Worn crankshaft thrust bearings Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit fore and aft movement of the crankshaft and create a DTC without an actual misfire condition.	Replace the crankshaft and bearings as required.

BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

Cause	Correction
Worn or loose followers, valve rocker arms The follower, valve rocker arm, roller bearing should be intact and in the proper position.	Replace the followers, valve rocker arms, as required.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chain or chains	Replace the timing chain or chains and sprockets as required.

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Worn camshaft lobes	Replace the camshaft or camshafts and SHLAs (valve lifters).
Sticking SHLAs (lifters)	Replace the SHLAs as required.

BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

Cause	Correction
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. Refer to **Diagnostic Starting Point - Vehicle** . Coolant consumption may or may not cause the engine to overheat.	• Inspect for spark plugs saturated by coolant. Refer to **Spark Plug Inspection** for the 3.6L engine. • Perform a cylinder leak down test. • Inspect the cylinder heads and engine block for damage to the coolant passages and/or a faulty head gasket. • Repair or replace as required.

BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION

Cause	Correction
Worn valves, valve guides and/or valve stem oil seals	1. Inspect the spark plugs for oil deposits. Refer to **Spark Plug Inspection** . 2. Repair or replace as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	1. Inspect the spark plugs for oil deposits. Refer to **Spark Plug Inspection** . 2. Inspect the cylinders for a loss of compression. Refer to **Engine Compression Test**. 3. Perform cylinder leak down and compression testing to determine the cause. 4. Repair or replace as required.

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

Cause	Correction
Incorrect oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	Drain the engine oil and replace with the correct viscosity oil.
High stationary hydraulic lash adjuster (SHLA), valve lifter, leak down rate	Replace the SHLAs, valve lifters, as required.
Worn crankshaft thrust bearing	• Inspect the thrust bearing and crankshaft. • Repair or replace as required.
Damaged or faulty oil filter by-pass valve	

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	• Inspect the oil filter by-pass valve for proper operation. • Repair or replace as required.

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Low oil pressure	1. Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. 2. Repair or replace as required.
Loose and/or worn follower, valve rocker arm	1. Inspect the follower, valve rocker arm. 2. Repair or replace as required.
Improper lubrication to the followers, valve rocker arms	Inspect the following components, and repair or replace as required: • The follower, valve rocker arm • The SHLA, valve lifter • The oil filter bypass valve • The oil pump and pump screen • The cylinder head oil galleries • The engine block oil galleries
Broken valve spring	Replace the valve spring.
Worn or dirty stationary hydraulic lash adjusters (SHLAs), valve lifters	Replace the SHLAs, valve lifters.
Stretched or broken timing chain or chains and/or damaged sprocket teeth	Replace the timing chain or chains and sprockets.
Worn timing chain tensioner or tensioners	Replace the timing chain tensioner or tensioners as required.
Worn timing chain shoe or shoes	Replace the timing chain shoe or shoes as required.
Worn timing chain guide or guides	Replace the timing chain guide or guides as required.
Worn engine camshaft lobes	1. Inspect the engine camshaft lobes. 2. Replace the camshaft or camshafts and SHLAs, 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	Inspect the following components, and repair as required:

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cause the valve to stay open	• 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 **Oil Pressure Diagnosis and Testing**. 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 controls system. Refer **Symptoms - Engine Controls** .
Loose torque converter bolts	1. Inspect the torque converter bolts and engine flywheel. 2. Repair or replace as required.
Loose or damaged engine flywheel	Repair or replace the engine 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.
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

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	• 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 NOISE UNDER LOAD

Cause	Correction
Low oil pressure	1. Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. 2. Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the ignition controls. Refer to **Symptoms - Engine Controls** .
Loose torque converter bolts	1. Inspect the torque converter bolts and engine flywheel. 2. Repair as required.
Cracked engine flywheel	1. Inspect the engine flywheel and bolts. 2. Repair as required.
Excessive connecting rod bearing clearance	Inspect the following components, and repair as required: • The connecting rod bearings • The connecting rods • The crankshaft
Excessive crankshaft bearing clearance	Inspect the following components, and repair as required: • The crankshaft bearings • The crankshaft journals • The cylinder block crankshaft bearing bore

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Cause	Correction

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Seized accessory drive system component	1. Remove the accessory drive belt or belts. 2. Rotate the crankshaft by hand at the crankshaft balancer or the engine flywheel location. 3. Repair or replace as required.
Hydraulically locked cylinder • Coolant/antifreeze in cylinder • Oil in cylinder • Fuel in cylinder	1. Remove the spark plugs and check for fluid. 2. Inspect for broken head gasket or gaskets. 3. Inspect for cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector. 5. Repair or replace as required.
Seized automatic transmission torque converter	1. Remove the torque converter bolts. 2. Rotate the crankshaft by hand at the crankshaft balancer or the engine flywheel location. 3. Repair or replace as required.
Material in cylinder • Broken valve • Piston material • Foreign material	1. Inspect the cylinder for damaged components and/or foreign materials. 2. Repair or replace as required.
Seized crankshaft or connecting rod bearings	1. Inspect the crankshaft and the connecting rod bearings. 2. Repair as required.
Bent or broken connecting rod	1. Inspect the connecting rods. 2. Repair as required.
Broken crankshaft	1. Inspect the crankshaft. 2. Repair as required.
Seized or broken camshaft	1. Inspect the camshaft or camshafts. 2. Inspect the cylinder head camshaft journals for damage. 3. Repair as required.
Seized or broken balance shaft	1. Inspect the balance shaft. 2. Inspect the block for damaged balance shaft bearings. 3. Repair as required.
Seized or broken camshaft timing components	1. Inspect the following sprockets: • The crankshaft sprocket

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	• The exhaust sprockets • The intake sprockets 2. Inspect the following chains: • The primary camshaft drive chain • The secondary camshaft drive chains 3. Inspect the following guides: • The lower primary camshaft drive chain guide • The upper primary camshaft drive chain guides 4. Inspect the secondary camshaft drive chain shoe. 5. Inspect the following tensioners: • The primary camshaft drive chain tensioner • The secondary camshaft drive chain tensioners 6. Repair as required.
Seized or broken valve train components	1. Inspect the followers, rocker arms. 2. Inspect the lifters. 3. Inspect the valves. 4. Inspect the valve springs. 5. Repair as required.

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 **Engine Will Not Crank - Crankshaft Will Not Rotate**. 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 Leakage Test**. During this test, excessive air bubbles within the coolant may indicate a faulty gasket or damaged component. 4. 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 **Engine Compression Test**.	
Cracked intake manifold or failed gasket	Replace the components as required.

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Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to **Cylinder Head Cleaning and Inspection** and **Cylinder Head Replacement - Left Side** or **Cylinder Head Replacement - Right Side** .
Warped cylinder head	Machine the cylinder head to the proper flatness, if applicable and replace the cylinder head gasket. Refer to **Cylinder Head Cleaning and Inspection** .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components as required.
Cylinder head or engine 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 **Lower Engine Noise, Regardless of Engine Speed**. 2. Inspect by performing a **Cylinder Leakage 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 **Engine Compression Test**.	
Faulty external engine oil cooler	Replace the components as required.
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to **Cylinder Head Cleaning and Inspection** and **Cylinder Head Replacement - Left Side** or **Cylinder Head Replacement - Right Side** .
Warped cylinder head	Machine the cylinder head to proper flatness, if applicable, and replace the cylinder head gasket. Refer to **Cylinder Head Cleaning and Inspection** .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components as required.
Cylinder head, block, or manifold porosity	Replace the components as required.

ENGINE COMPRESSION TEST

Tools Required

J 39313 Spark Plug Port Adapter. See **Special Tools** .

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

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

IMPORTANT: Remove the powertrain control module (PCM) and the ignition fuse from the instrument panel (I/P) fuse block.

3. Disable the ignition.
4. Disable the fuel systems.
5. Remove the spark plugs from all cylinders.
6. Remove the air duct from the throttle body.
7. Block the throttle plate in open position.
8. Measure the engine compression, using the following procedure:
    1. Thread the **J 39313** into the spark plug hole. See **Special Tools** .
    2. Thread the compression gauge into the **J 39313** . See **Special Tools** .
    3. Have an assistant crank the engine through, at least 4 compression strokes, in the testing cylinder.
    4. Check and record the readings on the gauge at each stroke.
    5. Remove the compression gauge from the **J 39313** . See **Special Tools** .
    6. Remove the **J 39313** from the spark plug hole. See **Special Tools** .
    7. Repeat the compression test for each cylinder.
9. Record the compression readings from all of the cylinders.
    - The lowest reading should not be less than 70 percent of the highest reading.
    - No cylinder reading should be less than 965 kPa (140 psi).
10. The following are examples of measurement problems:
    - When the compression measurement is normal, the compression builds up quickly and evenly to specified compression on each cylinder.
    - When low compression is caused by the piston rings, compression is low on the first stroke and tends to build up on the following strokes, but does not reach normal. Compression improves considerably with the addition of oil. Use approximately 3 squirts of oil from a plunger-type oiler.
    - When low compression is caused by the valves, the measurement is low on the first stroke and does not build up even with the addition of oil.
    - Leaking head gaskets will provide the same results as worn valves but engine coolant may be identified in the crankcase. In addition, a leaking head gasket will give low readings on paired cylinders.
11. Remove the block from the throttle plate.
12. Install the air duct to the throttle body.
13. Install the spark plugs.
14. Install the powertrain control module (PCM).

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15. Install the ignition fuses to the I/P fuse block.

CYLINDER LEAKAGE TEST

Special Tools

- **J-35667-A:** Cylinder Head Leakdown Tester
- **J-39313:** Spark Plug Port Adapter

For equivalent regional tools, refer to **Special Tools** .

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

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

WARNING: Refer to Battery Disconnect Warning .

1. Disconnect the battery ground negative cable.
2. Remove the spark plugs. Refer to **Spark Plug Replacement** .

CAUTION: Only turn the engine in a CLOCKWISE direction as viewed from the crankshaft balancer. Counterclockwise rotation may result in the timing chain jumping a tooth, causing poor running, DTCs, or severe engine damage.

3. Rotate the crankshaft to place the piston in the cylinder being tested at top dead center (TDC) of the compression stroke.
4. Thread the **J-39313:** adapter into the spark plug hole.
5. Install the **J-35667-A:** tester or equivalent.

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

6. Apply shop air pressure to the **J-35667-A:** tester and adjust according to the manufacturers instructions.
7. Record the cylinder leakage value. Cylinder leakage that exceeds 25 percent is considered excessive and may require component service. In excessive leakage situations, inspect for the following conditions:
   - Air leakage sounds at the throttle body or air inlet hose that may indicate a worn or burnt intake valve or a broken valve spring
   - Air leakage sounds at the exhaust system tailpipe that may indicate a worn or burnt exhaust valve or a broken valve spring
   - Air leakage sounds from the crankcase, oil level indicator tube, or oil fill tube that may indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged engine block or a damaged cylinder head
   - Air bubbles in the cooling system may indicate a damaged cylinder head or a damaged cylinder head gasket.
8. Perform the leakage test on the remaining cylinders and record the values.

OIL CONSUMPTION DIAGNOSIS

Checks	Causes
DEFINITION: Excessive oil consumption (not due to leaks) is the use of 0.946 L (1 qt) or more of engine oil within 3 200 km (2,000 mi). The causes of excessive oil consumption may include the following conditions:	
Preliminary	• External oil leaks - Refer to **Oil Leak Diagnosis**. • Incorrect oil level or improper reading of the oil level indicator With the vehicle on a level surface, run the engine for a few minutes, allow adequate drain down time (2-3 minutes) and check for the correct engine oil level. • Improper oil viscosity Refer to the vehicle owners manual and use the recommended SAE grade and viscosity for the prevailing temperatures. • Continuous high speed driving and/or severe usage • Crankcase ventilation system restrictions or malfunctioning components • Worn valve guides and/or valve stems • Worn, missing or improperly installed valve stem oil seals • Piston rings broken, worn, not seated properly Allow adequate time for the rings to seat.

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	Replace worn piston rings as necessary. • Piston and rings improperly installed or miss-fitted to the cylinder bore

OIL PRESSURE DIAGNOSIS AND TESTING

Tools Required

- **J 21867** Pressure Gauge. See **Special Tools** .
- **J-21867-6** Oil Pressure Adapter Fitting. See **Special Tools** .

1. With the vehicle on a level surface, run the vehicle for a few minutes, allow adequate drain down time, 2-3 minutes, and measure for a low oil level.
2. If required, add the recommended grade engine oil and fill the crankcase until the oil level measures full on the oil level indicator.
3. Run the engine briefly, 10-15 seconds, and verify low or no oil pressure on the vehicle gauge or light.
4. Listen for a noisy valve train or a knocking noise.
5. Inspect for the following:
    - Foamy oil
    - Slow idle speed
    - Plugged oil filter
    - Oil diluted by the following:
        - Water
        - Engine coolant
        - Unburned fuel mixtures
    - Malfunctioning oil filter bypass valve
    - Incorrect or faulty oil pressure gauge
    - Incorrect or faulty oil pressure gauge sensor
    - Improper engine oil viscosity for the expected temperature

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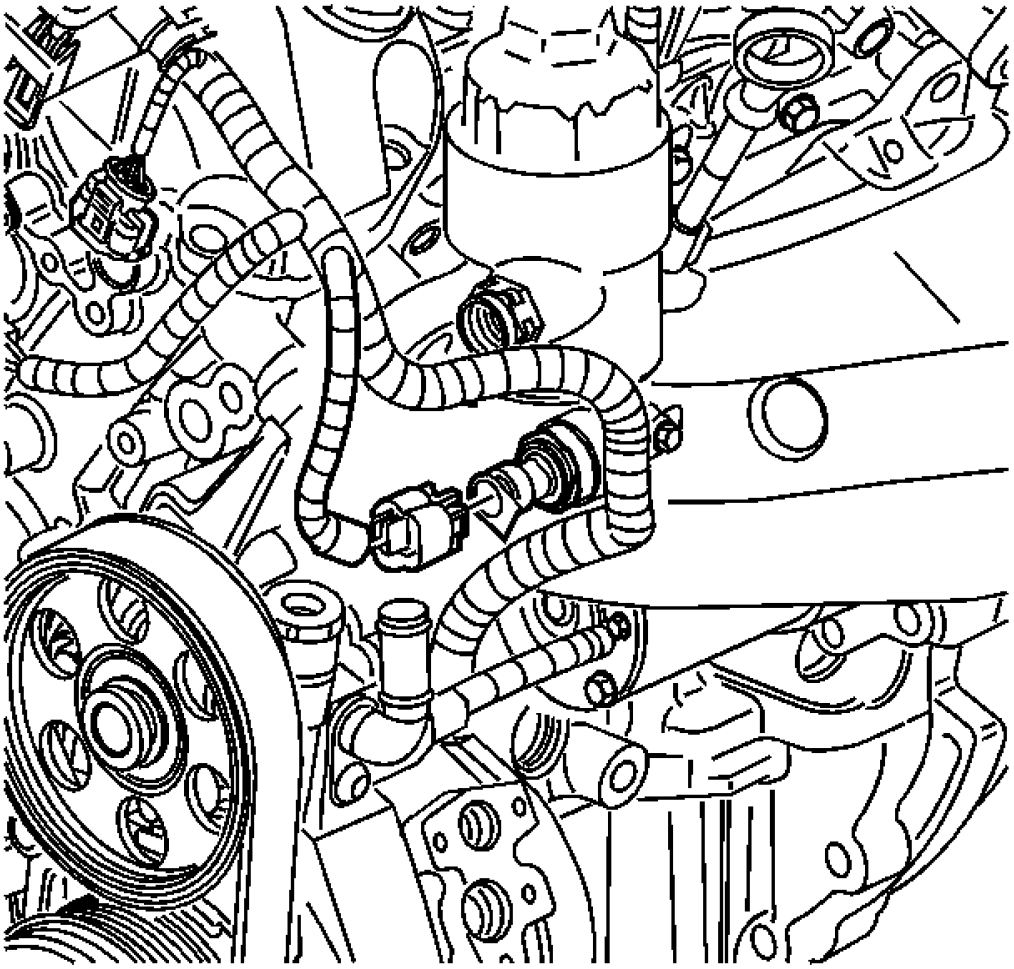


Fig. 1: View Of Oil Pressure Sensor Wiring Harness
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the oil pressure sensor wiring harness.

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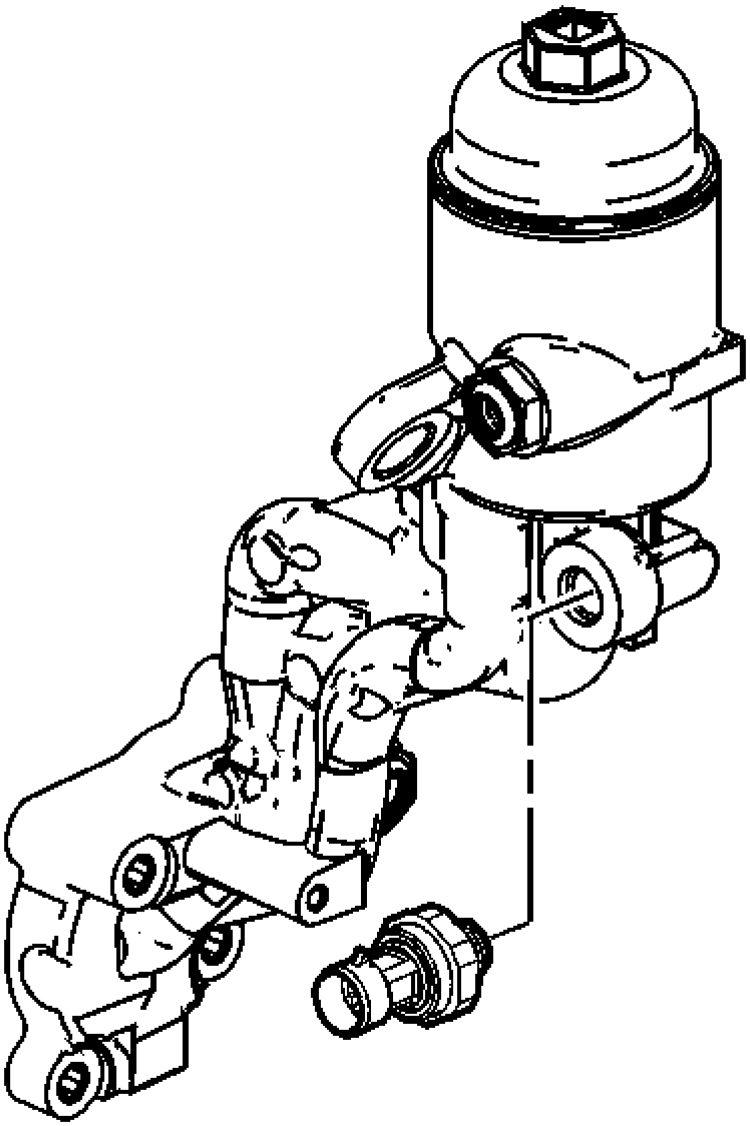


Fig. 2: View Of Oil Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

7. Remove the oil pressure sensor.
8. Install the **J 21867** with the **J-21867-6** . See **Special Tools** .
9. Measure the engine oil pressure.
10. Compare the readings to the **Engine Mechanical Specifications (LLT)** .

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11. If the engine oil pressure is below specifications, inspect the engine for one or more of the following:
    - Loose oil filter adapter bolts
    - Missing or damaged oil filter adapter O-ring seal or seals
    - Worn or dirty oil pump
    - Loose oil pump-to-engine block bolts
    - Loose, plugged or damaged oil pump screen
    - Missing or damaged oil pump screen O-ring seal
    - Damage or leak in the oil pump screen suction tube
    - Malfunctioning oil pump pressure regulator valve
    - Missing or incorrectly installed oil gallery plugs
    - Loose camshaft intermediate drive shaft bolts
    - Excessive bearing clearance for the following:
        - Connecting rod or rods
        - Crankshaft
        - Camshaft or camshafts
        - Camshaft intermediate drive shaft sprocket
    - Cracked, porous or restricted oil galleries
    - Broken valve lifters
12. Repair or replace components as necessary.

OIL LEAK DIAGNOSIS

Checks	Action
CAUTION: **It is important to correctly identify the source of an oil leak. A power steering fluid leak or spillage can travel across the valley area of the engine and run out the weep hole, which is located at the back of the block. Failure to correctly identify the source of an oil leak can lead to the incorrect or unnecessary replacement of components.** You can repair most fluid leaks by first visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the cause of the leak as well as the leak itself.	
Locating and identifying the leak	To determine if the leaking fluid is engine oil, transmission fluid, power steering fluid, brake fluid, or some other fluid, use the visual inspection method.
Visual Inspection Method	1. Bring the vehicle to normal operating temperature. 2. Park the vehicle over a large sheet of paper, or other clean surface. 3. Wait several minutes, then check for drippings. 4. Identify the type of fluid, and the approximate location of the leak.

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	5. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 6. Check for leaks at sealing surfaces, fittings, or from cracked or damaged components. 7. If you cannot locate the leak, do the following: 1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several miles at normal operation temperature and at varying speeds. 3. Park the vehicle over a large sheet of paper, or other clean surface. 4. Wait several minutes, then check for drippings. 5. Identify the type of fluid, and the approximate location of the leak. 6. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 7. See possible causes for leaks. 8. If you still cannot locate the leak, use the powder method or the black light and dye method.
Powder Method	1. Completely clean the entire engine and surrounding components. 2. Apply an aerosol-type powder (baby powder, foot powder, etc.) to the suspected area. 3. Operate the vehicle for several miles at normal operation temperature and at varying speeds. 4. Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface. 5. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 6. See possible causes for leaks.
Black Light and Dye Method	1. A dye and light kit is available for finding leaks. Use the **J-28428-E:** High-Intensity Black Light Kit or equivalent. Refer to the manufacturer's instructions when using the tool. 2. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 3. See possible causes for leaks.
Possible Causes for Leaks	Check for the following conditions: • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves • Plugged or malfunctioning engine ventilation system

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	• Improperly tightened or damaged fasteners • Cracked or porous components • Improper sealants or gaskets where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals • Damaged or worn sealing surfaces

CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS

Crankcase Ventilation (CV) System Inspection

- Test for vacuum at the vacuum hose where it connects to the crankcase ventilation housing. There should be manifold vacuum present at the hose. If there is no vacuum, inspect for a plugged hose, leaking hose or a plugged vent adapter.
- Plug the end of the vacuum hose while the engine is running. Inspect the hose for any areas that collapse when the end of the hose is blocked. Replace the hose if it collapses when blocked.
- If oil has accumulated in the intake air duct, inspect for the following conditions:
  - Plugged vacuum orifice in the crankcase ventilation housing
  - Plugged or restricted crankcase ventilation housing
  - Excessive crankcase pressure or blow-by, refer to **Oil Consumption Diagnosis**.
- Additional items to inspect:
  - Plugged or leaking fresh air vent hose assembly or vent adapter
  - Plugged or restricted passages in the throttle body
  - Missing or damaged O-ring seals on the vent adapter
  - Inspect the cam covers, the oil pan gasket, and other sealing areas for leaks

Results of Incorrect Operation

A plugged crankcase ventilation housing or hose may contribute to the following conditions:

- A rough idle
- Stalling or a slow idle speed
- Oil leaks
- Oil accumulation in the intake air duct
- Sludge in the engine

A leaking housing or hose may contribute to the following conditions:

- A rough idle
- Stalling
- Unstable idle speed

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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

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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 Belt Dressing Caution .** 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 **Symptoms - Engine Mechanical**
2	Verify that there is a chirping, squeal or whine noise. Does the engine make the chirping squeal or whine noise?	Go to **Step 3**	Go to Diagnostic Aids
3	1. Remove the drive belt. 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		

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	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 Fastener Caution .** 1. Tighten any loose fasteners. Refer to **Fastener Tightening Specifications** . 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?	Go to **Step 20**	Go to **Step 14**
14	If diagnosing a whine noise and the condition still exist, proceed to Diagnostic Aids. Test the drive belt tensioner for proper operation. Refer to **Drive Belt Tensioner Diagnosis**. Did you find and correct the condition?	Go to **Step 20**	Go to **Step 15**
15	Inspect for the correct drive belt length. Did you find and correct the condition?	Go to **Step 20**	Go to **Step 16**
16	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to **Step 20**	Go to **Step 17**
17	Inspect for the correct pulley size. Did you find and correct the condition?	Go to **Step 20**	Go to Diagnostic Aids
	Replace the bent pulley.		

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18	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 our felt as a lump in the belt.

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

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

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accessory component causing it to vibrate.

Step	Action	Yes	No
CAUTION: **Refer to Belt Dressing Caution .** DEFINITION: The following items are indications of drive belt rumbling: • A low pitch tapping, knocking, or thumping noise heard at or just above idle. • Heard once per revolution of the drive belt or a pulley. • Rumbling may be caused from: ○ Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove ○ The separation of the drive belt ○ A damaged drive belt DEFINITION: The following items are indications of drive belt vibration: • The vibration is engine-speed related. • The vibration may be sensitive to accessory load.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Engine Mechanical**
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 **Symptoms - Engine Mechanical** or Go to **Vibration Analysis - Engine**	Go to **Step 4**
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**

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6	1. Clean the drive belt pulleys using a suitable wire brush. 2. Reinstall the drive belts. Refer to **Drive Belt Replacement** . Did you correct the condition?	Go to **Step 8**	Go to **Step 7**
7	Install a new drive belt. Refer to **Drive Belt Replacement** . 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	1. Tighten any loose fasteners. Refer to **Fastener Tightening Specifications** . 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 **Water Pump Replacement (LLT)** or **Water Pump Replacement (LS3/L99)** . 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

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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 two wide or two narrow will cause wear on the drive belt. The drive belt ribs should match all of the grooves on all of the pulleys.

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 Belt Dressing Caution .** 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 **Symptoms - Engine Mechanical**
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 **Drive Belt Replacement** . Does the drive belt continue to fall off?	Go to **Step 4**	System OK

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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 Fastener Caution .** 1. Tighten any loose fasteners. Refer to **Fastener Tightening Specifications** . 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. Refer to **Drive Belt Tensioner Diagnosis**. Does the drive belt tensioner operate correctly?	Go to **Step 11**	Go to **Step 10**
10	Replace the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement** . 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 **Drive Belt Replacement** . 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 **Drive Belt Replacement** . Did you complete the replacement?	Go to **Step 17**	-
17	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

DRIVE BELT TENSIONER DIAGNOSIS

Step	Action	Yes	No

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1	Remove the drive belt and inspect the drive belt tensioner pulley. Is the drive belt tensioner pulley loose or misaligned?	Go to **Step 4**	Go to **Step 2**
2	Rotate the drive belt tensioner. Does the tensioner rotate without any unusual resistance or binding?	Go to **Step 3**	Go to **Step 4**
3	1. Use a torque wrench in order to measure the torque required to move the tensioner off of the stop. 2. Use a torque wrench on a known good tensioner in order to measure the torque required to move the tensioner off of the stop. Is the first torque reading within 10 percent of the second torque reading?	System OK	Go to **Step 4**
4	Replace the drive belt tensioner. Is the repair complete?	System OK	-

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2010 ENGINE

Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Repair Instructions - Off Vehicle - Camaro

DRIVE BELT TENSIONER REMOVAL

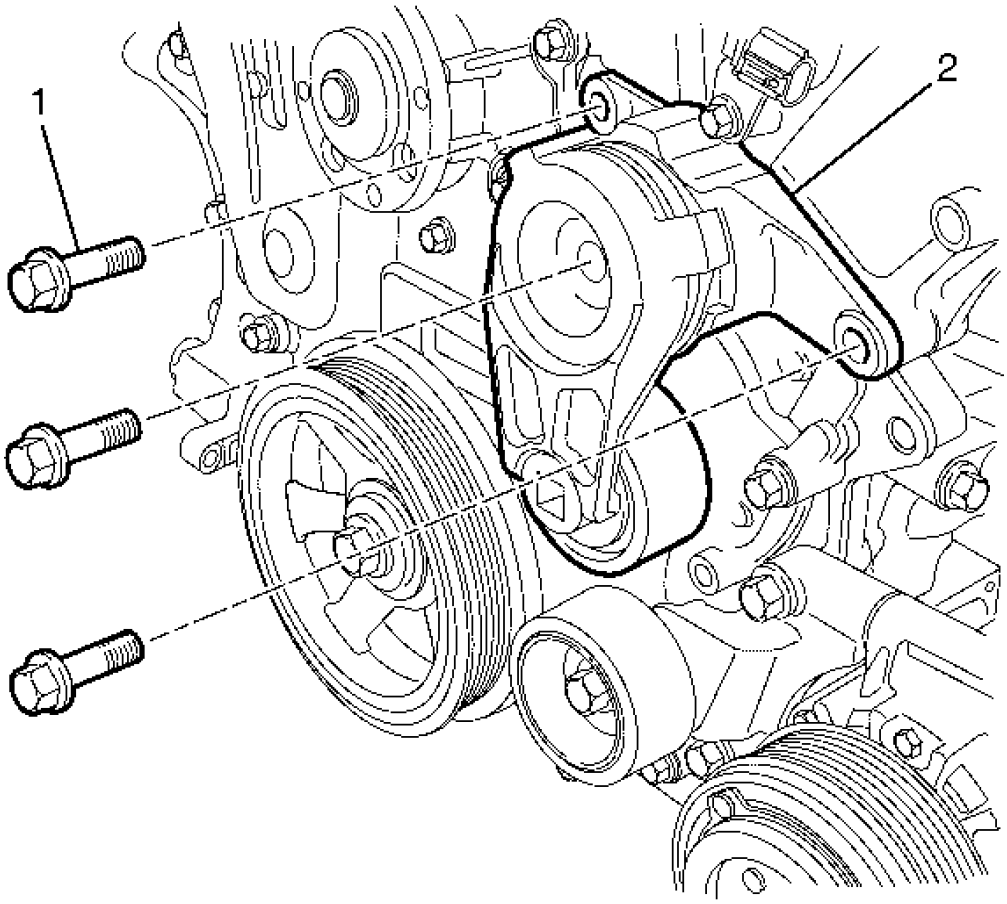


Fig. 1: Identifying Drive Belt Tensioner To Engine Front Cover Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the drive belt tensioner to engine front cover retaining bolts (1).
2. Remove the drive belt tensioner (2).

OIL LEVEL INDICATOR AND TUBE REMOVAL

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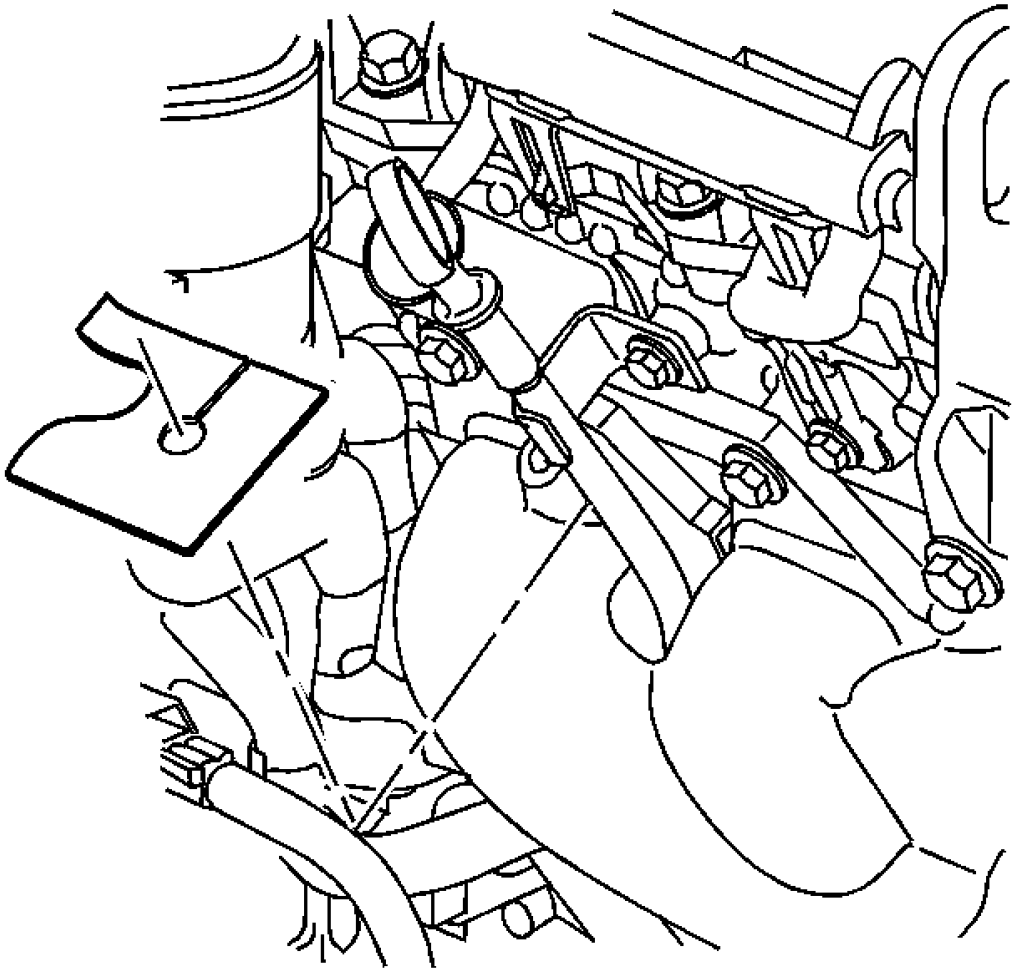


Fig. 2: View Of Left Exhaust Manifold Upper Insulator
Courtesy of GENERAL MOTORS CORP.

1. Remove the left exhaust manifold upper insulator from the oil level indicator tube.

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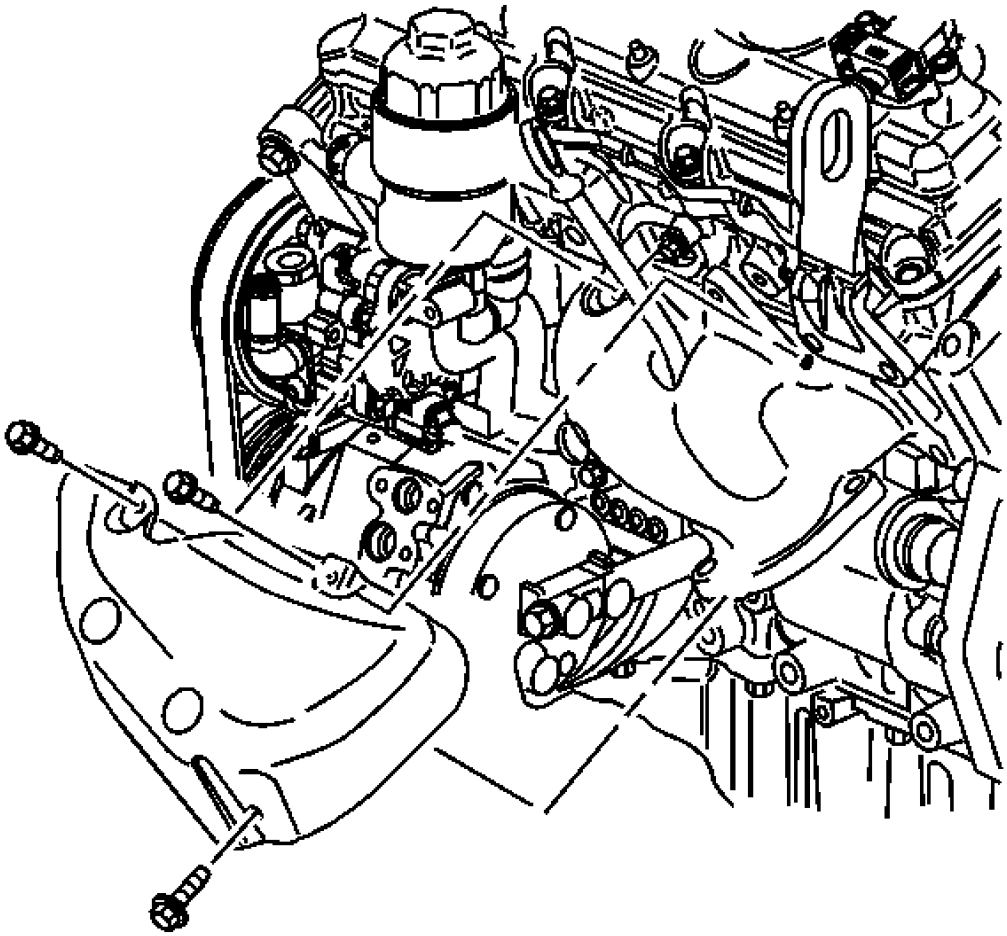


Fig. 3: View Of Left Exhaust Manifold Heat Shield
Courtesy of GENERAL MOTORS CORP.

2. Remove the left exhaust manifold heat shield bolts.
3. Remove the left exhaust manifold heat shield.

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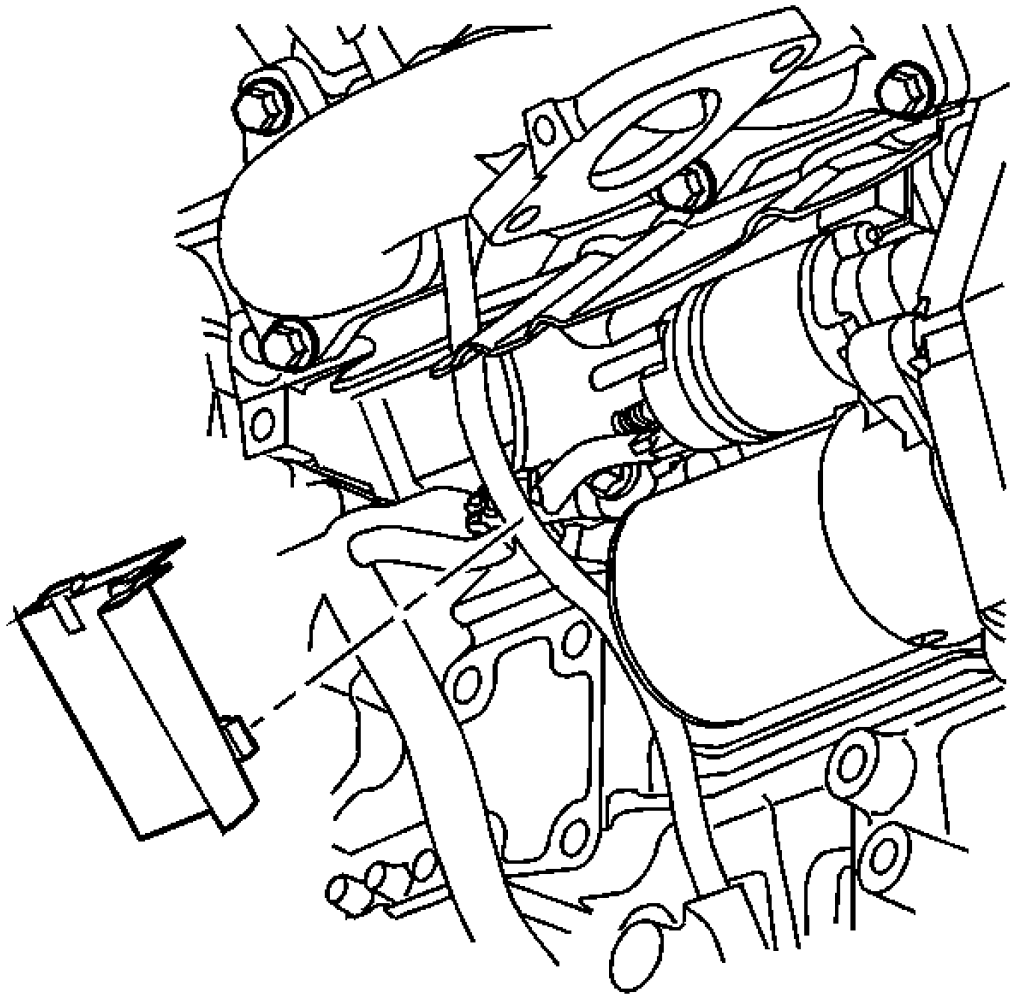


Fig. 4: View Of Left Exhaust Manifold Lower Insulator
Courtesy of GENERAL MOTORS CORP.

4. Remove the left exhaust manifold lower insulator from the oil level indicator tube.

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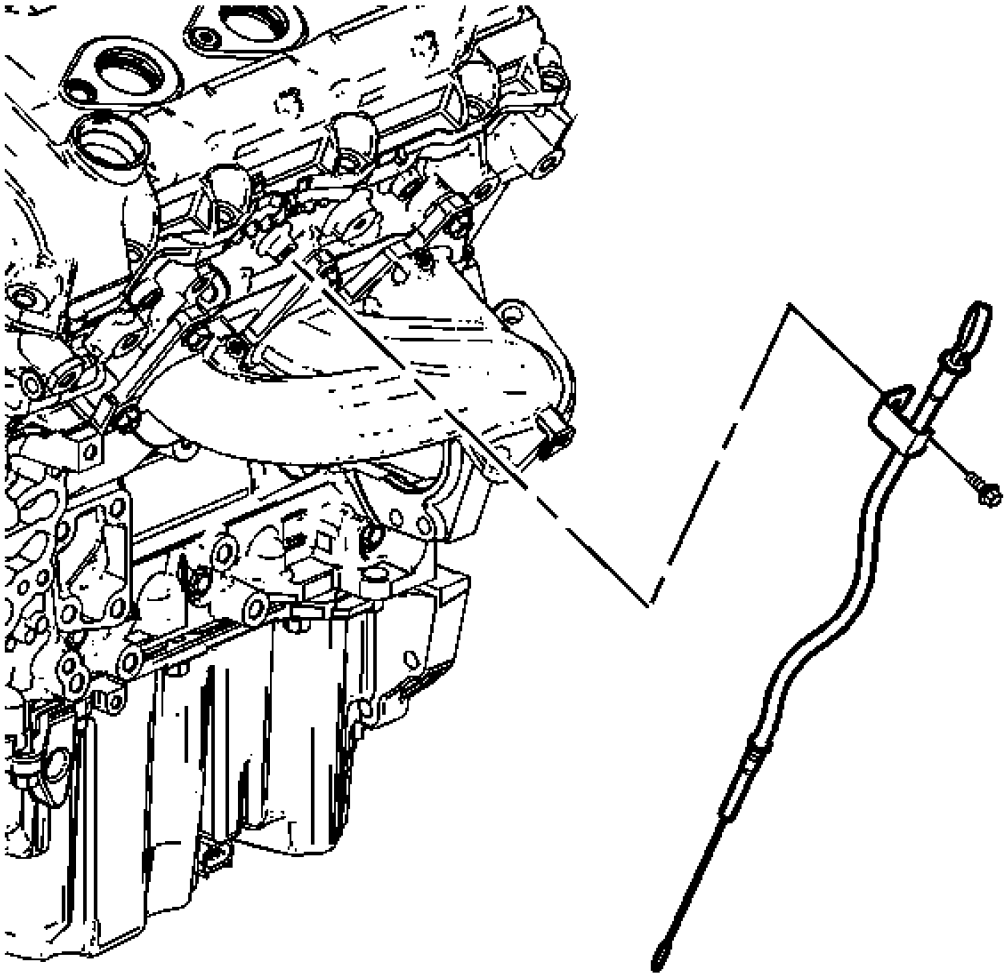


Fig. 5: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

5. Remove the oil level indicator tube bracket bolt.
6. Remove the oil level indicator and tube by sliding the tube out from the lower crankcase hole.

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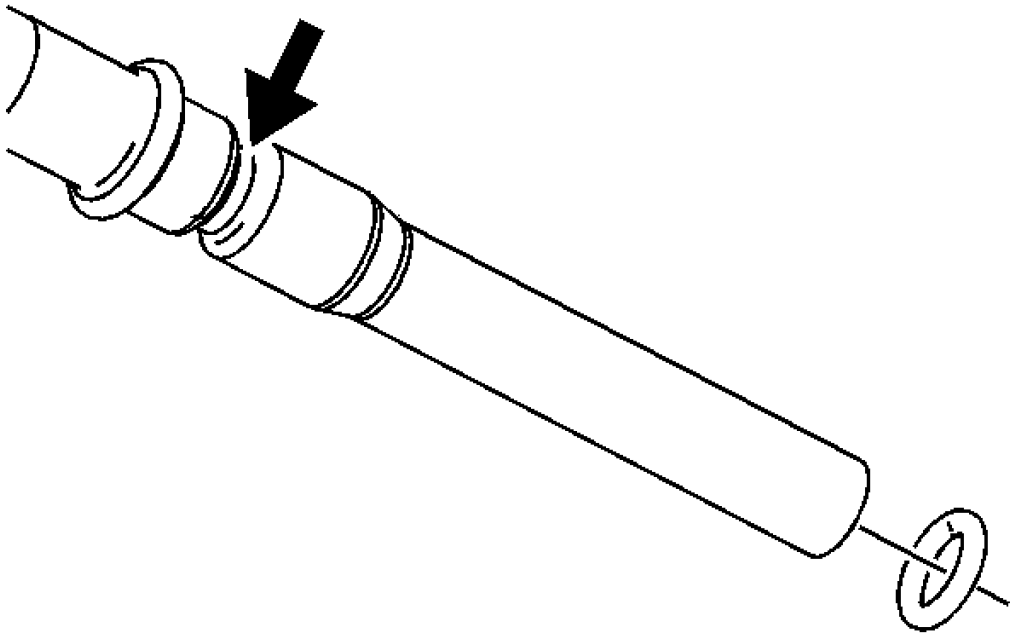


Fig. 6: View Of Oil Level Indicator Tube O-Ring
Courtesy of GENERAL MOTORS CORP.

7. Remove and discard the O-ring from the oil level indicator tube if damaged.

EXHAUST MANIFOLD REMOVAL - LEFT SIDE

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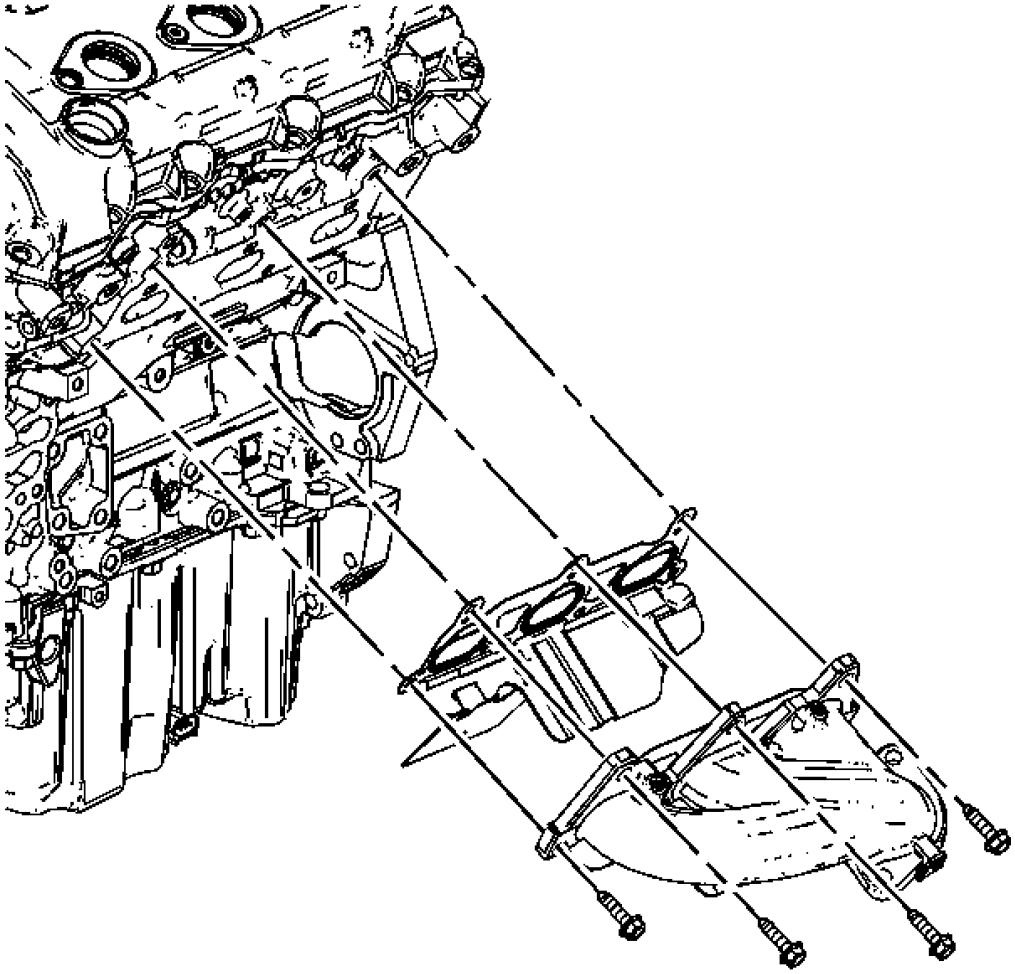


Fig. 7: View Of Left Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

1. Remove the exhaust manifold bolts from the left cylinder head.
2. Remove the left exhaust manifold.
3. Remove and discard the exhaust manifold gasket from the left cylinder head.

OIL FILTER ADAPTER REMOVAL

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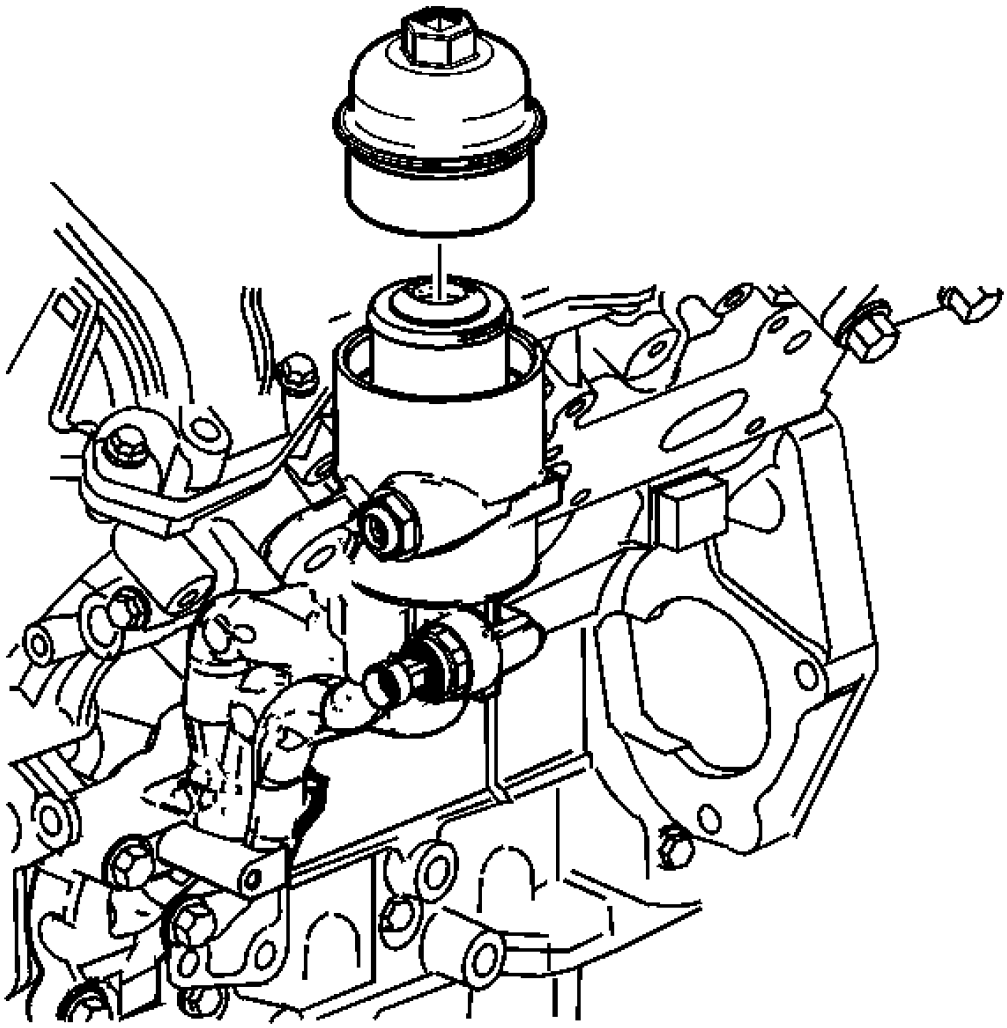


Fig. 8: View Of Oil Filter Cap
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil filter cap.

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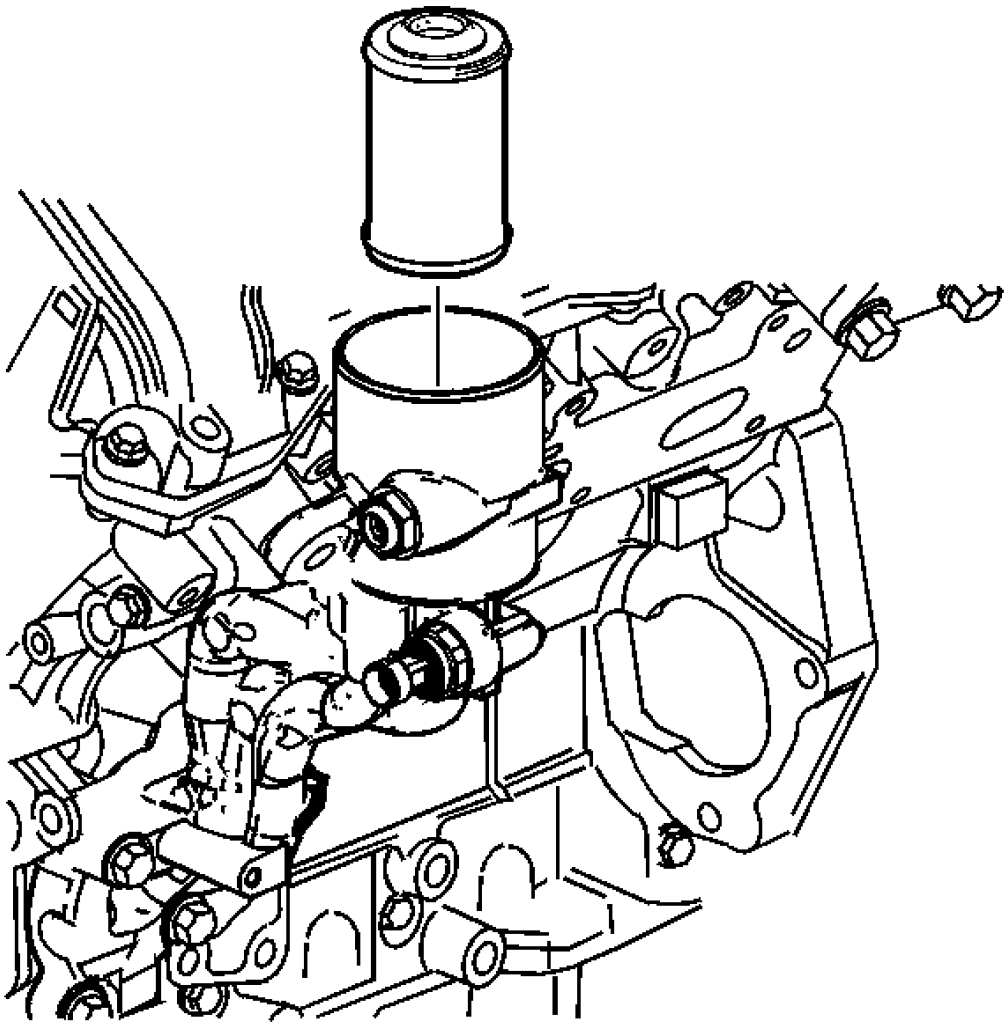


Fig. 9: View Of Oil Filter Cartridge
Courtesy of GENERAL MOTORS CORP.

2. Remove and properly dispose of the oil filter cartridge.
3. Re-install the oil filter cap.

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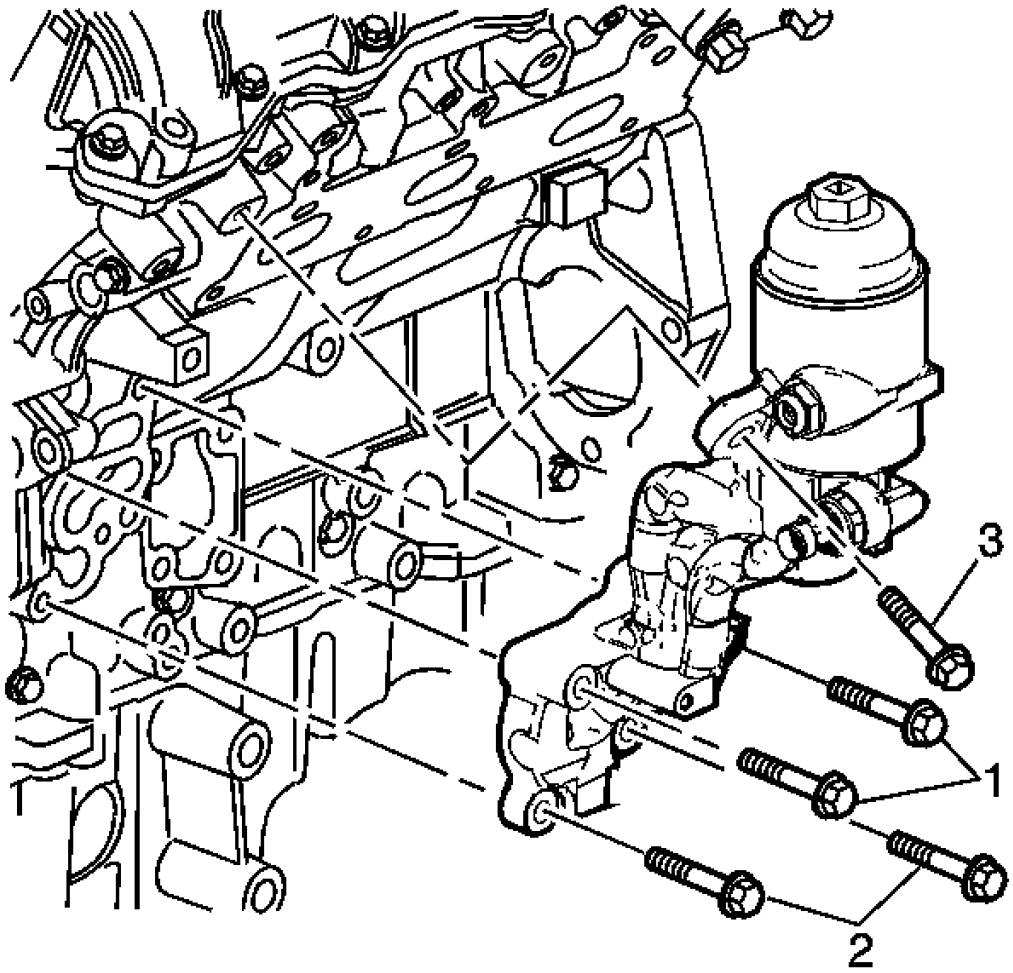


Fig. 10: View Of Oil Filter Adapter & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil filter adapter bolts (1-3) from the engine block.
5. Remove the oil filter adapter.

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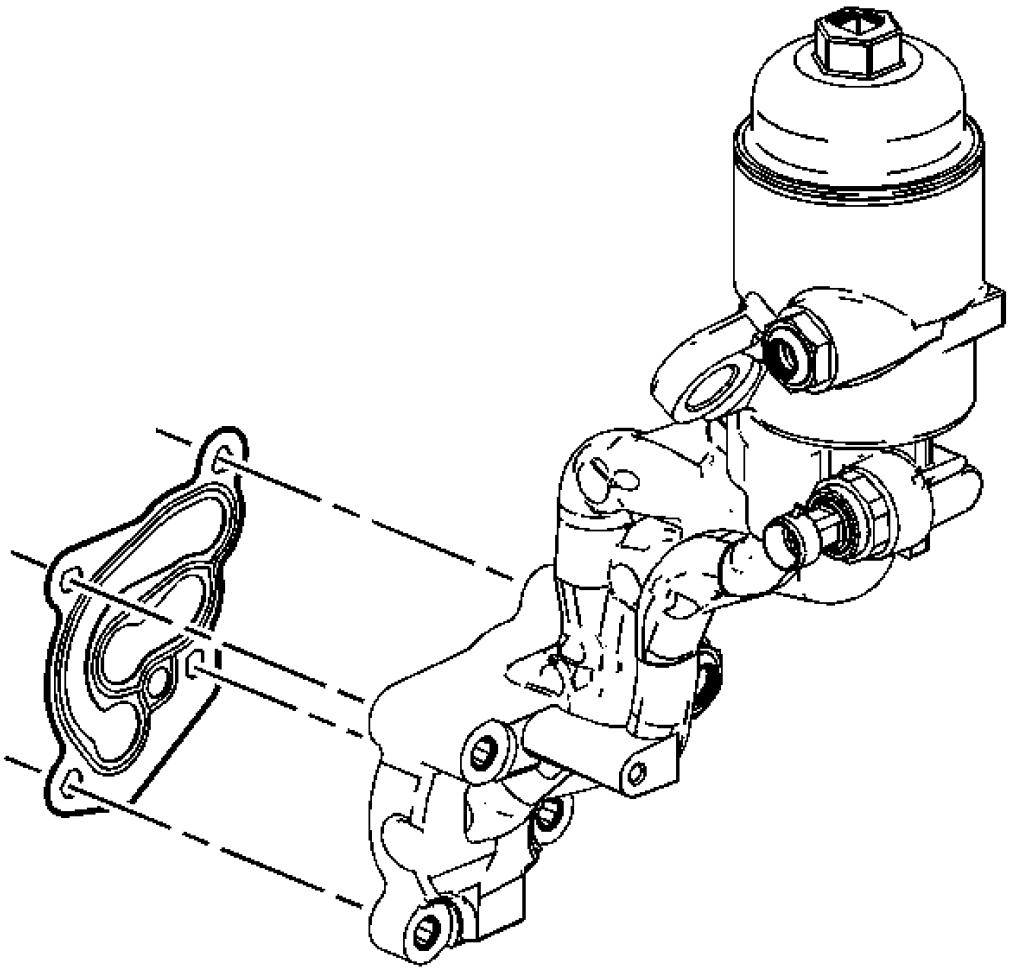


Fig. 11: View Of Oil Filter Adapter & Gasket
Courtesy of GENERAL MOTORS CORP.

6. Remove and discard the oil filter adapter gasket.

EXHAUST MANIFOLD REMOVAL - RIGHT SIDE

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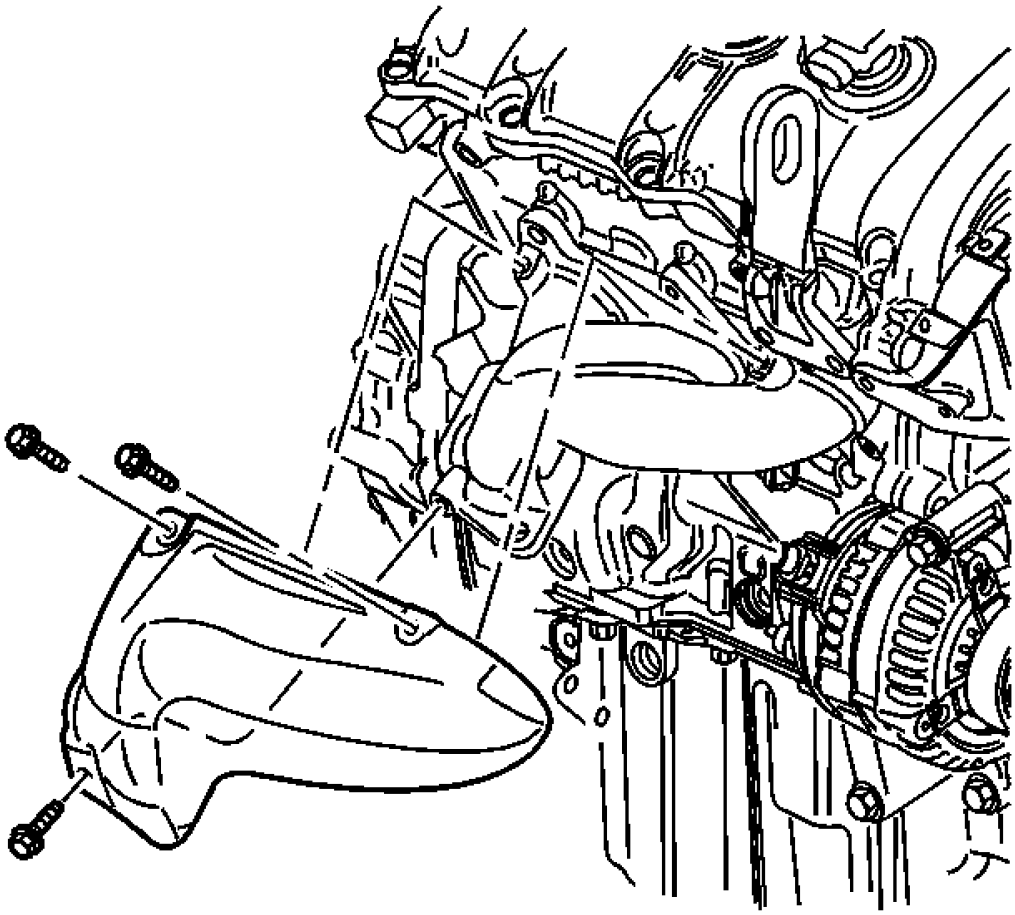


Fig. 12: View Of Right Exhaust Manifold Heat Shield
Courtesy of GENERAL MOTORS CORP.

1. Remove the right exhaust manifold heat shield bolts.
2. Remove the right exhaust manifold heat shield.

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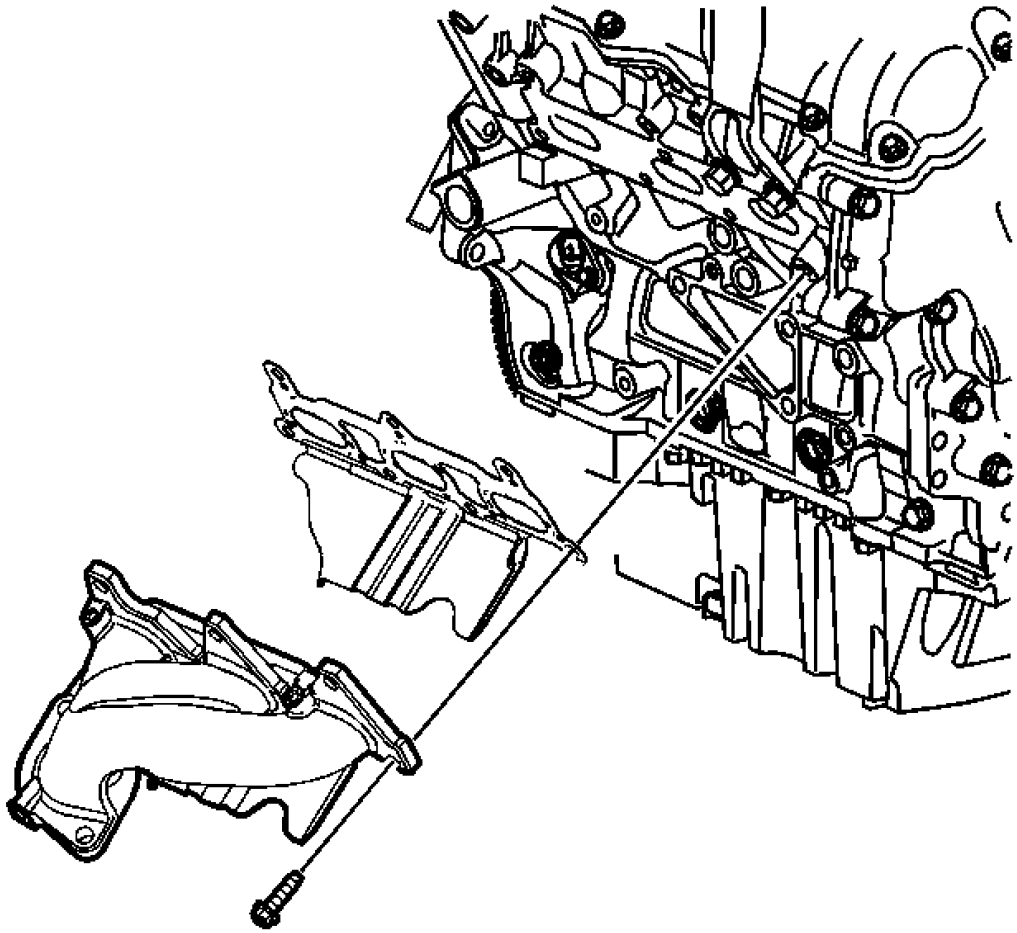


Fig. 13: Removing & Installing Right Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

3. Remove the exhaust manifold bolts from the right cylinder head.
4. Remove the right exhaust manifold.
5. Remove and discard the exhaust manifold gasket from the right cylinder head.

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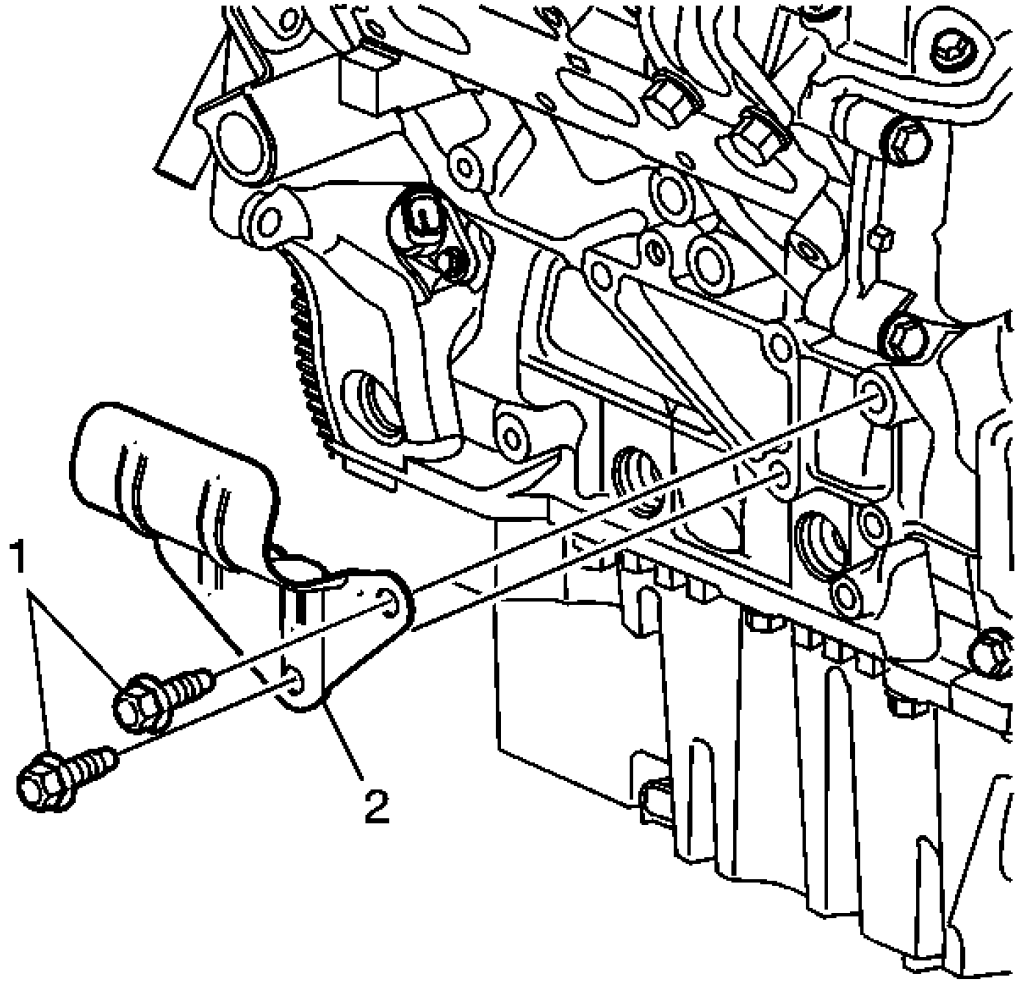


Fig. 14: Identifying Exhaust Manifold Lower Heat Shield & Bolts
Courtesy of GENERAL MOTORS CORP.

6. Remove the exhaust manifold lower heat shield bolts (1).
7. Remove the exhaust manifold lower heat shield (2).

INTAKE MANIFOLD REMOVAL (LLT)

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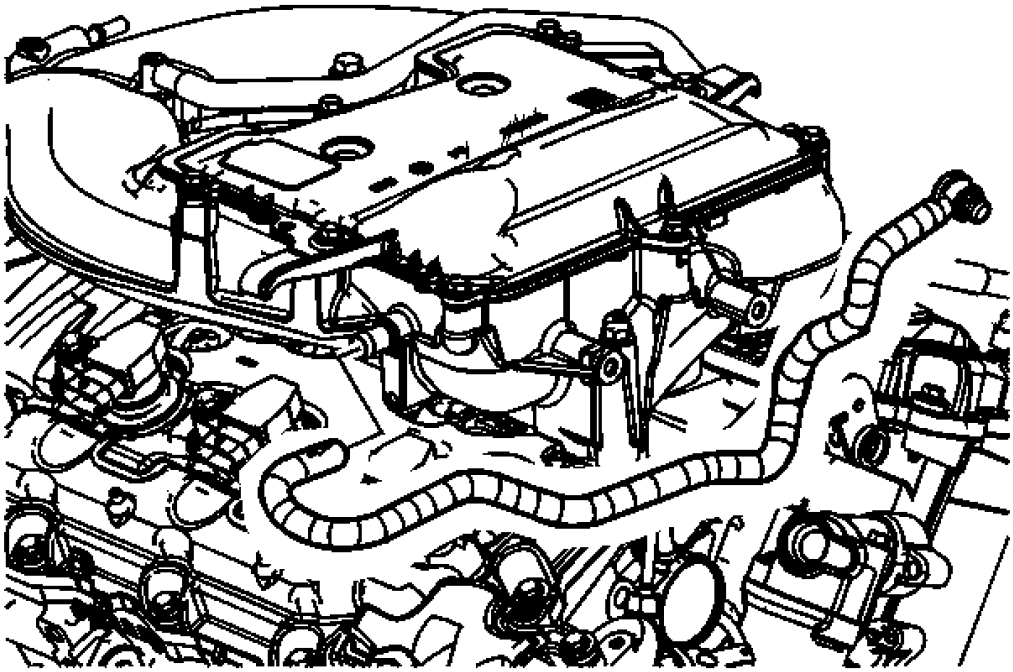


Fig. 15: View Of Booster Hose On Intake Manifold
Courtesy of GENERAL MOTORS CORP.

1. Disconnect and remove the brake booster hose from the intake manifold.

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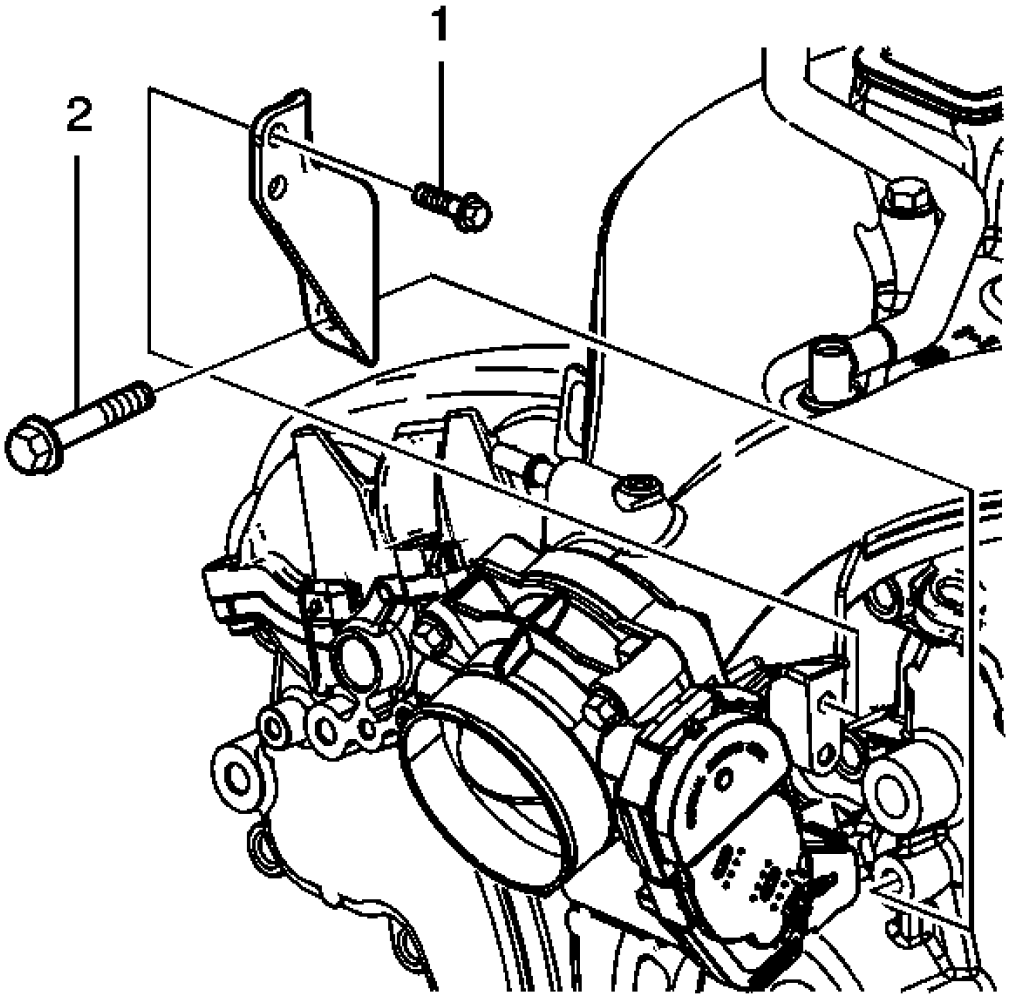


Fig. 16: Identifying Intake Manifold Brace & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the intake manifold brace bolts (1 and 2).
3. Remove the intake manifold brace.

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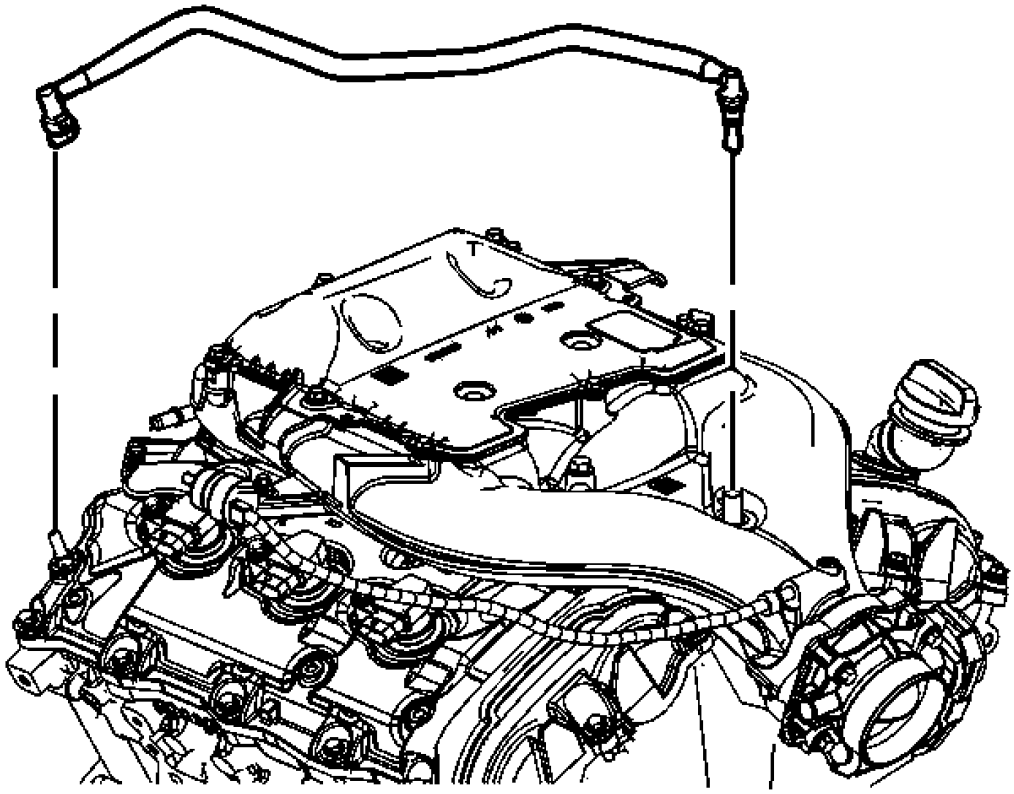


Fig. 17: View Of Positive Crankcase Ventilation Tube
Courtesy of GENERAL MOTORS CORP.

4. Disconnect and remove the positive crankcase ventilation (PCV) tube from the intake manifold and right camshaft cover.

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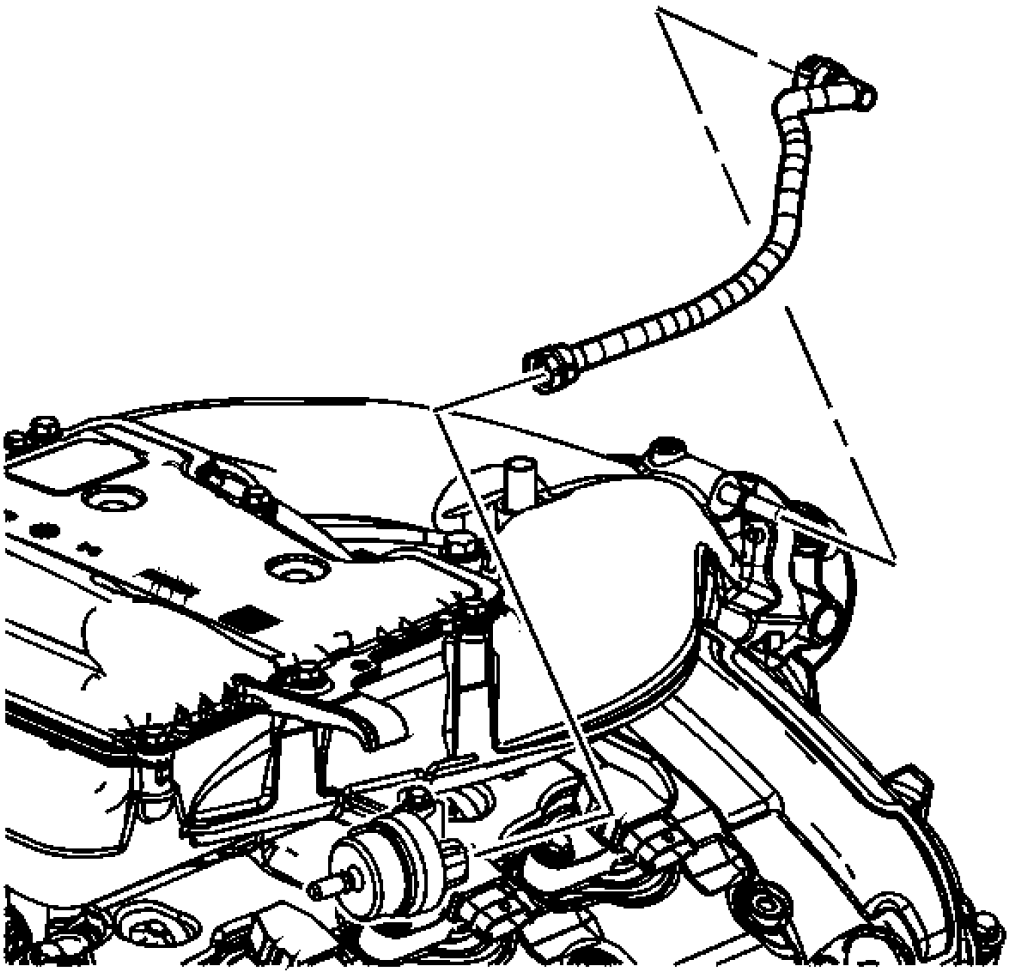


Fig. 18: View of EVAP Hose
Courtesy of GENERAL MOTORS CORP.

5. Remove the EVAP hose from the intake manifold and EVAP solenoid.

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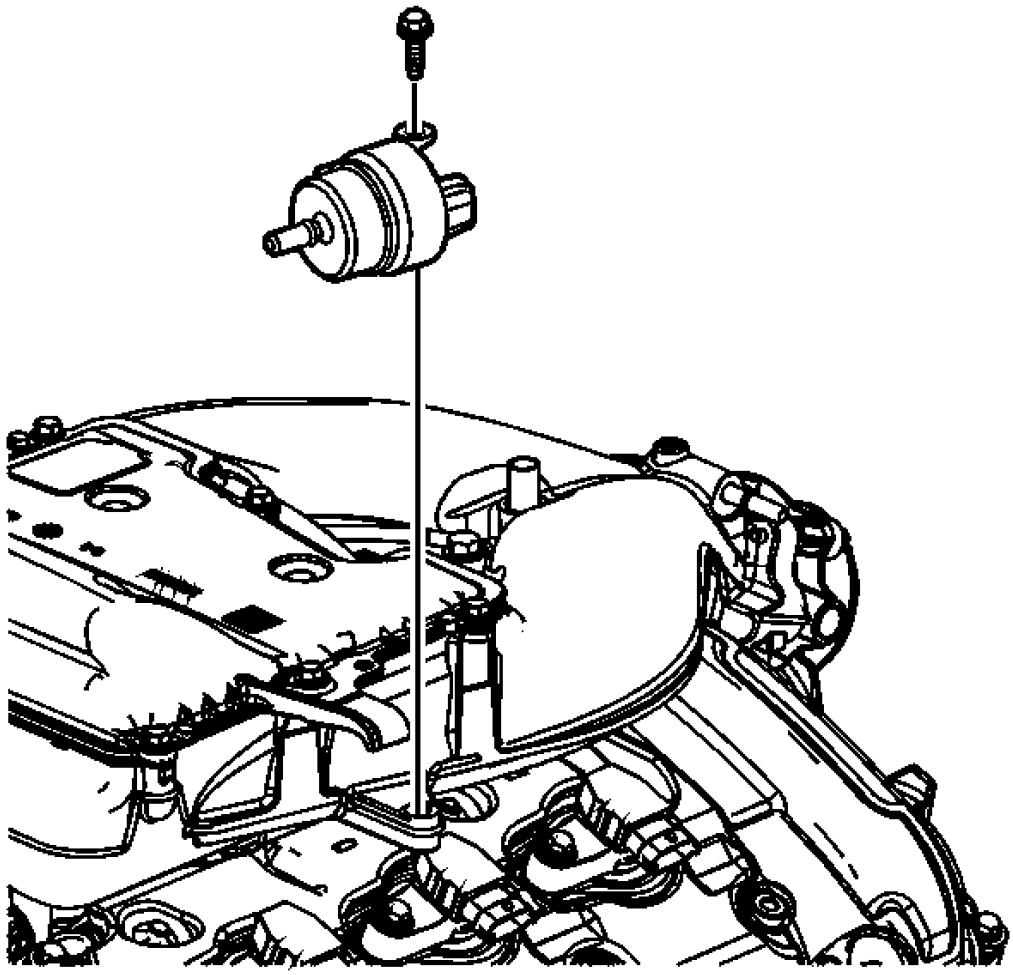


Fig. 19: View Of EVAP Solenoid
Courtesy of GENERAL MOTORS CORP.

6. Remove the EVAP solenoid bolt.
7. Remove the EVAP solenoid.

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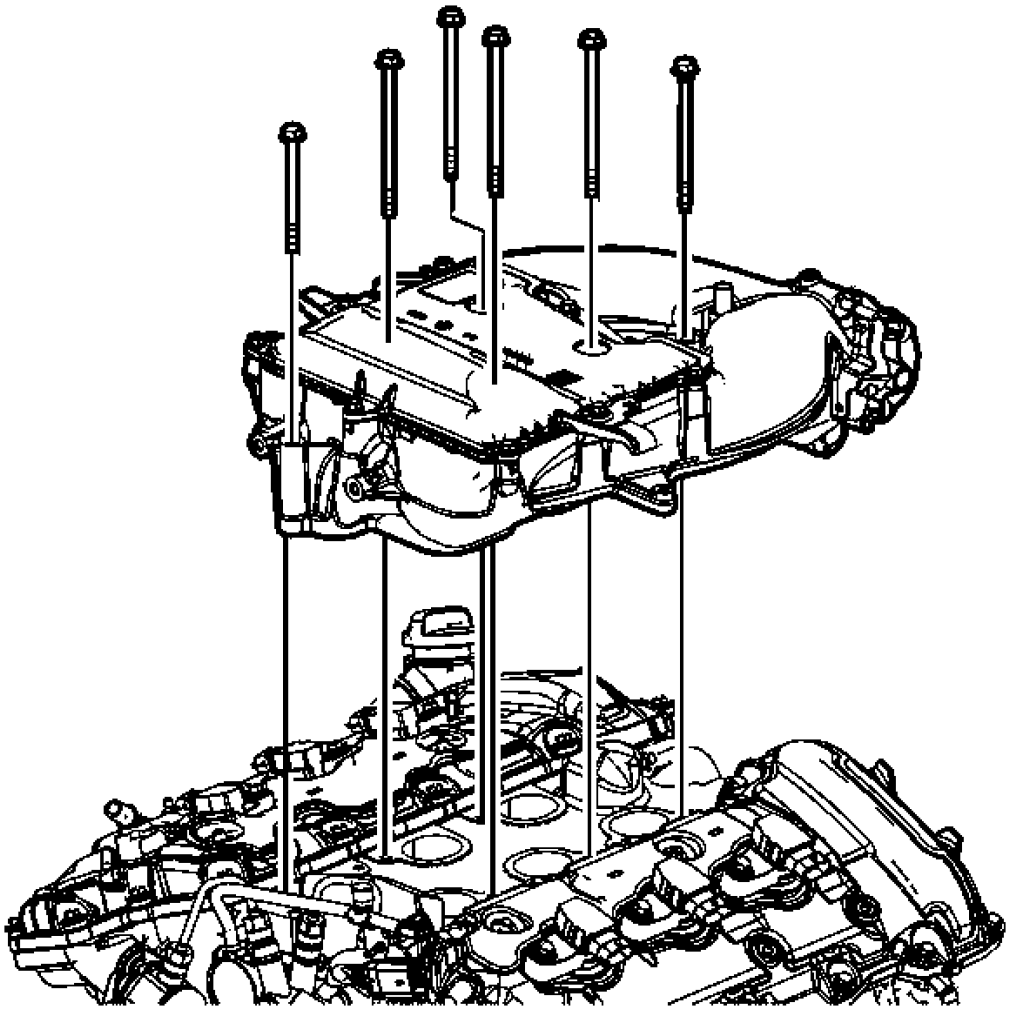


Fig. 20: View Of Intake Manifold Assembly
Courtesy of GENERAL MOTORS CORP.

8. Remove the intake manifold bolts.
9. Remove the intake manifold assembly.

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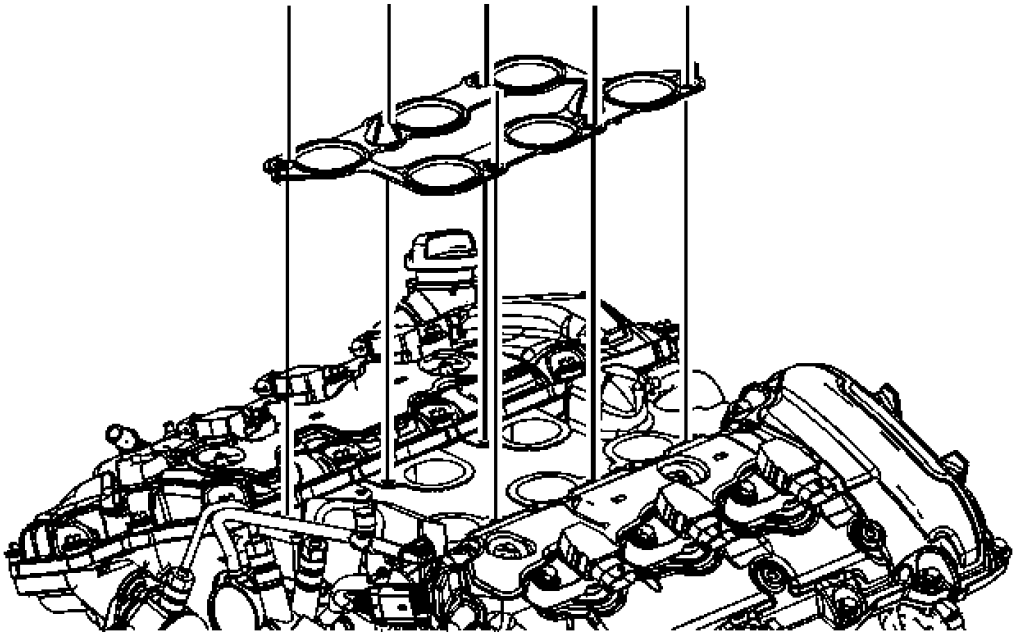


Fig. 21: Identifying Intake Manifold Gasket
Courtesy of GENERAL MOTORS CORP.

10. Remove and discard the lower intake manifold gasket.

WATER OUTLET REMOVAL

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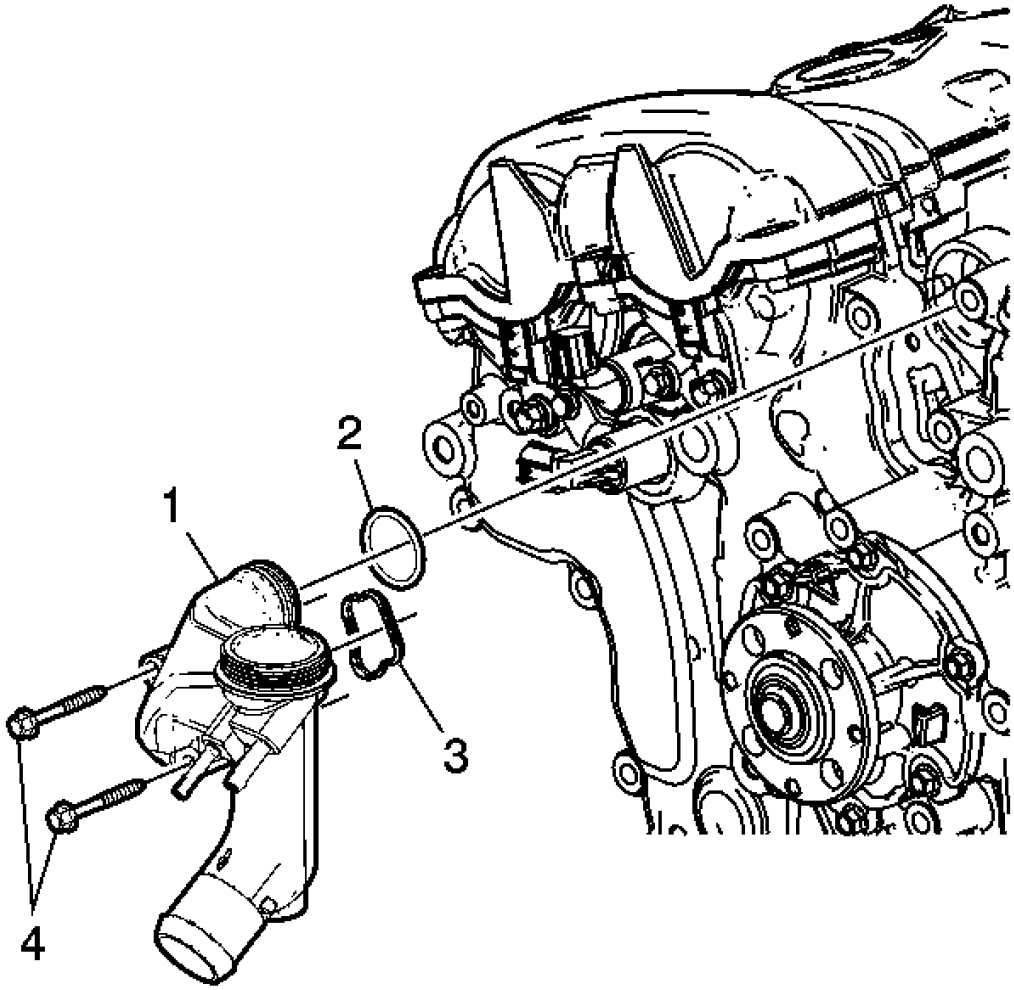


Fig. 22: Water Outlet Components
Courtesy of GENERAL MOTORS CORP.

1. Remove the water outlet bolts (4).
2. Remove the water outlet (1).
3. Remove and discard the water outlet gasket (3).
4. Remove and discard the water outlet O-ring seal (2).

ENGINE COOLANT THERMOSTAT HOUSING REMOVAL

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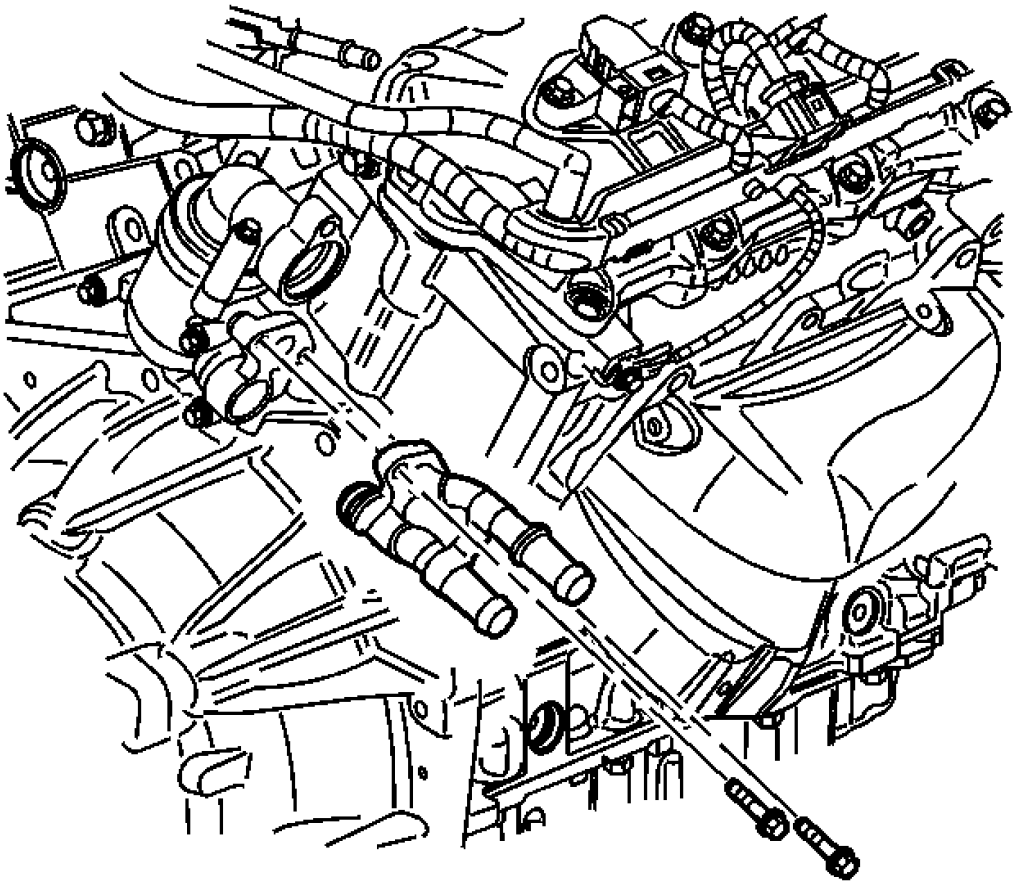


Fig. 23: View Of Heater Inlet/Outlet Pipe Assembly
Courtesy of GENERAL MOTORS CORP.

1. Remove the heater inlet/outlet pipe assembly bolts.
2. Remove the heater inlet/outlet pipe assembly.

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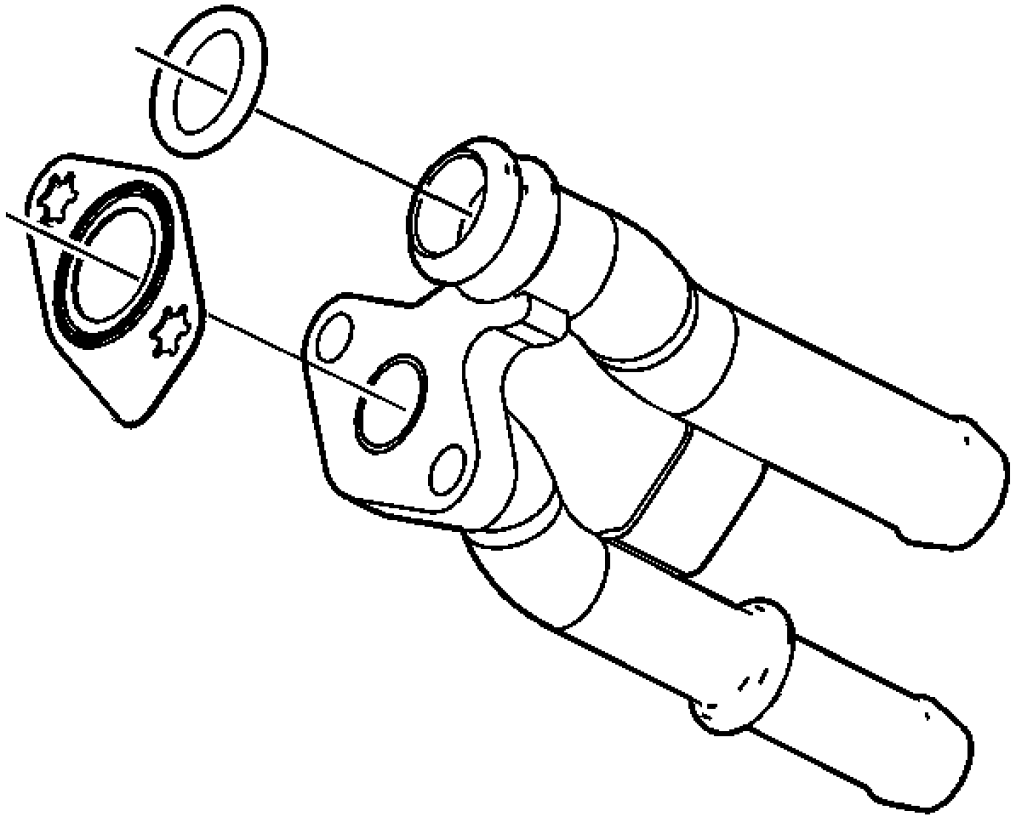


Fig. 24: View Of Heater Inlet/Outlet Pipe Assembly O-Ring & Gasket
Courtesy of GENERAL MOTORS CORP.

3. Remove and discard the heater inlet/outlet pipe assembly O-ring and gasket.

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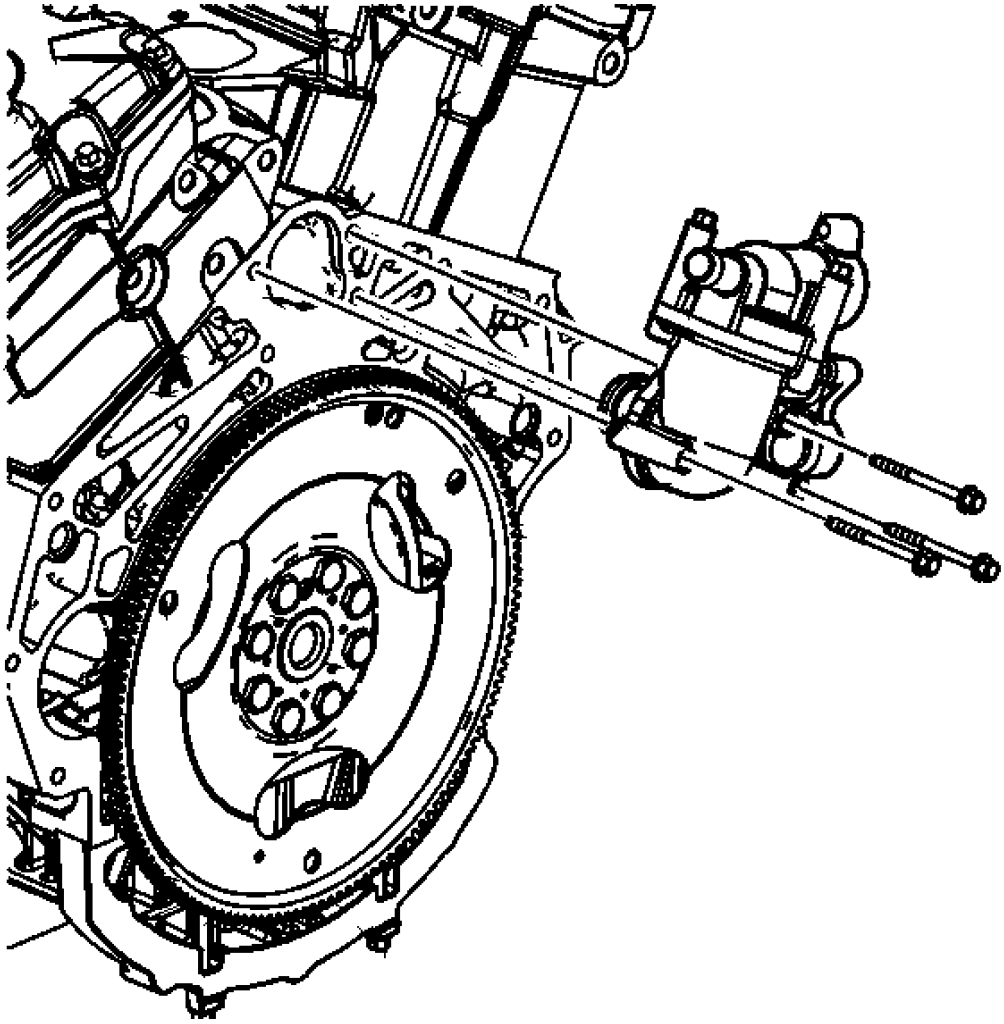


Fig. 25: View Of Thermostat Housing Assembly
Courtesy of GENERAL MOTORS CORP.

4. Remove the thermostat housing assembly bolts.
5. Remove the thermostat housing assembly.

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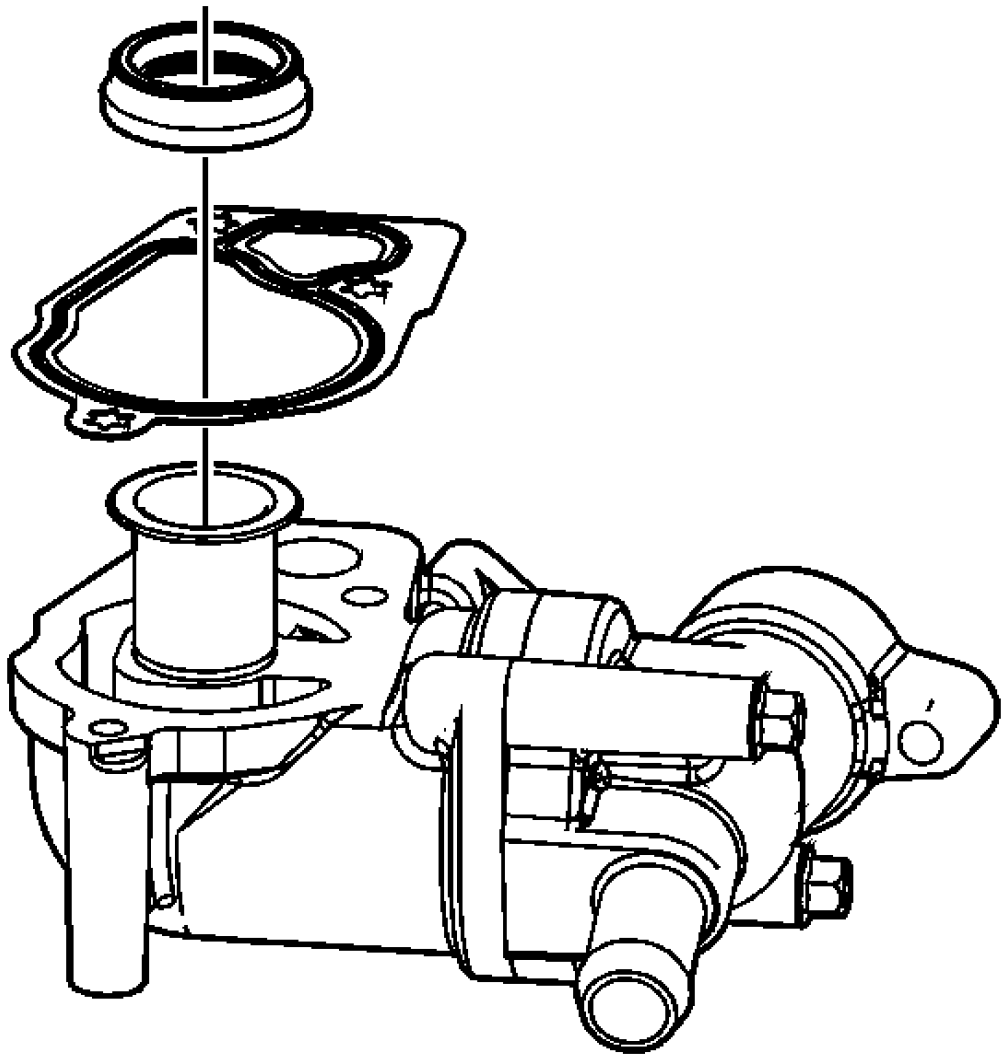


Fig. 26: View Of Thermostat Housing Assembly O-Ring & Gasket
Courtesy of GENERAL MOTORS CORP.

6. Remove and discard the thermostat housing assembly O-ring and gasket.

CRANKSHAFT BALANCER REMOVAL

Special Tools

- **EN 46106:** Flywheel Holding Tool

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- **J 38416-B:** Harmonic Balancer Remover
- **J 38416-2:** Crankshaft Button

For equivalent regional tools, refer to **Special Tools** .

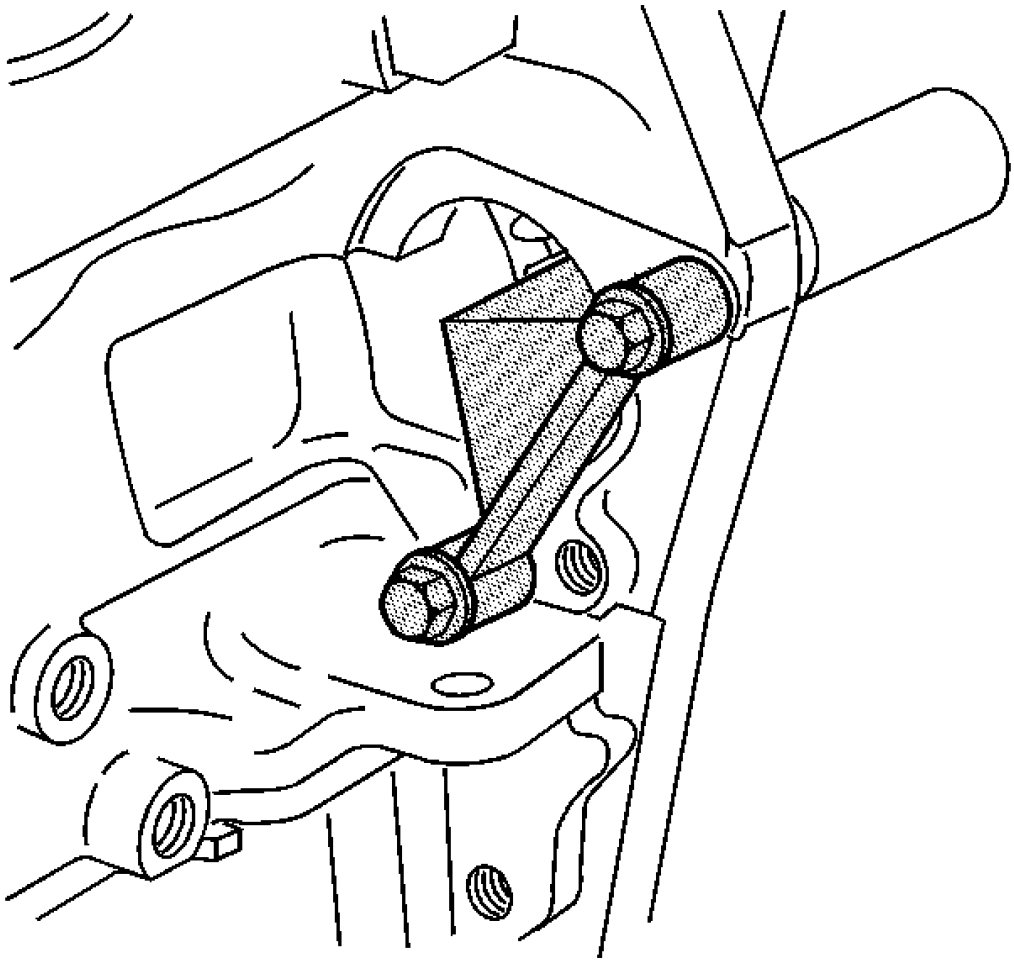


Fig. 27: Identifying Special Tool - EN 46106
Courtesy of GENERAL MOTORS CORP.

1. Install the **EN 46106:** tool through the starter mounting hole.

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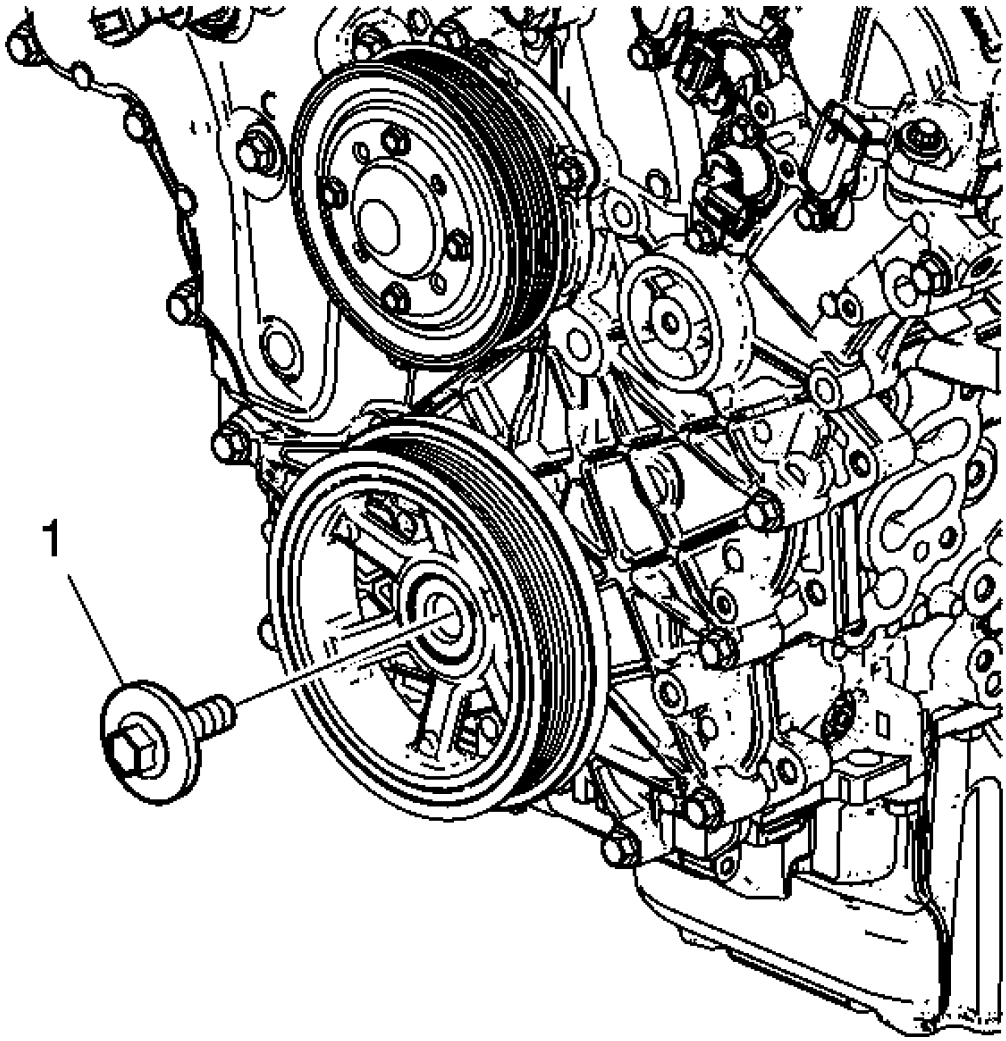


Fig. 28: Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

2. Remove and discard the crankshaft balancer bolt (1).

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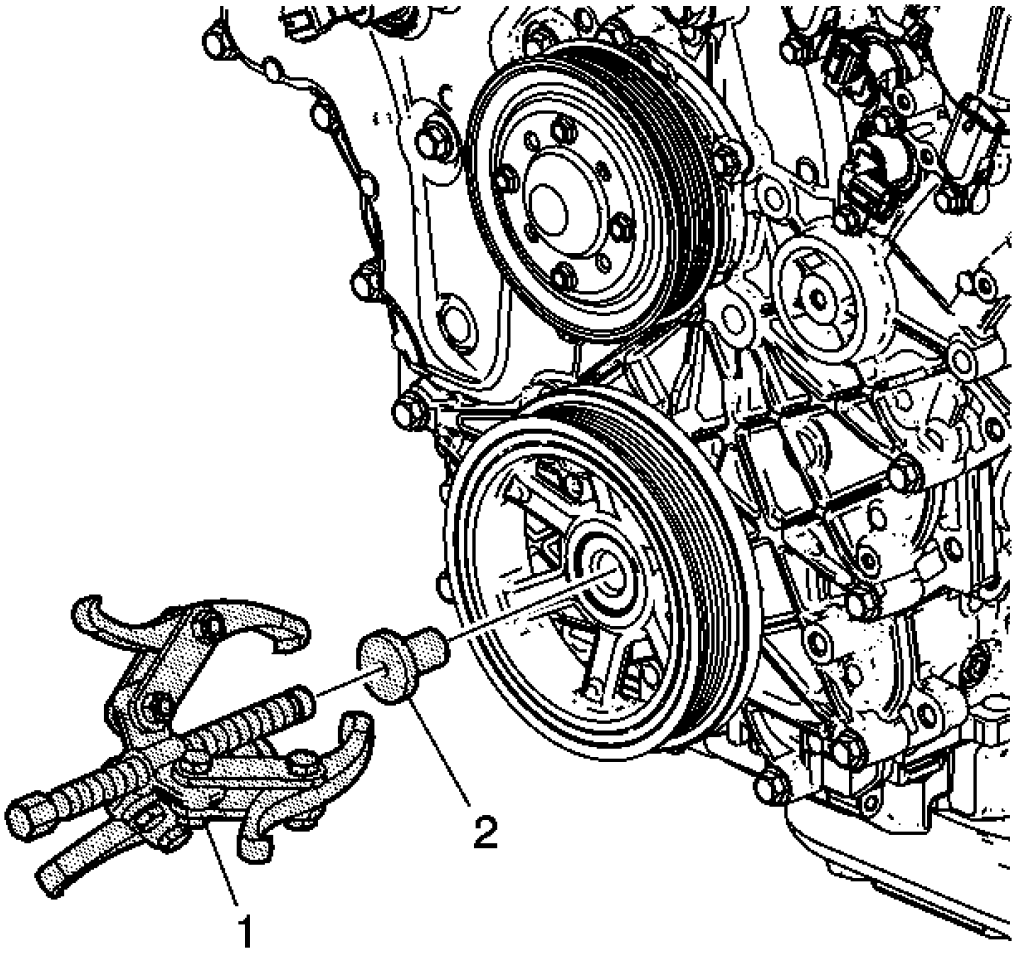


Fig. 29: Installing Crankshaft Balancer Remover
Courtesy of GENERAL MOTORS CORP.

3. Install the **J 38416-2:** button (2) in the nose of the crankshaft.
4. Install the **J 38416-B:** remover (1) in order to remove the crankshaft balancer.

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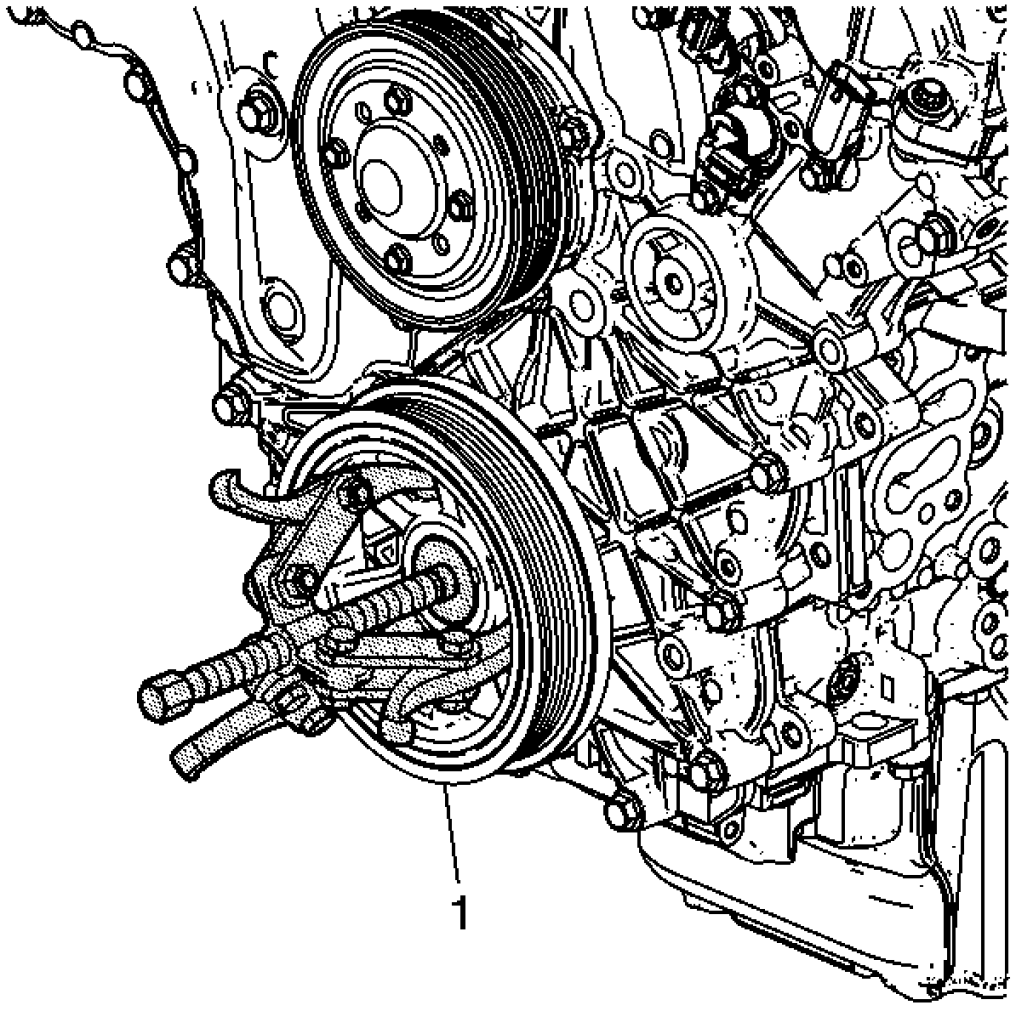


Fig. 30: Pulling Crankshaft Balancer Off
Courtesy of GENERAL MOTORS CORP.

5. Pull the crankshaft balancer (1) off by tightening the center bolt on the **J 38416-B:** remover until the crankshaft balancer pulls off of the crankshaft end.
6. Remove the **J 38416-B:** remover and **J 38416-2:** button from the crankshaft balancer.

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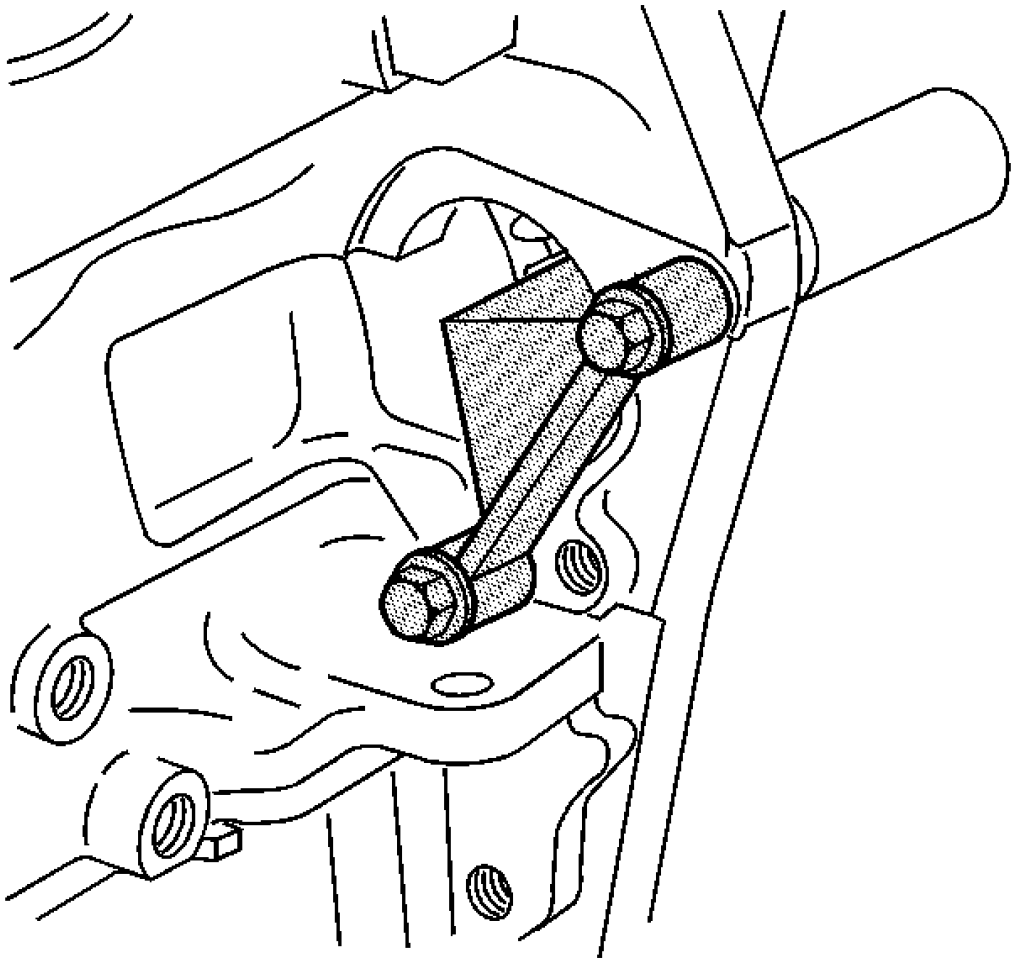


Fig. 31: Identifying Special Tool - EN 46106
Courtesy of GENERAL MOTORS CORP.

7. Remove the **EN 46106:** tool from the starter mounting hole.

ENGINE FLYWHEEL REMOVAL

Special Tools

EN 46106 Flywheel Holding Tool. See **Special Tools** .

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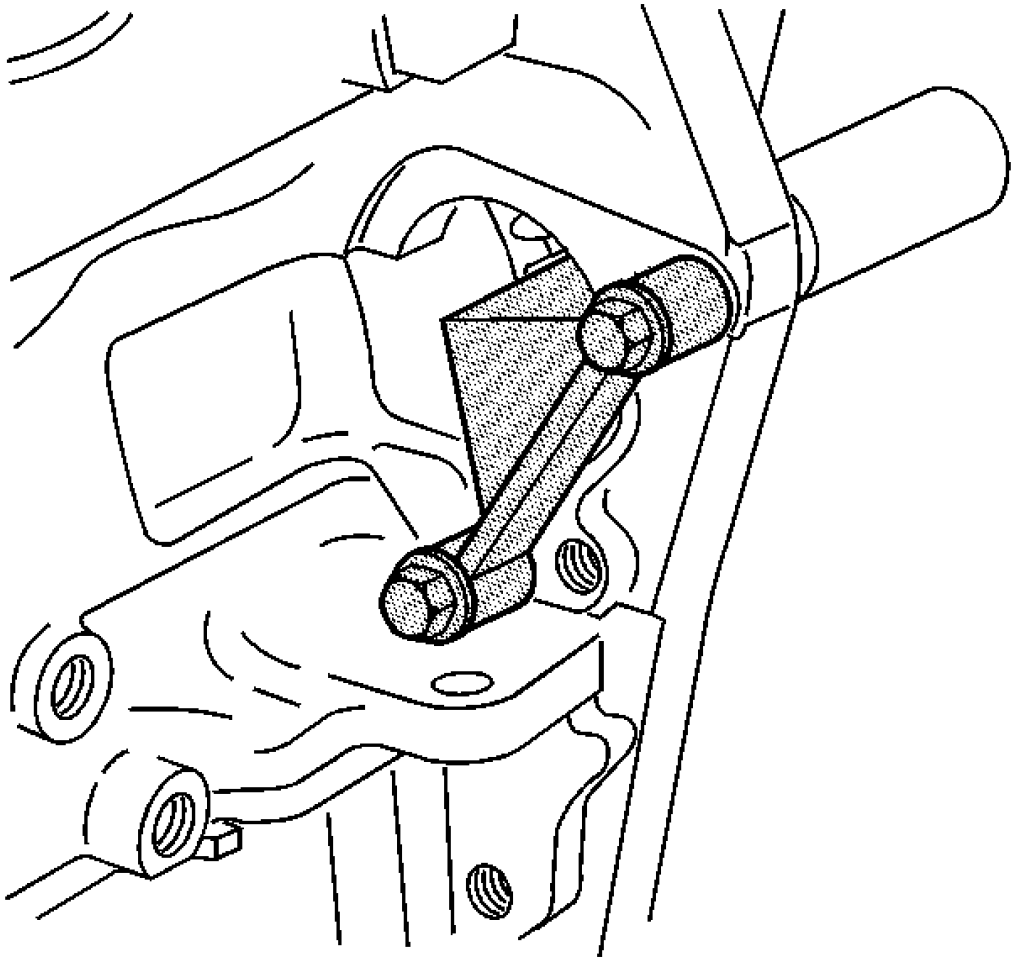


Fig. 32: Identifying Special Tool - EN 46106
Courtesy of GENERAL MOTORS CORP.

1. Install the **EN 46106** through the starter mounting hole. See **Special Tools** .

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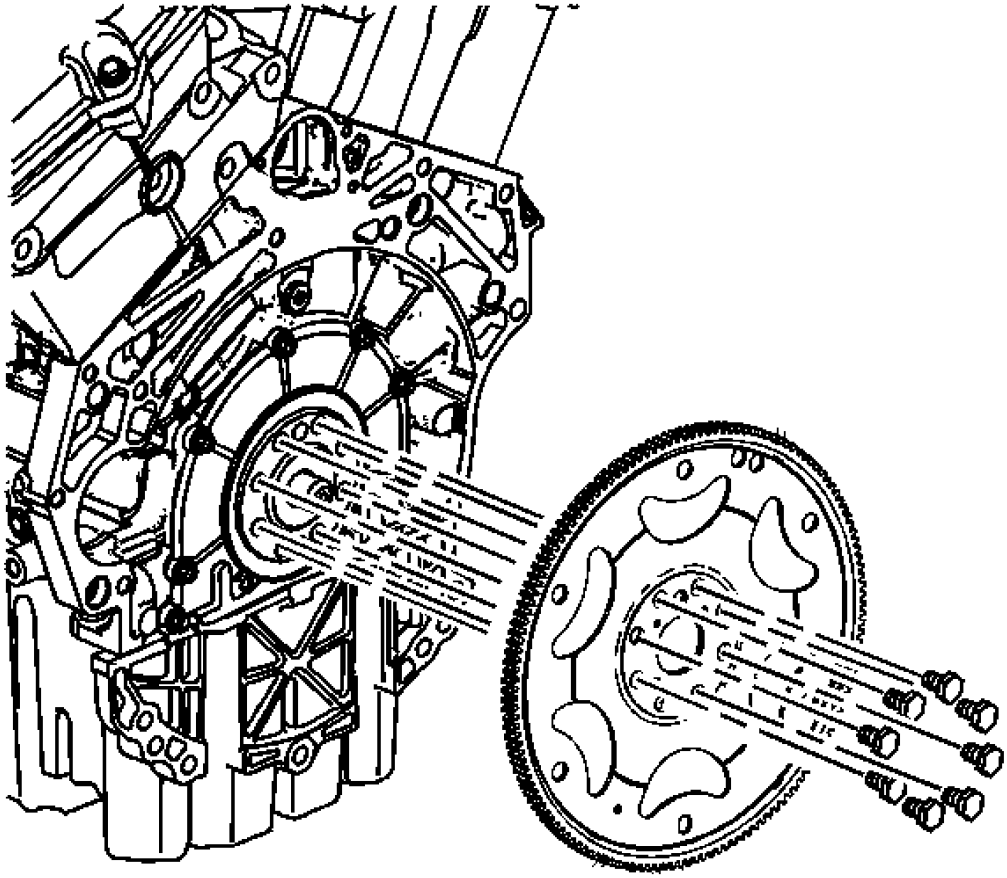


Fig. 33: View Of Engine Flywheel Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the engine flywheel bolts and discard.
3. Remove the engine flywheel from the crankshaft.

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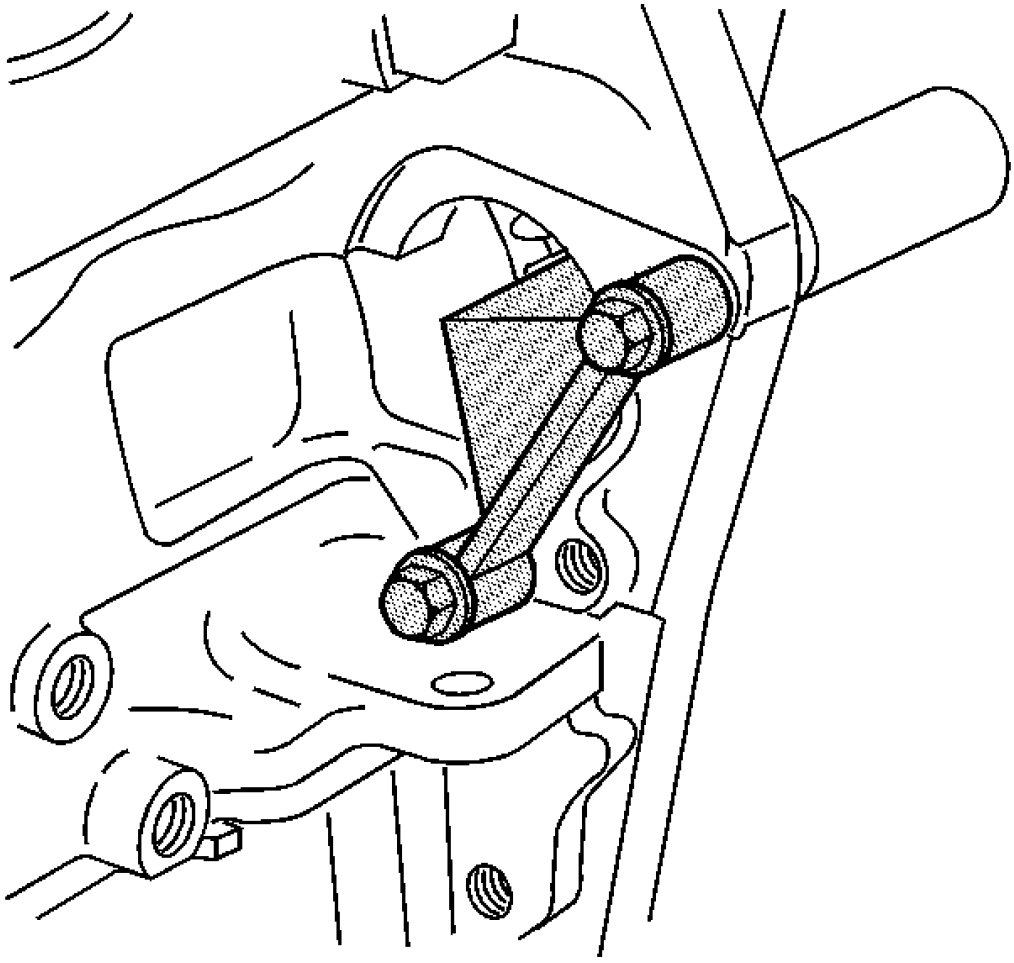


Fig. 34: Identifying Special Tool - EN 46106
Courtesy of GENERAL MOTORS CORP.

4. Remove the **EN 46106** . See **Special Tools** .

CAMSHAFT COVER REMOVAL - LEFT SIDE (LLT)

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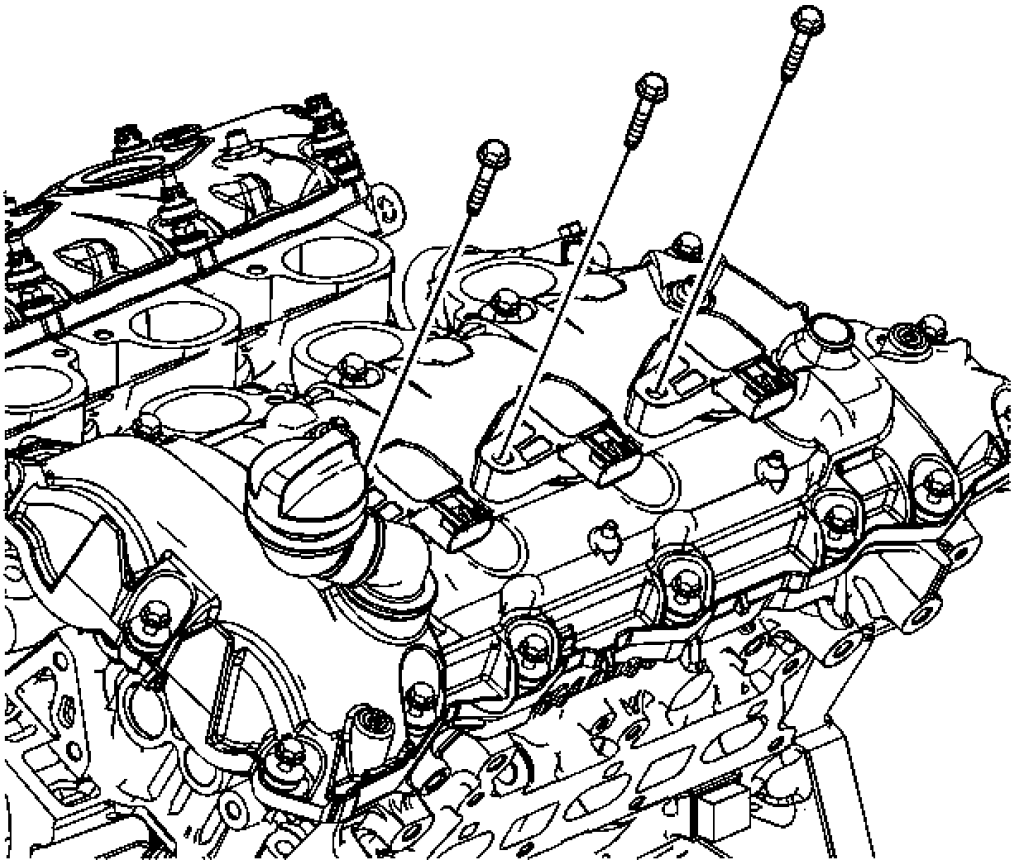


Fig. 35: View Of Ignition Coil Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the ignition coil bolts.

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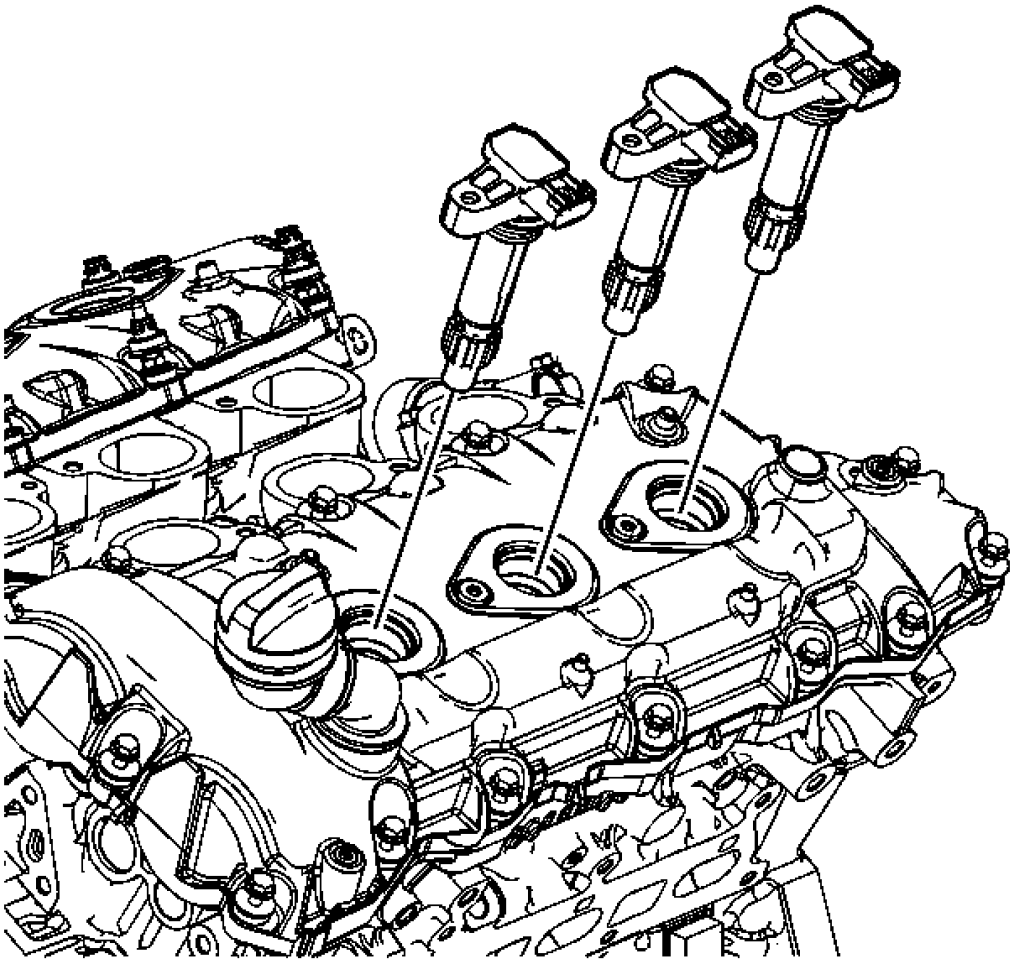


Fig. 36: Identifying Ignition Coils
Courtesy of GENERAL MOTORS CORP.

2. Remove the ignition coils.

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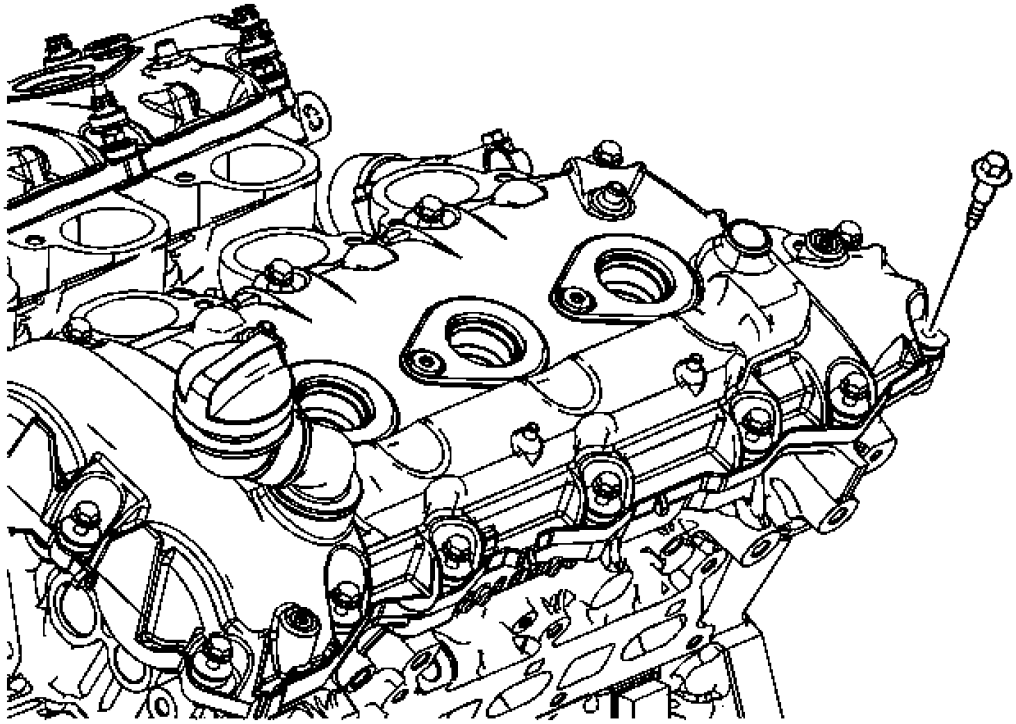


Fig. 37: Identifying Left Camshaft Cover Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the left camshaft cover bolts.
4. Remove and discard the camshaft cover grommets and camshaft cover bolts if they are serviced with the grommet.

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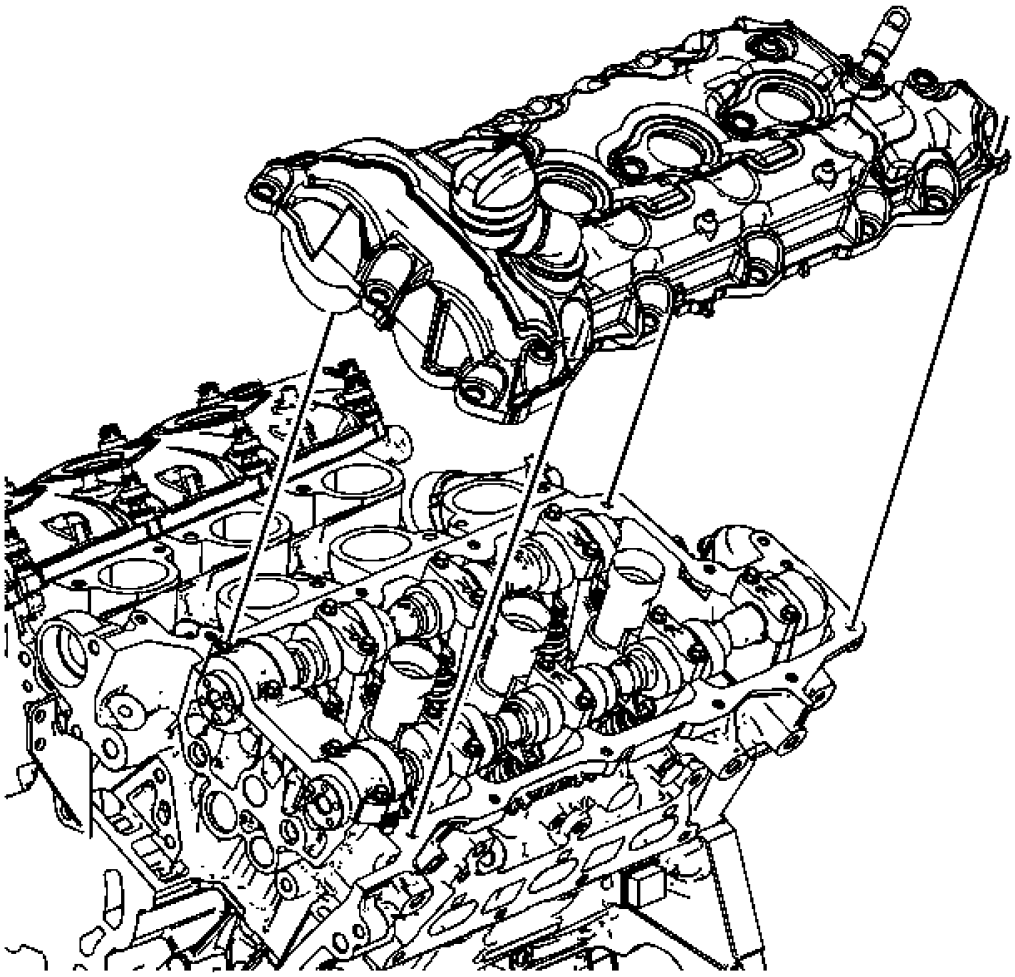


Fig. 38: Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

5. Remove the left camshaft cover from the left cylinder head.

CAMSHAFT COVER REMOVAL - RIGHT SIDE

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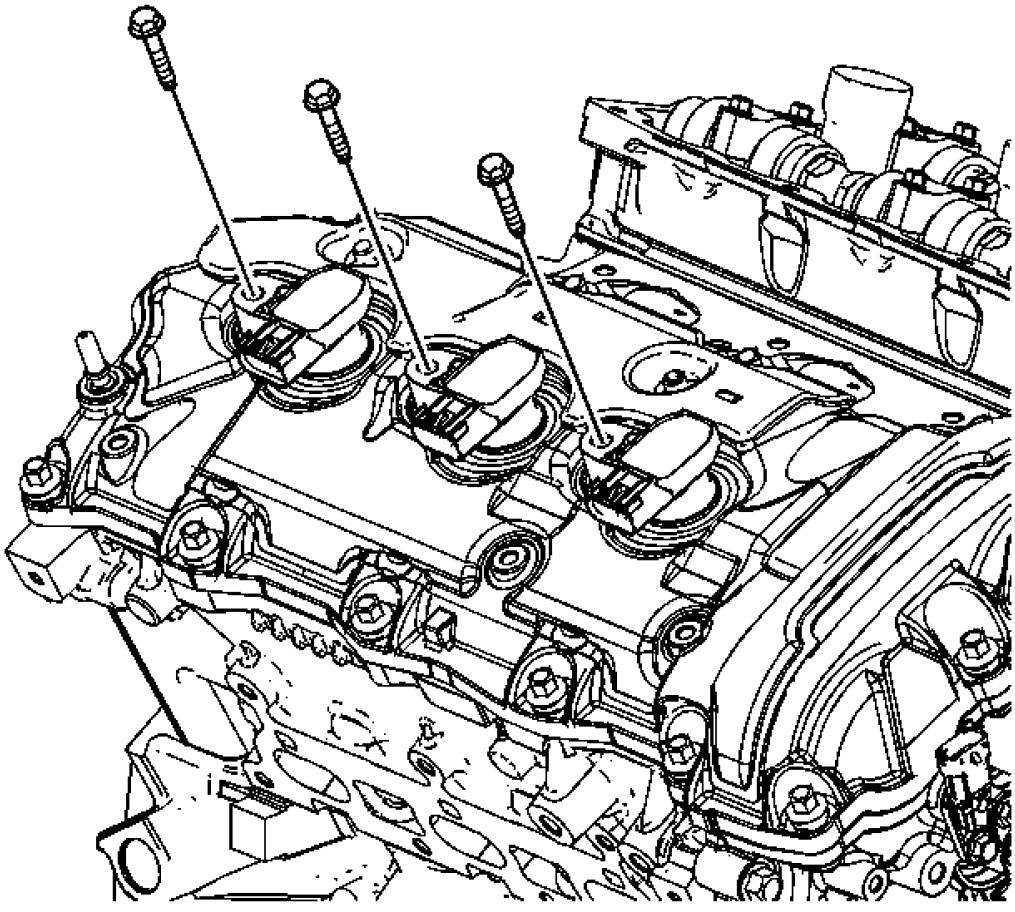


Fig. 39: Identifying Ignition Coil Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the ignition coil bolts.

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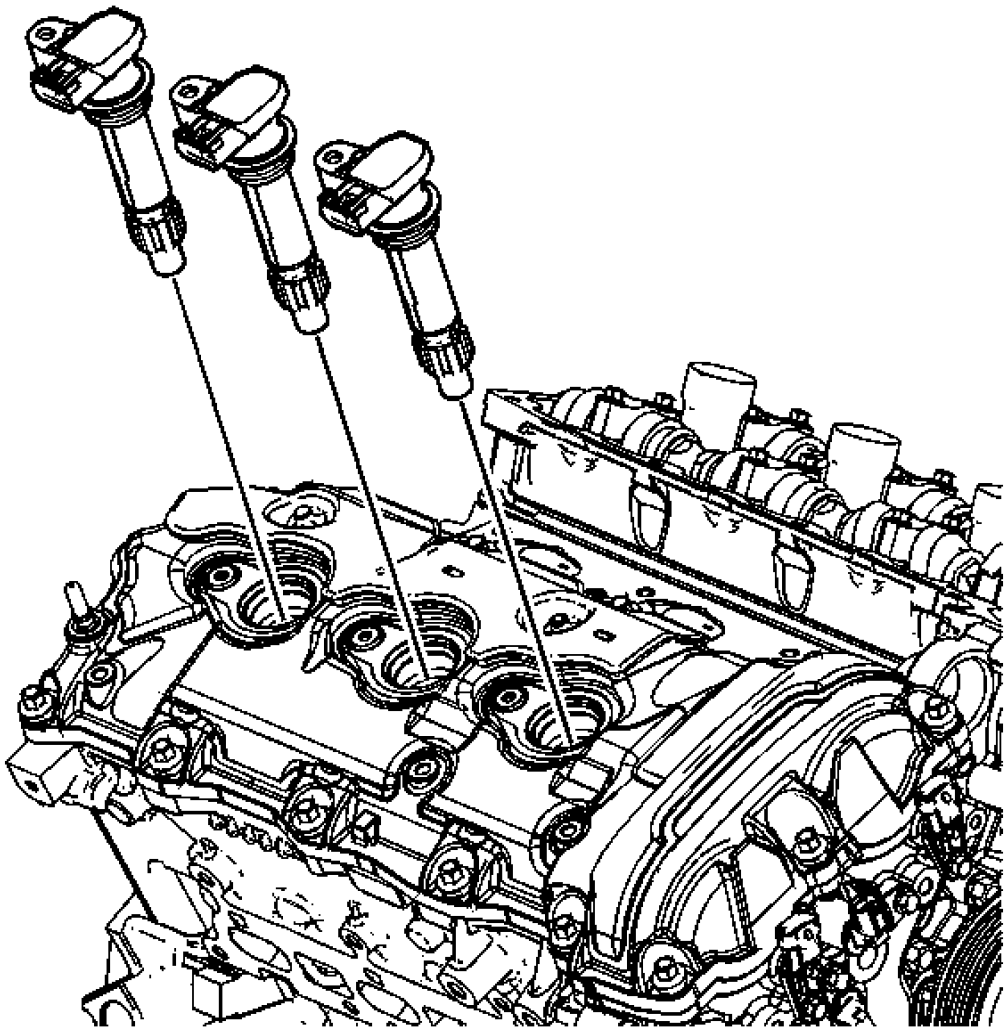


Fig. 40: View Of Ignition Coils
Courtesy of GENERAL MOTORS CORP.

2. Remove the ignition coils.

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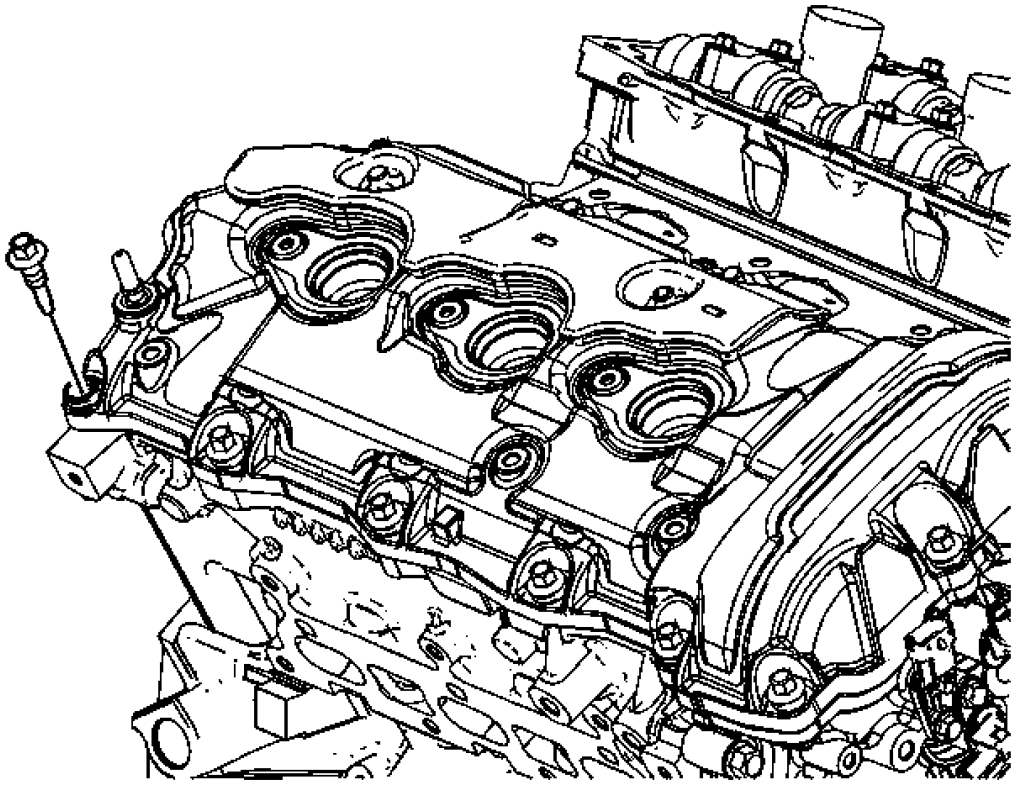


Fig. 41: View Of Camshaft Cover Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the right camshaft cover bolts.
4. Remove and discard the camshaft cover grommets and camshaft cover bolts if they are serviced with the grommet.

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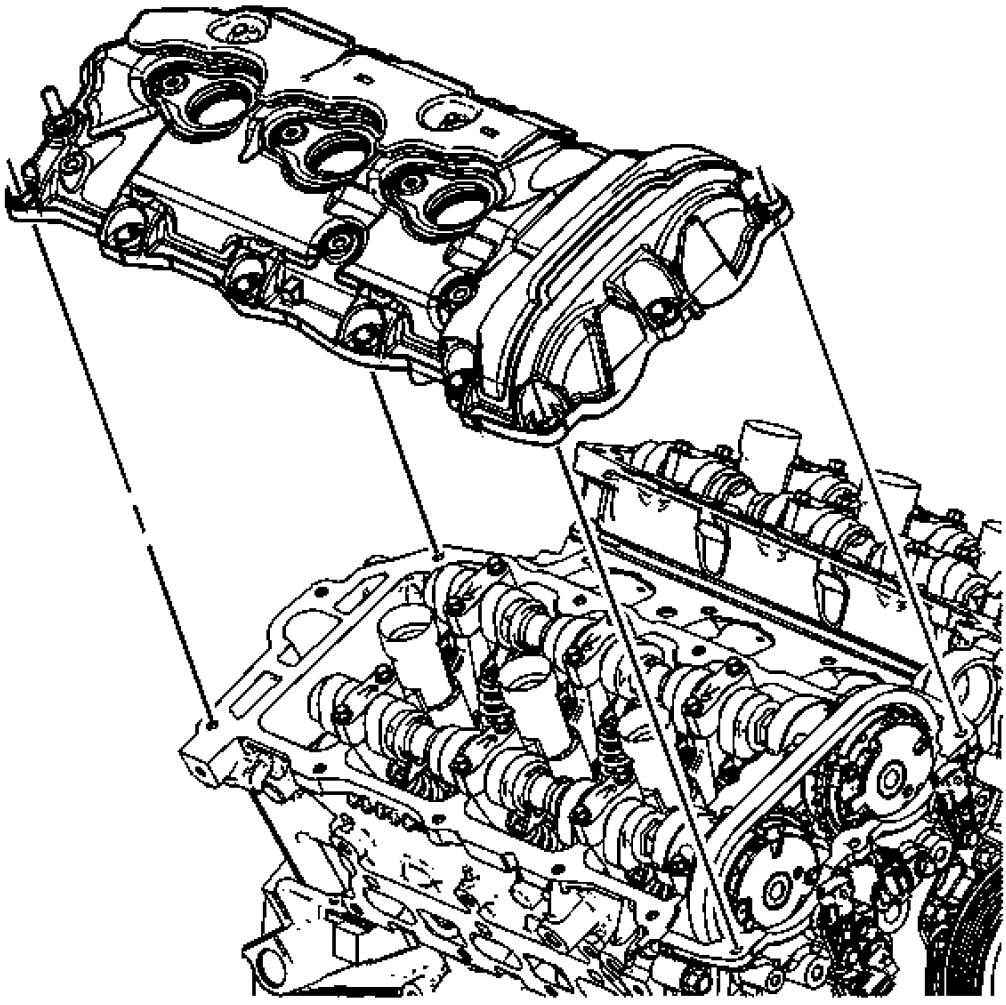


Fig. 42: Right Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

5. Remove the right camshaft cover from the right cylinder head.

WATER PUMP REMOVAL

Tools Required

EN 46104 Water Pump Pulley Holding Tool. See **Special Tools** .

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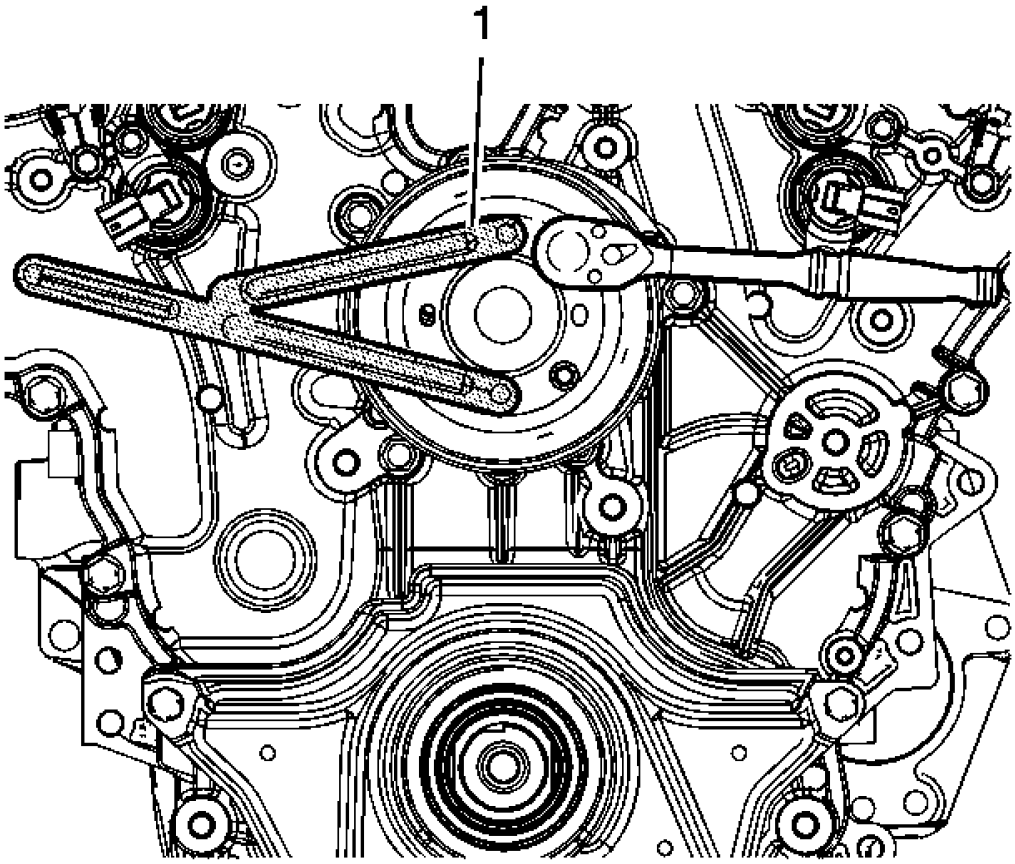


Fig. 43: View Of EN 46104
Courtesy of GENERAL MOTORS CORP.

1. Install the **EN 46104** (1) onto the water pump pulley. See **Special Tools** .

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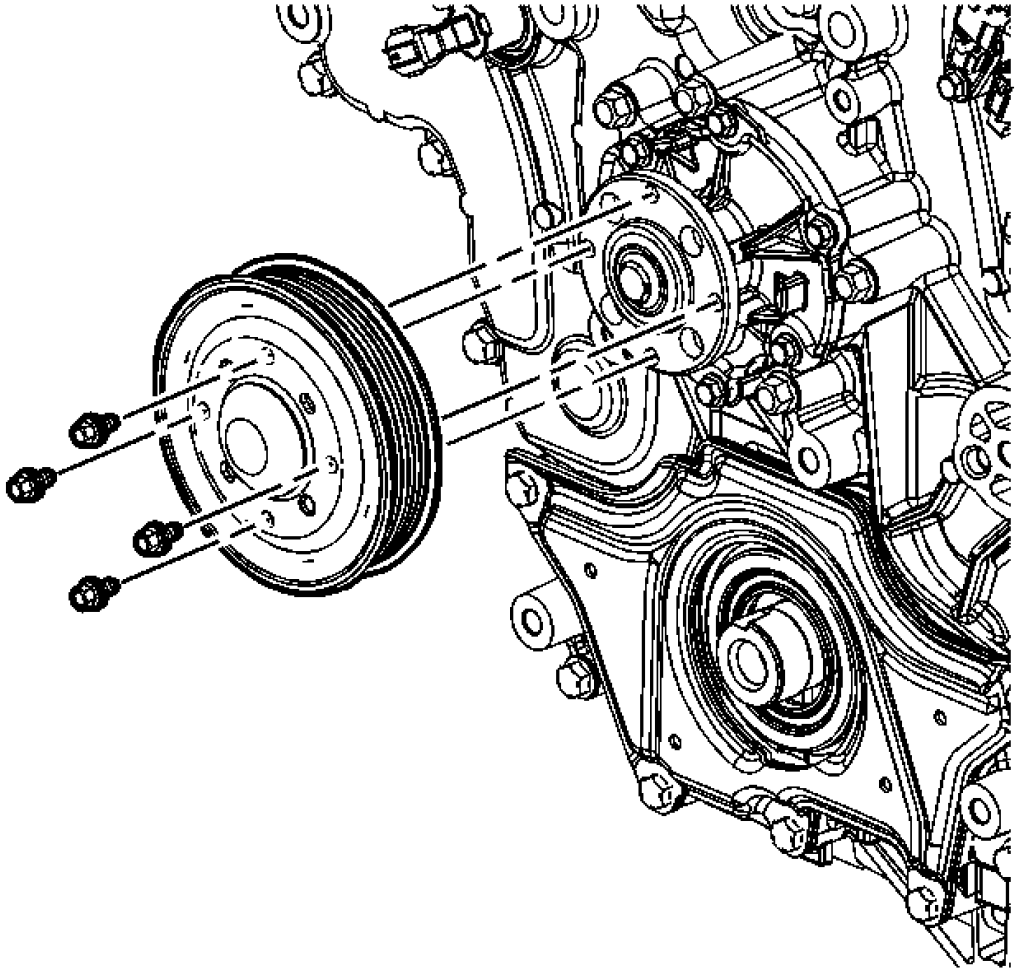


Fig. 44: View Of Water Pump Pulley Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the water pump pulley bolts.
3. Remove the water pump pulley.

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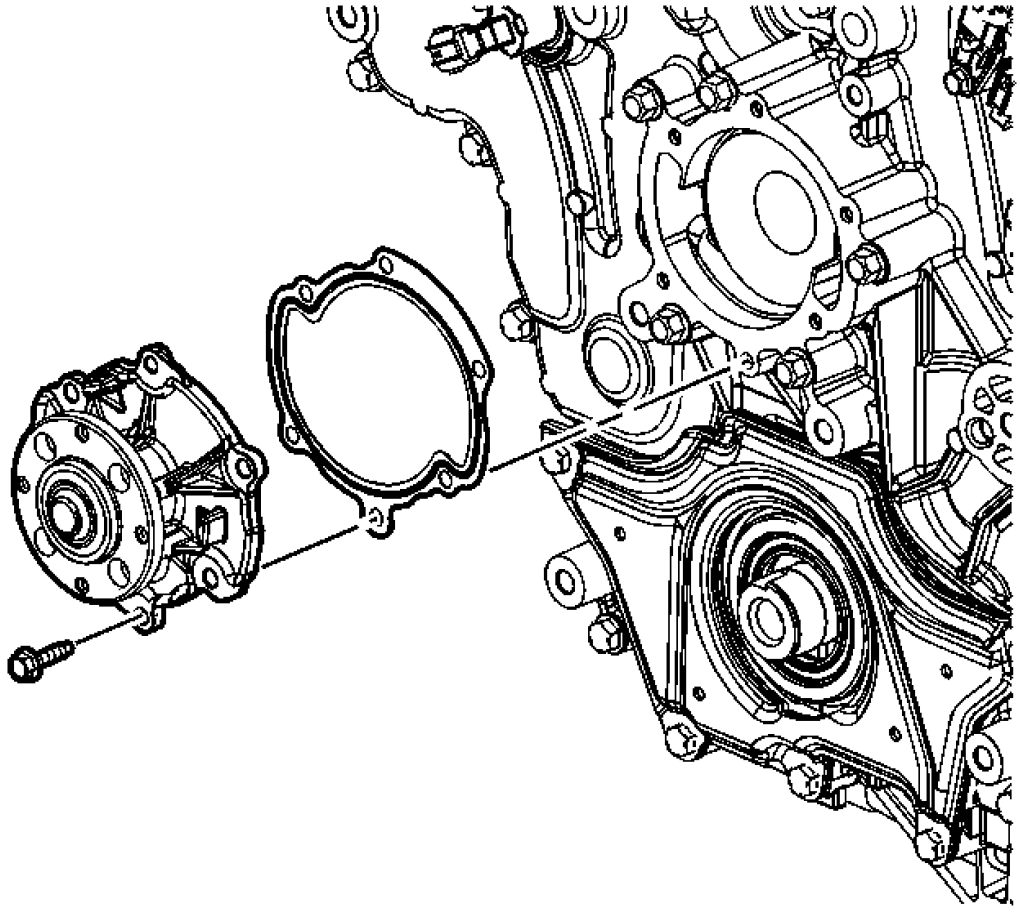


Fig. 45: View Of Water Pump Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the water pump bolts.
5. Remove the water pump from the front cover.
6. Remove the water pump gasket.

ENGINE FRONT COVER REMOVAL

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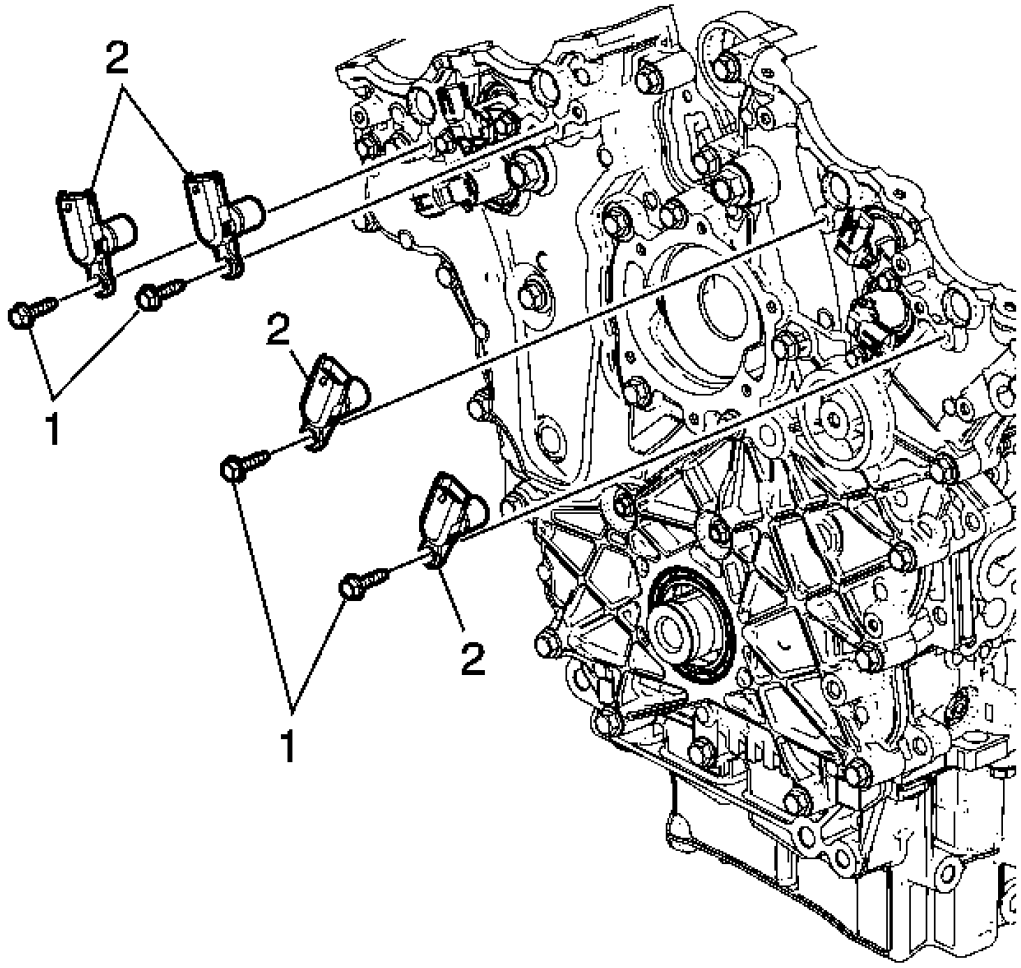


Fig. 46: Camshaft Position Sensors & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the camshaft position sensor bolts (1).
2. Remove the camshaft position sensors (2).

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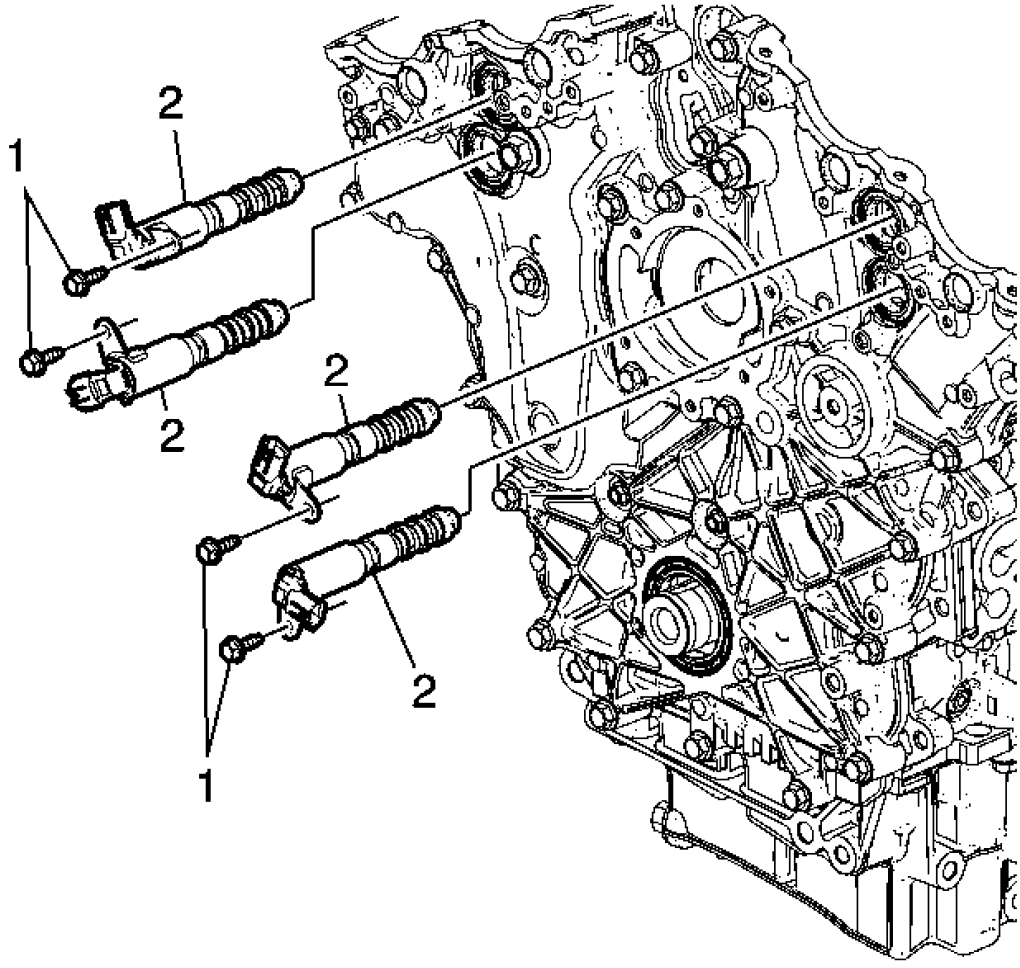


Fig. 47: Camshaft Position Actuator Valve & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the camshaft position actuator valve bolts (1).

CAUTION: The camshaft position actuator valves must be removed from the front cover prior to front cover removal or damage to the valves may occur.

4. Remove the camshaft position actuator valves (2) from the front cover.

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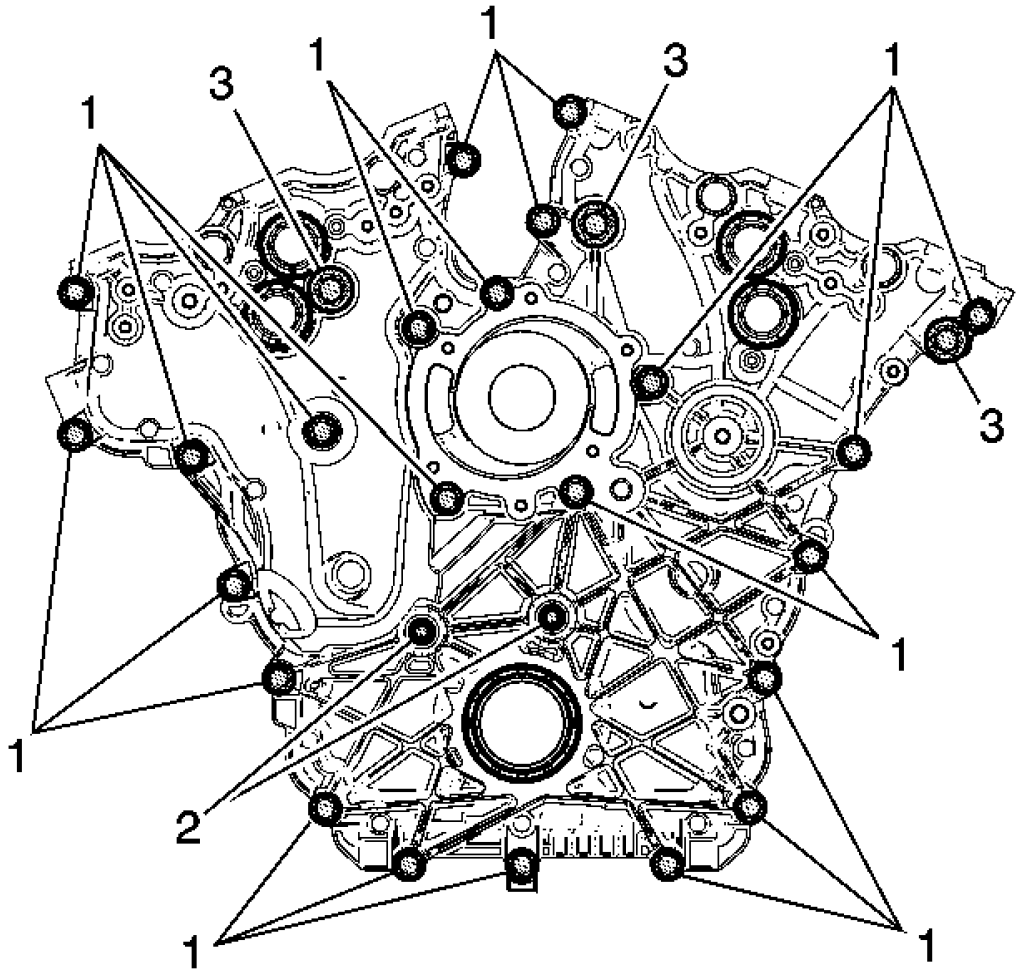


Fig. 48: Engine Front Cover Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Engine front cover bolts in the number (3) location are model dependent and may have already been removed.

NOTE: There are a total of 23 M8 bolts (1) and 2 M6 bolts (2) that must be removed, and 3 optional M12 bolts (3) that may need to be removed before the front cover will separate from the engine block.

5. Remove the engine front cover bolts (1-3).

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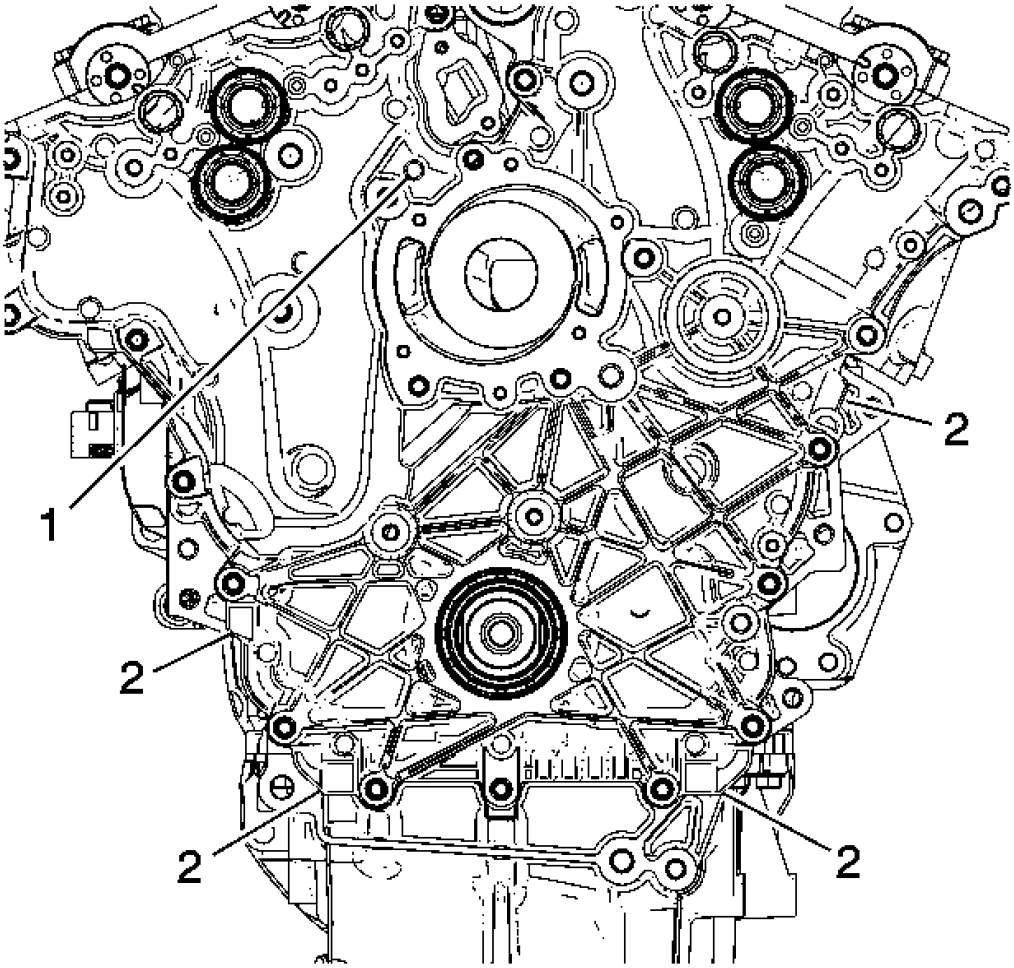


Fig. 49: Front Cover Jackscrew Hole & Pry Points
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not use the jackscrew hole without first removing all engine front cover bolts. Failure to remove all engine front cover bolts before using the jackscrew hole could result in damage to components.

CAUTION: Do not pry between the engine front cover and the camshaft position sensors or the camshaft position actuators in order to separate the RTV. Use the pry points and a bolt in the jackscrew hole in order to remove the engine front cover. Damage to the camshaft position sensors or the camshaft position actuators may occur if the camshaft position sensors or the camshaft position actuators are used to pry

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against in order to remove the engine front cover.

6. Loosely install a 10 x 1.5 mm bolt in the jackscrew hole (1).
7. Using the pry points (2) located at the edge of the front cover and the jackscrew, separate the room temperature vulcanizing (RTV) sealant.

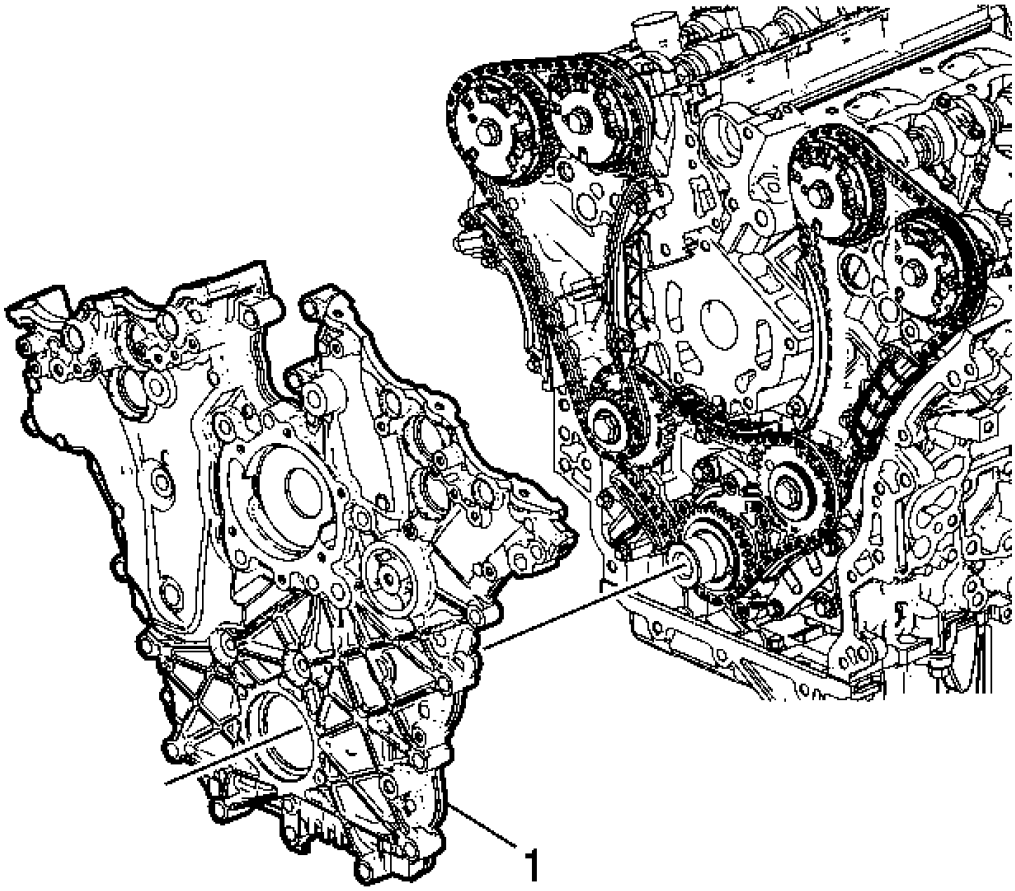


Fig. 50: Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

8. Remove the engine front cover (1).

SECONDARY TIMING CHAIN TENSIONER REMOVAL - RIGHT SIDE

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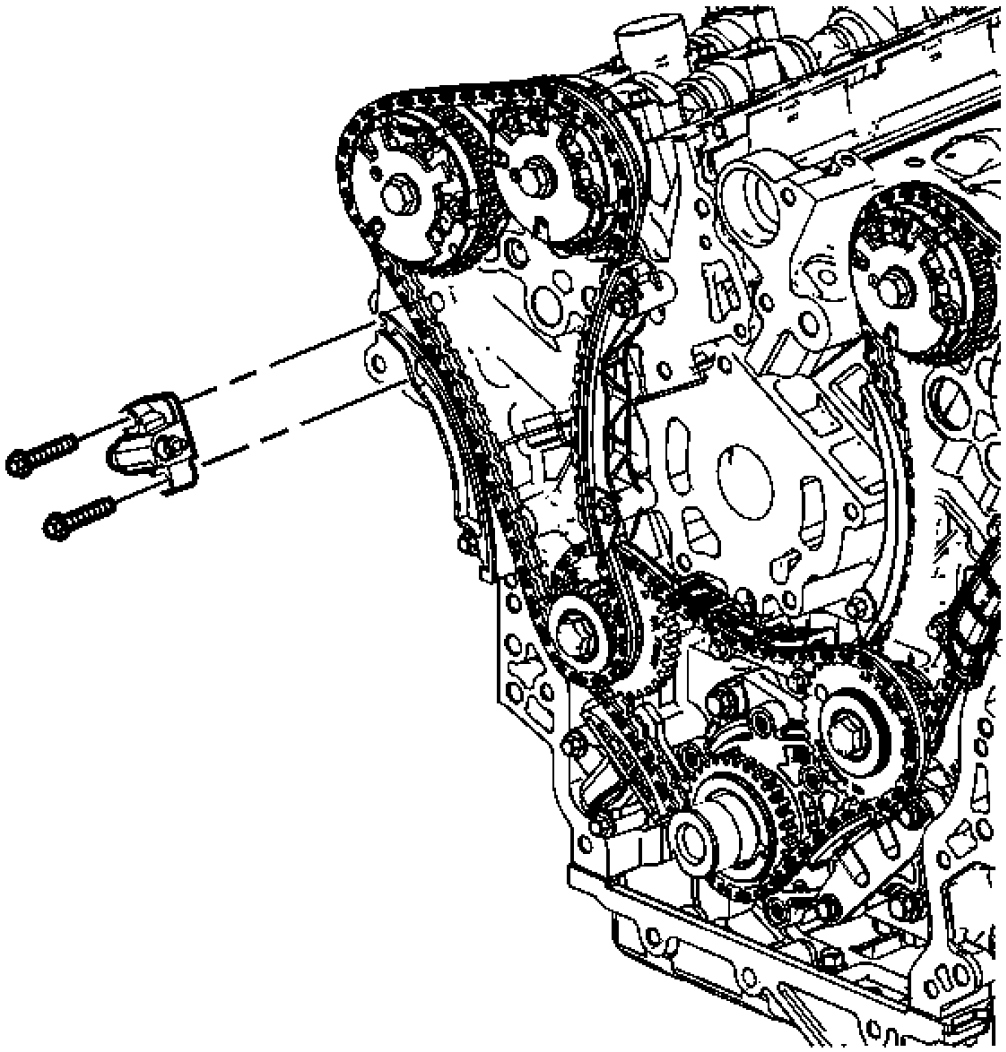


Fig. 51: View Of Secondary Camshaft Drive Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the right secondary camshaft drive chain tensioner bolts.
2. Remove the right secondary camshaft drive chain tensioner.

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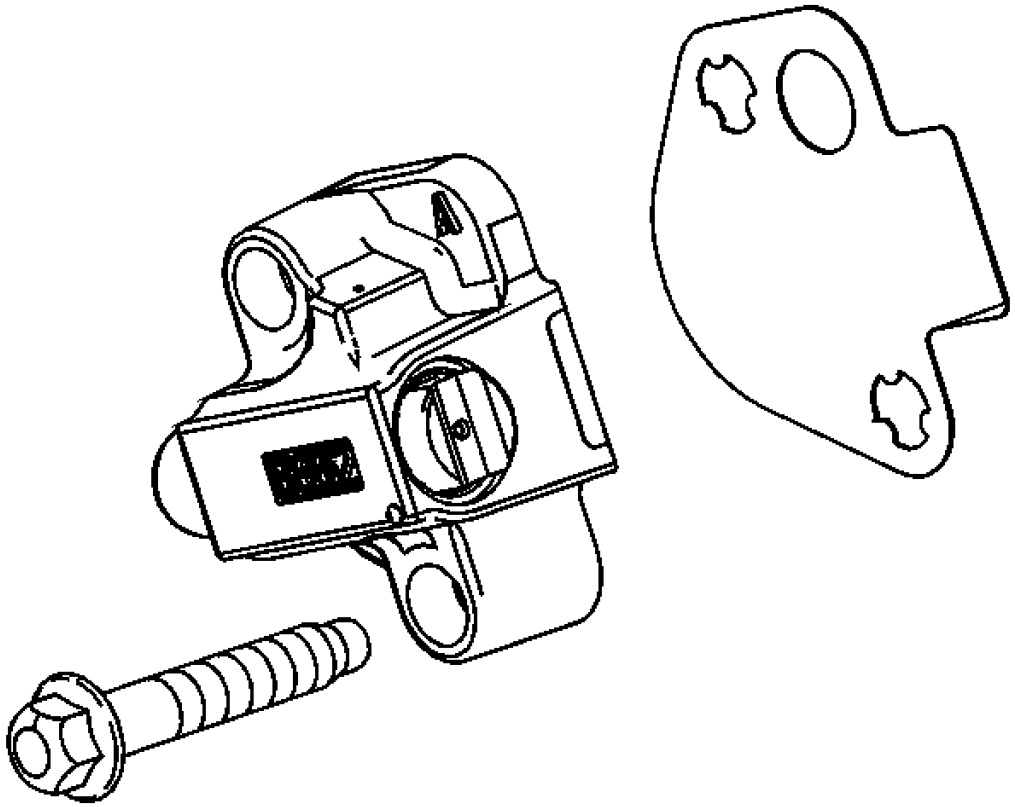


Fig. 52: Identifying Right Secondary Camshaft Drive Chain Tensioner Gasket
Courtesy of GENERAL MOTORS CORP.

3. Remove and discard the right secondary camshaft drive chain tensioner gasket.
4. Inspect the right secondary camshaft drive chain tensioner mounting surface on the right cylinder head for burrs or any defects that would degrade the sealing of the NEW right secondary camshaft drive chain tensioner gasket.

SECONDARY CAMSHAFT DRIVE CHAIN SHOE REMOVAL - RIGHT SIDE

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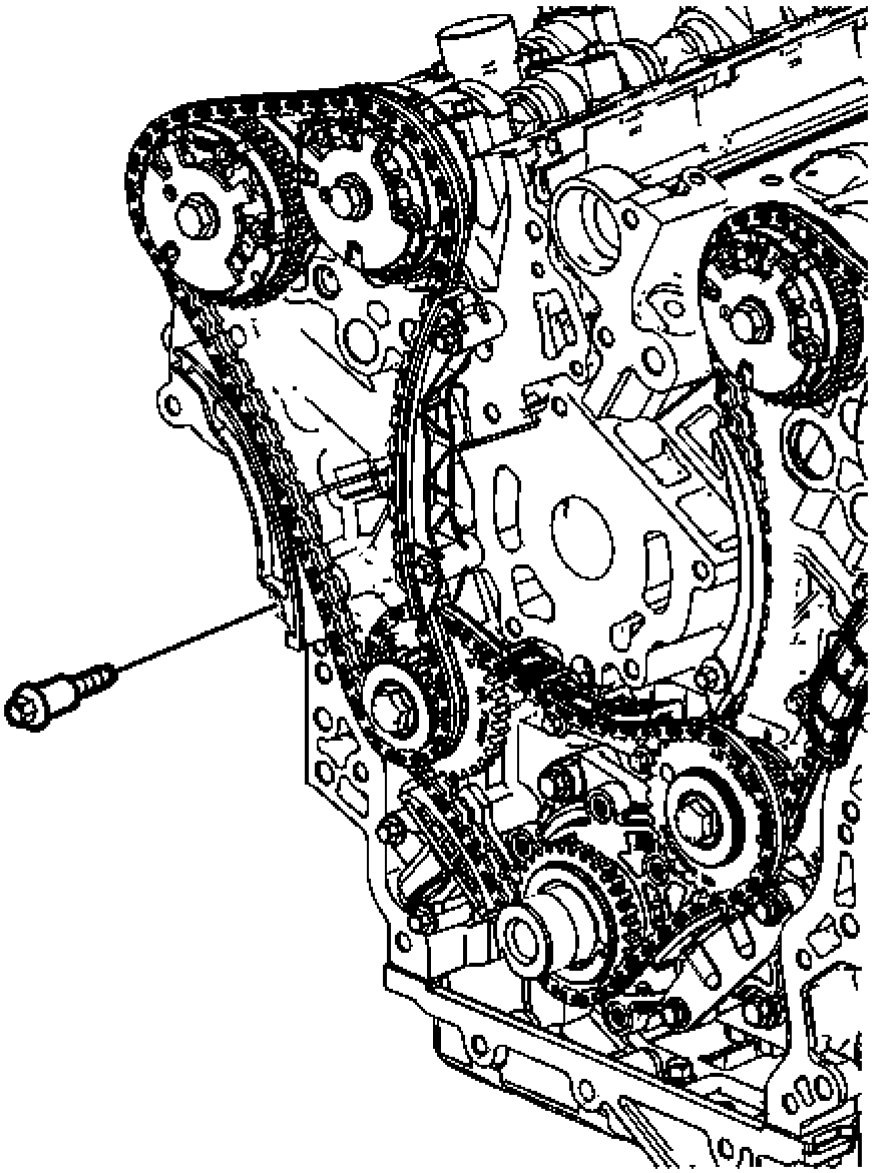


Fig. 53: Identifying Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the right secondary camshaft drive chain shoe bolt.

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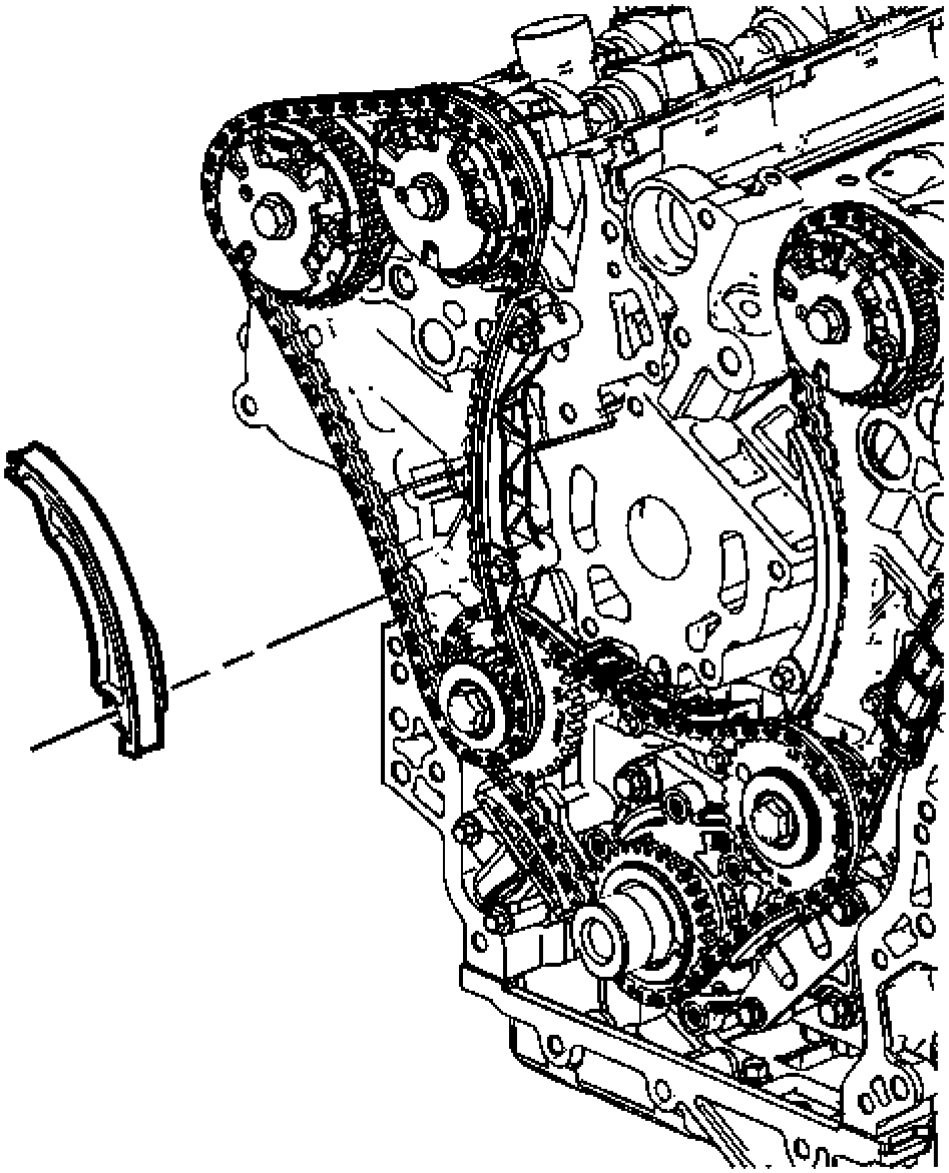


Fig. 54: View Of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS CORP.

2. Remove the right secondary camshaft drive chain shoe.

SECONDARY TIMING CHAIN GUIDE REMOVAL - RIGHT SIDE

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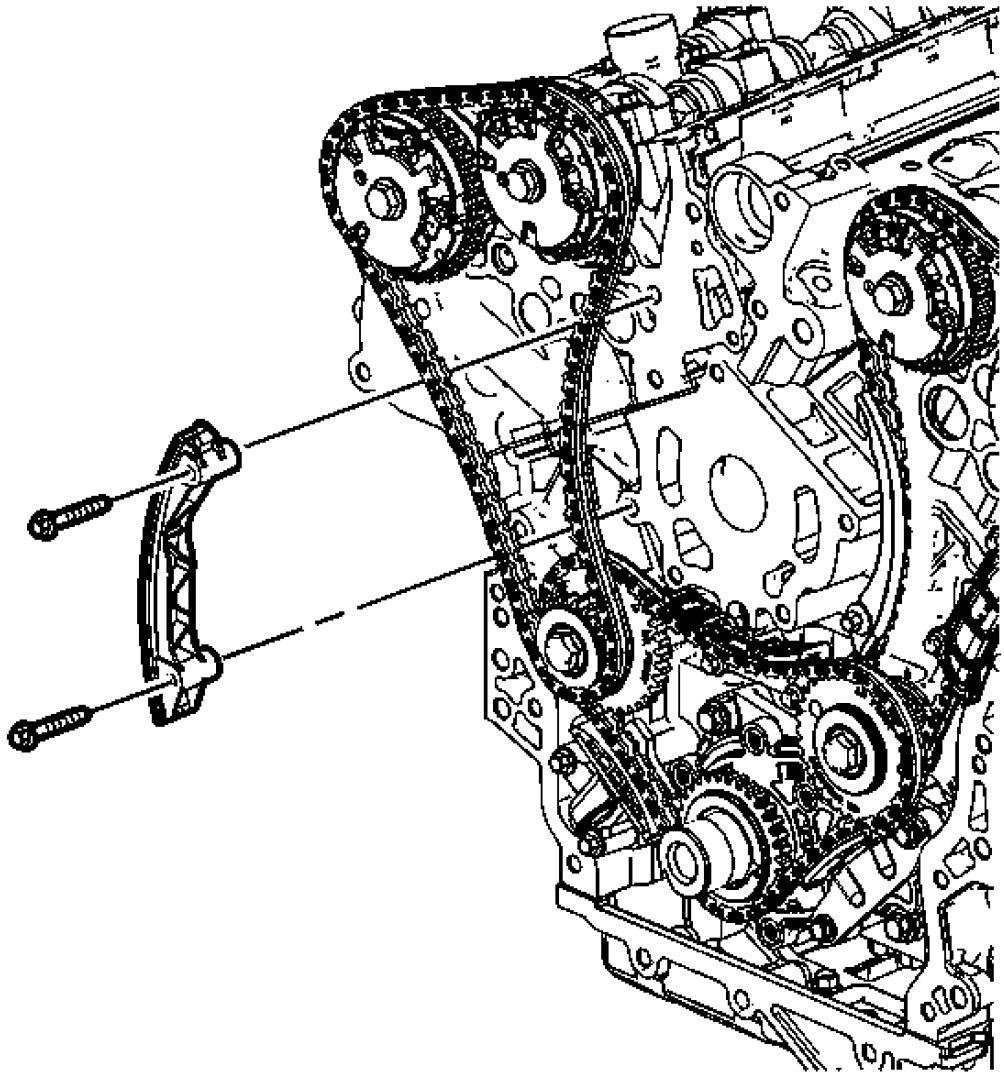


Fig. 55: Identifying Secondary Camshaft Drive Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the right secondary camshaft drive chain guide bolts.
2. Remove the right secondary camshaft drive chain guide.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REMOVAL - RIGHT SIDE

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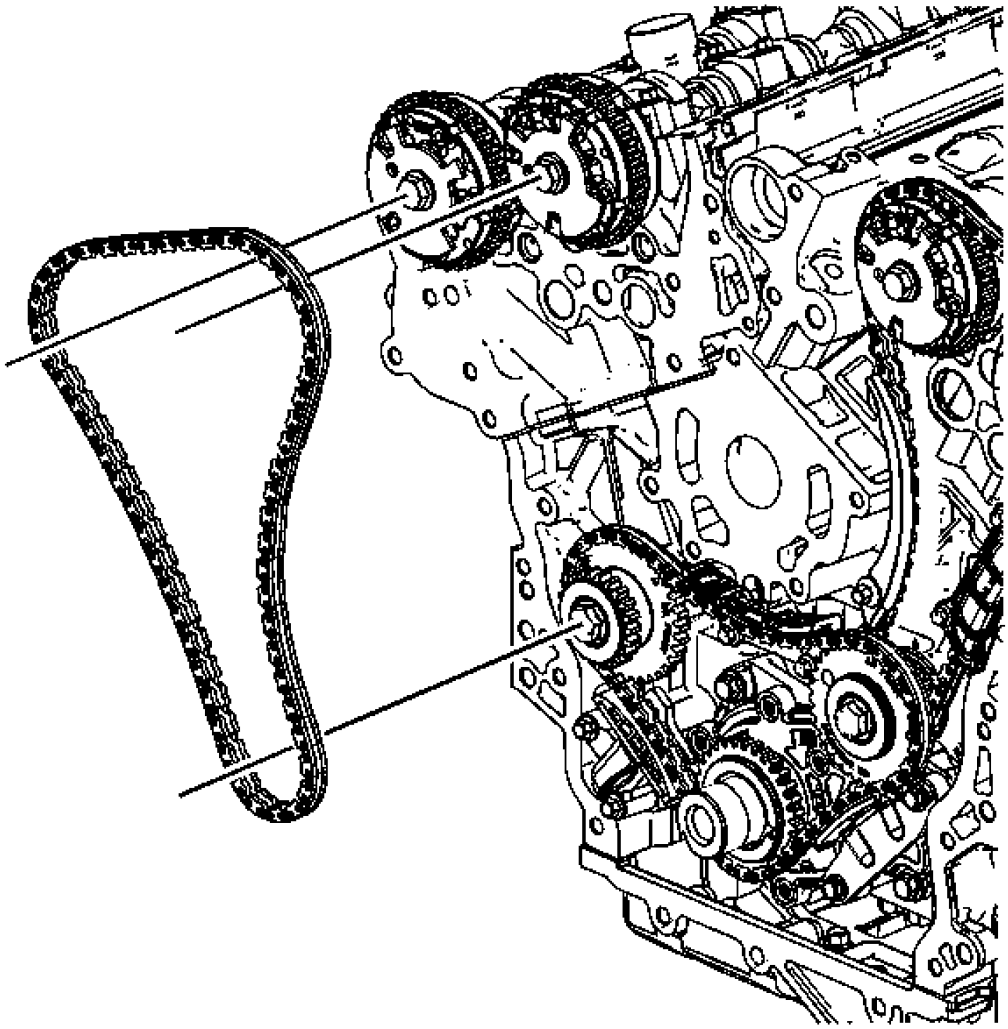


Fig. 56: View Of Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

Remove the right secondary camshaft drive chain from the right camshaft position actuators and the right camshaft intermediate drive chain idler sprocket.

PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REMOVAL

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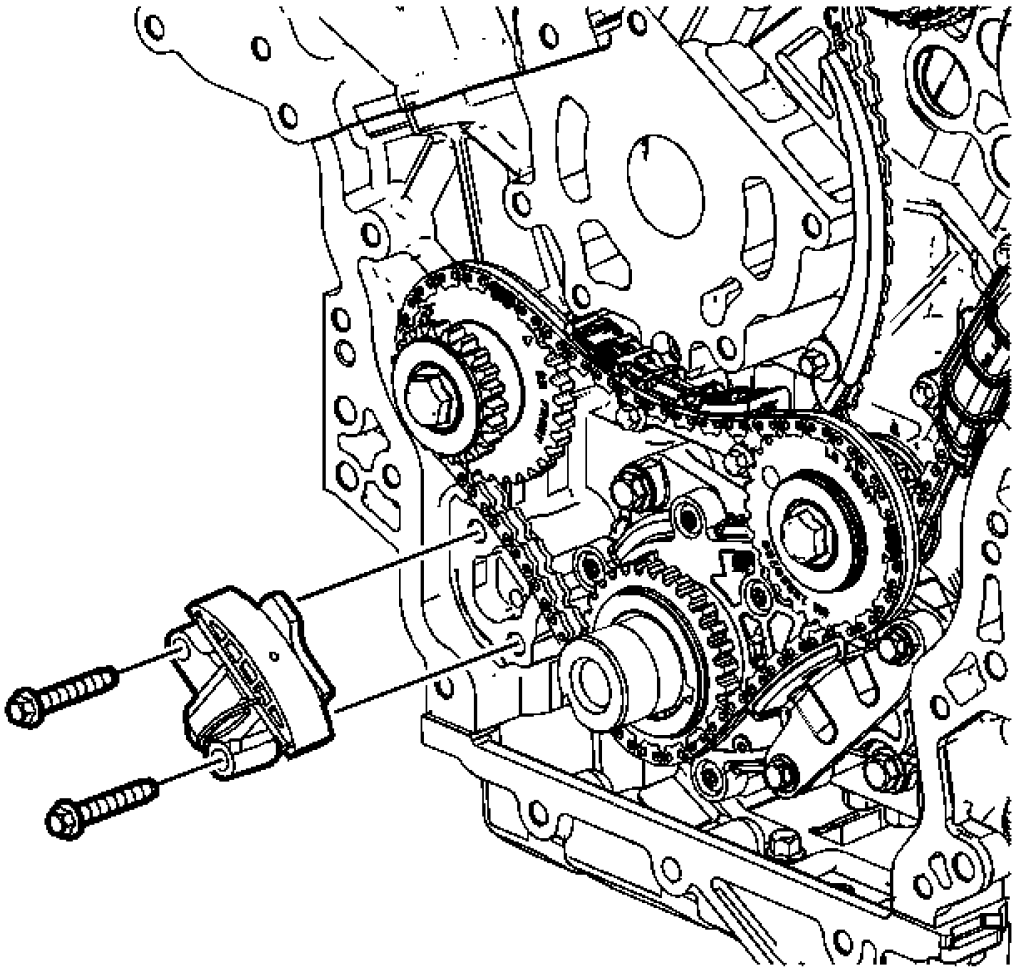


Fig. 57: View Of Primary Camshaft Drive Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the primary camshaft drive chain tensioner bolts.
2. Remove the primary camshaft drive chain tensioner.

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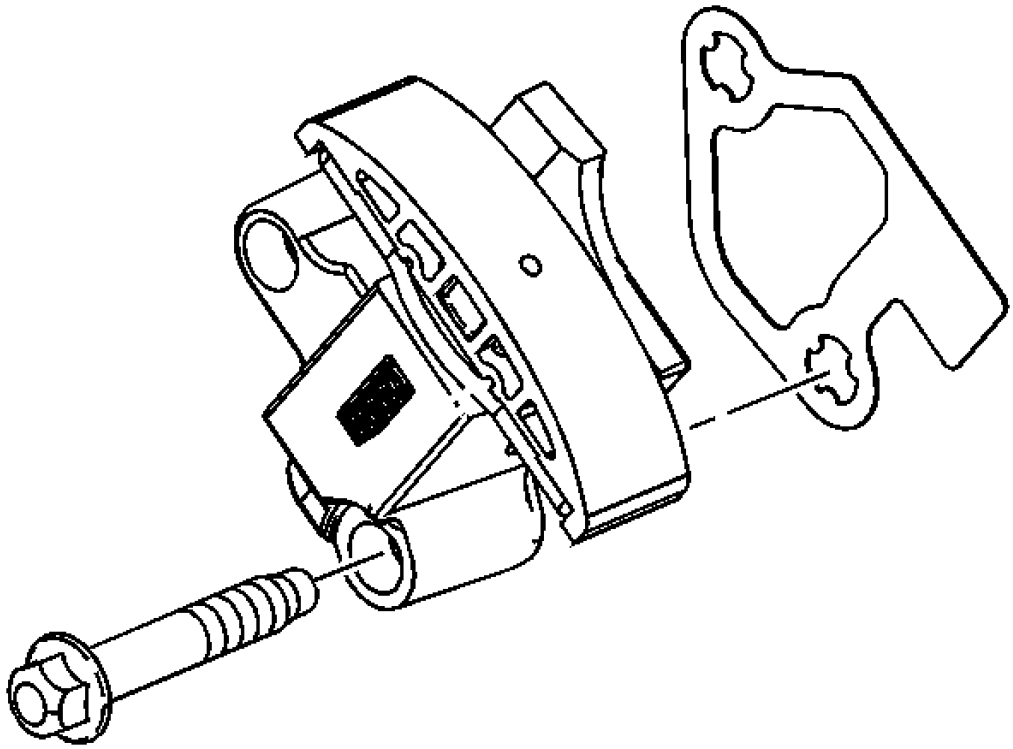


Fig. 58: Identifying Primary Camshaft Drive Chain Tensioner Gasket
Courtesy of GENERAL MOTORS CORP.

3. Remove and discard the primary camshaft drive chain tensioner gasket.
4. Inspect the primary camshaft drive chain tensioner mounting surface on the engine block for burrs or any defects that would degrade the sealing of the NEW primary camshaft drive chain tensioner gasket.

PRIMARY TIMING CHAIN GUIDE REMOVAL - UPPER

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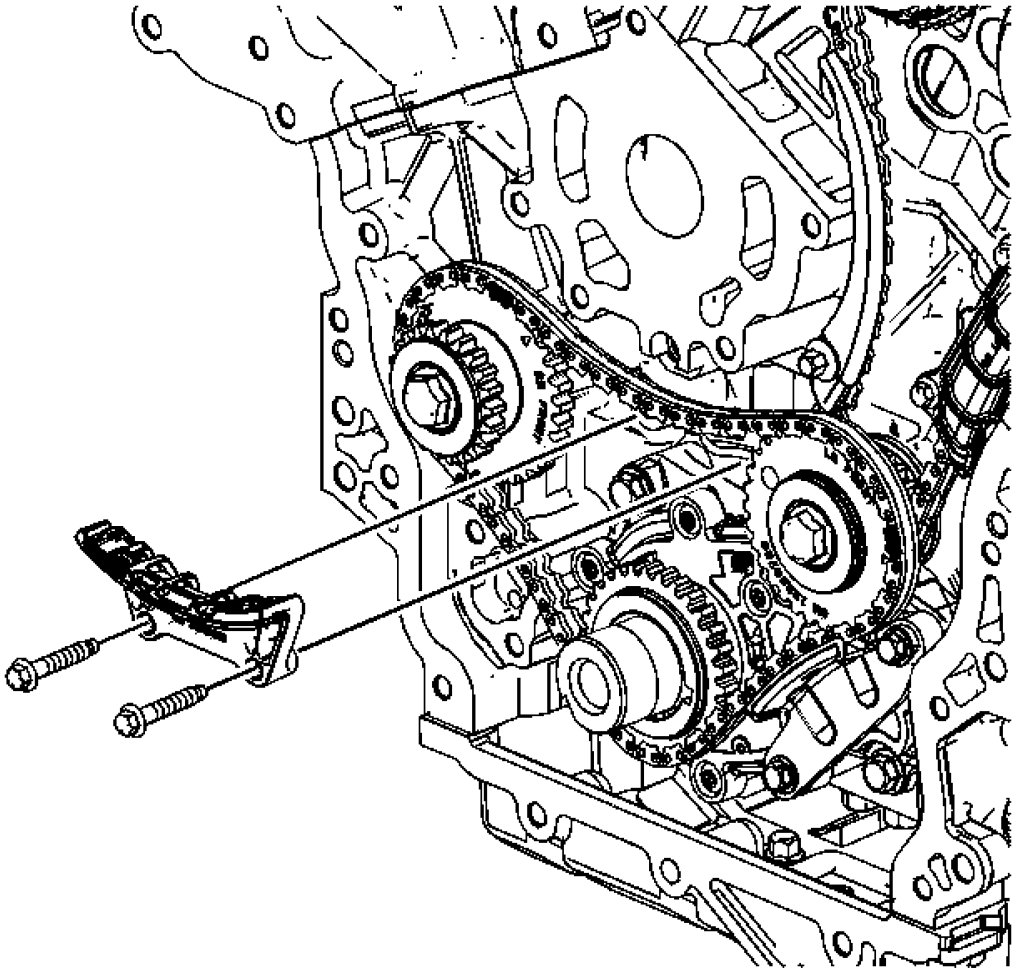


Fig. 59: Identifying Primary Camshaft Drive Chain Upper Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the primary camshaft drive chain upper guide bolts.
2. Remove the primary camshaft drive chain upper guides.

PRIMARY TIMING CHAIN GUIDE REMOVAL - LOWER

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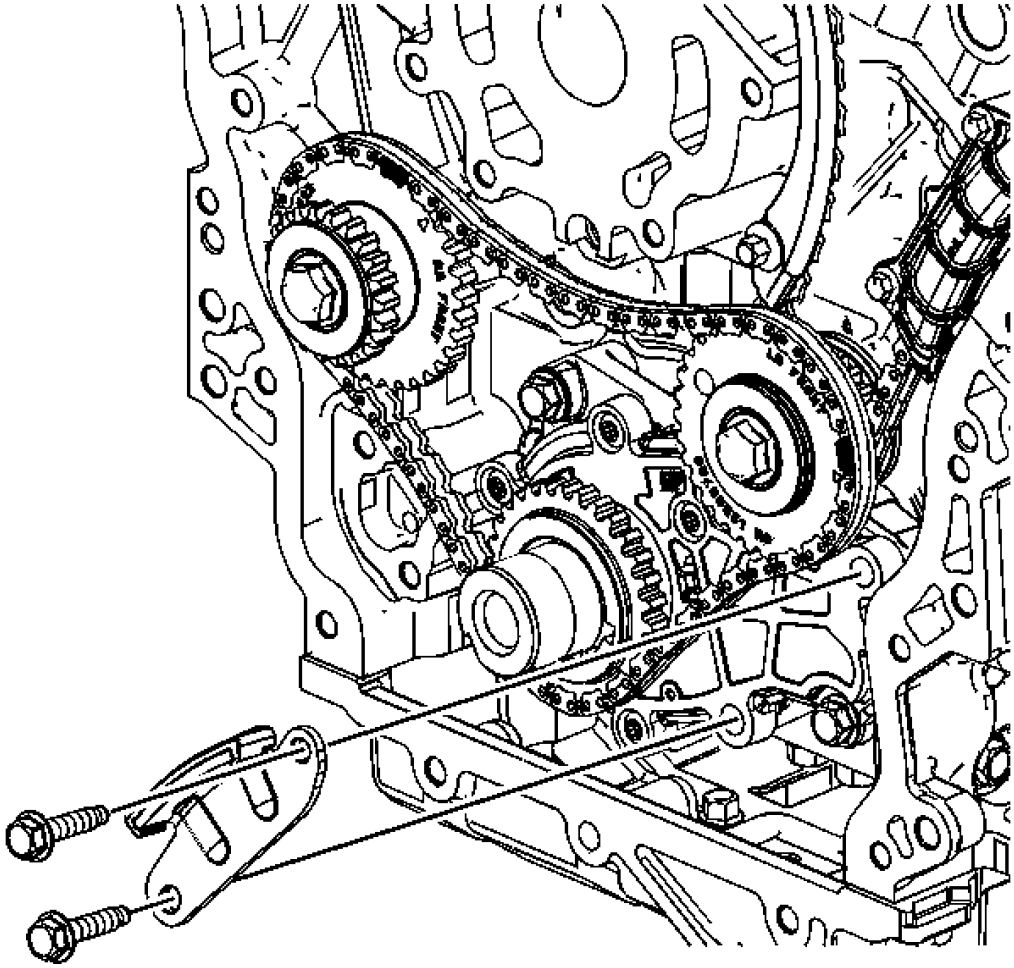


Fig. 60: View Of Primary Camshaft Drive Chain Lower Guide Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the primary camshaft drive chain lower guide bolts.
2. Remove the primary camshaft drive chain lower guide.

PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REMOVAL

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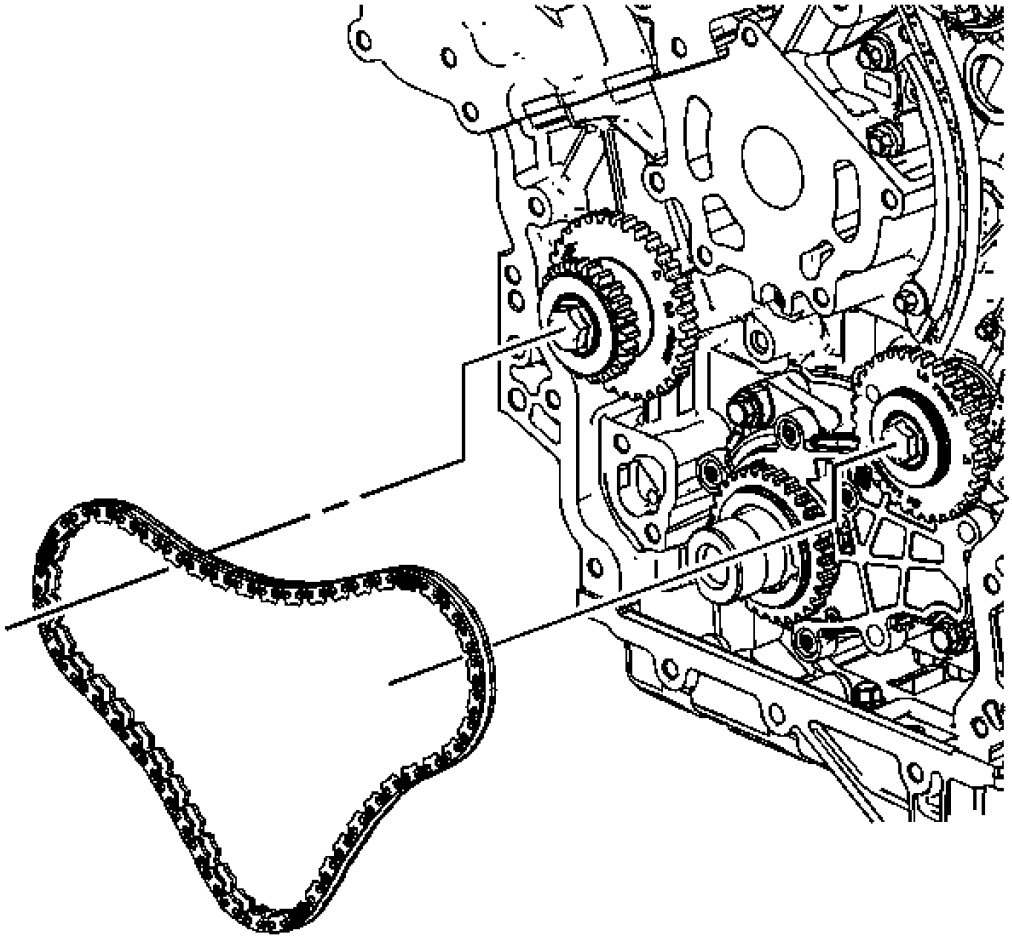


Fig. 61: Identifying Primary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

Remove the primary camshaft drive chain.

TIMING CHAIN IDLER SPROCKET REMOVAL - RIGHT SIDE

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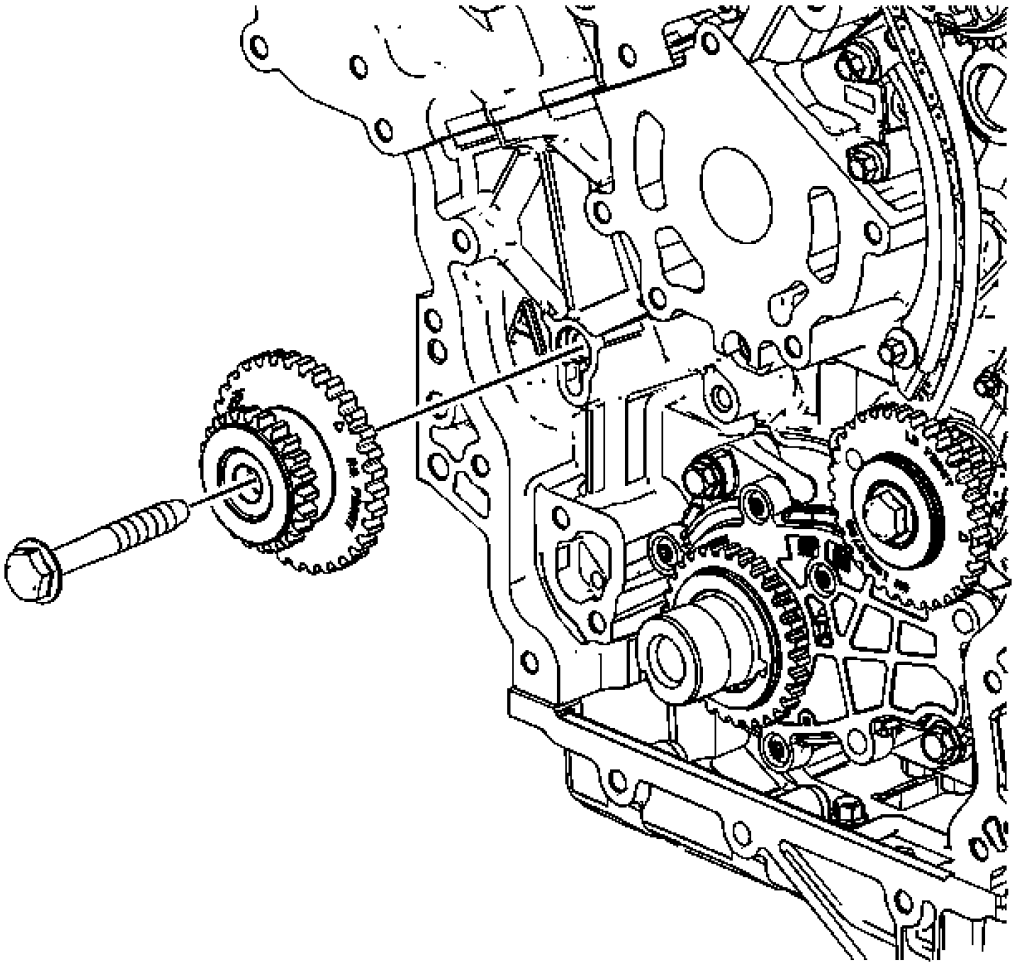


Fig. 62: Identifying Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the right camshaft intermediate drive chain idler bolt.
2. Remove the right camshaft intermediate drive chain idler.

SECONDARY TIMING CHAIN TENSIONER REMOVAL - LEFT SIDE

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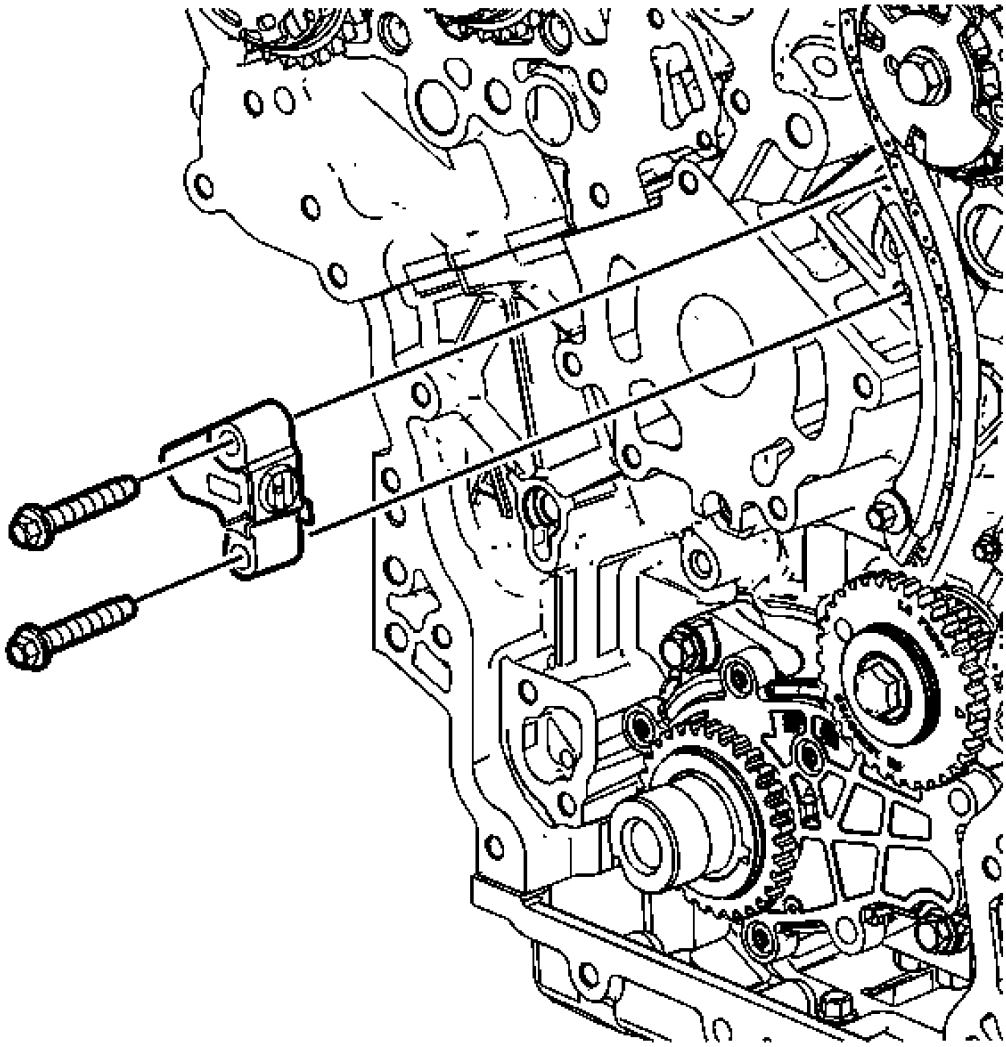


Fig. 63: View Of Secondary Camshaft Drive Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the left secondary camshaft drive chain tensioner bolts.
2. Remove the left secondary camshaft drive chain tensioner.

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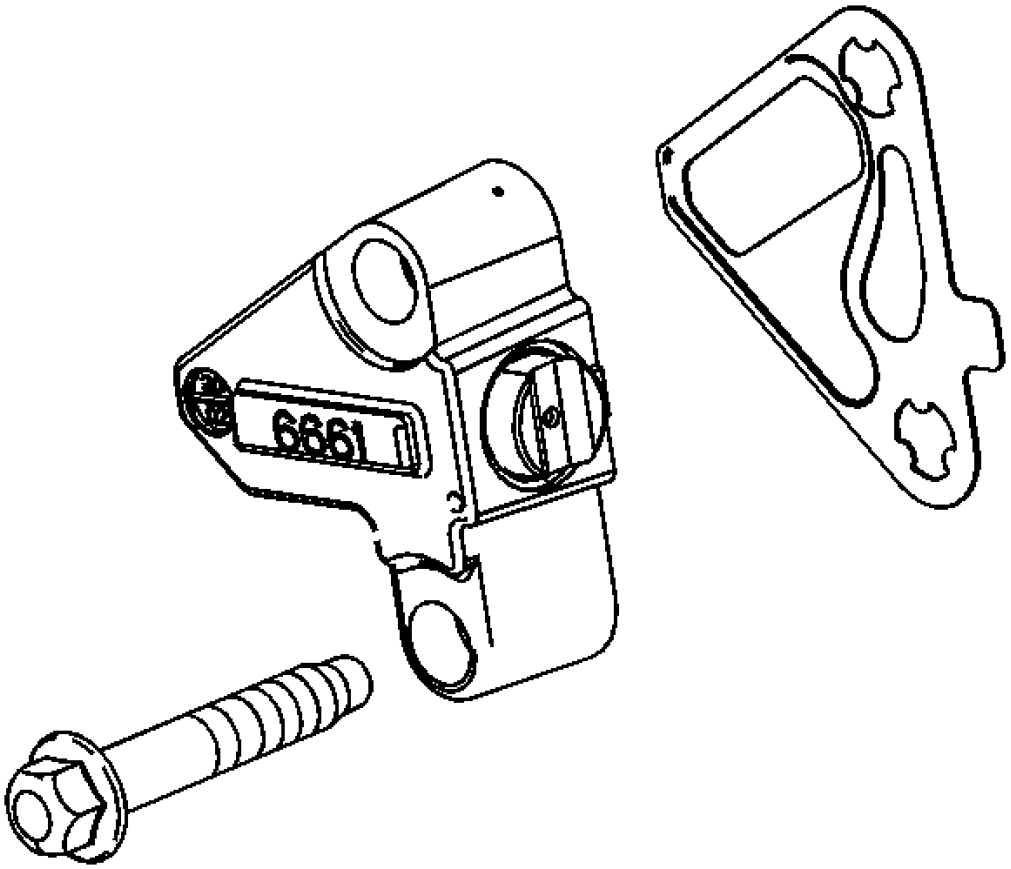


Fig. 64: Identifying Left Secondary Camshaft Drive Chain Tensioner & Gasket
Courtesy of GENERAL MOTORS CORP.

3. Remove and discard the left secondary camshaft drive chain tensioner gasket.
4. Inspect the left secondary camshaft drive chain tensioner mounting surface on the left cylinder head for burrs or any defects that would degrade the sealing of the NEW left secondary camshaft drive chain tensioner gasket.

SECONDARY CAMSHAFT DRIVE CHAIN SHOE REMOVAL - LEFT SIDE

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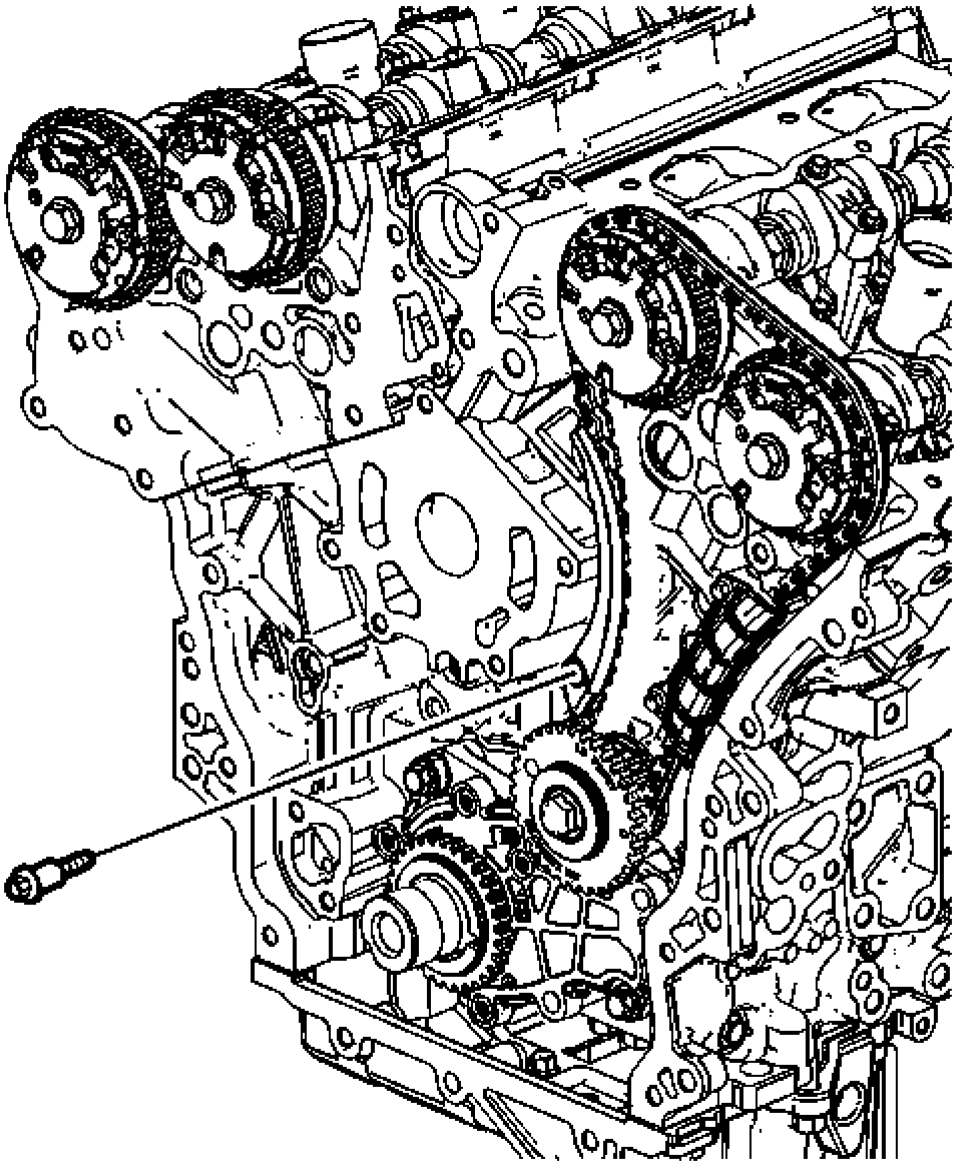


Fig. 65: Identifying Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the left secondary camshaft drive chain shoe bolt.

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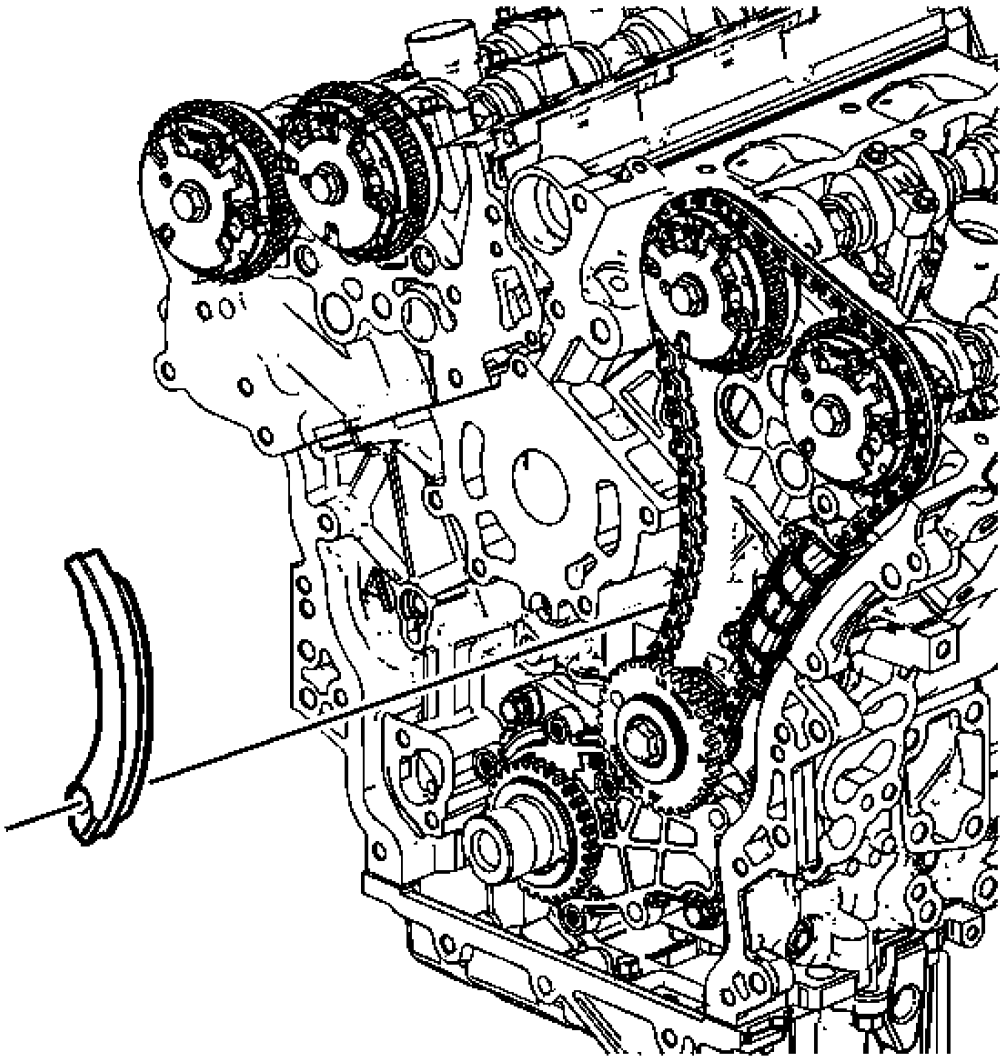


Fig. 66: View Of Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS CORP.

2. Remove the left secondary camshaft drive chain shoe.

SECONDARY TIMING CHAIN GUIDE REMOVAL - LEFT SIDE

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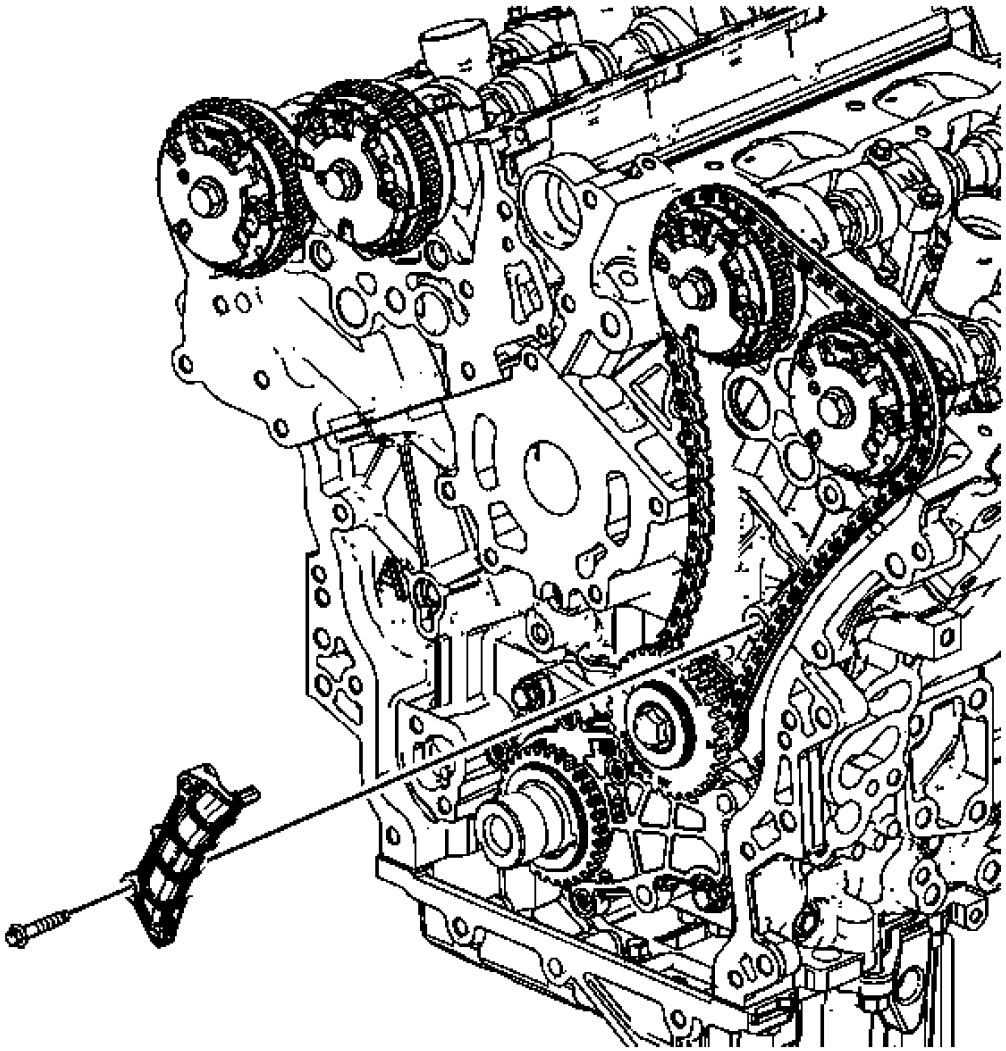


Fig. 67: View Of Secondary Camshaft Drive Chain Guide Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the left secondary camshaft drive chain guide bolts.
2. Remove the left secondary camshaft drive chain guide.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REMOVAL - LEFT SIDE

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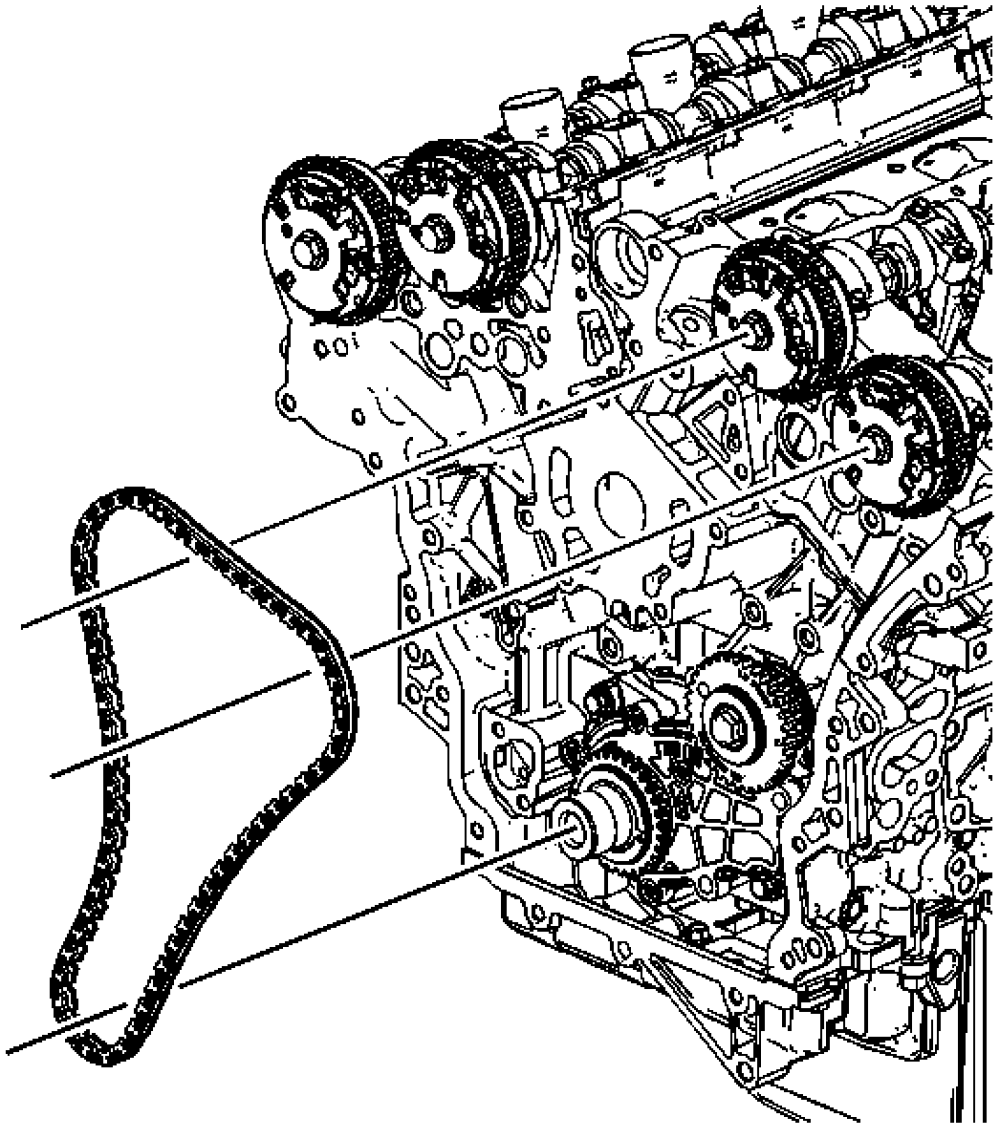


Fig. 68: Identifying Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

Remove the left secondary camshaft drive chain from the left camshaft position actuators and the left camshaft intermediate drive chain idler sprocket.

TIMING CHAIN IDLER SPROCKET REMOVAL - LEFT SIDE

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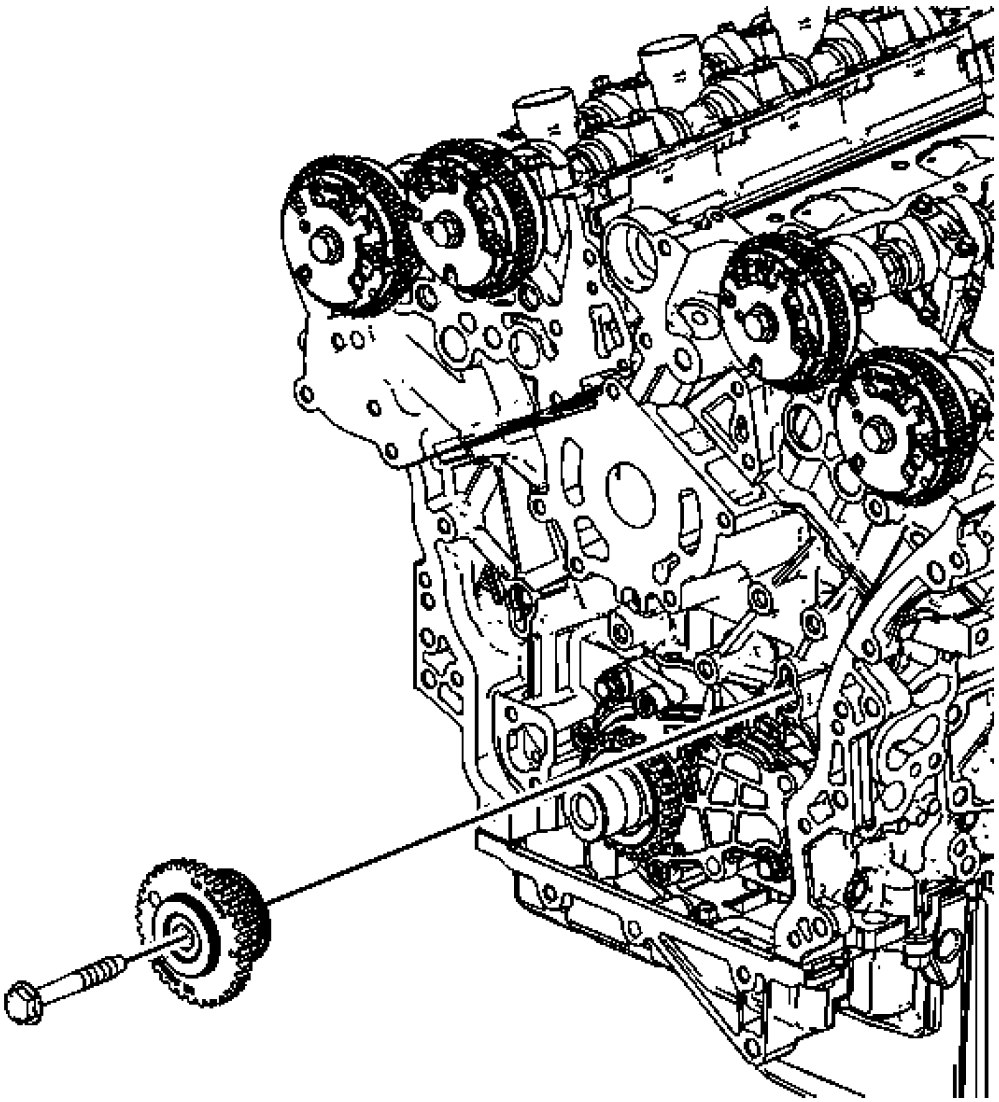


Fig. 69: View Of Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the left camshaft intermediate drive chain idler bolt.
2. Remove the left camshaft intermediate drive chain idler.

CRANKSHAFT SPROCKET REMOVAL

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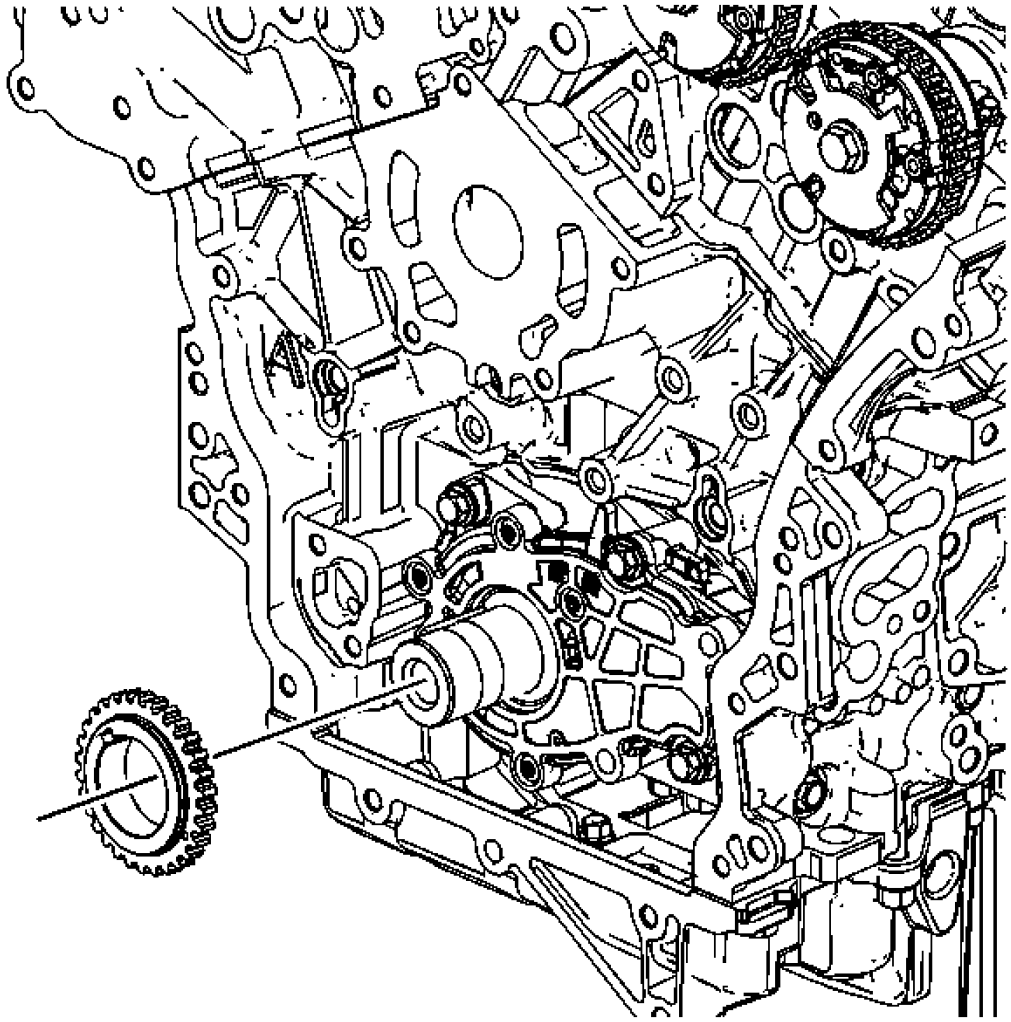


Fig. 70: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

Remove the crankshaft sprocket from the nose of the crankshaft.

CAMSHAFT POSITION ACTUATOR REMOVAL - LEFT SIDE EXHAUST

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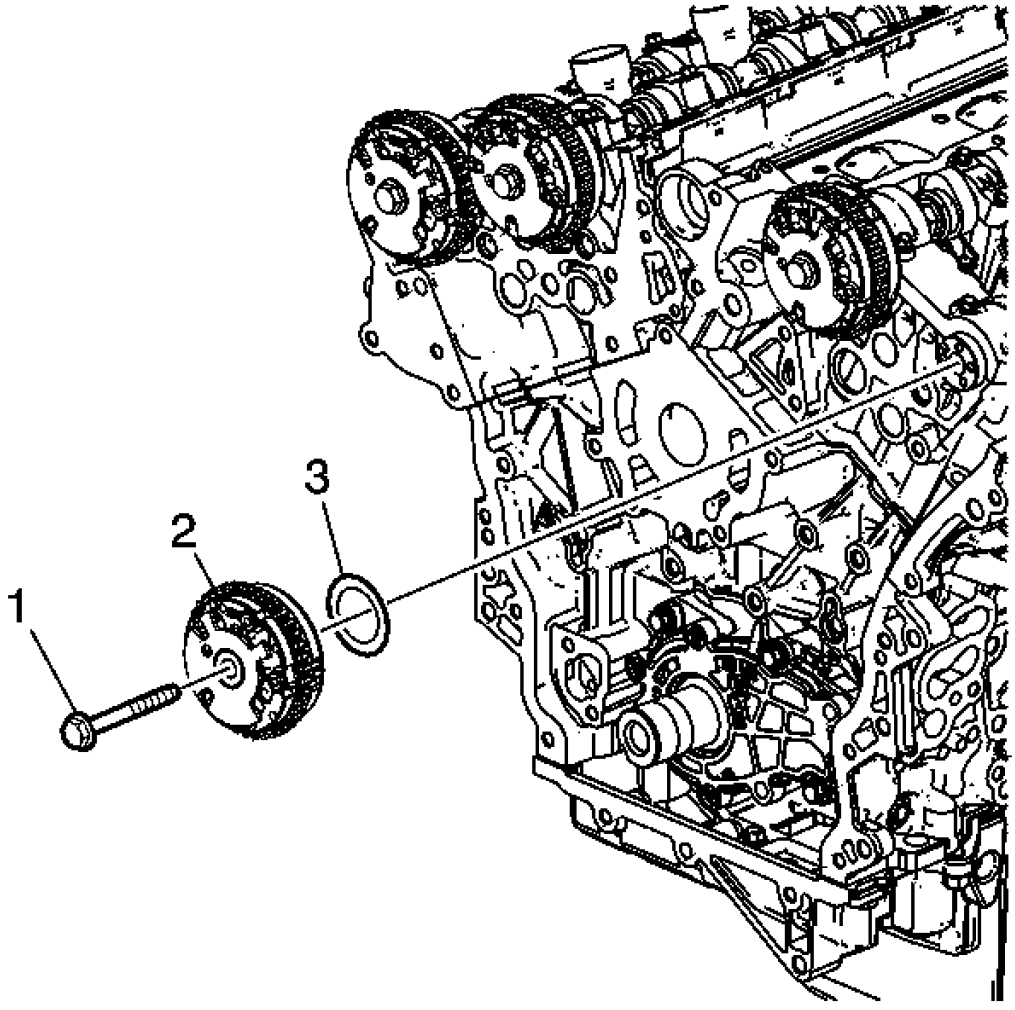


Fig. 71: Locating Exhaust Camshaft Position Actuator & Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

1. Use an open wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.
2. Remove the left exhaust camshaft position actuator bolt (1).
3. Remove the left exhaust camshaft position actuator (2).
4. Remove the camshaft thrust washer if applicable (3).

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CAMSHAFT POSITION ACTUATOR REMOVAL - LEFT SIDE INTAKE

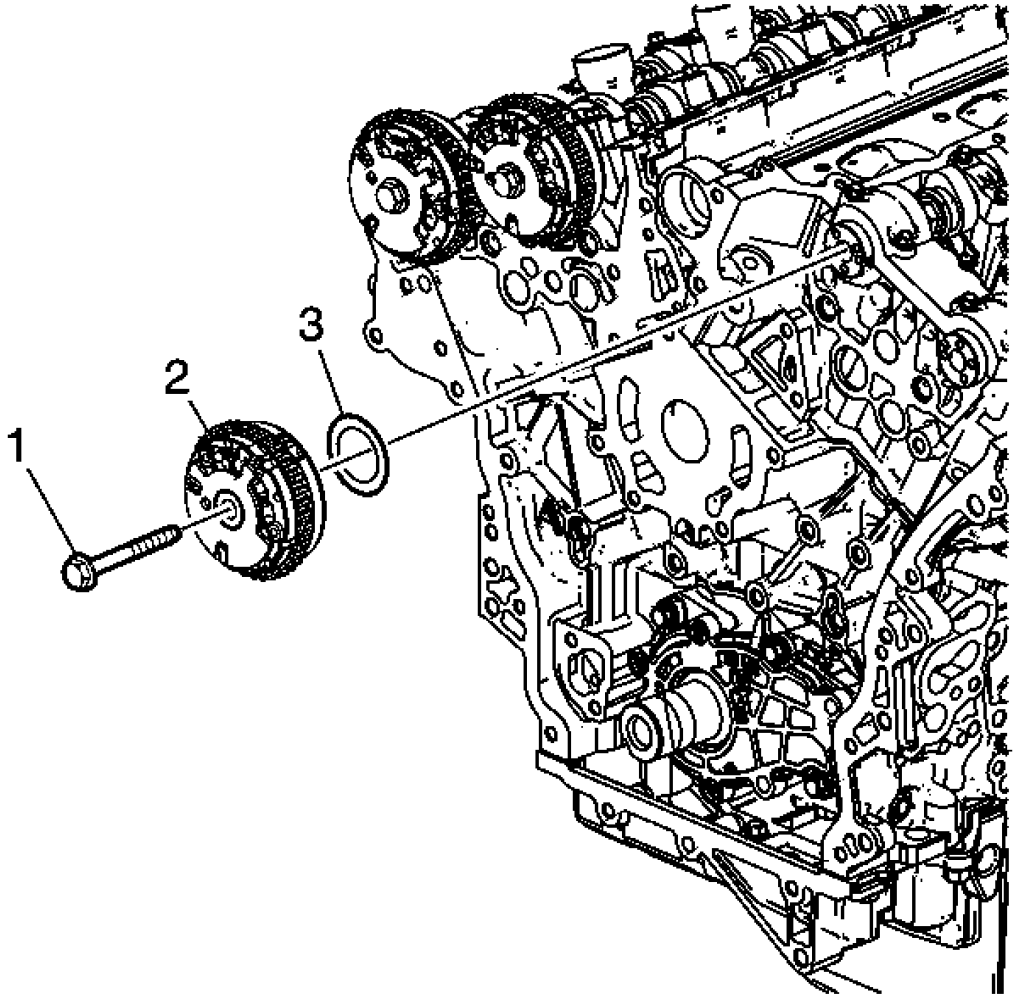


Fig. 72: View Of Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

1. Use an open wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.
2. Remove the left intake camshaft position actuator bolt (1).

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3. Remove the left intake camshaft position actuator (2).
4. Remove the camshaft thrust washer if applicable (3).

CAMSHAFT POSITION ACTUATOR REMOVAL - RIGHT SIDE EXHAUST

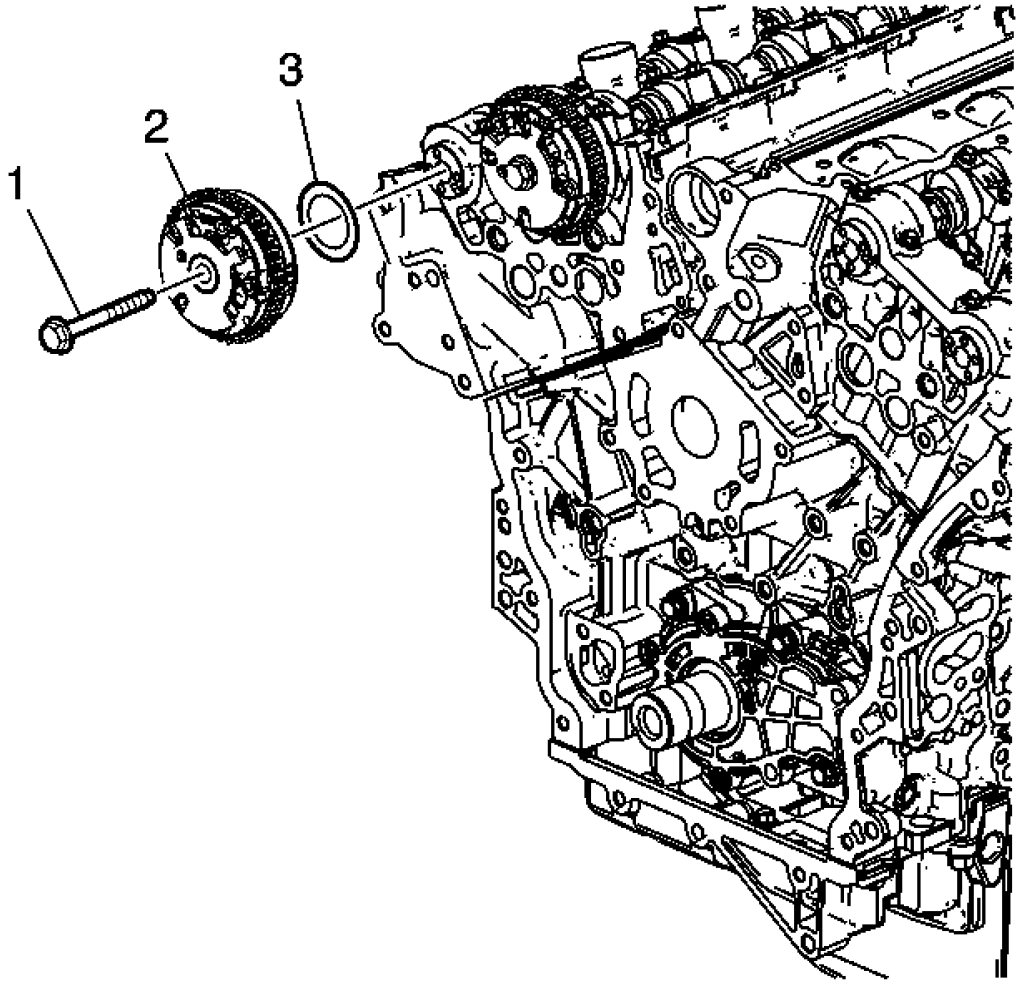


Fig. 73: Identifying Camshaft Position Actuator & Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

1. Use an open wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening

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the camshaft position actuator bolt.

2. Remove the right exhaust camshaft position actuator bolt (1).
3. Remove the right exhaust camshaft position actuator (2).
4. Remove the camshaft thrust washer if applicable (3).

CAMSHAFT POSITION ACTUATOR REMOVAL - RIGHT SIDE INTAKE

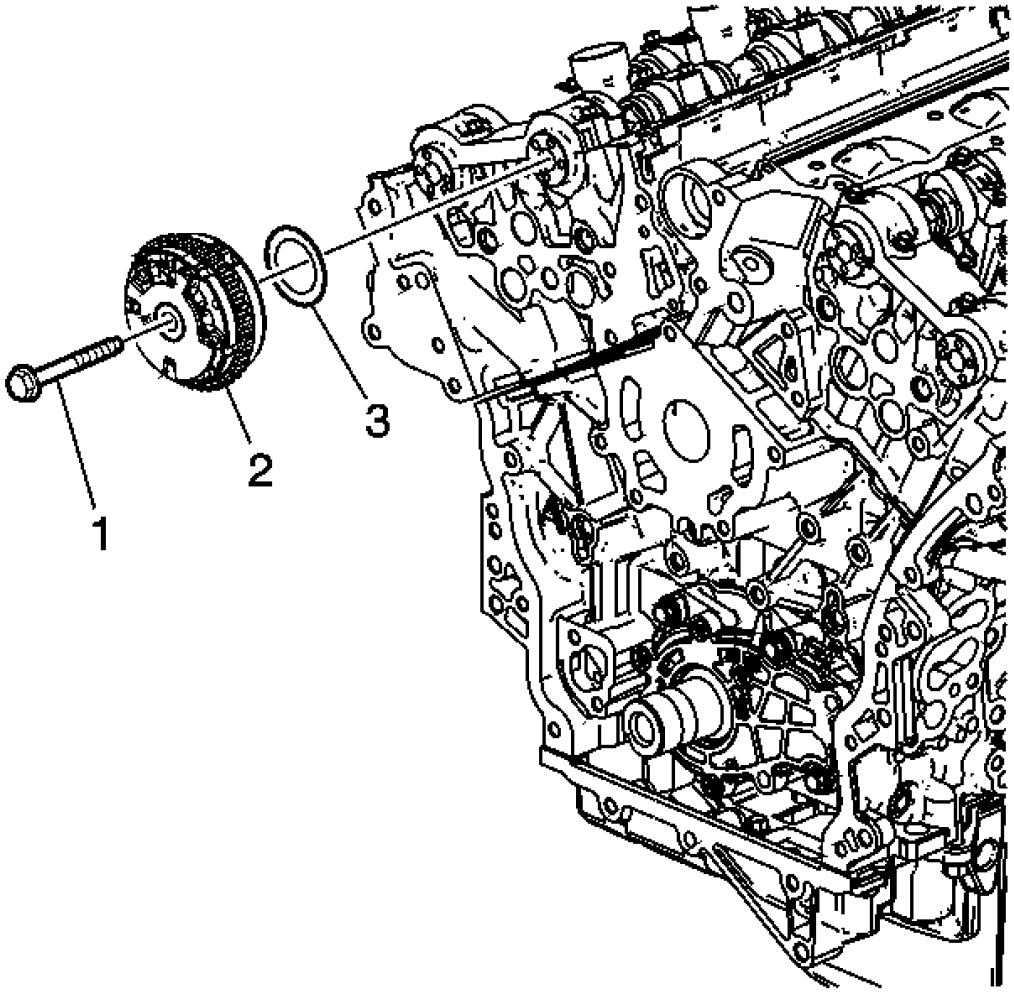


Fig. 74: Identifying Intake Camshaft Position Actuator & Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

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1. Use an open wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.
2. Remove the right intake camshaft position actuator bolt (1).
3. Remove the right intake camshaft position actuator (2).
4. Remove the camshaft thrust washer if applicable (3).

FUEL PUMP REMOVAL (LLT)

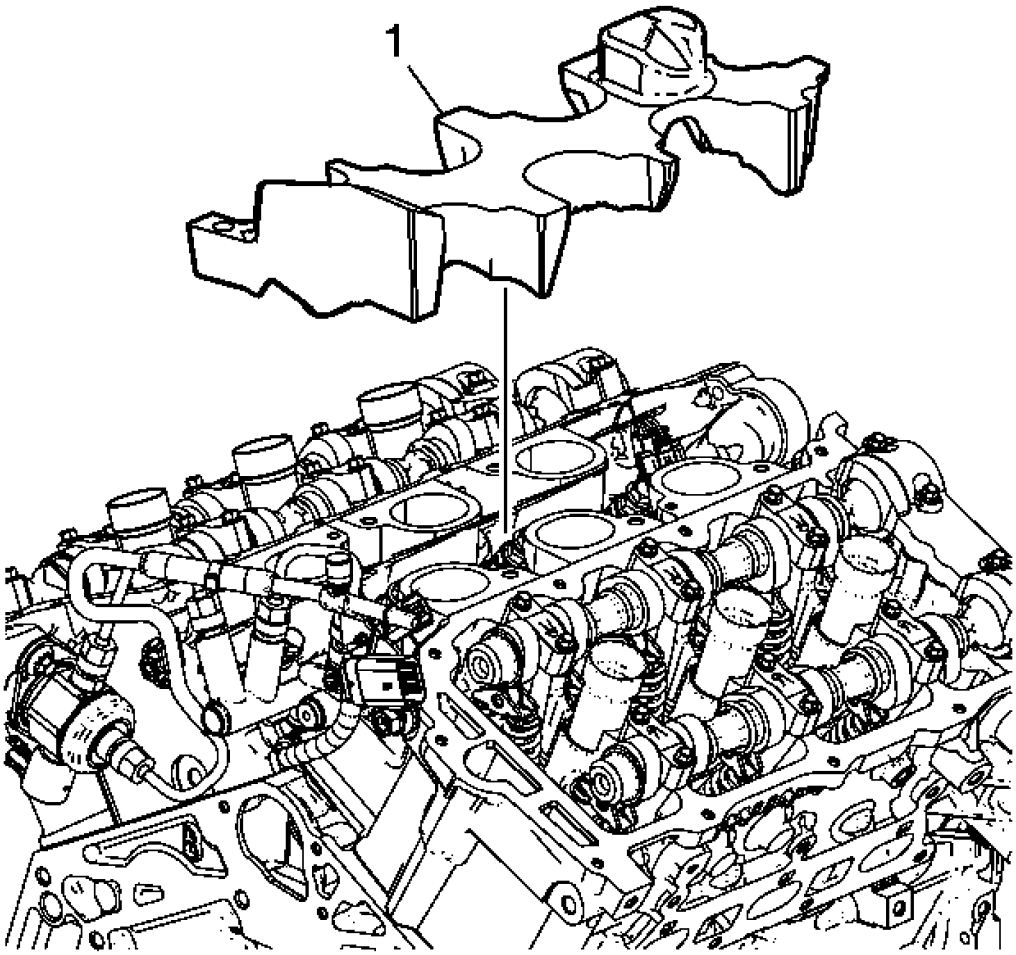


Fig. 75: Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel rail noise shield (1).

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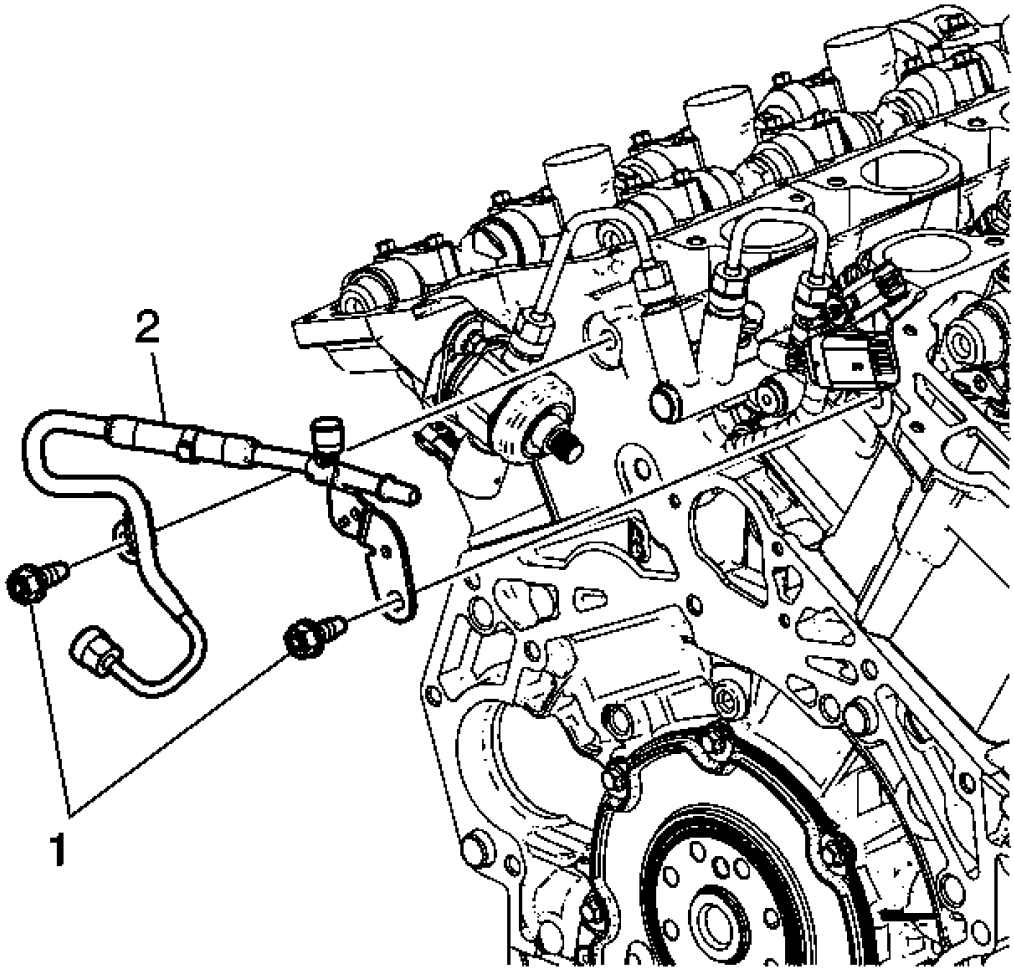


Fig. 76: Fuel Feed Pipe Components
Courtesy of GENERAL MOTORS CORP.

2. Remove the fuel rail wiring connectors from the fuel feed pipe bracket.
3. Remove the fuel feed pipe bolts (1).
4. Remove the fuel feed pipe (2).

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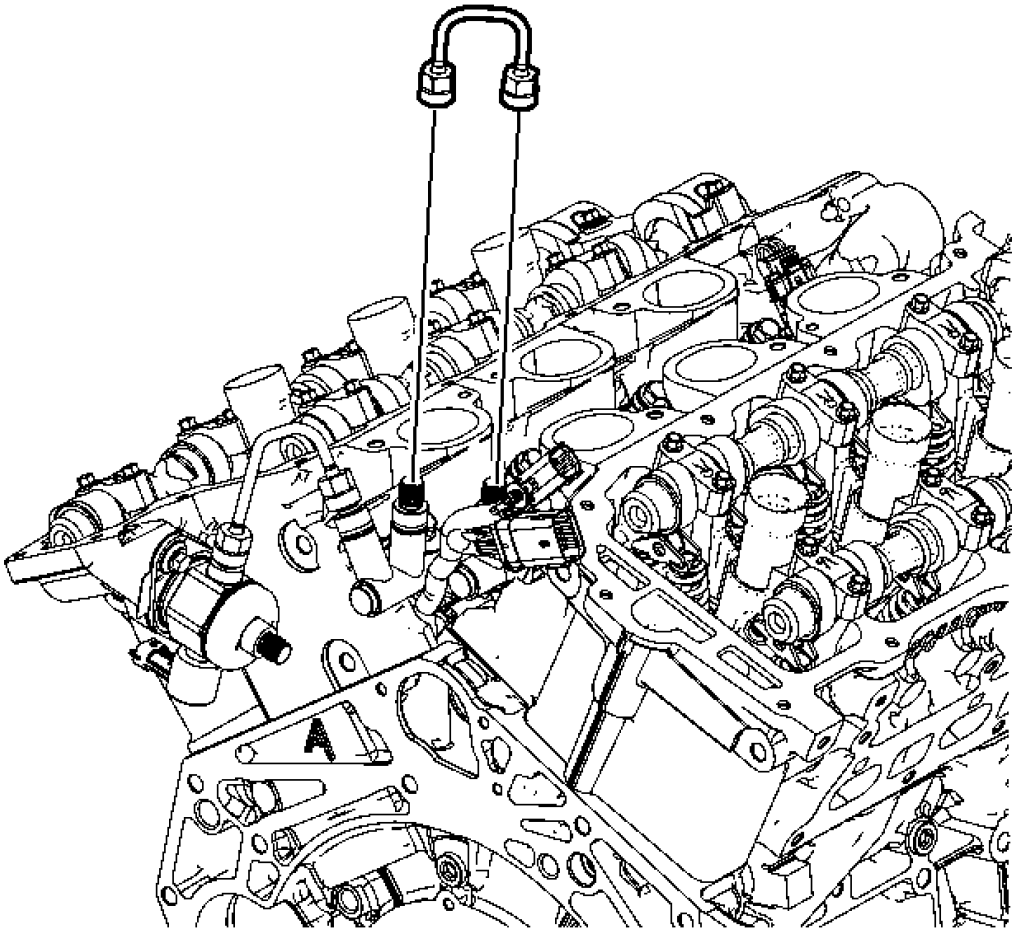


Fig. 77: Identifying Fuel Rail Crossover Pipe
Courtesy of GENERAL MOTORS CORP.

5. Remove the LH to RH fuel rail crossover pipe.

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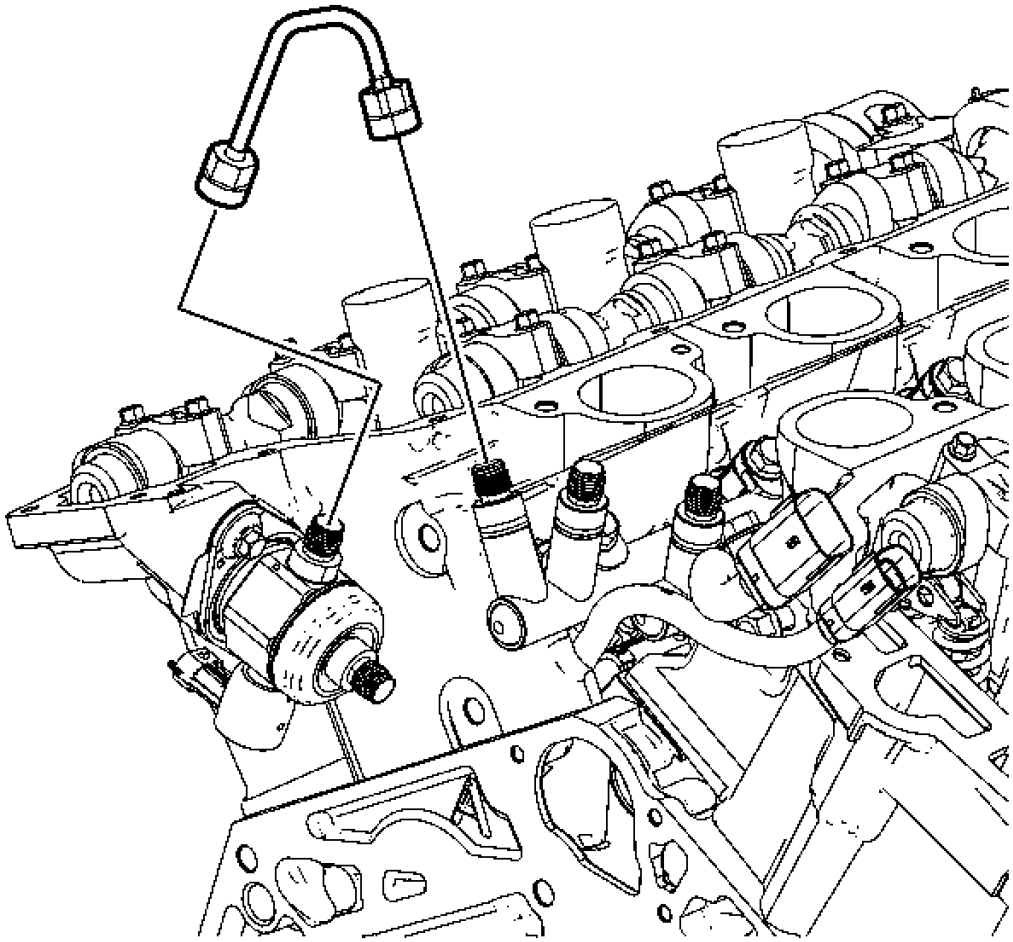


Fig. 78: High Pressure Fuel Line
Courtesy of GENERAL MOTORS CORP.

6. Remove and discard high pressure fuel line.

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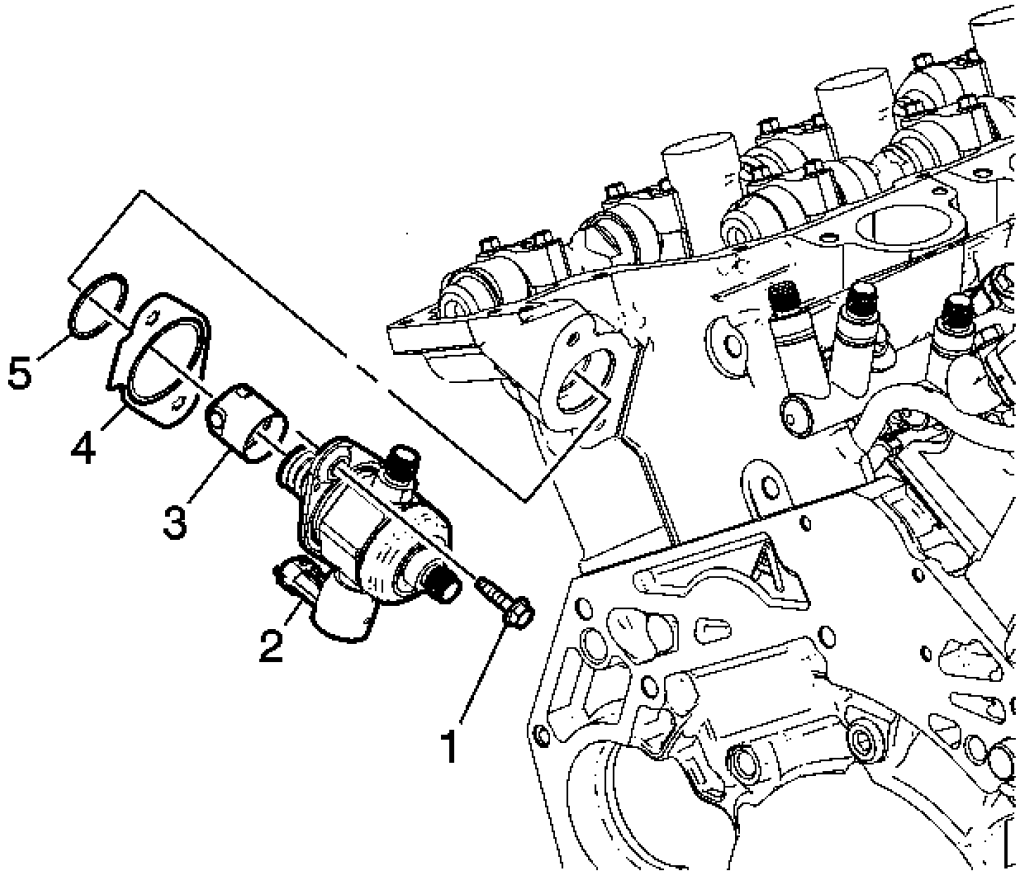


Fig. 79: Identifying High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS CORP.

7. Remove and discard high pressure fuel pump bolts (1).
8. Remove the high pressure fuel pump (2).
9. Remove the valve lifter follower (3).
10. Remove and discard the high pressure fuel pump gasket (4).
11. Remove and discard the high pressure fuel pump O-ring (5).

CAMSHAFT REMOVAL - LEFT SIDE (LLT)

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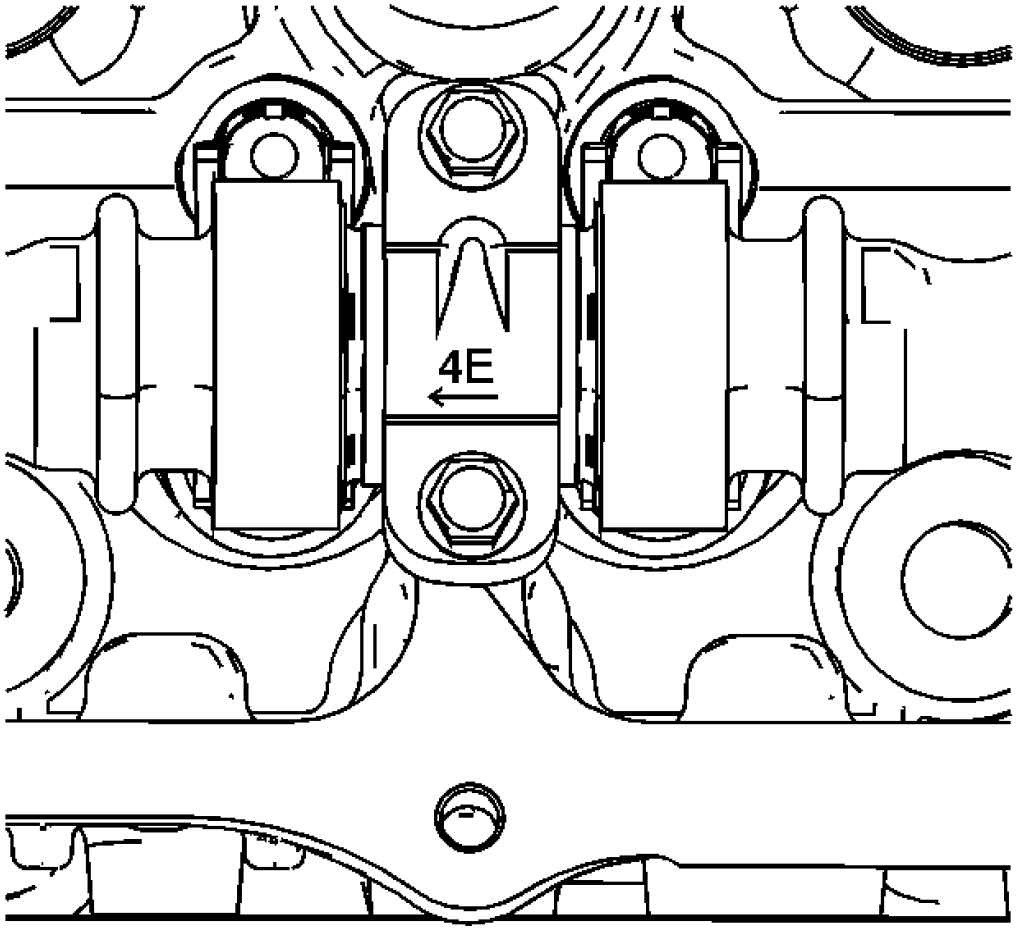


Fig. 80: Identifying Markings On Bearing Caps
Courtesy of GENERAL MOTORS CORP.

1. Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
    - The raised feature must always be oriented toward the center of the cylinder head.
    - The I indicates the intake camshaft.
    - The E indicates the exhaust camshaft.
    - The number indicates the journal position from the front of the engine.

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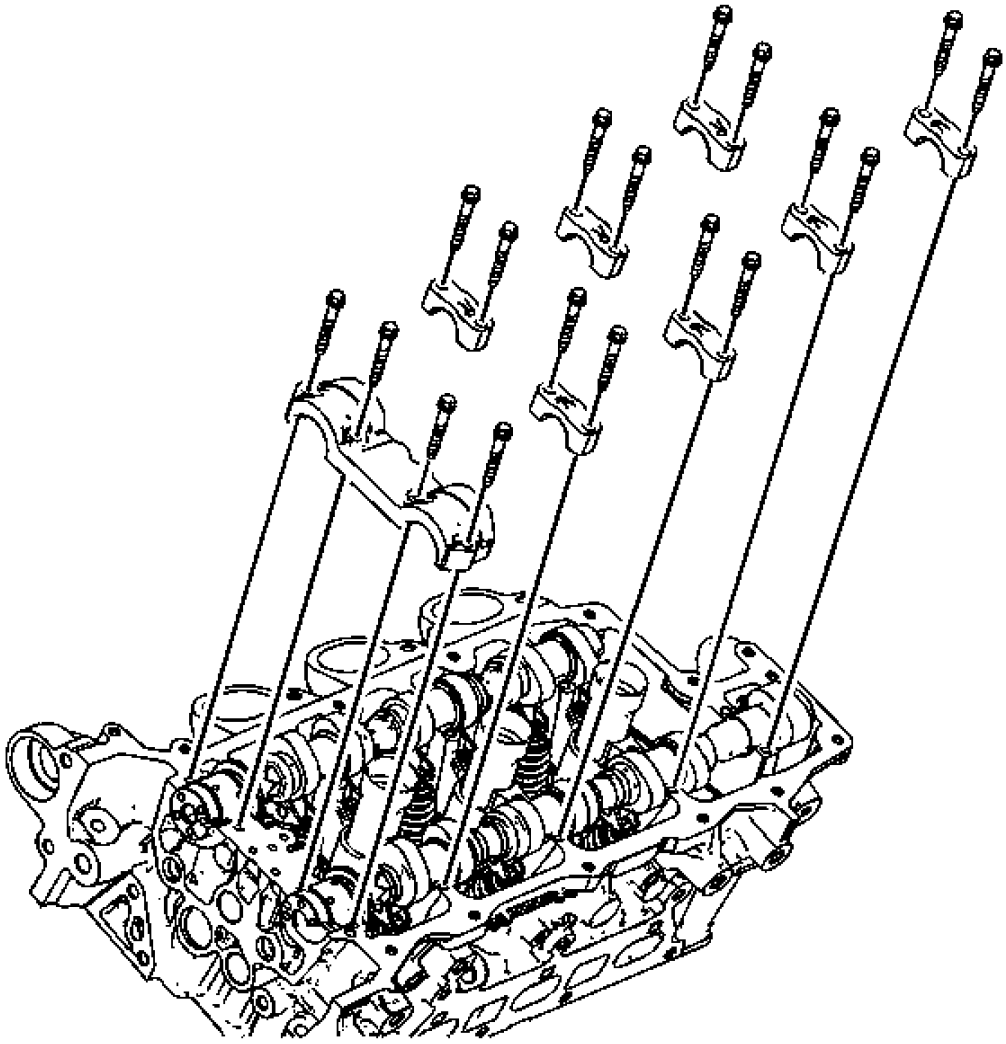


Fig. 81: Identifying Camshaft Bearing Cap Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the camshaft bearing cap bolts.
3. Remove the camshaft bearing caps.

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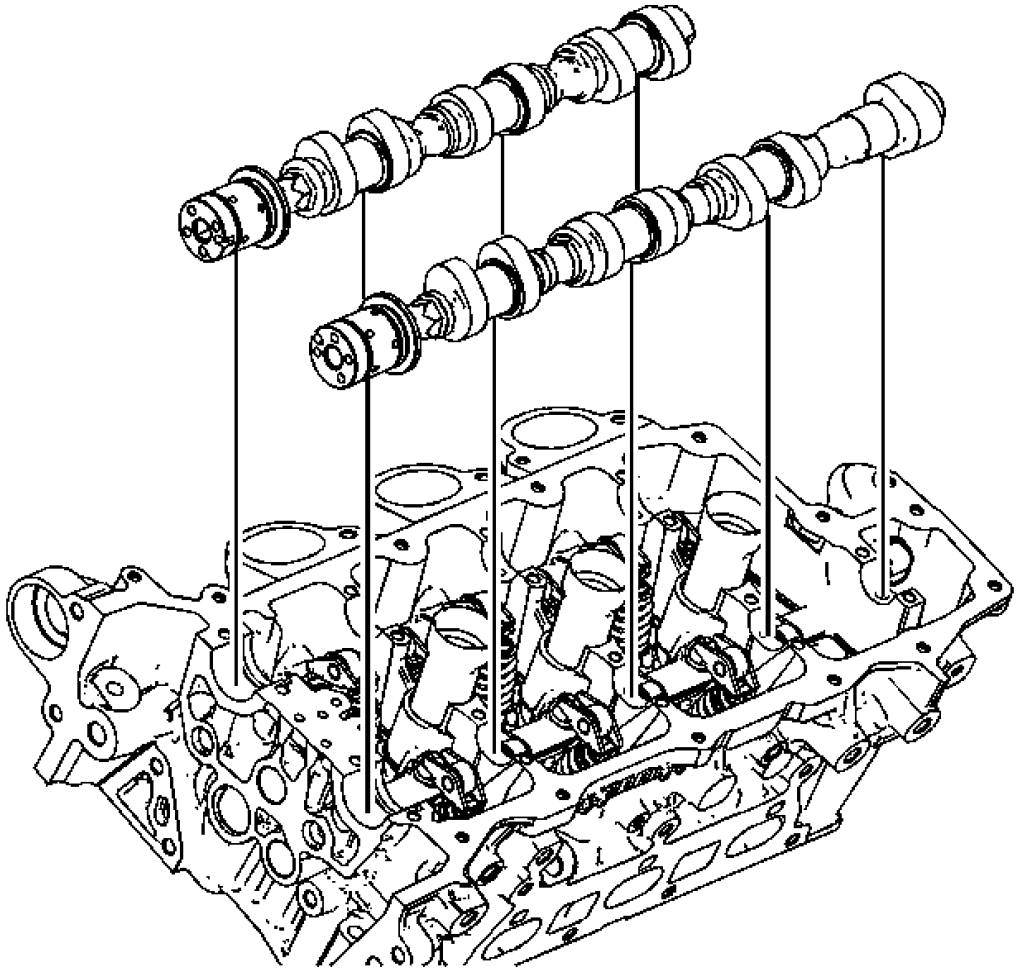


Fig. 82: Identifying Camshafts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Mark the camshafts upon removal to ensure installation is in the correct position.

4. Remove the camshafts.
5. Replace the camshaft bearing caps and bolts.

FUEL RAIL REMOVAL

Refer to **Cylinder Head Disassemble (LLT)** .

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VALVE ROCKER ARM REMOVAL - LEFT SIDE (LLT)

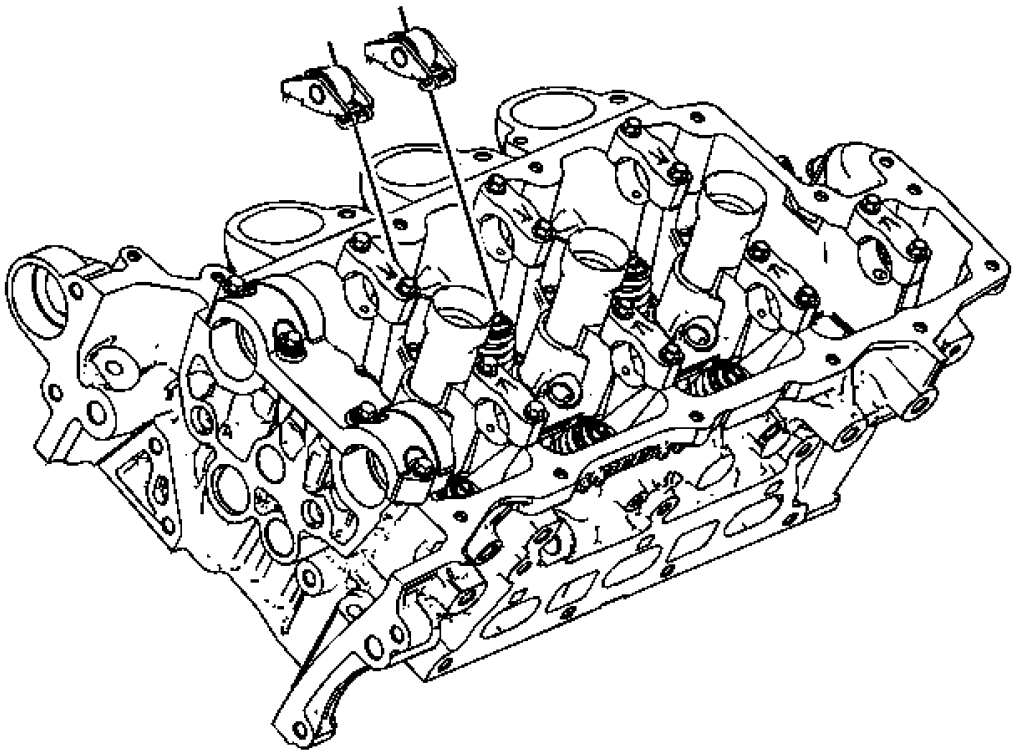


Fig. 83: View of Rocker Arm Assembly
Courtesy of GENERAL MOTORS CORP.

Remove the valve rocker arms from the cylinder head. If the rocker arms are to be reused, keep in order so they can be reinstalled in the same position.

VALVE LIFTER REMOVAL - LEFT SIDE (LLT)

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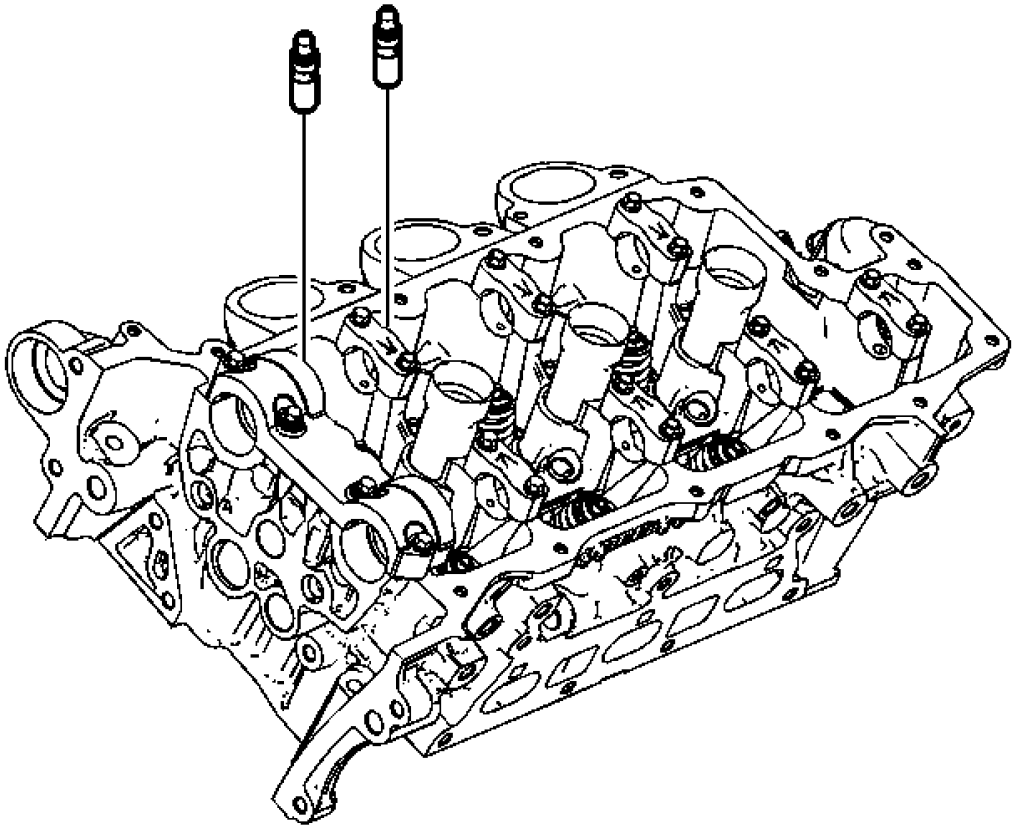


Fig. 84: Valve Lifter - Left Side (LLT)
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **Do not stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.**
- **Do not allow the stationary hydraulic lash adjuster to tip over, plunger down, after the oil fill.**

Remove the valve lifters (SHLAs) from the cylinder head. If the lifters are to be reused, keep in order so they can be reinstalled in the same position.

CYLINDER HEAD REMOVAL - LEFT SIDE (LLT)

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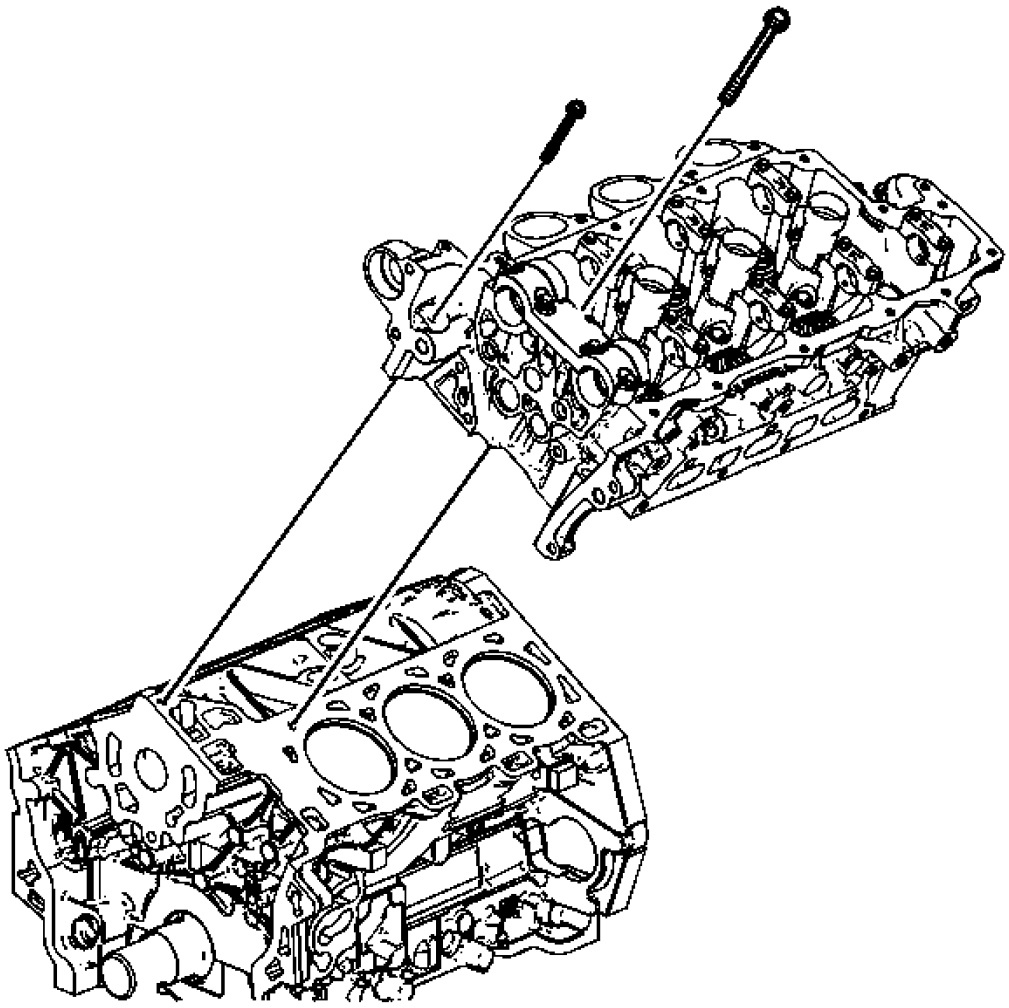


Fig. 85: View of Cylinder Head Assembly
Courtesy of GENERAL MOTORS CORP.

1. Remove the two front M8 left cylinder head bolts.
2. Remove the left cylinder head bolts.
3. Remove the left cylinder head.

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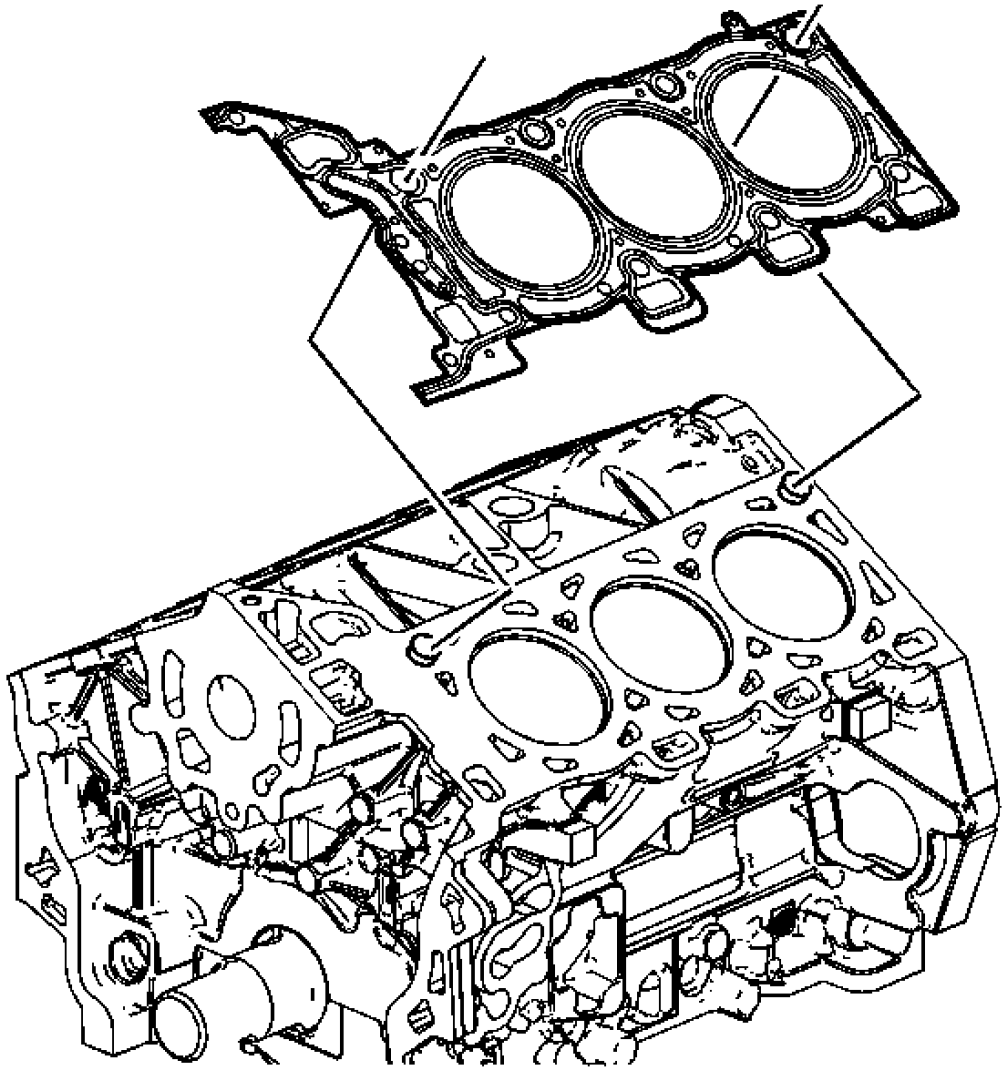


Fig. 86: Identifying Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

4. Remove and discard the left cylinder head gasket.

CAMSHAFT REMOVAL - RIGHT SIDE

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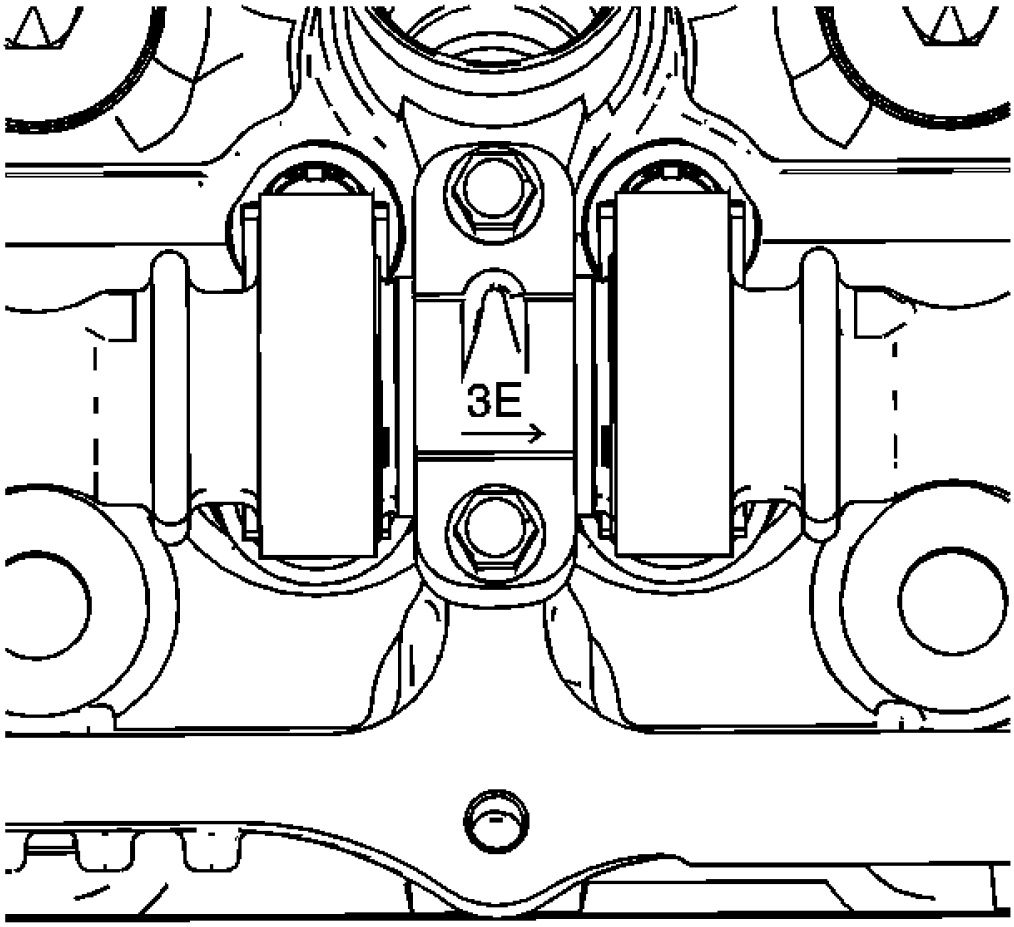


Fig. 87: Identifying Markings On Bearing Caps
Courtesy of GENERAL MOTORS CORP.

1. Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
    - The raised feature must always be oriented toward the center of the cylinder head.
    - The I indicates the intake camshaft.
    - The E indicates the exhaust camshaft.
    - The number indicates the journal position from the front of the engine.

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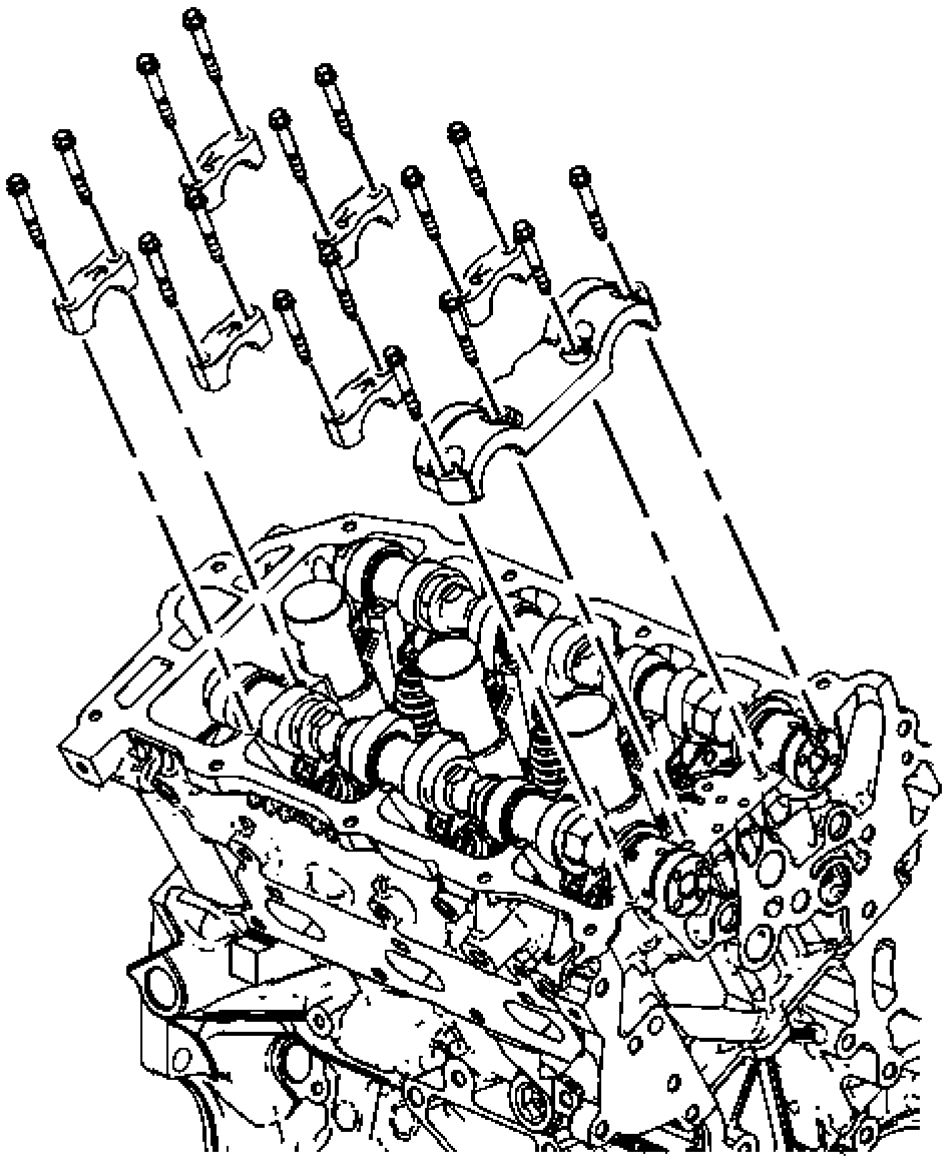


Fig. 88: View Of Camshaft Bearing Caps & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the camshaft bearing cap bolts.
3. Remove the camshaft bearing caps.

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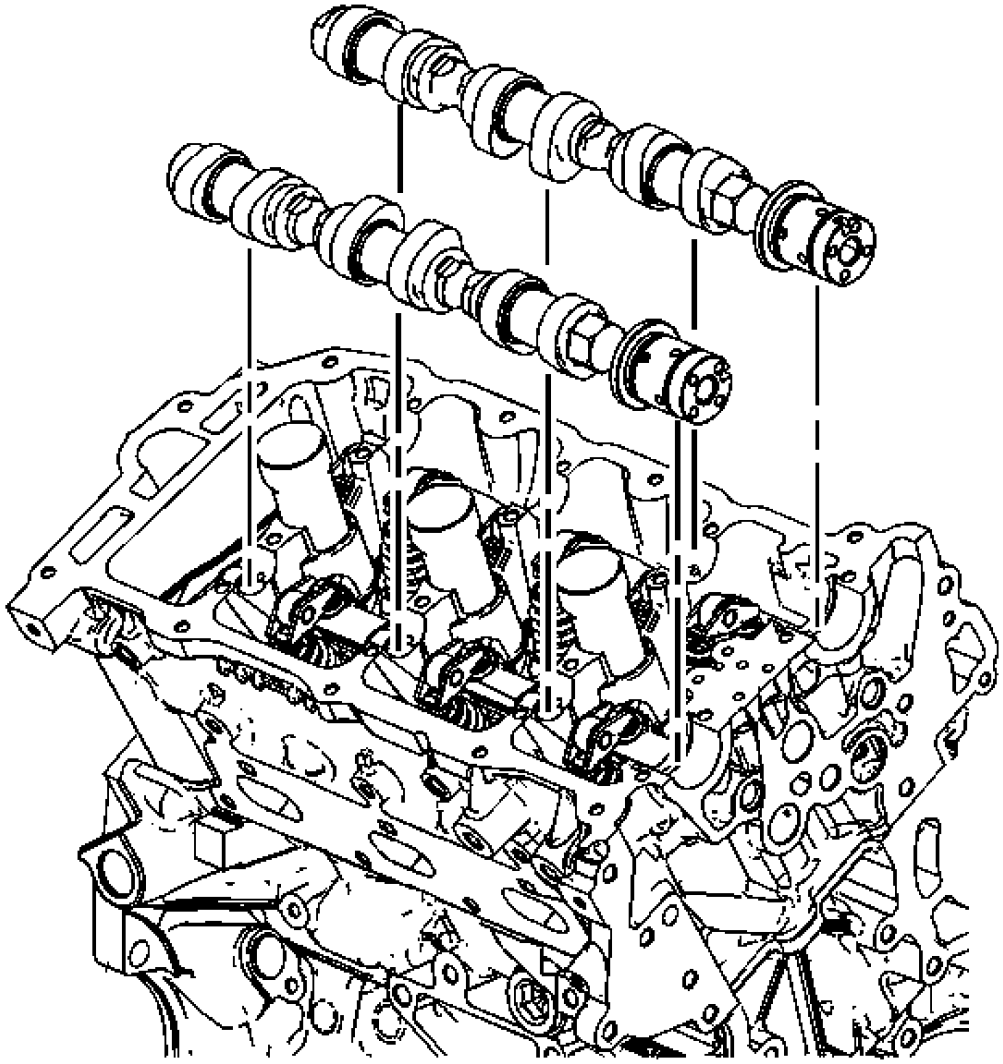


Fig. 89: Camshafts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Mark the camshafts upon removal to ensure installation is in the correct position.

4. Remove the camshafts.
5. Replace the camshaft bearing caps and bolts.

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VALVE ROCKER ARM REMOVAL - RIGHT SIDE

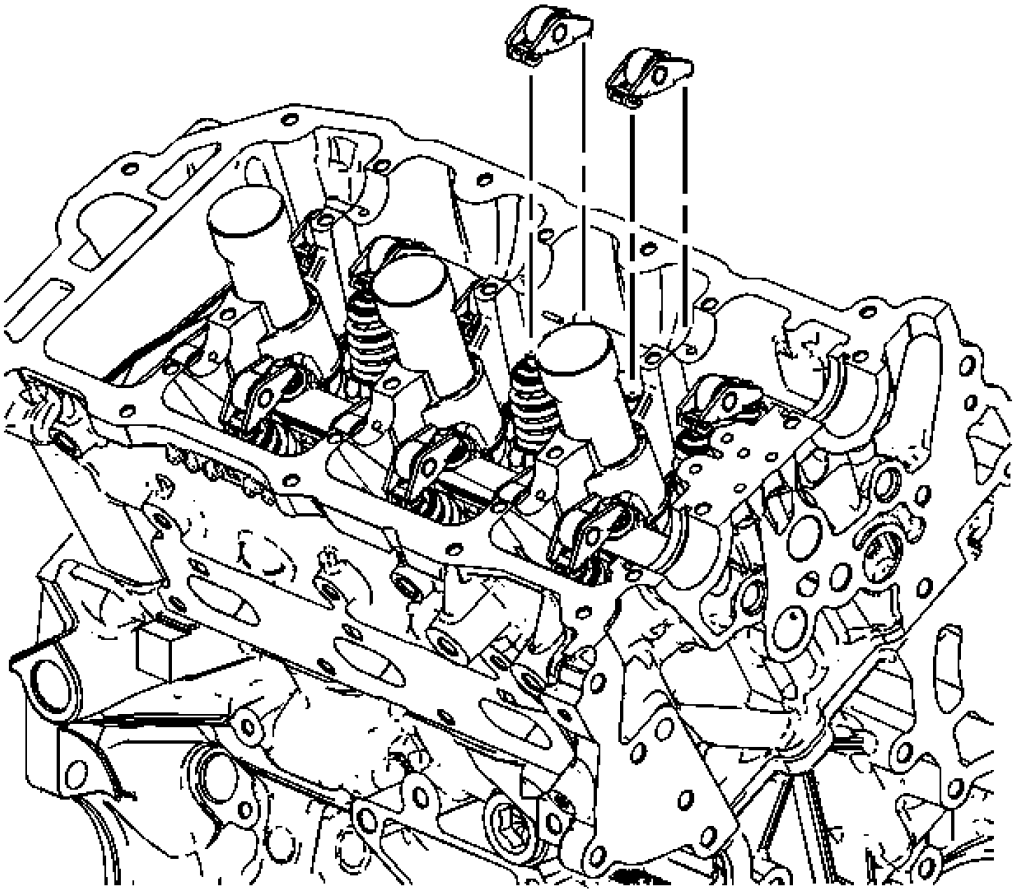


Fig. 90: Identifying Valve Rocker Arms
Courtesy of GENERAL MOTORS CORP.

Remove the valve rocker arms from the cylinder head. If the rocker arms are to be reused, keep in order so they can be reinstalled in the same position.

VALVE LIFTER REMOVAL - RIGHT SIDE

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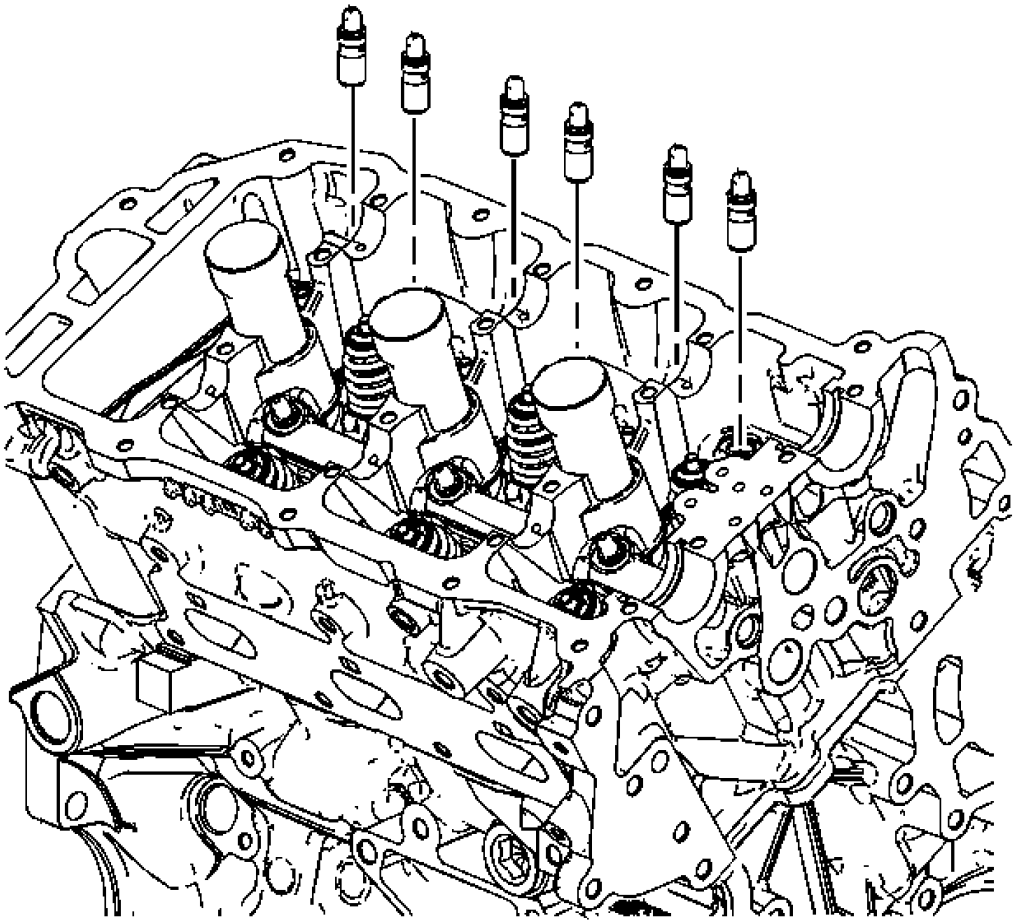


Fig. 91: Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

IMPORTANT:

- **Do not stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.**
- **Do not allow the stationary hydraulic lash adjuster to tip over, plunger down, after the oil fill.**

Remove the valve lifters (SHLAs) from the cylinder head. If the lifters are to be reused, keep in order so they can be reinstalled in the same position.

CYLINDER HEAD REMOVAL - RIGHT SIDE (LLT)

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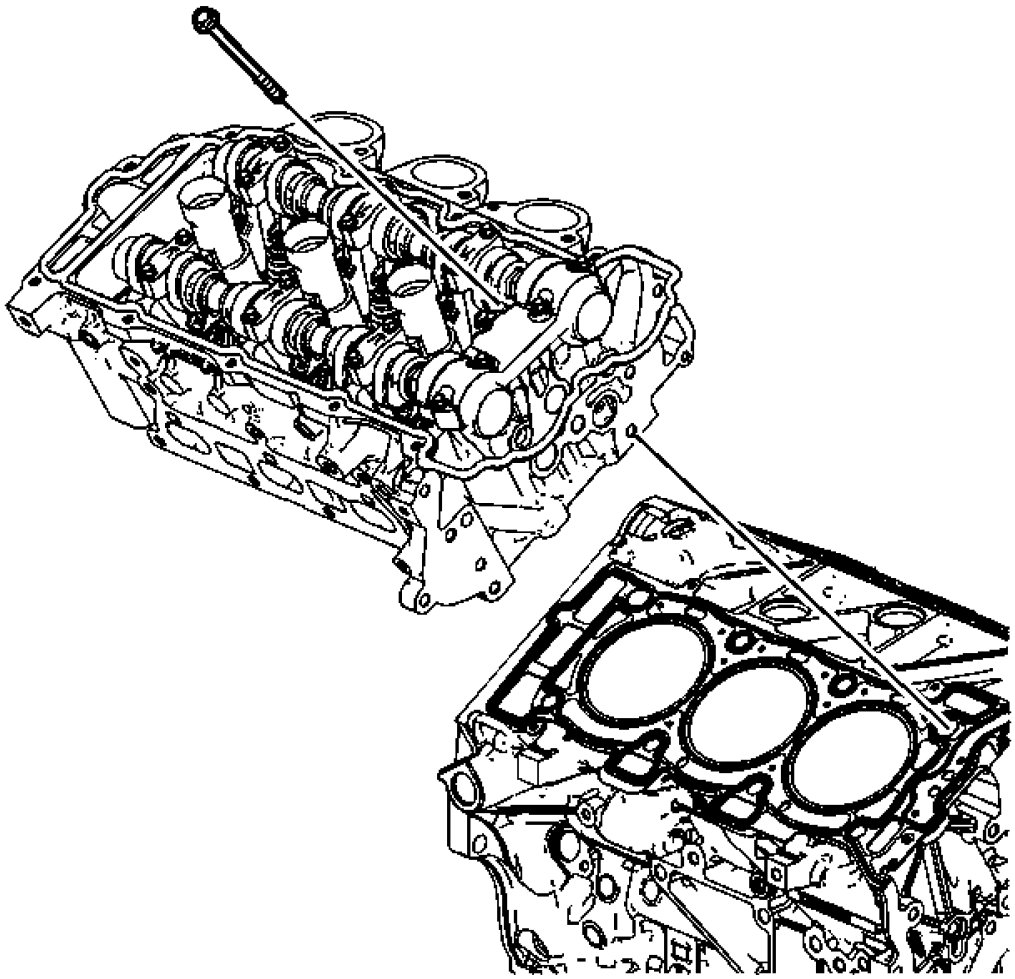


Fig. 92: Cylinder Head
Courtesy of GENERAL MOTORS CORP.

1. Remove the right cylinder head bolts.
2. Remove the right cylinder head.

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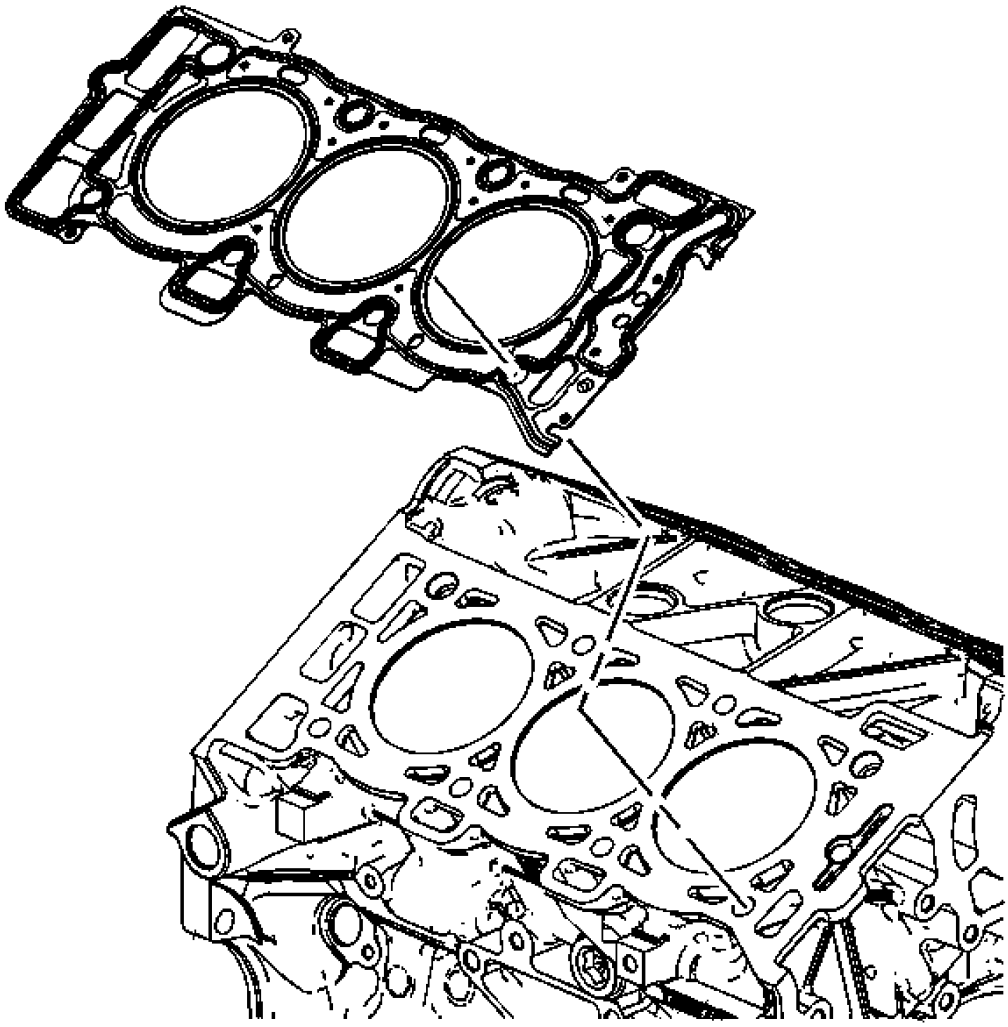


Fig. 93: Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

3. Remove and discard the right cylinder head gasket.

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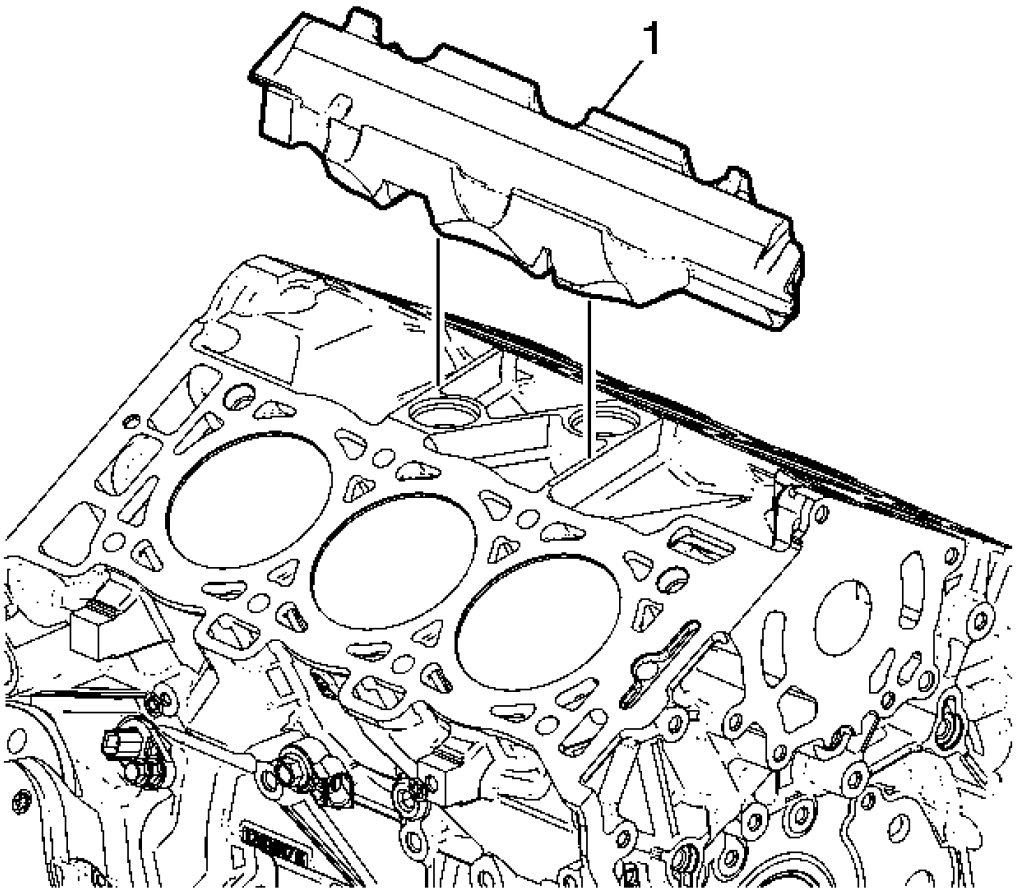


Fig. 94: Lower Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS CORP.

4. Remove the lower fuel rail noise shield (1).

OIL PAN REMOVAL

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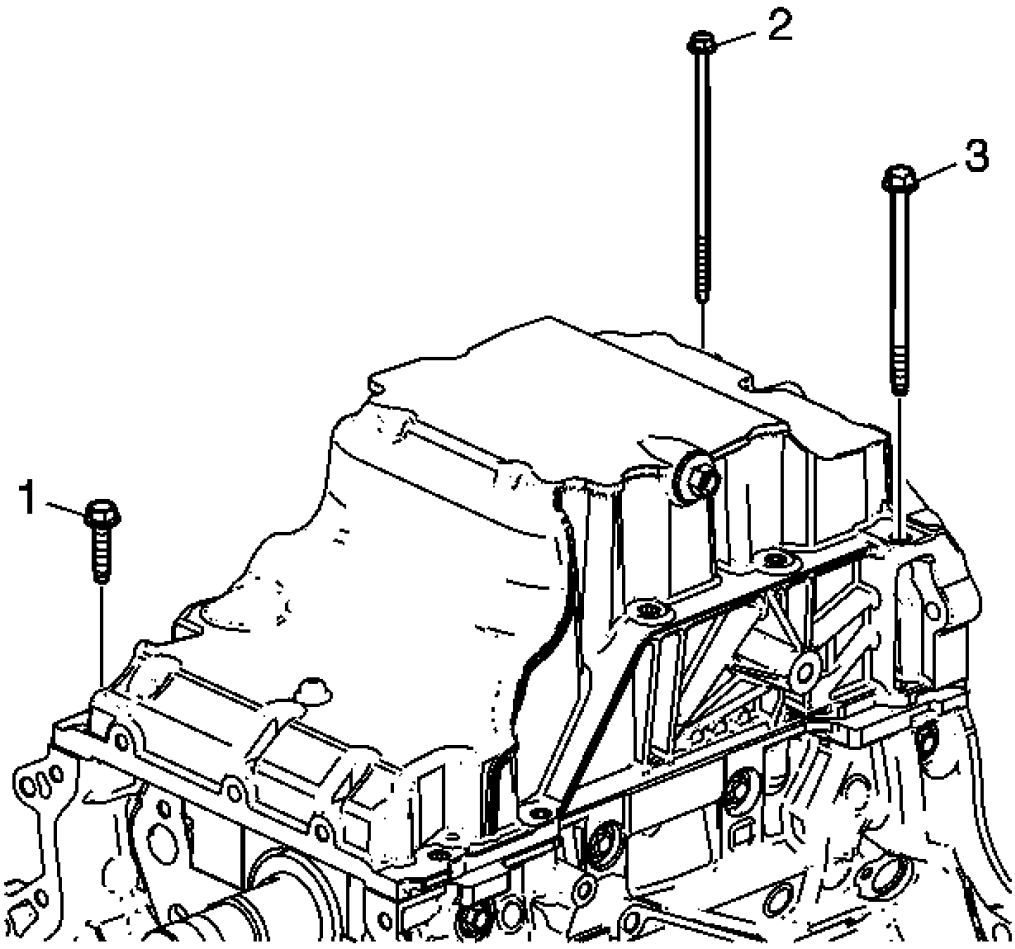


Fig. 95: Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pan bolts (1), (2) and (3).
2. Using the pry points located at the edge of the oil pan separate the RTV sealant.

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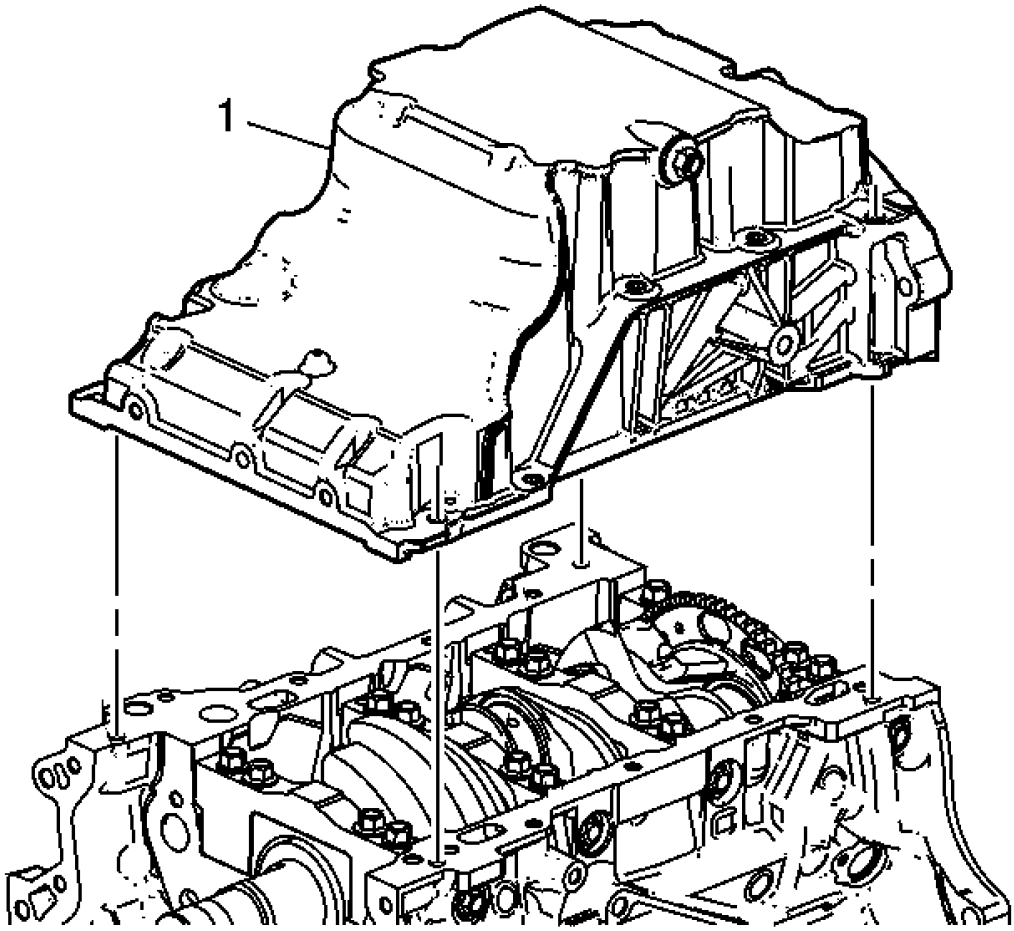


Fig. 96: Oil Pan
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pan (1) from the block.

OIL PUMP REMOVAL

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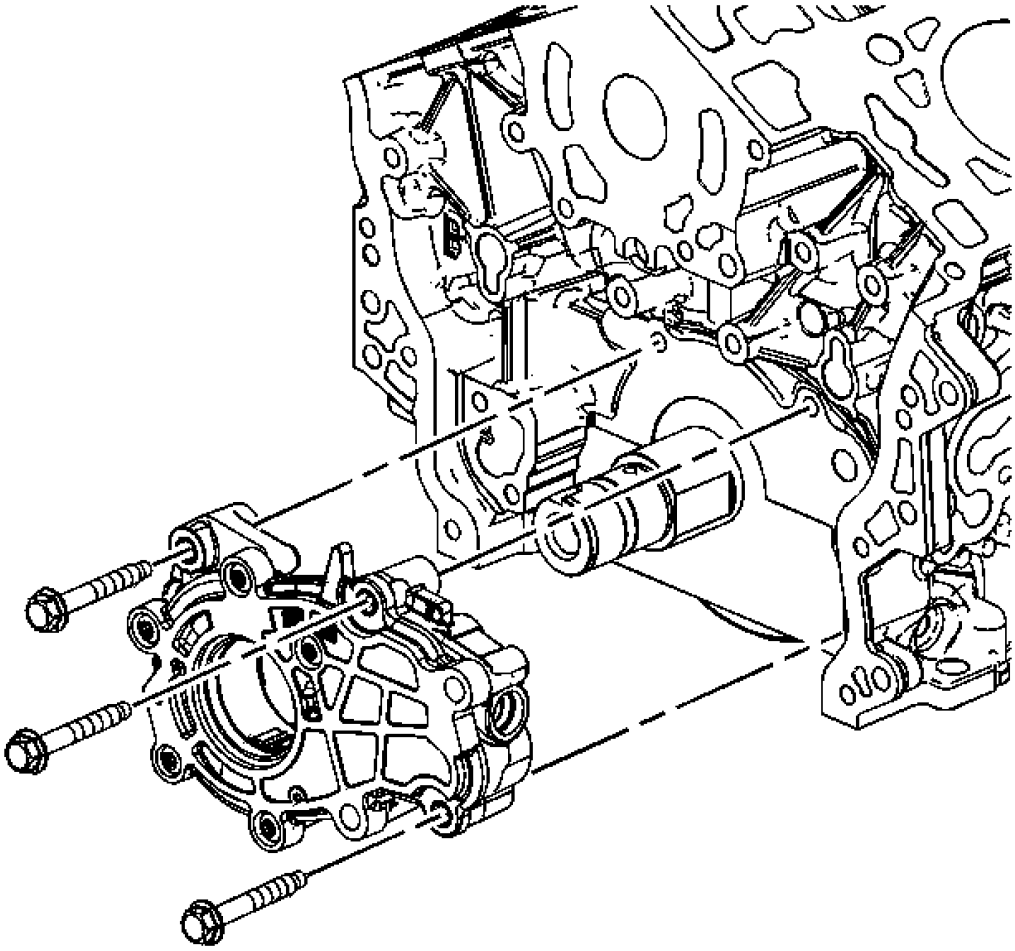


Fig. 97: Oil Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pump bolts.
2. Remove the oil pump.

CRANKSHAFT REAR OIL SEAL AND HOUSING REMOVAL

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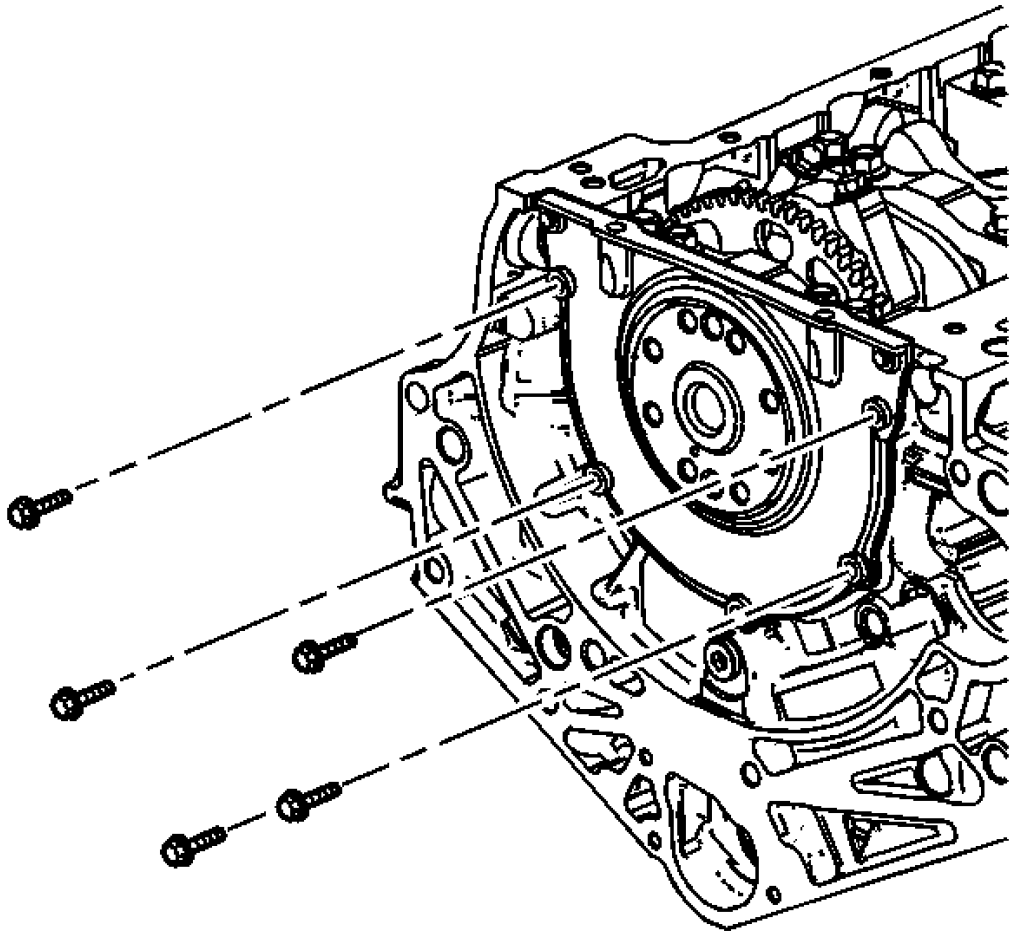


Fig. 98: Crankshaft Rear Oil Seal Housing Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft rear oil seal housing bolts.

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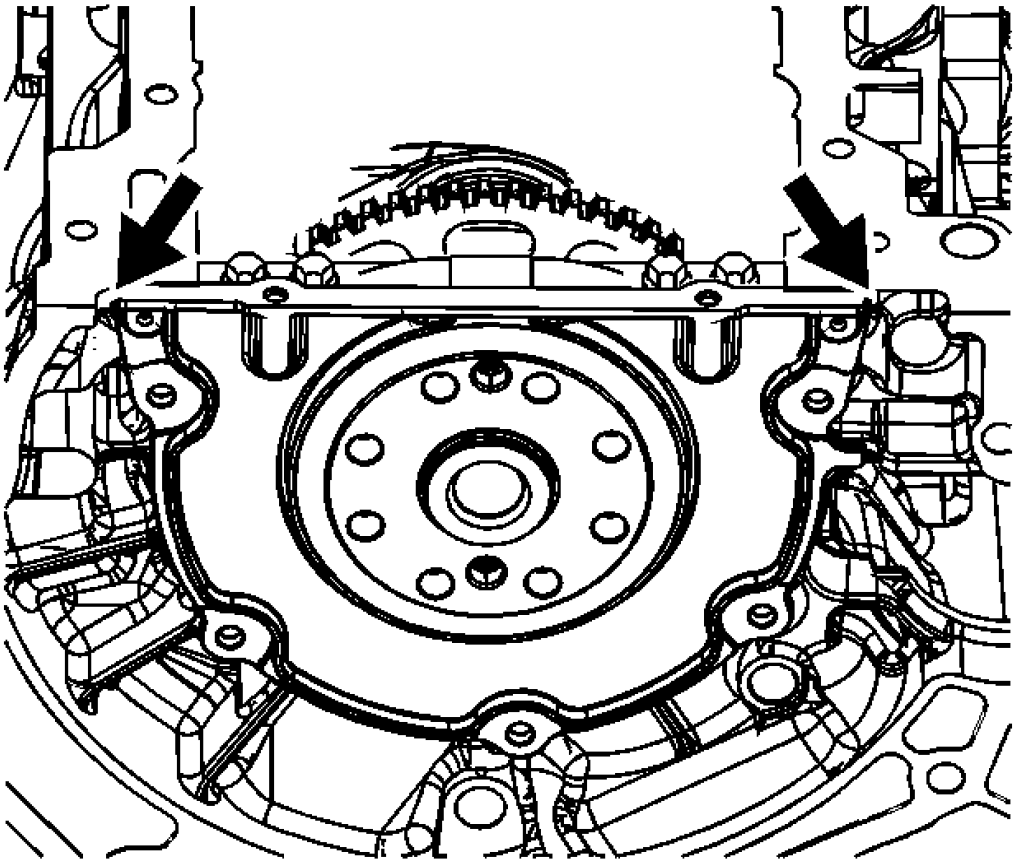


Fig. 99: Identifying Pry Points On Edge Of Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS CORP.

2. Use the pry points located at the edge of the crankshaft rear oil seal housing to separate the RTV sealant.

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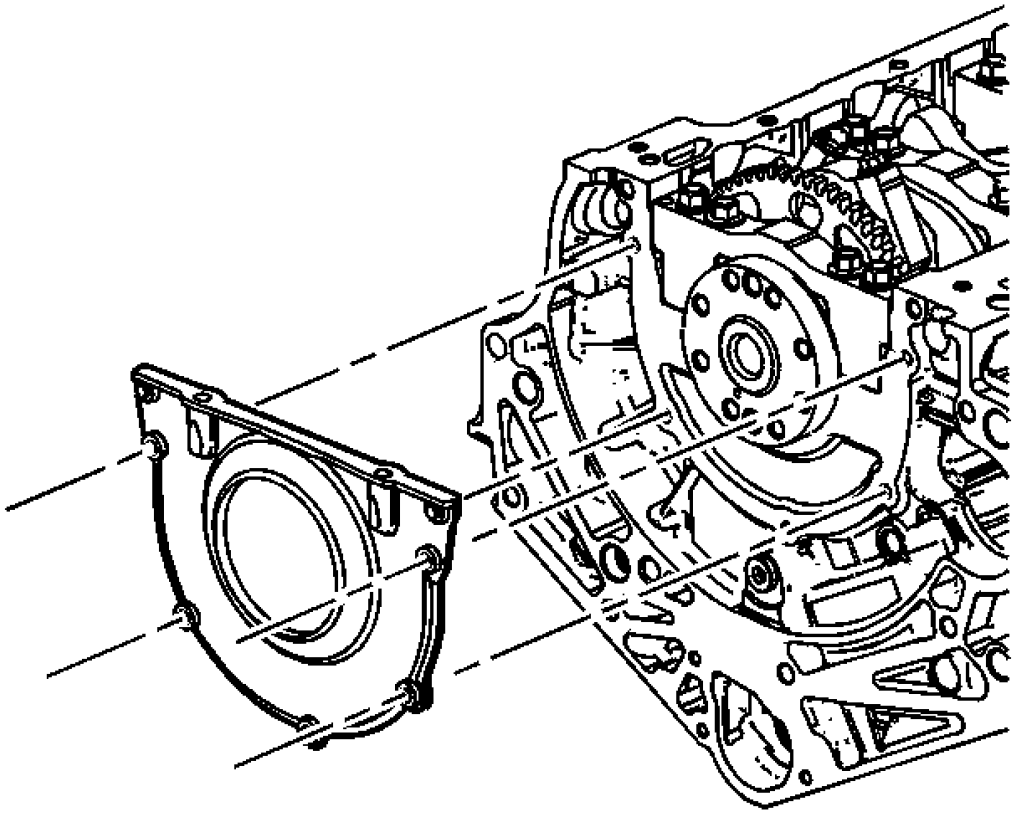


Fig. 100: Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS CORP.

3. Remove and discard the crankshaft rear oil seal housing.

PISTON, CONNECTING ROD, AND BEARING REMOVAL

Special Tools

EN 46121: Connecting Rod Guide Pin Set

For equivalent regional tools, refer to **Special Tools** .

NOTE:

- **An arrow/dot showing proper piston orientation is located on the top of the piston.**
- **If the connecting rod bearings have been used in a running engine, you must replace them with NEW connecting rod bearings for**

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reassembly.

1. Before removing the connecting rods, check the connecting rod side clearance using the following procedure:
    1. Tap the connecting rod to one end of the crankshaft journal with a dead-blow or wooden hammer.
    2. Using feeler gauges, measure the clearance between the crankshaft counterweight and the connecting rod.
    3. The connecting rod side clearance should not exceed specifications. Refer to **Engine Mechanical Specifications (LLT)** .
    4. If the end play exceeds the specified limits, measure the width of the crankpin end of the connecting rod. Refer to **Piston, Connecting Rod, and Bearing Cleaning and Inspection** .
    5. If the connecting rod width is significantly smaller than specified and severe wear is present on the side of the connecting rod, replace the connecting rod.
    6. If the connecting rod width is within specification and excessive scoring is present on the crankshaft journals, replace the crankshaft.
2. Using a marker, number each piston face. Draw an arrow along the centerline of the piston pointing toward the front of the engine.

    CAUTION: Do not use a stamp, punch or any other method that may distort or stress the connecting rod or connecting rod cap. Extensive engine damage may result from a connecting rod that is distorted or stressed.

3. Mark the cylinder number on the connecting rod and the connecting rod cap with a scribe, paint stick or permanent marker.

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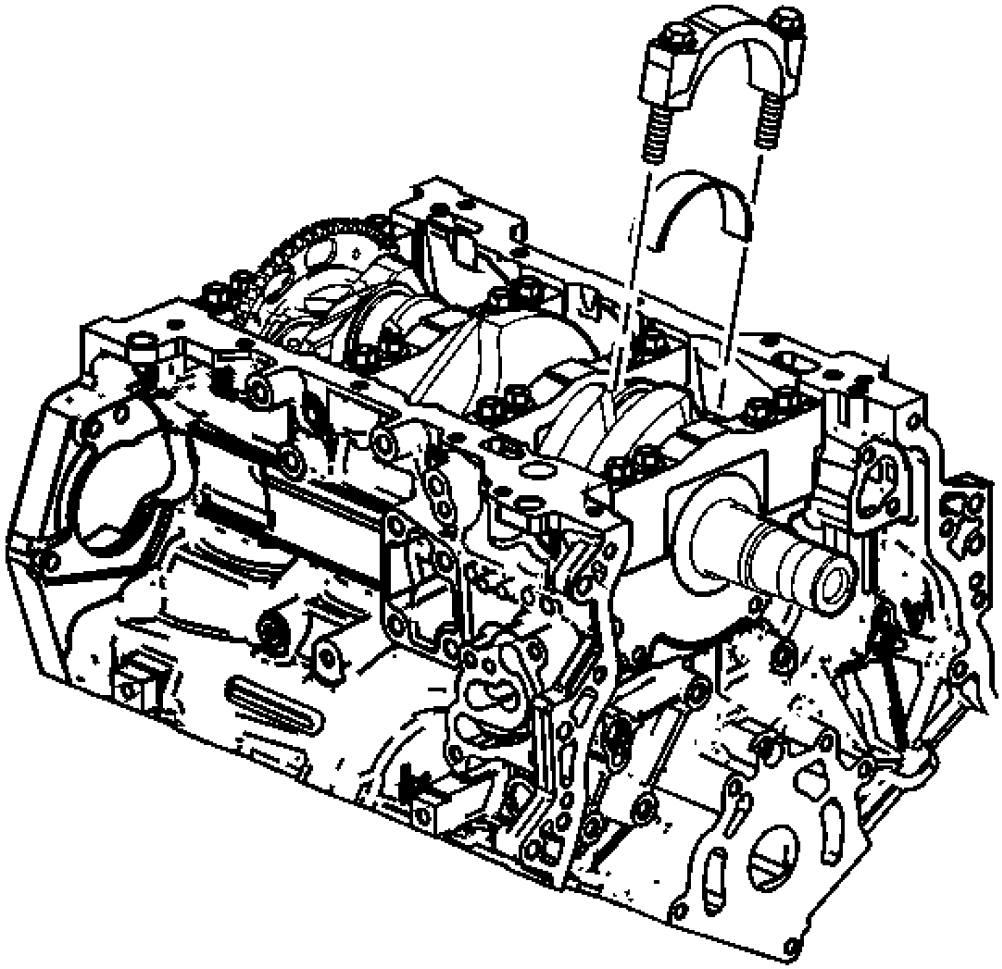


Fig. 101: View Of Connecting Rod Bearing & Cap
Courtesy of GENERAL MOTORS CORP.

CAUTION: Powdered metal connecting rods have rod bolts which yield when torqued. If the rod bolts are loosened or removed the rod bolts must be replaced. Rod bolts that are not replaced will not torque to the correct clamp load and can lead to serious engine damage.

4. Remove the connecting rod bolts.

NOTE: The connecting rod caps must remain with the original connecting rod.

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5. Remove the connecting rod cap.

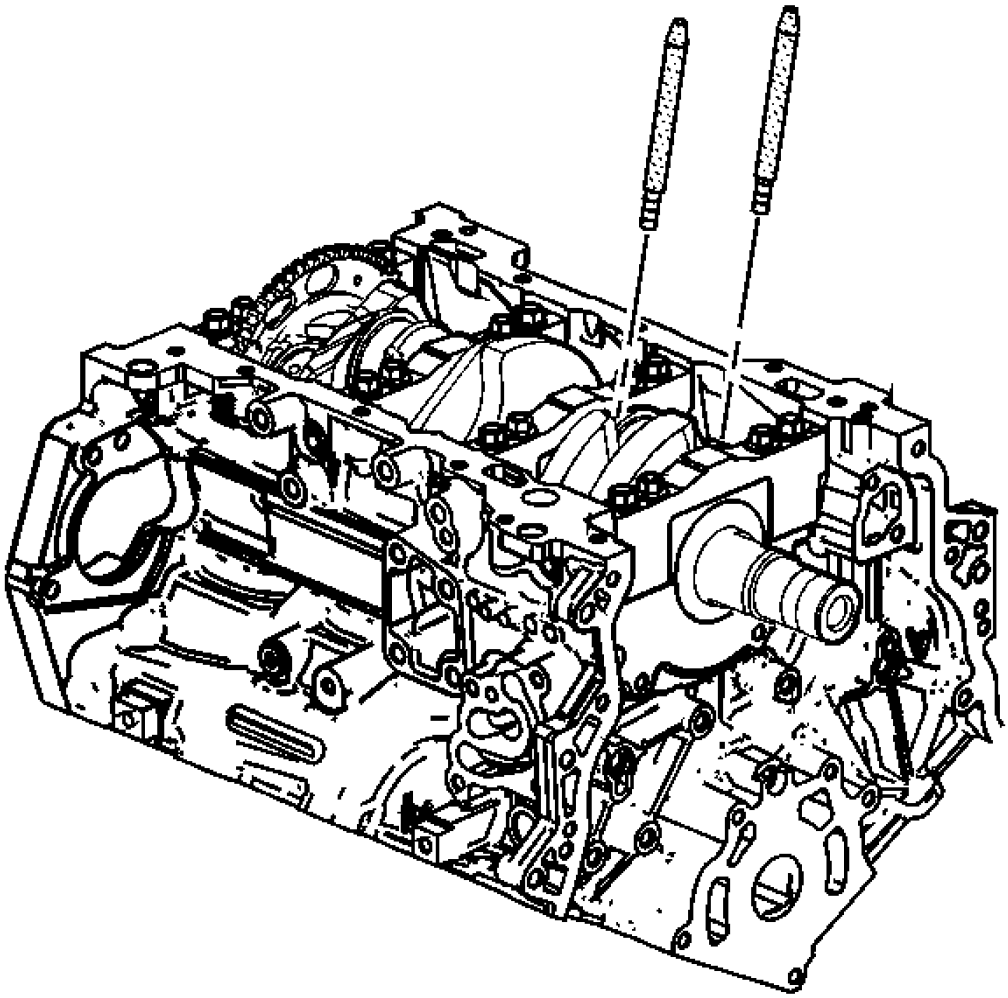


Fig. 102: Identifying EN 46121
Courtesy of GENERAL MOTORS CORP.

6. Install the **EN 46121:** set into the connecting rod bolt holes.

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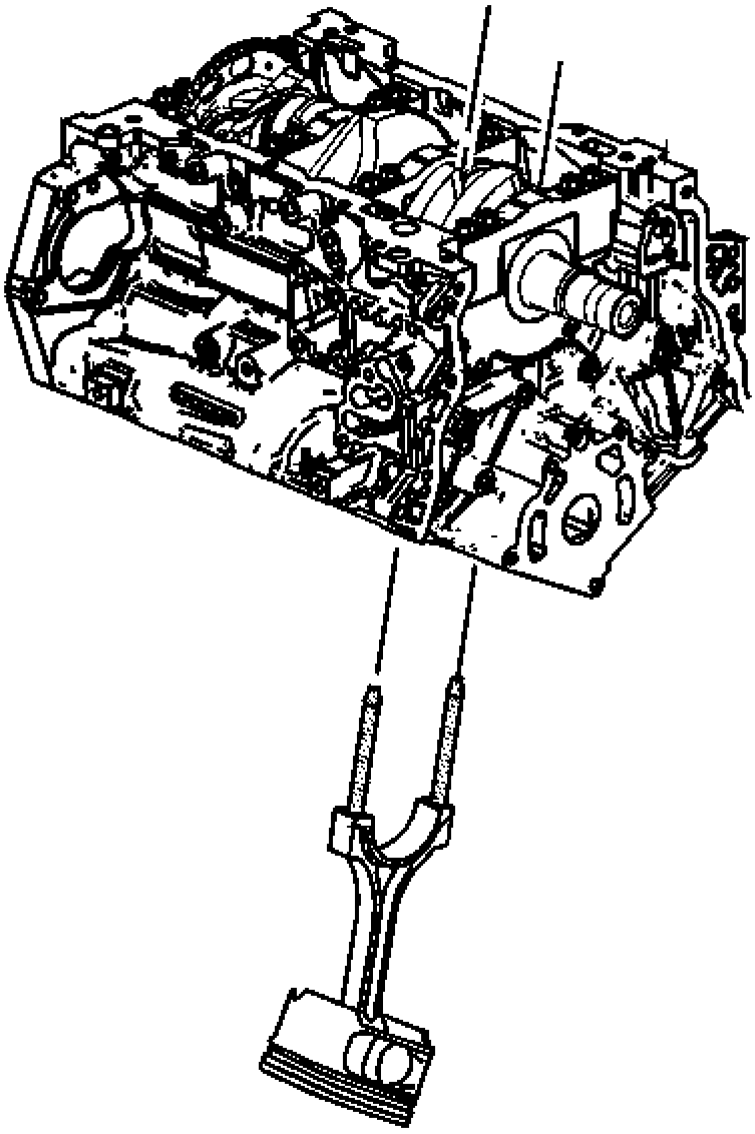


Fig. 103: View Of Connecting Rod & Piston Assembly
Courtesy of GENERAL MOTORS CORP.

7. Using the **EN 46121:** set, push the connecting rod and piston assembly through the top of the cylinder. DO NOT scratch the crankshaft journal or cylinder wall and DO NOT damage the oil jets when removing the connecting rod and piston assembly.

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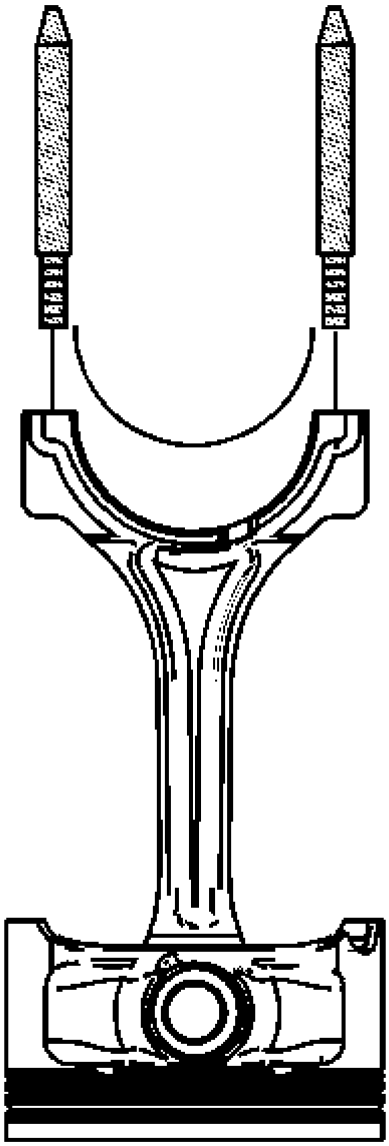


Fig. 104: View Of Piston/Connecting Rod Installation Tool
Courtesy of GENERAL MOTORS CORP.

8. Remove the **EN 46121:** set from the connecting rod bolt holes.
9. Remove the upper connecting rod bearing from the connecting rod.

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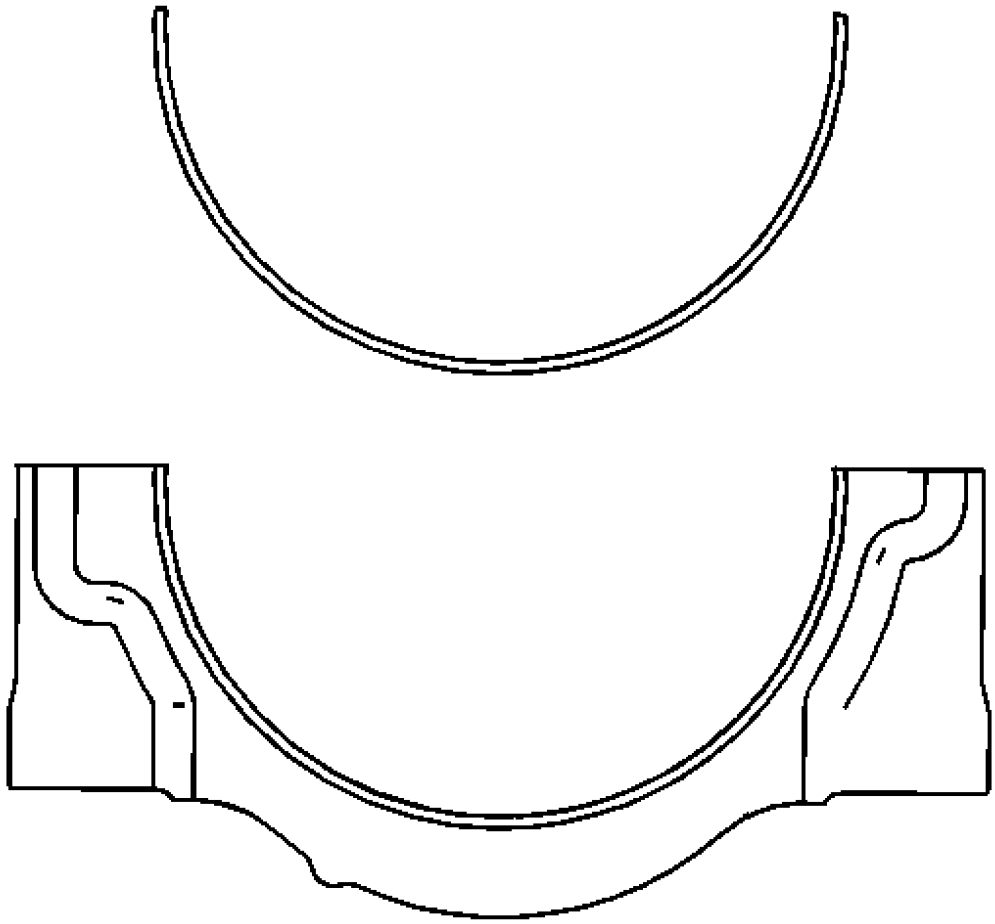


Fig. 105: View Of Lower Connecting Rod Cap & Bearing
Courtesy of GENERAL MOTORS CORP.

10. Remove the lower connecting rod bearing from the connecting rod cap.

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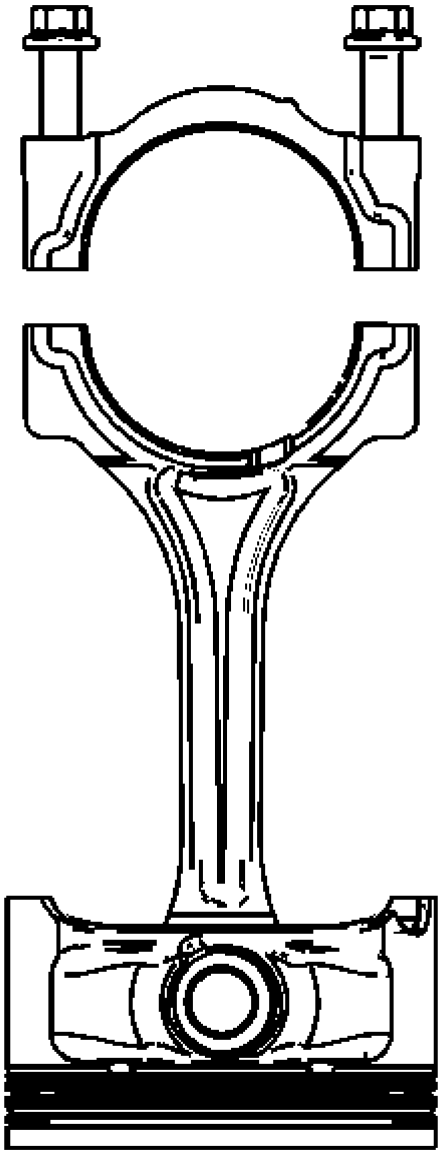


Fig. 106: View Of Connecting Rod Cap, Connecting Rod & Piston Assembly
Courtesy of GENERAL MOTORS CORP.

11. Reattach the connecting rod cap to the connecting rod to prevent damage to their mating surfaces. The cap and rod are a matched set and must be kept together.

CRANKSHAFT AND BEARING REMOVAL

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Special Tools

- **J 6125-1B** Slide Hammer Adapter. See **Special Tools** .
- **J 41818** Crankshaft Bearing Cap Remover. See **Special Tools** .

CRANKSHAFT END PLAY MEASUREMENT

1. Place a dial indicator at the crankshaft nose.
2. Gently force the crankshaft to the extreme front and rear positions with a pry tool while monitoring the movement of the dial indicator.
3. The crankshaft end play should not exceed specifications. Refer to **Engine Mechanical Specifications (LLT)** .
4. If the specifications are exceeded inspect the thrust bearing thrust OD and the crankshaft thrust wall for wear and/or excessive runout. Refer to **Engine Mechanical Specifications (LLT)** .
5. Replace the thrust bearing or crankshaft as necessary.

CRANKSHAFT REMOVAL

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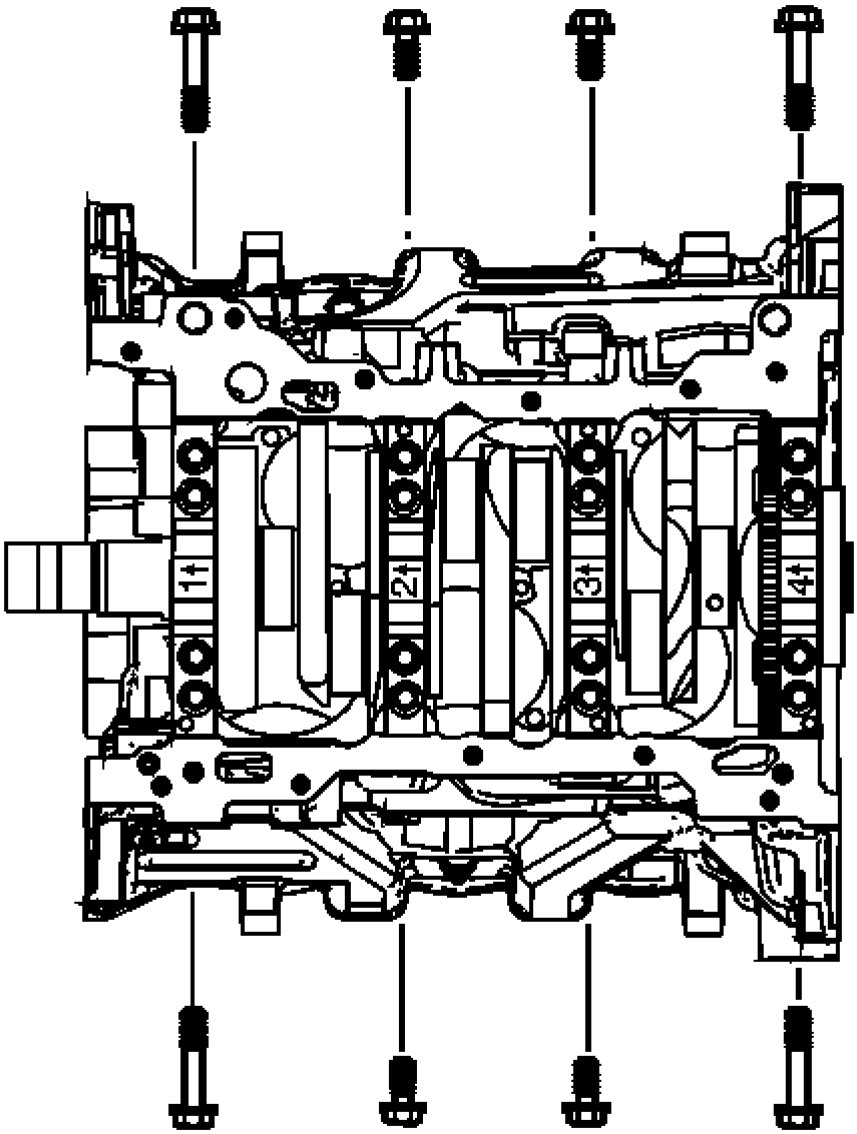


Fig. 107: Identifying Crankshaft Main Bearing Cap Side Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft bearing cap side bolts.
2. Remove the crankshaft bearing cap outer bolts.
3. Remove the crankshaft bearing cap inner bolts.

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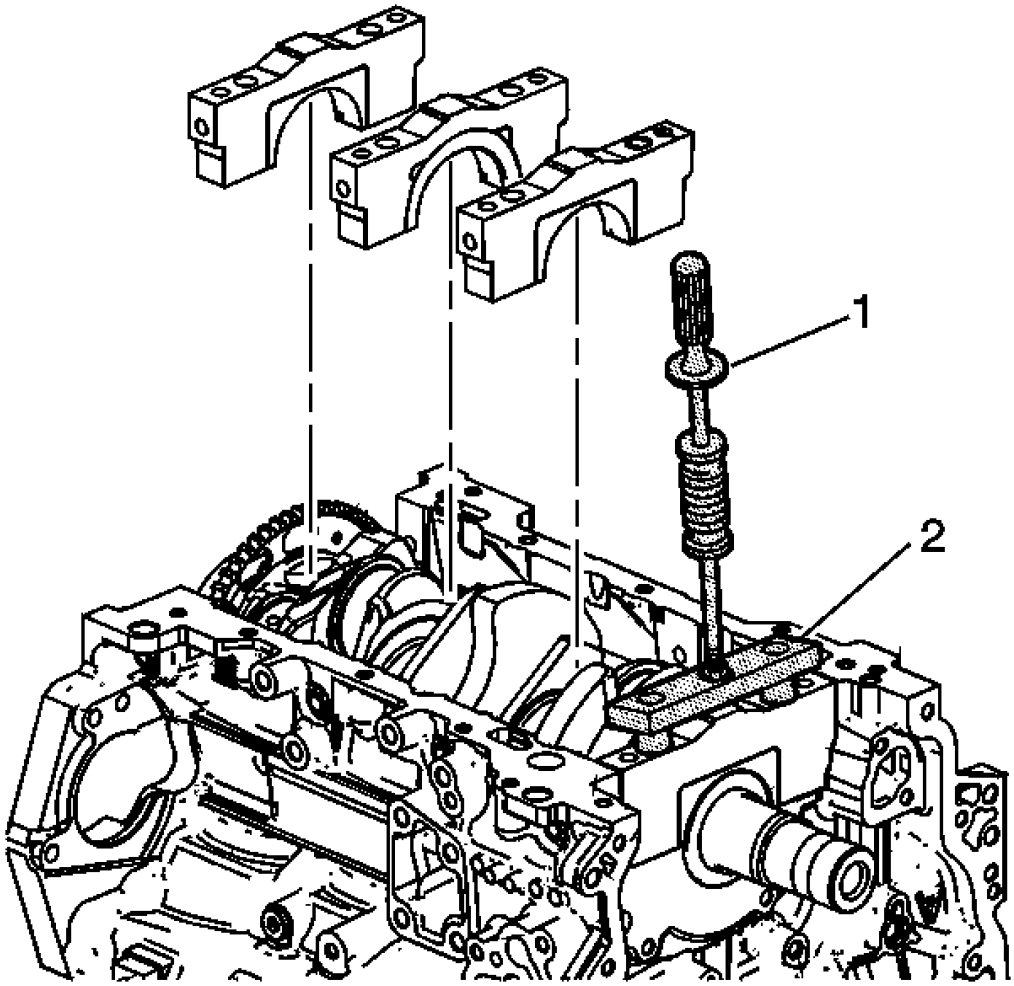


Fig. 108: View Of Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS CORP.

4. Remove the crankshaft bearing caps using the **J 6125-1B** (1) and **J 41818** (2). See **Special Tools** .

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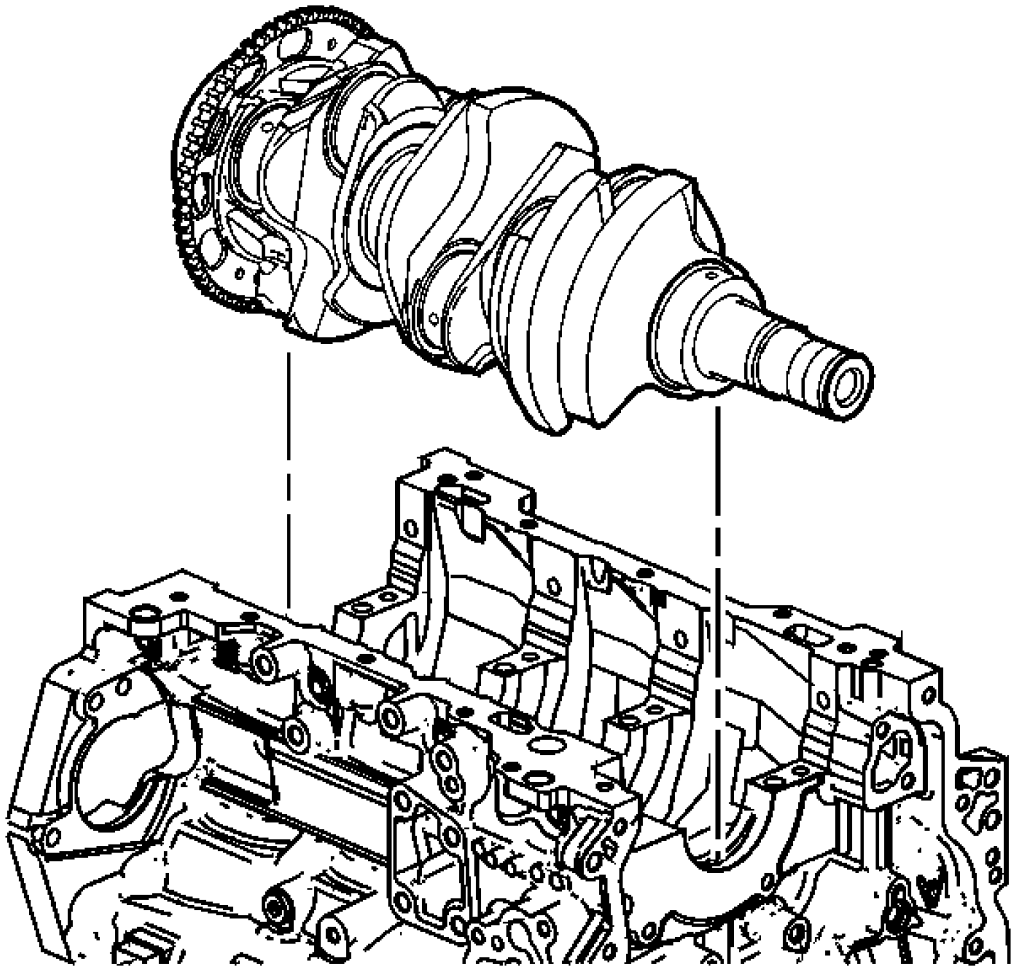


Fig. 109: View Of Crankshaft
Courtesy of GENERAL MOTORS CORP.

5. Using two hands, lift the crankshaft straight up from the engine block.
6. Place the crankshaft in a secure place.

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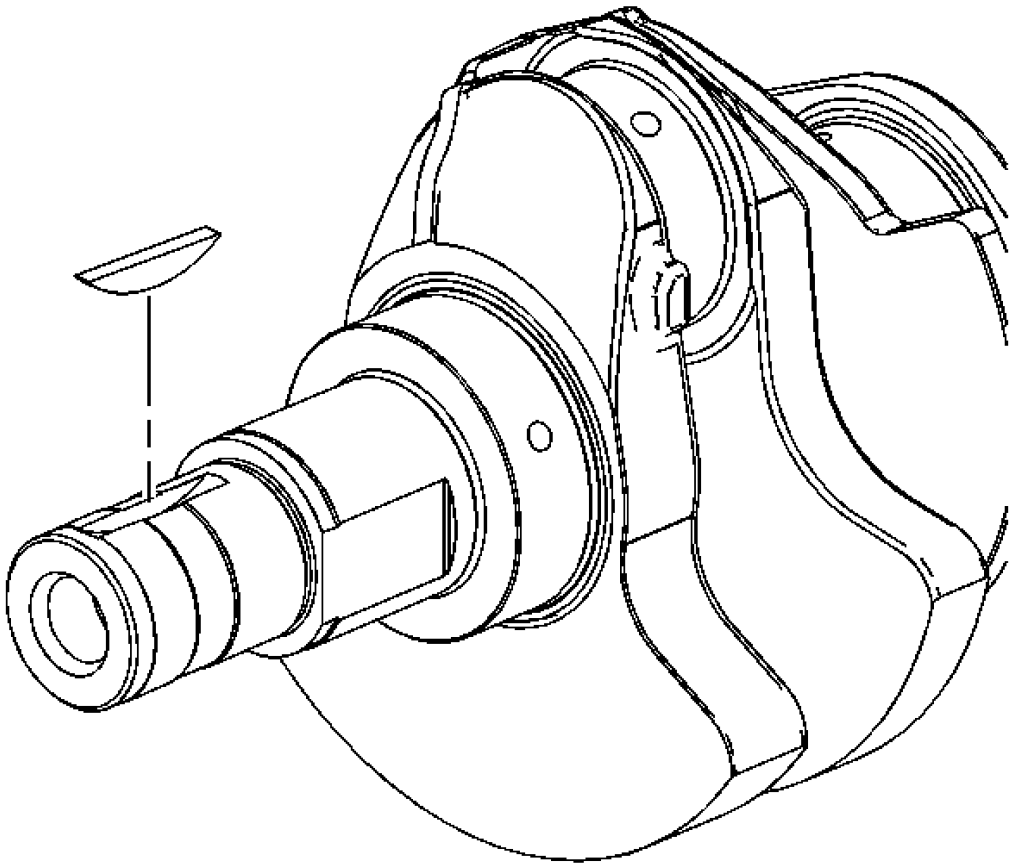


Fig. 110: View Of Crankshaft Key
Courtesy of GENERAL MOTORS CORP.

7. Remove the crankshaft key from the nose of the crankshaft, if damaged.

CRANKSHAFT BEARING REMOVAL

1. Prepare a piece of cardboard or equivalent, numbered 1-4 for bearing identification. Main bearing journals are numbered from the front of the engine.

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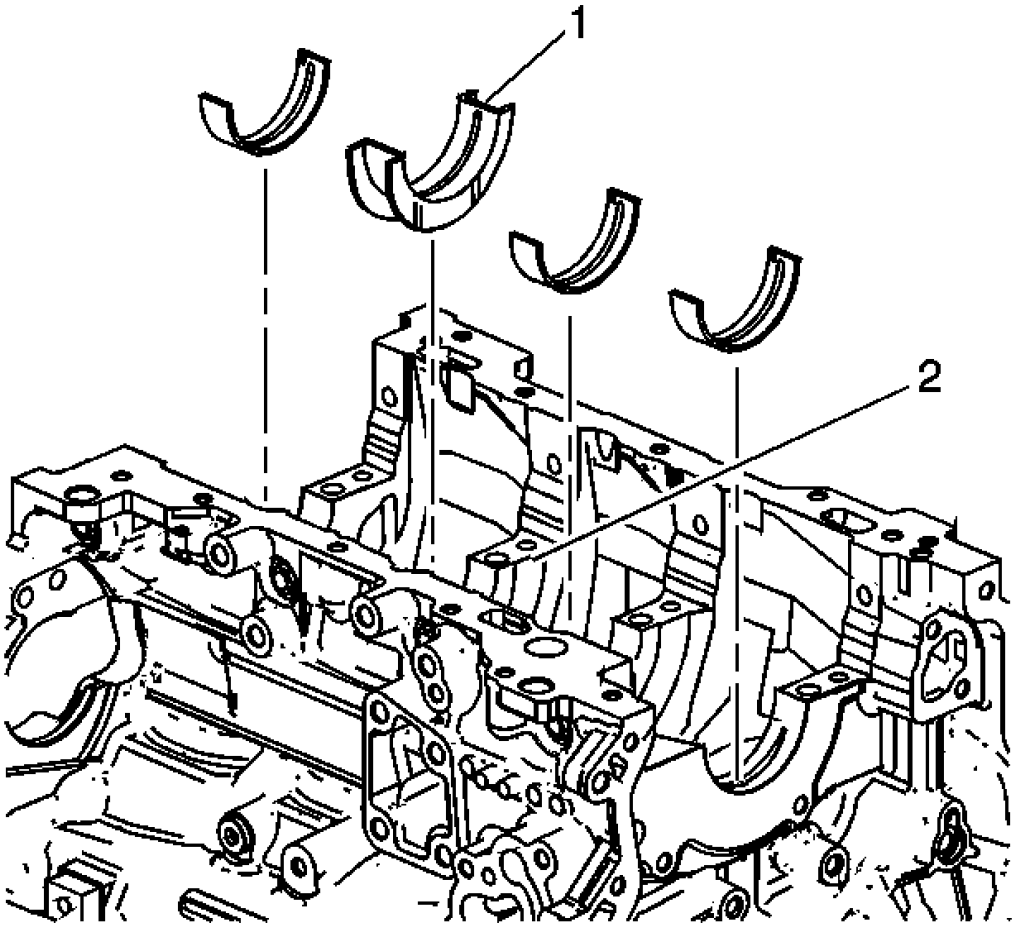


Fig. 111: Locating Thrust Bearing In Number 3 Journal
Courtesy of GENERAL MOTORS CORP.

2. Remove the crankshaft upper bearing halves from the cylinder block. Note the position of the thrust bearing (1) at the number 3 journal (2).
3. Place the crankshaft upper bearing halves on the cardboard in the correct positions. Note that the number 3 bearing is the thrust bearing.

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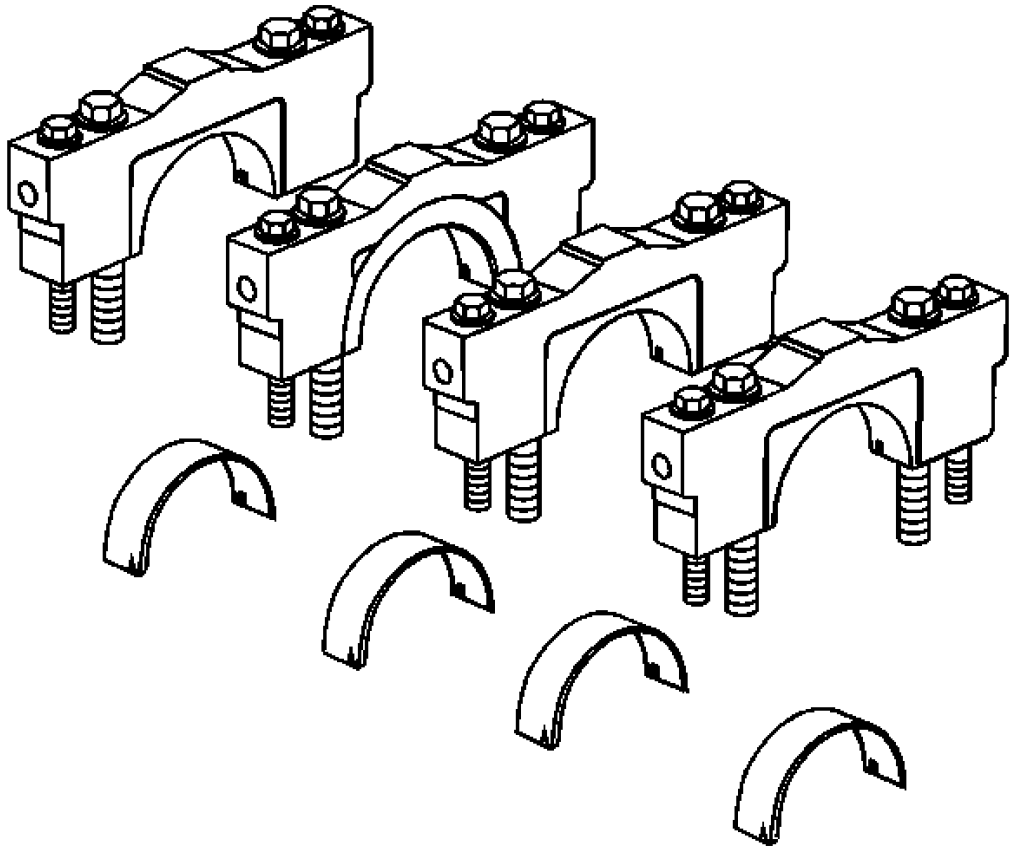


Fig. 112: Crankshaft Lower Bearing Halves & Crankshaft Bearing Caps
Courtesy of GENERAL MOTORS CORP.

4. Remove the crankshaft lower bearing halves from the crankshaft bearing caps.
5. Place the crankshaft lower bearing halves in the correct positions on the cardboard.

ENGINE BLOCK DISASSEMBLE

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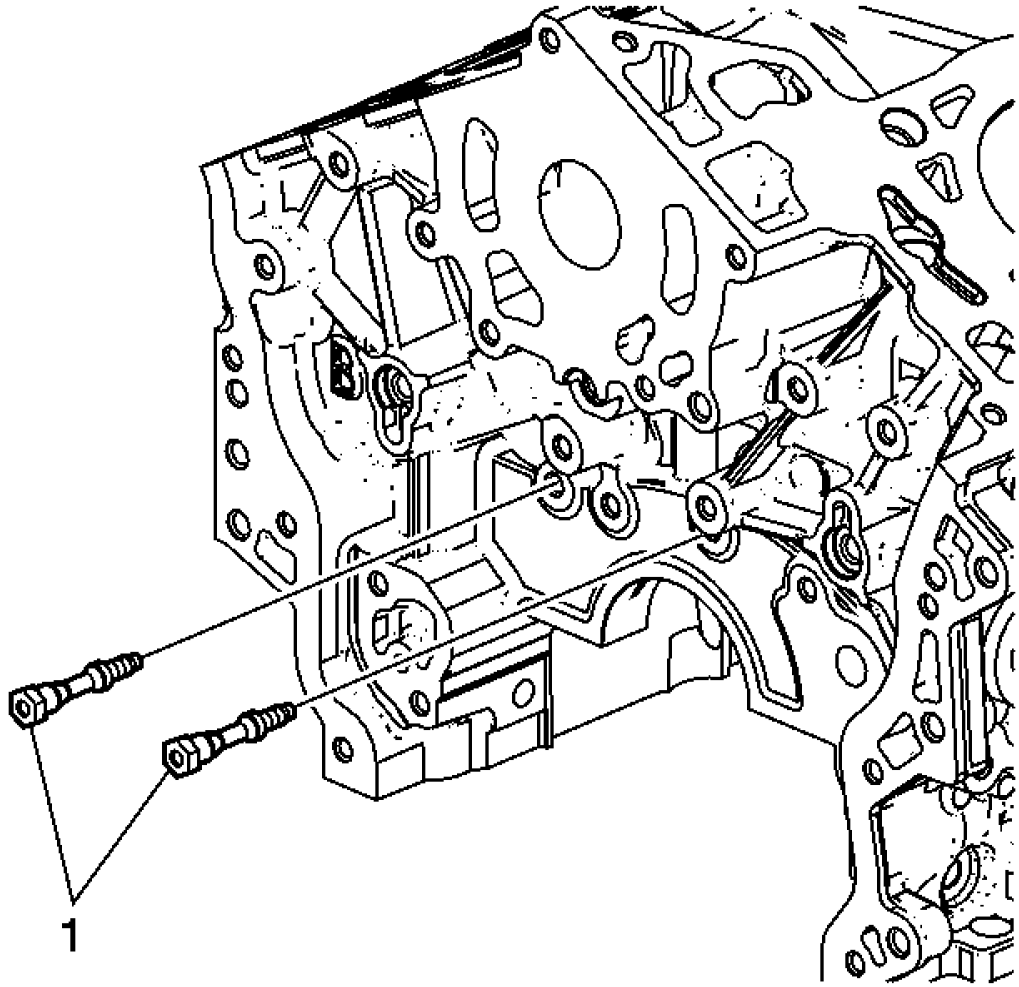


Fig. 113: Engine Front Cover Studs
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine front cover studs (1).

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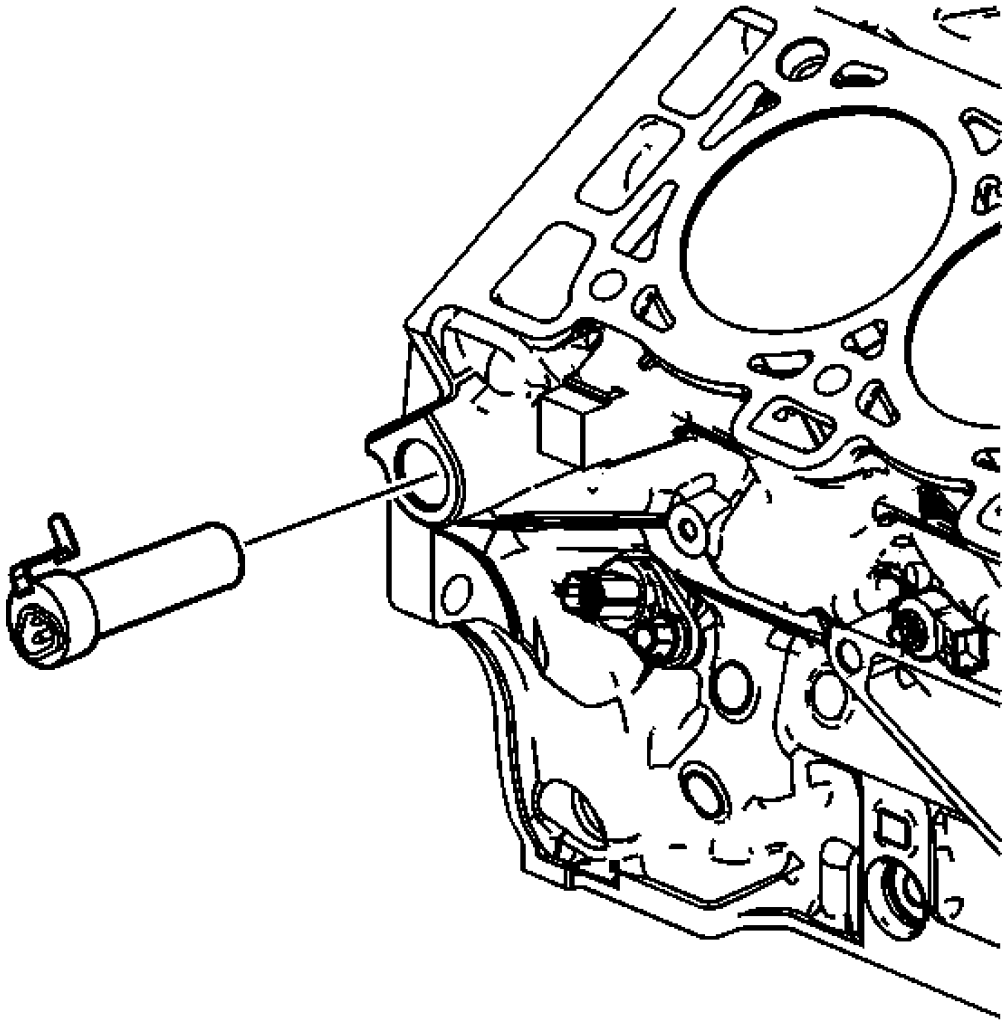


Fig. 114: View Of Block Heater Cartridge
Courtesy of GENERAL MOTORS CORP.

2. Remove the block heater cartridge, if equipped.

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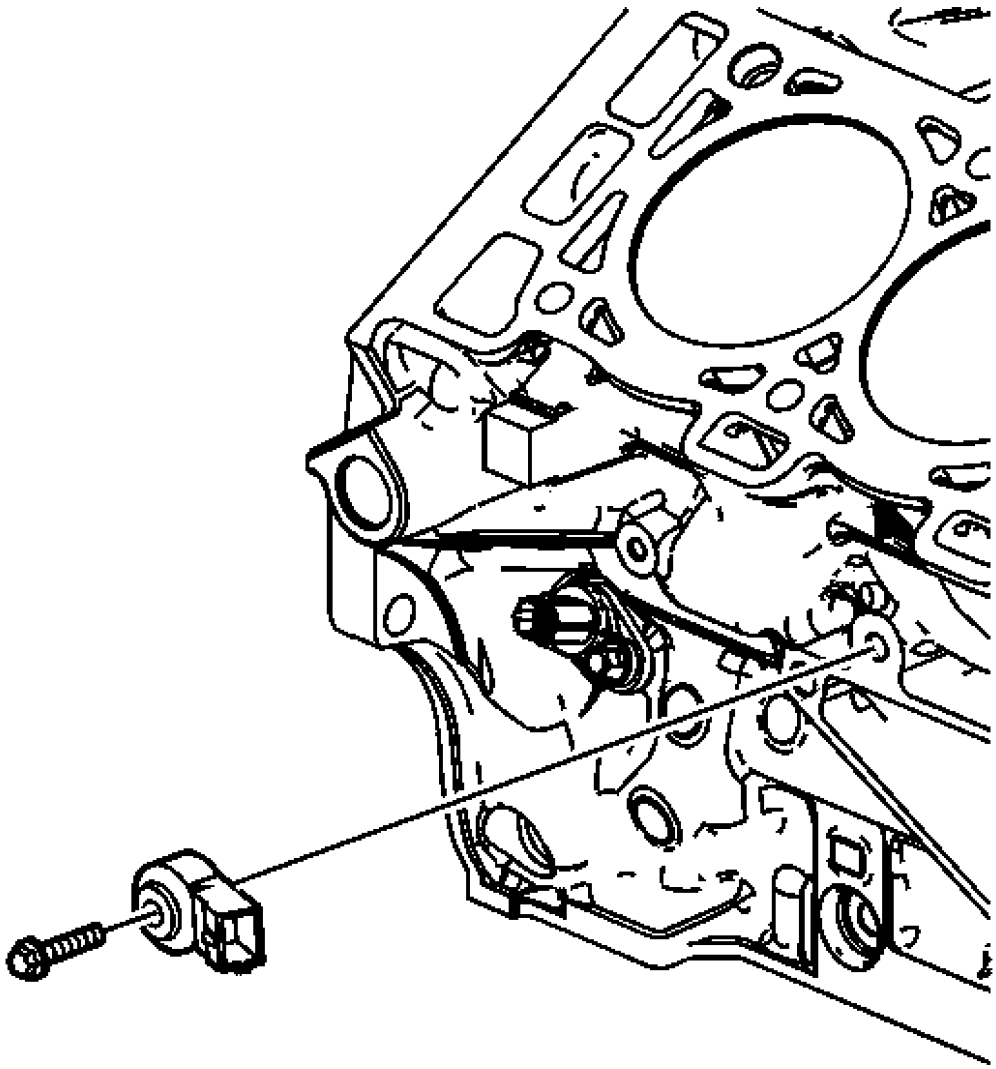


Fig. 115: View Of Right Knock Sensor
Courtesy of GENERAL MOTORS CORP.

3. Remove the right knock sensor bolt.
4. Remove the right knock sensor.

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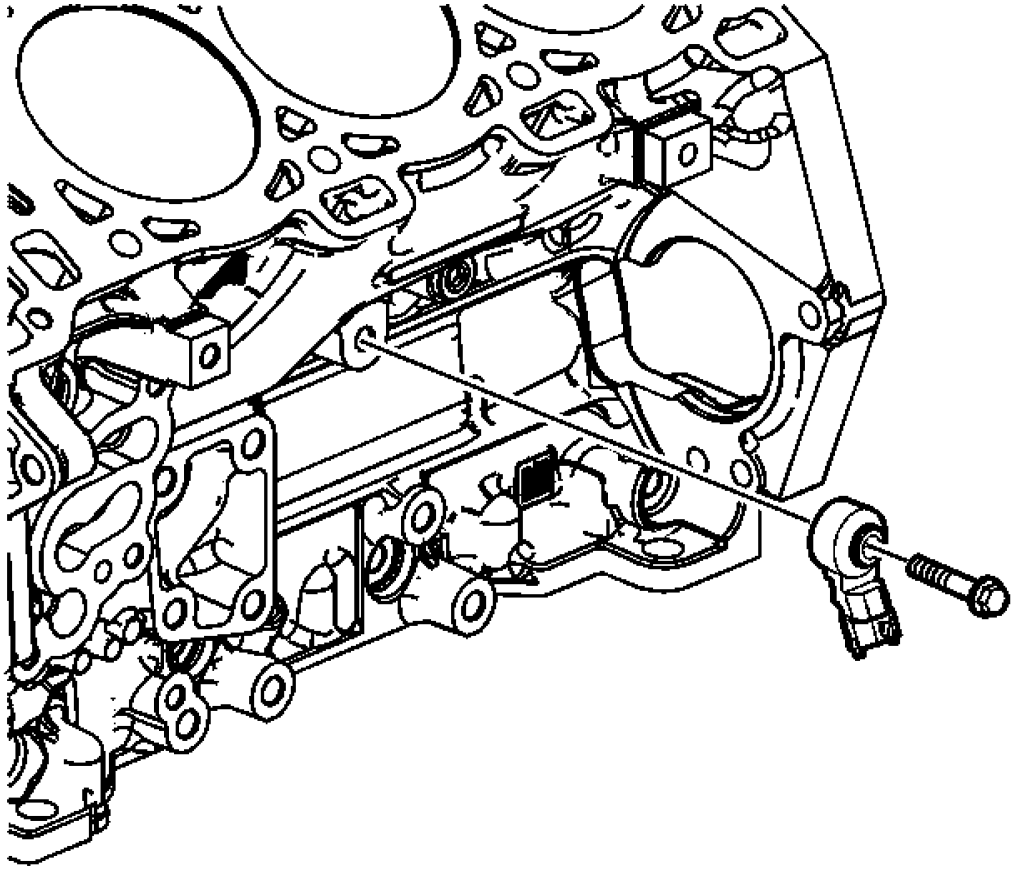


Fig. 116: Left Knock Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

5. Remove the left knock sensor bolt.
6. Remove the left knock sensor.

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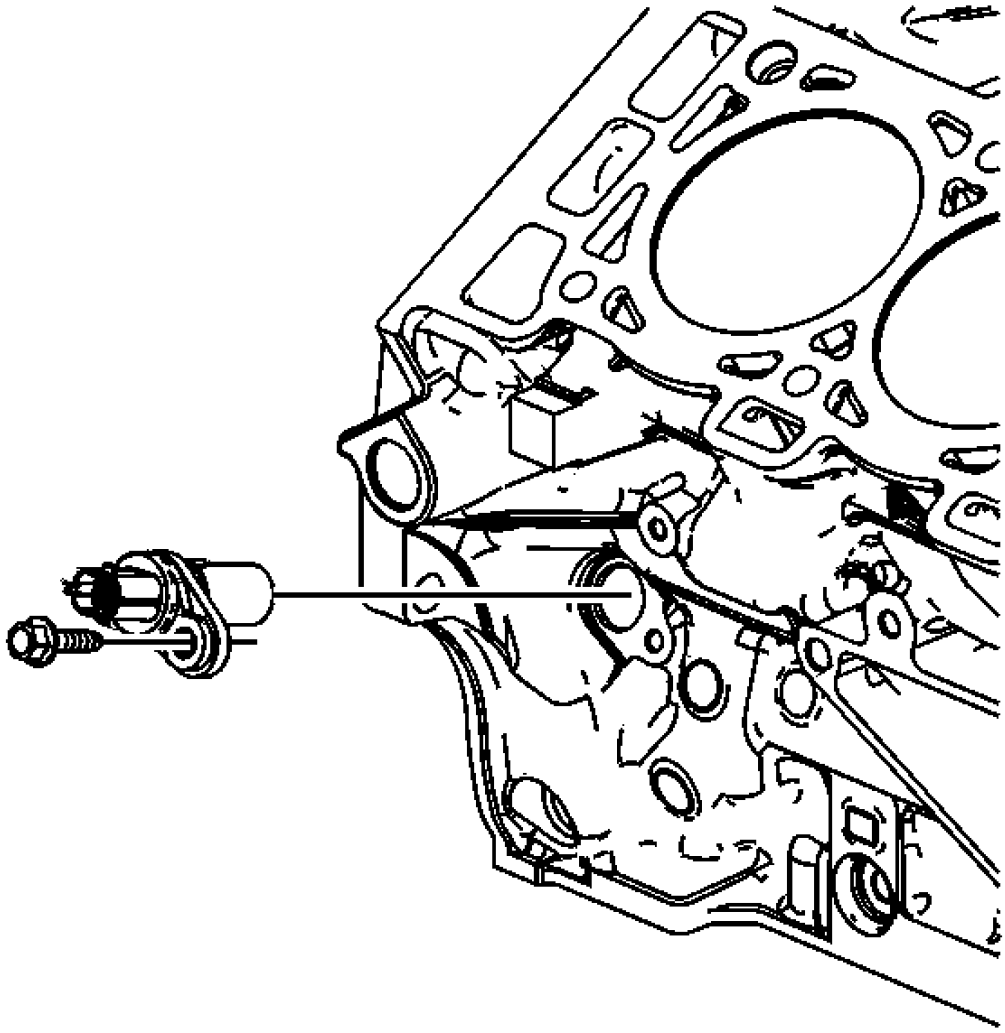


Fig. 117: View Of Crankshaft Position Sensor
Courtesy of GENERAL MOTORS CORP.

7. Remove the crankshaft position sensor bolt.
8. Remove the crankshaft position sensor.

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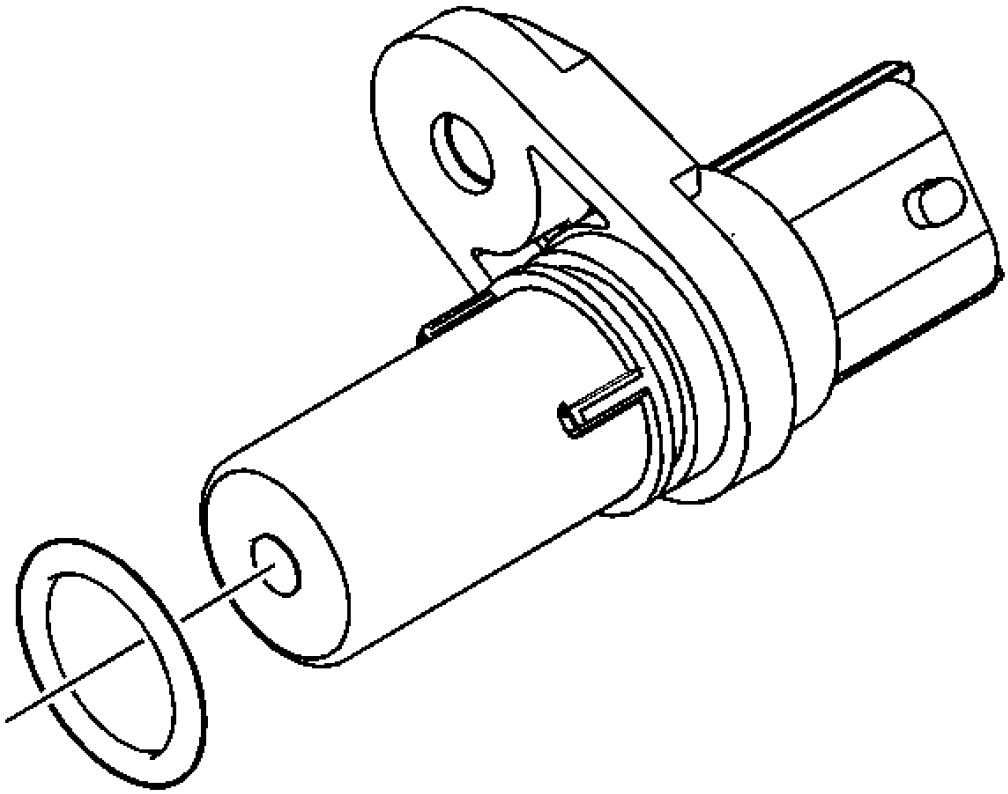


Fig. 118: View Of Crankshaft Position Sensor O-Ring
Courtesy of GENERAL MOTORS CORP.

9. Remove the crankshaft position sensor O-ring, if damaged.

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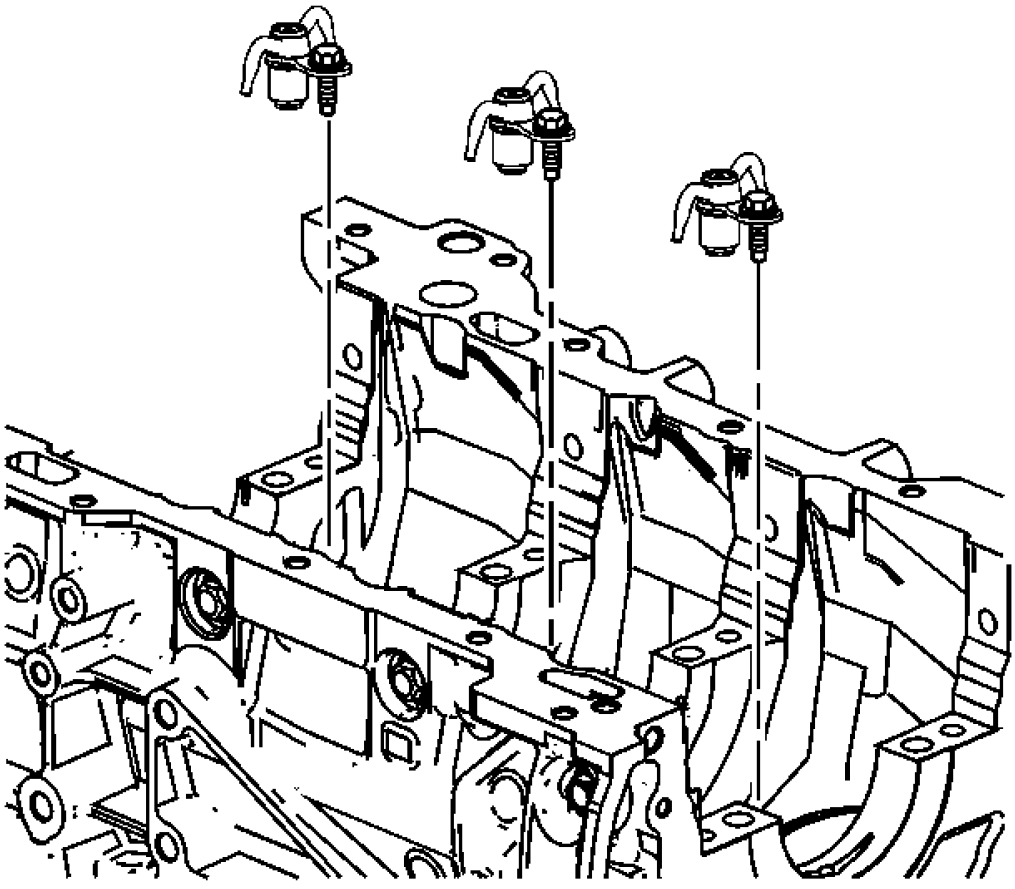


Fig. 119: Oil Jets & Bolts
Courtesy of GENERAL MOTORS CORP.

10. Remove oil jet bolts.
11. Remove oil jets.

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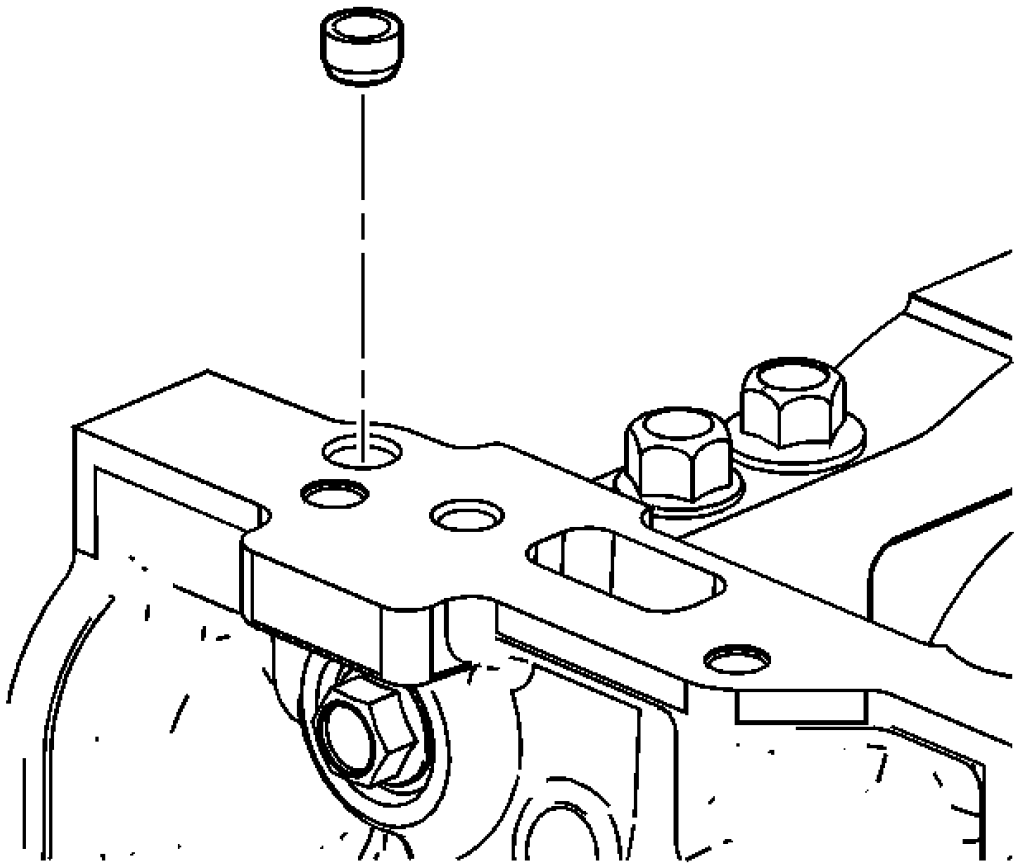


Fig. 120: Right Front Oil Pan Rail Oil Gallery Expansion Plug
Courtesy of GENERAL MOTORS CORP.

12. Remove the right front oil pan rail oil gallery expansion plug.

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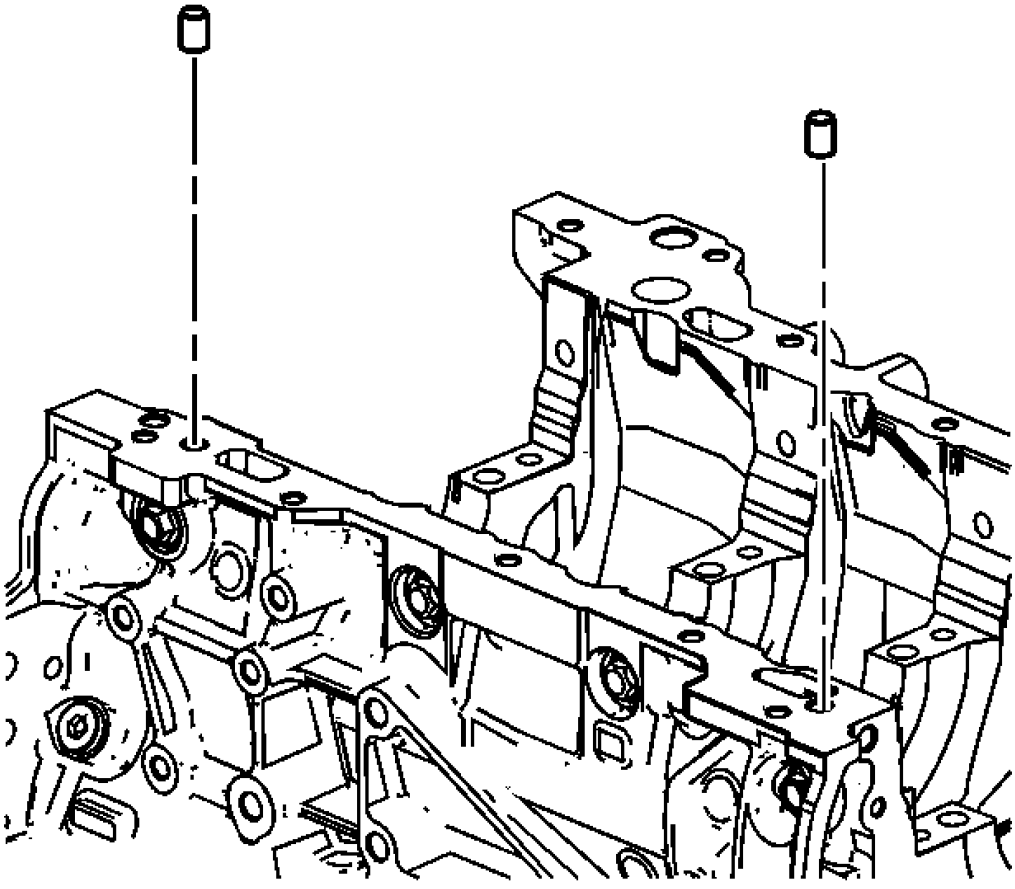


Fig. 121: Cylinder Block-To-Oil Pan Alignment Dowels
Courtesy of GENERAL MOTORS CORP.

13. Remove the cylinder block-to-oil pan alignment dowels.

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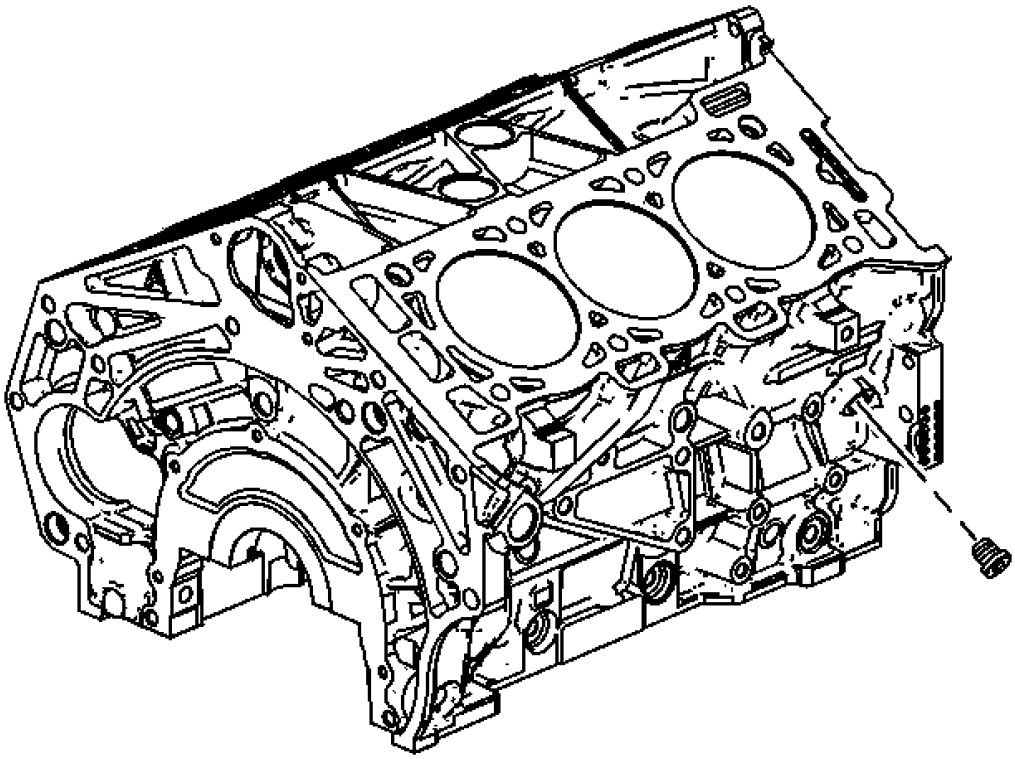


Fig. 122: M14 Right Side Oil Gallery Threaded Plug
Courtesy of GENERAL MOTORS CORP.

14. Remove the M14 right side oil gallery threaded plug.

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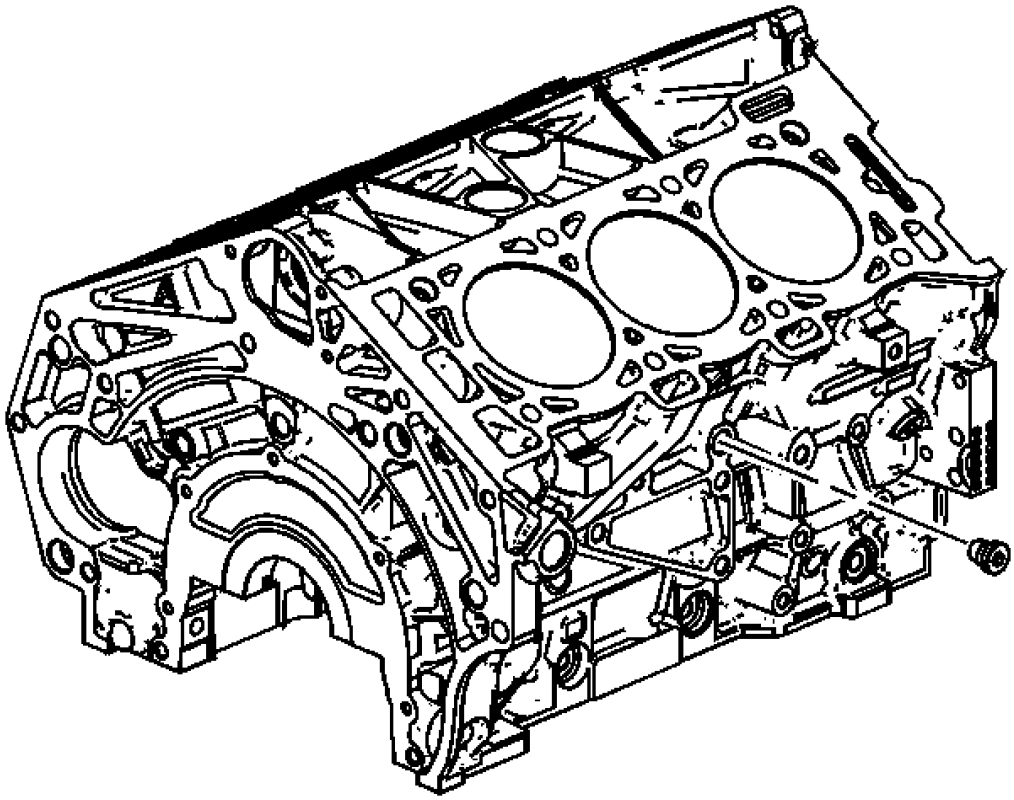


Fig. 123: M14 Right Side Coolant Drain Threaded Plug
Courtesy of GENERAL MOTORS CORP.

15. Remove the M14 right side coolant drain threaded plug.

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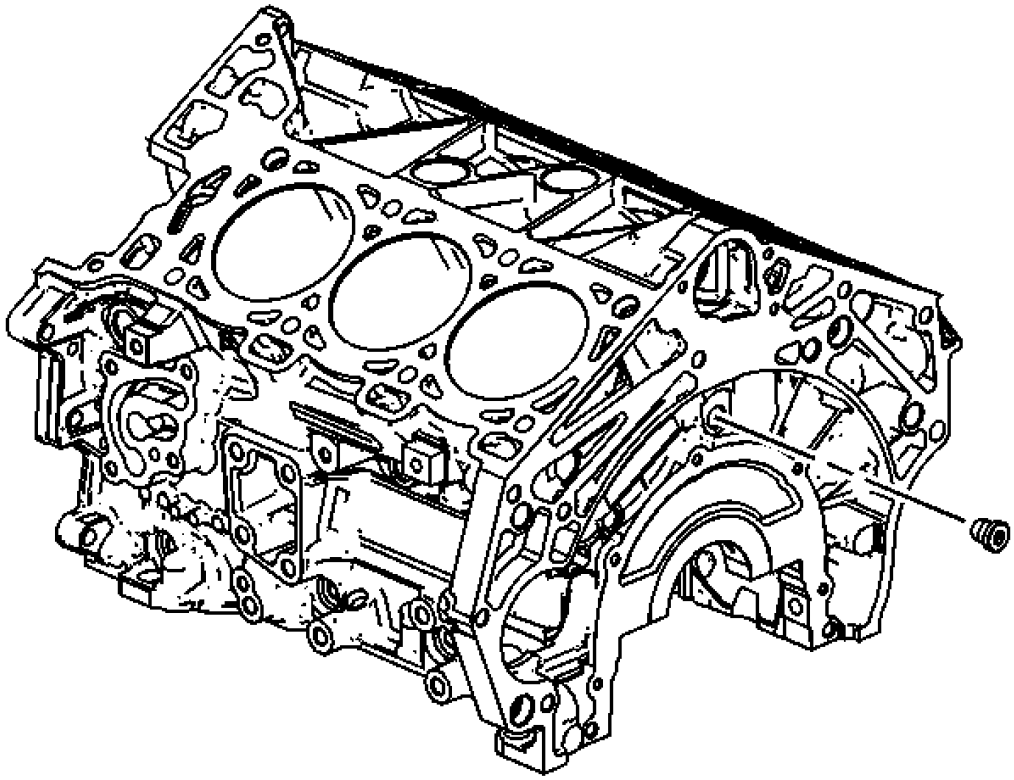


Fig. 124: M14 Rear Oil Gallery Threaded Plug
Courtesy of GENERAL MOTORS CORP.

16. Remove the M14 rear oil gallery threaded plug.

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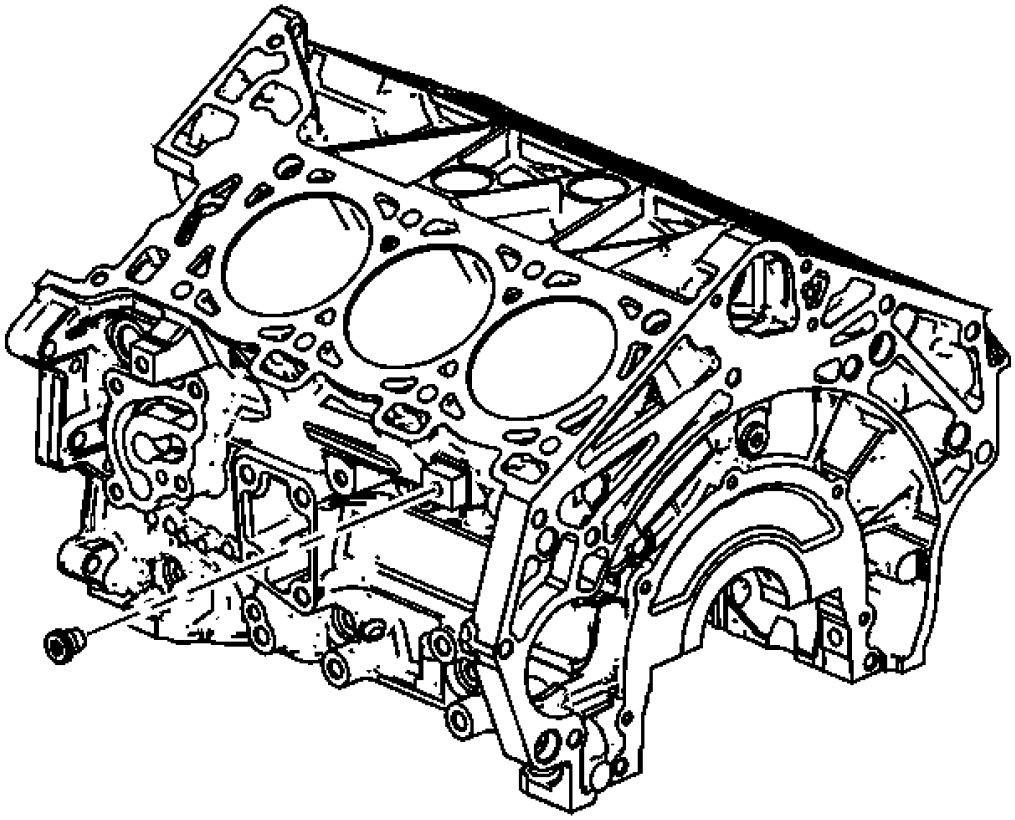


Fig. 125: M14 Left Side Coolant Drain Threaded Plug
Courtesy of GENERAL MOTORS CORP.

17. Remove the M14 left side coolant drain threaded plug.

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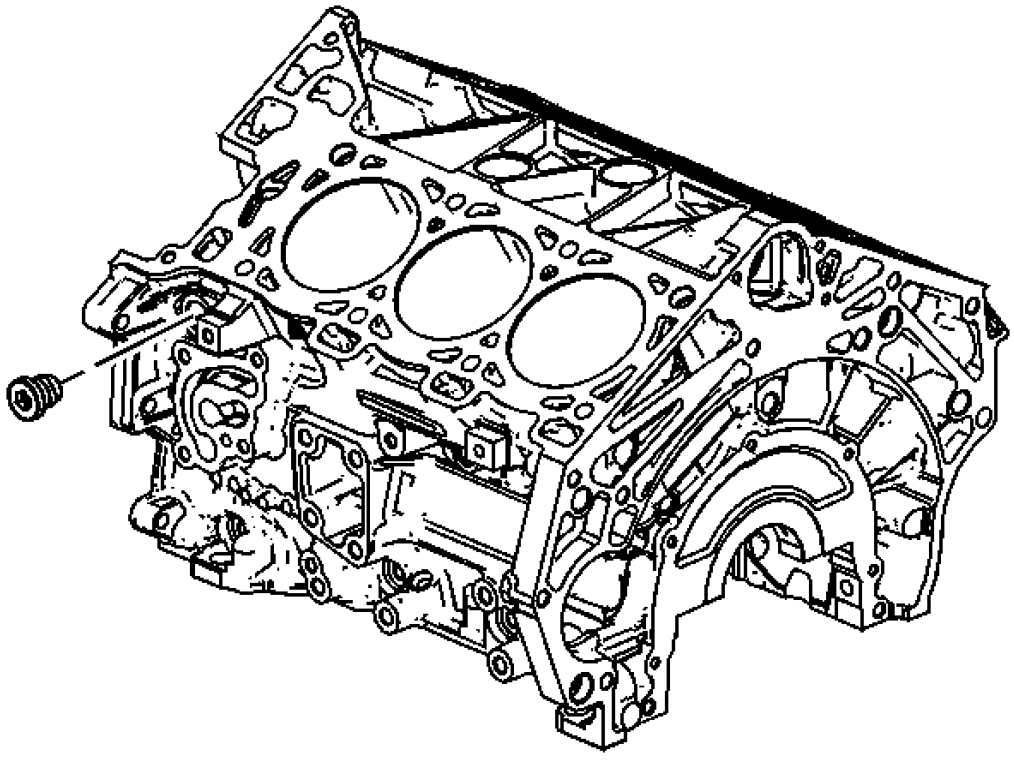


Fig. 126: M20 Left Side Oil Gallery Threaded Plug
Courtesy of GENERAL MOTORS CORP.

18. Remove the M20 left side oil gallery threaded plug.

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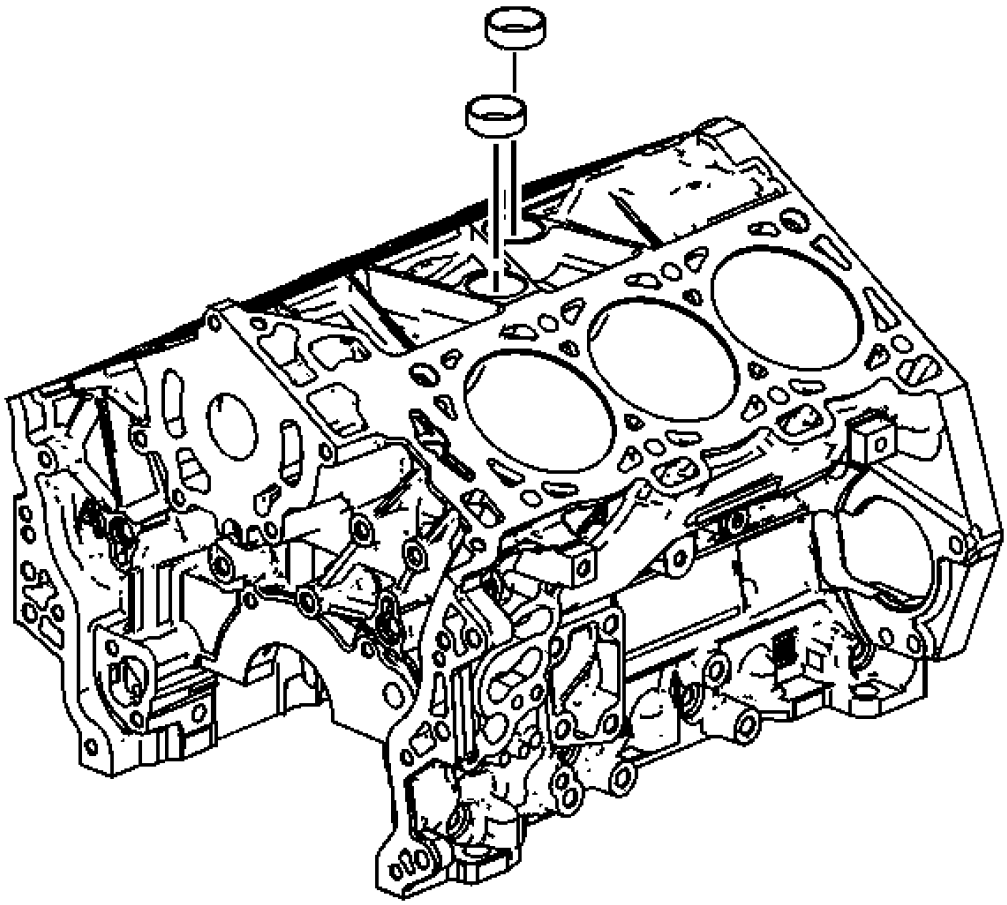


Fig. 127: Coolant Expansion Plugs
Courtesy of GENERAL MOTORS CORP.

19. Remove the coolant expansion plugs.

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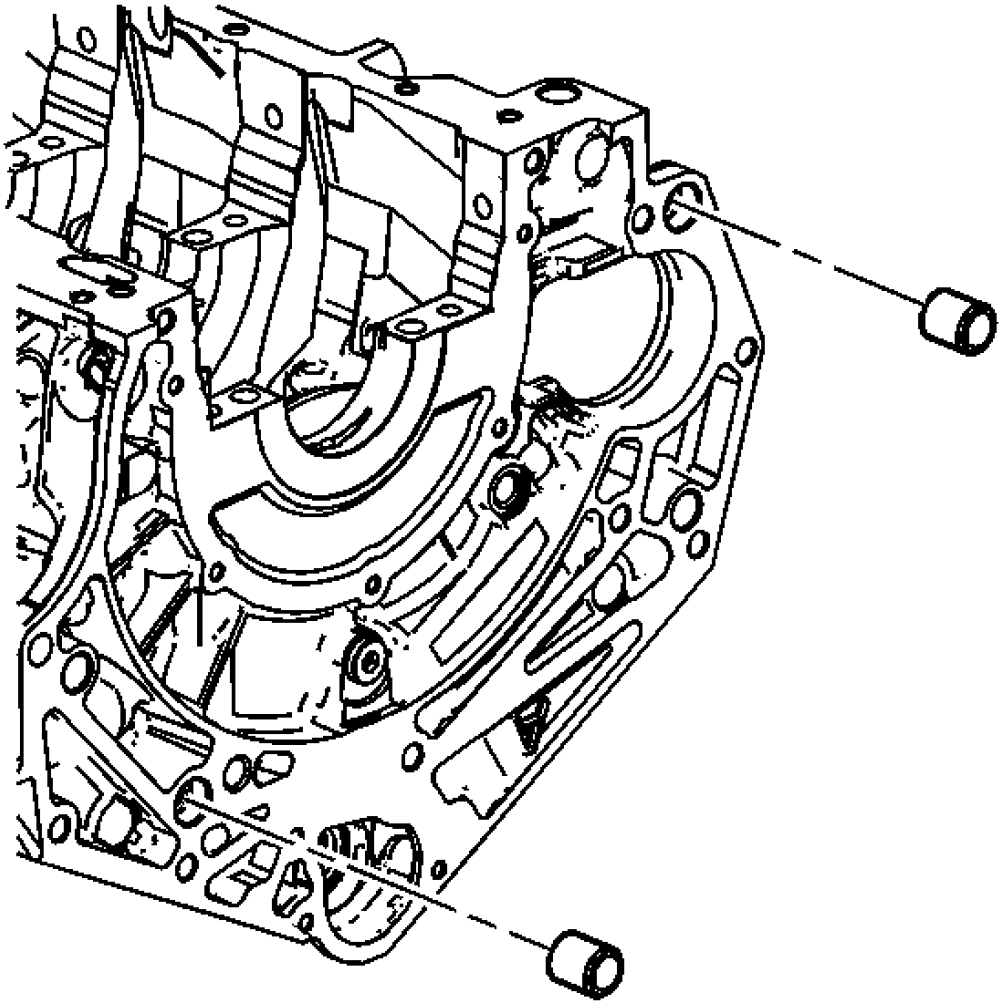


Fig. 128: Cylinder Block-To-Transmission Alignment Dowels
Courtesy of GENERAL MOTORS CORP.

20. Remove the cylinder block-to-transmission alignment dowels.

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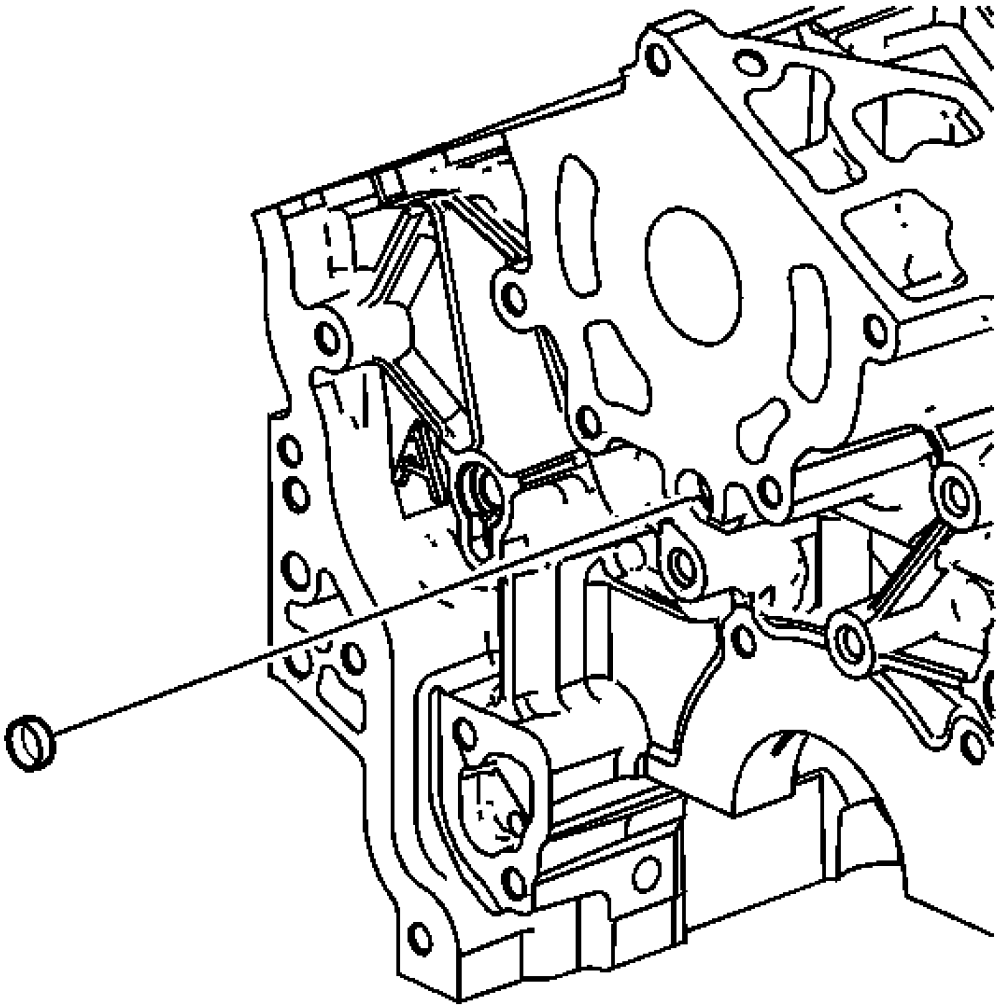


Fig. 129: Front Oil Gallery Expansion Plug
Courtesy of GENERAL MOTORS CORP.

21. Remove the front oil gallery expansion plug.

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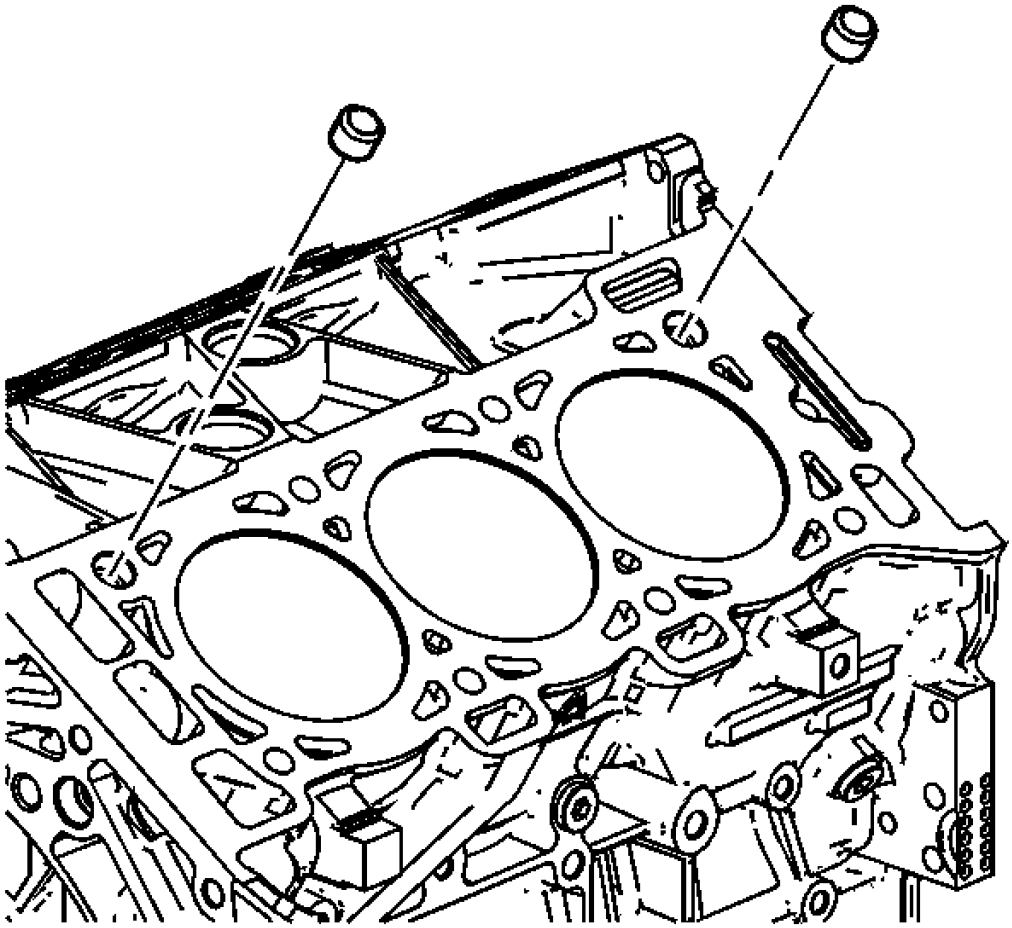


Fig. 130: Cylinder Block-To-Cylinder Head Alignment Dowels
Courtesy of GENERAL MOTORS CORP.

22. Remove the cylinder block-to-cylinder head alignment dowels.

ENGINE BLOCK CLEANING AND INSPECTION

Special Tools

- **J 8087:** Cylinder Bore Gauge
- **J 28410:** Gasket Remover

For equivalent regional tools, refer to **Special Tools** .

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CLEANING PROCEDURE

1. Remove any old thread sealant, gasket material or sealant using **J 28410:** remover.
2. Clean all the following areas with solvent:
    - Sealing surfaces
    - Cooling passages
    - Oil passages
    - Bearing journals
3. Clean all threaded and through holes with solvent.

WARNING: **Refer to Safety Glasses Warning .**

4. Dry the engine block with compressed air.

VISUAL INSPECTION

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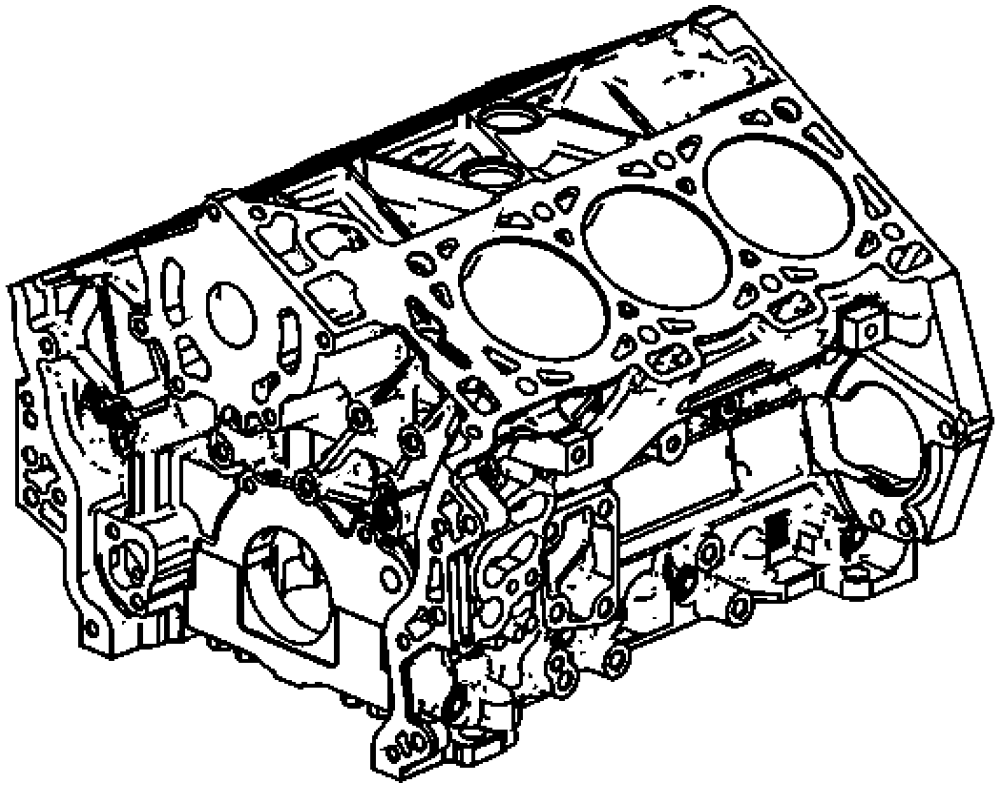


Fig. 131: View Of Engine Block
Courtesy of GENERAL MOTORS CORP.

1. Inspect the crankshaft bearings journals for damage or spun bearings. The crankshaft bearing journals are not repairable, if the crankshaft bearing journals are damaged the cylinder block assembly must be replaced.
2. Inspect the primary camshaft drive chain tensioner mounting surface on the engine block for burrs or any defects that would degrade the sealing of the NEW primary camshaft drive chain tensioner gasket.
3. Inspect all sealing and mating surfaces for damage, repair or replace the cylinder block assembly if necessary.
4. Inspect all threaded and through holes for damage or excessive debris.
5. Inspect all bolts for damage, if damaged replace with NEW bolts only.
6. Inspect the cylinder walls for cracks or damage. The cylinder sleeves are not serviced separately, if the cylinders are damaged the cylinder block assembly must be replaced.
7. Inspect the engine block for cracks. Do not repair any cracks. If cracks are found, the cylinder block assembly must be replaced.

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8. Repair any damaged threaded holes. Refer to **Thread Repair Specifications** and **Thread Repair** .

MEASURING CYLINDER BORE DIAMETER

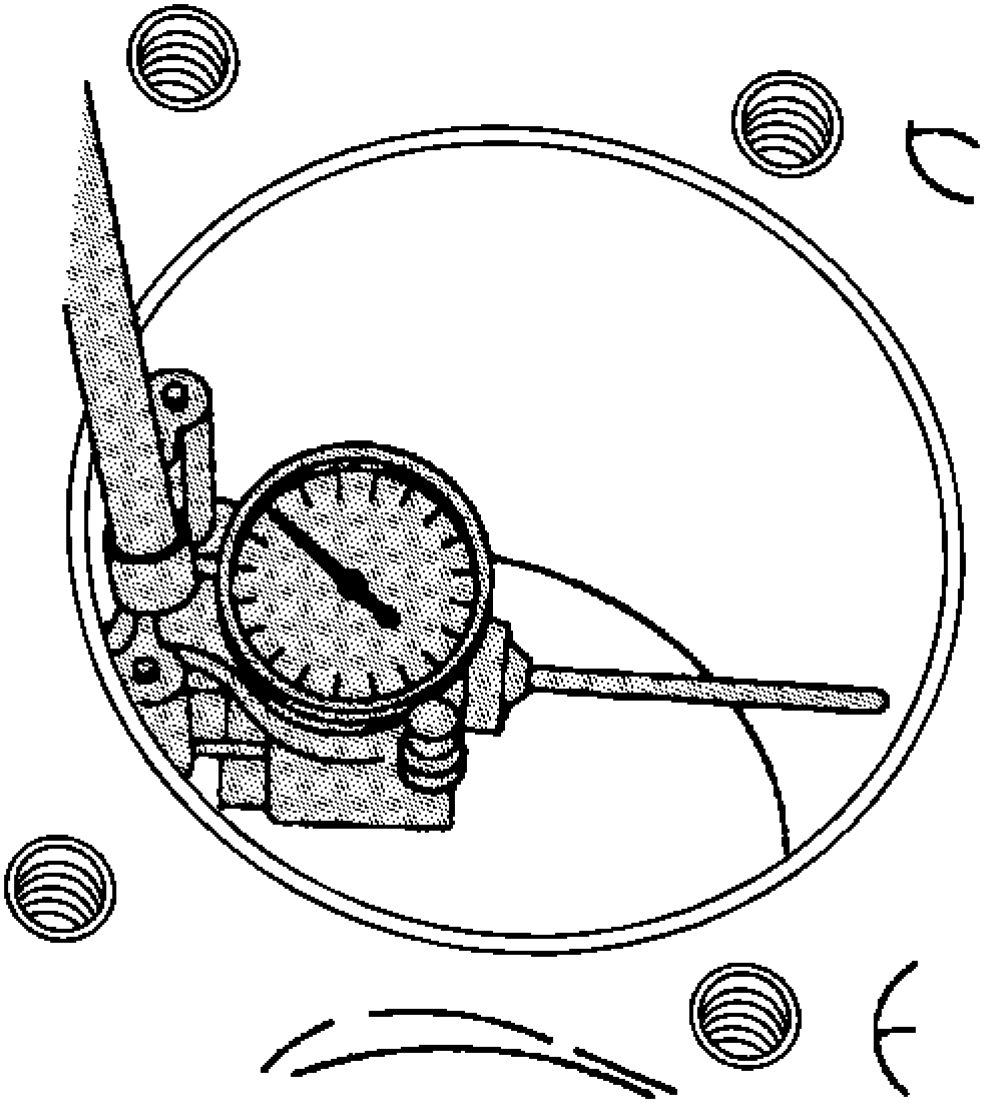


Fig. 132: Measuring Cylinder Bore
Courtesy of GENERAL MOTORS CORP.

Measure the cylinder bore diameter 37 mm (1.457 in) from the deck face using the **J 8087:** gauge.

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Compare your results with the **Engine Mechanical Specifications (LLT)** . If the cylinder diameter exceeds the specifications, the cylinder block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

MEASURING CYLINDER BORE TAPER

1. Measure the cylinder bore along the thrust surfaces, perpendicular to the crankshaft centerline, at 10 mm (0.397 in) below the deck surface and record your measurement.
2. Measure the cylinder bore along the thrust surfaces, perpendicular to the crankshaft centerline, at 100 mm (3.976 in) below the deck surface and record your measurement.
3. Calculate the difference between the 2 measurements. The result will be the cylinder taper.
4. Compare your results with the **Engine Mechanical Specifications (LLT)** . If the cylinders exceed the specifications, the cylinder block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

MEASURING CYLINDER BORE OUT-OF-ROUND

1. Measure both the thrust and non-thrust cylinder diameter at 10 mm (0.397 in) below the deck. Record your measurements.
2. Calculate the difference between the 2 measurements. The result will indicate out-of-round at the upper end of the cylinder.
3. Measure both the thrust and non-thrust cylinder diameter at 100 mm (3.976 in) below the deck surface. Record your measurements.
4. Calculate the difference between the 2 measurements. The result will indicate out-of-round at the lower end of the cylinder.
5. Compare your results with the **Engine Mechanical Specifications (LLT)** . If the cylinders exceed these specifications, the cylinder block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

DECK FLATNESS INSPECTION

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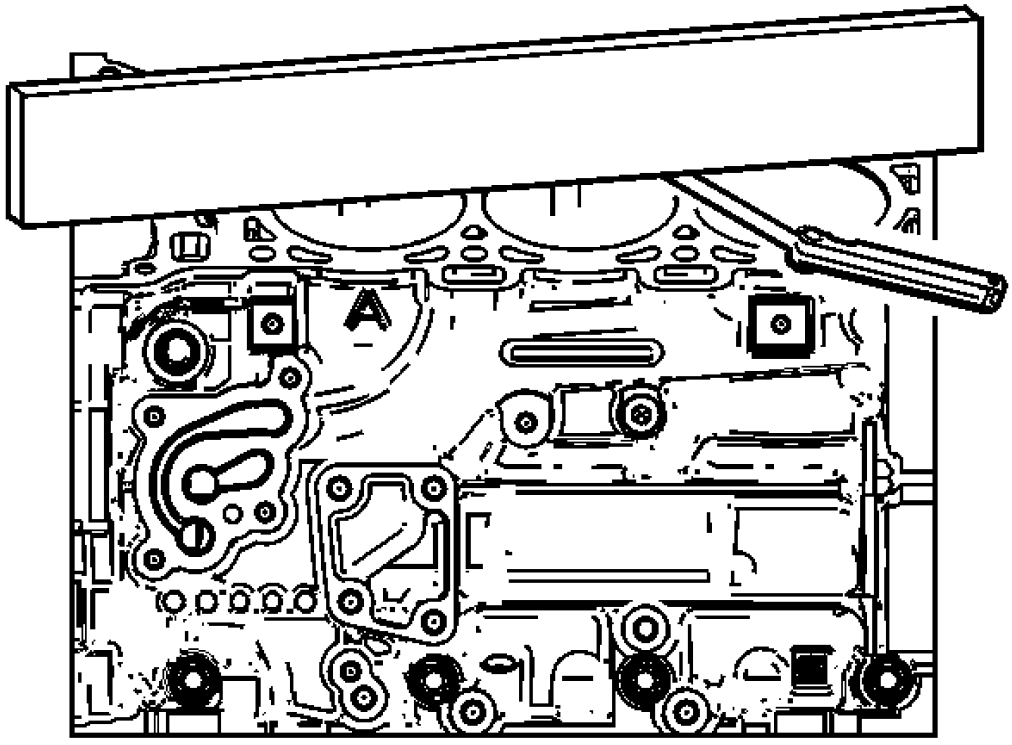


Fig. 133: Measuring Deck Flatness
Courtesy of GENERAL MOTORS CORP.

1. Ensure the engine block decks are clean and free of gasket material.
2. Inspect the surface for any imperfections or scratches that could inhibit proper cylinder head gasket sealing.
3. Place a straight-edge diagonally across the cylinder block deck face surface.
4. Measure the clearance between the straight-edge and the cylinder block deck face using a feeler gauge at 4 points along the straight-edge.
5. If the warpage is less than 0.05 mm (0.002 in), the cylinder block deck surface does not require resurfacing.
6. If the warpage is between 0.05-0.20 mm (0.002-0.008 in) or any imperfections or scratches that could inhibit proper cylinder head gasket sealing are present, the cylinder block deck surface requires resurfacing.
7. If resurfacing is required the maximum amount that can be removed is 0.25 mm (0.010 in).
8. If the cylinder block deck surface requires more than 0.25 mm (0.010 in) material removal the block must be replaced.

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2010 ENGINE

Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Repair Instructions - Off Vehicle - Camaro

CRANKSHAFT AND BEARING CLEANING AND INSPECTION

CLEANING PROCEDURE

1. Clean the following components in solvent:
    - Crankshaft bearings
    - Connecting rod bearings
    - Crankshaft journals
    - Crankpin journals
    - Crankshaft oil passages
    - Crankshaft threaded holes

    WARNING: Refer to Safety Glasses Warning .

2. Dry the following components with compressed air:
    - Crankshaft bearings
    - Connecting rod bearings
    - Crankshaft journals
    - Crankpin journals
    - Crankshaft oil passages
    - Crankshaft threaded holes

VISUAL INSPECTION

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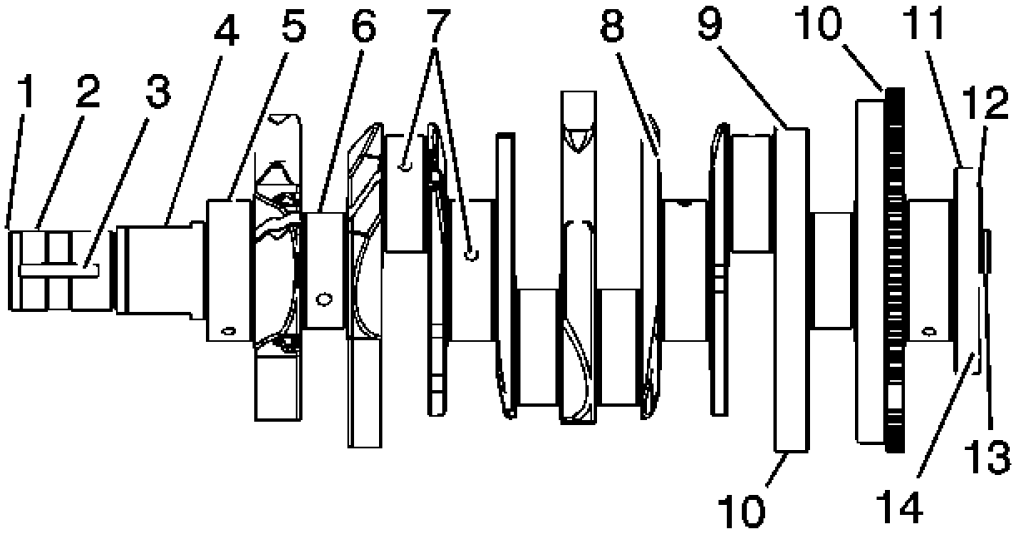


Fig. 1: Identifying Crankshaft Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Perform the following visual inspections:
    - Inspect the crankshaft balancer bolt hole (1) for thread damage.
    - Inspect the crankshaft balancer mounting area (2) for damage.
    - Inspect the crankshaft keyway (3) for damage.
    - Inspect the oil pump drive flats (4) for damage.
    - Inspect the crankshaft main journals (5) for damage.
    - Inspect the crankshaft connecting rod journals (6) for damage.
    - Inspect the crankshaft oil passages (7) for obstructions.
    - Inspect the crankshaft main bearing thrust wall surfaces (8) for damage.
    - Inspect the crankshaft counterweights (9) for damage.
    - Inspect the crankshaft reluctor ring teeth (10) for damage.
    - Inspect the crankshaft rear main oil seal surface (11) for damage.
    - Inspect the crankshaft engine flywheel mounting surface (12) for damage.
    - Inspect the crankshaft pilot hole (13) for damage.
    - Inspect the crankshaft engine flywheel bolt holes (14) for thread damage.
2. Repair or replace the crankshaft as necessary.

CRANKSHAFT BEARING INSPECTION

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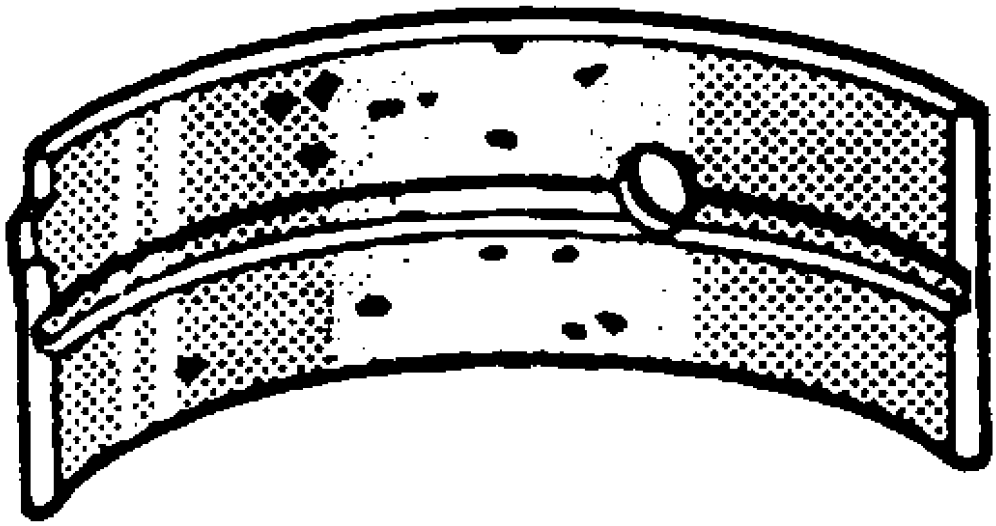


Fig. 2: Identifying Crankshaft Bearing Craters Or Pockets
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **All connecting rod and main journal bearings that have been used in a running engine must be replaced. Never re-use the crankshaft or connecting rod bearings.**
- **The following bearing wear conditions should be used to diagnose engine operating conditions or root cause of a condition.**

1. Inspect for fatigue indicated by craters or pockets. Flattened sections on the bearing halves also indicate fatigue.

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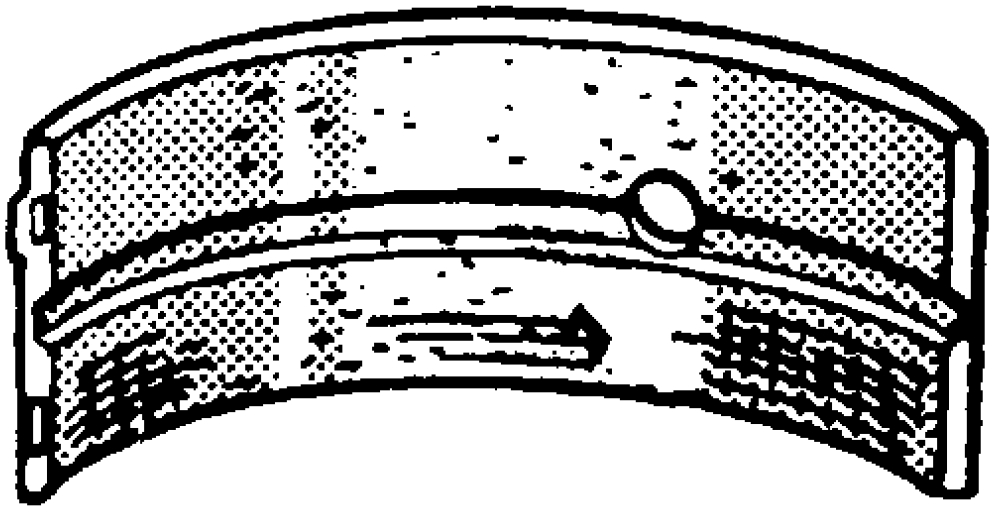


Fig. 3: Identifying Connecting Rod Bearing Scoring Or Discoloration
Courtesy of GENERAL MOTORS CORP.

2. Inspect for excessive scoring or discoloration on both front and back of the bearing halves.
3. Inspect the main bearings for dirt embedded into the bearing material.

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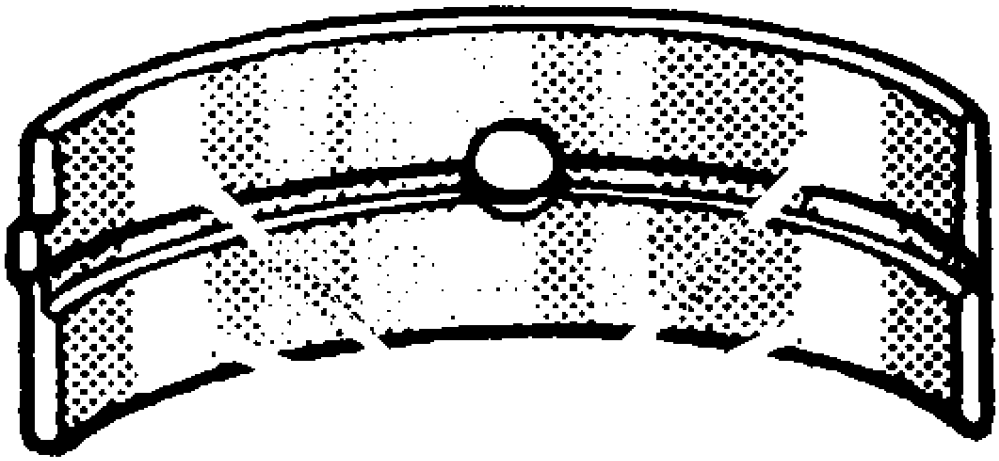


Fig. 4: View Of Improper Seating
Courtesy of GENERAL MOTORS CORP.

4. Inspect for improper seating indicated by bright, polished sections.

CRANKSHAFT MEASUREMENT

Special Tools

J 7872: Magnetic Base Dial Indicator

For equivalent regional tools, refer to **Special Tools**

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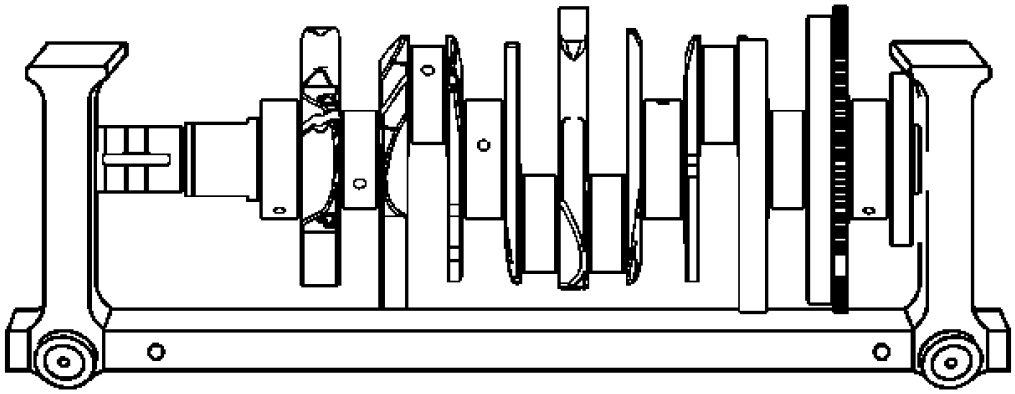


Fig. 5: View Of Crankshaft & Support
Courtesy of GENERAL MOTORS CORP.

1. Using a suitable fixture, support the crankshaft.

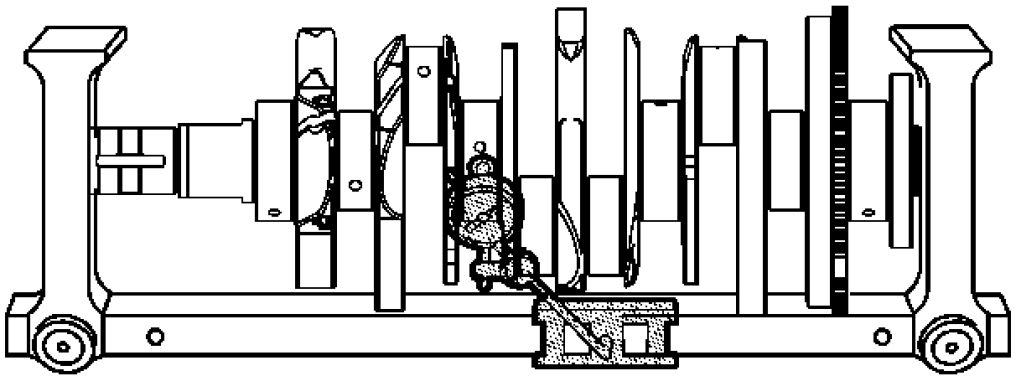


Fig. 6: Measuring Crankshaft Runout
Courtesy of GENERAL MOTORS CORP.

2. Install the **J 7872:** indicator.
3. Measure the crankshaft runout using the **J 7872:** indicator. Refer to **Engine Mechanical Specifications (LLT)** .

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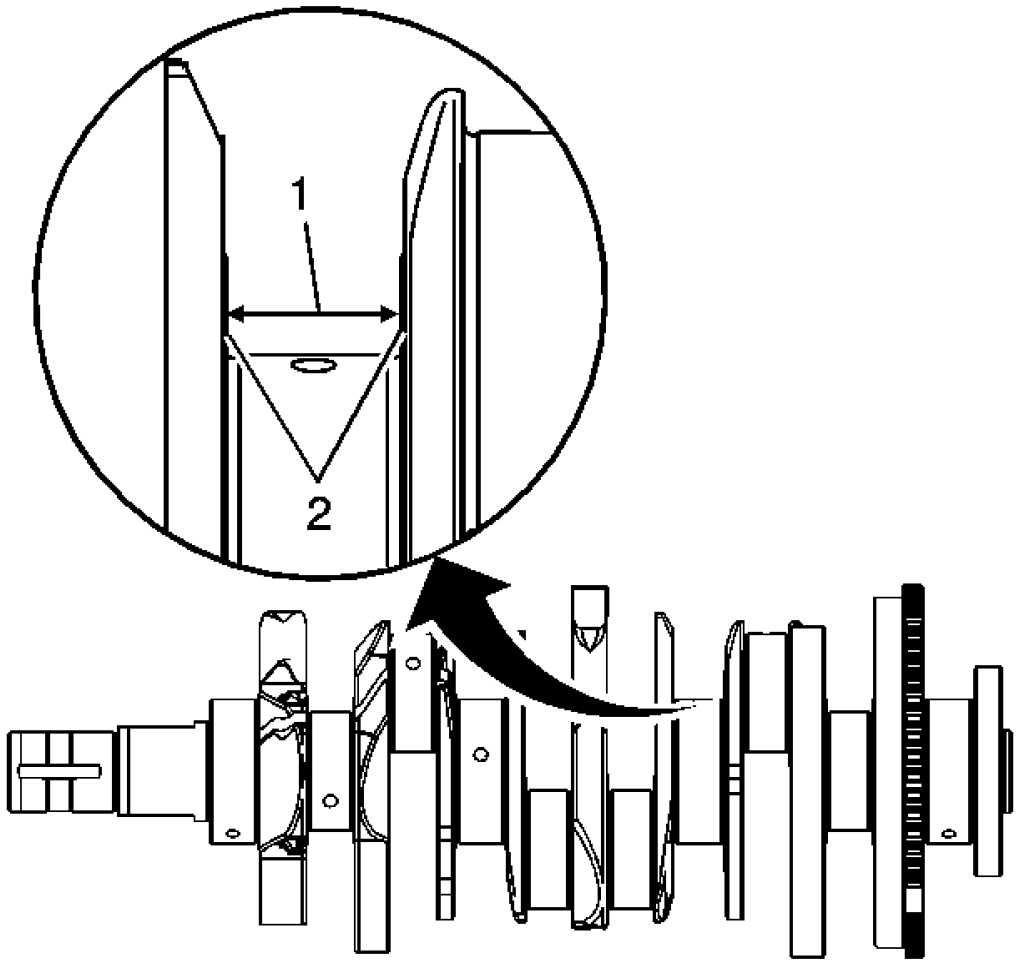


Fig. 7: Identifying Crankshaft Thrust Wall Width & Surface
Courtesy of GENERAL MOTORS CORP.

4. Measure the crankshaft thrust wall width (1) for wear using an inside micrometer. Refer to **Engine Mechanical Specifications (LLT)** .
5. Measure the crankshaft thrust wall surface (2) for runout using the **J 7872:** indicator. Refer to **Engine Mechanical Specifications (LLT)** .
6. If the crankshaft journals are damaged or worn beyond specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized main bearings available for service.

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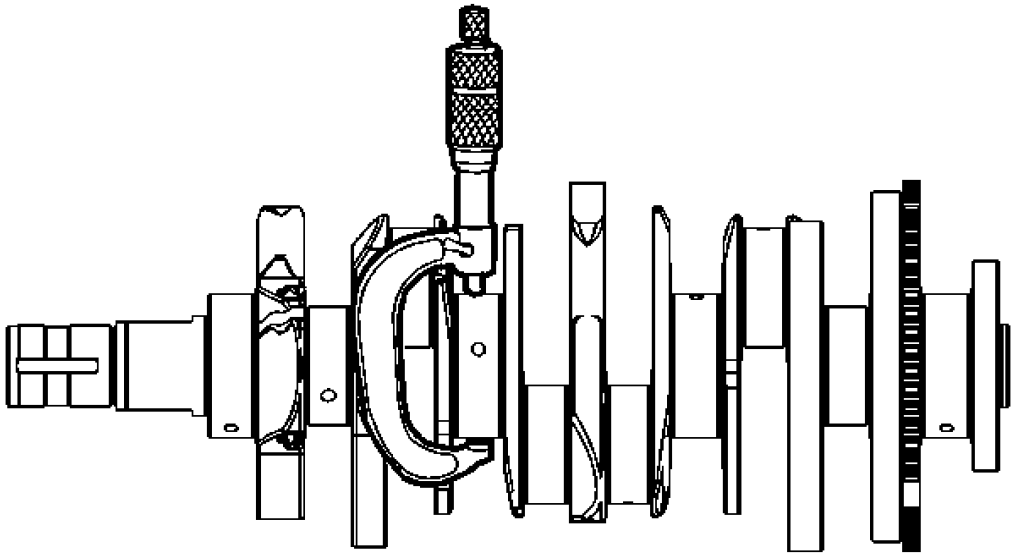


Fig. 8: Inspecting Crankshaft Main Journals For Undersize
Courtesy of GENERAL MOTORS CORP.

7. Inspect the crankshaft main journals for undersize, using an outside micrometer.

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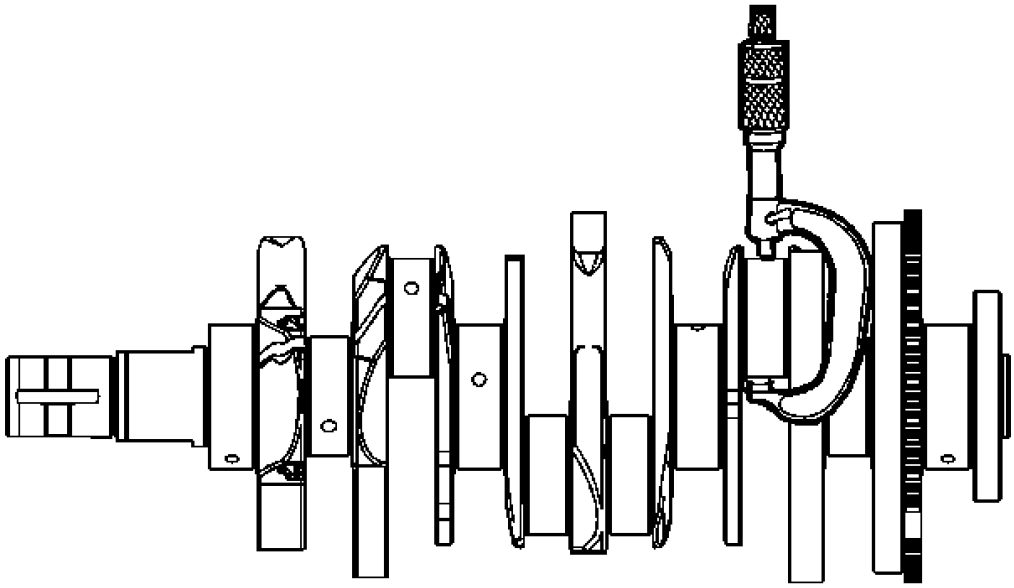


Fig. 9: Inspecting Crankpins For Undersize
Courtesy of GENERAL MOTORS CORP.

8. Inspect the crankpins for undersize using an outside micrometer.
9. Compare your measurements with those listed in the **Engine Mechanical Specifications (LLT)** . If the crankpin journals are worn beyond the specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized connecting rod bearings available for service.

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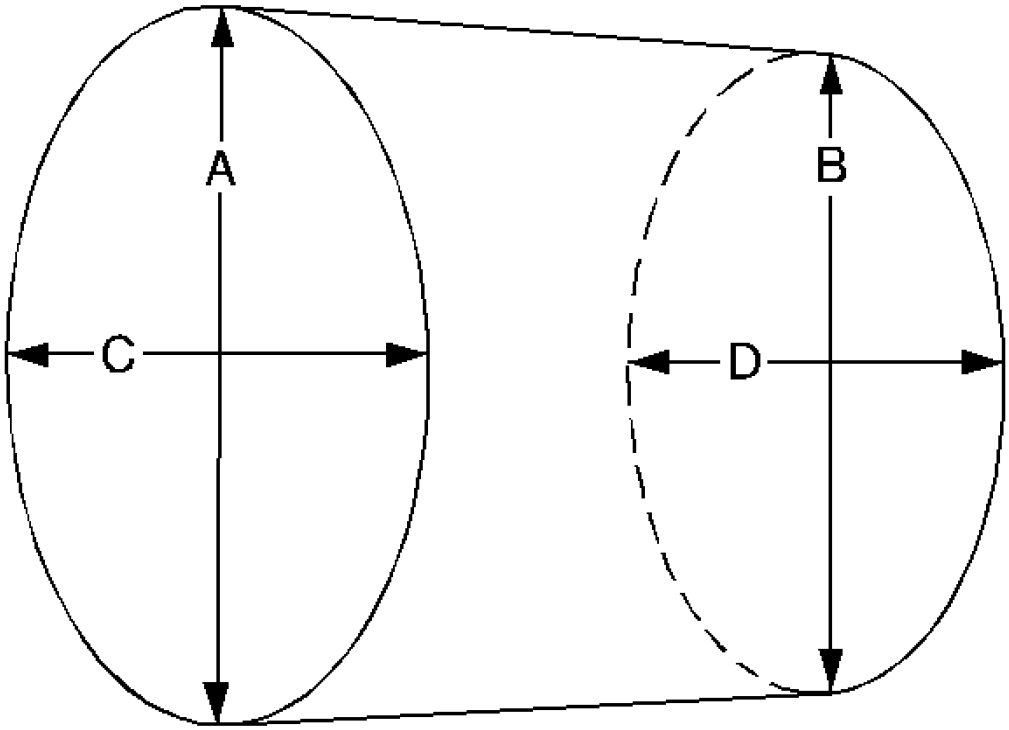


Fig. 10: Identifying Out-Of-Round Measurements
Courtesy of GENERAL MOTORS CORP.

10. Measure the main bearing and crankpin journals for out-of-round using the following procedure:
    1. Using an outside micrometer, measure the journal at the extreme front and rear locations on the journal. Call these points A and B.
    2. Measure the journal in 2 new locations exactly 90 degrees from the first points. Call these points C and D.
    3. Subtract A from C and B from D. The differences will indicate journal out-of-round.
    4. The out-of-round should not exceed 0.004 mm (0.00016 in) maximum.
    5. If the journals are worn beyond the specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized crankshaft and connecting rod bearings available for service.
11. Measure the main bearing and crankpin journals for taper using the following procedure:
    1. Using an outside micrometer, measure the journal at the extreme front (A) and rear (B) of the journal parallel to the crankshaft centerline.
    2. Subtract the smallest from the largest measurement. The result will be the journal taper.
    3. If the main bearing journal taper exceeds 0.004 mm (0.00016 in), replace the crankshaft.

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4. If the journals are worn beyond the specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized crankshaft and connecting rod bearings available for service.

CRANKSHAFT BALANCER CLEANING AND INSPECTION

CLEANING PROCEDURE

1. Clean the crankshaft balancer in solvent that is compatible with the rubber.

   WARNING: Refer to Safety Glasses Warning .

2. Dry the crankshaft balancer with compressed air.

INSPECTION PROCEDURE

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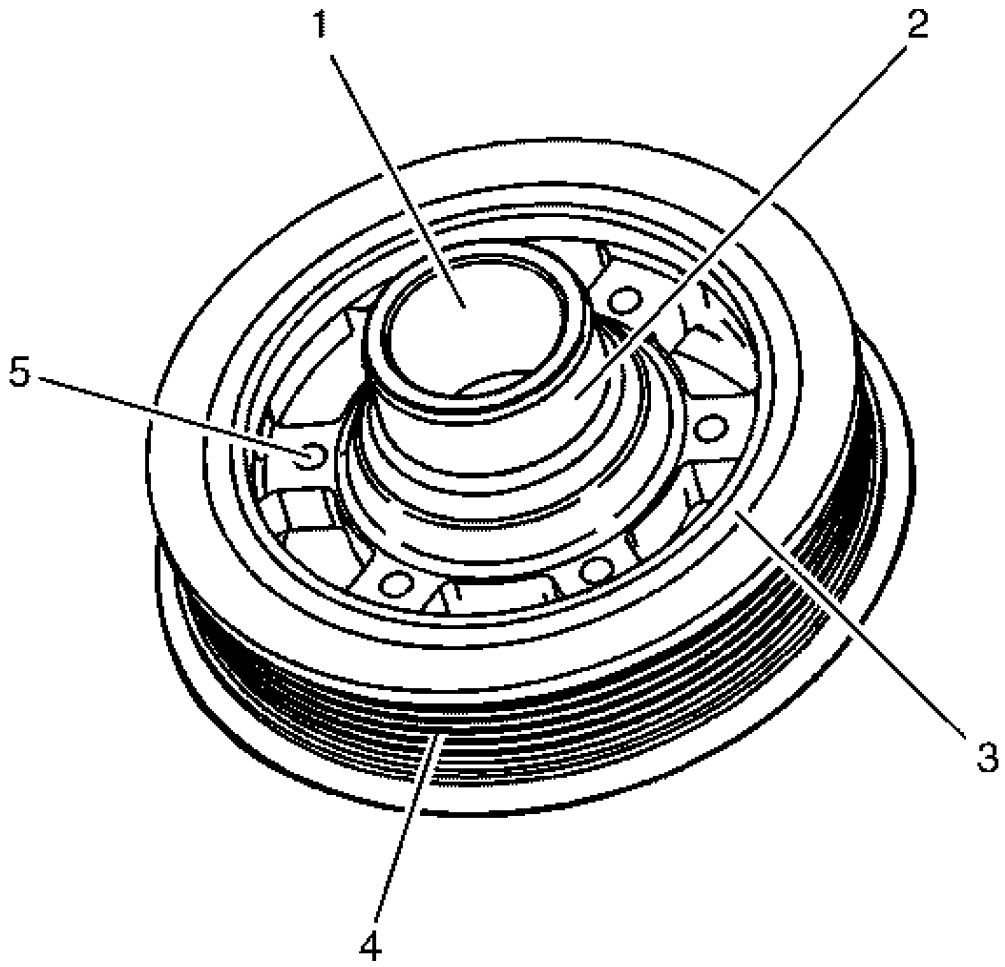


Fig. 11: Identifying Crankshaft Balancer Components
Courtesy of GENERAL MOTORS CORP.

1. Inspect the crankshaft balancer for the following:
   - Worn or damaged hub-to-crankshaft surface (1)
   - Worn, grooved or damaged hub seal surface (2).
   - Worn, chunking or deteriorated rubber between the hub and pulley (3)
   - Damaged drive belt ribs (4)
   - Damaged threaded holes (5)
2. Repair or replace the crankshaft balancer as required.

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ENGINE FLYWHEEL CLEANING AND INSPECTION

CLEANING PROCEDURE

NOTE: In order to maintain the proper component balance, contact surface taper and heat transfer, manual transmission flywheels are NOT to be machined.

1. Clean the engine flywheel in solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the engine flywheel with compressed air.

INSPECTION PROCEDURE

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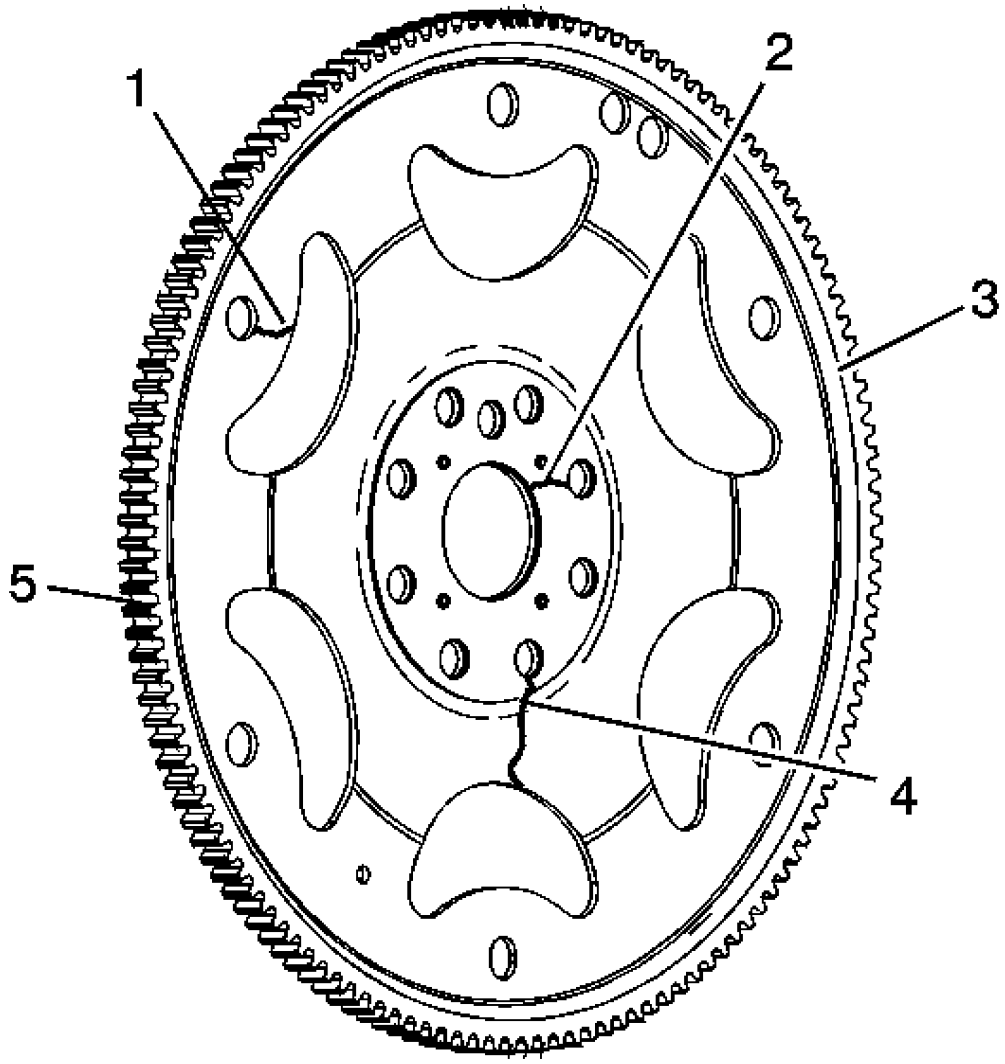


Fig. 12: Identifying Engine Flywheel Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Inspect the engine flywheel for the following conditions:
   - Stress cracks around the engine flywheel-to-torque converter mounting bolt hole locations (1) and/or engine flywheel-to-crankshaft (2, 4)

NOTE: **Do not attempt to repair the welded areas that retain the ring gear to the engine flywheel plate. Install a new engine flywheel.**

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- Cracks at welded areas that retain the ring gear onto the engine flywheel (3)
- Damaged or missing ring gear teeth (5)

2. Replace the engine flywheel as necessary.

PISTON AND CONNECTING ROD DISASSEMBLE

Special Tools

EN-46745: Piston Pin Clip Remover/Installer

For equivalent regional tools, refer to **Special Tools** .

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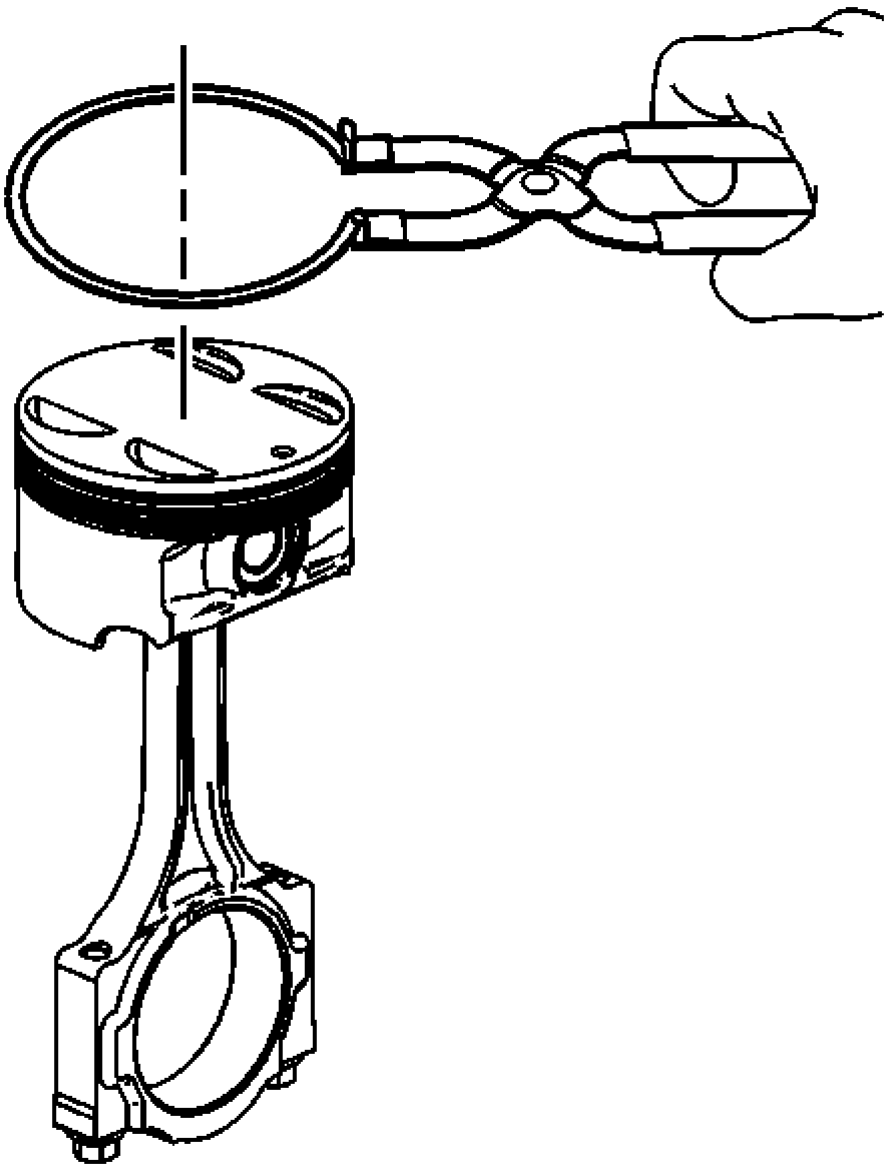


Fig. 13: View Of Piston Ring Expander
Courtesy of GENERAL MOTORS CORP.

CAUTION: You must use a piston ring expander to remove and install the piston rings. Only expand the rings far enough to fit over the piston lands. If the rings are overexpanded, the top ring will shatter and the others will distort.

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1. Remove the piston rings using a piston ring expander. Place each ring in a clean shop towel for storage.

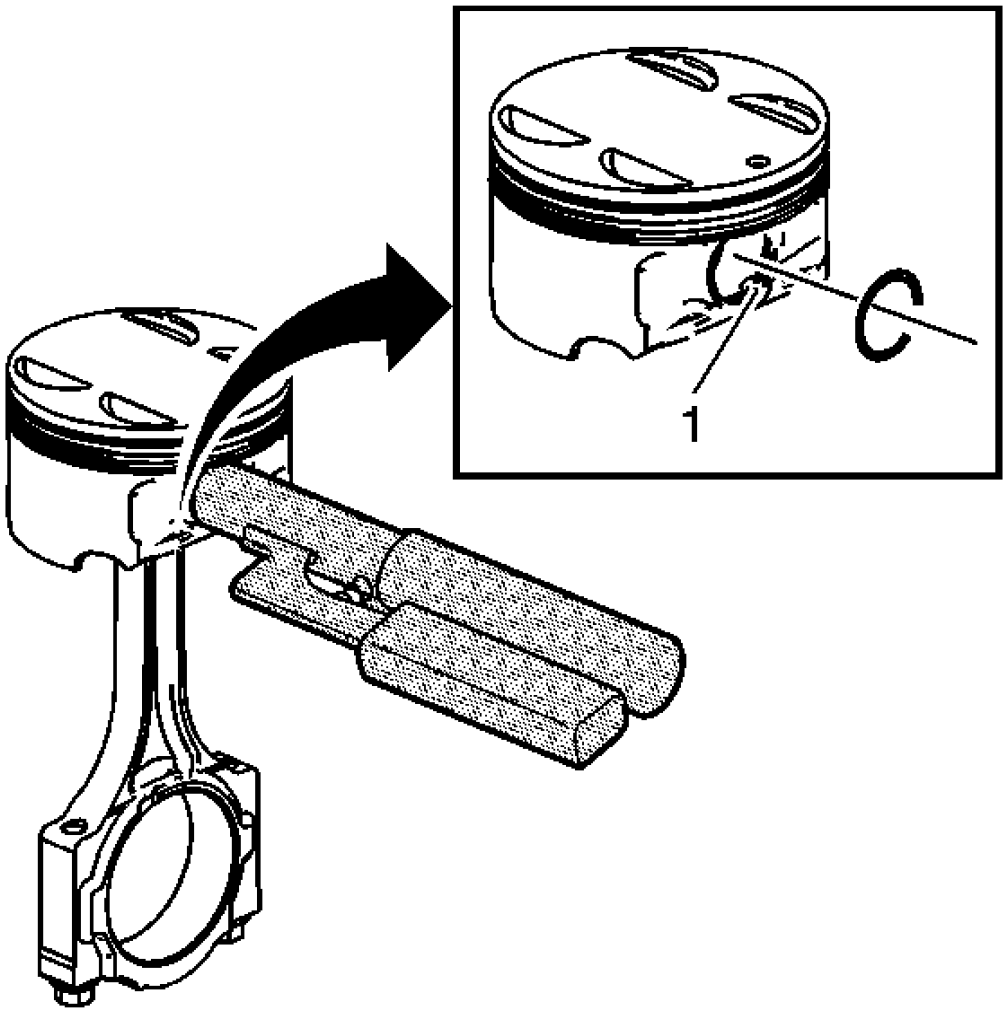


Fig. 14: Identifying Piston Pin Retainer Removal Access Notch
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **The connecting rod is non-directional and may be assembled/reassembled to the piston in either direction.**
- **DO NOT reuse the piston pin retainers.**

2. Using the **EN-46745:** remover/installer, remove the piston pin retainers by using the removal access notch (1) in the side of the piston. Discard the piston pin retainers.

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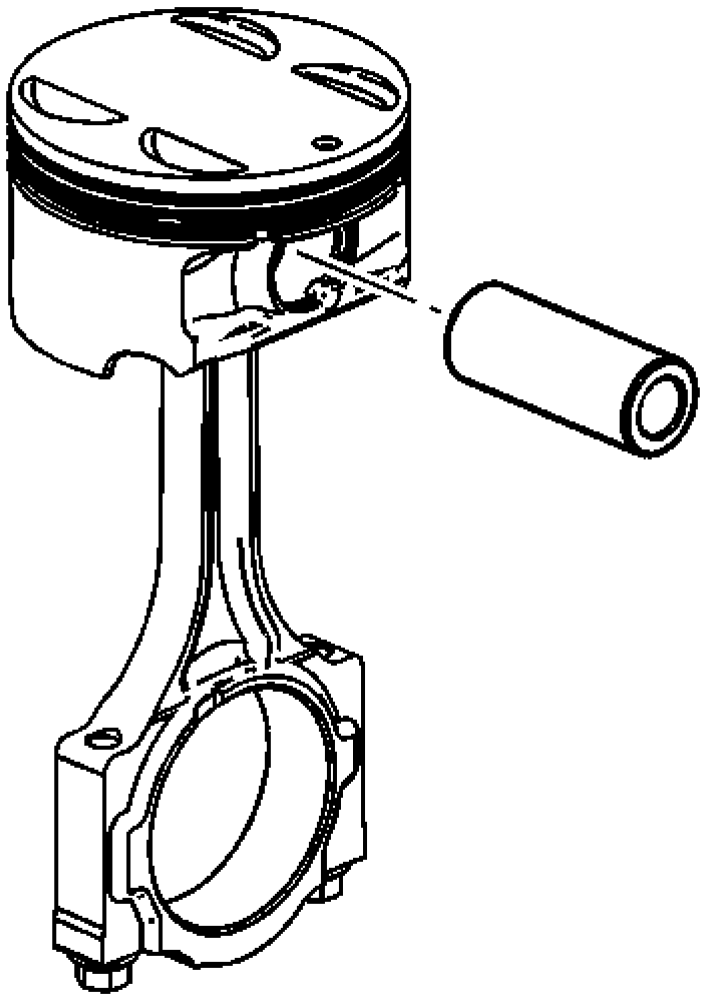


Fig. 15: View Of Piston Pin
Courtesy of GENERAL MOTORS CORP.

3. Slide the piston pin out of the piston. The piston will disconnect from the connecting rod.

PISTON, CONNECTING ROD, AND BEARING CLEANING AND INSPECTION

CLEANING PROCEDURE

NOTE: DO NOT wire brush any part of the piston.

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1. Clean the piston skirts and the pins with a cleaning solvent.
2. Clean the piston ring grooves with a groove cleaner. Ensure that the oil ring holes and slots are clean.

WARNING: Refer to Safety Glasses Warning .

3. Dry the piston with compressed air.

PISTON INSPECTION PROCEDURE

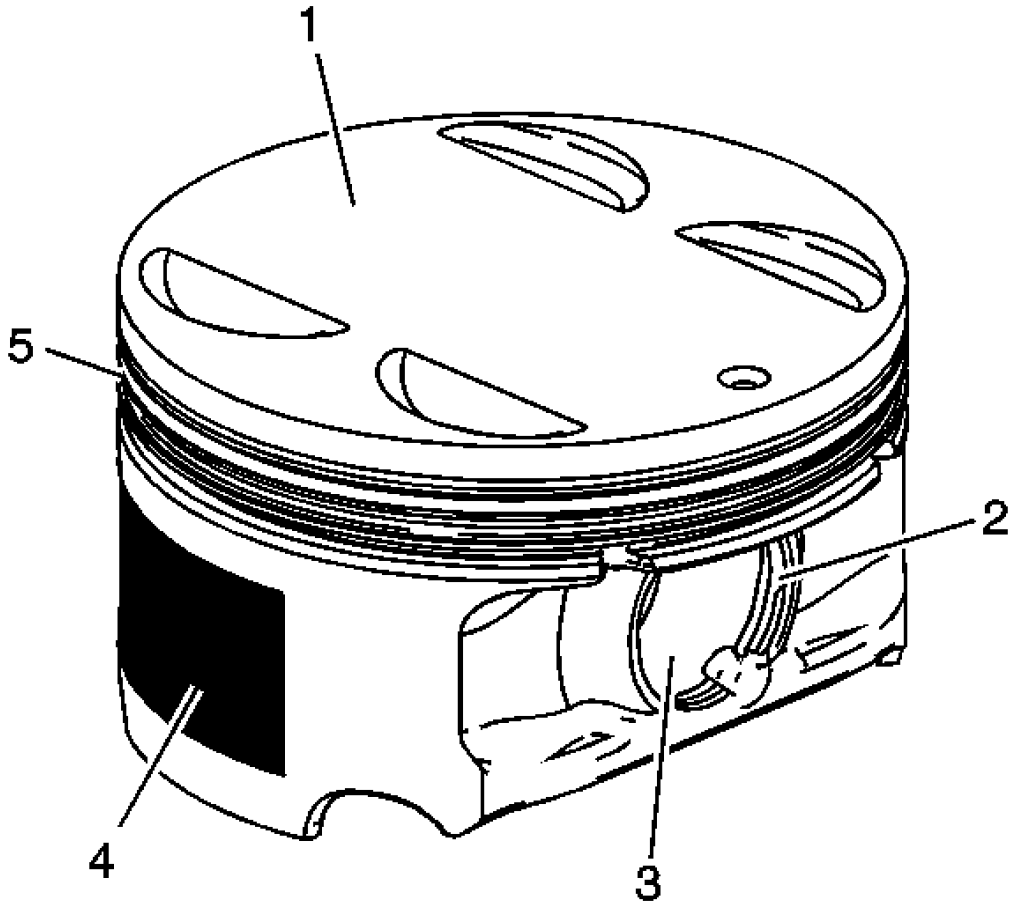


Fig. 16: Piston Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Inspect the pistons for the following conditions:

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- Cracked ring lands, skirts or pin bosses
- Ring grooves for nicks, burrs that may cause binding (5)
- Warped or worn ring lands (5)
- Piston pin retainer grooves for burrs (2)
- Eroded areas at the top of the piston (1)
- Scuffed or damaged skirt coating (4)
- Worn piston pin bores or worn piston pins (3)

2. Replace pistons that show any signs of damage or excessive wear.

PISTON MEASUREMENT PROCEDURE

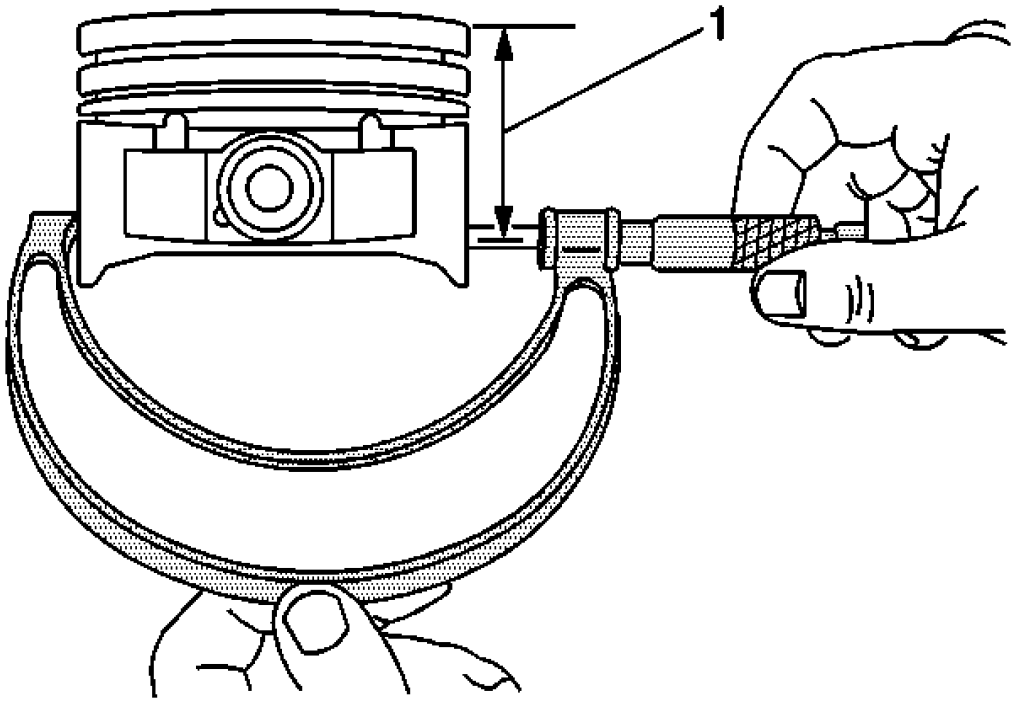


Fig. 17: Measuring Piston Width
Courtesy of GENERAL MOTORS CORP.

1. Measure piston width using the following procedure:
    1. Using an outside micrometer, measure the width of the piston at 30 mm (1.181 in) below the crown, top (1), at the thrust surfaces of the piston, perpendicular to the piston pin centerline.
    2. Compare the measurement of the piston to its original cylinder by subtracting the piston width from

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the cylinder diameter.

3. Check your measurements with the **Engine Mechanical Specifications (LLT)** .
4. If the clearance obtained through measurement is greater than the provided specifications and the cylinder bores are within specification, replace the piston.

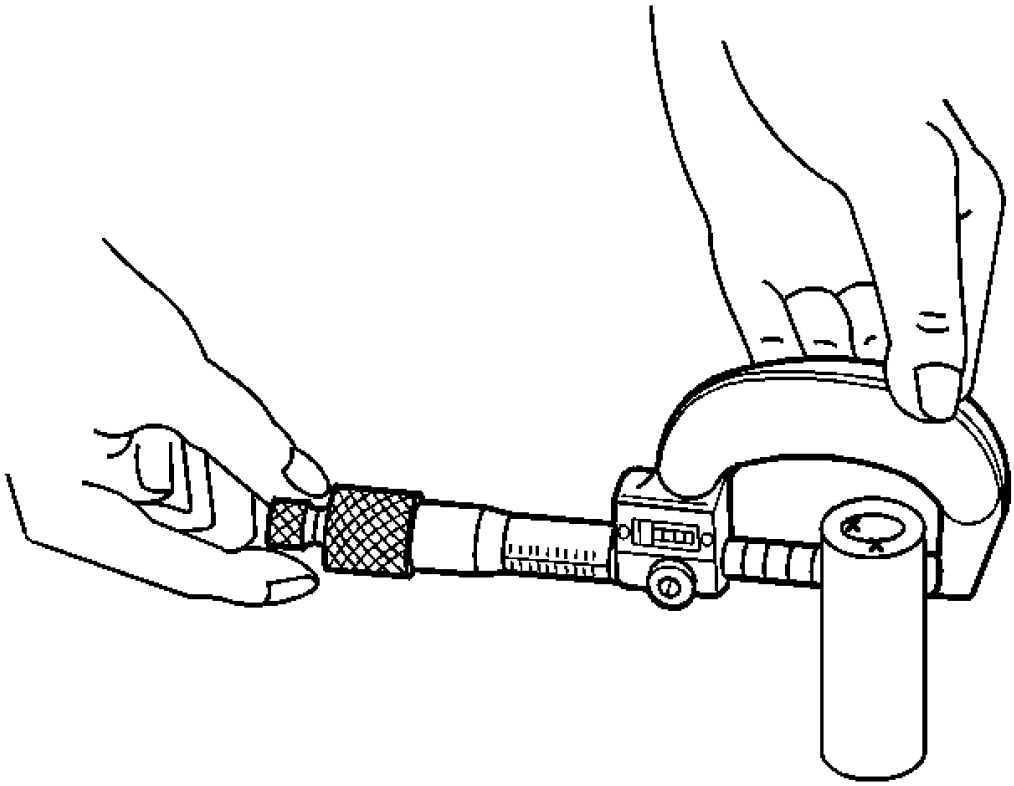


Fig. 18: Measuring Piston Pin Diameter
Courtesy of GENERAL MOTORS CORP.

2. Measure the piston pin bore to piston pin clearances using the following procedure:
    1. Piston pin bores and pins must be free of varnish or scuffing.
    2. Use an outside micrometer to measure the piston pin in the piston contact areas.

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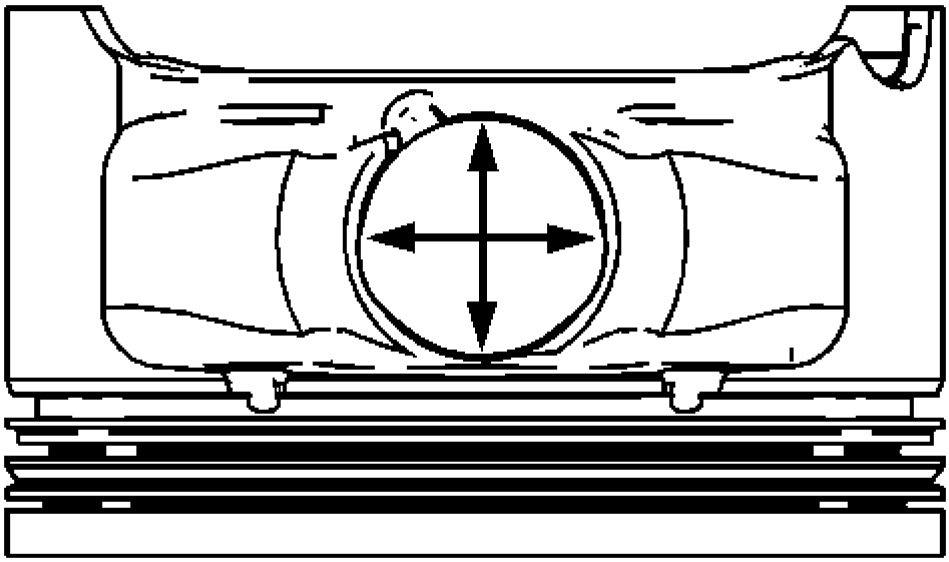


Fig. 19: Checking Piston Pin Bore Dimensions
Courtesy of GENERAL MOTORS CORP.

3. Using an inside micrometer, measure the piston pin bore. Compare your result with the piston pin diameter and piston pin to piston pin bore clearance listed in the **Engine Mechanical Specifications (LLT)** .
4. If the clearance is excessive, determine which piece is out of specification and replace as necessary.
5. You must replace the piston if any of its dimensions are out of specification.
6. If the new piston does not meet clearance specifications, the cylinder block may need to be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

PISTON RING MEASUREMENT PROCEDURE

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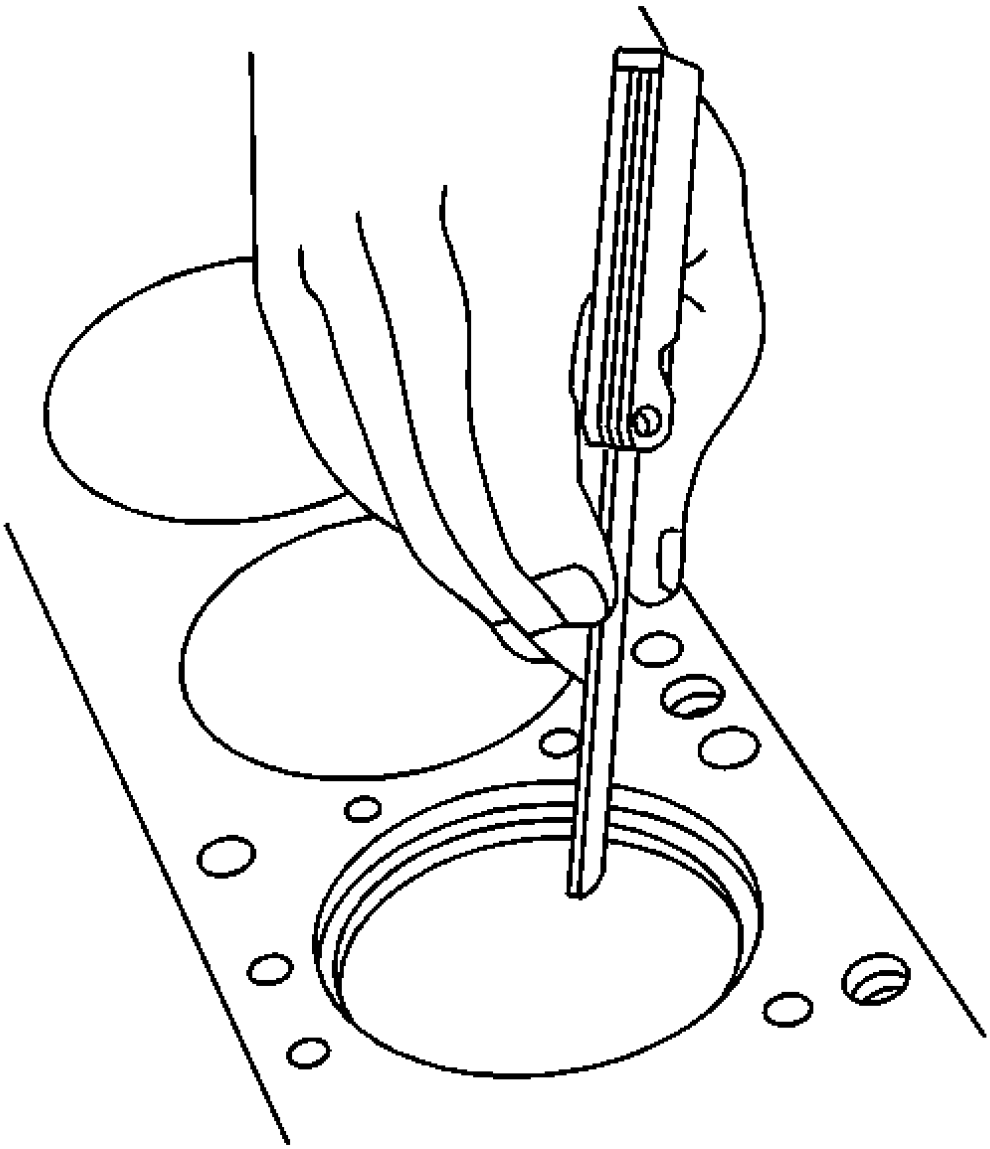


Fig. 20: Measuring Piston Ring End Gap
Courtesy of GENERAL MOTORS CORP.

1. Measure the piston ring end gap using the following procedure:
    1. Place the piston ring in the area of the bore where the piston ring will travel approximately 25 mm (1 in) down from the deck surface. Ensure that the ring is square with the cylinder bore by positioning the ring with the piston head.

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2. Measure the end gap of the piston ring with feeler gauges. Refer to **Engine Mechanical Specifications (LLT)** .
3. If the clearance exceeds the provided specifications, the piston rings must be replaced.
4. Repeat the procedure for all the piston rings.

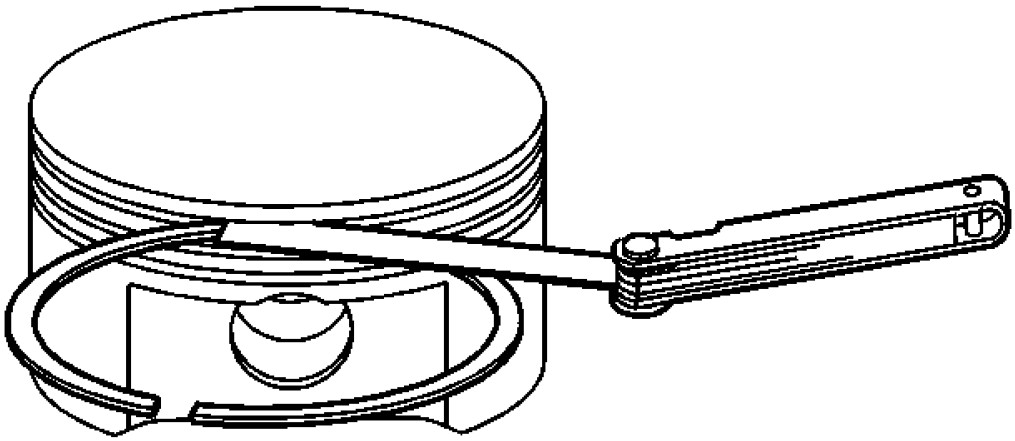


Fig. 21: Measuring Piston Ring Side Clearance
Courtesy of GENERAL MOTORS CORP.

2. Measure the piston ring side clearance using the following procedure:
    1. Roll the piston ring entirely around the piston ring groove. If any binding is caused by the ring groove, dress the groove with a fine file. If any binding is caused by a distorted piston ring, replace the ring.
    2. With the piston ring on the piston, use feeler gauges to check clearance at multiple locations.
    3. Compare the measurements with piston ring side clearance listed in the **Engine Mechanical Specifications (LLT)** .
    4. If the clearance is greater than specifications, replace the piston rings.

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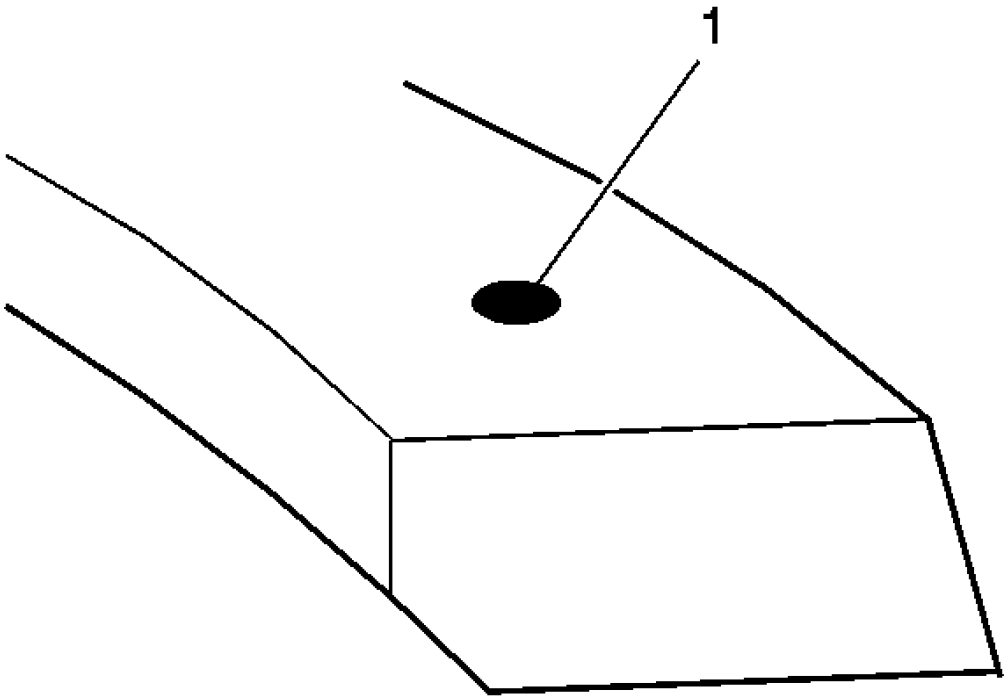


Fig. 22: Identifying Compression Ring Dimple
Courtesy of GENERAL MOTORS CORP.

3. There is a locating dimple (1) on the compression rings near the end for identification. Install the compression rings with the dimple facing up.
4. If the new ring does not reduce the clearance to the proper specification, install a new piston.
5. If the new piston does not meet clearance specifications, the cylinder block may need to be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

CONNECTING ROD CLEANING PROCEDURE

1. Clean the connecting rods in solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the connecting rod using compressed air.
3. Remove the connecting rod cap and clean the threads.
4. Remove the connecting rod bearing and discard. Never reuse a connecting rod bearing used in a running

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engine.

CONNECTING ROD VISUAL INSPECTION PROCEDURE

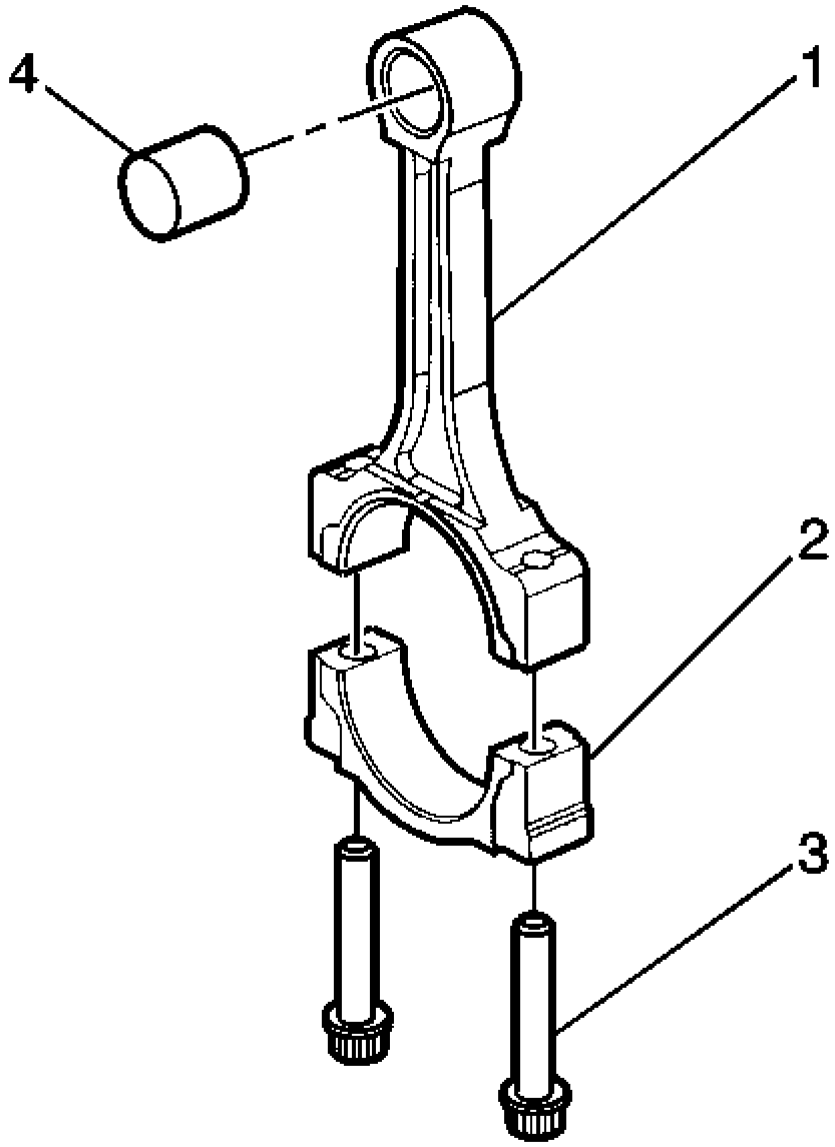


Fig. 23: Inspecting Connecting Rod Components
Courtesy of GENERAL MOTORS CORP.

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1. Inspect the piston pin bushing (4) for scoring or damage.
2. Inspect the connecting rod beam (1) for twisting or bending.
3. Inspect the rod cap (2) for any nicks or damage caused by possible interference.
4. Inspect for scratches or abrasion on the rod bearing seating surface.

NOTE: DO NOT scrape the rod or rod cap.

5. If the connecting rod bores contain minor scratches or abrasions, clean the bores in a circular direction with a light emery paper.

CONNECTING ROD MEASUREMENT PROCEDURE

Piston Pin End

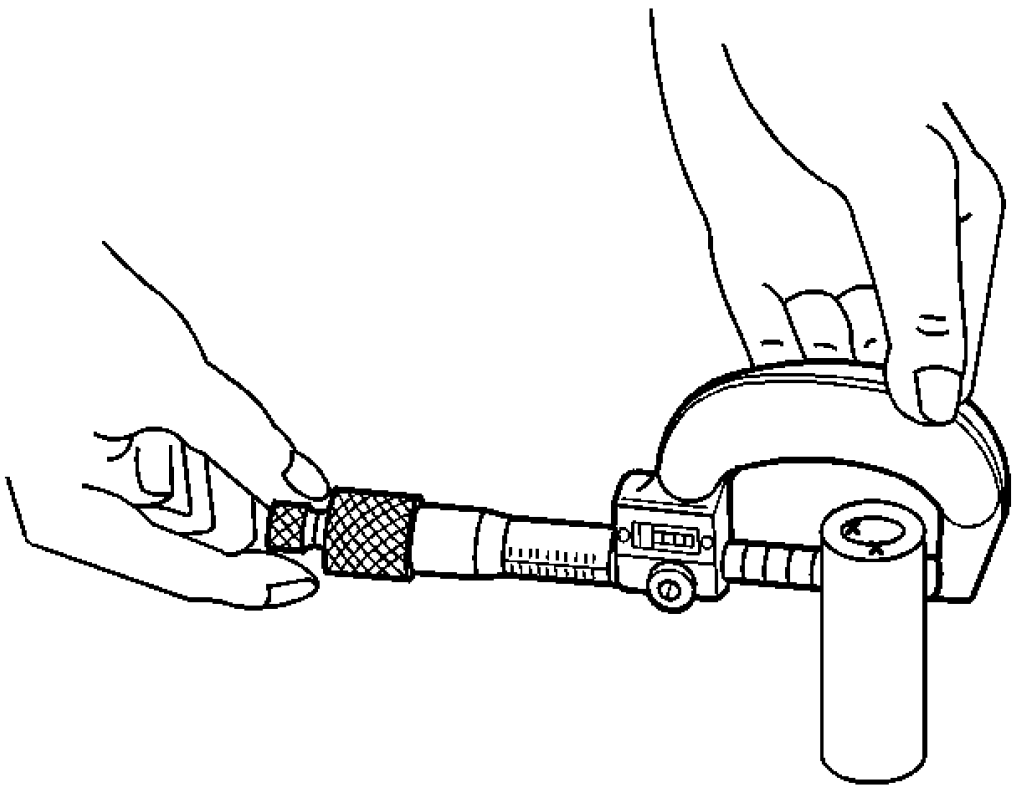


Fig. 24: Measuring Piston Pin Diameter
Courtesy of GENERAL MOTORS CORP.

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NOTE: Measurements of all components should be taken with the components at normal room temperature.

1. Using an outside micrometer, take 2 measurements of the piston pin in the area of the connecting rod contact.

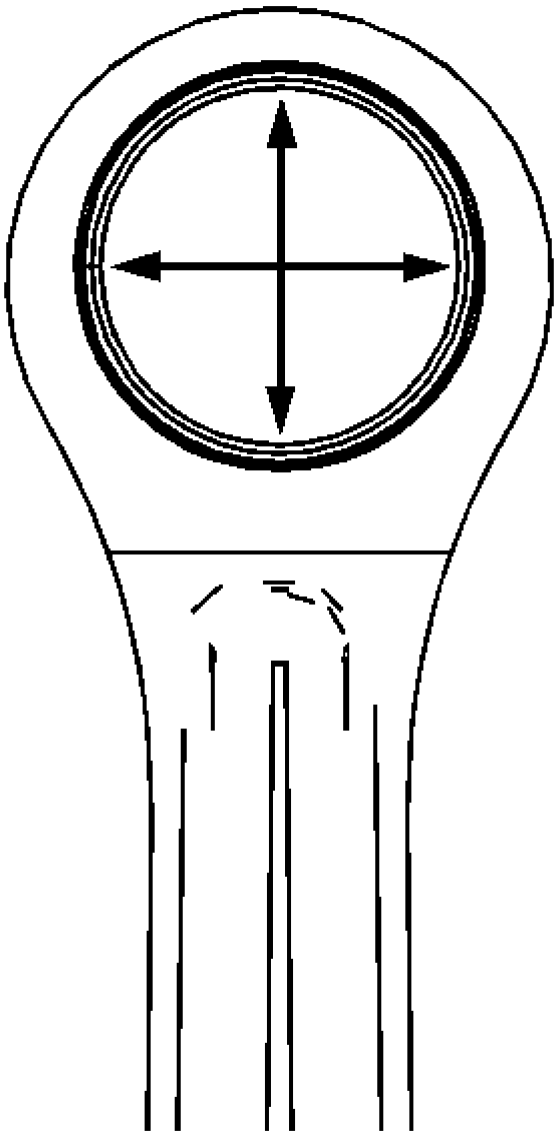


Fig. 25: Checking Connecting Rod Piston Pin Bore Dimensions

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Courtesy of GENERAL MOTORS CORP.

2. Using an inside micrometer, measure the connecting rod piston pin bore.
3. Subtract the piston pin diameter from the piston pin bore.
4. Compare the clearance measurements with the **Engine Mechanical Specifications (LLT)** .
5. If the clearance is excessive, replace the piston pin. If a new pin does not resolve the clearance problem, replace the connecting rod.

Connecting Rod Crankshaft Bearing End

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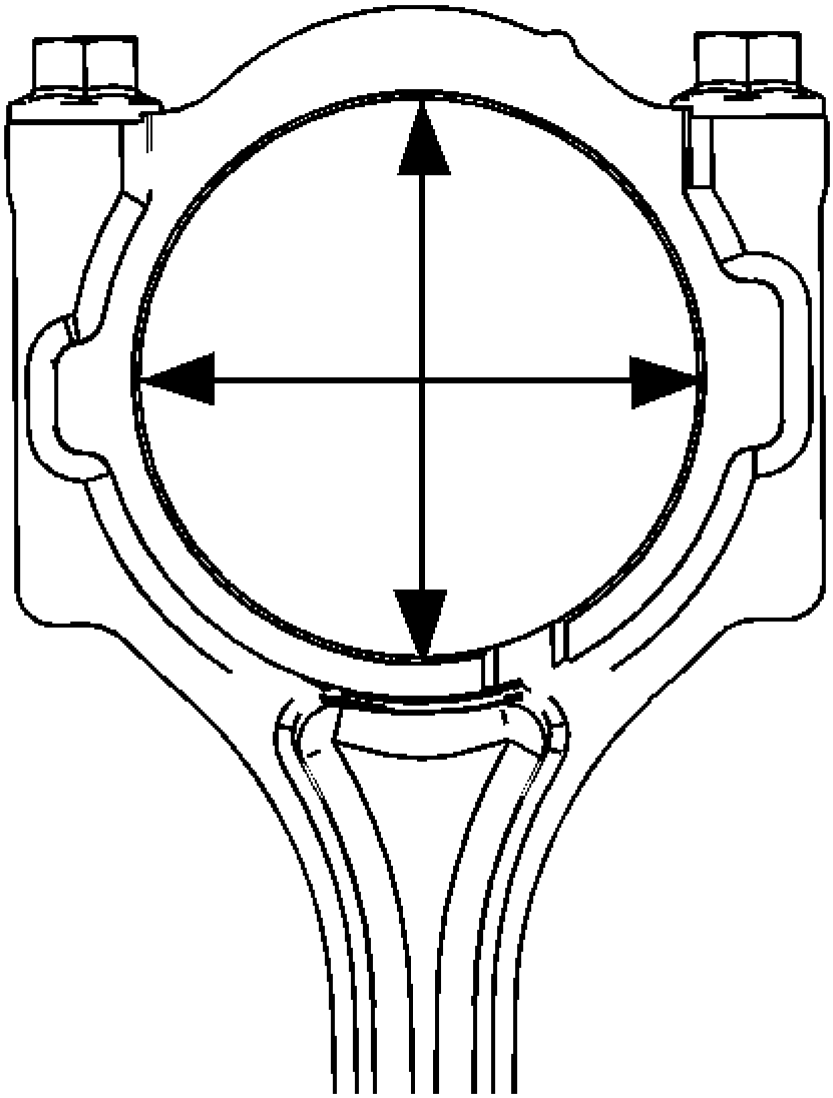


Fig. 26: Measuring Connecting Rod Crankshaft Bearing Bore
Courtesy of GENERAL MOTORS CORP.

NOTE: Measurements of all components should be taken with the components at normal room temperature.

1. Using an inside micrometer, measure the connecting rod crankshaft bearing bore.
2. Compare the bore measurements with the **Engine Mechanical Specifications (LLT)** .

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3. Replace the connecting rod if the bore is out of specifications. DO NOT recondition the connecting rod.

PISTON AND CONNECTING ROD ASSEMBLE

SPECIAL TOOLS

EN-46745: Piston Pin Clip Remover/Installer

For equivalent regional tools, refer to **Special Tools** .

PISTON AND PISTON PIN INSTALLATION PROCEDURE

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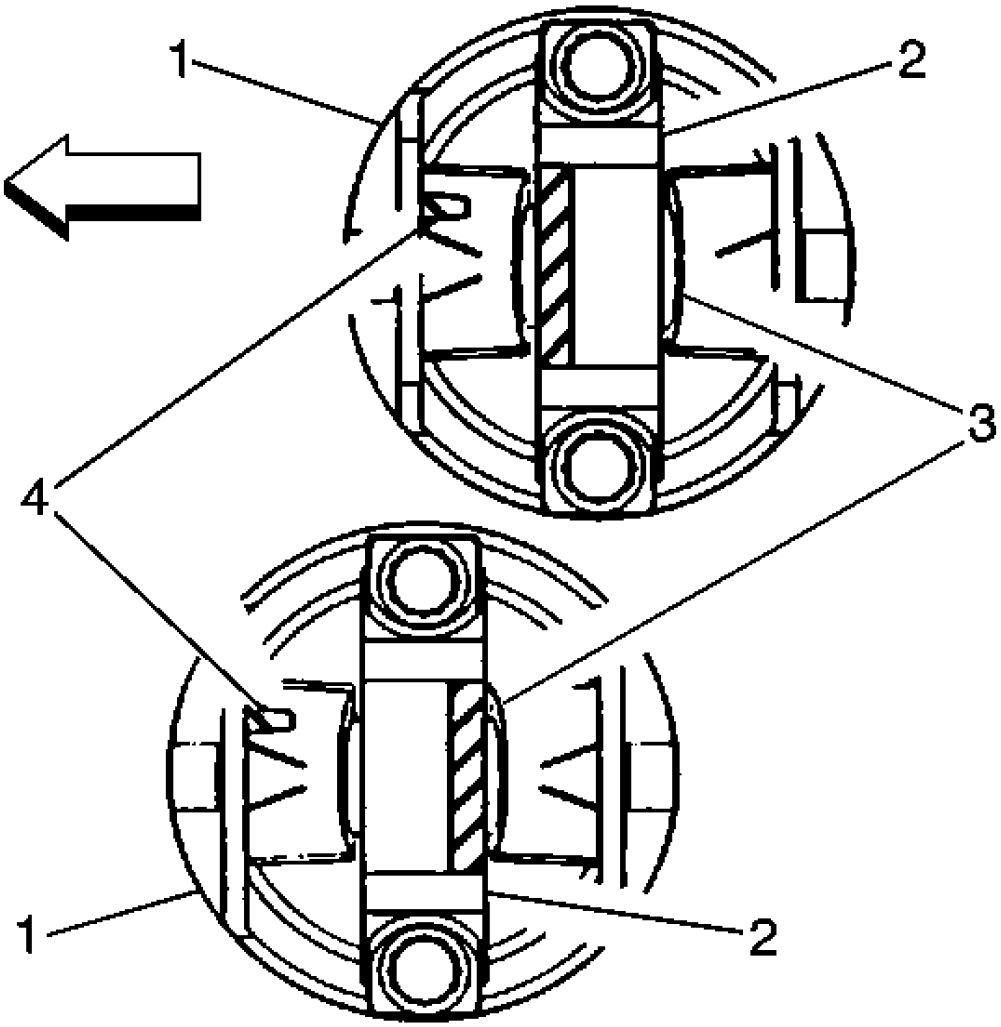


Fig. 27: Identifying Piston & Connecting Rod Locating Marks
Courtesy of GENERAL MOTORS CORP.

1. Properly orient the piston (1) on the connecting rod (2) as follows:
   - The locating mark (4) cast into the underside of the piston should point towards the front of the engine.
   - The locating notch (3) on the connecting rod cap should be pointing towards the rear of the engine on odd-numbered cylinders and towards the front of the engine on even-numbered cylinders.
2. Lubricate the piston pin bores in the piston and connecting rod. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

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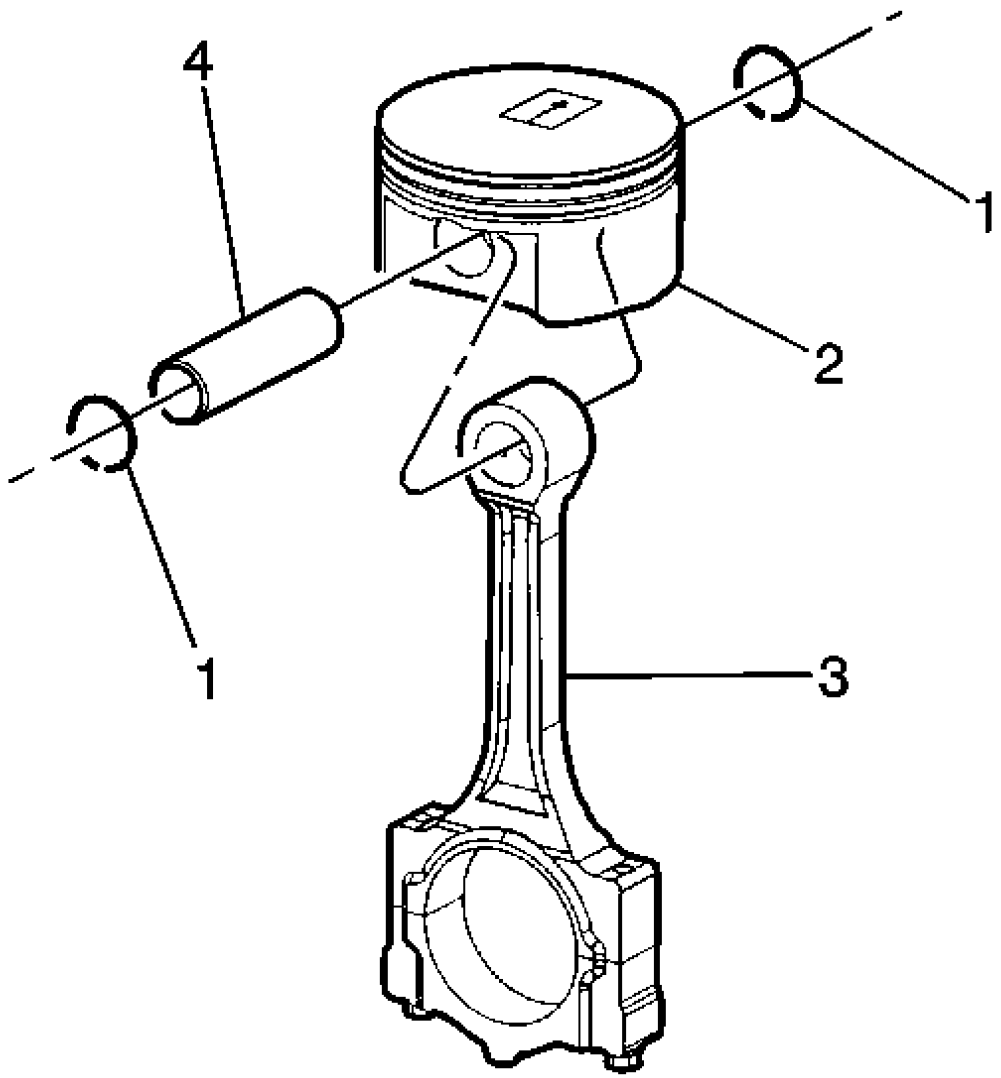


Fig. 28: Exploded View Of Piston & Connecting Rod Assembly
Courtesy of GENERAL MOTORS CORP.

3. Align the piston pin bore with the connecting rod pin bore.
4. Slide the piston pin (4) into the piston and the connecting rod (3).

NOTE: New piston pin retainers must be used. Never reuse the piston pin retainers.

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5. Install NEW piston pin retainers (1) using the **EN-46745:** remover/installer.
6. Ensure that the piston pin retainers are fully seated in their grooves.
7. Repeat these procedures for the remaining pistons.

PISTON RING INSTALLATION PROCEDURE

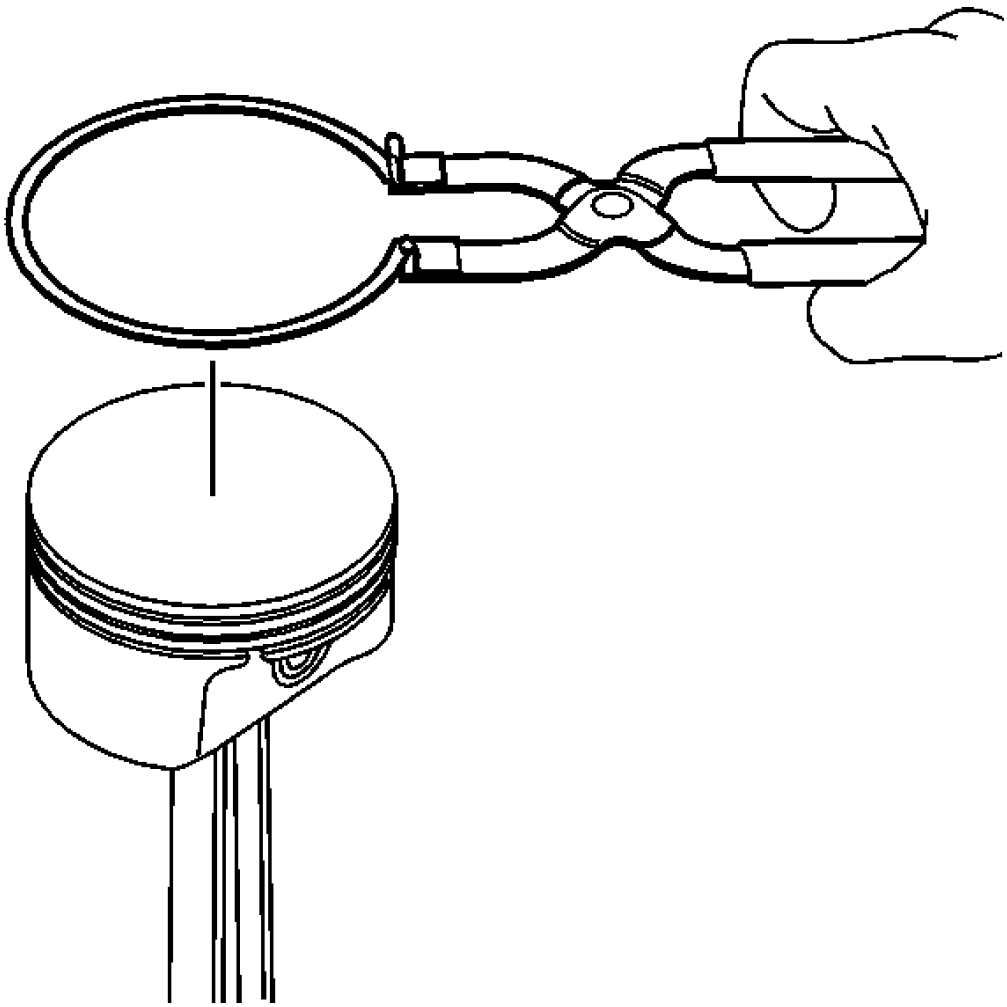


Fig. 29: Removing/Installing Piston Rings
Courtesy of GENERAL MOTORS CORP.

CAUTION: Use a piston ring expander to install the piston rings. The rings may be damaged if expanded more than necessary.

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1. Install the piston rings using a piston ring installer.

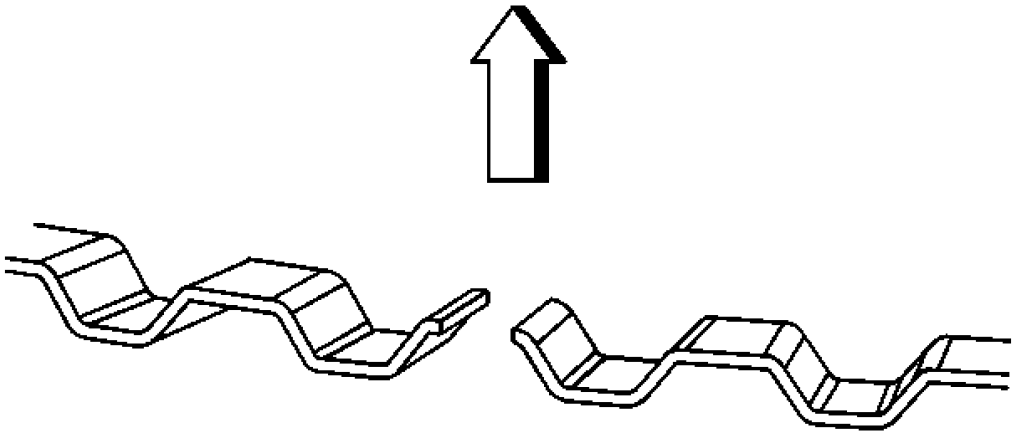


Fig. 30: Aligning Oil Control Ring Expander
Courtesy of GENERAL MOTORS CORP.

2. Properly orient the oil control ring expander as shown before installation. The ends of the expander must be facing toward the top of the piston.

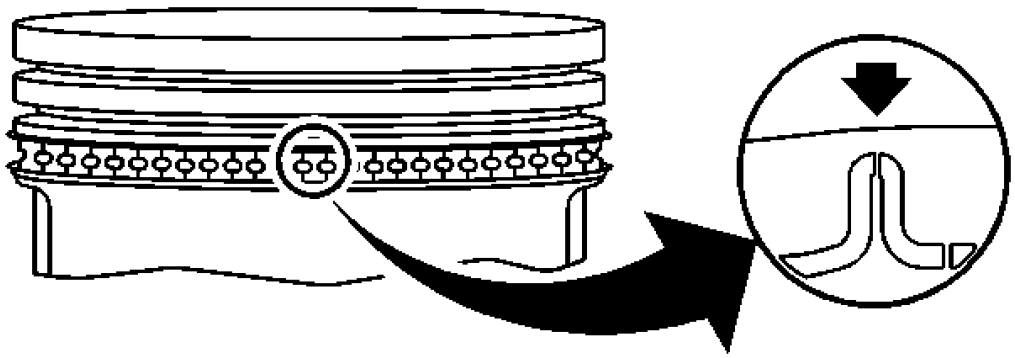


Fig. 31: View Of Lower Oil Control Piston Ring Spacer
Courtesy of GENERAL MOTORS CORP.

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3. Install the oil control piston ring spacer onto the piston.

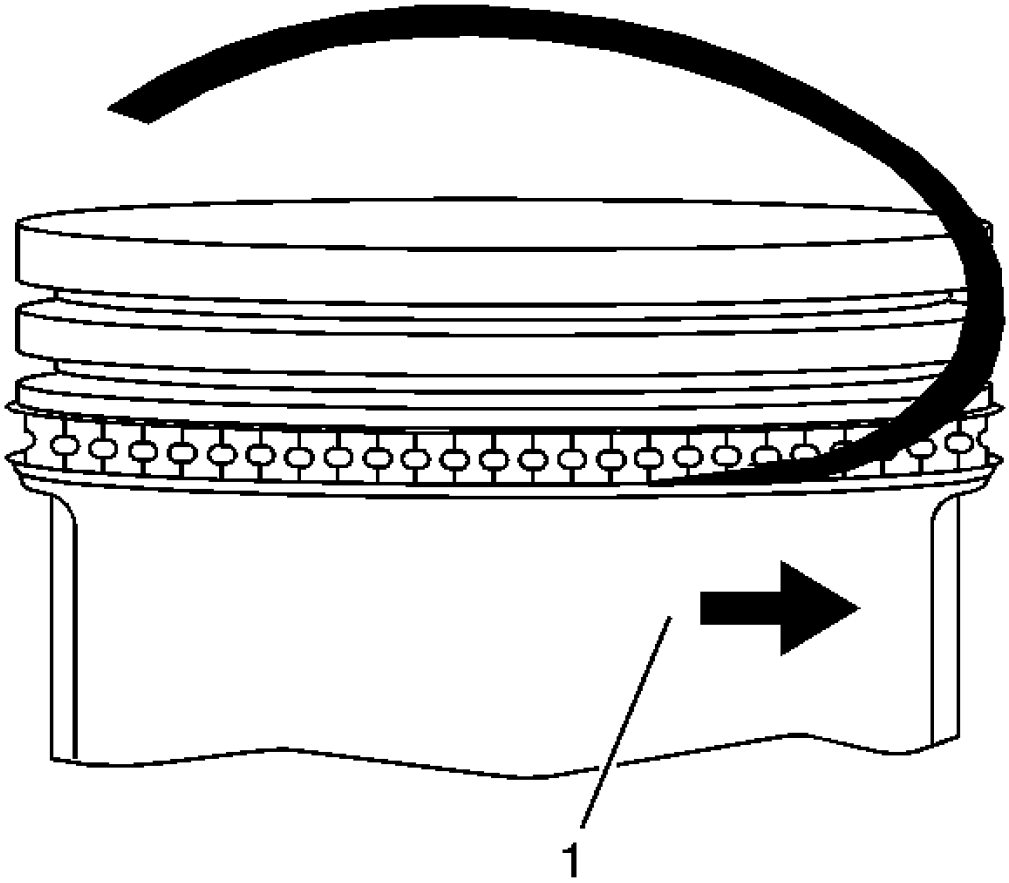


Fig. 32: View Of Lower Oil Control Piston Ring
Courtesy of GENERAL MOTORS CORP.

4. Install the lower oil control piston ring onto the piston (1).

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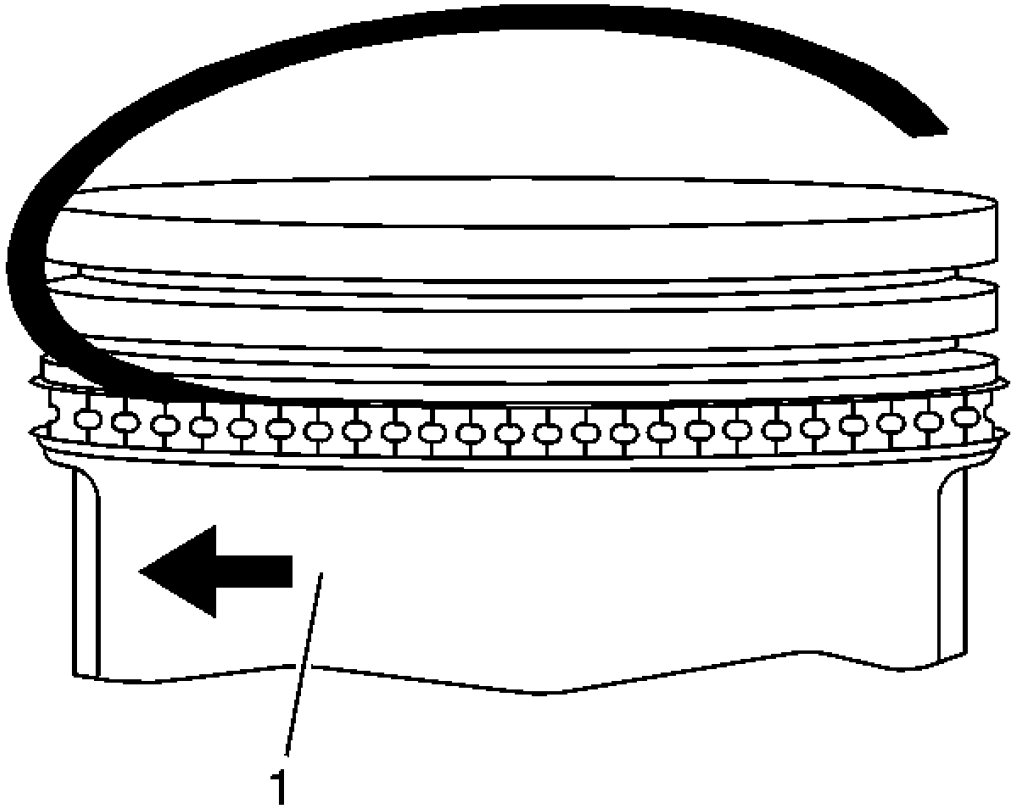


Fig. 33: View Of Upper Oil Control Piston Ring
Courtesy of GENERAL MOTORS CORP.

5. Install the upper oil control piston ring onto the piston (1).

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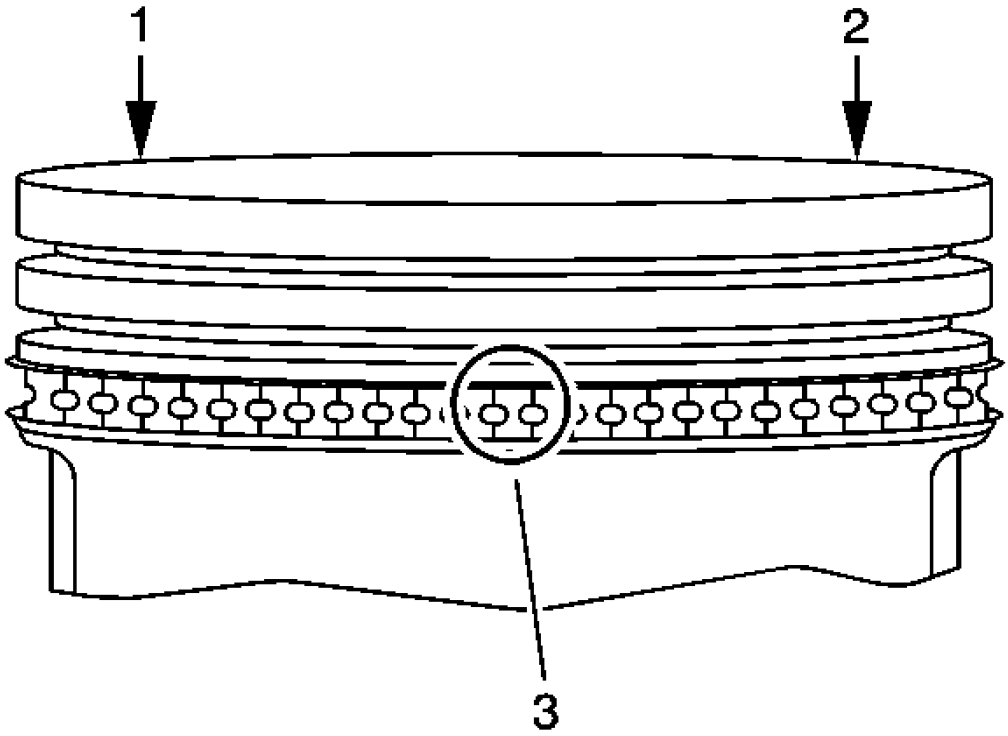


Fig. 34: Identifying Oil Control Piston Ring End Gaps
Courtesy of GENERAL MOTORS CORP.

6. Space the oil control piston ring end gaps (1, 2) a minimum of 90 degrees apart.

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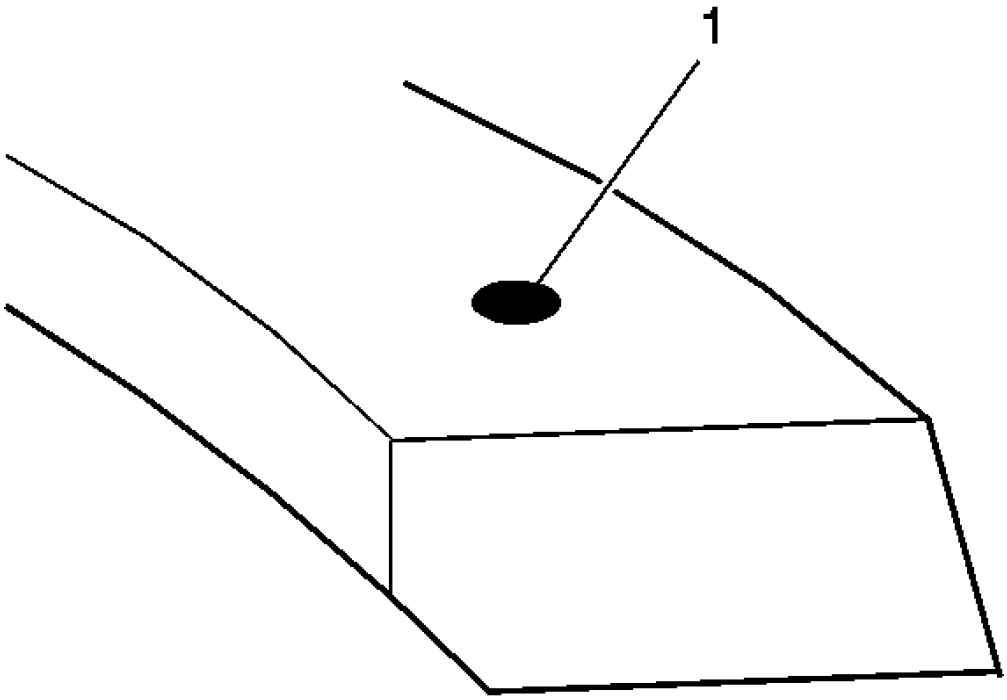


Fig. 35: Identifying Compression Ring Dimple
Courtesy of GENERAL MOTORS CORP.

7. Install the lower compression piston ring onto the piston (1).

   The mark on the side of the piston ring should face the top of the piston.

8. Install the upper compression piston ring onto the piston.

   The top compression ring may be installed with either side up.

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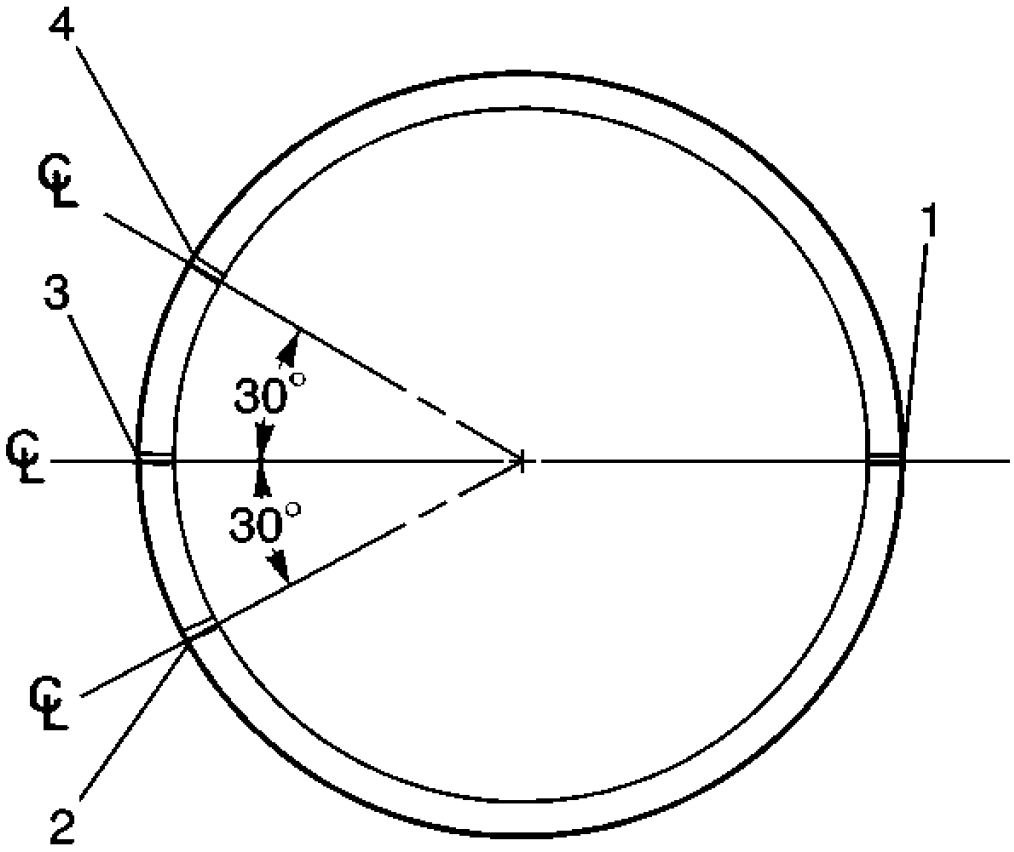


Fig. 36: Identifying Proper Oil Control Ring Gap Positioning
Courtesy of GENERAL MOTORS CORP.

9. Once the rings are installed, set the ring gaps for the oil control, second and top rings in the positions shown:
    1. Oil control ring expander and second compression ring gaps position 1.
    2. Upper oil control ring gap position 2.
    3. Top compression ring gap position 3.
    4. Lower oil control ring gap position 4.

CONNECTING ROD BEARING INSTALLATION PROCEDURE

NOTE: If the connecting rod bearings have been used in a running engine, you must replace them with NEW connecting rod bearings for reassembly.

1. Clean the connecting rod and the connecting rod cap bearing bore with a lint-free cloth.

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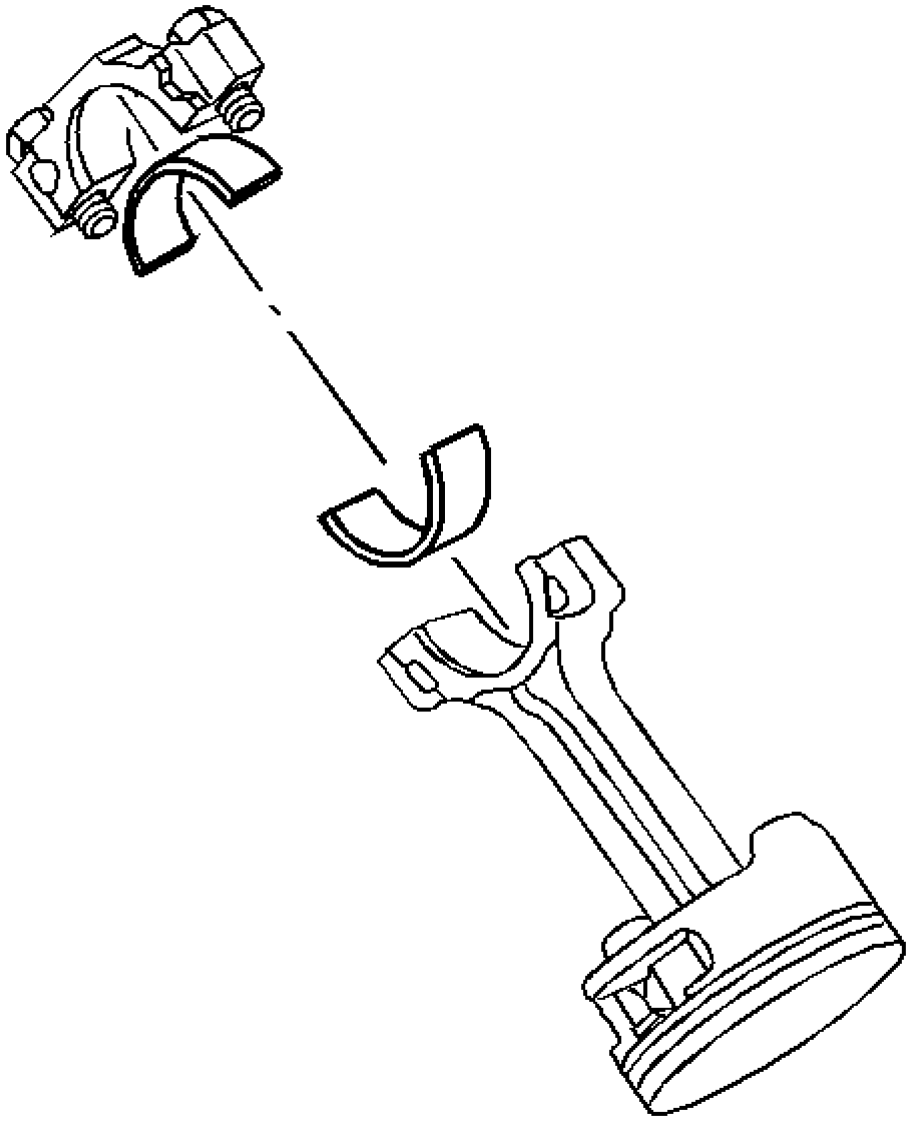


Fig. 37: View Of Piston, Connecting Rod, Bearing Cap, Bearing Halves & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Clean all the oil from behind the connecting rod bearing halves.
3. Install new upper connecting rod bearings into position. Roll the bearing into position so that the lock tang engages the alignment slot. The bearing must fit flush in the connecting rod.
4. Install new lower connecting rod bearings into position in the connecting rod cap. Roll the bearing into position so that the lock tang engages the alignment slot. The bearings must fit flush with the connecting

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rod cap.

CYLINDER HEAD DISASSEMBLE (LLT)

Special Tools

- **EN 46116:** Valve Stem Seal Remover/Installer
- **EN 46117:** Valve Stem Key Remover/Installer
- **EN 46119:** Off-Vehicle Valve Spring Compressor Adapter
- **EN 46122:** Camshaft Position Actuator Check-Ball Valve Remover/Installer
- **J 8062:** Valve Spring Compressor - Head Off
- **J 2619-01:** Slide Hammer
- **J 37281-A:** Injector Remover

For equivalent regional tools, refer to **Special Tools** .

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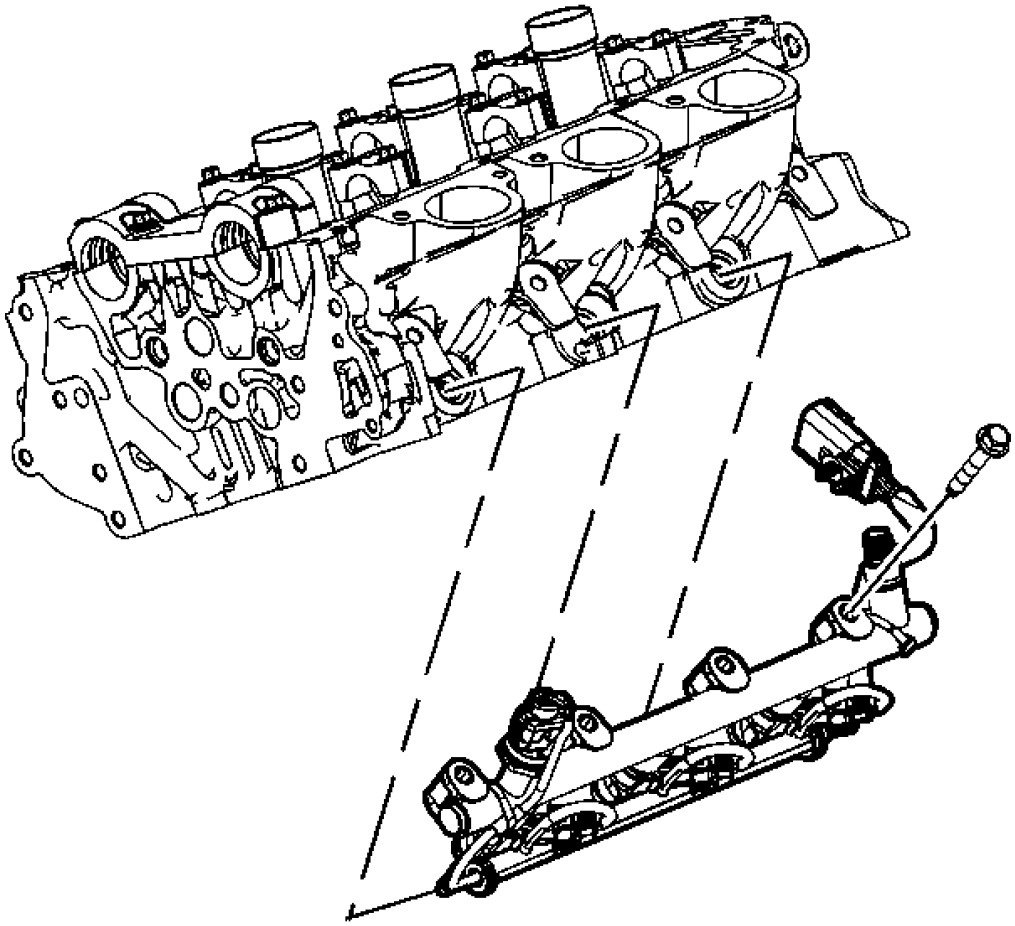


Fig. 38: Removing/Installing Fuel Rail
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel rail bolts.
2. Remove the fuel rail and injectors.

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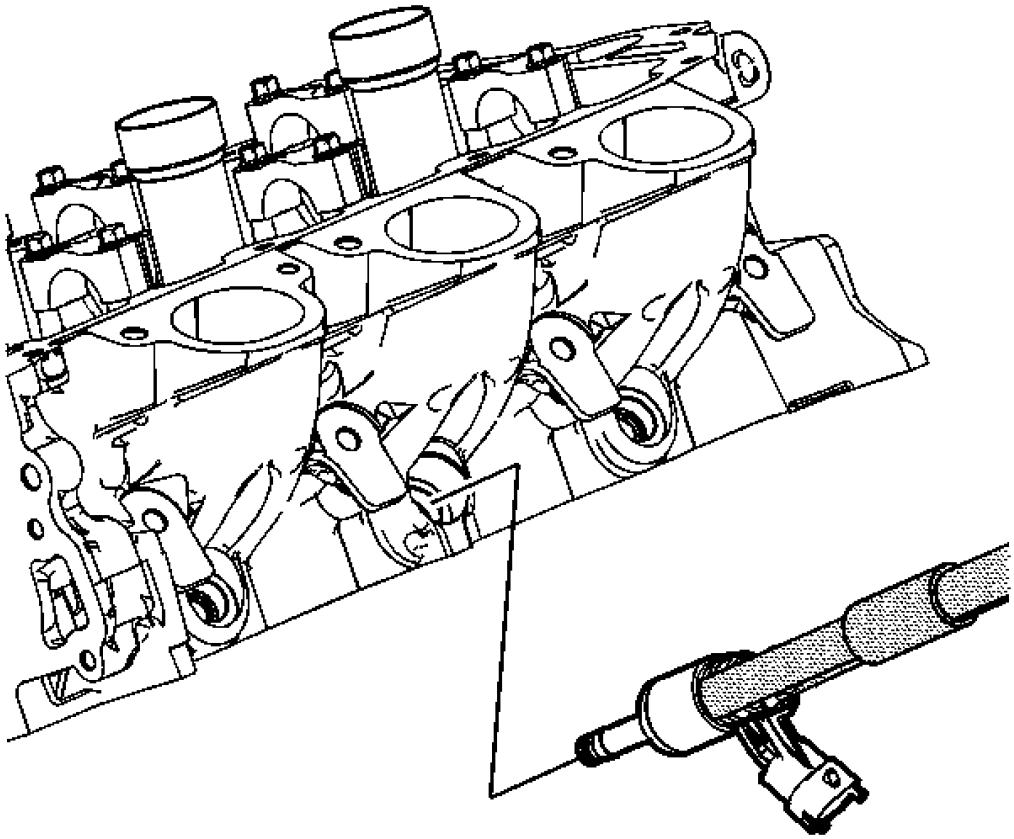


Fig. 39: Removing Injector
Courtesy of GENERAL MOTORS CORP.

3. The injectors may stay in the cylinder head. Remove the fuel injector hold-down clamp before removing the injector.
4. Use the **J 37281-A:** remover and the **J 2619-01:** hammer to remove the injector.

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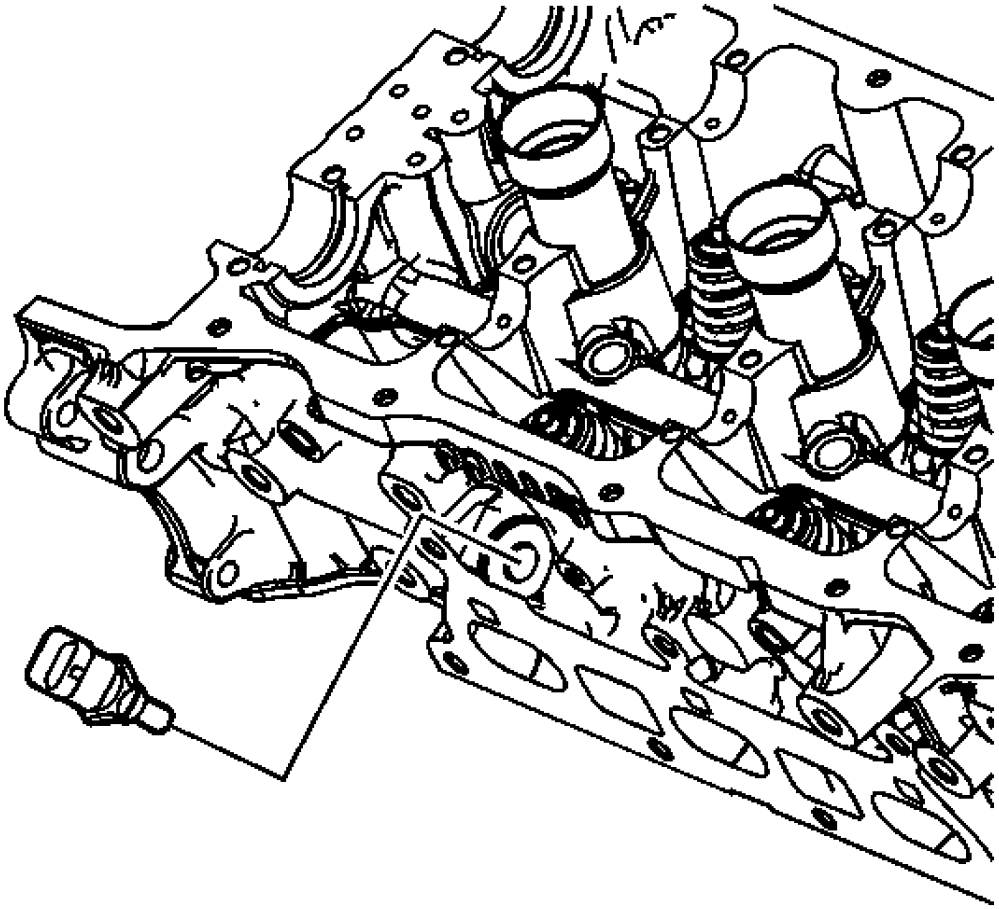


Fig. 40: Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS CORP.

5. Remove the engine coolant temperature (ECT) sensor.

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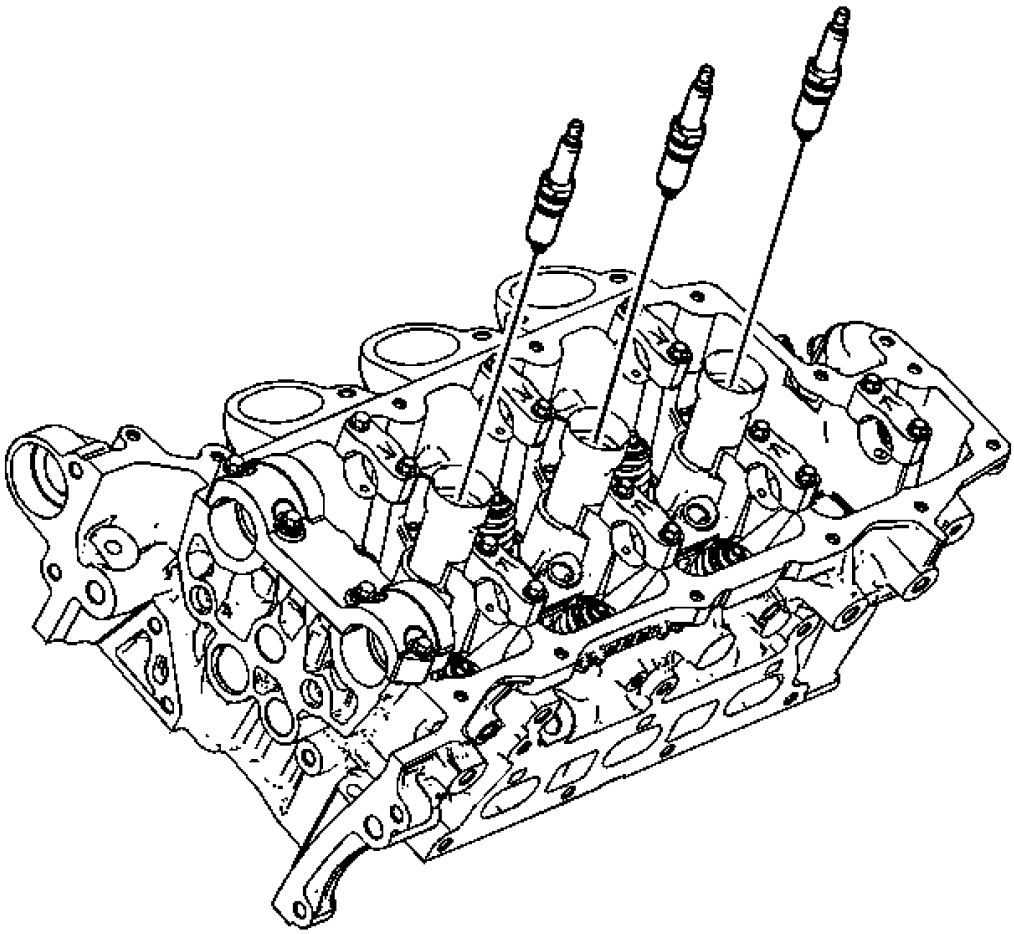


Fig. 41: View Of Spark Plugs
Courtesy of GENERAL MOTORS CORP.

6. Remove the spark plugs.

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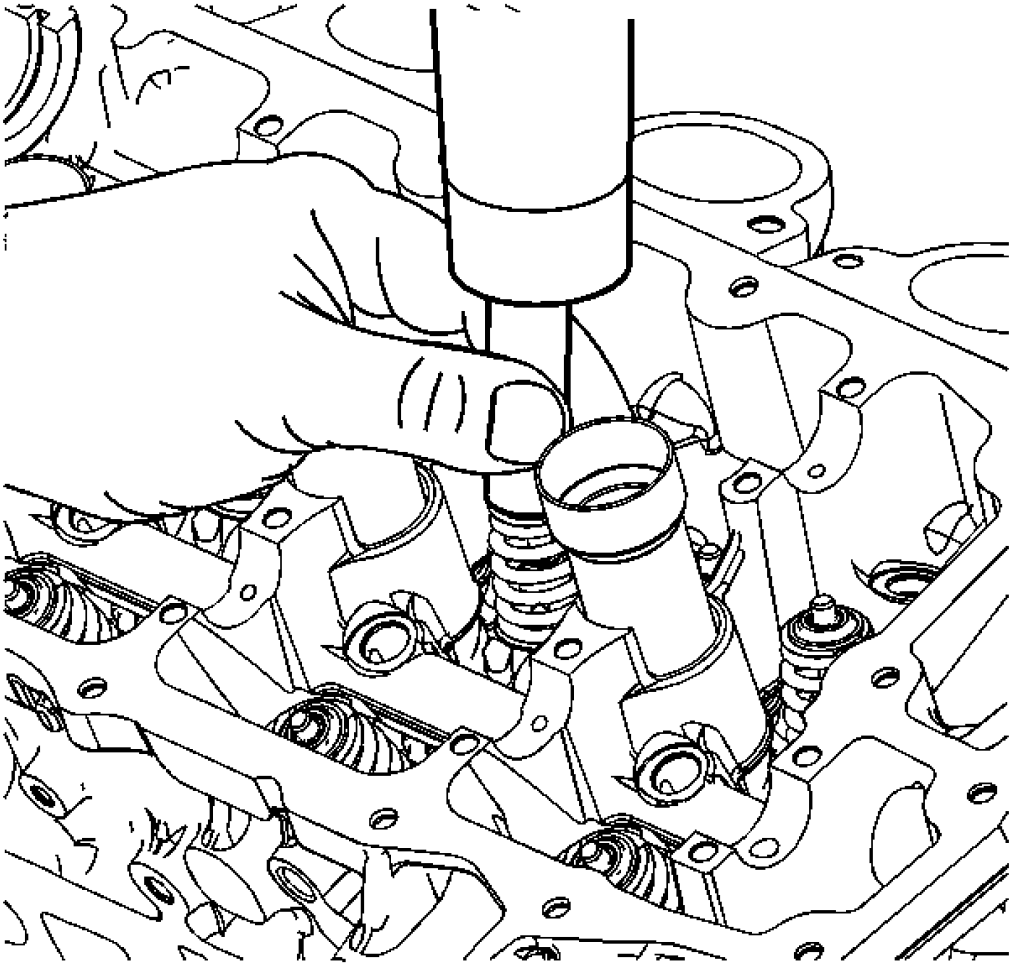


Fig. 42: Loosening Valve Keepers
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure valve heads will not contact anything during the following step in order to avoid bending or damage.

7. Using an appropriately sized deep socket and a plastic hammer, lightly tap on the valve spring retainer to loosen the valve keepers.

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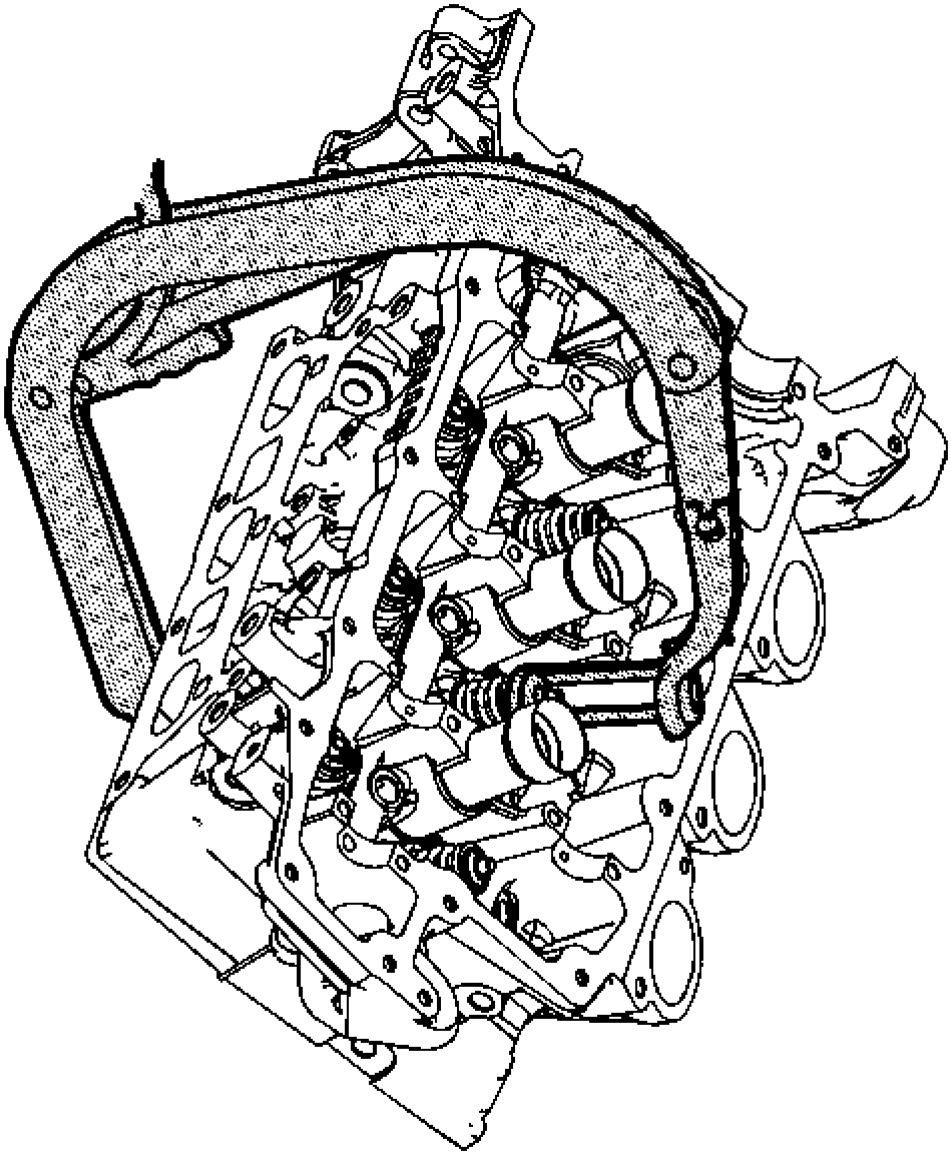


Fig. 43: Compressing Valve Spring
Courtesy of GENERAL MOTORS CORP.

WARNING: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when

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compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

CAUTION: Do not compress the valve springs to less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

8. Compress the valve spring using the **J 8062:** compressor and the **EN 46119:** adapter.

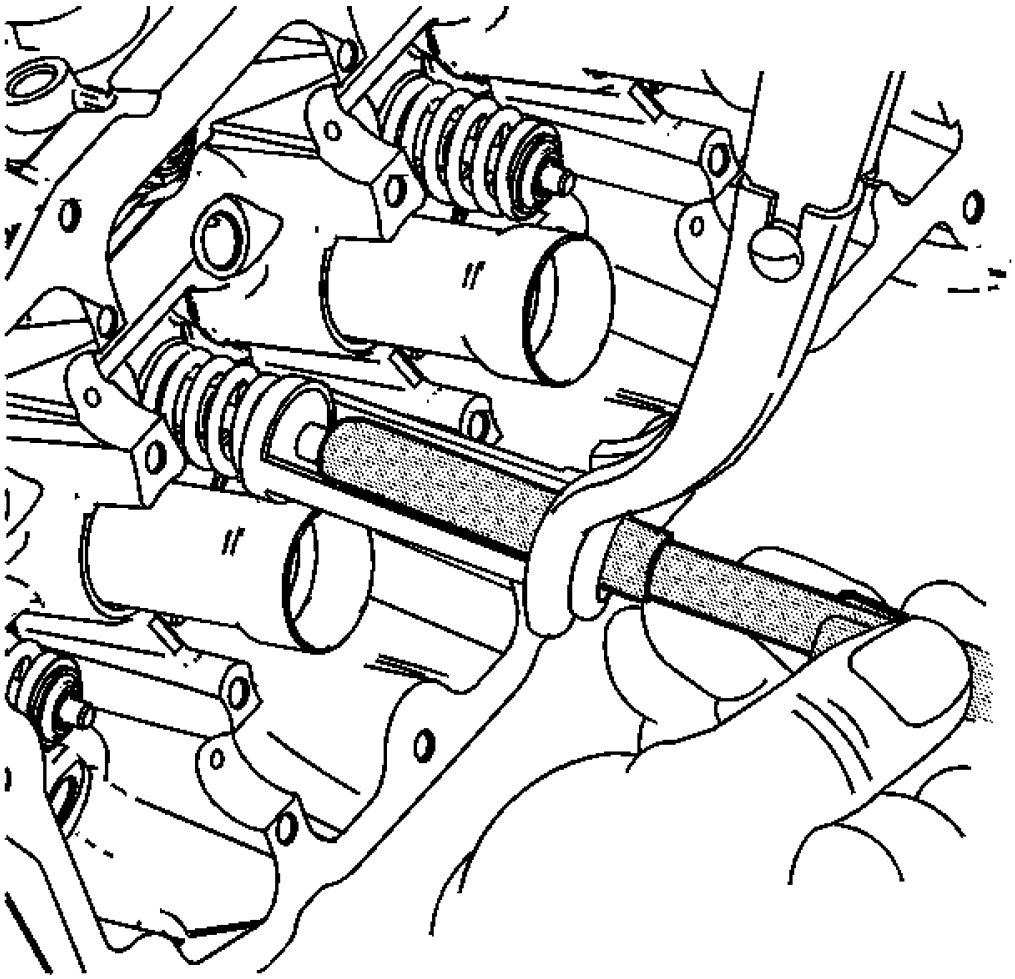


Fig. 44: Removing/Installing Valve Keepers
Courtesy of GENERAL MOTORS CORP.

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9. Use the magnet of the **EN 46117:** remover/installer in order to remove the valve keepers.
10. Remove the valve spring compressor and the adapter.

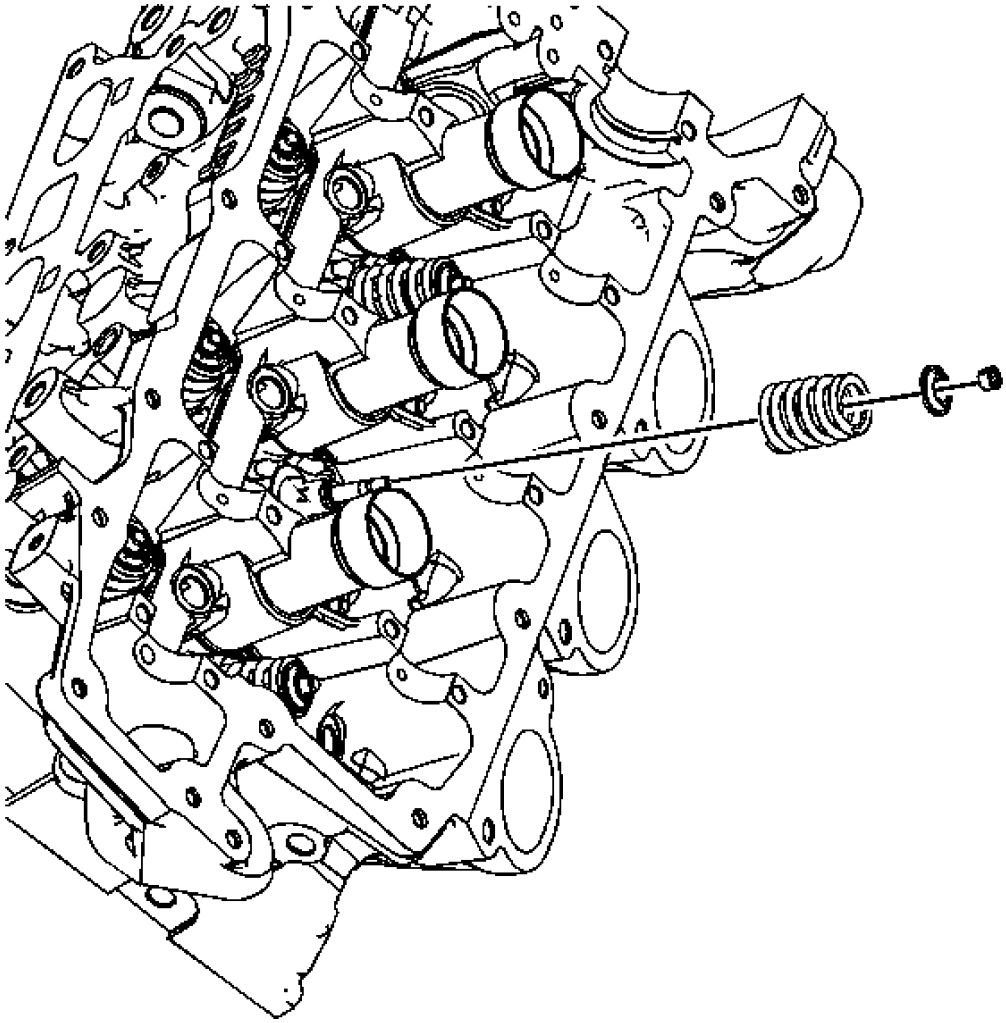


Fig. 45: View Of Valve Spring & Retainer
Courtesy of GENERAL MOTORS CORP.

11. Remove the valve spring retainer.
12. Remove the valve spring.

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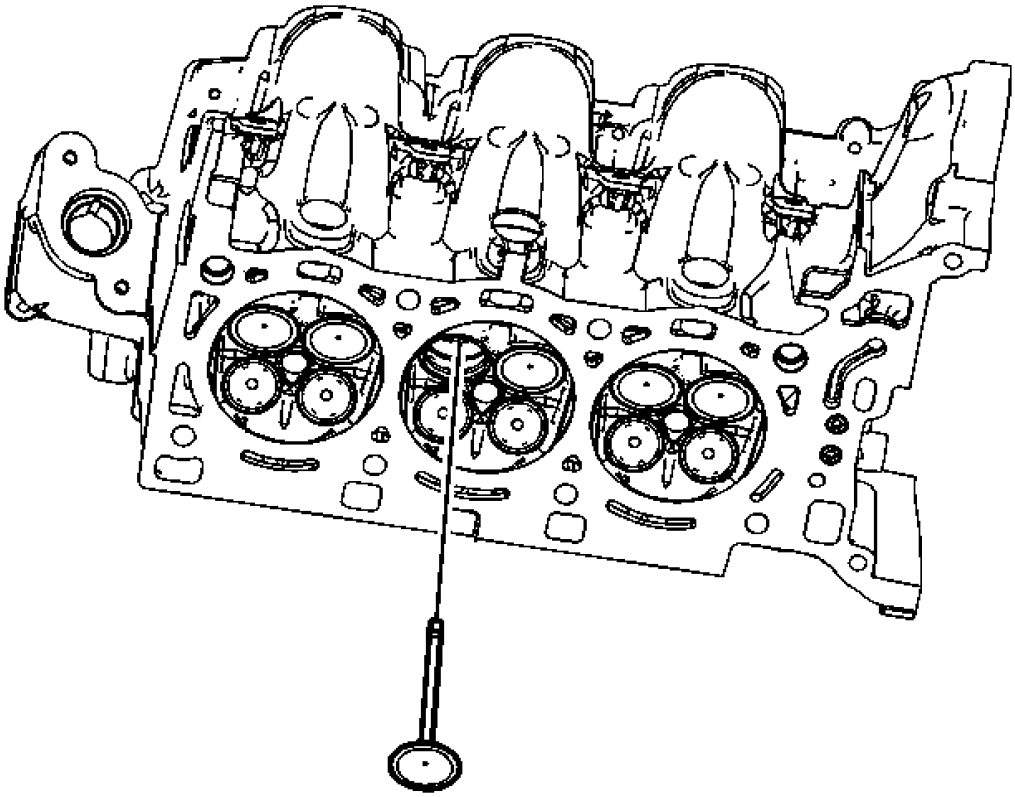


Fig. 46: Removing/Installing valve
Courtesy of GENERAL MOTORS CORP.

13. Remove the valve.

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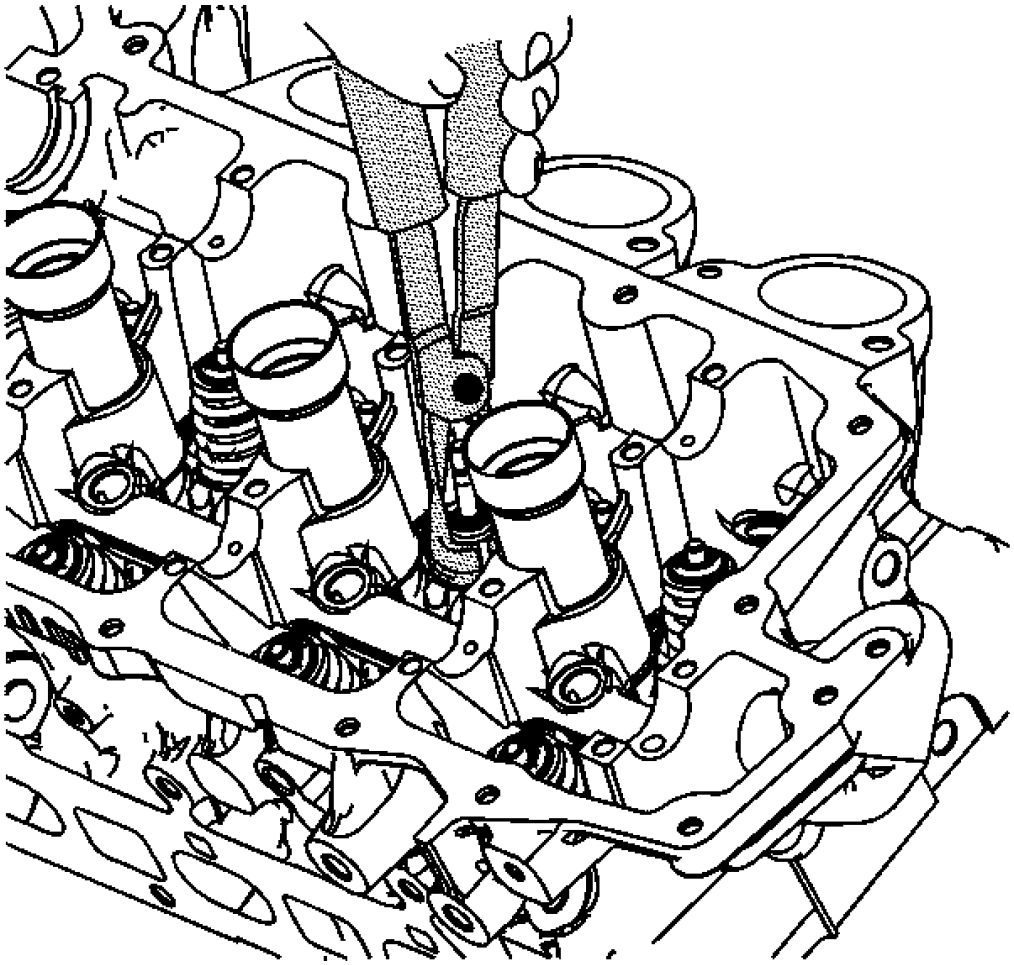


Fig. 47: Removing/Installing Valve Stem Oil Seals
Courtesy of GENERAL MOTORS CORP.

NOTE: NEVER reuse a valve stem oil seal.

14. Remove the valve stem oil seal using the **EN 46116:** remover/installer and discard.
15. Repeat these procedures for the remaining valves.

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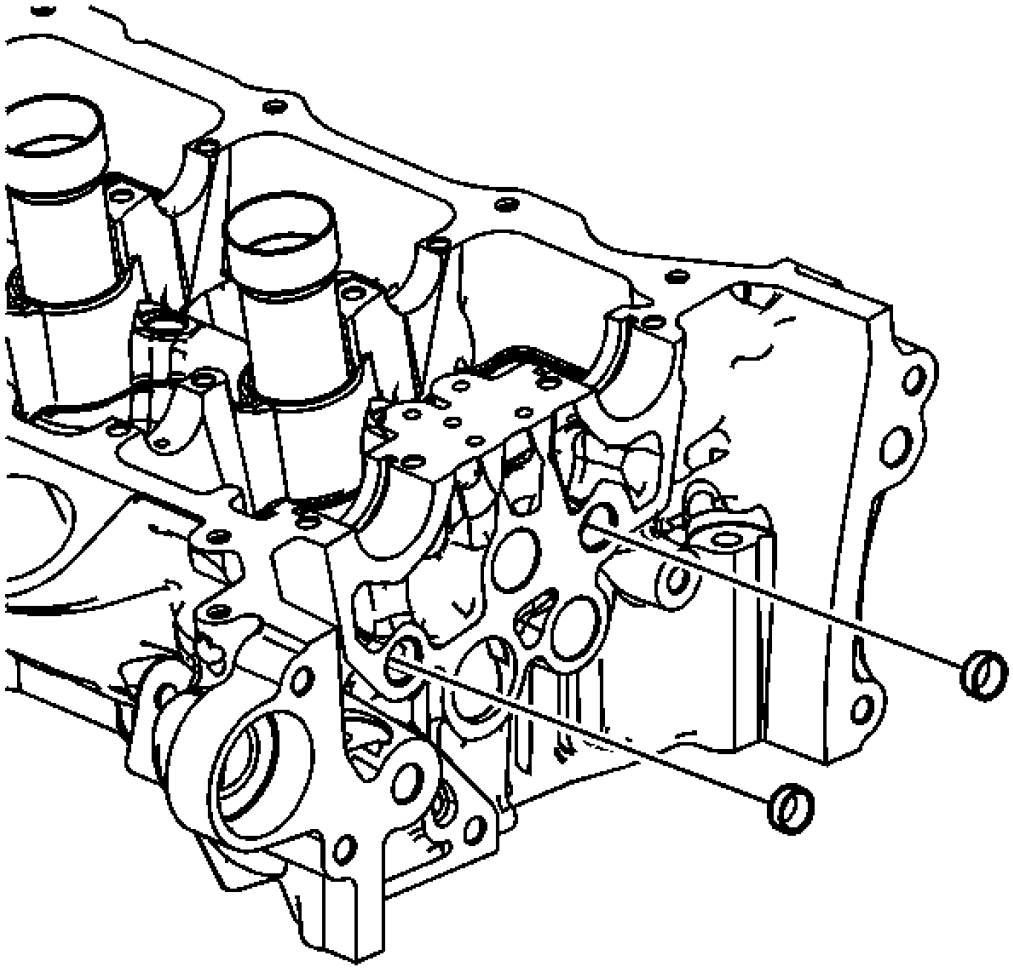


Fig. 48: View Of Cylinder Head Oil Gallery Expansion Plugs
Courtesy of GENERAL MOTORS CORP.

16. Remove the cylinder head oil gallery expansion plugs.

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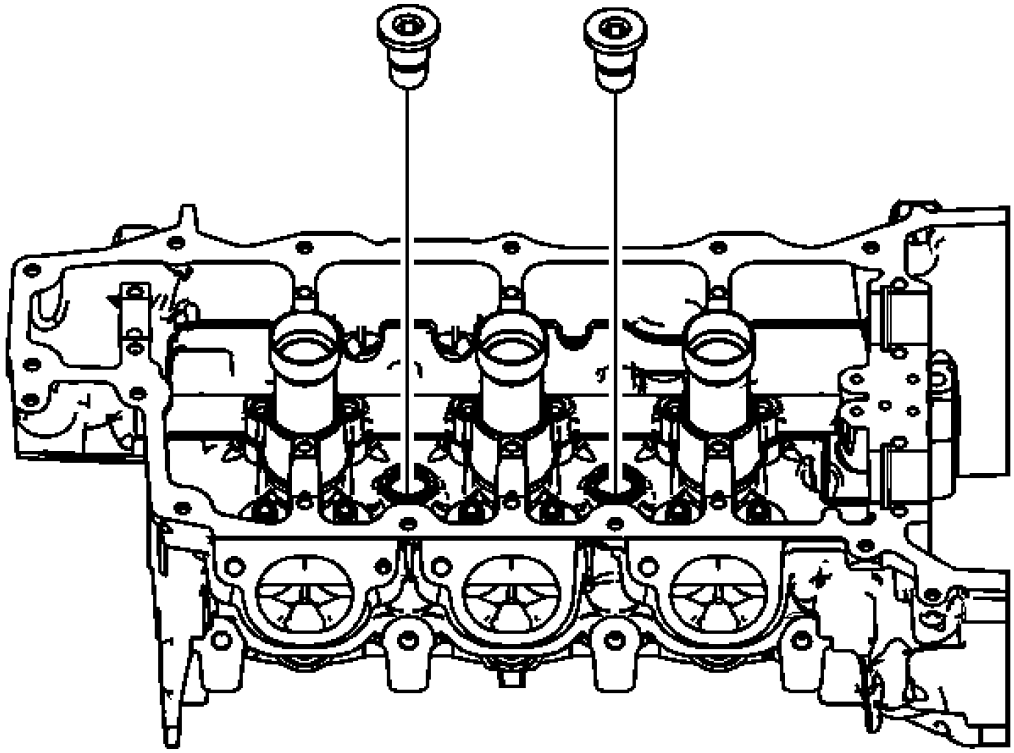


Fig. 49: View Of Cylinder Head Coolant Threaded Plugs
Courtesy of GENERAL MOTORS CORP.

17. Remove the cylinder head coolant threaded plugs.

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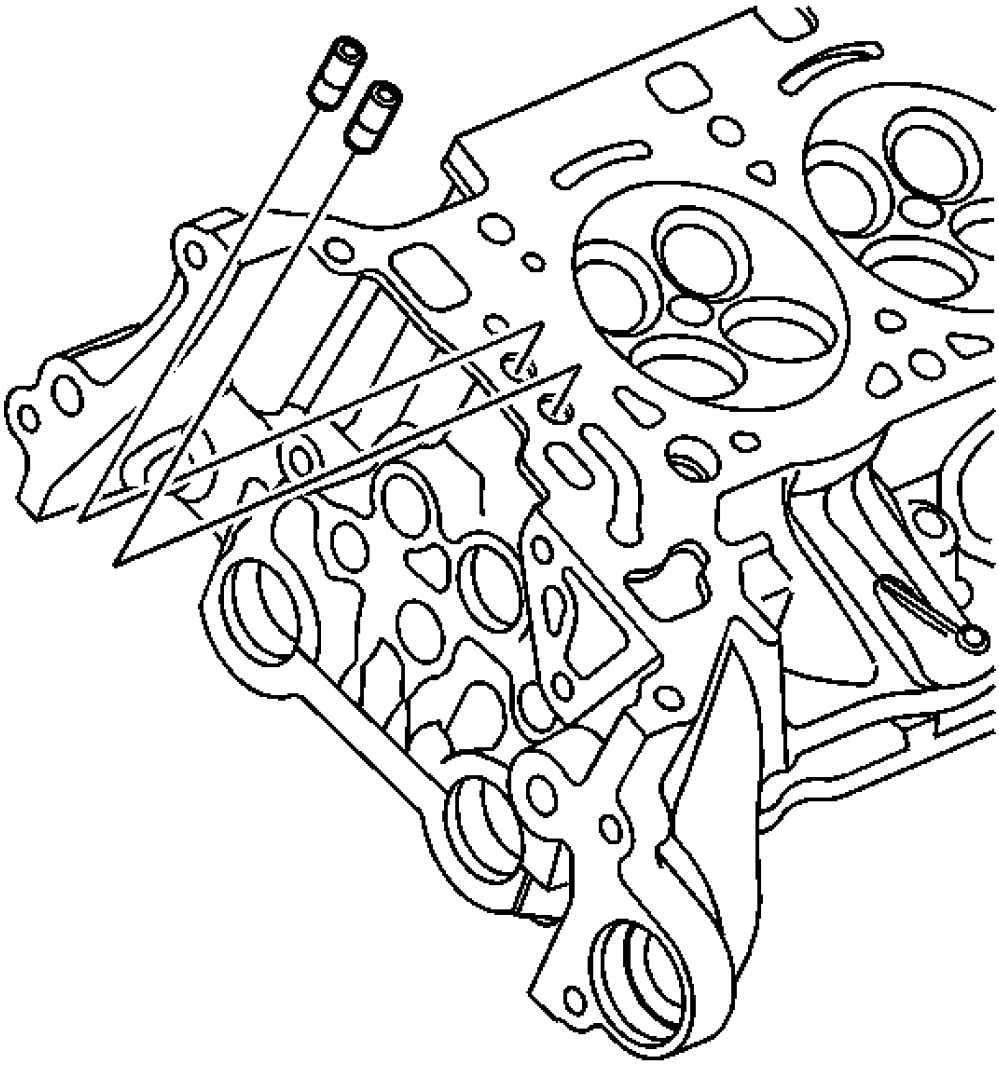


Fig. 50: View Of Camshaft Position Actuator Oil Feed Check Valves
Courtesy of GENERAL MOTORS CORP.

18. Inspect the camshaft position actuator oil feed check valves. Damaged, restricted or clogged check valves must be replaced.

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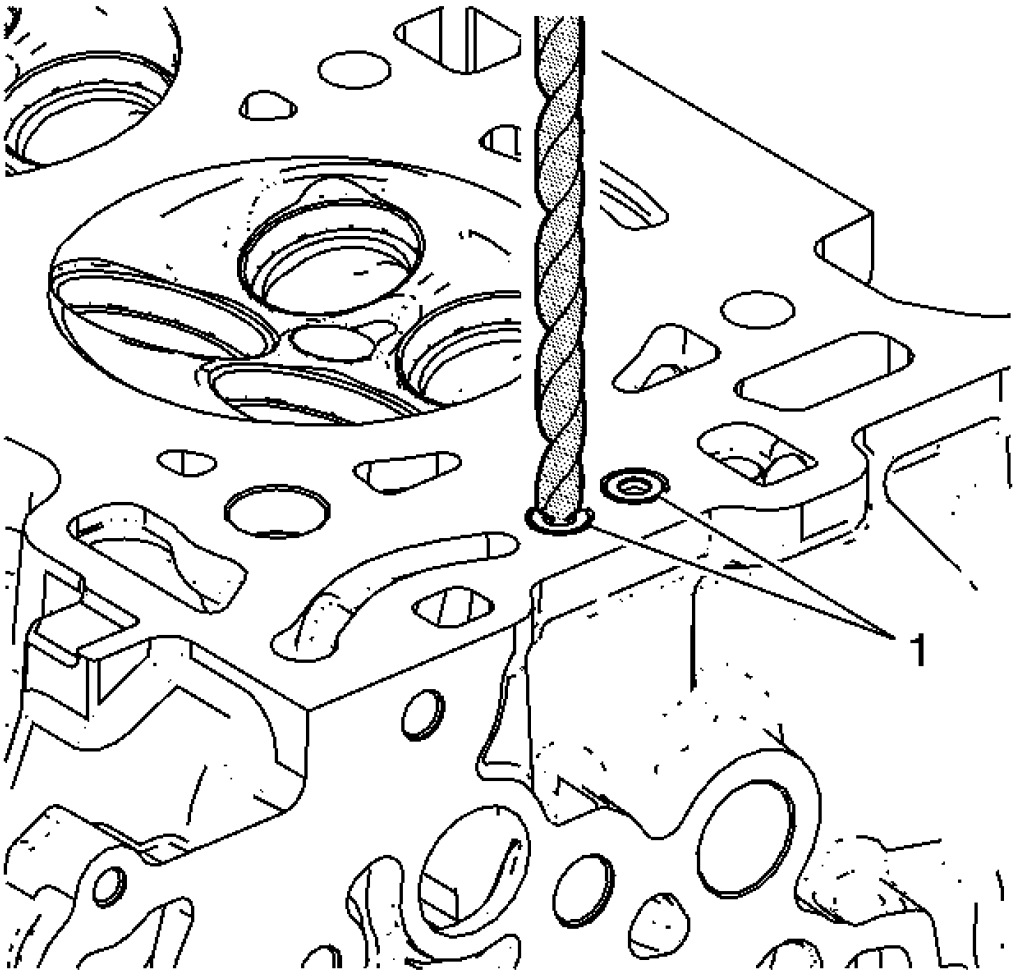


Fig. 51: Drilling Out Top Portion Of Check Valve
Courtesy of GENERAL MOTORS CORP.

19. Place cylinder head on firm surface with check valves (1) facing up. Protect all cylinder head components and machined surfaces.
20. Using drill bit EN 46122-3, drill out top portion of check valve to expose internal check ball.

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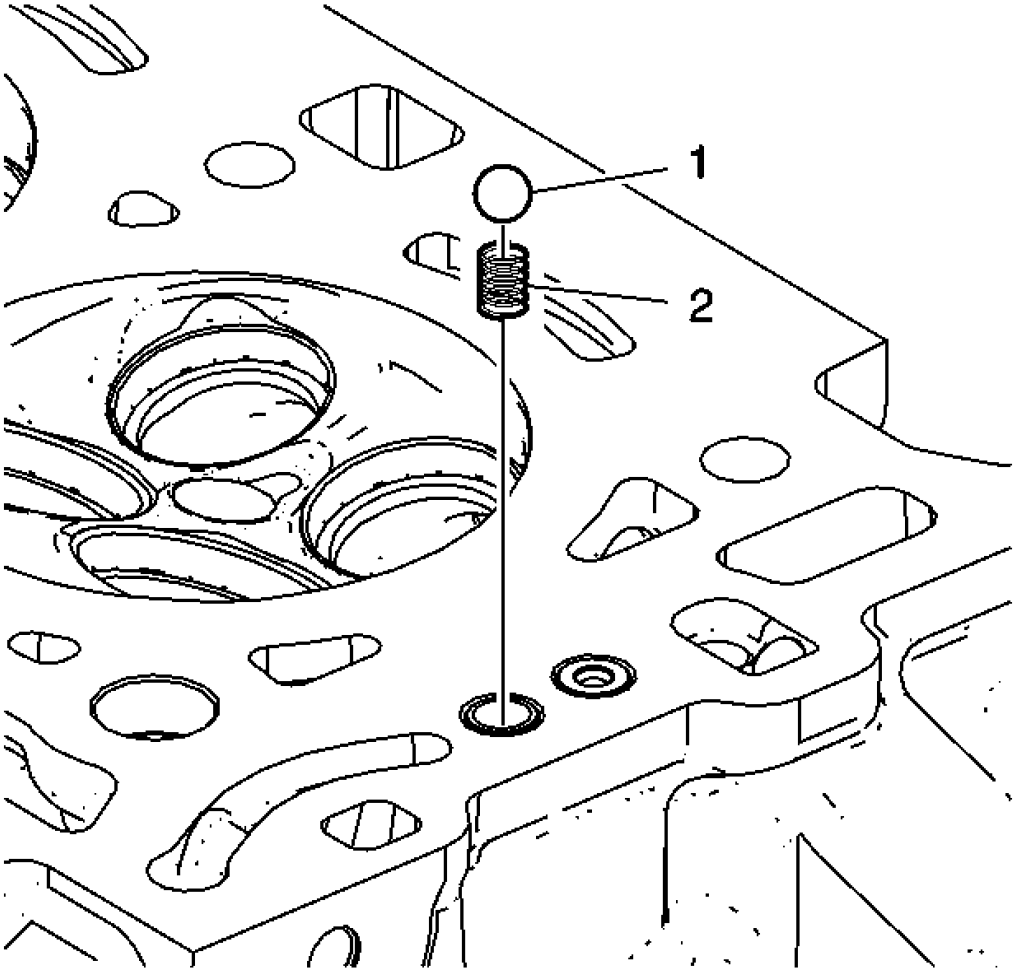


Fig. 52: Identifying Check Ball & Check Ball Spring
Courtesy of GENERAL MOTORS CORP.

21. Remove check ball (1) and check ball spring (2) from inside of check valve.

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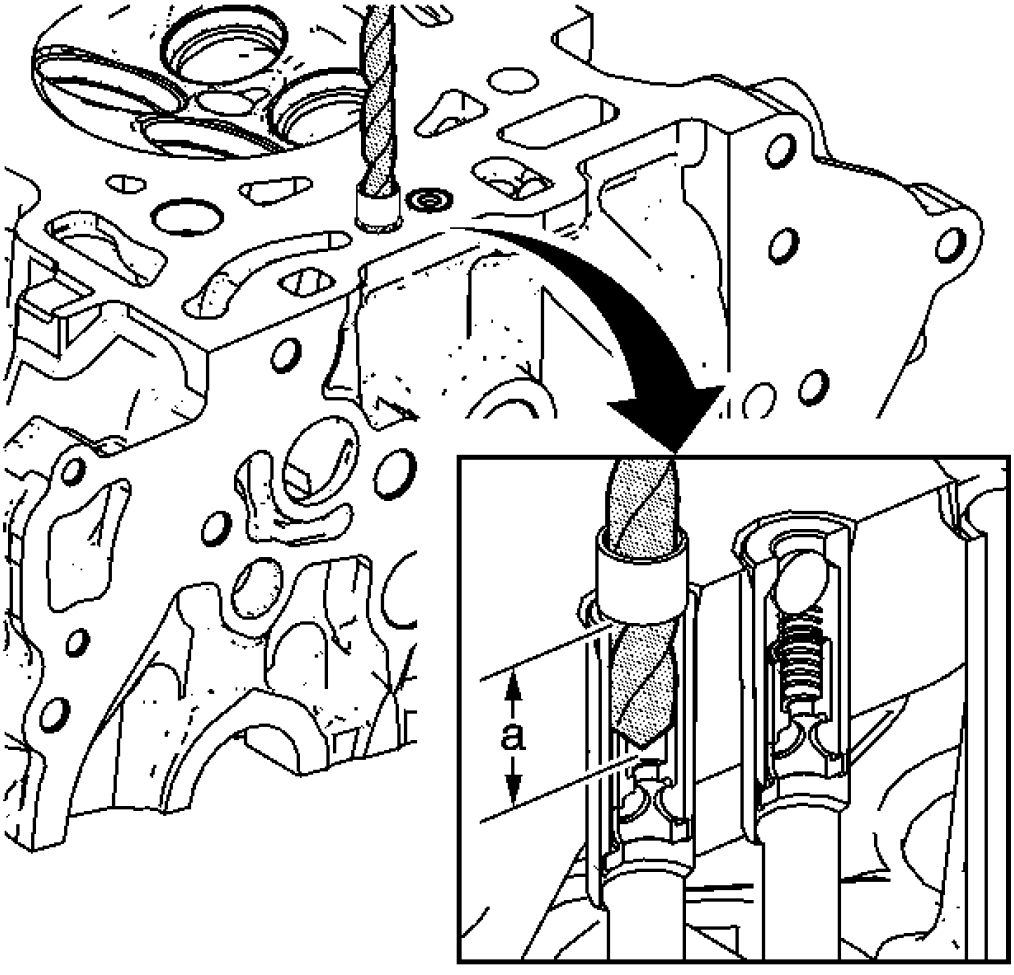


Fig. 53: Drilling Remainder Of Check Valve Sleeve
Courtesy of GENERAL MOTORS CORP.

22. Continue drilling remainder of check valve sleeve to a depth of approximately 19 mm (0.75 in) (a) by placing tape on drill bit as a depth gauge. It is not necessary or desirable to drill completely through the bottom of the check valve.

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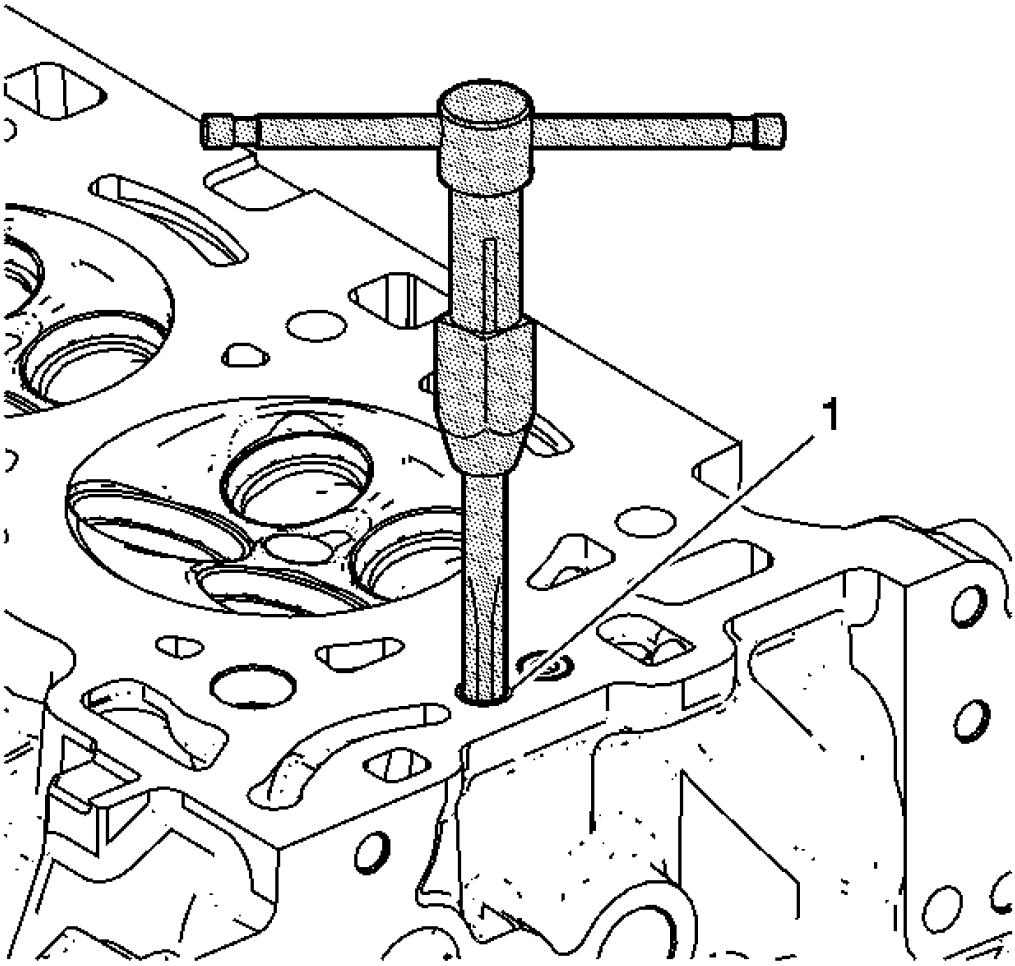


Fig. 54: Tapping Drilled Out Portion Of Check Valve
Courtesy of GENERAL MOTORS CORP.

23. Lubricate tap EN 46122-4 with lubricant included in **EN 46122:** remover/installer. Tap drilled out portion of check valve (1) remaining in cylinder head. Tap to full depth possible until tap bottoms out in head.

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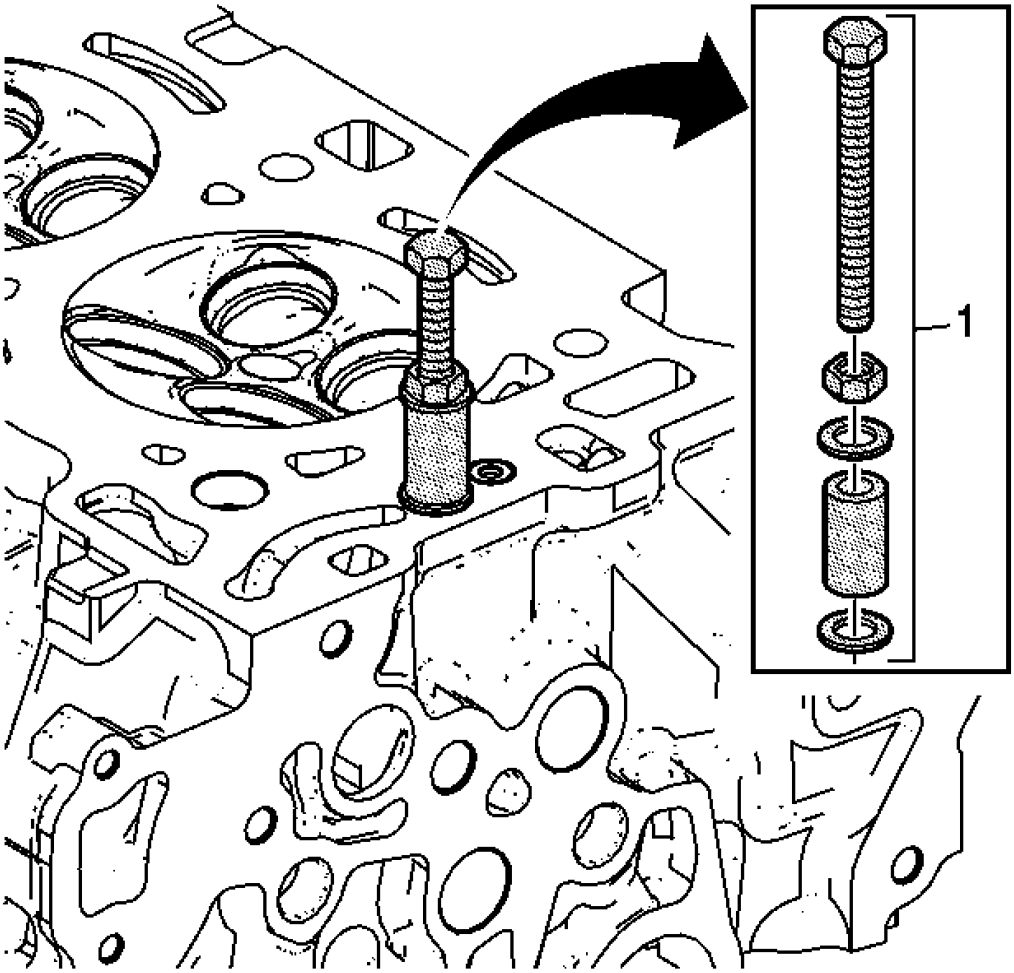


Fig. 55: Assembling Bolt, Nut, Washers & Collar EN-46122-2
Courtesy of GENERAL MOTORS CORP.

24. Assemble bolt, nut, washers, and collar EN 46122-2 (1) as shown. Position collar with slightly-larger inside diameter DOWN toward the cylinder head.
25. Screw bolt by hand fully down into threaded check valve sleeve, then lightly tighten nut against washer.

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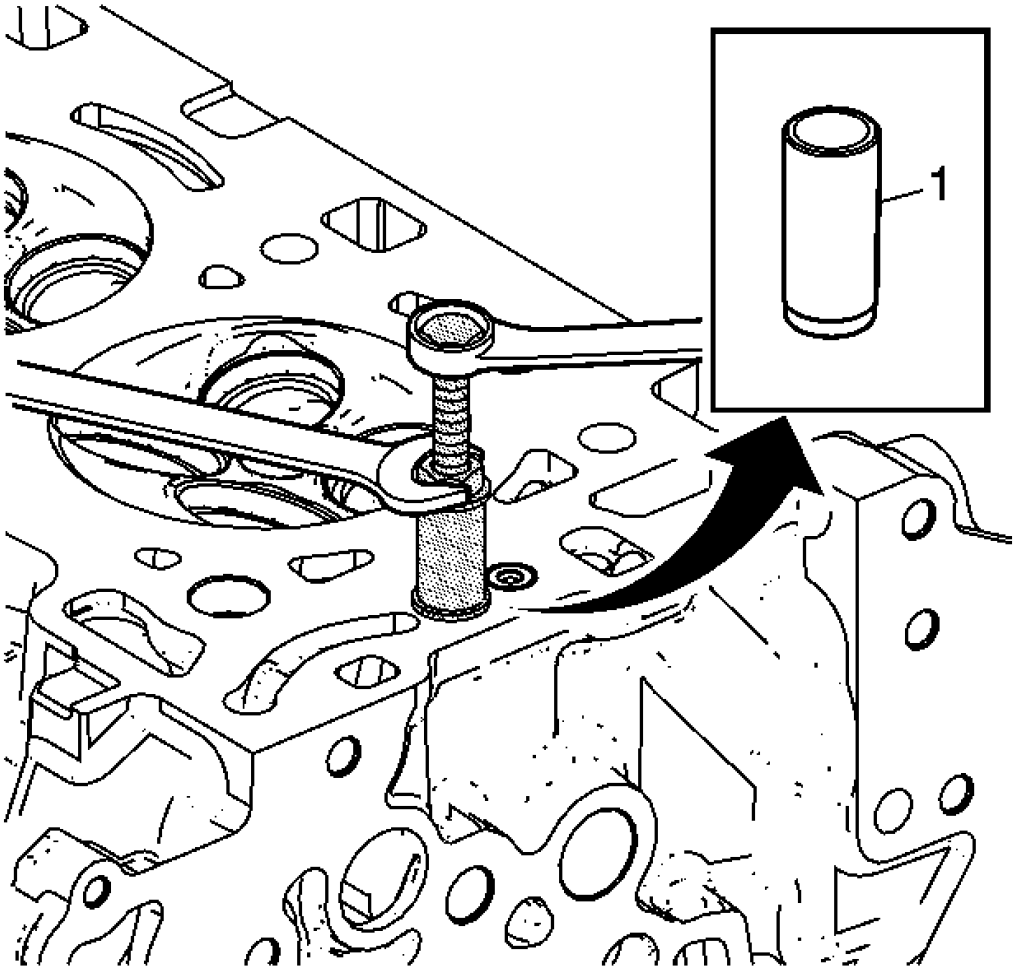


Fig. 56: Removing Check Valve Sleeve
Courtesy of GENERAL MOTORS CORP.

26. Hold bolt with one wrench, and use another to tighten the nut until the check valve sleeve (1) is removed from the cylinder head.
27. Clean check valve bore and related passages thoroughly to remove any drilling chips or other debris.

CYLINDER HEAD CLEANING AND INSPECTION

Special Tools

- **EN-47909:** Injector Bore and Sleeve Cleaning Kit
- **J 8001:** Dial Indicator Set

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- **J 8358:** Carbon Removal Brush
- **J 28410:** Gasket Remover
- **J 42096:** Valve Guide Reamer

For equivalent regional tools, refer to **Special Tools** .

CLEANING PROCEDURE

1. Remove any old thread sealant, gasket material or sealant using **J 28410:** remover.
2. Clean all cylinder head surfaces with non-corrosive solvent.

WARNING: Refer to Safety Glasses Warning .

3. Blow out all the oil galleries using compressed air.
4. Remove any carbon deposits from the combustion chambers using the **J 8358:** brush.
5. Clean any debris or build-up from the lifter pockets.

VISUAL INSPECTION

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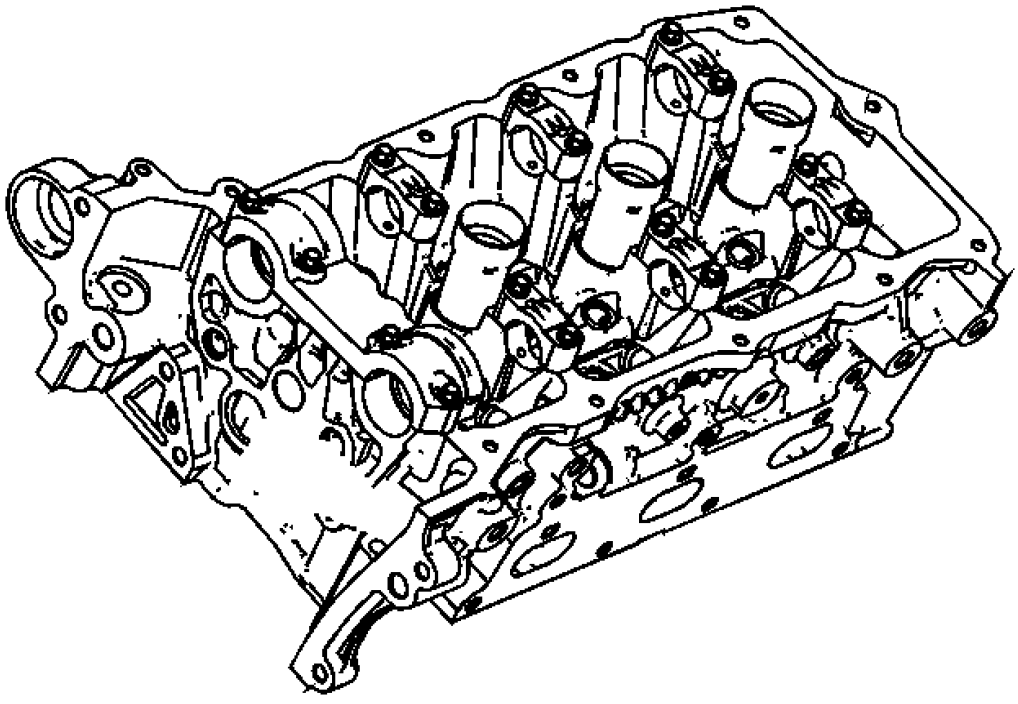


Fig. 57: View Of Cylinder Head
Courtesy of GENERAL MOTORS CORP.

1. Inspect the cylinder head camshaft bearing surfaces for the following conditions:
   - Excessive scoring or pitting
   - Discoloration from overheating
   - Deformation from excessive wear
   - If the camshaft bearing journals appear to be scored or damaged, you must replace the cylinder head. DO NOT machine the camshaft bearing journals.
2. If any of the above conditions exist on the camshaft bearing surfaces, replace the cylinder head.
3. 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 - If coolant leaks are present, measure the surface warpage as described under Cylinder Head Measurement - Deck Flatness Inspection.
   - Burrs or any defects that would degrade the sealing of the NEW secondary camshaft drive chain tensioner gasket
   - Damage to any gasket surfaces

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- 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

4. If the cylinder head is cracked or damaged, it must be replaced. No welding or patching of the cylinder head is recommended.

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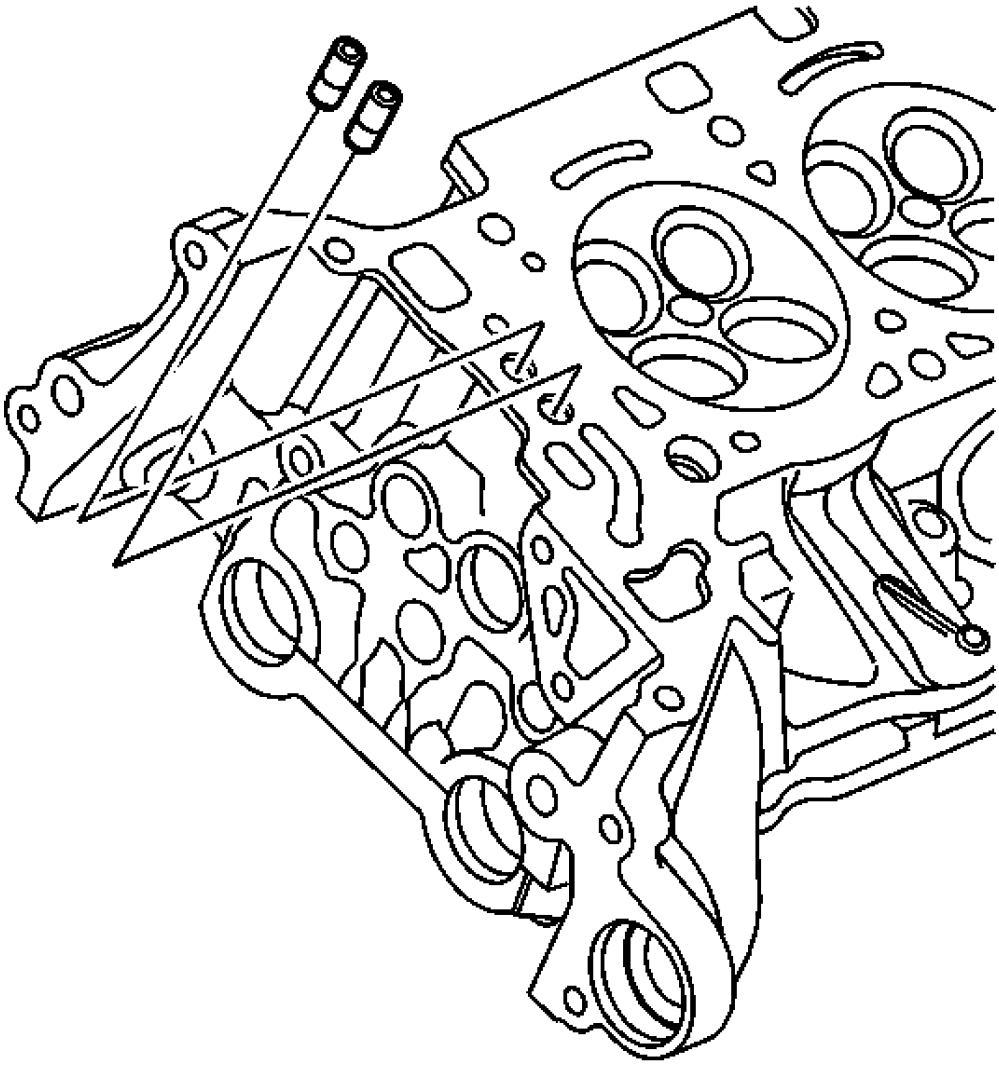


Fig. 58: View Of Camshaft Position Actuator Oil Feed Check Valves
Courtesy of GENERAL MOTORS CORP.

5. Inspect the camshaft position actuator oil feed check valves. Damaged, restricted or clogged check valves must be replaced. Refer to **Cylinder Head Disassemble (LLT)**.

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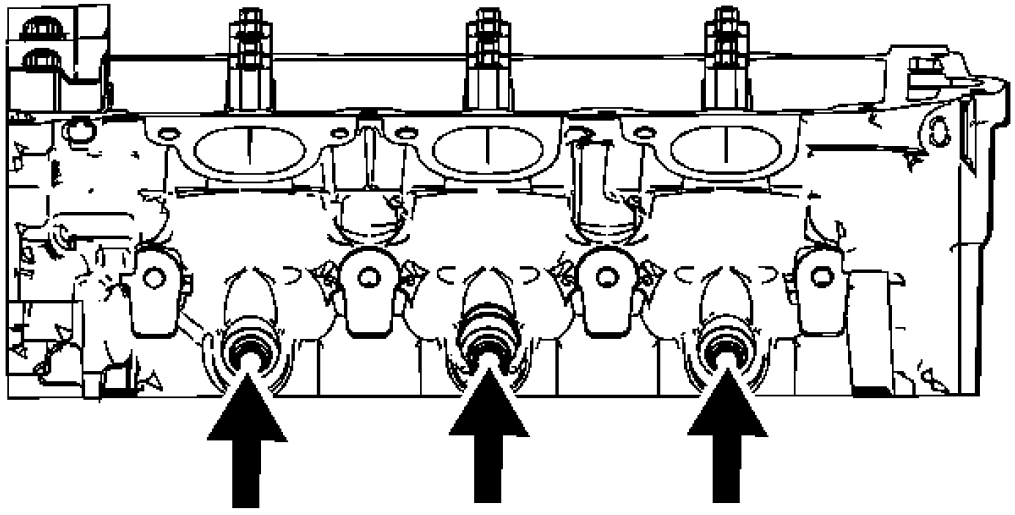


Fig. 59: View of Fuel Rail injector Bores
Courtesy of GENERAL MOTORS CORP.

6. Inspect the fuel rail injector bores and clean with **EN-47909:** kit, if required.

CYLINDER HEAD MEASUREMENT

Camshaft Journal Clearance

1. Install the camshaft bearing cap in the cylinder head without the camshaft.

CAUTION: Refer to Fastener Caution .

2. Install the camshaft cap bolts and tighten to 10 N.m (89 lb in).
3. Measure the camshaft bearings using an inside micrometer.
4. Subtract the camshaft journal diameter from the camshaft bearing diameter. This will provide the running clearance. If the running clearance exceeds specifications and the camshaft journals are within specification, replace the cylinder head.

Camshaft Journal Alignment

1. Ensure the camshafts are serviceable.
2. Inspect the cylinder head camshaft bearing surfaces for any imperfections or scratches that could inhibit proper camshaft clearances. Repair minor imperfections or scratches.

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3. Install the camshafts in the cylinder head.
4. Install the camshaft bearing caps.
5. Install the camshaft cap bolts and tighten to 10 N.m (89 lb in).
6. Ensure the camshafts spin freely in the cylinder head. If the camshaft does not run freely, replace the cylinder head.

Deck Flatness Inspection

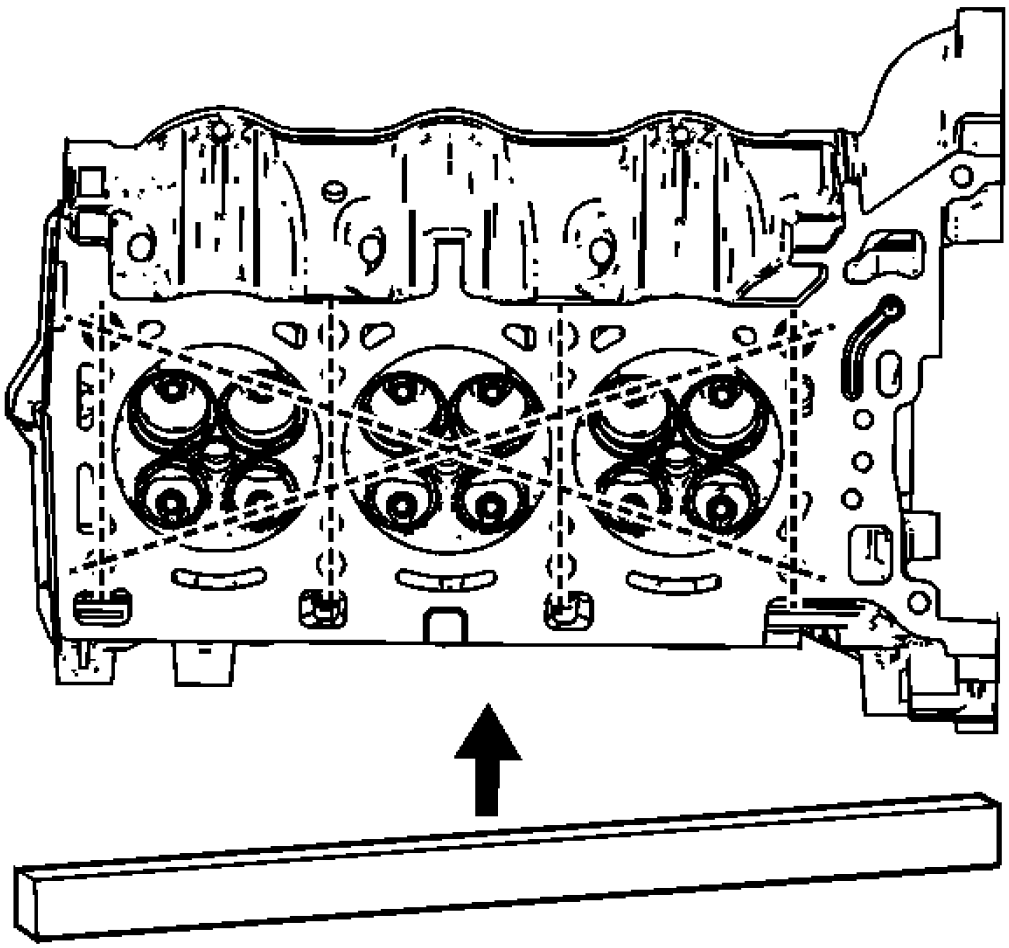


Fig. 60: Measuring Deck Flatness
Courtesy of GENERAL MOTORS CORP.

1. Ensure the cylinder head decks are clean and free of gasket material.
2. Inspect the surface for any imperfections or scratches that could inhibit proper cylinder head gasket

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sealing.

3. Place a straight-edge diagonally across the cylinder head deck face surface.
4. Measure the clearance between the straight-edge and the cylinder head deck face using a feeler gauge at 4 points along the straight-edge.
5. If the warpage is less than 0.05 mm (0.002 in), the cylinder head deck surface does not require resurfacing.
6. If the warpage is between 0.05-0.20 mm (0.002-0.008 in) or any imperfections or scratches that could inhibit proper cylinder head gasket sealing are present, the cylinder head deck surface requires resurfacing.
7. If resurfacing is required the maximum amount that can be removed is 0.25 mm (0.010 in).
8. If the cylinder head deck surface requires more than 0.25 mm (0.010 in) material removal the head must be replaced.

Valve Guide Measurement

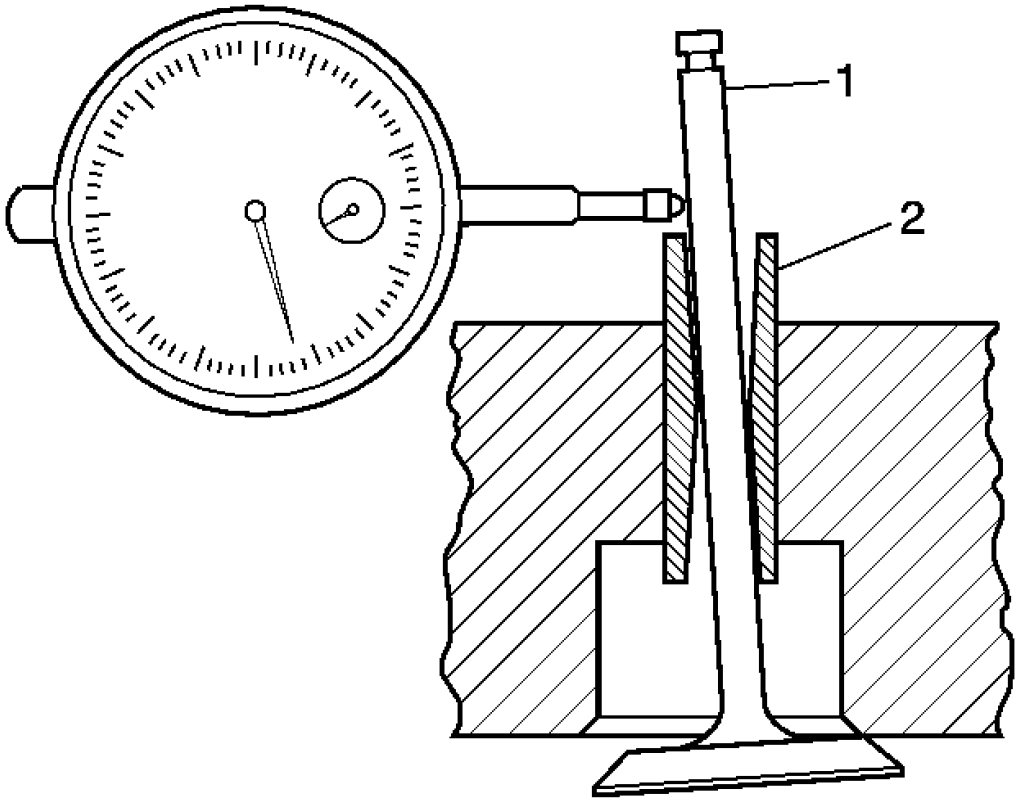


Fig. 61: Inspecting For Excessive Valve Stem To Guide Clearance
Courtesy of GENERAL MOTORS CORP.

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1. Measure the valve stem (1)-to-guide (2) clearance. Excessive valve stem-to-guide clearance may cause an excessive oil consumption and may also cause a valve to break. Insufficient clearance will result in noisy and sticky functioning of the valve and will disturb the engine assembly smoothness.
2. Clamp the **J 8001:** set to the cylinder head at the camshaft cover rail.
3. Locate the dial indicator so that the movement of the valve stem from side to side, crossways to the cylinder head, will cause a direct movement of the indicator stem. The dial indicator stem must contact the side of the valve stem just above the valve guide.
4. Drop the valve head about 0.064 mm (0.0025 in) off the valve seat.
5. Use light pressure when moving the valve stem from side to side in order to obtain a clearance reading. Refer to **Engine Mechanical Specifications (LLT)** for proper clearance.
    - If the clearance for the valve is greater than specifications and a new standard diameter valve stem will not bring the clearance within specifications, the valve guide may be oversized by 0.075 mm (0.003 in) using the **J 42096:** reamer. There is 1 size of oversized valve stem available for service.
    - Valve guide wear at the bottom 10 mm (0.390 in) of the valve guide is not significant to normal operation.
    - If oversizing the guide does not bring the clearance within specifications, replace the cylinder head.

VALVE SPRING INSPECTION AND MEASUREMENT

SPECIAL TOOLS

J 22738-B: Valve Spring Tester

For equivalent regional tools, refer to **Special Tools** .

INSPECTION PROCEDURE

1. Clean the valve springs in solvent.

    WARNING: Refer to Safety Glasses Warning .

2. Dry the valve springs with compressed air.
3. Inspect the valve springs for broken coils or coil ends.

MEASUREMENT PROCEDURE

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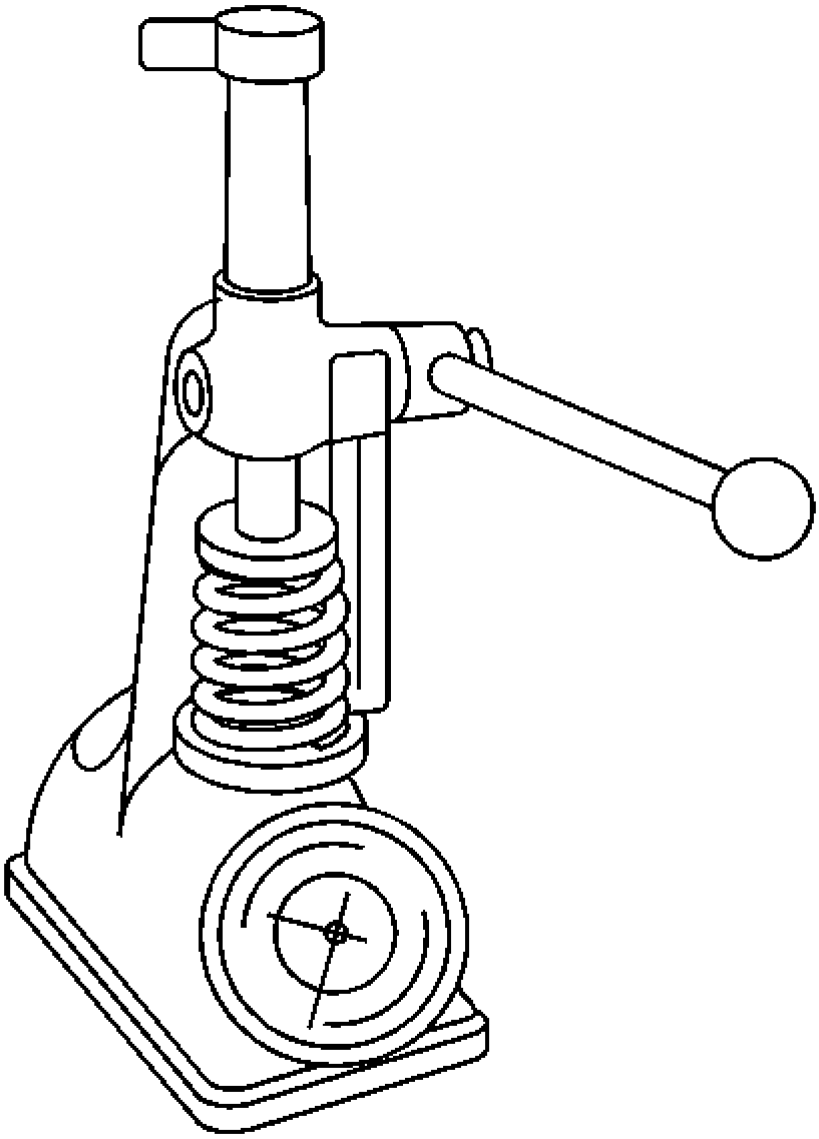


Fig. 62: Measuring Valve Spring Tension
Courtesy of GENERAL MOTORS CORP.

1. Measure the valve spring tension using the **J 22738-B:** tester. Refer to **Engine Mechanical Specifications (LLT)** .
2. If low valve spring load is found, replace the valve springs. DO NOT use shims to increase spring load. The use of shims can cause the valve spring to bottom out before the camshaft lobe is at peak lift.

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VALVE AND SEAT GRINDING

VALVE CLEANING PROCEDURE

1. Use soft bristle wire brush to clean any carbon build-up from the valve head. DO NOT use a wire brush on any part of the valve stem. The valve stem is chrome plated to provide enhanced wear characteristics. Wire brushing the stem could remove the chrome plating.
2. Thoroughly clean the valve with solvent and wipe dry.

VALVE VISUAL INSPECTION PROCEDURE

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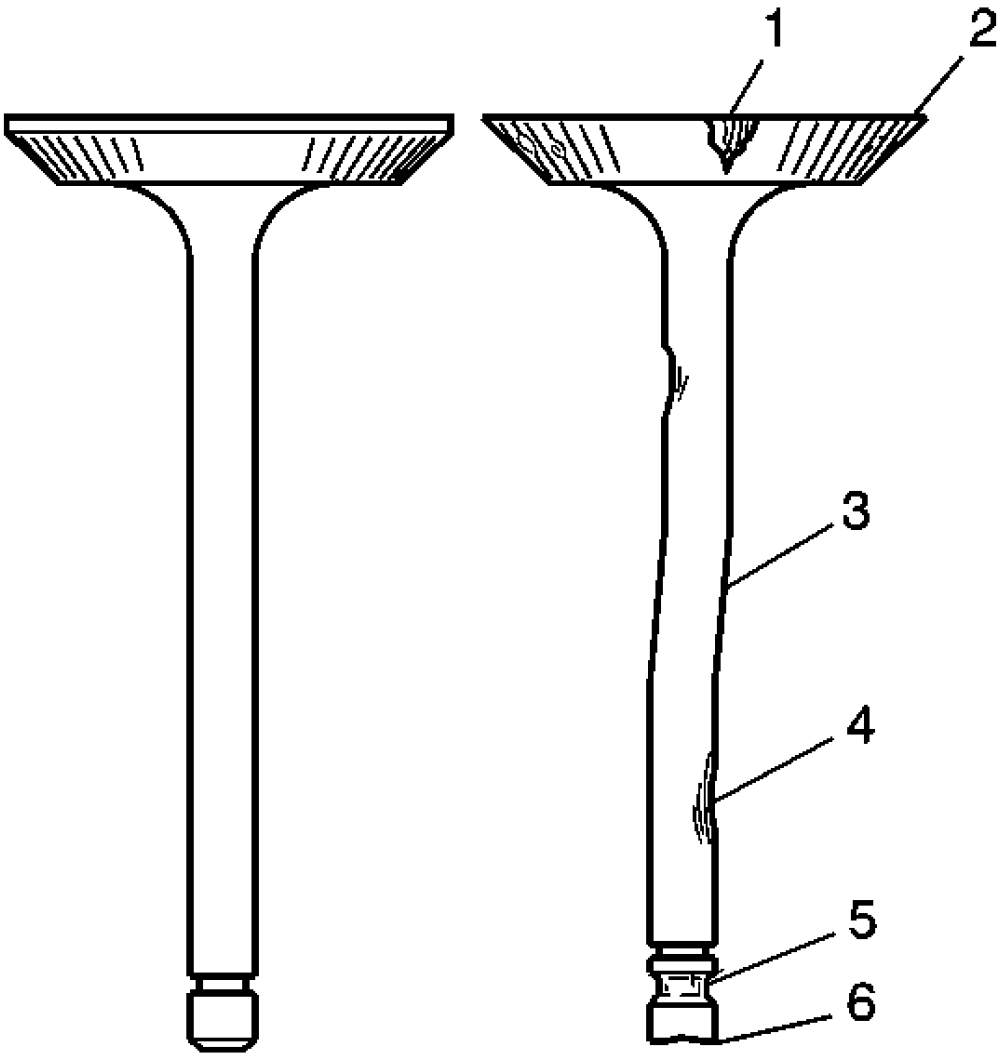


Fig. 63: Identifying Valve Damage
Courtesy of GENERAL MOTORS CORP.

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)

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- Worn valve tip (6)

2. Replace the valve if any of these conditions exist.

VALVE MEASUREMENT AND RECONDITIONING OVERVIEW

NOTE: The following measurement and reconditioning procedures must be followed to ensure proper engine performance.

1. Proper valve service is critical to engine performance. Therefore, all detailed measurement procedures must be followed to identify components that are out of specification.
2. If the measurement procedures reveal that the valve or valve seat must be reconditioned, it is critical to perform the measurement procedures after reconditioning.

VALVE SEAT WIDTH MEASUREMENT PROCEDURE

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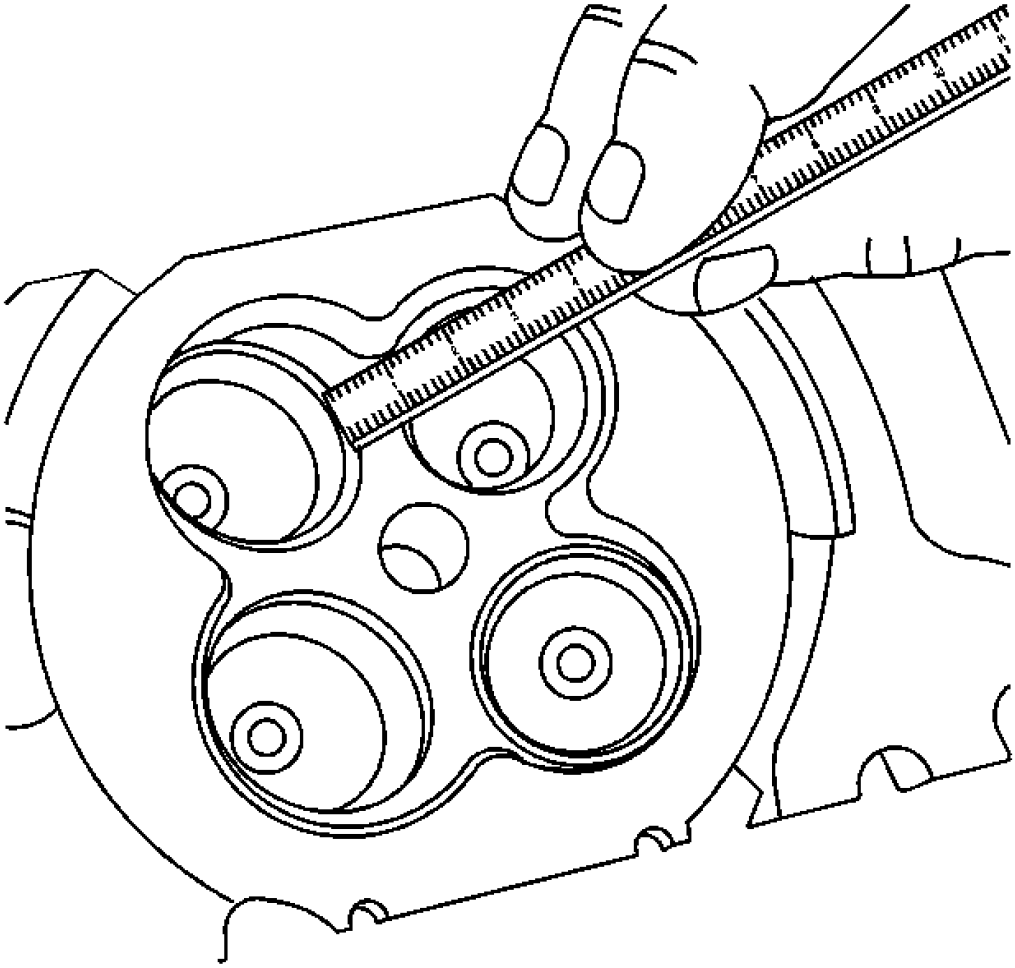


Fig. 64: Checking Valve Seat Width
Courtesy of GENERAL MOTORS CORP.

1. Measure the valve seat width in the cylinder head using a proper scale.

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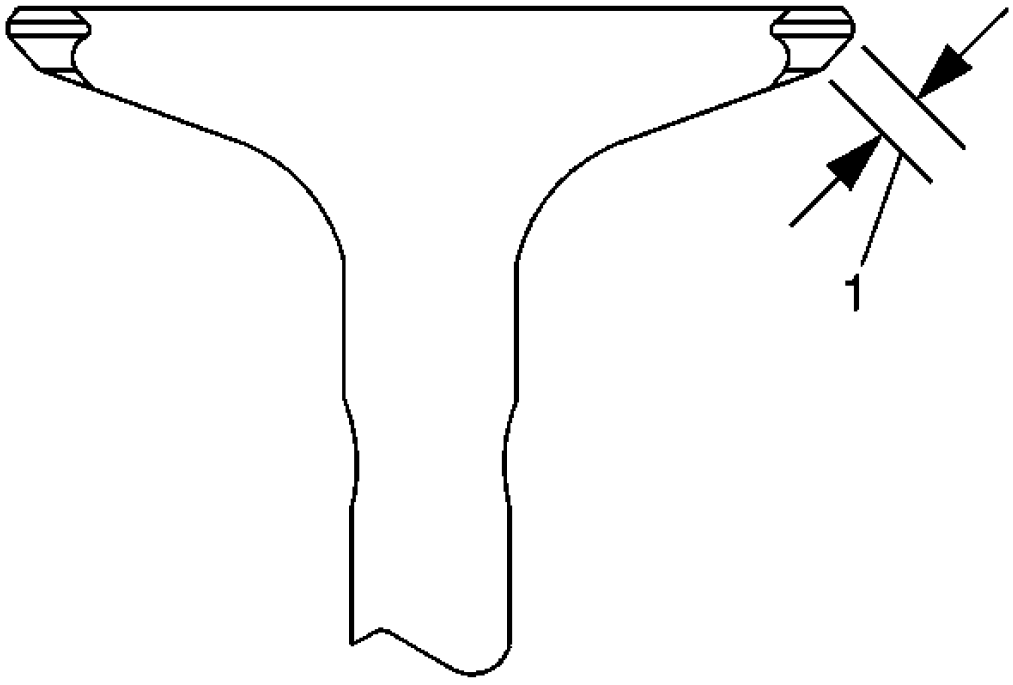


Fig. 65: Measuring Seat Width On Valve Face
Courtesy of GENERAL MOTORS CORP.

2. Measure the seat width on the valve face (1) using a proper scale.

NOTE: The seat contact area must be at least 0.5 mm (0.020 in) from the outer diameter (margin) of the valve. If the contact area is too close to the margins, the seat must be reconditioned to move the contact area away from the margin.

3. Compare your measurements with the specifications listed in **Engine Mechanical Specifications (LLT)** .
4. If the seat widths are acceptable, check the valve seat roundness using the Valve Seat Roundness Measurement Procedure.
5. If the seat width is not acceptable, you must grind the valve seat using the Valve and Seat Reconditioning Procedure to bring the width back into specification. Proper valve seat width is critical to providing the correct amount of valve heat dissipation.

VALVE SEAT ROUNDNESS MEASUREMENT PROCEDURE

1. Measure the valve seat roundness using a dial indicator attached to a tapered pilot installed in the guide. The pilot should have a slight bind when installed in the guide.

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CAUTION: The correct size pilot must be used. Do not use adjustable diameter pilots. Adjustable pilots may damage the valve guides.

2. Compare your measurements with the specifications listed in **Engine Mechanical Specifications (LLT)** .
3. If the valve seat exceeds the roundness specification, you must grind the valve and valve seat using the Valve and Seat Reconditioning Procedure.
4. If new valves are being used, the valve seat roundness must be within 0.05 mm (0.002 in).

VALVE MARGIN MEASUREMENT PROCEDURE

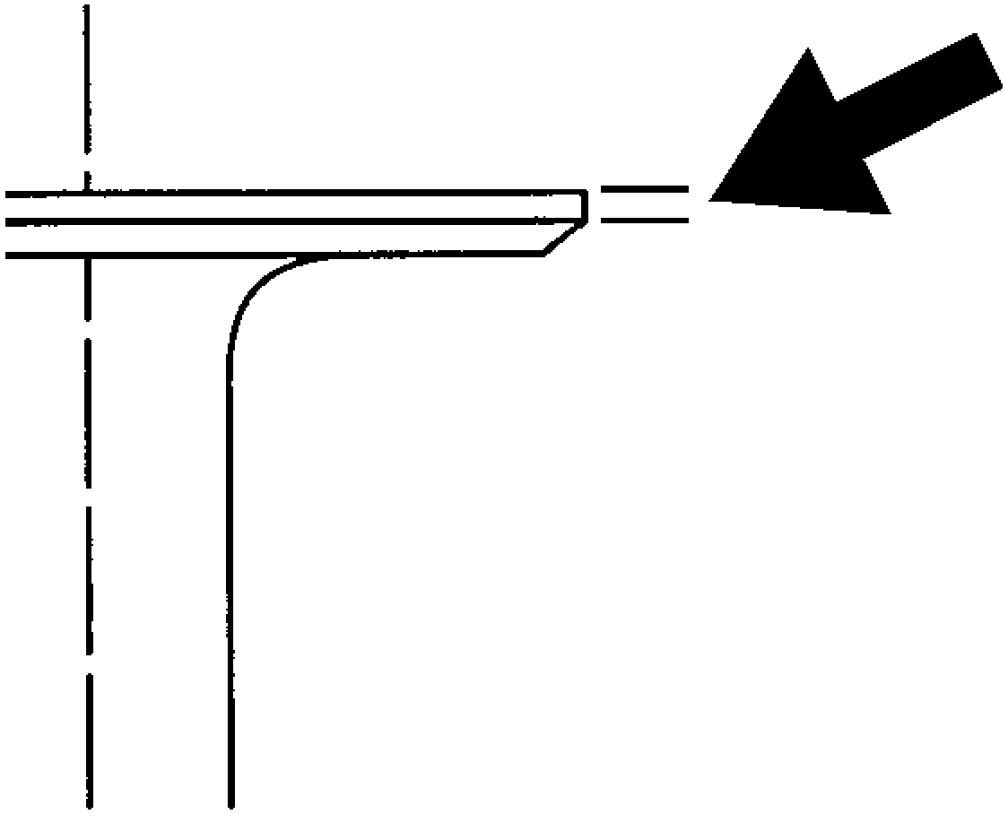


Fig. 66: View Of Valve Margin Measurement
Courtesy of GENERAL MOTORS CORP.

1. Measure the valve margin using an appropriate scale.
2. Reference the specifications in this section for minimum valve margin and compare them to your measurements.

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3. If the valve margins are beyond specification, replace the valves.
4. If the valve margins are within specification and do not require refacing, test the valve for seat concentricity using the Valve-to-Seat Concentricity Measurement Procedure.

VALVE-TO-SEAT CONCENTRICITY MEASUREMENT PROCEDURE

NOTE:

- **Checking the valve-to-seat concentricity determines whether the valve and seat are sealing properly.**
- **You must measure the valve face and the valve seat to ensure proper valve sealing.**

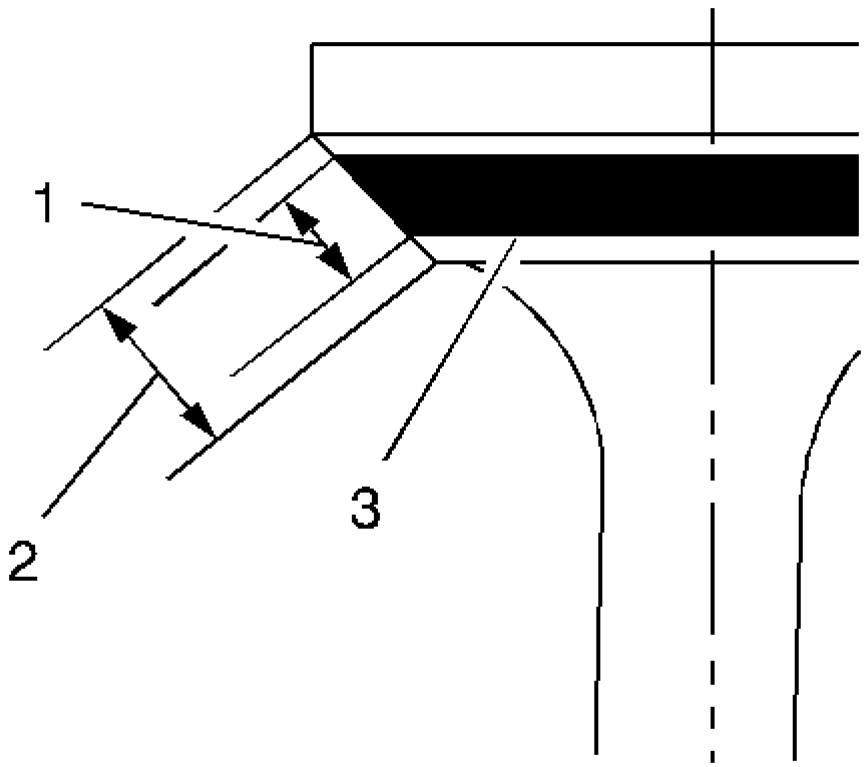


Fig. 67: Identifying Valve Contact Face Measurements
Courtesy of GENERAL MOTORS CORP.

1. Coat the valve face lightly with blue dye (3).
2. Install the valve in the cylinder head.

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3. Turn the valve against the seat with enough pressure to wear off the dye.
4. Remove the valve from the cylinder head.
5. Inspect the valve face.
    - If the valve face is concentric, providing a proper seal, with the valve stem, a continuous mark will be made around the entire face (1).

NOTE: **The wear mark MUST be at least 0.5 mm (0.020 in) from the outer diameter, the margin, of the valve. If the wear mark is too close to the margin, the seat must be reconditioned to move the contact area away from the margin.**

    - If the face is not concentric with the stem, the mark will NOT be continuous around the valve face. The valve should be refaced or replaced and the seat must be reconditioned using the Valve and Seat Reconditioning Procedure.

VALVE AND SEAT RECONDITIONING PROCEDURE

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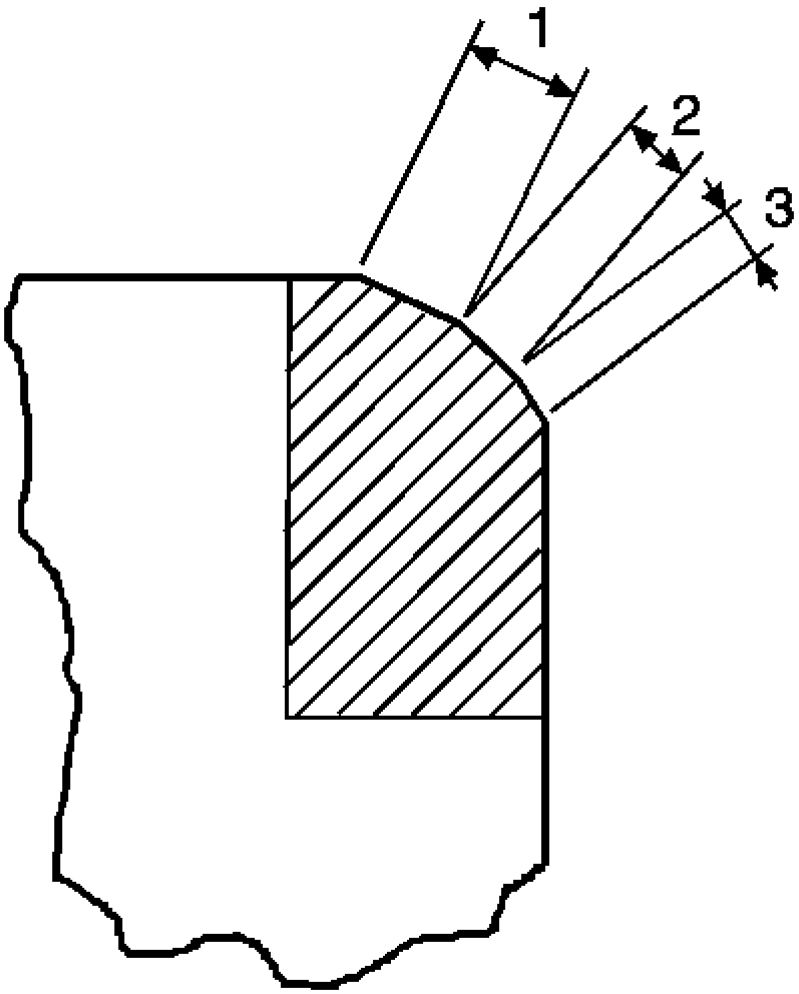


Fig. 68: Illustrating Valve Seat Proper Angles
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **If the valve seat width, roundness or concentricity is beyond specifications, you must grind the seats in order to ensure proper heat dissipation and prevent the build up of carbon on the seats.**
- **It is necessary to reface the valve if seat reconditioning is required unless a new valve is used.**

1. Grind the valve seats (2) to the proper angle specification listed in **Engine Mechanical Specifications (LLT)** .

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2. Using the proper angle specification listed in **Engine Mechanical Specifications (LLT)** , grind, relieve, the valve seats (1) to correctly position the valve seating surface (2) to the valve.
3. Using the proper angle specification listed in **Engine Mechanical Specifications (LLT)** , grind, undercut, the valve seats (3) to narrow the valve seat widths to the specifications listed in **Engine Mechanical Specifications (LLT)** .
4. If the original valve is being used, grind the valve to the specifications listed in **Engine Mechanical Specifications (LLT)** . Measure the valve margin again after grinding using the Valve Margin Measurement Procedure. Replace the valve if the margin is out of specification. New valves do not require grinding.
5. When grinding the valves and seats, grind off as little material as possible. Cutting valve seat results in lowering the valve spring pressure.
6. Install the valve in the cylinder head.
    - If you are using refaced valves, lap the valves into the seats with a fine grinding compound. The refacing and reseating operations should leave the refinished surfaces smooth and true so that minimal lapping is required. Excessive lapping will groove the valve face and prevent a good seat when hot.

      NOTE: Be sure to clean any remaining lapping compound from the valve and seat with solvent and compressed air prior to final assembly.

    - If you are using new valves, do not lap the valves under any condition.
7. After obtaining the proper valve seat width in the cylinder head, you must re-measure the valve stem height using the Valve Stem Height Measurement Procedure.
8. If the valve stem height is acceptable, test the seats for concentricity using the Valve-to-Seat Concentricity Measurement Procedure.

VALVE STEM HEIGHT MEASUREMENT PROCEDURE

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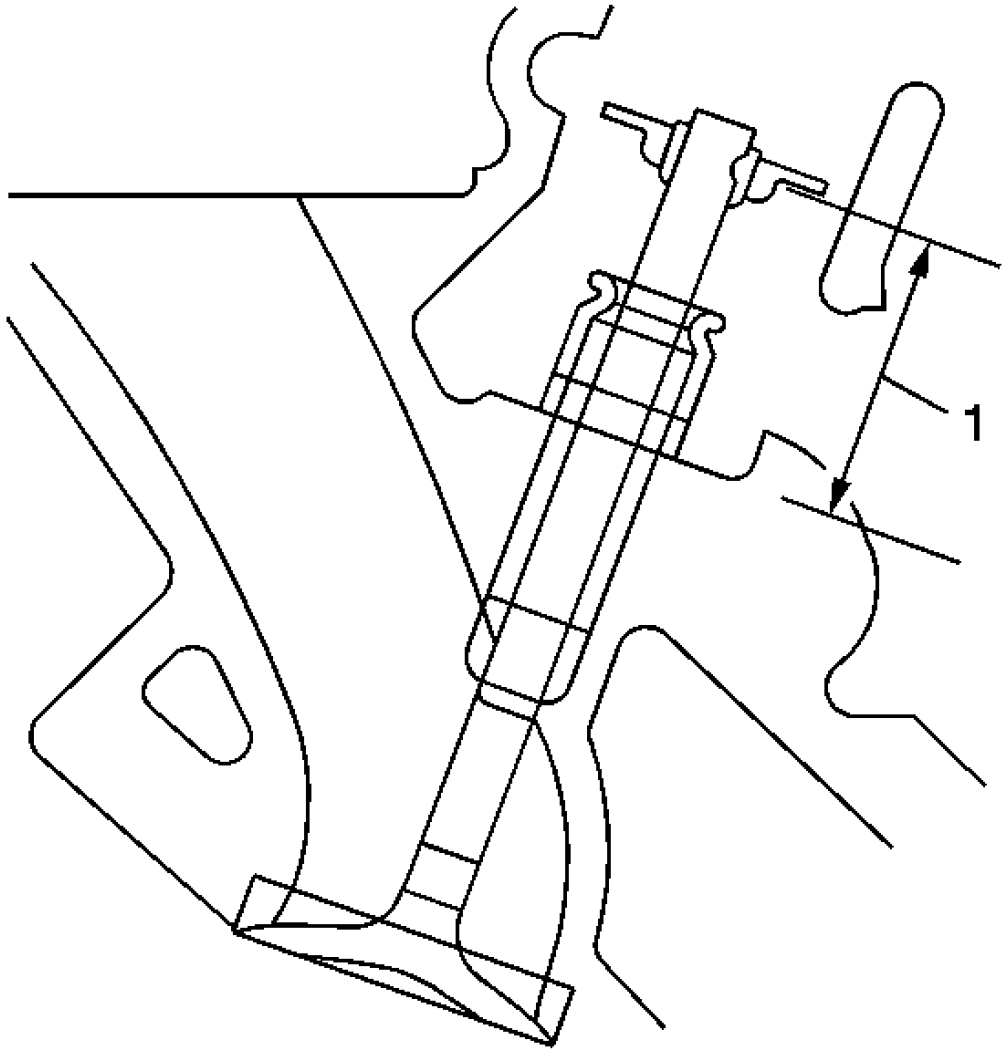


Fig. 69: Measuring Valve Stem Height
Courtesy of GENERAL MOTORS CORP.

NOTE: To determine the valve stem height measurement, measure from the valve spring seat to the valve spring retainer.

1. Install the valve into the valve guide.
2. Ensure the valve is seated to the cylinder head valve seat.
3. Install the valve stem oil seal.
4. Install the valve spring retainer and valve stem locks.

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5. Measure the distance (1) between the cylinder head to the bottom of the valve spring retainer. Refer to **Engine Mechanical Specifications (LLT)** .
6. If the maximum height specification is exceeded, a new valve should be installed and the valve stem height re-measured.

CAUTION: DO NOT grind the valve stem tip. The tip of the valve is hardened and grinding the tip will eliminate the hardened surface causing premature wear and possible engine damage.

CAUTION: DO NOT use shims in order to adjust valve stem height. The use of shims will cause the valve spring to bottom out before the camshaft lobe is at peak lift and engine damage could result.

7. If the valve stem height still exceeds the maximum height specification, the cylinder head must be replaced.

FUEL RAIL AND INJECTORS CLEANING AND INSPECTION (LLT)

Special Tools

- **EN-47909:** Injector Bore and Sleeve Cleaning Kit
- **EN-48266:** Injector Seal Installer and Sizer

For equivalent regional tools, refer to **Special Tools** .

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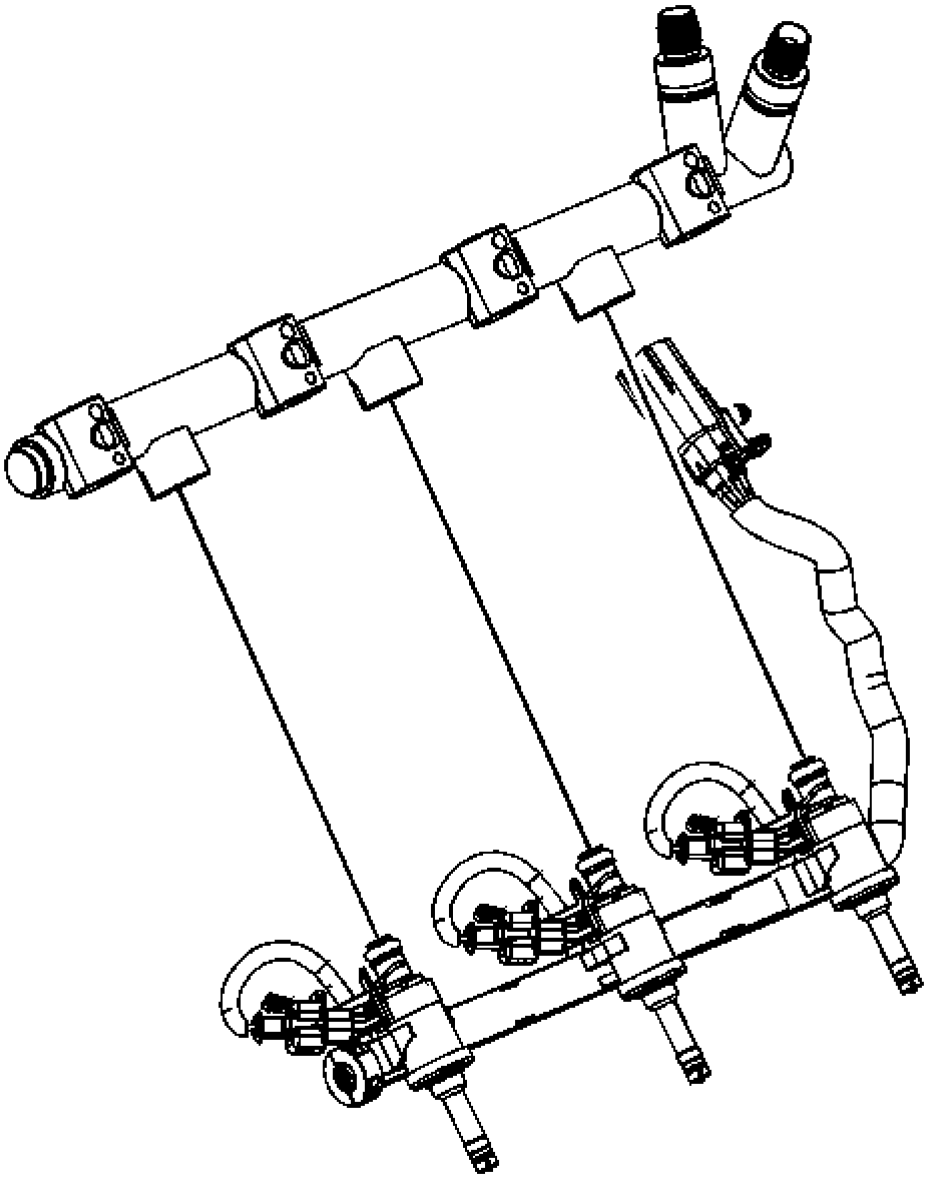


Fig. 70: View of Injector Assembly
Courtesy of GENERAL MOTORS CORP.

1. Remove the injectors from the fuel rail.

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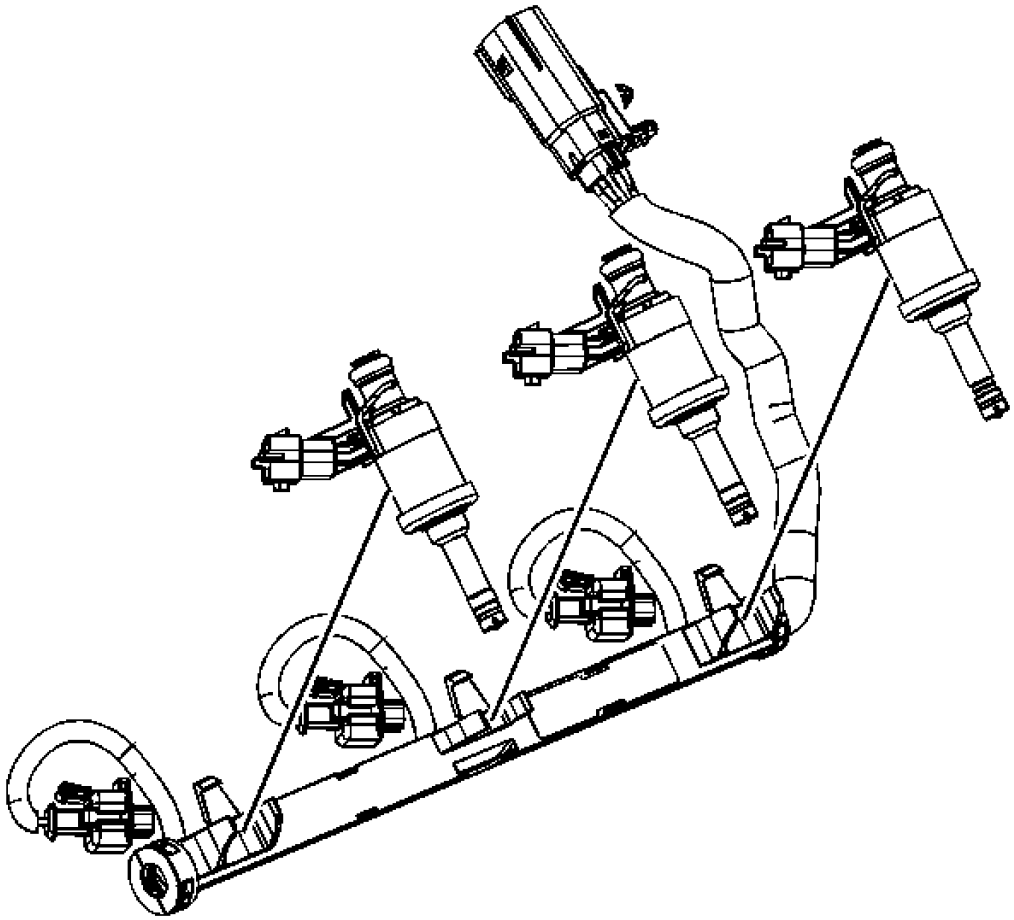


Fig. 71: View Of Wiring Harness & Injectors
Courtesy of GENERAL MOTORS CORP.

2. Remove the wiring harness from the fuel injectors.

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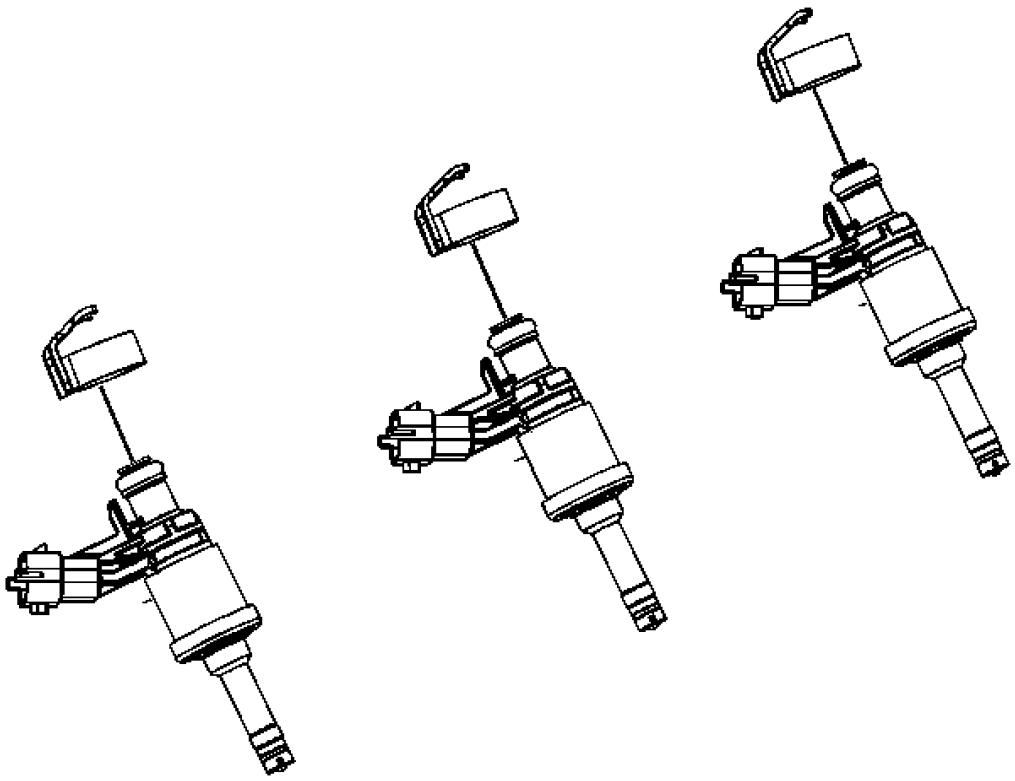


Fig. 72: View of Fuel Injector Clamp
Courtesy of GENERAL MOTORS CORP.

3. Remove and discard the fuel injector hold-down clamp.

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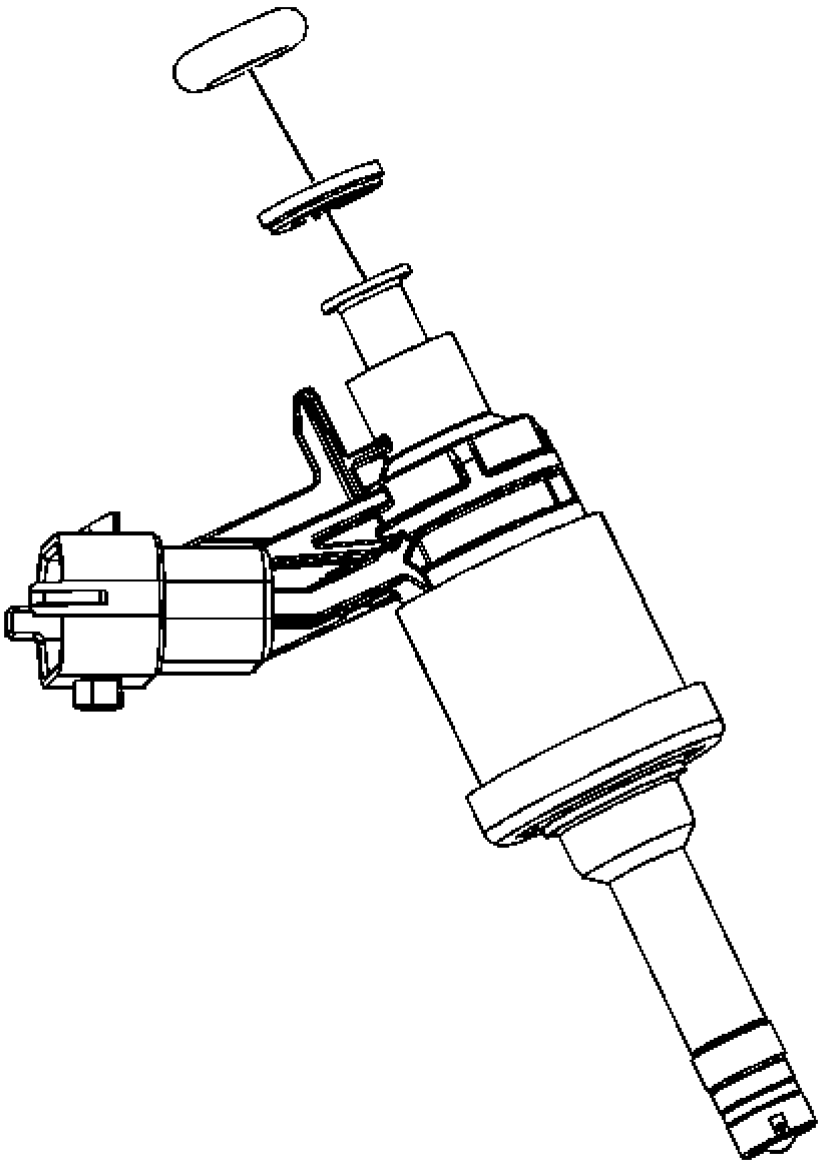


Fig. 73: View Of Fuel Injector O-ring & Plastic Spacer
Courtesy of GENERAL MOTORS CORP.

4. Remove and discard the fuel injector O-ring and plastic spacer.

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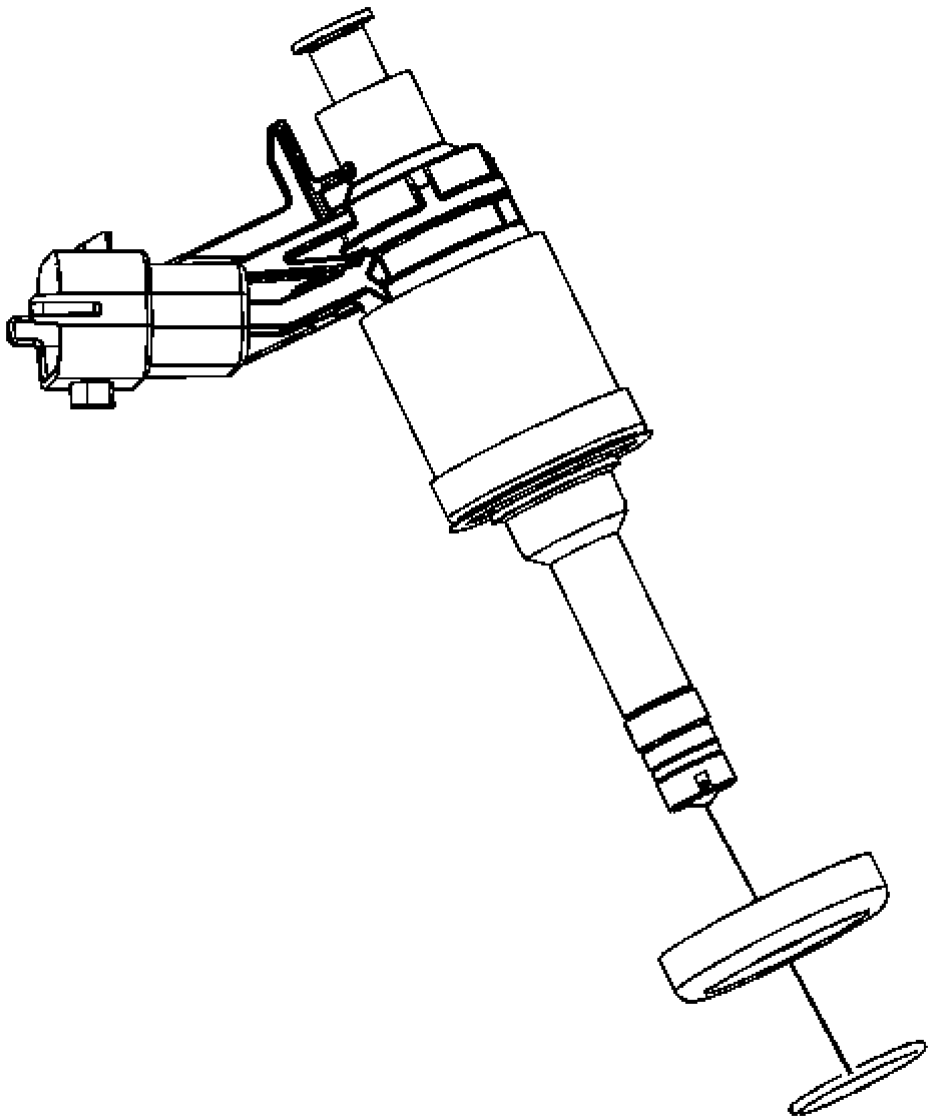


Fig. 74: View of Injector Assembly
Courtesy of GENERAL MOTORS CORP.

5. Remove and discard the isolator cup and retainer.

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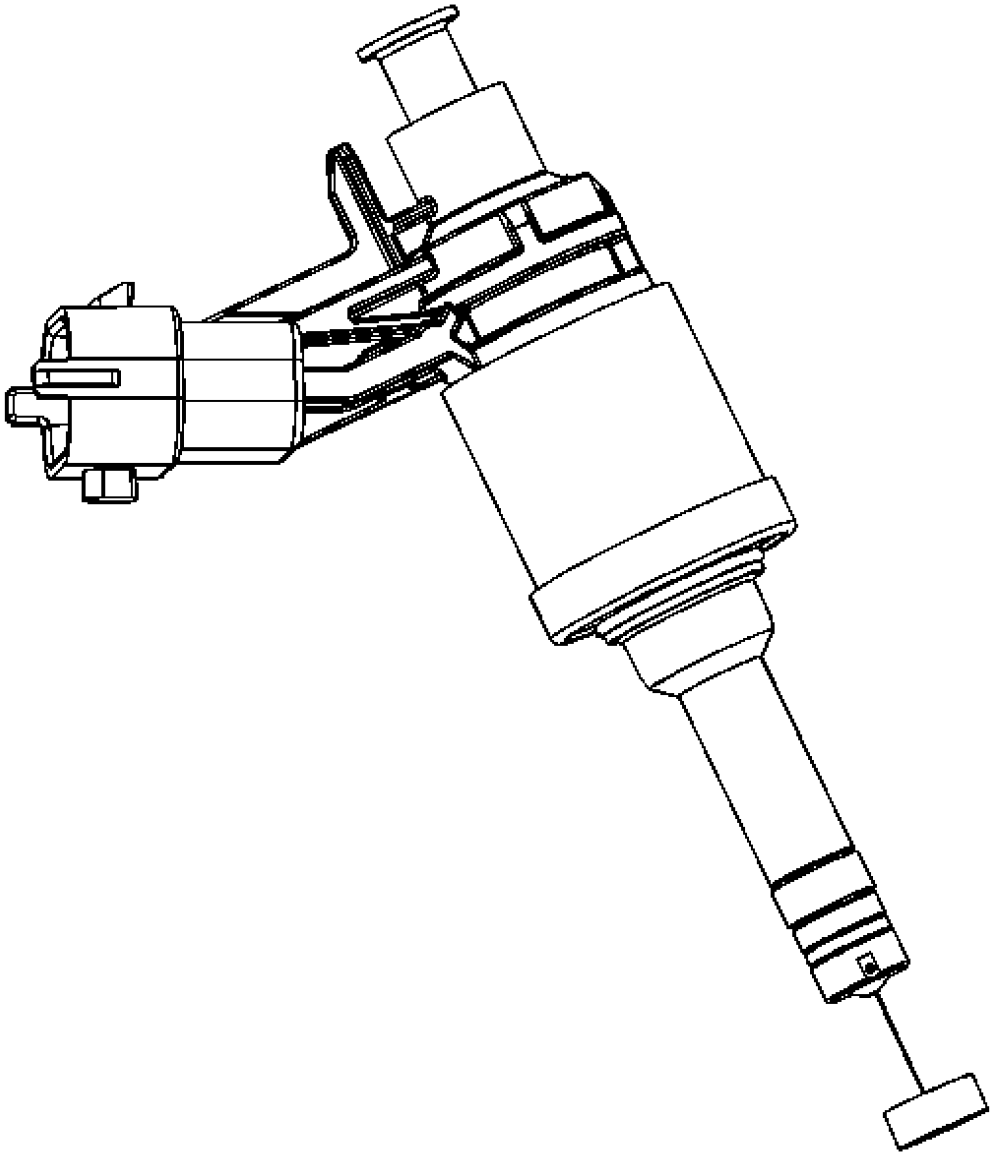


Fig. 75: View Of Fuel Injector Seal
Courtesy of GENERAL MOTORS CORP.

6. Remove and discard the fuel injector seal.

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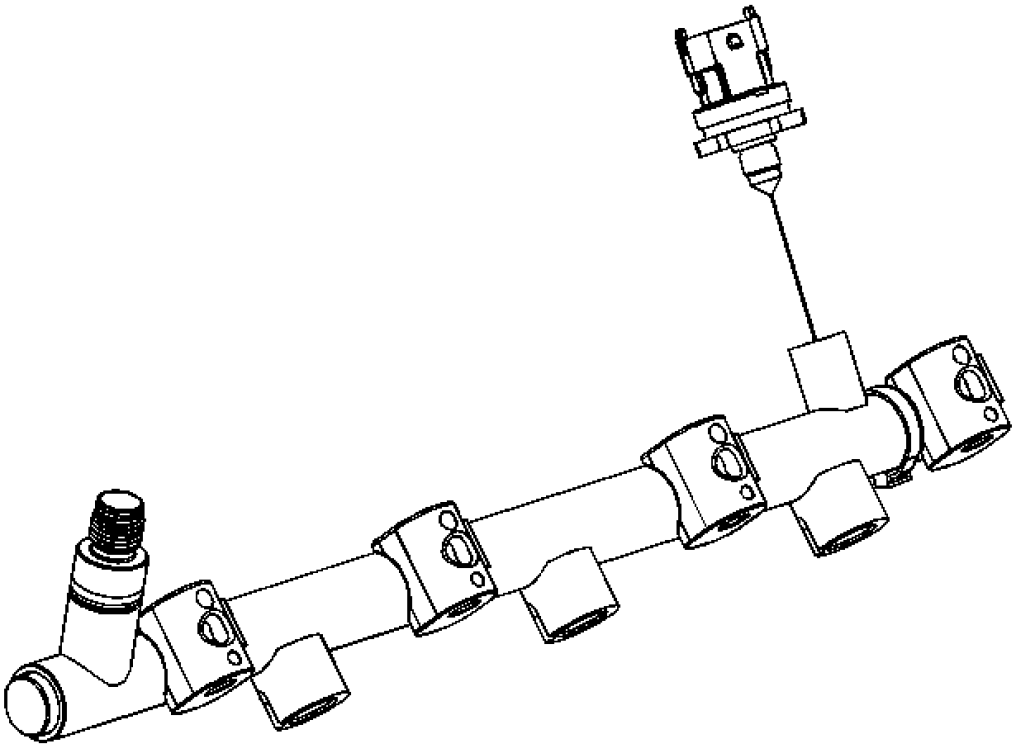


Fig. 76: View of Plastic Housing & Sensor
Courtesy of GENERAL MOTORS CORP.

NOTE: Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.

7. Remove and discard the fuel pressure sensor.

NOTE: Do not soak or submerge the fuel rail or injectors in solvent.

8. Clean the exterior of the fuel rail and injectors with solvent.

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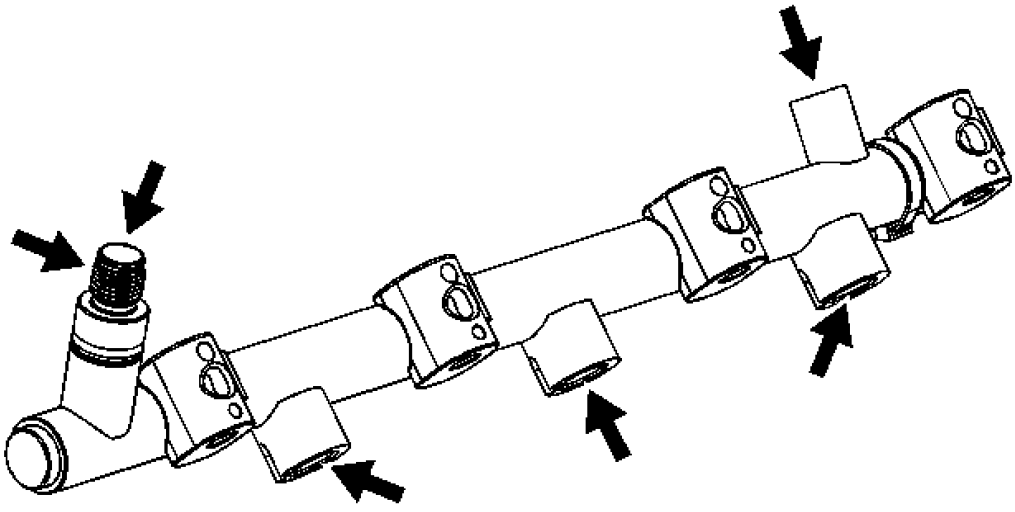


Fig. 77: View Of Fuel Rail & Components
Courtesy of GENERAL MOTORS CORP.

9. Inspect the fuel rail and components for the following conditions:
   - Damage, debris or restrictions to the fuel rail
   - Damage, debris or restrictions to the fuel ports in the fuel rail
   - Damage to the mounting area for the fuel rail
   - Damage to the fuel rail mounting bolts
   - Damage to the threads on the fuel rail feed fitting
   - Damage to the threads in the fuel pressure sensor bore

NOTE: Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.

10. Install the fuel pressure sensor.

NOTE: Ensure that the fuel rail threads have been cleaned of any excess fuel, or the NEW fuel injection fuel rail fuel pressure sensor will NOT seal properly.

- Lubricate the threads and the sealing cone in the fuel rail with silicon free engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.
- Lubricate the threads and the sealing cone on the NEW fuel injection fuel rail fuel pressure sensor with silicon free engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for

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recommended lubricant.

- Install the NEW fuel injection fuel rail fuel pressure sensor hand tight.
- Remove the NEW fuel injection fuel rail fuel pressure sensor, re-lubricate following steps 1 and 2 above.

CAUTION: Refer to Fastener Caution .

- Install the NEW fuel injection fuel rail fuel pressure sensor and tighten to 33 N.m (25 lb ft) .

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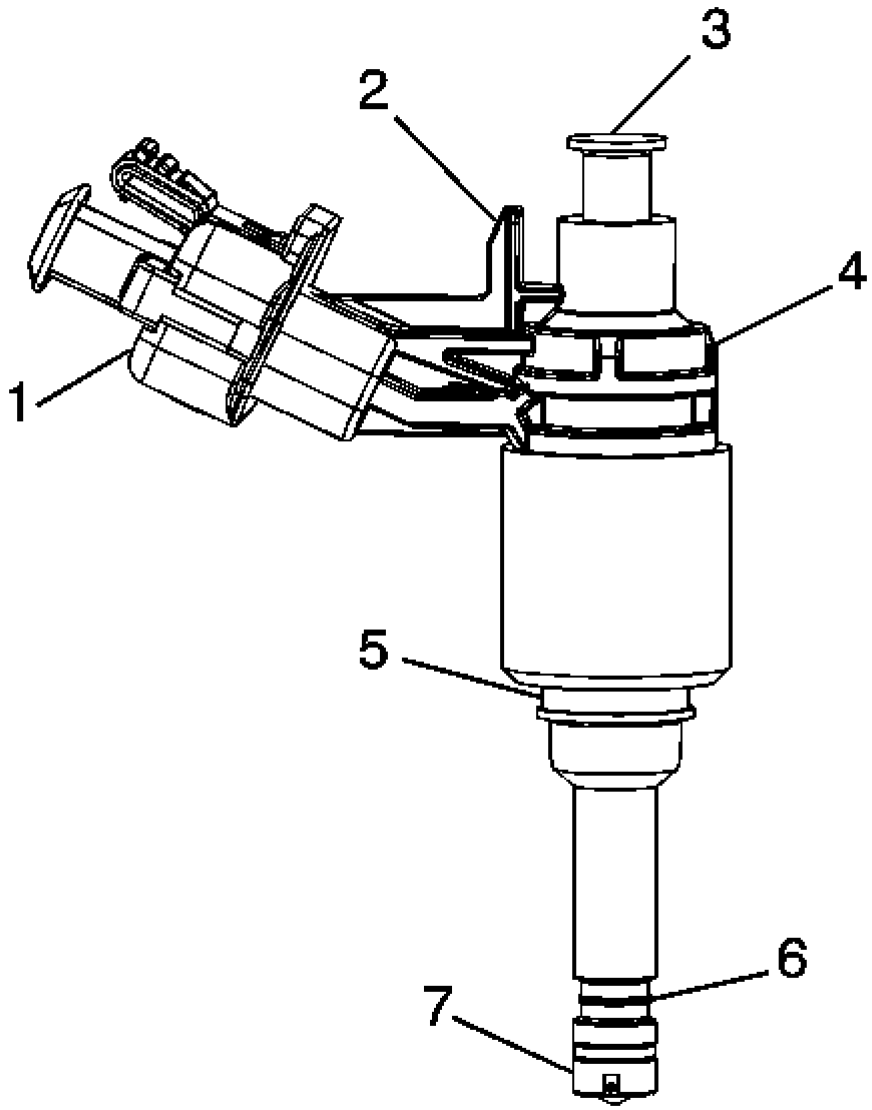


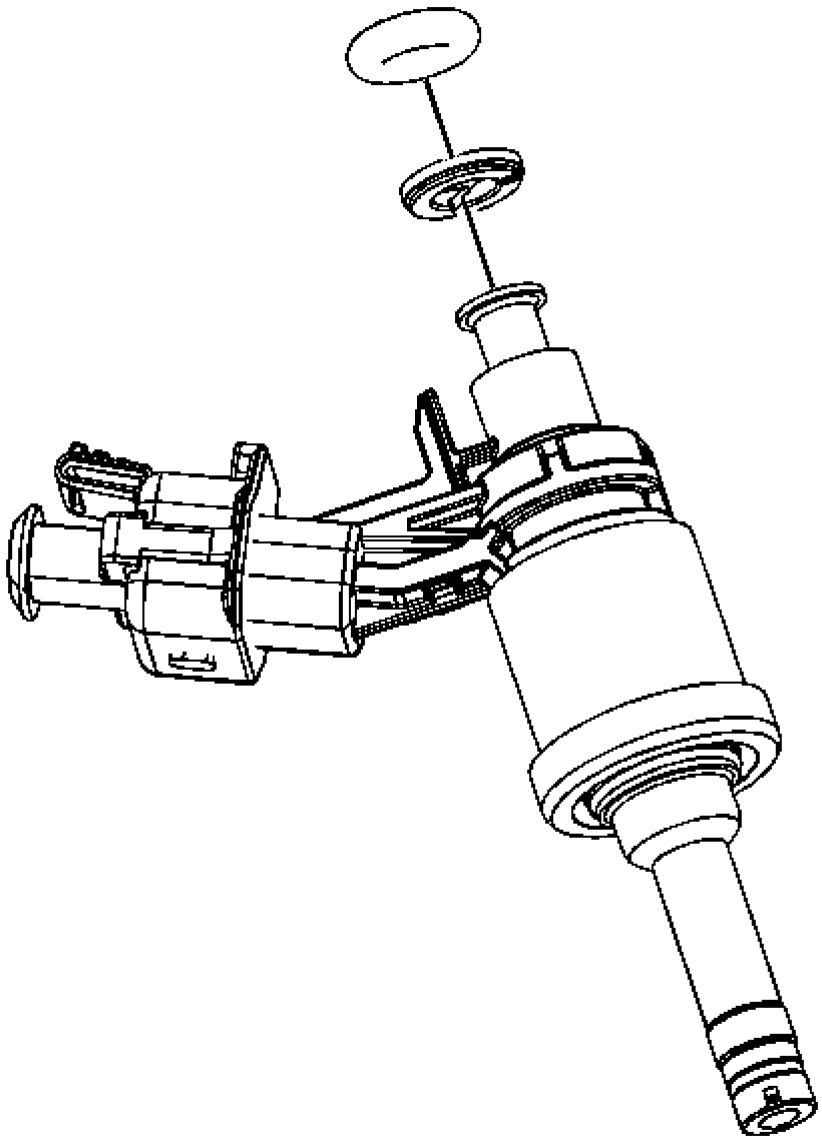
Fig. 78: Identifying Fuel Injector Inspection Areas
Courtesy of GENERAL MOTORS CORP.

11. Inspect the fuel injectors for the following conditions:
    - Damage to the fuel injector connector (1)
    - Damage to the injector locator tab (2)
    - Damage to the fuel inlet cone (3)

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- Damage the plastic fuel injector body (4)
- Damage to the isolator cup retainer groove (5)
- Damage to the teflon seal (6)
- Damage to the fuel injector tip (7)

12. Replace the fuel rail or injector if any damage is found. Do not attempt to repair a fuel rail or injector.



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Fig. 79: View Of Fuel Injector Plastic Spacer & O-Ring
Courtesy of GENERAL MOTORS CORP.

13. Lubricate the NEW O-ring with 5W30 engine oil.

NOTE: The plastic spacer has a top and a bottom. The top, O-ring sealing area, is wider.

14. Install the NEW plastic spacer and O-ring on the injector.

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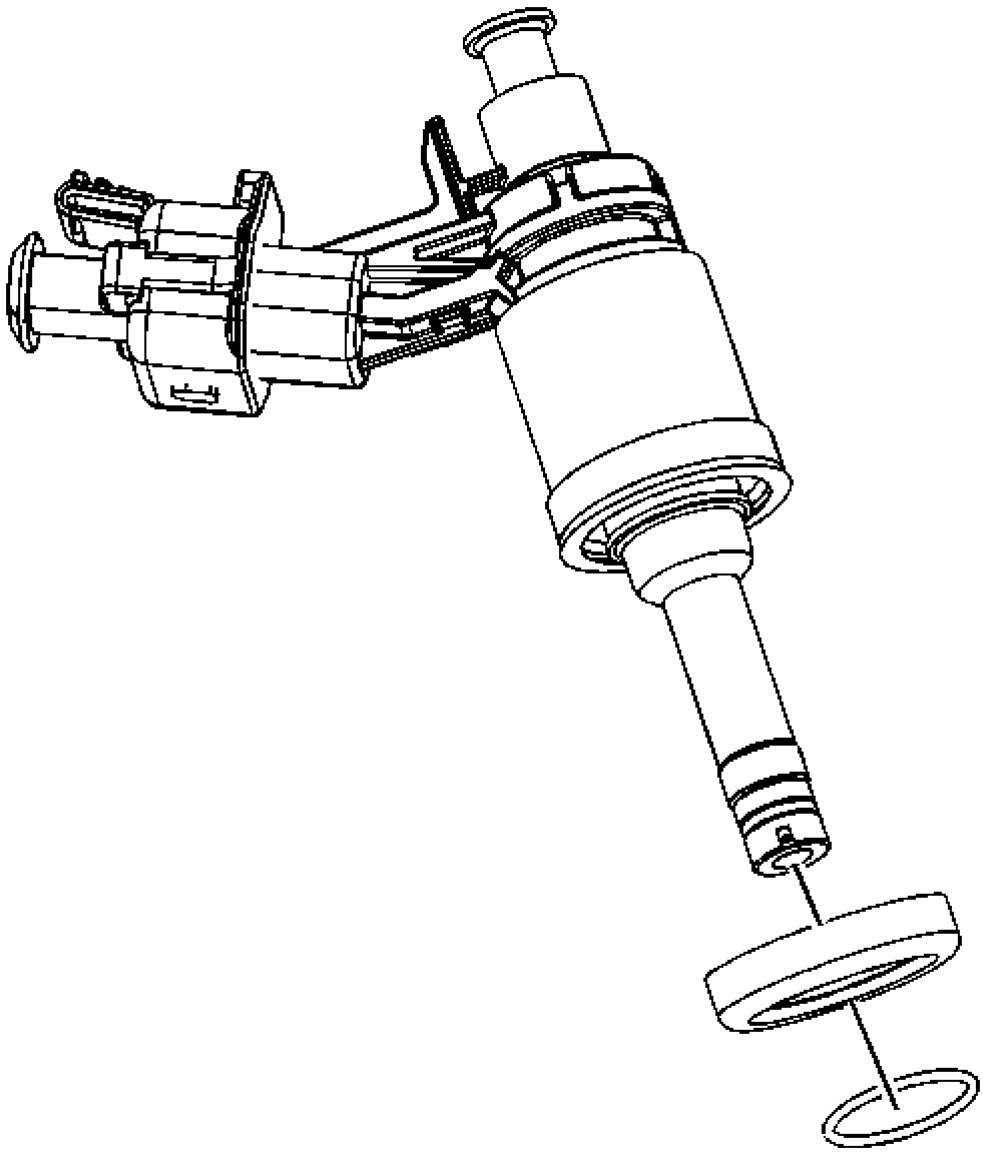


Fig. 80: View Of Isolator Cup & Retainer
Courtesy of GENERAL MOTORS CORP.

15. Install the isolator cup and retainer.

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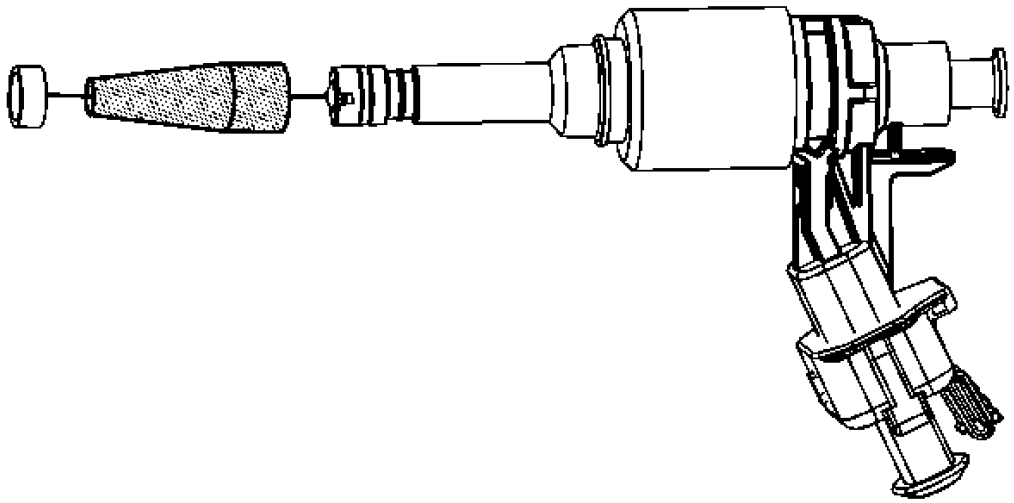


Fig. 81: View of Seal & Injector
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not use any type of lubricant when installing the NEW seal.

16. Install a NEW seal on the injector using the EN-48266-1. The seal must be installed/slid into the recessed area of the fuel injector.

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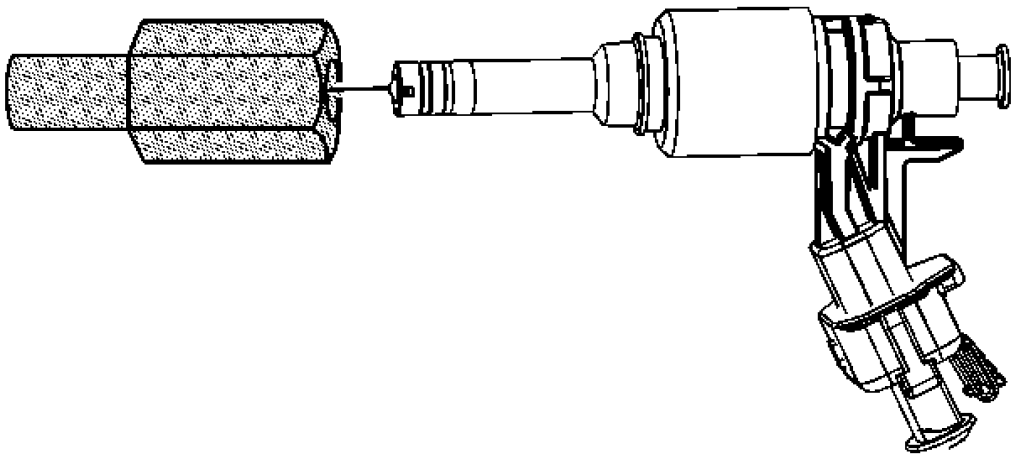


Fig. 82: View of special Tool EN-4866-2 & Injector
Courtesy of GENERAL MOTORS CORP.

17. Compress the seal with your fingers before resizing the seal using the EN-48266-2.

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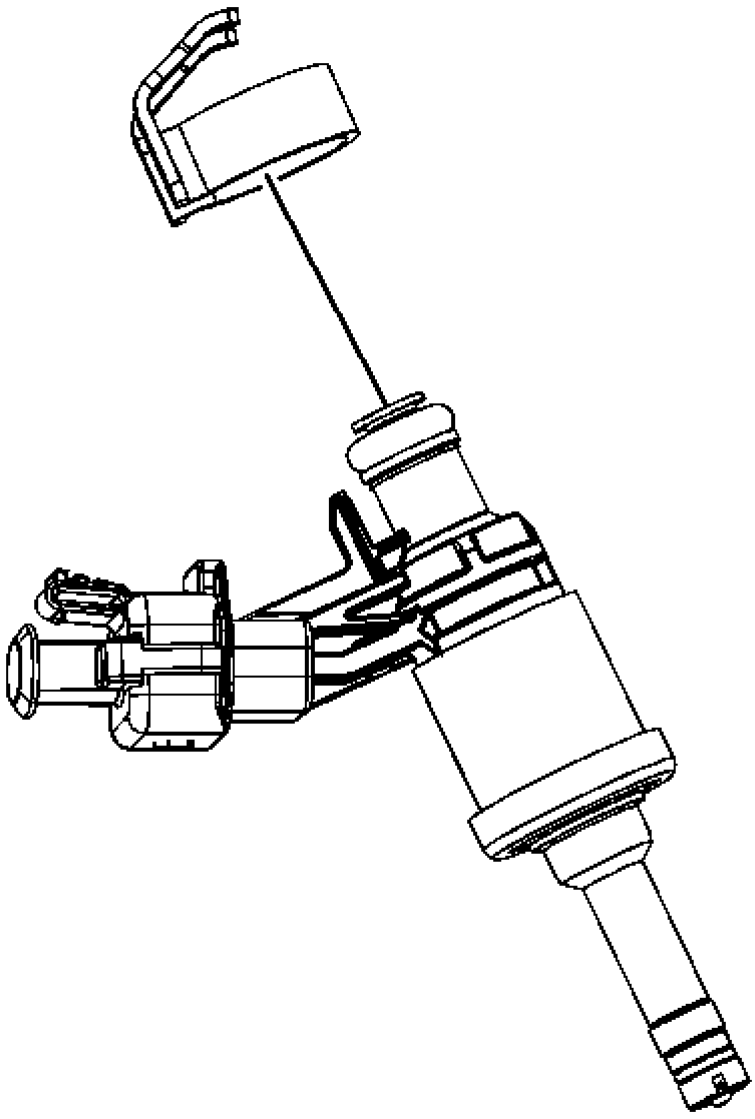


Fig. 83: View Of Fuel Injector Hold-Down Clamp
Courtesy of GENERAL MOTORS CORP.

18. Install a NEW fuel injector hold-down clamp.

CYLINDER HEAD ASSEMBLE (LLT OR LCS)

Special Tools

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- **EN 46116:** Valve Stem Seal Remover/Installer
- **EN 46117:** Valve Stem Key Remover/Installer
- **EN 46119:** Off-Vehicle Valve Spring Compressor Adapter
- **EN 46122:** Camshaft Position Actuator Check-Ball Valve Remover/Installer
- **J 8062:** Valve Spring Compressor - Head Off

For equivalent regional tools, refer to **Special Tools** .

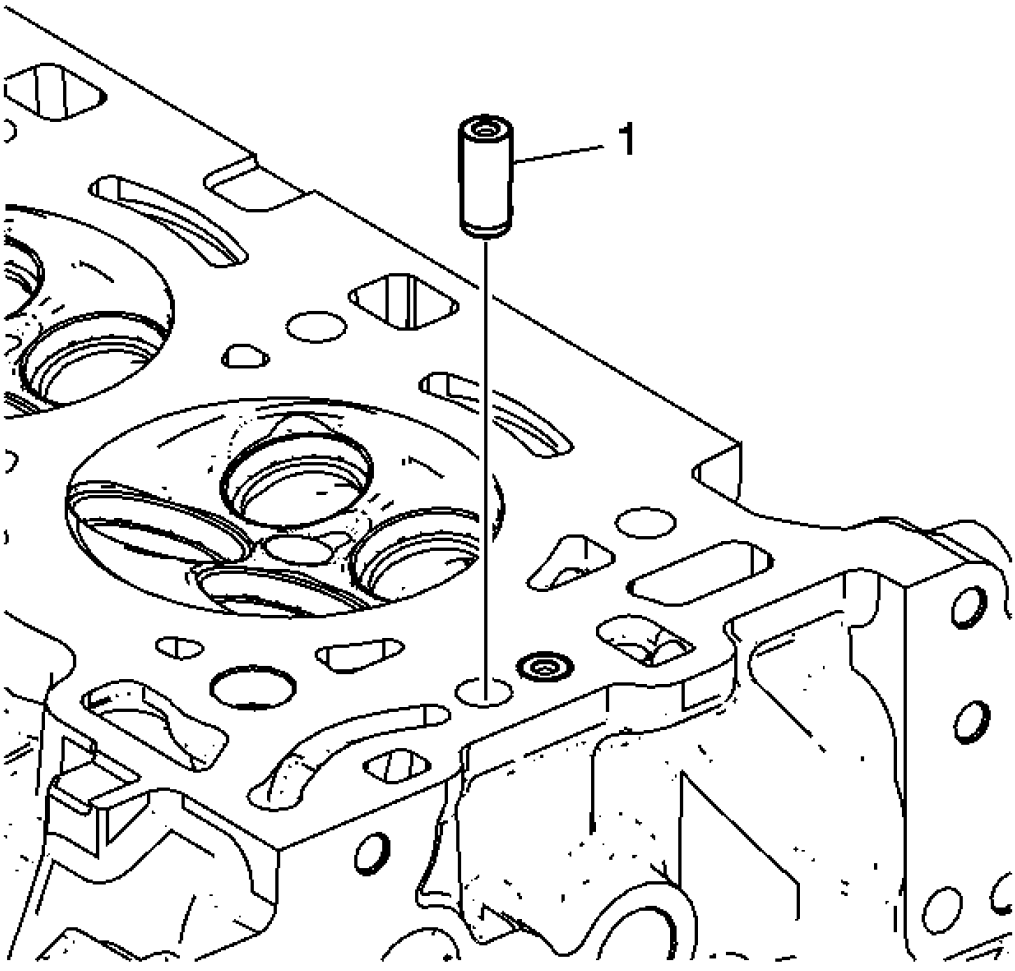


Fig. 84: Identifying Check Valve
Courtesy of GENERAL MOTORS CORP.

1. Use lubricant included with **EN 46122:** remover/installer to lubricate outside of new check valve (1).

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2. With the check ball end of the check valve facing UP, away from the head, insert the NEW check valve into the check valve bore in the cylinder head.

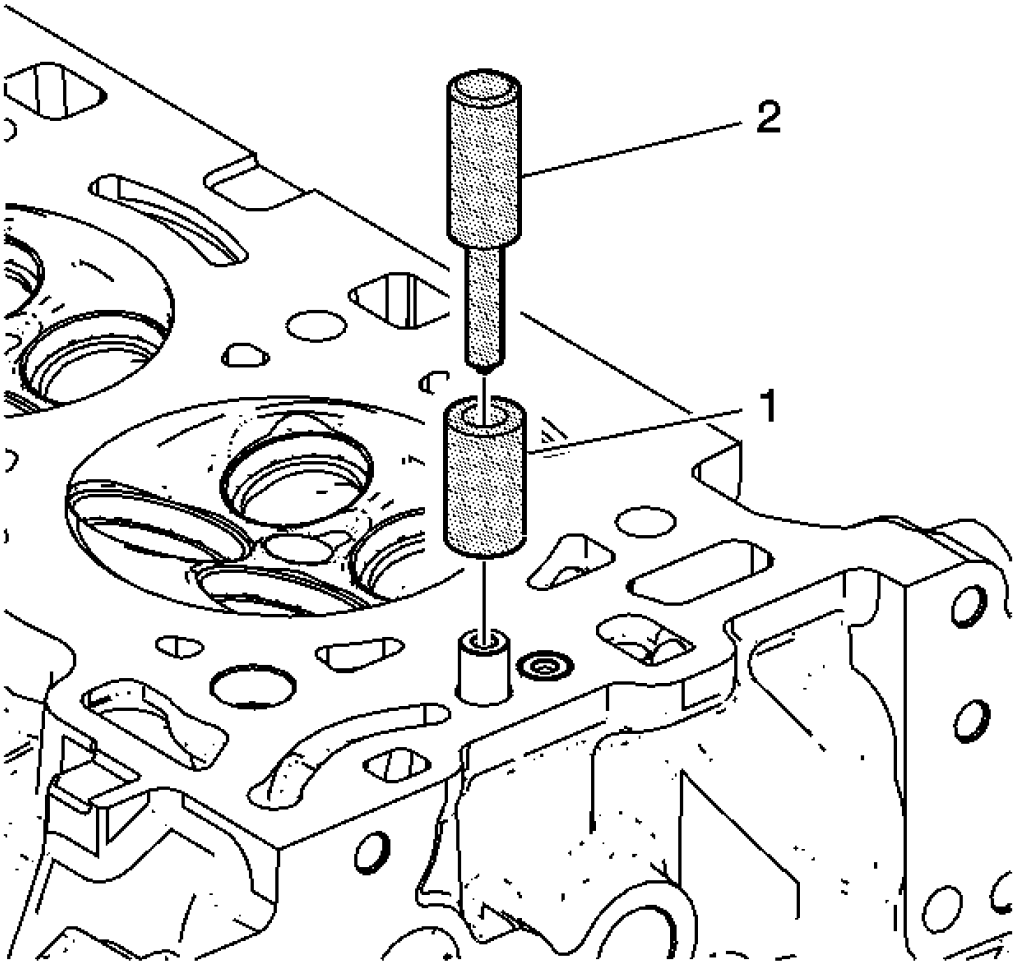


Fig. 85: Tapping Check Valve Into Place
Courtesy of GENERAL MOTORS CORP.

3. Place collar EN 46122-2 (1) over the new check valve with the slightly-larger inside diameter of the collar DOWN toward the cylinder head.
4. Using the driver EN 46122-1 (2), lightly tap the new check valve into place until the driver stops against the top of the collar.

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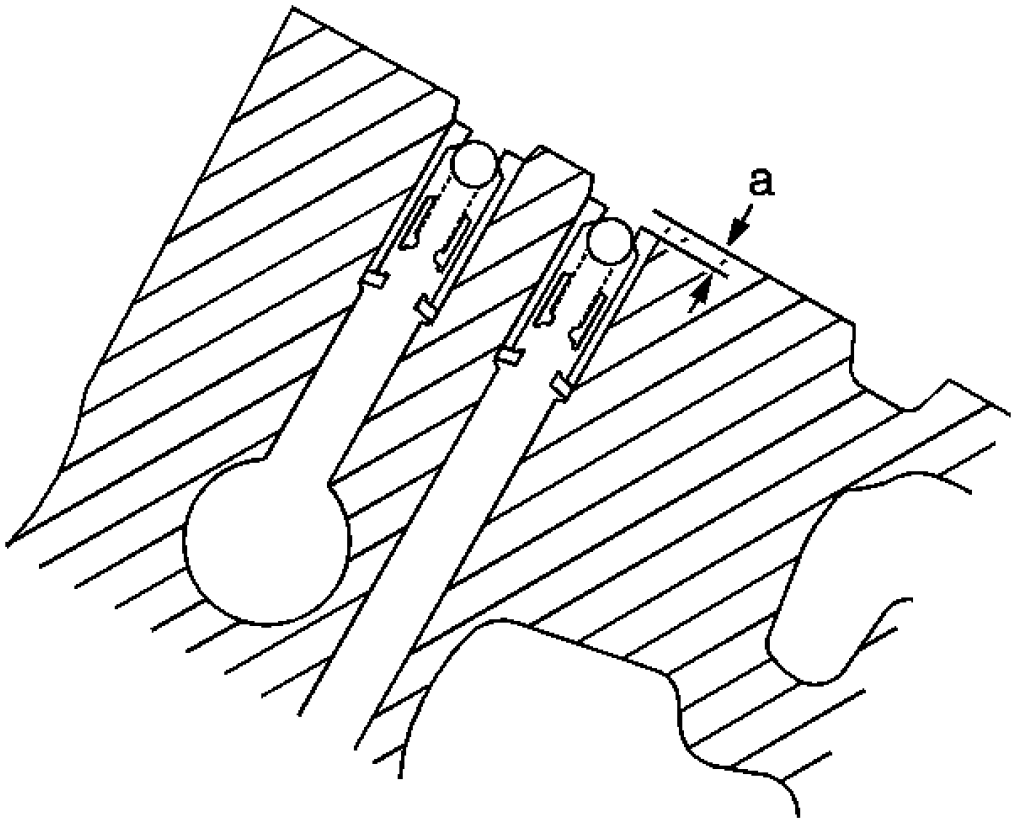


Fig. 86: Inspecting Camshaft Position Actuator Oil Feed Check Valve
Courtesy of GENERAL MOTORS CORP.

5. Inspect the camshaft position actuator oil feed check valves in order to ensure they are properly installed in the cylinder head. The camshaft position actuator oil feed check valve should be flush to 2 mm (0.0787 in) below the cylinder head deck surface (a).

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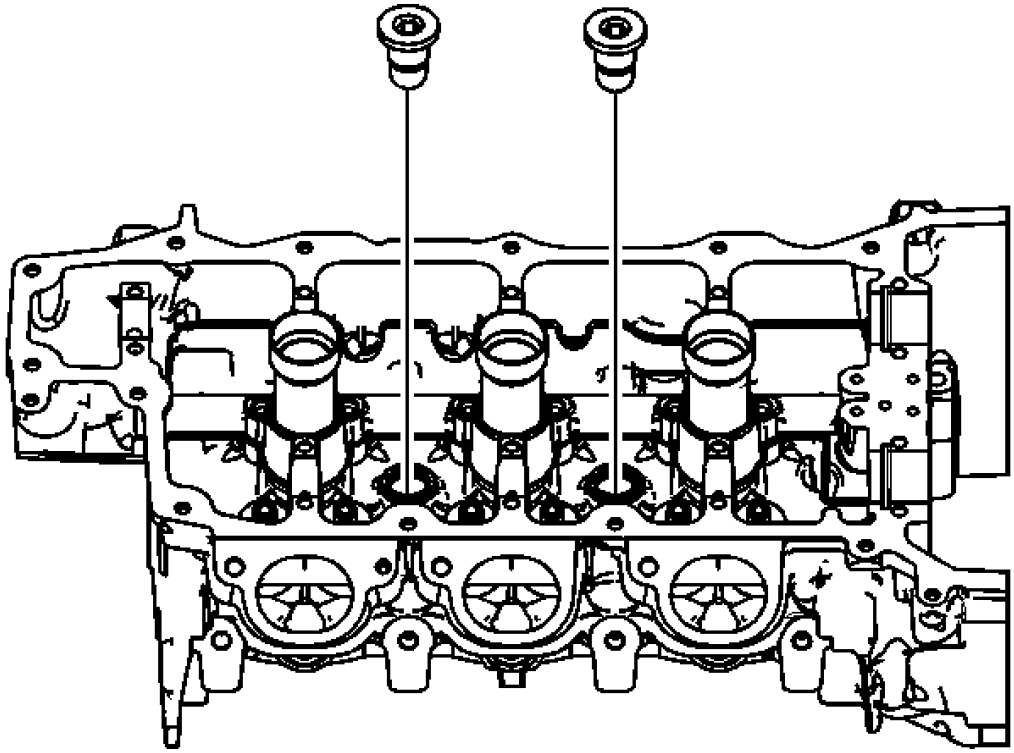


Fig. 87: View Of Cylinder Head Coolant Threaded Plugs
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

6. Install the cylinder head coolant threaded plugs and tighten to 31 N.m (23 lb ft).

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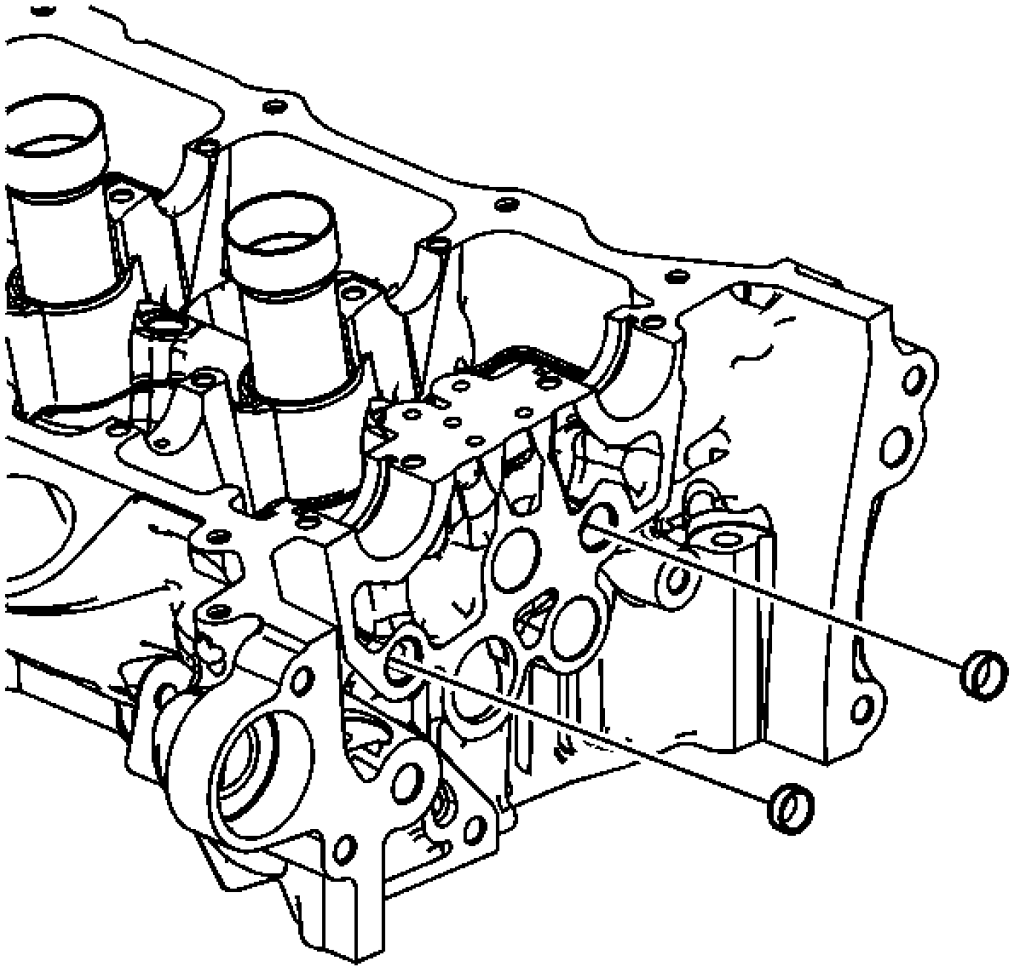


Fig. 88: View Of Cylinder Head Oil Gallery Expansion Plugs
Courtesy of GENERAL MOTORS CORP.

7. Install the NEW cylinder head oil gallery expansion plugs.

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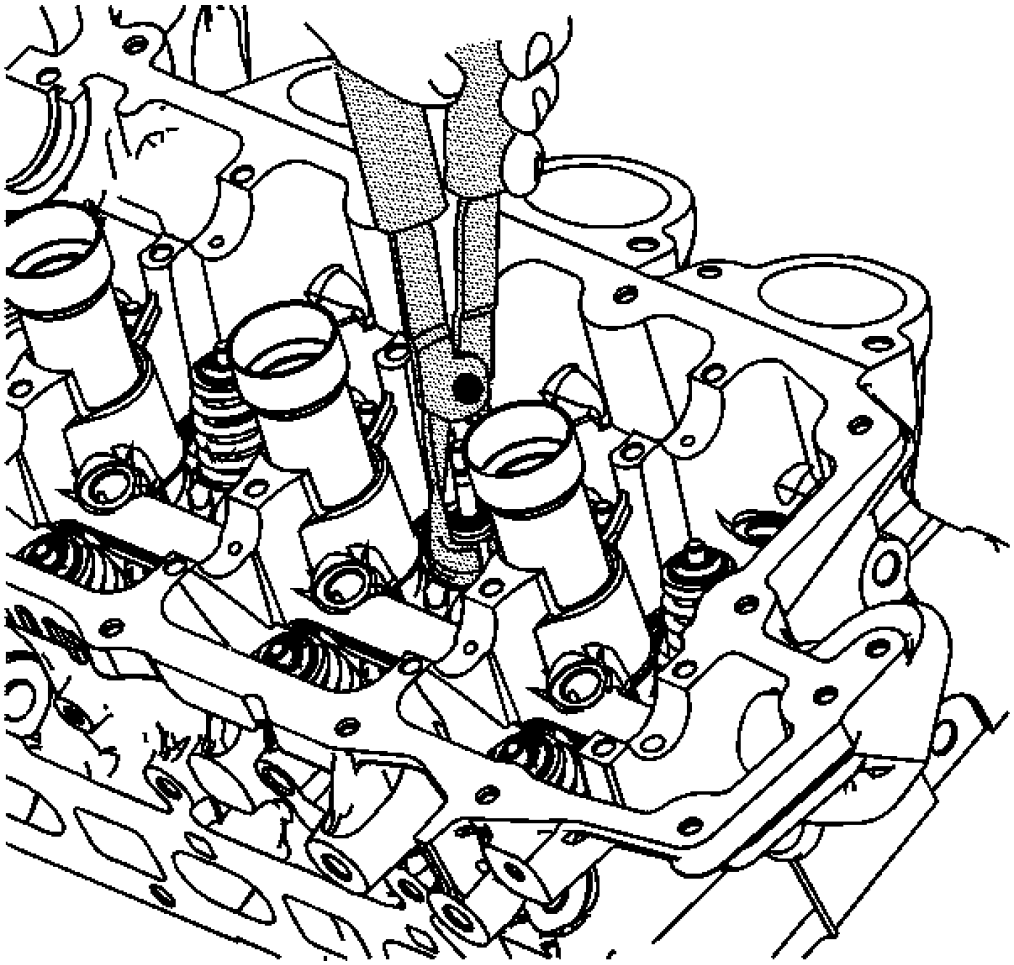


Fig. 89: Removing/Installing Valve Stem Oil Seals
Courtesy of GENERAL MOTORS CORP.

8. Place the valve stem oil seals onto the guides.

NOTE: NEVER reuse a valve stem oil seal. Always use new seals when assembling the cylinder head.

9. Mount a new valve stem oil seal using the **EN 46116:** remover/installer.

NOTE: Force should only be applied to the valve spring contact area of the new valve stem oil seal during installation.

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10. Push and twist the valve stem oil seal into position on the valve guide until the seal positively locks on the guide using the **EN 46116:** remover/installer.
11. Lubricate the valve stem and valve guide ID with clean engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

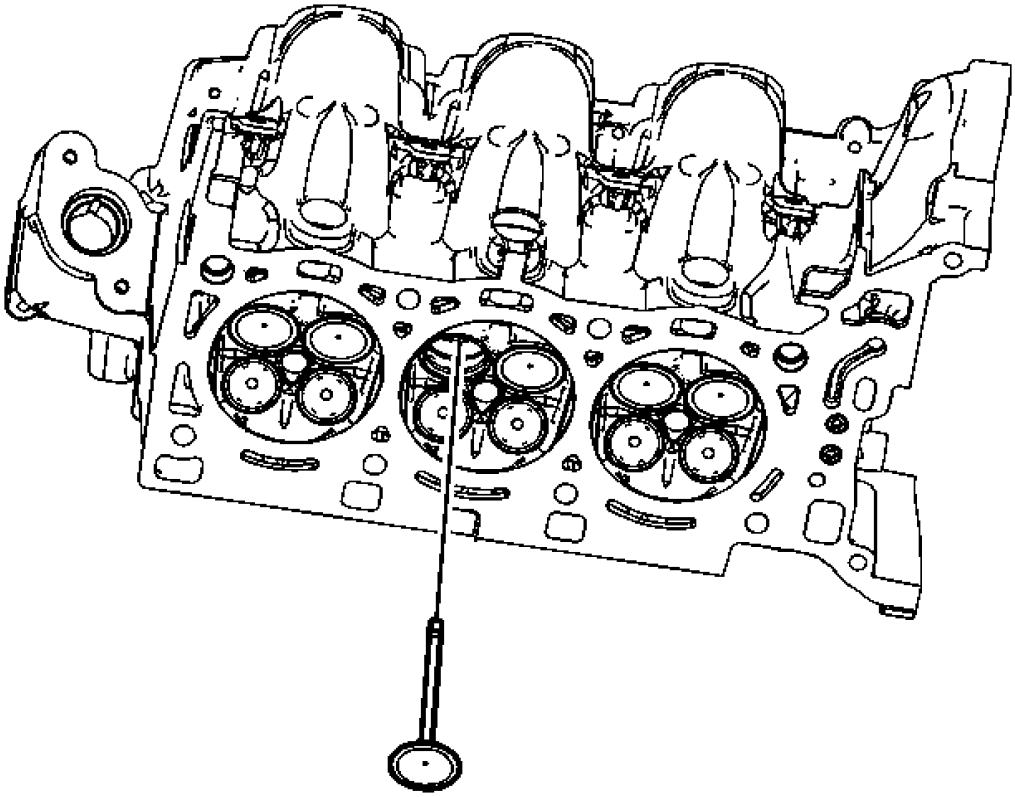


Fig. 90: Removing/Installing valve
Courtesy of GENERAL MOTORS CORP.

NOTE: The valve stem oil seal must not come loose from the valve guide when the valve is installed.

12. Insert the valve into the valve guide until it bottoms on the valve seat.

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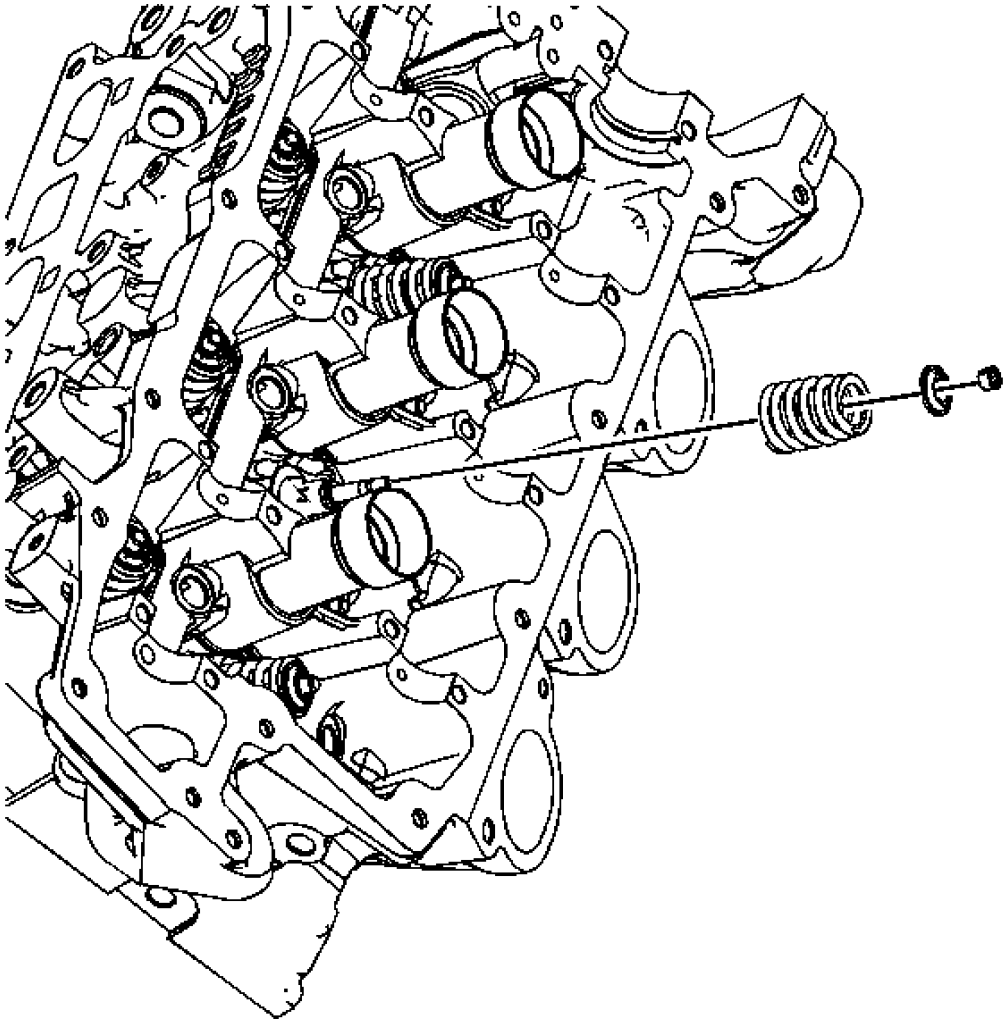


Fig. 91: View Of Valve Spring & Retainer
Courtesy of GENERAL MOTORS CORP.

13. Position the valve spring on the spring seat.
14. Place the valve spring retainer onto the valve spring.

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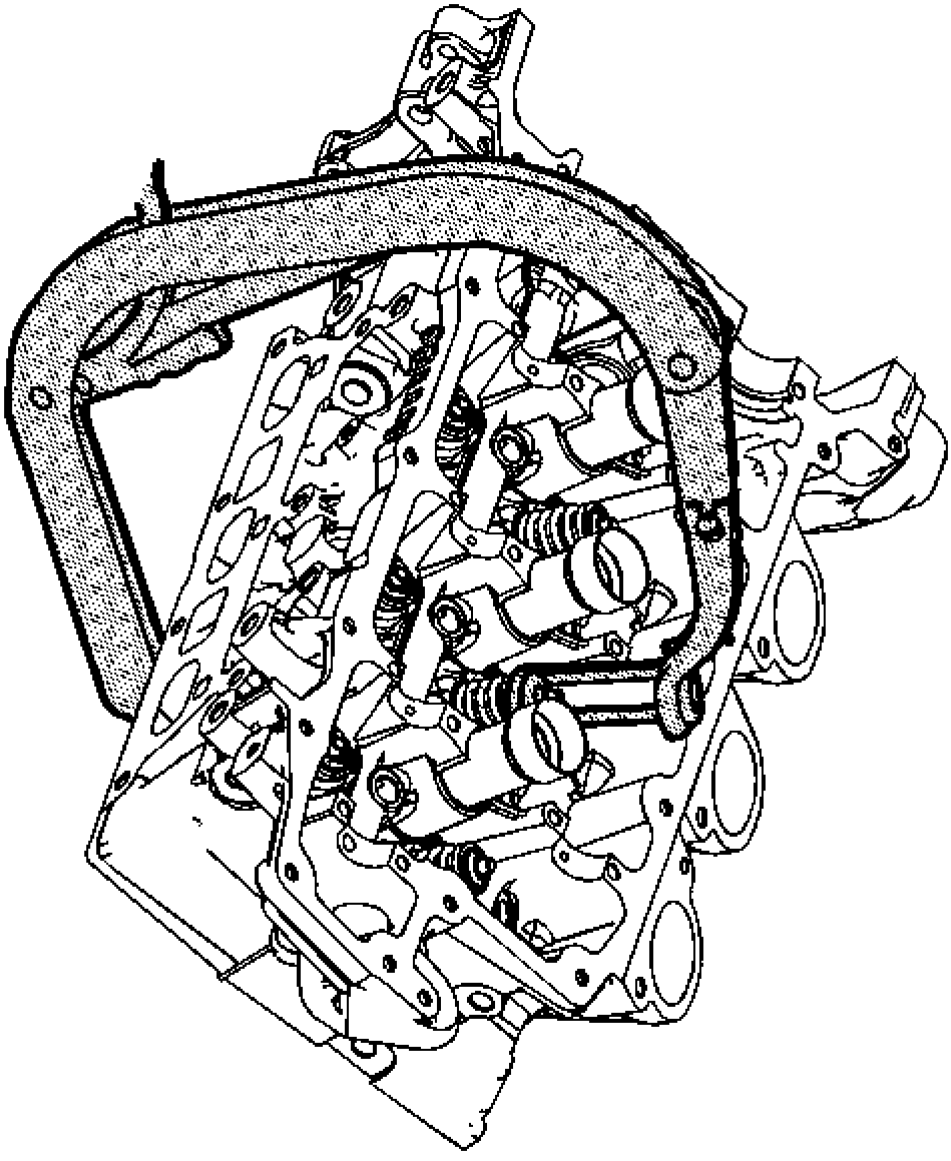


Fig. 92: Compressing Valve Spring
Courtesy of GENERAL MOTORS CORP.

WARNING: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when

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compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

CAUTION: Do not compress the valve springs to less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

15. Compress the valve spring using the **J 8062:** compressor and the **EN 46119:** adapter.

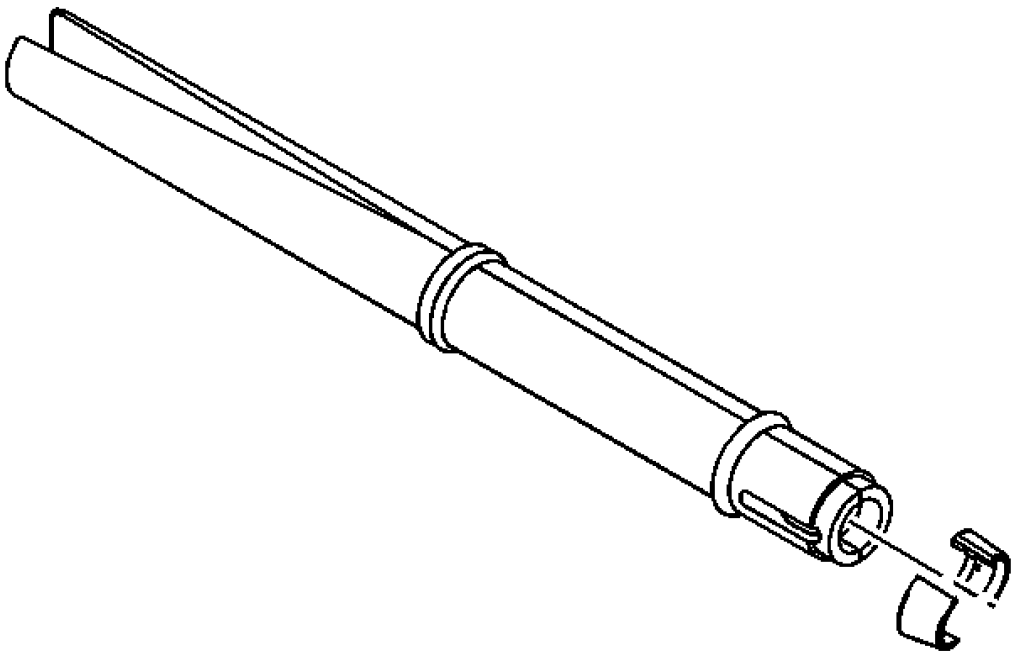


Fig. 93: Installing Valve Keepers In Special Tool
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure proper directional placement of valve keepers in the EN 46117: remover/installer. The valve keepers must be installed with the tapered end towards the valve stem seal.

16. With the spring compressed, install the valve keepers into the **EN 46117:** remover/installer.

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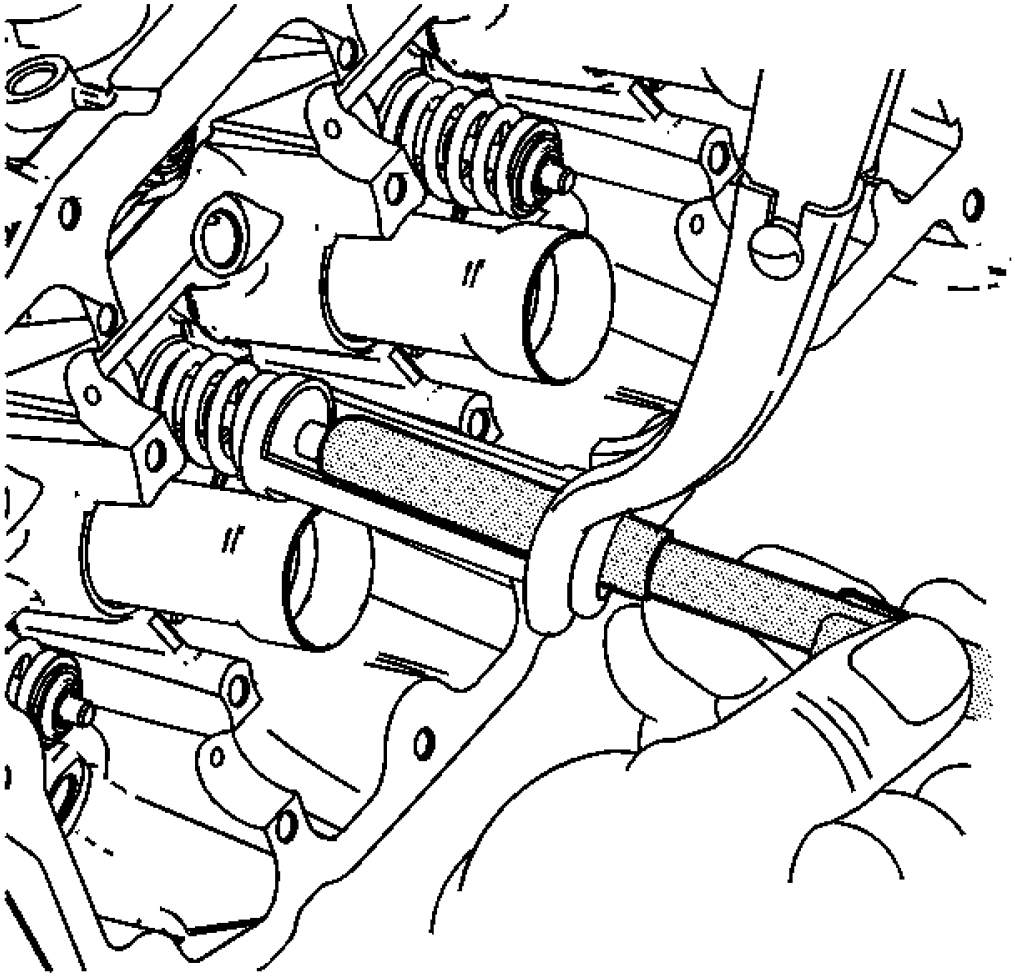


Fig. 94: Removing/Installing Valve Keepers
Courtesy of GENERAL MOTORS CORP.

17. Place the keepers into position by pushing the tool downward. While holding the tool lightly together in the area between the O-rings, using the thumb and forefinger, release tension on the **EN-46119:** adapter and the **J 8062:** compressor. This will slowly push the **EN-46117:** remover/installer off the valve stem, leaving the keepers in place.
18. Verify that the valve keepers are installed by placing a rag over the valve tip and tapping with a dead-blow hammer.

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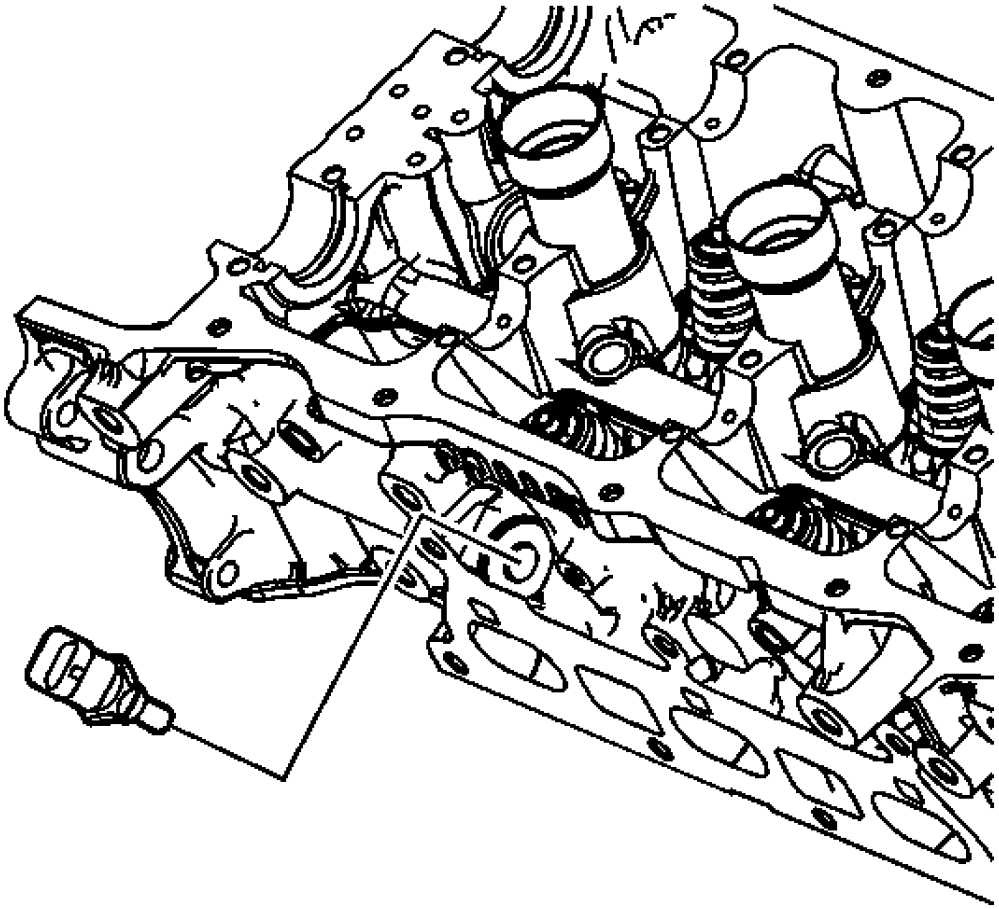


Fig. 95: Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS CORP.

19. Install the engine coolant temperature (ECT) sensor and tighten the ECT sensor to 30 N.m (22 lb ft).

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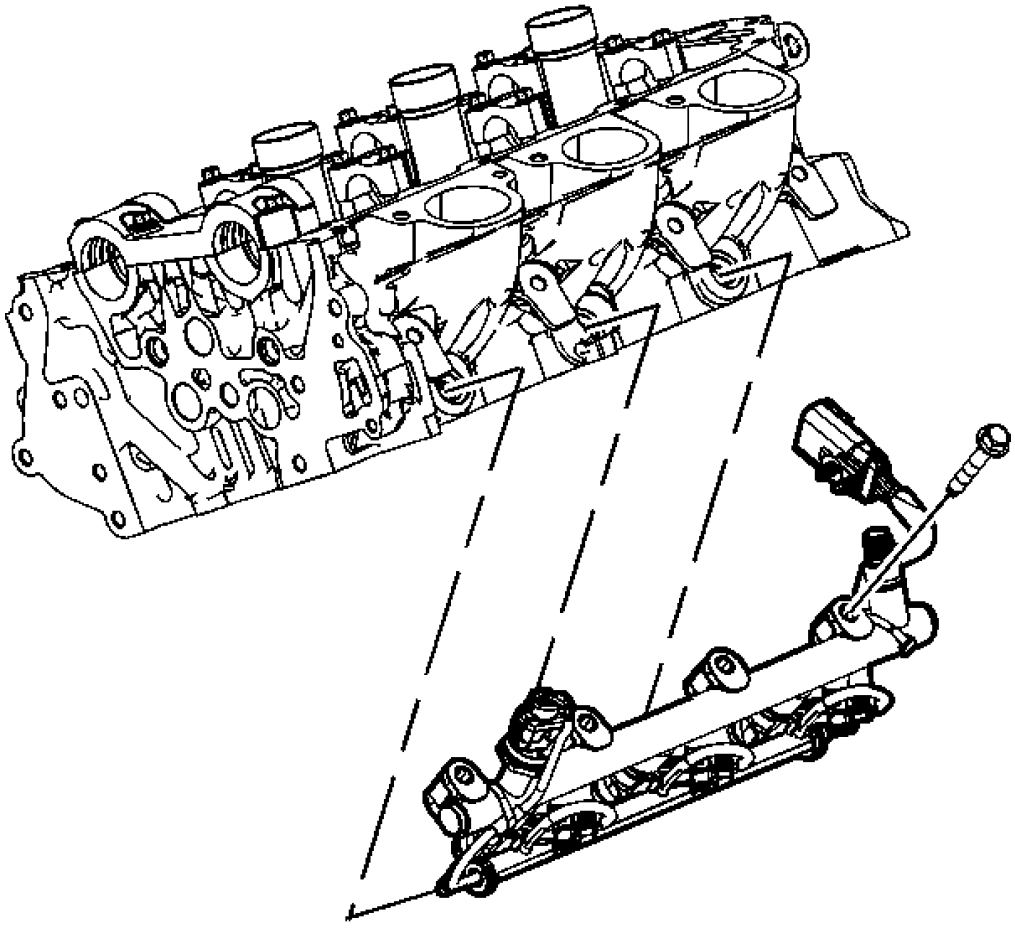


Fig. 96: Removing/Installing Fuel Rail
Courtesy of GENERAL MOTORS CORP.

20. Install the fuel rail with injectors into the cylinder head evenly.
21. Hand tighten the two outer fuel rail bolts to seat the injector in the injector bores.
22. Start and hand tighten the remaining fuel rail bolts.
    1. Tighten the fuel rail bolts in sequence to 25 N.m (18 lb ft) .
    2. Tighten the fuel rail bolts in sequence a second time to 25 N.m (18 lb ft) .

CAMSHAFT CLEANING AND INSPECTION

SPECIAL TOOLS

J 7872: Magnetic Base Dial Indicator

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For equivalent regional tools, refer to **Special Tools** .

CLEANING PROCEDURE

1. Clean the camshaft in solvent.

   WARNING: Refer to Safety Glasses Warning .

2. Dry the camshaft with compressed air.

VISUAL INSPECTION

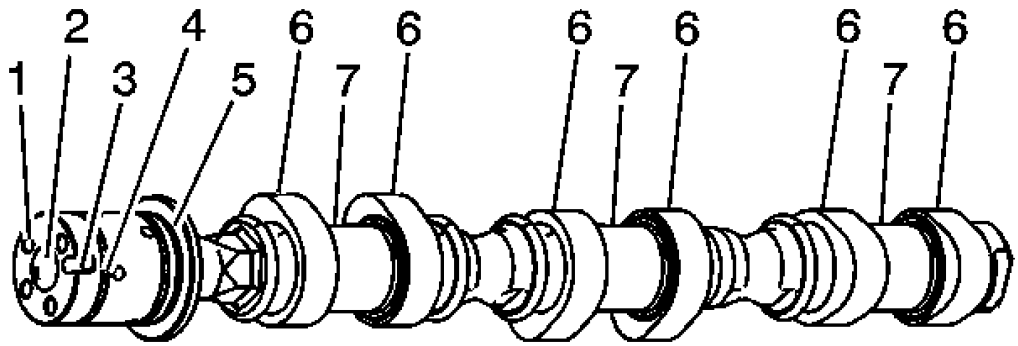


Fig. 97: Identifying Camshaft Inspection Areas
Courtesy of GENERAL MOTORS CORP.

1. Inspect the camshaft oil feed holes (1) to the camshaft position actuator for dirt, debris or blockage.
2. Inspect the threaded hole (2) for damage.
3. Inspect the camshaft position actuator locating notch (3) for damage or wear.
4. Inspect the camshaft sealing grooves (4) for damage.
5. Inspect the camshaft thrust surface (5) for damage.
6. Inspect the camshaft lobes (6) and journals (7) for the following conditions:
   - Excessive scoring or pitting
   - Discoloration from overheating
   - Deformation from excessive wear, especially the camshaft lobes
7. If any of the above conditions exist on the camshaft, replace the camshaft.

CAMSHAFT MEASUREMENT

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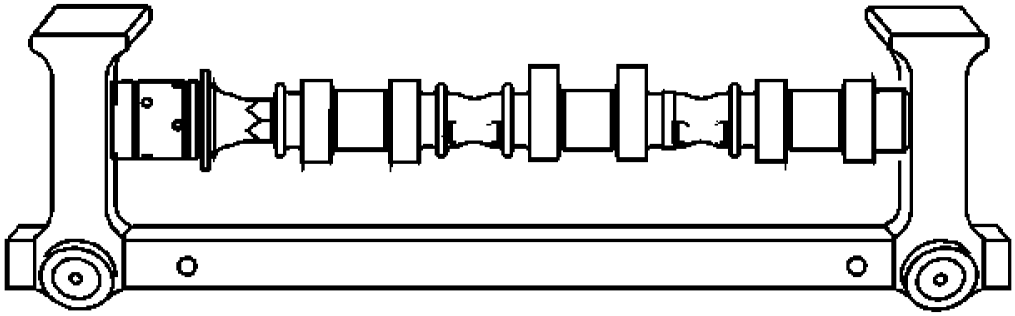


Fig. 98: Supporting Camshaft In Fixture
Courtesy of GENERAL MOTORS CORP.

1. With the camshaft in a suitable fixture, measure the camshaft for wear.

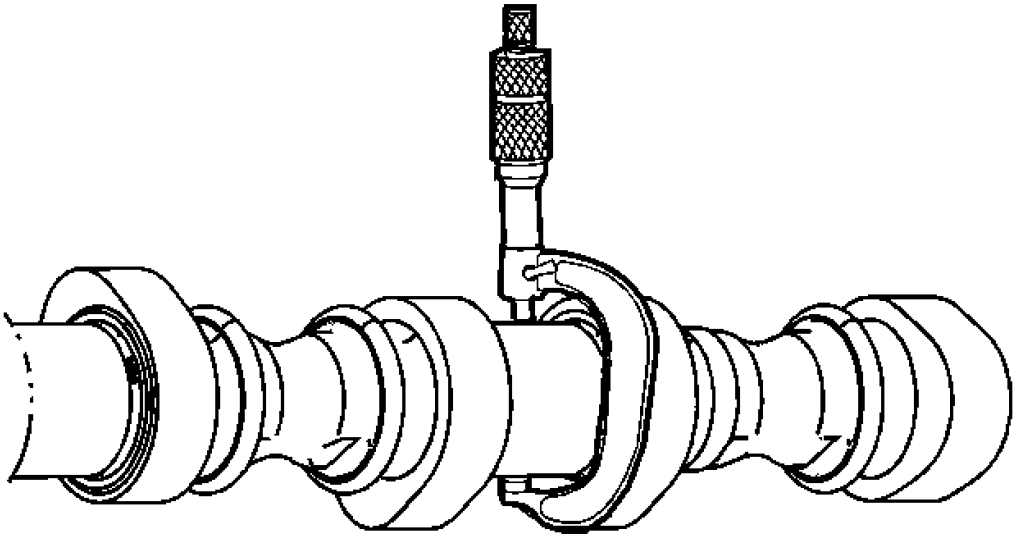


Fig. 99: Measuring Camshaft Journals
Courtesy of GENERAL MOTORS CORP.

2. Measure the camshaft journals for diameter and out-of-round using an outside micrometer. Refer to **Engine Mechanical Specifications (LLT)** .

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- If the diameter is smaller than specifications, replace the camshaft.
- If the out-of-round exceeds specifications, replace the camshaft.

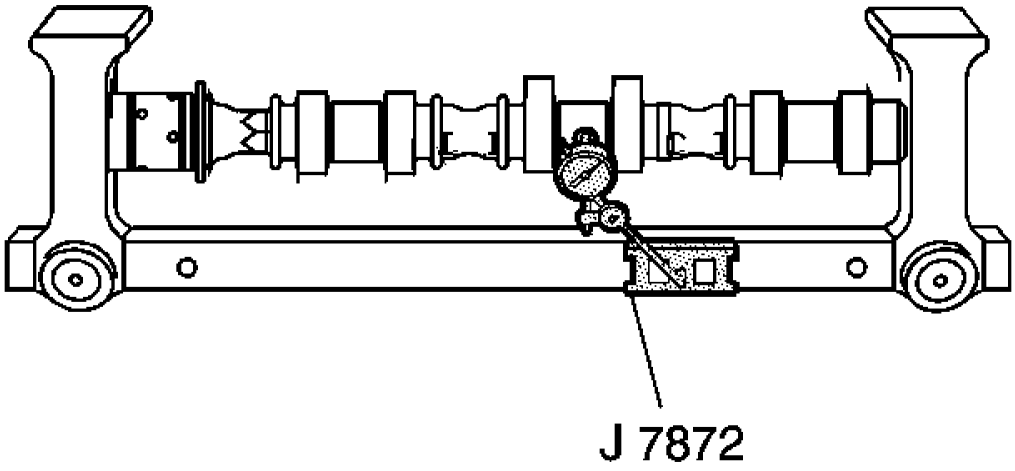


Fig. 100: Measuring Camshaft Runout
Courtesy of GENERAL MOTORS CORP.

3. Measure the camshaft runout using the **J 7872:** indicator. Refer to **Engine Mechanical Specifications (LLT)** .

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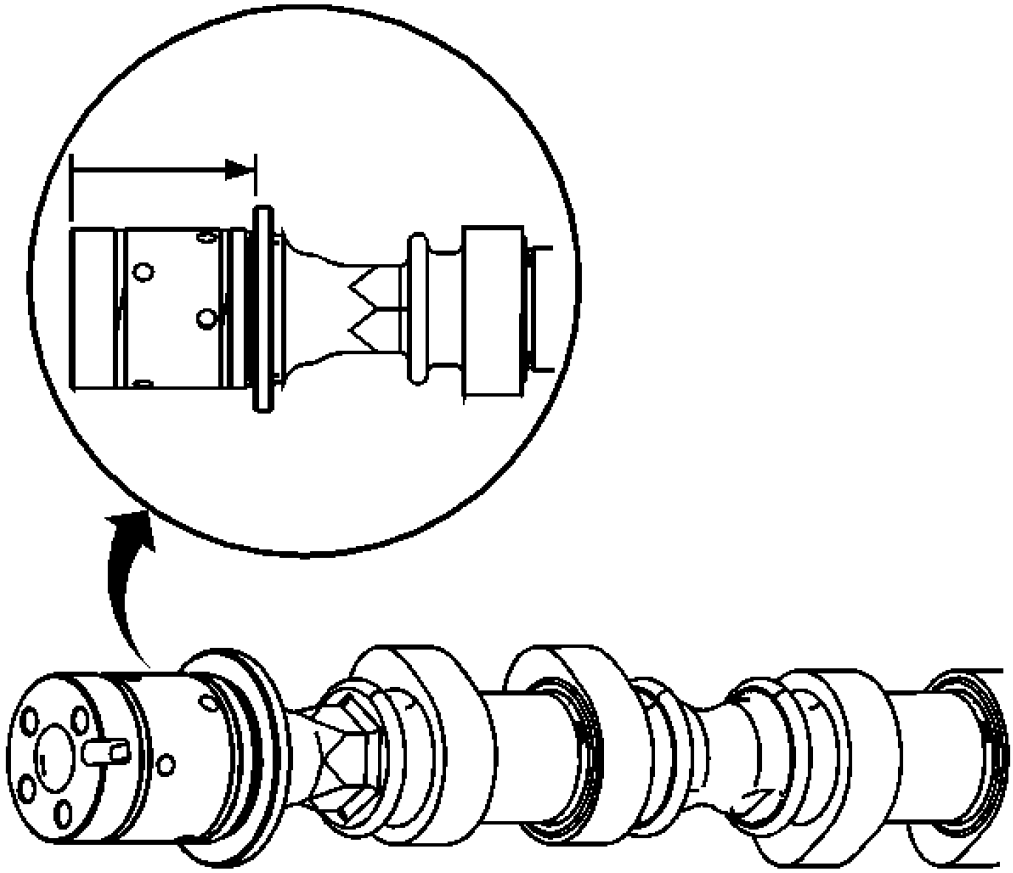


Fig. 101: Measuring Camshaft Thrust
Courtesy of GENERAL MOTORS CORP.

4. Measure the camshaft thrust width for wear using a depth micrometer. Refer to **Engine Mechanical Specifications (LLT)** .

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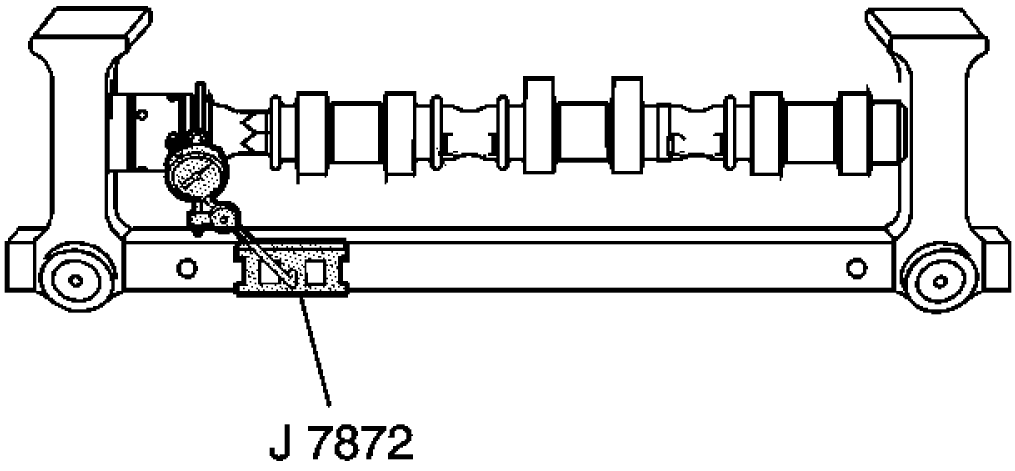
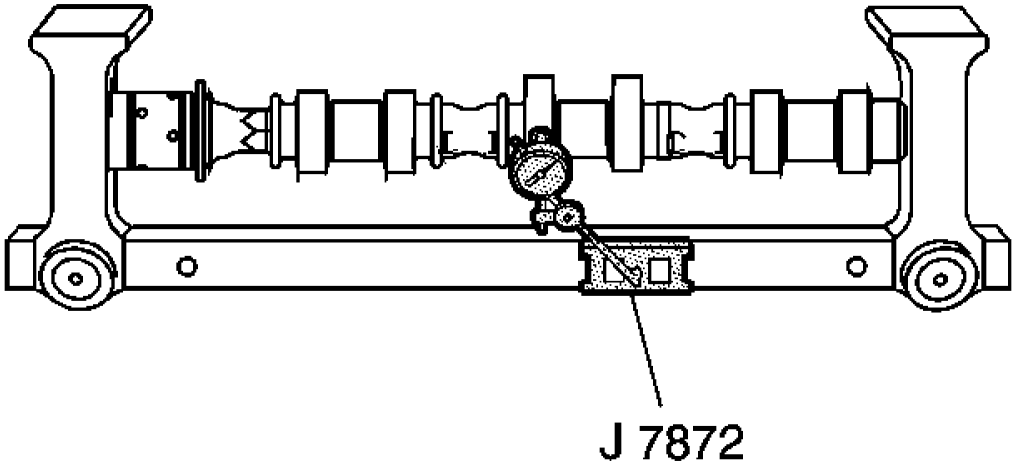


Fig. 102: Measuring Camshaft Thrust Wall Surface
Courtesy of GENERAL MOTORS CORP.

5. Measure the camshaft thrust wall surface for runout using **J 7872:** indicator. Refer to **Engine Mechanical Specifications (LLT)** .
6. If the camshaft is damaged or worn beyond specifications, replace the camshaft. No machining of the camshaft is allowed.



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Fig. 103: Measuring Camshaft Lobes
Courtesy of GENERAL MOTORS CORP.

7. Measure the camshaft lobes for wear using the **J 7872:** indicator.

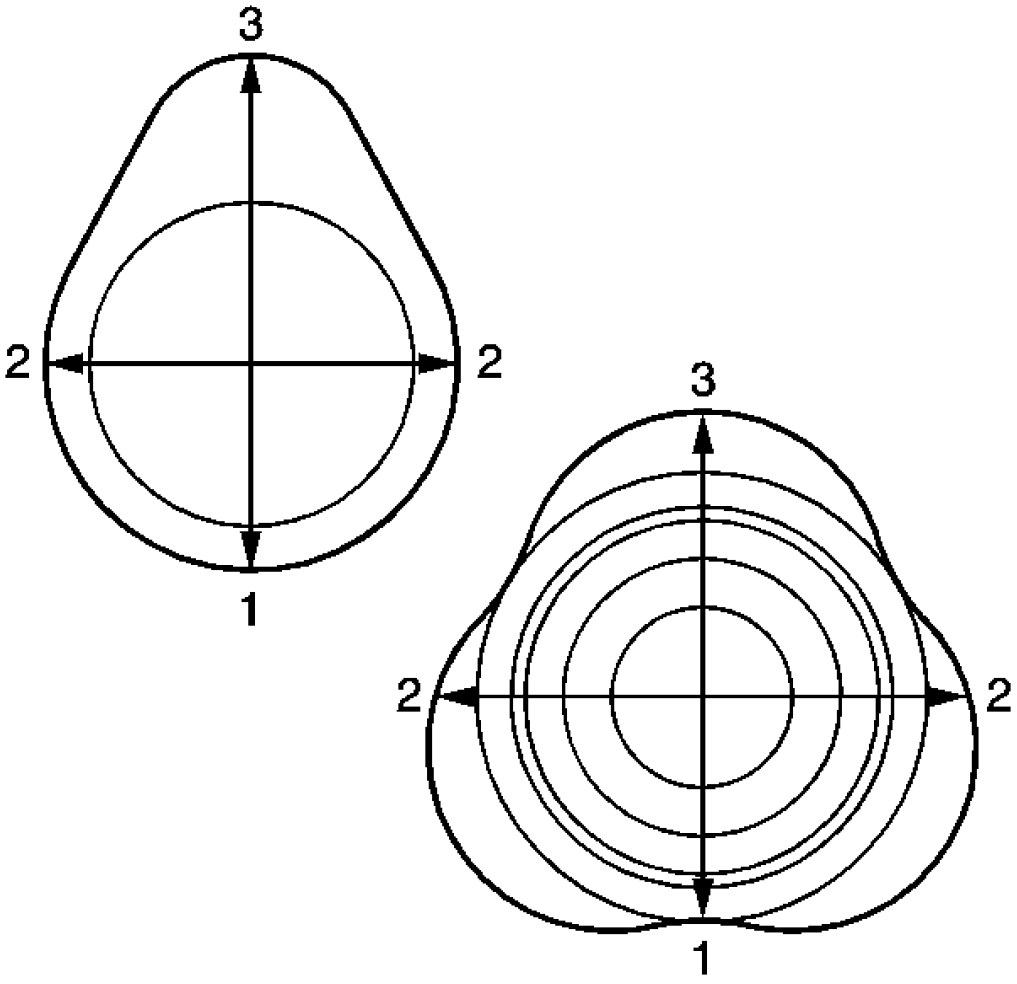


Fig. 104: View of Lobe Diagram
Courtesy of GENERAL MOTORS CORP.

8. Place the **J 7872:** indicator with the indicator tip on the base circle (1) of the camshaft lobe.
    1. Place the **J 7872:** indicator at zero.
    2. Rotate the camshaft until the indicator tip is at the highest point (3) on the lobe. This reading is the lift of the camshaft lobe. Refer to **Engine Mechanical Specifications (LLT)** .
    3. If the indicated measurement is significantly lower than these specifications, replace the camshaft

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or engine performance will be reduced.

VALVE LIFTER CLEANING AND INSPECTION

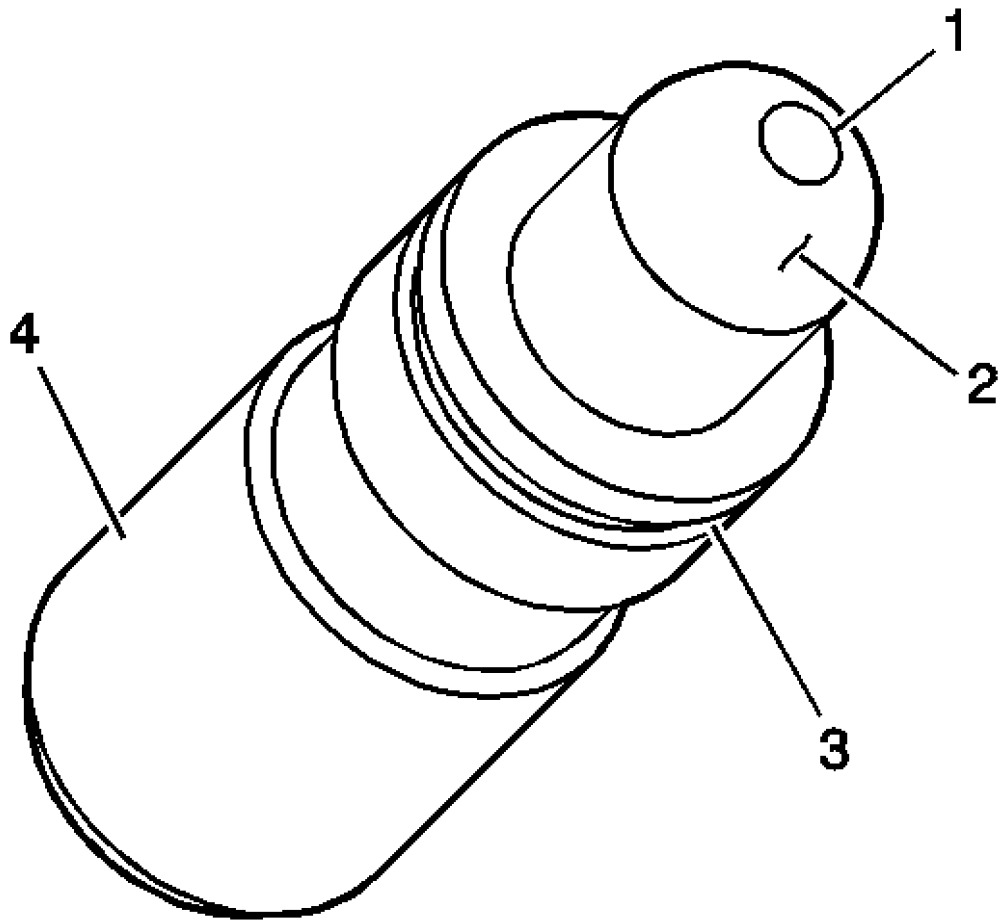


Fig. 105: Inspecting Stationary Hydraulic Lash Adjuster
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Valve Lifter Priming Caution .

1. Inspect the stationary hydraulic lash adjuster (SHLA) in the following areas:
   - A plugged oil passage (1)

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- A scored or worn camshaft follower pivot area (2)
- A damaged or broken retainer (3), some applications
- A severely scuffed or worn SHLA body (4)

2. Replace the SHLA or SHLAs as necessary.

VALVE ROCKER ARM CLEANING AND INSPECTION

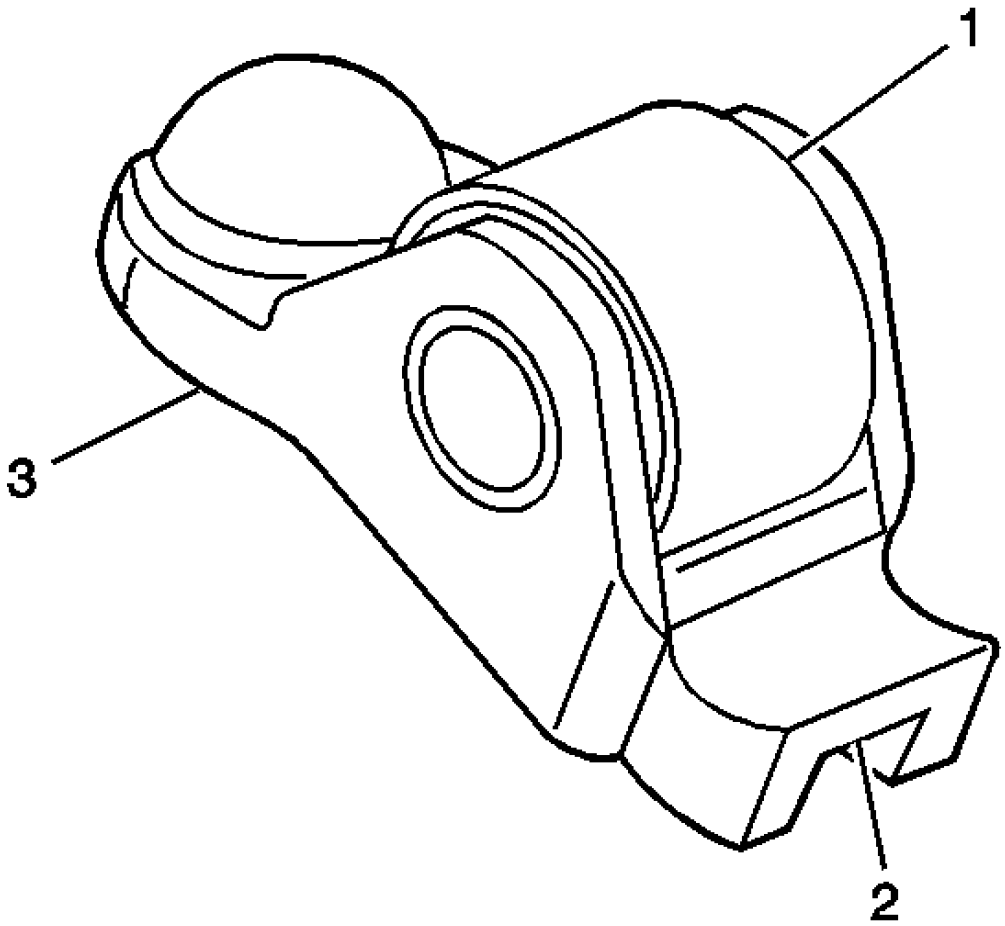


Fig. 106: Inspecting Valve Rocker Arms
Courtesy of GENERAL MOTORS CORP.

1. Inspect the camshaft follower roller (1) for the following:
   - Flat spots

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- Excessive scoring and pitting
- Ensure the roller spins freely

2. Inspect the camshaft follower valve tip area (2).
3. Inspect the camshaft follower stationary hydraulic lash adjuster (SHLA) pivot area (3).
4. Replace the camshaft follower or followers as necessary.

CAMSHAFT TIMING DRIVE COMPONENTS CLEANING AND INSPECTION

CLEANING PROCEDURE

1. Clean all the following components with solvent:
   - Crankshaft sprocket
   - Primary timing drive chain
   - Primary timing drive chain shoe
   - Primary timing drive chain guides
   - Primary timing drive chain tensioner
   - Secondary timing drive chains
   - Secondary timing drive chain shoes
   - Secondary timing drive chain guides
   - Secondary timing drive chain tensioners
   - Timing component fastening bolts
2. Clean each camshaft position actuator's exterior with solvent.

WARNING: Refer to Safety Glasses Warning .

3. Dry the timing components with compressed air.

VISUAL INSPECTION

Camshaft Thrust Washers

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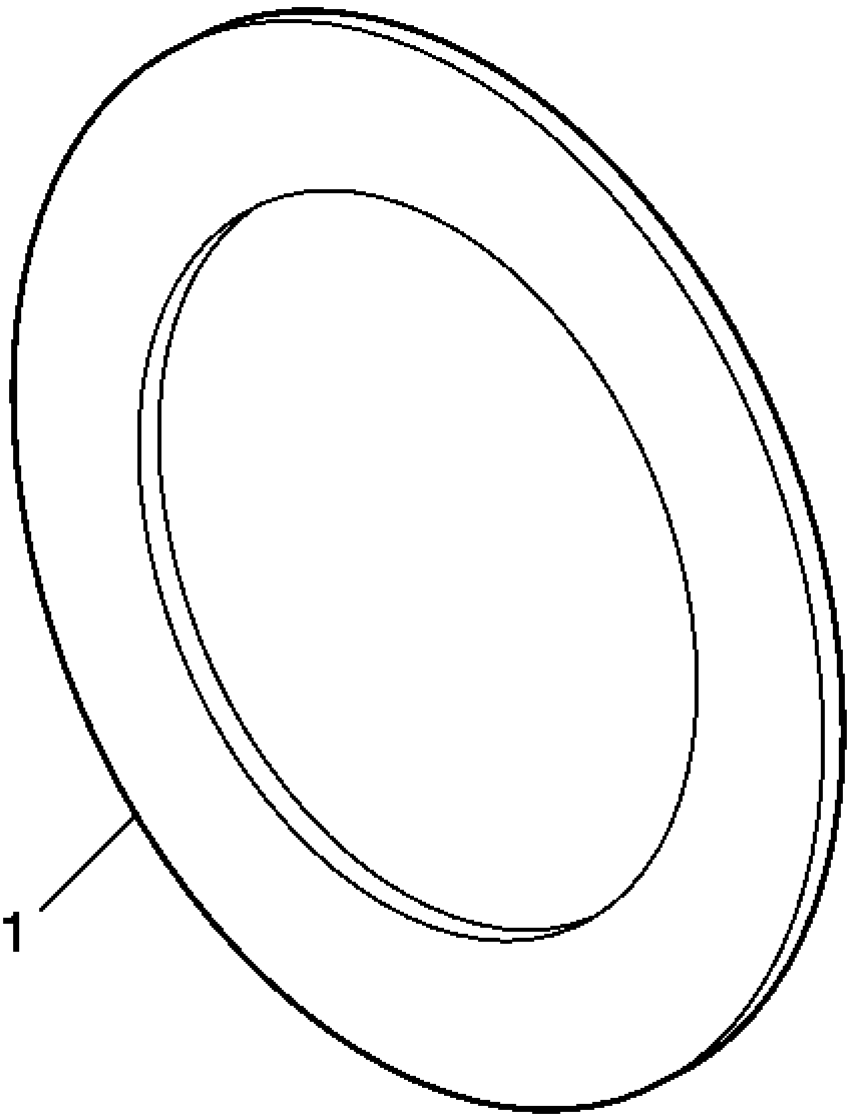


Fig. 107: Camshaft Thrust Washer
Courtesy of GENERAL MOTORS CORP.

1. Inspect the camshaft thrust washers for deep scoring or uneven wear (1).
2. Replace as necessary.

Camshaft Position Actuators

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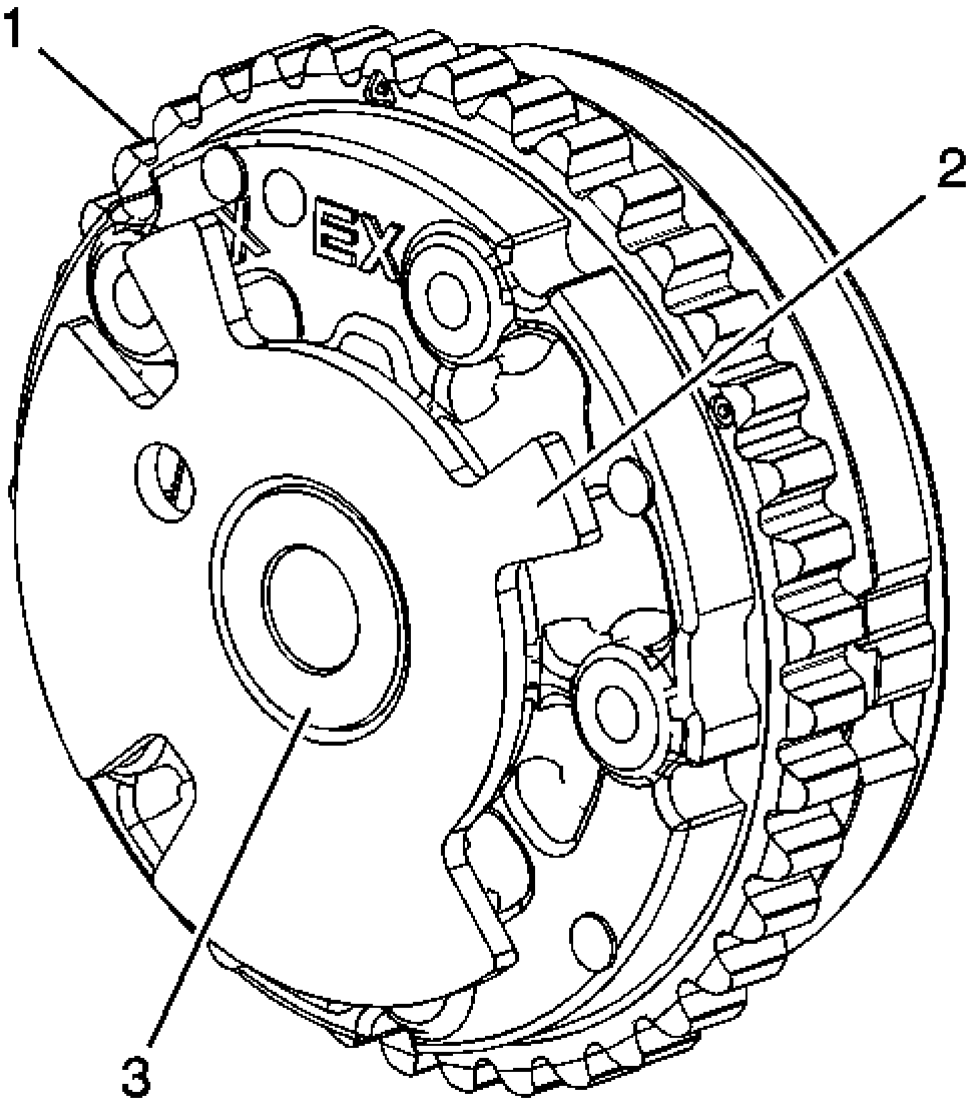


Fig. 108: Identifying Camshaft Position Actuator Damage
Courtesy of GENERAL MOTORS CORP.

NOTE: Actual camshaft position actuators may vary in appearance from the ones shown.

1. Inspect the front of the exhaust camshaft position actuators for the following:
   - Sprocket damage (1)

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- Reluctor/sensor wheel damage (2)
- Camshaft position actuator bolt seating/sealing inner hub flange damage (3)

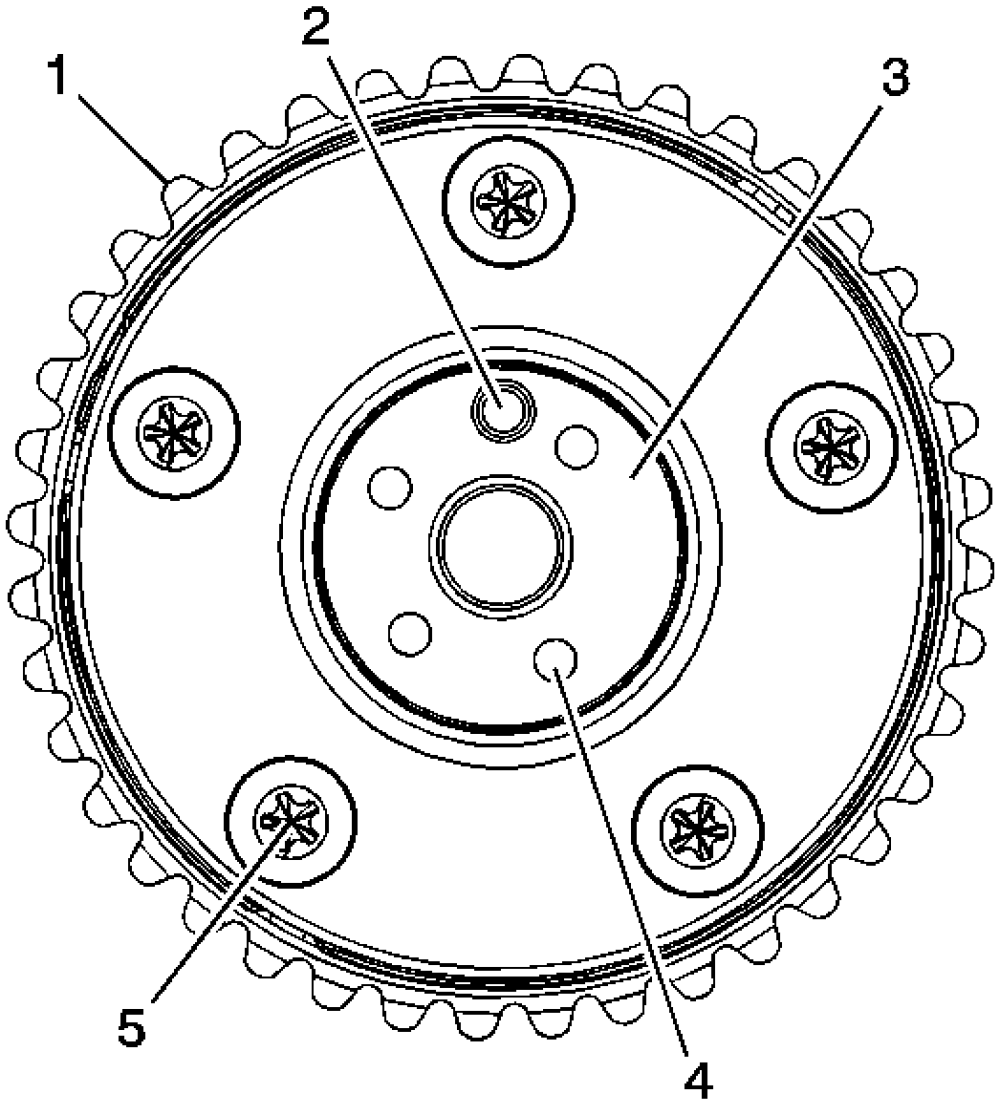


Fig. 109: Identifying Exhaust Camshaft Position Actuator Damage
Courtesy of GENERAL MOTORS CORP.

2. Inspect the back of the exhaust camshaft position actuators for the following:
   - Sprocket damage (1)

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- Camshaft locating pin damage (2)
- Camshaft seating/sealing inner hub flange damage (3)
- Blockage to the oil passages (4)
- Loose or missing housing bolts (5)

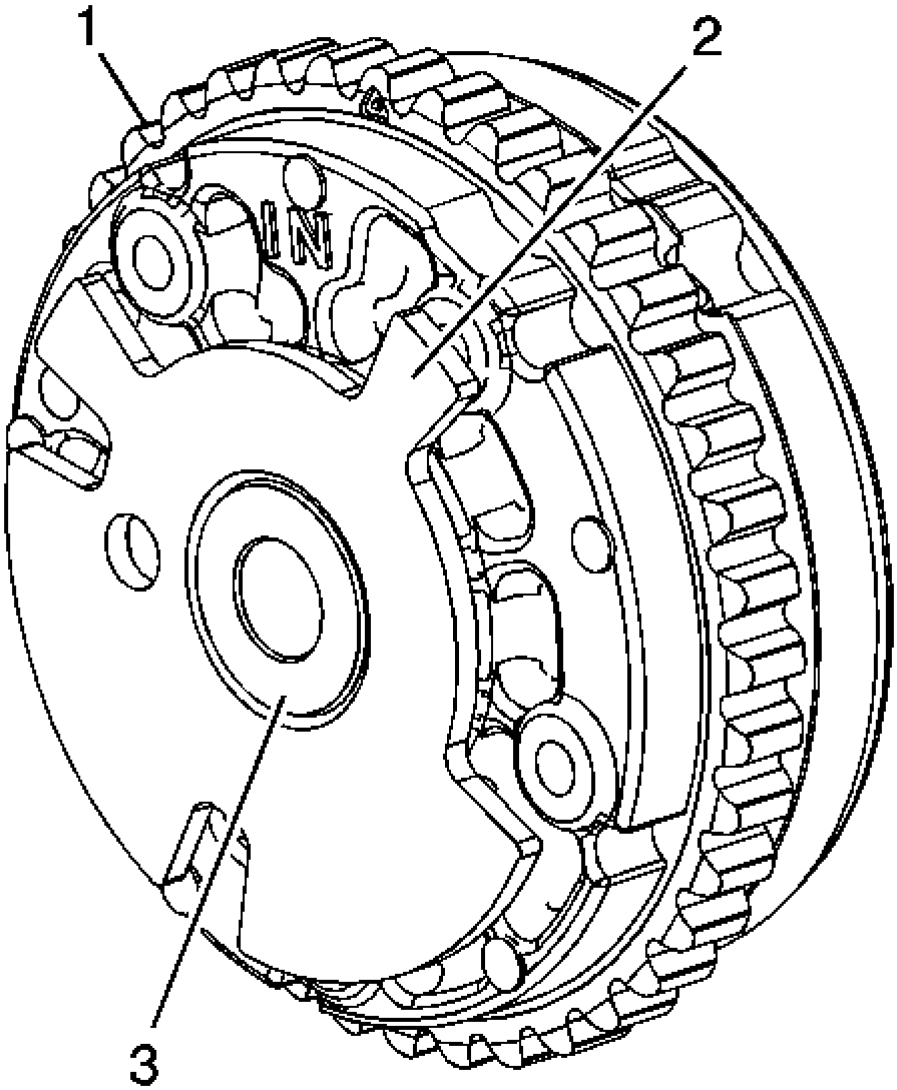


Fig. 110: Identifying Left Intake Camshaft Position Actuator Damage
Courtesy of GENERAL MOTORS CORP.

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3. Inspect the front of the left intake camshaft position actuators for the following:
    - Sprocket damage (1)
    - Reluctor/sensor wheel damage (2)
    - Camshaft position actuator oil control valve bolt seating/sealing inner hub flange damage (3)

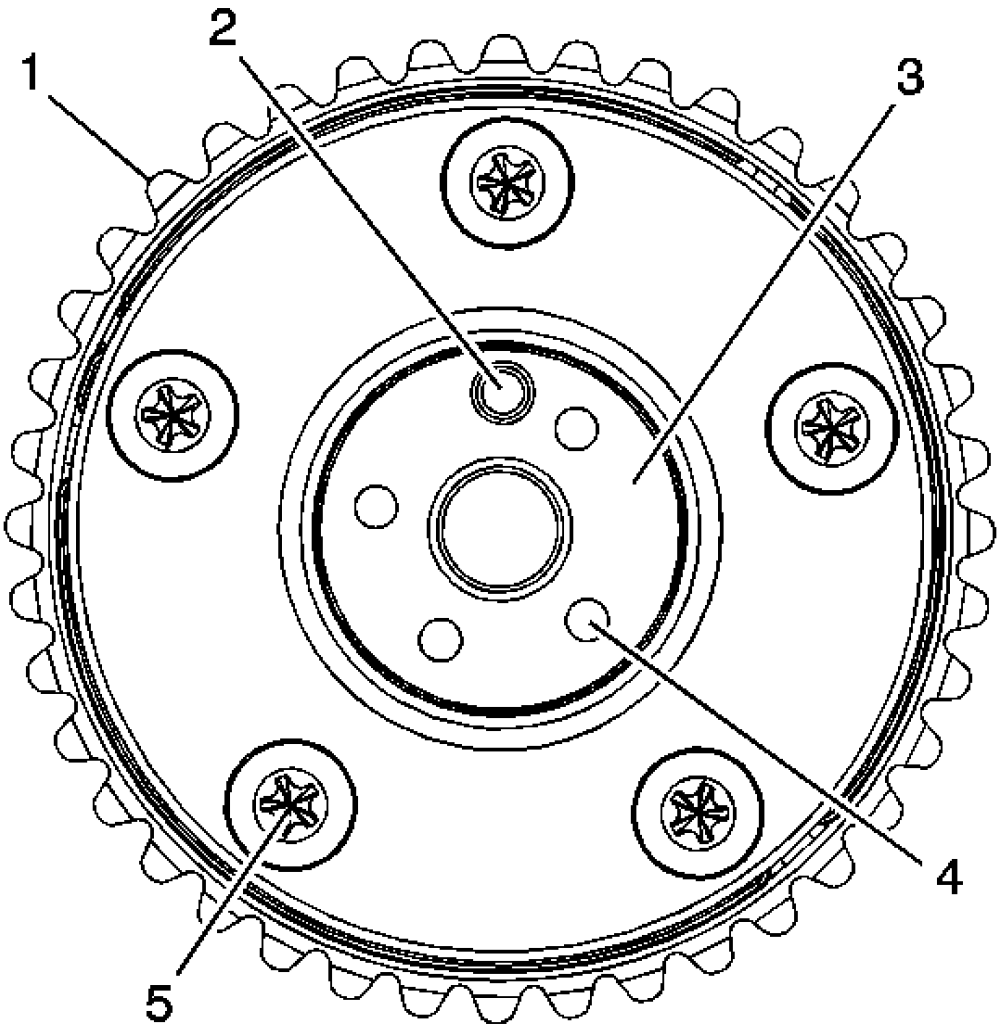


Fig. 111: Identifying Back Of Intake Camshaft Position Actuator Damage
Courtesy of GENERAL MOTORS CORP.

4. Inspect the back of the left intake camshaft position actuators for the following:
    - Sprocket damage (1)

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- Camshaft locating pin damage (2)
- Camshaft seating/sealing inner hub flange damage (3)
- Blockage to the oil passages (4)
- Loose or missing housing bolts (5)

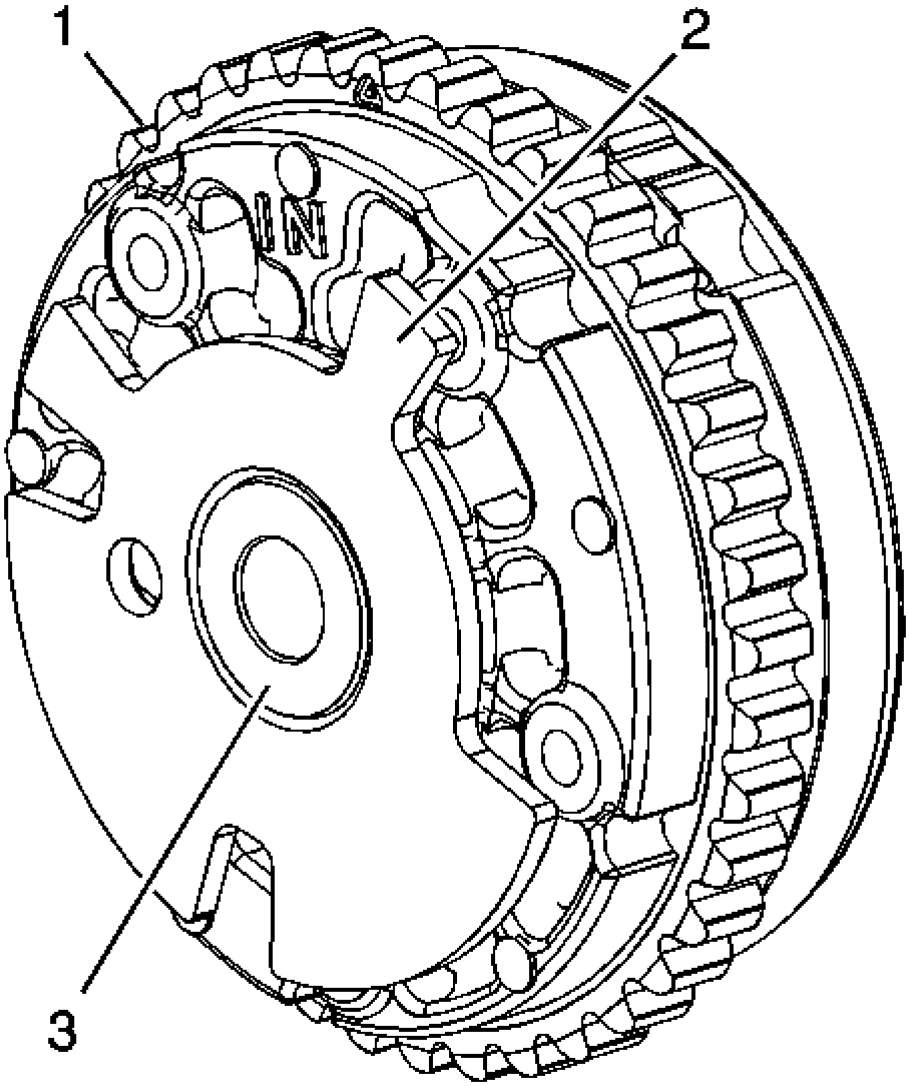


Fig. 112: Identifying Right Intake Camshaft Position Actuator Damage
Courtesy of GENERAL MOTORS CORP.

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5. Inspect the front of the right intake camshaft position actuators for the following:
    - Sprocket damage (1)
    - Reluctor/sensor wheel damage (2)
    - Camshaft position actuator oil control valve bolt seating/sealing inner hub flange damage (3)

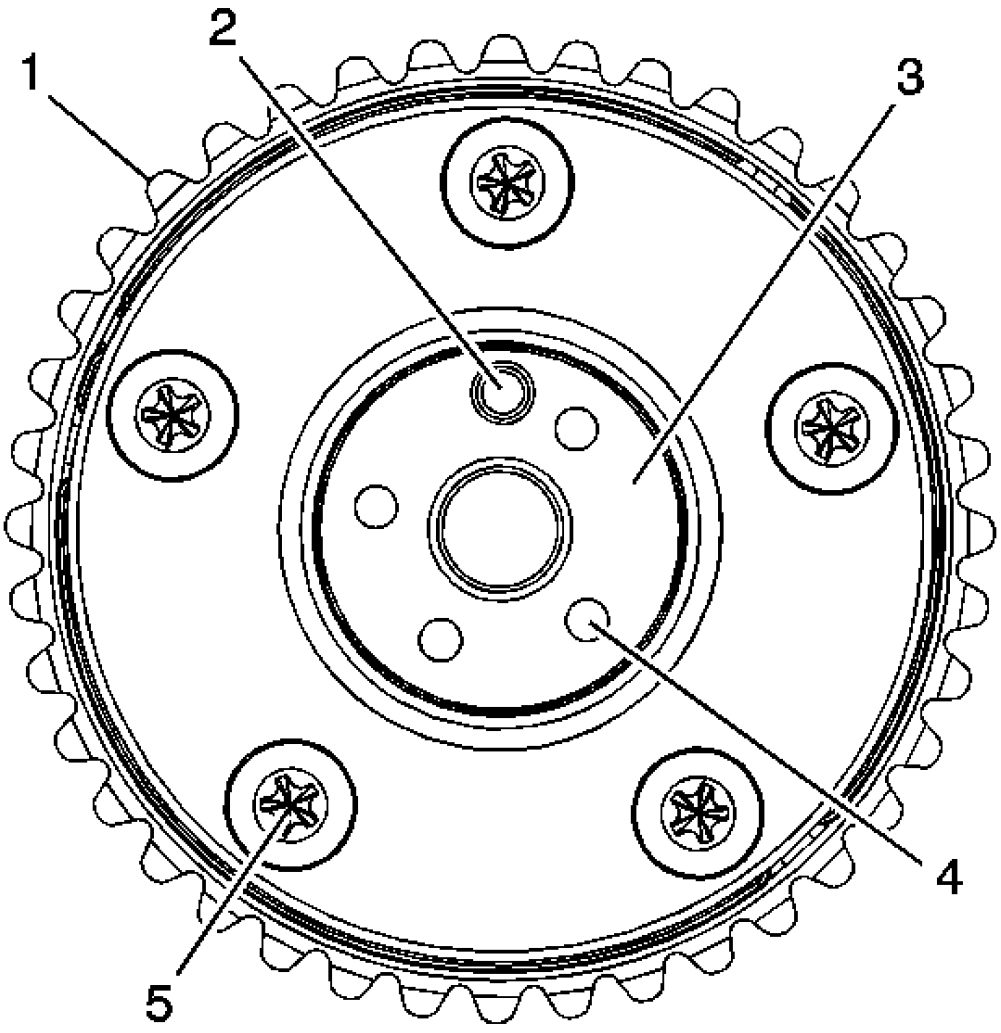


Fig. 113: Identifying Back Of Intake Camshaft Position Actuator Damage
Courtesy of GENERAL MOTORS CORP.

6. Inspect the back of the right intake camshaft position actuators for the following:
    - Sprocket damage (1)

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- Camshaft locating pin damage (2)
- Camshaft seating/sealing inner hub flange damage (3)
- Blockage to the oil passages (4)
- Loose or missing housing bolts (5)

7. Replace a damaged camshaft position actuator.

Camshaft Position Actuator Oil Control Valves

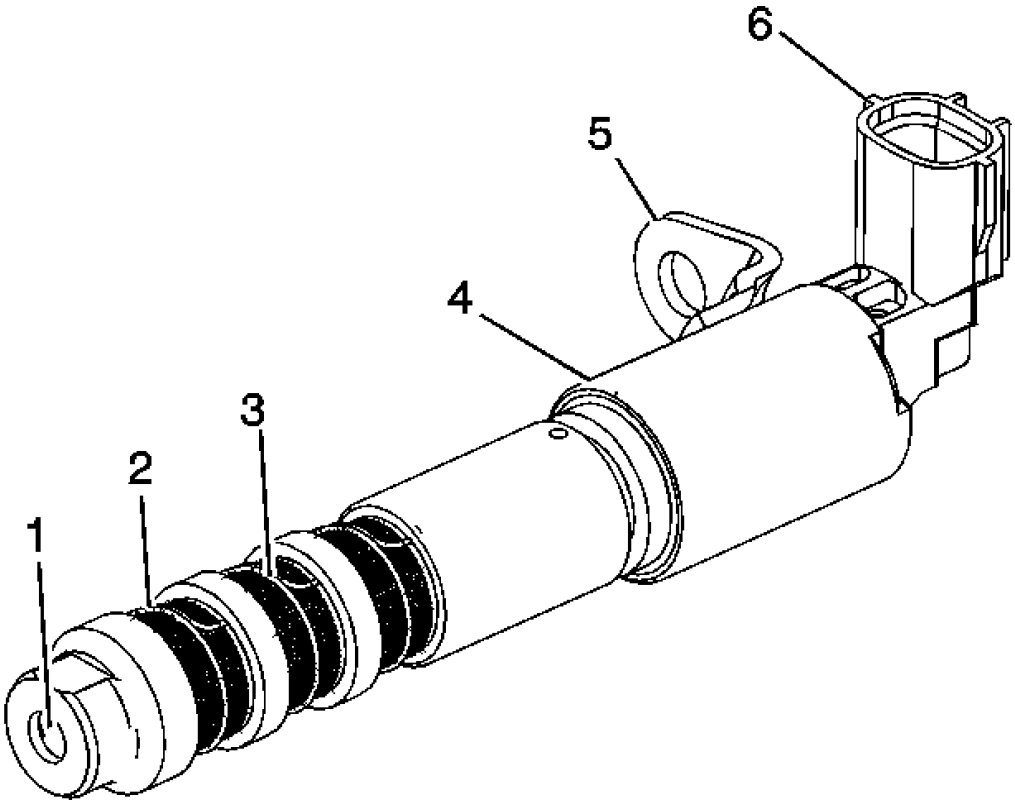


Fig. 114: Inspecting Camshaft Position Actuator Oil Control Valves
Courtesy of GENERAL MOTORS CORP.

1. Inspect the camshaft position actuator oil control valves for the following:
   - Blockage to the oil passage (1)
   - Missing or damaged oil screen clip (2)
   - Blockage or damage to the oil screen (3)
   - Damage to the sealing surface for the camshaft position actuator oil control valve solenoid oil seal

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(4)

- Damage to the bracket (5)
- Damage to the wiring harness connection and/or terminals (6)

2. Replace a damaged camshaft position actuator oil control valve.

Left Intermediate Sprocket with Primary and Secondary Inverted Tooth (IT) Chain

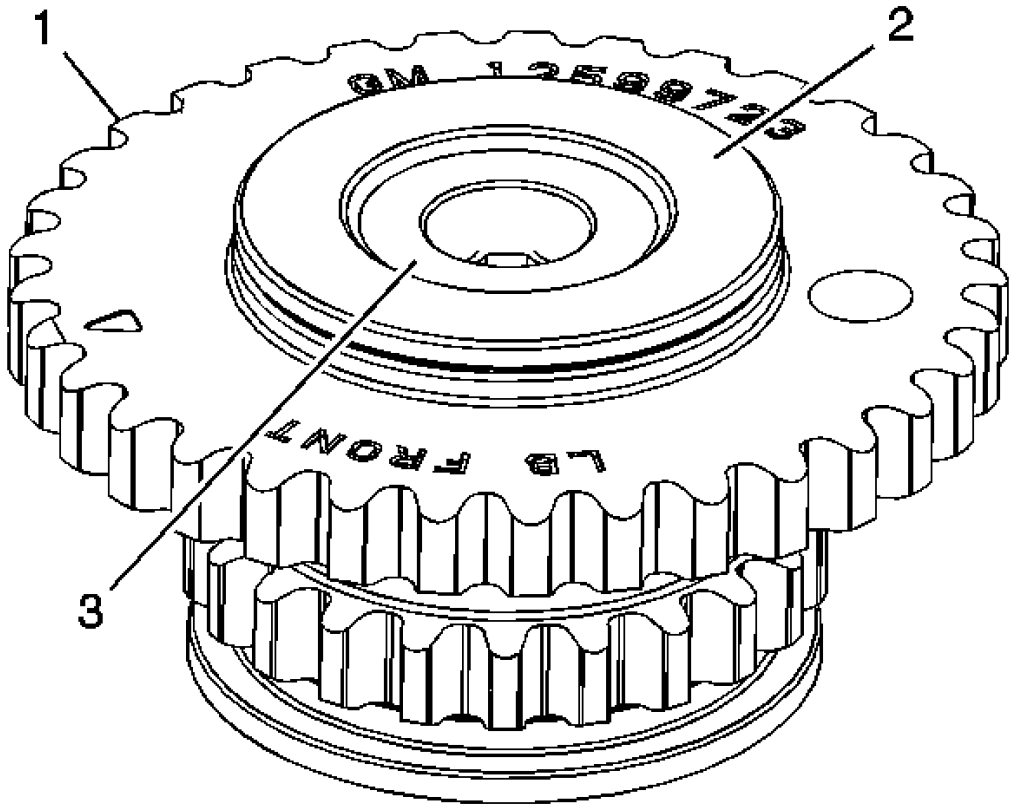


Fig. 115: Inspecting Front Of Left Intermediate Sprocket
Courtesy of GENERAL MOTORS CORP.

1. Inspect the front of the left intermediate sprocket for the following:
   - Damage to the primary camshaft drive chain sprocket (1)
   - Damage to the hub bearing (2)-Ensure the hub bearing spins freely. If the hub bearing wobbles, is noisy, or feels rough when rotated, replace the intermediate sprocket.
   - Damage to the bolt flange seating/sealing surface (3)

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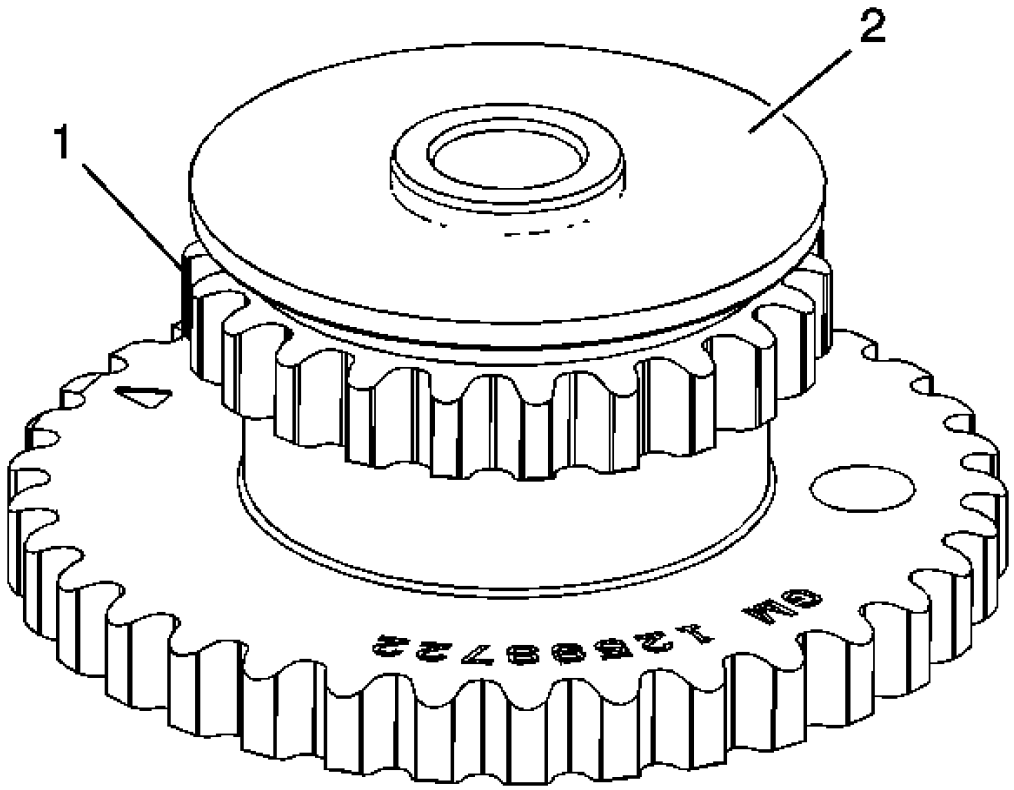


Fig. 116: Inspecting Back Of Left Intermediate Sprocket
Courtesy of GENERAL MOTORS CORP.

2. Inspect the back of the left intermediate sprocket for the following:
    - Damage to the left secondary camshaft drive chain sprocket (1)
    - Damage to the bearing hub-to-engine block sealing surface (2)
3. Replace a damaged left intermediate sprocket.

Right Intermediate Sprocket with Primary and Secondary Inverted Tooth (IT) Chain

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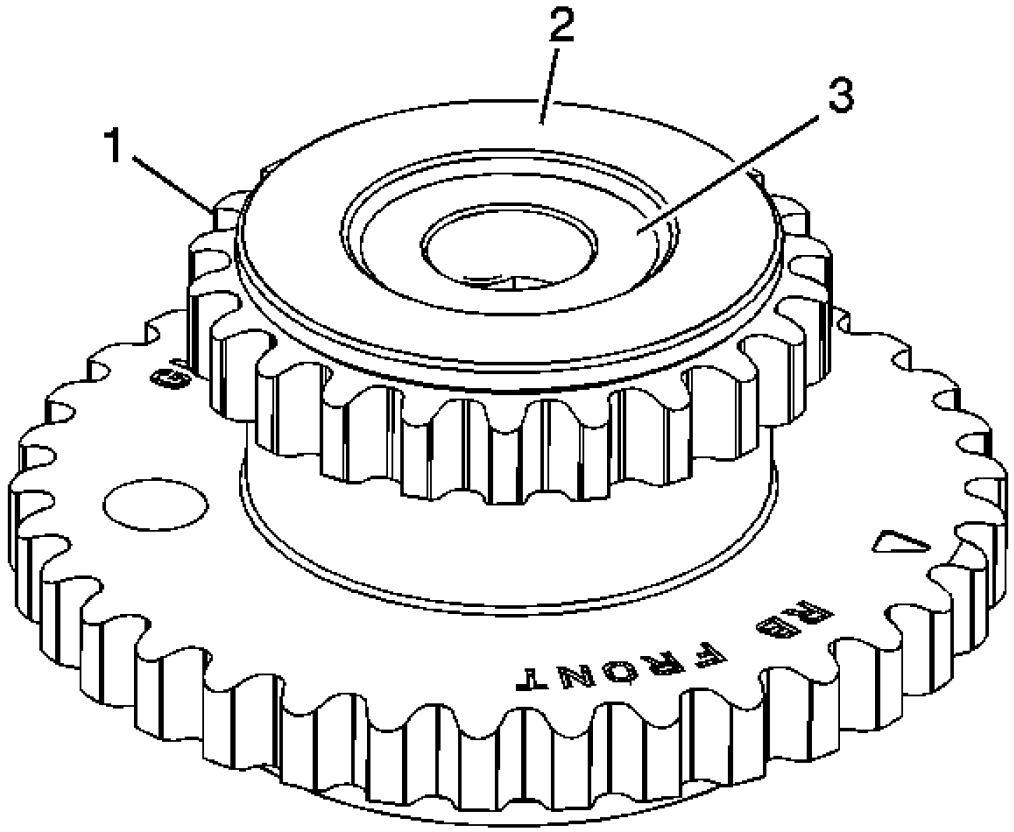


Fig. 117: Inspecting Front Of Right Intermediate Sprocket
Courtesy of GENERAL MOTORS CORP.

1. Inspect the front of the right intermediate sprocket for the following:
   - Damage to the right secondary camshaft drive chain sprocket (1)
   - Damage to the hub bearing (2)-Ensure the hub bearing spins freely. If the hub bearing wobbles, is noisy, or feels rough when rotated, replace the intermediate sprocket.
   - Damage to the bolt flange seating/sealing surface (3)

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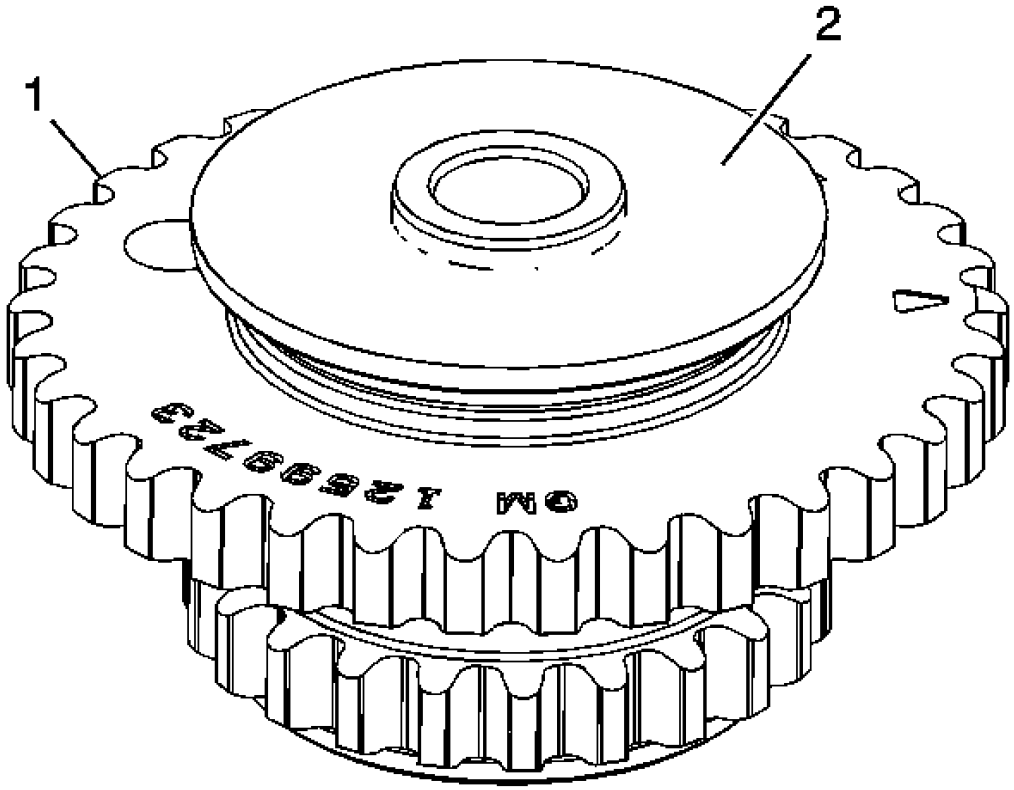


Fig. 118: Inspecting Back Of Right Intermediate Sprocket
Courtesy of GENERAL MOTORS CORP.

2. Inspect the back of the right intermediate sprocket for the following:
    - Damage to the primary camshaft drive chain sprocket (1)
    - Damage to the bearing hub-to-engine block sealing surface (2)
3. Replace a damaged right intermediate sprocket.

Crankshaft Sprocket with Primary Inverted Tooth (IT) Chain

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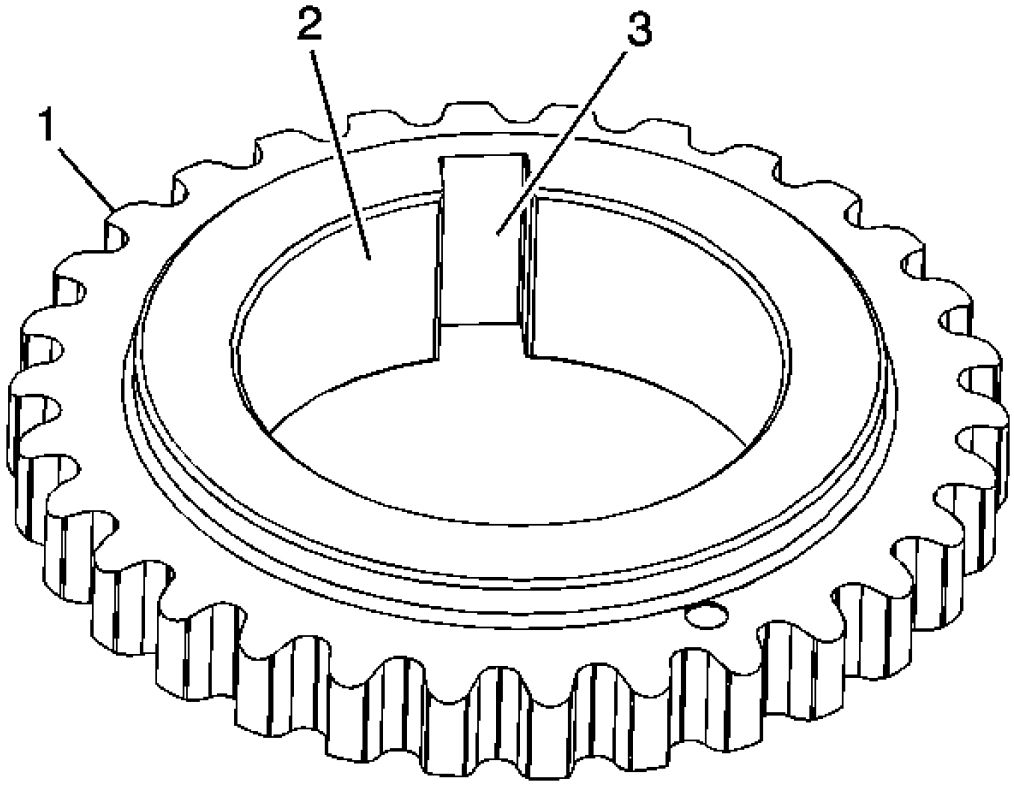


Fig. 119: Inspecting Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

1. Inspect the crankshaft sprocket for the following:
    - Sprocket damage (1)
    - Bore damage (2)
    - Keyway damage (3)
2. Replace a damaged crankshaft sprocket.

Secondary Timing Chains with Inverted Tooth (IT) Chain

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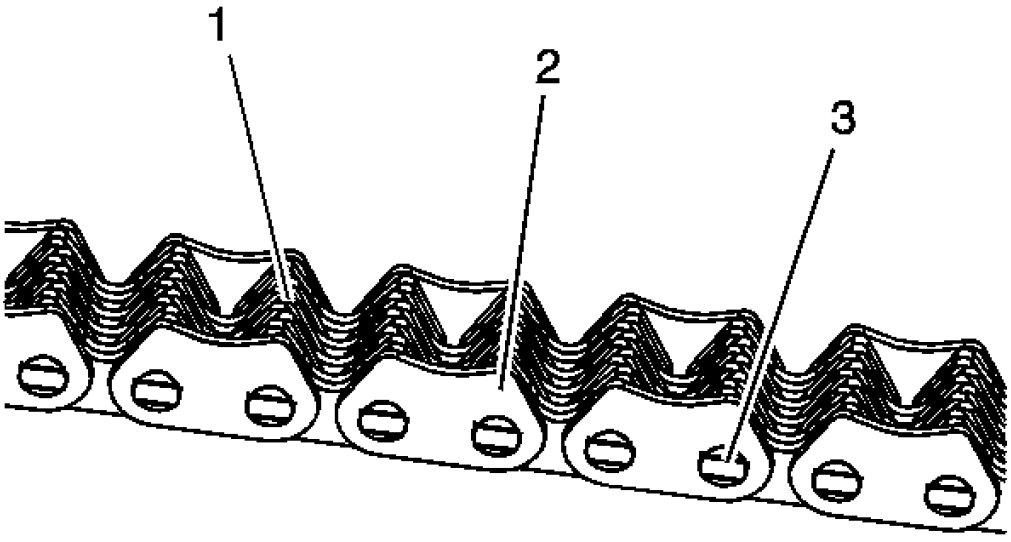


Fig. 120: Inspecting Primary & Secondary Timing Chain
Courtesy of GENERAL MOTORS CORP.

1. Inspect the secondary timing chain for the following:
    - Binding or worn links (1)
    - Loose links (2)
    - Loose pins (3)
2. Replace a damaged secondary timing chain.

Primary Timing Chain with Inverted Tooth (IT) Chain

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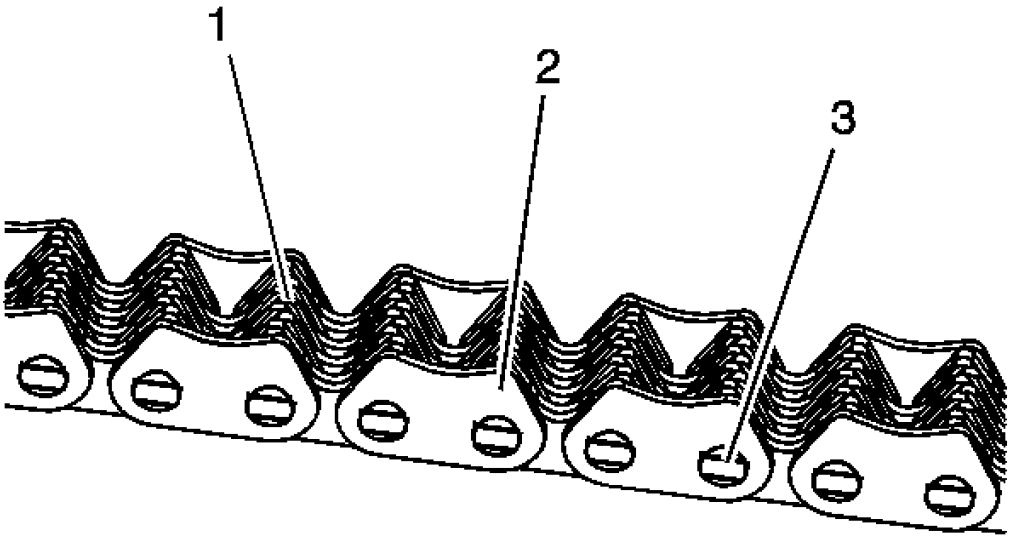


Fig. 121: Inspecting Primary & Secondary Timing Chain
Courtesy of GENERAL MOTORS CORP.

1. Inspect the primary timing chain for the following:
   - Binding or worn links (1)
   - Loose links (2)
   - Loose pins (3)
2. Replace a damaged primary timing chain.

Primary Timing Chain Upper Guide

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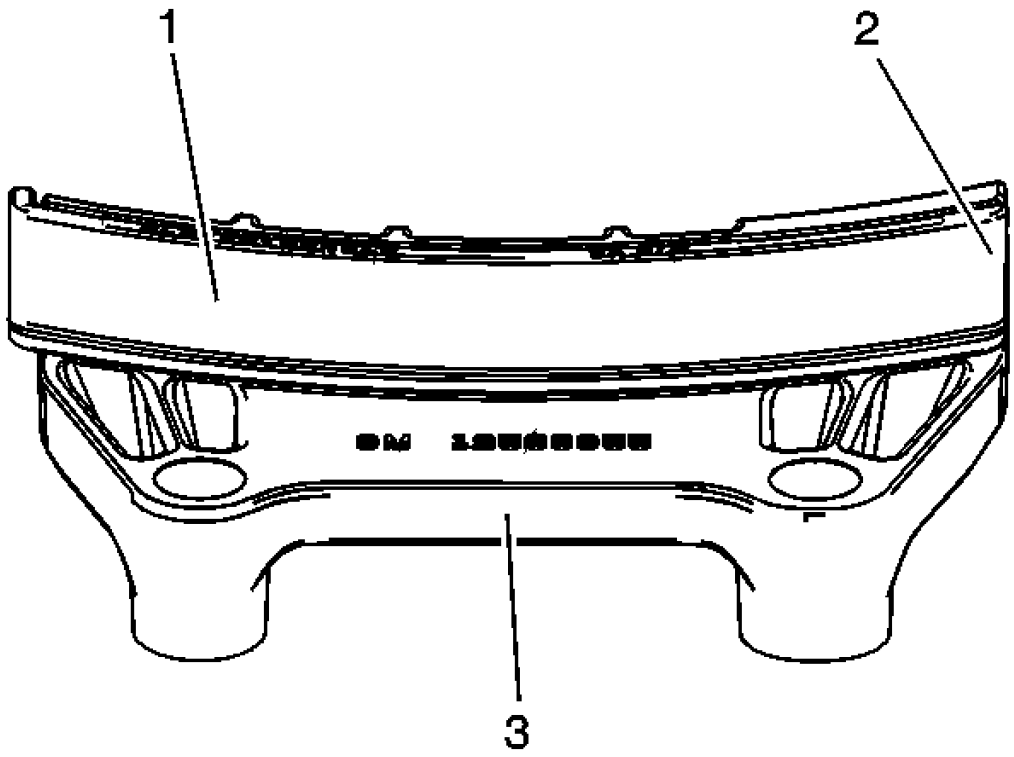


Fig. 122: Identifying Primary Timing Chain Upper Guide Damage
Courtesy of GENERAL MOTORS CORP.

1. Inspect the primary timing chain upper guide for the following:
    - Worn guide surface (1)
    - Cracked or broken guide surface (2)
    - Cracked or damaged guide base (3)
2. Replace a damaged primary timing chain upper guide.

Primary Timing Chain Lower Guide

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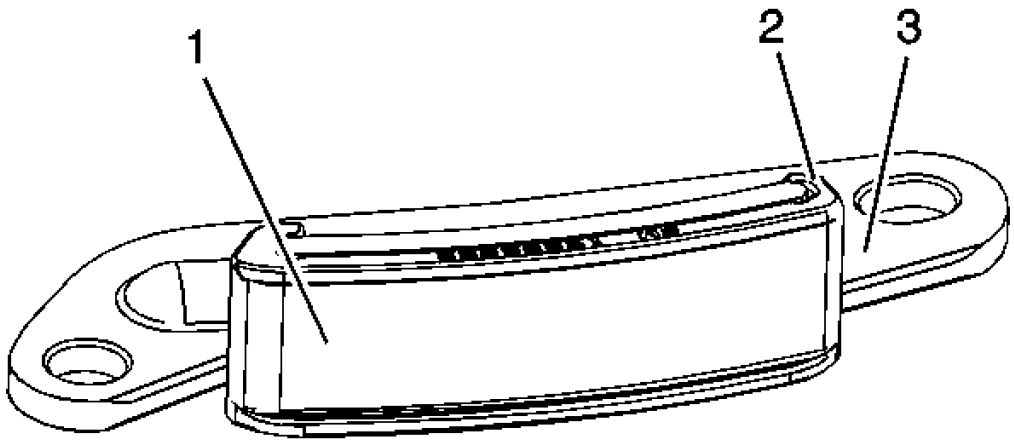


Fig. 123: Primary Camshaft Drive Chain Lower Guide
Courtesy of GENERAL MOTORS CORP.

1. Inspect the primary timing chain lower guide for the following:
    - Worn guide surface (1)
    - Cracked or broken guide surface (2)
    - Cracked or damaged guide base (3)
2. Replace a damaged primary timing chain lower guide.

Left Secondary Timing Chain Guide

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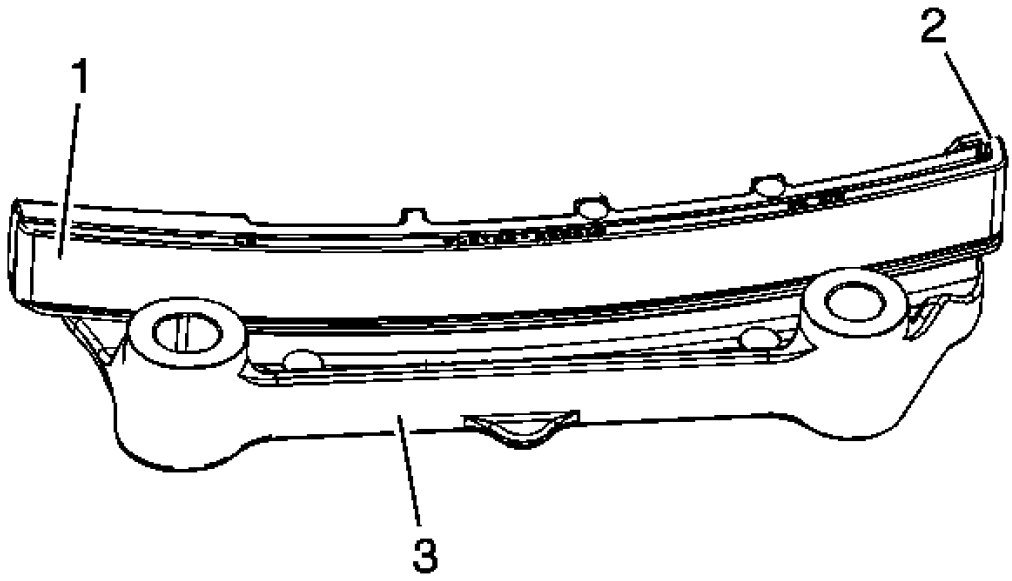


Fig. 124: Inspecting Left Secondary Timing Chain Guide
Courtesy of GENERAL MOTORS CORP.

1. Inspect the left secondary timing chain guides for the following:
    - Worn guide surface (1)
    - Cracked or broken guide surface (2)
    - Cracked or damaged guide base (3)
2. Replace a damaged left secondary timing chain guide.

Right Secondary Timing Chain Guide

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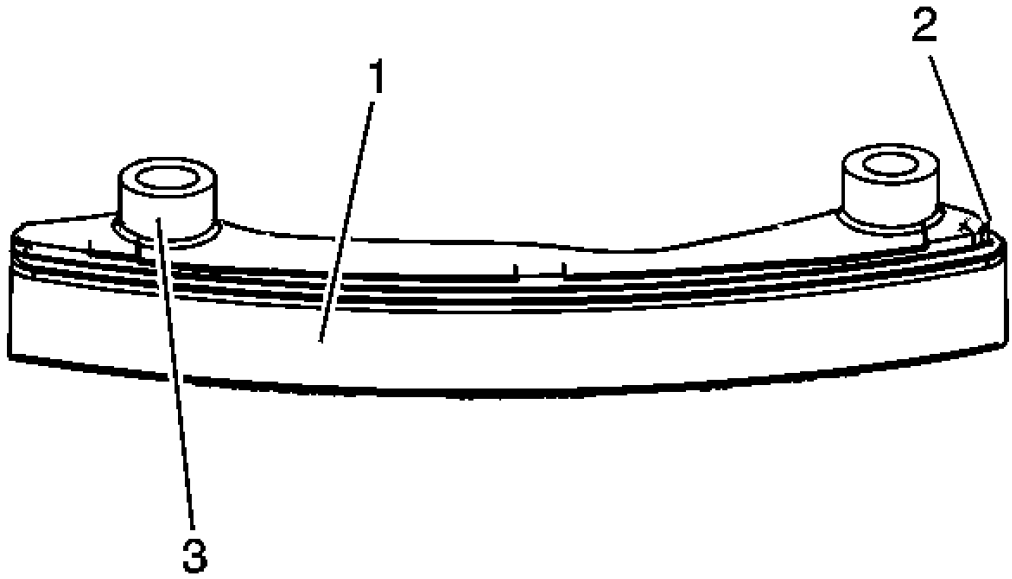


Fig. 125: Inspecting Right Secondary Timing Chain Guide
Courtesy of GENERAL MOTORS CORP.

1. Inspect the right secondary timing chain guides for the following:
    - Worn guide surface (1)
    - Cracked or broken guide surface (2)
    - Cracked or damaged guide base (3)
2. Replace a damaged right secondary timing chain guide.

Left Secondary Timing Chain Shoe

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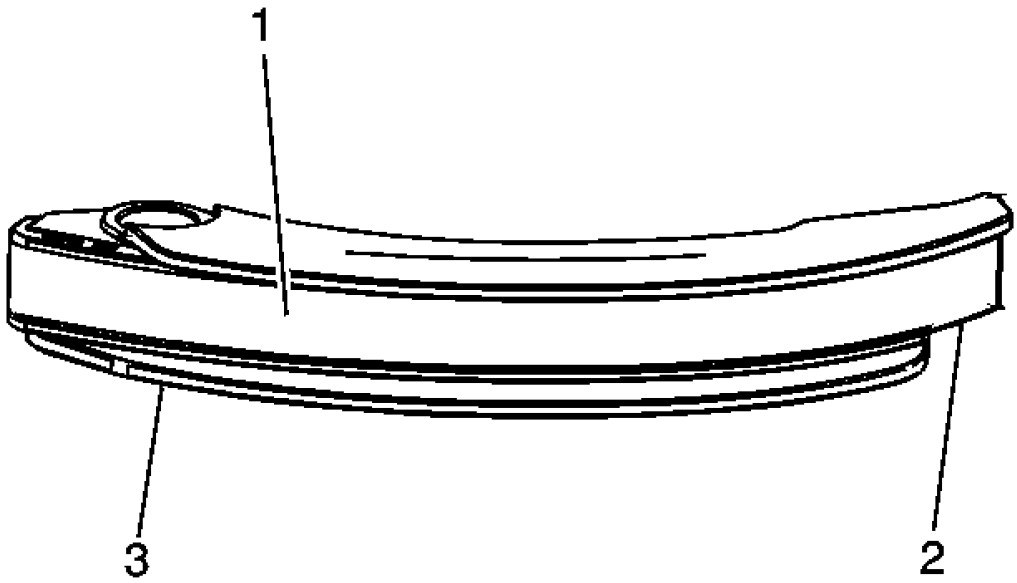


Fig. 126: Inspecting Front Of Left Secondary Timing Chain Shoe
Courtesy of GENERAL MOTORS CORP.

1. Inspect the front of the left secondary timing chain shoe for the following:
    - Worn shoe surface (1)
    - Cracked or broken shoe surface (2)
    - Cracked or damaged shoe (3)

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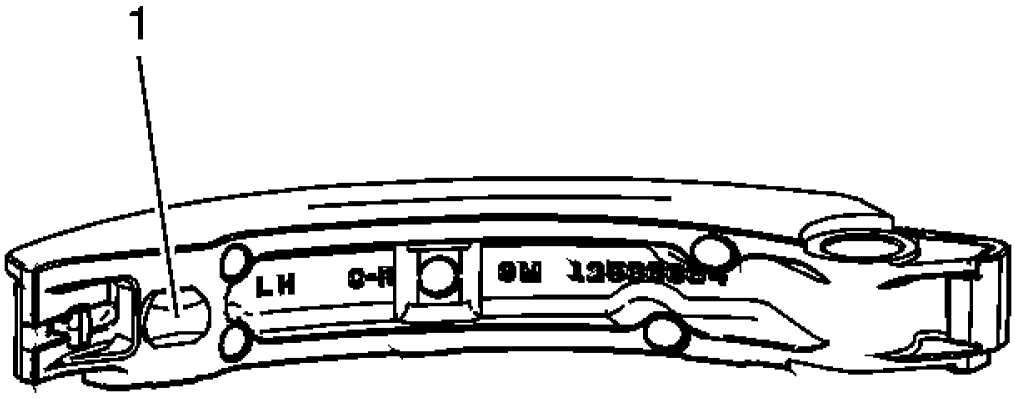


Fig. 127: Inspecting Left Secondary Timing Chain Tensioner Contact Pad
Courtesy of GENERAL MOTORS CORP.

2. Inspect the back of the left secondary timing chain shoe for a damaged, worn, or missing left secondary timing chain tensioner contact pad (1).
3. Replace a damaged left secondary timing chain shoe.

Right Secondary Timing Chain Shoe

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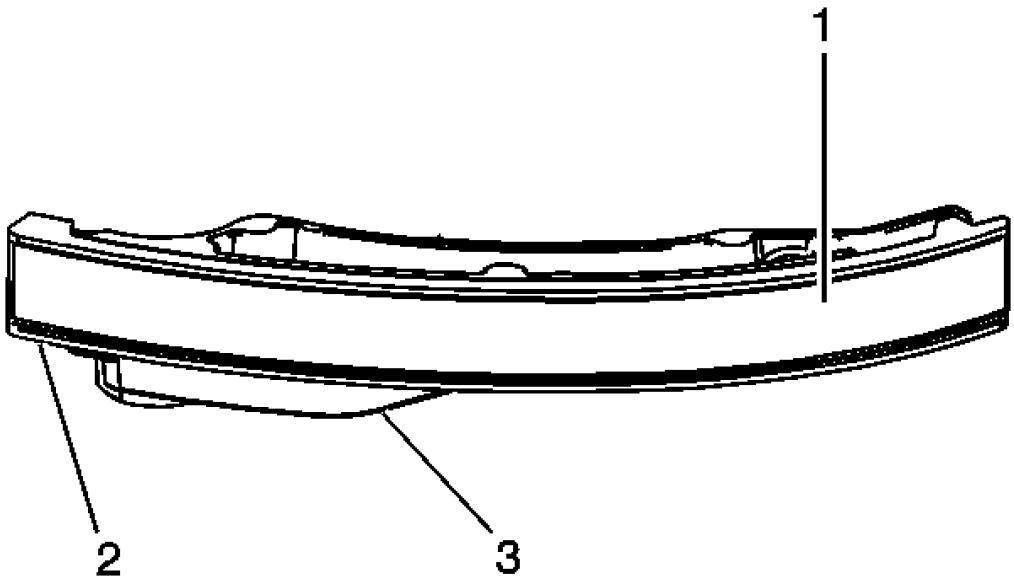


Fig. 128: Inspecting Front Of Right Secondary Timing Chain Shoe
Courtesy of GENERAL MOTORS CORP.

1. Inspect the front of the right secondary timing chain shoe for the following:
    - Worn shoe surface (1)
    - Cracked or broken shoe surface (2)
    - Cracked or damaged shoe (3)

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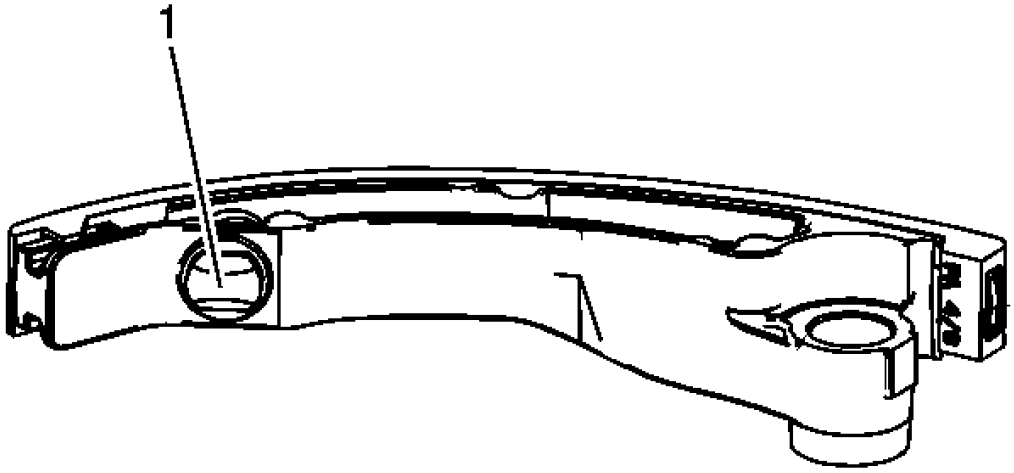


Fig. 129: Inspecting Right Secondary Timing Chain Tensioner Contact Pad
Courtesy of GENERAL MOTORS CORP.

2. Inspect the back of the right secondary timing chain shoe for a damaged, worn, or missing right secondary timing chain tensioner contact pad (1).
3. Replace a damaged right secondary timing chain shoe.

Primary Timing Chain Tensioner

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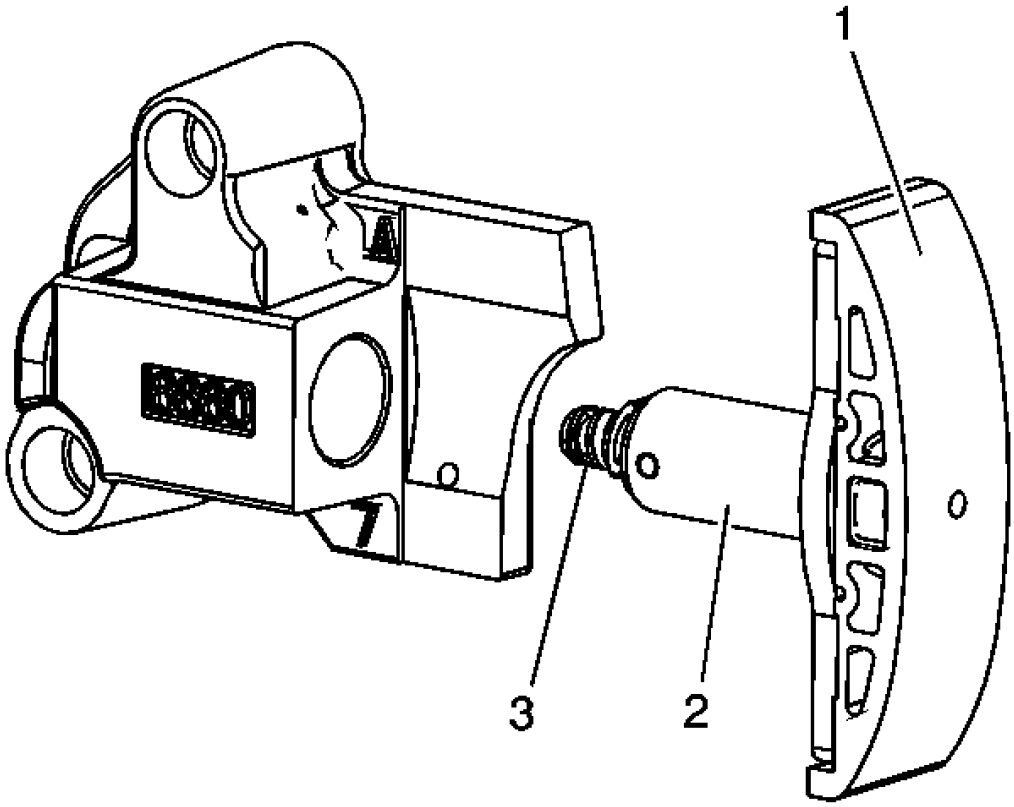


Fig. 130: Primary Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Inspect the primary timing chain tensioner for worn primary timing chain tensioner shoe surface (1).
2. Inspect the primary timing chain tensioner for locked or binding timing chain tensioner. Reset the plunger (3) and ensure the plunger moves freely (2) in and out of the body of the tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation** .
3. Replace a damaged primary timing chain tensioner.

Left Secondary Timing Chain Tensioner

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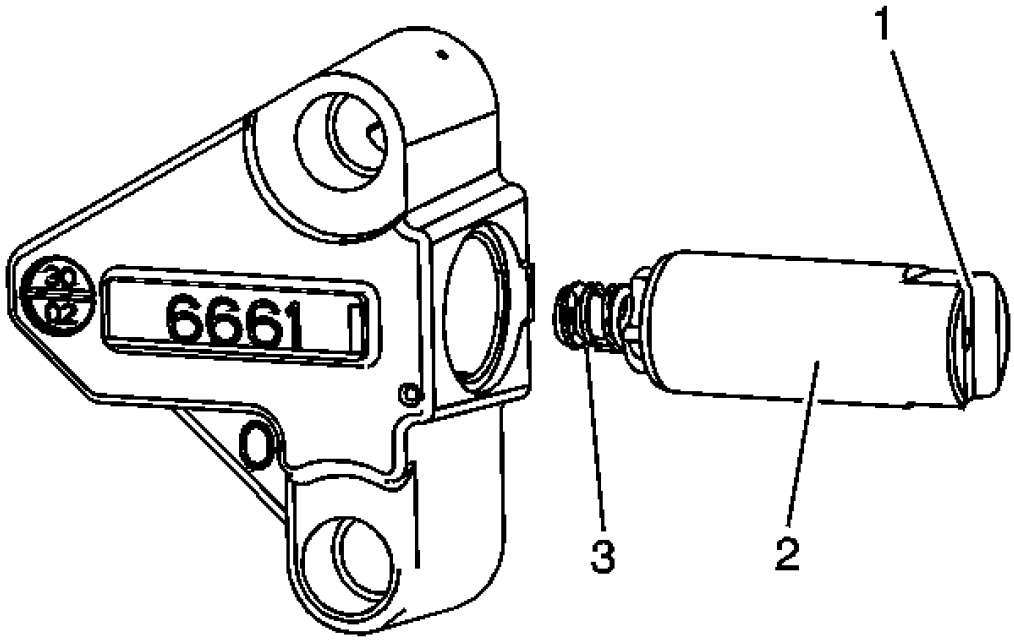


Fig. 131: Inspecting Left Secondary Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Inspect the left secondary timing chain tensioner for damaged plunger-to-shoe contact surface (1).
2. Inspect the left secondary timing chain tensioner for locked or binding timing chain tensioner. Reset the plunger (3) and ensure the plunger moves freely (2) in and out of the body of the tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Left Side** .
3. Replace a damaged left secondary timing chain tensioner.

Right Secondary Timing Chain Tensioner

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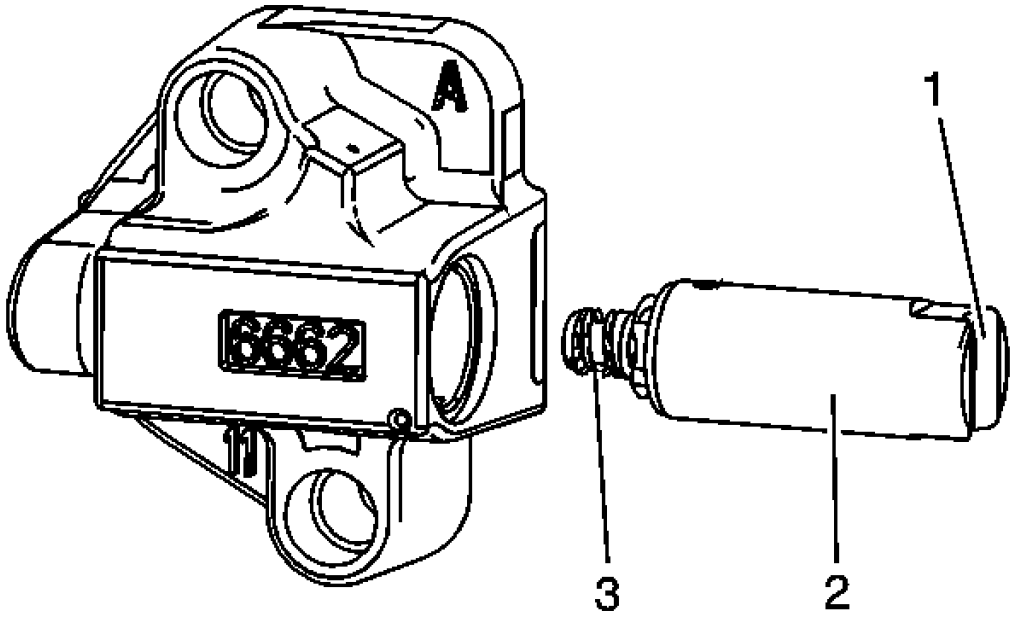


Fig. 132: Inspecting Right Secondary Timing Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Inspect the right secondary timing chain tensioner for damaged plunger-to-shoe contact surface (1).
2. Inspect the right secondary timing chain tensioner for locked or binding timing chain tensioner. Reset the plunger (3) and ensure the plunger moves freely (2) in and out of the body of the tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .
3. Replace a damaged right secondary timing chain tensioner.

OIL PUMP DISASSEMBLE

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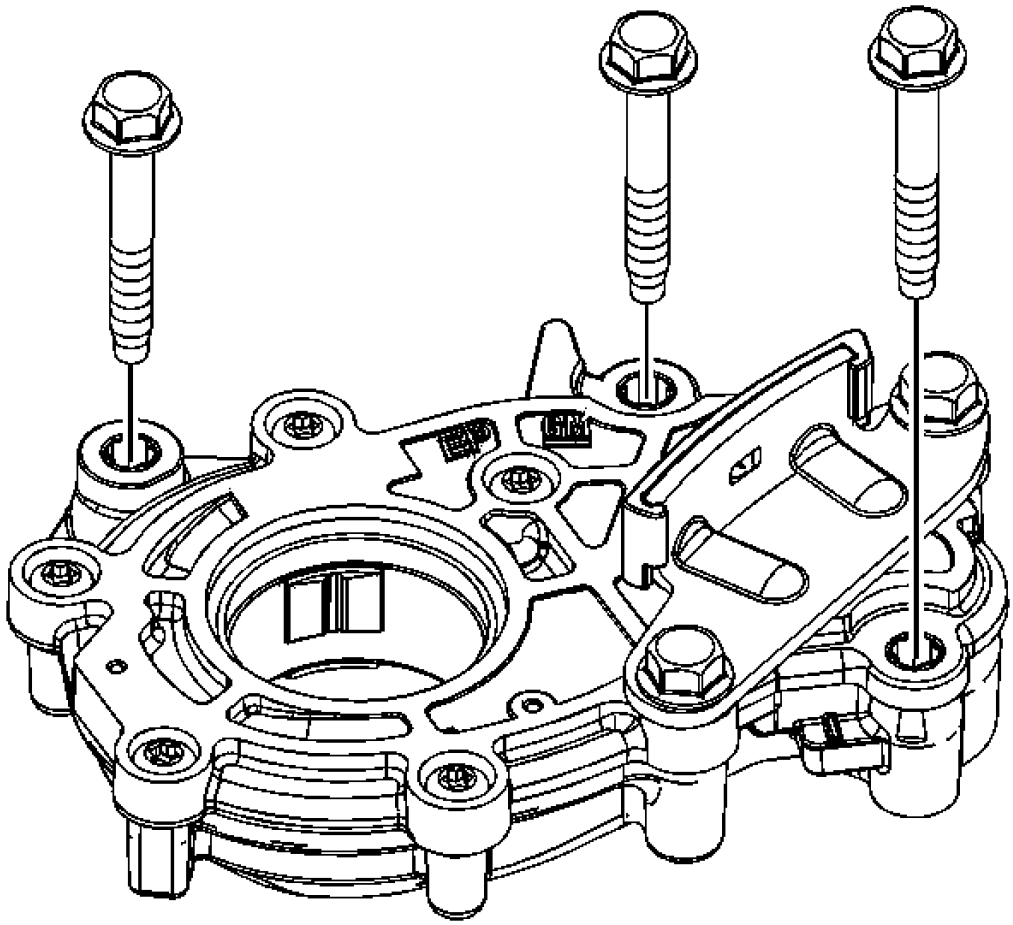


Fig. 133: Oil Pump Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: There are no serviceable components within the oil pump. Disassemble the pump only to diagnose an oiling concern. A disassembled oil pump must not be reused. A disassembled oil pump must be replaced.

1. Remove the oil pump mounting bolts.

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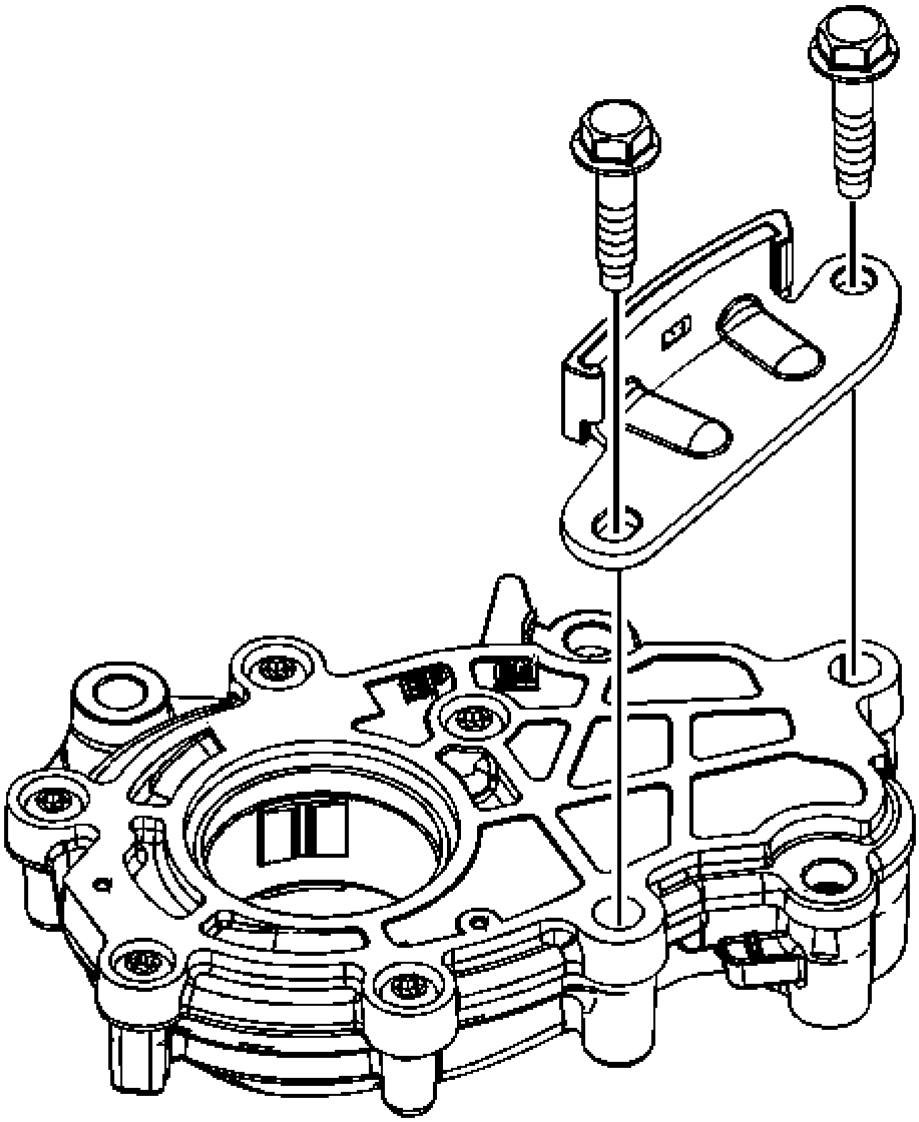


Fig. 134: Primary Camshaft Drive Chain Lower Guide
Courtesy of GENERAL MOTORS CORP.

2. Remove the primary camshaft drive chain lower guide bolts.
3. Remove the primary camshaft drive chain lower guide.

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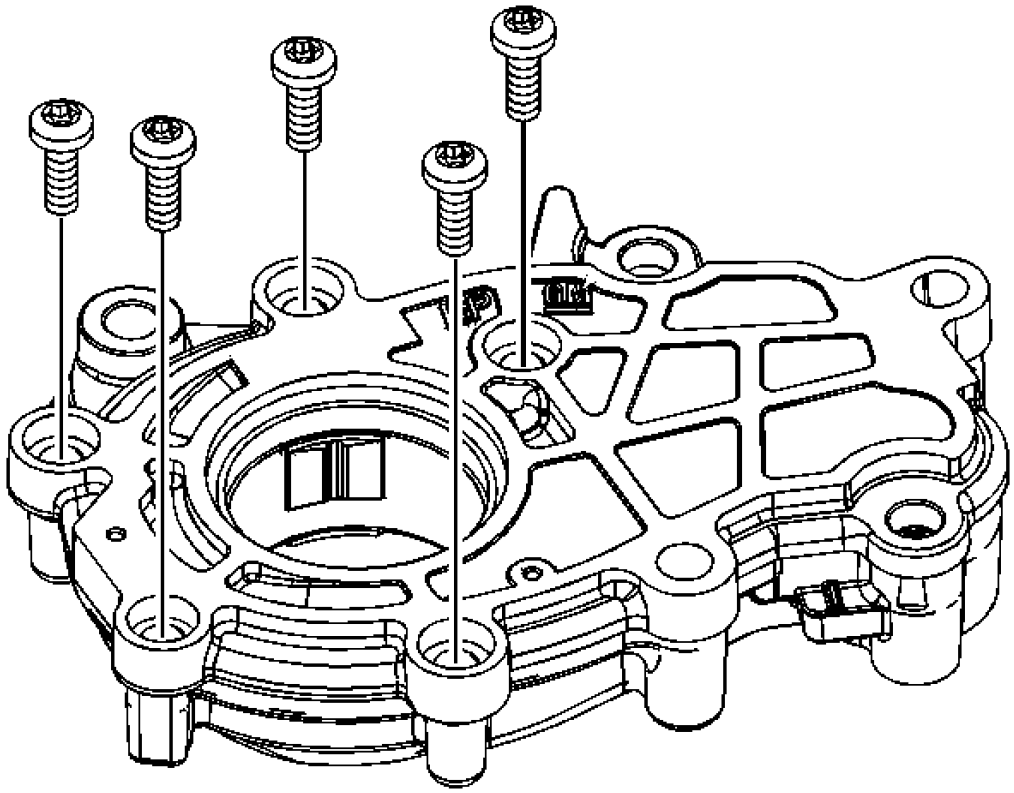


Fig. 135: Oil Pump Cover Bolts
Courtesy of GENERAL MOTORS CORP.

4. Remove the bolts holding the oil pump cover to the oil pump housing.

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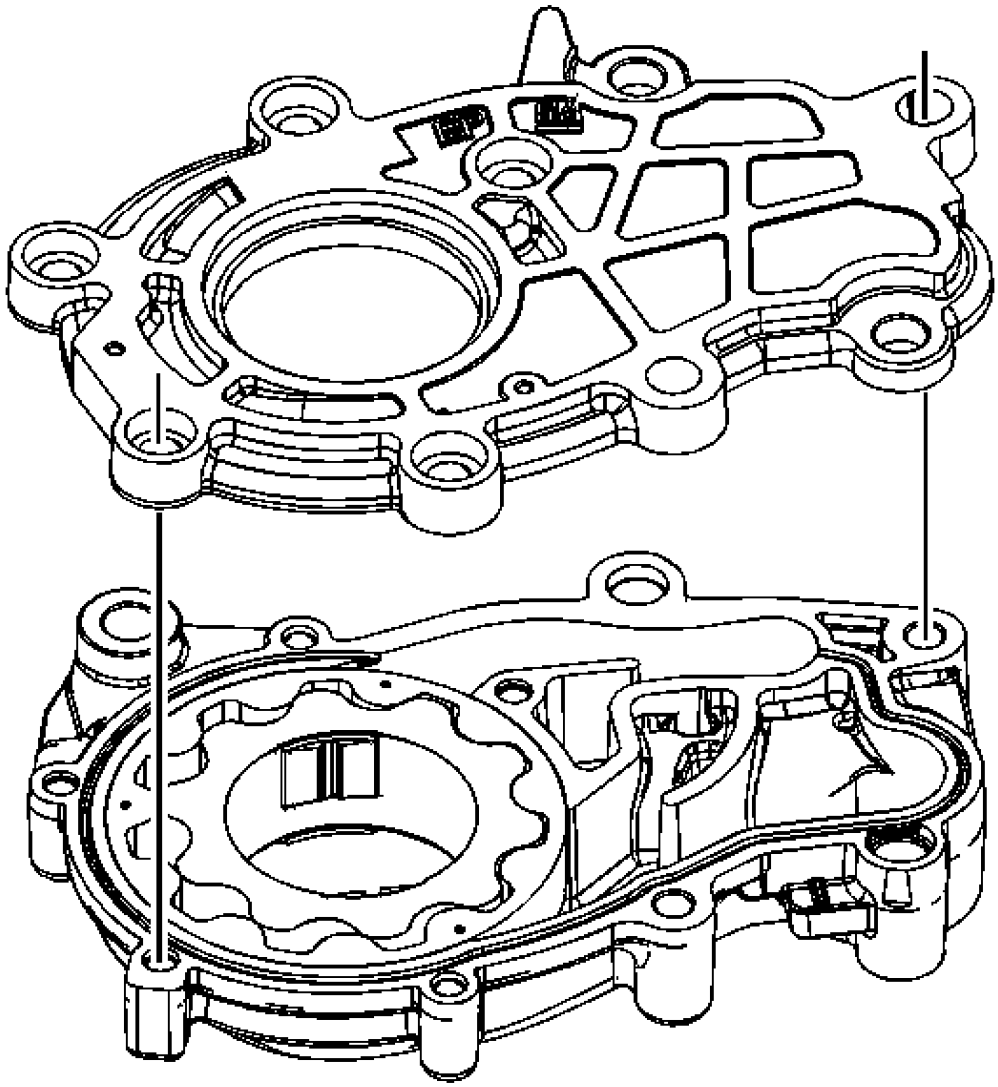


Fig. 136: View Of Oil Pump Housing & Cover
Courtesy of GENERAL MOTORS CORP.

5. Remove the oil pump cover from the oil pump housing.

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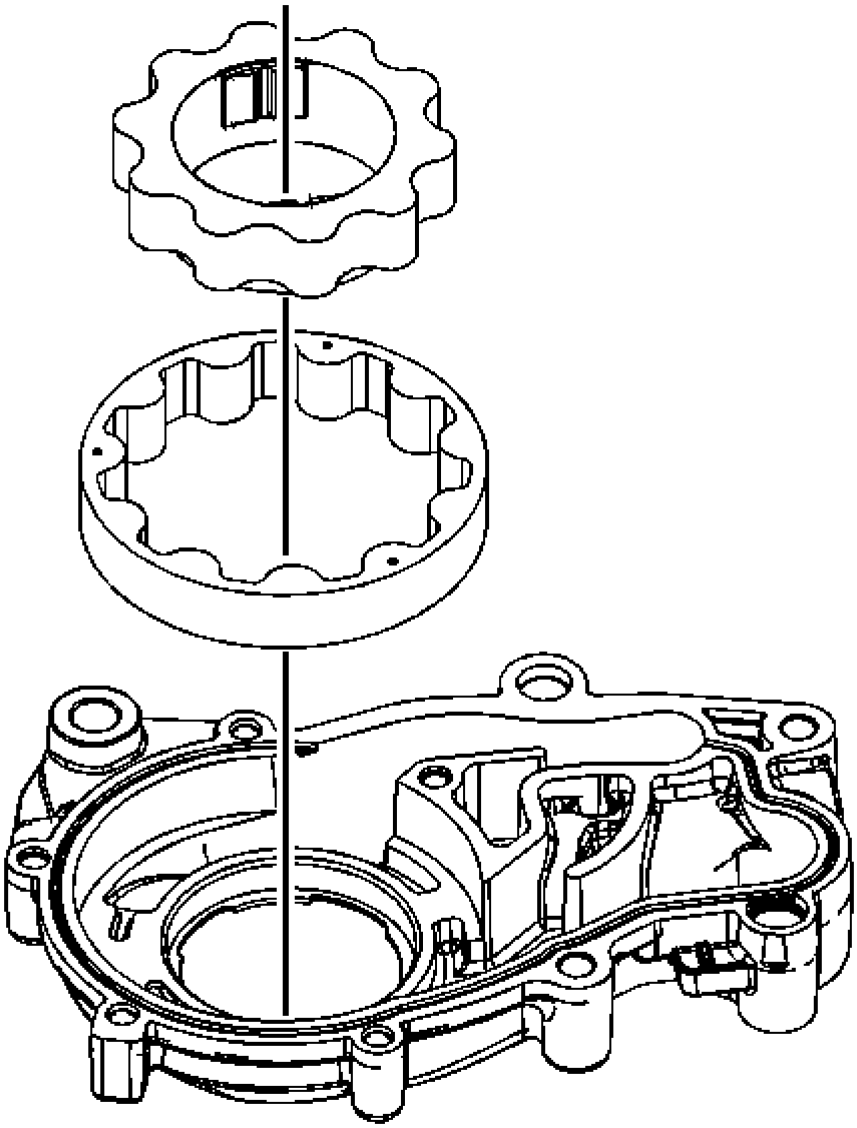


Fig. 137: View Of Oil Pump Gears
Courtesy of GENERAL MOTORS CORP.

6. Remove the inner oil pump drive gear.
7. Remove the outer oil pump driven gear.

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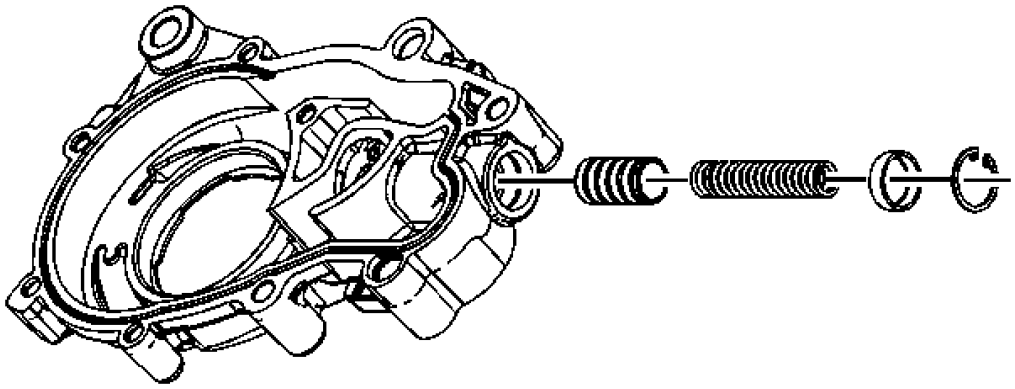


Fig. 138: Oil Relief Valve Components
Courtesy of GENERAL MOTORS CORP.

8. Remove the clip, holding the cap, for the oil relief valve components.
9. Remove the cap, spring, and plunger from the oil pump housing.

OIL PUMP CLEANING AND INSPECTION

CLEANING PROCEDURE

1. Clean the oil pump components with non-corrosive solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the oil pump components with compressed air.

INSPECTION PROCEDURE

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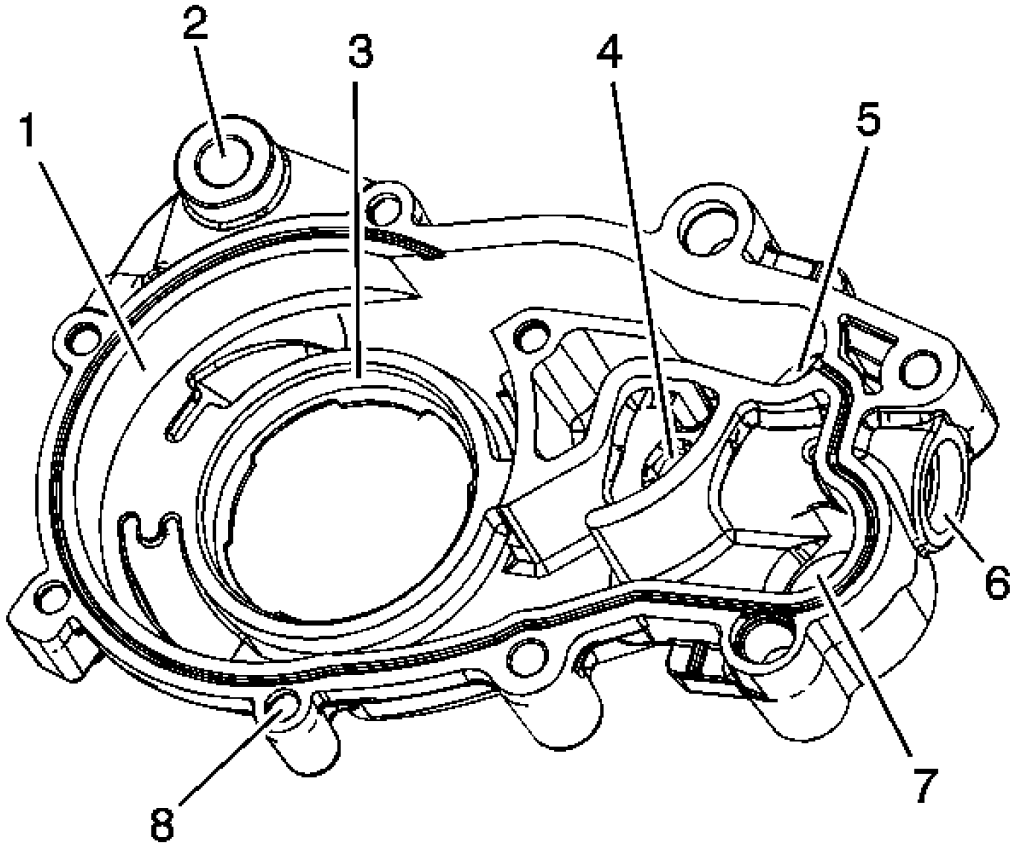


Fig. 139: Identifying Oil Pump Inspection Areas
Courtesy of GENERAL MOTORS CORP.

NOTE: There are no serviceable components within the oil pump. Disassemble the pump only to diagnose an oiling concern. A disassembled oil pump must not be reused. A disassembled oil pump must be replaced.

1. Inspect the oil pump housing for the following:
   - Damage, scoring, or debris on the housing surface for the driven gear (1)
   - Damage to the oil pump mounting bosses (2)
   - Damage, scoring, or debris on the housing surface for the drive gear (3)
   - Damage, scoring, or debris in the oil pump relief valve port (4)
   - Damage, scoring, or debris in the oil pump intake port (5)
   - Damage, scoring, or debris in the oil pump relief valve bore (6)
   - Damage, scoring, or debris in the oil pump output port (7)

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- Damage to the threads in the oil pump housing for the oil pump cover bolts (8)

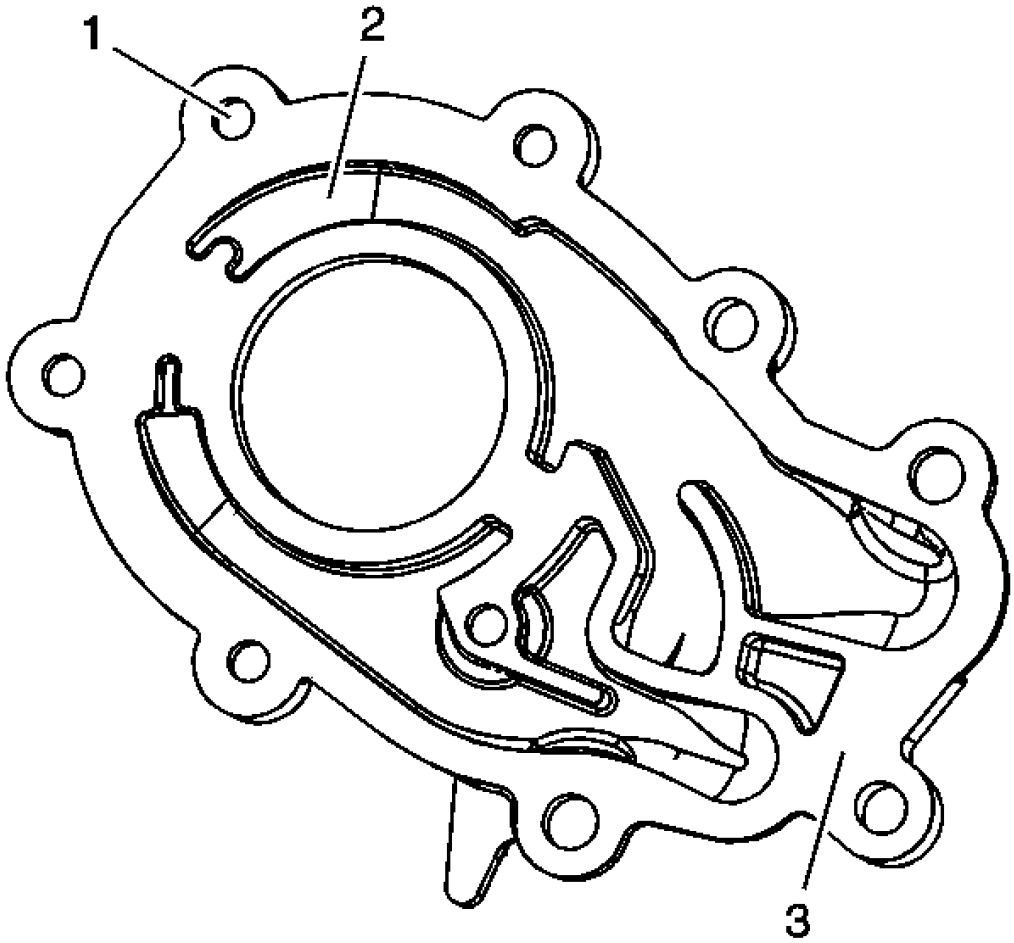


Fig. 140: Inspecting Oil Pump Cover
Courtesy of GENERAL MOTORS CORP.

2. Inspect the oil pump cover for the following conditions:
   - Damage to the oil pump cover mounting bosses (1)
   - Damage, scoring, or debris in the oil pump cover oil passages (2)
   - Damage to the sealing surface between the oil pump cover and the oil pump housing (3)

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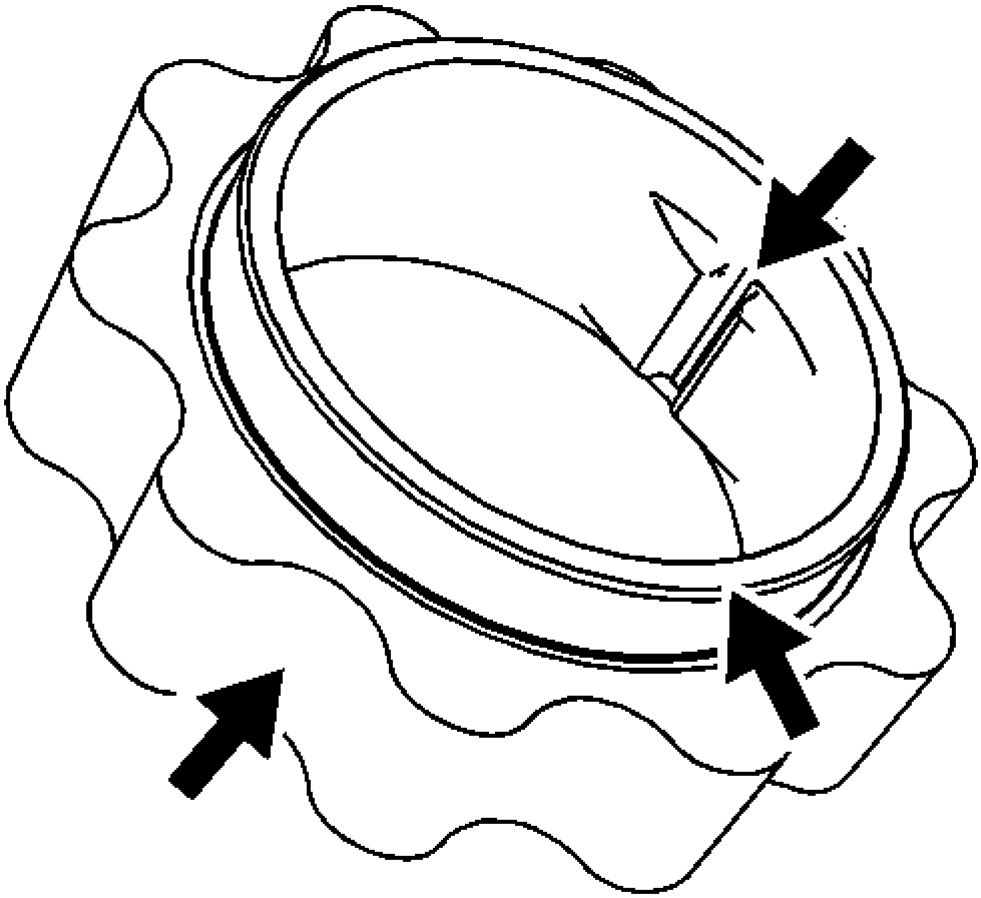


Fig. 141: Inspecting Inner Drive Gear
Courtesy of GENERAL MOTORS CORP.

3. Inspect the inner drive gear for damage. If inner diameter damage is found, ensure the crankshaft is also inspected.

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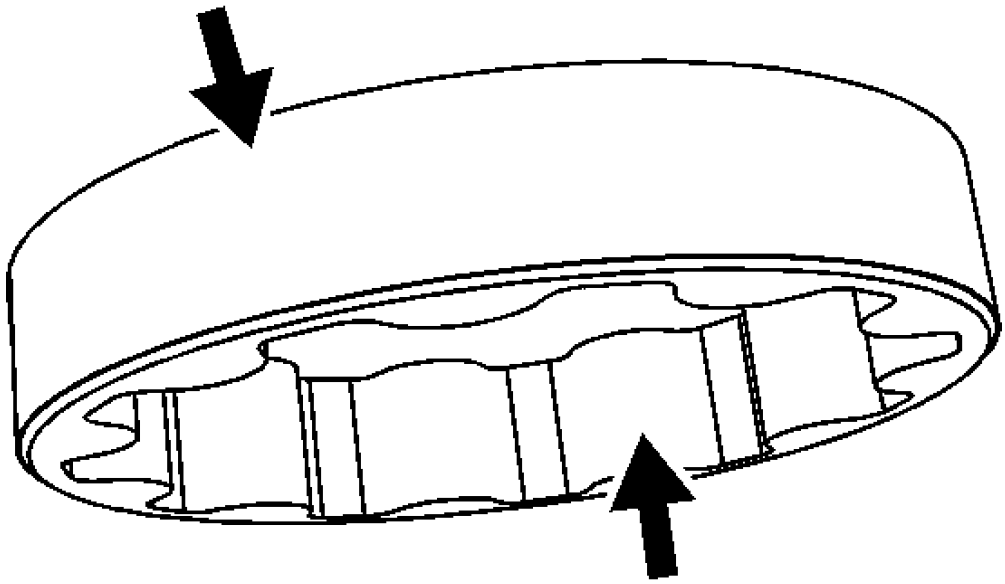


Fig. 142: Inspecting Outer Driven Gear
Courtesy of GENERAL MOTORS CORP.

4. Inspect the outer driven gear for damage.

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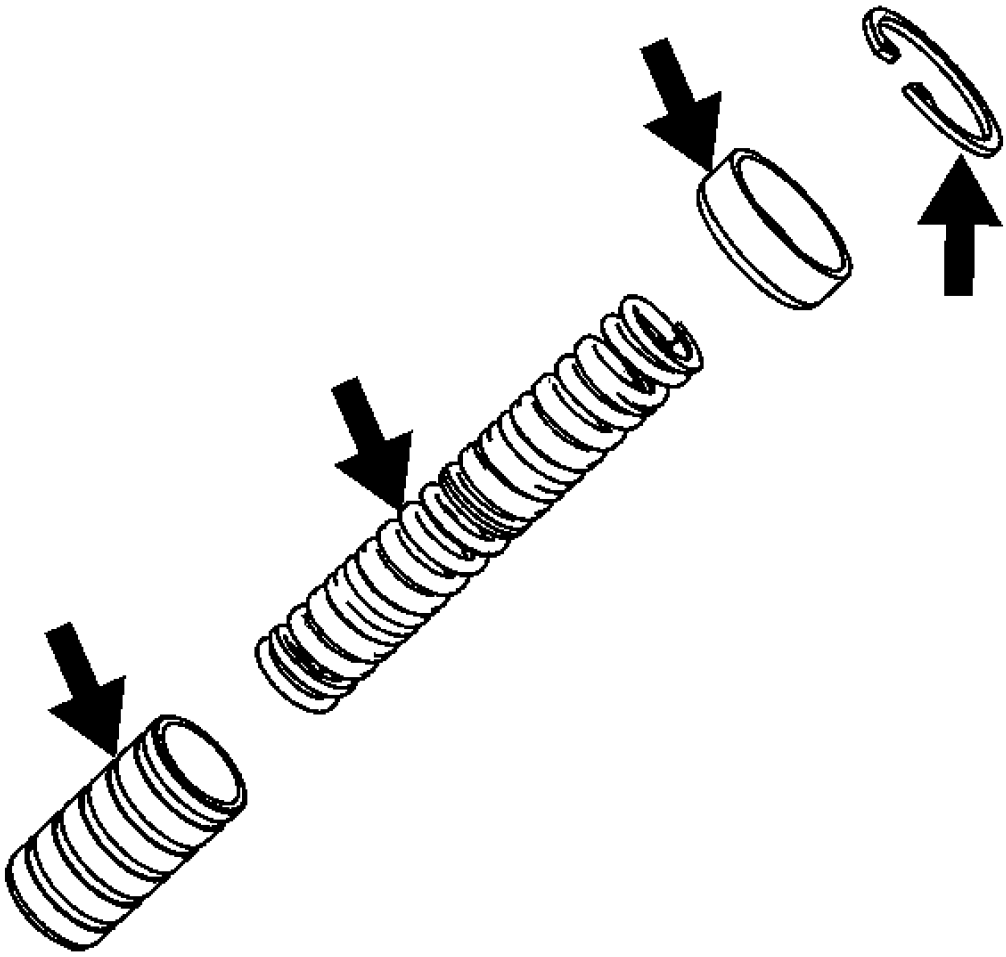


Fig. 143: Oil Pump Relief Valve Components
Courtesy of GENERAL MOTORS CORP.

5. Inspect the oil pump relief valve components for debris or damage.

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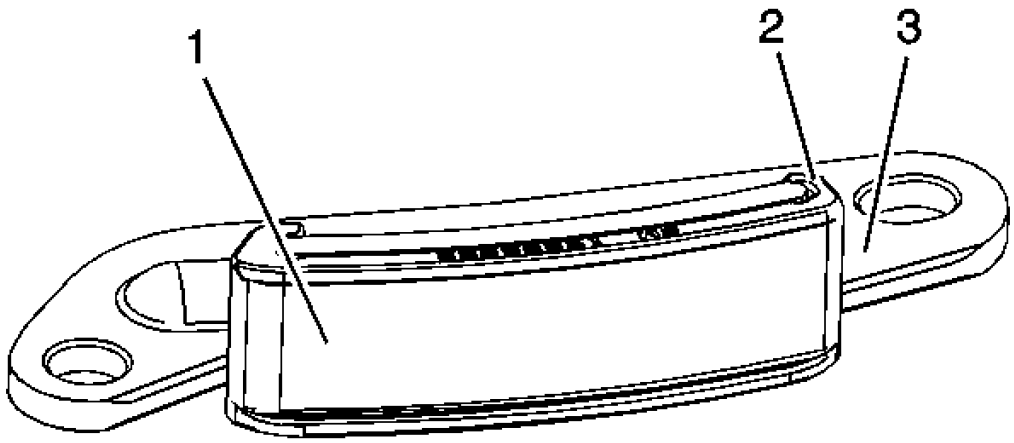


Fig. 144: Primary Camshaft Drive Chain Lower Guide
Courtesy of GENERAL MOTORS CORP.

6. Inspect the primary camshaft drive chain lower guide for damage (1-3).
7. If debris or damage is present within the oil pump, further inspection of all of the engine components is necessary.

OIL FILTER ADAPTER DISASSEMBLE

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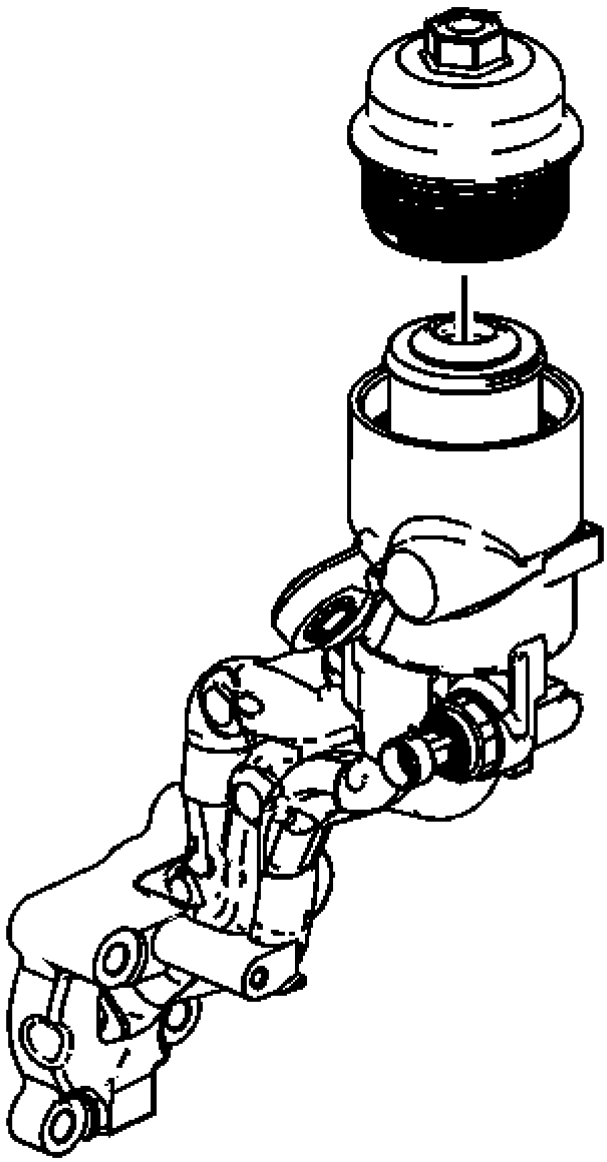


Fig. 145: View Of Oil Filter Cap
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil filter cap.

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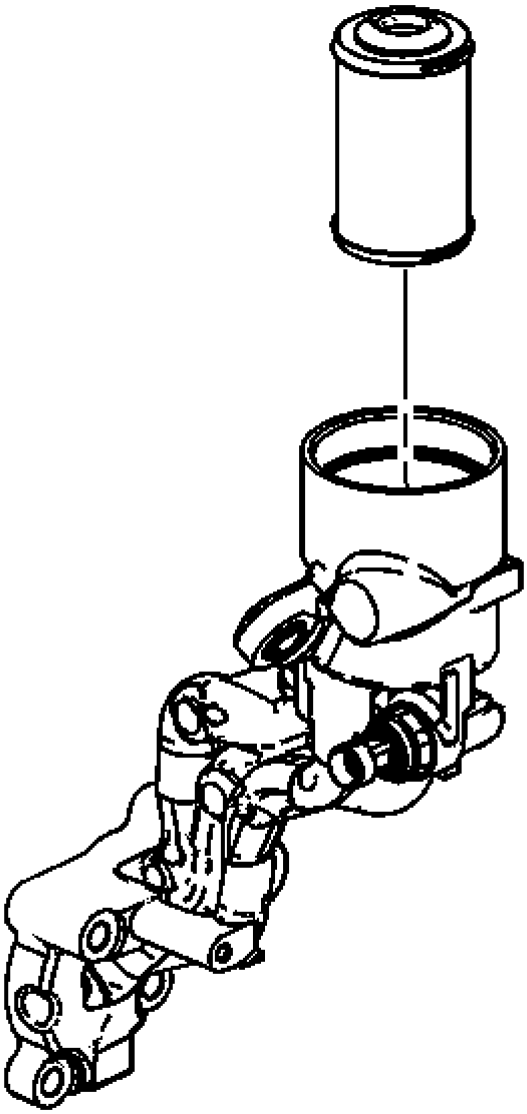


Fig. 146: View Of Oil Filter Cartridge
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil filter cartridge and discard.

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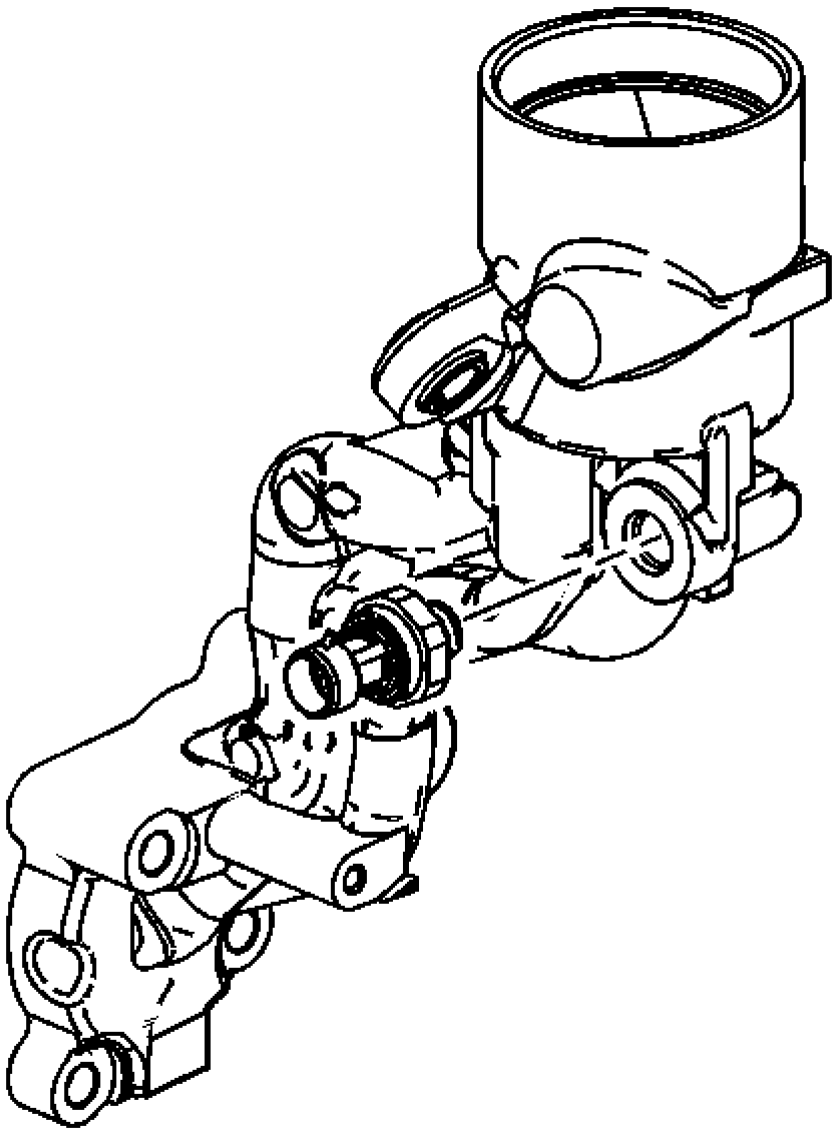


Fig. 147: View Of Oil Pressure Sender
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil pressure sender.

OIL FILTER ADAPTER CLEANING AND INSPECTION

CLEANING PROCEDURE

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1. Clean the oil filter adapter components with non-corrosive solvent.

   WARNING: Refer to Safety Glasses Warning .

2. Dry the oil filter adapter components with compressed air.

INSPECTION PROCEDURE

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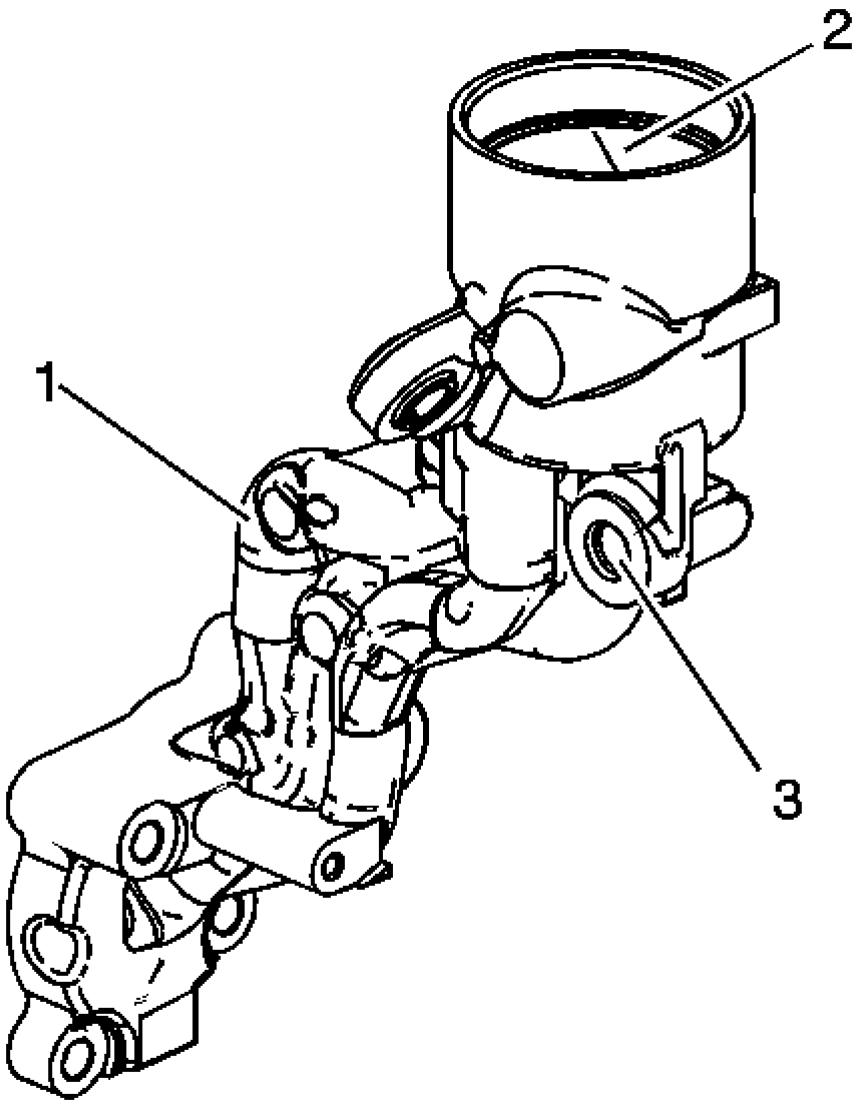


Fig. 148: Inspecting Oil Filter Adapter
Courtesy of GENERAL MOTORS CORP.

NOTE: The internal parts of the oil filter adapter are not serviced separately. If wear or damage is noted, replace the entire oil filter adapter assembly.

1. Inspect the oil filter housing for cracks, scoring, casting imperfections (1) and damaged threads (3).
2. Inspect the drain back valve (2) for damage or blockage.

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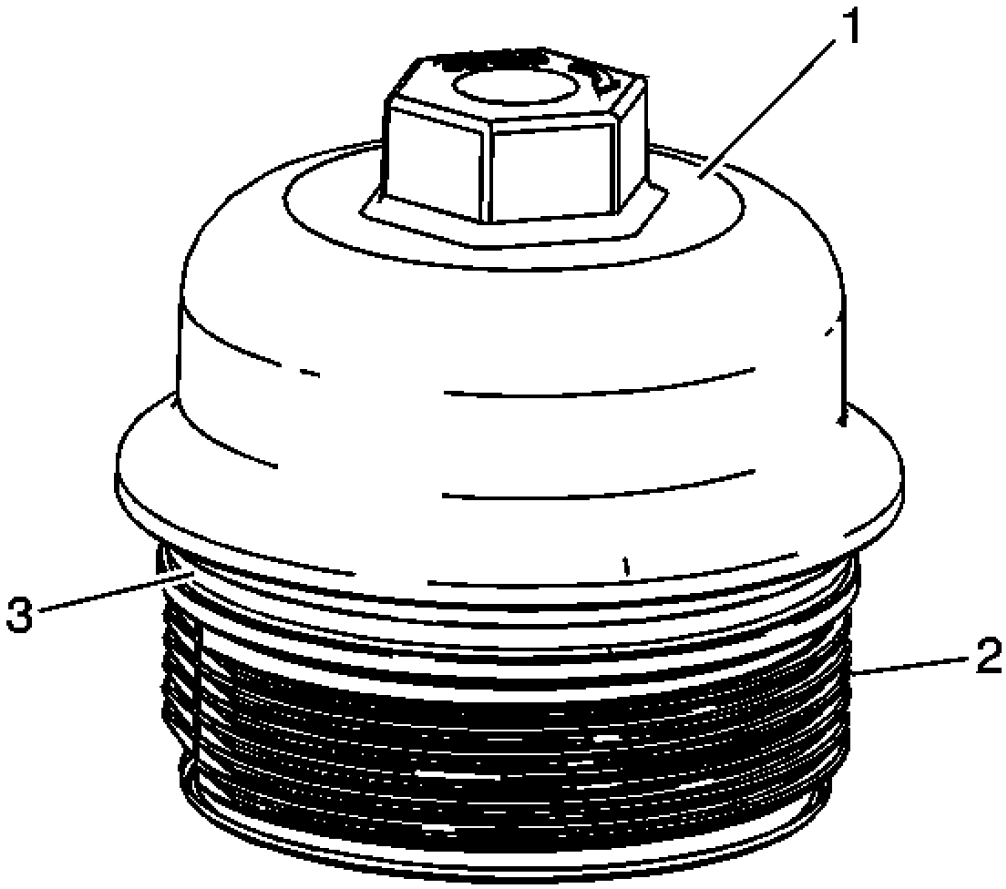


Fig. 149: Inspecting Oil Filter Cap
Courtesy of GENERAL MOTORS CORP.

3. Inspect the oil filter cap for cracks, scoring, casting imperfections (1) and damaged threads (2). Replace as necessary.
4. Inspect the oil filter cap O-ring (3) for damage. Replace as necessary.
5. If the O-ring is damaged, carefully remove the O-ring using a tool that will not damage the oil filter cap O-ring groove. If the oil filter cap O-ring groove is damaged the oil filter cap must be replaced.

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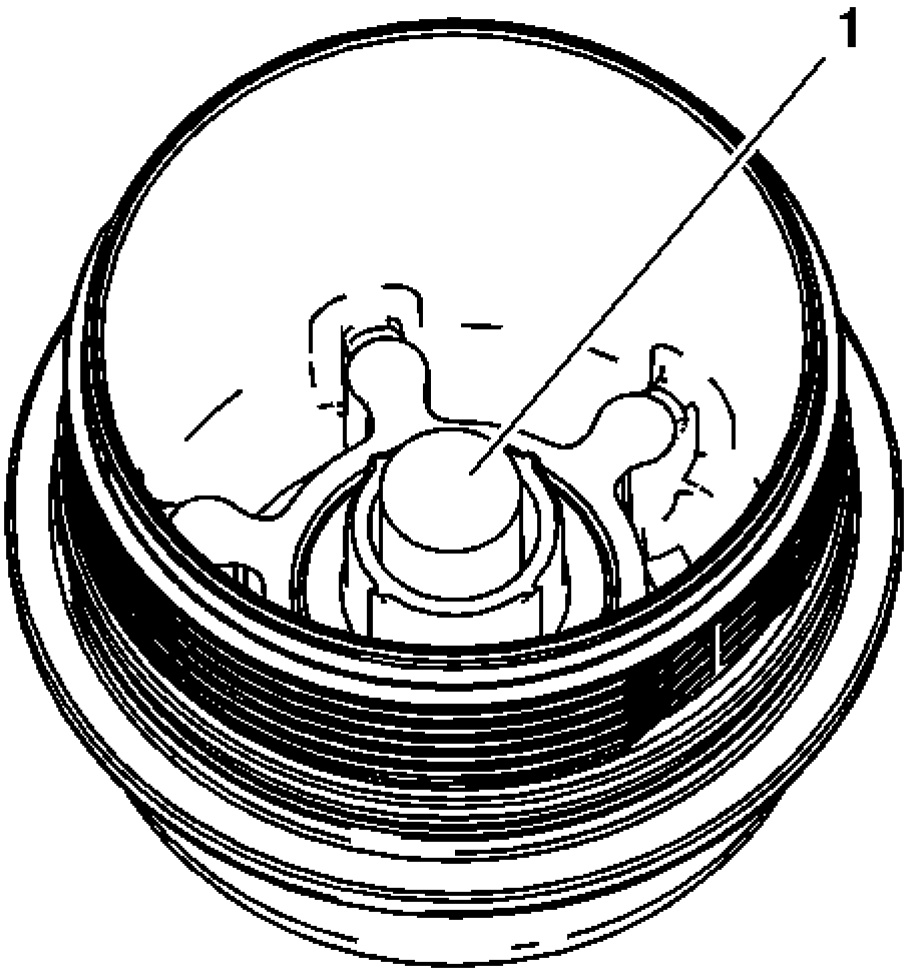


Fig. 150: Inspecting Bypass Valve
Courtesy of GENERAL MOTORS CORP.

6. Inspect the bypass valve (1) for damage or blockage.

OIL FILTER ADAPTER ASSEMBLE

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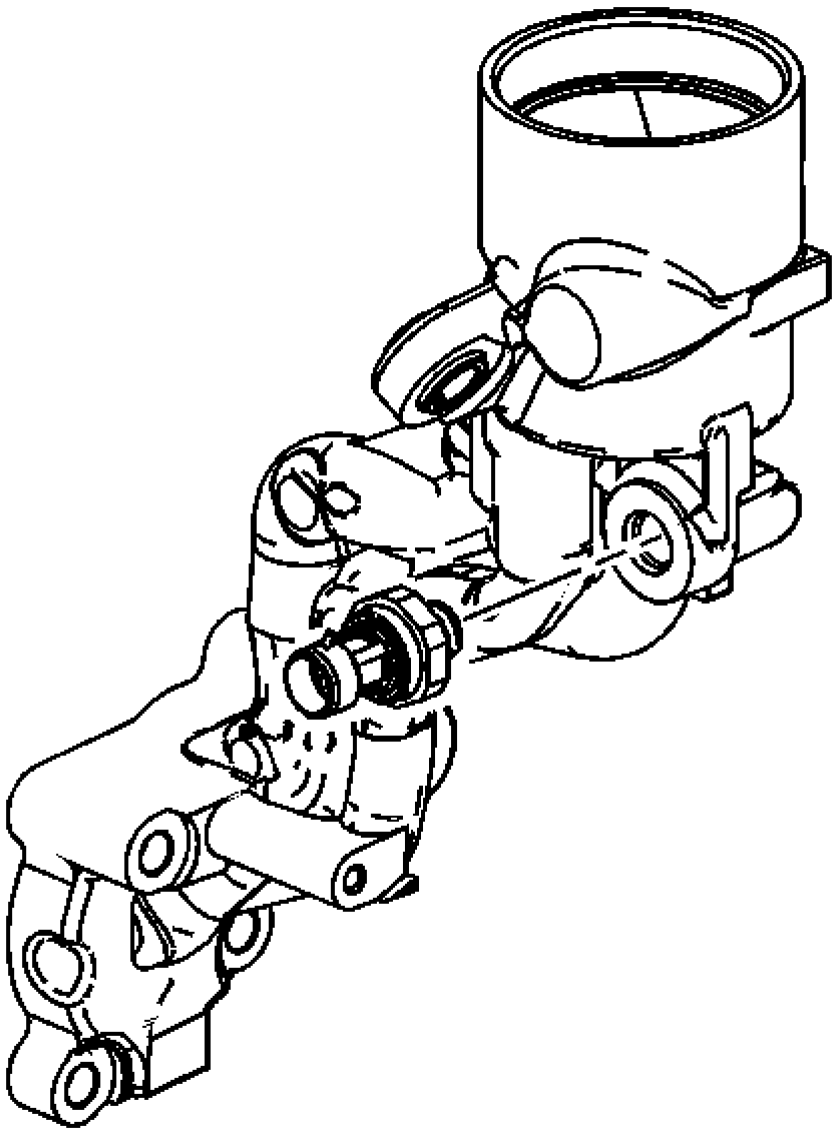


Fig. 151: View Of Oil Pressure Sender
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the oil pressure sender and tighten to 20 N.m (15 lb ft).

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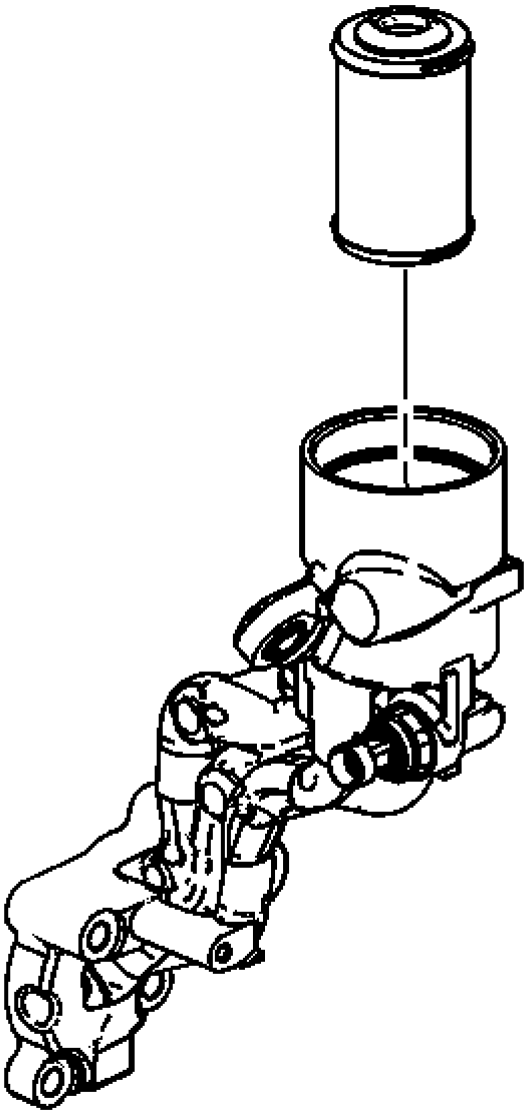


Fig. 152: View Of Oil Filter Cartridge
Courtesy of GENERAL MOTORS CORP.

2. Install the NEW oil filter cartridge.
3. If the oil filter cap O-ring is removed, install a NEW O-ring on the oil filter cap.
    1. Ensure the O-ring groove is not damaged. Replace the oil filter cap if the O-ring groove is damaged.
    2. Protect the O-ring from damage during installation by covering the threads of the oil filter cap with

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tape or plastic wrap.

3. DO NOT stretch the O-ring during installation.
4. Roll the O-ring into position over the covered threads.
5. Remove the tape or plastic wrap from the oil filter cap threads.
6. Ensure the oil filter cap threads are clean.

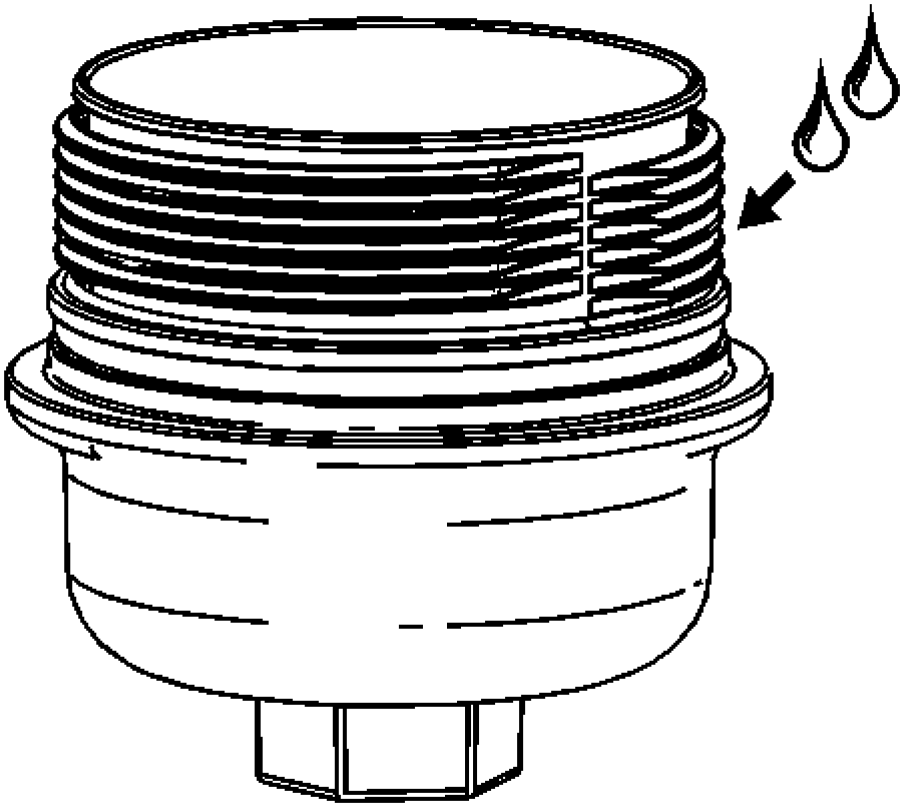


Fig. 153: Lubricating Threads Of Oil Filter Cap
Courtesy of GENERAL MOTORS CORP.

CAUTION: Lubrication must be applied to the threads of the oil filter cap prior to installation. Failure to lubricate the oil filter cap threads can hinder later removal and cause possible oil filter cap damage.

4. Lubricate the oil filter cap threads and O-ring with clean engine oil.

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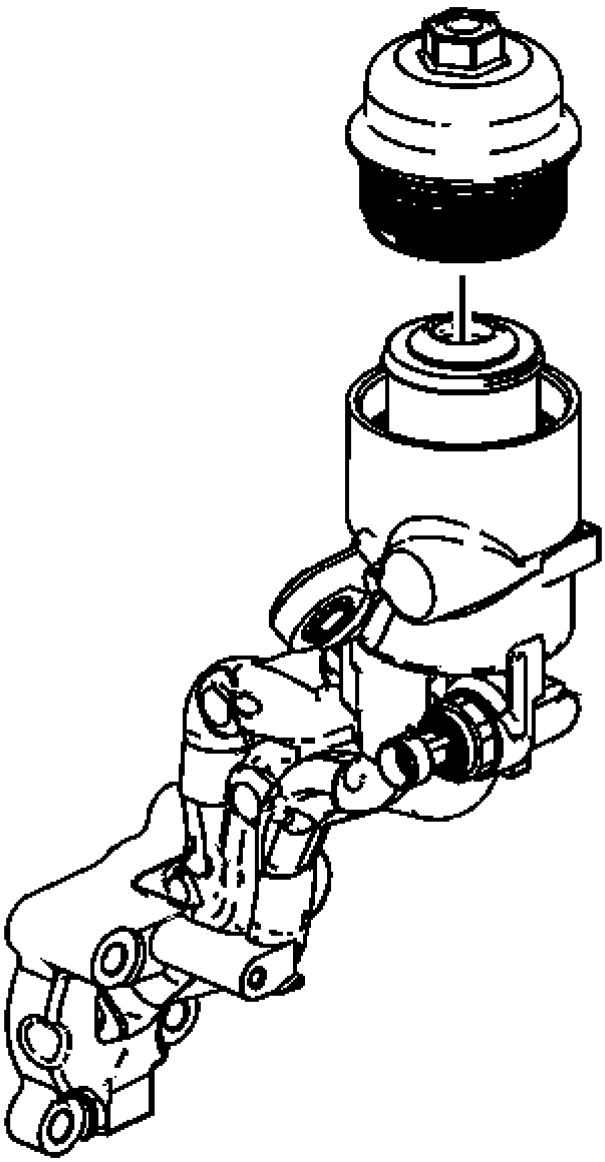


Fig. 154: View Of Oil Filter Cap
Courtesy of GENERAL MOTORS CORP.

5. Install the oil filter cap and tighten to 25 N.m (18 lb ft).

OIL PAN DISASSEMBLE

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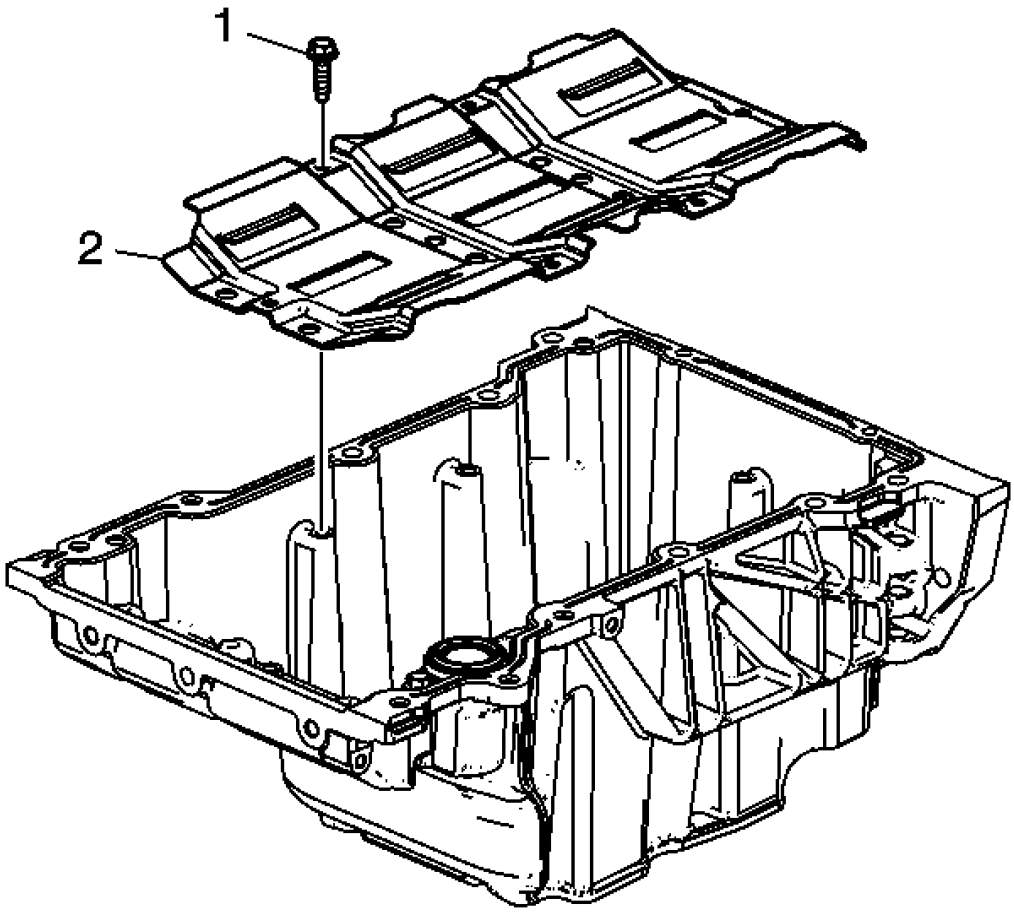


Fig. 155: Oil Pan Scraper & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil pan scraper bolts (1).
2. Remove the oil pan scraper (2).

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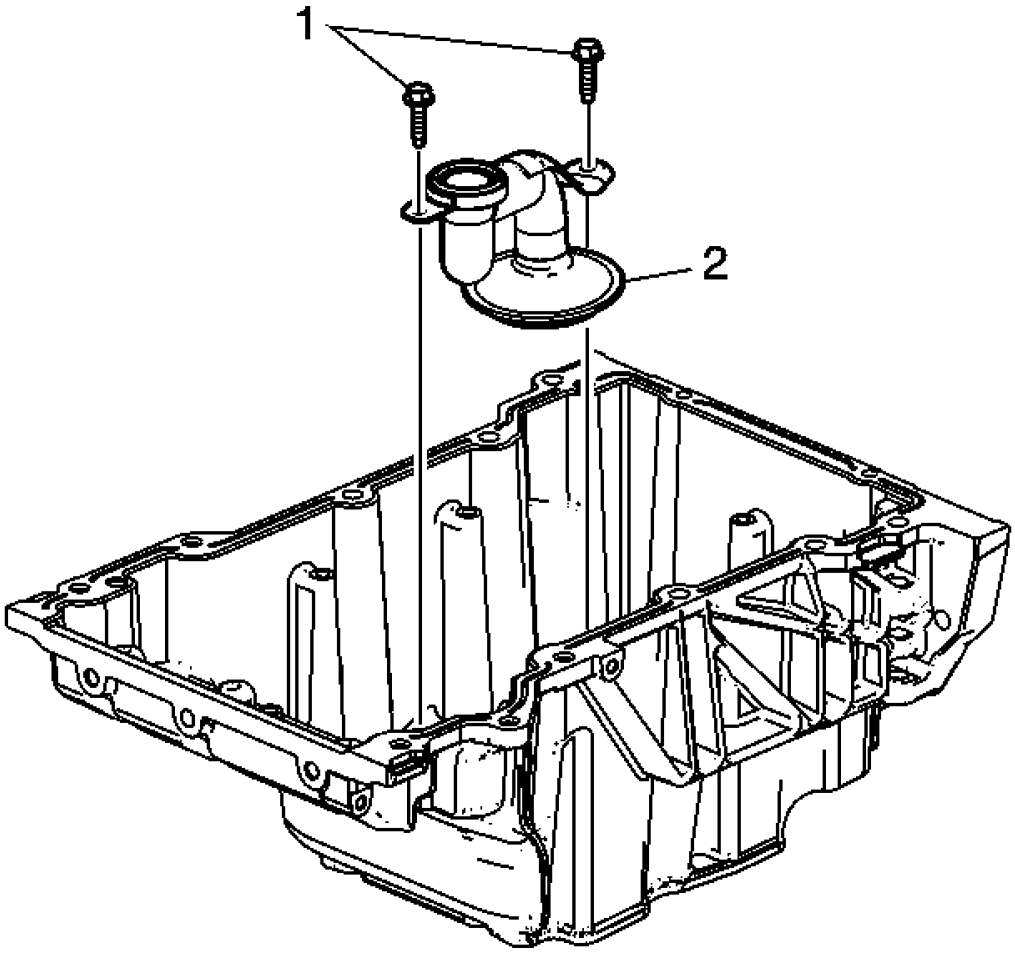


Fig. 156: Oil Suction & Pipe Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil suction pipe bolts (1).
4. Remove the oil suction pipe (2).

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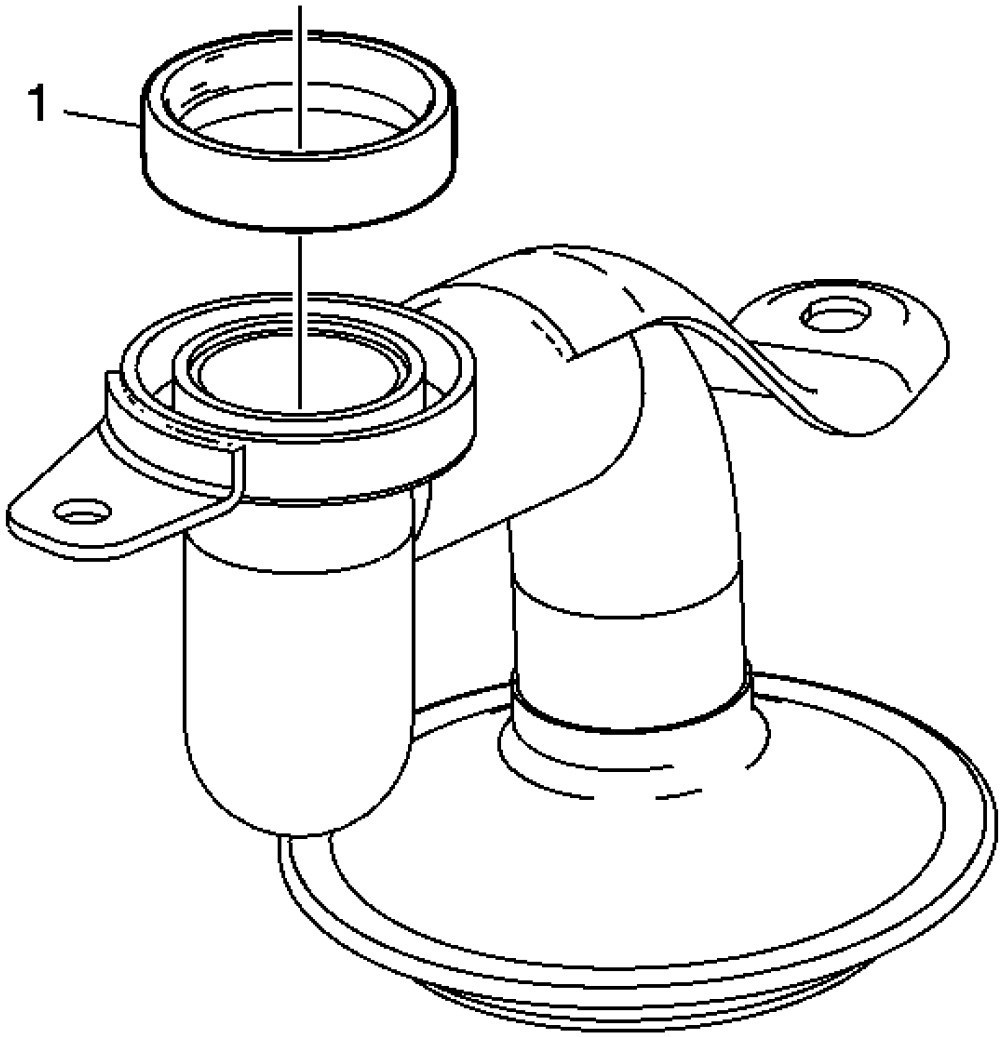


Fig. 157: Oil Suction Pipe Seal
Courtesy of GENERAL MOTORS CORP.

5. Remove and discard the oil suction pipe seal (1).

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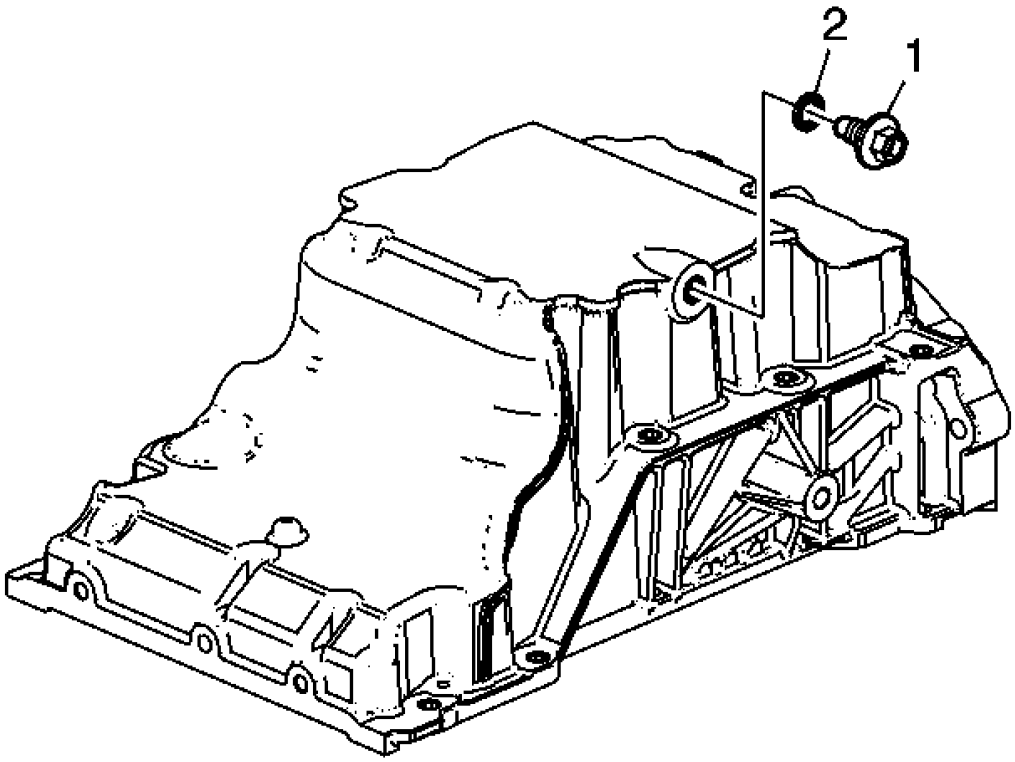


Fig. 158: Oil Pan Drain Plug & Seal
Courtesy of GENERAL MOTORS CORP.

6. Remove the oil pan drain plug (1).
7. Remove and discard the oil pan drain plug seal (2).

OIL PAN CLEANING AND INSPECTION

SPECIAL TOOLS

J 28410: Gasket Remover

For equivalent regional tools, refer to **Special Tools** .

CLEANING PROCEDURE

1. Remove any old thread sealant, gasket material or sealant using **J 28410:** remover.
2. Clean the oil pan and oil pan components in solvent.

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3. Clean out debris from the bolt holes.

WARNING: Refer to Safety Glasses Warning .

4. Dry the oil pan and oil pan components with compressed air.

INSPECTION PROCEDURE

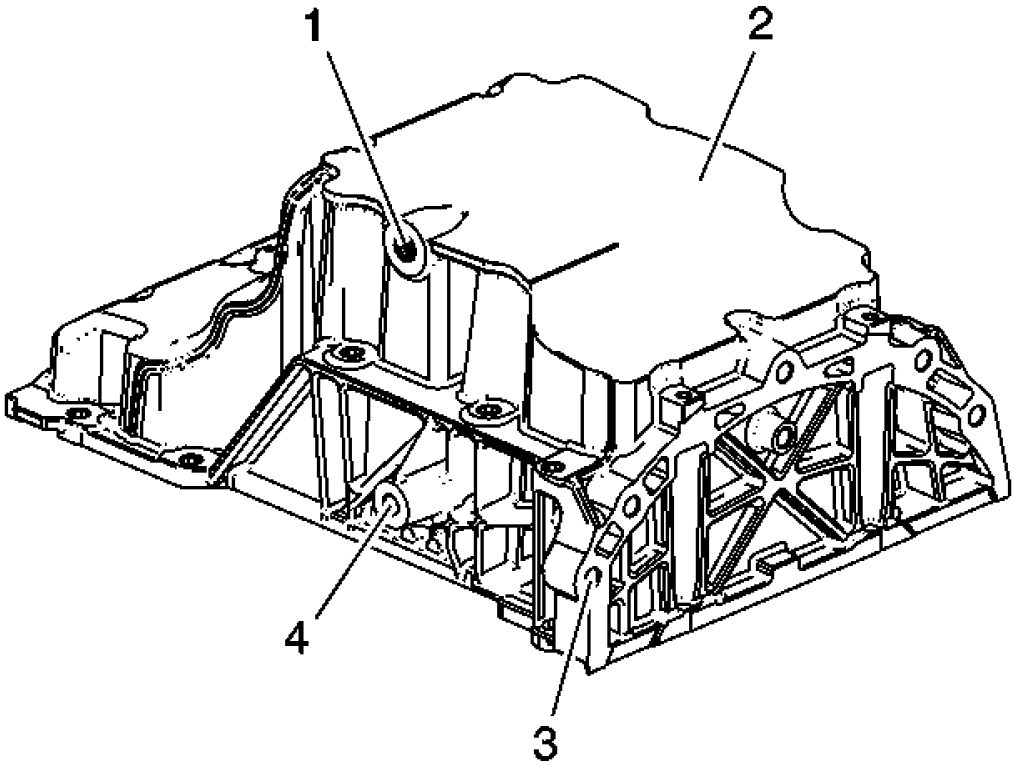


Fig. 159: Oil Pan Components
Courtesy of GENERAL MOTORS CORP.

1. Inspect the exterior of the oil pan for the following conditions:
   - Dents or damage to the exterior (2)
   - Damage to the drain plug or drain plug hole (1)
   - Damage to the brace mounting bosses (4)
   - Damage to the mounting bosses (3)

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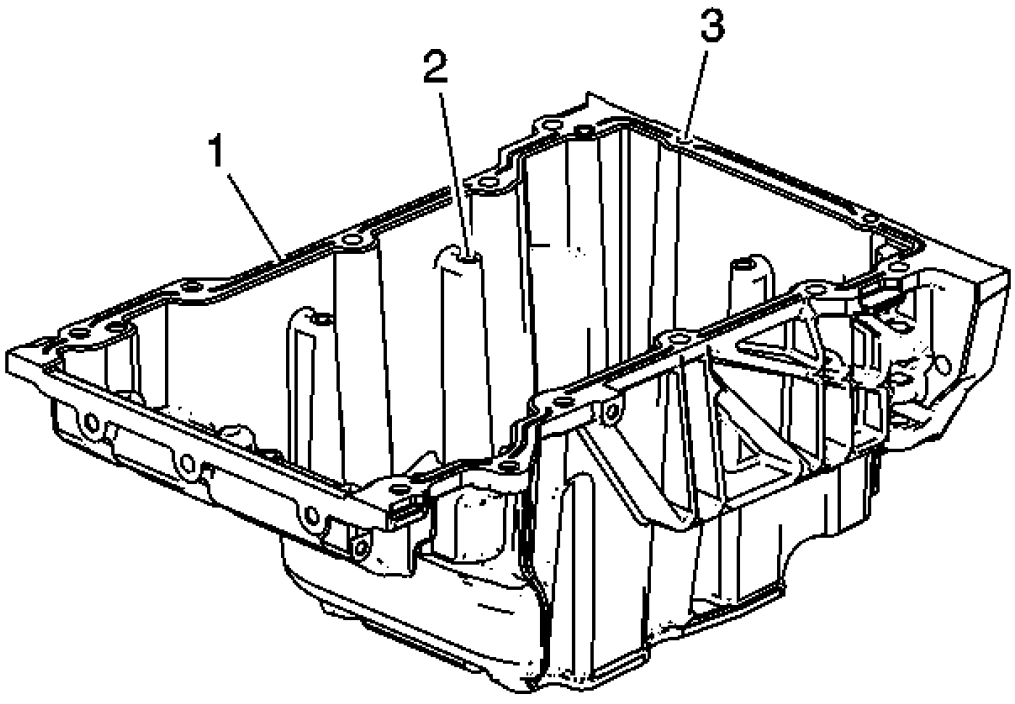


Fig. 160: Interior Of Oil Pan
Courtesy of GENERAL MOTORS CORP.

2. Inspect the interior of the oil pan for the following conditions:
   - Gouges or damage to the oil pan sealing surfaces (1)
   - Damage to the oil pan scraper mounting holes (2)
   - Damage to the bolt holes (3)
3. Repair or replace the oil pan and/or oil pan components as necessary.

OIL PUMP SUCTION PIPE AND SCREEN CLEANING AND INSPECTION

CLEANING PROCEDURE

1. Clean the oil pump pipe and screen with solvent.

   WARNING: Refer to Safety Glasses Warning .

2. Dry the oil pump pipe and screen with compressed air.

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INSPECTION PROCEDURE

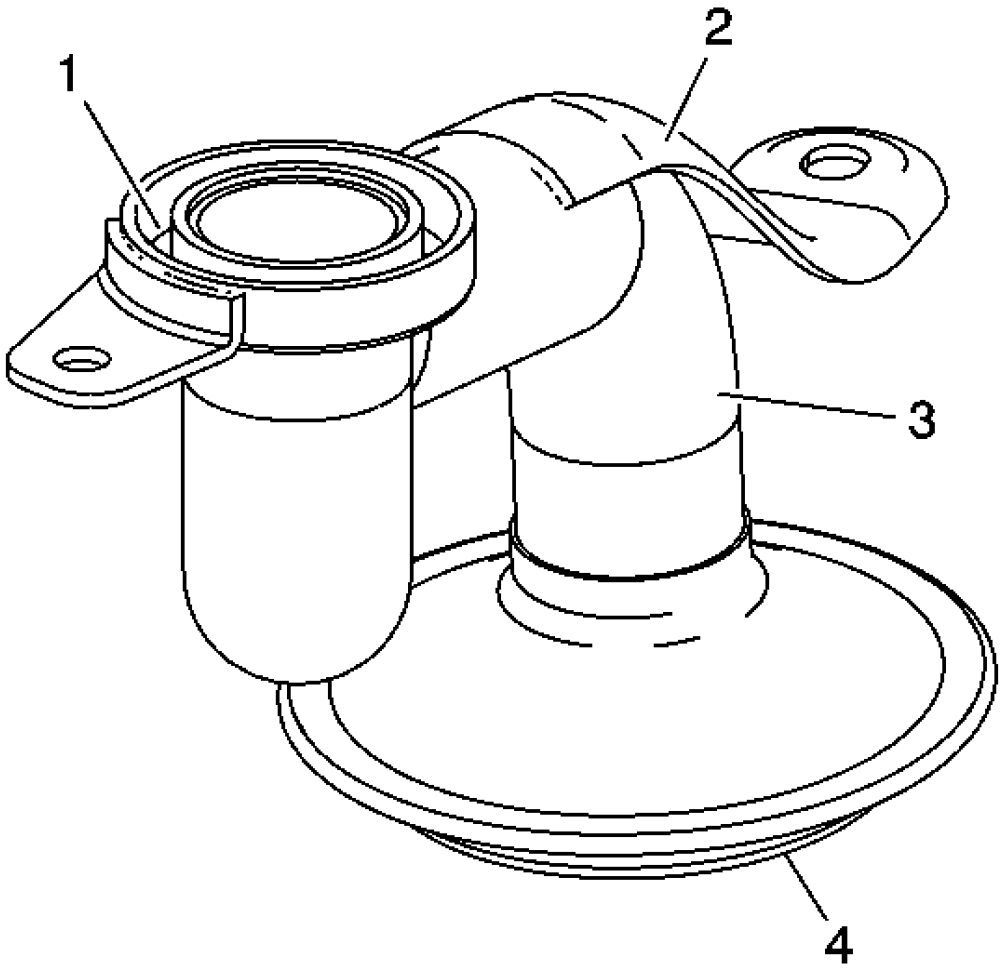


Fig. 161: Oil Pump Suction Pipe & Screen
Courtesy of GENERAL MOTORS CORP.

1. Inspect the mounting surface (1) for possible leakage paths.
2. Inspect the oil pump pipe tube (3) for cracks, imperfections and/or damage.
3. Inspect the oil pump pipe support bracket (2) for cracks or damage.
4. Inspect the oil pump screen (4) for blockage, foreign material, tears, cracks and/or damage.

OIL PAN ASSEMBLE

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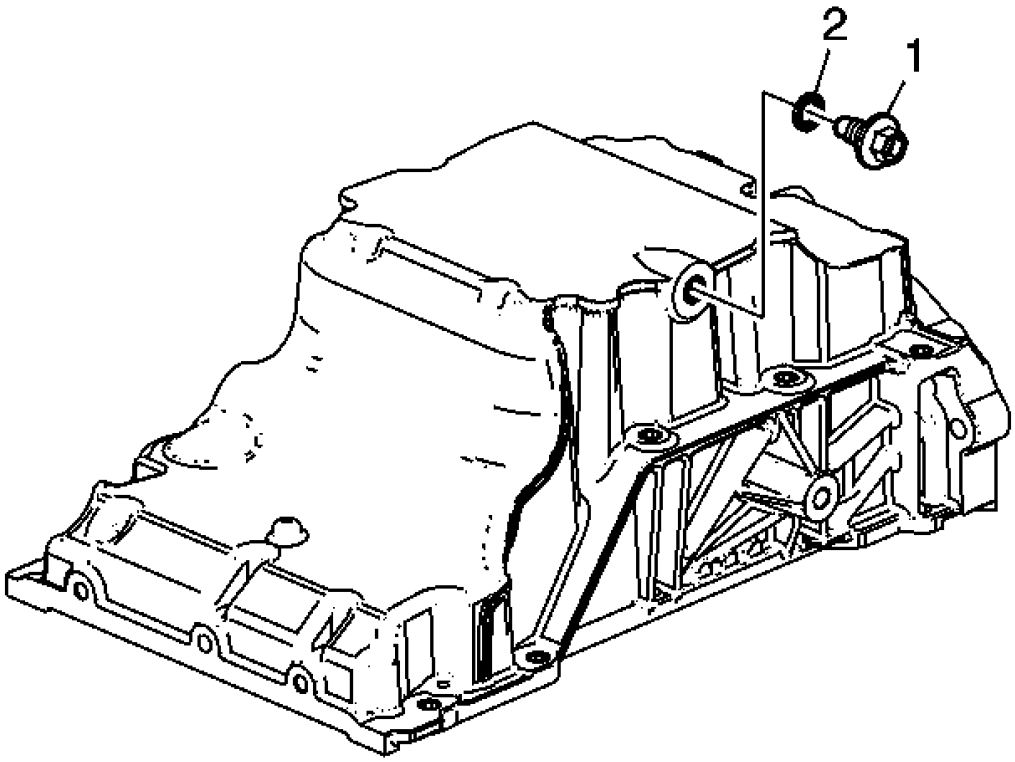


Fig. 162: Oil Pan Drain Plug & Seal
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the oil pan drain plug (1) and NEW drain plug seal (2) and tighten the oil pan drain plug to 25 N.m (18 lb ft).

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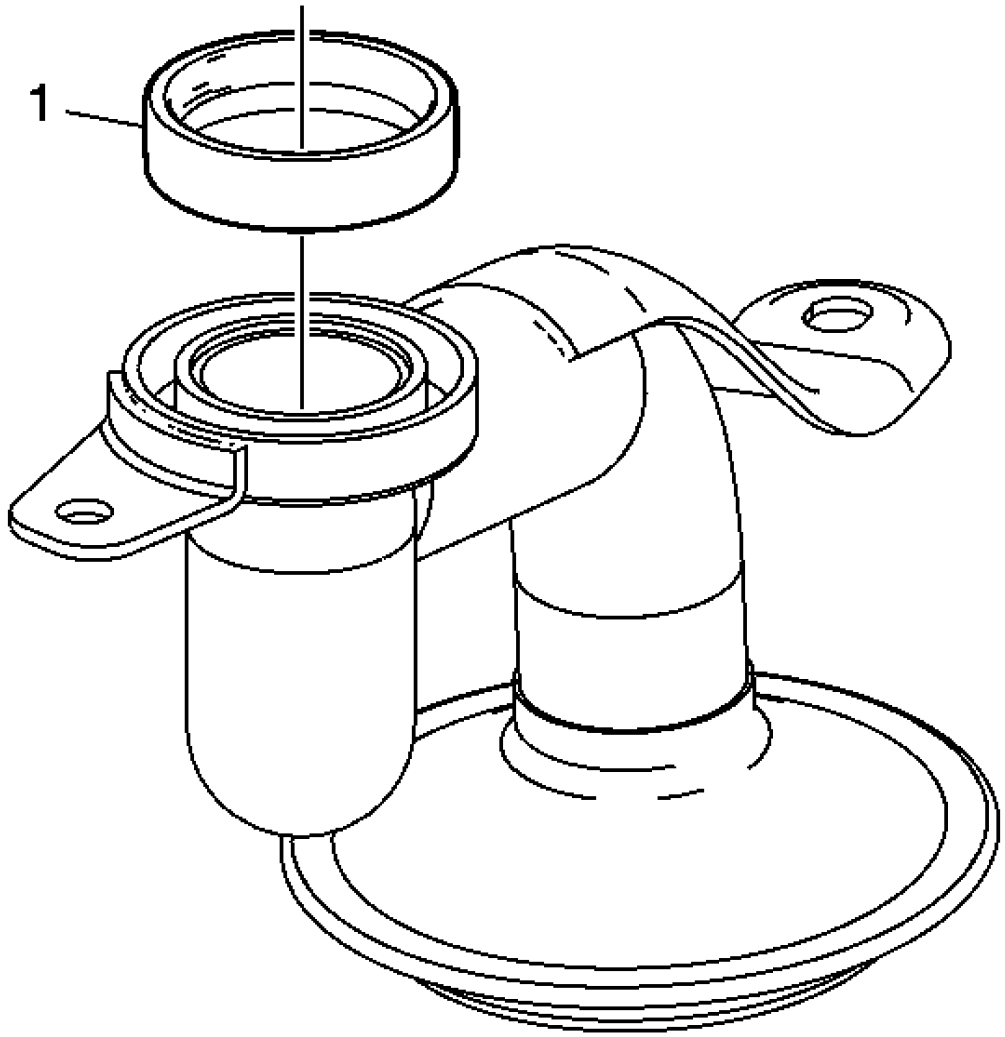


Fig. 163: Oil Suction Pipe Seal
Courtesy of GENERAL MOTORS CORP.

2. Install the NEW oil suction pipe seal (1).

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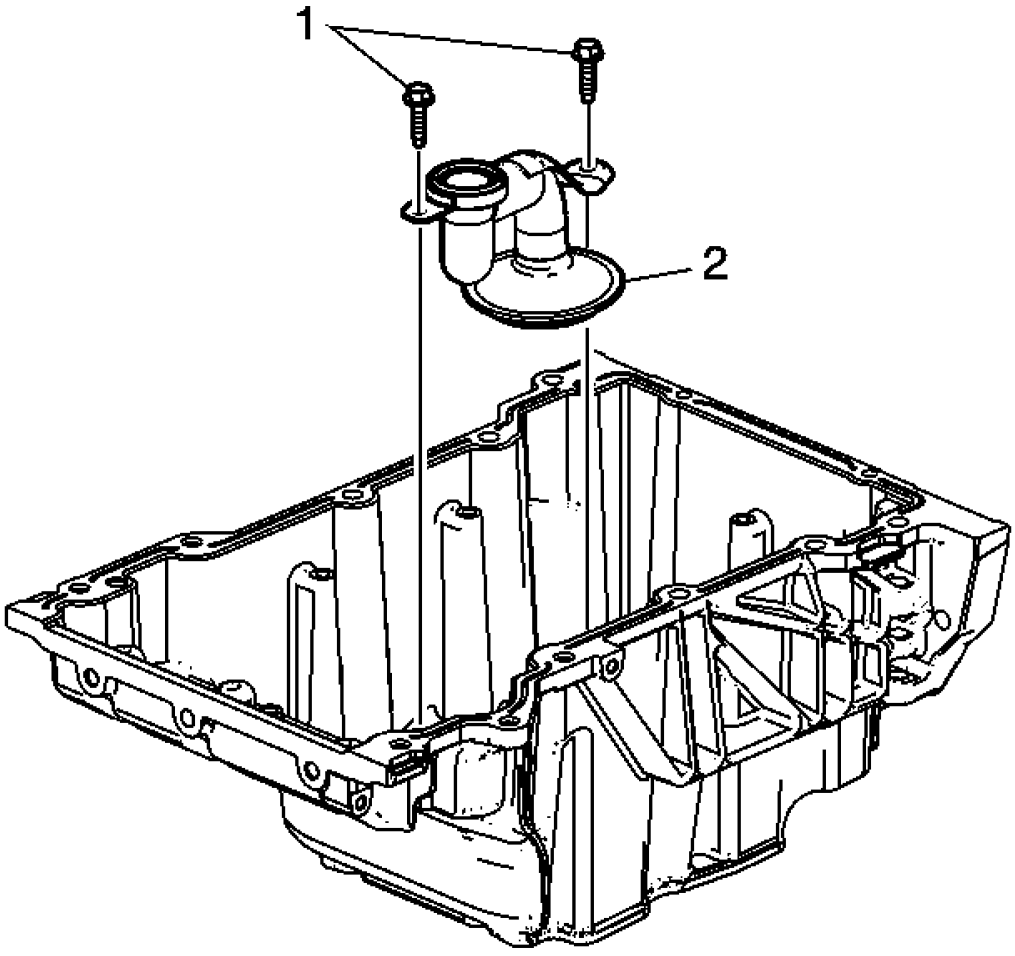


Fig. 164: Oil Suction & Pipe Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the oil suction pipe (2).
4. Install the oil suction pipe bolts (1) and tighten to 10 N.m (89 lb in).

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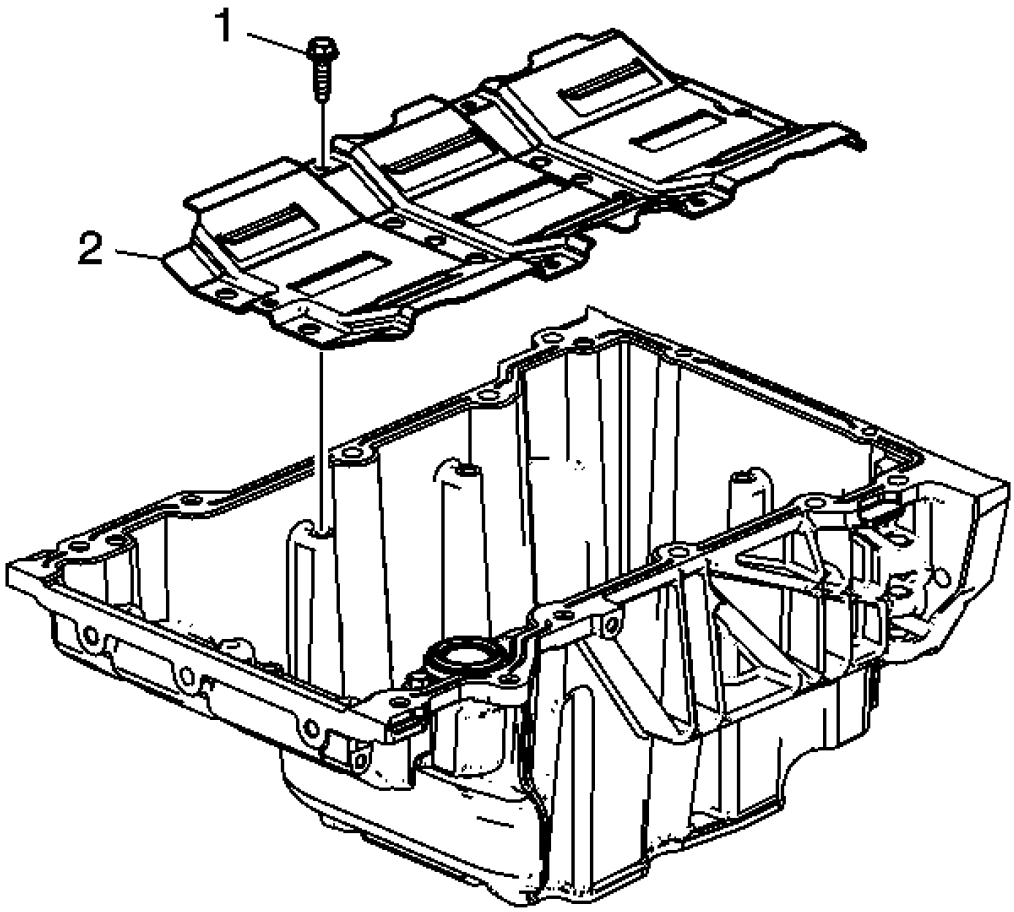


Fig. 165: Oil Pan Scraper & Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the oil pan scraper (2).
6. Install the oil pan scraper bolts (1) and tighten to 10 N.m (89 lb in).

ENGINE FRONT COVER DISASSEMBLE

Tools Required

J 45000 Seal Remover. See **Special Tools** .

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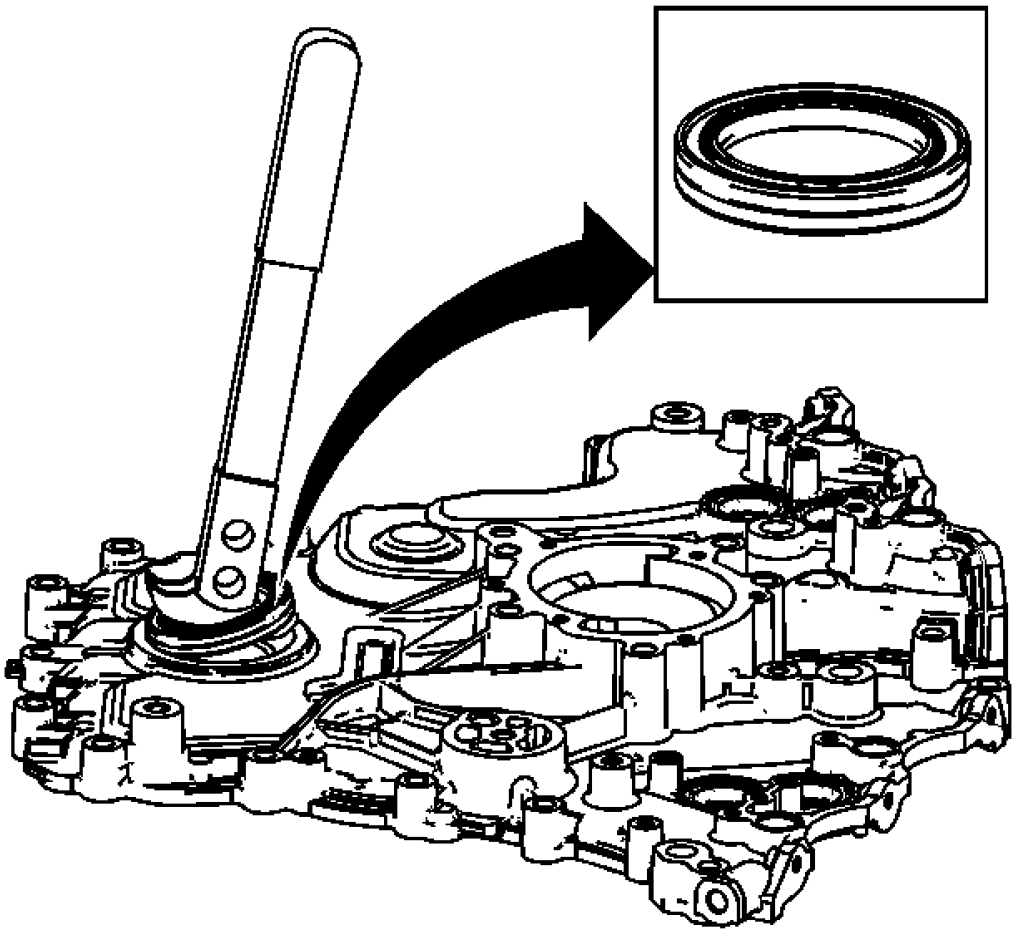


Fig. 166: Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft front oil seal from the engine front cover using the **J 45000** . See **Special Tools** .

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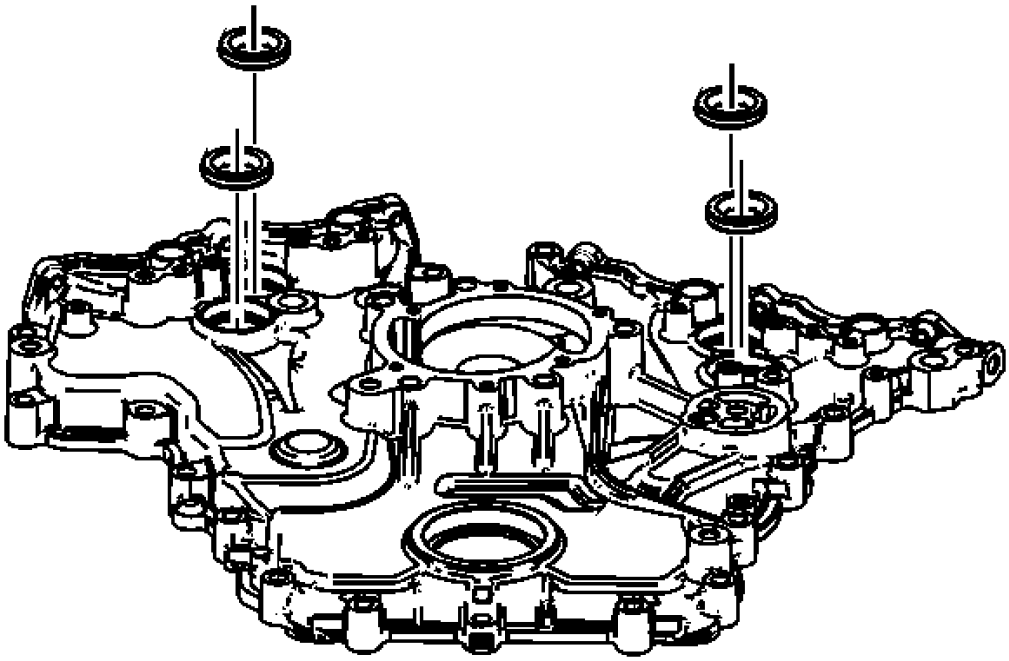


Fig. 167: View Of Camshaft Position Actuator Valve Oil Seals
Courtesy of GENERAL MOTORS CORP.

2. Remove the camshaft position actuator valve oil seals from the engine front cover.

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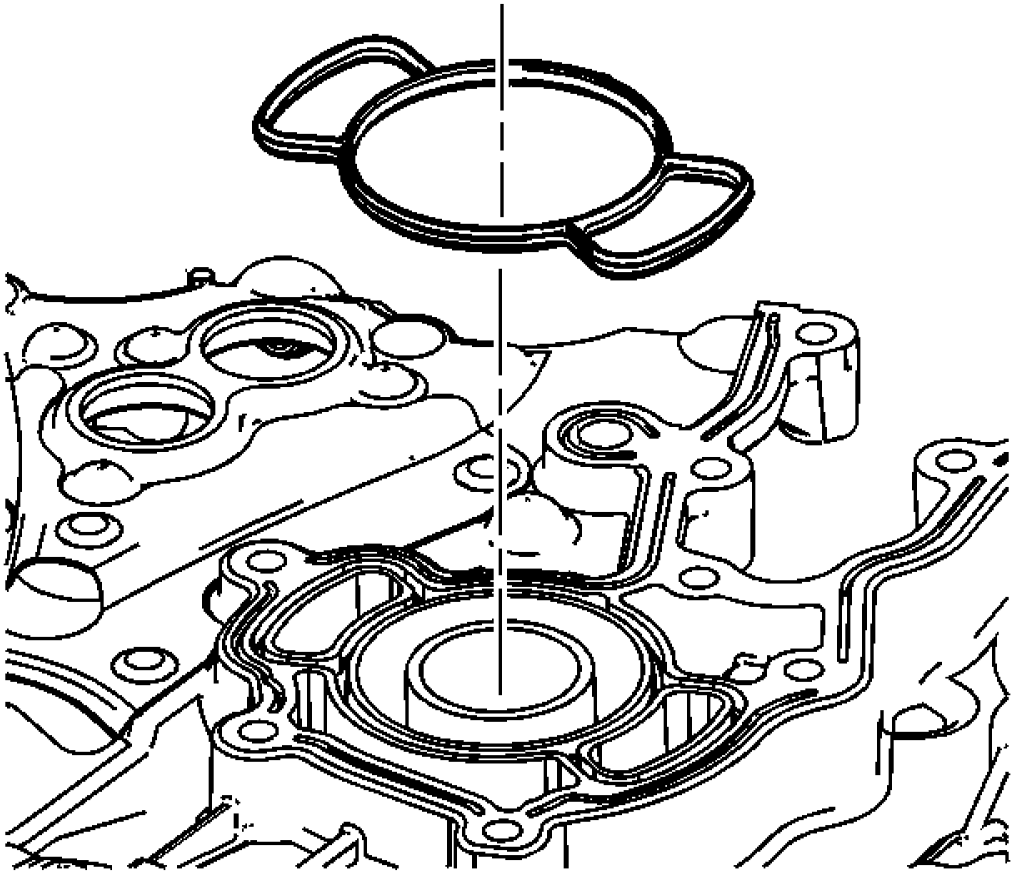


Fig. 168: View Of Water Pump Seal
Courtesy of GENERAL MOTORS CORP.

3. Remove the water pump seal from the engine front cover.
4. Discard the water pump seal.

ENGINE FRONT COVER CLEANING AND INSPECTION

SPECIAL TOOLS

J 28410: Gasket Remover

For equivalent regional tools, refer to **Special Tools** .

CLEANING PROCEDURE

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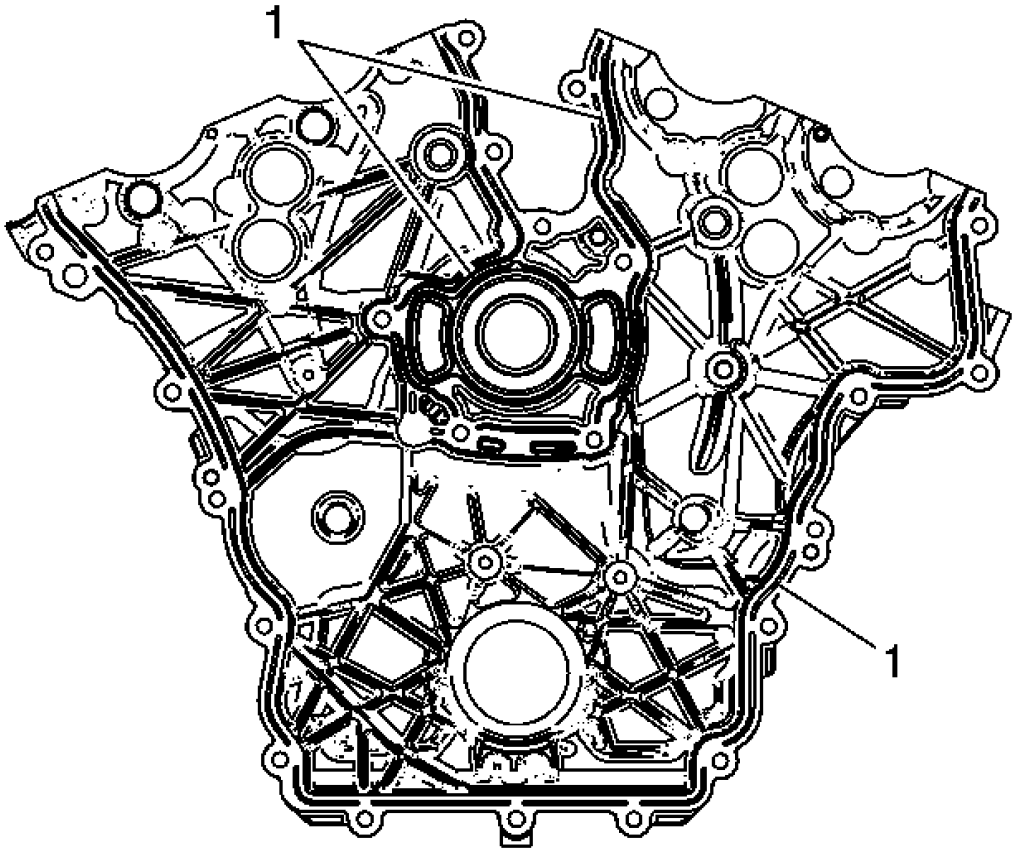


Fig. 169: Locating Sealant On Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

1. Remove any RTV sealant (1) from the engine front cover using **J 28410:** remover.
2. Clean out debris from the bolt holes.
3. Clean the engine front cover in solvent.

WARNING: Refer to Safety Glasses Warning .

4. Dry the engine front cover with compressed air.

INSPECTION PROCEDURE

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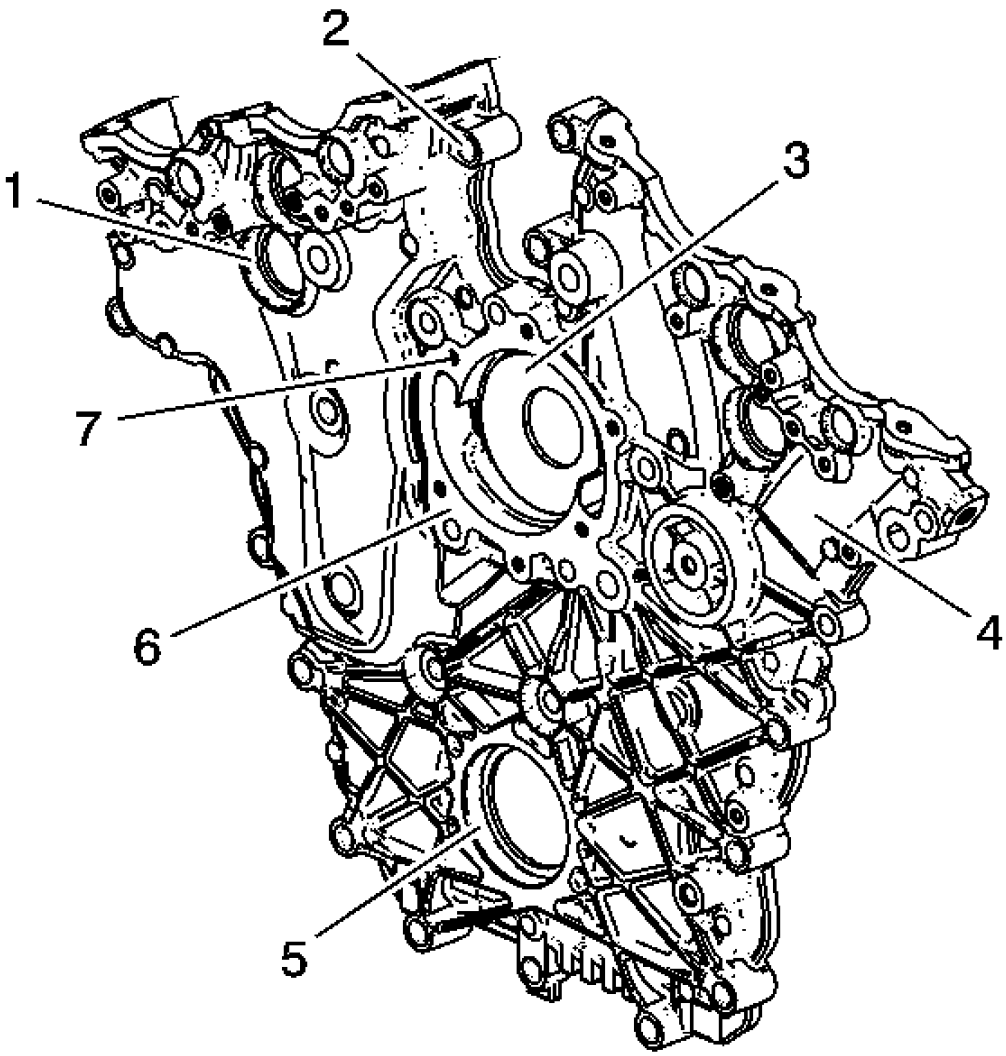


Fig. 170: Exterior Of Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

1. Inspect the exterior of the engine front cover for the following conditions:
    - Damage to the water pump bolt hole threads (7)
    - Gouges or damage to the water pump sealing surfaces (6)
    - Damage to the crankshaft front oil seal bore (5)
    - Damage to the camshaft position actuator valve oil seal bores (1)
    - Damage to the engine front cover bolt holes (2)

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- Damage and/or corrosion to the engine coolant passage (3)
- Dents or damage to the exterior (4)

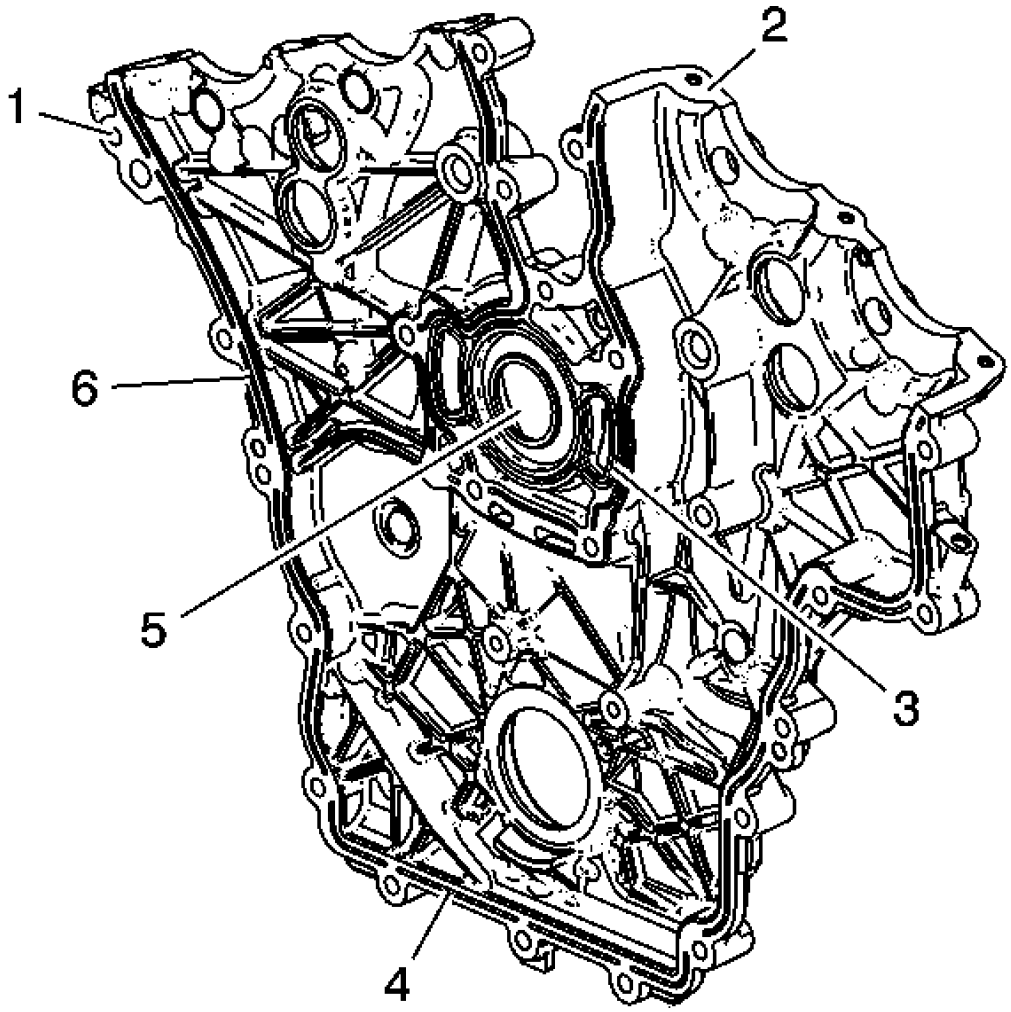


Fig. 171: Interior Of Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

2. Inspect the interior of the engine front cover for the following conditions:
   - Gouges or damage to the engine front cover sealing surfaces to the engine block (6), oil pan (4), and/or camshaft covers (2)
   - Damage and/or corrosion to the engine coolant passage (5)
   - Damage to the crankshaft front oil seal bore

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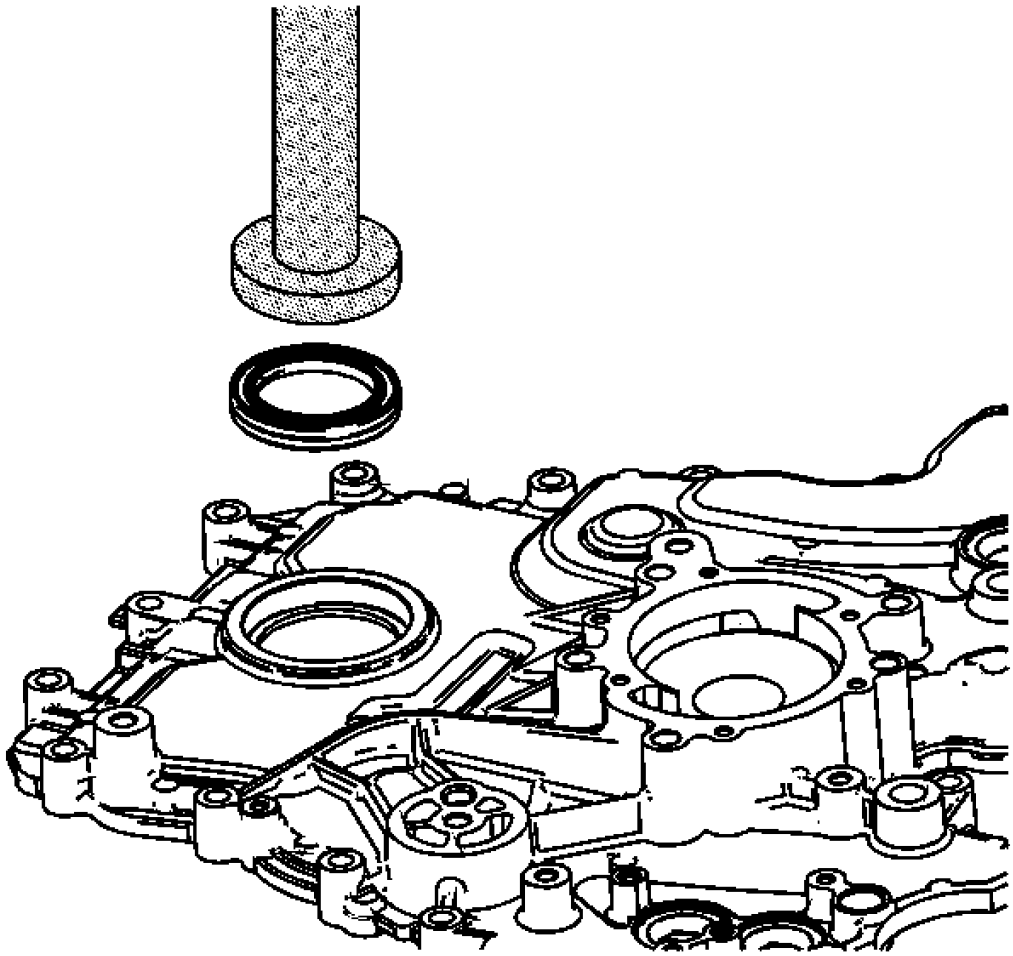
- Gouges or damage to the O-ring sealing areas
- Gouges or damage to the water pump seal area (3)
- Damage to the engine front cover bolt holes (1)

3. Repair or replace the engine front cover as necessary.

ENGINE FRONT COVER ASSEMBLE

Tools Required

- **EN-46103** Camshaft Actuator Valve Seal Installer. See **Special Tools** .
- **J 29184** Oil Seal Installer. See **Special Tools** .



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Fig. 172: Installing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not lubricate the crankshaft front oil seal or crankshaft balancer sealing surfaces. The crankshaft balancer is installed into a dry seal.

1. Install the NEW crankshaft front oil seal into the engine front cover using the **J 29184** . See **Special Tools** .

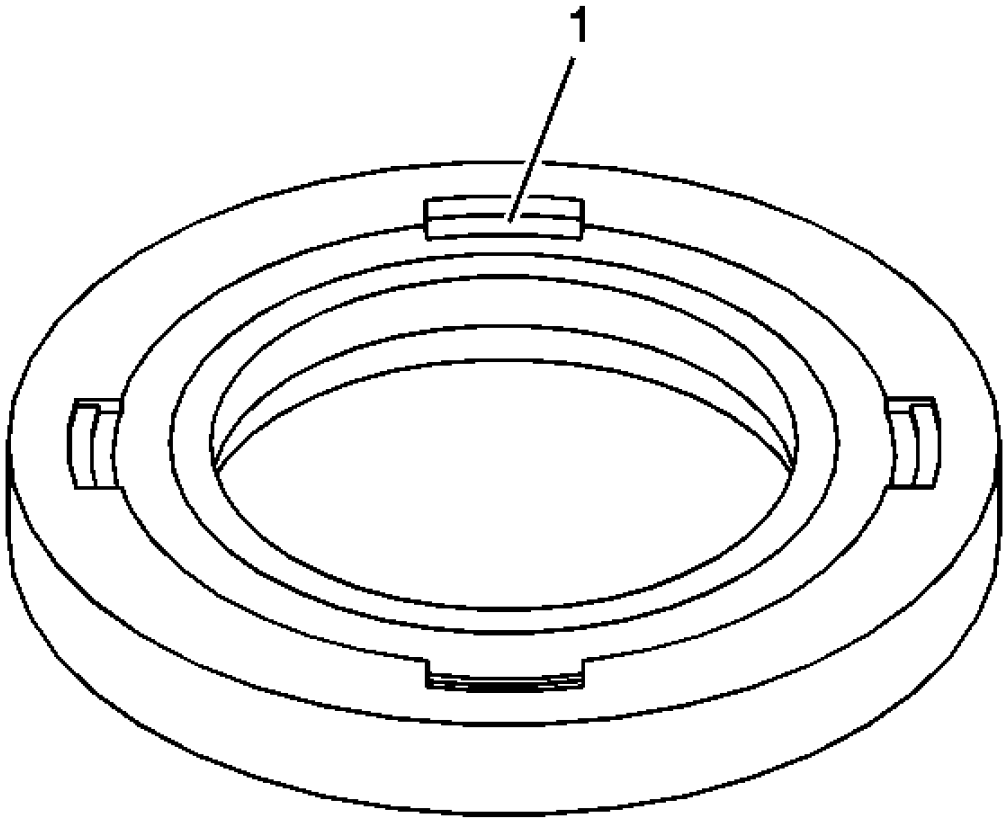


Fig. 173: View of Crankshaft Front Oil Seal Notches
Courtesy of GENERAL MOTORS CORP.

2. Place the seal into position with the notches (1) in the seal down. The notches (1) will face inboard when properly installed.

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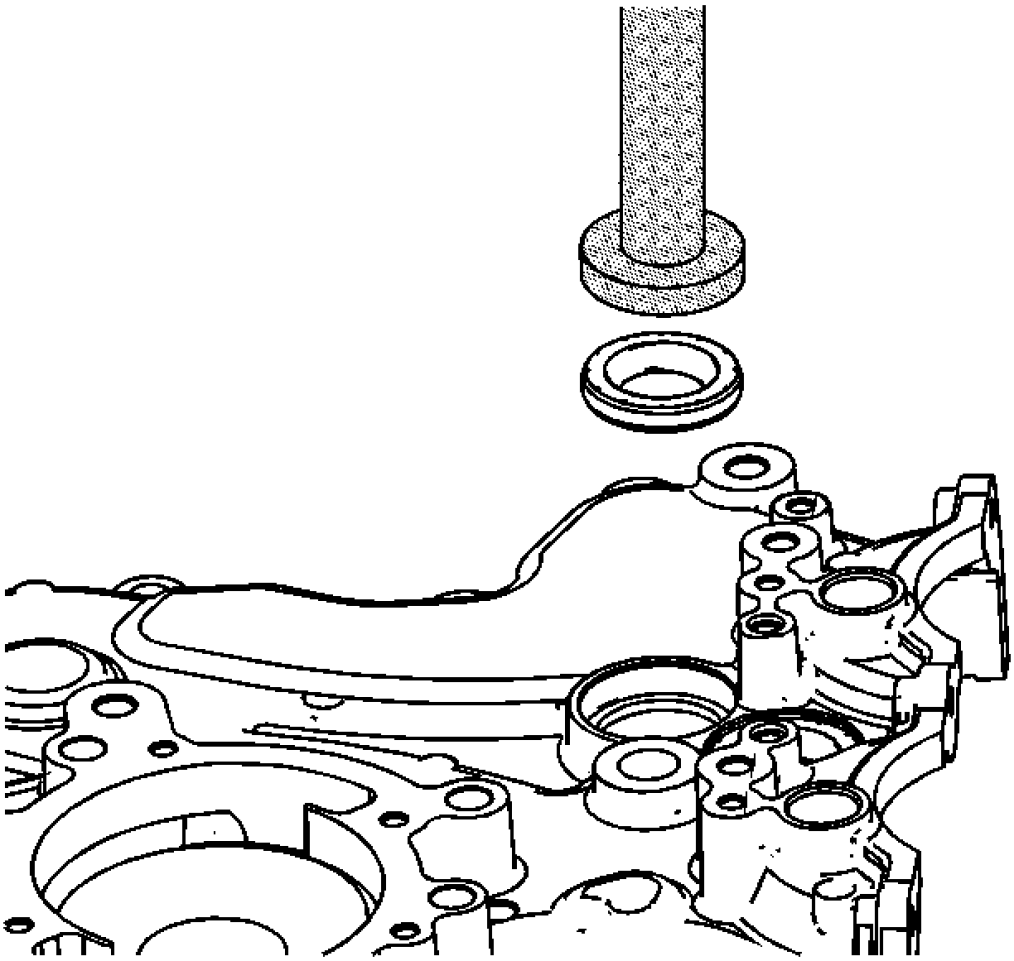


Fig. 174: Installing Camshaft Position Actuator Valve Oil Seals
Courtesy of GENERAL MOTORS CORP.

3. Install the NEW camshaft position actuator valve oil seals into the engine front cover using the **EN-46103** . See **Special Tools** .

CAMSHAFT COVER DISASSEMBLE (LLT)

LEFT CAMSHAFT COVER

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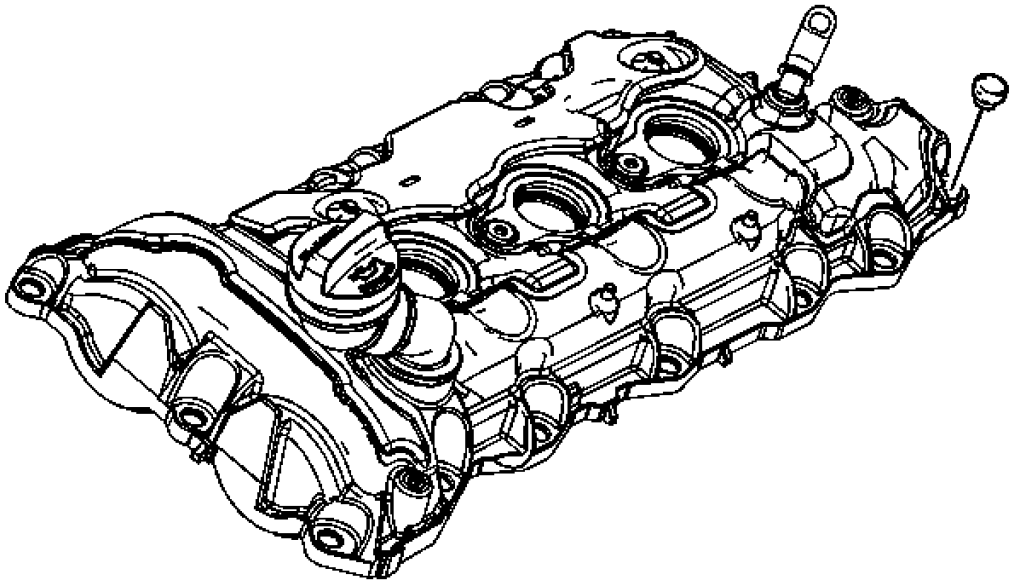


Fig. 175: View Of Left Camshaft Cover Bolt Grommet
Courtesy of GENERAL MOTORS CORP.

1. Remove and discard the left camshaft cover bolt grommets.

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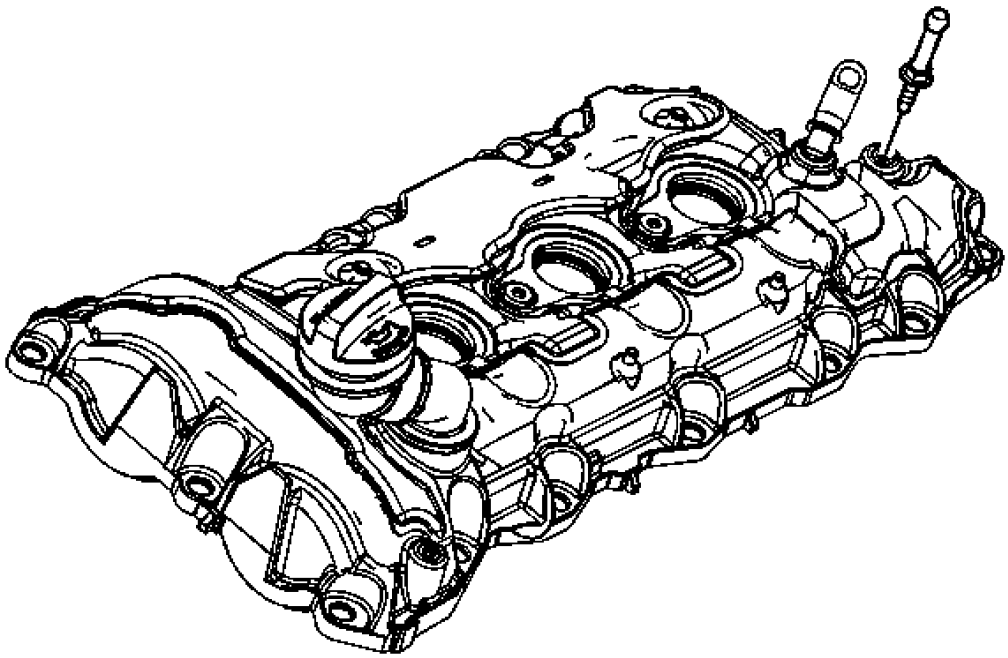


Fig. 176: Fuel Injector Sight Shield Cover Ballstud
Courtesy of GENERAL MOTORS CORP.

2. Remove the fuel injector sight shield ballstud.

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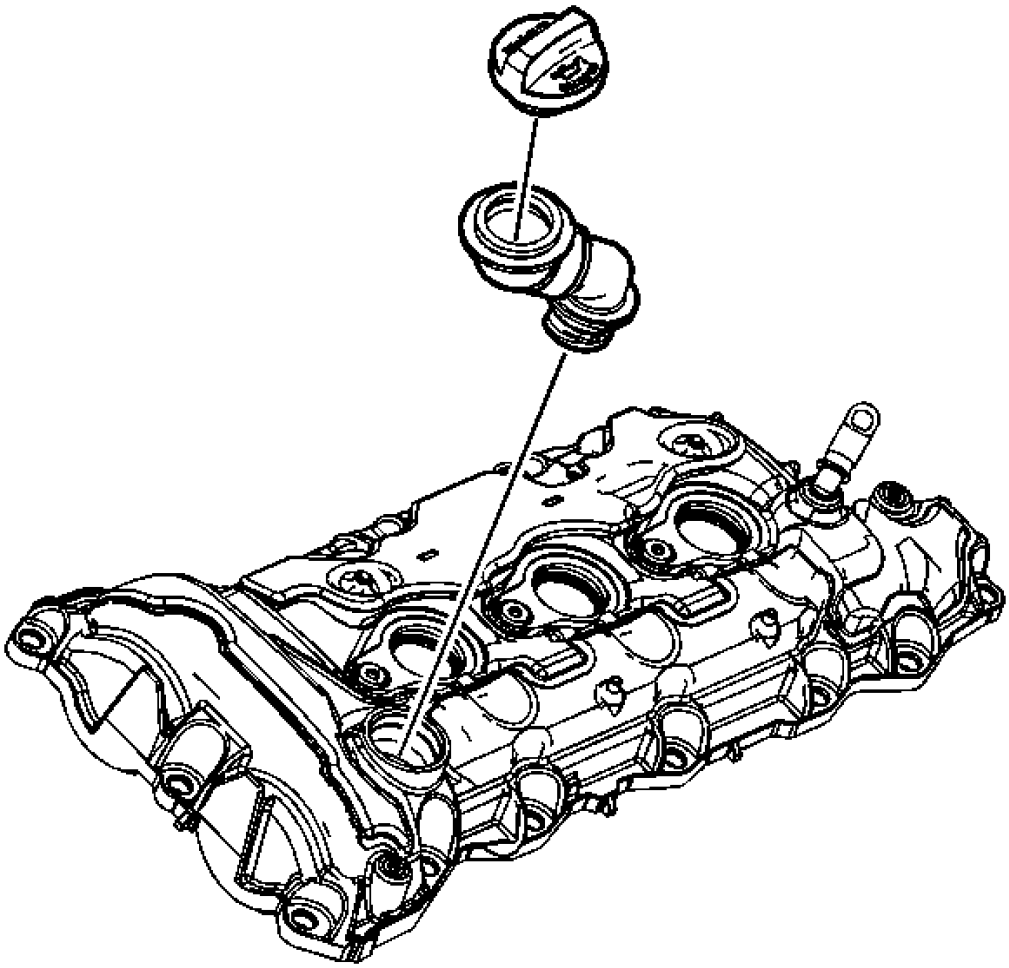


Fig. 177: Identifying Oil Fill Cap
Courtesy of GENERAL MOTORS CORP.

3. Remove the oil fill cap.

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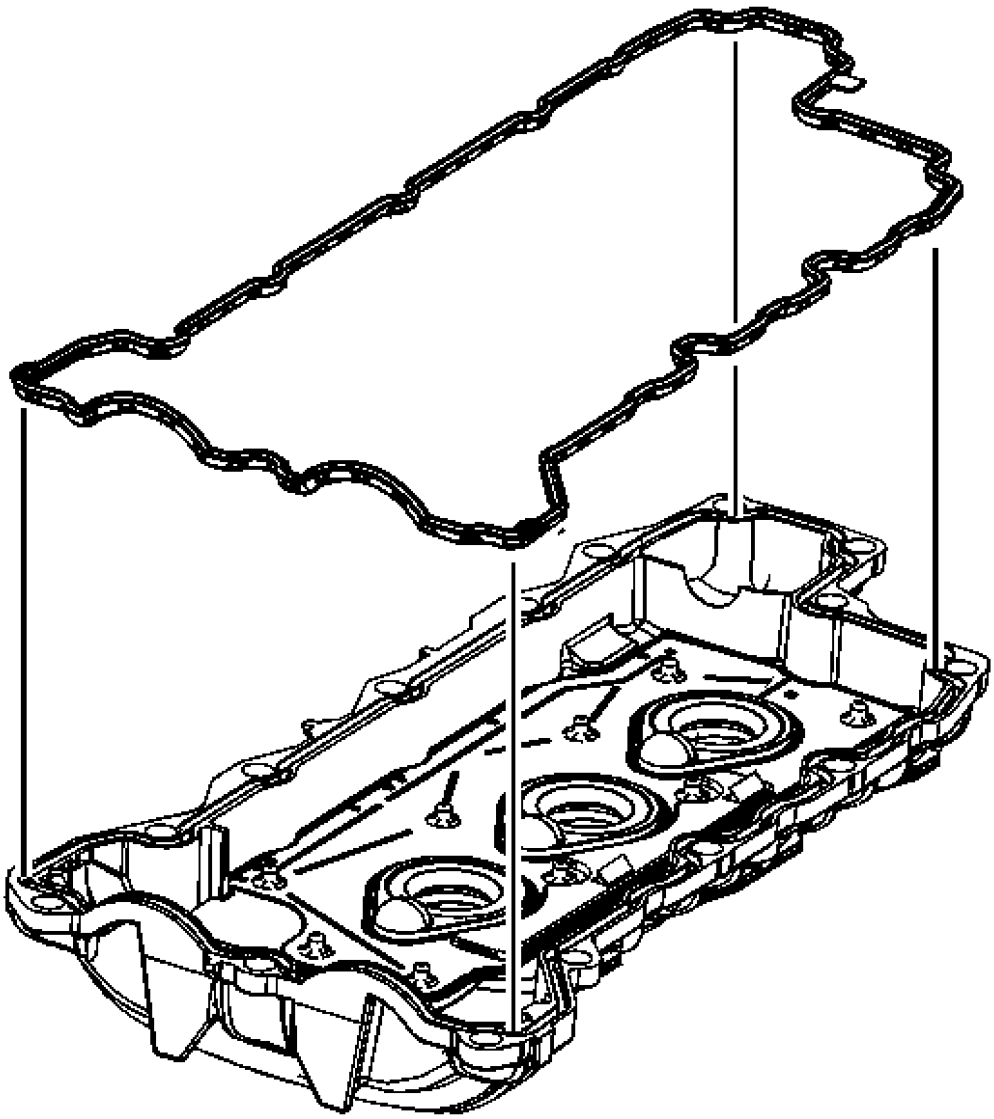


Fig. 178: Left Camshaft Cover Gasket Assembly
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not reuse the camshaft cover gasket and spark plug shield tube seals.

4. Remove and discard the left camshaft cover gasket.

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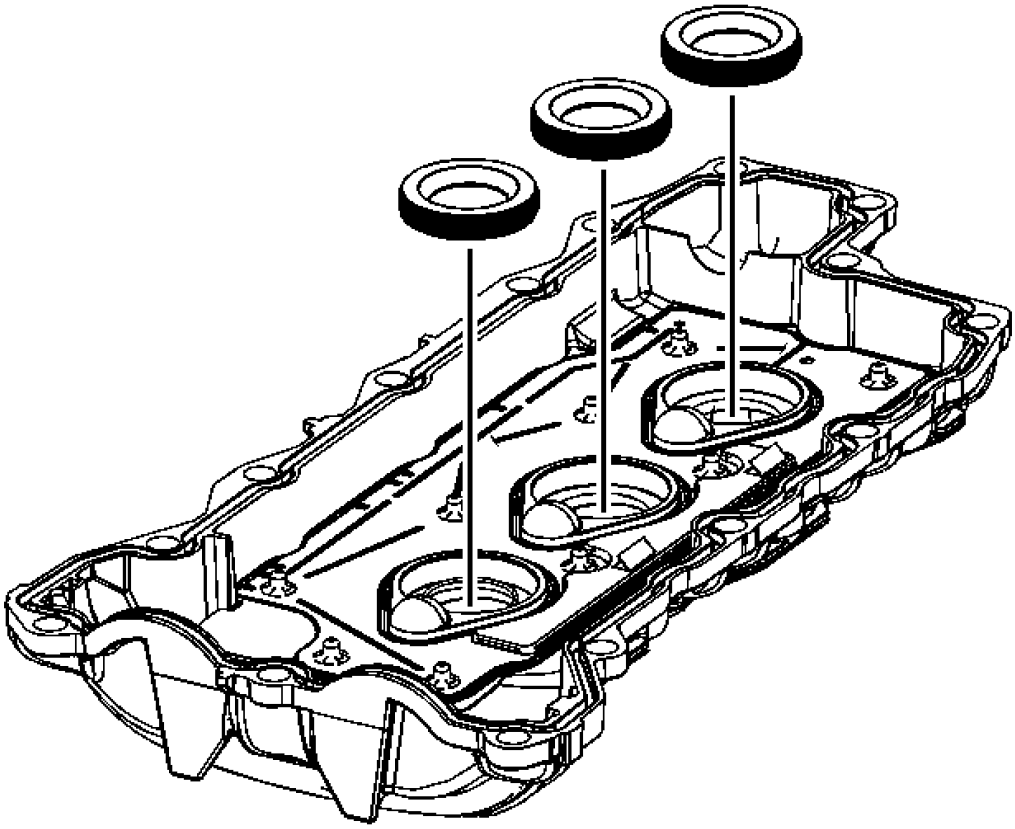


Fig. 179: Spark Plug Shield Tube Seals
Courtesy of GENERAL MOTORS CORP.

5. Remove and discard the left spark plug shield tube seals.

RIGHT CAMSHAFT COVER

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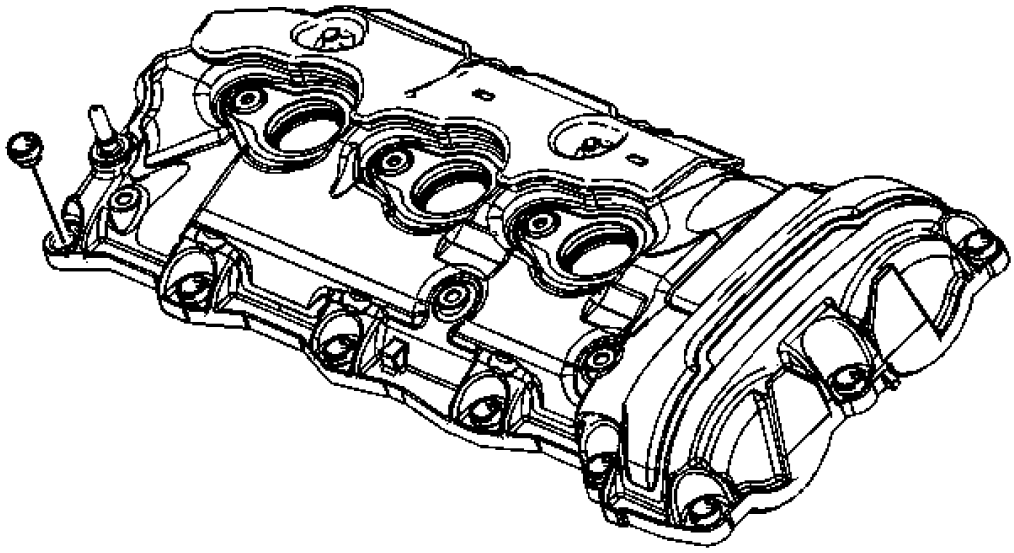


Fig. 180: View Of Right Camshaft Cover Bolt Grommet
Courtesy of GENERAL MOTORS CORP.

1. Remove and discard the right camshaft cover bolt grommets.

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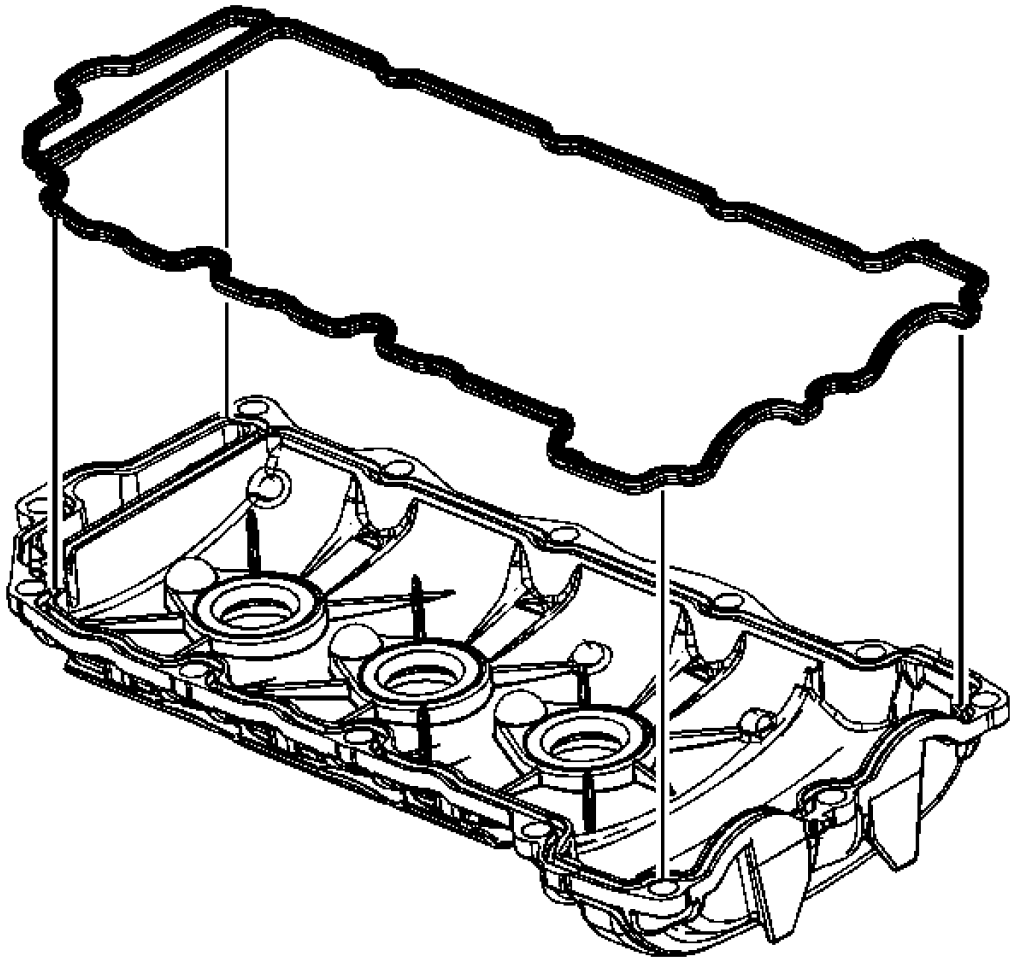


Fig. 181: View Of Right Camshaft Cover Gasket
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not reuse the camshaft cover gasket and spark plug shield tube seals.

2. Remove and discard the right camshaft cover gasket.

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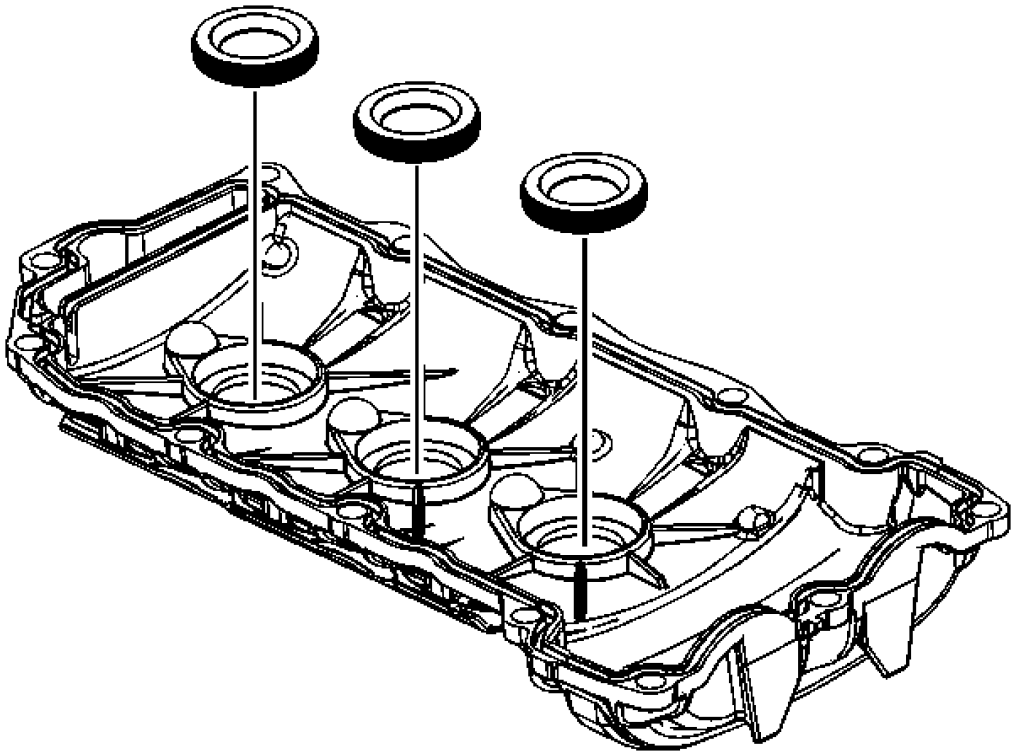


Fig. 182: View Of Right Spark Plug Shield Tube Seals
Courtesy of GENERAL MOTORS CORP.

3. Remove and discard the right spark plug shield tube seals.

CAMSHAFT COVER CLEANING AND INSPECTION (LLT)

CLEANING PROCEDURE

1. Clean the camshaft covers in solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the camshaft covers with compressed air.

INSPECTION PROCEDURE

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1. Inspect each camshaft cover for the dents or damage to the exterior. A dented or damaged camshaft cover may:
    - Leak engine oil
    - Effect crankcase ventilation
    - Interfere with the camshafts
    - Interfere with the ignition coil sealing
    - Allow water or condensation to enter the engine

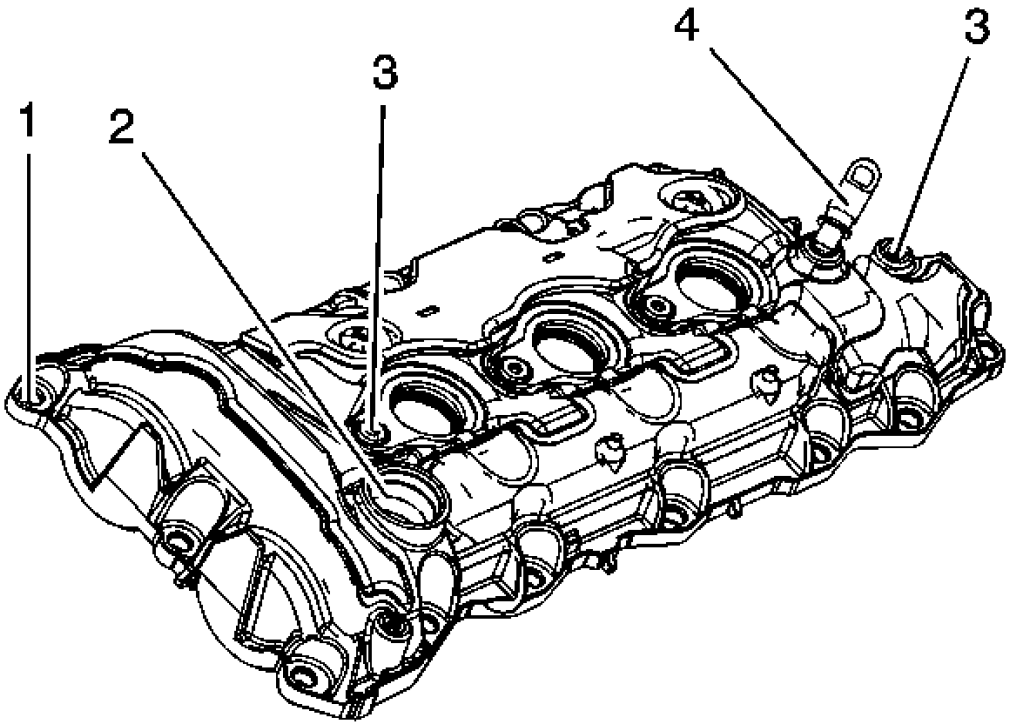


Fig. 183: Inspecting Exterior Of Left Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

2. Inspect the exterior of the left camshaft cover for the following conditions:
    - Damage to the camshaft cover bolt holes (1)
    - Damage to the oil fill hole (2)
    - Damage to the mounting holes (3) for the ignition coil assembly and fuel injector sight shield ballstud.
    - Damage to the positive crankcase ventilation (PCV) hose connector (4)-A damaged PCV hose connector is replaceable.

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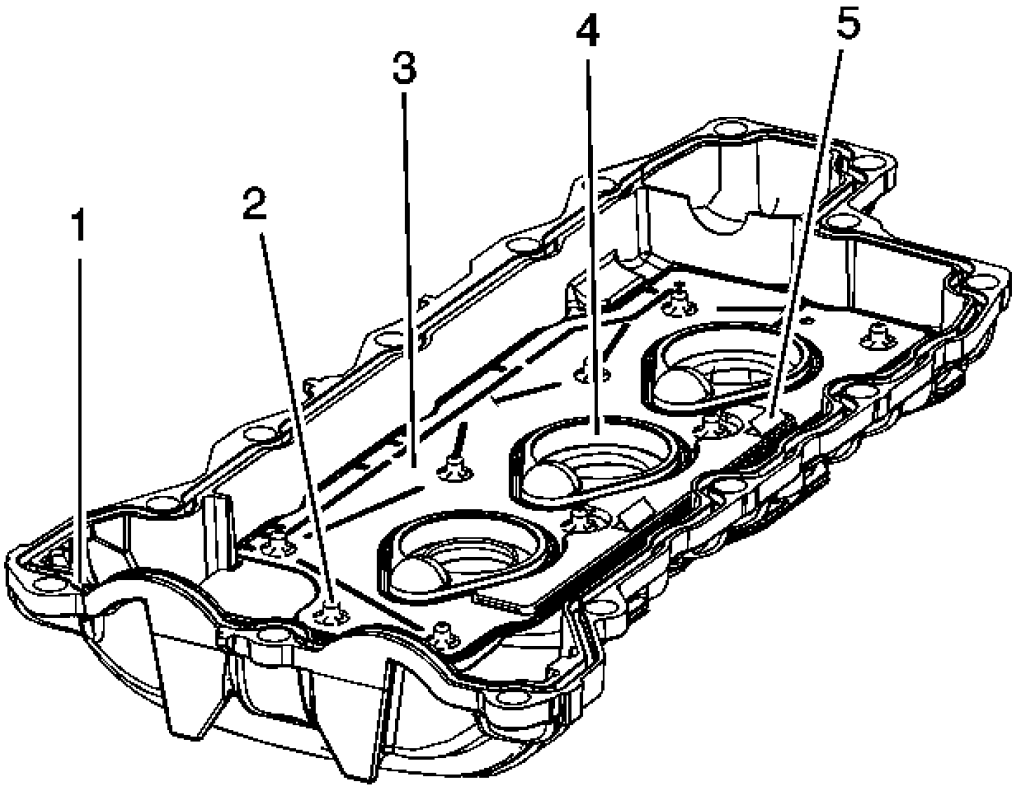


Fig. 184: Inspecting Interior Of Left Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

3. Inspect the interior of the left camshaft cover for the following conditions:
    - Gouges or damage to the camshaft cover sealing groove (1)
    - Damaged, loose or missing baffle fasteners (2)
    - Damaged, loose or missing baffle (3)
    - Gouges or damage to the spark plug shield seal bore (4)
    - Restrictions to the ventilation system (5)

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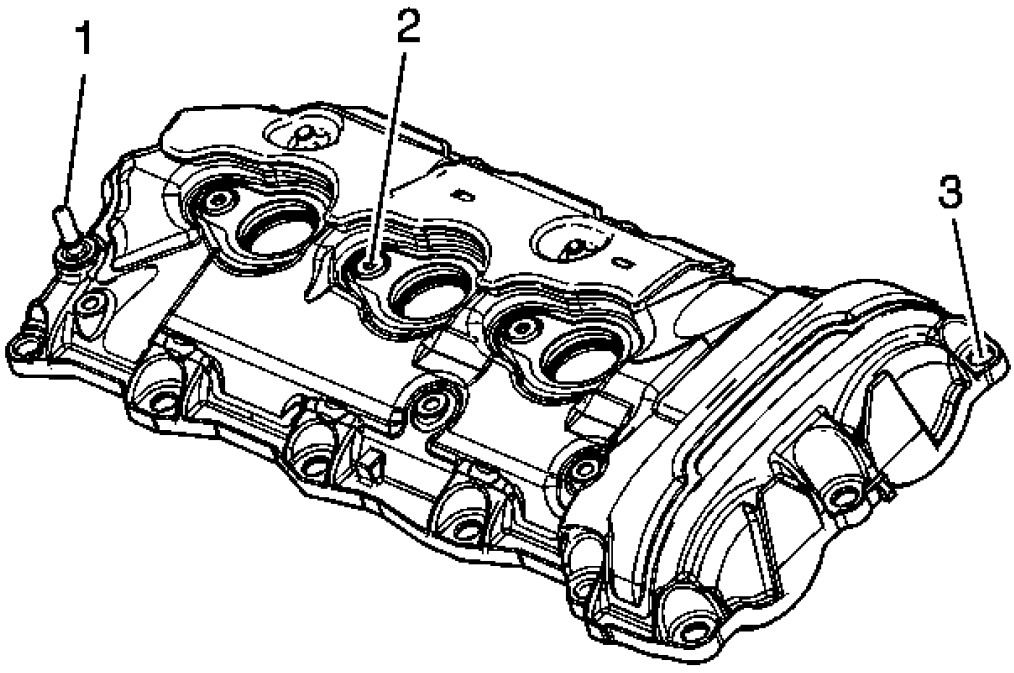


Fig. 185: Inspecting Exterior Of Right Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

4. Inspect the exterior of the right camshaft cover for the following conditions:
    - Damage to the PCV orifice (1)-A damaged PCV orifice can be replaced. Refer to PCV Orifice Replacement.
    - Damage to the mounting holes (2) for the ignition coil assembly
    - Damage to the camshaft cover bolt holes (3)

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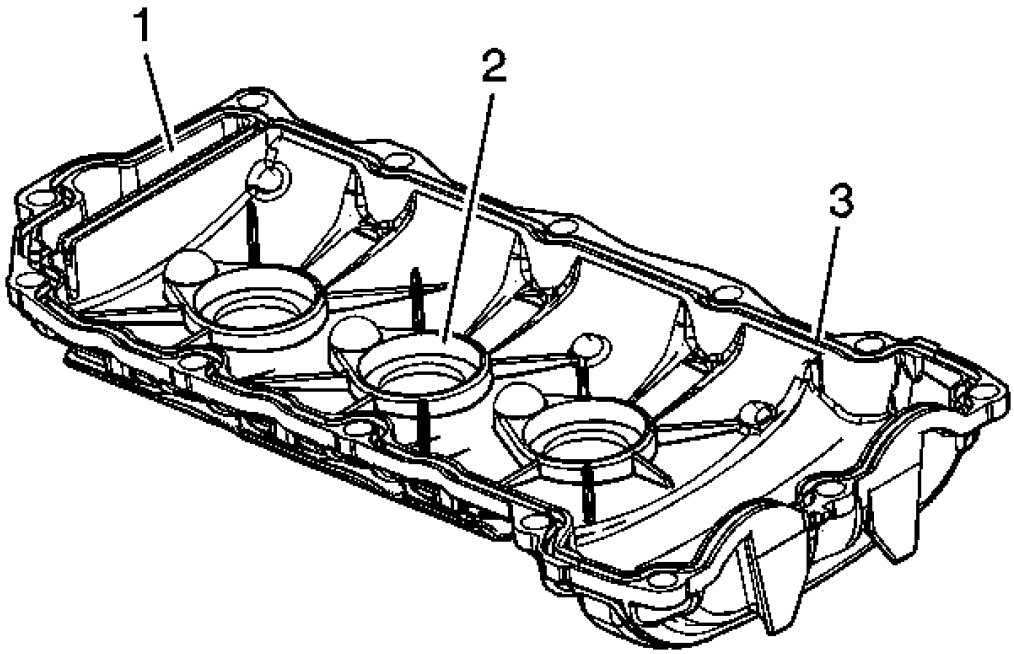


Fig. 186: Inspecting Interior Of Right Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

5. Inspect the interior of the right camshaft cover for the following conditions:
    - Restrictions to the ventilation system (1)
    - Gouges or damage to the spark plug shield seal bore (2)
    - Gouges or damage to the camshaft cover sealing groove (3)
6. Repair or replace the camshaft cover or covers as necessary.

PCV ORIFICE REPLACEMENT

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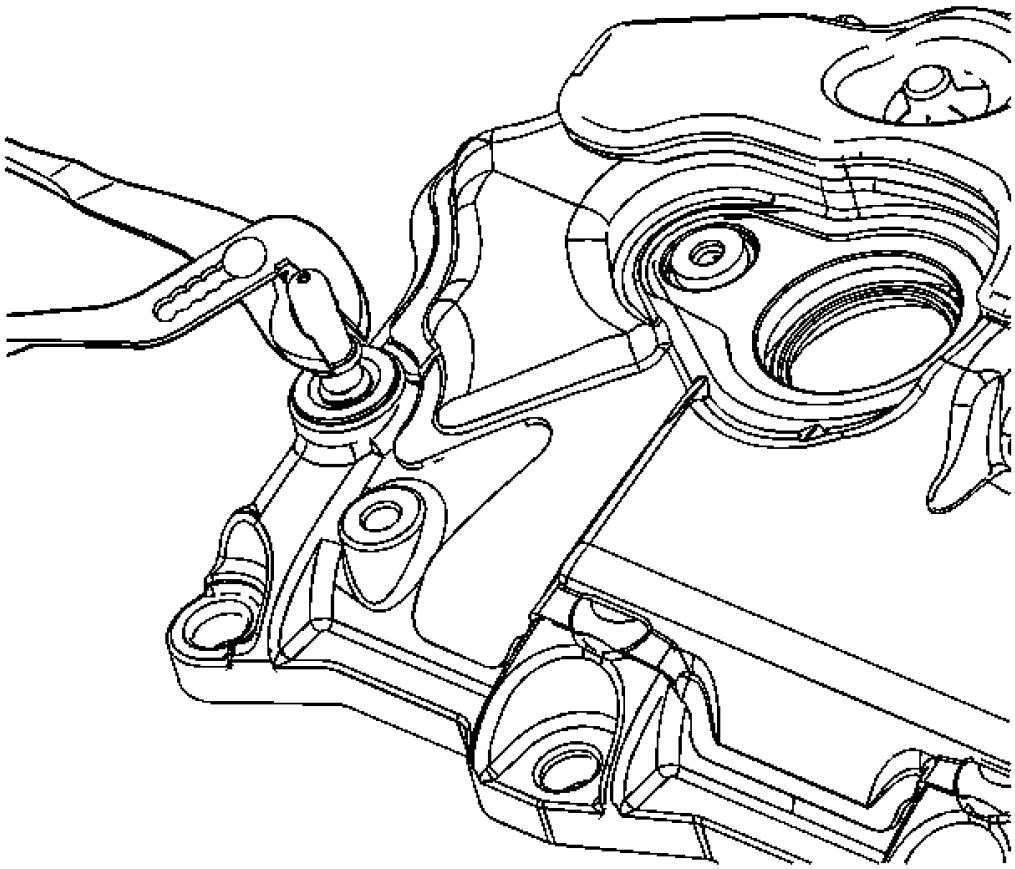


Fig. 187: Removing PCV Orifice
Courtesy of GENERAL MOTORS CORP.

NOTE: If the PCV orifice is damaged or plugged and cannot be cleaned out, the PCV orifice can be replaced.

1. Remove the old PCV orifice by gripping the neck of the orifice with pliers and twisting and pulling out of the right camshaft cover.

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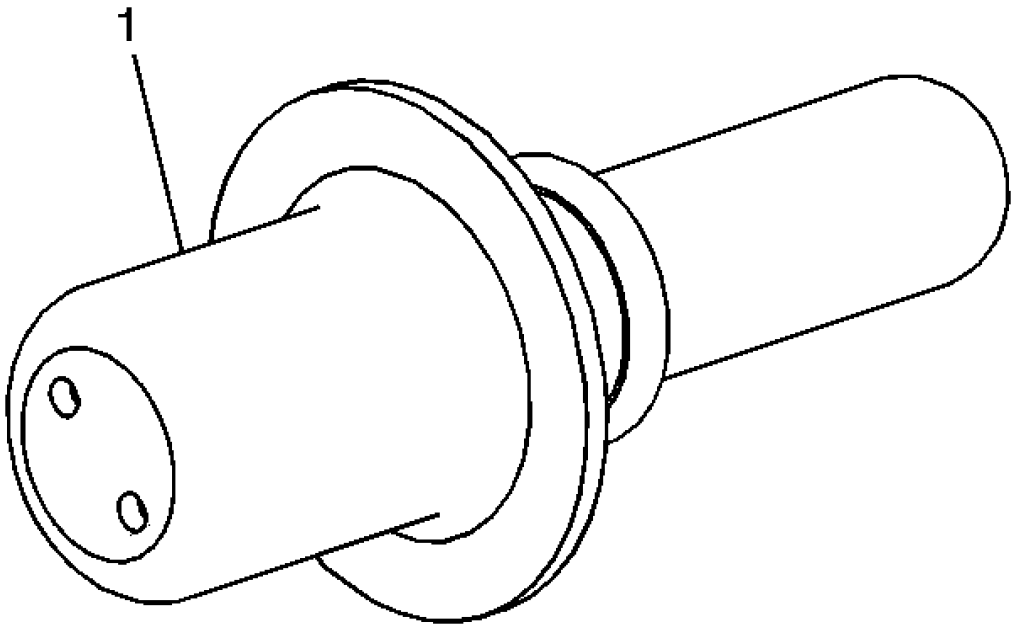


Fig. 188: Identifying Sealant Area On PCV Orifice
Courtesy of GENERAL MOTORS CORP.

2. Apply sealant GM P/N 12378521 (Canadian P/N 88901148) or equivalent to the NEW PCV orifice (1).

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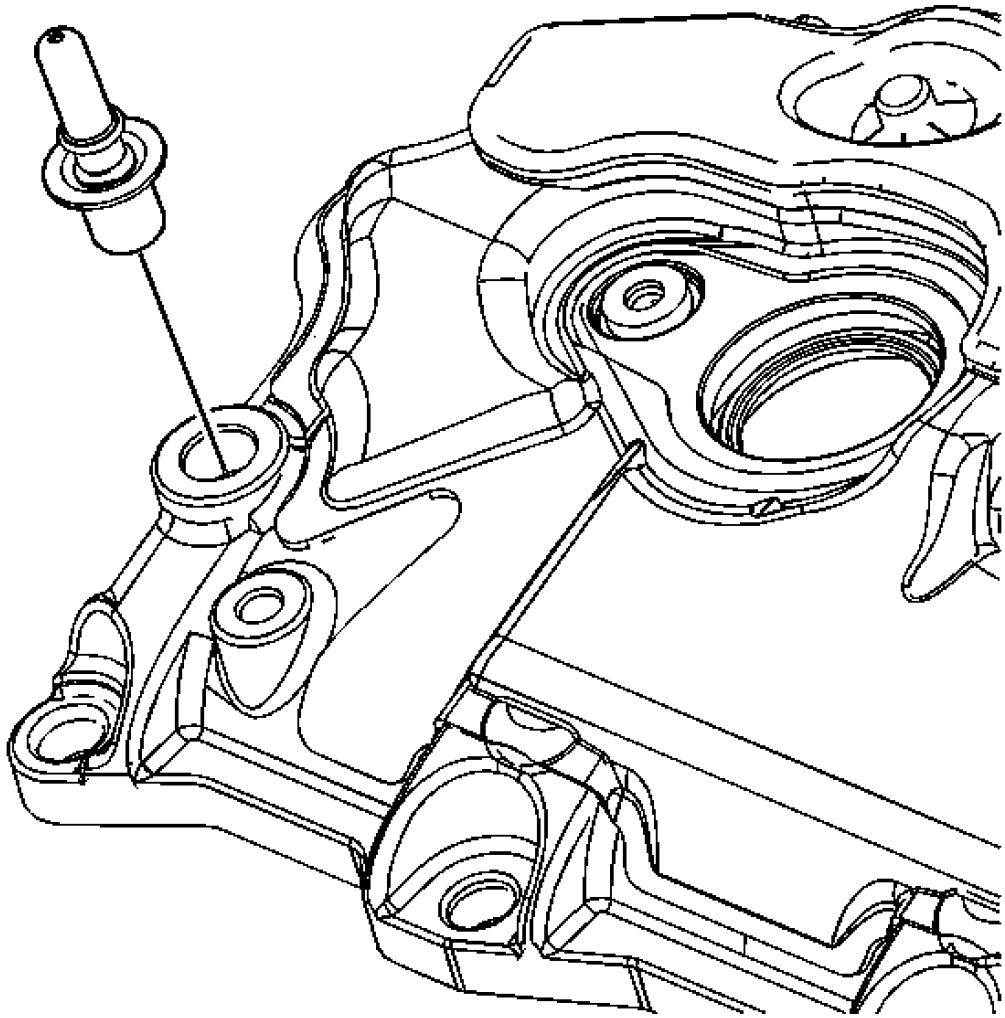


Fig. 189: View Of PCV Orifice & Right Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

3. Install the NEW PCV orifice into the right camshaft cover. After insertion, twist the PCV orifice in order to eliminate any vertical leak paths in the sealant.

PCV FITTING REPLACEMENT

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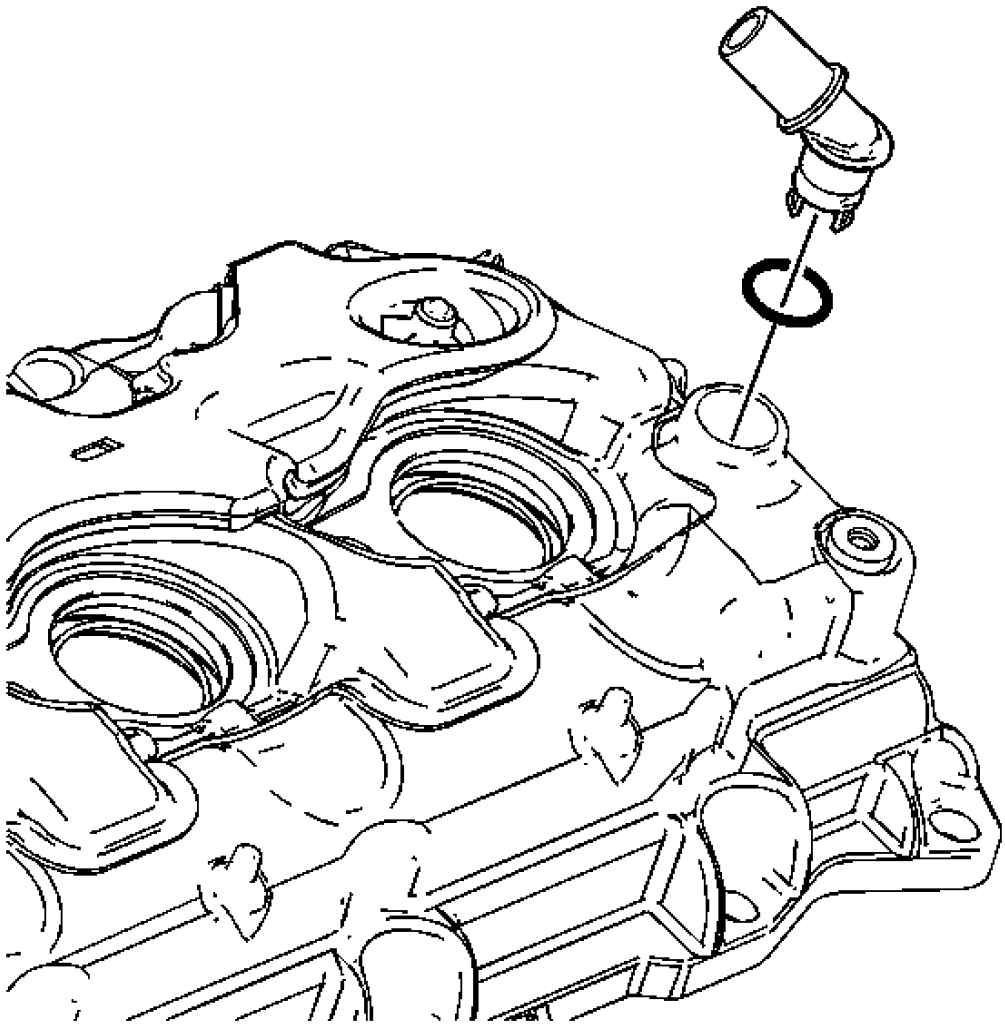


Fig. 190: View Of PCV Fitting & O-Ring
Courtesy of GENERAL MOTORS CORP.

NOTE: If the PCV fitting is damaged or plugged and cannot be cleaned out, the PCV fitting can be replaced.

1. Remove the old PCV fitting.
2. Install the new PCV fitting with a NEW O-ring.

CAMSHAFT COVER ASSEMBLE (LLT)

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Special Tools

- **J 5590:** Bearing and Seal Driver
- **J 24254-A:** Oil Seal Installer

For equivalent regional tools, refer to **Special Tools** .

LEFT CAMSHAFT COVER

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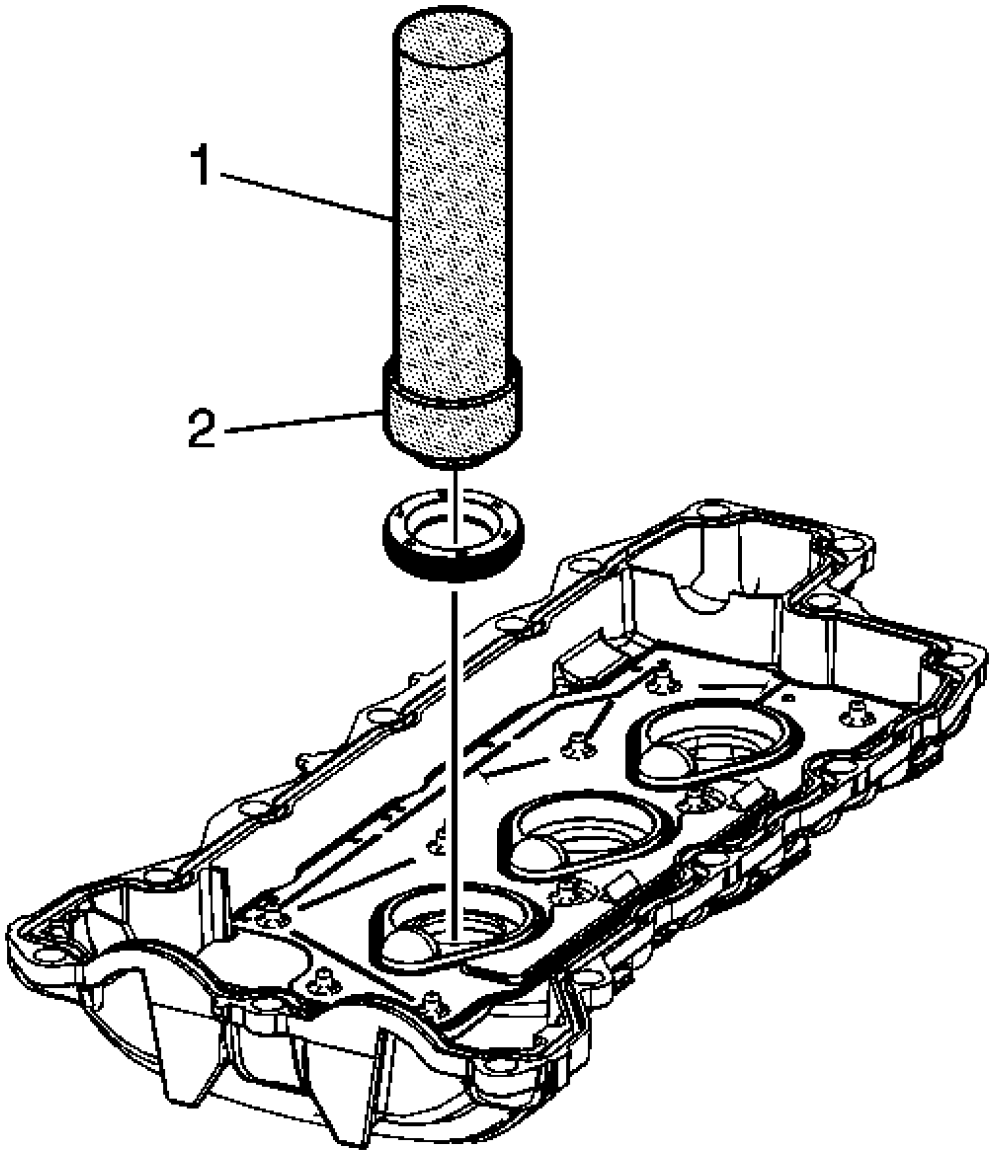


Fig. 191: Installing Left Spark Plug Shield Tube Seals
Courtesy of GENERAL MOTORS CORP.

1. Install the NEW left spark plug shield tube seals using the **J 5590:** driver (1) and **J 24254-A:** installer (2).

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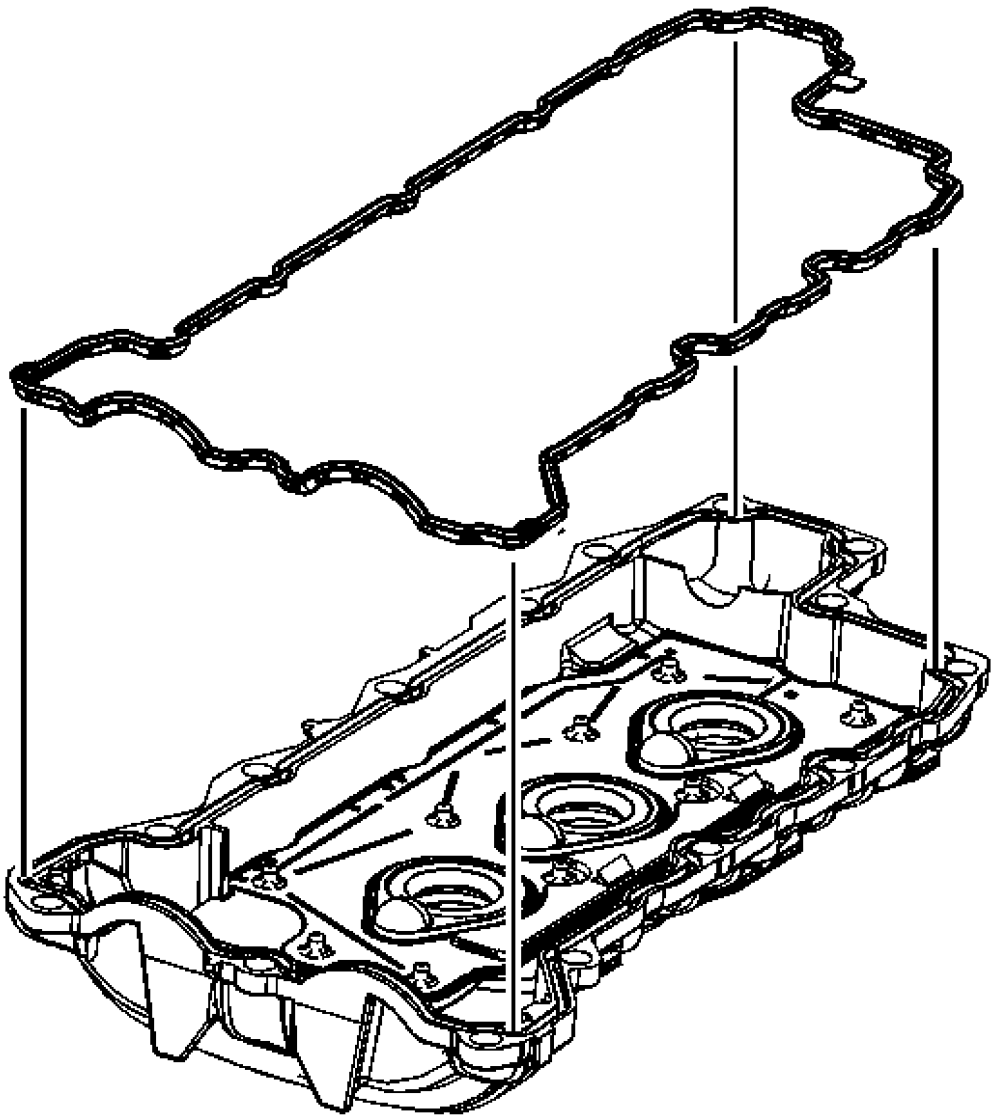


Fig. 192: Left Camshaft Cover Gasket Assembly
Courtesy of GENERAL MOTORS CORP.

2. Install the NEW left camshaft cover gasket.

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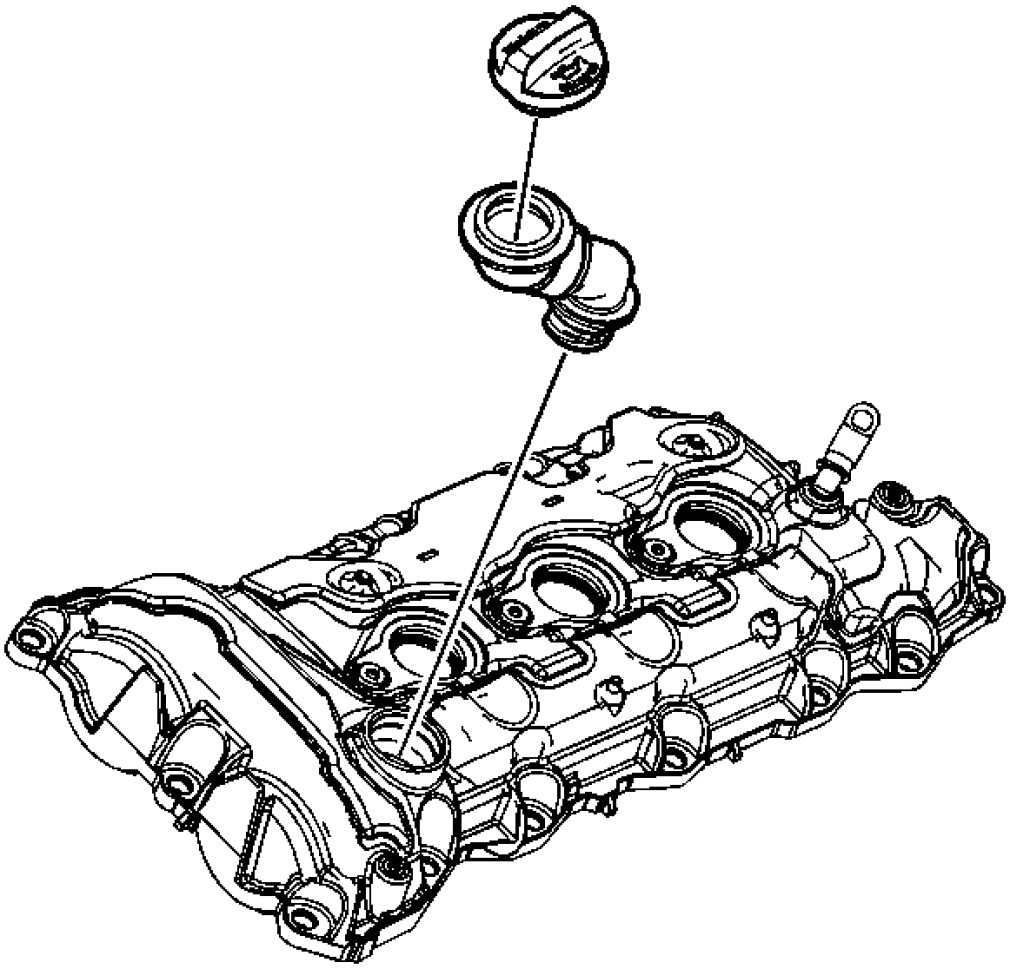


Fig. 193: Identifying Oil Fill Cap
Courtesy of GENERAL MOTORS CORP.

3. Install the oil fill cap.

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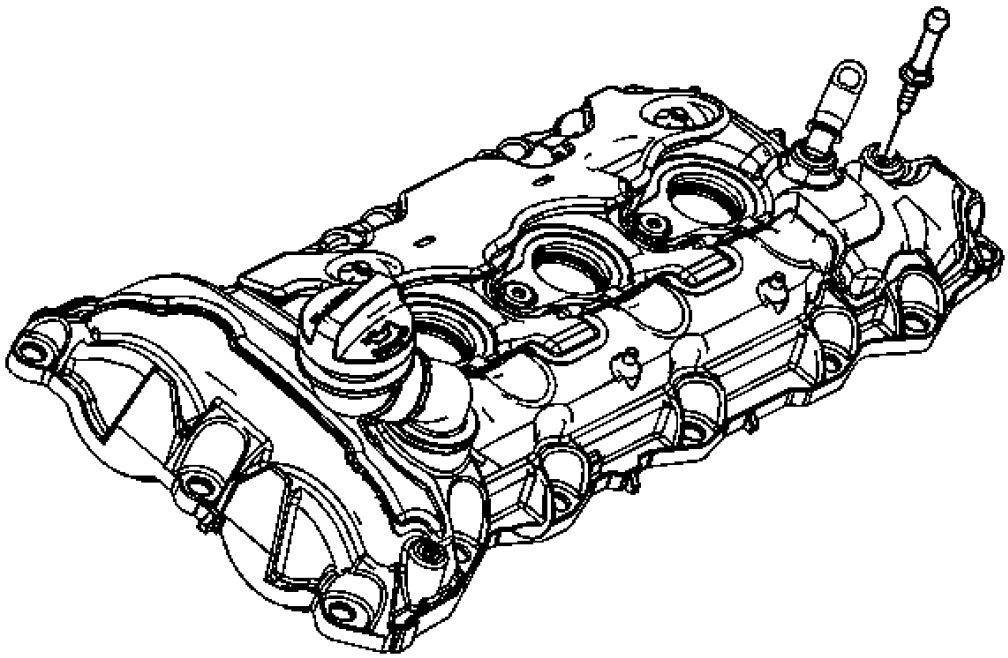


Fig. 194: Fuel Injector Sight Shield Cover Ballstud
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

4. Install the fuel injector sight shield cover ballstud and tighten to 10 N.m (89 lb in).

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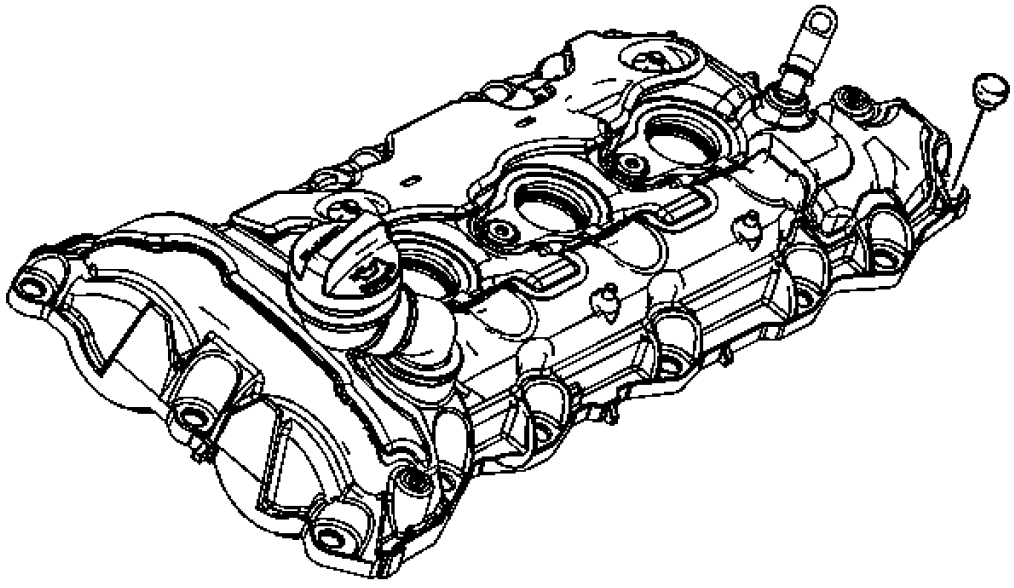


Fig. 195: View Of Left Camshaft Cover Bolt Grommet
Courtesy of GENERAL MOTORS CORP.

NOTE: The camshaft cover bolt grommet must be installed into the camshaft cover bolt hole before installing the camshaft cover bolt.

5. Install the NEW left camshaft cover bolt grommets.

RIGHT CAMSHAFT COVER

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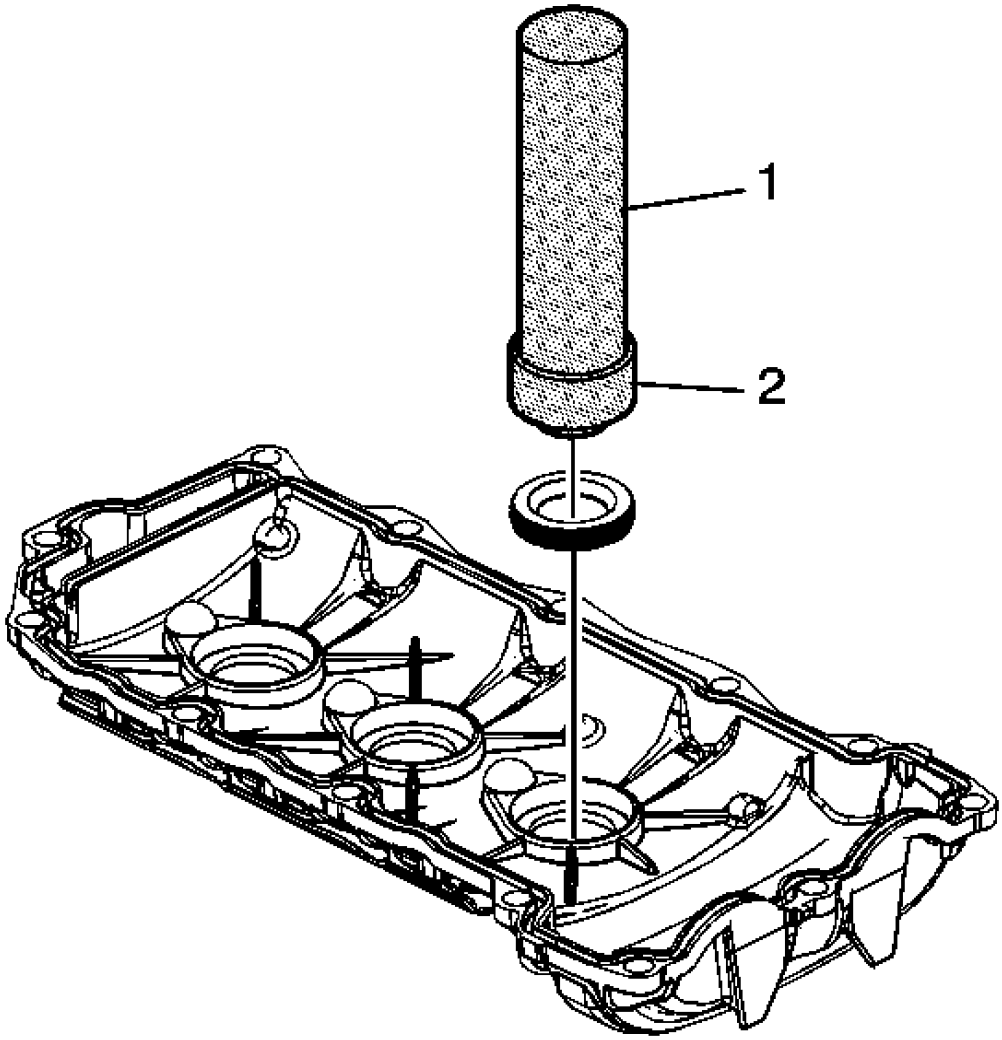


Fig. 196: Installing Right Spark Plug Shield Tube Coil Seals
Courtesy of GENERAL MOTORS CORP.

1. Install the NEW right spark plug shield tube coil seals using the **J 5590:** driver (1) and **J 24254-A:** installer (2).

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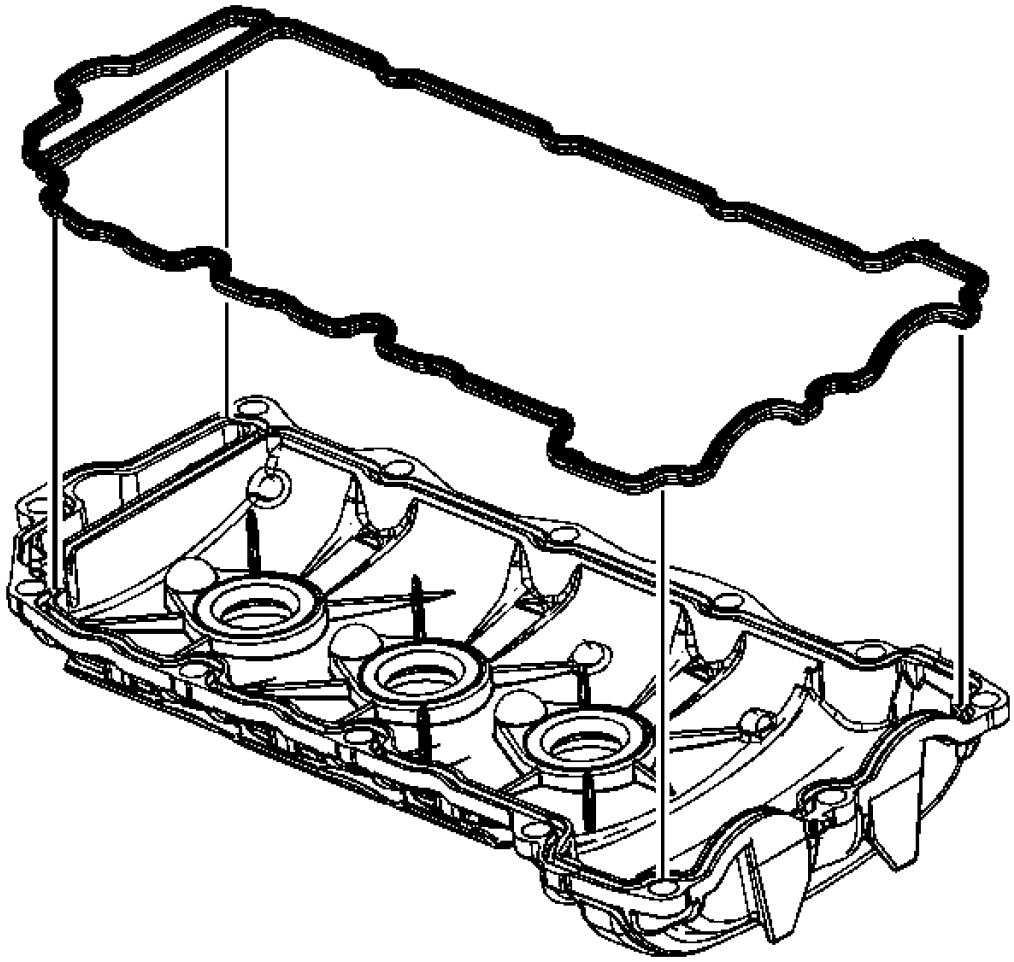


Fig. 197: View Of Right Camshaft Cover Gasket
Courtesy of GENERAL MOTORS CORP.

2. Install the NEW right camshaft cover gasket.

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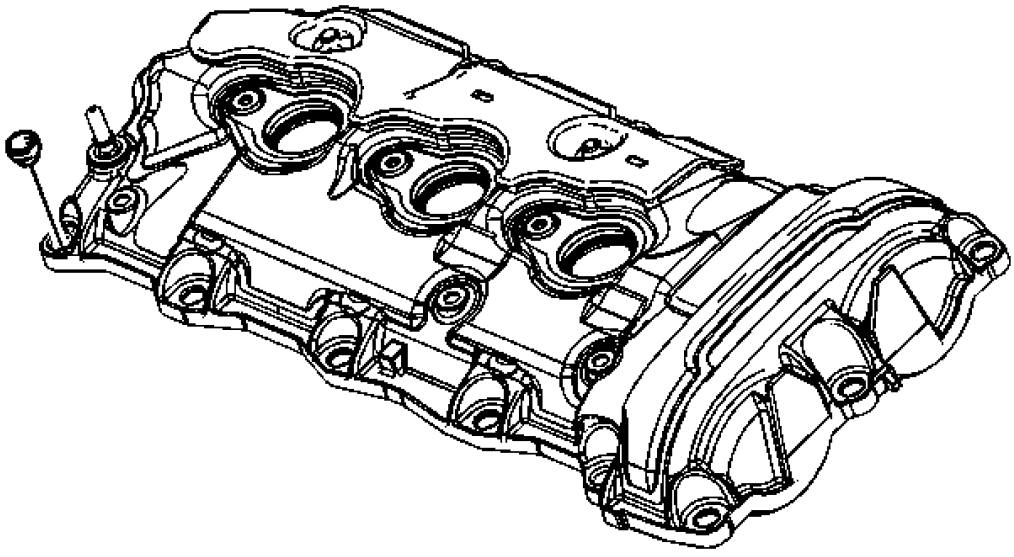


Fig. 198: View Of Right Camshaft Cover Bolt Grommets
Courtesy of GENERAL MOTORS CORP.

NOTE: The camshaft cover bolt grommet must be installed into the camshaft cover bolt hole before installing the camshaft cover bolt.

3. Install the NEW right camshaft cover bolt grommets.

INTAKE MANIFOLD DISASSEMBLE (LLT)

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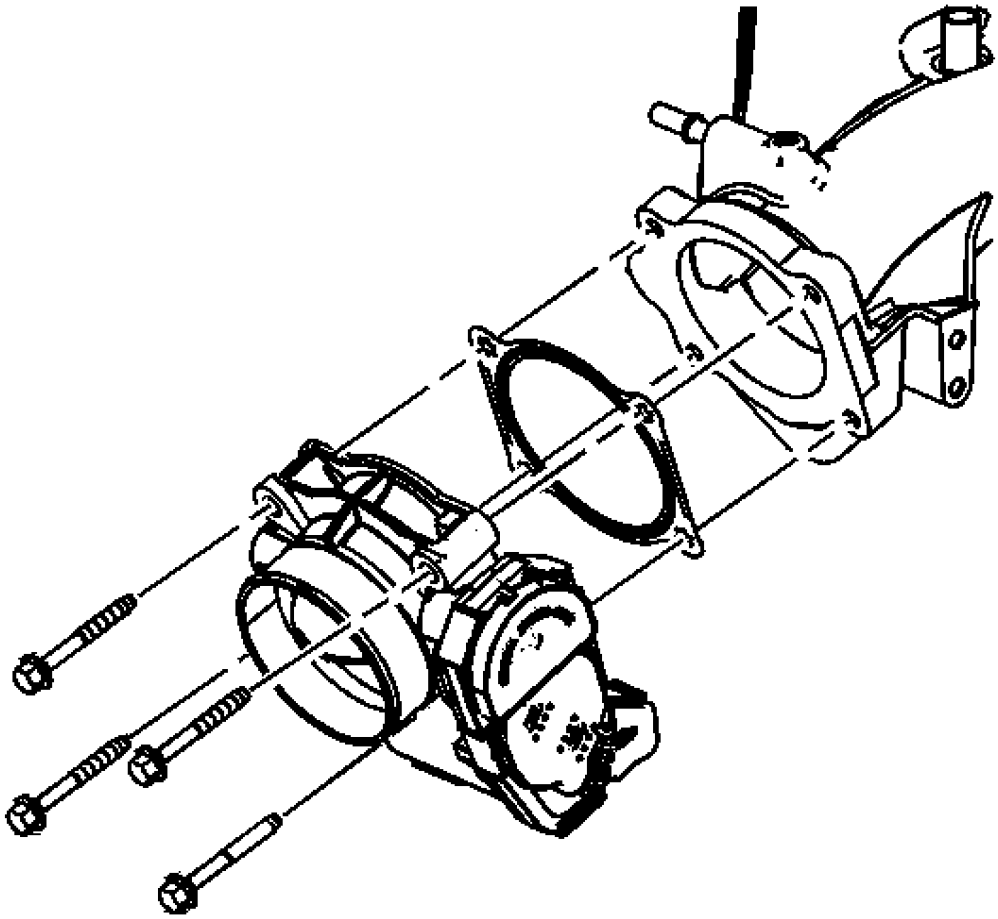


Fig. 199: View Of Throttle Body Assembly
Courtesy of GENERAL MOTORS CORP.

1. Remove the throttle body bolts.
2. Remove the throttle body.
3. Remove and discard the throttle body gasket.

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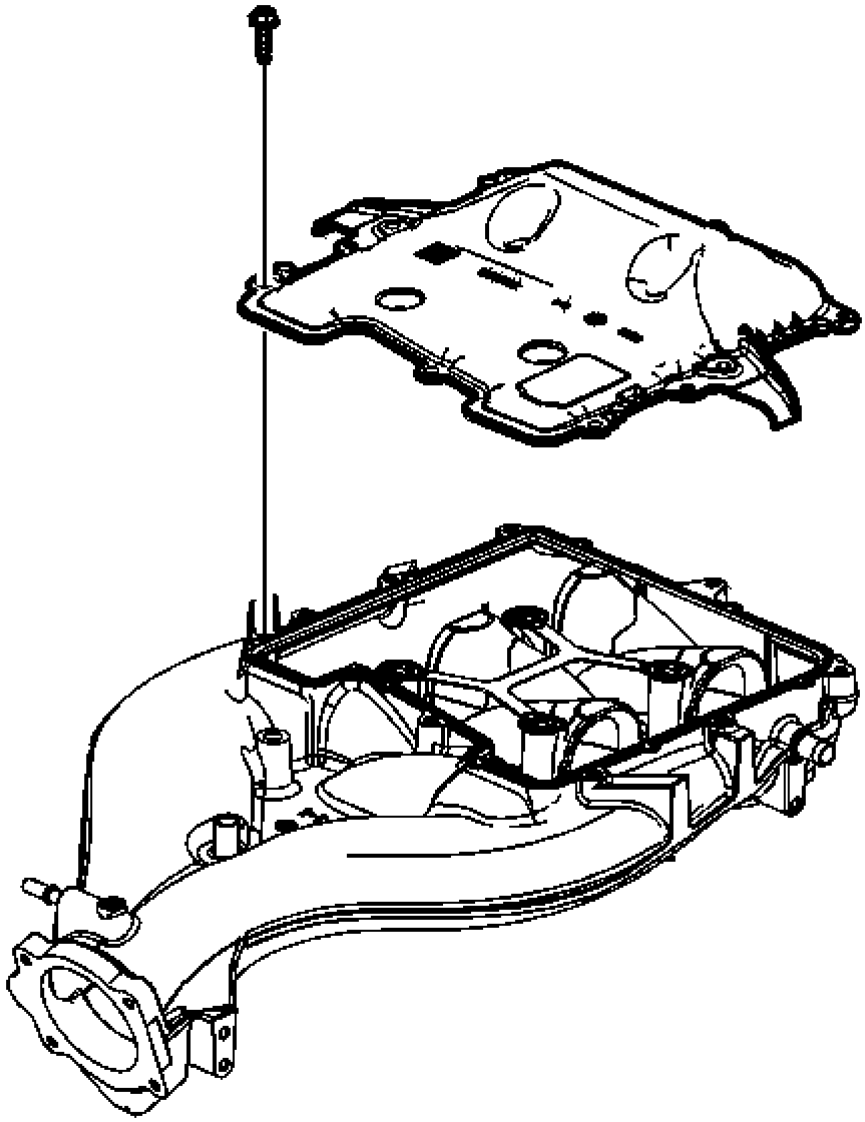


Fig. 200: Removing/Installing Intake Manifold Cover
Courtesy of GENERAL MOTORS CORP.

4. Remove the intake manifold cover bolts.
5. Remove the intake manifold cover.

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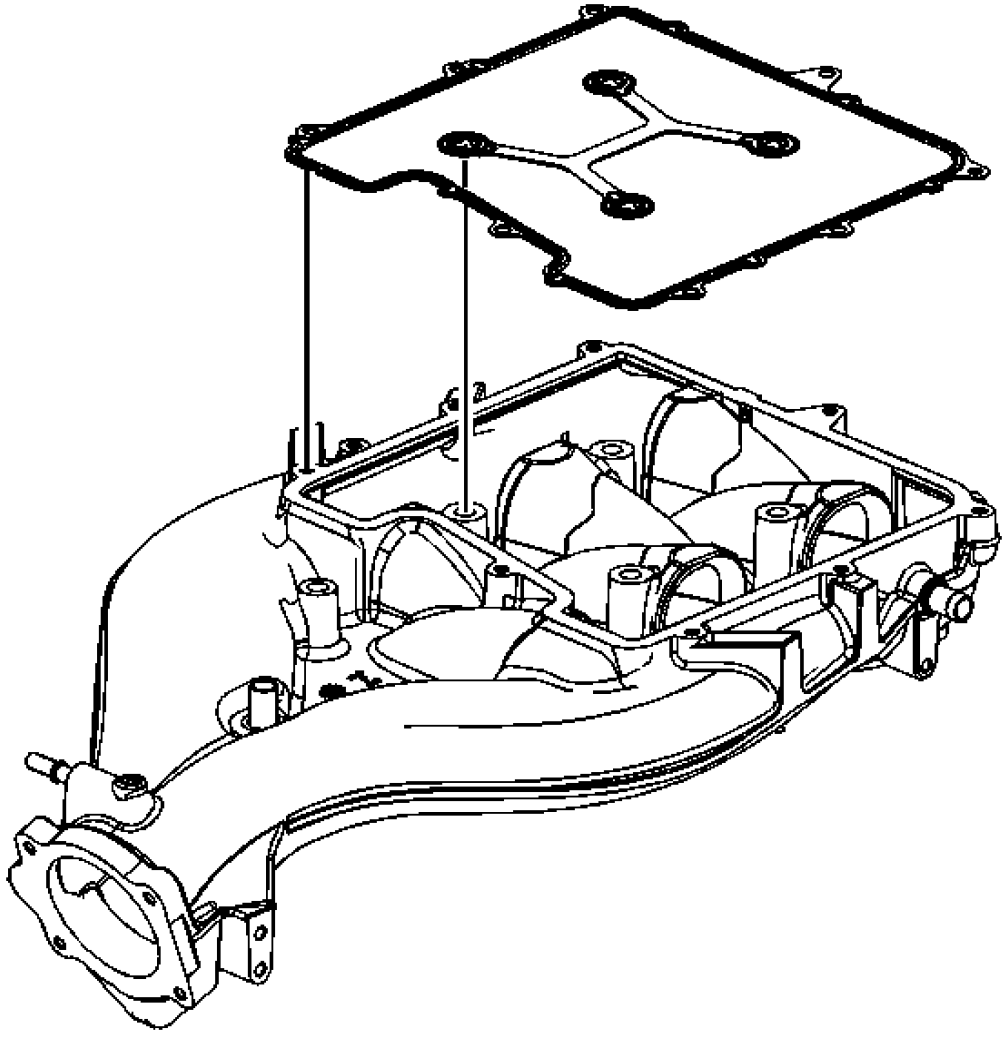


Fig. 201: Removing/Installing Intake Manifold Cover Gaskets
Courtesy of GENERAL MOTORS CORP.

6. Remove and discard the intake manifold cover gaskets.

INTAKE MANIFOLD CLEANING AND INSPECTION (LLT)

UPPER INTAKE MANIFOLD CLEANING PROCEDURE

1. Remove any remaining gasket and/or gasket material from the following:
    - Throttle body

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- Intake manifold

2. Clean the following intake manifold areas in solvent.
   - Intake manifold gasket sealing areas
   - Intake manifold passages
   - Brake booster hose passage
   - Evaporative emission (EVAP) solenoid passage
   - Positive crankcase ventilation (PCV) vacuum hose passages

WARNING: Refer to Safety Glasses Warning .

3. Dry the upper intake manifold and throttle body with compressed air.

INSPECTION PROCEDURE

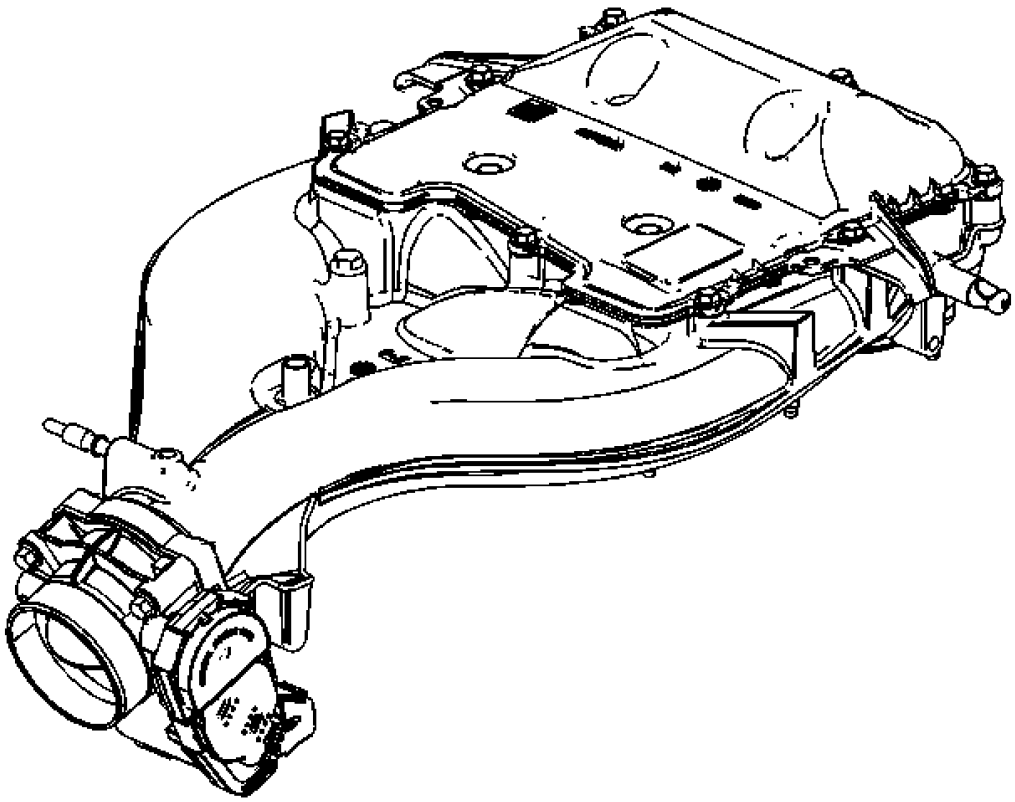


Fig. 202: View Of Upper Intake Manifold

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Courtesy of GENERAL MOTORS CORP.

1. Inspect the upper intake manifold for the following conditions:
    - Damage, debris or restrictions to the brake vacuum booster hose port
    - Damage to the throttle body bolt holes
    - Damage, debris or restrictions to the PCV system hose ports
    - Damage to the gasket sealing surface for the intake manifold cover

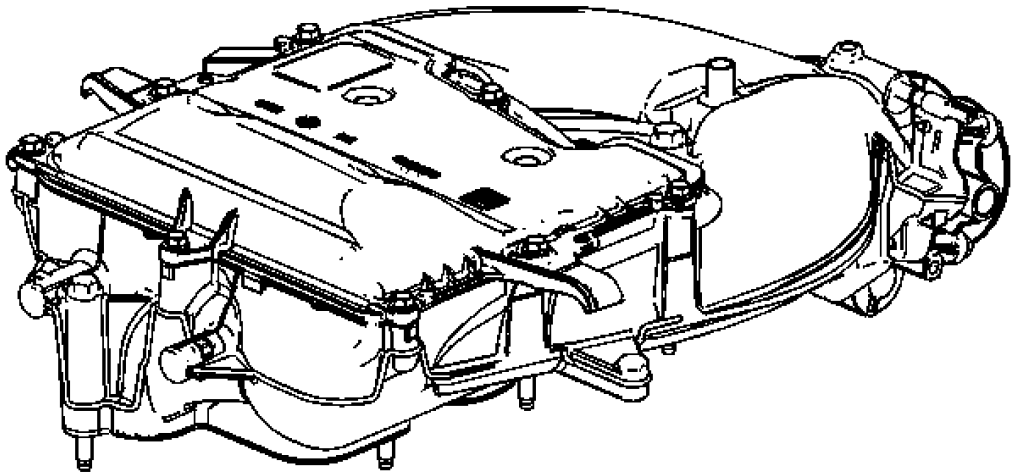


Fig. 203: View Of Upper Intake Manifold
Courtesy of GENERAL MOTORS CORP.

2. Inspect the upper intake manifold for the following conditions:
    - Damage to the intake manifold bolt bosses
    - Damage to the EVAP purge solenoid mounting boss
    - Damage, debris or restrictions to the EVAP purge solenoid port
    - Damage, debris or restrictions in the vacuum passage

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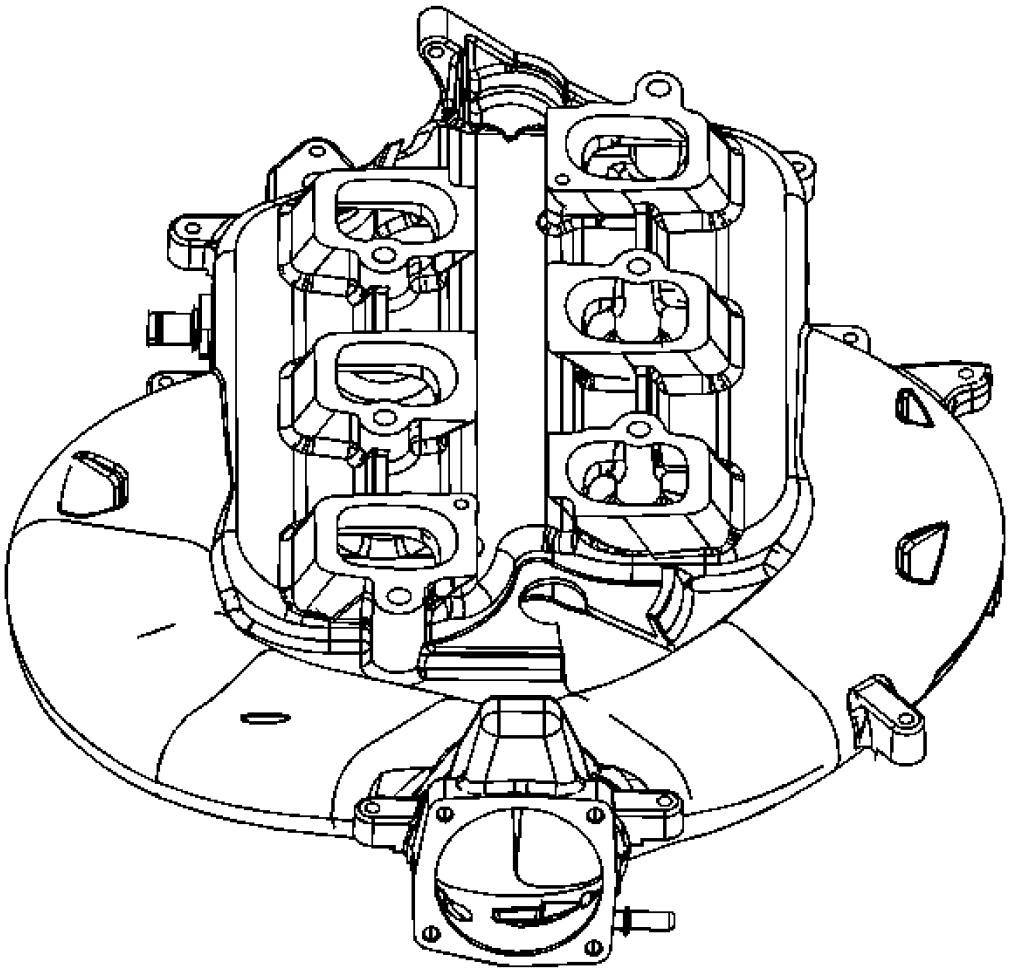


Fig. 204: Inspecting Upper Intake Manifold Sealing Surfaces
Courtesy of GENERAL MOTORS CORP.

3. Inspect the intake manifold for the following conditions:
    - Gouges or damage to the intake manifold sealing surfaces
    - Damage to the gasket sealing surface for the throttle body

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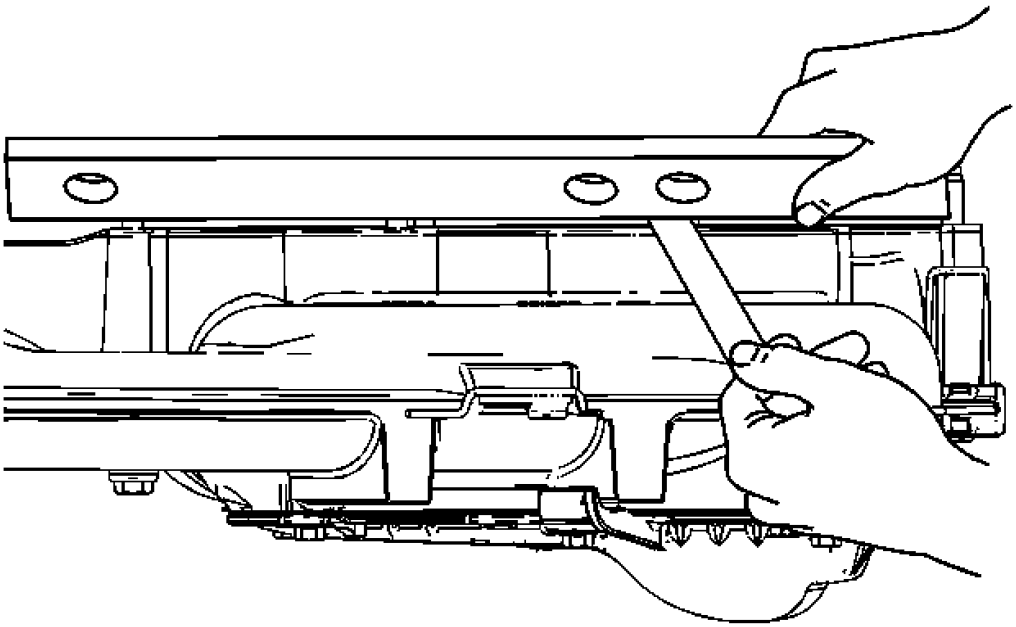


Fig. 205: Inspecting Upper Intake Manifold Sealing Surface For Warpage
Courtesy of GENERAL MOTORS CORP.

4. Inspect the upper intake manifold sealing surface for warpage.
    1. Locate a straight edge across the intake manifold sealing surface.
    2. Insert a feeler gauge between the upper intake manifold and the straight edge. An intake manifold with warpage in excess of 0.50 mm (0.020 in) must be replaced.
5. Repair or replace the upper intake manifold as necessary.

INTAKE MANIFOLD ASSEMBLE (LLT)

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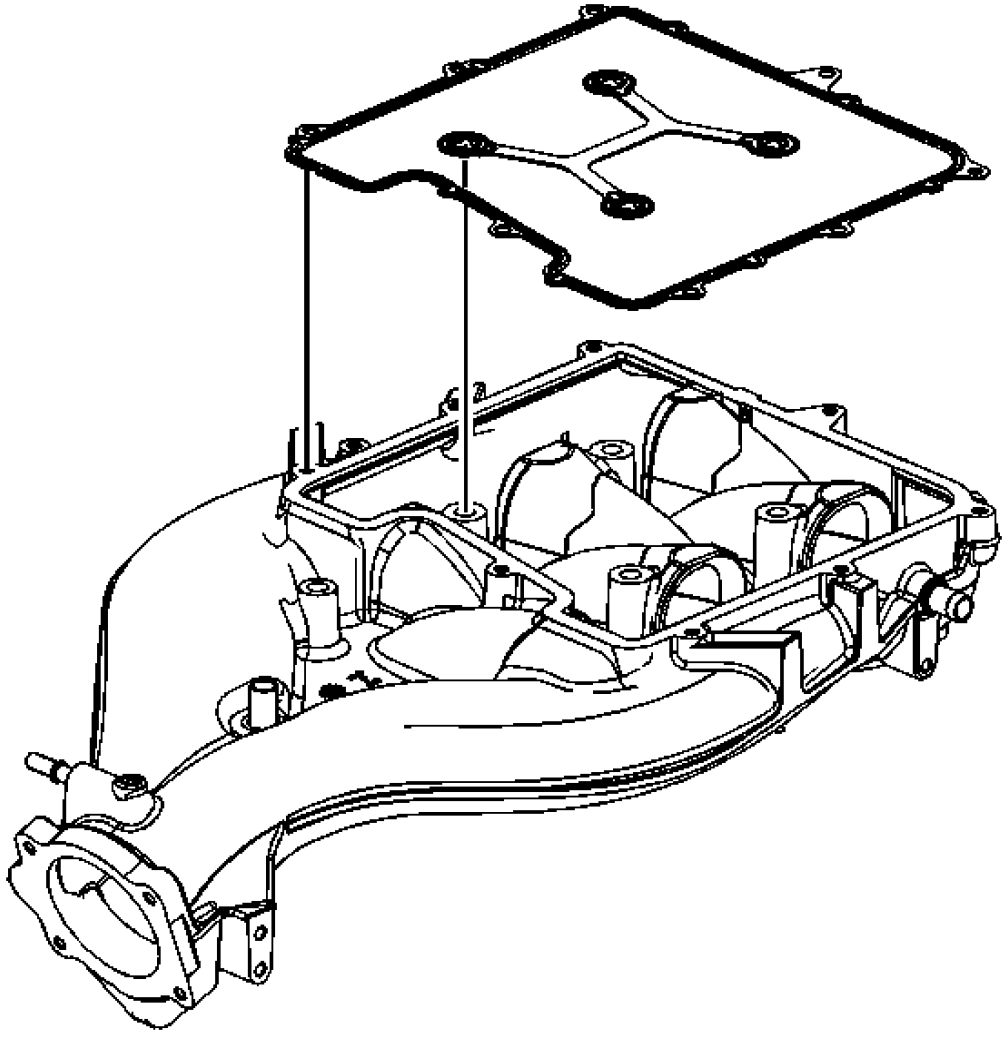


Fig. 206: Removing/Installing Intake Manifold Cover Gaskets
Courtesy of GENERAL MOTORS CORP.

1. Install the NEW intake manifold cover gaskets.

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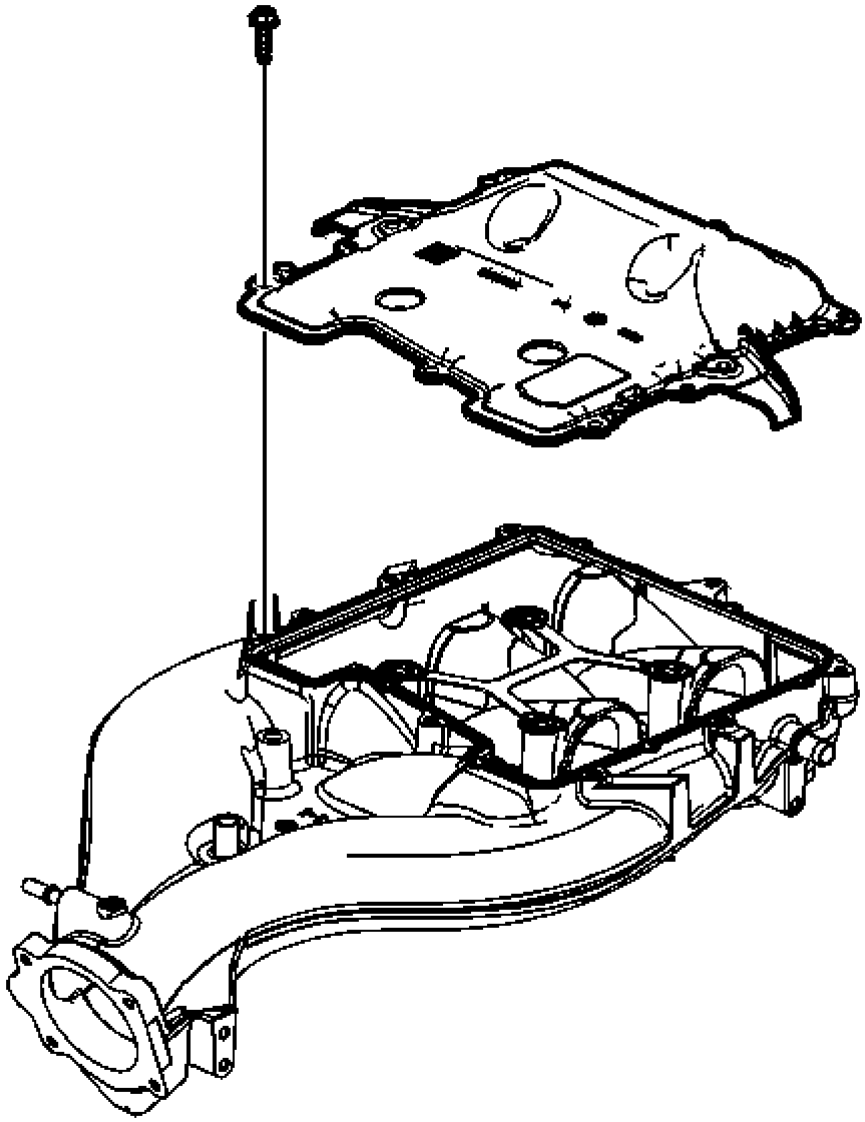


Fig. 207: Removing/Installing Intake Manifold Cover
Courtesy of GENERAL MOTORS CORP.

2. Install the intake manifold cover.

CAUTION: Refer to Fastener Caution .

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3. Install the intake manifold cover bolts and tighten to 10 N.m (89 lb in).

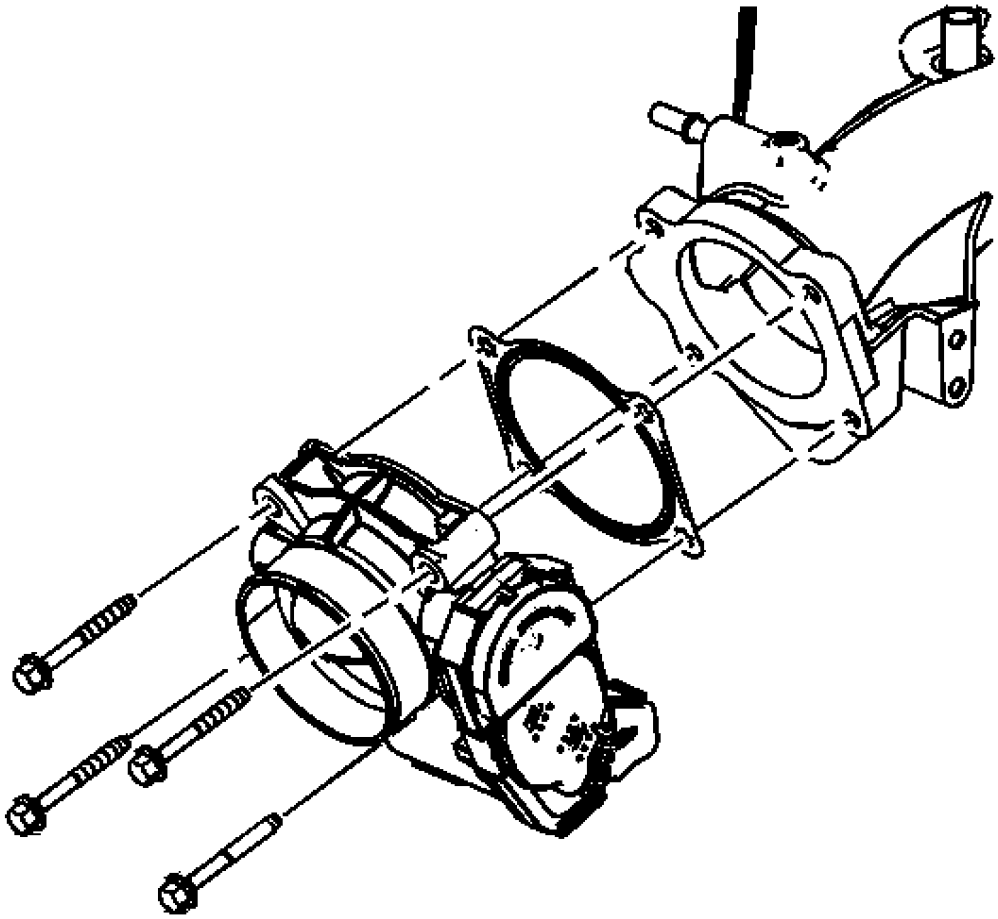


Fig. 208: View Of Throttle Body Assembly
Courtesy of GENERAL MOTORS CORP.

4. Install the NEW throttle body gasket.
5. Install the throttle body.
6. Install the throttle body bolts and tighten to 10 N.m (89 lb in)..

EXHAUST MANIFOLD CLEANING AND INSPECTION - LEFT SIDE

CLEANING PROCEDURE

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1. Clean the exhaust manifold in solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the exhaust manifold with compressed air.

INSPECTION PROCEDURE

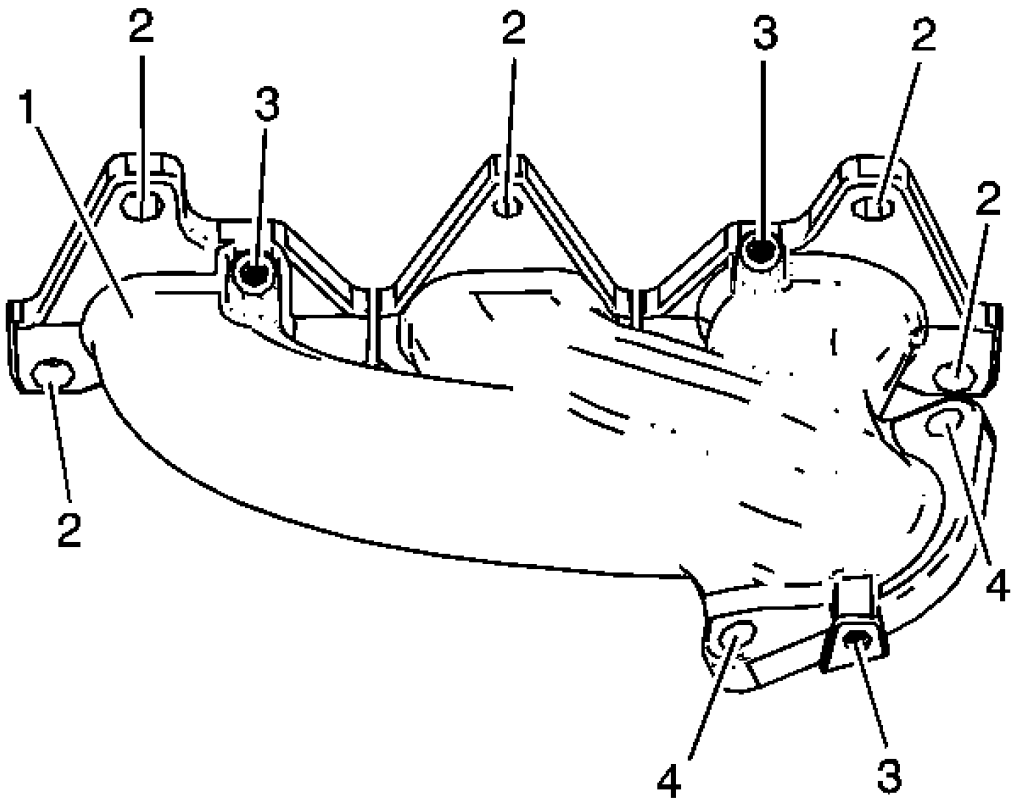


Fig. 209: Inspecting Left Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

1. Inspect the left exhaust manifold for the following:
   - Damage or excessive corrosion to the exhaust manifold exterior (1)
   - Damage to the exhaust manifold mounting holes (2)
   - Damage to the threaded holes (3) for the heat shield

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- Damage to the exhaust manifold flange bolt holes (4)

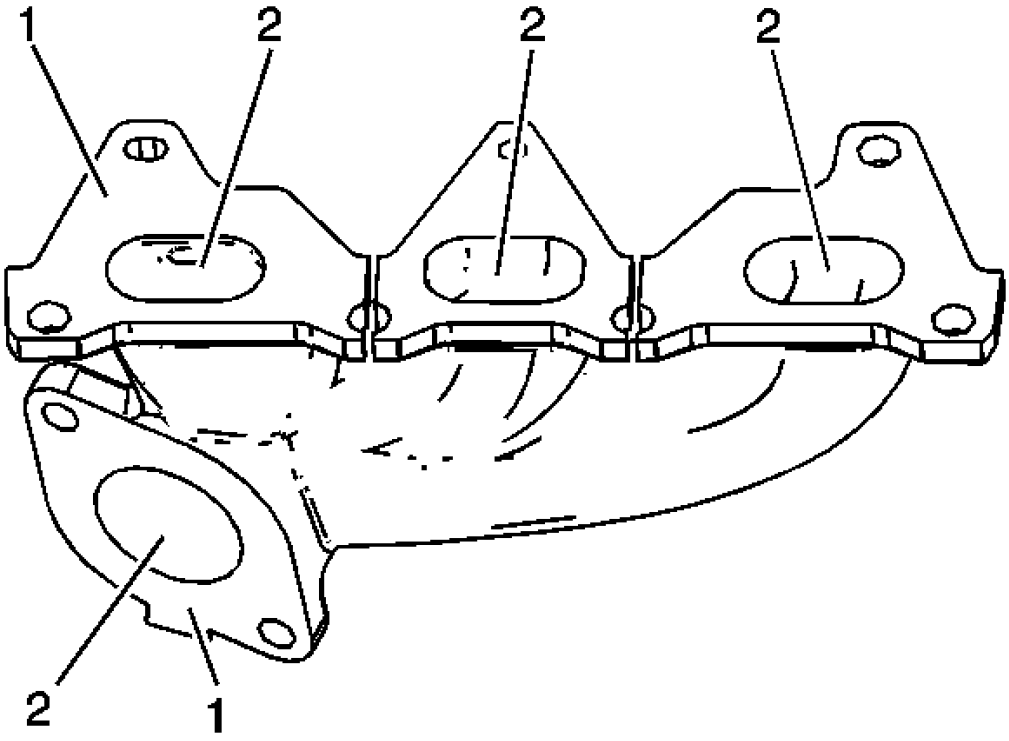


Fig. 210: Identifying Left Exhaust Manifold Gasket Sealing Surfaces & Exhaust Passages
Courtesy of GENERAL MOTORS CORP.

2. Inspect the left exhaust manifold for the following:
   - Damage to the gasket sealing surfaces (1)
   - Damage or restrictions within the exhaust passages (2)
3. Repair or replace the left exhaust manifold and/or components as necessary.

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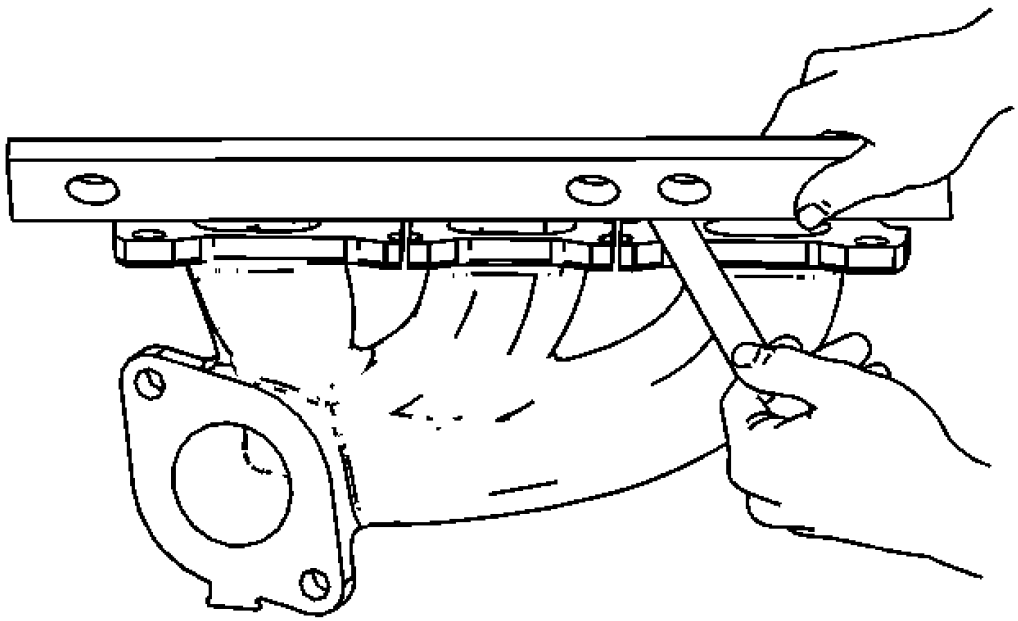


Fig. 211: Measuring Alignment Of Left Exhaust Manifold Flanges
Courtesy of GENERAL MOTORS CORP.

4. Measure the alignment or surface flatness of the exhaust manifold flanges, using a straight edge and a feeler gauge. Exhaust manifold surface flatness must not exceed 0.254 mm (0.010 in).
5. If the surface flatness is not within specifications, the exhaust manifold is warped and must be replaced.

EXHAUST MANIFOLD CLEANING AND INSPECTION - RIGHT SIDE

CLEANING PROCEDURE

1. Clean the exhaust manifold in solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the exhaust manifold with compressed air.

INSPECTION PROCEDURE

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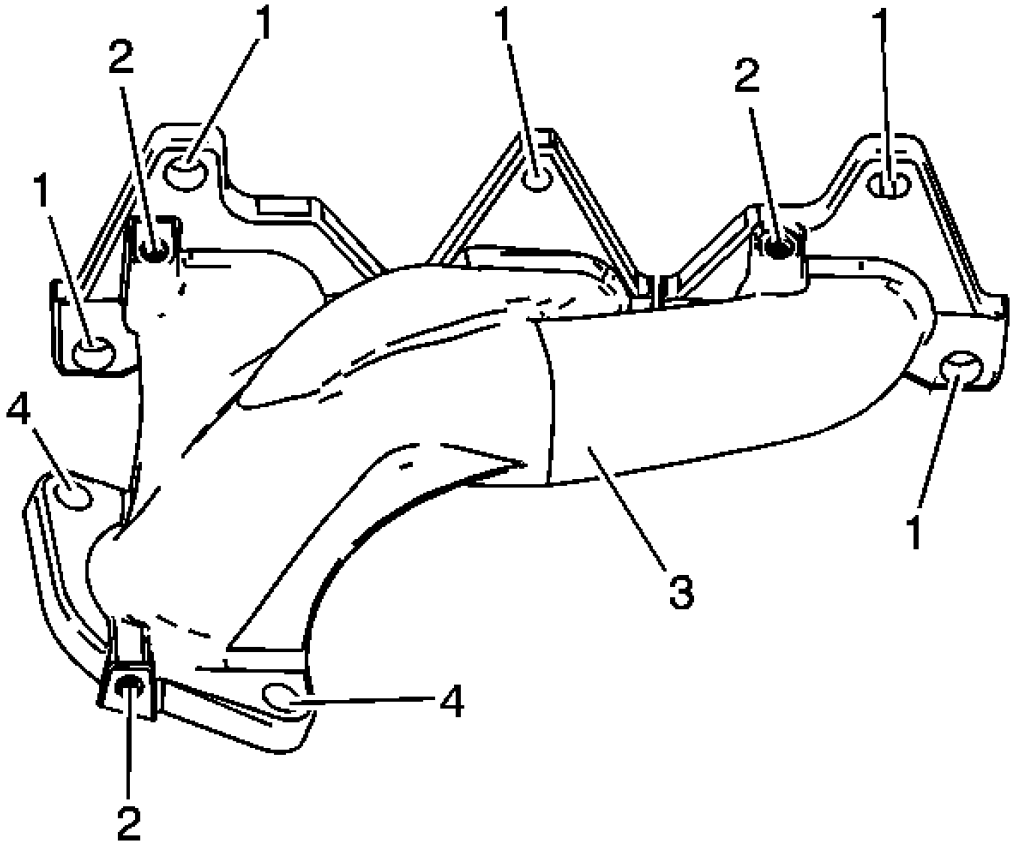


Fig. 212: Inspecting Right Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

1. Inspect the right exhaust manifold for the following:
    - Damage to the exhaust manifold mounting holes (1)
    - Damage to the threaded holes (2) for the heat shield
    - Damage or excessive corrosion to the exhaust manifold exterior (3)
    - Damage to the exhaust manifold flange bolt holes (4)

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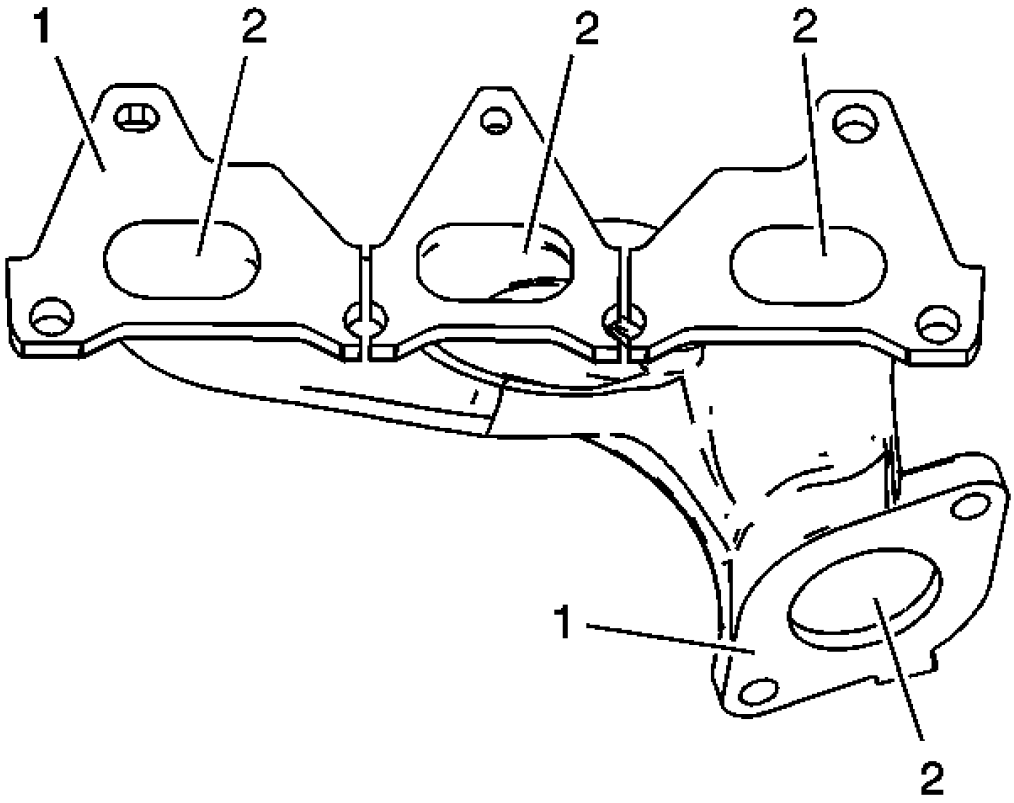


Fig. 213: Inspecting Right Exhaust Manifold Exhaust Passages & Gasket Sealing Surfaces
Courtesy of GENERAL MOTORS CORP.

2. Inspect the right exhaust manifold for the following:
   - Damage to the gasket sealing surfaces (1)
   - Damage or restrictions within the exhaust passages (2)
3. Repair or replace the right exhaust manifold and/or components as necessary.

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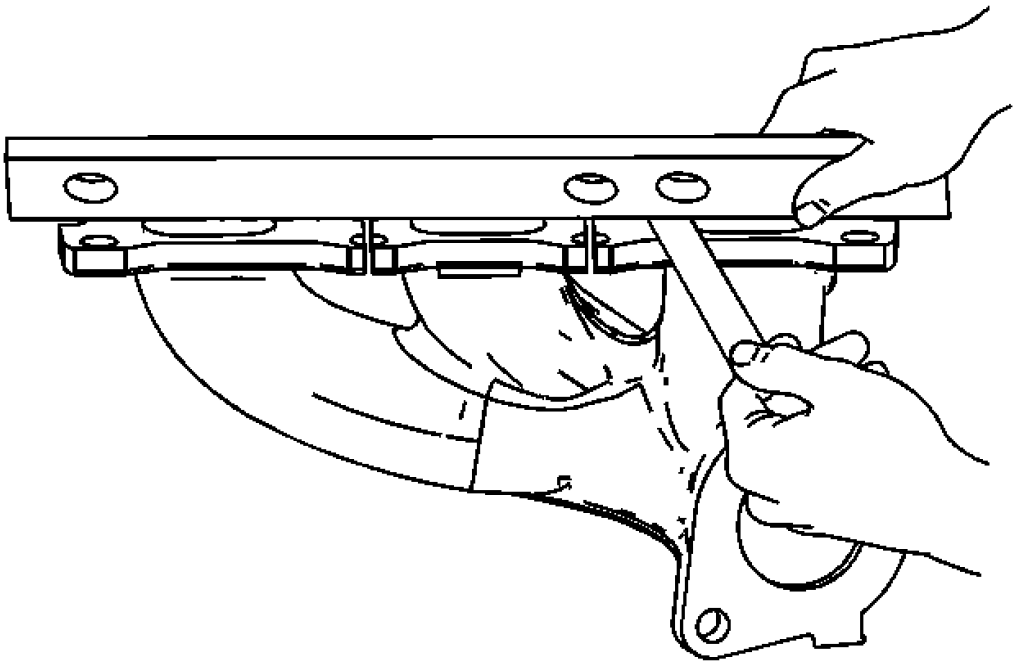


Fig. 214: Measuring Alignment Of Right Exhaust Manifold Flanges
Courtesy of GENERAL MOTORS CORP.

4. Measure the alignment or surface flatness of the exhaust manifold flanges, using a straight edge and a feeler gauge. Exhaust manifold surface flatness must not exceed 0.254 mm (0.010 in).
5. If the surface flatness is not within specifications, the exhaust manifold is warped and must be replaced.

WATER PUMP CLEANING AND INSPECTION

CLEANING PROCEDURE

CAUTION: Do not immerse the water pump in solvent. The solvent may enter the water pump's permanently lubricated bearings and cause premature bearing failure.

1. Remove the old gasket material from the water pump sealing surfaces.
2. Clean all excess dirt and debris from the water pump housing.

INSPECTION PROCEDURE

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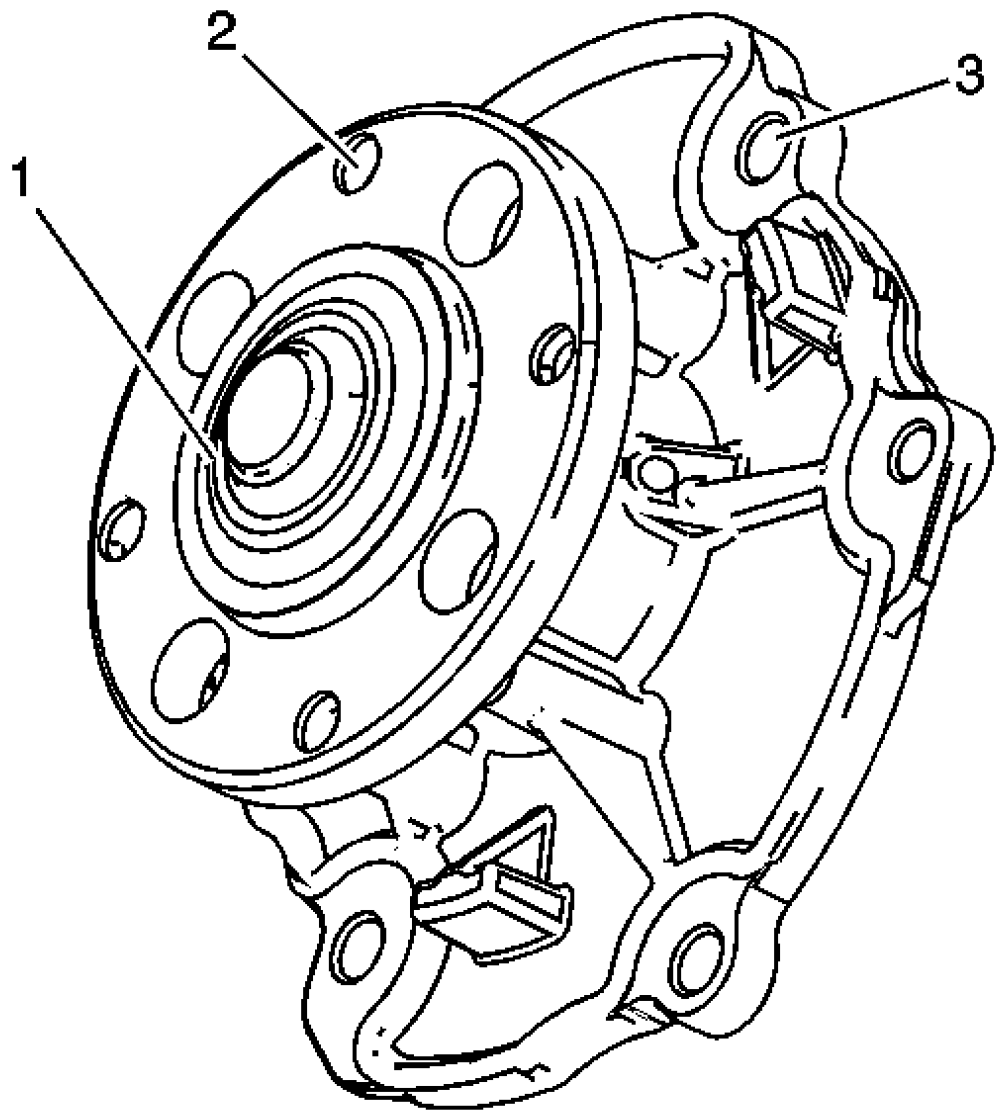


Fig. 215: Inspecting Water Pump & Hub
Courtesy of GENERAL MOTORS CORP.

1. Rotate the water pump hub (1). The water pump hub and impeller should turn straight and smoothly. If the hub wobbles, is noisy, or feels rough when rotated, replace the water pump.
2. Inspect the exterior of the water pump for the following:
   - Damage to the water pump hub bolt threads (2) for the water pump pulley
   - Damage to the water pump bolt holes (3)

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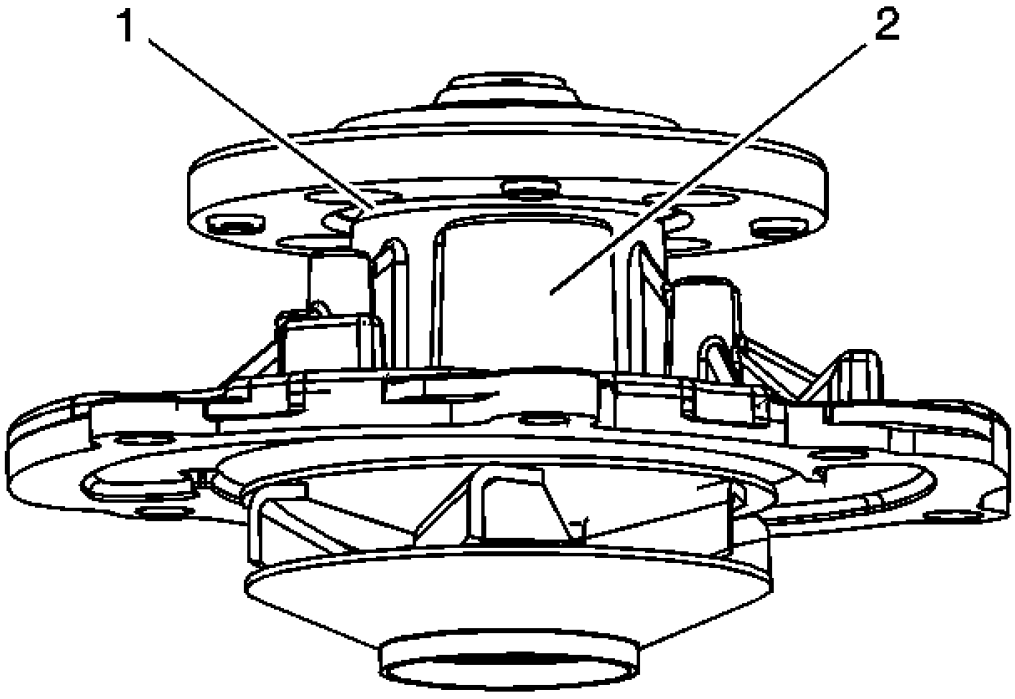


Fig. 216: Checking Water Pump Shaft & Weep Hole
Courtesy of GENERAL MOTORS CORP.

3. Examine the water pump shaft (1) and the weep hole reservoir (2) in the water pump body for signs of leakage. If coolant leakage is evident, replace the water pump.

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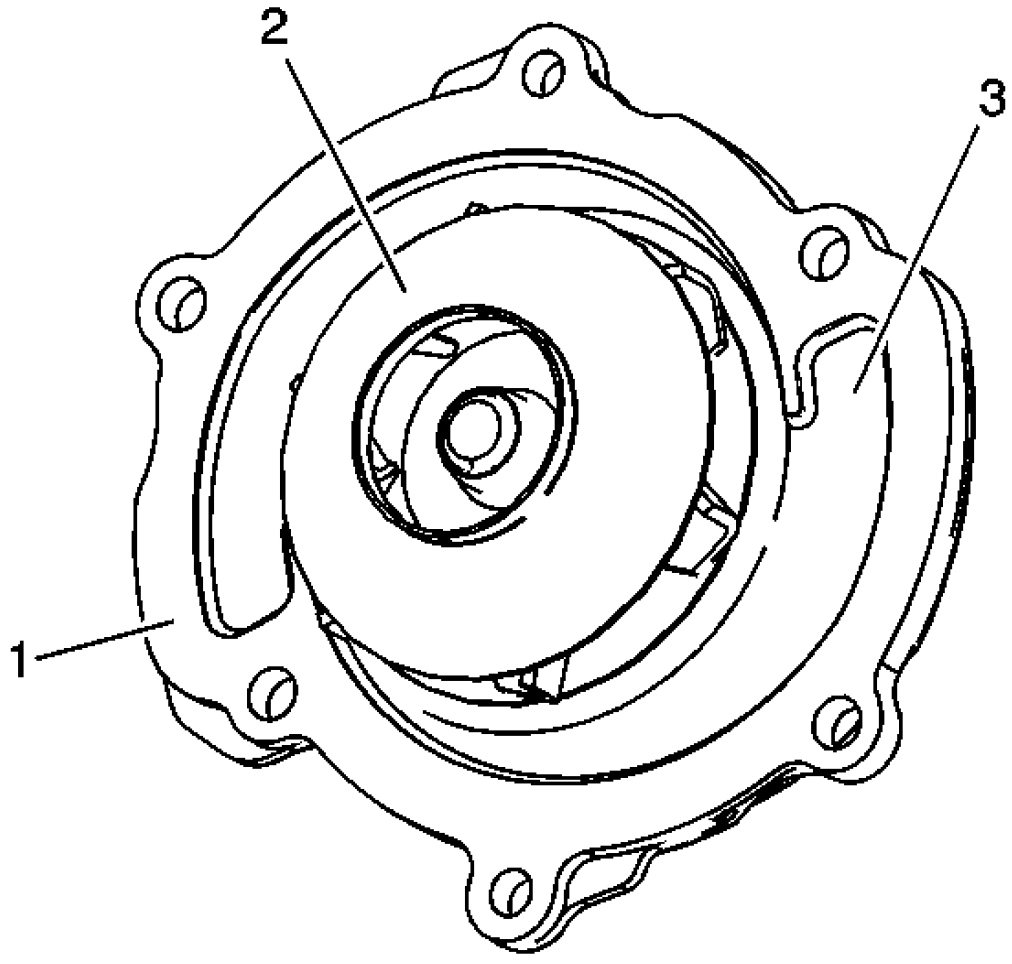


Fig. 217: Inspecting Interior Of Water Pump
Courtesy of GENERAL MOTORS CORP.

4. Inspect the interior of the water pump for the following:
    - Damage to the water pump gasket sealing surface (1)
    - Damage, corrosion or restrictions to the water pump impeller (2)
    - Damage, corrosion or restrictions to the coolant passages (3)
5. Repair or replace the water pump as necessary.

THREAD REPAIR

Special Tools

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- **J-42385-700:** High Feature Thread Repair Kit
- **J-42385-2000:** Thread Insert Kit
- **J-43965:** Thread Repair Extension Kit

For equivalent regional tools, refer to **Special Tools** .

The thread repair process involves a solid, thin walled, self-locking, carbon steel, bushing type insert. During the insert installation process, the installation driver tool cold-rolls the bottom internal threads and expands the bottom external threads of the insert into the base material. This action mechanically locks the insert into place.

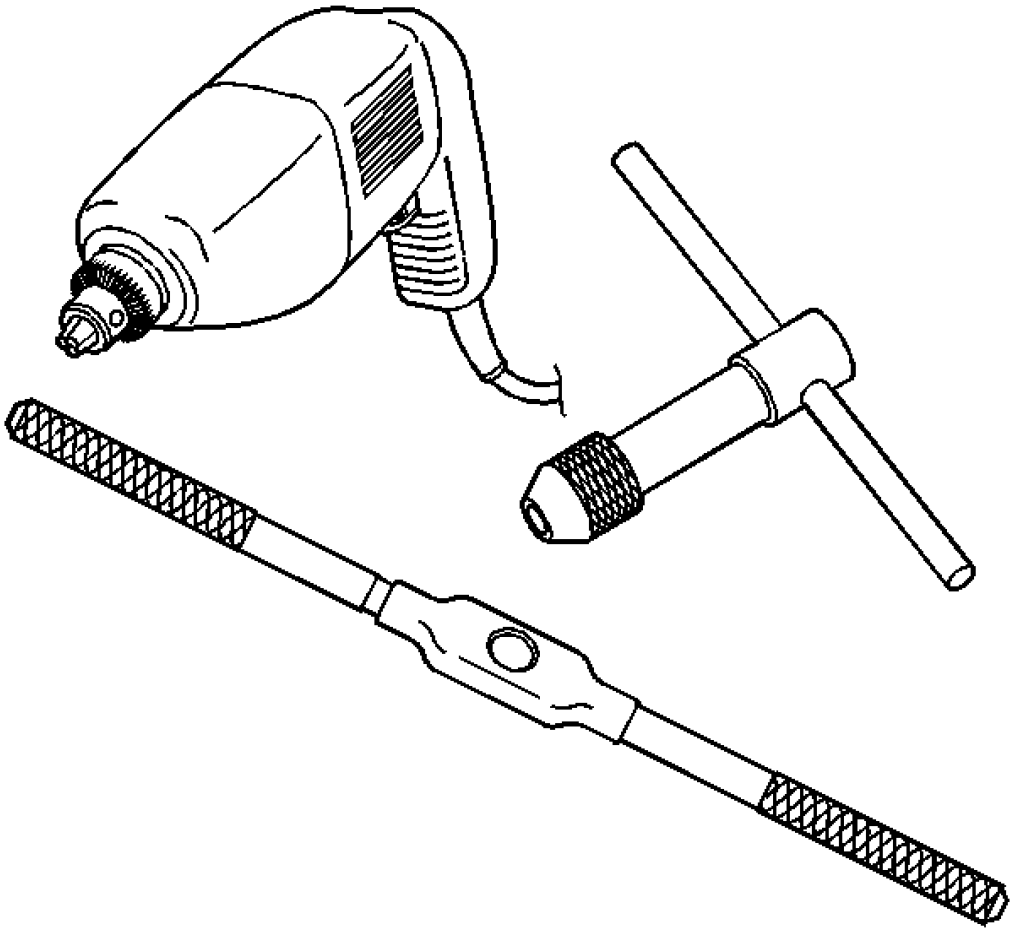


Fig. 218: View Of Tools
Courtesy of GENERAL MOTORS CORP.

The drill bit and counter bore tool from the tool kit **J-42385-700:** kit and **J-42385-2000:** insert kit is designed

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for use with either a suitable tap wrench or drill motor. Limited access and larger hole repair may process better using a tap wrench. An extension from kit **J-43965:** extension kit may also be necessary to drive the thread repair tooling dependent on access to the hole being repaired. Use only a tap wrench when tapping the hole and during installation of the insert.

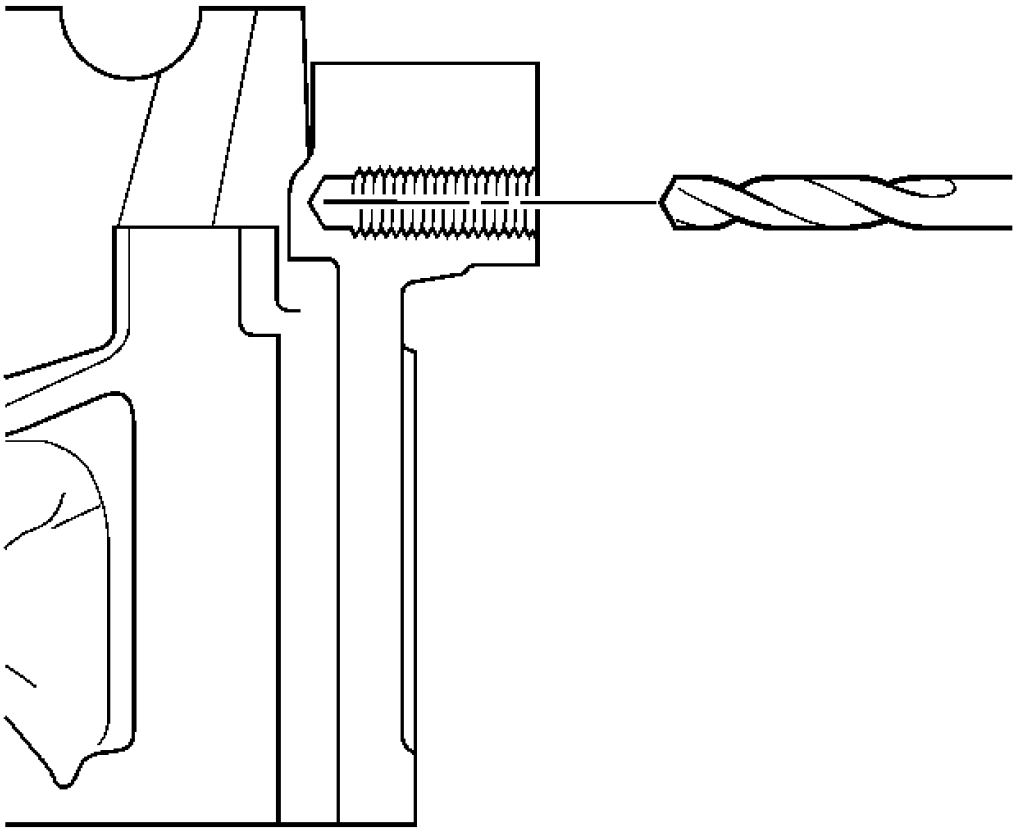


Fig. 219: Drilling Hole Centerline
Courtesy of GENERAL MOTORS CORP.

It is critical that the drilling, counterboring and tapping of the hole to be repaired follows the same centerline as the original hole.

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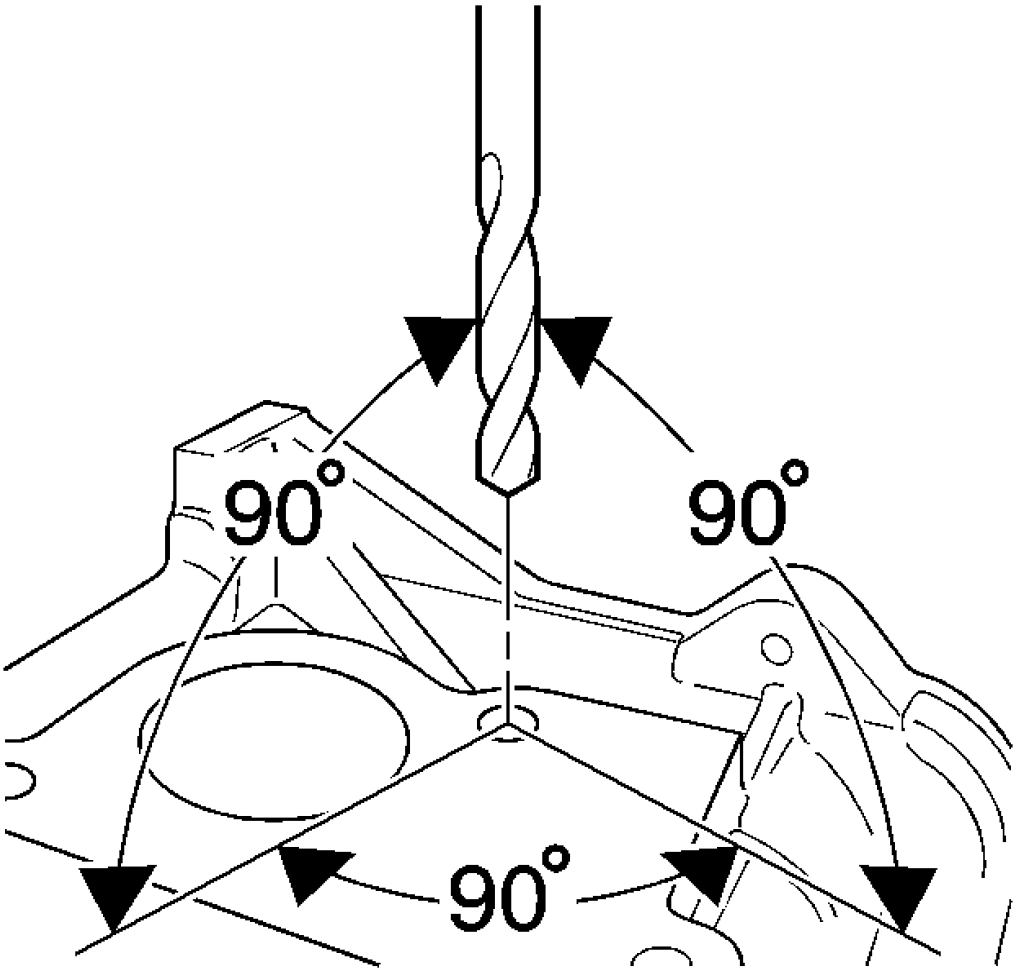


Fig. 220: Identifying Proper Drilling Angle
Courtesy of GENERAL MOTORS CORP.

During the drilling and tapping of the hole being repaired ensure the tooling is consistently machining perpendicular to the surface of the base material.

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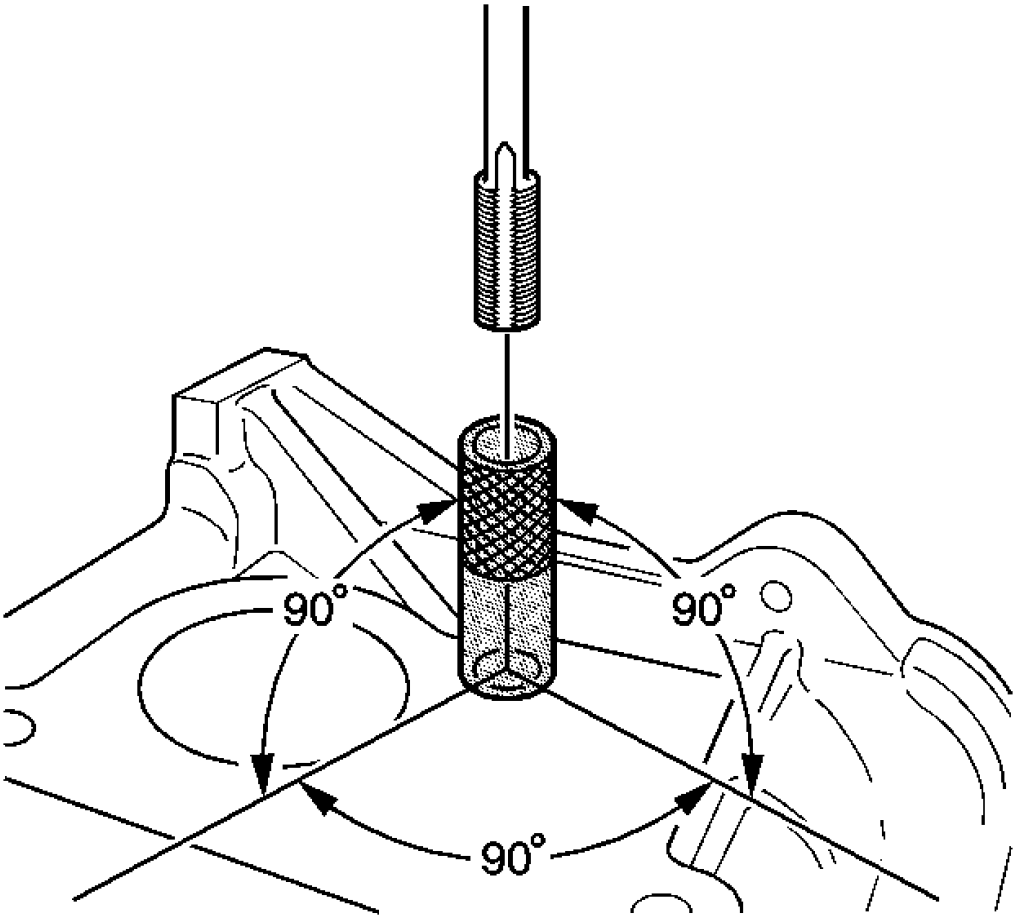


Fig. 221: View Of Tapping Guide
Courtesy of GENERAL MOTORS CORP.

If the threaded hole being repaired has a base surface perpendicular to the hole centerline, tapping guides are available to aid in tapping the hole.

Tap Size	Tap Guide	Tap Size	Tap Guide	Tap Size	Tap Guide
-	J 42385-	-	J 42385-	-	J 42385-
6 x 1.0	729	10 x 1.5	731	14 x 1.5	736
8 x 1.25	730	12 x 1.5	732	20 x 1.5	737

STANDARD THREAD REPAIR - FLUSH HOLE

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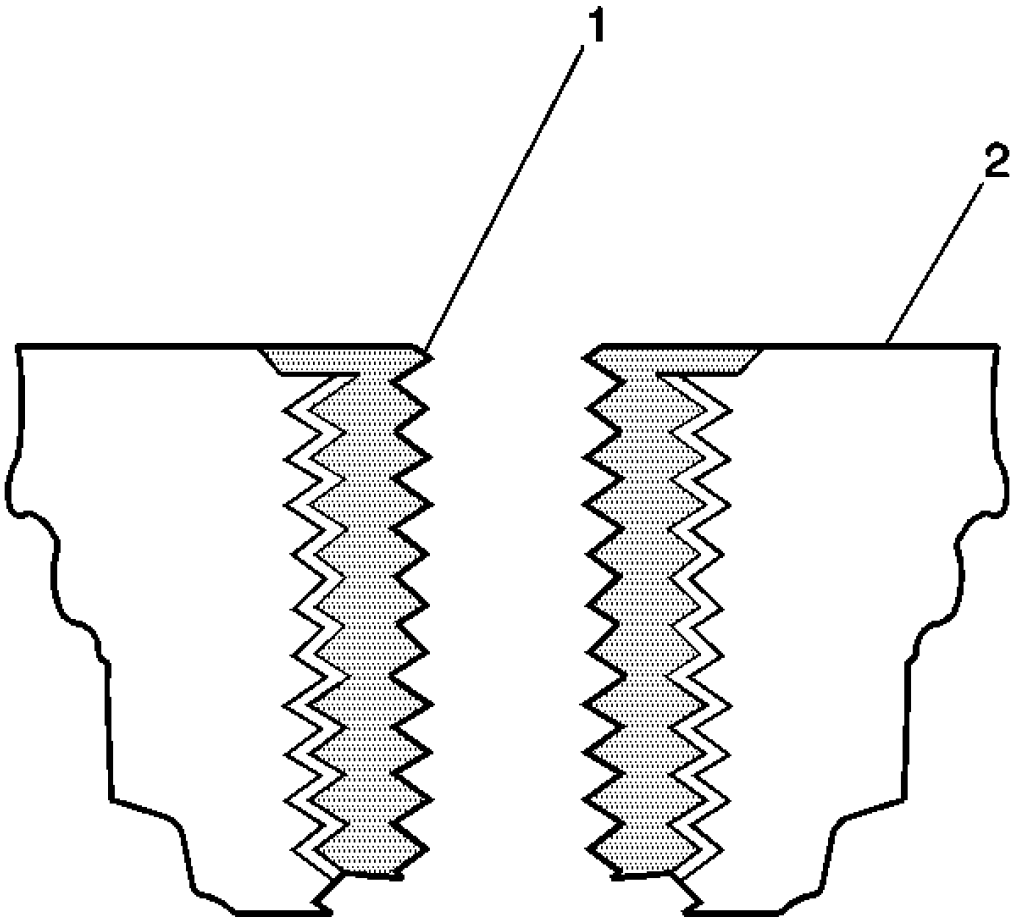


Fig. 222: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Safety Glasses Warning .

NOTE: The use of a cutting type fluid is recommended when performing the drilling, counterboring and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers for recommended cutting fluid.
When installed to the proper depth, the flange (1) of the insert will be seated against the counterbore of the drilled/tapped hole and just below the surface (2) of the base material.

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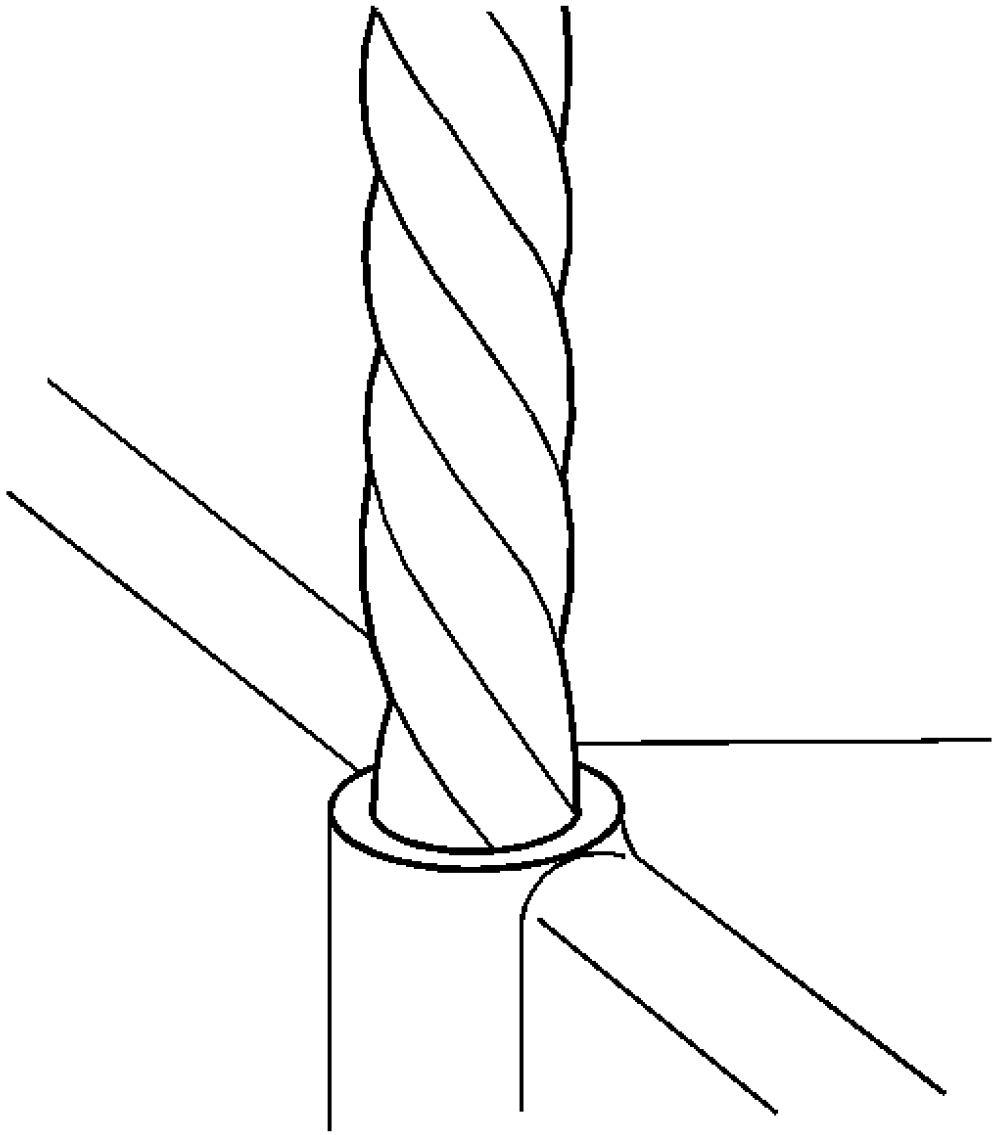


Fig. 223: Drilling Out Threads Of Damaged Hole
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.**
- **Do NOT drill any further than the original hole depth.**

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1. Drill out the threads of the damaged hole.

   Specifications:
   - M6 inserts require a minimum drill depth of 15 mm (0.59 in).
   - M8 inserts require a minimum drill depth of 20 mm (0.79 in).
   - M10 inserts require a minimum drill depth of 23.5 mm (0.93 in).

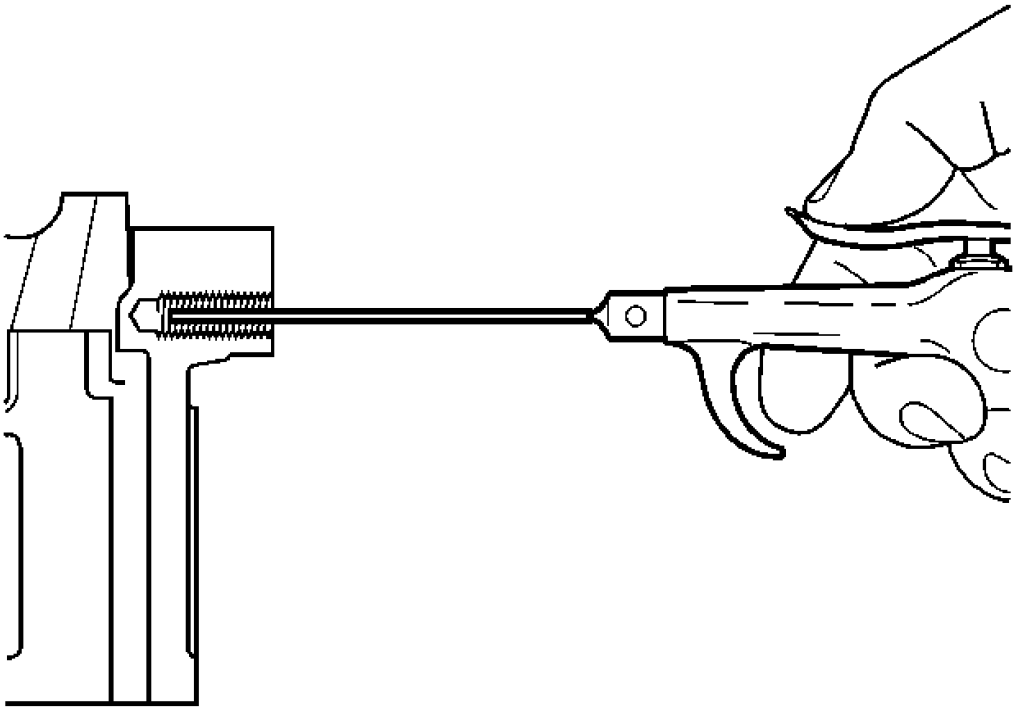


Fig. 224: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the drilled hole prior to tapping.

2. Using compressed air, clean out any chips.

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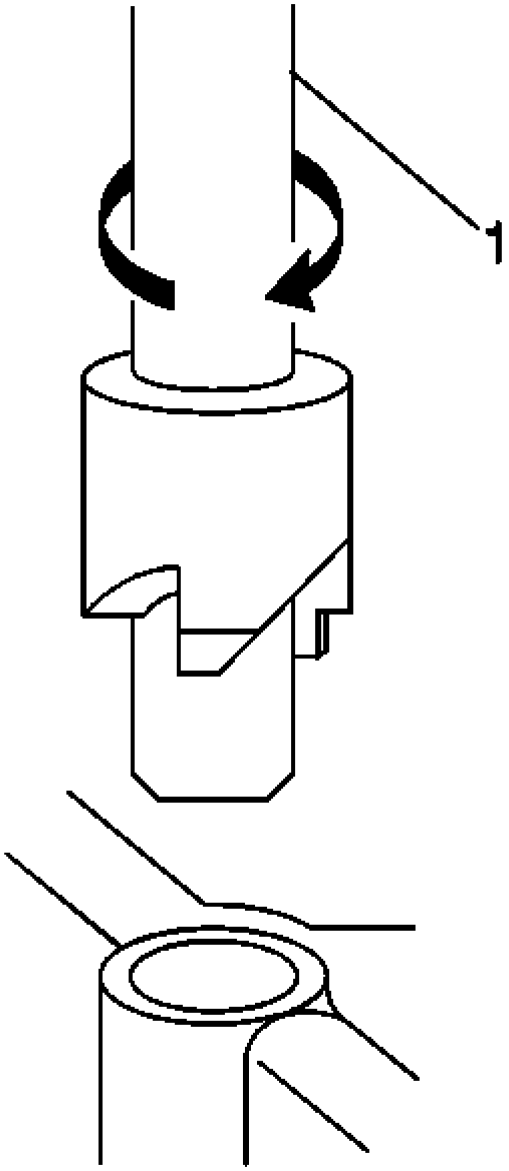


Fig. 225: Identifying Counterbore Drill
Courtesy of GENERAL MOTORS CORP.

NOTE: **A properly counterbored hole will show a slight burnishing on the surface of the base material for 360 degrees around the drilled hole.**

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3. Counterbore the drilled hole to the full depth permitted by the tool (1).

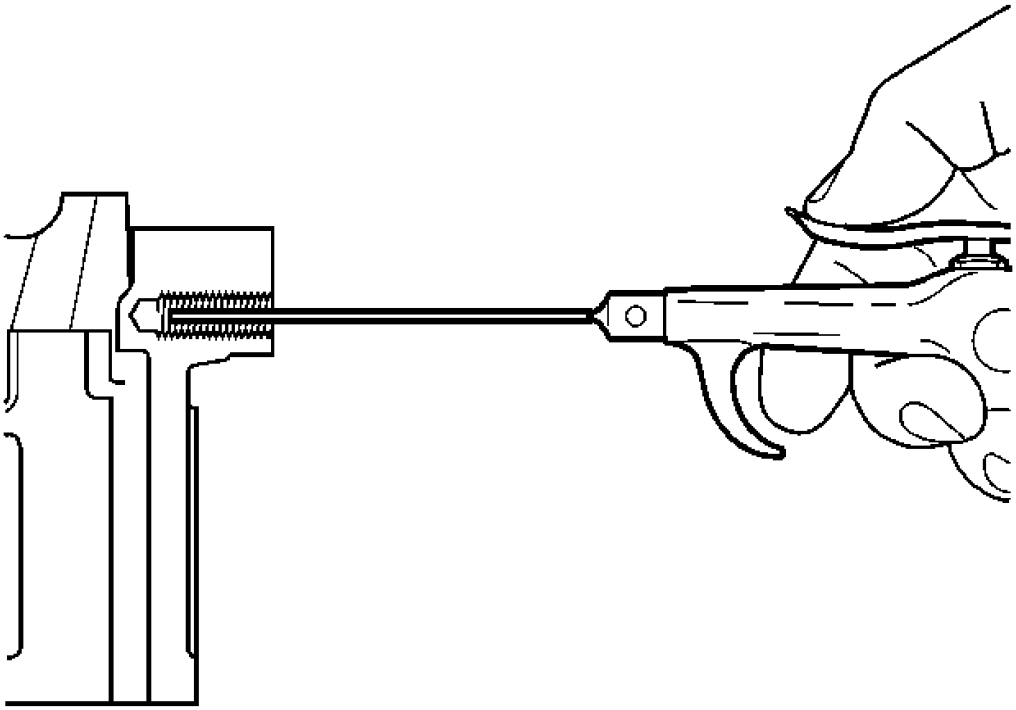


Fig. 226: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the drilled hole prior to tapping.

4. Using compressed air, clean out any chips.

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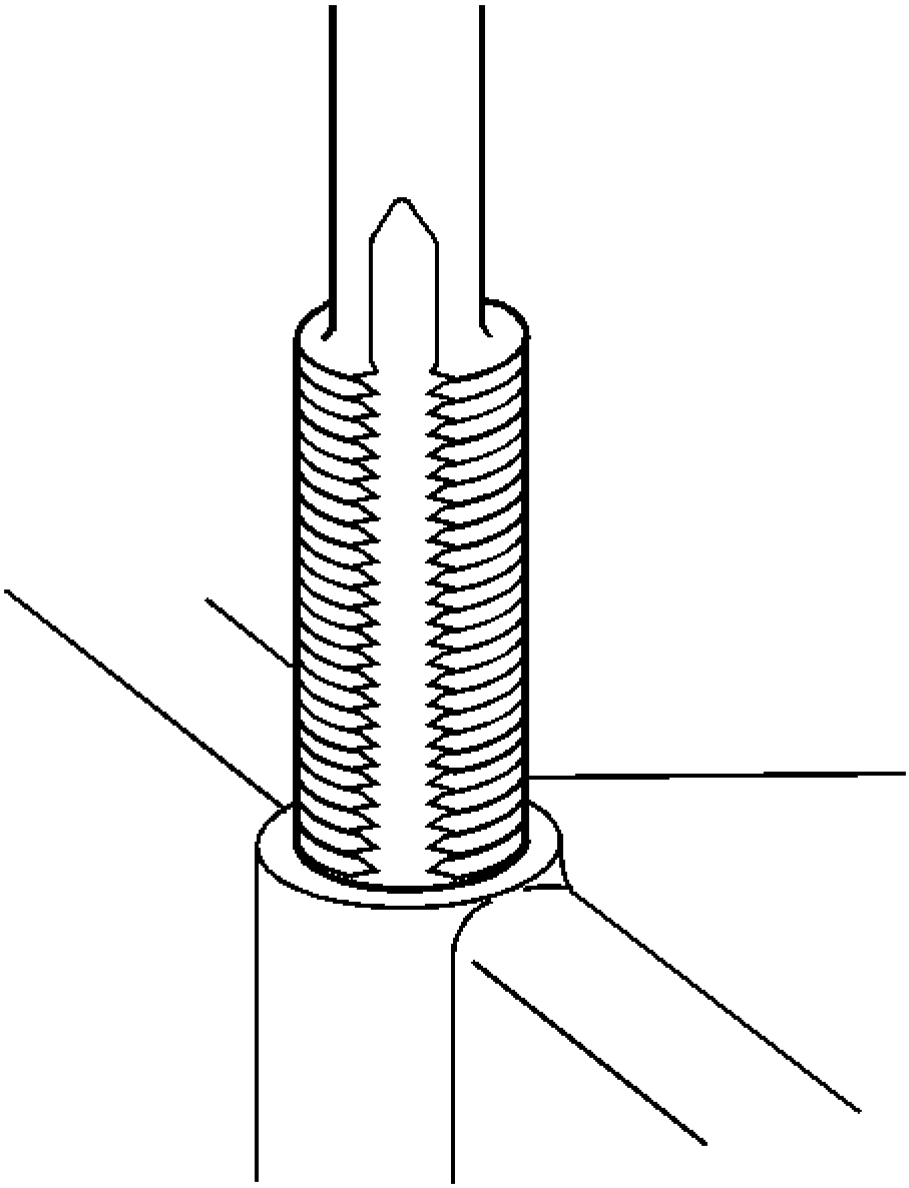


Fig. 227: Tapping Threads Of Drilled Hole
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.**

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- **Ensure the tap has created full threads at least to the depth equal to the insert length.**

5. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.

Specifications:

- M6 inserts require a minimum tap depth of 15 mm (0.59 in).
- M8 inserts require a minimum tap depth of 20 mm (0.79 in).
- M10 inserts require a minimum tap depth of 23.5 mm (0.93 in).

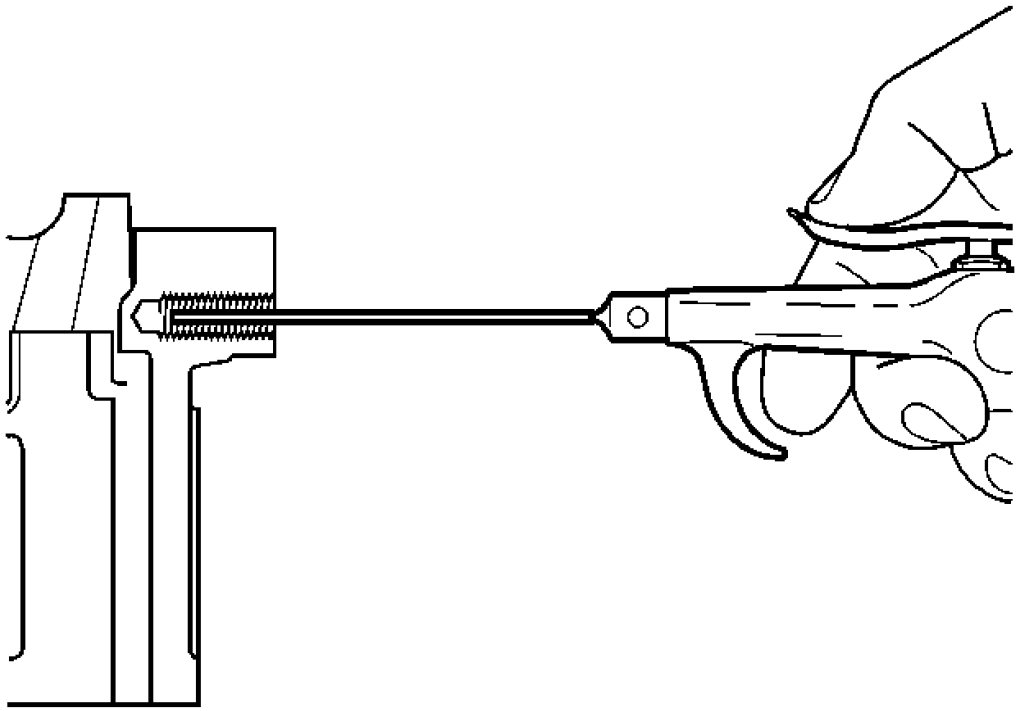


Fig. 228: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the tapped hole prior to insert installation.

6. Using compressed air, clean out any chips.

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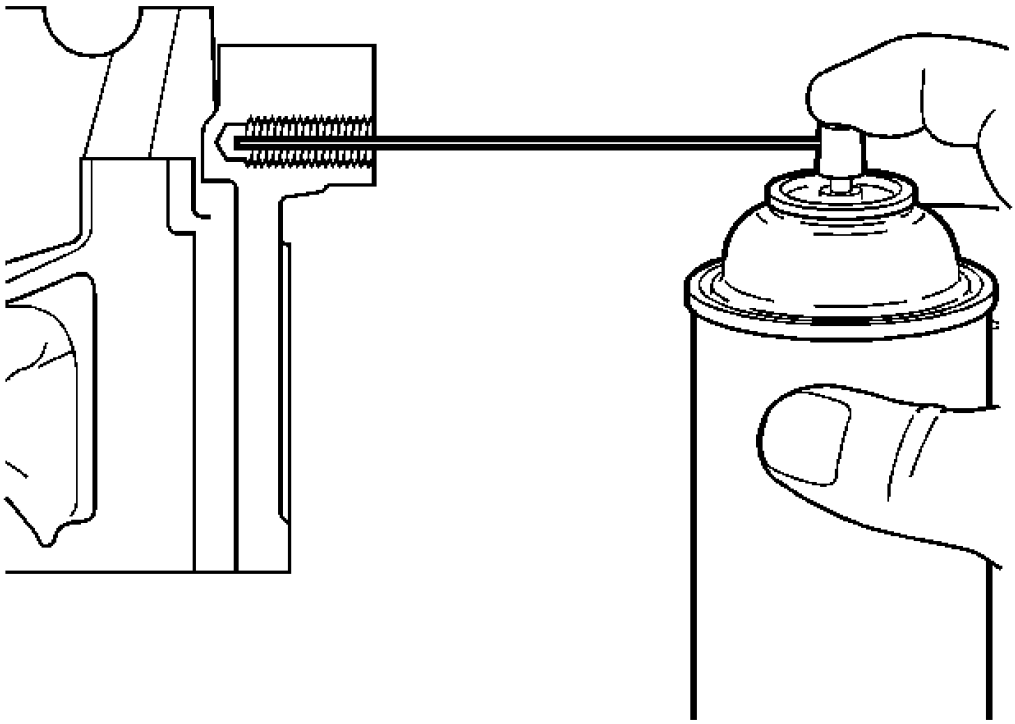


Fig. 229: Spraying Cleaner Into Tapped Hole
Courtesy of GENERAL MOTORS CORP.

7. Spray cleaner into the tapped hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended cleaner.

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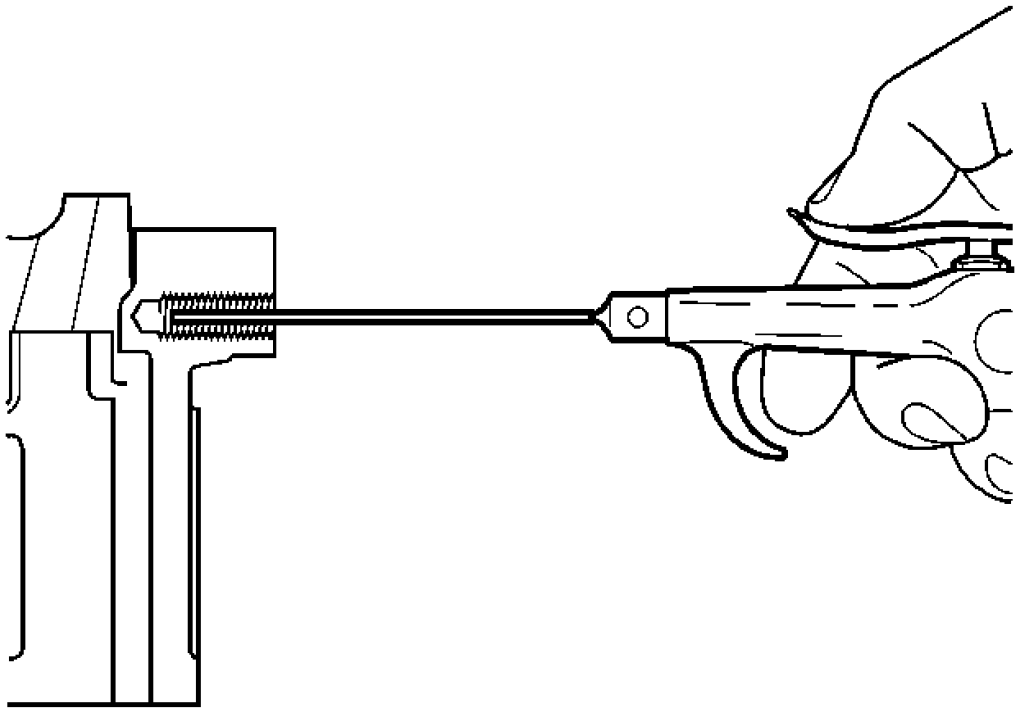


Fig. 230: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the tapped hole prior to insert installation.

8. Using compressed air, clean out any chips.

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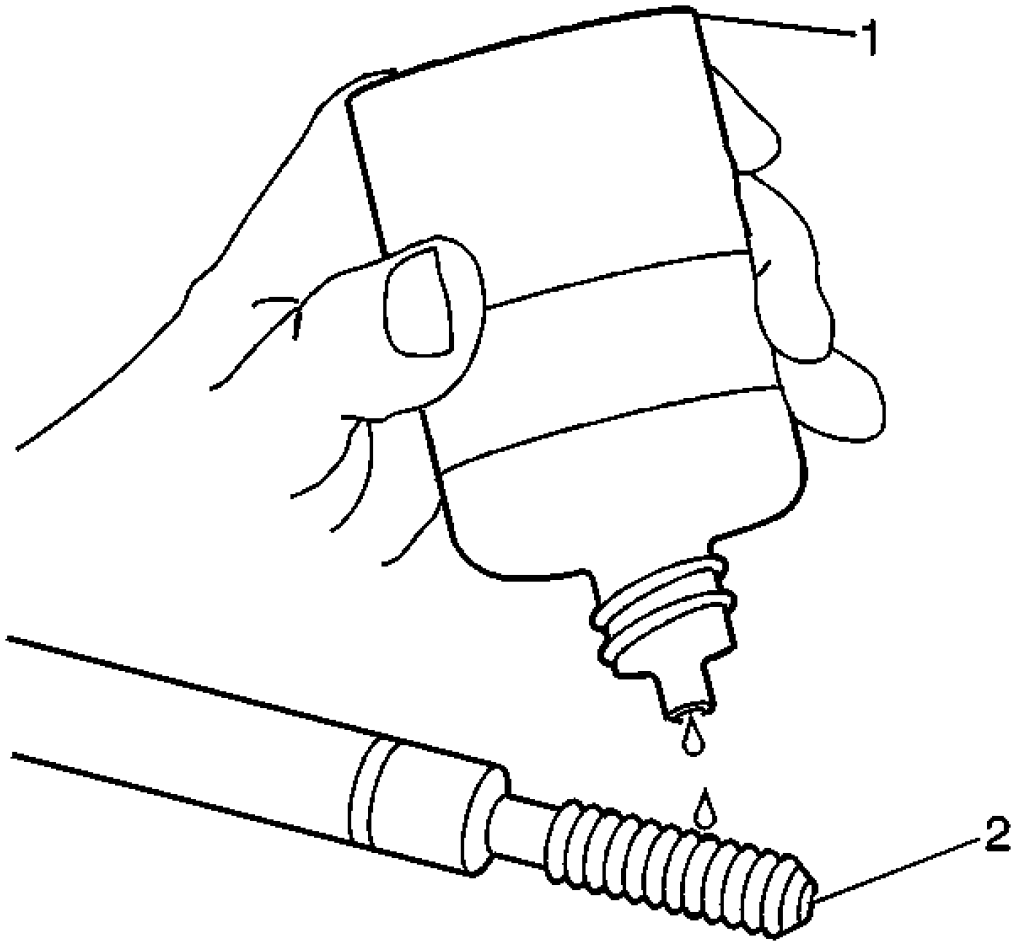


Fig. 231: Lubricating Installer Tool
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

9. Lubricate the threads of the driver installation tool (2) with the J 42385-110 (1).

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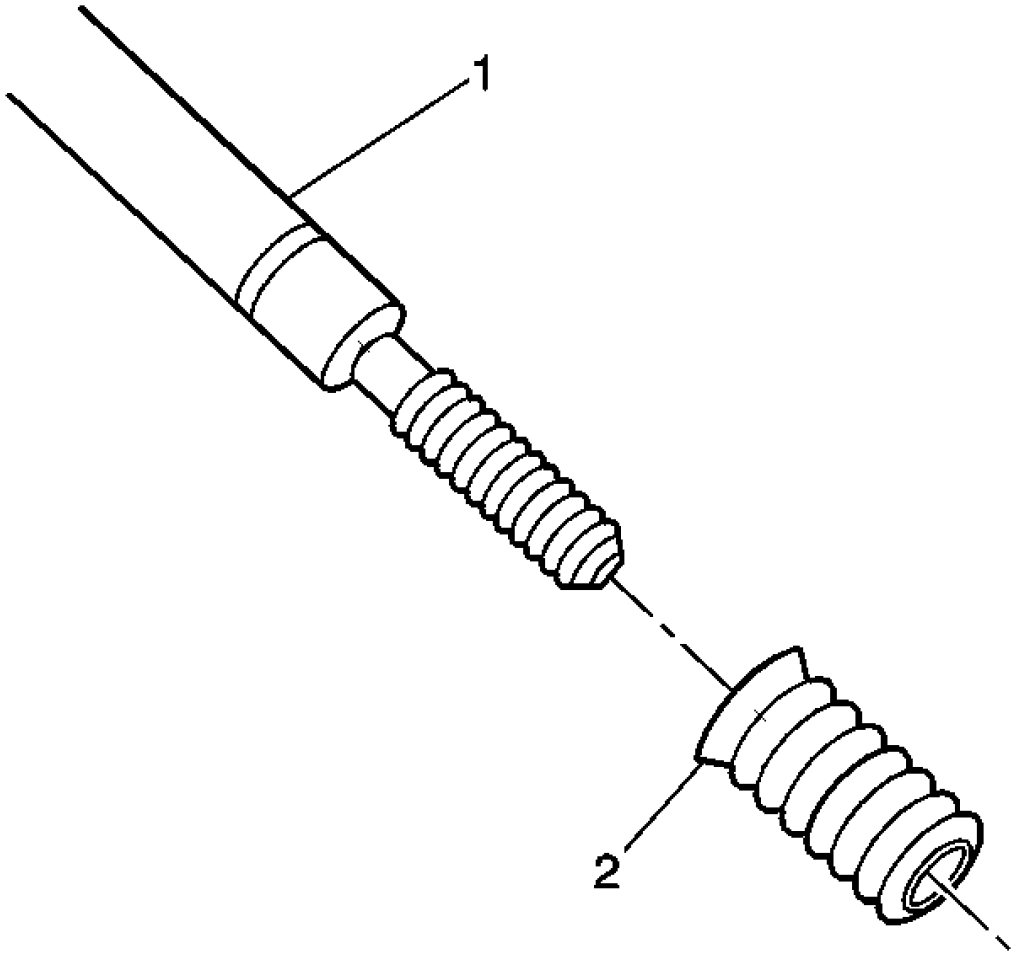


Fig. 232: View of Bushing Type Insert
Courtesy of GENERAL MOTORS CORP.

10. Install the insert (2) onto the driver installation tool (1).

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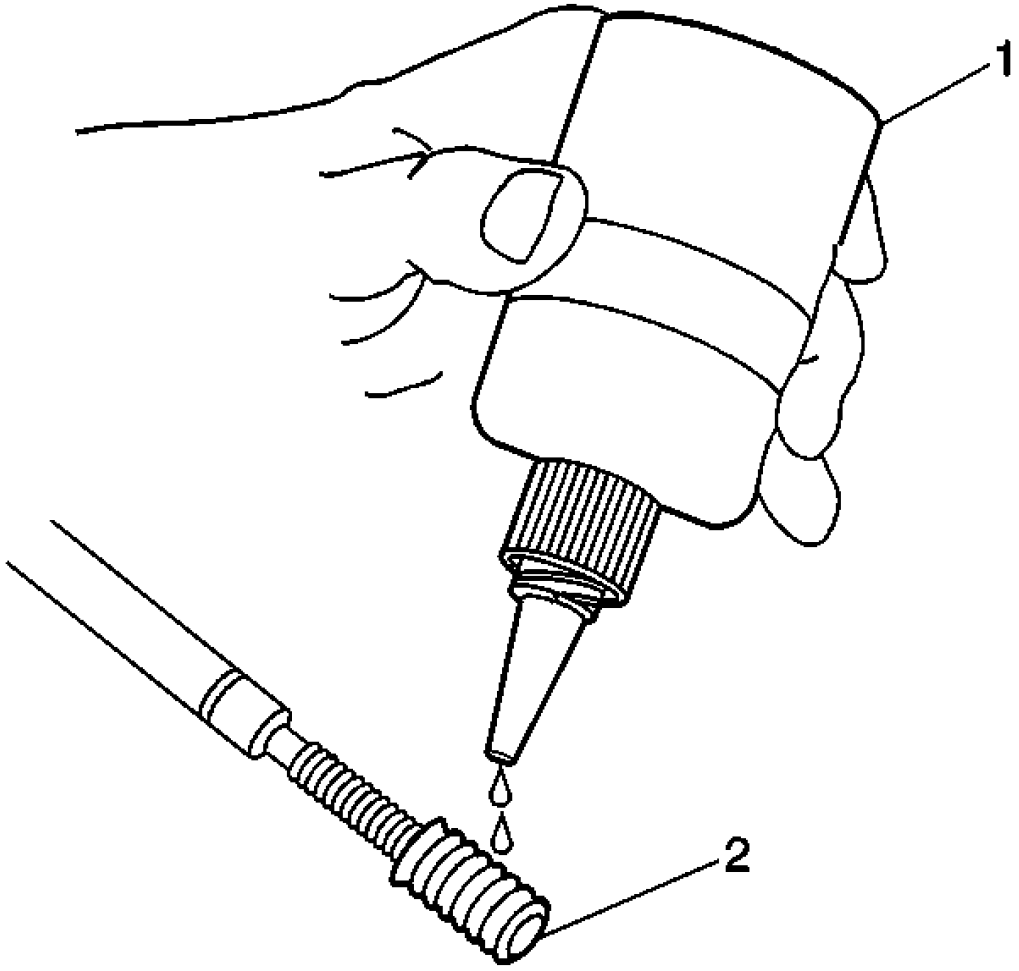


Fig. 233: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS CORP.

11. Apply threadlock sealant, J 42385-109, LOCTITE 277® or equivalent (1) to the insert OD threads (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

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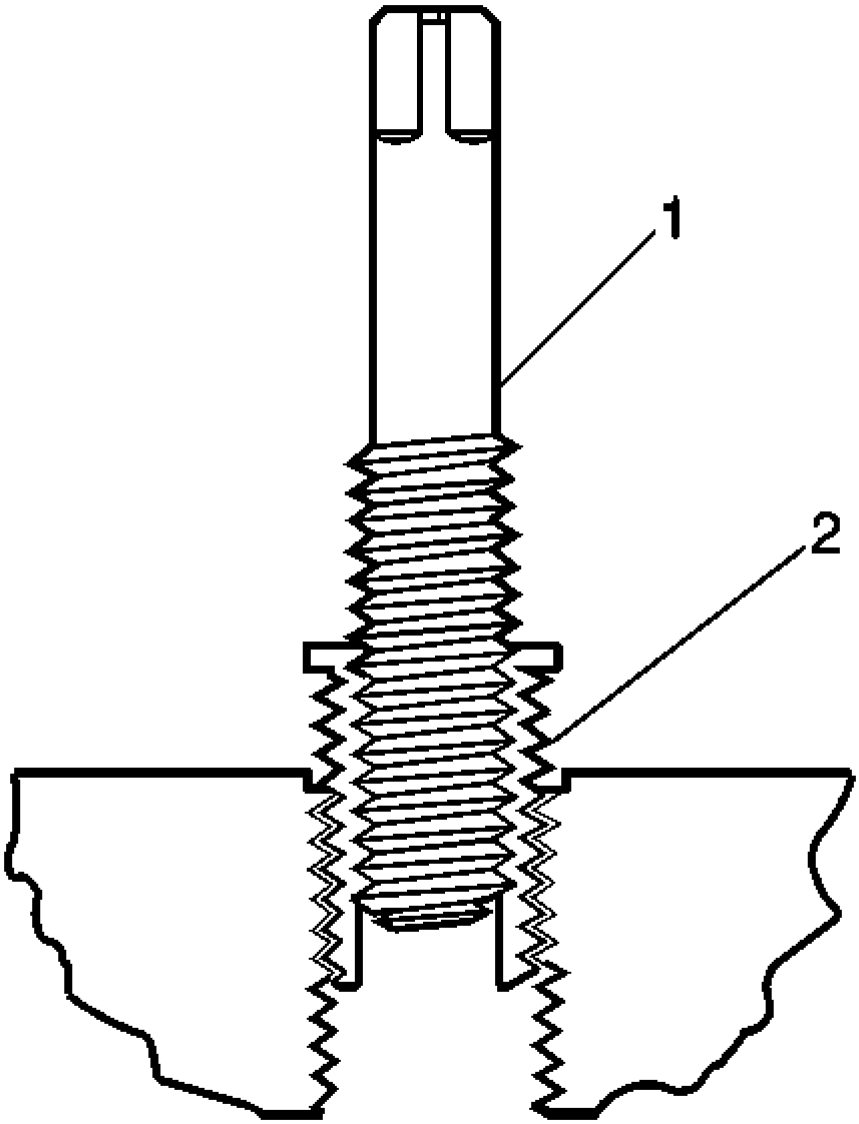


Fig. 234: Installing Insert Into Tapped Bolt Hole
Courtesy of GENERAL MOTORS CORP.

12. Install the insert (2) into the tapped hole by hand only.

NOTE: If the insert will not thread down until the flange contacts the counterbored surface, remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.

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13. Install the insert until the flange (2) of the insert contacts the counterbored surface.

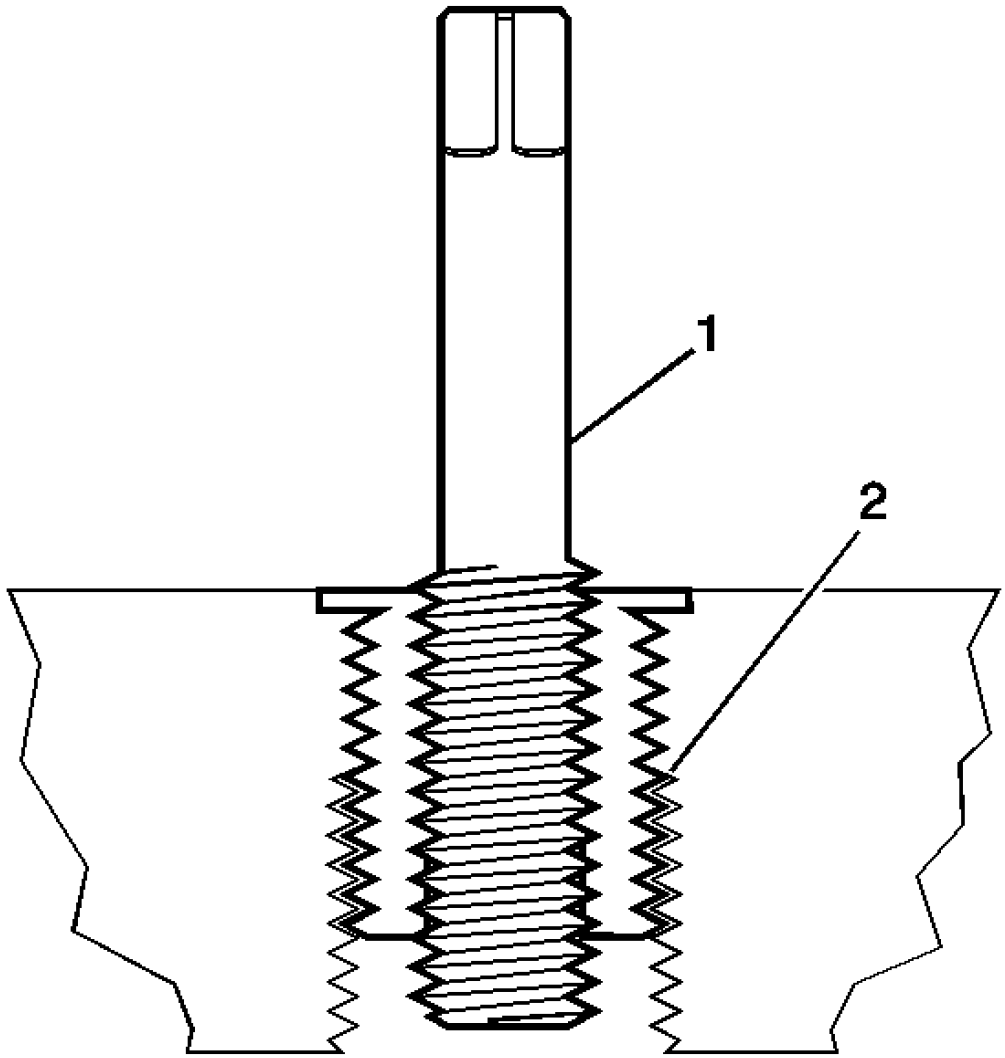


Fig. 235: View Insert & Tool - Standard Thread
Courtesy of GENERAL MOTORS CORP.

NOTE: **The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.**

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14. Continue to rotate the driver installation tool (1) through the insert (2).

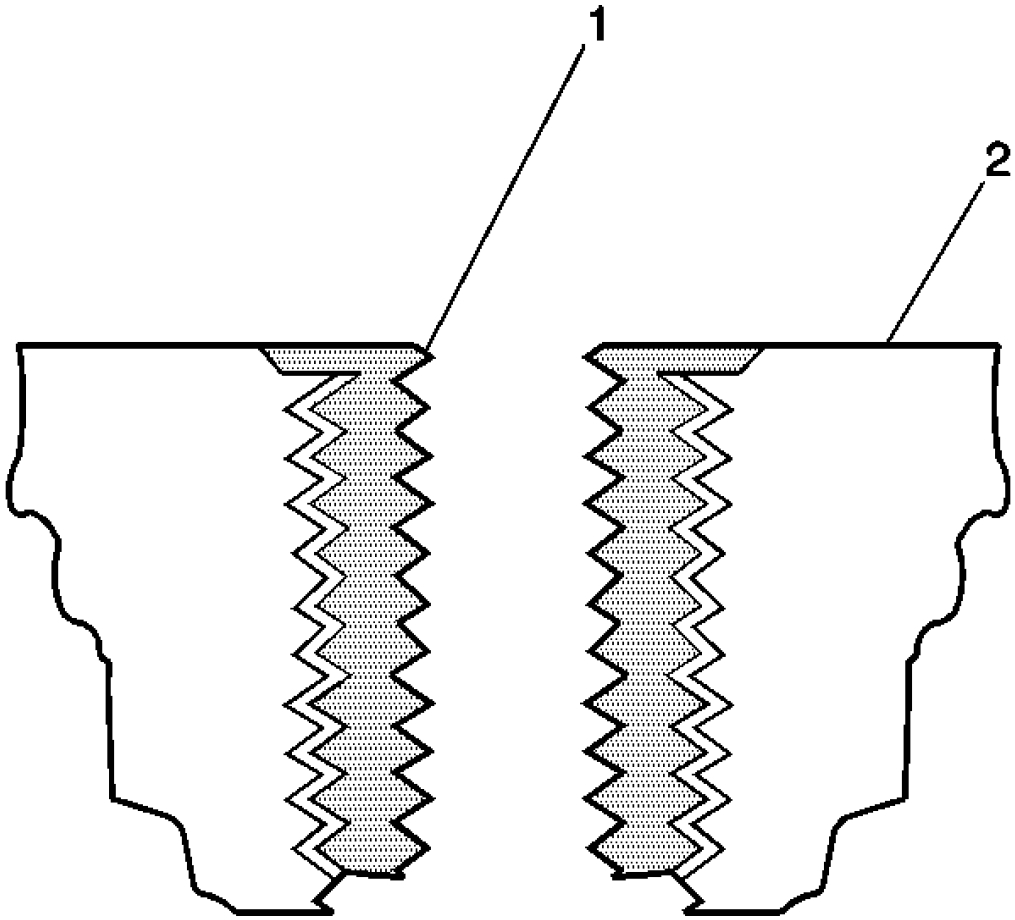


Fig. 236: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS CORP.

15. Inspect the insert for proper installation into the tapped hole. A properly installed insert (1) will be either flush or slightly below flush with the surface of the base material (2).

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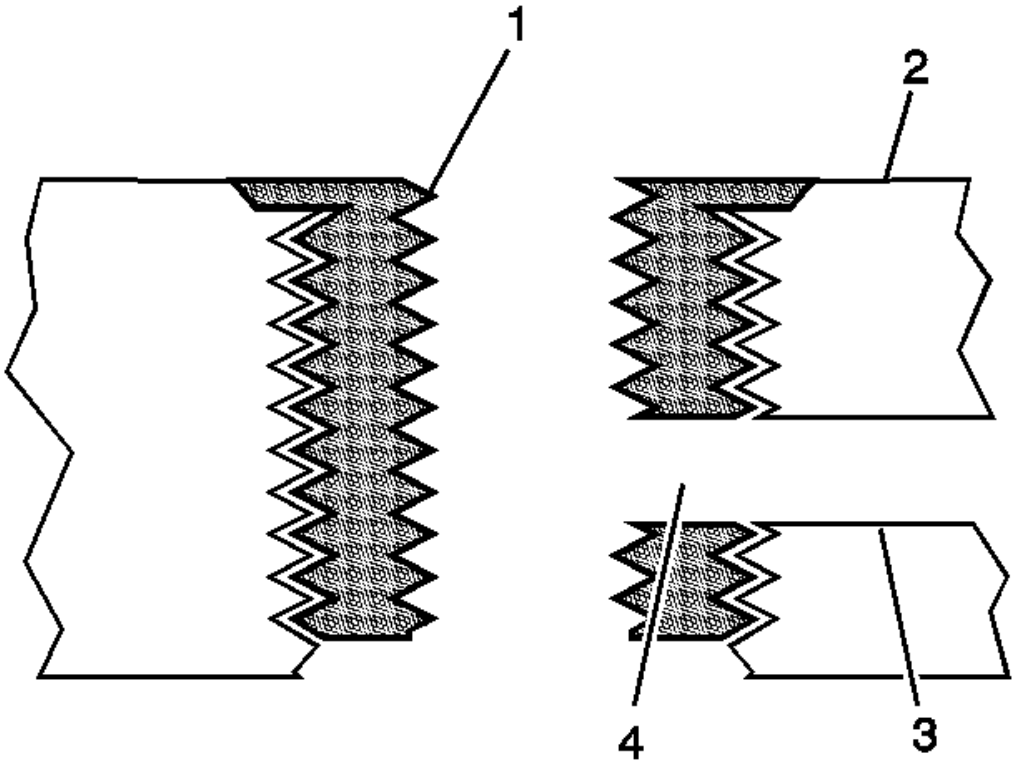


Fig. 237: View Of Restricted Engine Coolant Passages - Standard Thread Repair
Courtesy of GENERAL MOTORS CORP.

16. Any installed insert that restricts or blocks an oil or engine coolant passage (3) will need to have the oil or engine coolant passage drilled out (4) to the original size of the oil or engine coolant passage. After drilling the restriction or blockage, clean out any chips and thread the installation driver tool through the insert again to remove any burrs caused by the drilling of the oil or engine coolant passage.

RECESSED THREAD REPAIR

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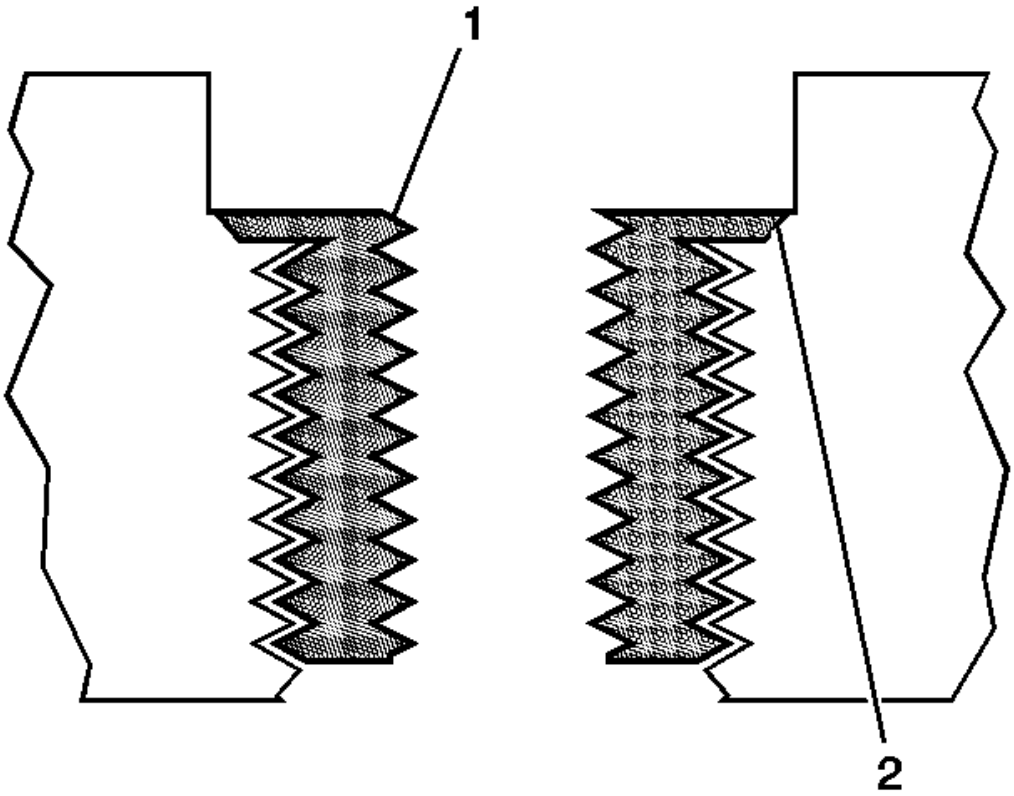


Fig. 238: Identifying Insert For Proper Installation - Recessed Thread
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Safety Glasses Warning .

NOTE:

- **The use of a cutting type fluid, WD 40® or equivalent is recommended when performing the drilling, counterboring and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers for recommended cutting fluid.**
- **Do NOT remove the original stop collar from a counterbore drill.**

When installed to the proper depth, the flange of the insert (1) will be seated against the counterbore (2) of the drilled/tapped hole.

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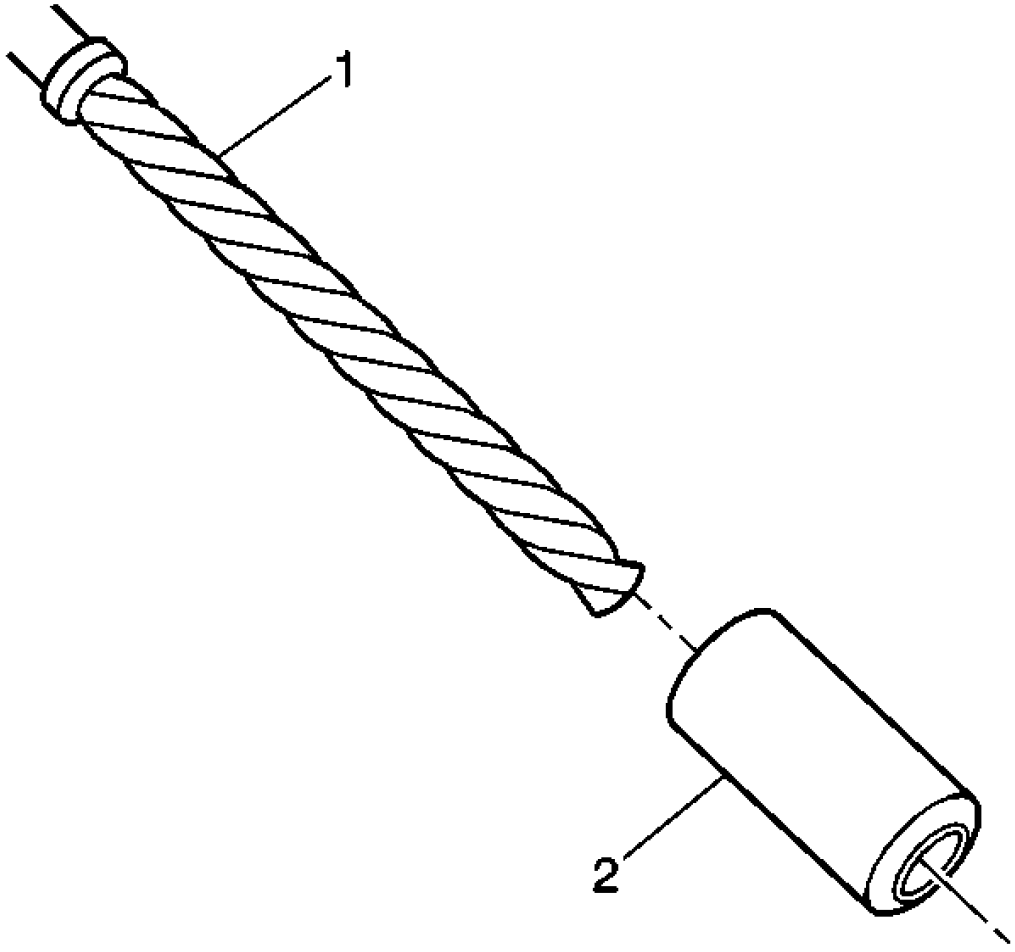


Fig. 239: Identifying Stop Collar & Counterbore Drill
Courtesy of GENERAL MOTORS CORP.

1. Install a stop collar (2) on the counterbore drill (1), if required.

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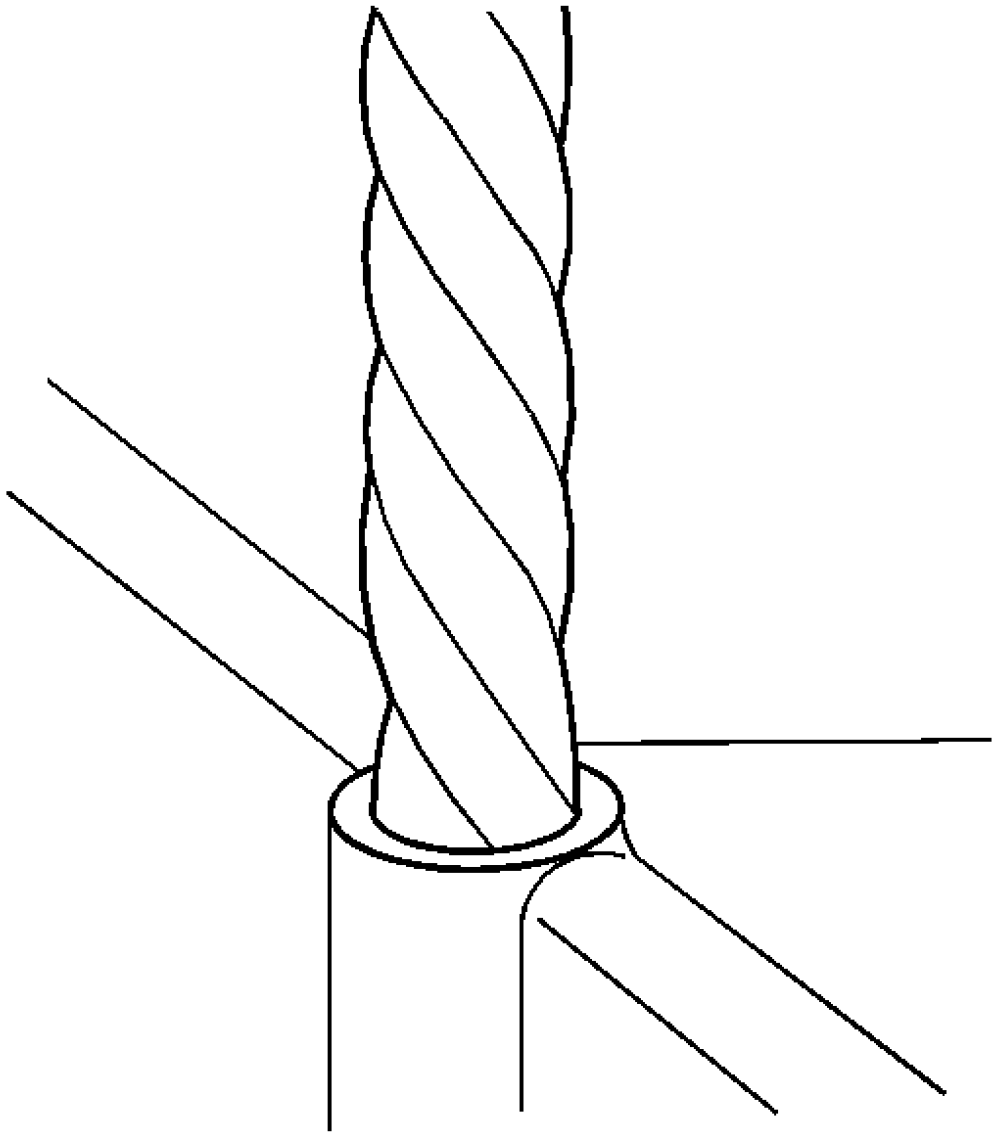


Fig. 240: Drilling Out Threads Of Damaged Hole
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.**
- **Drill the hole until the stop collar contacts the surface of the base material.**

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2. Drill out the threads of the damaged hole.

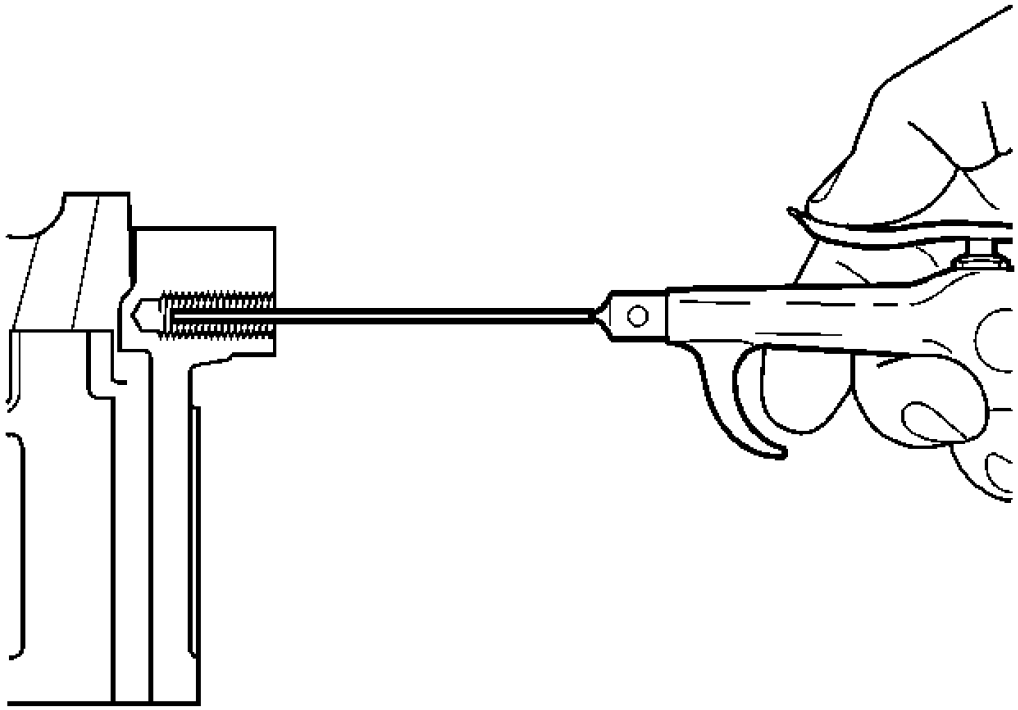


Fig. 241: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the drilled hole prior to tapping.

3. Using compressed air, clean out any chips.

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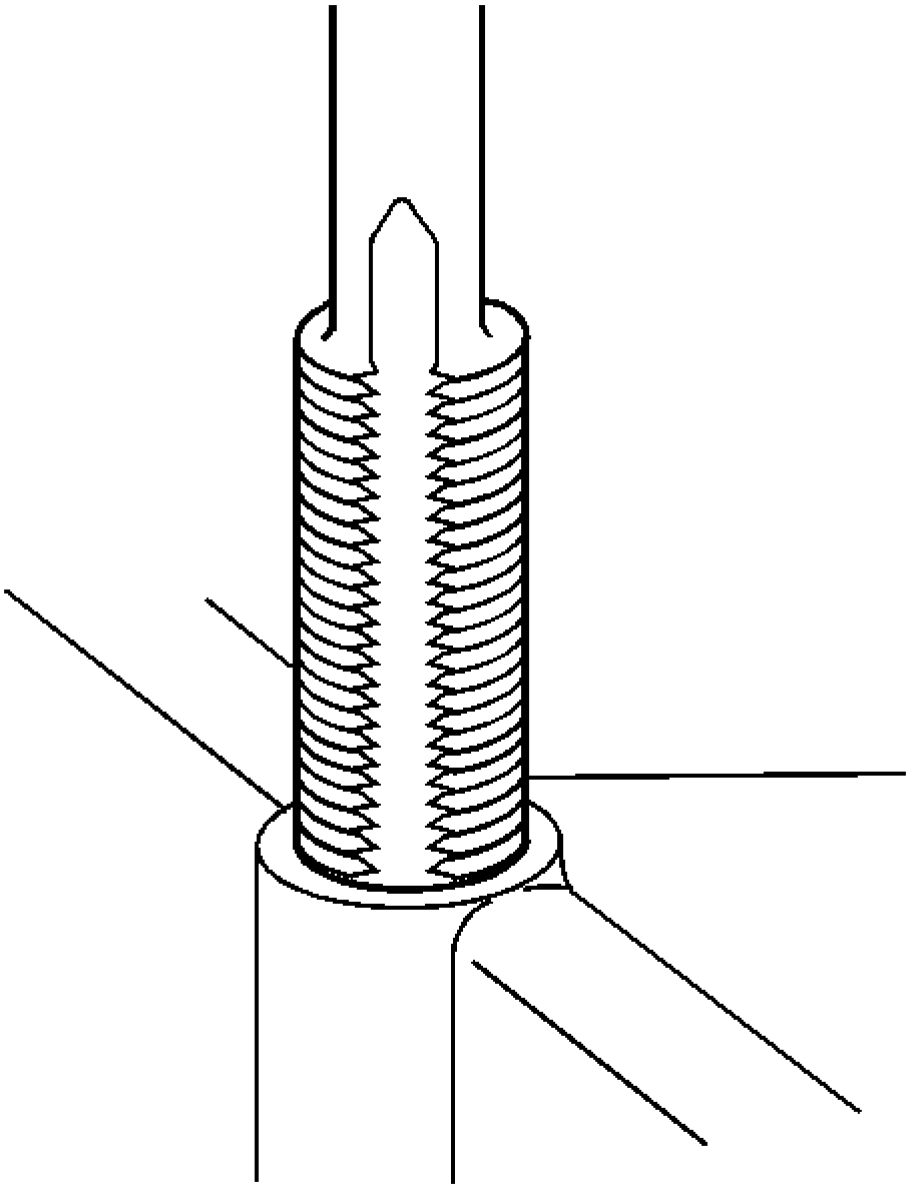


Fig. 242: Tapping Threads Of Drilled Hole
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.**

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- **Ensure the tap has created full threads at least to the depth equal to the insert length.**

4. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.

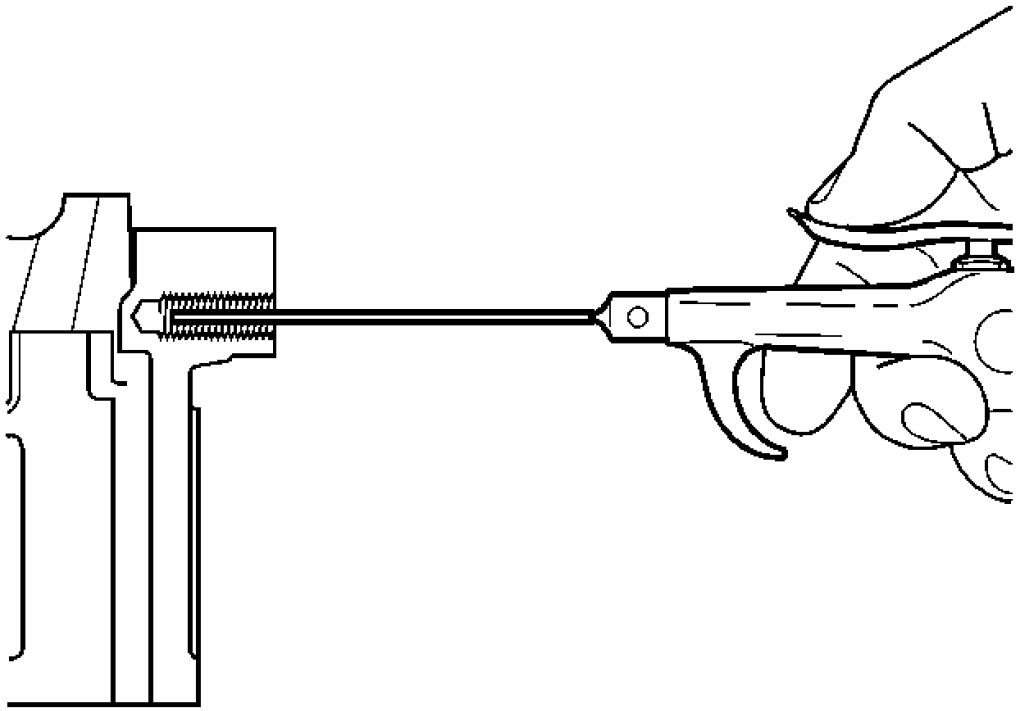


Fig. 243: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the tapped hole prior to insert installation.

5. Using compressed air, clean out any chips.

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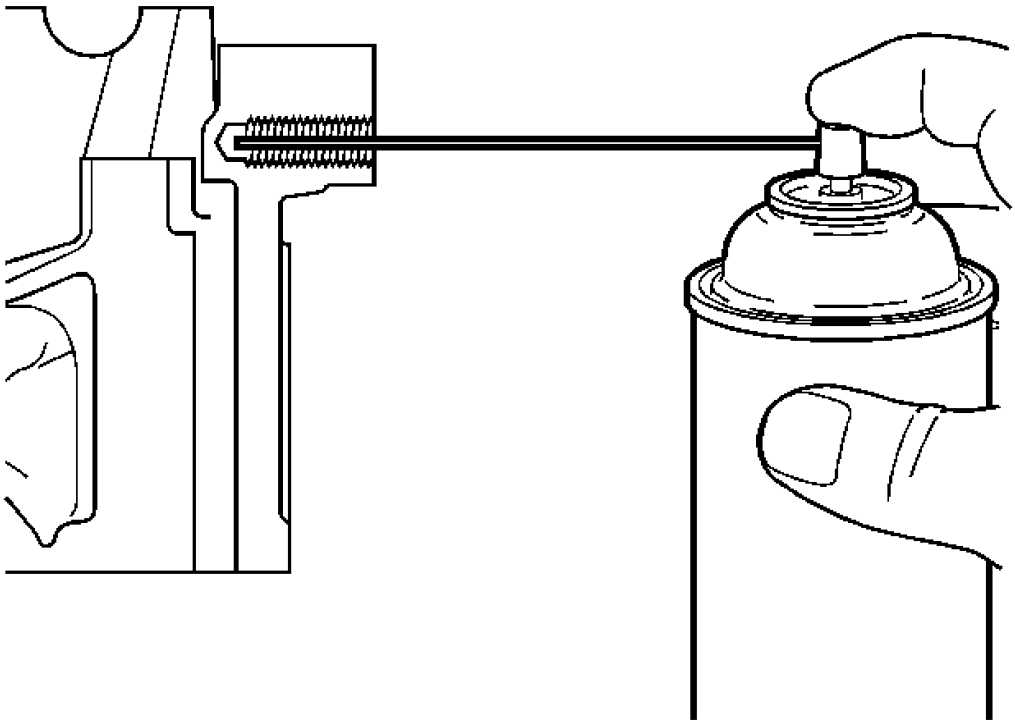


Fig. 244: Spraying Cleaner Into Tapped Hole
Courtesy of GENERAL MOTORS CORP.

6. Spray cleaner into the tapped hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended cleaner.

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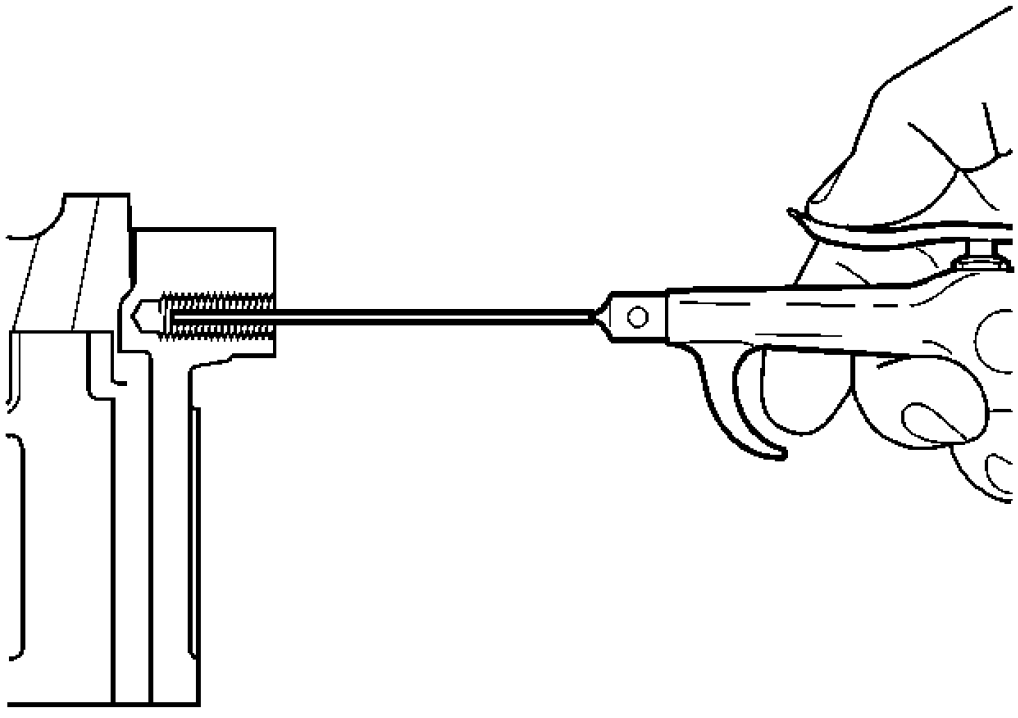


Fig. 245: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the tapped hole prior to insert installation.

7. Using compressed air, clean out any chips.

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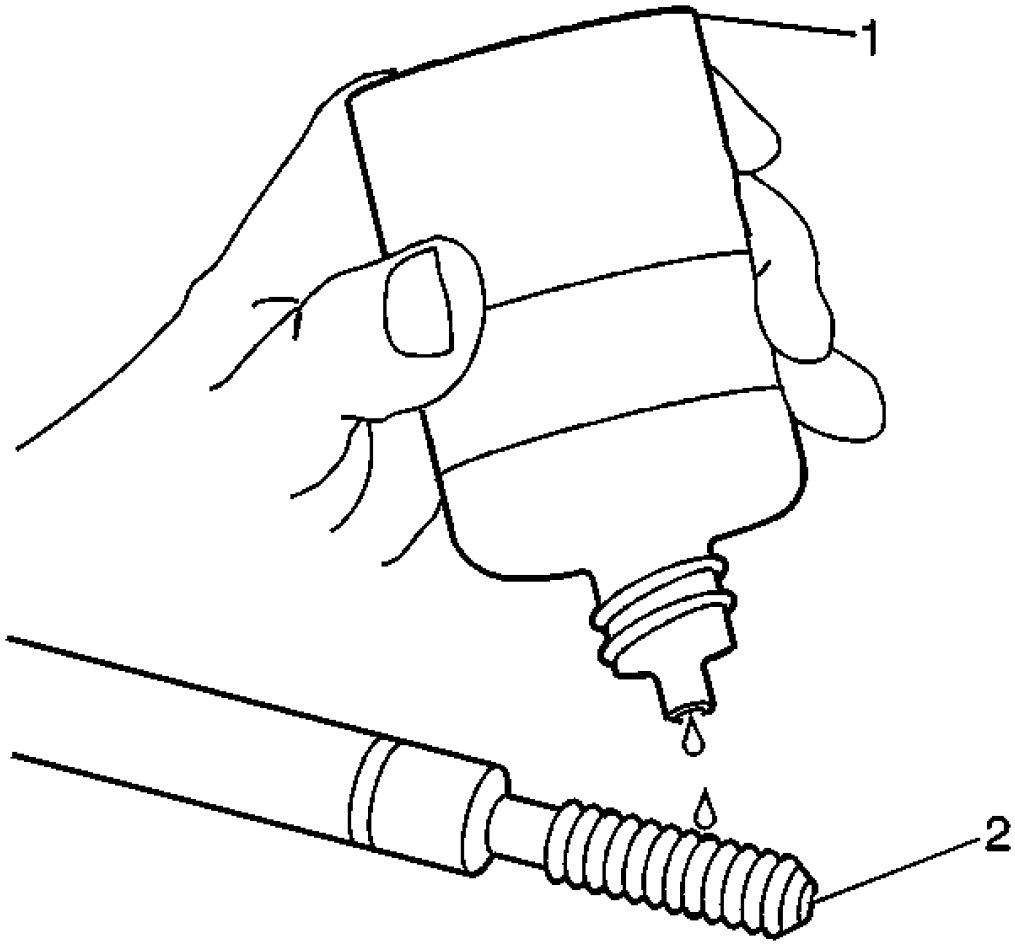


Fig. 246: Lubricating Installer Tool
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

8. Lubricate the threads of the driver installation tool (2) with the J 42385-110 (1).

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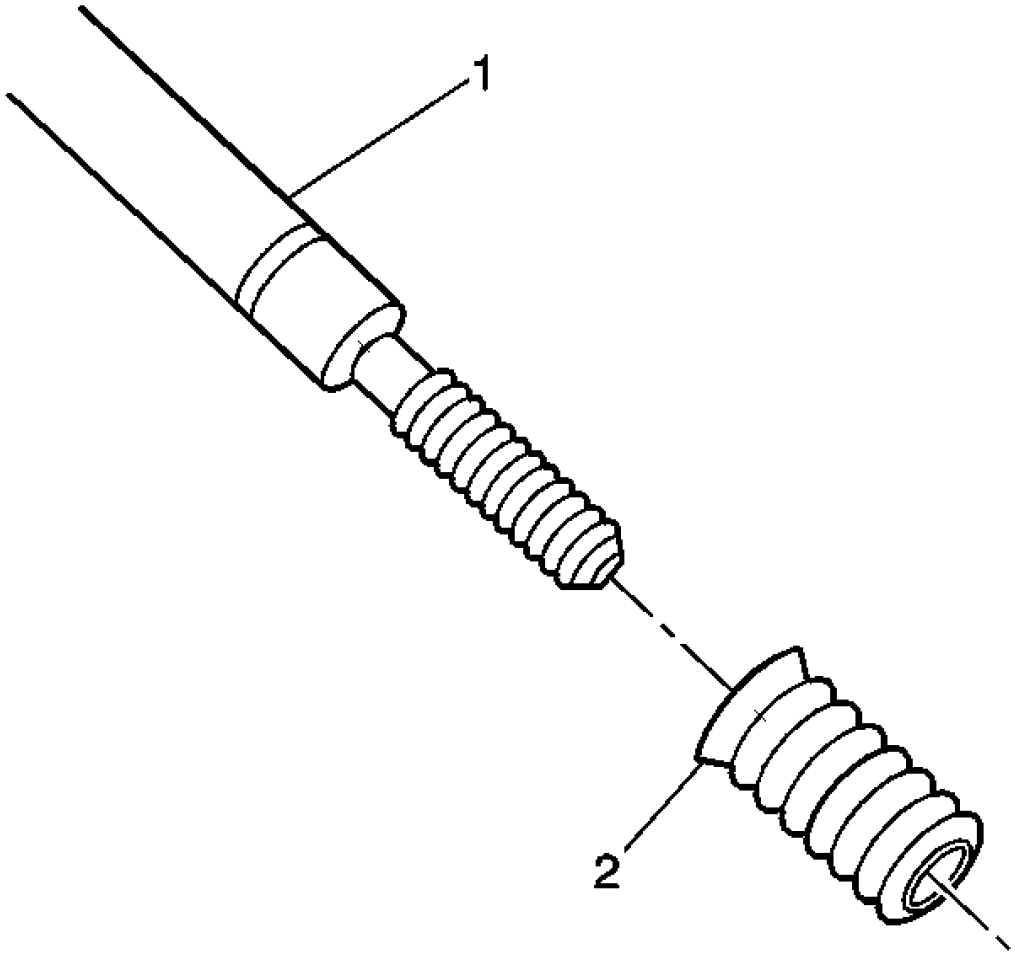


Fig. 247: View of Bushing Type Insert
Courtesy of GENERAL MOTORS CORP.

9. Install the insert (2) onto the driver installation tool (1).

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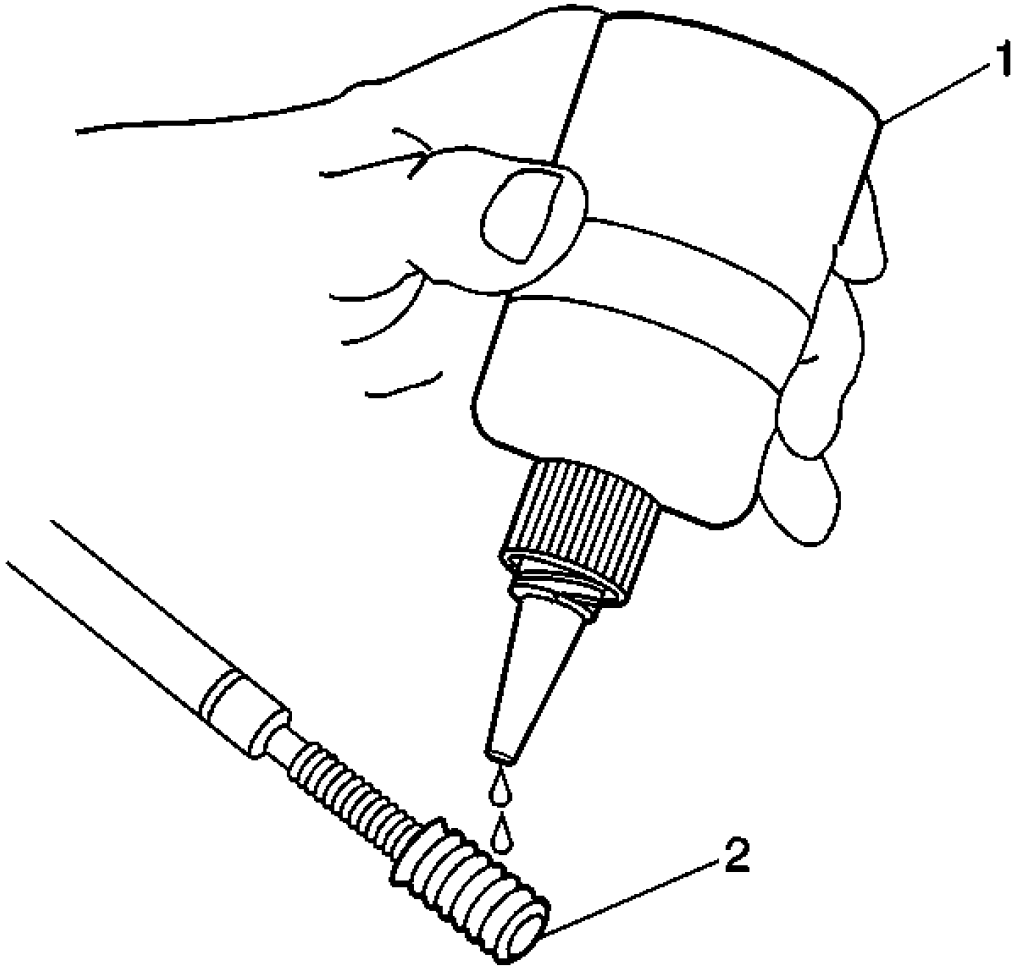


Fig. 248: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS CORP.

10. Apply threadlock sealant, J 42385-109, LOCTITE 277® or equivalent (1) to the insert OD threads (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

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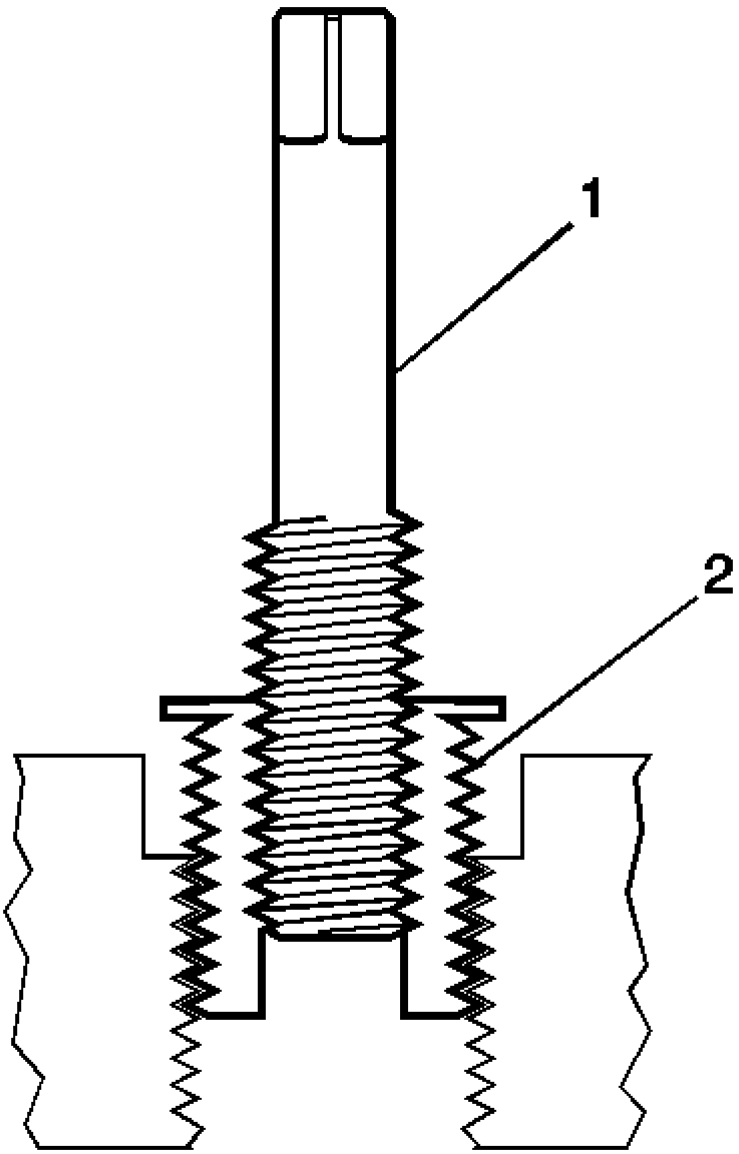


Fig. 249: Identifying Insert - Recessed Thread
Courtesy of GENERAL MOTORS CORP.

11. Install the insert (2) into the tapped hole by hand only.

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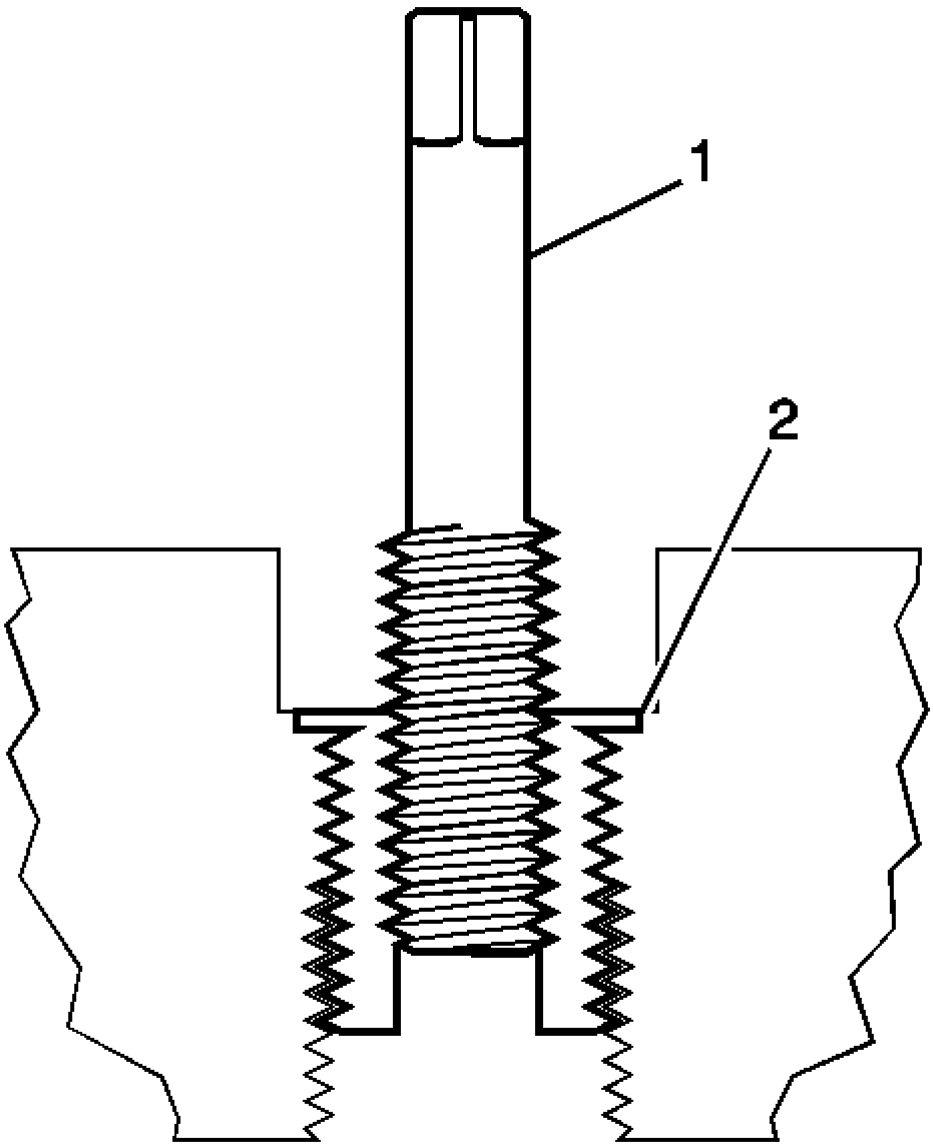


Fig. 250: View Of Installed Insert - Recessed Thread
Courtesy of GENERAL MOTORS CORP.

NOTE: **If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.**

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12. Install the insert until the flange (2) of the insert contacts the counterbored surface.

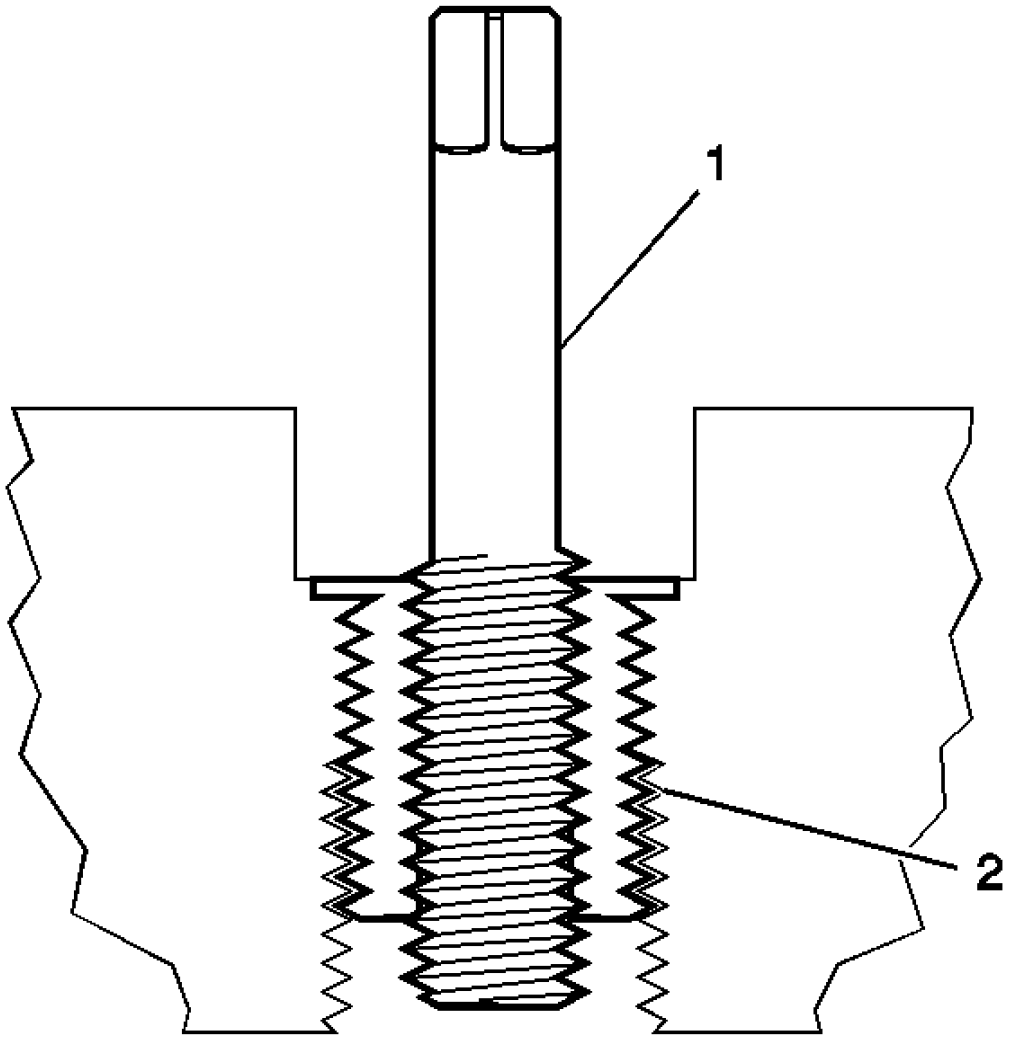


Fig. 251: Identifying Installed Insert - Recessed Thread Repair
Courtesy of GENERAL MOTORS CORP.

NOTE: The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

13. Continue to rotate the driver installation tool (1) through the insert (2).

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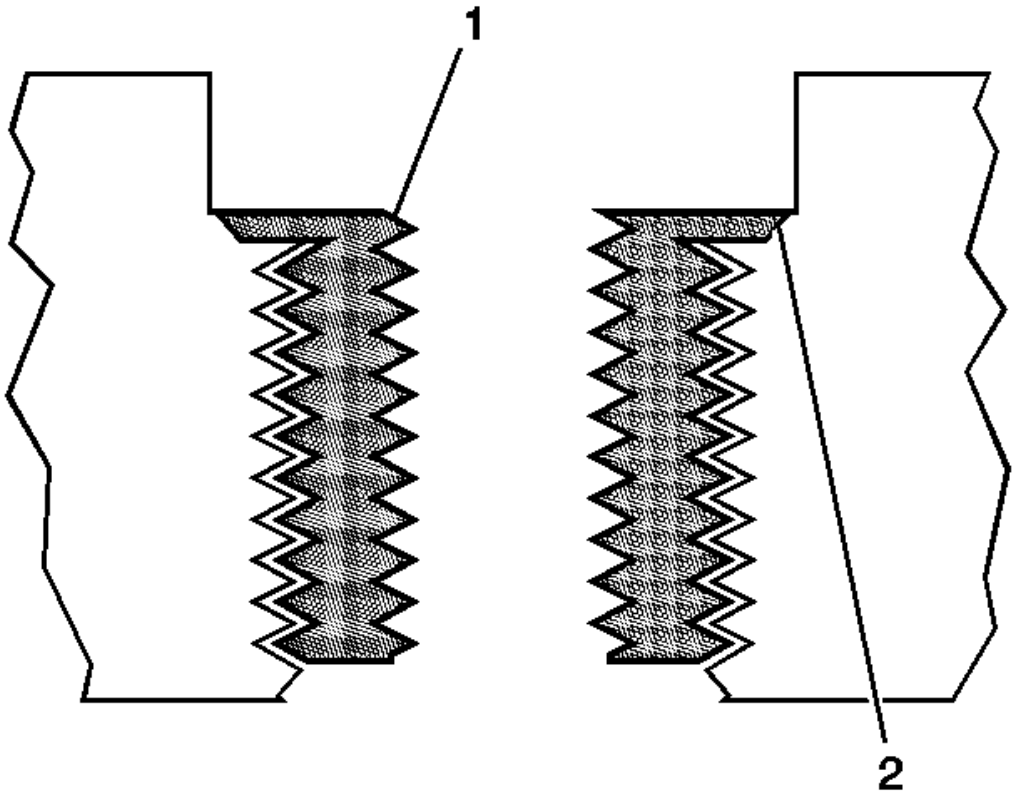


Fig. 252: Identifying Insert For Proper Installation - Recessed Thread
Courtesy of GENERAL MOTORS CORP.

14. Inspect the insert (1) for proper installation (2) into the tapped hole.

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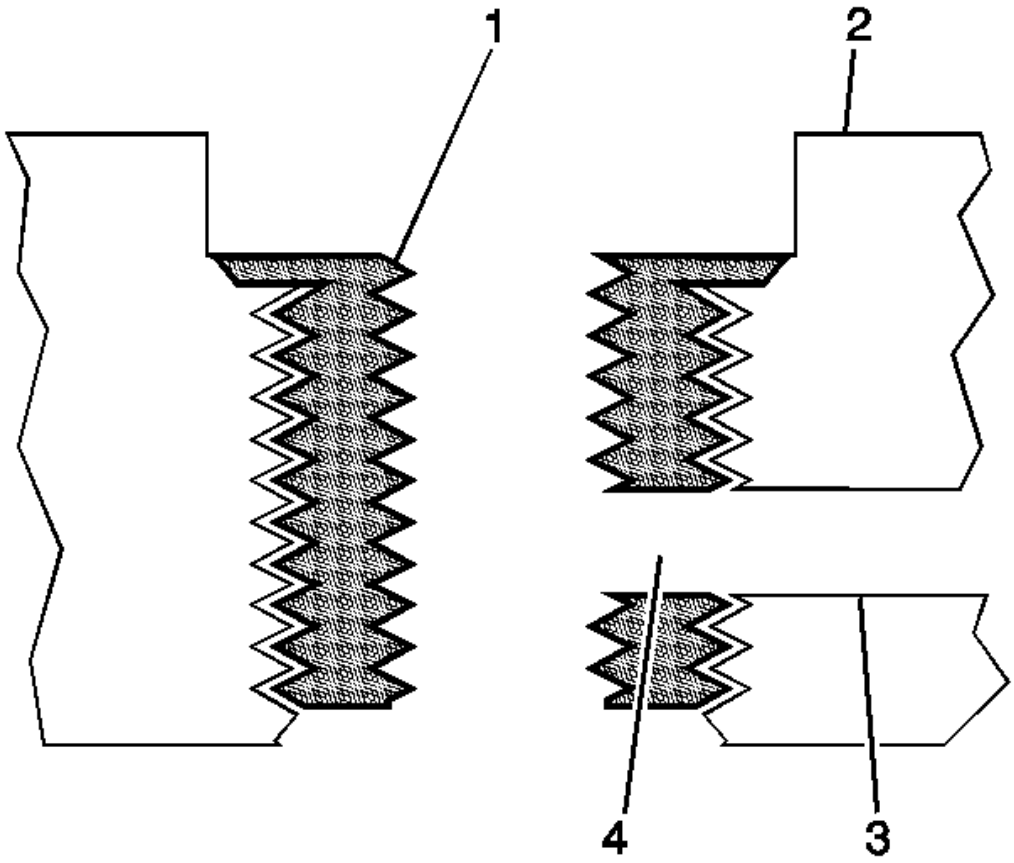


Fig. 253: View Of Restricted Engine Coolant Passage - Recessed Thread Repair
Courtesy of GENERAL MOTORS CORP.

15. Any installed insert that restricts or blocks an oil or engine coolant passage (3) will need to have the oil or engine coolant passage drilled out (4) to the original size of the oil or engine coolant passage. After drilling the restriction or blockage, clean out any chips and thread the installation driver tool through the insert again to remove any burrs caused by the drilling of the oil or engine coolant passage.

TAPERED PIPE THREAD REPAIR

The thread repair insert for tapered pipe threads is coated with a clear silver zinc coating.

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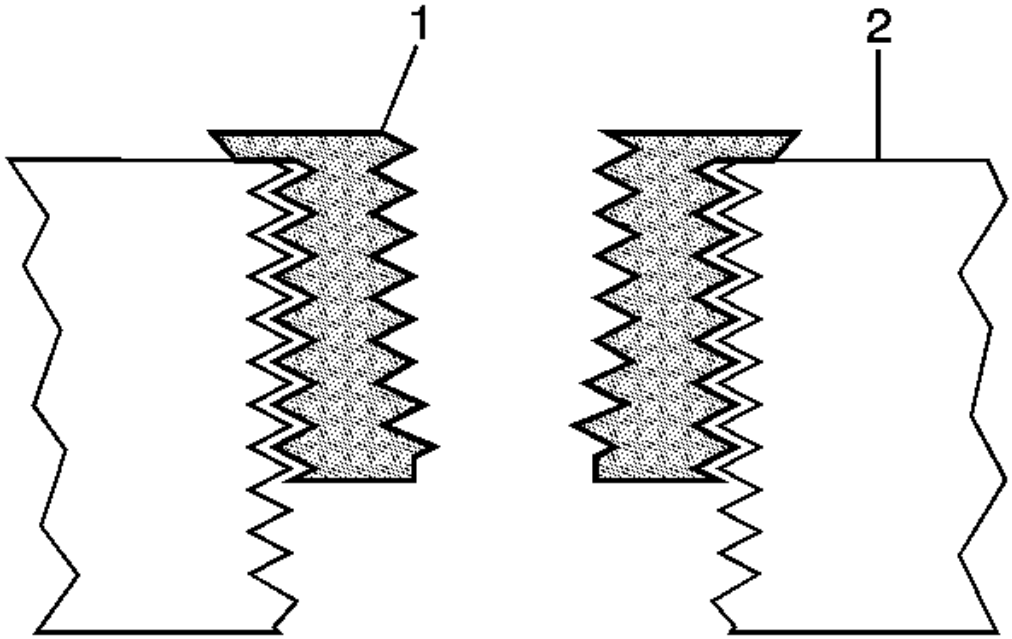


Fig. 254: Identifying Insert Flange & Base Material - Tapered Thread
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Safety Glasses Warning .

NOTE: The use of a cutting type fluid, WD 40® or equivalent is recommended when performing the drilling, counterboring and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers for recommended cutting fluid.

When installed to the proper depth, the flange (1) of the insert will be seated against surface (2) of the base material of the drilled/tapped hole.

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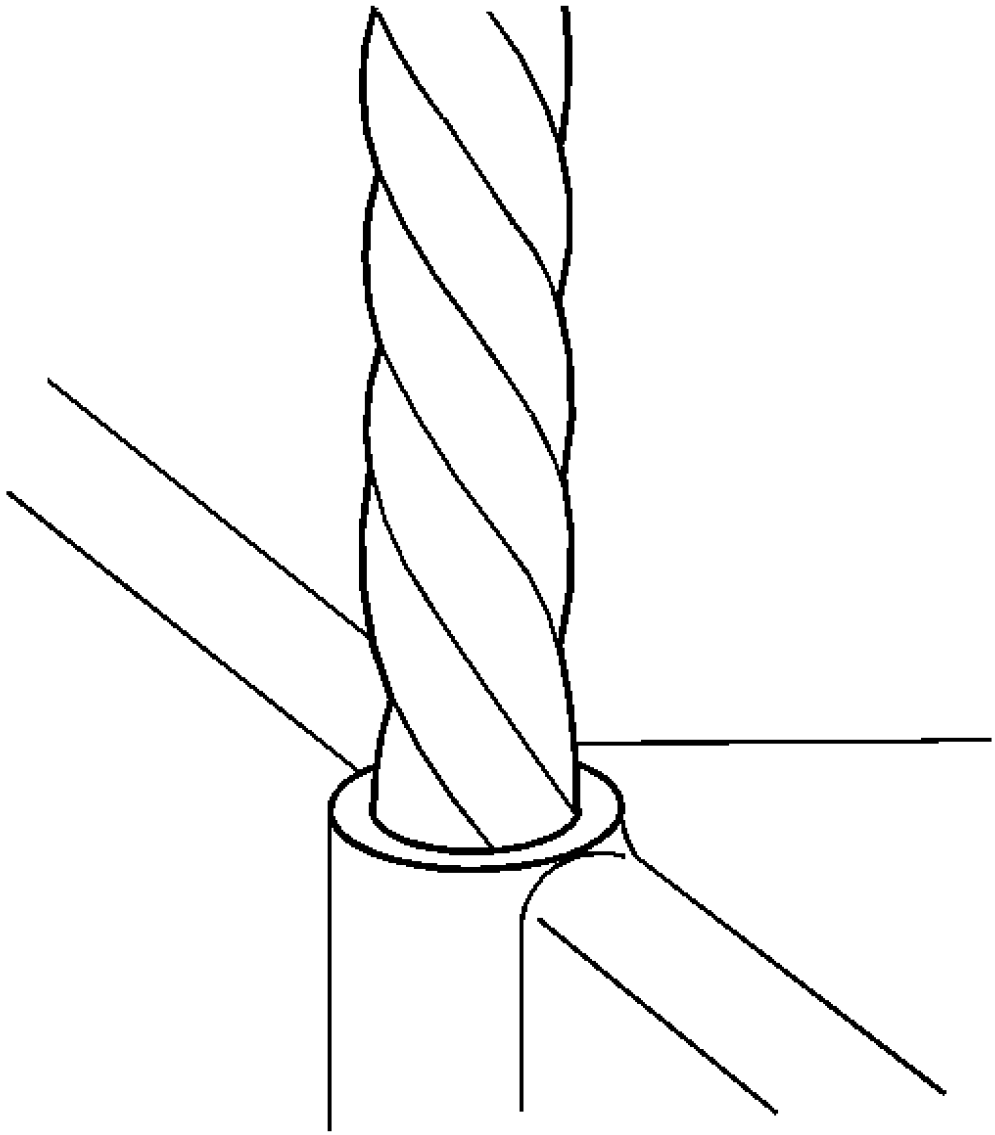


Fig. 255: Drilling Out Threads Of Damaged Hole
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.**
- **Drill the hole until the stop collar contacts the surface of the base material.**

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1. Drill out the threads of the damaged hole.

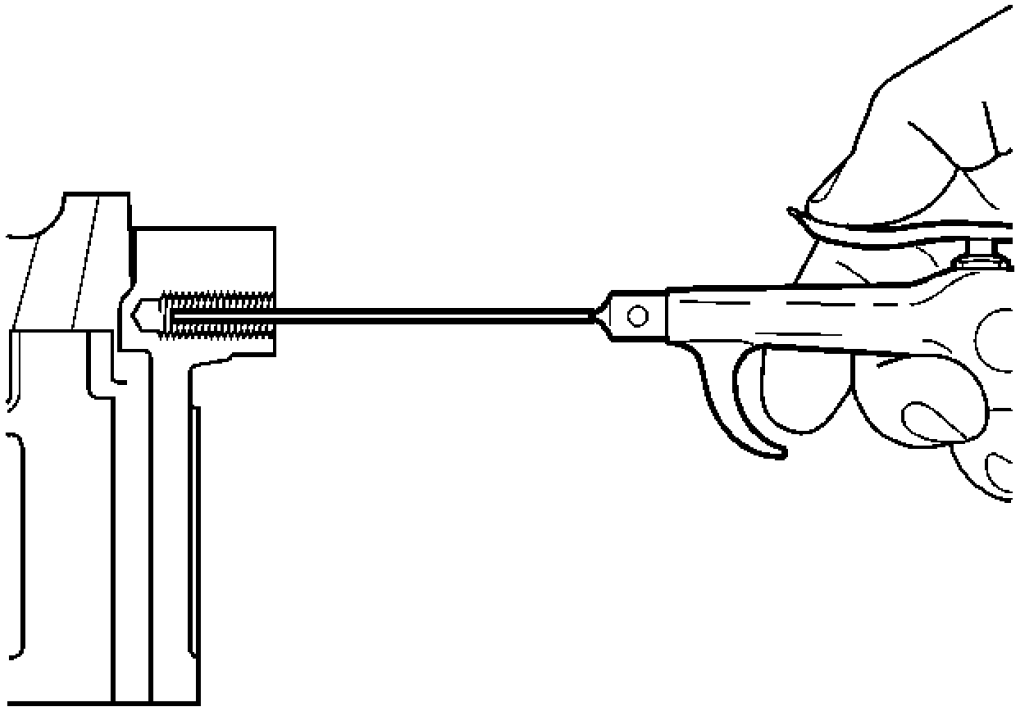


Fig. 256: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the drilled hole prior to tapping.

2. Using compressed air, clean out any chips.

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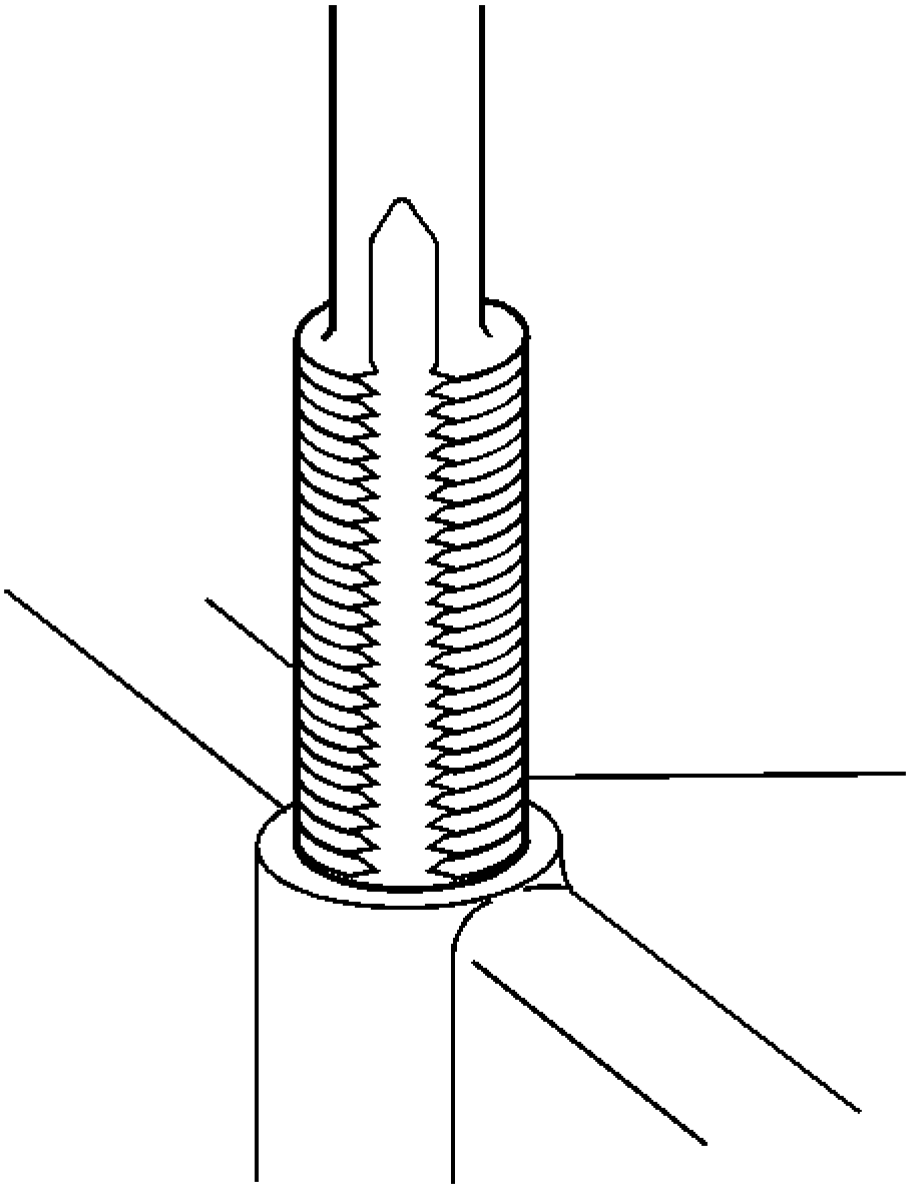


Fig. 257: Tapping Threads Of Drilled Hole
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.**

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- **Ensure the tap has created full threads at least to the depth equal to the insert length.**

3. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.

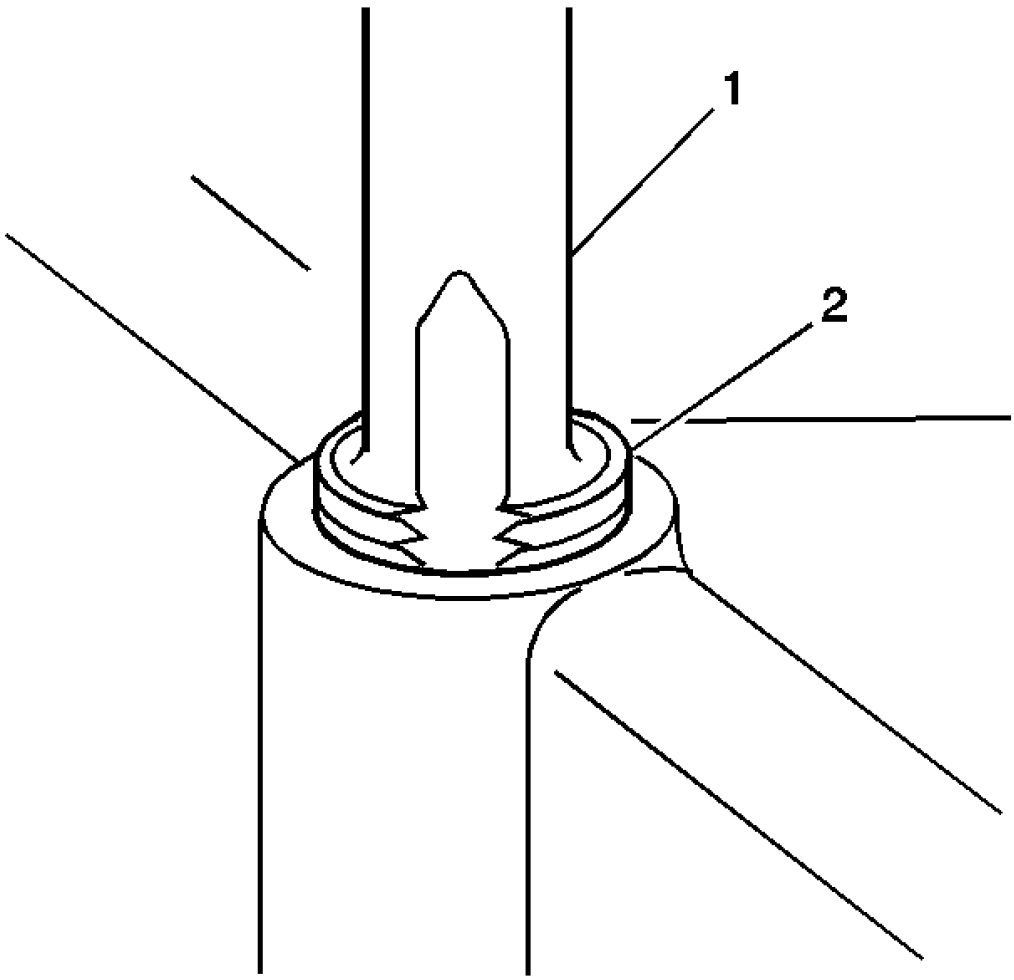


Fig. 258: View Of Proper Tapping Distance - Tapered Thread
Courtesy of GENERAL MOTORS CORP.

4. Tap the drilled hole until the threads at the top of the tap (2) are down to the surface of the base material.

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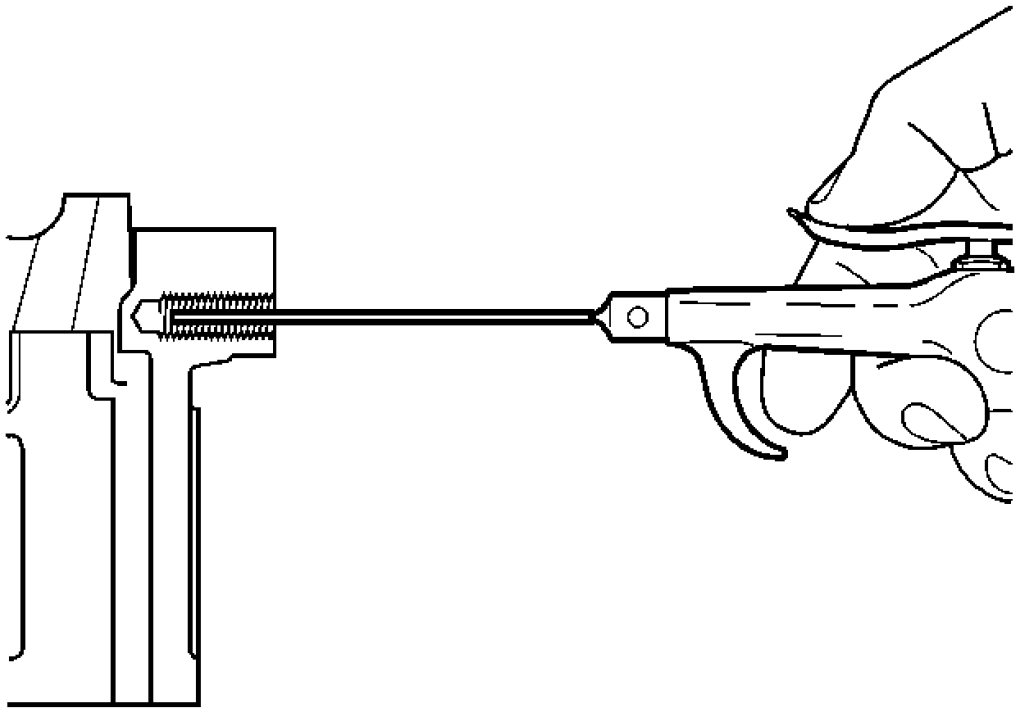


Fig. 259: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the tapped hole prior to insert installation.

5. Using compressed air, clean out any chips.

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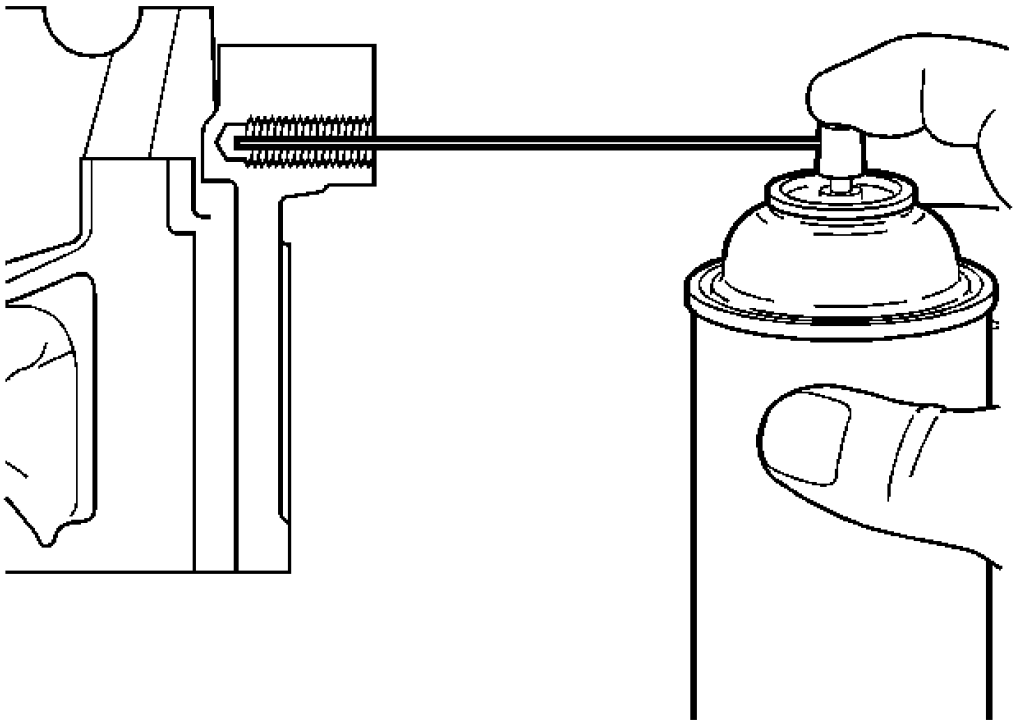


Fig. 260: Spraying Cleaner Into Tapped Hole
Courtesy of GENERAL MOTORS CORP.

6. Spray cleaner into the tapped hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended cleaner.

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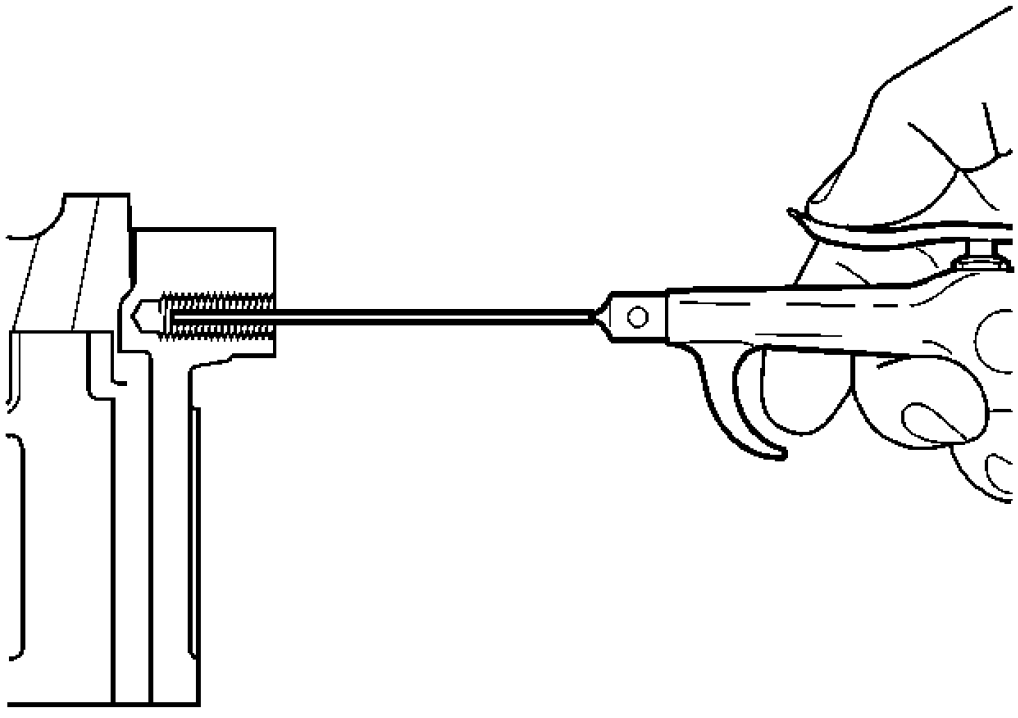


Fig. 261: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the tapped hole prior to insert installation.

7. Using compressed air, clean out any chips.

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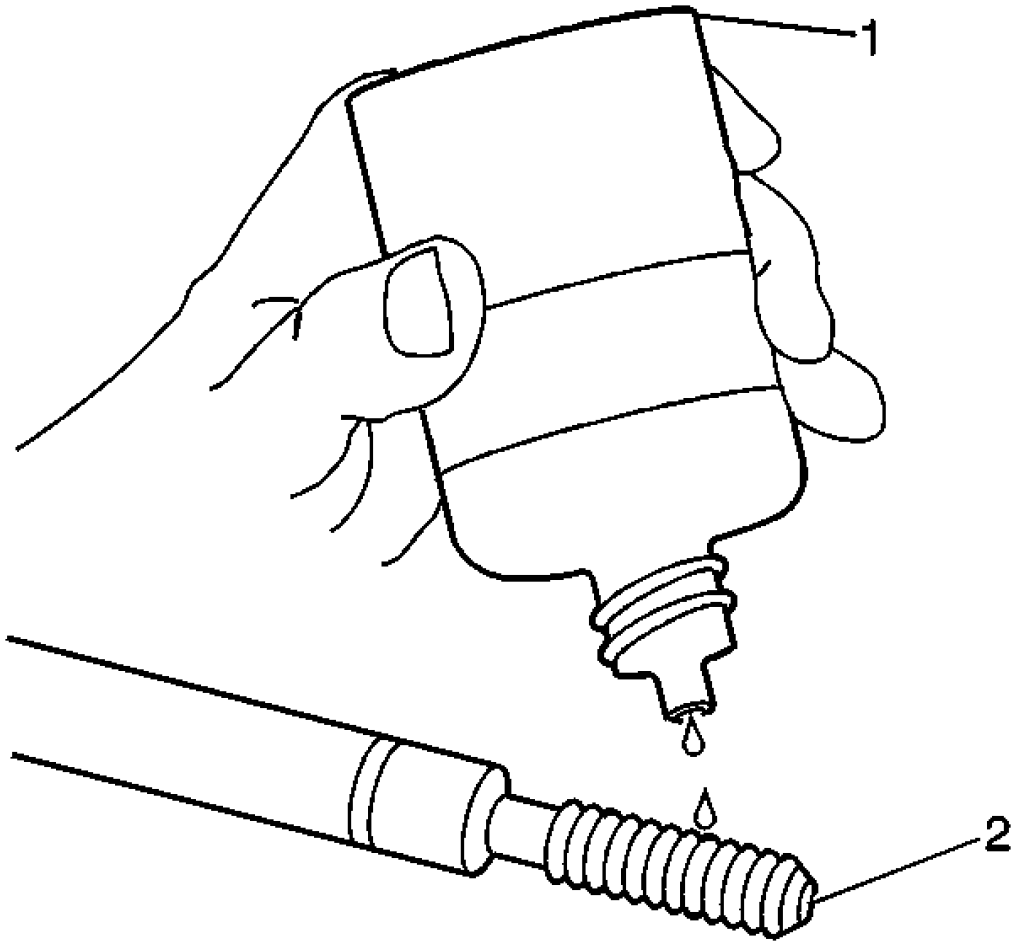


Fig. 262: Lubricating Installer Tool
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

8. Lubricate the threads of the driver installation tool (2) with the J 42385-110 (1).

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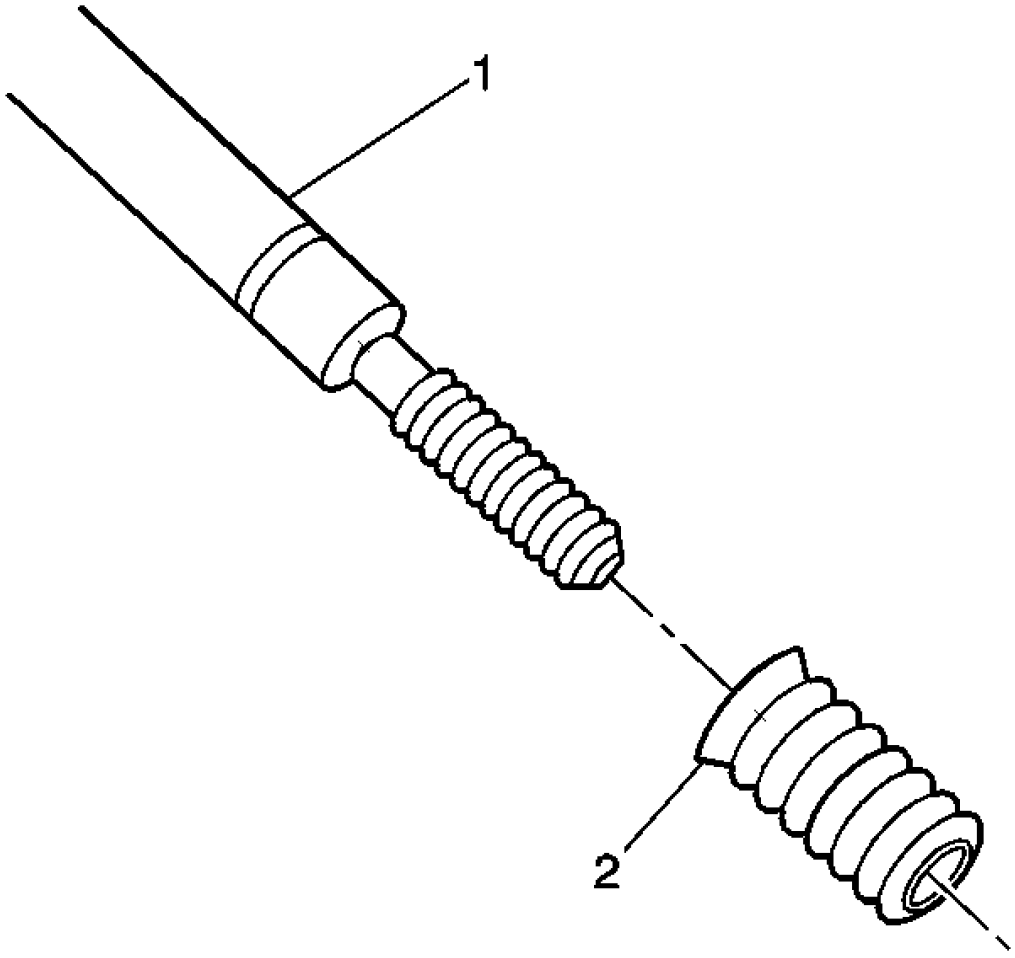


Fig. 263: View of Bushing Type Insert
Courtesy of GENERAL MOTORS CORP.

9. Install the insert (2) onto the driver installation tool (1).

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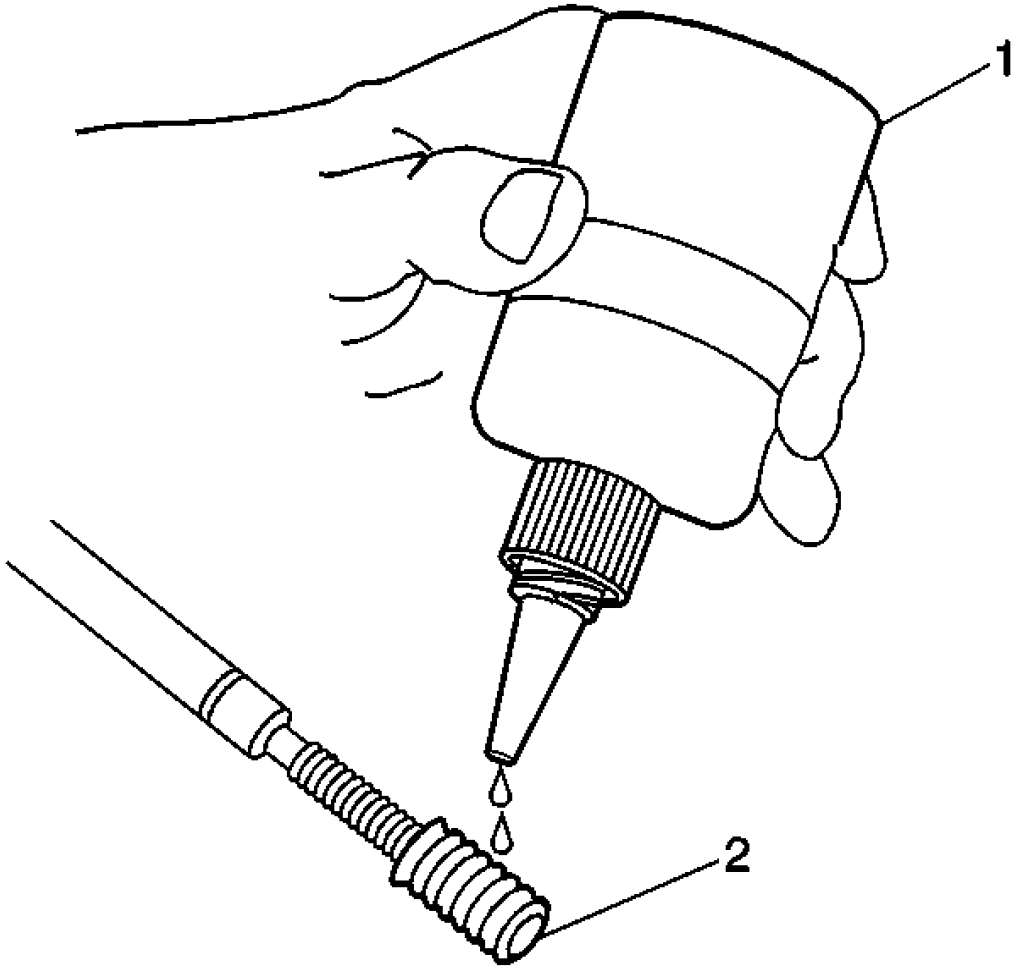


Fig. 264: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS CORP.

10. Apply threadlock sealant, J 42385-109, LOCTITE 277® or equivalent (1) to the insert OD threads (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

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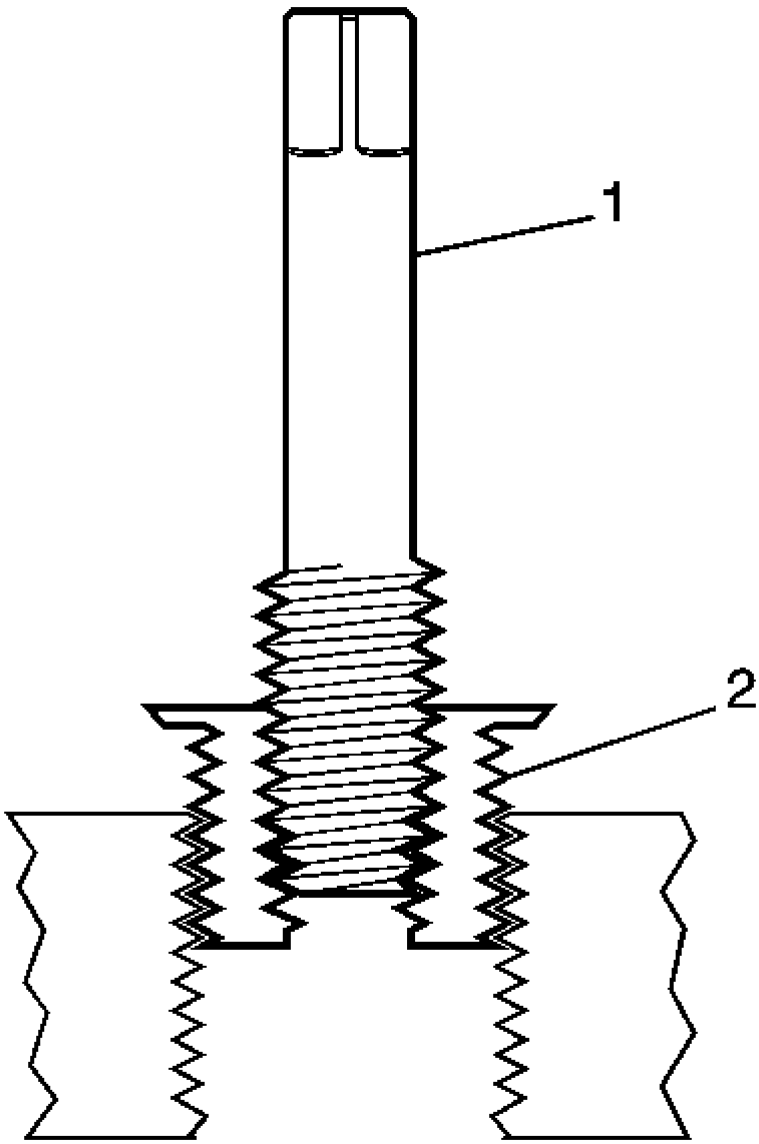


Fig. 265: Identifying Insert - Tapered Thread
Courtesy of GENERAL MOTORS CORP.

11. Install the insert (2) into the tapped hole by hand only.

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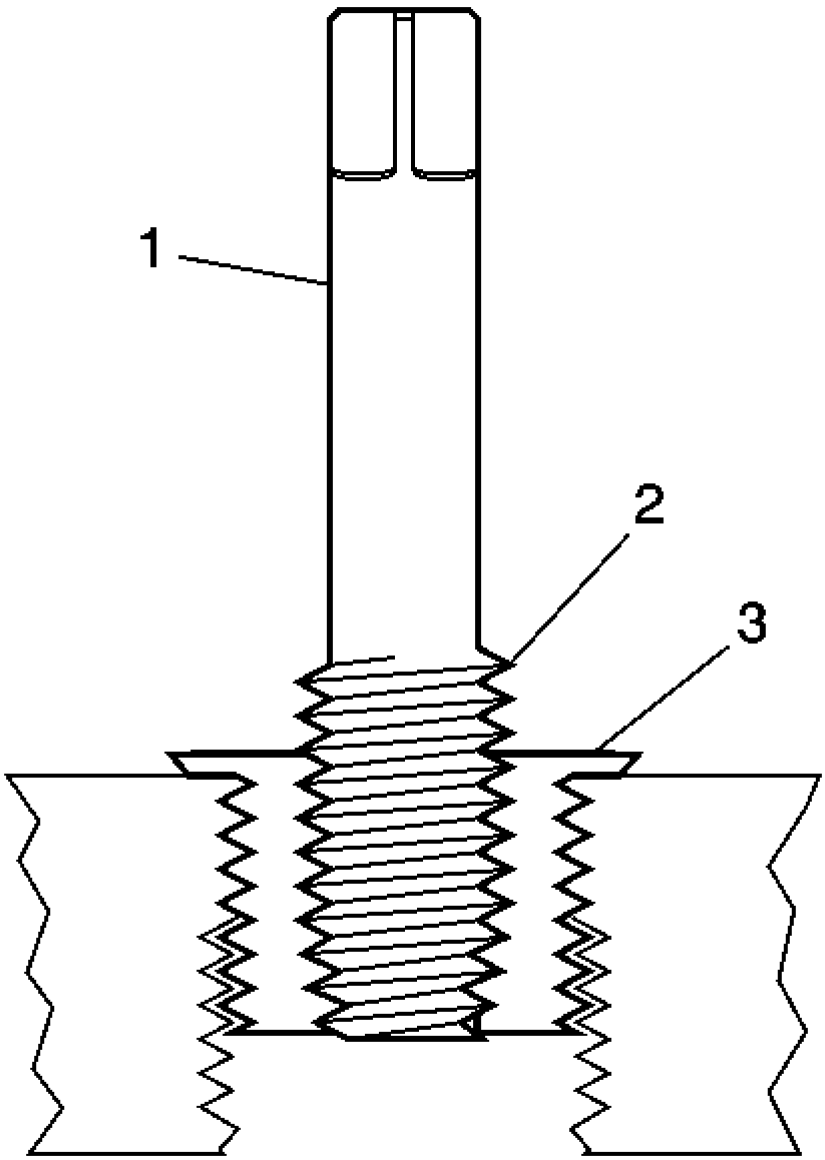


Fig. 266: Identifying Insert & Flange
Courtesy of GENERAL MOTORS CORP.

NOTE: **If the insert will not thread down until the flange contacts the surface of the base material remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.**

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12. Install the insert until the flange of the insert (3) contacts the surface of the base material.

NOTE: The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

13. Continue to rotate the driver installation tool (1) until the top of the threaded section (2) is level with the top of the insert (3).

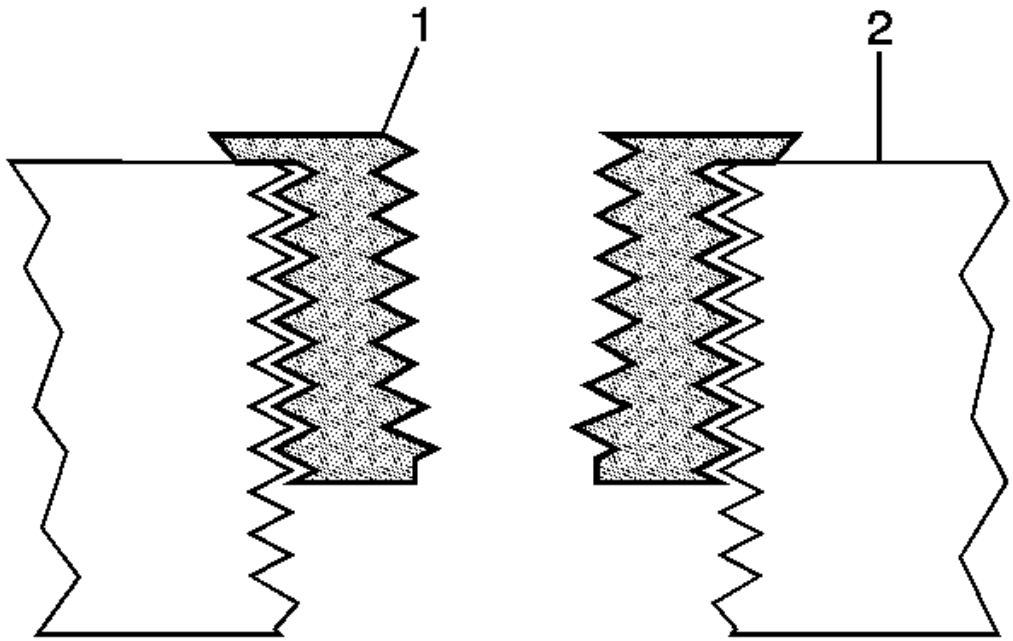


Fig. 267: Identifying Insert Flange & Base Material - Tapered Thread
Courtesy of GENERAL MOTORS CORP.

14. Inspect the insert (1) for proper installation (2) into the tapped hole.

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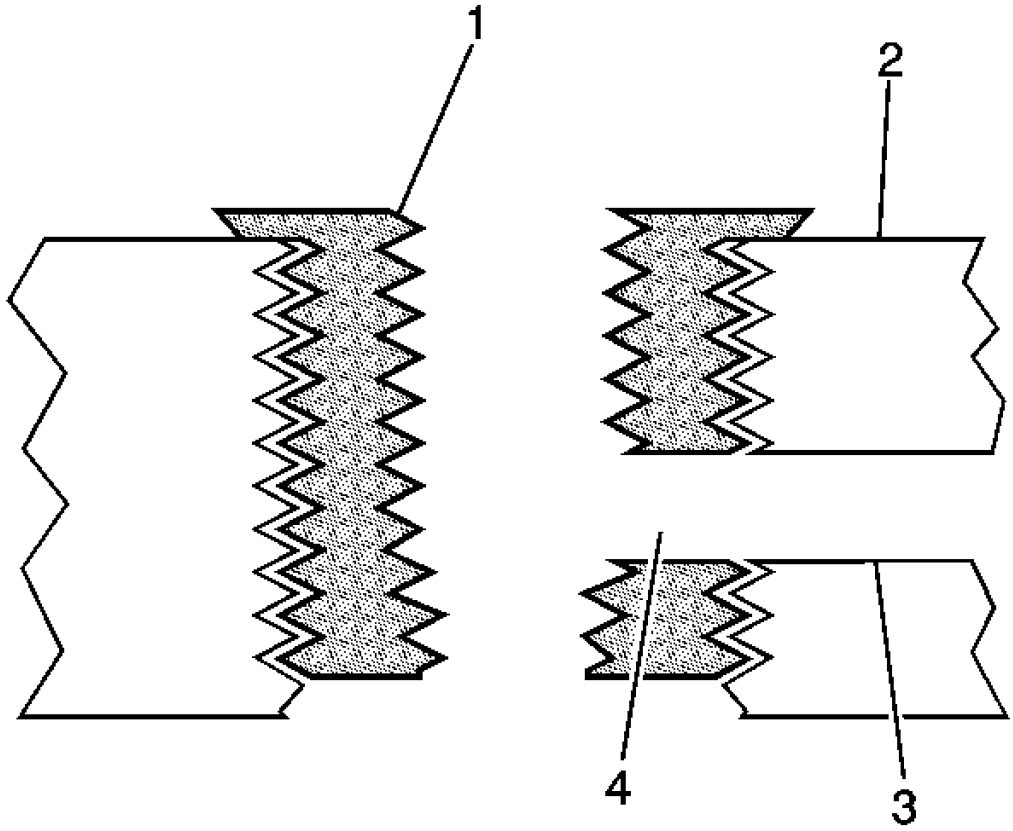


Fig. 268: View Of Restricted Engine Coolant Passages - Tapered Pipe Thread Repair
Courtesy of GENERAL MOTORS CORP.

15. Any installed insert that restricts or blocks an oil or engine coolant passage (3) will need to have the oil or engine coolant passage drilled out (4) to the original size of the oil or engine coolant passage. After drilling the restriction or blockage, clean out any chips and thread the installation driver tool through the insert again to remove any burrs caused by the drilling of the oil or engine coolant passage.

CYLINDER HEAD BOLT HOLE THREAD REPAIR

Special Tools

- **J-42385-700:** High Feature Thread Repair Kit
- **J-42385-2000:** Thread Insert Kit

For equivalent regional tools, refer to **Special Tools** .

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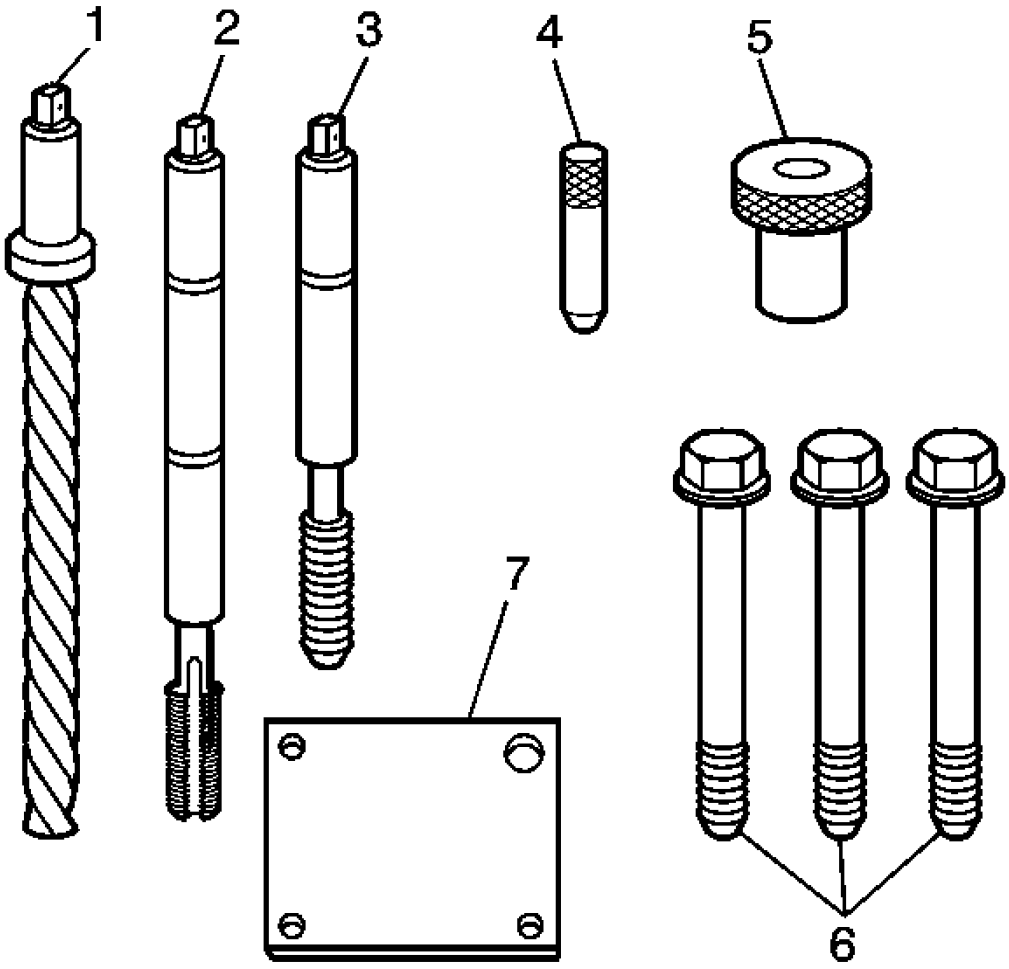


Fig. 269: Identifying Cylinder Head Bolt Hole Thread Repair Components
Courtesy of GENERAL MOTORS CORP.

The cylinder head bolt hole thread repair tooling are in the kits **J-42385-2000:** insert kit and **J-42385-700:** kit. The cylinder head bolt hole thread repair components consist of the following:

- J 42385-723 Drill (1)
- J 42385-724 Tap (2)
- J 42385-725 Installation driver (3)
- J 42385-303 Alignment pin (4)
- J 42385-302 Bushing (5)
- J 42385-733 Bolts (6)

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- J 42385-401 Fixture plate (7)

WARNING: **Refer to Safety Glasses Warning .**

NOTE:

- **Remove the fixture plate prior to installing the insert with the installer tool.**
- **The use of a cutting type fluid, WD 40®; or equivalent is recommended when performing the drilling, counterboring and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers for recommended cutting fluid.**

When installed to the proper depth, the flange of the insert will be seated against the counterbore of the drilled/tapped hole.

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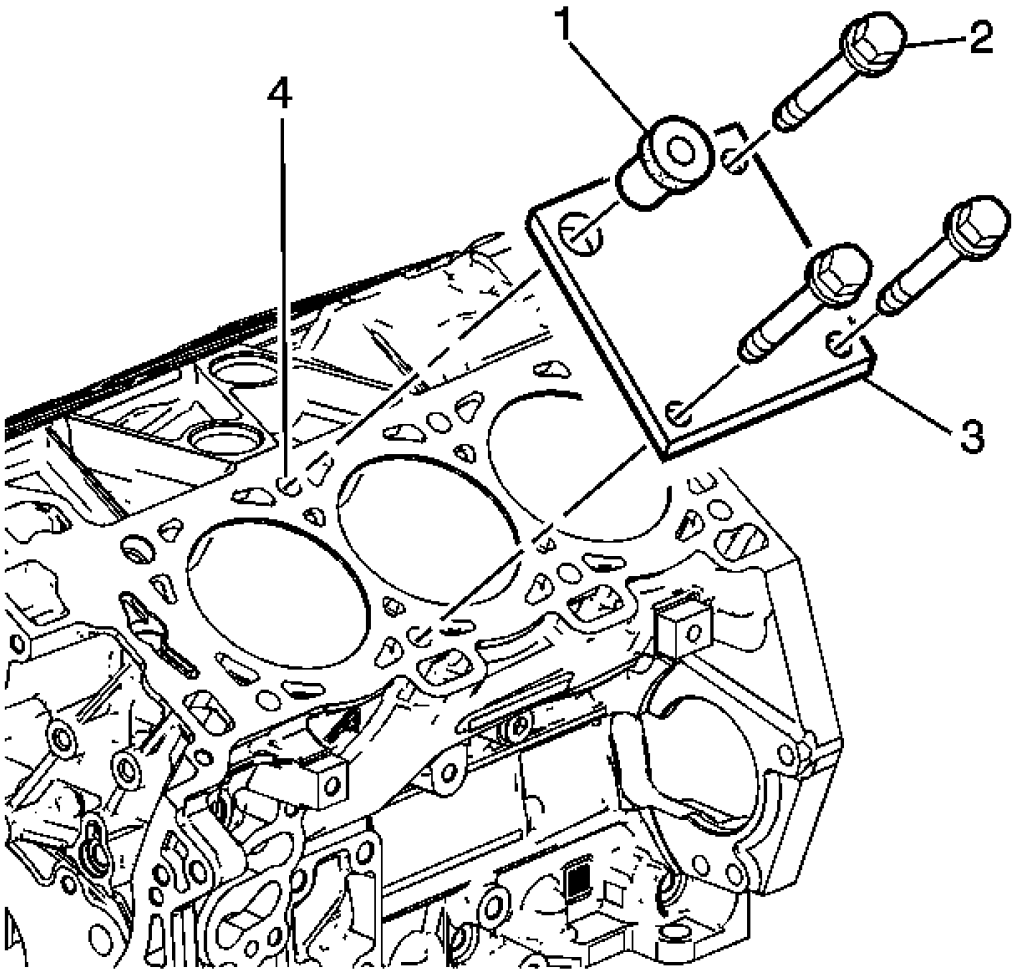


Fig. 270: View Of Fixture Plate & Components - Cylinder Head Bolt Hole
Courtesy of GENERAL MOTORS CORP.

1. Position the fixture plate (3) with the bushing (1) installed over the cylinder head bolt hole to be repaired (4).
2. Loosely install the fixture plate bolts (2) into the remaining cylinder head bolt holes.

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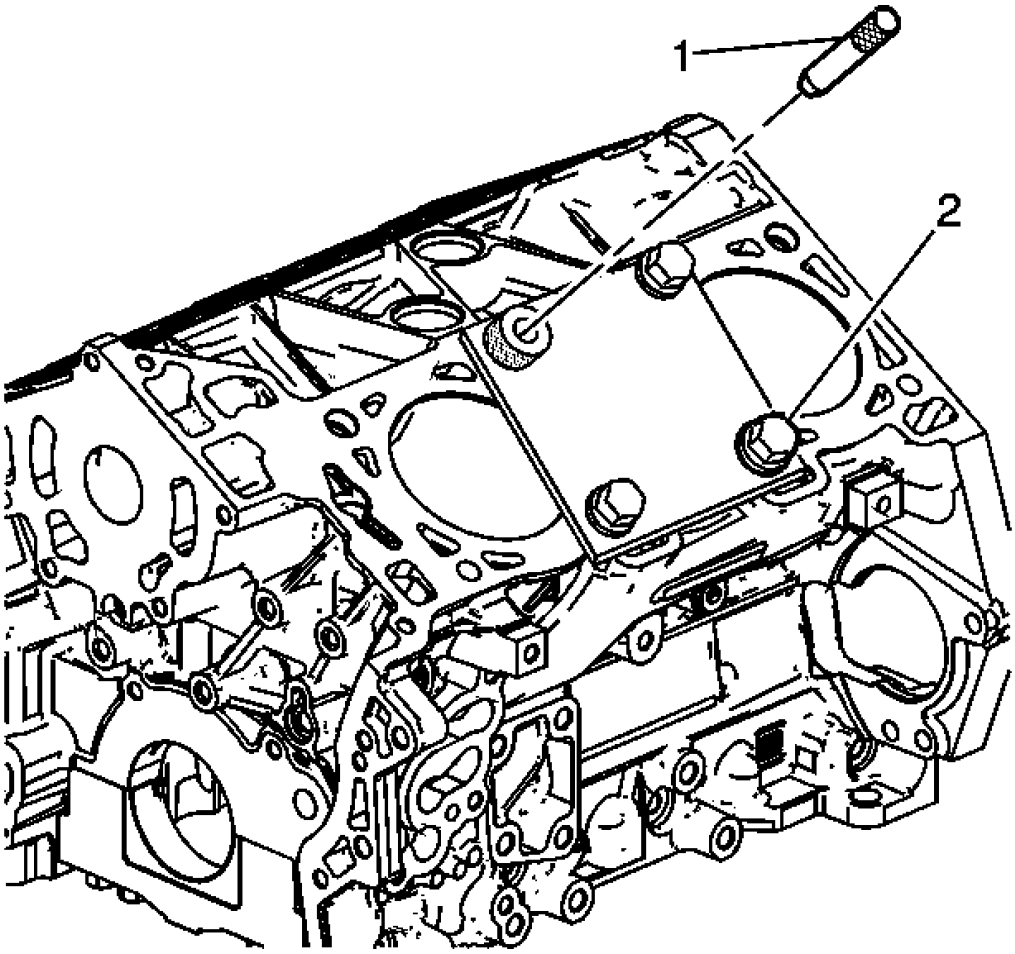


Fig. 271: Identifying Alignment Pin
Courtesy of GENERAL MOTORS CORP.

3. Position the alignment pin (1) through the bushing and into the cylinder head bolt hole.
4. With the alignment pin in the desired cylinder head bolt hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin (1) from the cylinder head bolt hole.

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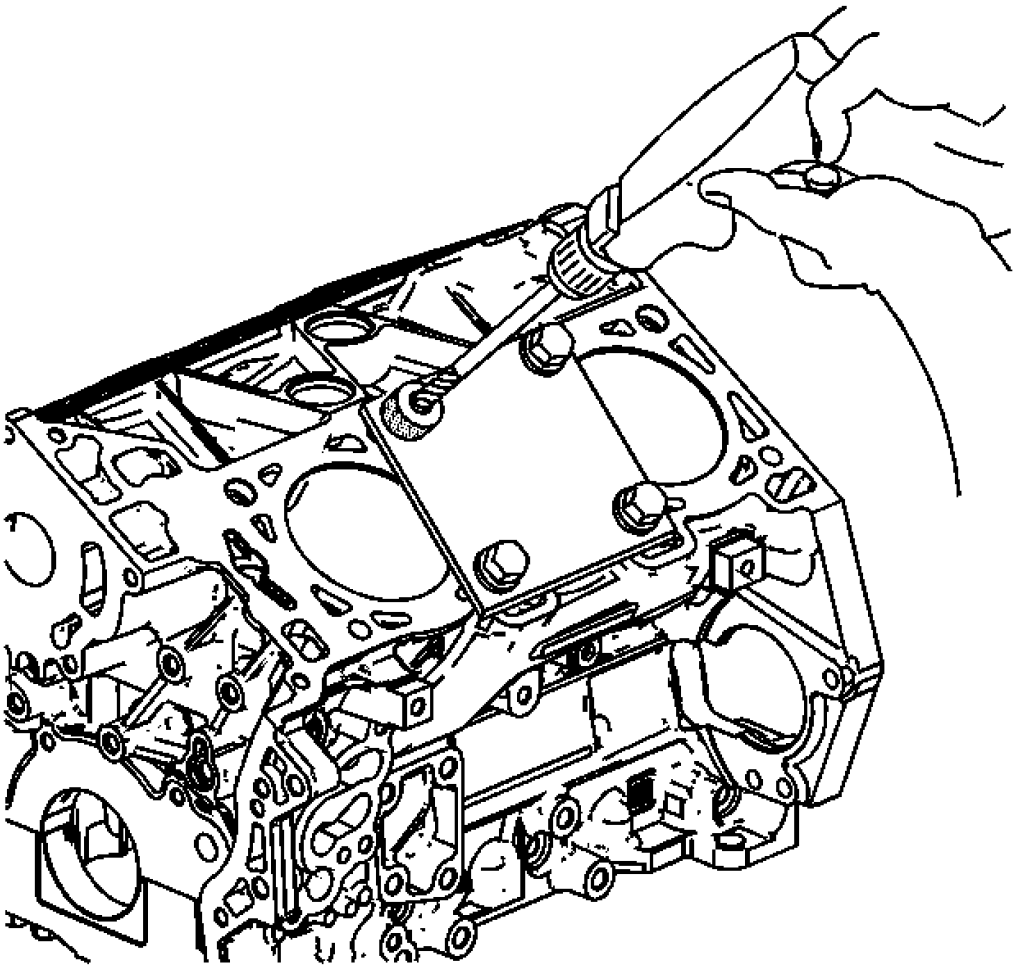


Fig. 272: Drilling Out Threads Of Damaged Hole
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.**
- **Drill the hole until the stop collar contacts the top of the drill bushing.**

6. Drill out the threads of the damaged hole.

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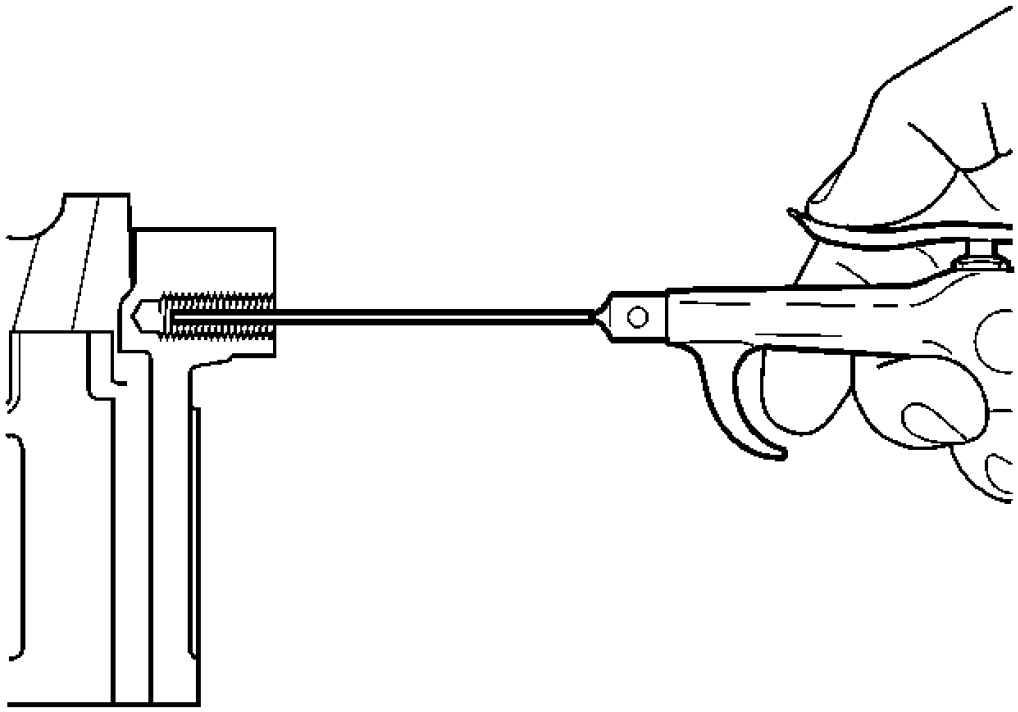


Fig. 273: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the drilled hole prior to tapping.

7. Using compressed air, clean out any chips.

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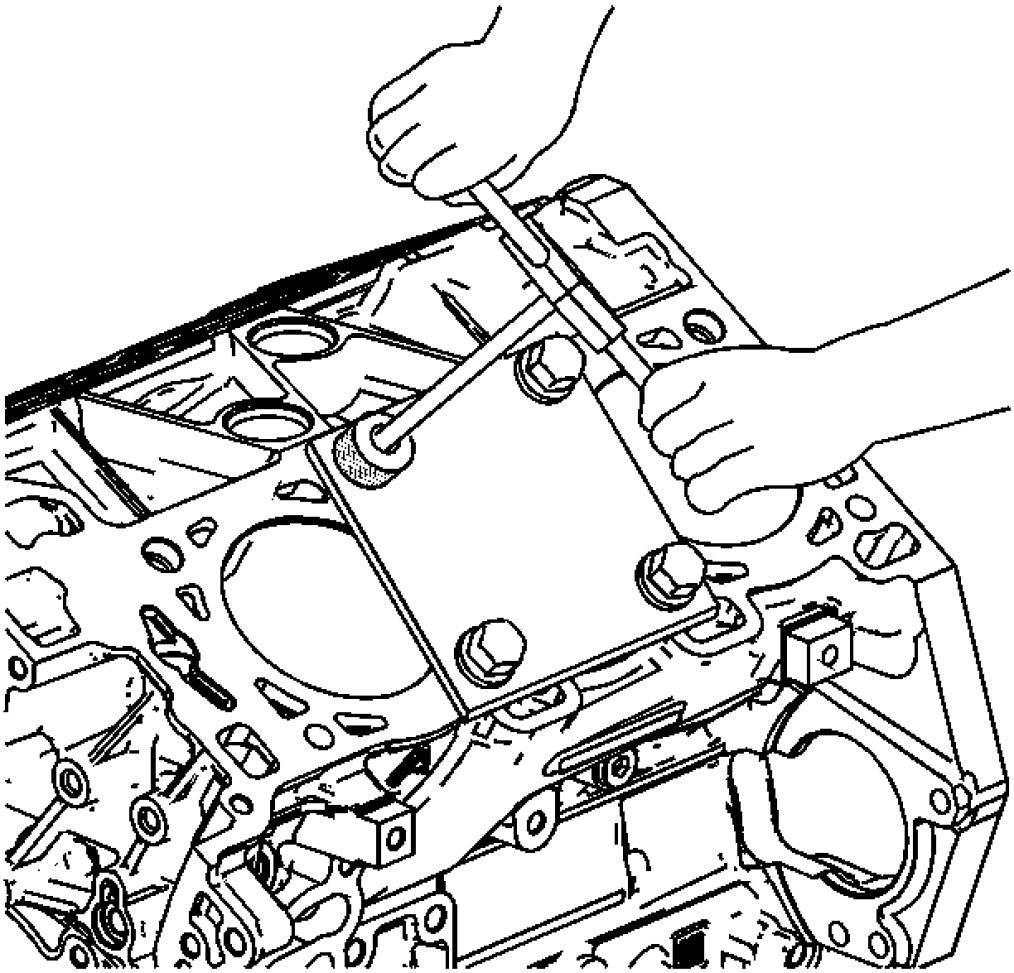


Fig. 274: Tapping Threads In Hole
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.**
- **Ensure the tap has created full threads at least to the depth equal to the insert length.**

8. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.

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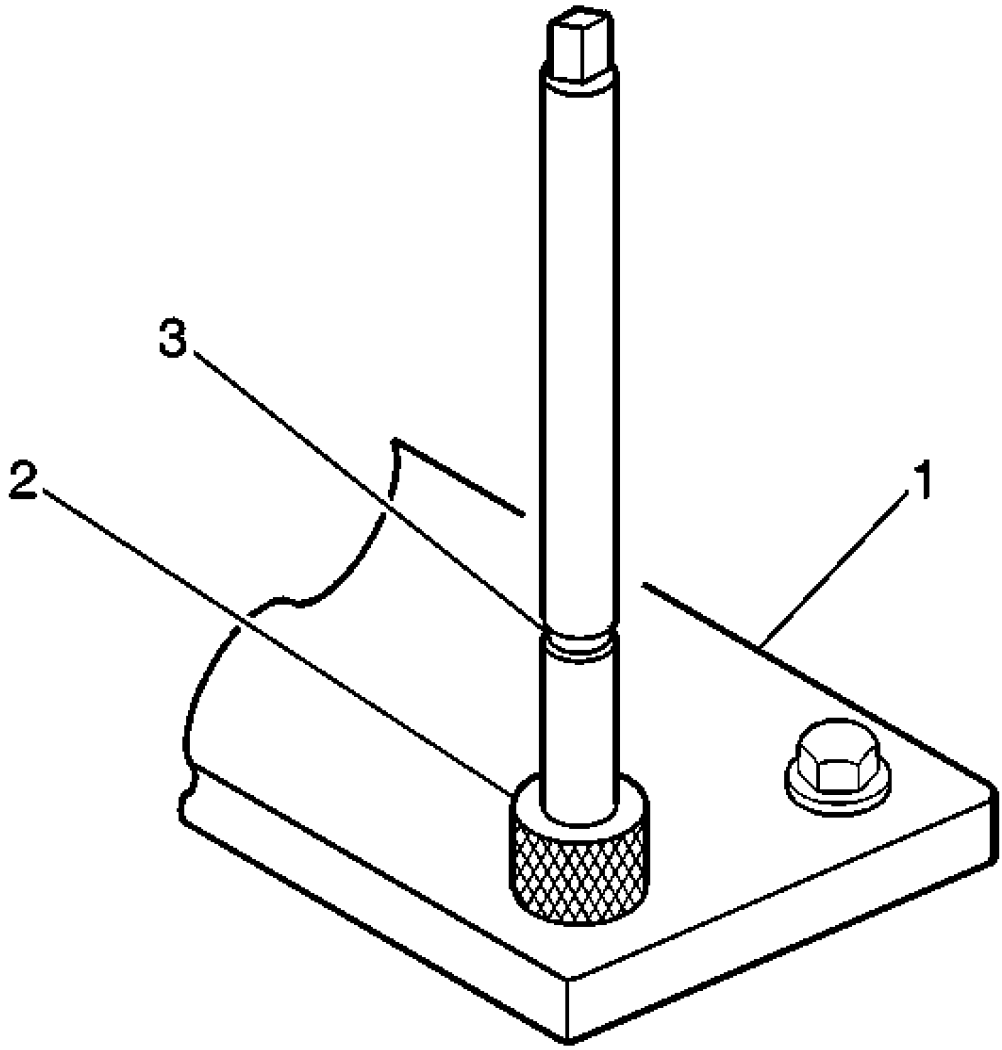


Fig. 275: View Of Driver, Bushing & Tool Marking
Courtesy of GENERAL MOTORS CORP.

9. In order to tap the new threads for the insert to the proper depth, rotate the tap into the cylinder head bolt hole until the mark (3) on the tap aligns with the top of the drill bushing (2).

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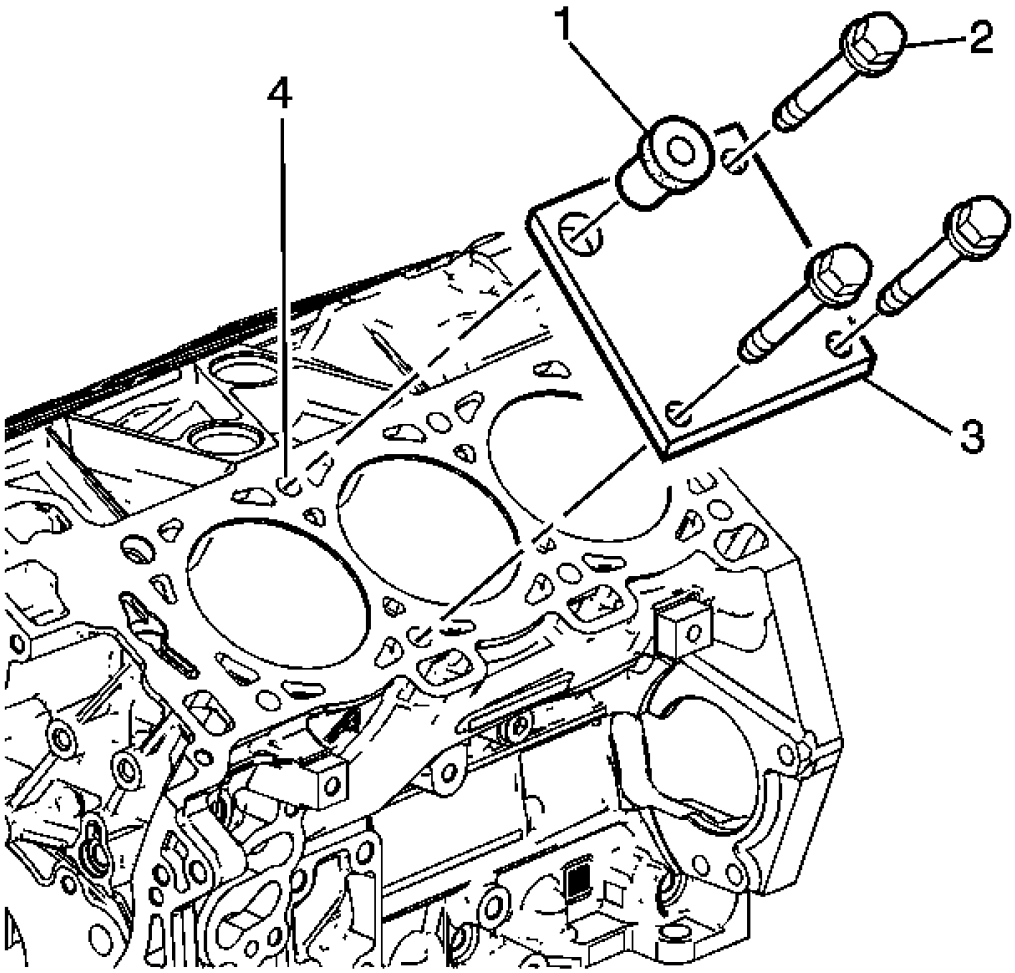


Fig. 276: View Of Fixture Plate & Components - Cylinder Head Bolt Hole
Courtesy of GENERAL MOTORS CORP.

NOTE: Remove the fixture plate prior to installing the insert with the installer tool.

10. Remove the fixture plate bolts (2).
11. Remove the fixture plate (3) and bushing (1).

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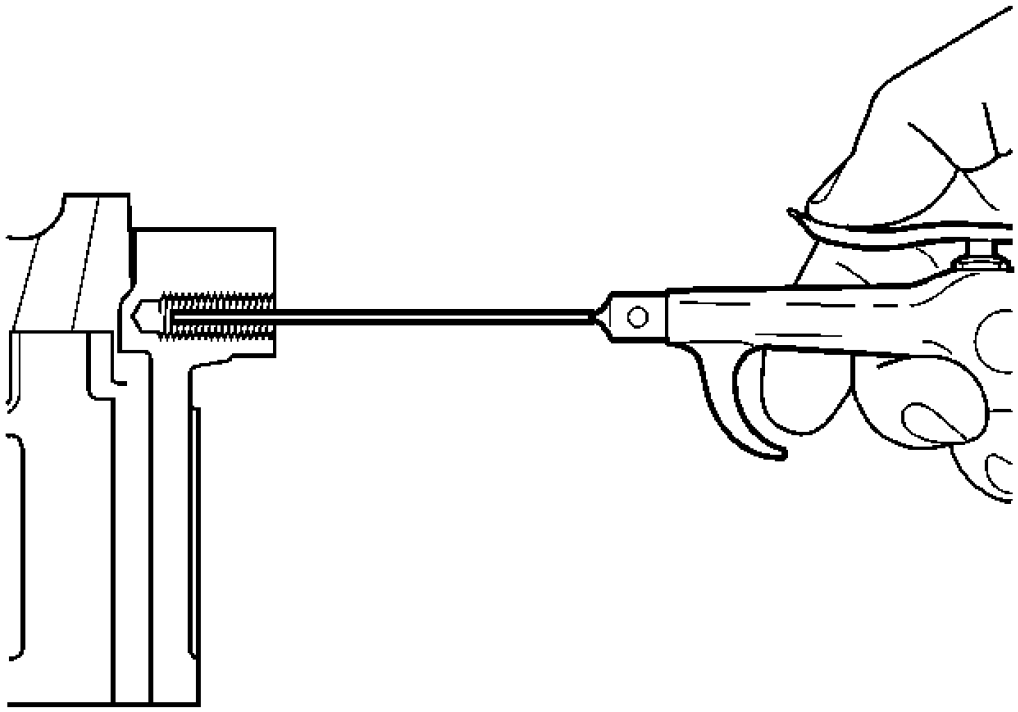


Fig. 277: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the tapped hole prior to insert installation.

12. Using compressed air, clean out any chips.

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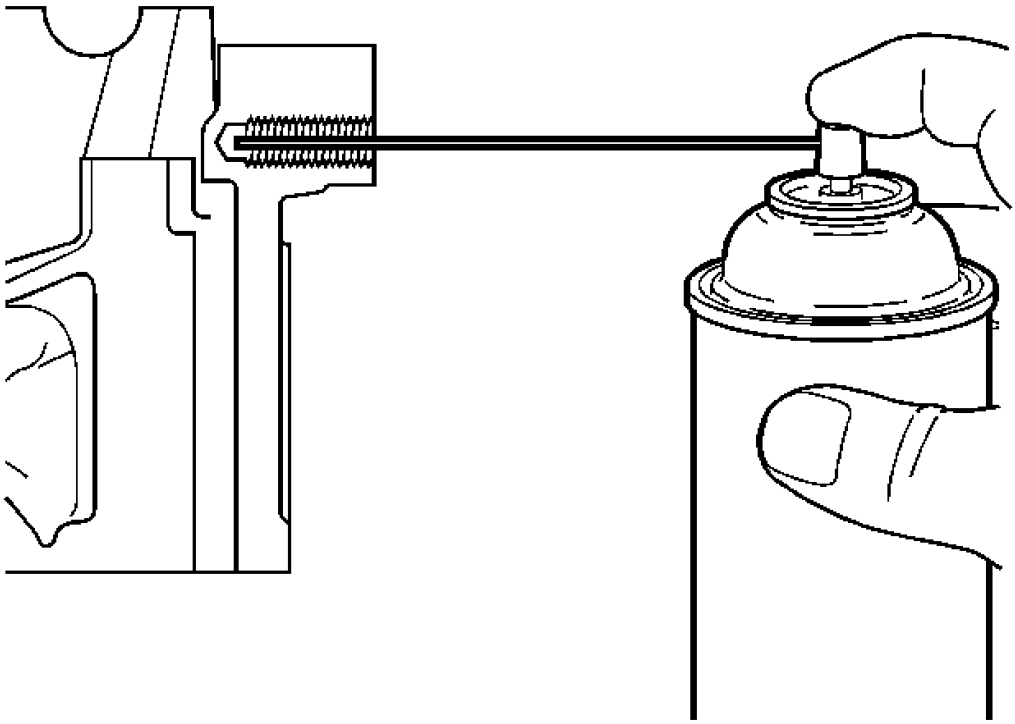


Fig. 278: Spraying Cleaner Into Tapped Hole
Courtesy of GENERAL MOTORS CORP.

13. Spray cleaner into the tapped hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended cleaner.

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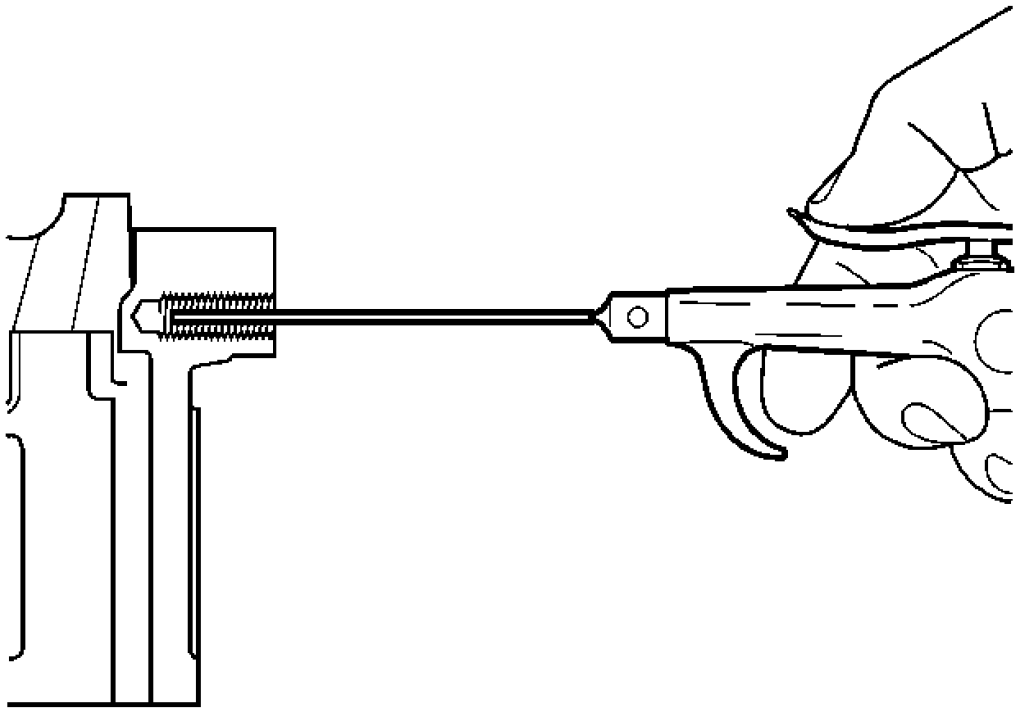


Fig. 279: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the tapped hole prior to insert installation.

14. Using compressed air, clean out any chips.

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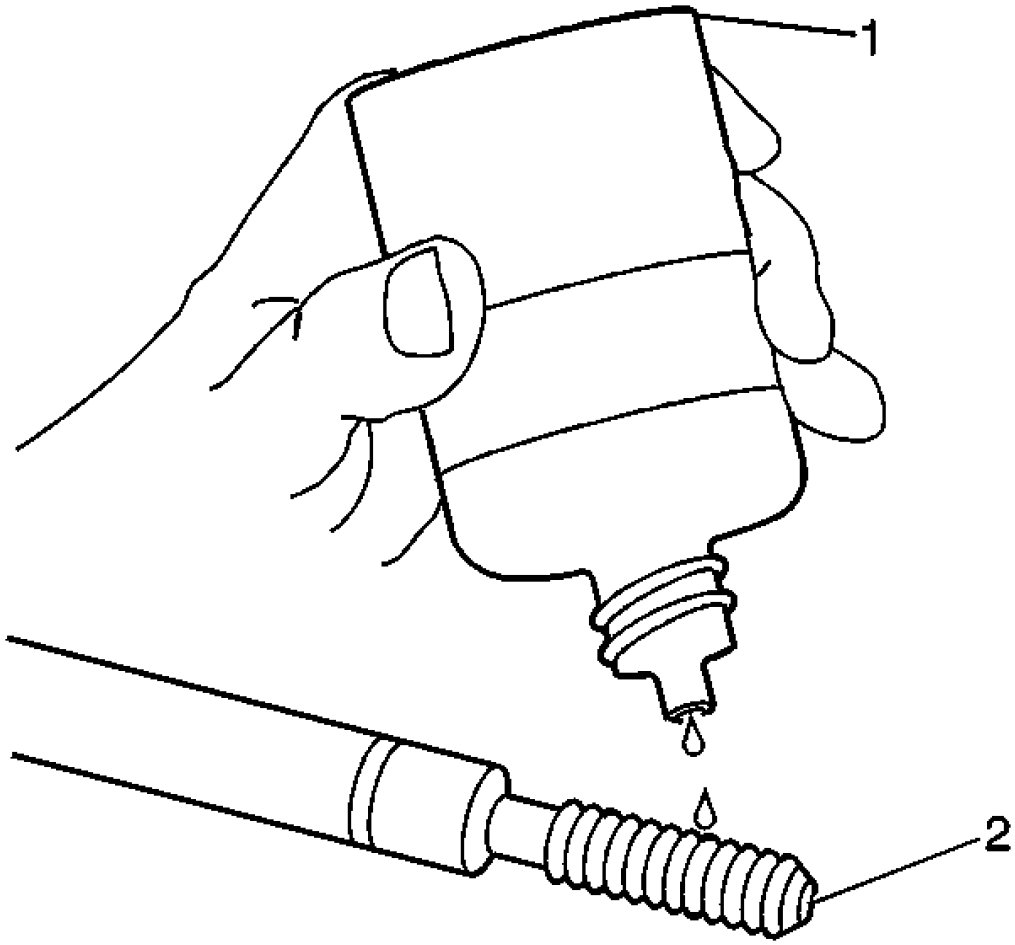


Fig. 280: Lubricating Installer Tool
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.

15. Lubricate the threads of the driver installation tool (2) with the J 42385-110 (1).

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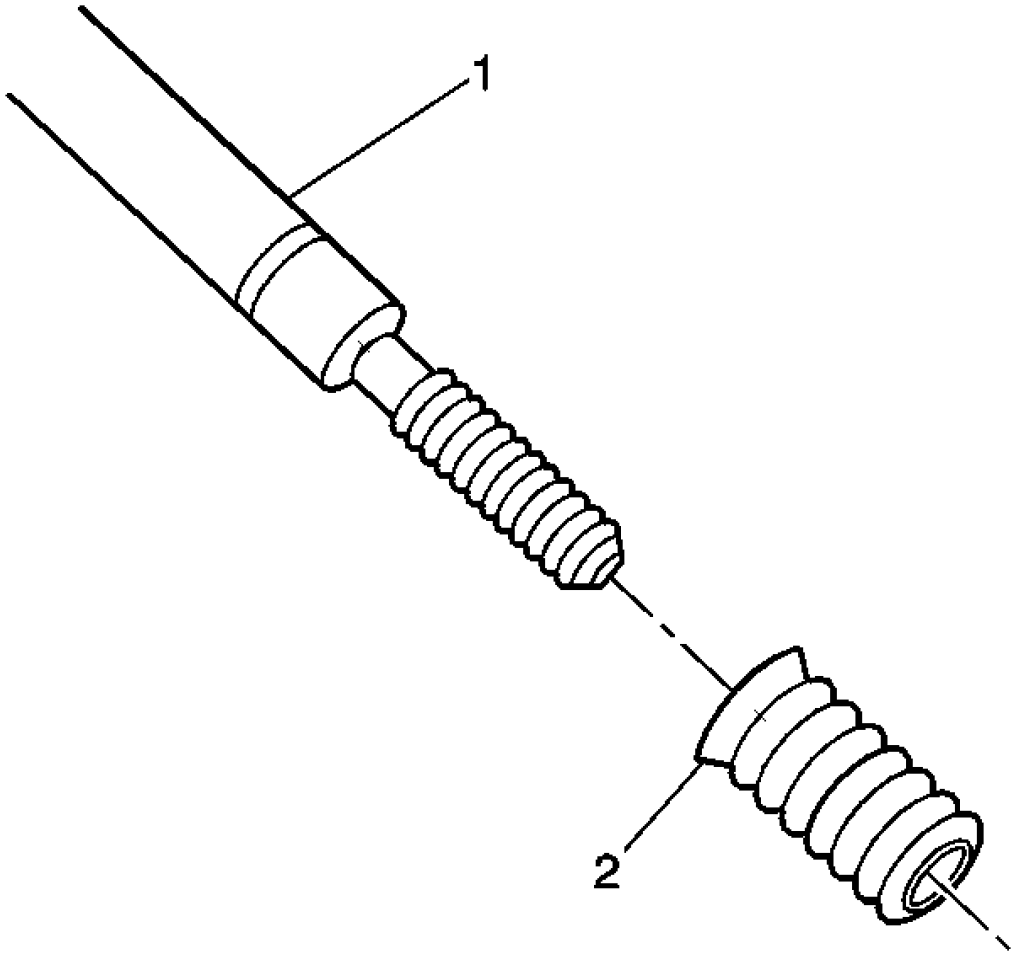


Fig. 281: View of Bushing Type Insert
Courtesy of GENERAL MOTORS CORP.

16. Install the insert (2) onto the driver installation tool (1).

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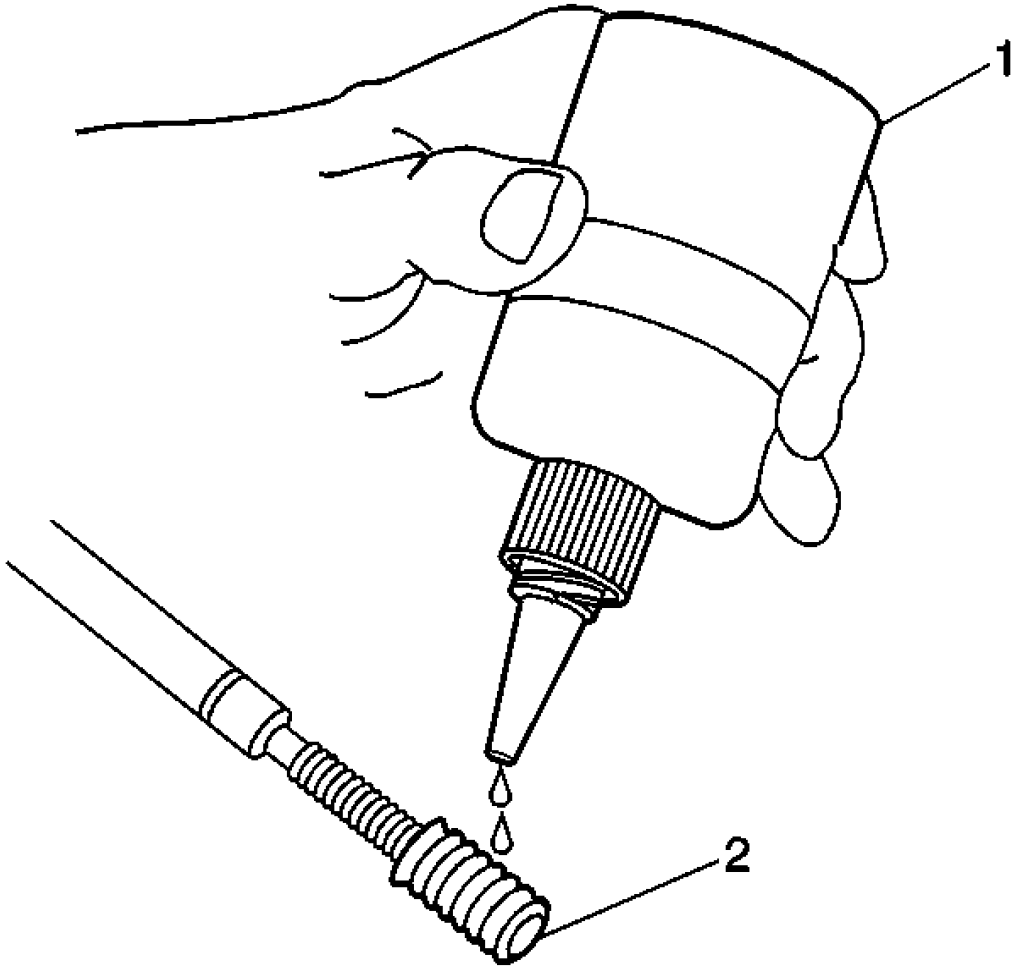


Fig. 282: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS CORP.

17. Apply threadlock sealant, J 42385-109, LOCTITE 277®; or equivalent (1) to the insert OD threads (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

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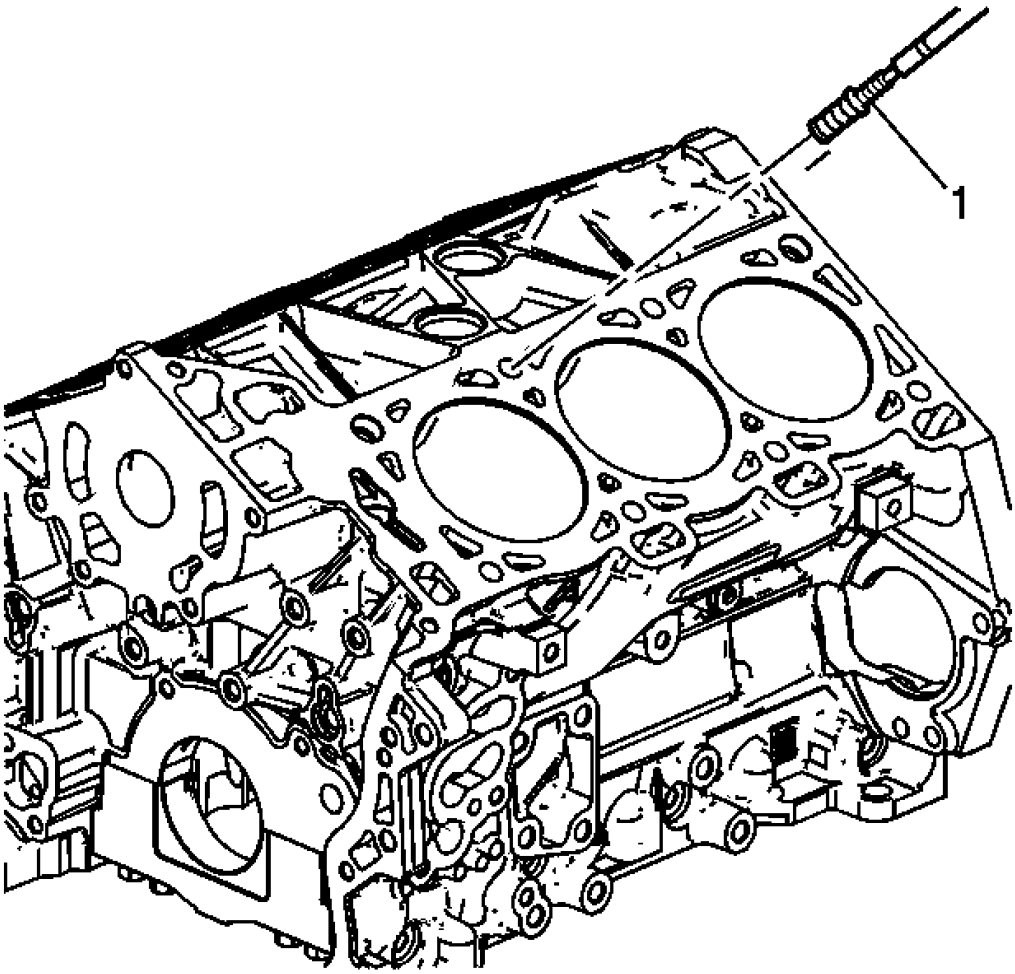


Fig. 283: Identifying Insert & Installation Driver
Courtesy of GENERAL MOTORS CORP.

18. Install the insert and installation driver (1) into the tapped hole by hand only.
19. Start the insert into the threaded hole.

NOTE: If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.

20. Install the insert until the flange of the insert contacts the counterbored surface.

NOTE: The driver installation tool will tighten up before screwing completely

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through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

21. Continue to rotate the driver installation tool through the insert.

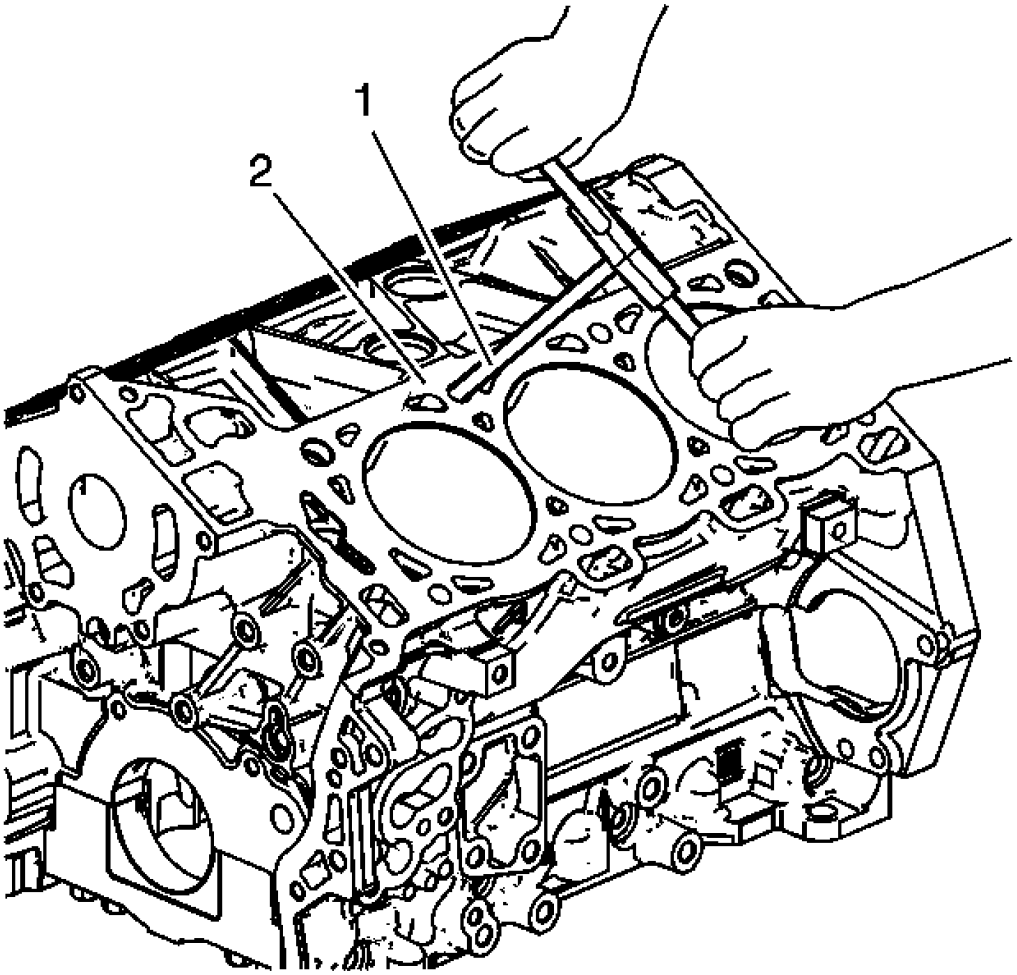


Fig. 284: Aligning Driver Installation Tool With Surface Of Engine Block Deck
Courtesy of GENERAL MOTORS CORP.

22. In order to completely form the new threads in the insert, rotate the driver installation tool through the insert until the mark (1) on the driver installation tool aligns with the surface of the engine block deck (2).
23. Inspect the insert for proper installation into the tapped hole.

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CRANKSHAFT MAIN BOLT HOLE THREAD REPAIR

Special Tools

- **J-42385-700:** High Feature Thread Repair Kit
- **J-42385-2000:** Thread Insert Kit

For equivalent regional tools, refer to **Special Tools** .

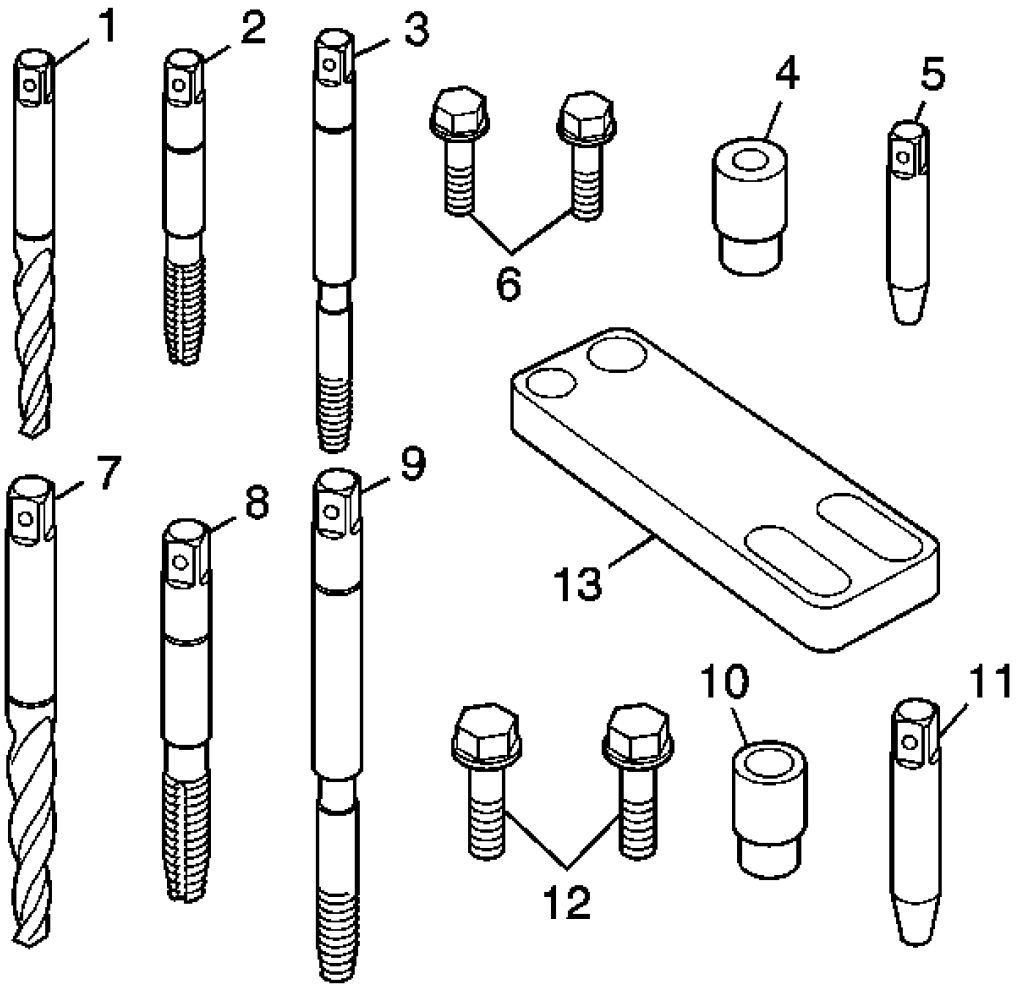


Fig. 285: Identifying Special Tool Components
Courtesy of GENERAL MOTORS CORP.

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NOTE:

- **In order to repair some crankshaft main bolt holes it will be necessary to mount the fixture plate upside down.**
- **Do NOT remove the fixture plate prior to installing the insert with the installation driver. The fixture plate remains in position throughout the thread repair process.**

The crankshaft main bearing bolt hole thread repair tooling are in the kits **J-42385-2000:** insert kit and **J-42385-700:** kit. The crankshaft main bearing bolt hole thread repair components consist of the following:

- J 42385-702 Drill (1) for outboard holes
- J 42385-703 Tap (2) for outboard holes
- J 42385-704 Installation driver (3) for outboard holes
- J 42385-726 Bushing (4) for outboard holes
- J 42385-727 Alignment pin (5) for outboard holes
- J 42385-728 Bolts (6) for outboard holes
- J 42385-720 Drill (7) for inboard holes
- J 42385-721 Tap (8) for inboard holes
- J 42385-722 Installation driver (9) for inboard holes
- J 42385-713 Bushing (10)
- J 42385-308 Alignment pin (11)
- J 42385-734 Bolts (12)
- J 42385-712 Fixture plate (13)

OUTBOARD BOLT HOLES

WARNING: Refer to Safety Glasses Warning .

NOTE:

- **Ensure the fixture plate is installed during the machining and installation processes of the insert.**
- **The use of a cutting type fluid, WD 40® or equivalent is recommended when performing the drilling, counterboring and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers for recommended cutting fluid.**

When installed to the proper depth, the flange of the insert will be seated against the counterbore of the drilled/tapped hole.

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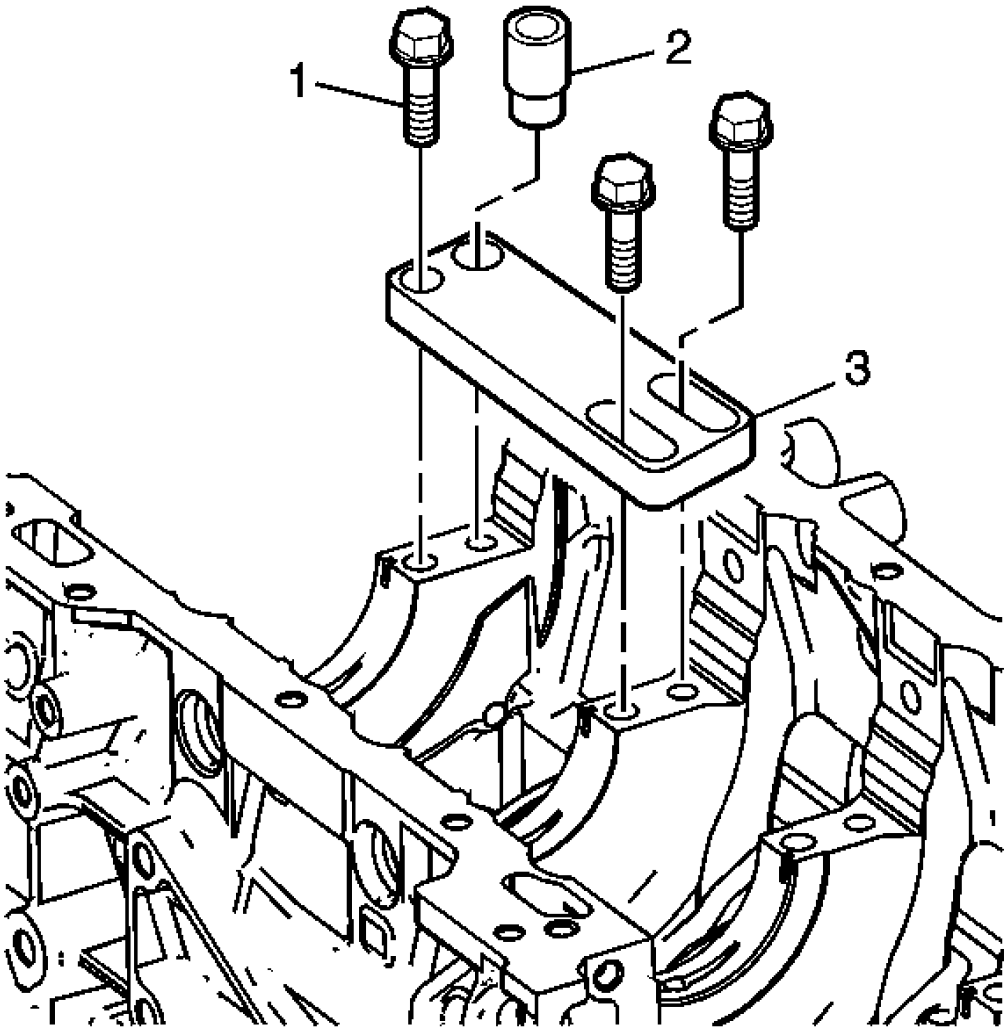


Fig. 286: Identifying Fixture Plate Over Crankshaft Main Cap Bolt Hole
Courtesy of GENERAL MOTORS CORP.

1. Position the fixture plate (3) with the bushing (2) installed over the crankshaft main cap bolt hole to be repaired.
2. Loosely install the fixture plate bolts (1) into the remaining crankshaft main cap bolt holes.

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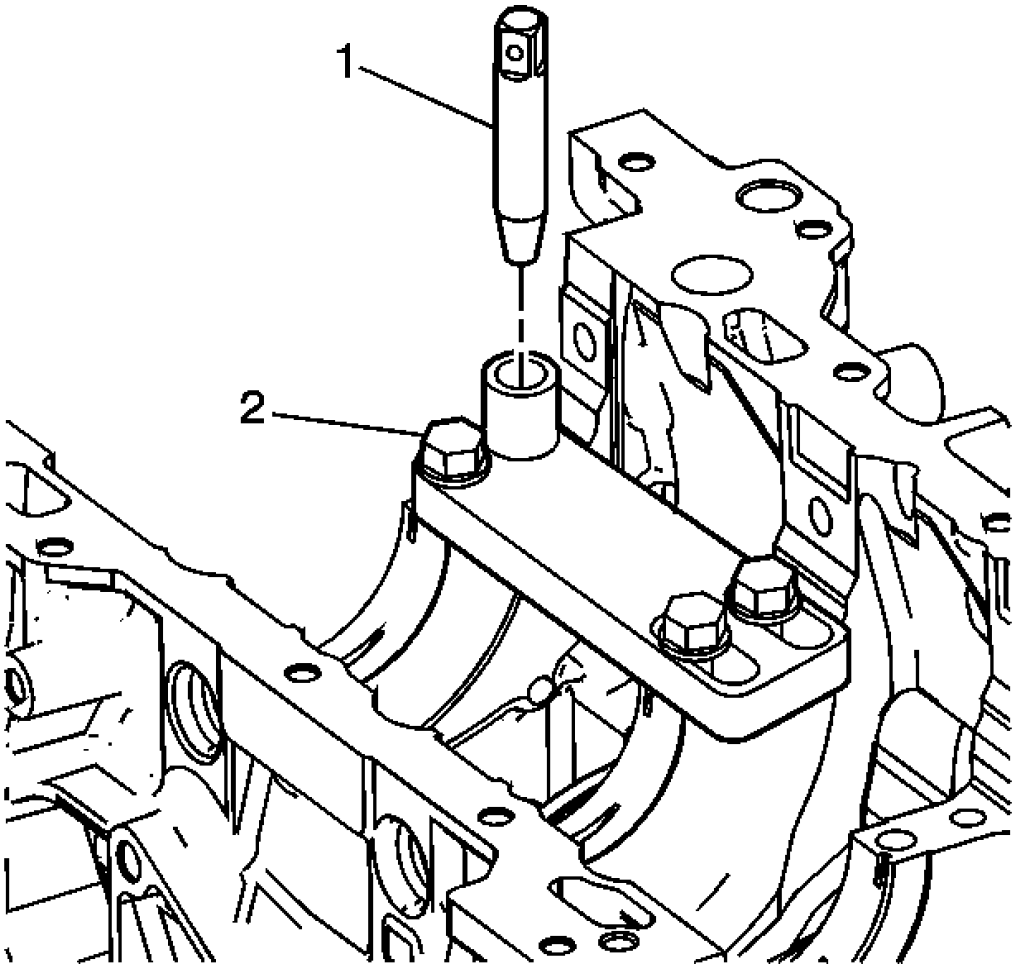


Fig. 287: Identifying Alignment Pin & Bushing
Courtesy of GENERAL MOTORS CORP.

3. Position the alignment pin (1) through the bushing and into the crankshaft main cap bolt hole.
4. With the alignment pin in the desired crankshaft main cap bolt hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin (1) from the crankshaft main cap bolt hole.

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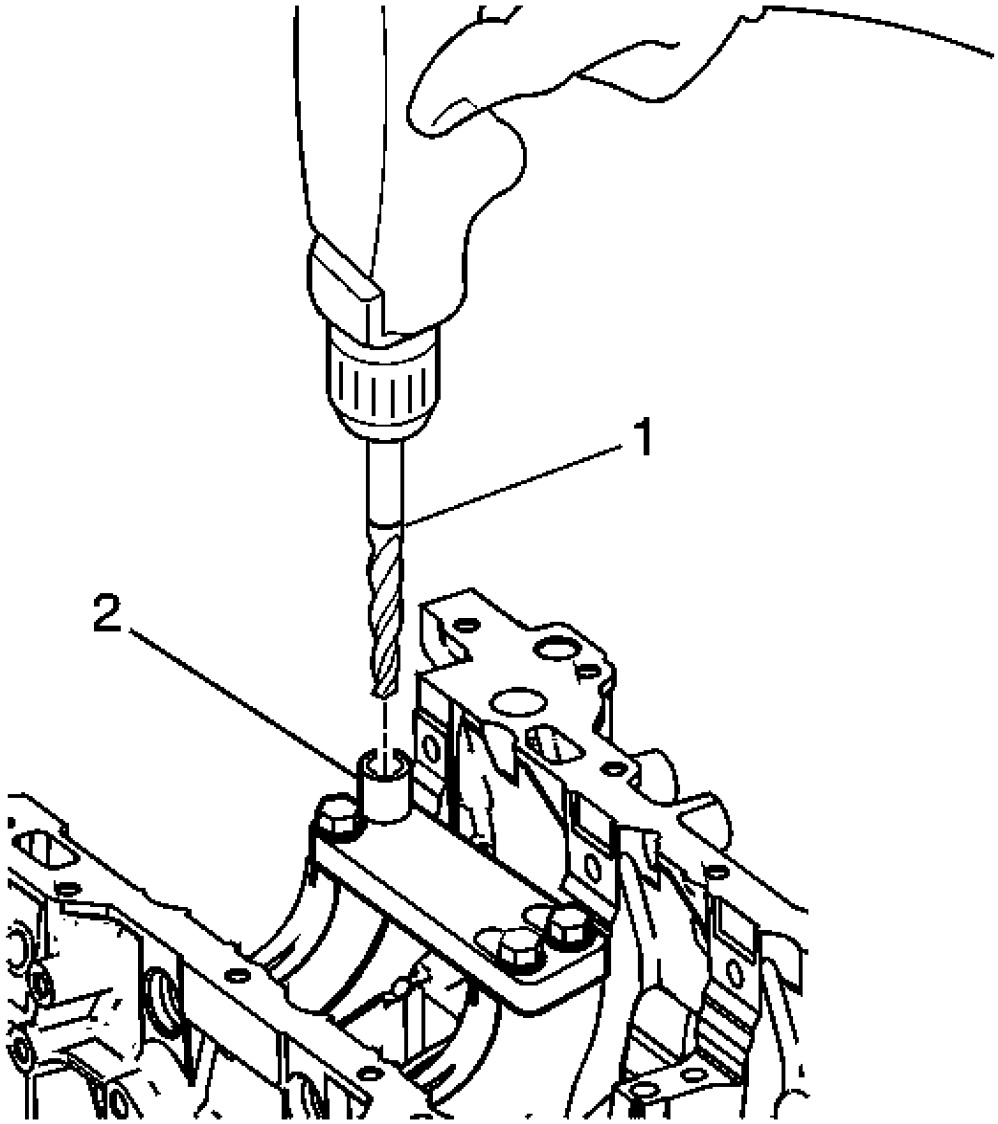


Fig. 288: Aligning Drill & Drill Bushing
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.**
- **Drill the crankshaft main bolt hole until the mark (1) on the drill aligns with the top of the drill bushing (2).**

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6. Drill out the threads of the damaged hole.

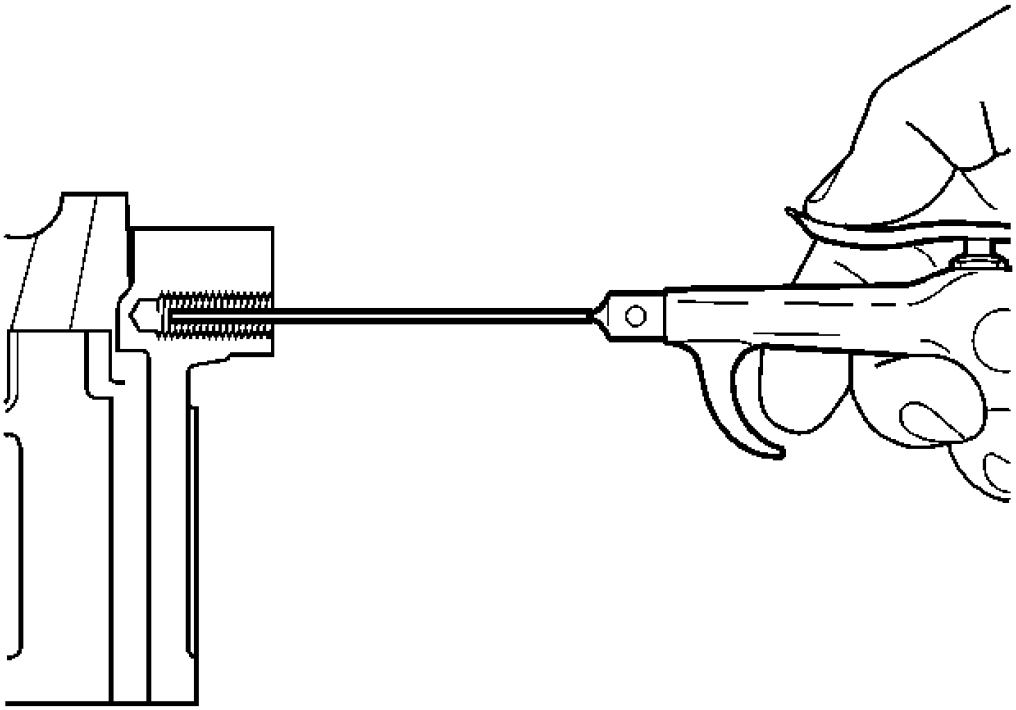


Fig. 289: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the drilled hole prior to tapping.

7. Using compressed air, clean out any chips.

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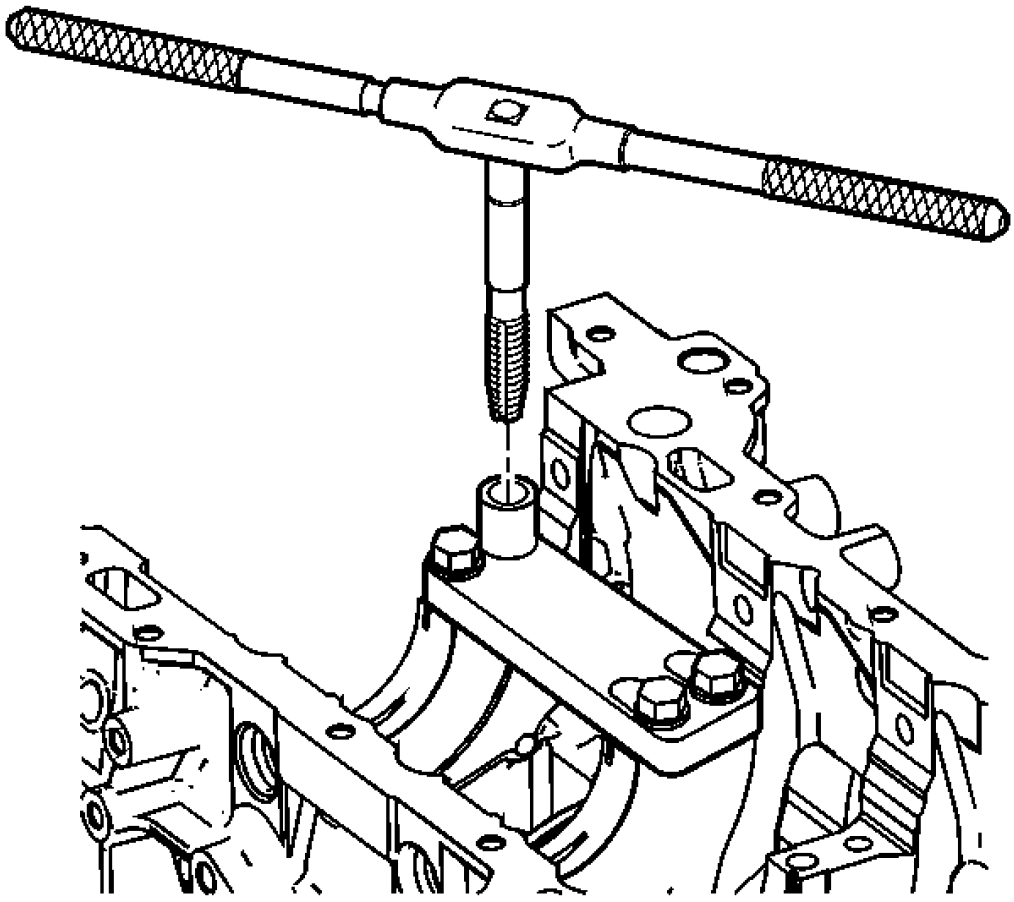


Fig. 290: View Of Tapping Wrench
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Do not remove the fixture plate, ensure the fixture plate is installed during the machining and installation processes of the insert.**
- **During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.**
- **Ensure the tap has created full threads at least to the depth equal to the insert length.**

8. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.

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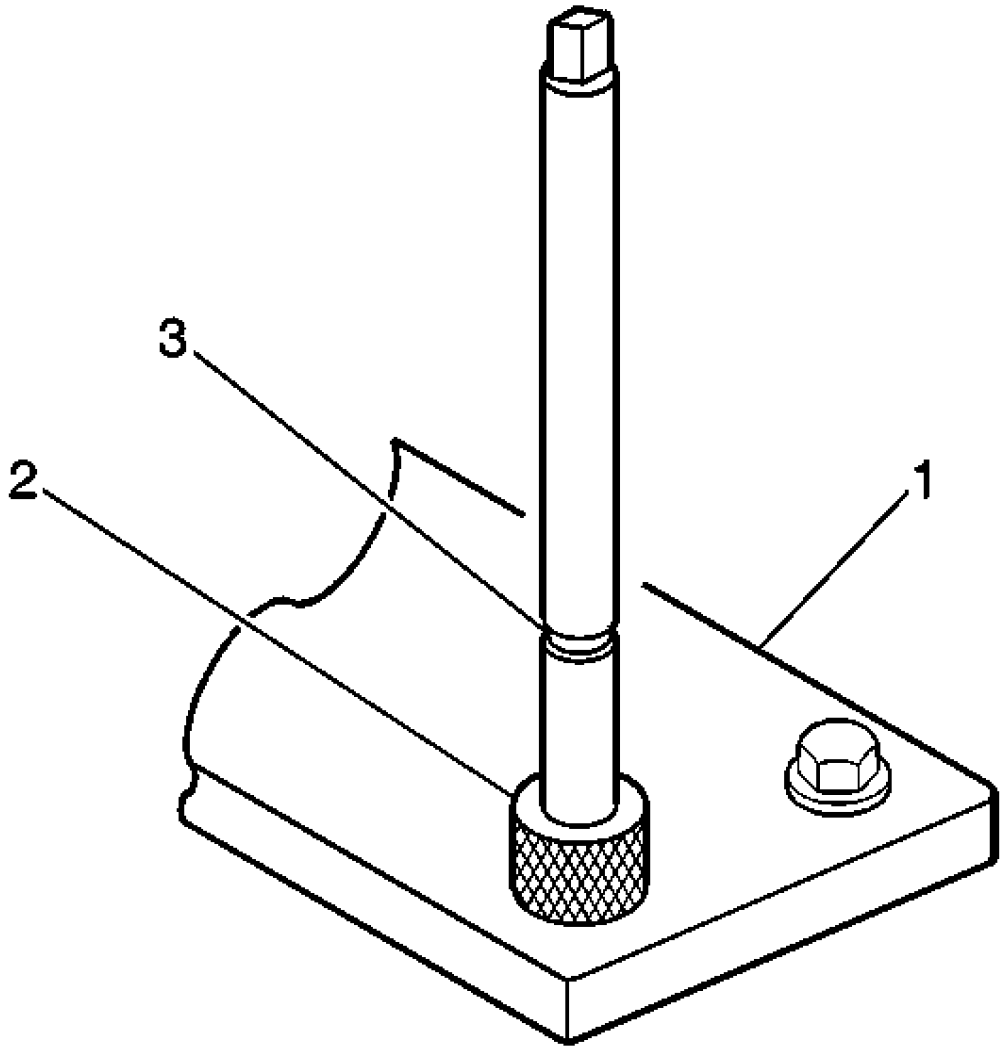


Fig. 291: View Of Driver, Bushing & Tool Marking
Courtesy of GENERAL MOTORS CORP.

9. In order to tap the new threads for the insert to the proper depth, rotate the tap into the crankshaft main cap bolt hole until the mark (3) on the tap aligns with the top of the drill bushing (2).

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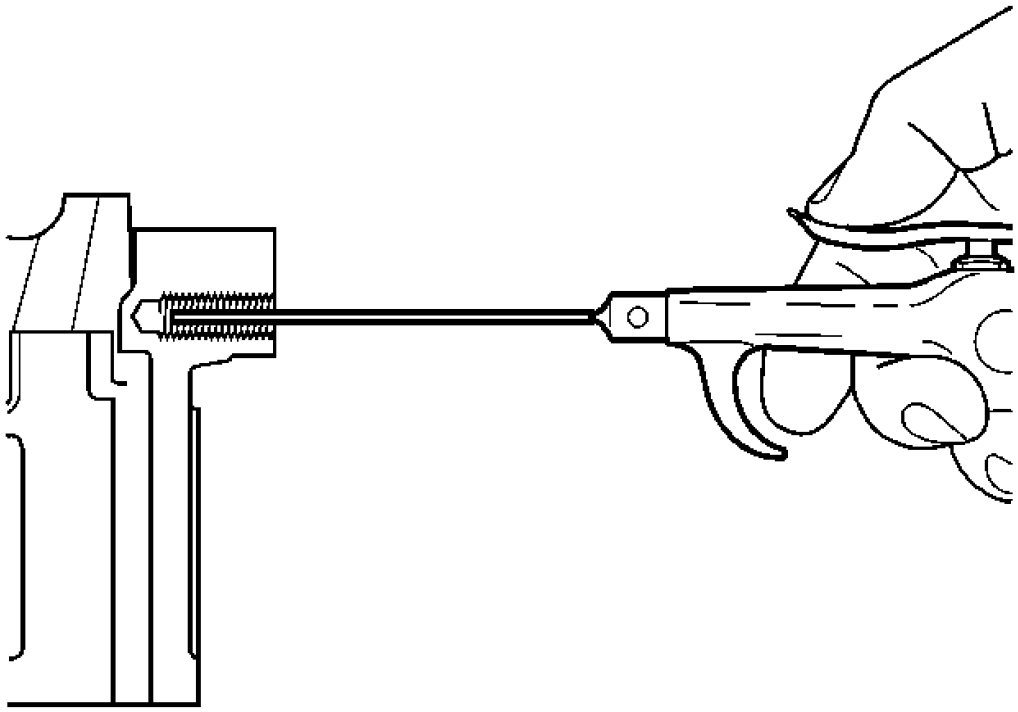


Fig. 292: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the tapped hole prior to insert installation.

10. Using compressed air, clean out any chips.

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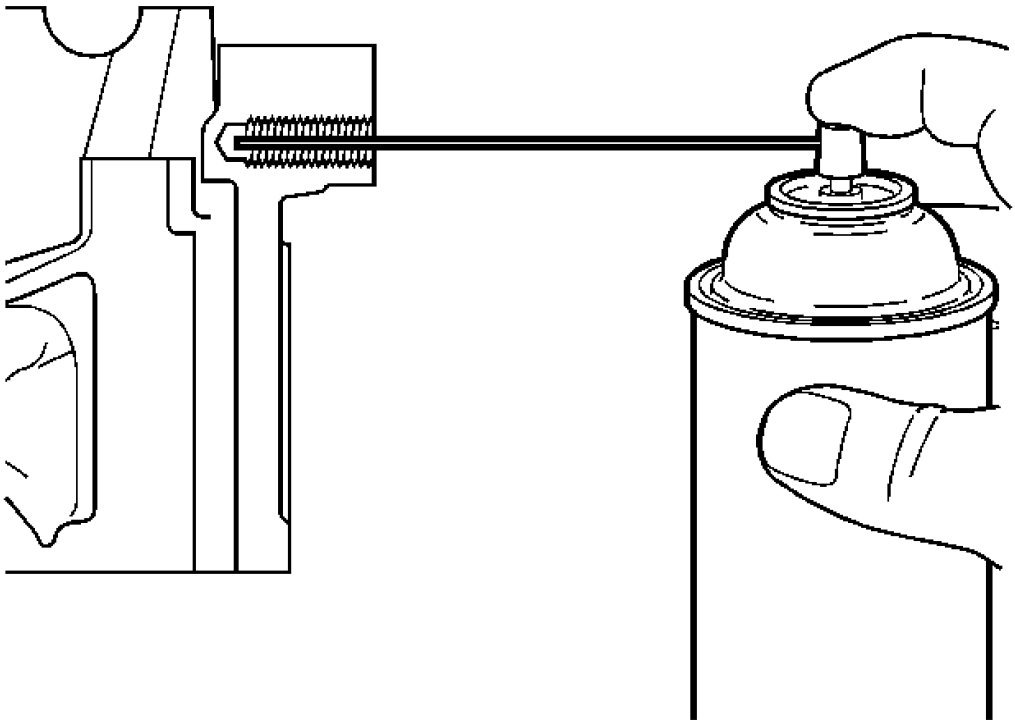


Fig. 293: Spraying Cleaner Into Tapped Hole
Courtesy of GENERAL MOTORS CORP.

11. Spray cleaner into the tapped hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended cleaner.

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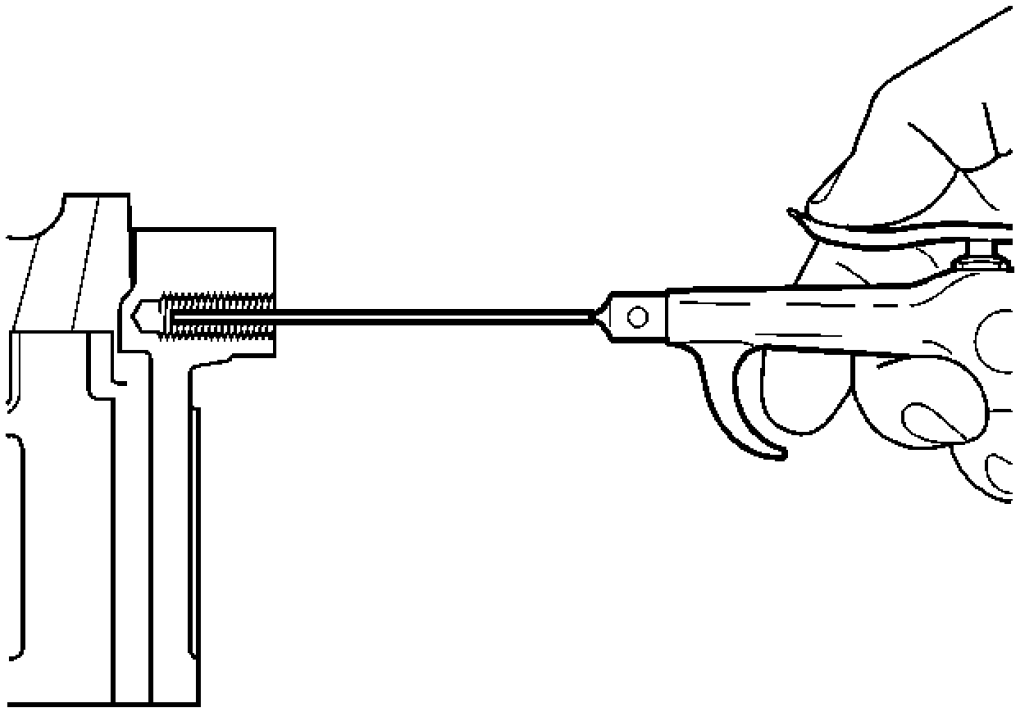


Fig. 294: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the tapped hole prior to insert installation.

12. Using compressed air, clean out any chips.

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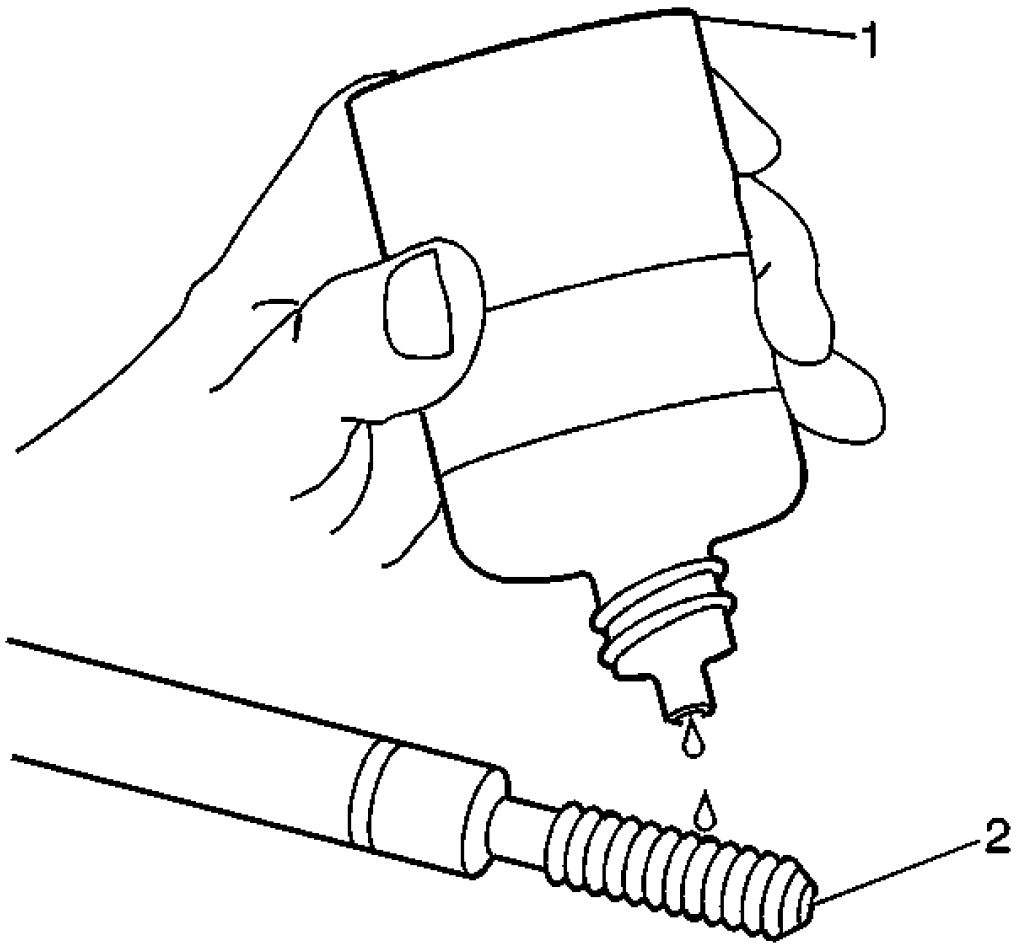


Fig. 295: Lubricating Installer Tool
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Do not remove the fixture plate, ensure the fixture plate is installed during the installation process of the insert.**
- **Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.**

13. Lubricate the threads of the driver installation tool (2) with the J 42385-110 (1).

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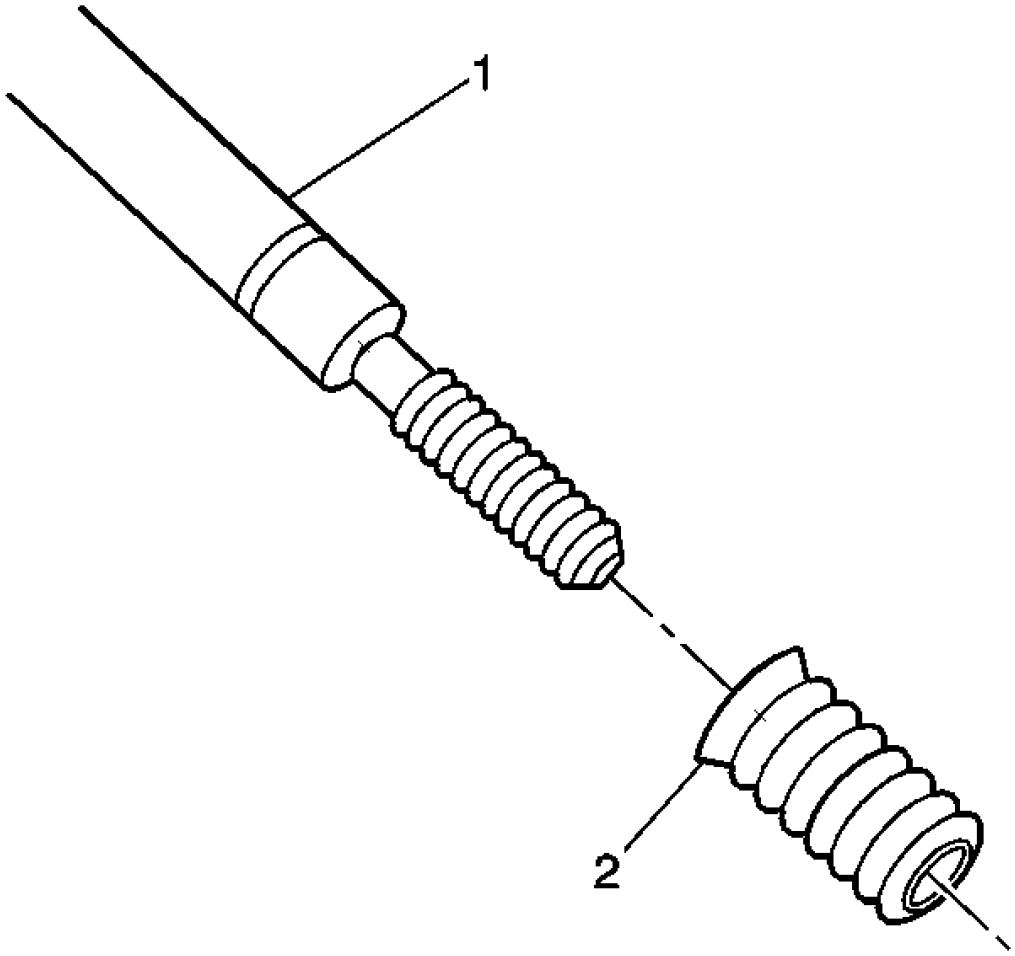


Fig. 296: View of Bushing Type Insert
Courtesy of GENERAL MOTORS CORP.

14. Install the insert (2) onto the driver installation tool (1).

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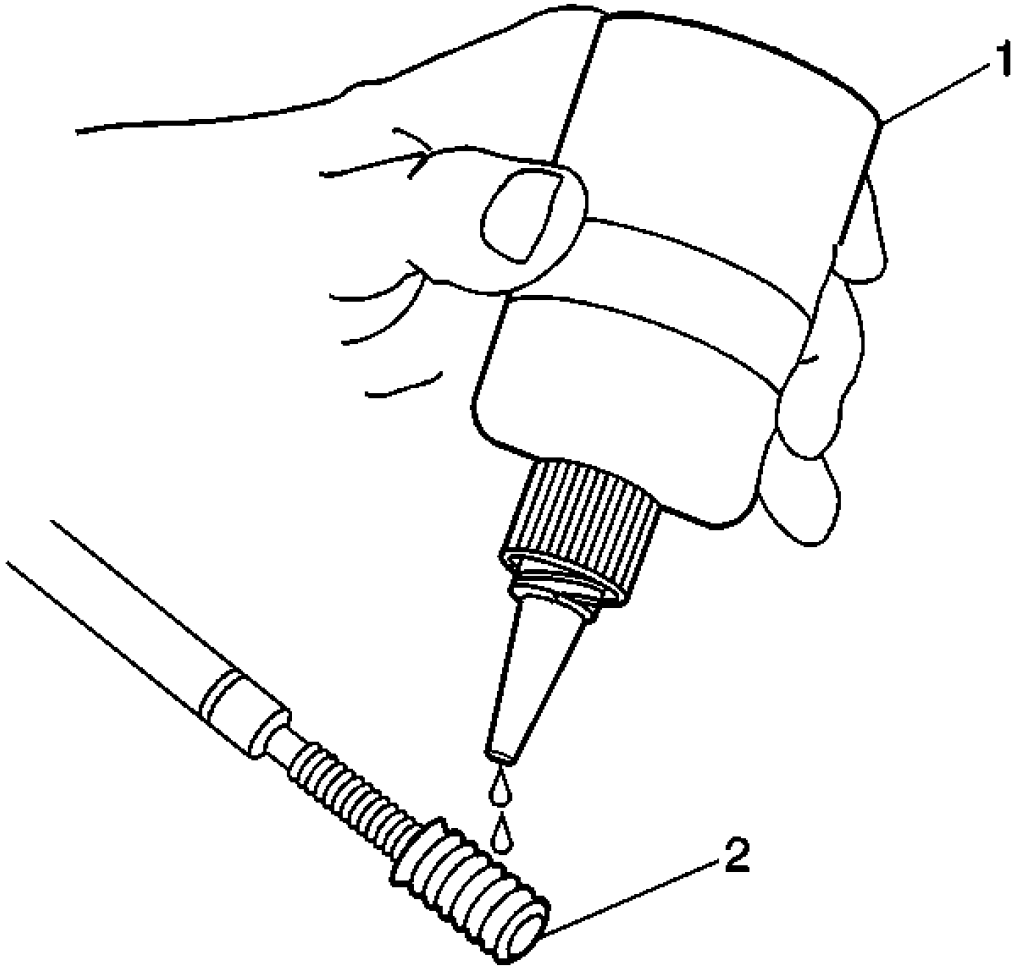


Fig. 297: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS CORP.

15. Apply threadlock sealant, J 42385-109, LOCTITE 277®, or equivalent (1) to the insert OD threads (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

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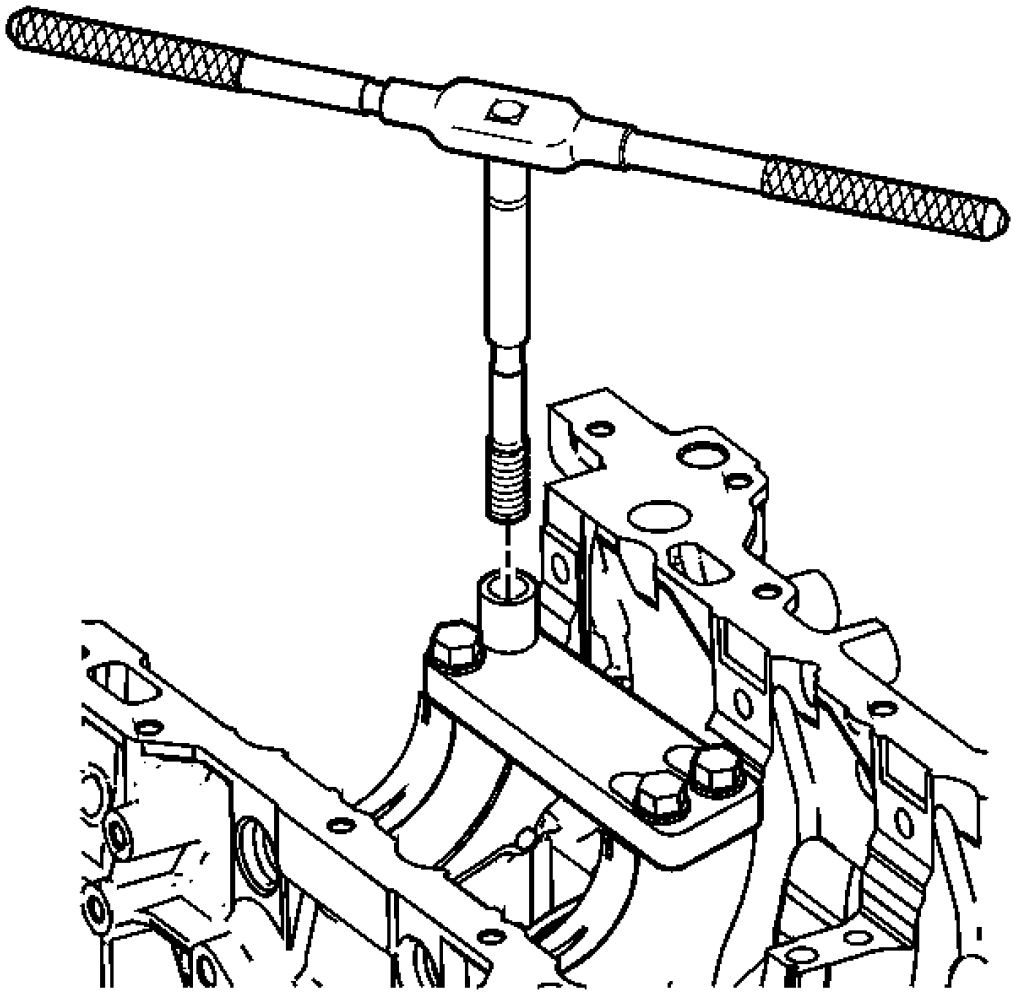


Fig. 298: Tapping New Threads
Courtesy of GENERAL MOTORS CORP.

16. Install the insert and installation driver into the tapped hole by hand only.
17. Start the insert into the threaded hole.

NOTE: If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.

18. Install the insert until the flange of the insert contacts the counterbored surface.

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NOTE: The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

19. Continue to rotate the driver installation tool through the insert.

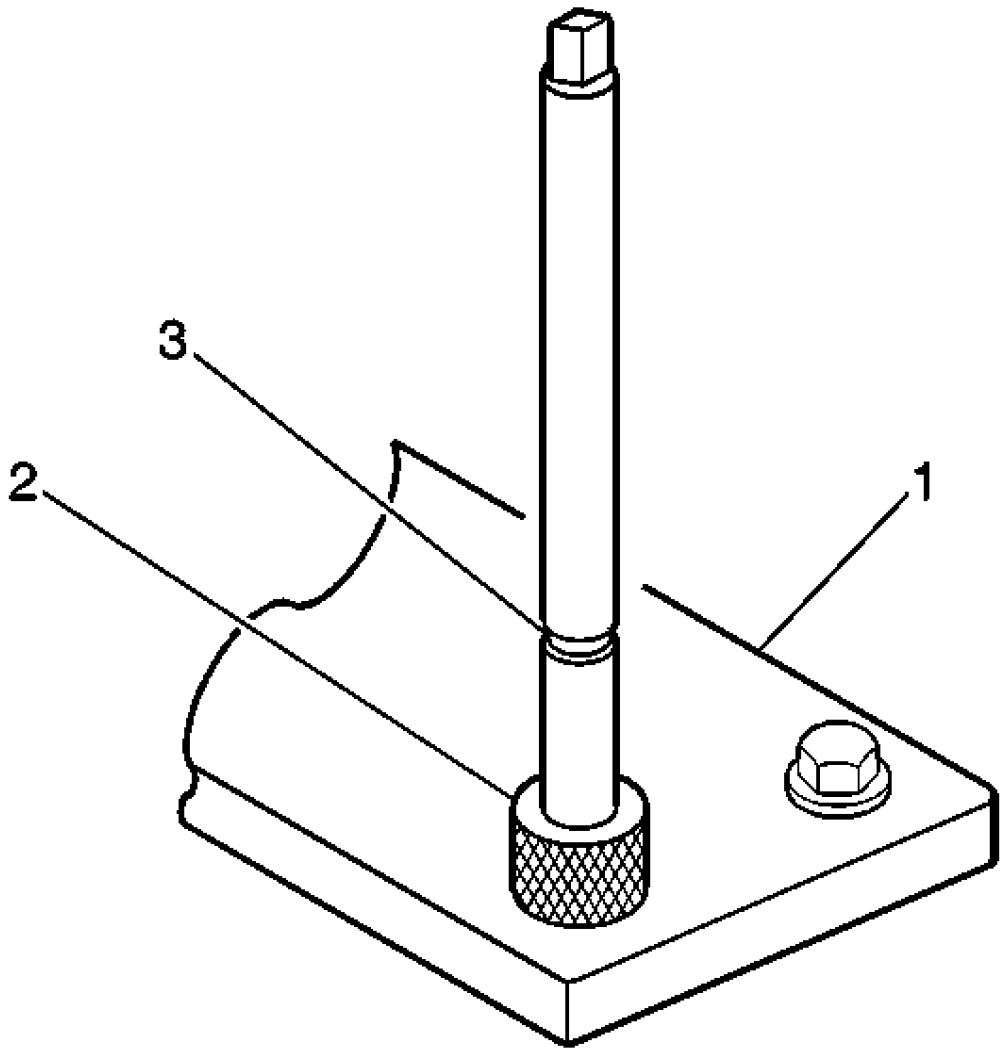


Fig. 299: View Of Driver, Bushing & Tool Marking
Courtesy of GENERAL MOTORS CORP.

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20. Rotate the driver installation tool until the mark (3) on the driver installation tool aligns with the top of the drill bushing (2).
21. Inspect the insert for proper installation into the tapped hole.

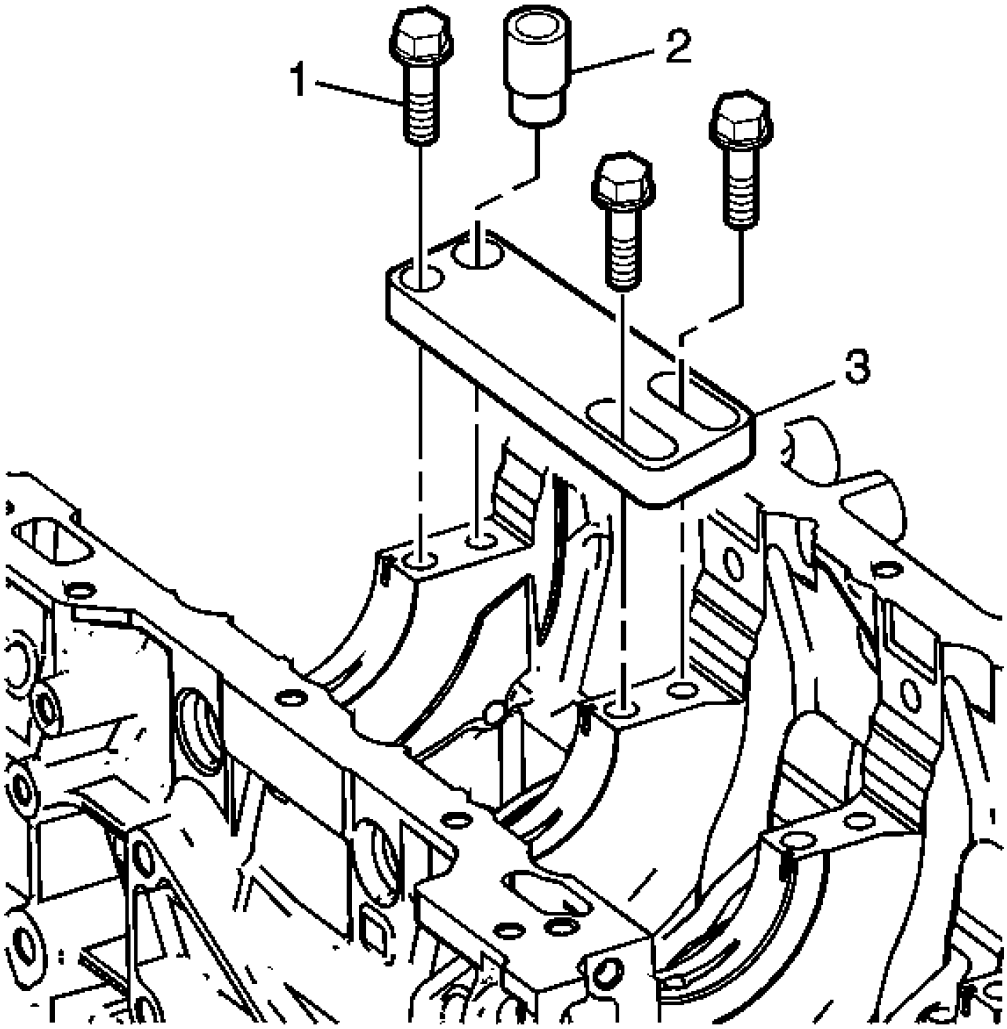


Fig. 300: Identifying Fixture Plate Over Crankshaft Main Cap Bolt Hole
Courtesy of GENERAL MOTORS CORP.

22. Remove the fixture plate bolts (1).
23. Remove the fixture plate (3) and bushing (2).

INBOARD BOLT HOLES

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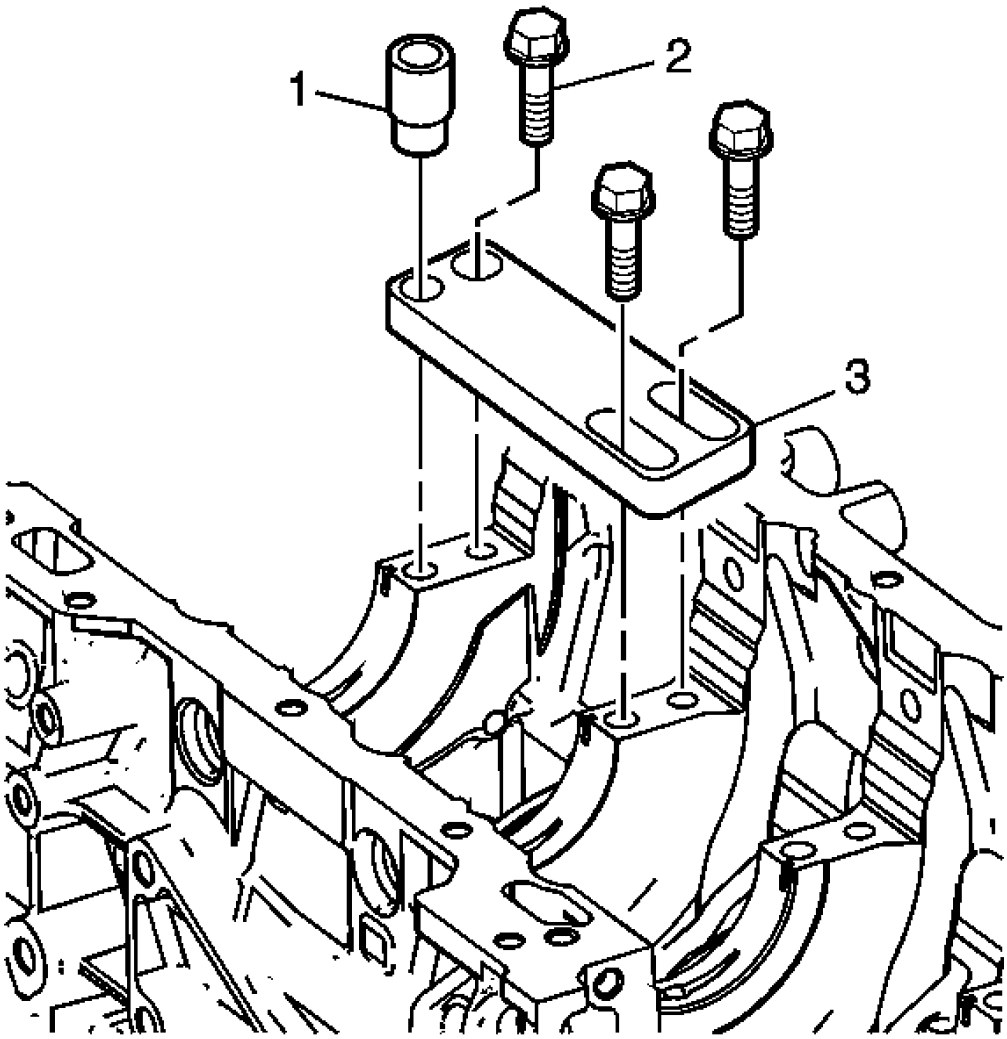


Fig. 301: View Of Fixture Plate
Courtesy of GENERAL MOTORS CORP.

WARNING: Refer to Safety Glasses Warning .

NOTE:

- **Ensure the fixture plate is installed during the machining and installation processes of the insert.**
- **The use of a cutting type fluid, WD 40® or equivalent is recommended when performing the drilling, counterboring and**

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tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers for recommended cutting fluid.

When installed to the proper depth, the flange of the insert will be seated against the counterbore of the drilled/tapped hole.

1. Position the fixture plate (3) with the bushing (1) installed over the crankshaft main cap bolt hole to be repaired.
2. Loosely install the fixture plate bolts (2) into the remaining crankshaft main cap bolt holes.

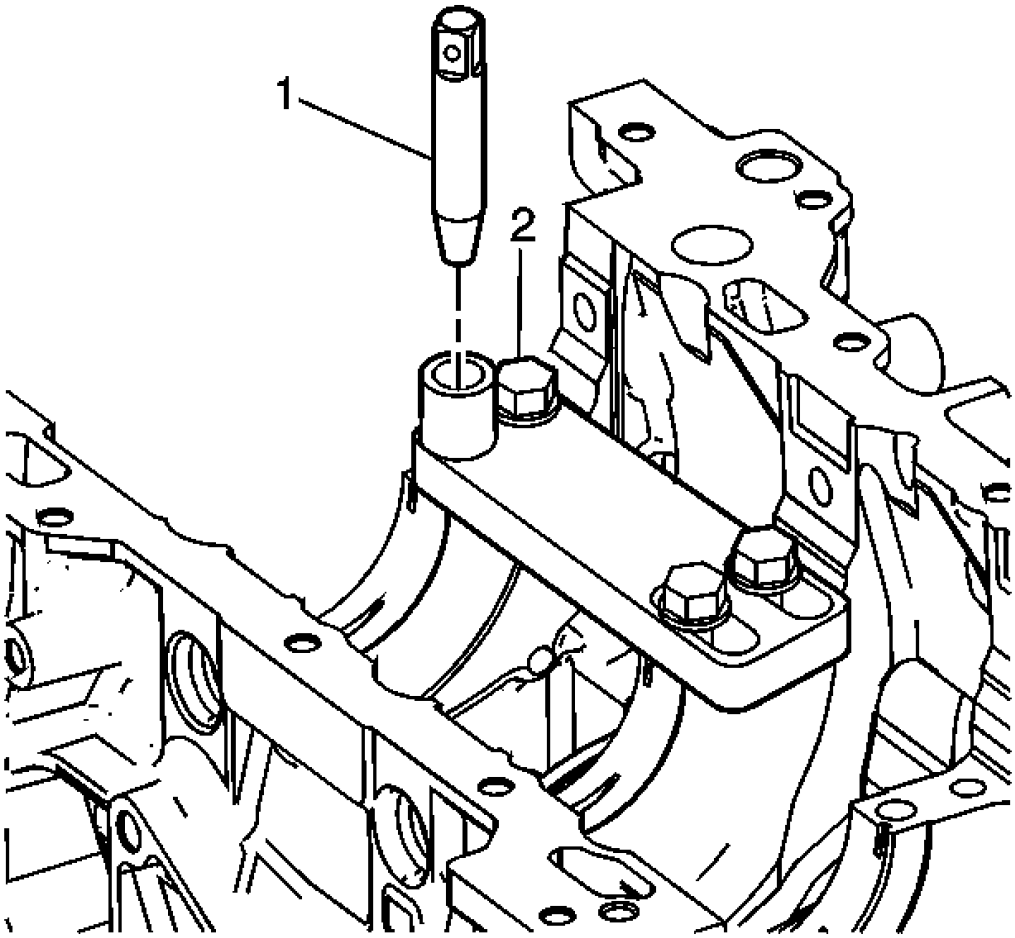


Fig. 302: Identifying Alignment Pin
Courtesy of GENERAL MOTORS CORP.

3. Position the alignment pin (1) through the bushing and into the crankshaft main cap bolt hole.

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4. With the alignment pin in the desired crankshaft main cap bolt hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin (1) from the crankshaft main cap bolt hole.

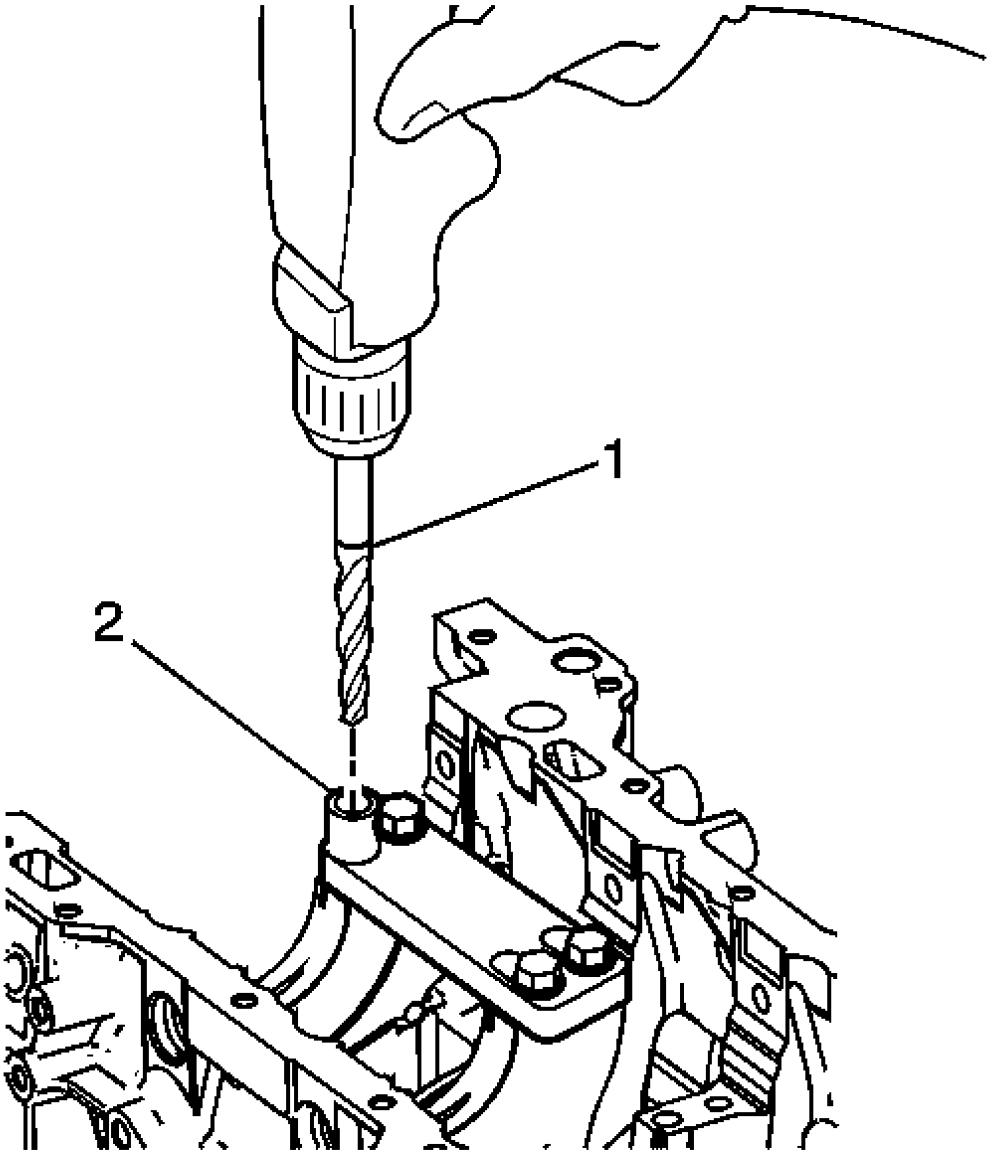


Fig. 303: Drilling Out Damaged Threads
Courtesy of GENERAL MOTORS CORP.

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NOTE:

- **During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.**
- **Drill the crankshaft main bolt hole until the mark (1) on the drill aligns with the top of the drill bushing (2).**

6. Drill out the threads of the damaged hole.

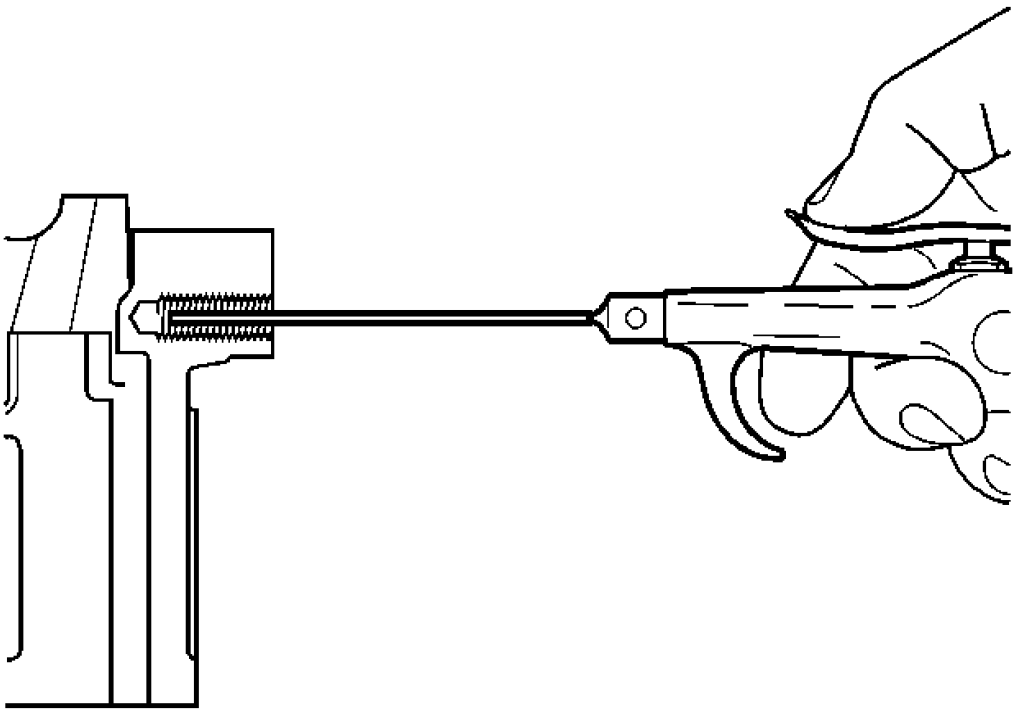


Fig. 304: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the drilled hole prior to tapping.

7. Using compressed air, clean out any chips.

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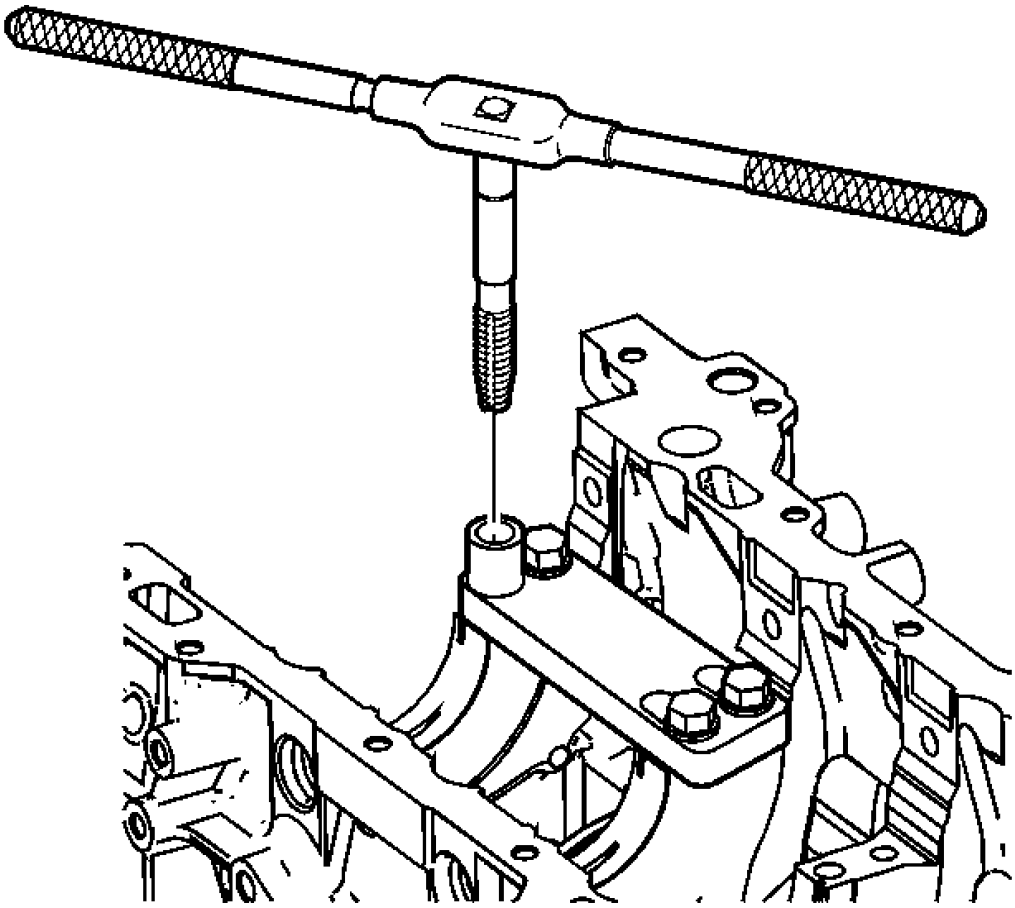


Fig. 305: Positioning Tapping Wrench
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Do not remove the fixture plate, ensure the fixture plate is installed during the machining and installation processes of the insert.**
- **During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.**
- **Ensure the tap has created full threads at least to the depth equal to the insert length.**

8. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.

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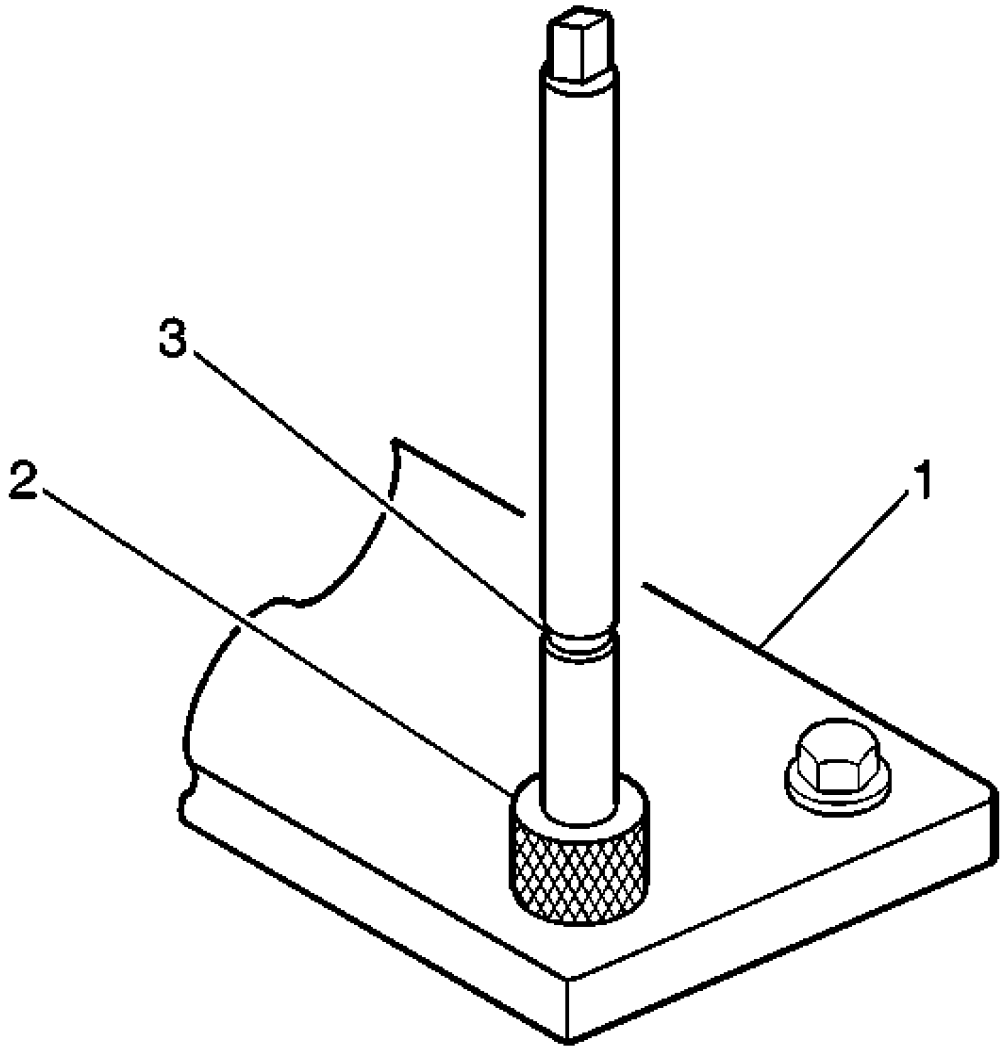


Fig. 306: View Of Driver, Bushing & Tool Marking
Courtesy of GENERAL MOTORS CORP.

9. In order to tap the new threads for the insert to the proper depth, rotate the tap into the crankshaft main cap bolt hole until the mark (3) on the tap aligns with the top of the drill bushing (2).

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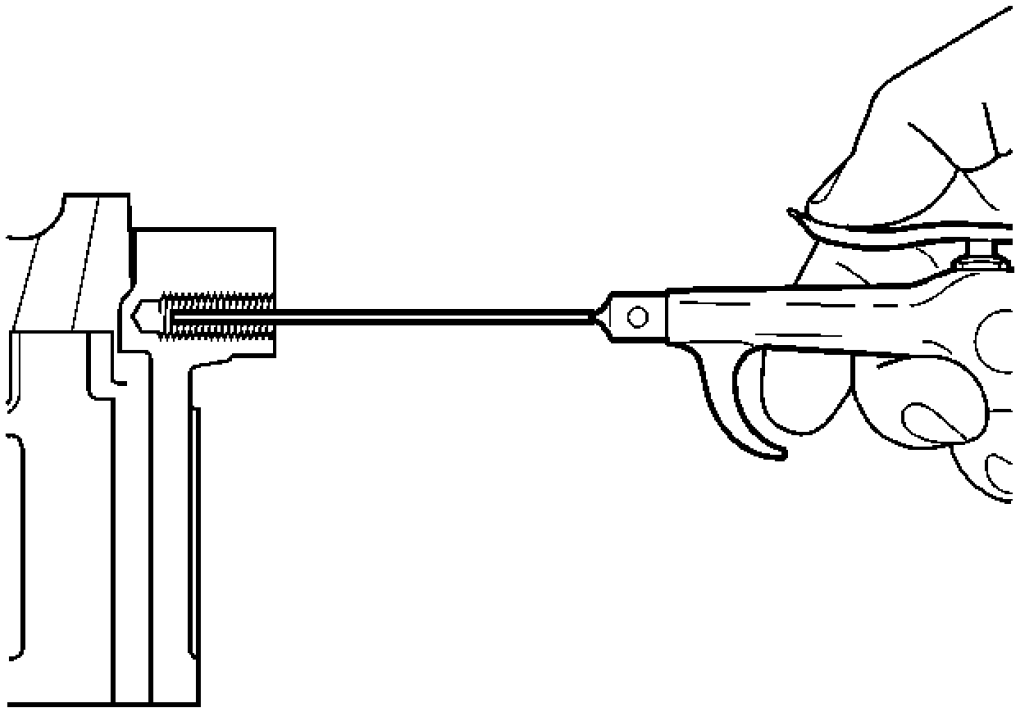


Fig. 307: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the tapped hole prior to insert installation.

10. Using compressed air, clean out any chips.

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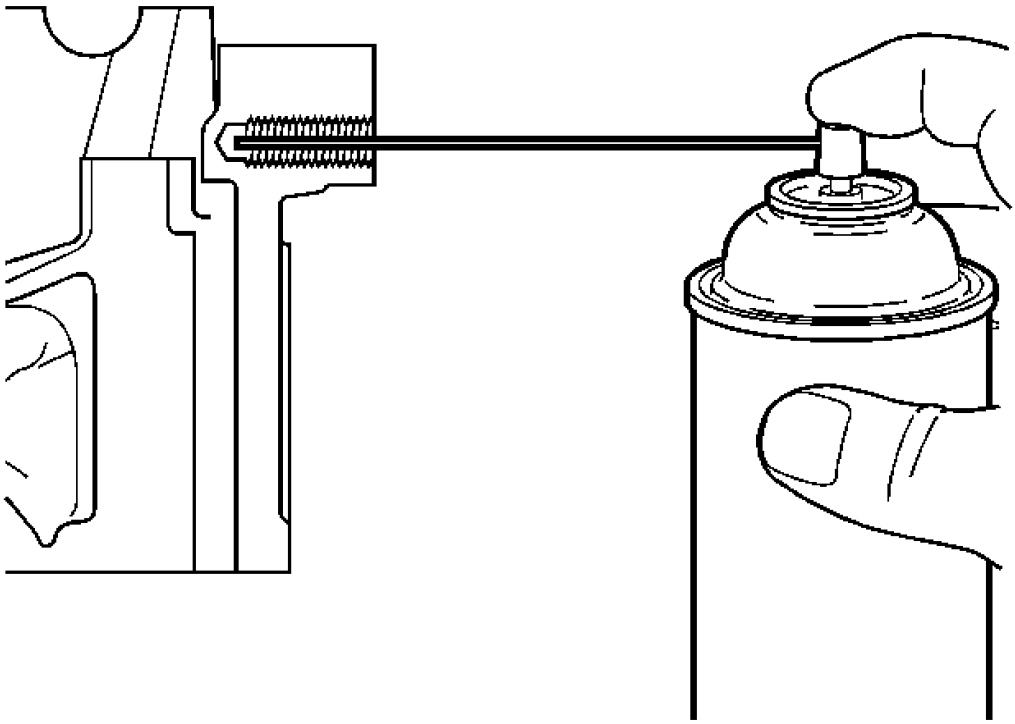


Fig. 308: Spraying Cleaner Into Tapped Hole
Courtesy of GENERAL MOTORS CORP.

11. Spray cleaner into the tapped hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended cleaner.

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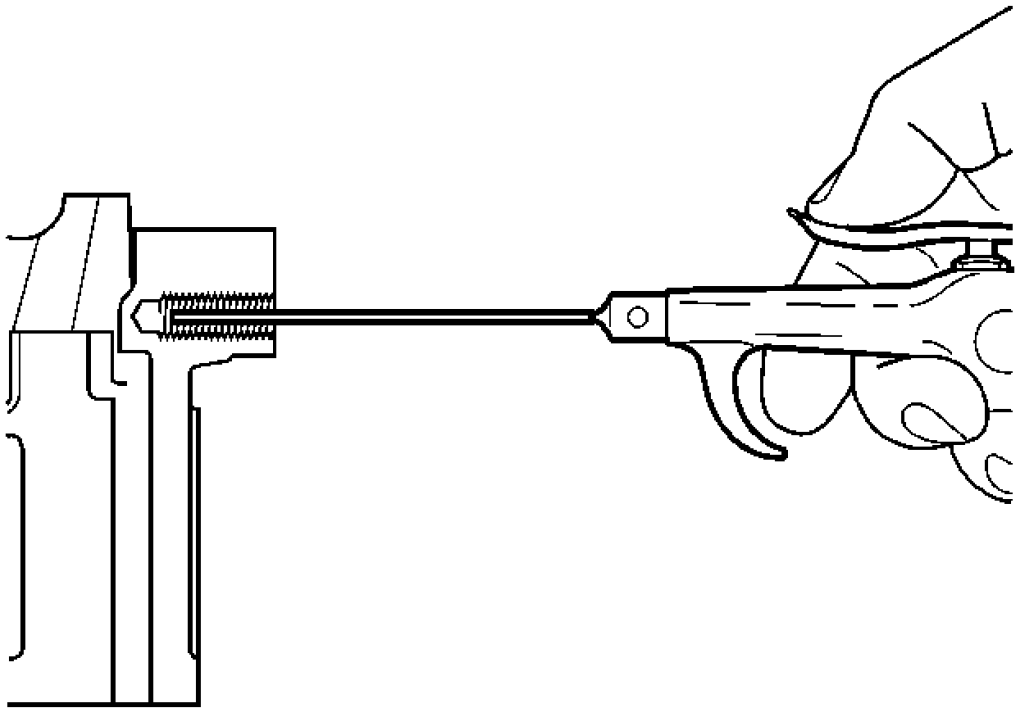


Fig. 309: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS CORP.

NOTE: All chips must be removed from the tapped hole prior to insert installation.

12. Using compressed air, clean out any chips.

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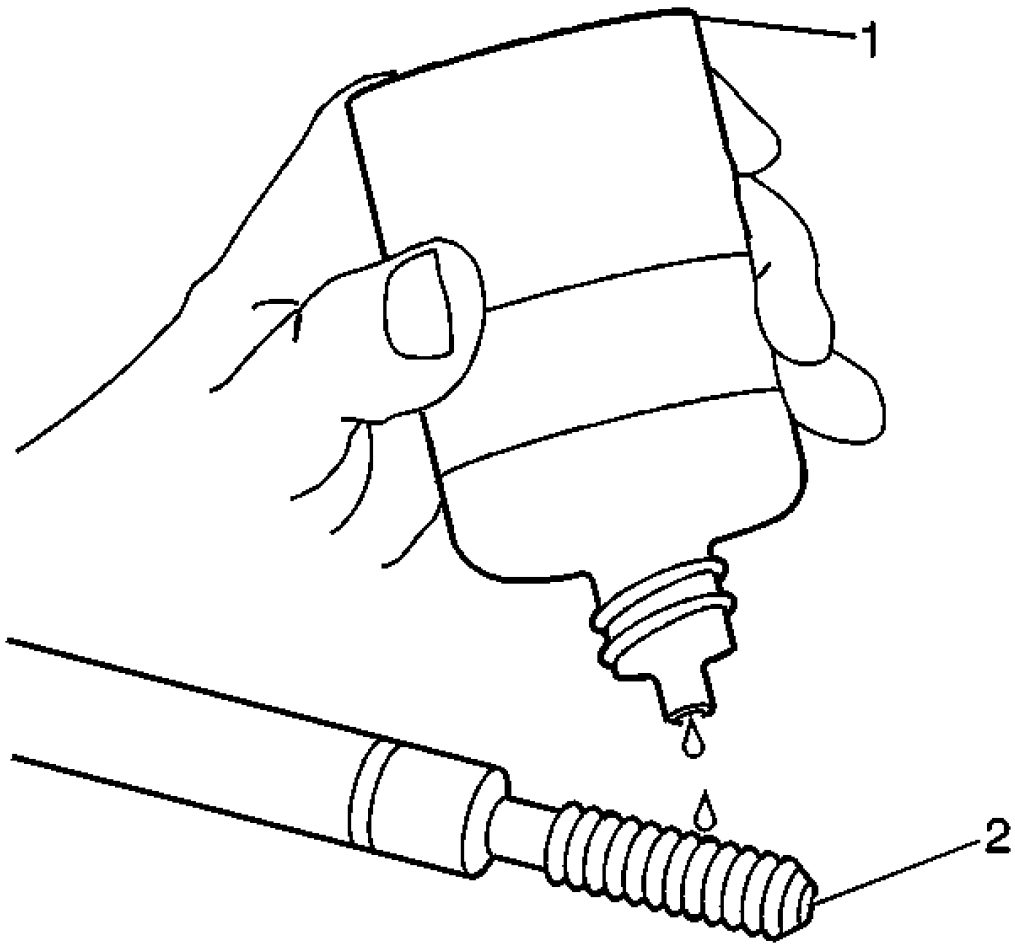


Fig. 310: Lubricating Installer Tool
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Do not remove the fixture plate, ensure the fixture plate is installed during the installation process of the insert.**
- **Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.**

13. Lubricate the threads of the driver installation tool (2) with the J 42385-110 (1).

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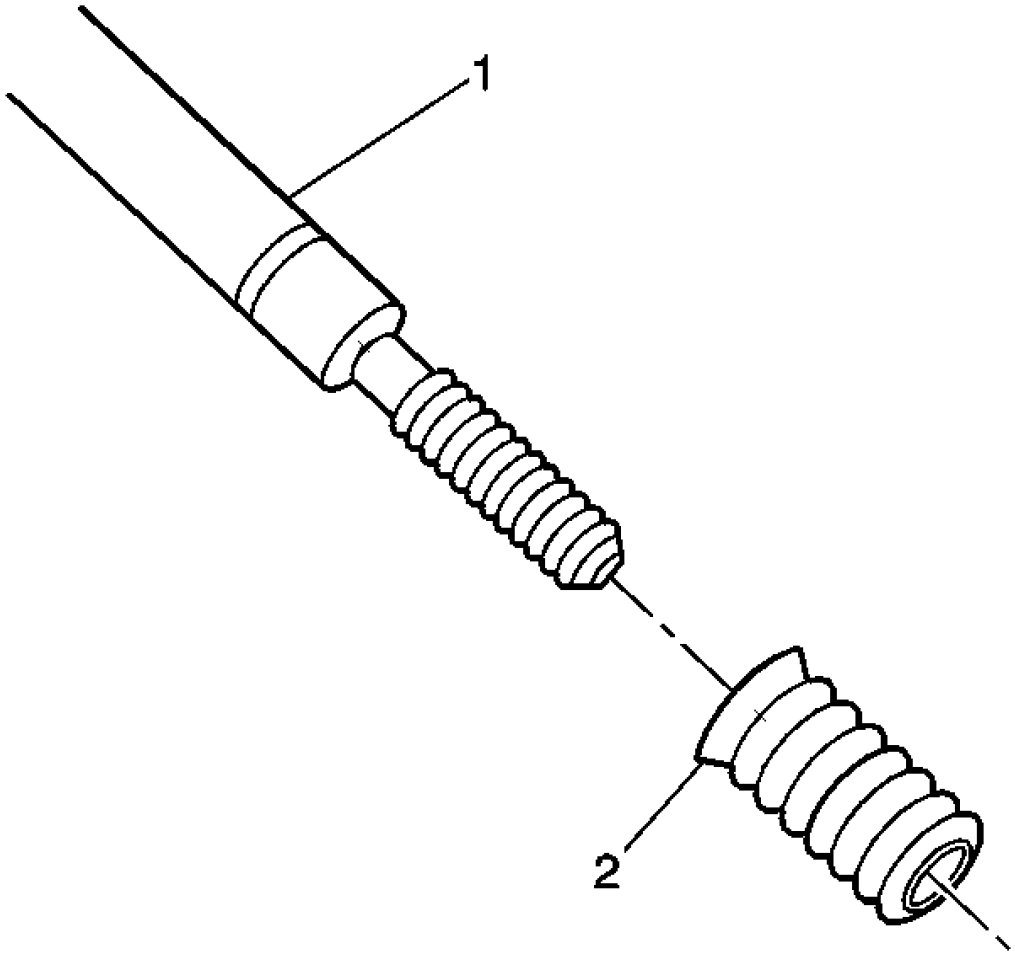


Fig. 311: View of Bushing Type Insert
Courtesy of GENERAL MOTORS CORP.

14. Install the insert (2) onto the driver installation tool (1).

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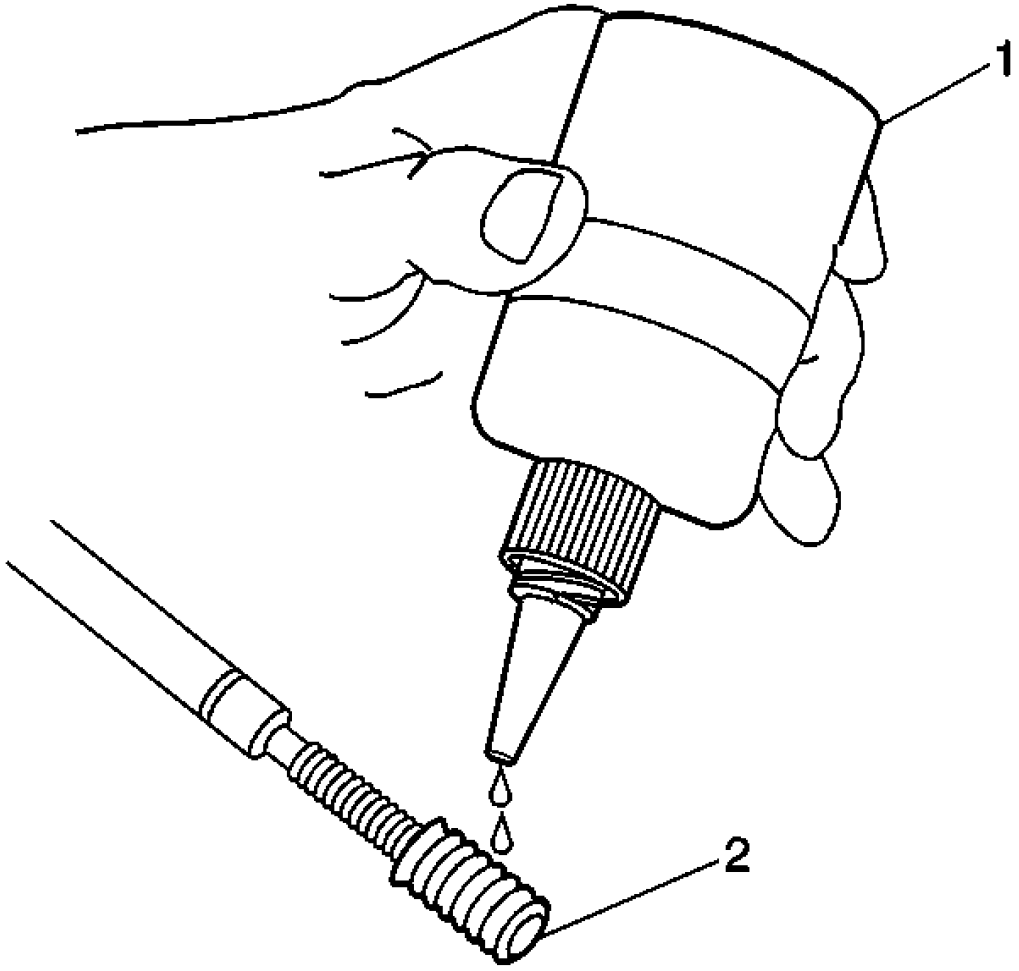


Fig. 312: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS CORP.

15. Apply threadlock sealant, J 42385-109, LOCTITE 277®, or equivalent (1) to the insert OD threads (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

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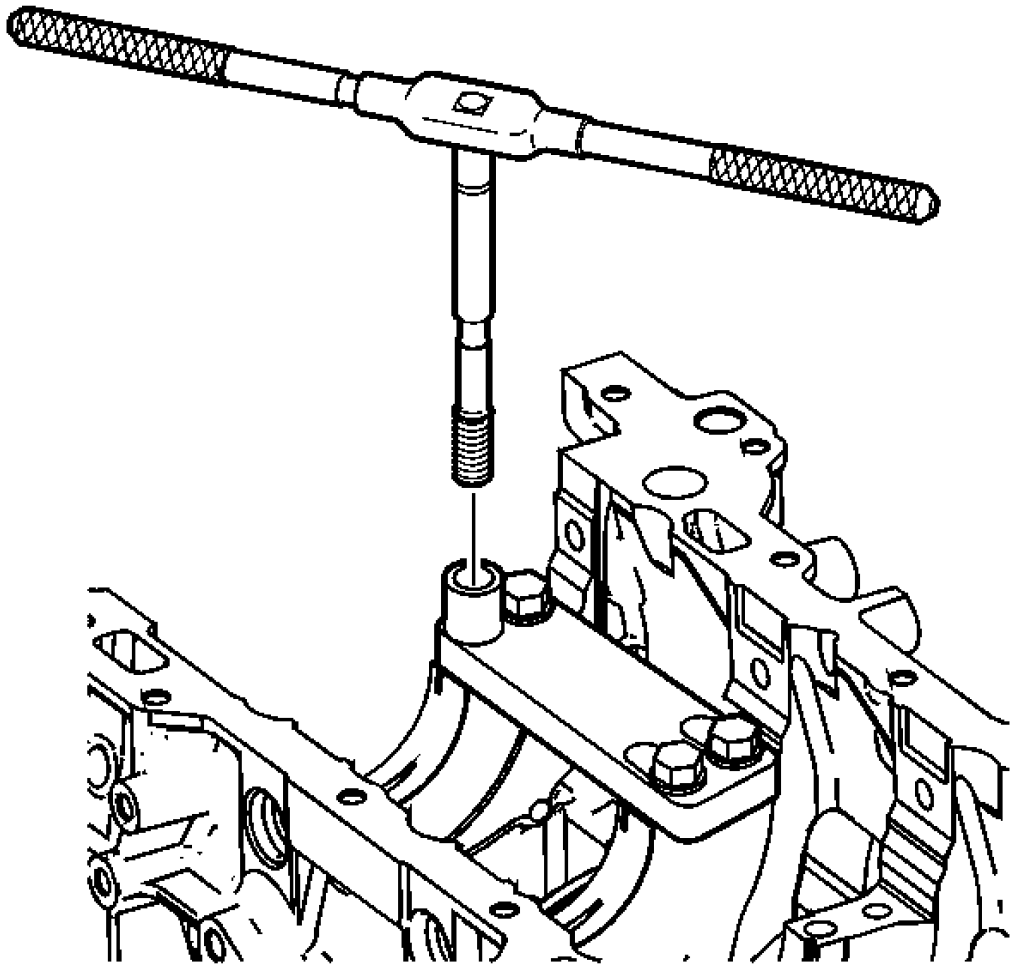


Fig. 313: Insert & Installation Driver
Courtesy of GENERAL MOTORS CORP.

16. Install the insert and installation driver into the tapped hole by hand only.
17. Start the insert into the threaded hole.

NOTE: If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.

18. Install the insert until the flange of the insert contacts the counterbored surface.

NOTE: The driver installation tool will tighten up before screwing completely

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through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.

19. Continue to rotate the driver installation tool through the insert.

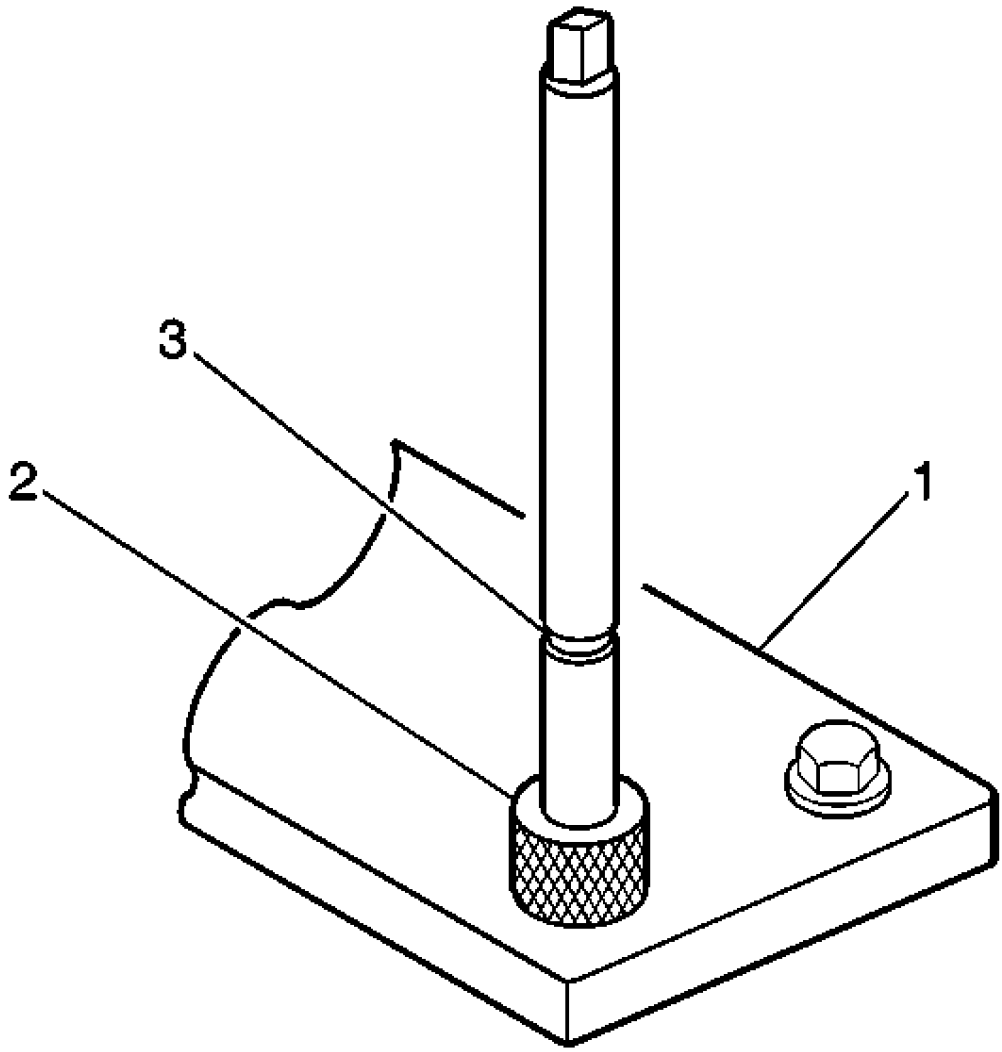


Fig. 314: View Of Driver, Bushing & Tool Marking
Courtesy of GENERAL MOTORS CORP.

20. Rotate the driver installation tool until the mark (3) on the driver installation tool aligns with the top of

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the drill bushing (2).

21. Inspect the insert for proper installation into the tapped hole.

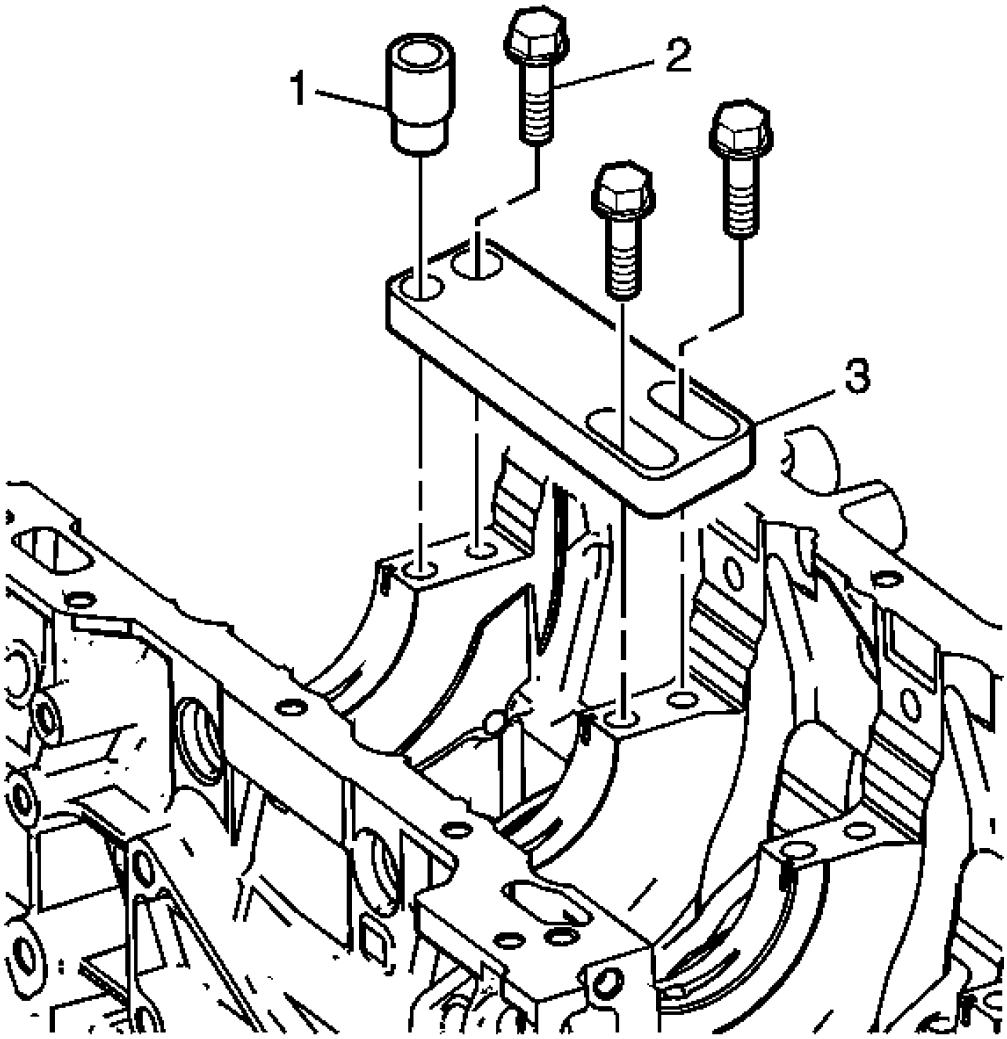


Fig. 315: View Of Fixture Plate
Courtesy of GENERAL MOTORS CORP.

22. Remove the fixture plate bolts (2).
23. Remove the fixture plate (3) and bushing (1).

SERVICE PRIOR TO ASSEMBLY

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- Dirt will cause premature wear of the rebuilt engine. Clean all the components.
- Use the proper tools to measure the components when checking for excessive wear. Components not within the manufacturer's specification must be repaired or replaced.
- When the components are reinstalled into an engine, return the components to their original location, position, and direction.
- During assembly, lubricate all the moving parts with clean engine oil (unless otherwise specified). This will provide initial lubrication when the engine is first started.

ENGINE BLOCK ASSEMBLE

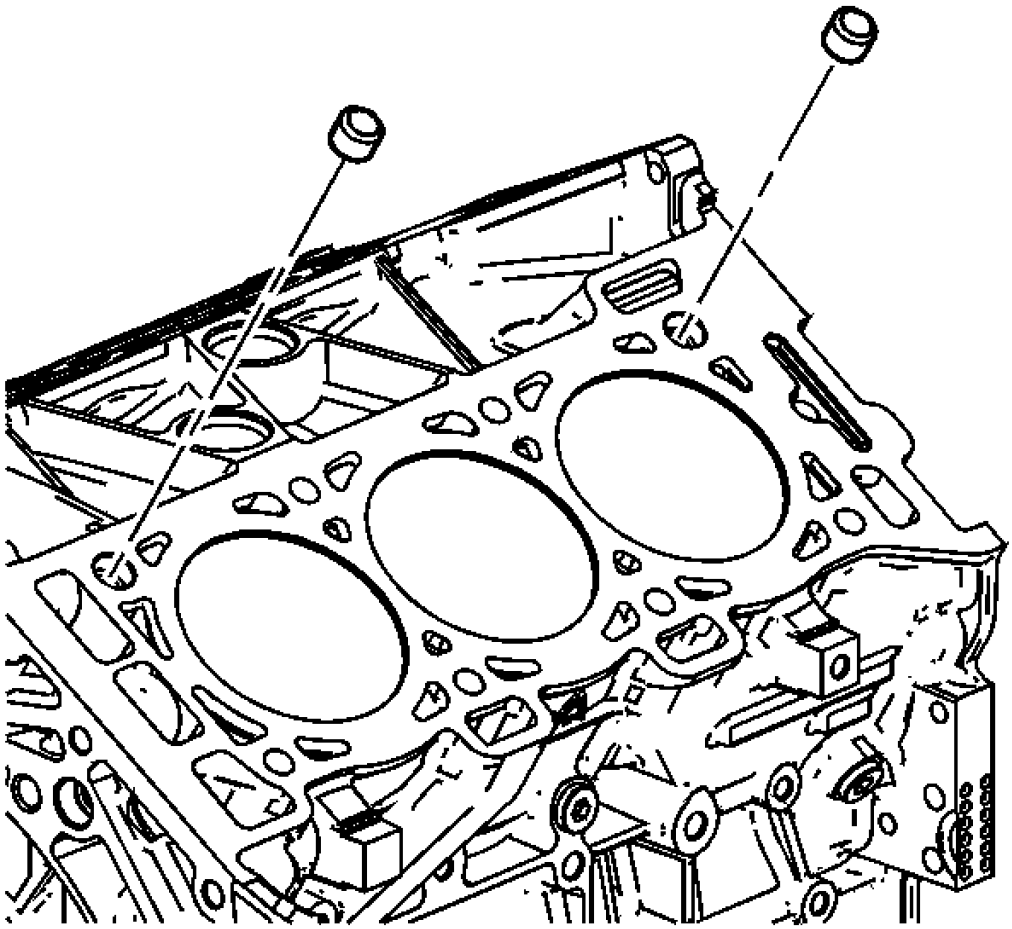


Fig. 316: Cylinder Block-To-Cylinder Head Alignment Dowels
Courtesy of GENERAL MOTORS CORP.

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1. Install the cylinder block-to-cylinder head alignment dowels.

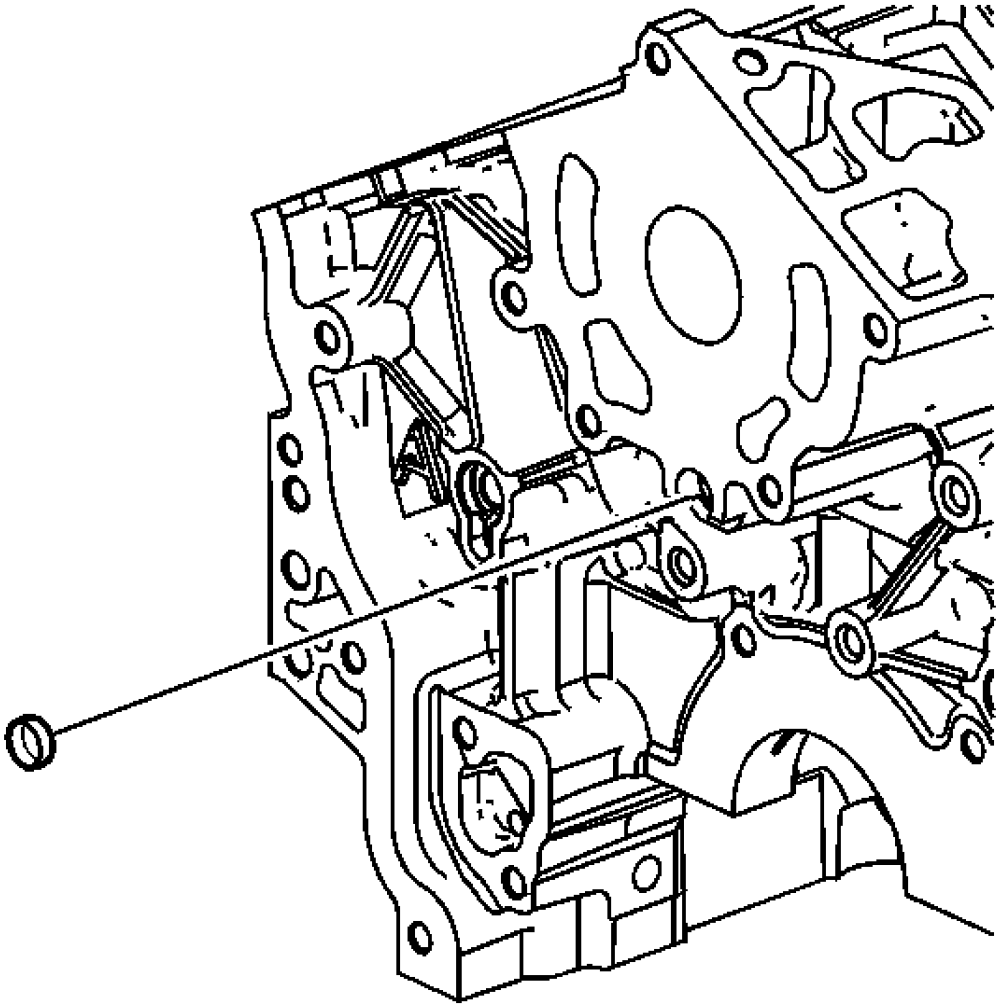


Fig. 317: Locating Front Oil Gallery Expansion Plug
Courtesy of GENERAL MOTORS CORP.

2. Install the NEW front oil gallery expansion plug.
3. Ensure the NEW front oil gallery expansion plug is installed to the proper depth.

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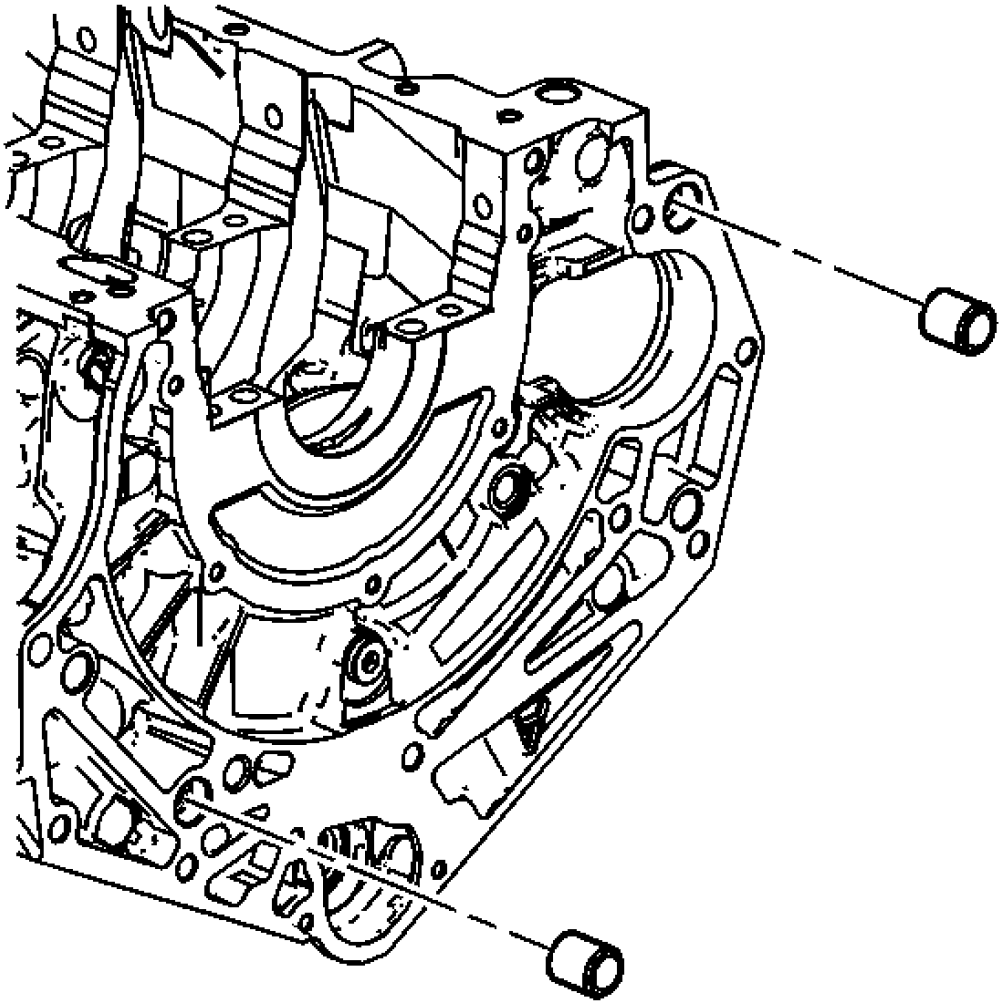


Fig. 318: Cylinder Block-To-Transmission Alignment Dowels
Courtesy of GENERAL MOTORS CORP.

4. Install the cylinder block-to-transmission alignment dowels.

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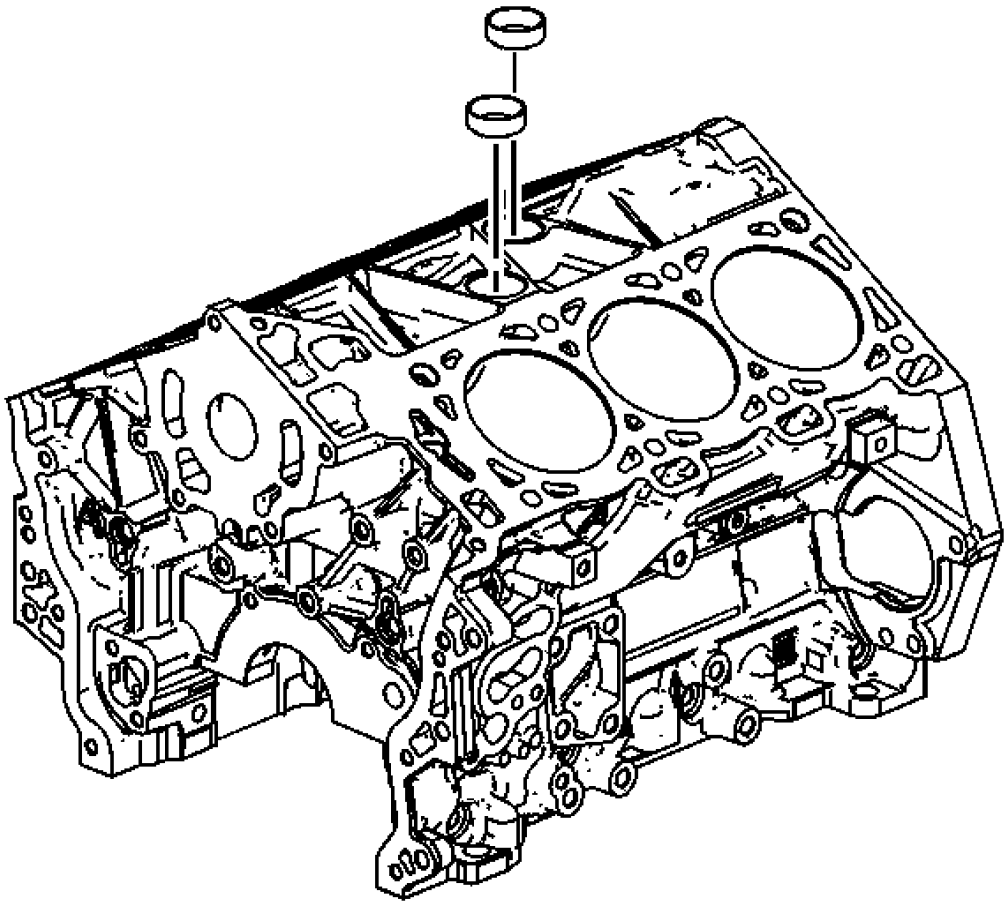


Fig. 319: Coolant Expansion Plugs
Courtesy of GENERAL MOTORS CORP.

5. Apply the RTV sealant, GM P/N 12378521 (Canadian P/N 88901148) or equivalent on the NEW coolant expansion plugs.
6. Install the NEW coolant expansion plugs.
7. Ensure the NEW coolant expansion plugs are installed to the proper depth.

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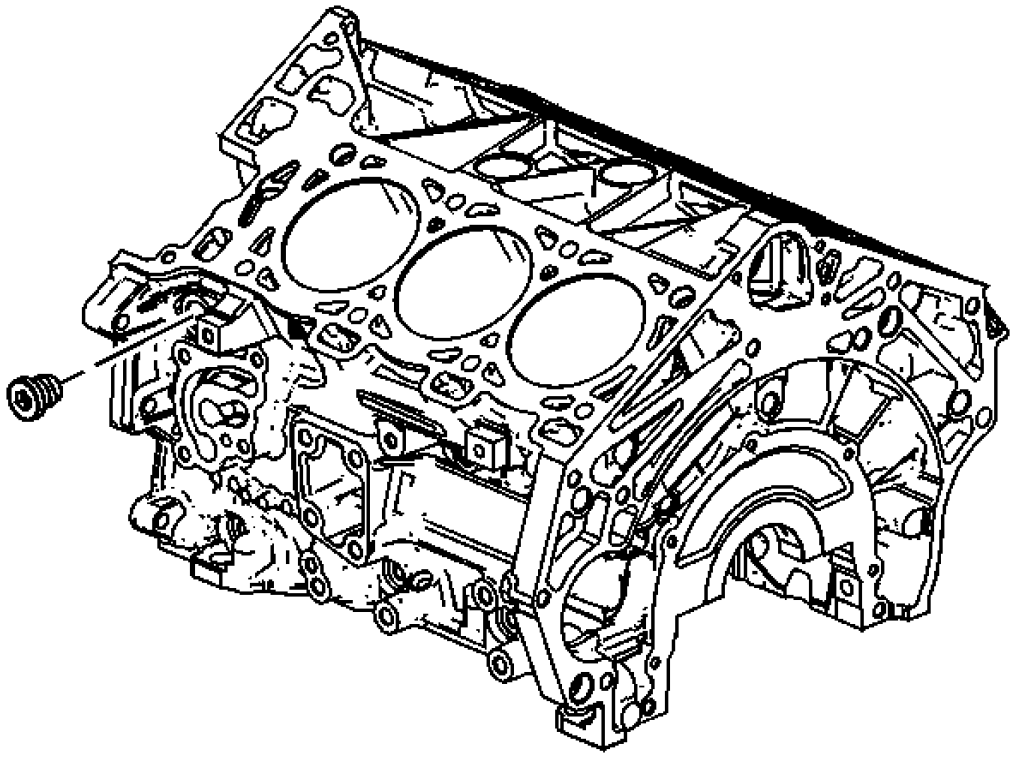


Fig. 320: M20 Left Side Oil Gallery Threaded Plug
Courtesy of GENERAL MOTORS CORP.

8. Apply thread sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent on the threads of the M20 left side oil gallery threaded plug.

CAUTION: Refer to Fastener Caution .

9. Install the M20 left side oil gallery threaded plug and tighten to 31 N.m (23 lb ft).

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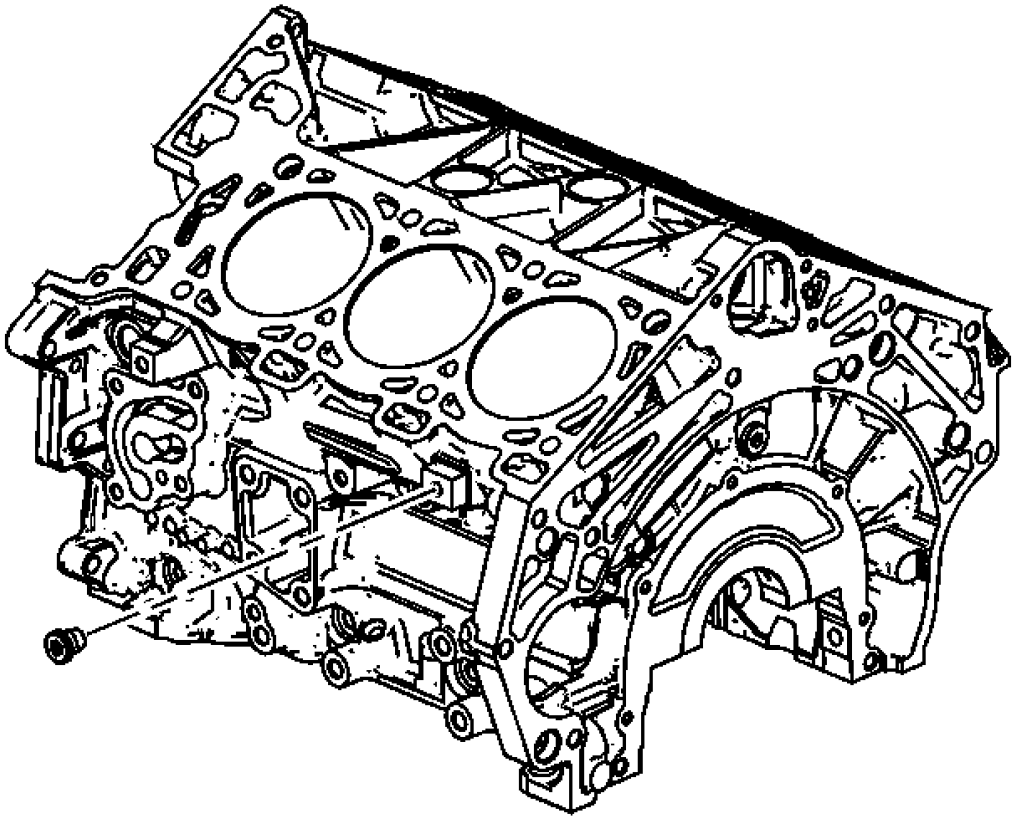


Fig. 321: M14 Left Side Coolant Drain Threaded Plug
Courtesy of GENERAL MOTORS CORP.

10. Apply thread sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent on the threads of the M14 left side coolant drain threaded plug.
11. Install the M14 left side coolant drain threaded plug and tighten to 31 N.m (23 lb ft).

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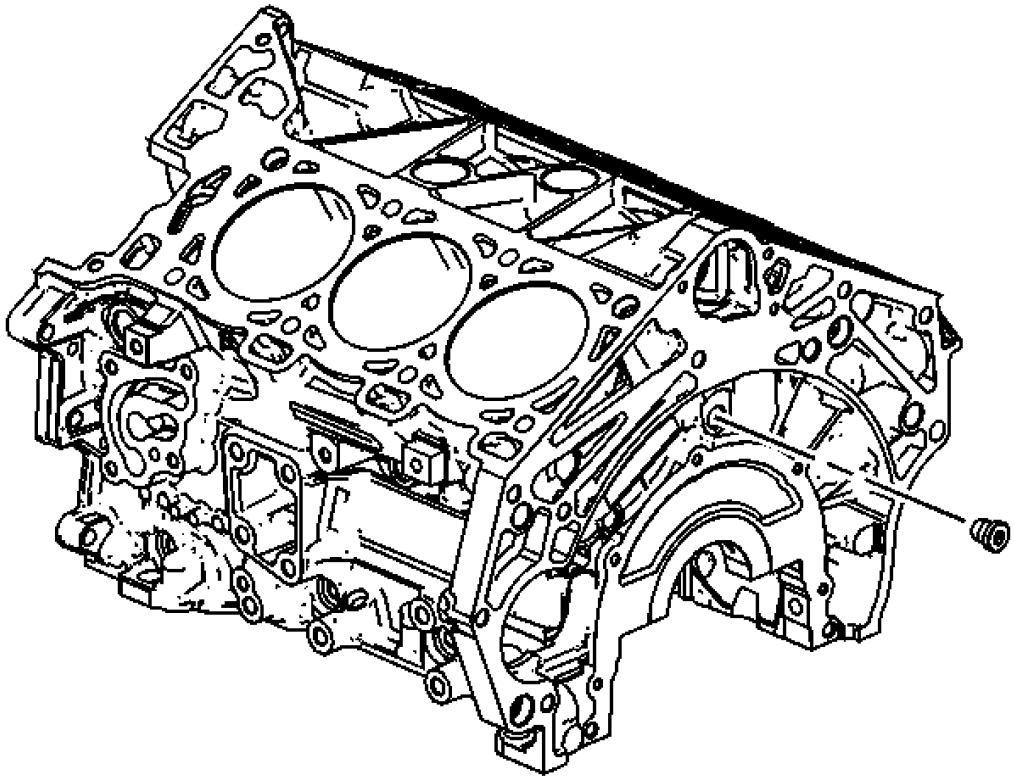


Fig. 322: M14 Rear Oil Gallery Threaded Plug
Courtesy of GENERAL MOTORS CORP.

12. Apply thread sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent on the threads of the M14 rear oil gallery threaded plug.
13. Install the M14 rear oil gallery threaded plug and tighten to 31 N.m (23 lb ft).

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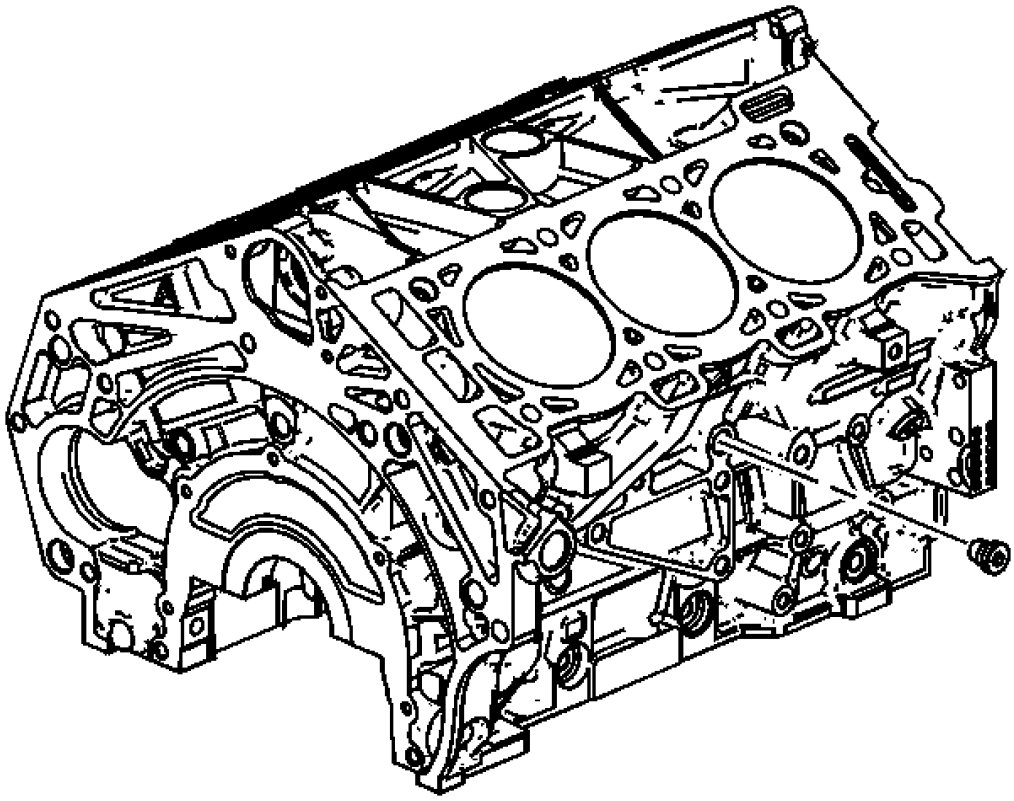


Fig. 323: M14 Right Side Coolant Drain Threaded Plug
Courtesy of GENERAL MOTORS CORP.

14. Apply thread sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent on the threads of the M14 right side coolant drain threaded plug.
15. Install the M14 right side coolant drain threaded plug and tighten to 31 N.m (23 lb ft).

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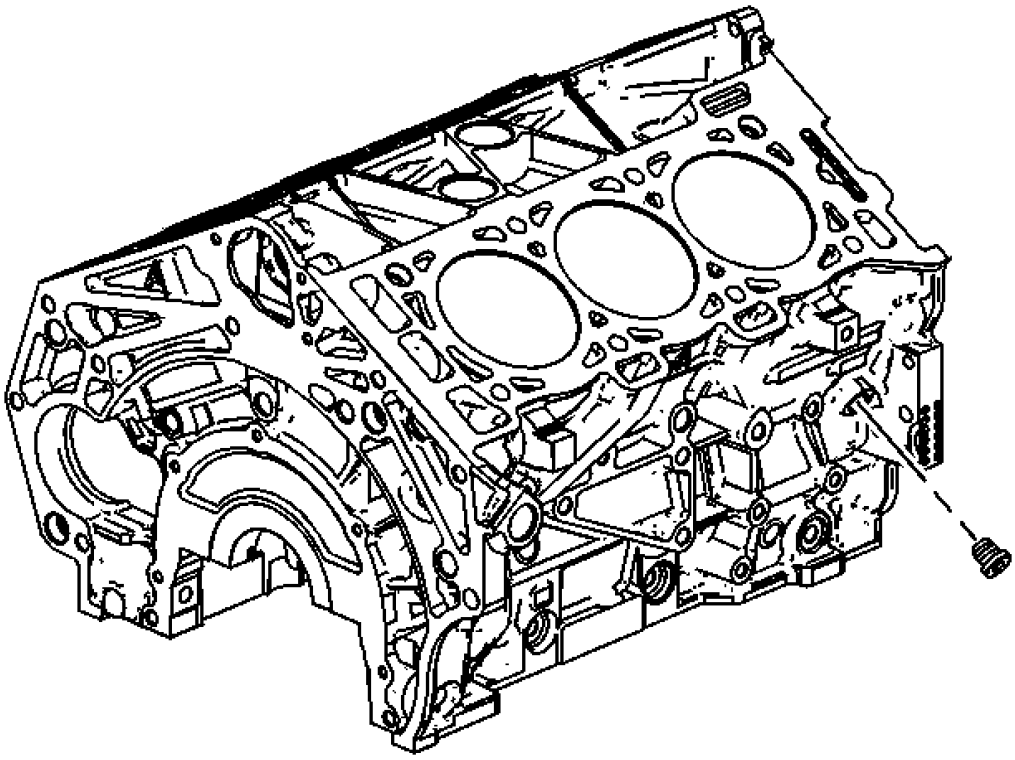


Fig. 324: M14 Right Side Oil Gallery Threaded Plug
Courtesy of GENERAL MOTORS CORP.

16. Apply thread sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent on the threads of the M14 right side oil gallery threaded plug.
17. Install the M14 right side oil gallery threaded plug and tighten to 31 N.m (23 lb ft).

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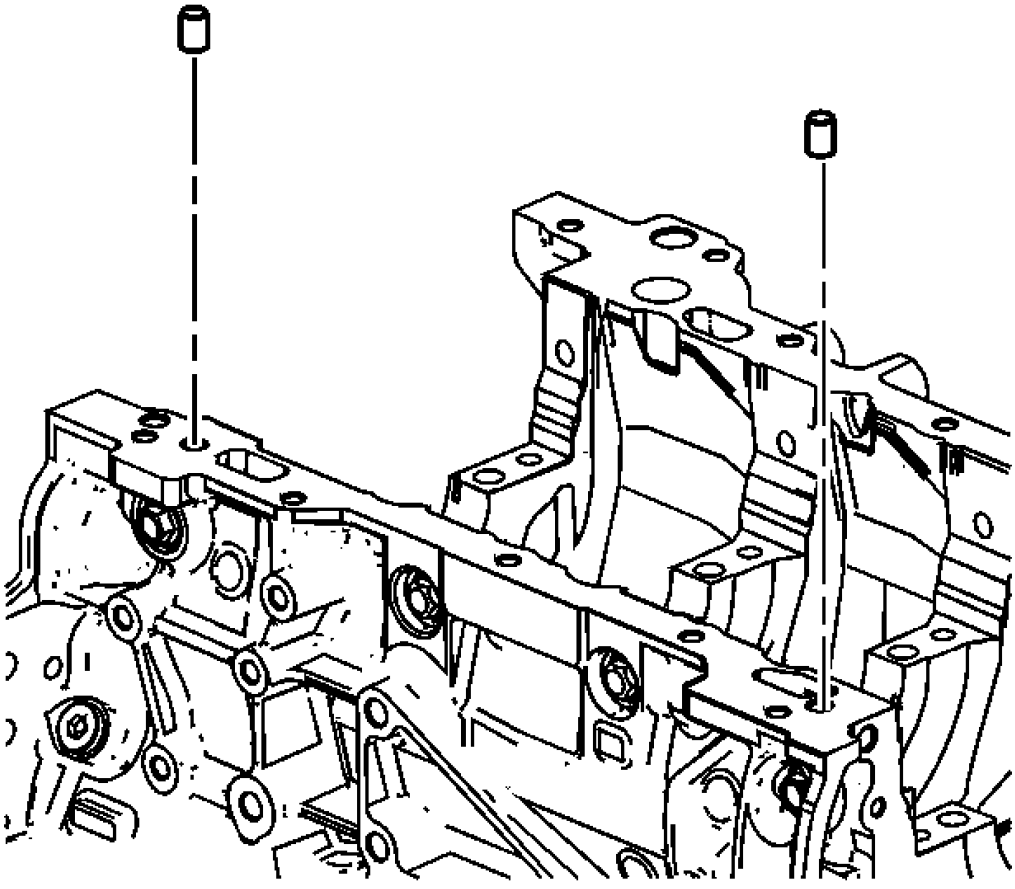


Fig. 325: Cylinder Block-To-Oil Pan Alignment Dowels
Courtesy of GENERAL MOTORS CORP.

18. Install the cylinder block-to-oil pan alignment dowels.

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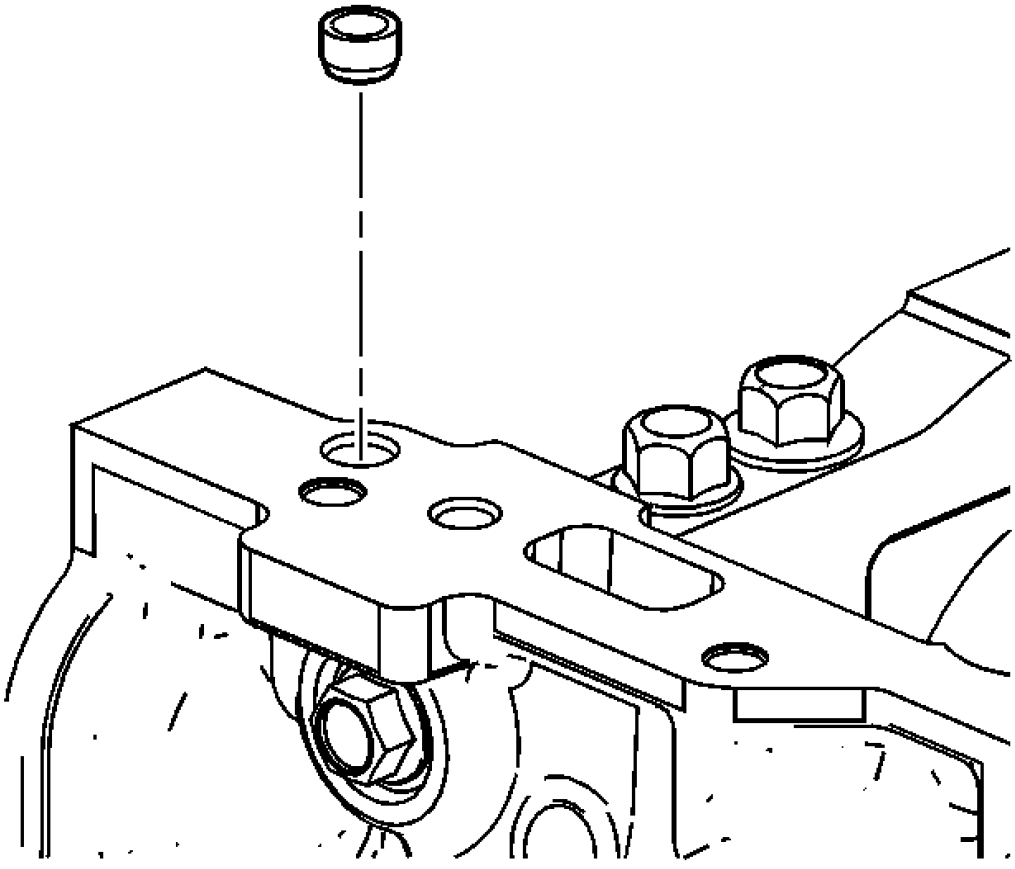


Fig. 326: Right Front Oil Pan Rail Oil Gallery Expansion Plug
Courtesy of GENERAL MOTORS CORP.

19. Install the NEW right front oil pan rail oil gallery expansion plug.
20. Ensure the NEW right front oil pan rail oil gallery expansion plug is installed to the proper depth.

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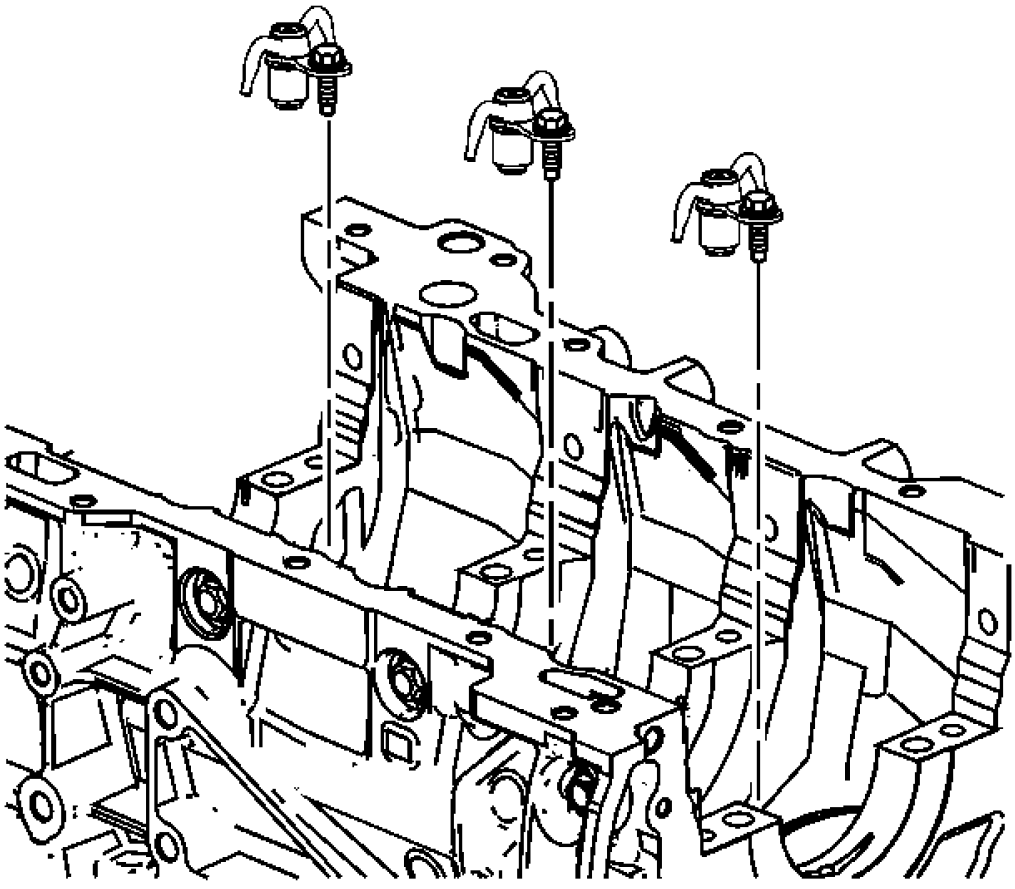


Fig. 327: Oil Jets & Bolts
Courtesy of GENERAL MOTORS CORP.

21. Install the oil jets.
22. Install the oil jet bolts and tighten to 10 N.m (89 lb in).

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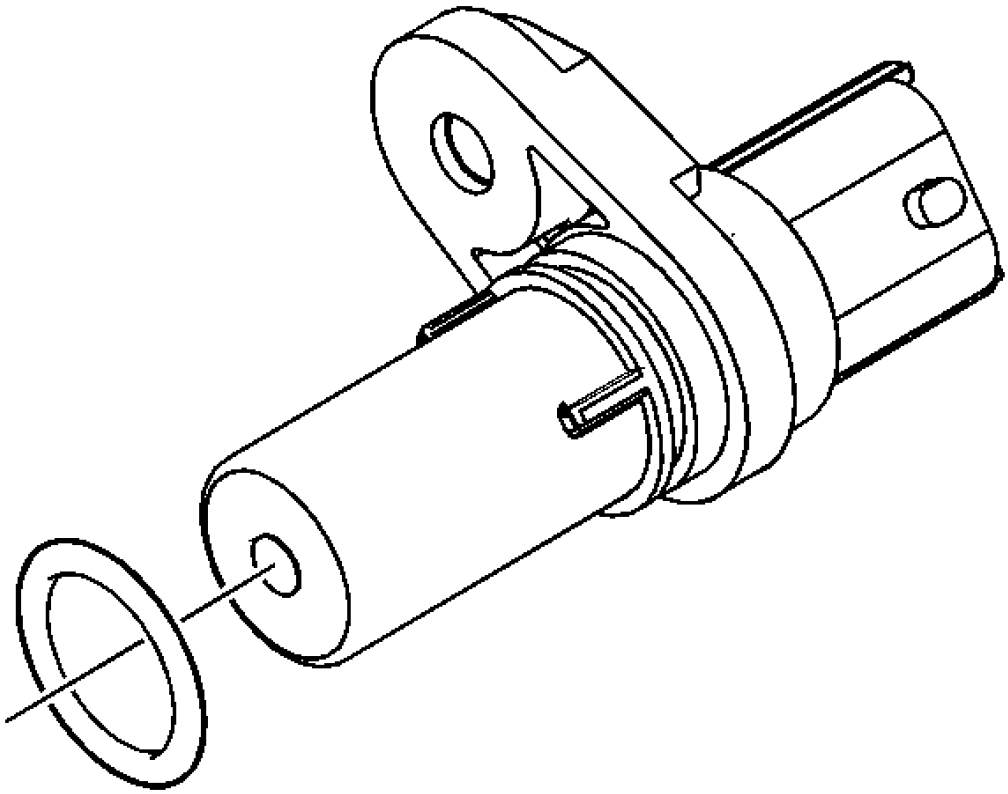


Fig. 328: View Of Crankshaft Position Sensor O-Ring
Courtesy of GENERAL MOTORS CORP.

23. Install the NEW crankshaft position sensor O-ring, if damaged.

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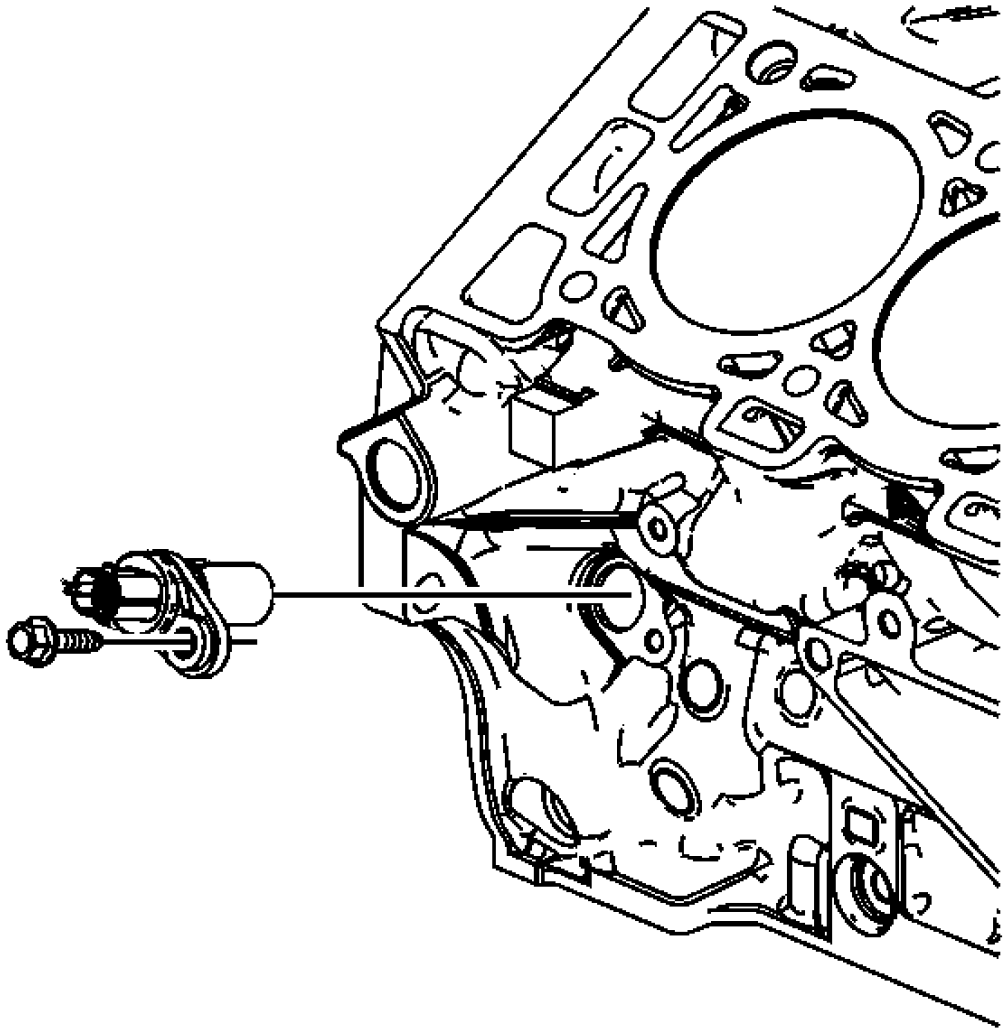


Fig. 329: View Of Crankshaft Position Sensor
Courtesy of GENERAL MOTORS CORP.

24. Install the crankshaft position sensor.
25. Install the crankshaft position sensor bolt and tighten to 10 N.m (89 lb in).

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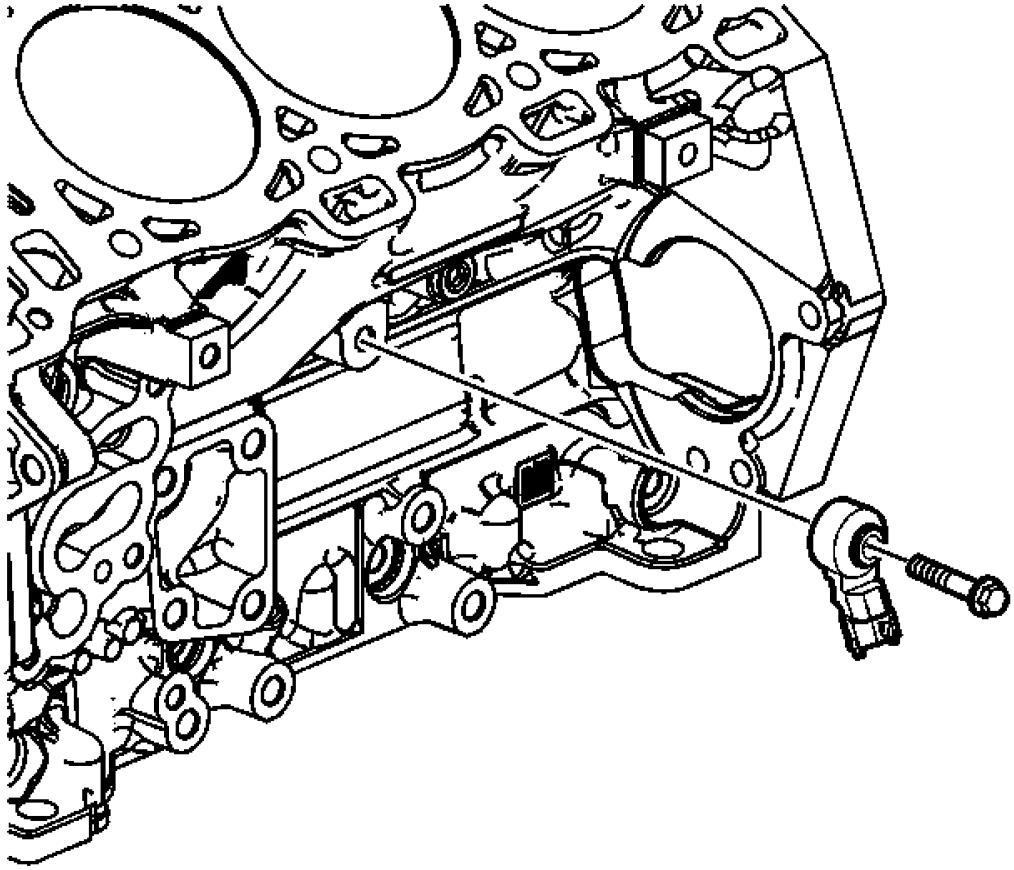


Fig. 330: Left Knock Sensor & Bolt
Courtesy of GENERAL MOTORS CORP.

26. Install the left knock sensor to the cylinder block, as shown.
27. Install the left knock sensor bolt and tighten to 25 N.m (18 lb ft).
28. Ensure proper sensor orientation.

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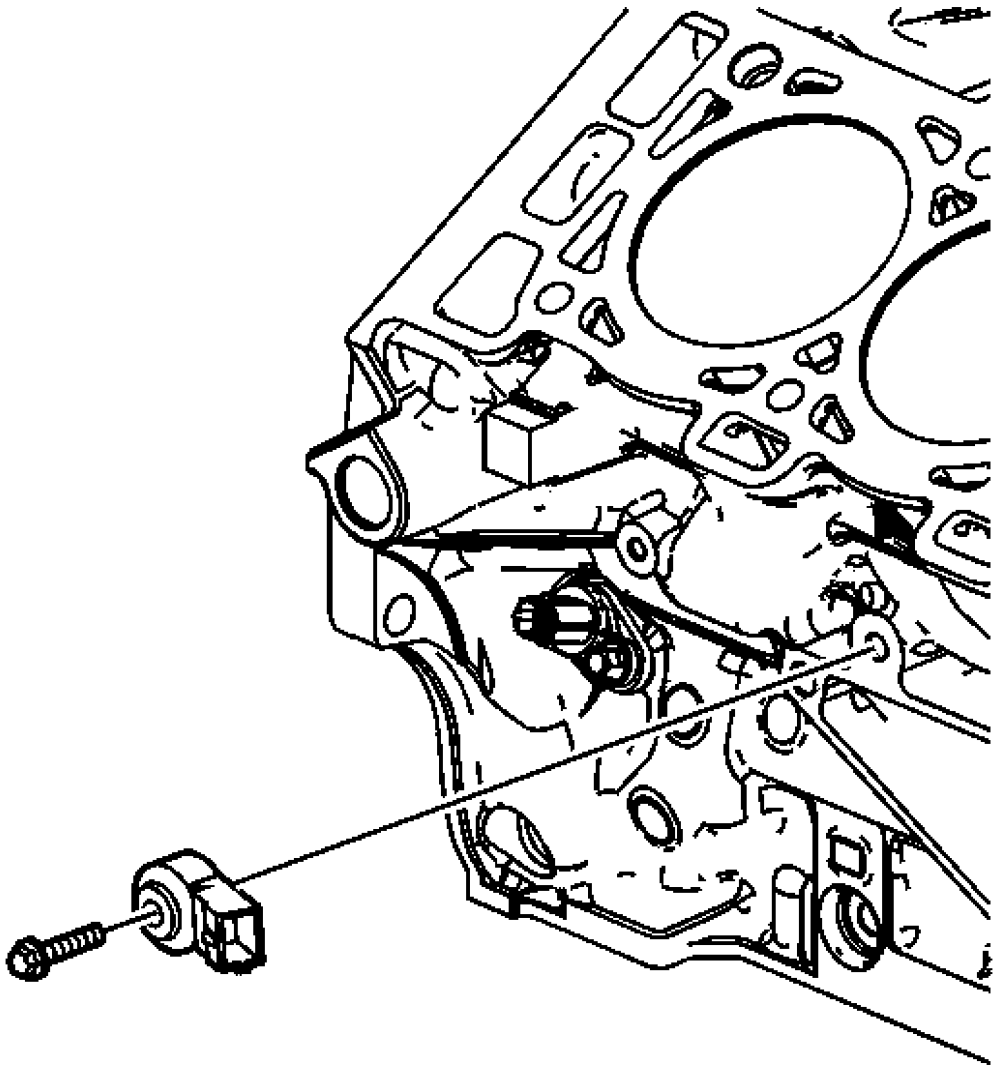


Fig. 331: View Of Right Knock Sensor
Courtesy of GENERAL MOTORS CORP.

29. Install the right knock sensor to the cylinder block, as shown.
30. Install the right knock sensor bolt and tighten to 25 N.m (18 lb ft).
31. Ensure proper sensor orientation.

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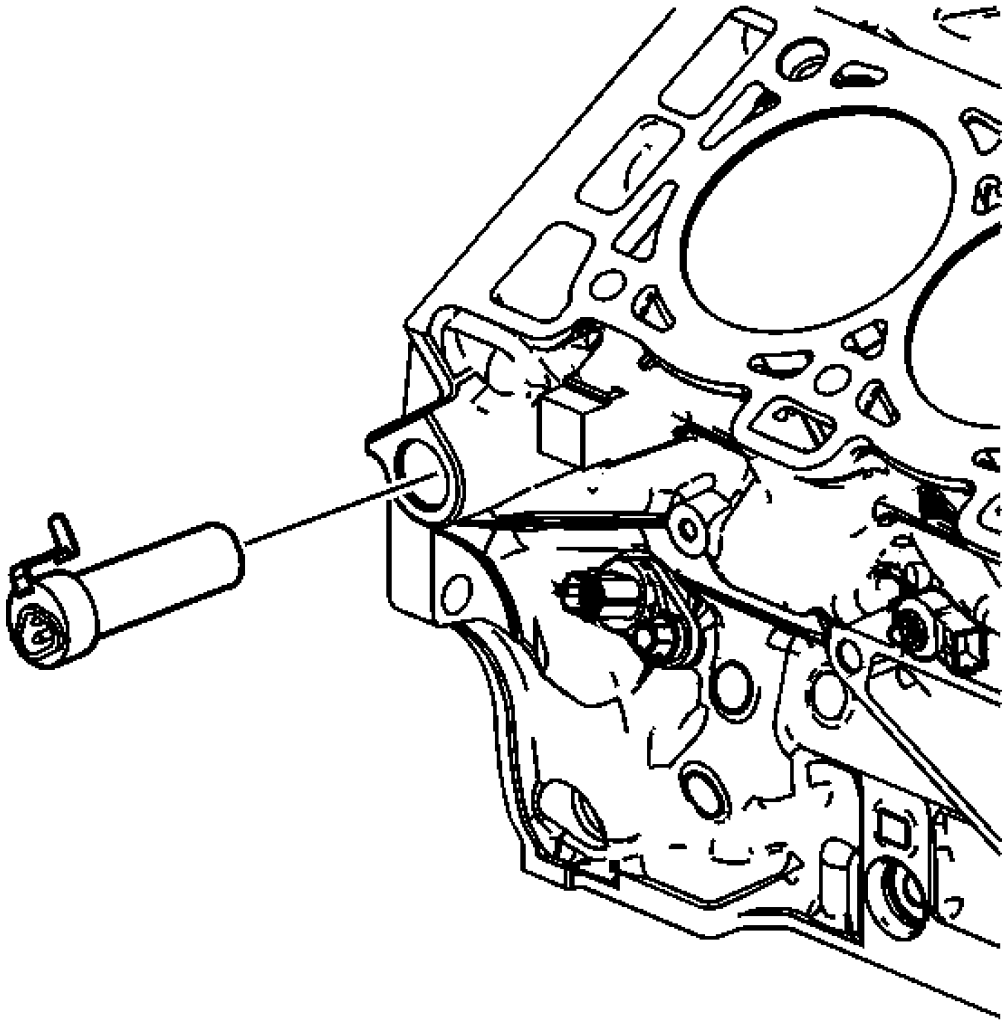


Fig. 332: View Of Block Heater Cartridge
Courtesy of GENERAL MOTORS CORP.

32. Install the block heater cartridge, if equipped.

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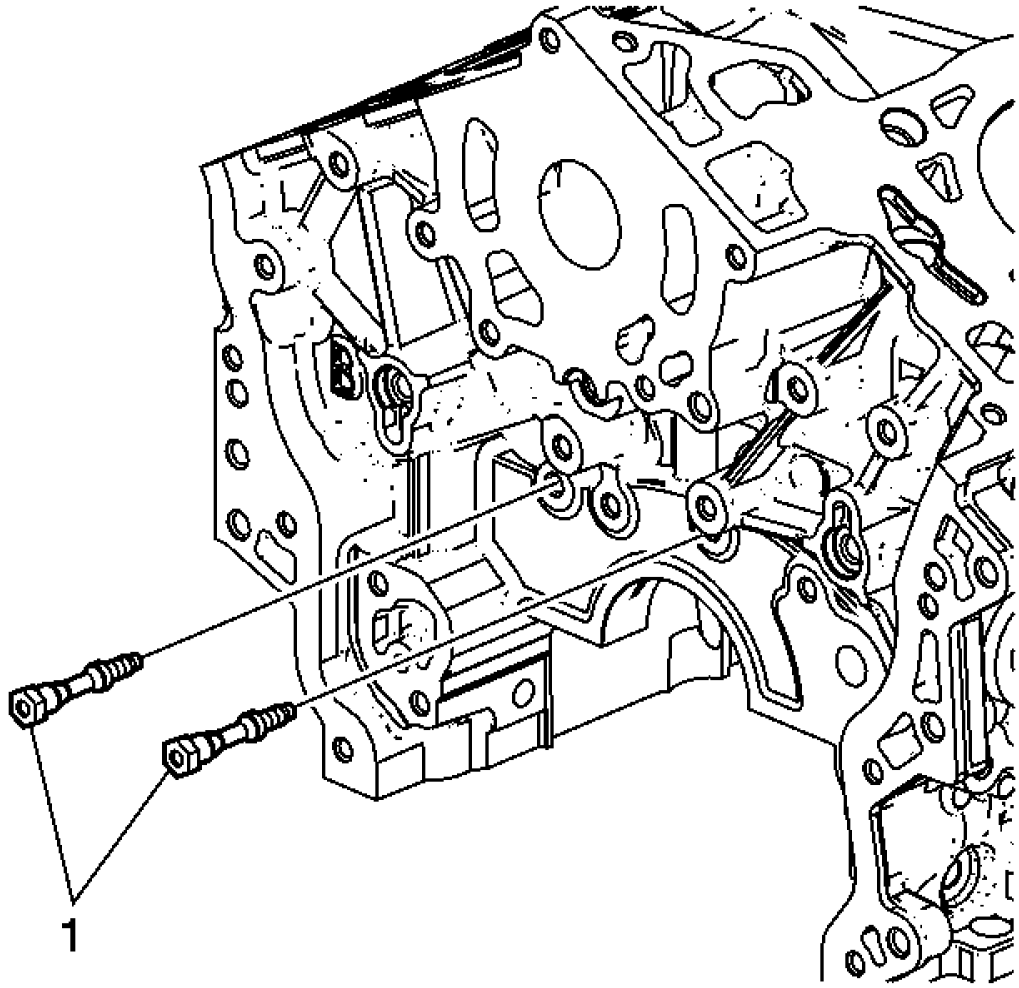


Fig. 333: Engine Front Cover Studs
Courtesy of GENERAL MOTORS CORP.

33. Install the engine front cover studs (1) and tighten to 15 N.m (11 lb ft).

CRANKSHAFT AND BEARING INSTALLATION

Special Tools

- **J 6125-1B:** Slide Hammer Adapter
- **J 41818:** Crankshaft Bearing Cap Remover
- **J 45059:** Angle Meter

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For equivalent regional tools, refer to **Special Tools** .

CRANKSHAFT BEARING INSTALLATION PROCEDURE

NOTE: If the crankshaft bearings have been used in a running engine, you must replace them with NEW crankshaft bearings for reassembly.

1. Clean the crankcase crank bore with a lint-free cloth.
2. Clean all the oil from the backside of new bearing halves.

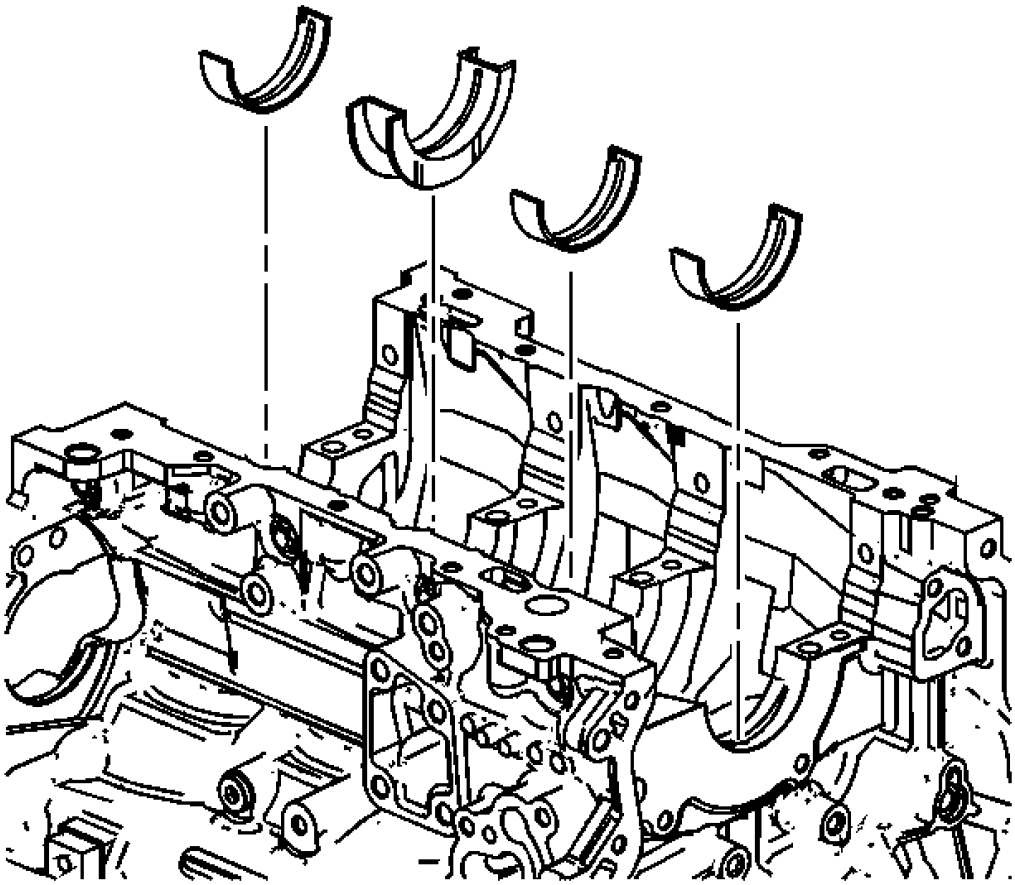


Fig. 334: Locating Upper Crankshaft Bearings
Courtesy of GENERAL MOTORS CORP.

3. Install the new upper crankshaft bearings into position. The thrust bearing belongs in the number 3 journal. Ensure that the upper bearing insert contains the oil transfer hole and groove. Roll the bearing

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into position so that the lock tang engages the crank slot. The bearing must fit flush with the upper crankcase.

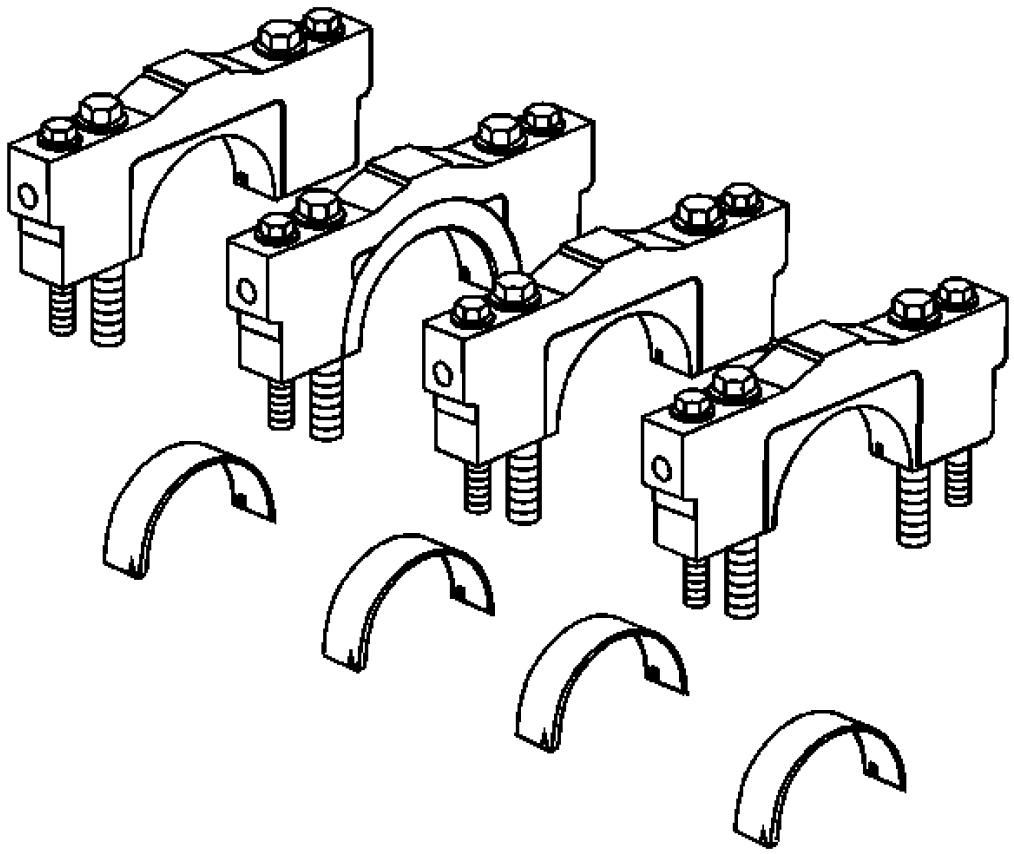


Fig. 335: Lower Crankshaft Bearings & Main Bearing Caps
Courtesy of GENERAL MOTORS CORP.

4. Install the new lower crankshaft bearings into position in the main bearing caps. The lower crankshaft bearings are identified by NO grooves or holes. The bearings must fit flush with the crankshaft bearing caps.

CRANKSHAFT INSTALLATION PROCEDURE

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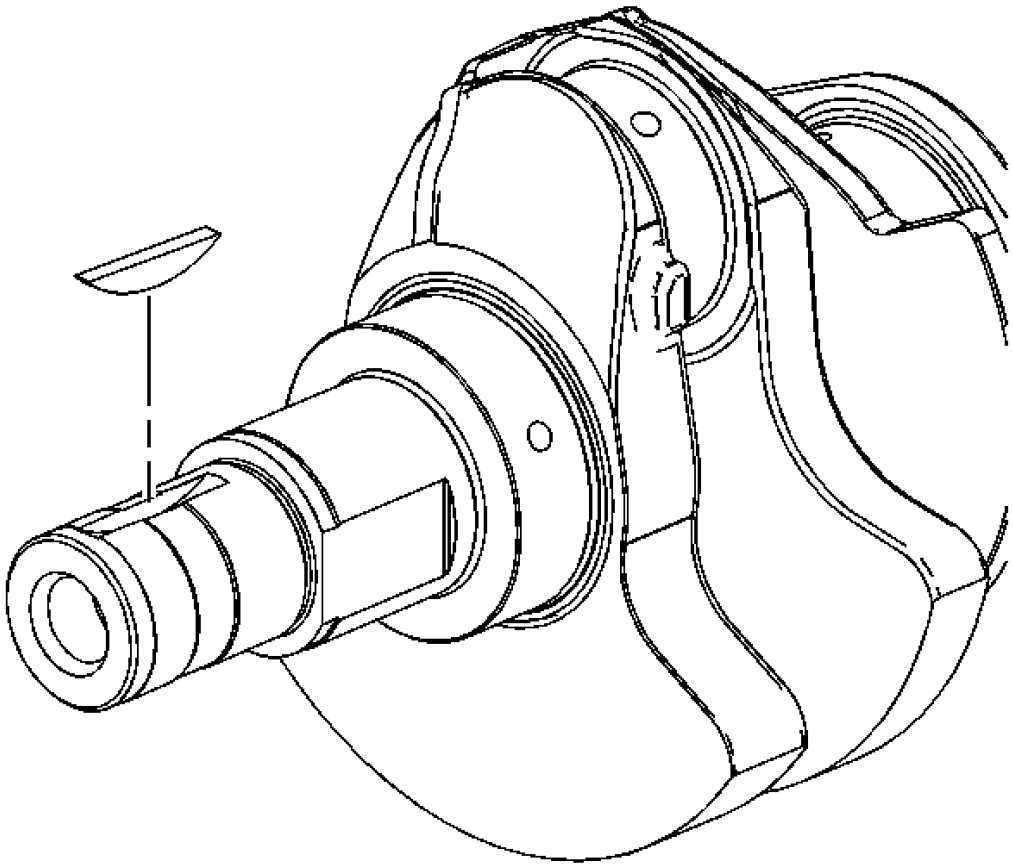


Fig. 336: View Of Crankshaft Key
Courtesy of GENERAL MOTORS CORP.

1. If removed, install the crankshaft key. Lightly tap the key in place with a small soft face, bronze/plastic, hammer until it bottoms in the keyway.

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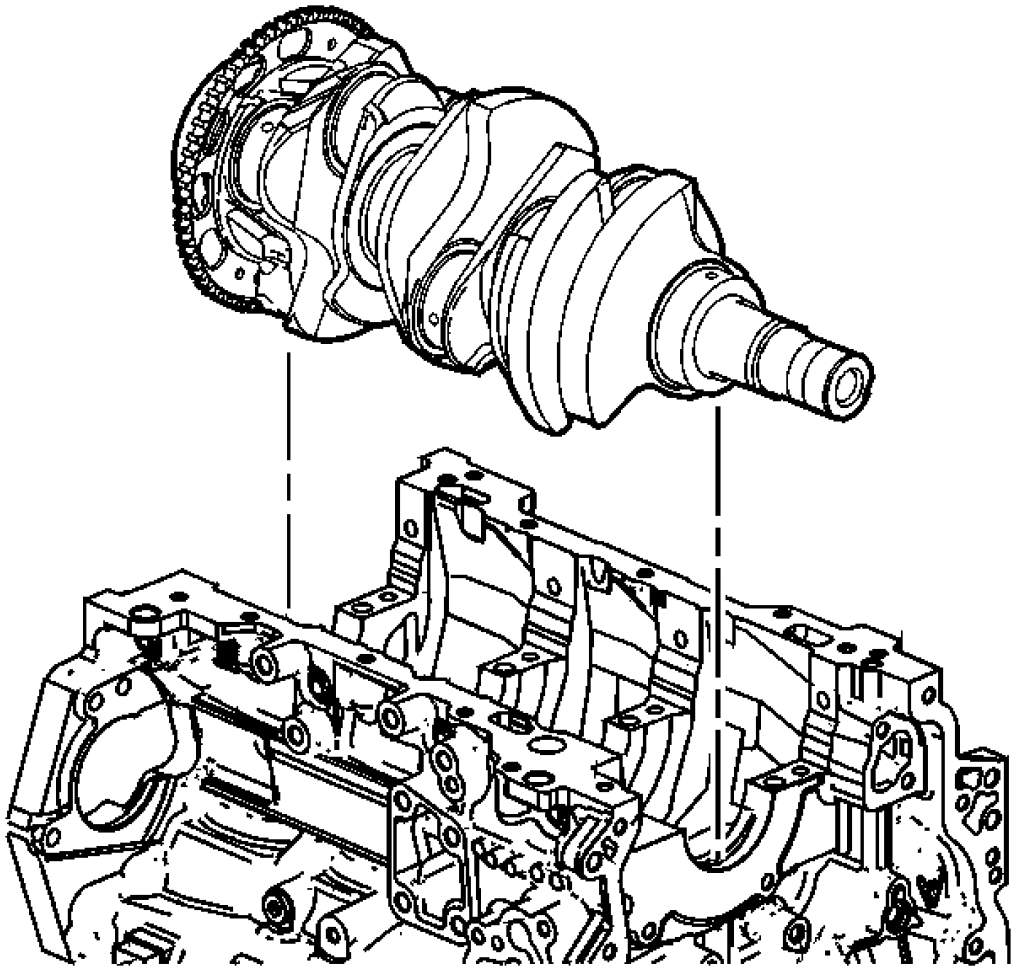


Fig. 337: View Of Crankshaft
Courtesy of GENERAL MOTORS CORP.

2. Gently lower the crankshaft into position in the cylinder block.

CRANKSHAFT BEARING CLEARANCE MEASUREMENT PROCEDURE

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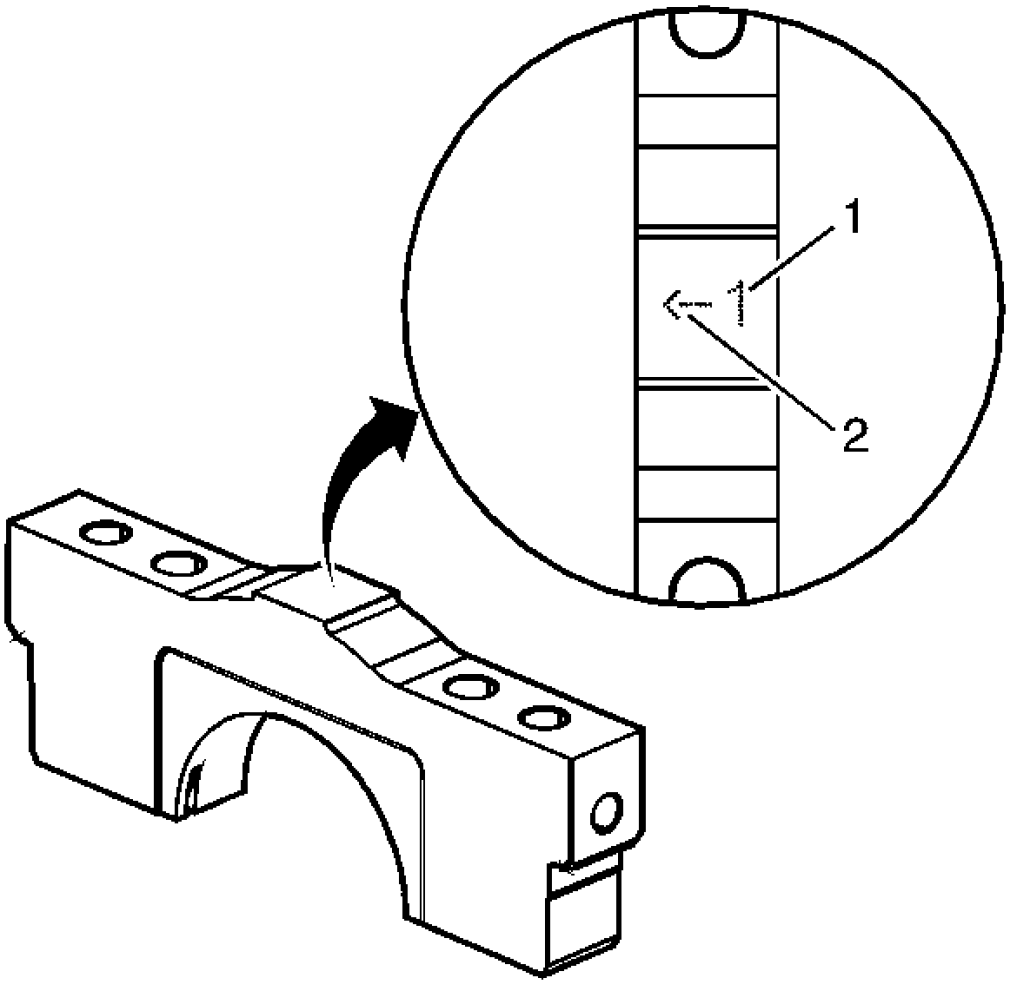


Fig. 338: View Of Main Bearing Cap Markings
Courtesy of GENERAL MOTORS CORP.

1. Place a length of fresh, room temperature plastic gaging material all the way across all the crankshaft bearing journals.
2. Identify the proper order of the main bearing caps. The main bearing caps are numbered 1 (1) through 4, with the front main bearing cap marked with the number 1. The arrow (2) is to be oriented to the front of the engine.

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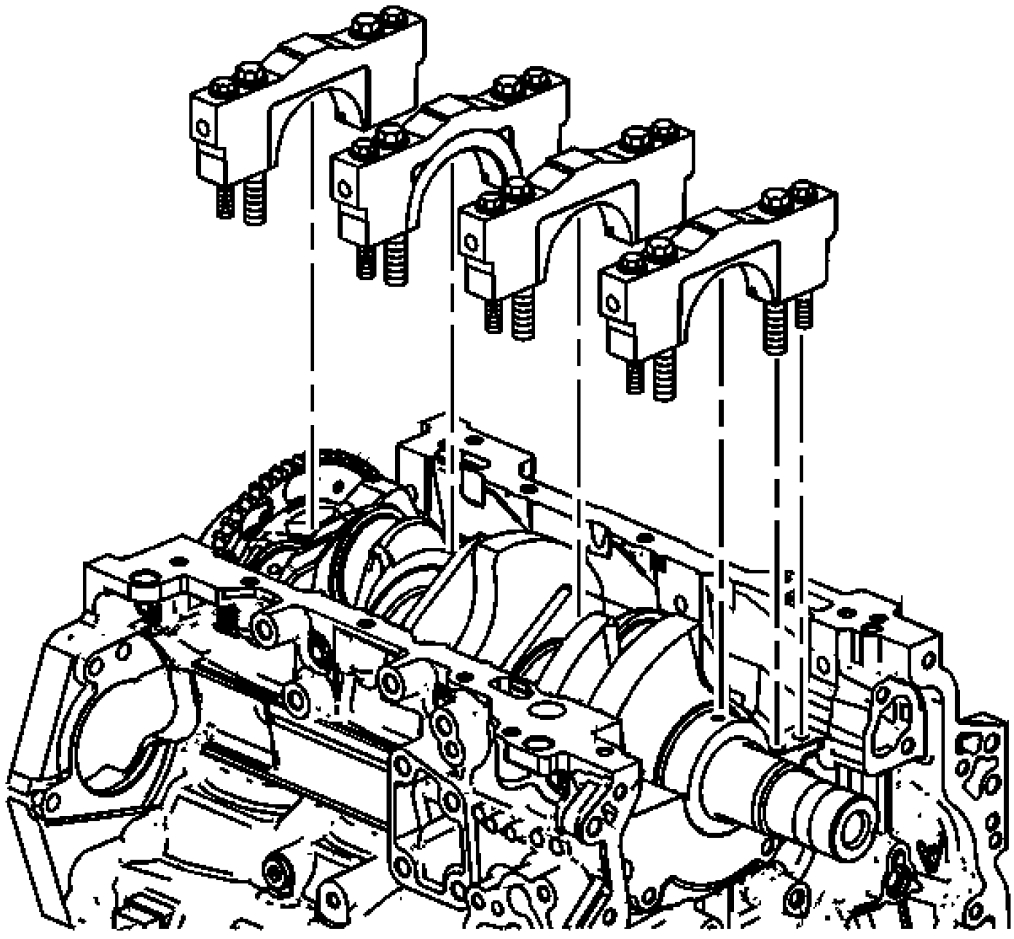


Fig. 339: View Of Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS CORP.

3. Install the crankshaft main bearing caps.
4. Loosely install the original inner main cap bolts.
5. Loosely install the original outer main cap bolts.

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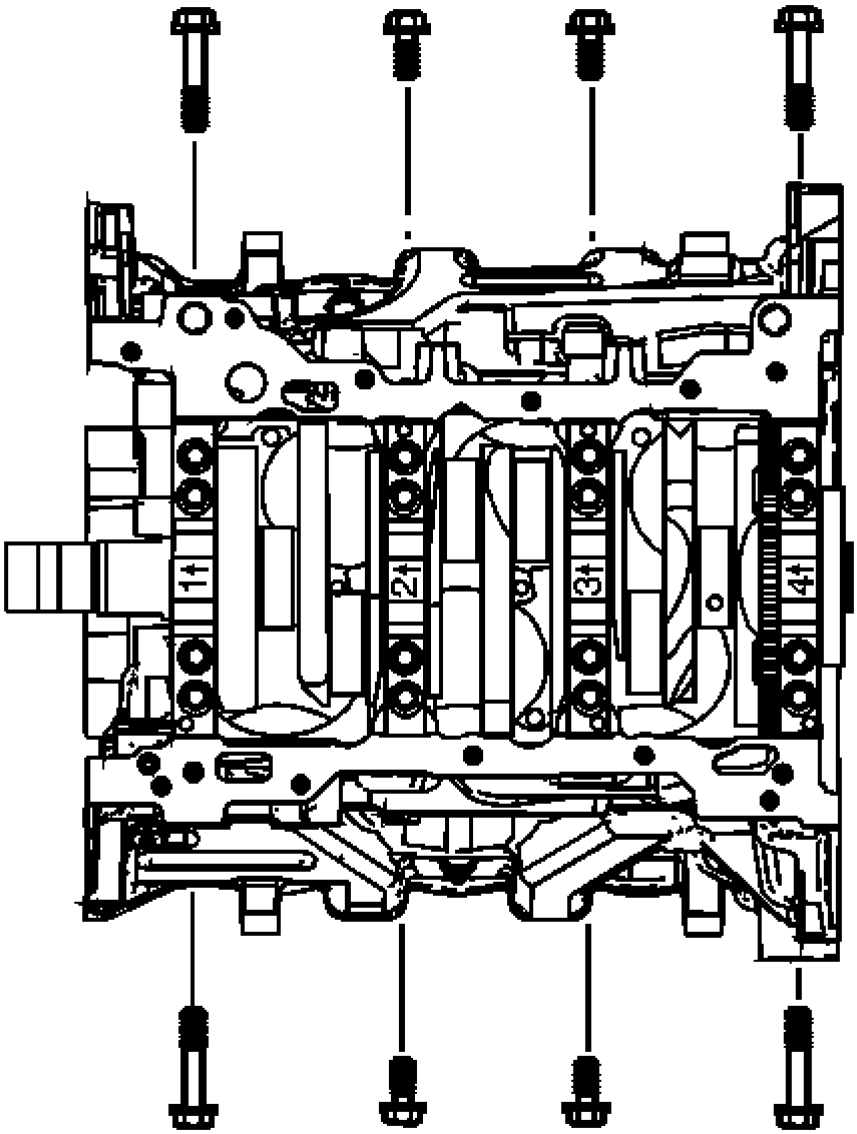


Fig. 340: Identifying Side Main Cap Bolts
Courtesy of GENERAL MOTORS CORP.

6. Loosely install the original short/inner side main cap bolts.
7. Loosely install the original long/outer side main cap bolts.

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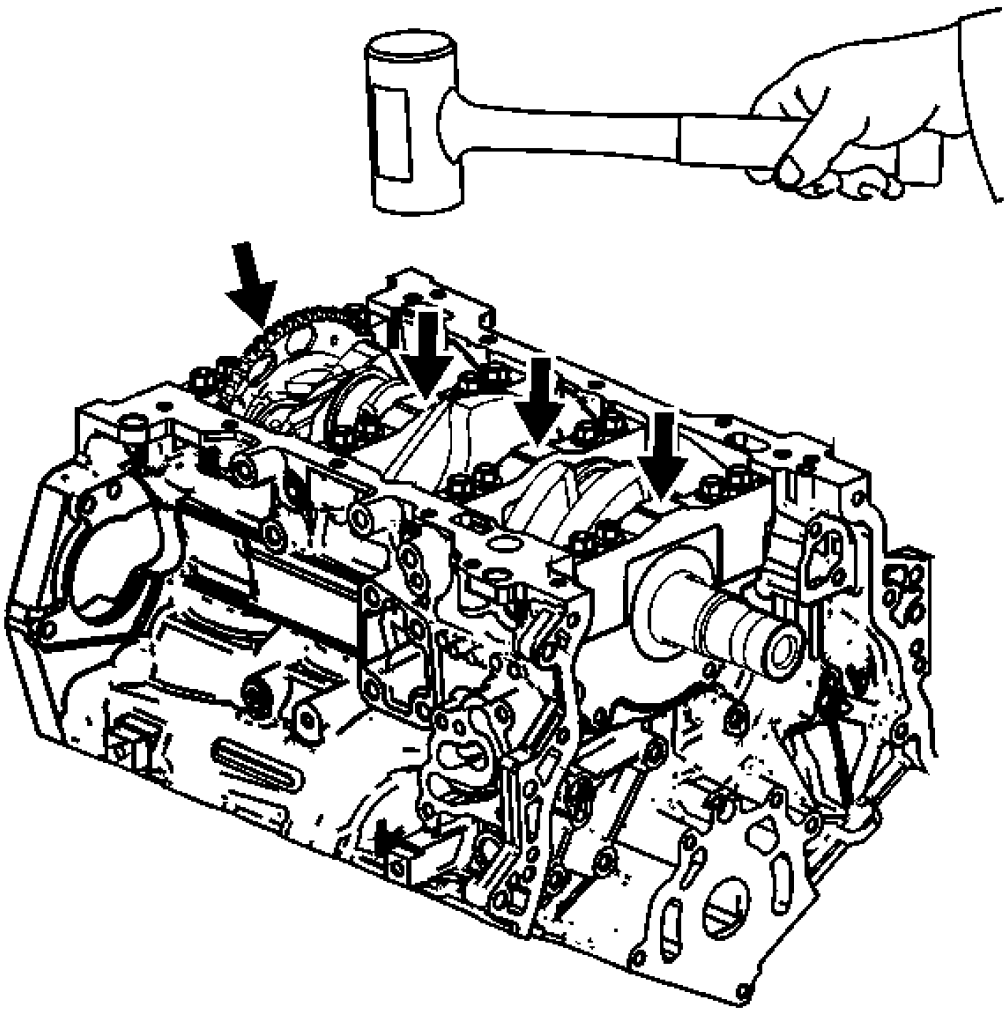


Fig. 341: Tapping Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS CORP.

8. Tap the crankshaft main bearing caps with a soft-faced hammer.

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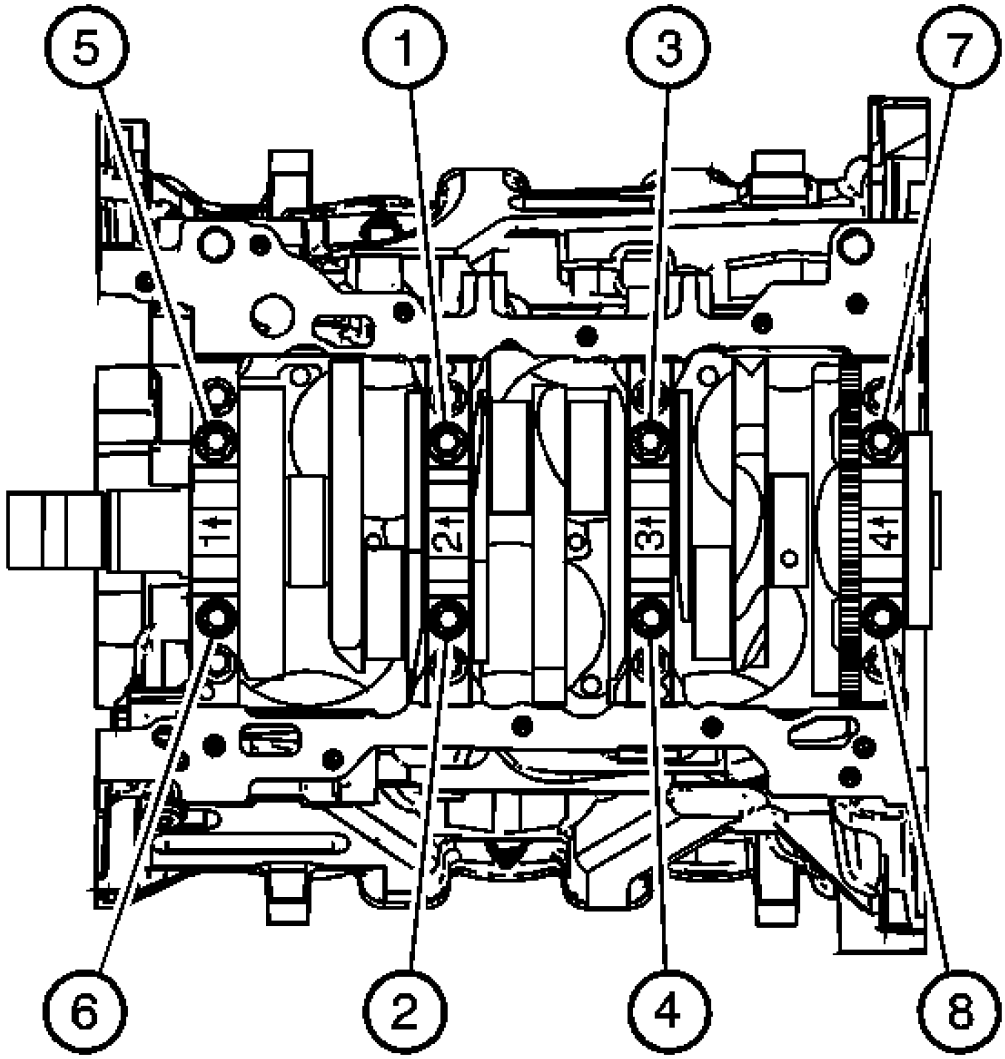


Fig. 342: Identifying Main Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

9. Tighten the main caps bolts using the **J 45059:** meter in the following sequence:

   CAUTION: Refer to Fastener Caution .

10. Tighten the inboard bolts (1-8) first, in two passes.
    1. Tighten the inboard bolts to 20 N.m (15 lb ft) on the first pass.

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2. Tighten the inboard bolts (1-8) an additional 80 degrees on the 2nd pass.

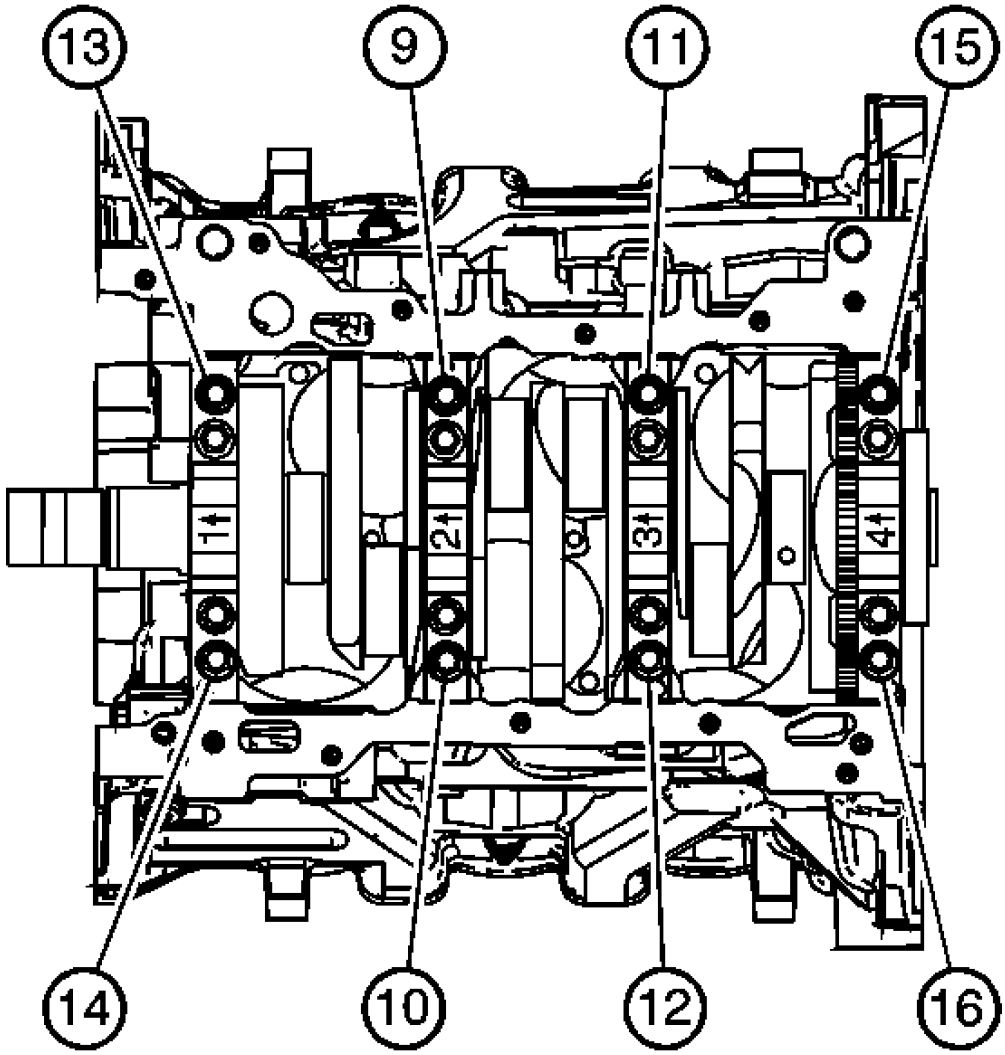


Fig. 343: Identifying Outboard Crankshaft Main Bearing Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

11. Tighten the outboard bolts (9-16) second, in two passes.
    1. Tighten the outboard bolts to 15 N.m (11 lb ft) on the first pass.
    2. Tighten the outboard bolts (9-16) an additional 110 degrees on the 2nd pass.

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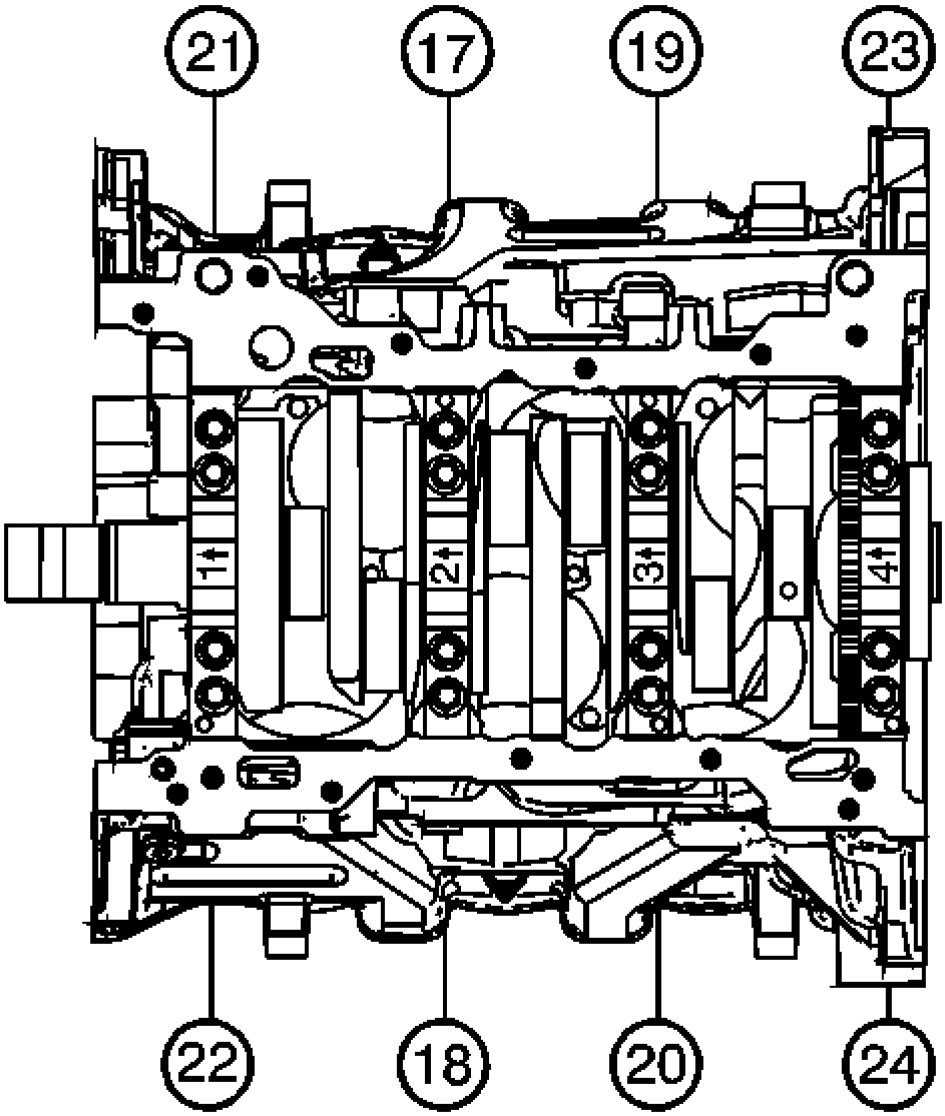


Fig. 344: Identifying Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

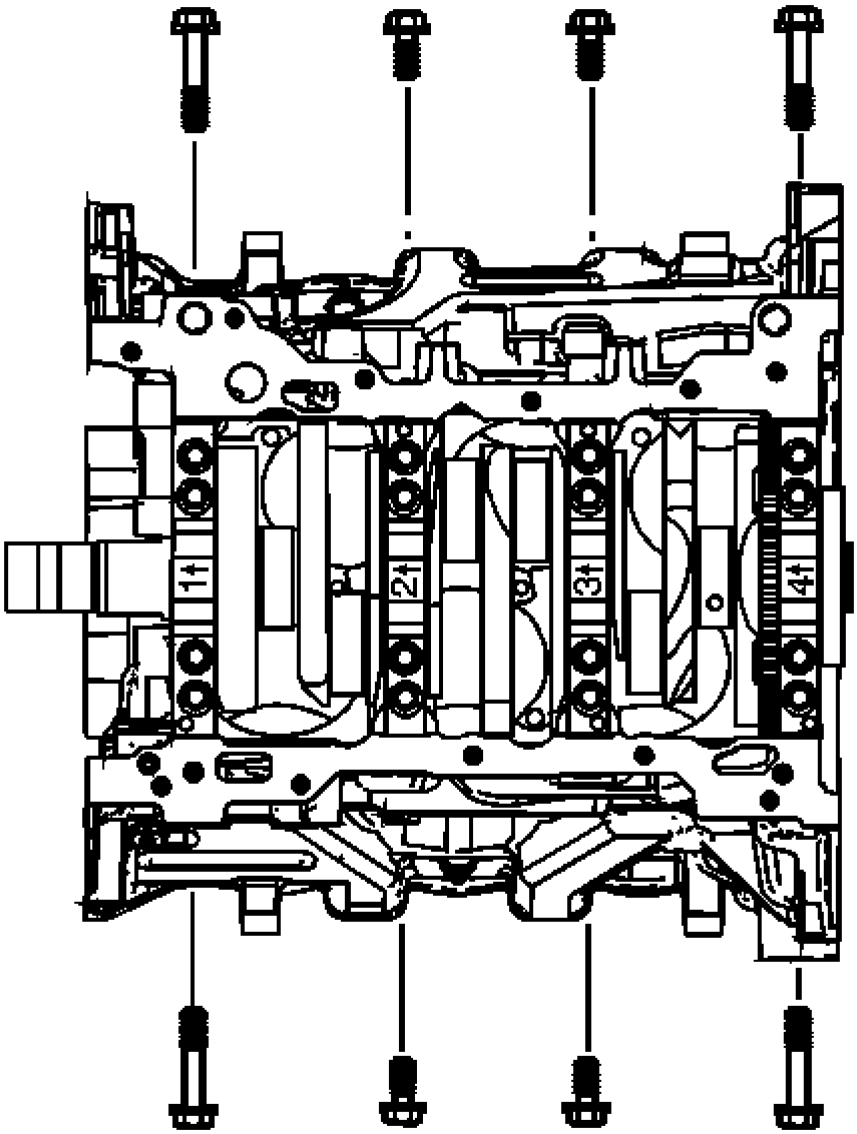
12. Tighten the short/inner bolts (17-20) third, in two passes.
    1. Tighten the short/inner bolts to 30 N.m (22 lb ft) on the first pass.
    2. Tighten the short/inner bolts (17-20) an additional 60 degrees on the 2nd pass.
13. Tighten the long/outer bolts (21-24) fourth, in two passes.

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1. Tighten the long/outer bolts to 30 N.m (22 lb ft) on the first pass.
2. Tighten the long/outer bolts (21-24) an additional 60 degrees on the 2nd pass.

NOTE: Do not rotate the crankshaft.

14. After reaching final torque, allow the assembly to sit for 2 minutes.



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Fig. 345: Identifying Side Main Cap Bolts
Courtesy of GENERAL MOTORS CORP.

15. Remove the crankshaft bearing cap side bolts.

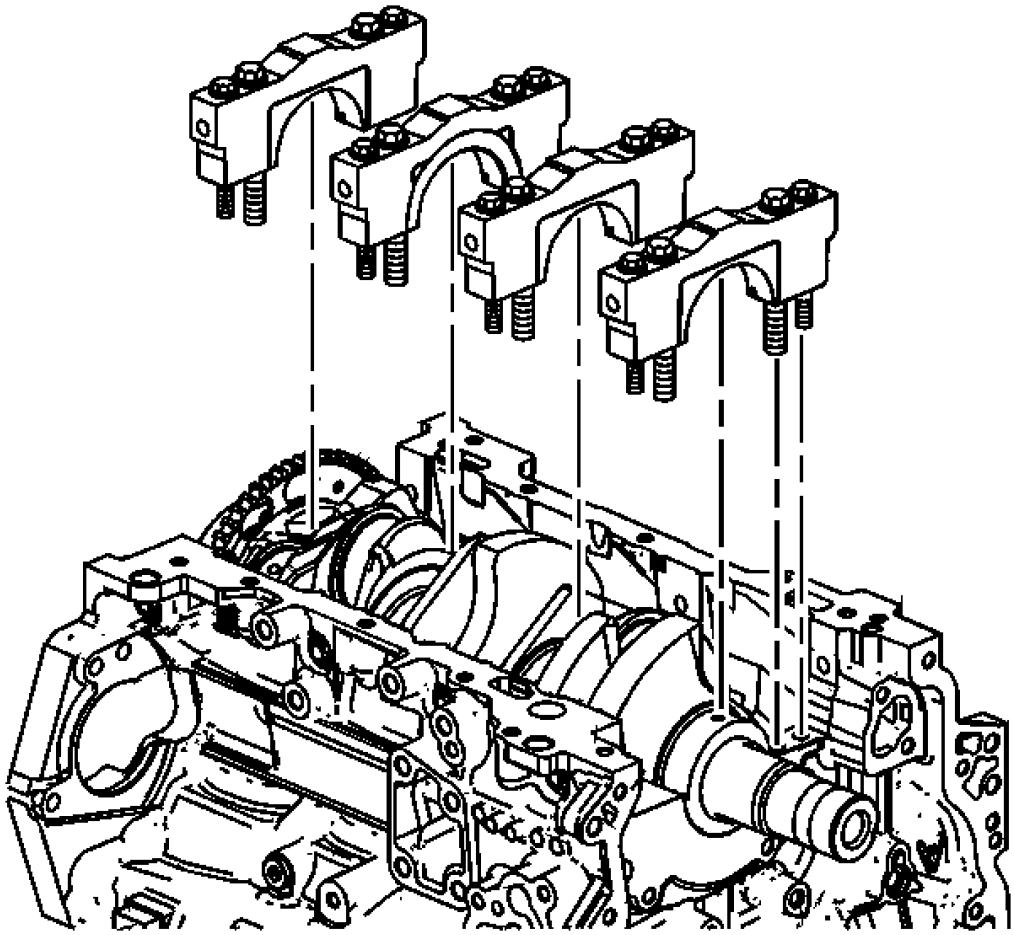


Fig. 346: View Of Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS CORP.

16. Remove the crankshaft bearing cap outer bolts.
17. Remove the crankshaft bearing cap inner bolts.
18. Remove the crankshaft bearing caps using the **J 6125-1B:** adapter and **J 41818:** remover.

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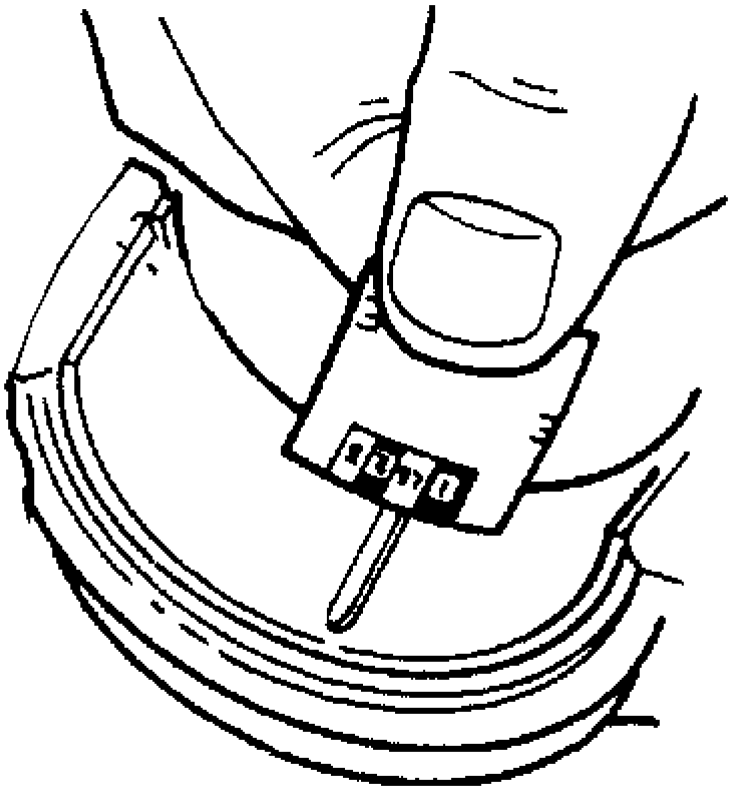


Fig. 347: Measuring Plastigage
Courtesy of GENERAL MOTORS CORP.

19. Determine the crankshaft bearing clearance by comparing the width of the flattened plastic gaging material at its widest point with the graduation on the gaging material container.

NOTE: The crankshaft bearings CAN be reused after checking the clearance if the bearings have never been used in a running engine.

20. Compare your measurements with the **Engine Mechanical Specifications (LLT)** . If the new bearings do not provide the proper crankshaft to bearing clearance, inspect the following:
    1. Re-measure the crankshaft journals for the correct specified size and ensure the proper new bearings are being installed. If the crankshaft journals are incorrectly sized, replace or regrind the crankshaft. Crankshaft machining is permitted and undersized bearings are available.
    2. Re-measure the engine block crankshaft bearing bore diameter to ensure proper size. The engine block crankshaft bearing bore is not machinable and the block must be replaced if out of

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specification.

21. Clean the plastic gaging material from the crankshaft bearing journals with a soft, lint-free cloth.

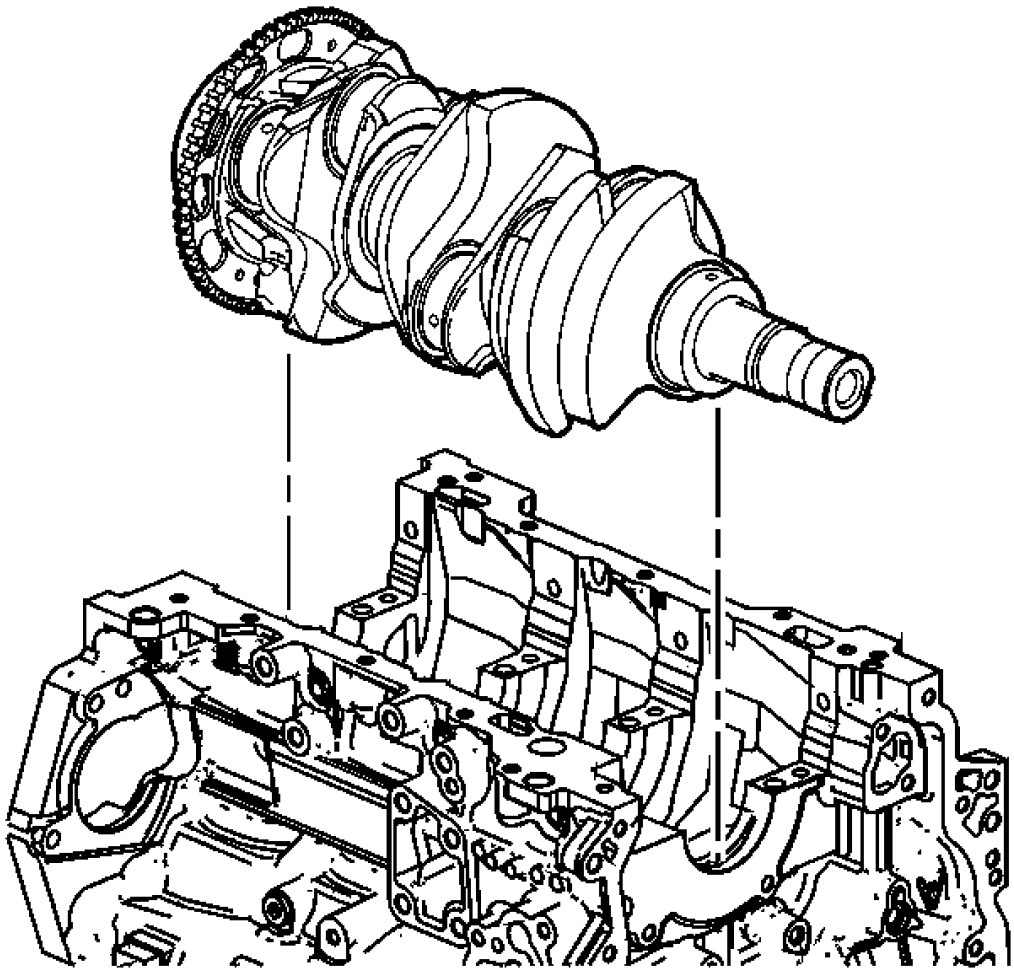


Fig. 348: View Of Crankshaft
Courtesy of GENERAL MOTORS CORP.

22. Lift the crankshaft out of the cylinder block.

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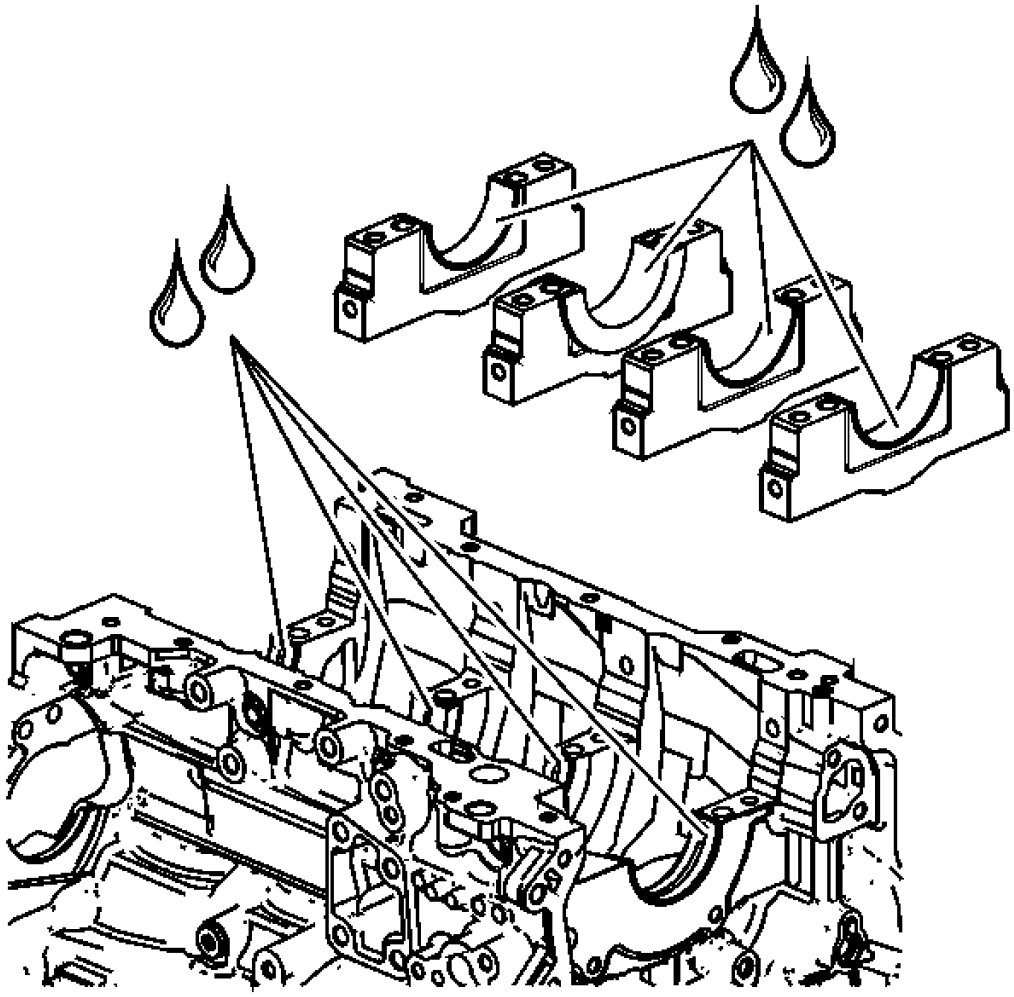


Fig. 349: Prelubing Upper & Lower Bearing Surfaces
Courtesy of GENERAL MOTORS CORP.

23. Apply a liberal amount of crankshaft prelube or clean engine oil to the upper and lower bearing surfaces. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

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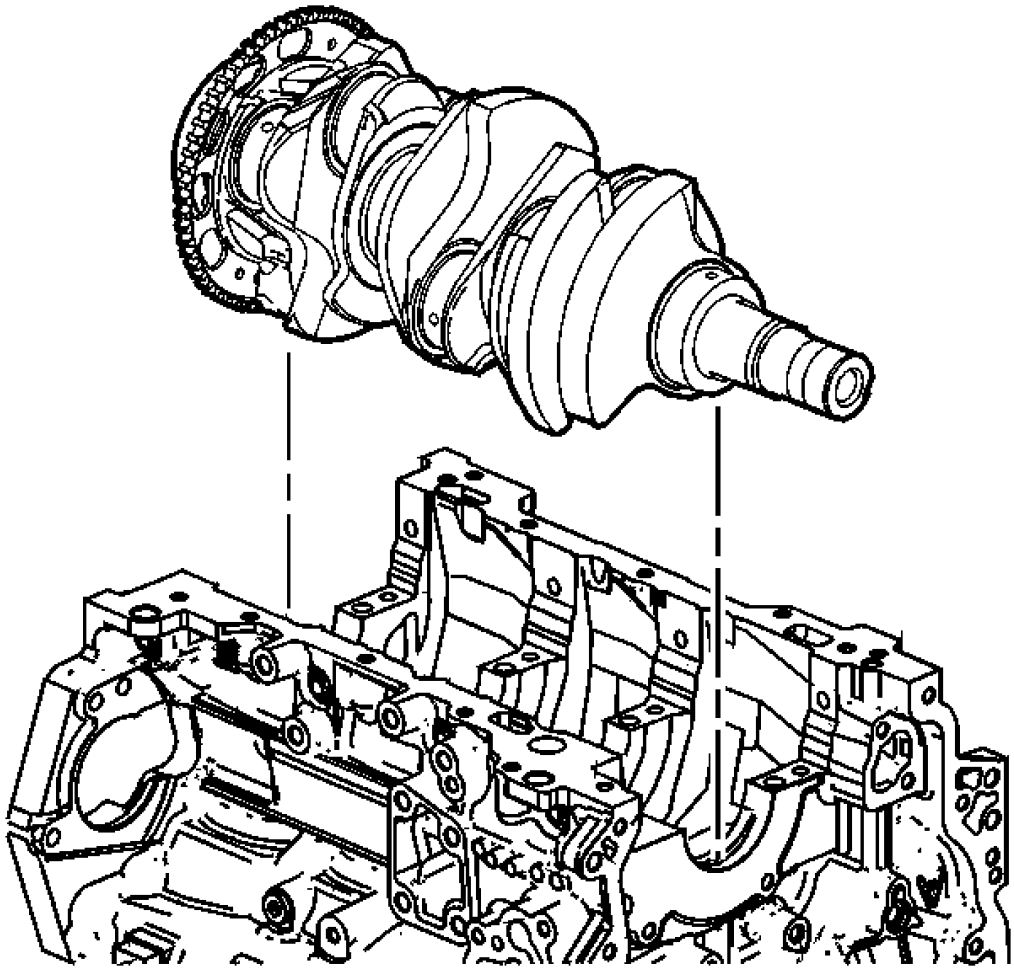


Fig. 350: View Of Crankshaft
Courtesy of GENERAL MOTORS CORP.

24. Gently lower the crankshaft into position in the cylinder block.

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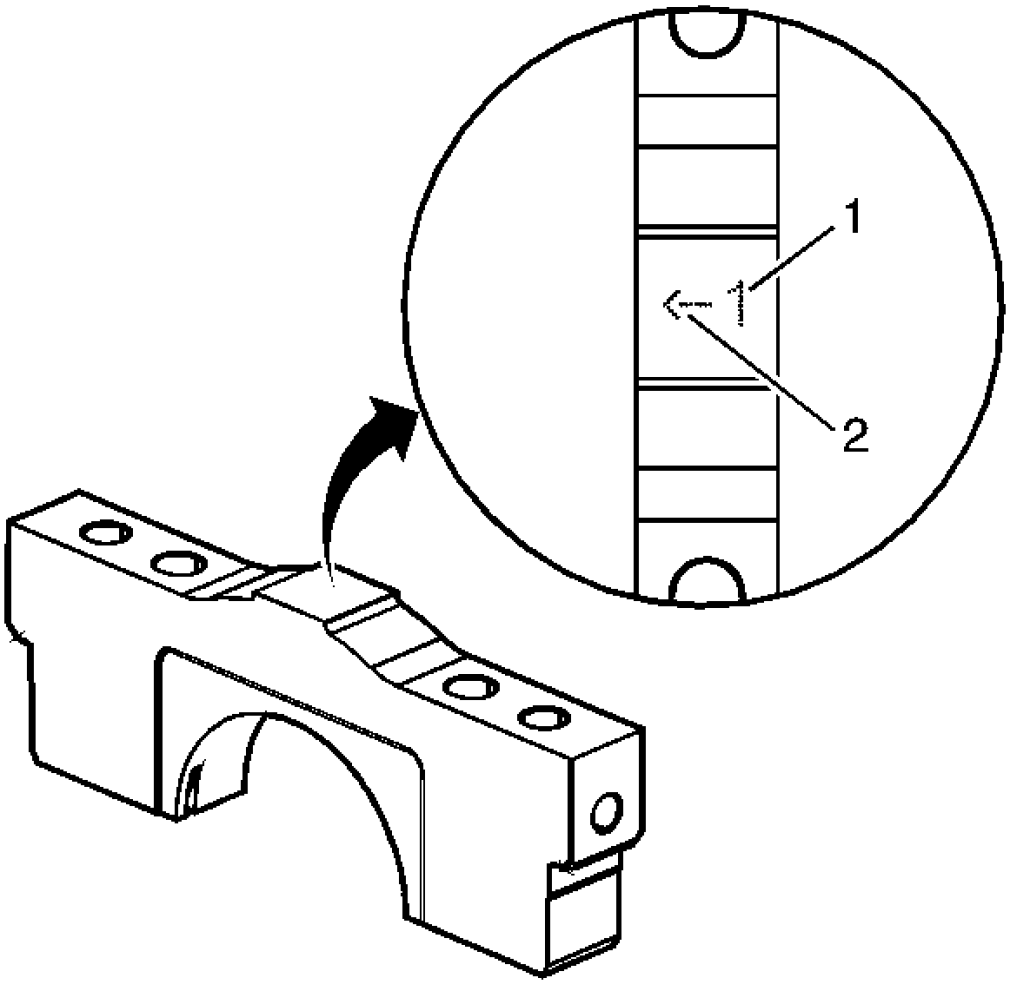


Fig. 351: Identifying Front Main Bearing Cap
Courtesy of GENERAL MOTORS CORP.

25. Identify the proper order of the main bearing caps. The main bearing caps are numbered 1 (1) through 4, with the front main bearing cap marked with the number 1. The arrow (2) is to be oriented to the front of the engine.

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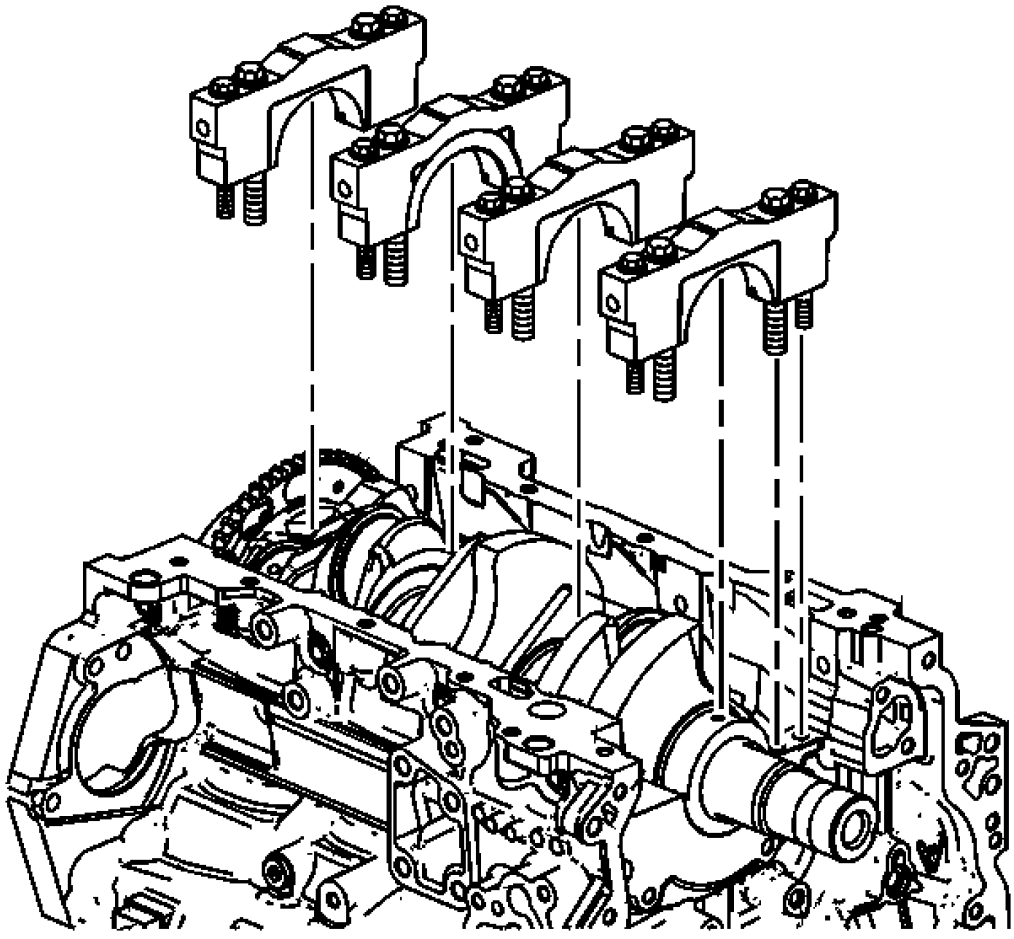


Fig. 352: View Of Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS CORP.

26. Install the crankshaft main bearing caps.
27. Loosely install the original inner main cap bolts.
28. Loosely install the NEW outer main cap bolts.

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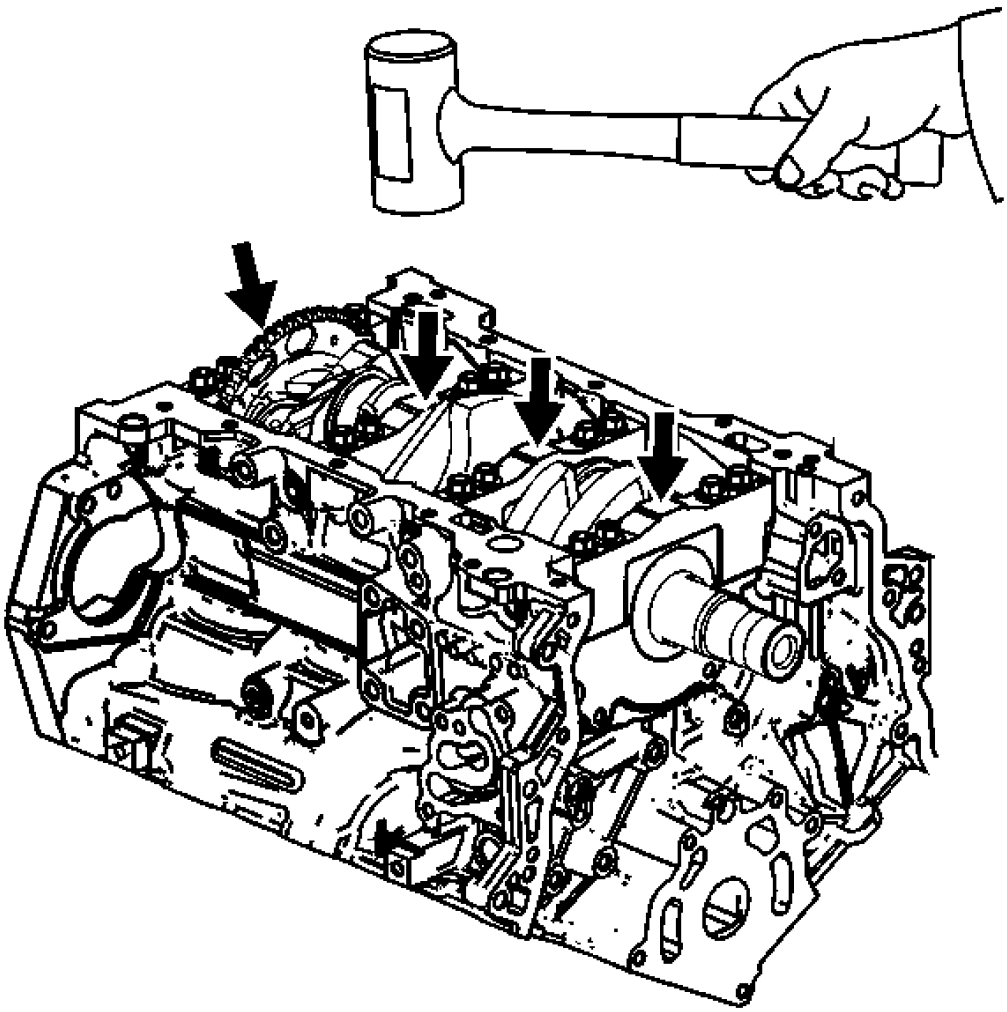


Fig. 353: Tapping Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS CORP.

29. Tap the crankshaft main bearing caps with a soft-faced hammer.

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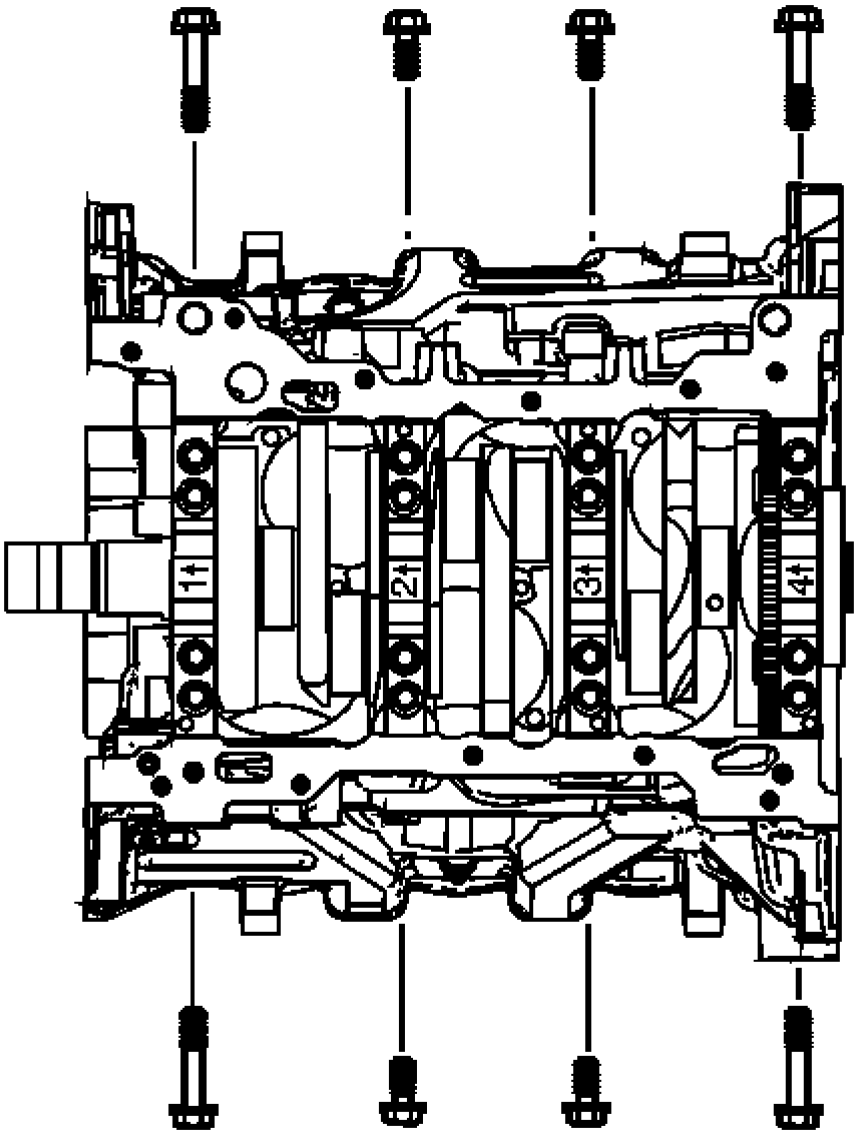


Fig. 354: Identifying Side Main Cap Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: **The side main cap bolts originally have a sealant on the flange of the bolt head. NEW bolts must be used. If NEW bolts are not used, oil can leak from the crankcase past the bolts.**

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30. Loosely install the NEW short/inner side main cap bolts.
31. Loosely install the NEW long/outer side main cap bolts.

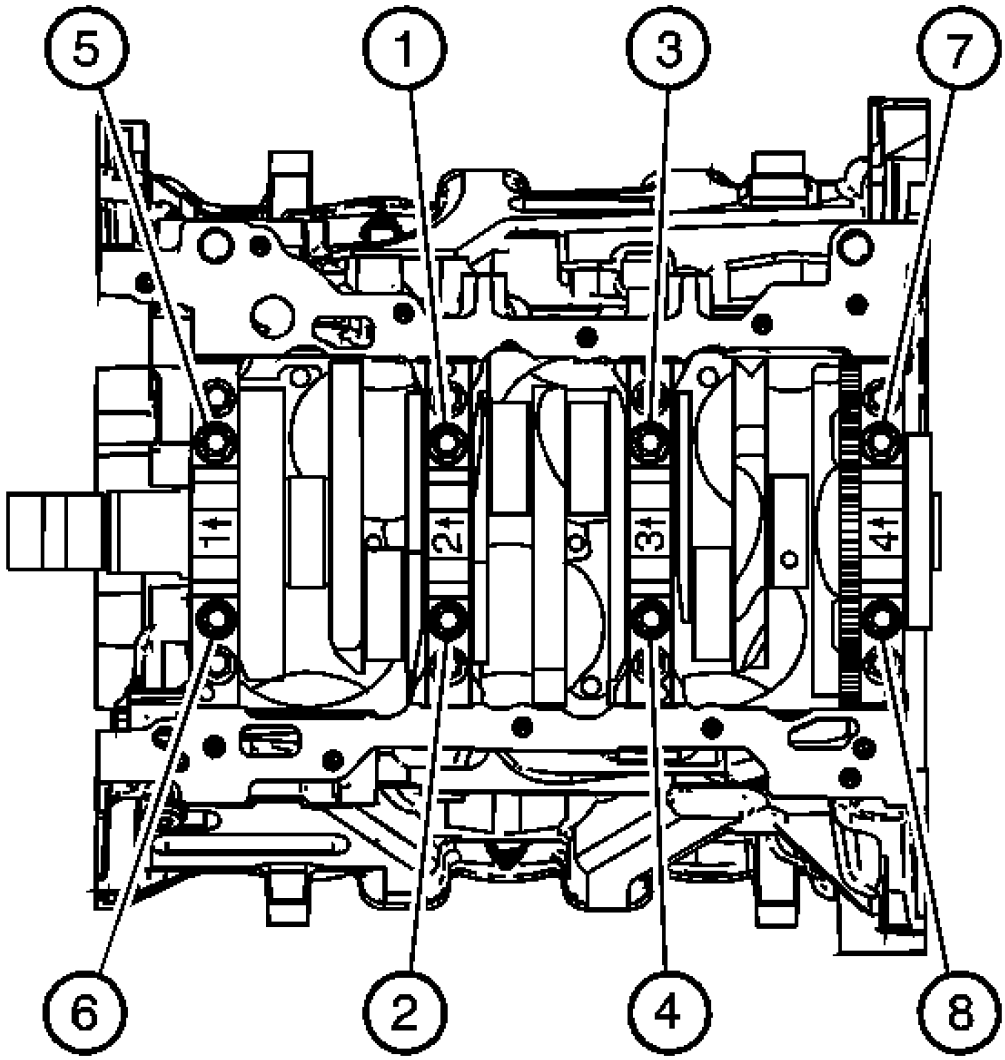


Fig. 355: Identifying Crankshaft Main Bearing Inboard Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

32. Tighten the main cap bolts using the **J 45059:** meter in the following sequence:
33. Tighten the inboard bolts (1-8) first, in two passes.
    1. Tighten the inboard bolts to 20 N.m (15 lb ft) on the first pass.

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2. Tighten the inboard bolts (1-8) an additional 80 degrees on the 2nd pass.

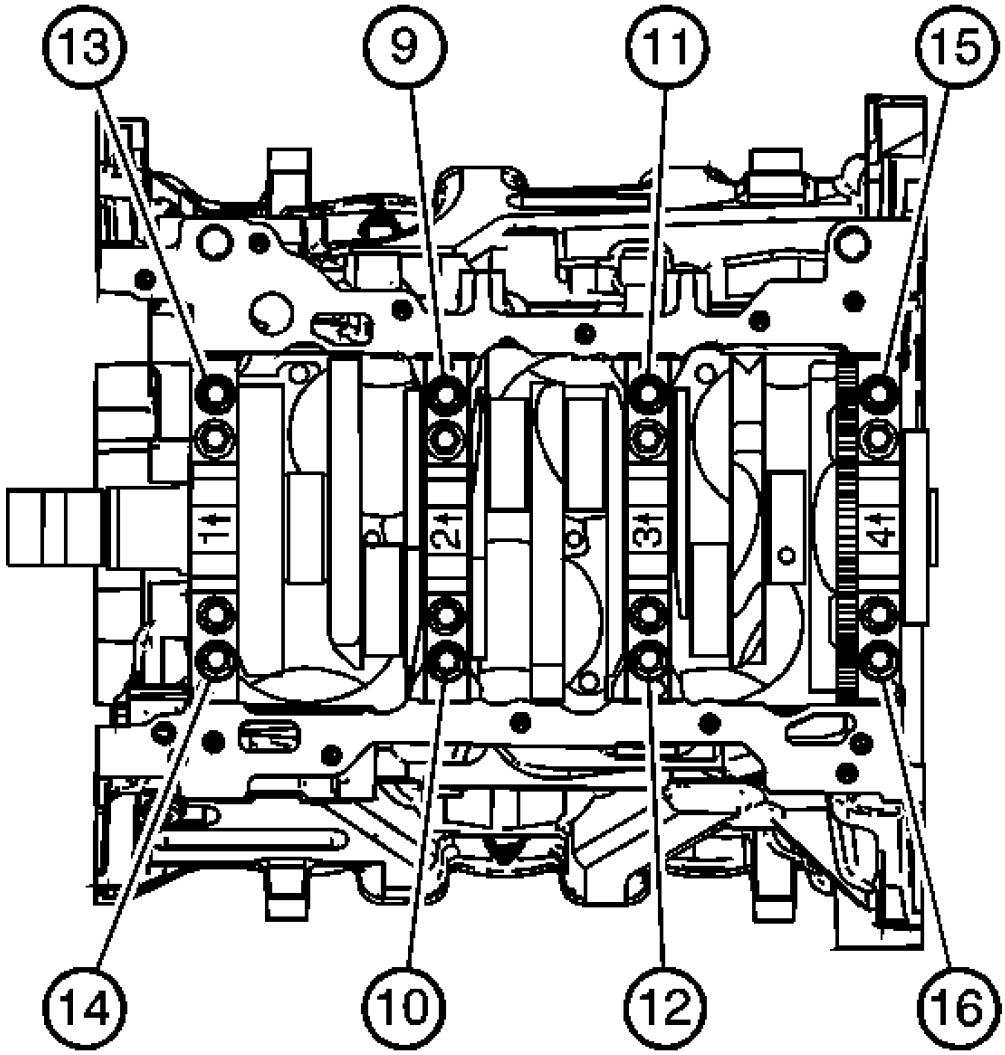


Fig. 356: Identifying Outboard Crankshaft Main Bearing Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

34. Tighten the outboard bolts (9-16) second, in two passes.
    1. Tighten the outboard bolts to 15 N.m (11 lb ft) on the first pass.
    2. Tighten the outboard bolts (9-16) an additional 110 degrees on the 2nd pass.

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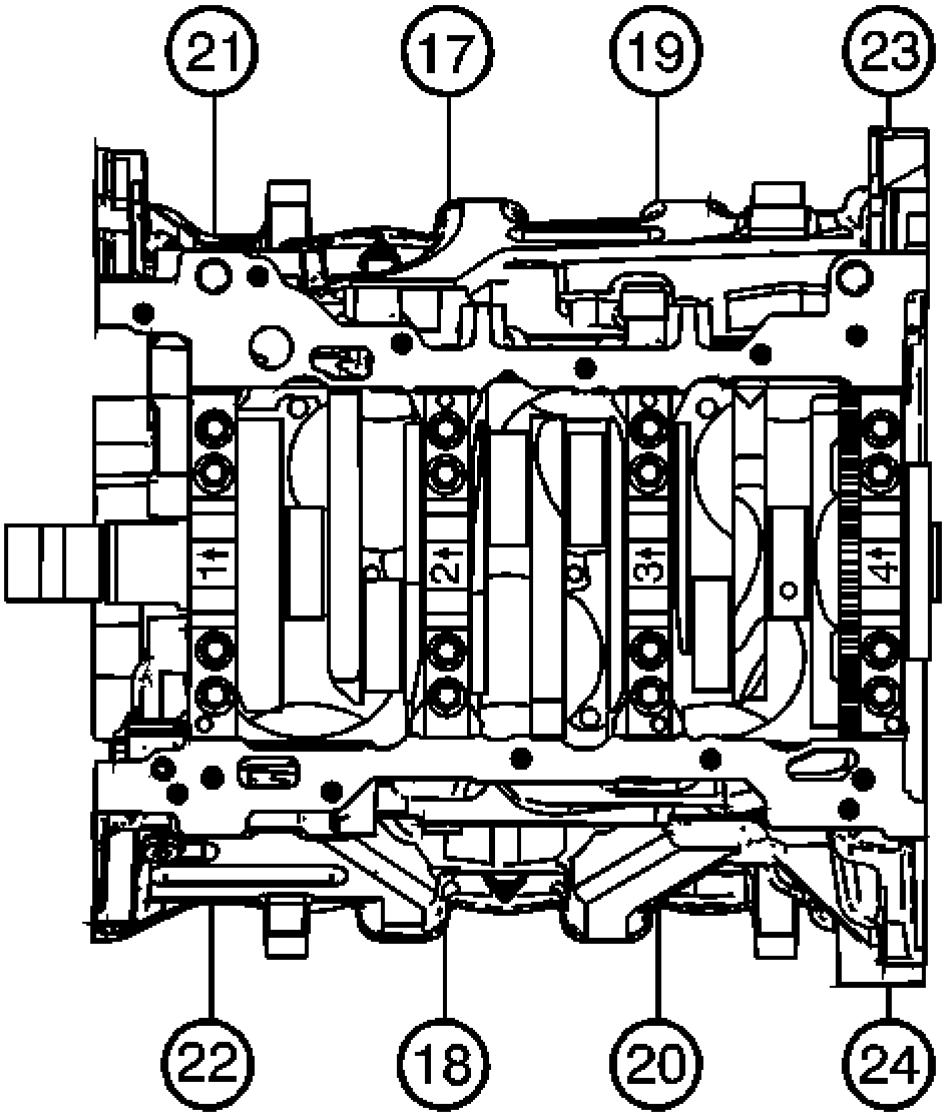


Fig. 357: Identifying Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

35. Tighten the short/inner bolts (17-20) third, in two passes.
    1. Tighten the short/inner bolts to 30 N.m (22 lb ft) on the first pass.
    2. Tighten the short/inner bolts (17-20) an additional 60 degrees on the 2nd pass.
36. Tighten the long/outer bolts (21-24) fourth, in two passes.

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1. Tighten the long/outer bolts to 30 N.m (22 lb ft) on the first pass.
2. Tighten the long/outer bolts (21-24) an additional 60 degrees on the 2nd pass.

37. Ensure that the crankshaft turns without binding or noise.

PISTON, CONNECTING ROD, AND BEARING INSTALLATION

Special Tools

- **EN 46121:** Connecting Rod Guide Pin Set
- **EN-48589:** Crankshaft Rotation Socket
- **J 8037:** Ring Compressor
- **J 43690:** Rod Bearing Clearance Checking Tool
- **J 43690-100:** Rod Bearing Clearance Checking Tool - Adapter Kit
- **J 45059:** Angle Meter

For equivalent regional tools, refer to **Special Tools** .

PISTON AND CONNECTING ROD ASSEMBLY PROCEDURE

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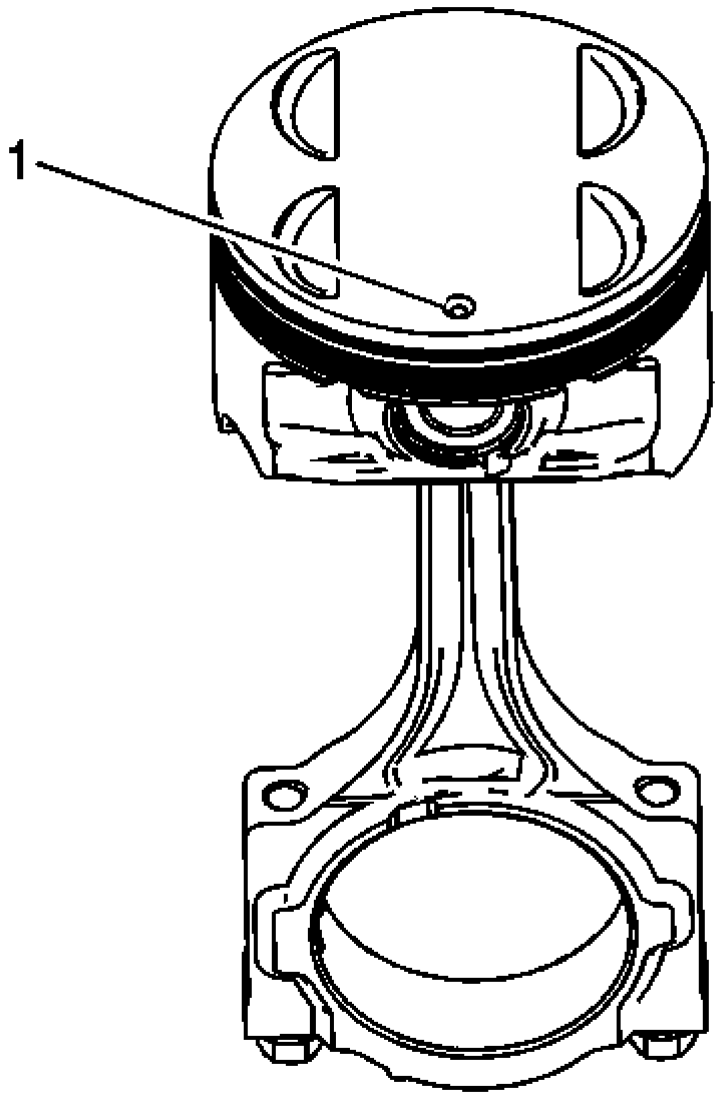


Fig. 358: Locating Dot On Top Of Piston
Courtesy of GENERAL MOTORS CORP.

1. Liberally lubricate the cylinder walls, piston rings and piston skirts with engine oil.

NOTE: The piston is directional and must be installed in the engine block in the proper direction. The dot on the top of the piston must face the front of the engine.

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2. Select the correctly numbered piston/connecting rod assembly for the cylinder. A dot (1) showing proper piston orientation is located on the top of the piston.

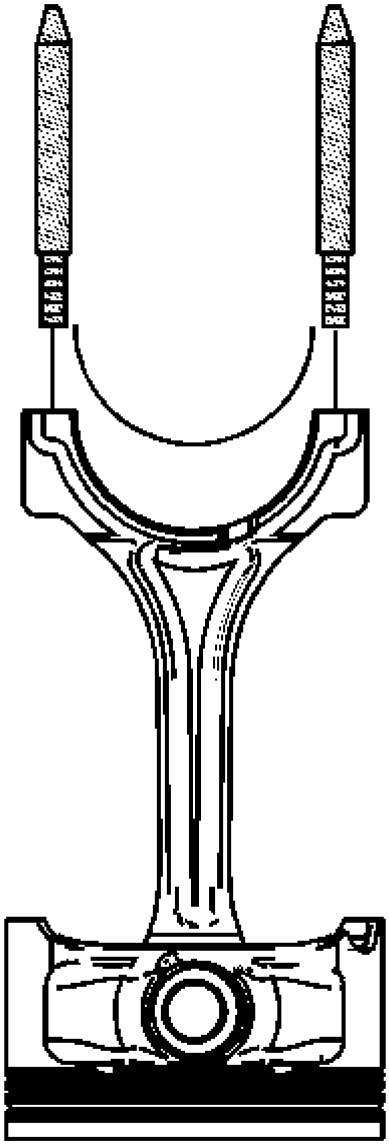


Fig. 359: View Of Piston/Connecting Rod Installation Tool
Courtesy of GENERAL MOTORS CORP.

NOTE: If the connecting rod bearings have been used in a running engine, you

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must replace them with NEW connecting rod bearings for reassembly.

3. Install the connecting rod bearing into the connecting rod.
4. Install the **EN 46121:** pin set into the connecting rod bolt holes.
5. Compress the piston rings using the **J 8037:** compressor or equivalent.

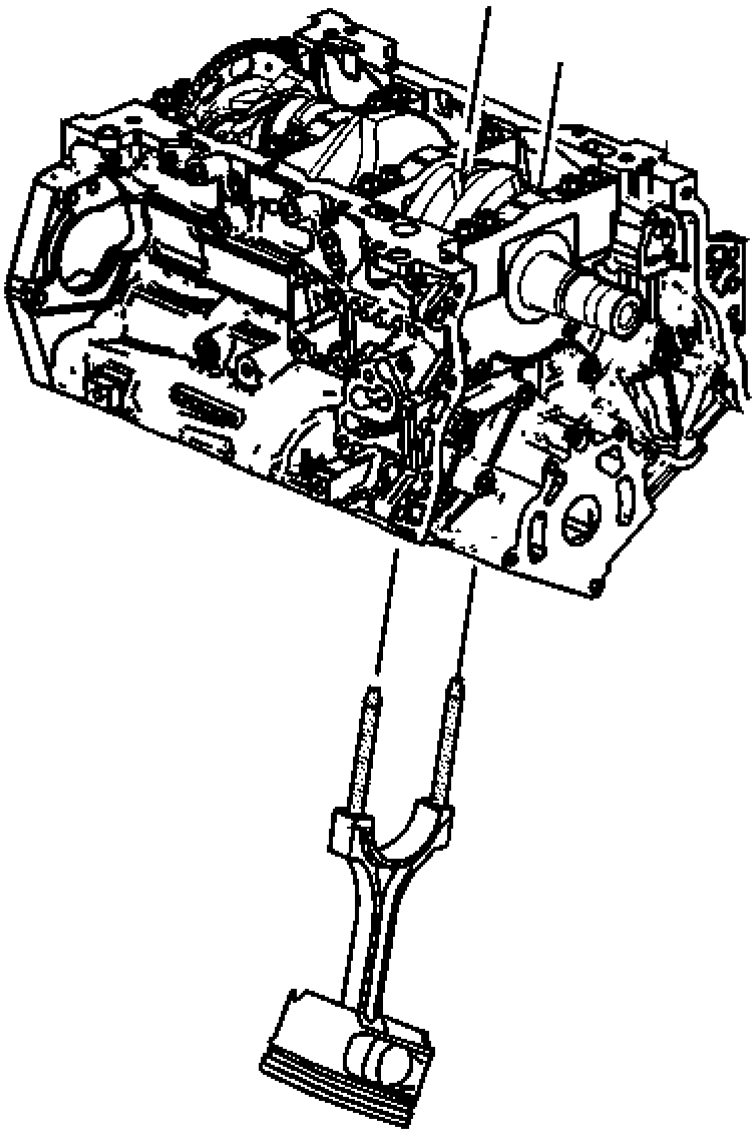


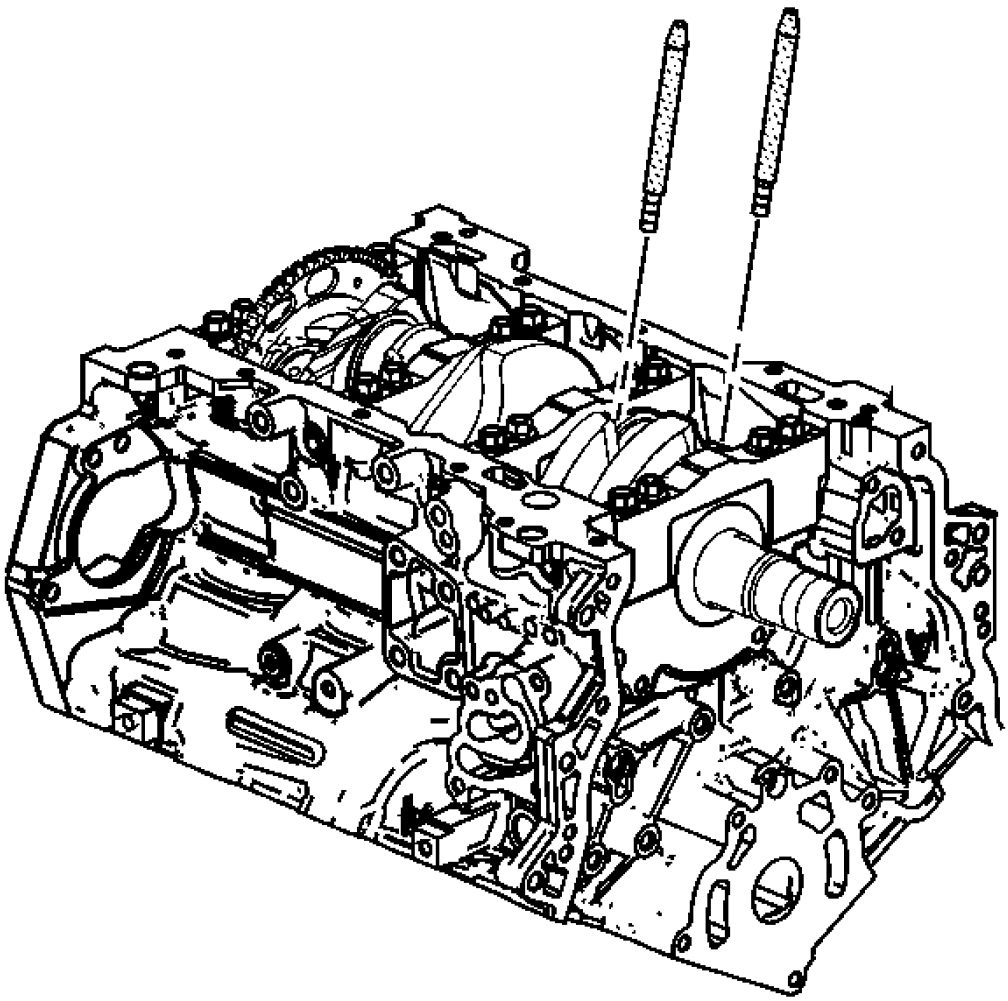
Fig. 360: View Of Connecting Rod & Piston Assembly

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Courtesy of GENERAL MOTORS CORP.

NOTE: Extreme care must be used when installing the piston and connecting rod in order to be sure the rod does not scrape or nick the cylinder bore, the oil jets, or the crankshaft surfaces.

6. Using both hands, slowly guide the piston and connecting rod assembly into the cylinder from the top and bottom of the cylinder. DO NOT allow the connecting rod to contact the cylinder wall.
7. When the **J 8037:** compressor contacts the deck surface, gently tap the piston into the cylinder using the handle end of a dead-blow hammer. Guide the connecting rod onto the crankshaft bearing journal using the **EN 46121:** pin set while gently tapping the piston into the cylinder with a soft-blow hammer.



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Fig. 361: Removing Special Tool
Courtesy of GENERAL MOTORS CORP.

8. Remove the **EN 46121:** pin set from the connecting rod bolt holes.

CONNECTING ROD BEARING CLEARANCE MEASUREMENT PROCEDURE - USING PLASTIC GAGING

NOTE: Connecting rod bearings that have been run in an engine should NEVER be reused.
Before final assembly it is important to check the clearance of the new connecting rod bearings.

1. Place a length of fresh, room temperature plastic gaging material all the way across the connecting rod bearing journal.
2. Install the connecting rod bearing into the connecting rod cap.

NOTE: The connecting rod is non-directional therefore the connecting rod bearing lock tangs can face inboard or outboard.

3. Install the connecting rod end cap on its original connecting rod and ensure the bearing lock tangs are aligned on the same side of the rod.

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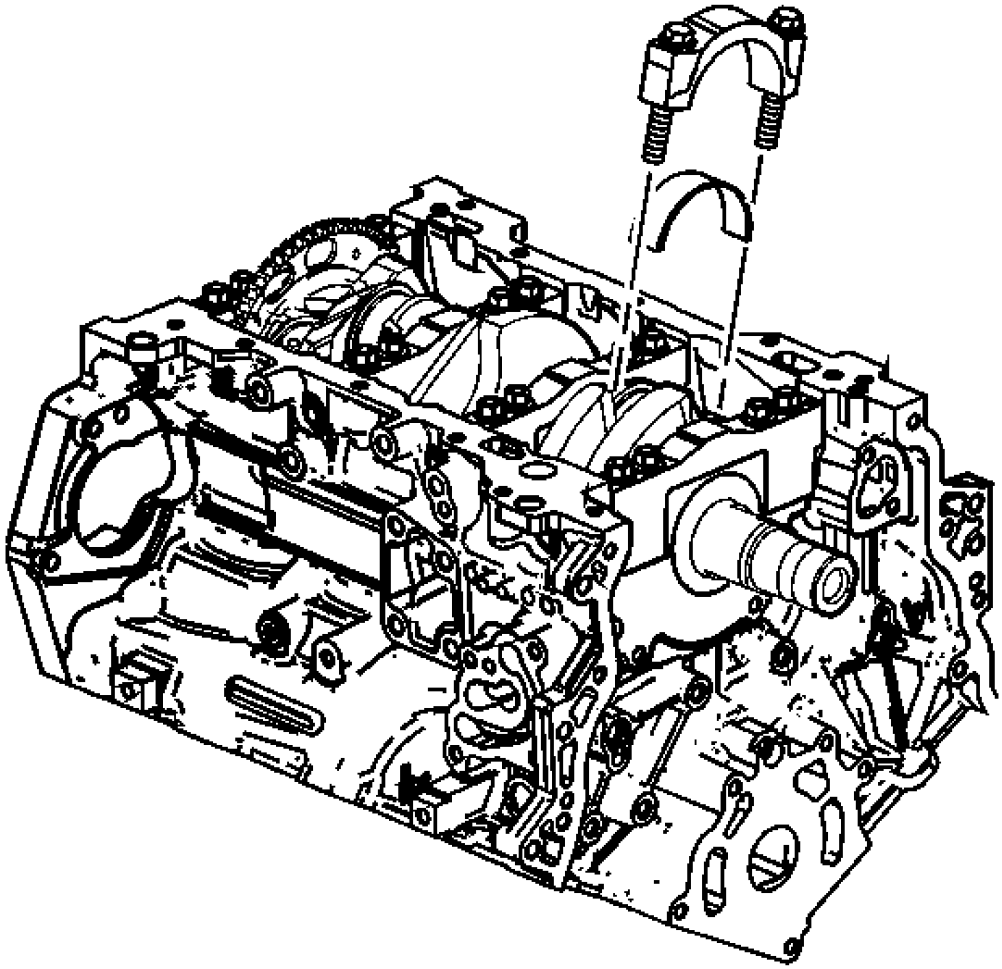


Fig. 362: View Of Connecting Rod Bearing & Cap
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

CAUTION: Do not lubricate the NEW connecting rod bolts. The NEW bolts have a pre-applied graphite lubricant. Applying lubricant to the connecting rod bolts will effect the clamp load when the connecting rod bolts are torqued. Improper clamp load can lead to component failure and extensive engine damage.

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NOTE: Reuse the old connecting rod bolts ONLY for measuring the connecting rod bearing clearance.

4. Install the connecting rod bolts into the connecting rod cap and tighten the connecting rod bolts to 30 N.m (22 lb ft).
5. Loosen the connecting rod bolts until the torque reading is zero.
6. Re-tighten the connecting rod bolts.
    1. First Pass

       Tighten the connecting rod bolts to 25 N.m (18 lb ft).

    2. Final Pass

       Tighten the connecting rod bolts an additional 110 degrees using the **J 45059:** meter.
7. Allow the assembly to sit for at least 2 minutes.
8. Remove the connecting rod cap bolts.
9. Remove the connecting rod cap.

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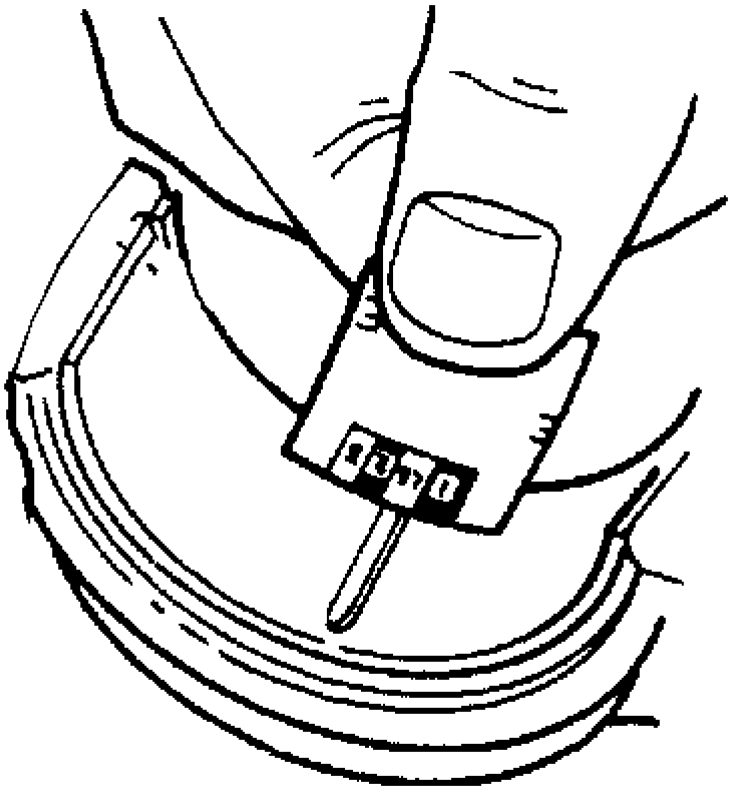


Fig. 363: Measuring Plastigage
Courtesy of GENERAL MOTORS CORP.

10. Determine the connecting rod bearing clearance by comparing the width of the flattened plastic gaging material at its widest point with the graduation on the gaging material container.
11. Compare your measurements with the engine mechanical specifications. If the new bearings do not provide the proper crankshaft to connecting rod bearing clearance, inspect the following:
    1. Re-measure the crankshaft connecting rod journals for the correct specified size and ensure the proper new bearings are being installed. If the crankshaft connecting rod journals are incorrectly sized, replace or regrind the crankshaft. Crankshaft machining is permitted and undersized bearings are available.
    2. Re-measure the connecting rod bearing bore diameter to ensure proper size. The connecting rod is not machinable and the connecting rod must be replaced if out of specification.
12. Clean the plastic gaging material from the connecting rod bearing journals using a soft lint-free cloth.

CONNECTING ROD BEARING CLEARANCE MEASUREMENT PROCEDURE - USING J 43690

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AND J 43690-100

The **J 43690:** checking tool and the **J 43690-100:** adapter kit have been developed as a more accurate method to measure connecting rod bearing clearances. The instructions below provide an overview of tool set-up and usage. For more detailed information, refer to the tool instruction sheets as supplied by the tool manufacturer.

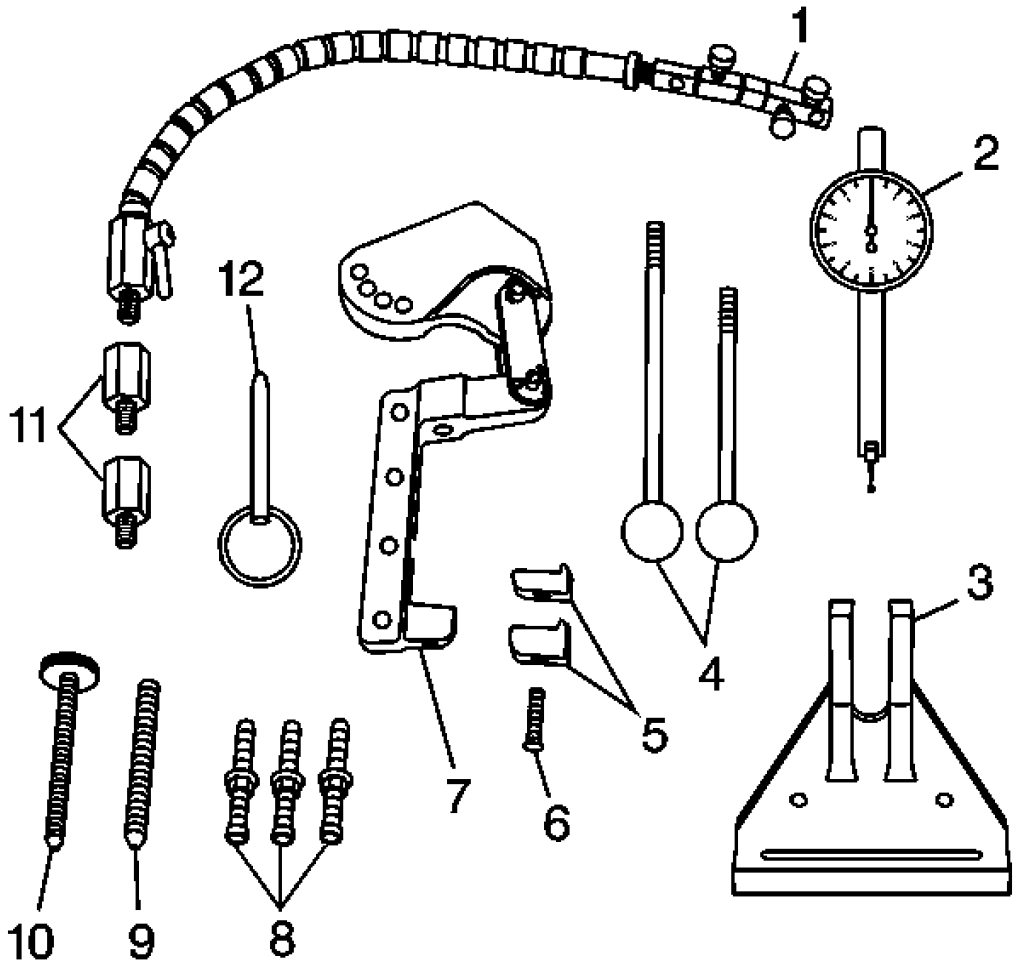


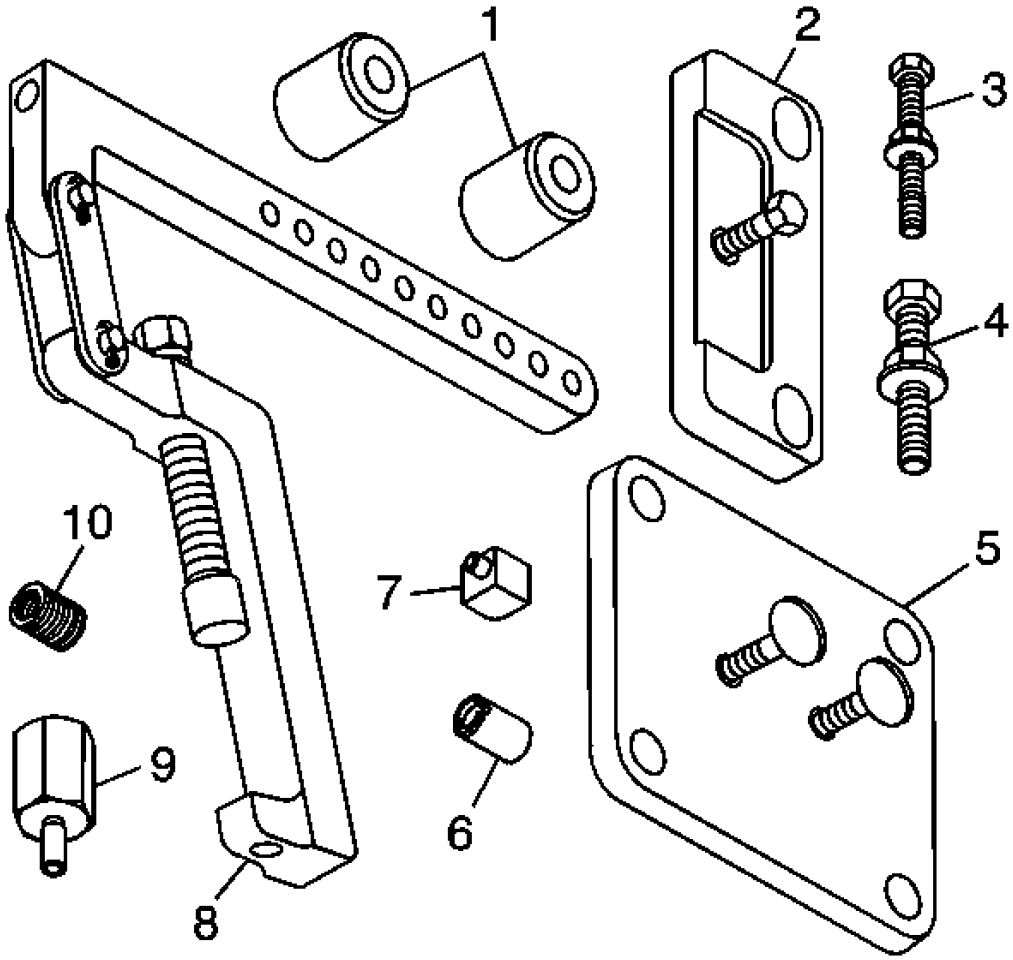
Fig. 364: Identifying Rod Bearing Clearance Checking Tool Components
Courtesy of GENERAL MOTORS CORP.

J 43690: checking tool

- J 43690-20 Swivel Base (1)
- J 43690-19 Dial Indicator (2)

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- J 43690-2 Base (3)
- J 43690-5, -6 Handle (4)
- J 43690-10, -11 Foot (5)
- 280307 Screw (6)
- J 43690-1 Pivot Arm Assembly (7)
- J 43690-3, -7, -8 Screws (8)
- 280319 Screw (9)
- 280311 Screw (10)
- J 43690-17, -18 Adapter (11)
- 280310 Pin (12)



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Fig. 365: Identifying Rod Bearing Clearance Tool - Adapter Kit Components
Courtesy of GENERAL MOTORS CORP.

J 43690-100: adapter kit

- J 43690-104 Spacer (1)
- J 43690-105 Retainer Plate (2)
- 505478 Bolt (3)
- 511341 Bolt (4)
- J 43690-106 Retainer Plate (5)
- J 43690-107 Cap (6)
- J 43690-102 Foot (7)
- J 43690-101 Pivot Arm Assembly (8)
- J 43690-103 Adapter (9)
- 505439 Adapter (10)

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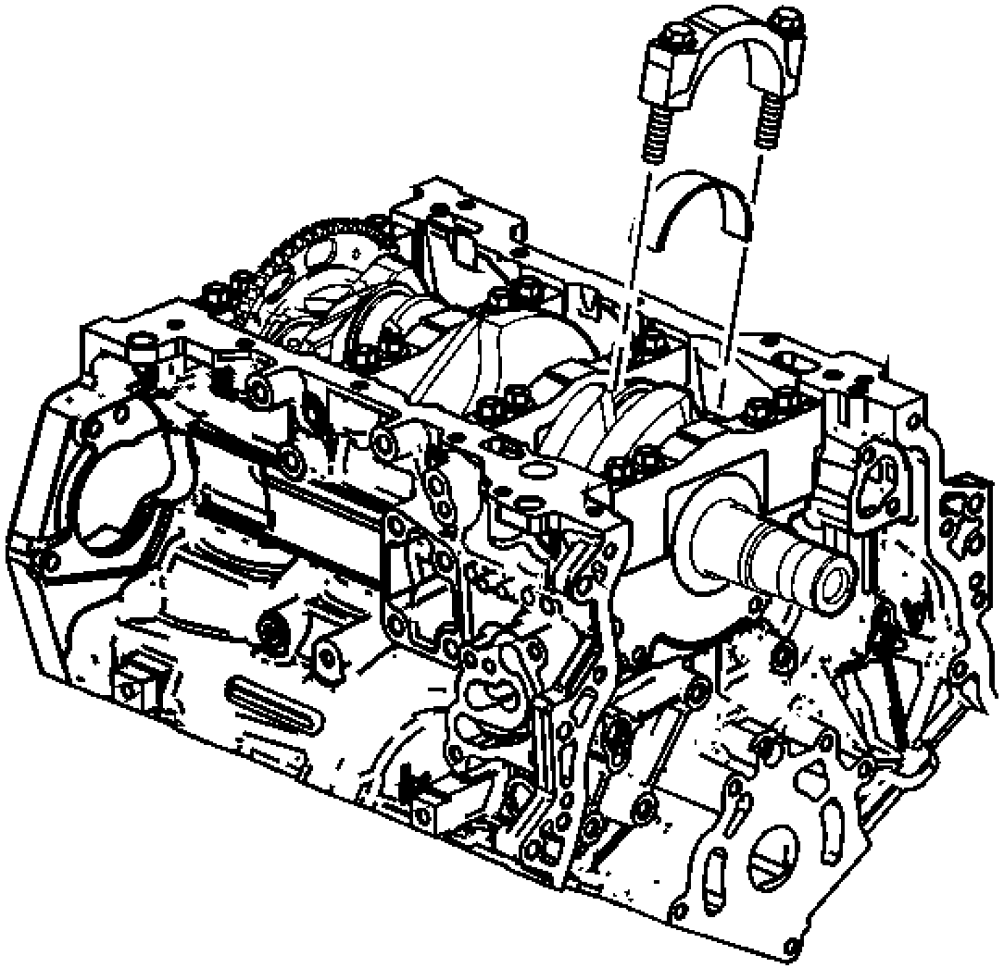


Fig. 366: View Of Connecting Rod Bearing & Cap
Courtesy of GENERAL MOTORS CORP.

NOTE: Connecting rod bearings that have been run in an engine should NEVER be reused.
Before final assembly it is important to check the clearance of the new connecting rod bearings.

1. Install the connecting rod bearing into the connecting rod cap.

NOTE: The connecting rod is non-directional therefore the connecting rod bearing lock tangs can face inboard or outboard.

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2. Install the connecting rod end cap on its original connecting rod and ensure the bearing lock tangs are aligned on the same side of the rod.

CAUTION: Refer to Fastener Caution .

CAUTION: Do not lubricate the NEW connecting rod bolts. The NEW bolts have a pre-applied graphite lubricant. Applying lubricant to the connecting rod bolts will effect the clamp load when the connecting rod bolts are torqued. Improper clamp load can lead to component failure and extensive engine damage.

NOTE: Reuse the old connecting rod bolts ONLY for measuring the connecting rod bearing clearance.

3. Install the connecting rod bolts into the connecting rod cap and tighten the connecting rod bolts to 30 N.m (22 lb ft).
4. Loosen the connecting rod bolts until the torque reading is zero.
5. Re-tighten the connecting rod bolts.
    1. First Pass

       Tighten the connecting rod bolts to 25 N.m (18 lb ft).

    2. Final Pass

       Tighten the connecting rod bolts an additional 110 degrees using the **J 45059:** meter.

6. Rotate the crankshaft until the crankshaft journal and the connecting rod to be measured is in the 12 o'clock position.

NOTE: The crankshaft must be secure with no movement or rotation in order to obtain an accurate reading.

7. Remove the crankshaft main bolts required to install the retainer plate J 43690-105.

NOTE: Do not allow the J 43690-105 retainer plate screw to contact the reluctor ring.

8. Install the J 43690-105 and crankshaft main bolts.
9. Loosen the connecting rod bolts until the torque reading is zero.
10. Re-tighten the connecting rod bolts.
    1. First Pass

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Tighten the connecting rod bolts to 25 N.m (18 lb ft).

2. Final Pass

   Tighten the connecting rod bolts an additional 110 degrees using the **J 45059:** meter.

11. During and after installation, ensure each piston is positioned properly in the correct cylinder. The locating arrow on the top of each piston must be pointing toward the front of the engine.
12. Repeat these procedures for the remaining piston/connecting rod assemblies using the **EN-48589:** socket in order to rotate the crankshaft.

CONNECTING ROD FINAL ASSEMBLY PROCEDURE

1. Guide the connecting rod away from the crankshaft connecting rod journal in order to lubricate the crankshaft connecting rod bearing journal.
2. Apply a liberal amount of crankshaft prelube or clean engine oil to the crankshaft connecting rod bearing journal. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.
3. Guide the connecting rod to the crankshaft connecting rod journal.
4. Install the connecting rod end cap on its original connecting rod and ensure the bearing lock tangs are aligned on the same side of the rod.

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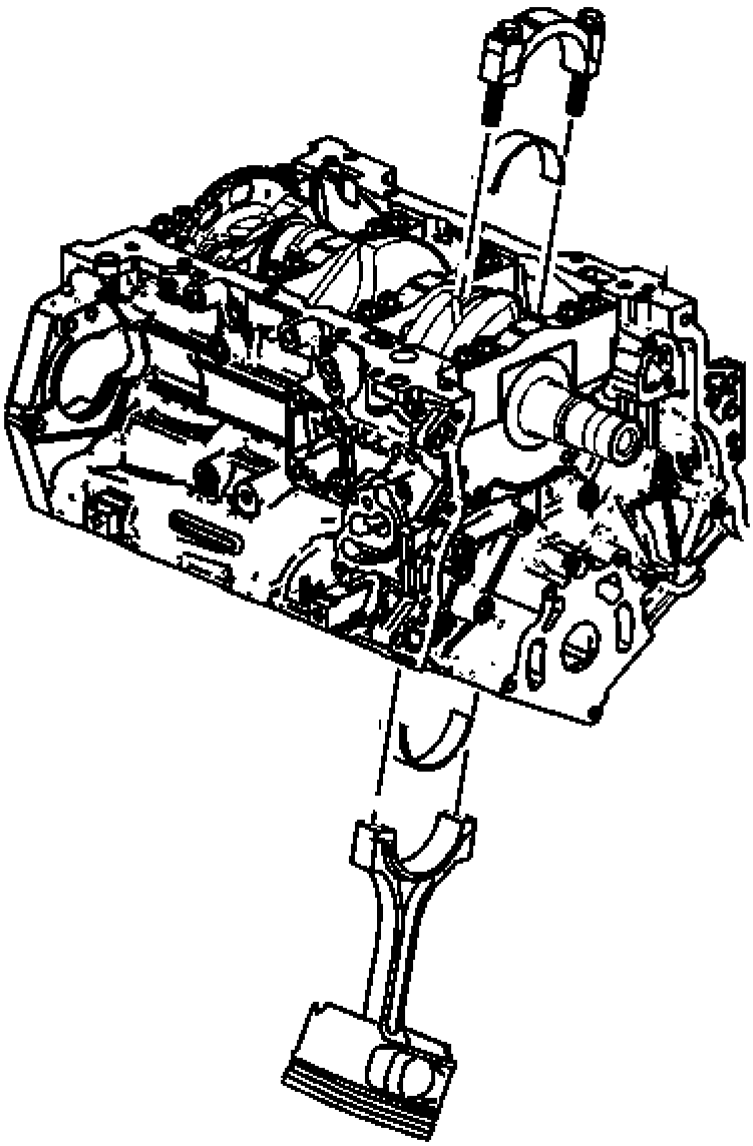


Fig. 367: View Of Piston & Connecting Rod Assembly
Courtesy of GENERAL MOTORS CORP.

CAUTION: Do not lubricate the NEW connecting rod bolts. The NEW bolts have a pre-applied graphite lubricant. Applying lubricant to the connecting rod bolts will effect the clamp load when the connecting rod bolts are torqued. Improper clamp load can lead to component failure and

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extensive engine damage.

NOTE: DO NOT reuse the old connecting rod bolts.

5. Install the NEW connecting rod bolts into the connecting rod cap and tighten the NEW connecting rod bolts to 30 N.m (22 lb ft).
6. Loosen the connecting rod bolts until the torque reading is zero.
7. Re-tighten the connecting rod bolts.
    1. First Pass

       Tighten the connecting rod bolts to 25 N.m (18 lb ft).

    2. Final Pass

       Tighten the connecting rod bolts an additional 110 degrees using the **J 45059:** meter.
8. During and after installation, ensure each piston is positioned properly in the correct cylinder. The locating arrow on the top of each piston must be pointing toward the front of the engine.
9. Repeat these procedures for the remaining piston/connecting rod assemblies using the **J 45059:** meter in order to rotate the crankshaft.

CRANKSHAFT REAR OIL SEAL AND HOUSING INSTALLATION

Special Tools

- **EN-46109:** Guide Pin Set
- **EN-47839:** Crankshaft Rear Oil Seal Installation Tool
- **J-42183:** Handle

For equivalent regional tools, refer to **Special Tools** .

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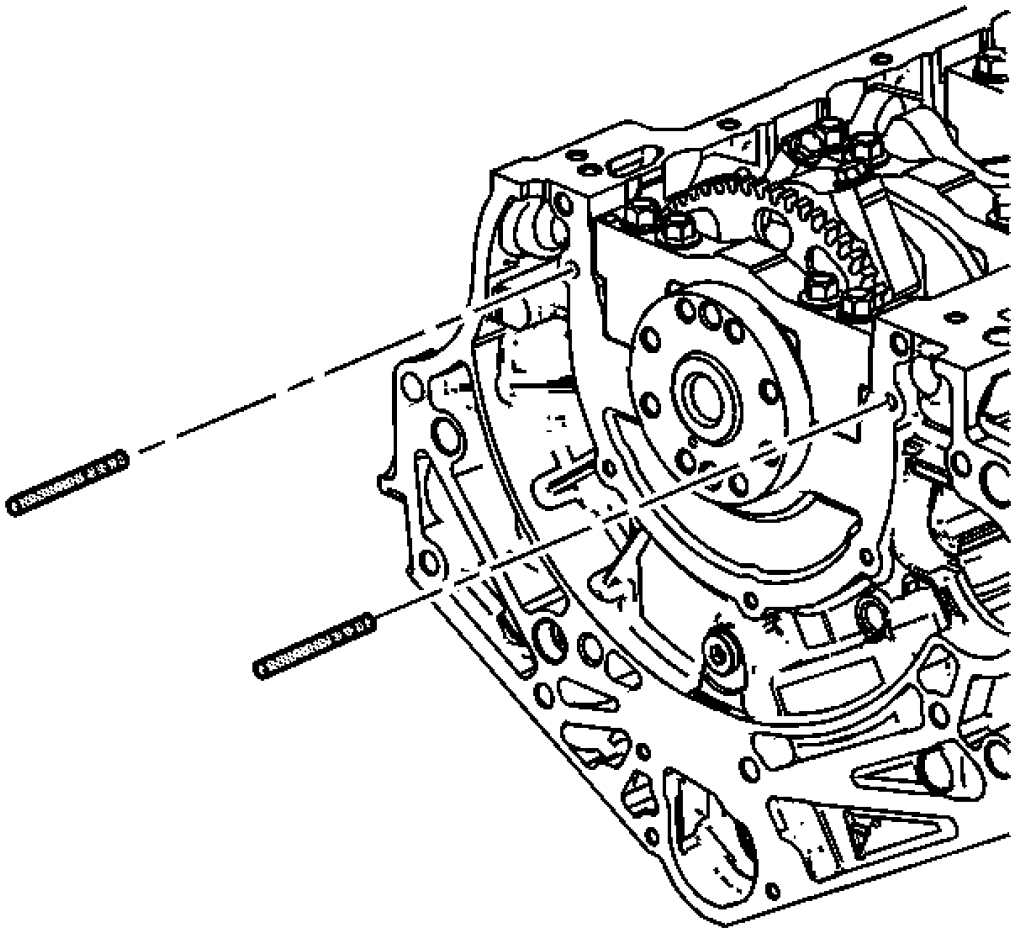


Fig. 368: View Of Guides
Courtesy of GENERAL MOTORS CORP.

1. Install the 6 mm (0.236 in) guides from the **EN-46109:** pin set into the 2 crankshaft rear oil seal housing corner bolt holes of the engine block.

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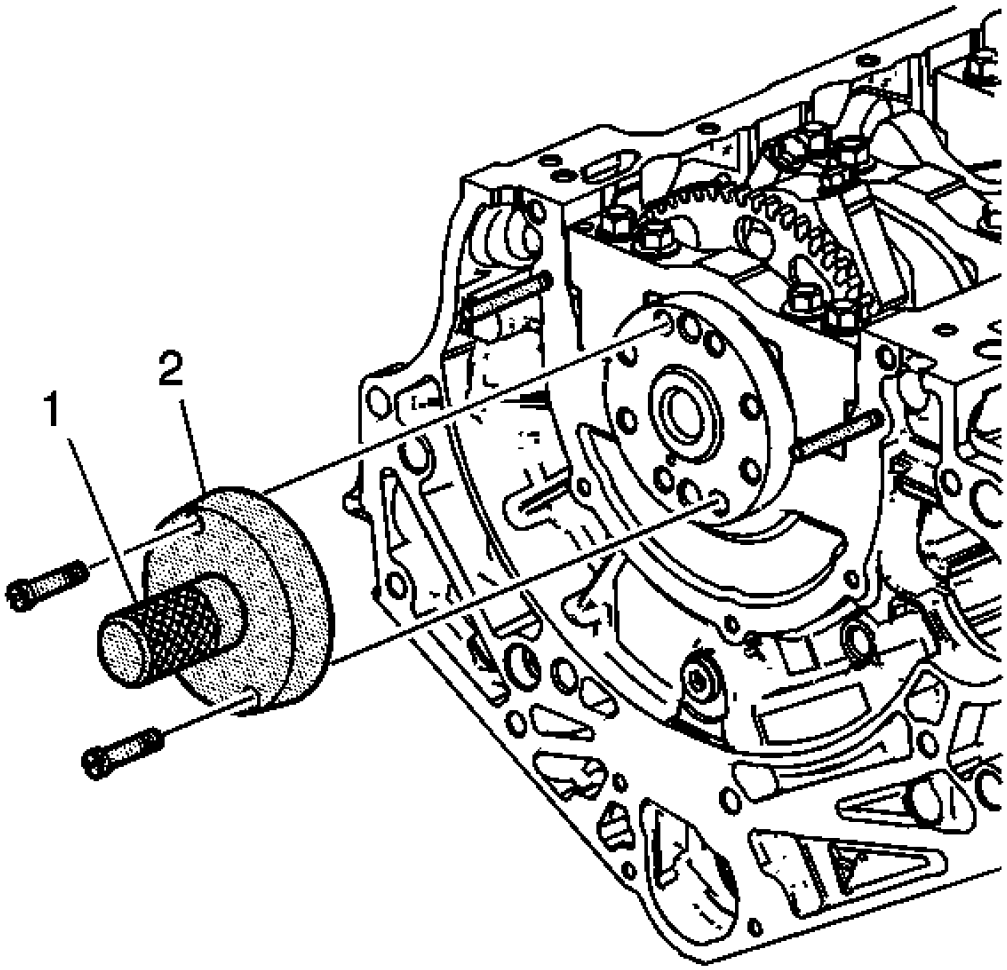


Fig. 369: Identifying Special Tools EN-47839 & J-42183
Courtesy of GENERAL MOTORS CORP.

2. Install the **EN-47839:** tool with the **J-42183:** handle (1, 2) onto the rear of the crankshaft flange.

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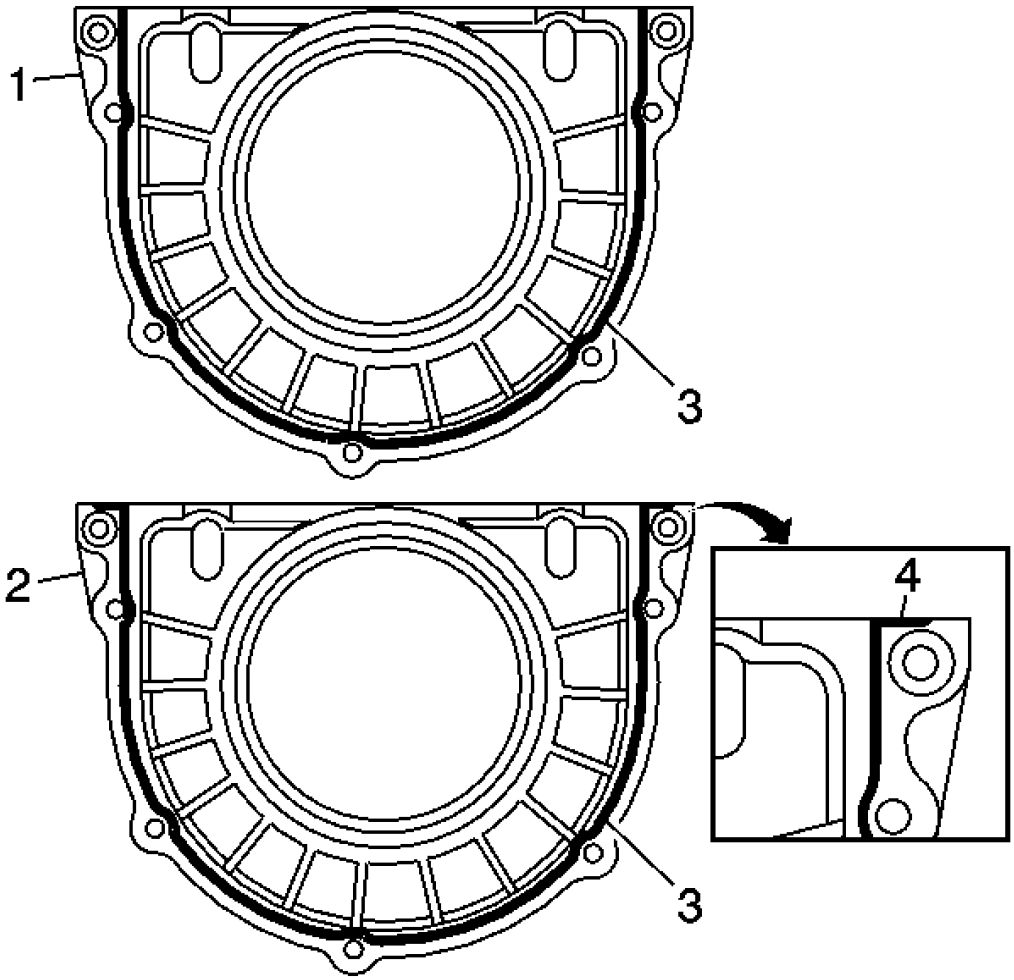


Fig. 370: First Design & Second Design Crankshaft Rear Oil Seal Housings
Courtesy of GENERAL MOTORS CORP.

NOTE: There are first design (1) and second design (2) crankshaft rear oil seal housings. Second design oil seal housings include additional grooves for RTV sealant near the oil seal housing to oil pan interface (4).

3. Place a 3 mm (0.118 in) bead of RTV sealant to the NEW crankshaft rear oil seal housing as shown (3). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

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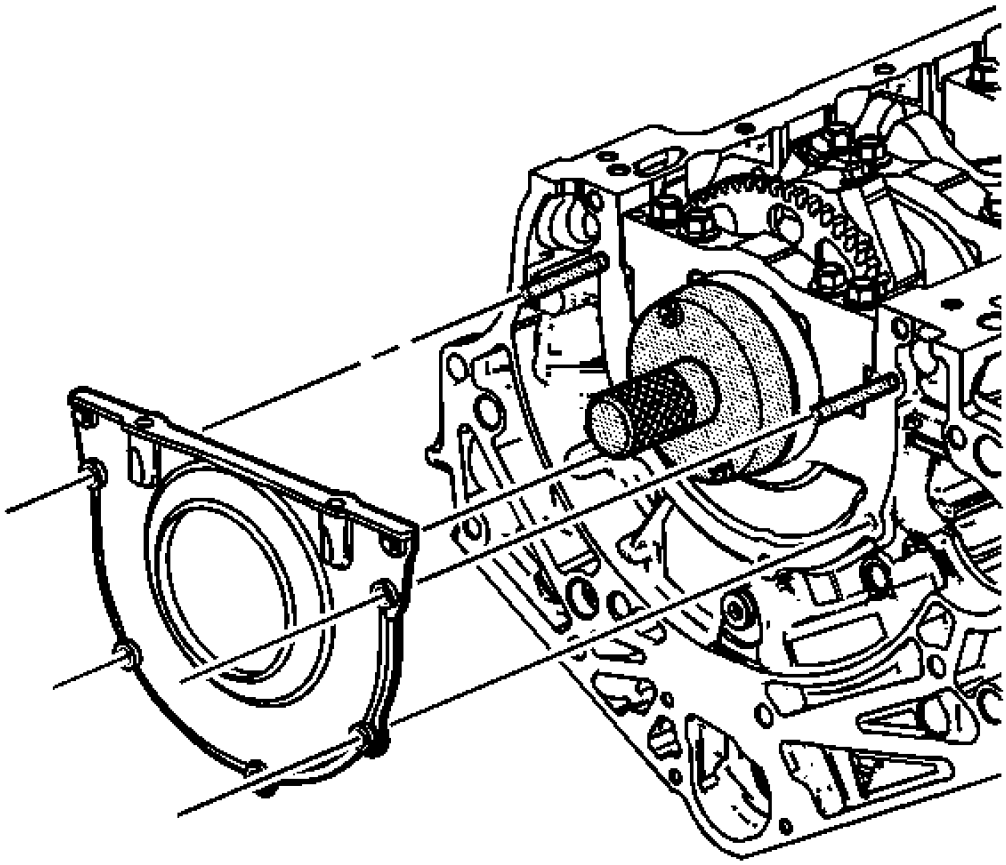


Fig. 371: Installing Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS CORP.

NOTE: DO NOT allow any engine oil on the area where the crankshaft rear oil seal housing is to be installed.

4. Install the crankshaft rear oil seal housing to the engine block.

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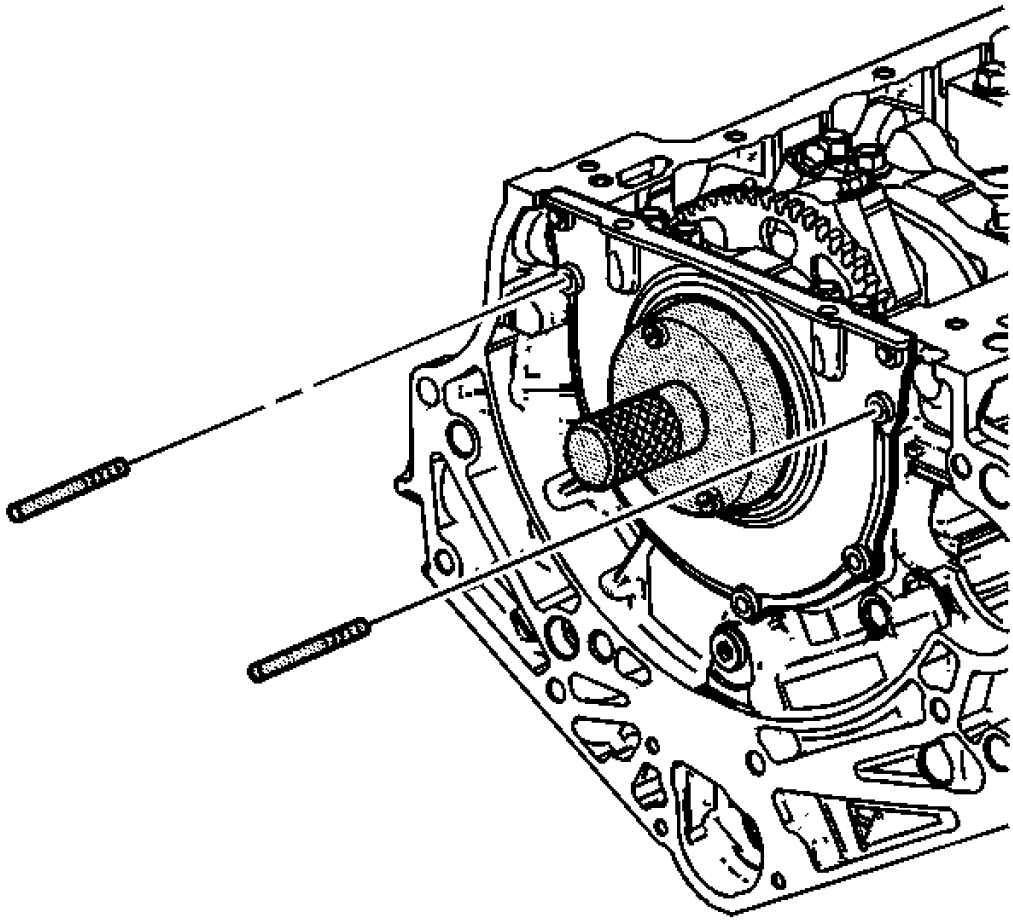


Fig. 372: View Of Pin Set guides
Courtesy of GENERAL MOTORS CORP.

5. Remove the **EN-46109:** pin set 6 mm (0.236 in) guides from the engine block.

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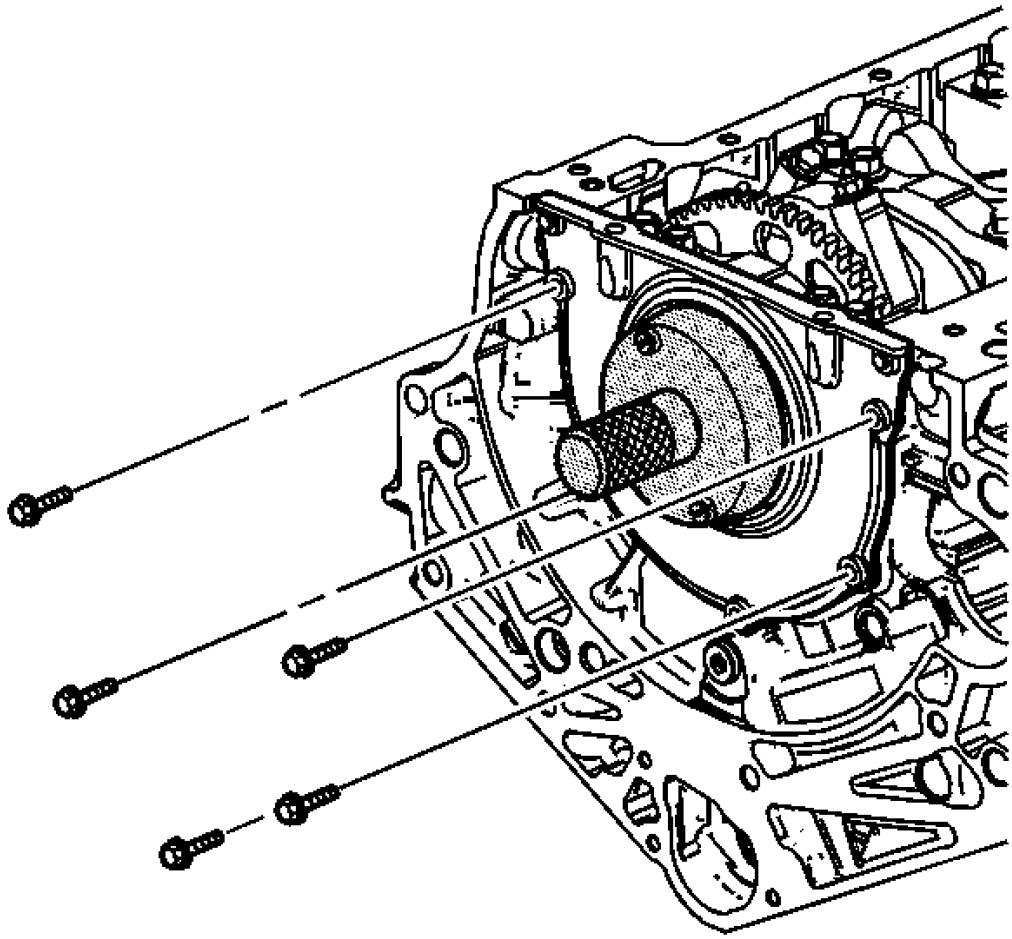


Fig. 373: Crankshaft Rear Oil Seal Housing Bolts
Courtesy of GENERAL MOTORS CORP.

6. Install the crankshaft rear oil seal housing bolts.

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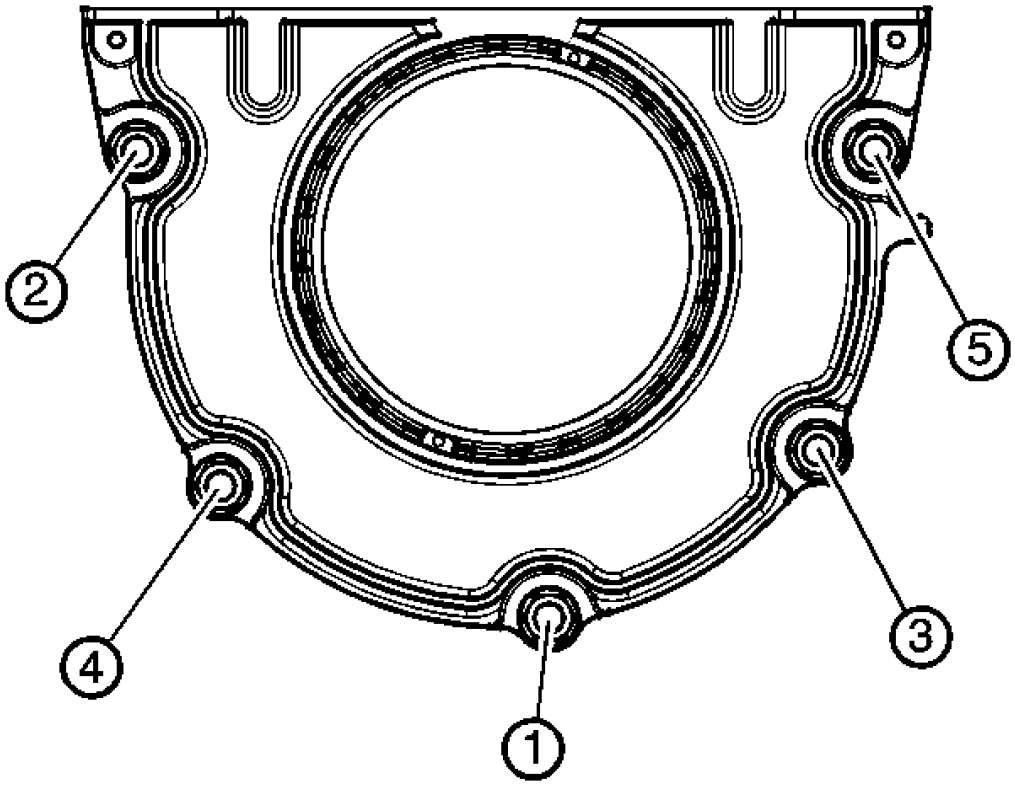


Fig. 374: Identifying Crankshaft Rear Oil Seal Housing Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

7. Tighten the crankshaft rear oil seal housing bolts in sequence and tighten to 10 N.m (89 lb in).

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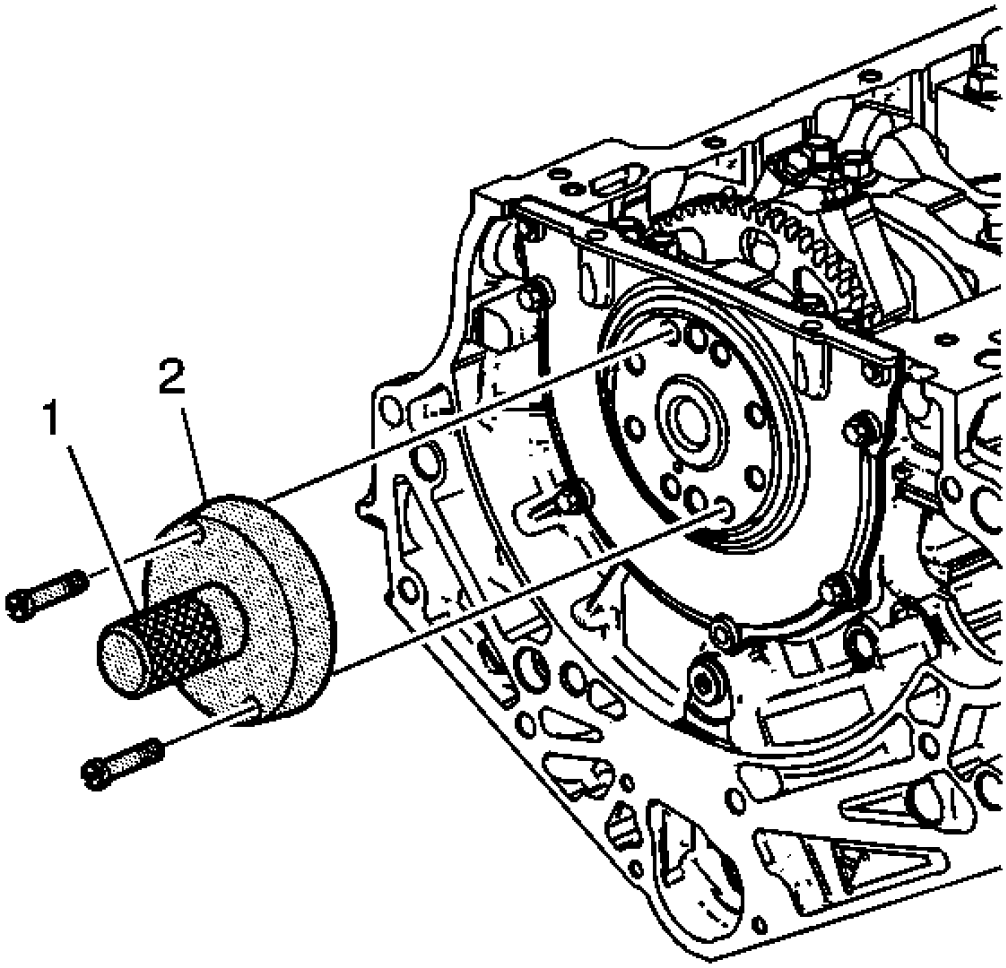


Fig. 375: Identifying Special Tools EN-47839 & J-42183
Courtesy of GENERAL MOTORS CORP.

8. Remove the **EN-47839:** tool and **J-42183:** handle (1, 2) from the crankshaft flange.

OIL PUMP INSTALLATION

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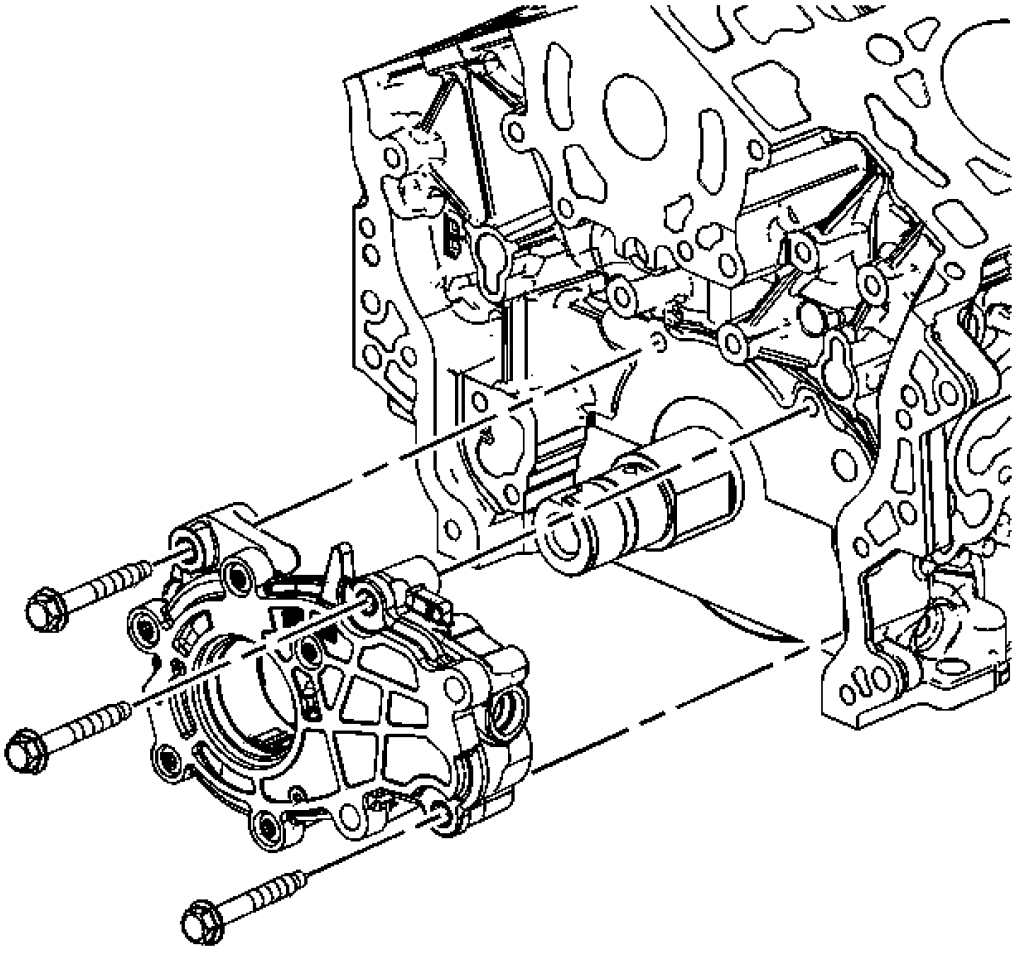


Fig. 376: Oil Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Align the oil pump drive gear with the crankshaft flats and install the oil pump to the engine block.
2. Align the pump body with the mounting holes in the cylinder block.

CAUTION: Refer to Fastener Caution .

3. Install the oil pump bolts and tighten to 25 N.m (18 lb ft).

OIL PAN INSTALLATION

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SPECIAL TOOLS

EN 46109: Guide Pin Set

For equivalent regional tools, refer to **Special Tools**

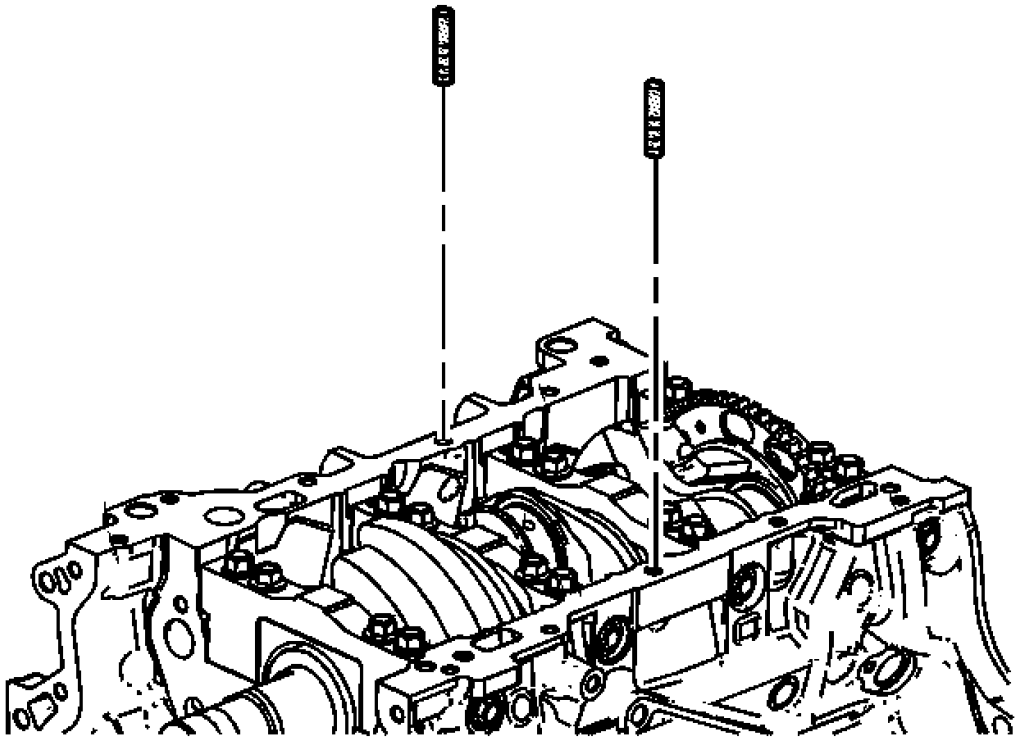


Fig. 377: View Of Guides
Courtesy of GENERAL MOTORS CORP.

1. Install the 8 mm (0.315 in) guides from the **EN 46109:** set into the center oil pan rail bolt hole on each side of the engine block.

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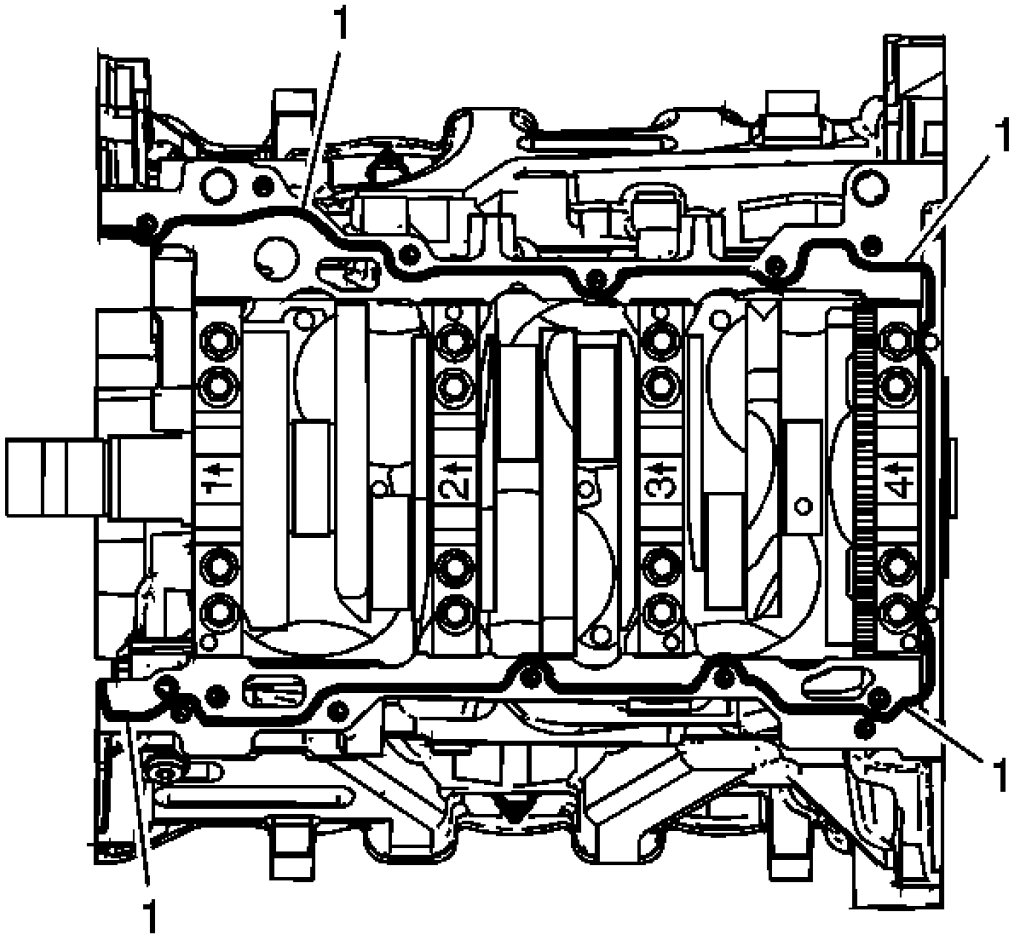


Fig. 378: Applying Sealant On Block Pan Rail & Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS CORP.

2. Place a 3 mm (0.118 in) bead of RTV sealant, GM P/N 12378521 (Canadian P/N 88901148) or equivalent, on the block pan rail and the crankshaft rear oil seal housing (1).

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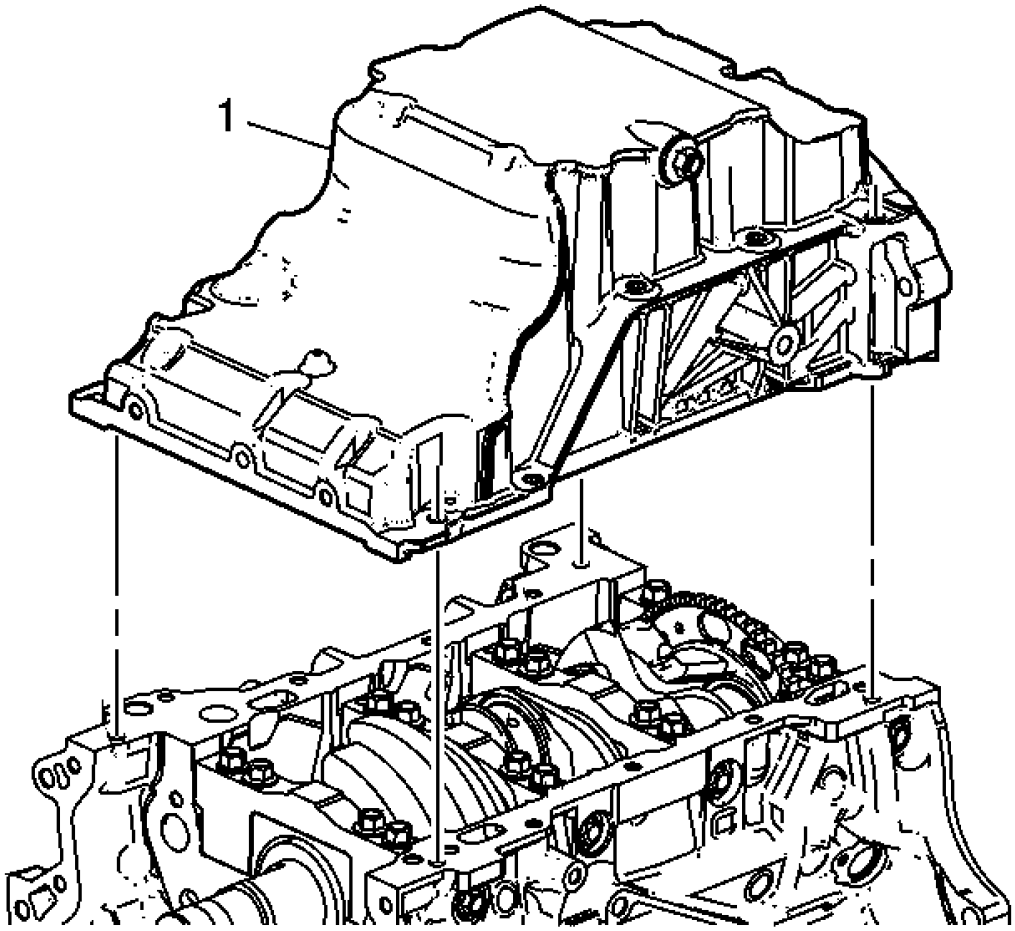


Fig. 379: Oil Pan
Courtesy of GENERAL MOTORS CORP.

3. Position the oil pan (1) onto the block.
4. Remove the **EN 46109:** set 8 mm (0.315 in) guides from the engine block.

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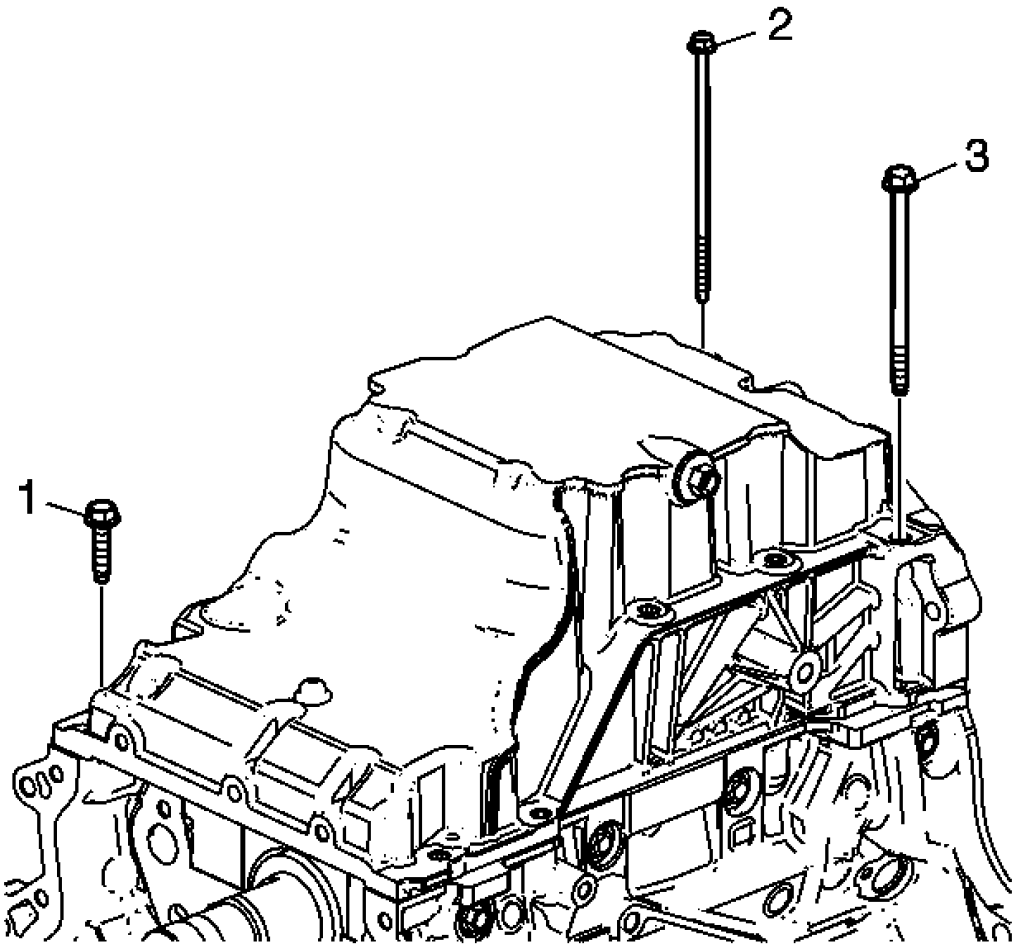


Fig. 380: Oil Pan Bolts
Courtesy of GENERAL MOTORS CORP.

5. Loosely install the oil pan bolts (1), (2) and (3).

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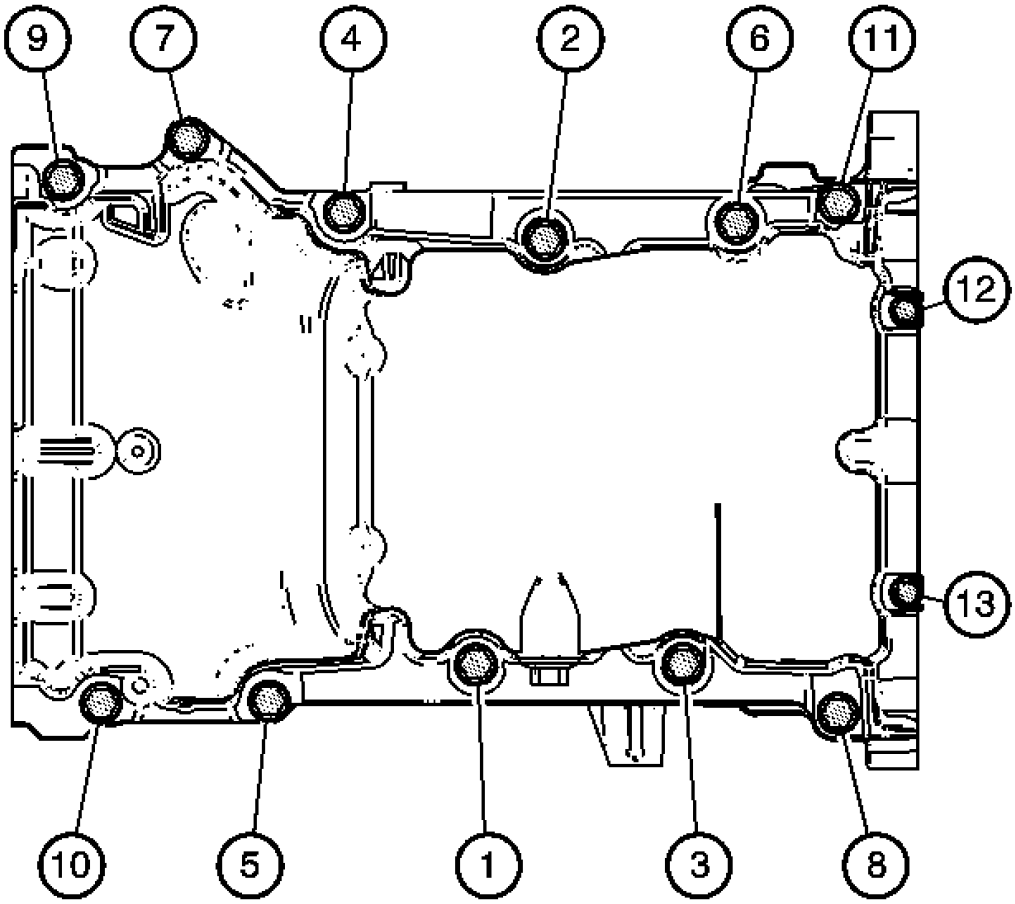


Fig. 381: Oil Pan Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

6. Tighten the oil pan bolts in sequence shown.
    1. Tighten the 8 mm bolts (1-11) to 23 N.m (17 lb ft) .
    2. Tighten the 6 mm bolts (12, 13) to 10 N.m (89 lb in) .

CYLINDER HEAD INSTALLATION - RIGHT SIDE (LLT)

SPECIAL TOOLS

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J 45059: Angle Meter

For equivalent regional tools, refer to **Special Tools**

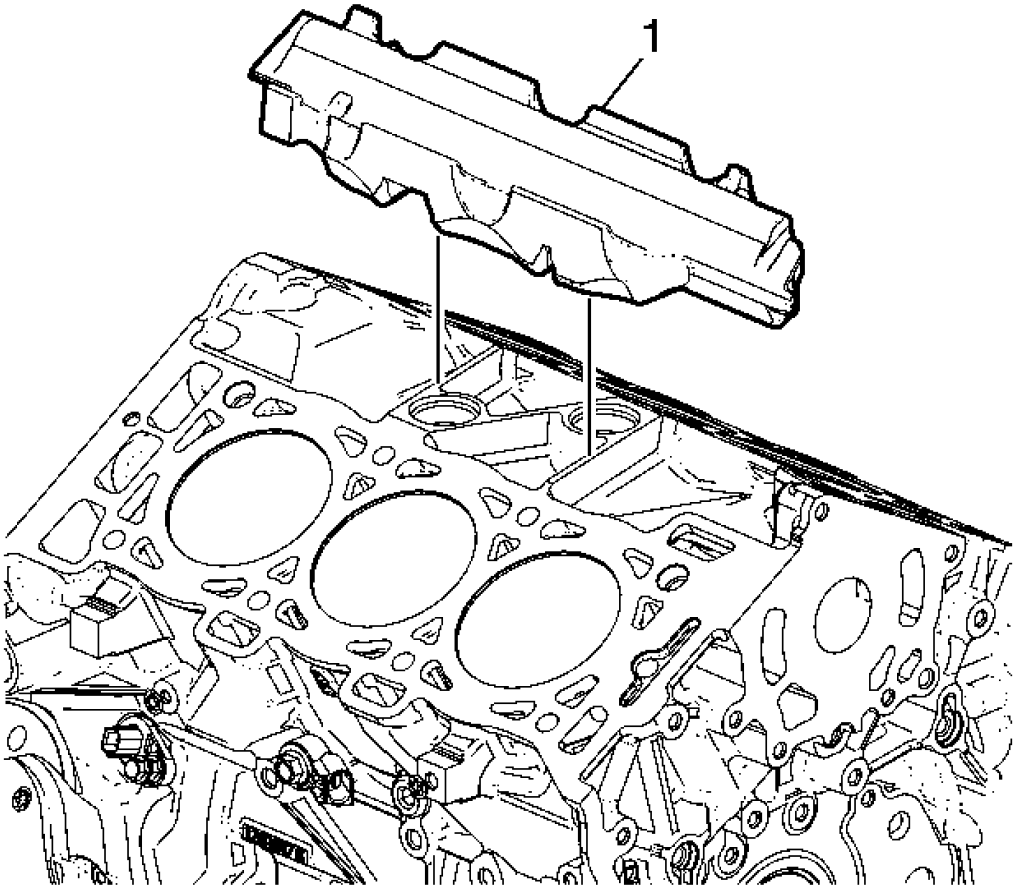


Fig. 382: Lower Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS CORP.

1. Install the lower fuel rail noise shield (1).

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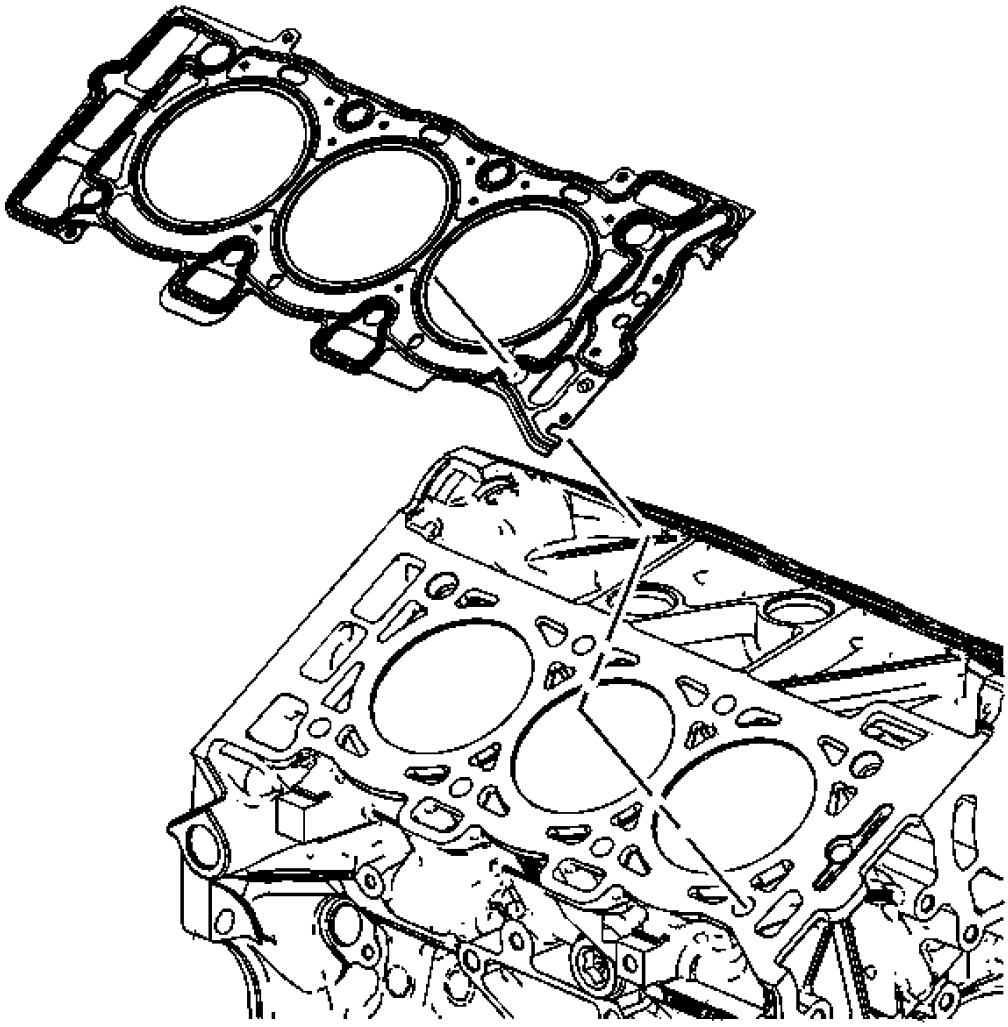


Fig. 383: View Of Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

2. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.
3. Install a NEW right cylinder head gasket using the deck face locating pins for retention.

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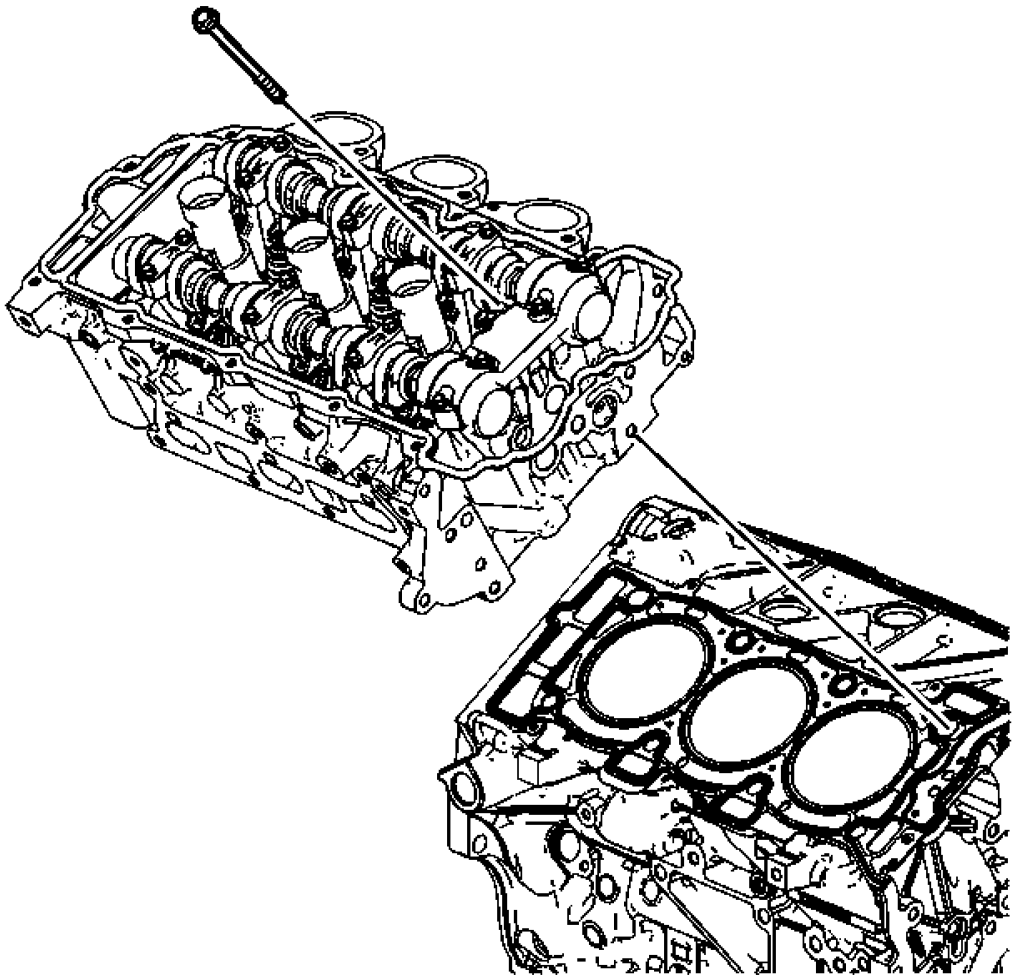


Fig. 384: Cylinder Head & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Align the right cylinder head with the deck face locating pins.
5. Place the right cylinder head in position on the deck face.

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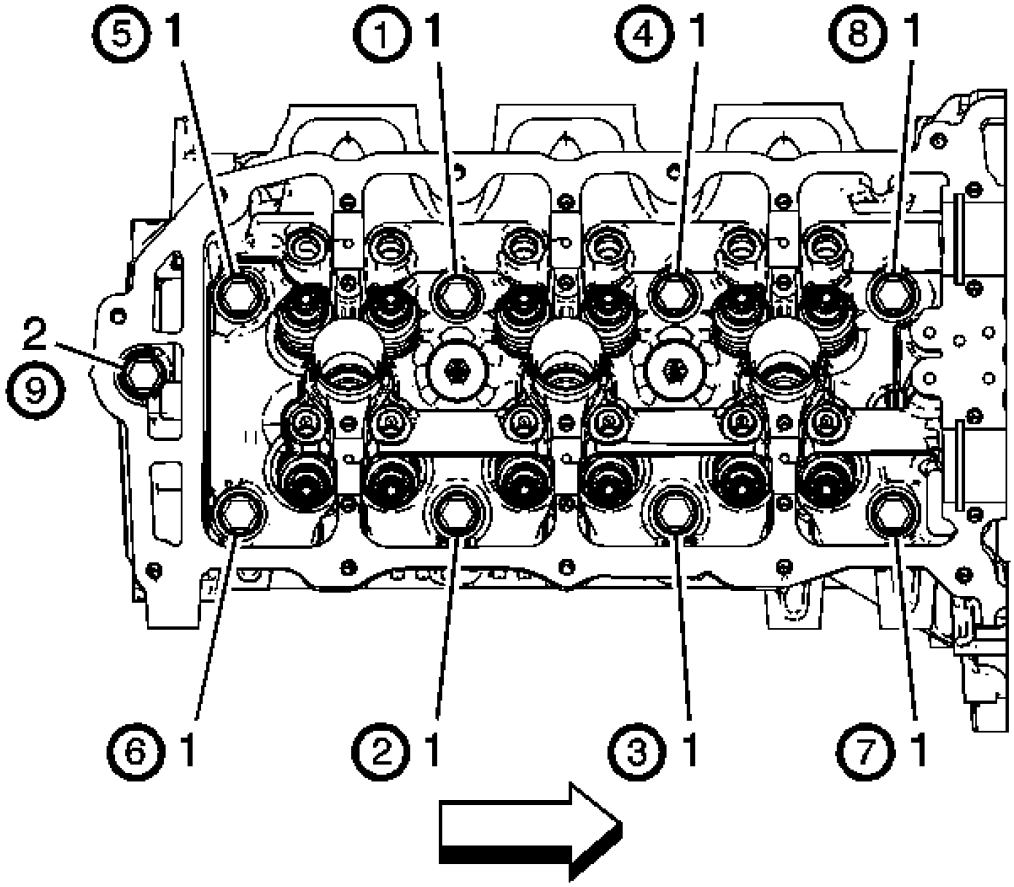


Fig. 385: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: DO NOT allow oil on the cylinder head bolt bosses.

NOTE: DO NOT reuse the old cylinder head bolts.

6. Install the NEW M11 cylinder head bolts (1).
   1. Tighten the M11 cylinder head bolts a first pass in sequence to 30 N.m (22 lb ft) .
   2. Tighten the M11 cylinder head bolts a second pass in sequence an additional 150 degrees using the **J 45059:** meter .

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7. Install the NEW M8 cylinder head bolt (2).
    1. Tighten the M8 cylinder head bolt a first pass to 15 N.m (11 lb ft).
    2. Tighten the M8 cylinder head bolt a second pass an additional 75 degrees using the **J 45059:** meter .

VALVE LIFTER INSTALLATION - RIGHT SIDE

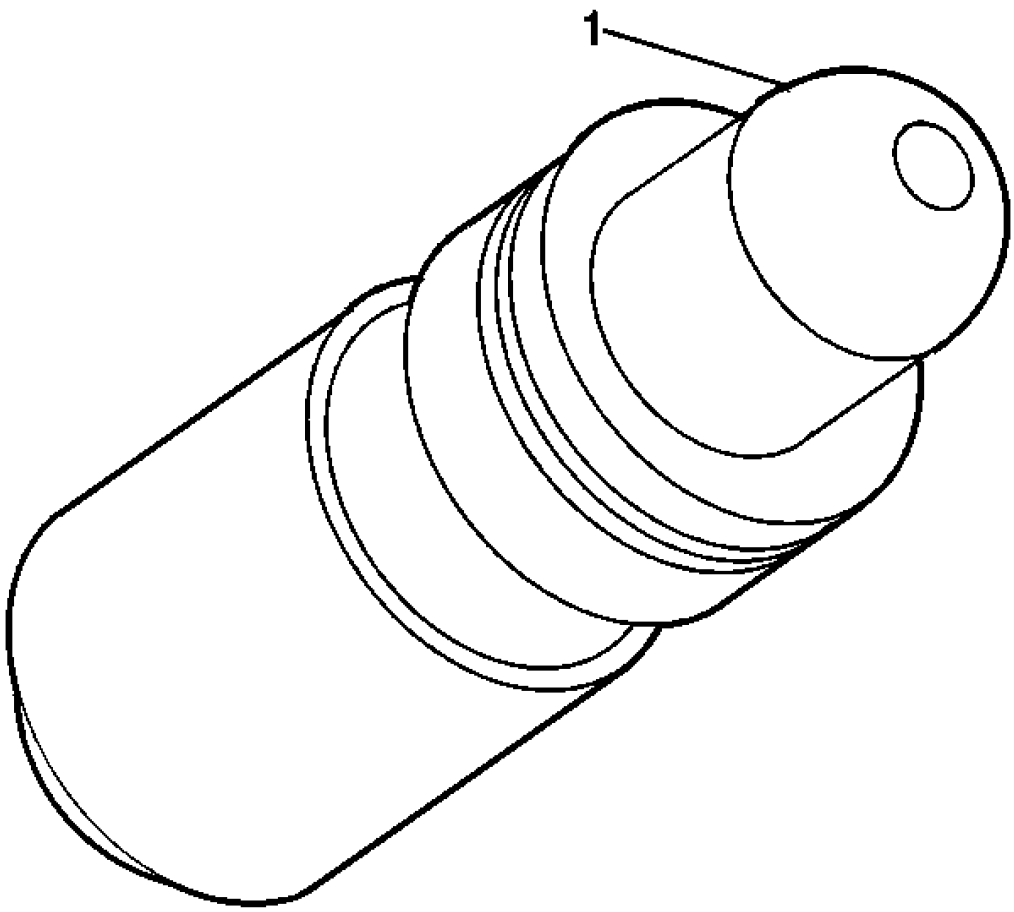


Fig. 386: Identifying Pivot Sphere Area Of SHLA
Courtesy of GENERAL MOTORS CORP.

NOTE: **Do not stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.**

NOTE: **Do not allow the stationary hydraulic lash adjuster to tip over, plunger**

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down, after the oil fill.

1. Fill the stationary hydraulic lash adjuster (SHLA) with clean engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended engine oil. Take precautions to prevent scratching the pivot sphere area (1) of the SHLA.
2. Lubricate the SHLA bores in the cylinder head with clean engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended engine oil.

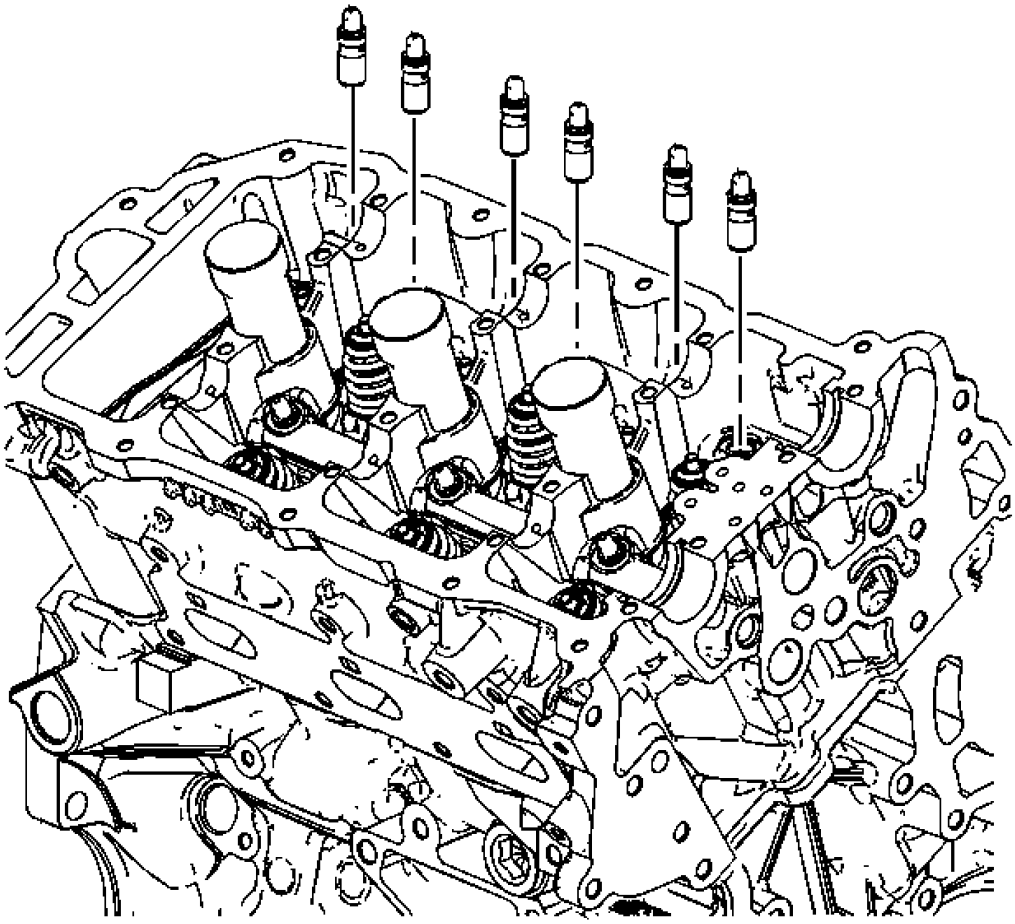


Fig. 387: Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

3. Install the SHLAs in the cylinder head.
4. Apply a liberal amount of lubricant to the SHLA pivot spheres. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

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VALVE ROCKER ARM INSTALLATION - RIGHT SIDE

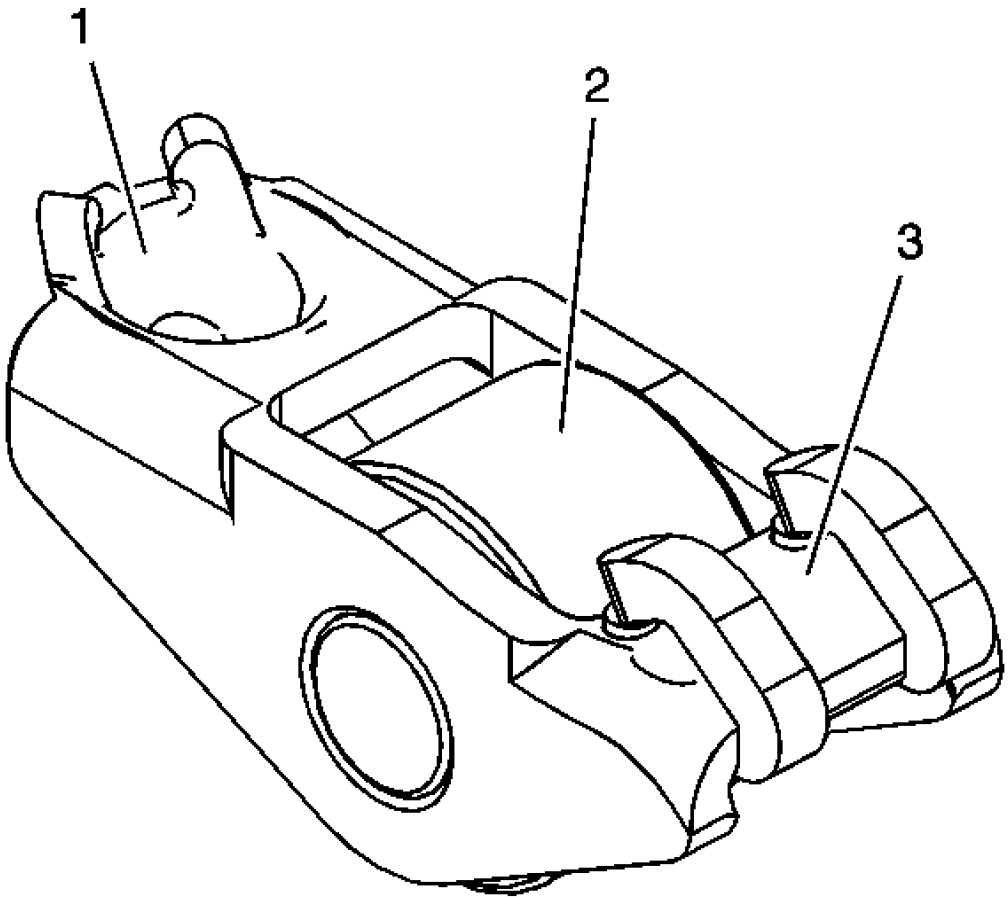


Fig. 388: Identifying Valve Rocker Arm Lubrication Areas
Courtesy of GENERAL MOTORS CORP.

1. Apply a liberal amount of lubricant to the pivot pocket (1), roller (2) and valve slot (3) areas of the camshaft followers. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

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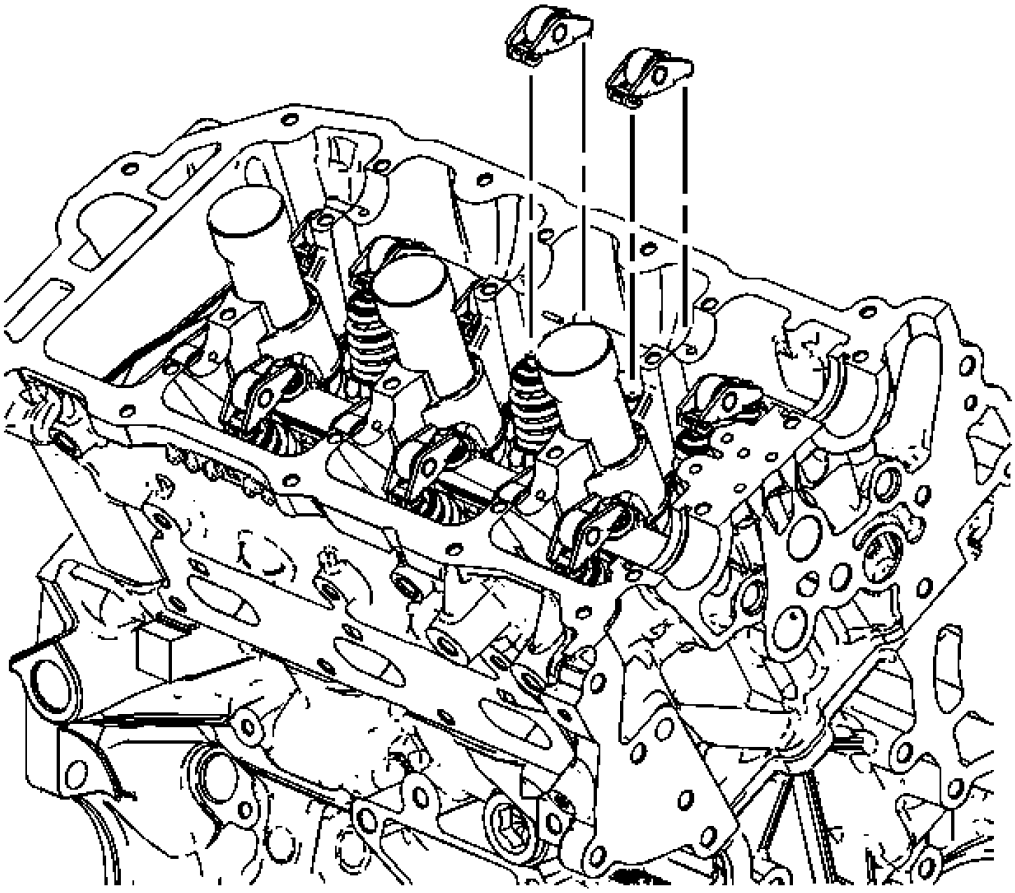


Fig. 389: Valve Rocker Arms
Courtesy of GENERAL MOTORS CORP.

NOTE: The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.

2. Place the camshaft followers in position on the valve tip and stationary hydraulic lash adjuster (SHLA).
3. The rounded head end of the follower goes on the SHLA while the flat end goes on the valve tip.
4. Clean the camshaft journals and carriers with a clean, lint-free cloth.

CAMSHAFT INSTALLATION - RIGHT SIDE (LLT)

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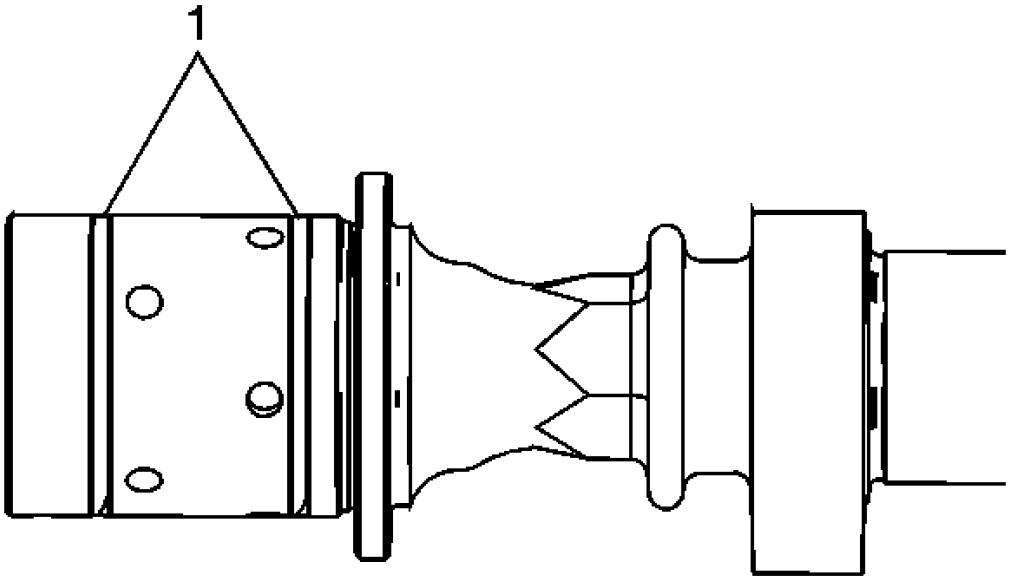


Fig. 390: Locating Camshaft Sealing Rings In Camshaft Grooves
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

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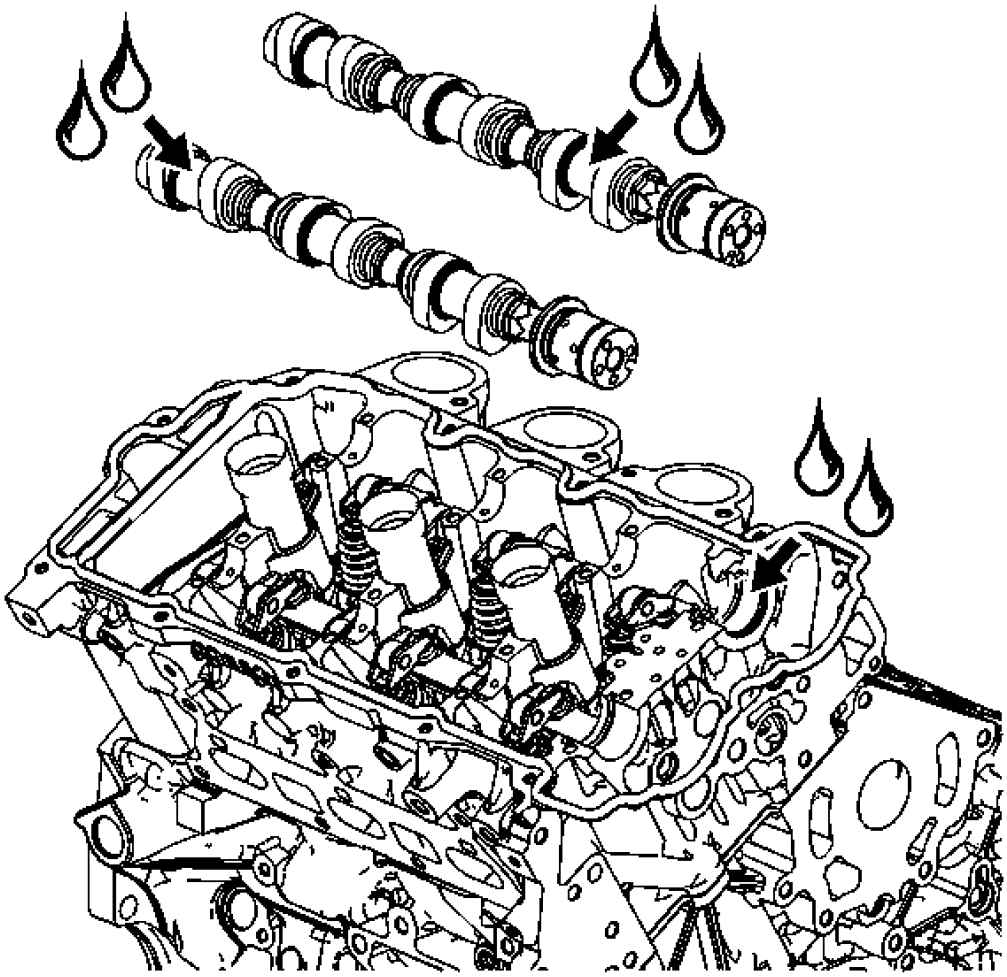


Fig. 391: Applying Lubricant To Camshaft Journals & Right Cylinder Head Camshaft Carriers
Courtesy of GENERAL MOTORS CORP.

2. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the camshaft journals and the right cylinder head camshaft carriers.

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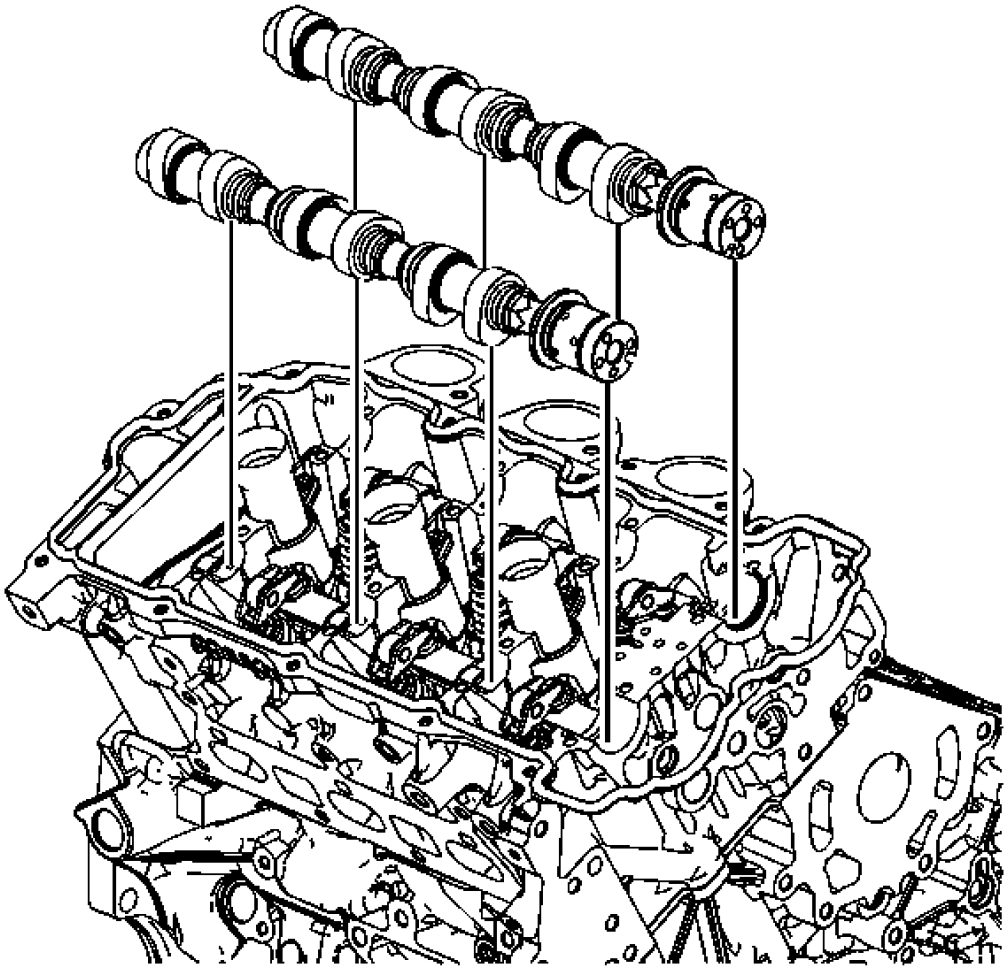


Fig. 392: Positioning Right Intake & Right Exhaust Camshafts In Right Cylinder Head
Courtesy of GENERAL MOTORS CORP.

3. Place the right intake and right exhaust camshafts in position in the right cylinder head.

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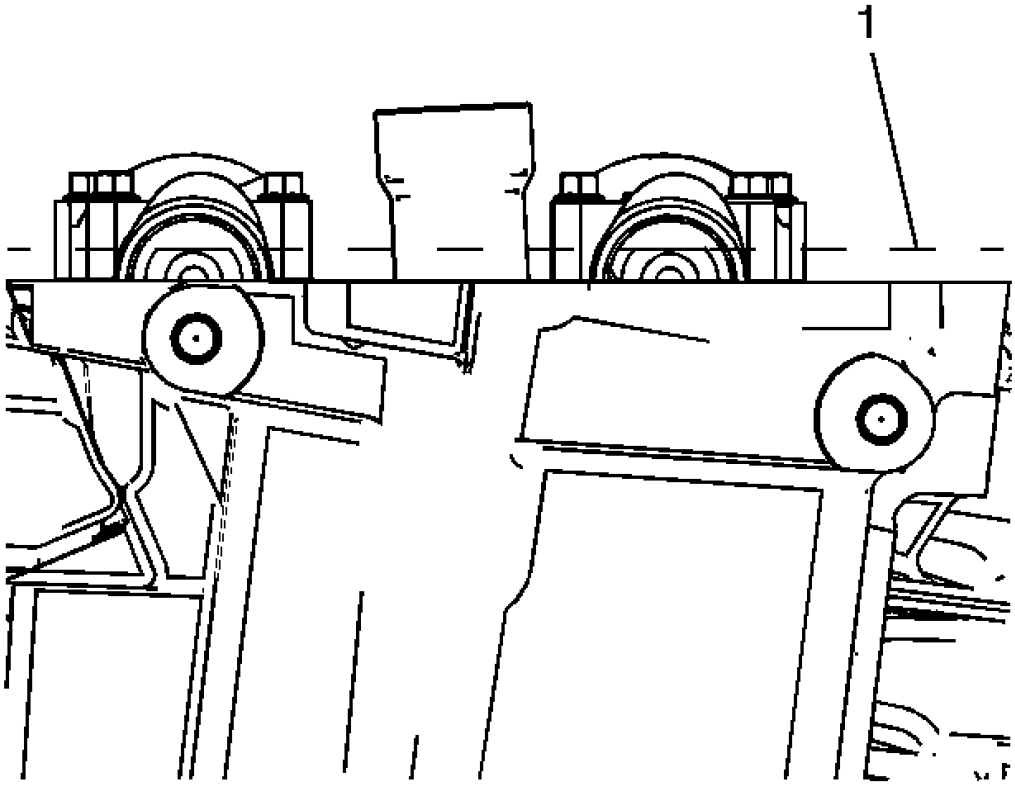


Fig. 393: Identifying Camshaft Neutral (Low Tension) Position
Courtesy of GENERAL MOTORS CORP.

4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the right cylinder head camshaft cover rail.

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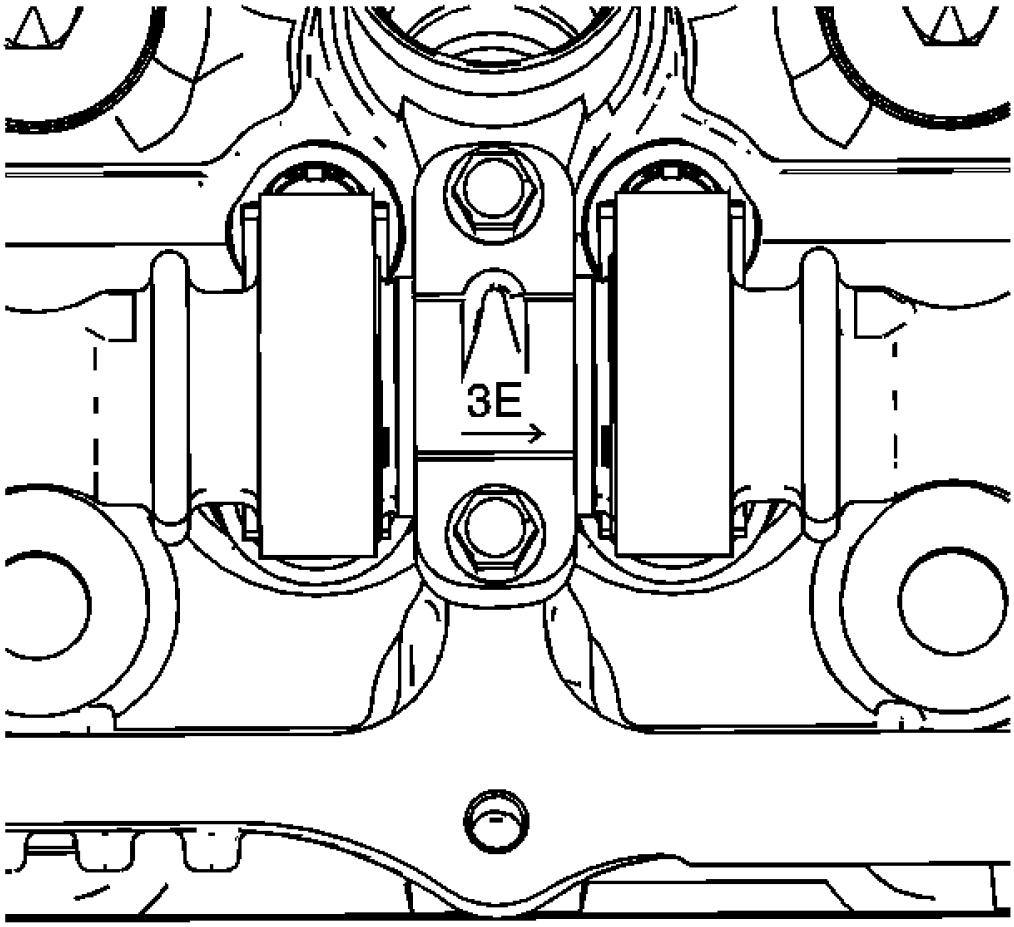


Fig. 394: View Of Markings On Bearing Caps
Courtesy of GENERAL MOTORS CORP.

5. Observe the markings on the right cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
   - The raised feature must always be oriented toward the center of the cylinder head.
   - The I indicates the intake camshaft.
   - The E indicates the exhaust camshaft.
   - The number 1, 3, 5 indicates the cylinder position from the front of the engine.
6. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the camshaft bearing caps.

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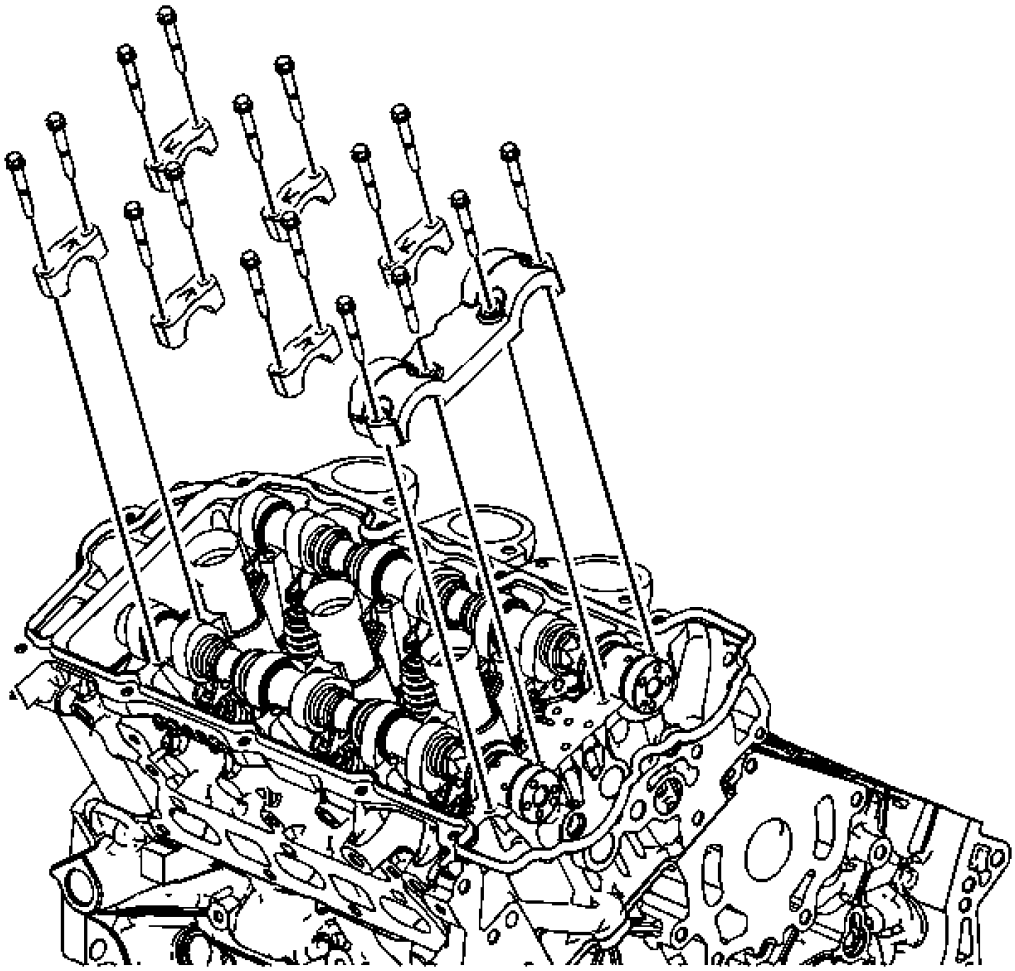


Fig. 395: Camshaft Bearing Caps & Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the camshaft bearing thrust caps in the first journal of the right cylinder head.
8. Install the remaining bearing caps with their orientation mark toward the center of the cylinder head.
9. Hand start all the camshaft bearing cap bolts.

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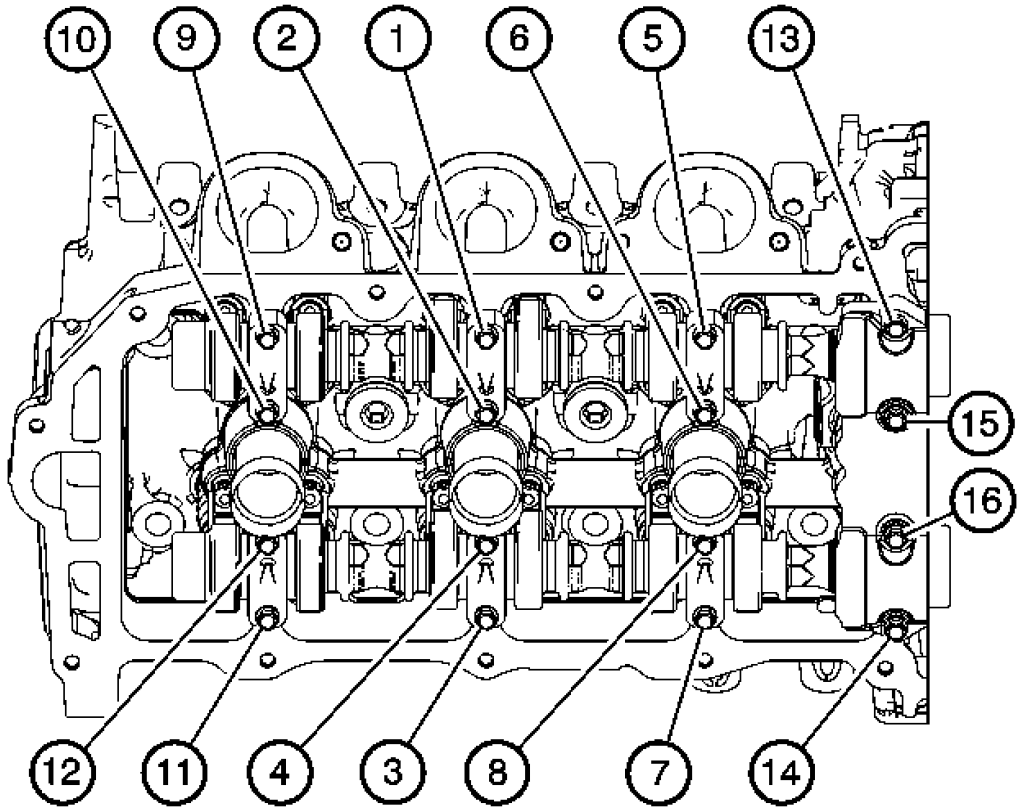


Fig. 396: Camshaft Bearing Cap Bolt Tighten Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

10. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).
11. Loosen the center intake camshaft bearing cap bolts (1, 2) and the center exhaust camshaft bearing cap bolts (3, 4).
12. Retighten the center camshaft bearing cap bolts (1, 2, 3, 4) and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).

FUEL RAIL INSTALLATION

Refer to **Cylinder Head Assemble (LLT or LCS)**.

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2010 ENGINE

Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Repair Instructions - Off Vehicle - Camaro

CYLINDER HEAD INSTALLATION - LEFT SIDE (LLT)

Special Tools

J 45059: Angle Meter

For equivalent regional tools, refer to **Special Tools** .

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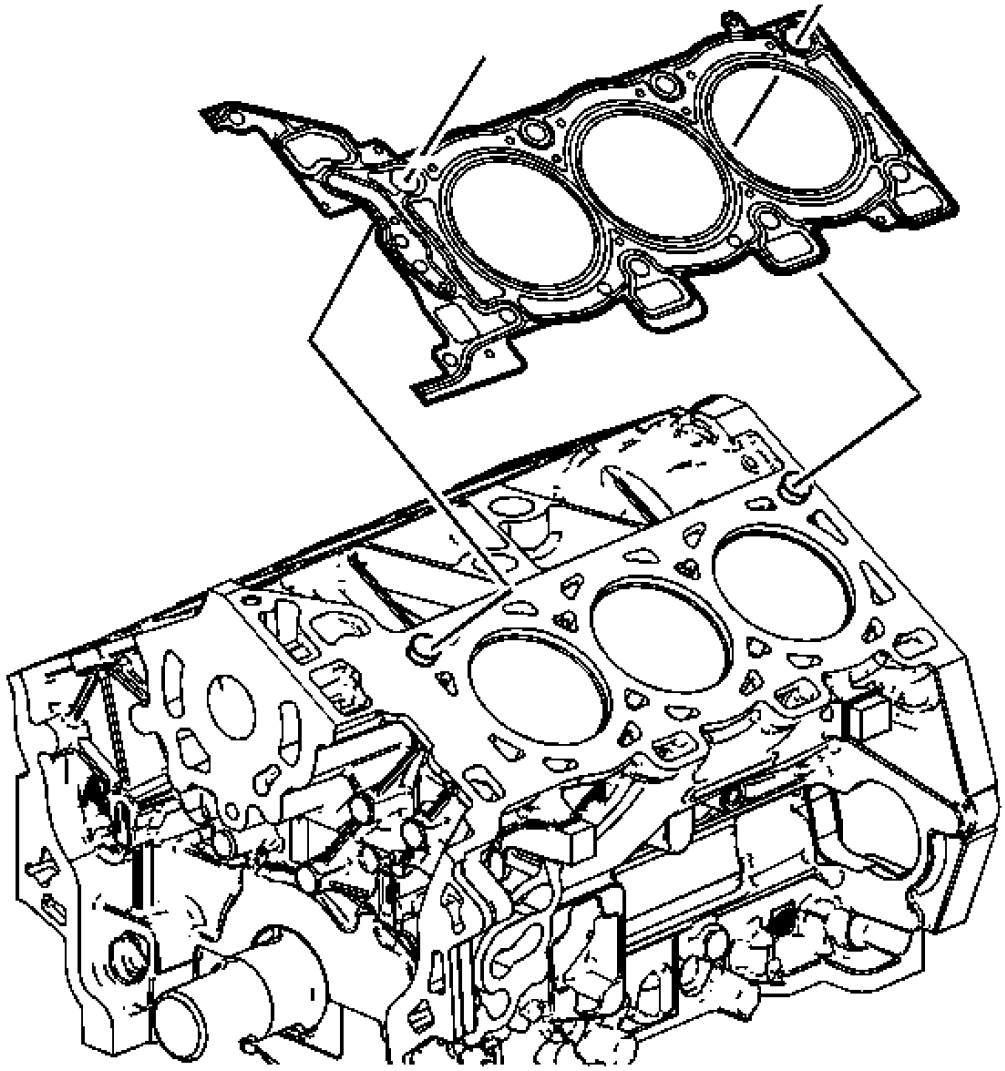


Fig. 1: Identifying Cylinder Head Gasket Assembly
Courtesy of GENERAL MOTORS CORP.

1. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.
2. Install a NEW left cylinder head gasket using the deck face locating pins for retention.

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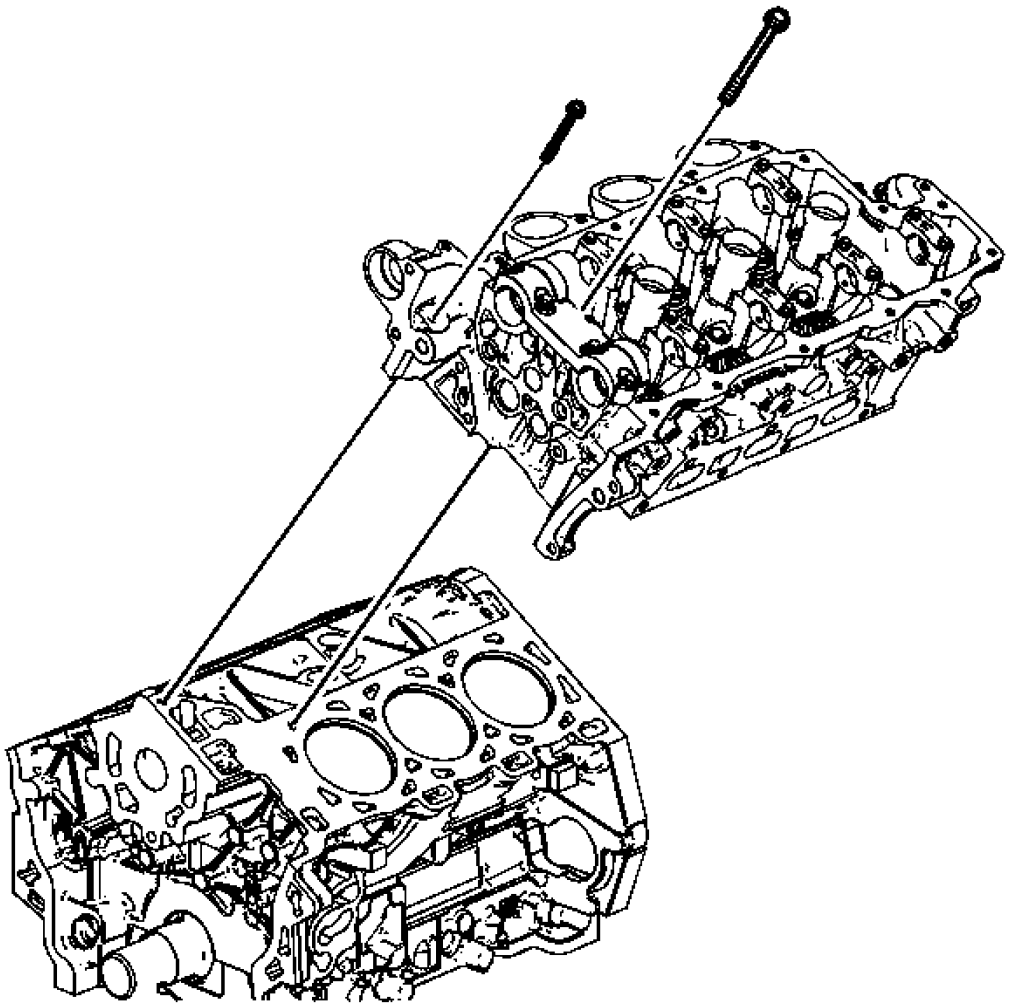


Fig. 2: View Of Left Cylinder Head (LLT)
Courtesy of GENERAL MOTORS CORP.

3. Align the left cylinder head with the deck face locating pins.
4. Place the left cylinder head in position on the deck face.

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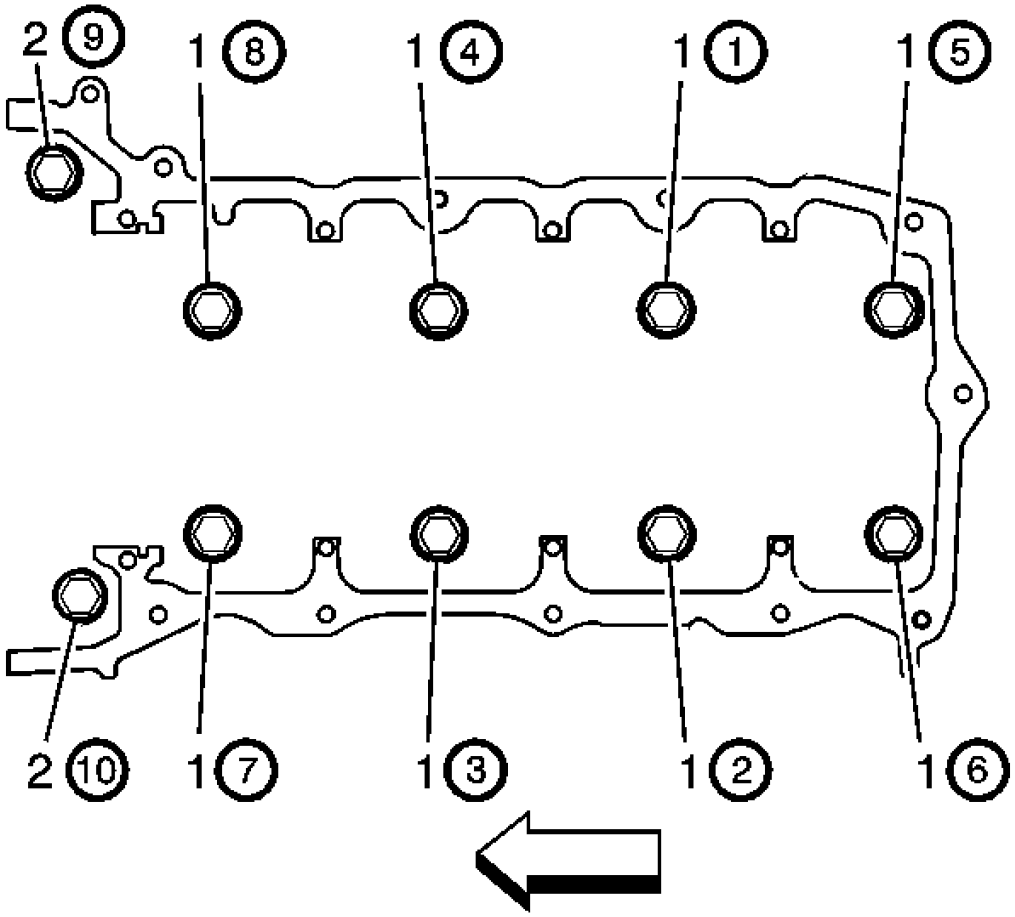


Fig. 3: Identifying Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: DO NOT allow oil on the cylinder head bolt bosses.

NOTE: DO NOT reuse the old cylinder head bolts.

5. Install the NEW M11 cylinder head bolts (1).
    1. Tighten the M11 cylinder head bolts a first pass in sequence to 30 N.m (22 lb ft) .
    2. Tighten the M11 cylinder head bolts a second pass in sequence an additional 150 degrees using the

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J 45059: meter .

6. Install the 2 NEW front M8 left cylinder head bolts (2).
    1. Tighten the M8 cylinder head bolts a first pass to 15 N.m (11 lb ft) .
    2. Tighten the M8 cylinder head bolts a second pass in sequence an additional 75 degrees using the **J 45059:** meter .

VALVE LIFTER INSTALLATION - LEFT SIDE (LLT)

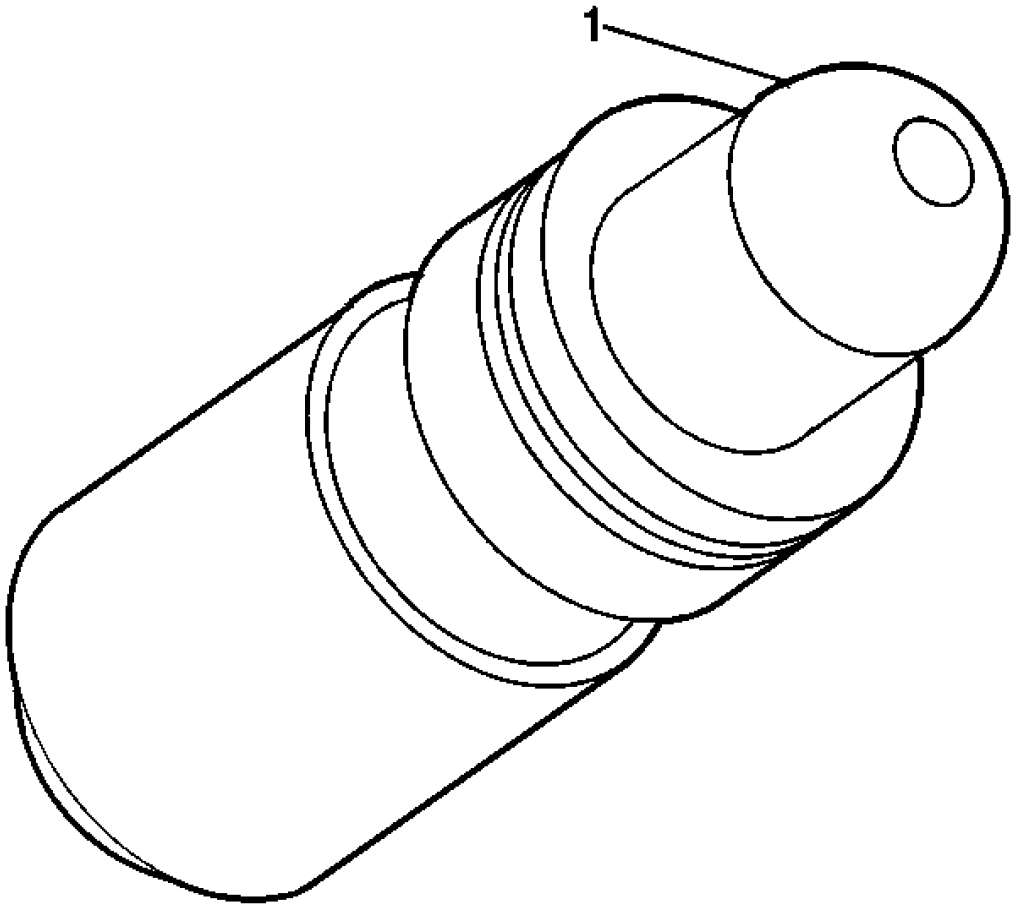


Fig. 4: Identifying Pivot Sphere Area Of SHLA
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.

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IMPORTANT: Do not allow the stationary hydraulic lash adjuster to tip over, plunger down, after the oil fill.

1. Fill the stationary hydraulic lash adjuster (SHLA) with clean engine oil GM P/N 12378006 or equivalent. Take precautions to prevent scratching the pivot sphere area (1) of the SHLA.
2. Lubricate the SHLA bores in the cylinder head with clean engine oil GM P/N 12378006 or equivalent.

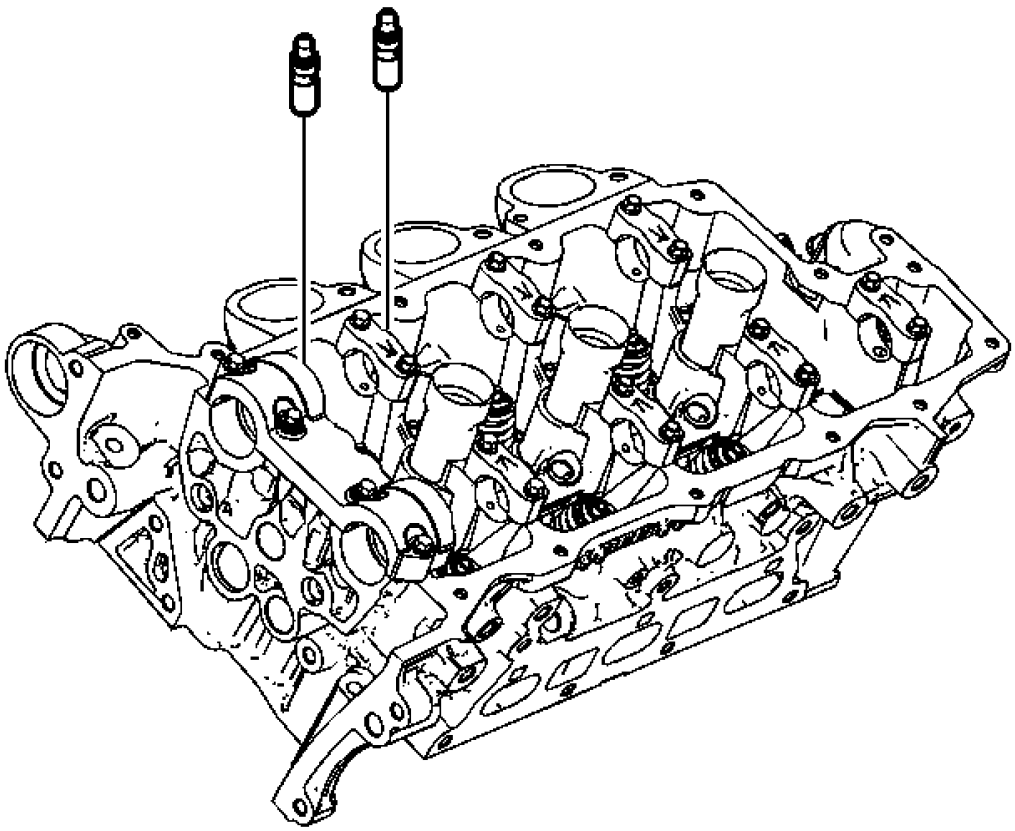


Fig. 5: Removing/Installing SHLAs In Cylinder Head
Courtesy of GENERAL MOTORS CORP.

3. Install the SHLAs in the cylinder head.
4. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the SHLA pivot spheres.

VALVE ROCKER ARM INSTALLATION - LEFT SIDE (LLT)

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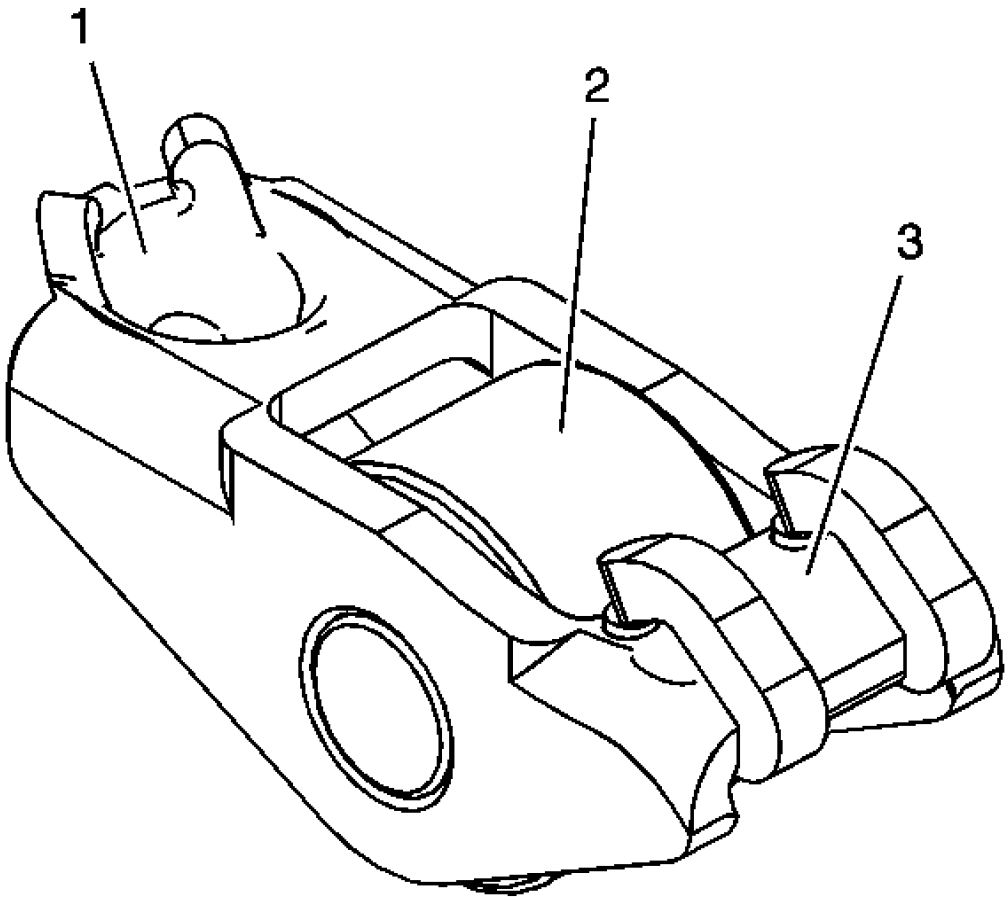


Fig. 6: Identifying Valve Rocker Arm Lubrication Areas
Courtesy of GENERAL MOTORS CORP.

1. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the pivot pocket (1), roller (2) and valve slot (3) areas of the camshaft followers.

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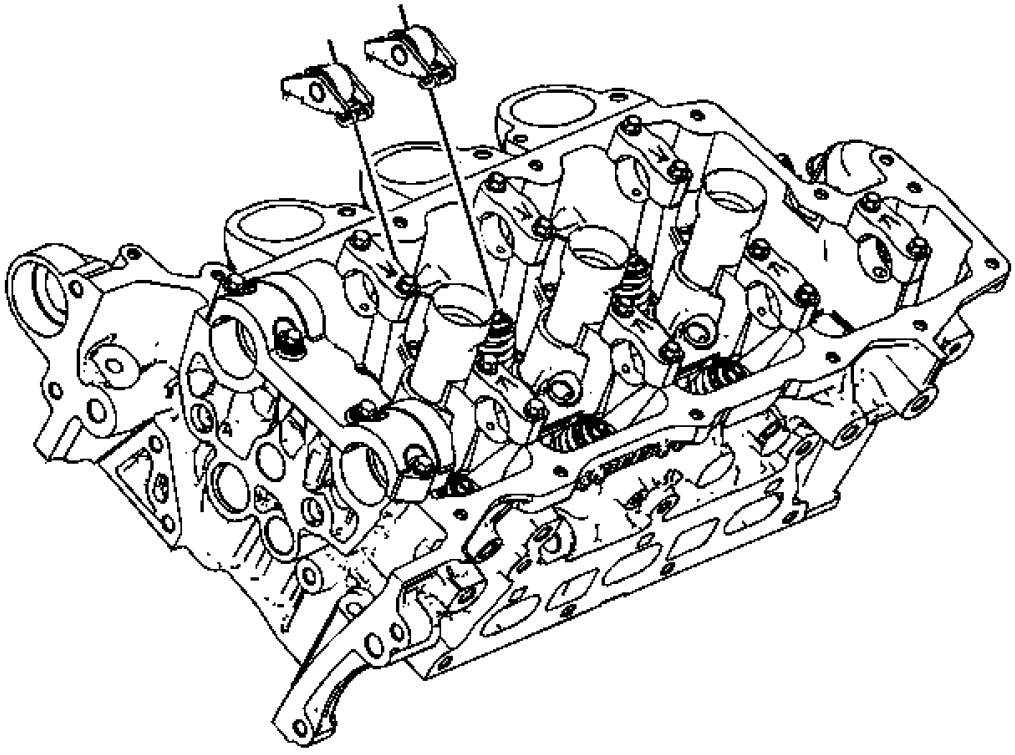


Fig. 7: View of Rocker Arm Assembly
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.

2. Place the camshaft followers in position on the valve tip and stationary hydraulic lash adjuster (SHLA).
3. The rounded head end of the follower goes on the SHLA while the flat end goes on the valve tip.
4. Clean the camshaft journals and carriers with a clean, lint-free cloth.

CAMSHAFT INSTALLATION - LEFT SIDE (LLT)

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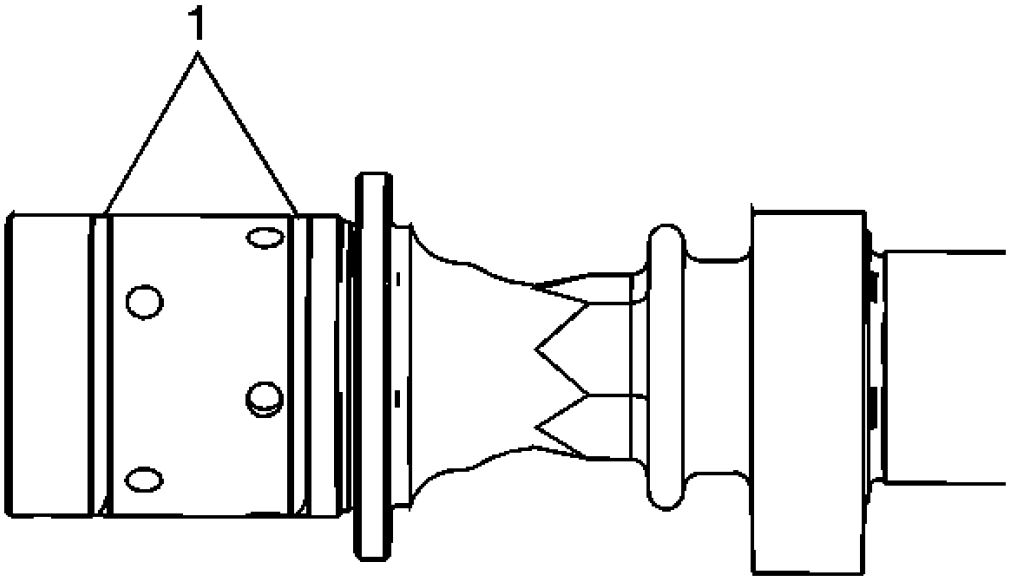


Fig. 8: Locating Camshaft Sealing Rings In Camshaft Grooves
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

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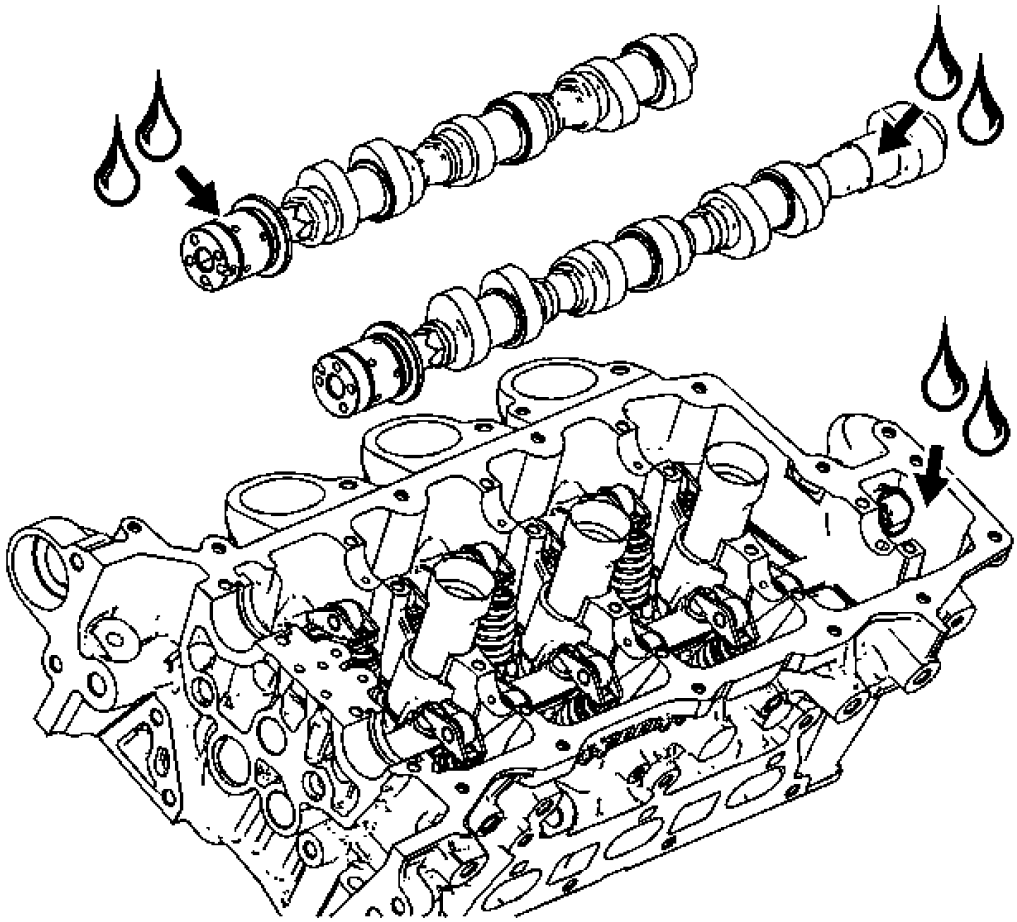


Fig. 9: Lubricating Camshaft Journals
Courtesy of GENERAL MOTORS CORP.

2. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the camshaft journals and the left cylinder head camshaft carriers.

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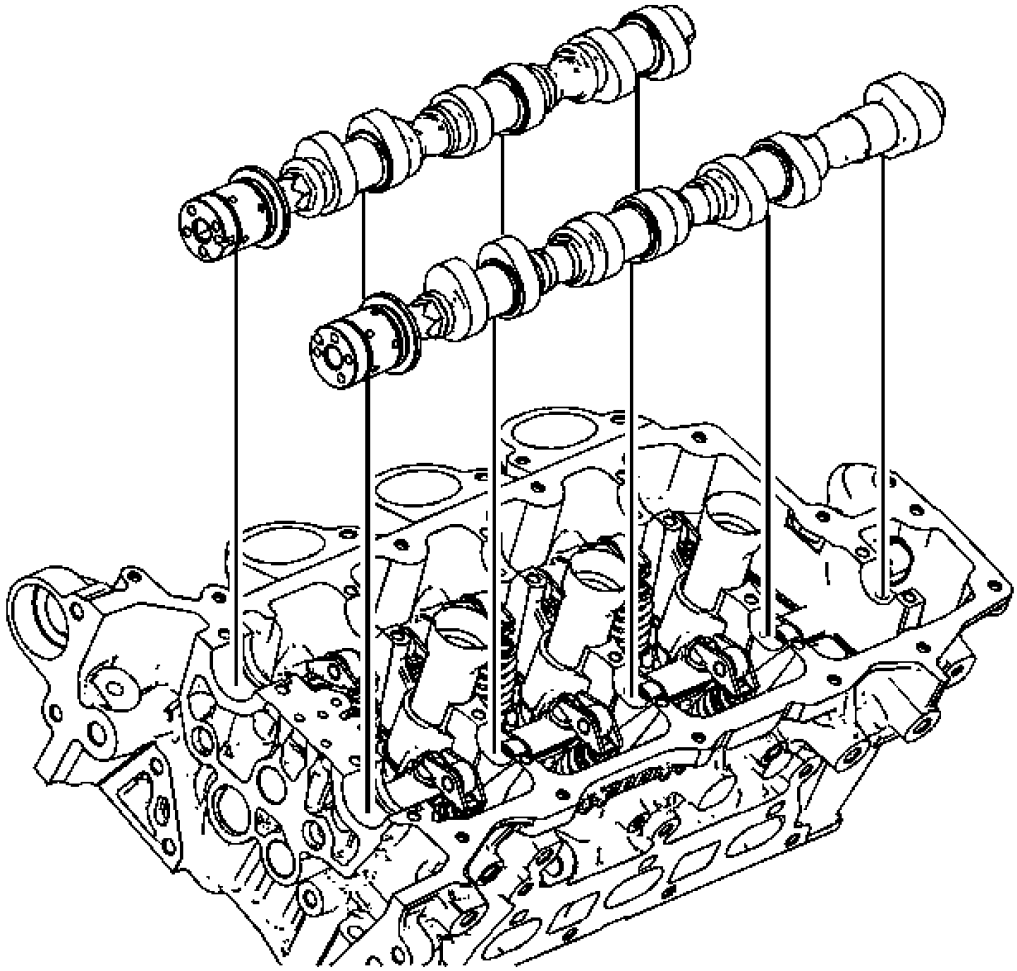


Fig. 10: Identifying Camshafts
Courtesy of GENERAL MOTORS CORP.

3. Place the left intake and left exhaust camshafts in position in the left cylinder head.

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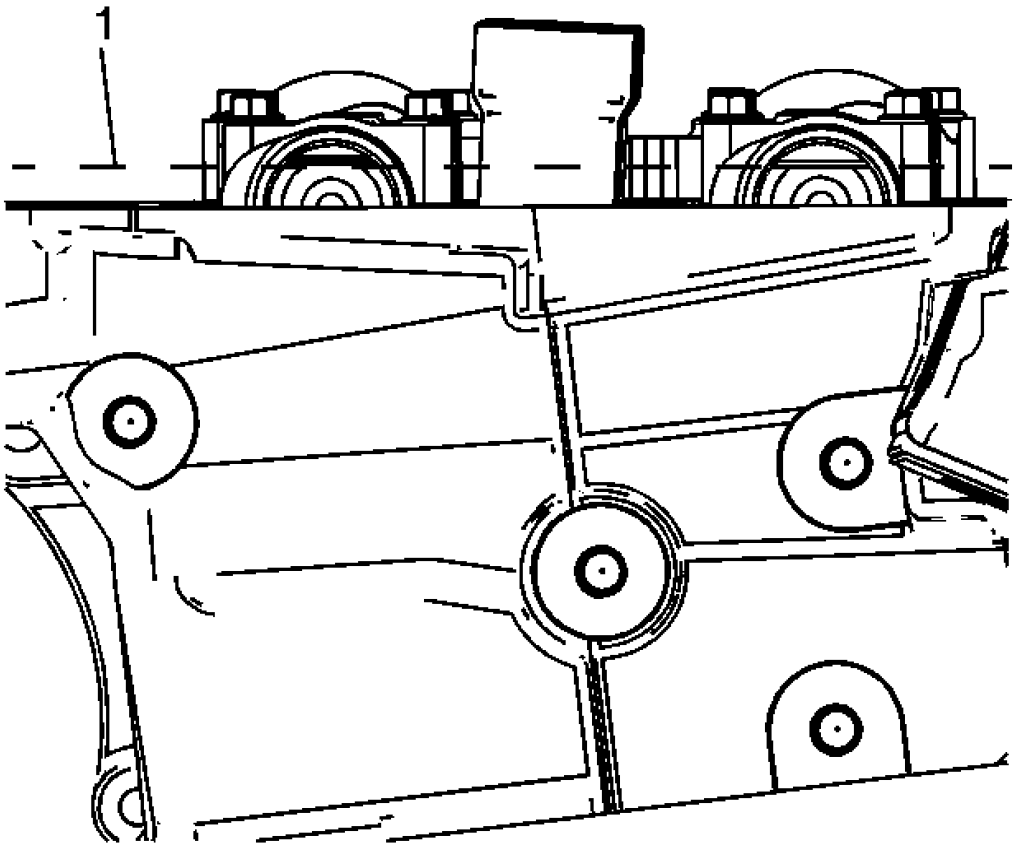


Fig. 11: Camshaft Flats Parallel With Camshaft Cover Rail
Courtesy of GENERAL MOTORS CORP.

4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the left cylinder head camshaft cover rail.

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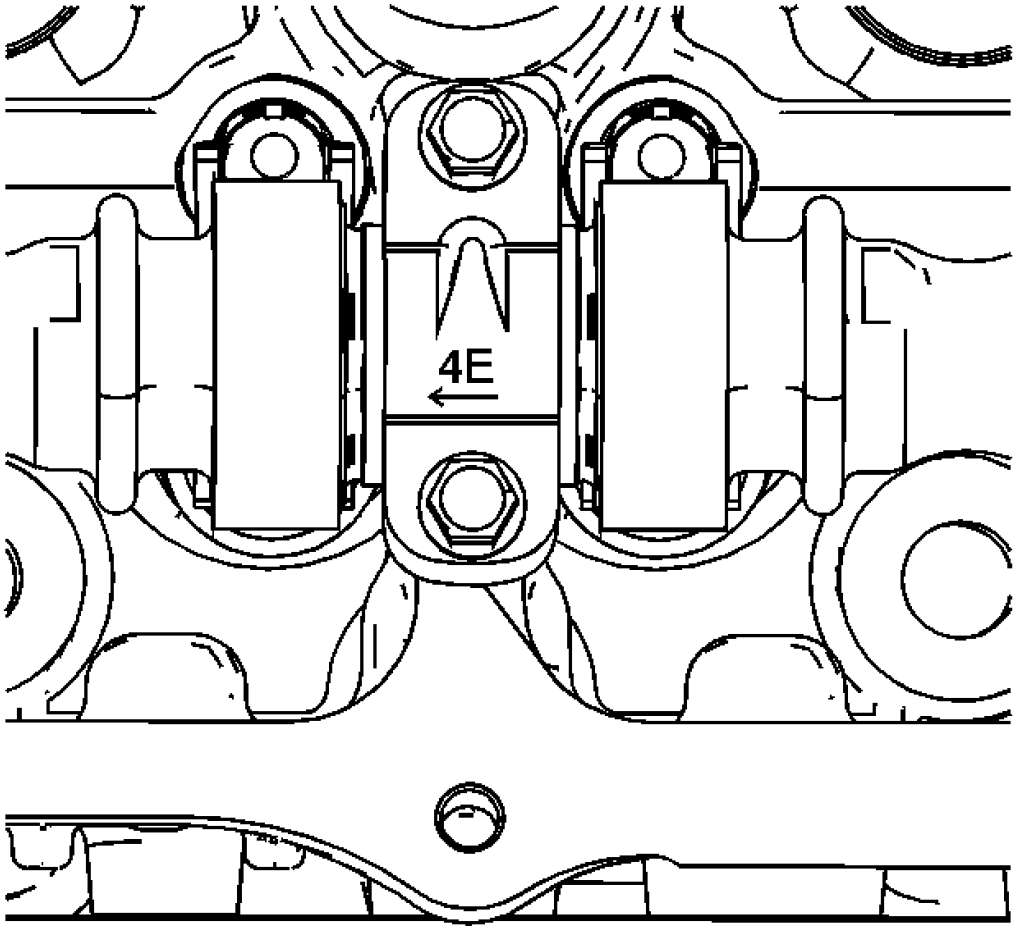


Fig. 12: Identifying Markings On Bearing Caps
Courtesy of GENERAL MOTORS CORP.

5. Observe the markings on the left cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
   - The raised feature must always be oriented toward the center of the cylinder head.
   - The I indicates the intake camshaft.
   - The E indicates the exhaust camshaft.
   - The number 2, 4, 6 indicates the cylinder position from the front of the engine.
6. Apply a liberal amount of lubricant GM P/N 12345501 (Canadian P/N 992704) or equivalent to the camshaft bearing caps.

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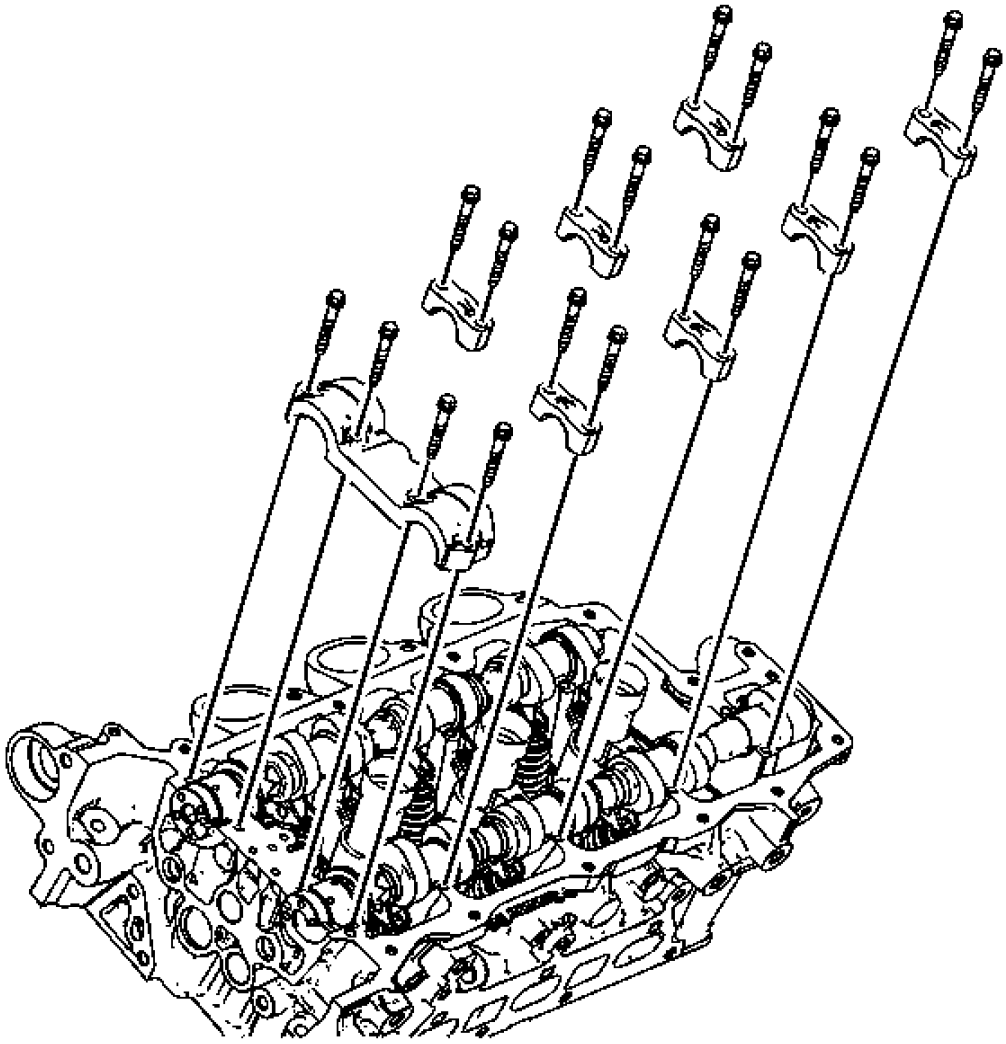


Fig. 13: Identifying Camshaft Bearing Cap Bolts
Courtesy of GENERAL MOTORS CORP.

7. Install the camshaft bearing thrust cap in the first journal of the left cylinder head.
8. Install the remaining bearing caps with their orientation mark toward the center of the cylinder head.
9. Hand start all the camshaft bearing cap bolts.

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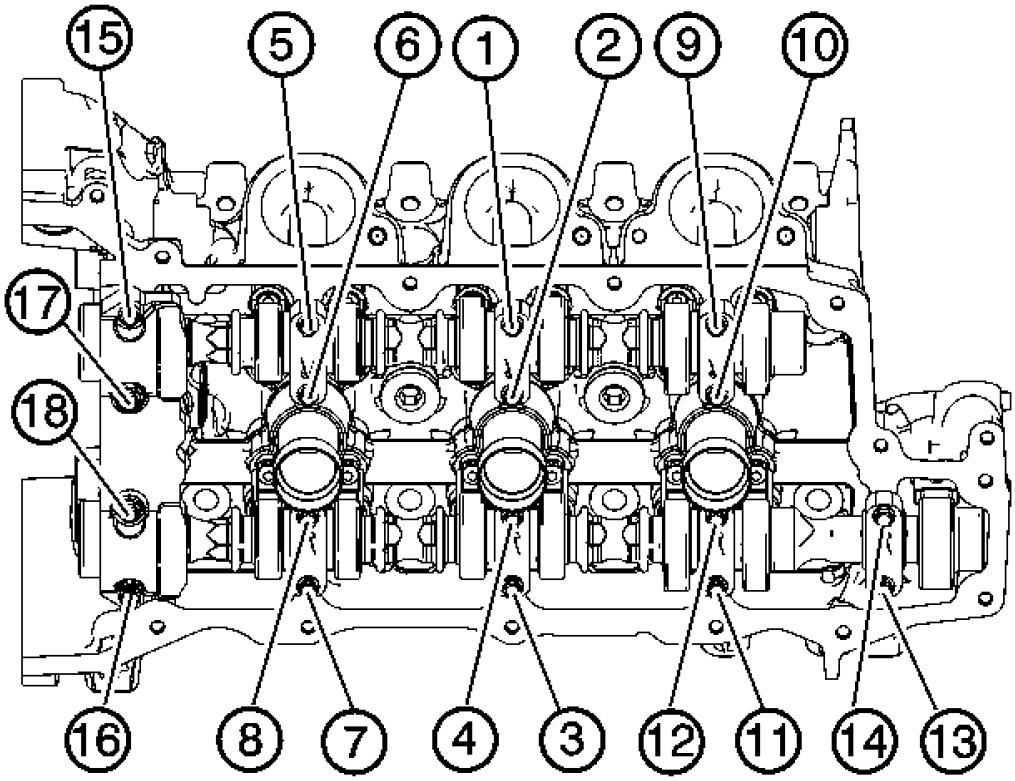


Fig. 14: Identifying Camshaft Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

10. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).
11. Loosen the center intake camshaft bearing cap bolts 1, 2 and the center exhaust camshaft bearing cap bolts 3, 4.
12. Retighten the center camshaft bearing cap bolts 1, 2, 3, 4 and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).

FUEL PUMP INSTALLATION (LLT)

SPECIAL TOOLS

EN 48896: HP Fuel Pump Installation Alignment Gauge

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For equivalent regional tools, refer to **Special Tools** .

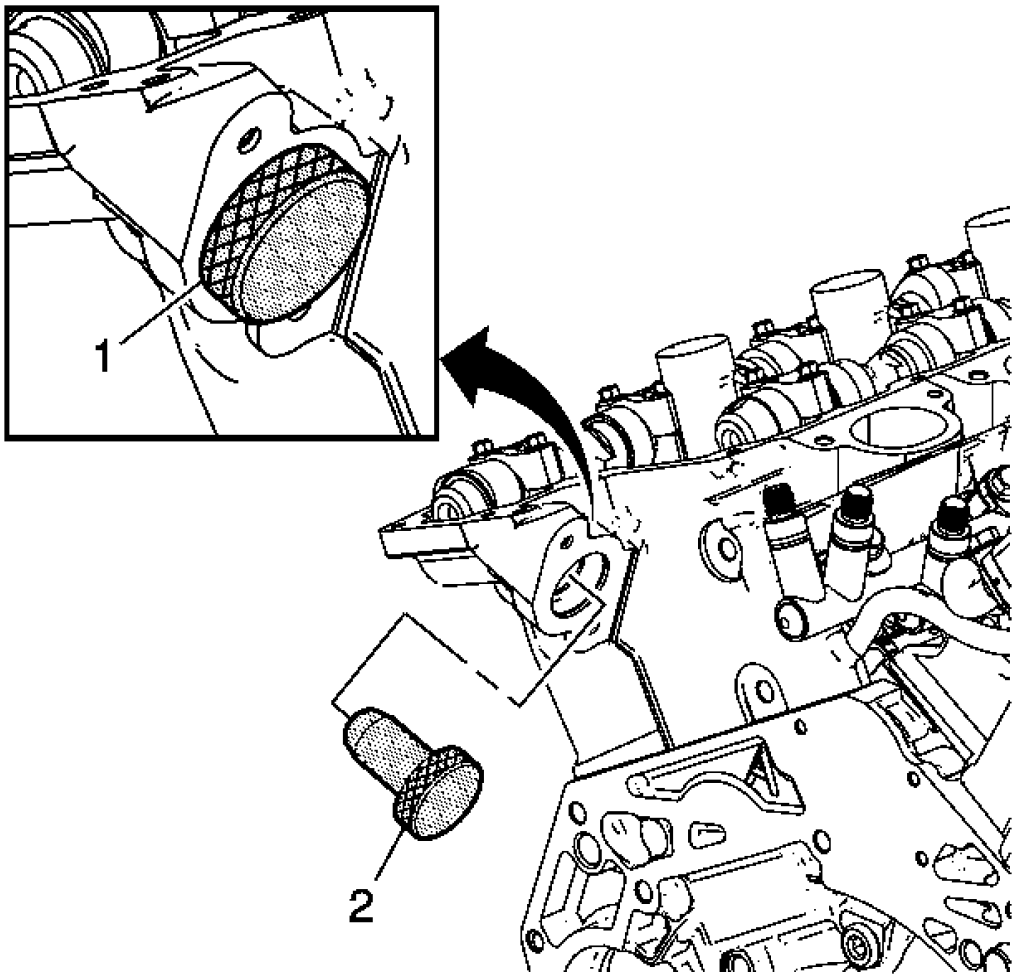


Fig. 15: Alignment Gauge
Courtesy of GENERAL MOTORS CORP.

NOTE: The camshaft must be in the base circle position before the high pressure fuel pump is installed.

1. Use the **EN 48896:** alignment gauge (2) to ensure that the camshaft lobe is in the base circle position. At base circle position, the tool will be flush with the head (1).

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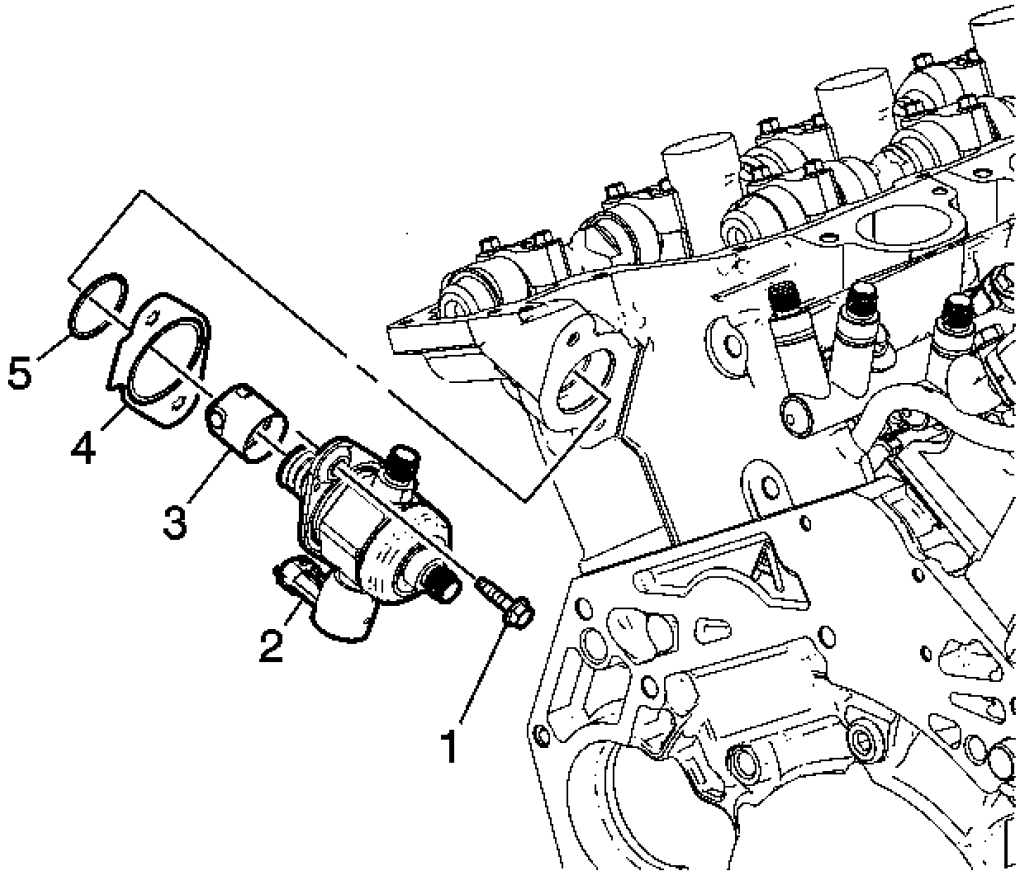


Fig. 16: Identifying High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS CORP.

2. Lubricate the high pressure fuel pump cylinder head bore with 5W30 engine oil.

NOTE: **Ensure that the high pressure fuel pump roller lifter is oriented properly, the camshaft is at base circle and the number 1 piston is at top dead center (TDC) on the exhaust stroke. The distance from the mounting flange surface to the camshaft at base circle should be 52 mm (2.05 in).**

3. Lubricate the high pressure fuel pump roller lifter with 5W30 engine oil and install into the cylinder head bore.
4. Install a NEW high pressure fuel pressure fuel pump gasket (4).
5. Install a NEW high pressure fuel pump O-ring (5).

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NOTE: Ensure the plastic bolt retainers are installed in the high pressure fuel pump mounting holes before installing.

6. Install the valve lifter follower (3).
7. Install the high pressure fuel pump (2).

CAUTION: Refer to Fastener Caution .

CAUTION: Alternately hand-tighten the fuel pump bolts one turn at a time until the pump is fully seated. Trying to draw down the pump without even side-to-side tightening may result in pump plunger damage.

8. Start and hand-tighten the NEW high pressure fuel pump bolts (1) evenly and tighten the high pressure fuel pump bolts to 15 N.m (11 lb ft).

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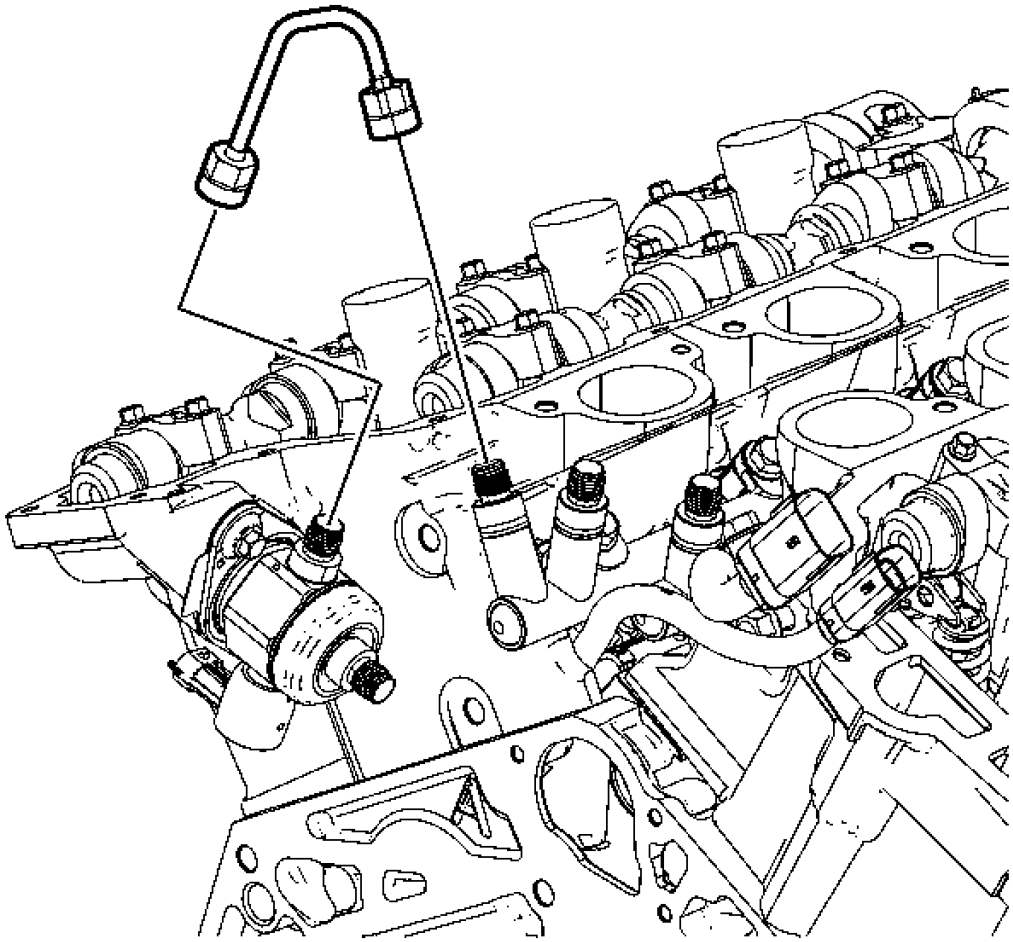


Fig. 17: View of Fuel Line & Cylinder Head
Courtesy of GENERAL MOTORS CORP.

9. Install and hand-tighten both ends of the NEW high pressure fuel line and tighten the high pressure fuel line fitting nuts to 30 N.m (22 lb ft).

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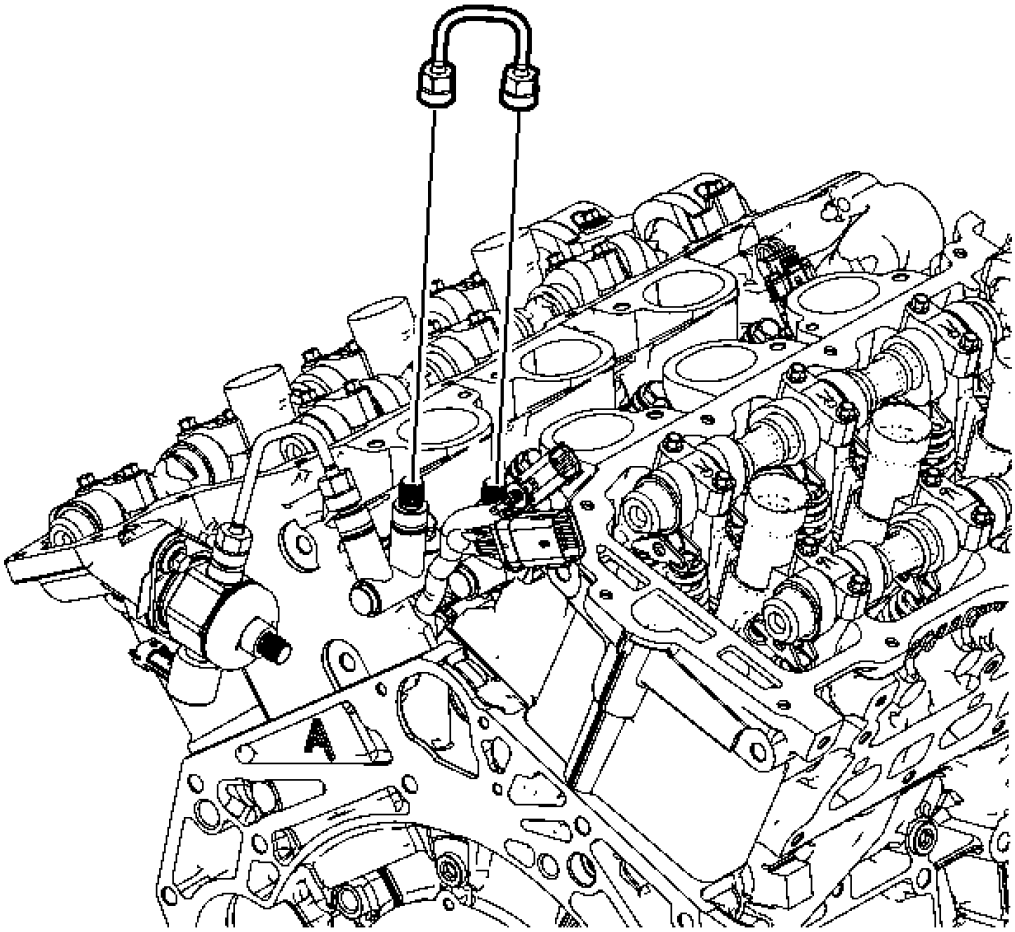


Fig. 18: Identifying Fuel Rail Crossover Pipe
Courtesy of GENERAL MOTORS CORP.

10. Install the LH to RH fuel rail crossover pipe and tighten the fuel rail crossover pipe fittings to 30 N.m (22 lb ft).

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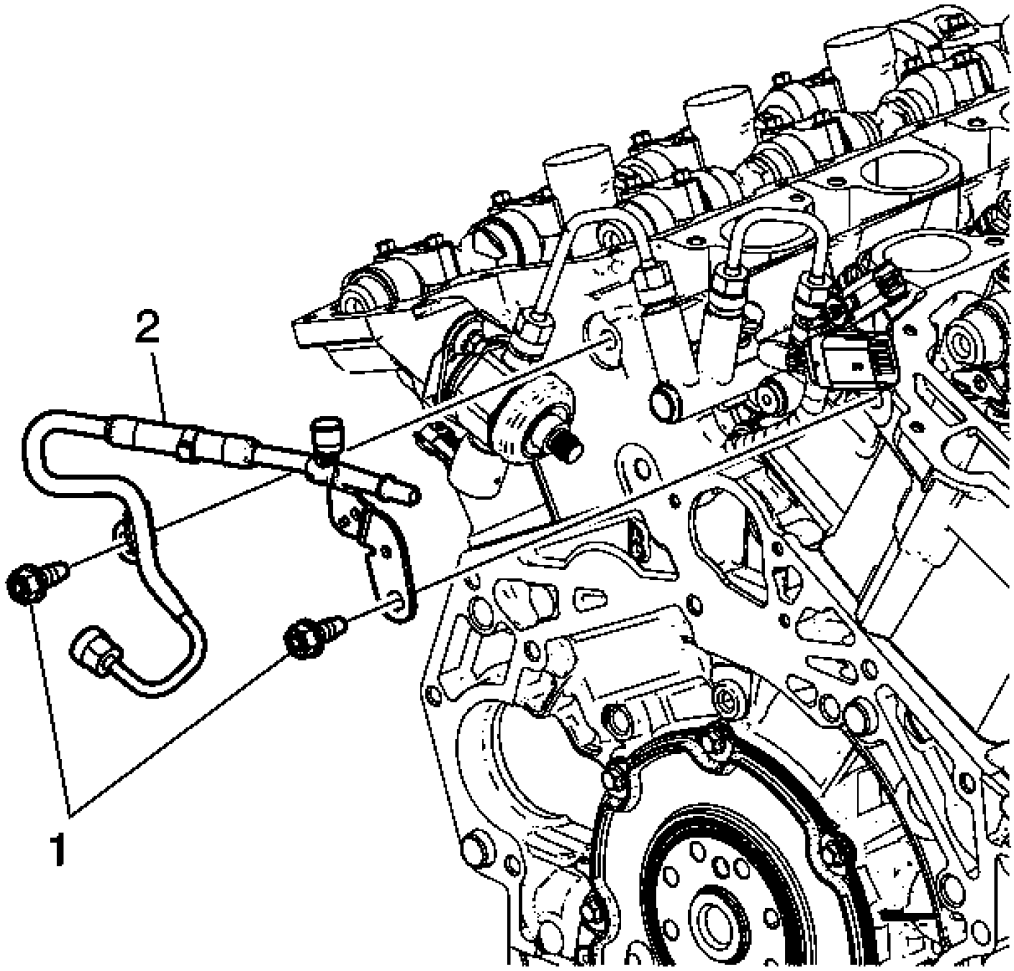


Fig. 19: Fuel Feed Pipe Components
Courtesy of GENERAL MOTORS CORP.

11. Install the fuel feed pipe (2).
12. Install the fuel feed pipe bolts (1) and tighten to 10 N.m (89 lb in).
13. Install the fuel rail wiring connectors to the fuel feed pipe bracket.

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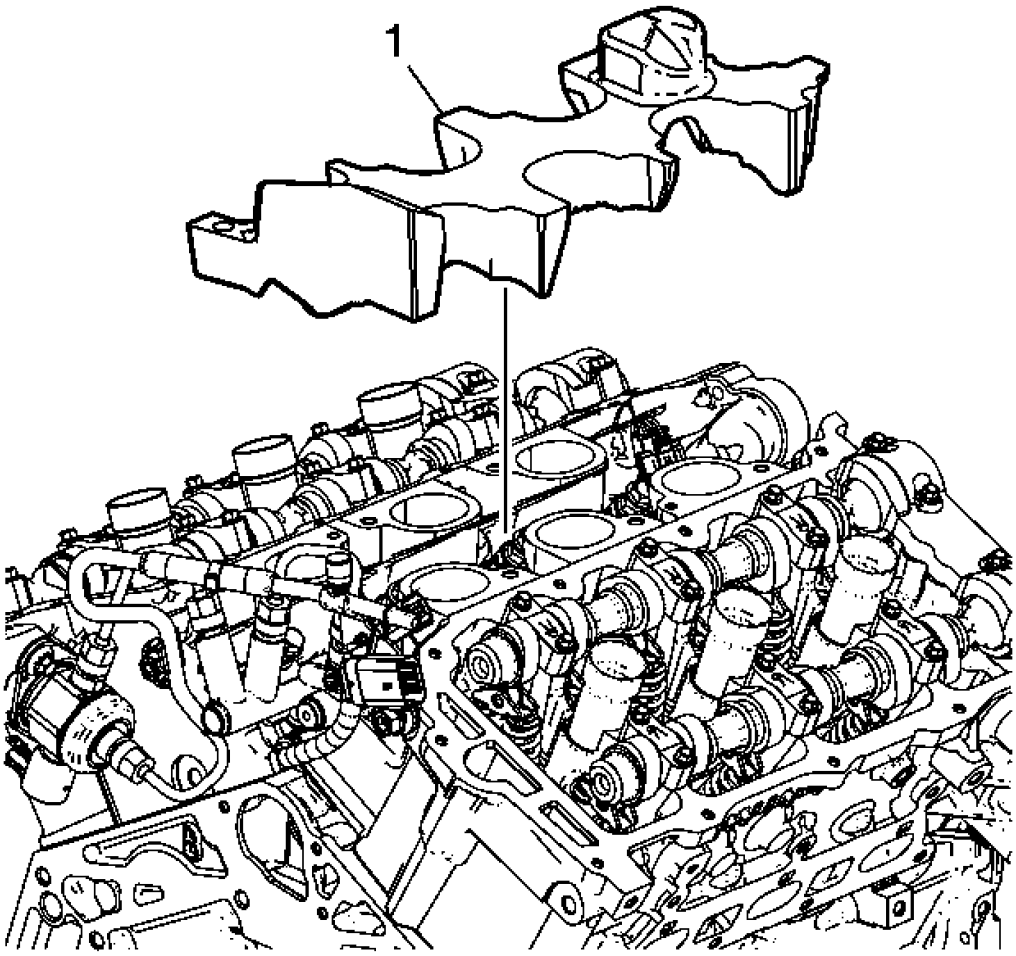


Fig. 20: Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS CORP.

14. Install the fuel rail noise shield (1).

CAMSHAFT POSITION ACTUATOR INSTALLATION - RIGHT SIDE INTAKE

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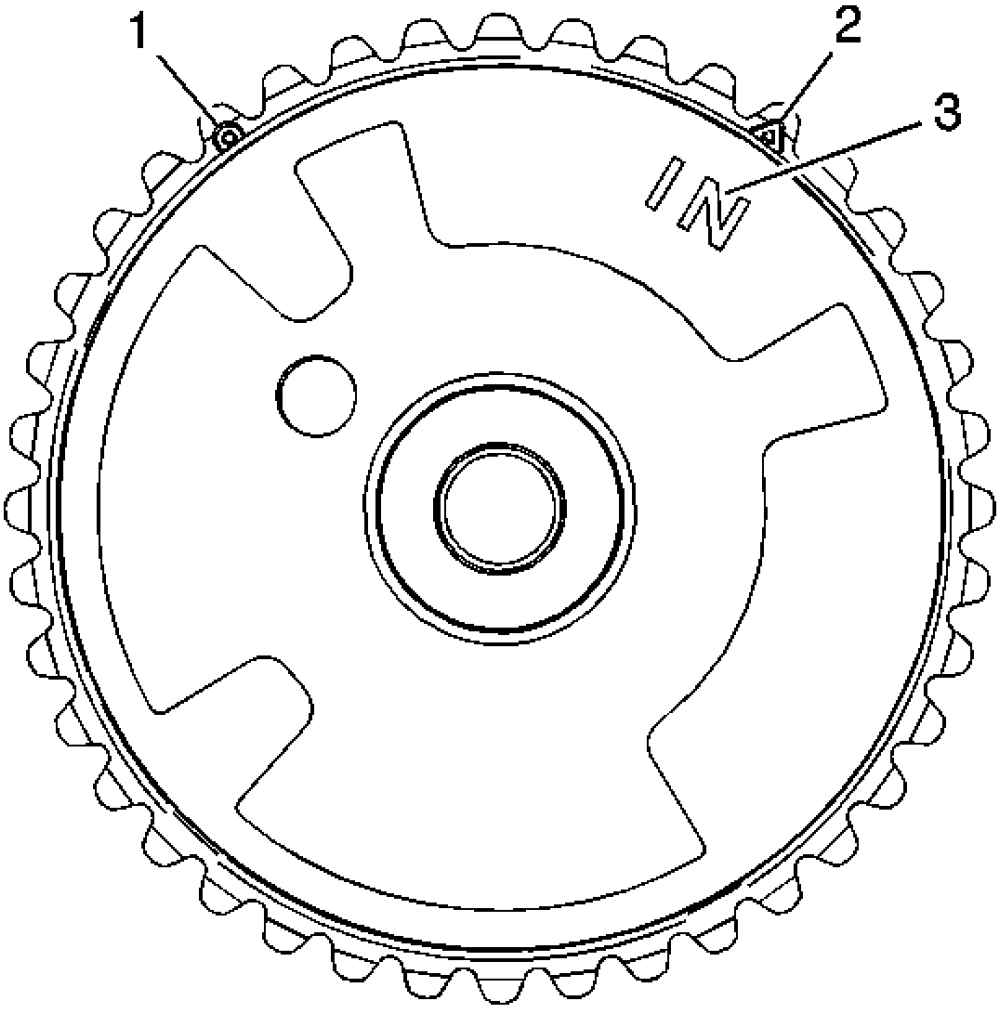


Fig. 21: View Of Camshaft Position Actuator Markings
Courtesy of GENERAL MOTORS CORP.

1. Ensure the proper camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "IN" marking (3). The marking is for an intake camshaft position actuator.

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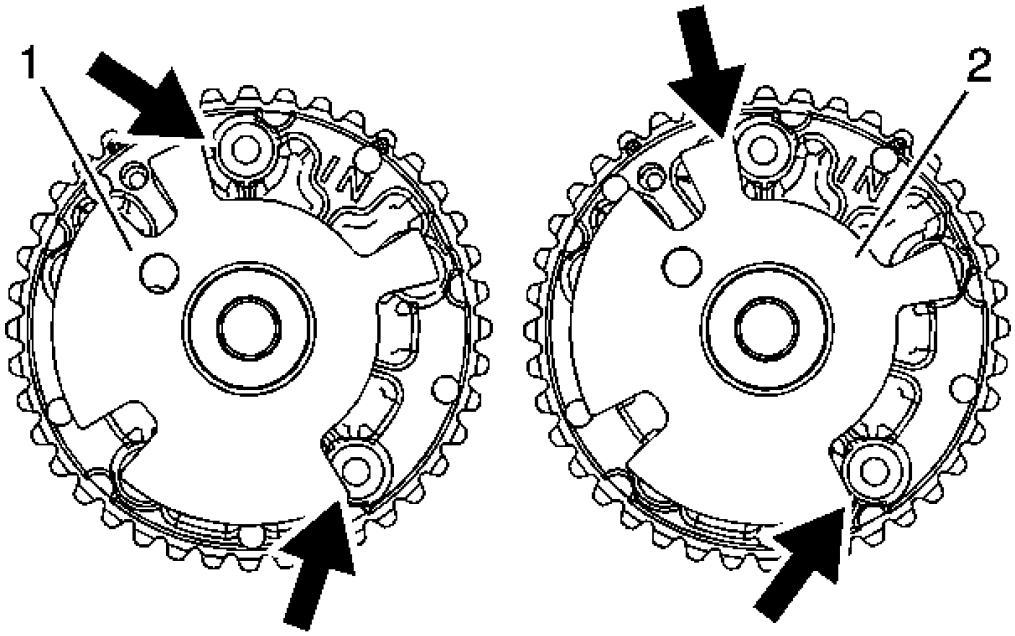


Fig. 22: View Of Right Intake Camshaft Position Actuator & Left Intake Camshaft Position Actuator
Courtesy of GENERAL MOTORS CORP.

CAUTION: Ensure the proper camshaft position actuator is installed in the correct position. Failure to install the proper camshaft position actuator can effect engine performance and set an engine code.

2. Ensure the proper camshaft position actuator is being installed. The reluctor wheel on the right intake camshaft position actuator (1) is indexed in a different position compared to the left intake camshaft position actuator (2).

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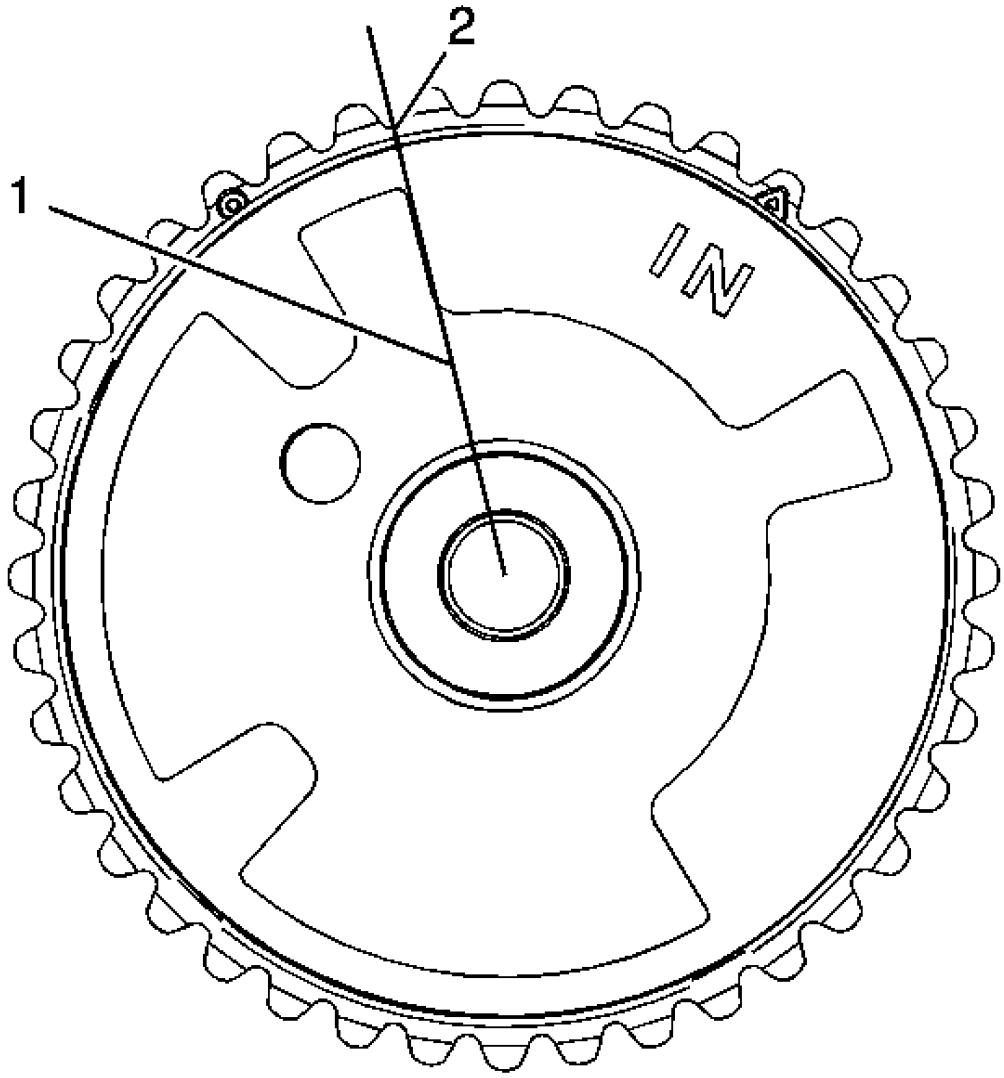


Fig. 23: View Of Reluctor Wheel & Valley
Courtesy of GENERAL MOTORS CORP.

3. On the right intake camshaft actuator the edge of the reluctor wheel (1) lines up with the valley (2) of the sprocket tooth.

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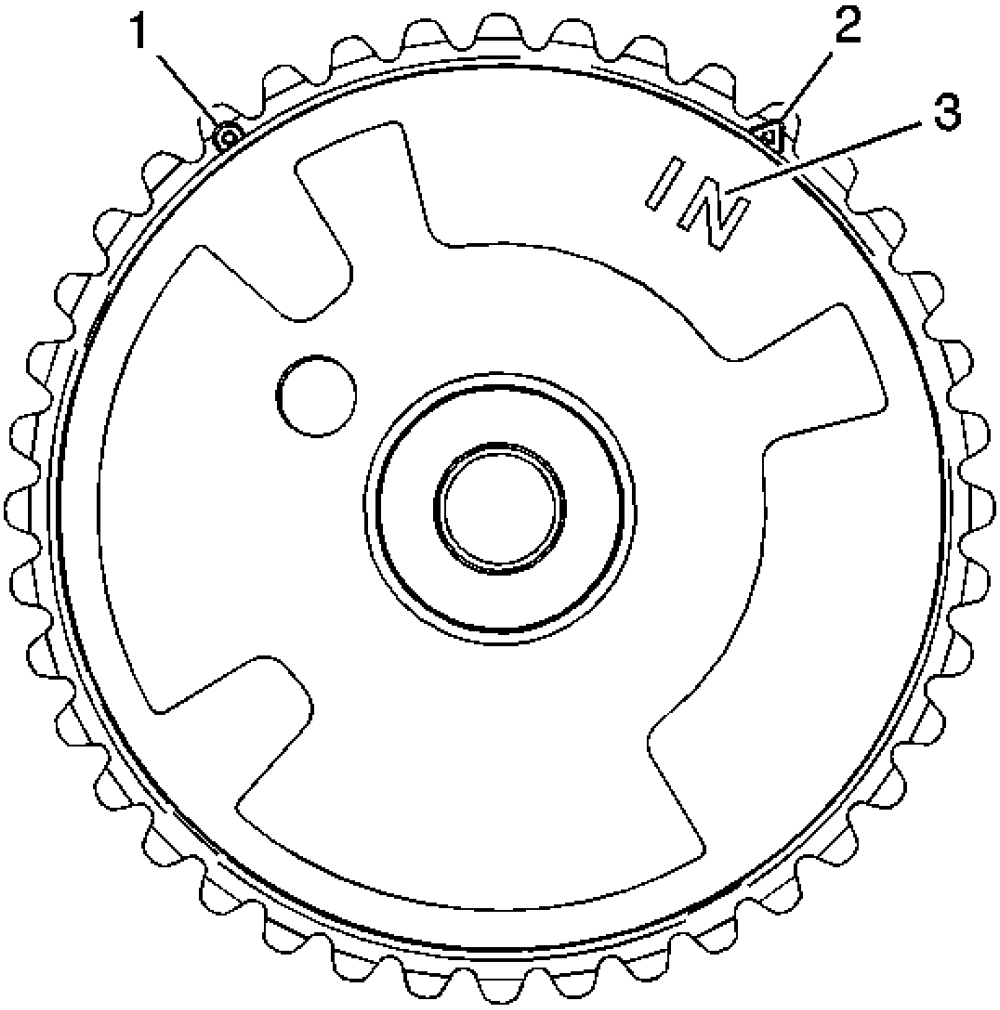


Fig. 24: View Of Camshaft Position Actuator Markings
Courtesy of GENERAL MOTORS CORP.

4. Ensure the proper timing mark is used. Observe the outer ring of the camshaft position actuator for the triangle marking (2). The triangle marking is for alignment to the highlighted timing chain link on the right side of the engine.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

5. Use an open wrench on the hex cast into the camshaft in order to prevent camshaft rotation when

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tightening the camshaft position actuator bolt.

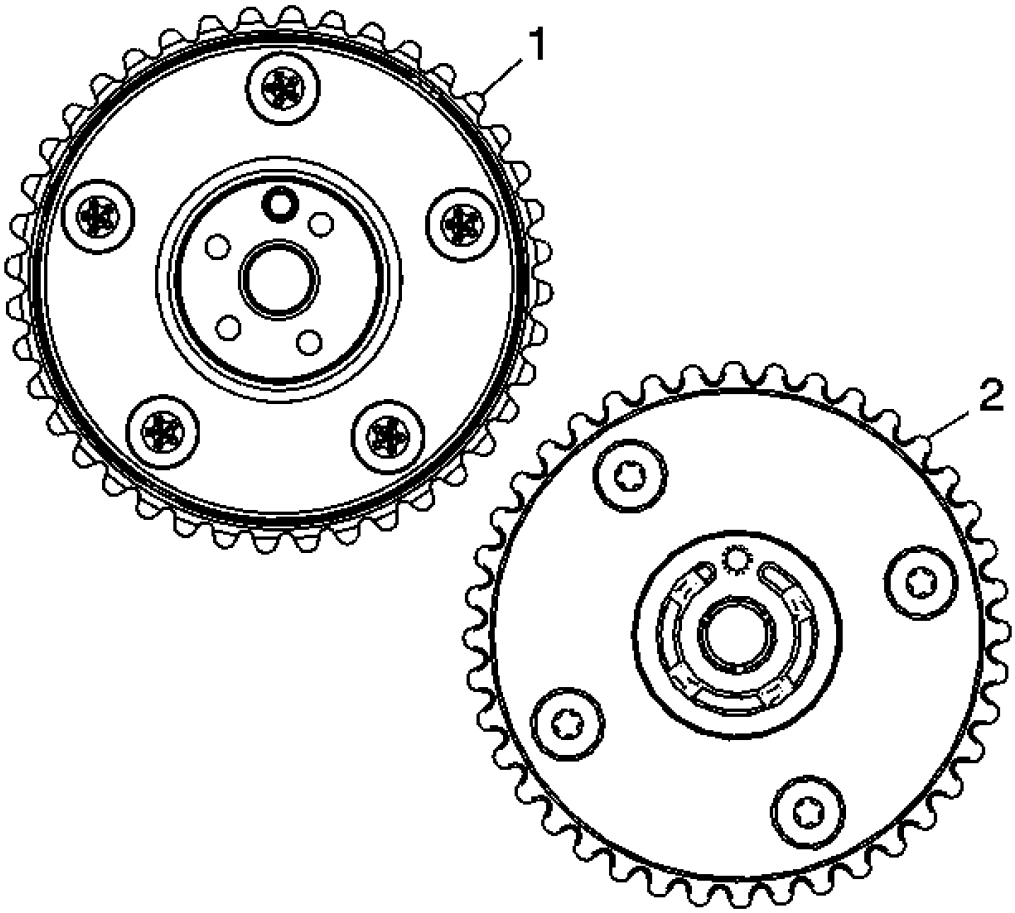


Fig. 25: Identifying Camshaft Position Actuators
Courtesy of GENERAL MOTORS CORP.

NOTE: The camshaft position actuator will vary depending on application.

NOTE: Camshaft thrust washers must be installed on all 2010 applications when servicing the camshaft position actuators. Do not install washers on 2009 applications if they are not already present.

6. Ensure the proper camshaft thrust washer is used. Use a 1.6 mm (0.063 in) thrust washer on applications that have 5 attaching screws on the back side of the camshaft position actuator (1). Use a 1.1 mm (0.043 in) thick thrust washer with yellow speckles on applications that have 4 attaching screws on the back side of the camshaft position actuator (2).

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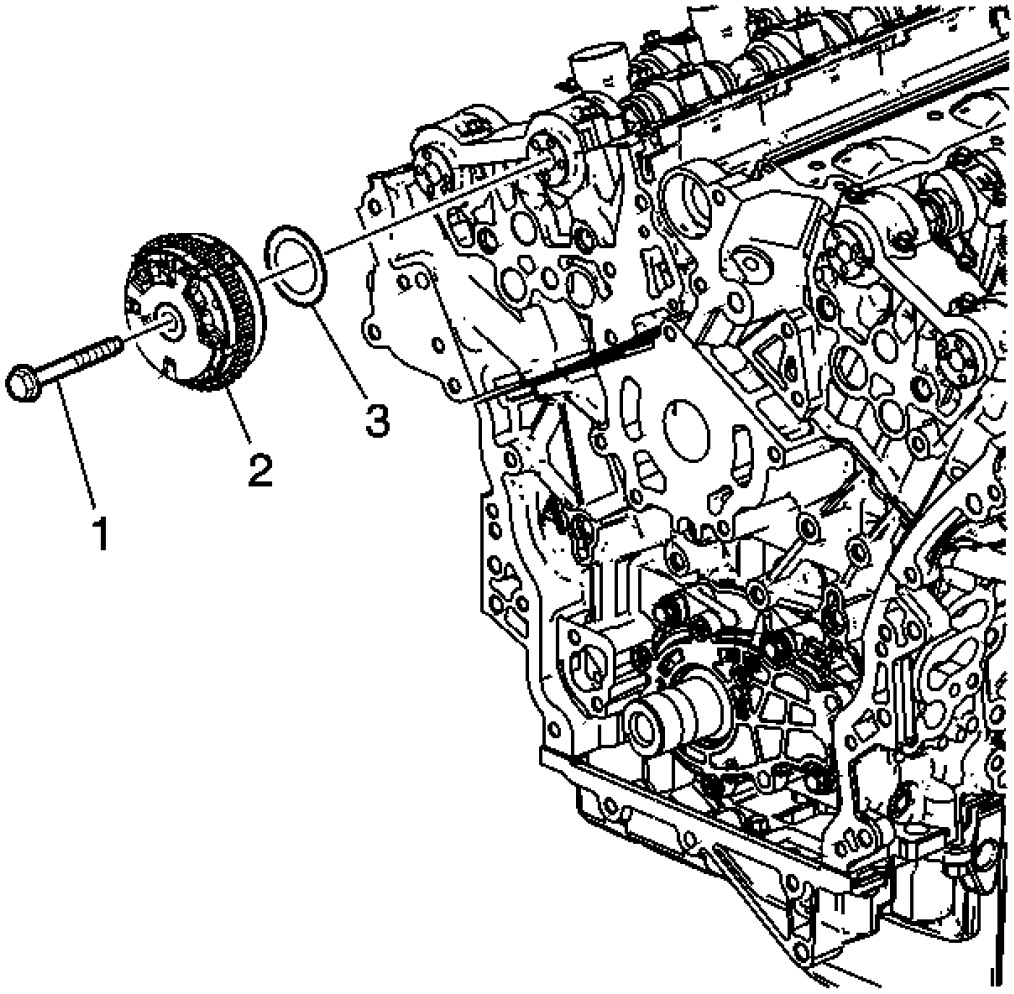


Fig. 26: Identifying Intake Camshaft Position Actuator & Bolt
Courtesy of GENERAL MOTORS CORP.

7. Install the thrust washer if applicable (3).
8. Install the right intake camshaft position actuator (2).

CAUTION: Refer to Fastener Caution .

9. Install the camshaft position actuator bolt (1) and tighten to 58 N.m (43 lb ft).

CAMSHAFT POSITION ACTUATOR INSTALLATION - RIGHT SIDE EXHAUST

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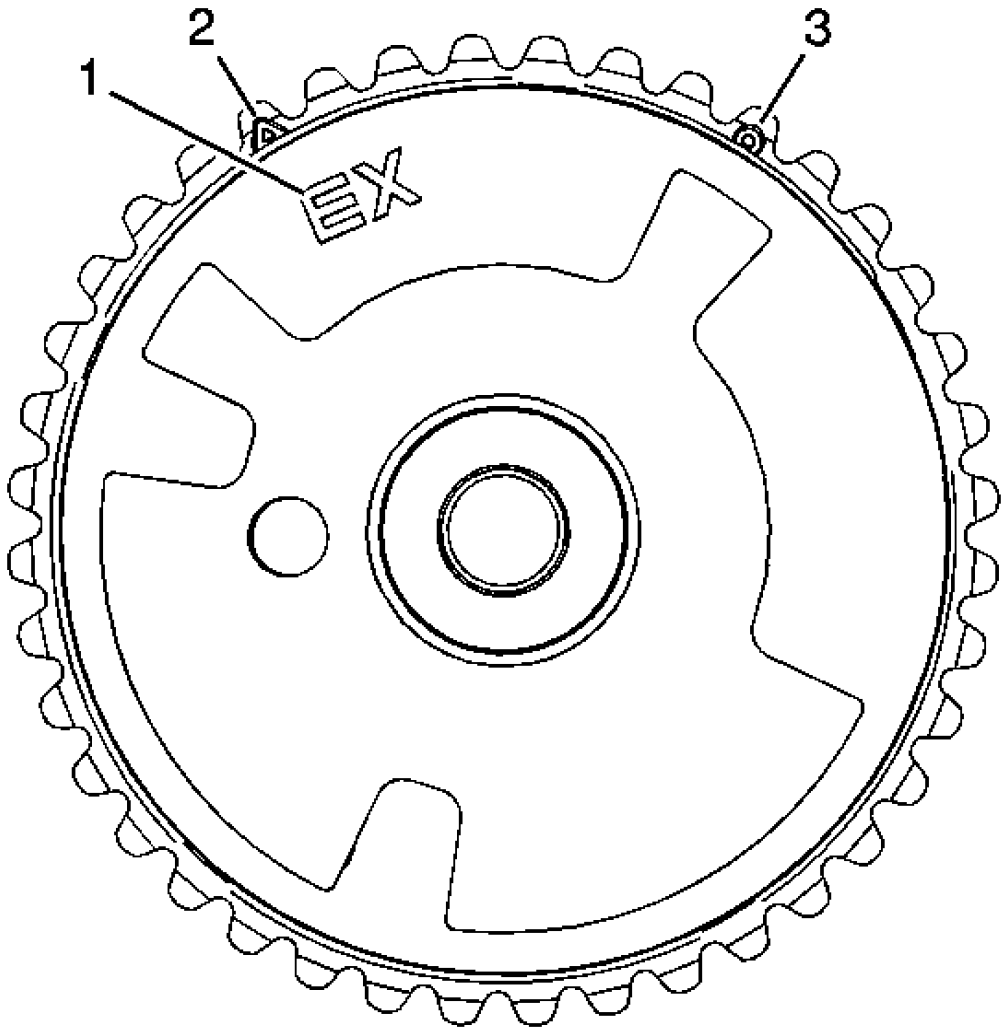


Fig. 27: View Of EX Marking, Triangle & Circle Marking
Courtesy of GENERAL MOTORS CORP.

1. Ensure the proper camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "EX" marking (1). The marking is for an exhaust camshaft position actuator.
2. Ensure the proper timing mark is used. Observe the outer ring of the camshaft position actuator for the triangle marking (2). The marking is for alignment to the highlighted timing chain link on the right side of the engine.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

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3. Use an open wrench on the hex cast into the camshaft in order to prevent camshaft rotation when tightening the camshaft position actuator bolt.

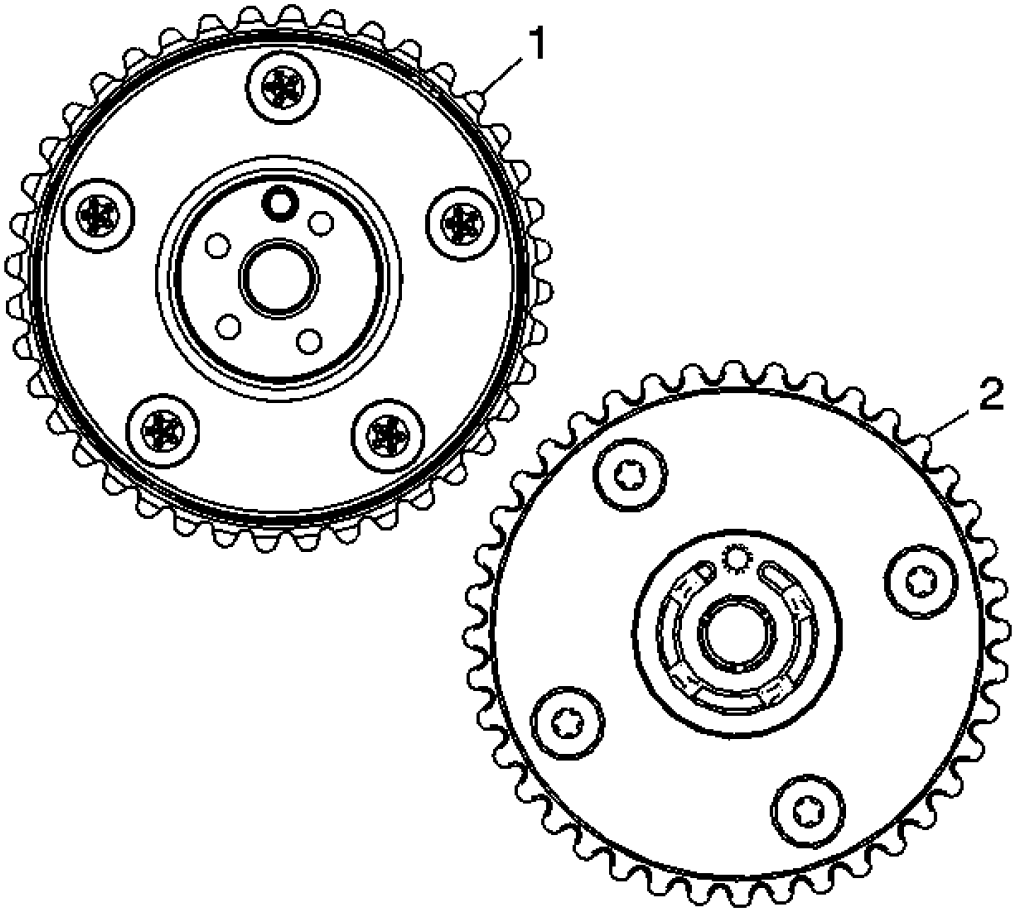


Fig. 28: Identifying Camshaft Position Actuators
Courtesy of GENERAL MOTORS CORP.

NOTE: The camshaft position actuator will vary depending on application.

NOTE: Camshaft thrust washers must be installed on all 2010 applications when servicing the camshaft position actuators. Do not install washers on 2009 applications if they are not already present.

4. Ensure the proper camshaft thrust washer is used. Use a 1.6 mm (0.063 in) thrust washer on applications

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that have 5 attaching screws on the back side of the camshaft position actuator (1). Use a 1.1 mm (0.043 in) thick thrust washer with yellow speckles on applications that have 4 attaching screws on the back side of the camshaft position actuator (2).

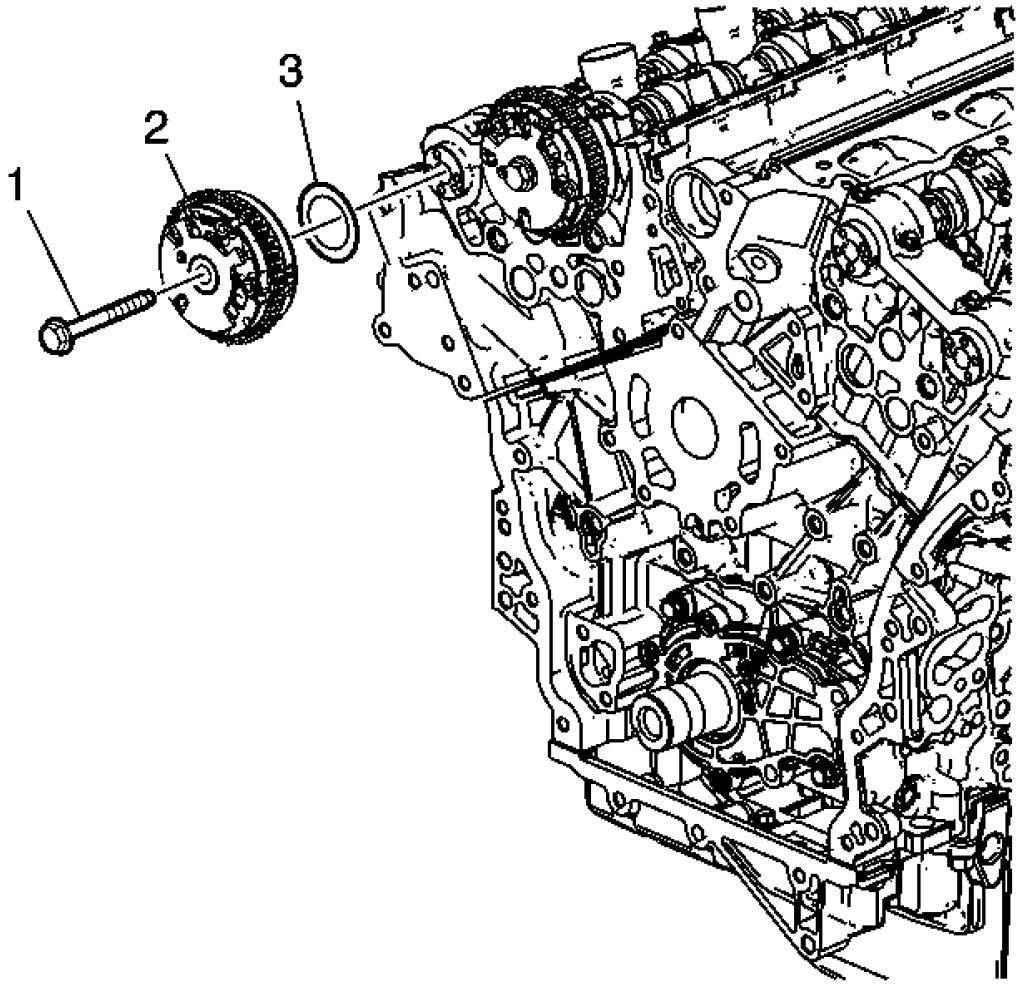


Fig. 29: Identifying Camshaft Position Actuator & Bolt
Courtesy of GENERAL MOTORS CORP.

5. Install the thrust washer if applicable (3).
6. Install the right exhaust camshaft position actuator (2).

CAUTION: Refer to Fastener Caution .

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7. Install the camshaft position actuator bolt (1) and tighten to 58 N.m (43 lb ft).

CAMSHAFT POSITION ACTUATOR INSTALLATION - LEFT SIDE INTAKE

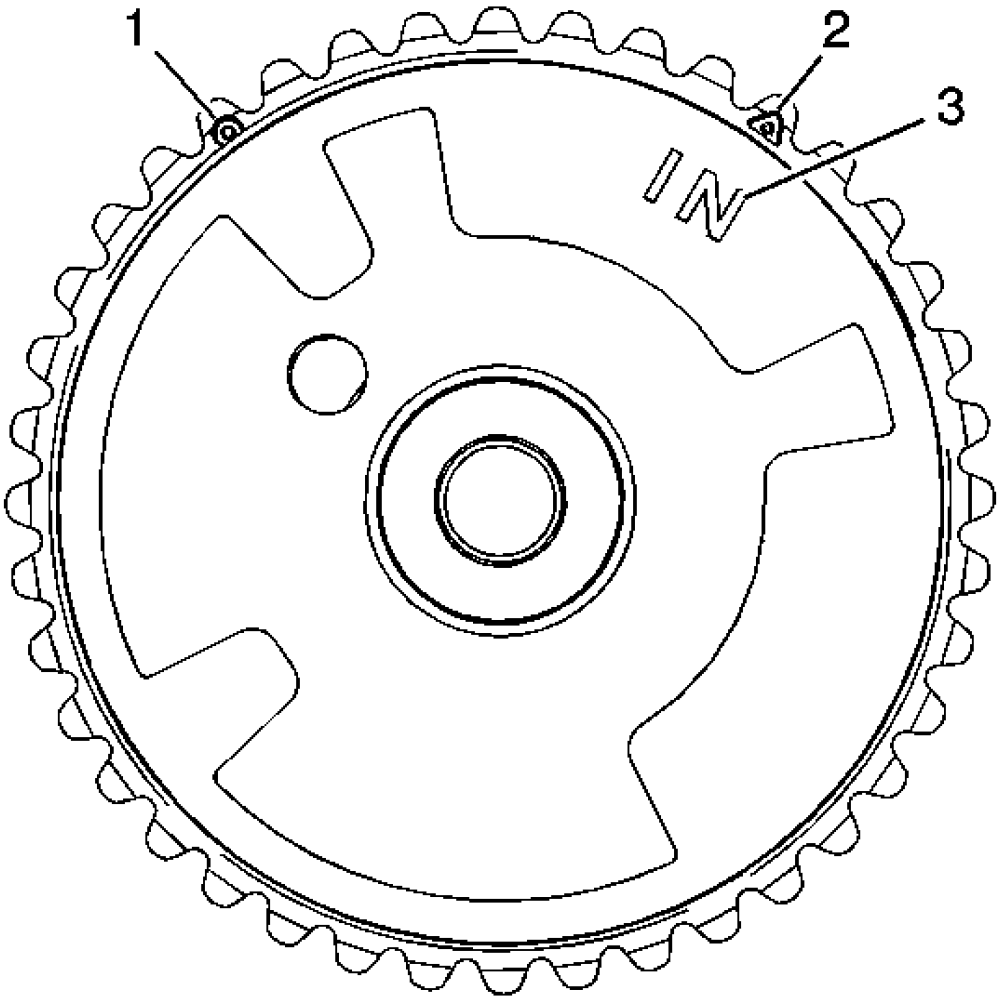


Fig. 30: Identifying Camshaft Position Actuator Marks
Courtesy of GENERAL MOTORS CORP.

1. Ensure the proper camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "IN" marking (3). The marking is for an intake camshaft position actuator.

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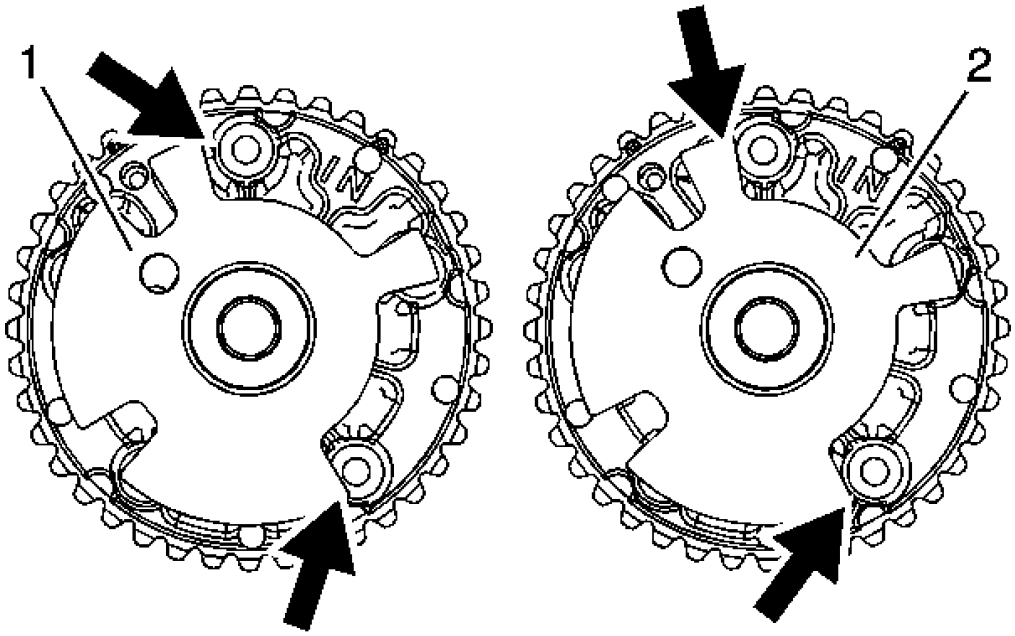


Fig. 31: View Of Right Intake Camshaft Position Actuator & Left Intake Camshaft Position Actuator
Courtesy of GENERAL MOTORS CORP.

CAUTION: Ensure the proper camshaft position actuator is installed in the correct position. Failure to install the proper camshaft position actuator can effect engine performance and set an engine code.

2. Ensure the proper camshaft position actuator is being installed. The reluctor wheel on the right intake camshaft position actuator (1) is indexed in a different position compared to the left intake camshaft position actuator (2).

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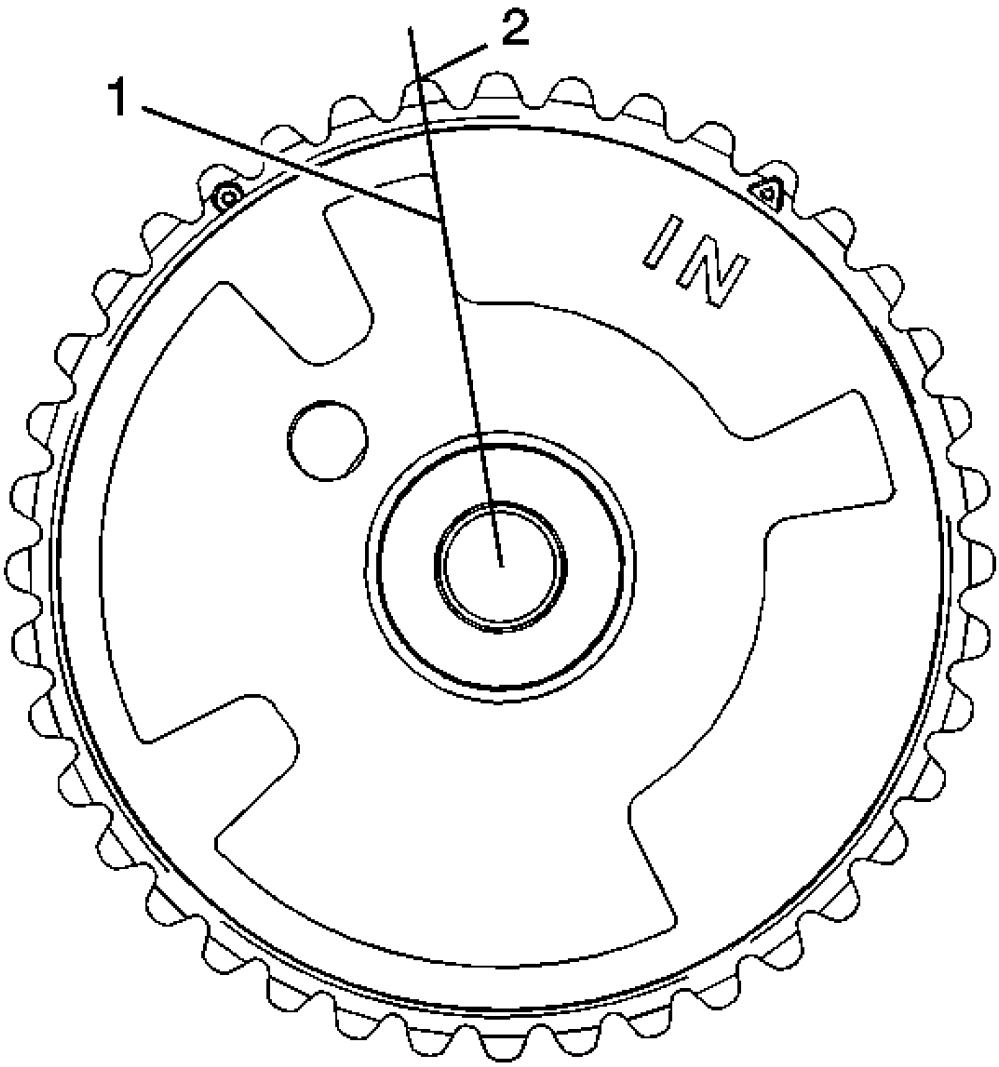


Fig. 32: Identifying Left Intake Camshaft Actuator
Courtesy of GENERAL MOTORS CORP.

3. On the left intake camshaft actuator the edge of the reluctor wheel (1) lines up with the peak (2) of the sprocket tooth.

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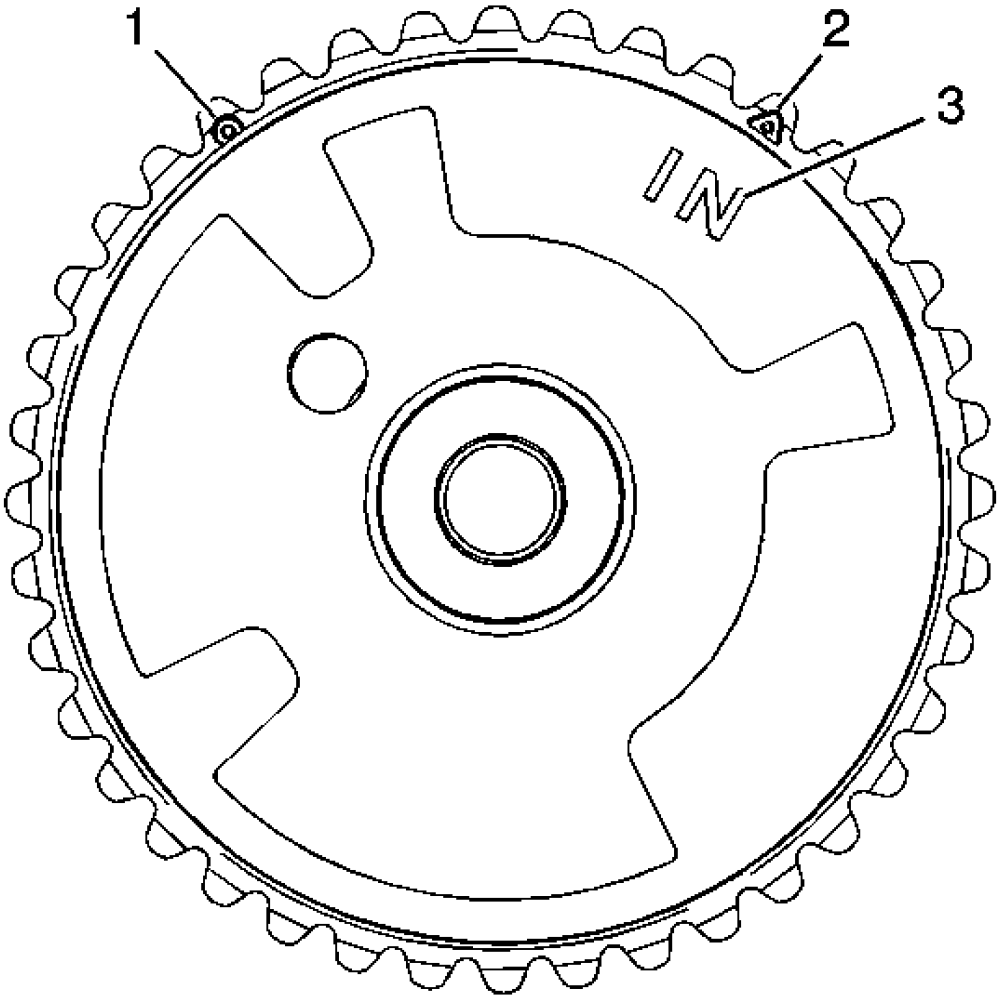


Fig. 33: Identifying Camshaft Position Actuator Marks
Courtesy of GENERAL MOTORS CORP.

4. Ensure the proper timing mark is used. Observe the outer ring of the camshaft position actuator for the circle marking (1). The circle marking is for alignment to the highlighted timing chain link on the left side of the engine.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

5. Use an open wrench on the hex cast into the camshaft in order to prevent camshaft rotation when

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tightening the camshaft position actuator bolt.

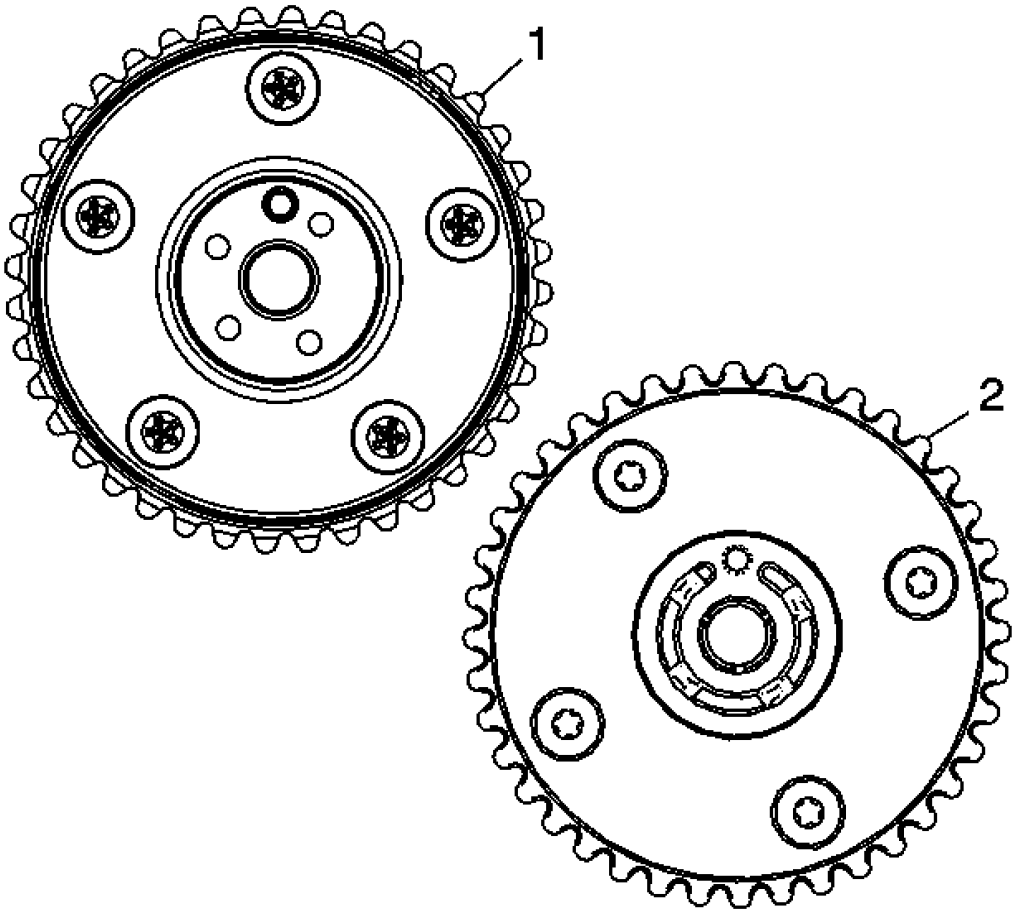


Fig. 34: Identifying Camshaft Position Actuators
Courtesy of GENERAL MOTORS CORP.

NOTE: The camshaft position actuator will vary depending on application.

NOTE: Camshaft thrust washers must be installed on all 2010 applications when servicing the camshaft position actuators. Do not install washers on 2009 applications if they are not already present.

6. Ensure the proper camshaft thrust washer is used. Use a 1.6 mm (0.063 in) thrust washer on applications that have 5 attaching screws on the back side of the camshaft position actuator (1). Use a 1.1 mm (0.043 in) thick thrust washer with yellow speckles on applications that have 4 attaching screws on the back side of the camshaft position actuator (2).

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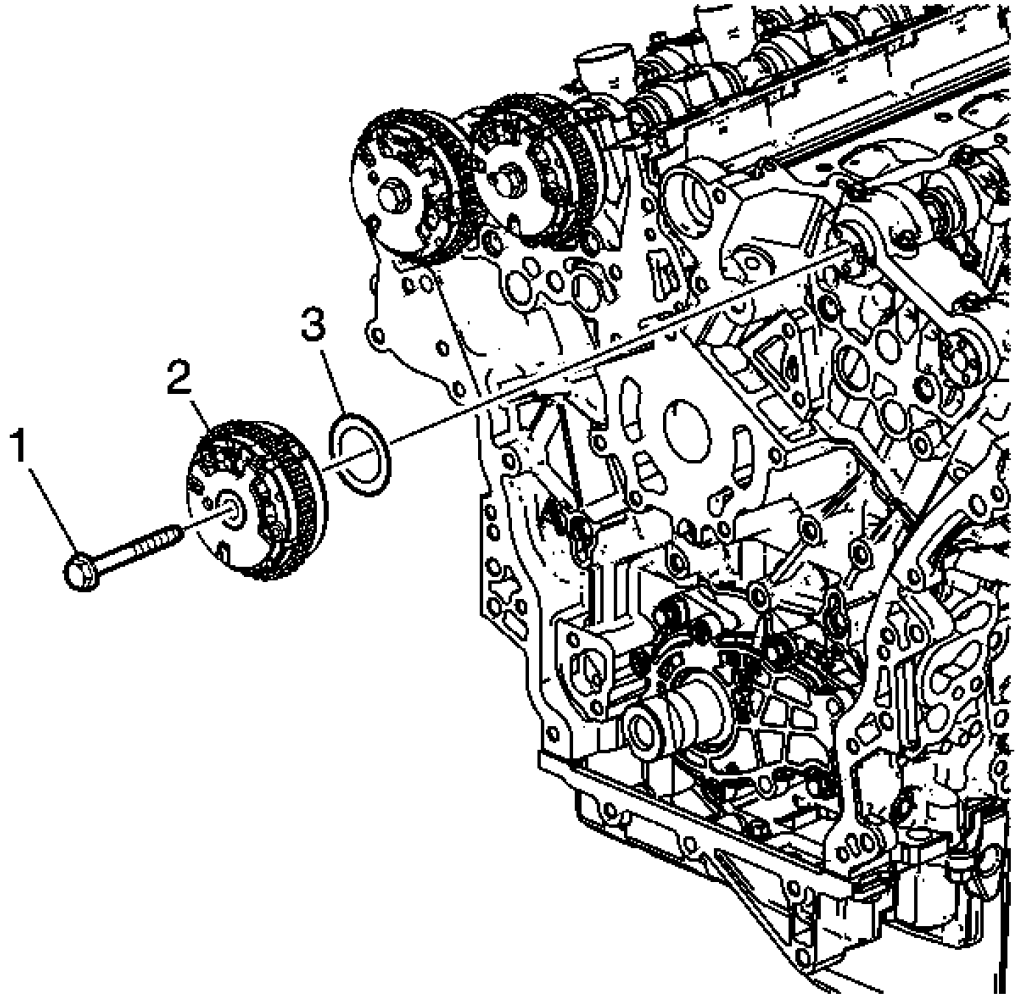


Fig. 35: View Of Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS CORP.

7. Install the thrust washer if applicable (3).
8. Install the left intake camshaft position actuator (2).

CAUTION: Refer to Fastener Caution .

9. Install the camshaft position actuator bolt (1) and tighten to 58 N.m (43 lb ft).

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CAMSHAFT POSITION ACTUATOR INSTALLATION - LEFT SIDE EXHAUST

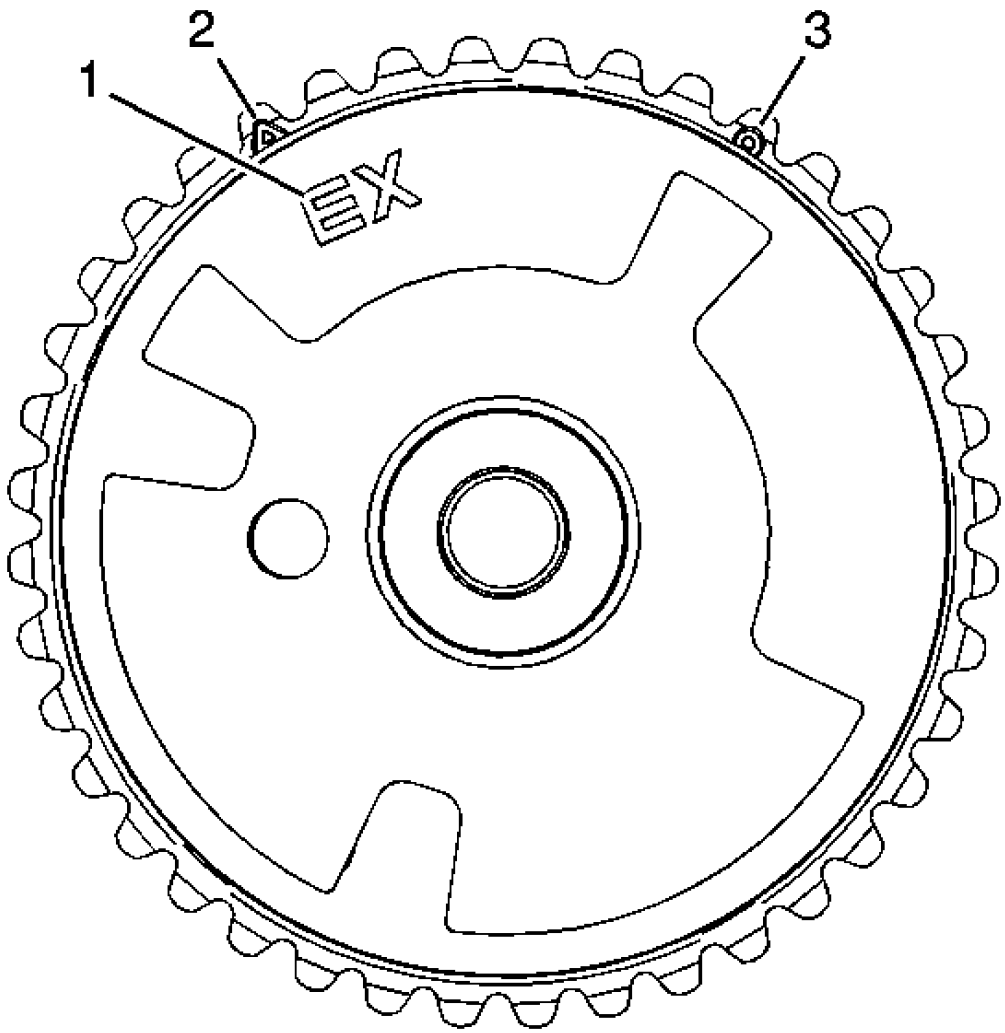


Fig. 36: View Of EX Marking, Triangle & Circle Marking
Courtesy of GENERAL MOTORS CORP.

1. Ensure the proper camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "EX" marking (1). The marking is for an exhaust camshaft position actuator.
2. Ensure the proper timing mark is used. Observe the outer ring of the camshaft position actuator for the circle marking (3). The marking is for alignment to the highlighted timing chain link on the left side of the engine.

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CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

3. Use an open wrench on the hex cast into the camshaft in order to prevent camshaft rotation when tightening the camshaft position actuator bolt.

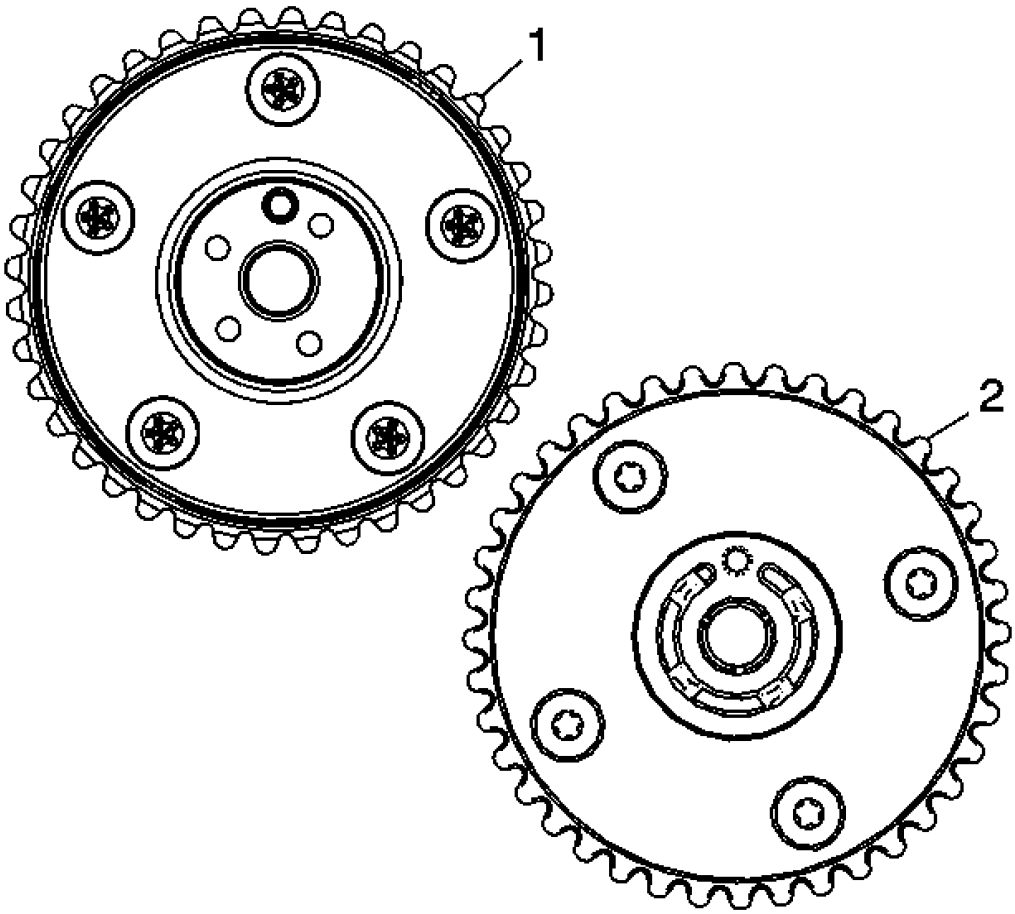


Fig. 37: Identifying Camshaft Position Actuators
Courtesy of GENERAL MOTORS CORP.

NOTE: The camshaft position actuator will vary depending on application.

NOTE: Camshaft thrust washers must be installed on all 2010 applications when servicing the camshaft position actuators. Do not install washers on 2009 applications if they are not already present.

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4. Ensure the proper camshaft thrust washer is used. Use a 1.6 mm (0.063 in) thrust washer on applications that have 5 attaching screws on the back side of the camshaft position actuator (1). Use a 1.1 mm (0.043 in) thick thrust washer with yellow speckles on applications that have 4 attaching screws on the back side of the camshaft position actuator (2).

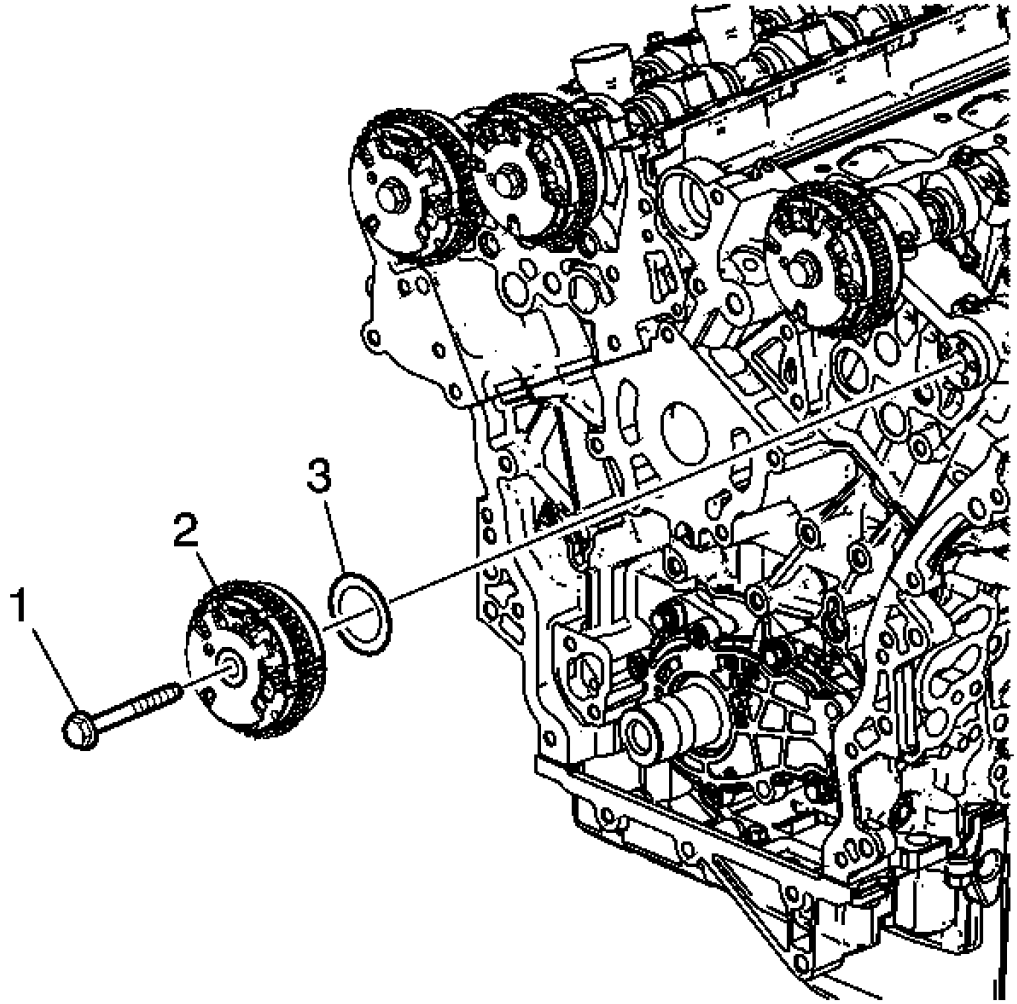


Fig. 38: Locating Exhaust Camshaft Position Actuator & Bolt
Courtesy of GENERAL MOTORS CORP.

5. Install the thrust washer if applicable (3).
6. Install the left exhaust camshaft position actuator (2).

CAUTION: Refer to Fastener Caution .

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7. Install the camshaft position actuator bolt (1) and tighten to 58 N.m (43 lb ft).

CRANKSHAFT SPROCKET INSTALLATION

SPECIAL TOOLS

EN-48589: Crankshaft Rotation Socket

For equivalent regional tools, refer to **Special Tools** .

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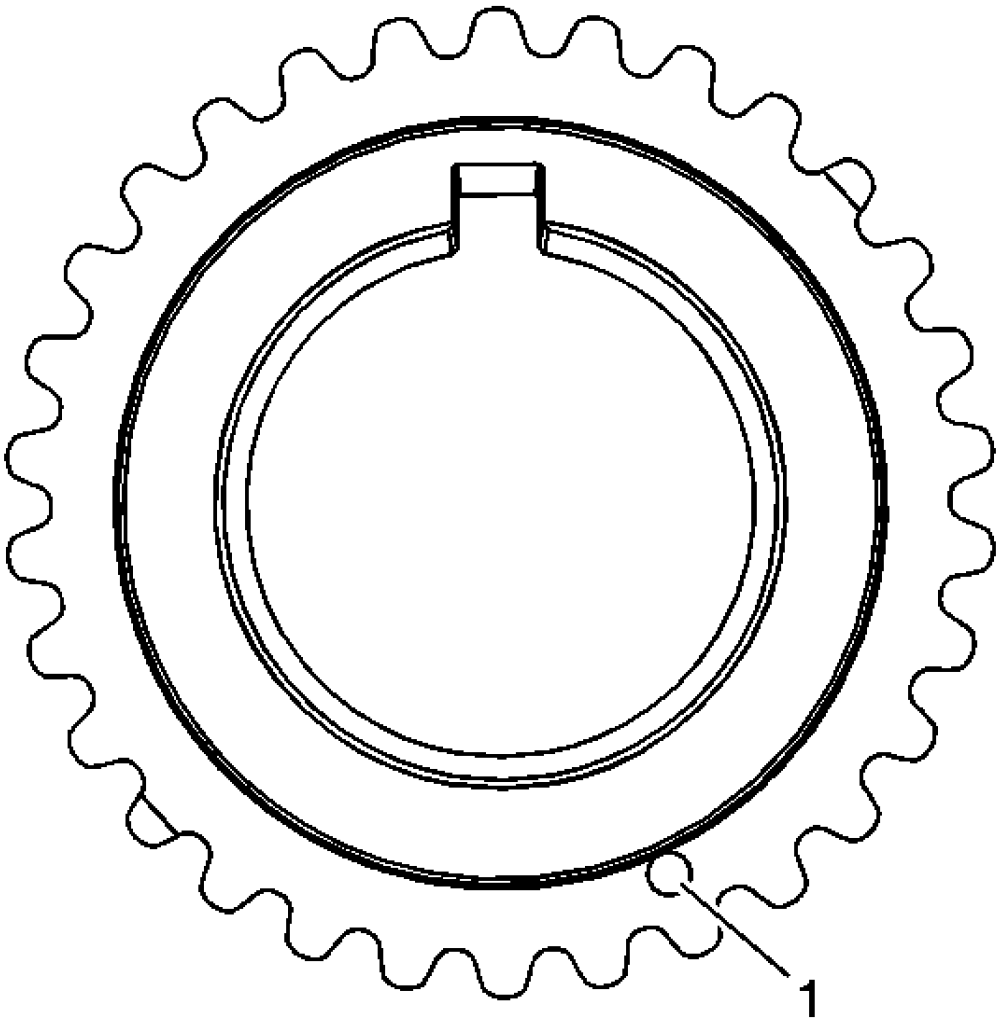


Fig. 39: Identifying Crankshaft Sprocket Timing Mark
Courtesy of GENERAL MOTORS CORP.

1. Ensure the crankshaft sprocket is installed with the timing mark (1) visible.

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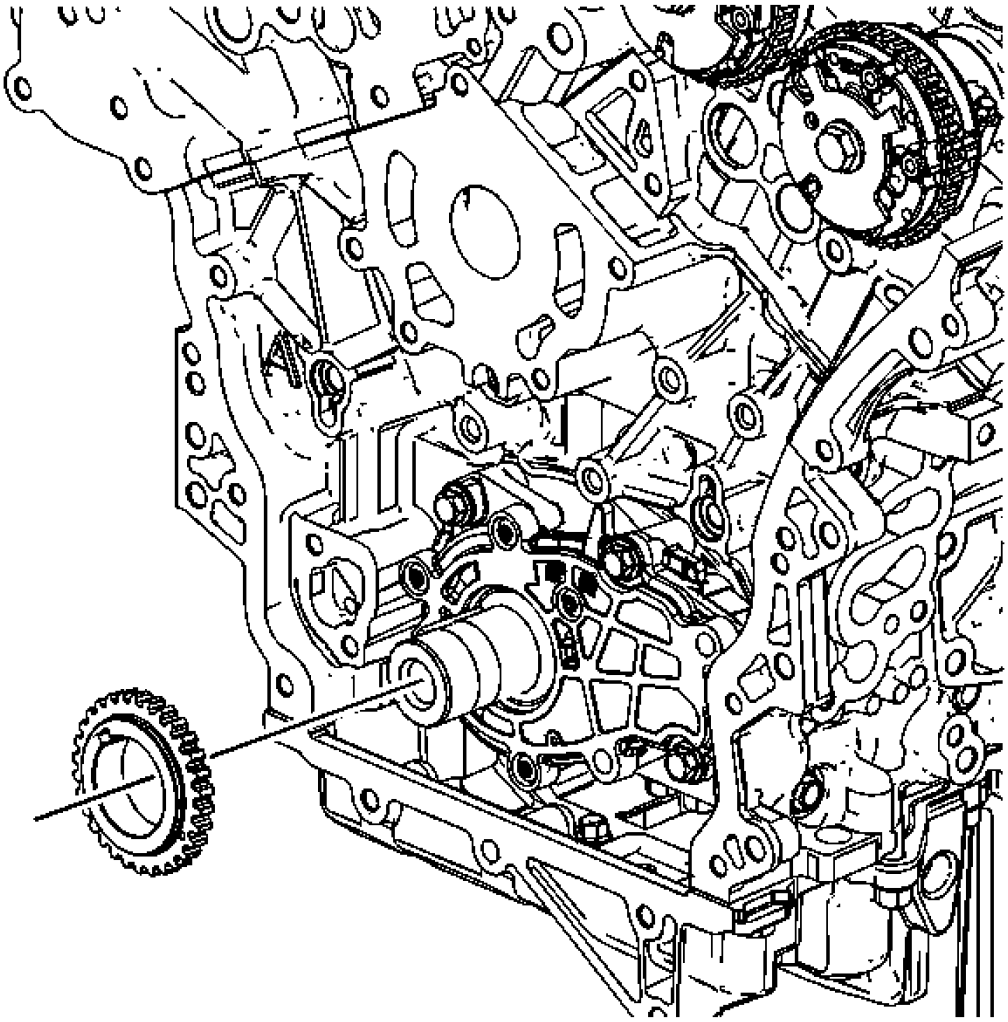


Fig. 40: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS CORP.

2. Install the crankshaft sprocket onto the nose of the crankshaft.
3. Align the notch in the crankshaft sprocket with the pin in the crankshaft.
4. Slide the crankshaft sprocket on the crankshaft nose until the crankshaft sprocket contacts the step in the crankshaft.

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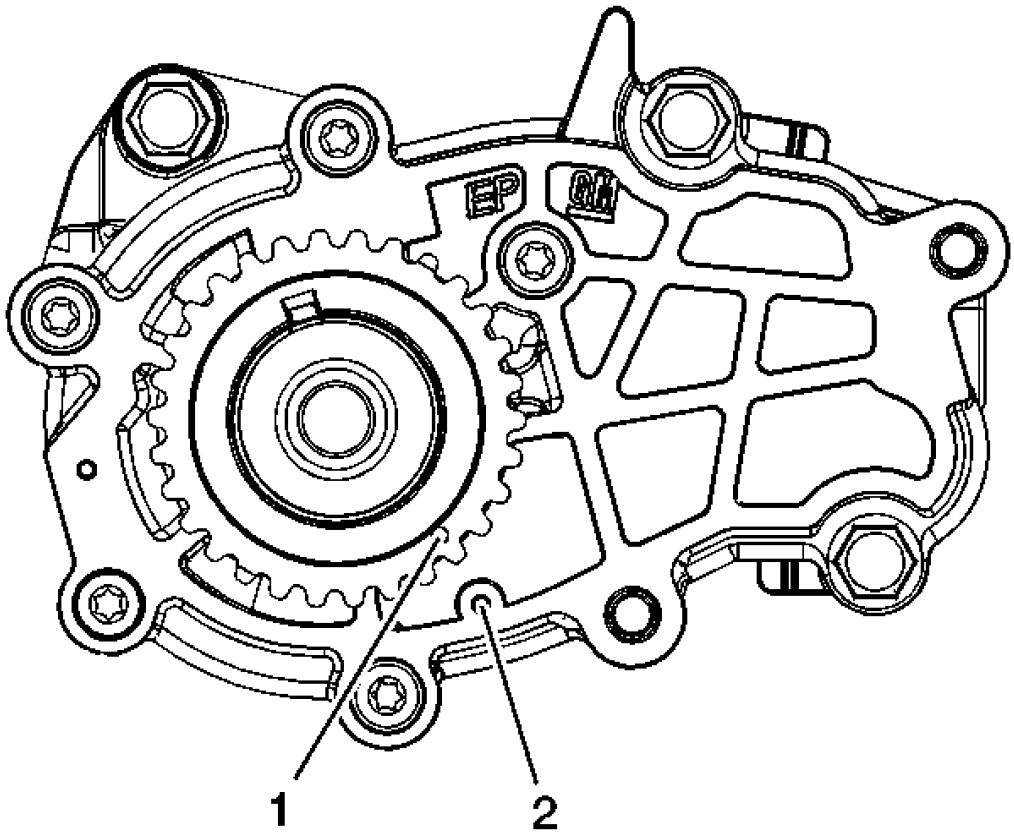


Fig. 41: View Of Stage One Timing Mark On Oil Pump Cover & Sprocket Timing Mark
Courtesy of GENERAL MOTORS CORP.

5. Ensure the crankshaft is in the stage one timing position with the crankshaft sprocket timing mark (1) aligned to the stage one timing mark on the oil pump cover (2) using the **EN-48589:** socket. Refer to **Timing Chain Alignment Diagram** .

TIMING CHAIN IDLER SPROCKET INSTALLATION - LEFT SIDE

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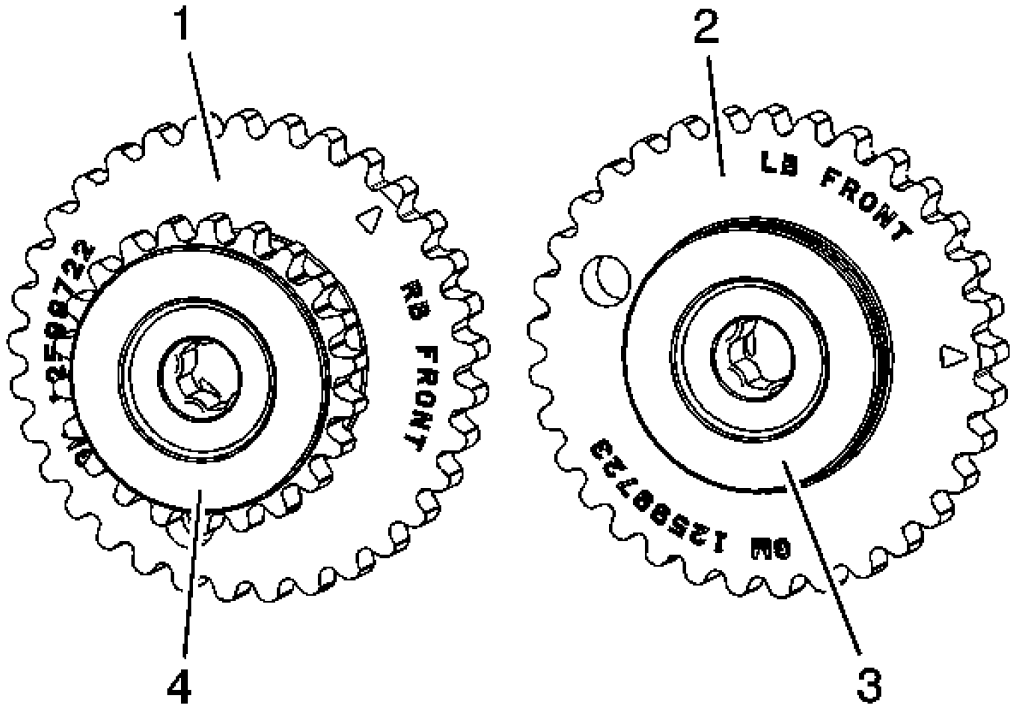


Fig. 42: Identifying Camshaft Intermediate Drive Chain Idlers
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the left camshaft intermediate drive chain idler (2) is being installed. The recessed hub (3) and the larger sprocket of the left camshaft intermediate drive chain idler is installed outward. The raised hub and the smaller sprocket of the left camshaft intermediate drive chain idler is installed towards the block.

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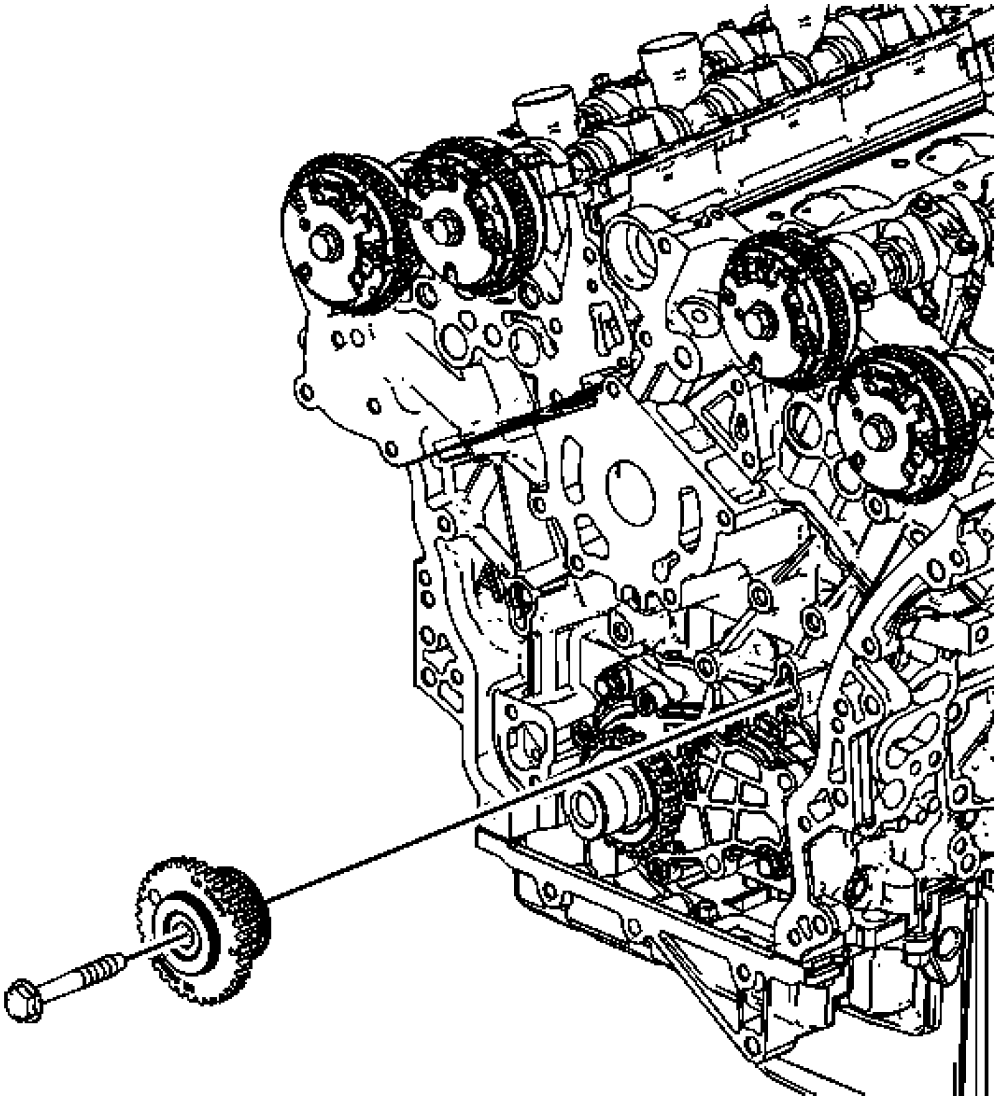


Fig. 43: View Of Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS CORP.

2. Place the left camshaft intermediate drive chain idler to the cylinder block.

CAUTION: Refer to Fastener Caution .

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3. Install the camshaft intermediate drive chain idler bolt and tighten to 58 N.m (43 lb ft).

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN INSTALLATION - LEFT SIDE (LLT)

Special Tools

- **EN-48383** Camshaft Retaining Tools. See **Special Tools** .
- **EN-48589** Crankshaft Rotation Socket. See **Special Tools** .

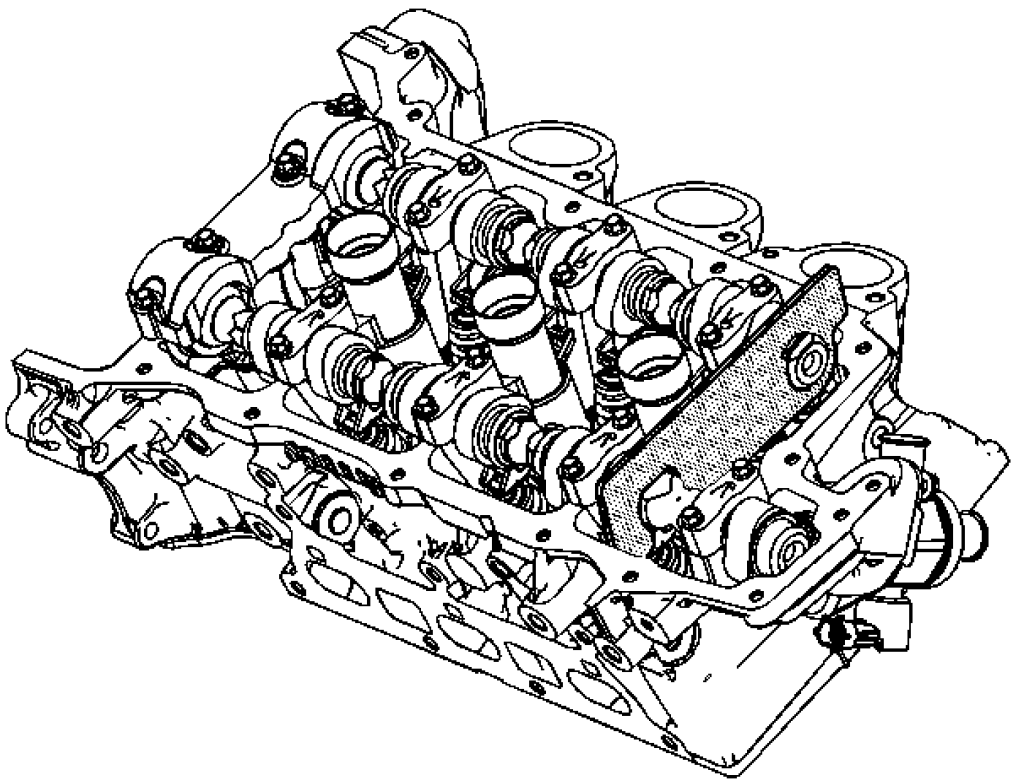


Fig. 44: View Of Camshafts & EN 48383-1
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: There should be no need to rotate the camshaft more than 10 degrees. Using the hex cast into the camshaft rotate the camshaft in order to install the EN-48383 . See Special Tools .

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1. Install the EN 48383-1 onto the rear of the left camshafts.

IMPORTANT: All camshafts must be locked in place before installation of any camshaft drive chains.

2. Ensure that the EN 48383-1 is fully seated onto the camshafts.

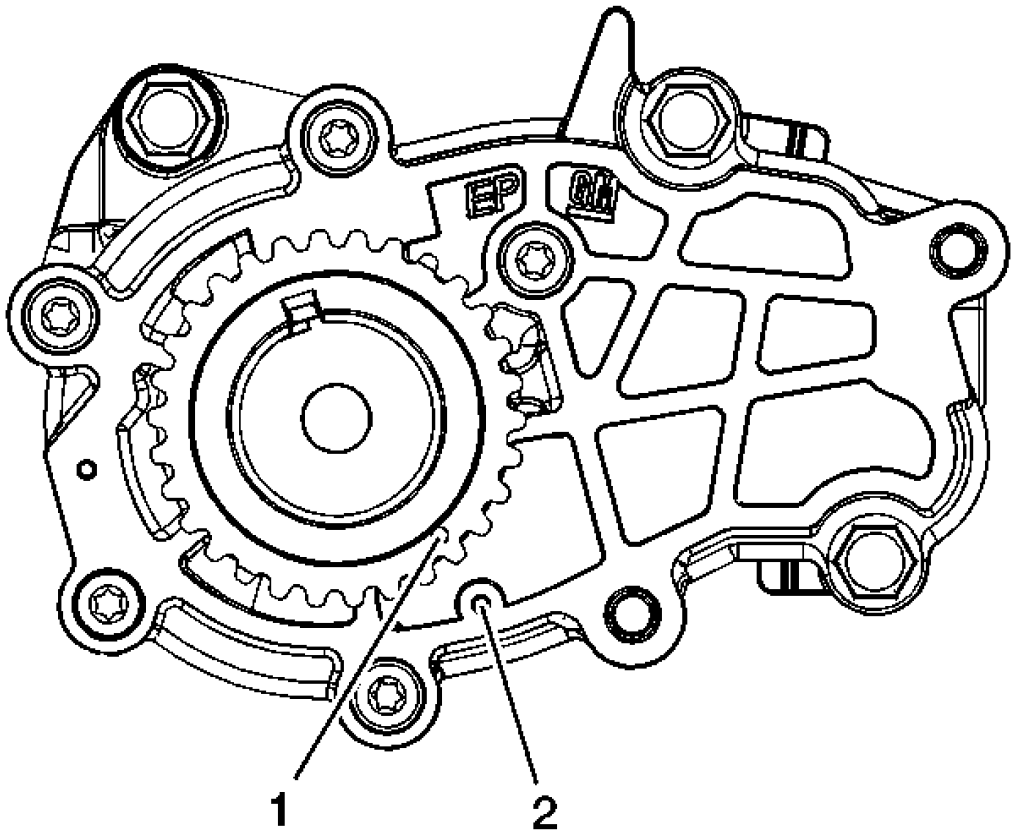


Fig. 45: View Of Crankshaft Sprocket Timing Mark & Oil Pump Cover
Courtesy of GENERAL MOTORS CORP.

3. Ensure the crankshaft is in the stage one timing position with the crankshaft sprocket timing mark (1) aligned to the stage one timing mark on the oil pump cover (2) using the **EN-48589** . See **Special Tools** . Refer to **Timing Chain Alignment Diagram** .

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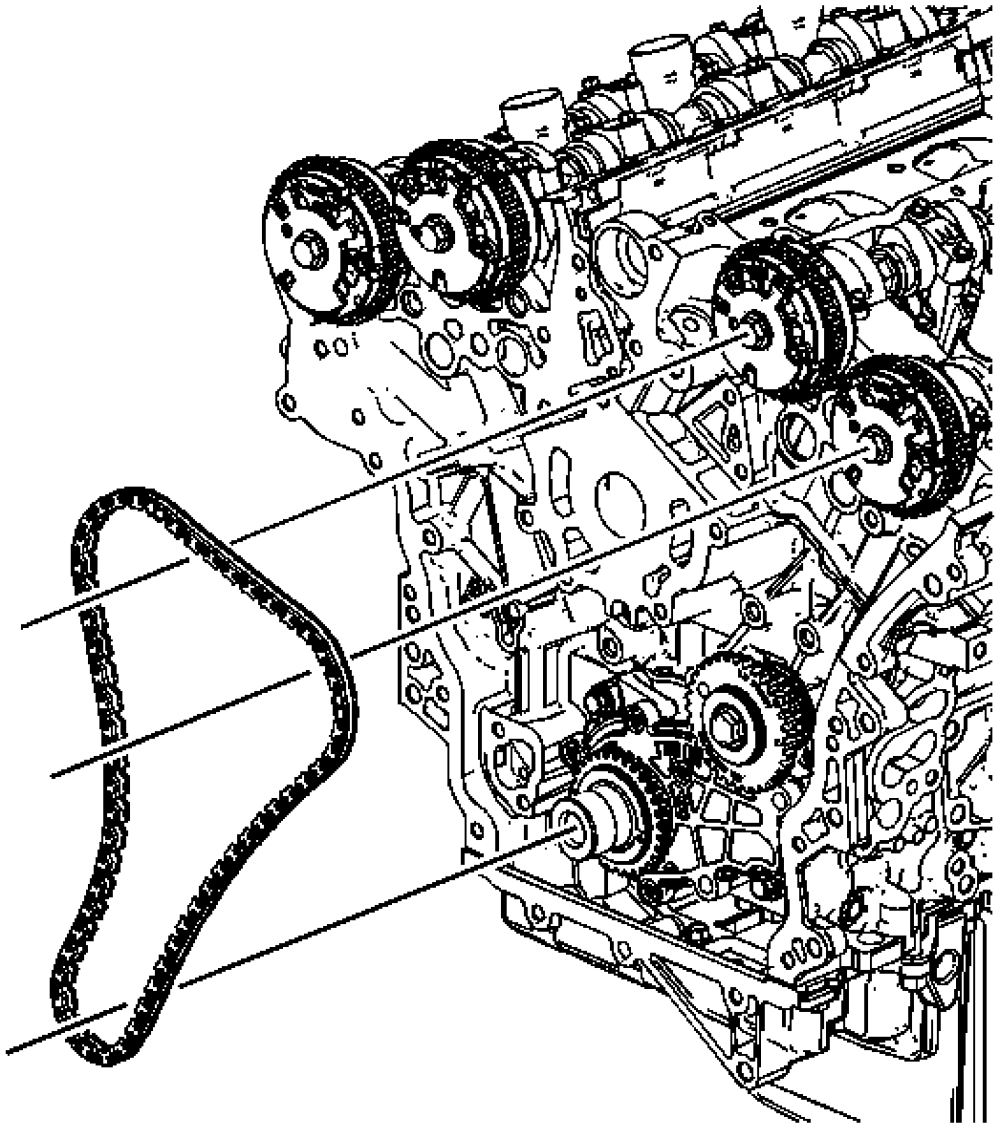


Fig. 46: Identifying Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

4. Install the left secondary camshaft drive chain.

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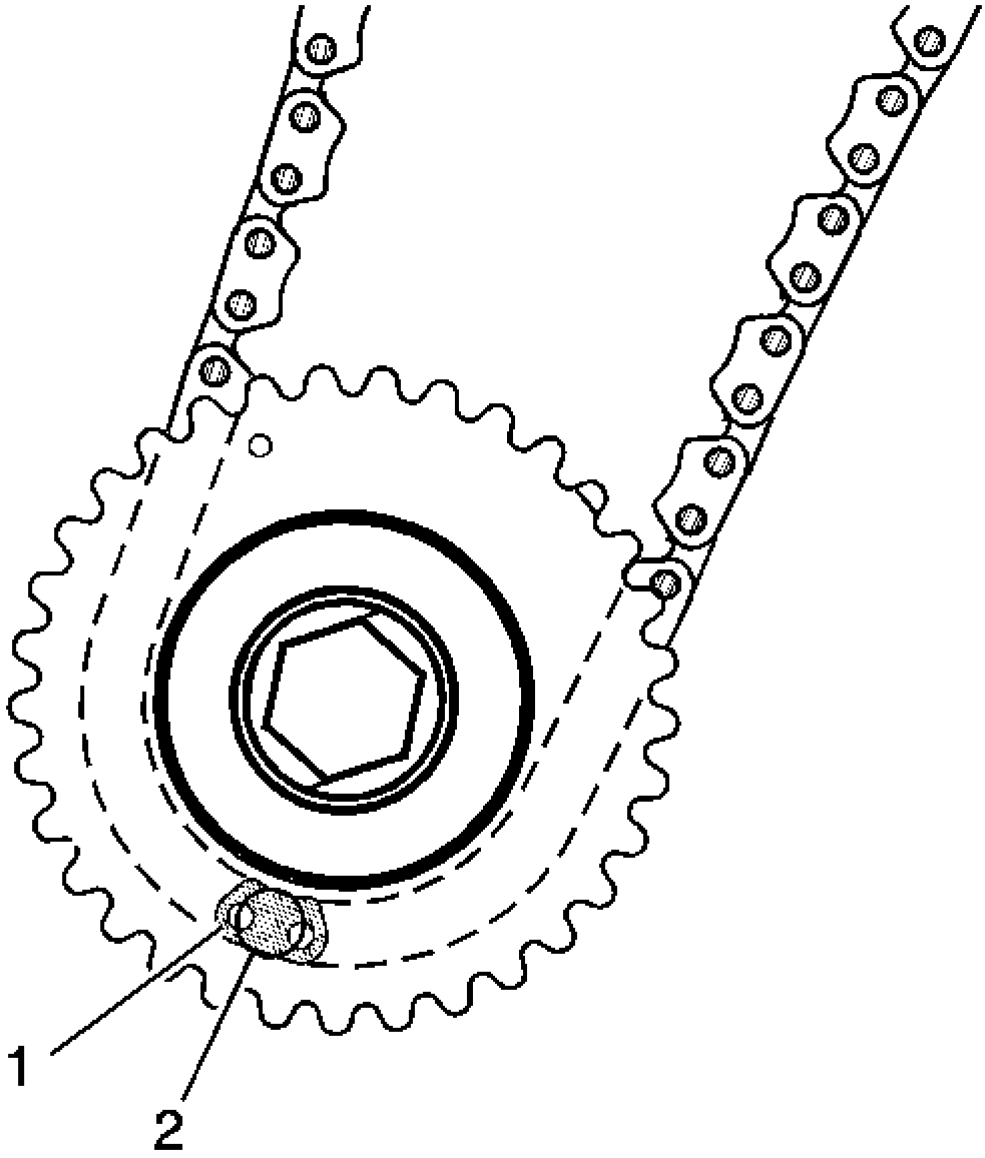


Fig. 47: Identifying Timing Camshaft Drive Chain Link & Alignment Access Hole
Courtesy of GENERAL MOTORS CORP.

5. Place the left secondary camshaft drive chain around the inner sprocket of the left camshaft intermediate drive chain idler with the timing camshaft drive chain link (1) aligned to the alignment access hole (2) made in the left camshaft intermediate drive chain idler outer sprocket.

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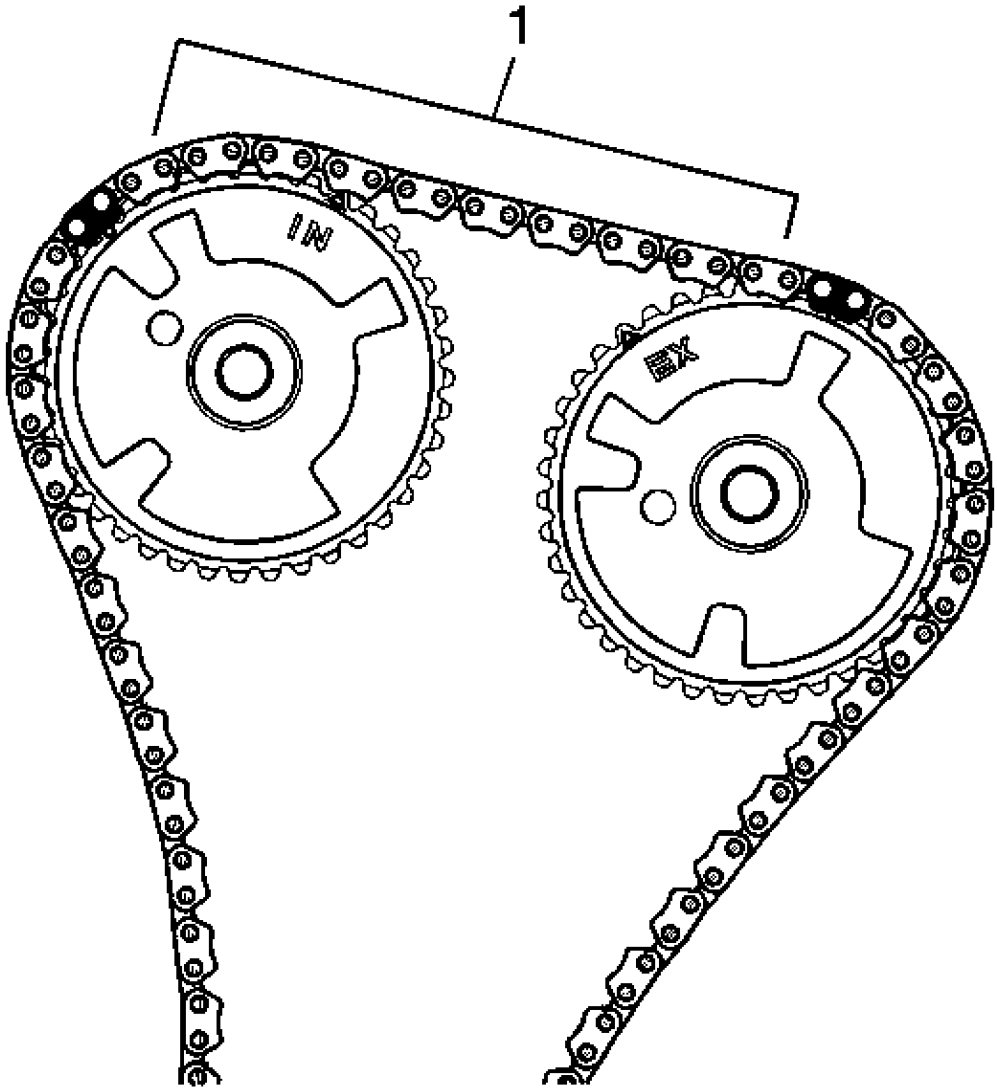


Fig. 48: View Of Camshaft Drive Chain Links
Courtesy of GENERAL MOTORS CORP.

6. Wrap the secondary camshaft drive chain around both left actuator drive sprockets.
7. Ensure there are 10 links (1) between the timing camshaft drive chain links for the camshaft position actuator sprockets.

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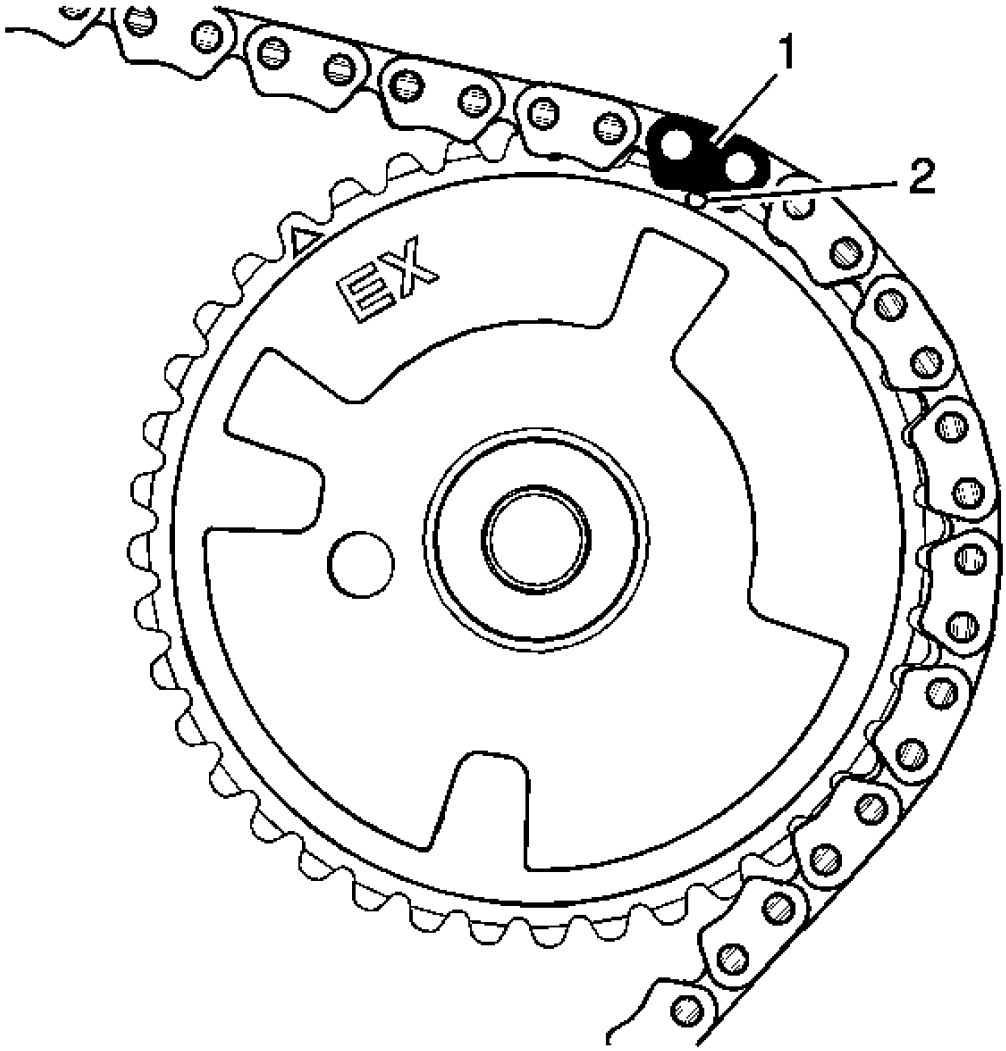


Fig. 49: View Of Exhaust Camshaft Marks
Courtesy of GENERAL MOTORS CORP.

8. Align the left exhaust camshaft position actuator sprocket alignment circle mark (2) with the timing camshaft drive chain link (1).

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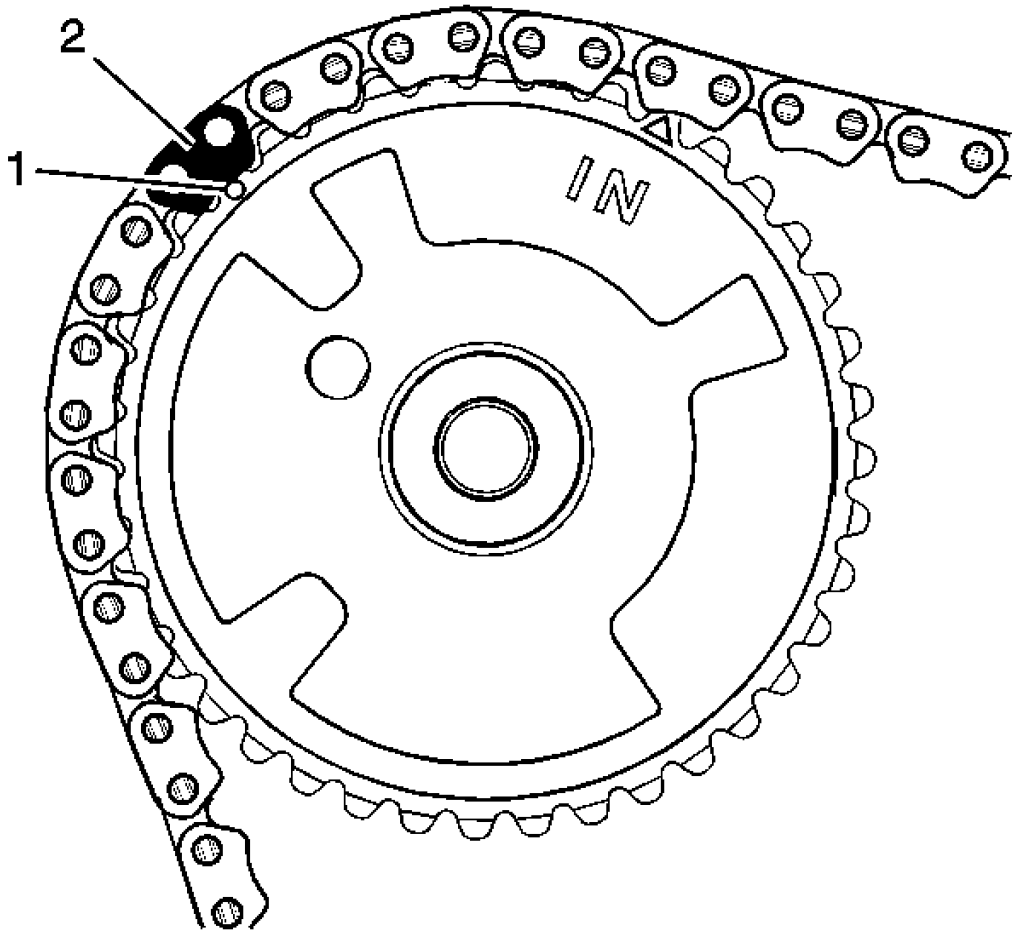


Fig. 50: View Of Intake Camshaft Marks
Courtesy of GENERAL MOTORS CORP.

9. Align the left intake camshaft position actuator sprocket alignment circle mark (1) with the timing camshaft drive chain link (2).

SECONDARY TIMING CHAIN GUIDE INSTALLATION - LEFT SIDE

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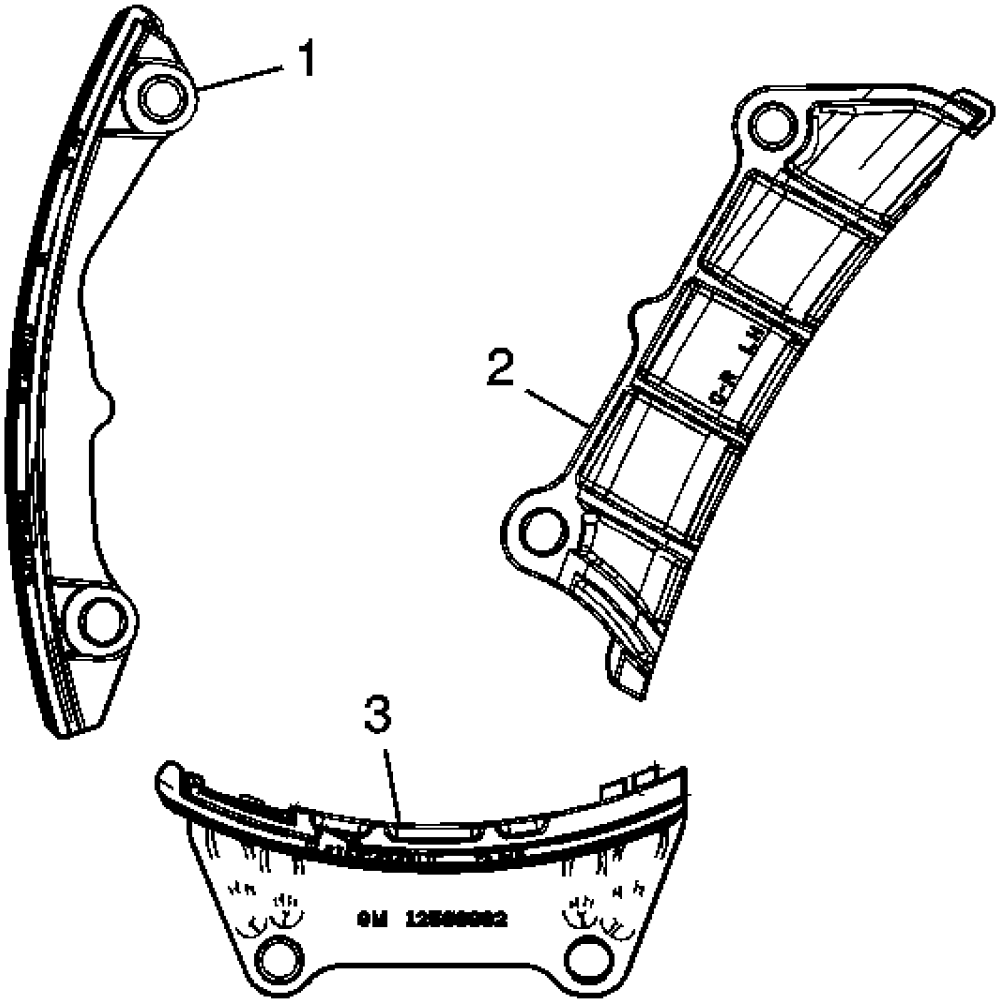


Fig. 51: Identifying Camshaft Drive Chain Guides
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the left secondary camshaft drive chain guide (2) is being installed.

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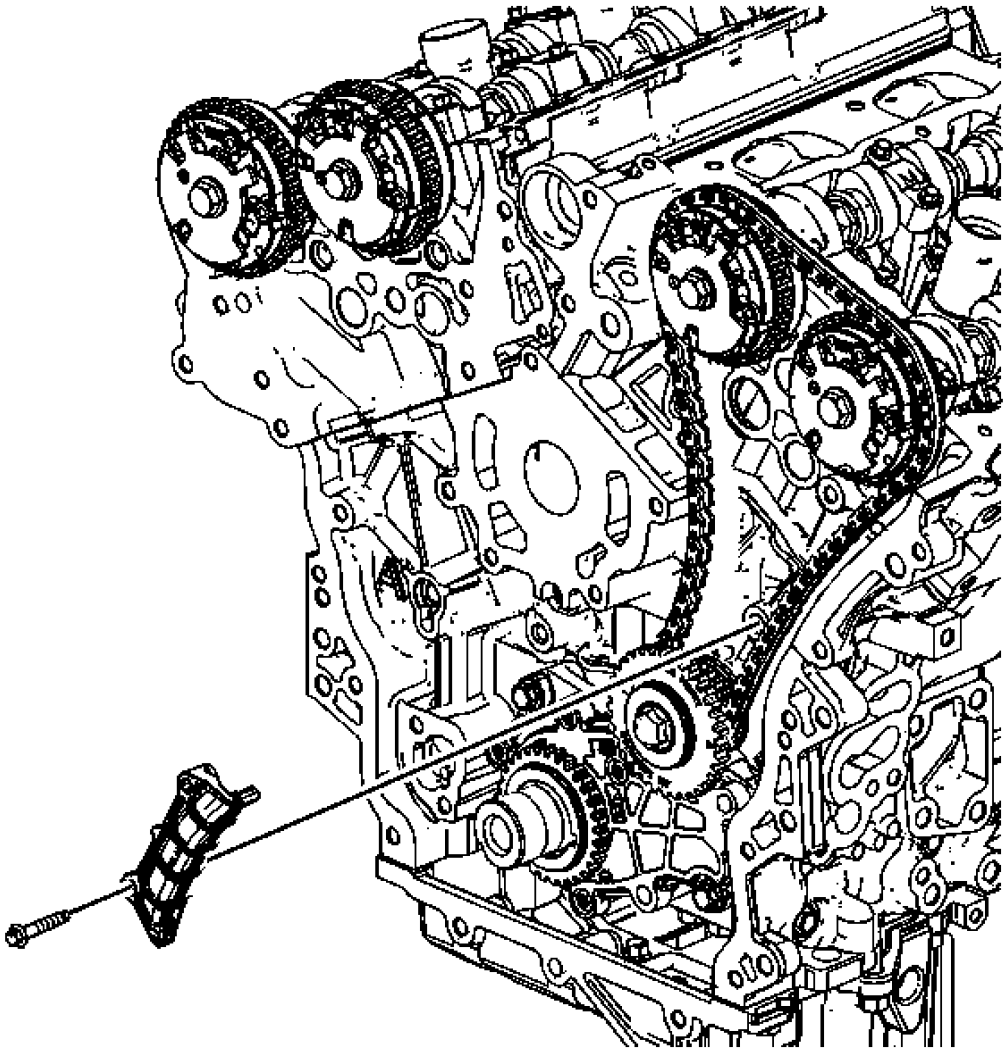


Fig. 52: View Of Secondary Camshaft Drive Chain Guide Bolts
Courtesy of GENERAL MOTORS CORP.

2. Position the left secondary camshaft drive chain guide.

CAUTION: Refer to Fastener Caution .

3. Install the secondary camshaft drive chain guide bolts and tighten to 25 N.m (18 lb ft).

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SECONDARY CAMSHAFT DRIVE CHAIN SHOE INSTALLATION - LEFT SIDE

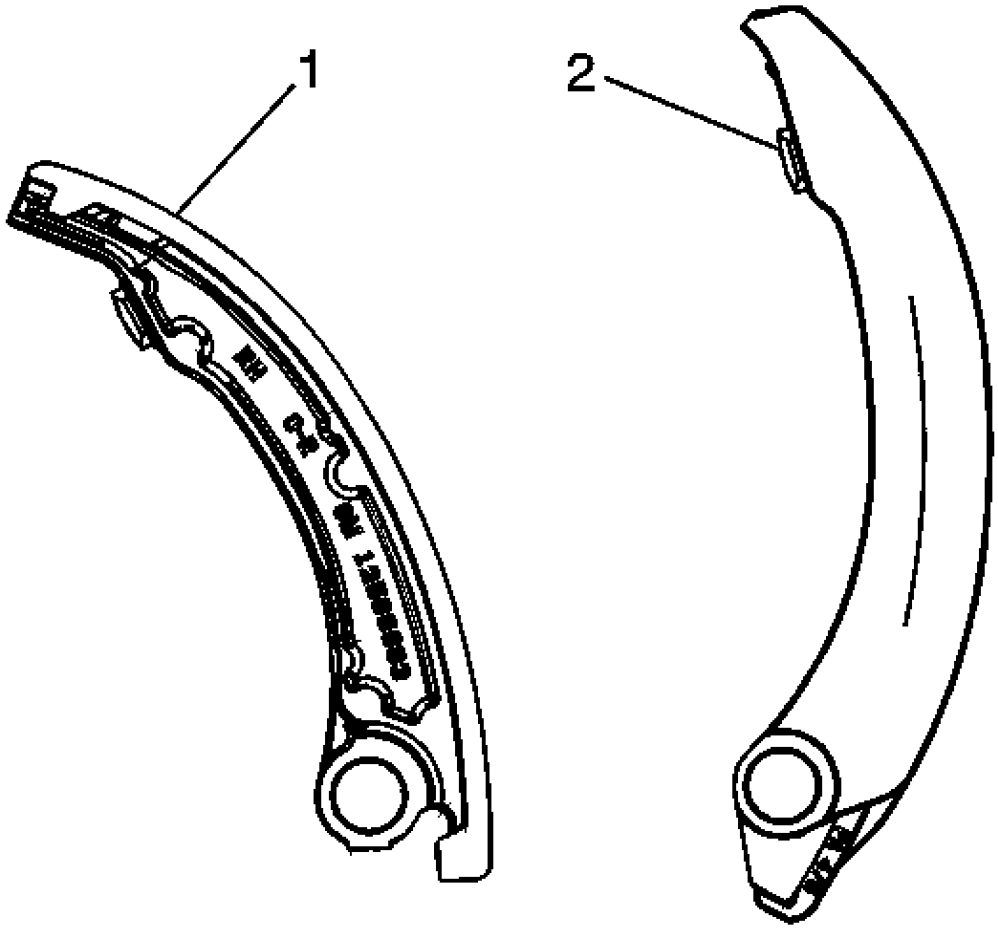


Fig. 53: Identifying Secondary Camshaft Drive Chain Shoes
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the left secondary camshaft drive chain shoe (2) is being installed.

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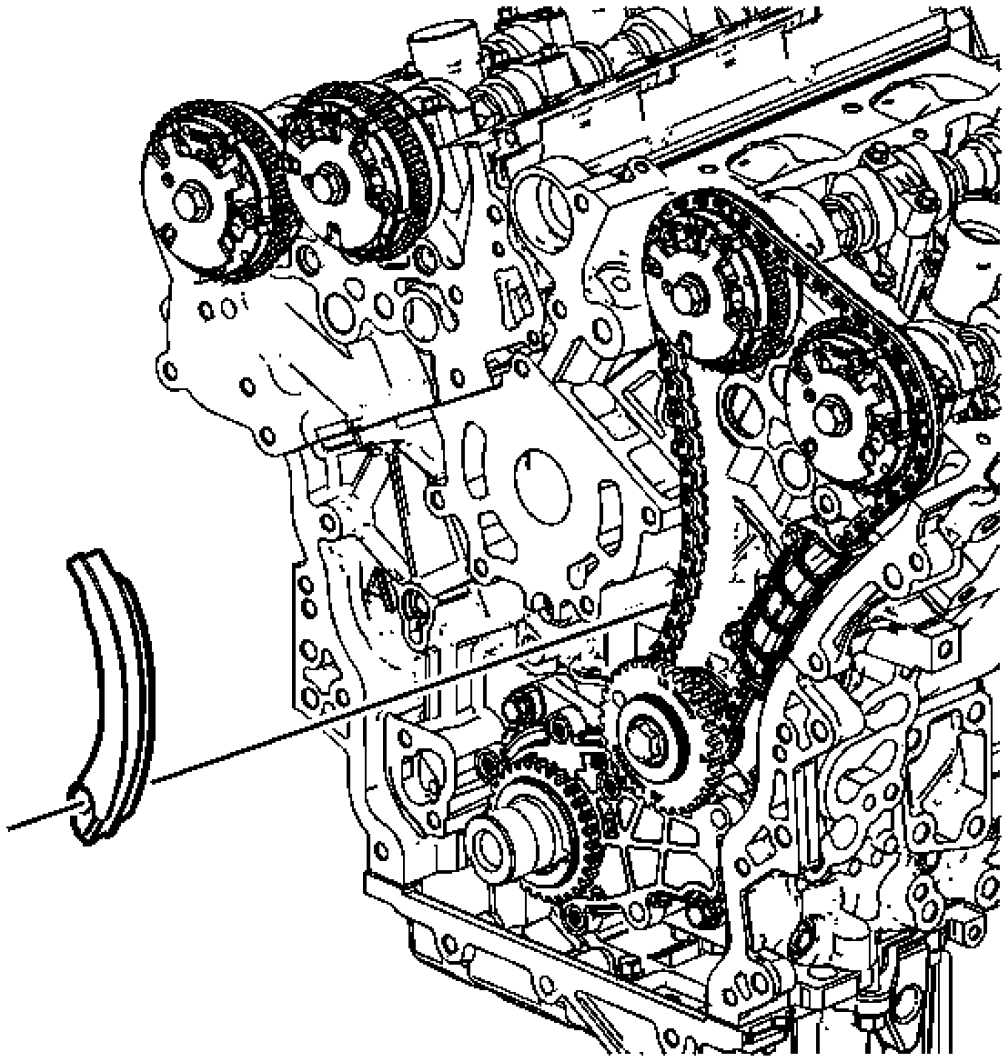


Fig. 54: View Of Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS CORP.

2. Position the left secondary camshaft drive chain shoe.

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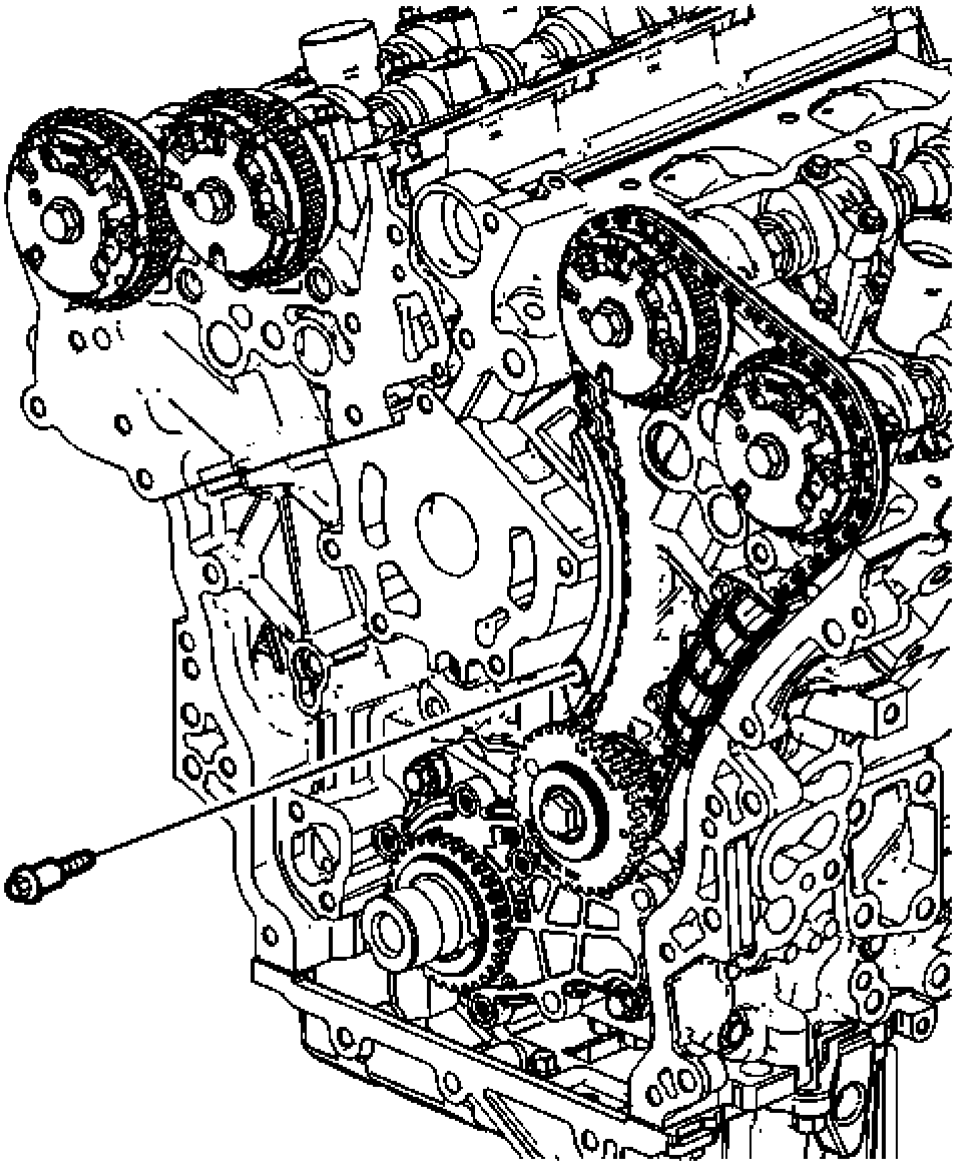


Fig. 55: Identifying Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

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3. Install the secondary camshaft drive chain shoe bolt and tighten to 25 N.m (18 lb ft).

SECONDARY TIMING CHAIN TENSIONER INSTALLATION - LEFT SIDE

Special Tools

- **EN-46112:** Tensioner Retraction Pins
- **J-45027:** Tensioner Tool

For equivalent regional tools, refer to **Special Tools** .

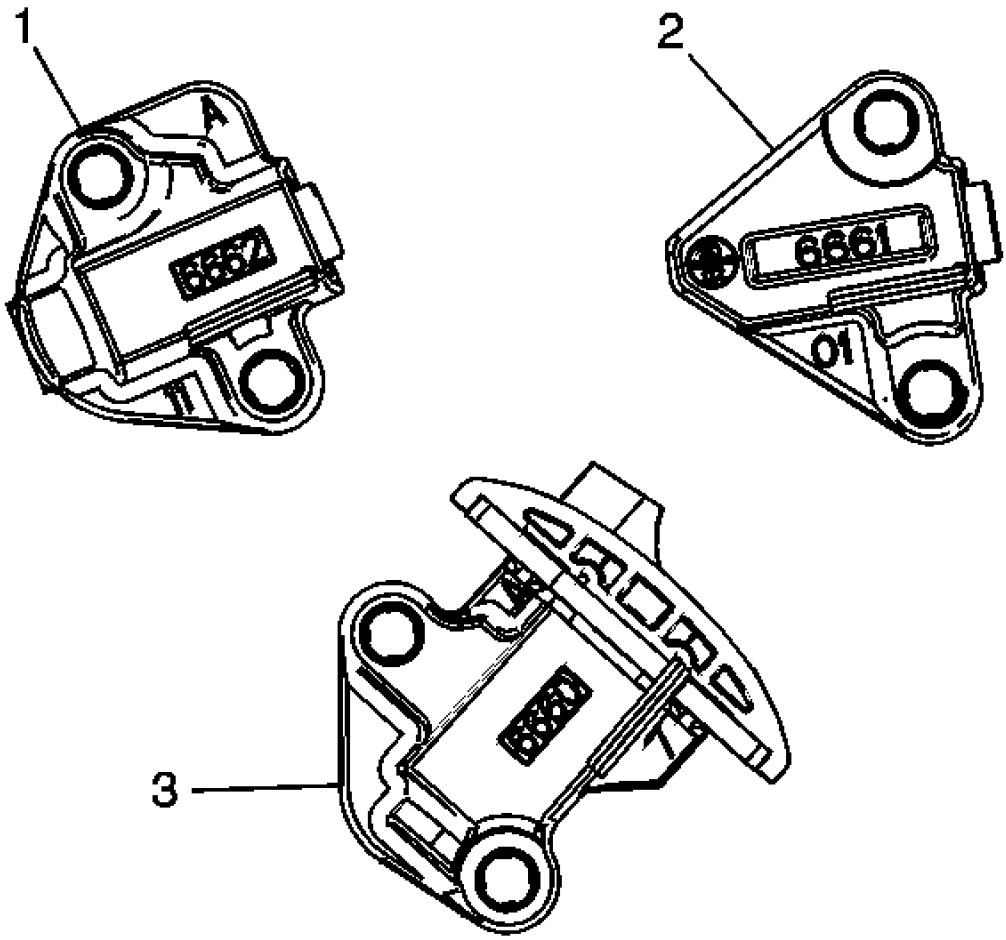


Fig. 56: Identifying Left & Right Secondary Camshaft Drive Chain Tensioner & Primary Camshaft Drive Chain Tensioner

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Courtesy of GENERAL MOTORS CORP.

1. Ensure that the left secondary camshaft drive chain tensioner (2) is being installed.

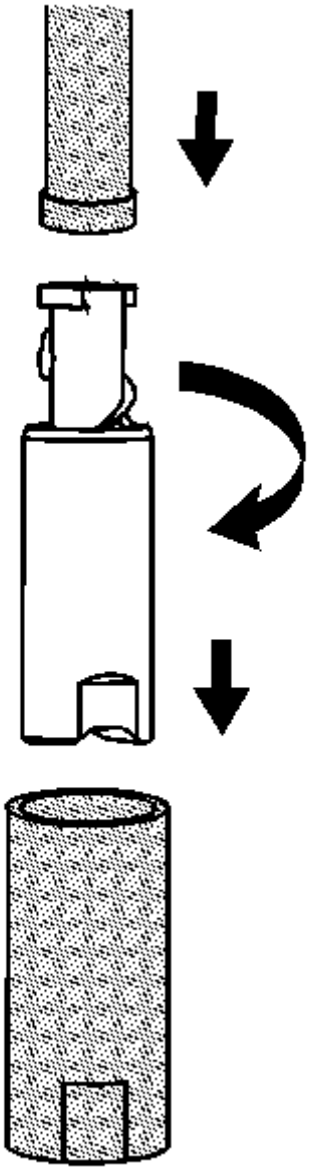


Fig. 57: Resetting Secondary Camshaft Drive Chain Tensioner Plunger With J 45027
Courtesy of GENERAL MOTORS CORP.

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2. Using the **J-45027:** tool, reset the left secondary camshaft drive chain tensioner plunger.

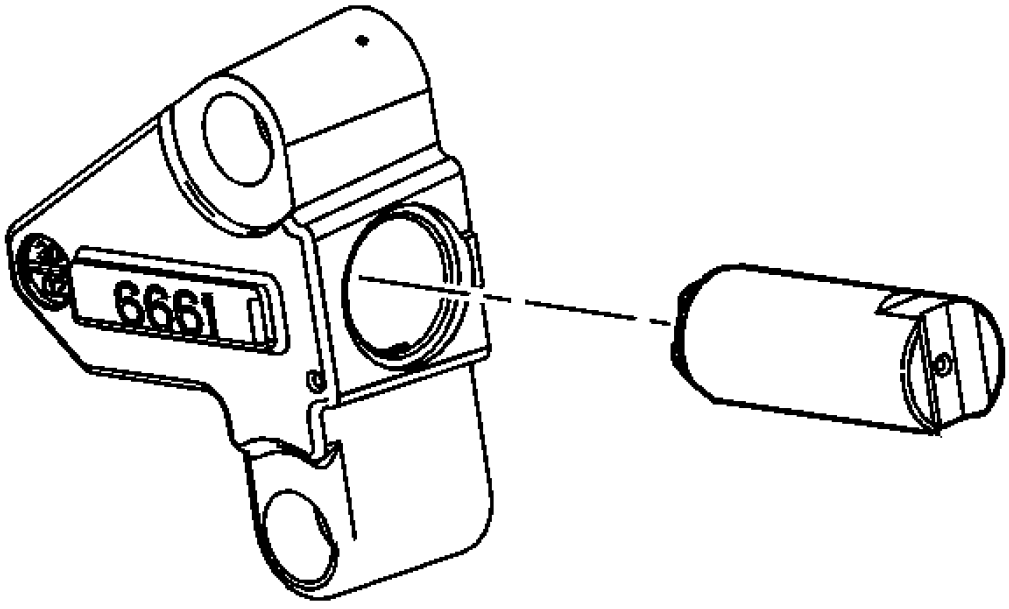


Fig. 58: Installing Plunger Into Left Secondary Camshaft Drive Chain Tensioner Body
Courtesy of GENERAL MOTORS CORP.

3. Install the plunger into the left secondary camshaft drive chain tensioner body.

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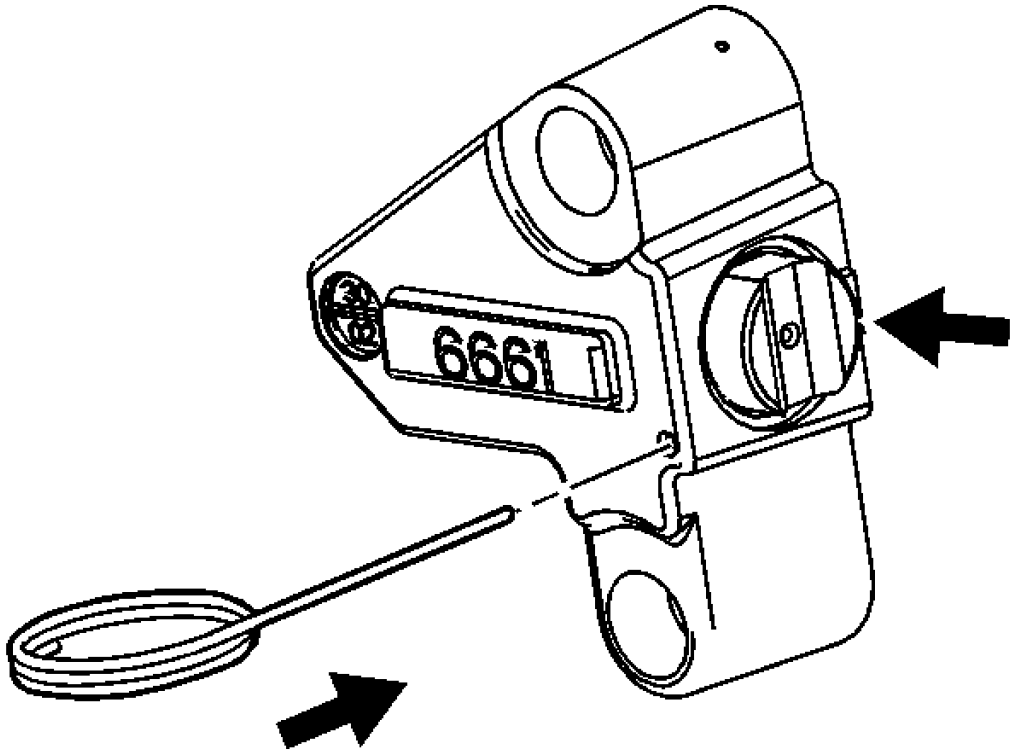


Fig. 59: Inserting EN 46112 Into Access Hole In Side Of Left Secondary Camshaft Drive Chain Tensioner Body
Courtesy of GENERAL MOTORS CORP.

4. Compress the plunger into the body and lock the left secondary camshaft drive chain tensioner by inserting the **EN-46112:** pins into the access hole in the side of the left secondary camshaft drive chain tensioner body.
5. Slowly release pressure on the left secondary camshaft drive chain tensioner. The left secondary camshaft drive chain tensioner should remain compressed.

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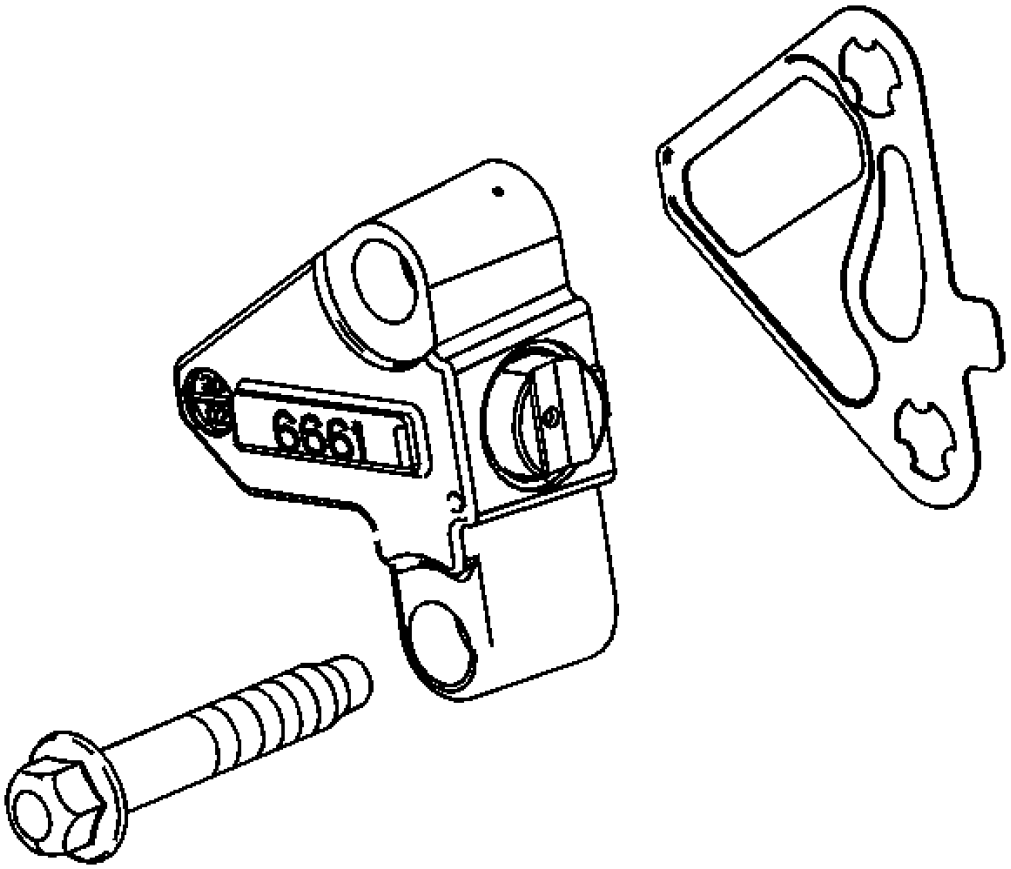


Fig. 60: Identifying Left Secondary Camshaft Drive Chain Tensioner & Gasket
Courtesy of GENERAL MOTORS CORP.

6. Install a NEW left secondary camshaft drive chain tensioner gasket to the left secondary camshaft drive chain tensioner.
7. Install the left secondary camshaft drive chain tensioner bolts through the left secondary camshaft drive chain tensioner and gasket.
8. Ensure the left secondary camshaft drive chain tensioner mounting surface on the left cylinder head does not have any burrs or defects that would degrade the sealing of the NEW left secondary camshaft drive chain tensioner gasket.

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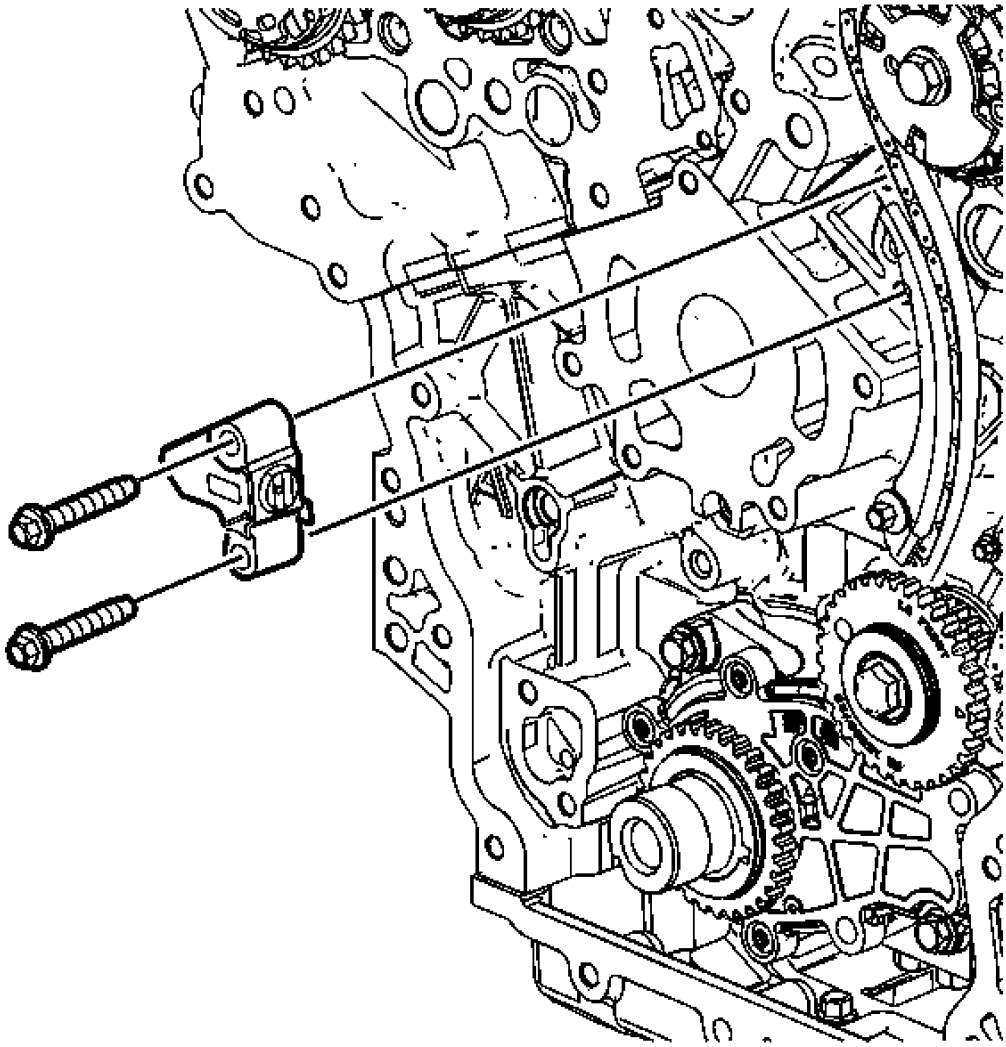


Fig. 61: View Of Secondary Camshaft Drive Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Place the left secondary camshaft drive chain tensioner into position and loosely install the bolts to the block.

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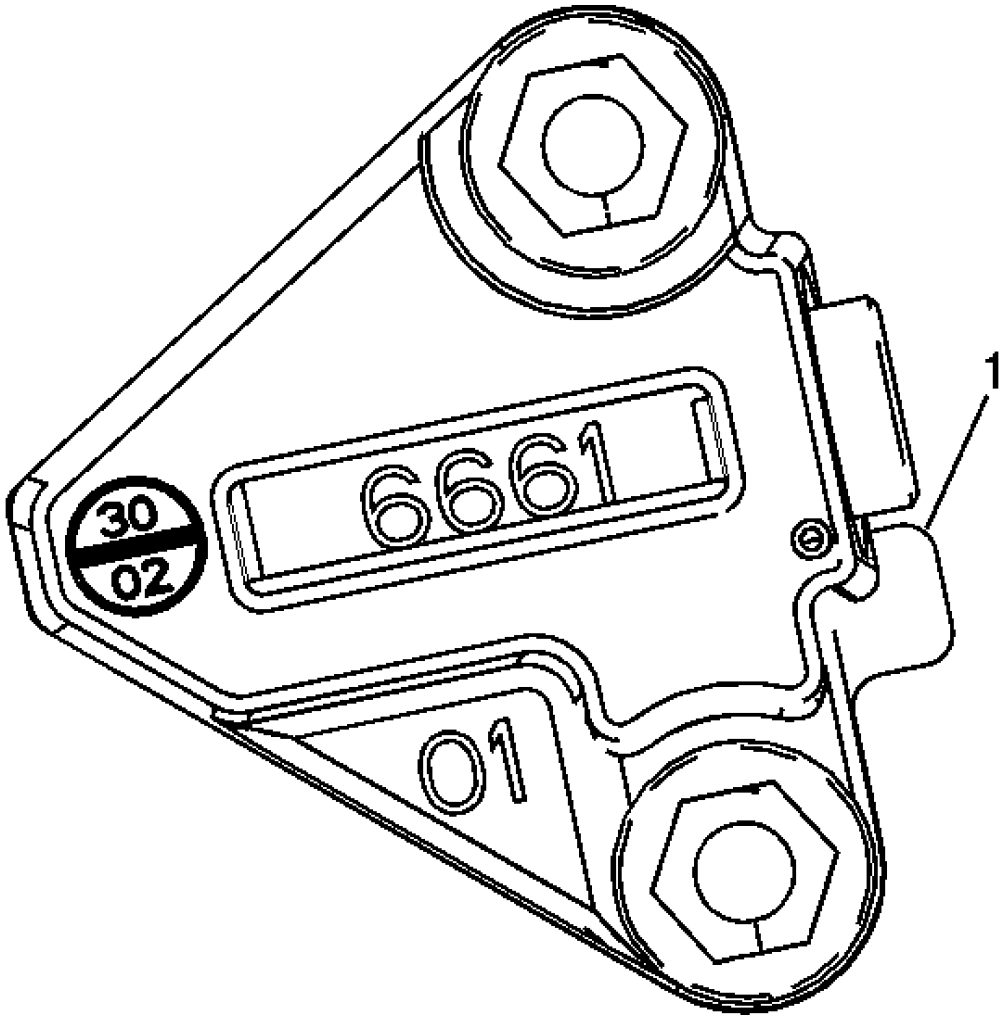


Fig. 62: Locating Left Secondary Camshaft Drive Chain Tensioner Gasket Tab
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

10. Verify the proper placement of the left secondary camshaft drive chain tensioner gasket tab (1).
    1. First Pass

    Tighten the left secondary camshaft drive chain tensioner bolts to 5 N.m (44 lb in) .

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2. Final Pass

   Tighten the left secondary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft) .

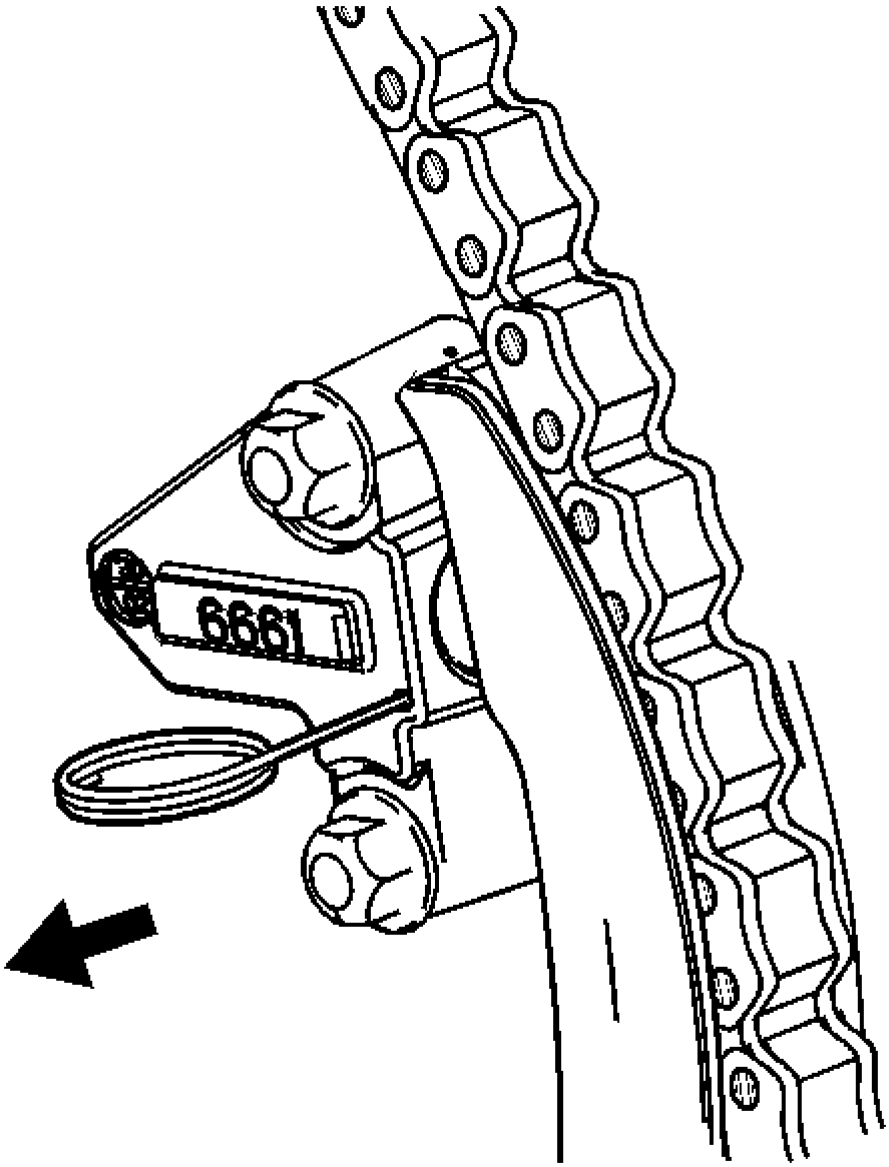


Fig. 63: View Of Left Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

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11. Release the left secondary camshaft drive chain tensioner by pulling out the **EN-46112:** pins and unlocking the tensioner plunger.
12. Verify the left secondary camshaft drive chain timing mark alignments by referring to **Timing Chain Alignment Diagram** - Stage One.

TIMING CHAIN IDLER SPROCKET INSTALLATION - RIGHT SIDE

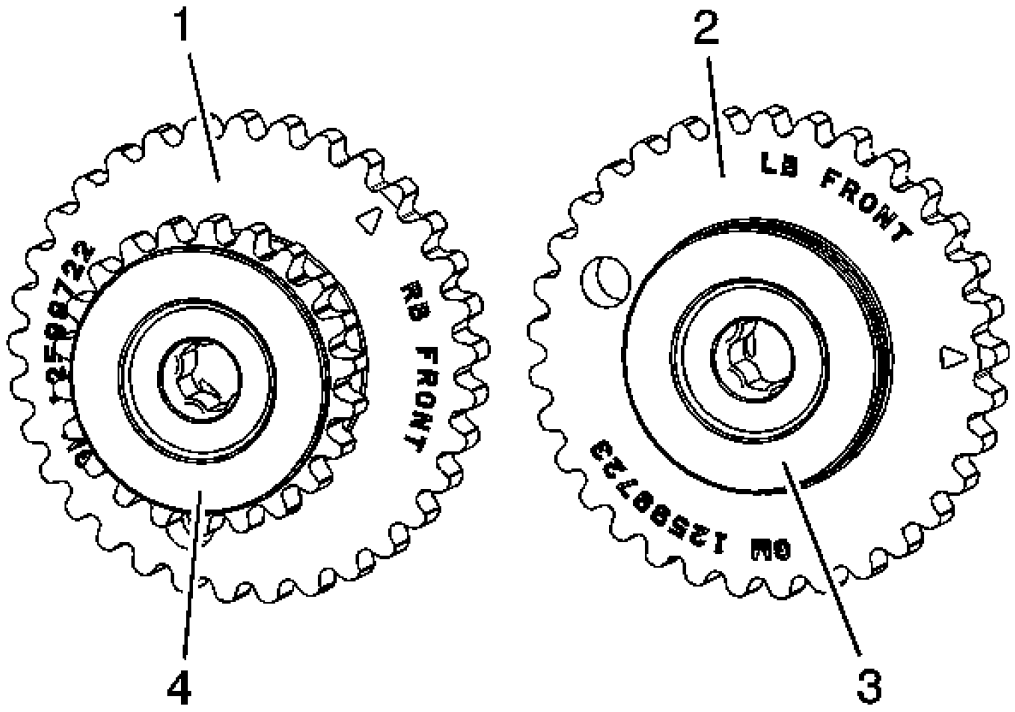


Fig. 64: Identifying Camshaft Intermediate Drive Chain Idlers
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the right camshaft intermediate drive chain idler (1) is being installed. The recessed hub (4) and the smaller sprocket of the right camshaft intermediate drive chain idler is installed outward. The raised hub and the larger sprocket of the right camshaft intermediate drive chain idler is installed towards the block.

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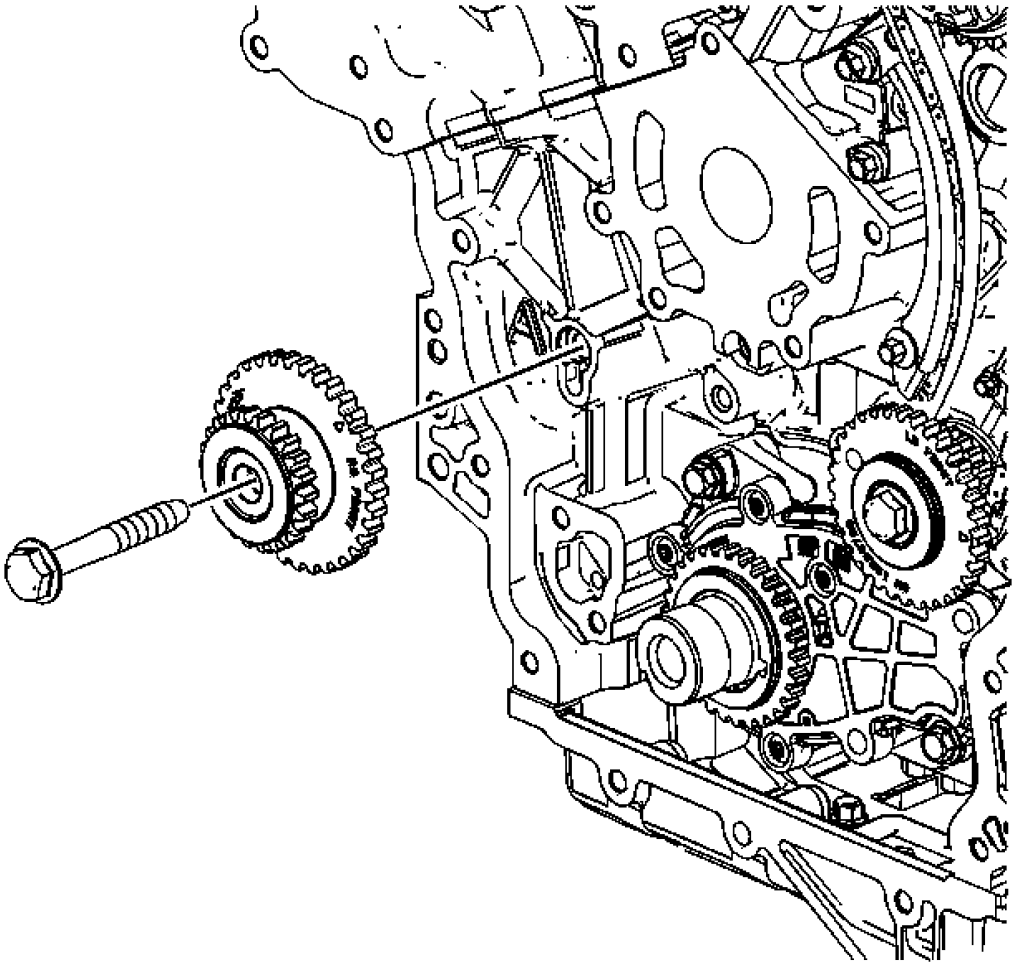


Fig. 65: Identifying Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS CORP.

2. Install the right camshaft intermediate drive chain idler.

CAUTION: Refer to Fastener Caution .

3. Install the camshaft intermediate drive chain idler bolt and tighten to 58 N.m (43 lb ft).

PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN INSTALLATION

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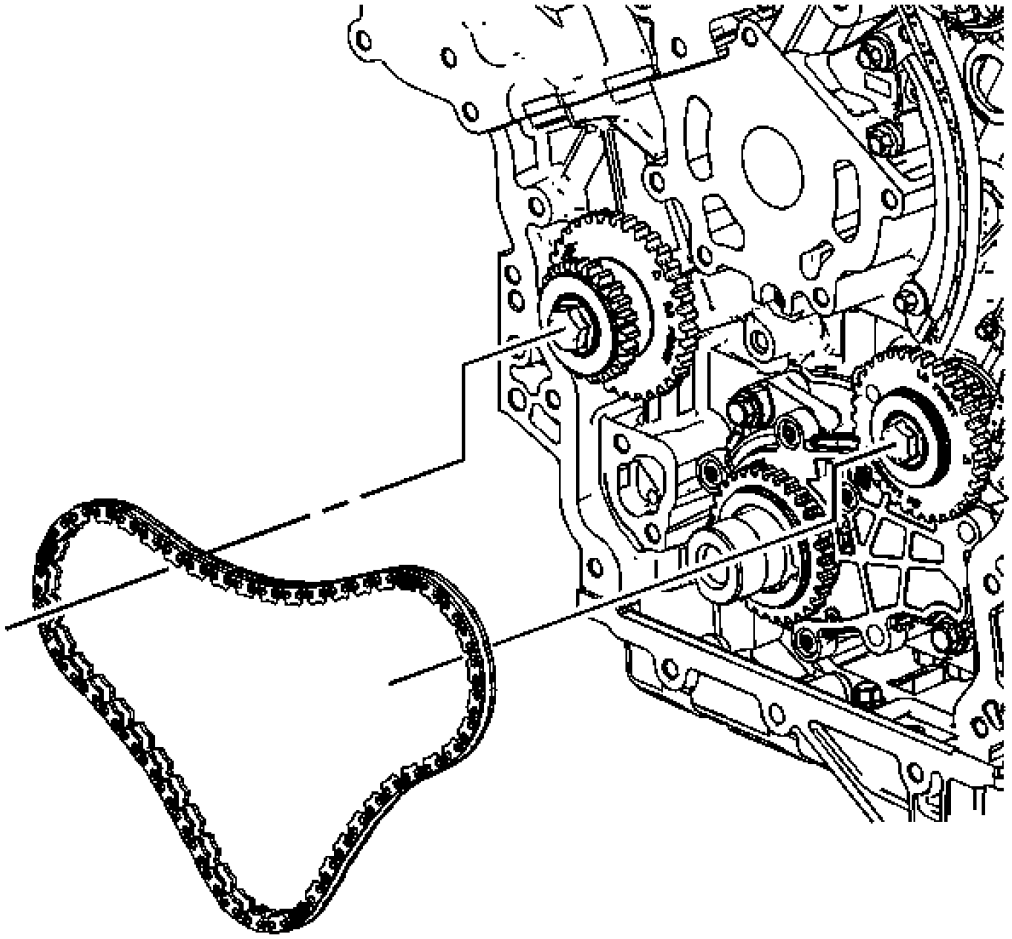


Fig. 66: Identifying Primary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the crankshaft is in the stage one timing drive assembly position.

1. Install the primary camshaft drive chain.

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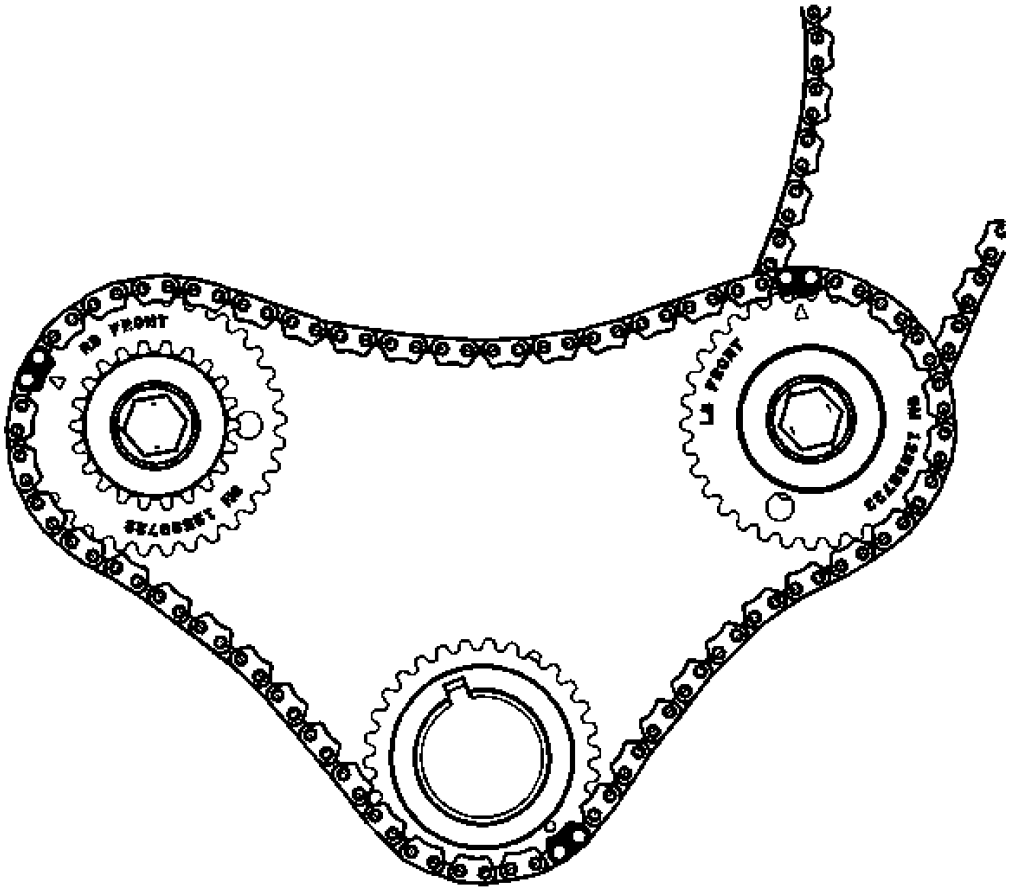


Fig. 67: View Of Primary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

2. Wrap the primary camshaft drive chain around the large sprockets of each camshaft intermediate drive chain idler and the crankshaft sprocket.

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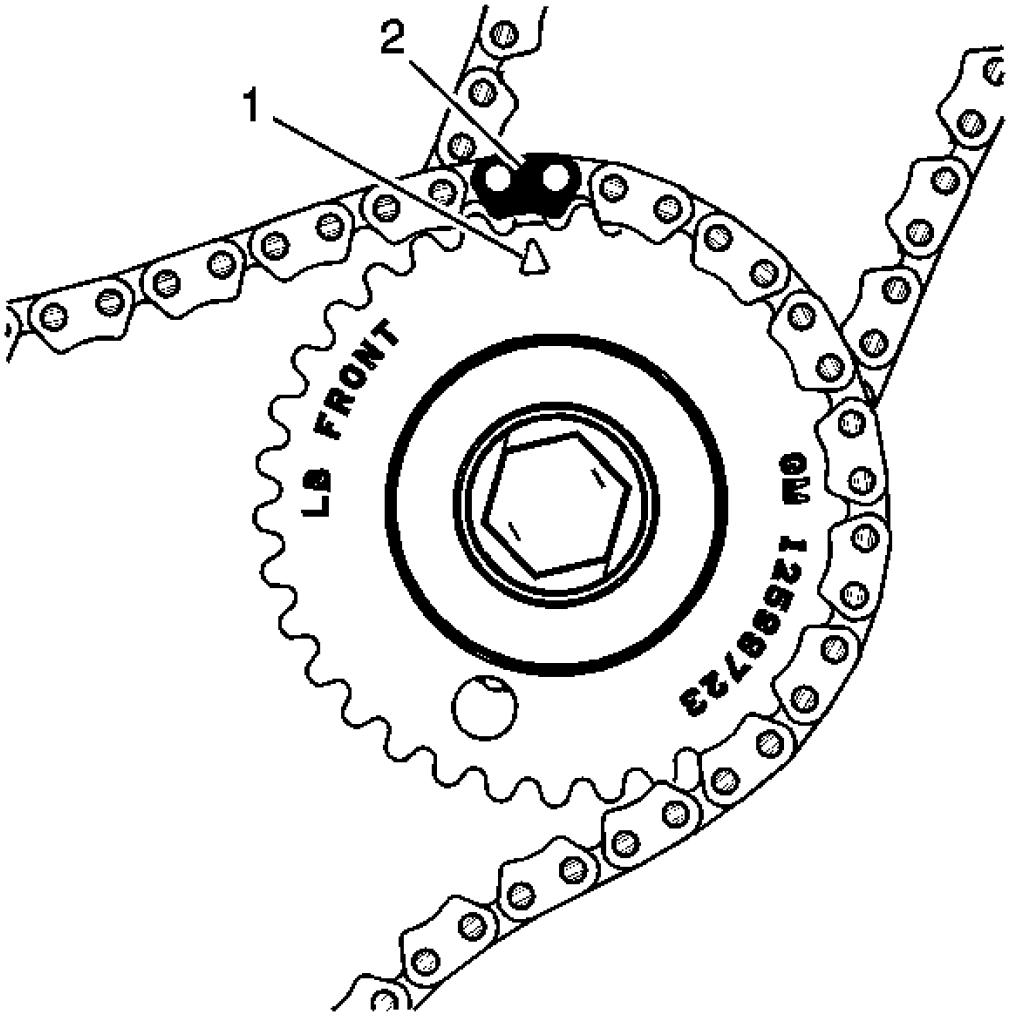


Fig. 68: View Of Left Camshaft Timing Marks
Courtesy of GENERAL MOTORS CORP.

3. The left camshaft intermediate drive chain idler timing mark (1) will align with a timing camshaft drive chain link (2).

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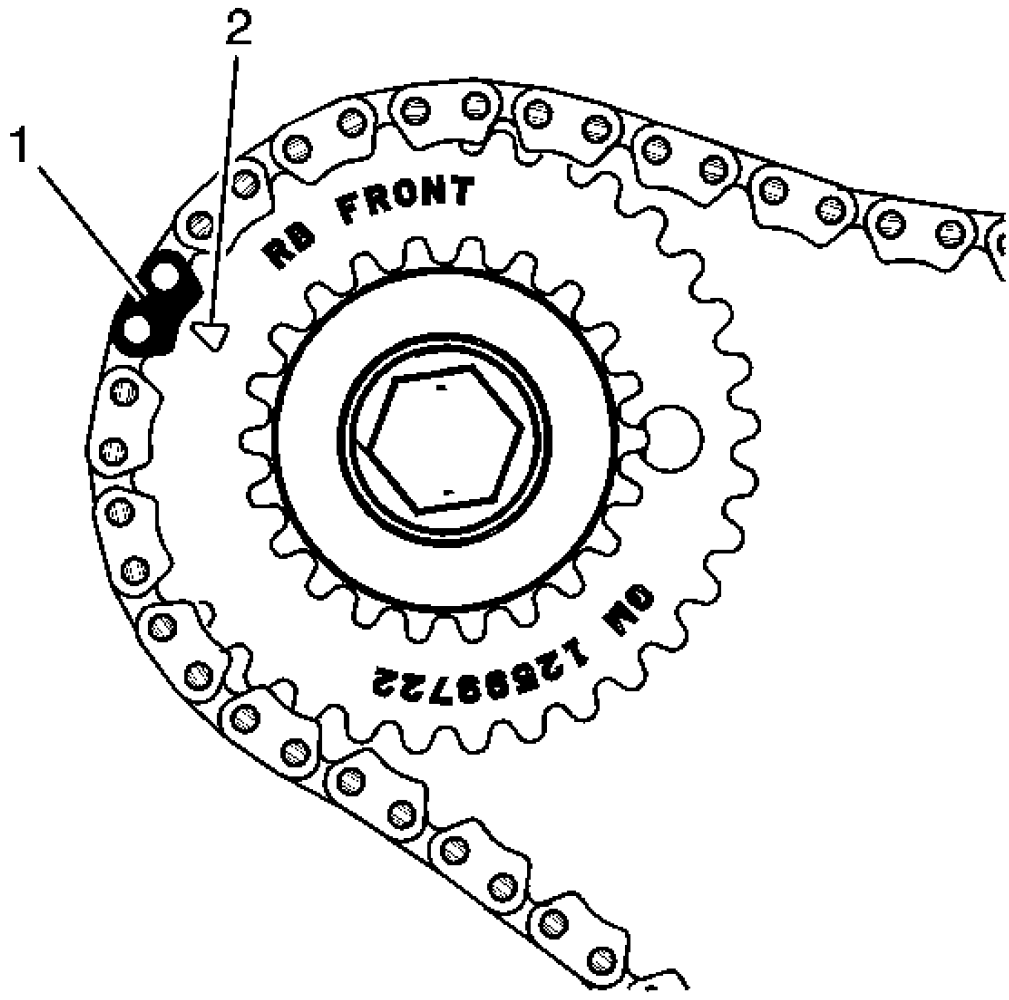


Fig. 69: View Of Right Camshaft Timing Marks
Courtesy of GENERAL MOTORS CORP.

4. The right camshaft intermediate drive chain idler timing mark (2) will align with a timing camshaft drive chain link (1).

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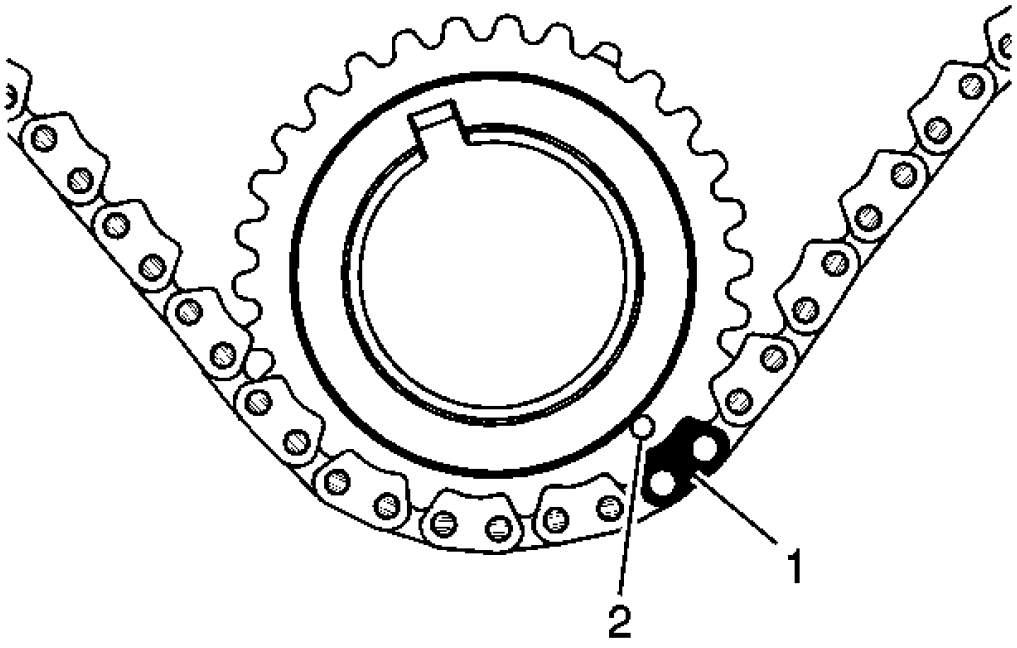


Fig. 70: View Of Crankshaft Sprocket Timing Mark & Timing Camshaft Drive Chain Link
Courtesy of GENERAL MOTORS CORP.

5. The crankshaft sprocket timing mark (2) will align with a timing camshaft drive chain link (1).

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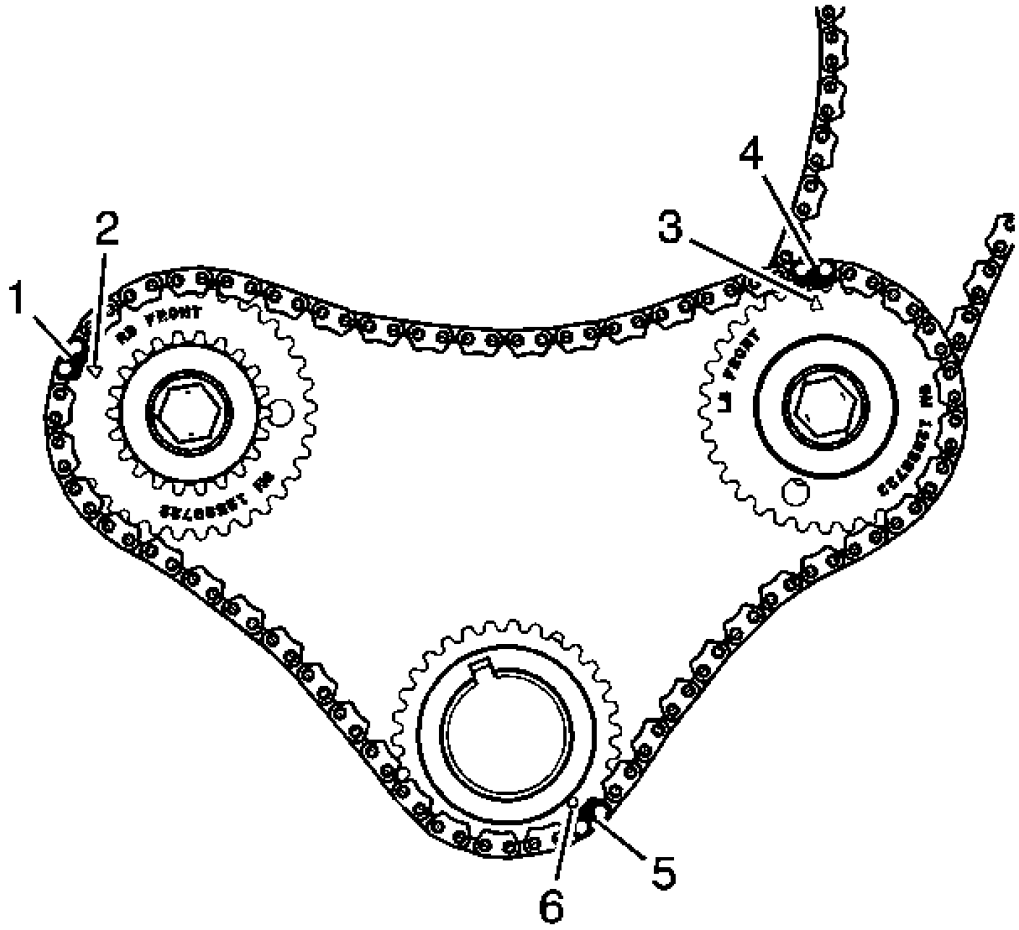


Fig. 71: View Of All Timing Marks Aligned With Timing Chain Links
Courtesy of GENERAL MOTORS CORP.

6. Ensure all the timing marks (2, 3, 6) are properly aligned with the timing camshaft drive chain links (1, 4, 5).

PRIMARY TIMING CHAIN GUIDE INSTALLATION - LOWER

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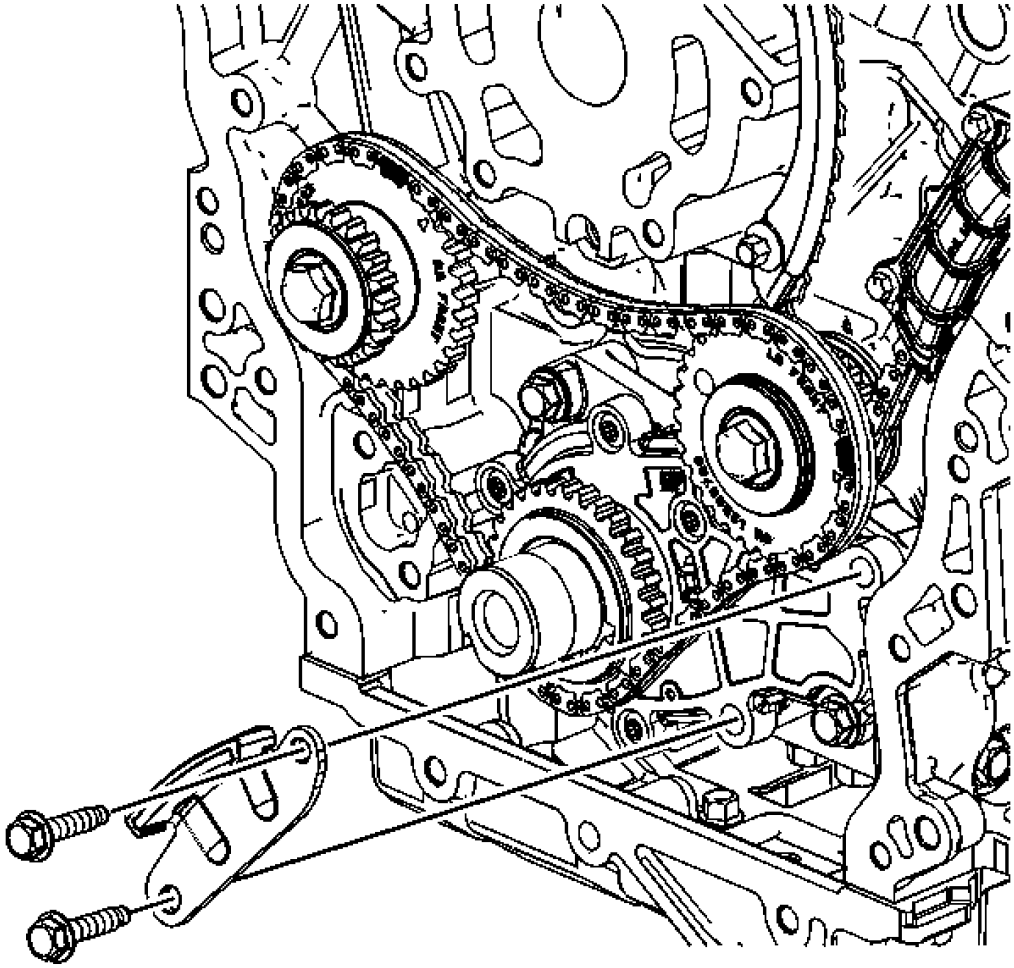


Fig. 72: View Of Primary Camshaft Drive Chain Lower Guide Bolts
Courtesy of GENERAL MOTORS CORP.

1. Position the primary camshaft drive chain lower guide to the oil pump.

CAUTION: Refer to Fastener Caution .

2. Install the primary camshaft drive chain lower guide bolts and tighten to 25 N.m (18 lb ft).

PRIMARY TIMING CHAIN GUIDE INSTALLATION - UPPER

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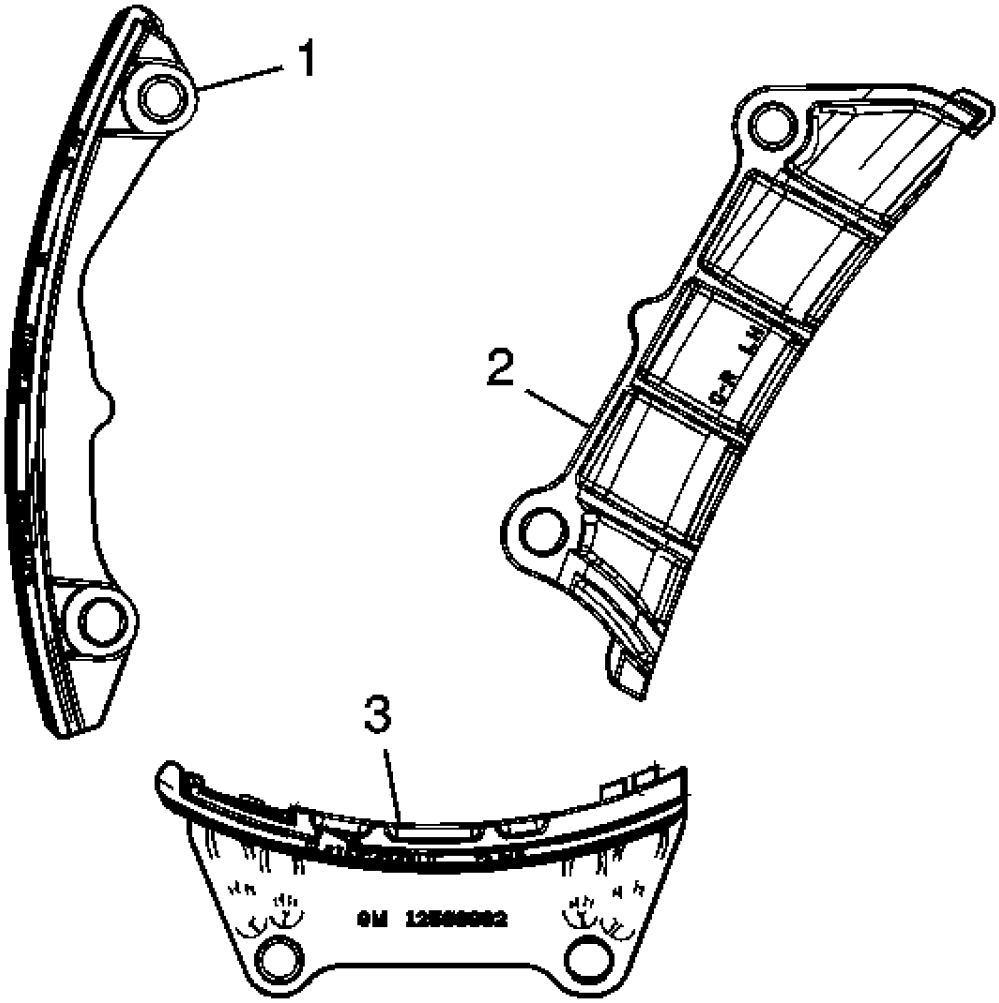


Fig. 73: Identifying Camshaft Drive Chain Guides
Courtesy of GENERAL MOTORS CORP.

1. Ensure the upper primary camshaft drive chain guide (3) is being installed.

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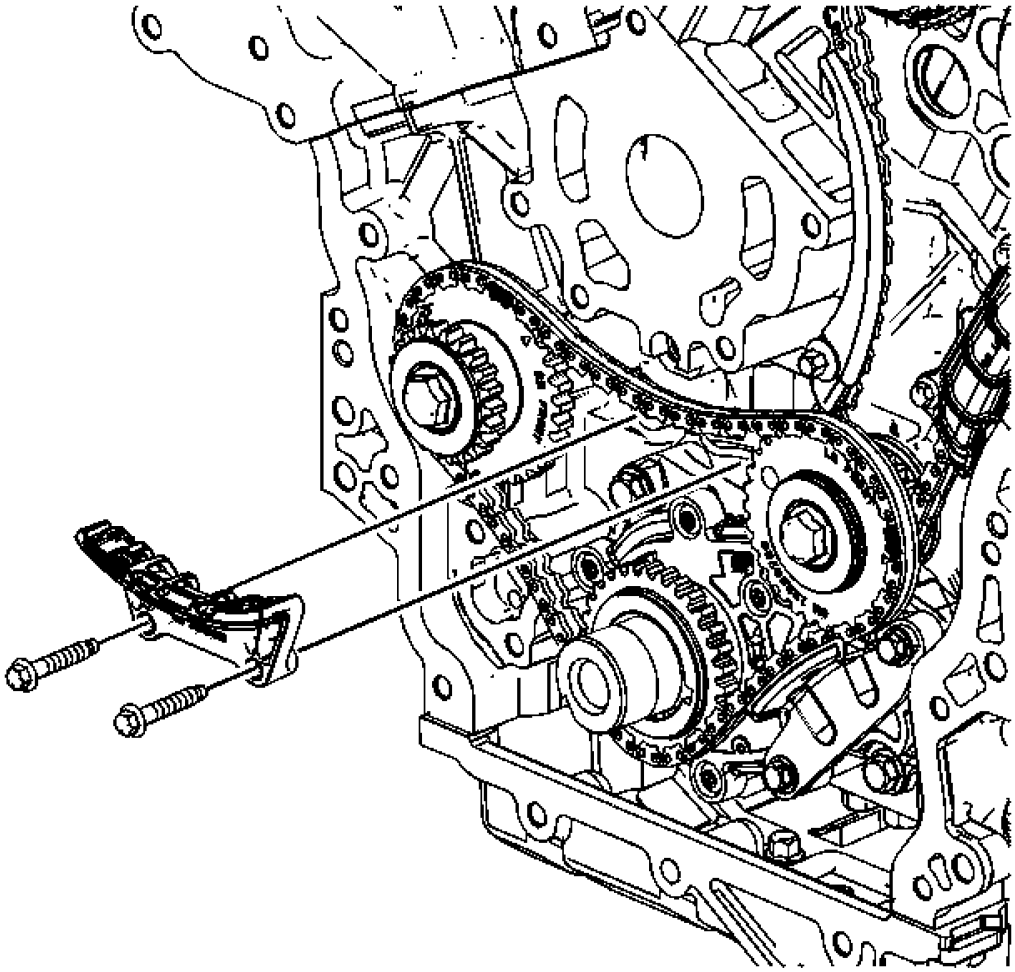


Fig. 74: Identifying Primary Camshaft Drive Chain Upper Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Install the upper primary camshaft drive chain guides.

CAUTION: Refer to Fastener Caution .

3. Install the upper primary camshaft drive chain guide bolts and tighten to 25 N.m (18 lb ft).

PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER INSTALLATION

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Special Tools

- **EN-46112:** Tensioner Retraction Pins
- **EN-48383:** Camshaft Retaining Tools
- **EN-48589:** Crankshaft Rotation Socket
- **J-45027:** Tensioner Tool

For equivalent regional tools, refer to **Special Tools** .

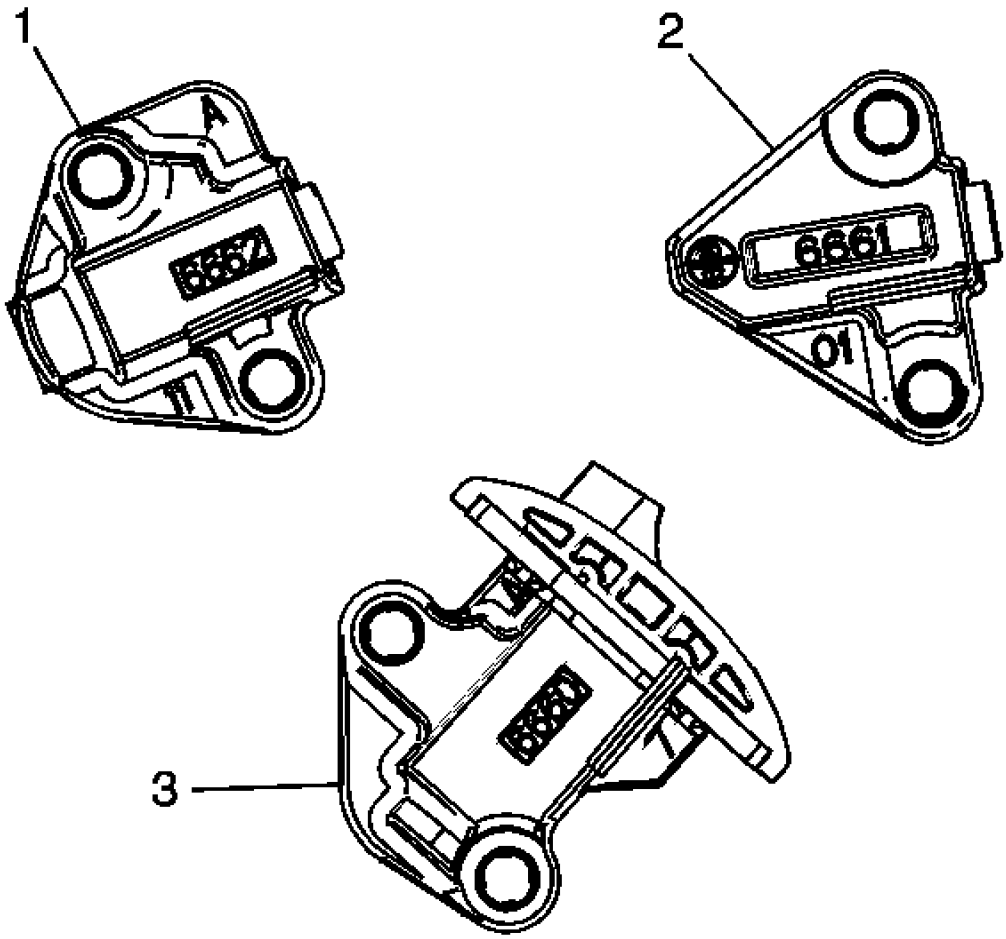


Fig. 75: Identifying Left & Right Secondary Camshaft Drive Chain Tensioner & Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

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1. Ensure that the primary camshaft drive chain tensioner (3) is being installed.

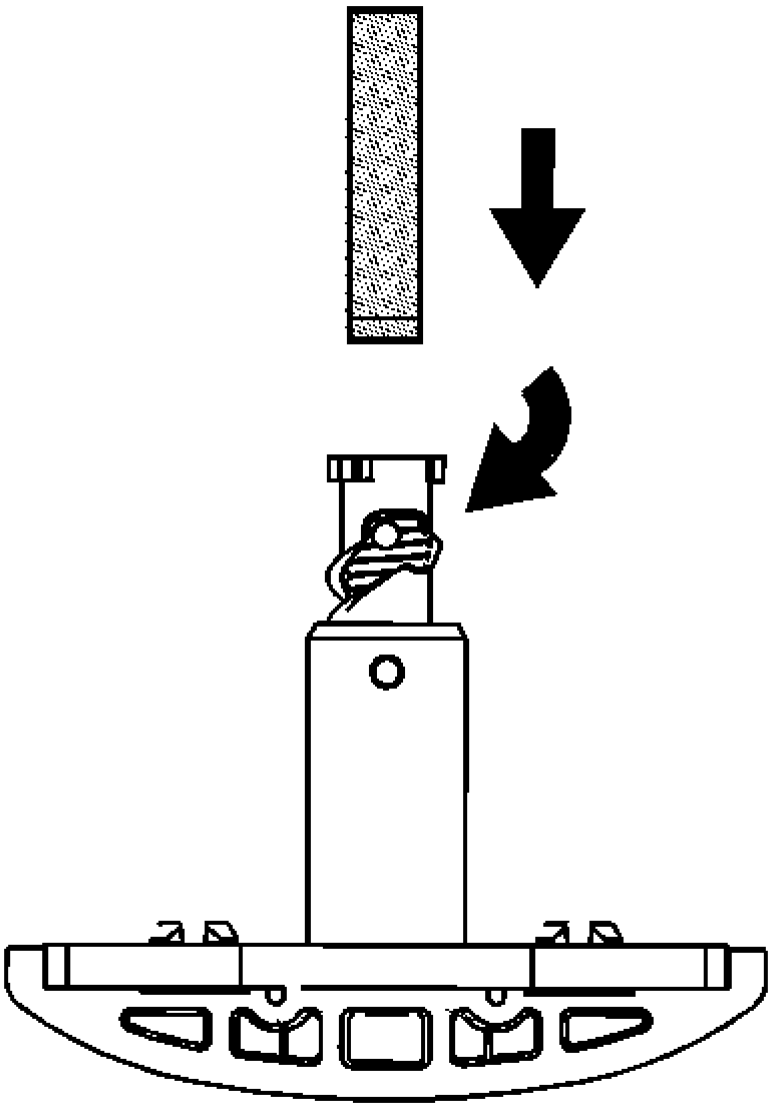


Fig. 76: View Of Primary Camshaft Drive Chain Tensioner Plunger & J 45027
Courtesy of GENERAL MOTORS CORP.

2. Using the **J-45027:** tool, reset the primary camshaft drive chain tensioner plunger.

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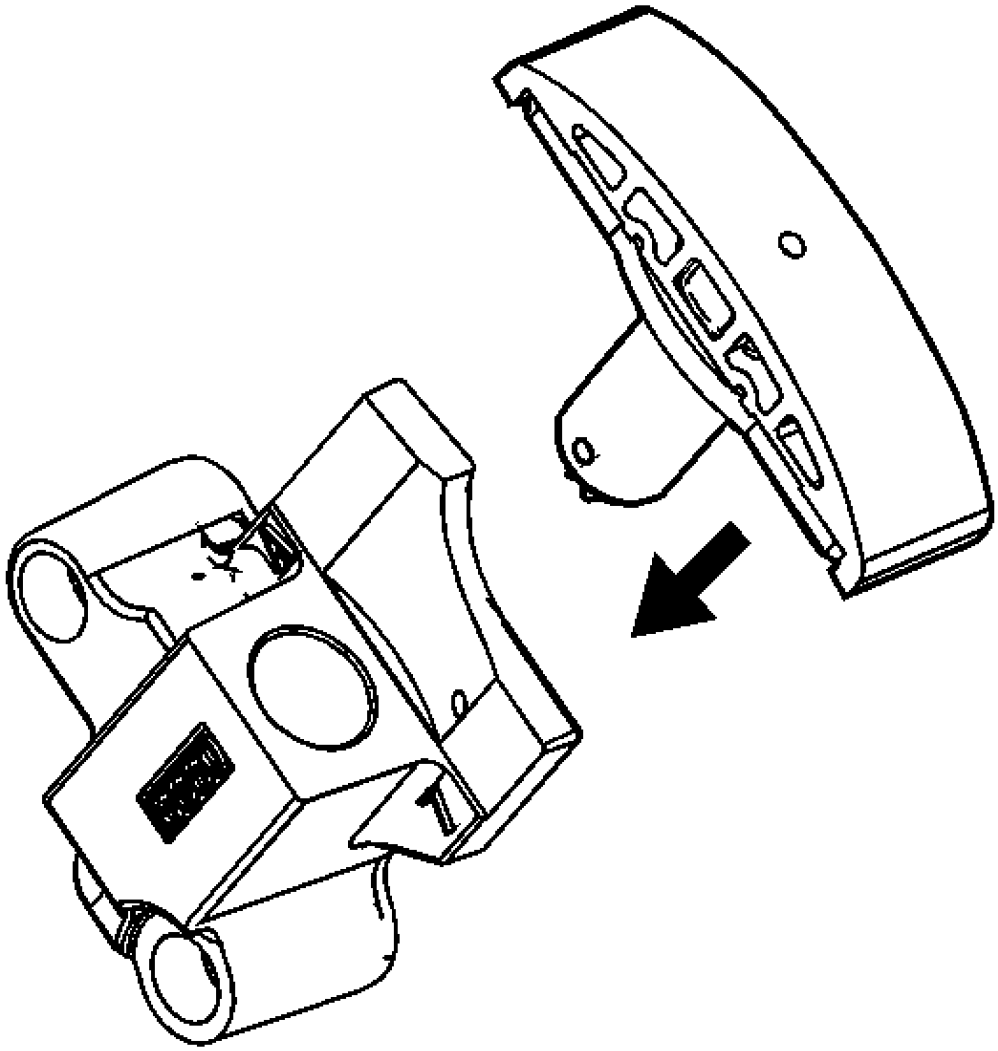


Fig. 77: Installing Plunger Into Primary Camshaft Drive Chain Tensioner Body
Courtesy of GENERAL MOTORS CORP.

3. Install the plunger into the primary camshaft drive chain tensioner body.

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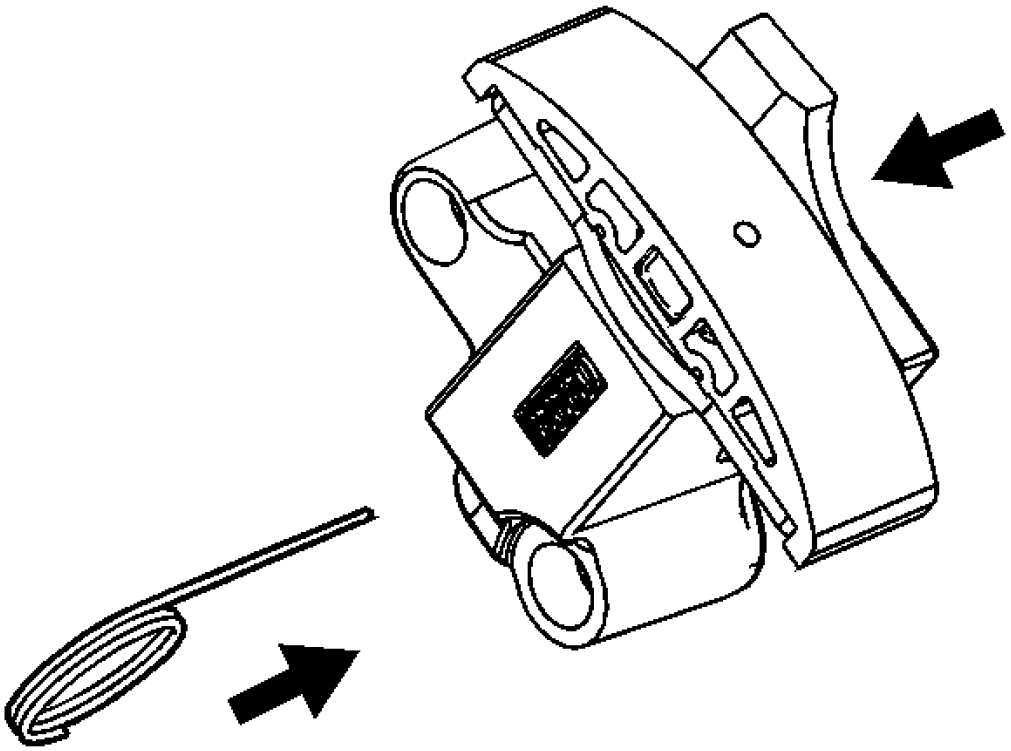


Fig. 78: Identifying EN 46112
Courtesy of GENERAL MOTORS CORP.

4. Compress the plunger into the body and lock the primary camshaft drive chain tensioner by inserting the **EN-46112:** pins into the access hole in the side of the primary camshaft drive chain tensioner body.
5. Slowly release pressure on the primary camshaft drive chain tensioner. The primary camshaft drive chain tensioner should remain compressed.

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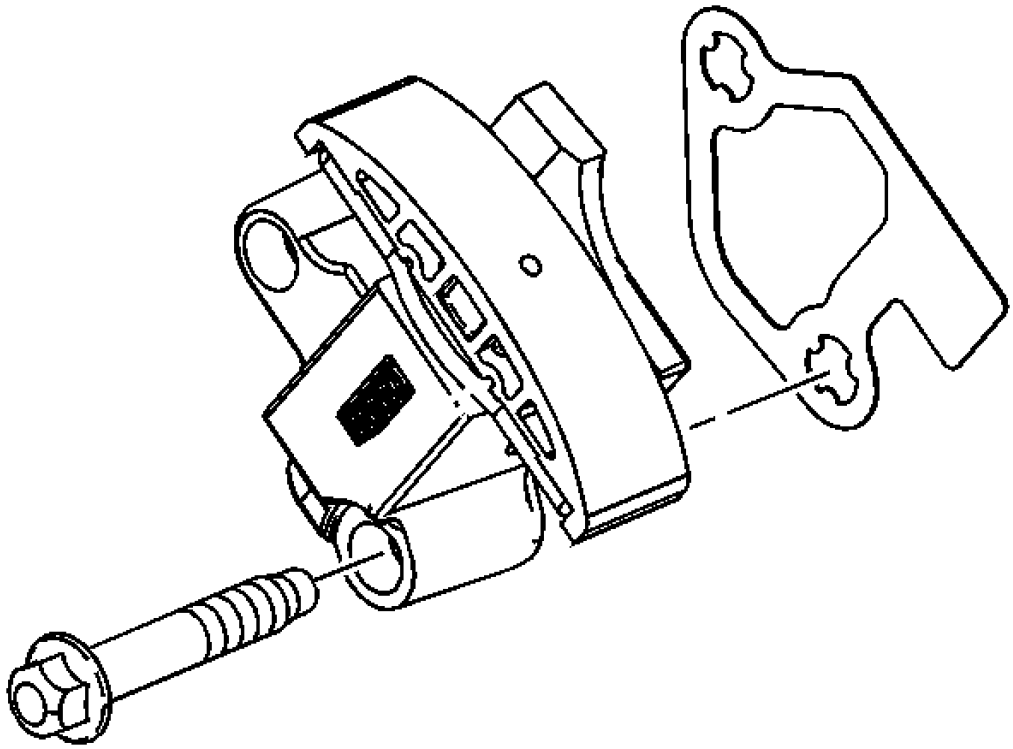


Fig. 79: Identifying Primary Camshaft Drive Chain Tensioner Gasket
Courtesy of GENERAL MOTORS CORP.

6. Install a NEW primary camshaft drive chain tensioner gasket to the primary camshaft drive chain tensioner.
7. Install the primary camshaft drive chain tensioner bolts through the primary camshaft drive chain tensioner and gasket.
8. Ensure the primary camshaft drive chain tensioner mounting surface on the engine block does not have any burrs or defects that would degrade the sealing of the NEW primary camshaft drive chain tensioner gasket.

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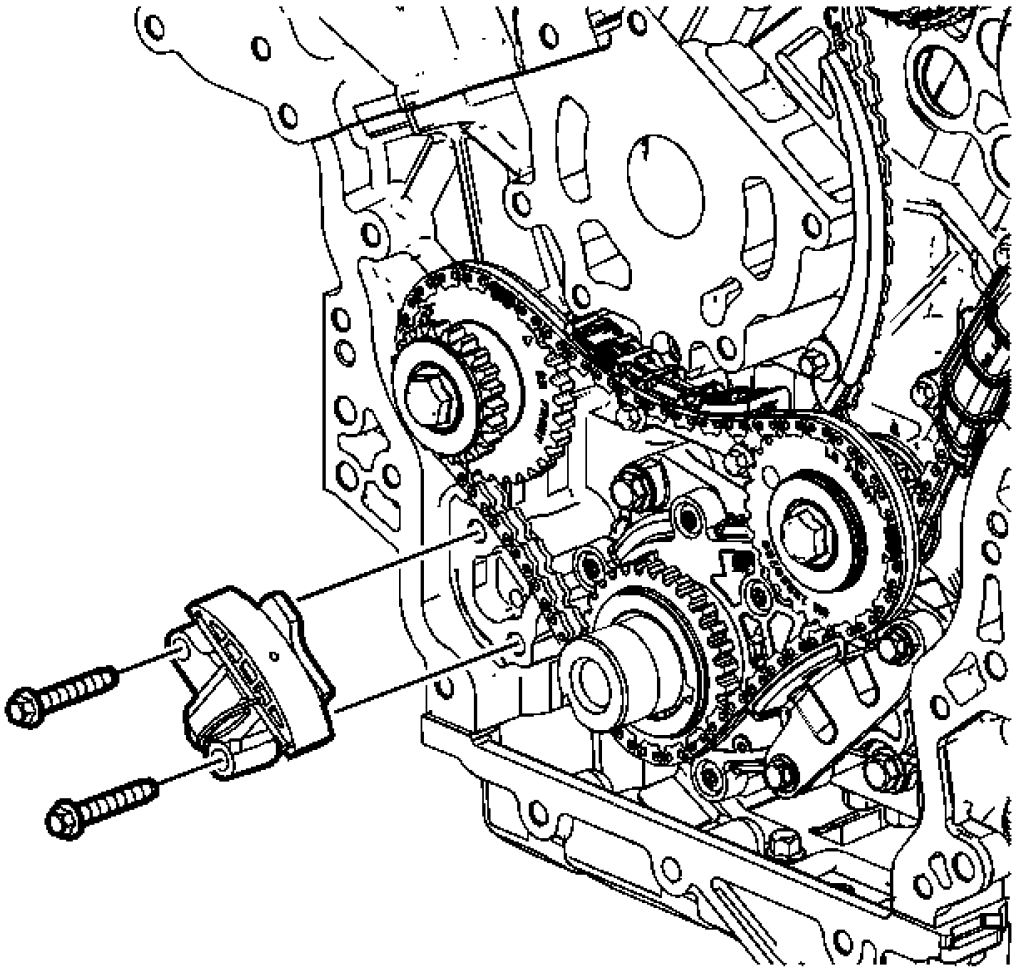


Fig. 80: View Of Primary Camshaft Drive Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Place the primary camshaft drive chain tensioner into position and loosely install the bolts to the block.

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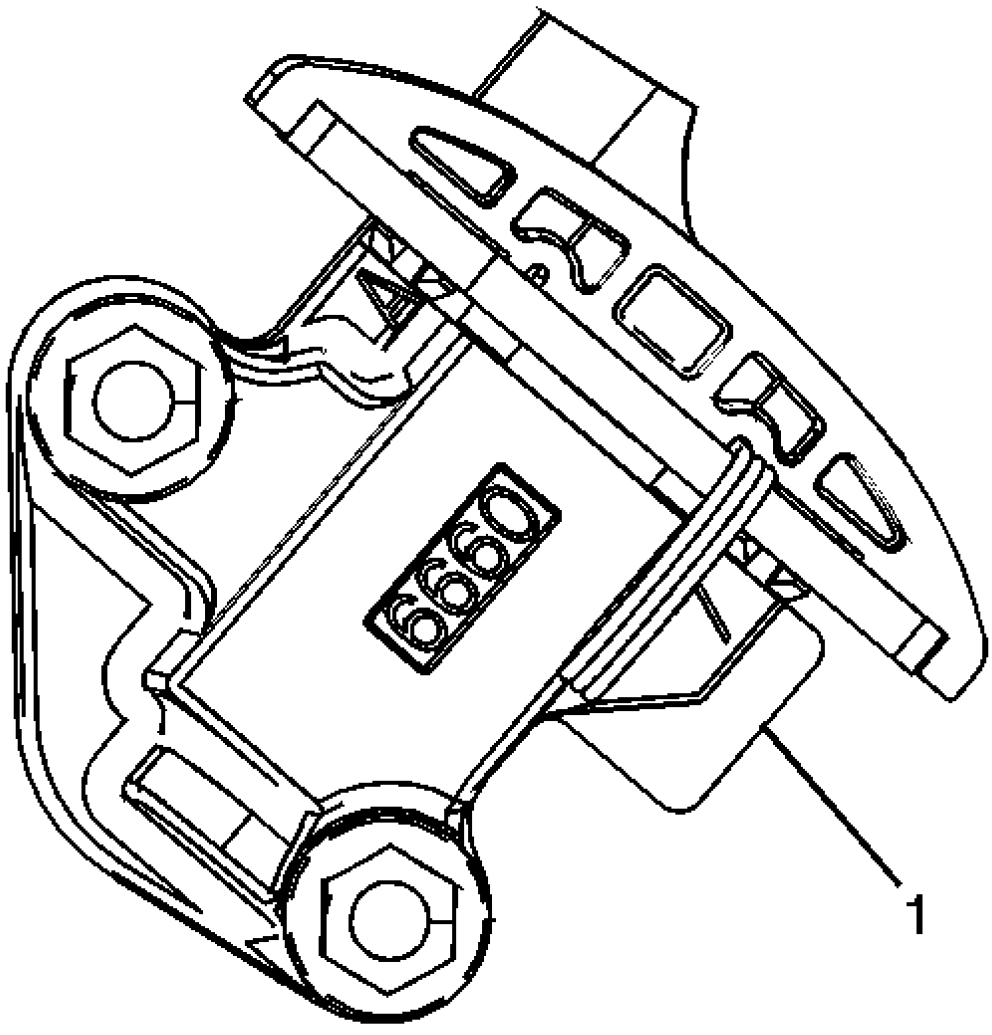


Fig. 81: Locating Primary Camshaft Drive Chain Tensioner Gasket Tab
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

10. Verify the proper placement of the primary camshaft drive chain tensioner gasket tab (1).
    1. First Pass

    Tighten the primary camshaft drive chain tensioner bolts to 5 N.m (44 lb in) .

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2. Final Pass

   Tighten the primary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft) .

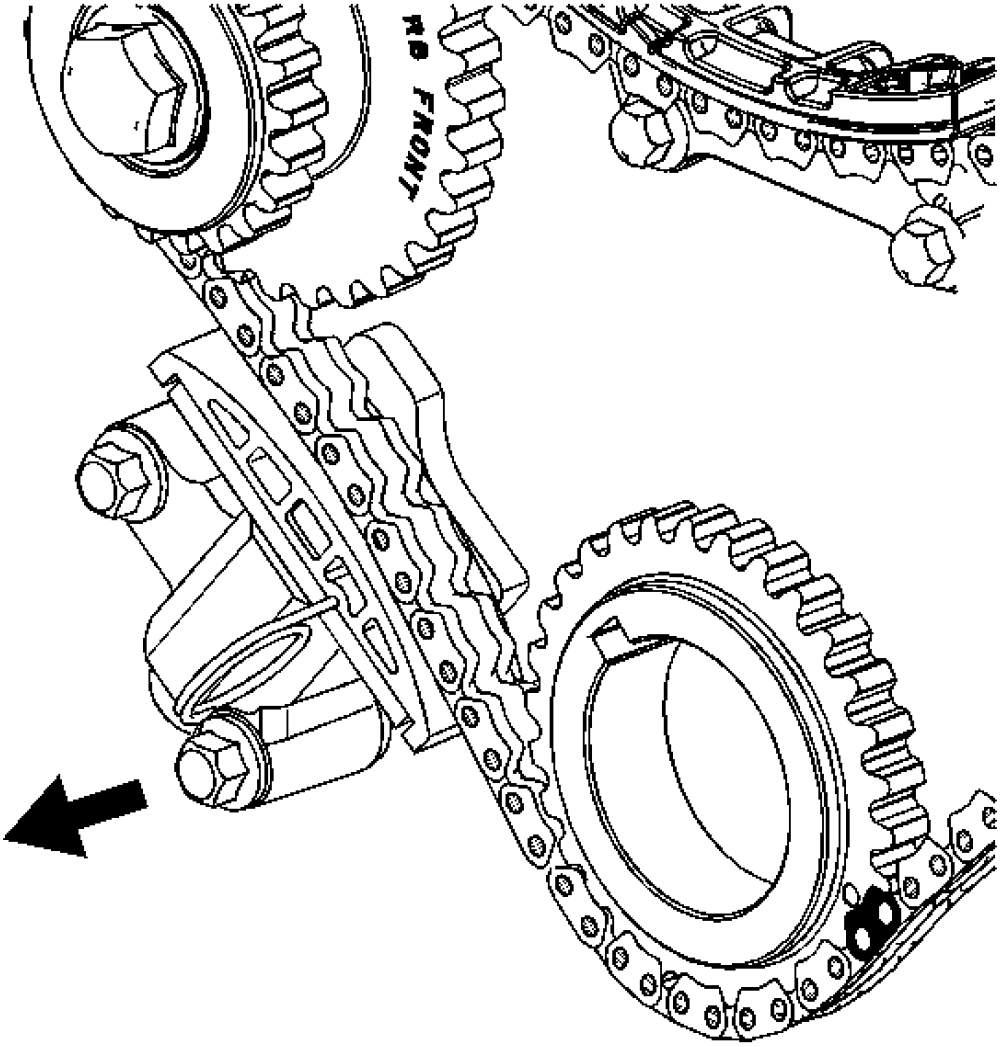


Fig. 82: View Of Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

11. Release the primary camshaft drive chain tensioner by pulling out the **EN-46112:** pins and unlocking the tensioner plunger.
12. Verify the primary and left secondary camshaft drive chain timing mark alignments. Refer to **Timing**

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Chain Alignment Diagram - Stage One.

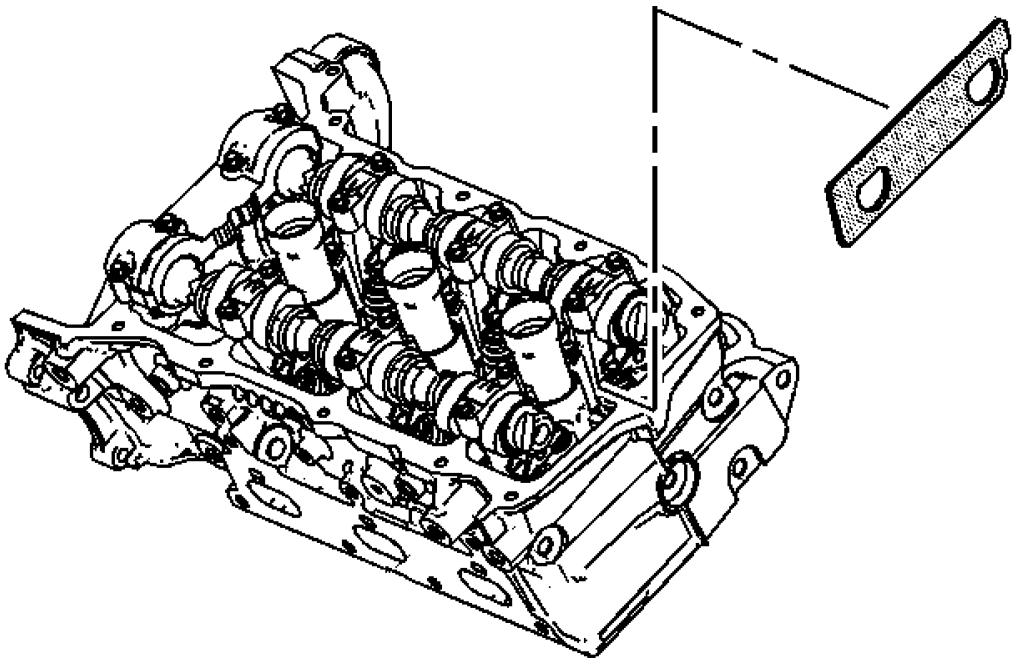


Fig. 83: Removing Special Tool
Courtesy of GENERAL MOTORS CORP.

13. Remove the EN 48383-1 from the rear of the left camshafts.

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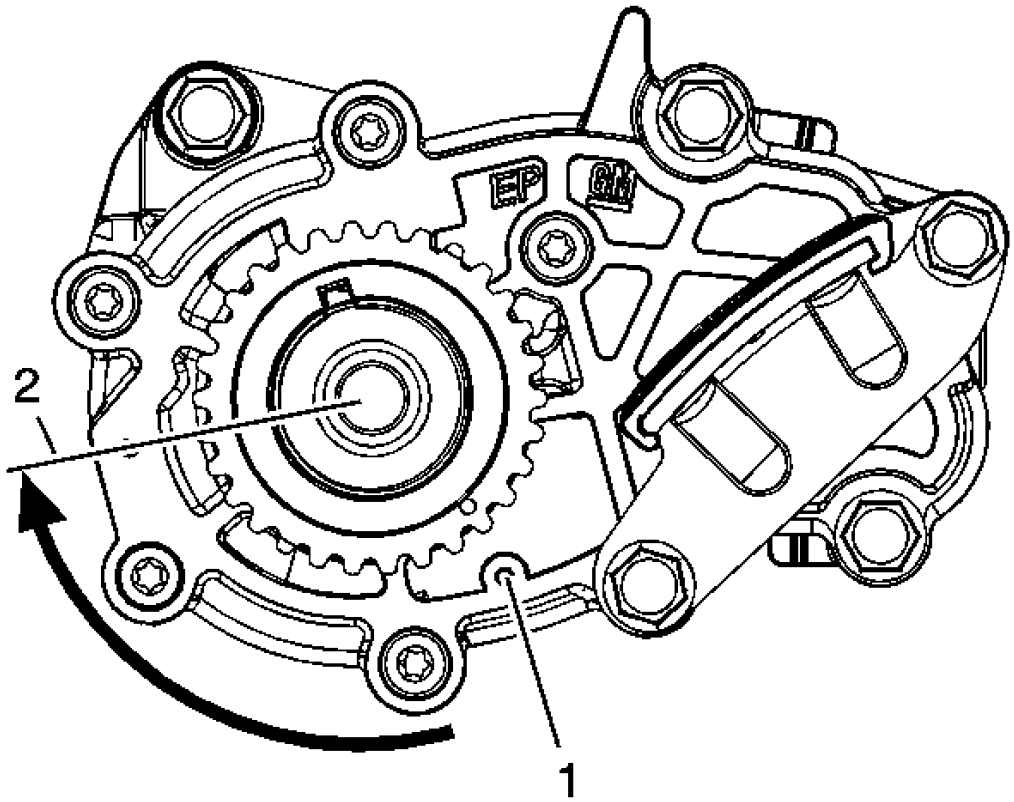


Fig. 84: Identifying Stage 1 & Stage 2 Alignment Positions
Courtesy of GENERAL MOTORS CORP.

14. Using the **EN-48589:** socket, rotate the crankshaft and crankshaft sprocket from the stage 1 alignment position (1) to the stage 2 alignment position (2), 115 crankshaft degrees, in order to install the right secondary camshaft drive chain components.

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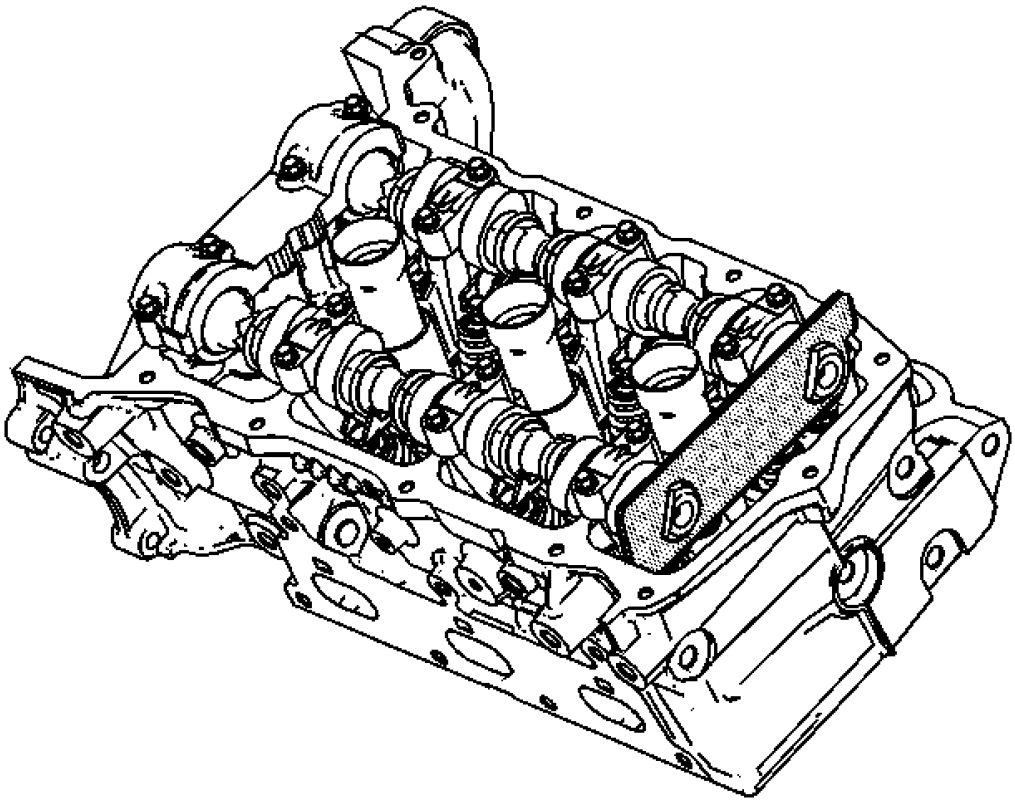


Fig. 85: Installing Special Tool To Left Camshafts
Courtesy of GENERAL MOTORS CORP.

15. Install the EN 48383-2 onto the rear of the left camshafts.

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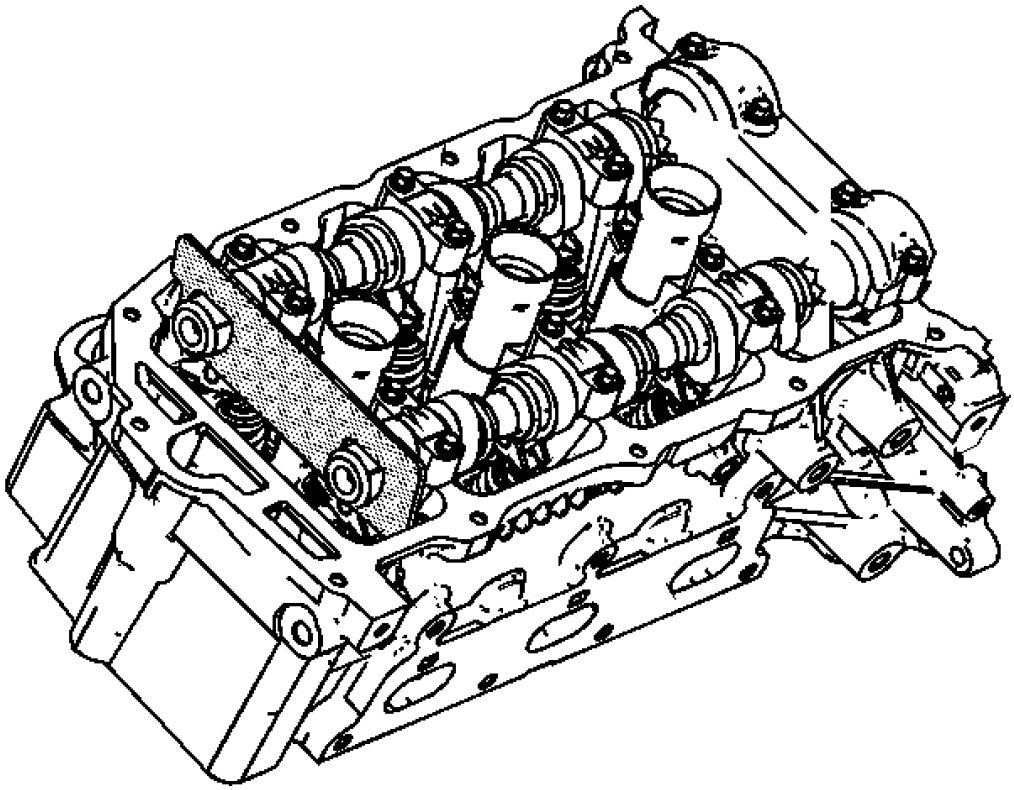


Fig. 86: Installing Special Tool To Right Camshafts
Courtesy of GENERAL MOTORS CORP.

16. Install the EN 48383-3 onto the rear of the right camshafts.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN INSTALLATION - RIGHT SIDE

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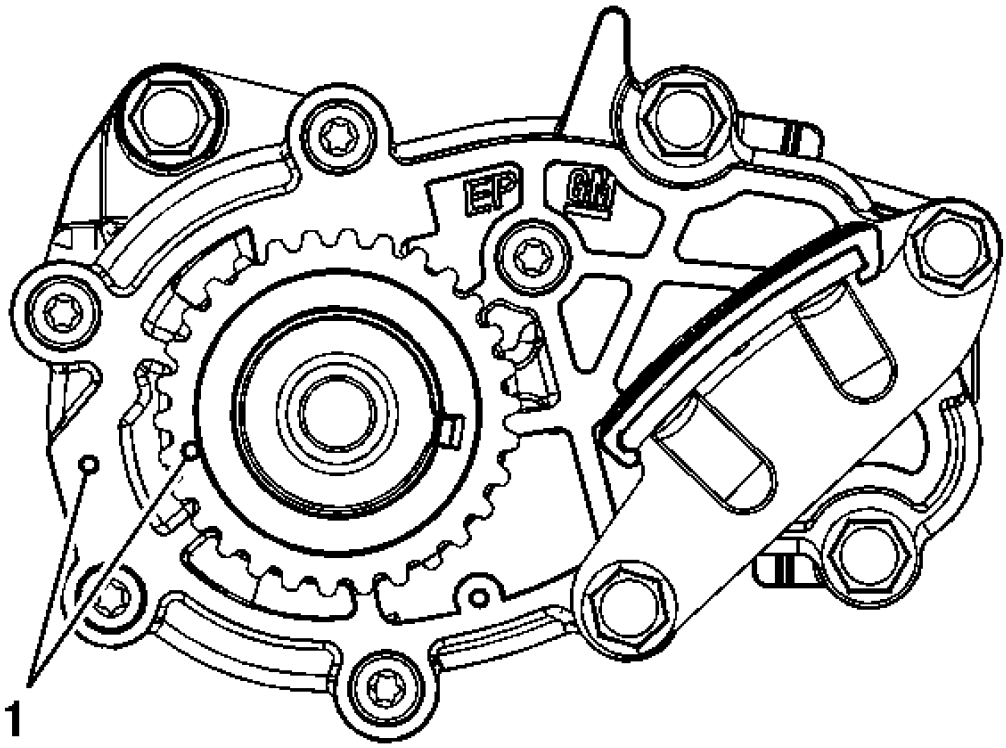


Fig. 87: View Of Crankshaft In Stage 2 Timing Drive Assembly Position
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the crankshaft is in the stage 2 timing drive assembly position (1).

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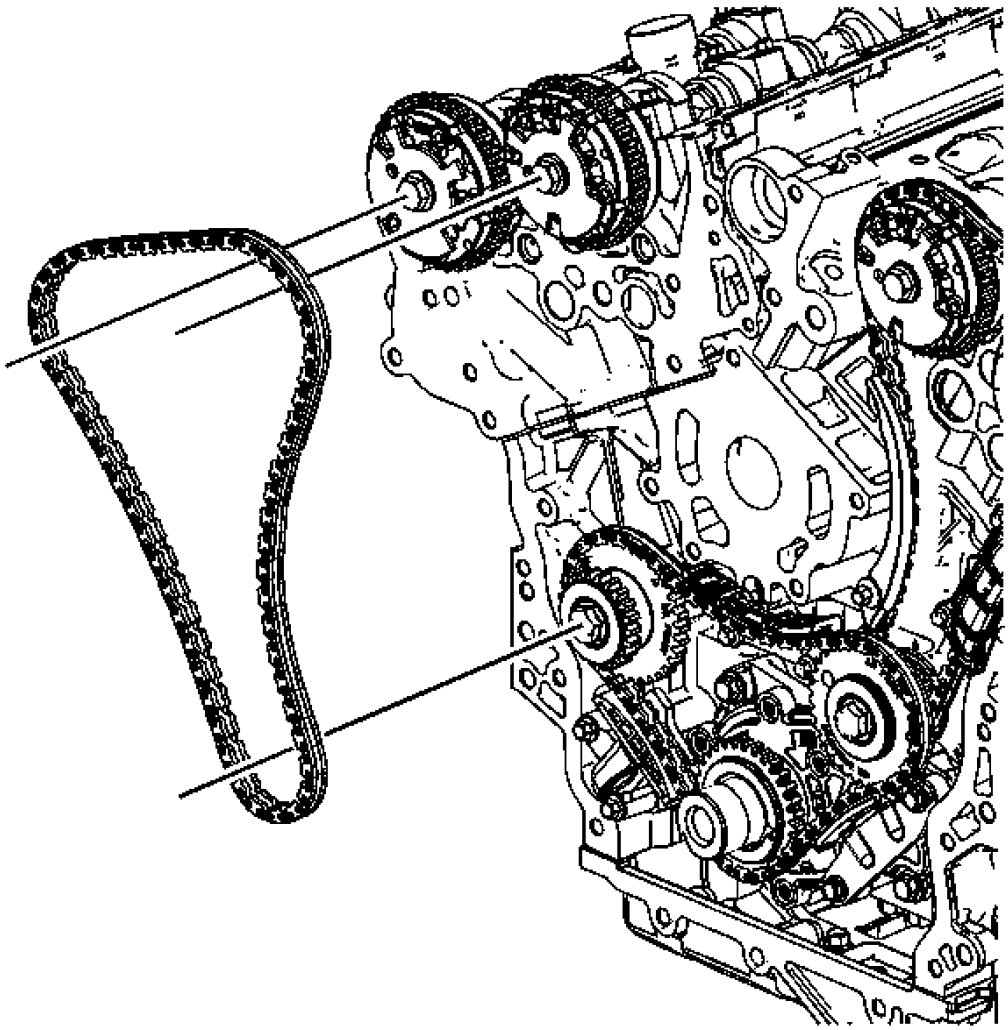


Fig. 88: View Of Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

2. Install the right secondary camshaft drive chain.

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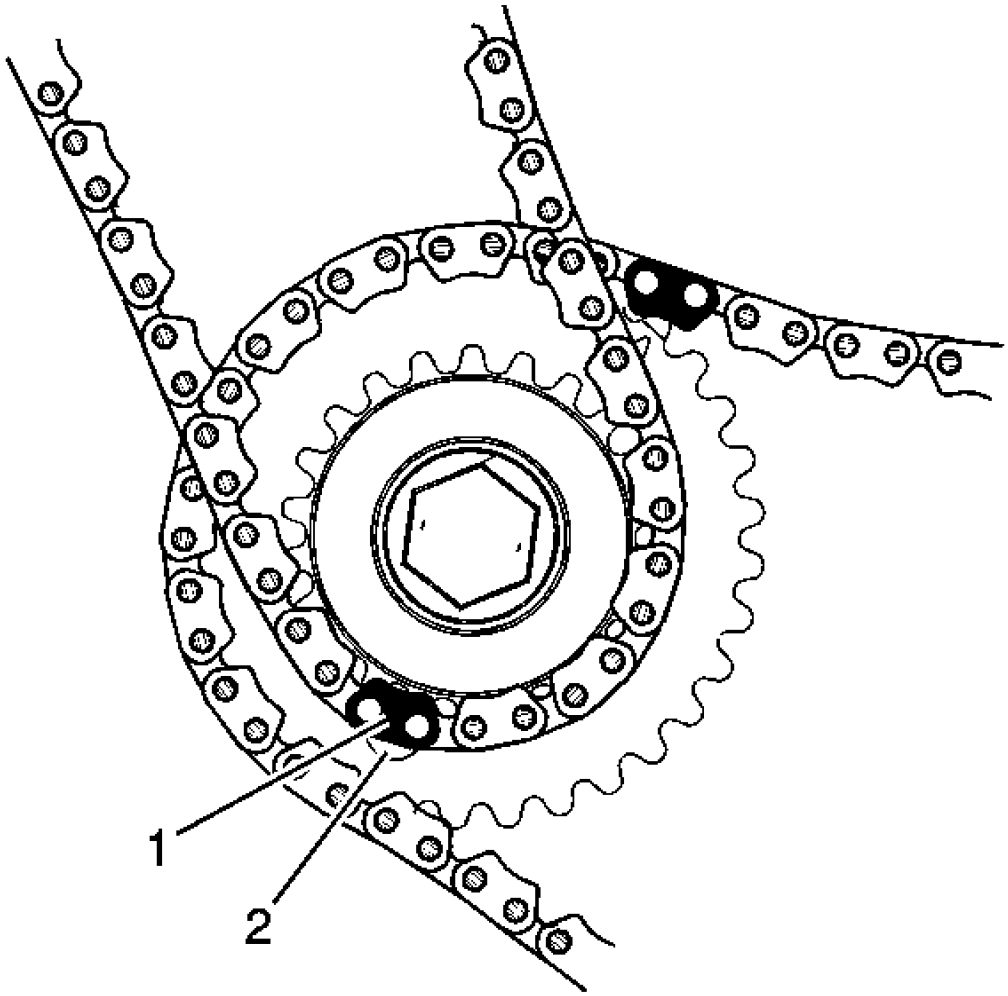


Fig. 89: View Of Timing Camshaft Drive Chain Link & Alignment Access Hole
Courtesy of GENERAL MOTORS CORP.

3. Place the secondary camshaft drive chain around the right camshaft intermediate drive chain idler outer sprocket, aligning the timing camshaft drive chain link (1) with the alignment access hole (2) made in the right camshaft intermediate drive chain idler inner sprocket.

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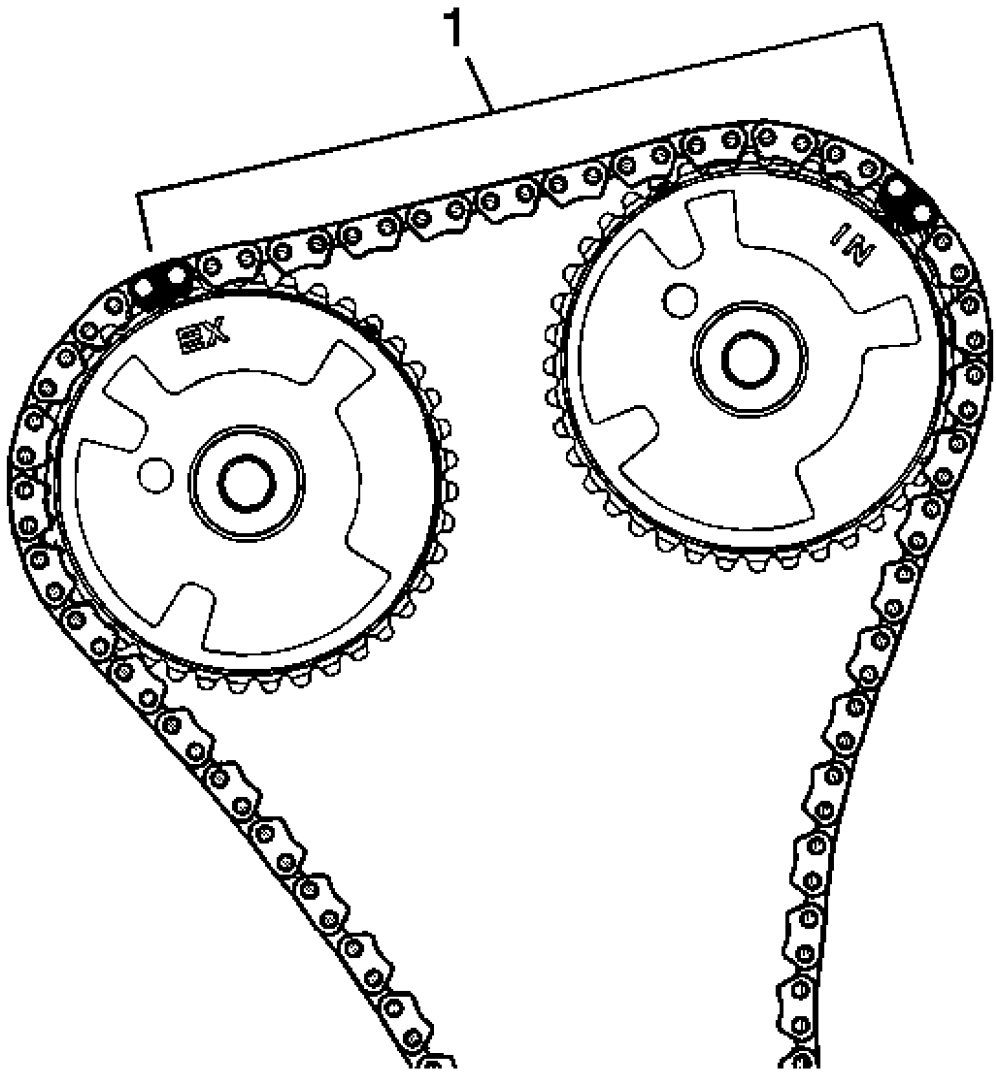


Fig. 90: Identifying Correct Number Of Links
Courtesy of GENERAL MOTORS CORP.

4. Wrap the secondary camshaft drive chain around both right actuator drive sprockets.
5. Ensure there are 10 links (1) between the timing camshaft drive chain links for the camshaft position actuator sprockets.

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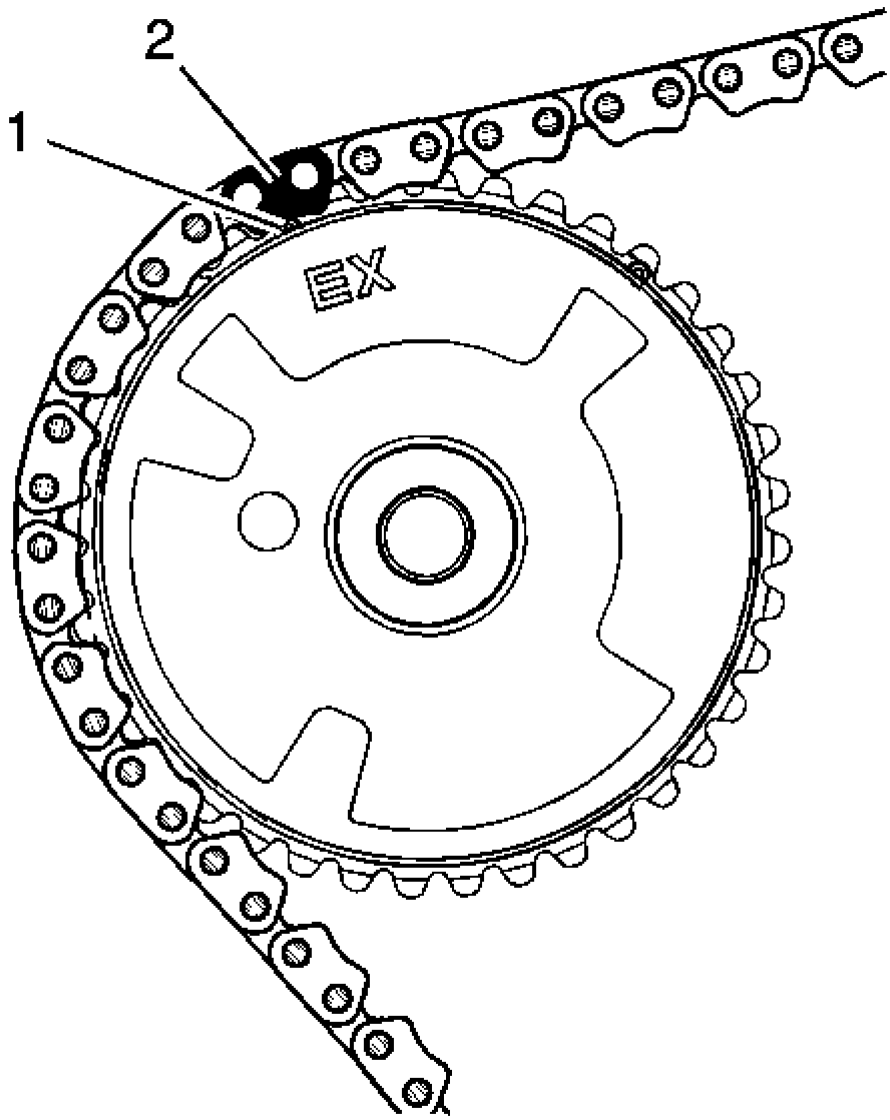


Fig. 91: View Of Camshaft Marks
Courtesy of GENERAL MOTORS CORP.

6. Align the right exhaust camshaft position actuator sprocket alignment triangle mark (1) with the timing camshaft drive chain link (2).

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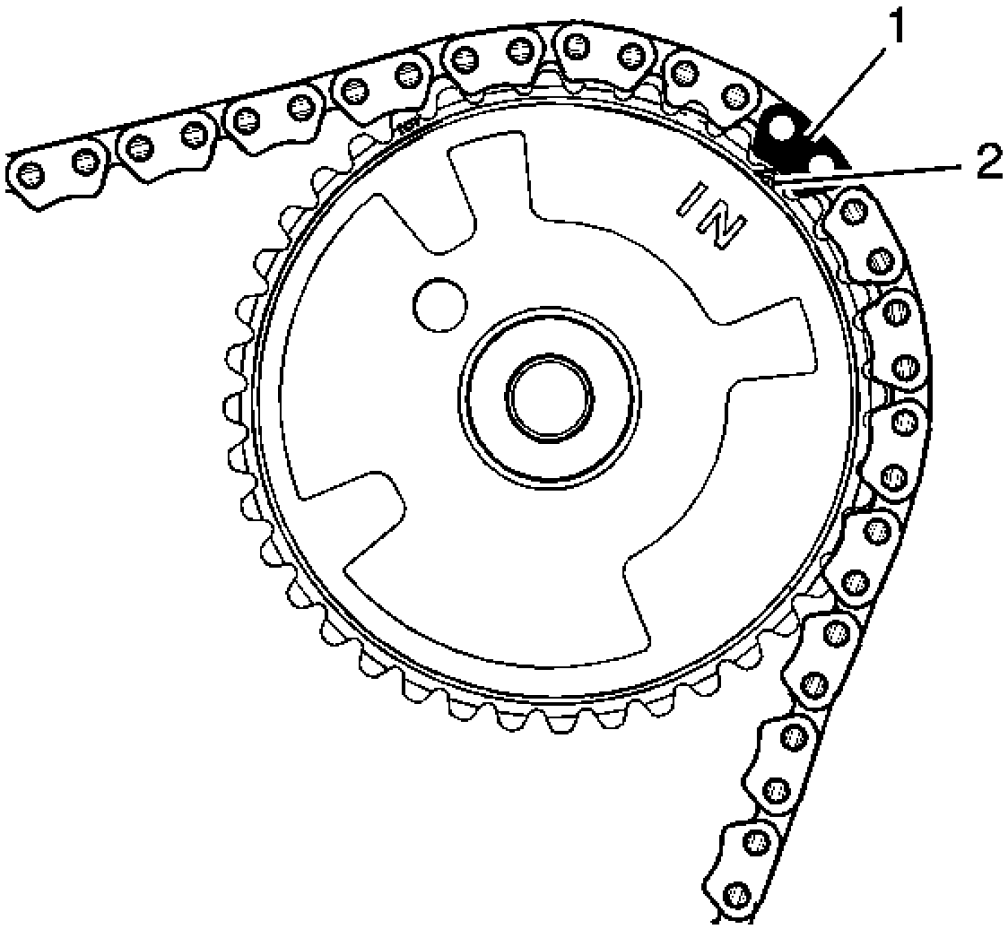


Fig. 92: View Of Right Intake Camshaft Position Actuator Sprocket Alignment Triangle Mark
Courtesy of GENERAL MOTORS CORP.

7. Align the right intake camshaft position actuator sprocket alignment triangle mark (2) with the timing camshaft drive chain link (1).

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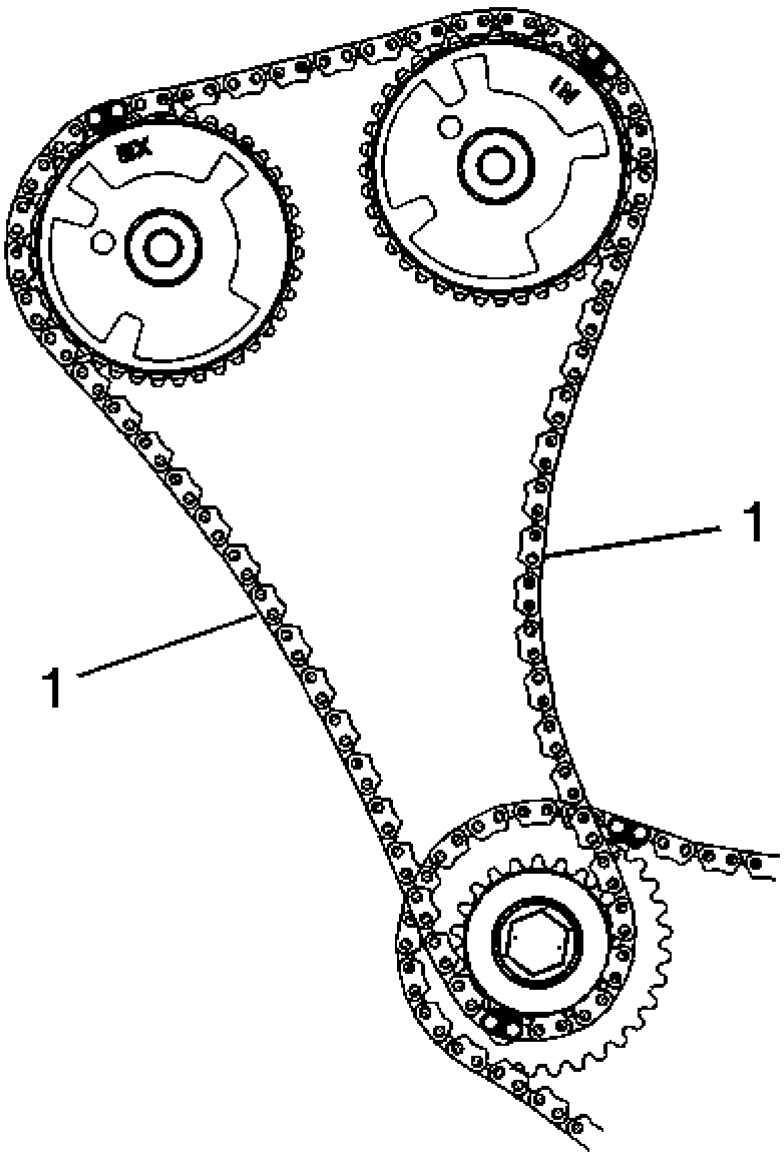


Fig. 93: Identifying Correct Number Of Links Between Points
Courtesy of GENERAL MOTORS CORP.

8. There will be 22 links (1) between the right camshaft intermediate drive chain idler timing camshaft drive chain link and each right camshaft position actuator sprocket timing camshaft drive chain link.

SECONDARY TIMING CHAIN GUIDE INSTALLATION - RIGHT SIDE

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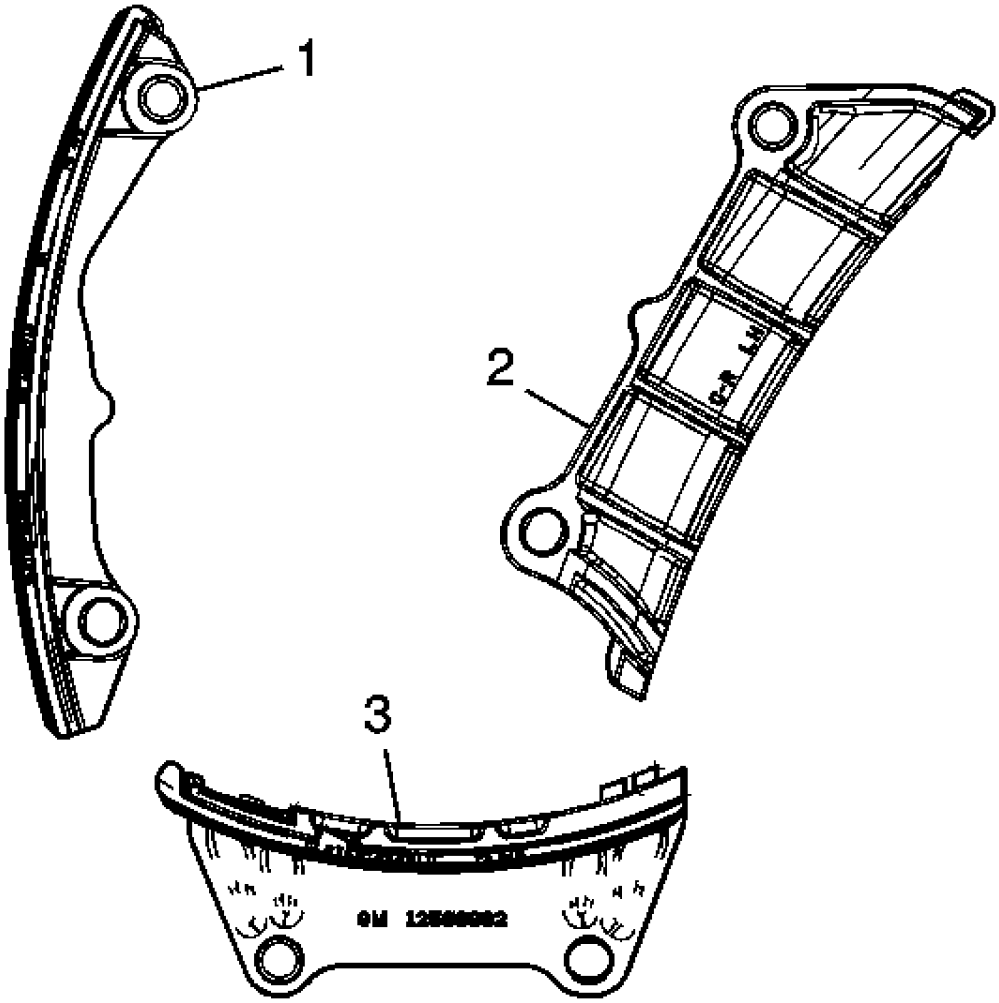


Fig. 94: Identifying Camshaft Drive Chain Guides
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the right secondary camshaft drive chain guide (1) is being installed.

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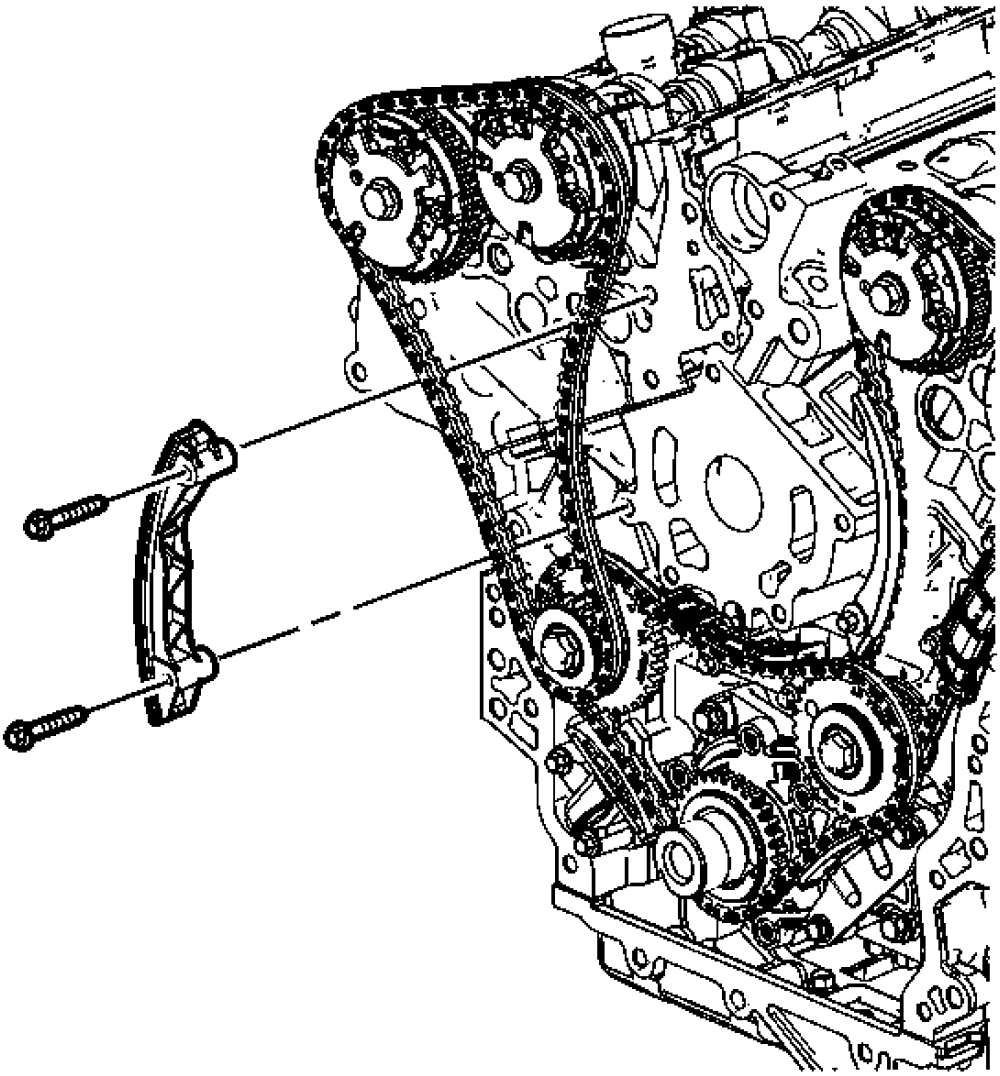


Fig. 95: View Of Right Secondary Camshaft Drive Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Position the right secondary camshaft drive chain guide.

CAUTION: Refer to Fastener Caution .

3. Install the secondary camshaft drive chain guide bolts and tighten to 25 N.m (18 lb ft).

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SECONDARY CAMSHAFT DRIVE CHAIN SHOE INSTALLATION - RIGHT SIDE

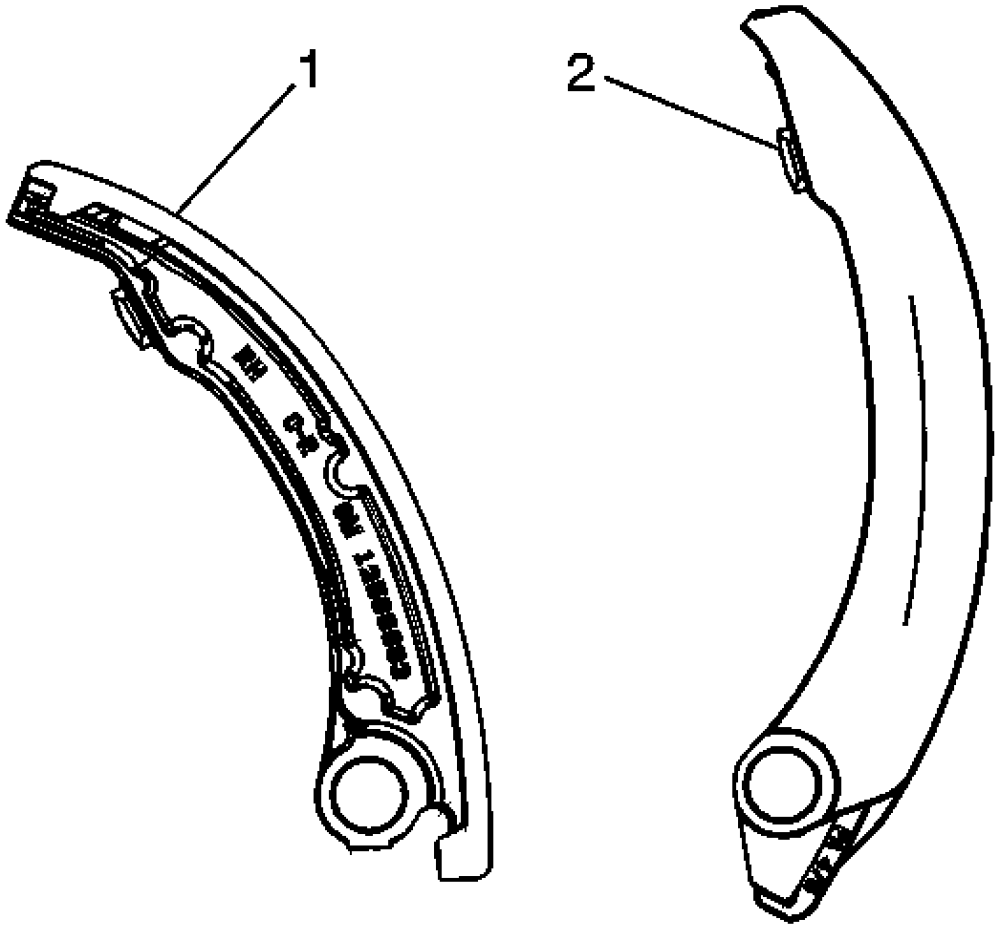


Fig. 96: Identifying Secondary Camshaft Drive Chain Shoes
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the right secondary camshaft drive chain shoe (1) is being installed.

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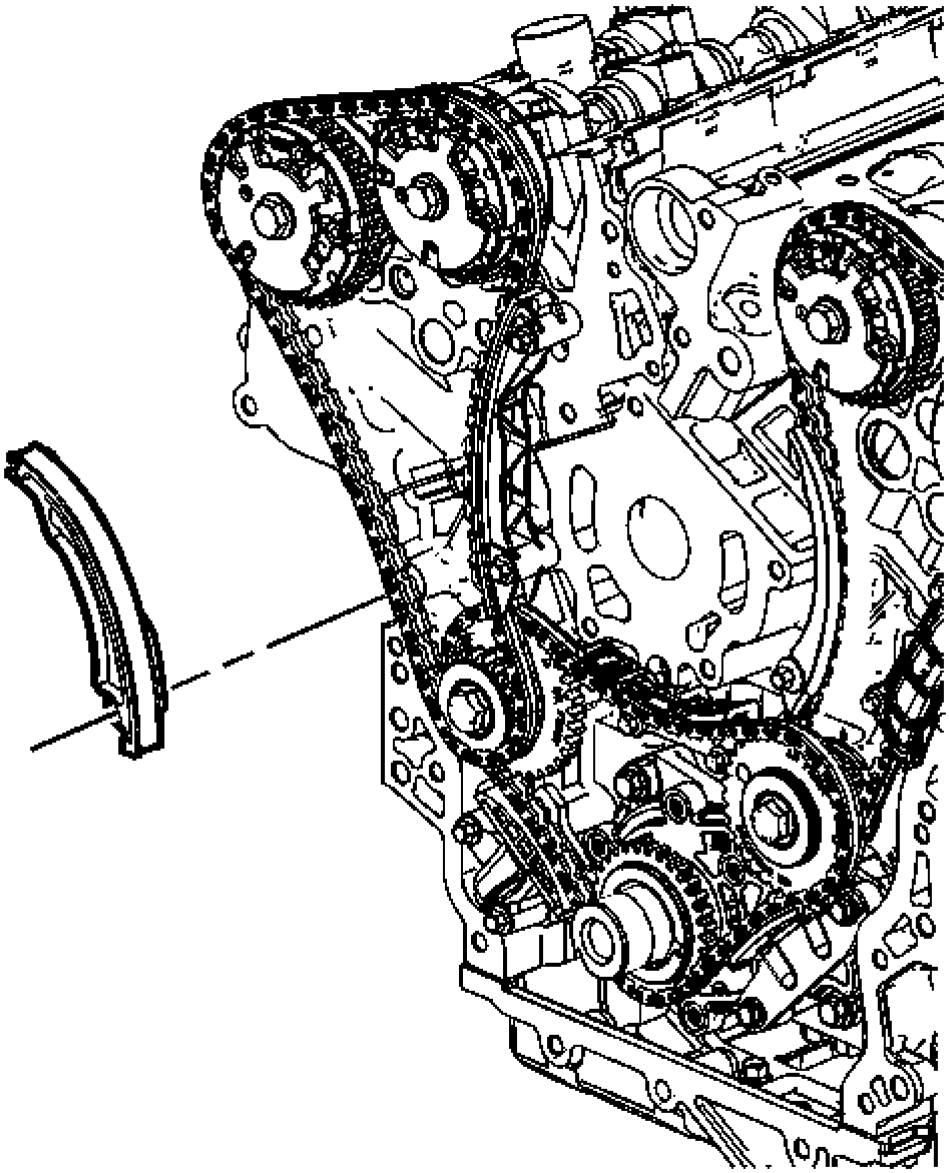


Fig. 97: View Of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS CORP.

2. Position the right secondary camshaft drive chain shoe.

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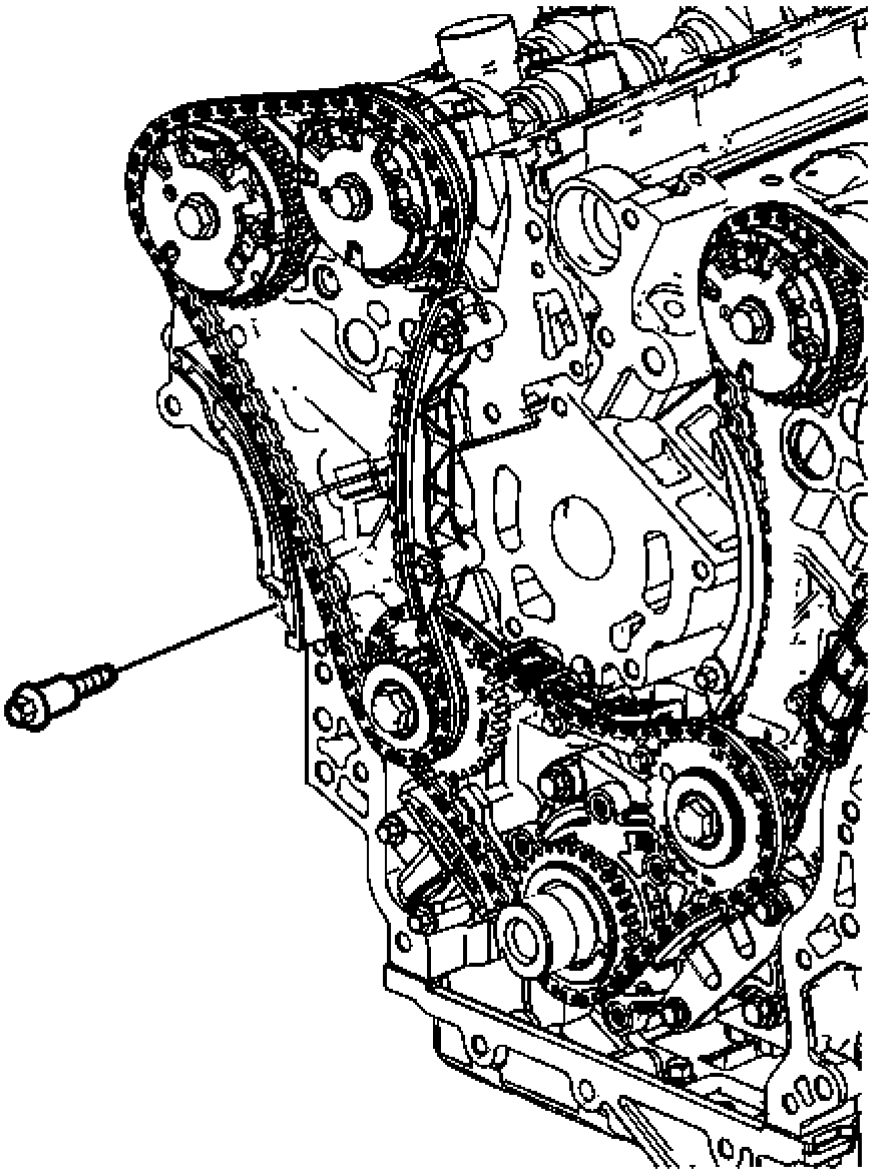


Fig. 98: Identifying Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

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3. Install the secondary camshaft drive chain shoe bolt and tighten to 25 N.m (18 lb ft).

SECONDARY TIMING CHAIN TENSIONER INSTALLATION - RIGHT SIDE

Special Tools

- **EN 46112:** Tensioner Retraction Pins
- **J 45027:** Tensioner Tool

For equivalent regional tools, refer to **Special Tools** .

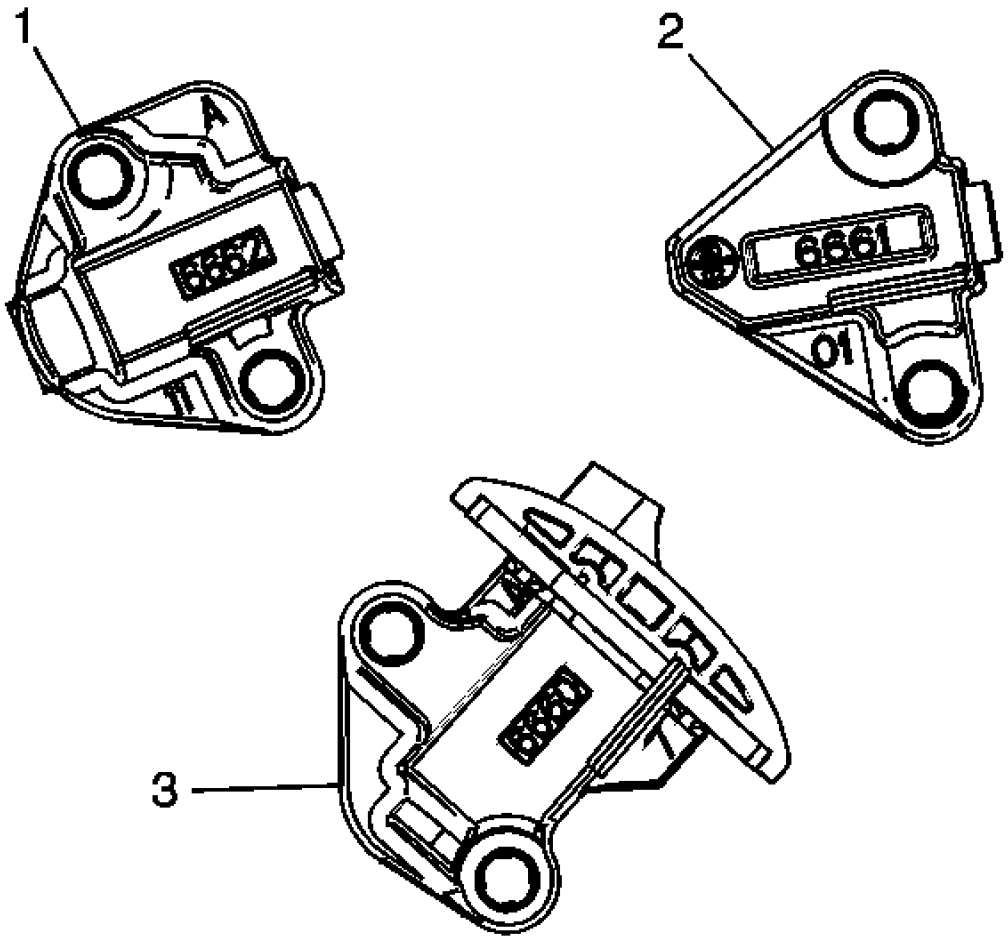


Fig. 99: Identifying Left & Right Secondary Camshaft Drive Chain Tensioner & Primary Camshaft Drive Chain Tensioner

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Courtesy of GENERAL MOTORS CORP.

1. Ensure that the right secondary camshaft drive chain tensioner (1) is being installed.

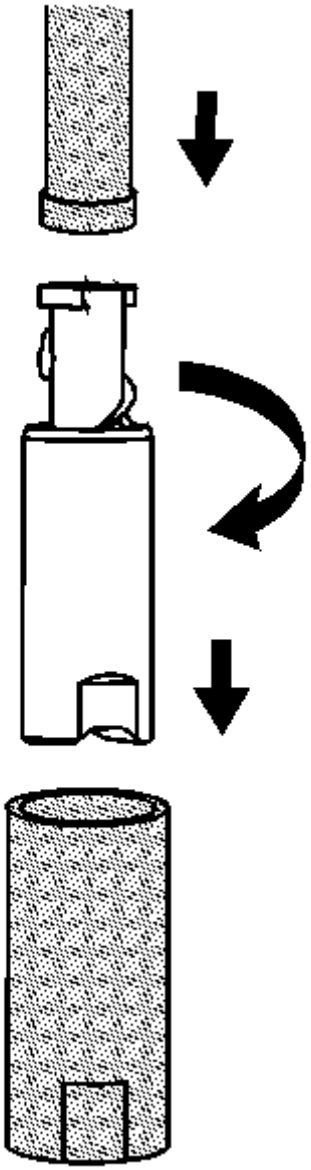


Fig. 100: Resetting Secondary Camshaft Drive Chain Tensioner Plunger With J 45027
Courtesy of GENERAL MOTORS CORP.

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2. Using the **J 45027:** tool, reset the right secondary camshaft drive chain tensioner plunger.

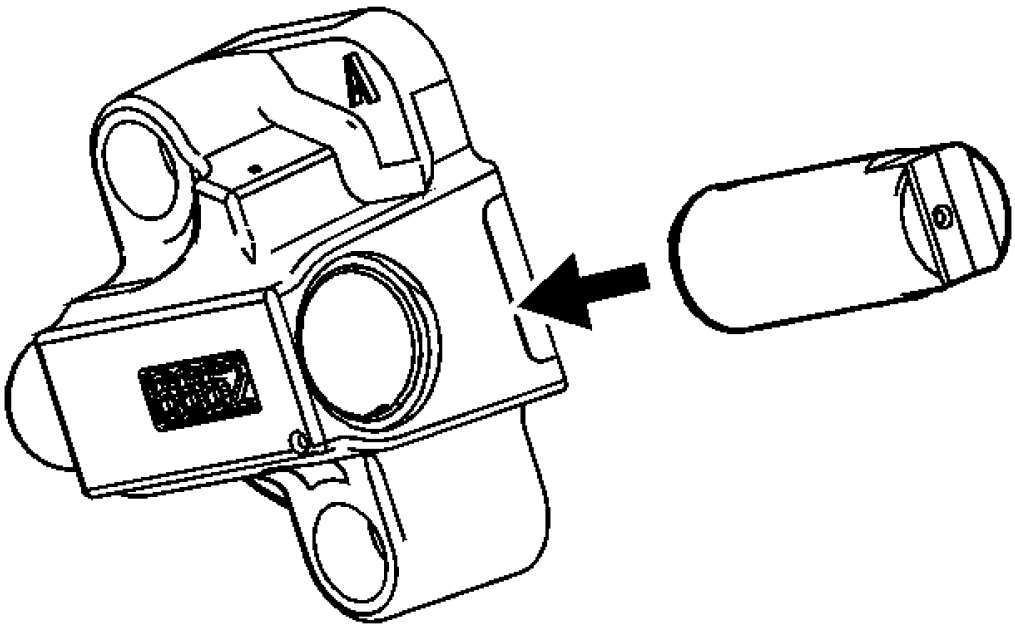


Fig. 101: Installing Plunger Into Right Secondary Camshaft Drive Chain Tensioner Body
Courtesy of GENERAL MOTORS CORP.

3. Install the plunger into the right secondary camshaft drive chain tensioner body.

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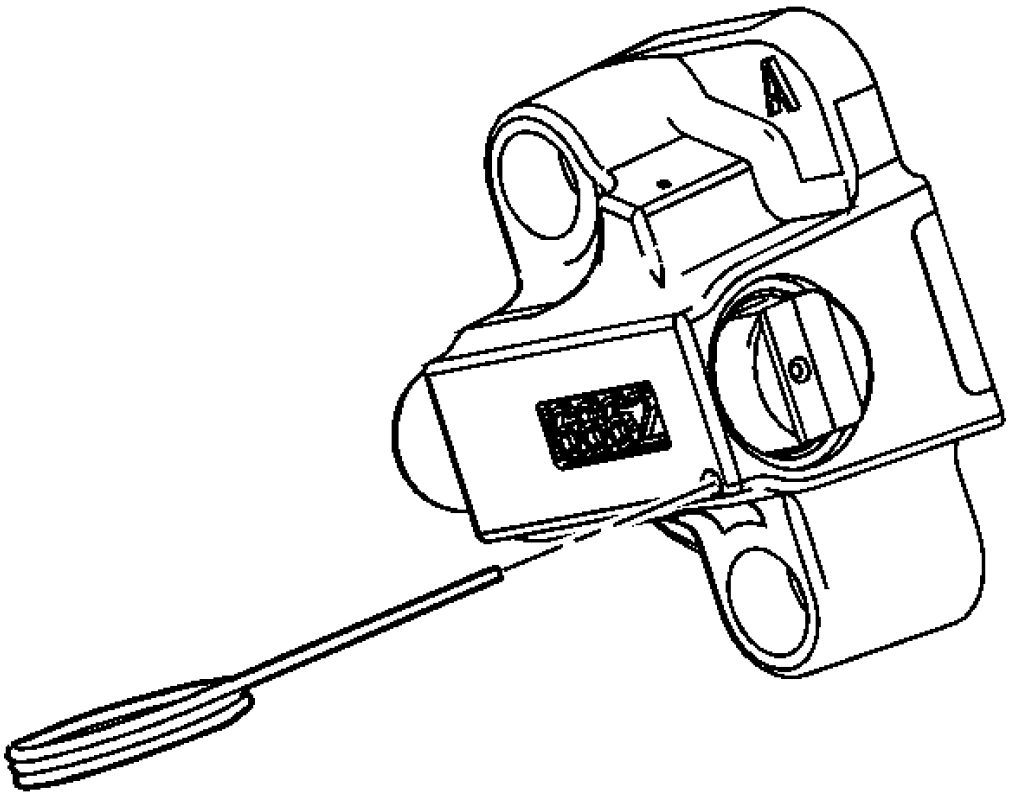


Fig. 102: Identifying EN 46112
Courtesy of GENERAL MOTORS CORP.

4. Compress the plunger into the body and lock the right secondary camshaft drive chain tensioner by inserting the **EN 46112:** pins into the access hole in the side of the right secondary camshaft drive chain tensioner body.
5. Slowly release pressure on the right secondary camshaft drive chain tensioner. The right secondary camshaft drive chain tensioner should remain compressed.

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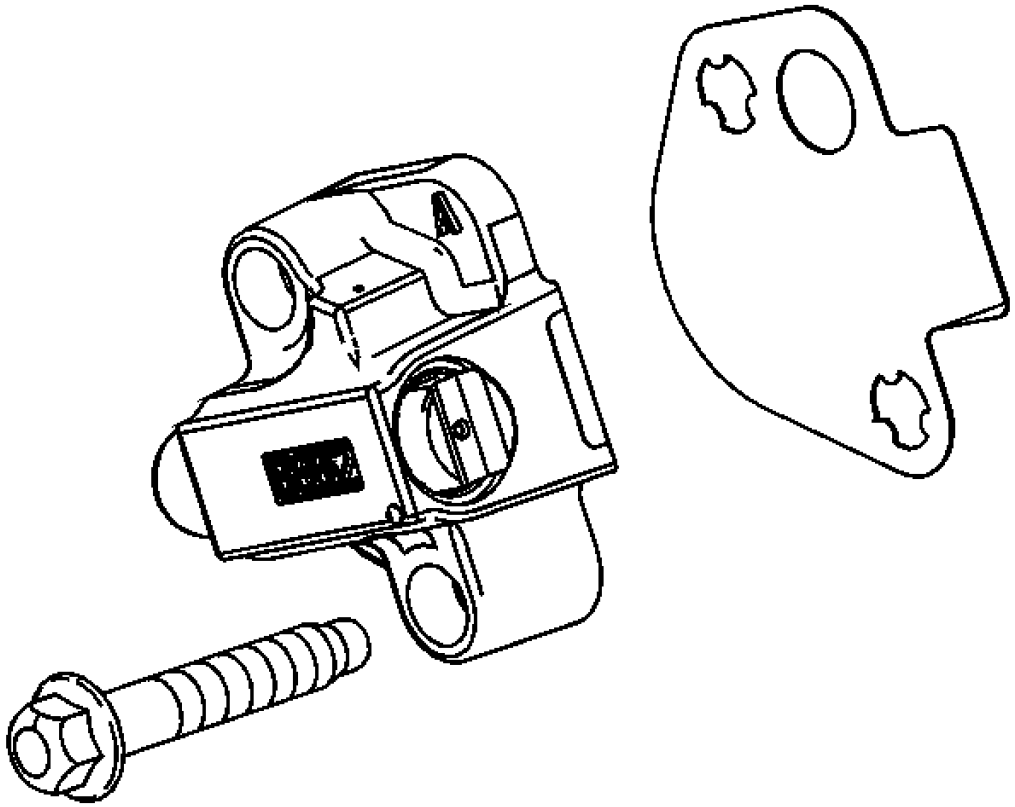


Fig. 103: Identifying Right Secondary Camshaft Drive Chain Tensioner Gasket
Courtesy of GENERAL MOTORS CORP.

6. Install a NEW right secondary camshaft drive chain tensioner gasket to the right secondary camshaft drive chain tensioner.
7. Install the right secondary camshaft drive chain tensioner bolts through the right secondary camshaft drive chain tensioner and gasket.
8. Ensure the right secondary camshaft drive chain tensioner mounting surface on the right cylinder head does not have any burrs or defects that would degrade the sealing of the NEW right secondary camshaft drive chain tensioner gasket.

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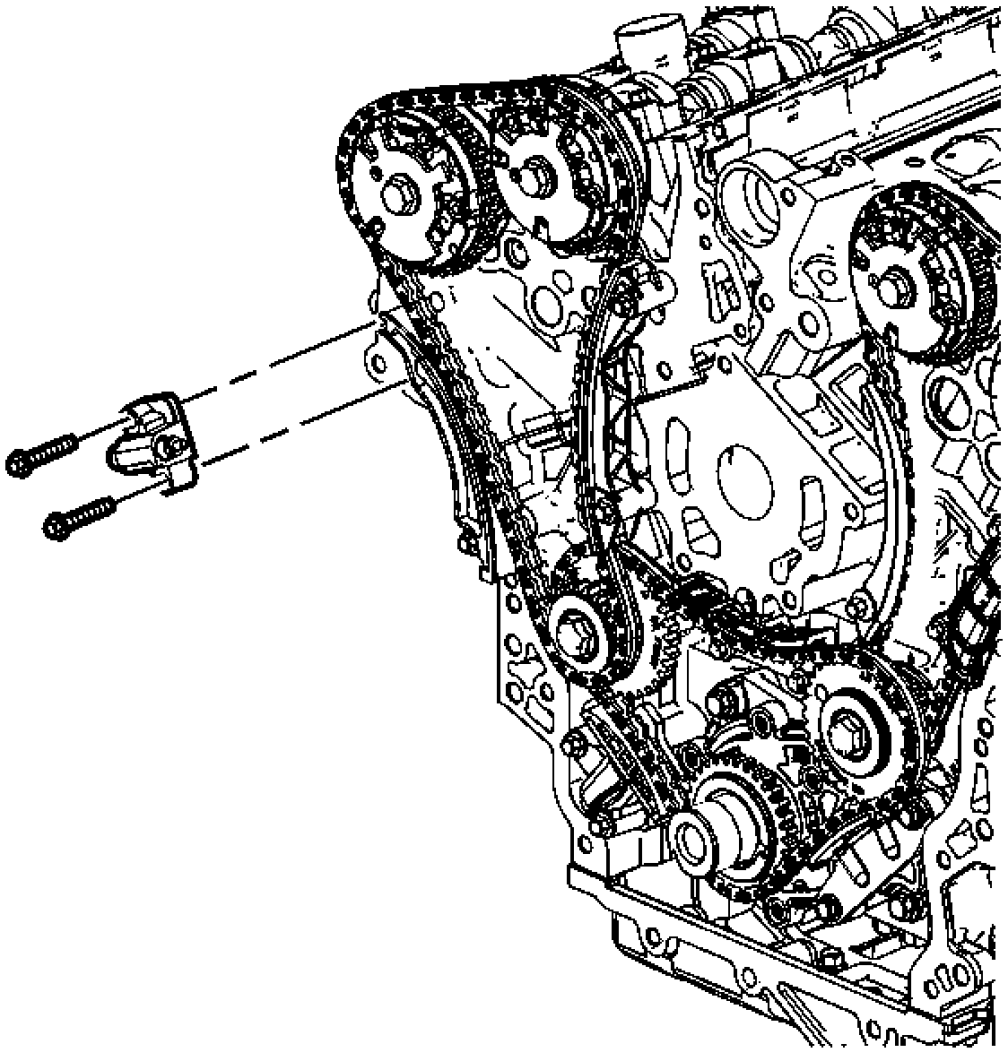


Fig. 104: View Of Secondary Camshaft Drive Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS CORP.

9. Place the right secondary camshaft drive chain tensioner into position and loosely install the bolts to the block.

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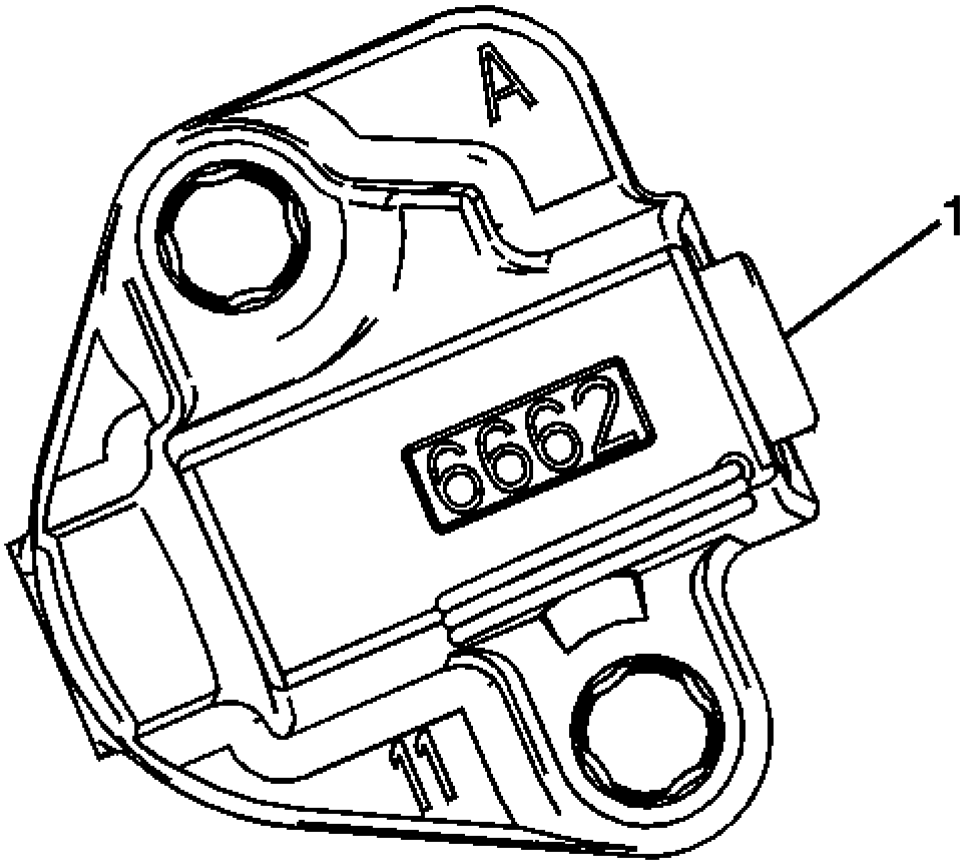


Fig. 105: Identifying Right Secondary Camshaft Drive Chain Tensioner Gasket Tab
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

10. Verify the proper placement of the right secondary camshaft drive chain tensioner gasket tab (1).
    1. First Pass

       Tighten the right secondary camshaft drive chain tensioner bolts to 5 N.m (44 lb in) .

    2. Final Pass

       Tighten the right secondary camshaft drive chain tensioner bolts to 25 N.m (18 lb ft) .

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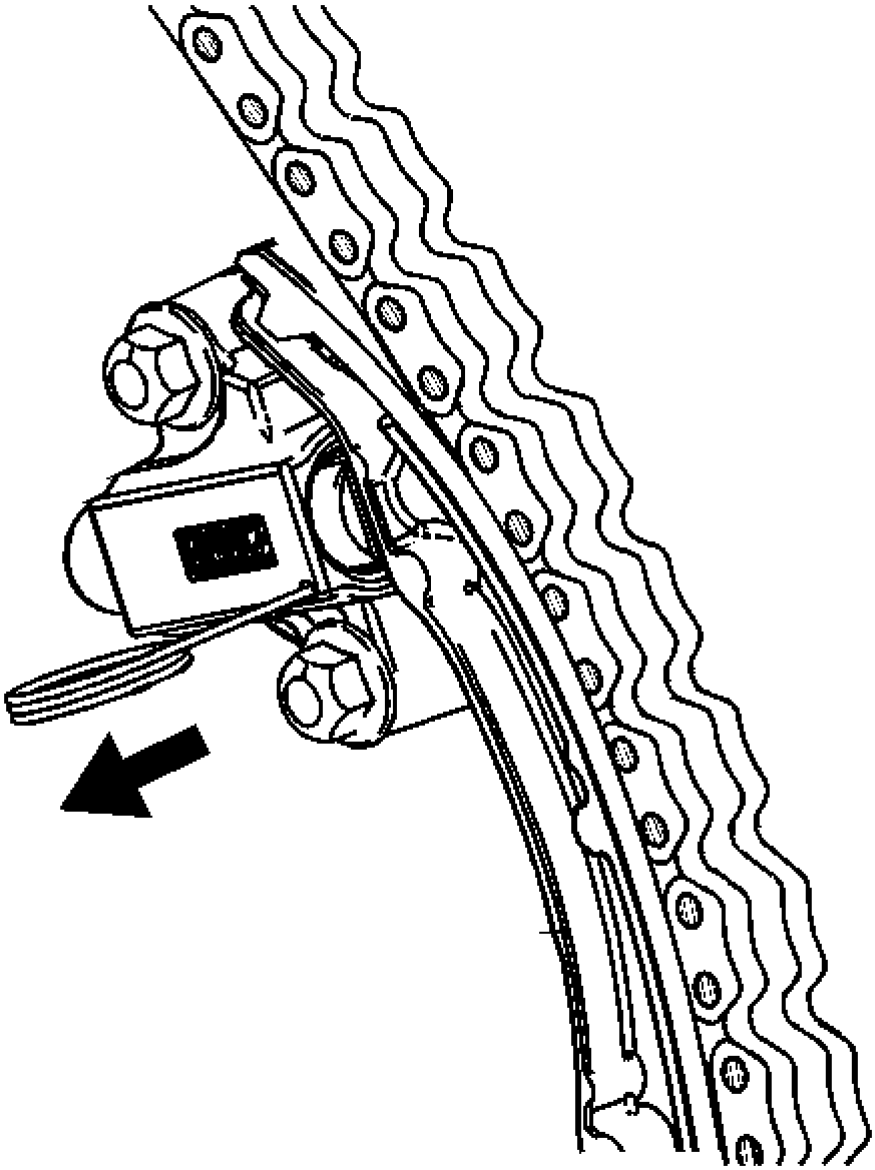


Fig. 106: Identifying Right Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

11. Release the right camshaft drive chain tensioner by pulling out the **EN 46112:** pins and unlocking the tensioner plunger.

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CAUTION: Ensure that all timing chain tensioners are completely released. A timing chain tensioner that is not properly released can lead to serious engine damage.

12. Verify all primary and secondary camshaft drive chain timing mark alignments. Refer to **Timing Chain Alignment Diagram** - Stage Two.

ENGINE FRONT COVER INSTALLATION

Special Tools

EN 46109: Guide Pins

For equivalent regional tools, refer to **Special Tools** .

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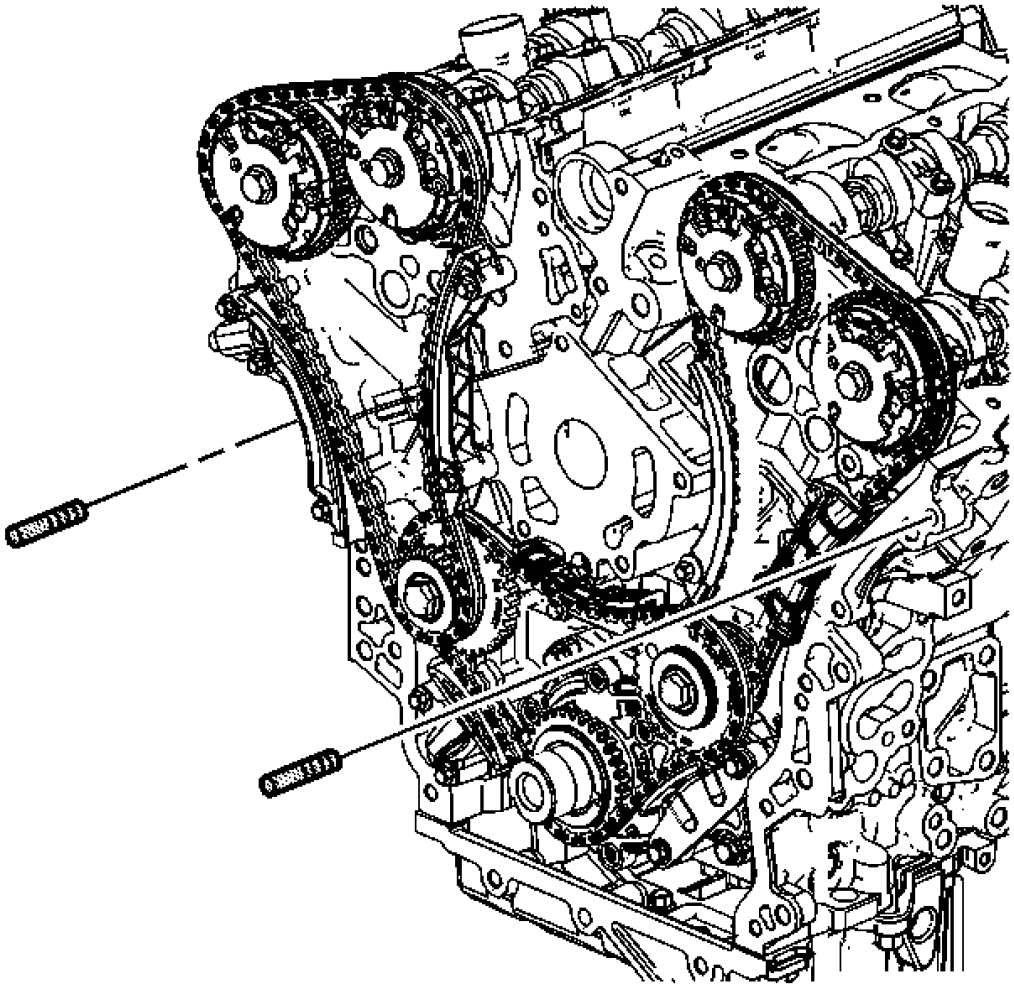


Fig. 107: Identifying Cylinder Block Guide Studs
Courtesy of GENERAL MOTORS CORP.

1. Install the 8 mm (0.315 in) guide from the **EN 46109:** pins into the cylinder block positions as shown.

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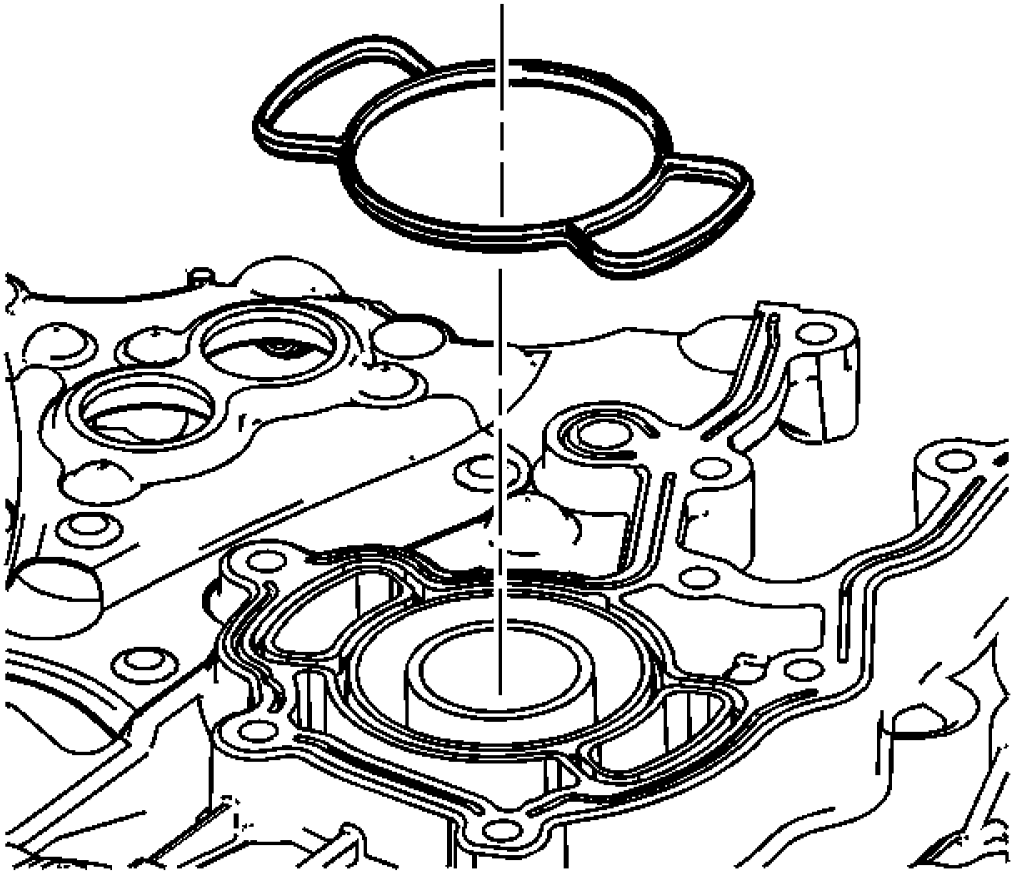


Fig. 108: Identifying Cylinder Block Seal
Courtesy of GENERAL MOTORS CORP.

2. Install the NEW engine front cover to cylinder block seal.

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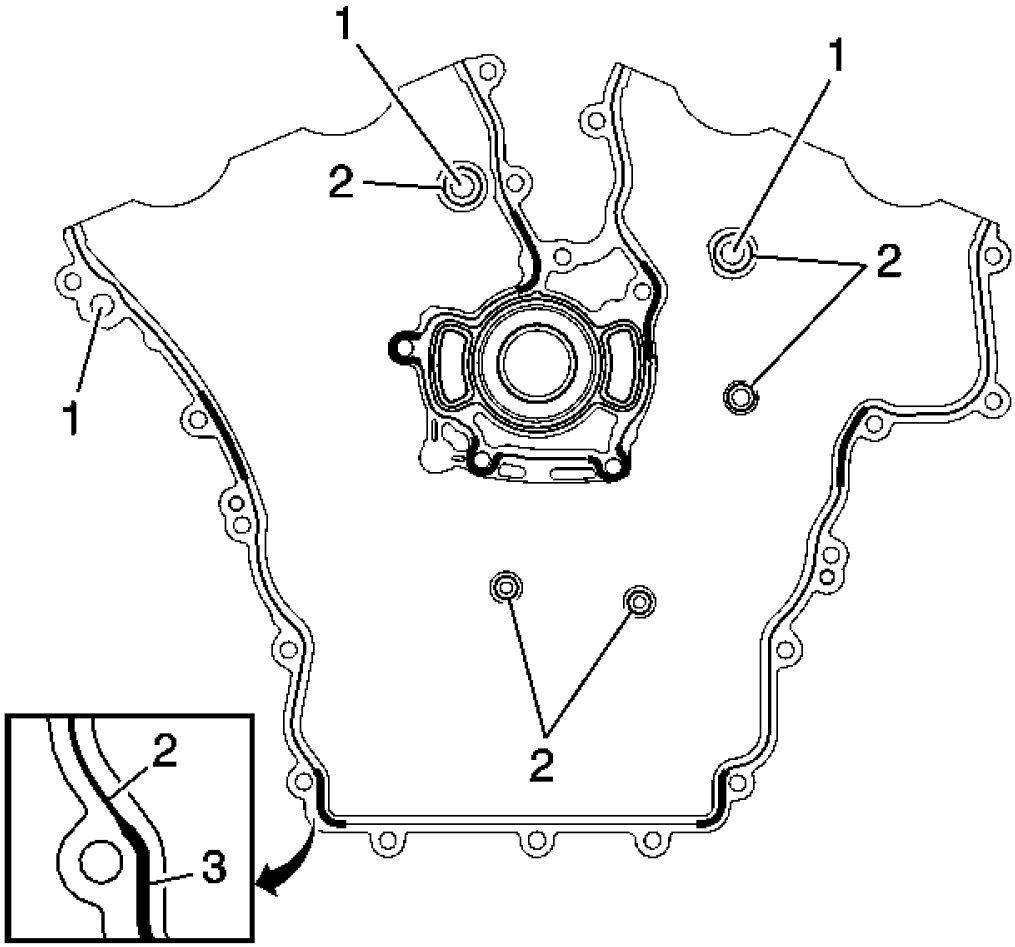


Fig. 109: Applying Sealant
Courtesy of GENERAL MOTORS CORP.

NOTE: No RTV sealant should be visible in the M12 bolt holes (1) upon final assembly of front cover to engine.

3. Apply a 3 mm (0.118 in) bead of RTV sealant, GM P/N 12378521 (Canadian P/N 88901148) or equivalent, on the engine front cover as shown (2). Apply a 5 mm (0.197 in) bead of RTV sealant on the engine front cover as shown (3).

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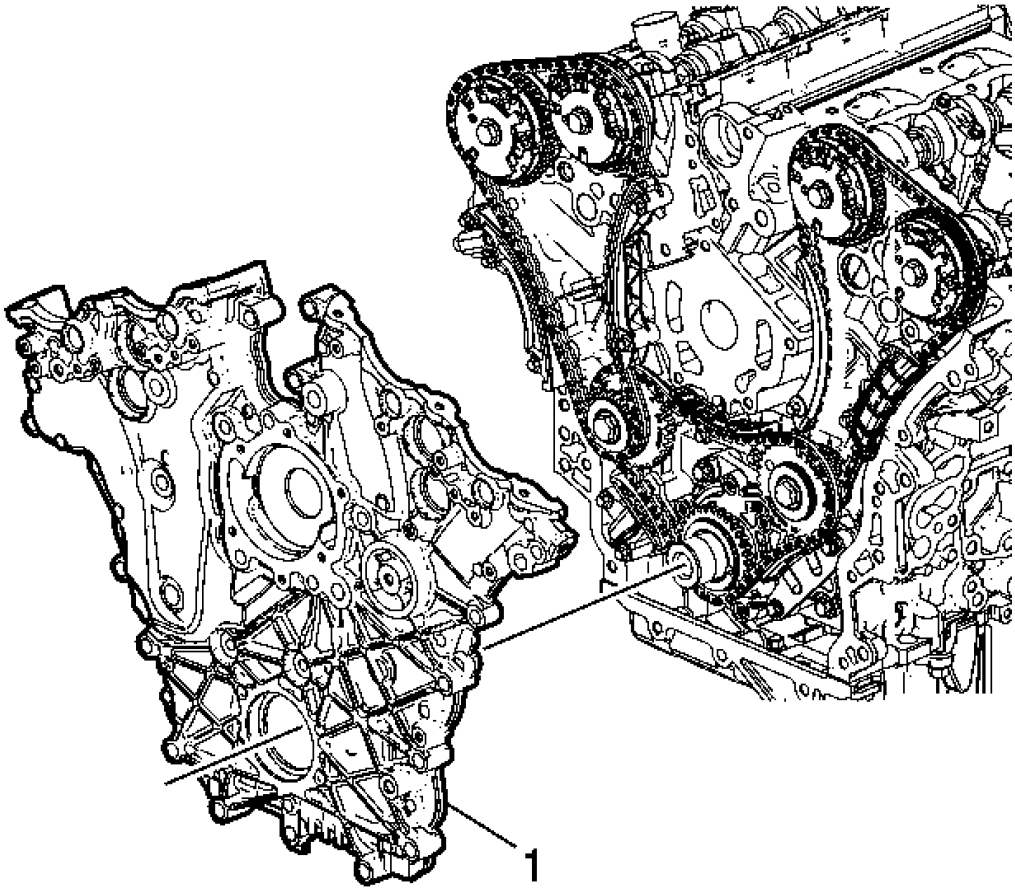


Fig. 110: Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

4. Place the engine front cover (1) onto the **EN 46109:** pins and slide into position.
5. Remove the **EN 46109:** pins from the cylinder block.
6. Hand start all the engine front cover bolts.

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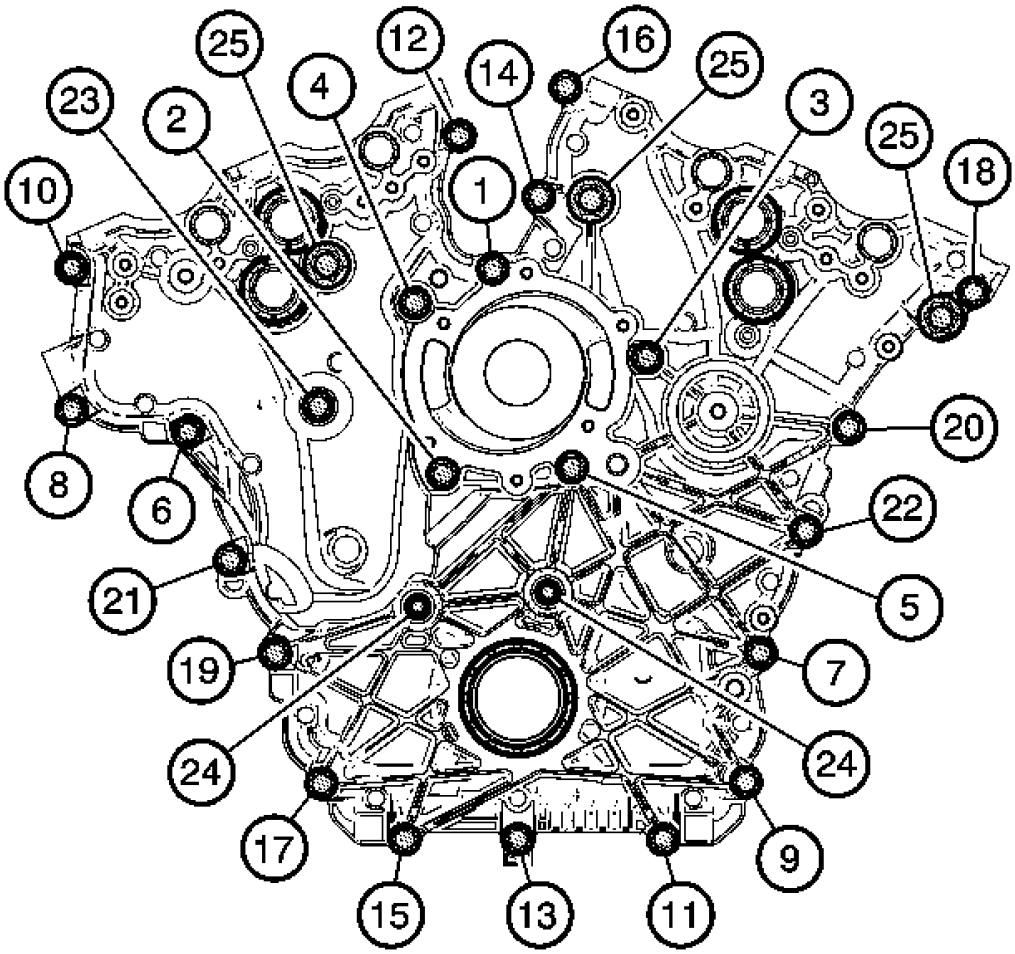


Fig. 111: Identifying Engine Front Cover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

NOTE: Engine front cover bolts in the number (25) location are model dependent and may not apply.

7. Tighten the engine front cover bolts (1-23) in the sequence shown to 20 N.m (14 lb ft).
    1. Tighten the engine front cover bolts (1-23) a second pass in sequence to 20 N.m (14 lb ft) .
    2. Tighten the engine front cover bolts (1-23) a third pass in sequence an additional 60 degrees .

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3. Tighten the engine front cover bolts (24) to 15 N.m (11 lb ft) .
4. Tighten the engine front cover bolts (25) to 65 N.m (48 lb ft) .

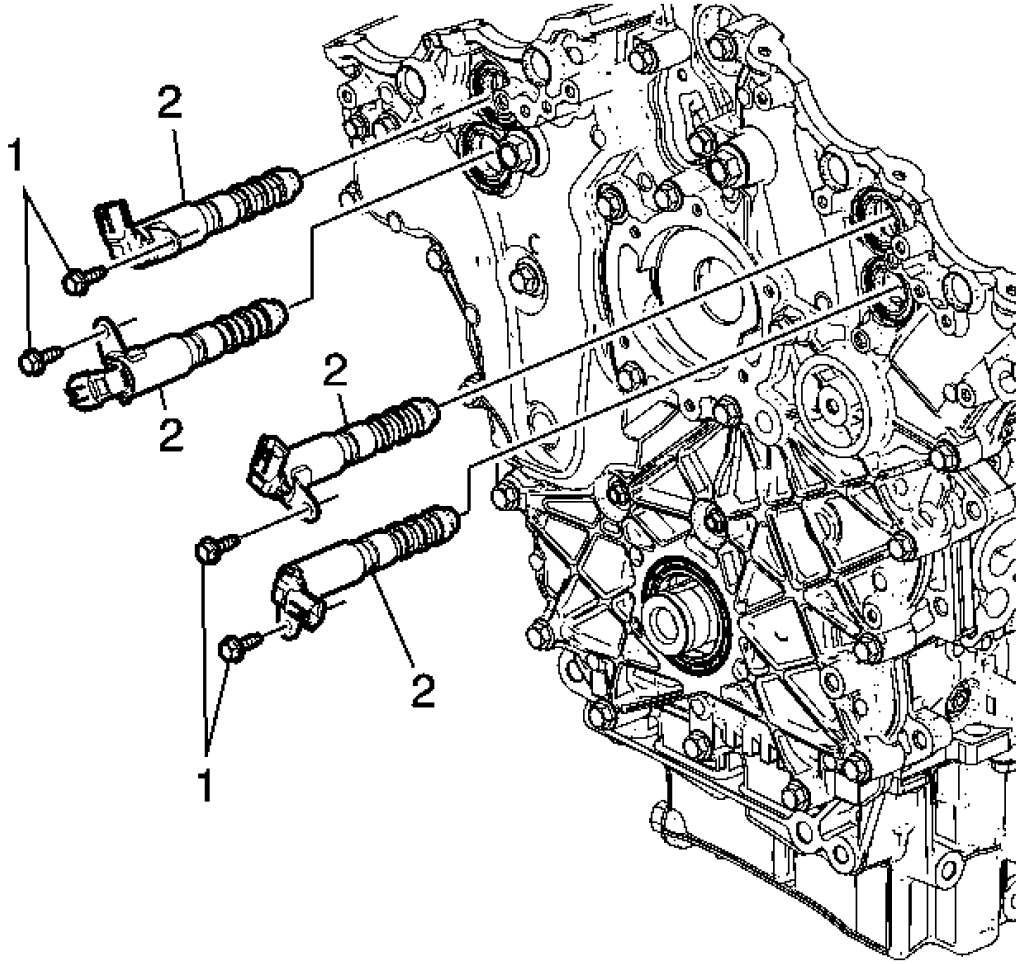


Fig. 112: Placing Camshaft Position Actuator Valves
Courtesy of GENERAL MOTORS CORP.

8. Place the camshaft position actuator valves (2) in position on the front cover.
9. Install the camshaft position actuator valve bolts (1) and tighten to 10 N.m (89 lb in).

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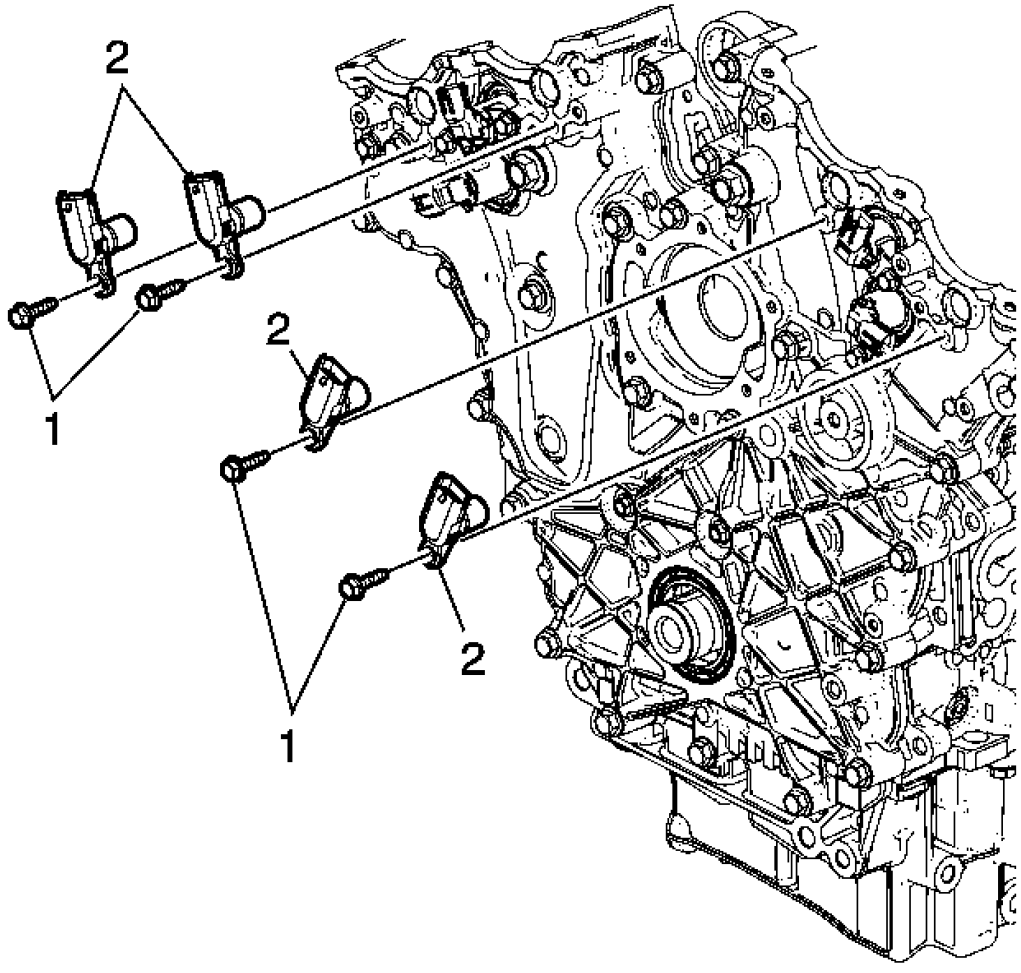


Fig. 113: Camshaft Position Sensors & Bolts
Courtesy of GENERAL MOTORS CORP.

10. Install NEW O-rings on the camshaft position sensor.
11. Place the camshaft position sensors (2) in position on the front cover.
12. Install the camshaft position sensor bolts (1) and tighten to 10 N.m (89 lb in).

WATER PUMP INSTALLATION

Special Tools

EN 46104: Water Pump Pulley Holding Tool

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For equivalent regional tools, refer to **Special Tools** .

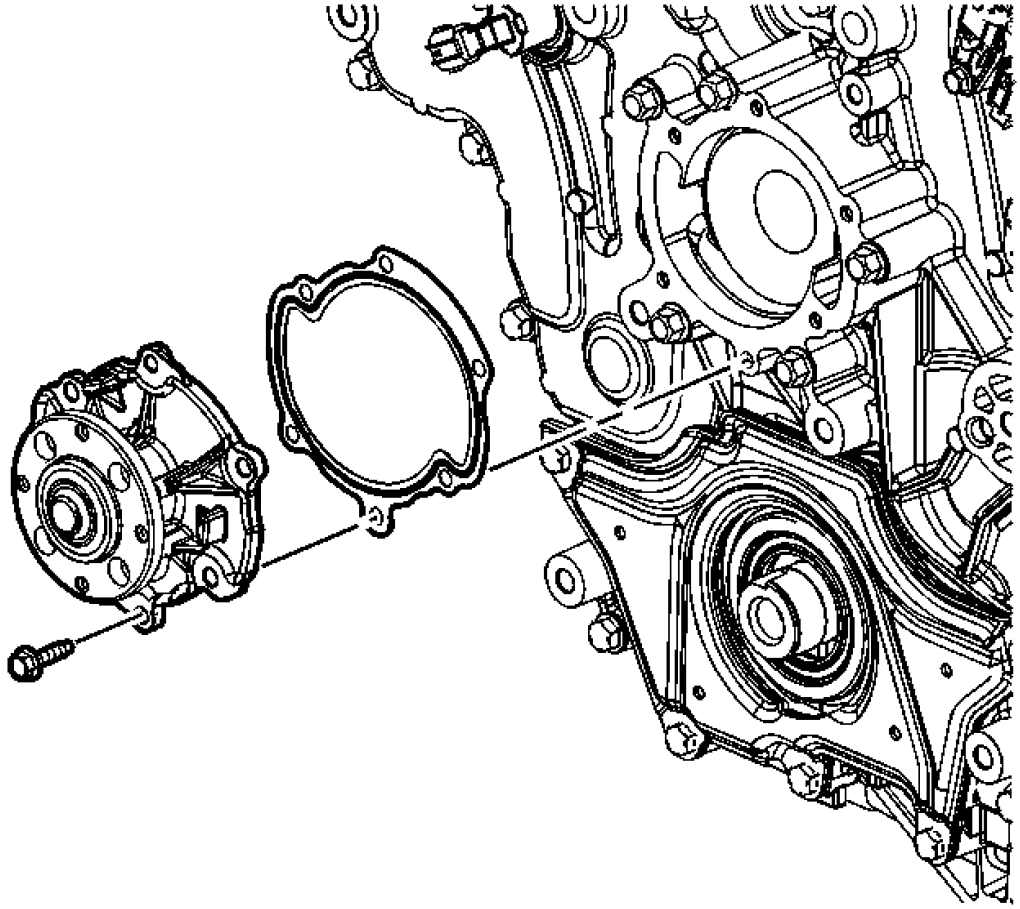


Fig. 114: View Of Water Pump & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Ensure that the engine front cover and water pump are clear of old gasket material.
2. Place a new water pump gasket on the water pump.
3. Place the water pump in position on the front cover.

CAUTION: Refer to Fastener Caution .

4. Install the water pump bolts and tighten to 10 N.m (89 lb in).

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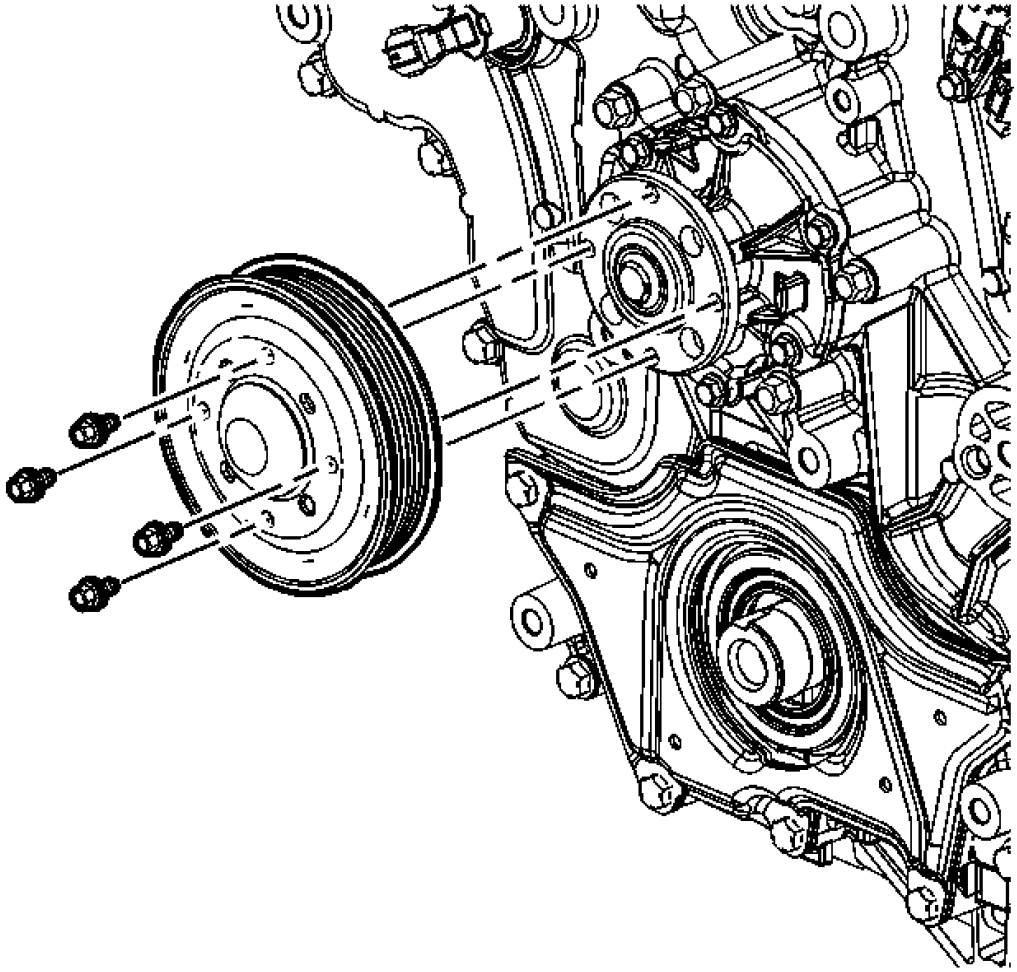


Fig. 115: View Of Water Pump Pulley Bolts
Courtesy of GENERAL MOTORS CORP.

5. Install the water pump pulley.
6. Loosely install the water pump pulley bolts.

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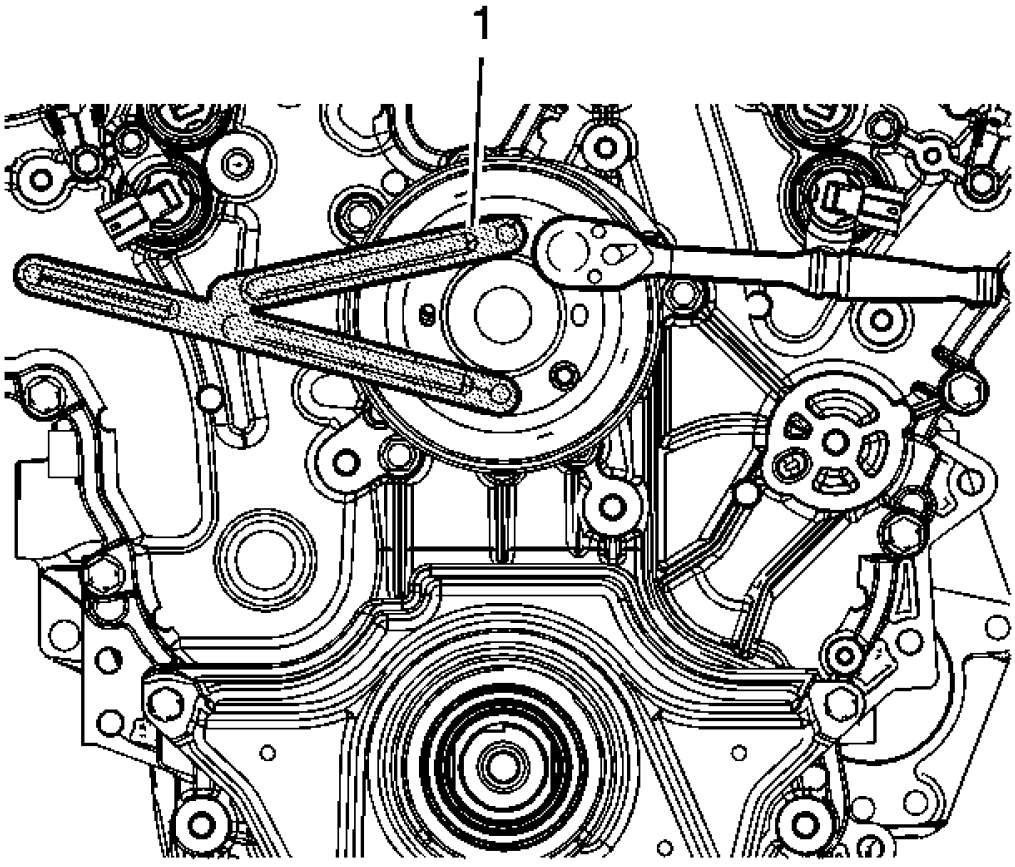


Fig. 116: View Of EN 46104
Courtesy of GENERAL MOTORS CORP.

7. Install the **EN 46104:** tool (1) onto the water pump pulley and tighten the water pump pulley bolts to 10 N.m (89 lb in)

.

CAMSHAFT COVER INSTALLATION - LEFT SIDE (LLT)

Special Tools

- **EN 46101:** Spark Plug Tube Seal Guide
- **EN-48383:** Camshaft Retaining Tools

For equivalent regional tools, refer to **Special Tools** .

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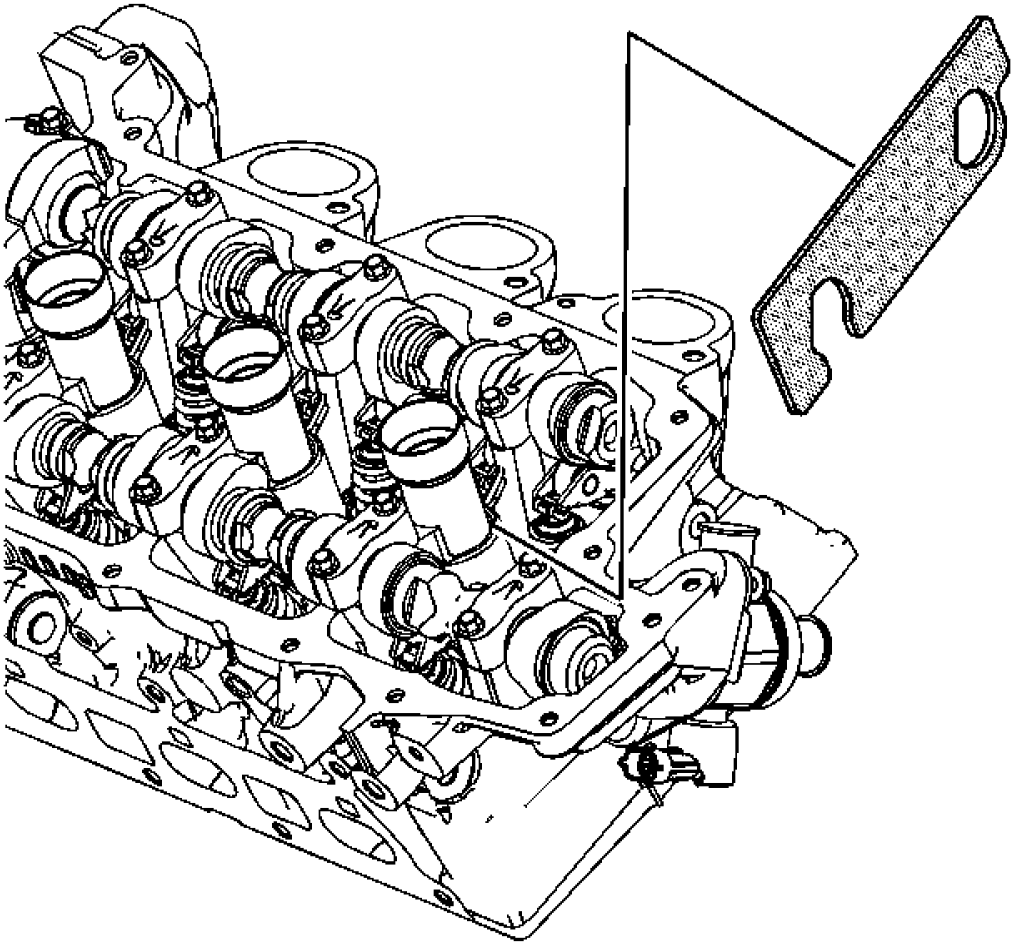


Fig. 117: View Of EN 48383-2 & Camshaft
Courtesy of GENERAL MOTORS CORP.

1. Remove the EN 48383-2 from the rear of the left camshafts.

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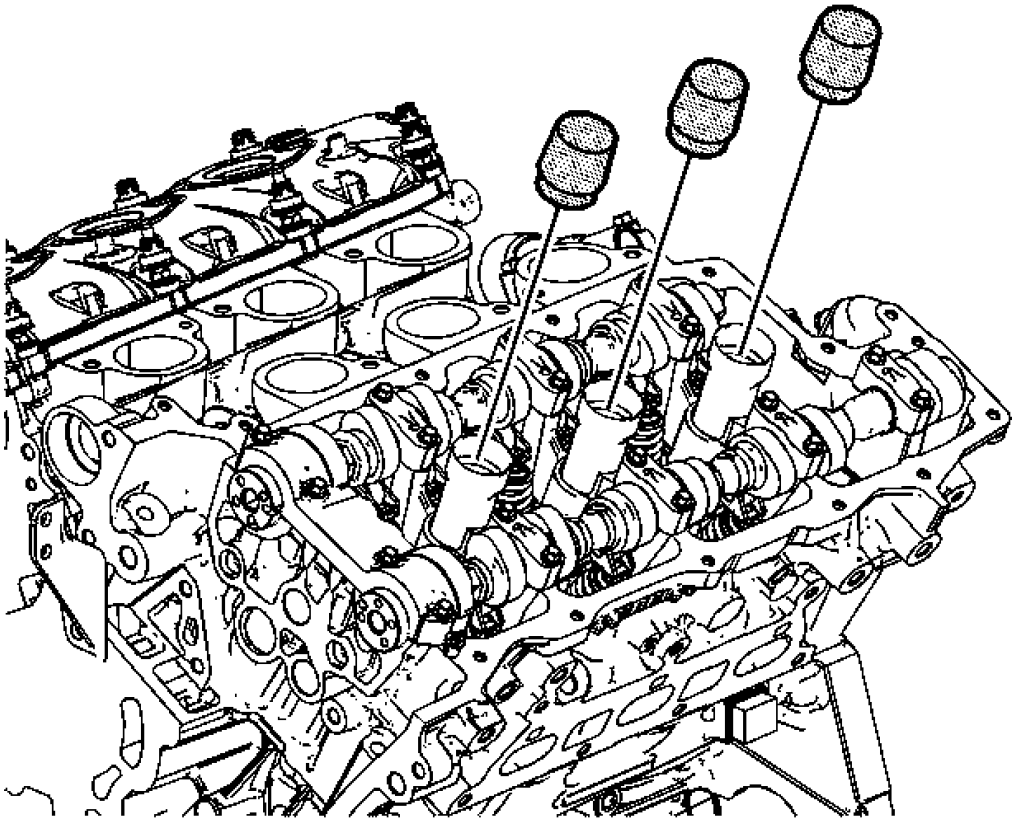


Fig. 118: View Of Spark Plug Tubes & Left Cylinder Head
Courtesy of GENERAL MOTORS CORP.

2. Install the **EN 46101:** guide onto the spark plug tubes of the left cylinder head.

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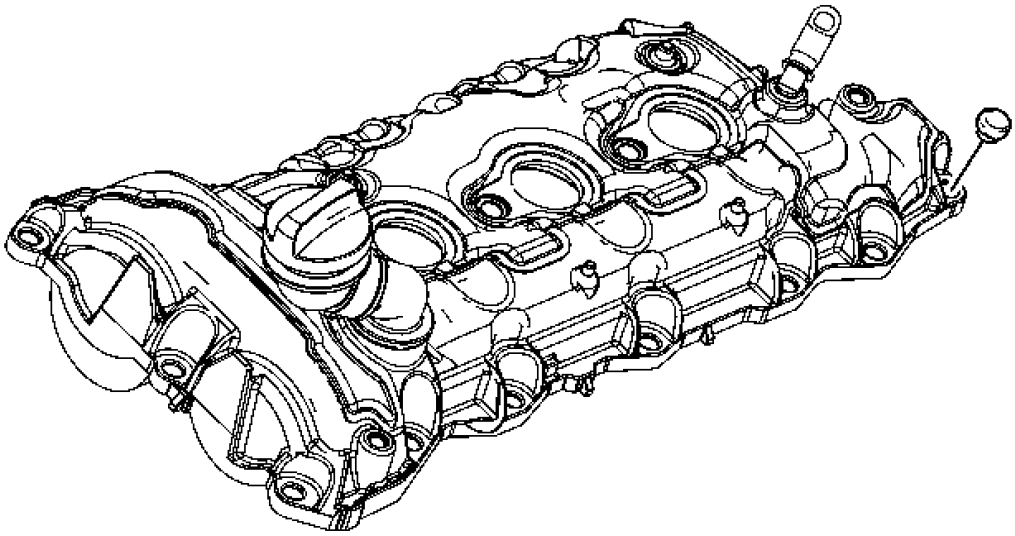


Fig. 119: View of Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

3. Install the NEW camshaft cover bolt grommets prior to installing the camshaft cover bolts.
4. Wipe the camshaft cover sealing surface on the left cylinder head with a clean, lint-free cloth.

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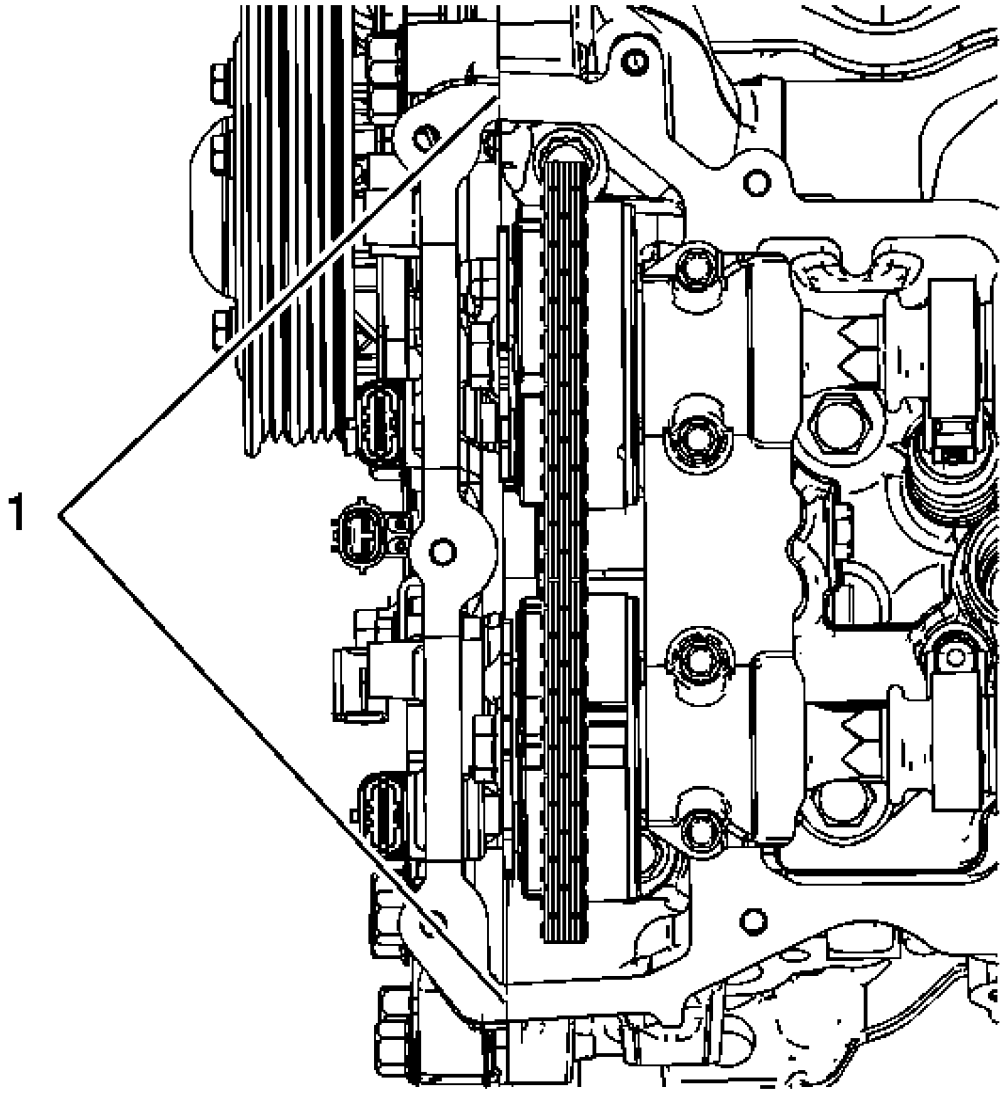


Fig. 120: Locating Engine Front Cover Split Lines
Courtesy of GENERAL MOTORS CORP.

5. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant, GM P/N 12378521 (Canadian P/N 88901148) or equivalent, on the engine front cover split lines (1).

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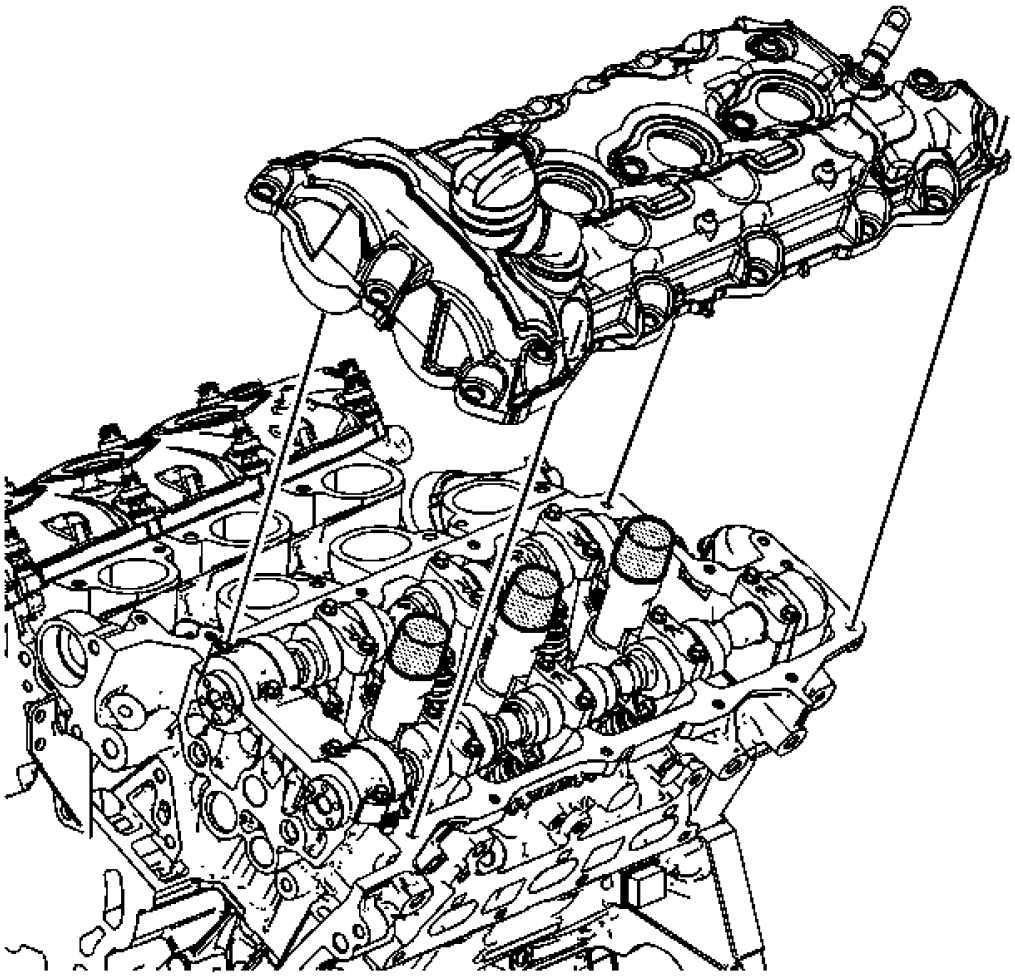


Fig. 121: Removing/Installing Left Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

6. Place the left camshaft cover into position onto the left cylinder head.

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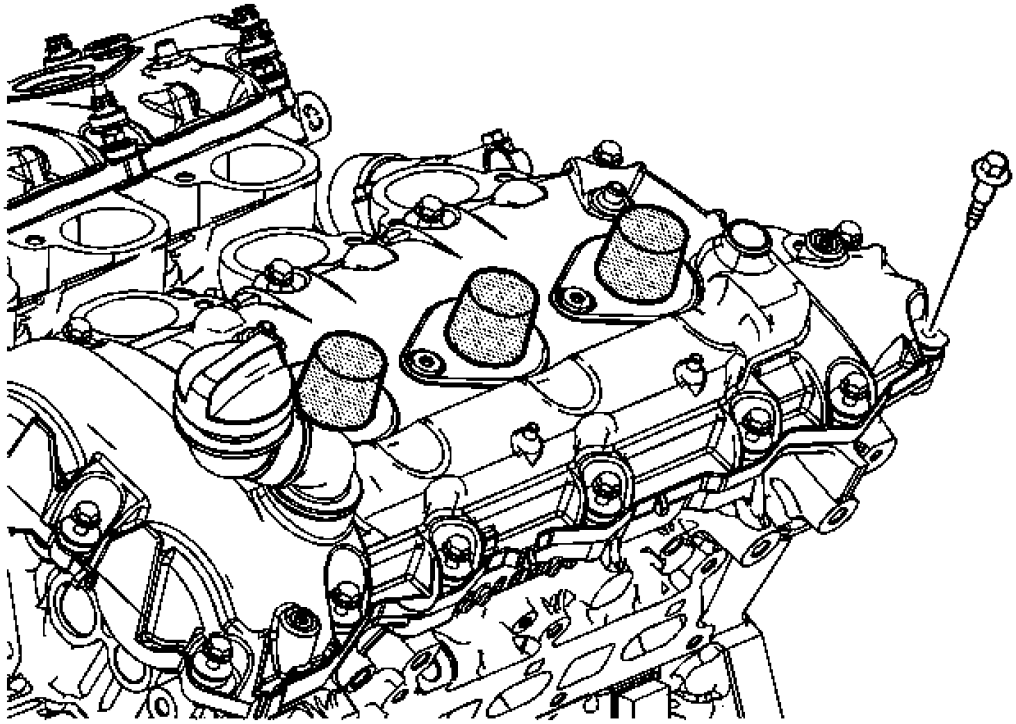


Fig. 122: Removing/Installing Left Camshaft Cover Bolts
Courtesy of GENERAL MOTORS CORP.

7. Loosely install the left camshaft cover bolts.

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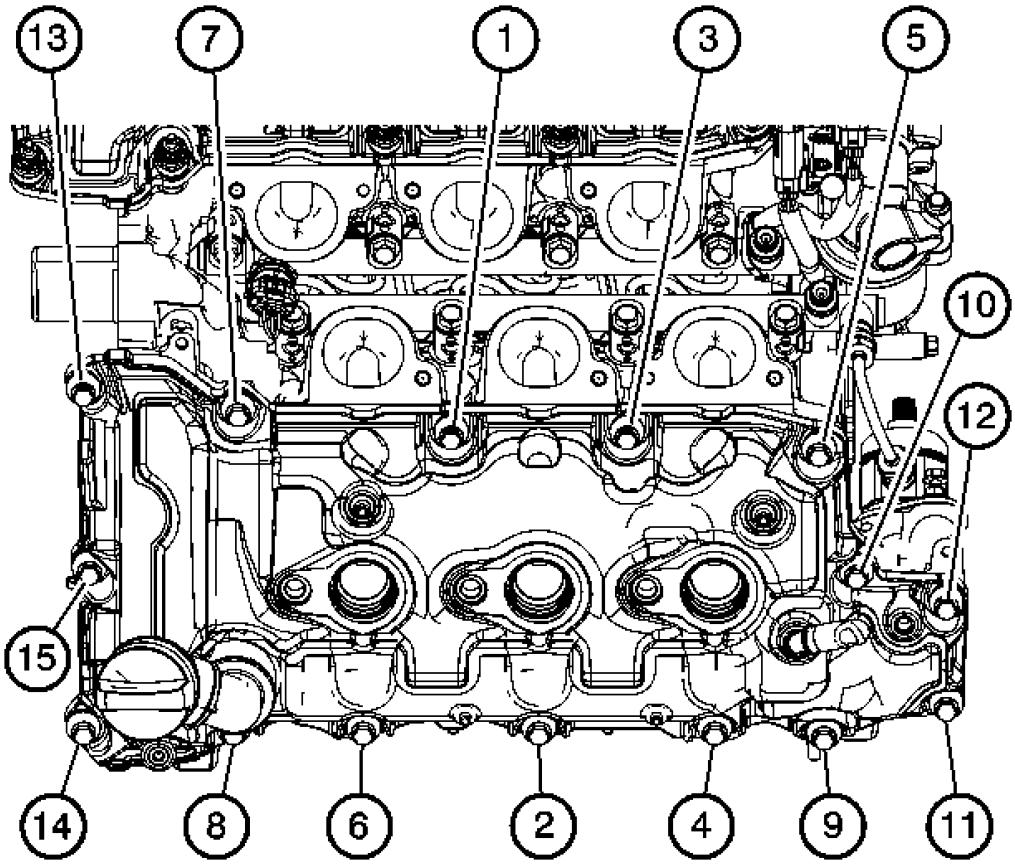


Fig. 123: Identifying Left Camshaft Cover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

8. Tighten the left camshaft cover bolts in the sequence shown.
    1. Tighten the left camshaft cover bolts in the sequence to 10 N.m (89 lb in).
    2. Tighten the left camshaft cover bolts a second pass in the sequence to 10 N.m (89 lb in) .

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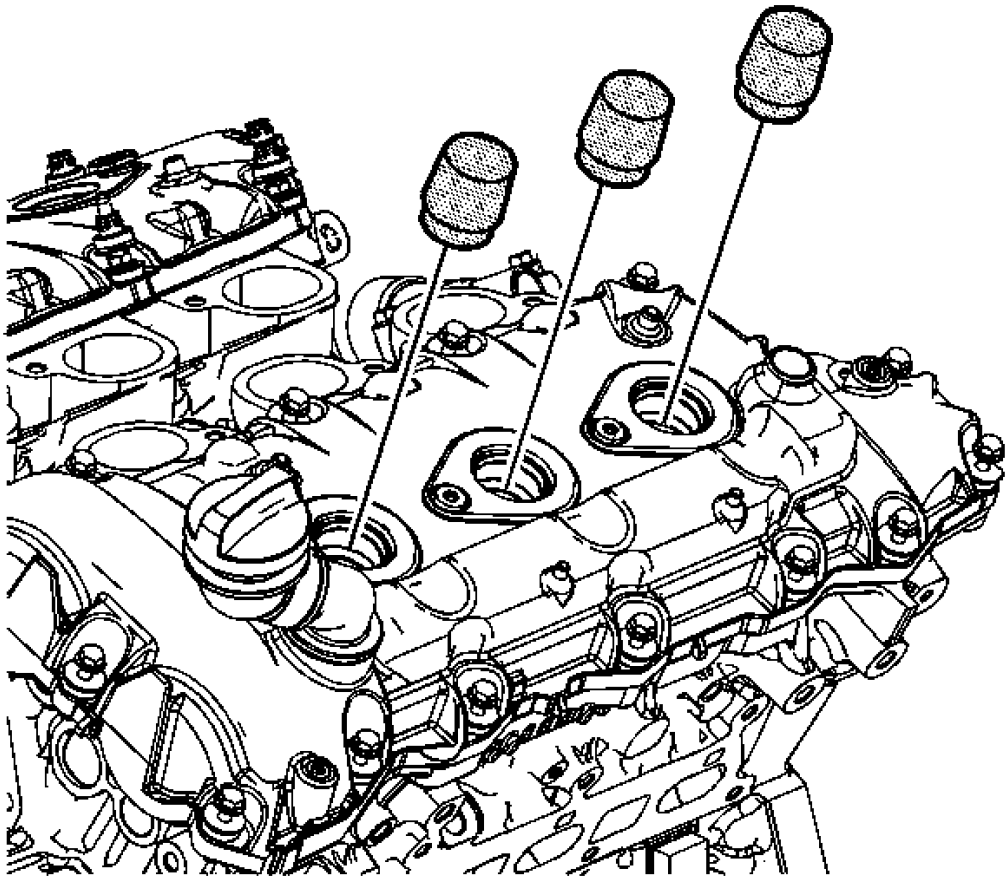


Fig. 124: Removing/Installing EN 46101 From Spark Plug Tubes
Courtesy of GENERAL MOTORS CORP.

9. Remove the **EN 46101:** guide from the spark plug tubes of the left cylinder head.

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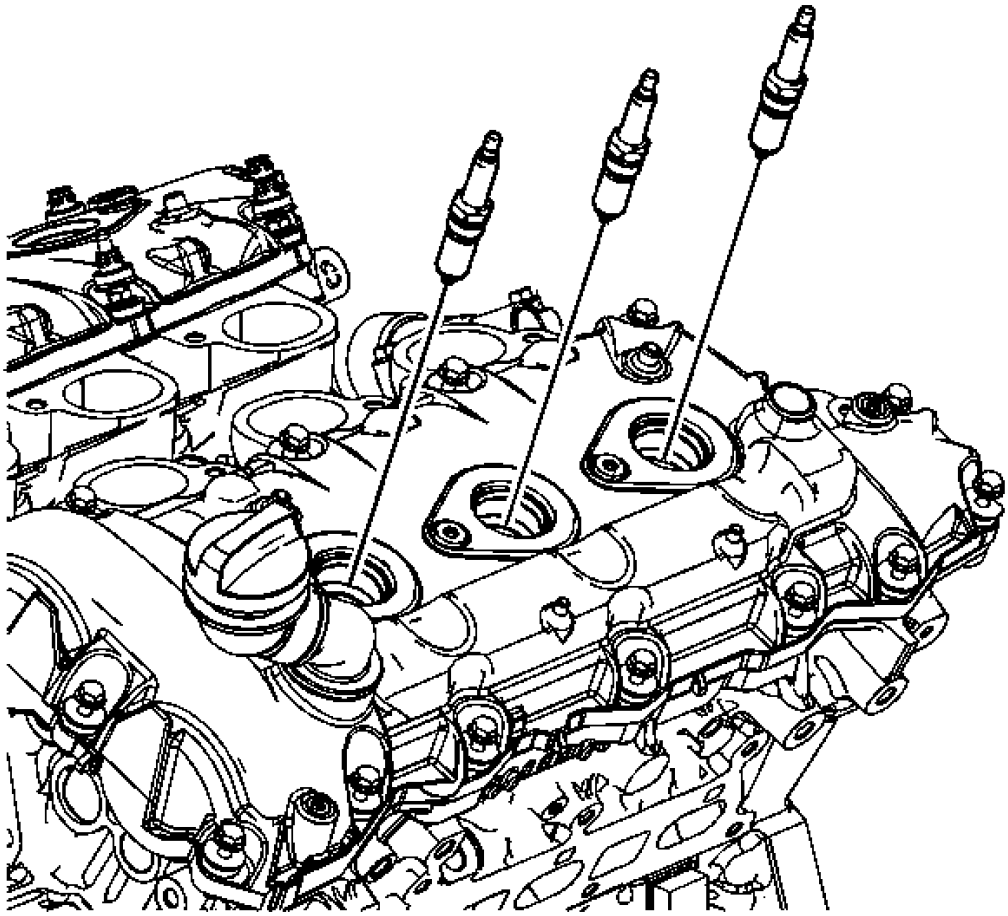


Fig. 125: Spark Plugs
Courtesy of GENERAL MOTORS CORP.

10. Install the NEW spark plugs into the left cylinder head and tighten to 20 N.m (15 lb ft)..

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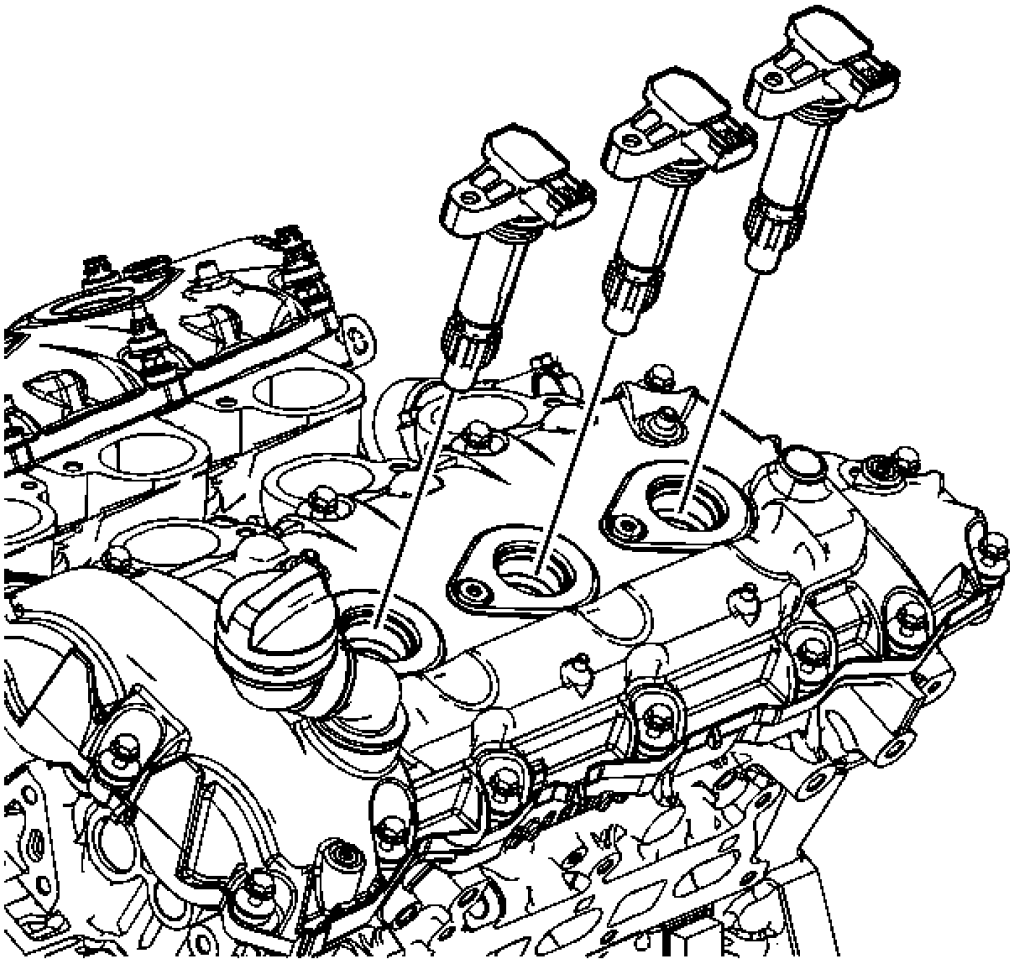


Fig. 126: Ignition Coils
Courtesy of GENERAL MOTORS CORP.

11. Install the ignition coils.

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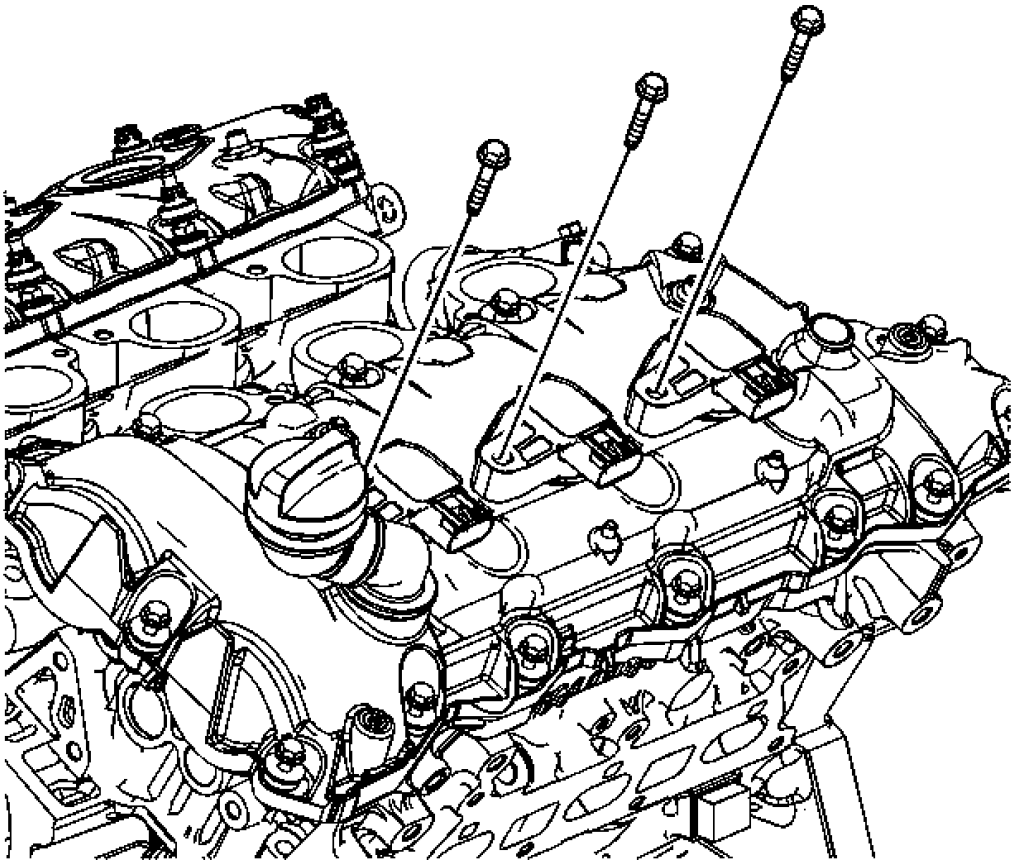


Fig. 127: Ignition Coil Bolts
Courtesy of GENERAL MOTORS CORP.

12. Install the ignition coil bolts and tighten to 10 N.m (89 lb in).

CAMSHAFT COVER INSTALLATION - RIGHT SIDE

Special Tools

EN-46101: Spark Plug Tube Seal Guide

For equivalent regional tools, refer to **Special Tools** .

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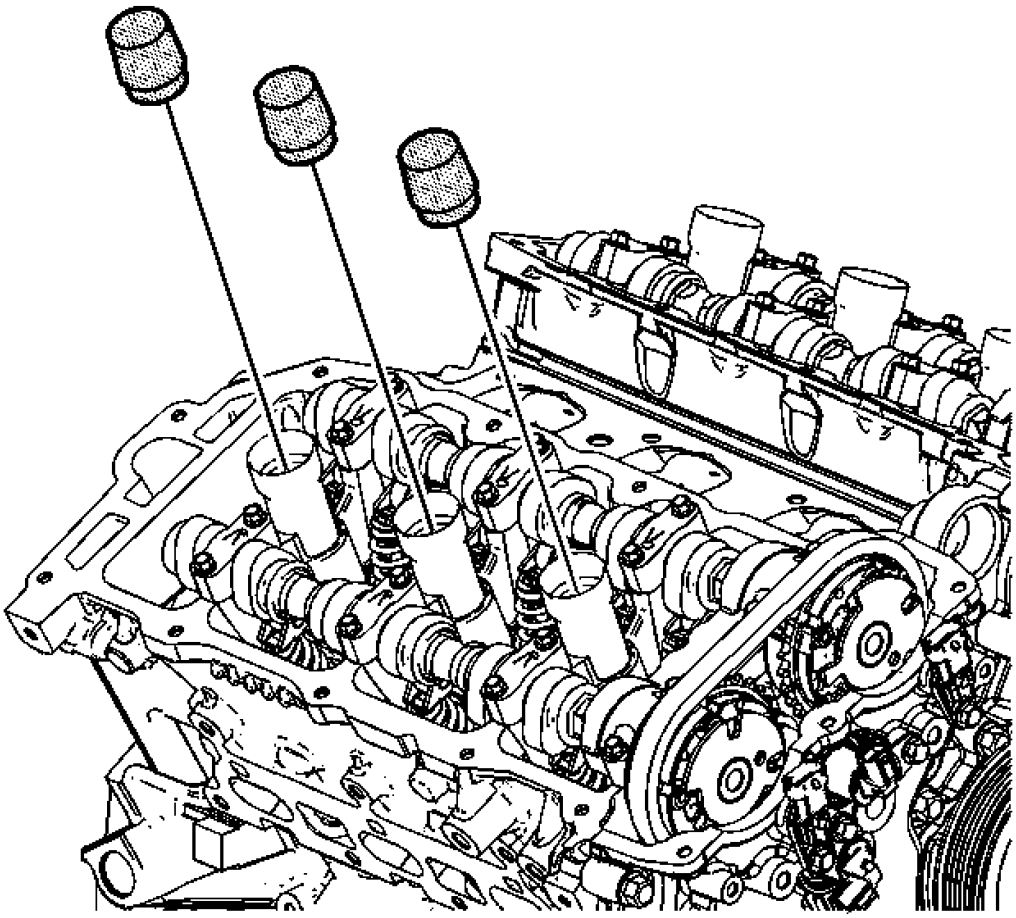


Fig. 128: Installing EN 46101 Onto Spark Plug Tubes
Courtesy of GENERAL MOTORS CORP.

1. Install the **EN-46101:** guide onto the spark plug tubes of the right cylinder head.

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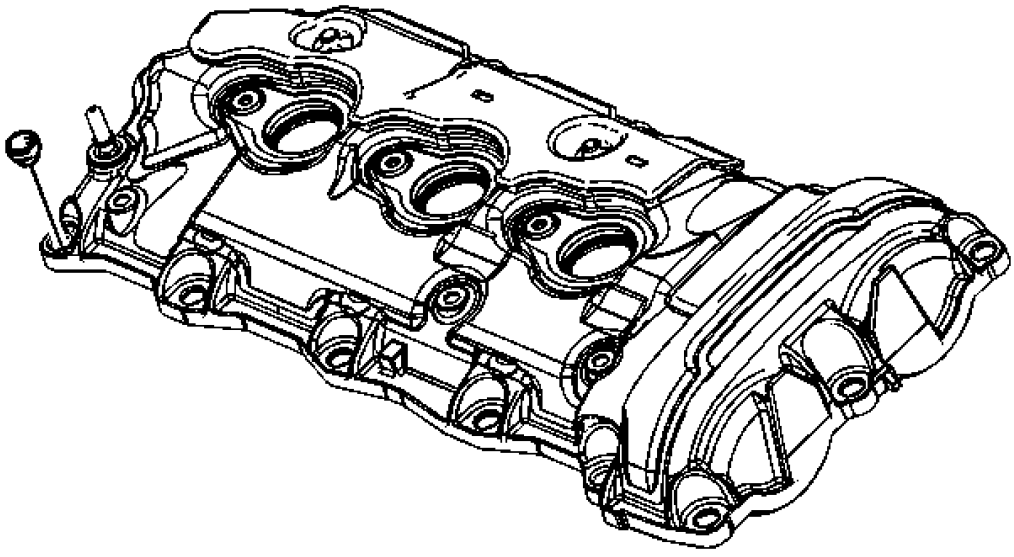


Fig. 129: View Of Right Camshaft Cover Bolt
Courtesy of GENERAL MOTORS CORP.

2. Install the NEW camshaft cover bolt grommets prior to installing the camshaft cover bolts.
3. Wipe the camshaft cover sealing surface on the right cylinder head with a clean, lint-free cloth.

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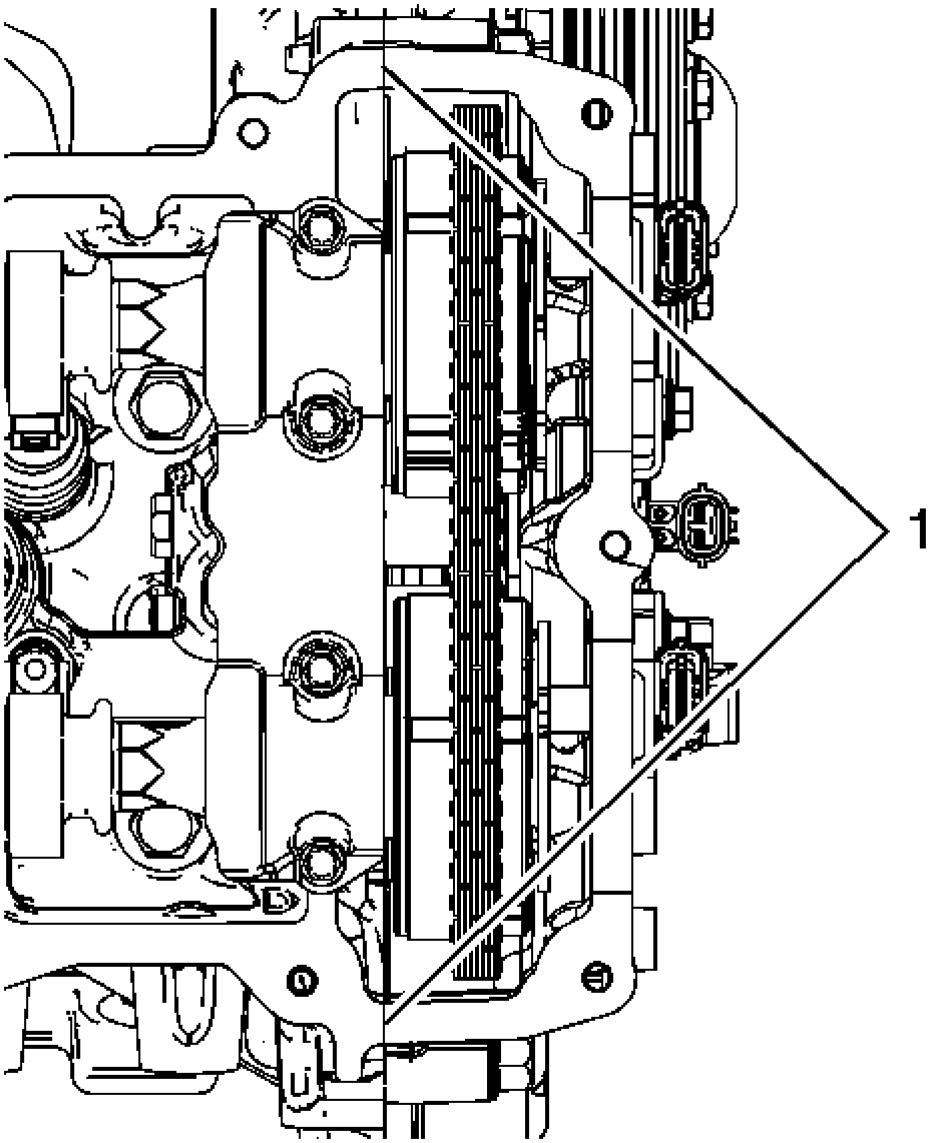


Fig. 130: Identifying Engine Front Cover Split Lines
Courtesy of GENERAL MOTORS CORP.

4. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant on the engine front cover split lines (1). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

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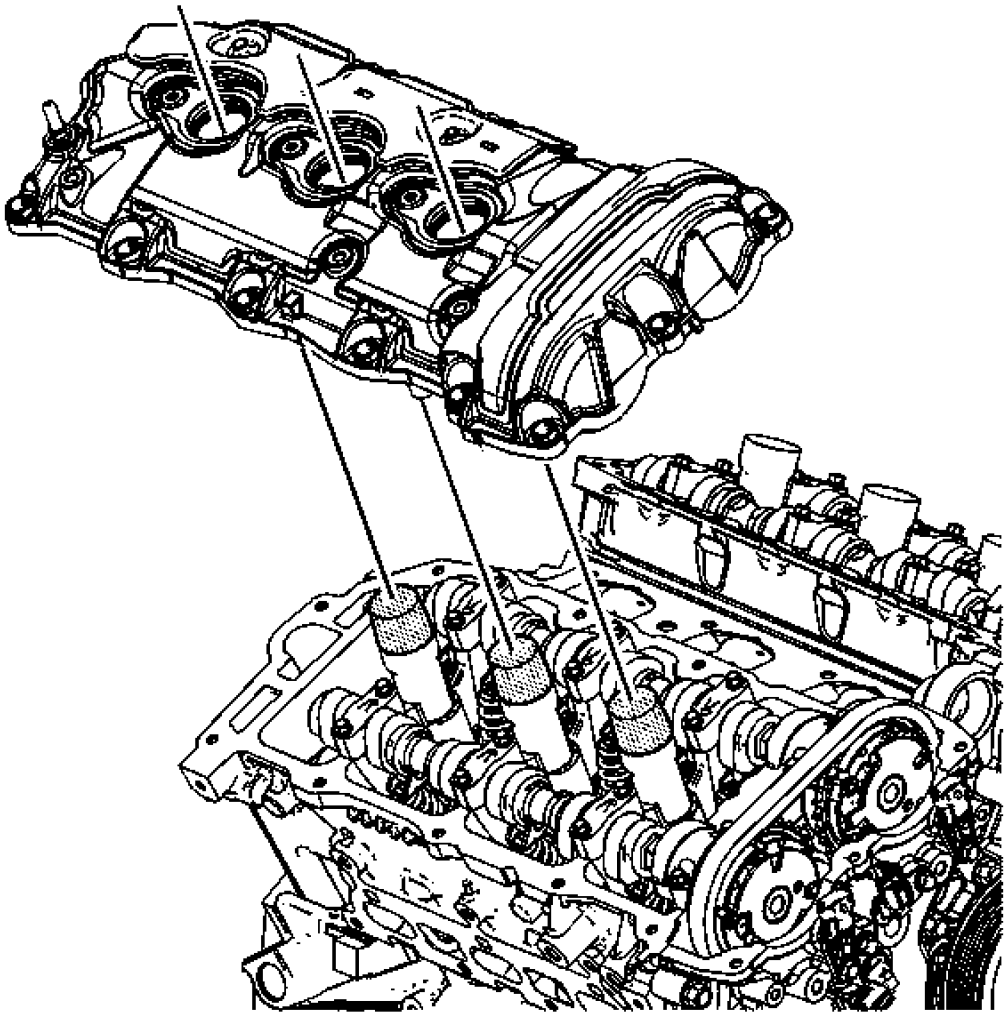


Fig. 131: View Of Right Camshaft Cover
Courtesy of GENERAL MOTORS CORP.

5. Place the right camshaft cover into position onto the right cylinder head.

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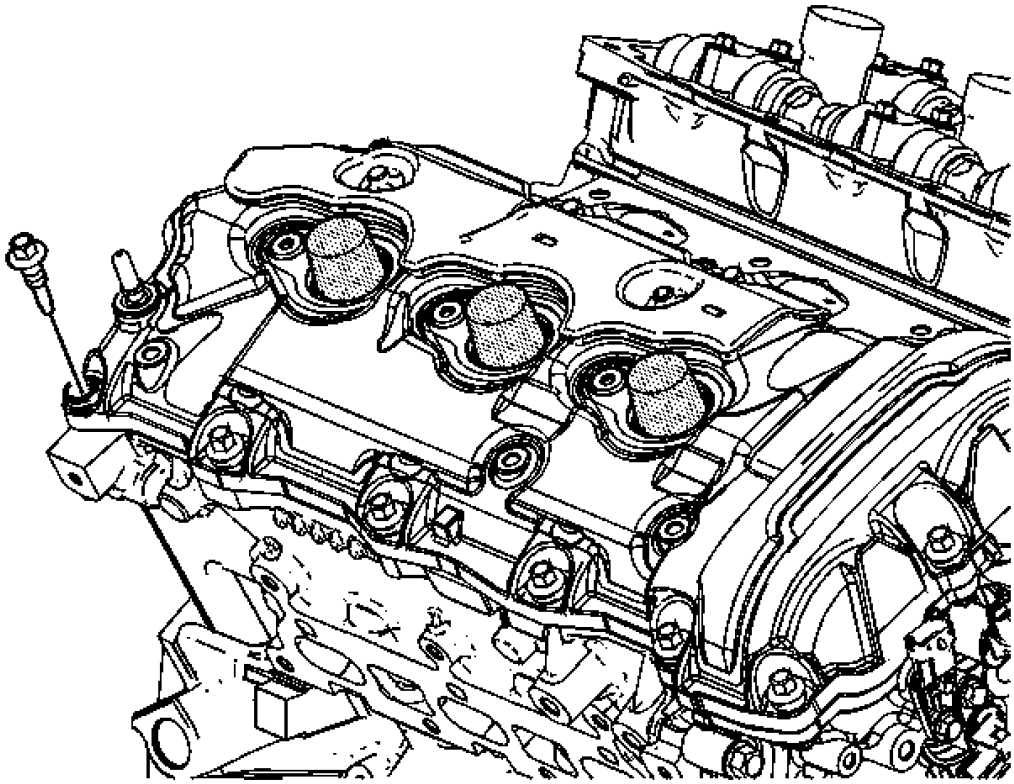


Fig. 132: View Of Right Camshaft Cover Bolts
Courtesy of GENERAL MOTORS CORP.

6. Loosely install the right camshaft cover bolts.

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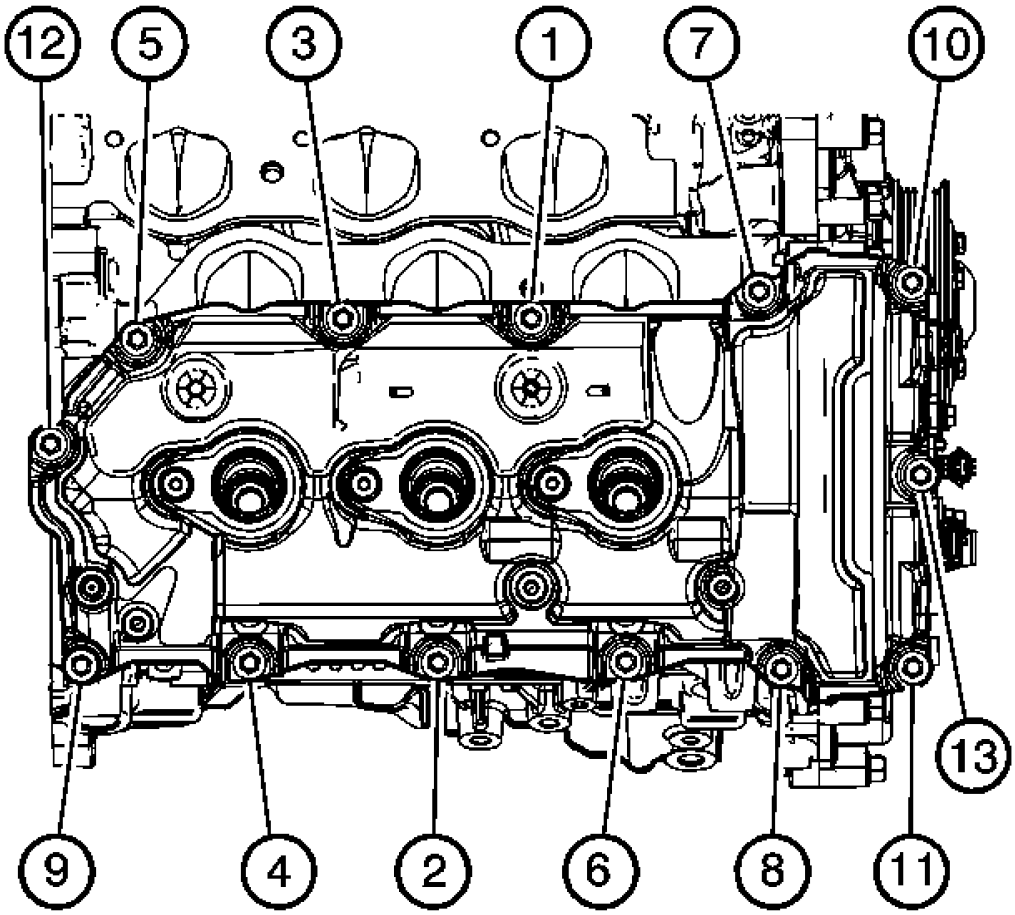


Fig. 133: Identifying Right Camshaft Cover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

7. Tighten the right camshaft cover bolts in the sequence shown.
   - Tighten the right camshaft cover bolts to 10 N.m (89 lb in) .
   - Tighten the right camshaft cover bolts a second pass to 10 N.m (89 lb in) .

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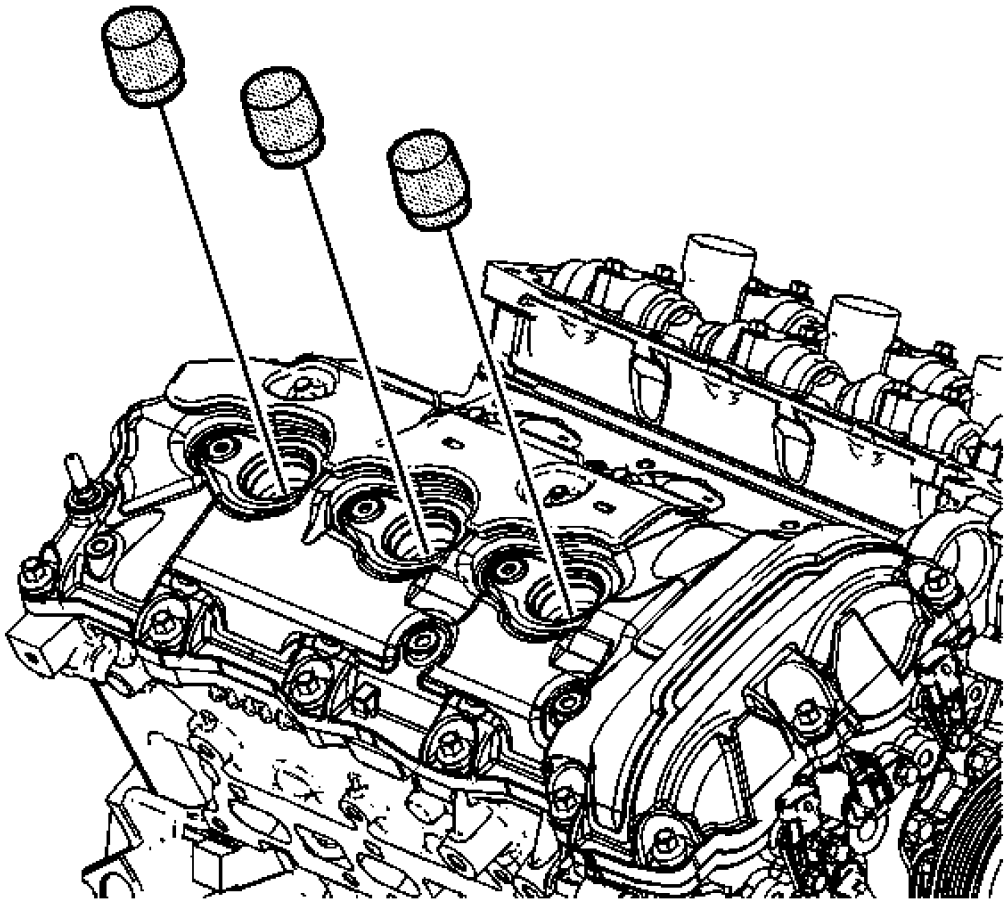


Fig. 134: View Of Spark Plug Tube Guides
Courtesy of GENERAL MOTORS CORP.

8. Remove the **EN-46101:** guide from the spark plug tubes of the right cylinder head.

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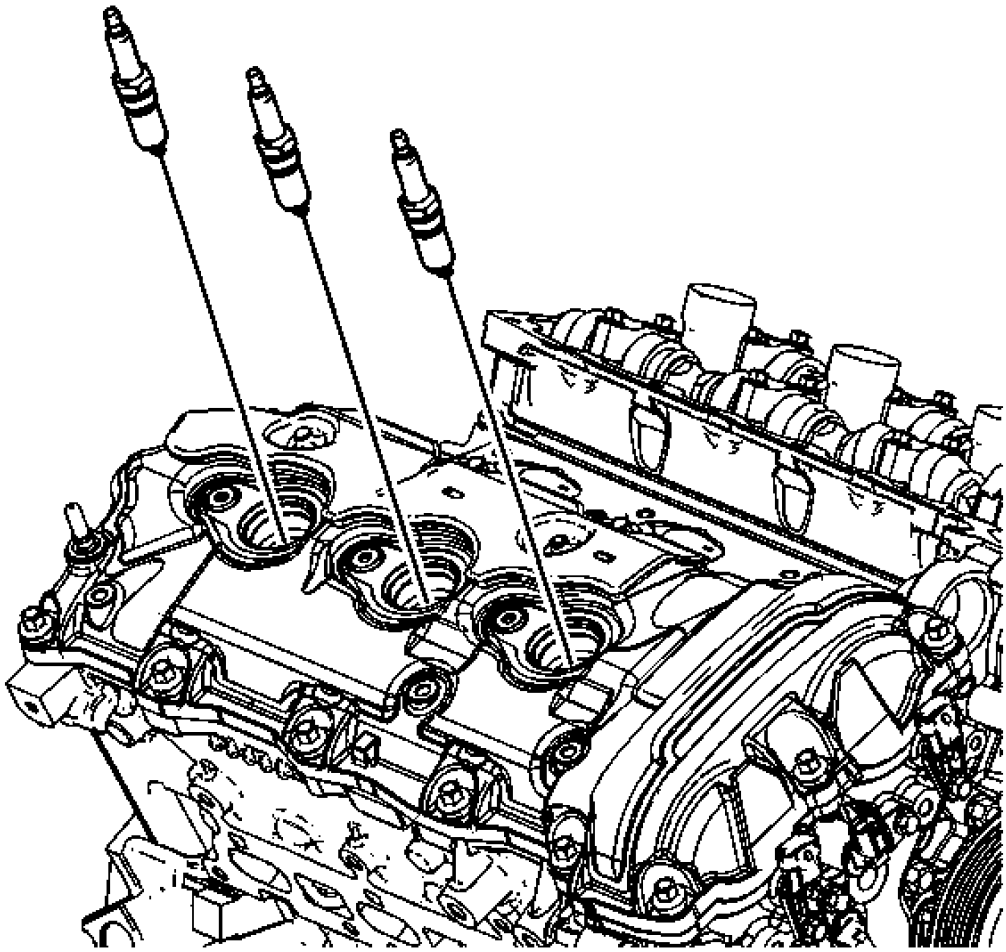


Fig. 135: View Of Spark Plugs
Courtesy of GENERAL MOTORS CORP.

9. Install the NEW spark plugs into the right cylinder head and tighten to 18 N.m (13 lb ft).

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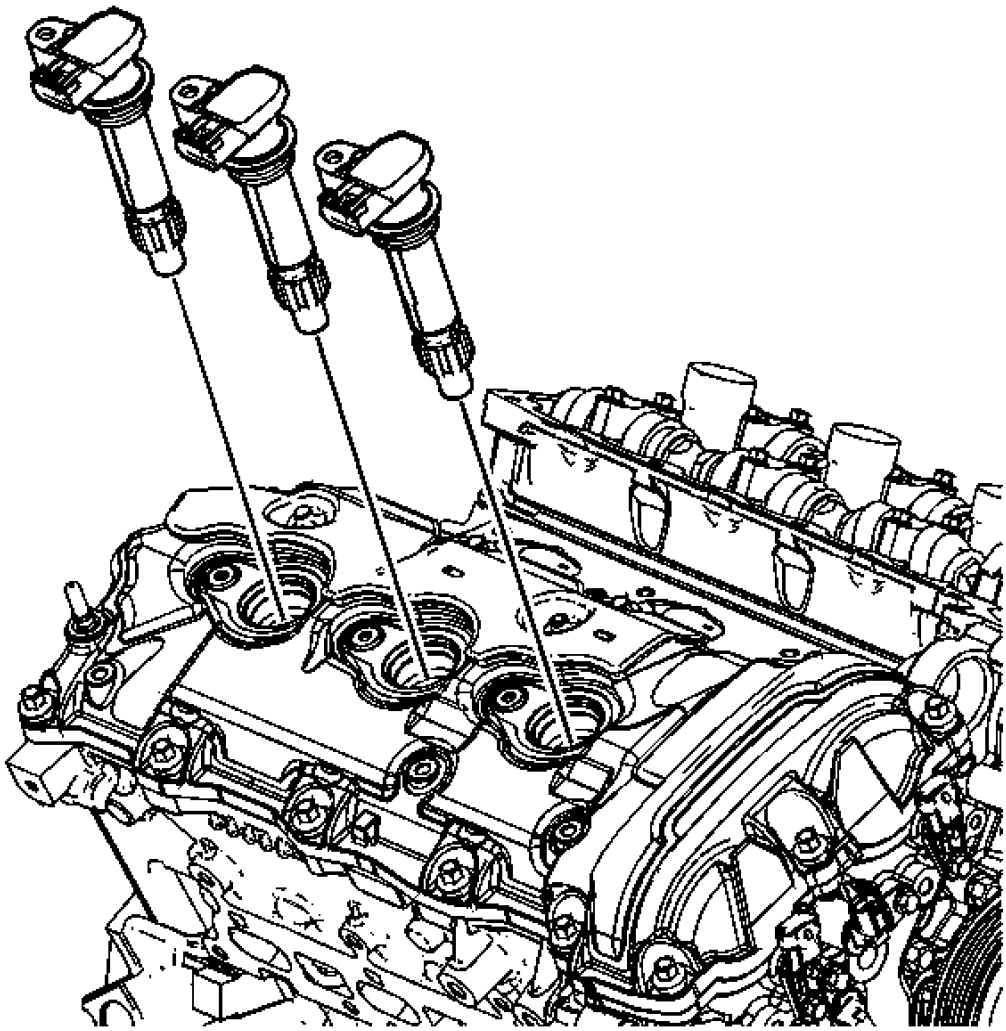


Fig. 136: View Of Ignition Coils
Courtesy of GENERAL MOTORS CORP.

10. Install the ignition coils.

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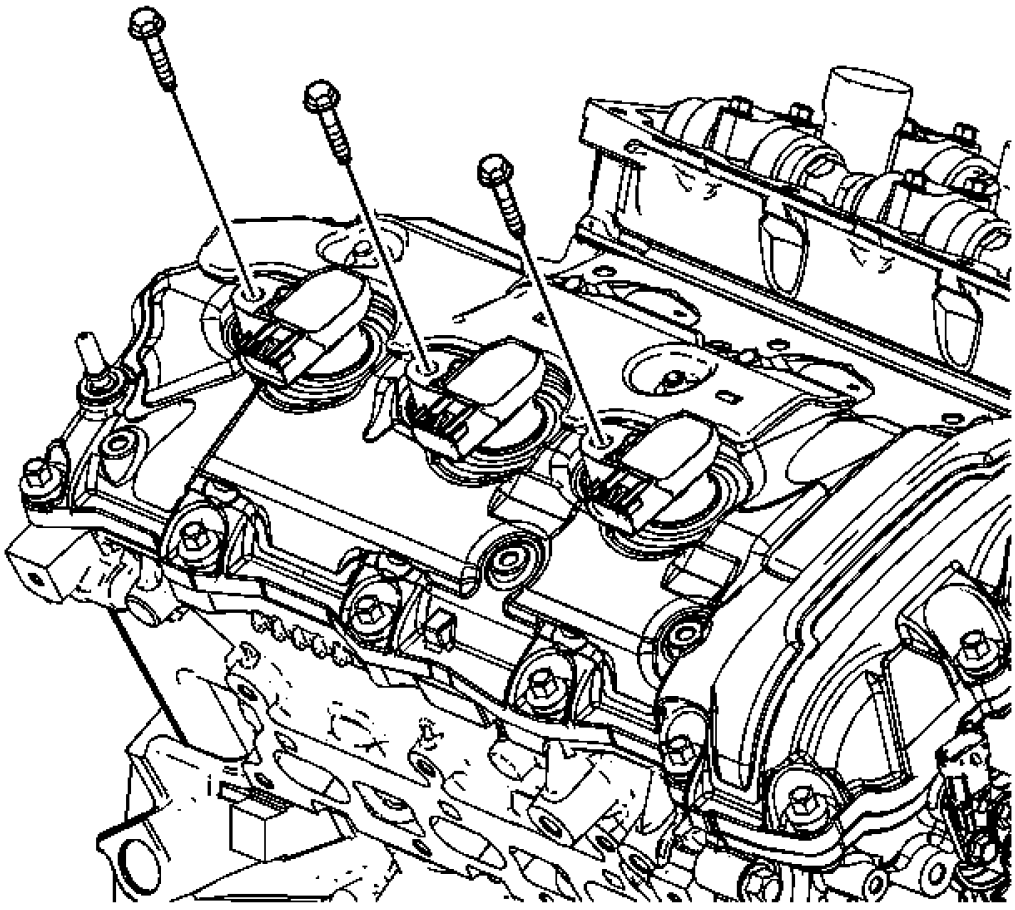


Fig. 137: Ignition Coil Bolts
Courtesy of GENERAL MOTORS CORP.

11. Install the ignition coil bolts and tighten to 10 N.m (89 lb in).

INTAKE MANIFOLD INSTALLATION (LLT)

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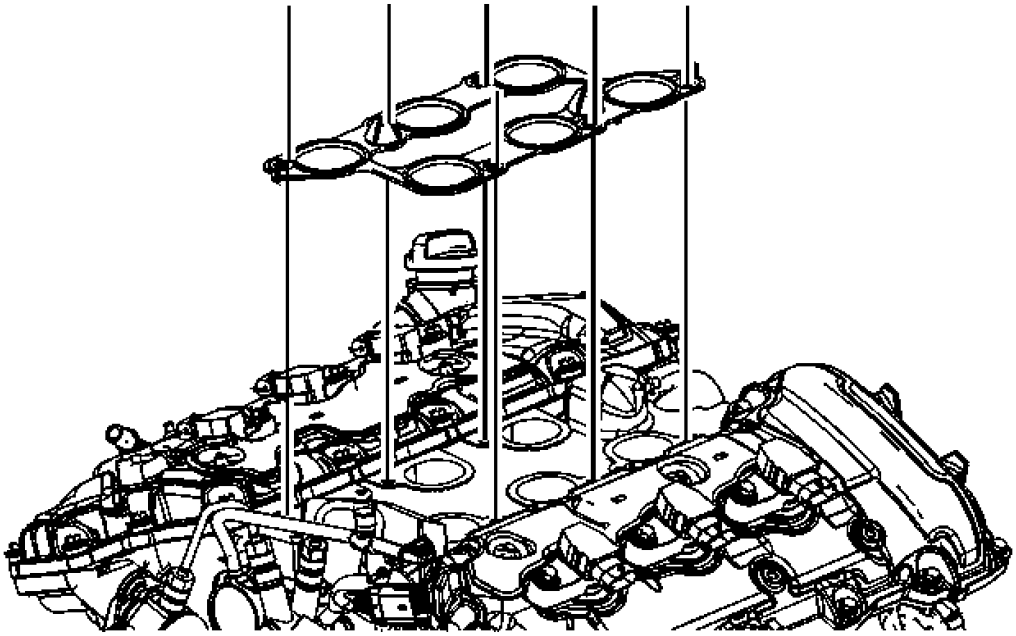


Fig. 138: Removing/Installing Intake Manifold Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install the NEW intake manifold gasket.

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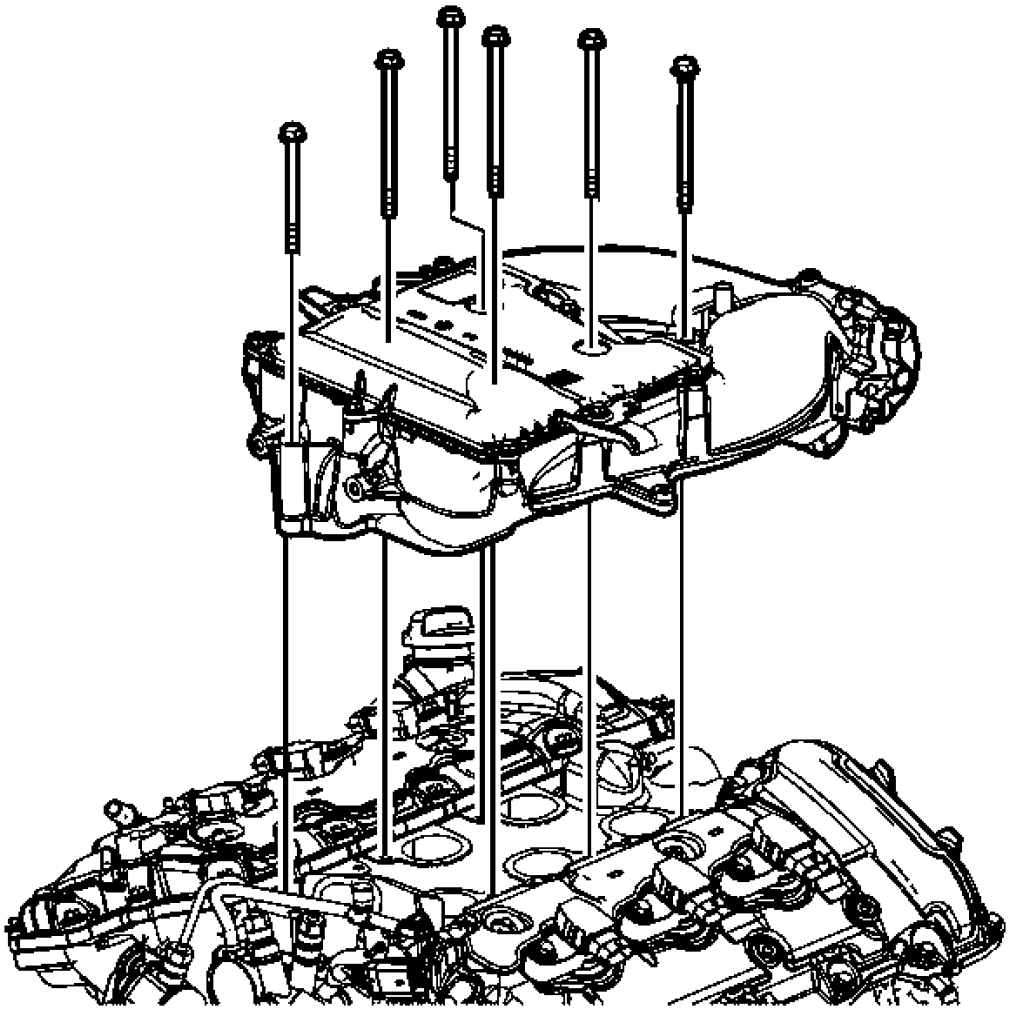


Fig. 139: View Of Intake Manifold Assembly
Courtesy of GENERAL MOTORS CORP.

2. Install the intake manifold assembly.
3. Install the intake manifold bolts.

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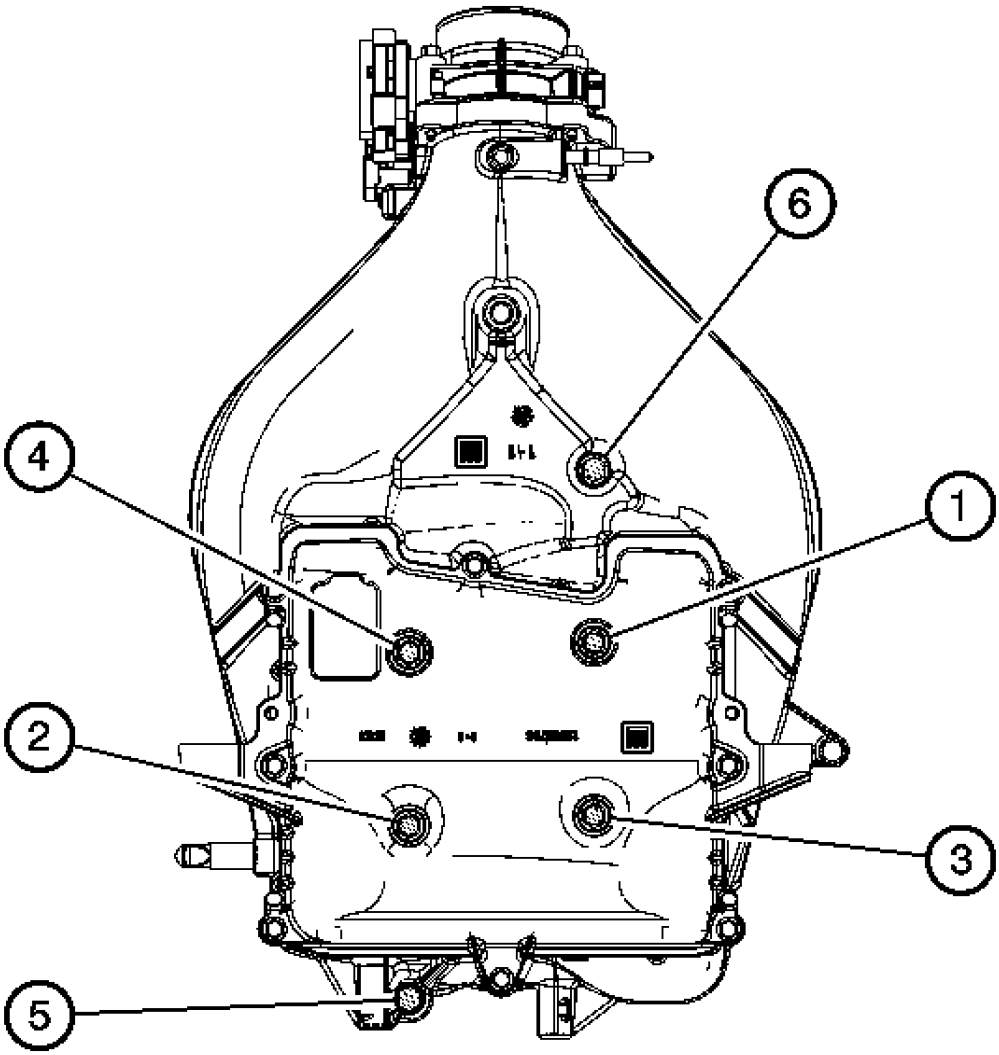


Fig. 140: Identifying Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

4. Tighten the intake manifold bolts in the sequence shown (1-6).
    1. Tighten the intake manifold bolts in sequence to 25 N.m (18 lb ft) .
    2. Tighten the intake manifold bolts a second pass in sequence to 25 N.m (18 lb ft) .

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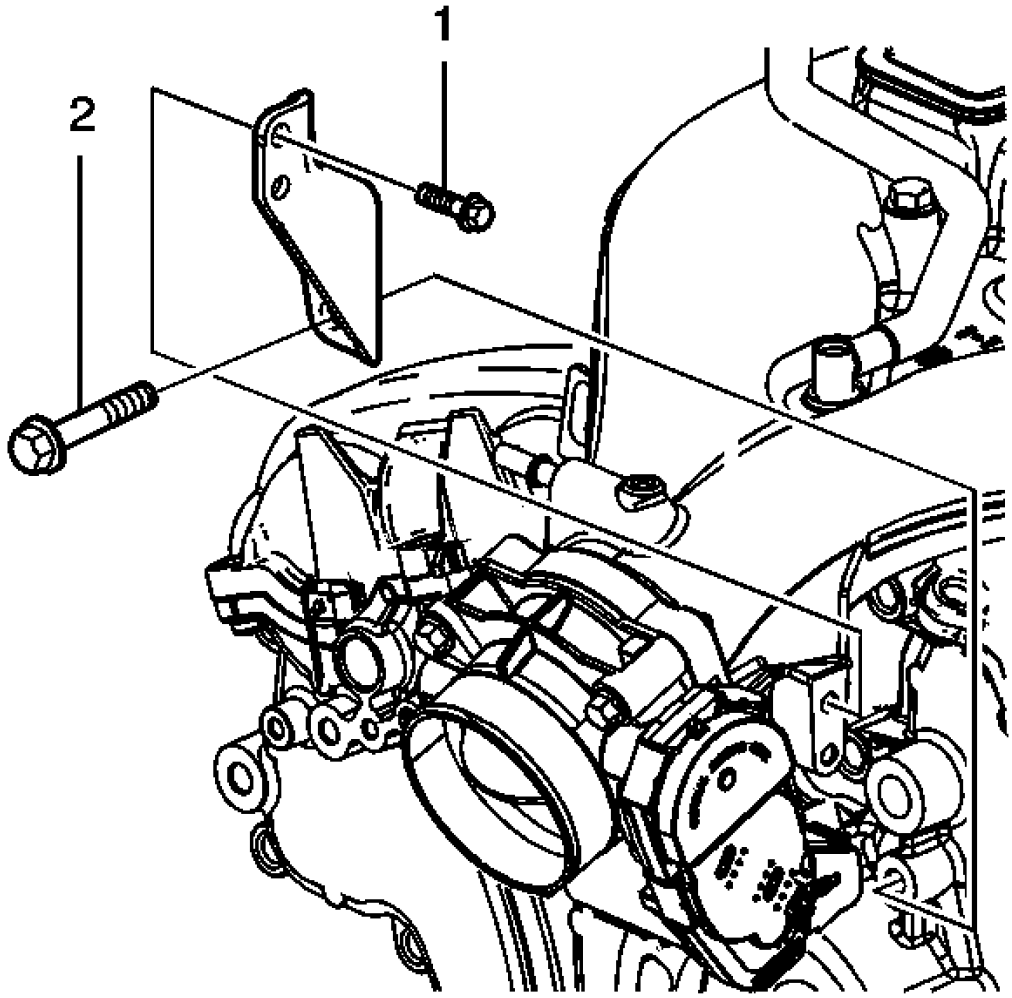


Fig. 141: Intake Manifold Brace
Courtesy of GENERAL MOTORS CORP.

5. Place the intake manifold brace to the engine front cover and intake manifold.
6. Loosely install the bolts.
7. First tighten the intake manifold brace bolt (1) to the intake manifold and tighten to 10 N.m (89 lb in).
8. Finally tighten the intake manifold brace bolt (2) to the engine front cover and tighten to 65 N.m (48 lb ft).

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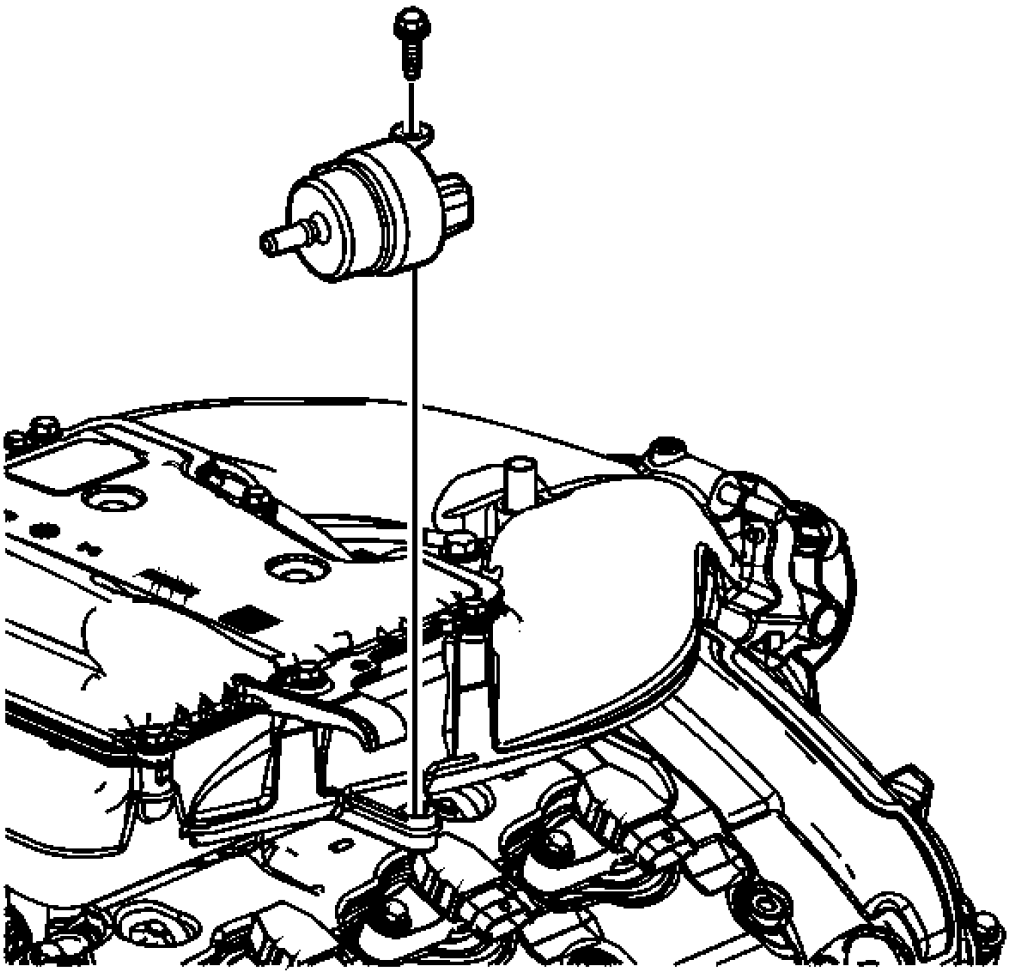


Fig. 142: View Of EVAP Solenoid
Courtesy of GENERAL MOTORS CORP.

9. Install the evaporative (EVAP) solenoid.
10. Install the EVAP solenoid bolt and tighten to 10 N.m (89 lb in)

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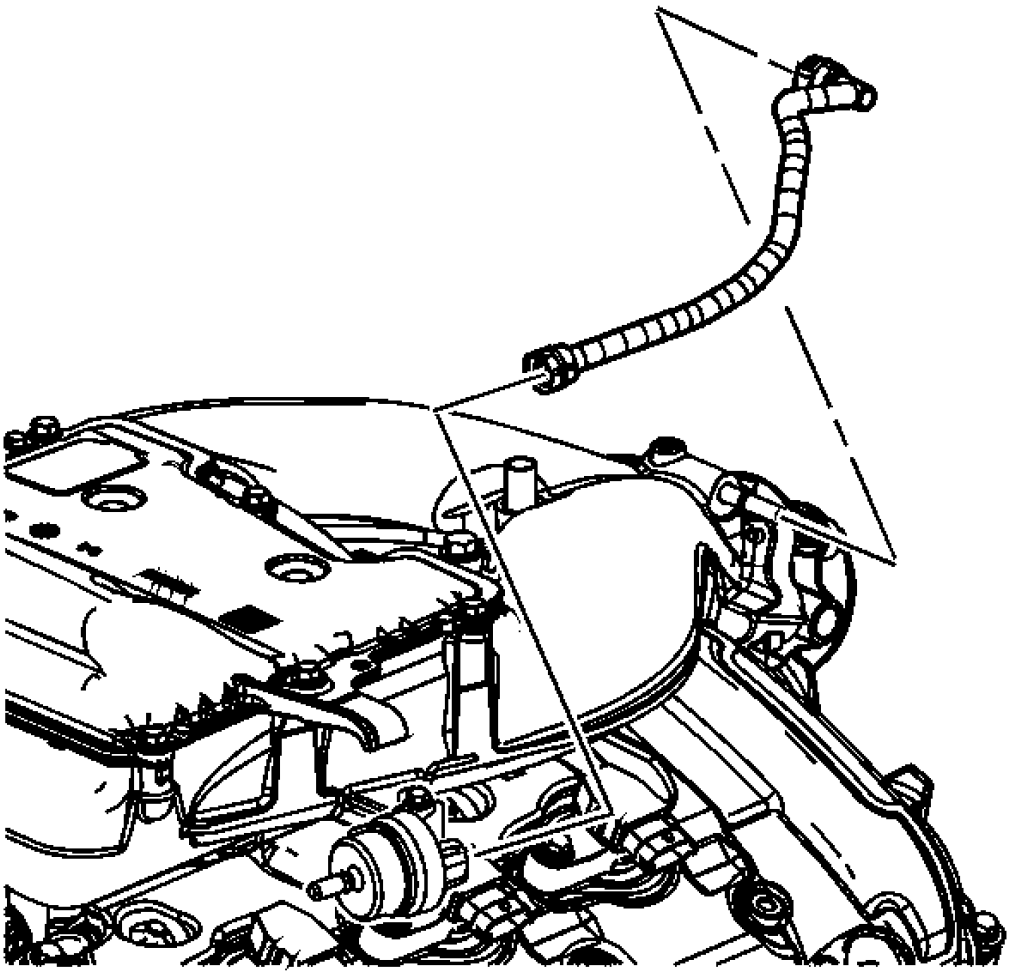


Fig. 143: EVAP Hose
Courtesy of GENERAL MOTORS CORP.

11. Connect the EVAP hose to the upper intake manifold and EVAP solenoid.

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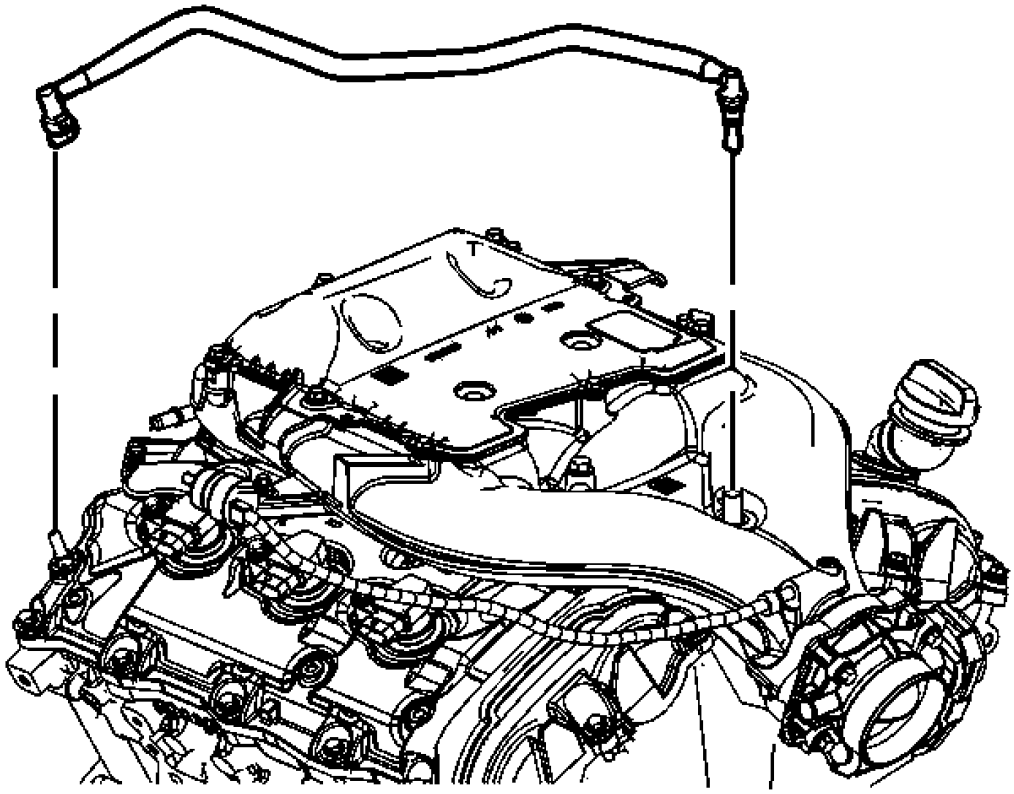


Fig. 144: View Of Positive Crankcase Ventilation Tube
Courtesy of GENERAL MOTORS CORP.

12. Connect the positive crankcase ventilation (PCV) tube assembly to the upper intake manifold and the right camshaft cover.
13. Install the PCV tube assembly bracket bolts and tighten to 10 N.m (89 lb in).

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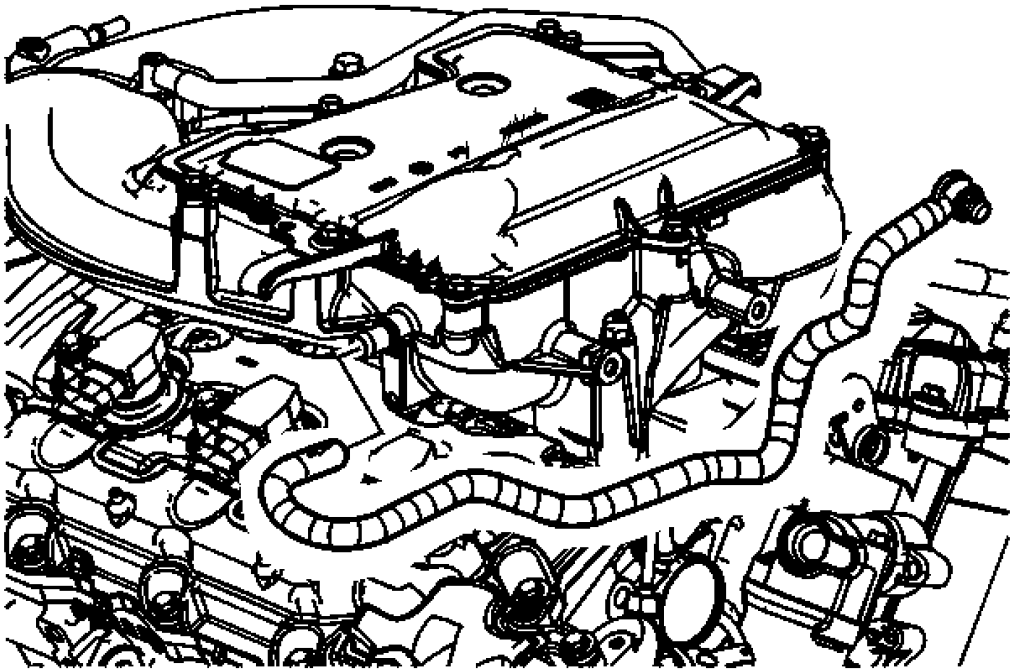


Fig. 145: View Of Brake Booster Hose
Courtesy of GENERAL MOTORS CORP.

14. Install the brake booster hose to the upper intake manifold.

ENGINE FLYWHEEL INSTALLATION

Special Tools

- **EN 46106:** Engine Flywheel Holding Tool
- **J 45059:** Angle Meter

For equivalent regional tools, refer to **Special Tools**

1. Place the engine flywheel in position on the crankshaft.
2. Install 2 NEW bolts in location at the top and bottom of the engine flywheel bolt pattern allowing the engine flywheel to hang in position.

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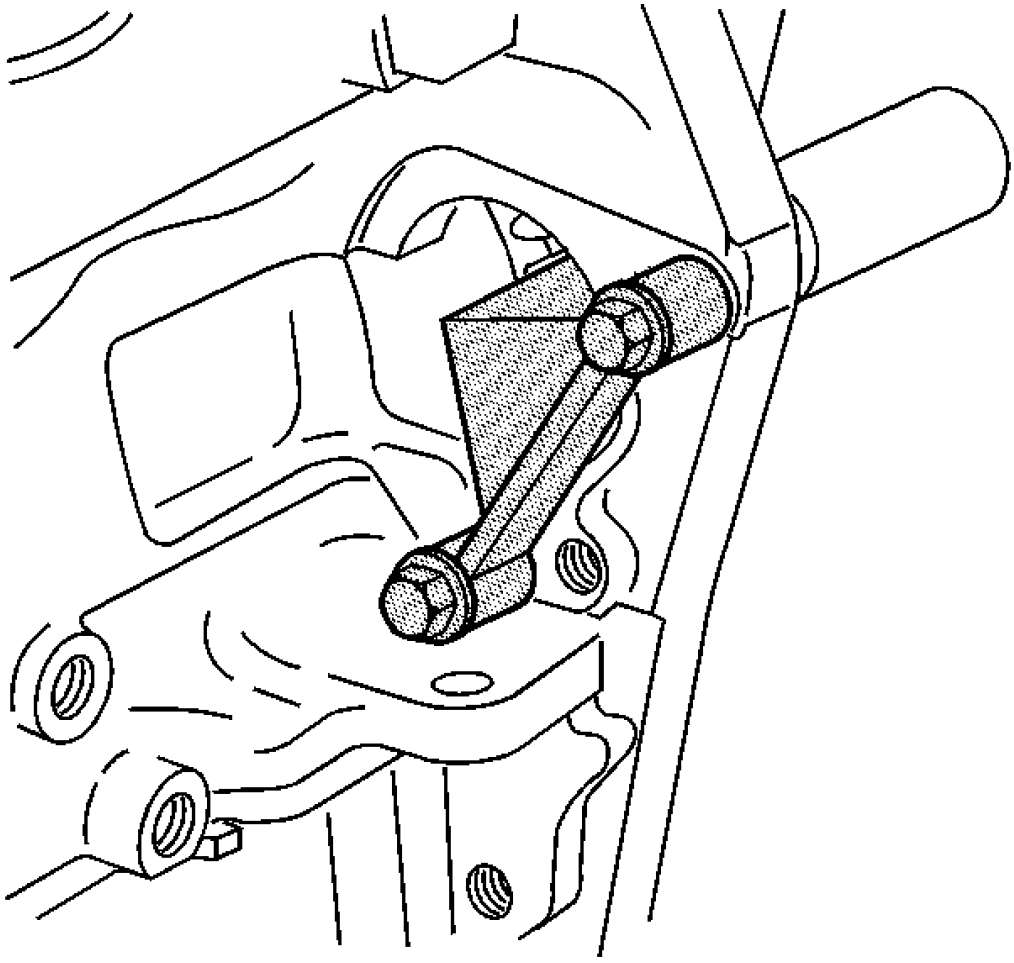


Fig. 146: View Of Special Tool EN 46106
Courtesy of GENERAL MOTORS CORP.

3. Install the **EN 46106:** tool.

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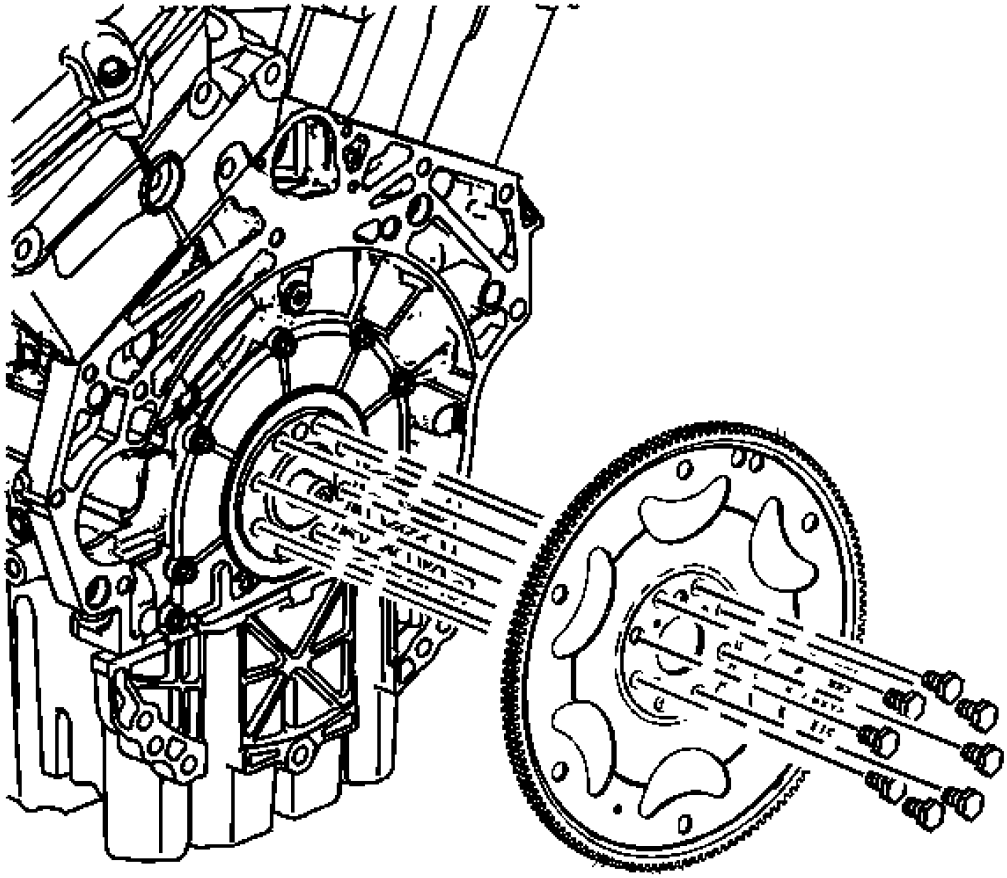


Fig. 147: View Of Engine Flywheel Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

4. Install the remaining NEW engine flywheel bolts.
   - Tighten the NEW engine flywheel bolts to 30 N.m (22 lb ft) .
   - Tighten the NEW engine flywheel bolts an additional 45 degrees using the **J 45059:** meter .

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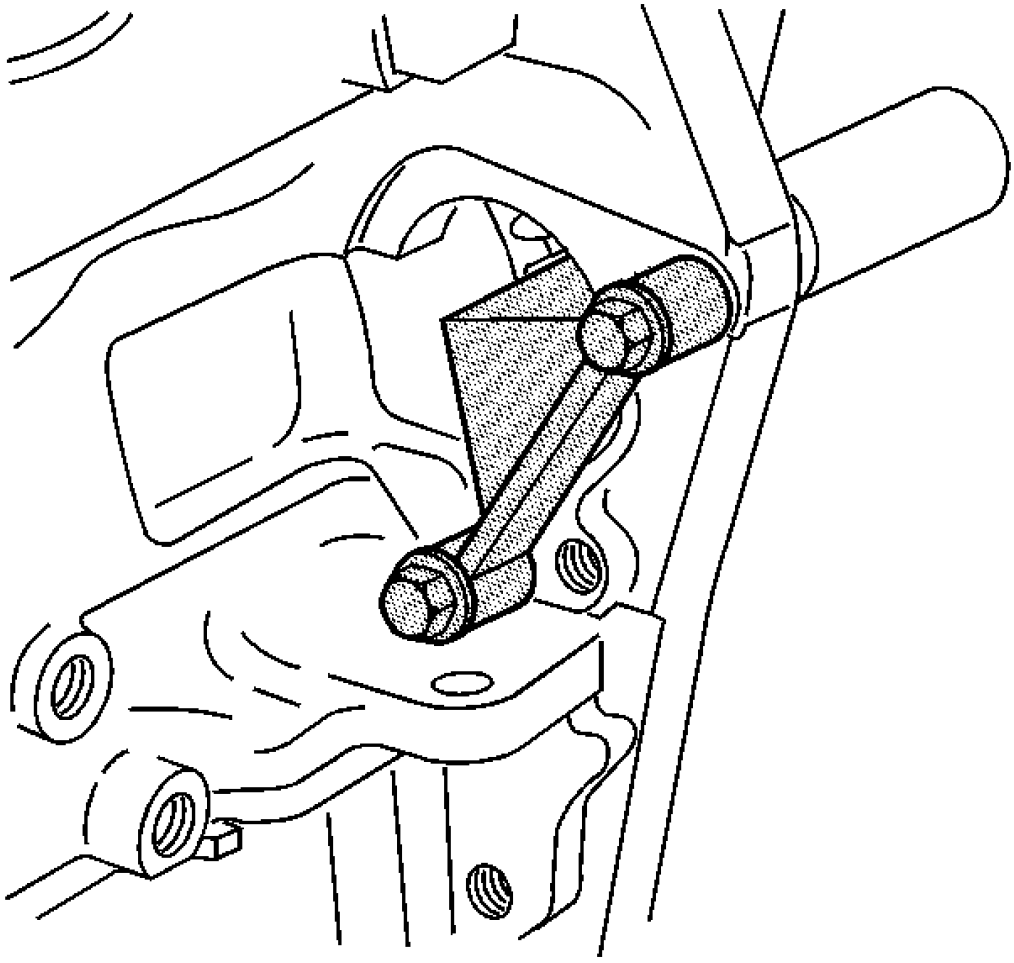


Fig. 148: View Of Special Tool EN 46106
Courtesy of GENERAL MOTORS CORP.

5. Remove the **EN 46106:** tool.

CRANKSHAFT BALANCER INSTALLATION

Special Tools

- **EN 46106:** Engine Flywheel Holding Tool
- **J 41998-B:** Crankshaft Balancer Installer
- **J 45059:** Angle Meter

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For equivalent regional tools, refer to **Special Tools** .

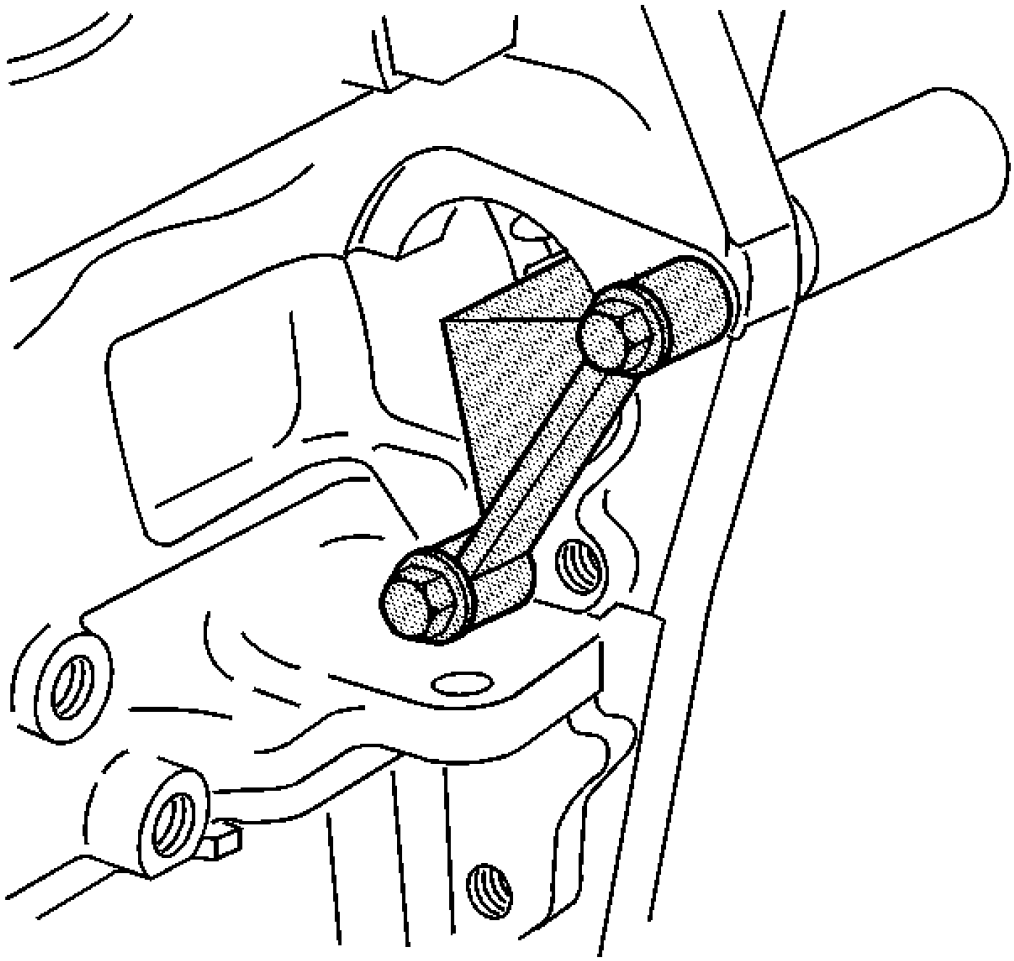


Fig. 149: View Of Special Tool EN 46106
Courtesy of GENERAL MOTORS CORP.

1. The **EN 46106:** tool must be installed onto the flywheel.
2. Use the **J 41998-B:** installer, nut, bearing and washer to install the crankshaft balancer.

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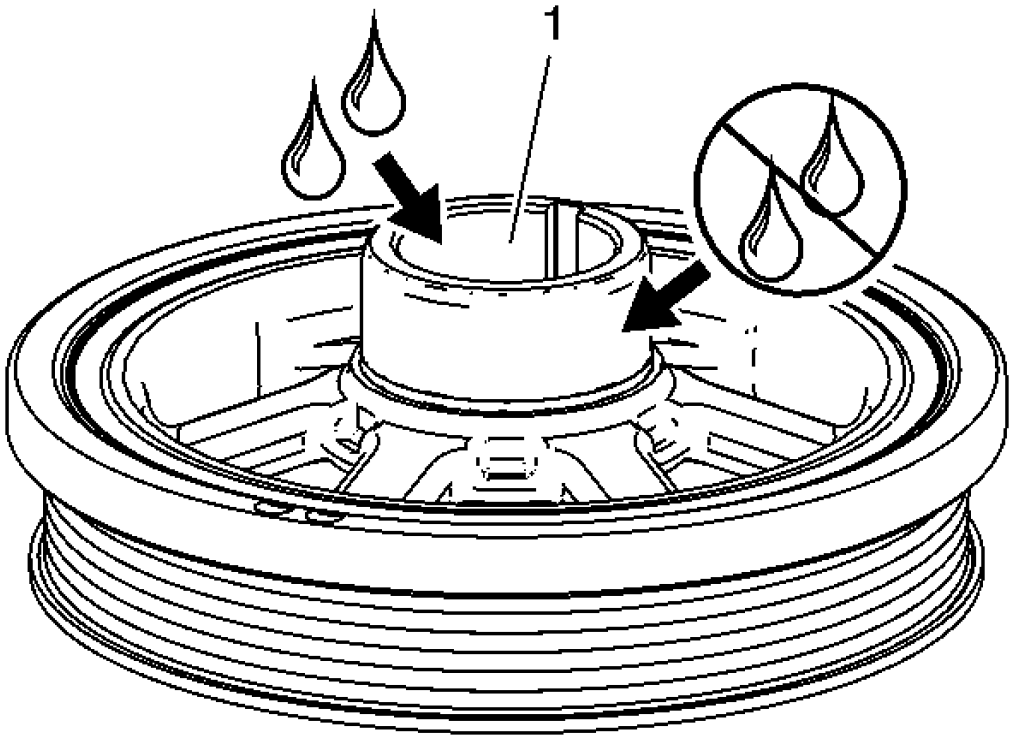


Fig. 150: Applying Lubricant To Inside Of Crankshaft Balancer Hub Bore
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not lubricate the crankshaft front oil seal or crankshaft balancer sealing surfaces. The crankshaft balancer is installed into a dry seal.

3. Apply lubricant to the inside of the crankshaft balancer hub bore (1).

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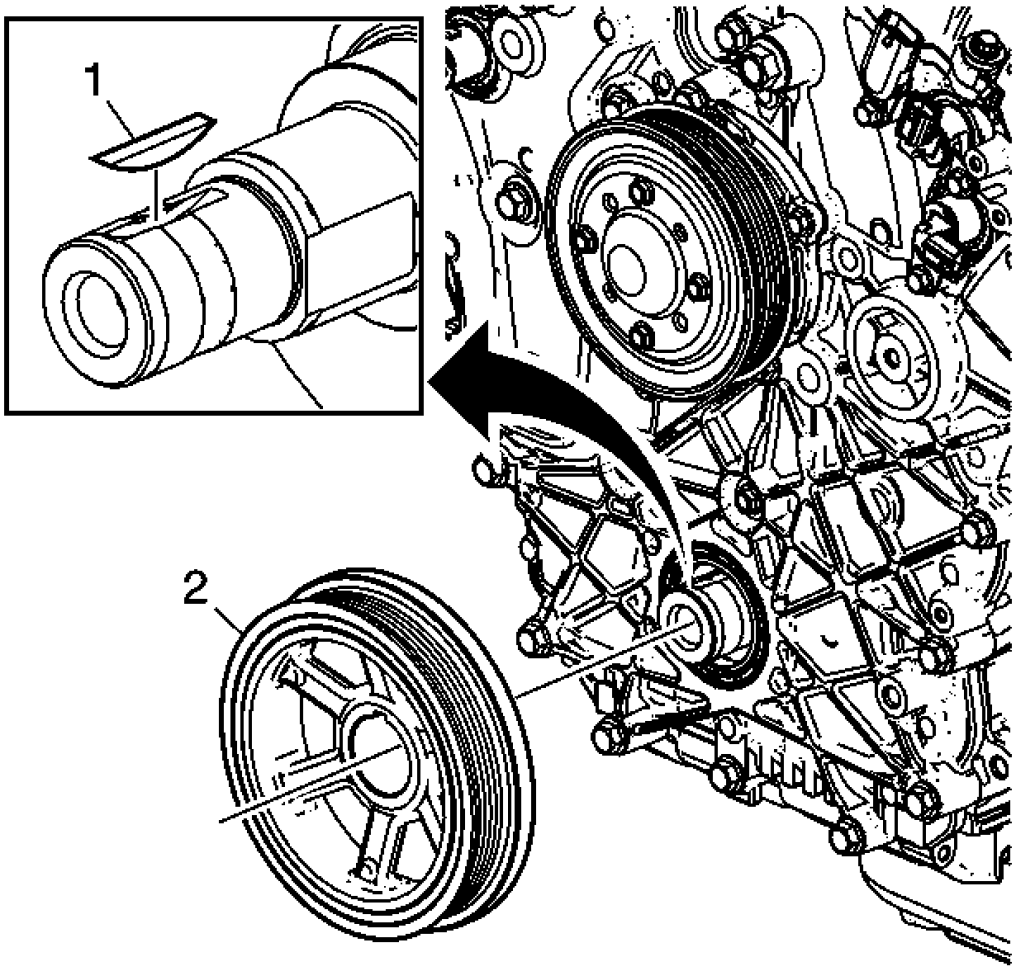


Fig. 151: Crankshaft Balancer & Key
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure the key (1) located on the top of the crankshaft is correctly installed in the crankshaft. Failure to adhere to this may cause engine damage.

4. Slide the crankshaft balancer (2) into position on the crankshaft.

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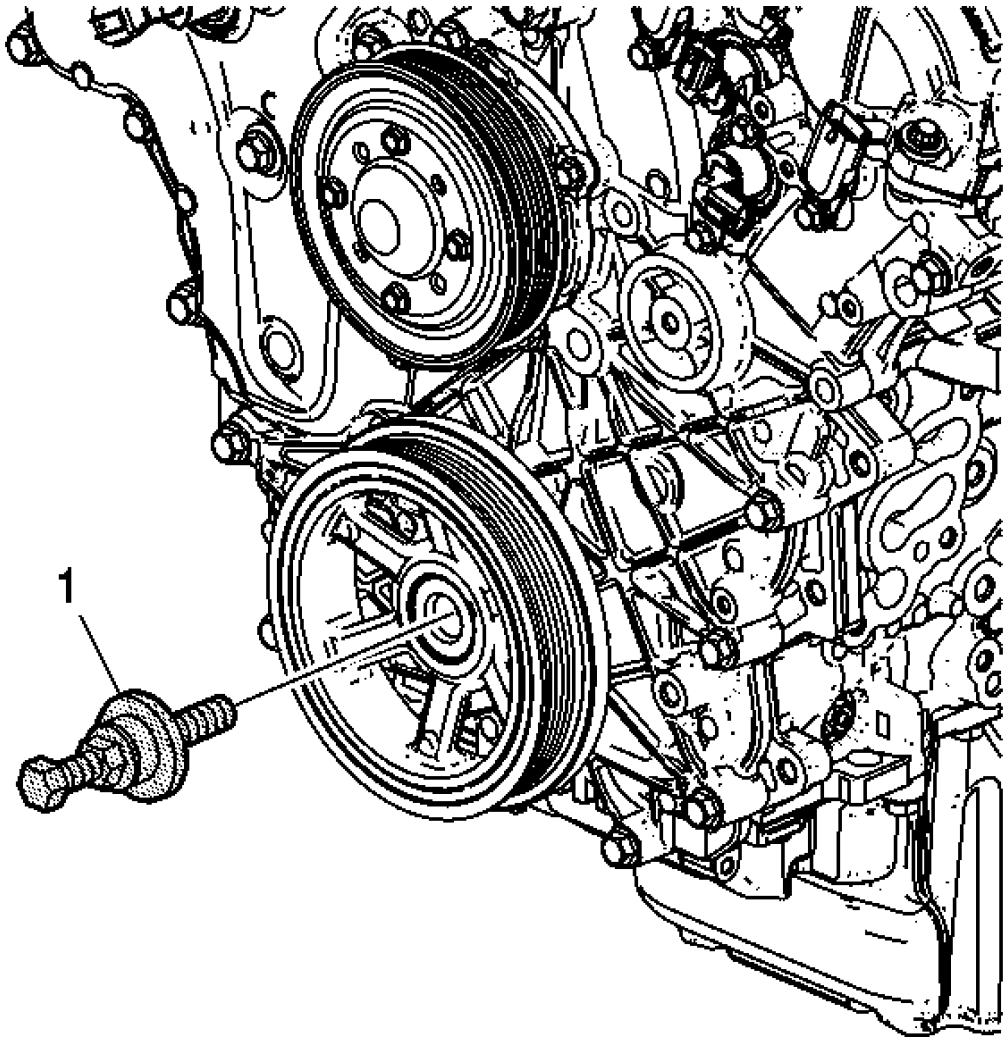


Fig. 152: Crankshaft Balancer Installer
Courtesy of GENERAL MOTORS CORP.

5. Thread the **J 41998-B:** installer (1) in the crankshaft. Ensure you engage at least 10 threads of the **J 41998-B:** installer before pressing the crankshaft balancer in place.
6. Push the crankshaft balancer into position by tightening the nut on the **J 41998-B:** installer until the large washer bottoms out on the crankshaft end.
7. Remove the **J 41998-B:** installer.

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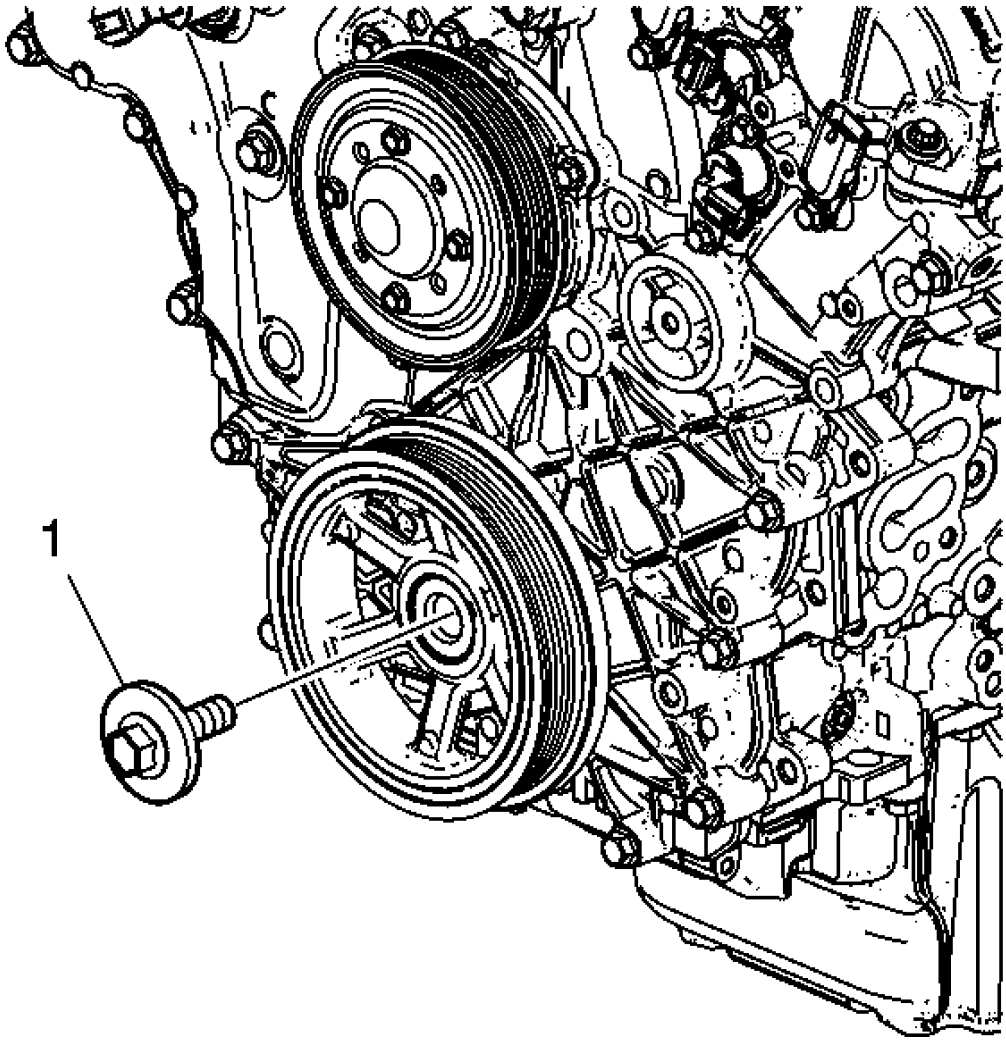


Fig. 153: Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS CORP.

8. Install the NEW crankshaft balancer bolt (1).

CAUTION: Refer to Fastener Caution .

9. Tighten the crankshaft balancer bolt.
    1. Tighten the crankshaft balancer bolt to 100 N.m (74 lb ft) .

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2. Tighten the crankshaft balancer bolt an additional 150 degrees using the **J 45059:** meter .

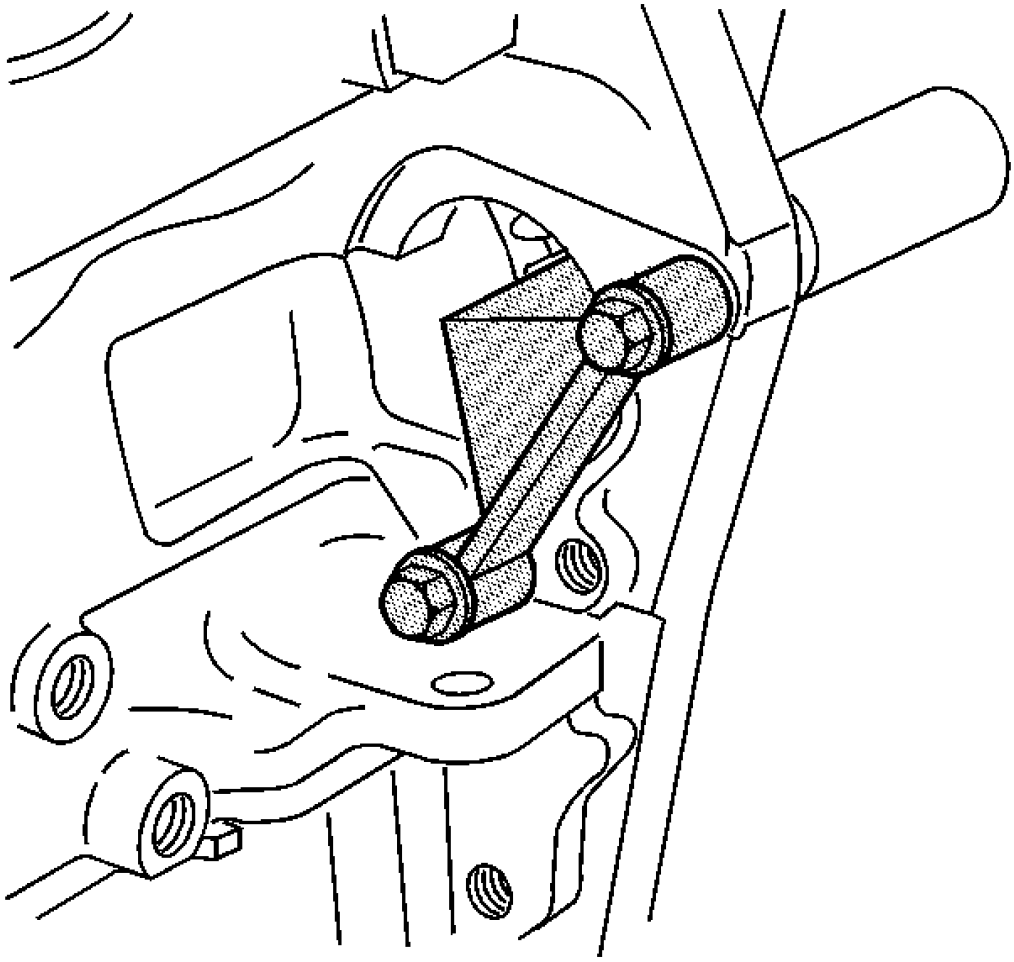


Fig. 154: View Of Special Tool EN 46106
Courtesy of GENERAL MOTORS CORP.

10. Remove the **EN 46106:** tool.

OIL FILTER ADAPTER INSTALLATION

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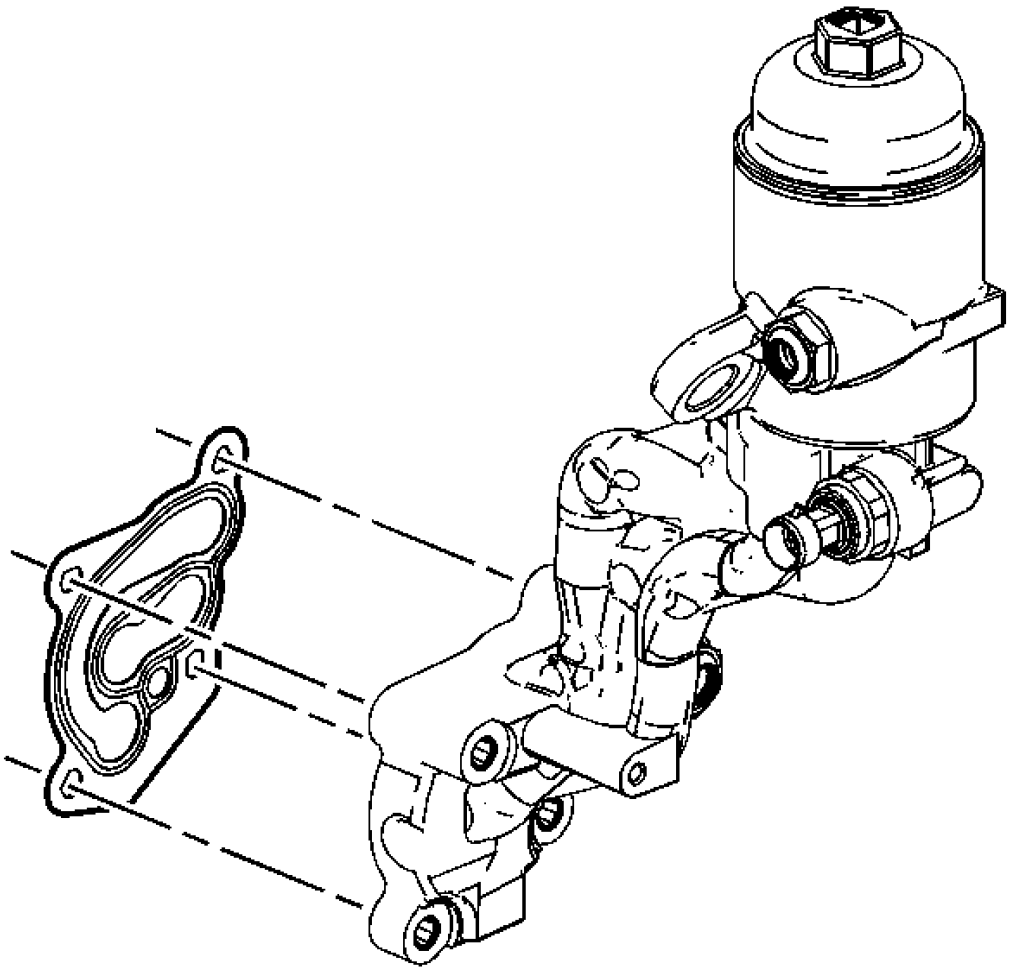


Fig. 155: View Of Oil Filter Adapter & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Position a NEW oil filter adapter gasket onto the oil filter adapter.

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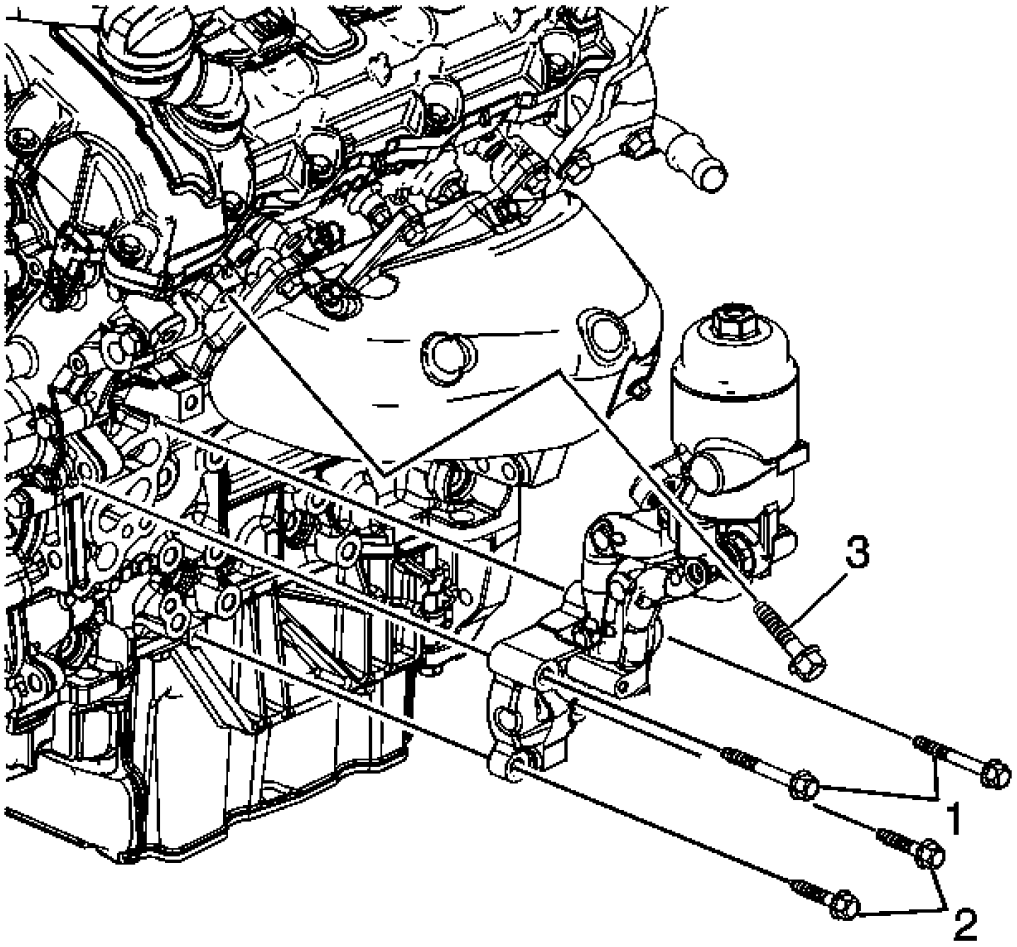


Fig. 156: Identifying Oil Filter Adapter Bolts
Courtesy of GENERAL MOTORS CORP.

2. Install the oil filter adapter bolts (1, 2) into the oil filter adapter.
3. Loosely tighten the oil filter adapter bolts (1, 2).
4. Install and loosely tighten the oil filter adapter bolt (3) into the oil filter adapter.

CAUTION: Refer to Fastener Caution .

5. Tighten the oil filter adapter bolts (1, 2) to 25 N.m (18 lb ft).
6. Tighten the oil filter adapter bolt (3) to 58 N.m (43 lb ft).

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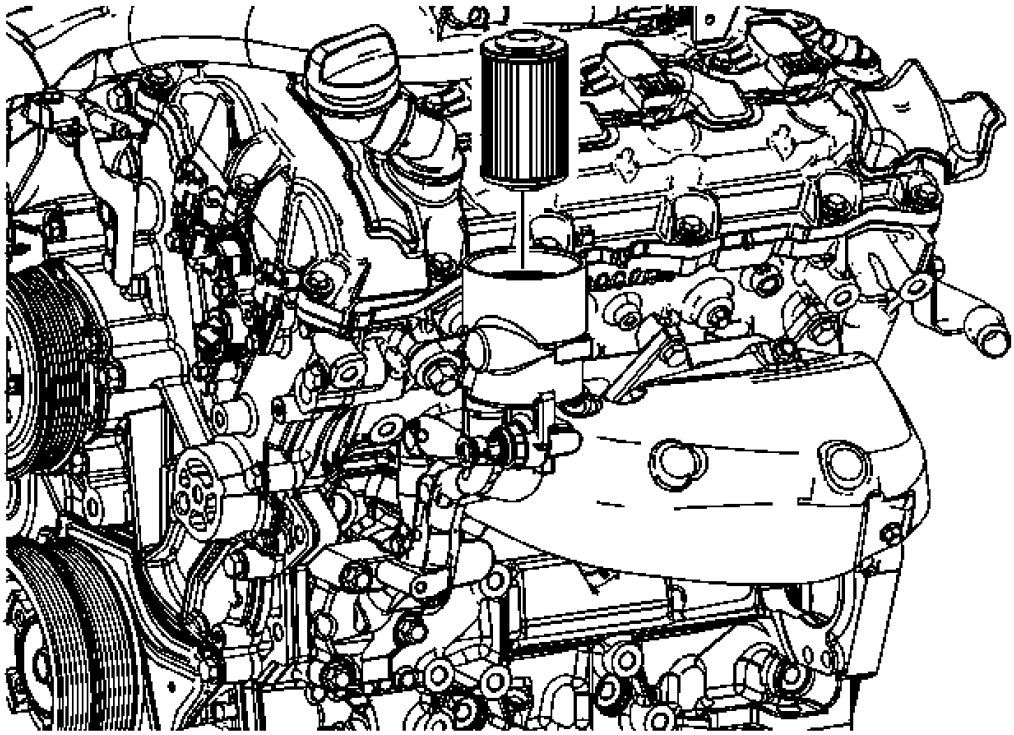


Fig. 157: View Of Oil Filter Cartridge
Courtesy of GENERAL MOTORS CORP.

7. Install a NEW oil filter cartridge.

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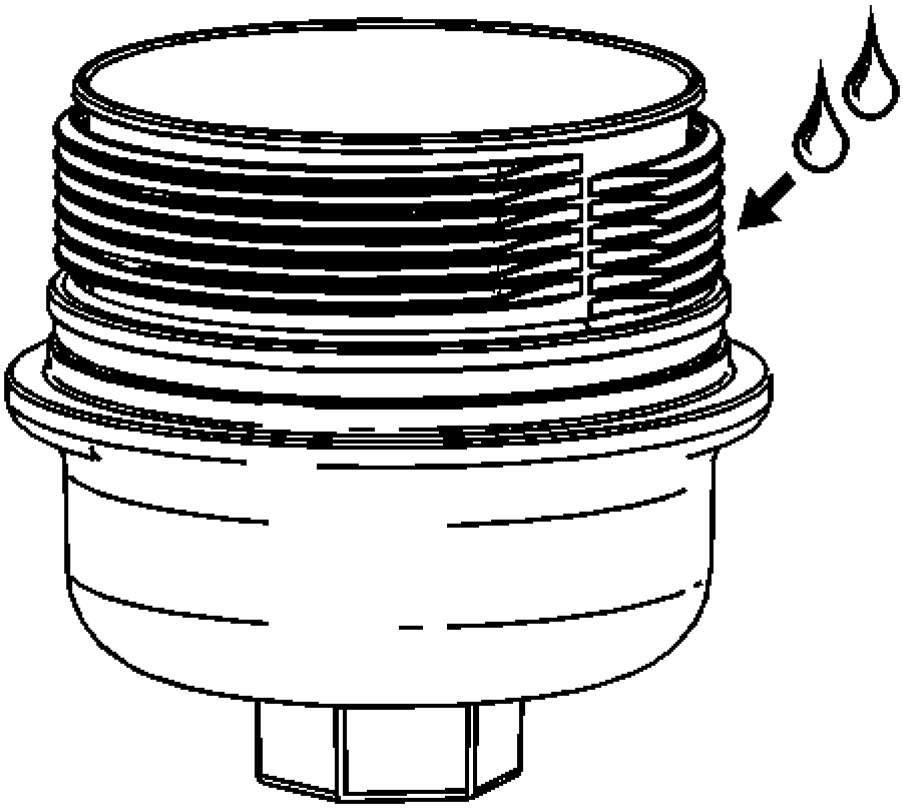


Fig. 158: Lubricating Threads Of Oil Filter Cap
Courtesy of GENERAL MOTORS CORP.

CAUTION: Lubrication must be applied to the threads of the oil filter cap prior to installation. Failure to lubricate the oil filter cap threads can hinder later removal and cause possible oil filter cap damage.

8. Lubricate the oil filter cap threads with clean engine oil.

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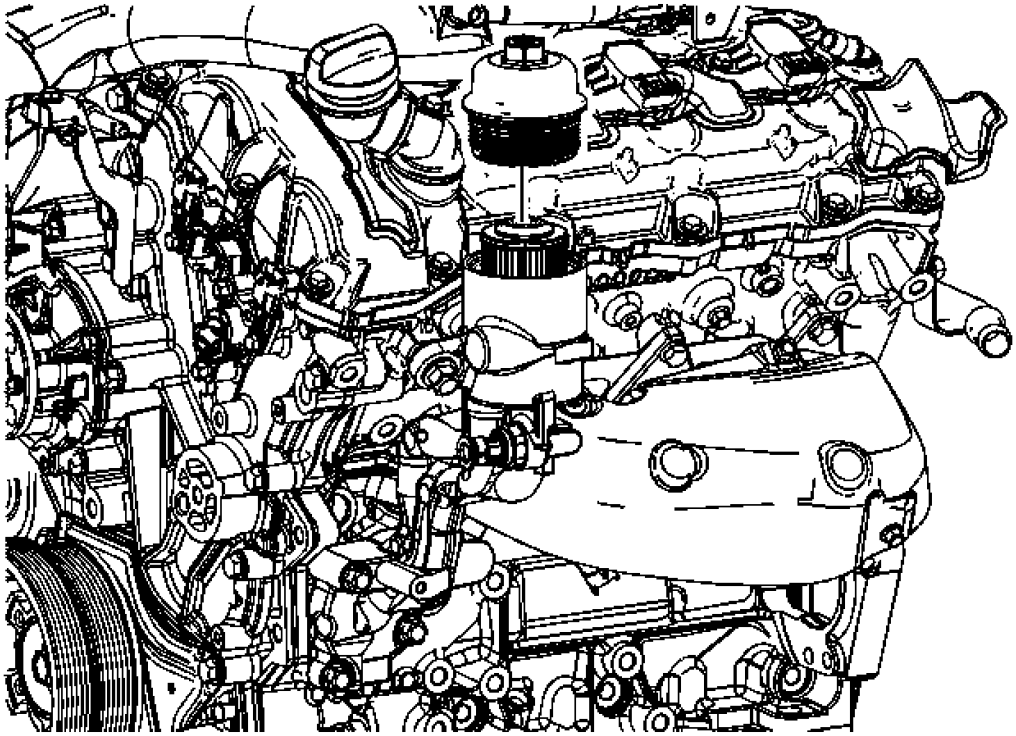


Fig. 159: View Of Oil Filter Cap
Courtesy of GENERAL MOTORS CORP.

CAUTION: Proper oil filter cap tightening is mandatory. Failure to tighten the oil filter cap to the proper specification can hinder later removal and cause possible oil filter cap damage.

9. Install the oil filter cap and tighten to 25 N.m (18 lb ft).

EXHAUST MANIFOLD INSTALLATION - LEFT SIDE

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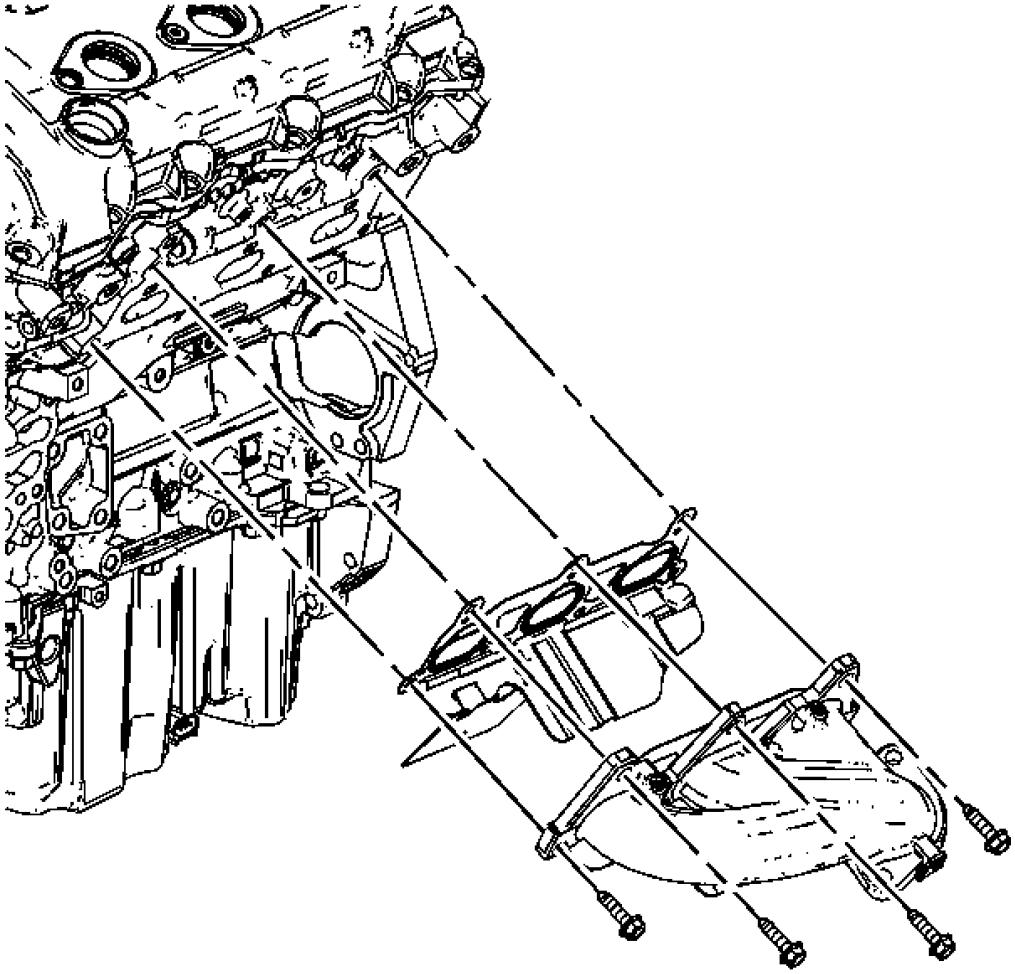


Fig. 160: View Of Left Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

1. Position a NEW exhaust manifold gasket onto the left exhaust manifold.
2. Install the exhaust manifold bolts into the left exhaust manifold.
3. Place the left exhaust manifold, exhaust manifold gasket and bolts as an assembly in position on the left cylinder head.

CAUTION: Refer to Fastener Caution .

4. Install the exhaust manifold bolts into the left cylinder head and tighten to 20 N.m (15 lb ft).

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OIL LEVEL INDICATOR AND TUBE INSTALLATION

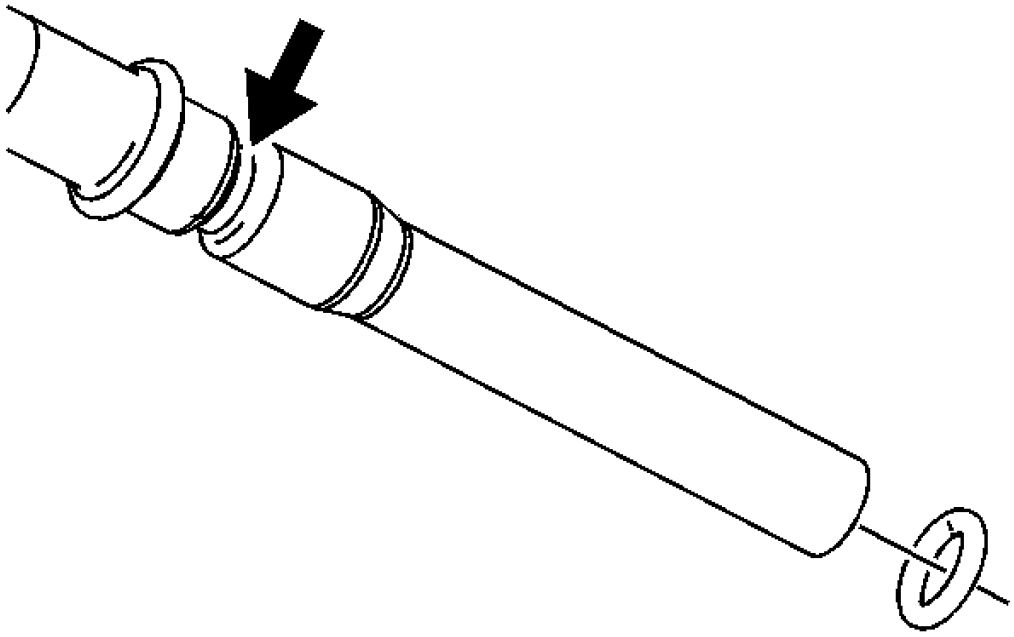


Fig. 161: View Of Oil Level Indicator Tube O-Ring
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW O-ring on the oil level indicator tube.

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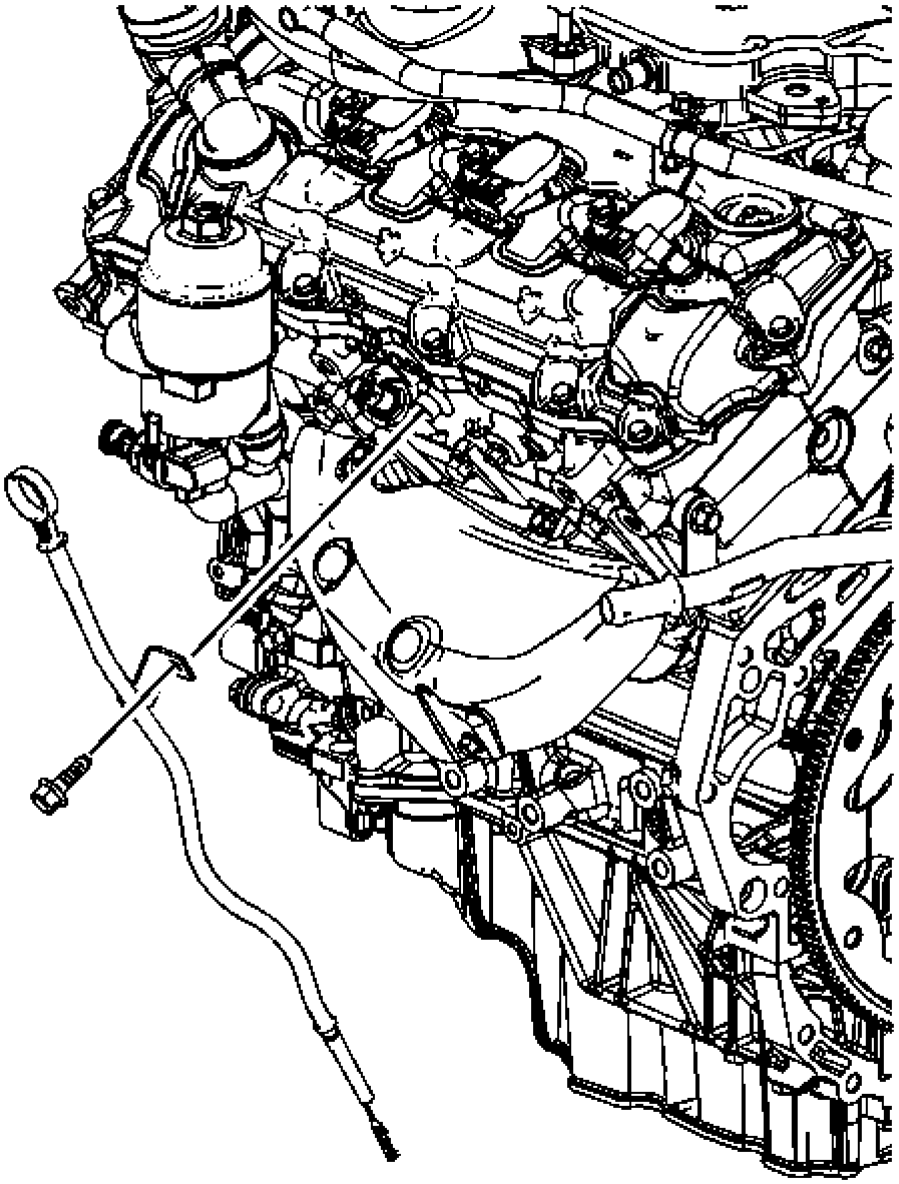


Fig. 162: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

2. Install the oil level indicator and tube by sliding the tube down through the lower crankcase hole.

CAUTION: Refer to Fastener Caution .

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3. Install the oil level indicator tube bracket bolt and tighten to 10 N.m (89 lb in).

EXHAUST MANIFOLD INSTALLATION - RIGHT SIDE

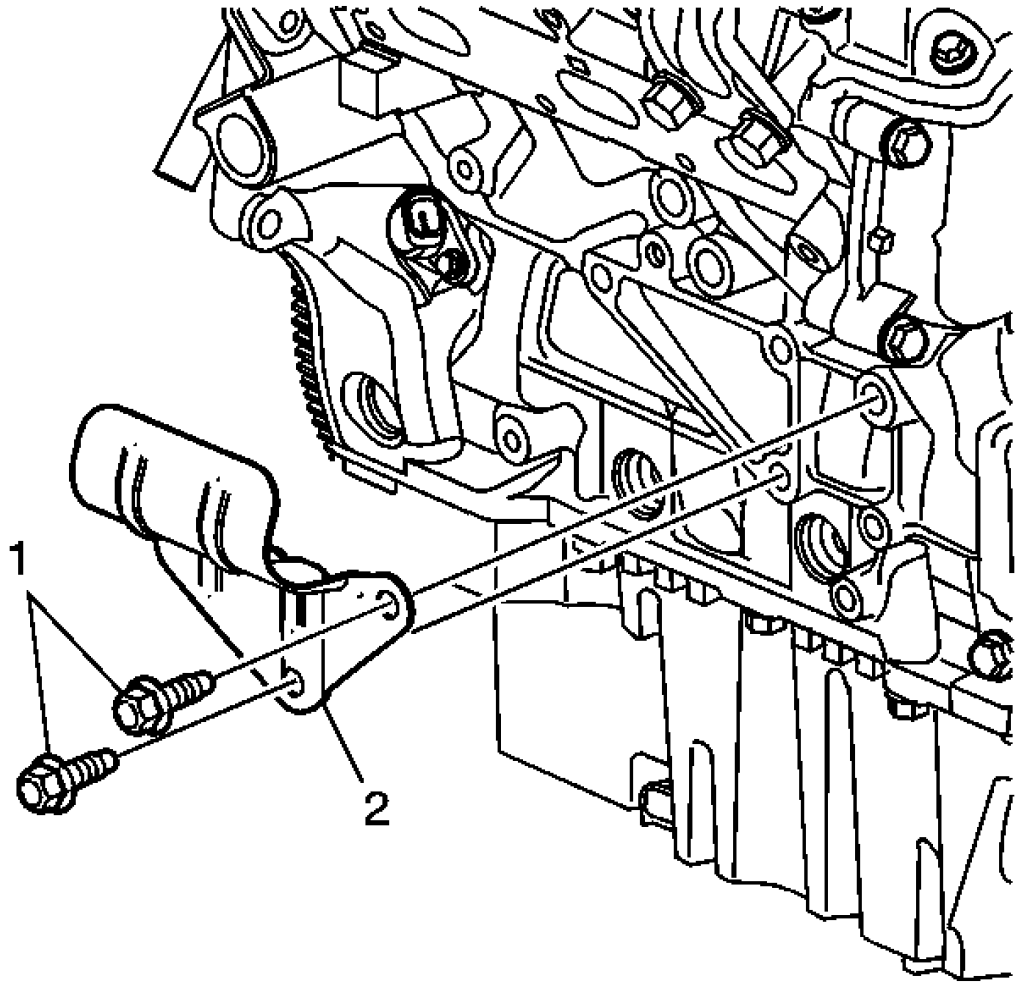


Fig. 163: Identifying Exhaust Manifold Lower Heat Shield & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the exhaust manifold lower heat shield (2).

CAUTION: Refer to Fastener Caution .

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2. Install the exhaust manifold lower heat shield bolts (1) and tighten to 10 N.m (89 lb in).

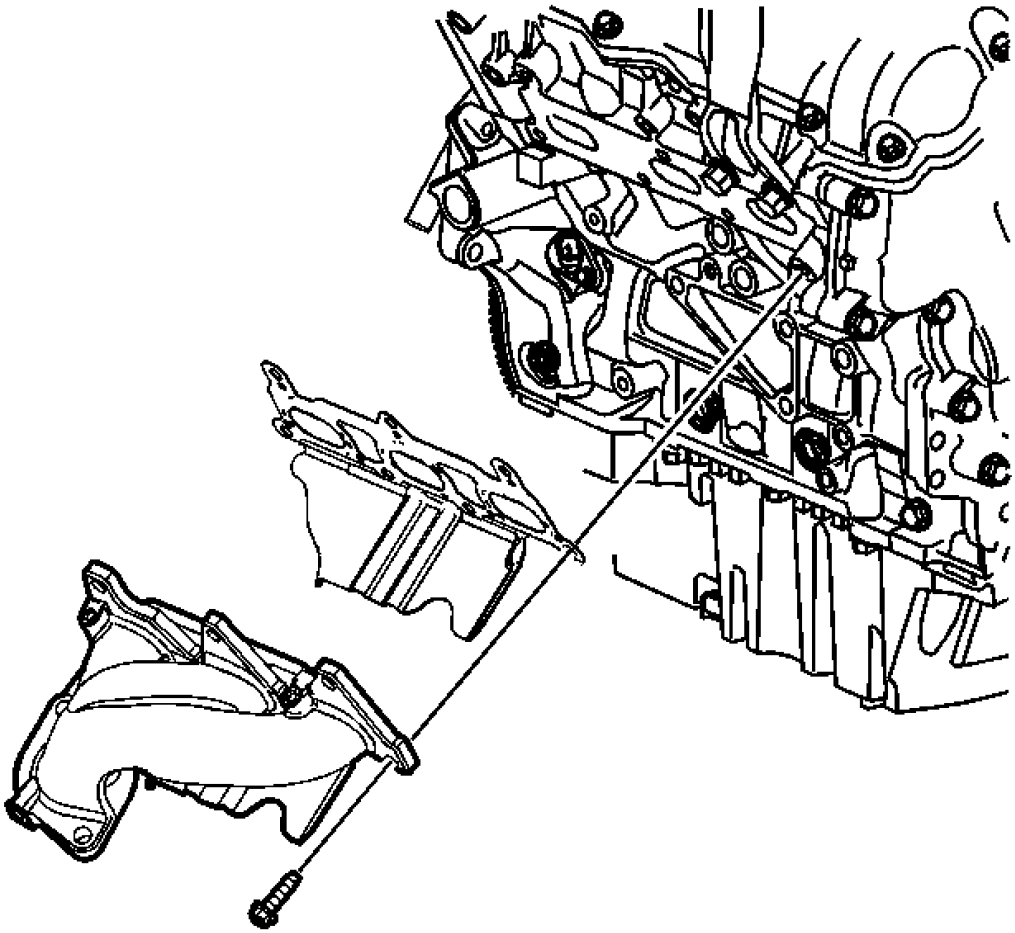


Fig. 164: Removing & Installing Right Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

3. Position a NEW exhaust manifold gasket onto the right exhaust manifold.
4. Install the exhaust manifold bolts into the right exhaust manifold.
5. Place the right exhaust manifold, exhaust manifold gasket and bolts as an assembly in position on the right cylinder head.
6. Install the exhaust manifold bolts into the right cylinder head and tighten the bolts to 20 N.m (15 lb ft).

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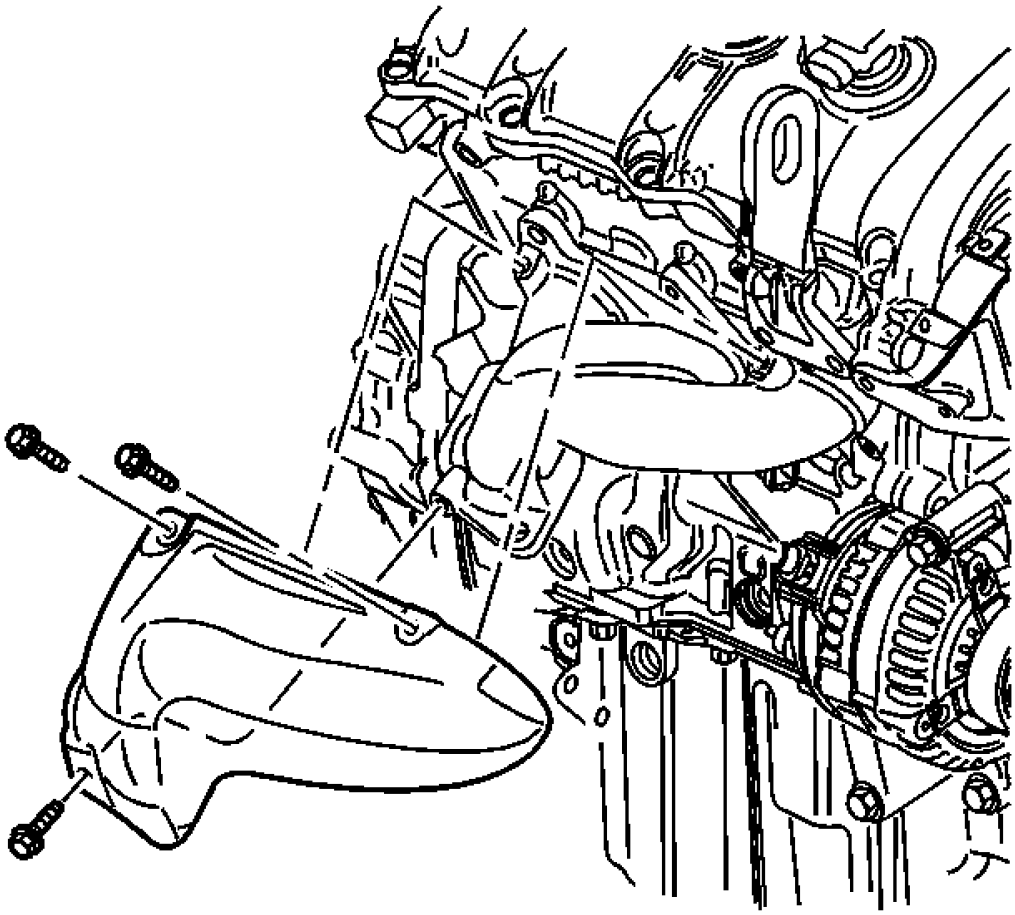


Fig. 165: View Of Right Exhaust Manifold Heat Shield
Courtesy of GENERAL MOTORS CORP.

7. Place the right exhaust manifold heat shield in position.
8. Install the exhaust manifold heat shield bolts and tighten to 10 N.m (89 lb in).

ENGINE COOLANT THERMOSTAT HOUSING INSTALLATION

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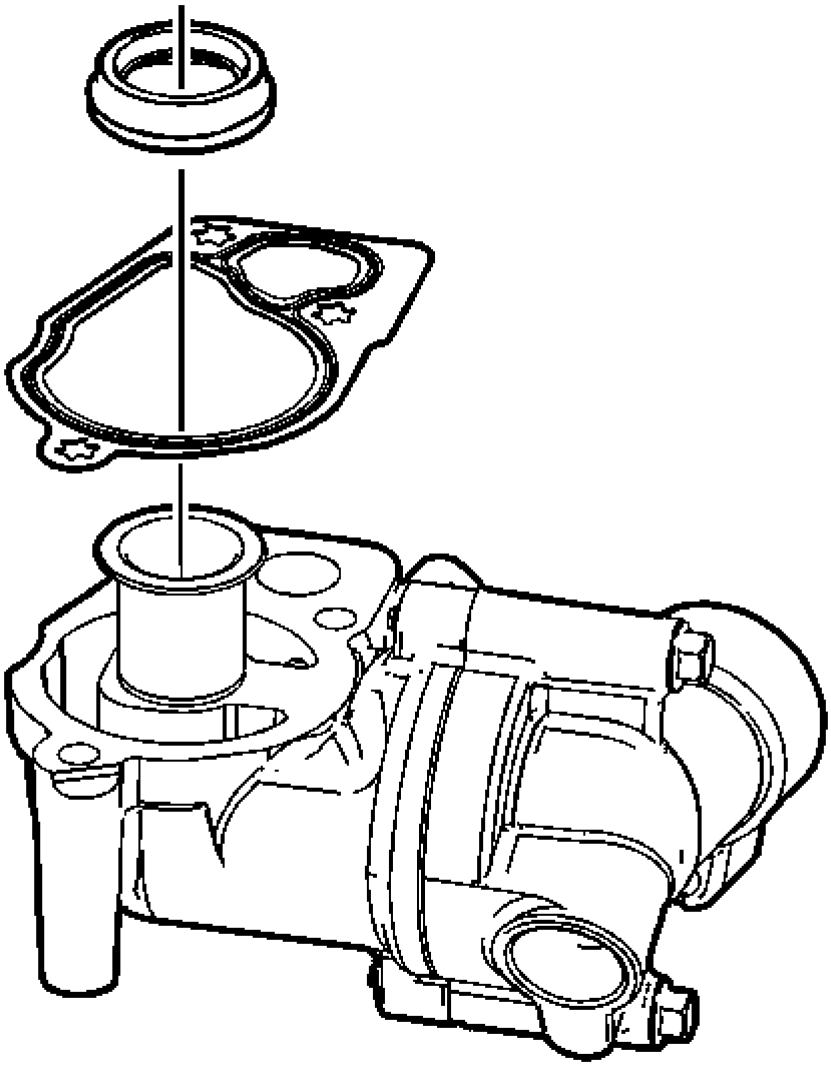


Fig. 166: View Of Thermostat Housing Assembly O-Ring & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install the NEW thermostat housing assembly O-ring and gasket.

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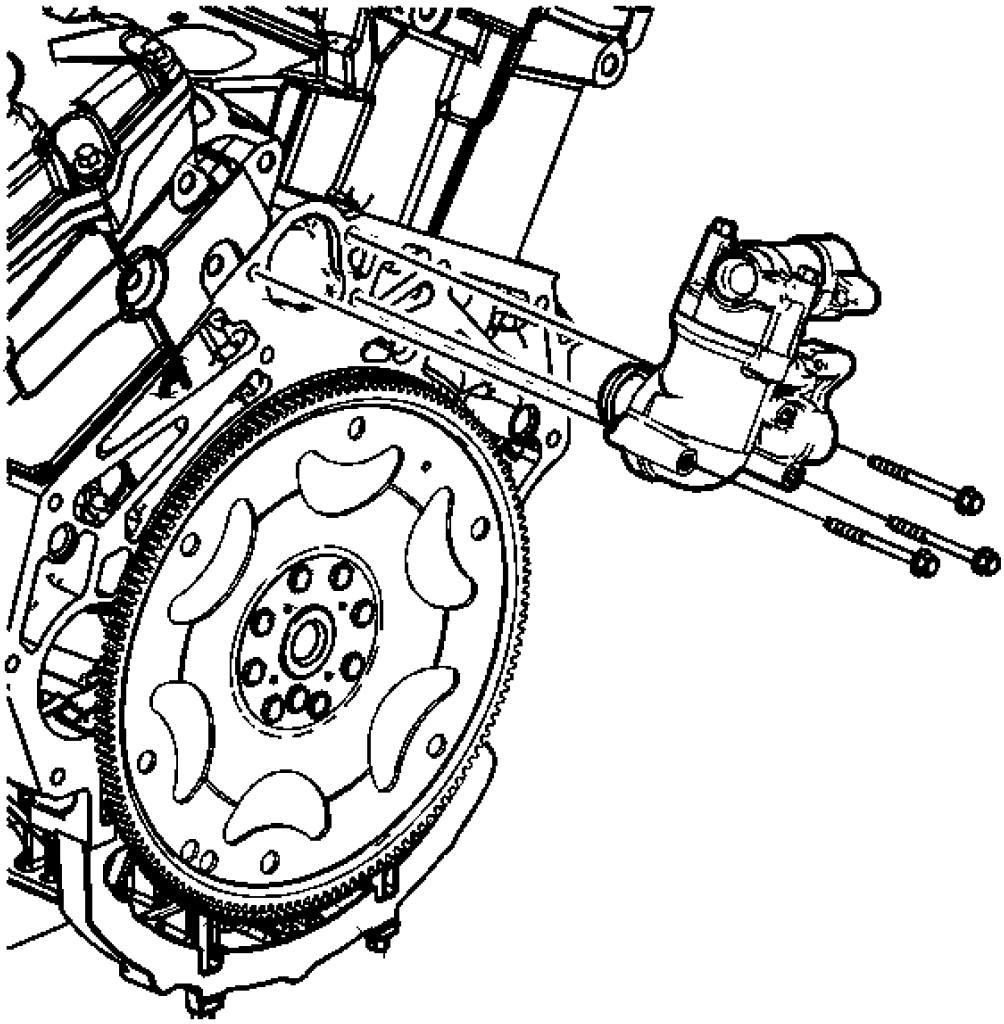


Fig. 167: View Of Thermostat Housing Assembly Bolts
Courtesy of GENERAL MOTORS CORP.

2. Install the thermostat housing assembly.

CAUTION: Refer to Fastener Caution .

3. Install the thermostat housing assembly bolts and tighten to 10 N.m (89 lb in).

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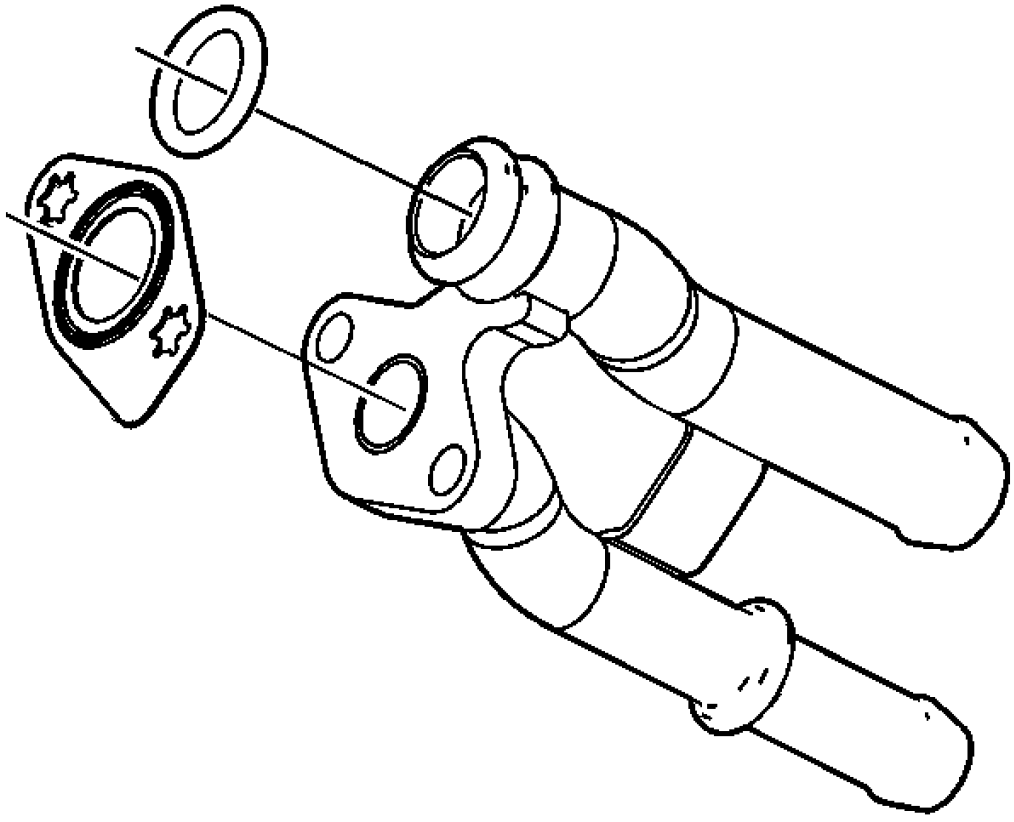


Fig. 168: View Of Heater Inlet/Outlet Pipe Assembly O-Ring & Gasket
Courtesy of GENERAL MOTORS CORP.

4. Install the NEW heater inlet/outlet pipe assembly O-ring and gasket.

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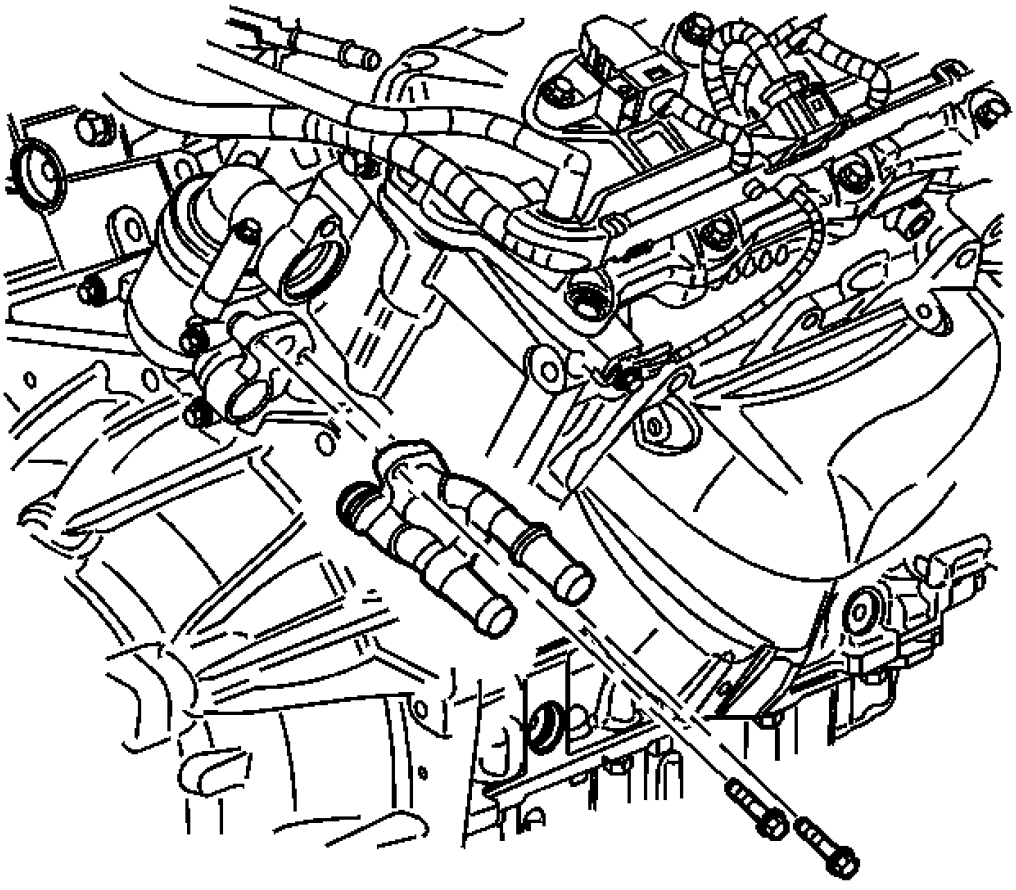


Fig. 169: View Of Heater Inlet/Outlet Pipe Assembly
Courtesy of GENERAL MOTORS CORP.

5. Install the heater inlet/outlet pipe assembly.
6. Install the heater inlet/outlet pipe assembly bolts and tighten to 10 N.m (89 lb in).

WATER OUTLET INSTALLATION

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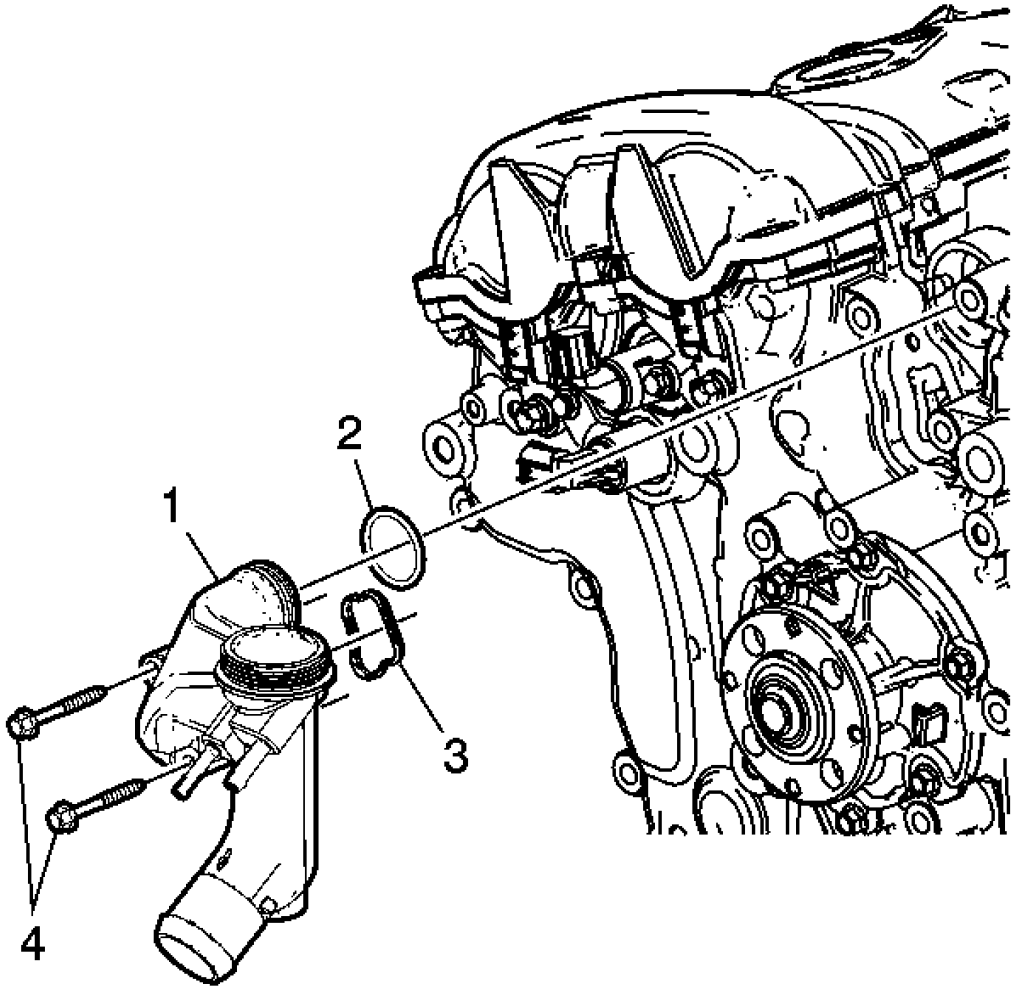


Fig. 170: Water Outlet Components
Courtesy of GENERAL MOTORS CORP.

1. Install the NEW water outlet gasket (3).
2. Install the NEW water outlet O-ring seal (2).
3. Install the water outlet (1).

CAUTION: Refer to Fastener Caution .

4. Install the water outlet bolts (4) and tighten to 10 N.m (89 lb in).

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DRIVE BELT TENSIONER INSTALLATION

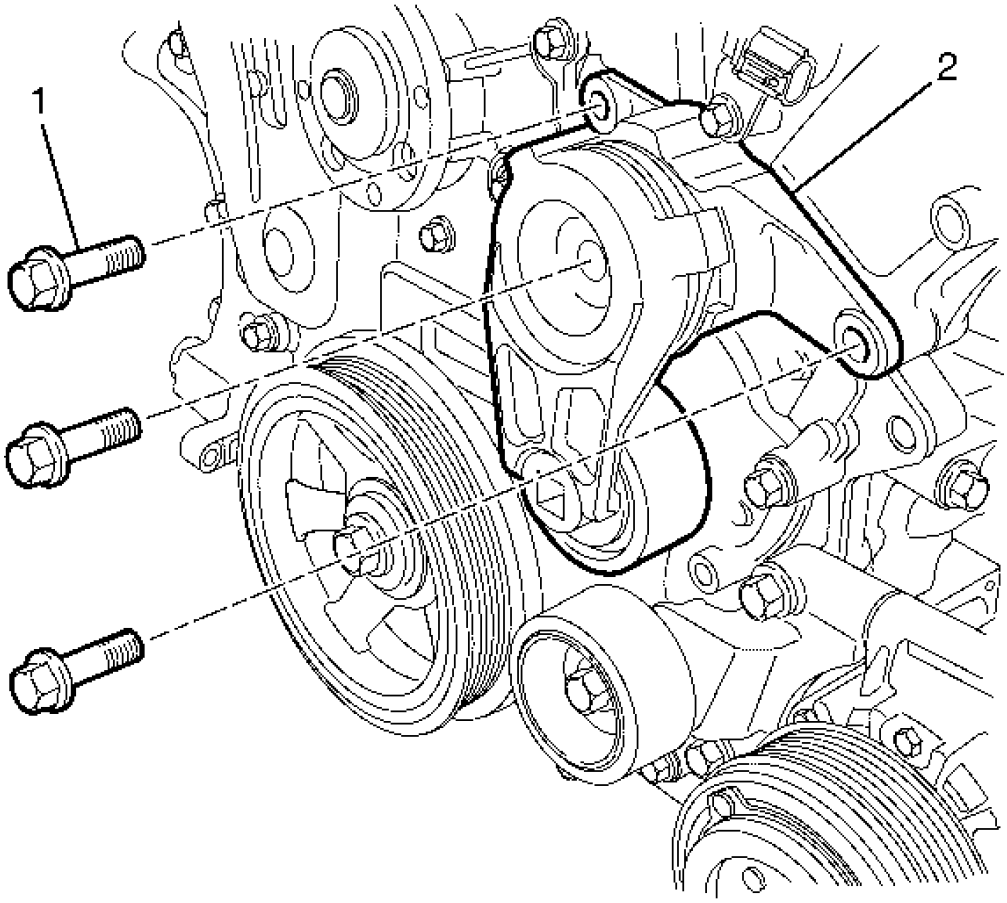


Fig. 171: Identifying Drive Belt Tensioner To Engine Front Cover Retaining Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the drive belt tensioner (2) to the engine front cover.

CAUTION: Refer to Fastener Caution .

2. Install the drive belt tensioner to engine front cover retaining bolts (1) and tighten to 58 N.m (43 lb ft).

ENGINE PRELUBING

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Special Tools

- **J-21867-6:** Oil Pressure Adapter Fitting
- **J 45299:** Engine Preluber

For equivalent regional tools, refer to **Special Tools**

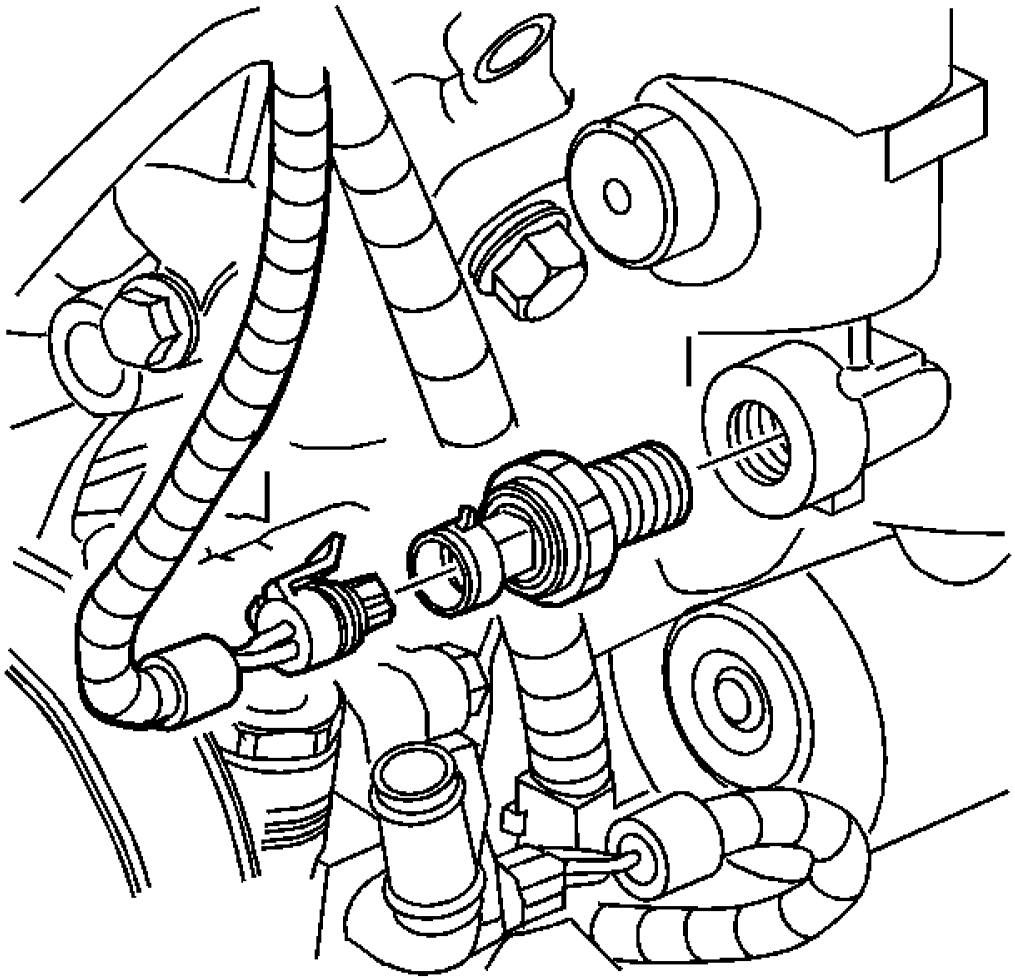


Fig. 172: View Of Oil Pressure Sending Unit
Courtesy of GENERAL MOTORS CORP.

NOTE: **A constant and continuous flow of clean engine oil is required in order to properly prime the engine. Be sure to use an approved engine oil as specified in the owners manual.**

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1. Remove the oil filter cap.
2. Install the NEW oil filter cartridge.
3. Lubricate the threads of the oil filter cap with clean engine oil.

CAUTION: Refer to Fastener Caution .

4. Install the oil filter cap and tighten to 25 N.m (18 lb ft).
5. Remove the oil pressure sending unit from the oil filter adapter.
6. Install the **J-21867-6:** fitting.

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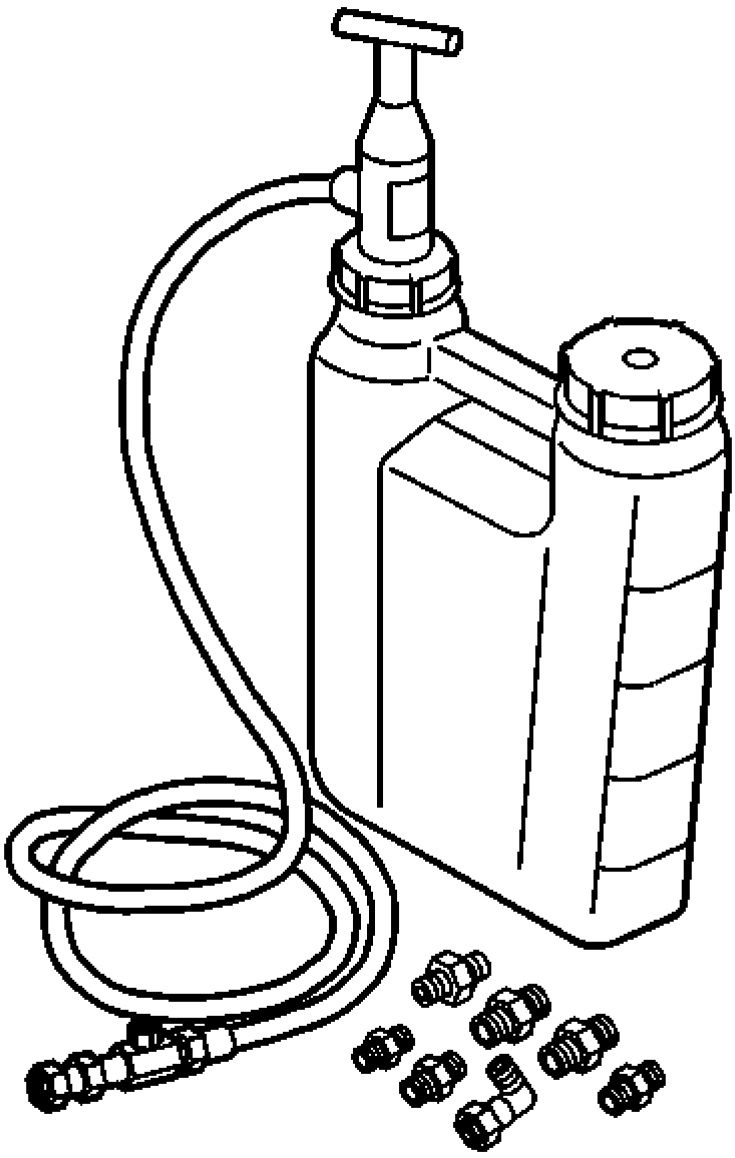


Fig. 173: Engine Preluber J 45299
Courtesy of GENERAL MOTORS CORP.

7. Install the flexible hose to the adapter and open the valve.
8. Pump the handle on the **J 45299:** preluber in order to flow a minimum of 1-1.9 liters (1-2 quarts) of engine oil. Observe the flow of engine oil through the flexible hose and into the engine assembly.
9. Close the valve and remove the flexible hose and adapter from the engine.

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10. Install the oil pressure sending unit and tighten to 20 N.m (15 lb ft).
11. Top-off the engine oil to the proper level.

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2010 ENGINE

Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Repair Instructions - On Vehicle - Camaro

DRIVE BELT REPLACEMENT

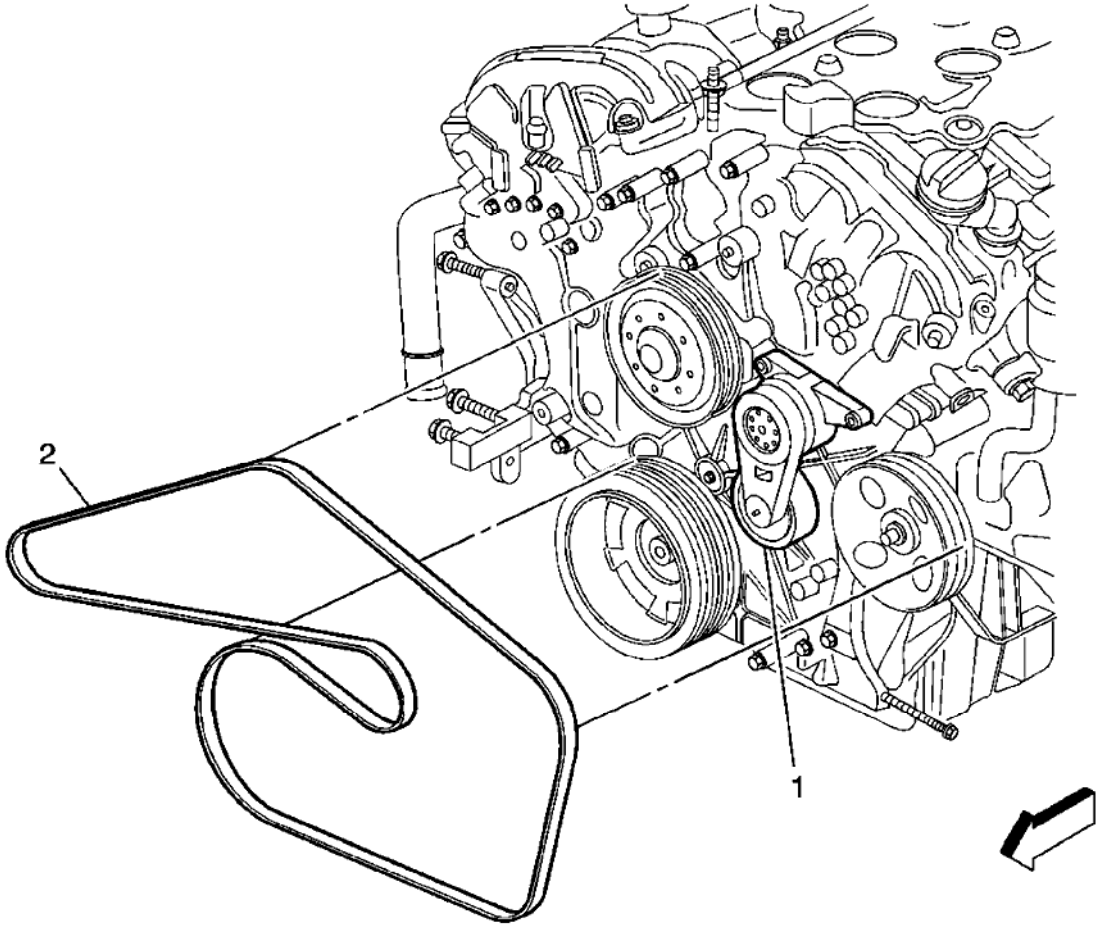


Fig. 1: Drive Belt
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the air cleaner outlet duct, if necessary. Refer to **Air Cleaner Outlet Duct Replacement** .	
1	Drive Belt **Procedure** 1. Use a breaker bar to rotate the drive belt tensioner. 2. Remove the drive belt from the pulleys and tensioner

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2	Drive Belt **Procedure** 1. Clean and inspect the drive belt surfaces of all the pulleys. 2. Inspect the drive belt for correct alignment.

DRIVE BELT TENSIONER REPLACEMENT

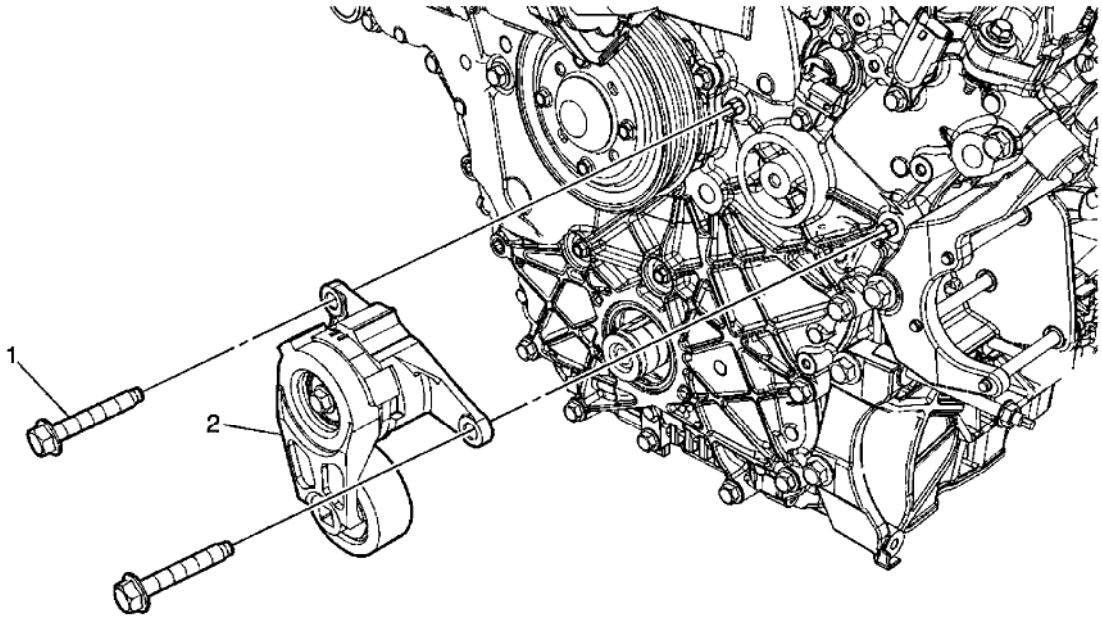


Fig. 2: Drive Belt Tensioner
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the power steering pump out of the way. refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)** .	
1	Drive Belt Tensioner Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 50 N.m (37 lb ft)
2	Drive Belt Tensioner

ENGINE SUPPORT FIXTURE (V6)

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SPECIAL TOOLS

J 28467-81: Engine Support Fixture Kit

INSTALLATION PROCEDURE

1. Remove the engine cover. Refer to **Intake Manifold Cover Replacement - Rear**.

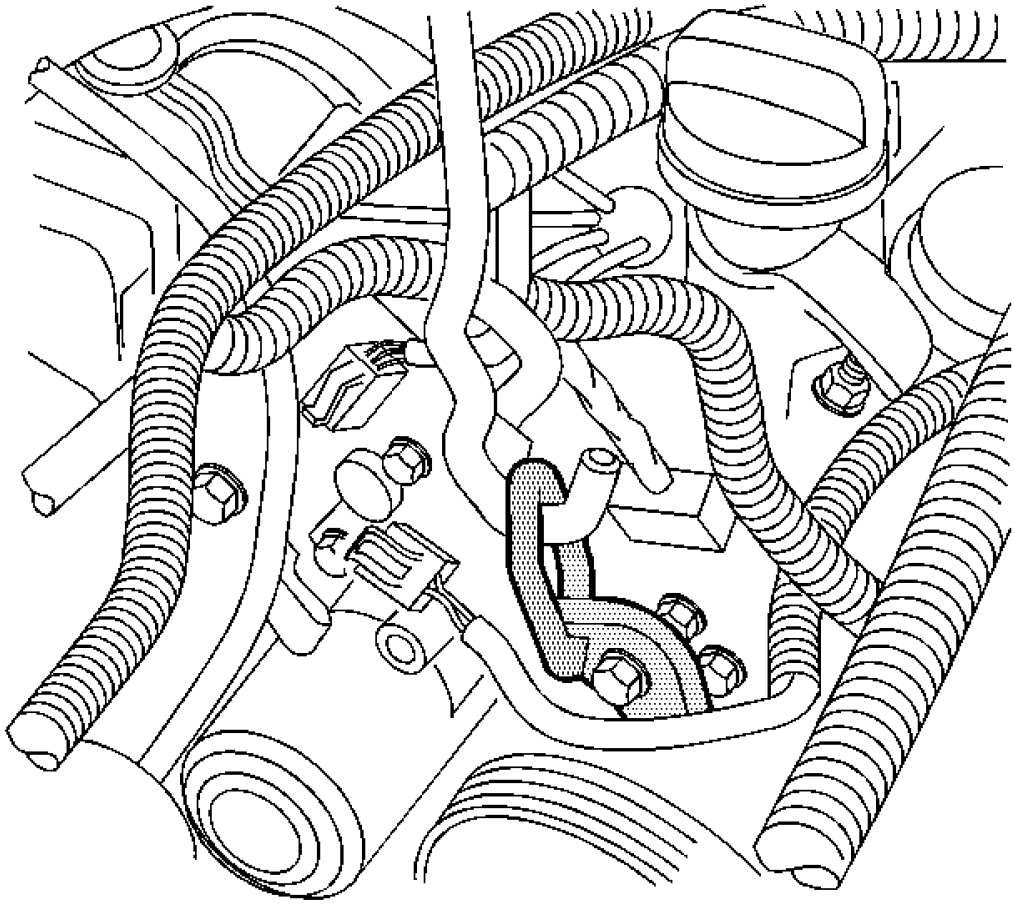


Fig. 3: Locating Engine Lift Bracket
Courtesy of GENERAL MOTORS CORP.

2. Use a grade 10.9, M10 X 1.5 X 35 bolt, GM P/N 11519182 or equivalent, in order to install an engine lift bracket (OTC #7100, J 36857 or equivalent) to the front of the left cylinder head in the location shown.
3. Support the hood and remove the hood support strut.

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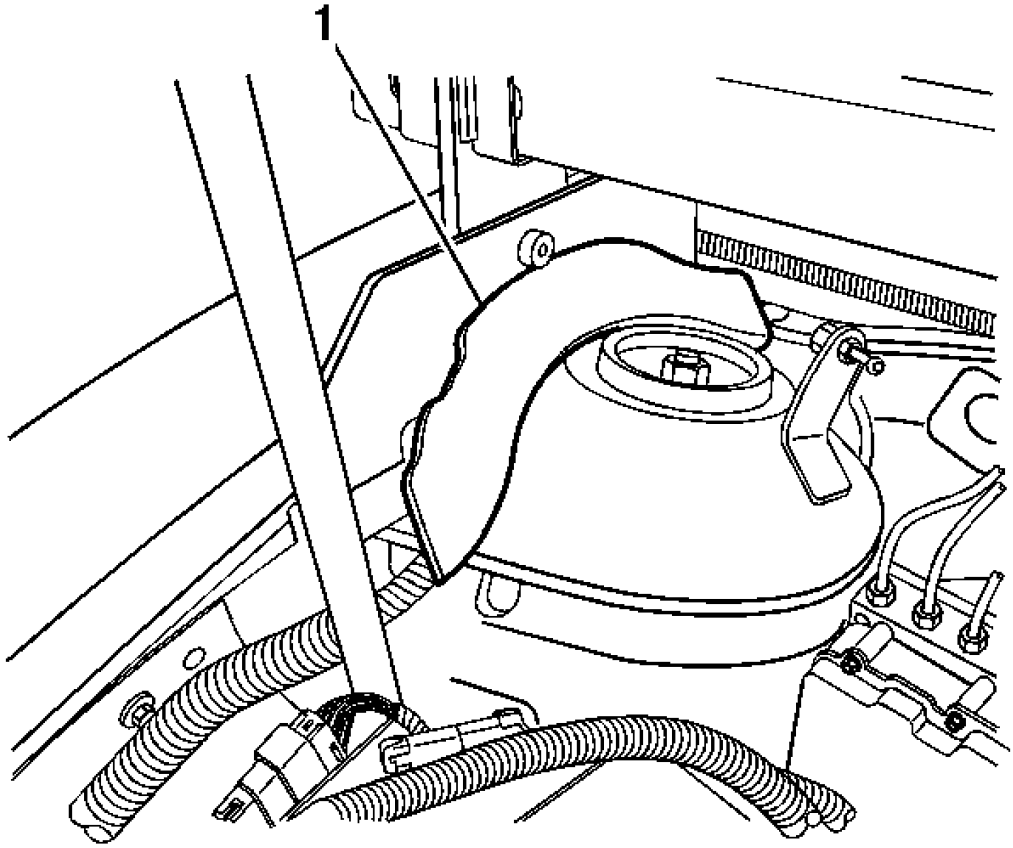


Fig. 4: Passenger Side Wire Harness
Courtesy of GENERAL MOTORS CORP.

4. Reposition the passenger side wire harness (1) to provide clearance for support fixture leg.

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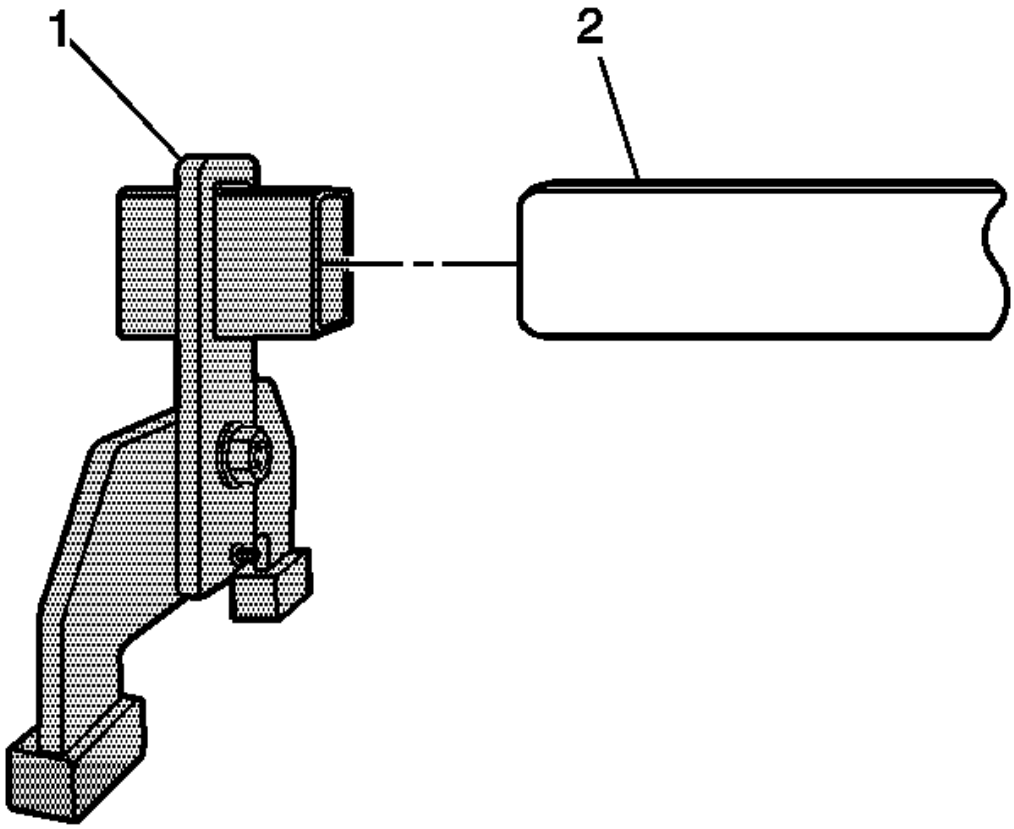


Fig. 5: Identifying Support Leg & Main Bar
Courtesy of GENERAL MOTORS CORP.

5. Assemble a **J 28467-501:** support leg (1) to each end of the **J 28467-518:** main bar (2).

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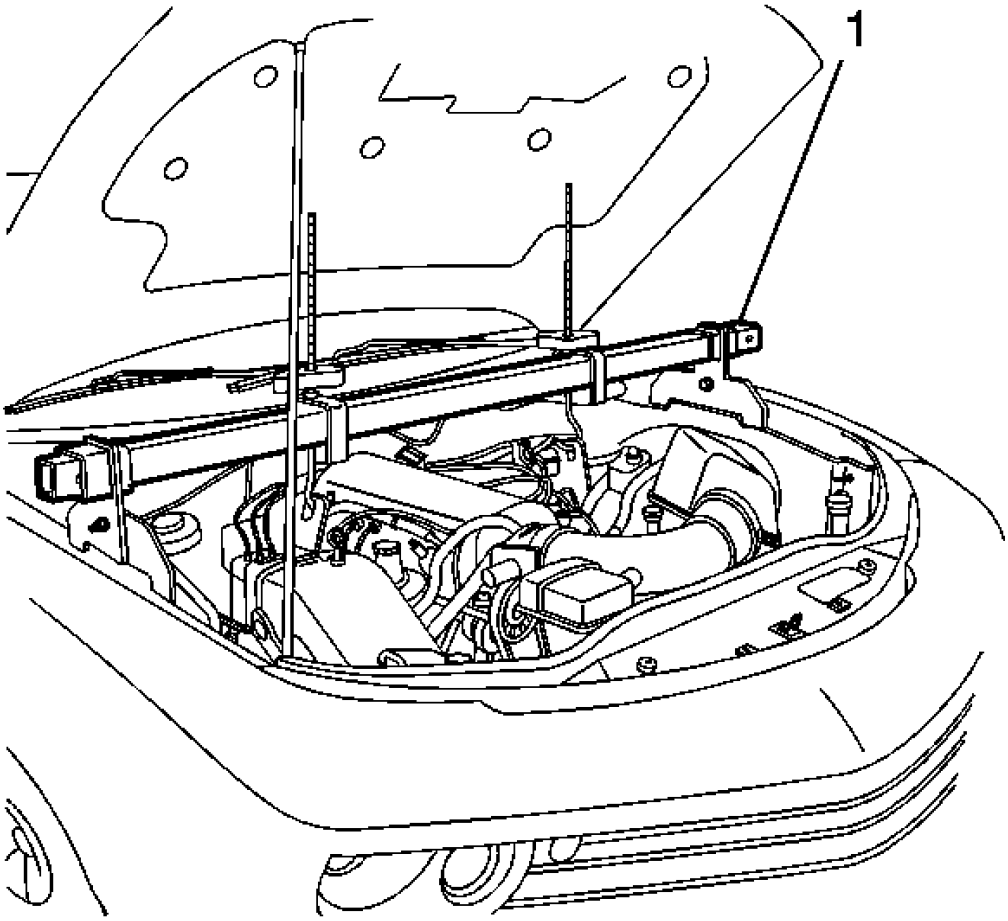


Fig. 6: Main Bar
Courtesy of GENERAL MOTORS CORP.

6. Position the main bar (1) with the support legs over each shock tower. Ensure the rear support legs are located over the reinforced section of the shock tower.

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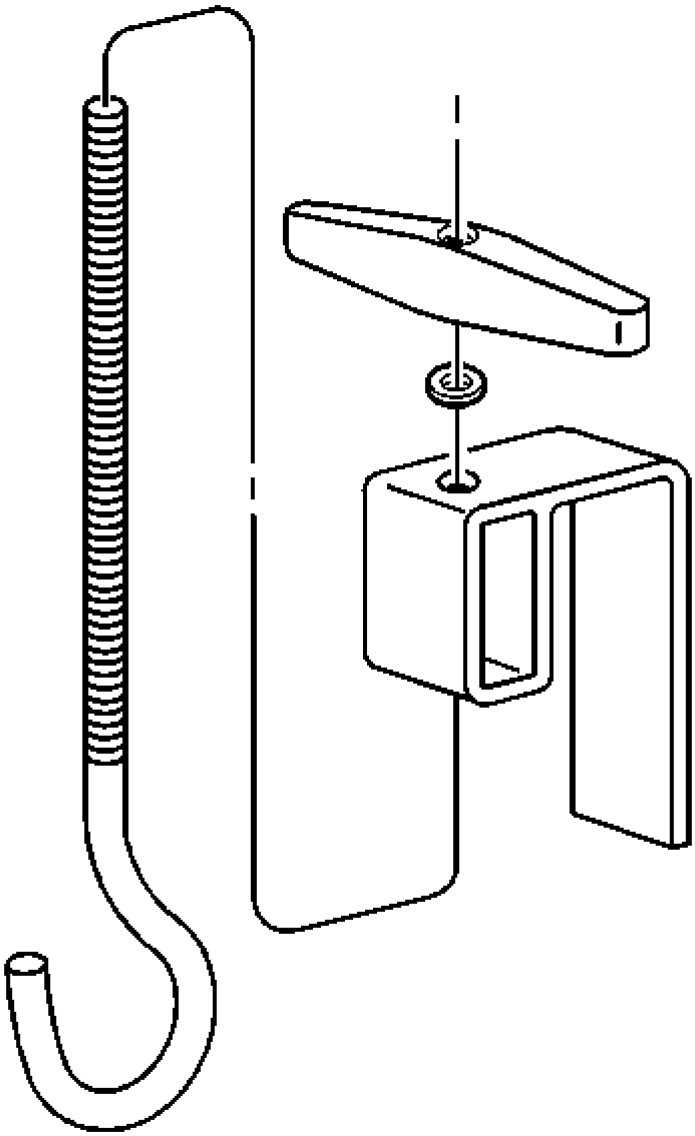


Fig. 7: View Of Lift Hook Assembly
Courtesy of GENERAL MOTORS CORP.

7. Install the **J 28467-7A:** lift hook through the **J 28467-6A:** lift hook bracket.
8. Install the 1/2 inch lift hook washer and the **J 28467-34:** handle onto the **J 28467-7A:** lift hook.

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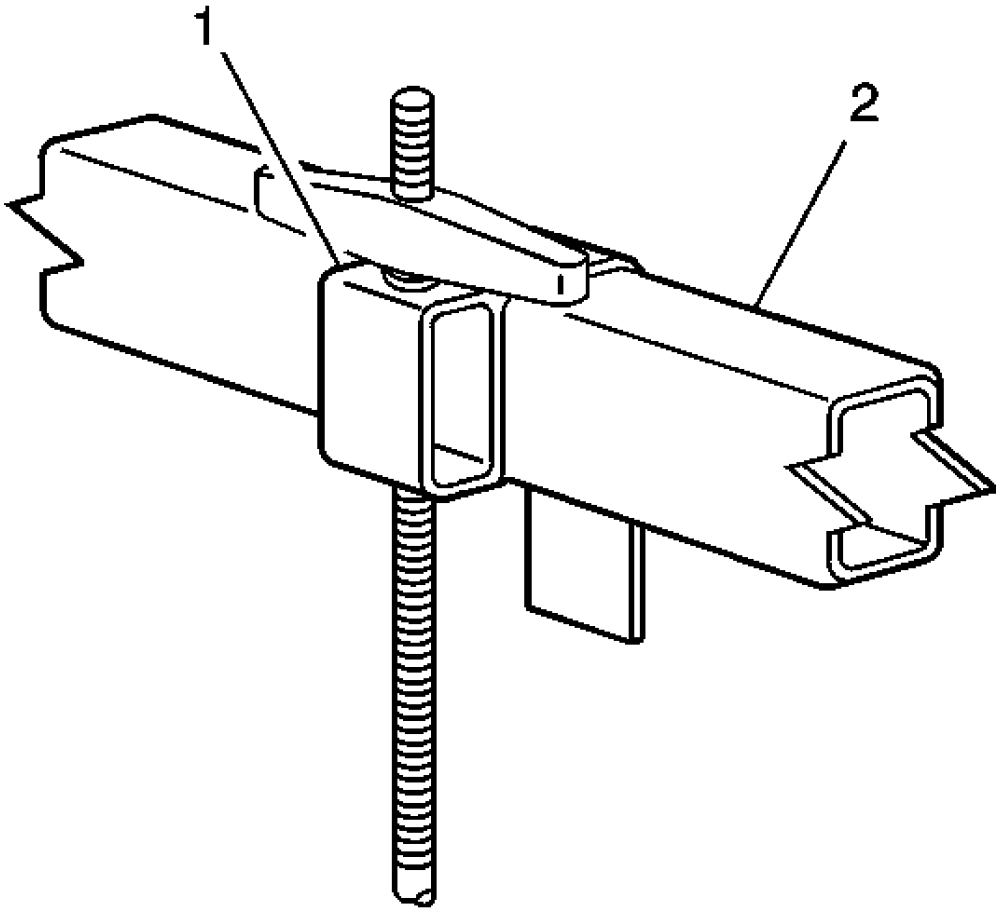


Fig. 8: View Of Lift Hook & Bracket Assembly At Longitudinal Mounted Cross Bar
Courtesy of GENERAL MOTORS CORP.

9. Install the **J 28467-6A:** assembled lift hook bracket (1) over the **J 28467-16:** main bar (2).
10. Adjust the **J 28467-6A:** assembled lift hook bracket (1) in order to align the hook with the **J 41798:** engine bracket.
11. Repeat steps 8-11 for the right lift hook.
12. Hand-tighten the lift hook wing nuts securely to remove all slack from the engine support fixture assembly.
13. The engine is now supported in the vehicle to perform repairs that require front frame removal..

REMOVAL PROCEDURE

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1. Loosen and remove the J 28467-81 Engine Support Fixture Kit.

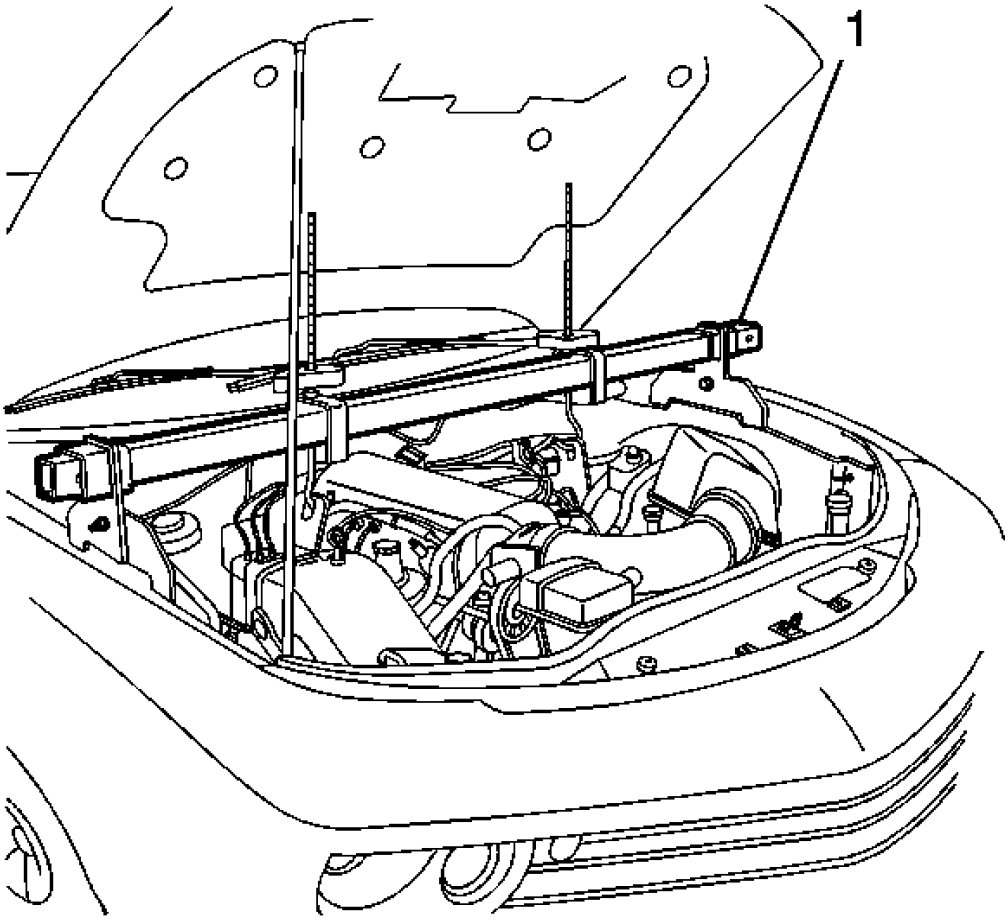


Fig. 9: Main Bar
Courtesy of GENERAL MOTORS CORP.

2. Remove the **J 28467-81:** kit (1) **J 28467-81** .

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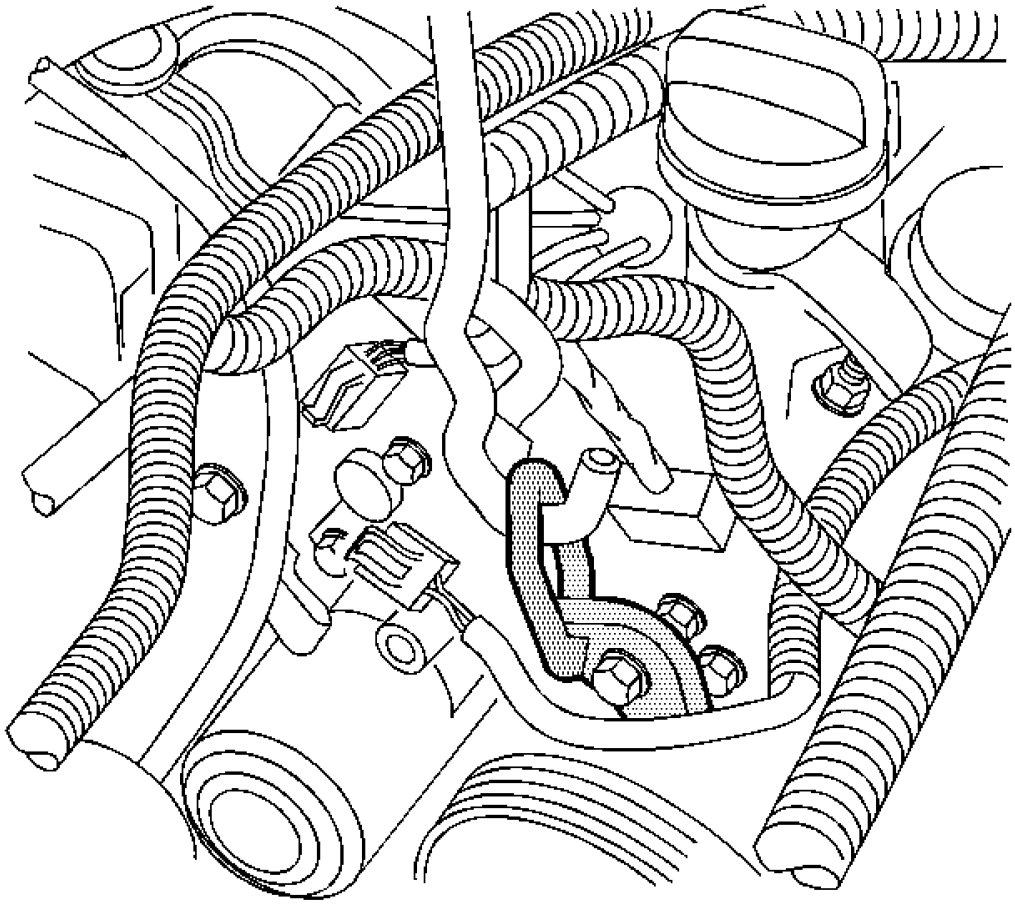


Fig. 10: Locating Engine Lift Bracket
Courtesy of GENERAL MOTORS CORP.

3. Remove the Engine Brackets from the cylinder heads.
4. Install the hood support strut.
5. Install the engine cover. Refer to **Intake Manifold Cover Replacement - Rear**.

ENGINE MOUNT INSPECTION

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

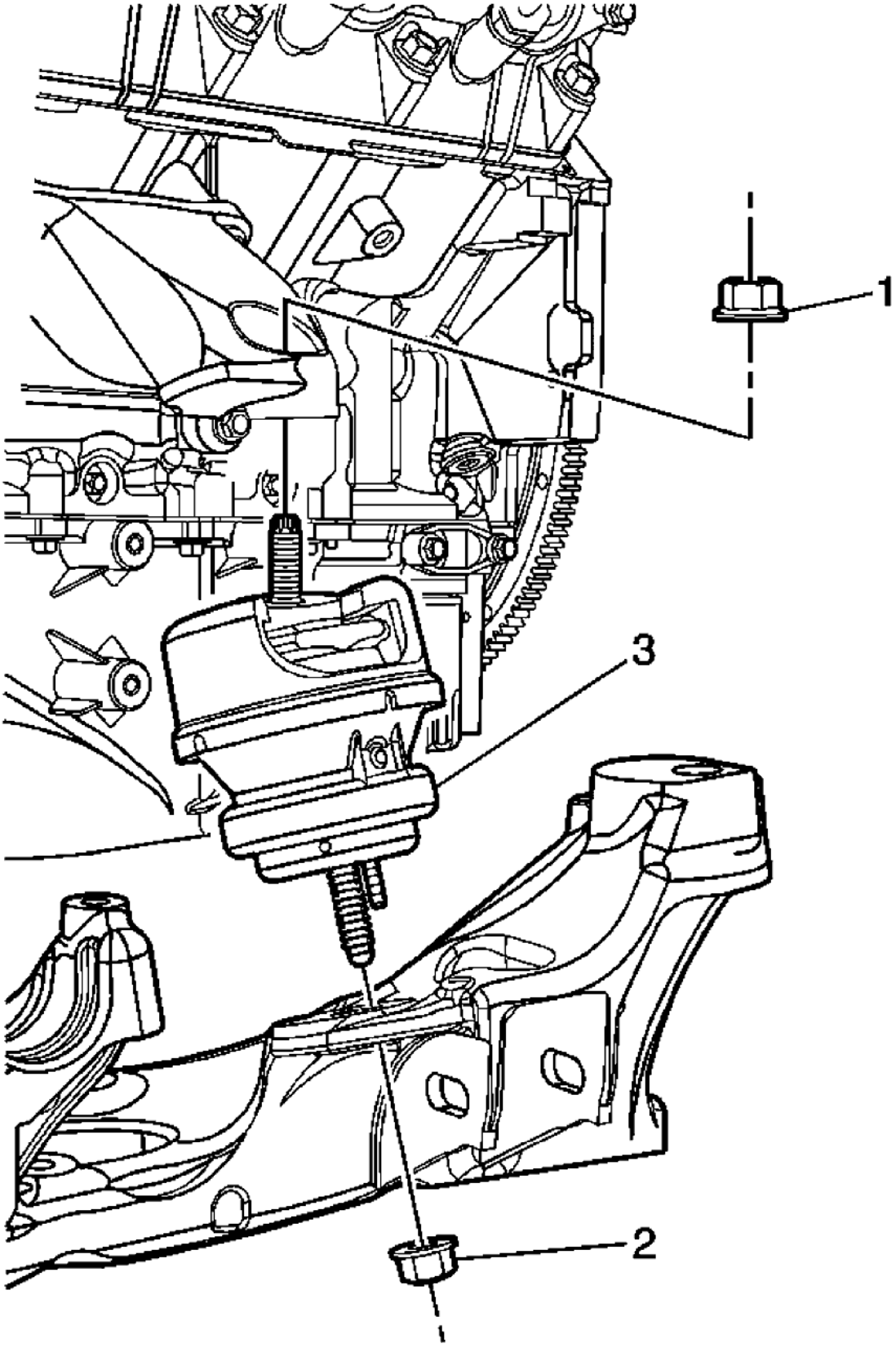
1. Install the engine support fixture. Raising the engine removes the weight from the engine mount and creates slight tension in the rubber.

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2. Observe the engine mount while raising the engine. Replace the engine mount if the engine mount exhibits any of the following conditions:
    - The hard rubber surface is covered with heat check cracks.
    - The rubber is separated from the metal plate of the engine mount.
    - The rubber is split through the center of the engine mount.
    - The GLYCOL™ fluid is leaking from the engine mount.
3. If there is movement between the metal plate of the engine mount and its attaching points, lower the engine on the engine mount. Tighten the bolts or nuts attaching the engine mount to the frame or engine mount bracket. Refer to **Engine Mount Replacement - Left Side** or **Engine Mount Replacement - Right Side**.

ENGINE MOUNT REPLACEMENT - LEFT SIDE

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Fig. 11: Identifying Engine Mount - Left Side (RWD)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Mount Fastener **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Procedure** 1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Position a screw jack and a block of wood under the engine oil pan. **Tighten:** 80 N.m (59 lb ft)
2	Engine Mount Fastener **Procedure:** The engine mounts must be replaced once loosened or removed. **Tighten:** 80 N.m (59 lb ft)
3	Engine Mount **Procedure** 1. Using the screw jack, raise the engine enough to remove the engine mount. 2. Install the new right and left engine mount lower nut first.

ENGINE MOUNT REPLACEMENT - RIGHT SIDE

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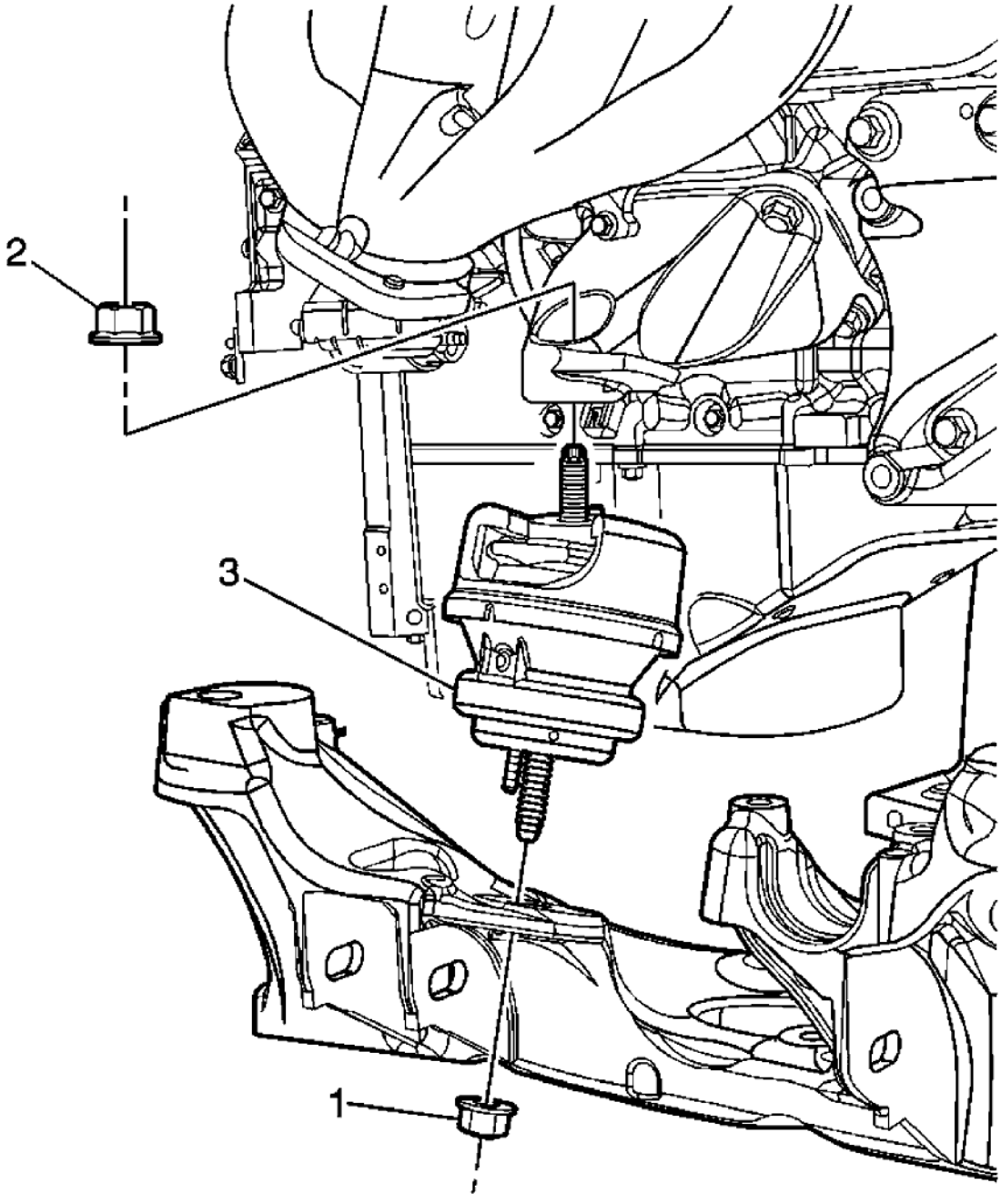


Fig. 12: Engine Mount - Right Side
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
	Engine Mount Fastener **CAUTION:** **Refer to Component Fastener Tightening Caution .**

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1	**Procedure** 1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Position a screw jack and a block of wood under the engine oil pan. **Tighten:** 80 N.m (59 lb ft)
2	Engine Mount Fastener **Procedure:** The engine mounts must be replaced once loosened or removed. **Tighten:** 80 N.m (59 lb ft)
3	Engine Mount **Procedure** 1. Using the screw jack, raise the engine enough to remove the engine mount. 2. Install the new right and left engine mount lower nut first.

ENGINE MOUNT BRACKET REPLACEMENT - LEFT SIDE

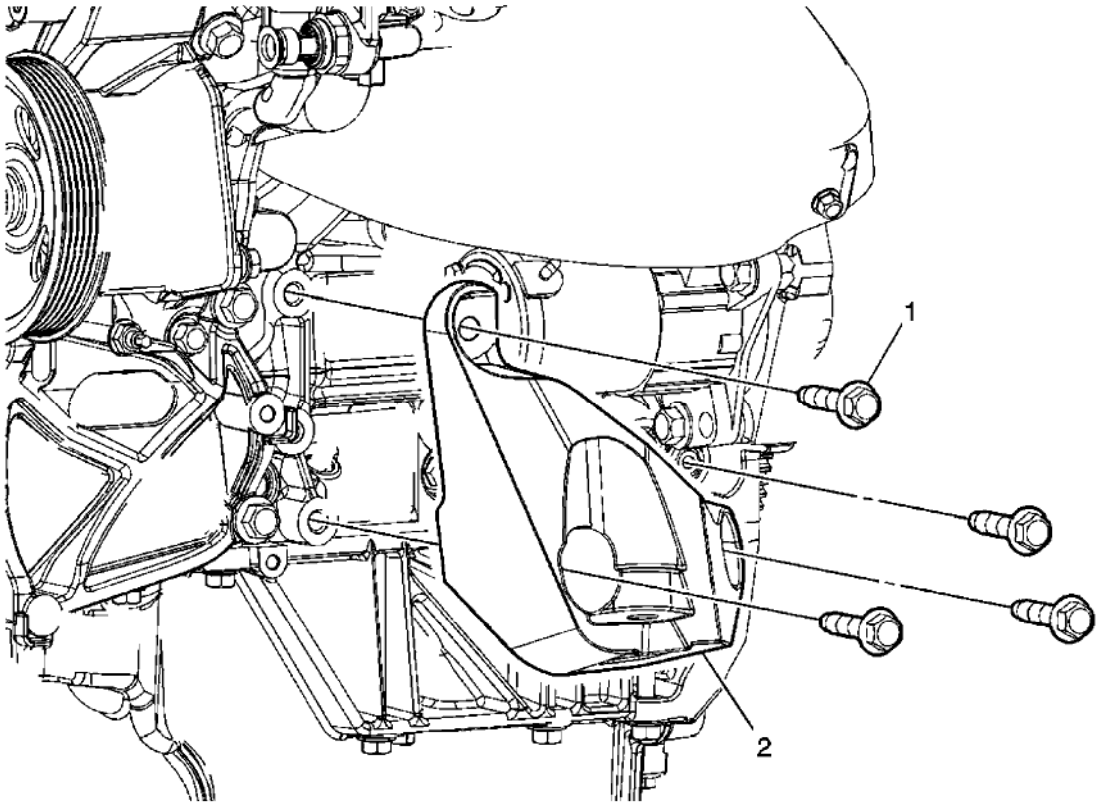


Fig. 13: Engine Mount Bracket - Left Side

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Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the engine mount. Refer to **Engine Mount Replacement - Left Side**.	
1	Engine Mount Bracket Fastener (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 60 N.m (44 lb ft)
2	Engine Mount Bracket **Procedure:** Transfer components as necessary.

ENGINE MOUNT BRACKET REPLACEMENT - RIGHT SIDE

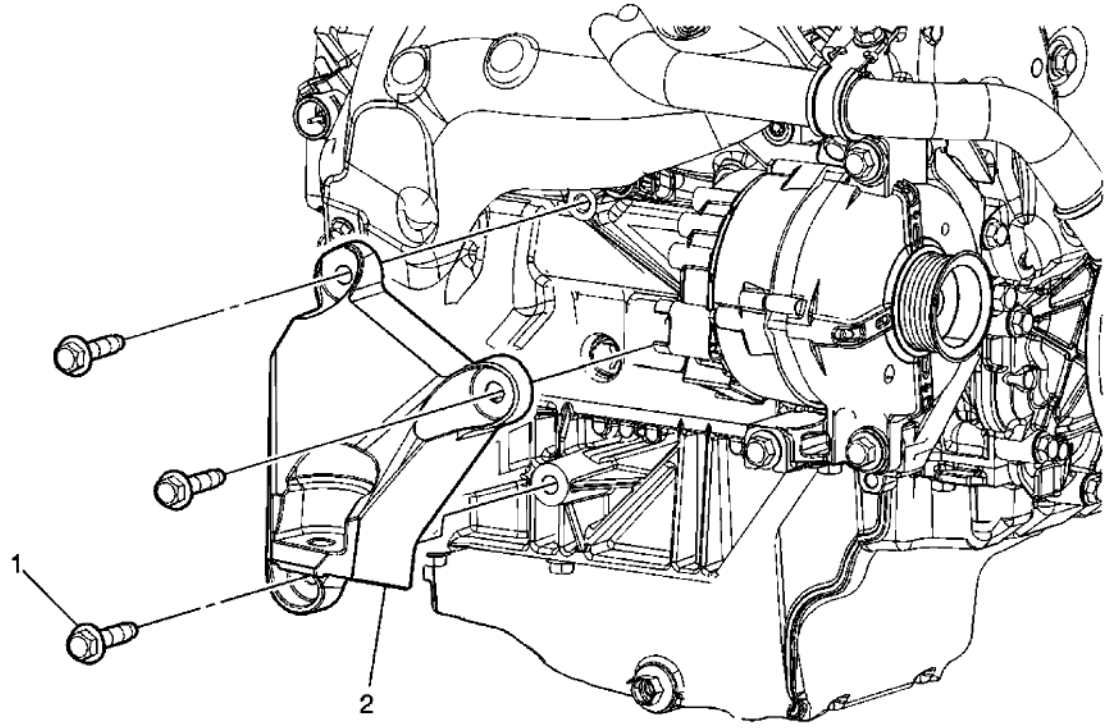


Fig. 14: Engine Mount Bracket - Right Side
Courtesy of GENERAL MOTORS CORP.

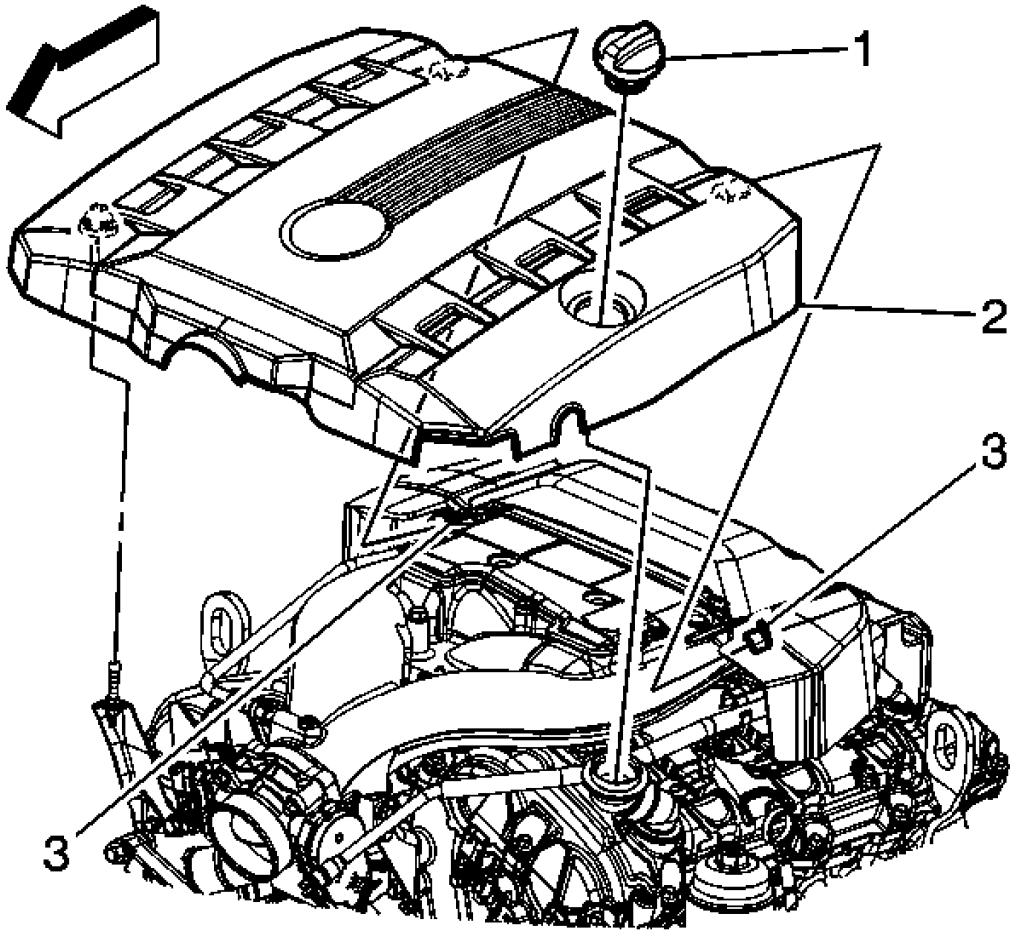
Callout	Component Name
Preliminary Procedure: Remove the engine mount. Refer to **Engine Mount Replacement - Right Side**.	

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1	Engine Mount Bracket Fastener (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 60 N.m (44 lb ft)
2	Engine Mount Bracket **Procedure:** Transfer components as necessary.

INTAKE MANIFOLD COVER REPLACEMENT - FRONT

REMOVAL PROCEDURE



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Fig. 15: Removing/Installing Front Compartment Sight Shield
Courtesy of GENERAL MOTORS CORP.

1. Remove the oil fill cap (1).
2. Disengage the cover/shield (2) from the ball studs by pulling up firmly on the right and left front of the engine cover.
3. Pull the engine cover/sight shield forward to remove from the rear tabs (3).
4. Remove the engine cover/sight shield.

INSTALLATION PROCEDURE

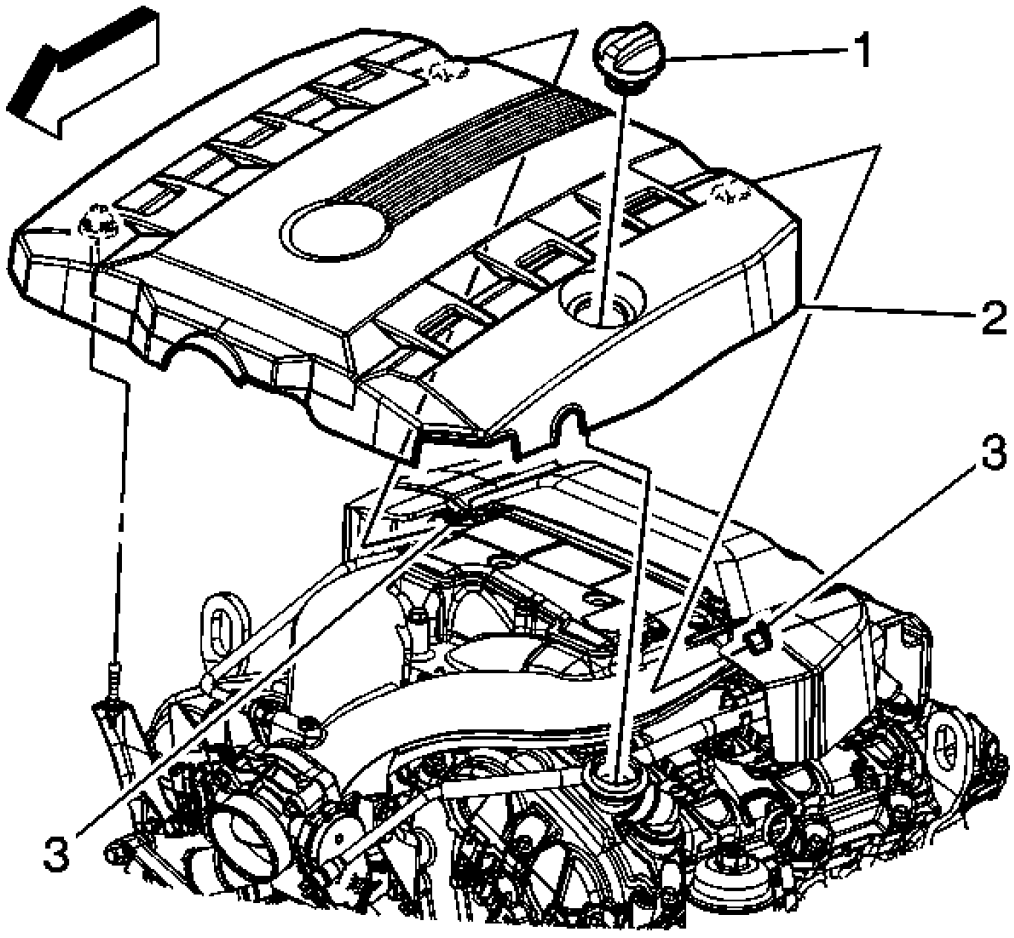


Fig. 16: Removing/Installing Front Compartment Sight Shield
Courtesy of GENERAL MOTORS CORP.

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1. Raise the front edge of the cover (2) while inserting the rear tabs.
2. Lower the front edge of the cover and slide the cover rearward so that the rear tabs slide under the retainers.
3. Align the cover over the oil fill tube.
4. Press the cover down firmly on the ball stud at the right front corner.
5. Install the oil fill cap (1).

INTAKE MANIFOLD COVER REPLACEMENT - REAR

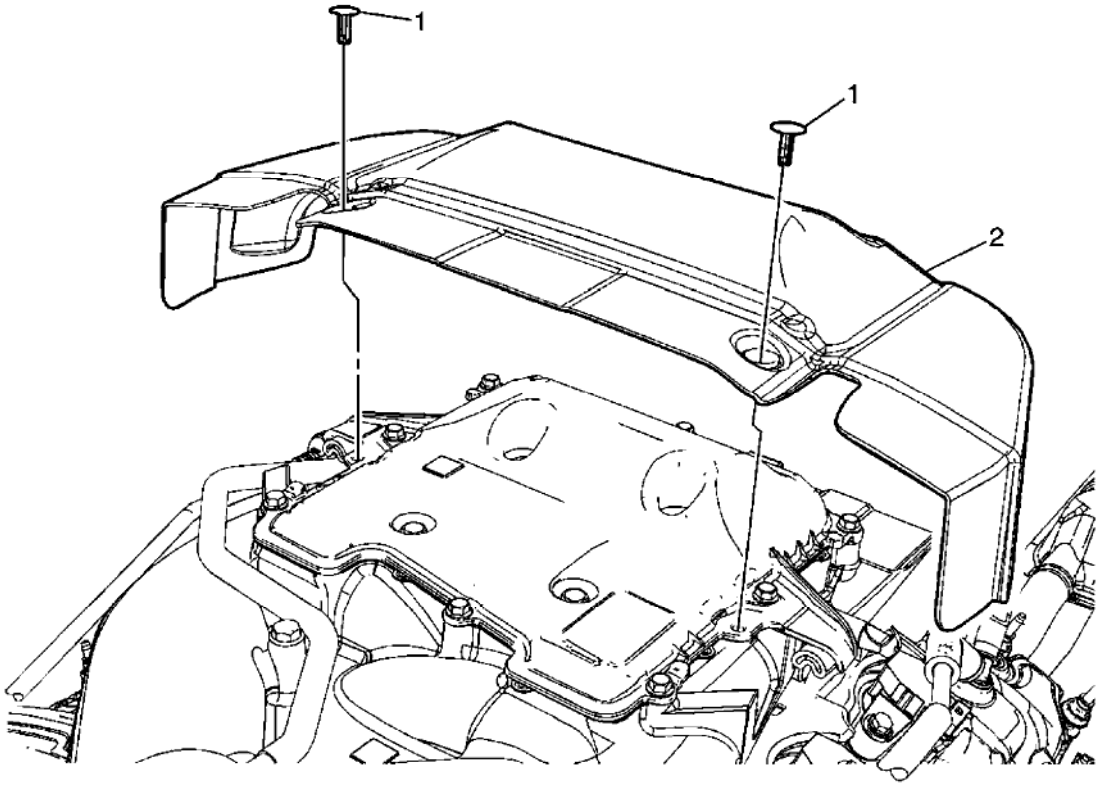


Fig. 17: Intake Manifold Cover - Rear
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedure: Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Front**.	
1	Intake Manifold Cover Fastener (Qty: 2)
2	Intake Manifold Cover **Procedure:** Transfer components as necessary.

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT

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REMOVAL PROCEDURE

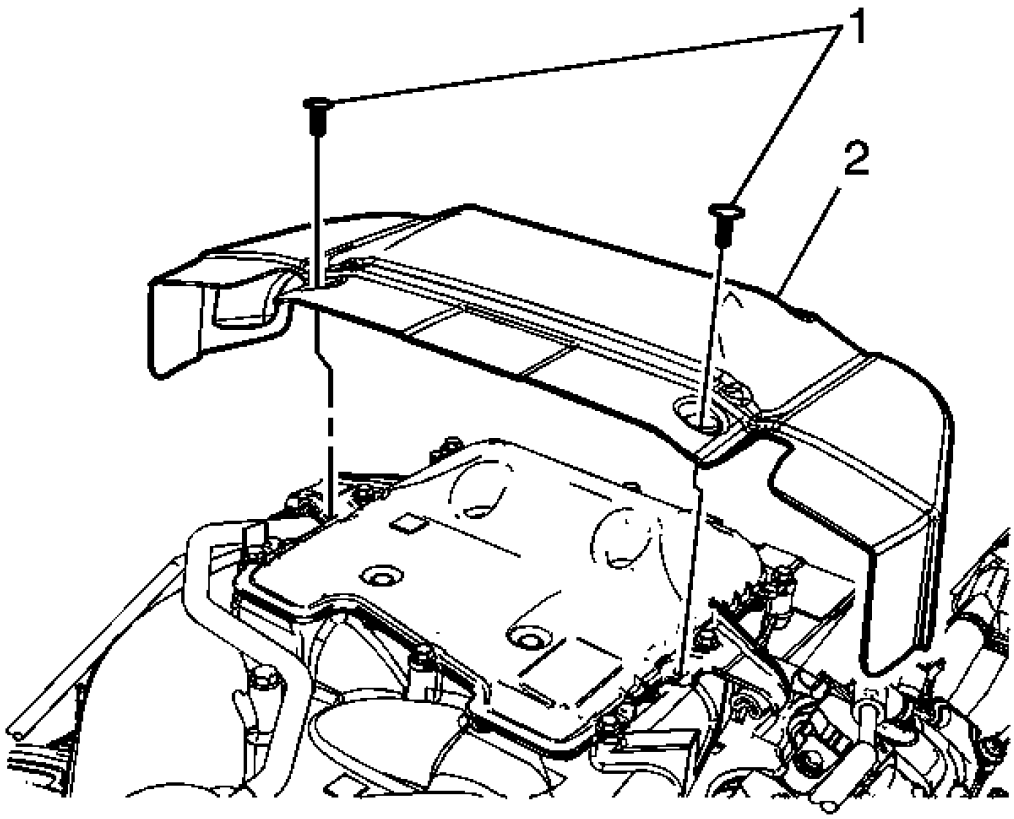


Fig. 18: Removing/Installing Intake Manifold Insulator
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Rear**
2. Remove the two intake manifold insulator retaining pins (1).
3. Remove the intake manifold insulator (2).

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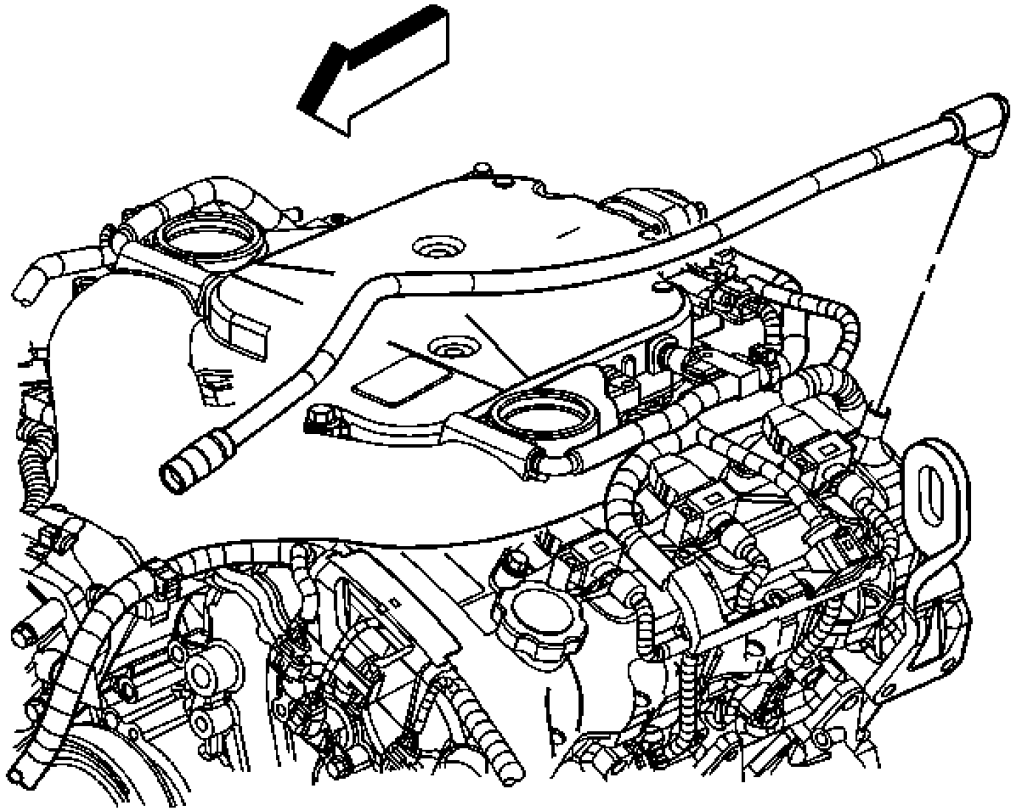


Fig. 19: View Of PCV Fresh Air Tube
Courtesy of GENERAL MOTORS CORP.

4. Remove the positive crankcase ventilation (PCV) fresh air tube from the left camshaft cover.
5. Remove the PCV fresh air tube from the air inlet.

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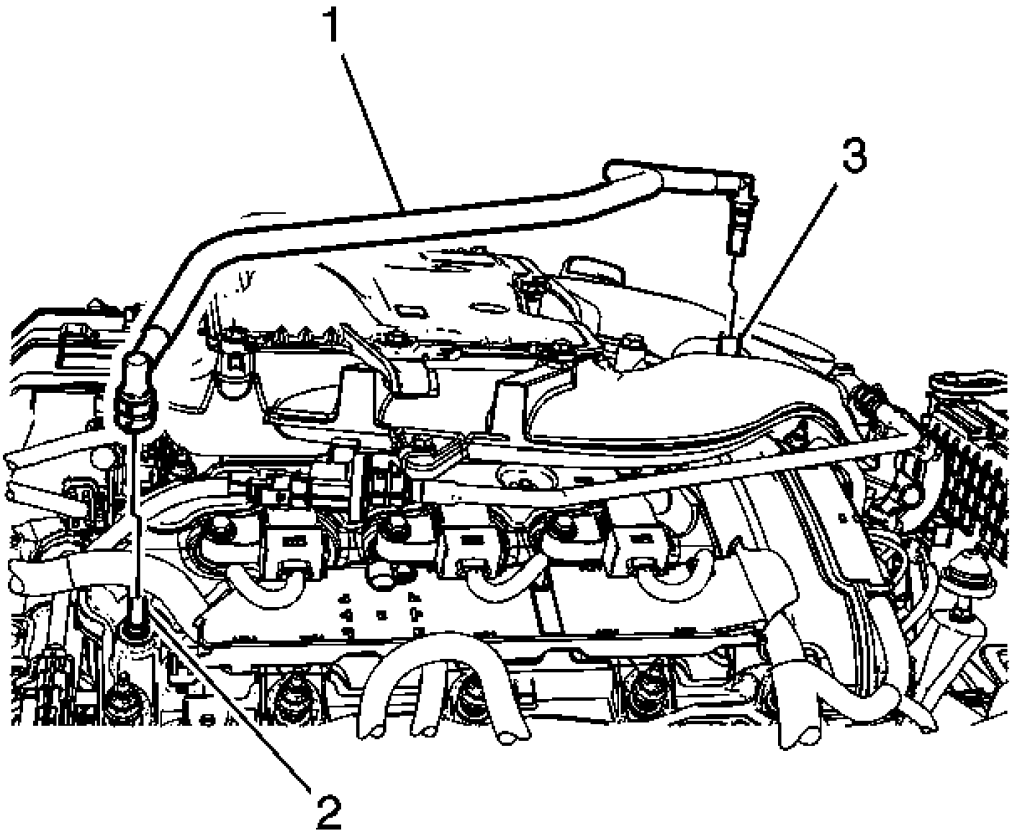


Fig. 20: Identifying PCV Dirty Air Tube
Courtesy of GENERAL MOTORS CORP.

6. Remove the PCV dirty air tube (1) from the right camshaft cover (2).
7. Remove the PCV dirty air tube (1) from the intake manifold (3).

INSTALLATION PROCEDURE

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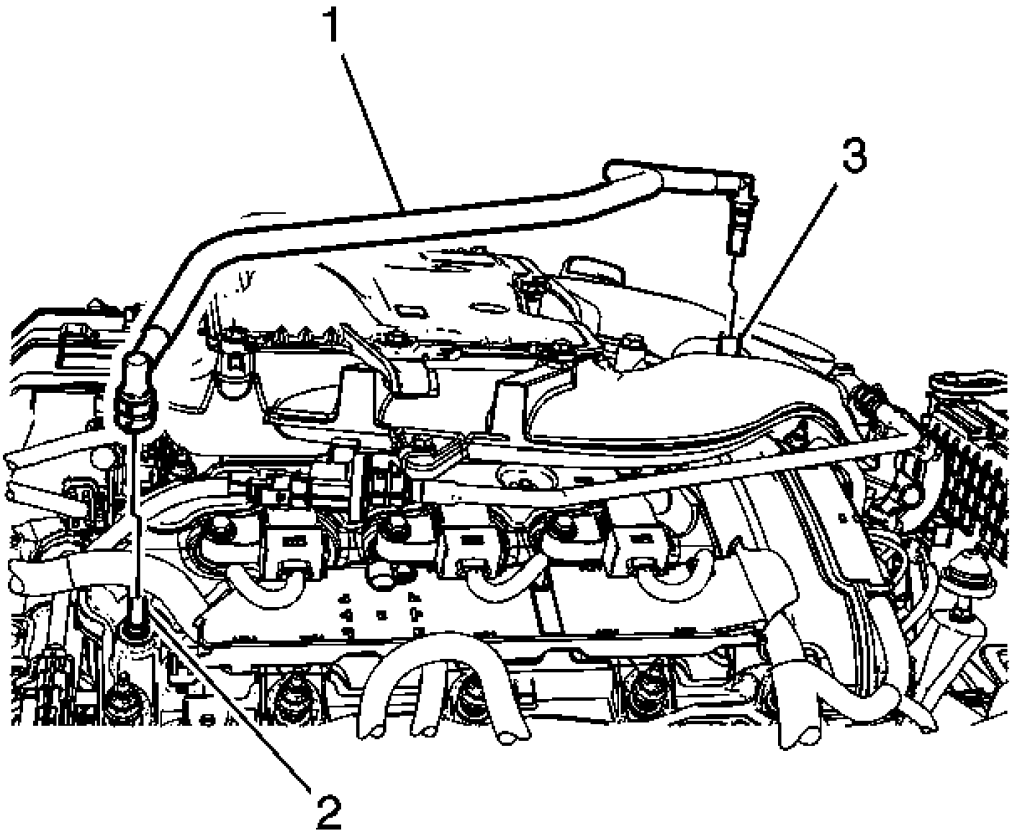


Fig. 21: Identifying PCV Dirty Air Tube
Courtesy of GENERAL MOTORS CORP.

1. Install the PCV dirty air tube (1) to the intake manifold (3).
2. Install the PCV dirty air tube (1) to the right camshaft cover (2).

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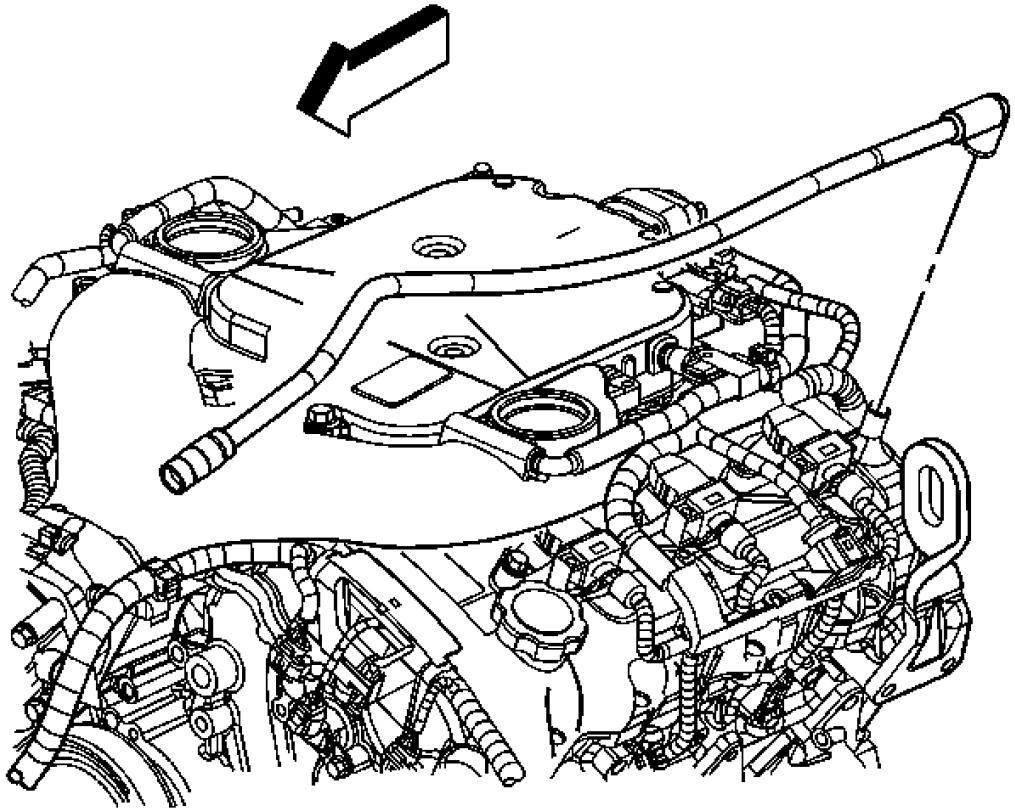


Fig. 22: View Of PCV Fresh Air Tube
Courtesy of GENERAL MOTORS CORP.

3. Install the PCV fresh air tube to the air inlet.
4. Install the PCV fresh air tube to the left camshaft cover.

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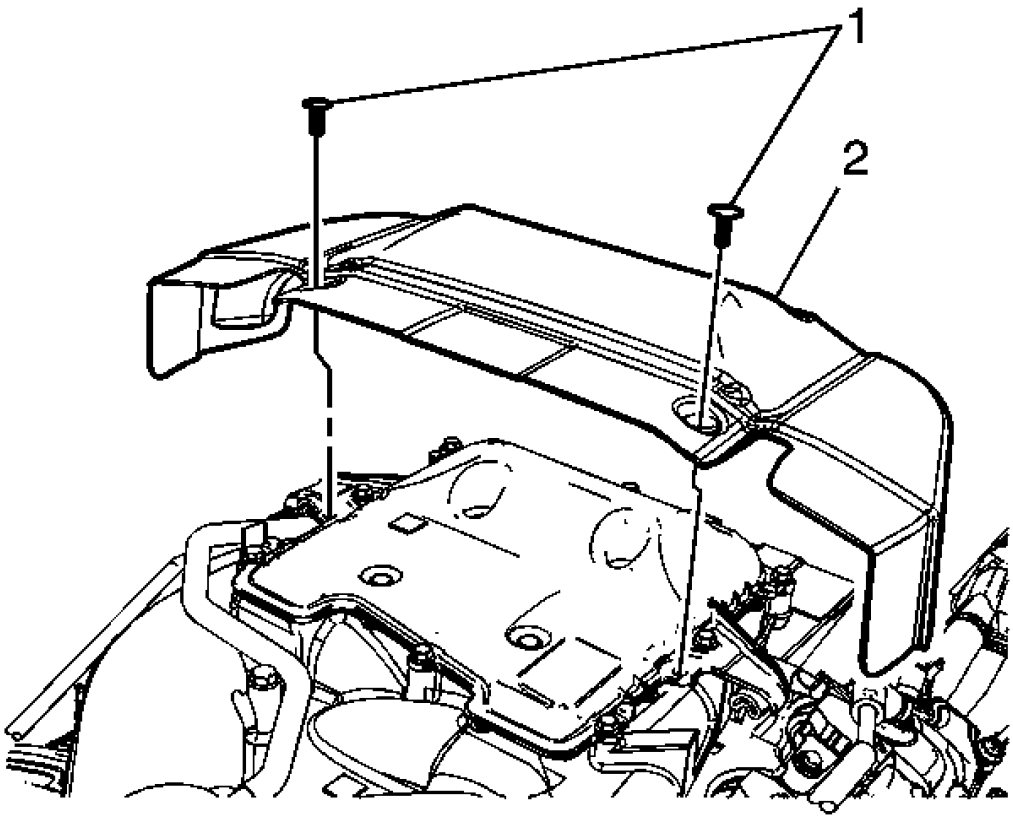


Fig. 23: Removing/Installing Intake Manifold Insulator
Courtesy of GENERAL MOTORS CORP.

5. Install the intake manifold insulator (2).
6. Install the two intake manifold insulator retaining pins (1).
7. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Rear**

INTAKE MANIFOLD REPLACEMENT

REMOVAL PROCEDURE

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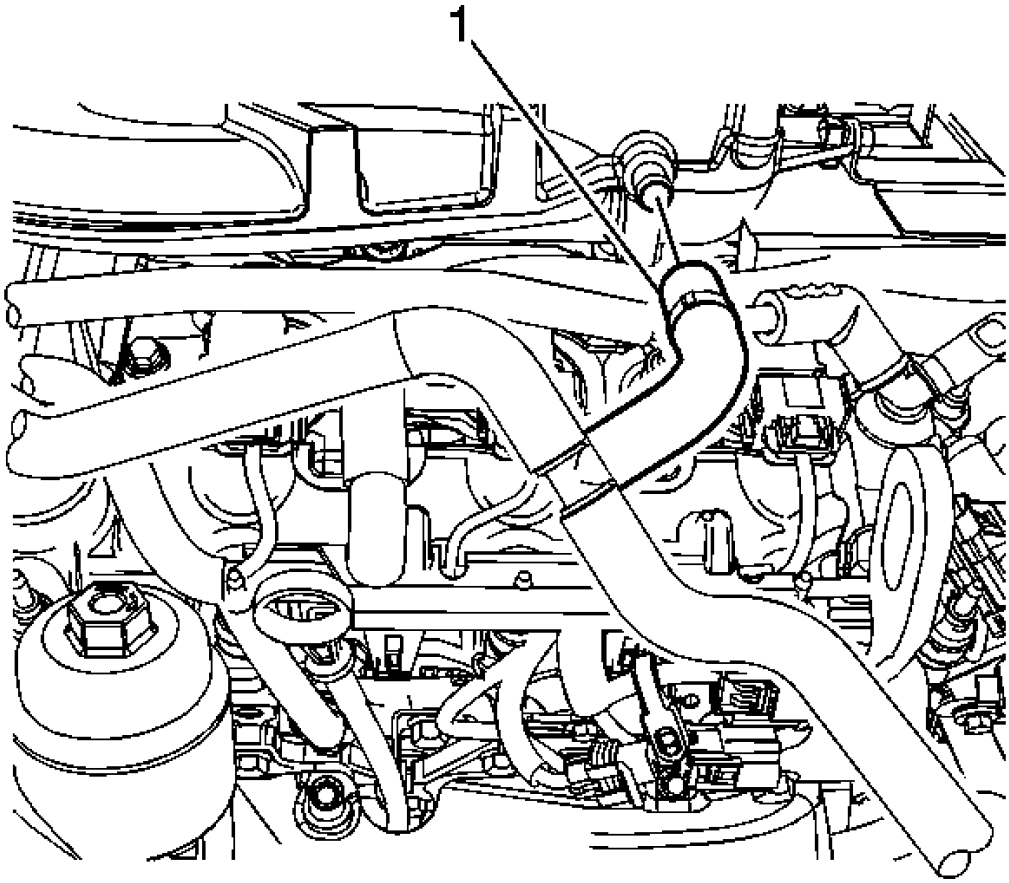


Fig. 24: Identifying Brake Booster Vacuum Hose
Courtesy of GENERAL MOTORS CORP.

1. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement** .
2. Remove the air outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
3. Disconnect the brake booster vacuum hose (1) from the intake manifold.

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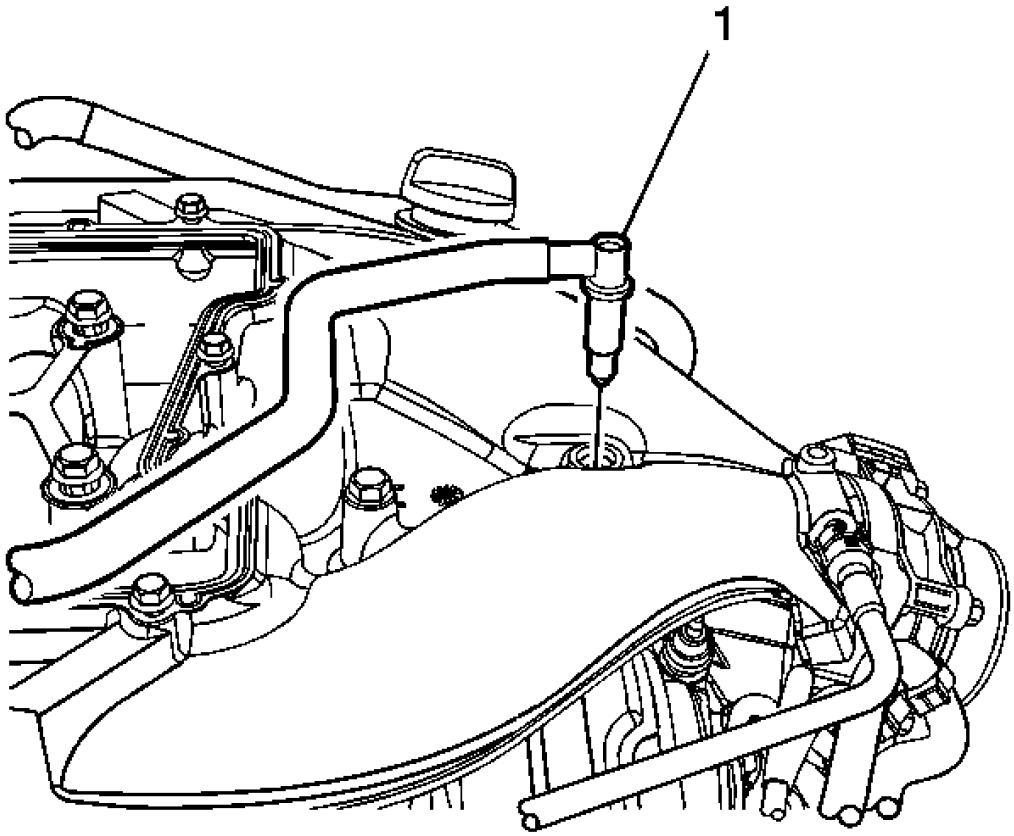


Fig. 25: Identifying Positive Crankcase Ventilation Hose
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the positive crankcase ventilation (PCV) hose (1) from the intake manifold.

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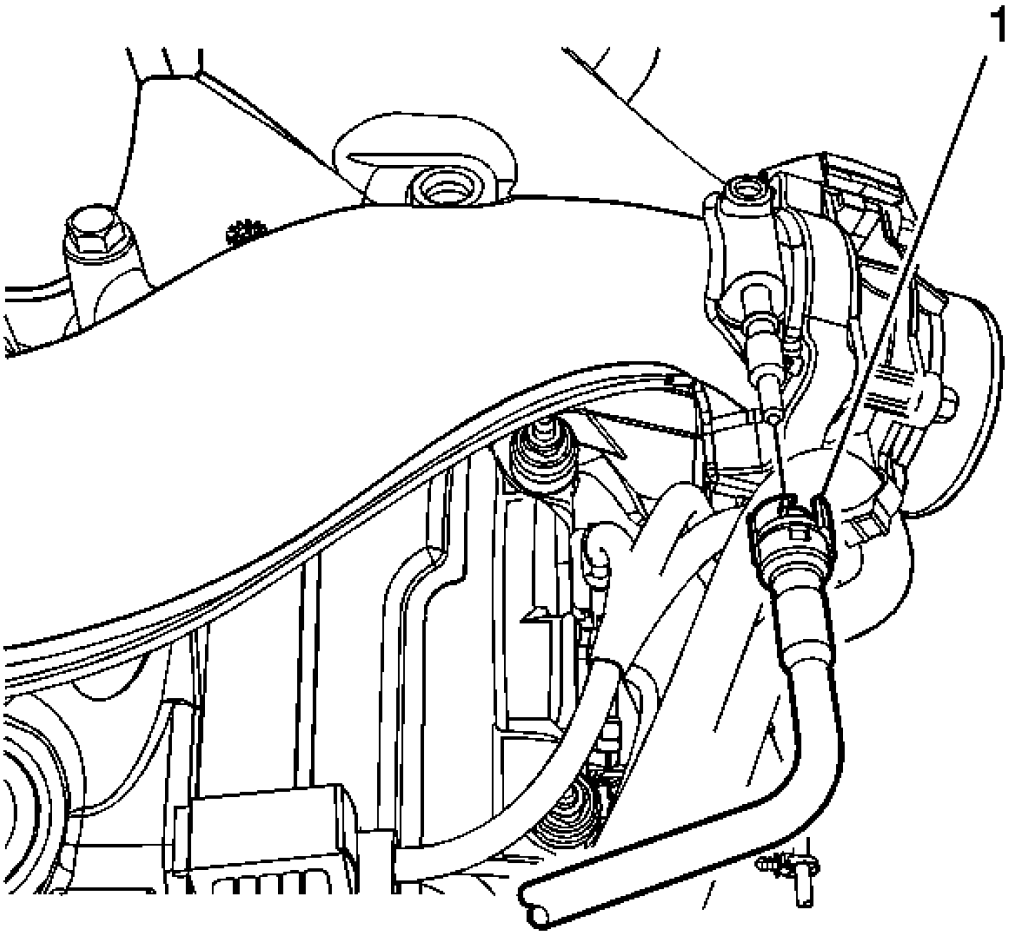


Fig. 26: Identifying Purge Line
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the purge line (1) from the intake manifold.

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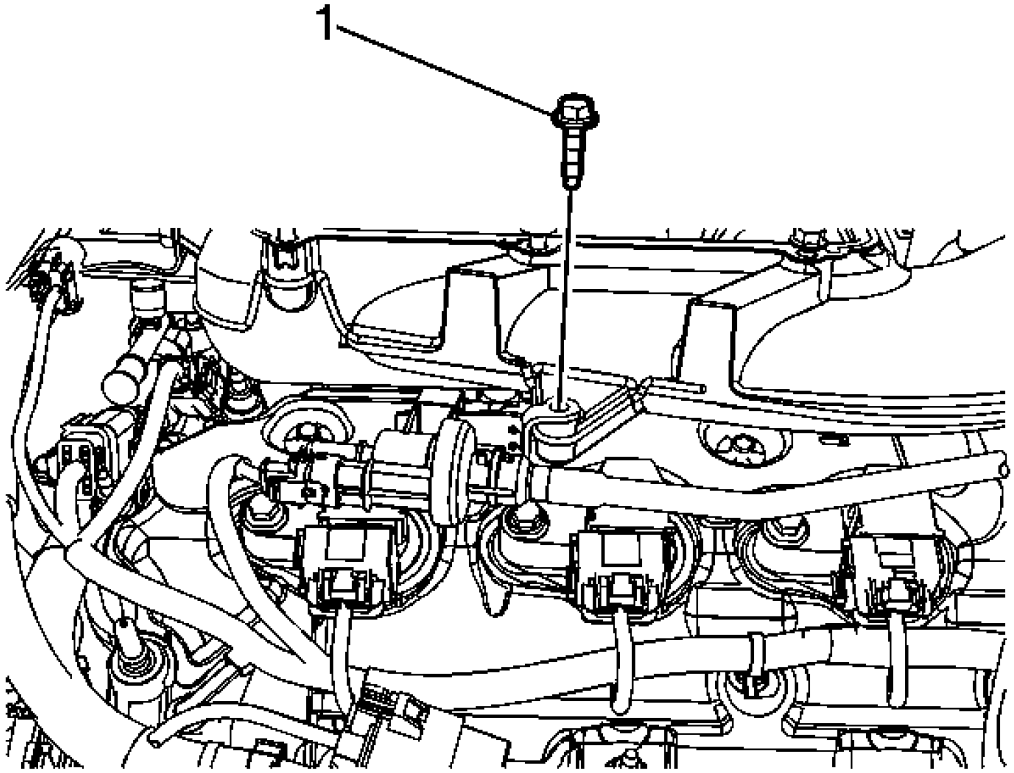


Fig. 27: Identifying Purge Solenoid Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the purge solenoid bolt (1) from the intake manifold and set the purge solenoid aside.

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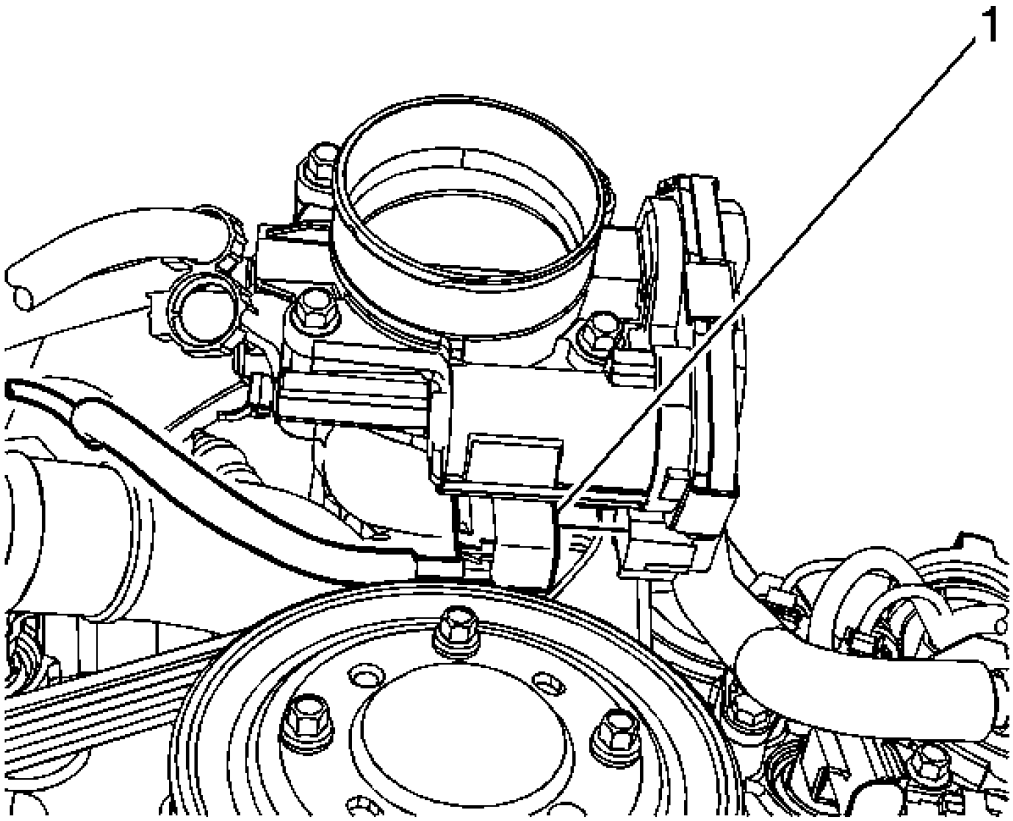


Fig. 28: Identifying Throttle Body Electrical Connector
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the throttle body electrical connector (1).

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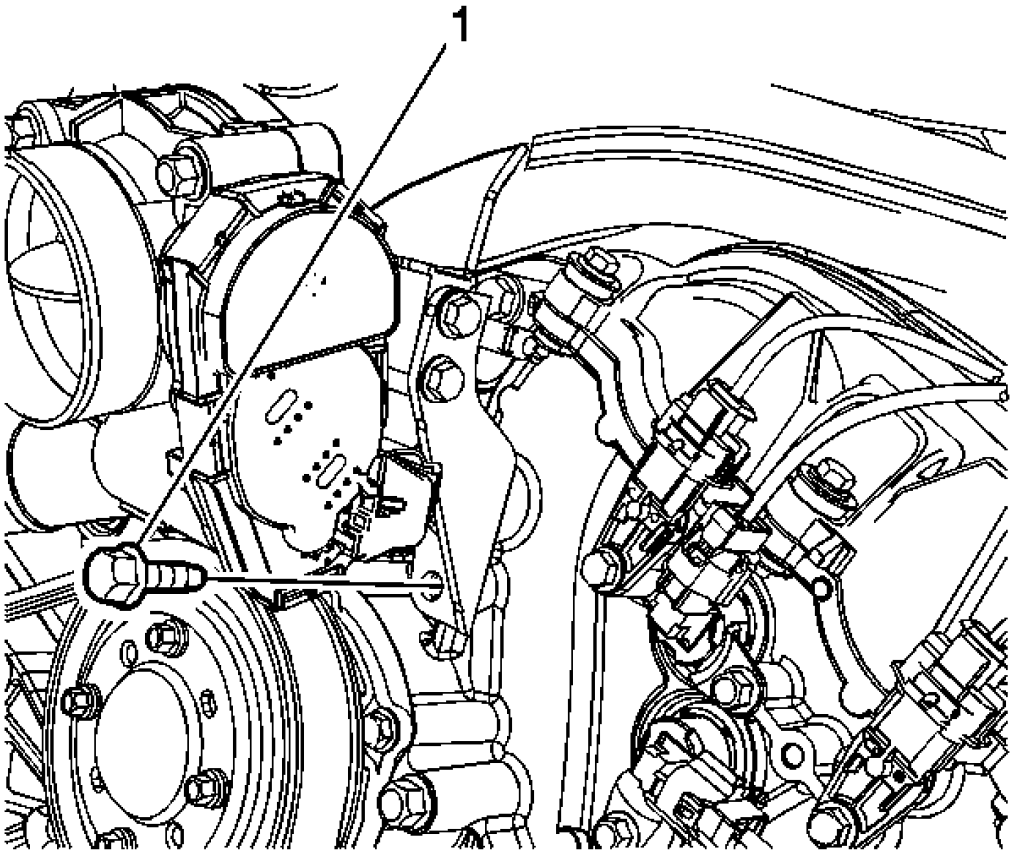


Fig. 29: Identifying Intake Manifold Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

8. Remove the intake manifold bracket bolt (1).
9. Unclip the engine wiring harness from the intake manifold.

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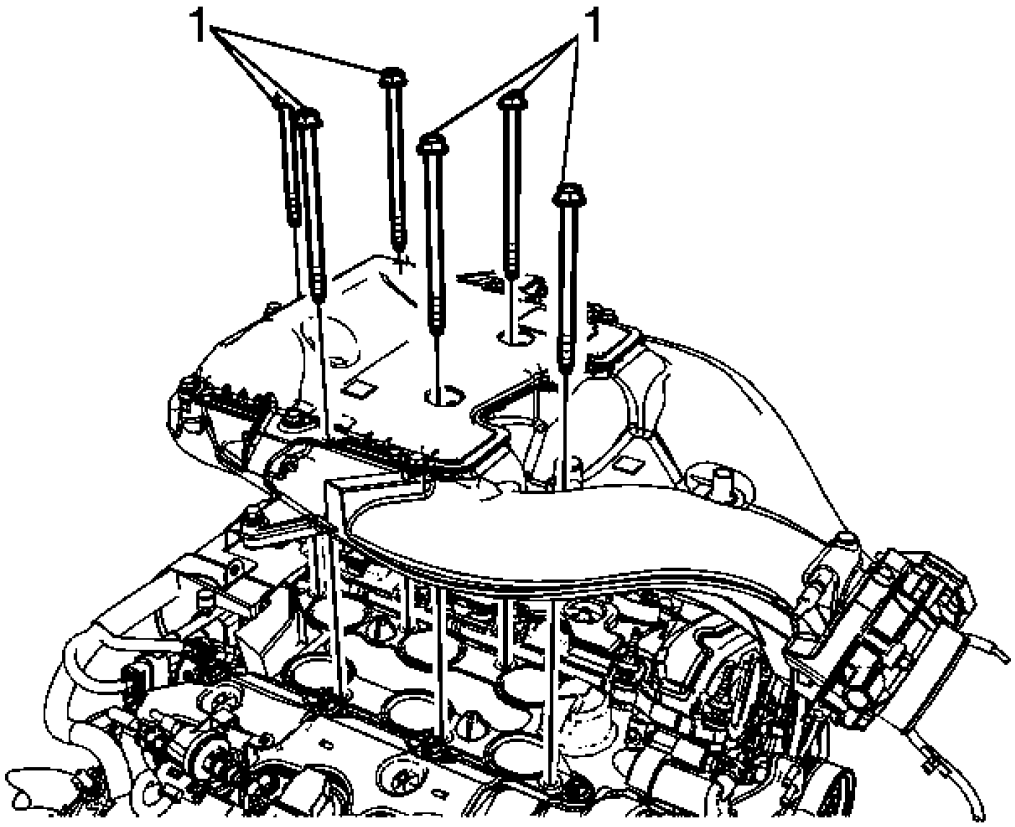


Fig. 30: Identifying Intake Manifold Bolts
Courtesy of GENERAL MOTORS CORP.

10. Remove the intake manifold bolts (1).
11. Remove the intake manifold and gasket.
12. If replacing the intake manifold, disassemble the intake manifold. Refer to **Intake Manifold Disassemble (LLT)** .

INSTALLATION PROCEDURE

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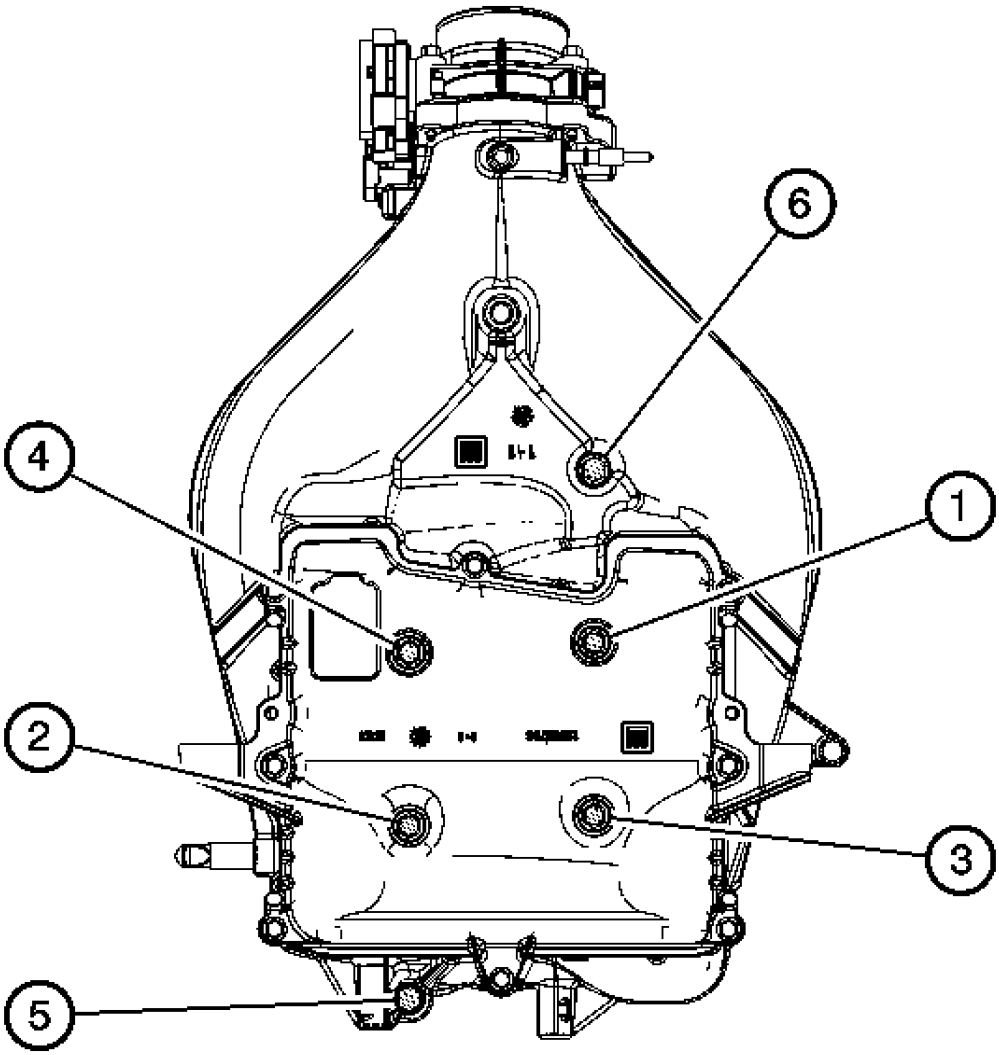


Fig. 31: Identifying Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

1. If installing a new intake manifold, assemble the intake manifold. Refer to **Intake Manifold Assemble (LLT)** .
2. Install the NEW intake manifold gasket.
3. Tighten the intake manifold bolts in the sequence shown (1-6).

CAUTION: Refer to Fastener Caution .

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4. Install the intake manifold bolts (1) and tighten to 25 N.m (18 lb ft).

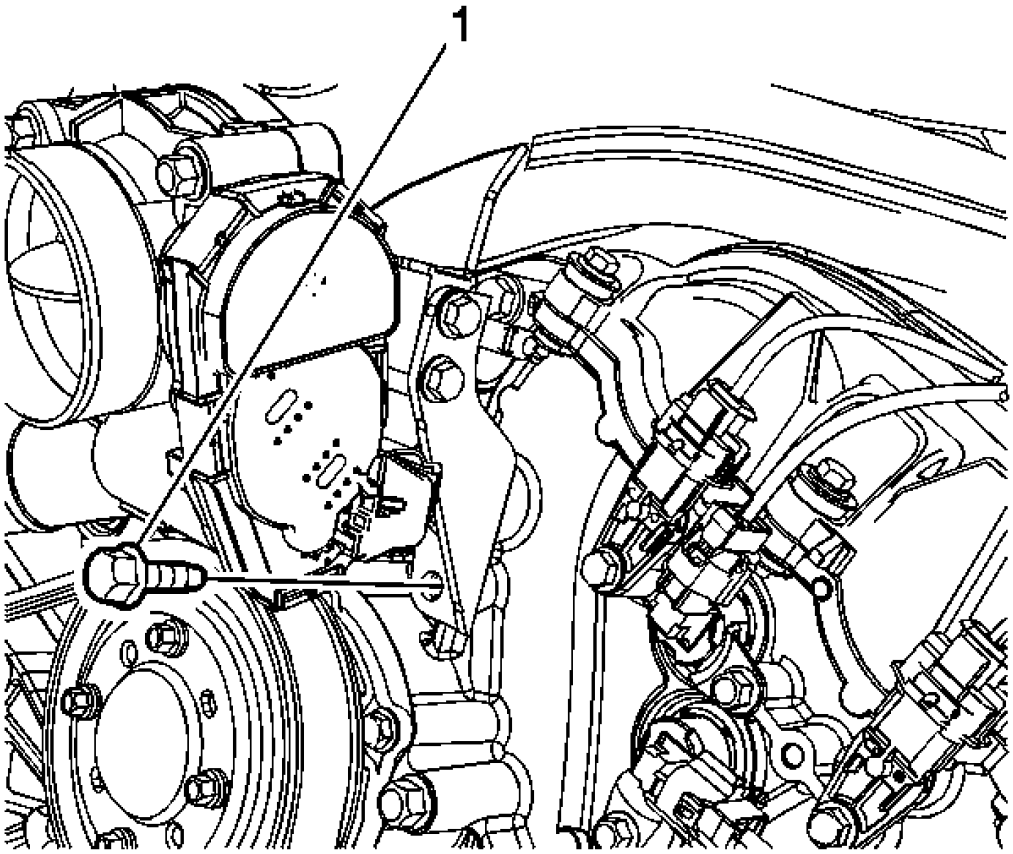


Fig. 32: Identifying Intake Manifold Bracket Bolt
Courtesy of GENERAL MOTORS CORP.

5. Clip the engine wiring harness from the intake manifold.
6. Install the intake manifold bracket bolt (1) and tighten to 23 N.m (17 lb ft).

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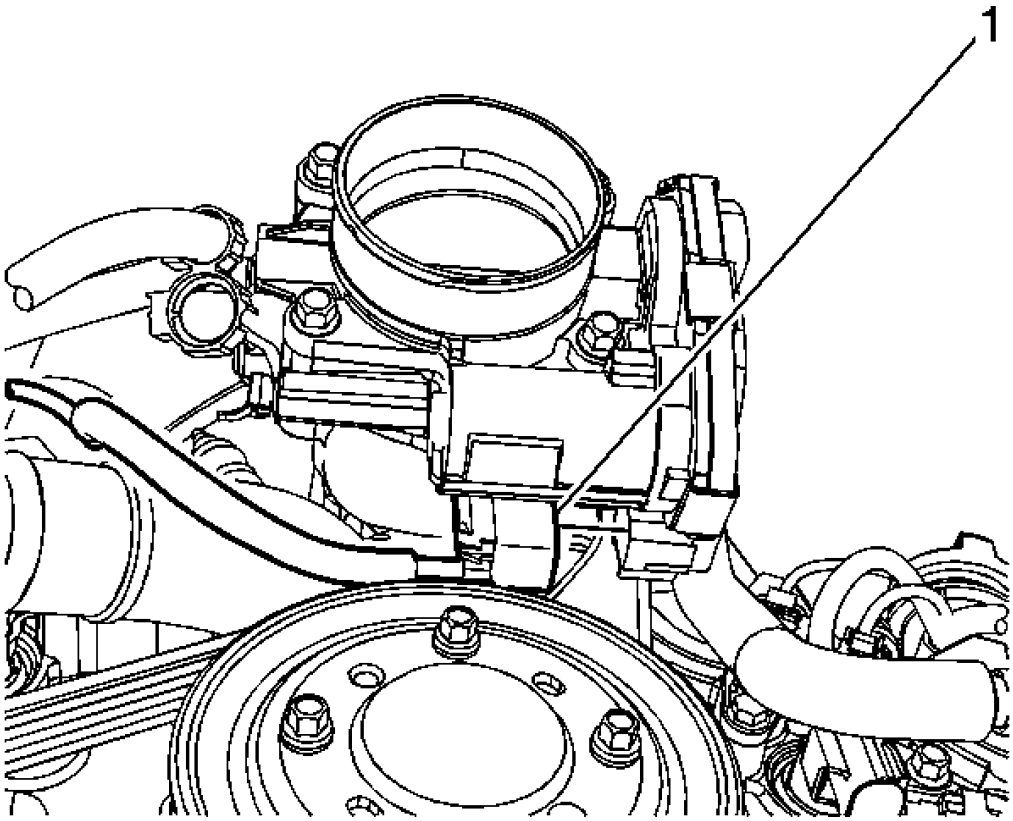


Fig. 33: Identifying Throttle Body Electrical Connector
Courtesy of GENERAL MOTORS CORP.

7. Connect the throttle body electrical connector (1).

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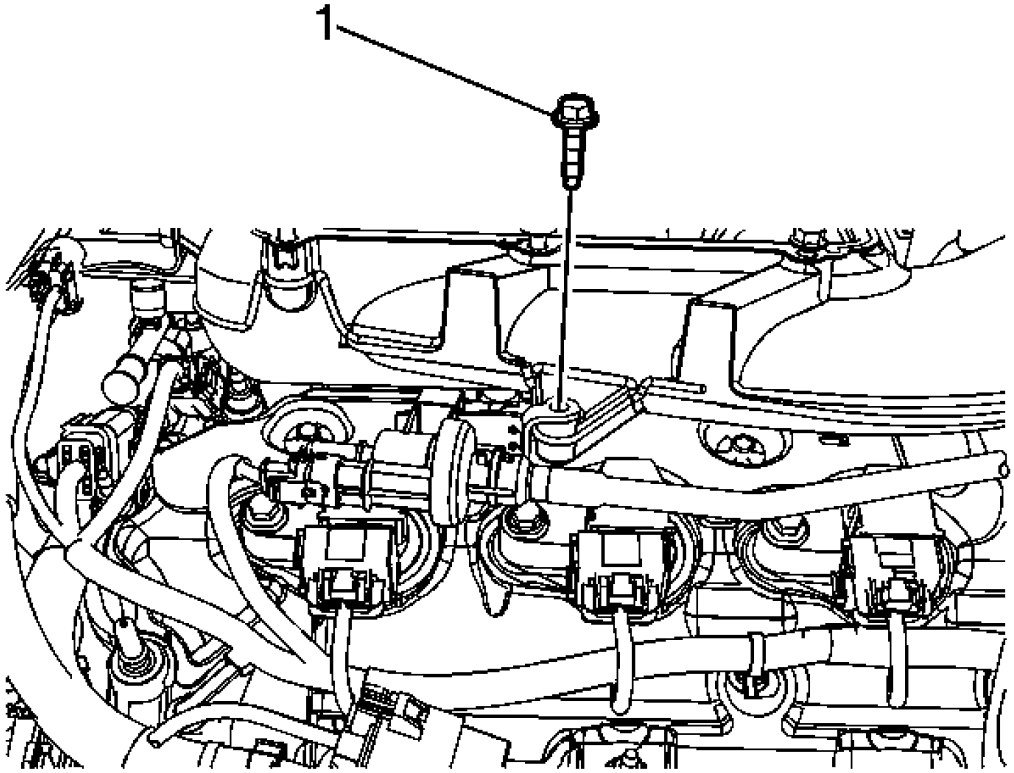


Fig. 34: Identifying Purge Solenoid Bolt
Courtesy of GENERAL MOTORS CORP.

8. Install the purge solenoid bolt (1) to the intake manifold.

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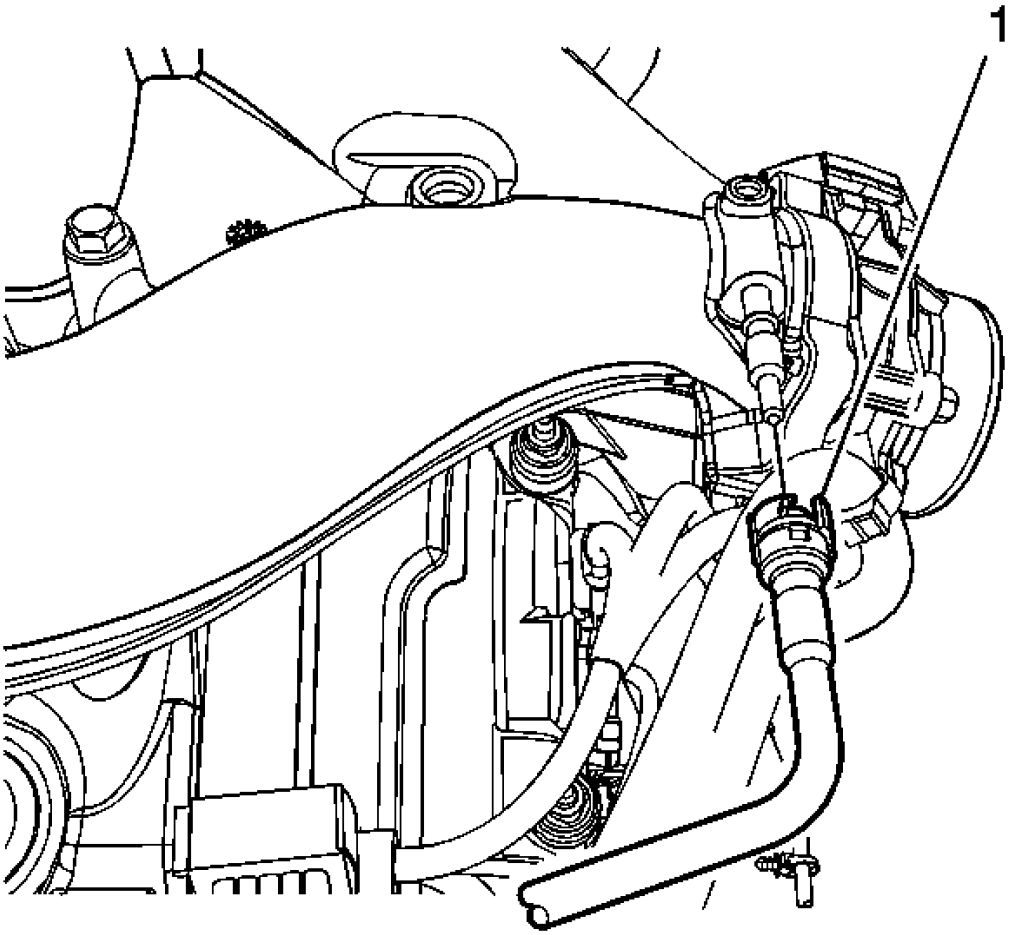


Fig. 35: Identifying Purge Line
Courtesy of GENERAL MOTORS CORP.

9. Connect the purge line (1) to the intake manifold.

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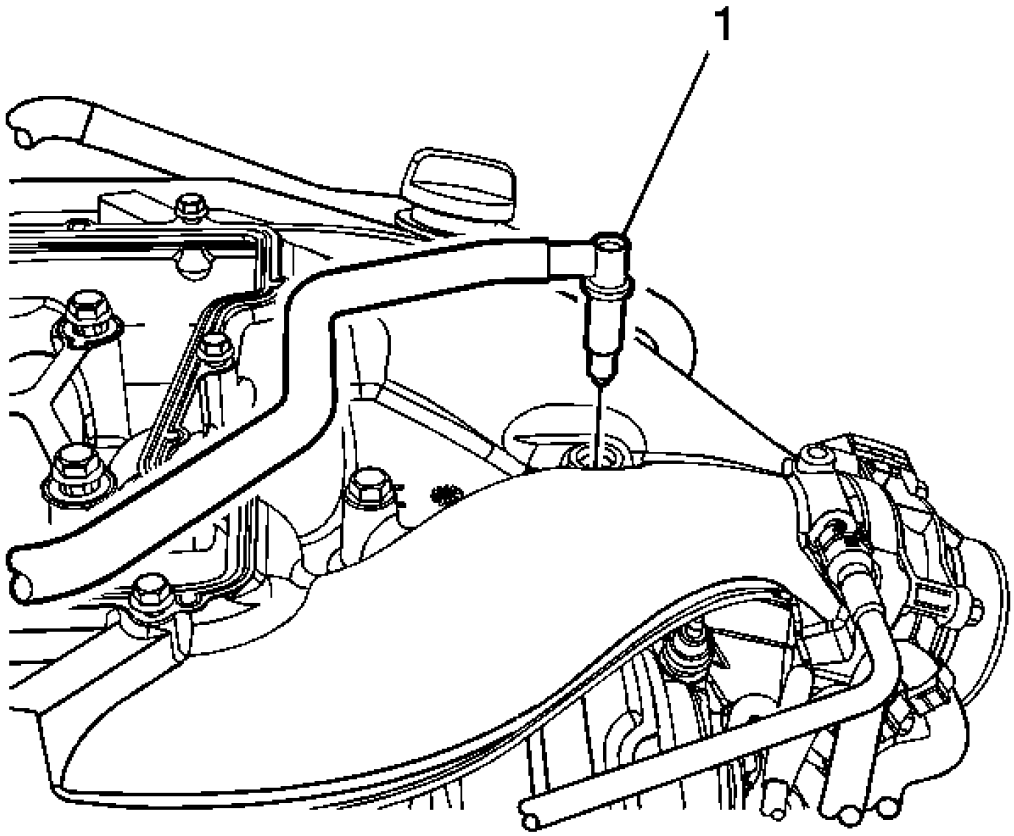


Fig. 36: Identifying Positive Crankcase Ventilation Hose
Courtesy of GENERAL MOTORS CORP.

10. Connect the PCV hose (1) to the intake manifold.

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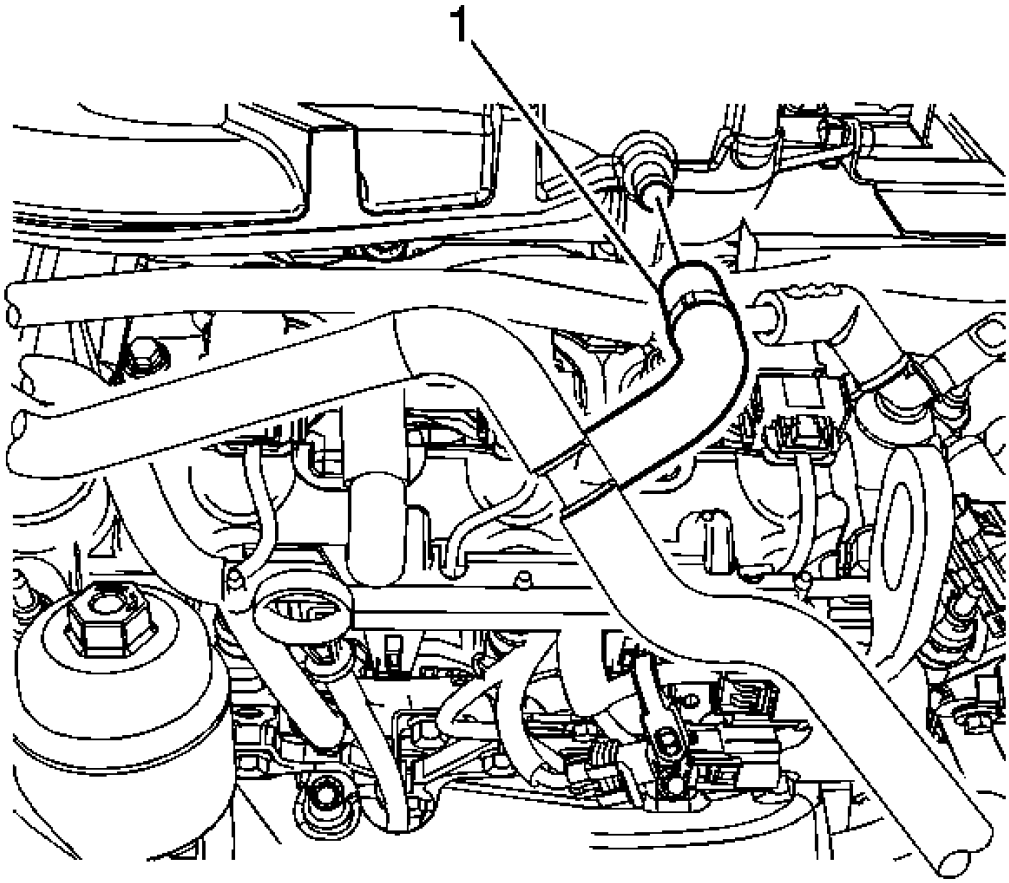


Fig. 37: Identifying Brake Booster Vacuum Hose
Courtesy of GENERAL MOTORS CORP.

11. Connect the brake booster vacuum hose (1) from the intake manifold.
12. Install the air outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
13. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement** .

OIL LEVEL INDICATOR TUBE REPLACEMENT

REMOVAL PROCEDURE

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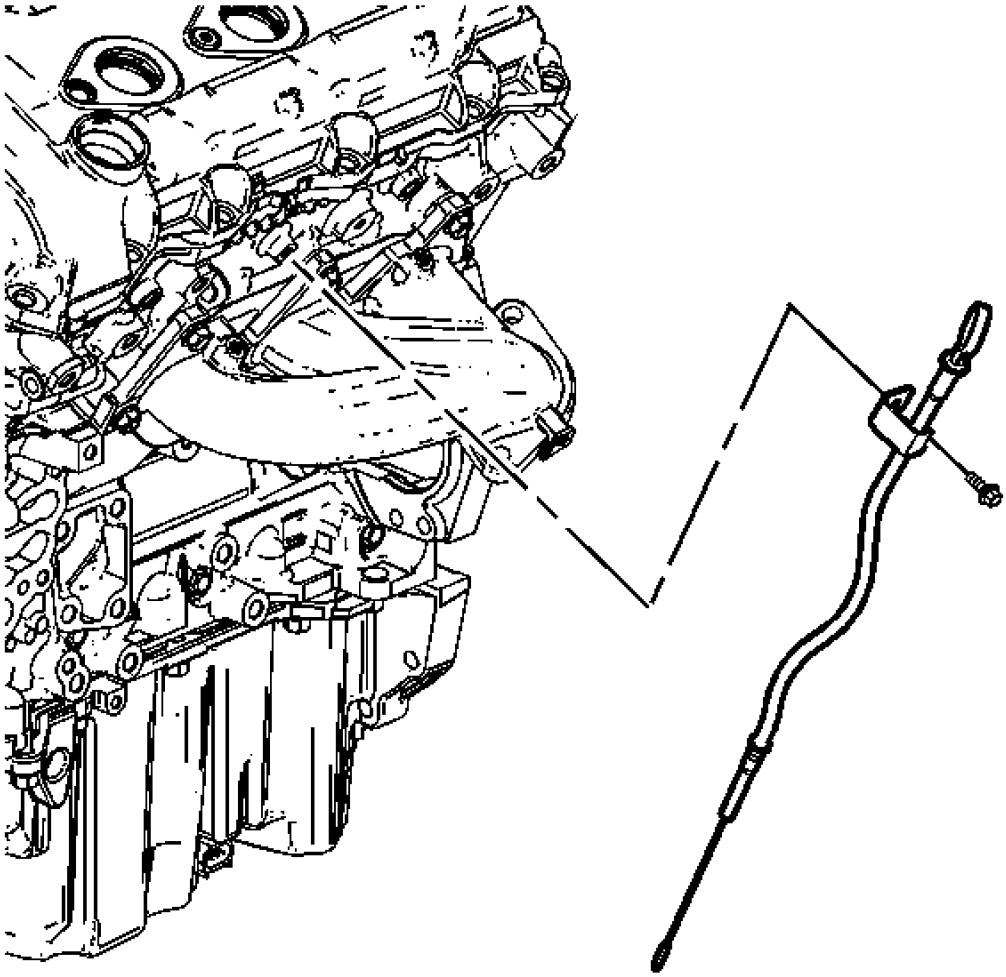


Fig. 38: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Rear**.
2. Remove the oil level indicator from the oil level indicator tube.
3. Remove the oil level indicator tube bolt.
4. Lower the vehicle.
5. Remove the oil level indicator tube up through the exhaust manifold.
6. If you are replacing only the oil level indicator tube seal, remove and discard the old seal.

INSTALLATION PROCEDURE

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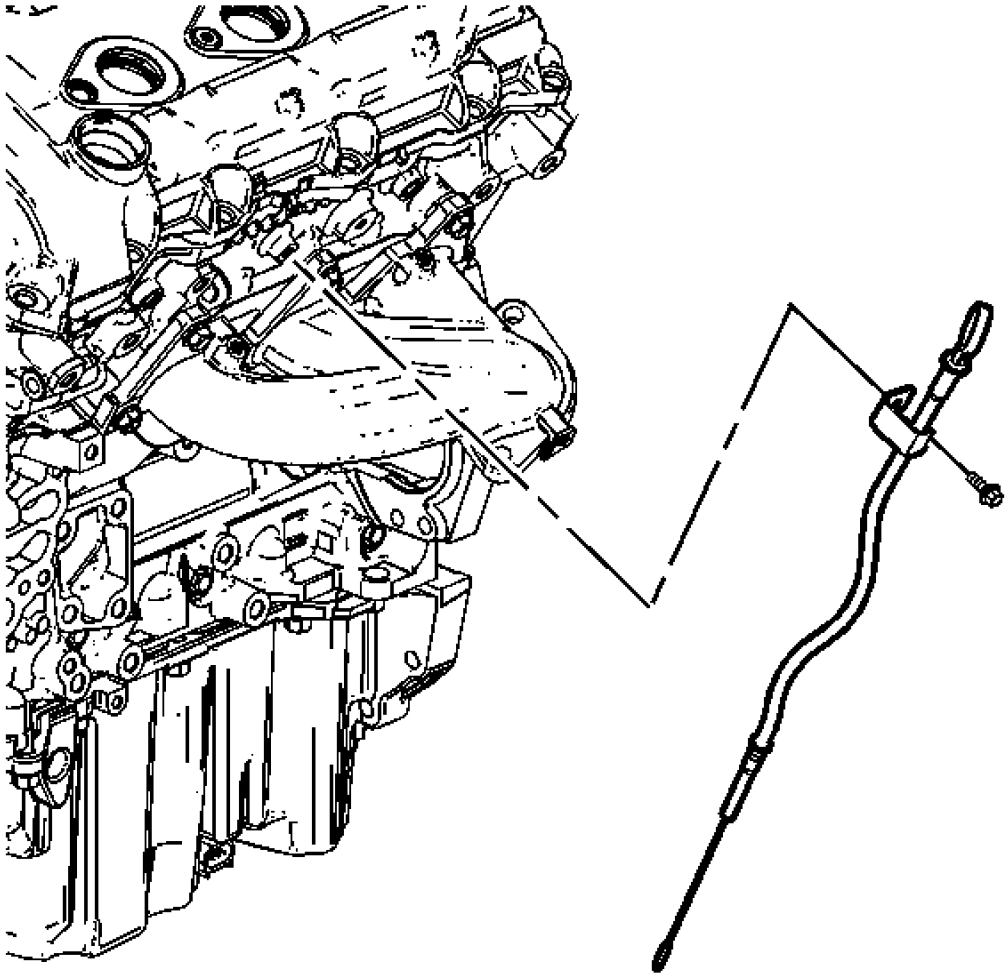


Fig. 39: View Of Oil Level Indicator Tube
Courtesy of GENERAL MOTORS CORP.

Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Rear**.

OIL FILTER ADAPTER REPLACEMENT

REMOVAL PROCEDURE

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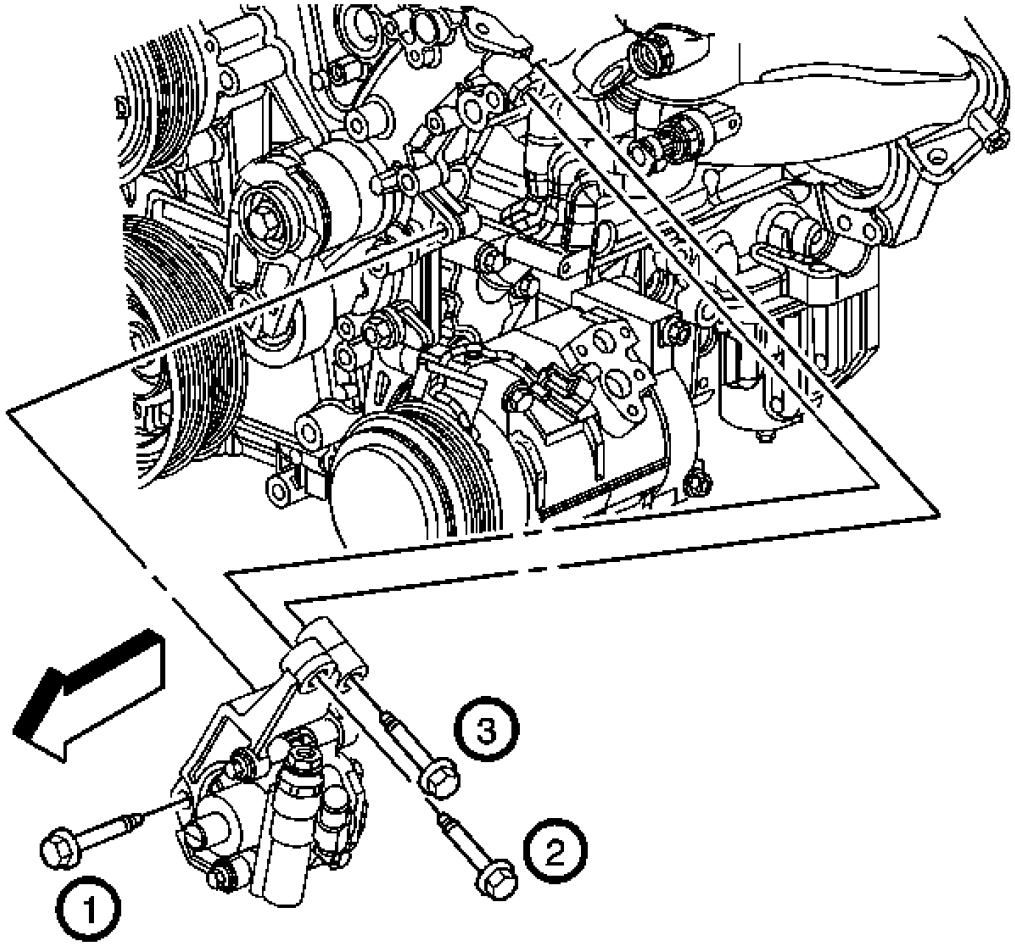


Fig. 40: View Of Power Steering Pump Bracket Bolt Loosening/Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the oil filter. Refer to **Engine Oil and Oil Filter Replacement (LLT)** .
3. Remove the A/C compressor and power steering drive belt. Refer to **Drive Belt Replacement**.
4. Disconnect the oil pressure sensor electrical connector.

NOTE: Do not disconnect the power steering lines from the power steering pump.

5. Remove the power steering pump bolts (1-3) and position the pump aside in order to gain access to the oil filter adapter fasteners. Refer to **Power Steering Pump Replacement (V6)** or **Power Steering Pump Replacement (V8)** .

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6. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .

NOTE: Do not disconnect the A/C pipes from the A/C compressor.

7. Remove the A/C compressor bolts and reposition the A/C compressor in order to gain access to the oil filter adapter fasteners. Refer to **Air Conditioning Compressor Replacement (LLT)** or **Air Conditioning Compressor Replacement (LS3, L99)** .

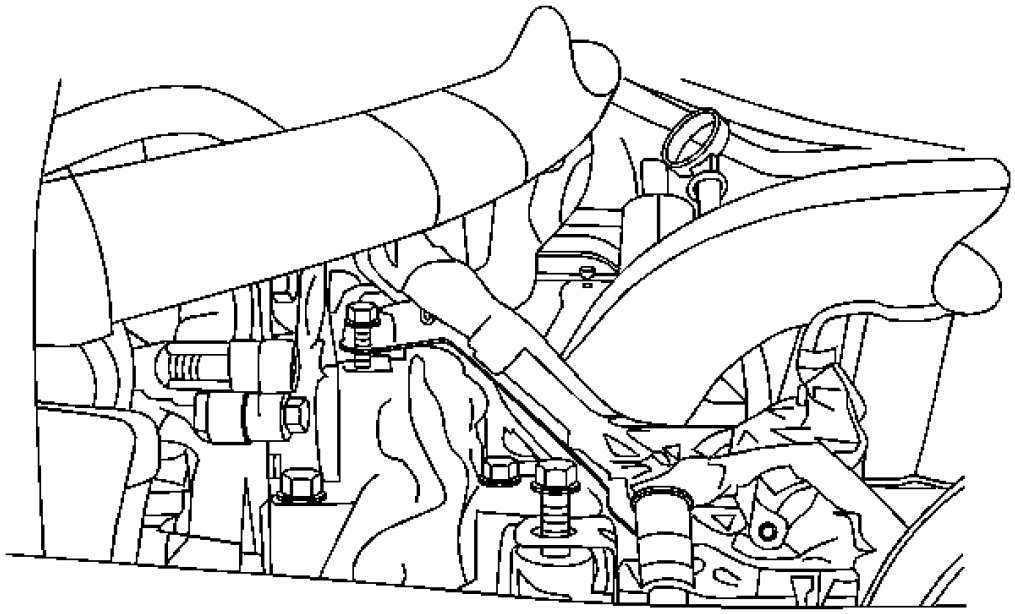


Fig. 41: View Of Wire Harness Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the bolts (1) securing the wire harness bracket to the oil filter adapter.

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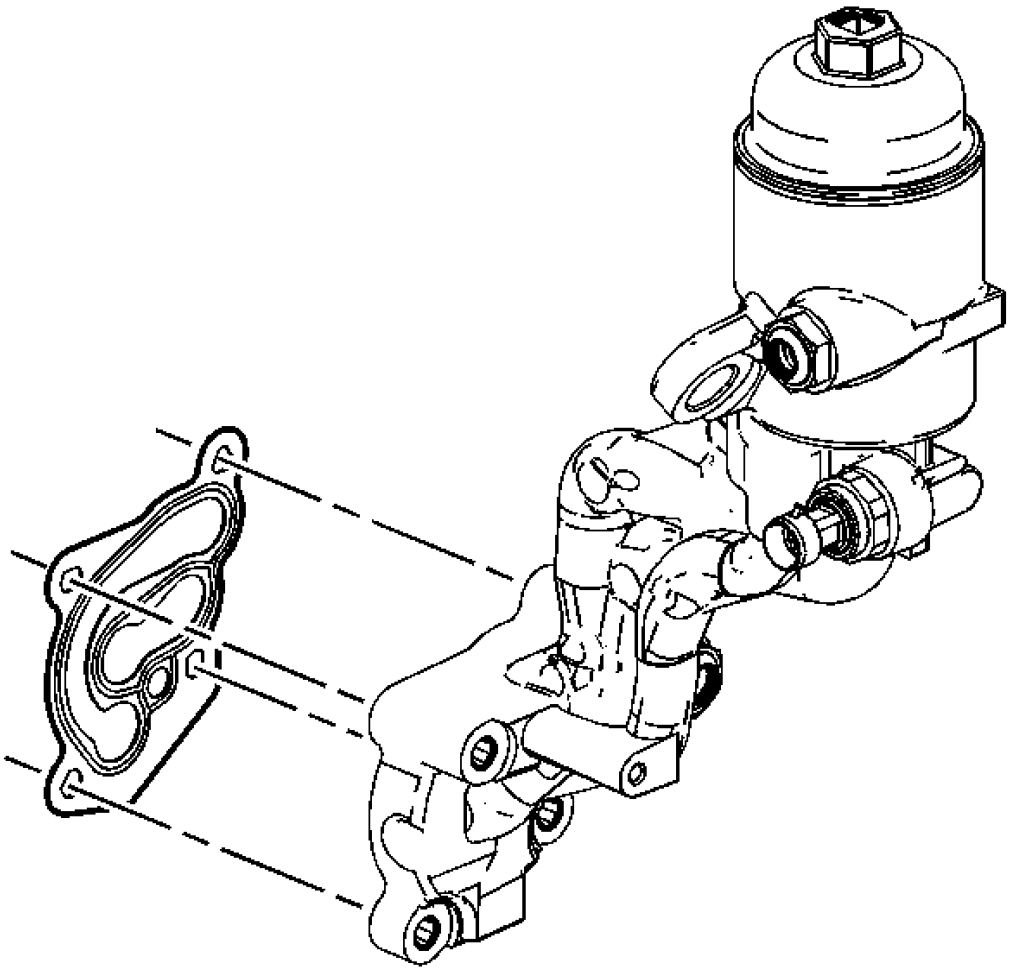


Fig. 42: View Of Oil Filter Adapter & Gasket
Courtesy of GENERAL MOTORS CORP.

9. Place a drain pan under the vehicle.
10. Remove the oil filter adapter bolts.
11. Lower the vehicle.
12. Remove the oil filter adapter.

INSTALLATION PROCEDURE

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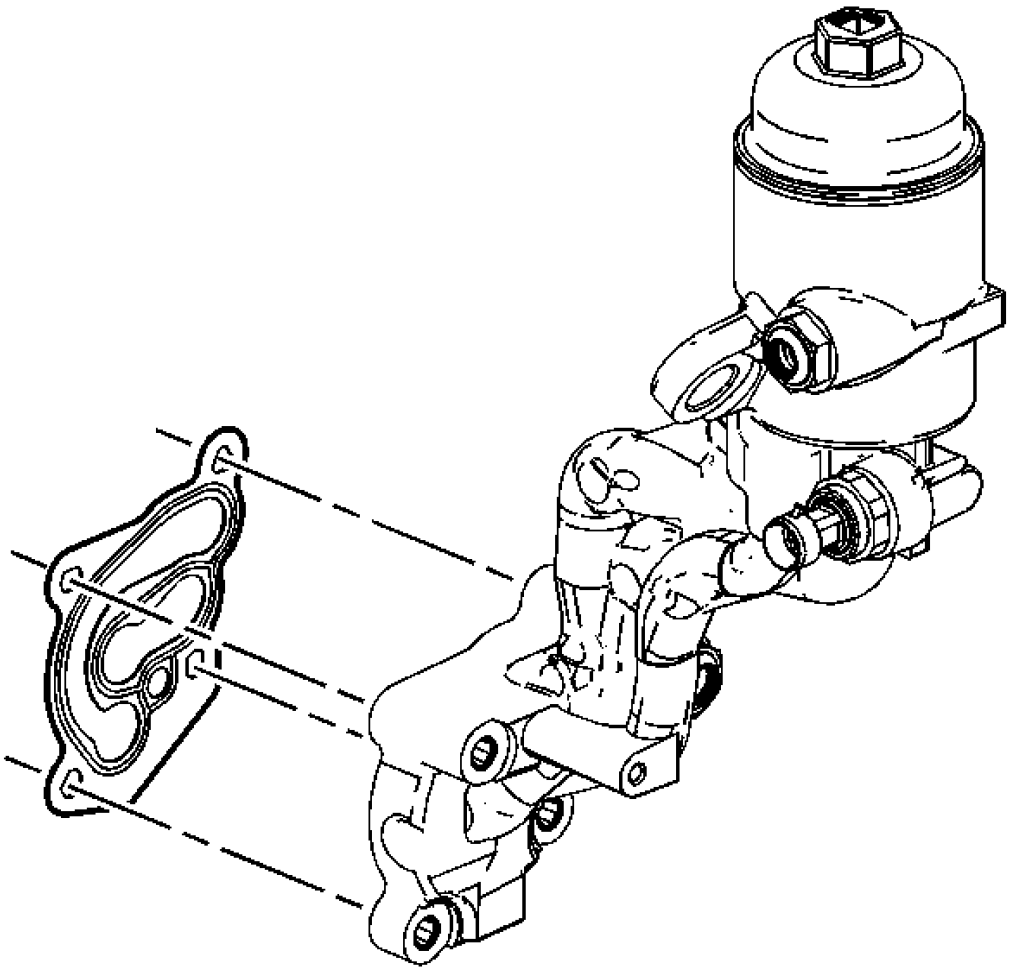


Fig. 43: View Of Oil Filter Adapter & Gasket
Courtesy of GENERAL MOTORS CORP.

1. Install the oil filter adapter.

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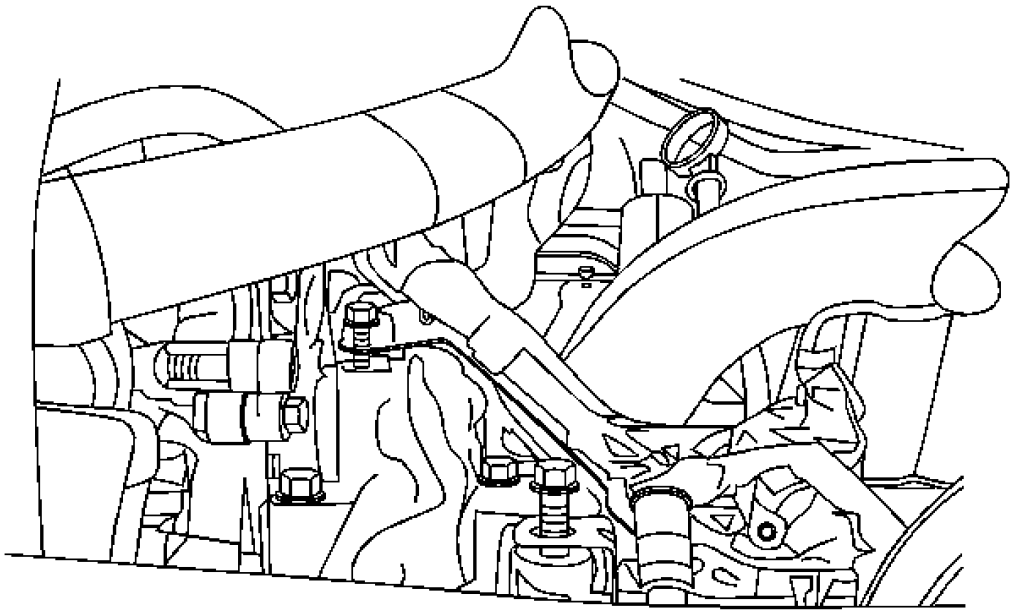


Fig. 44: View Of Wire Harness Bracket Bolts
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

2. Install the bolts (1) securing the wire harness bracket to the oil filter adapter.
    1. Tighten the large wire harness bracket bolt to 23 N.m (17 lb ft).
    2. Tighten the small wire harness bracket bolt to 10 N.m (89 lb in).
3. Install the A/C compressor with the A/C pipes to the engine. Refer to **Air Conditioning Compressor Replacement (LLT)** or **Air Conditioning Compressor Replacement (LS3, L99)** .
4. Lower the vehicle.

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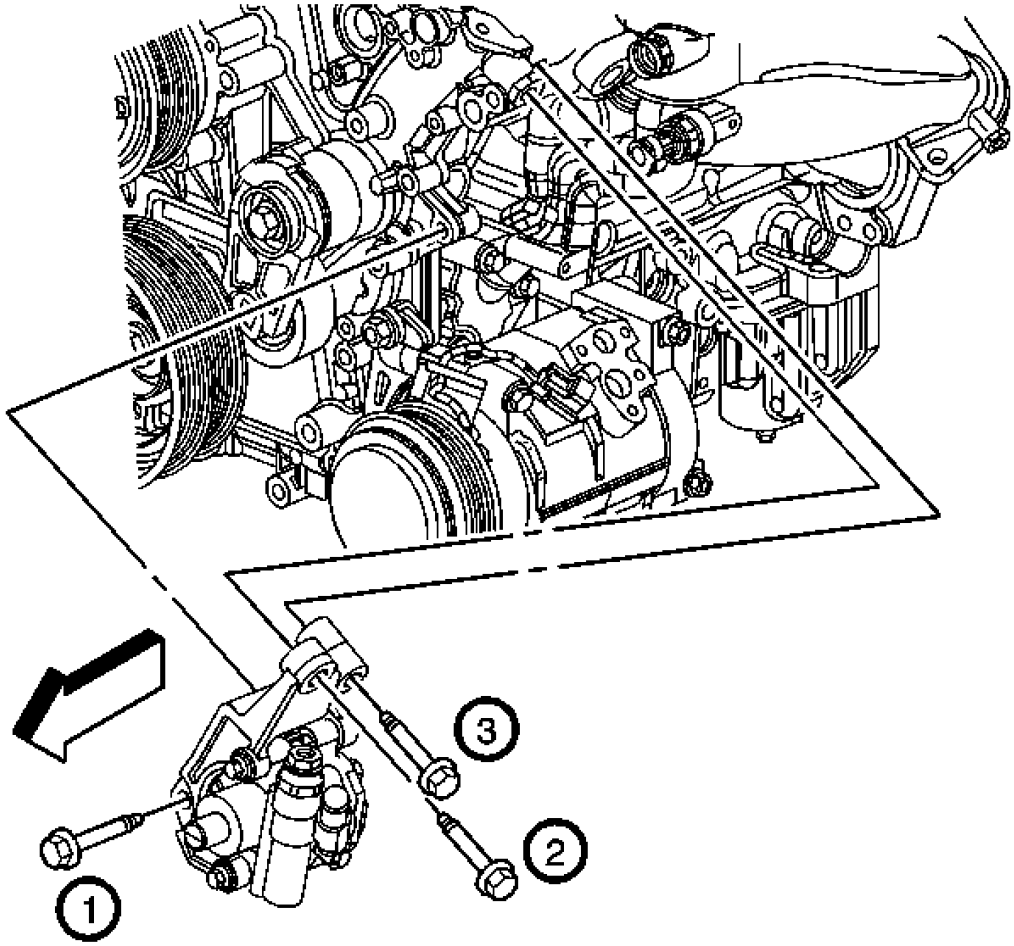


Fig. 45: View Of Power Steering Pump Bracket Bolt Loosening/Tightening Sequence
Courtesy of GENERAL MOTORS CORP.

5. Install the power steering pump bolts (1-3). Refer to **Power Steering Pump Replacement (V6)** or **Power Steering Pump Replacement (V8)** .
6. Connect the oil pressure sensor electrical connector.
7. Install the A/C compressor and power steering drive belt. Refer to **Drive Belt Replacement**.
8. Install the oil filter. Refer to **Engine Oil and Oil Filter Replacement (LLT)** .
9. Connect the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
10. Check and add engine oil as necessary.

CRANKSHAFT BALANCER REPLACEMENT

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SPECIAL TOOLS

EN-48018 Flywheel Holding Tool. See **Special Tools** .

REMOVAL PROCEDURE

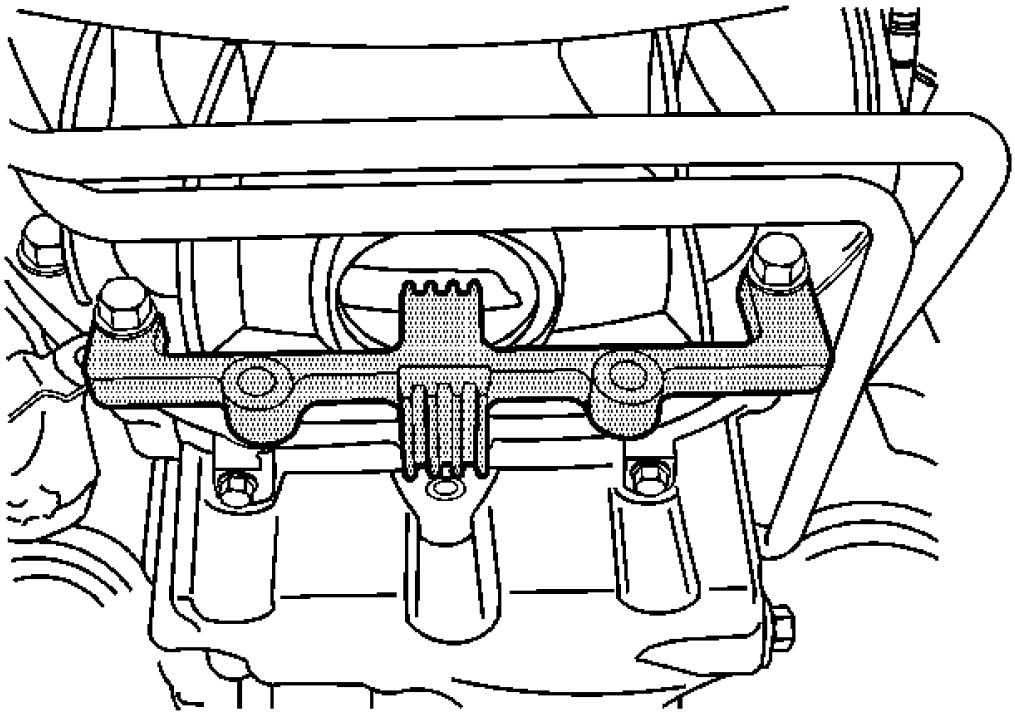


Fig. 46: View Of Flywheel Holding Tool
Courtesy of GENERAL MOTORS CORP.

1. Remove the drive belt. Refer to **Drive Belt Replacement**
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the transmission bell housing inspection hole cover.
4. Install the **EN-48018** flywheel holding tool as shown. See **Special Tools** .
5. Remove the front air deflector.

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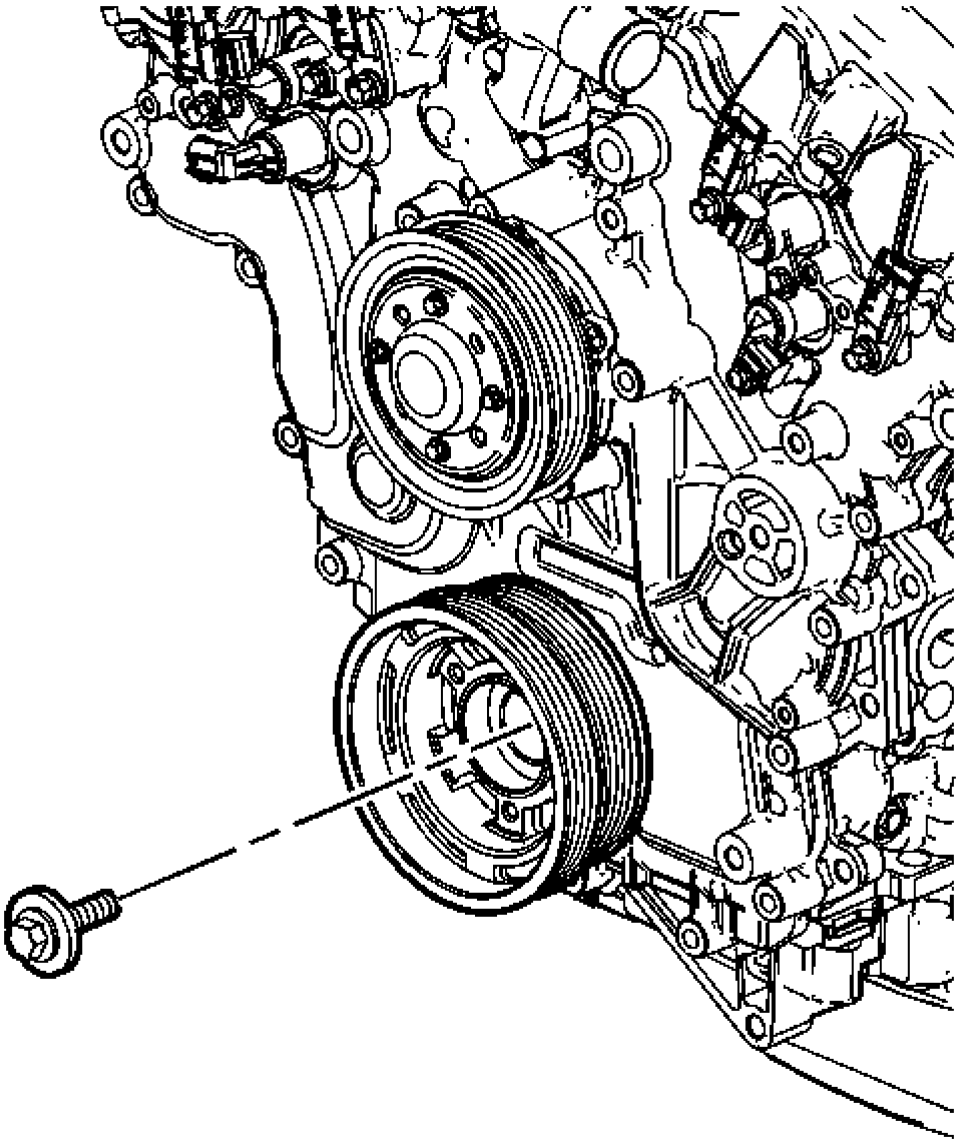


Fig. 47: View Of Crankshaft Balancer & Bolt
Courtesy of GENERAL MOTORS CORP.

6. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Removal** .

INSTALLATION PROCEDURE

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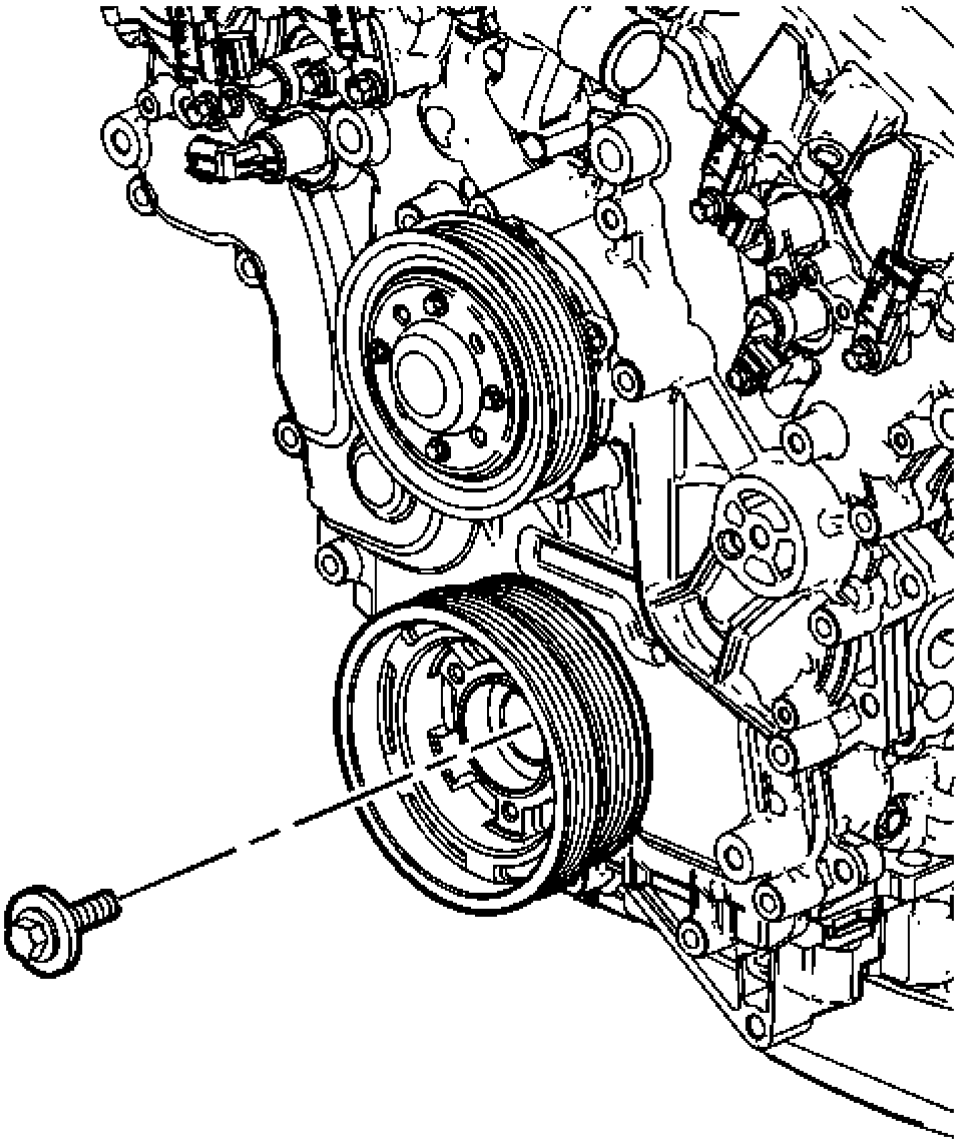


Fig. 48: View Of Crankshaft Balancer & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the crankshaft balancer. Refer to **Crankshaft Balancer Installation** .

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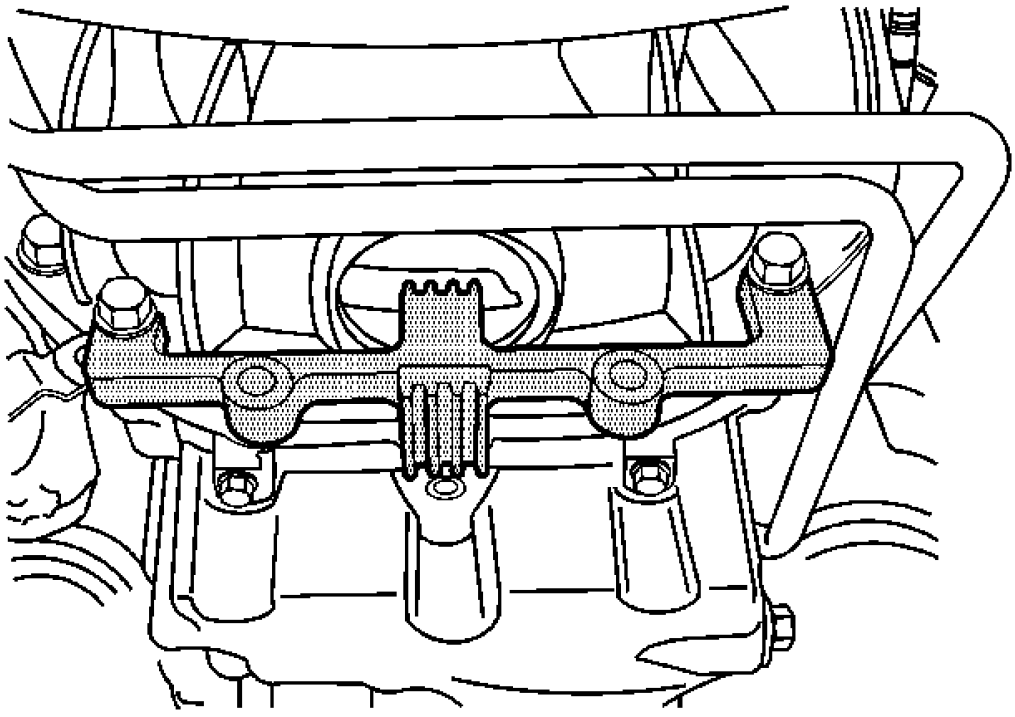


Fig. 49: View Of Flywheel Holding Tool
Courtesy of GENERAL MOTORS CORP.

2. Install the front air deflector.
3. Remove the **EN-48018** flywheel holding tool. See **Special Tools** .
4. Install the transmission bell housing inspection hole cover.
5. Install the drive belt. Refer to **Drive Belt Replacement**

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

SPECIAL TOOLS

J 29184 Oil Seal Installer. See **Special Tools** .

REMOVAL PROCEDURE

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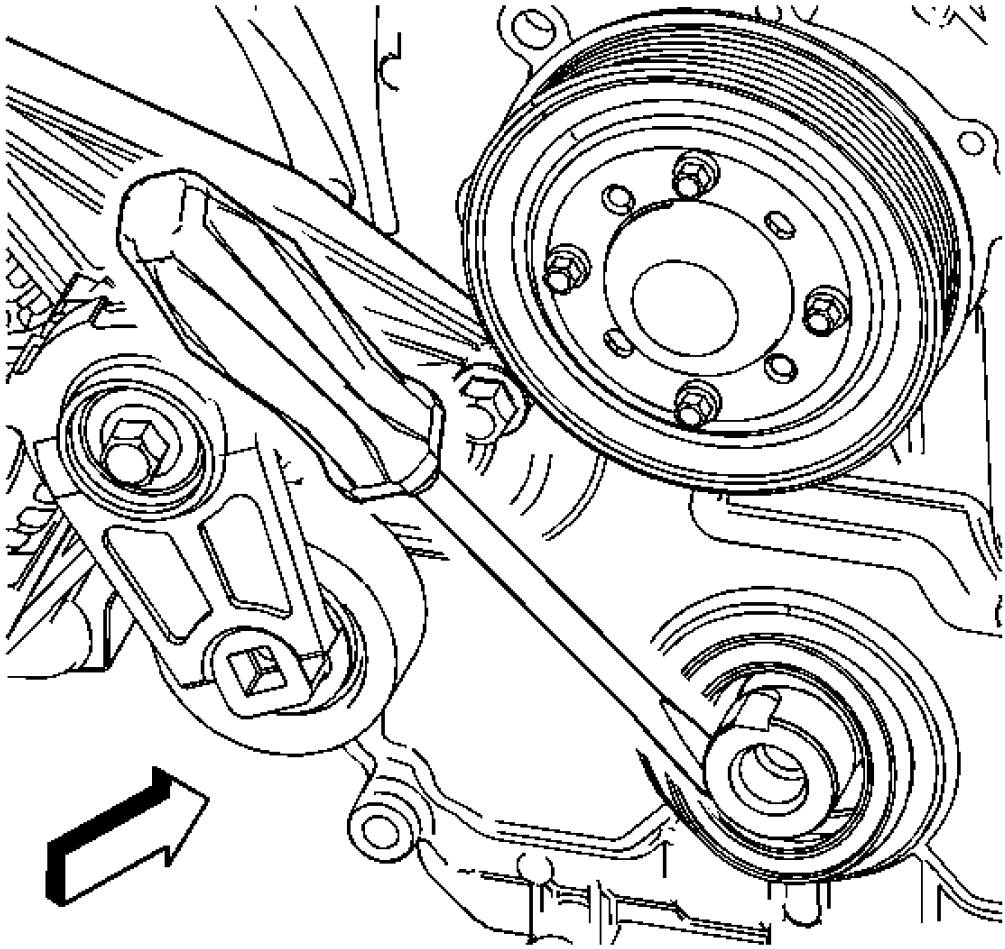


Fig. 50: Removing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
2. Use a flat-bladed tool in order to remove the crankshaft oil seal.

INSTALLATION PROCEDURE

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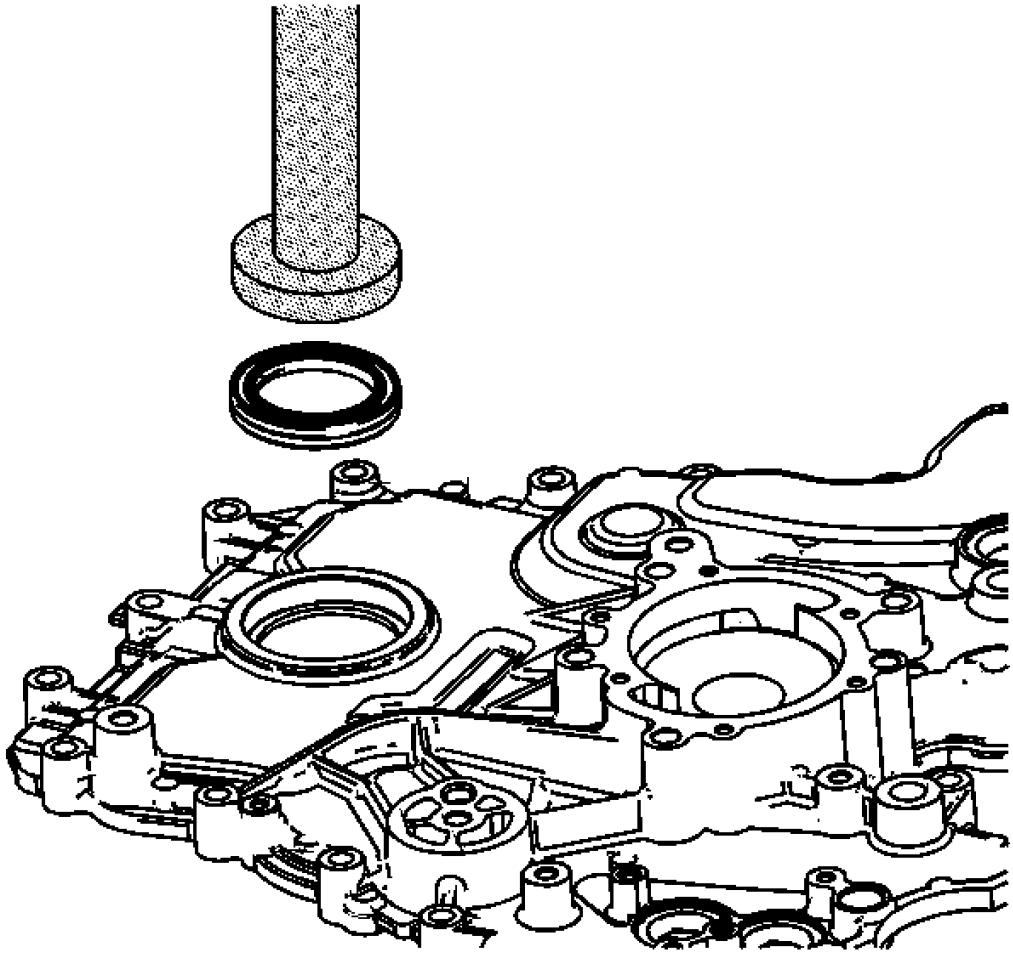


Fig. 51: Installing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not lubricate the crankshaft front oil seal or the crankshaft balancer sealing surfaces.

1. Use the **J 29184** or equivalent to install the crankshaft front oil seal. See **Special Tools** .
2. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

CAMSHAFT COVER REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

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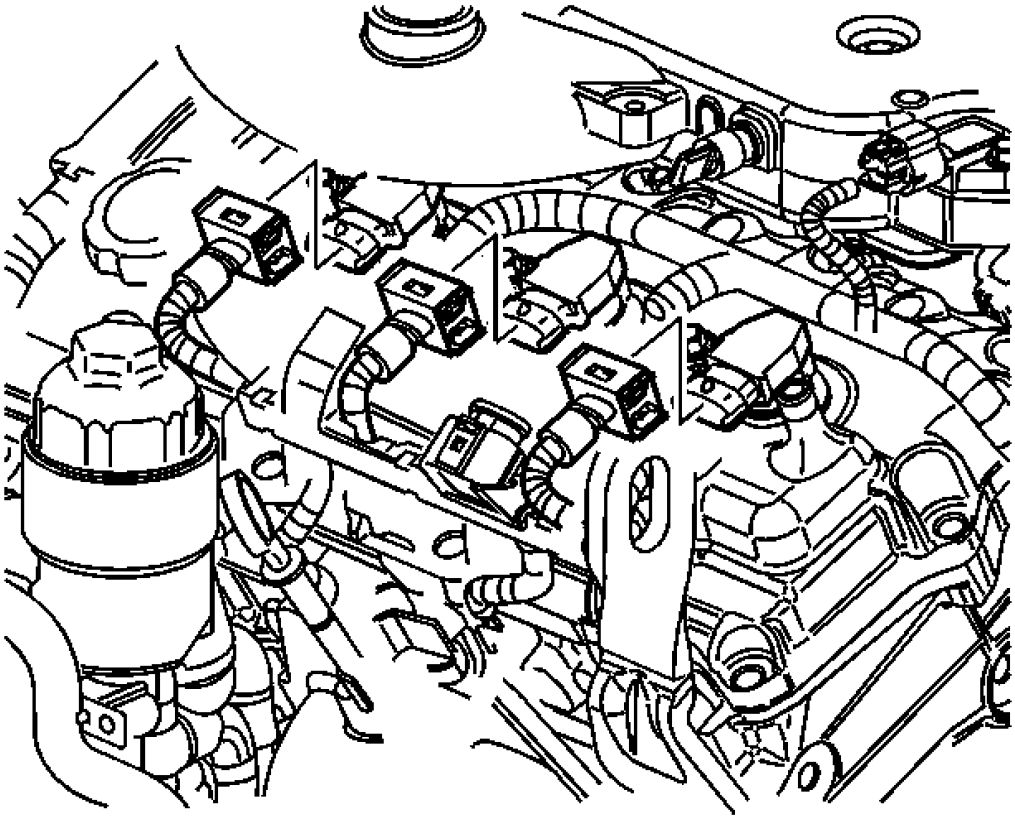


Fig. 52: View Of Left Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
2. Remove the crankcase ventilation pipe. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement**.
3. Disconnect the ignition coil electrical connectors.

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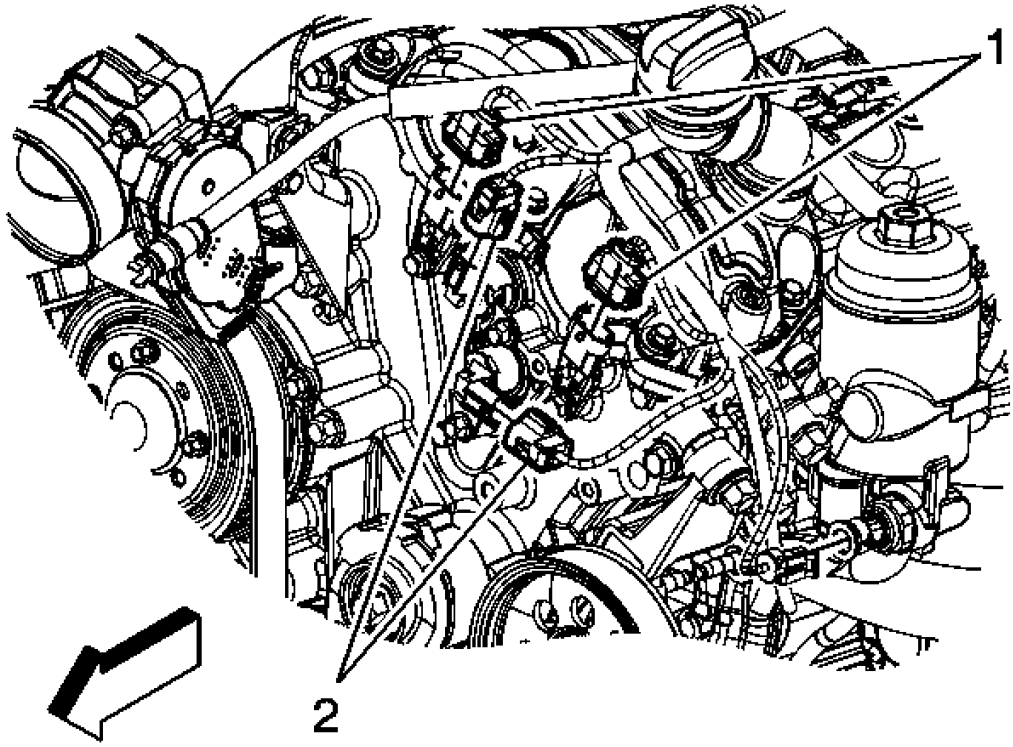


Fig. 53: Identifying Camshaft Actuator Valves, Position Sensor & Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

4. Remove the wiring harness from the side of the camshaft cover by sliding the conduit down and outboard.
5. Remove the wiring conduit retainers from the camshaft cover by rotating the wiring harness conduit retainers counterclockwise.

NOTE: It is not necessary to disconnect the engine front cover electrical connectors.

6. Disconnect the camshaft position sensors (1) and camshaft actuator valve (2) electrical connectors.
7. Reposition and secure the wiring harnesses away from the camshaft cover in order to provide clearance.

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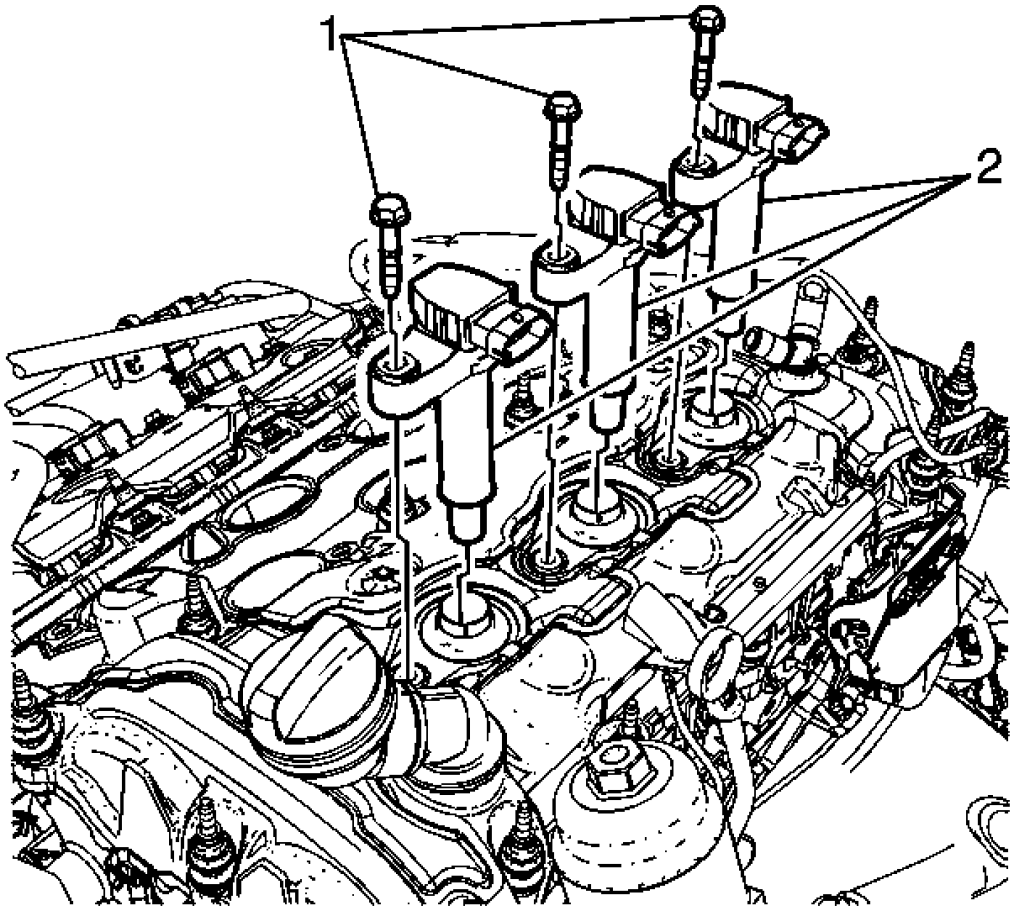


Fig. 54: Identifying Ignition Coils & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the ignition coil bolts (1).
9. Remove the ignition coils (2).

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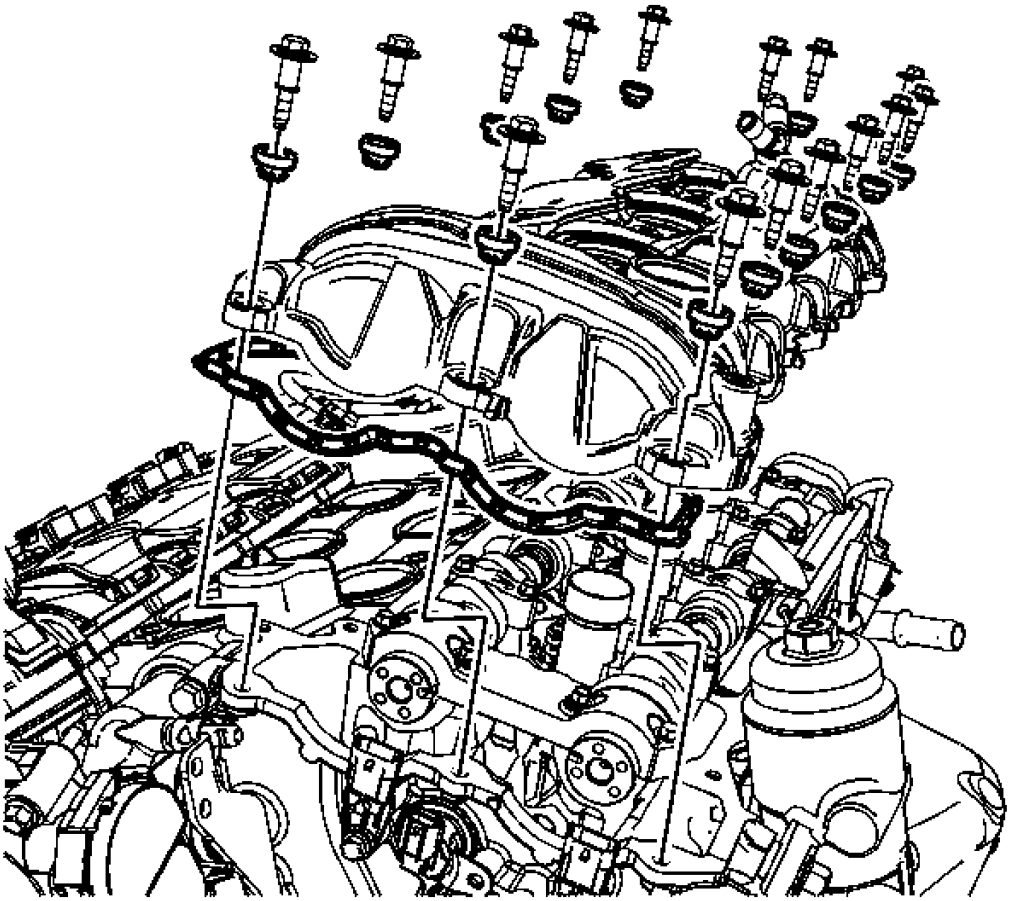


Fig. 55: View Of Camshaft Cover Seal & Grommets
Courtesy of GENERAL MOTORS CORP.

10. Remove the camshaft cover. Refer to **Camshaft Cover Removal - Left Side (LLT)** .
11. Inspect the camshaft cover. Refer to **Camshaft Cover Cleaning and Inspection (LLT)** .
12. Remove and discard the camshaft cover seal (1) and grommets (2).

INSTALLATION PROCEDURE

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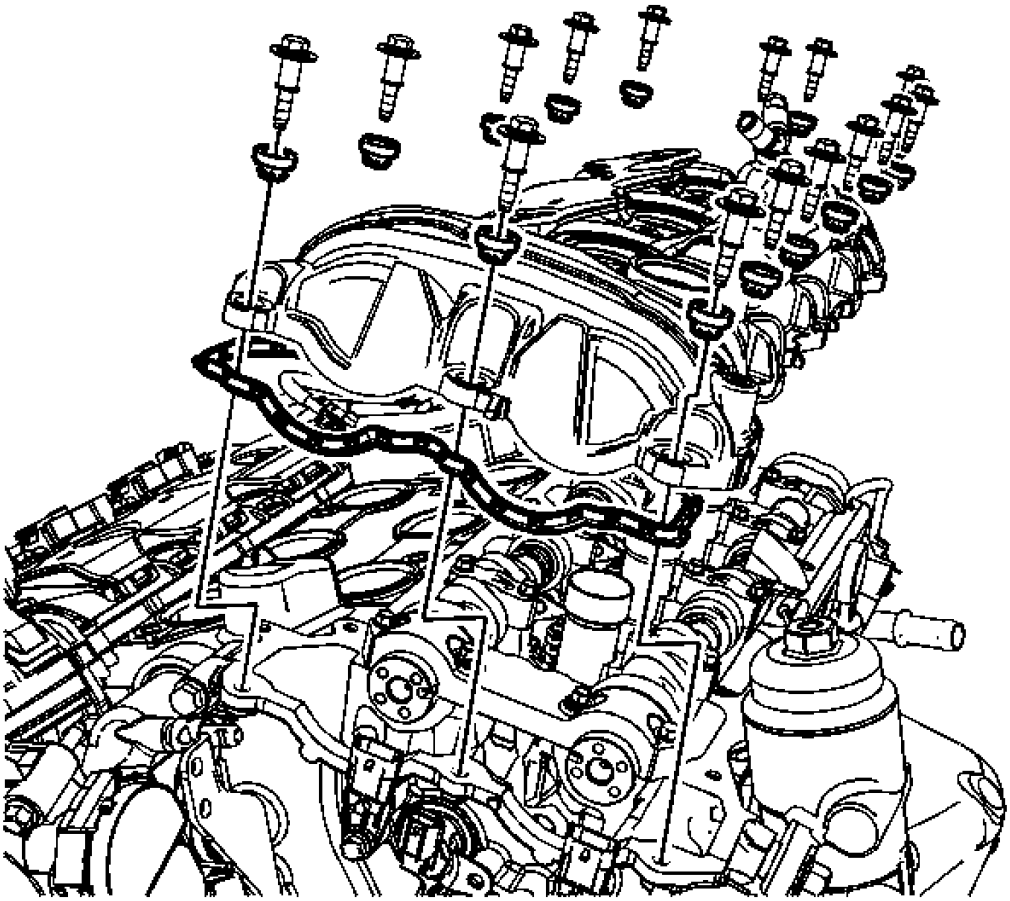


Fig. 56: View Of Camshaft Cover Seal & Grommets
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW camshaft cover seal (1) and NEW grommets (2).
2. Install the camshaft cover. Refer to **Camshaft Cover Installation - Left Side (LLT)** .

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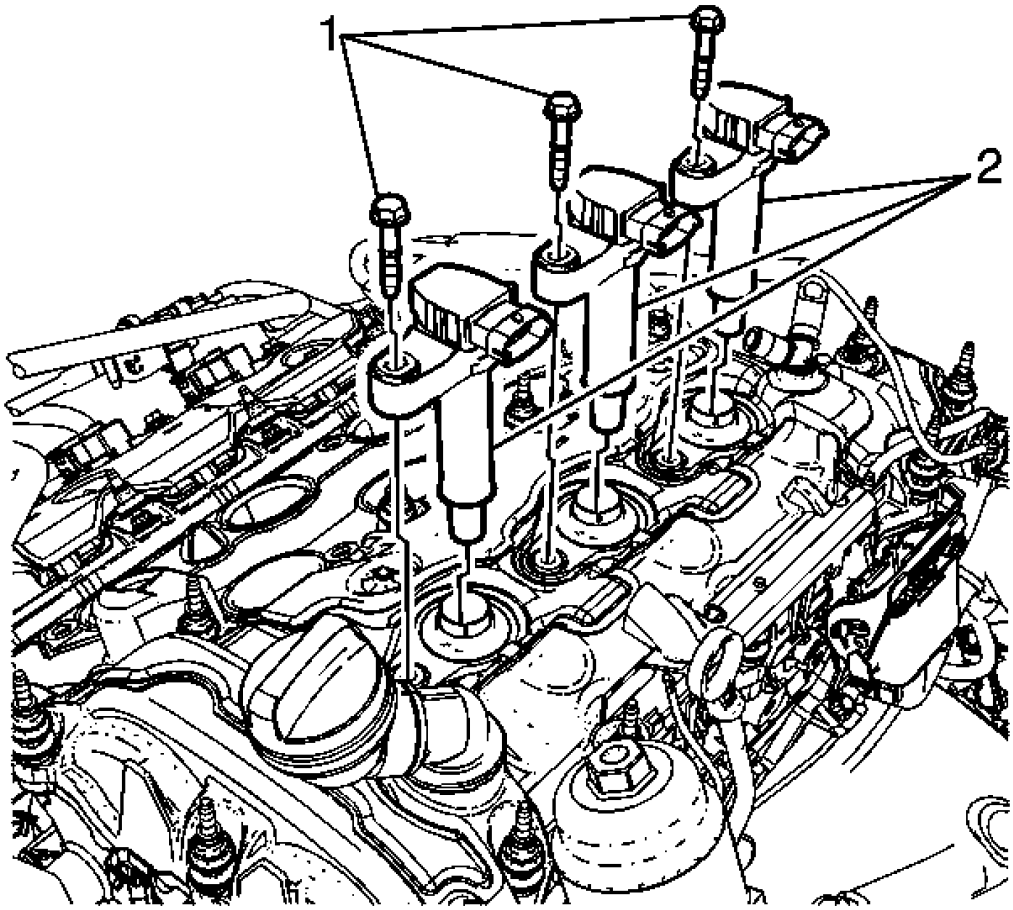


Fig. 57: Identifying Ignition Coils & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Install the ignition coils (2).

CAUTION: Refer to Fastener Caution .

4. Install the ignition coil bolts (1) and tighten to 10 N.m (89 lb in).

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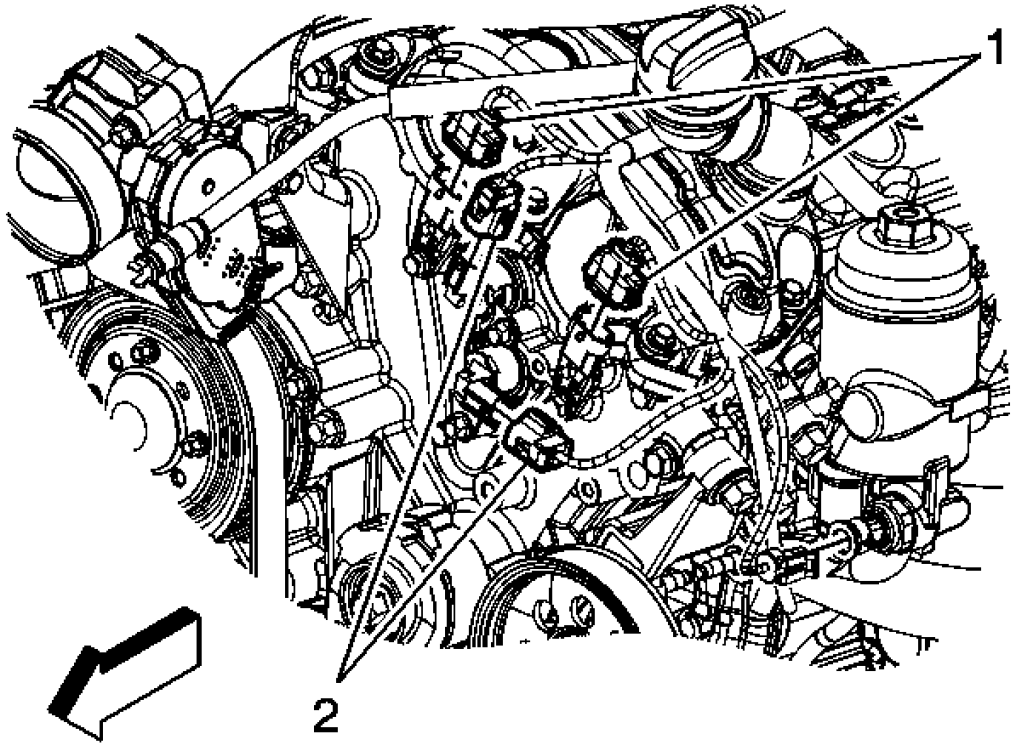


Fig. 58: Identifying Camshaft Actuator Valves, Position Sensor & Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

5. Connect the camshaft actuator valves (2) and the camshaft position sensor (1) electrical connectors.
6. Install the wiring harness conduit retainers to the wiring harness conduit.

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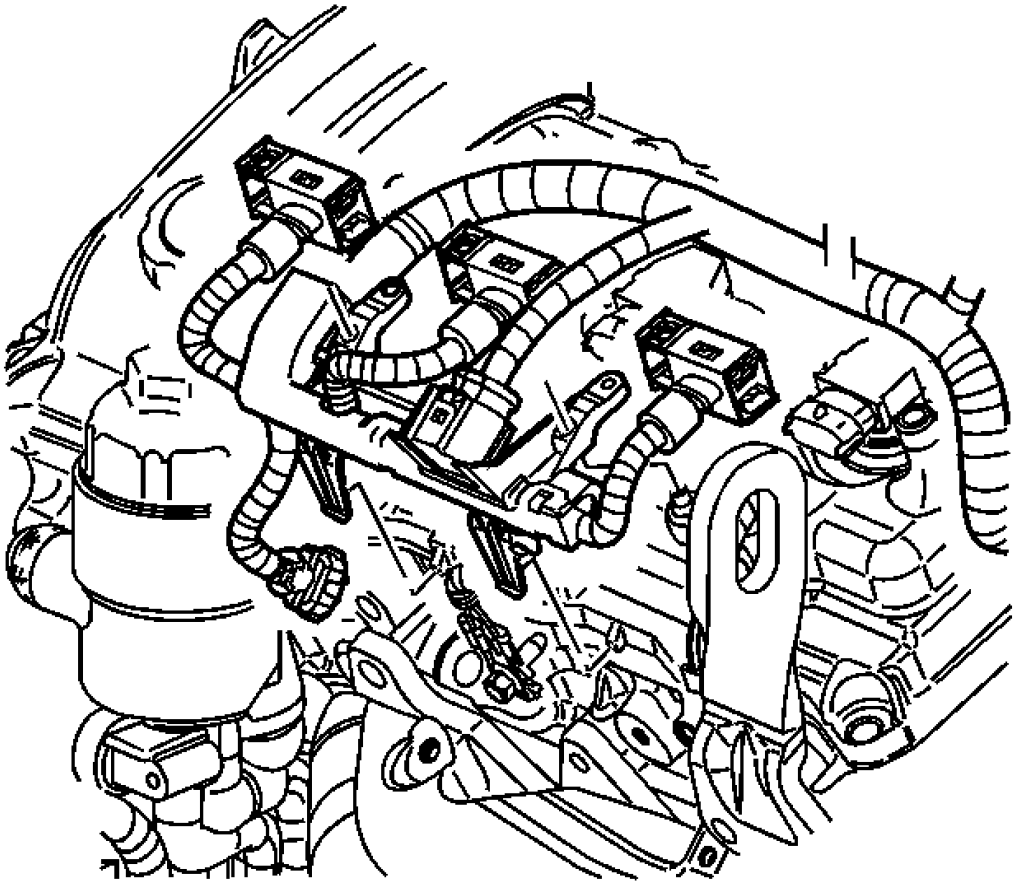


Fig. 59: View Of Left Camshaft Cover Wiring Harness Connectors
Courtesy of GENERAL MOTORS CORP.

7. Install the wiring harness to the side of the camshaft cover.

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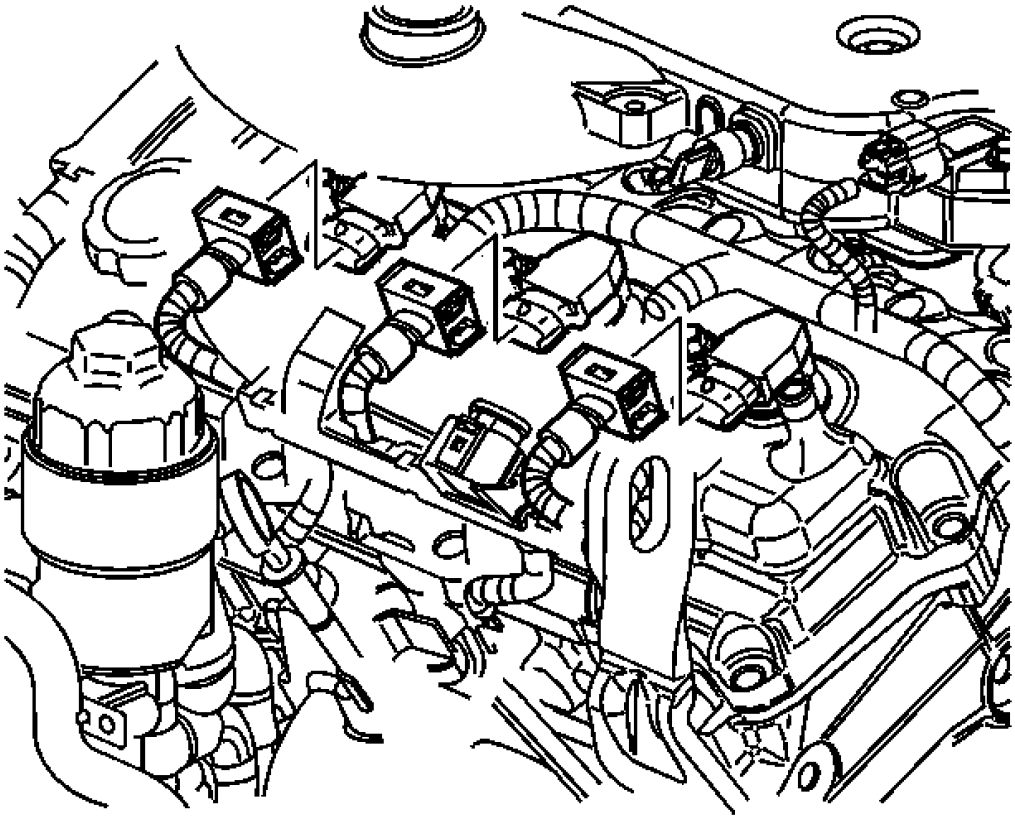


Fig. 60: View Of Left Ignition Coil Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

8. Connect the ignition coil electrical connectors.
9. Install the crankcase ventilation pipe. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement**.
10. Install the intake manifold. Refer to **Intake Manifold Replacement**.

CAMSHAFT COVER REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

1. Remove the upper intake manifold. Refer to **Intake Manifold Replacement**.

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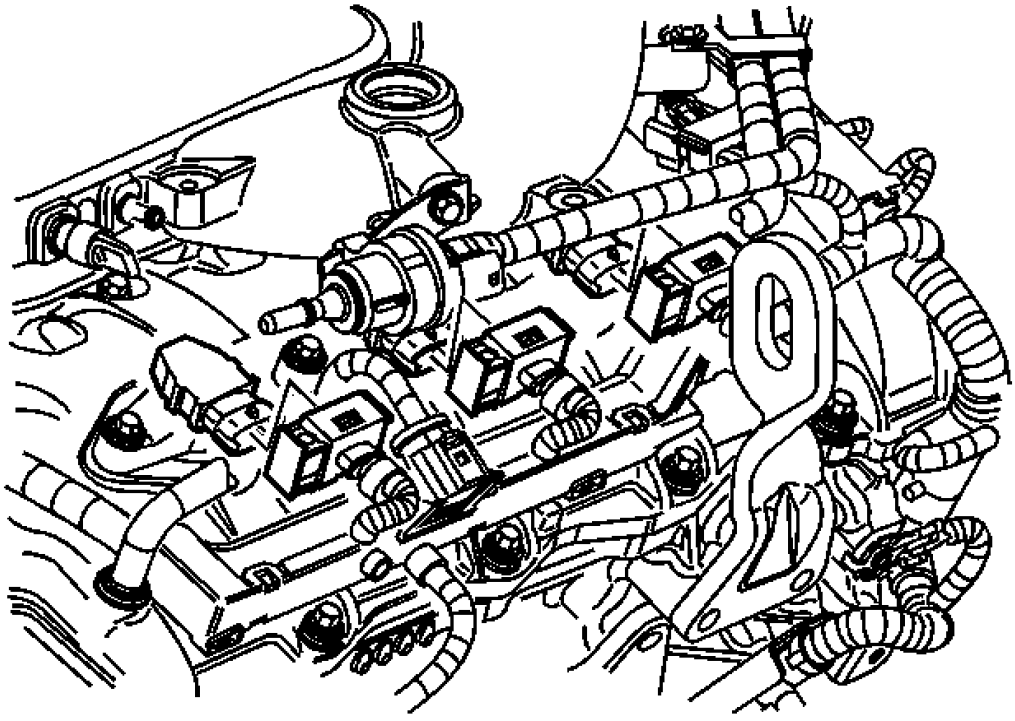


Fig. 61: View Of Right Ignition Coils Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

2. Disconnect the ignition coil electrical connectors.

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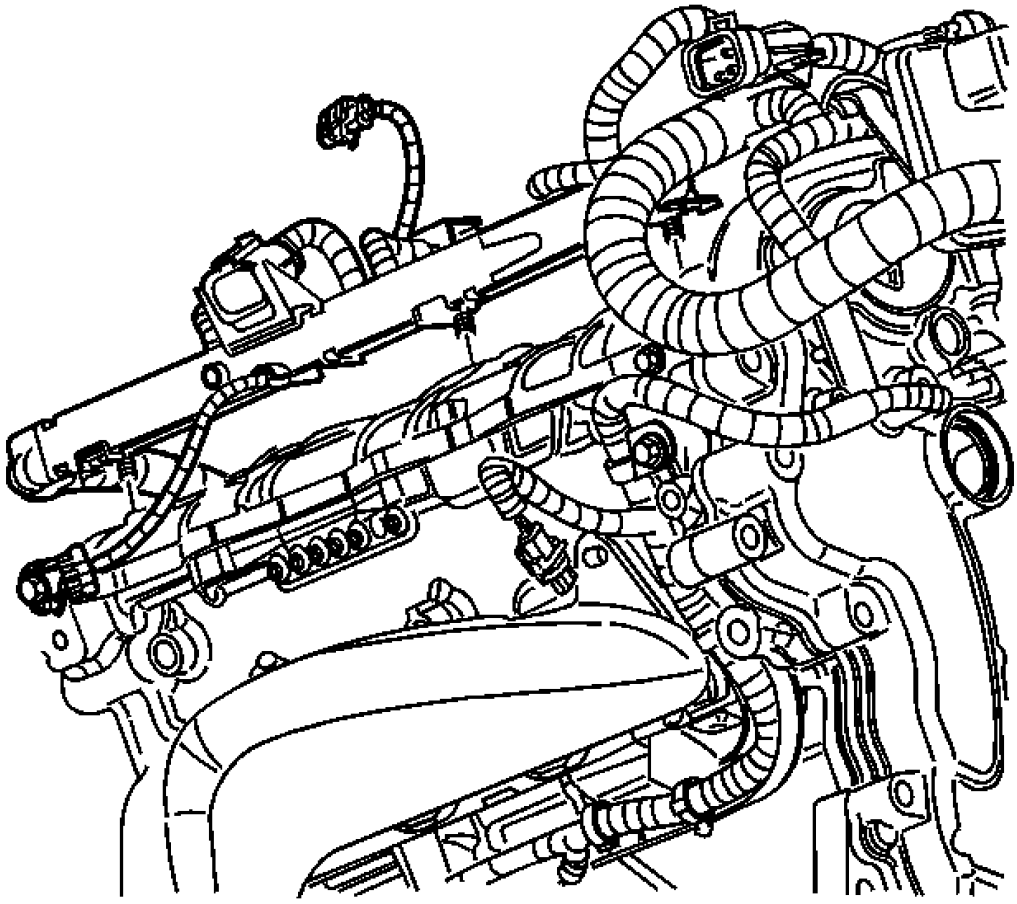


Fig. 62: View Of Right Camshaft Cover Wiring Harness Connector - Top
Courtesy of GENERAL MOTORS CORP.

3. Remove the wiring harness from the side of the camshaft cover by sliding the conduit down and outboard.
4. Remove the wiring conduit retainers from the camshaft cover by rotating the wiring harness conduit retainers counterclockwise.

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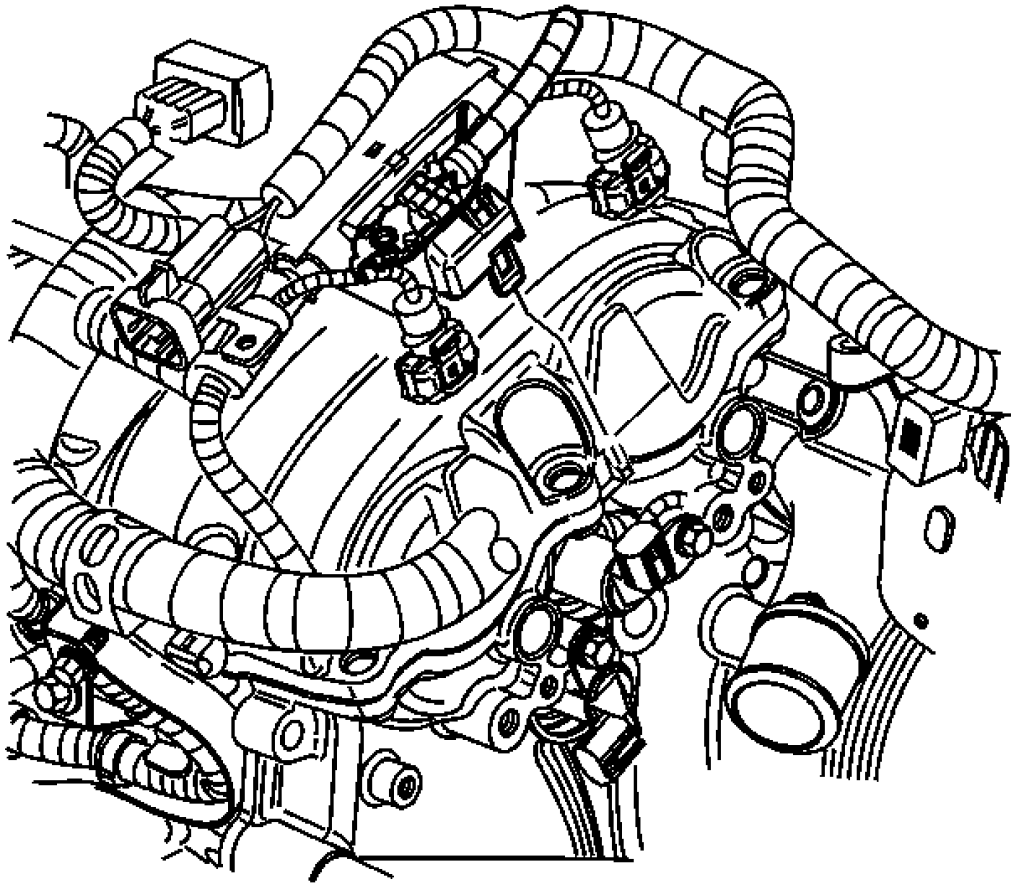


Fig. 63: View Of Right Camshaft Cover Wiring Harness Connector - Front
Courtesy of GENERAL MOTORS CORP.

NOTE: It is not necessary to disconnect the engine front cover electrical connectors.

5. Remove the wiring harness from the front of the camshaft cover.
6. Reposition and secure the wiring harnesses away from the camshaft cover in order to provide clearance.

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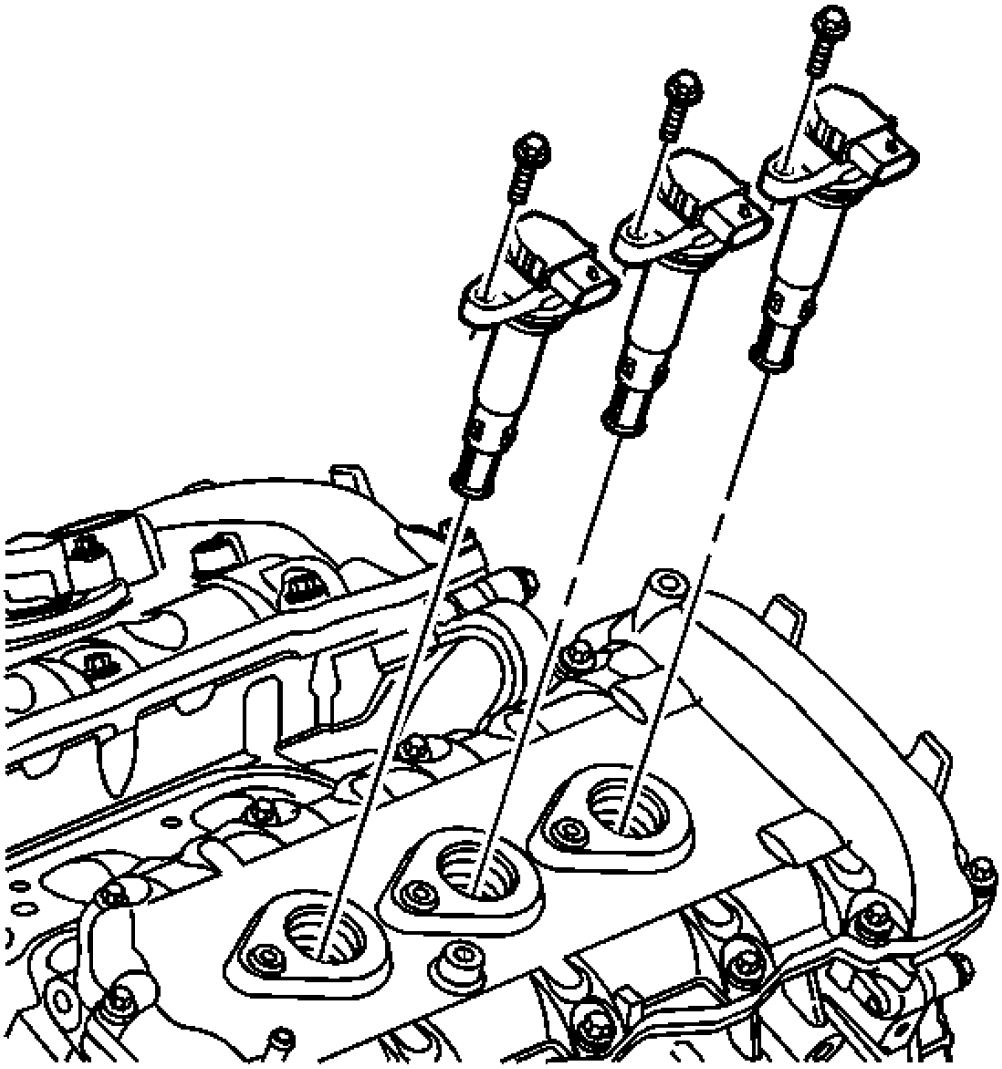


Fig. 64: View Of Ignition Coils
Courtesy of GENERAL MOTORS CORP.

7. Remove the ignition coils.

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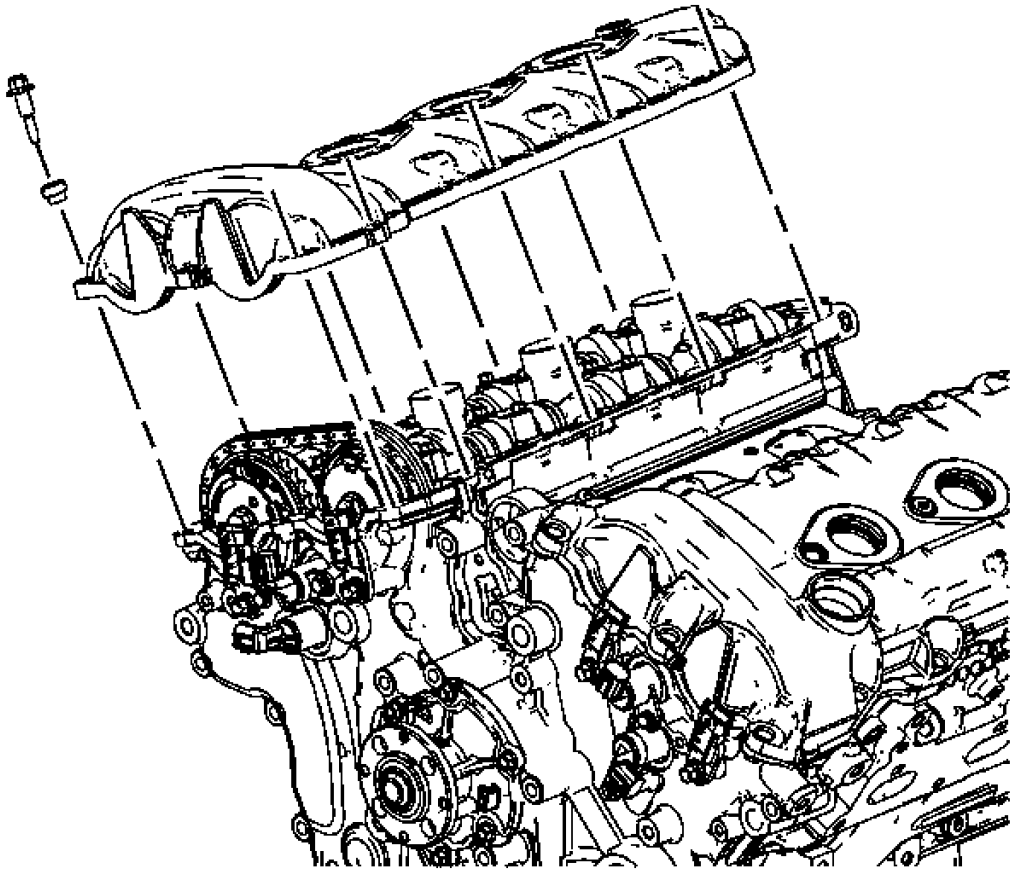


Fig. 65: Identifying Right Camshaft Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the camshaft cover. Refer to **Camshaft Cover Removal - Right Side** .
9. Inspect the camshaft cover. Refer to **Camshaft Cover Cleaning and Inspection (LLT)** .
10. Remove and discard the camshaft cover seal and grommets.

INSTALLATION PROCEDURE

1. Install a NEW camshaft cover seal and NEW grommets.

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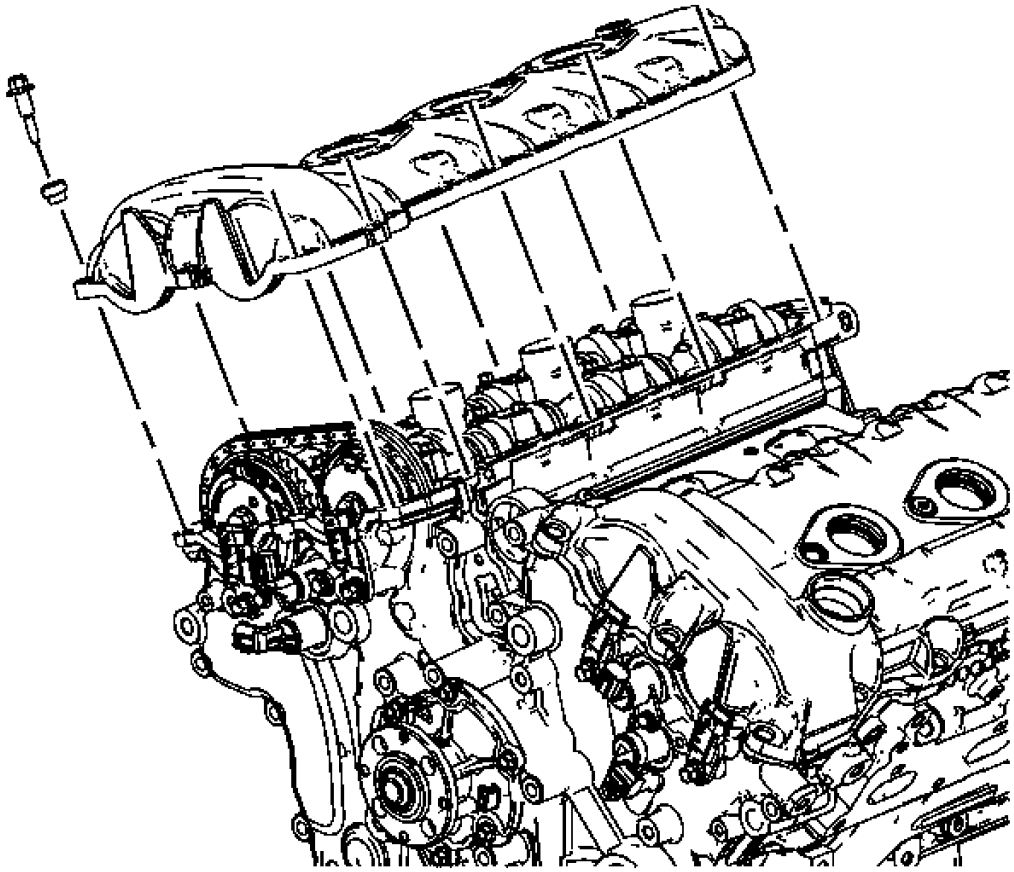


Fig. 66: Identifying Right Camshaft Cover & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Install the camshaft cover. Refer to **Camshaft Cover Installation - Right Side** .

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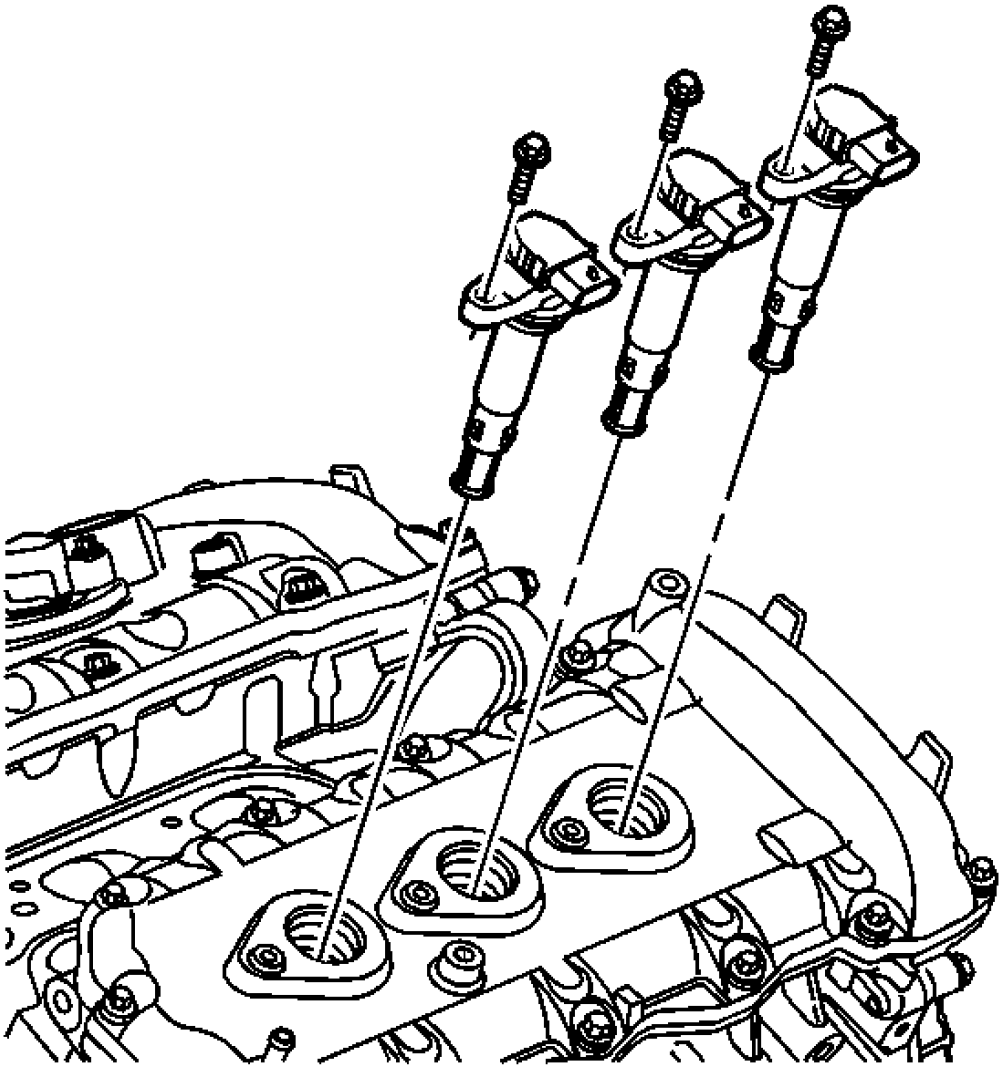


Fig. 67: View Of Ignition Coils
Courtesy of GENERAL MOTORS CORP.

3. Install the ignition coils.

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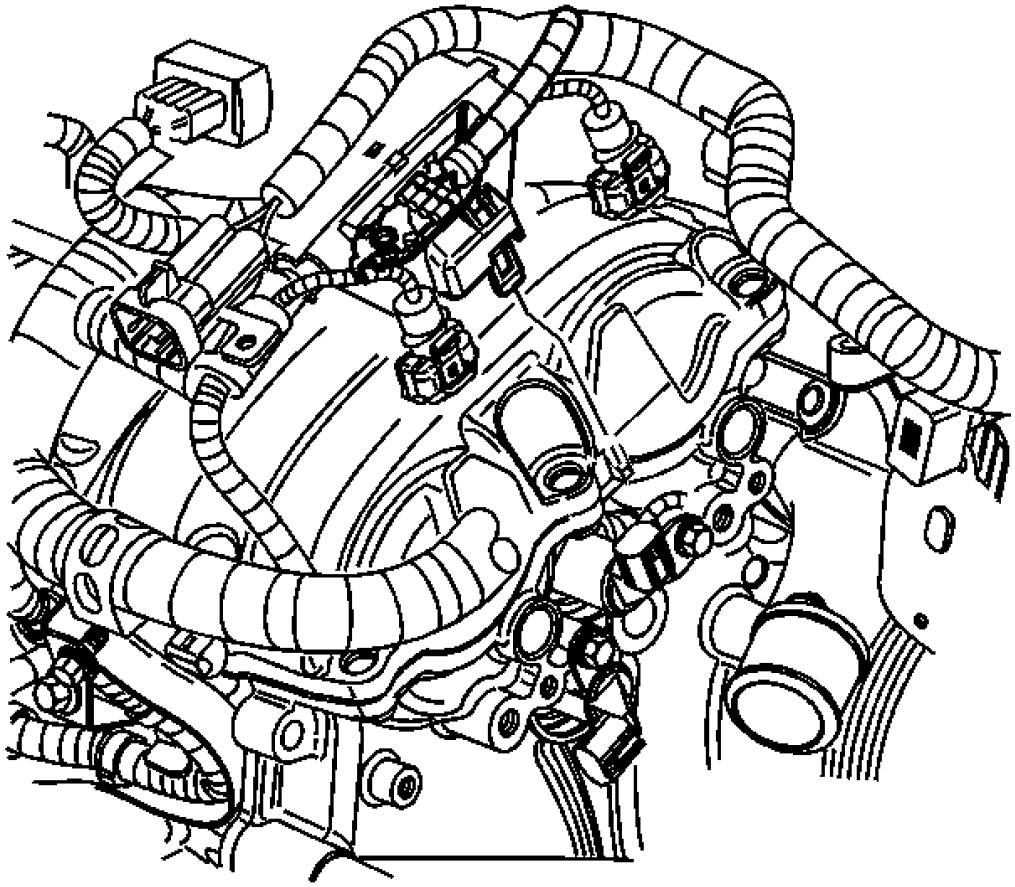


Fig. 68: View Of Right Camshaft Cover Wiring Harness Connector - Front
Courtesy of GENERAL MOTORS CORP.

4. Install the wiring harness to the front of the camshaft cover.
5. Install the wiring harness conduit retainers to the wiring harness conduit.

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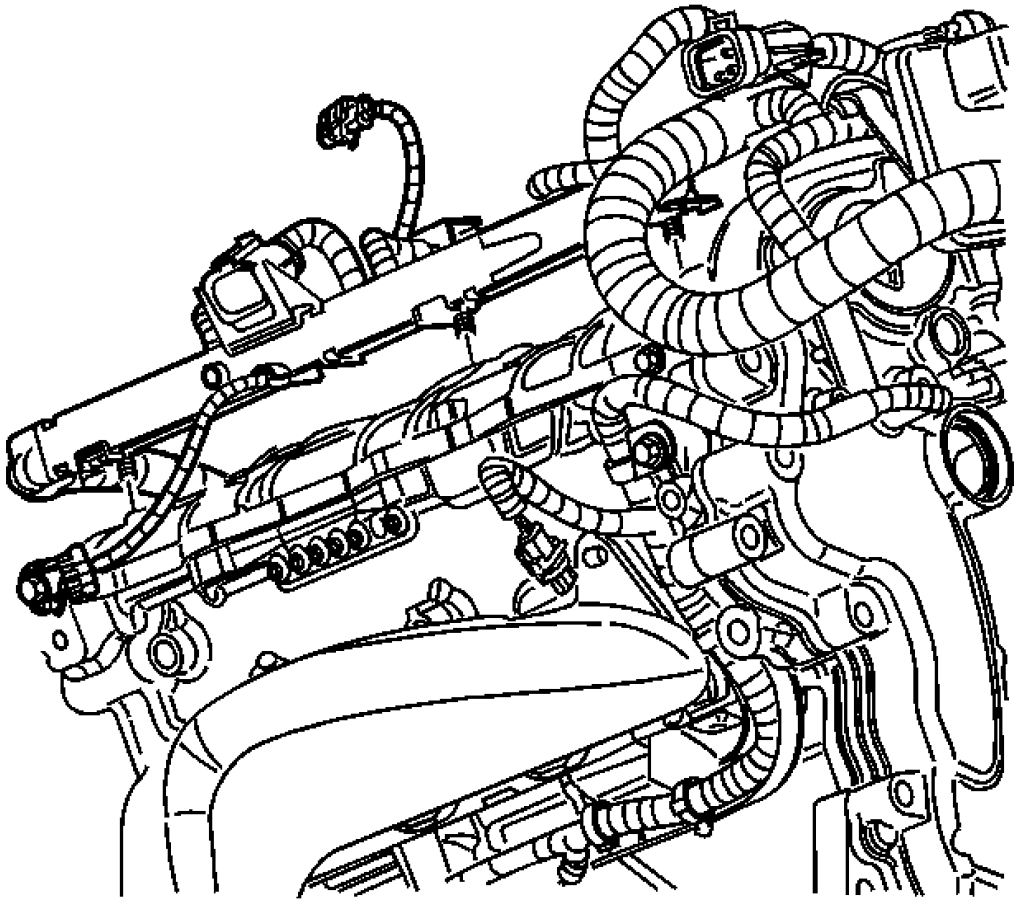


Fig. 69: View Of Right Camshaft Cover Wiring Harness Connector - Top
Courtesy of GENERAL MOTORS CORP.

6. Install the wiring harness to the side of the camshaft cover.

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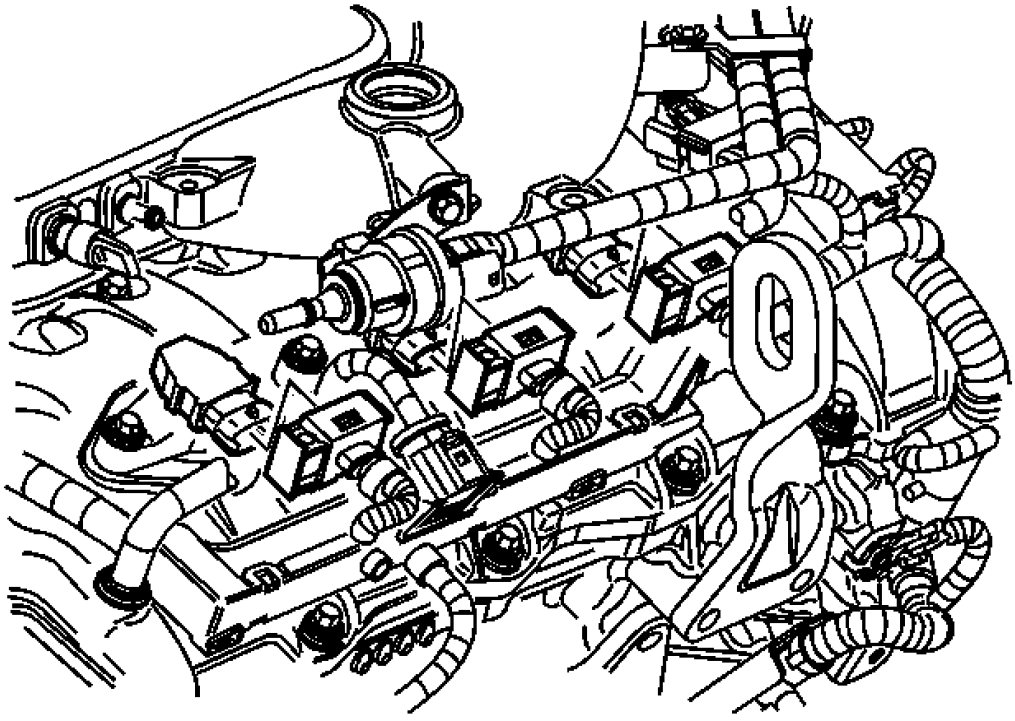


Fig. 70: View Of Right Ignition Coils Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

7. Connect the ignition coil electrical connectors.
8. Install the upper intake manifold. Refer to **Intake Manifold Replacement**.

ENGINE FRONT COVER REPLACEMENT

SPECIAL TOOLS

EN 46109 Engine Front Cover Installation Guide Pins. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the engine cover. **Intake Manifold Cover Replacement - Rear**.
2. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
3. Remove the camshaft covers. Refer to **Camshaft Cover Replacement - Left Side** and **Camshaft Cover Replacement - Right Side**.
4. Drain the engine coolant. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or

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Cooling System Draining and Filling (LLT Static Fill) or **Cooling System Draining and Filling (GE 47716)** .

5. Disconnect the purge vent hose from the water outlet.
6. Remove the water outlet with the radiator hose and reposition aside. Refer to **Radiator Outlet Hose Replacement (LLT)** or **Radiator Outlet Hose Replacement (LS3, L99)**
7. Remove the accessory drive belts. Refer to **Drive Belt Replacement**
8. Remove the A/C compressor and power steering belt tensioner.Refer to **Drive Belt Tensioner Replacement**
9. Remove the generator bracket with the generator and the belt tensioner. Refer to **Generator Bracket Replacement (LS3/L99)** .

NOTE: Do not disconnect the power steering pipes or drain the power steering fluid.

10. Remove the power steering fluid reservoir and reposition the power steering fluid reservoir in order to provide access. Refer to **Power Steering Fluid Reservoir Bracket Replacement (V6)**

NOTE: Do not disconnect the power steering pipes/hoses.

11. Remove the power steering pump upper front bolt and loosen the remaining two bolts.
12. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Removal** .
13. Remove the camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** , **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** , **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** and **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake** .
14. Remove the camshaft position actuator solenoid valves from the front cover. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake** , **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust** , **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** , and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust** .

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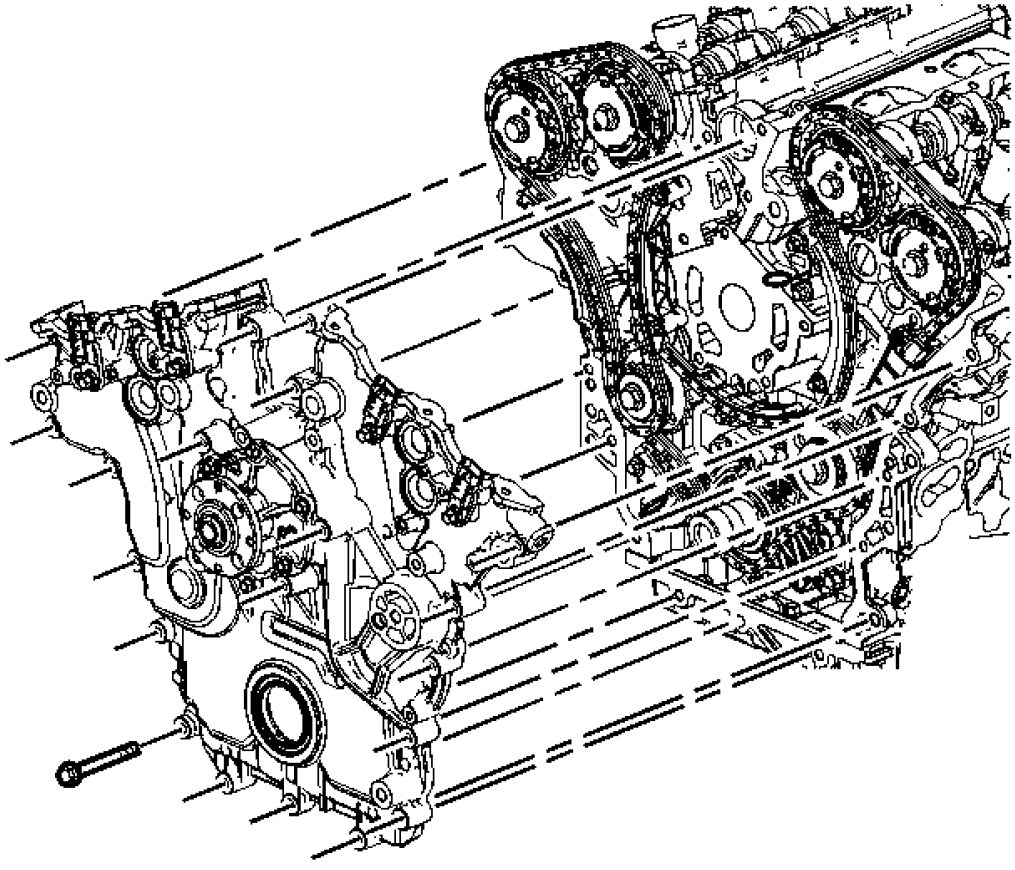


Fig. 71: Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

15. Remove the engine front cover with the water pump. Refer to **Engine Front Cover Removal** .
16. Disassemble the engine front cover. Refer to **Engine Front Cover Disassemble** .

NOTE: Do NOT use sharp and/or metal gasket scrapers in order to clean the sealing surfaces.

17. Carefully clean the engine front cover sealing surfaces. Refer to **Engine Front Cover Cleaning and Inspection** .

NOTE: Insert a piece of cardboard between the oil pan front and the oil pump in order to prevent any contaminants from falling into the oil pan.

18. Carefully clean the engine front cover sealing surfaces. Refer to **Engine Front Cover Cleaning and**

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Inspection .

19. Use compressed air in order to remove any engine coolant from the engine cooling passages and from the top of the oil pan scraper (windage tray).

INSTALLATION PROCEDURE

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

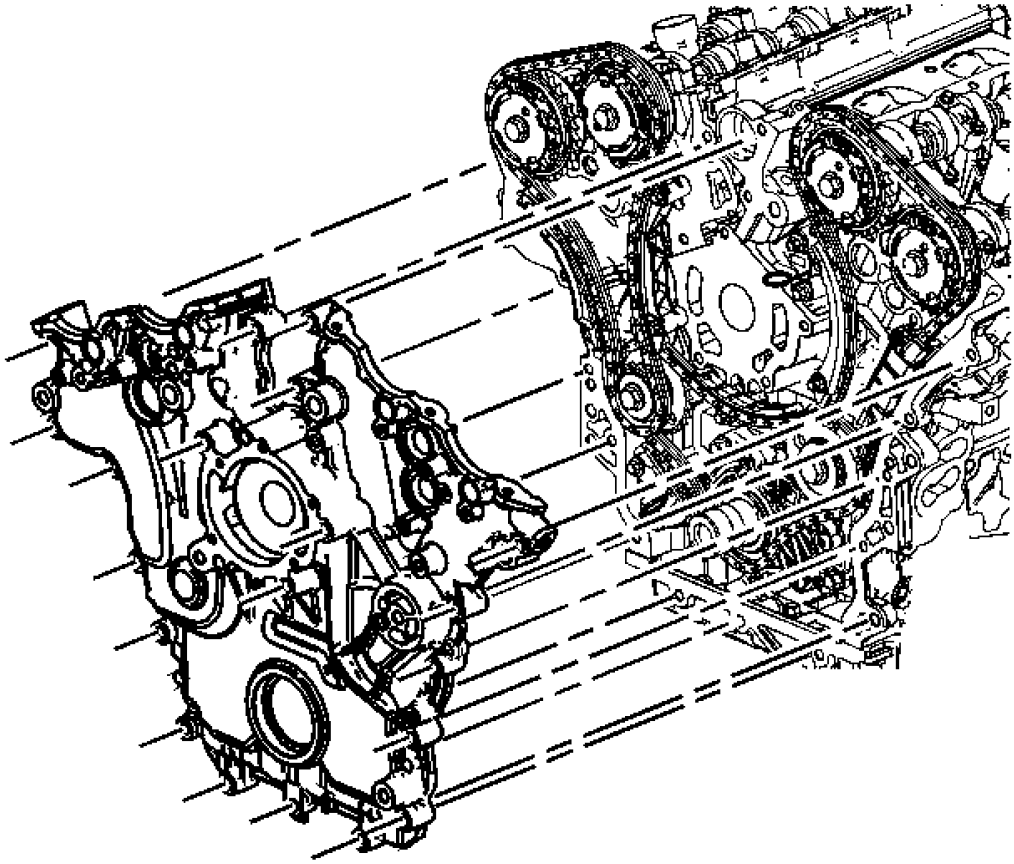


Fig. 72: Engine Front Cover
Courtesy of GENERAL MOTORS CORP.

2. Use the **EN 46109** in order to install the engine front cover. See **Special Tools** . Refer to **Engine Front Cover Installation** .
3. Install the camshaft position actuator solenoid valves to the front cover. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake** , **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust** , **Camshaft Position**

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Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake , and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust** .

4. Install the camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** , **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** , **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** and **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake** .
5. Install the crankshaft balancer. Refer to **Crankshaft Balancer Installation** .
6. Install the power steering pump.
7. Install the power steering pump pulley.
8. Install the power steering fluid reservoir. Refer to **Power Steering Fluid Reservoir Replacement (V6)** or **Power Steering Fluid Reservoir Replacement (V8)** .
9. Install the generator bracket with the generator and the belt tensioner. Refer to **Generator Bracket Replacement (LS3/L99)** .
10. Install the A/C compressor and power steering belt tensioner.
11. Install the accessory drive belts.
12. Install the water outlet.
13. Install the purge vent hose to the water outlet.
14. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** .
15. Install the camshaft covers. Refer to **Camshaft Cover Replacement - Left Side** and **Camshaft Cover Replacement - Right Side**.
16. Install the intake manifold. Refer to **Intake Manifold Replacement**.
17. Install the engine cover. Refer to **Intake Manifold Cover Replacement - Rear**.
18. Fill the cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** .

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side** .
3. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side** .
4. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Right Side** .
5. Remove the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Right Side** .

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6. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Removal** .
7. Remove the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Removal - Upper** .
8. Remove the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain Removal** .
9. Remove the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Removal - Right Side** .
10. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Left Side** .
11. Remove the left bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Left Side** .
12. Remove the left bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Left Side** .
13. Remove the left bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Removal - Left Side** .

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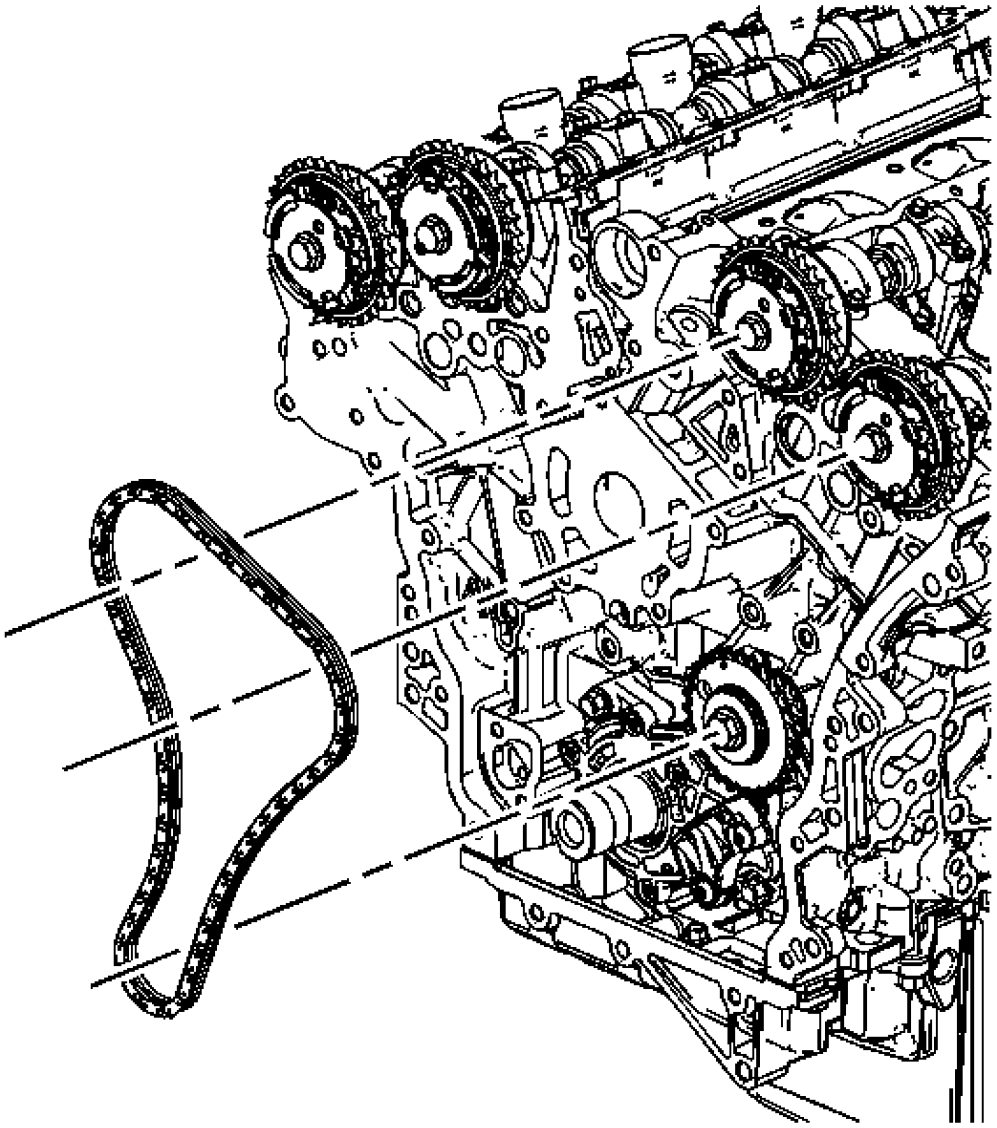


Fig. 73: View Of Left Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

14. Remove the left bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Left Side** .
15. Clean and inspect all of the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** . Replace components as necessary.

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INSTALLATION PROCEDURE

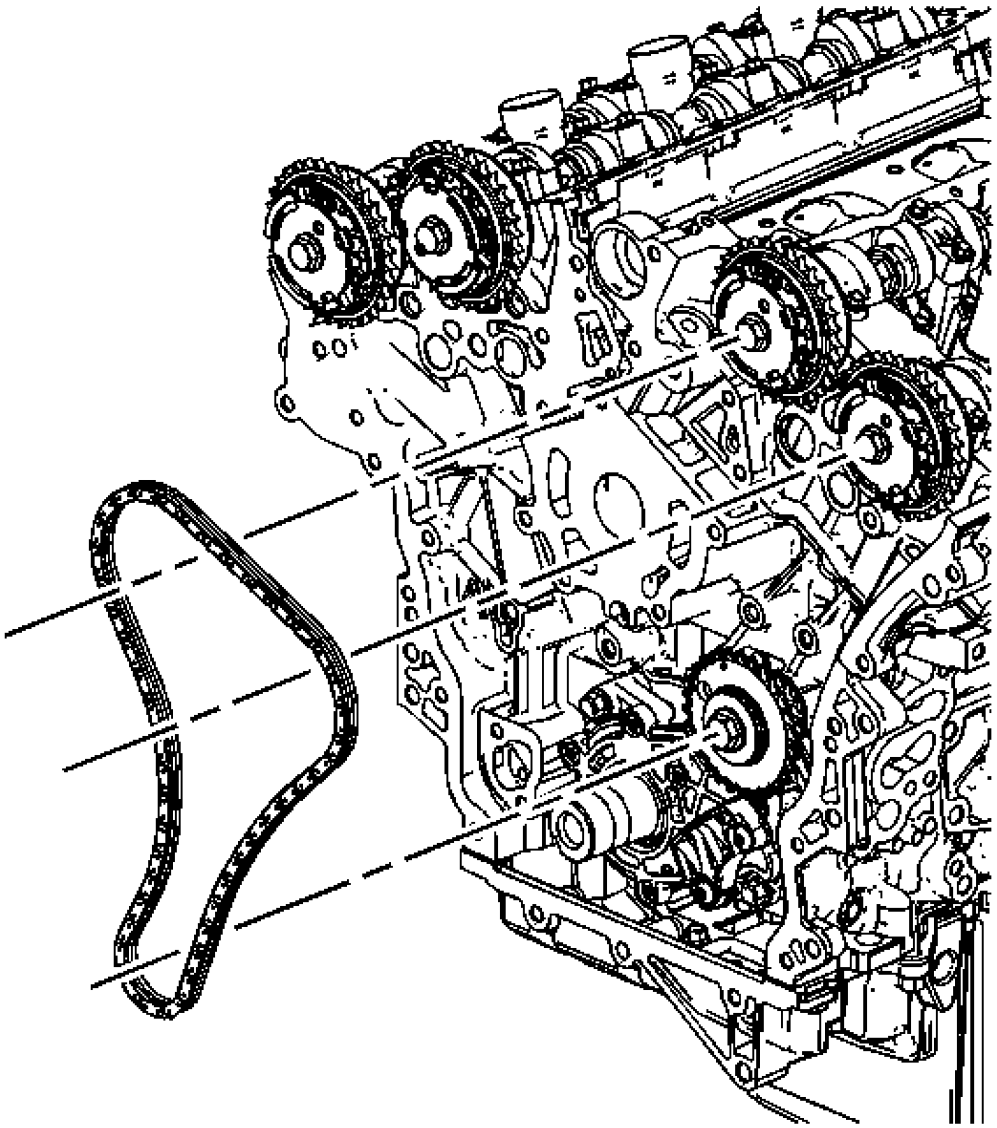


Fig. 74: View Of Left Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

1. Install the left bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Left Side (LLT)** .
2. Install the left bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket**

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Installation - Left Side .

3. Install the left bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Left Side** .
4. Install the left bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Left Side** .
5. Install the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Left Side** .
6. Install the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Installation - Right Side** .
7. Install the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain Installation** .
8. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Installation - Upper** .
9. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation** .
10. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Right Side** .
11. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side** .
12. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side** .
13. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .
14. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side** .
3. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side** .
4. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Right Side** .

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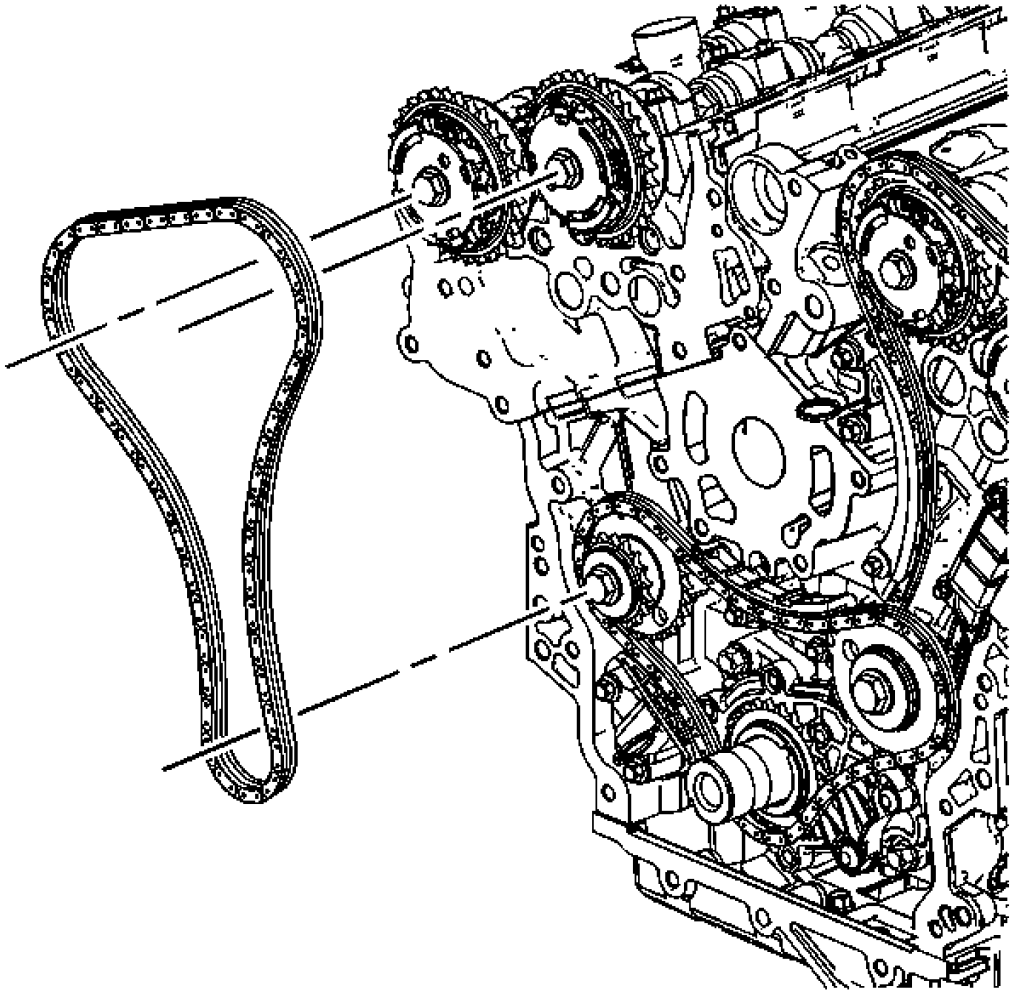


Fig. 75: View Of Right Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

5. Remove the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Right Side** .

INSTALLATION PROCEDURE

1. Ensure the stage 1 camshaft timing is correct. Refer to **Setting Camshaft Timing**.

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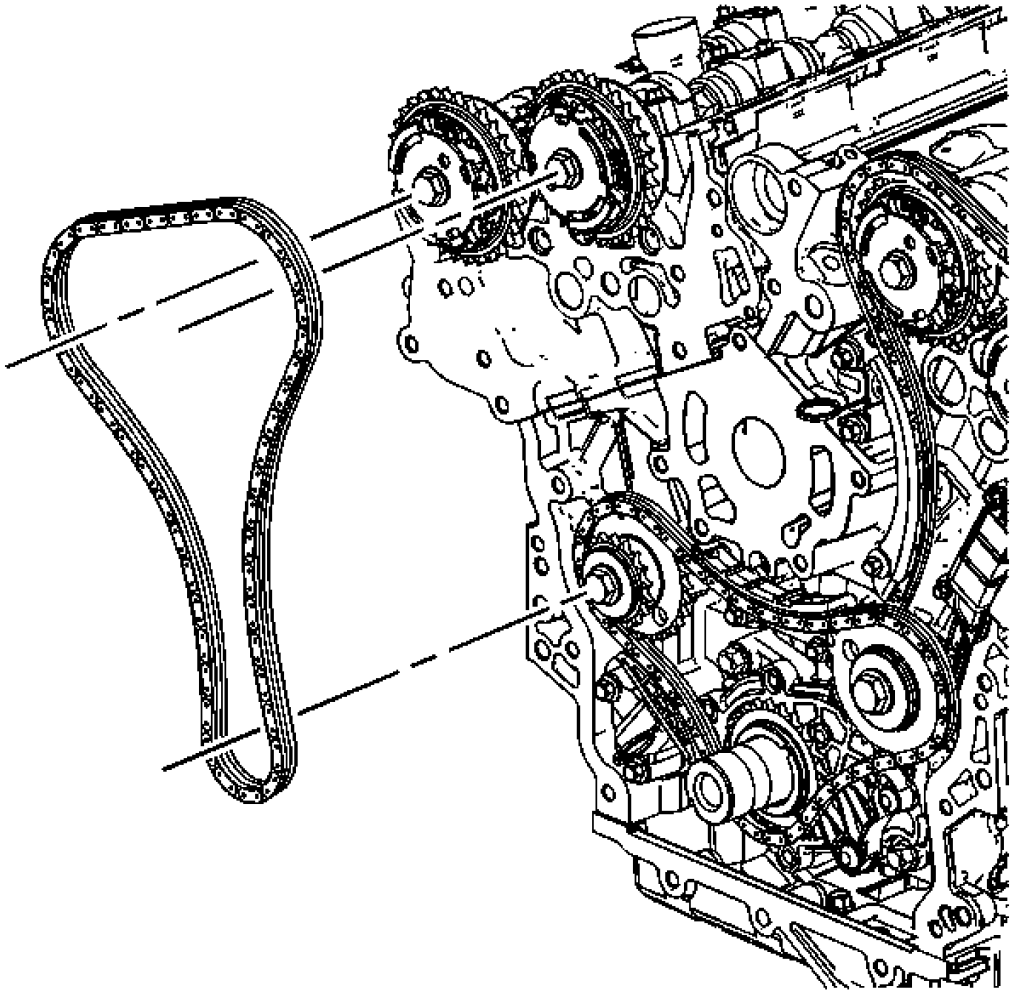


Fig. 76: View Of Right Bank Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS CORP.

2. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Right Side** .
3. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side** .
4. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side** .
5. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .
6. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

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SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

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

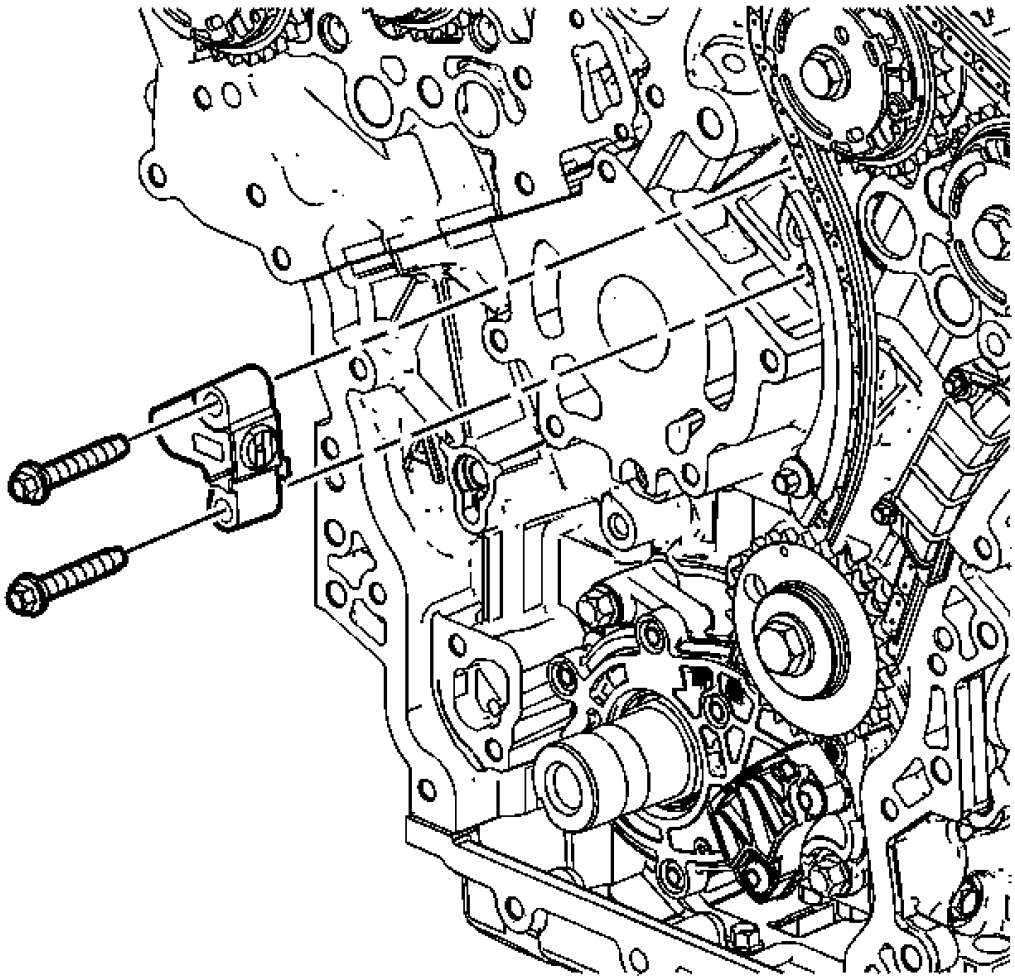


Fig. 77: Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

2. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Left Side** .

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INSTALLATION PROCEDURE

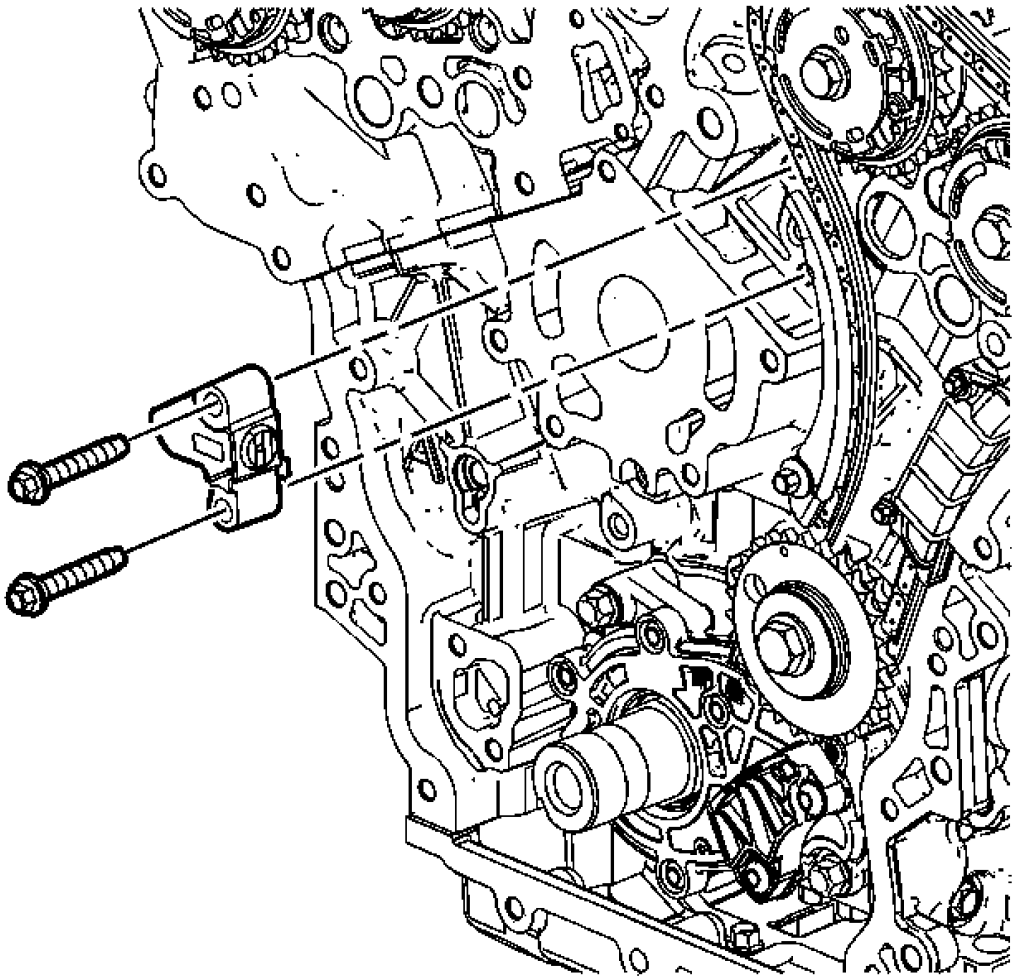


Fig. 78: Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Install the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Left Side** .
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

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

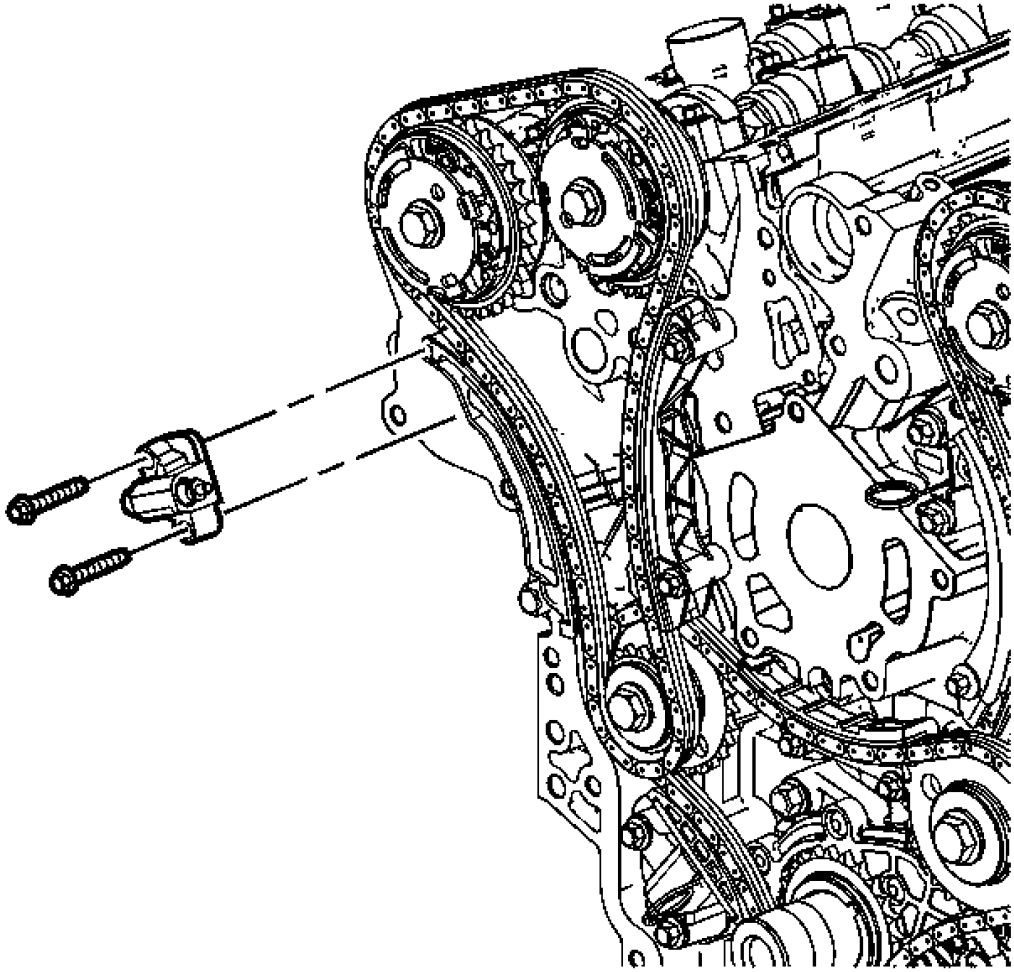


Fig. 79: Right Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

2. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side** .

INSTALLATION PROCEDURE

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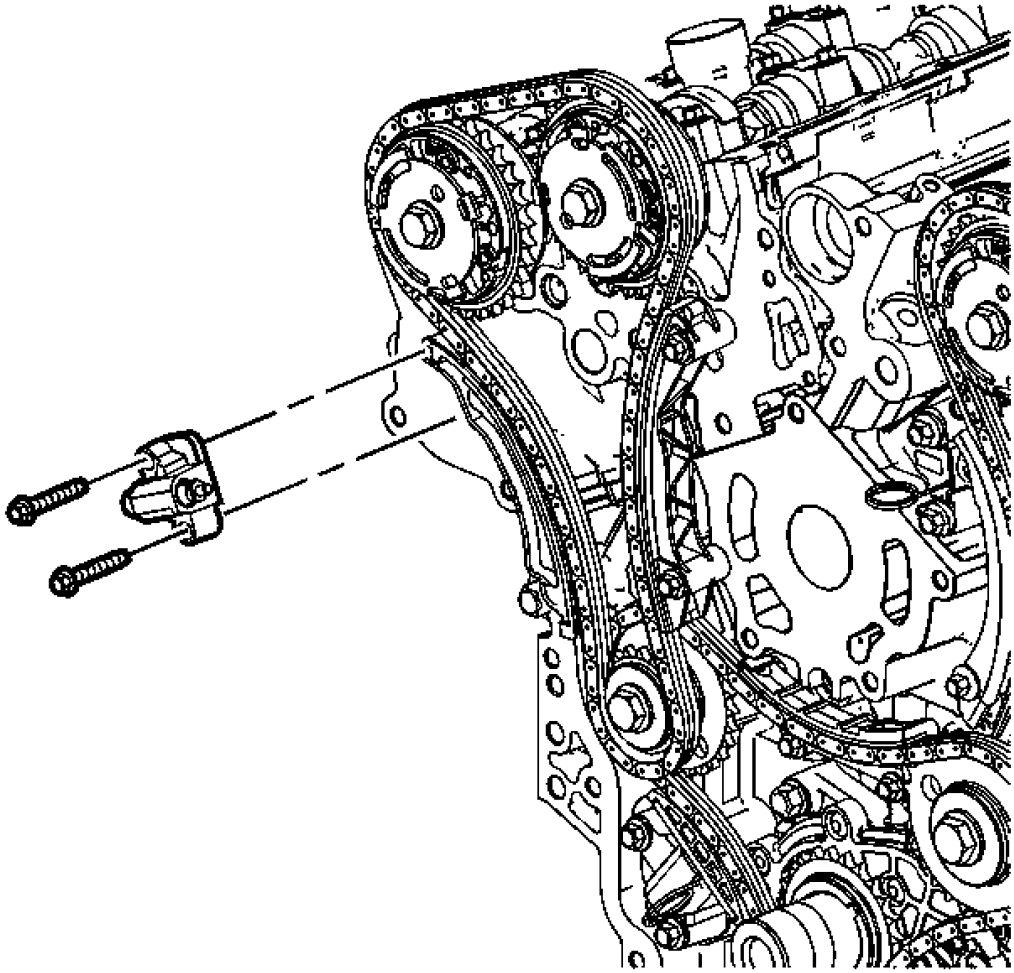


Fig. 80: Right Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

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

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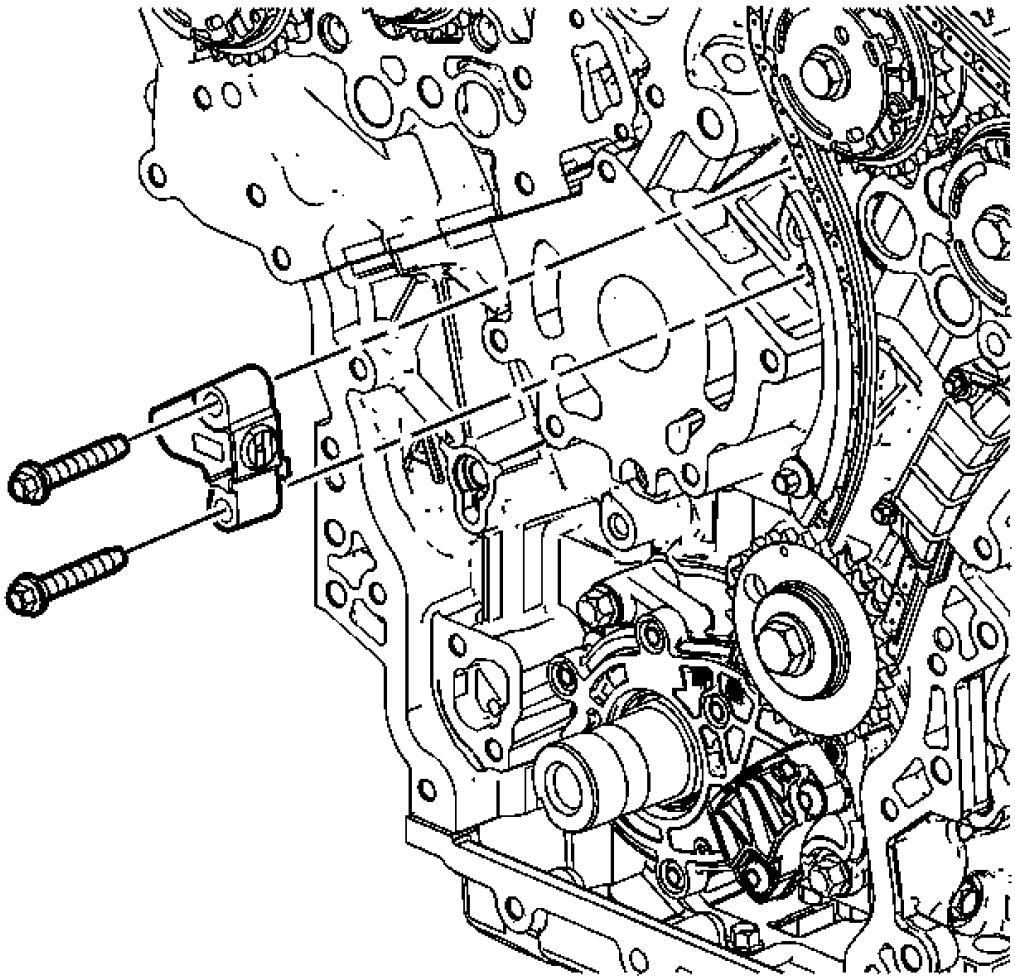


Fig. 81: Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

2. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Left Side** .

INSTALLATION PROCEDURE

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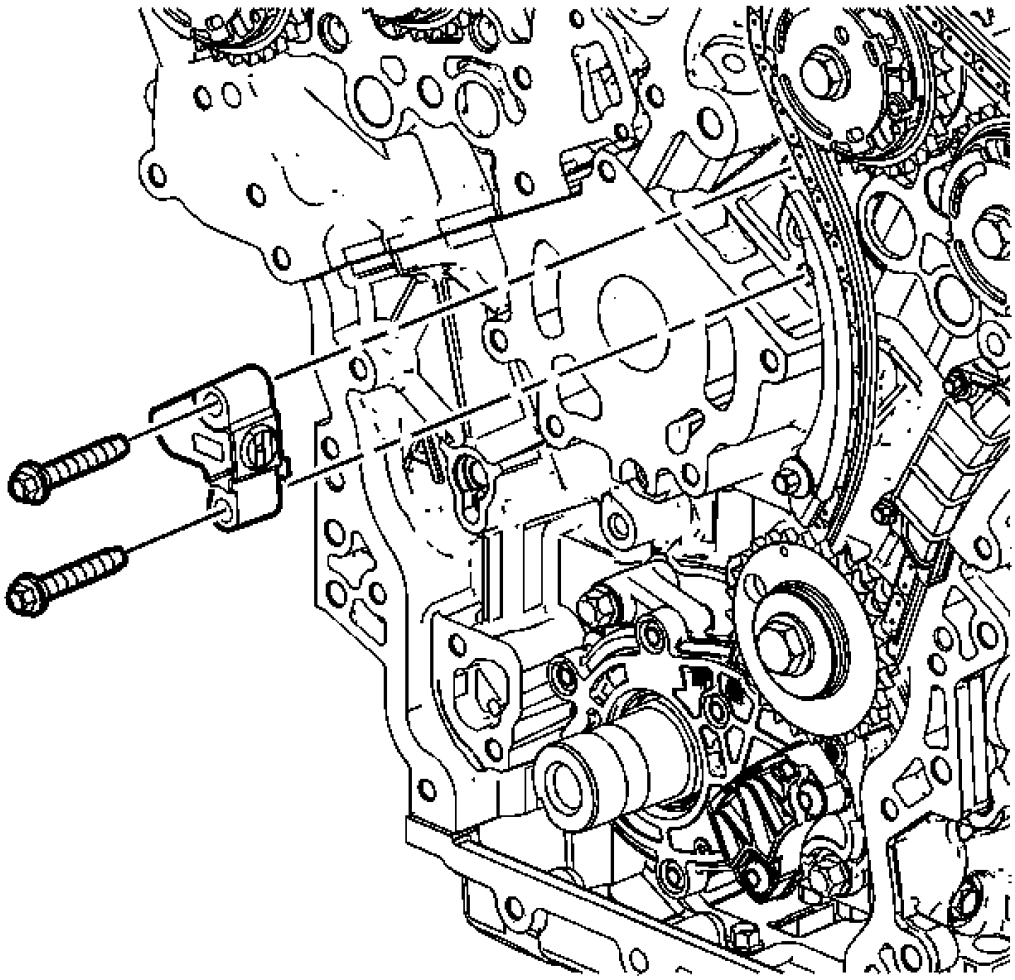


Fig. 82: Left Bank Secondary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Install the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Left Side** .
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

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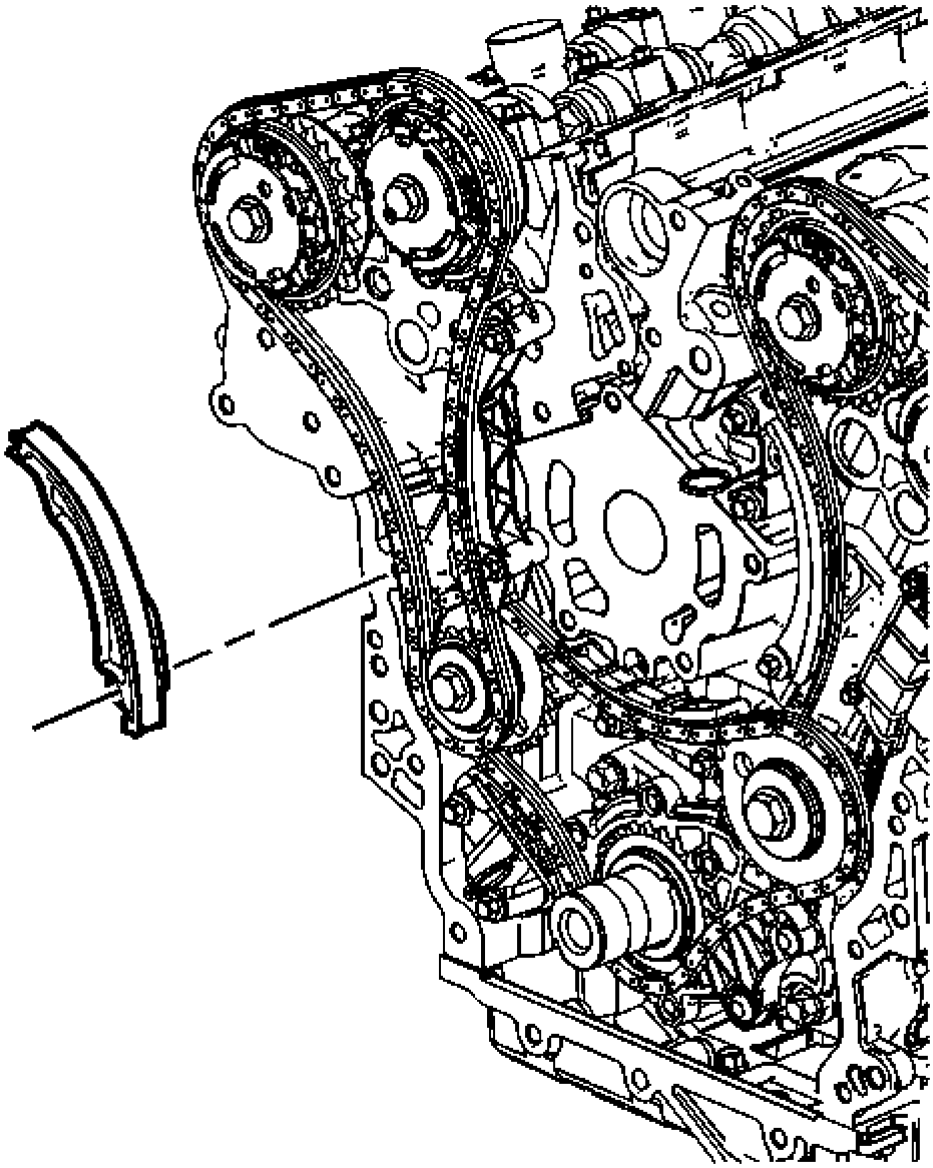


Fig. 83: View Of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side** .

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3. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side** .

INSTALLATION PROCEDURE

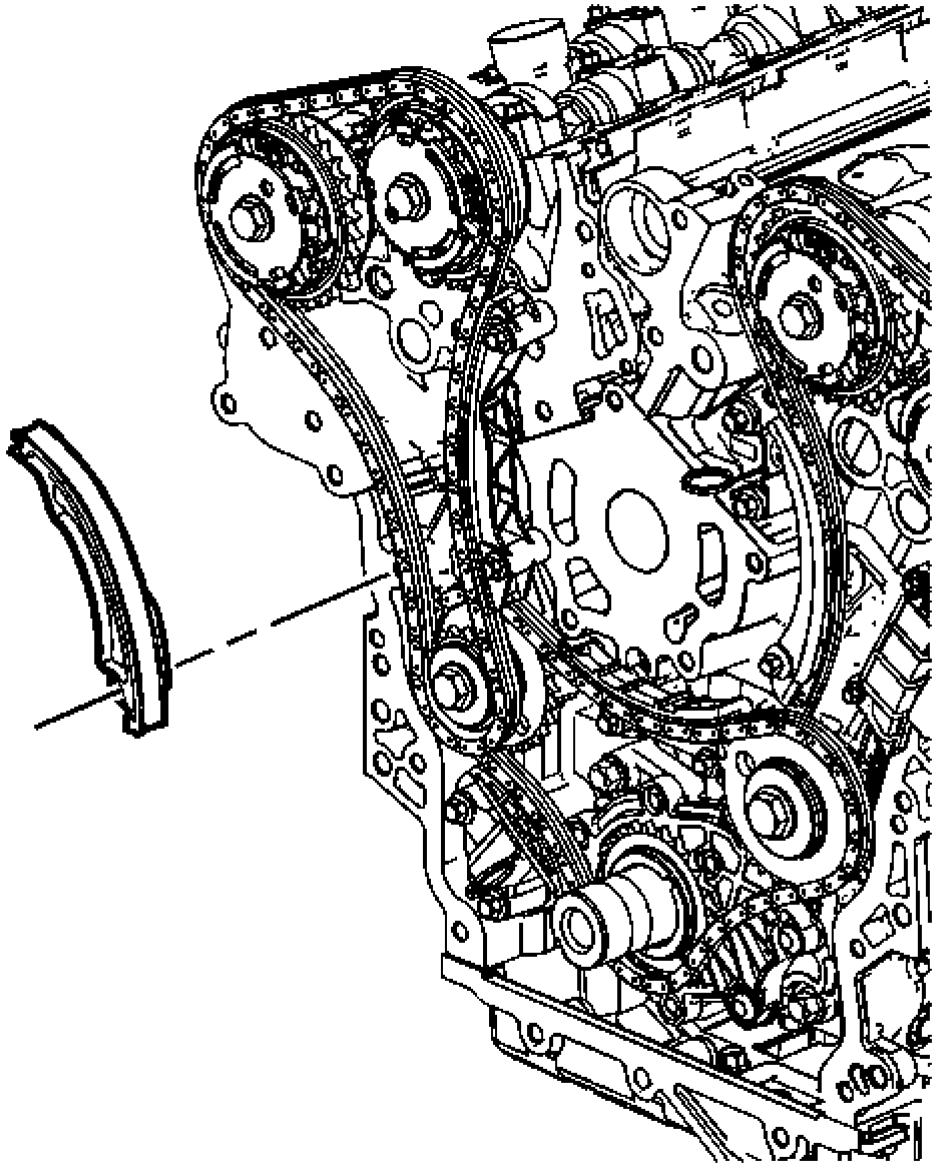


Fig. 84: View Of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS CORP.

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1. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side** .
2. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY TIMING CHAIN GUIDE REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Left Side** .

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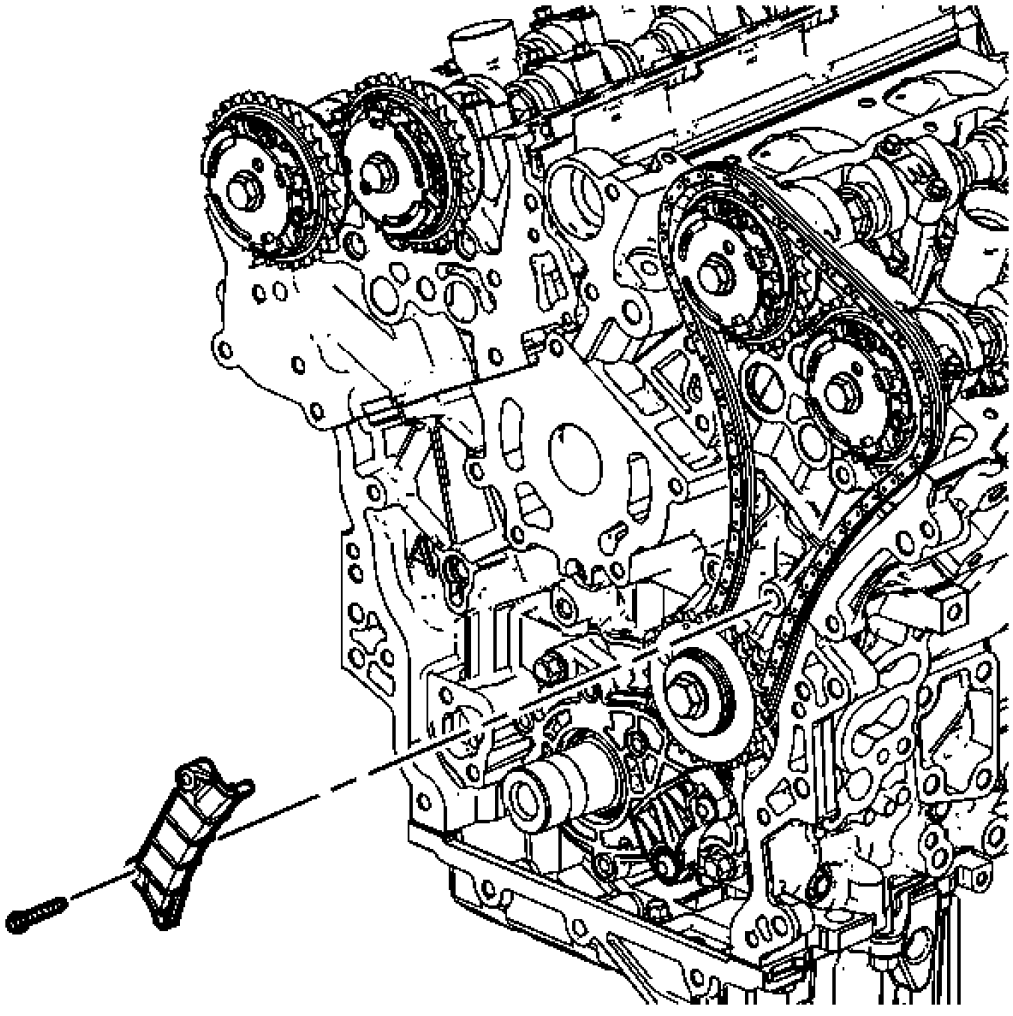


Fig. 85: View Of Left Bank Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

3. Remove the left bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Left Side** .

INSTALLATION PROCEDURE

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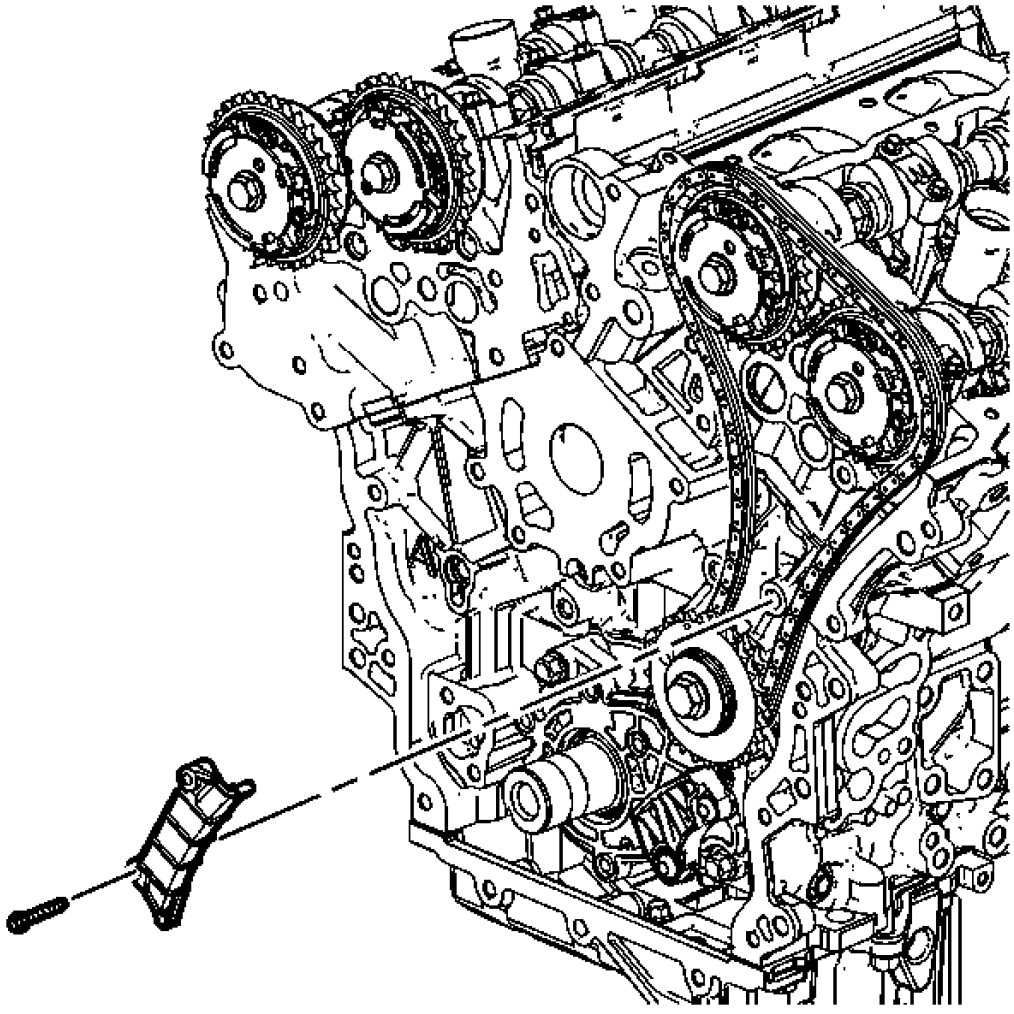


Fig. 86: View Of Left Bank Secondary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

1. Install the left bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Left Side** .
2. Install the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Left Side** .
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY TIMING CHAIN GUIDE REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

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1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side** .

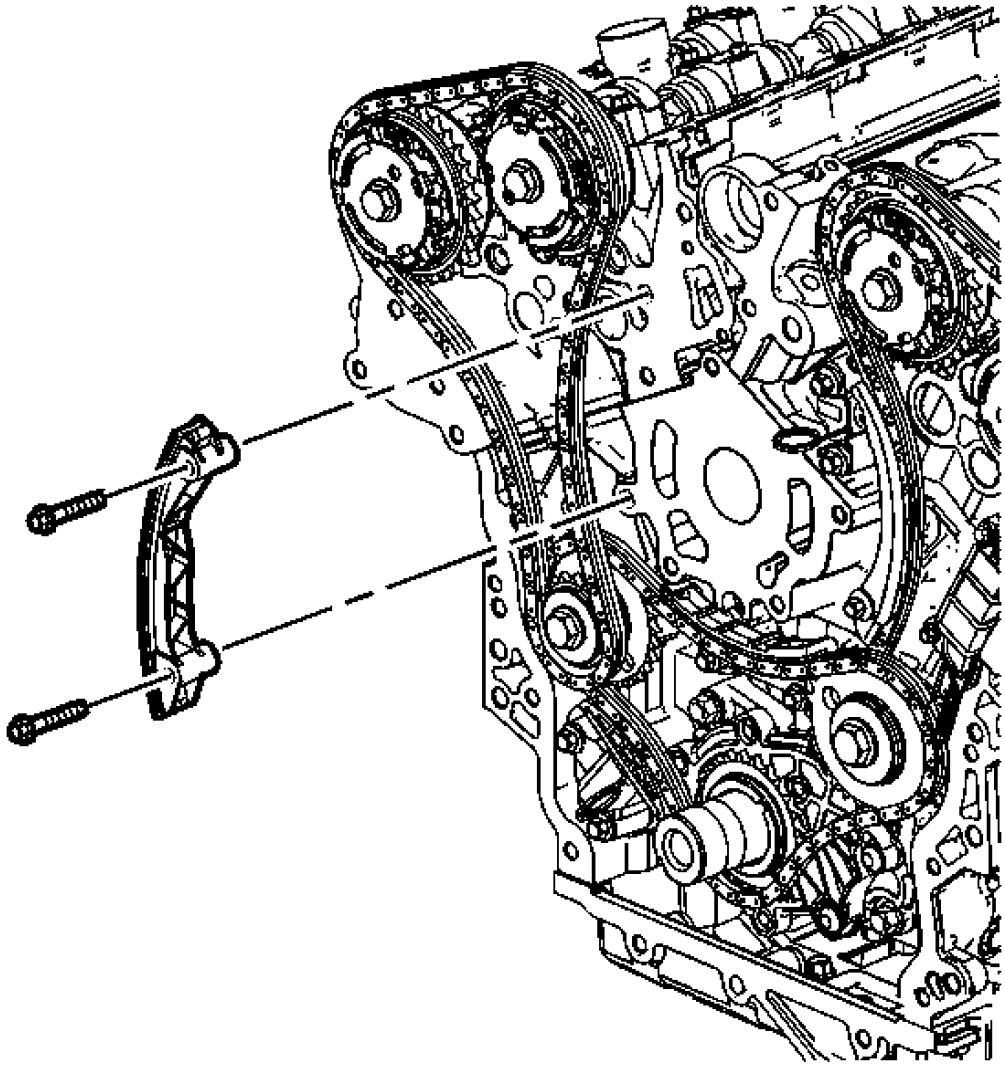


Fig. 87: View Of Right Secondary Camshaft Drive Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

3. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Right Side** .

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INSTALLATION PROCEDURE

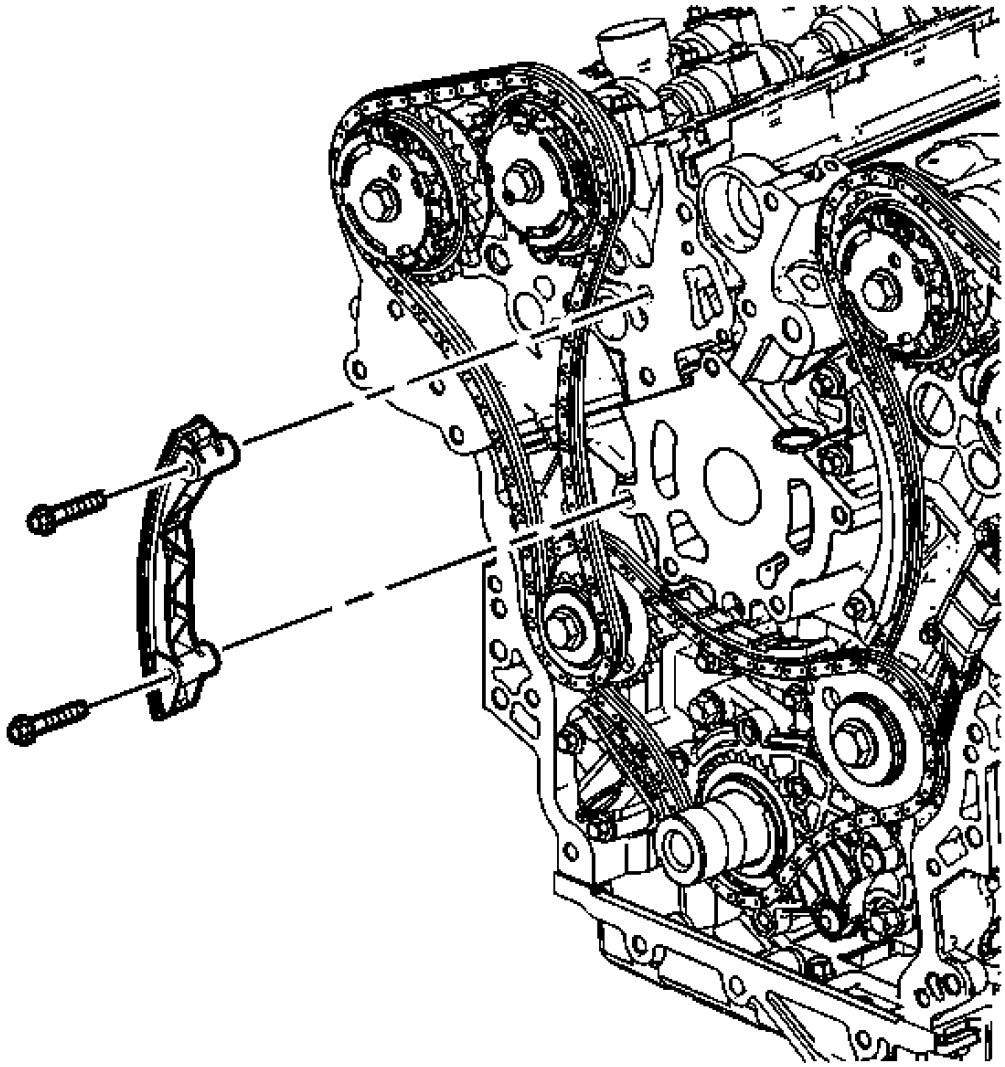


Fig. 88: View Of Right Secondary Camshaft Drive Chain Guide & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side** .
2. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

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PRIMARY CAMSHAFT DRIVE CHAIN AND SPROCKETS REPLACEMENT

REMOVAL PROCEDURE

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side** .
3. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side** .
4. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Right Side** .
5. Remove the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Right Side** .
6. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Removal** .
7. Remove the primary camshaft drive chain upper guide. **Primary Timing Chain Guide Removal - Upper** .

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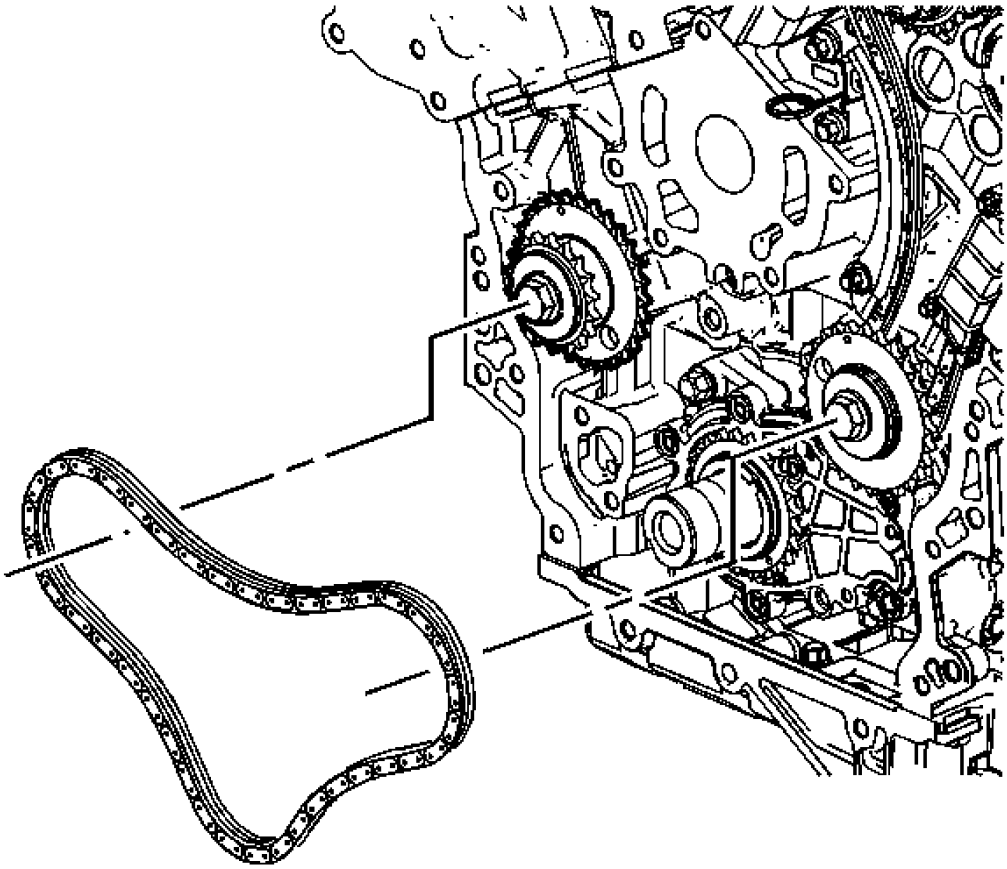


Fig. 89: View Of Primary Camshaft Timing Chain
Courtesy of GENERAL MOTORS CORP.

8. Remove the primary camshaft timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Right Side** .

INSTALLATION PROCEDURE

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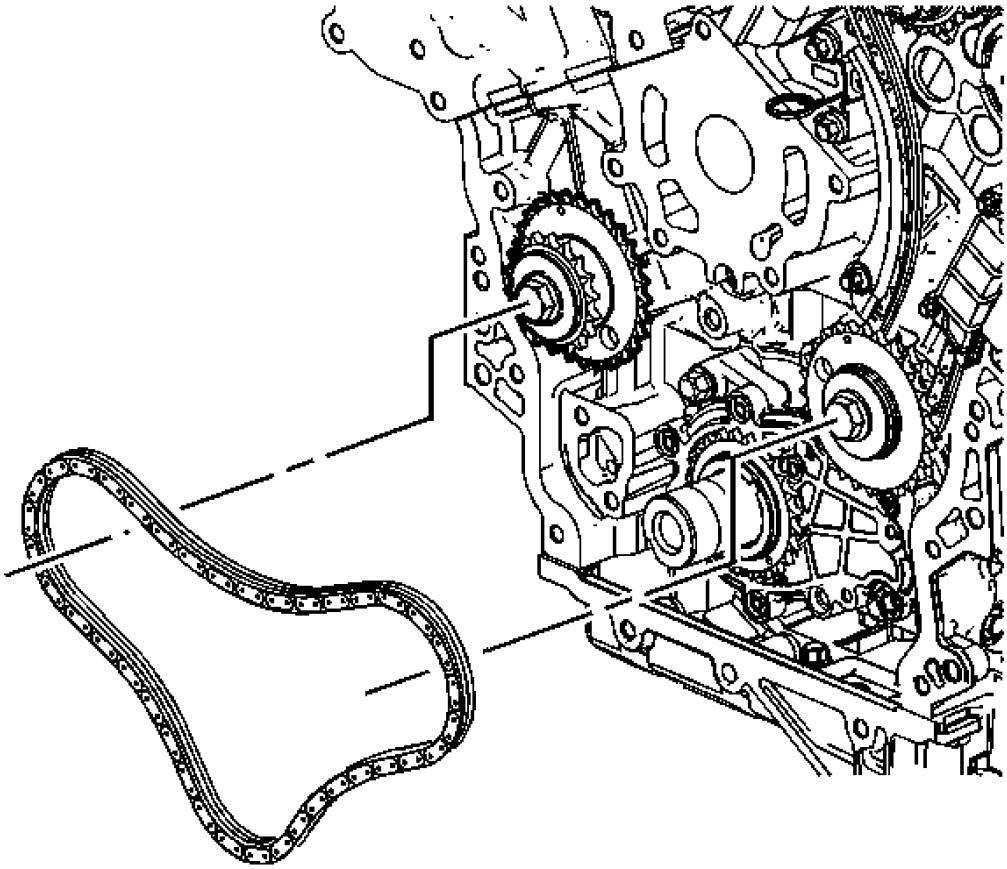


Fig. 90: View Of Primary Camshaft Timing Chain
Courtesy of GENERAL MOTORS CORP.

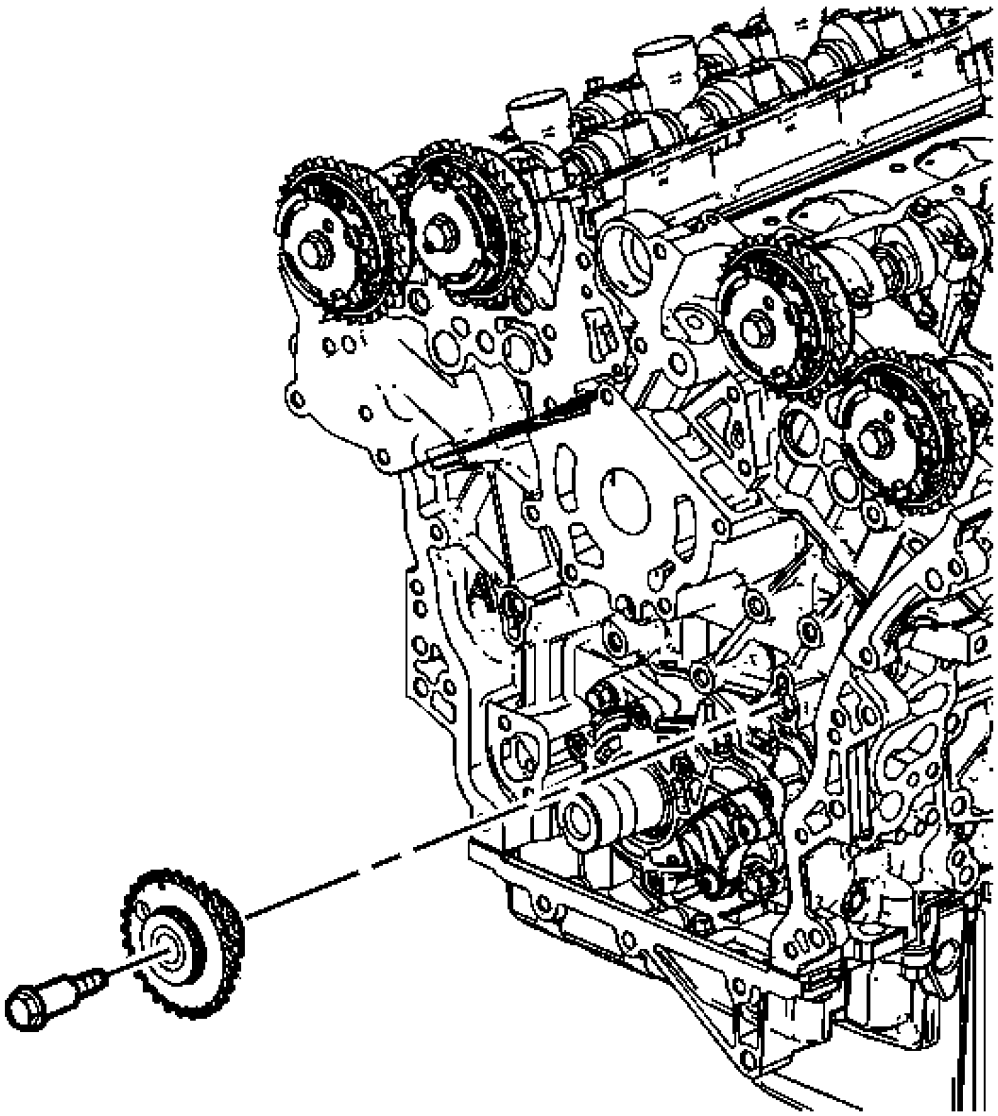
1. Install the primary camshaft timing chain. Refer to **Primary Camshaft Intermediate Drive Chain Installation** .
2. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Installation - Upper** .
3. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation** .
4. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Right Side** .
5. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side** .
6. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side** .

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7. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .
8. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

TIMING CHAIN IDLER SPROCKET REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE



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Fig. 91: View Of Left Camshaft Intermediate Drive Chain Idler
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side** .
3. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side** .
4. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Right Side** .
5. Remove the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Right Side** .
6. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Removal** .
7. Remove the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Removal - Upper** .
8. Remove the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain Removal** .
9. Remove the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Removal - Right Side** .

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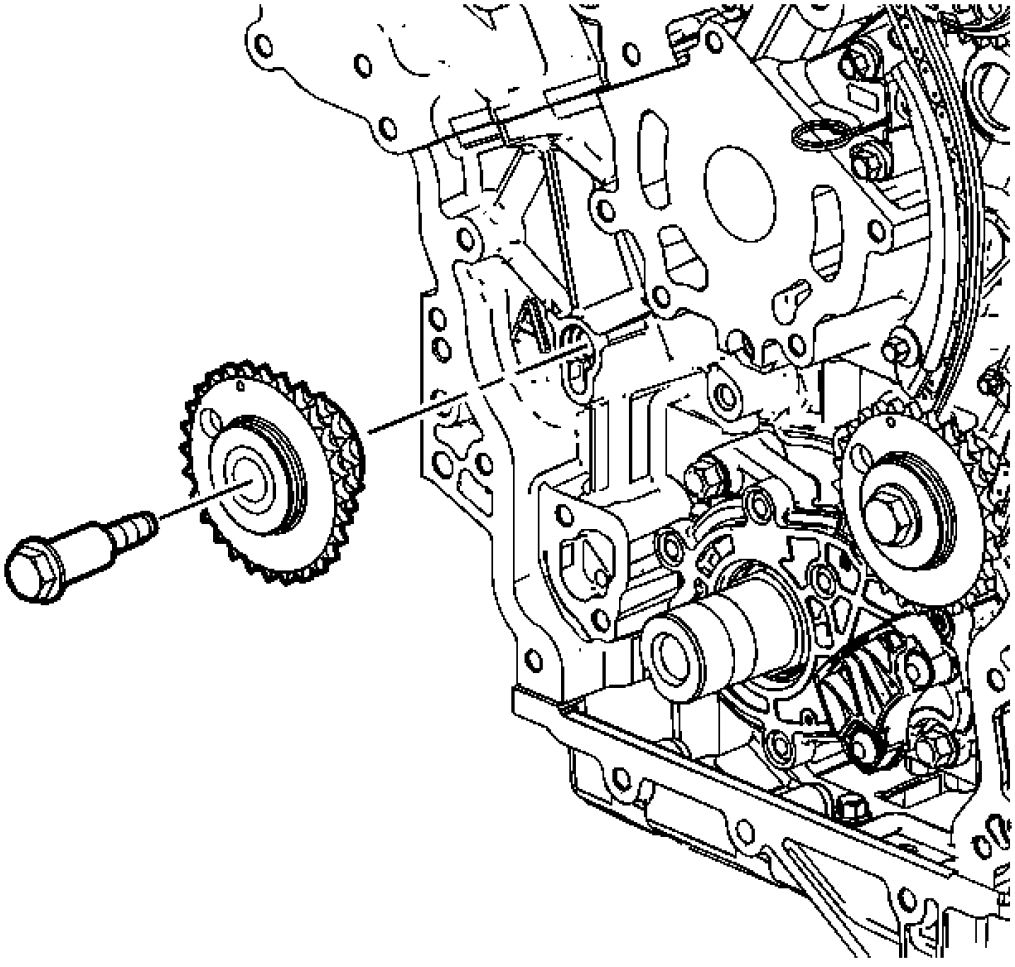


Fig. 92: View Of Camshaft Intermediate Drive Chain Idler
Courtesy of GENERAL MOTORS CORP.

10. If you are servicing the left bank camshaft intermediate drive chain idler, perform the following steps:
    1. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Left Side** .
    2. Remove the left bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Left Side** .
    3. Remove the left bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Left Side** .
    4. Remove the left bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Left Side** .
    5. Remove the left bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler**

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Sprocket Removal - Left Side .

INSTALLATION PROCEDURE

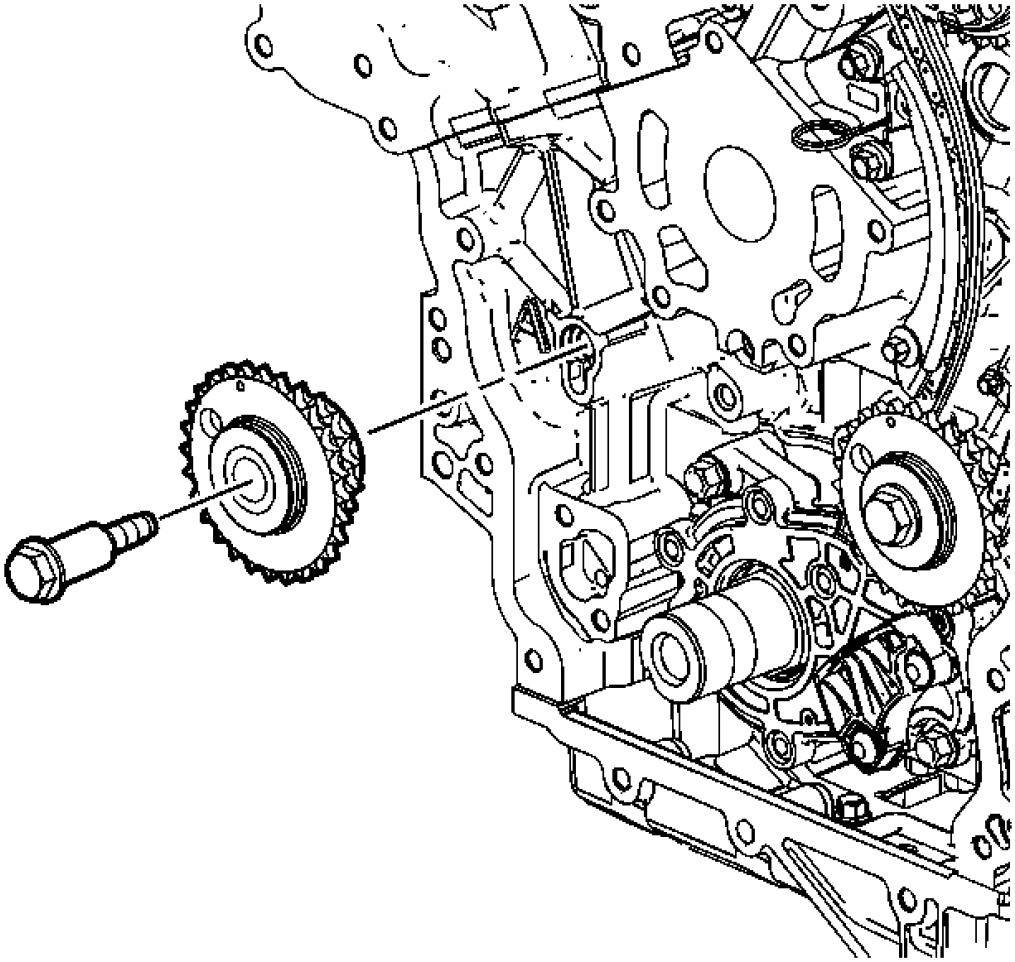


Fig. 93: View Of Camshaft Intermediate Drive Chain Idler
Courtesy of GENERAL MOTORS CORP.

1. If you are servicing the left bank idler sprocket, perform the following steps:
    1. Install the left bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Installation - Left Side** .
    2. Install the left bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Left Side (LLT)** .
    3. Install the left bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain**

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Guide Installation - Left Side .

4. Install the left bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Left Side** .
5. Install the left bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Left Side** .

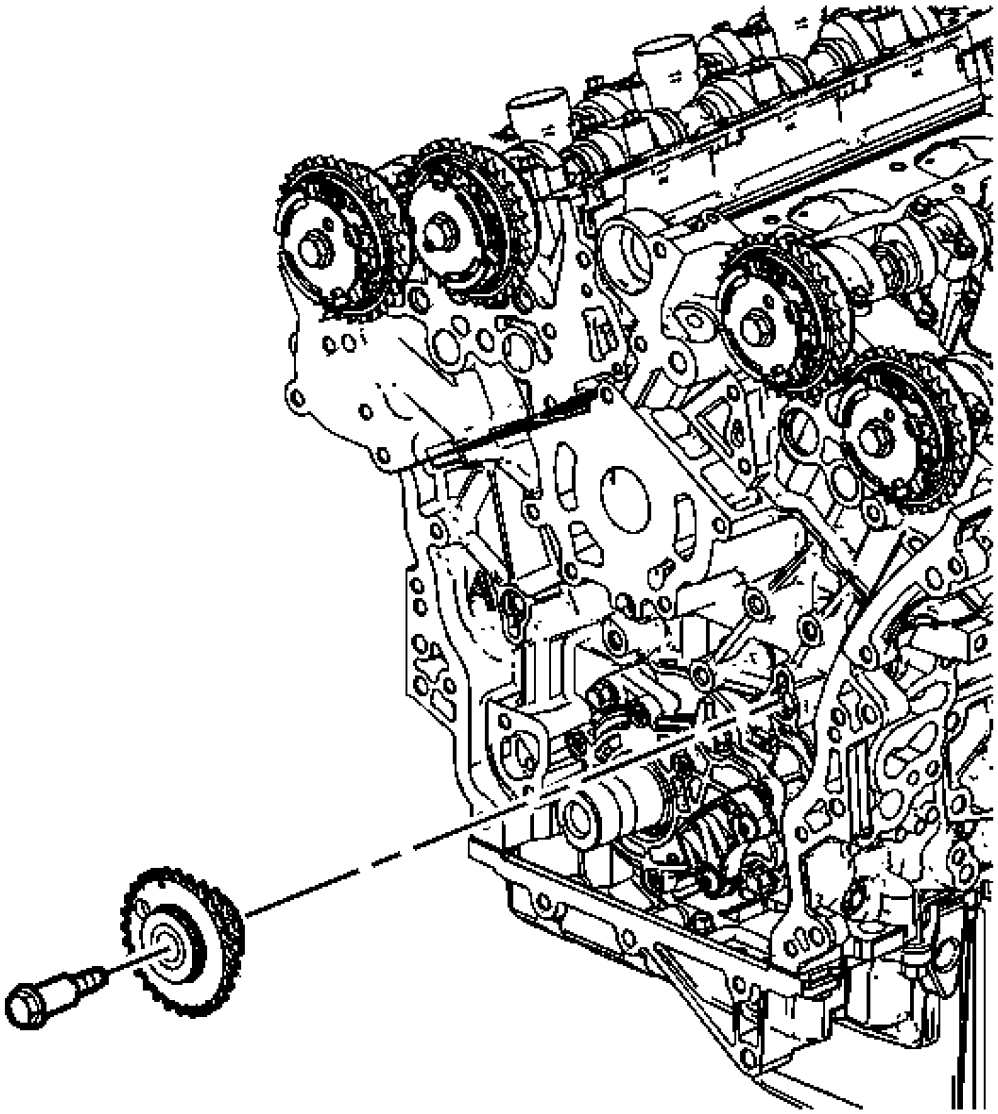


Fig. 94: View Of Left Camshaft Intermediate Drive Chain Idler
Courtesy of GENERAL MOTORS CORP.

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2. Install the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Installation - Right Side** .
3. Install the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain Installation** .
4. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Installation - Upper** .
5. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation** .
6. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Right Side** .
7. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side** .
8. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side** .
9. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .
10. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

TIMING CHAIN IDLER SPROCKET REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

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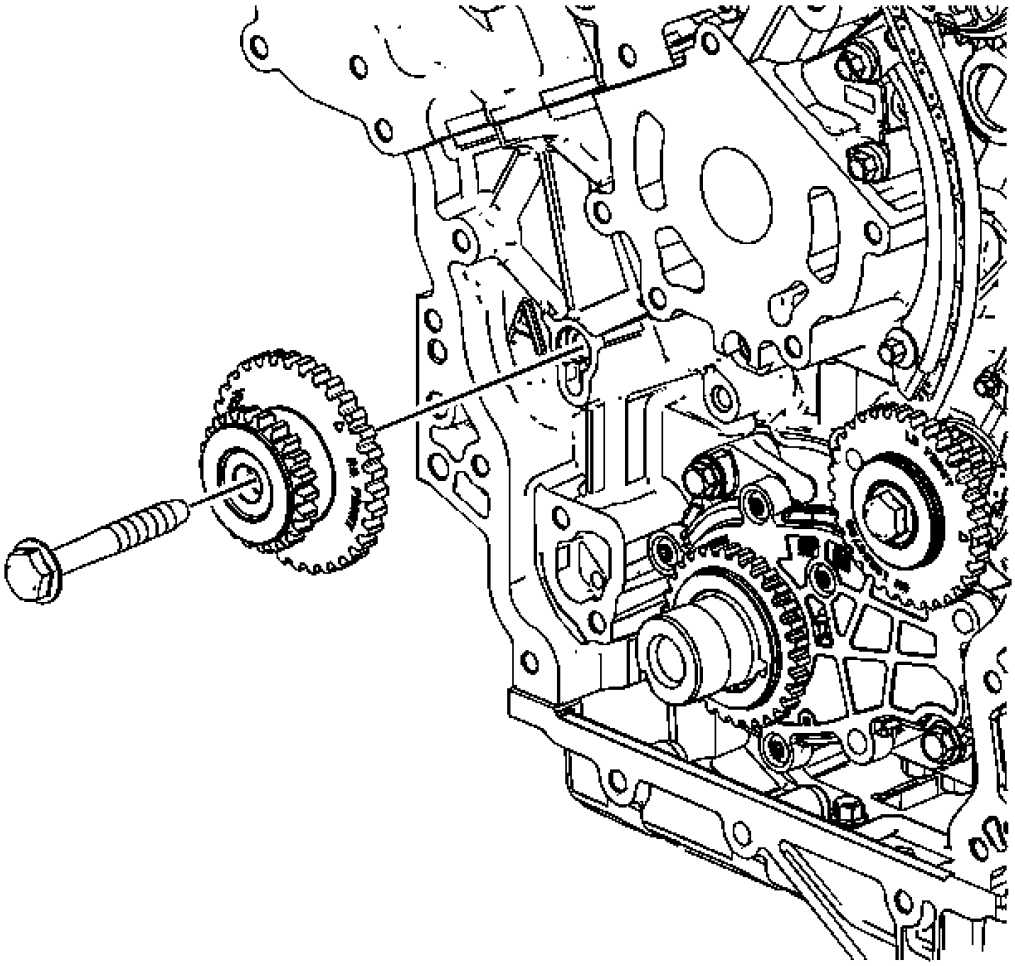


Fig. 95: Identifying Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the spark plugs in order to ease crankshaft/engine rotation. Refer to **Spark Plug Replacement** .
3. Remove the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Removal - Right Side** .
4. Remove the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Removal - Right Side** .
5. Remove the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Removal - Right Side** .
6. Remove the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Removal - Right Side** .

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7. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Removal** .
8. Remove the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Removal - Upper** .
9. Remove the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain Removal** .
10. Remove the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Removal - Right Side** .

INSTALLATION PROCEDURE

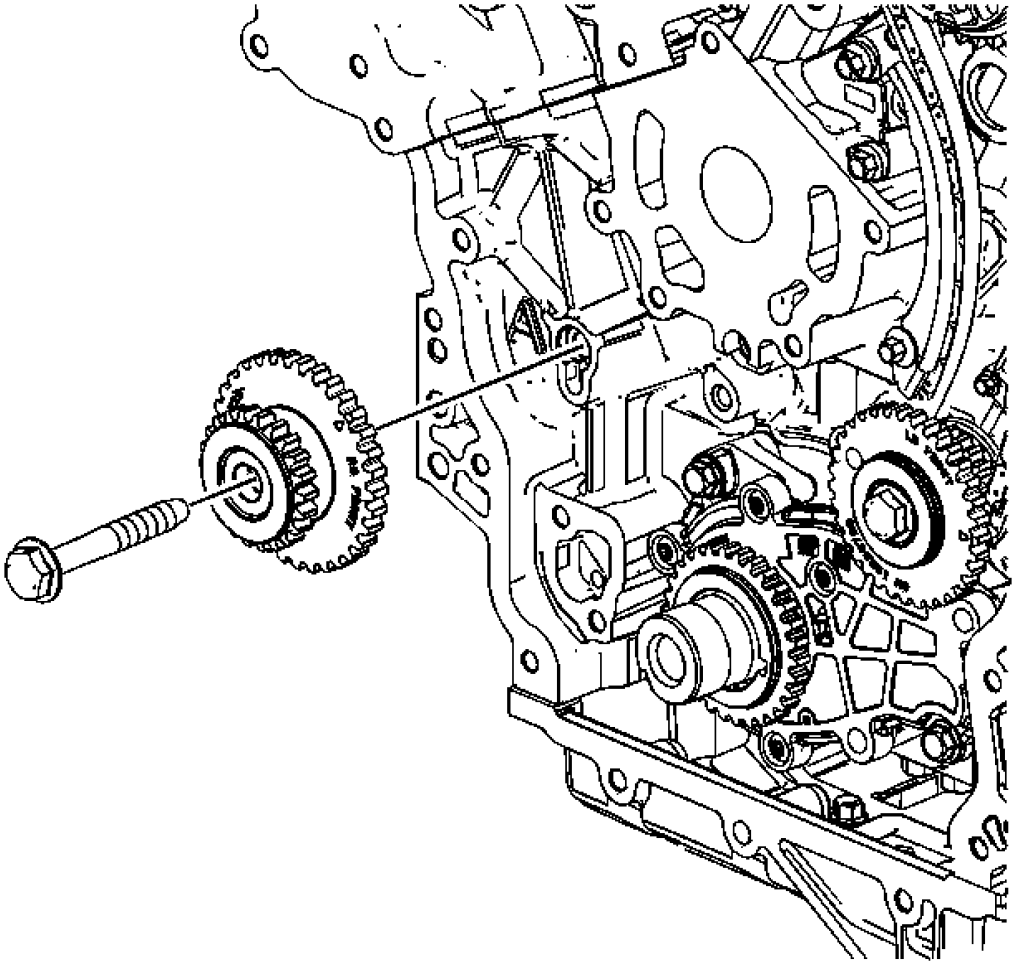


Fig. 96: Identifying Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS CORP.

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1. Install the right bank camshaft intermediate drive chain idler. Refer to **Timing Chain Idler Sprocket Installation - Right Side** .
2. Install the primary camshaft drive chain. Refer to **Primary Camshaft Intermediate Drive Chain Installation** .
3. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Installation - Upper** .
4. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation** .
5. Install the right bank secondary camshaft drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Installation - Right Side** .
6. Install the right bank secondary camshaft drive chain guide. Refer to **Secondary Timing Chain Guide Installation - Right Side** .
7. Install the right bank secondary camshaft drive chain shoe. Refer to **Secondary Camshaft Drive Chain Shoe Installation - Right Side** .
8. Install the right bank secondary camshaft drive chain tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side** .
9. Install the spark plugs. Refer to **Spark Plug Replacement** .
10. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT

REMOVAL PROCEDURE

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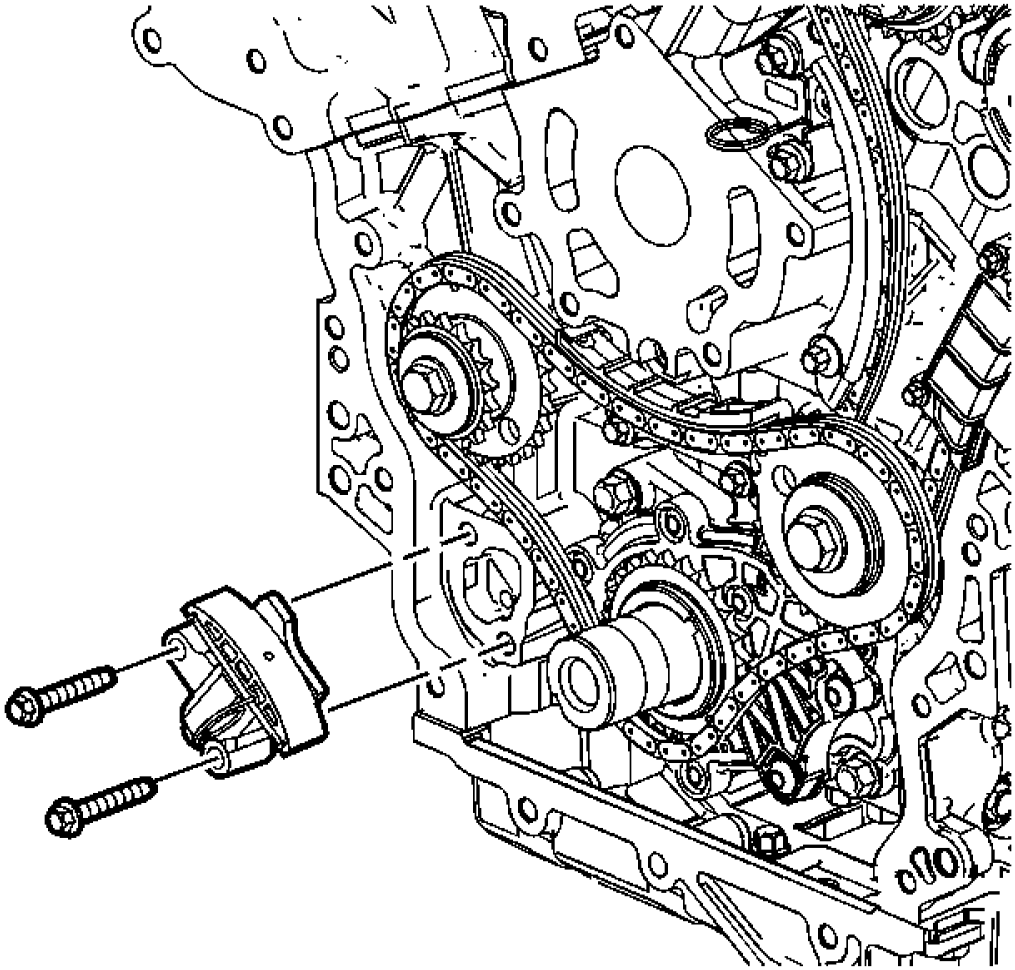


Fig. 97: View Of Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

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

NOTE: **If the entire camshaft timing system is not in Stage 2, Timing Chain Alignment Diagram , mark the timing chain and sprockets in order to ensure proper reassembly.**

2. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Removal** .

INSTALLATION PROCEDURE

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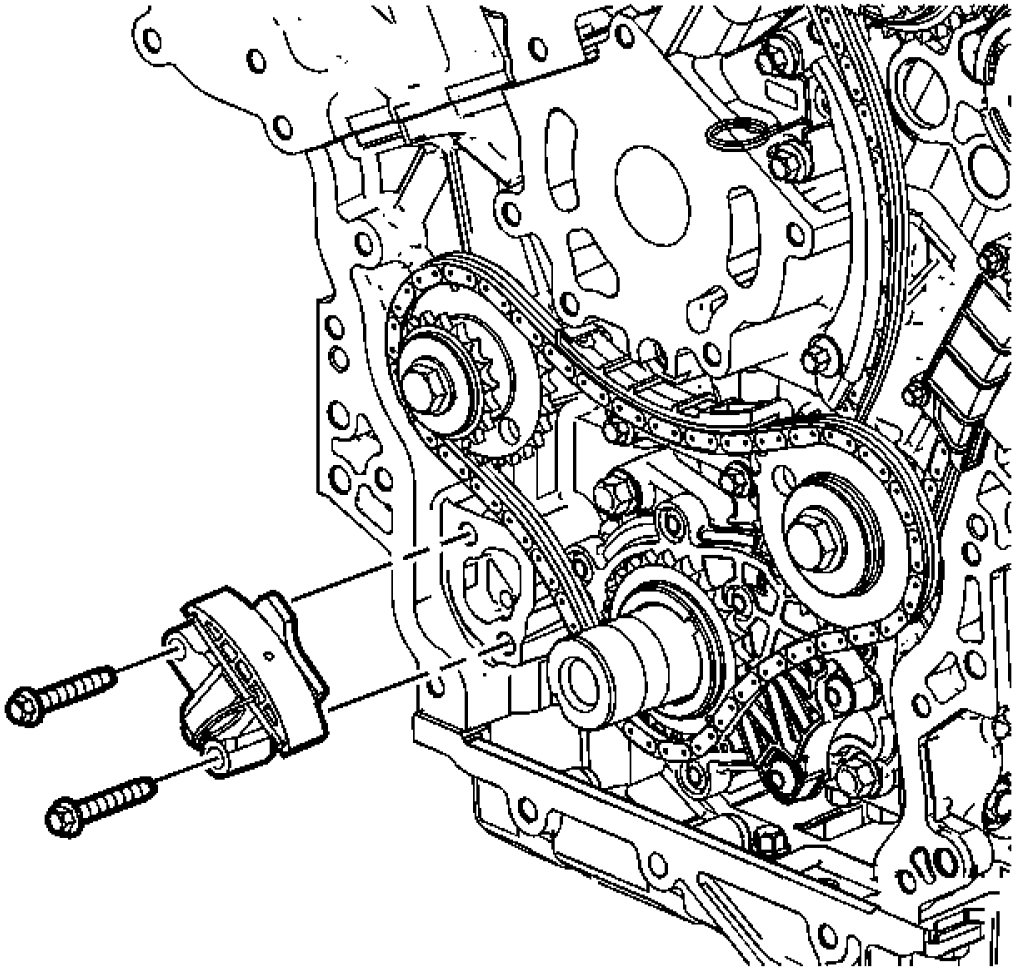


Fig. 98: View Of Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS CORP.

1. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation** .
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

PRIMARY TIMING CHAIN GUIDE REPLACEMENT - LOWER

REMOVAL PROCEDURE

1. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Replacement**.

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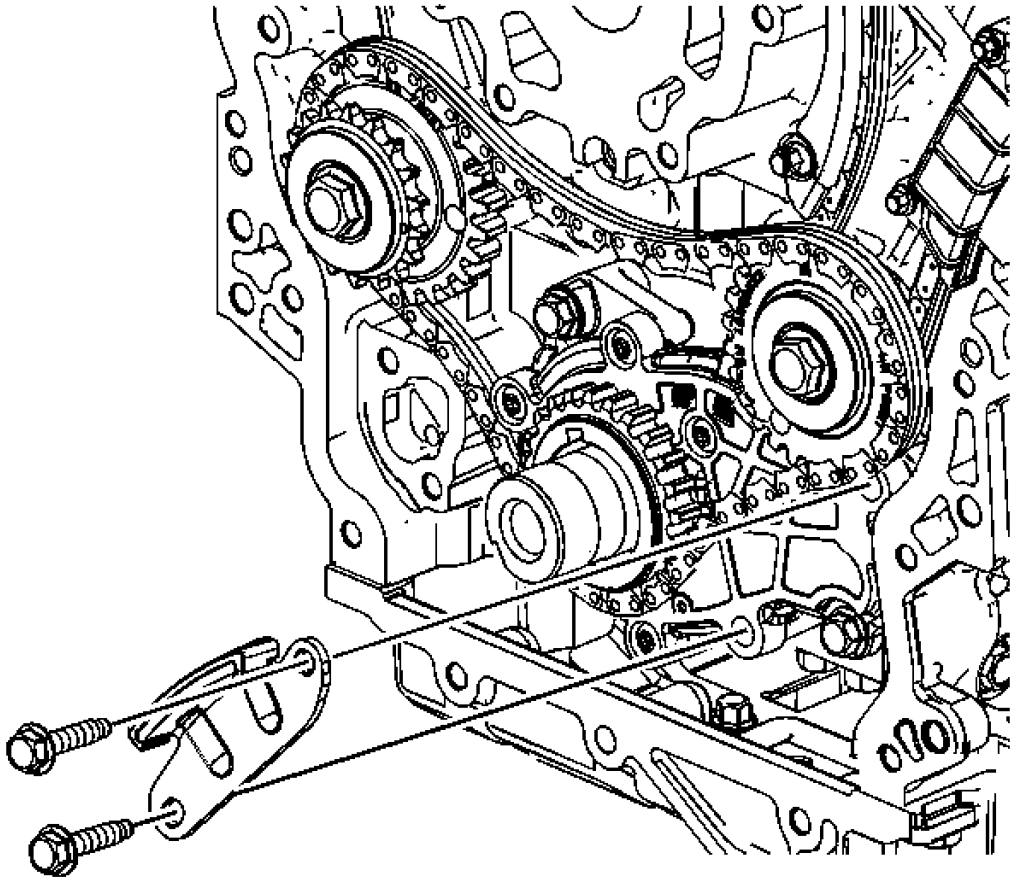


Fig. 99: View Of Primary Camshaft Drive Chain Lower Guide Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the primary camshaft drive chain lower guide bolts.
3. Remove the primary camshaft drive chain lower guide.

INSTALLATION PROCEDURE

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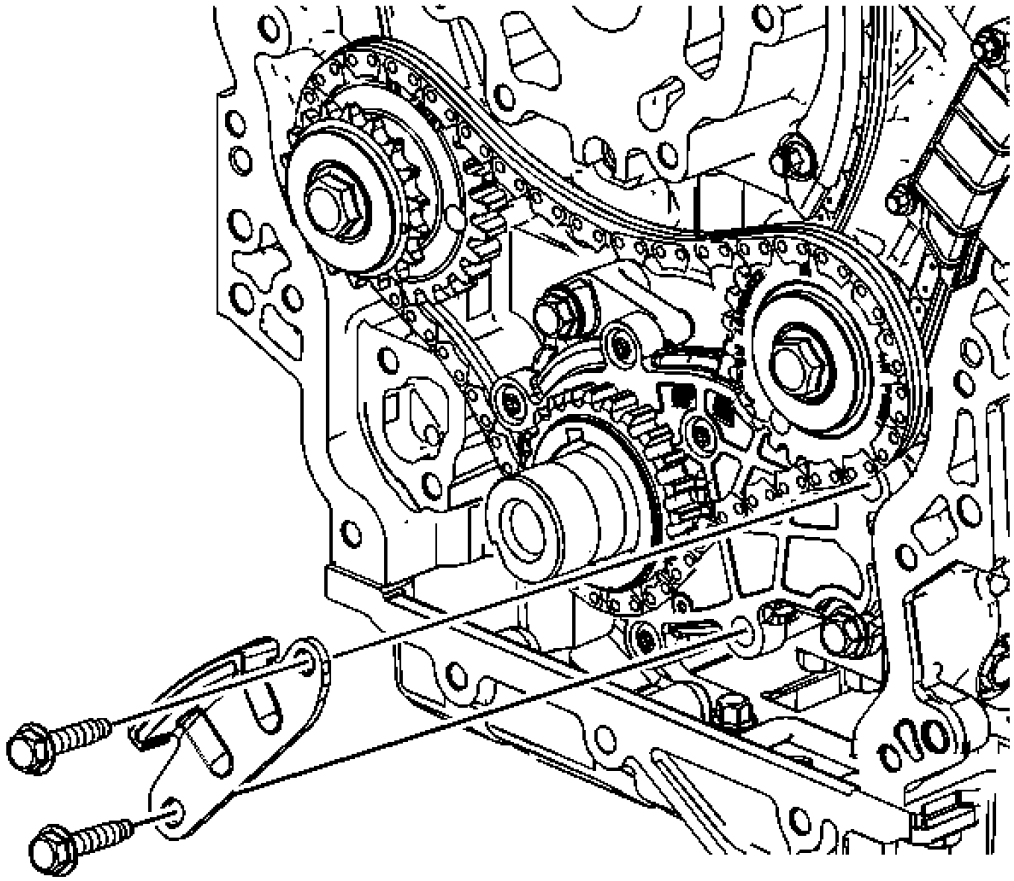


Fig. 100: View Of Primary Camshaft Drive Chain Lower Guide Bolts
Courtesy of GENERAL MOTORS CORP.

1. Position the primary camshaft drive chain lower guide to the oil pump.

CAUTION: Refer to Fastener Caution .

2. Install the primary camshaft drive chain lower guide bolts and tighten to 23 N.m (17 lb ft).
3. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Replacement**.

PRIMARY TIMING CHAIN GUIDE REPLACEMENT - UPPER

REMOVAL PROCEDURE

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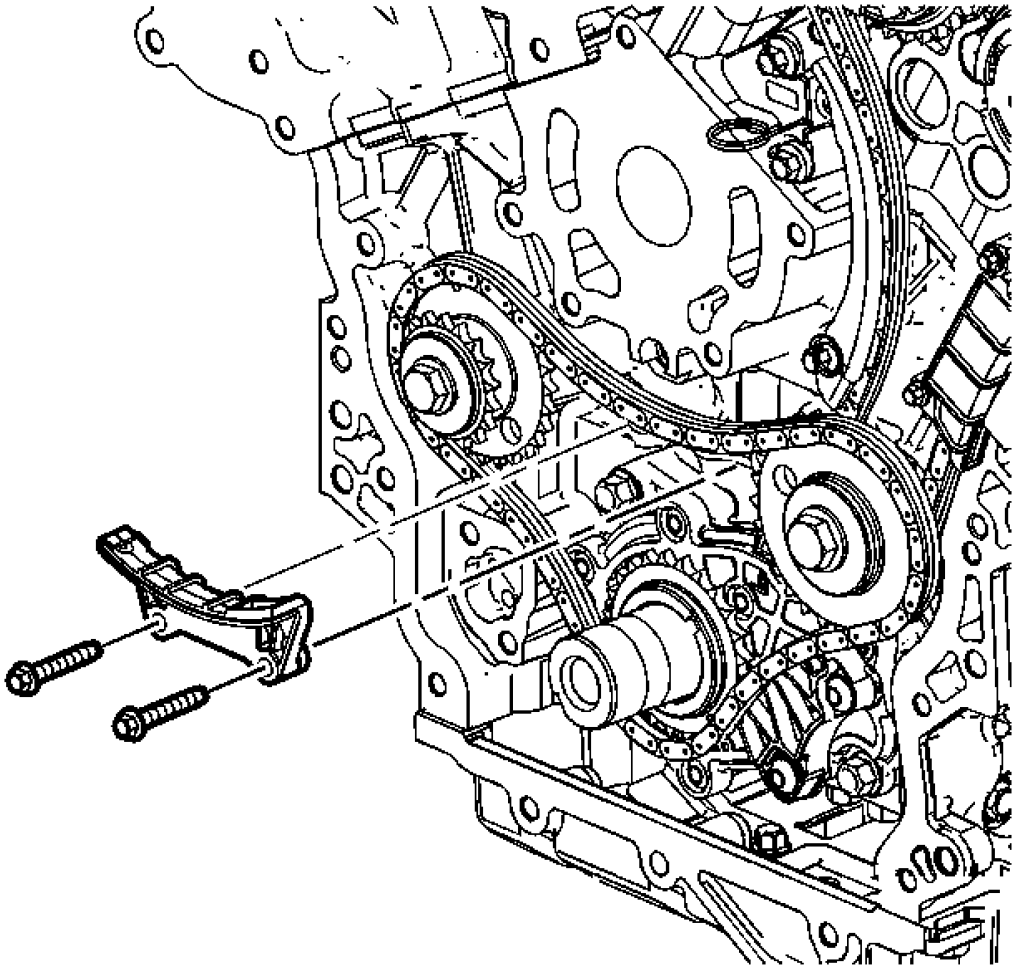


Fig. 101: View Of Upper Primary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Removal** .
3. Remove the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Removal - Upper** .

INSTALLATION PROCEDURE

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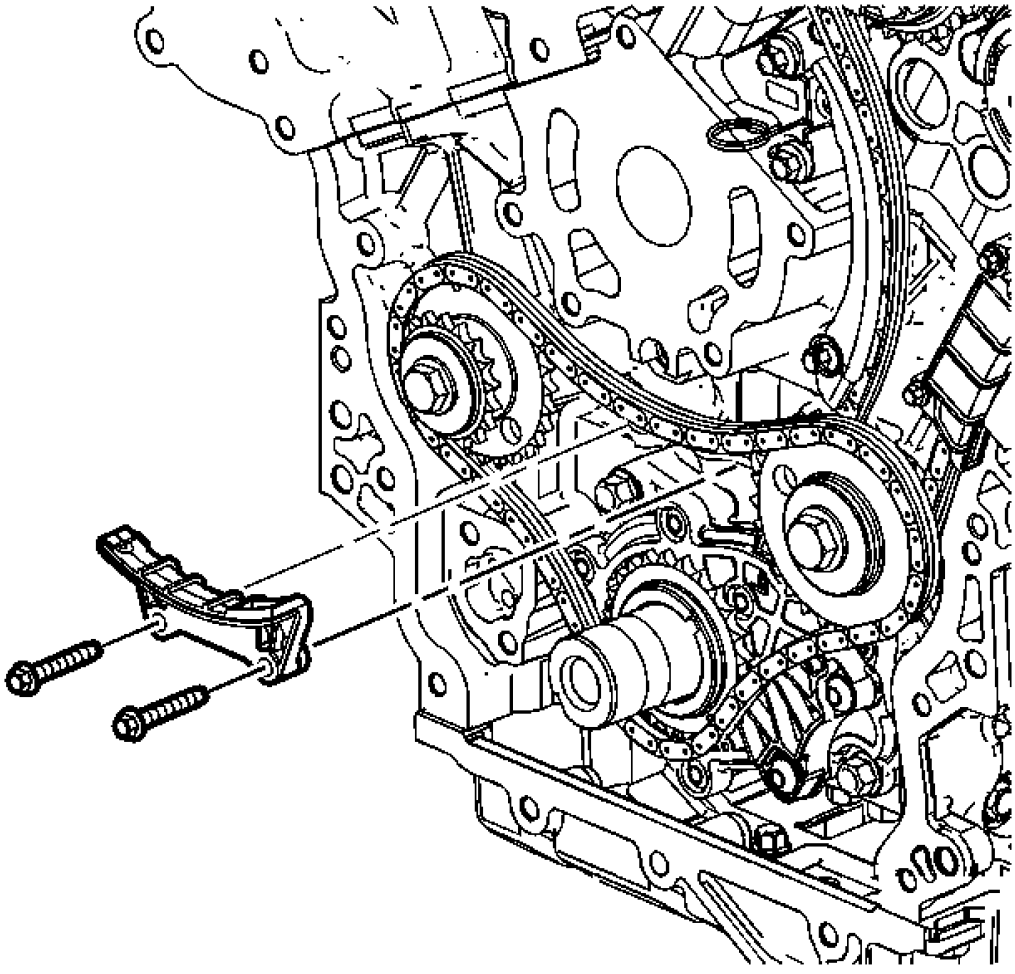


Fig. 102: View Of Upper Primary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS CORP.

1. Install the primary upper camshaft drive chain guide. Refer to **Primary Timing Chain Guide Installation - Upper** .
2. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation** .
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 2 (LEFT SIDE) EXHAUST

SPECIAL TOOLS

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EN-48313: Timing Chain Retention Tool

REMOVAL PROCEDURE

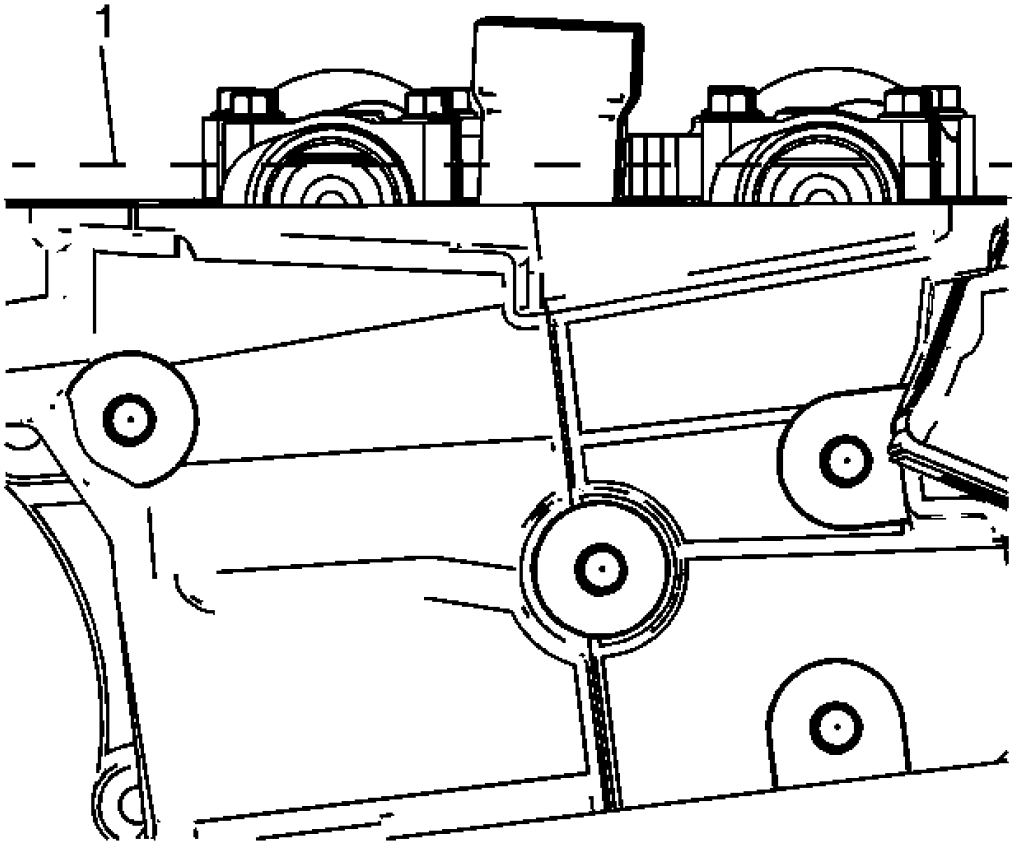


Fig. 103: Camshaft Flats Parallel With Camshaft Cover Rail
Courtesy of GENERAL MOTORS CORP.

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
2. Remove the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
3. Remove the left intake and exhaust camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** and **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** .
4. Remove the left intake and exhaust camshaft position actuator solenoids. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust** .

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NOTE: Rotate the crankshaft balancer bolt in a clockwise direction ONLY.

5. Rotate the crankshaft balancer using the balancer bolt until the camshafts are in a neutral (low tension) position. The camshafts will be parallel with the camshaft cover rail (1).

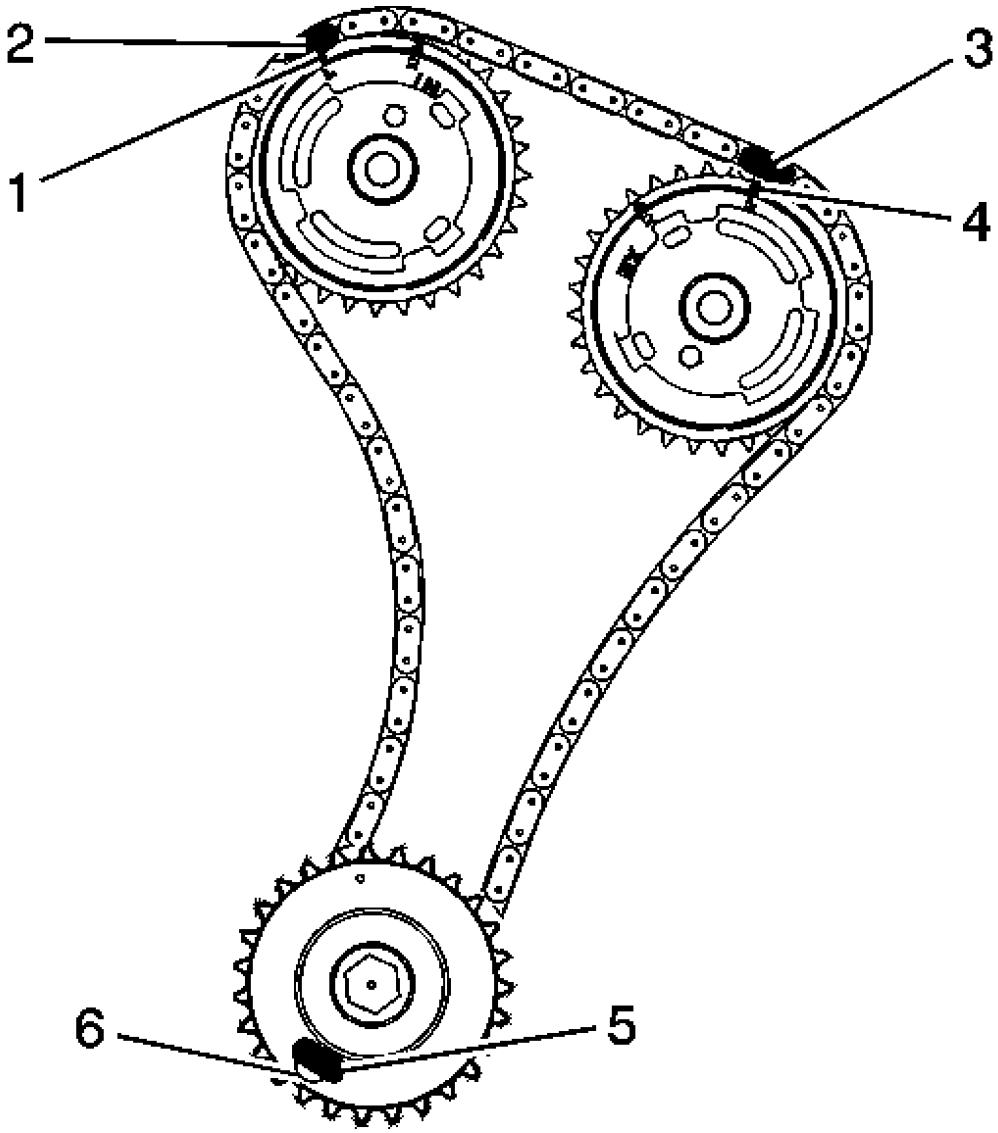


Fig. 104: Locating Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS CORP.

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NOTE: Ensure that the camshaft timing chain and the camshaft position actuators are marked for proper assembly.

6. Use a paint stick to create an alignment mark on one of the timing chain links (2) and the adjacent tooth on the exhaust camshaft position actuator (1).
7. Use a paint stick to create an alignment mark on one of the timing chain links (3) and the adjacent tooth on the intake camshaft position actuator (4).

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

8. Use an open end wrench on the hex cast into the left intake and exhaust camshafts and rotate the camshafts toward each other in order to create slack in the chain between the actuators.

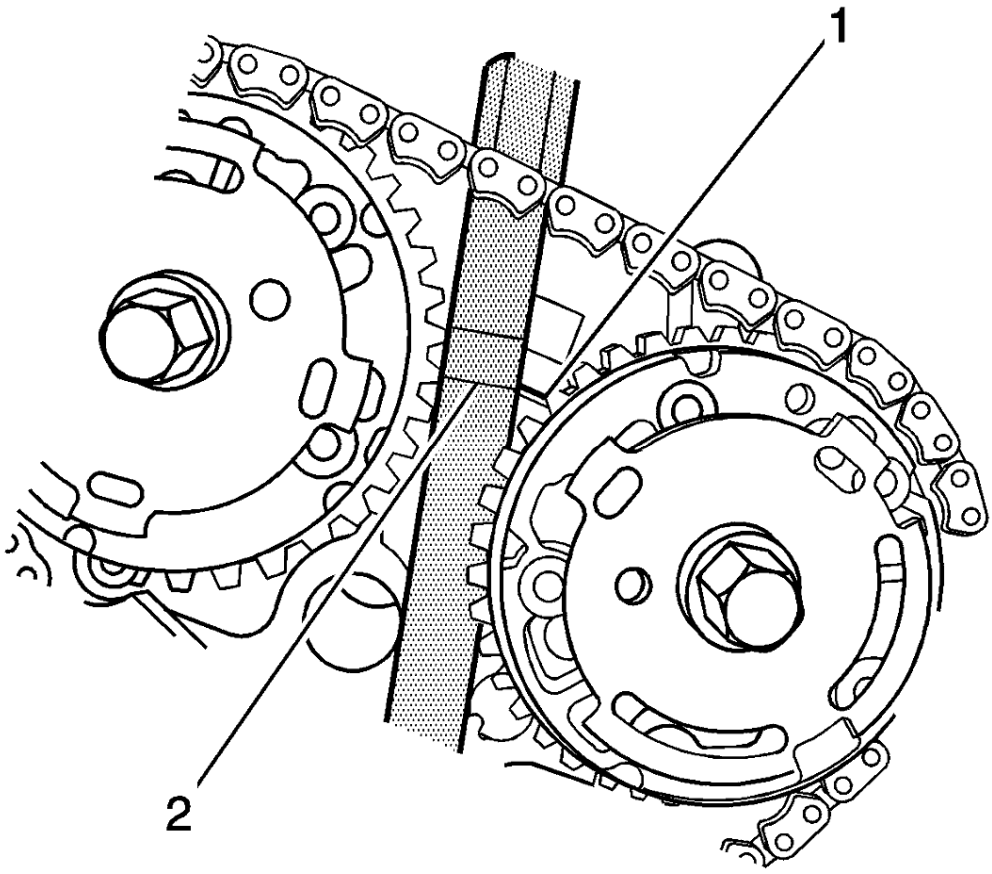


Fig. 105: Inserting Timing Chain Rentention Tool
Courtesy of GENERAL MOTORS CORP.

9. Unscrew the **EN-48313:** tool so that the legs of the tool are retracted.

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10. Insert the **EN-48313:** tool between the camshaft actuators, rearward of the timing chain until the bottom line that is scribed in the body of the tool (2) is adjacent to the top surface of the cylinder head (1). This is the approximate installed position.

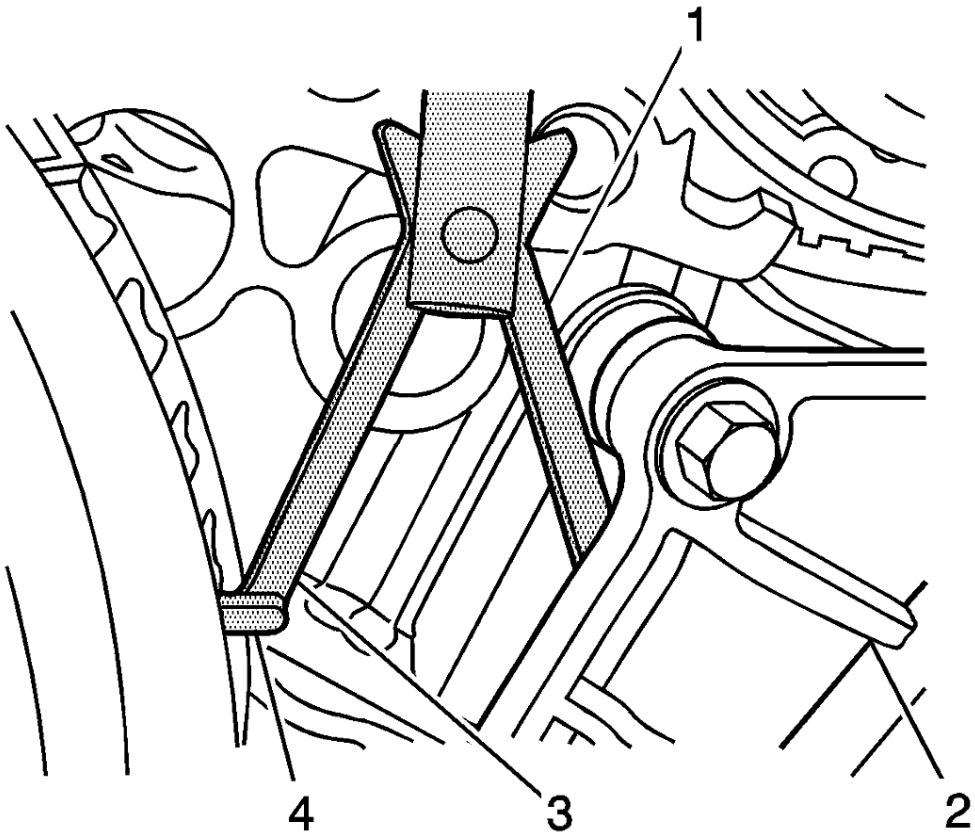


Fig. 106: Identifying Feet & Legs Of Timing Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

NOTE: The engine front cover is removed for clarity in the following graphics, but NOT required to perform the procedure.

11. Ensure that the feet (4) on the legs of the tool are facing the front of the engine.
12. Partially expand the legs (1, 3) of the **EN-48313:** tool by turning the T-shaped handle clockwise.
13. Insert the leg of the tool (1) behind the timing chain guide (2).
14. Continue expanding the **EN-48313:** tool until the legs (1, 3) contact the timing chain. Do not tighten at this time.

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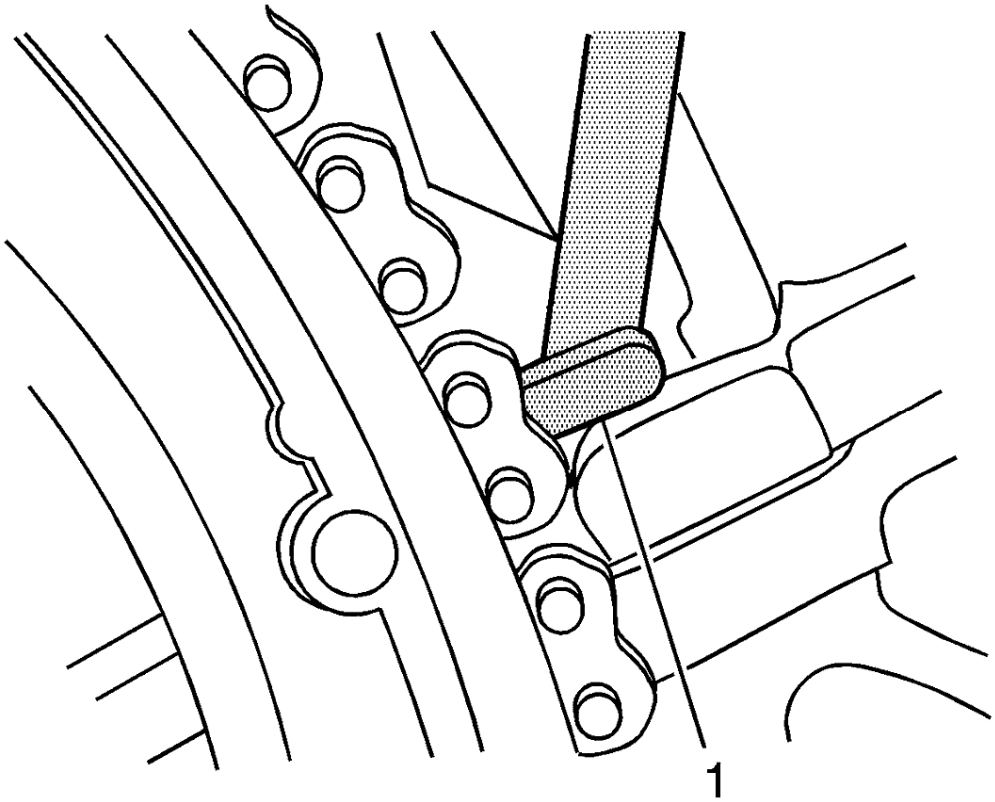


Fig. 107: Foot Of Timing Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the foot (1) of the EN-48313: tool is engaged into one of the link pockets to prevent tool slippage during tightening of the EN-48313: tool.

15. Hand tighten the **EN-48313:** tool.
16. Use an open end wrench on the hex cast into the left intake and exhaust camshafts and rotate the camshafts toward each other in order to create slack in the chain between the actuators.

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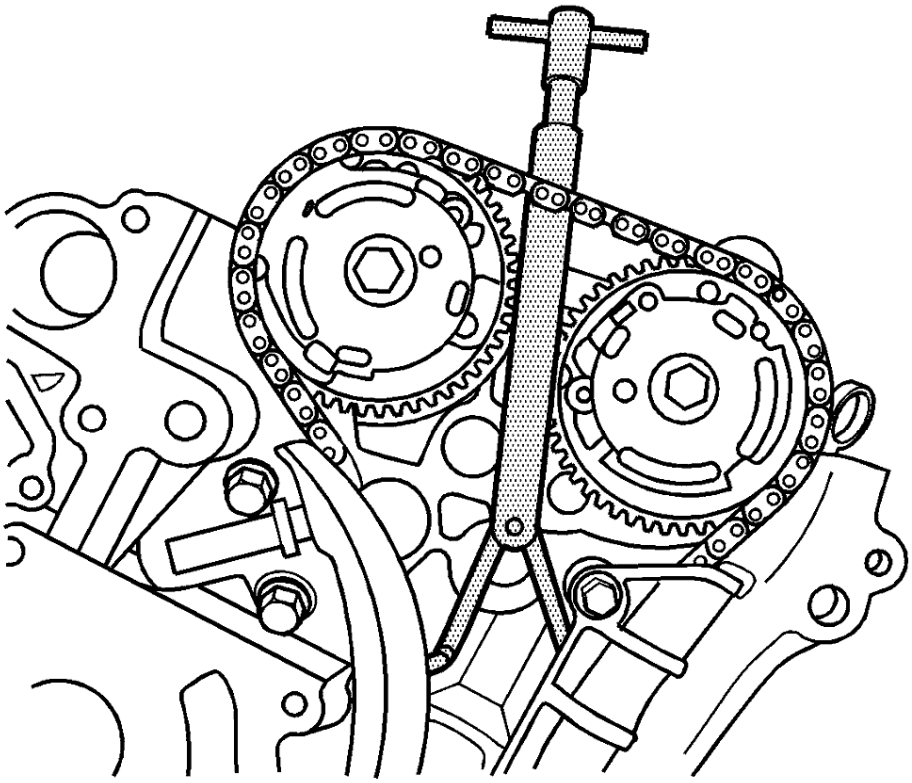


Fig. 108: Timing Chain Retention Tool
Courtesy of GENERAL MOTORS CORP.

17. The **EN-48313:** tool is now properly installed to hold the timing chain in position.

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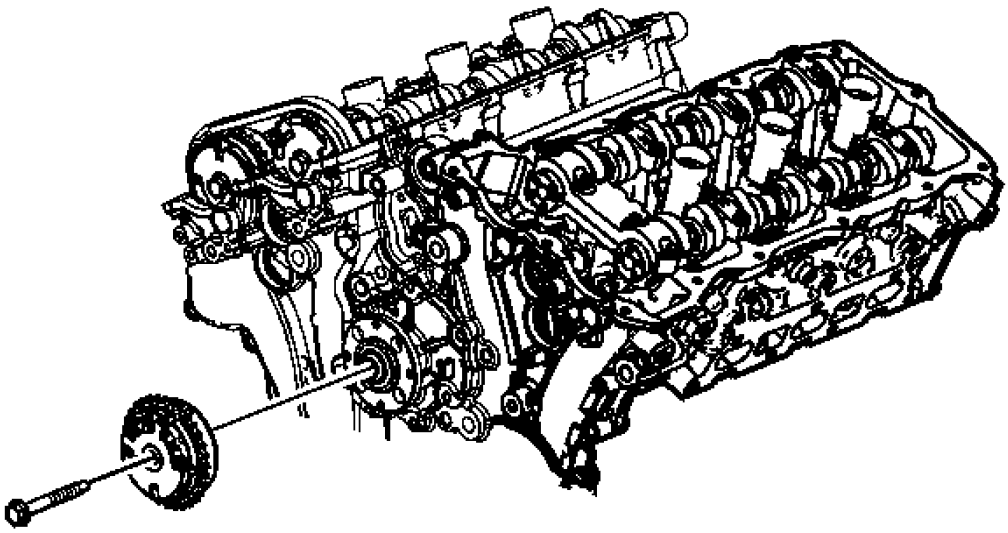


Fig. 109: Camshaft Position Actuator
Courtesy of GENERAL MOTORS CORP.

18. Use an open end wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.
19. Remove the left exhaust camshaft position actuator bolt.
20. Remove the left exhaust camshaft position actuator. When removing the actuator, place the chain on the engine cover side of the actuators.
21. Rotate the actuator in order to align the opening in the actuator reluctor wheel with the cam sensor boss in the front cover, to allow actuator removal.
22. Remove the camshaft thrust washer.
23. If removing both the exhaust and intake camshaft actuators, the timing chain can be draped over the **EN-48313:** tool once the actuators have been removed.

INSTALLATION PROCEDURE

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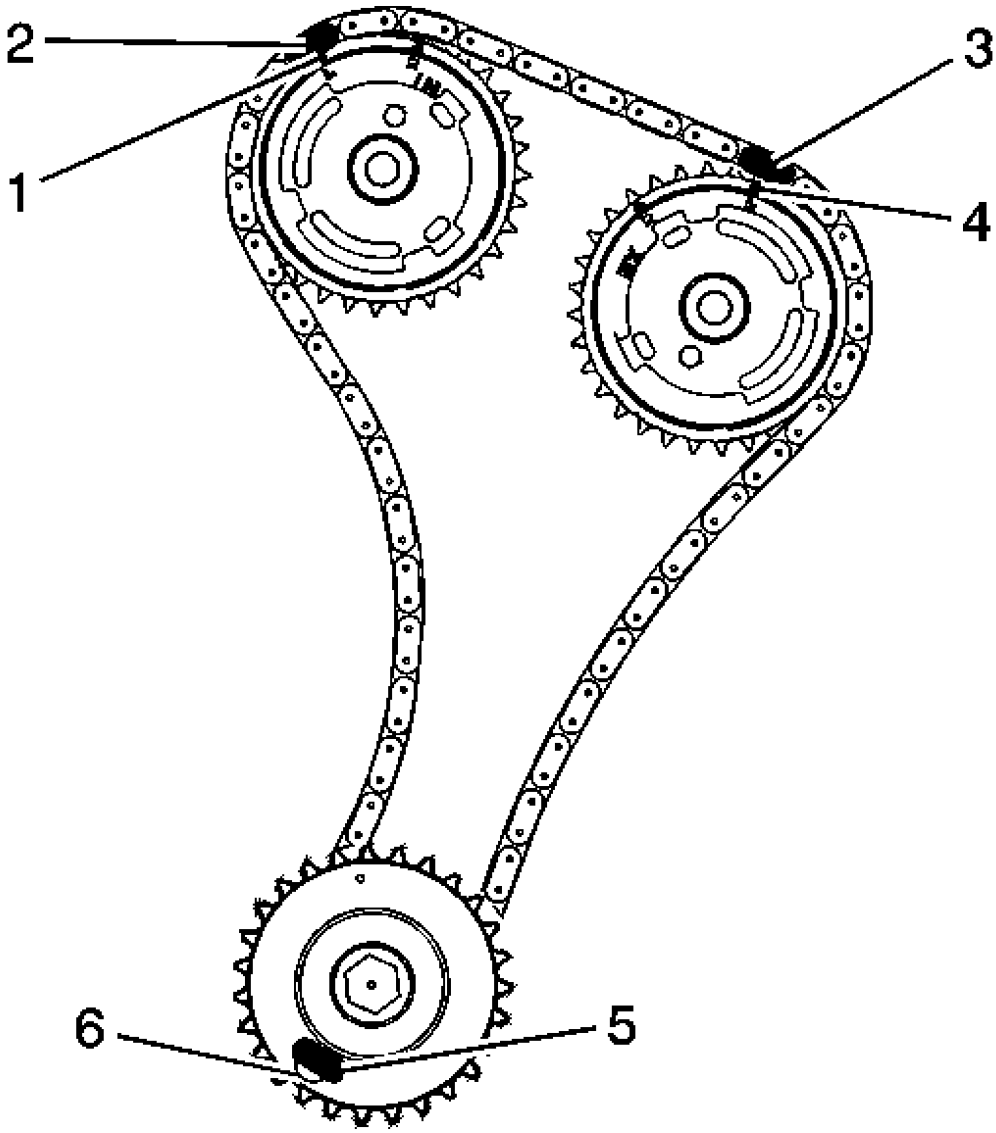


Fig. 110: Locating Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the camshaft timing chain and the camshaft position actuators are marked for proper assembly.

1. Align the exhaust camshaft actuator alignment mark (1) to the timing chain alignment mark (2) made during disassembly.

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2. Ensure that the intake camshaft actuator alignment mark (4) and the timing chain alignment mark (3) are also aligned.
3. Position the exhaust camshaft actuator to the camshaft and install the actuator bolt hand tight.
4. Remove the **EN-48313:** tool.

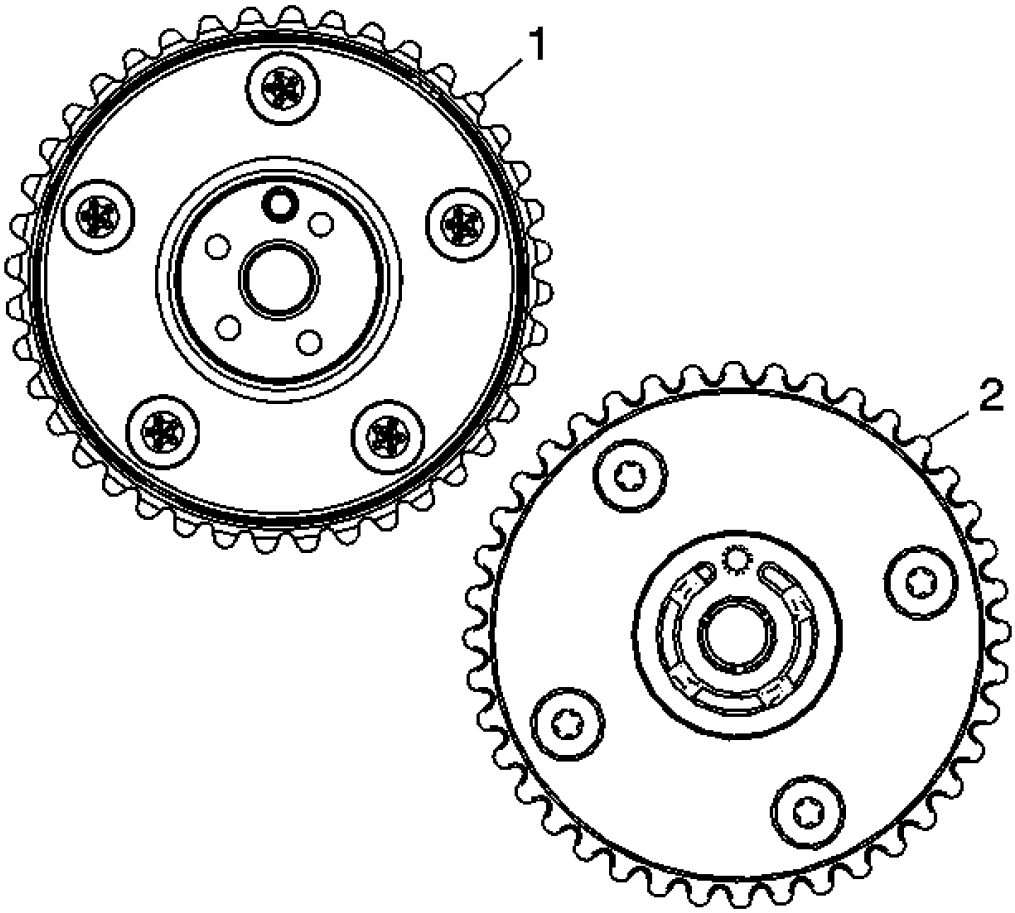


Fig. 111: Identifying Camshaft Position Actuators
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **The camshaft position actuator will vary depending on application.**
- **Camshaft thrust washers must be installed on all 2010 applications when servicing the camshaft position actuators. Do not install washers on 2009 applications if they are not already present.**

5. Ensure the proper camshaft thrust washer is used. Use a 1.6 mm (0.063 in) thrust washer on applications

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that have 5 attaching screws on the back side of the camshaft position actuator (1). Use a 1.1 mm (0.043 in) thick thrust washer with yellow speckles on applications that have 4 attaching screws on the back side of the camshaft position actuator (2).

6. Install the thrust washer, if applicable.

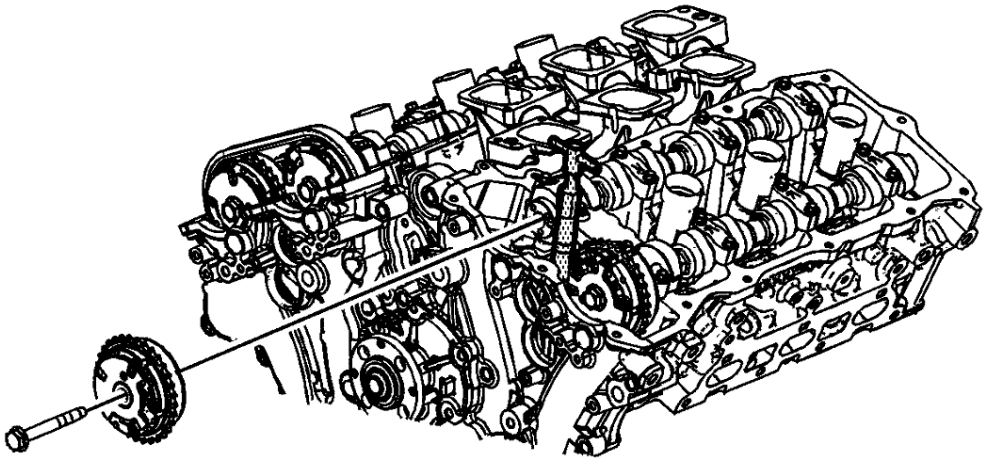


Fig. 112: View Of Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

7. Tighten the exhaust camshaft position actuator bolt to 58 N.m (43 lb ft).
8. Install the left intake and exhaust camshaft position actuator solenoids. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust** .
9. Install the left intake and exhaust camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** and **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** .

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10. Install the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
11. Install the intake manifold. Refer to **Intake Manifold Replacement**.

CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 1 (RIGHT SIDE) EXHAUST

REMOVAL PROCEDURE

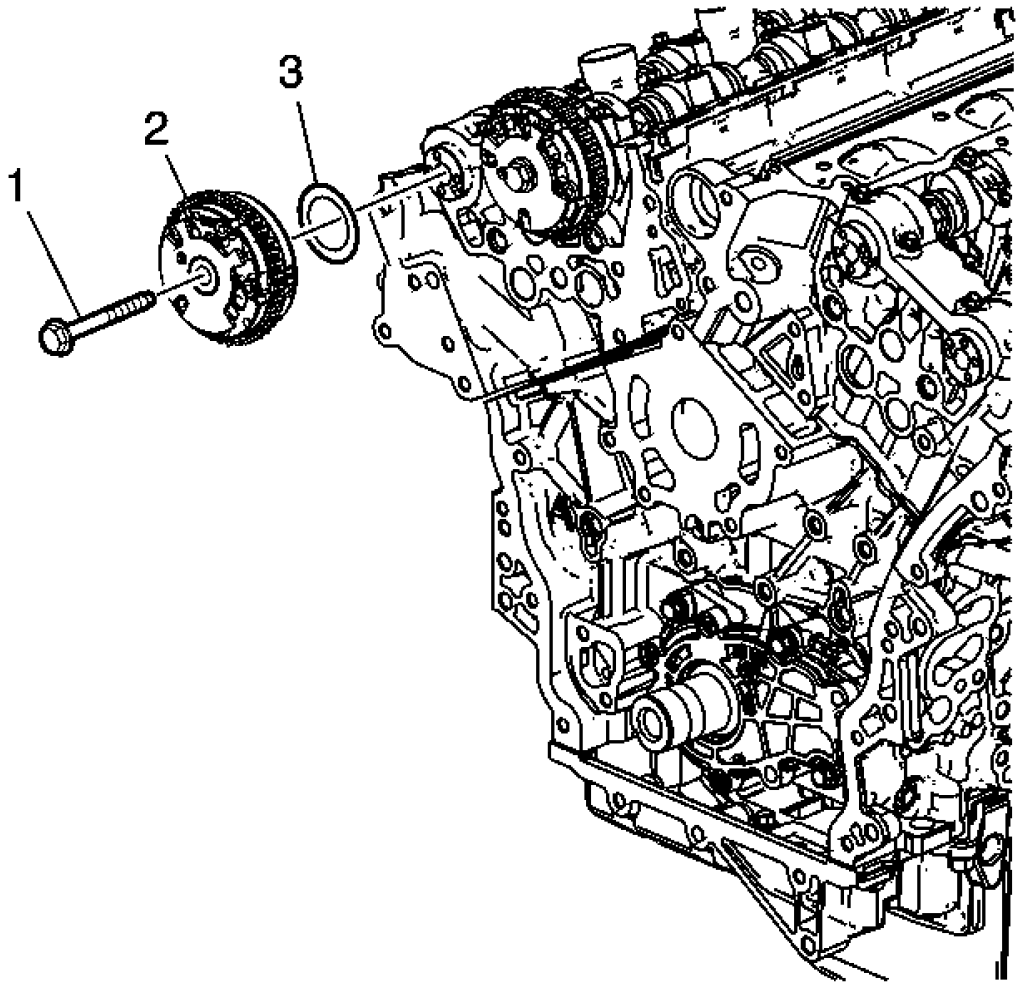


Fig. 113: Identifying Camshaft Position Actuator & Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the right hand secondary camshaft intermediate drive chain. Refer to **Secondary Camshaft**

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Intermediate Drive Chain Replacement - Right Side.

2. Use an open end wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.
3. Remove the right exhaust camshaft position actuator bolt (1).
4. Remove the right exhaust camshaft position actuator (2).
5. Remove the camshaft thrust washer (3), if applicable.

INSTALLATION PROCEDURE

1. Install the exhaust camshaft position actuator. Refer to **Camshaft Position Actuator Installation - Right Side Exhaust** .
2. Install the right side secondary camshaft intermediate drive chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.

CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 2 (LEFT SIDE) INTAKE

REMOVAL PROCEDURE

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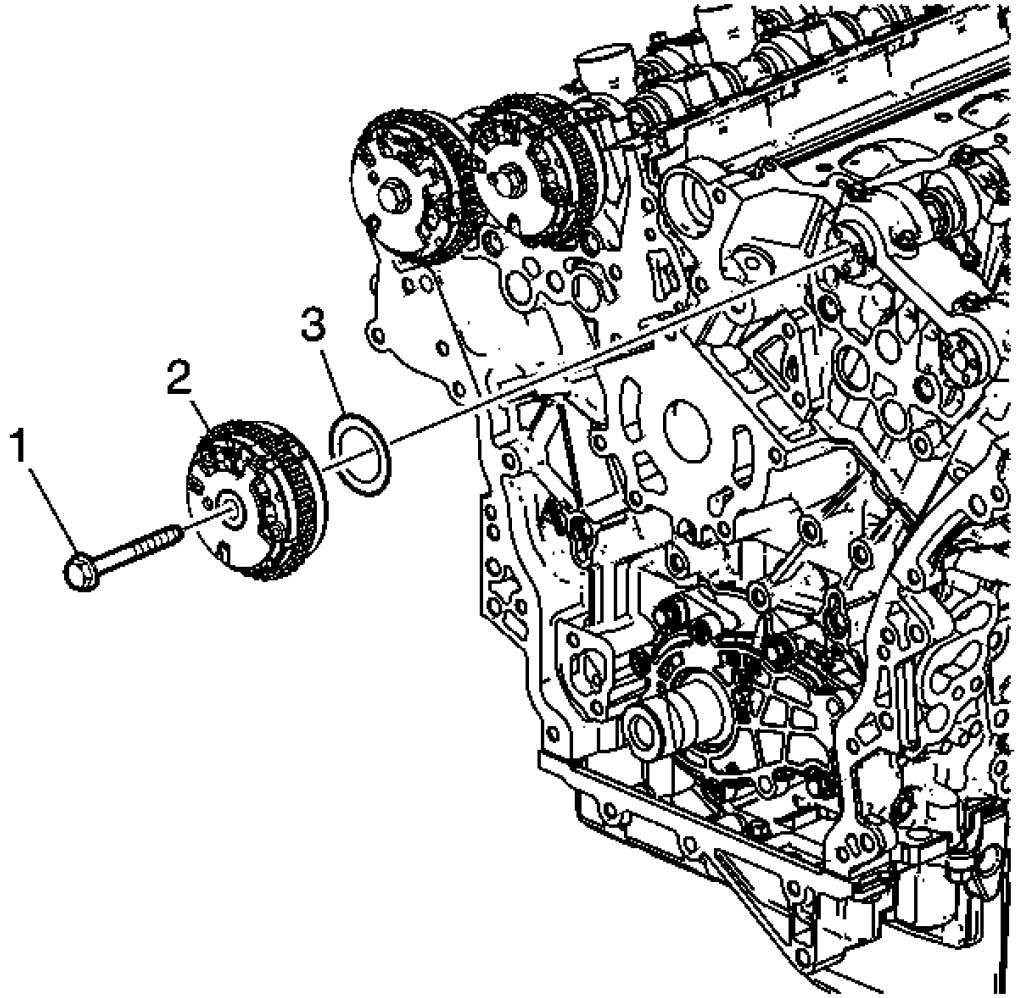


Fig. 114: View Of Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the left exhaust camshaft actuator. Refer to **Camshaft Position Actuator Replacement - Bank 2 (Left Side) Exhaust**.
2. Remove the intake camshaft position actuator bolt.
3. Remove the left intake camshaft position actuator.

INSTALLATION PROCEDURE

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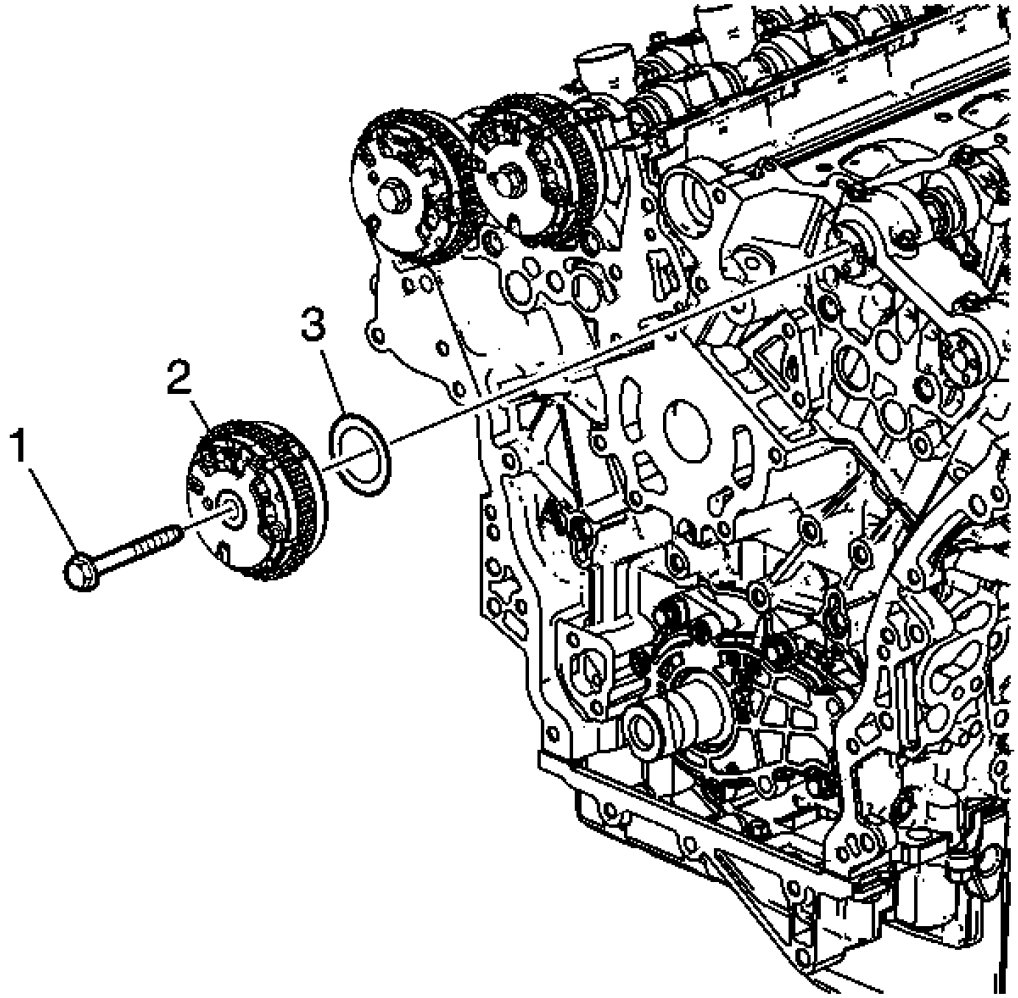


Fig. 115: View Of Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS CORP.

1. Locate the intake camshaft position actuator to the camshaft and loosely install the bolt.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

NOTE: Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.

2. Tighten the camshaft position actuator bolt. Refer to **Camshaft Position Actuator Installation - Left**

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Side Intake .

3. Install the left exhaust camshaft actuator. Refer to **Camshaft Position Actuator Replacement - Bank 2 (Left Side) Exhaust**.

CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 1 (RIGHT SIDE) INTAKE

REMOVAL PROCEDURE

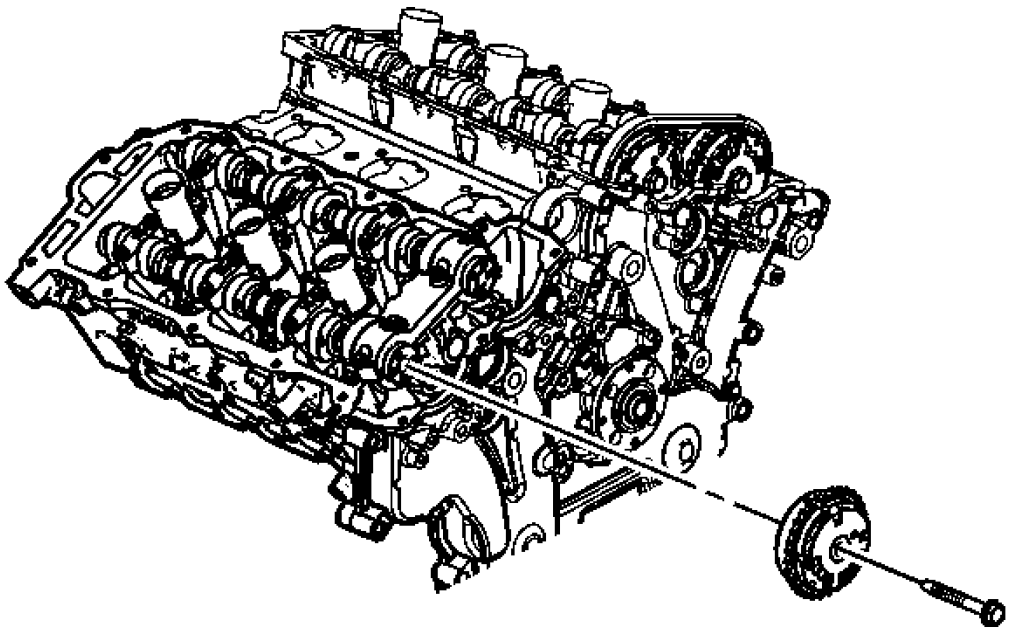


Fig. 116: View Of Intake Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS CORP.

1. Remove the right exhaust camshaft actuator. Refer to **Camshaft Position Actuator Replacement - Bank 1 (Right Side) Exhaust**.
2. Remove the intake camshaft position actuator bolt.
3. Remove the right intake camshaft position actuator.

INSTALLATION PROCEDURE

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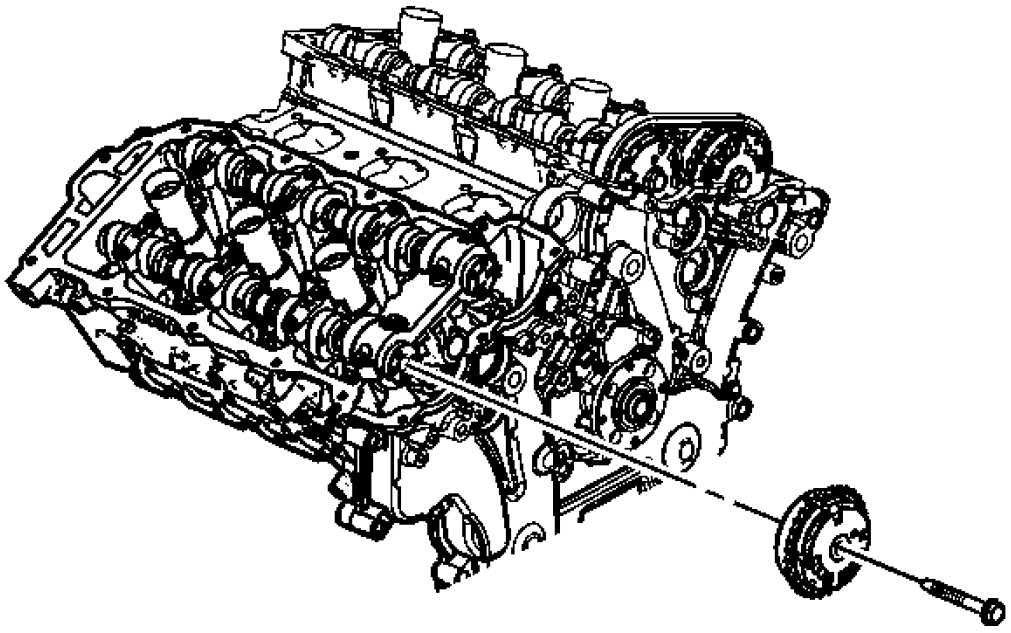


Fig. 117: View Of Intake Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS CORP.

1. Locate the intake camshaft position actuator to the camshaft and loosely install the bolt.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

NOTE: Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.

2. Tighten the camshaft position actuator bolt. Refer to **Camshaft Position Actuator Installation - Right Side Intake** .
3. Install the right exhaust camshaft actuator. Refer to **Camshaft Position Actuator Replacement - Bank 1 (Right Side) Exhaust**.

SETTING CAMSHAFT TIMING

NOTE: Setting the camshaft timing is necessary whenever the camshaft drive system has been disturbed such that the relationship between any chain and sprocket has been lost. Even when only one sprocket is involved, multiple crankshaft

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rotations will not produce conditions where correct timing can be confirmed.

Follow the left bank secondary camshaft drive chain replacement procedures to reset the camshaft timing. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**.

CAMSHAFT REPLACEMENT - LEFT SIDE

Special Tools

- **EN-48313** Timing Chain Retention Tool. See **Special Tools** .
- **EN 46111** Crankshaft Rotation Socket. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the lower intake manifold. Refer to **Intake Manifold Replacement**.
2. Remove the left bank camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
3. Remove the camshaft sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** and **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** .
4. Remove the camshaft position actuator solenoids. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust** .
5. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

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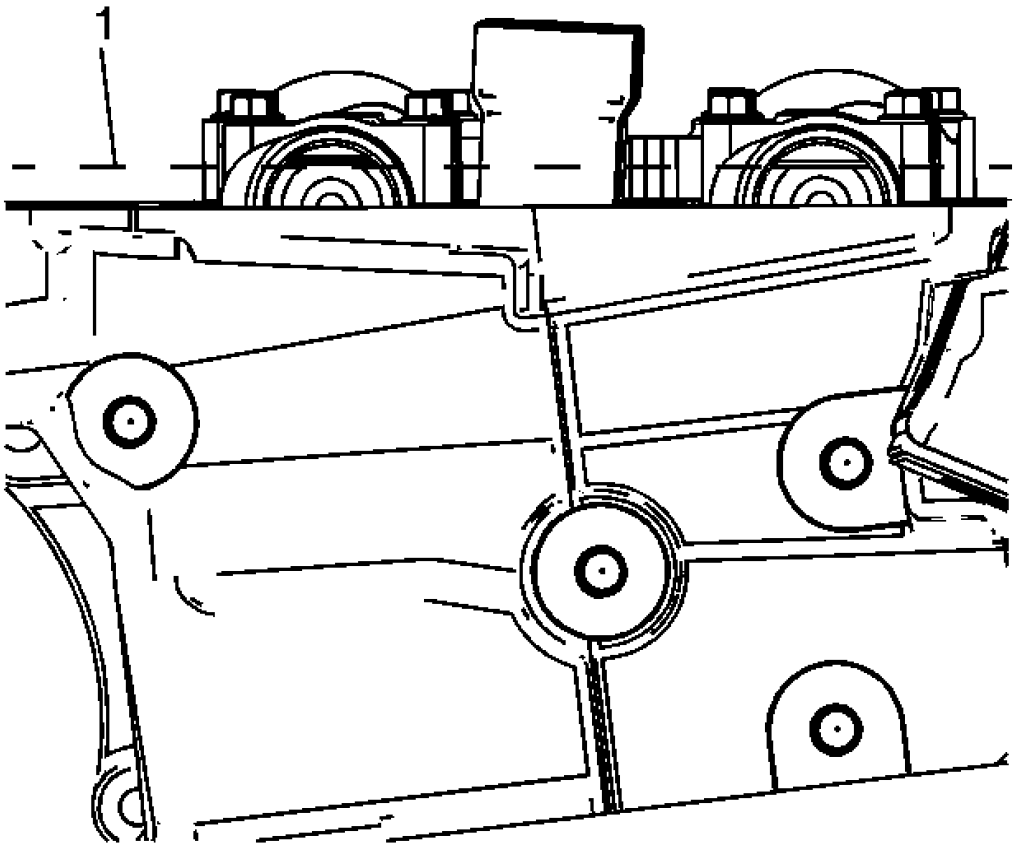


Fig. 118: Camshaft Flats Parallel With Camshaft Cover Rail
Courtesy of GENERAL MOTORS CORP.

6. Rotate the crankshaft with the **EN 46111** until the camshafts are in a neutral (low tension) position. See **Special Tools** . The camshaft flats will be parallel with the camshaft cover rail (1).

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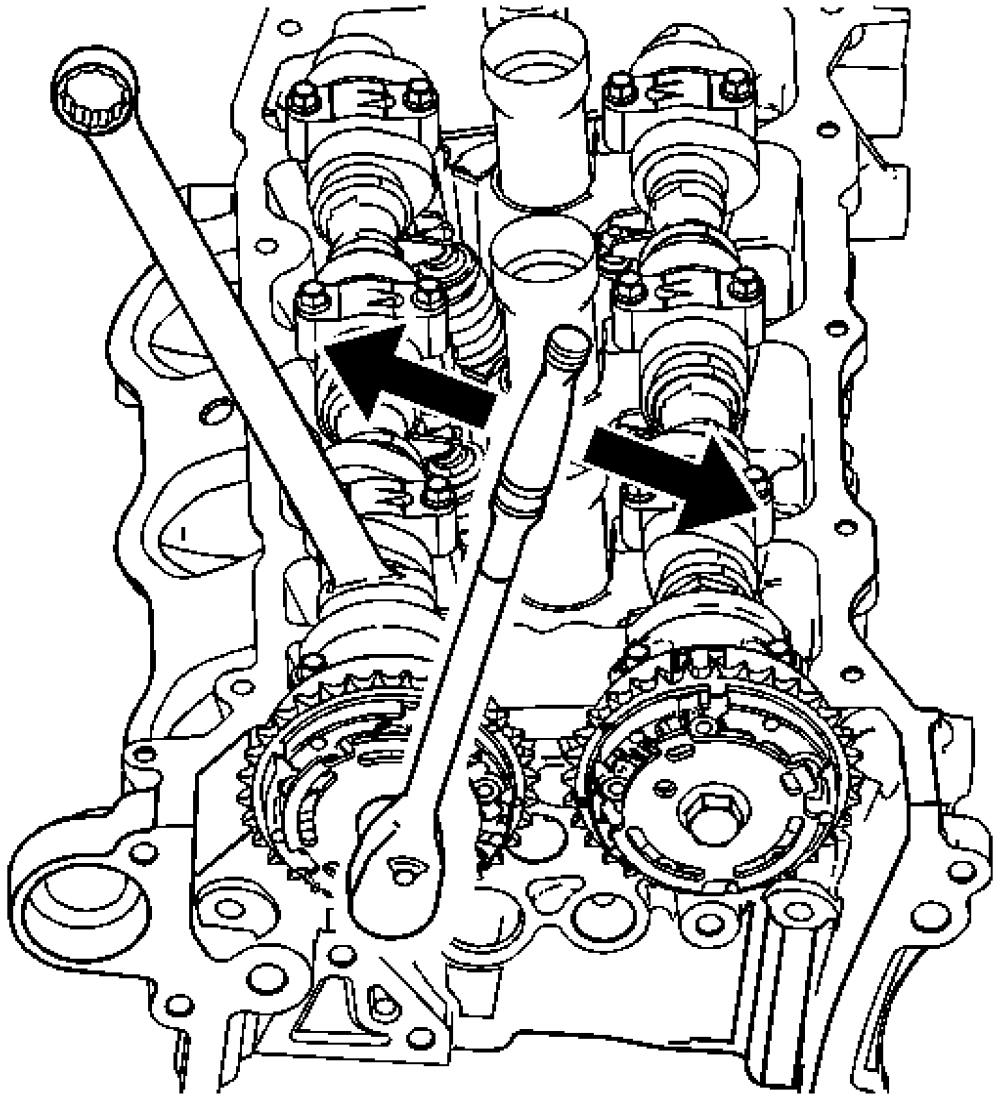


Fig. 119: Preventing Camshaft/Engine Rotation
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

NOTE:

- **Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.**

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- **DO NOT remove the camshaft position actuator bolt at this time.**

7. Loosen the camshaft position actuator bolt.

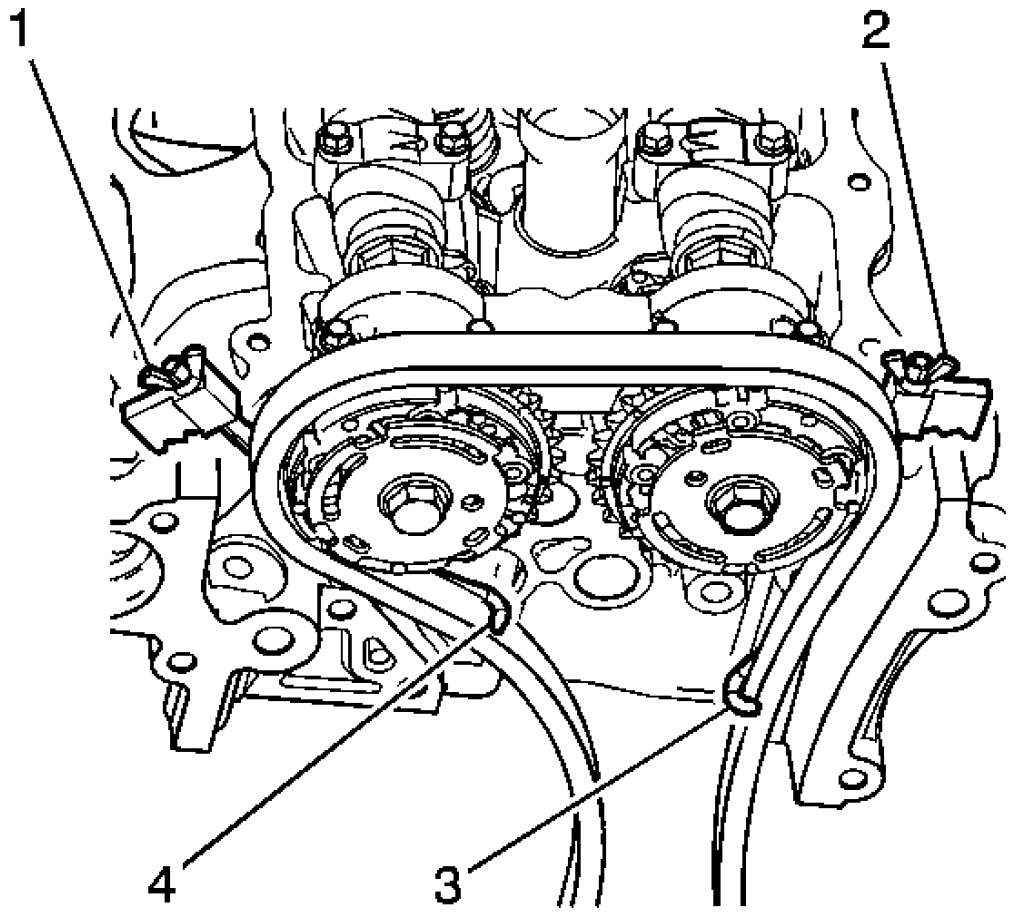


Fig. 120: Identifying Special Timing Chain Retention Tools
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the tips of the EN-48313 are fully engaged into the timing chain (3 and 4). See Special Tools .

8. Install the **EN-48313** (1 and 2) in order to retain the timing chain. See **Special Tools** .

   Firmly tighten the **EN-48313** nuts. See **Special Tools** .

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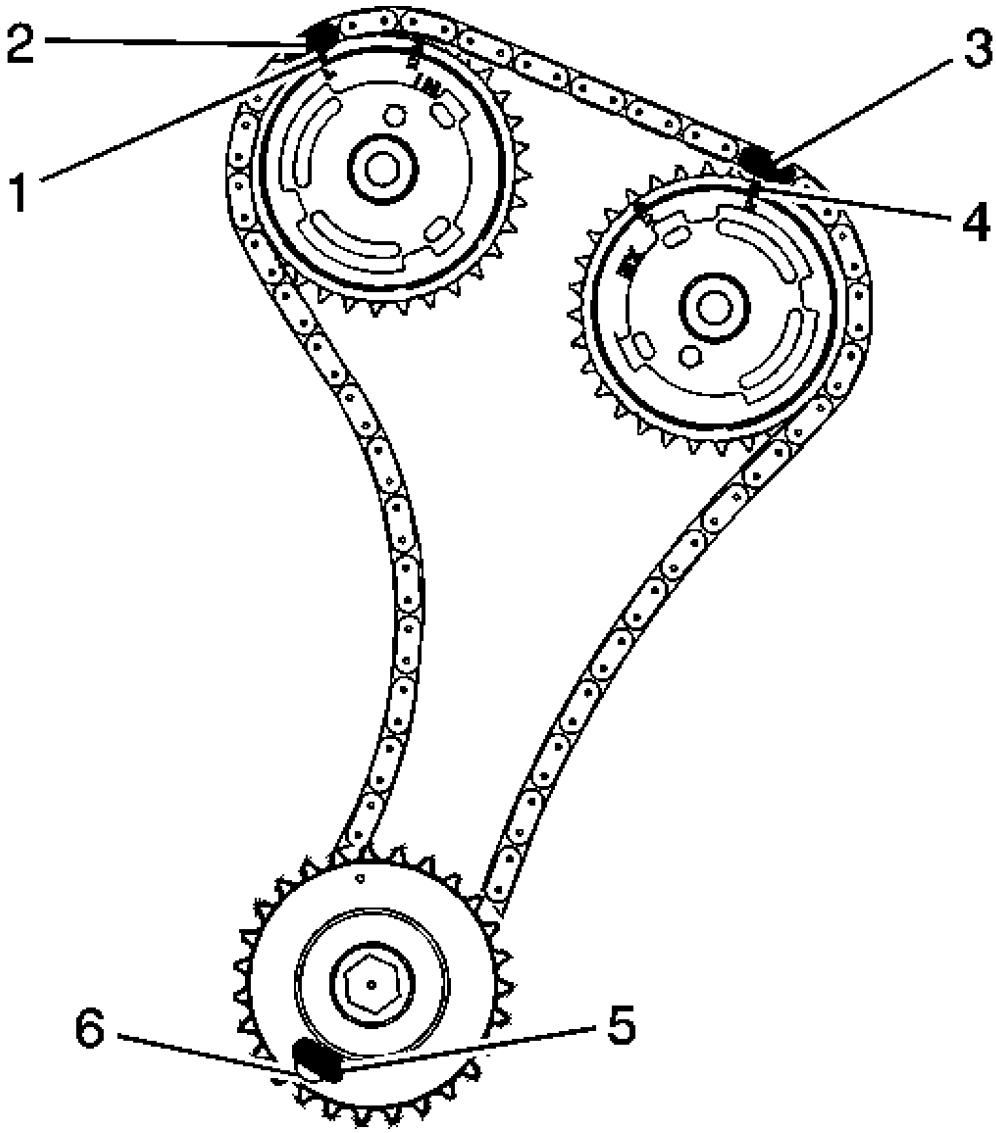


Fig. 121: Locating Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the camshaft timing chain and the camshaft position actuators are marked for proper assembly.

9. Mark the timing chain and the respective locations on the camshaft position actuators (1-4).

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10. Remove the camshaft position actuator bolt.
11. Remove the camshafts. Refer to **Camshaft Removal - Left Side (LLT)** .

INSTALLATION PROCEDURE

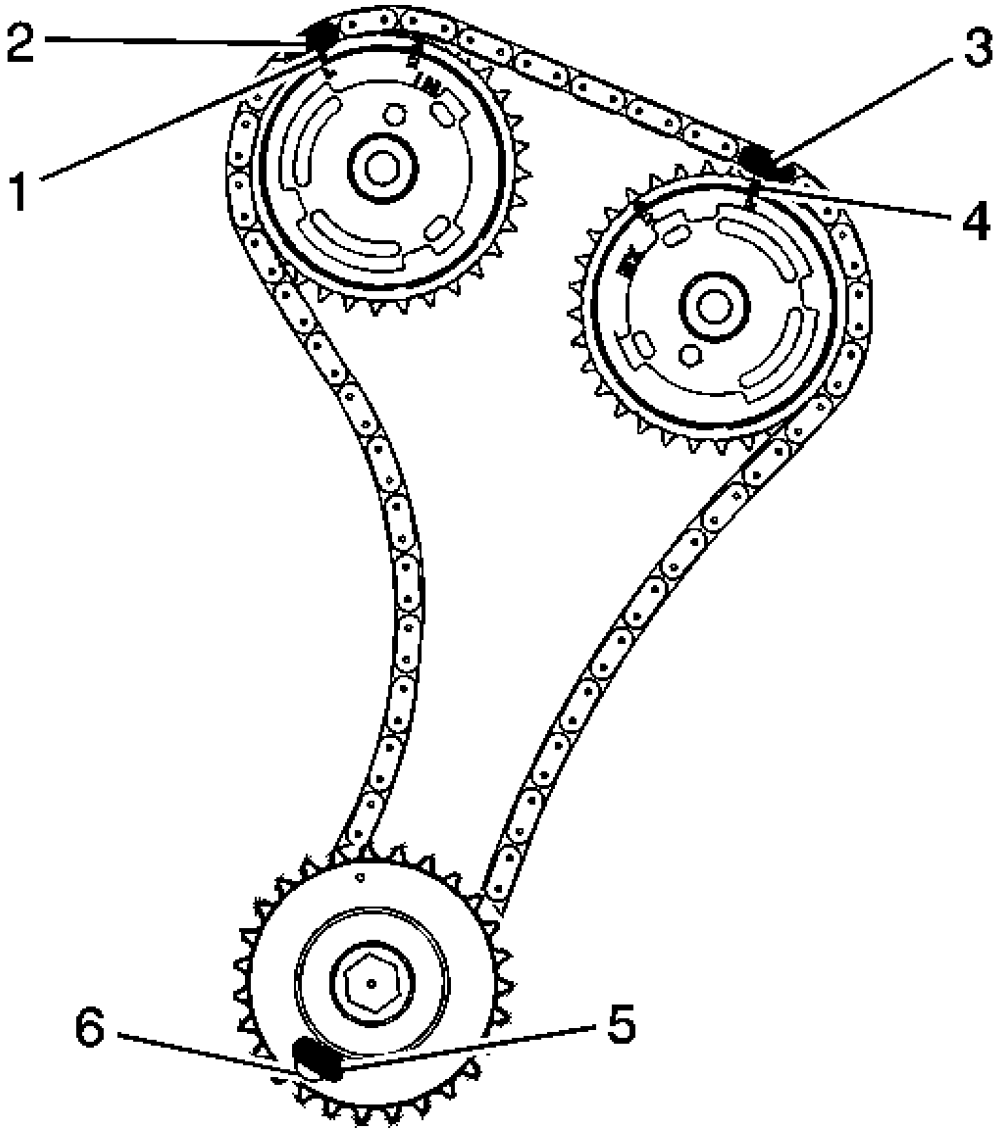


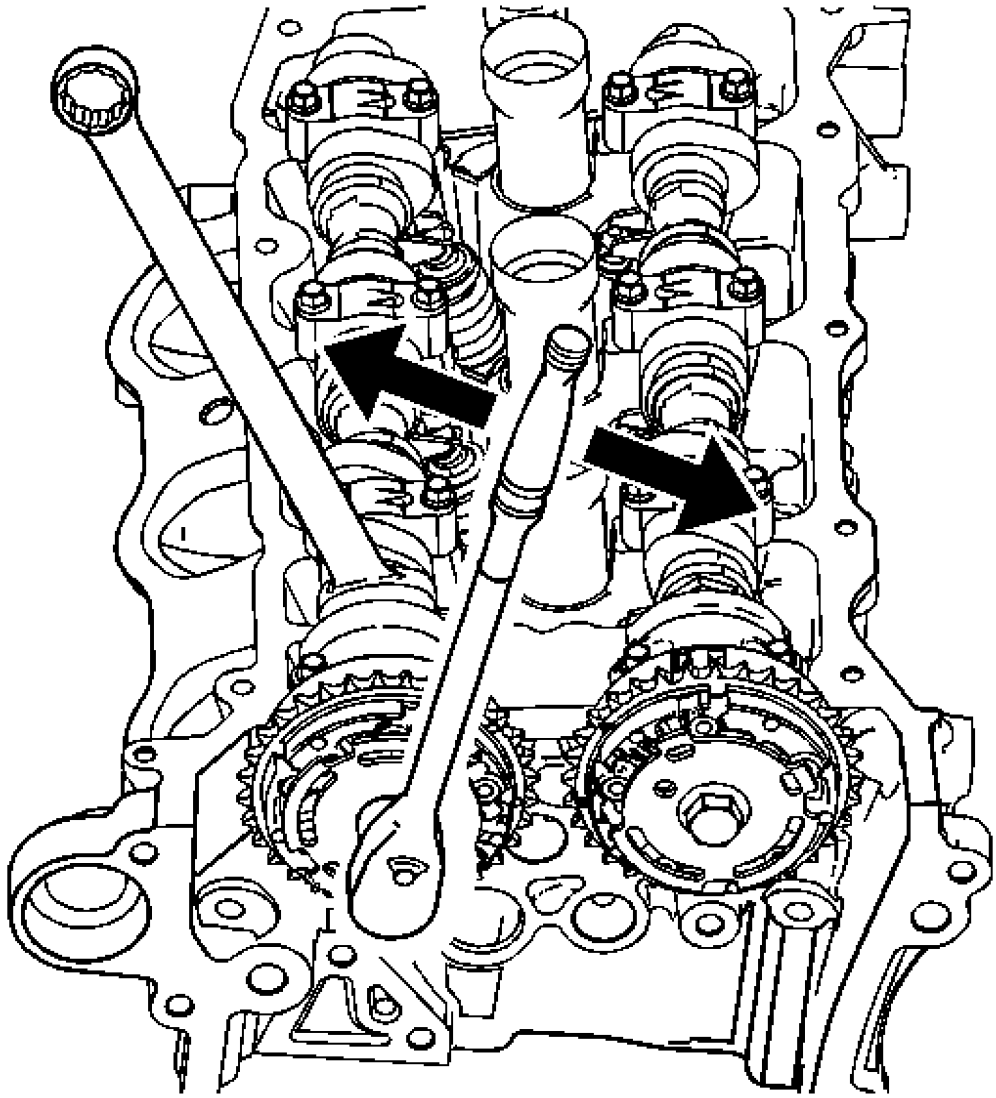
Fig. 122: Locating Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS CORP.

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NOTE:

- **Ensure that the marks on the camshaft position actuator and the timing chain (1-4) are aligned.**
- **DO NOT tighten the camshaft position actuator bolt at this time.**

1. Locate the camshafts to the cylinder head and assemble the camshaft actuators to the camshafts.
2. Install the camshafts and the camshaft bearing caps. Refer to **Camshaft Installation - Left Side (LLT)** .
3. Remove the **EN-48313** . See **Special Tools** .



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Fig. 123: Preventing Camshaft/Engine Rotation
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

NOTE: Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.

4. Install and tighten the camshaft position actuators. Refer to **Camshaft Position Actuator Installation - Left Side Intake** and **Camshaft Position Actuator Installation - Left Side Exhaust** .
5. Install the intake camshaft position actuator solenoids. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust** .
6. Install the camshaft sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** and **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** .
7. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
8. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
9. Install the lower intake manifold. Refer to **Intake Manifold Replacement**.

CAMSHAFT REPLACEMENT - RIGHT SIDE

Special Tools

- **EN-48313** Timing Chain Retention Tool. See **Special Tools** .
- **EN 46111** Crankshaft Rotation Socket. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the lower intake manifold. Refer to **Intake Manifold Replacement**.
2. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.
3. Remove the camshaft sensors. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** and **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake** .
4. Remove the intake camshaft position actuator solenoids. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake** and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust** .
5. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

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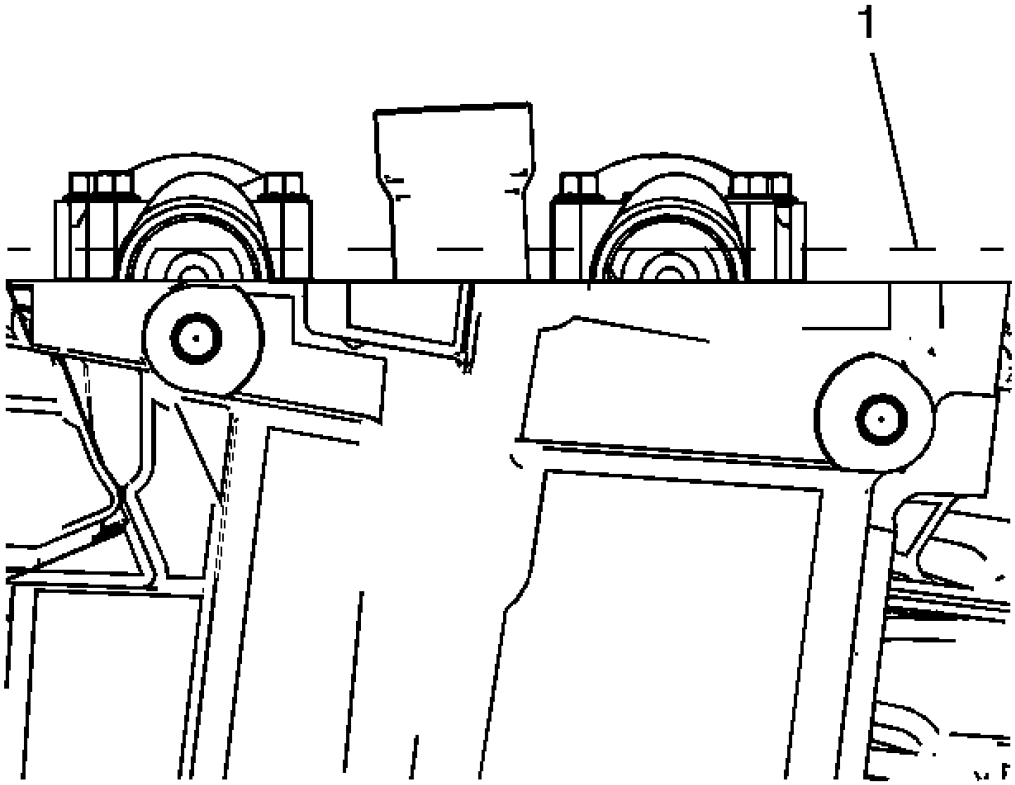


Fig. 124: Identifying Camshaft Neutral (Low Tension) Position
Courtesy of GENERAL MOTORS CORP.

6. Rotate the crankshaft with the **EN 46111** until the camshafts are in a neutral (low tension) position. See **Special Tools** .

   The camshaft flats will be parallel with the camshaft cover rail (1).

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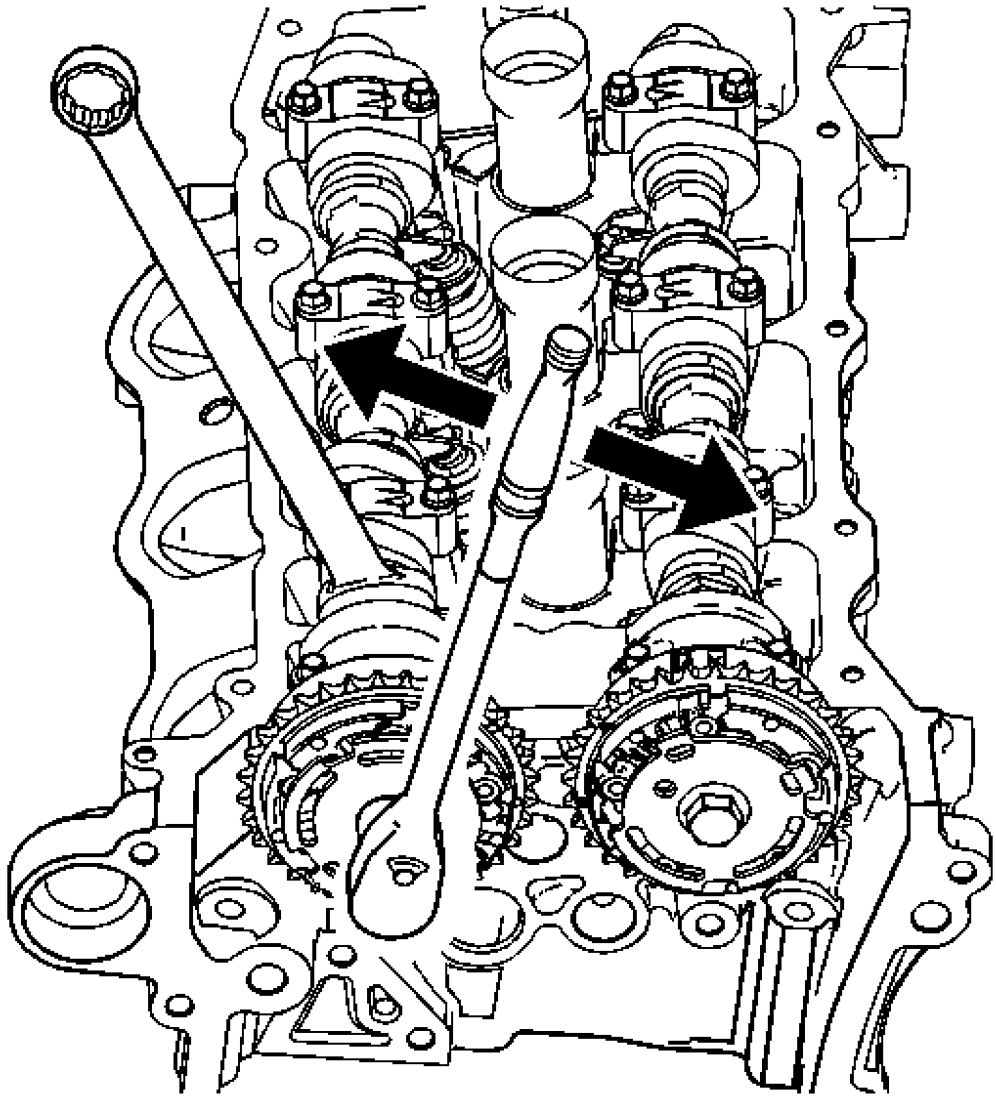


Fig. 125: Preventing Camshaft/Engine Rotation
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

NOTE:

- **Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.**

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- **DO NOT remove the camshaft position actuator bolt at this time.**

7. Loosen the camshaft position actuator bolt.

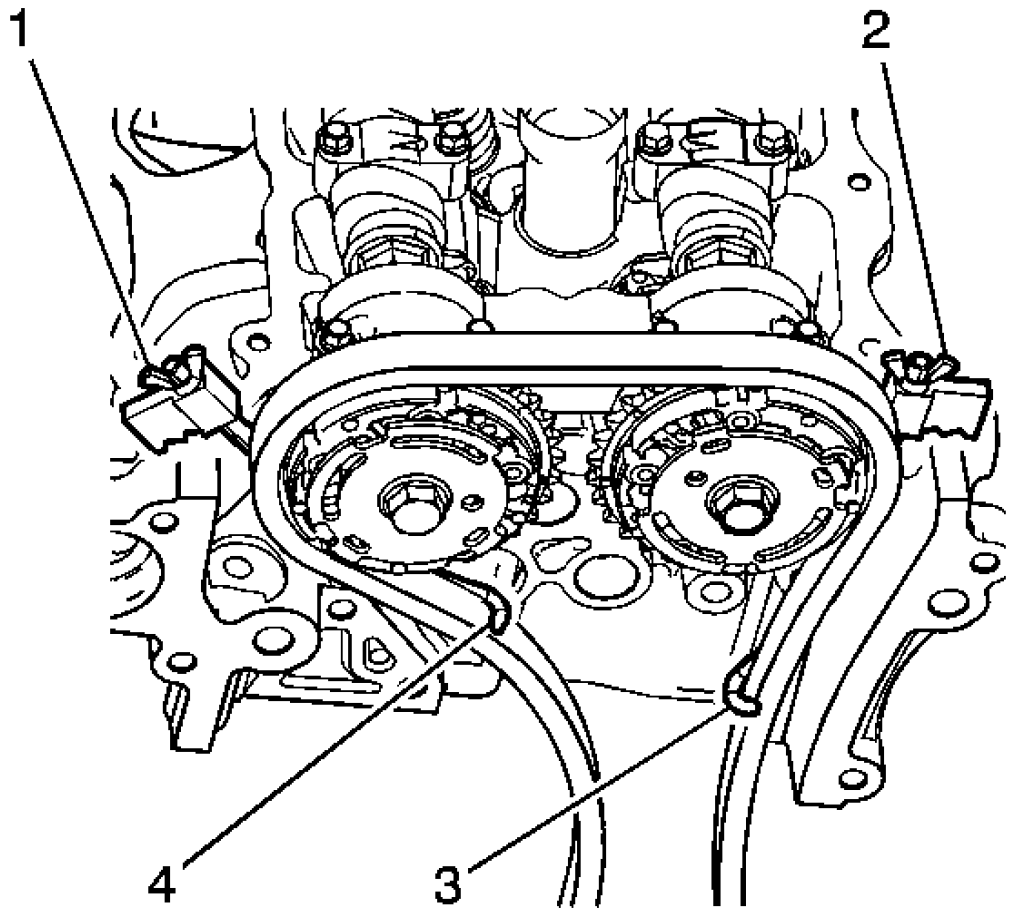


Fig. 126: Identifying Special Timing Chain Retention Tools
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the tips of the EN-48313 are fully engaged into the timing chain (3 and 4). See Special Tools .

8. Install the **EN-48313** (1 and 2) in order to retain the timing chain. See **Special Tools** .

   Firmly tighten the **EN-48313** nuts. See **Special Tools** .

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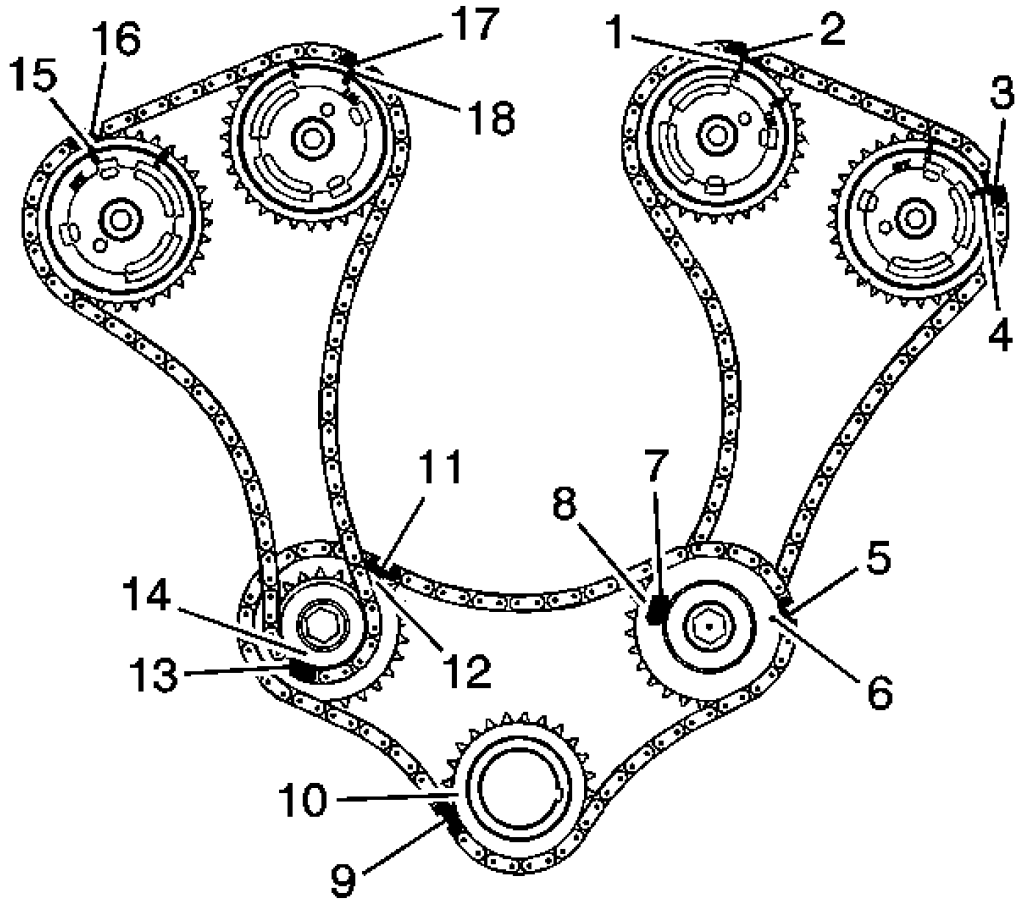


Fig. 127: Identifying Timing Chain Marks
Courtesy of GENERAL MOTORS CORP.

NOTE: Ensure that the camshaft timing chain and the camshaft position actuators are marked for proper assembly.

9. Mark the timing chain and the respective locations on camshaft position actuators (15-18).
10. Remove the camshaft position actuator bolt.
11. Remove the camshaft bearing caps and the camshaft. Refer to **Camshaft Removal - Right Side** .

INSTALLATION PROCEDURE

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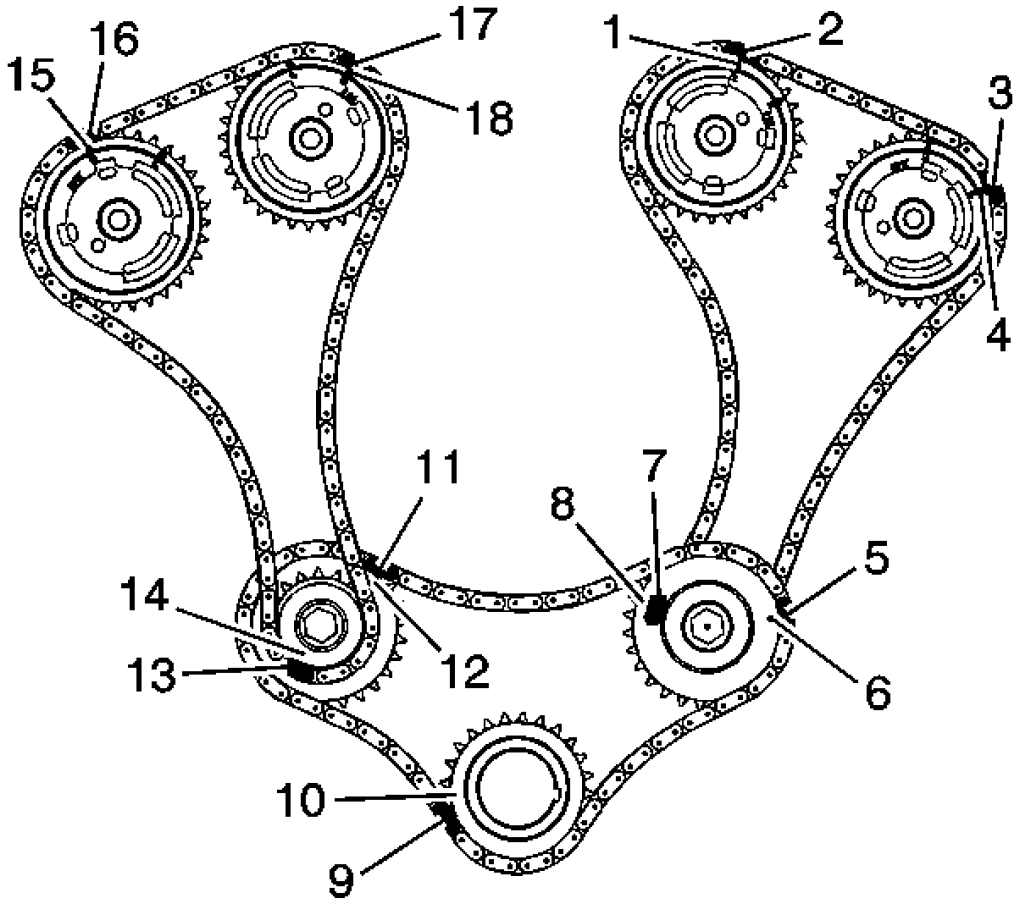


Fig. 128: Identifying Timing Chain Marks
Courtesy of GENERAL MOTORS CORP.

NOTE:

- **Ensure that the marks on the camshaft position actuators and the timing chain (15-18) are aligned.**
- **DO NOT tighten the camshaft position actuator bolt at this time.**

1. Locate the camshafts to the cylinder head and assemble the camshaft actuators to the camshafts.
2. Install the camshafts and the camshaft bearing caps. Refer to **Camshaft Installation - Right Side (LLT)** .
3. Remove the **EN-48313** . See **Special Tools** .
4. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

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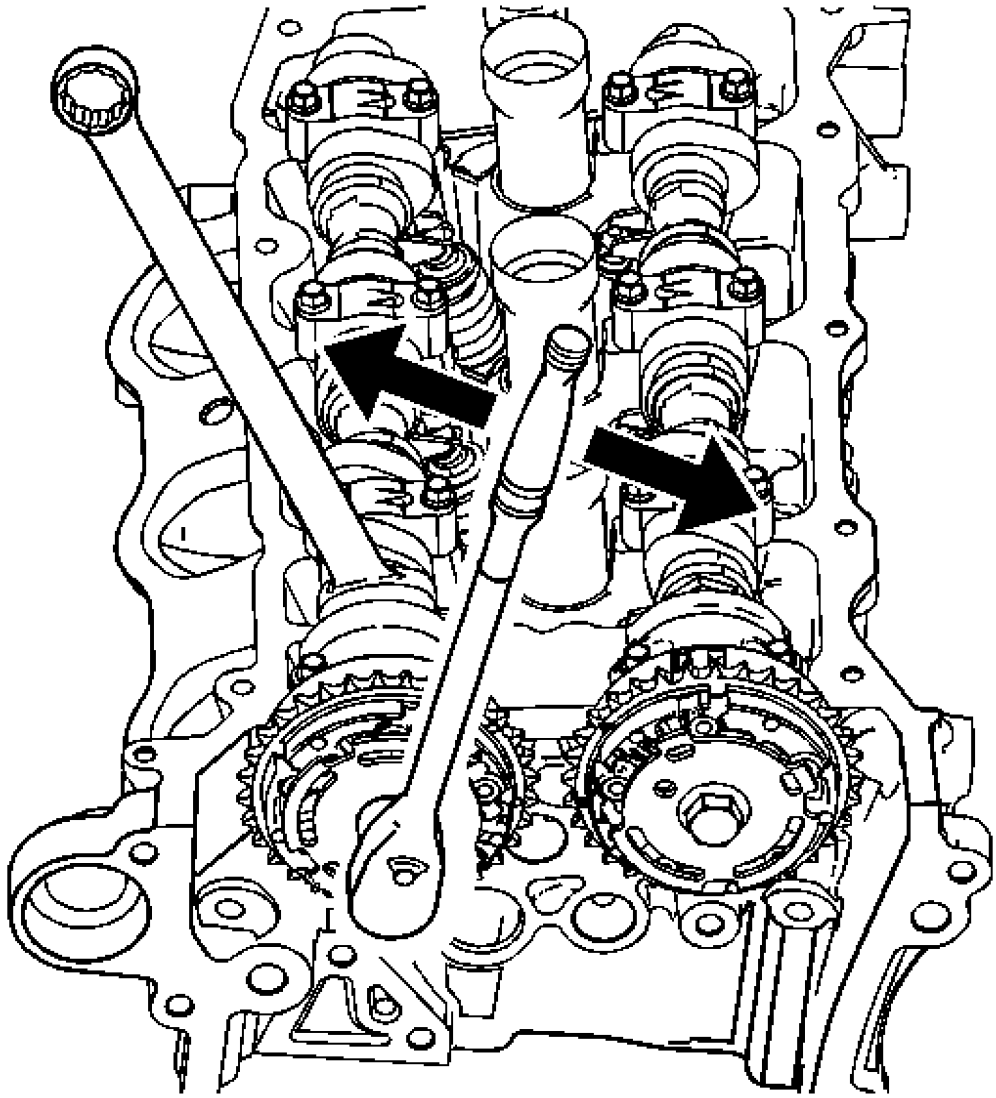


Fig. 129: Preventing Camshaft/Engine Rotation
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

NOTE: Use an open-end wrench at the camshaft hex to prevent camshaft/engine rotation.

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5. Install and tighten the camshaft position actuators. Refer to **Camshaft Position Actuator Installation - Right Side Intake** and **Camshaft Position Actuator Installation - Right Side Exhaust** .
6. Install the intake camshaft position actuator solenoids. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake** and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust** .
7. Install the camshaft sensors. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** and **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake** .
8. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.
9. Install the lower intake manifold. Refer to **Intake Manifold Replacement**.

VALVE ROCKER ARM REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

1. Remove the applicable camshaft(s). Refer to **Camshaft Replacement - Left Side**.

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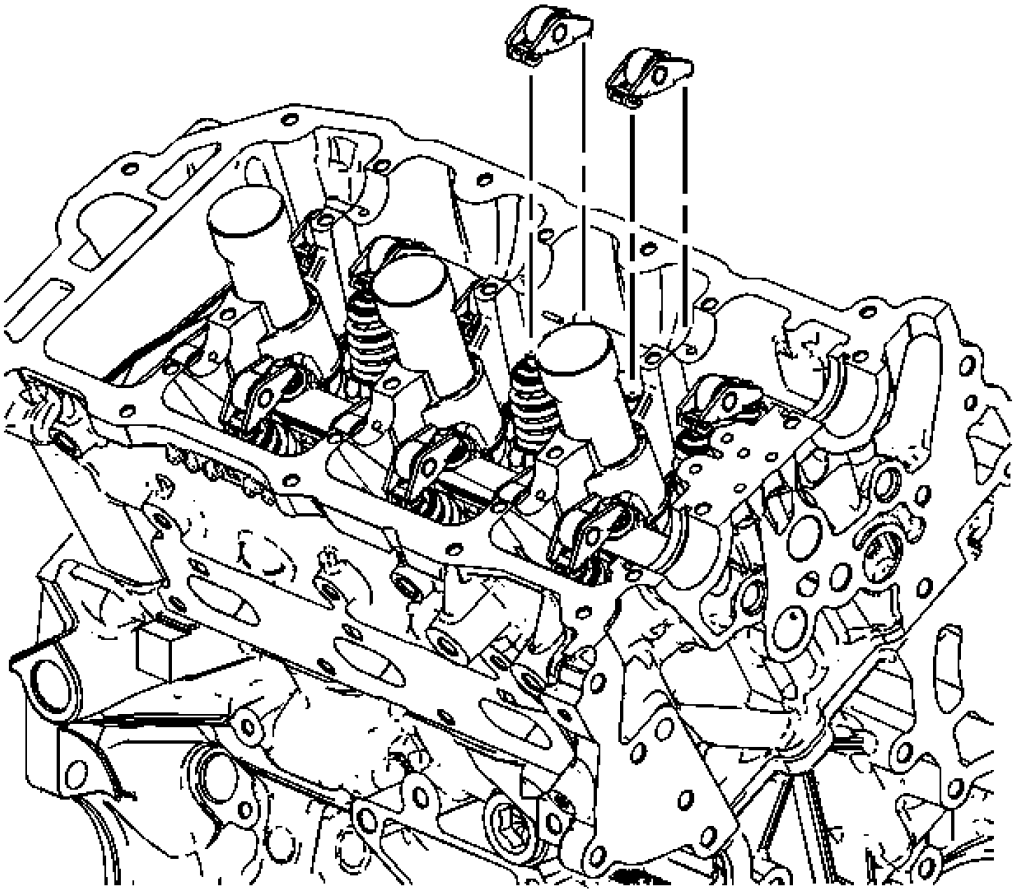


Fig. 130: Identifying Valve Rocker Arms
Courtesy of GENERAL MOTORS CORP.

2. Remove the rocker arms. Refer to **Valve Rocker Arm Removal - Left Side (LLT)** .
3. Clean and inspect the camshaft(s) and the rocker arm(s). Repair or replace as necessary. Refer to **Camshaft Cleaning and Inspection** and **Valve Rocker Arm Cleaning and Inspection** .

INSTALLATION PROCEDURE

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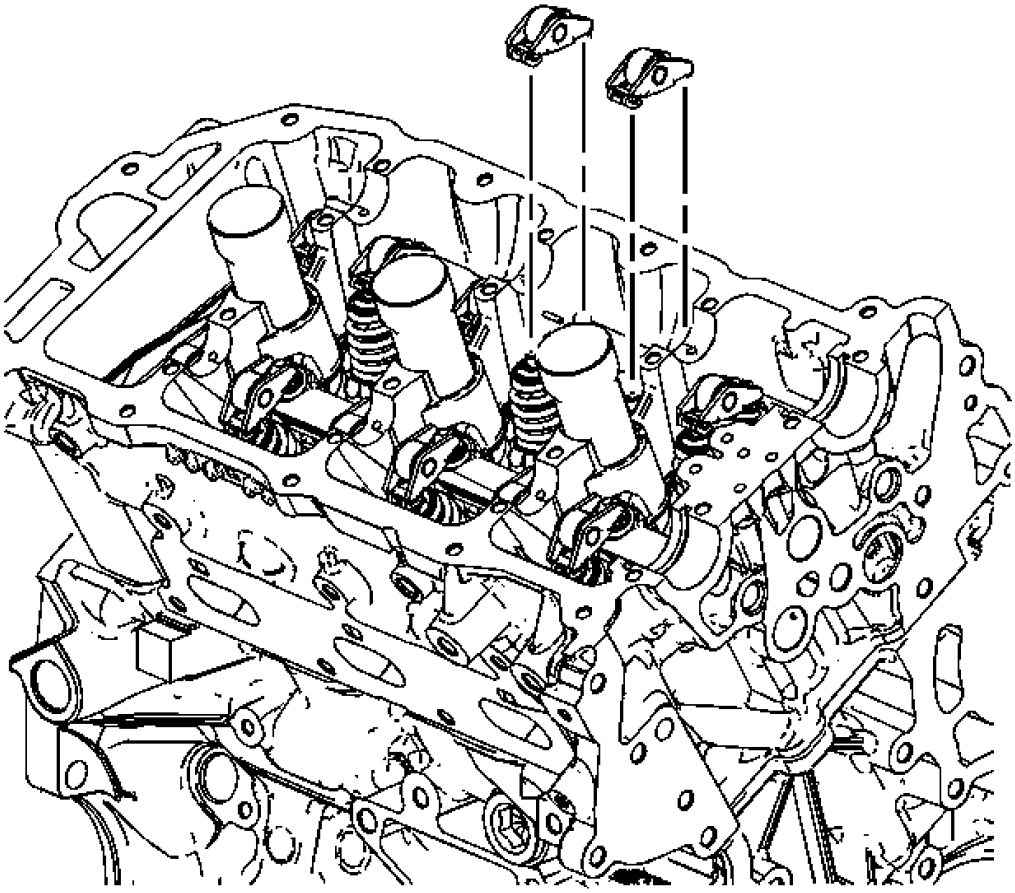


Fig. 131: Identifying Valve Rocker Arms
Courtesy of GENERAL MOTORS CORP.

1. Install the rocker arms. Refer to **Valve Rocker Arm Installation - Left Side (LLT)** .
2. Install the applicable camshaft(s). Refer to **Camshaft Replacement - Left Side**.

VALVE ROCKER ARM REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

1. Remove the applicable camshaft(s). Refer to **Camshaft Replacement - Right Side**.

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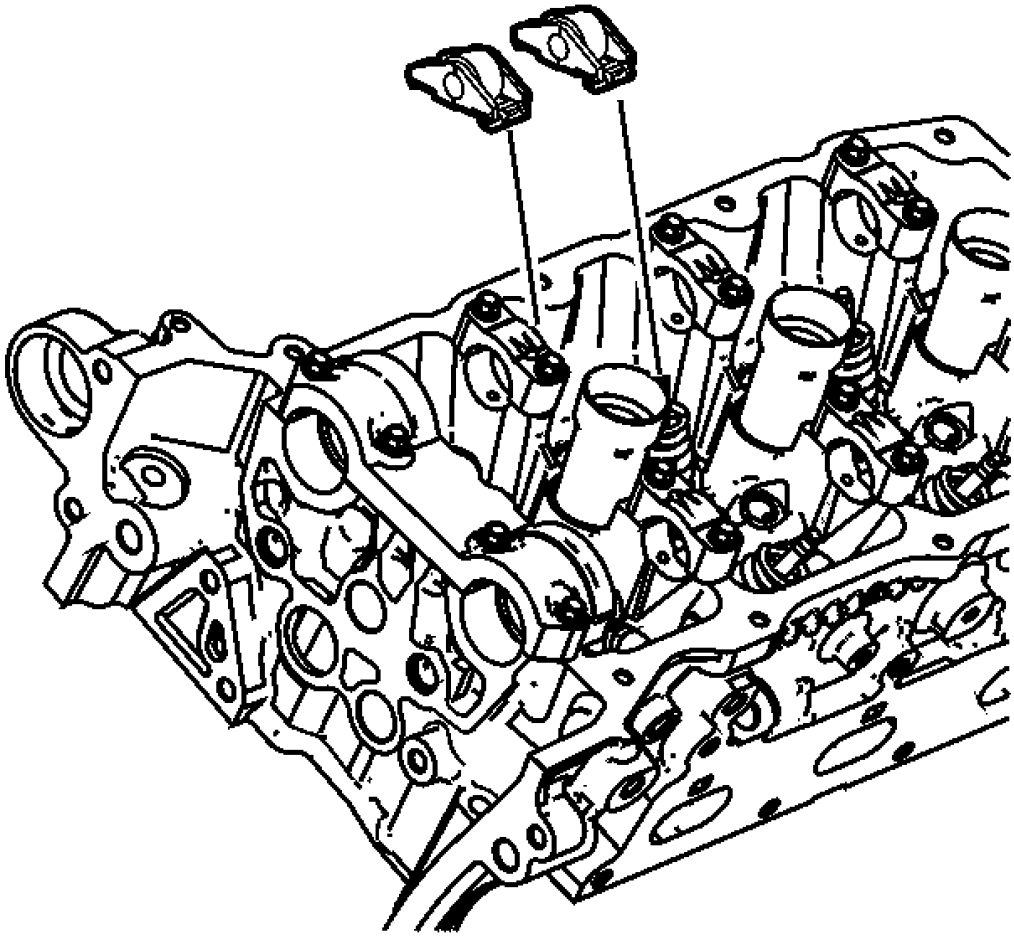


Fig. 132: View Of Valve Rocker Arm
Courtesy of GENERAL MOTORS CORP.

2. Remove the rocker arms. Refer to **Valve Rocker Arm Removal - Right Side** .
3. Clean and inspect the camshaft(s) and the rocker arm(s). Repair or replace as necessary. Refer to **Camshaft Cleaning and Inspection** and **Valve Rocker Arm Cleaning and Inspection** .

INSTALLATION PROCEDURE

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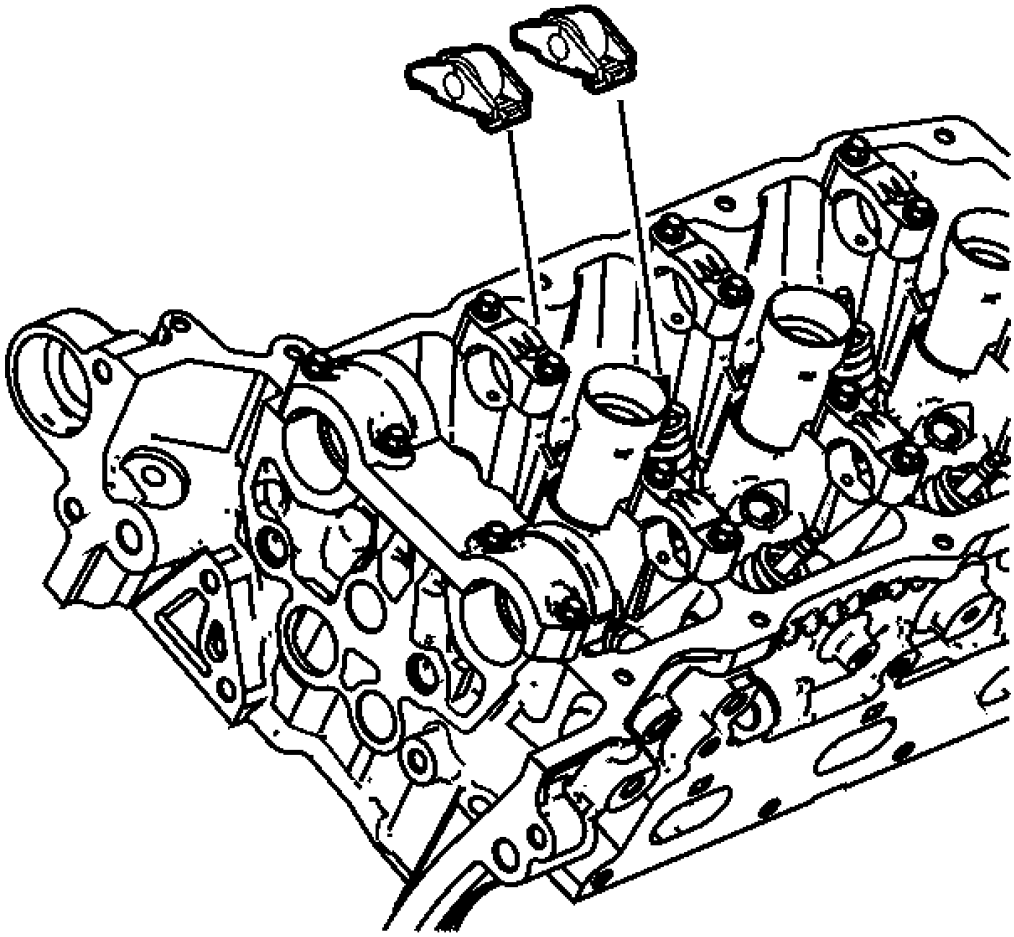


Fig. 133: View Of Valve Rocker Arm
Courtesy of GENERAL MOTORS CORP.

1. Install the rocker arms. Refer to **Valve Rocker Arm Installation - Right Side** .
2. Install the applicable camshaft(s). Refer to **Camshaft Replacement - Right Side**.

VALVE LIFTER REPLACEMENT - LEFT SIDE

REMOVAL PROCEDURE

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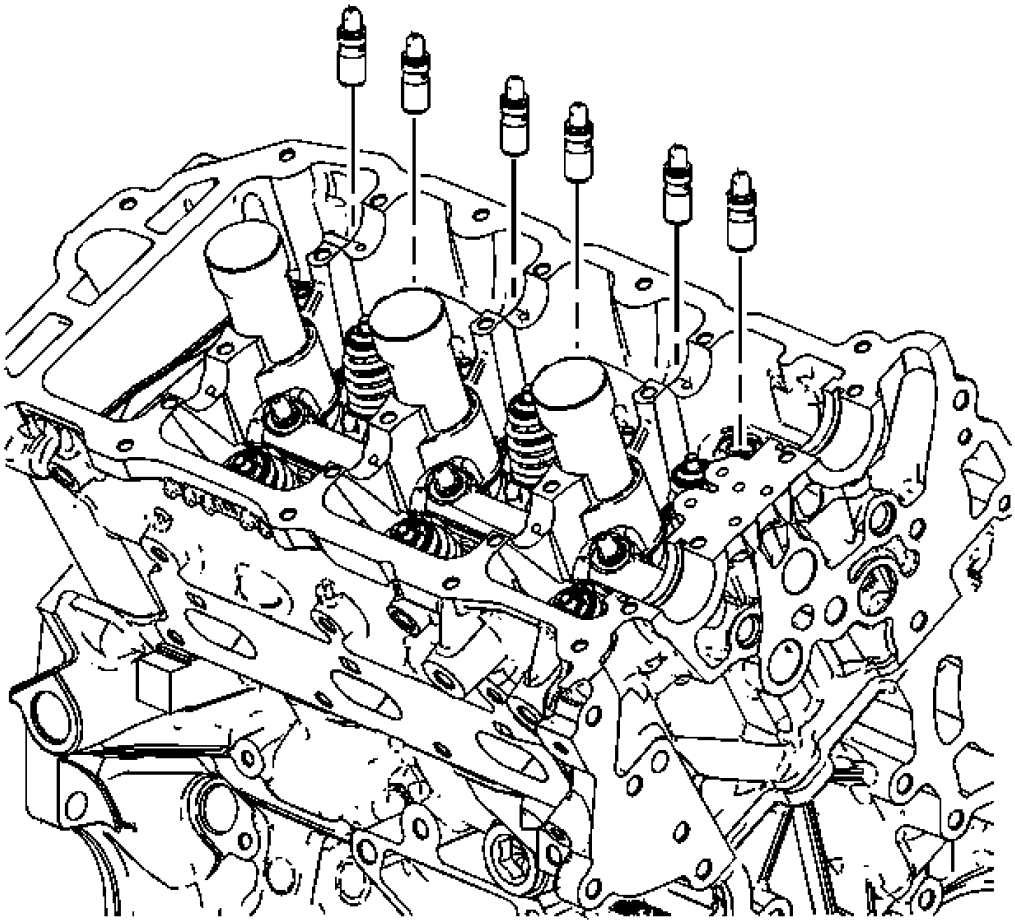


Fig. 134: Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

1. Remove the applicable camshafts. Refer to **Camshaft Replacement - Left Side**.
2. Remove the rocker arms. Refer to **Valve Rocker Arm Replacement - Left Side**.
3. Remove the lifters. Refer to **Valve Lifter Removal - Left Side (LLT)** .
4. Clean and inspect the camshafts, rocker arms and lifters. Repair or replace as necessary. Refer to **Camshaft Cleaning and Inspection** , **Valve Rocker Arm Cleaning and Inspection** and**Valve Lifter Cleaning and Inspection** .

INSTALLATION PROCEDURE

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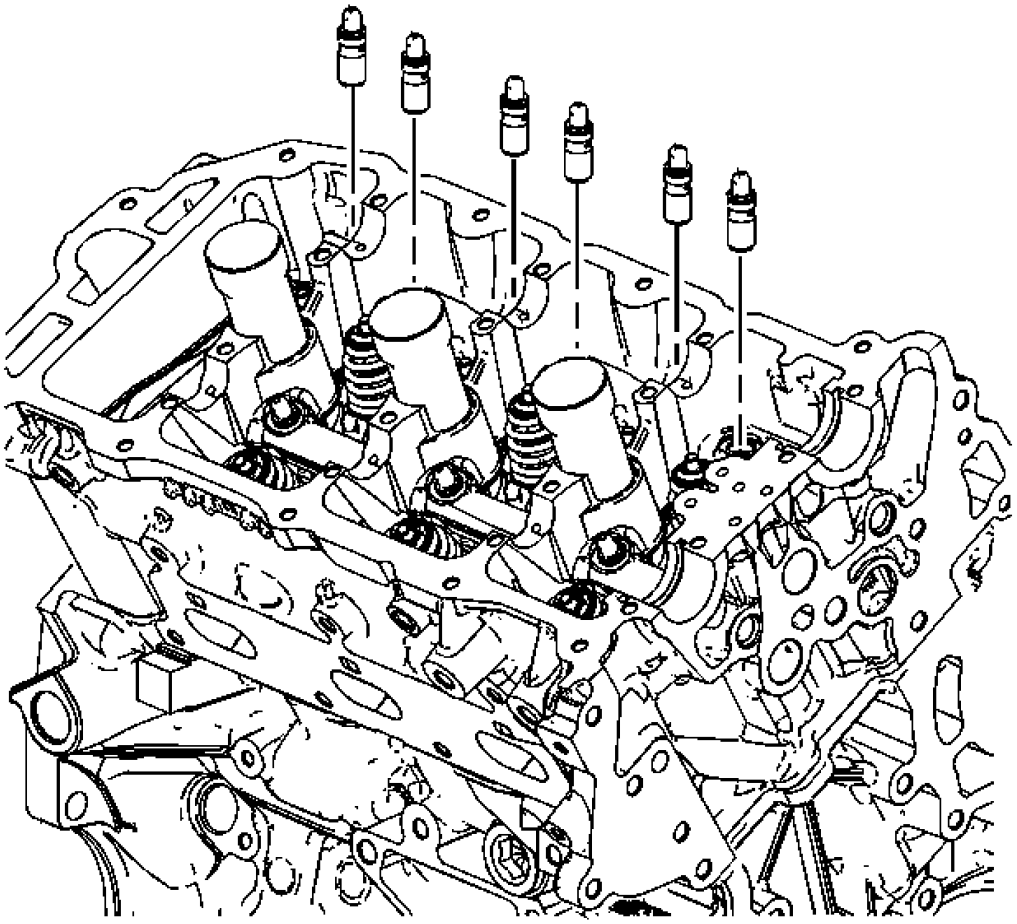


Fig. 135: Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

1. Install the lifters. Refer to **Valve Lifter Installation - Left Side (LLT)** .
2. Install the rocker arms. Refer to **Valve Rocker Arm Replacement - Left Side**.
3. Install the applicable camshafts. Refer to **Camshaft Replacement - Left Side**.

VALVE LIFTER REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

1. Remove the applicable camshaft(s). Refer to **Camshaft Replacement - Right Side**.
2. Remove the rocker arms. Refer to **Valve Rocker Arm Removal - Right Side** .

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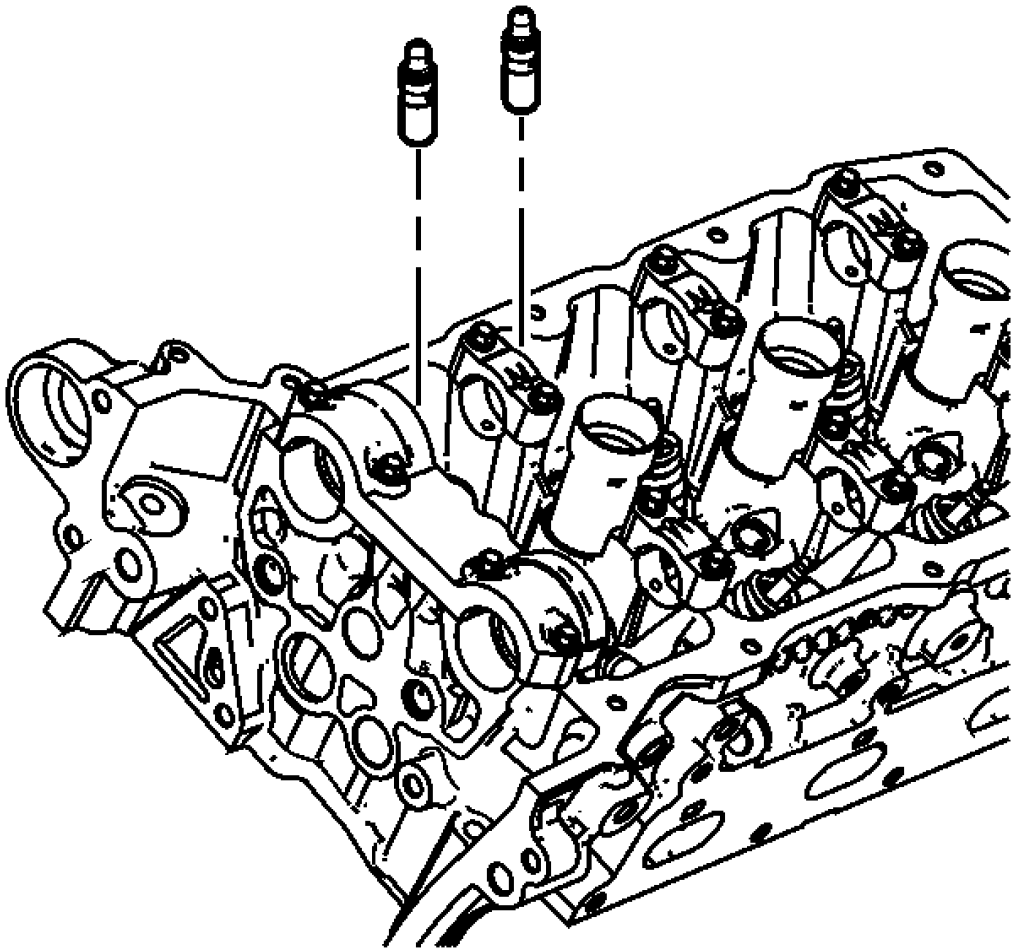


Fig. 136: View Of Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

3. Remove the lifters. Refer to **Valve Lifter Removal - Right Side** .
4. Clean and inspect the camshaft(s) and the rocker arm(s) and lifters. Repair or replace as necessary. Refer to **Camshaft Cleaning and Inspection** and **Valve Lifter Cleaning and Inspection** and **Valve Rocker Arm Cleaning and Inspection** .

INSTALLATION PROCEDURE

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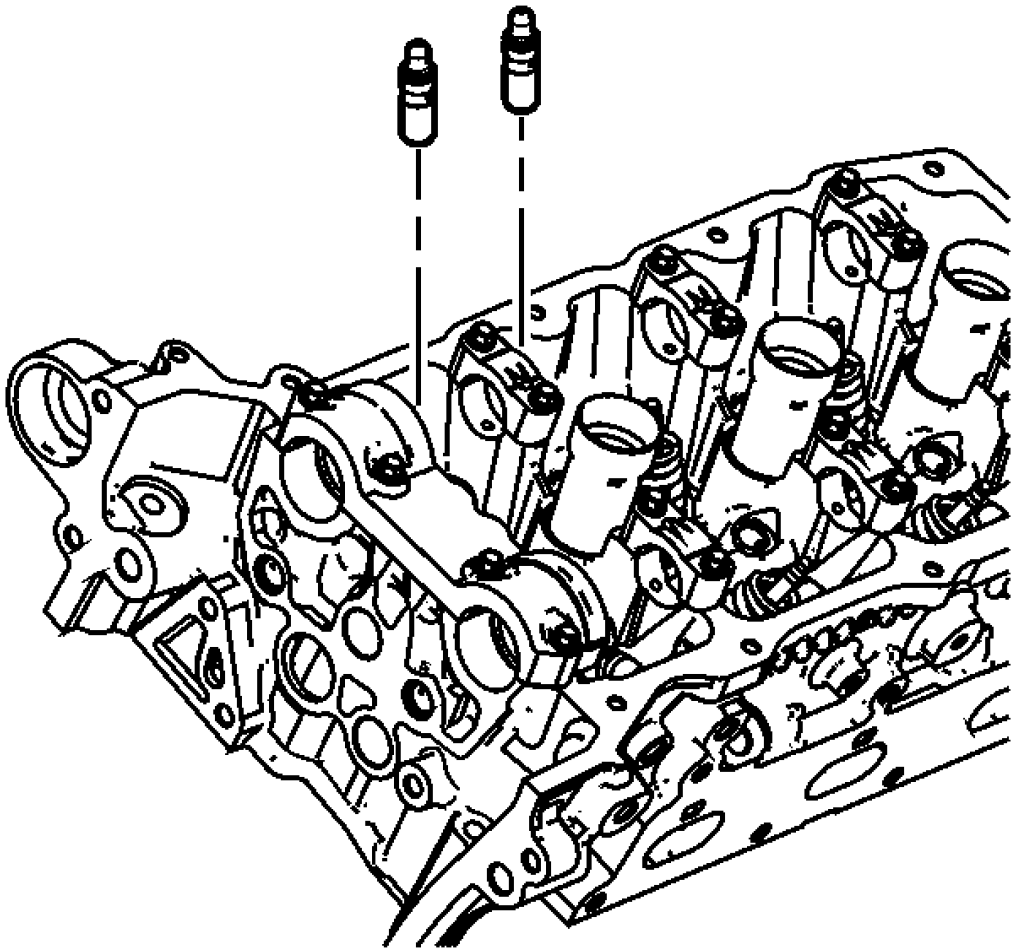


Fig. 137: View Of Stationary Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS CORP.

1. Install the lifters. Refer to **Valve Lifter Installation - Right Side** .
2. Install the rocker arms. Refer to **Valve Rocker Arm Installation - Right Side** .
3. Install the applicable camshaft(s). Refer to **Camshaft Replacement - Right Side**.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - LEFT SIDE

Special Tools

- **EN 46106** Flywheel Holding Tool. See **Special Tools** .
- **EN-48313** Timing Chain Retention Tool. See **Special Tools** .

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- **EN 46110** On-Vehicle Valve Spring Compressor. See **Special Tools** .
- **EN 46116** Valve Stem Seal Remover/Installer. See **Special Tools** .
- **J 39313** Spark Plug Port Adapter. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the starter motor. Refer to **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)** .
2. Remove the camshafts and rocker arms. Refer to **Camshaft Replacement - Left Side** and **Valve Rocker Arm Replacement - Left Side**.

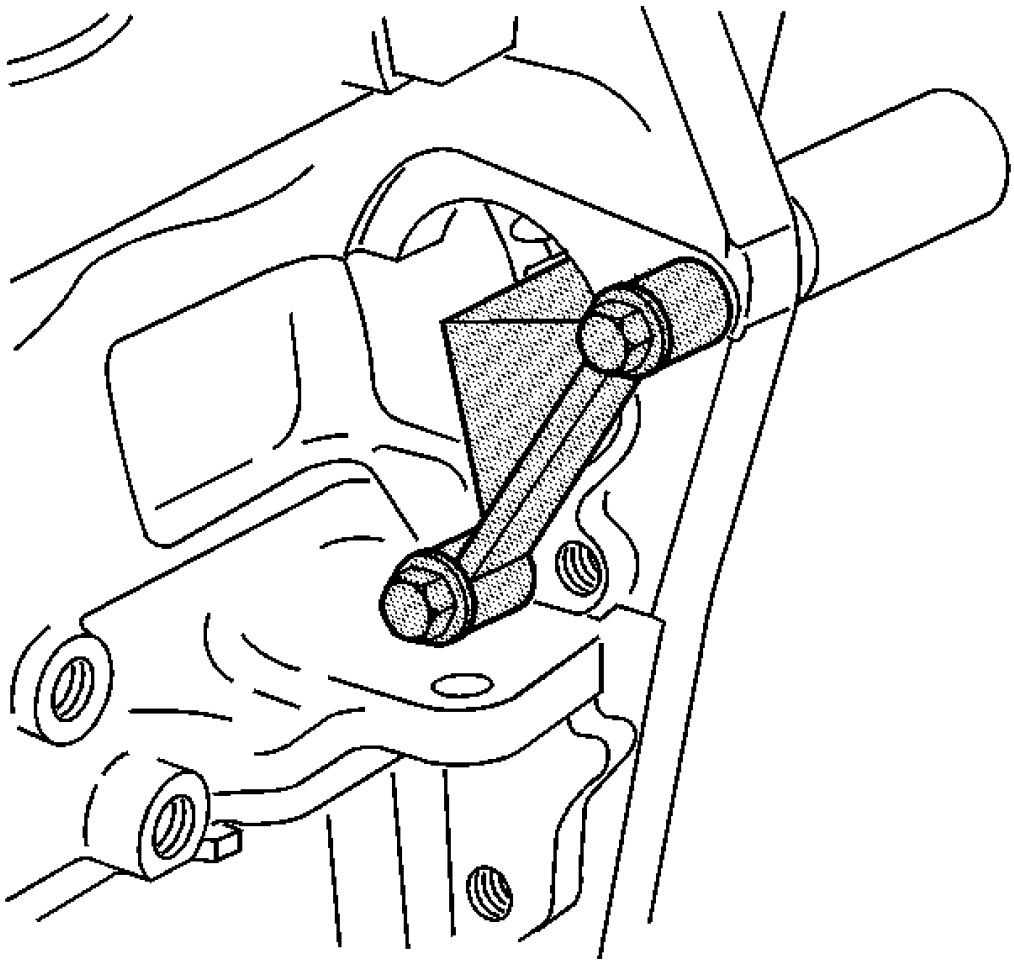


Fig. 138: View Of Special Tool EN 46106
Courtesy of GENERAL MOTORS CORP.

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NOTE: **If the EN 46106 is not installed, the crankshaft may rotate. See Special Tools . If the crankshaft rotates, disassembly and reassembly of the entire camshaft timing system may be required.**

3. Install the **EN 46106** in order to prevent crankshaft rotation. See **Special Tools** .
4. Remove the spark plug from the applicable cylinder. Refer to **Spark Plug Replacement** .
5. Install the **J 39313** to the applicable cylinder. See **Special Tools** .
6. Connect the **J 39313** to a compressed air source. See **Special Tools** .

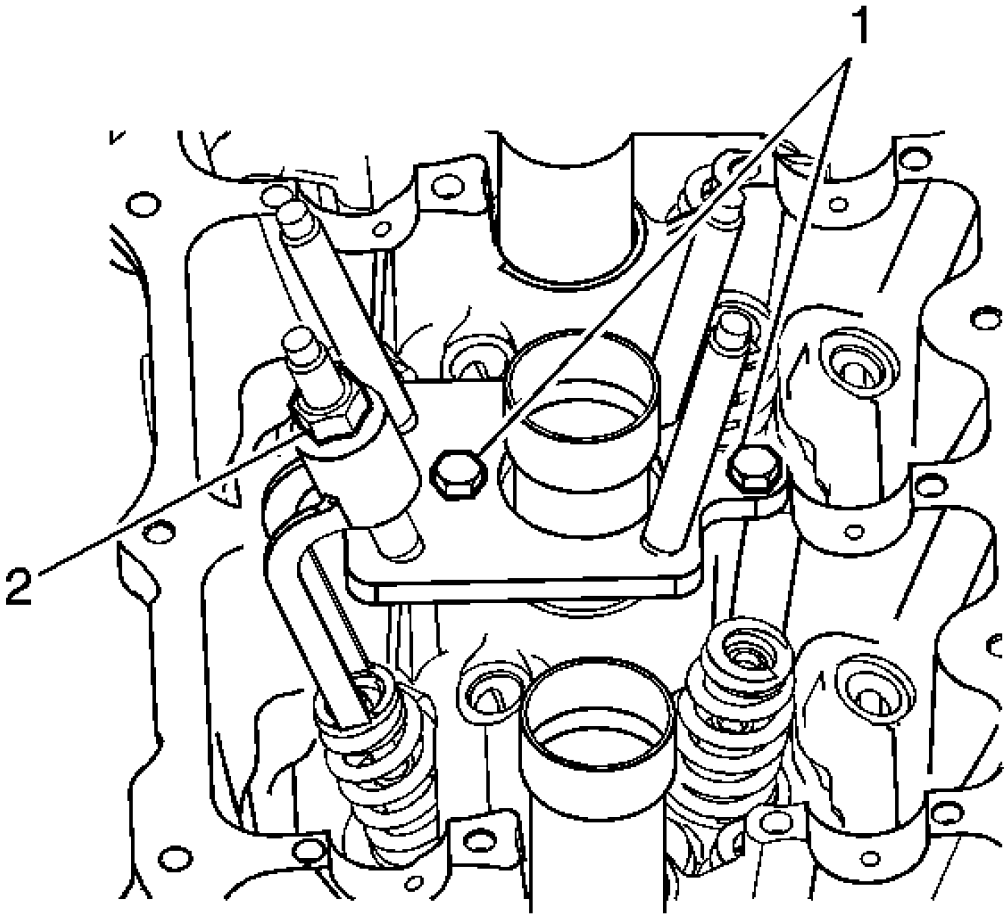


Fig. 139: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS CORP.

7. Install the **EN 46110** above the applicable cylinder as shown. See **Special Tools** .

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8. Tighten the **EN 46110** valve spring compressor nut (2). See **Special Tools** .

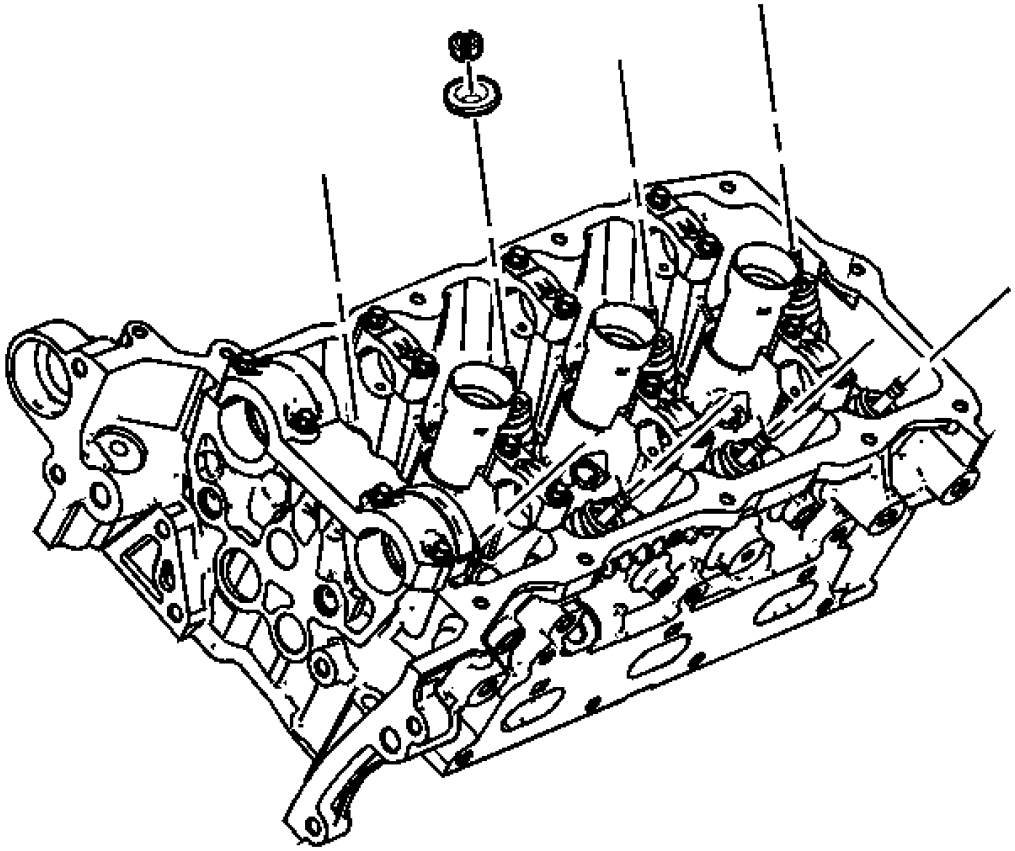


Fig. 140: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS CORP.

9. Remove the valve keepers.
10. Loosen the **EN 46110** valve spring compressor nut. See **Special Tools** .
11. Remove the valve spring retainer.

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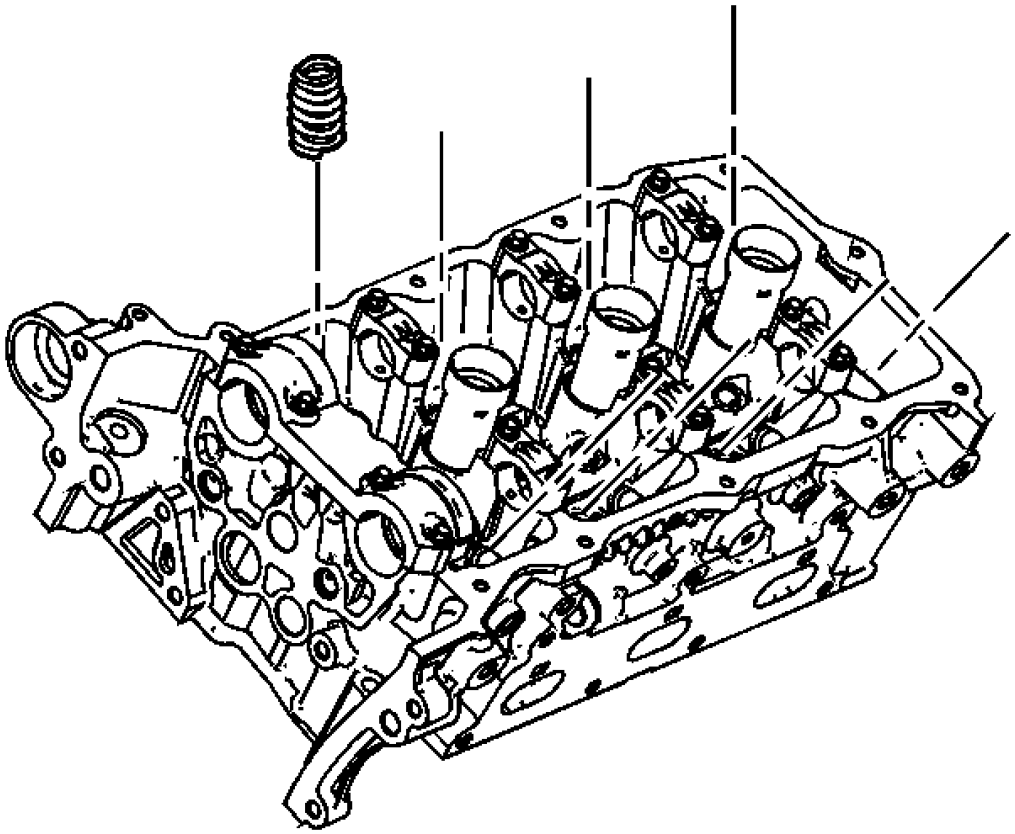


Fig. 141: View Of Valve Spring
Courtesy of GENERAL MOTORS CORP.

12. Remove the valve spring.

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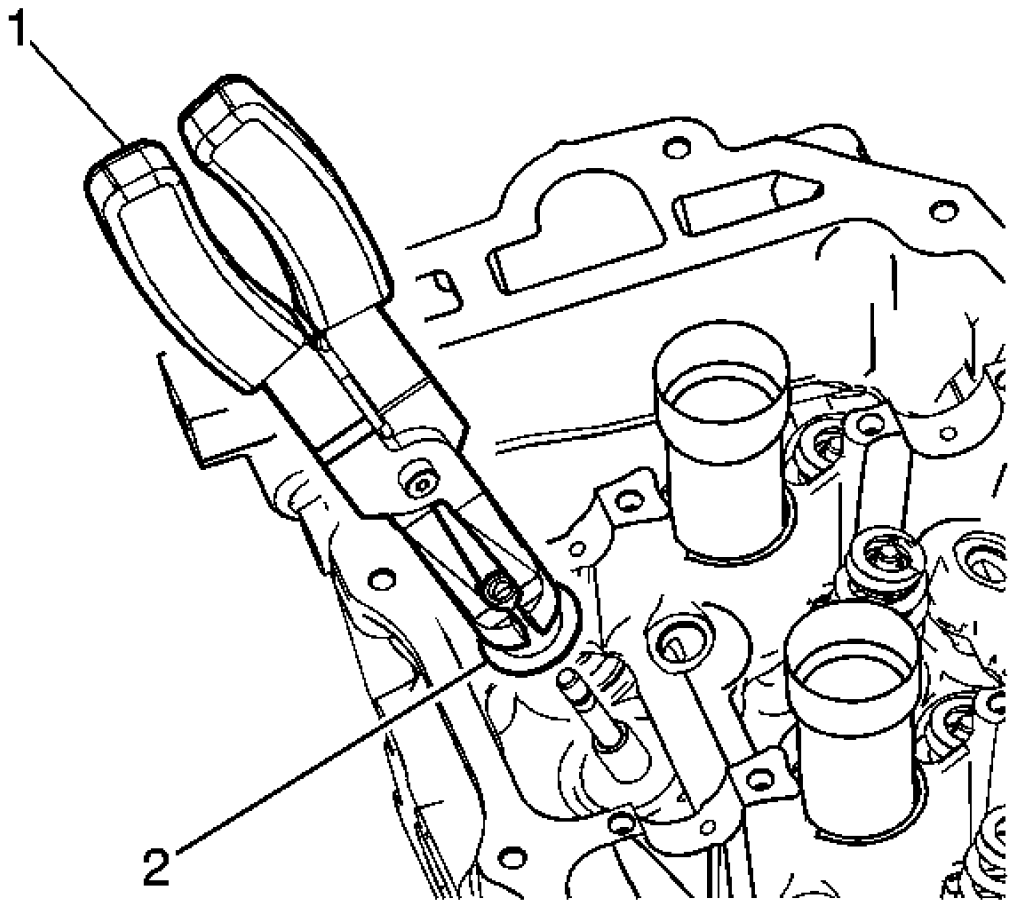


Fig. 142: Removing/Installing Valve Stem Seal
Courtesy of GENERAL MOTORS CORP.

13. Use the **EN 46116** (1) in order to remove the valve stem seal (2). See **Special Tools** .

INSTALLATION PROCEDURE

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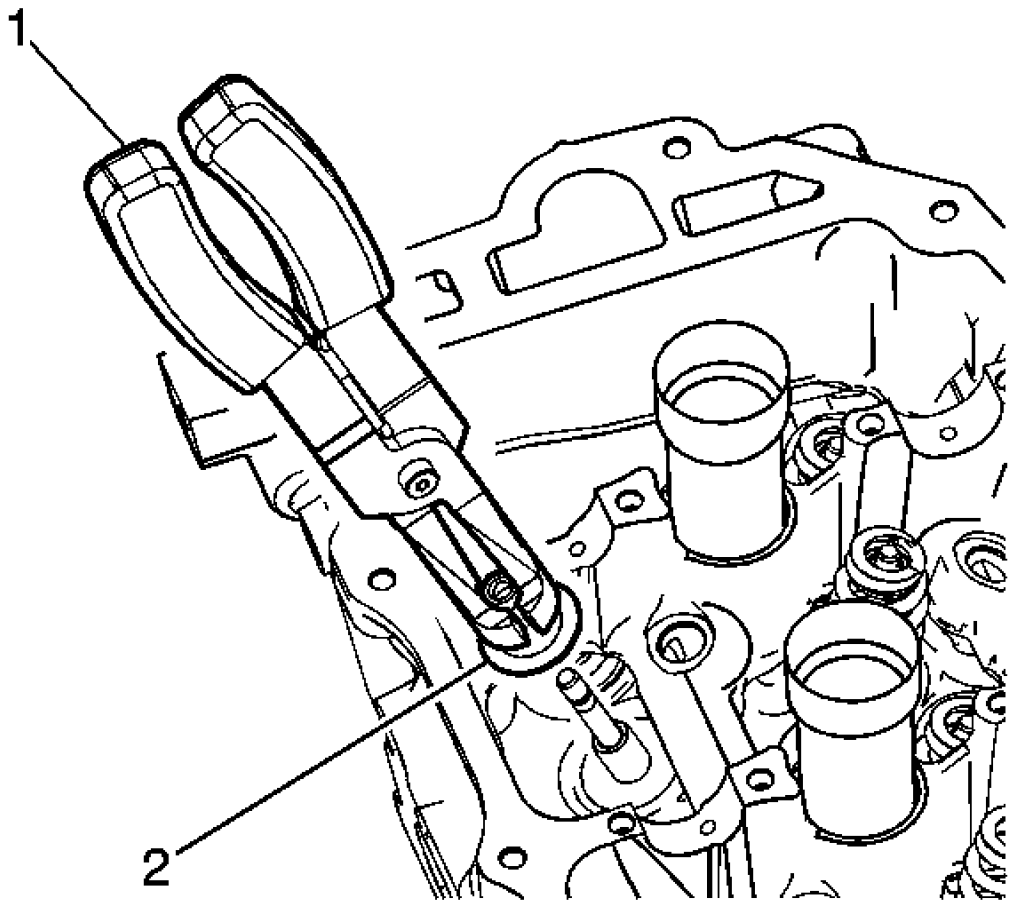


Fig. 143: Removing/Installing Valve Stem Seal
Courtesy of GENERAL MOTORS CORP.

1. Use the **EN 46116** (1) in order to install the valve stem seal (2). See **Special Tools** .

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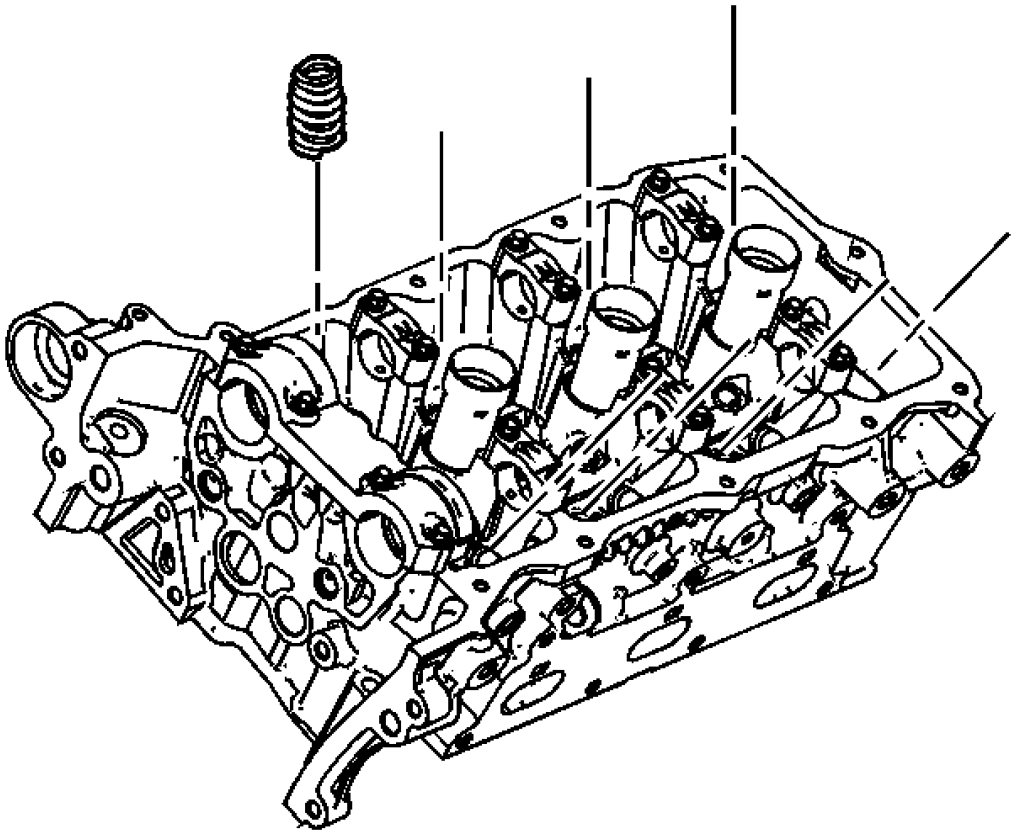


Fig. 144: View Of Valve Spring
Courtesy of GENERAL MOTORS CORP.

2. Install the valve spring.
3. Install the valve spring retainer.

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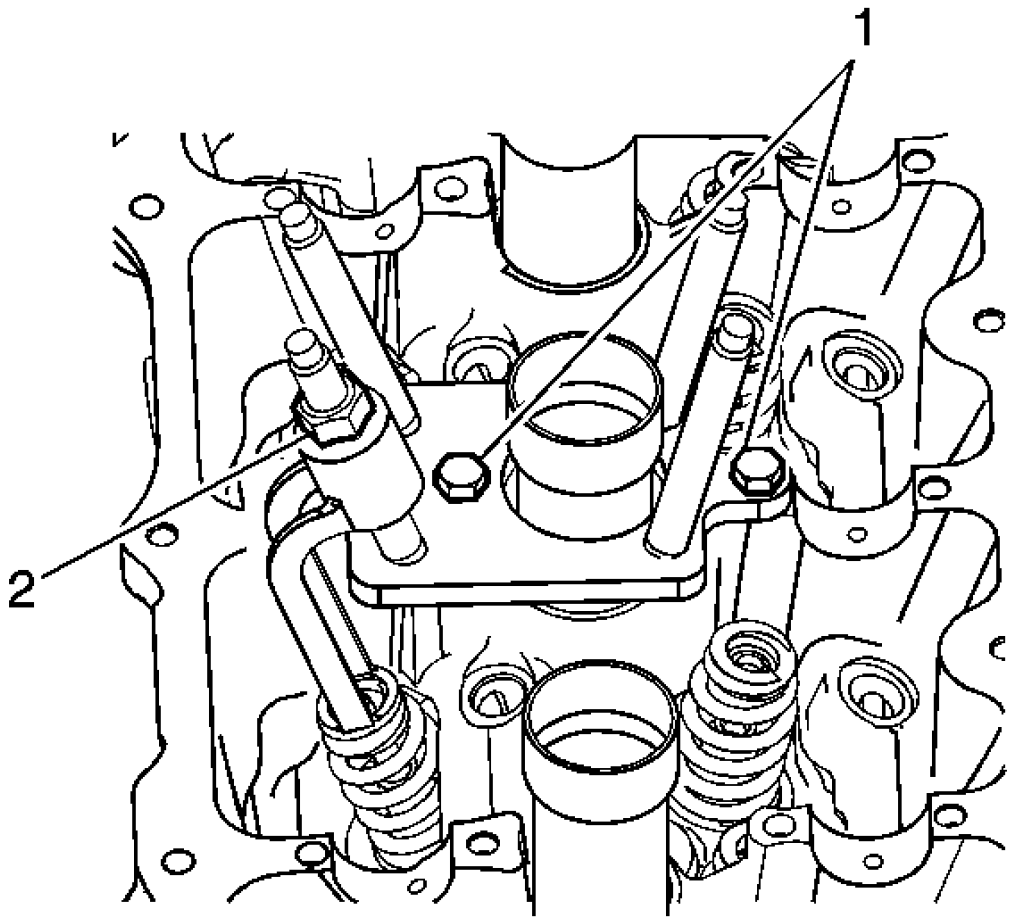


Fig. 145: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS CORP.

4. Install the **EN 46110** above the applicable valve spring as shown. See **Special Tools** .

   Tighten the **EN 46110** valve spring compressor nut (2). See **Special Tools** .

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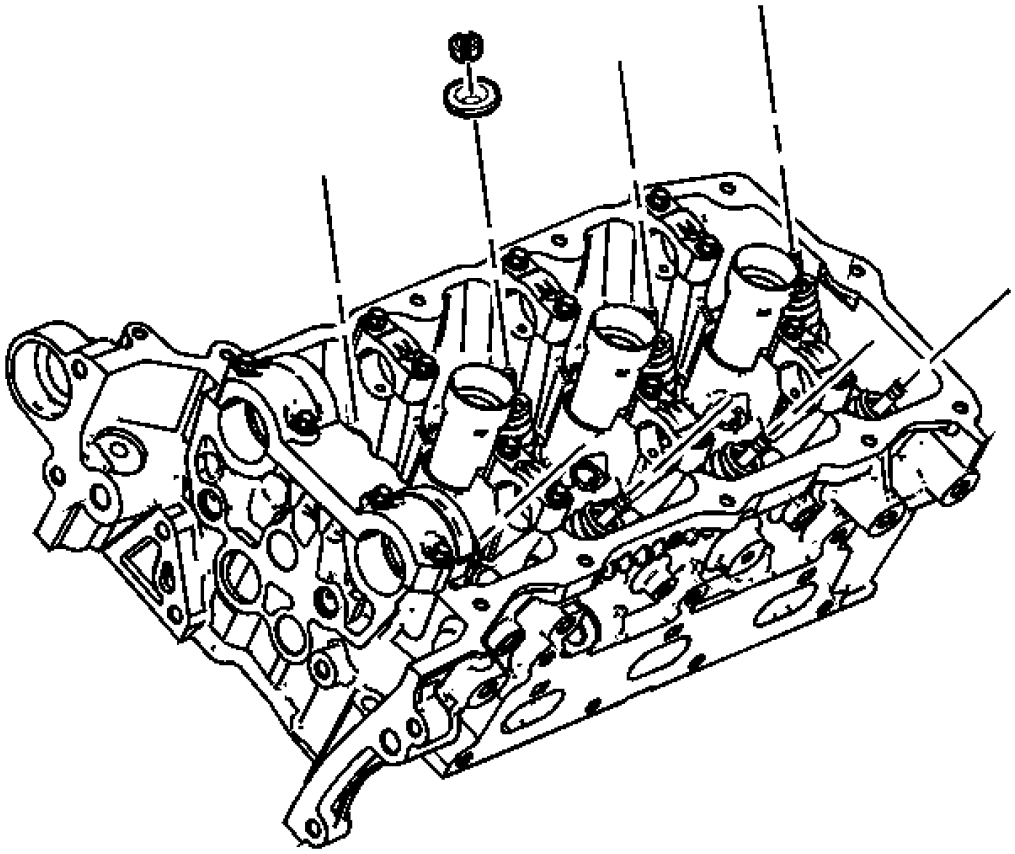


Fig. 146: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS CORP.

5. Install the valve spring keepers.
6. Remove the **EN 46110** . See **Special Tools** .
7. Disconnect the **J 39313** from the compressed air source. See **Special Tools** .
8. Remove the **J 39313** . See **Special Tools** .
9. Install the spark plugs. Refer to **Spark Plug Replacement** .
10. Install the rocker arms and camshafts. Refer to **Valve Rocker Arm Replacement - Left Side** and **Camshaft Replacement - Left Side**.
11. Remove the **EN 46106** . See **Special Tools** .
12. Install the starter motor. Refer to **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)** .

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - RIGHT SIDE

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Special Tools

- **EN 46106** Flywheel Holding Tool. See **Special Tools** .
- **EN-48313** Timing Chain Retention Tool. See **Special Tools** .
- **EN 46110** On-Vehicle Valve Spring Compressor. See **Special Tools** .
- **EN 46116** Valve Stem Seal Remover/Installer. See **Special Tools** .
- **J 39313** Spark Plug Port Adapter. See **Special Tools** .

REMOVAL PROCEDURE

1. Remove the starter motor. Refer to **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)** .
2. Remove the camshafts and rocker arms. Refer to **Camshaft Replacement - Right Side** and **Valve Rocker Arm Replacement - Right Side**.

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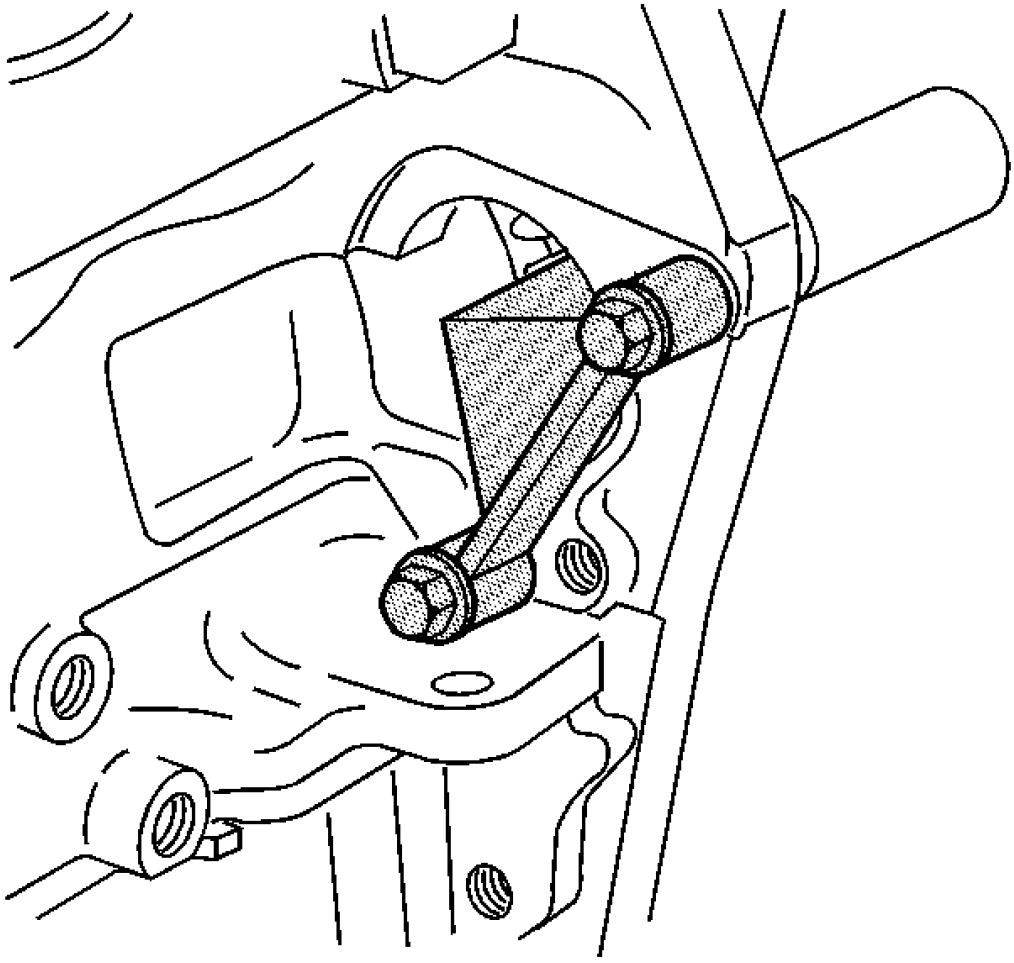


Fig. 147: View Of Special Tool EN 46106
Courtesy of GENERAL MOTORS CORP.

NOTE: **If the EN 46106 is not installed, the crankshaft may rotate. See Special Tools . If the crankshaft rotates, disassembly and reassembly of the entire camshaft timing system may be required.**

3. Install the **EN 46106** in order to prevent crankshaft rotation. See **Special Tools** .
4. Remove the spark plug from the applicable cylinder. Refer to **Spark Plug Replacement** .
5. Install the **J 39313** to the applicable cylinder. See **Special Tools** .
6. Connect the **J 39313** to a compressed air source. See **Special Tools** .

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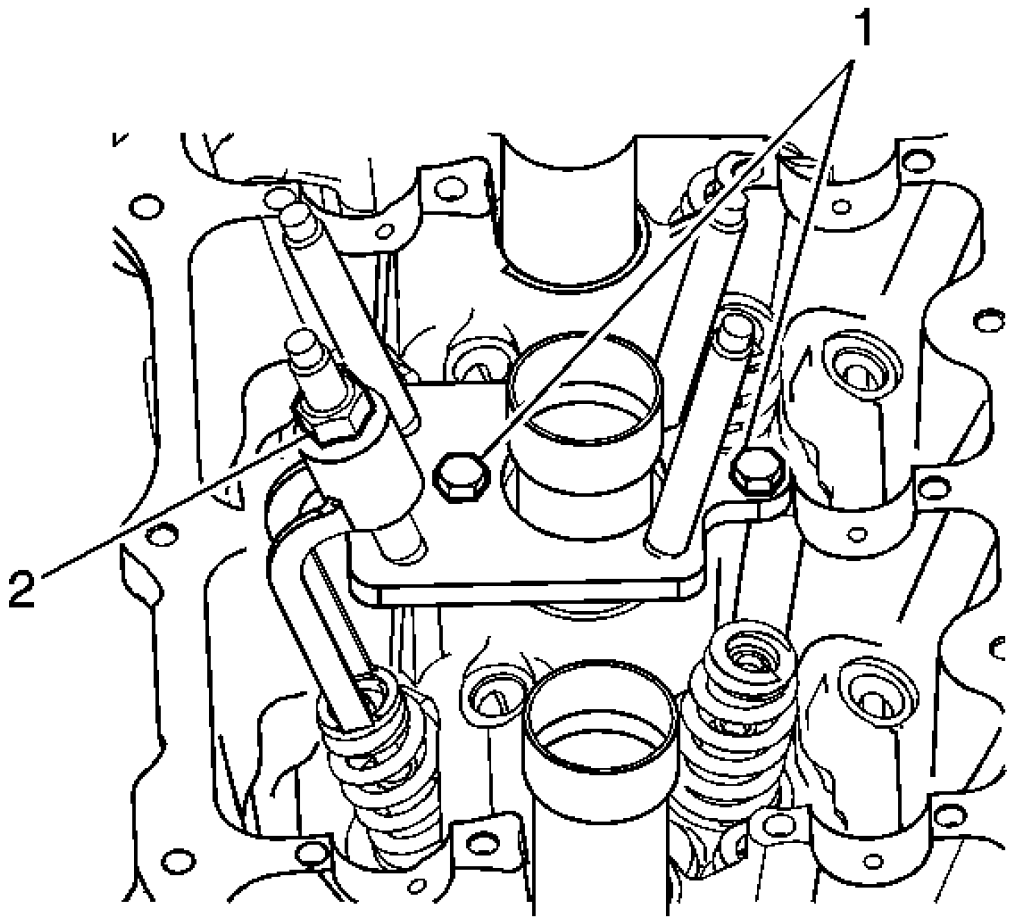


Fig. 148: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS CORP.

7. Install the **EN 46110** above the applicable cylinder as shown. See **Special Tools** .
8. Tighten the **EN 46110** valve spring compressor nut (2). See **Special Tools** .

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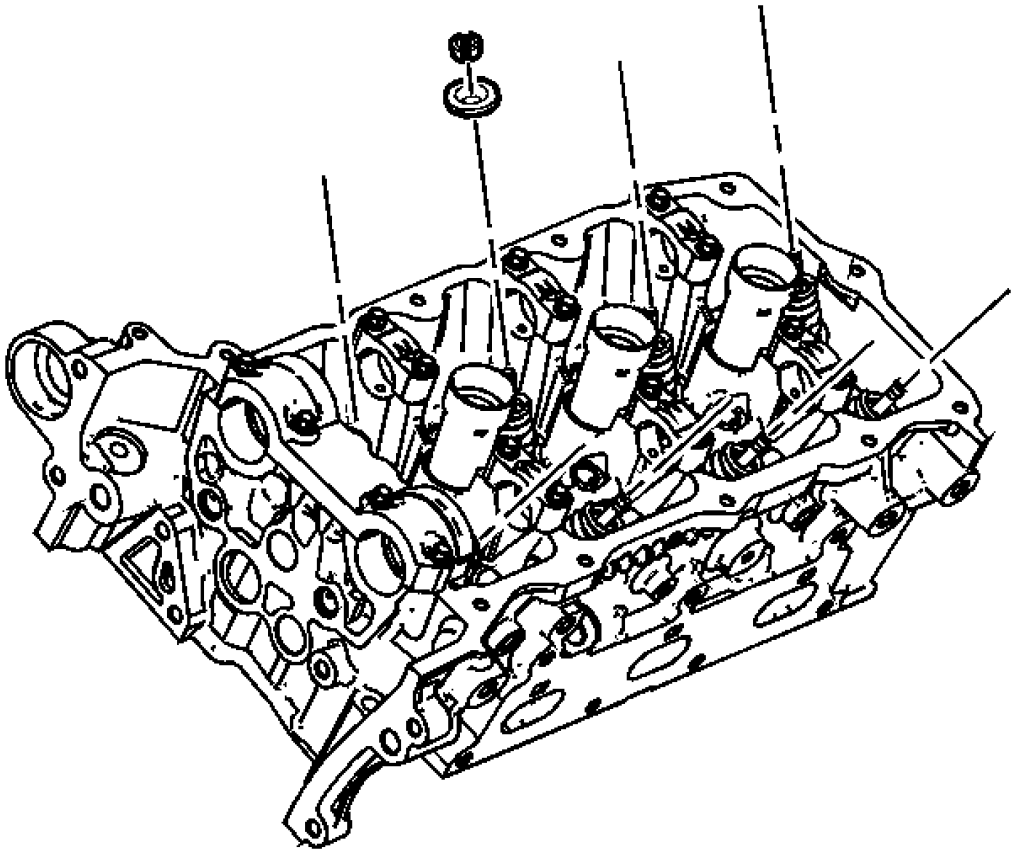


Fig. 149: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS CORP.

9. Remove the valve keepers.
10. Loosen the **EN 46110** valve spring compressor nut. See **Special Tools** .
11. Remove the valve spring retainer.

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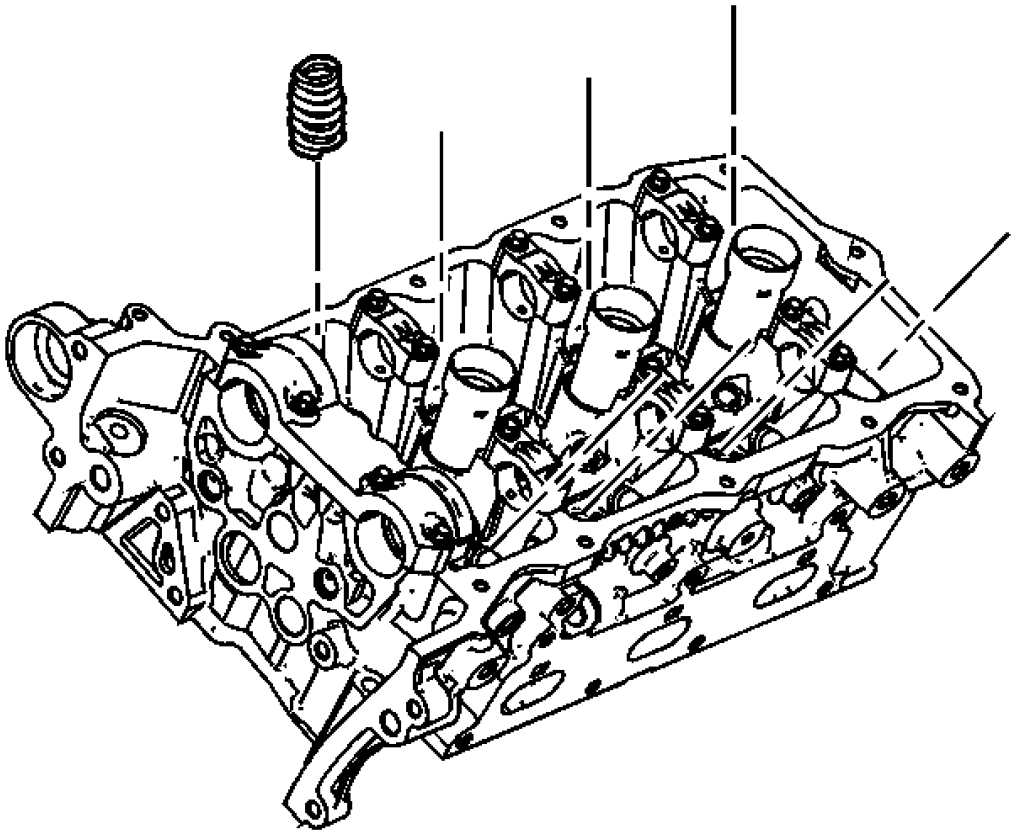


Fig. 150: View Of Valve Spring
Courtesy of GENERAL MOTORS CORP.

12. Remove the valve springs.

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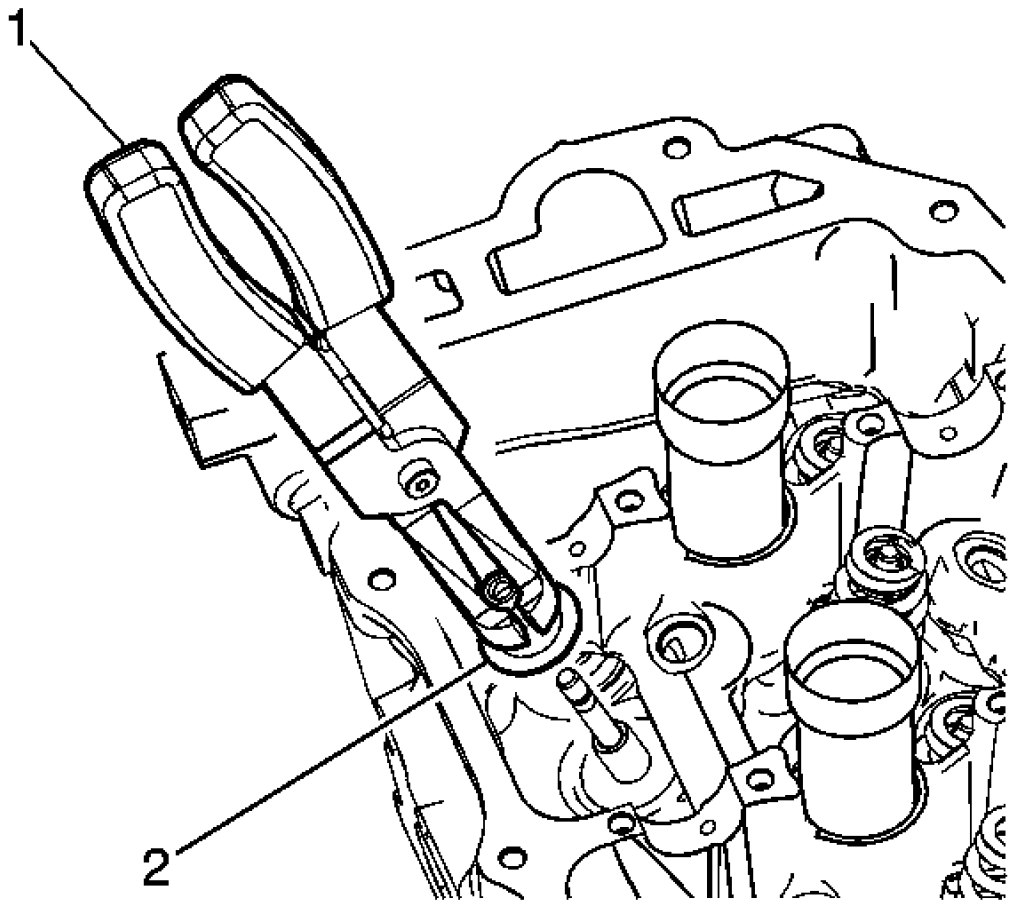


Fig. 151: Removing/Installing Valve Stem Seal
Courtesy of GENERAL MOTORS CORP.

13. Use the **EN 46116** (1) in order to remove the valve stem seal (2). See **Special Tools** .

INSTALLATION PROCEDURE

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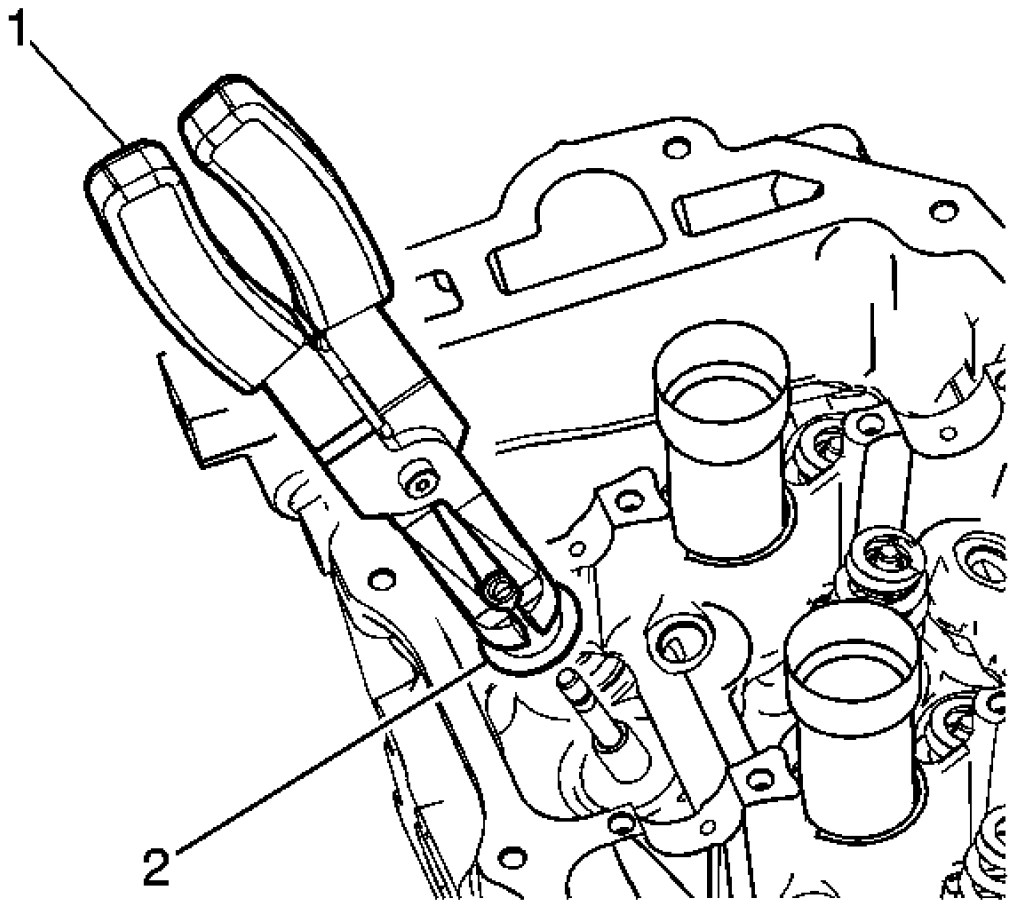


Fig. 152: Removing/Installing Valve Stem Seal
Courtesy of GENERAL MOTORS CORP.

1. Use the **EN 46116** (1) in order to install the valve stem seals (2). See **Special Tools** .

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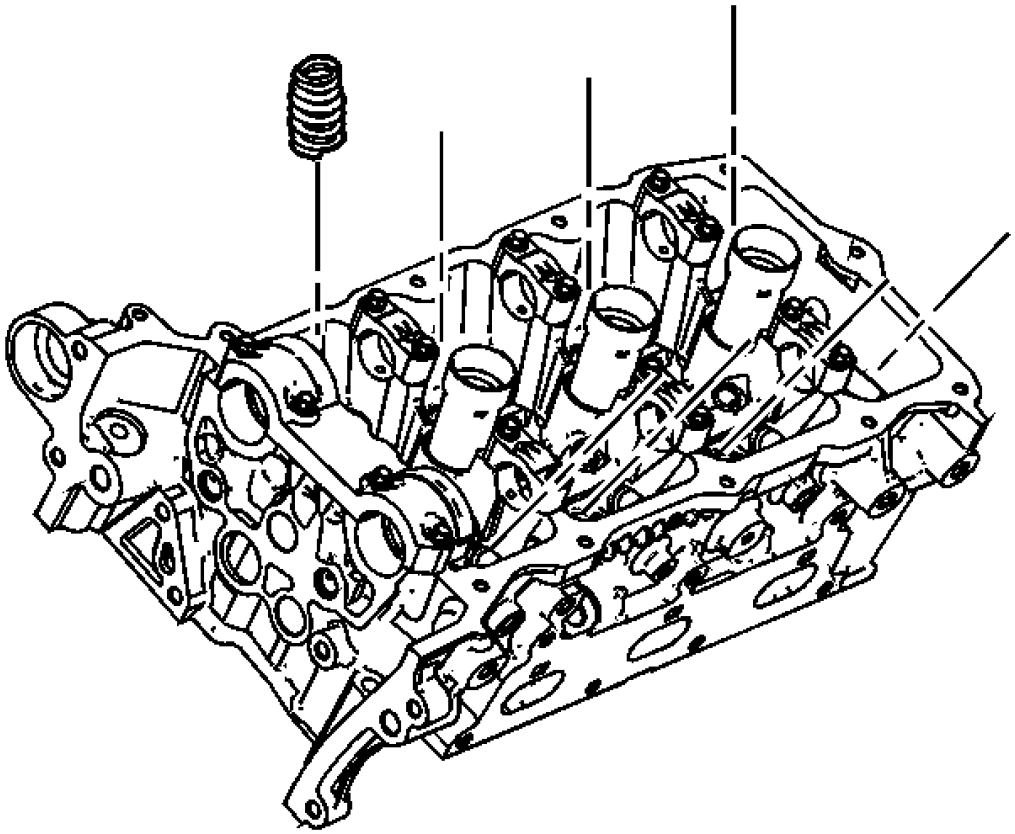


Fig. 153: View Of Valve Spring
Courtesy of GENERAL MOTORS CORP.

2. Install the valve spring.
3. Install the valve spring retainer.

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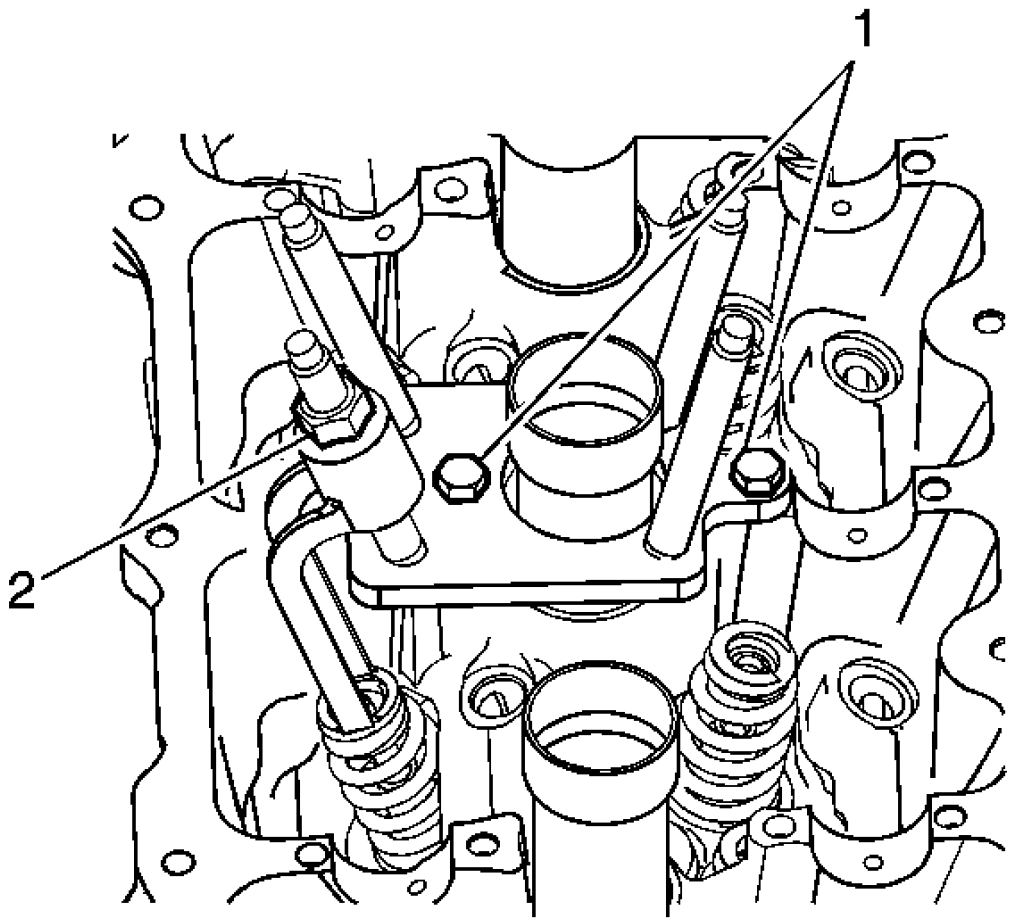


Fig. 154: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS CORP.

4. Install the **EN 46110** above the applicable valve spring as shown. See **Special Tools** .

   Tighten the **EN 46110** valve spring compressor nut (2). See **Special Tools** .

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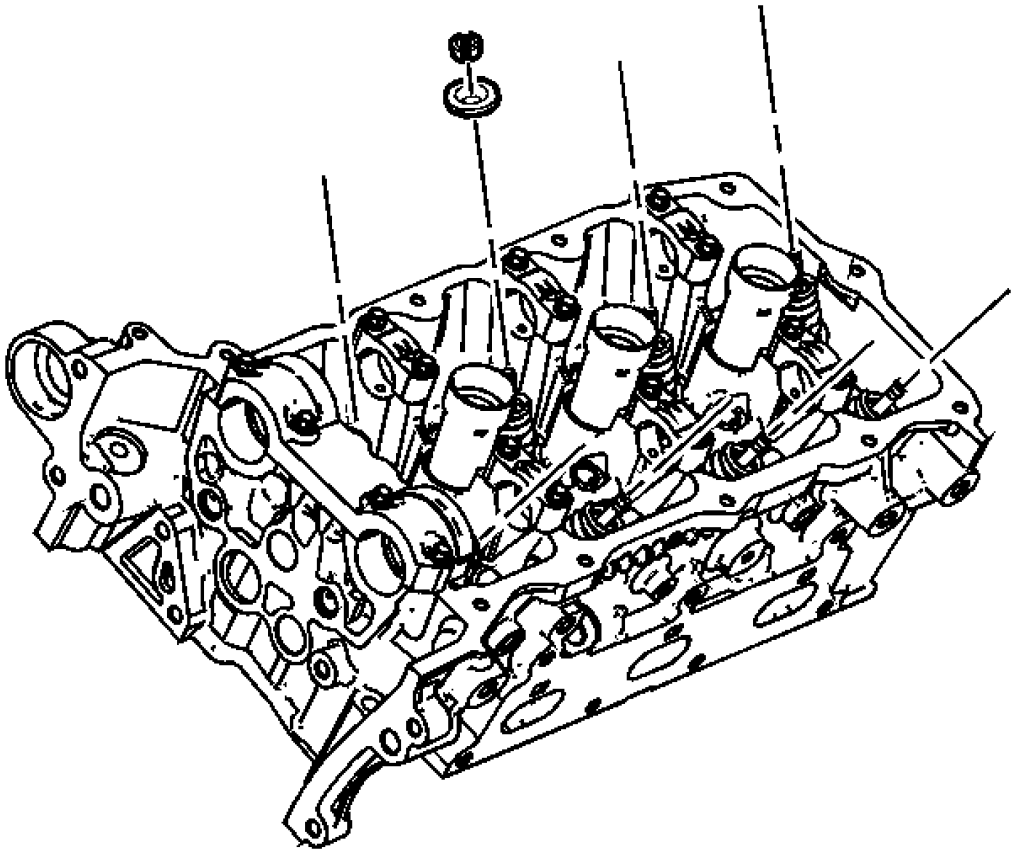


Fig. 155: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS CORP.

5. Install the valve spring keepers.
6. Remove the **EN 46110** . See **Special Tools** .
7. Disconnect the **J 39313** from the compressed air source. See **Special Tools** .
8. Remove the **J 39313** . See **Special Tools** .
9. Install the spark plugs. Refer to **Spark Plug Replacement** .
10. Install the rocker arms and camshafts. Refer to **Valve Rocker Arm Replacement - Right Side** and **Camshaft Replacement - Right Side**.
11. Remove the **EN 46106** . See **Special Tools** .
12. Install the starter motor. Refer to **Starter Replacement (LLT)** or **Starter Replacement (LS3/L99)** .

CYLINDER HEAD REPLACEMENT - LEFT SIDE

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REMOVAL PROCEDURE

1. Remove the left bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**.
2. Remove the oil level indicator. Refer to **Oil Level Indicator Tube Replacement**.
3. Remove the fuel pump. Refer to **Fuel Pump Replacement** .
4. Remove the fuel injection fuel rail crossover tube. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement** .
5. Disconnect the injector harnesses.

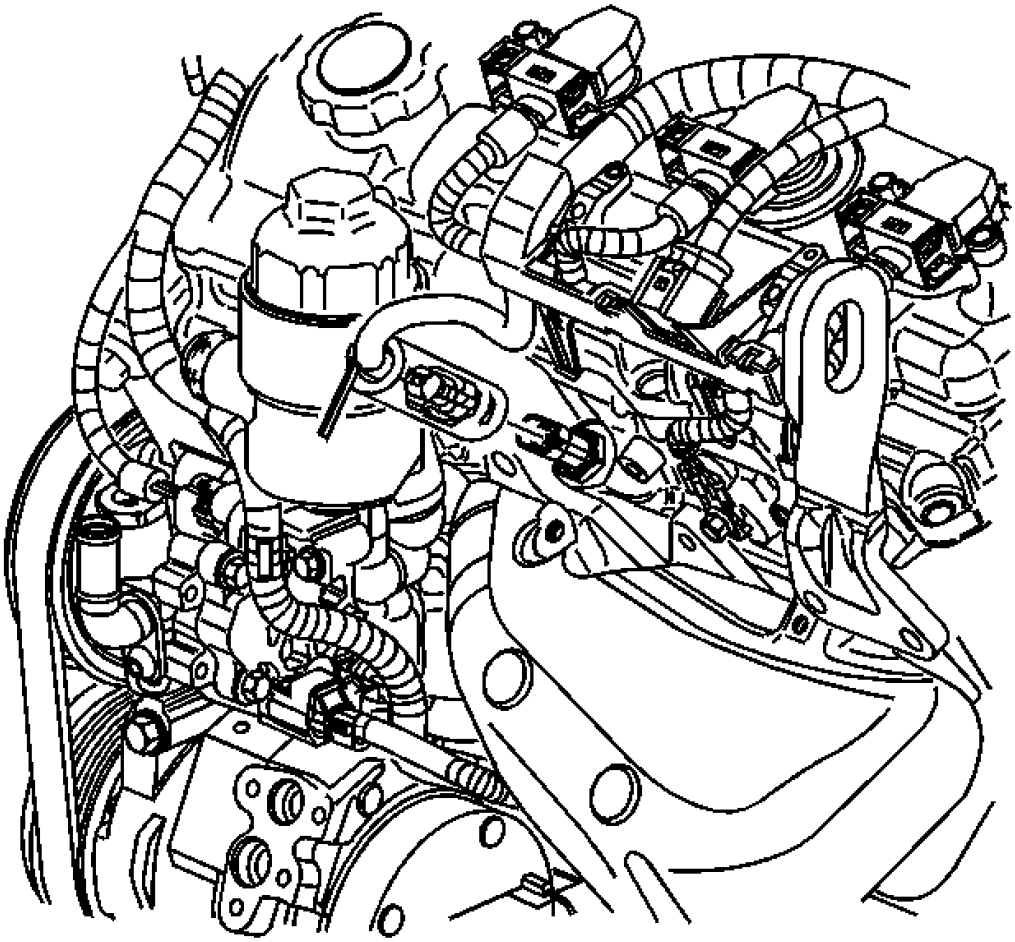


Fig. 156: View Of Coolant Temperature Sensor Electrical Connector & Heat Shield
Courtesy of GENERAL MOTORS CORP.

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6. Remove the heat shield from the coolant temperature sensor and disconnect the coolant temperature sensor electrical connector.

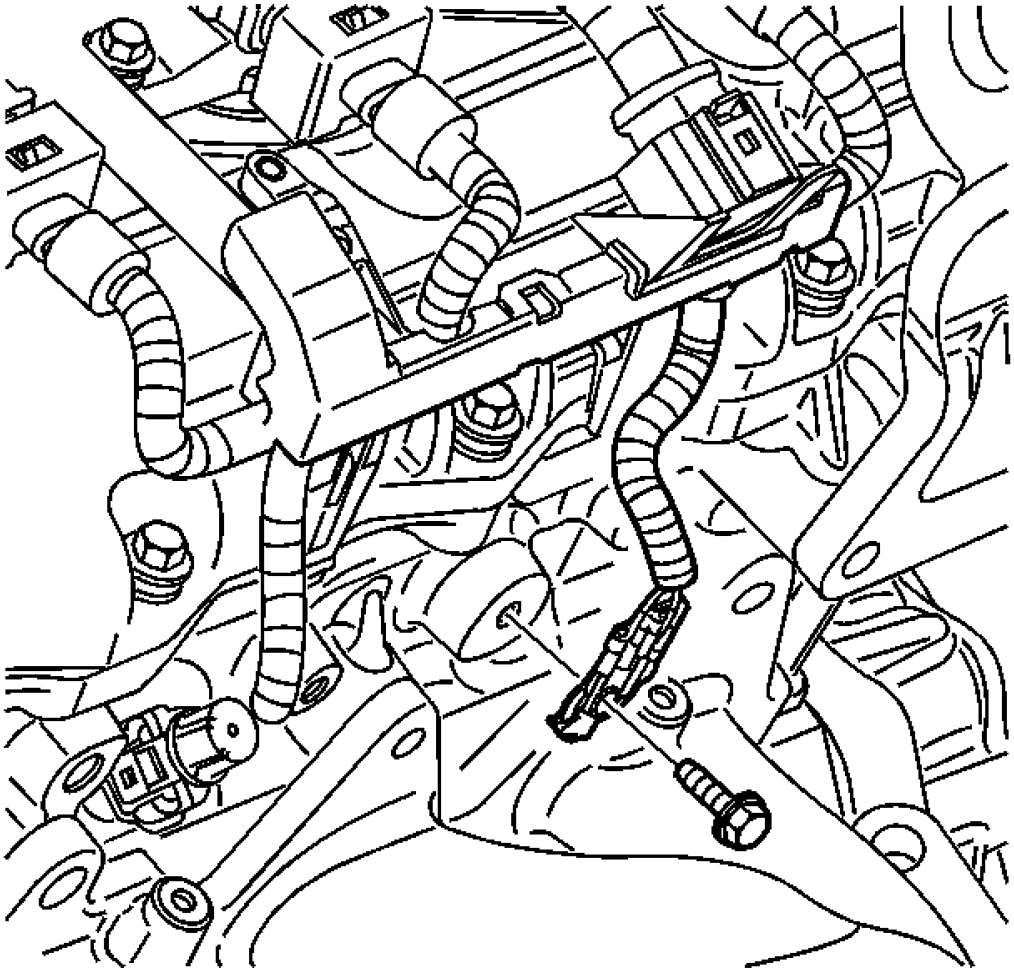


Fig. 157: View Of Left Cylinder Head Wiring Harness Ground Bolt
Courtesy of GENERAL MOTORS CORP.

7. Remove the wiring harness grounds from the cylinder head.
8. Disconnect the wiring harness electrical connector located at the side of the cylinder head.
9. Remove the wiring harness connector bracket from the side of the cylinder head.

NOTE: DO NOT disconnect the power steering pipes and/or hoses.

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10. Remove the power steering pump bolts. Refer to **Power Steering Pump Replacement (V6)** or **Power Steering Pump Replacement (V8)** .
11. Remove the catalytic converter. Refer to **Catalytic Converter Replacement - Left Side (LLT)** or **Catalytic Converter Replacement - Left Side (L99/LS3)** .
12. Remove the oil level indicator. Refer to **Oil Level Indicator Tube Replacement**.

NOTE: Do not remove the oil filter adapter.

13. Remove the oil filter adapter upper bolt.

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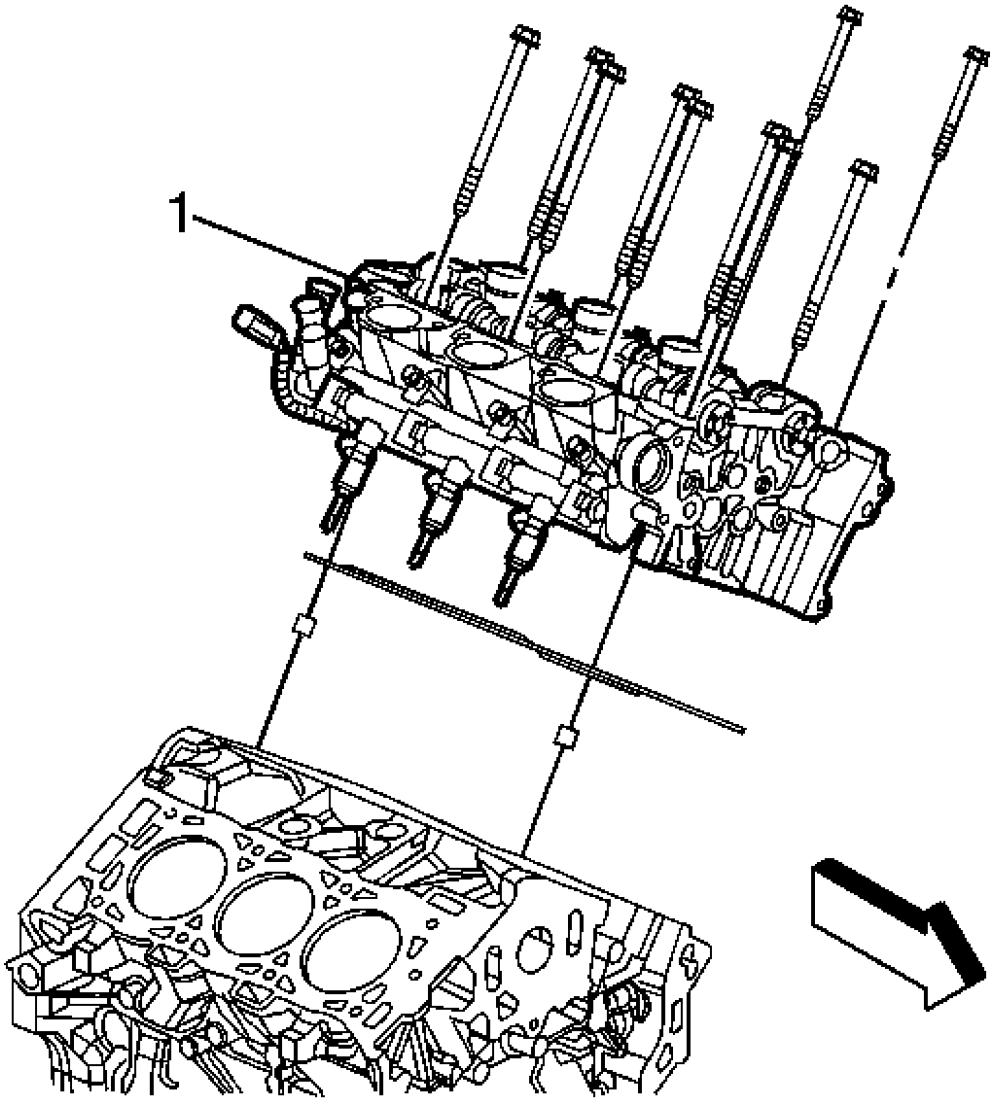


Fig. 158: Removing/Installing Cylinder Head & Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

14. Remove the cylinder head (1) with the exhaust manifold. Refer to **Cylinder Head Removal - Right Side (LLT)** .

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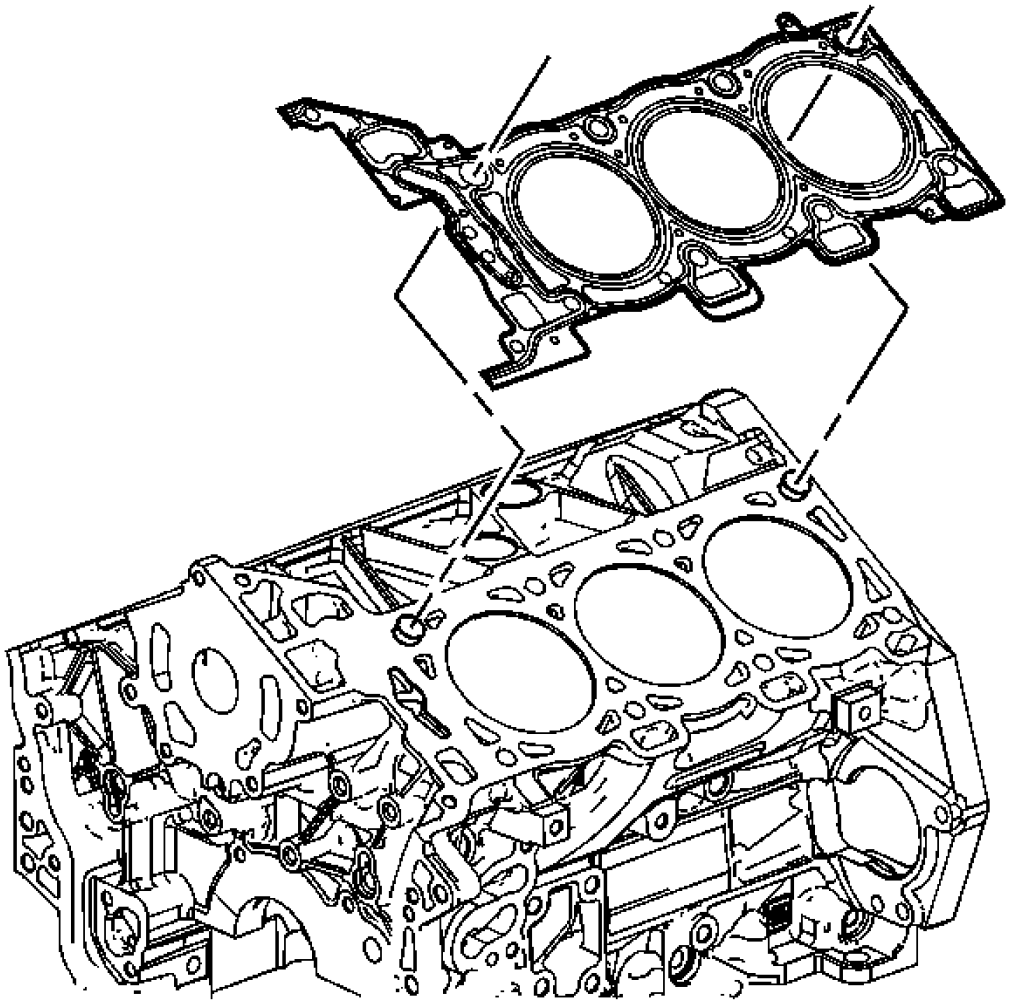


Fig. 159: View Of Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

15. Remove and discard the cylinder head gasket.
16. Clean and inspect the cylinder head and the engine block sealing surfaces. Refer to **Cylinder Head Cleaning and Inspection** and **Engine Block Cleaning and Inspection** .
17. If necessary, perform the following steps:
    1. Remove the exhaust manifold from the cylinder head. Refer to **Exhaust Manifold Removal - Left Side** .
    2. Disassemble the cylinder head. Refer to **Cylinder Head Disassemble (LLT)** .

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INSTALLATION PROCEDURE

1. If necessary, perform the following steps:
    1. Assemble the cylinder head. Refer to **Cylinder Head Assemble (LLT or LCS)** .
    2. Install the exhaust manifold to the cylinder head. Refer to **Exhaust Manifold Installation - Left Side** .

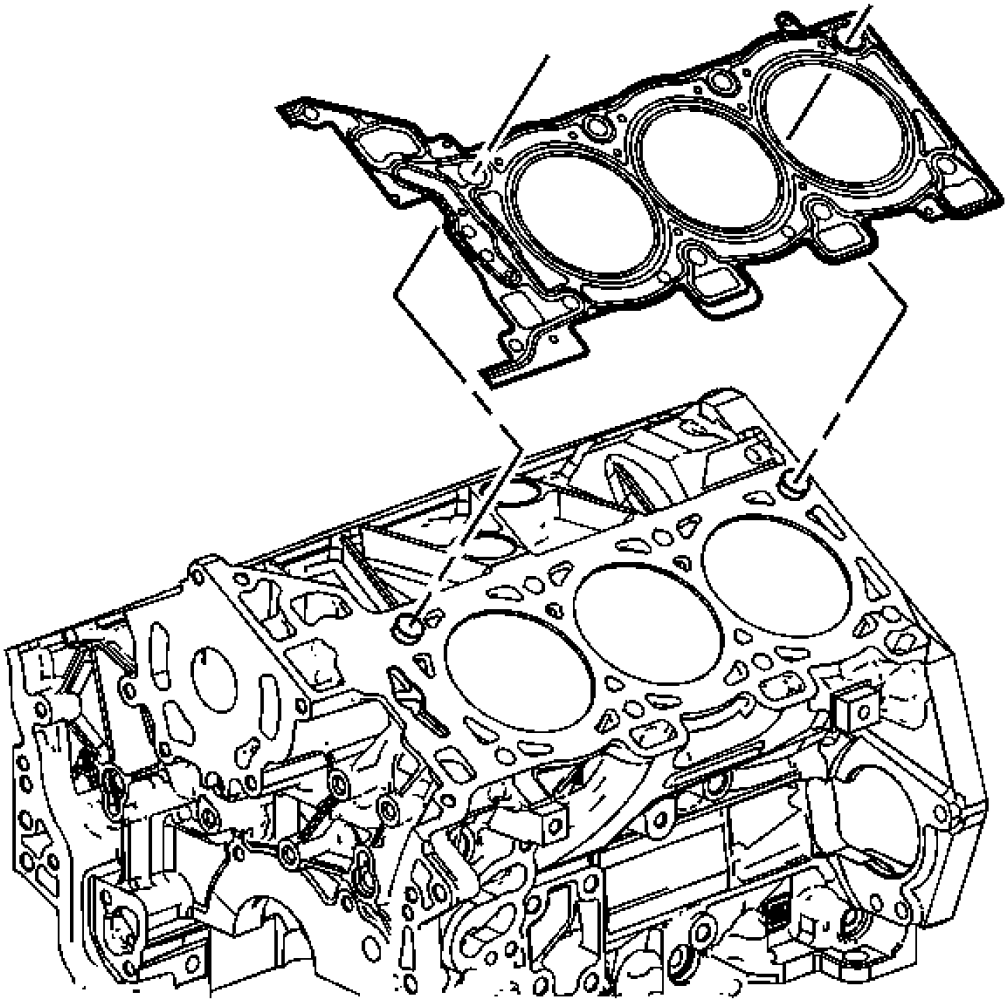


Fig. 160: View Of Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

2. Install a NEW cylinder head gasket.

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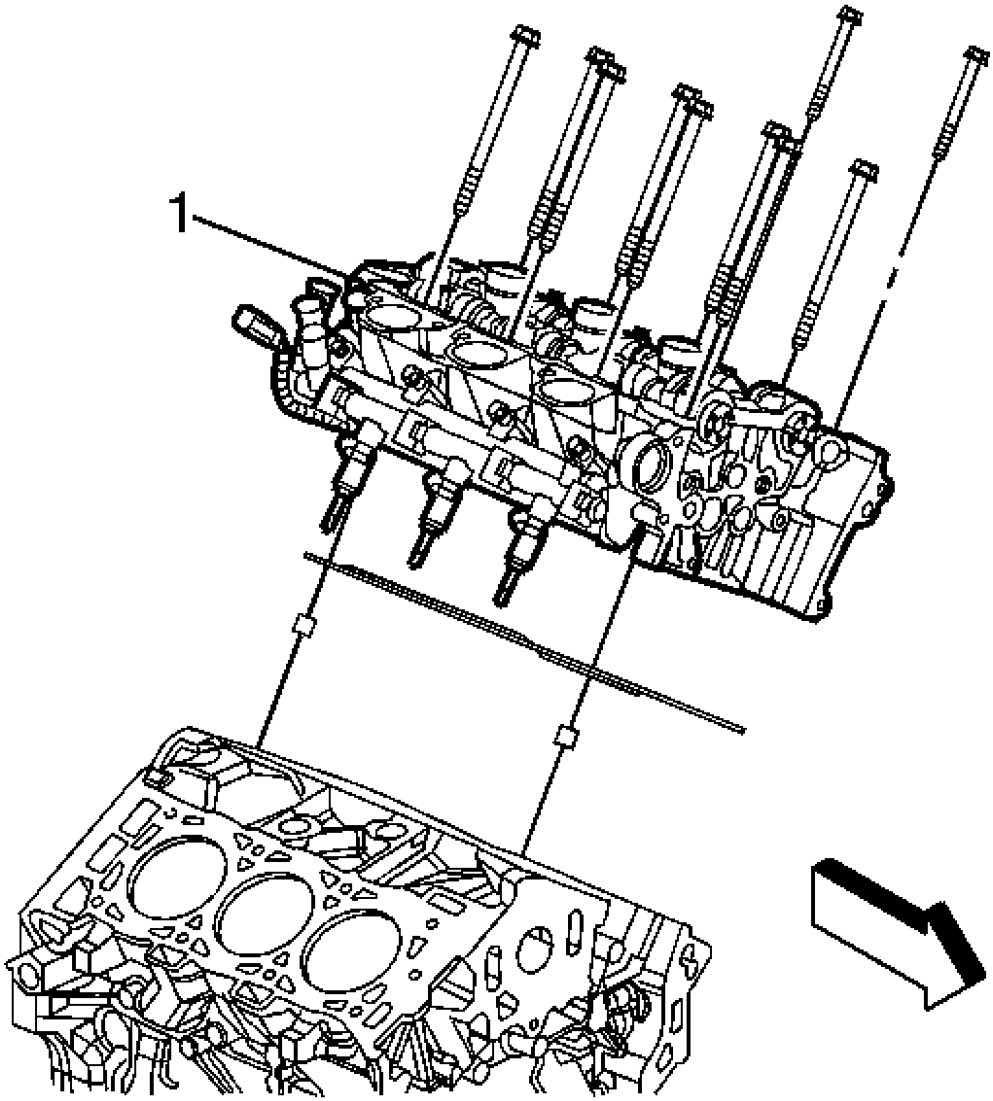


Fig. 161: Removing/Installing Cylinder Head & Exhaust Manifold
Courtesy of GENERAL MOTORS CORP.

3. Carefully install the cylinder head (1) with the exhaust manifold to the engine. Refer to **Cylinder Head Installation - Left Side (LLT)** .
4. Install the oil filter adapter upper bolt. Refer to **Oil Filter Adapter Installation** .
5. Install the oil level indicator. Refer to **Oil Level Indicator Tube Replacement**.
6. Install the catalytic converter to the exhaust manifold. Refer to **Catalytic Converter Replacement - Left**

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Side (LLT) or **Catalytic Converter Replacement - Left Side (L99/LS3)** .

7. Install the power steering pump bolts. Refer to **Power Steering Pump Replacement (V6)** or **Power Steering Pump Replacement (V8)** .
8. Install the wiring harness connector bracket from the side of the cylinder head.
9. Disconnect the wiring harness electrical connector located at the side of the cylinder head.

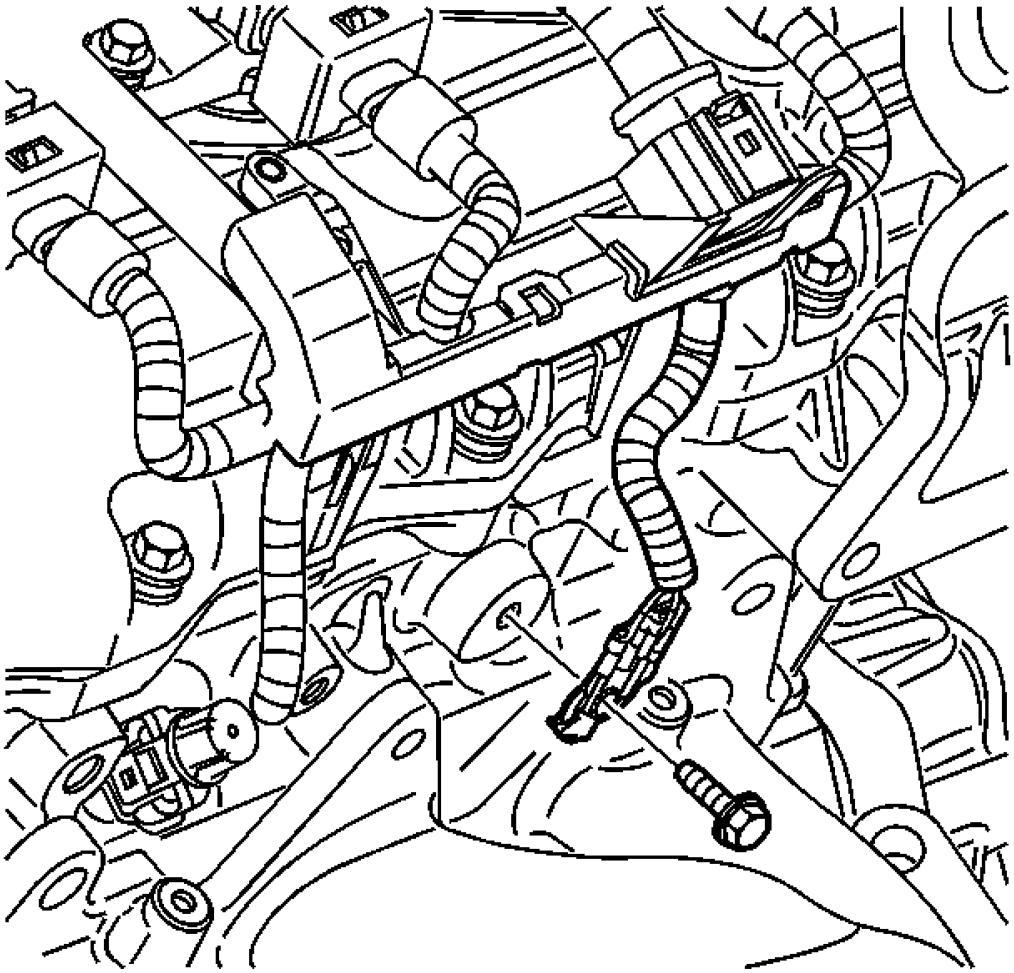


Fig. 162: View Of Left Cylinder Head Wiring Harness Ground Bolt
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

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10. Install the wiring harness ground to the cylinder head and tighten the bolt to 10 N.m (89 lb in).

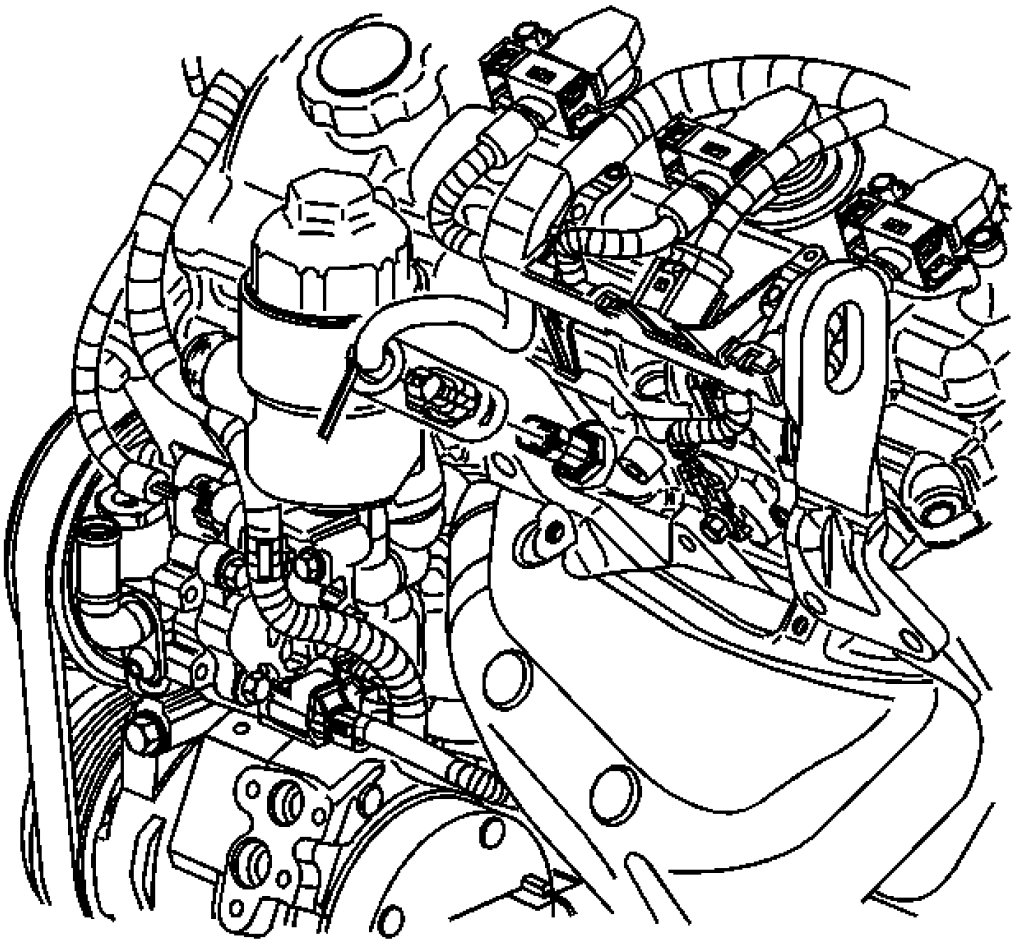


Fig. 163: View Of Coolant Temperature Sensor Electrical Connector & Heat Shield
Courtesy of GENERAL MOTORS CORP.

11. Install the coolant temperature sensor electrical connector heat shield.
12. Connect the injector harnesses.
13. Install the fuel injection fuel rail crossover tube. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement** .
14. Install the fuel pump. Refer to **Fuel Pump Replacement** .
15. Install the oil level indicator. Refer to **Oil Level Indicator Tube Replacement**.
16. Install the left bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**.

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CYLINDER HEAD REPLACEMENT - RIGHT SIDE

REMOVAL PROCEDURE

1. Remove the right bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.
2. Remove the fuel injection fuel rail crossover tube. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement** .
3. Disconnect the injector harnesses.
4. Remove the coolant inlet pipe bolts and reposition the coolant inlet pipe to provide access.
5. Remove the catalytic converter. Refer to **Catalytic Converter Replacement - Right Side (LLT)** or **Catalytic Converter Replacement - Right Side (L99/LS3)** .

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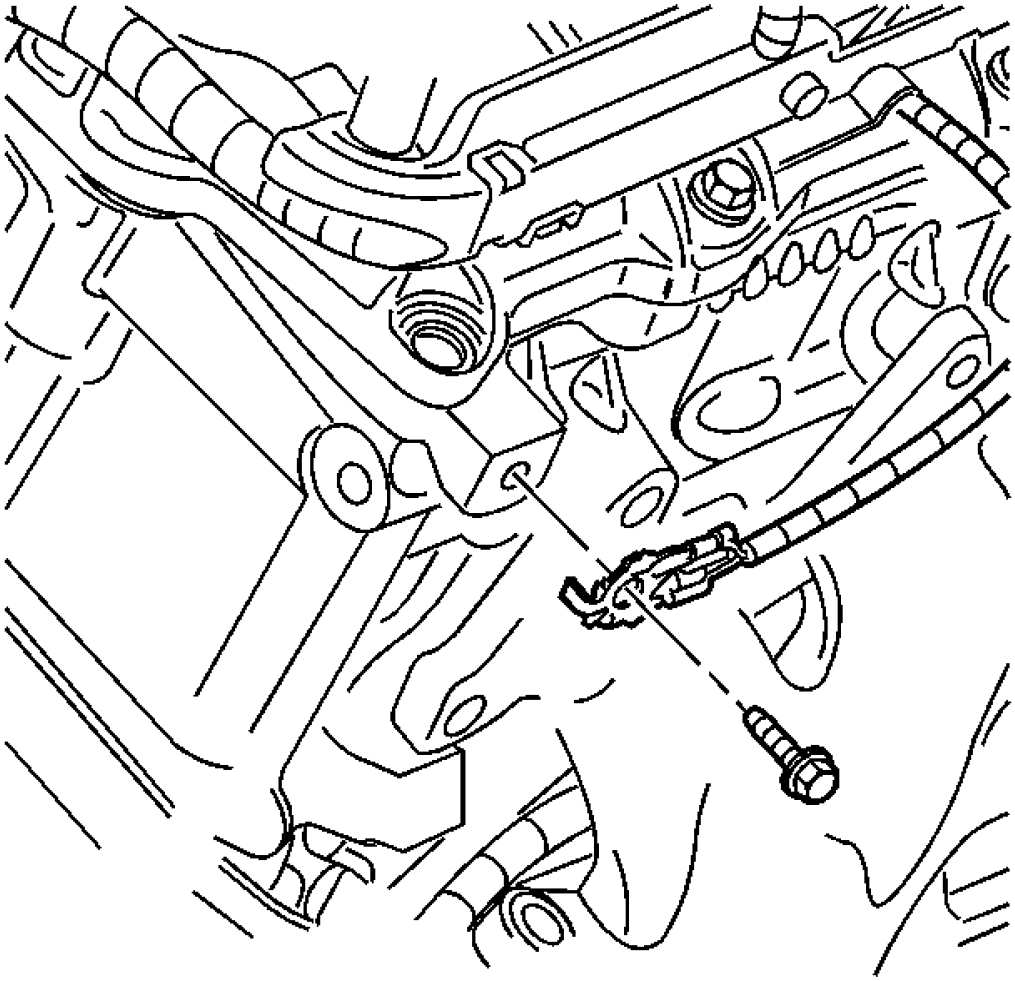


Fig. 164: View Of Wiring Harness Ground Bolt At Side Of Right Cylinder Head
Courtesy of GENERAL MOTORS CORP.

6. Remove the wiring harness ground from the side of the cylinder head.

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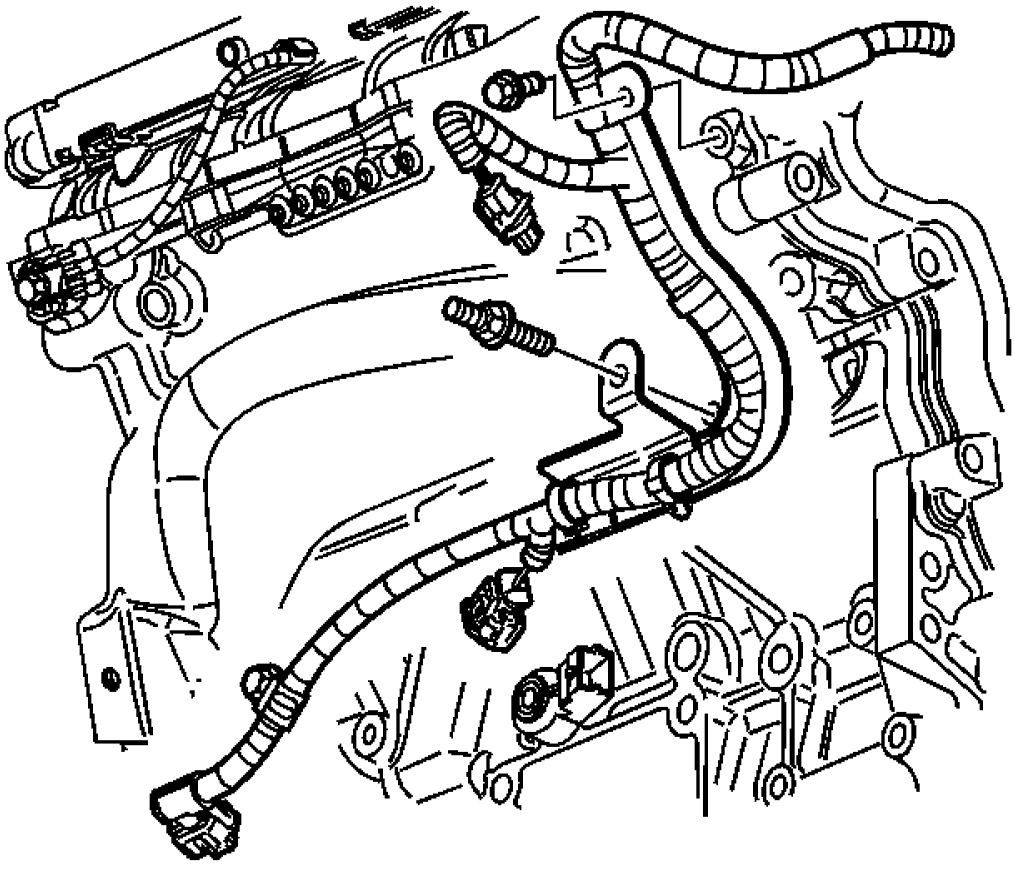


Fig. 165: Locating Engine Wiring Harness Bracket Bolt & Engine Wiring Harness Bracket Stud
Courtesy of GENERAL MOTORS CORP.

7. Remove the wiring harness conduit upper bolt from the cylinder head and reposition the conduit to provide access.
8. Remove the battery cable from the cylinder head. Refer to **Battery Negative Cable Replacement** .

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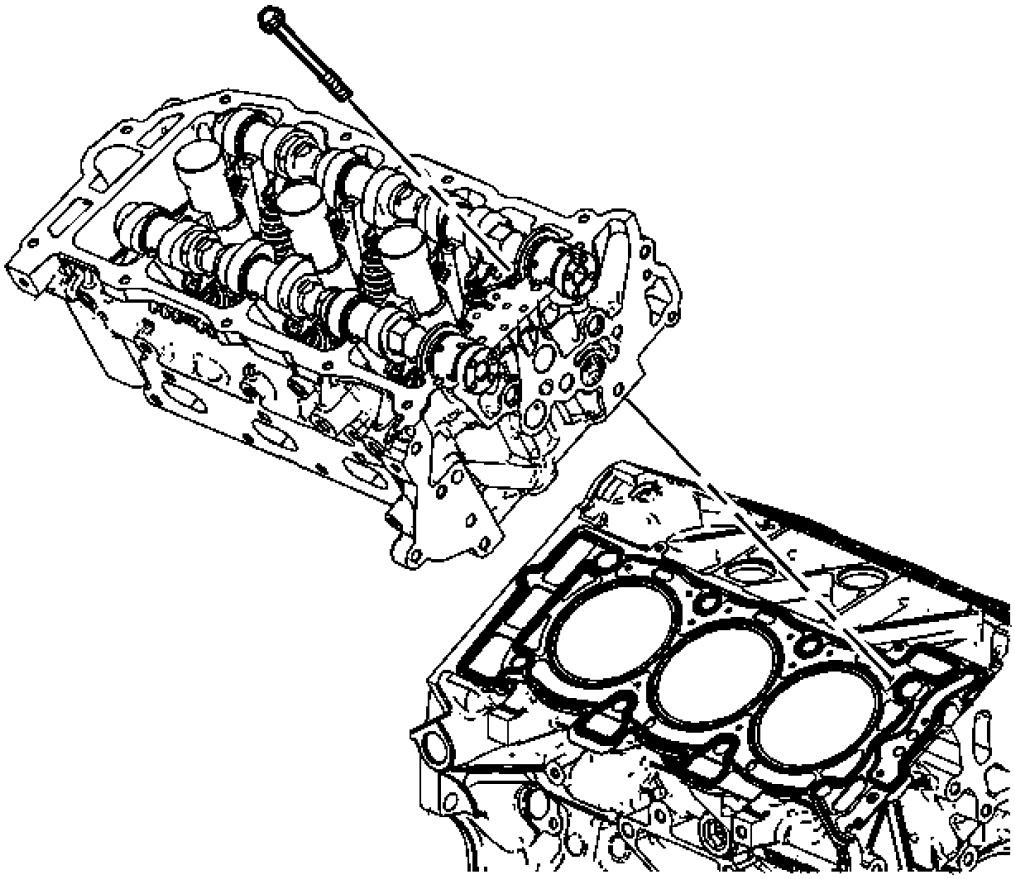


Fig. 166: View Of Right Cylinder Head
Courtesy of GENERAL MOTORS CORP.

9. Remove the cylinder head with the exhaust manifold. Refer to **Cylinder Head Removal - Right Side (LLT)** .

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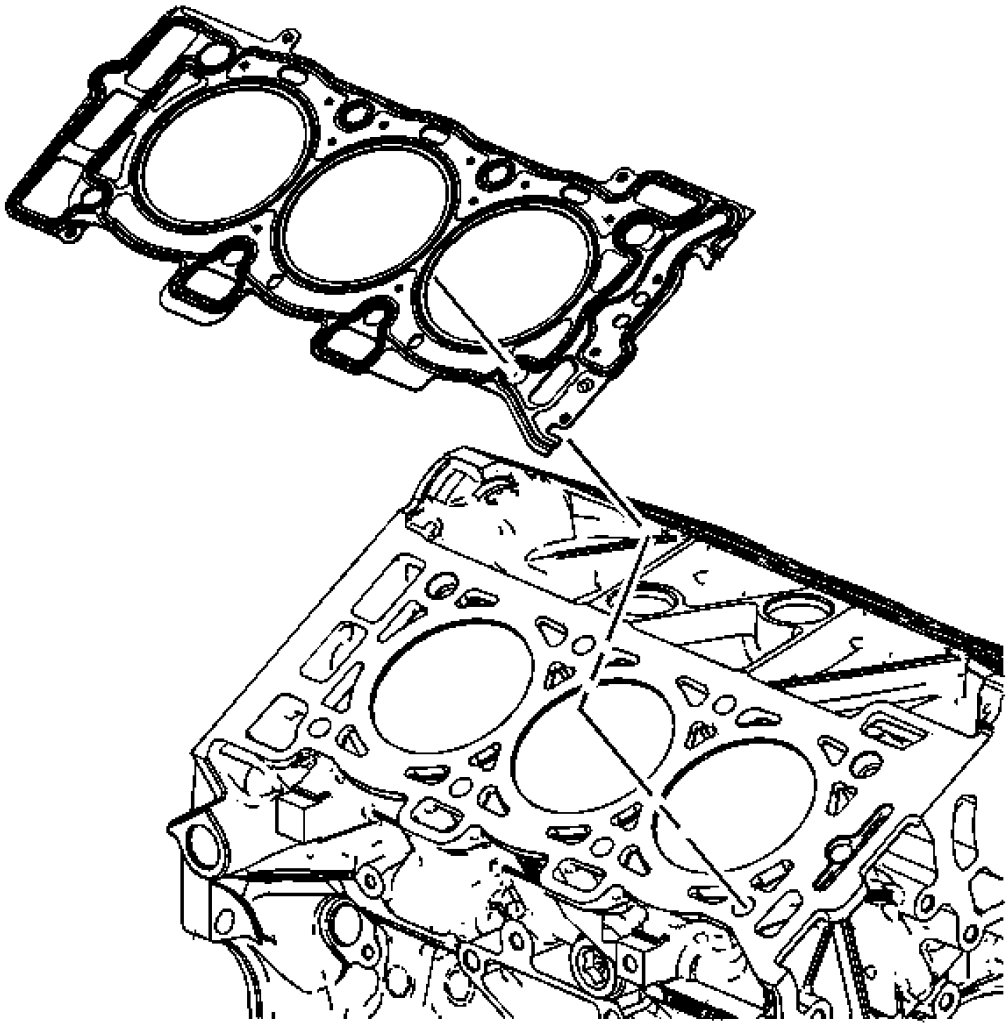


Fig. 167: View Of Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

10. Remove and discard the cylinder head gasket.
11. Clean and inspect the cylinder head and the engine block sealing surfaces. Refer to **Cylinder Head Cleaning and Inspection** and **Engine Block Cleaning and Inspection** .
12. If necessary, perform the following steps:
    - Remove the exhaust manifold from the cylinder head. Refer to **Exhaust Manifold Removal - Right Side** .
    - Disassemble the cylinder head. Refer to **Cylinder Head Disassemble (LLT)** .

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INSTALLATION PROCEDURE

1. If necessary, perform the following steps:
   - Assemble the cylinder head. Refer to **Cylinder Head Assemble (LLT or LCS)** .
   - Install the exhaust manifold to the cylinder head. Refer to **Exhaust Manifold Installation - Right Side** .

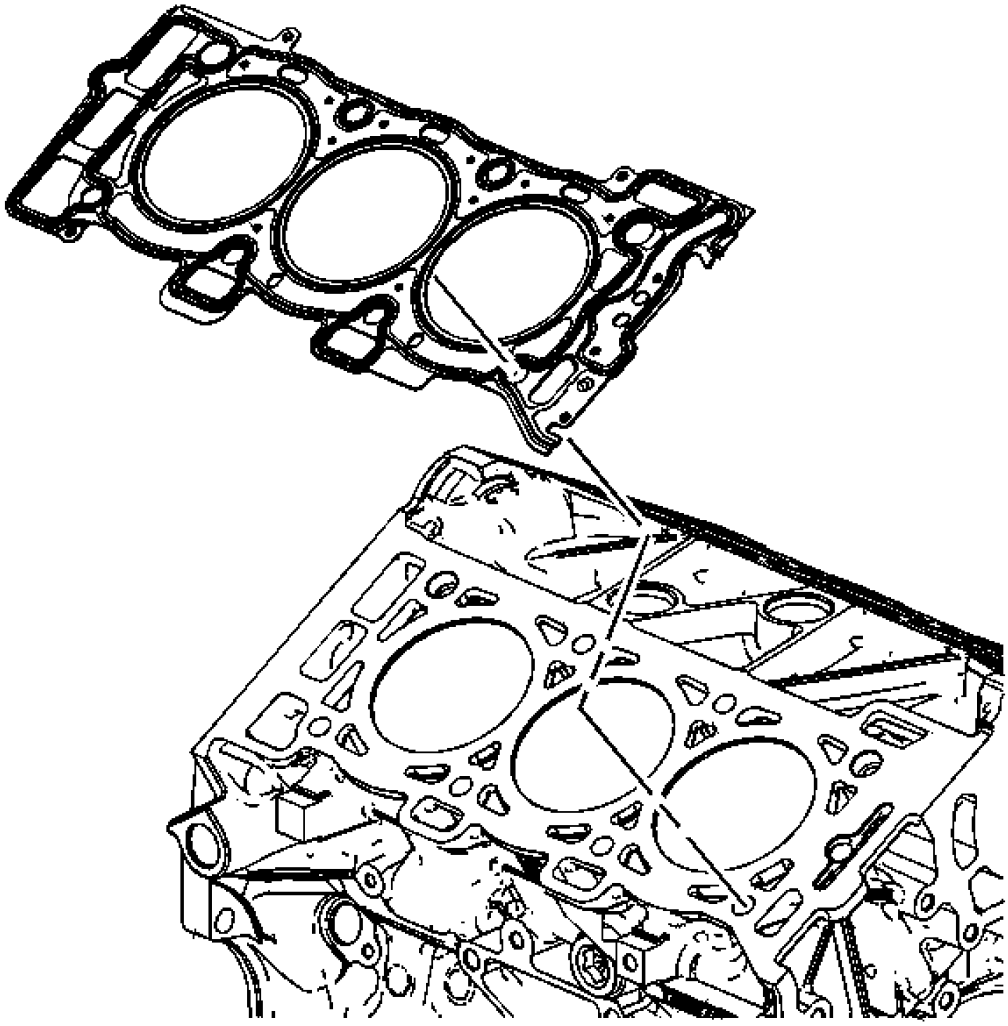


Fig. 168: View Of Cylinder Head Gasket
Courtesy of GENERAL MOTORS CORP.

2. Install a NEW cylinder head gasket.

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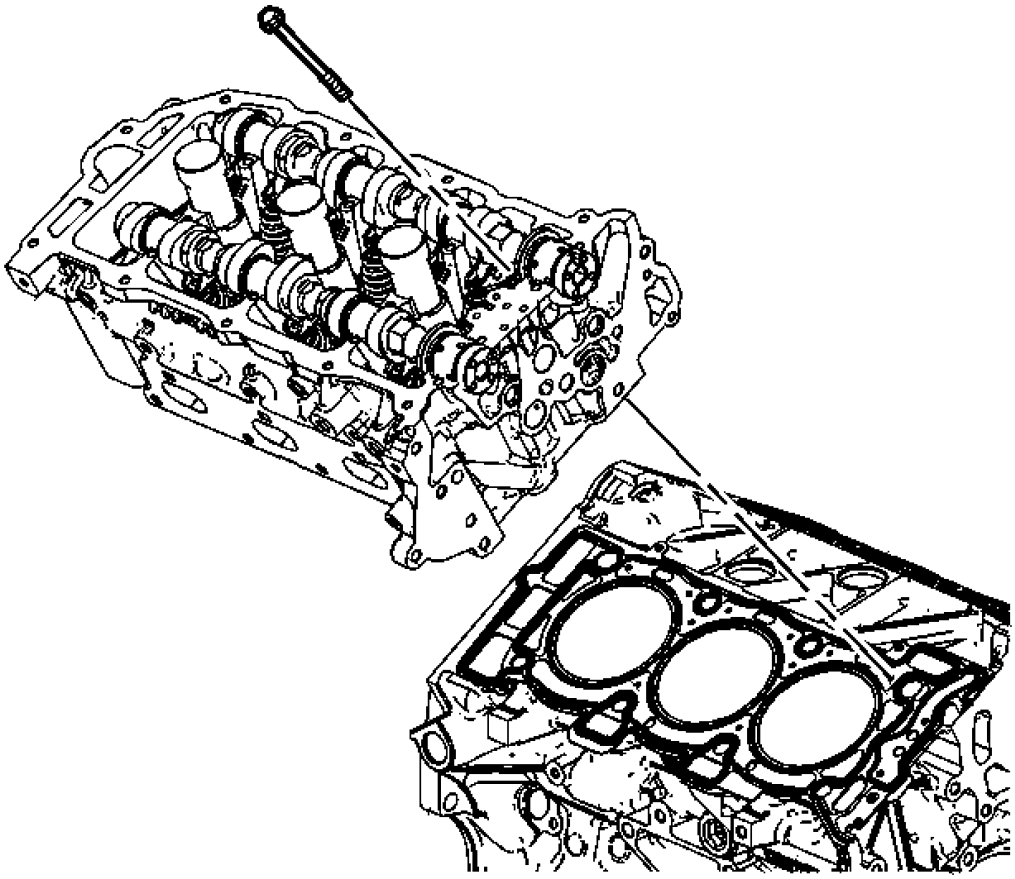


Fig. 169: View Of Right Cylinder Head
Courtesy of GENERAL MOTORS CORP.

3. Carefully install the cylinder head with the exhaust manifold to the engine. Refer to **Cylinder Head Installation - Right Side (LLT)** .
4. Connect the catalytic converter to the exhaust manifold.
5. Install the battery negative cable to the cylinder head. Refer to **Battery Negative Cable Replacement** .

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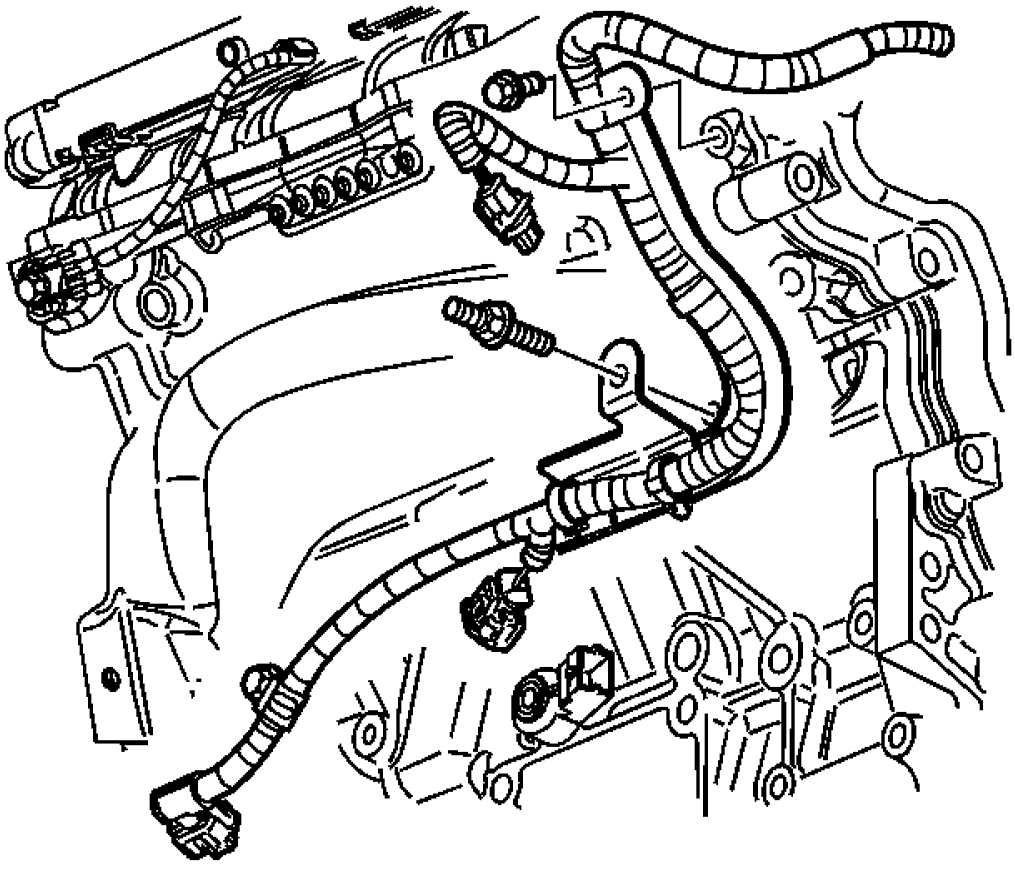


Fig. 170: Locating Engine Wiring Harness Bracket Bolt & Engine Wiring Harness Bracket Stud
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

6. Install the wiring harness conduit to the cylinder head. Tighten the wiring harness upper bolt to 10 N.m (89 lb in).

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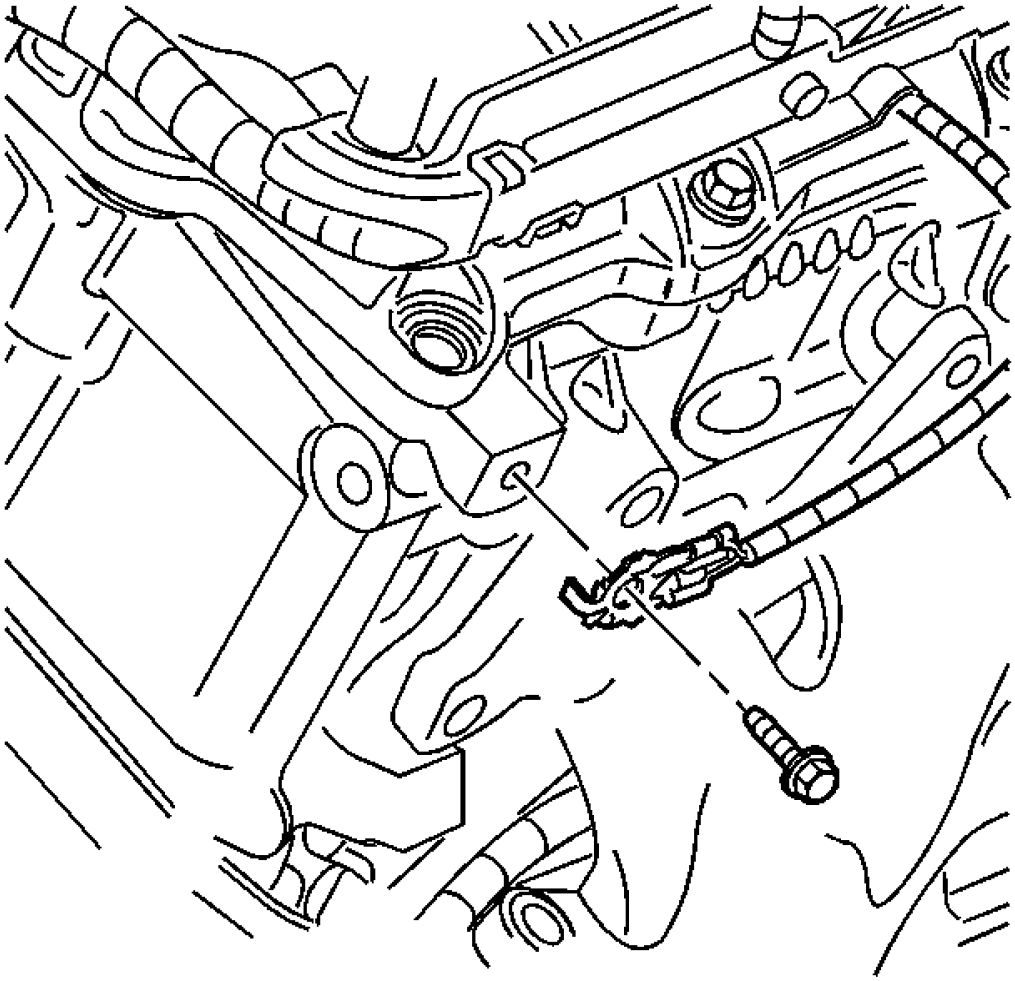


Fig. 171: View Of Wiring Harness Ground Bolt At Side Of Right Cylinder Head
Courtesy of GENERAL MOTORS CORP.

7. Install the wiring harness ground to the side of the cylinder head. Tighten the wiring harness ground bolt to 10 N.m (89 lb in).
8. Install the catalytic converter. Refer to **Catalytic Converter Replacement - Right Side (LLT)** or **Catalytic Converter Replacement - Right Side (L99/LS3)** .
9. Install the coolant inlet pipe.
10. Connect the injector harnesses.
11. Install the fuel injection fuel rail crossover tube. Refer to **Fuel Injection Fuel Rail Crossover Tube Replacement** .
12. Install the right bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain**

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Replacement - Right Side.

ENGINE FLYWHEEL REPLACEMENT (MANUAL)

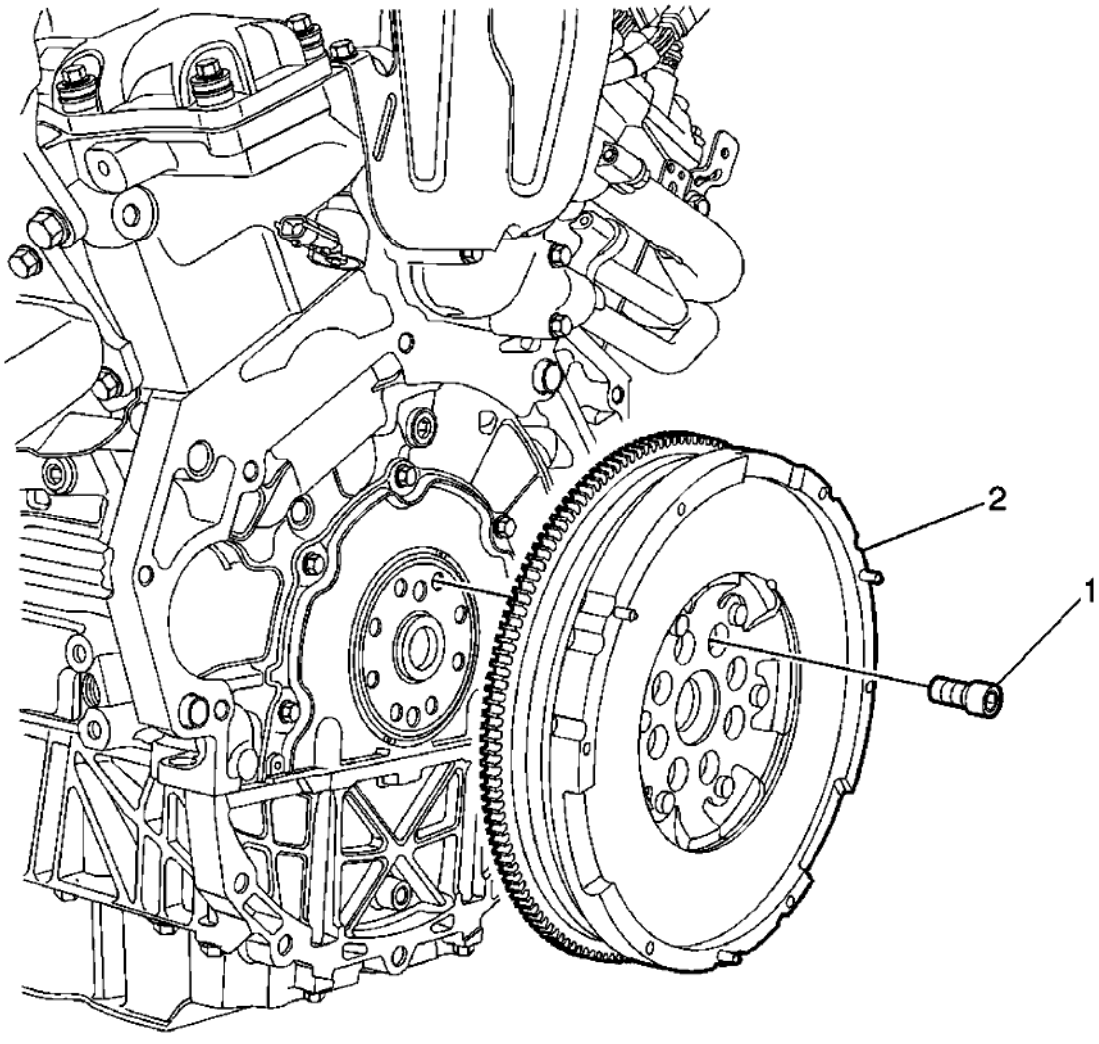


Fig. 172: Engine Flywheel (Manual)
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Procedure: Remove the Clutch Assembly. Refer to **Clutch Assembly Replacement** .	
1	Flywheel Fastener (Qty, 8) **CAUTION:** **Refer to Fastener Caution .**

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	67 N.m (49 lb ft) **Procedure:** New bolts must be used whenever removing the flywheel
2	Flywheel **Procedure:** Transfer parts as needed.

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

REMOVAL PROCEDURE

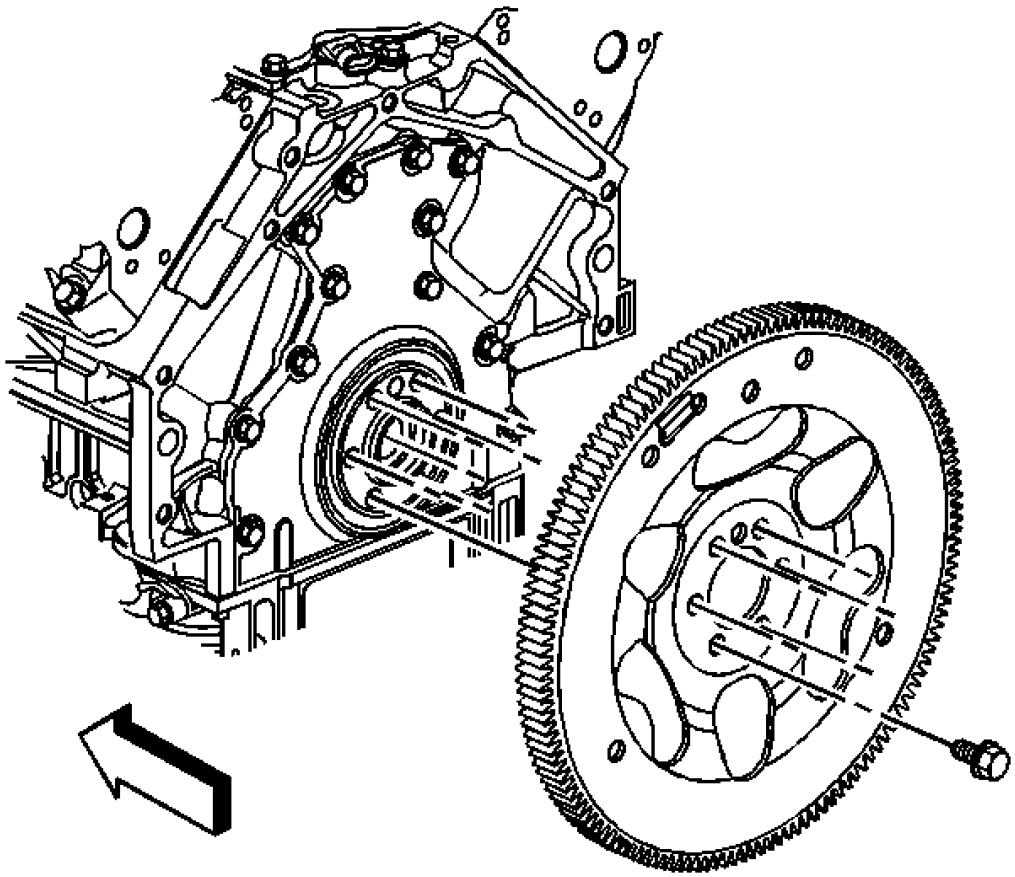


Fig. 173: View Of Engine Flywheel & Bolts
Courtesy of GENERAL MOTORS CORP.

1. Remove the automatic transmission. Refer to **Transmission Replacement** .

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NOTE: Note the position and direction of the engine flywheel before removal.

2. Remove the flywheel bolts.
3. Remove the flywheel.

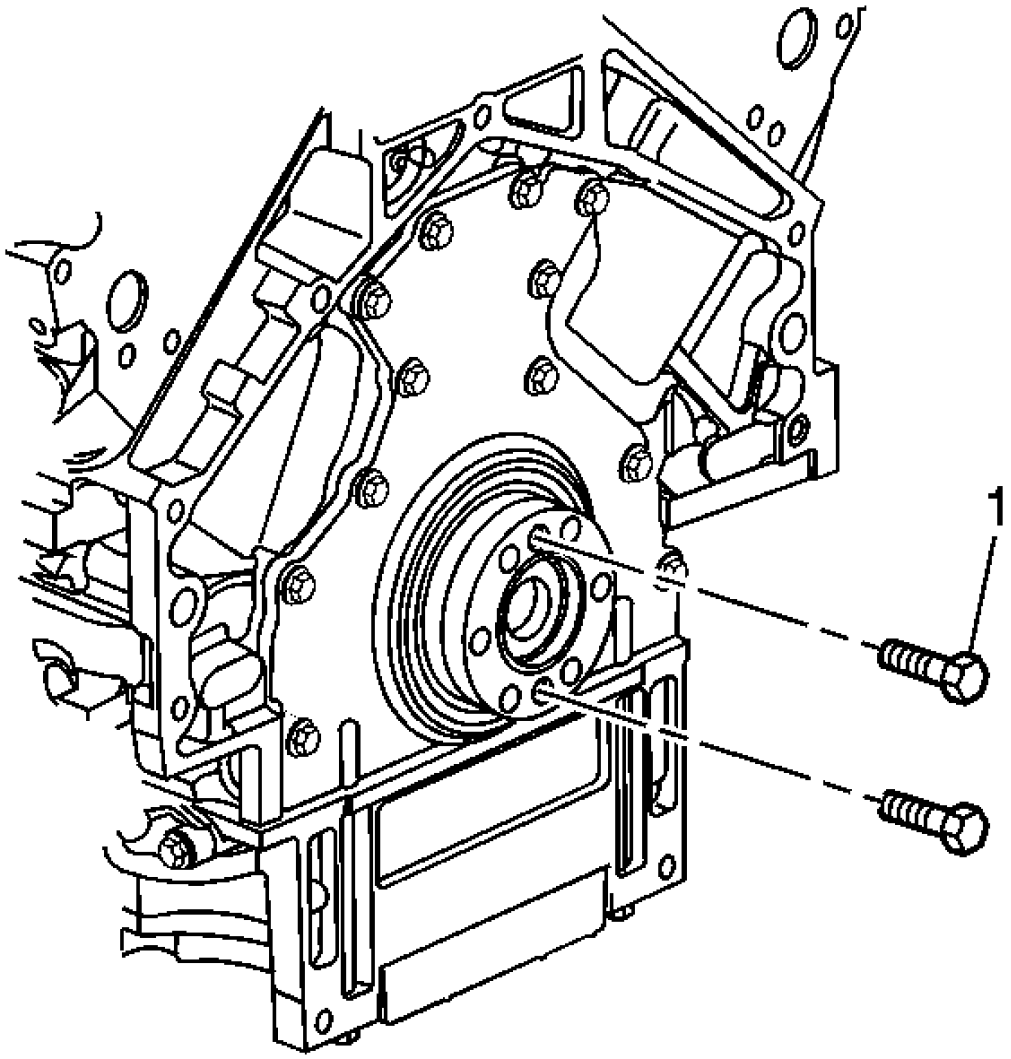


Fig. 174: View Of Bolts & Spacer
Courtesy of GENERAL MOTORS CORP.

4. Install two M11x1.5 mm bolts (1) to the threaded holes of the spacer, if applicable.
5. Rotate the bolts clockwise to remove the spacer.

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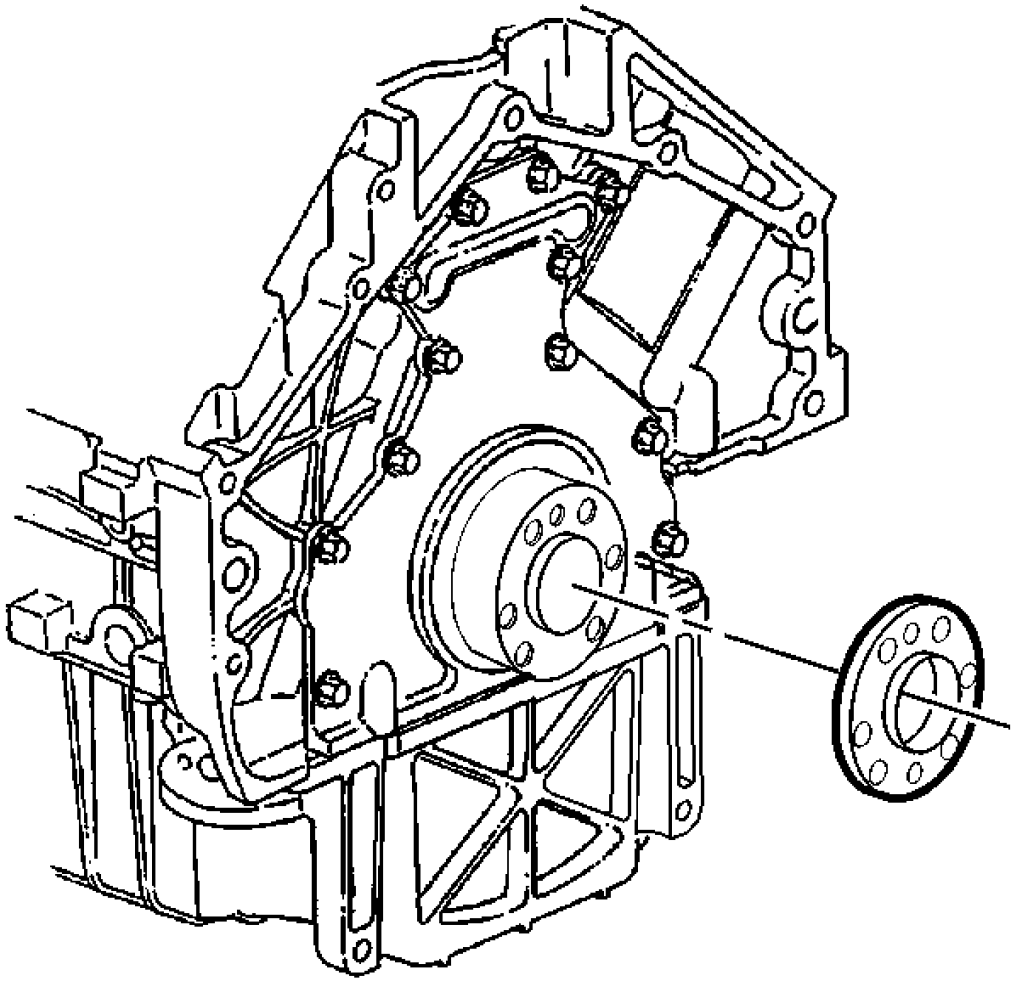


Fig. 175: View Of Rear Spacer
Courtesy of GENERAL MOTORS CORP.

6. Remove the spacer from the rear of the crankshaft, if applicable.

INSTALLATION PROCEDURE

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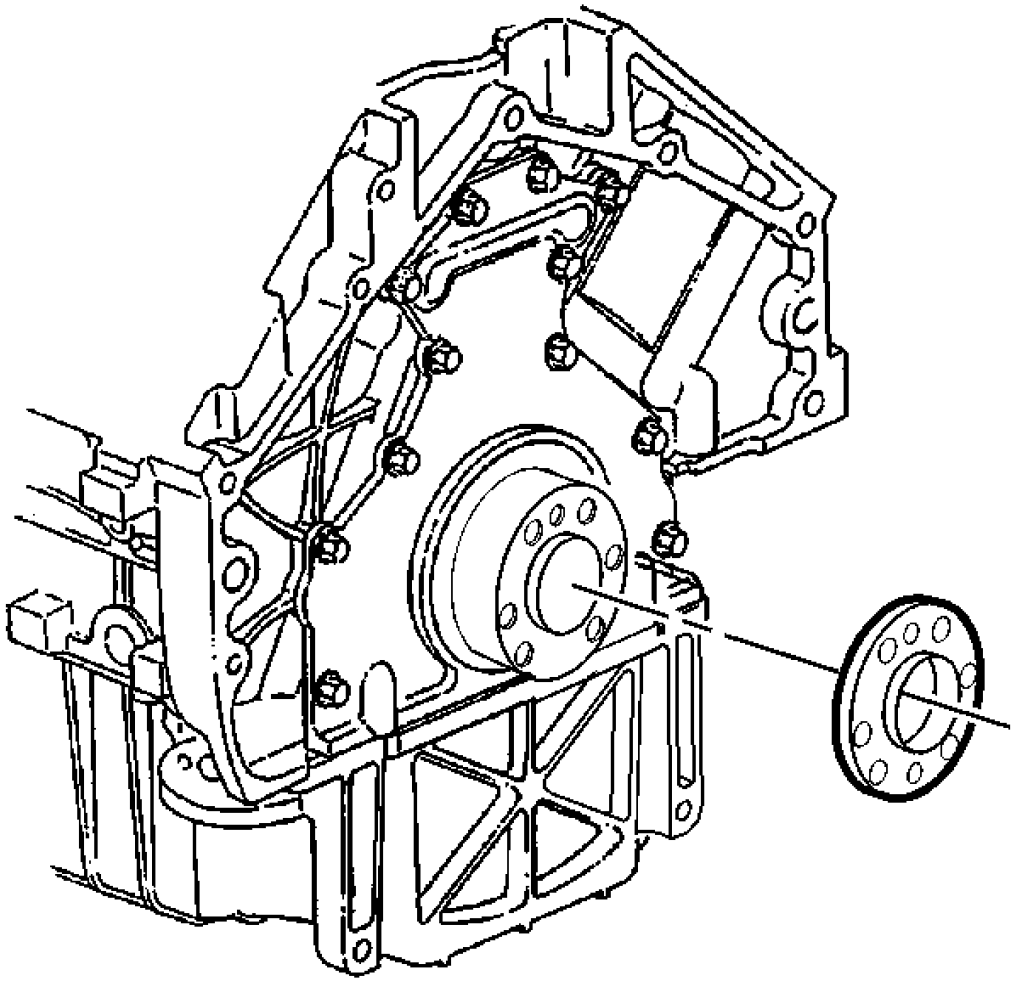


Fig. 176: View Of Rear Spacer
Courtesy of GENERAL MOTORS CORP.

NOTE: The flywheel does not use a locating pin for alignment and will not initially seat against the crankshaft flange or spacer, if applicable, but will be pulled onto the crankshaft by the engine flywheel bolts. This procedure requires a three stage tightening process.

1. Install the spacer, if applicable, onto the rear of the crankshaft.

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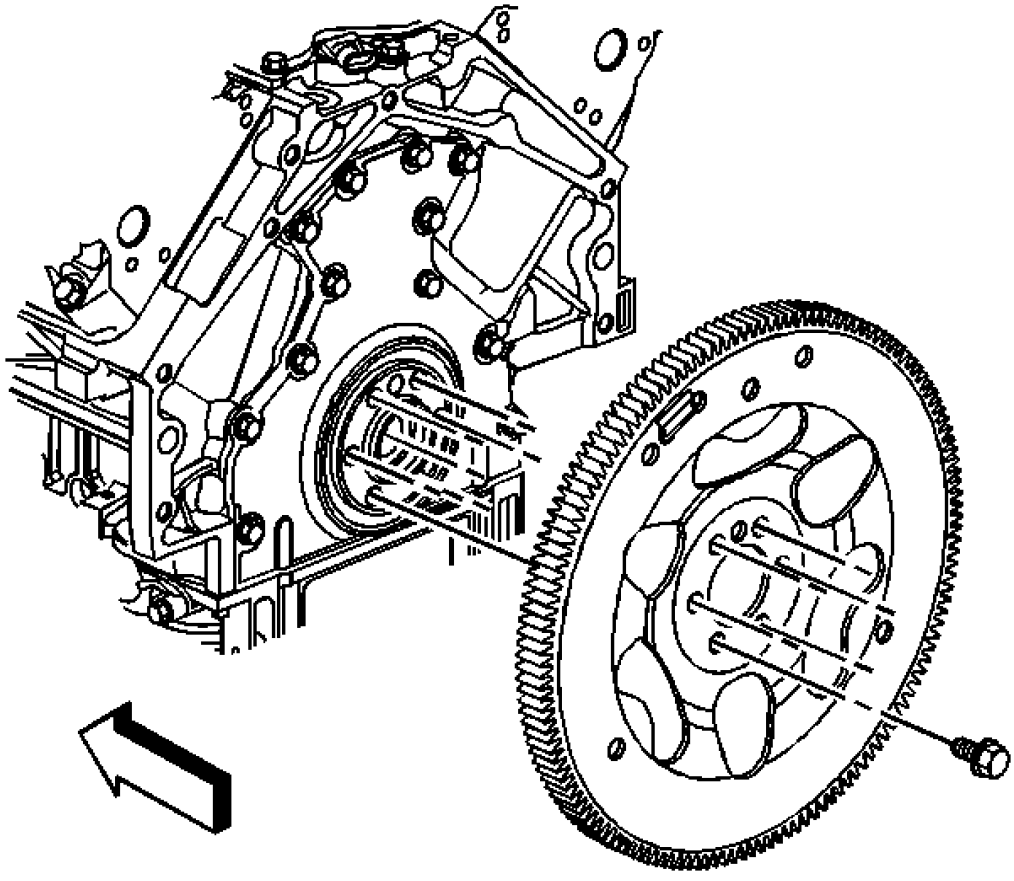


Fig. 177: View Of Engine Flywheel & Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Longer flywheel bolts must be used on applications using a flywheel spacer.

2. Install the flywheel and bolts to the crankshaft.
3. Apply threadlock to the threads of the flywheel bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the correct part number.

CAUTION: Refer to Fastener Caution .

4. Tighten the flywheel bolts.
    1. Tighten the bolts (1-6) a first pass in sequence to 20 N.m (15 lb ft).

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2. Tighten the bolts (1-6) a second pass in sequence to 50 N.m (37 lb ft).
3. Tighten the bolts (1-6) a final pass in sequence to 100 N.m (74 lb ft).

5. Install the automatic transmission. Refer to **Transmission Replacement** .

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2010 ENGINE

Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Repair Instructions - On Vehicle - Camaro

CRANKSHAFT REAR OIL SEAL AND HOUSING REPLACEMENT

REMOVAL PROCEDURE

1. Remove the engine flywheel. Refer to **Engine Flywheel Replacement (Manual)** .
2. Remove the oil pan. Refer to **Oil Pan Replacement**.

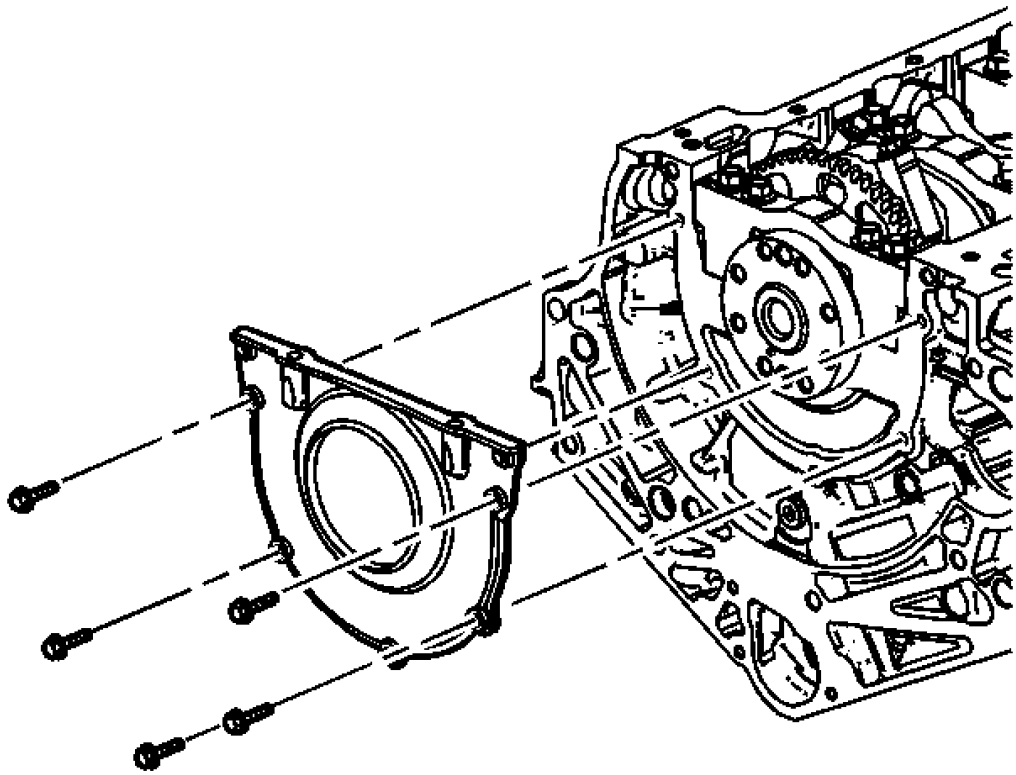


Fig. 1: View Of Crankshaft Rear Oil Seal & Housing
Courtesy of GENERAL MOTORS CORP.

3. Remove the crankshaft rear oil seal and housing. Refer to **Crankshaft Rear Oil Seal and Housing Removal** .

INSTALLATION PROCEDURE

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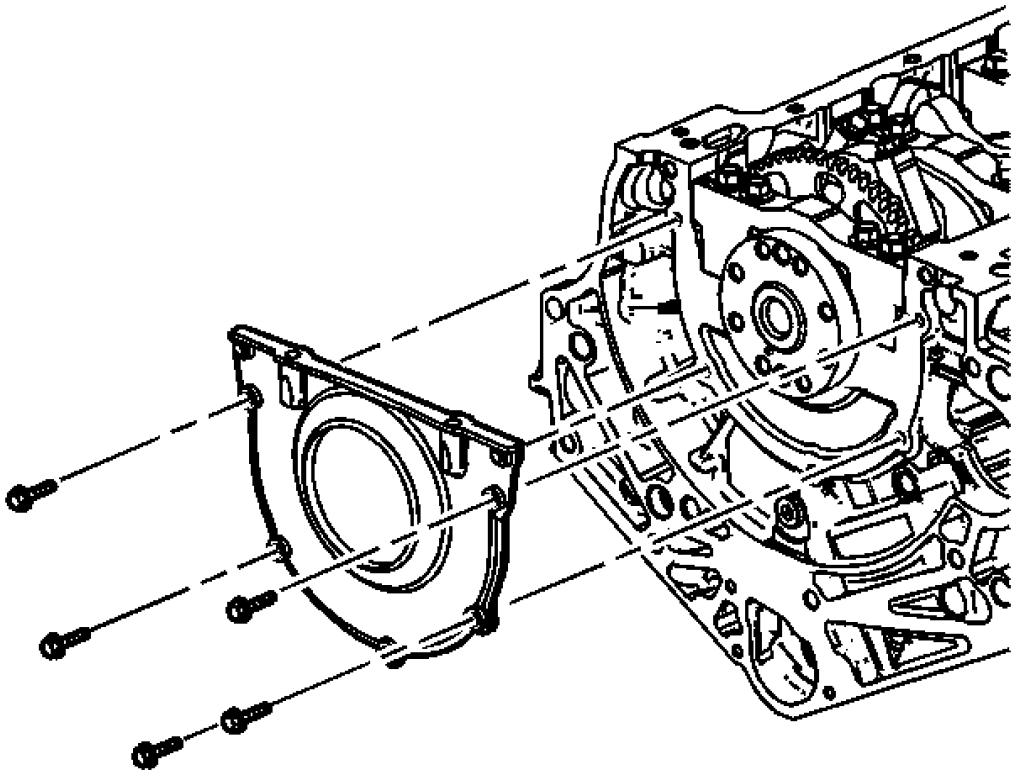


Fig. 2: View Of Crankshaft Rear Oil Seal & Housing
Courtesy of GENERAL MOTORS CORP.

1. Install the crankshaft rear oil seal and housing. Refer to **Crankshaft Rear Oil Seal and Housing Installation** .
2. Install the oil pan. Refer to **Oil Pan Replacement**.
3. Install the engine flywheel. Refer to **Engine Flywheel Replacement (Manual)** .

OIL PUMP REPLACEMENT

REMOVAL PROCEDURE

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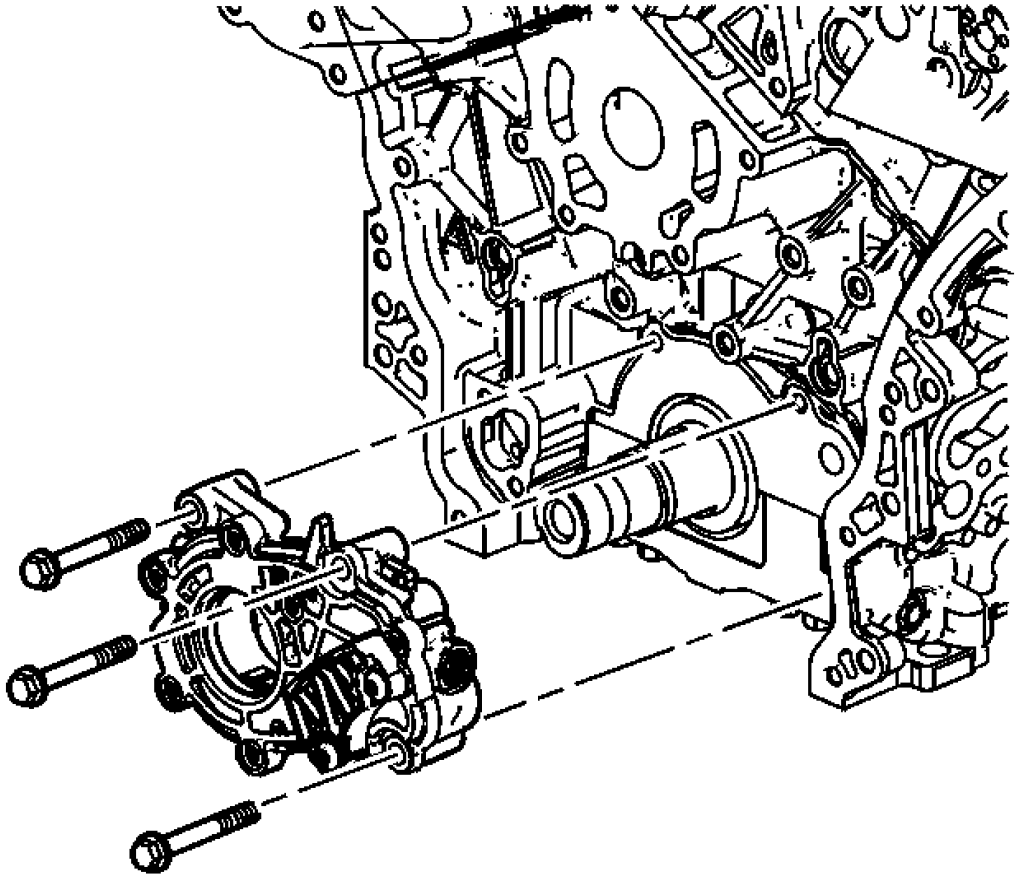


Fig. 3: View Of Oil Pump & Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

NOTE: Do not remove the left bank idler sprocket.

1. Remove the primary timing chain. Refer to **Primary Camshaft Drive Chain and Sprockets Replacement** .
2. Remove the crankshaft sprocket. Refer to **Crankshaft Sprocket Removal** .
3. Remove the oil pump bolts and the oil pump. Refer to **Oil Pump Removal** .

INSTALLATION PROCEDURE

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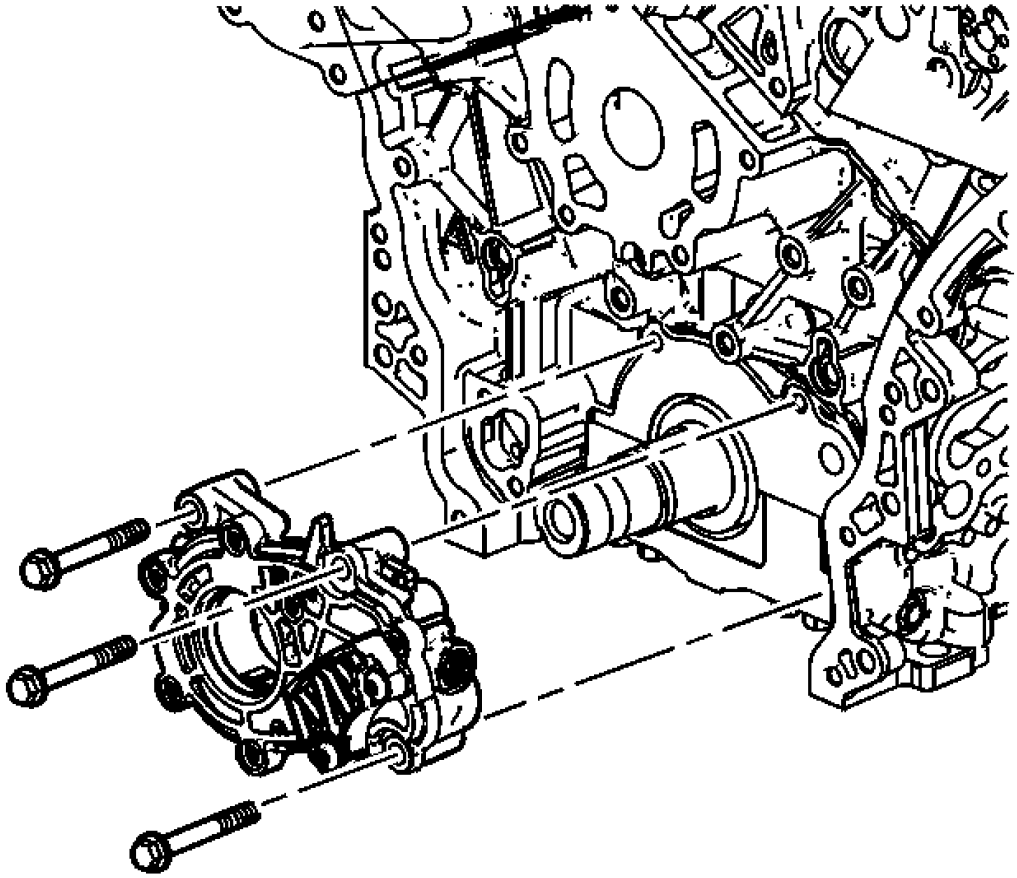


Fig. 4: View Of Oil Pump & Mounting Bolts
Courtesy of GENERAL MOTORS CORP.

1. Install the oil pump. Refer to **Oil Pump Installation** .
2. Install the crankshaft sprocket. Refer to **Crankshaft Sprocket Installation** .
3. Install the primary timing chain. Refer to **Primary Camshaft Drive Chain and Sprockets Replacement** .

OIL PAN REPLACEMENT

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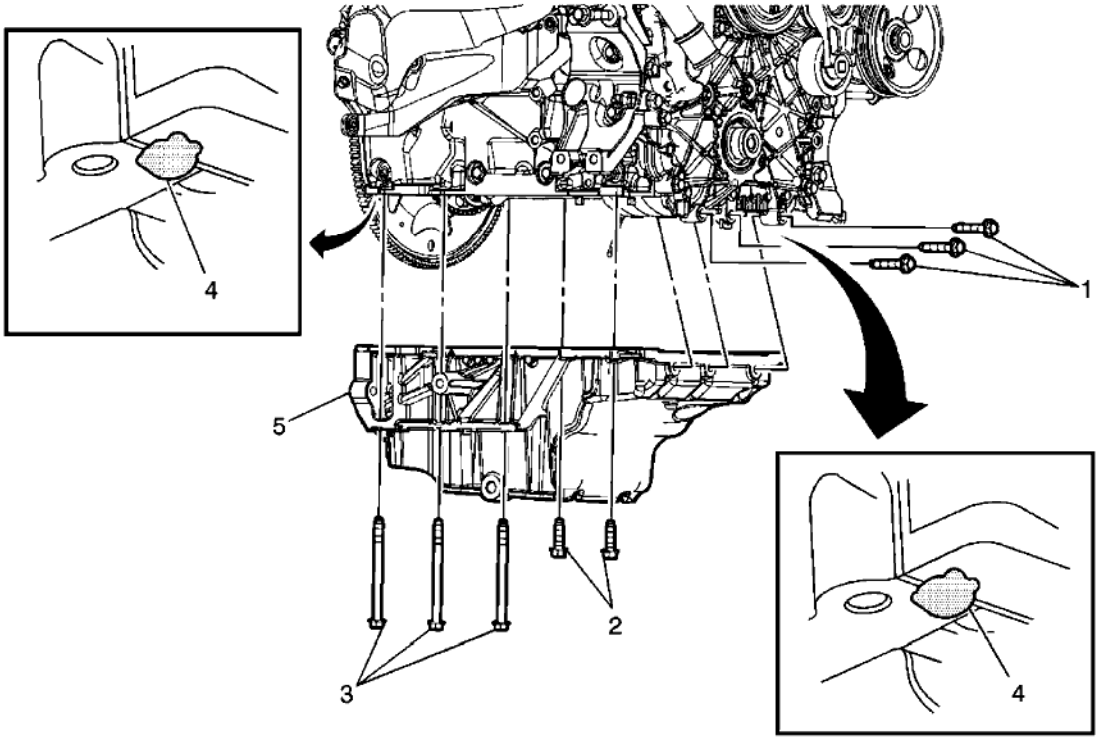


Fig. 5: Oil Pan
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Remove the front cover. Refer to **Engine Front Cover Replacement** . 2. Remove the front frame. Refer to **Drivetrain and Front Suspension Frame Replacement** . 3. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement (LLT)**. 4. Remove the right side mount bracket. Refer to **Engine Mount Bracket Replacement - Right Side** .	
1	Oil Pan Fastener (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 23 N.m (17 lb ft)
2	Oil Pan Fastener (Qty: 5) **Tighten:** 25 N.m (18 lb ft)
	Oil Pan Fastener (Qty: 6) **Procedure**

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3	1. Remove the 2 oil pan to rear seal housing bolts. 2. Remove the transmission to oil pan bolts. **Tighten:** 23 N.m (17 lb ft)
4	Oil Pan Sealant **Procedure** 1. Apply a 5 mm (0.2 in) bead of sealant 20 mm (0.8 in) long to the engine block. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . 2. Apply the sealant directly onto the tabs of the front cover gasket that protrude into the oil pan surface. **Tip:** • The alignment of the structural oil pan is critical. The rear bolt hole locations of the oil pan provide mounting points for the transmission housing. To ensure the rigidity of the powertrain and correct transmission alignment, it is important that the rear of the block and the rear of the oil pan are flush or even. The rear of the oil pan must NEVER protrude beyond the engine block and the transmission housing plane. • A new oil pan gasket should be used whenever the oil pan is removed from the engine assembly.
5	Oil Pan **Procedure** 1. Disconnect any electrical connectors. 2. Transfer components as necessary.

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT

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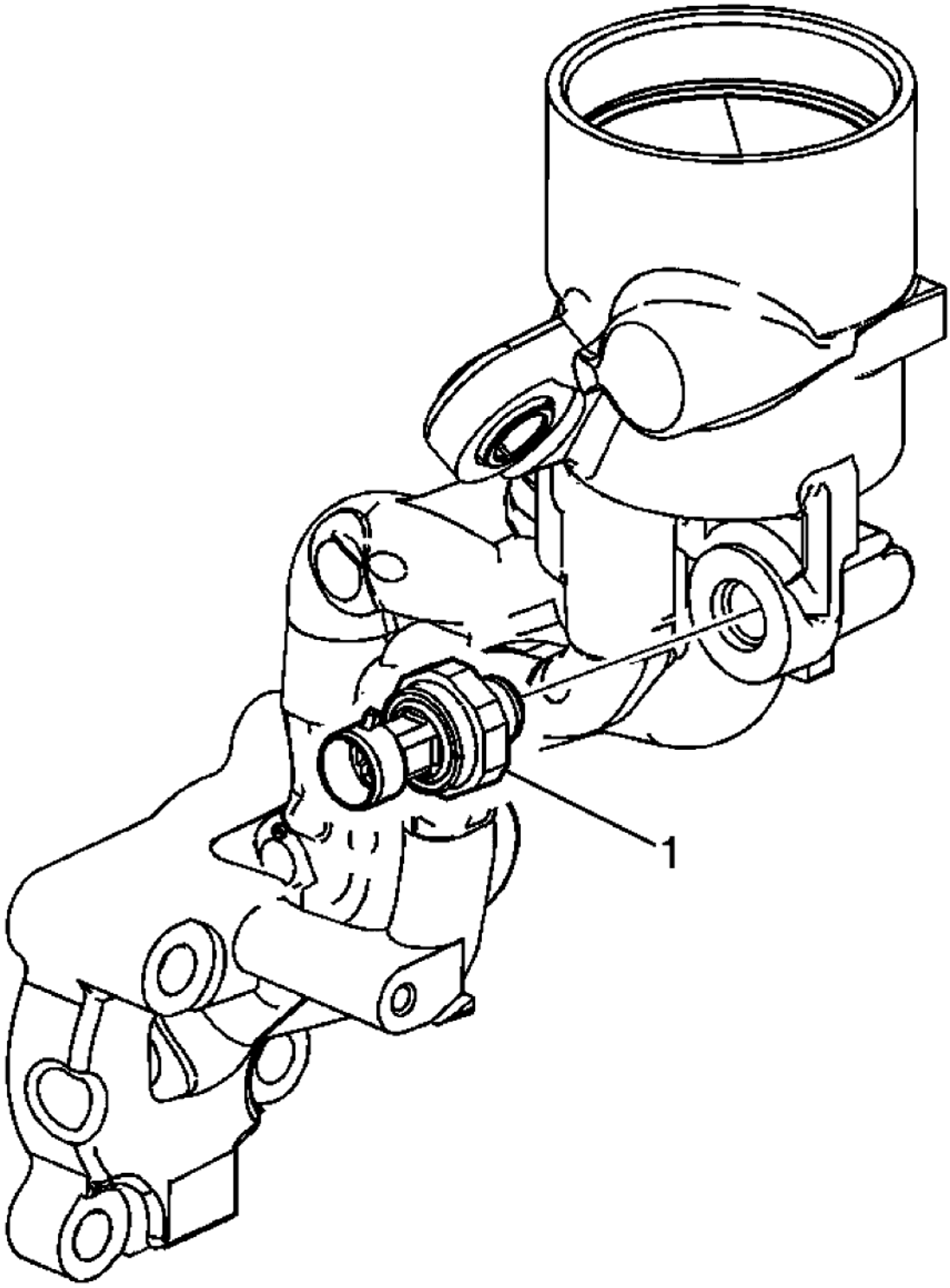


Fig. 6: Engine Oil Pressure Sensor & Switch
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name

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	Engine Oil Pressure Sensor and/or Switch **CAUTION:** **Refer to Component Fastener Tightening Caution .**
1	**Procedure** 1. Disconnect the oil pressure sensor electrical connector. 2. Transfer components as necessary. **Tighten:** 20 N.m (15 lb ft)

OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REPLACEMENT

REMOVAL PROCEDURE

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

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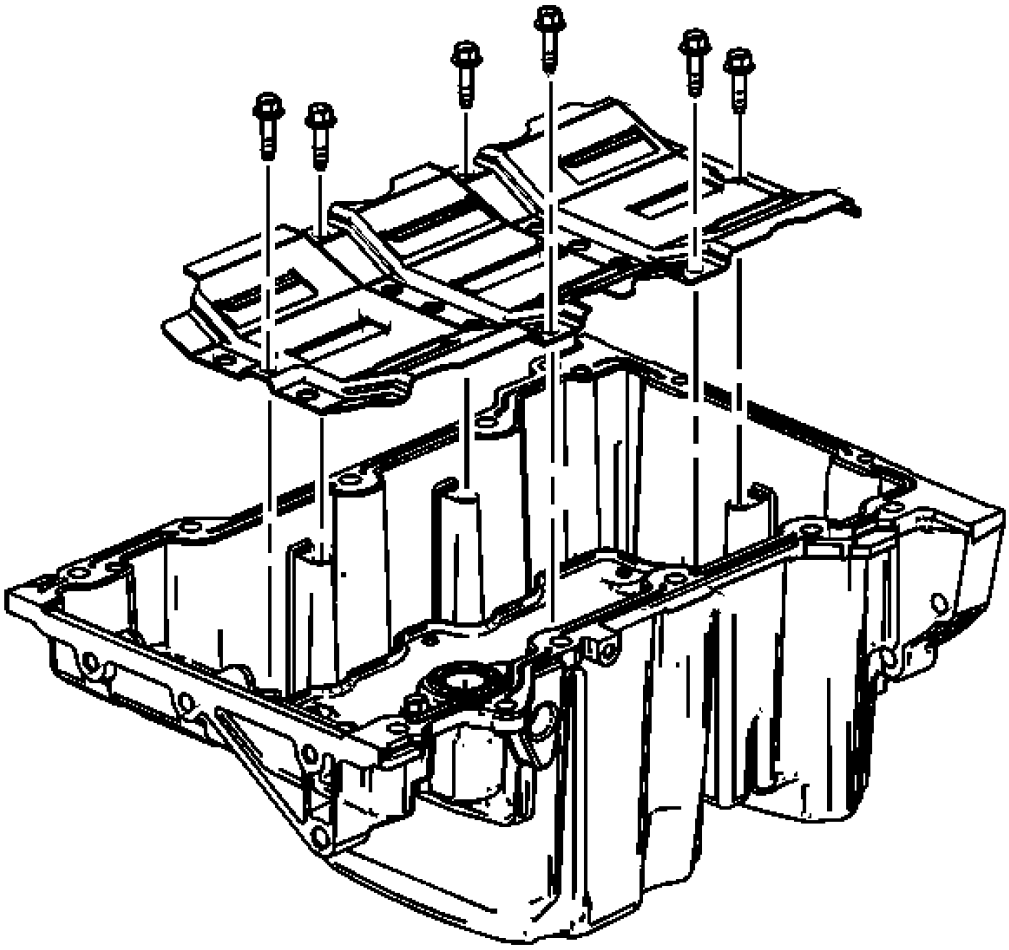


Fig. 7: View Of Oil Pan Scraper & Bolts
Courtesy of GENERAL MOTORS CORP.

2. Remove the oil pan scraper bolts.
3. Remove the oil pan scraper.

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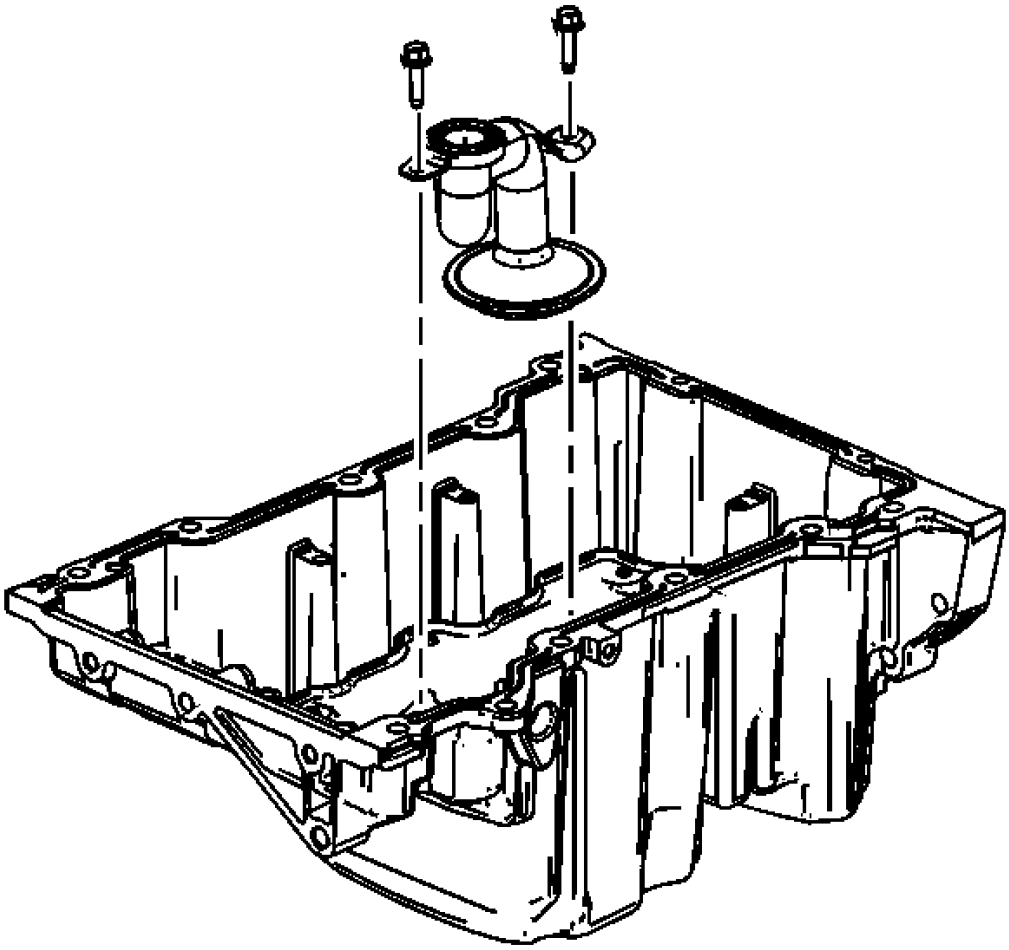


Fig. 8: View Of Oil Suction Pipe
Courtesy of GENERAL MOTORS CORP.

4. Remove the oil suction pipe bolts.
5. Remove the oil suction pipe.

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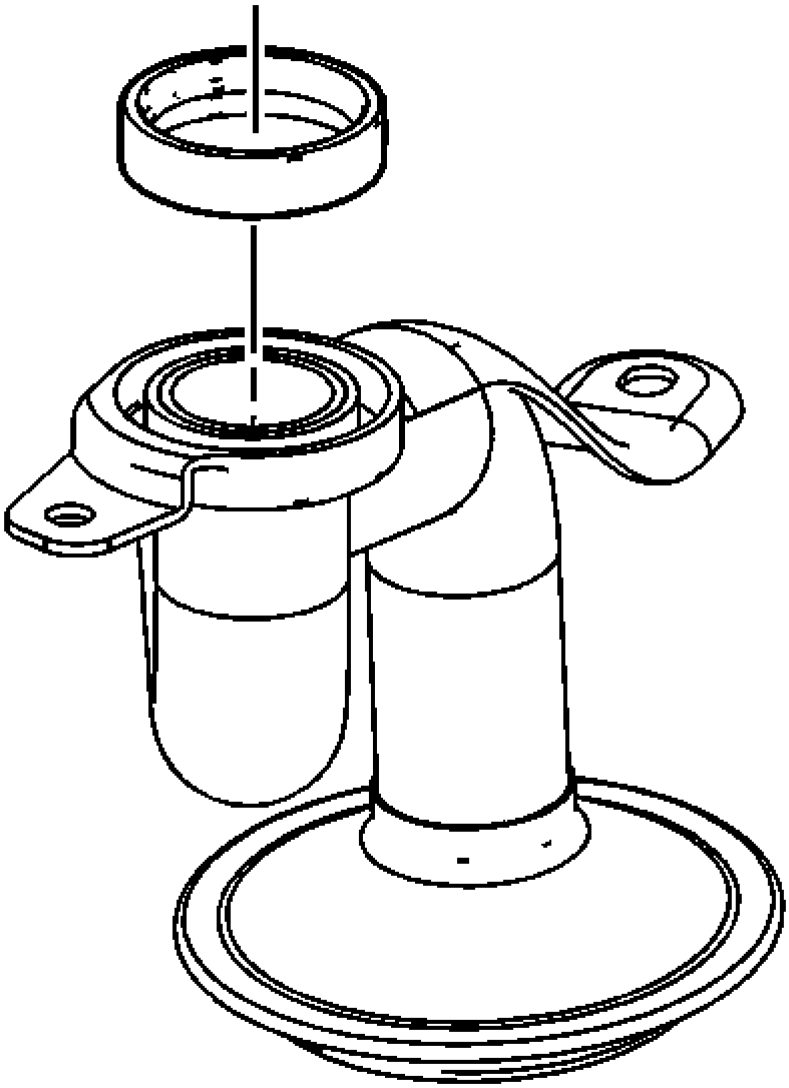


Fig. 9: View Of Oil Suction Tube Seal & Oil Suction Tube
Courtesy of GENERAL MOTORS CORP.

6. Remove the oil suction tube seal from the oil suction tube. Discard the oil suction tube seal.

INSTALLATION PROCEDURE

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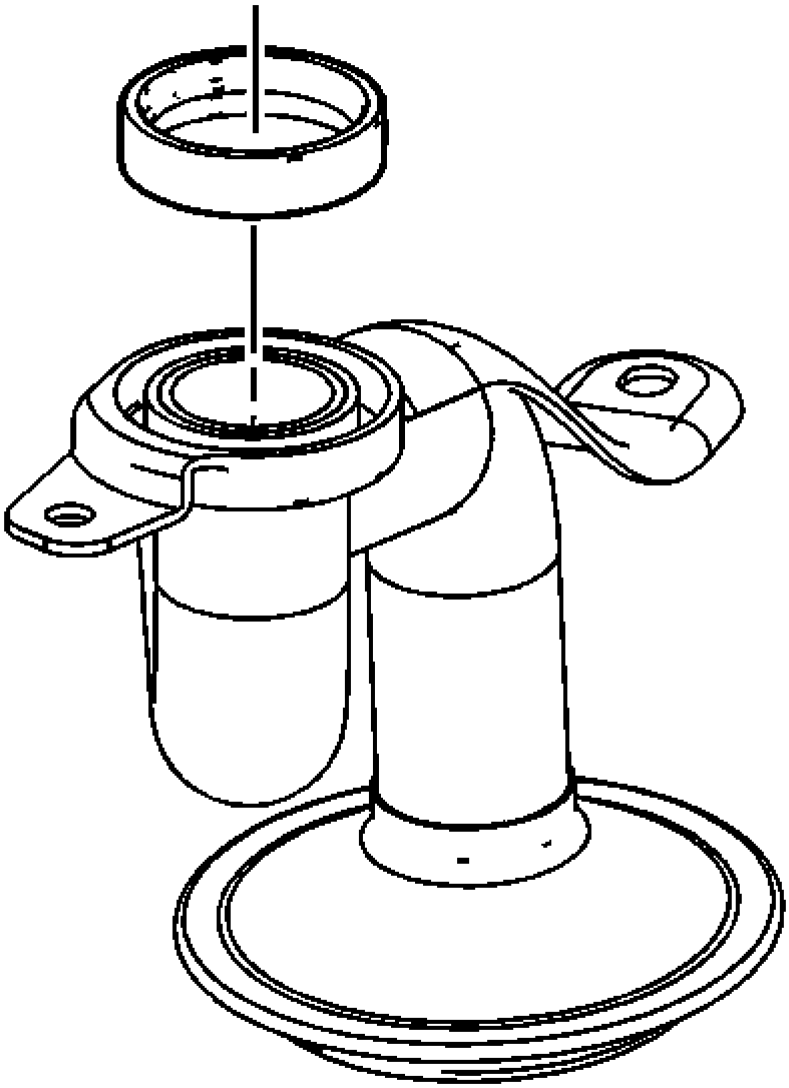


Fig. 10: View Of Oil Suction Tube Seal & Oil Suction Tube
Courtesy of GENERAL MOTORS CORP.

1. Install a NEW oil suction tube seal onto the oil suction tube. DO NOT reuse the old oil suction tube seal.

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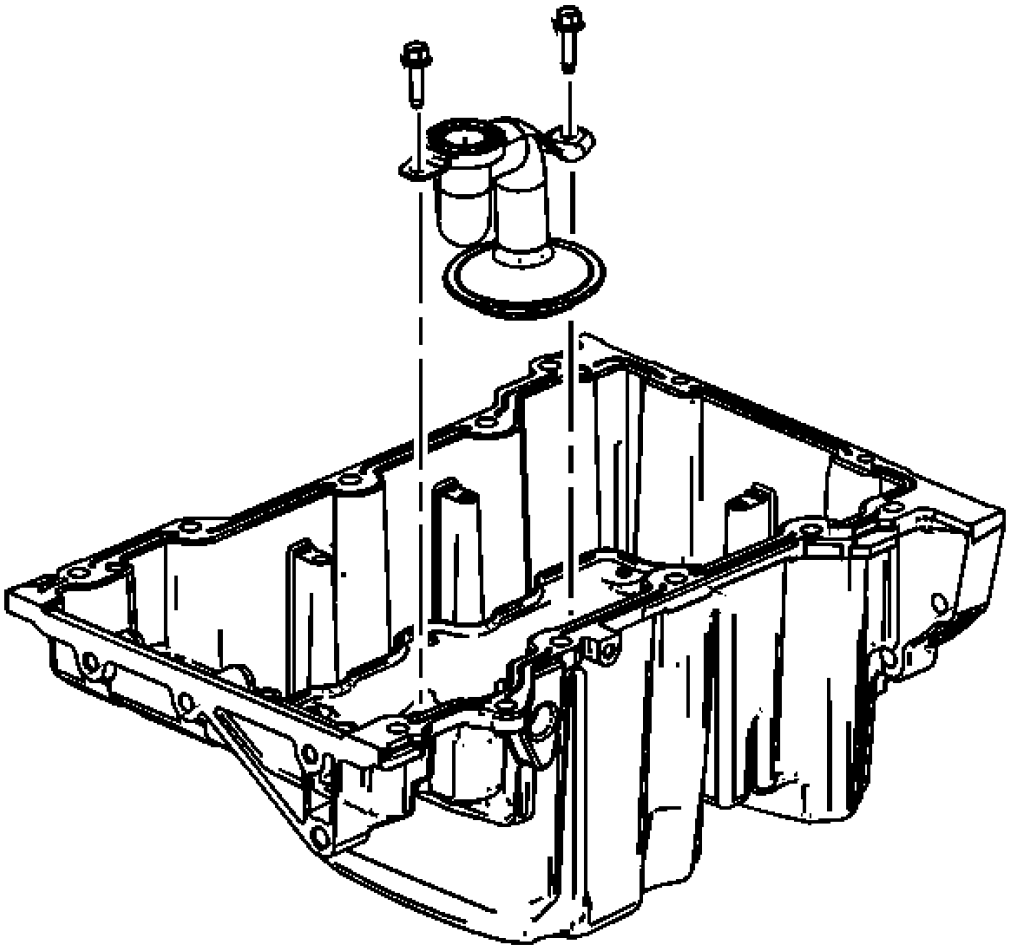


Fig. 11: View Of Oil Suction Pipe
Courtesy of GENERAL MOTORS CORP.

2. Install the oil suction pipe.

CAUTION: Refer to Fastener Caution .

3. Install the oil suction pipe bolts and tighten to 10 N.m (89 lb in).

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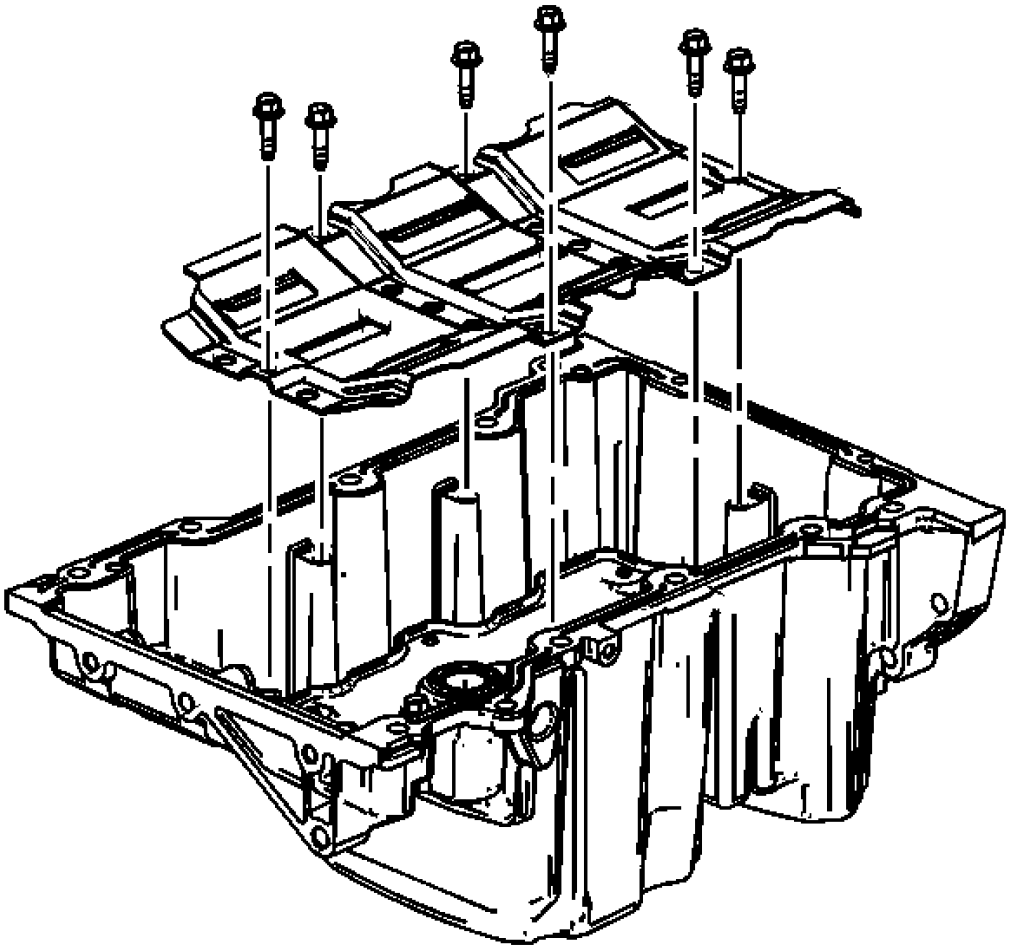


Fig. 12: View Of Oil Pan Scraper & Bolts
Courtesy of GENERAL MOTORS CORP.

4. Install the oil pan scraper.
5. Install the oil pan scraper bolts and tighten to 10 N.m (89 lb in).
6. Install the oil pan. Refer to **Oil Pan Replacement**.

ENGINE REPLACEMENT

REMOVAL PROCEDURE

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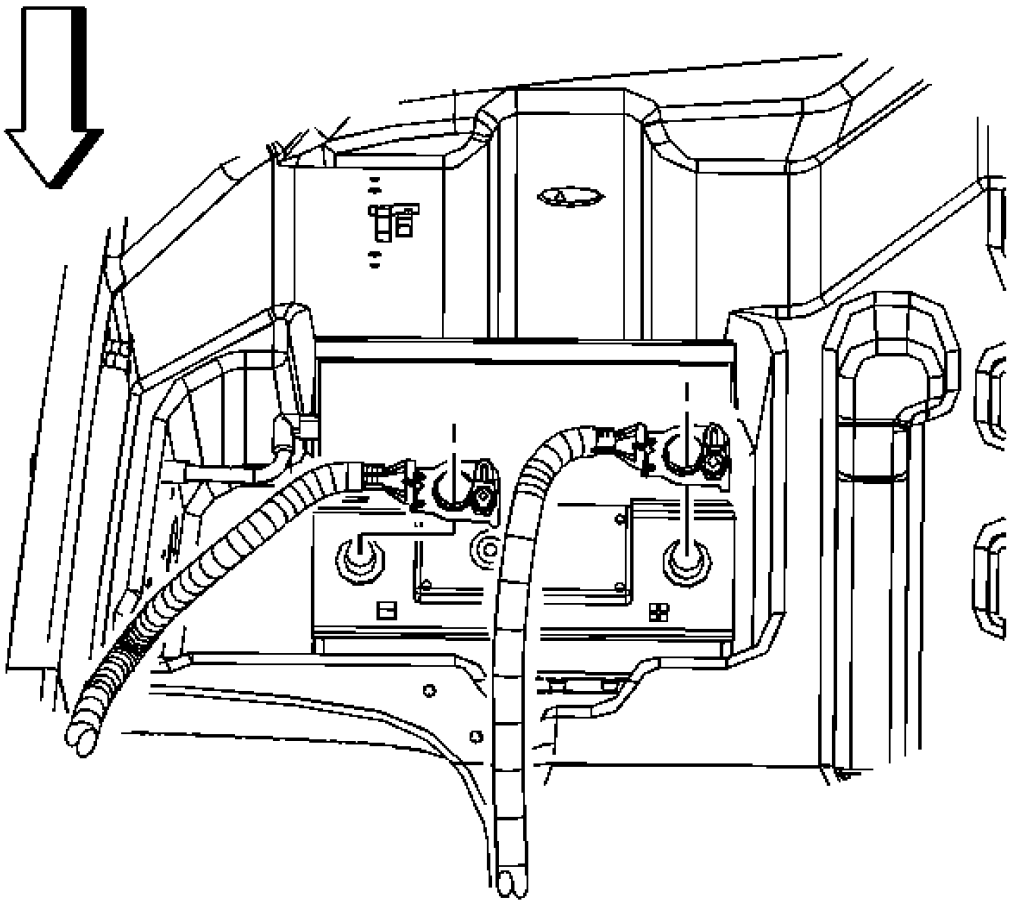


Fig. 13: View Of Battery, Negative Cable & Nut
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Rear** .
3. Disconnect the fuel feed and evaporative emission (EVAP) lines.
4. Discharge the air conditioning (A/C) system. Refer to **Refrigerant Recovery and Recharging** .
5. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .
6. Remove the front tires. Refer to **Tire and Wheel Removal and Installation** .
7. Remove the transmission. Refer to **Transmission Replacement** for the 6L45/6L50/6L80/6L90 transmission or **Transmission Replacement** for the Aisin AY6 transmission or**Transmission Replacement** for the Tremec 6-speed transmission.

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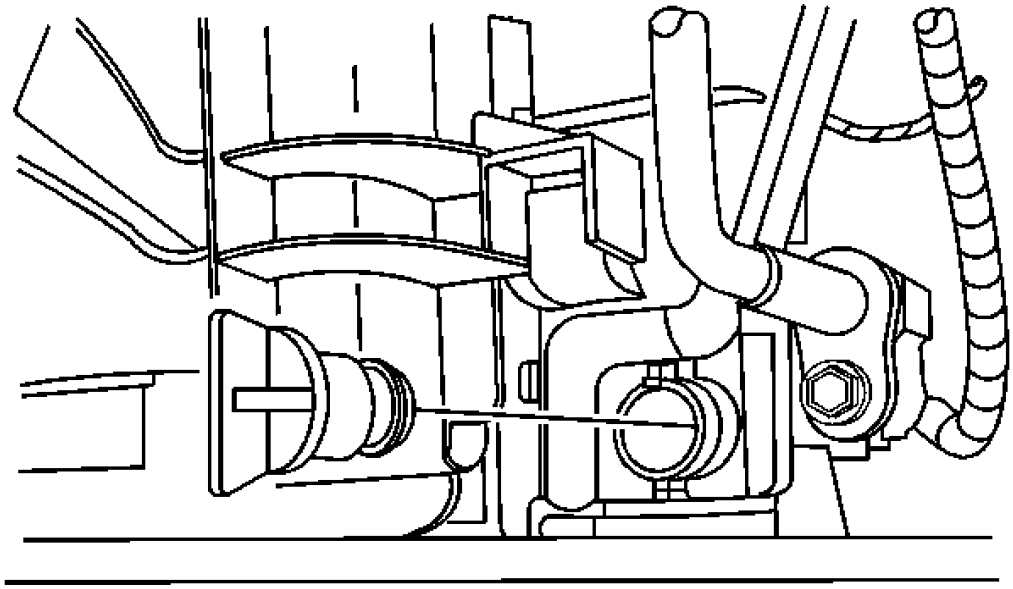


Fig. 14: Identifying Radiator Drain Cock
Courtesy of GENERAL MOTORS CORP.

8. Drain the engine cooling system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** .

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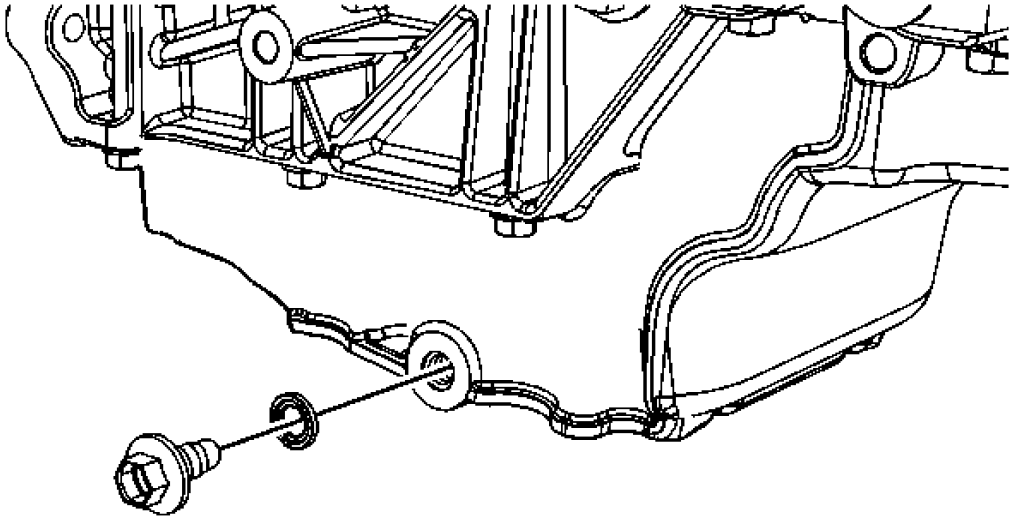


Fig. 15: Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

9. Drain the engine oil from the oil pan. Refer to **Engine Oil and Oil Filter Replacement (LLT)**.
10. Install the drain plugs to the oil pan and tighten.
11. Lower the vehicle.
12. Remove the air cleaner resonator outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
13. Tie the radiator/condenser to the body.
14. Disconnect the booster vacuum hose.
15. Disconnect the A/C lines from the compressor and reposition.
16. Disconnect the coolant overflow and air bleed hoses from the water outlet.
17. Disconnect the power steering lines from the pump.
18. Disconnect the heater core hoses. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose Replacement (L99)** or **Radiator Inlet Hose Replacement (LS3)** .
19. Remove the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose Replacement (L99)** or **Radiator Inlet Hose Replacement (LS3)** .
20. Remove the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LLT)** or **Radiator Outlet Hose Replacement (LS3, L99)** .
21. Disconnect all necessary engine harness electrical connectors. Refer to **Powertrain Component Views** and **Harness Routing Views** .
22. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
23. Lower the frame with the engine still attached. Refer to **Drivetrain and Front Suspension Frame**

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Replacement .

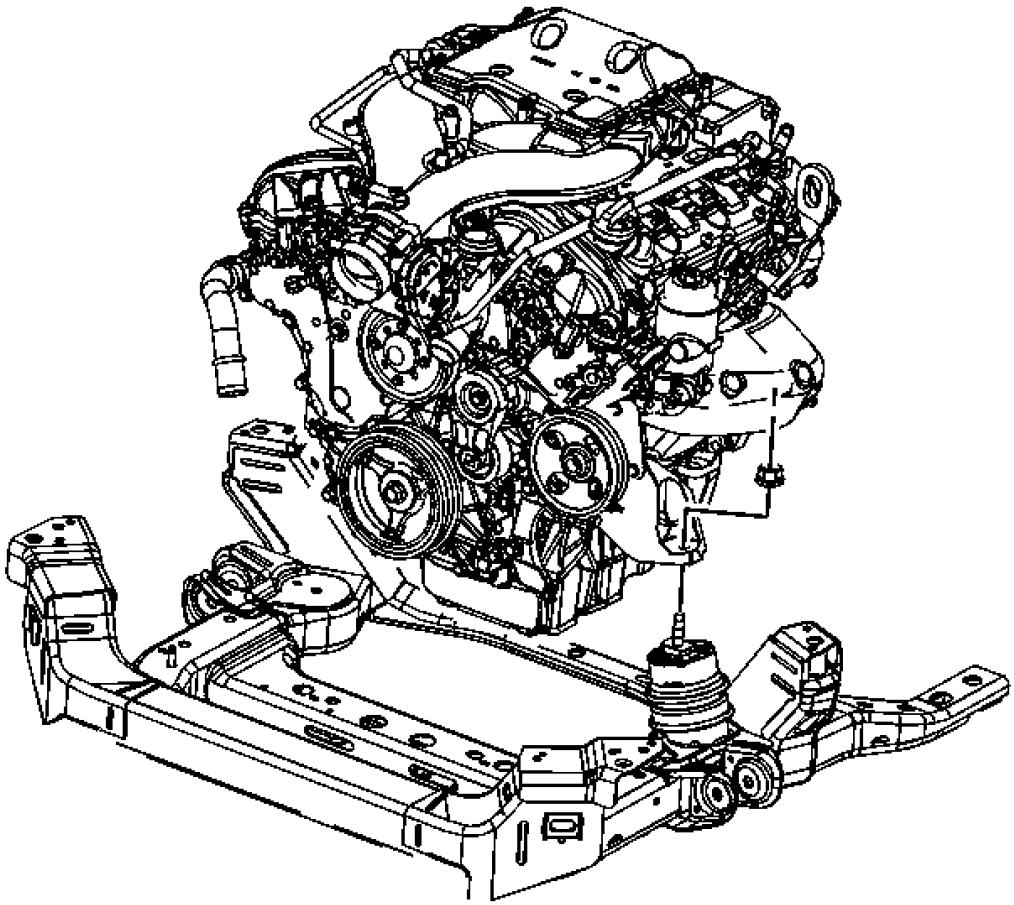


Fig. 16: Engine Mount Nuts
Courtesy of GENERAL MOTORS CORP.

24. Remove the engine mount nuts and remove the engine from the crossmember.
25. Transfer components as required. Refer to the appropriate procedures.

INSTALLATION PROCEDURE

1. Install the engine.

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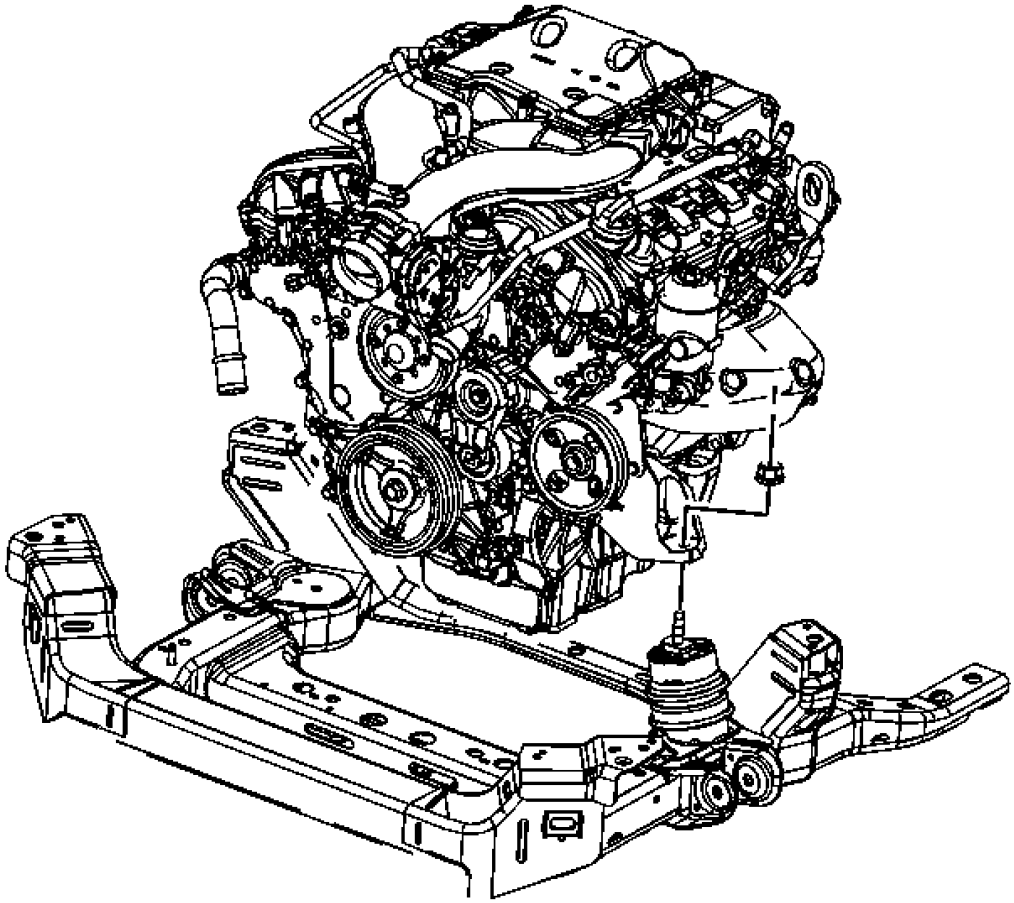


Fig. 17: Engine Mount Nuts
Courtesy of GENERAL MOTORS CORP.

2. Install the engine to the crossmember.
3. Install the frame with the engine still attached. Refer to **Drivetrain and Front Suspension Frame Replacement** .
4. Install the transmission. Refer to **Transmission Replacement** for the 6L45/6L50/6L80/6L90 transmission or **Transmission Replacement** for the Aisin AY6 transmission or**Transmission Replacement** for the Tremec 6-speed transmission.
5. Install all necessary engine harness electrical connectors. Refer to **Powertrain Component Views** and **Harness Routing Views** .
6. Install the radiator outlet hose. Refer to **Radiator Outlet Hose Replacement (LLT)** or **Radiator Outlet Hose Replacement (LS3, L99)** .
7. Install the radiator inlet hose. Refer to **Radiator Inlet Hose Replacement (LLT)** or **Radiator Inlet Hose**

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Replacement (L99) or **Radiator Inlet Hose Replacement (LS3)** .

8. Connect the power steering lines to the pump.
9. Connect the coolant overflow and air bleed hoses to the water outlet.
10. Connect the A/C lines to the compressor and reposition.
11. Connect the booster vacuum hose.
12. Install the air cleaner resonator outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**
13. Add engine coolant to the system. Refer to **Cooling System Draining and Filling (LS3, L99 Static Fill)** or **Cooling System Draining and Filling (LLT Static Fill)** or **Cooling System Draining and Filling (GE 47716)** .
14. Charge the A/C system. Refer to **Refrigerant Recovery and Recharging** .
15. Connect the fuel feed and EVAP lines.
16. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement - Rear** .
17. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
18. Road test the vehicle when done.

ENGINE OIL AND OIL FILTER REPLACEMENT (LLT)

REMOVAL PROCEDURE

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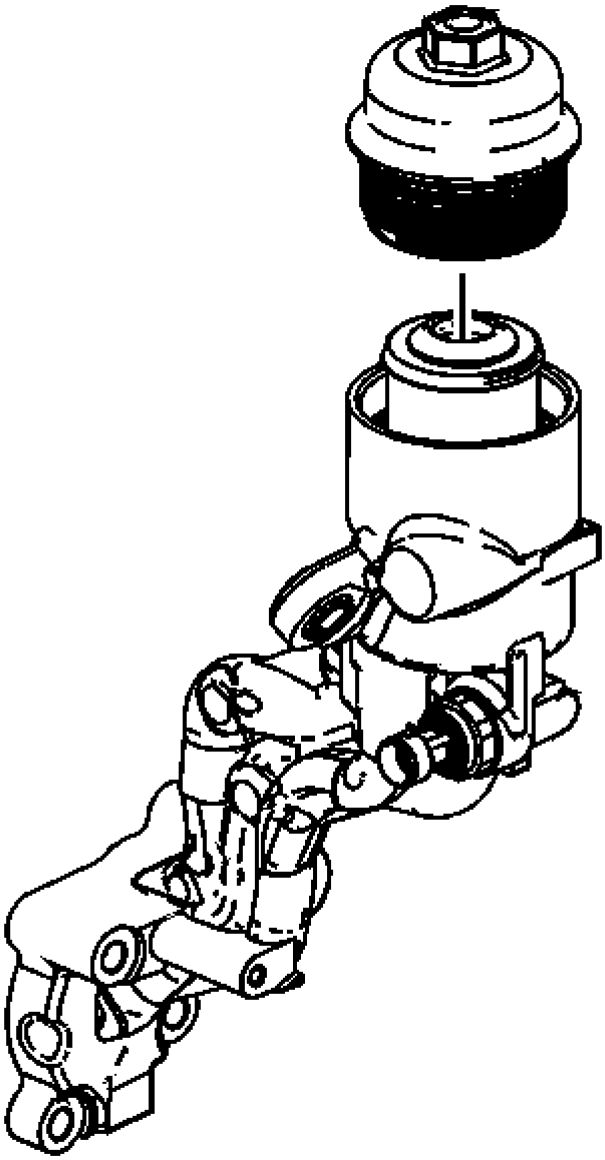


Fig. 18: View Of Oil Filter Cap
Courtesy of GENERAL MOTORS CORP.

1. Turn the ignition OFF.
2. Remove the front compartment sight shield as necessary.

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NOTE: Use a 6-point socket to remove the oil filter cap.

3. Remove the oil filter cap.

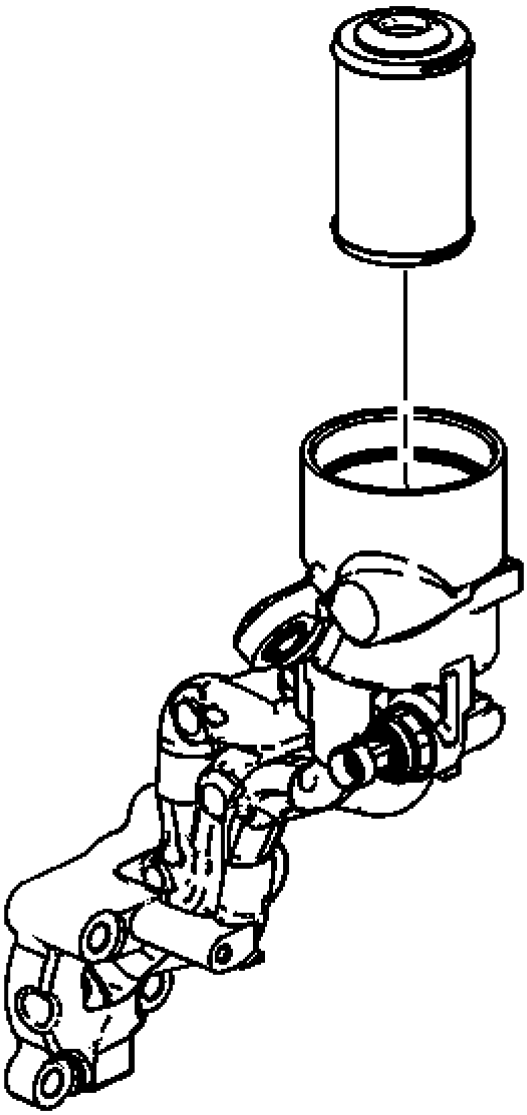


Fig. 19: View Of Oil Filter Cartridge
Courtesy of GENERAL MOTORS CORP.

NOTE: It is normal for oil to drain from the oil filter chamber in the oil filter

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adapter housing. Do NOT replace the oil filter adapter for this condition.

4. Remove and discard the oil filter cartridge.
5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
6. Place a suitable drain below the oil pan drain plug.

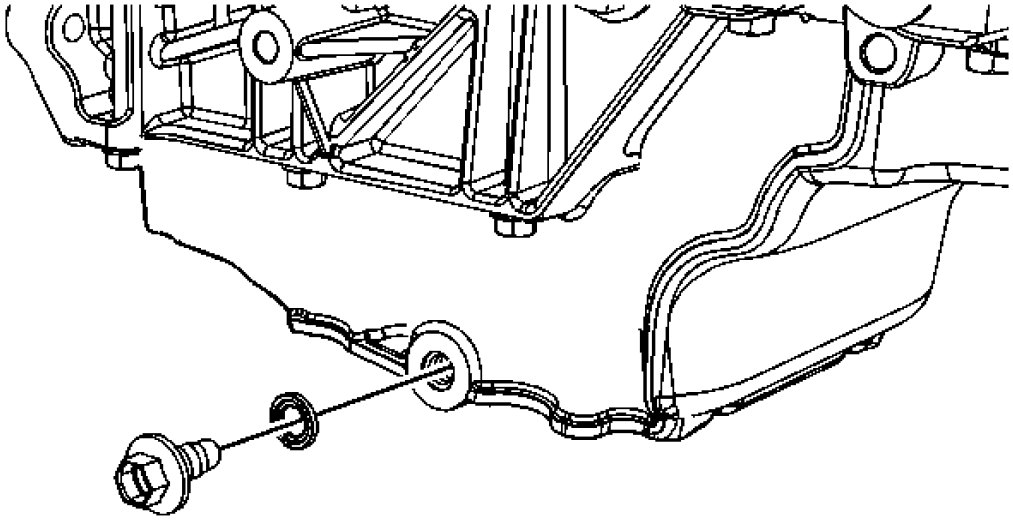


Fig. 20: Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

7. Remove the oil pan drain plug.
8. Allow the oil to drain completely.

INSTALLATION PROCEDURE

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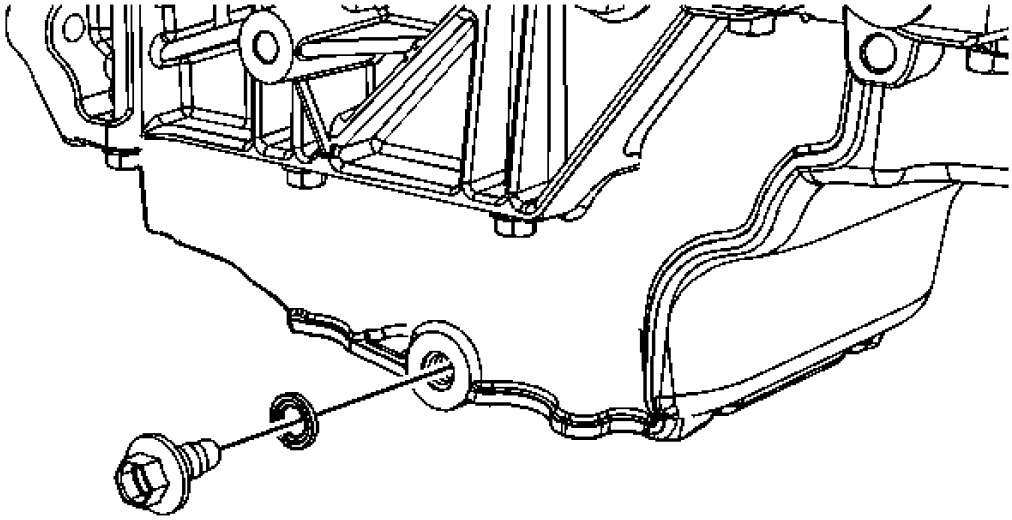


Fig. 21: Oil Pan Drain Plug
Courtesy of GENERAL MOTORS CORP.

CAUTION: Refer to Fastener Caution .

1. Install the oil pan drain plug and NEW O-ring seal and tighten to 20 N.m (15 lb ft).
2. Lower the vehicle.

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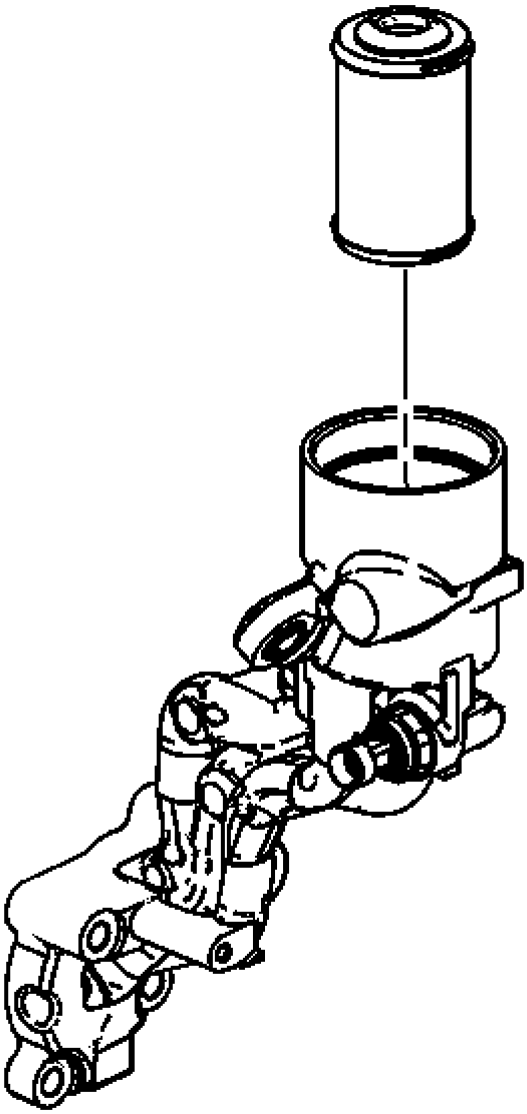


Fig. 22: View Of Oil Filter Cartridge
Courtesy of GENERAL MOTORS CORP.

3. Install the NEW oil filter cartridge.

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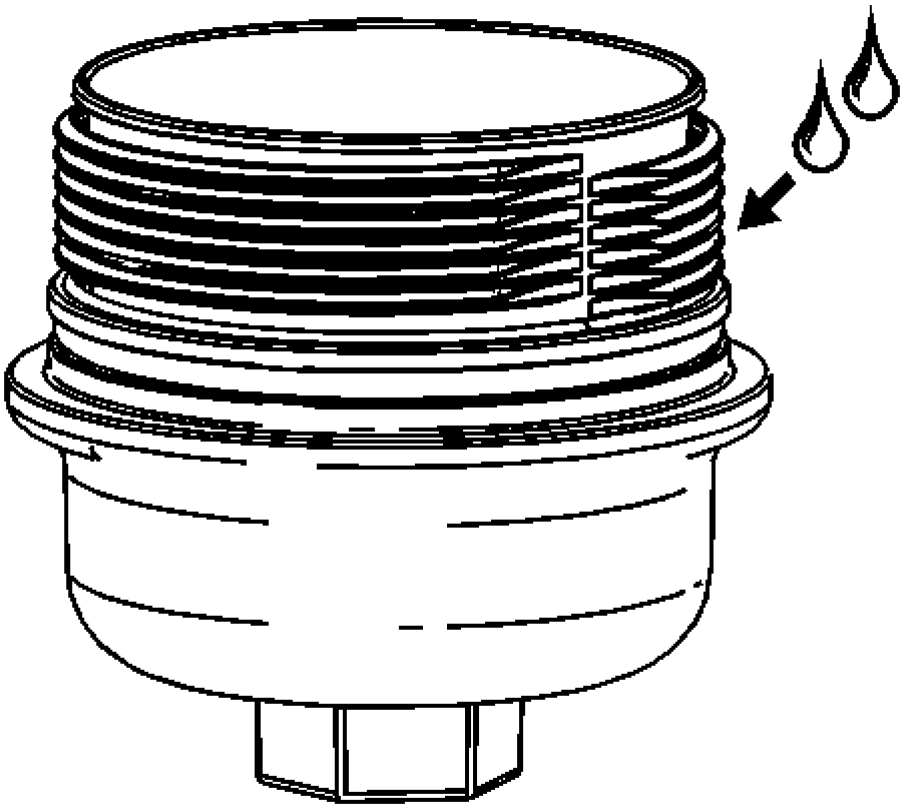


Fig. 23: Lubricating Threads Of Oil Filter Cap
Courtesy of GENERAL MOTORS CORP.

CAUTION: Lubrication must be applied to the threads of the oil filter cap prior to installation. Failure to lubricate the oil filter cap threads can hinder later removal and cause possible oil filter cap damage.

4. Lubricate the oil filter cap threads with clean engine oil.

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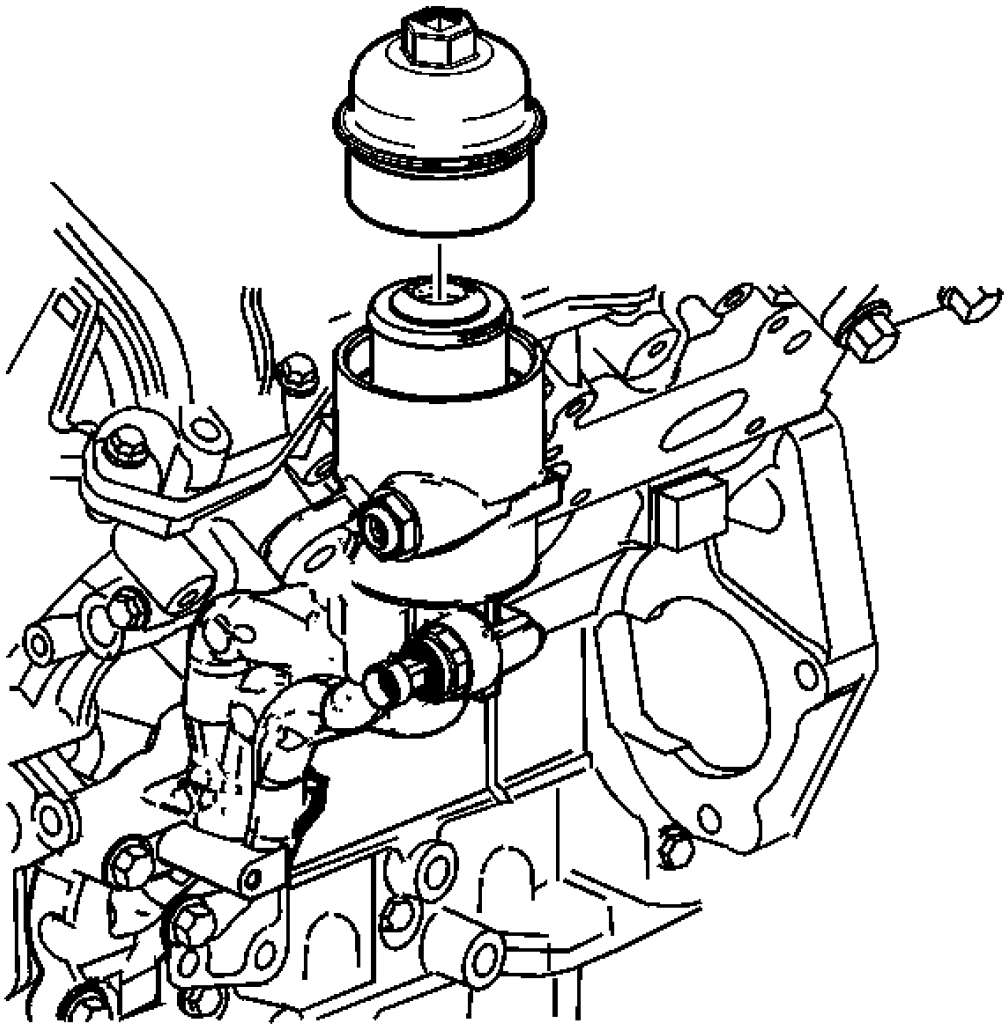


Fig. 24: Installing Oil Filter Cap
Courtesy of GENERAL MOTORS CORP.

CAUTION: Proper oil filter cap tightening is mandatory. Failure to tighten the oil filter cap to the proper specification can hinder later removal and cause possible oil filter cap damage.

NOTE: Use a 6-point socket to install the oil filter cap.

5. Install the oil filter cap and tighten to 25 N.m (18 lb ft).
6. Install the oil fill cap.

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7. Fill the engine with the appropriate oil type and quantity. Refer to **Fluid and Lubricant Recommendations (USA and Canada)** and **Approximate Fluid Capacities** .
8. Install the front compartment sight shield as necessary.

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2010 ENGINE

Engine Mechanical - 2.8L, 3.0L, 3.2L, or 3.6L - Camaro

SCHEMATIC AND ROUTING DIAGRAMS

ENGINE MECHANICAL SCHEMATICS

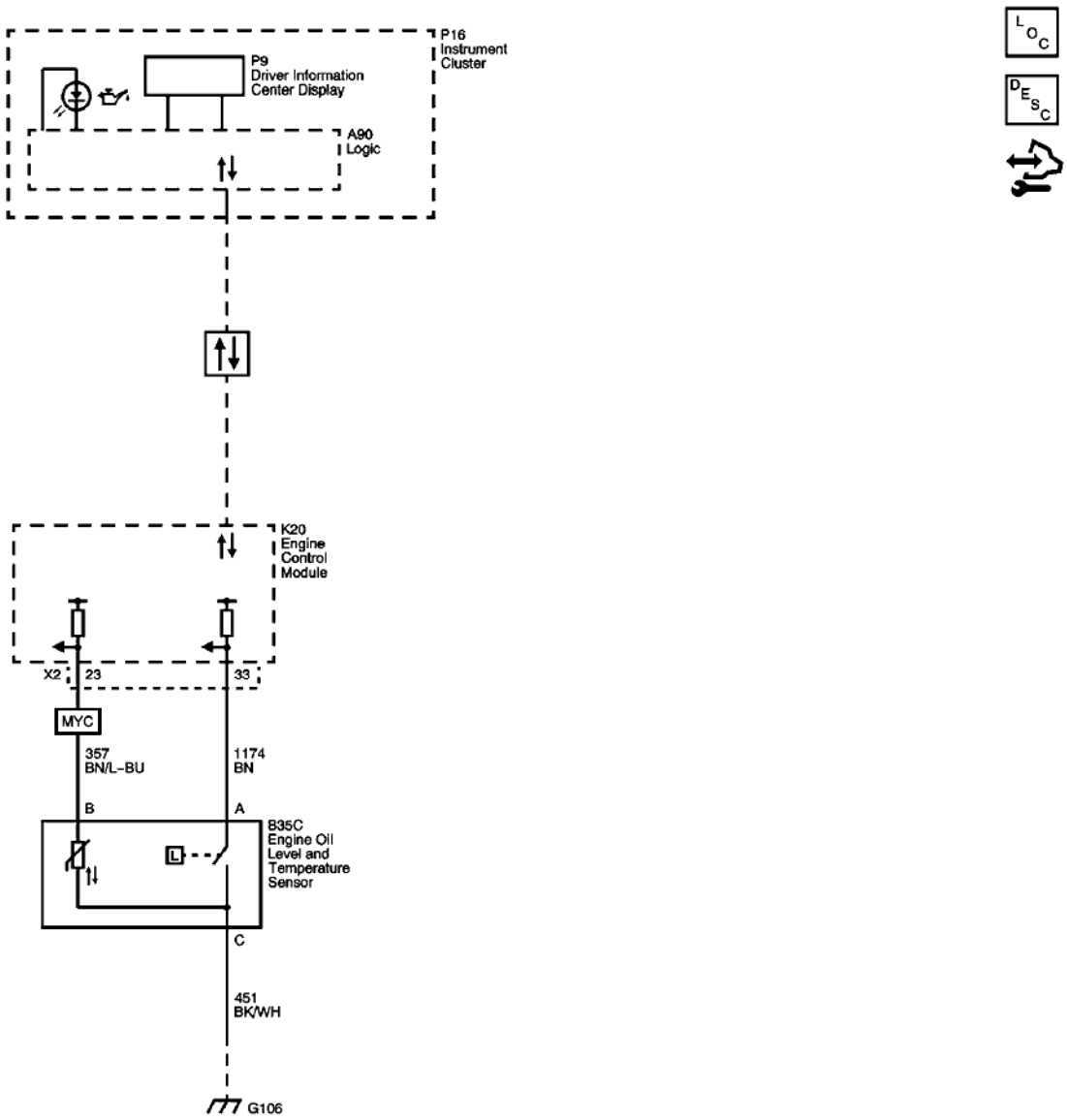


Fig. 1: Engine Mechanical
Courtesy of GENERAL MOTORS CORP.

TIMING CHAIN ALIGNMENT DIAGRAM

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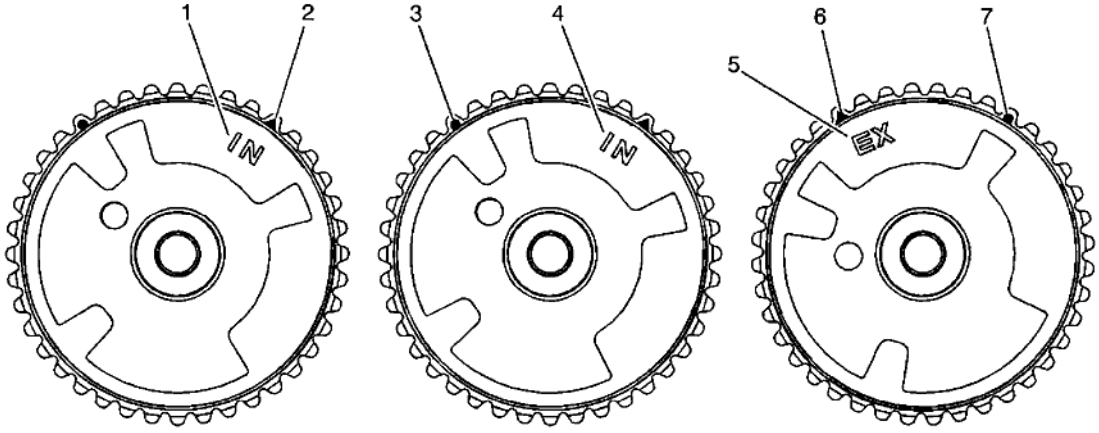


Fig. 2: Camshaft Position Actuator Timing Marks
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Right Intake Camshaft Position Actuator Identifier
2	Right Intake Camshaft Position Actuator Right Side Timing Mark - Triangle
3	Left Intake Camshaft Position Actuator Left Side Timing Mark - Circle
4	Left Intake Camshaft Position Actuator Identifier
5	Exhaust Camshaft Position Actuator Identifier
6	Exhaust Camshaft Position Actuator Right Side Timing Mark - Triangle
7	Exhaust Camshaft Position Actuator Left Side Timing Mark - Circle

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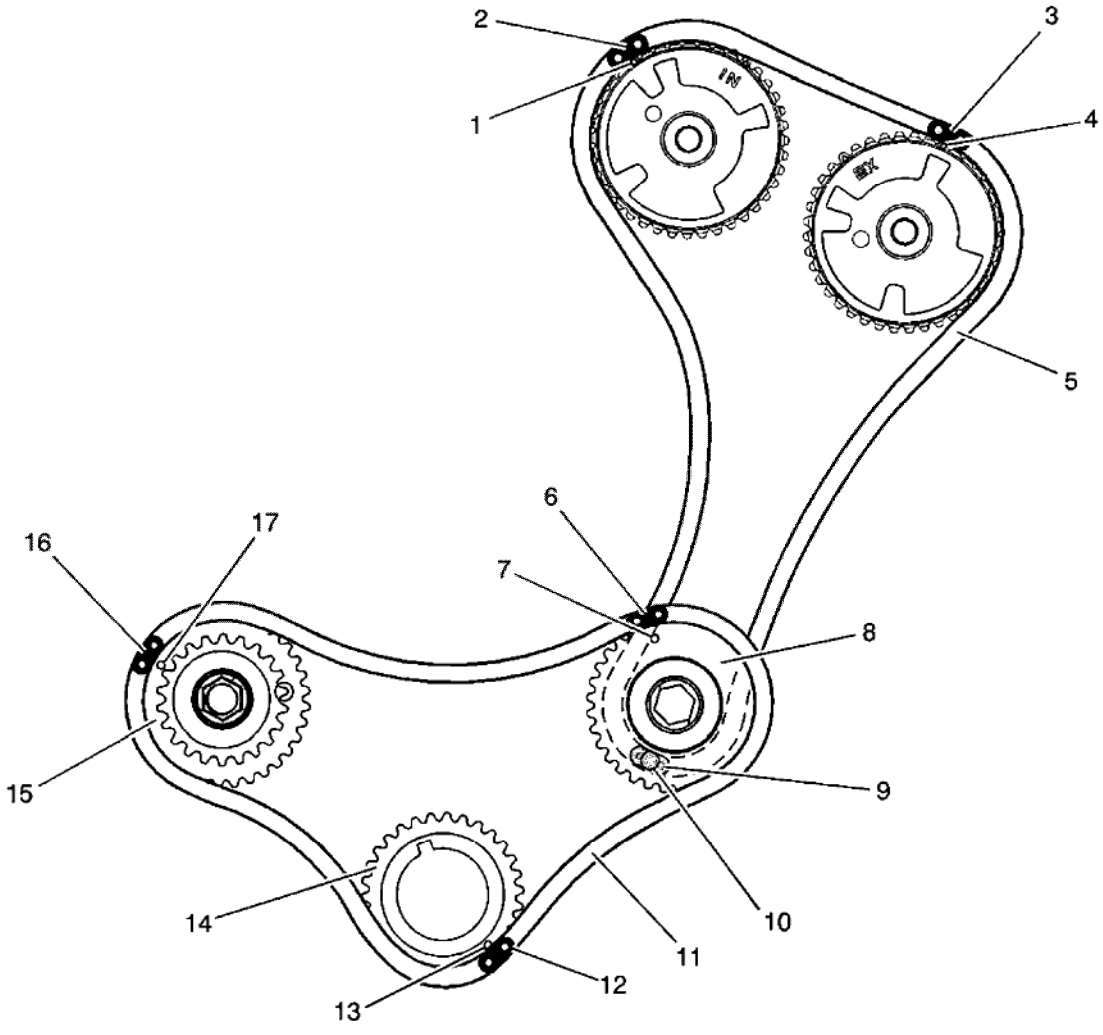


Fig. 3: Stage One
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Left Intake Camshaft Position (CMP) Actuator Timing Mark - Circle
2	Left Intake Secondary Camshaft Timing Drive Chain Timing Link
3	Left Exhaust Secondary Camshaft Timing Drive Chain Timing Link
4	Left Exhaust Camshaft Position (CMP) Actuator Timing Mark - Circle
5	Left Secondary Camshaft Timing Drive Chain
6	Primary Camshaft Drive Chain Timing Link for the Left Primary Camshaft Intermediate Drive Chain Sprocket
7	Left Primary Camshaft Intermediate Drive Chain Sprocket Timing Mark for the Primary Camshaft Drive Chain
8	Left Primary Camshaft Intermediate Drive Chain Sprocket
9	Left Secondary Camshaft Timing Drive Chain Timing Link for the Left Primary

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	Camshaft Intermediate Drive Chain Sprocket, behind hole in sprocket
10	Left Primary Camshaft Intermediate Drive Chain Sprocket Timing Window for the Left Secondary Camshaft Timing Drive Chain Timing Link
11	Primary Camshaft Drive Chain
12	Primary Camshaft Drive Chain Timing Link for the Crankshaft Sprocket
13	Crankshaft Sprocket Timing Mark
14	Crankshaft Sprocket
15	Right Primary Camshaft Intermediate Drive Chain Sprocket
16	Primary Camshaft Drive Chain Timing Link for the Right Primary Camshaft Intermediate Drive Chain Sprocket
17	Right Primary Camshaft Intermediate Drive Chain Sprocket Timing Mark

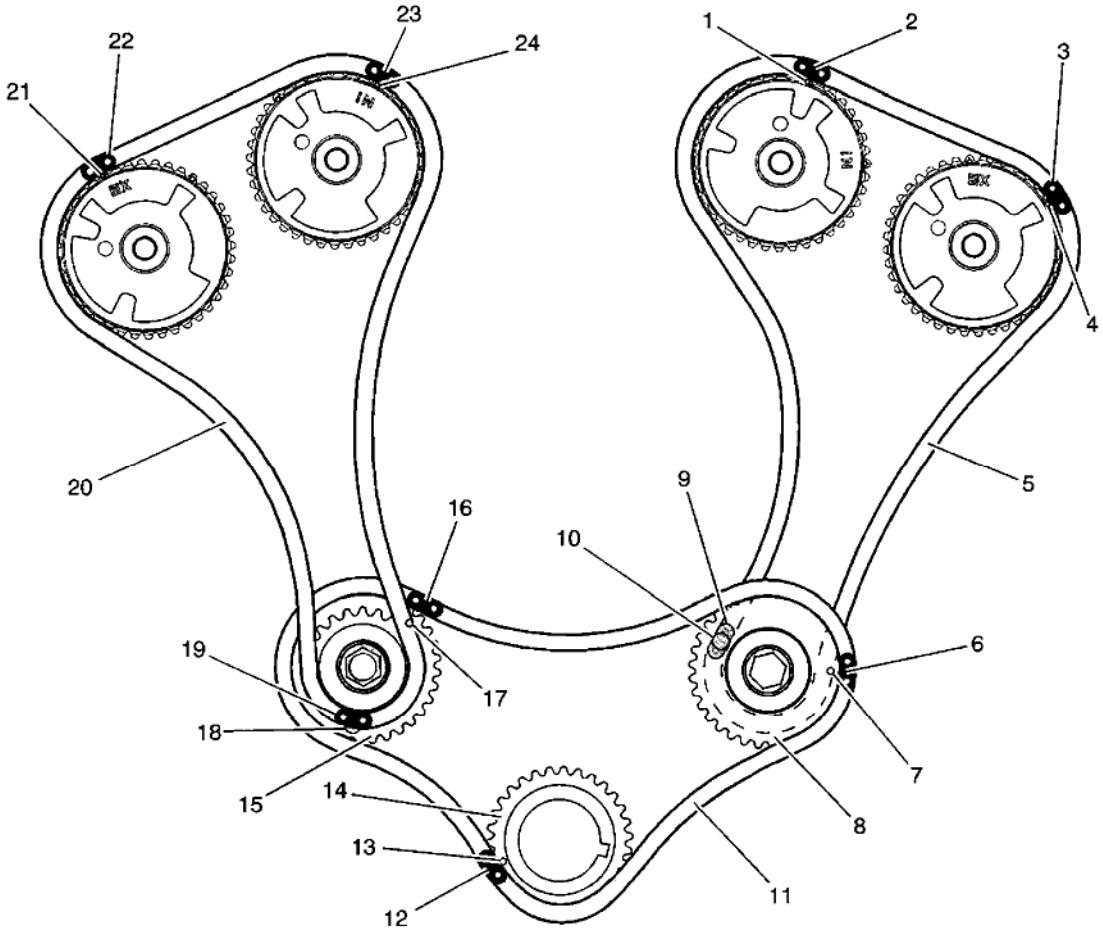


Fig. 4: Stage Two
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Left Intake Camshaft Position (CMP) Actuator Timing Mark - Circle

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2	Left Intake Secondary Camshaft Timing Drive Chain Timing Link
3	Left Exhaust Secondary Camshaft Timing Drive Chain Timing Link
4	Left Exhaust Camshaft Position (CMP) Actuator Timing Mark - Circle
5	Left Secondary Camshaft Timing Drive Chain
6	Primary Camshaft Drive Chain Timing Link for the Left Primary Camshaft Intermediate Drive Chain Sprocket
7	Left Primary Camshaft Intermediate Drive Chain Sprocket Timing Mark for the Primary Camshaft Drive Chain
8	Left Primary Camshaft Intermediate Drive Chain Sprocket
9	Left Secondary Camshaft Timing Drive Chain Timing Link for the Left Primary Camshaft Intermediate Drive Chain Sprocket, behind hole in sprocket
10	Left Primary Camshaft Intermediate Drive Chain Sprocket Timing Window
11	Primary Camshaft Drive Chain
12	Primary Camshaft Drive Chain Timing Link for the Crankshaft Sprocket
13	Crankshaft Sprocket Timing Mark
14	Crankshaft Sprocket
15	Right Primary Camshaft Intermediate Drive Chain Sprocket
16	Primary Camshaft Drive Chain Timing Link for the Right Primary Camshaft Intermediate Drive Chain Sprocket
17	Right Primary Camshaft Intermediate Drive Chain Sprocket Timing Mark for the Primary Camshaft Drive Chain
18	Right Primary Camshaft Intermediate Drive Chain Sprocket Timing Mark/Window for the Right Secondary Camshaft Timing Drive Chain
19	Right Secondary Camshaft Timing Drive Chain Timing Link for the Right Primary Camshaft Intermediate Drive Chain Sprocket
20	Right Secondary Camshaft Timing Drive Chain
21	Right Exhaust Camshaft Position (CMP) Actuator Timing Mark - Triangle
22	Right Exhaust Secondary Camshaft Timing Drive Chain Timing Link
23	Right Intake Secondary Camshaft Timing Drive Chain Timing Link
24	Right Intake Camshaft Position (CMP) Actuator Timing Mark - Triangle

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2010 MAINTENANCE

Maintenance and Lubrication - Camaro

SPECIFICATIONS

APPROXIMATE FLUID CAPACITIES

The following approximate capacities are given in US English and metric conversions. See **Fluid and Lubricant Recommendations (USA and Canada)**, for more information. All capacities are approximate. When adding, be sure to fill to the approximate level, as recommended in this manual. Re-check fluid level after filling.

Application	Specification	
	Metric	US English
Cooling System		
V6 Engine		
• Automatic Transmission	10.25 liters	10.83 quarts
• Manual Transmission	10.7 liters	11.3 quarts
V8 Engine		
• Automatic Transmission	10.85 liters	11.5 quarts
• Manual Transmission	11.05 liters	11.7 quarts
Engine Oil with Filter		
• V6 Engine	5.7 liters	6.0 quarts
• V8 Engine	7.6 liters	8.0 quarts
Fuel Tank	71.0 liters	18.8 gallons
Automatic Transmission		
• 6L80E 6-Speed - Pan Removal and Filter Replacement	6.3 liters	6.7 quarts
• 6L80E 6-Speed - Complete Overhaul	9.9 liters	10.5 quarts
• 6L80E 6-Speed - Dry	10.6 liters	11.2 quarts
Manual Transmission		
• Aisin AV6	1.8 liters	1.9 quarts
• Tremec 6-Speed	3.9 liters	4.2 quarts
Differential		
• Rear Axle - V6 Automatic Transmission	0.9 liters	0.95 quarts
• Rear Axle - V6 Manual Transmission V8 All	0.925 liter base lubricant 0.075 liter friction modifier	0.975 quart base lubricant 0.079 quart friction modifier

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FLUID AND LUBRICANT RECOMMENDATIONS (USA AND CANADA)

The Recommended Fluids and Lubricants information will be found in the Owner's Manual. Refer to the Maintenance Schedule subsection of the Owner's Manual.

You may be able to use the Search information function using the words Fluids or Lubricants.

Most transmission, transfer case, front and rear axle lubricant recommendations will be found in those service categories (subsections).

MAINTENANCE ITEMS

The Normal Maintenance Replacement Parts information will only be found in the Owner's Manual. Refer to the Maintenance Schedule subsection of the Owner's Manual.

You may be able to use the Search information function using the words Replacement Parts.

MAINTENANCE

MAINTENANCE SCHEDULE (NORTH AMERICAN EMISSIONS)

The Maintenance Schedule information will only be found in the Owner's Manual.

Refer to the Maintenance Schedule subsection of the Owner's Manual, or you may be able to use the Search information function using the words Scheduled Maintenance.

GM OIL LIFE SYSTEM RESETTING

When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. A CHANGE ENGINE OIL message or light will come on. Change the engine oil as soon as possible within the next 600 miles (1 000 km). It is possible that, if driving under the best conditions, the oil life system may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at this time the system must be reset.

If the system is ever reset accidentally, change the engine oil at 3,000 miles (5 000 km) since last oil change.

How to Reset the Engine Oil Life System

Vehicles with Driver Information Center (DIC)

1. Press the option button on the DIC until ENGINE OIL MONITOR appears on the DIC screen.
2. Press the set/reset button to reset the system. The next screen indicates that the CHANGE OIL SOON message has been reset. If the vehicle has the uplevel DIC, when the gauges button is pressed and the OIL LIFE REMAINING mode appears, it should read 100 percent OIL LIFE REMAINING.
3. Turn the key to OFF.

Vehicles without DIC

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1. With the engine OFF, turn the ignition key to RUN.
2. Fully press and release the accelerator pedal slowly three times within five seconds.
3. Turn the key to OFF, than start the vehicle.

If the light or message comes back on when you start the vehicle, the OIL LIFE SYSTEM has not reset. Repeat the procedure.

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