Back To Article

SPECIFICATIONS

FASTENER SPECIFICATIONS

Reusable Threaded Fastener Tightening Specifications

NOTE:
All fasteners listed in this table can be reused after removal.

Application	Specification Metric (English)
Battery Hold Down Retainer Nut	5 N.m (44 lb in)
Battery Negative Cable @ Battery Sensor Nut	9 N.m (80 lb in)
Battery Negative Cable Extension Cable @ Frame Rail Fastener	9 N.m (80 lb in)
Battery Negative Cable Extension Cable @ Shift Cable Bracket Fastener	22 N.m (16 lb ft)
Battery Negative Cable Ground Fastener	22 N.m (16 lb ft)
Battery Negative Post Clamp Nut	4.5 N.m (40 lb in)
Battery Positive Cable @ Battery Distribution Engine Compartment Fuse Block Nut	12 N.m (106 lb in)
Battery Positive Junction Block Cable Nut	12 N.m (106 lb in)
Battery Positive Post Clamp Nut	4.5 N.m (40 lb in)
Battery Sensor Module Fastener	9 N.m (80 lb in)
Battery Tray Mounting Bolt	22 N.m (16 lb ft)
Battery Tray Mounting Nut	22 N.m (16 lb ft)
Engine Wiring Harness Junction Block Mounting Bolt	7 N.m (62 lb in)
Engine Wiring Harness Junction Block Nut	4.7 N.m (42 lb in)
Generator Mounting Bolt (LTG, LYX)	22 N.m (16 lb ft)
Generator Mounting Nut (LTG, LYX)	22 N.m (16 lb ft)
Generator Mounting Stud (LTG, LYX)	9 N.m (80 lb in)
Starter Bracket Fastener (Large Bolt)	58 N.m (43 lb ft)
Starter Bracket Fastener (Small Bolt)	22 N.m (16 lb ft)
Starter Motor Mounting Bolt (LTG)	22 N.m (16 lb ft)
Starter Motor Mounting Bolt (LYX)	58 N.m (43 lb ft)
Starter Motor Mounting Nut (LYX)	58 N.m (43 lb ft)
Starter Solenoid Cable @ Battery Distribution Engine Compartment Fuse Block Nut (LTG, LYX)	12 N.m (106 lb in)
Starter Solenoid Cable @ Generator Nut (LTG, LYX)	15 N.m (11 lb ft)
Starter Solenoid Cable @ Starter Nut (LTG, LYX)	12 N.m (106 lb in)
Stud	22 N.m (106 lb in)

SCHEMATIC WIRING DIAGRAMS

STARTING AND CHARGING WIRING SCHEMATICS

Starting (With KL9) (1 of 2)

mex30.com

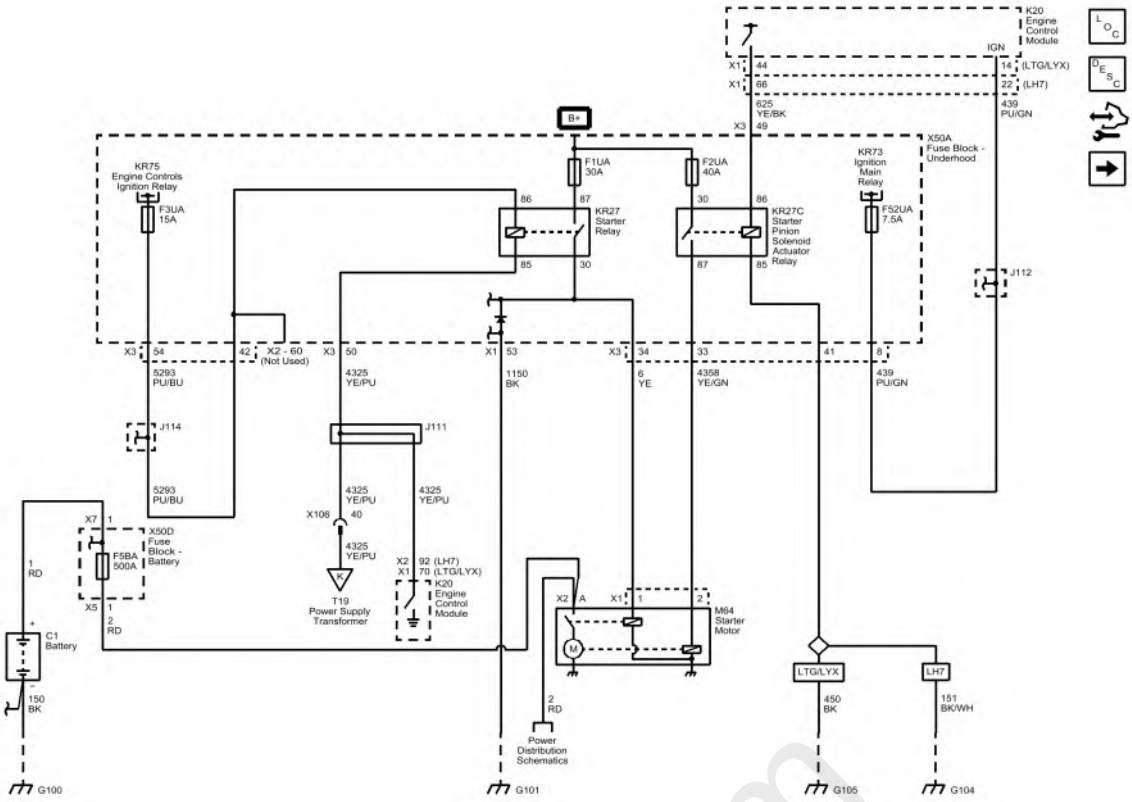


Fig. 1: Starting (With KL9) (1 of 2)

Courtesy of GENERAL MOTORS COMPANY

Starting (With KL9) (2 of 2)

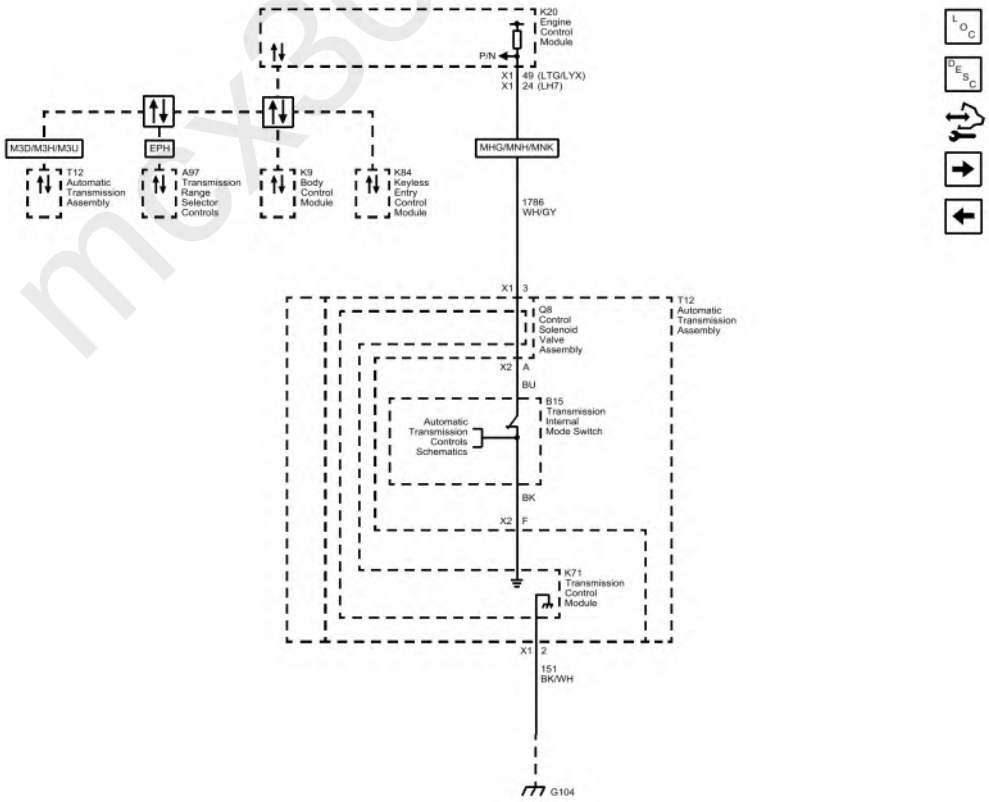


Fig. 2: Starting (With KL9) (2 of 2)

Courtesy of GENERAL MOTORS COMPANY

Starting (Without KL9)

mcx30.com

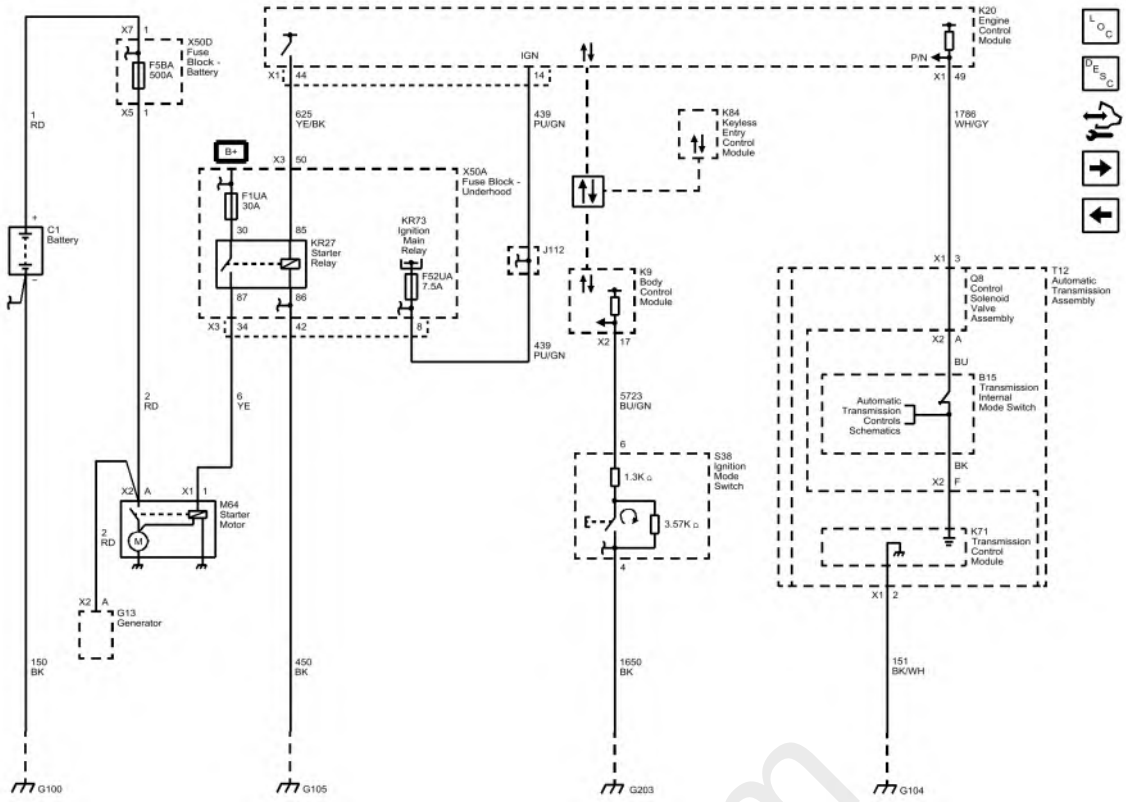


Fig. 3: Starting (Without KL9)
Courtesy of GENERAL MOTORS COMPANY

Charging (With KL9)

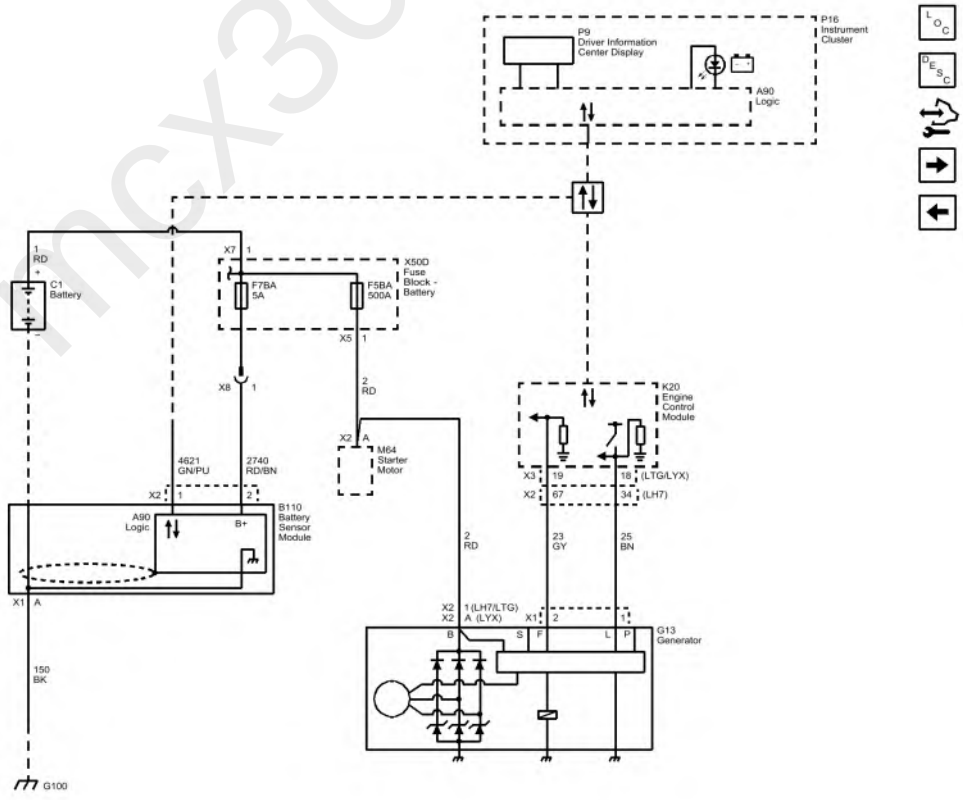


Fig. 4: Charging (With KL9)
Courtesy of GENERAL MOTORS COMPANY

Charging (Without KL9)

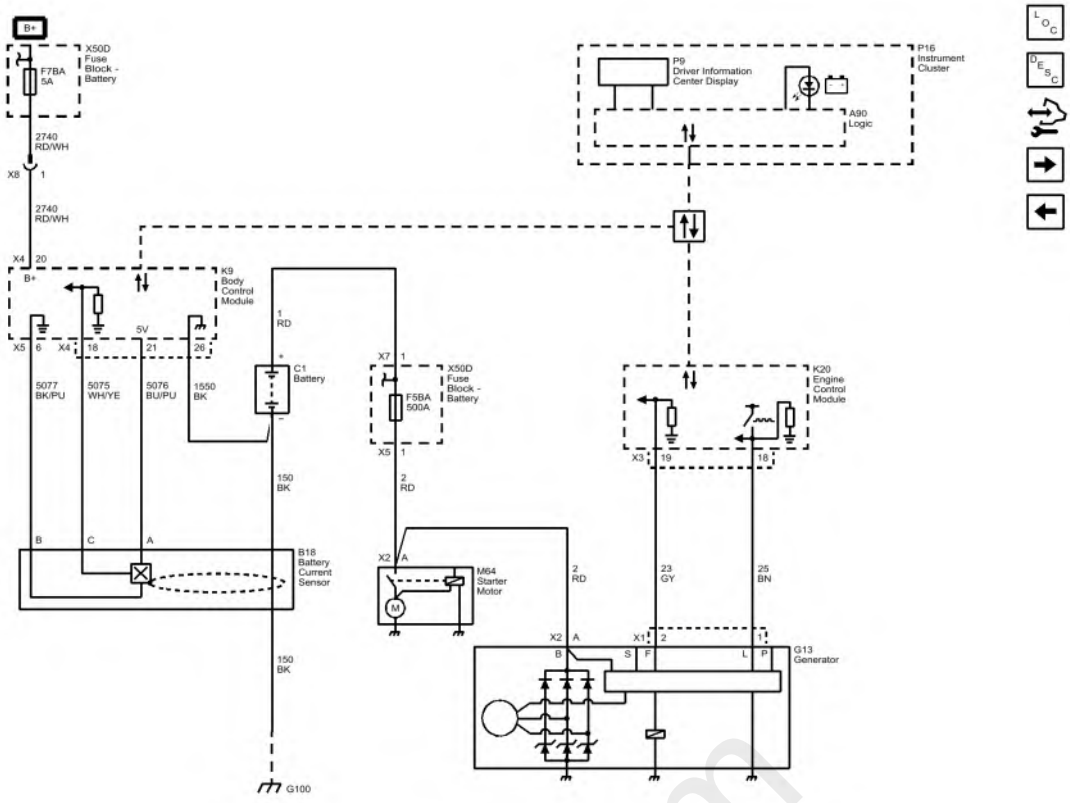


Fig. 5: Charging (Without KL9)
Courtesy of GENERAL MOTORS COMPANY

Stop/Start System (KL9)

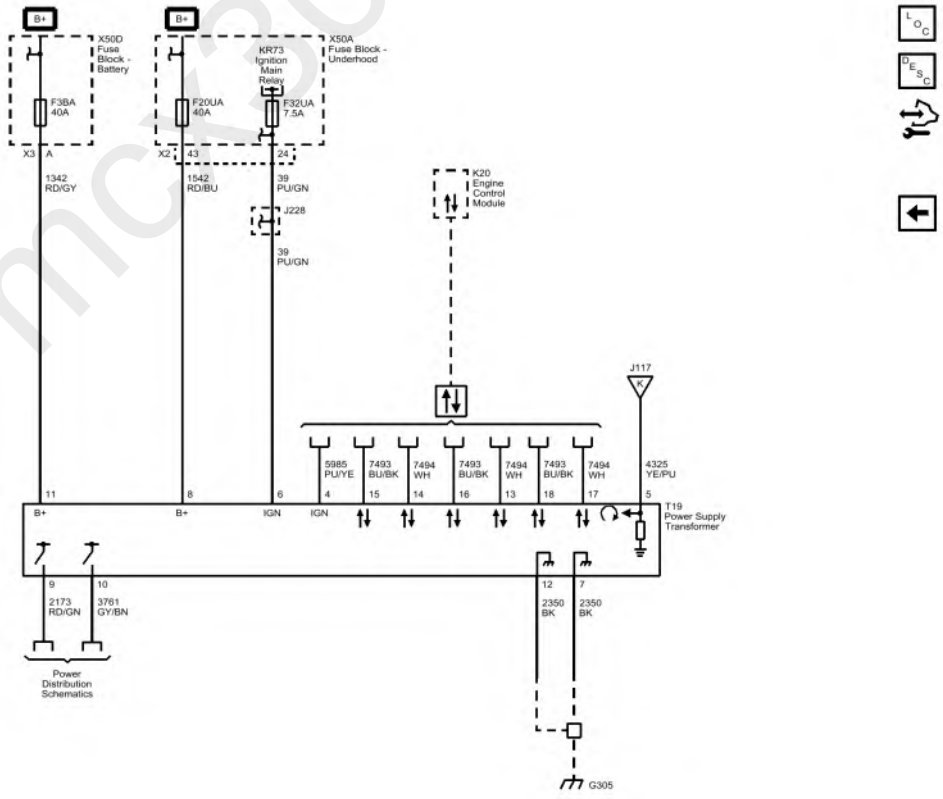


Fig. 6: Stop/Start System (KL9)
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B1325, B1327, B1328, B1330, B1390, B1395, B1400, B1410, B1415, B1424, B1425, B1439, B1517, C0800, C0805, C0870, C0880, C0895, C0899, C0900, P0560, P0561, P0562, P0563, P0611, P1002, P129B, P129C,

mg30.com

P15AE, P15AF, P17B0, P17B1, P17B2, P17DD, P17DE, P17DF, P1E19 OR P1E1A:

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

Device Power Circuit Voltage

DTC B1327

Device Voltage Circuit

DTC B1328

Device Voltage Circuit

DTC B1330

Device Power 2 Circuit

DTC B1390

Control Module Supply Circuit 1

DTC B1395

Control Module Voltage Reference Output 1

DTC B1400

Control Module Supply Circuit 2

DTC B1410

Control Module Supply Circuit 3

DTC B1415

Control Module Voltage Reference Output 3

DTC B1424

Control Module Power Circuit

DTC B1425

Control Module Power Circuit

DTC B1439

Intermittent Device Voltage

DTC B1517

Battery Voltage

DTC C0800

Device Power 1 Circuit Voltage

DTC C0805

mcx30.com

Control Module Power 2 Circuit

DTC C0870

Control Module Voltage Reference

DTC C0880

Control Module Voltage Reference

DTC C0895

Device Voltage

DTC C0899

Device Voltage

DTC C0900

Device Voltage

DTC P0560

System Voltage Low

DTC P0561

System Voltage Performance

DTC P0562

System Voltage Low

DTC P0563

System Voltage High

DTC P0611

Fuel Injector Control Module Performance

DTC P1002

Fuel Pump Driver Control Module System Voltage Performance

DTC P129B

System Voltage Low

DTC P129C

System Voltage High

DTC P15AE

Fuel Injector Control Module System Voltage Low Voltage

DTC P15AF

Fuel Injector Control Module System Voltage High Voltage

DTC P17B0

Transmission Range Control Module System Voltage Low

DTC P17B1

mcx30.com

Transmission Range Control Module System Voltage Performance

DTC P17B2

Transmission Range Control Module System High Voltage

DTC P17DD

Transmission Range Control Module System Voltage Low

DTC P17DE

Transmission Range Control Module System Voltage Performance

DTC P17DF

Transmission Range Control Module System High Voltage

DTC P1E19

Auxiliary Transmission Fluid Pump Control Module System Voltage Low Voltage

DTC P1E1A

Auxiliary Transmission Fluid Pump Control Module System Voltage High Voltage

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

The vehicle control modules or sensors monitor the system voltage to verify the system voltage is within the normal operating range.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The control module or sensor detects a system voltage below or above a threshold.

Action Taken When the DTC Sets

- A driver information center message and/or warning indicator may be displayed.
- The control module may be temporarily disabled.

Conditions for Clearing the DTC

The system voltage returns to normal operating range.

Diagnostic Aids

- A high or low voltage DTC set or voltage value in multiple modules/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

Control Module References

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

mcx30.com

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. Ignition OFF, measure and record the battery voltage at the battery terminals.
2. Verify the battery voltage stabilizes between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
   - **If battery voltage is less than 12.4 V or more than 12.8 V**

     Refer to **Battery Inspection/Test**.

   - **Go to next step: If battery voltage is between 12.4 and 12.8 V**
3. Engine running, headlights ON, measure and record the battery voltage at the battery terminals.
4. Verify the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.
   - **If the voltage is not at least 1 V greater than the voltage measured in step 1 or is greater than 15 V.**

     Refer to **Charging System Test**.

   - **Go to next step: If the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.**
5. Verify the appropriate control module battery voltage and ignition voltage parameters are available in the scan tool.
   - **If parameters are not available in the scan tool**

     Refer to Circuit/System Testing

   - **Go to next step: If parameters are available in the scan tool**
6. Verify the appropriate control module scan tool battery voltage and ignition voltage parameters are within 1 V of the battery voltage.
   - **If not within 1 V of the battery voltage**

     Refer to Circuit/System Testing

   - **Go to next step: If within 1 V of the battery voltage**
7. All OK.

Circuit/System Testing

NOTE: **Use the schematic to identify the following:**

- **Control modules the vehicle is equipped with**
- **The control module's ground, B+, and Ignition circuit terminal IDs and connectors**

NOTE: **Some control module ground circuits may require up to 20 min after the ignition is**

mcx30.com

turned off before achieving a resistance reading of less than 5 Ω. In most cases the readings will drop below 20 Ω within 1 min indicating the control module is going to sleep.

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connectors at the appropriate control module. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between each ground circuit terminal and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **Go to next step: If less than 10 Ω**
3. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the B+ circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for infinite resistance between the B+ circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the appropriate control module.
    - **Go to next step: If the test lamp illuminates**
4. Ignition ON.
5. If equipped, verify a test lamp illuminates between each ignition circuit terminal and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ignition circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for infinite resistance between the ignition circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the appropriate control module.
    - **Go to next step: If the test lamp illuminates**
6. Replace the control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for control module replacement, programming and setup.

DTC B1516: BATTERY CURRENT SENSOR SIGNAL

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

mex30.com

DTC B1516

Battery Current Sensor Signal

For symptom byte information, refer to **Symptom Byte List** .

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	-	-

Circuit/System Description

The B18 Battery Current Sensor is a 3-wire hall effect current sensor. The Body Control Module (BCM) supplies 5 V and ground to the B18 Battery Current Sensor. The B18 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 is disabled.

Conditions for Clearing the DTC

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

Diagnostic Aids

DTC B1516 08 could be set by overcharging with a battery charger or jump starting.

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

mcx30.com

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 Testing

B1516 08

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B18 Battery Current Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 30 Ω between the low reference circuit terminal B and ground.
    - **If 30 Ω or greater**
    1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K9 Body Control Module.
    - **Go to next step: If less than 30 Ω**
3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal A and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K9 Body Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module, ignition ON.
    2. Test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K9 Body Control Module.
    - **Go to next step: If between 4.8 - 5.2 V**
5. Test for 4.8 - 5.2 V between the signal circuit terminal C and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K9 Body Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.

mcx30.com

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the K9 Body Control Module.

- **Go to next step: If between 4.8 - 5.2 V**

6. Test or 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 B18 Battery Current Sensor properly.

   - **Go to next step: If the B18 Battery Current Sensor is installed correctly**
2. Replace the B18 Battery Current Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Battery Negative Cable Replacement**
- **Control Module References** for K9 Body Control Module replacement, programming, and setup.

DTC B151A: LOW BATTERY CAPACITY DETECTED

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

Low Battery Capacity Detected

For symptom byte information, refer to **Symptom Byte List** .

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 vehicle is ON

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 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

Schematic Reference

mcx30.com

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 the **Battery Inspection/Test**.
- Refer to the **Charging System Test**.

DTC B1527: PARASITIC LOAD

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

Parasitic Load

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

The body control module (BCM) monitors the state of charge of the electrical system.

Conditions for Running the DTC

The ignition is in Accessory or Run mode.

Conditions for Setting the DTC

The state of charge at ignition ON is 30% 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%.

Reference Information

mcx30.com

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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**.

DTC P0615, P0616 OR P0617: STARTER MOTOR RELAY CONTROL CIRCUIT (KL9)

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 Motor Relay Control Circuit

DTC P0616

Starter Motor Relay Control Circuit Low Voltage

DTC P0617

Starter Motor Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Switch B+ Terminal 87	1	2	-	-
Relay Coil Control Terminal 85	P0616	P0615, P0616, P305E	P0617	-
Relay Switch Control Terminal 30	2	2	3	-
Relay Coil Ignition Terminal 86	-	P0615, P0616, P305E	-	-
1. Opens fuse, Starter Solenoid does not click. 2. Starter Solenoid does not click. 3. Cranks all the time.				

mcx30.com

Circuit/System Description

When the ignition is activated to start the vehicle, a discrete signal is supplied to the body control module (BCM). 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 pressed 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 activated to START.
- 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 Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**

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 and all vehicle systems OFF, disconnect the KR27 Starter Relay. It may take up to 2 min for all vehicle systems to power down.
2. Ignition ON.
3. Verify a test lamp illuminates between the B+ circuit terminal 87 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the B+ circuit end to end.

mcx30.com

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω, verify the fuse is good and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF.
2. Test for infinite resistance between the B+ circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance,
3. Test for infinite resistance between the control circuit terminal 30 and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the M64 Starter Motor.

- **Go to next step: If the test lamp illuminates**

4. Verify a test lamp illuminates between the ignition circuit terminal 86 and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF, remove the test lamp.
2. Test for less than 2 Ω in the ignition circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, refer to **Power Mode Mismatch**

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp.
2. Test for infinite resistance between the ignition circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance,
3. Connect the KR27 Starter Relay.
4. Verify the fuse does not open when connecting or working the KR27 Starter Relay.
    - If the fuse opens, replace the KR27 Starter Relay
    - If the fuse is OK
5. All OK

- **Go to next step: If the test lamp illuminates**

5. Connect a test lamp between the control circuit terminal 85 and the ignition circuit terminal 86.

NOTE: **If the Starter Relay command is not available in the scan tool, verify the test lamps turns on and off when cycling the ignition between the OFF and CRANK position with the parking brake set and clutch pedal pressed (manual transmission) or the transmission in park (automatic transmission).**

6. Verify the test lamp turns ON and OFF when commanding the Starter Relay ON and OFF with a scan tool.

- **If the test lamp is always OFF**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module and disconnect the harness connector at the T19 Power Supply Transformer, Ignition ON.
2. Test for less than 1 V between the control circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V
3. Test for less than 2 Ω in the control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If the test lamp is always ON**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module and disconnect the harness connector at the T19 Power Supply Transformer, Ignition ON.
2. Test for infinite resistance between the control circuit and ground

- If less than infinite resistance, repair the short to ground on the circuit
- If infinite resistance

mcx30.com

7. Reconnect the K20 Engine Control Module
8. Test for infinite resistance between control circuit and ground.
    - If less than infinite resistance, replace the K20 Engine Control Module.
    - If infinite resistance, replace the T19 Power Supply Transformer
    - **Go to next step: If the test lamp turns ON and OFF**
9. Ignition ON, connect a 30 A fused jumper wire between the B+ circuit terminal 87 and the control circuit terminal 30.
10. Verify the M64 Starter Motor is activated.
    - **If the M64 Starter Motor does not activate**
    1. Ignition OFF, disconnect the harness connector at the M64 Starter Motor.
    2. Test for infinite resistance between the control circuit terminal X1 A or X1 1 and ground..
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the M64 Starter Motor.
    - **Go to next step: If the M64 Starter Motor activates**
11. Test or replace the KR27 Starter Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the appropriate relay.
2. Test for 70 - 150 Ω between terminals (85 or 1) and (86 or 2).
    - **If less than 70 or greater than 150 Ω**

      Replace the relay.

    - **Go to next step: If between 70 - 150 Ω**
3. Test for infinite resistance between the terminals listed below:
    - (30 or 3) and (86 or 2)
    - (30 or 3) and (87 or 5)
    - (30 or 3) and (85 or 1)
    - (85 or 1) and (87 or 5)
    - (86 or 2) and (87 or 5)
    - **If less than infinite resistance**

      Replace the relay.

    - **Go to next step: If infinite resistance**
4. Install a 3 A fused jumper wire between relay terminal (85 or 1) and 12 V. Install a jumper wire between relay terminal (86 or 2) and ground.
5. Test for less than 5.0 Ω between terminals (30 or 3) and (87 or 5).
    - **If 5.0 Ω or greater**

      Replace the relay.

    - **Go to next step: If less than 5.0 Ω**
6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for control module replacement, programming and setup.

mcx30.com

DTC P0615, P0616 OR P0617: STARTER RELAY CONTROL CIRCUIT (WITHOUT KL9)

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
Control	P0615, P0616	P0615, P0616, P305E	P0615, P0617	-
Ground	-	P0615, P0616	-	-

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 Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

mcx30.com

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 Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the KR27 starter relay. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal 86 and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **Go to next step: If less than 10 Ω**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is OK**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the B+ circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is OK and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for infinite resistance between the B+ circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance,
    3. Test for infinite resistance between the control circuit terminal 87 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the KR27 starter relay.
    - **Go to next step: If the test lamp illuminates**
5. Connect a test lamp between the control circuit terminal 85 and the ground circuit terminal 86.
6. Verify the test lamp turns ON and OFF when commanding the starter relay ON and OFF with a scan tool.
    - **If the test lamp is always OFF**
    1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 engine control module.
    - **If the test lamp is always ON**
    1. Ignition OFF, disconnect the harness connector at the K20 engine control module, ignition ON.

mcx30.com

2. Test for less than 1 V between the control circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 engine control module.
- **Go to next step: If the test lamp turns ON and OFF**

7. Ignition ON, connect a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.
8. Verify the M64 starter motor is activated.
    - **If the M64 starter motor does not activate**
    1. Ignition OFF, disconnect the harness connector at the M64 starter motor.
    2. Test for infinite resistance between the control circuit terminal X1 A or X1 1 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the M64 starter motor.
    - **Go to next step: If the M64 starter motor activates**
9. Test or replace the KR27 starter relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the appropriate relay.
2. Test for 70 - 150 Ω between terminals (85 or 1) and (86 or 2).
    - **If less than 70 or greater than 150 Ω**

      Replace the relay.

    - **Go to next step: If between 70 - 150 Ω**
3. Test for infinite resistance between the terminals listed below:
    - (30 or 3) and (86 or 2)
    - (30 or 3) and (87 or 5)
    - (30 or 3) and (85 or 1)
    - (85 or 1) and (87 or 5)
    - (86 or 2) and (87 or 5)
    - **If less than infinite resistance**

      Replace the relay.

    - **Go to next step: If infinite resistance**
4. Install a 3 A fused jumper wire between relay terminal (85 or 1) and 12 V. Install a jumper wire between relay terminal (86 or 2) and ground.
5. Test for less than 5.0 Ω between terminals (30 or 3) and (87 or 5).
    - **If 5.0 Ω or greater**

      Replace the relay.

    - **Go to next step: If less than 5.0 Ω**
6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

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

mcx30.com

DTC P0621: GENERATOR L-TERMINAL CIRCUIT

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	P0621	P0621	-
Control	P0621	P0621	P0621	-
Signal	P0622	P0622	P0622	P0622

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 Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

mcx30.com

- 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

Circuit/System Testing

1. Verify that a test lamp illuminates between the G13 Generator B+ circuit terminal A X1, A X2 (LYX), AX2 (LH7/LTG), B X1, 1 X1 or 1 X2 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF.
   2. Test for greater than 100 Ω between the B+ circuit and ground.
      - If 100 Ω or less, repair the short to ground on the circuit.
      - If greater than 100 Ω, replace the generator.
   - **Go to next step: If the test lamp illuminates**
2. Ignition OFF, disconnect the X2 harness connector at the G13 Generator, engine running.
3. Test for 1 V or greater between the control circuit terminal 1 X1 and ground.
   - **If less than 1 V**
   1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module.
   2. Test for infinite resistance between the control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the control circuit end to end.
      - If greater the 2 Ω, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If 1 V or greater**
4. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module, ignition ON.
5. Test for less than 1 V between the control circuit and ground.
   - **If greater than 1 V,**

     Repair the short to voltage on the circuit.

   - **Go to next step: If 1 V or less**
6. Test or replace the G13 Generator.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Generator Replacement (LYX)Generator Replacement (LTG)Generator Replacement (LH7 - All Wheel Drive)Generator Replacement (LH7 - Front Wheel Drive)
- Control Module References for control module replacement, programming, and setup

mx30.com

DTC P0622: GENERATOR F-TERMINAL CIRCUIT

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+	P0622	P0621	-	-
Control - L Terminal	P0621	P0621	P0621	-
Signal - F Terminal	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%. When the engine is running, the duty cycle should be between 5 - 99%.

Conditions for Running the DTC

- Ignition ON, engine OFF (Prior to Ignition ON, the ignition must have been OFF for at least 5 s)
- Engine running at less than 3, 000 RPM

Conditions for Setting the DTC

- DTC P0621 is not set.
- Ignition ON, engine OFF (Prior to Ignition ON, the ignition must have been OFF for at least 5 s), the ECM detects a PWM signal that is greater than 65% for 5 s
- Engine running at less than 3, 000 RPM - The ECM detects a PWM signal that is less than 5% for 30 s

Action Taken When the DTC Sets

DTC P0622 is a C type DTC

Conditions for Clearing the DTC

- Ignition ON, Engine OFF - Low / no PWM signal detected
- Engine running - A 5 - 90% duty cycle is detected

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

mcx30.com

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

NOTE: **Do not have a battery charger connected during the generator testing.**

1. Engine running.
2. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is between 5 - 90%.
   - **If not between 5 - 90%**

     Refer to Circuit/System Testing.

   - **Go to next step: If between 5 - 90%**
3. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter changes when commanding the headlamps ON and OFF.
   - **If the parameter does not change**

     Refer to Circuit/System Testing.

   - **Go to next step: If the parameter changes**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing below.

   - **Go to next step: If the DTC does not set**
6. All OK.

Circuit/System Testing

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal A X1, A X2 (LYX), AX2 (LH7/LTG), B X1, 1 X1 or 1 X2 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
   2. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Remove the test lamp, disconnect the battery negative cable, and disconnect the G13 Generator B+ cable.
   2. Test for infinite resistance between the B+ circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.

mx30.com

- If infinite resistance, test or replace the G13 Generator.
- **Go to next step: If the test lamp illuminates**

2. Disconnect the X2 harness connector at the G13 Generator, engine running.
3. Verify the scan tool Engine Control Module Generator F - Terminal Signal parameter is less than 5%.
   - **If 5% or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the signal circuit terminal 2 and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If less than 5%**
4. Install a 3 A fused jumper wire between the signal circuit terminal 2 X1 and B+, engine running.
5. Verify the scan tool Engine Control Module Generator F - Terminal Signal parameter is greater than 95%.
   - **If 95% or less**
   1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **Go to next step: If greater than 95%**
6. Test or replace the G13 Generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Generator Replacement (LYX)Generator Replacement (LTG)Generator Replacement (LH7 - All Wheel Drive)Generator Replacement (LH7 - Front Wheel Drive)**
- **Control Module References** for engine control module replacement, programming and setup

DTC P100C OR P100D: BATTERY SENSOR MODULE

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 P100C

Battery Sensor Module Temperature Erratic

DTC P100D

Battery Sensor Module Internal Temperature Circuit Erratic

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

The B110 Battery Sensor Module monitors the battery module and performs internal diagnostics.

Conditions for Running the DTC

- The system voltage is above 11.00 V

mcx30.com

- Engine running

Conditions for Setting the DTC

DTC P100C or P100D

The battery sensor module detects an internal fault.

Action Taken When the DTC Sets

- DTC P100C is a type B DTC.
- DTC P100D is a type B DTC.

Conditions for Clearing the DTC

- DTC P100C is a type B DTC.
- DTC P100D is a type B DTC.

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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. Ignition ON.
2. Verify DTC P100C or P100D is not set.
    - **If the DTC is set**

      Replace the B110 Battery Sensor Module

    - **Go to next step: If the DTC is not set**
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Battery Sensor Replacement (KL9) for B110 Battery Sensor Module replacement

DTC P155E, P155F OR P156E: DC/DC CONVERTER

mcx30.com

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 P155E

DC/DC Converter Actuator Voltage Signal Message Counter Incorrect

DTC P155F

DC/DC Converter Performance Signal Message Counter Incorrect

DTC P156E

DC/DC Converter Crank Control Signal Message Counter Incorrect

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

The T19 Power Supply Transformer is used to boost battery voltage to sensitive loads during engine restart. It provides two voltage outputs that provide the boosted voltage. The power supply transformer communicates to the ECM, and the ECM sets faults for any mismatch between alive rolling counts and protection values.

Conditions for Running the DTC

- Engine running

Conditions for Setting the DTC

P155E

The ECM detects an error in the communication of the Power Supply Transformer actuator voltage signal for greater than 10 counts.

P155F

The ECM detects an error in the communication of the Power Supply Transformer internal health signal for greater than 10 counts.

P156E

The ECM detects an error in the communication of the Power Supply Transformer crank control terminal signal for greater than 10 counts.

Action Taken When the DTC Sets

- DTC P155E, DTC P155F and DTC P156E are type B DTCs.

Conditions for Clearing the DTC

- DTC P155E, DTC P155F and DTC P156E are type B DTCs.

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

mcx30.com

Description and Operation

Stop/Start 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. Ignition ON.
2. Verify that no other DTCs are set except for DTC P155E, DTC P155F or DTC P156E
   - **If any other DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If no other DTCs are set**
3. Replace the T19 Power Supply Transformer.
4. Verify DTC P155E, DTC P155F or DTC P156E does not set while operating the vehicle within the conditions for running the DTC.
   - **If any of the DTCs are set**

     Replace the K20 Engine Control Module.

   - **Go to next step: If none of the DTCs are set**
5. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Multifunction Power Supply Converter Replacement (Equinox)Multifunction Power Supply Converter Replacement (Terrain)**
- **Control Module References** for control module replacement, programming and setup

DTC P156D: DC/DC CONVERTER IGNITION SWITCH RUN/START POSITION SIGNAL MESSAGE COUNTER INCORRECT

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 P156D

DC/DC Converter Ignition Switch Run/Start Position Signal Message Counter Incorrect

For symptom byte information, refer to **Symptom Byte List** .

mcx30.com

Circuit/System Description

The DC/DC converter provides continuous power to certain devices during a stop start event to achieve uninterrupted performance during engine cranking. The ECM monitors the ignition status of the DC/DC converter during start stop events.

Conditions for Running the DTC

- The ignition is ON.
- Ignition voltage is greater than 11 V.

Conditions for Setting the DTC

The engine control module detects a corrupted data message from the DC/DC converter. Communication of the Alive Rolling Count from the DC/DC Converter over CAN bus is incorrect for at least 10 counts for greater than a 3 s period.

Action Taken When the DTC Sets

DTC P156D is a Type B DTC.

Conditions for Clearing the DTC

DTC P156D is a Type B DTC.

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Stop/Start 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 Testing

1. Verify that no other DTCs are set except for DTC P156D.
    - **If any other DTCs are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

    - **Go to next step: If only DTC P156D is set**
2. Replace the T19 Power Supply Transformer.
3. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.
    - **If DTC sets**

      Replace the K20 Engine Control Module.

    - **Go to next step: If DTC does not set**

mcx30.com

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for control module replacement, programming and setup.

DTC P15A3: STOP/START SELECT SWITCH CIRCUIT SIGNAL MESSAGE COUNTER INCORRECT

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 P15A3

Stop/Start Select Switch Circuit Signal Message Counter Incorrect

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

The Engine Control Module (ECM) receives the Stop/Start switch speed signal via CAN from the Body Control Module (BCM).

Conditions for Running the DTC

- The ignition is ON.
- The DTCs run continuously once the above condition is met.

Conditions for Setting the DTC

The ECM receives an invalid Stop/Start switch status serial data message from the BCM.

Action Taken When the DTC Sets

DTC P15A3 00 is a Type C DTC.

Conditions for Clearing the DTC

DTC P15A3 00 is a Type C DTC.

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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

mcx30.com

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition ON
2. Verify with a scan tool that no DTC is set in the BCM.
   - **If any DTC is set**

     Refer to Diagnostic Trouble Code (DTC) List - Vehicle

   - **Go to next step: If no DTC is set**
3. Verify with a scan tool the Engine Control Module Stop/Start Select Switch parameter changes between Yes and No while pressing the Stop/Start switch.
   - **If the parameter does not change**

     Refer to Circuit/System Testing below

   - **Go to next step: If the parameter changes**
4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the S124 Stop/Start Select Switch.
2. Test for less than 10 Ω between the ground circuit terminal 1 and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF.
   2. Test for less than 2 Ω at the ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **Go to next step: If less than 10 Ω**
3. Ignition ON, verify with a scan tool the Engine control Module Stop/Start Select Switch parameter is No.
   - **If the parameter is YES**
   1. Ignition OFF, disconnect the harness connector X3 at the K9 Body Control Module.
   2. Test for infinite resistance between the control circuit and ground.
      - If less than infinite resistance, repair the short to ground at the circuit.
      - If infinite resistance, replace the K9 Body Control Module.
   - **Go to next step: If the parameter is NO**
4. Install a 3 A fused jumper wire between the signal circuit terminal 3 and ground. Verify the ECM scan tool Stop/Start Select Switch parameter is Yes.
   - **If the parameter is NO**
   1. Ignition OFF.
   2. Disconnect the harness connector X3 at the K9 Body Control Module.
   3. Test for less than 1 V the control circuit and ground.
      - If greater than 1 V, repair the short to voltage.
      - If less than 1 V, replace the K9 Body Control Module.
   - **Go to next step: If the parameter is YES**
5. Test or replace the S124 Stop/Start Select Switch.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Floor Console Accessory Function Switch Replacement (Equinox) Floor Console Accessory Function Switch Replacement (Terrain)
- Control Module References for Body Control Module replacement, programming and setup.

mcx30.com

DTC P15FF: BATTERY MONITOR SENSOR SIGNAL MESSAGE COUNTER INCORRECT

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 P15FF

Battery Monitor Sensor Signal Message Counter Incorrect

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

The B110 Battery Sensor Module monitors battery module and performs internal diagnostics. The Battery Sensor Module also communicates to the K20 Engine Control Module (ECM), and the ECM sets faults for any errors in the reported alive rolling counts.

Conditions for Running the DTC

- The system voltage is above 11.00 V
- Engine running

Conditions for Setting the DTC

DTC P15FF

The Battery Sensor Module detects an internal fault, or an error in communication of the alive rolling count is detected for greater than 10 counts.

Action Taken When the DTC Sets

- DTC P15FF is a type B DTC.

Conditions for Clearing the DTC

- DTC P15FF is a type B DTC.

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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

mcx30.com

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P15FF is not set.
    - **If the DTC is set**
    1. Replace the B110 Battery Sensor Module
    - **Go to next step: If the DTC is not set**
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Battery Sensor Replacement (KL9) for Battery Sensor Module replacement

DTC P166F: GENERATOR INFORMATION NOT PROGRAMMED ENGINE CONTROL MODULE (ECM)

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 P166F

Generator Information Not Programmed Engine Control Module (ECM)

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

This DTC sets when the K20 Engine Control Module (ECM) has determined that the G13 Generator information is not stored in the ECM memory. The control functions for the generator are integrated in the ECM. The generator configuration programming must be done when either of the following procedures are performed:

- The ECM is replaced
- The generator has been replaced

Conditions for Running the DTC

- The control module is ON or awake.
- The DTC runs continuously when the above condition is met.

Conditions for Setting the DTC

The ECM detects the generator configuration is not stored in memory.

Action Taken When the DTC Sets

DTCs P166F is a Type A DTC.

Conditions for Clearing the DTC

DTCs P166F is a Type A DTC.

Reference Information

DTC Type Reference

mcx30.com

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
    1. Configure the K20 Engine Control Module.
    2. Verify the DTC does not set.
        - If the DTC sets, replace the K20 Engine Control Module.
        - If the DTC does not set
    3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for ECM replacement, programming, and setup.

DTC P058A, P058B, P058C, P058D, P058E, P058F, P16D4, P16D5, P16D6, P16DC, P16DD, P16DE, P16DF OR P16E1, P16E2, P16E3: BATTERY SENSOR MODULE

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 P058A

Battery Sensor Module Performance

DTC P058B

Battery Sensor Module Current Monitoring Performance

DTC P058C

Battery Sensor Module Temperature Monitoring Performance

DTC P058D

Battery Sensor Module Voltage Monitoring Performance

DTC P058E

Battery Sensor Module Temperature Too High

DTC P058F

Battery Sensor Module Temperature Too Low

DTC P16D4

Battery Sensor Module Circuit Low Voltage

DTC P16D5

Battery Sensor Module Circuit High Voltage

DTC P16D6

mcx30.com

Battery Sensor Module Current Low

DTC P16DC

Battery Sensor Monitor Timer Performance

DTC P16DD

Battery Sensor Module Current High

DTC P16DE

Battery Sensor Internal Temperature Circuit Low Voltage

DTC P16DF

Battery Sensor Internal Temperature Circuit High Voltage

DTC P16E1

Battery Sensor Module Random Access Memory (RAM)

DTC P16E2

Battery Sensor Module Read Only Memory (ROM)

DTC P16E3

Battery Sensor Module Data Incompatible Diagnostic

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

The vehicle control module monitors the system voltage, current, and internal temperature to verify they are within the normal operating range. It also monitors ROM or RAM memory faults, and performs other internal diagnostics.

Conditions for Running the DTC

- The system voltage is above 9.0 V
- The ignition is not OFF

Conditions for Setting the DTC

DTC P058A

The Battery Sensor Module detects an internal fault.

DTC P058B

The Battery Sensor Module detects an internal fault after comparing an induced 50 µA current to the battery sensor module calculated current.

DTC P058C

The Battery Sensor Module detects a difference between raw temperature values to be 10Ã‚Â° C (50.0Ã‚Â° F) for more for 8 out of 10 samples.

DTC P058D

An absolute difference of 5.00 V or more is detected between the 12 V system reference voltage measured by the ECM, and 12 V battery voltage measured by the Battery Sensor Module for 32 out of 40 samples.

DTC P058E

The Battery Sensor Module detects a raw temperature 2 value of 120Ã‚Â° C (248.0Ã‚Â° F) or more for 4 out of 5 samples.

mcx30.com

DTC P058F

The Battery Sensor Module detects a raw temperature 2 value of -43Ã‚Â° C (-45.4Ã‚Â° F) or less for 4 out of 5 samples.

DTC P16DC

The Battery Sensor Module does not properly execute wakeups while the vehicle is asleep.

DTC P16DD

The Battery Sensor Module detects a current of greater than 1400 A.

DTC P16DE

The Battery Sensor Module detects an internal temperature of 120Ã‚Â° C (248.0Ã‚Â° F) or more for 4 out of 5 samples.

DTC P16DF

The Battery Sensor Module detects an internal temperature of -43Ã‚Â° C (-45.4Ã‚Â° F) or less for 4 out of 5 samples.

DTC P16D4

The Battery Sensor Module detects a voltage of less than 3 V.

DTC P16D5

The Battery Sensor Module detects a voltage of greater than 26 V.

DTC P16D6

The Battery Sensor Module detects a current of less than -1400 A.

DTC P16E1

The Battery Sensor Module detects a RAM memory fault.

DTC P16E2

TheBattery Sensor Module detects a ROM memory fault.

DTC P16E3

The Battery Sensor Module is not using the correct configuration information it receives from the ECM.

Action Taken When the DTC Sets

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The MIL will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- The driver information center, if equipped, may display a message.
- Stop/Start system may be disabled.

Conditions for Clearing the DTC

- DTC P058A, DTC P058B, DTC P058C, DTC P058D, DTC P058E, DTC P058F, DTC P16DC, DTC P16DD, DTC P16DE, DTC P16DF, DTC P16D4, DTC P16D5, DTC P16D6, DTC P16E1, DTC P16E2 and DTC P16E3 and are Type C DTCs..
- A current DTC Last Test Failed clears when the diagnostic runs and passes
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.

mc730.com

- Clear the DTC with a scan tool.

Diagnostic Aids

- A high or low voltage DTC set or voltage value in multiple modules/sensors indicates a concern in the charging system.
- A possible cause of this DTC could be overcharging with a battery charger or jump starting.
- A possible cause of this DTC is a discharged battery or a poor/intermittent connection at X1 Battery Sensor Module.

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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. Ignition OFF, measure and record the battery voltage at the battery terminals.
2. Verify the battery voltage stabilizes between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
   - **If battery voltage is less than 12.4 V or more than 12.8 V**

     Refer to **Battery Inspection/Test**.

   - **Go to next step: If battery voltage is between 12.4 and 12.8 V**
3. Engine running, headlights ON, measure and record the battery voltage at the battery terminals.
4. Verify the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.
   - **If the voltage is not at least 1 V greater than the voltage measured in step 1 or is greater than 15 V.**

     Refer to **Charging System Test**.

   - **Go to next step: If the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.**
5. Refer to Circuit/System Testing below.

Circuit/System Testing

NOTE: **Some control module ground circuits may require up to 20 min after the ignition is turned off before achieving a resistance reading of less than 5 Ω. In most cases the**

mcx30.com

readings will drop below 20 Ω within 1 min indicating the control module is going to sleep.

1. Ignition OFF and all vehicle systems OFF.
2. Disconnect the C1 Battery.
3. Test for less than 2 Ω between the B110 Battery Sensor Module clamp and B110 Battery Sensor Module ground connection.
   - **If 2 Ω or greater**

     Replace B110 Battery Sensor Module.

   - **Go to next step: If less than 2 Ω**
4. Reconnect the C1 Battery.
5. Disconnect the harness connector at the B110 Battery Sensor Module.
6. Verify a test lamp illuminates between B+ circuit terminal 2 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF.
   2. Disconnect the C1 Battery.
   3. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF.
   2. Disconnect the C1 Battery
   3. Test for infinite resistance between the B+ circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the B110 Battery Sensor Module.
   - **Go to next step: If the test lamp illuminates**
7. Replace the B110 Battery Sensor Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Battery Sensor Replacement (KL9) for B110 Battery Sensor Module replacement

DTC P26E4, P26E5, P26E6: STARTER DRIVE PINION RELAY CONTROL CIRCUIT

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 P26E4

Starter Drive Pinion Relay Control Circuit

DTC P26E5

Starter Drive Pinion Relay Control Circuit Low Voltage

DTC P26E6

Starter Drive Pinion Relay Control Circuit High Voltage

Diagnostic Fault Information

mcx30.com

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Switch B+ Terminal 30	1	1	-	-
Relay Starter Enable Control Terminal 86	P26E5	P26E4, P26E6	P26E6	-
Relay Switch Control Terminal 87	2	1	2	-
Relay Coil Ground Terminal 85	-	P26E4, P26E6	-	-
1. Opens fuse, Starter pinion inop. 2. Starter pinion spins all the time.				

Circuit/System Description

When the ignition is activated to start the vehicle, a discrete signal is supplied to the engine control module (ECM). The ECM then verifies that the clutch pedal is pressed or the transmission is in park/neutral. If it is, the ECM then supplies 12 V to the control circuit of the starter drive pinion relay. When this occurs, battery voltage is supplied through the switch of the starter relay to the starter pinion.

Conditions for Running the DTC

- The ignition is activated to START.
- 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 P26E4, P26E5, and P26E6 are C type DTCs.

Conditions for Clearing the DTC

DTC P26E4, P26E5, and P26E6 are C type DTCs.

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

mcx30.com

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the KR27C Starter Pinion Solenoid Actuator Relay. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal 85 and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **Go to next step: If less than 10 Ω**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is good and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF.
   2. Test for infinite resistance between the B+ circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance,
   3. Test for infinite resistance between the control circuit terminal 87 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the M64 Starter Motor.
   - **Go to next step: If the test lamp illuminates**
5. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85.

   NOTE: **If the Starter Pinion Relay command is not available in the scan tool, verify the test lamps turns on and off when cycling the ignition between the OFF and CRANK position with the parking brake set and clutch pedal pressed (manual transmission) or the transmission in park (automatic transmission).**

6. Verify the test lamp turns ON and OFF when commanding the Starter Pinion Relay ON and OFF with a scan tool.
   - **If the test lamp is always OFF**
   1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If the test lamp is always ON**
   1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **Go to next step: If the test lamp turns ON and OFF**
7. Ignition ON, connect a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.

mx30.com

8. Verify the M64 Starter Motor is activated.
    - **If the M64 Starter Motor does not activate**
    1. Ignition OFF, disconnect the harness connector at the M64 Starter Motor.
    2. Test for infinite resistance between the control circuit terminal X1 2 or X1 B and ground..
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the M64 Starter Motor.
    - **Go to next step: If the M64 Starter Motor activates**
9. Test or replace the KR27C Starter Pinion Solenoid Actuator Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the appropriate relay.
2. Test for 70 - 150 Ω between terminals (85 or 1) and (86 or 2).
    - **If less than 70 or greater than 150 Ω**

      Replace the relay.

    - **Go to next step: If between 70 - 150 Ω**
3. Test for infinite resistance between the terminals listed below:
    - (30 or 3) and (86 or 2)
    - (30 or 3) and (87 or 5)
    - (30 or 3) and (85 or 1)
    - (85 or 1) and (87 or 5)
    - (86 or 2) and (87 or 5)
    - **If less than infinite resistance**

      Replace the relay.

    - **Go to next step: If infinite resistance**
4. Install a 3 A fused jumper wire between relay terminal (85 or 1) and 12 V. Install a jumper wire between relay terminal (86 or 2) and ground.
5. Test for less than 5.0 Ω between terminals (30 or 3) and (87 or 5).
    - **If 5.0 Ω or greater**

      Replace the relay.

    - **Go to next step: If less than 5.0 Ω**
6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for control module replacement, programming and setup.

DTC P3051, P3053 OR P3055: DC/DC CONVERTER ACTUATOR VOLTAGE

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

mcx30.com

DTC P3051

DC/DC Converter Actuator Voltage Sensor Circuit 1 Low Voltage

DTC P3053

DC/DC Converter Actuator Voltage Sensor Circuit 1 High Voltage

DTC P3055

DC/DC Converter Actuator Voltage 1 Performance

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ Terminal 11	-	P3051, P3055, U260A, B3980, B1325, U0155, U0184, U0198, U0230, U1501*	-	-
B+ Terminal 8	-	P3052, P3056, U18D2, U18D3, U0101, U0422*	-	-
Control Terminal 5	B1445 0B, P3051	B1445 04, P305E*	P3053	P3055
Ignition terminal 4	-	U18A7	-	-
Ignition terminal 6	-	P305C, P305E	-	-
* Other DTCs may set with this fault.				

Circuit/System Description

The T19 Power Supply Transformer is used to boost battery voltage to sensitive loads during engine restart. It provides two voltage outputs that provide the boosted voltage. The Power Supply Transformer communicates to the Engine Control Module (ECM). When the engine is not cranking, the Power Supply Transformer passes through voltage from the two supply circuits. The ECM receives data about the sensed output voltages provided by the Power Supply Transformer.

Diagnostic Aids

- If P3055 is set, verify ECM and T19 Power Supply Transformer grounds are clean and tight.
- Ground circuits for the area of customer concern are clean, tight, and in the correct location. Refer to Ground Distribution Schematics and Harness Routing Views
- Verify all devices powered by the T19 Power Supply Transformer are operating properly.
- B+ circuit terminal 11 supplies voltage to output circuit terminal 10, function 12 V regulated supply voltage 1
- B+ circuit terminal 8 supplies voltage to output circuit terminal 9, function 12 V regulated supply voltage 2

Conditions for Running the DTC

Ignition ON

Conditions for Setting the DTC

P3051

The ECM detects the DC/DC converter actuator voltage 1 is less than 1 V.

P3053

The ECM detects the DC/DC converter actuator voltage 1 is greater than 28 V.

P3055

The ECM detects the difference between the ECM IGN voltage and DC/DC converter output is greater than or equal to 1 V.

Action Taken When the DTC Sets

- DTC P3051, P3053 and P3055 are type B DTCs.

Conditions for Clearing the DTC

- DTC P3051, P3053 and P3055 are type B DTCs.

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Stop/Start 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

NOTE: **Use schematics to determine which devices are powered up on the T19 Power Supply Transformer B+ supply circuit terminal 10 X1.**

1. Ignition OFF, measure and record the battery voltage at the battery terminals.
2. Verify the battery voltage stabilizes between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
   - **If battery voltage is less than 12.4 V or more than 12.8 V**

     Refer to **Battery Inspection/Test**.

   - **Go to next step: If battery voltage is between 12.4 and 12.8 V**
3. Verify ECM ground is clean and tight.
4. Engine running, headlights ON, measure and record the battery voltage at the battery terminals.
5. Verify the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.
   - **If the voltage is not at least 1 V greater than the voltage measured in step 1 or is greater than 15 V.**

     Refer to **Charging System Test**.

   - **Go to next step: If the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.**
6. Ignition ON.

mcx30.com

7. Verify that the appropriate devices controlled by the T19 Power Supply Transformer control circuit terminal 10 X1 turn ON when cycling the ignition ON.
    - **If the devices do not turn ON**

      Refer to Circuit/System Testing below.

    - **Go to next step: If the devices turn ON**
8. Verify DTC P3051, P3053 or P3055 does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing below.

    - **Go to next step: If the DTC does not set**
9. All OK.

Circuit/System Testing

NOTE: **You must perform Circuit/System Verification before Circuit/System Testing.**

1. Ign Off and all vehicle systems OFF, disconnect harness connector at T19 Power Supply Transformer. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between each circuit ground terminal at the T19 Power Supply Transformer listed below and ground:
    - Terminal 7
    - Terminal 12
3. Disconnect harness connector at the K20 Engine Control Module.
4. Test for less than 5 Ω between each ground circuit terminal and ground.
    - **If 5 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **Go to next step: If less than 5 Ω**
5. Verify a test lamp illuminates between each of the B+ circuits at the T19 Power Supply Transformer listed below and ground:
    - Terminal 8
    - Terminal 11
    - **If the test lamp does not illuminate**
    1. Ignition OFF, remove the test lamp, remove appropriate fuses.
    2. Test for infinite resistance between the B+ circuit and ground.
        - less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the B+ circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the T19 Power Supply Transformer.
    - **Go to next step: If the test lamp illuminates**
6. Ignition ON.
7. Verify a test lamp illuminates between each of the Ign circuits at the T19 Power Supply Transformer listed below and ground:
    - Terminal 4
    - Terminal 6
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF, remove the test lamp.
    2. Test for less than 2 Ω in the ignition circuit end to end.

mcx30.com

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω, verify the fuse is OK and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp.
2. Test for infinite resistance between the ignition circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the T19 Power Supply Transformer.

- **Go to next step: If the test lamp illuminates**

8. Ignition Off. Reconnect T19 Power Supply Transformer.
9. Clear codes and operate vehicle in conditions for an autostop.
10. Verify DTC P3051, P3053 or P3055 does not set.
    - **If any of the DTCs are set**

      If DTC sets, replace T19 Power Supply Transformer.

    - **Go to next step: If none of the DTCs are set**
11. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Multifunction Power Supply Converter Replacement (Equinox)Multifunction Power Supply Converter Replacement (Terrain)** for T19 Power Supply Transformer replacement
- **Control Module References** for control module replacement, programming, and setup

DTC P3052, P3054 OR P3056: DC/DC CONVERTER ACTUATOR VOLTAGE

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 P3052

DC/DC Converter Actuator Voltage Sensor Circuit 2 Low Voltage

DTC P3054

DC/DC Converter Actuator Voltage Sensor Circuit 2 High Voltage

DTC P3056

DC/DC Converter Actuator Voltage 2 Performance

For symptom byte information, refer to **Symptom Byte List** .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ Terminal 11	-	P3051, P3055, U260A, B3980, B1325, U0155, U0184, U0198, U0230, U1501*	-	-
B+ Terminal 8	-	P3052, P3056, U18D2, U18D3, U0101, U0422*	-	-
Control Terminal 5	B1445 0B, P3051	B1445 04, P305E*	P3053	P3055

mc30.com

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition terminal 4	-	U18A7	-	-
Ignition terminal 6	-	P305C, P305E	-	-
* Other DTC's may set with this fault.				

Circuit/System Description

The T19 Power Supply Transformer is used to boost battery voltage to sensitive loads during engine restart. It provides two voltage outputs that provide the boosted voltage. The Power Supply Transformer communicates to the Engine Control Module (ECM). When the engine is not cranking, the power supply transformer passes through voltage from the two supply circuits. The ECM receives data about the sensed output voltages provided by the power supply transformer.

Diagnostic Aids

- If P3056 is set, verify ECM and T19 Power Supply Transformer grounds are clean and tight.
- Ground circuits for the area of customer concern are clean, tight, and in the correct location. Refer to Ground Distribution Wiring Schematics and Harness Routing Views
- Verify all devices powered by the T19 Power Supply Transformer are operating properly.
- B+ circuit terminal 11 supplies voltage to output circuit terminal 10, function 12 V regulated supply voltage 1
- B+ circuit terminal 8 supplies voltage to output circuit terminal 9, function 12 V regulated supply voltage 2

Conditions for Running the DTC

Ignition ON

Conditions for Setting the DTC

P3052

The ECM detects the DC/DC converter actuator voltage 1 is less than 1 V.

P3054

The ECM detects the DC/DC converter actuator voltage 1 is greater than 28 V.

P3056

The ECM detects the difference between the ECM IGN voltage and DC/DC converter output is greater than or equal to 1 V.

Action Taken When the DTC Sets

- DTC P3052, P3054 and P3056 are type B DTCs

Conditions for Clearing the DTC

- DTC P3052, P3054 and P3056 are type B DTCs

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Stop/Start System Description and Operation

Electrical Information Reference

mcx30.com

- 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

NOTE: **Use schematics to determine which devices are powered up on the T19 Power Supply Transformer B+ supply circuit terminal 10 X1.**

1. Ignition OFF, measure and record the battery voltage at the battery terminals.
2. Verify the battery voltage stabilizes between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
   - **If battery voltage is less than 12.4 V or more than 12.8 V**

     Refer to Battery Inspection/Test.

   - **Go to next step: If battery voltage is between 12.4 and 12.8 V**
3. Verify ECM ground is clean and tight.
4. Engine running, headlights ON, measure and record the battery voltage at the battery terminals.
5. Verify the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.
   - **If the voltage is not at least 1 V greater than the voltage measured in step 1 or is greater than 15 V.**

     Refer to Charging System Test.

   - **Go to next step: If the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.**
6. Ignition ON.
7. Verify that the appropriate devices controlled by the T19 Power Supply Transformer control circuit terminal 10 X1 turn ON when cycling the ignition ON.
   - **If the devices do not turn ON**

     Refer to Circuit/System Testing below.

   - **Go to next step: If the devices turn ON**
8. Verify DTC P3052, P3054 or P3056 does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing below.

   - **Go to next step: If the DTC does not set**
9. All OK.

Circuit/System Testing

NOTE: **You must perform Circuit/System Verification before Circuit/System Testing.**

1. Ign Off and all vehicle systems OFF, disconnect harness connector at T19 Power Supply Transformer. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between each circuit ground terminal at the T19 Power Supply Transformer listed below and ground:
   - Terminal 7

mcx30.com

- Terminal 12

3. Disconnect harness connector at the K20 Engine Control Module.
4. Test for less than 5 Ω between each ground circuit terminal and ground.
    - **If 5 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **Go to next step: If less than 5 Ω**
5. Verify a test lamp illuminates between each of the B+ circuits at the T19 Power Supply Transformer listed below and ground:
    - Terminal 8
    - Terminal 11
    - **If the test lamp does not illuminate**
    1. Ignition OFF, remove the test lamp, remove appropriate fuses.
    2. Test for infinite resistance between the B+ circuit and ground.
        - less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the B+ circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the T19 Power Supply Transformer.
    - **Go to next step: If the test lamp illuminates**
6. Ignition ON.
7. Verify a test lamp illuminates between each of the Ign circuits at the T19 Power Supply Transformer listed below and ground:
    - Terminal 4
    - Terminal 6
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF, remove the test lamp.
    2. Test for less than 2 Ω in the ignition circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is OK and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF, remove the test lamp.
    2. Test for infinite resistance between the ignition circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the T19 Power Supply Transformer.
    - **Go to next step: If the test lamp illuminates**
8. Ignition Off. Reconnect T19 Power Supply Transformer.
9. Clear codes and operate vehicle in conditions for an autostop.
10. Verify DTC P3052, P3054, or P3056 does not set.
    - **If any of the DTCs are set**

      If DTC sets, replace T19 Power Supply Transformer.

    - **Go to next step: If none of the DTCs are set**
11. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

mx30.com

- Multifunction Power Supply Converter Replacement (Equinox)Multifunction Power Supply Converter Replacement (Terrain) for T19 Power Supply Transformer replacement
- Control Module References for control module replacement, programming and setup.

DTC P305D OR P305E: DC/DC CONVERTER CRANK CONTROL CIRCUIT

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 P305D

DC/DC Converter Crank Control Circuit High Voltage

DTC P305E

DC/DC Converter Crank Control Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Starter Relay B+	1	1	-	-
Starter Relay Control	P305E, 2	1	P305D	-
Power Supply Transformer Control	P305E, 2	P305E	P305D	-
1. Starter Solenoid Does Not Click 2. Starter spins all the time				

Circuit/System Description

The power supply transformer is used to boost battery voltage to sensitive loads during engine restart. It provides two voltage outputs that provide the boosted voltage. The power supply transformer communicates to the ECM, and sends to the ECM the state of the crank control input.

Conditions for Running the DTC

- Ignition ON

Conditions for Setting the DTC

P305D

The ECM detects the DC/DC converter crank control is high when it should be low.

P305E

The ECM detects the DC/DC converter crank control is low when it should be high.

Action Taken When the DTC Sets

- DTC P305D is a type B DTC.
- DTC P305E is a type A DTC.

Conditions for Clearing the DTC

- DTC P305D is a type B DTC.
- DTC P305E is a type A DTC.

Diagnostic Aids

mx30.com

- These DTC's can be set when programming the Engine Control Module. Please follow the programming and setup instructions if a DTC sets.

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Stop/Start 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 Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the KR27 Starter Relay. It may take up to 2 minutes for all vehicle systems to power down, Ignition ON.
2. Verify a test lamp illuminates between the ignition circuit terminal 86 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF, remove the test lamp.
    2. Test for less than 2 Ω in the ignition circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, refer to **Power Mode Mismatch** .
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF, remove the test lamp.
    2. Test for infinite resistance between the ignition circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Connect the KR27 Starter Relay and replace the fuse.
    4. Verify the fuse does not open when connecting the KR27 Starter Relay.
        - If the fuse opens, replace the KR27 Starter Relay.
        - If the fuse is OK
    5. All OK
    - **Go to next step: If the test lamp illuminates**
3. Ignition OFF, disconnect the harness connector at the T19 Power Supply Transformer, Ignition ON.
4. Connect a test lamp between ignition circuit terminal 86 and the control circuit terminal 85 at the KR27 Starter Relay.

NOTE: **If the Starter Relay command is not available in the scan tool, verify the test lamps turns on and off when cycling the ignition between the OFF and CRANK**

position with the parking brake set and clutch pedal pressed (manual transmission) or the transmission in park (automatic transmission).

5. Verify the test lamp turns ON and OFF when commanding the KR27 Starter Relay ON and OFF with a scan tool.
    - **If the test lamp is always OFF**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, Ignition ON.
    2. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1V
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If the test lamp is always ON**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, Ignition ON.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module
    - **Go to next step: If the test lamp turns ON and OFF**
6. Connect a test lamp between the control circuit terminal 5 at the T19 Power Supply Transformer and B+.

    NOTE: **If the Starter Relay command is not available in the scan tool, verify the test lamps turns on and off when cycling the ignition between the OFF and CRANK position with the parking brake set and clutch pedal pressed (manual transmission) or the transmission in park (automatic transmission).**

7. Verify the test lamp turns ON and OFF when commanding the KR27 Starter Relay ON and OFF with a scan tool.
    - **If the test lamp is always OFF**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, Ignition ON.
    2. Test for less than 1 V between the control circuit terminal 5 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1V
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If the test lamp is always ON**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, Ignition ON.
    2. Test for infinite resistance between the control circuit terminal 5 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module
    - **Go to next step: If the test lamp turns ON and OFF**
8. Replace the T19 Power Supply Transformer

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Multifunction Power Supply Converter Replacement (Equinox)Multifunction Power Supply Converter Replacement (Terrain)** for T19 Power Supply Transformer replacement
- **Control Module References** for control module replacement, programming, and setup

PROACTIVE ALERT IDENTIFIER SAC001

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** for an overview of the diagnostic approach.

Proactive Alert Identifier Descriptor

Proactive Alert Identifier Service Message Identifier SAC001

Predicted Starting and Charging - Battery - Low Cranking Capacity Due to Shorted Cell

Conditions for Running the Proactive Alert Identifier

Service message present.

Conditions for Setting the Proactive Alert Identifier

Battery low cranking capacity due to shorted cell detected.

Diagnostic Aids

- This Service Message does not require any diagnosis.
- DO NOT use the EL-50313 Midtronics GR8 Battery Tester/Charger. Refer to Battery Replacement in SI.
- No other action is required as the Service Message will automatically clear once the battery is replaced and the vehicle is operated over a number of ignition cycles. Other on board DTCs may have set if the vehicle experienced a low voltage condition.

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Electrical Information Reference

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

Special Tools

Equivalent regional tools **Special Tools**

Circuit/System Verification

1. Verify if Service Message is present.
    - **If Service message is present.**

      Refer to **Battery Replacement**

    - **Go to next step: If Service Message is not present.**
2. All Ok.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Battery Replacement**

PROACTIVE ALERT IDENTIFIER SAC002

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**

mcx30.com

- Review the description of Strategy Based Diagnosis:**Strategy Based Diagnosis**
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Proactive Alert Identifier Descriptor

Proactive Alert Identifier Service Message Identifier SAC002

Predicted Starting and Charging - Low Cranking Capability Due to High Resistance**.**

Conditions for Running the Proactive Alert Identifier

Service message present.

Conditions for Setting the Proactive Alert Identifier

Low Cranking Capability Due to High Resistance

Diagnostic Aids

- No other action is required as the Service Message will automatically clear once the system is replaced. Other on board DTCs may have set if the vehicle experienced a low voltage condition.
- Use the scan tool to clear ALL DTCs prior to releasing the vehicle to the Customer.

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Electrical Information Reference

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

Special Tools

Equivalent regional tools **Special Tools**

Circuit/System Testing

1. Verify the battery cable connections are clean and tight.
2. Verify Voltage is between 12.0 - 15.0 V
   - **If not within the specified range** Refer to **Battery Inspection/Test**
   - **Go to next step: If within the specified range**
3. Test for less than the 0.5 V drop between the positive battery cable at the battery and the positive battery cable at the M64 starter motor as the ignition is placed in the CRANK/START position.
   - **If greater than 0.5 V**

     Replace the positive battery cable.

   - **Go to next step: If less than 0.5 V**
4. Test for less than 0.5 V drop between the negative battery cable and the M64 starter motor case as the ignition switch is placed in the CRANK/START position.
   - **If greater than 0.5 V**

     Replace the negative battery cable.

   - **Go to next step: If less than 0.5 V**
5. Replace the Battery.

Repair Instructions

mcx30.com

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Battery Replacement**
- **Battery Negative Cable Replacement**
- **Starter Solenoid Cable Replacement (LYX - All Wheel Drive)Starter Solenoid Cable Replacement (LYX - Front Wheel Drive)Starter Solenoid Cable Replacement (Chevrolet LTG - All Wheel Drive)Starter Solenoid Cable Replacement (Chevrolet LTG - Front Wheel Drive)Starter Solenoid Cable Replacement (Chevrolet LH7 - Front Wheel Drive)Starter Solenoid Cable Replacement (Chevrolet LH7 - All Wheel Drive)Starter Solenoid Cable Replacement (GMC LH7 - All Wheel Drive)Starter Solenoid Cable Replacement (GMC LH7 - Front Wheel Drive)Starter Solenoid Cable Replacement (GMC LTG - All Wheel Drive)Starter Solenoid Cable Replacement (GMC LTG - Front Wheel Drive)**

PROACTIVE ALERT IDENTIFIER SAC003

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.
- Review **Diagnostic Procedure Instructions** for an overview of the diagnostic approach.

Proactive Alert Identifier Descriptor

Proactive Alert Identifier Service Message Identifier SAC003

Predicted Starting and Charging - Battery - Low Cranking Capability Due to Low State of Charge

Conditions for Running the Proactive Alert Identifier

Service message present.

Conditions for Setting the Proactive Alert Identifier

Battery Low Cranking Capability Due to Low State of Charge.

Diagnostic Aids

- Follow the instructions in SI for Battery Inspection/Test and Battery Charging using the EL-50313 Midtronics GR8 Battery Tester/Charger.
- Perform the Battery Electrical Drain/Parasitic Load Test in order to verify the cause of the low battery, such as aftermarket equipment, Customer driving habits, etc. Refer to SI.
- No other action is required as the Service Message will automatically clear once the battery is charged properly and the vehicle is operated over a number of ignition cycles. Other on board DTCs may have set if the vehicle experienced a low voltage condition.
- Use the scan tool to clear ALL DTCs prior to releasing the vehicle to the Customer.

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Electrical Information Reference

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

Special Tools

Equivalent regional tools **Special Tools**

Circuit/System Verification

mc730.com

1. Verify the Service Message is present.
    - **If Service Message is Present**

      Refer to **Battery Inspection/Test** and **Battery Charging**

      Perform **Battery Electrical Drain/Parasitic Load Test**

    - **Go to next step: If Service Message is not Present.**
2. All Ok.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

PROACTIVE ALERT IDENTIFIER SAC004

Diagnostic Instructions

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

Proactive Alert Identifier Descriptor

Proactive Alert Identifier Service Message Identifier SAC004

Predicted Starting and Charging - Low Cranking Capability Due to High Resistance in Starter System

Conditions for Running the Proactive Alert Identifier

Service message present.

Conditions for Setting the Proactive Alert Identifier

Low Cranking Capability Due to High Resistance in Starter System.

Diagnostic Aids

- No other action is required as the Service Message will automatically clear once the system is replaced. Other on board DTCs may have set if the vehicle experienced a low voltage condition.
- Use the scan tool to clear ALL DTCs prior to releasing the vehicle to the Customer.

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Electrical Information Reference

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

Special Tools

Equivalent regional tools: **Special Tools**

Circuit/System Testing

1. Verify the battery cable connections are clean and tight.
2. Verify Voltage is between 12.0 - 15.0 V

mcx30.com

- **If not within the specified range** Refer to **Battery Inspection/Test**
- **Go to next step: If within the specified range**

3. Test for less than the 0.5 V drop between the positive battery cable at the battery and the positive battery cable at the M64 starter motor as the ignition is placed in the CRANK/START position.
   - **If greater than 0.5 V**

     Replace the positive battery cable.

   - **Go to next step: If less than 0.5 V**
4. Test for less than 0.5 V drop between the negative battery cable and the M64 starter motor case as the ignition switch is placed in the CRANK/START position.
   - **If greater than 0.5 V**

     Replace the negative battery cable.

   - **Go to next step: If less than 0.5 V**
5. Replace the Starter.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Starter Replacement (LYX - All Wheel Drive)Starter Replacement (LYX - Front Wheel Drive)Starter Replacement (LTG - All Wheel Drive)Starter Replacement (LTG - Front Wheel Drive)Starter Replacement (LH7 - All Wheel Drive)Starter Replacement (LH7 - Front Wheel Drive)**

PROACTIVE ALERT IDENTIFIER SAC005

Diagnostic Instructions

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

Proactive Alert Identifier Descriptor

Proactive Alert Identifier Service Message Identifier SAC005

System Performance - Low Cranking Capability Due to High Resistance in Battery or Short in Starter

Conditions for Running the Proactive Alert Identifier

Service message present.

Conditions for Setting the Proactive Alert Identifier

Low Cranking Capability Due to High Resistance in Battery or Short in Starter.

Diagnostic Aids

- No other action is required as the Service Message will automatically clear once the system is replaced. Other on board DTCs may have set if the vehicle experienced a low voltage condition.
- Use the scan tool to clear ALL DTCs prior to releasing the vehicle to the Customer.

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Electrical Information Reference

- **Circuit Testing**

mcx30.com

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

Special Tools

Equivalent regional tools: Special Tools

Circuit/System Testing

1. Ignition OFF, measure and record the C1 Battery voltage at the terminals.
2. Verify the measured voltage is between 12.0 - 15.0 V.
   - **If voltage is less than 12.0 V or greater than 15.0 V**

     Refer to Battery Inspection/Test.

   - **Go to next step: If voltage is between 12.0 - 15.0 V**
3. Test for less than 0.5 V between the positive battery terminal and positive terminal at the X50D Fuse Block - Battery with the ignition in the CRANK/START position.
   - **If 0.5 V or greater**

     Replace the positive battery cable.

   - **Go to next step: If less than 0.5 V**
4. Test for less than 0.5 V between the positive battery cable at the X50D Fuse Block - Battery and terminal 1 X2 or A X2 at the M64 Starter Motor with the ignition in the CRANK/START position.
   - **If 0.5 V or greater**

     Replace the positive battery cable.

   - **Go to next step: If less than 0.5 V**
5. Test for less than 0.5 V between the negative battery cable and the M64 Starter Motor case with the ignition in the CRANK/START position.
   - **If 0.5 V or greater**

     Replace the negative battery cable.

   - **Go to next step: If less than 0.5 V**
6. Perform Battery Inspection/Test Using the EL-50313 Midtronics Battery Tester/Charger.
   - **If Battery Fails the Test**

     Replace the C1 battery.

   - **Go to next step: If the Battery Passes the Test**

     Replace the M64 Starter Motor.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: Diagnostic Repair Verification

- Battery Replacement
- Battery Negative Cable Replacement
- Battery Positive Junction Block Cable Replacement
- Starter Replacement (LYX - All Wheel Drive)Starter Replacement (LYX - Front Wheel Drive)Starter Replacement (LTG - All Wheel Drive)Starter Replacement (LTG - Front Wheel Drive)Starter Replacement (LH7 - All Wheel Drive)Starter Replacement (LH7 - Front Wheel Drive)
- Starter Solenoid Cable Replacement (LYX - All Wheel Drive)Starter Solenoid Cable Replacement (LYX - Front Wheel Drive)Starter Solenoid Cable Replacement (Chevrolet LTG - All Wheel Drive)Starter Solenoid Cable Replacement (Chevrolet LTG - Front Wheel Drive)Starter Solenoid Cable Replacement (Chevrolet LH7 - Front Wheel Drive)Starter Solenoid Cable Replacement (Chevrolet LH7 - All Wheel

mcx30.com

Drive)Starter Solenoid Cable Replacement (GMC LH7 - All Wheel Drive)Starter Solenoid Cable Replacement (GMC LH7 - Front Wheel Drive)Starter Solenoid Cable Replacement (GMC LTG - All Wheel Drive)Starter Solenoid Cable Replacement (GMC LTG - Front Wheel Drive)

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

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 (Without KL9)Starter Solenoid Does Not Click (KL9)
- Starter Solenoid Clicks, Engine Does Not Crank (Without KL9)Starter Solenoid Clicks, Engine Does Not Crank (KL9)
- Engine Cranks Slowly
- Starter Noise Diagnosis

BATTERY INSPECTION/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.

Diagnostic Aids

NOTE: **For Warranty repairs you must use regionally required battery test equipment for warranty repairs.**

For accurate test results the battery must be disconnected from the vehicle and the equipment connected directly to the battery posts. When setting up the equipment,

mcx30.com

select "Out of Vehicle" and then the correct battery type (Flooded, AGM or Stop/Start AGM) and rated CCA (both from the battery label) must be entered.

- **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 (battery disconnected with test equipment connected directly to the posts) for each battery when testing a vehicle with dual batteries.**

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 50313 Battery Tester For equivalent regional tools, refer to **Special Tools**

Circuit/System Testing

WARNING: **Unless directed otherwise, the ignition must be OFF with the key removed, 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 OnStarÃ‚Â® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStarÃ‚Â® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStarÃ‚Â®module). Do not disconnect the main vehicle battery or remove the OnStarÃ‚Â® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStarÃ‚Â® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStarÃ‚Â® Back-Up Battery 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 back-up battery is not rechargeable and once activated the back-up battery must be replaced.

mcx30.com

1. Verify the C1 Battery or C1B Battery - Auxiliary (if equipped) case is not cracked, broken, or damaged, which may be indicated by battery acid leakage.
    - **If there is any apparent damage**

      Replace the C1 Battery or C1B Battery - Auxiliary.

    - **Go to next step: If there is no damage**
2. Verify that the battery cables are clean and tight. The battery terminal bolts should be torqued as specified in **Fastener Specifications**.
    - **If the battery cables need to be cleaned or tightened**

      Clean as required and tighten as specified.

    - **Go to next step: If the battery cables are clean and tight**
3. Disconnect battery from the vehicle. There is no need to remove the battery from the vehicle.
4. Connect the EL-50313 directly to the battery terminal posts.
5. Select "Charging," "Diagnostic" and "Out of Vehicle" when setting up the test.
6. Select the proper battery type, Flooded, AGM or Stop/Start AGM.
7. Enter the CCA as shown on the battery label.
8. Verify the test result is not REPLACE BATTERY or BAD CELL-REPLACE

    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 Out of Vehicle test.**

    - **If the test result is REPLACE BATTERY or BAD CELL-REPLACE**

      Replace the C1 Battery or C1B Battery - Auxiliary.

    - **Go to next step: If the test result is not REPLACE BATTERY or BAD CELL-REPLACE**
9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Battery Replacement

BATTERY CHARGING

Special Tools

EL 50313 Battery Tester

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

Diagnostic Aids

- 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 50313 before charging.
- An AGM battery may be damaged if charged to more than 14.5 V.
- A Flooded Cell battery may be damaged if charged to more than 16.5 V.
- Vehicles with dual batteries must be charged individually which will result in two printouts.

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**

mcx30.com

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 battery's 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 % 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 0Ã‚Â°C (32Ã‚Â°F)	% Charge at 25Ã‚Â°C (75Ã‚Â°F)
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% must always be recharged before returning it to service or continuing storage.
- A battery with a state of charge that is 65% 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%, 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.

1. Ensure that all of the battery terminal connections are clean and tight.
2. 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.**

3. 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.
4. Select "Charging," "PDI" and "In Vehicle" when setting up the charger.
5. Select the proper battery type, Flooded, AGM, Spiral AGM or Stop/Start AGM.
6. Enter the CCA as shown on the battery label.

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 vehicles 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 min or longer after turning the ignition off before going to sleep. Other modules may periodically wake up then go back to sleep. These are all normal conditions.

Diagnostic Aids

- 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 may 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 OnStarÃ‚Â®, and regulated voltage control, 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 min. The typical current draw for this is about 1 A.
- Digital OnStar generation 6 and later vehicle communication interface module do not "wake up" every 10 min for the first 48 h as the generation 5 and prior. generation 6 and later vehicle communication interface module current draw is very low, less than 40 mA, so the OnStar system is left in that state for up to the first 48 h.

mex30.com

Parasitic draw of up to 40 mA with an occasional spike as high as 80 mA through the vehicle communication interface module for the first 48 h 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 remote keyless entry receiver for monitoring purposes, actual system wake up only occurs when the fobs for the vehicle are used. When other devices on the same remote keyless entry operating frequency are activated, such as the 4 tire pressure monitoring sensors and other vehicle FOBs in the vicinity, the remote keyless entry 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 remote keyless entry 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 the label on the original battery 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 may be longer. If the reserve capacity is lower, then the battery run down time may be shorter. The graph below indicates roughly how many days a 690 cold cranking amperage battery with a 110 min reserve capacity starting at 80% state of charge will last with a constant current draw until it reaches 50% state of charge. Differences in battery reserve capacity and temperature will affect the results.

Current Drain	Days
25 mA	33
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

mcx30.com

Reference Information

Schematic Reference

Control Module References

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 min but it can take up to 2 h 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 s.**
- **Closing the door latches/ajar switch while leaving the doors open is recommended, this allows the vehicle systems to perform in a "doors 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 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 min 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 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 (KL9).
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.

mcx30.com

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.
    - Failed: If the jumper wire fuse is blown, refer to Circuit/System Testing.
    - Passed
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 Wiring Schematics to diagnose exactly which circuit of the suspect system is causing the high parasitic drain. The following is a list of common components that could cause a high current draw:

- Stuck switch
- Stuck relay
- Control module

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

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.

Diagnostic Fault Information

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

Circuit/System Description

mcx30.com

The K20 Engine Control Module (ECM) uses the G13 Generator turn ON control circuit, or L-terminal circuit, to control the load of the Generator on the engine. A high side driver in the ECM applies a duty cycled voltage to the voltage regulator. The duty cycle 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 the 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 when the duty cycle voltage is commanded high and a low voltage when the duty cycle voltage is commanded low on the generator turn on control circuit.

The 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%. When the engine is running, the duty cycle should be between 5 - 99%.

Diagnostic Aids

- Verify the following component is properly installed: Drive Belt
- If necessary, perform the following steps:**Battery Electrical Drain/Parasitic Load Test**
- To save fuel, the generator does not charge when the following parameter shows the given state: Fuel Economy Mode is Active
- When an accessory is switched on, the response of the charge current (respectively the battery voltage) is not instantaneous. The generator slowly ramps up the charge current. If the battery is fully charged, the charge current may not increase at all. This behavior can make it difficult to measure the charge current or a change in battery voltage.
- Voltmeter gauge fluctuation is not an indicator of a charging system malfunction. Depending on the charging system mode and system loading, battery voltage can fluctuate between 12.0 V to 15.8 V. Refer to Description and Operation.
- A charging system malfunction is indicated by illuminating the charge indicator, and/or a Driver Information Center Message: BATTERY NOT CHARGING SERVICE CHARGING SYSTEM or SERVICE BATTERY CHARGING SYSTEM.
- The generator will default to a voltage output of 13.8 V if the G13 Generator X1 connector is disconnected.

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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

NOTE: **Do not have a battery charger connected during the generator testing.**

1. Ignition - On / Vehicle - In Service Mode
2. Verify the charge indicator is On while the instrument cluster performs the bulb check. Approximately 4 seconds.

mcx30.com

- **If the indicator is Off during the bulb check. Approximately 4 seconds**

  Replace P16 Instrument Cluster

- **Go to next step: If the indicator is On during the bulb check. Approximately 4 seconds**

3. Verify there are no DTCs set related to the following system/component:
   - B18 Battery Current Sensor (If applicable)
   - B110 Battery Sensor Module (If applicable)
   - G13 Generator
   - Energy Management
   - Stop/Start System (KL9)
   - **If any DTC is set**

     Refer to: **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If no DTC is set**
4. Increase the engine speed slowly to 2500 RPM. All accessories OFF.
5. Verify the scan tool Battery Voltage parameter is between 12.0 - 15.8 V
   - **If not between 12.0 - 15.8 V**

     Refer to Circuit System Testing

   - **Go to next step: If between 12.0 - 15.8 V**
6. Turn the following components ON:
   - Headlamps
   - Rear Defogger
   - Blower Motor at maximum speed
7. Increase the engine speed slowly to 2500 RPM. Verify the scan tool Battery Voltage parameter is between 12.6 - 15.8 V.
   - **If not between 12.6 - 15.8 V**

     Refer to Circuit System Testing

   - **Go to next step: If between 12.6 - 15.8 V**
8. Verify the charge indicator on the instrument cluster is Off and the Driver Information Center (DIC) does not display any charging system error message.
   - **If the indicator is On**

     Refer to Circuit System Testing

   - **Go to next step: If the indicator is Off**
9. Verify the scan tool Body Control Module Battery Voltage parameter increases when controlling the Body Control Module Generator Regulator Setpoint from 40% to 80% with a scan tool. It may take up to 10 s for the battery voltage to stabilize between each Setpoint change.

   Refer to **Charging System Description and Operation**.

   - **If the battery voltage does not increase**

     Refer to Circuit/System Testing.

   - **Go to next step: If the battery voltage increases**
10. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.**

mcx30.com

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal 1 X2 or 2 X2 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
    2. Test for less than 2 Ω in the B+ circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Remove the test lamp, disconnect the battery negative cable, and disconnect the G13 Generator B+ cable.
    2. Test for infinite resistance between the B+ circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, test or replace the G13 Generator.
    - **Go to next step: If the test lamp illuminates**
2. Disconnect the X1 harness connector at the G13 Generator, engine running.
3. Test for 13.4 V to 14 V between the engine block and B+ circuit at G13 Generator.
    - If not between 13.4 and 14 V, Test or replace the G13 Generator.
    - If between 13.4 and 14 V
4. Verify the scan tool Engine Control Module Generator F - Terminal Signal parameter is less than 5%.
    - **If 5% or greater**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the G13 Generator signal circuit terminal 2 X1 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If less than 5%**
5. Install a 3 A fused jumper wire between the signal circuit terminal 2 X1 and B+, engine running.
6. Verify the scan tool Engine Control Module Generator F - Terminal Signal parameter is greater than 95%.
    - **If 95% or less**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If greater than 95%**
7. Remove jumper wire. X1 disconnected at G13 Generator, engine running.
8. Test for 1 V or greater between the control circuit terminal 1 X1 and ground.
    - **If less than 1 V**
    1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If greater than 2 Ω, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If 1 V or greater**
9. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module, Ignition ON
10. Test for less than 1 V between the G13 Generator control circuit terminal 1 X1 and ground.
    - **If greater than 1 V**

mcx30.com

Repair the short to voltage on the circuit.

- **Go to next step: If 1 V or less**

11. Test or replace the G13 Generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Control Module References** Control Module replacement, programming and setup.
- **Generator Replacement (LYX)Generator Replacement (LTG)Generator Replacement (LH7 - All Wheel Drive)Generator Replacement (LH7 - Front Wheel Drive)**

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. Perform a charging system test. Verify that the generator is charging properly.
3. 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.
4. Ignition OFF, remove the engine drive belt. Verify the generator, A/C compressor, water pump pulley, power steering pump, idler pulley, and tensioner pulley spin freely.
    - If any of the pulleys do not spin freely, replace the affected component.
5. Start the engine, with the drive belt removed. Verify that the noise goes away. Operate the engine for no longer than 30-40 seconds.
    - If the noise is still present, the generator is not the cause of the noise.
6. Loosen all generator mounting bolts and ensure the generator is properly aligned. Tighten the mounting bolts to specification, refer to **Generator Replacement (LYX)Generator Replacement (LTG)Generator Replacement (LH7 - All Wheel Drive)Generator Replacement (LH7 - Front Wheel Drive)**.

Repair Instructions

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

- **Drive Belt Replacement** for the 1.5L engine
- **Drive Belt Tensioner Replacement** for the 1.5L engine
- **Drive Belt Replacement** for the 2.0L engine
- **Drive Belt Tensioner Replacement** for the 2.0L engine
- **Generator Replacement (LYX)Generator Replacement (LTG)Generator Replacement (LH7 - All Wheel Drive)Generator Replacement (LH7 - Front Wheel Drive)**

STOP/START SYSTEM MALFUNCTION

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 12 volt start/stop system is used to reduced fuel consumption and emissions by automatically turning off the engine when coming to a stop and restarting when moving again. When coming to a stop, assuming no disable conditions exist, the engine will automatically turn off. The engine will automatically restart when the driver releases the brake pedal.

To eliminate unwanted infotainment system effects during engine cranking, the 12 volt start/stop system utilizes a power supply transformer that provides a steady B+ to the infotainment system though the battery saver relay. During engine cranking, system voltage may momentarily drop below 10 volts. This momentary drop in voltage may cause the vehicle infotainment to turn off and restart during a start/stop event. The power supply transformer maintains steady B+ to the infotainment system to prevent an infotainment restart during cranking.

Diagnostic Aids

- If the driver does not fully depress the brake pedal, the vehicle may not enter Auto Stop mode.
- Auto Stop may be deactivated if any of the following conditions are present:
  - Ambient and coolant temperature correlation does not match specified values
  - Ambient temperature is less than 4Ã‚Â°C (40Ã‚Â°F)
  - Battery temperature is less than 0Ã‚Â°C (32Ã‚Â°F) or greater than 55Ã‚Â°C (131Ã‚Â°F)
  - HVAC system demand is high
  - HVAC defrost has been selected
  - Battery charge is low
  - The battery was improperly charged or jump started.

    To properly charge the battery or jump start the vehicle, the negative lead of the charger must be connected to chassis ground, NOT directly to the negative battery post. Connecting to chassis ground allows current to flow through the battery sensor module during charging and be measured. Connecting directly to the negative battery post charges the battery, but the current is not measured by the battery sensor module.

  - Power on Reset is active when the parameters Battery Sensor Module Battery State Information and Battery Sensor Module Reset Occurred - Using Estimated State of Charge read Not Available (Not Learned) and Yes (Estimated). Stop/start is enabled when Power on Reset is active.
  - Vehicle has not been allowed to sit for at least 3 hours over 1 week.
  - Parasitic current draw 100 mA or greater
- When using a vehicle hoist to verify autostop and autostart operation, ensure the following conditions are also met:
  - Transmission gear selector is in the drive position
  - No DTCs are set
  - Traction control is off

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Stop/Start System Description and Operation

Electrical Information Reference

- **Circuit Testing**

mc330.com

- 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 ON.
2. Verify no DTCs are set.
   - **If any DTCs are set**

     Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

   - **Go to next step: If no DTCs are set**
3. Test for greater than 12 V between the battery positive terminal and negative terminal.
   - **If 12 V or less**

     Refer to Battery Inspection/Test.

   - **Go to next step: If greater than 12 V**
4. Press the air conditioning switch located on the climate control system and make sure it turns ON and OFF.
   - **If the air conditioning switch does not turn ON and OFF**

     Refer to HVAC System Malfunction .

   - **Go to next step: If the air conditioning switch turns on and off**
5. Verify that when air conditioning switch is pressed it toggles from Green to Amber.
   - **If the air conditioning switch indicator does not toggle to Green and Amber.**

     Refer to HVAC System Malfunction .

   - **Go to next step: If the switch indicator toggles to Green and Amber**
6. Verify the scan tool parameter:
   - Battery Sensor Module Battery State Information parameter reads Available.
   - Battery Sensor Module Reset Occurred - Using Estimated State of Charge reads No.
   - **If not the specified value**
   1. Disconnect and reconnect the C1 Battery Negative cable.

      NOTE: **Allowing the vehicle to sit for 3 hours undisturbed, will allow the Battery Sensor Module Learn the parameters Battery Sensor Module Battery State Information and Battery Sensor Module Reset Occurred - Using Estimated State of Charge will change to Available (Learned) and No (Measured) after the engine is cranked.**

   2. Wait a minimum of 3 hours.
   3. Start the engine.
   4. Test drive the vehicle.

      Verify the Stop/Start System is functioning correctly.

      - if a condition exists

        Refer to Stop/Start Disable, Inhibit, and Restart Reasons

      - If No Conditions exists
   5. All OK.
   - **Go to next step: If the Specified Value**

mcx30.com

7. Test drive the vehicle.

   Verify the Stop/Start System is functioning correctly.

   - **if a condition exists**

     Refer to **Stop/Start Disable, Inhibit, and Restart Reasons**

   - **Go to next step: If No Conditions exists**

8. Verify the infotainment system remains active during a start/stop event.
   - **If the infotainment system turns off or restarts during a start/stop event.**

     Refer to Circuit/System Testing - Power Supply Transformer Circuit Malfunction

   - **Go to next step: If the infotainment system remains active during a start/stop event**
9. All OK.

Circuit/System Testing

Power Supply Transformer Circuit Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the T19 Power Supply Transformer. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between each ground circuit terminal and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **Go to next step: If less than 10 Ω**
3. Ignition ON.
4. Verify a test lamp illuminates between each B+ circuit terminal and ground.
   - **If the test amp does not illuminate and the circuit fuse is good**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF.
   2. Test for infinite resistance between the B+ circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, test or replace the T19 Power Supply Transformer.
      - **Go to next step: If the test lamp illuminates**
5. Verify a test lamp illuminates between each ignition circuit and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ignition circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than If 2 Ω, verify, Refer to **Power Mode Mismatch** .
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF.
   2. Test for infinite resistance between the ignition circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, test or replace the T19 Power Supply Transformer.
   - **Go to next step: If the test lamp illuminates**

mcx30.com

6. Install a test lamp between the control circuit terminal 5 and ground.
7. Verify the test lamp illuminates while cranking the engine.
    - **If the test lamp does not illuminate**
    1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module and disconnect the KR27 Starter Relay.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If the test lamp illuminates**
8. Test or replace the T19 Power Supply Transformer.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Multifunction Power Supply Converter Replacement (Equinox)Multifunction Power Supply Converter Replacement (Terrain)** for T19 Power Supply Transformer replacement
- **Control Module References** for control module replacement, programming, and setup.

STOP/START DISABLE, INHIBIT AND RESTART REASONS

NOTE: **Not all parameters may be available in all vehicles**

The following Autostop Disable parameters are only valid when Engine is Running. It indicated why are we currently inhibiting autostop at that moment in time.

Autostop Disable

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - Transmission Range	Engine Running	Transmission not in Drive	No	Ensure transmission is in drive. Stop/start will not function in manual mode.	If OK: Inform Customer - Normal Disable Condition If not OK: Refer to transmission diagnostics.
Autostop Disable Reason - Passenger Compartment Heater On	Engine Running	Passenger Compartment Heater ON	No	Turn off passenger compartment heater.	As Required
Autostop Disable Reason - Driver Exited Vehicle	Engine Running	Seat belt un buckled and driver's door opened.	No	Make sure driver's seatbelt is secured and driver's door latch is closed..	As Required

mcx30.com

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - 12V Start Counter Exceeded	Engine Running	Backup Start Performed indicates that an autostop was prevented due to the expiration of backup start counter. If the motor generator cannot autostart the ICE, a calibratable number of attempts to start the engine with the 12V starter will be performed.	No	Determine cause of the previous no start condition.	As required
Autostop Disable Reason - Vehicle Inclination	Engine Running	Vehicle Grade indicates that an autostop was prevented (or an autostart was commanded) due to the current grade level of the vehicle.	No	Verify vehicle is not on level ground.	If not OK: Verify Multi-Axis Accelerator Sensor.
Autostop Disable Reason - Remote Vehicle Start Request	Engine Running	Remote Start indicates the internal combustion engine has been requested to run through a remote start command.	No	Verify remote start operation.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Acceleration Request	Engine Running	Driveability indicates an autostart was command based on torque conditions requested from the driver (generally a tip-in on the throttle). When this condition is detected, autostops are disallowed.	No	Ensure accelerator pedal is fully released	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Transmission In Reverse	Engine Running	Transmission in reverse gear.	No	Ensure transmission is in drive. Stop/start will not function in any other mode.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Reduced Engine Power Active	Engine Running	Reduced Power indicates that AutoStops are disallowed when a situation has been detected that causes the vehicle to operate with reduced power.	No	Check ECM DTC's.	As required.
Autostop Disable Reason - HYBRID/EV Battery Pack Temperature	Engine Running	HV Battery Pack Temperature indicates Disallow AutoStops/Command AutoStart when battery temperature is high.	No	Ensure parameter in scan tool is not indicating high. Check DTC's..	If OK: Inform Customer - Normal Disable Condition

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - Transmission Range	Engine Running	Transmission Range indicates that an autostop was prevented (or an autostart was commanded) due to the selected transmission range.	No	Ensure transmission is in drive. Stop/start will not function in manual mode.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Ignition Switch Start	Engine Running	Key Forced AutoStart Request: The driver can request an autostart in park or neutral by cranking the key. Autostops are not allowed again until out of park/neutral.	No	As required.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - TCM Request	Engine Running	TCM Override indicates that AutoStops are disallowed based on transmission PRNDL position.	No	Ensure transmission is in drive. Stop/start will not function in manual mode.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - System Optimization	Engine Running	System Optimization indicates Command AutoStart based on overall system conditions (engine speed & torque optimization). When this condition is detected, AutoStops are disallowed.	No	Ensure vehicle is over 3MPH/5KMH before autostop is enabled.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - System Voltage Low	Engine Running	12V battery state of function low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostop Disable Reason - Engine Coolant Temperature Out Of Range	Engine Running	Engine Coolant Temperature indicates that an autostop was prevented (or an autostart was commanded) due to engine coolant temperature out of range (high or low).	No	Ensure coolant temperature isn't too high or low.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Catalyst Test In Progress	Engine Running	Catalyst indicates a requested inhibit for Catalyst monitor from gas or Diesel.	No	Ensure catalyst parameter isn't out of range	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - HO2S Test In Progress	Engine Running	Oxygen Sensor indicates a requested inhibit for Oxygen Sensor Monitor.	No	Ensure oxygen sensor parameter isn't out of range	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Misfire Test In Progress	Engine Running	Misfire Monitor indicates a requested inhibit for Misfire Monitor.	No	Ensure no misfire detected in scan tool.	If OK: Inform Customer - Normal Disable Condition

mcx30.com

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - Catalyst not at Operating Temperature	Engine Running	Catalyst not at Operating Temperature	No	Ensure Catalyst is within operating temperature	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Intake Manifold Temperature Too High	Engine Running	Engine Manifold Temperature indicates an inhibit due to high Manifold Temp.	No	Ensure Manifold Temperature isn't high	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Engine Speed Test in Progress	Engine Running	Engine Speed Diagnostics indicates a requested inhibit due to Engine Speed diagnostics.	No	As required	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - MAF sensor Test In Progress	Engine Running	Mass Air Flow Diagnostics indicates a requested inhibit due to MAF diagnostics.	No	Check ECM DTC's	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - MAP Sensor Test In Progress	Engine Running	Manifold Absolute Pressure Diagnostics indicates a requested inhibit due to MAP diagnostics.	No	Check ECM DTC's	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Engine Oil Temperature Too High	Engine Running	Engine Oil Temp indicates an inhibit due to high Engine Oil Temp.	No	Check Oil temperature is not too high.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Engine Stop/Start Test in Progress	Engine Running	Starting System indicates an inhibit due to Engine Start Stop functions.	No	Ensure control functions are done before proper function of stop/start	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Engine Coolant Temperature Test In Progress	Engine Running	Engine Coolant Temperature indicates a requested inhibit due to low or high Engine Coolant Temperature.	No	Ensure control function is done before expecting stop/start to function	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - EVAP System Test In Progress	Engine Running	Evap System indicates a requested inhibit for Evap System Monitor	No	Ensure control function is complete before stop/start can function	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Fuel Injector Test In Progress	Engine Running	Fuel Injector Diagnostics indicates a requested inhibit due to Fuel Injector diagnostics.	No	Ensure control function is complete before stop/start can function	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Fuel Pressure Test In Progress	Engine Running	Fuel Pressure indicates a requested inhibit for Fuel Pressure Pump monitor.	No	Ensure control function is complete before stop/start can function	If OK: Inform Customer - Normal Disable Condition

mg30.com

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - Fuel System Test In Progress	Engine Running	Fuel Systems indicates a requested inhibit for Fuel Systems monitor.	No	Ensure control function is complete before stop/start can function	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Parking Maneuver Detected	Engine Running	Parking maneuver detection indicates a requested inhibit due to parking maneuver active.	No	Check functionality after parking	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - High Engine Rotating Torque	Engine Running	Engine Friction indicates a requested inhibit due to cold engine, friction high.	No	Wait for vehicle to reach proper temperature	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - BARO Pressure Too Low	Engine Running	Ambient Air Pressure indicates a requested inhibit due to low Barometric Pressure	No	Ensure barometric temperature isn't too low in scan tool	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Fuel Temperature Too High	Engine Running	Boil Off Diagnostics indicates a requested inhibit due to Fuel Boil Off diagnostics.	No	Ensure fuel temperature isn't too high	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - System Malfunction	Engine Running	Starting System indicates that a condition in the starting system has been detected that would prevent a re-start of the vehicle and thus, autostops, have been disabled.	No	Check ECM DTC's	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Turbocharger Temperature Too High	Engine Running	Turbo Temp indicates an inhibit due to high Turbo Temp.	No	Check ECM DTC's	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Hood Ajar	Engine Running	Hood not latched	No	Ensure hood is closed and latched.	If OK: Refer to Hood Ajar Malfunction. If not OK: close hood.
Autostop Disable Reason - ECM Request	Engine Running	ECM tasks are currently running that will not allow an autostop	No	Autostop will function once the task is complete.	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Run/Crank Not Active	Engine Running	Vehicle must be in Run Mode	No	Verify ECM Run/Crank signal	If OK: Inform Customer - Normal Disable Condition If not OK: refer to Power Mode Mismatch.

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - Minimum Engine Run Time Not Met	Engine Running	Engine must run a minimum time before stop/start is allowed.	No	Autostop will function once the minimum run time is met	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Control Function Active	Engine Running	Scantool control function active	No	Release control function in scantool	None
Autostop Disable Reason - Auxiliary Transmission Fluid Pump/Accumulator Not Available	Engine Running	Transmission aux pump or accumulator not available	No	Check for transmission DTCs, refer to automatic transmission service information	As Required
Autostop Disable Reason - Engine Coolant Temperature Out of Range	Engine Running	Coolant temperature too hot or cold	No	Verify cooling temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition If not OK: Refer to Engine Heating and Cooling diagnostics.
Autostop Disable Reason - Invalid Data Received	Engine Running	ECM has received invalid data	No	Check ECM DTC's	As Required
Autostop Disable Reason - Vehicle Speed Too High	Engine Running	Vehicle speed detected	No	Ensure vehicle is at a complete stop	If OK: Inform Customer - Normal Disable Condition If not OK: refer to SI
Autostop Disable Reason - Transmission Fluid Temperature Out of Range	Engine Running	Transmission temperature too hot or cold	No	Verify transmission temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition. If not OK: Refer to transmission diagnostics.
Autostop Disable Reason - Brake Pedal Released	Engine Running	Brake pedal not pressed (enough)	No	Ensure brake pedal is pressed sufficiently to active autostop	If OK: Inform Customer - Normal Disable Condition If not OK: Verify brake pedal switch operation and calibration.
Autostop Disable Reason - Brake Booster Weak Vacuum	Engine Running	Weak brake booster vacuum	No	Ensure brake booster vacuum is within normal operating values	Check DTCs. Refer to brake booster diagnostics.

mcx30.com

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - Accelerator Pedal Pressed	Engine Running	Accelerator pedal pressed	No	Ensure accelerator pedal is fully released	If OK: Inform Customer - Normal Disable Condition If not OK: Ensure pedal sensor operation and calibration.
Autostop Disable Reason - A/C Request	Engine Running	HVAC system is requesting AC compressor due to high cabin temperature and/or humidity	No	Allow cabin temperature/humidity to reach setpoint, change setpoint, turn off blower	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Low-Voltage Battery Voltage Low	Engine Running	12V battery voltage is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostop Disable Reason - Low-Voltage Battery State of Health Low	Engine Running	12V battery has low state of health	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostop Disable Reason - Low-Voltage Battery State of Charge Low	Engine Running	12V battery state of charge is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostop Disable Reason - Low-Voltage Battery Discharge Current High	Engine Running	Excessive current draw is placing a high demand on the generator	No	Check electrical loads, turn off unnecessary loads	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Intake Manifold Weak Vacuum	Engine Running	Low manifold vacuum	No	Verify manifold vacuum	Check DTCs, refer to SI
Autostop Disable Reason - Engine Speed High	Engine Running	High idle condition	No	Correct cause of high idle	Check DTCs, refer to SI
Autostop Disable Reason - Wheel Slip Detected	Engine Running	Slippery road conditions	No	Ensure good road conditions	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Vehicle Speed Threshold Not Reached	Engine Running	Vehicle must reach a minimum speed	No	Operate at sufficient speeds	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Maximum Vehicle Stop Time Exceeded	Engine Running	Engine was shut off for maximum allowable off time	No	Operate at sufficient speeds to reactivate	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Starter System Malfunction	Engine Running	Starter System Inoperable	No	Check ECM DTCs, refer to SI	As Required

mcx30.com

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - System Malfunction	Engine Running	Starter System Inoperable	No	Check for Vehicle DTCs	As Required
Autostop Disable Reason - Stop/Start Select Switch	Engine Running	Switch not enabled	No	Turn switch on.	If OK: Inform Customer - Normal Disable Condition If Not OK: refer to Stop/Start System Malfunction
Autostop Disable Reason - Idle Boost Mode Active	Engine Running	Idle boost requested	No	Check electrical loads, turn off unnecessary loads	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Generator Load High	Engine Running	Excessive current draw is placing a high demand on the generator	No	Check electrical loads, turn off unnecessary loads	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Clutch Pedal Applied	Engine Running	Clutch pedal (manual trans) not released	No	Ensure clutch pedal is released	If OK: Inform Customer - Normal Disable Condition If not OK: Refer to clutch switch diagnostic and verify calibration.
Autostop Disable Reason - Low-Voltage Battery Temperature Out of Range	Engine Running	Battery temperature too cold or hot	No	Ensure battery is kept within normal operating range	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Low-Voltage Battery State of Function Low	Engine Running	12V battery state of function low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required

The following Autostart Inhibit parameters show why the engine is off or was turned off. There are a couple different things this can mean. Forced Off (Mostly Hybrid), Propulsion System Shutdown (Stall), Cannot Start Engine (Hybrid).

Autostart Inhibit

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostart Inhibit Reason - Hood Ajar	Engine off	Hood not latched	No	Ensure hood is closed and latched.	If not OK: close hood.
Autostart Inhibit Reason - ECM Request	Engine off	ECM tasks are currently running that will not allow an autostart	No	Autostop will function once the task is complete.	Inform Customer - Normal Disable Condition

mcx30.com

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostart Inhibit Reason - Run/Crank Not Active	Engine off	Vehicle must be in Run Mode	No	Verify ECM Run/Crank signal	If OK: Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - System Malfunction	Engine off	Vehicle System Issue	No	Check for Vehicle DTCs	As Required
Autostart Inhibit Reason - Autostart Not Commanded	Engine off	Vehicle is in a normal autostop mode	Yes	None	Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - Crank Aborted	Engine off	ECM has disabled propulsion system	No	Check ECM DTCs	As Required
Autostart Inhibit Reason - Control Function Active	Engine off	Scantool control function active	No	Release control function in scantool	As Required
Autostart Inhibit Reason - ECM Malfunction	Engine off	ECM has disabled propulsion system	No	Check ECM DTCs	As Required
Autostart Inhibit Reason - Autostart/Autostop Malfunction	Engine off	ECM has disabled propulsion system	No	Check ECM DTCs	As Required
Autostart Inhibit Reason - Driver Exited Vehicle	Engine off	Seat belt unbuckled and driver's door opened.	No	Not in all vehicles. Verify seat belt and driver's door switches.	If OK: Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - Engine Coolant Temperature Out of Range	Engine off	Coolant temperature too hot or cold	No	Verify cooling temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - Remote Vehicle Start Disabled	Engine off	Remote Vehicle Start Disabled	No	As Required	As Required
Autostart Inhibit Reason - Calibration Override	Engine off	Calibration forced to shut off by calibration	No	Verify cooling temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - Compression Test	Engine off	Engine was forced to shut off following the completion of a compression test	No	As Required	As Required
Autostart Inhibit Reason - TCM Request	Engine off	TCM can force the engine off depending on transmission conditions.	No	As Required	If OK: Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - Engine Stop Required	Engine off	Detection of a situation that might otherwise cause a stall of the vehicle.	No	As Required	As Required

The following Autostart Reasons parameters are only valid when Engine is Running. It indicates why we started the engine the last time it was autostarted.

Autostart Reasons

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostart Reason - TCM Demand	Engine Running	TCM has requested an autostart	No	Ensure transmission is in drive. Stop/start will not function in manual mode.	If OK: Inform Customer - Normal Disable Condition. If not OK: Refer to transmission diagnostics.
Autostart Reason - Reduced Engine Power Active	Engine Running	ECM has requested Reduced Engine Power	No	Check ECM DTCs.	As required.
Autostart Reason - Maximum Autostop Time Exceeded	Engine Running	Maximum autostop time is limited.	No	Maximum autostop time is typically 2 minutes.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Transmission Fluid Temperature Out of Range	Engine Running	Transmission temperature too hot or cold	No	Verify transmission temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition. If not OK: Refer to transmission diagnostics.
Autostart Reason - System Malfunction	Engine Running	Vehicle System Issue	No	Check for Vehicle DTCs	As required.
Autostart Reason - Transmission in Reverse	Engine Running	Transmission was placed in reverse.	No	Ensure transmission is in drive.	If OK: Inform Customer - Normal Disable Condition. If not OK: Refer to transmission diagnostics.
Autostart Reason - Invalid Data Received	Engine Running	ECM has received invalid data	No	Check ECM DTCs.	As required.
Autostart Reason - Vehicle Speed Too High	Engine Running	Vehicle speed detected	No	Ensure vehicle is at a complete stop	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - System Optimization	Engine Running	ECM has determined that the engine needs to be started.	No	Check DTCs.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - System Voltage Low	Engine Running	12V battery state of charge is low.	No	Charge and test battery, operate vehicle for longer drives, check generator operation	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Acceleration Request	Engine Running	Accelerator pedal pressed	No	Ensure accelerator pedal is fully released	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Minimum Engine Run Time Not Met	Engine Running	Engine must run a minimum time before stop/start is allowed.	No	Autostop will function once the minimum run time is met	Inform Customer - Normal Disable Condition
Autostart Reason - Control Function Active	Engine Running	Scantool control function active	No	Release control function in scantool	As Required

mc30.com

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostart Reason - Auxiliary Transmission Fluid Pump/Accumulator Not Available	Engine Running	Transmission aux pump or accumulator not available	No	Check for transmission DTCs, refer to automatic transmission service information	As Required
Autostart Reason - Engine Coolant Temperature Out of Range	Engine Running	Coolant temperature too hot or cold	No	Verify cooling temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Transmission Range	Engine Running	Transmission not in Drive	No	Ensure transmission is in drive. Stop/start will not function in manual mode.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Hood Ajar	Engine Running	Hood not latched	No	Ensure hood is closed and latched.	If not OK: close hood.
Autostart Reason - ECM Request	Engine Running	ECM tasks are currently running that will not allow an autostop	No	Autostop will function once the task is complete.	Inform Customer - Normal Disable Condition
Autostart Reason - Low-Voltage Battery Discharge Current High	Engine Running	Excessive current draw is placing a high demand on the generator	No	Check electrical loads, turn off unnecessary loads	Inform Customer - Normal Disable Condition
Autostart Reason - Brake Pedal Released	Engine Running	Brake pedal not pressed (enough)	No	Ensure brake pedal is pressed sufficiently to active autostop	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Brake Booster Weak Vacuum	Engine Running	Weak brake booster vacuum	No	Ensure brake booster vacuum is within normal operating values	Check DTCs. Refer to brake booster diagnostics.
Autostart Reason - Accelerator Pedal Pressed	Engine Running	Accelerator pedal pressed	No	Ensure accelerator pedal is fully released	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - A/C Request	Engine Running	HVAC system is requesting AC compressor due to high cabin temperature and/or humidity	No	Allow cabin temperature/humidity to reach setpoint, change setpoint, turn off blower	Inform Customer - Normal Disable Condition
Autostart Reason - Low-Voltage Battery Voltage Low	Engine Running	12V battery voltage is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostart Reason - Driver Exited Vehicle	Engine Running	Seat belt unbuckled and driver's door opened.	No	Not in all vehicles. Verify seat belt and driver's door switches.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Passenger Compartment Heater On	Engine Running	Passenger Compartment Heater On	No	Check Vehicle DTCs	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Stop/Start select Switch	Engine Running	Stop/Start select Switch off	No	Not in all vehicles.	If OK: Inform Customer - Normal Disable Condition

mcx30.com

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostart Reason - Driver Exited Vehicle	Engine Running	Seat belt unbuckled and driver's door opened.	No	Not in all vehicles. Verify seat belt and driver's door switches.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Low Voltage Battery State of Charge Low	Engine Running	12V battery voltage is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostart Reason - Inclination	Engine Running	Vehicle Grade indicates that an autostop was prevented (or an autostart was commanded) due to the current grade level of the vehicle.	No	As Required	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Low Voltage Battery State of Function Low	Engine Running	12V battery voltage is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation.	As Required
Autostart Reason - Remote Vehicle Start Request	Engine Running	Remote start requested	No	As Required.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Ignition Switch Start	Engine Running	Switch Start Request	No	The driver can request an autostart in park or neutral by cranking the key. Autostops are not allowed again until out of park/neutral.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Low Voltage Battery State of Health Low	Engine Running	12V battery voltage is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required

mx30.com

STARTER SOLENOID DOES NOT CLICK (WITHOUT KL9)

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+ (relay terminal 30)	1	1	-	-
Relay Coil Control (relay terminal 85)	P0615	P0615	2	-
Starter Control (relay terminal 87)	1	1	2	-
Ground (relay terminal 86)	-	P0615	-	-
1. Starter Solenoid Does Not Click 2. 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

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that no ignition, starter relay, brake pedal position sensor, immobilizer, engine, 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** .

   - **Go to next step: If no DTCs are set**
3. Verify the scan tool BCM 5 V Ignition Switch (vehicles without push button start) or ECM Power Mode (vehicles with push button start) parameter is Crank Request while attempting to start the vehicle.
   - **If parameter does not display Crank Request**

     Refer to **Vehicle Will Not Change Power Mode**

   - **Go to next step: If parameter displays Crank Request**
4. Verify the scan tool TCM Internal Mode Switch parameter displays Park with the transmission range selector in park.
   - **If the TCM Internal Mode Switch parameter does not indicate Park**

     Refer to **Transmission Internal Mode Switch Logic** for the M32 Transmission.

   - **Go to next step: If the TCM Internal Mode Switch parameter indicates Park**
5. Verify the scan tool ECM Crankshaft Position Active Counter parameter is not incrementing.
   - **If the counter increments**

     Replace the B26 Crankshaft Position Sensor.

mx30.com

- **Go to next step: If the counter does not increment**

6. Verify the crank relay clicks and the engine begins cranking with the ignition in the Crank position.
    - **If the KR27 Starter Relay does not click**

      Refer to Circuit/System Testing below.

    - **Go to next step: If the KR27 Starter Relay clicks**
7. All OK.

Circuit/System Testing

1. Ignition ON.
2. Verify the scan tool ECM Ignition 1 Signal parameter is greater than 10 V.
    - **If 10 V or less**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the ignition voltage circuits and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If greater than 10 V**
3. Ignition OFF, disconnect the KR27 Starter Relay, ignition ON.
4. Verify that a test lamp illuminates between the B+ circuit terminal 30 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the B+ circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for infinite resistance between the B+ circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance,
    3. Disconnect X1 harness connector at the M64 Starter Motor.
    4. Test for infinite resistance between the control circuit terminal 87 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the M64 Starter Motor.
    - **Go to next step: If the test lamp illuminates**
5. Ensure the parking brake is applied and the T12 Transmission is in PARK. Momentarily install a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.
6. Verify the M64 Starter Motor is activated.
    - **If the M64 Starter Motor does not activate**
    1. Disconnect the X1 harness connector at the M64 Starter Motor.
    2. Test for less than 2 Ω in the control circuit end to end.
        - If greater the 2 Ω, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the M64 Starter Motor.
    - **Go to next step: If the M64 Starter Motor activates**
7. Test or replace the KR27 Starter Relay.

Component Testing

Relay Test

mcx30.com

1. Ignition OFF, disconnect the appropriate relay.
2. Test for 70 - 150 Ω between terminals (85 or 1) and (86 or 2).
    - **If less than 70 or greater than 150 Ω**

      Replace the relay.

    - **Go to next step: If between 70 - 150 Ω**
3. Test for infinite resistance between the terminals listed below:
    - (30 or 3) and (86 or 2)
    - (30 or 3) and (87 or 5)
    - (30 or 3) and (85 or 1)
    - (85 or 1) and (87 or 5)
    - (86 or 2) and (87 or 5)
    - **If less than infinite resistance**

      Replace the relay.

    - **Go to next step: If infinite resistance**
4. Install a 3 A fused jumper wire between relay terminal (85 or 1) and 12 V. Install a jumper wire between relay terminal (86 or 2) and ground.
5. Test for less than 5.0 Ω between terminals (30 or 3) and (87 or 5).
    - **If 5.0 Ω or greater**

      Replace the relay.

    - **Go to next step: If less than 5.0 Ω**
6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Manual Shift Detent Lever with Shaft Position Switch Assembly Replacement**
- **Crankshaft Position Sensor Replacement (FWD)** **Crankshaft Position Sensor Replacement (AWD)**
- **Control Module References** for control module replacement, programming and setup.

STARTER SOLENOID DOES NOT CLICK (KL9)

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+ (KR27C Starter Pinion Solenoid Actuator Relay terminal 30)	1	1	-	-
Control (KR27C Starter Pinion Solenoid Actuator Relay terminal 87)	1	1	2	-
Control (KR27C Starter Pinion Solenoid Actuator Relay terminal 86)	1	1, DTC P0615	2	-
Ground (KR27C Starter Pinion Solenoid Relay Terminal 85)	-	1, DTC P0615	1	-

mex30.com

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
1. Starter Solenoid Does Not Click 2. Starter pinion solenoid is applied 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 a low reference to the control circuit of the starter relay. When this occurs, battery voltage is supplied through the switch of the starter relay and the starter pinion solenoid actuator relay to the starter motor.

Reference Information

Schematic Reference

- **Starting and Charging Wiring Schematics**
- **Automatic Transmission Controls Wiring Schematics (6T40 (MNH MNK) or 6T45 (MHG))**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 ON.
2. Verify that no ignition, starter pinion solenoid actuator relay, starter motor relay, brake pedal position sensor, immobilizer, engine, 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** .

   - **Go to next step: If no DTCs are set**
3. Verify the scan tool BCM 5 V Ignition Switch (vehicles without push button start) or ECM Power Mode (vehicles with push button start) parameter is Crank Request while attempting to start the vehicle.
   - **If parameter does not display Crank Request**

     Refer to **Vehicle Will Not Change Power Mode**

   - **Go to next step: If parameter displays Crank Request**
4. Verify the scan tool TCM Internal Mode Switch parameter displays Park with the transmission range selector in park.
   - **If the TCM Internal Mode Switch parameter does not indicate Park**

     Refer to **Transmission Internal Mode Switch Logic** for the M2D Transmission.

mcx30.com

- **Go to next step: If the TCM Internal Mode Switch parameter indicates Park**

5. Verify the scan tool ECM Crankshaft Position Active Counter parameter is not incrementing.
    - **If the counter increments**

      Replace the B26 Crankshaft Position Sensor.

    - **Go to next step: If the counter does not increment**
6. Verify the crank relay clicks and the engine begins cranking with the ignition in the Crank position.
    - **If the KR27C Starter Pinion Solenoid Actuator Relay does not click**

      Refer to Circuit/System Testing.

    - **Go to next step: If the KR27C Starter Pinion Solenoid Actuator Relay clicks**
7. All OK.

Circuit/System Testing

1. Ignition ON.
2. Verify the scan tool ECM Ignition 1 Signal parameter is greater than 10 V.
    - **If 10 V or less**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the ignition voltage circuits and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If greater than 10 V**
3. Ignition OFF and all vehicle systems OFF, disconnect the KR27C Starter Pinion Solenoid Actuator Relay. It may take up to 2 min for all vehicle systems to power down.
4. Test for less than 10 Ω between the ground circuit terminal 85 and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **Go to next step: If less than 10 Ω**
5. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF, remove the test lamp.
    2. Test for less than 2 Ω in the B+ circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω verify the fuse is good and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for infinite resistance between the B+ circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance,
    3. Disconnect X1 harness connector at the M64 Starter Motor.
    4. Test for infinite resistance between the control circuit terminal 87 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the M64 Starter Motor.
    - **Go to next step: If the test lamp illuminates**

mcx30.com

6. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85.
7. Verify the test lamps turns on and off when cycling the ignition between the OFF and CRANK position with the parking brake set and clutch pedal pressed (manual transmission) or the transmission in park (automatic transmission).
    - **If the test lamp is always OFF**
    1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
        - **If the test lamp is always ON**
    4. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    5. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
        - **Go to next step: If the test lamp turns ON and OFF**
8. Ensure the parking brake is applied and the T12 Transmission is in PARK. Momentarily install a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.
9. Verify the M64 Starter Motor pinion engages.
    - **If the M64 Starter Motor pinion does not engage**
    1. Disconnect the X1 harness connector at the M64 Starter Motor.
    2. Test for less than 2 Ω in the control circuit end to end.
        - If greater the 2 Ω, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the M64 Starter Motor.
    - **Go to next step: If the M64 Starter Motor pinion engages**
10. Ignition OFF, reconnect the KR27C Starter Pinion Solenoid Actuator Relay, ignition CRANK.
11. Verify the M64 Starter Motor is activated.
    - **If the M64 Starter Motor does not activate**

      Replace M64 Starter Motor.

    - **Go to next step: If the M64 Starter Motor activates**
12. Test or replace the KR27C Starter Pinion Solenoid Actuator Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the appropriate relay.
2. Test for 70 - 150 Ω between terminals (85 or 1) and (86 or 2).
    - **If less than 70 or greater than 150 Ω**

      Replace the relay.

    - **Go to next step: If between 70 - 150 Ω**
3. Test for infinite resistance between the terminals listed below:
    - (30 or 3) and (86 or 2)
    - (30 or 3) and (87 or 5)
    - (30 or 3) and (85 or 1)
    - (85 or 1) and (87 or 5)
    - (86 or 2) and (87 or 5)

mexa.com

- **If less than infinite resistance**

  Replace the relay.

- **Go to next step: If infinite resistance**

4. Install a 3 A fused jumper wire between relay terminal (85 or 1) and 12 V. Install a jumper wire between relay terminal (86 or 2) and ground.
5. Test for less than 5.0 Ω between terminals (30 or 3) and (87 or 5).
   - **If 5.0 Ω or greater**

     Replace the relay.

   - **Go to next step: If less than 5.0 Ω**
6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

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

STARTER SOLENOID CLICKS, ENGINE DOES NOT CRANK (WITHOUT KL9)

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 Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 C1 Battery terminals.
2. Verify the measured voltage is between 12.0 - 15.0 V.
   - **If voltage is less than 12.0 V or greater than 15.0 V**

     Refer to **Battery Inspection/Test**.

mcx30.com

- **Go to next step: If voltage is between 12.0 - 15.0 V**

3. Remove the drive belts as described in, **Drive Belt Replacement** .
4. Verify the crankshaft rotates rotate the crankshaft by hand using the appropriate tools.
   - **If the crankshaft does not rotate**

     Refer to **Engine Will Not Crank - Crankshaft Will Not Rotate** .

   - **Go to next step: If the crankshaft rotates**
5. Verify the engine does not crank when attempting to start the vehicle.
   - **If the engine cranks**

     Inspect the engine and belt drive system for mechanical binding, seized engine, or seized generator.

   - **Go to next step: If the engine does not crank**
6. Verify that a test lamp illuminates between the M64 Starter Motor B+ terminal A X2 or 1 X2 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF.
   2. Test for greater than 100 Ω between the B+ circuit and ground.
      - If 100 Ω or less, repair the short to ground on the circuit.
      - If greater than 100 Ω, replace the M64 Starter Motor.
   - **Go to next step: If the test lamp illuminates**
7. Test for less than 0.5 V between the positive battery cable and terminal A X2 or 1 X2 at the M64 Starter Motor with the ignition in the START position.
   - **If 0.5 V or greater**

     Replace the positive battery cable.

   - **Go to next step: If less than 0.5 V**
8. Test for less than 0.5 V between the negative battery cable and the M64 Starter Motor case with the ignition in the START position.
   - **If 0.5 V or greater**

     Replace the negative battery cable.

   - **Go to next step: less than 0.5 V**
9. Replace the M64 Starter Motor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Battery Negative Cable Replacement**
- **Starter Replacement (LYX - All Wheel Drive)Starter Replacement (LYX - Front Wheel Drive)Starter Replacement (LTG - All Wheel Drive)Starter Replacement (LTG - Front Wheel Drive)Starter Replacement (LH7 - All Wheel Drive)Starter Replacement (LH7 - Front Wheel Drive)**

STARTER SOLENOID CLICKS, ENGINE DOES NOT CRANK (KL9)

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.

mcx30.com

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 Testing

1. Ignition OFF, measure and record the battery voltage at the C1 terminals.
2. Verify the measured voltage is between 12 - 15 V.
    - **If voltage is less than 12 V or greater than 15 V**

      Refer to **Battery Inspection/Test**.

    - **Go to next step: If voltage is between 12 - 15V**
3. Remove the drive belts. Refer to **Drive Belt Replacement** , for 2.0L (LTG) engines and **Drive Belt Replacement** for 1.5 (LYX).
4. Verify the crankshaft rotates rotate the crankshaft by hand using the appropriate tools.
    - **If the crankshaft does not rotate**

      Refer to **Engine Will Not Crank - Crankshaft Will Not Rotate** , for 2.0L (LTG) engine and **Engine Will Not Crank - Crankshaft Will Not Rotate** for 1.5L (LYX).

    - **Go to next step: If the crankshaft rotates**
5. Verify the engine does not crank when attempting to start the vehicle.
    - **If the engine cranks**

      Inspect the engine and belt drive system for mechanical binding, seized engine, or seized generator.

    - **Go to next step: If the engine does not crank**
6. Verify that a test lamp illuminates between the M64 Starter Motor B+ terminal 1 X2 or A X2 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the B+ circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for greater than 100 Ω between the B+ circuit and ground.
        - If 100 Ω or less, repair the short to ground on the circuit.
        - If greater than 100 Ω, replace the M64 Starter Motor.

mexeo.com

- **Go to next step: If the test lamp illuminates**

7. Test for less than 0.5 V between the positive battery cable and M64 Starter Motor B+ terminal 1 X2 or A X2 with the ignition in the START position.
   - **If 0.5 V or greater**

     Replace the positive battery cable.

   - **Go to next step: If less than 0.5 V**
8. Test for less than 0.5 V between the negative battery cable and the M64 Starter Motor case with the ignition in the START position.
   - **If 0.5 V or greater**

     Replace the negative battery cable.

   - **Go to next step: less than 0.5 V**
9. Ignition OFF and all vehicle systems OFF, disconnect the KR27 Starter Relay. It may take up to 2 minutes for all vehicle systems to power down, Ignition ON.
10. Verify a test lamp illuminates between the B+ circuit terminal 87 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the B+ circuit end to end.
       - If 2 Ω or greater, repair the open/high resistance in the circuit.
       - If less than 2 Ω, verify the fuse is good and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for infinite resistance between the B+ circuit and ground.
       - If less than infinite resistance, repair the short to ground on the circuit.
       - If infinite resistance
    3. Disconnect the X1 harness connector at the M64 Starter Motor.
    4. Test for infinite resistance between the control circuit terminal 30 and ground.
       - If less than infinite resistance, repair the short to ground on the circuit.
       - If infinite resistance, replace the M64 Starter Motor.
    - **Go to next step: If the test lamp illuminates**
11. Verify a test lamp illuminates between the ignition circuit terminal 86 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF, remove the test lamp.
    2. Test for less than 2 Ω in the ignition circuit end to end.
       - If 2 Ω or greater, repair the open/high resistance in the circuit.
       - If less than 2 Ω, refer to **Power Mode Mismatch** .
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF, remove the test lamp.
    2. Test for infinite resistance between the ignition circuit and ground.
       - If less than infinite resistance, repair the short to ground on the circuit.
       - If infinite resistance
    3. Connect the KR27 Starter Relay and replace the fuse.
    4. Verify the fuse does not open when connecting the KR27 Starter Relay.
       - If the fuse opens, replace the KR27 Starter Relay.
       - If the fuse is OK
    5. All OK
    - **Go to next step: If the test lamp illuminates**
12. Connect a test lamp between ignition circuit terminal 86 and the control circuit terminal 85 at the KR27 Starter Relay.

mcx30.com

NOTE: **If the Starter Relay command is not available in the scan tool, verify the test lamps turns on and off when cycling the ignition between the OFF and CRANK position with the parking brake set and clutch pedal pressed (manual transmission) or the transmission in park (automatic transmission).**

- **If the test lamp is always OFF**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module and disconnect the harness connector at the T19 Power Supply Transformer, Ignition ON.
2. Test for less than 1 V between the control circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V
3. Test for less than 2 Ω in the control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If the test lamp is always ON**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module and disconnect the harness connector at the T19 Power Supply Transformer, Ignition ON.
2. Test for infinite resistance between the control circuit and ground
- If less than infinite resistance, repair the short to ground on the circuit
- If infinite resistance

13. Reconnect the K20 Engine Control Module
14. Test for infinite resistance between control circuit and ground.
    - If less than infinite resistance, replace the K20 Engine Control Module.
    - If infinite resistance, replace the T19 Power Supply Transformer
    - **Go to next step: If the test lamp turns ON and OFF**
15. Ignition ON, connect a 30 A fused jumper wire between the B+ circuit terminal 87 and the control circuit terminal 30.
16. Verify the M64 Starter Motor is activated.
    - **If the M64 Starter Motor does not activate**
    1. Ignition OFF, disconnect the X1 harness connector at the M64 Starter Motor.
    2. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the M64 Starter Motor.
    - **Go to next step: If the M64 Starter Motor activates**
17. Test or replace the KR27 Starter Relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Battery Negative Cable Replacement**
- **Starter Replacement (LYX - All Wheel Drive)Starter Replacement (LYX - Front Wheel Drive)Starter Replacement (LTG - All Wheel Drive)Starter Replacement (LTG - Front Wheel Drive)Starter Replacement (LH7 - All Wheel Drive)Starter Replacement (LH7 - Front Wheel Drive)**

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

mcx30.com

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 C1 battery terminals. The voltage should be between 12.0 - 15.0 V.
   - If not within the specified range, refer to **Battery Charging**.
2. Test for less than 0.5 V between the positive battery cable and terminal A X2 at the M64 starter motor as the ignition is placed to the CRANK position.
   - If greater than the specified value, replace the positive battery cable.
3. Test for less than 0.5 V between the negative battery cable and the M64 starter motor case as the ignition switch is placed to the CRANK position.
   - If greater than the specified value, replace the negative battery cable.
4. Remove the drive belts. Refer to **Drive Belt Replacement** for the 1.5L engine
5. Place the ignition to the CRANK position. verify the engine does not crank normal.
   - If the engine cranks normal, inspect the engine and belt drive system for mechanical binding, seized generator etc.
6. If all circuits test normal, replace the M64 starter motor.

Repair Instructions

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

- **Starter Solenoid Cable Replacement (LYX - All Wheel Drive)Starter Solenoid Cable Replacement (LYX - Front Wheel Drive)Starter Solenoid Cable Replacement (Chevrolet LTG - All Wheel Drive)Starter Solenoid Cable Replacement (Chevrolet LTG - Front Wheel Drive)Starter Solenoid Cable Replacement (Chevrolet LH7 - Front Wheel Drive)Starter Solenoid Cable Replacement (Chevrolet LH7 - All Wheel Drive)Starter Solenoid Cable Replacement (GMC LH7 - All Wheel Drive)Starter Solenoid Cable Replacement (GMC LH7 - Front Wheel Drive)Starter Solenoid Cable Replacement (GMC LTG - All Wheel Drive)Starter Solenoid Cable Replacement (GMC LTG - Front Wheel Drive)**
- **Starter Replacement (LYX - All Wheel Drive)Starter Replacement (LYX - Front Wheel Drive)Starter Replacement (LTG - All Wheel Drive)Starter Replacement (LTG - Front Wheel Drive)Starter Replacement (LH7 - All Wheel Drive)Starter Replacement (LH7 - Front Wheel Drive)**

STARTER 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.

mcx30.com

Circuit/System Description

The starter motors are non-repairable. They have pole pieces that are arranged 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.

Reference Information

Description and Operation

Starting System Description and Operation

Circuit/System Verification

Start the engine. Listen to the starter noise, while the engine is cranking. Compare the concern to a similar vehicle.

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
    - Debris in the bell housing
    - If not within specifications, remove the debris, tighten the flywheel bolts, or repair or replace the flywheel.
3. If all inspections were within specification, replace the starter motor.

Repair Instructions

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

- Replace the starter, refer to the affected component's procedure for service.
- Replace the engine flywheel, refer to the affected component's procedure for service.

REPAIR INSTRUCTIONS

BATTERY NEGATIVE CABLE DISCONNECTION AND CONNECTION (KL9)

mx30.com

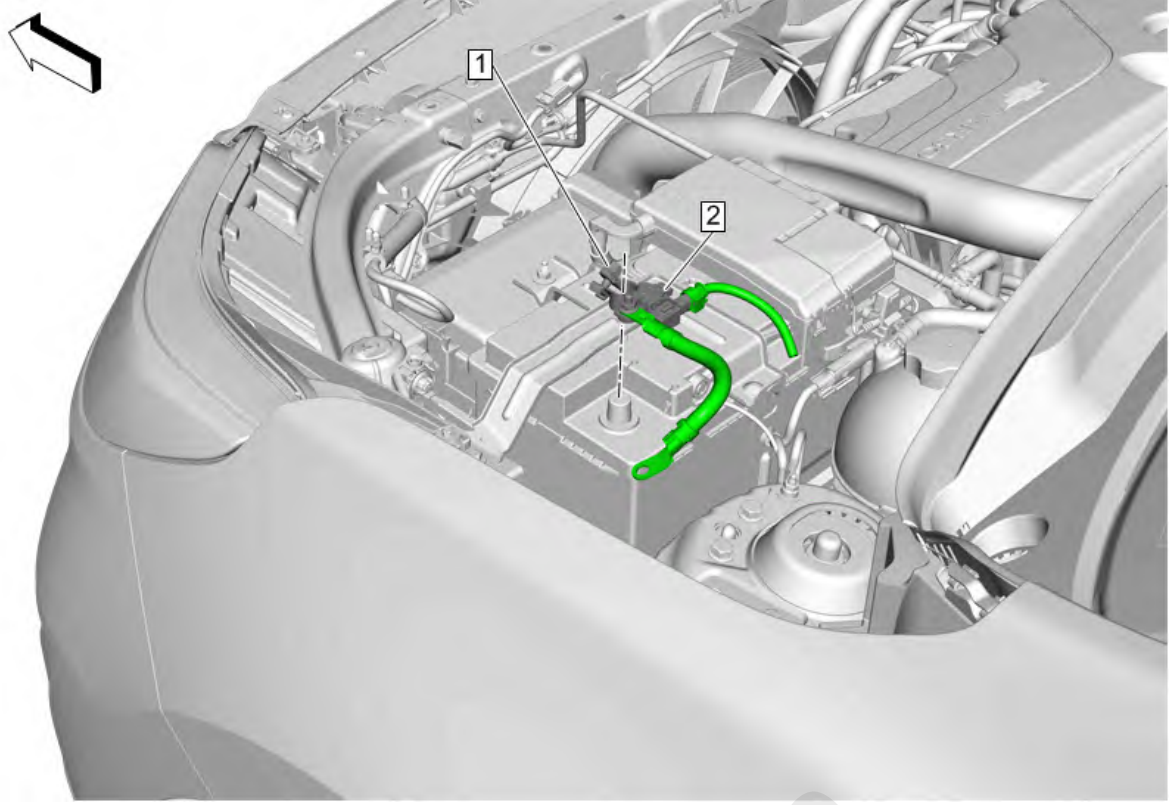


Fig. 7: Battery Negative Cable (KL9)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	**WARNING:** **Unless directed otherwise, the ignition must be OFF with the key removed, 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 OnStarÃ‚Â® (UE1) with Back Up Battery:** **The Back Up Battery is a redundant power supply to allow limited OnStarÃ‚Â® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStarÃ‚Â® module). Do not disconnect the main vehicle battery or remove the OnStarÃ‚Â® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStarÃ‚Â® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStarÃ‚Â® Back-Up Battery 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 back-up battery is not rechargeable and once activated the back-up battery must be replaced.** **CAUTION:** **Refer to Fastener Caution .** Battery Negative Post Clamp Nut**Tighten** 4.5 N.m (40 lb in)
2	Battery Sensor Module

BATTERY SENSOR REPLACEMENT (KL9)

Removal Procedure

WARNING: **Unless directed otherwise, the ignition must be OFF with the key removed,**

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 OnStarÃ‚Â® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStarÃ‚Â® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStarÃ‚Â®module). Do not disconnect the main vehicle battery or remove the OnStarÃ‚Â® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStarÃ‚Â® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStarÃ‚Â® Back-Up Battery 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 back-up battery is not rechargeable and once activated the back-up battery must be replaced.

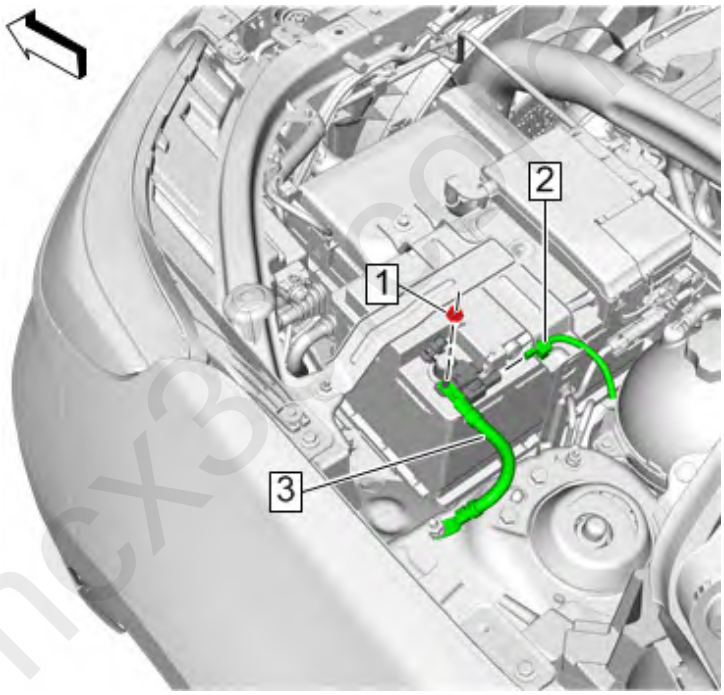


Fig. 8: Battery Negative Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

1. Remove Battery Negative Cable Nut (1).
2. Disconnect Electrical Connector (2).
3. Reposition away Battery Negative Cable (3).

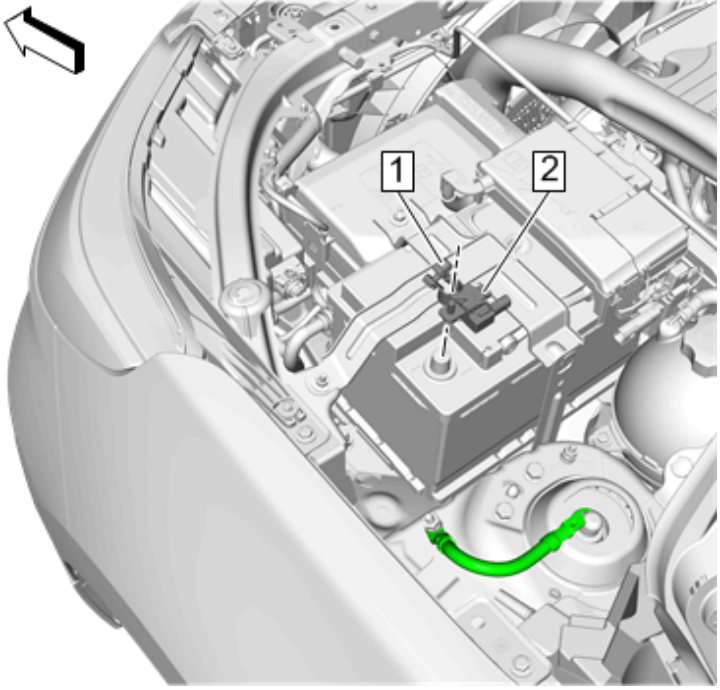


Fig. 9: Battery Sensor Module
Courtesy of GENERAL MOTORS COMPANY

4. Loosen Battery Negative Post Clamp Nut (1).
5. Remove Battery Sensor Module (2).

Installation Procedure

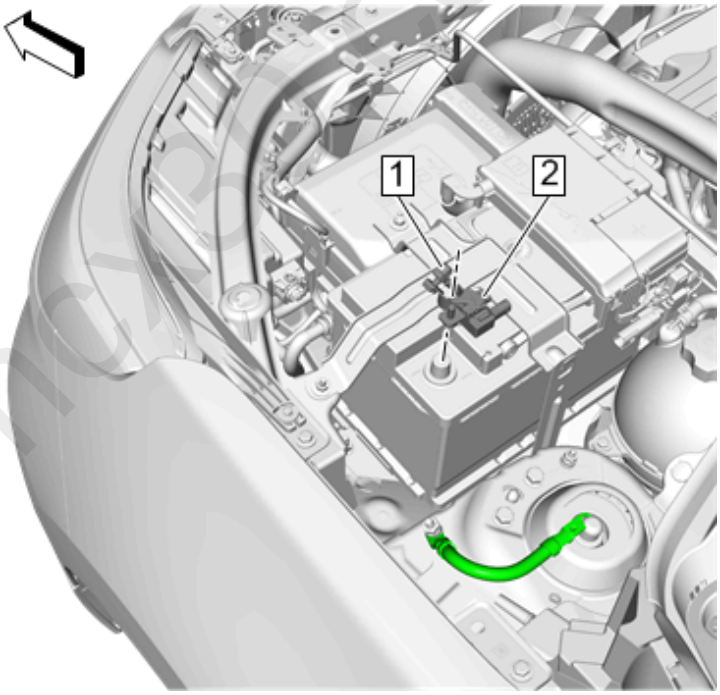


Fig. 10: Battery Sensor Module
Courtesy of GENERAL MOTORS COMPANY

1. Connect Battery Sensor Module (2).

CAUTION: **Refer to Fastener Caution**

2. Battery Negative Post Clamp Nut (1) - Tighten 4.5 N.m (40 lb in)

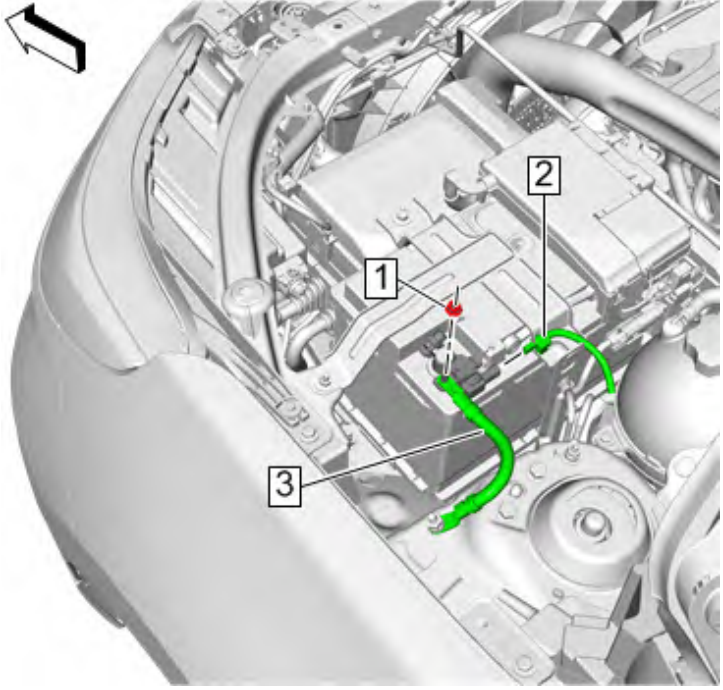


Fig. 11: Battery Negative Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

3. Connect Electrical Connector (2).
4. Install Battery Negative Cable (3).
5. Battery Negative Cable Nut (1) - Tighten 9 N.m (80 lb in)

BATTERY NEGATIVE CABLE REPLACEMENT

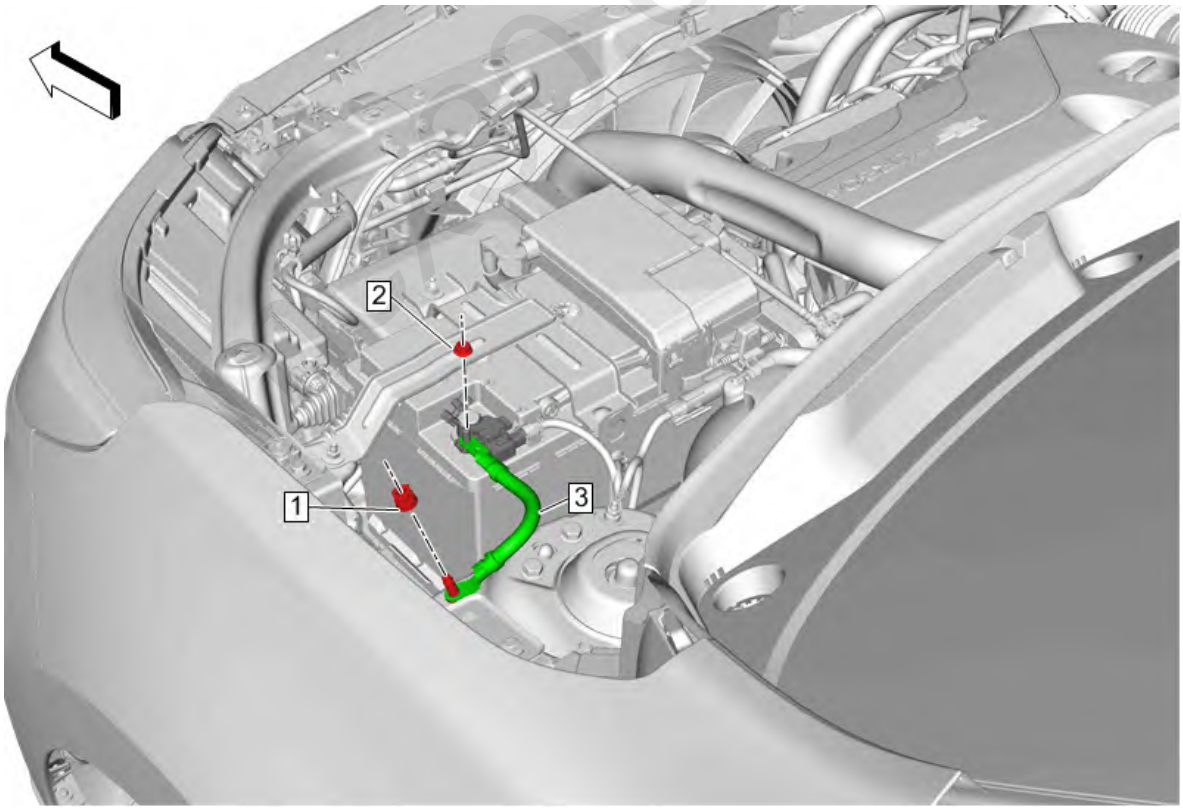


Fig. 12: Battery Negative Cable
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

Callout	Component Name
1	**WARNING:** **Unless directed otherwise, the ignition must be OFF with the key removed, 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 OnStarÃ‚Â® (UE1) with Back Up Battery:** **The Back Up Battery is a redundant power supply to allow limited OnStarÃ‚Â® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStarÃ‚Â®module). Do not disconnect the main vehicle battery or remove the OnStarÃ‚Â® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStarÃ‚Â® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStarÃ‚Â® Back-Up Battery 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 back-up battery is not rechargeable and once activated the back-up battery must be replaced.** **CAUTION:** **Refer to Fastener Caution .** Battery Negative Cable Ground Fastener**Tighten** 22 N.m (16 lb ft)
2	Battery Sensor Module Fastener **Tighten** 9 N.m (80 lb in)
3	Battery Negative Cable

BATTERY NEGATIVE CABLE EXTENSION CABLE REPLACEMENT (LYX)

Removal Procedure

1. Remove the battery tray. **Battery Tray Replacement**

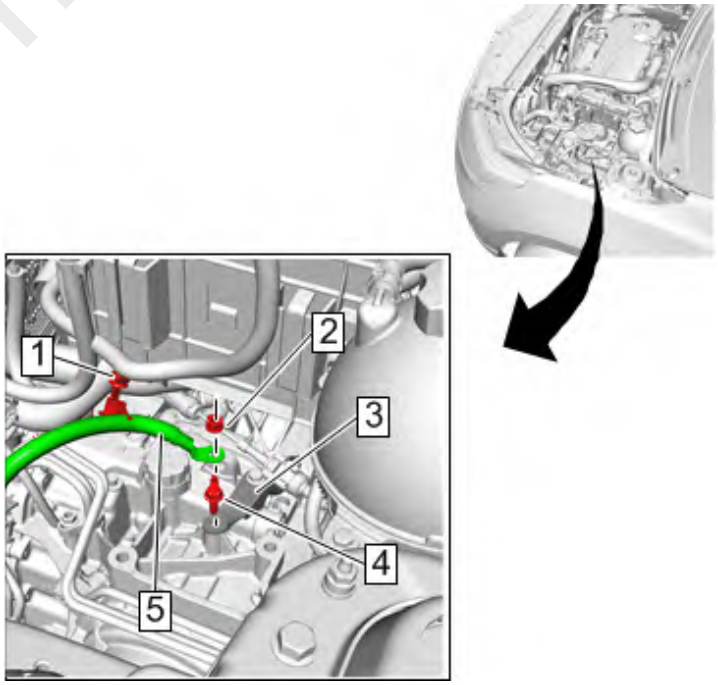


Fig. 13: Battery Negative Cable Extension Cable And Retainer
Courtesy of GENERAL MOTORS COMPANY

mcx30.com

NOTE: **Transmission mounts removed for clarity.**

2. Remove Battery Negative Cable Extension Cable Fastener (2) @ Shift Cable Bracket (3) and DISCARD
3. Battery Negative Cable Extension Cable Retainer (1).
4. Remove Battery Negative Cable Extension Cable (5).
5. Remove Stud (4) and DISCARD

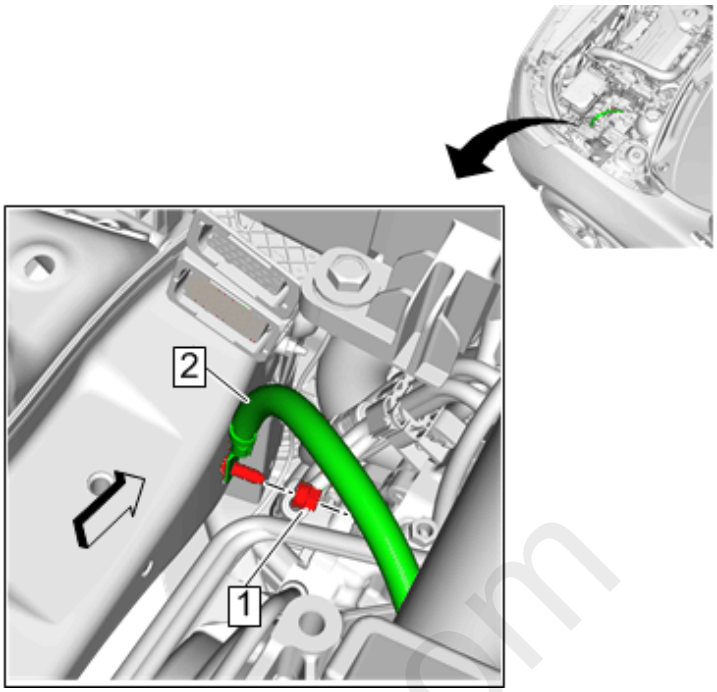


Fig. 14: Battery Negative Cable Extension Cable Fastener And Extension Cable
Courtesy of GENERAL MOTORS COMPANY

6. Remove Battery Negative Cable Extension Cable Fastener (1).
7. Remove Battery Negative Cable Extension Cable (2).

Installation Procedure

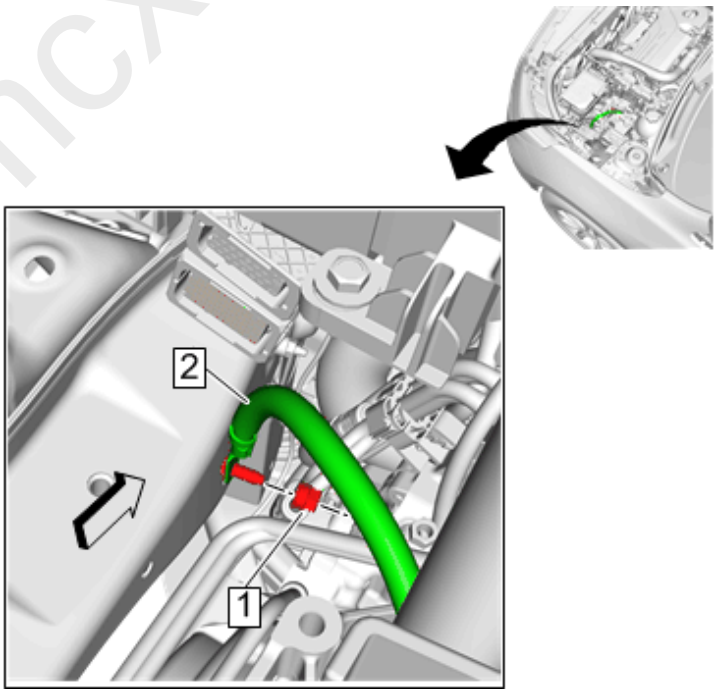


Fig. 15: Battery Negative Cable Extension Cable Fastener And Extension Cable
Courtesy of GENERAL MOTORS COMPANY

1. Install Battery Negative Cable Extension Cable (2).

CAUTION: **Refer to Fastener Caution**

mcx30.com

2. Install Battery Negative Cable Extension Cable Fastener (1) and tighten 9 N.m (80 lb in)

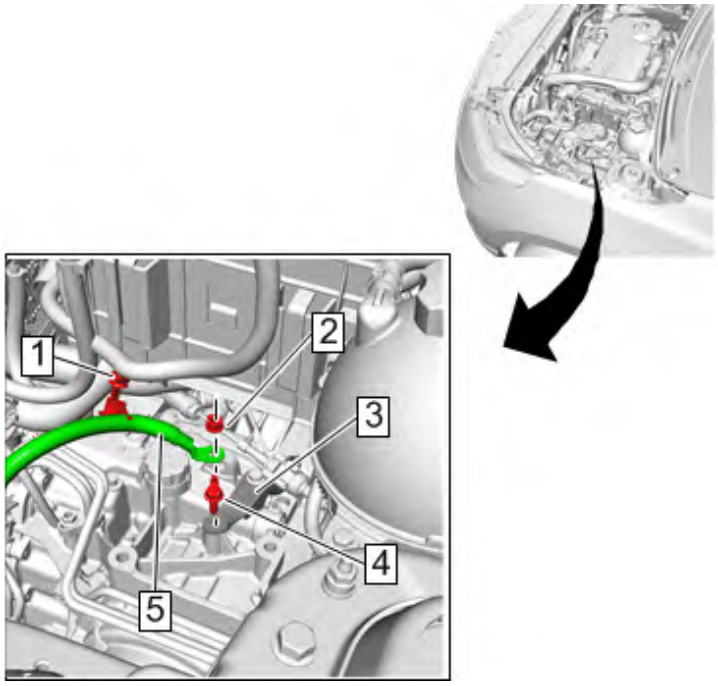


Fig. 16: Battery Negative Cable Extension Cable And Retainer
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Transmission mounts removed for clarity.**

3. Install Battery Negative Cable Extension Cable (5).
4. Engage Battery Negative Cable Extension Cable Retainer (1).
5. Install Stud (4) and tighten the NEW stud. 22 N.m (16 lb ft)
6. Install Battery Negative Cable Extension Cable Fastener (2) @ Shift Cable Bracket (3) and tighten the NEW fastener. 22 N.m (16 lb ft)
7. Install the battery tray. **Battery Tray Replacement**

ENGINE WIRING HARNESS JUNCTION BLOCK REPLACEMENT

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

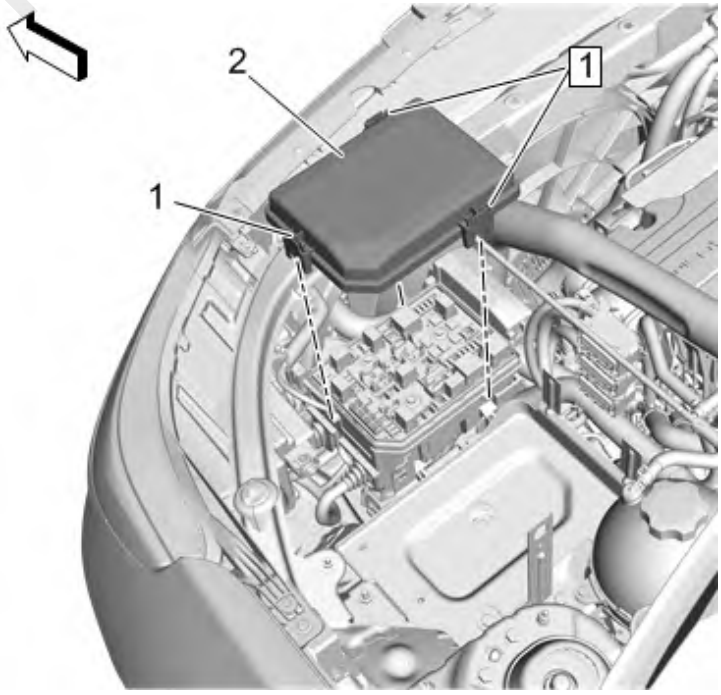


Fig. 17: Engine Wiring Harness Junction Block Cover And Retaining Tab
Courtesy of GENERAL MOTORS COMPANY

2. Disengage Retaining Tab (1) - [3x]
3. Remove Engine Wiring Harness Junction Block Cover (2).

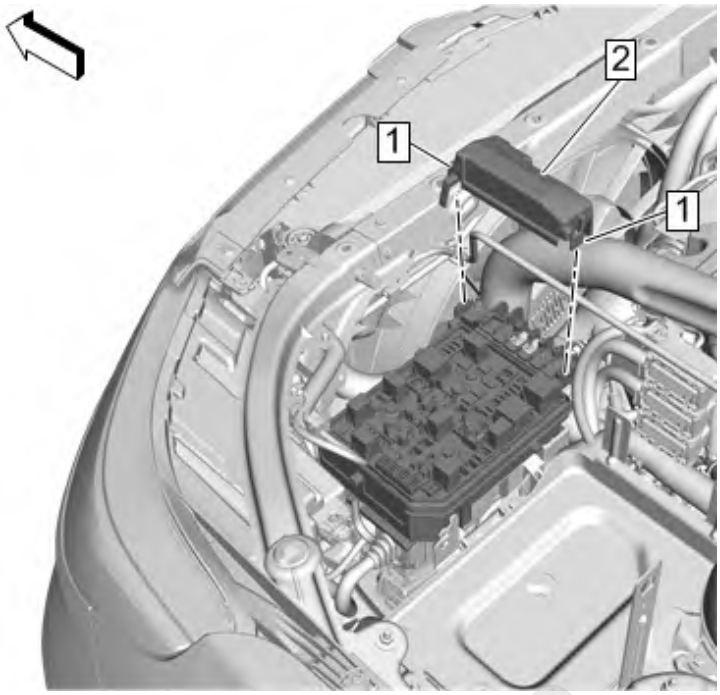


Fig. 18: Junction Block Cover And Retaining Tab
Courtesy of GENERAL MOTORS COMPANY

4. Disengage Retaining Tab (1) - [2x]
5. Remove Junction Block Cover (2).

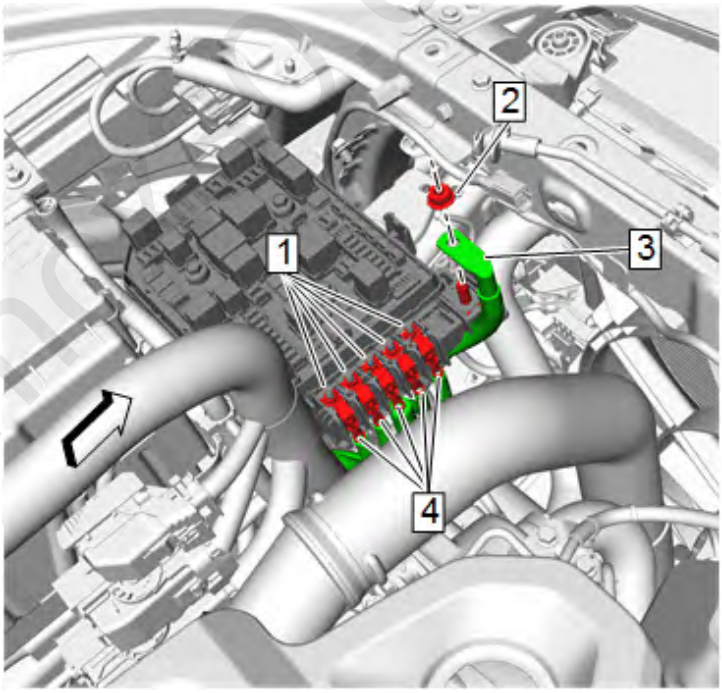


Fig. 19: Engine Wiring Harness Junction Block Nut And Cable Nut
Courtesy of GENERAL MOTORS COMPANY

6. Remove Engine Wiring Harness Junction Block Nut (1) - [5x]
7. Remove Battery Positive Junction Block Cable Nut (2).
8. Reposition away Battery Positive Junction Block Cable (3).
9. Reposition away Wiring Harness Terminal (4) - [5x]

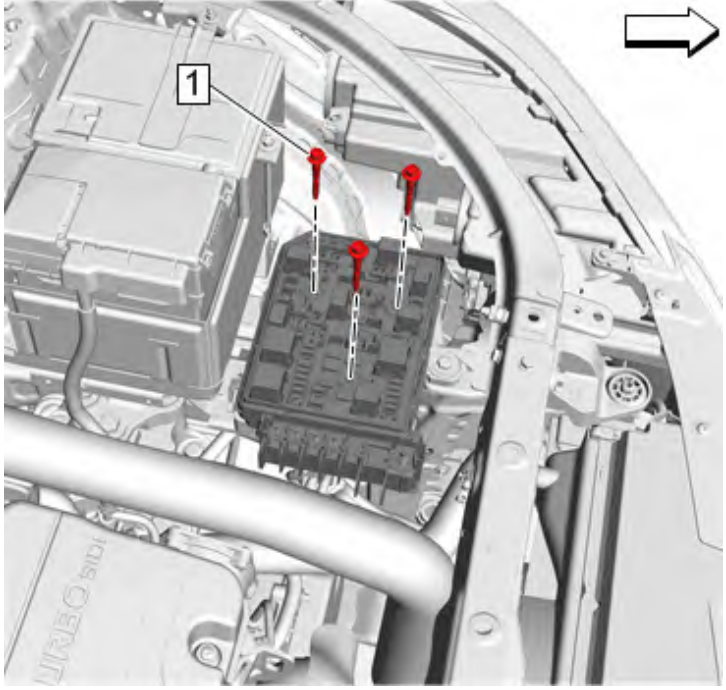


Fig. 20: Engine Wiring Harness Junction Block Mounting Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Remove Engine Wiring Harness Junction Block Mounting Bolt (1) - [3x]

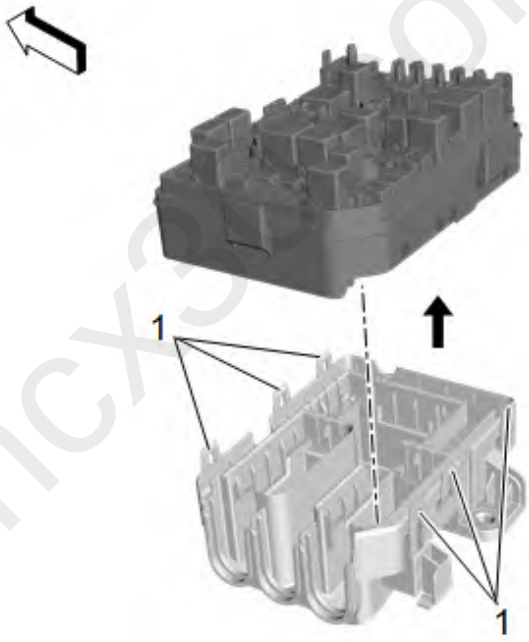


Fig. 21: Retaining Tab
Courtesy of GENERAL MOTORS COMPANY

11. Disengage Retaining Tab (1) - [6x]

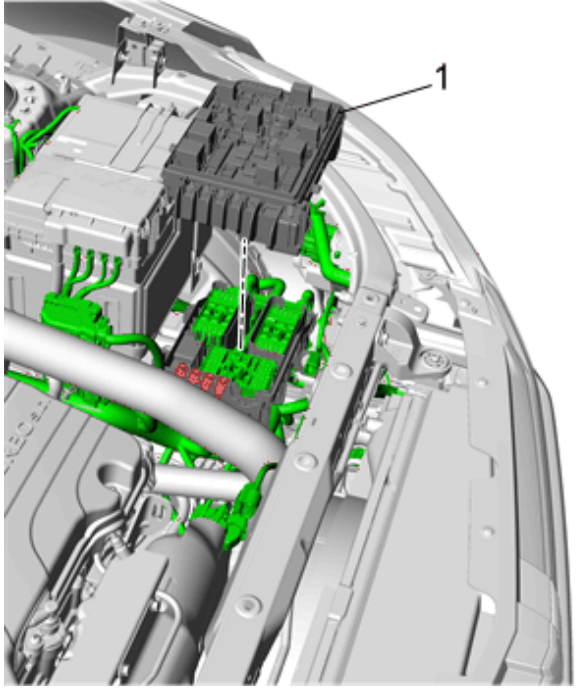


Fig. 22: Wiring Harness Junction Block
Courtesy of GENERAL MOTORS COMPANY

12. Remove Engine Wiring Harness Junction Block (1).

Installation Procedure

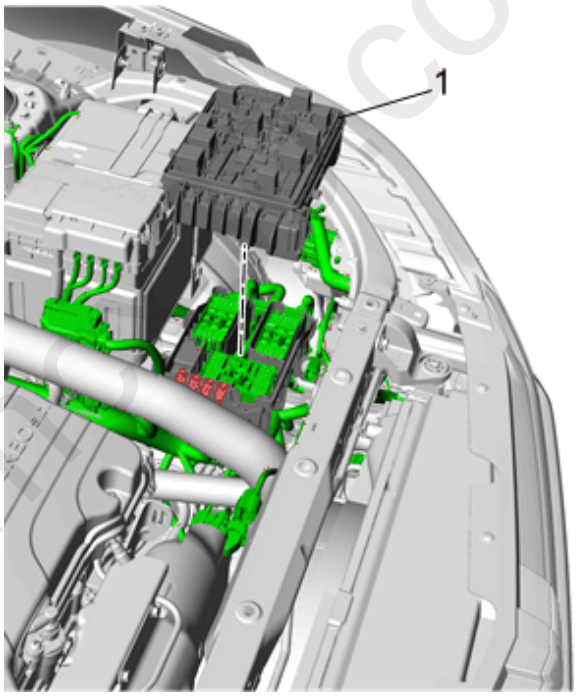


Fig. 23: Wiring Harness Junction Block
Courtesy of GENERAL MOTORS COMPANY

1. Install Engine Wiring Harness Junction Block (1).

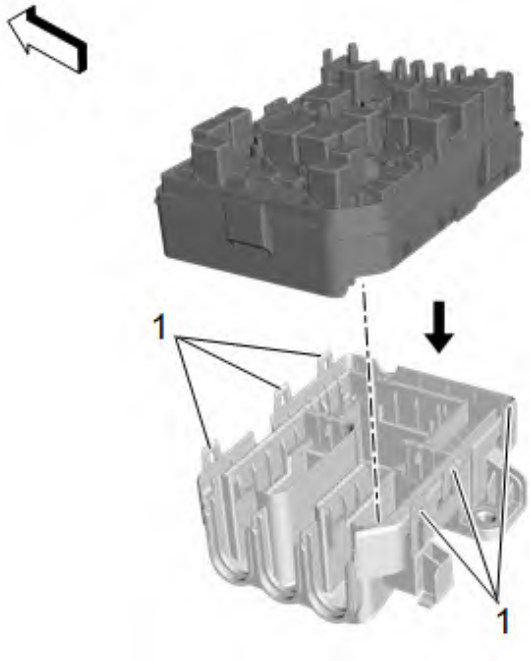


Fig. 24: Retaining Tab
Courtesy of GENERAL MOTORS COMPANY

2. Engage Retaining Tab (1) - [6x]

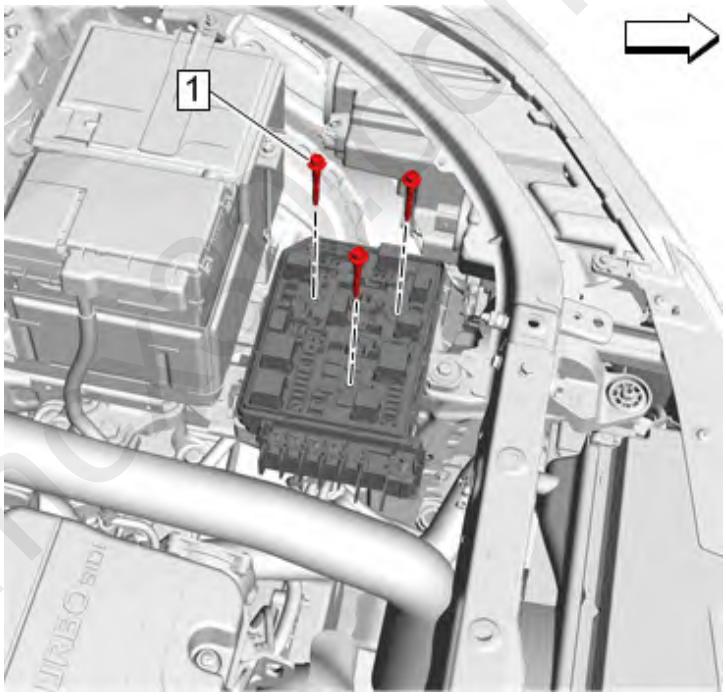


Fig. 25: Engine Wiring Harness Junction Block Mounting Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution**

3. Install Engine Wiring Harness Junction Block Mounting Bolt (1) and tighten [3x] 7 N.m (62 lb in)

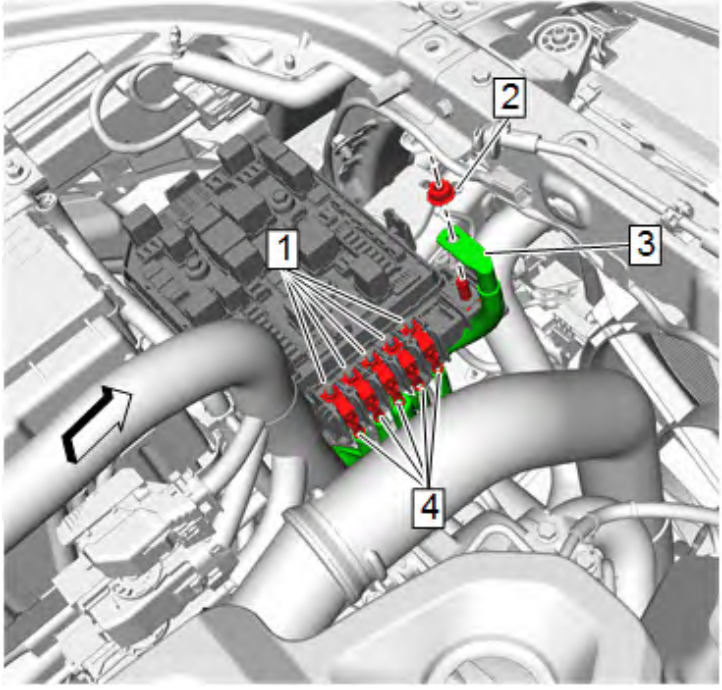


Fig. 26: Engine Wiring Harness Junction Block Nut And Cable Nut
Courtesy of GENERAL MOTORS COMPANY

4. Install Wiring Harness Terminal (4) - [5x]
5. Install Engine Wiring Harness Junction Block Nut (1) and tighten [5x] 4.7 N.m (42 lb in)
6. Install Battery Positive Junction Block Cable (3).
7. Install Battery Positive Junction Block Cable Nut (2) and tighten 12 N.m (106 lb in)

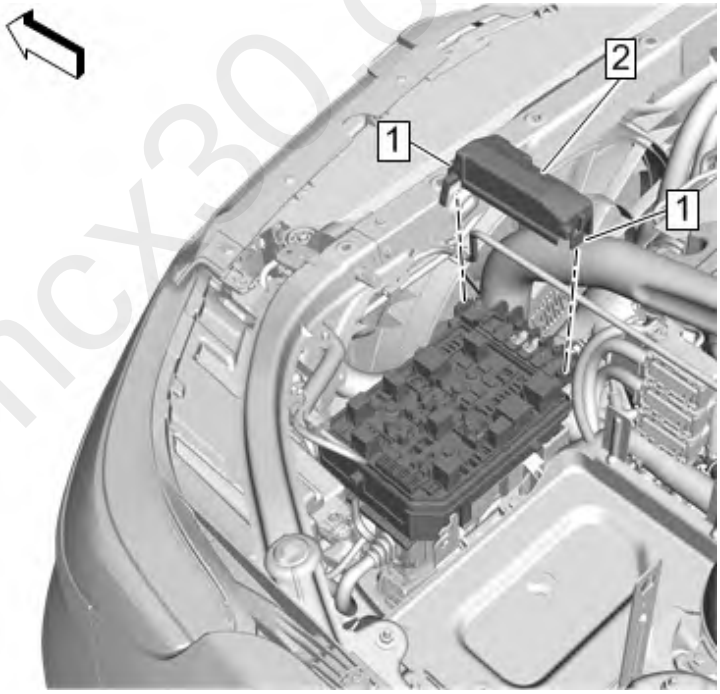


Fig. 27: Junction Block Cover And Retaining Tab
Courtesy of GENERAL MOTORS COMPANY

8. Install Junction Block Cover (2).
9. Engage Retaining Tab (1) - [2x]

mcx30.com

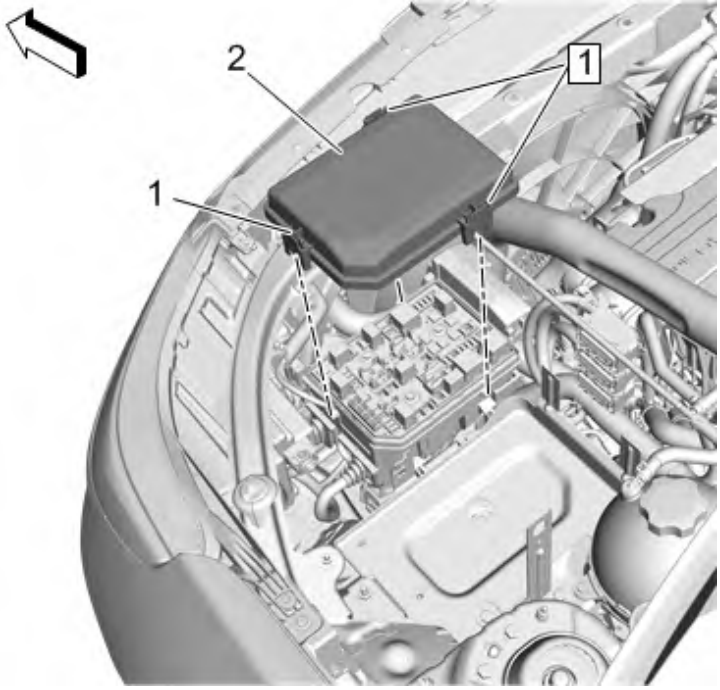


Fig. 28: Engine Wiring Harness Junction Block Cover And Retaining Tab
Courtesy of GENERAL MOTORS COMPANY

10. Install Engine Wiring Harness Junction Block Cover (2).
11. Engage Retaining Tab (1) - [3x]
12. Connect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

BATTERY POSITIVE JUNCTION BLOCK CABLE REPLACEMENT

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

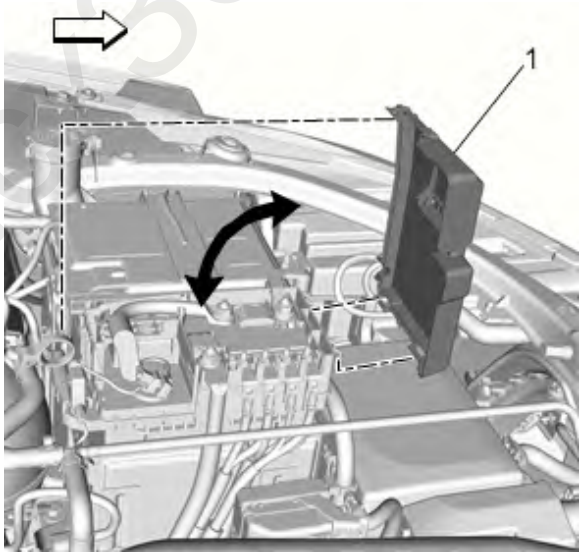


Fig. 29: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

2. Open Battery Distribution Engine Compartment Fuse Block Cover (1).

mg30.com

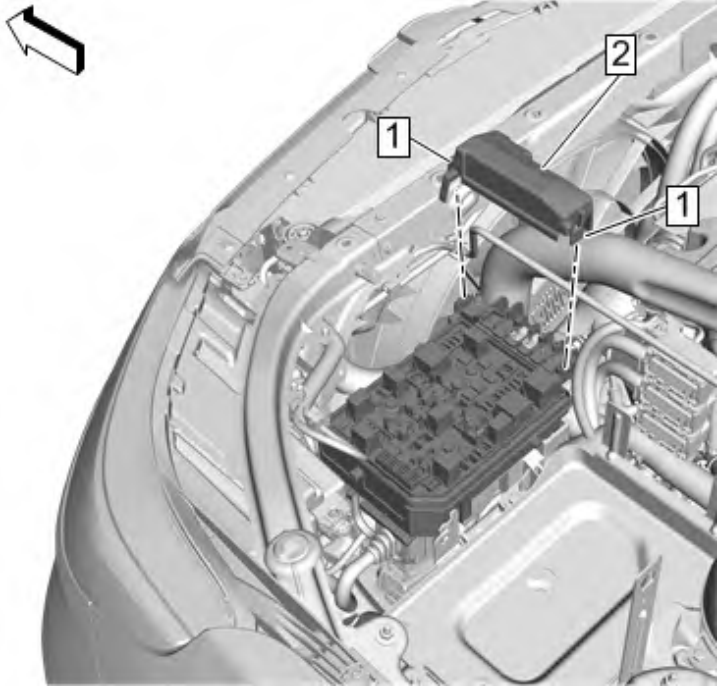


Fig. 30: Junction Block Cover And Retaining Tab
Courtesy of GENERAL MOTORS COMPANY

3. Disengage Retaining Tab (1) - [2x]
4. Remove Junction Block Cover (2).

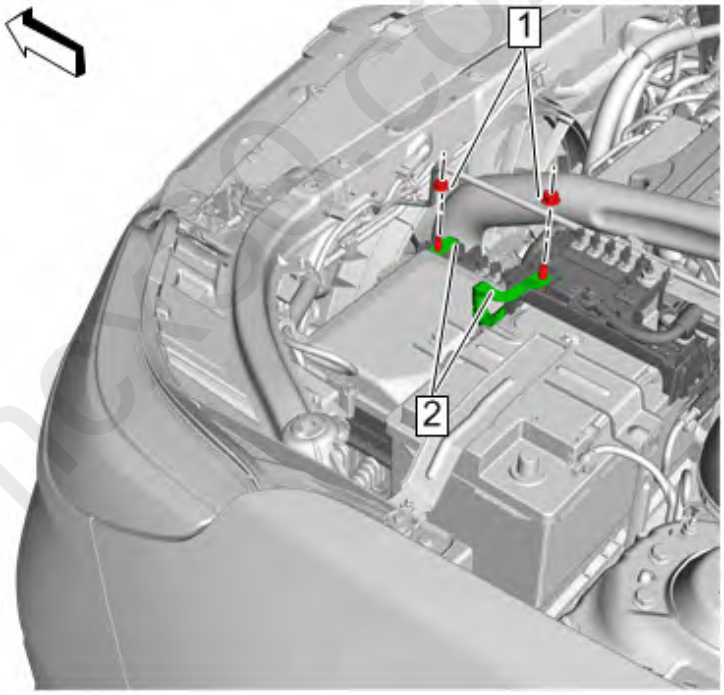


Fig. 31: Battery Positive Junction Block Cable Nut
Courtesy of GENERAL MOTORS COMPANY

5. Remove Battery Positive Junction Block Cable Nut (1) - [2x]
6. Reposition away Battery Positive Junction Block Cable (2).

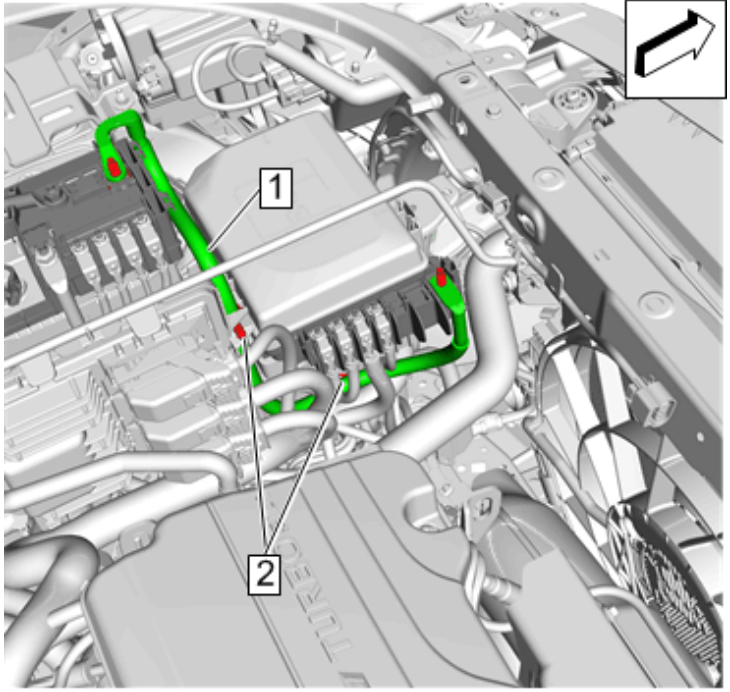


Fig. 32: Battery Positive Junction Block Cable And Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Disengage Retainer (2) - [2x]
8. Remove Battery Positive Junction Block Cable (1).

Installation Procedure

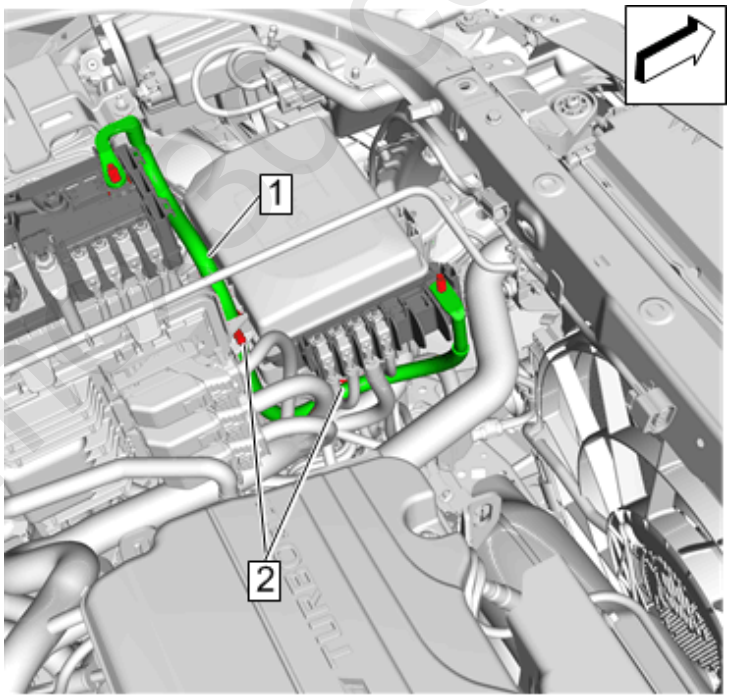


Fig. 33: Battery Positive Junction Block Cable And Retainer
Courtesy of GENERAL MOTORS COMPANY

1. Install Battery Positive Junction Block Cable (1).
2. Engage Retainer (2) - [2x]

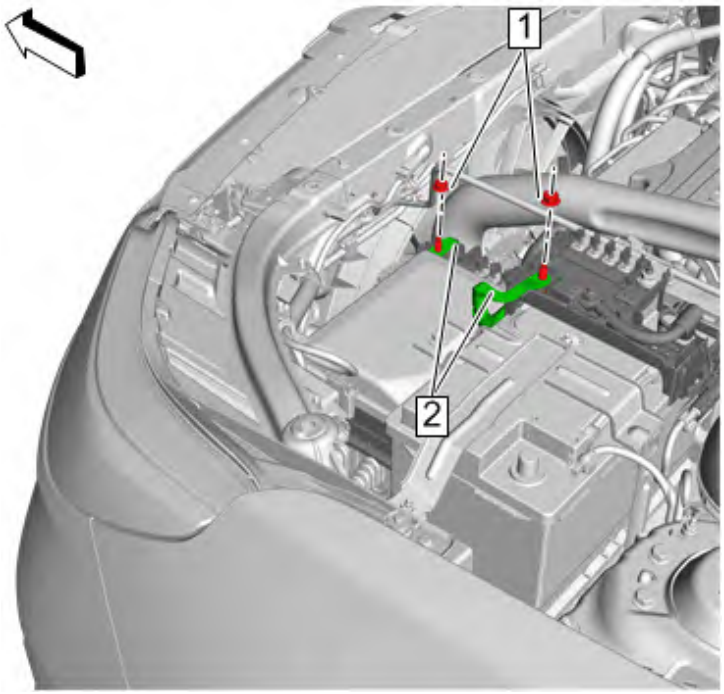


Fig. 34: Battery Positive Junction Block Cable Nut
Courtesy of GENERAL MOTORS COMPANY

3. Install Battery Positive Junction Block Cable (2).

CAUTION: **Refer to Fastener Caution**

4. Install Battery Positive Junction Block Cable Nut (1) and tighten [2x] 12 N.m (106 lb in)

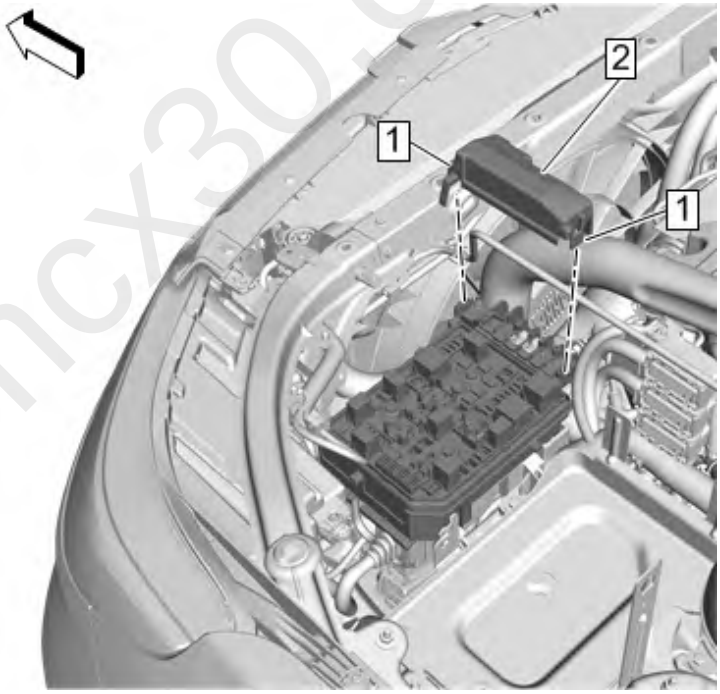


Fig. 35: Junction Block Cover And Retaining Tab
Courtesy of GENERAL MOTORS COMPANY

5. Install Junction Block Cover (2).
6. Engage Retaining Tab (1) - [2x]

mcx30.com

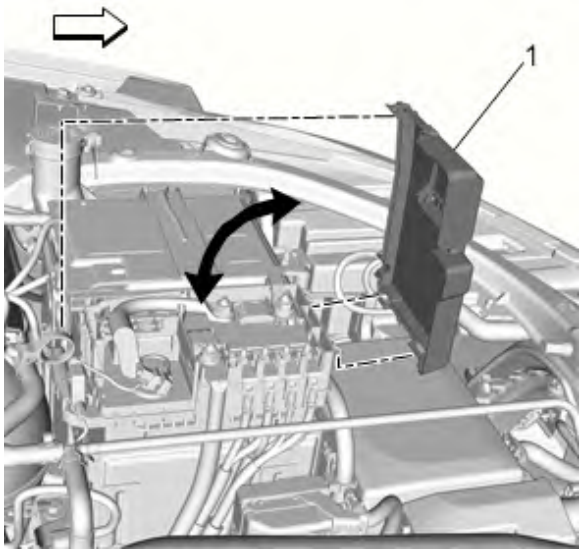


Fig. 36: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

7. Close Battery Distribution Engine Compartment Fuse Block Cover (1).
8. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

STARTER SOLENOID CABLE REPLACEMENT (LYX - ALL WHEEL DRIVE)

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

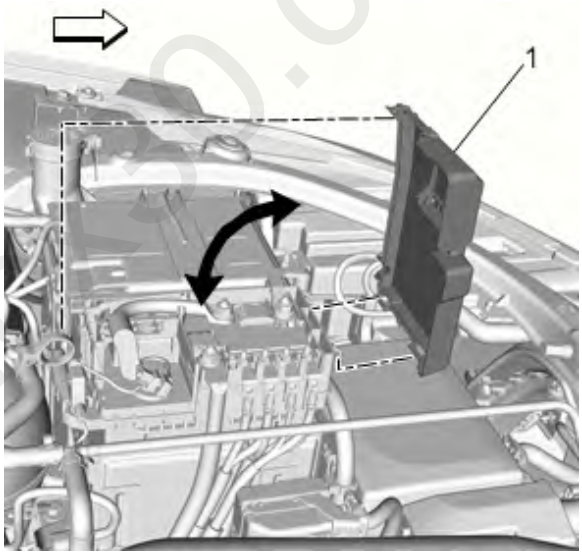


Fig. 37: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

2. Open Battery Distribution Engine Compartment Fuse Block Cover (1).

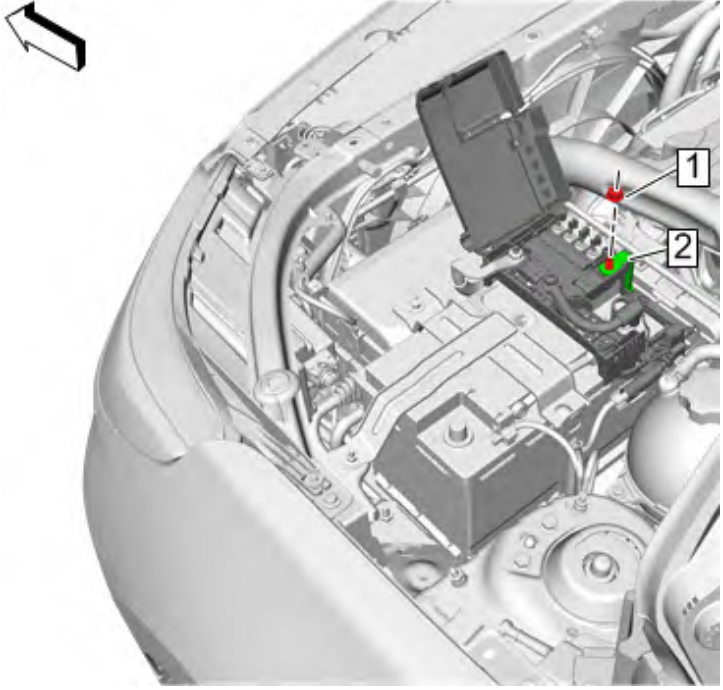


Fig. 38: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

3. Remove Starter Solenoid Cable Nut (1).
4. Remove Starter Solenoid Cable (2).

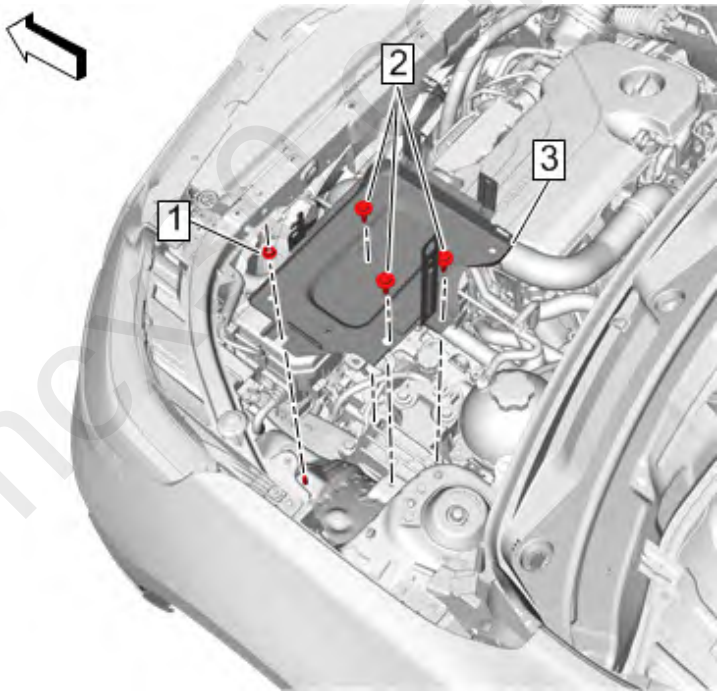


Fig. 39: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

5. Remove Battery Tray (3) - **Battery Tray Replacement**

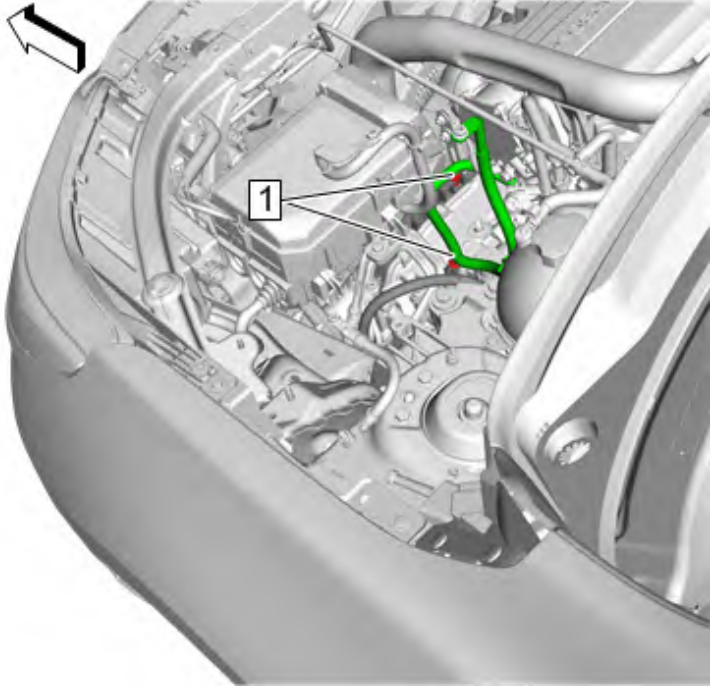


Fig. 40: Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Disengage Retainer (1) - [2x]

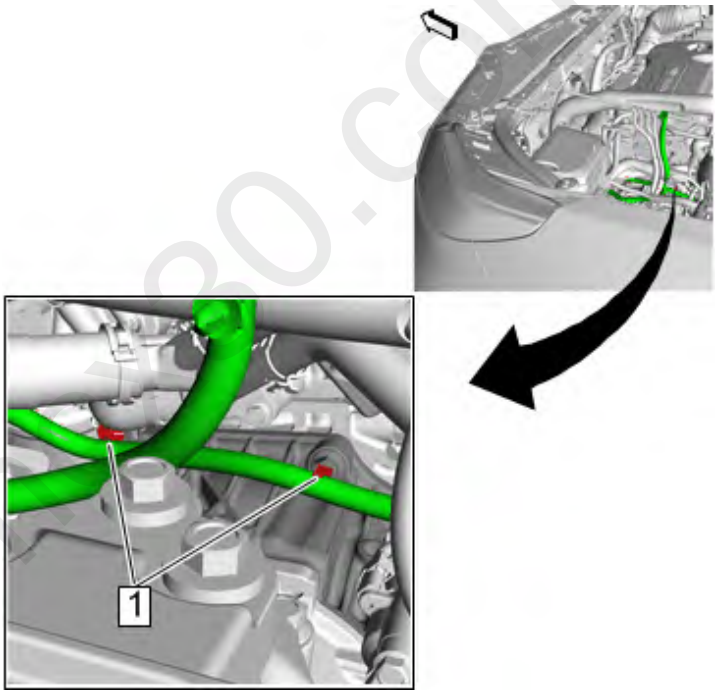


Fig. 41: Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Retainer Retainer (1) - [2x]

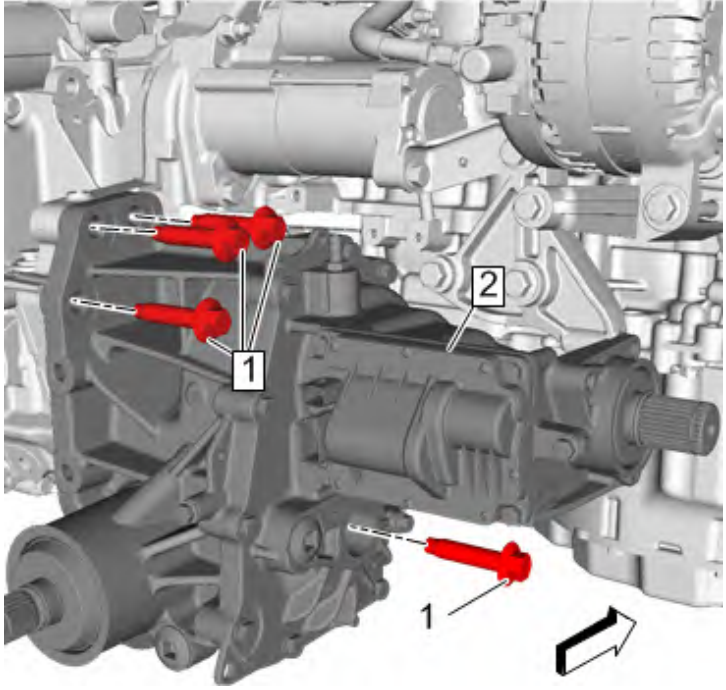


Fig. 42: Power Transfer Unit Case
Courtesy of GENERAL MOTORS COMPANY

8. Remove Power Transfer Unit Case (2) - **Power Transfer Unit Case Replacement (MNH Transmission with LYX Engine)**

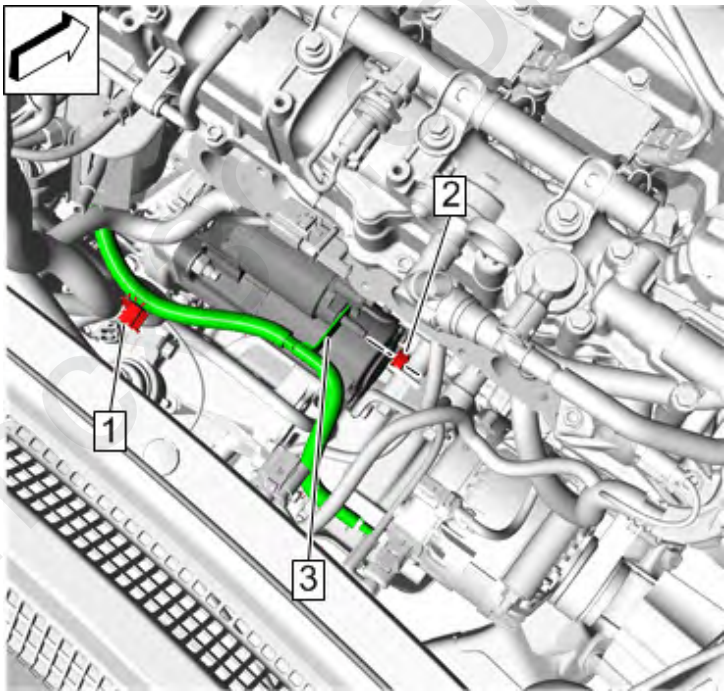


Fig. 43: Retainer
Courtesy of GENERAL MOTORS COMPANY

9. Disengage Retainer (1).
10. Remove Starter Solenoid Cable Nut (2) @ Starter Solenoid.
11. Remove Starter Solenoid Cable (3).

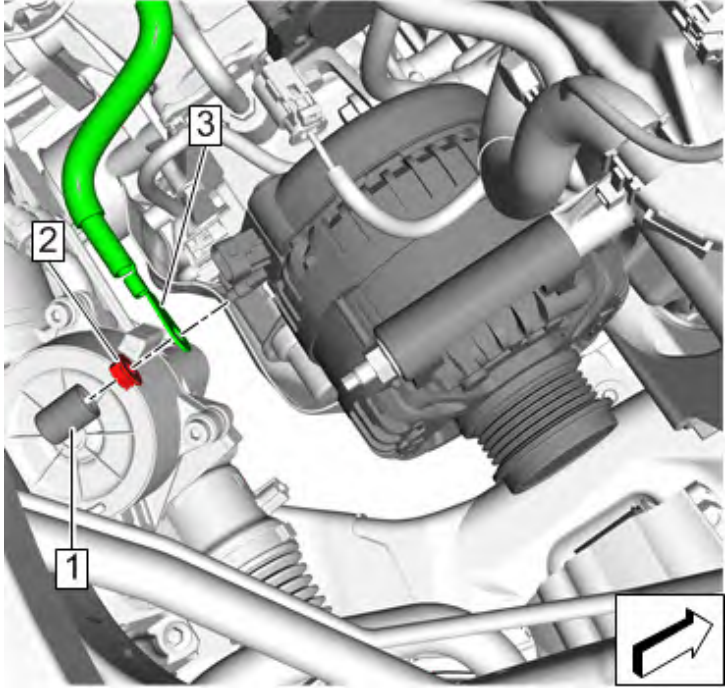


Fig. 44: Protective Cap, Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

12. Remove Protective Cap (1).
13. Remove Starter Solenoid Cable Nut (2) @ Generator.
14. Remove Starter Solenoid Cable (3).

Installation Procedure

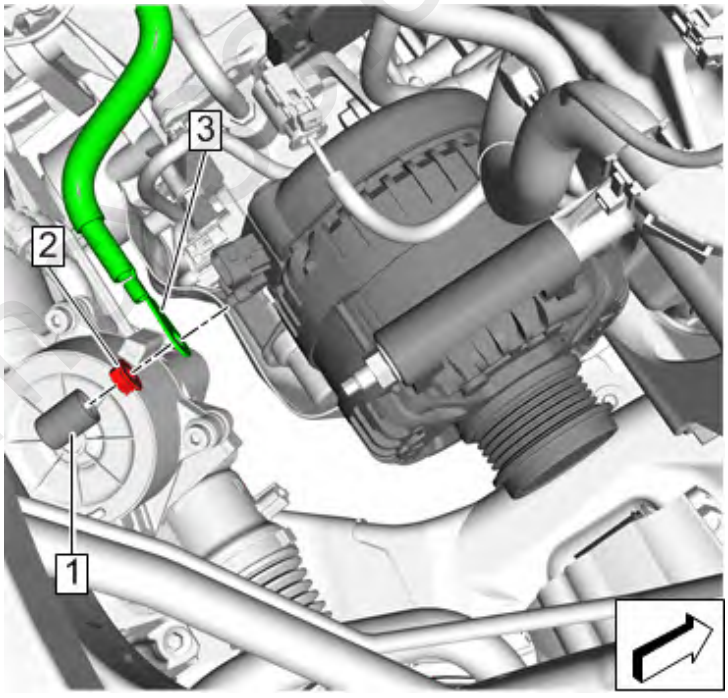


Fig. 45: Protective Cap, Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

1. Install Starter Solenoid Cable (3).

CAUTION: **Refer to Fastener Caution**

2. Install Starter Solenoid Cable Nut (2) @ Generator and tighten 15 N.m (11 lb ft)
3. Install Protective Cap (1).

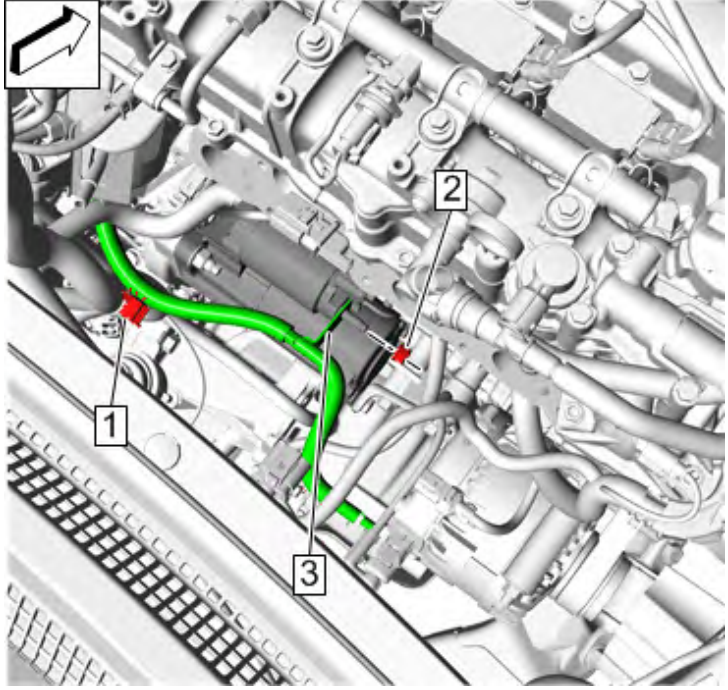


Fig. 46: Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install Starter Solenoid Cable (3).
5. Install Starter Solenoid Cable Nut (2) @ Starter Solenoid and tighten 12 N.m (106 lb in)
6. Engage Retainer (1).

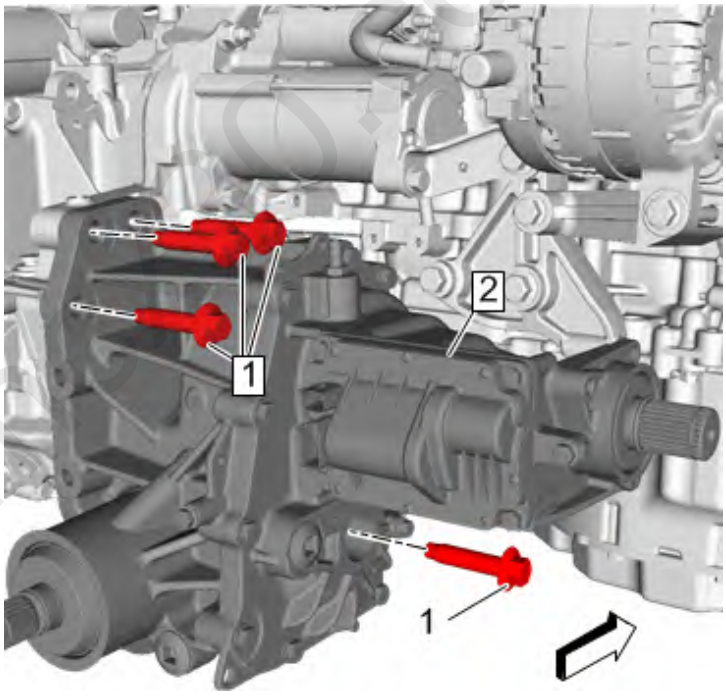


Fig. 47: Power Transfer Unit Case
Courtesy of GENERAL MOTORS COMPANY

7. Install Power Transfer Unit Case (2) -**Power Transfer Unit Case Replacement (MNH Transmission with LYX Engine)**

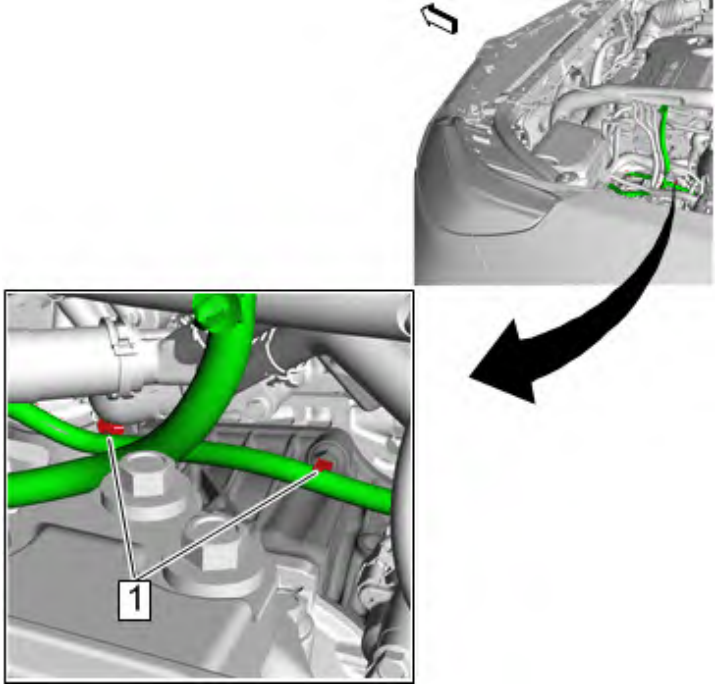


Fig. 48: Retainer
Courtesy of GENERAL MOTORS COMPANY

8. Engage Retainer (1) - [2x]

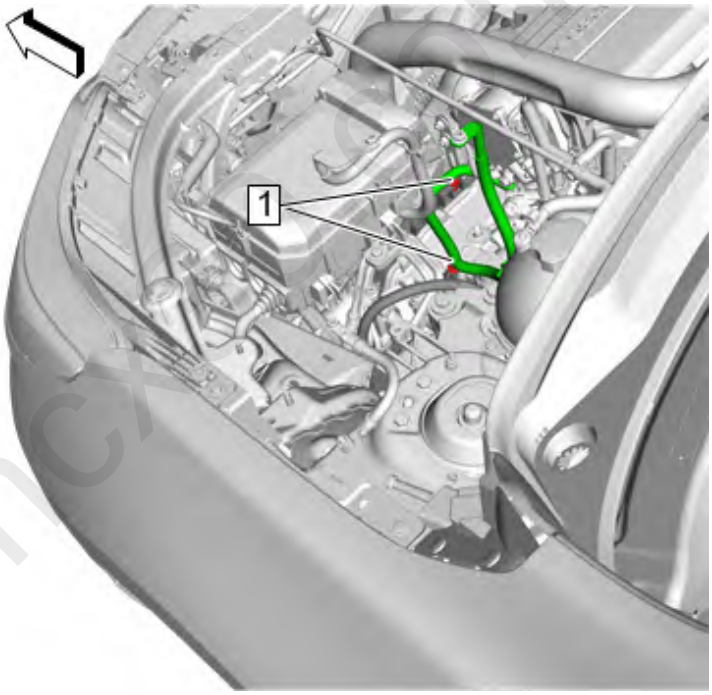


Fig. 49: Retainer
Courtesy of GENERAL MOTORS COMPANY

9. Engage Retainer (1) - [2x]

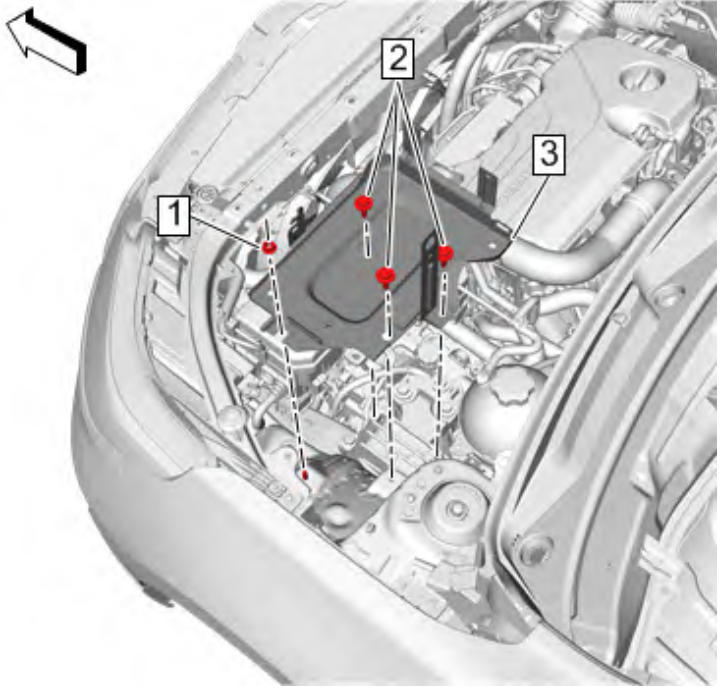


Fig. 50: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

10. Install Battery Tray (3) - **Battery Tray Replacement**

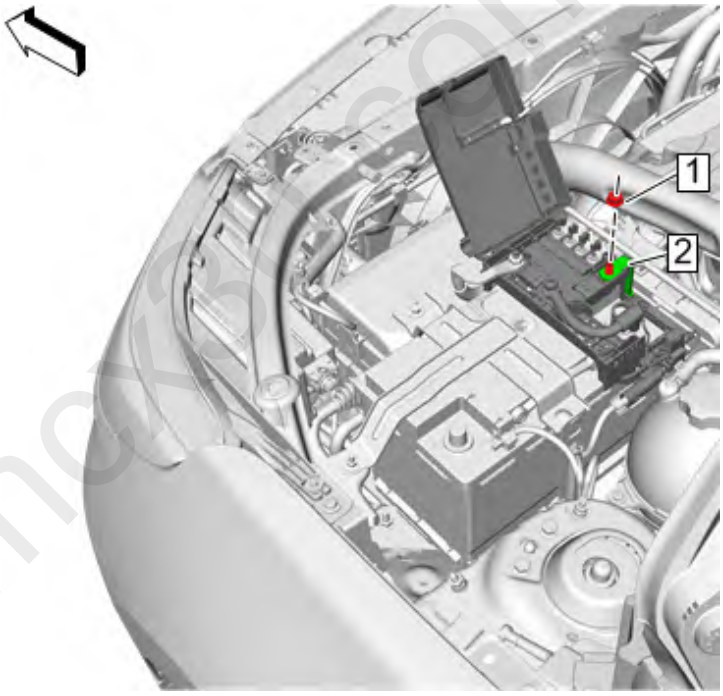


Fig. 51: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

11. Install Starter Solenoid Cable (2).
12. Install Starter Solenoid Cable Nut (1) @ Battery Distribution Engine Compartment Fuse Block and tighten 12 N.m (106 lb in)

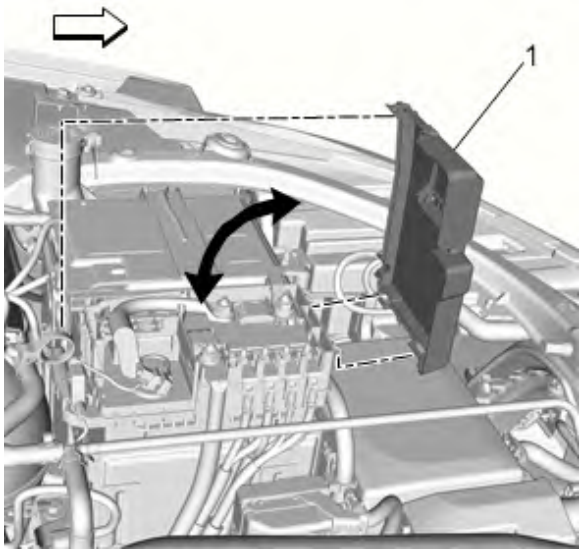


Fig. 52: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

13. Close Battery Distribution Engine Compartment Fuse Block Cover (1).
14. Connect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

STARTER SOLENOID CABLE REPLACEMENT (LYX - FRONT WHEEL DRIVE)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

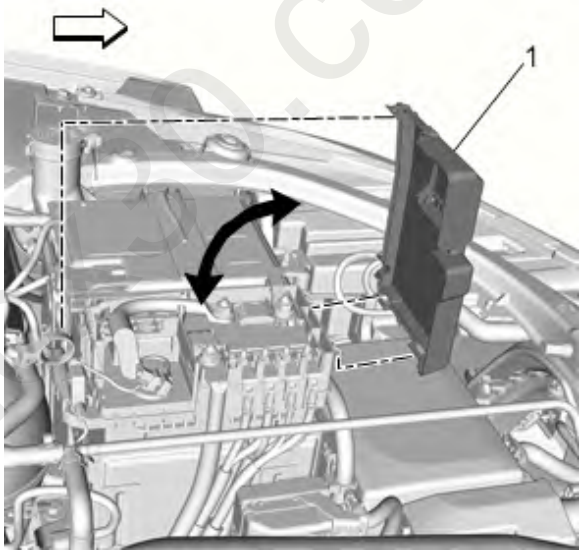


Fig. 53: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

2. Open Battery Distribution Engine Compartment Fuse Block Cover (1).

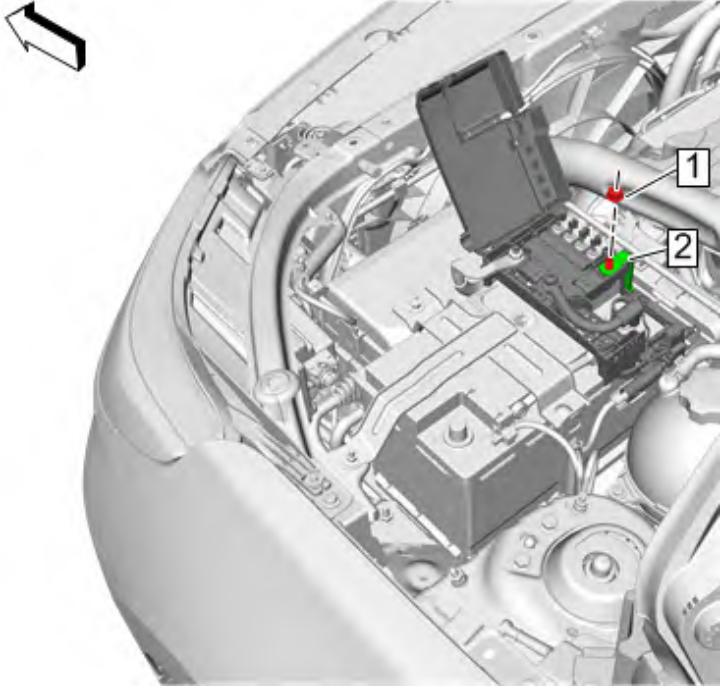


Fig. 54: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

3. Remove Starter Solenoid Cable Nut (1).
4. Remove Starter Solenoid Cable (2).

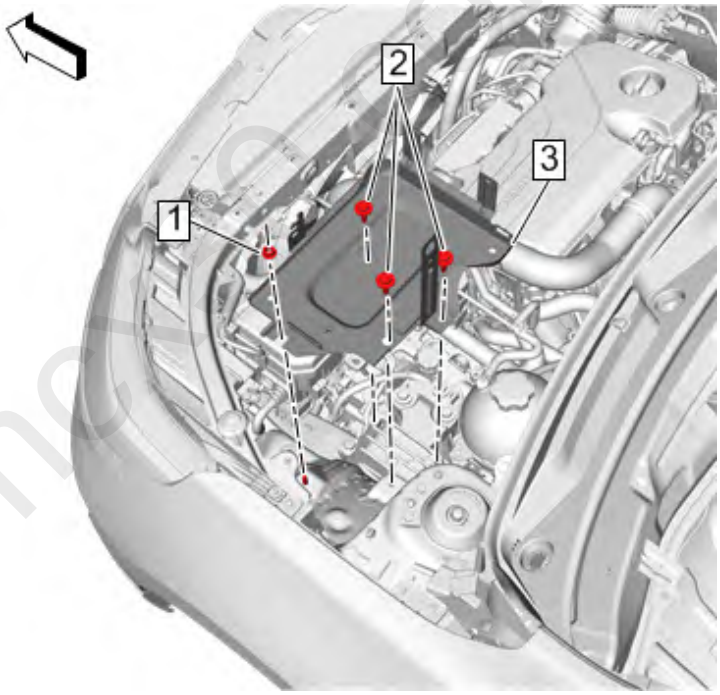


Fig. 55: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

5. Remove Battery Tray (3) - **Battery Tray Replacement**

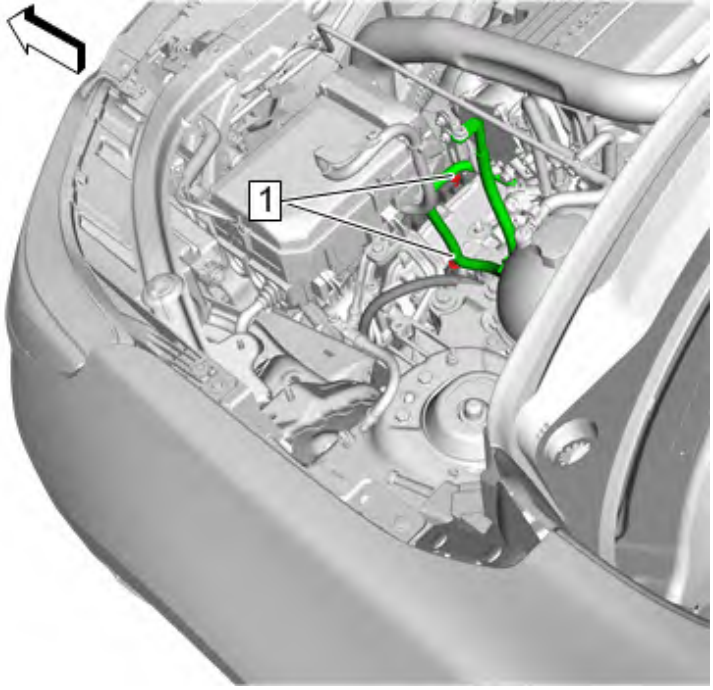


Fig. 56: Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Disengage Retainer (1) - [2x]

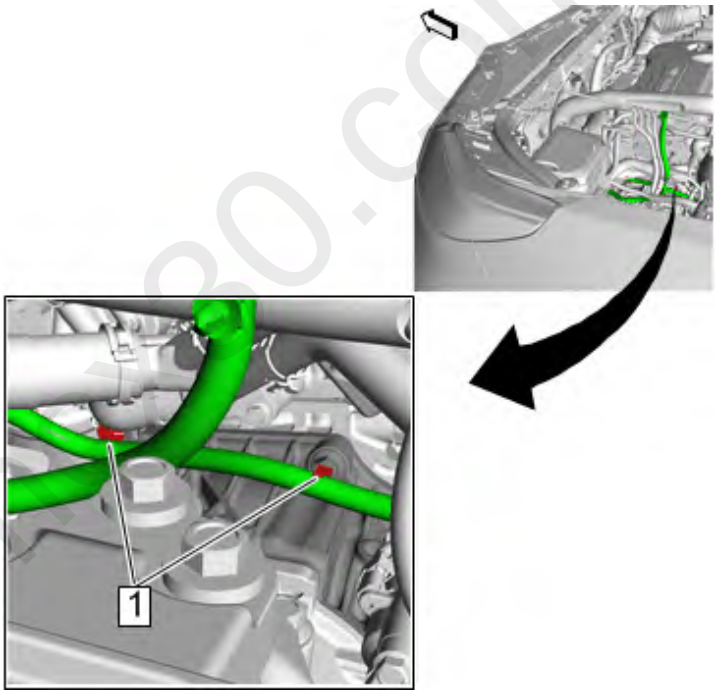


Fig. 57: Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Disengage Retainer (1) - [2x]

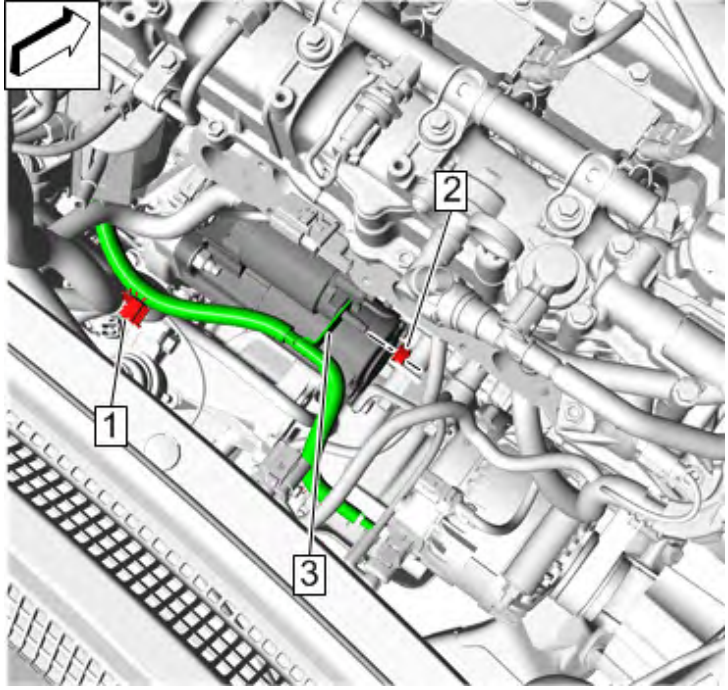


Fig. 58: Retainer
Courtesy of GENERAL MOTORS COMPANY

8. Disengage Retainer (1).
9. Remove Starter Solenoid Cable Nut (2) @ Starter Solenoid
10. Remove Starter Solenoid Cable (3).

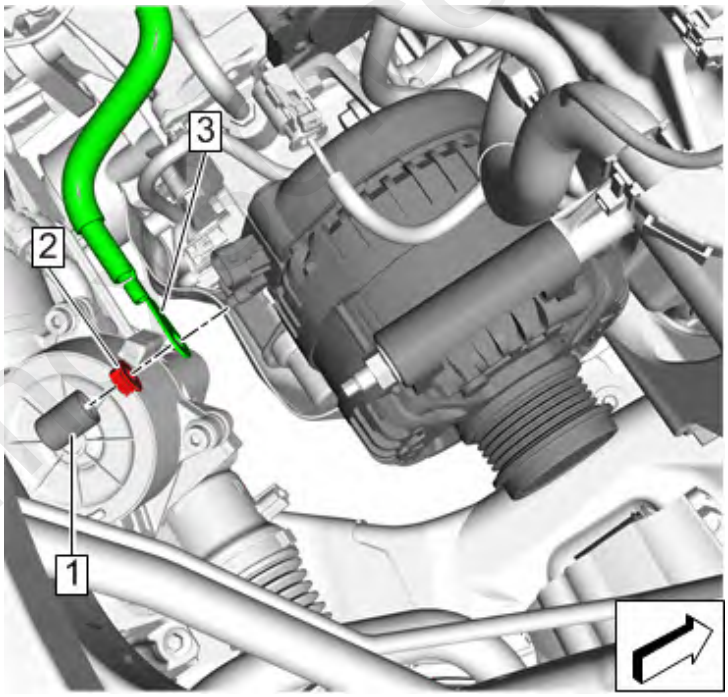


Fig. 59: Protective Cap, Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

11. Remove Protective Cap (1).
12. Remove Starter Solenoid Cable Nut (2) @ Generator.
13. Remove Starter Solenoid Cable (3).

Installation Procedure

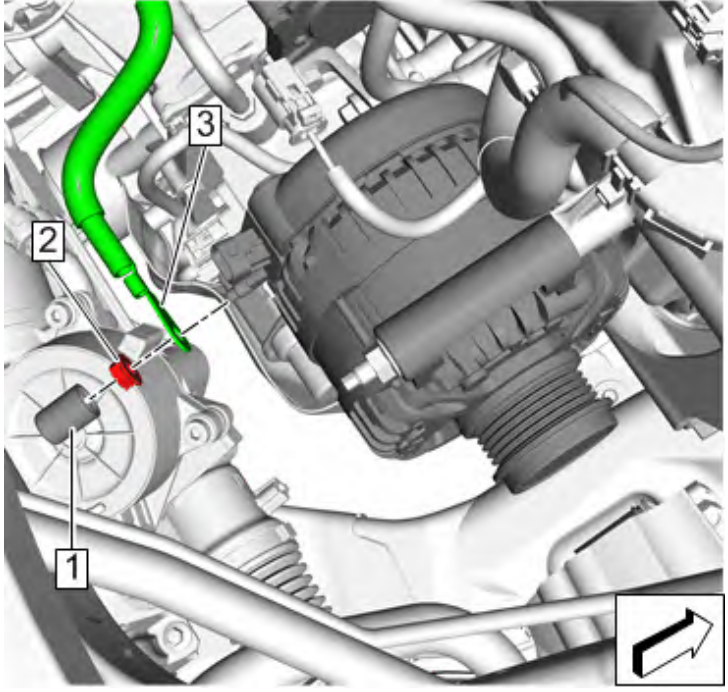


Fig. 60: Protective Cap, Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

1. Install Starter Solenoid Cable (3).

CAUTION: **Refer to Fastener Caution**

2. Install Starter Solenoid Cable Nut (2) @ Generator and tighten 15 N.m (11 lb ft)
3. Install Protective Cap (1).

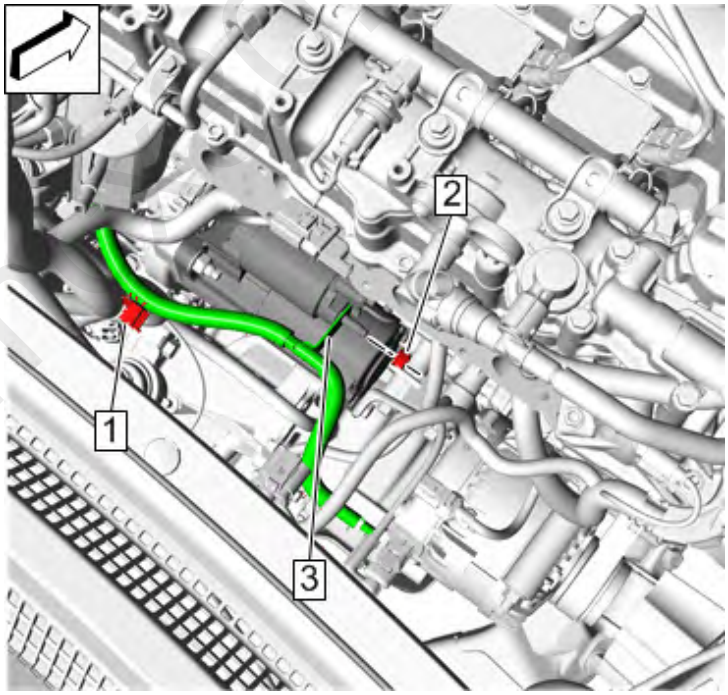


Fig. 61: Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install Starter Solenoid Cable (3)
5. Install Starter Solenoid Cable Nut (2) @ Starter Solenoid and tighten 12 N.m (106 lb in)
6. Engage Retainer (1)

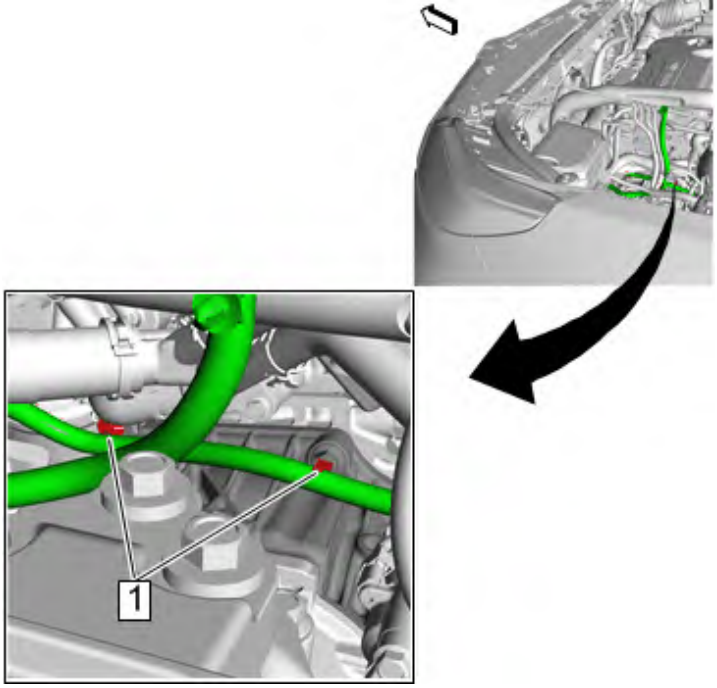


Fig. 62: Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Retainer (1) - [2x]

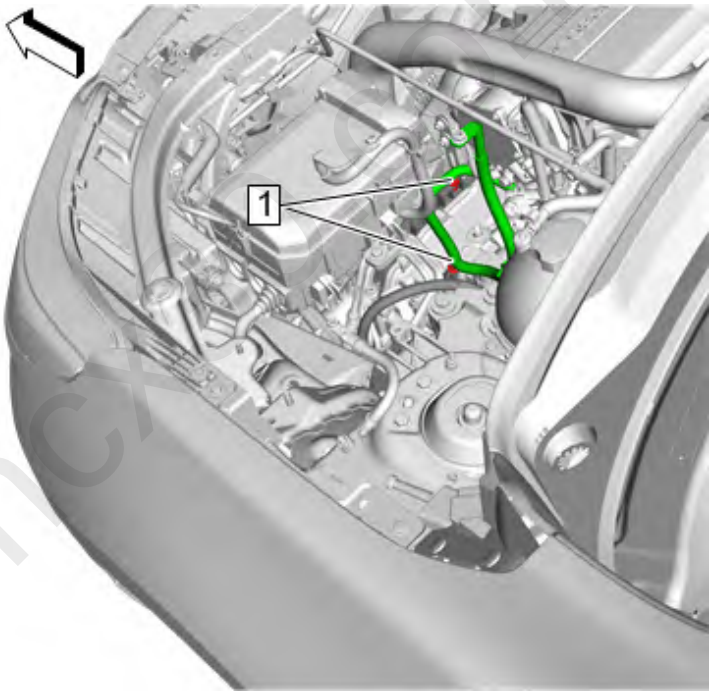


Fig. 63: Retainer
Courtesy of GENERAL MOTORS COMPANY

8. Retainer (1) - [2x]

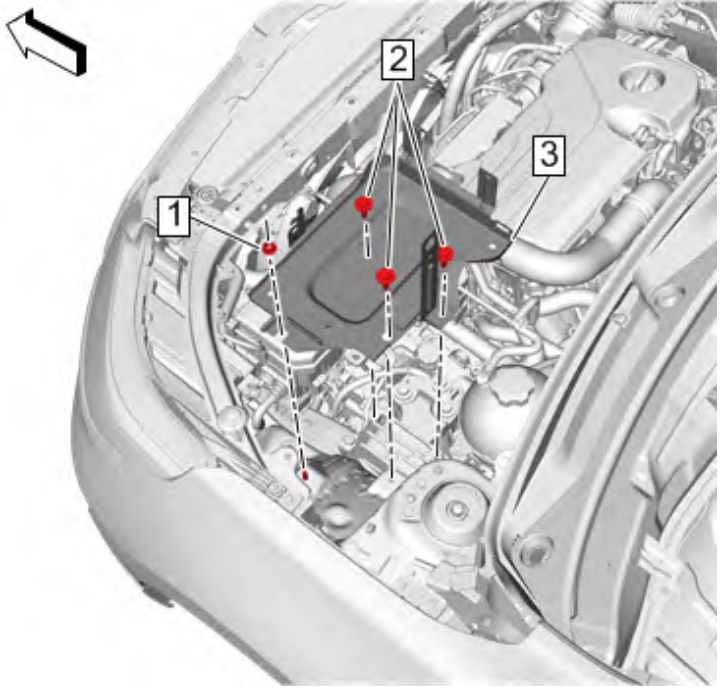


Fig. 64: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

9. Install Battery Tray (3) - **Battery Tray Replacement**

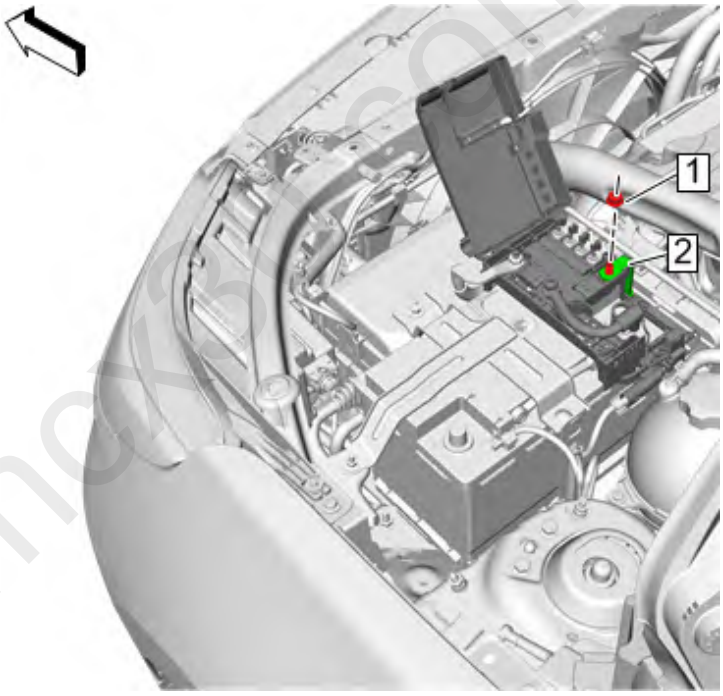


Fig. 65: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

10. Install Starter Solenoid Cable (2).
11. Install Starter Solenoid Cable Nut (1) and tighten 12 N.m (106 lb in)

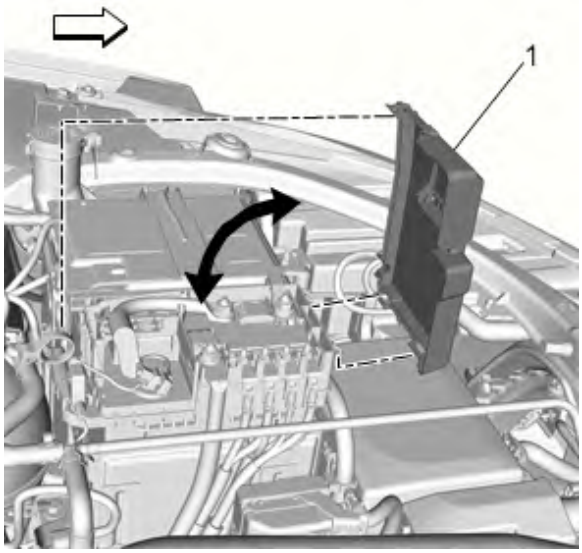


Fig. 66: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

12. Close Battery Distribution Engine Compartment Fuse Block Cover (1).
13. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

STARTER SOLENOID CABLE REPLACEMENT (CHEVROLET LTG - ALL WHEEL DRIVE)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

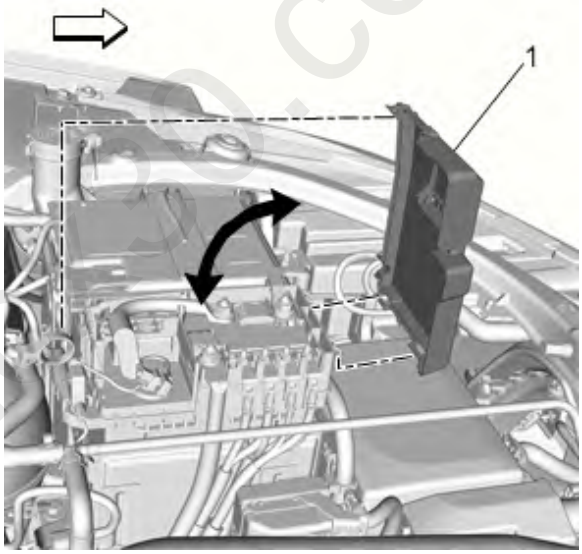


Fig. 67: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

2. Open Battery Distribution Engine Compartment Fuse Block Cover (1).

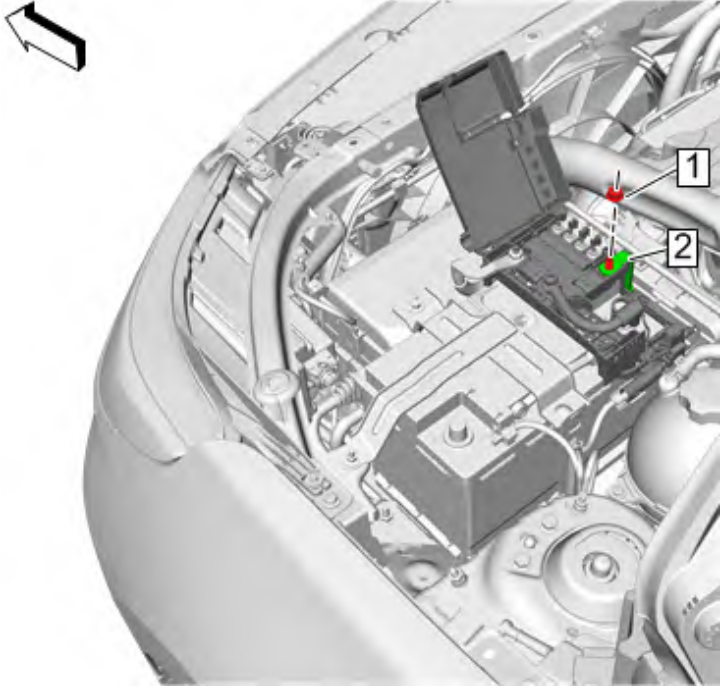


Fig. 68: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

3. Remove Starter Solenoid Cable Nut (1).
4. Remove Starter Solenoid Cable (2).

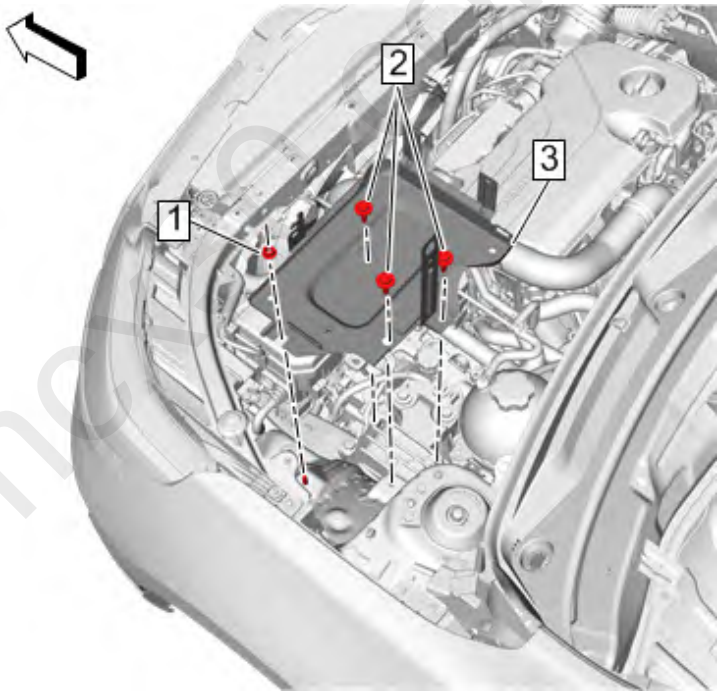


Fig. 69: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

5. Remove Battery Tray (3) - **Battery Tray Replacement**

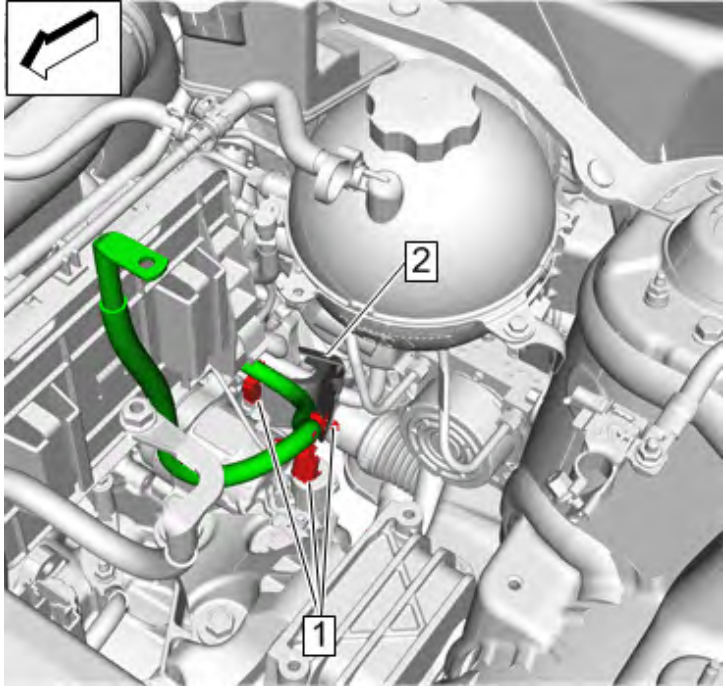


Fig. 70: Retainer And Transmission Wiring Harness Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Disengage Retainer (1) @ Transmission Wiring Harness Bracket (2) - [3x]

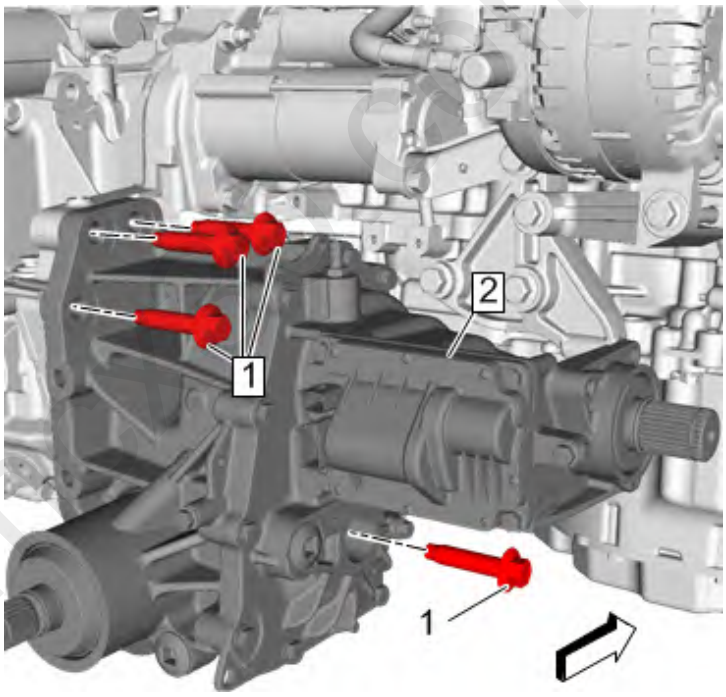


Fig. 71: Power Transfer Unit Case
Courtesy of GENERAL MOTORS COMPANY

7. Remove Power Transfer Unit Case (2) - **Power Transfer Unit Case Replacement (M3D Transmission with LTG Engine)**

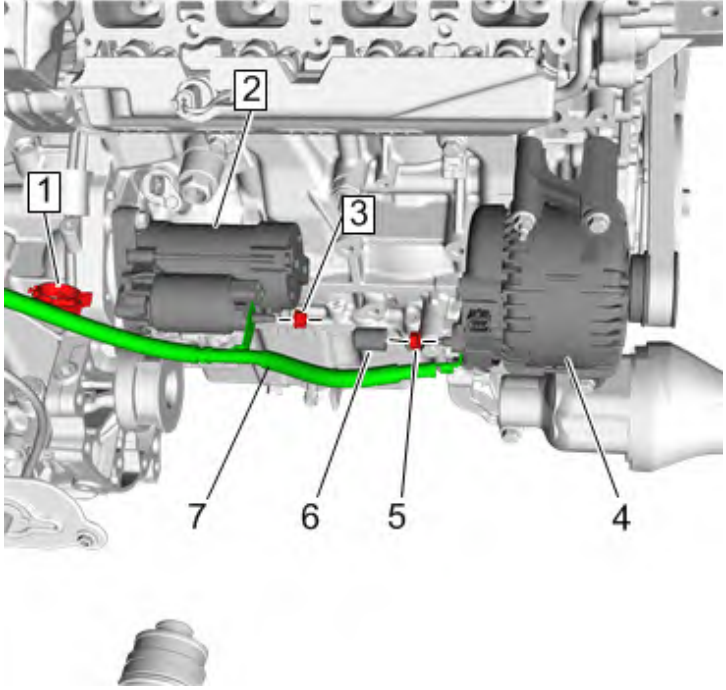


Fig. 72: Retainer Clip And Starter Solenoid Cable Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Intake manifold is removed for clarity.**

8. Disengage Retainer Clip (1).
9. Remove Starter Solenoid Cable Nut (3) @ Starter Solenoid (2).
10. Remove Protective Cap (6).
11. Remove Starter Solenoid Cable Nut (5) @ Generator (4).
12. Remove Starter Solenoid Cable (7).

Installation Procedure

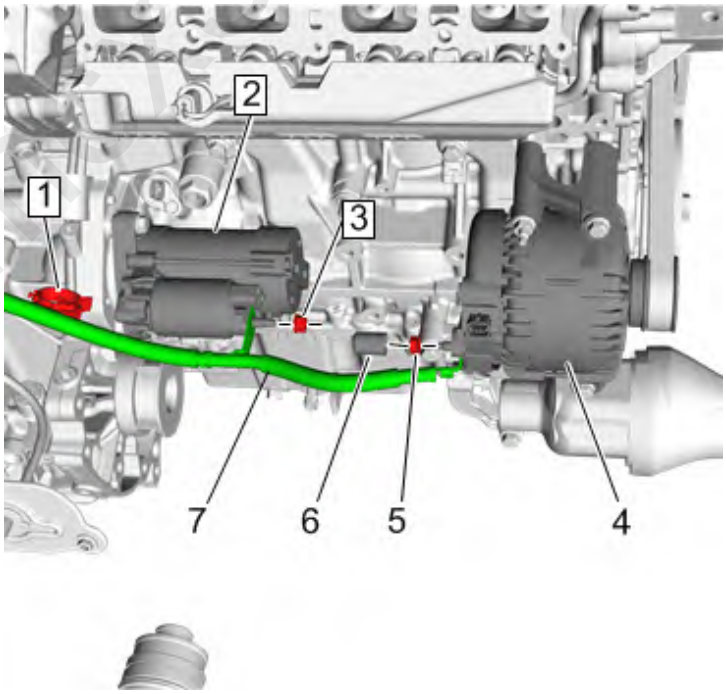


Fig. 73: Retainer Clip And Starter Solenoid Cable Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Intake manifold is removed for clarity.**

1. Install Starter Solenoid Cable (7).

CAUTION: **Refer to Fastener Caution**

2. Install Starter Solenoid Cable Nut (3) @ Starter Solenoid (2) and tighten 12 N.m (106 lb in)
3. Install Protective Cap (6).
4. Install Starter Solenoid Cable Nut (5) @ Generator (4) and tighten 15 N.m (11 lb ft)
5. Engage Retainer Clip (1).

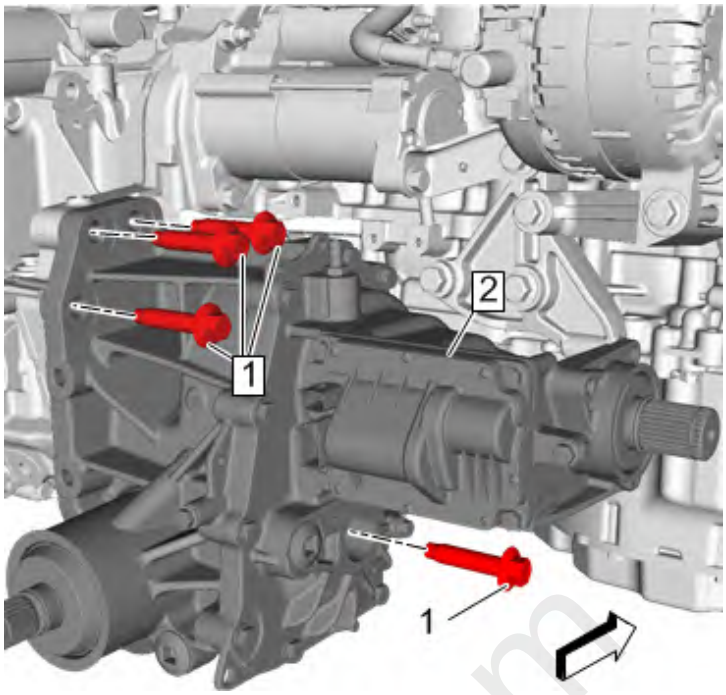


Fig. 74: Power Transfer Unit Case
Courtesy of GENERAL MOTORS COMPANY

6. Install Power Transfer Unit Case (2) - **Power Transfer Unit Case Replacement (M3D Transmission with LTG Engine)**

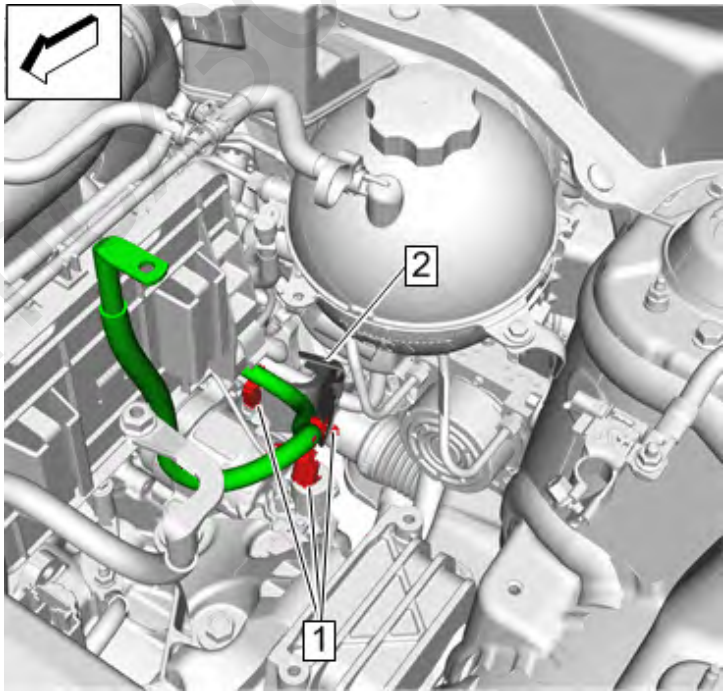


Fig. 75: Retainer And Transmission Wiring Harness Bracket
Courtesy of GENERAL MOTORS COMPANY

7. Engage Retainer (1) @ Transmission Wiring Harness Bracket (2) - [3x]

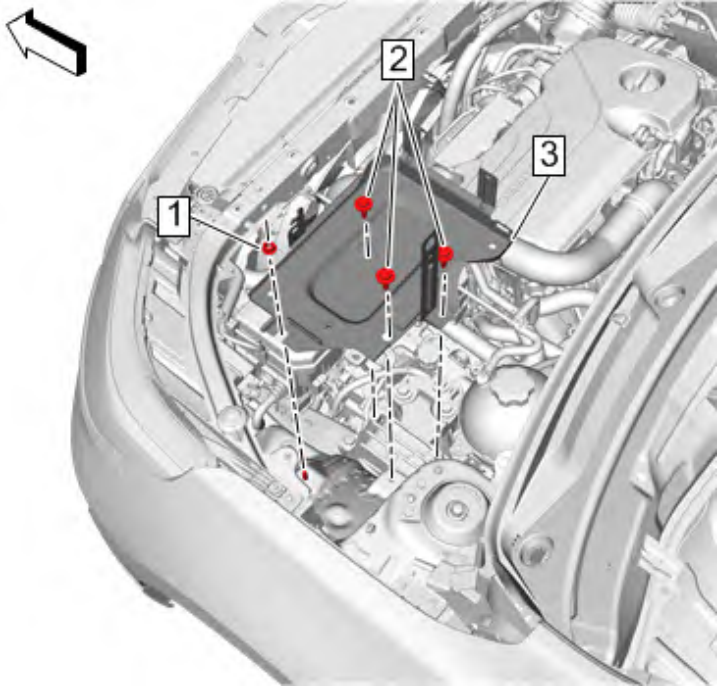


Fig. 76: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

8. Install Battery Tray (3) - **Battery Tray Replacement**

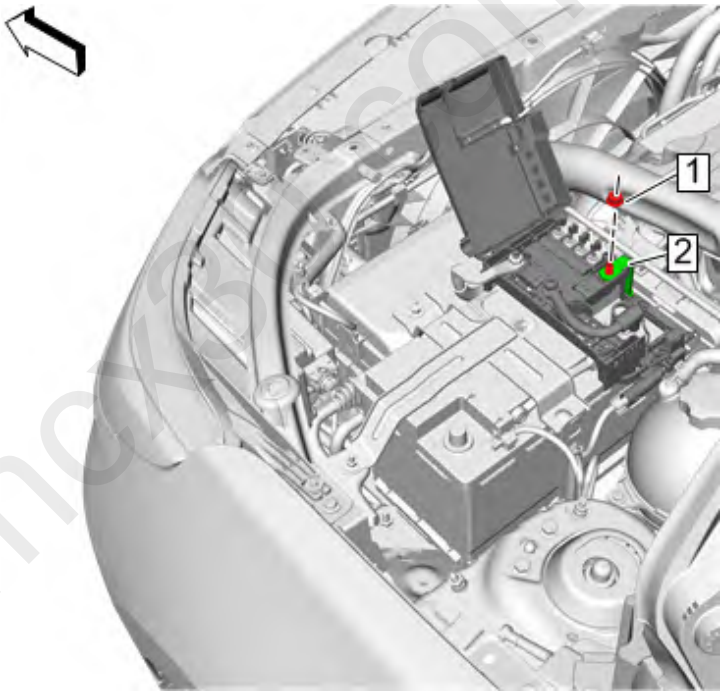


Fig. 77: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

9. Install Starter Solenoid Cable (2).
10. Install Starter Solenoid Cable Nut (1) and tighten 12 N.m (106 lb in)

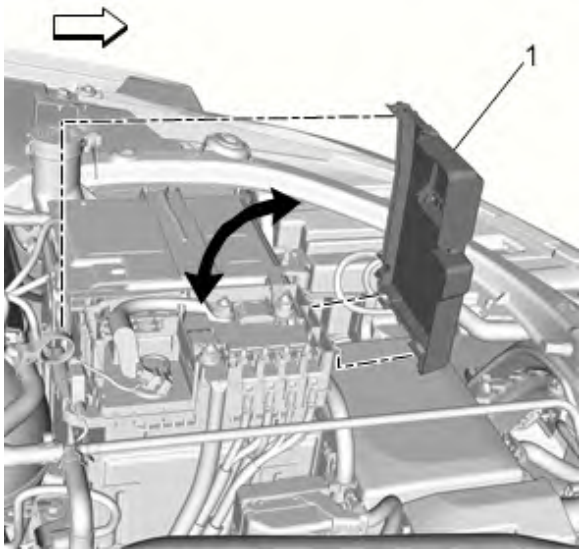


Fig. 78: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

11. Close Battery Distribution Engine Compartment Fuse Block Cover (1).
12. Connect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

STARTER SOLENOID CABLE REPLACEMENT (CHEVROLET LTG - FRONT WHEEL DRIVE)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

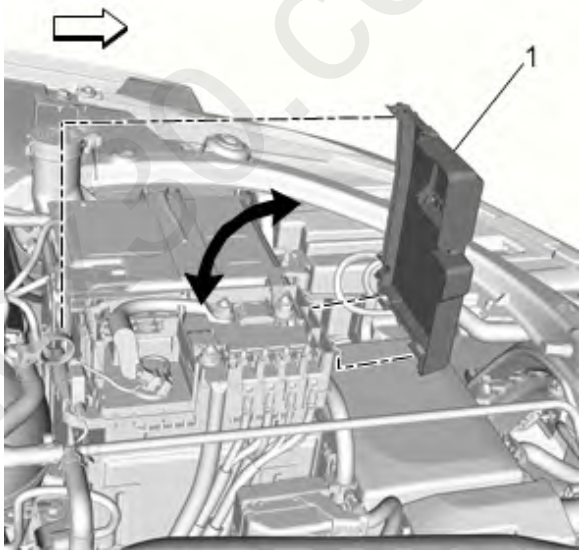


Fig. 79: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

2. Open Battery Distribution Engine Compartment Fuse Block Cover (1).

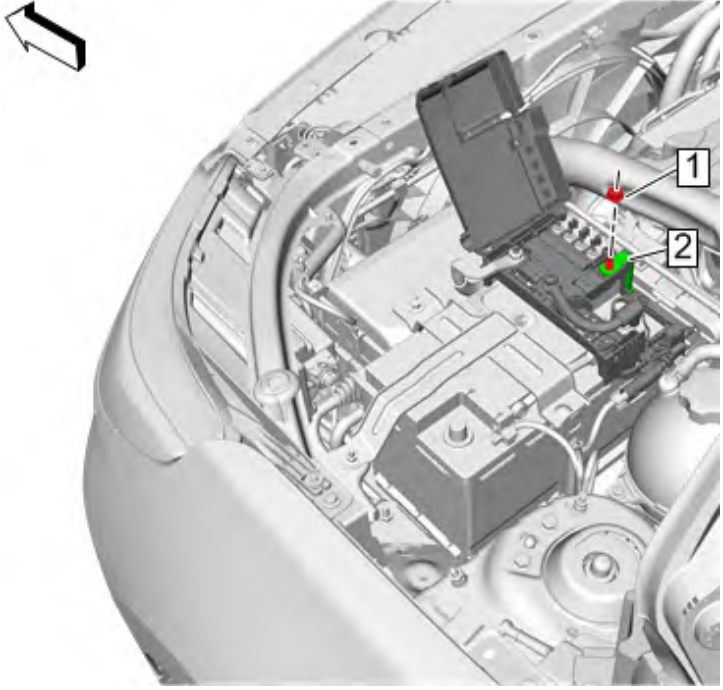


Fig. 80: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

3. Remove Starter Solenoid Cable Nut (1).
4. Remove Starter Solenoid Cable (2).

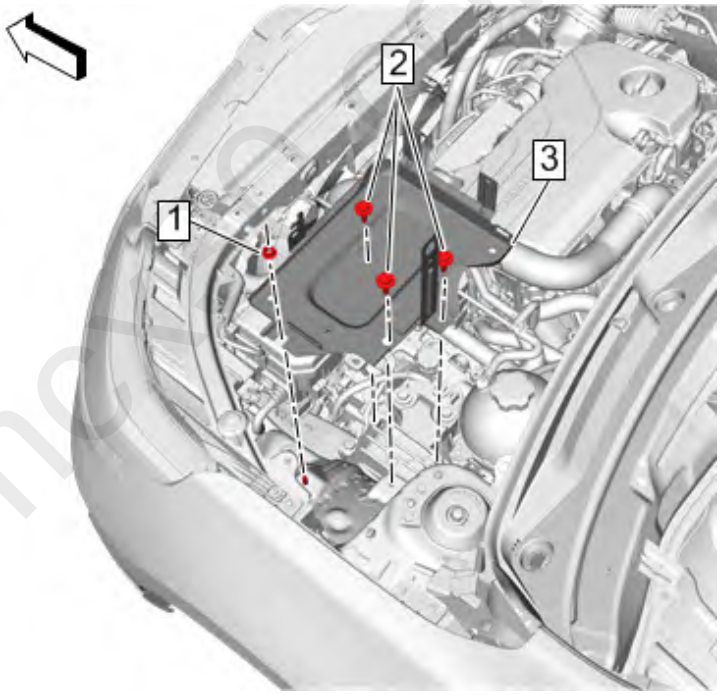


Fig. 81: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

5. Remove Battery Tray (3) - **Battery Tray Replacement**

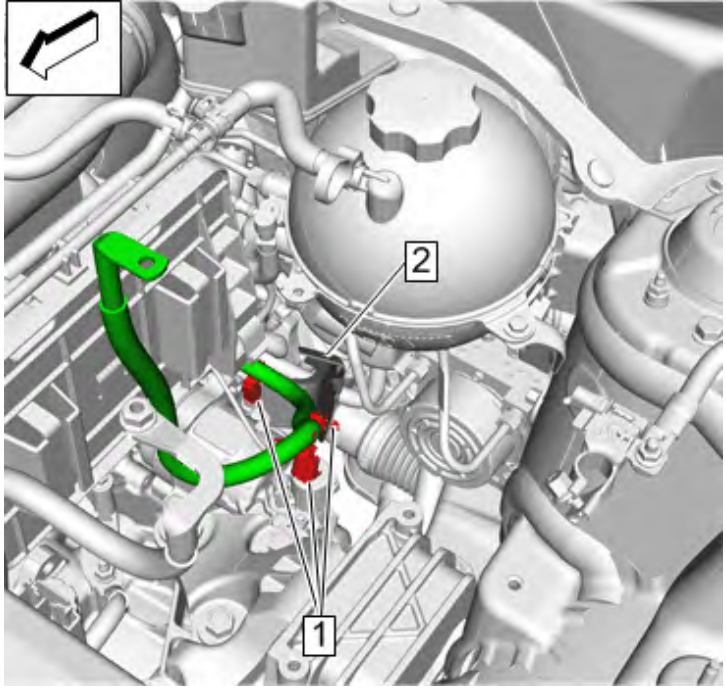


Fig. 82: Retainer And Transmission Wiring Harness Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Disengage Retainer (1) @ Transmission Wiring Harness Bracket (2) - [3x]

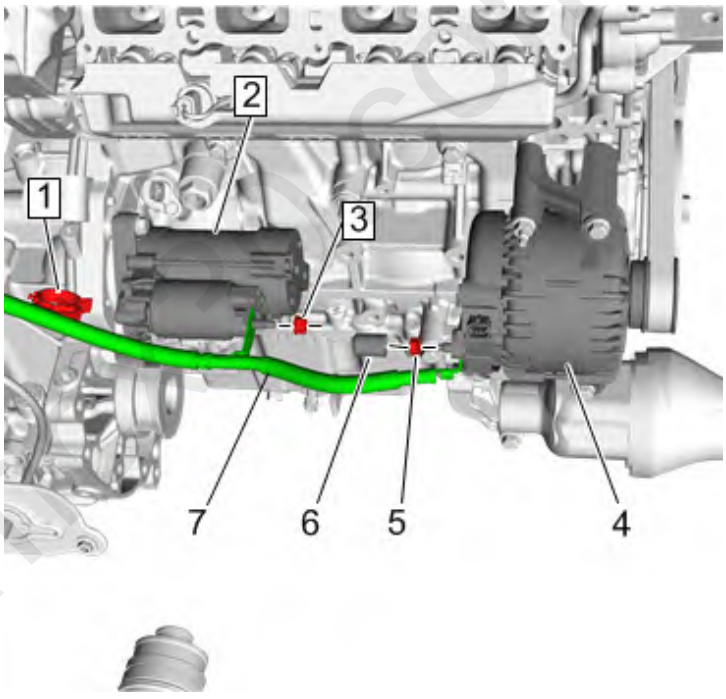


Fig. 83: Retainer Clip And Starter Solenoid Cable Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Intake manifold is removed for clarity.**

7. Disengage Retainer Clip (1).
8. Remove Starter Solenoid Cable Nut (3) @ Starter Solenoid (2).
9. Remove Protective Cap (6).
10. Remove Starter Solenoid Cable Nut (5) @ Generator (4).
11. Remove Starter Solenoid Cable (7).

Installation Procedure

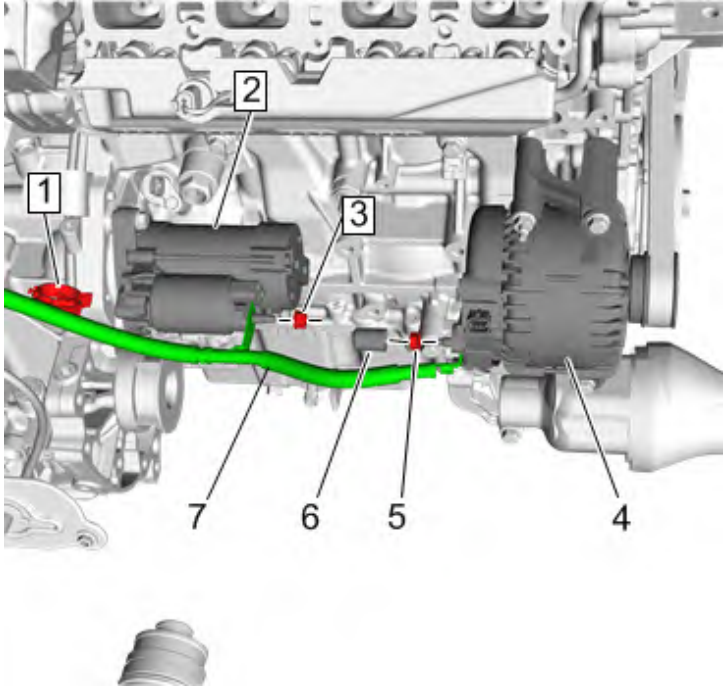


Fig. 84: Retainer Clip And Starter Solenoid Cable Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Intake manifold is removed for clarity.**

1. Install Starter Solenoid Cable (7).

CAUTION: **Refer to Fastener Caution**

2. Install Starter Solenoid Cable Nut (3) @ Starter Solenoid (2) and tighten 12 N.m (106 lb in)
3. Install Protective Cap (6).
4. Install Starter Solenoid Cable Nut (5) @ Generator (4) and tighten 15 N.m (11 lb ft)
5. Engage Retainer Clip (1).

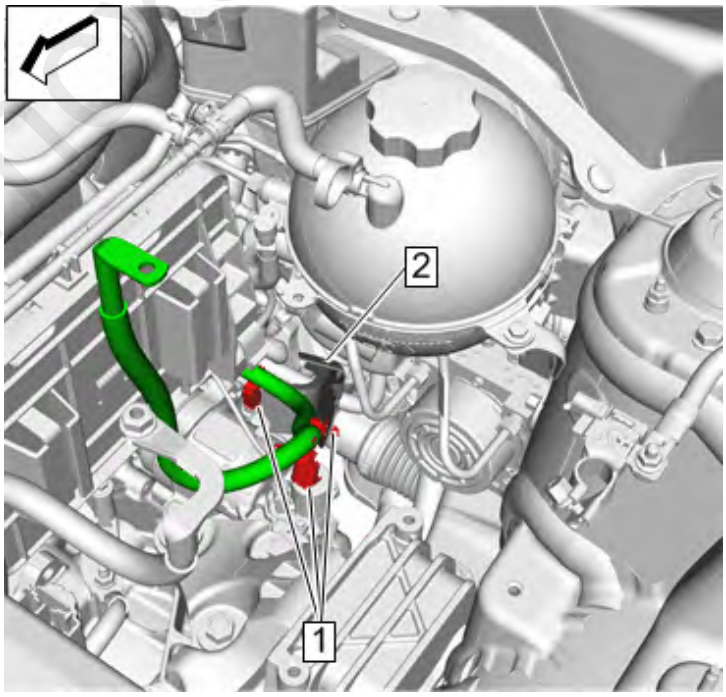


Fig. 85: Retainer And Transmission Wiring Harness Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Engage Retainer (1) @ Transmission Wiring Harness Bracket (2) - [3x]

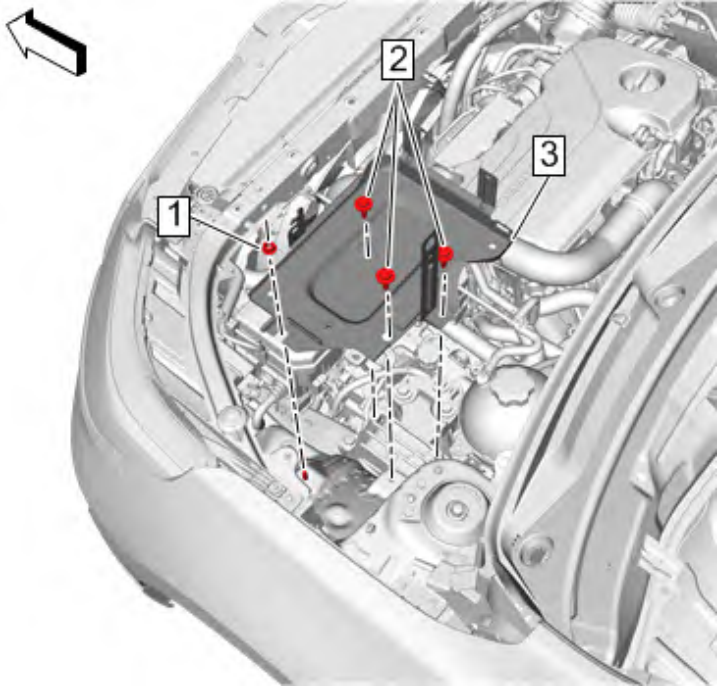


Fig. 86: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

7. Install Battery Tray (3) - **Battery Tray Replacement**

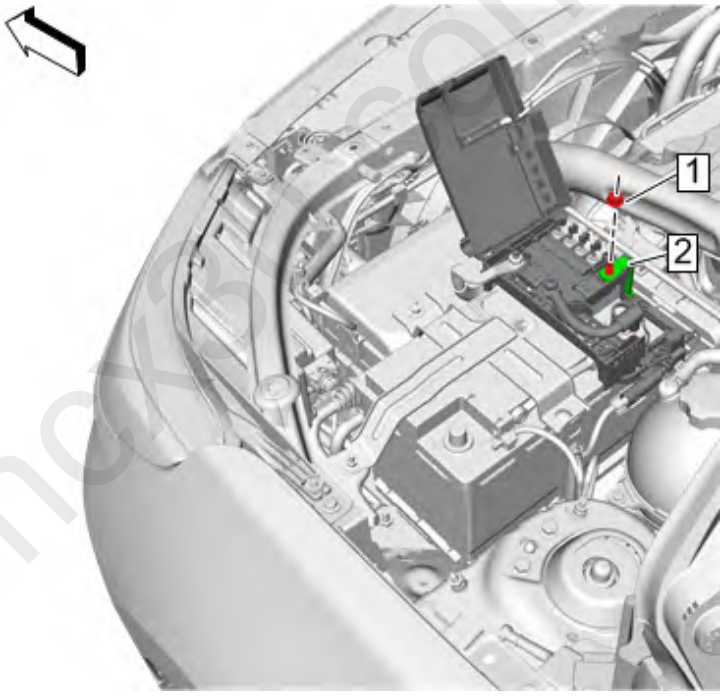


Fig. 87: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

8. Install Starter Solenoid Cable (2).
9. Install Starter Solenoid Cable Nut (1) and tighten 12 N.m (106 lb in)

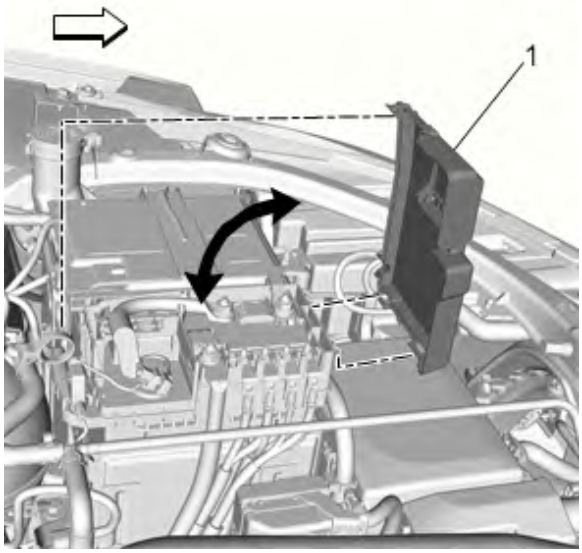


Fig. 88: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

10. Close Battery Distribution Engine Compartment Fuse Block Cover (1).
11. Connect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

STARTER SOLENOID CABLE REPLACEMENT (CHEVROLET LH7 - FRONT WHEEL DRIVE)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

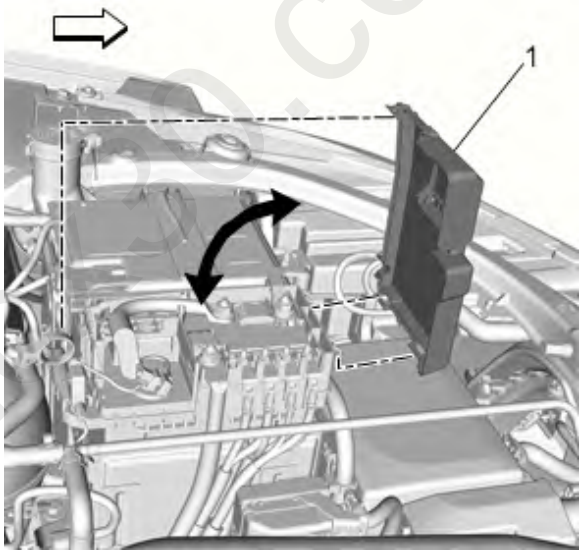


Fig. 89: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

2. Open Battery Distribution Engine Compartment Fuse Block Cover (1).

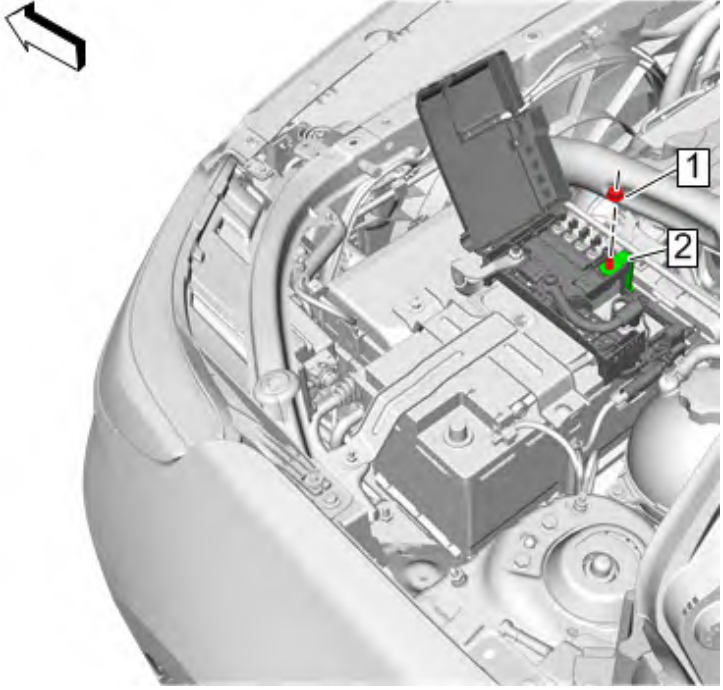


Fig. 90: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

3. Remove Starter Solenoid Cable Nut (1).
4. Remove Starter Solenoid Cable (2).
5. Remove the engine control module bracket. **Engine Control Module Bracket Replacement**

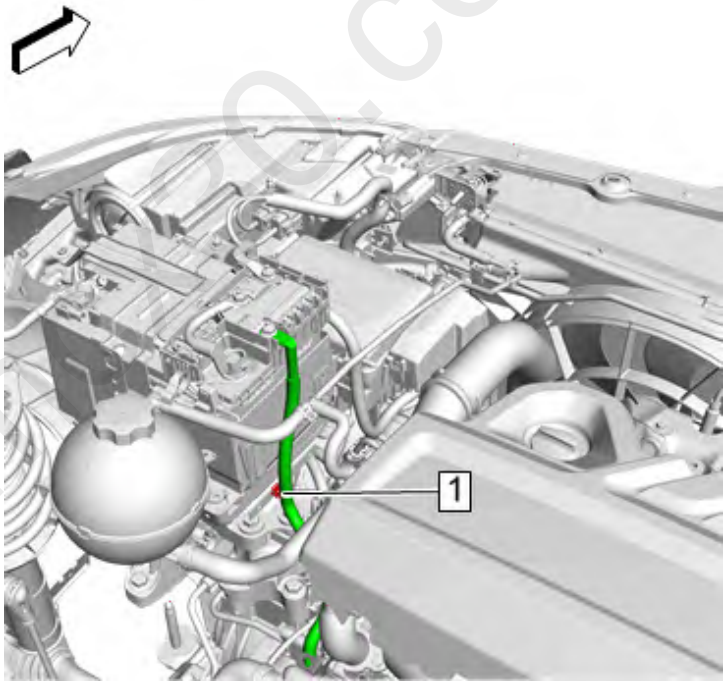


Fig. 91: Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Disengage Retainer (1) @ Battery Tray.

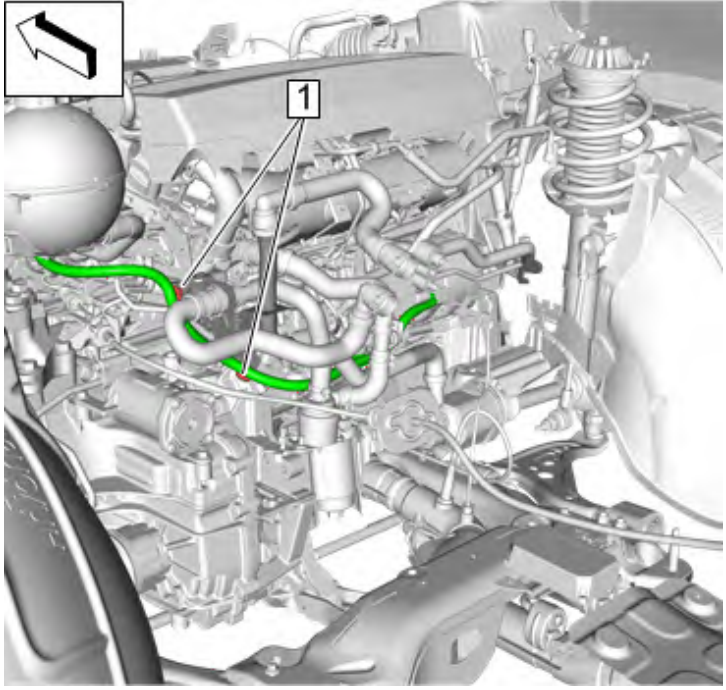


Fig. 92: Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Disengage Retainer (1) - [2x]

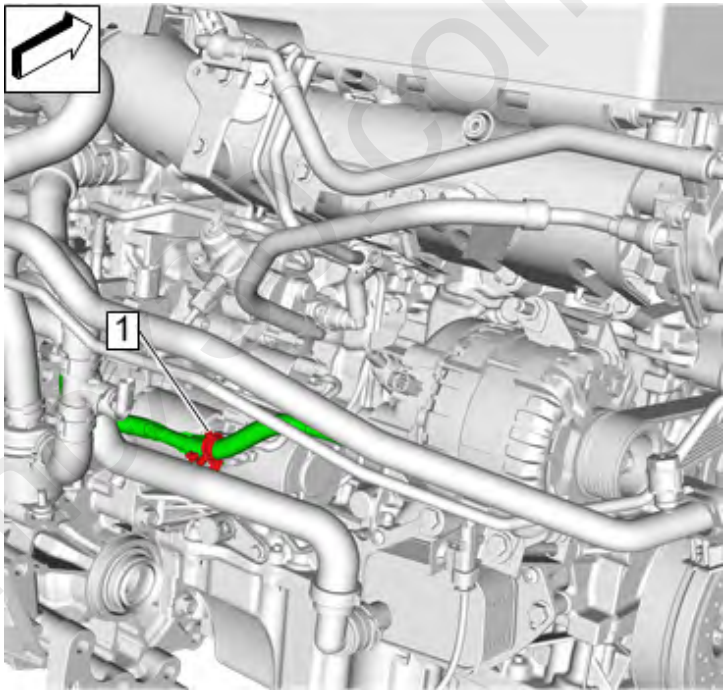


Fig. 93: Retainer Clip
Courtesy of GENERAL MOTORS COMPANY

8. Disengage Retainer Clip (1).

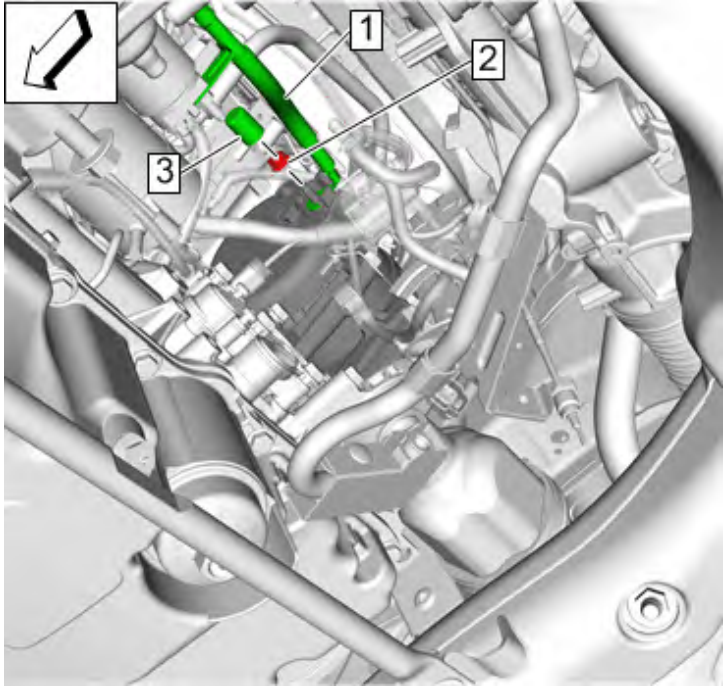


Fig. 94: Protective Cap
Courtesy of GENERAL MOTORS COMPANY

9. Remove Protective Cap (3).
10. Remove Battery Positive Cable Nut (2).
11. Remove Starter Solenoid Cable (1).

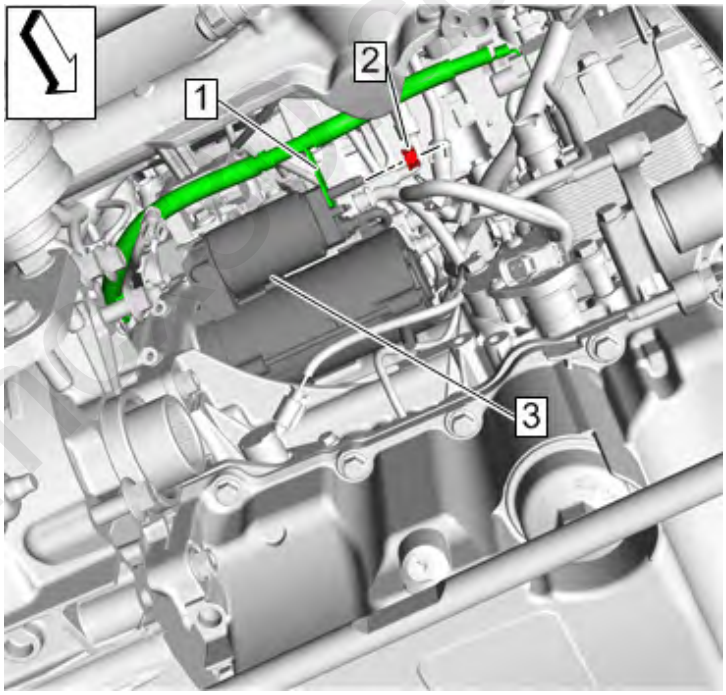


Fig. 95: Starter Solenoid Cable Nut And Cable
Courtesy of GENERAL MOTORS COMPANY

12. Remove Starter Solenoid Cable Nut (2) @ Starter Solenoid (3).
13. Remove Starter Solenoid Cable (1).

Installation Procedure

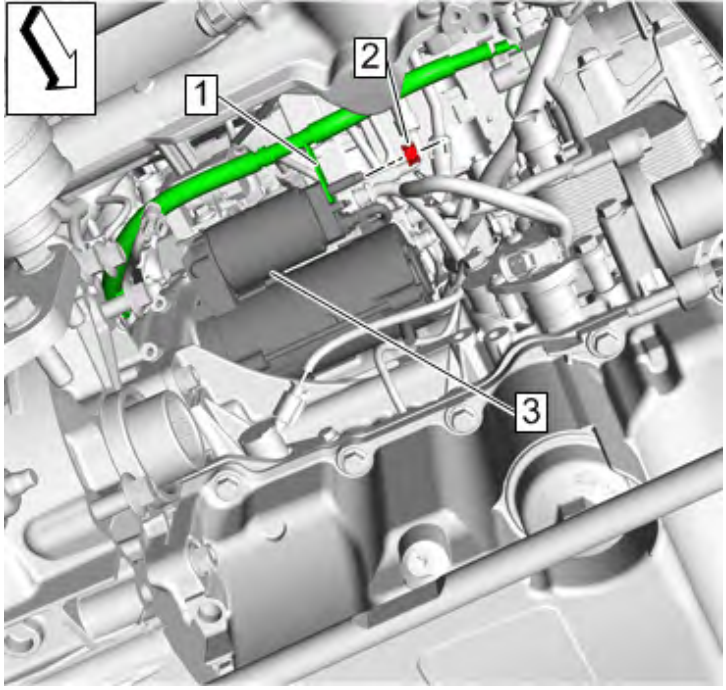


Fig. 96: Starter Solenoid Cable Nut And Cable
Courtesy of GENERAL MOTORS COMPANY

1. Install Starter Solenoid Cable (1) @Starter Solenoid.

CAUTION: **Refer to Fastener Caution**

2. Install Starter Solenoid Cable Nut (2) and tighten 12 N.m (106 lb in)

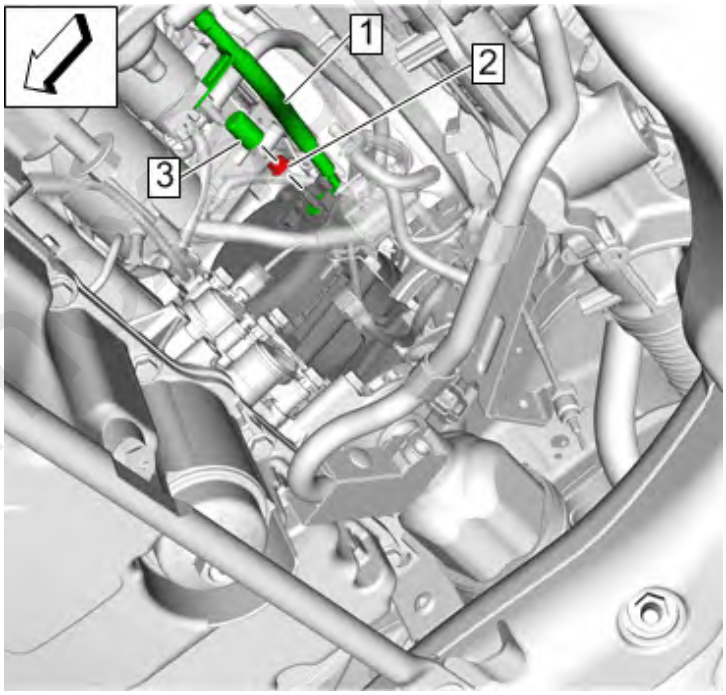


Fig. 97: Protective Cap
Courtesy of GENERAL MOTORS COMPANY

3. Install Starter Solenoid Cable (1)
4. Install Battery Positive Cable Nut (2) and tighten 15 N.m (11 lb ft)
5. Install Protective Cap (3).

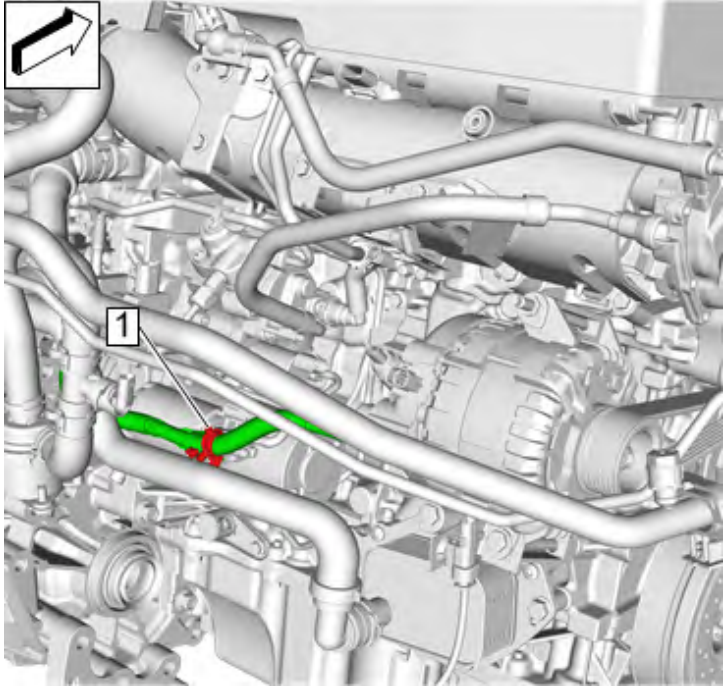


Fig. 98: Retainer Clip
Courtesy of GENERAL MOTORS COMPANY

6. Engage Retainer Clip (1).

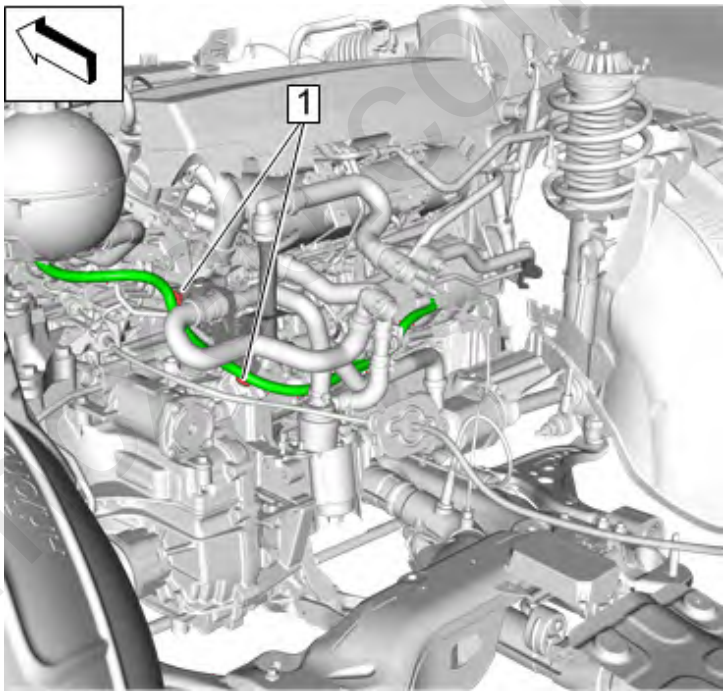


Fig. 99: Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Engage Retainer (1) - [2x]

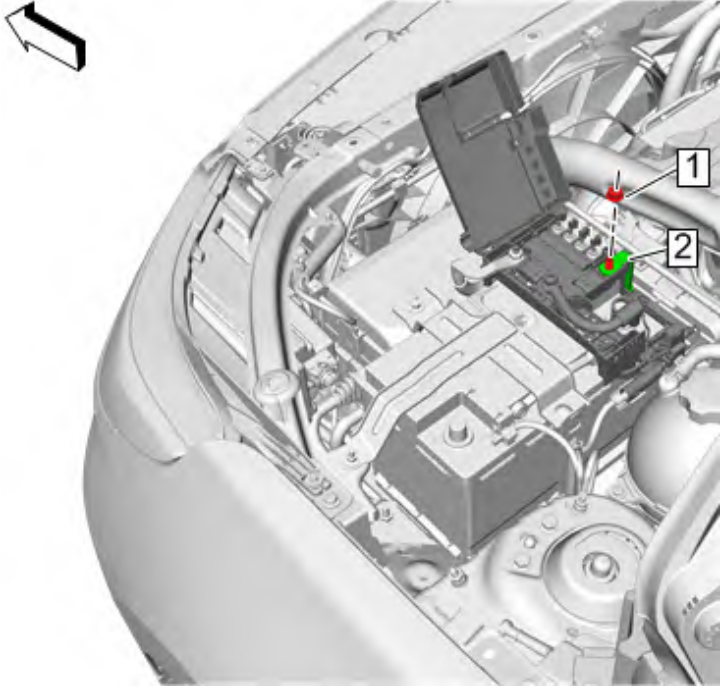


Fig. 100: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

8. Install Starter Solenoid Cable (2).
9. Install Starter Solenoid Cable Nut (1) and tighten 12 N.m (106 lb in)

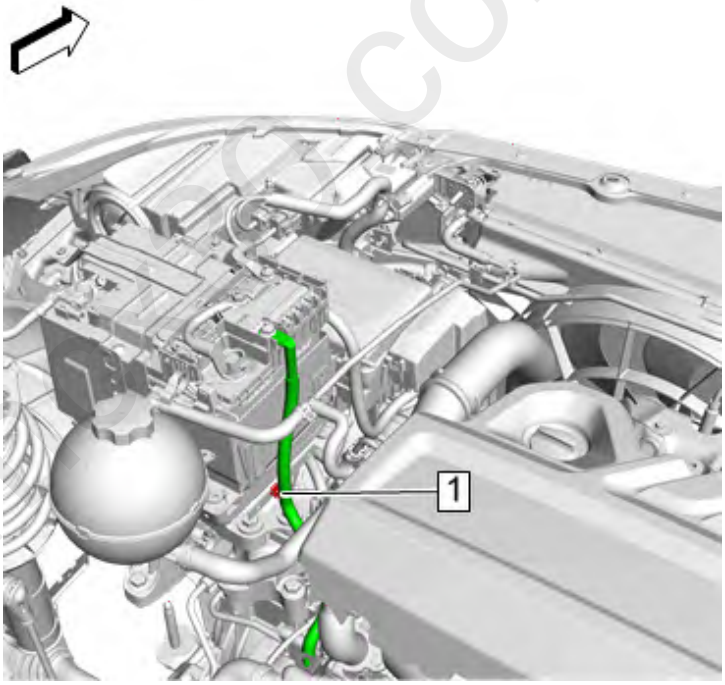


Fig. 101: Retainer
Courtesy of GENERAL MOTORS COMPANY

10. Engage Retainer (1) @ Battery Tray.

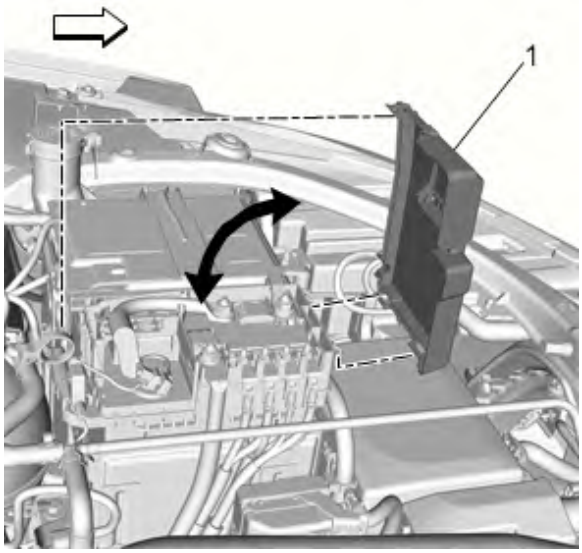


Fig. 102: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

11. Close Battery Distribution Engine Compartment Fuse Block Cover (1).
12. Install the engine control module bracket. **Engine Control Module Bracket Replacement**
13. Connect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

STARTER SOLENOID CABLE REPLACEMENT (CHEVROLET LH7 - ALL WHEEL DRIVE)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

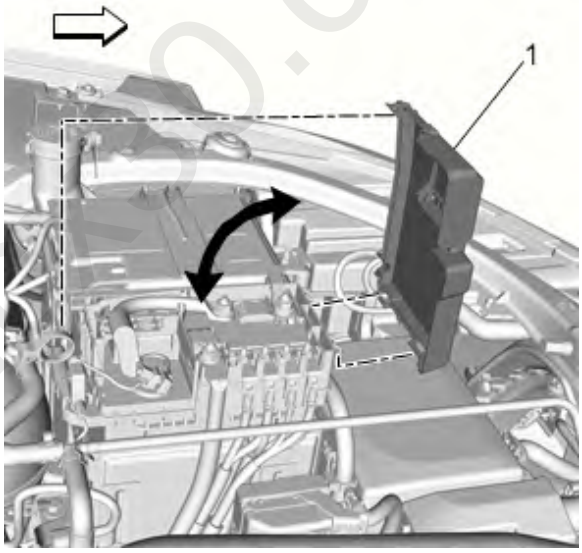


Fig. 103: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

2. Open Battery Distribution Engine Compartment Fuse Block Cover (1).

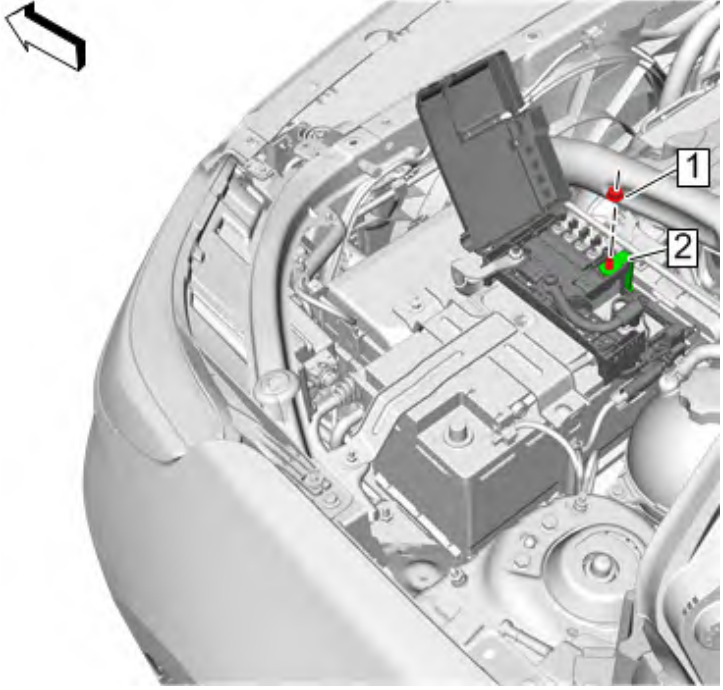


Fig. 104: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

3. Remove Starter Solenoid Cable Nut (1).
4. Remove Starter Solenoid Cable (2).
5. Remove the engine control module bracket. **Engine Control Module Bracket Replacement**

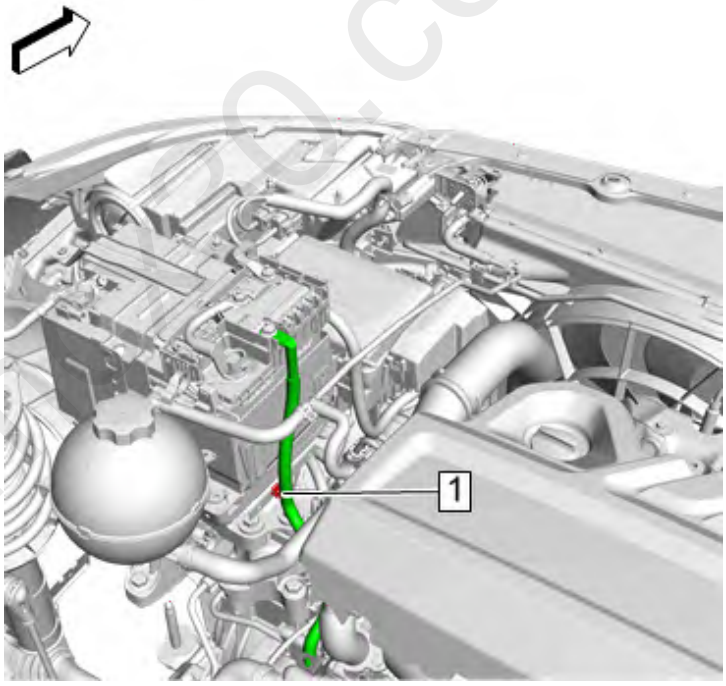


Fig. 105: Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Disengage Retainer (1) @Battery Tray.

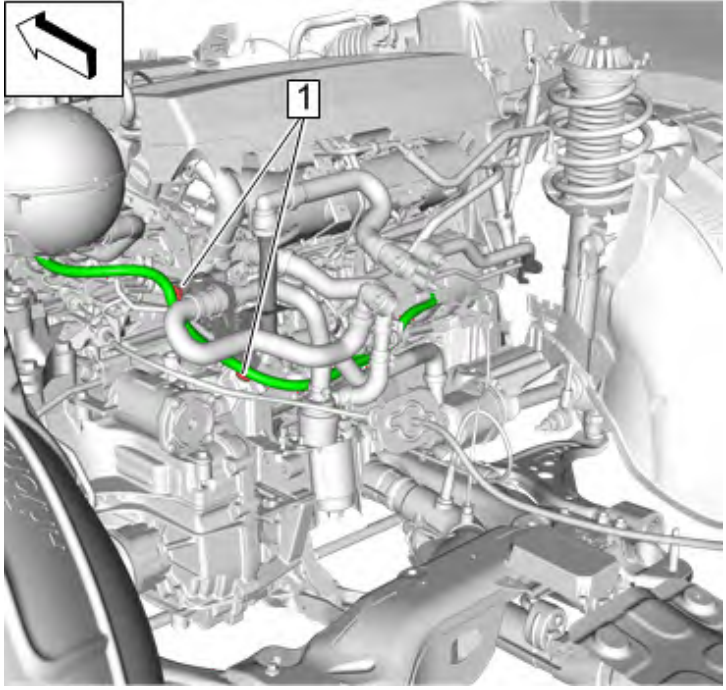


Fig. 106: Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Disengage Retainer (1) - [2x]
8. Raise and support the vehicle. **Lifting and Jacking the Vehicle**
9. Remove the power transfer unit case. **Power Transfer Unit Case Replacement (MHG Transmission with LH7 Engine)**

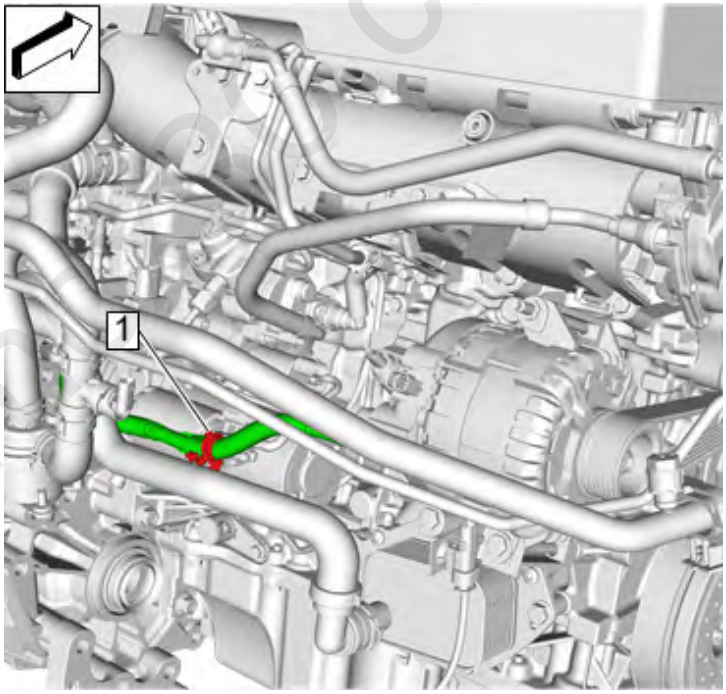


Fig. 107: Retainer Clip
Courtesy of GENERAL MOTORS COMPANY

10. Disengage Retainer Clip (1).

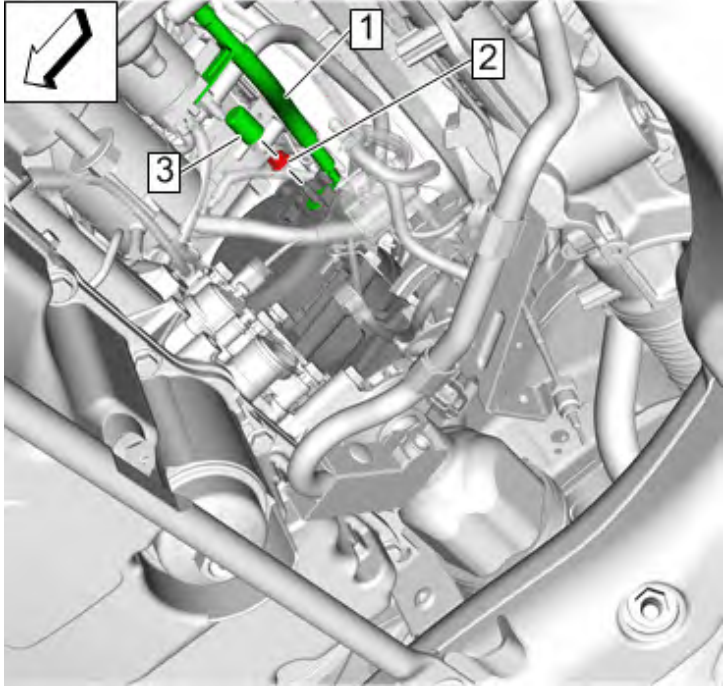


Fig. 108: Protective Cap
Courtesy of GENERAL MOTORS COMPANY

11. Remove Protective Cap (3).
12. Remove Battery Positive Cable Nut (2).
13. Remove Starter Solenoid Cable (1).

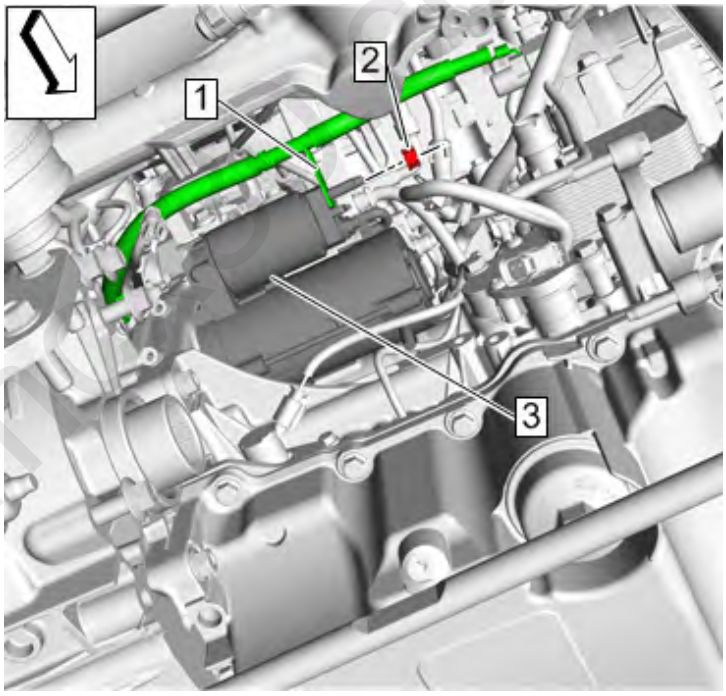


Fig. 109: Starter Solenoid Cable Nut And Cable
Courtesy of GENERAL MOTORS COMPANY

14. Remove Starter Solenoid Cable Nut (2) @ Starter Solenoid (3).
15. Remove Starter Solenoid Cable (1).

Installation Procedure

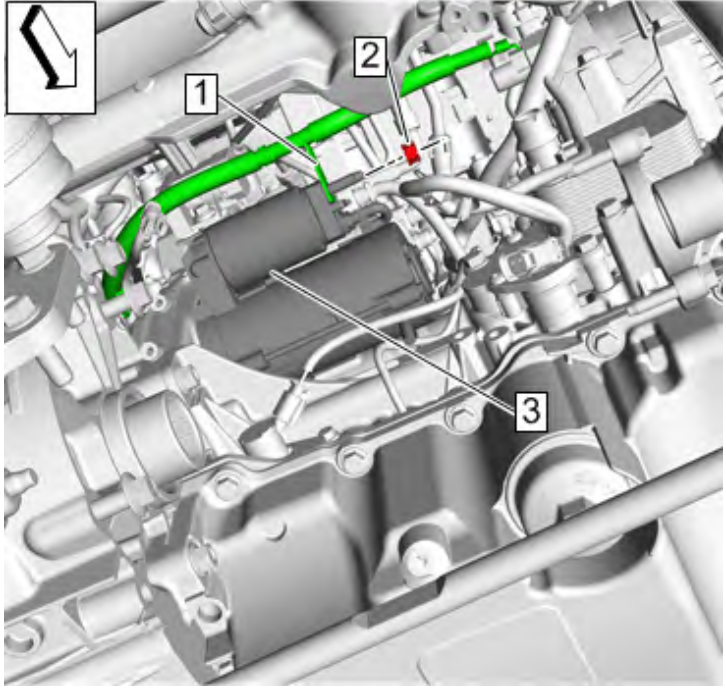


Fig. 110: Starter Solenoid Cable Nut And Cable
Courtesy of GENERAL MOTORS COMPANY

1. Install Starter Solenoid Cable (1) @ Starter Solenoid (3)

CAUTION: **Refer to Fastener Caution**

2. Install Starter Solenoid Cable Nut (2) and tighten 12 N.m (106 lb in)

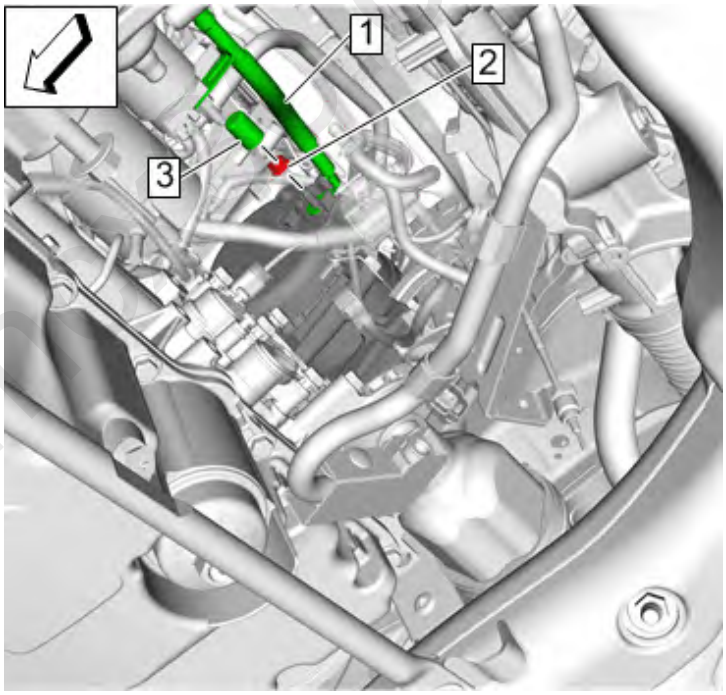


Fig. 111: Protective Cap
Courtesy of GENERAL MOTORS COMPANY

3. Install Starter Solenoid Cable (1).
4. Install Battery Positive Cable Nut (2) and tighten 15 N.m (11 lb ft)
5. Install Protective Cap (3).

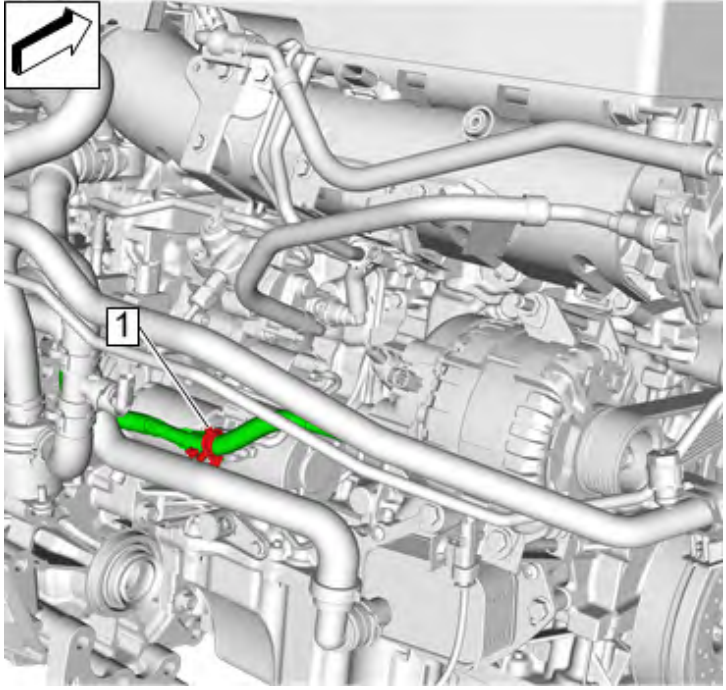


Fig. 112: Retainer Clip
Courtesy of GENERAL MOTORS COMPANY

6. Engage Retainer Clip (1).

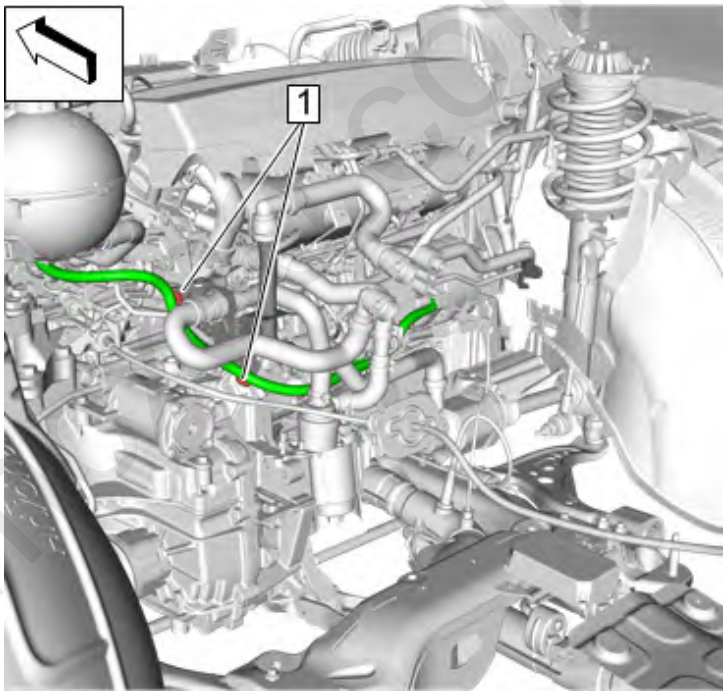


Fig. 113: Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Engage Retainer (1) - [2x]
8. Install the power transfer unit case. **Power Transfer Unit Case Replacement (MHG Transmission with LH7 Engine)**
9. Lower the vehicle.

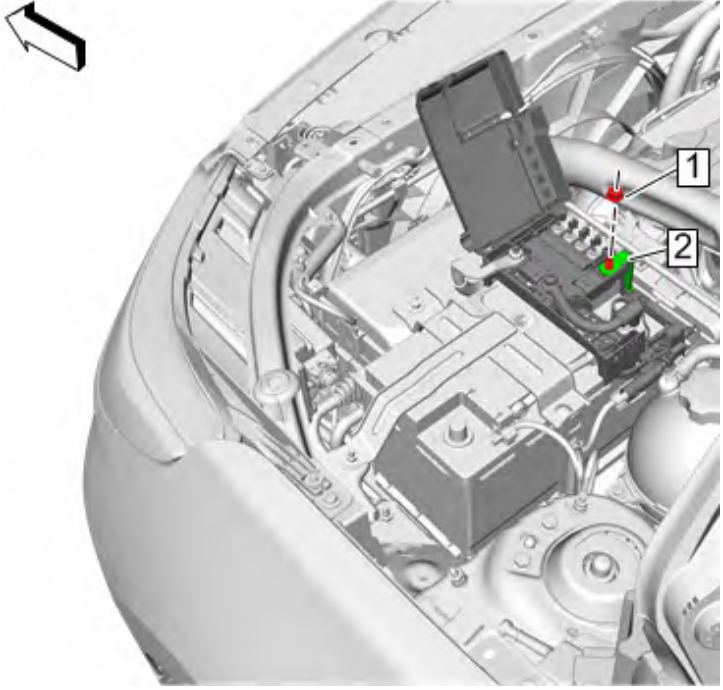


Fig. 114: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

10. Install Starter Solenoid Cable (2).
11. Install Starter Solenoid Cable Nut (1) and tighten 12 N.m (106 lb in)

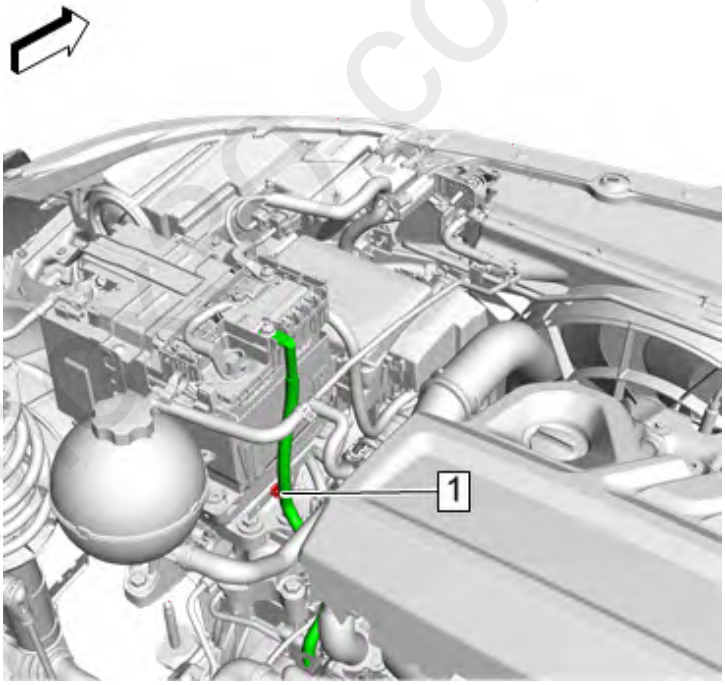


Fig. 115: Retainer
Courtesy of GENERAL MOTORS COMPANY

12. Engage Retainer (1) @ Battery Tray.

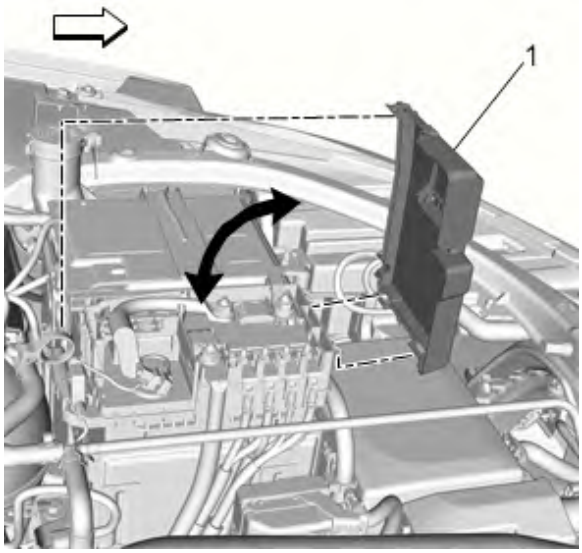


Fig. 116: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

13. Close Battery Distribution Engine Compartment Fuse Block Cover (1).
14. Install the engine control module bracket. **Engine Control Module Bracket Replacement**
15. Connect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

STARTER SOLENOID CABLE REPLACEMENT (GMC LH7 - ALL WHEEL DRIVE)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

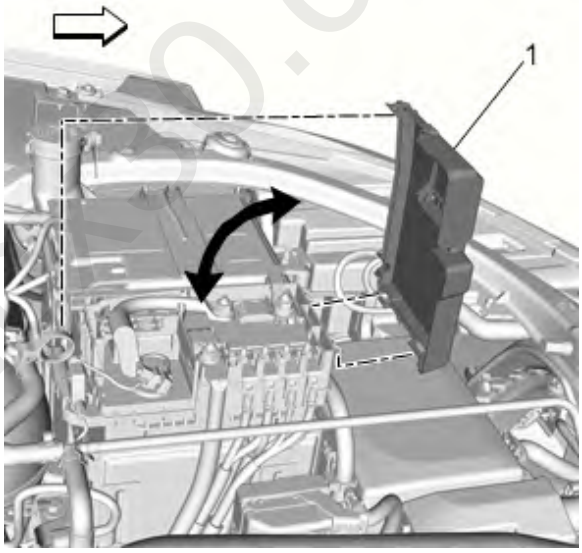


Fig. 117: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

2. Open Battery Distribution Engine Compartment Fuse Block Cover (1).

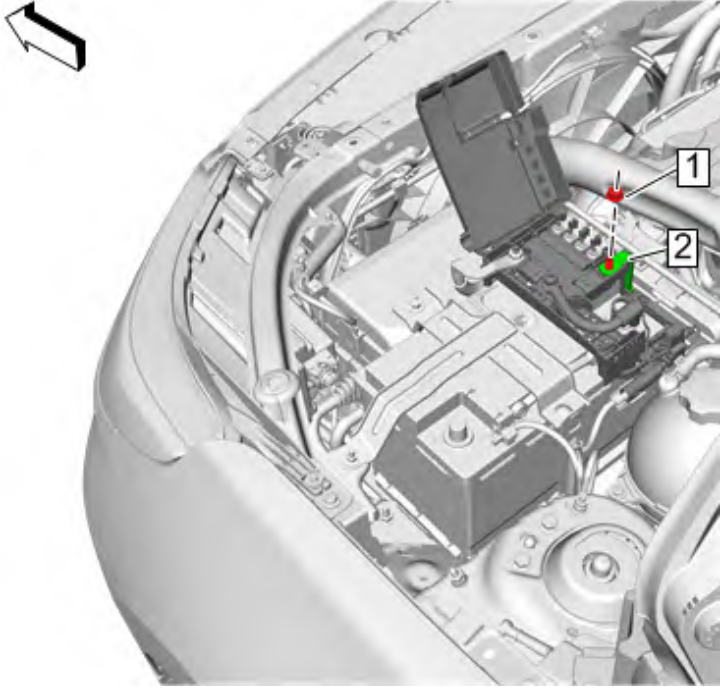


Fig. 118: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

3. Remove Starter Solenoid Cable Nut (1).
4. Remove Starter Solenoid Cable (2).
5. Remove the engine control module bracket. **Engine Control Module Bracket Replacement**

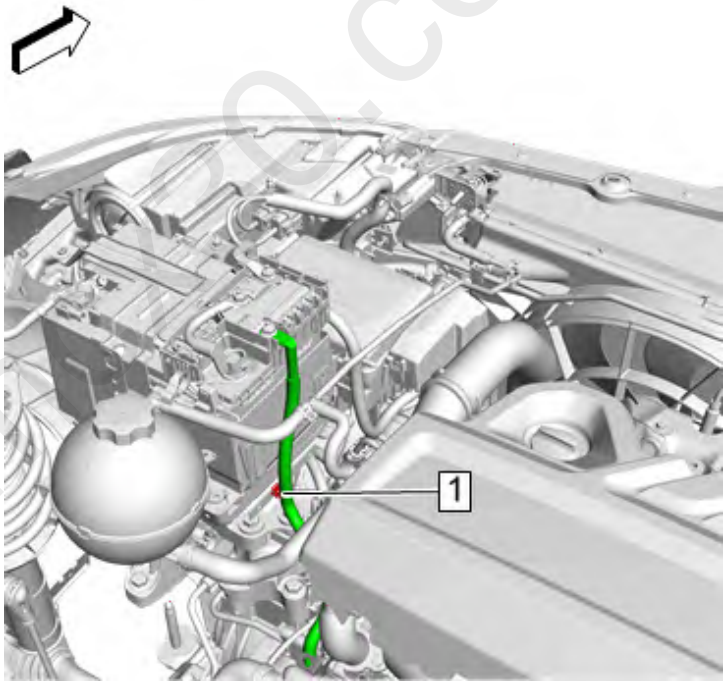


Fig. 119: Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Disengage Retainer (1) @ Battery Tray.

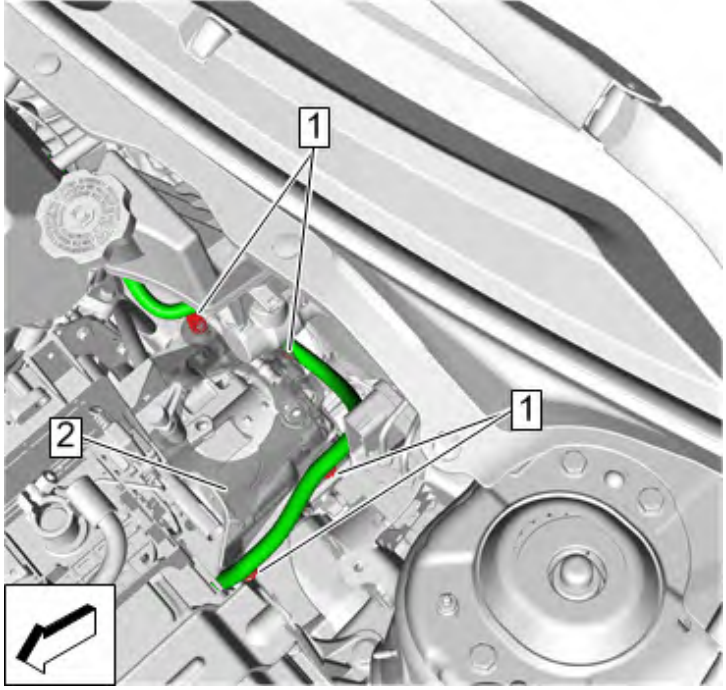


Fig. 120: Retainer And Automatic Transmission Range Selector Actuator Bracket
Courtesy of GENERAL MOTORS COMPANY

7. Disengage Retainer (1) @ Automatic Transmission Range Selector Actuator Bracket (2) - [4x]
8. Raise and support the vehicle. **Lifting and Jacking the Vehicle**
9. Remove the power transfer unit case. **Power Transfer Unit Case Replacement (MHG Transmission with LH7 Engine)**

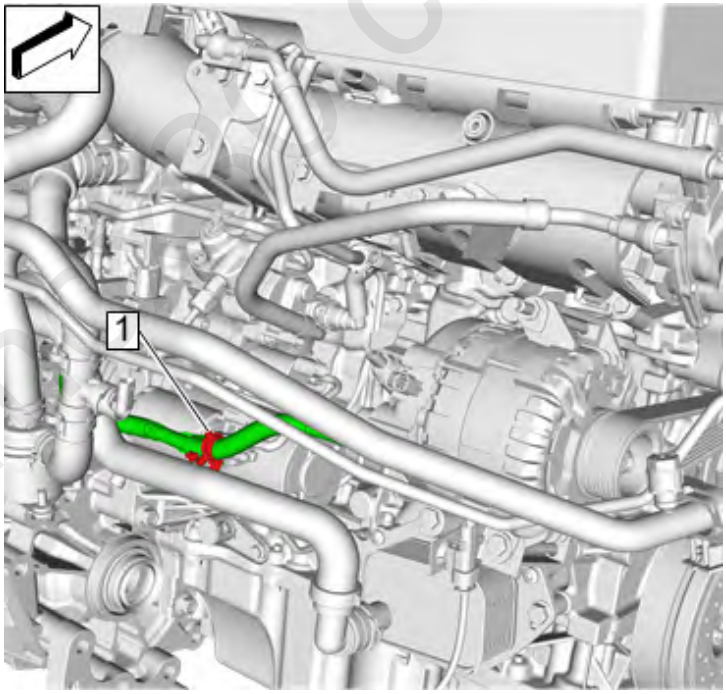


Fig. 121: Retainer Clip
Courtesy of GENERAL MOTORS COMPANY

10. Disengage Retainer Clip (1) -

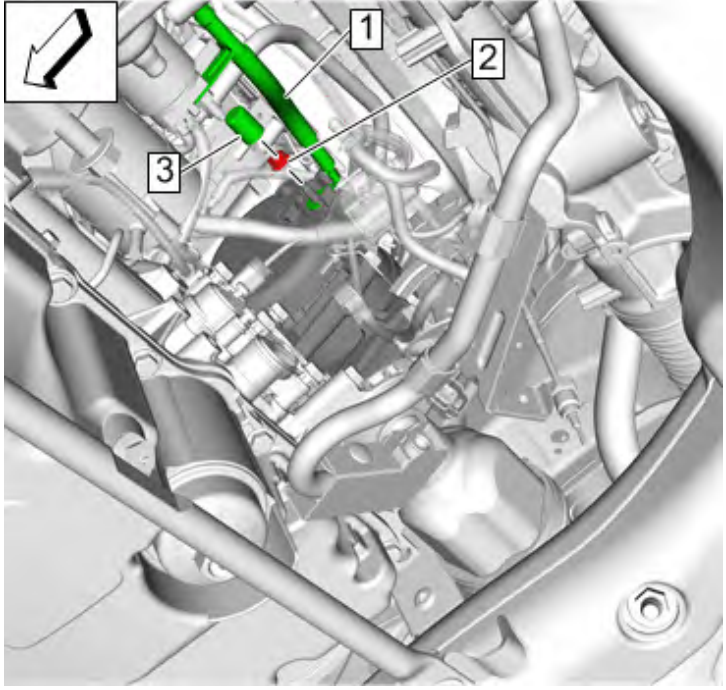


Fig. 122: Protective Cap
Courtesy of GENERAL MOTORS COMPANY

11. Remove Protective Cap (3).
12. Remove Battery Positive Cable Nut (2).
13. Remove Starter Solenoid Cable (1).

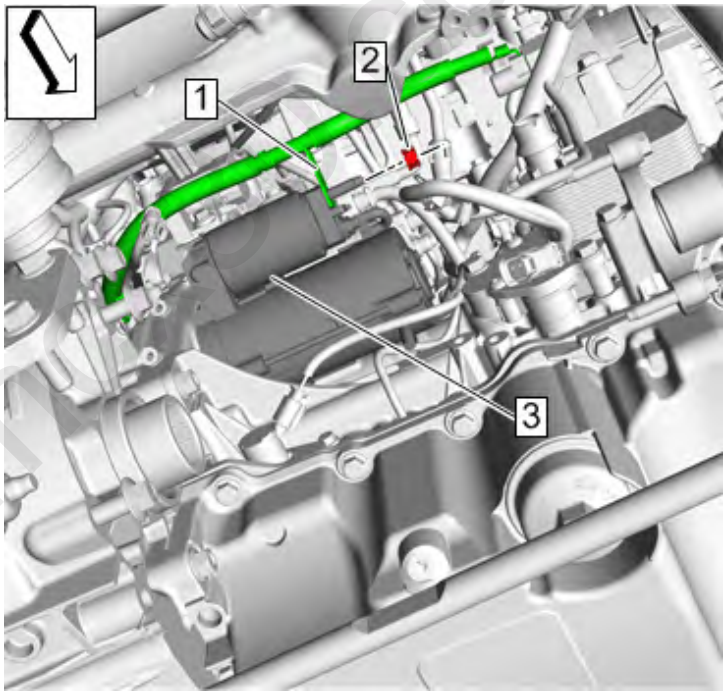


Fig. 123: Starter Solenoid Cable Nut And Cable
Courtesy of GENERAL MOTORS COMPANY

14. Remove Starter Solenoid Cable Nut (2) @ Starter Solenoid (3).
15. Remove Starter Solenoid Cable (1).

Installation Procedure

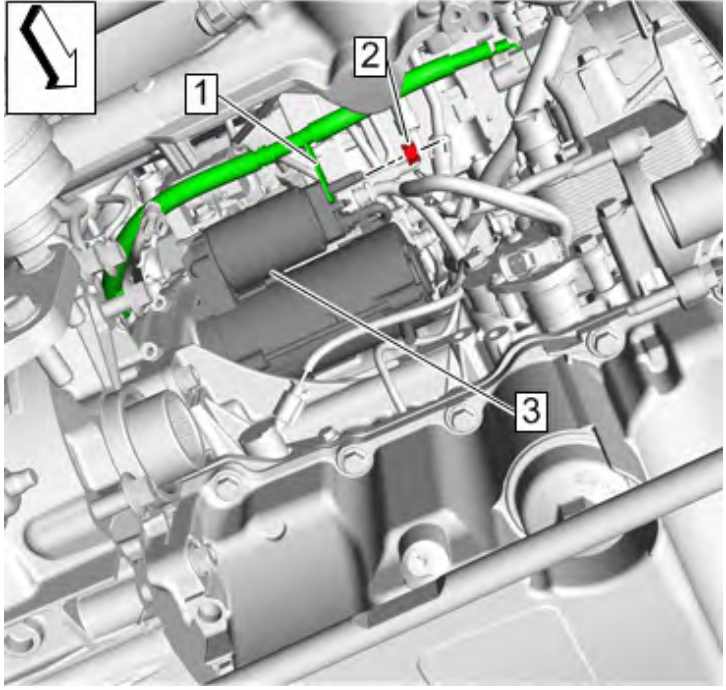


Fig. 124: Starter Solenoid Cable Nut And Cable
Courtesy of GENERAL MOTORS COMPANY

1. Install Starter Solenoid Cable (1) @ Starter Solenoid (3).

CAUTION: **Refer to Fastener Caution**

2. Install Starter Solenoid Cable Nut (2) and tighten 12 N.m (106 lb in)

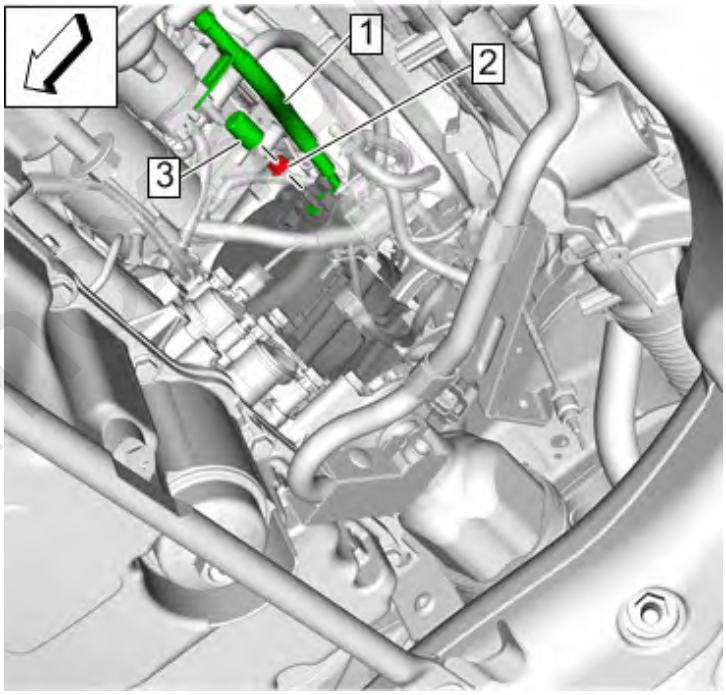


Fig. 125: Protective Cap
Courtesy of GENERAL MOTORS COMPANY

3. Install Starter Solenoid Cable (1)
4. Install Battery Positive Cable Nut (2) and tighten 15 N.m (11 lb ft)
5. Install Protective Cap (3).

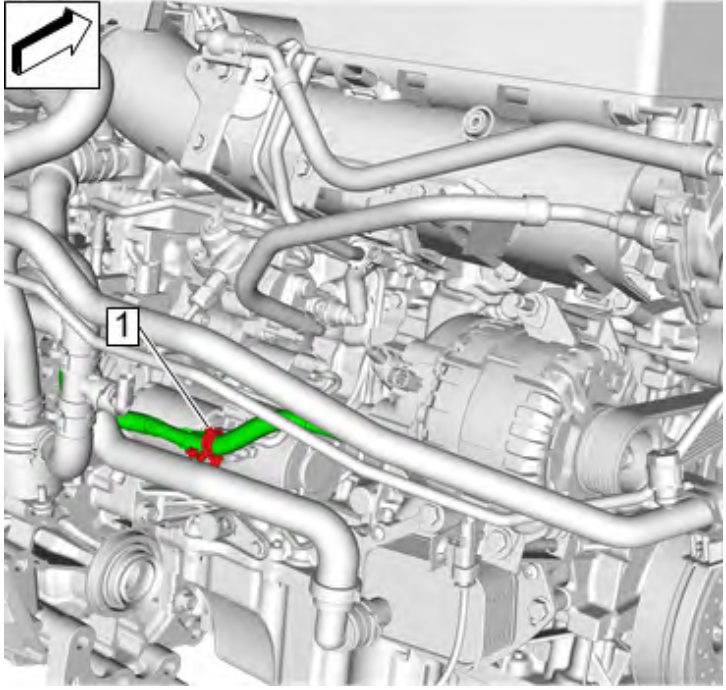


Fig. 126: Retainer Clip
Courtesy of GENERAL MOTORS COMPANY

6. Engage Retainer Clip (1).
7. Install the power transfer unit case. **Power Transfer Unit Case Replacement (MHG Transmission with LH7 Engine)**
8. Lower the vehicle.

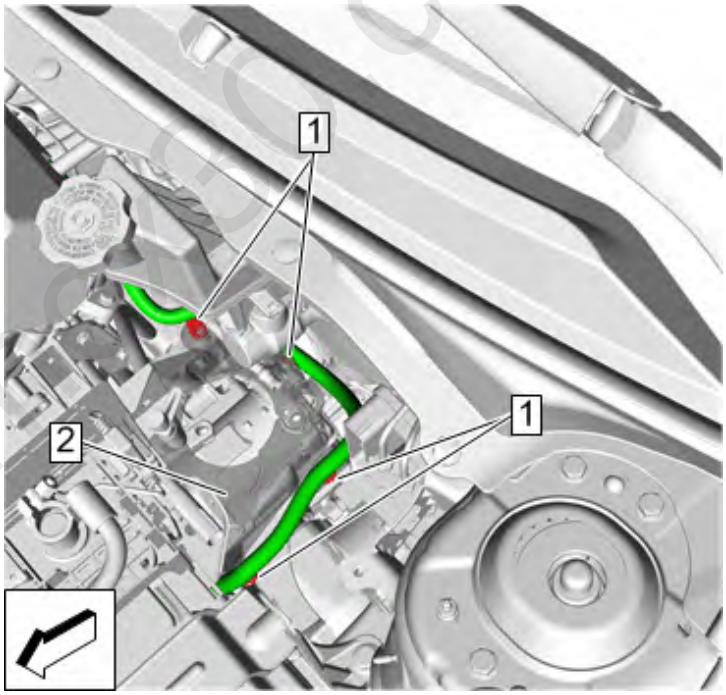


Fig. 127: Retainer And Automatic Transmission Range Selector Actuator Bracket
Courtesy of GENERAL MOTORS COMPANY

9. Engage Retainer (1) @ Automatic Transmission Range Selector Actuator Bracket (2) - [4x]

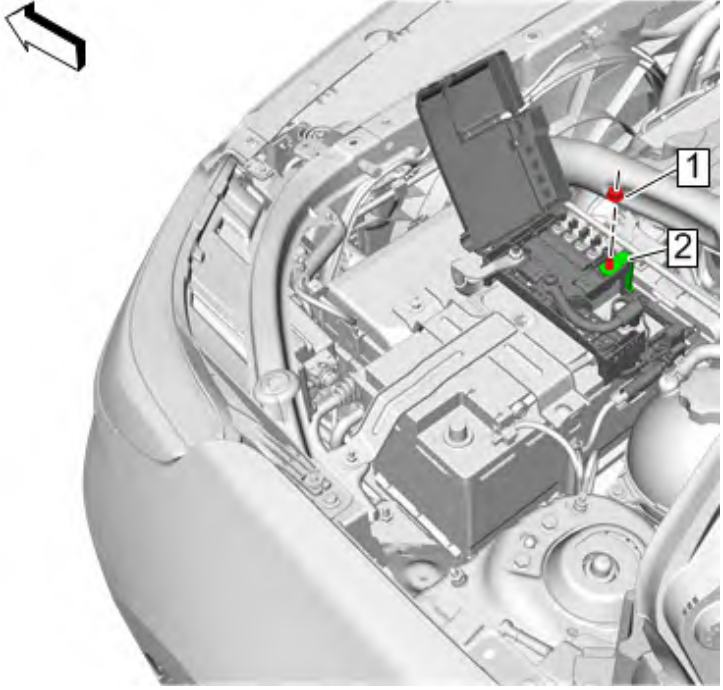


Fig. 128: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

10. Install Starter Solenoid Cable (2).
11. Install Starter Solenoid Cable Nut (1) and tighten 12 N.m (106 lb in)

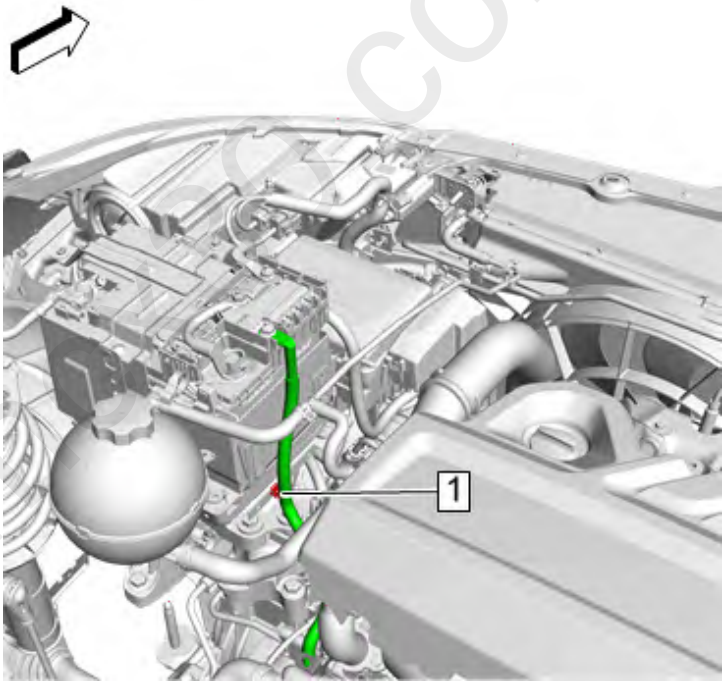


Fig. 129: Retainer
Courtesy of GENERAL MOTORS COMPANY

12. Engage Retainer (1) @ Battery Tray.

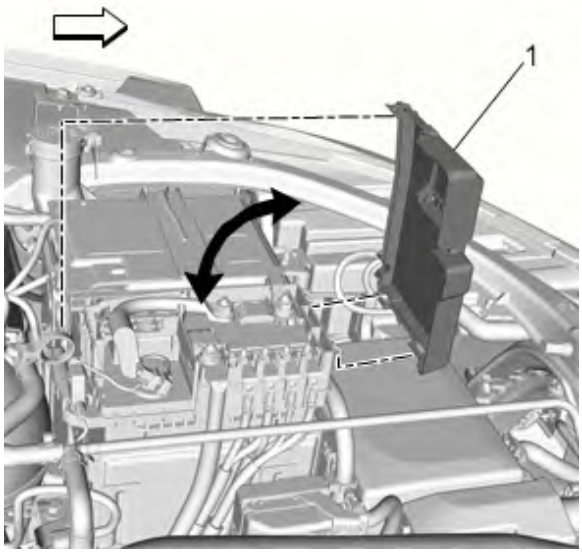


Fig. 130: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

13. Close Battery Distribution Engine Compartment Fuse Block Cover (1).
14. Install the engine control module bracket. **Engine Control Module Bracket Replacement**
15. Connect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

STARTER SOLENOID CABLE REPLACEMENT (GMC LH7 - FRONT WHEEL DRIVE)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

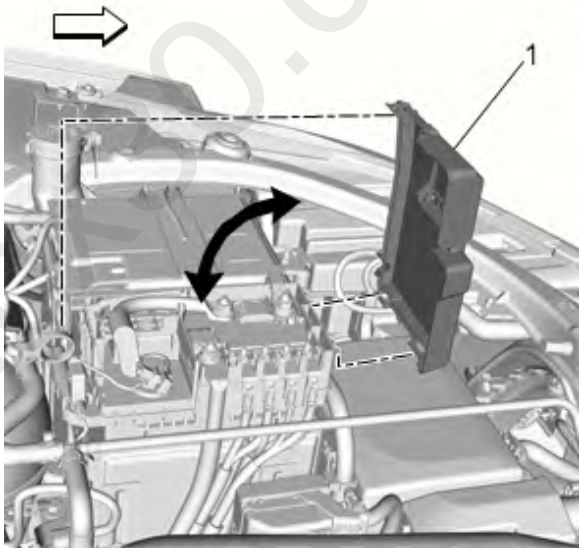


Fig. 131: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

2. Open Battery Distribution Engine Compartment Fuse Block Cover (1).

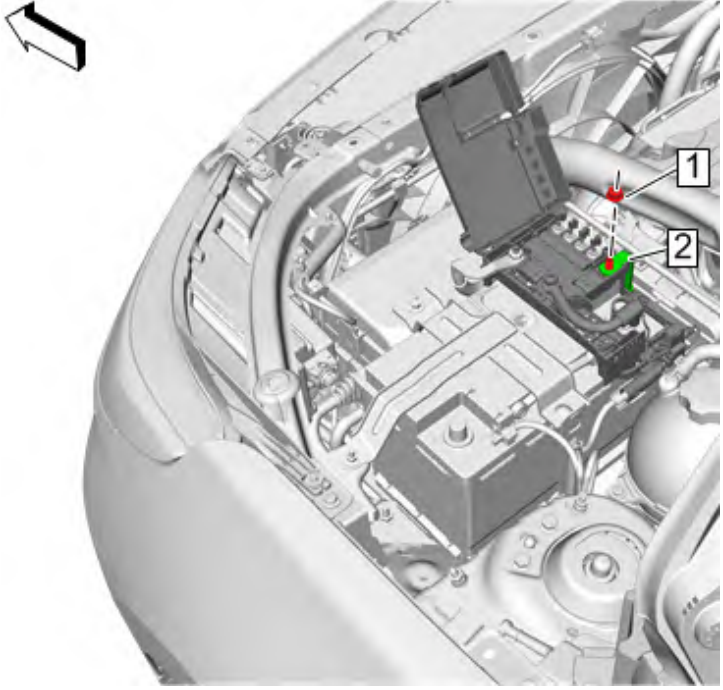


Fig. 132: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

3. Remove Starter Solenoid Cable Nut (1).
4. Remove Starter Solenoid Cable (2).
5. Remove the engine control module bracket. **Engine Control Module Bracket Replacement**

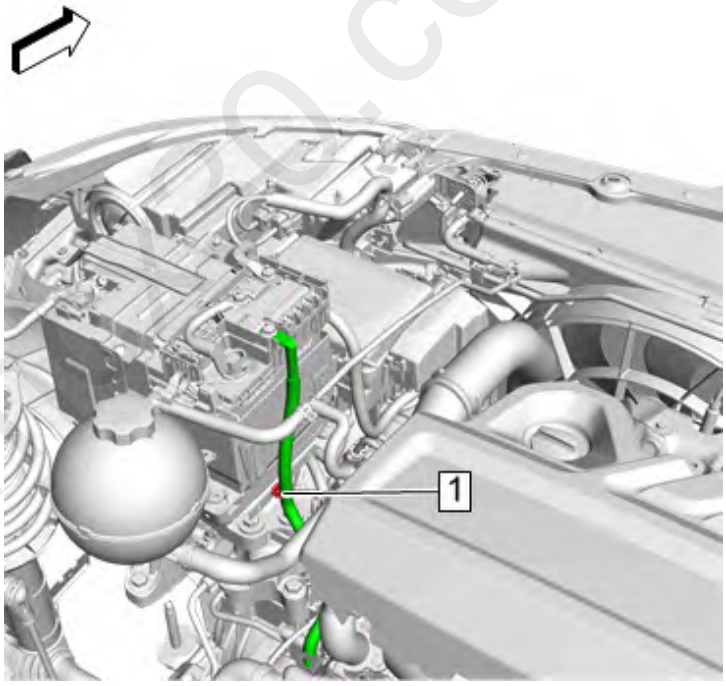


Fig. 133: Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Disengage Retainer (1) @ Battery Tray.

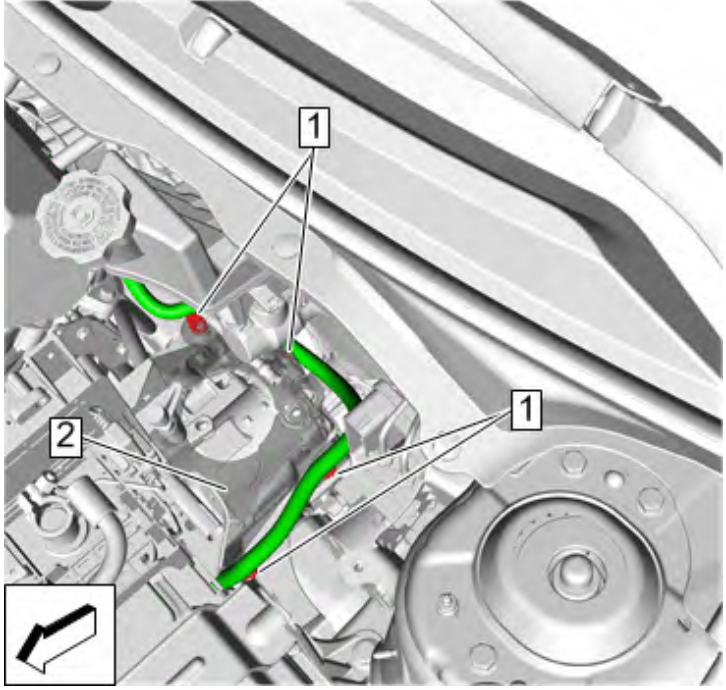


Fig. 134: Retainer And Automatic Transmission Range Selector Actuator Bracket
Courtesy of GENERAL MOTORS COMPANY

7. Disengage Retainer (1) @ Automatic Transmission Range Selector Actuator Bracket (2) - [4x]
8. Raise and support the vehicle. **Lifting and Jacking the Vehicle**

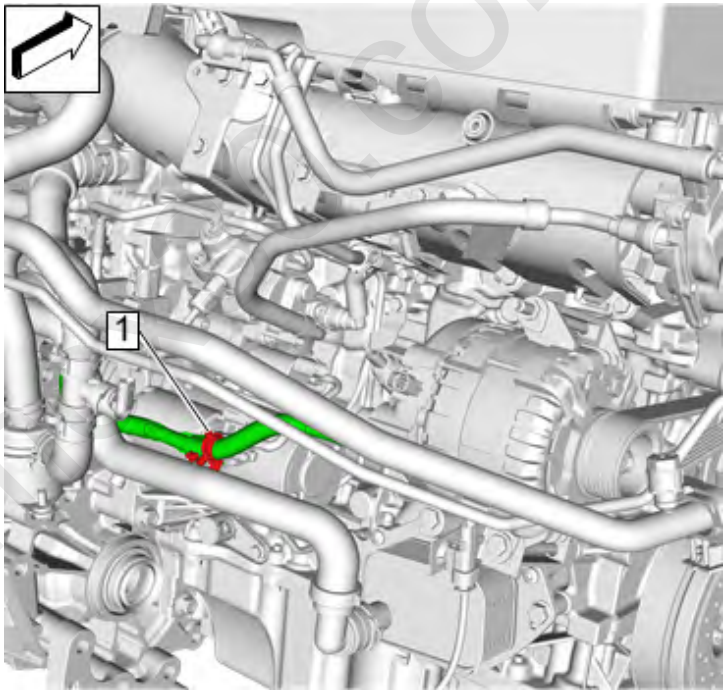


Fig. 135: Retainer Clip
Courtesy of GENERAL MOTORS COMPANY

9. Disengage Retainer Clip (1).

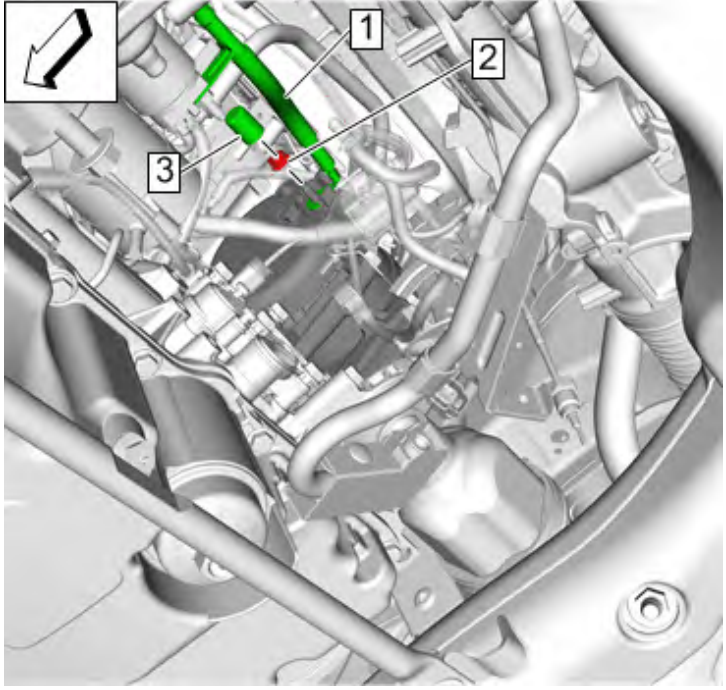


Fig. 136: Protective Cap
Courtesy of GENERAL MOTORS COMPANY

10. Remove Protective Cap (3).
11. Remove Battery Positive Cable Nut (2).
12. Remove Starter Solenoid Cable (1).

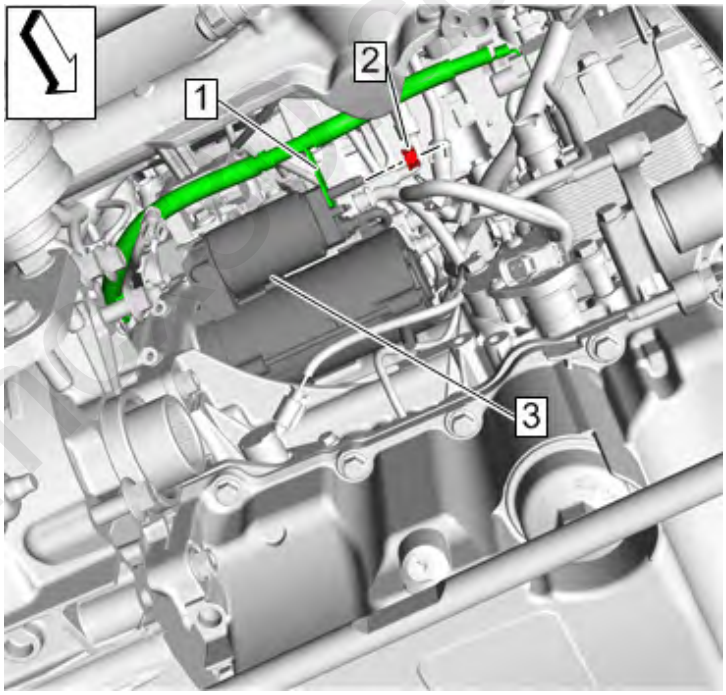


Fig. 137: Starter Solenoid Cable Nut And Cable
Courtesy of GENERAL MOTORS COMPANY

13. Remove Starter Solenoid Cable Nut (2) @ Starter Solenoid (3).
14. Remove Starter Solenoid Cable (1).

Installation Procedure

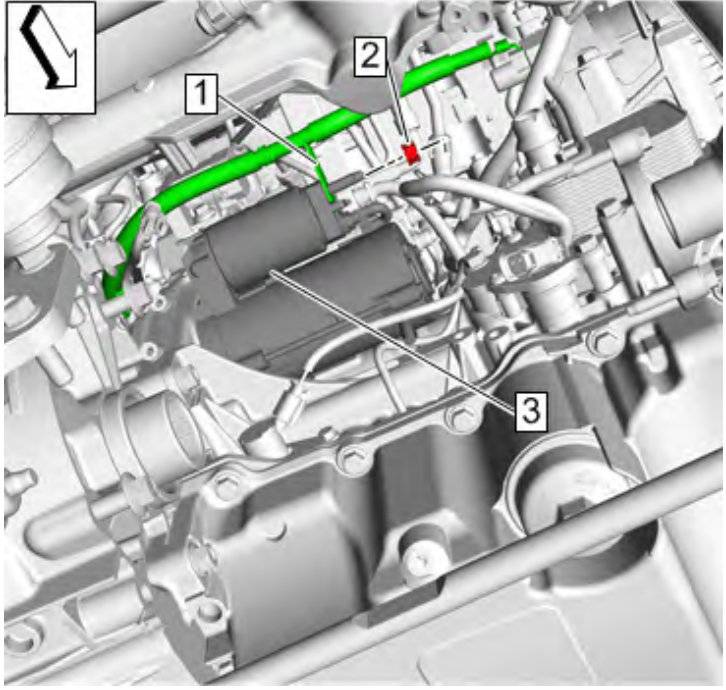


Fig. 138: Starter Solenoid Cable Nut And Cable
Courtesy of GENERAL MOTORS COMPANY

1. Install Starter Solenoid Cable (1) @ Starter Solenoid (3).

CAUTION: **Refer to Fastener Caution**

2. Install Starter Solenoid Cable Nut (2) and tighten 12 N.m (106 lb in)

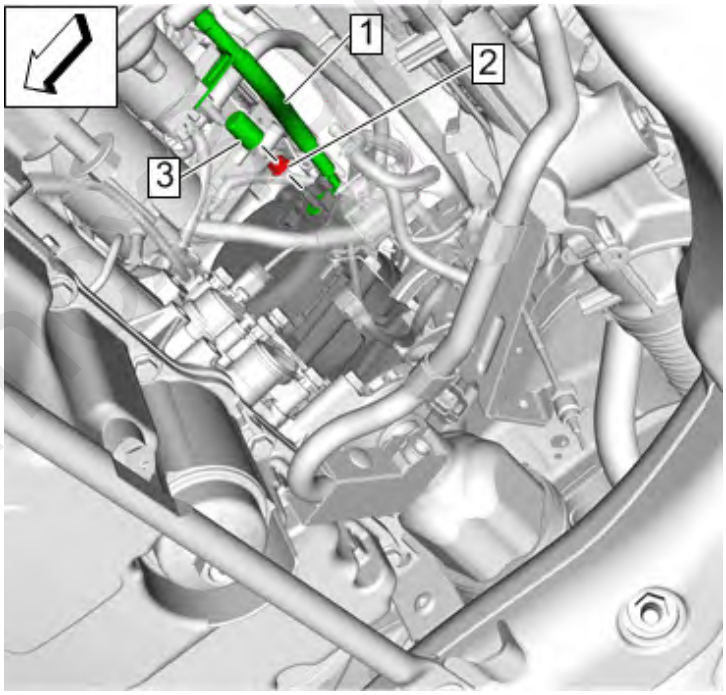


Fig. 139: Protective Cap
Courtesy of GENERAL MOTORS COMPANY

3. Install Starter Solenoid Cable (1).
4. Install Battery Positive Cable Nut (1) and tighten 15 N.m (11 lb ft)
5. Install Protective Cap (3).

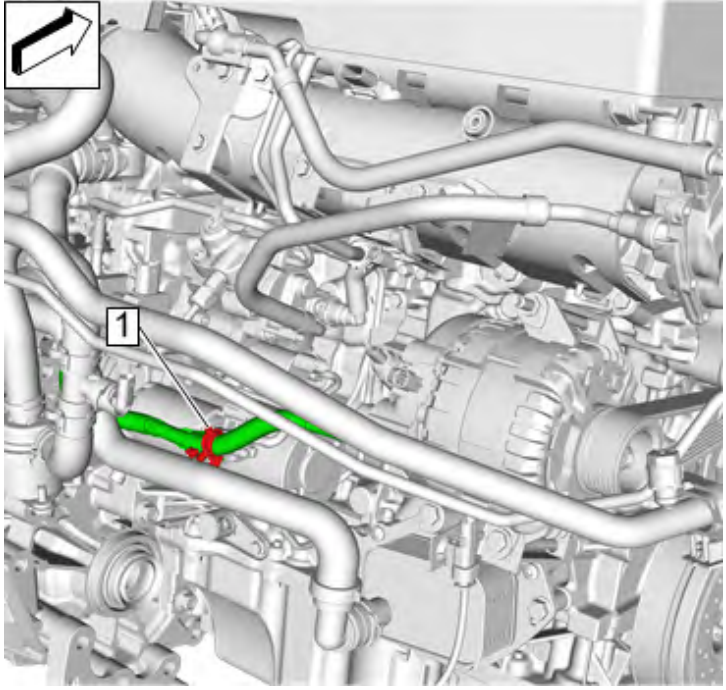


Fig. 140: Retainer Clip
Courtesy of GENERAL MOTORS COMPANY

6. Engage Retainer Clip (1).
7. Lower the vehicle.

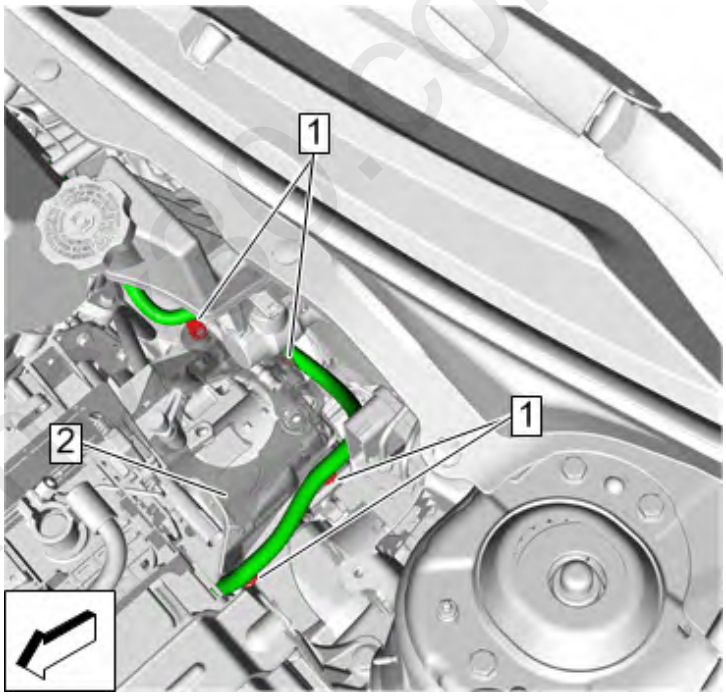


Fig. 141: Retainer And Automatic Transmission Range Selector Actuator Bracket
Courtesy of GENERAL MOTORS COMPANY

8. Engage Retainer (1) @ Automatic Transmission Range Selector Actuator Bracket (2) - [4x]

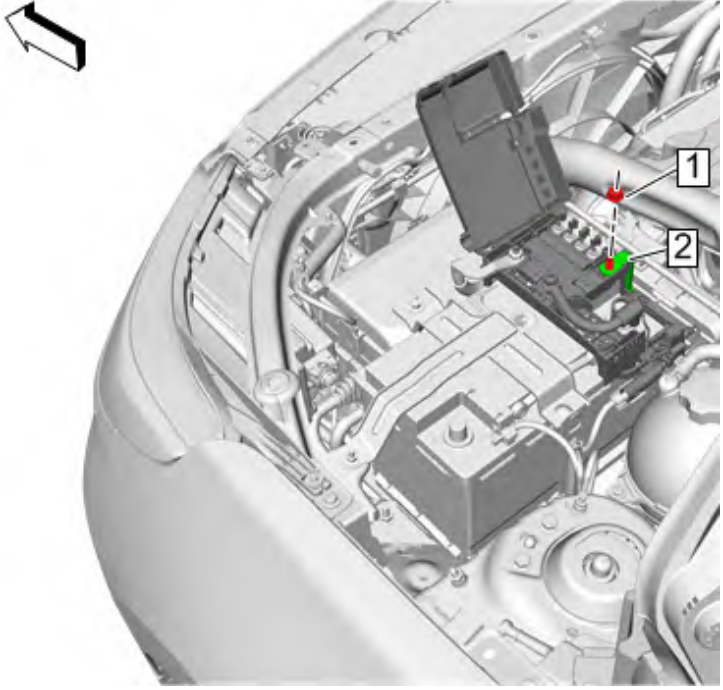


Fig. 142: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

9. Install Starter Solenoid Cable (2).
10. Install Starter Solenoid Cable Nut (1) and tighten 12 N.m (106 lb in)

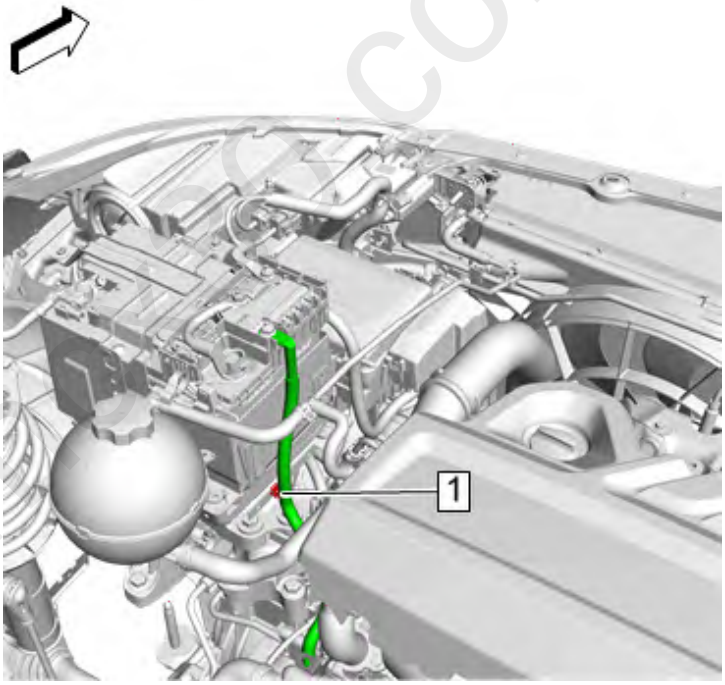


Fig. 143: Retainer
Courtesy of GENERAL MOTORS COMPANY

11. Engage Retainer (1) @ Battery Tray.

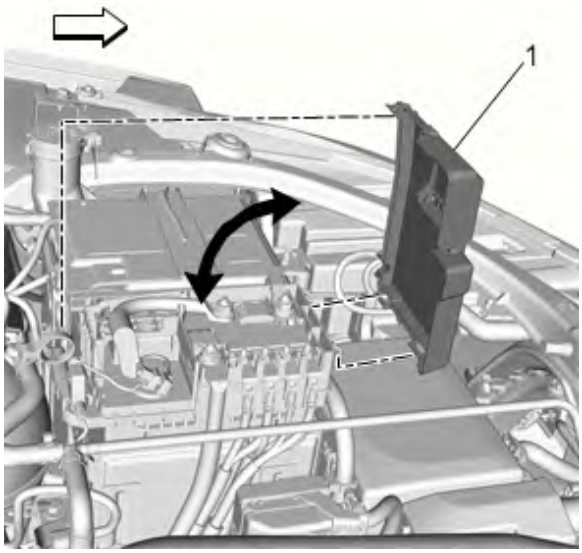


Fig. 144: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

12. Close Battery Distribution Engine Compartment Fuse Block Cover (1)
13. Install the engine control module bracket. **Engine Control Module Bracket Replacement**
14. Connect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

STARTER SOLENOID CABLE REPLACEMENT (GMC LTG - ALL WHEEL DRIVE)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

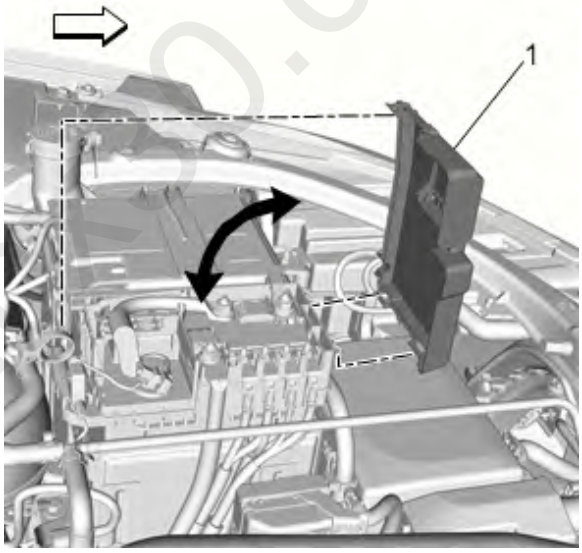


Fig. 145: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

2. Open Battery Distribution Engine Compartment Fuse Block Cover (1).

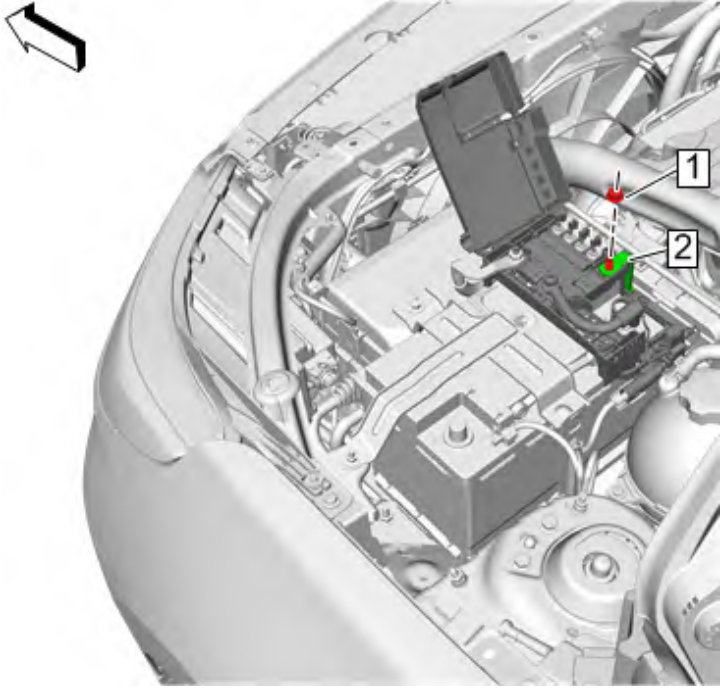


Fig. 146: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

3. Remove Starter Solenoid Cable Nut (1).
4. Remove Starter Solenoid Cable (2).

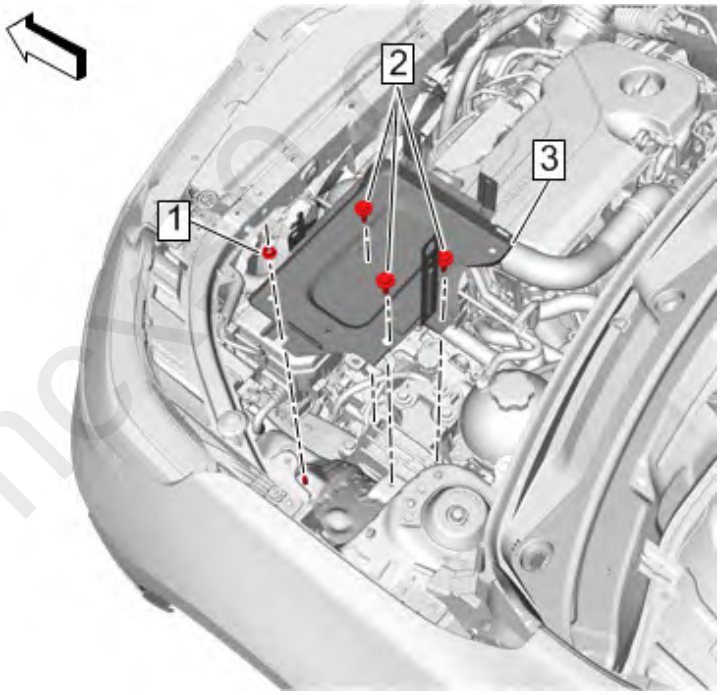


Fig. 147: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

5. Remove Battery Tray (3) - **Battery Tray Replacement**

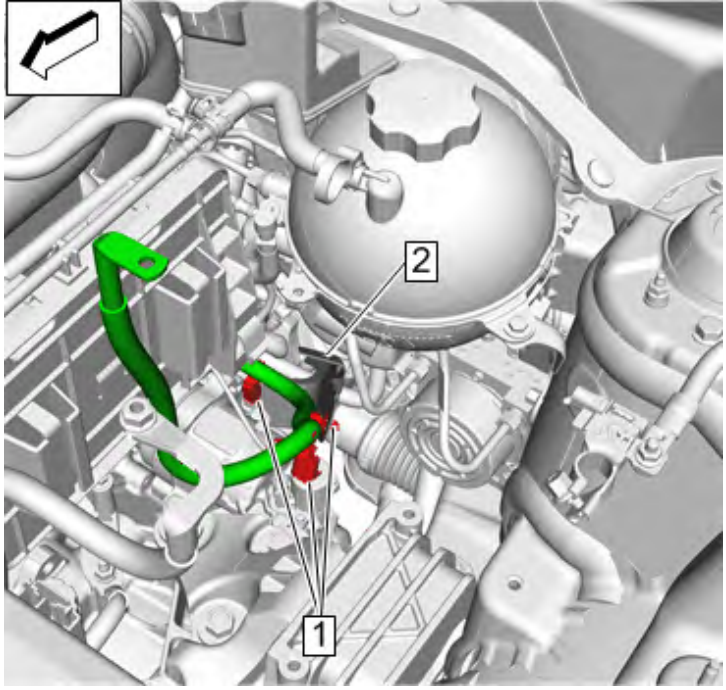


Fig. 148: Retainer And Transmission Wiring Harness Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Disengage Retainer (1) @ Transmission Wiring Harness Bracket (2) - [3x]

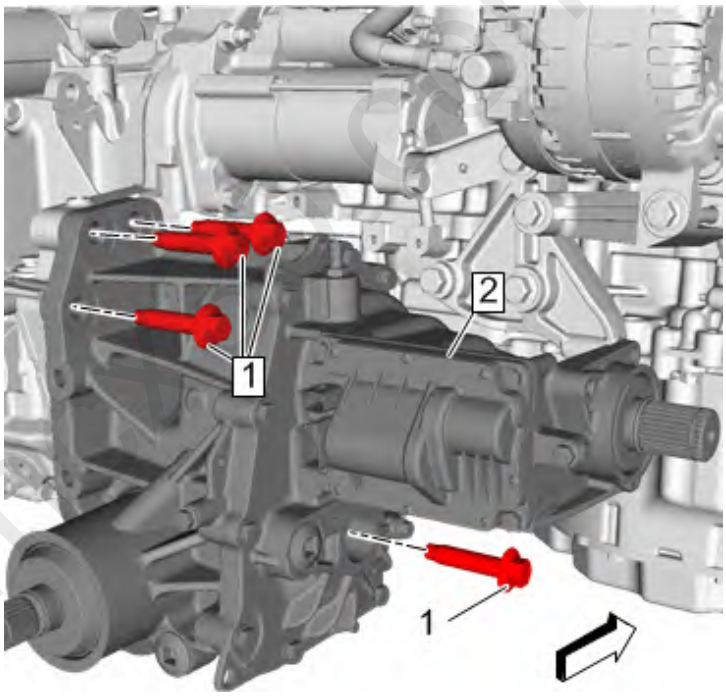


Fig. 149: Power Transfer Unit Case
Courtesy of GENERAL MOTORS COMPANY

7. Remove Power Transfer Unit Case (2) - **Power Transfer Unit Case Replacement (M3D Transmission with LTG Engine)**

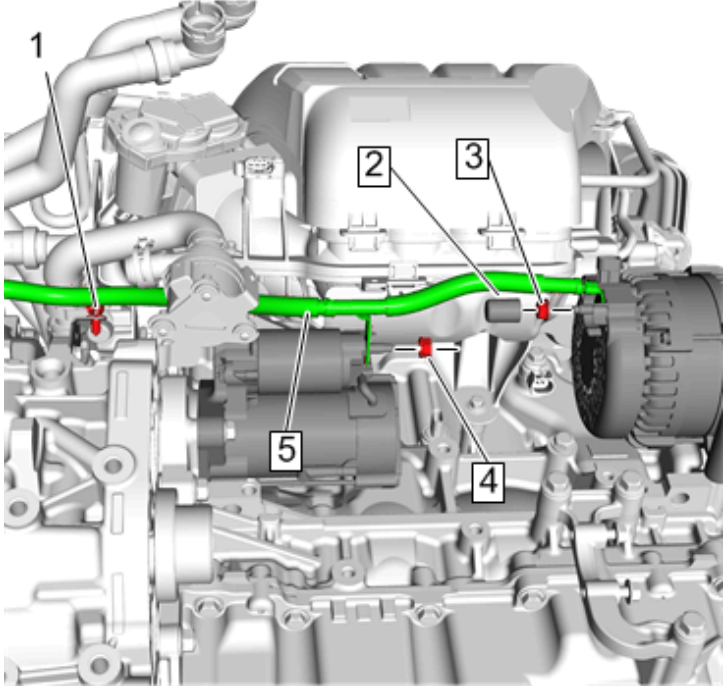


Fig. 150: Starter Solenoid Cable, Nut And Protective Cap
Courtesy of GENERAL MOTORS COMPANY

8. Disengage Retainer (1).
9. Remove Starter Solenoid Cable Nut (4) @ Starter Solenoid.
10. Remove Protective Cap (2).
11. Remove Starter Solenoid Cable Nut (3) @ Generator.
12. Remove Starter Solenoid Cable (5).

Installation Procedure

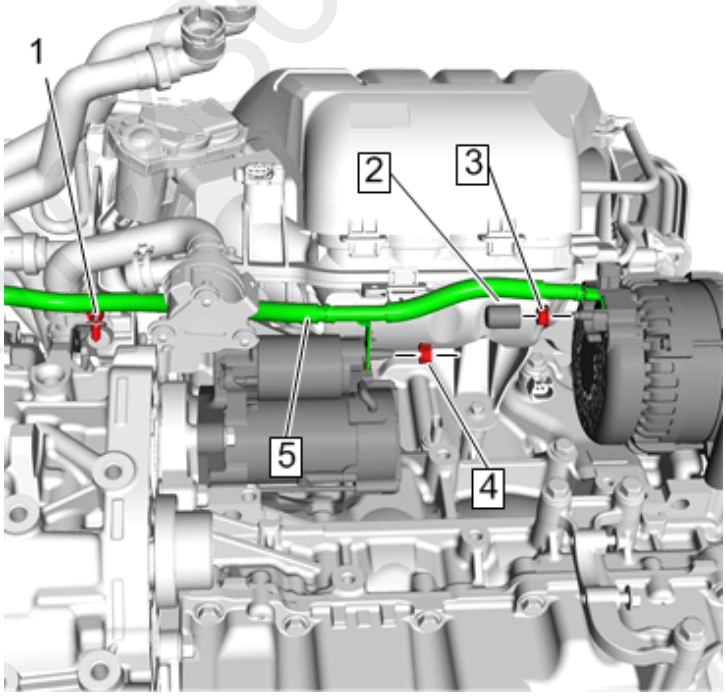


Fig. 151: Starter Solenoid Cable, Nut And Protective Cap
Courtesy of GENERAL MOTORS COMPANY

1. Install Starter Solenoid Cable (5).

CAUTION: **Refer to Fastener Caution**

2. Install Starter Solenoid Cable Nut (4) @ Starter Solenoid and tighten 12 N.m (106 lb in)
3. Install Starter Solenoid Cable Nut (3) @ Generator and tighten 15 N.m (11 lb ft)
4. Install Protective Cap (2).

5. Engage Retainer (1).

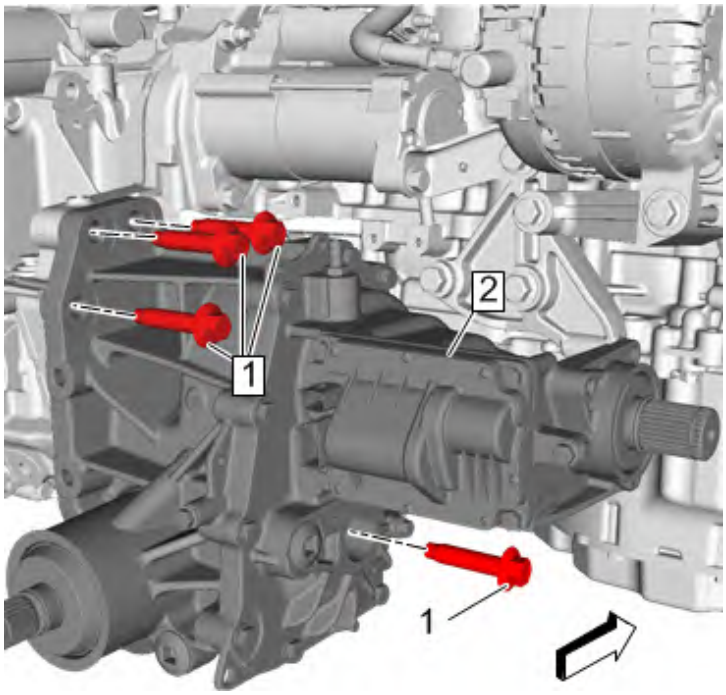


Fig. 152: Power Transfer Unit Case
Courtesy of GENERAL MOTORS COMPANY

6. Install Power Transfer Unit Case (2) - **Power Transfer Unit Case Replacement (M3D Transmission with LTG Engine)**

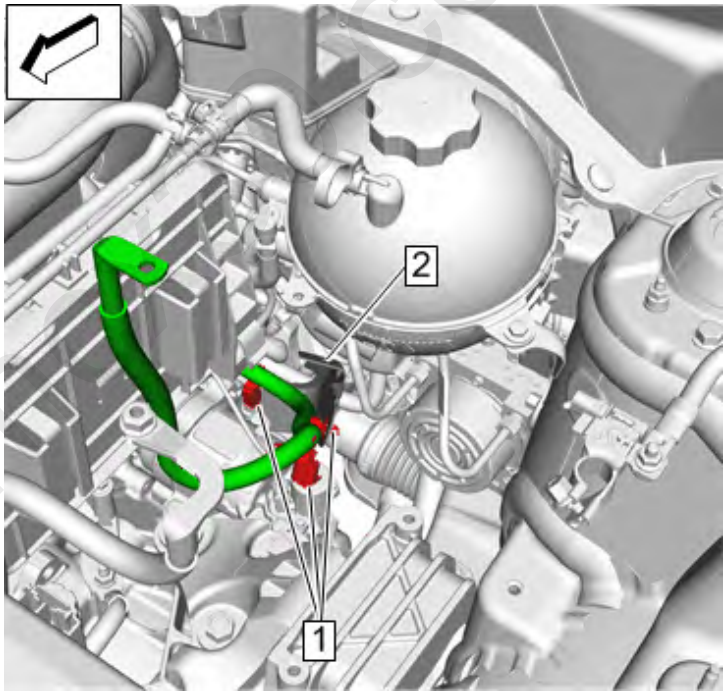


Fig. 153: Retainer And Transmission Wiring Harness Bracket
Courtesy of GENERAL MOTORS COMPANY

7. Engage Retainer (1) @ Transmission Wiring Harness Bracket (2) - [3x]

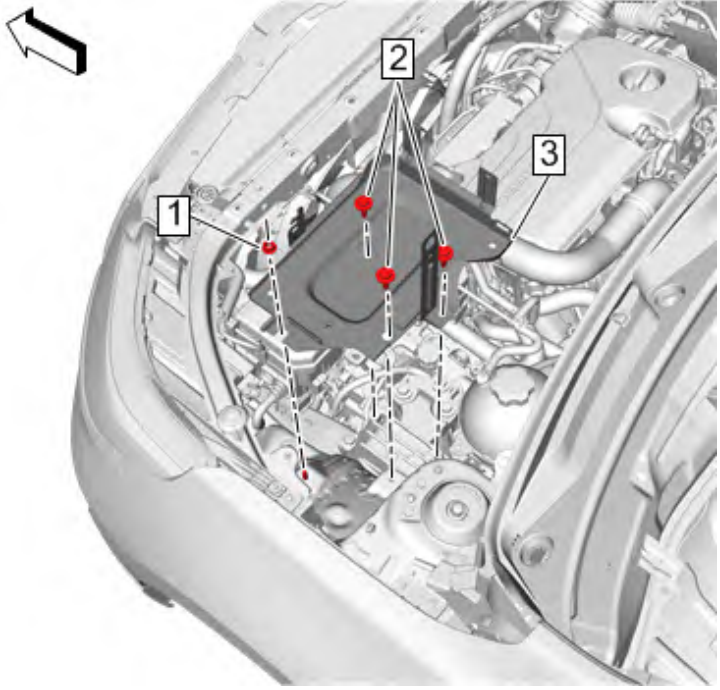


Fig. 154: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

8. Install Battery Tray (3) - **Battery Tray Replacement**

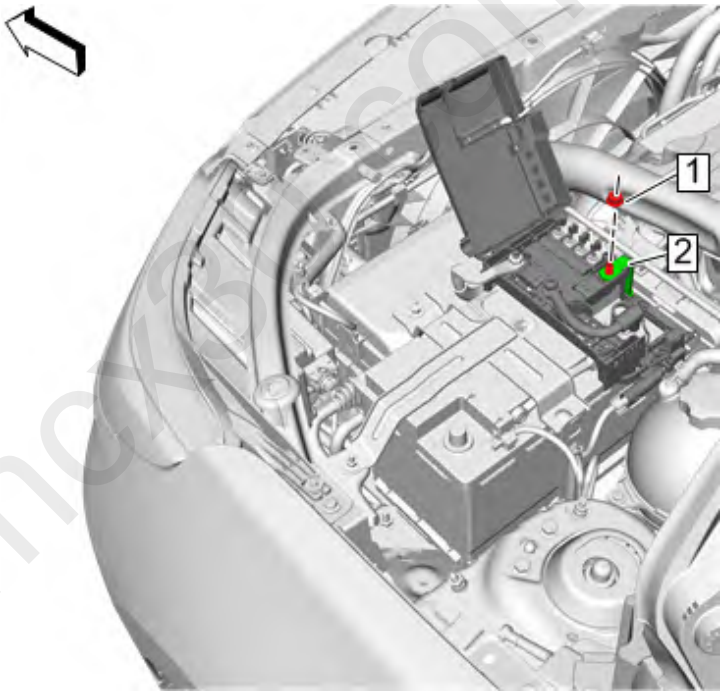


Fig. 155: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

9. Install Starter Solenoid Cable (2).
10. Install Starter Solenoid Cable Nut (1) and tighten 12 N.m (106 lb in)

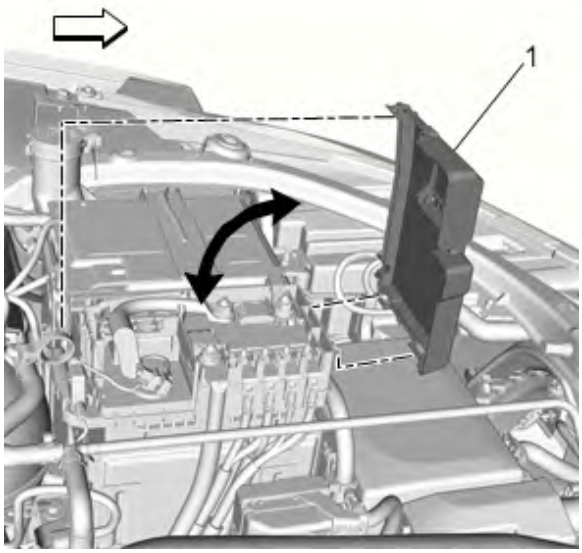


Fig. 156: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

11. Close Battery Distribution Engine Compartment Fuse Block Cover (1).
12. Connect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

STARTER SOLENOID CABLE REPLACEMENT (GMC LTG - FRONT WHEEL DRIVE)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

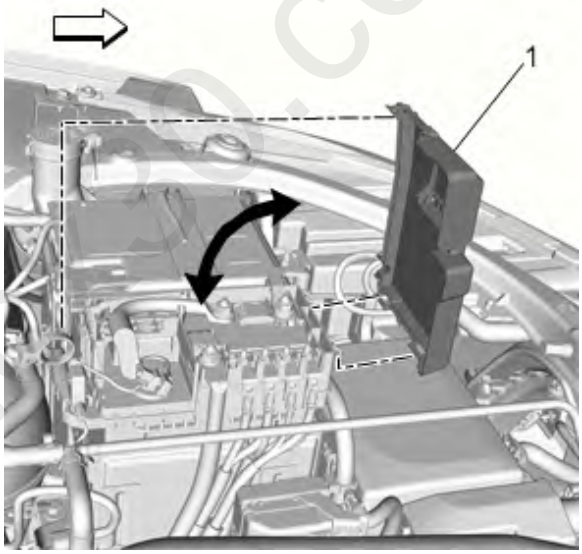


Fig. 157: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

2. Open Battery Distribution Engine Compartment Fuse Block Cover (1).

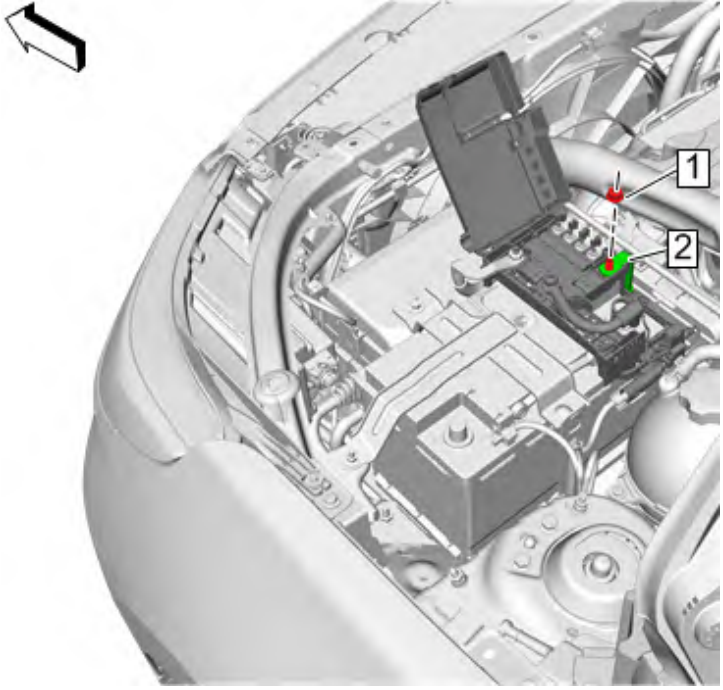


Fig. 158: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

3. Remove Starter Solenoid Cable Nut (1).
4. Remove Starter Solenoid Cable (2).

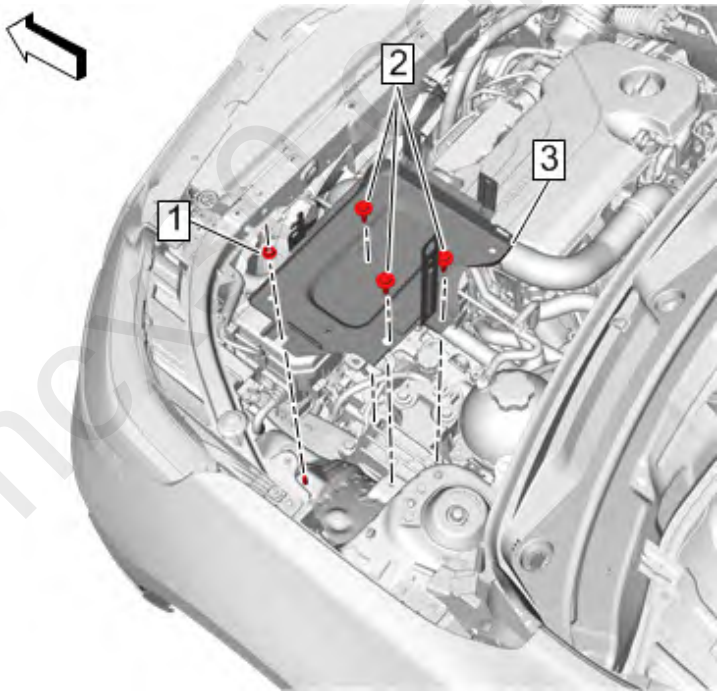


Fig. 159: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

5. Remove Battery Tray (3) - **Battery Tray Replacement**

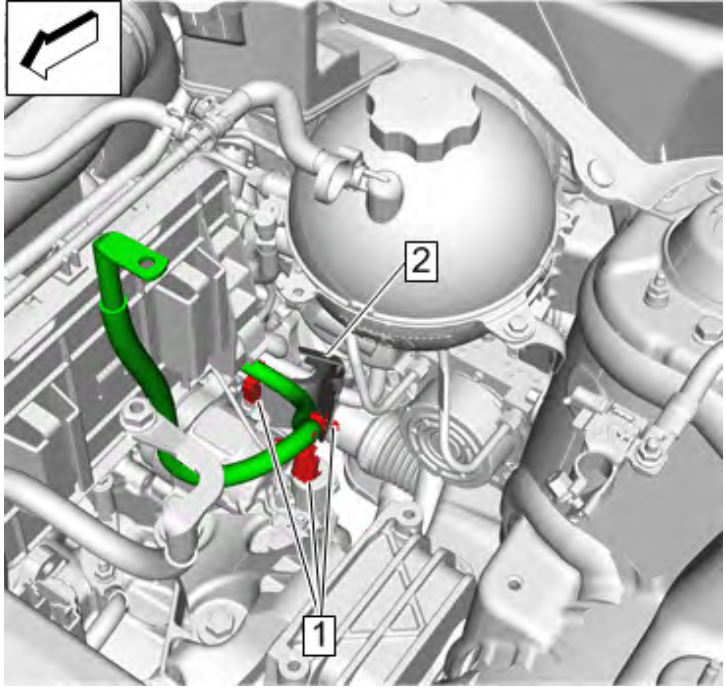


Fig. 160: Retainer And Transmission Wiring Harness Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Retainer (1) @ Transmission Wiring Harness Bracket (2) - [3x]

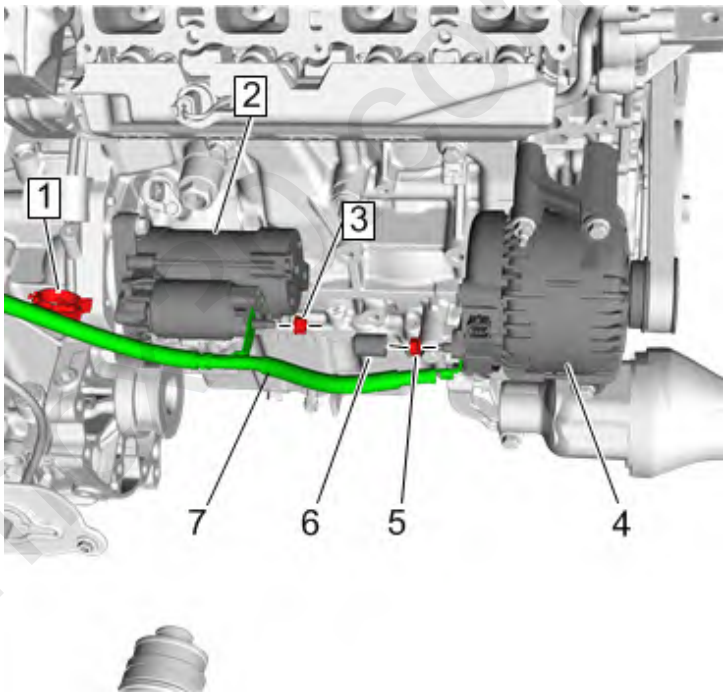


Fig. 161: Retainer Clip And Starter Solenoid Cable Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Intake manifold is removed for clarity.**

7. Disengage Retainer Clip (1).
8. Remove Starter Solenoid Cable Nut (3) @ Starter Solenoid (2).
9. Remove Protective Cap (6).
10. Remove Starter Solenoid Cable Nut (5) @ Generator (4).
11. Remove Starter Solenoid Cable (7).

Installation Procedure

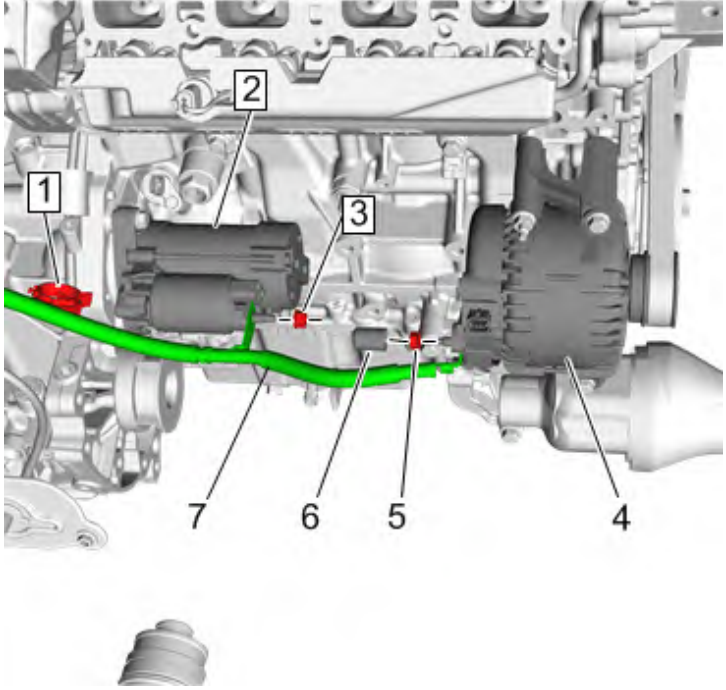


Fig. 162: Retainer Clip And Starter Solenoid Cable Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Intake manifold is removed for clarity.**

1. Install Starter Solenoid Cable (7).

CAUTION: **Refer to Fastener Caution**

2. Install Starter Solenoid Cable Nut (3) @ Starter Solenoid (2) and tighten 12 N.m (106 lb in)
3. Install Protective Cap (6)
4. Install Starter Solenoid Cable Nut (5) @ Generator (4) and tighten 15 N.m (11 lb ft)
5. Engage Retainer Clip (1).

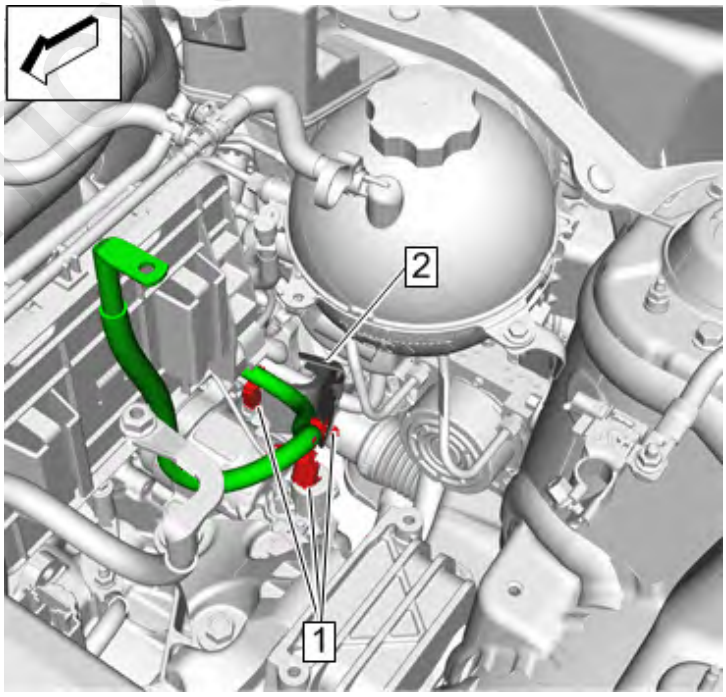


Fig. 163: Retainer And Transmission Wiring Harness Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Engage Retainer (1) @ Transmission Wiring Harness Bracket (2) - [3x]

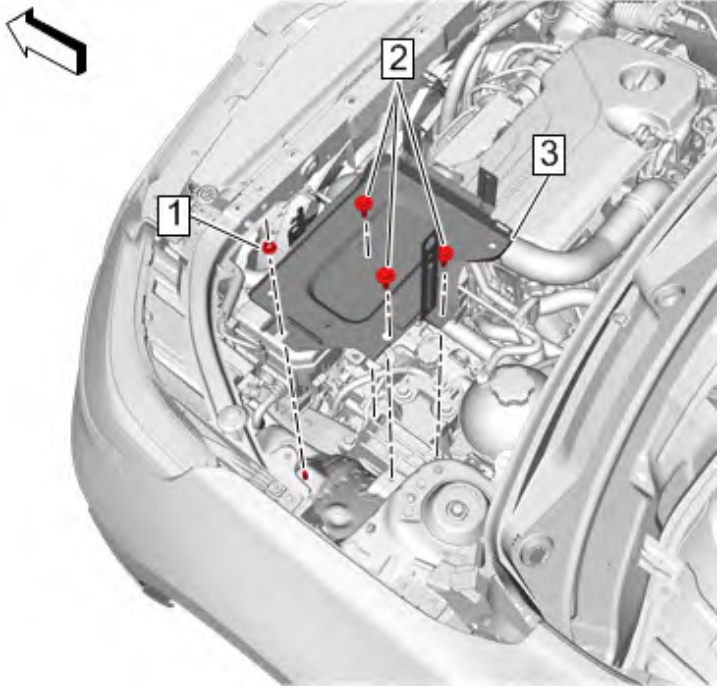


Fig. 164: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

7. Install Battery Tray (3) - **Battery Tray Replacement**

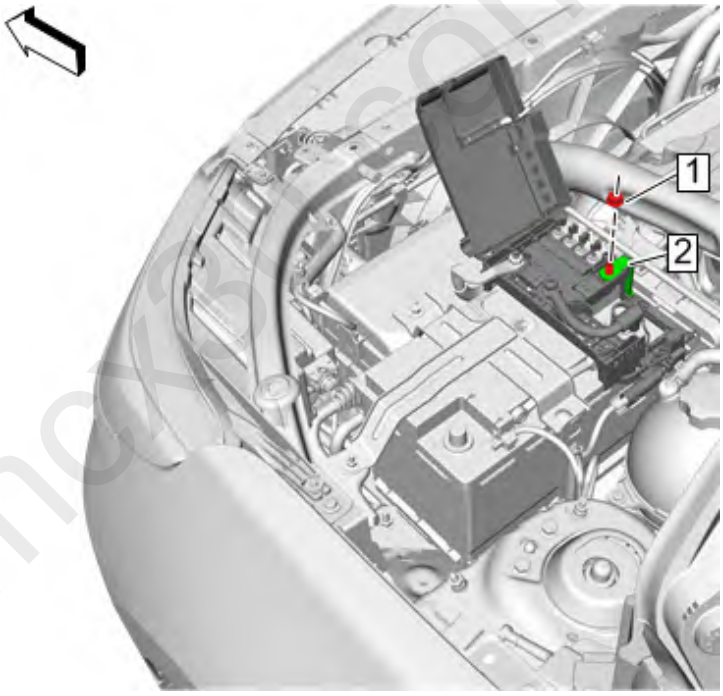


Fig. 165: Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

8. Install Starter Solenoid Cable (2).
9. Install Starter Solenoid Cable Nut (1) and tighten 12 N.m (106 lb in)

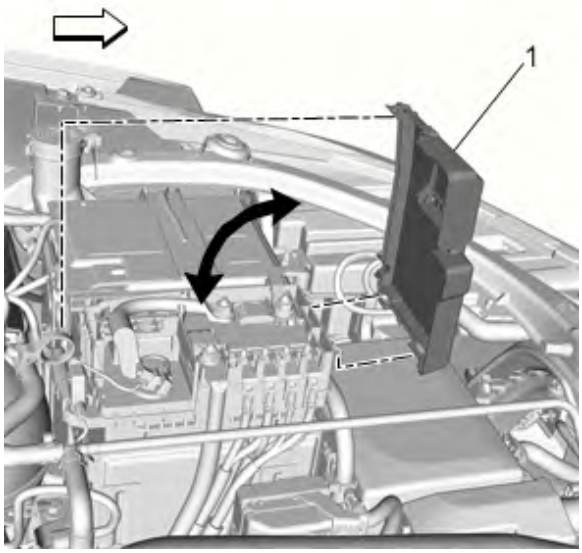


Fig. 166: Battery Distribution Engine Compartment Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

10. Close Battery Distribution Engine Compartment Fuse Block Cover (1).
11. Connect the battery negative cable. Battery Negative Cable Disconnection and Connection (KL9)

MULTIFUNCTION POWER SUPPLY CONVERTER REPLACEMENT (EQUINOX)

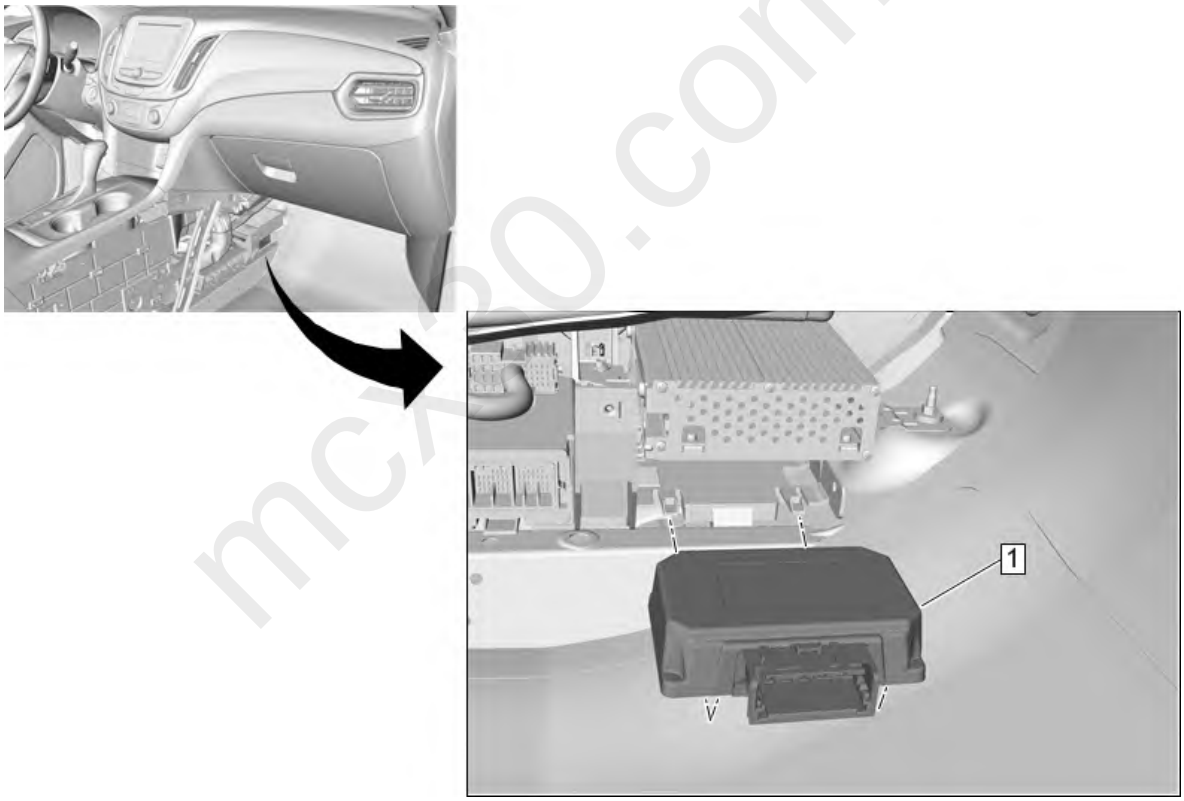


Fig. 167: Multifunction Power Supply Converter (Equinox)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Front Floor Console Extension Panel Replacement - Right Side (Equinox)	
1	Multifunction Power Supply Converter **Procedure** 1. Disconnect the electrical connector. 2. Release the retaining tabs.

MULTIFUNCTION POWER SUPPLY CONVERTER REPLACEMENT (TERRAIN)

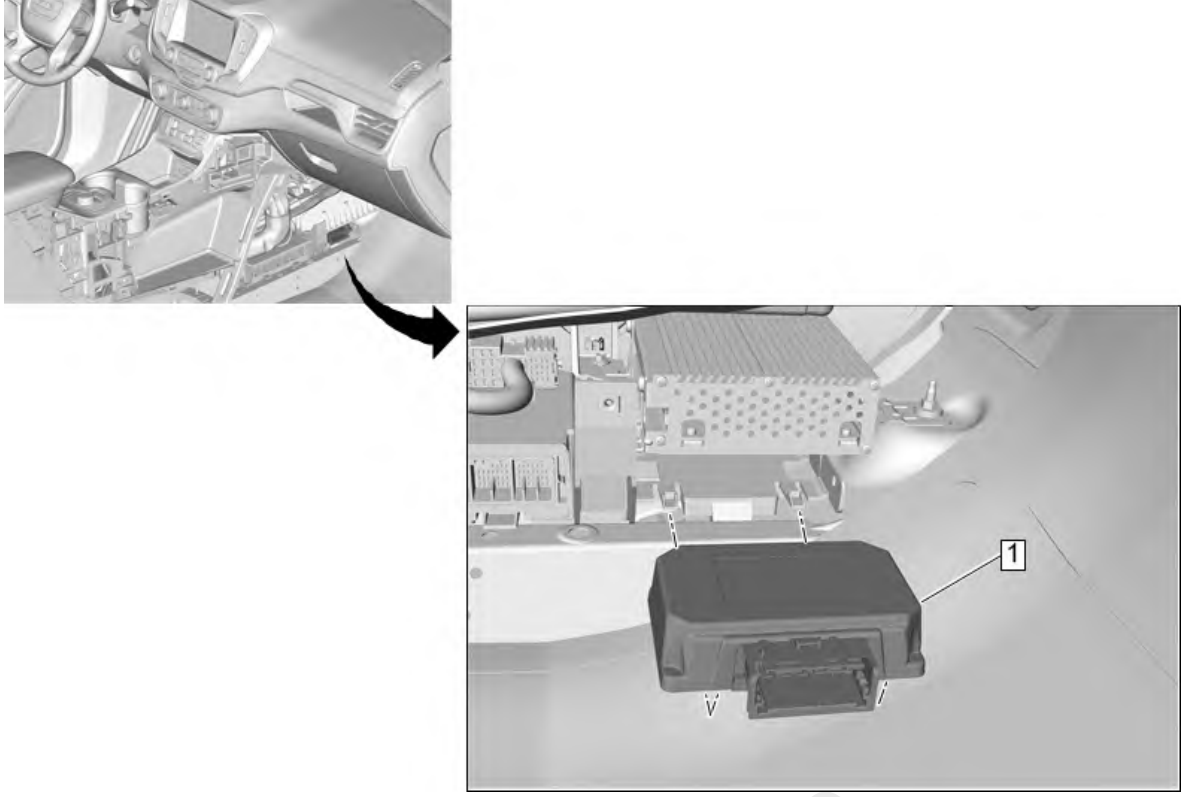


Fig. 168: Multifunction Power Supply Converter (Terrain)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Front Floor Console Extension Panel Replacement - Right Side (Terrain)	
1	Multifunction Power Supply Converter **Procedure** 1. Disconnect the electrical connector. 2. Release the retaining tabs.

BATTERY REPLACEMENT

Removal Procedure

1. Disconnect the battery negative cable. Battery Negative Cable Disconnection and Connection (KL9)

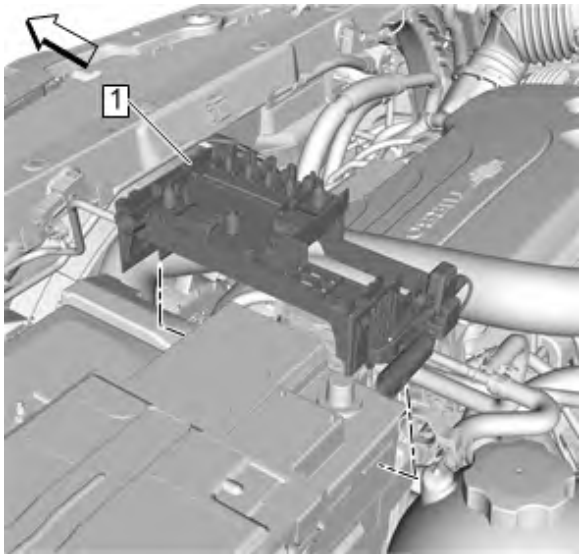


Fig. 169: Battery Distribution Engine Compartment Fuse Block
Courtesy of GENERAL MOTORS COMPANY

mcx30.com

2. Remove Battery Distribution Engine Compartment Fuse Block (1) - **Battery Distribution Engine Compartment Fuse Block Replacement**

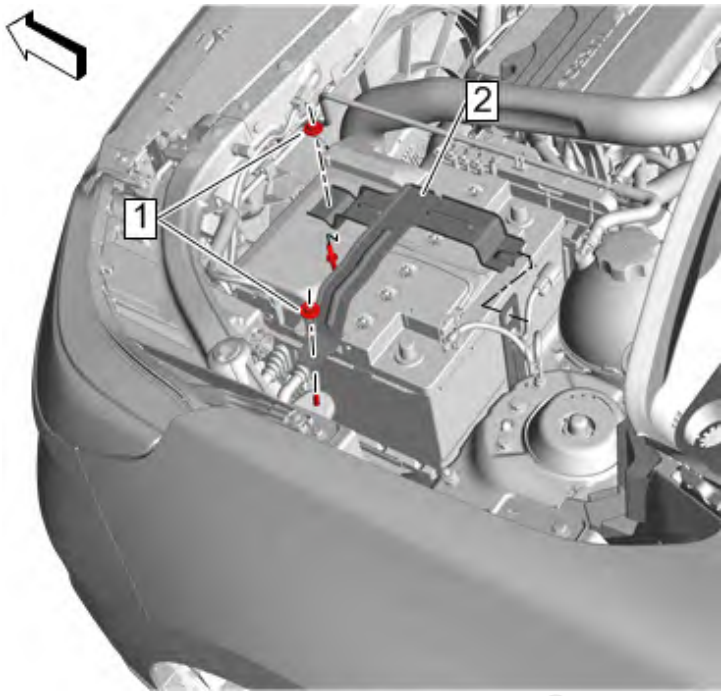


Fig. 170: Battery Hold Down Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Remove Battery Hold Down Retainer Nut (1) - [2x]
4. Remove Battery Hold Down Retainer (2).

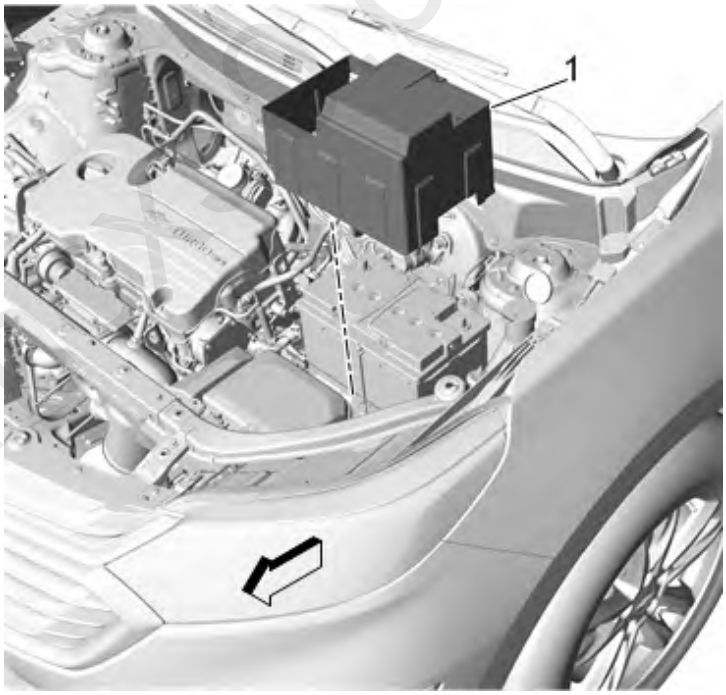


Fig. 171: Battery Cover
Courtesy of GENERAL MOTORS COMPANY

5. Remove Battery Cover (1).

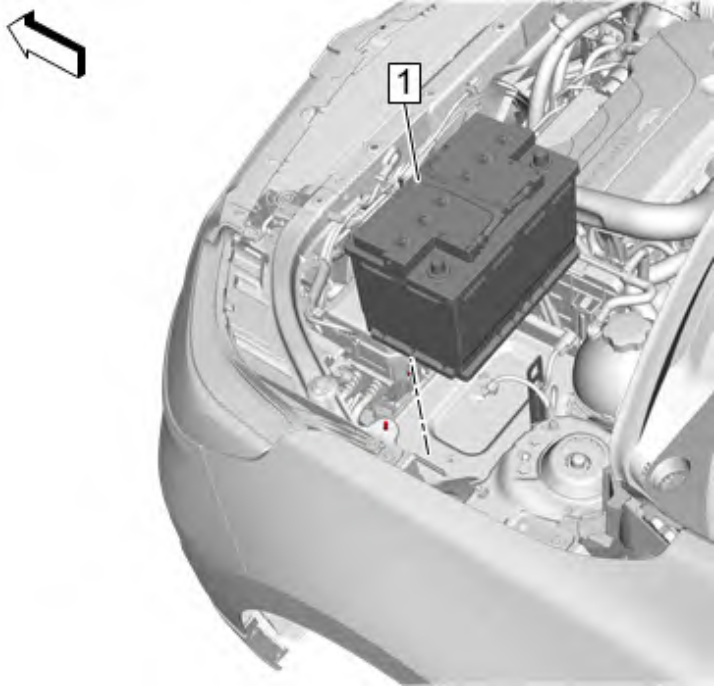


Fig. 172: Battery
Courtesy of GENERAL MOTORS COMPANY

6. Remove Battery (1)

Installation Procedure

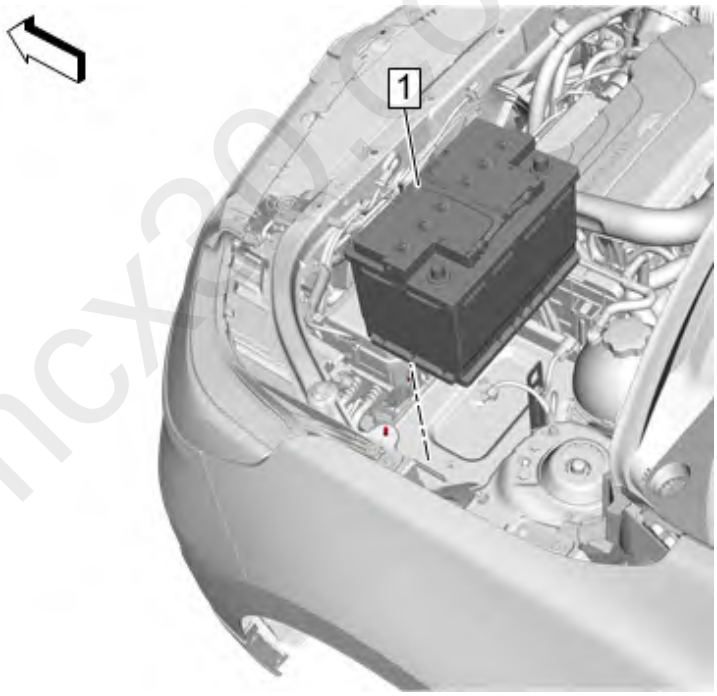


Fig. 173: Battery
Courtesy of GENERAL MOTORS COMPANY

1. Install Battery (1)

mcx30.com

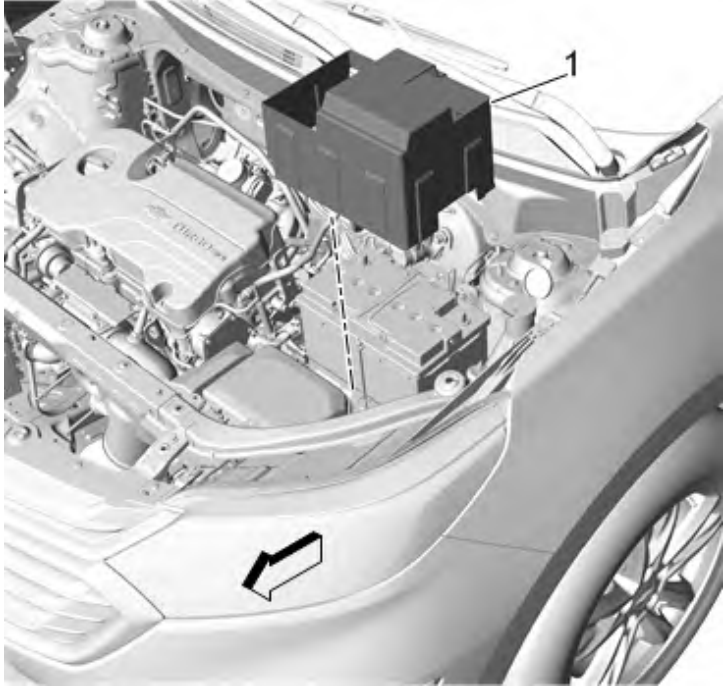


Fig. 174: Battery Cover
Courtesy of GENERAL MOTORS COMPANY

2. Install Battery Cover (1)

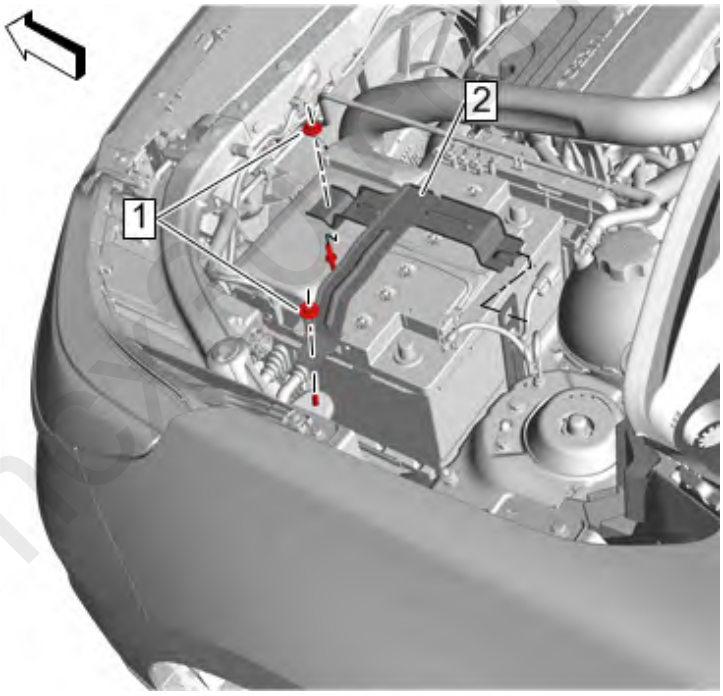


Fig. 175: Battery Hold Down Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Install Battery Hold Down Retainer (2)

CAUTION: **Refer to Fastener Caution**

4. Install Battery Hold Down Retainer Nut (1) and tighten [2x] 5 N.m (44 lb in)

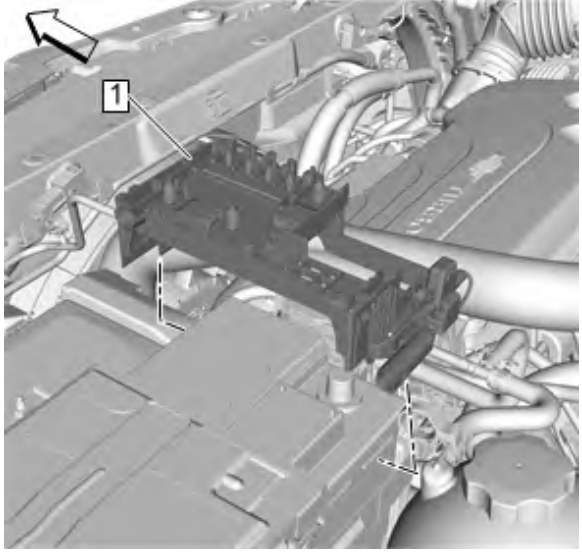


Fig. 176: Battery Distribution Engine Compartment Fuse Block
Courtesy of GENERAL MOTORS COMPANY

5. Install Battery Distribution Engine Compartment Fuse Block (1) -**Battery Distribution Engine Compartment Fuse Block Replacement**
6. Connect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

BATTERY TRAY REPLACEMENT

Removal Procedure

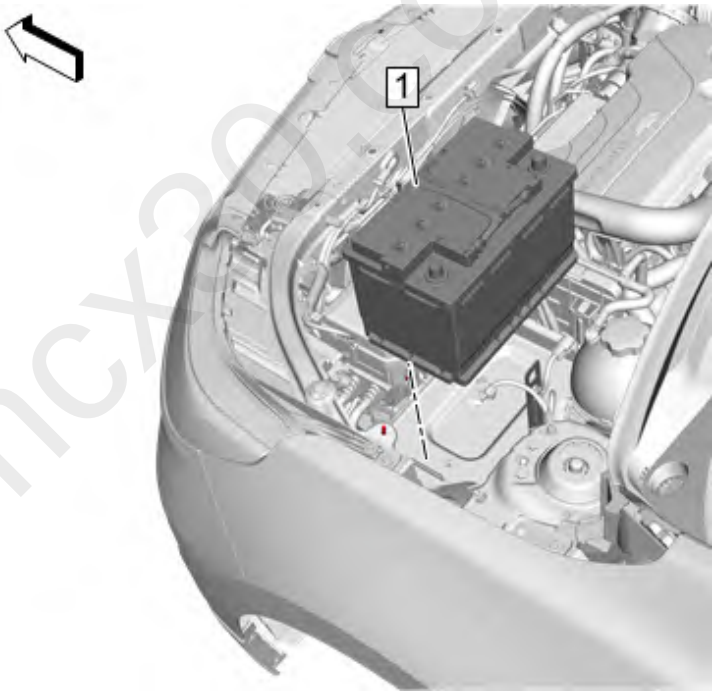


Fig. 177: Battery
Courtesy of GENERAL MOTORS COMPANY

1. Remove Battery (1) - **Battery Replacement**
2. Remove the engine control module bracket. **Engine Control Module Bracket Replacement**

mcx30.com

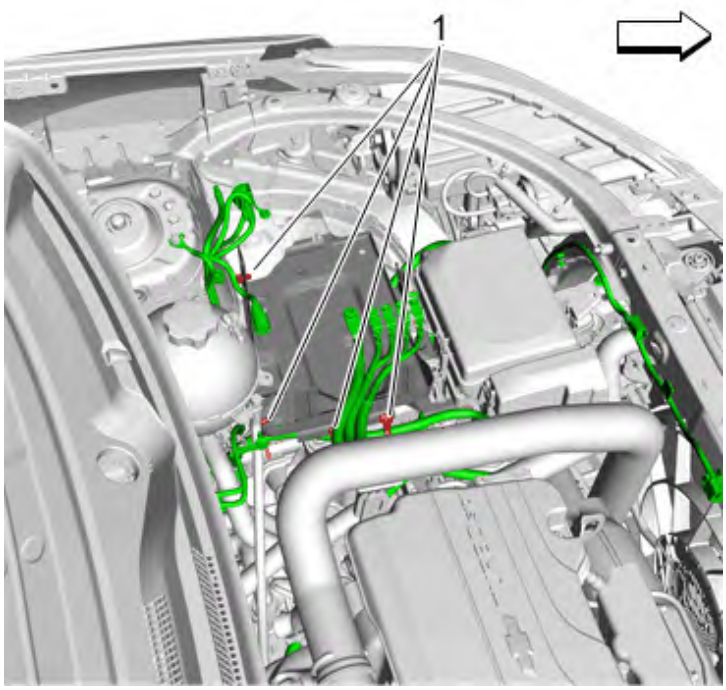


Fig. 178: Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Disengage Retainer (1) - [4x]

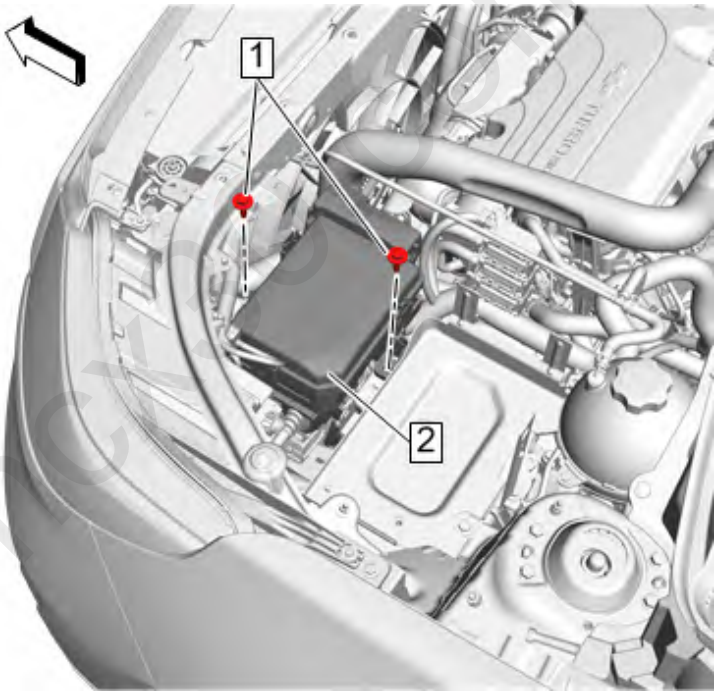


Fig. 179: Engine Wiring Harness Fuse Block Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove Engine Wiring Harness Fuse Block Bracket Bolt (1) - [2x]
5. Reposition Engine Wiring Harness Junction Block (2).

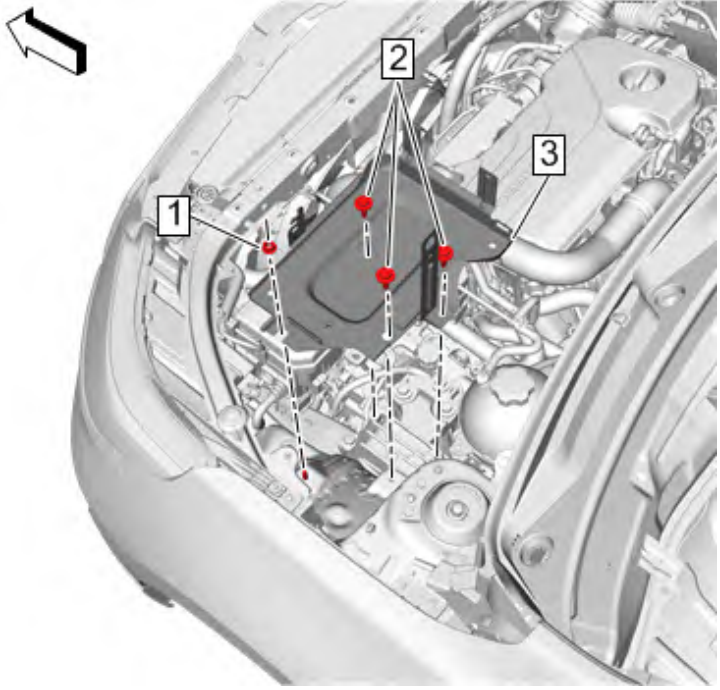


Fig. 180: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

6. Remove Battery Tray Mounting Nut (1).
7. Remove Battery Tray Mounting Bolt (2) - [3x]
8. Remove Battery Tray (3).

Installation Procedure

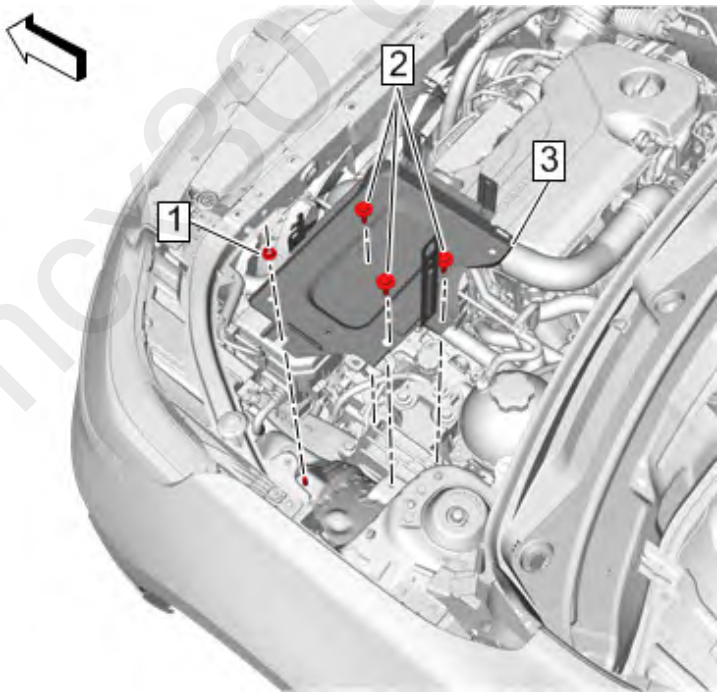


Fig. 181: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

1. Install Battery Tray (3).

CAUTION: **Refer to Fastener Caution**

2. Install Battery Tray Mounting Bolt (2) and tighten [3x] 22 N.m (16 lb ft)
3. Install Battery Tray Mounting Nut (1) and tighten 22 N.m (16 lb ft)

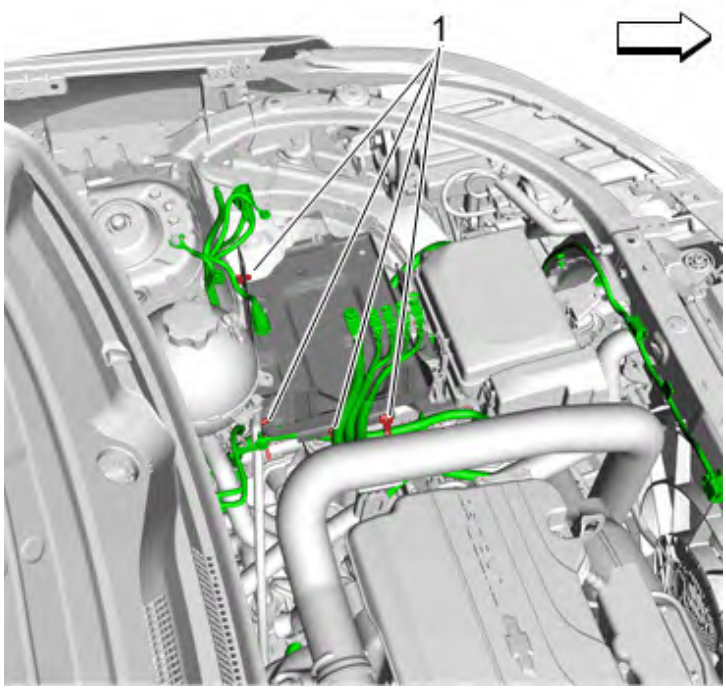


Fig. 182: Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Engage Retainer (1) - [4x]
5. Install the engine control module bracket. **Engine Control Module Bracket Replacement**

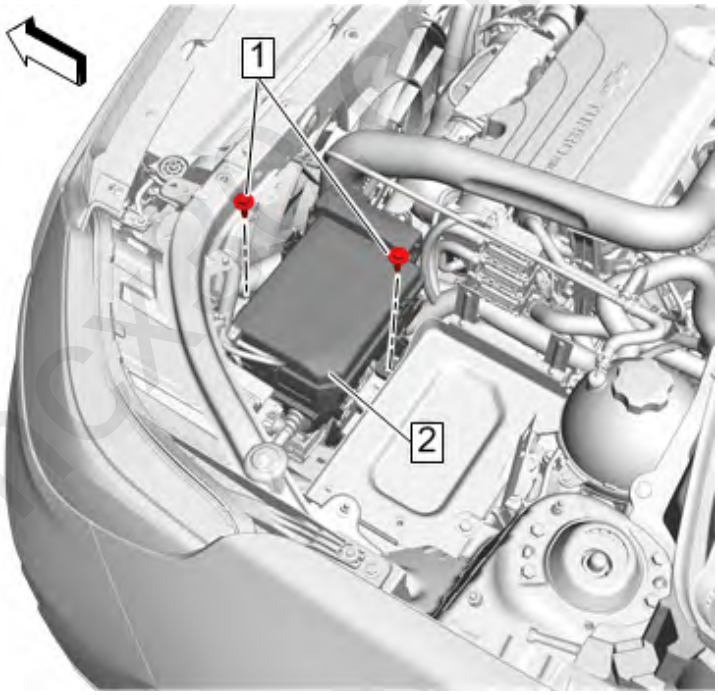


Fig. 183: Engine Wiring Harness Fuse Block Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Install Engine Wiring Harness Junction Block (2).
7. Install Engine Wiring Harness Fuse Block Bracket Bolt (1) and tighten [2x] 22 N.m (16 lb ft)

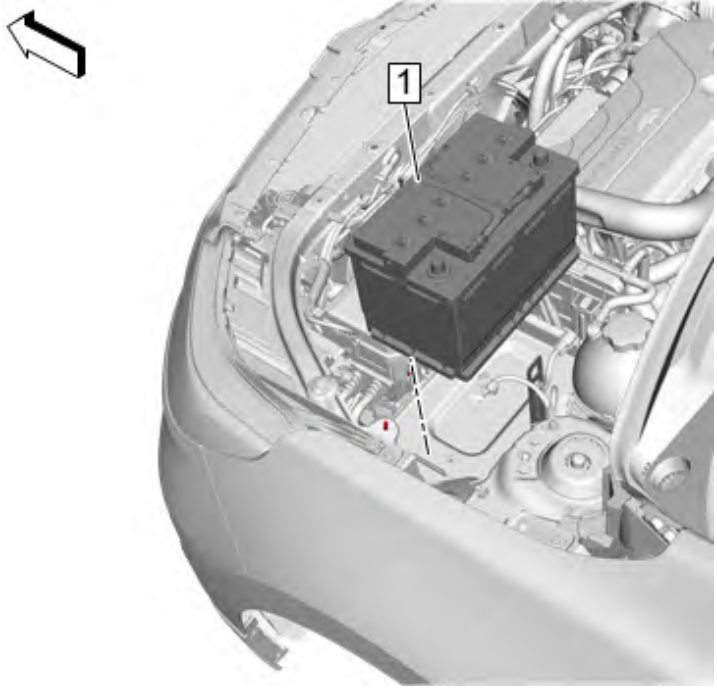


Fig. 184: Battery
Courtesy of GENERAL MOTORS COMPANY

8. Install Battery (1) - **Battery Replacement**

STARTER REPLACEMENT (LYX - ALL WHEEL DRIVE)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**
2. Raise and support the vehicle. **Lifting and Jacking the Vehicle**

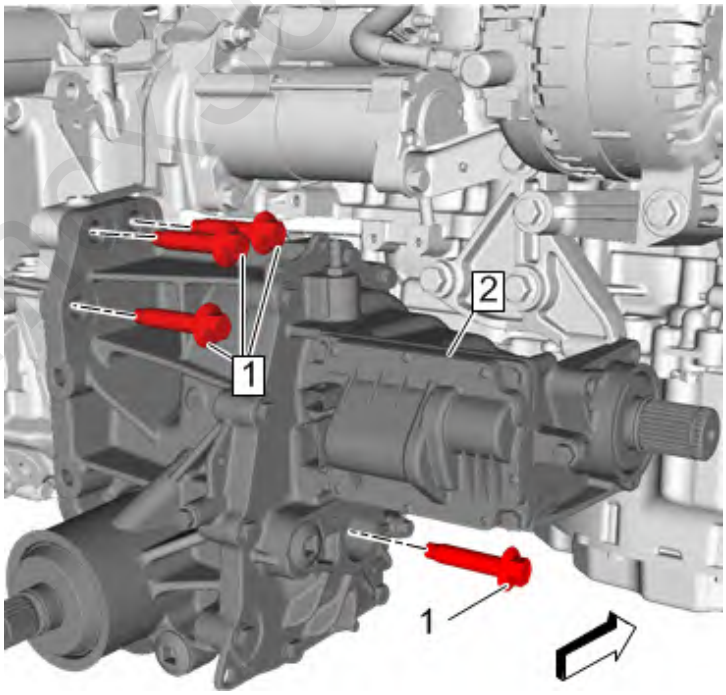


Fig. 185: Power Transfer Unit Case
Courtesy of GENERAL MOTORS COMPANY

3. Remove Power Transfer Unit Case (2) -**Power Transfer Unit Case Replacement (MNH Transmission with LYX Engine)**

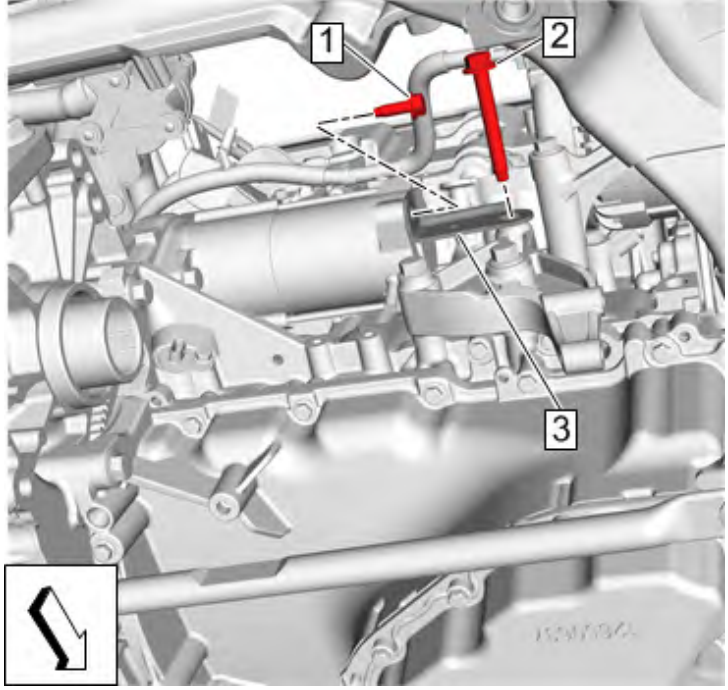


Fig. 186: Starter Bracket Fastener And Bracket
Courtesy of GENERAL MOTORS COMPANY

4. Remove Starter Bracket Fastener (1).
5. Remove Starter Bracket Fastener (2).
6. Remove Starter Bracket (3).

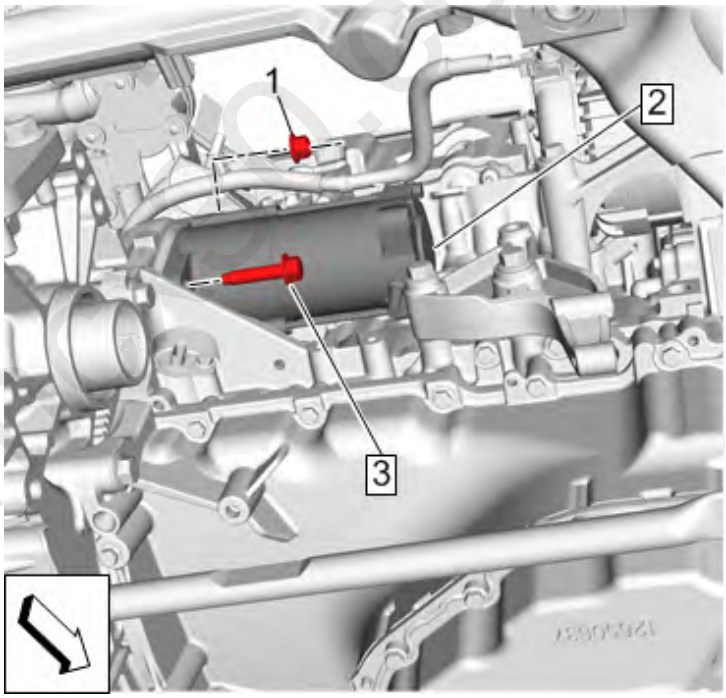


Fig. 187: Starter Mounting Nut And Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Remove Starter Mounting Nut (1).
8. Remove Starter Mounting Bolt (3).
9. Reposition and rotate the starter (2) to access the electrical connections.

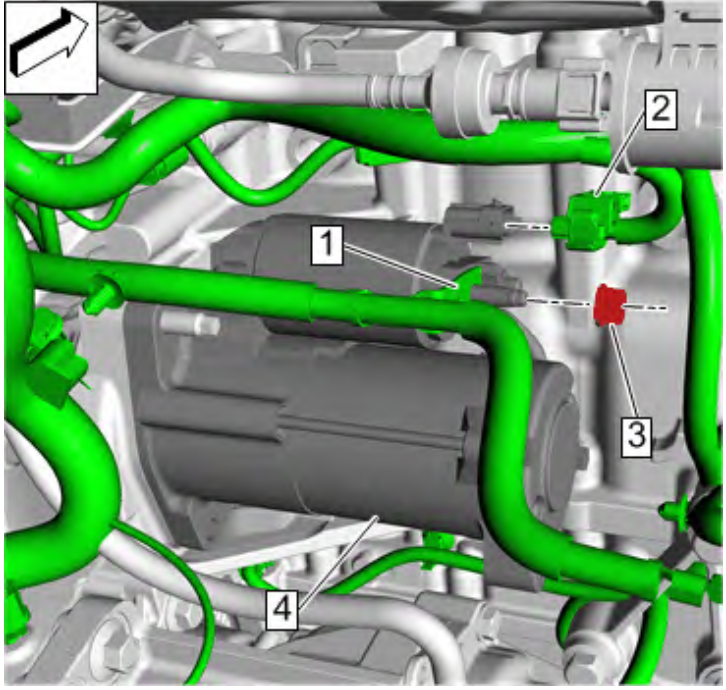


Fig. 188: Electrical Connector, Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

10. Disconnect Electrical Connector (2).
11. Remove Starter Solenoid Cable Nut (3).
12. Remove Starter Solenoid Cable (1).
13. Disconnect Starter (4).

Installation Procedure

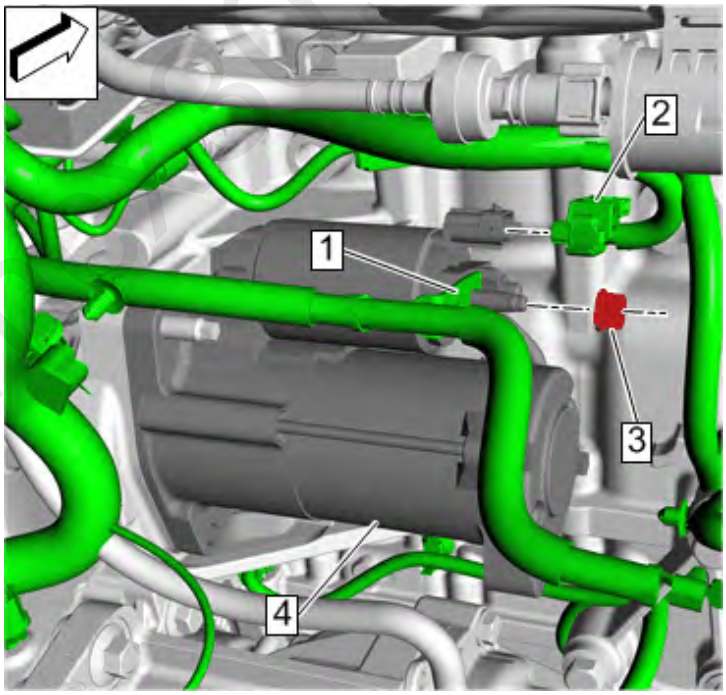


Fig. 189: Electrical Connector, Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

1. Connect Electrical Connector (2).
2. Install Starter Solenoid Cable (1).

CAUTION: **Refer to Fastener Caution .**

3. Install Starter Solenoid Cable Nut (3) and tighten 12 N.m (106 lb in)
4. Install Starter (4).

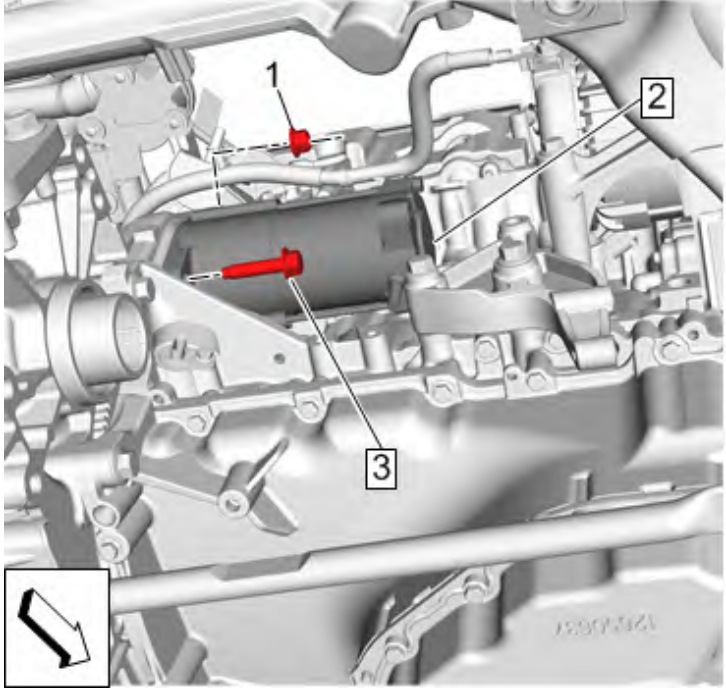


Fig. 190: Starter Mounting Nut And Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Install Starter Mounting Nut (1) and tighten 58 N.m (43 lb ft)
6. Install Starter Mounting Bolt (3) and tighten 58 N.m (43 lb ft)

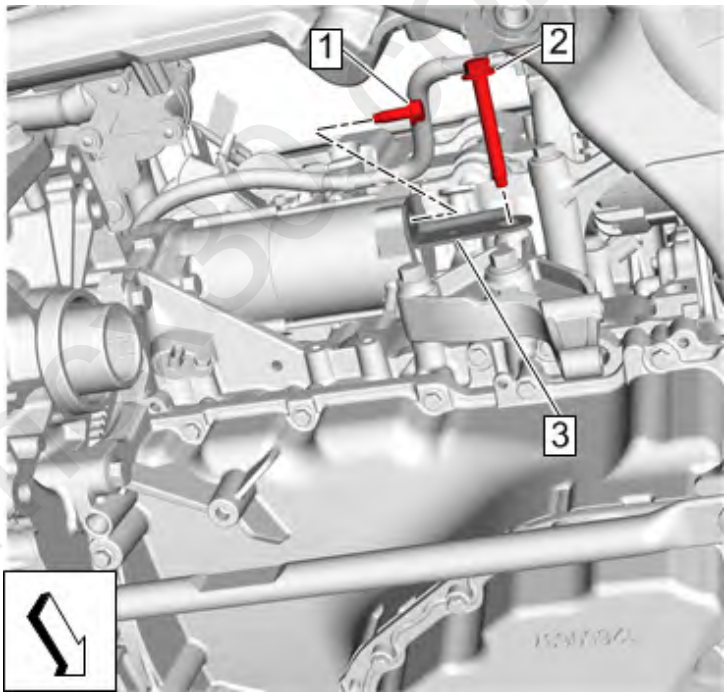


Fig. 191: Starter Bracket Fastener And Bracket
Courtesy of GENERAL MOTORS COMPANY

7. Install Starter Bracket (3).
8. Install Starter Bracket Fastener (2) and tighten 58 N.m (43 lb ft)
9. Install Starter Bracket Fastener (1) and tighten 22 N.m (16 lb ft)

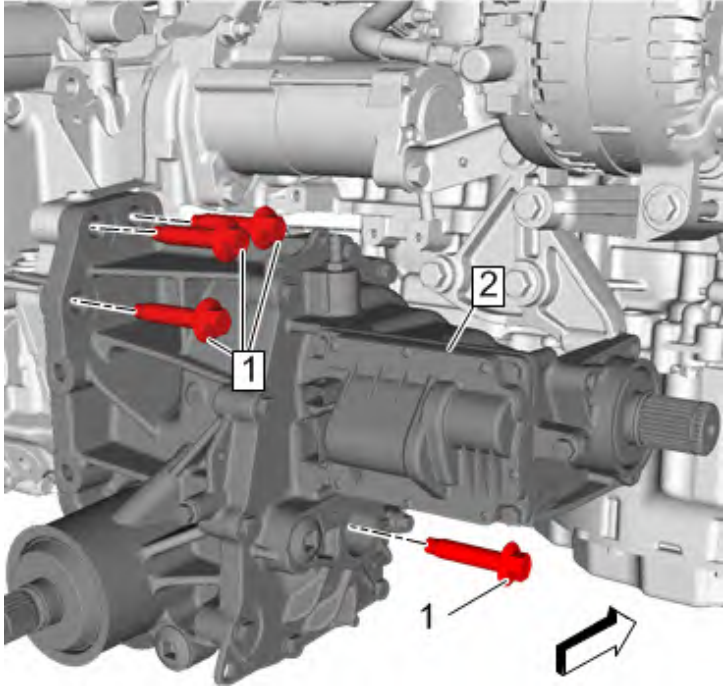


Fig. 192: Power Transfer Unit Case
Courtesy of GENERAL MOTORS COMPANY

10. Install Power Transfer Unit Case (2) **Power Transfer Unit Case Replacement (MNH Transmission with LYX Engine)**
11. Lower the vehicle.
12. Connect the negative battery cable. **Battery Negative Cable Disconnection and Connection (KL9)**

STARTER REPLACEMENT (LYX - FRONT WHEEL DRIVE)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**
2. Raise and support the vehicle. **Lifting and Jacking the Vehicle**

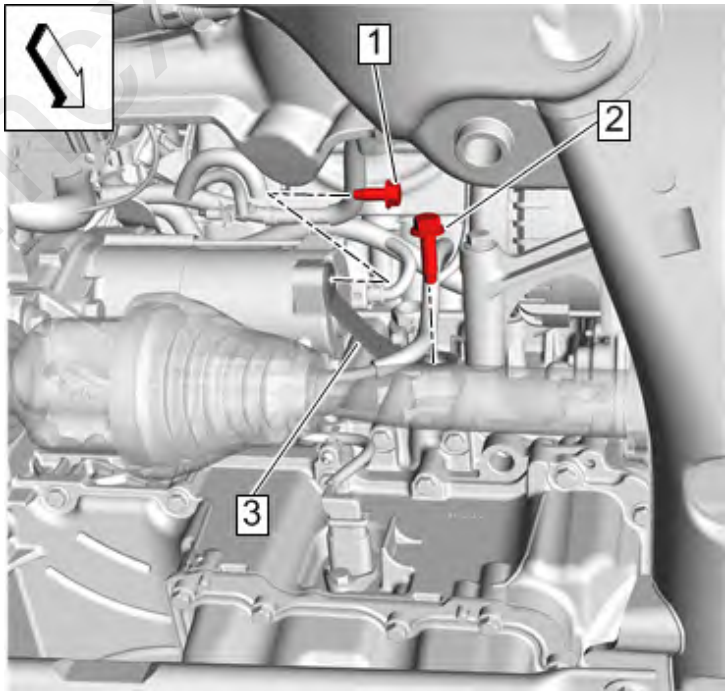


Fig. 193: Starter Bracket And Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Remove the harness retainer from the starter bracket.
4. Remove Starter Bracket Fastener (1).
5. Remove Starter Bracket Fastener (2).
6. Remove Starter Bracket (3).

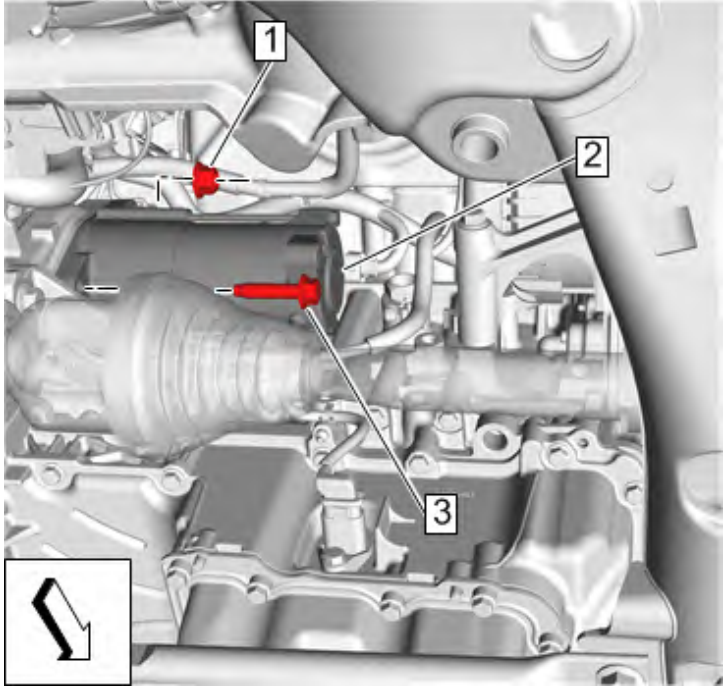


Fig. 194: Starter Mounting Nut And Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Remove Starter Mounting Nut (1).
8. Remove Starter Mounting Bolt (3).
9. Reposition and rotate the starter (2) to access the electrical connections.

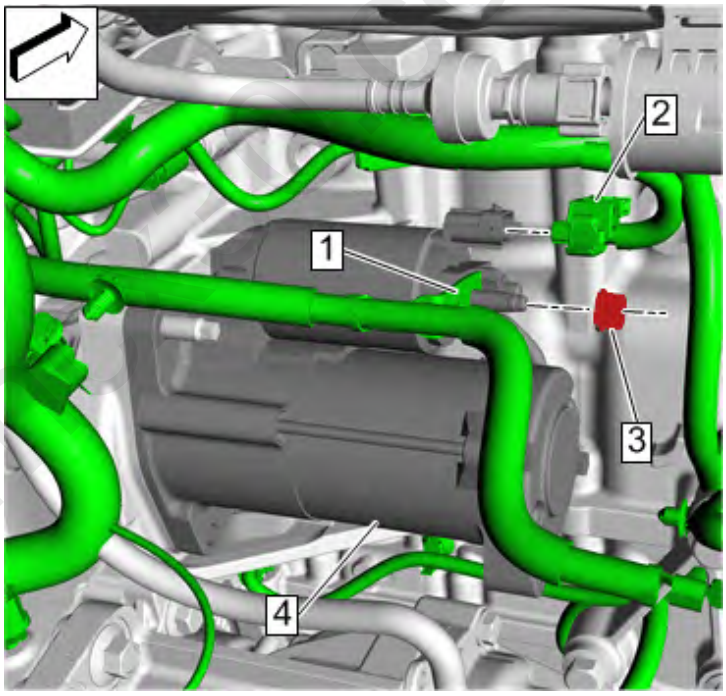


Fig. 195: Electrical Connector, Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

10. Disconnect Electrical Connector (2).
11. Remove Starter Solenoid Cable Nut (3).
12. Remove Starter Solenoid Cable (1).
13. Remove Starter (4).

Installation Procedure

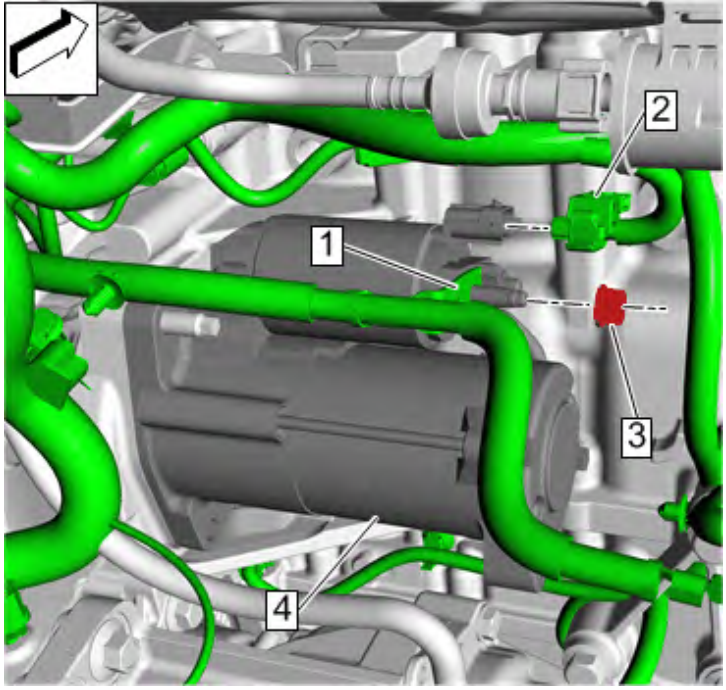


Fig. 196: Electrical Connector, Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

1. Connect Electrical Connector (2).
2. Install Starter Solenoid Cable (1).

CAUTION: **Refer to Fastener Caution .**

3. Install Starter Solenoid Cable Nut (3) and tighten 12 N.m (106 lb in)
4. Install Starter (4).

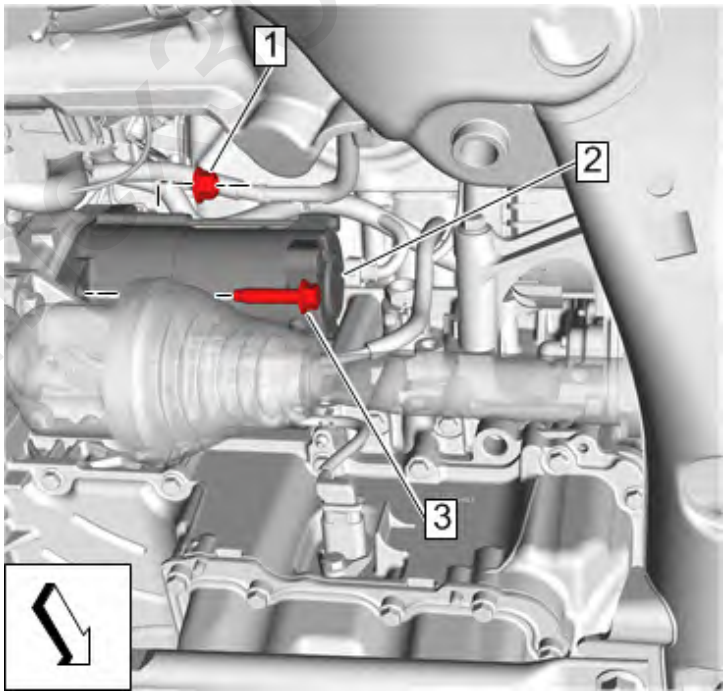


Fig. 197: Starter Mounting Nut And Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Install Starter Mounting Nut (1) and tighten 58 N.m (43 lb ft)
6. Install Starter Mounting Bolt (3) and tighten 58 N.m (43 lb ft)

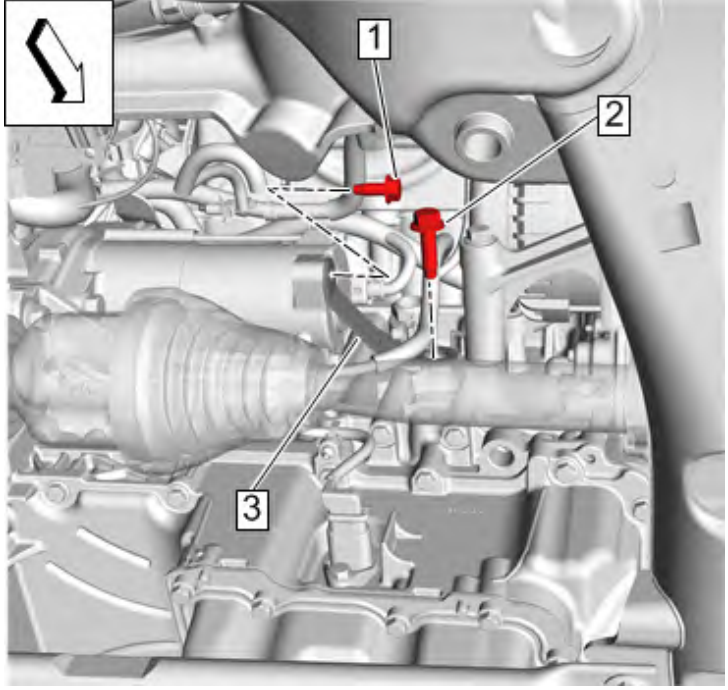


Fig. 198: Starter Bracket And Fastener
Courtesy of GENERAL MOTORS COMPANY

7. Install Starter Bracket (3).
8. Install Starter Bracket Fastener (2) and tighten 58 N.m (43 lb ft)
9. Install Starter Bracket Fastener (1) and tighten 22 N.m (16 lb ft)
10. Install the harness retainer to the starter bracket.
11. Lower the vehicle.
12. Connect the negative battery cable. **Battery Negative Cable Disconnection and Connection (KL9)**

STARTER REPLACEMENT (LTG - ALL WHEEL DRIVE)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

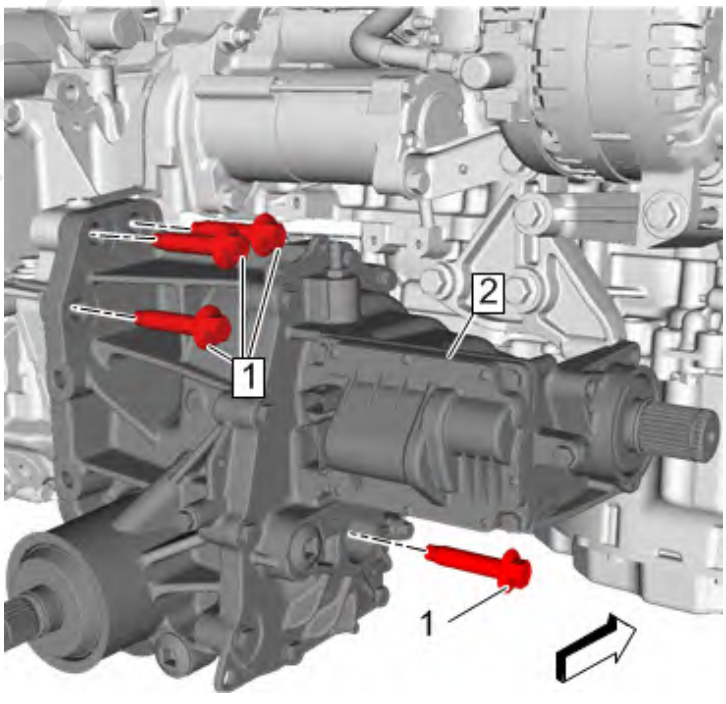


Fig. 199: Power Transfer Unit Case
Courtesy of GENERAL MOTORS COMPANY

2. Remove Power Transfer Unit Case (2) - **Power Transfer Unit Case Replacement (M3D Transmission with LTG Engine)**

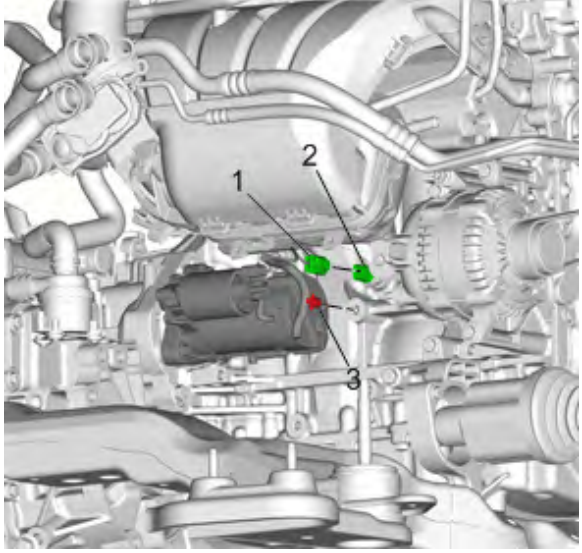


Fig. 200: Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect Electrical Connector (1) @ Oil Pressure Switch (2).
4. Disconnect the engine harness retainer (3) and reposition the harness.

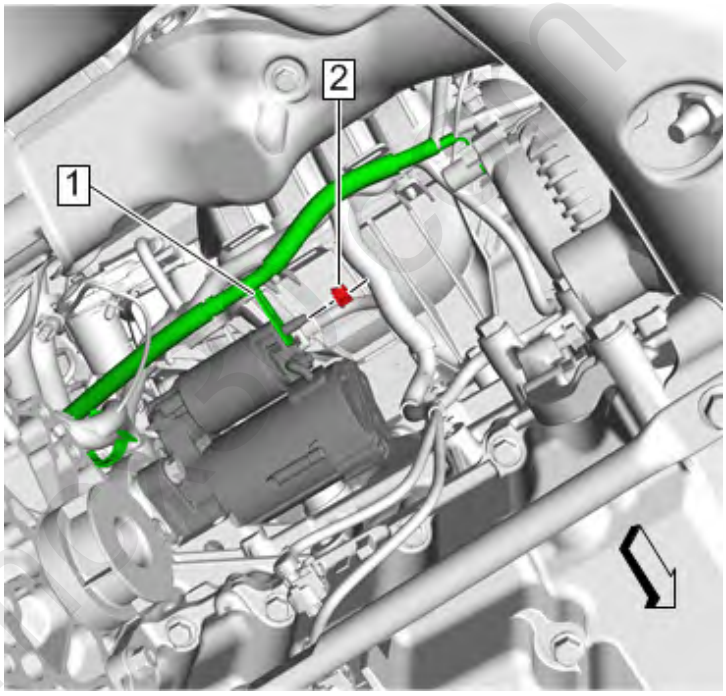


Fig. 201: Starter Solenoid Cable Nut And Cable
Courtesy of GENERAL MOTORS COMPANY

5. Remove Starter Solenoid Cable Nut (2)
6. Remove Starter Solenoid Cable (1)

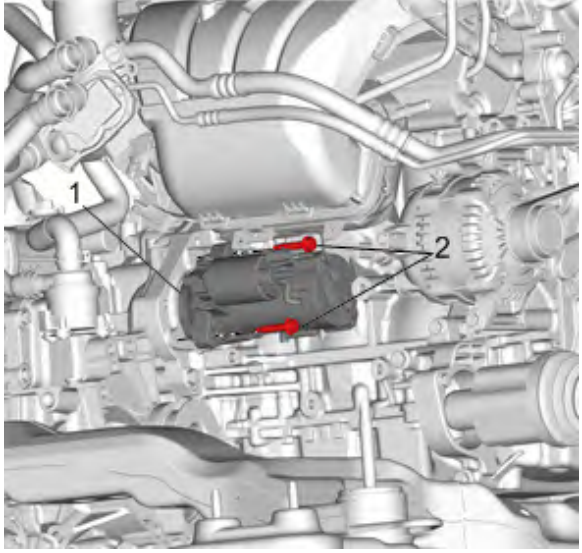


Fig. 202: Starter
Courtesy of GENERAL MOTORS COMPANY

7. Remove Starter Mounting Bolt (2) - [2x]
8. Reposition the starter (1) to access the electrical connector.

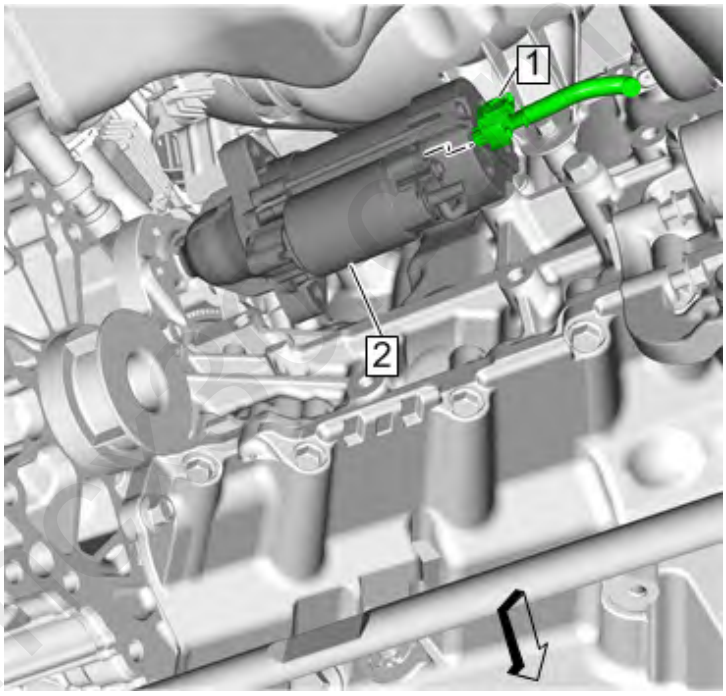


Fig. 203: Electrical Connector And Starter
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect Electrical Connector (1).
10. Remove Starter (2).

Installation Procedure

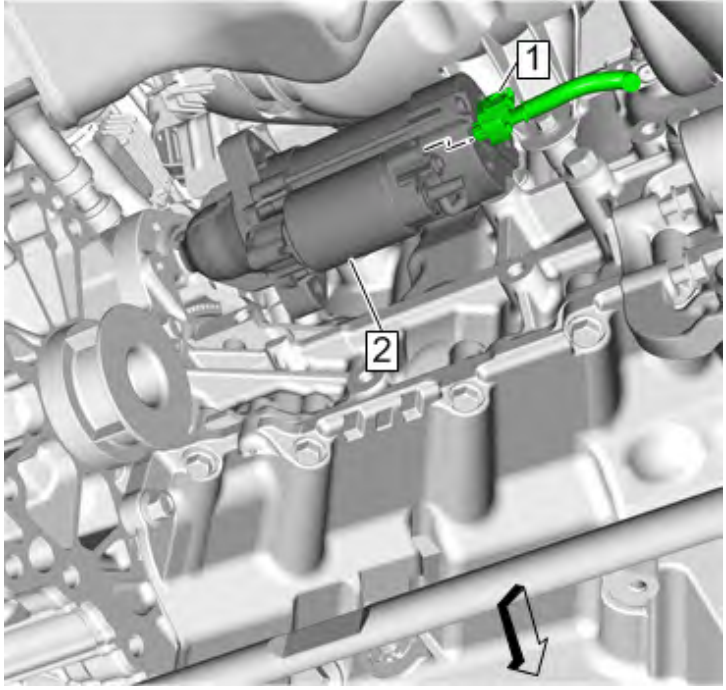


Fig. 204: Electrical Connector And Starter
Courtesy of GENERAL MOTORS COMPANY

1. Connect Electrical Connector (1).
2. Install Starter (2).

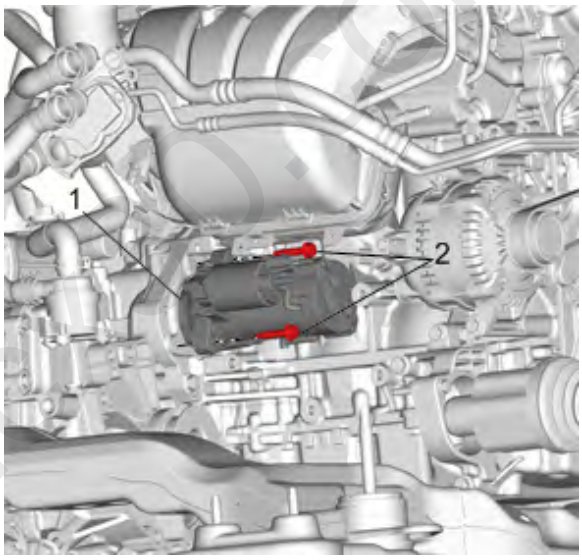


Fig. 205: Starter
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

3. Install Starter Mounting Bolt (2) and tighten [2x] 22 N.m (16 lb ft)

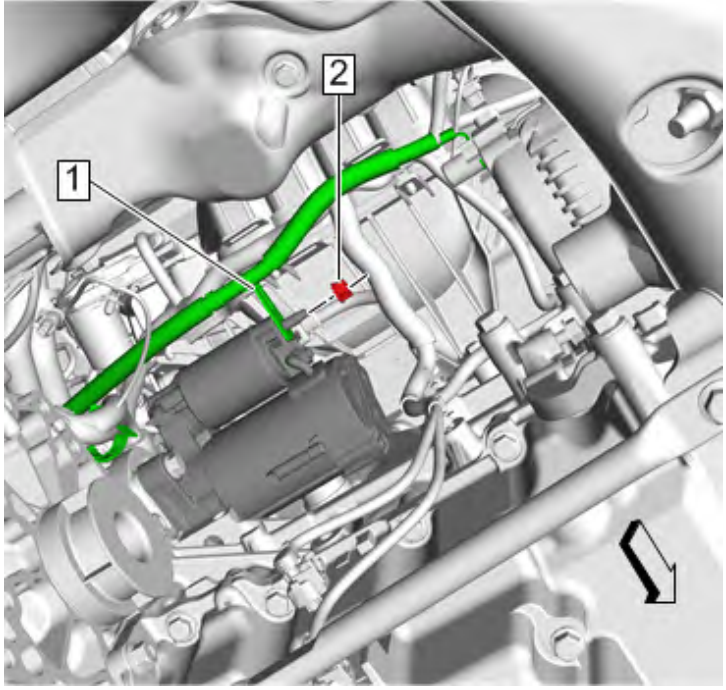


Fig. 206: Starter Solenoid Cable Nut And Cable
Courtesy of GENERAL MOTORS COMPANY

4. Install Starter Solenoid Cable (1).
5. Install Starter Solenoid Cable Nut (2) and tighten 12 N.m (106 lb in)

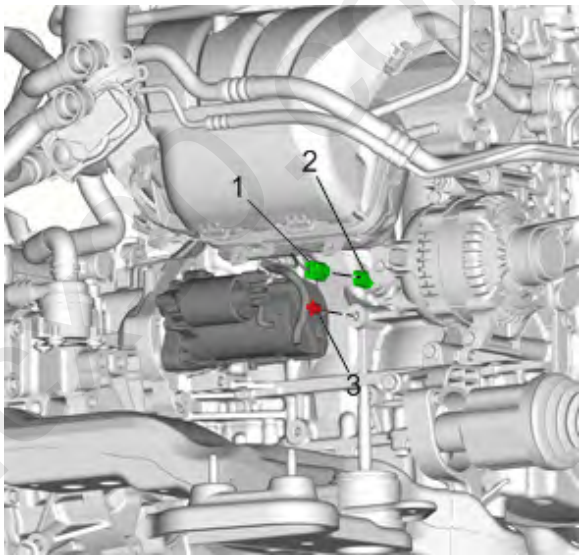


Fig. 207: Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

6. Connect Electrical Connector (1) @ Oil Pressure Switch (2).
7. Engage Retainer (3).

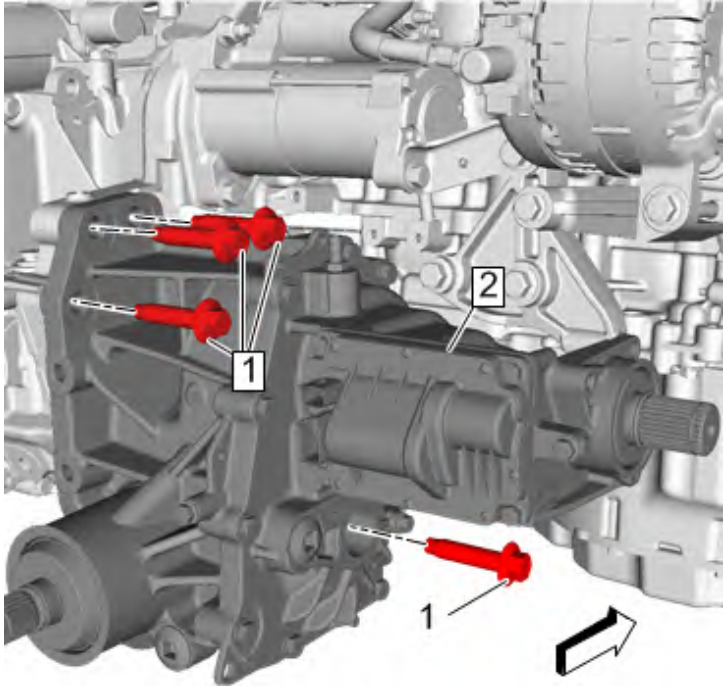


Fig. 208: Power Transfer Unit Case
Courtesy of GENERAL MOTORS COMPANY

8. Install Power Transfer Unit Case (2) - **Power Transfer Unit Case Replacement (M3D Transmission with LTG Engine)**
9. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

STARTER REPLACEMENT (LTG - FRONT WHEEL DRIVE)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**
2. Raise and support the vehicle. **Lifting and Jacking the Vehicle**

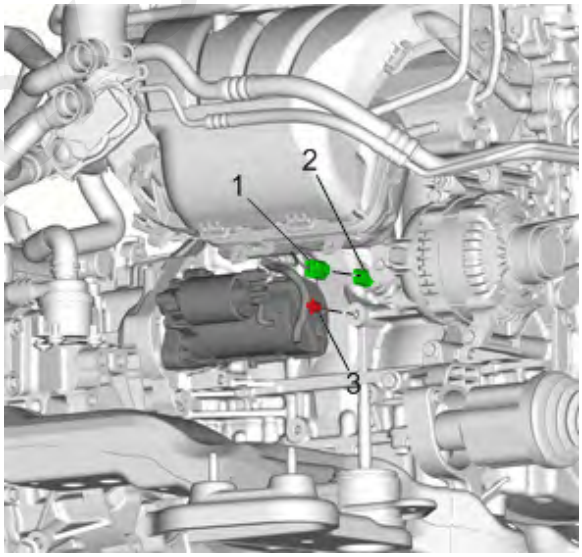


Fig. 209: Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect Electrical Connector (1) @ Oil Pressure Switch (2).
4. Disconnect the engine harness retainer (3) and reposition the harness.

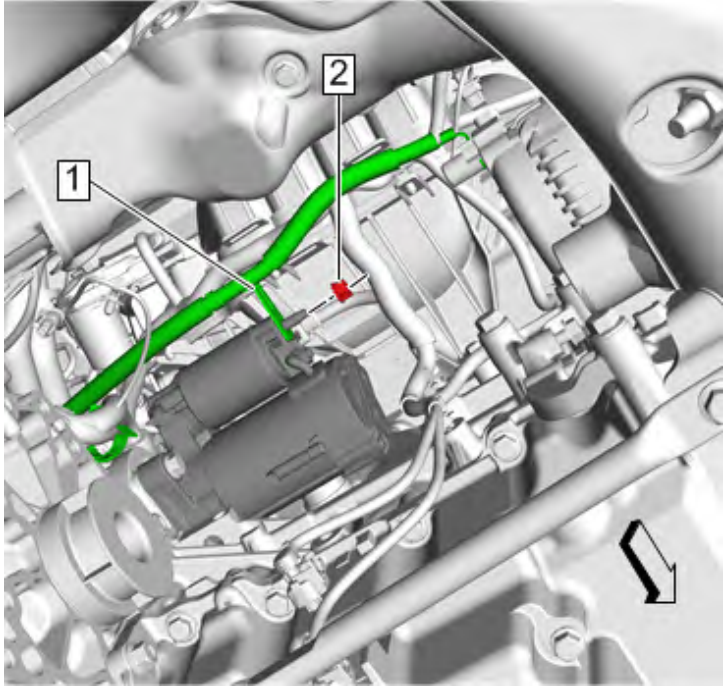


Fig. 210: Starter Solenoid Cable Nut And Cable
Courtesy of GENERAL MOTORS COMPANY

5. Remove Starter Solenoid Cable Nut (2).
6. Remove Starter Solenoid Cable (1).

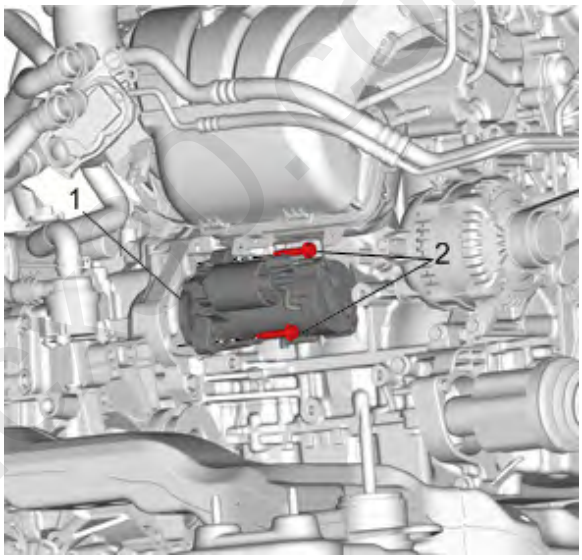


Fig. 211: Starter
Courtesy of GENERAL MOTORS COMPANY

7. Remove Starter Mounting Bolt (2) - [2x]
8. Reposition the starter (1) to access the electrical connector.

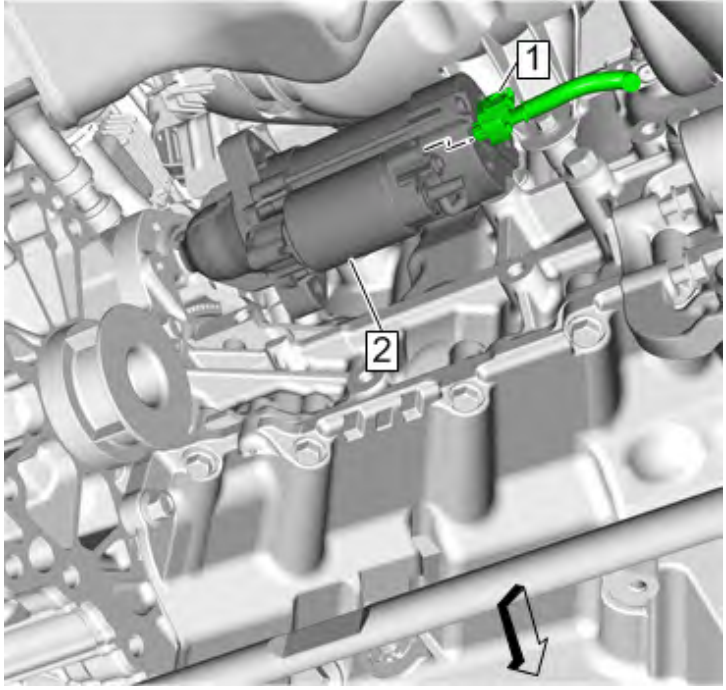


Fig. 212: Electrical Connector And Starter
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect Electrical Connector (1).
10. Remove Starter (2).

Installation Procedure

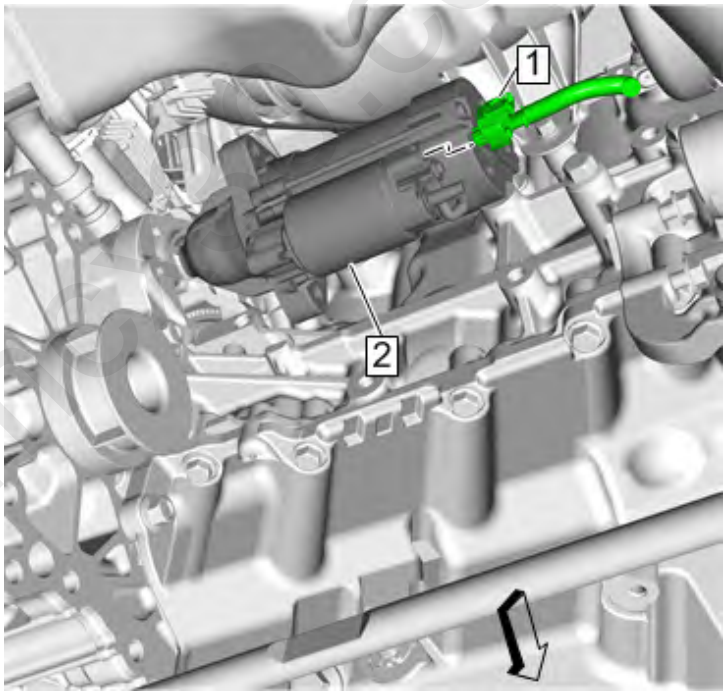


Fig. 213: Electrical Connector And Starter
Courtesy of GENERAL MOTORS COMPANY

1. Connect Electrical Connector (1)
2. Install Starter (2)

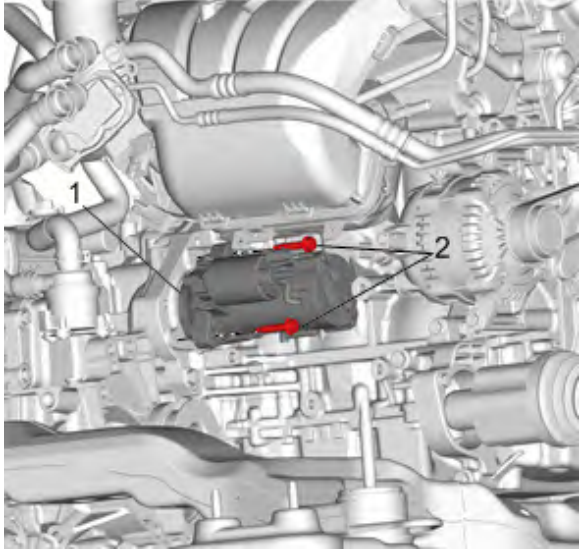


Fig. 214: Starter
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

3. Install Starter Mounting Bolt (2) and tighten [2x] 22 N.m (16 lb ft)

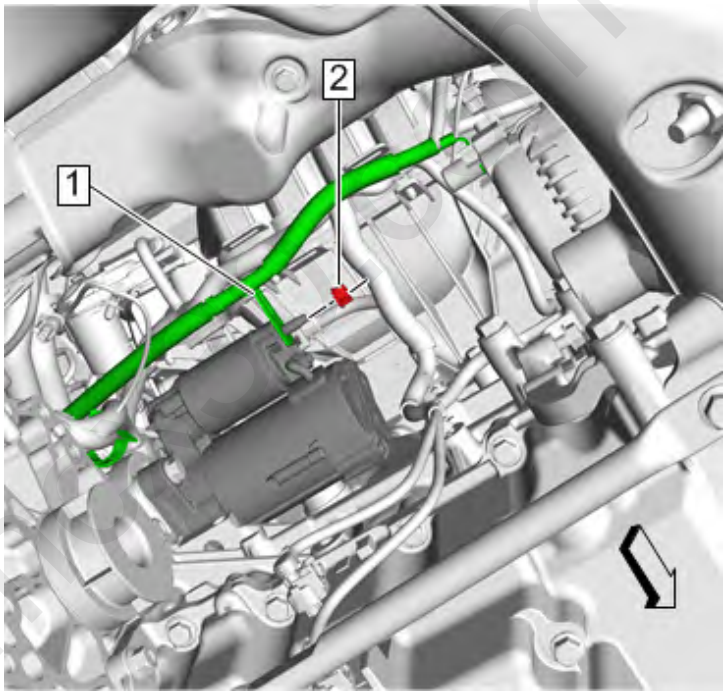


Fig. 215: Starter Solenoid Cable Nut And Cable
Courtesy of GENERAL MOTORS COMPANY

4. Install Starter Solenoid Cable (1).
5. Install Starter Solenoid Cable Nut (2) and tighten 12 N.m (106 lb in)

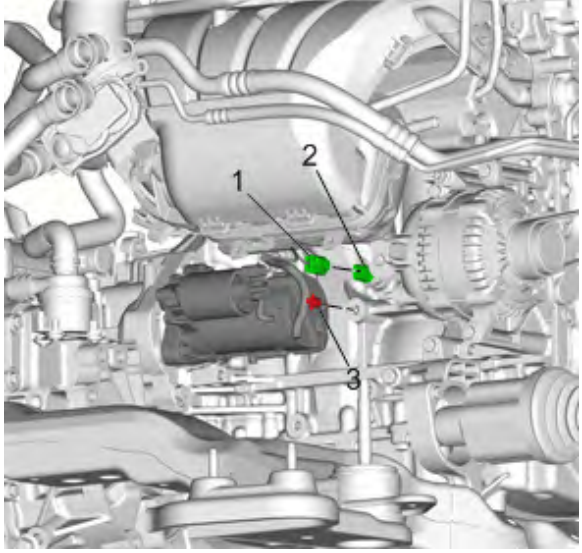


Fig. 216: Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

6. Connect Electrical Connector (1) @ Oil Pressure Switch (2).
7. Engage Retainer (3).
8. Lower the vehicle.
9. Connect the negative battery cable. **Battery Negative Cable Disconnection and Connection (KL9)**

STARTER REPLACEMENT (LH7 - ALL WHEEL DRIVE)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**
2. Raise and support the vehicle. **Lifting and Jacking the Vehicle**
3. Remove the power transfer unit case. **Power Transfer Unit Case Replacement (MHG Transmission with LH7 Engine)**

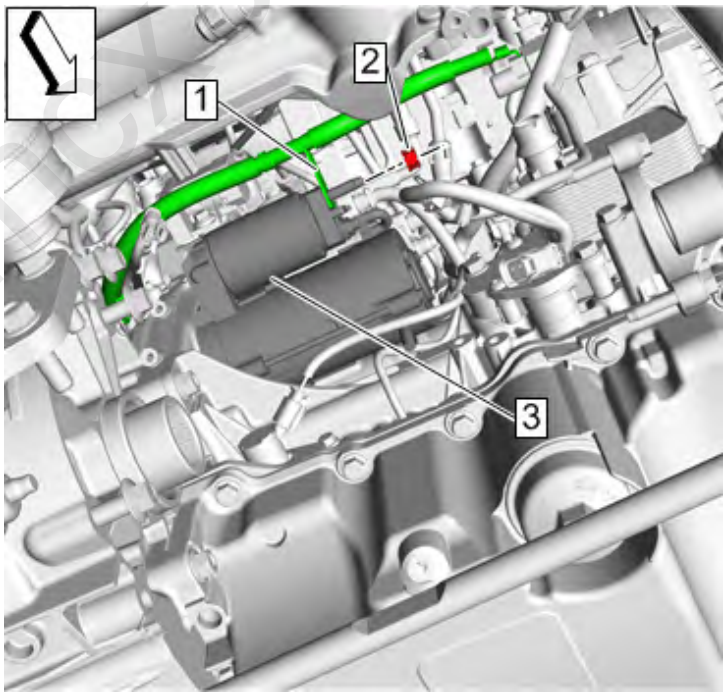


Fig. 217: Starter Solenoid Cable Nut And Cable
Courtesy of GENERAL MOTORS COMPANY

4. Remove Starter Solenoid Cable Nut (2) @ Starter Solenoid (3).
5. Remove Starter Solenoid Cable (1).

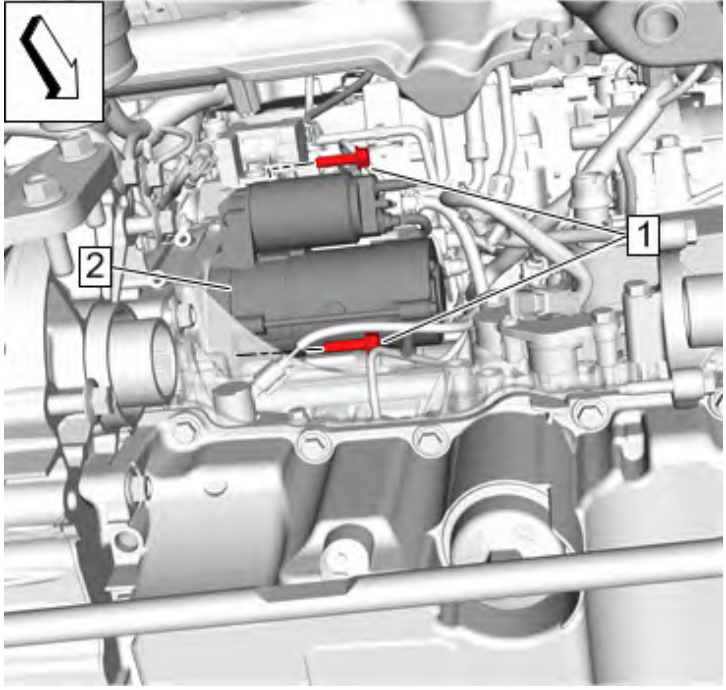


Fig. 218: Starter Mounting Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove Starter Mounting Bolt (1) - [2x]
7. Reposition and rotate the starter (2) to access the electrical connector.

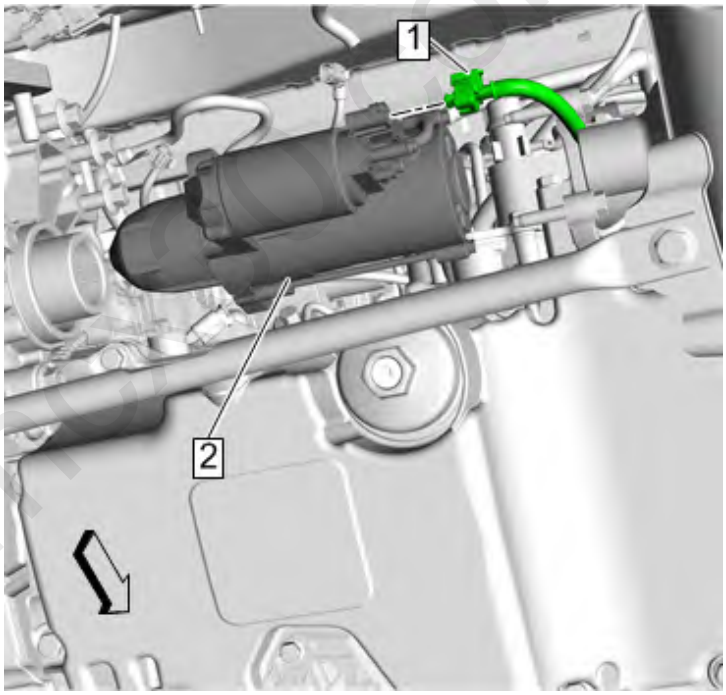


Fig. 219: Electrical Connector And Starter
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect Electrical Connector (1).
9. Remove Starter (2).

Installation Procedure

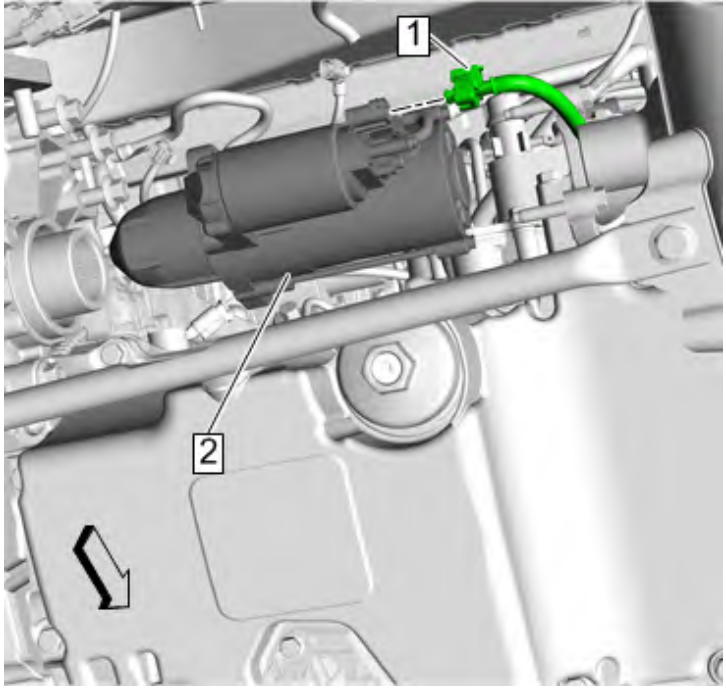


Fig. 220: Electrical Connector And Starter
Courtesy of GENERAL MOTORS COMPANY

1. Connect Electrical Connector (1).
2. Install Starter (2).

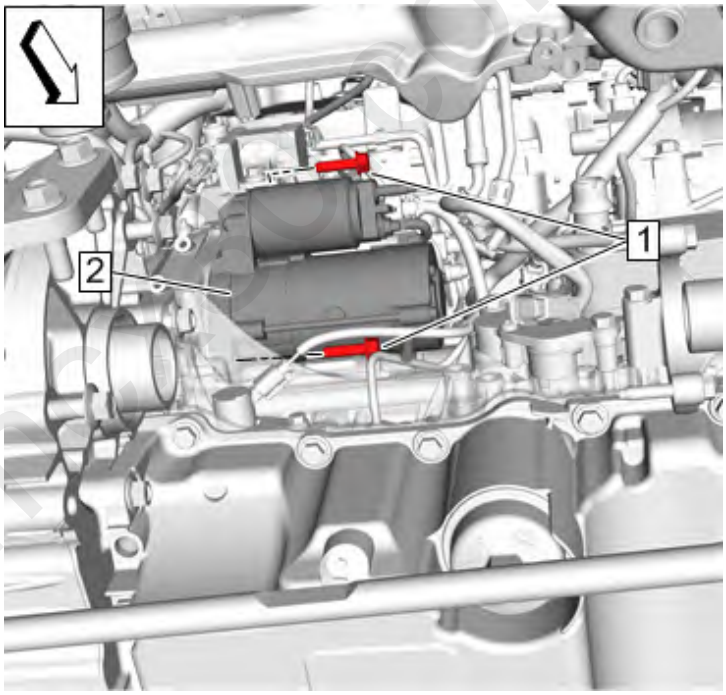


Fig. 221: Starter Mounting Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

3. Install Starter Mounting Bolt (1) and tighten [2x] 22 N.m (16 lb ft)

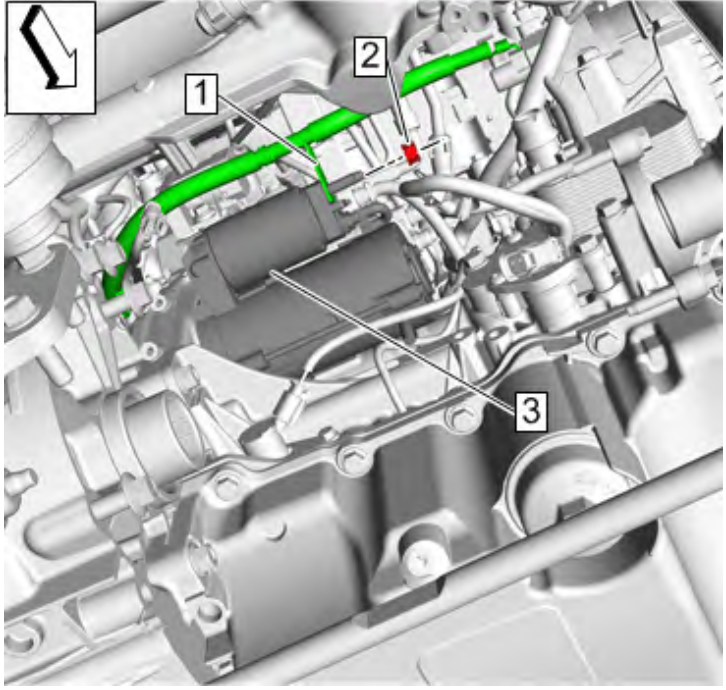


Fig. 222: Starter Solenoid Cable Nut And Cable
Courtesy of GENERAL MOTORS COMPANY

4. Install Starter Solenoid Cable (1) @ Starter Solenoid (3).
5. Install Starter Solenoid Cable Nut (2) and tighten 12 N.m (106 lb in)
6. Install the power transfer unit case. **Power Transfer Unit Case Replacement (MHG Transmission with LH7 Engine)**
7. Lower the vehicle.
8. Connect the negative battery cable. **Battery Negative Cable Disconnection and Connection (KL9)**

STARTER REPLACEMENT (LH7 - FRONT WHEEL DRIVE)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**
2. Raise and support the vehicle. **Lifting and Jacking the Vehicle**
3. Remove the exhaust front pipe. **Exhaust Front Pipe Replacement (LH7)**

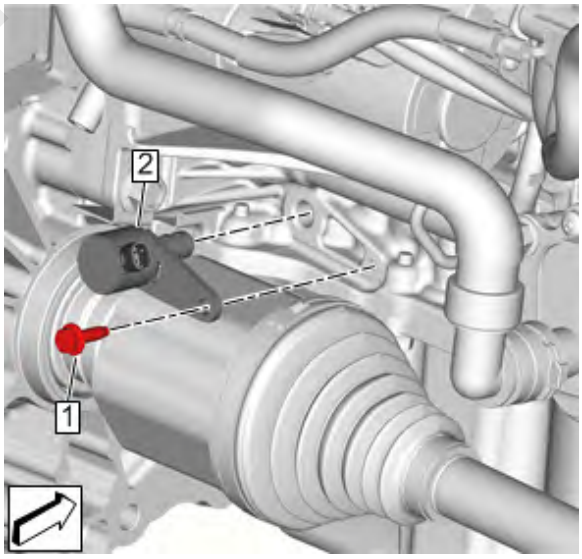


Fig. 223: Oil Pump Flow Control Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

4. Remove Oil Pump Flow Control Solenoid Valve (2) - **Oil Pump Flow Control Solenoid Valve Replacement (FWD)**

mx30.com

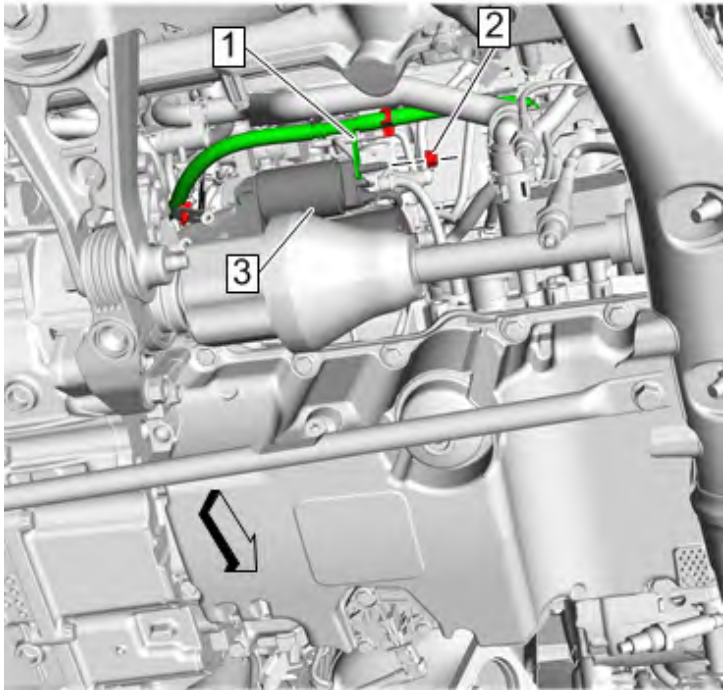


Fig. 224: Starter Solenoid Cable Nut And Starter Solenoid
Courtesy of GENERAL MOTORS COMPANY

5. Remove Starter Solenoid Cable Nut (2) @ Starter Solenoid (3).
6. Remove Starter Solenoid Cable (1).

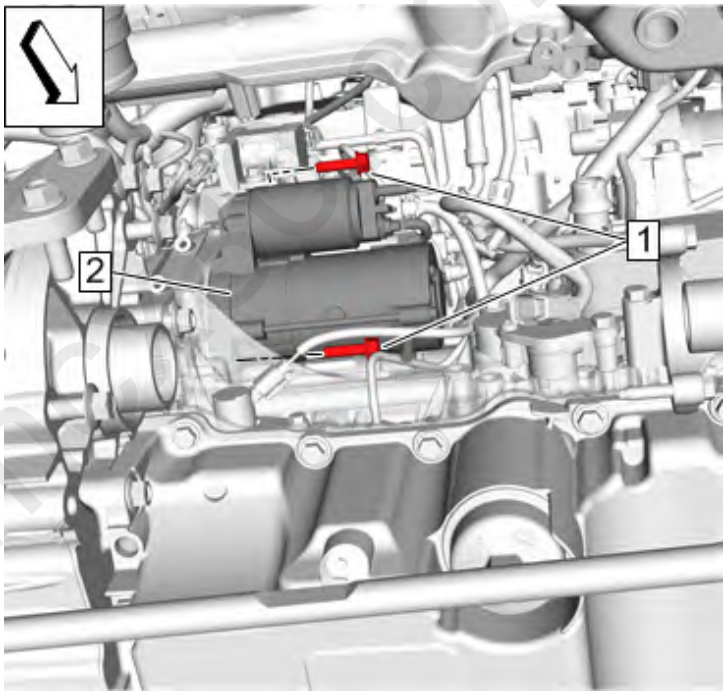


Fig. 225: Starter Mounting Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Remove Starter Mounting Bolt (1) - [2x]
8. Reposition and rotate the starter (2) to access the electrical connector.

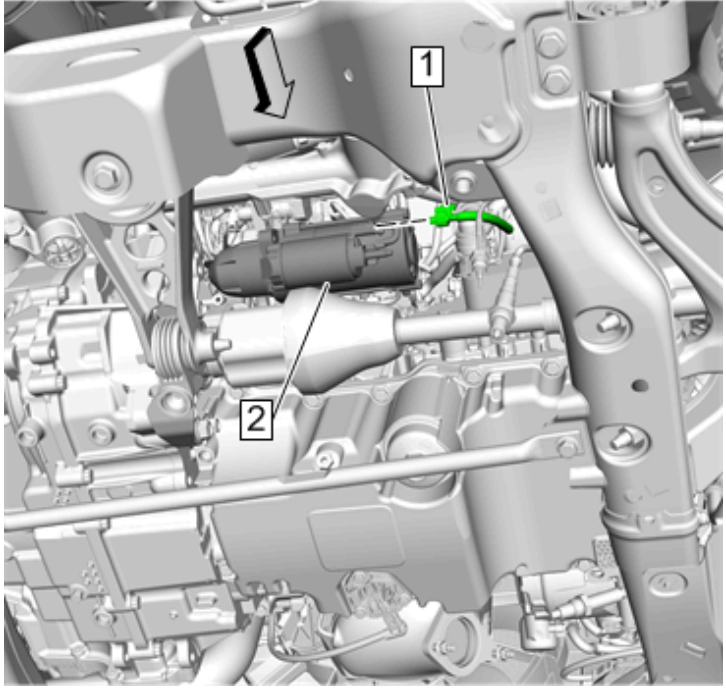


Fig. 226: Electrical Connector And Starter
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect Electrical Connector (1).
10. Remove Starter (2).

Installation Procedure

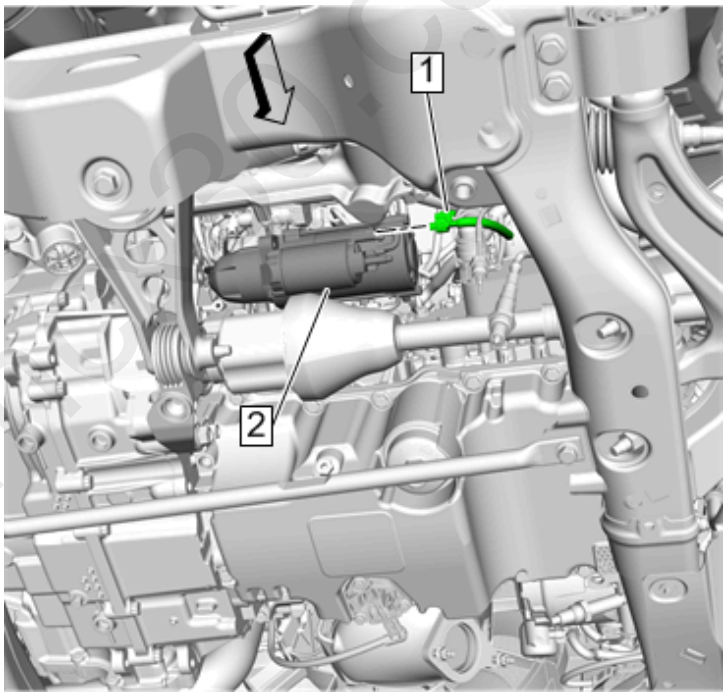


Fig. 227: Electrical Connector And Starter
Courtesy of GENERAL MOTORS COMPANY

1. Connect Electrical Connector (1).
2. Install Starter (2).

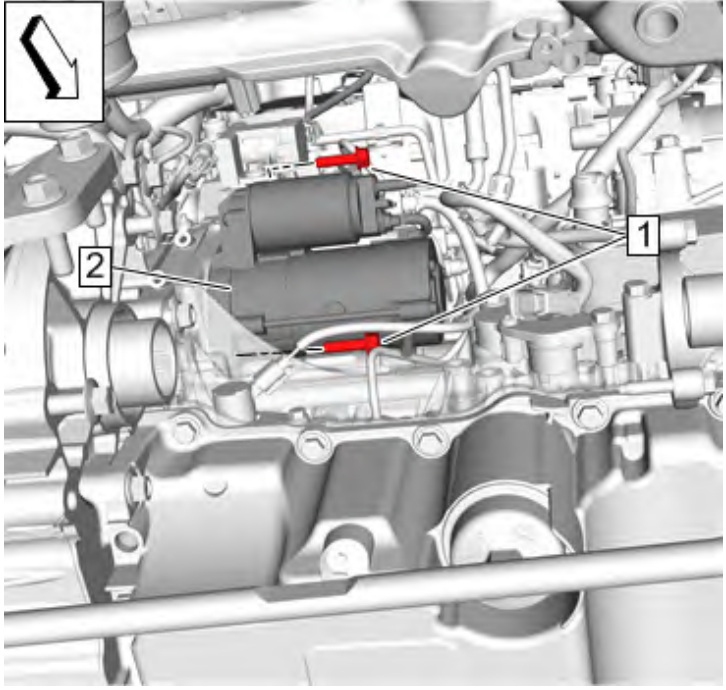


Fig. 228: Starter Mounting Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

3. Install Starter Mounting Bolt (1) and tighten [2x] 22 N.m (16 lb ft)

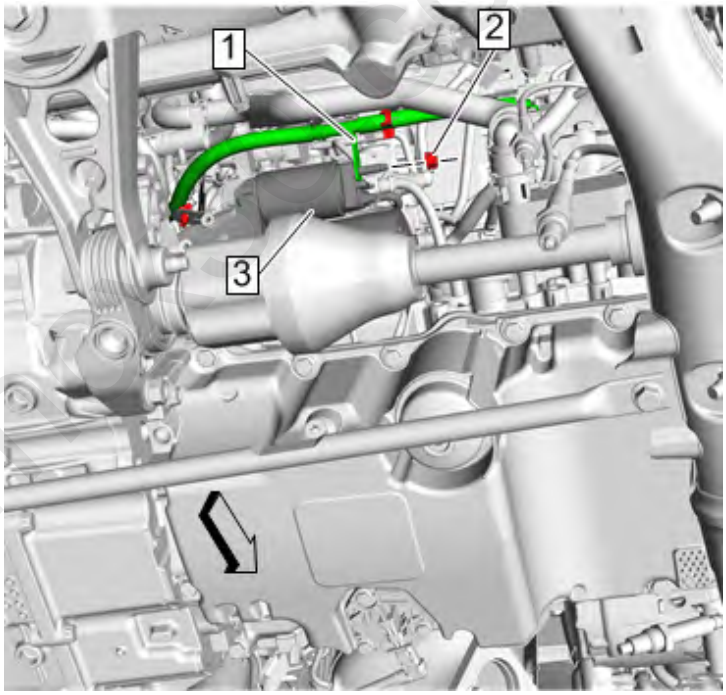


Fig. 229: Starter Solenoid Cable Nut And Starter Solenoid
Courtesy of GENERAL MOTORS COMPANY

4. Install Starter Solenoid Cable (1) @ Starter Solenoid (3).
5. Install Starter Solenoid Cable Nut (2) and tighten 12 N.m (106 lb in)

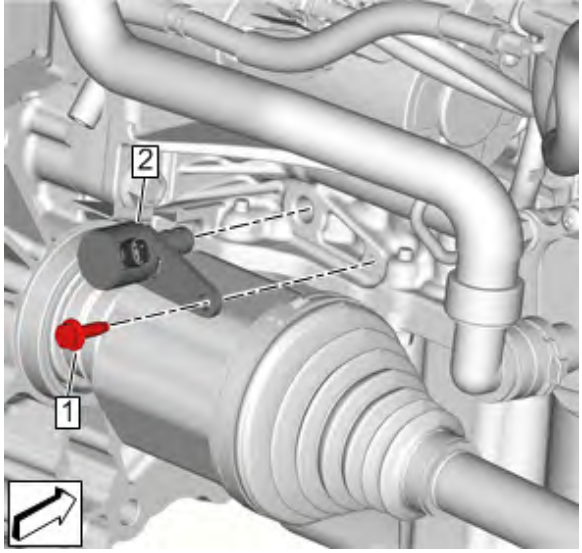


Fig. 230: Oil Pump Flow Control Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

6. Install Oil Pump Flow Control Solenoid Valve (2) - **Oil Pump Flow Control Solenoid Valve Replacement (FWD)**
7. Install the exhaust front pipe. **Exhaust Front Pipe Replacement (LH7)**
8. Lower the vehicle.
9. Connect the negative battery cable. **Battery Negative Cable Disconnection and Connection (KL9)**

GENERATOR REPLACEMENT (LYX)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove the drive belt. **Drive Belt Replacement**
3. Remove the air cleaner assembly. **Air Cleaner Assembly Replacement**

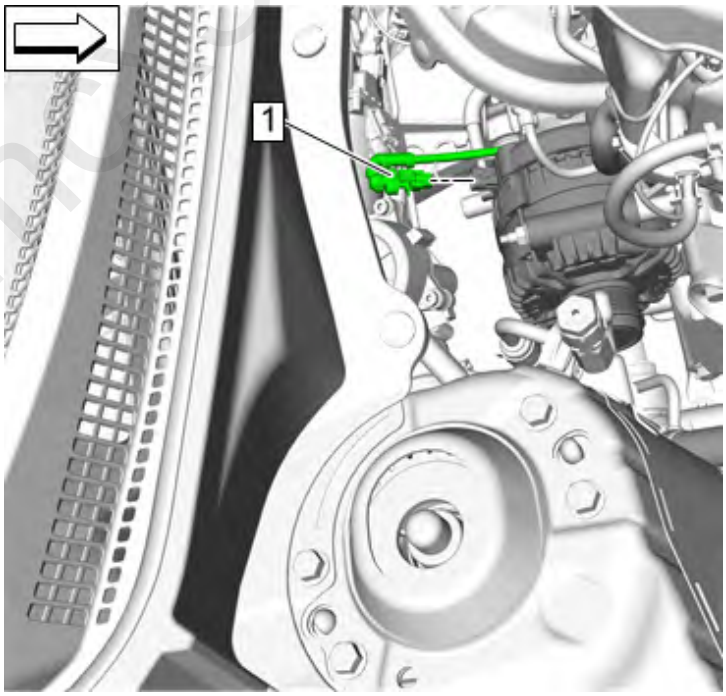


Fig. 231: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect Electrical Connector (1).

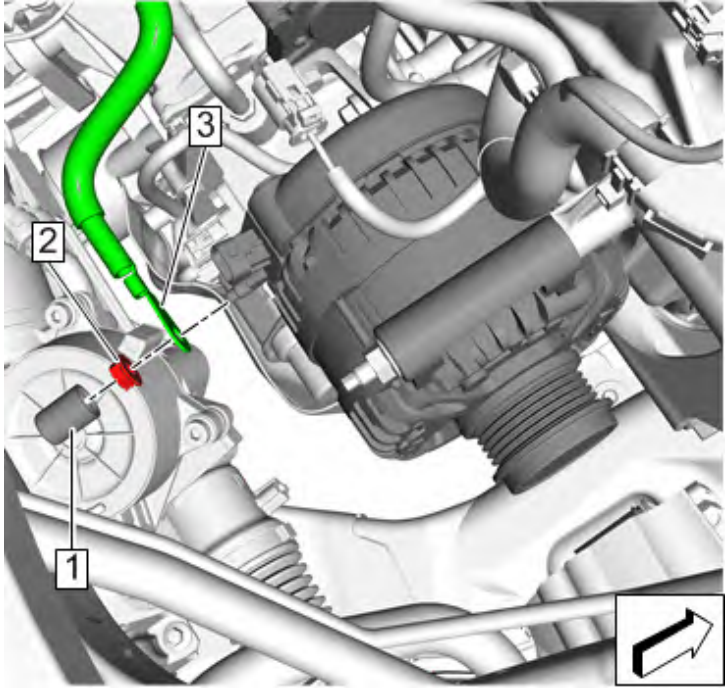


Fig. 232: Protective Cap, Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

5. Remove Protective Cap (1).
6. Remove Starter Solenoid Cable Nut (2).
7. Remove Starter Solenoid Cable (3).

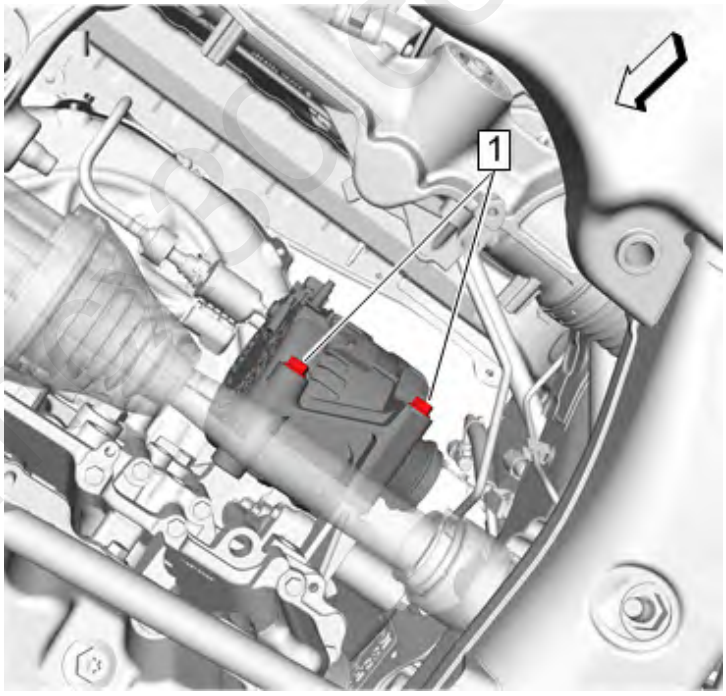


Fig. 233: Generator Mounting Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove Generator Mounting Bolt (1) - [2x]

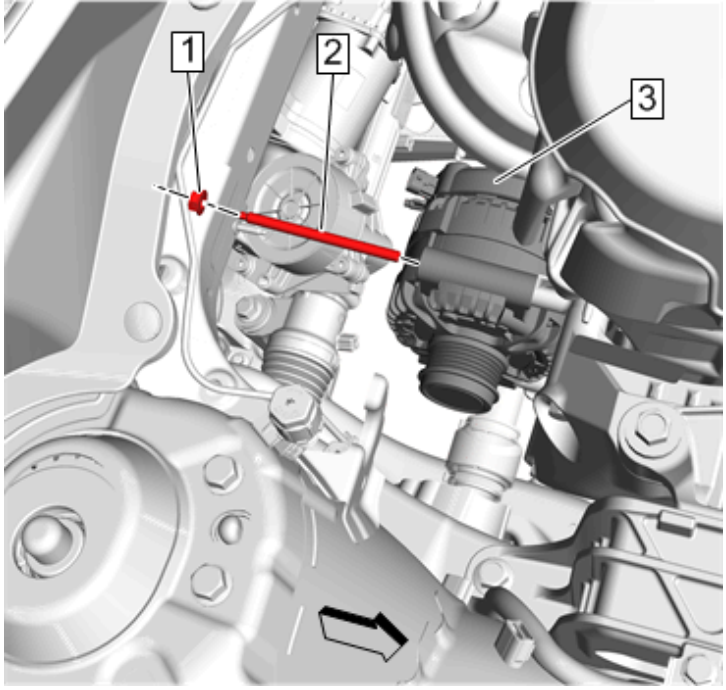


Fig. 234: Generator Mounting Nut And Generator
Courtesy of GENERAL MOTORS COMPANY

9. Remove Generator Mounting Nut (1).
10. Remove the generator mounting stud, if necessary. (2)
11. Remove Generator (3).

Installation Procedure

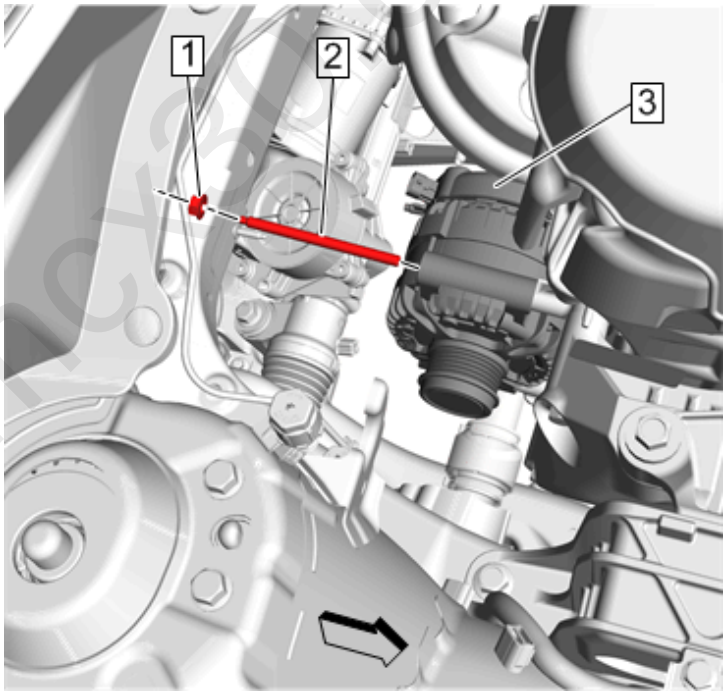


Fig. 235: Generator Mounting Nut And Generator
Courtesy of GENERAL MOTORS COMPANY

1. Install Generator (3).

CAUTION: **Refer to Fastener Caution**

2. Install the generator mounting stud, if necessary. (2) Tighten 9 N.m (80 lb in)
3. Install Generator Mounting Nut (1) and tighten 22 N.m (16 lb ft)

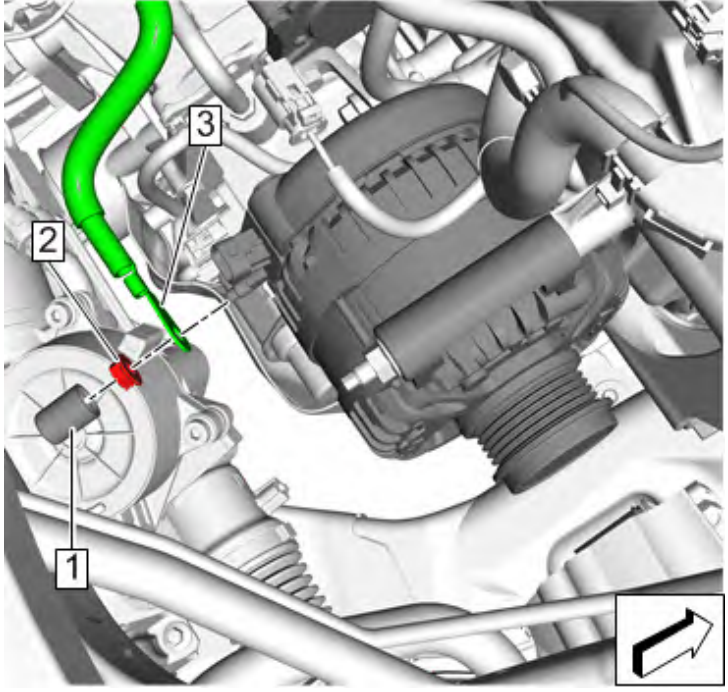


Fig. 236: Protective Cap, Starter Solenoid Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

4. Install Starter Solenoid Cable (3).
5. Install Starter Solenoid Cable Nut (2) and tighten 15 N.m (11 lb ft)
6. Install Protective Cap (1).

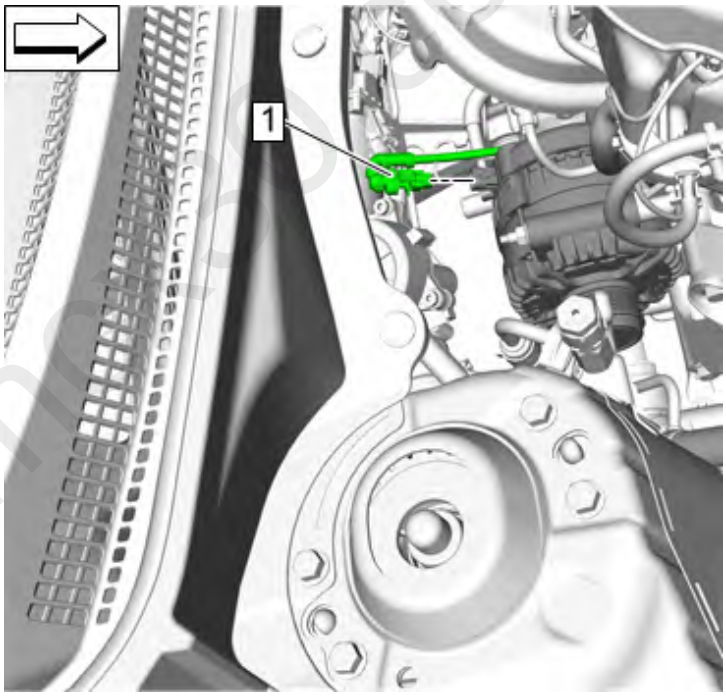


Fig. 237: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

7. Connect Electrical Connector (1).

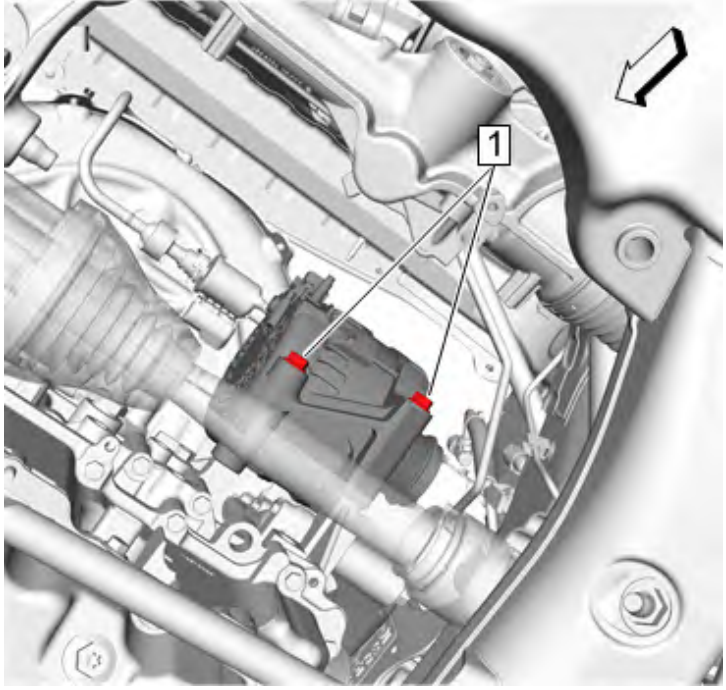


Fig. 238: Generator Mounting Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Install Generator Mounting Bolt (1) and tighten [2x] 22 N.m (16 lb ft)
9. Install the drive belt. **Drive Belt Replacement**
10. Install the air cleaner assembly. **Air Cleaner Assembly Replacement**
11. Connect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

GENERATOR REPLACEMENT (LTG)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

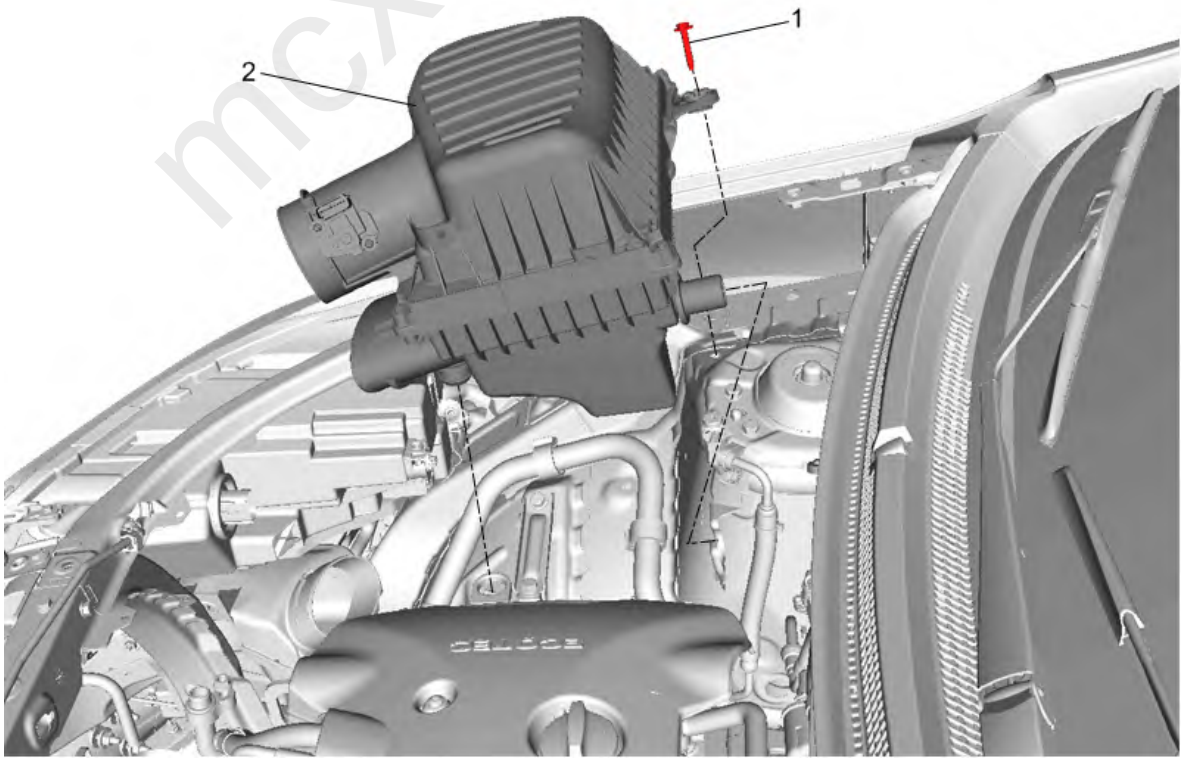


Fig. 239: Air Cleaner Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Remove Air Cleaner Assembly (2) - **Air Cleaner Assembly Replacement**
3. Remove Intake Manifold Cover - **Intake Manifold Cover Replacement**

mcx30.com

4. If necessary, disconnect the fuel feed pipe and reposition. **Fuel Feed Front Pipe Replacement**
5. Remove Drive Belt - **Drive Belt Replacement**

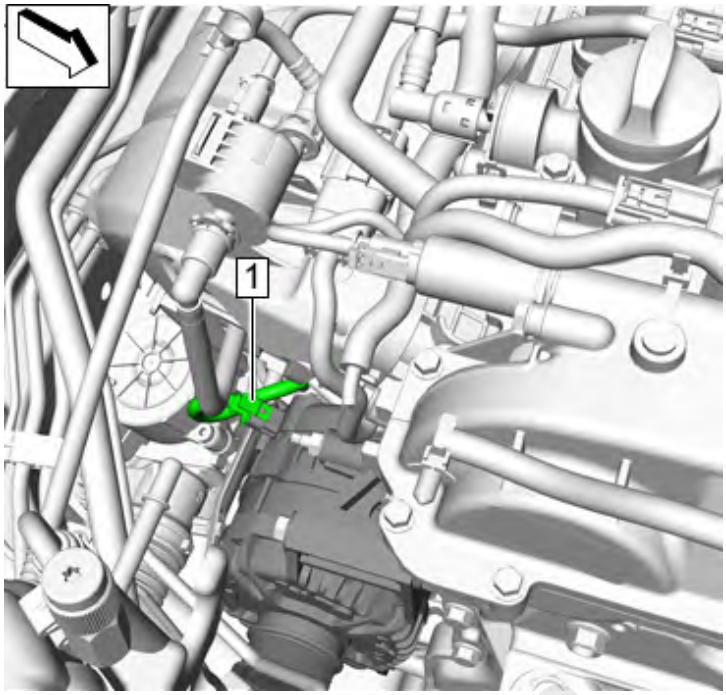


Fig. 240: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect Electrical Connector (1).
7. Raise and support the vehicle. **Lifting and Jacking the Vehicle**

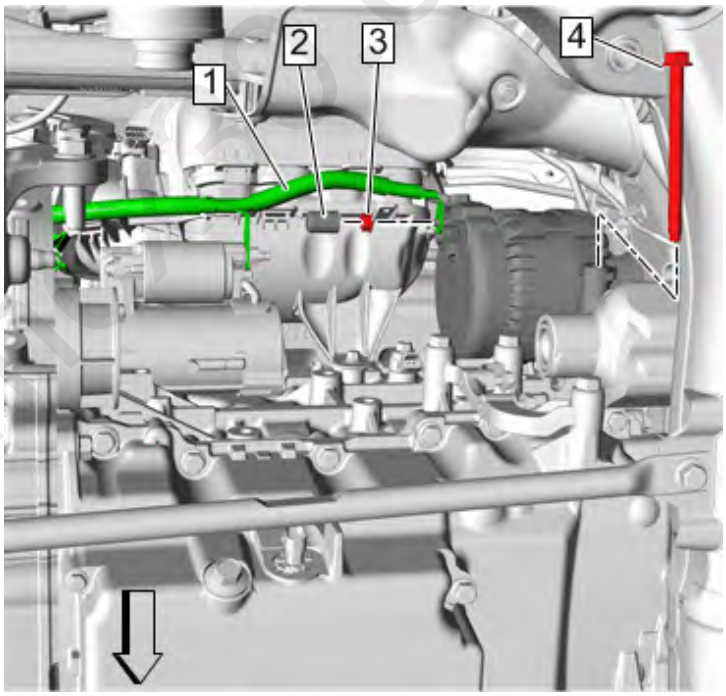


Fig. 241: Protective Cap, Generator Nut And Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove Protective Cap (2).
9. Remove Generator Nut (3).
10. Remove Starter Solenoid Cable (1).
11. Remove Generator Bolt (4).
12. Lower the vehicle.

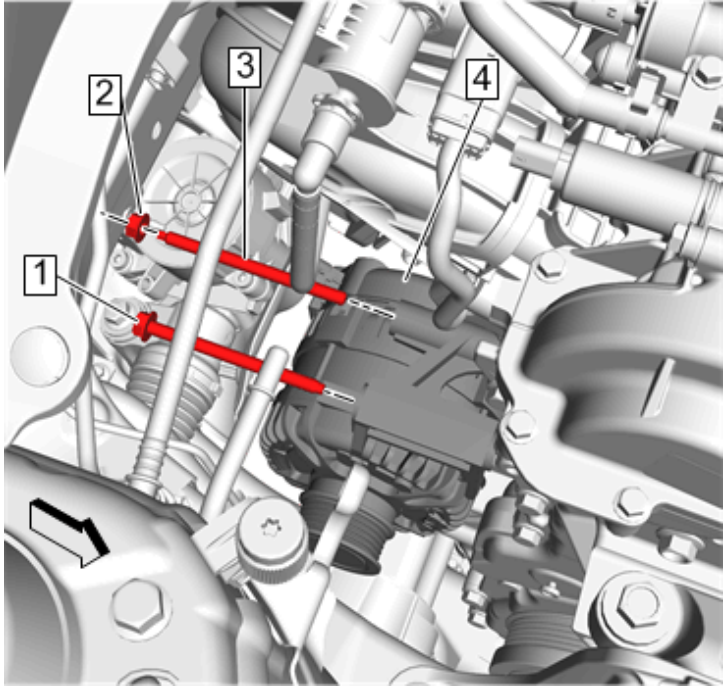


Fig. 242: Generator, Nut And Bolt
Courtesy of GENERAL MOTORS COMPANY

13. Remove Generator Nut (2).
14. Remove Generator Bolt (1).
15. If necessary, remove the generator mounting stud. (3)
16. Remove Generator (4).

Installation Procedure

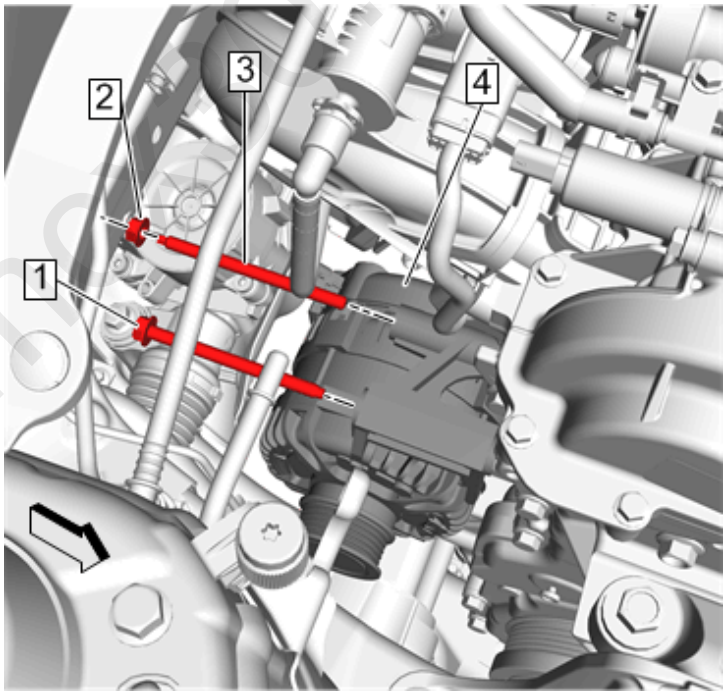


Fig. 243: Generator, Nut And Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution**

1. If necessary, install the generator mounting stud. (3) - Tighten 9 N.m (80 lb in)
2. Install Generator (4).
3. Install Generator Nut (2) and tighten 22 N.m (16 lb ft)
4. Install Generator Bolt (1) and tighten 22 N.m (16 lb ft)

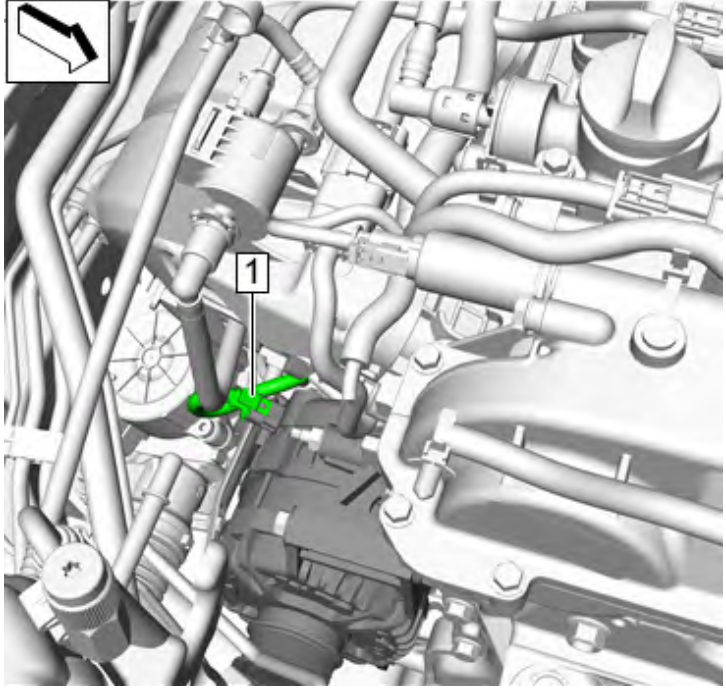


Fig. 244: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Connect Electrical Connector (1).
6. Raise and support the vehicle. **Lifting and Jacking the Vehicle**

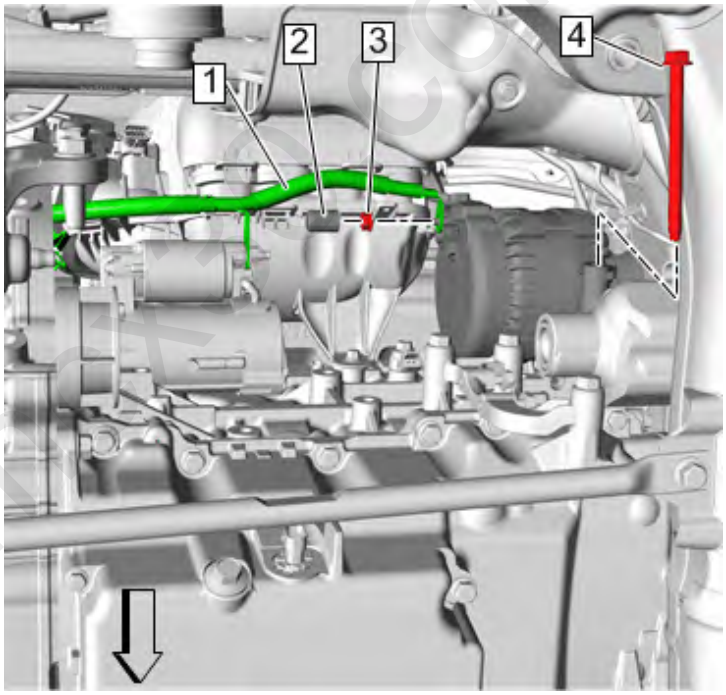


Fig. 245: Protective Cap, Generator Nut And Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Install Generator Bolt (4) and tighten 22 N.m (16 lb ft)
8. Install Starter Solenoid Cable (1).
9. Install Generator Nut (3) and tighten 15 N.m (11 lb ft)
10. Install Protective Cap (2).
11. Install Drive Belt (1) - **Drive Belt Replacement**
12. Lower the vehicle.
13. If necessary, connect the fuel feed pipe. **Fuel Feed Front Pipe Replacement**
14. Intake Manifold Cover -**Intake Manifold Cover Replacement**

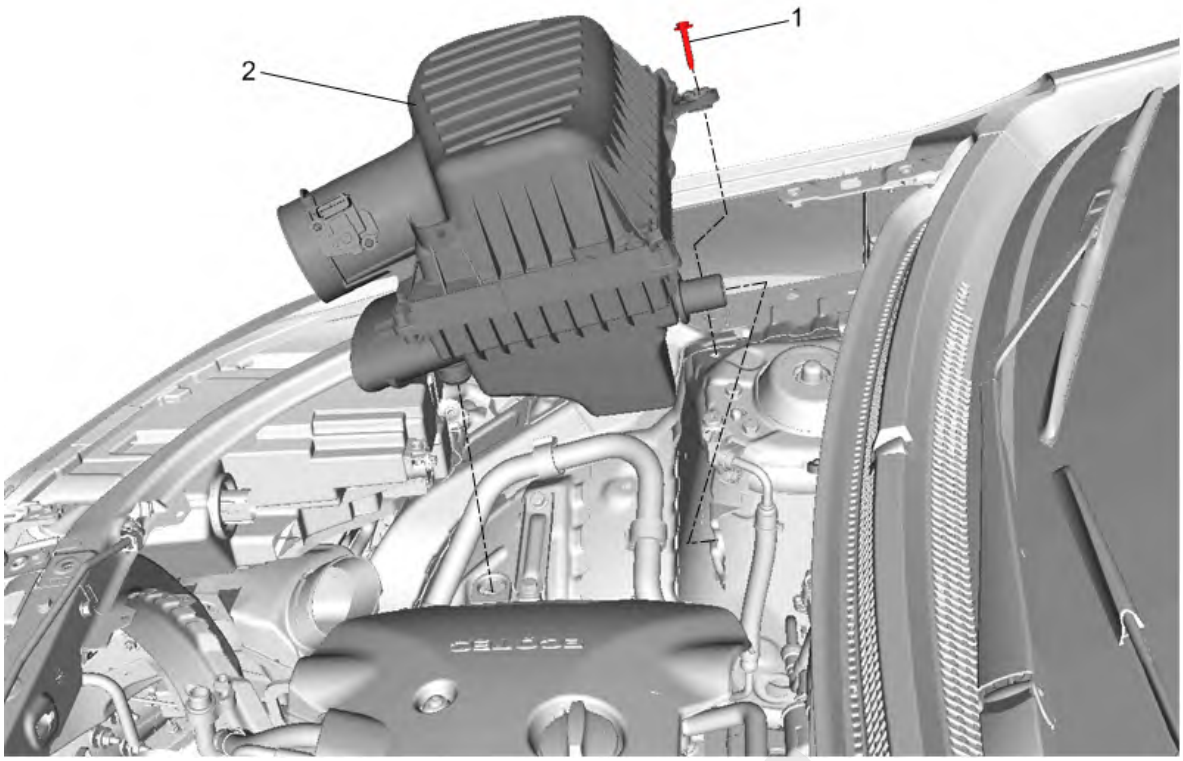


Fig. 246: Air Cleaner Assembly
Courtesy of GENERAL MOTORS COMPANY

15. Install Air Cleaner Assembly (2) -**Air Cleaner Assembly Replacement**
16. Connect the negative battery cable. **Battery Negative Cable Disconnection and Connection (KL9)**

GENERATOR REPLACEMENT (LH7 - ALL WHEEL DRIVE)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove the generator and air conditioning compressor belt from the generator pulley only. **Generator and Air Conditioning Compressor Belt Replacement**
3. Remove the intake manifold cover.

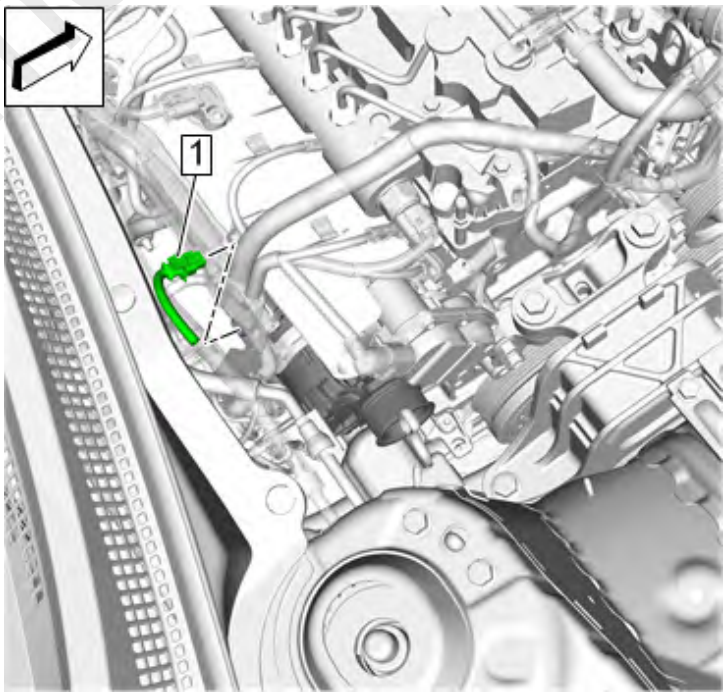


Fig. 247: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect Electrical Connector (1) -

mcx30.com

5. Raise and support the vehicle. **Lifting and Jacking the Vehicle**

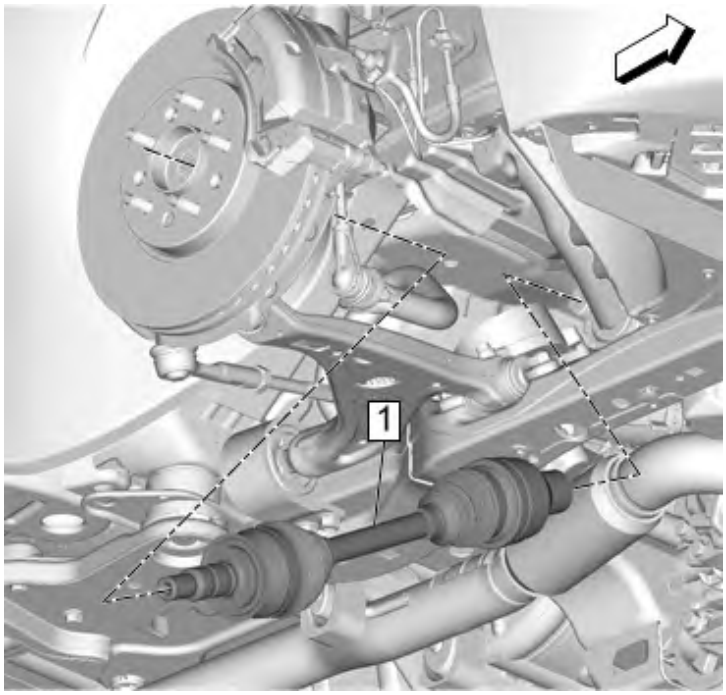


Fig. 248: Wheel Drive Shaft
Courtesy of GENERAL MOTORS COMPANY

6. Remove Front Wheel Drive Shaft-Right Side - **Front Wheel Drive Half Shaft Replacement - Right Side (AWD)**

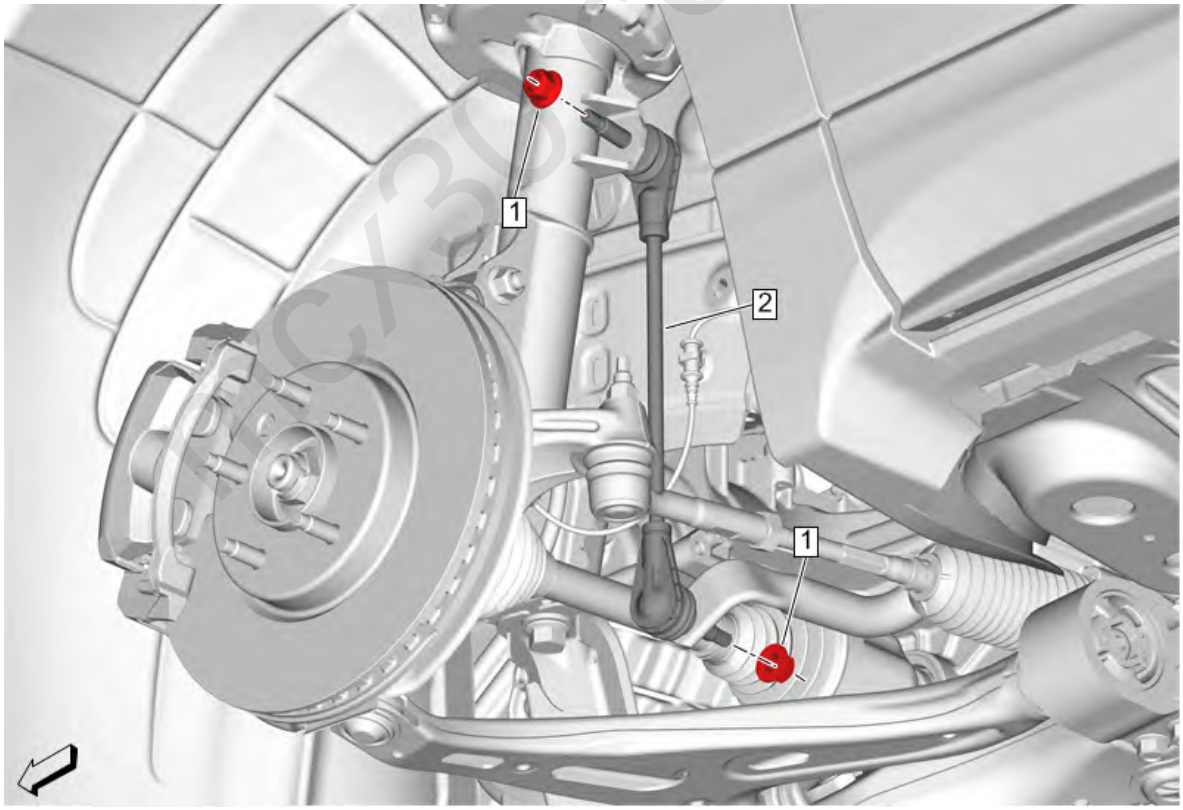


Fig. 249: Upper Stabilizer Shaft Link Nut
Courtesy of GENERAL MOTORS COMPANY

7. Remove the upper stabilizer shaft link nut (1) and reposition away. **Stabilizer Shaft Link Replacement (Equinox)** **Stabilizer Shaft Link Replacement (Terrain)**

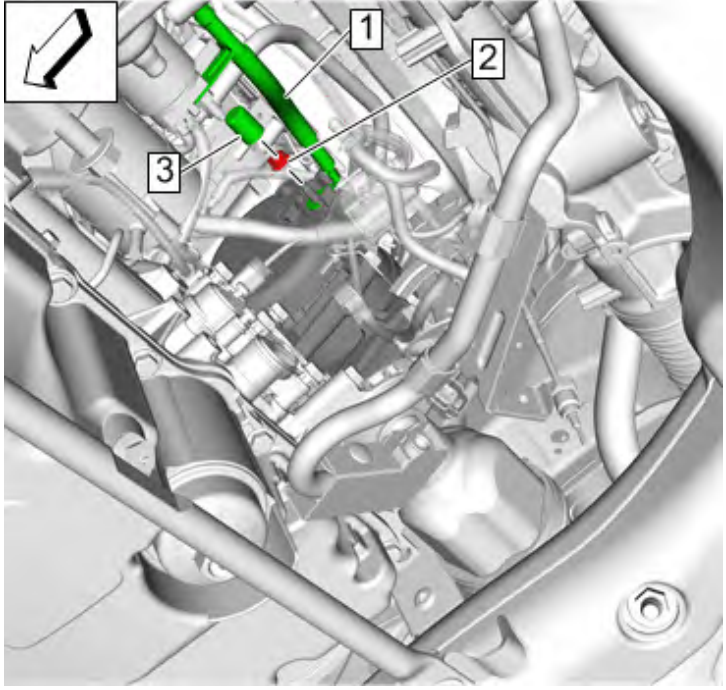


Fig. 250: Protective Cap
Courtesy of GENERAL MOTORS COMPANY

8. Remove Protective Cap (3).
9. Remove Battery Positive Cable Nut (2).
10. Remove Starter Solenoid Cable (1).

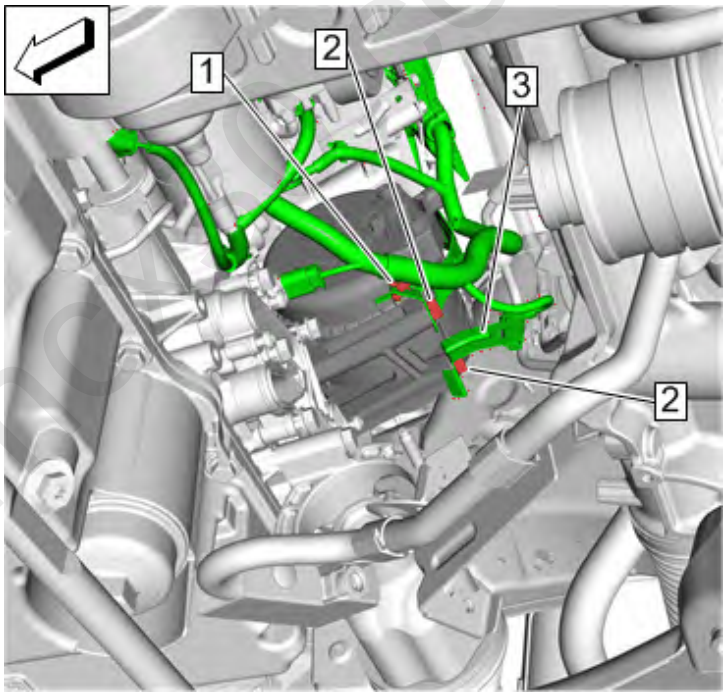


Fig. 251: Generator Mounting Bolt, Retainer And Exhaust Temperature Sensor Bracket
Courtesy of GENERAL MOTORS COMPANY

11. Disengage Retainer (1).
12. Remove Generator Mounting Bolt (2) - [2x]
13. Reposition away Exhaust Temperature Sensor Bracket (3).
14. Lower the vehicle.

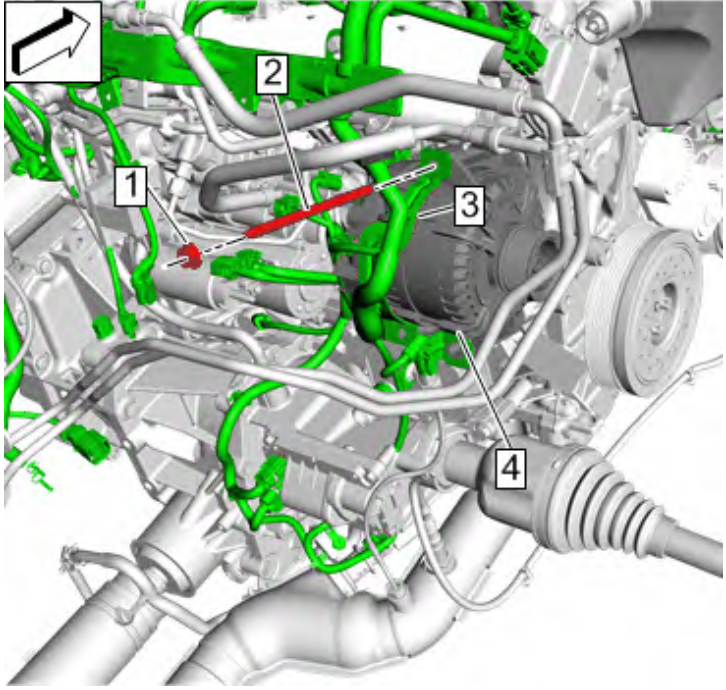


Fig. 252: Generator And Engine Wiring Harness Bracket
Courtesy of GENERAL MOTORS COMPANY

15. Remove Generator Mounting Nut (1).
16. Remove Generator Mounting Stud (2).
17. Reposition away Engine Wiring Harness Bracket (3).
18. Remove Generator (4).

Installation Procedure

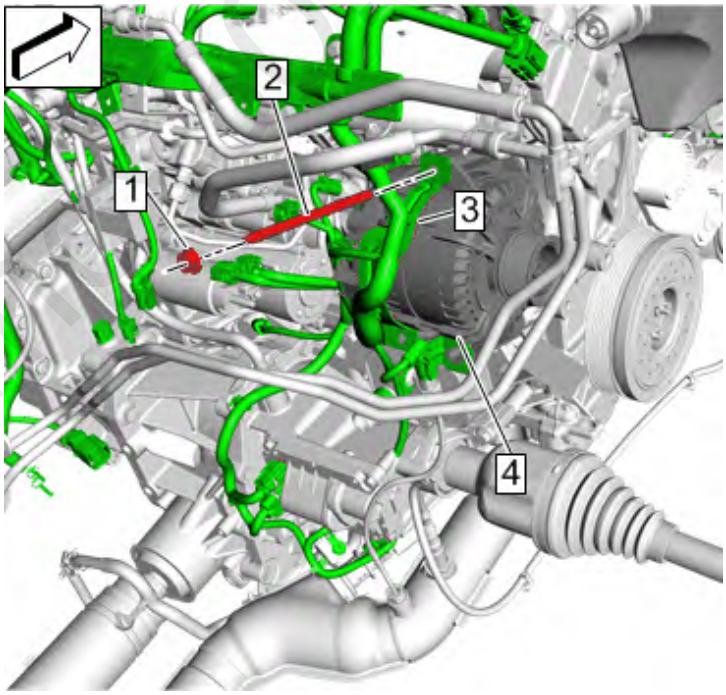


Fig. 253: Generator And Engine Wiring Harness Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Install Generator (4)
2. Install Engine Wiring Harness Bracket (3)

CAUTION: **Refer to Fastener Caution .**

3. Install Generator Mounting Stud (2) and tighten 9 N.m (80 lb in)
4. Install Generator Mounting Nut (1) and tighten 22 N.m (16 lb ft)

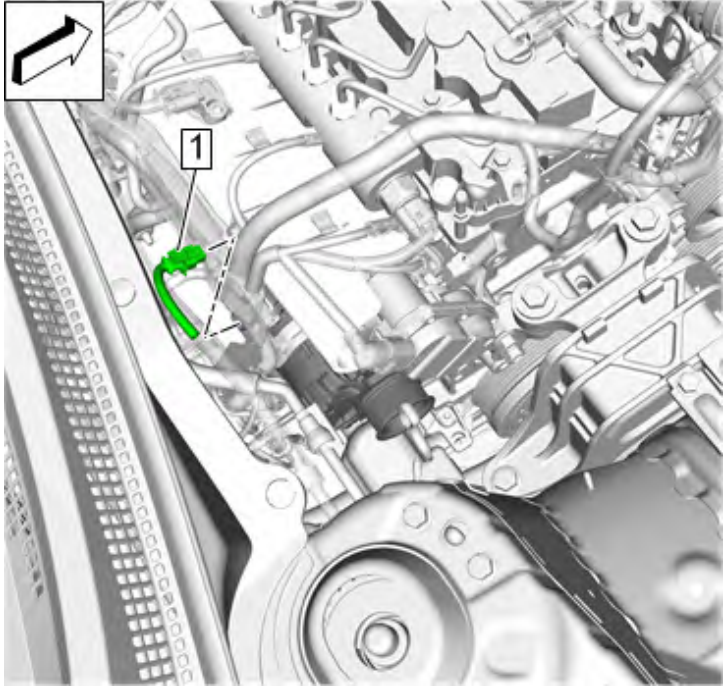


Fig. 254: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Connect Electrical Connector (1).
6. Install the intake manifold cover.
7. Raise and support the vehicle. **Lifting and Jacking the Vehicle**

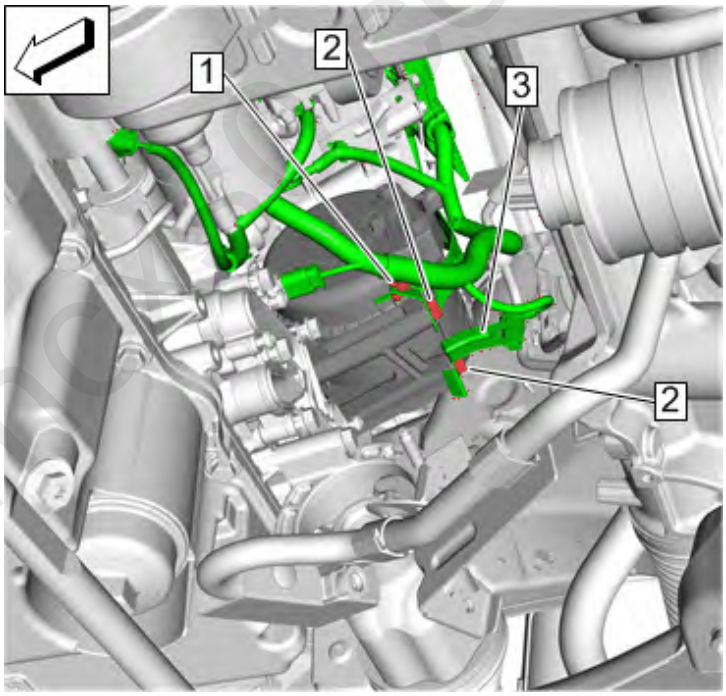


Fig. 255: Generator Mounting Bolt, Retainer And Exhaust Temperature Sensor Bracket
Courtesy of GENERAL MOTORS COMPANY

8. Install Exhaust Temperature Sensor Bracket (3).
9. Install Generator Mounting Bolt (2) and tighten [2x] 22 N.m (16 lb ft)
10. Engage Retainer (1).

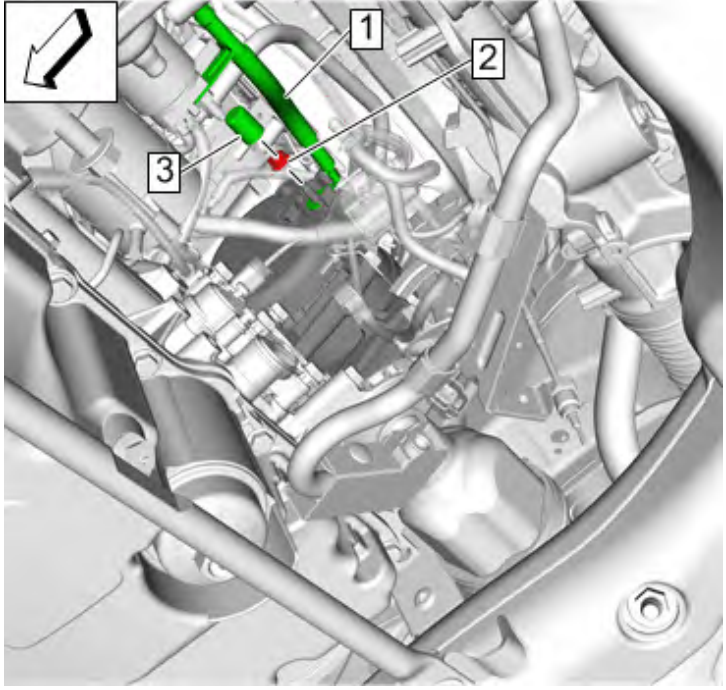


Fig. 256: Protective Cap
Courtesy of GENERAL MOTORS COMPANY

11. Install Starter Solenoid Cable (1).
12. Install Battery Positive Cable Nut (2) and tighten 15 N.m (11 lb ft)
13. Install Protective Cap (3).

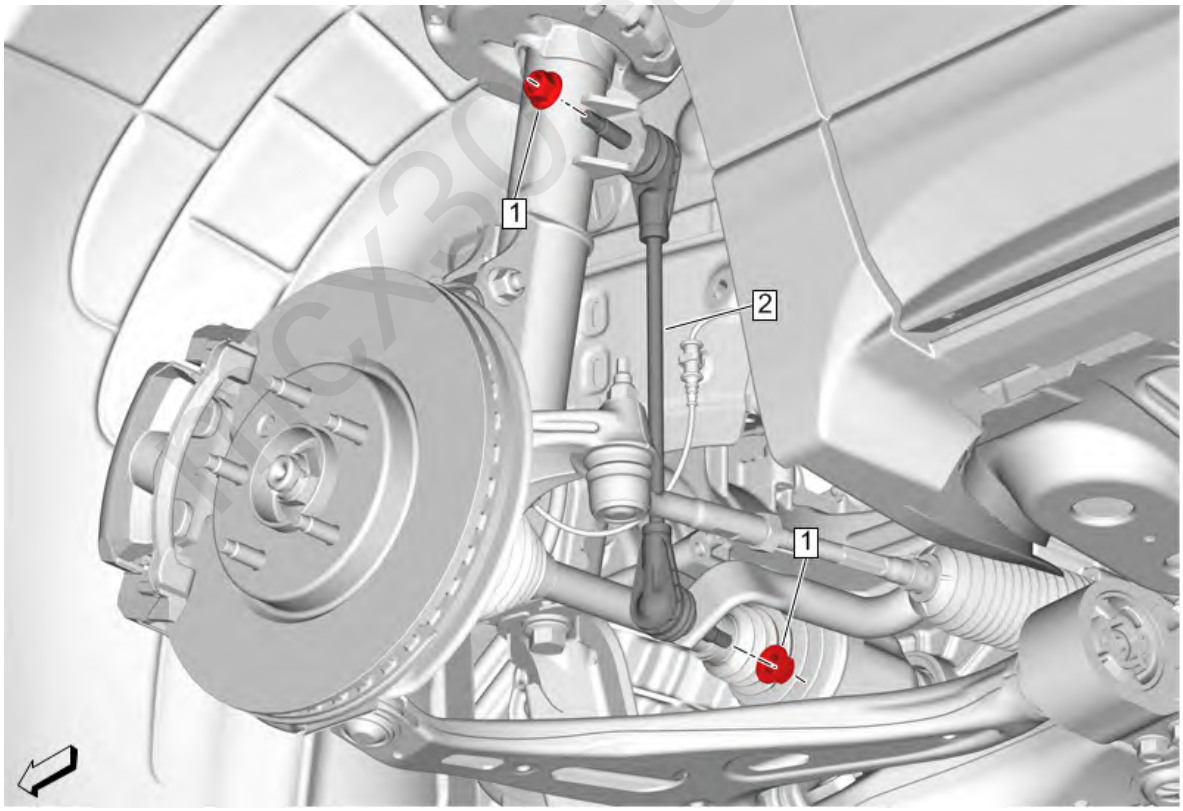


Fig. 257: Upper Stabilizer Shaft Link Nut
Courtesy of GENERAL MOTORS COMPANY

14. Install the upper stabilizer shaft link nut (1). **Stabilizer Shaft Link Replacement (Equinox)** **Stabilizer Shaft Link Replacement (Terrain)**

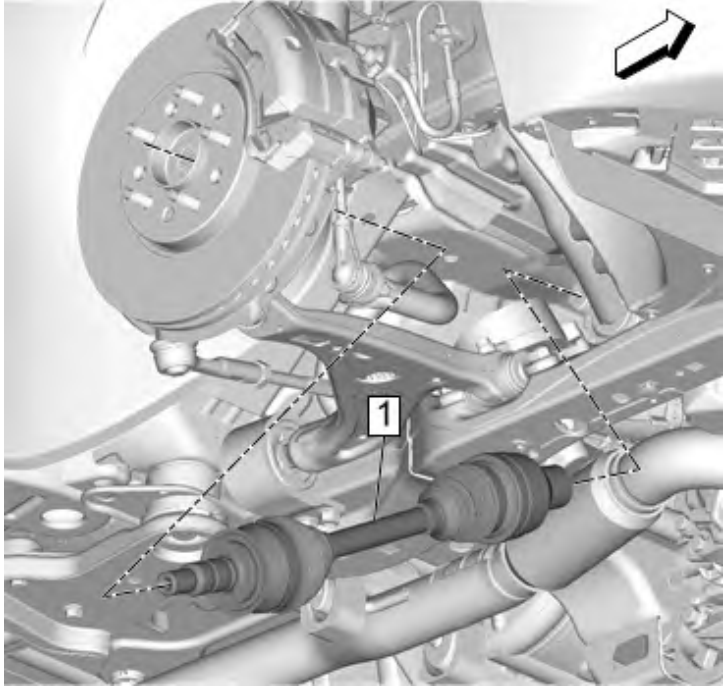


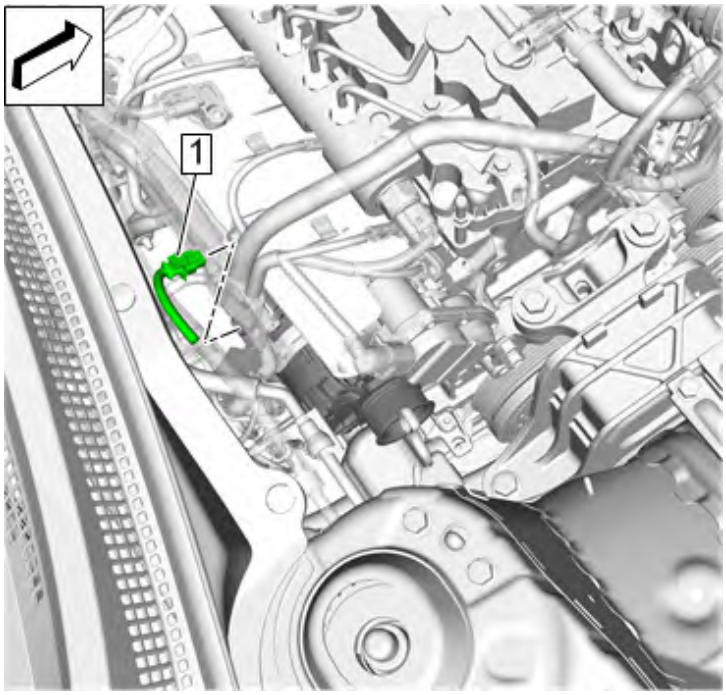
Fig. 258: Wheel Drive Shaft
Courtesy of GENERAL MOTORS COMPANY

15. Install Front Wheel Drive Shaft-Right Side - **Front Wheel Drive Half Shaft Replacement - Right Side (AWD)**
16. Install Generator and Air Conditioning Compressor Belt - **Generator and Air Conditioning Compressor Belt Replacement**
17. Lower the vehicle.
18. Connect Battery Negative Cable -**Battery Negative Cable Disconnection and Connection (KL9)**

GENERATOR REPLACEMENT (LH7 - FRONT WHEEL DRIVE)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove the generator and air conditioning compressor belt from the generator pulley only. **Generator and Air Conditioning Compressor Belt Replacement**
3. Remove the intake manifold cover. **Intake Manifold Cover Replacement**
4. Remove the upper stabilizer shaft link nut and reposition away. **Stabilizer Shaft Link Replacement (Equinox)** **Stabilizer Shaft Link Replacement (Terrain)**



mx30.com

Fig. 259: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect Electrical Connector (1).
6. Raise and support the vehicle. Lifting and Jacking the Vehicle

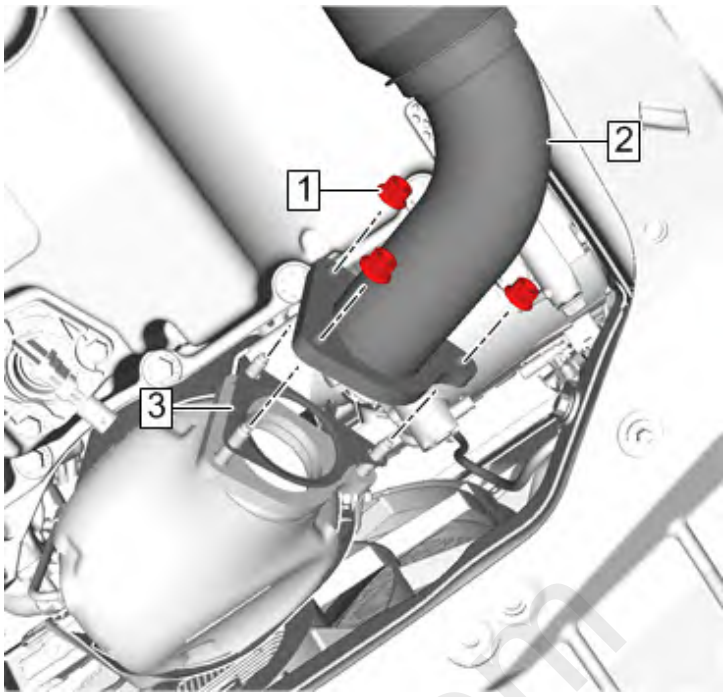


Fig. 260: Exhaust Front Pipe
Courtesy of GENERAL MOTORS COMPANY

7. Remove Exhaust Front Pipe (2) - Exhaust Front Pipe Replacement (LH7)

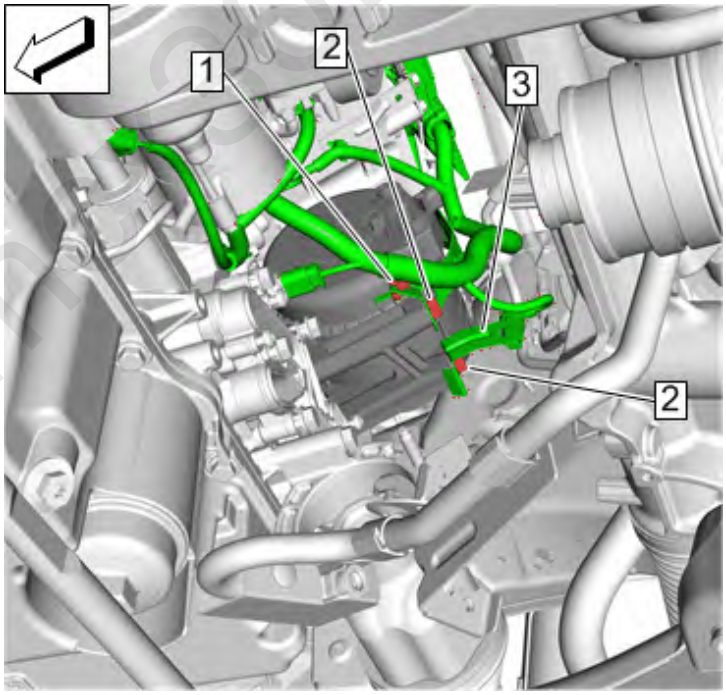


Fig. 261: Generator Mounting Bolt, Retainer And Exhaust Temperature Sensor Bracket
Courtesy of GENERAL MOTORS COMPANY

8. Remove Generator Mounting Bolt (2) - [2x]
9. Reposition away Exhaust Temperature Sensor Bracket (3).

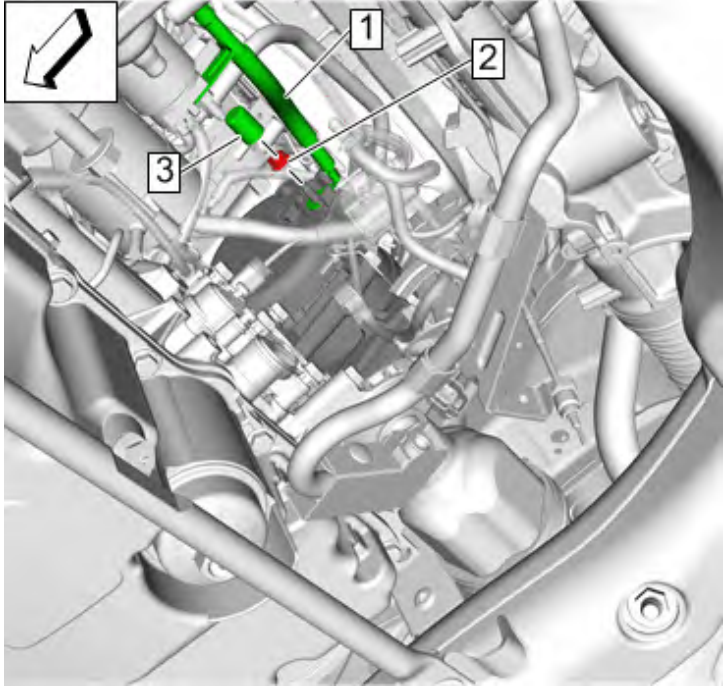


Fig. 262: Protective Cap
Courtesy of GENERAL MOTORS COMPANY

10. Remove Protective Cap (3).
11. Remove Battery Positive Cable Nut (2).
12. Remove Starter Solenoid Cable (1).

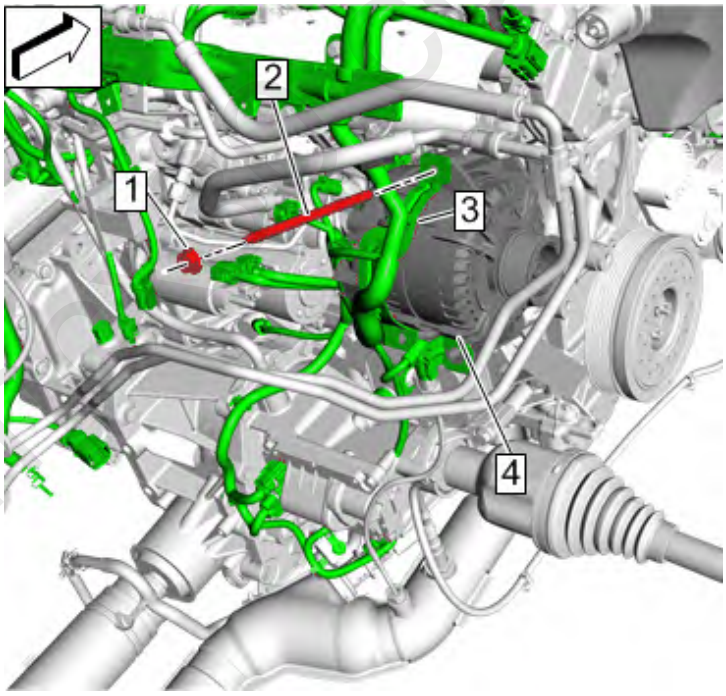


Fig. 263: Generator And Engine Wiring Harness Bracket
Courtesy of GENERAL MOTORS COMPANY

13. Remove Generator Mounting Nut (1).
14. Remove Generator Mounting Stud (2).
15. Reposition away Engine Wiring Harness Bracket (3).
16. Remove Generator (4).

Installation Procedure

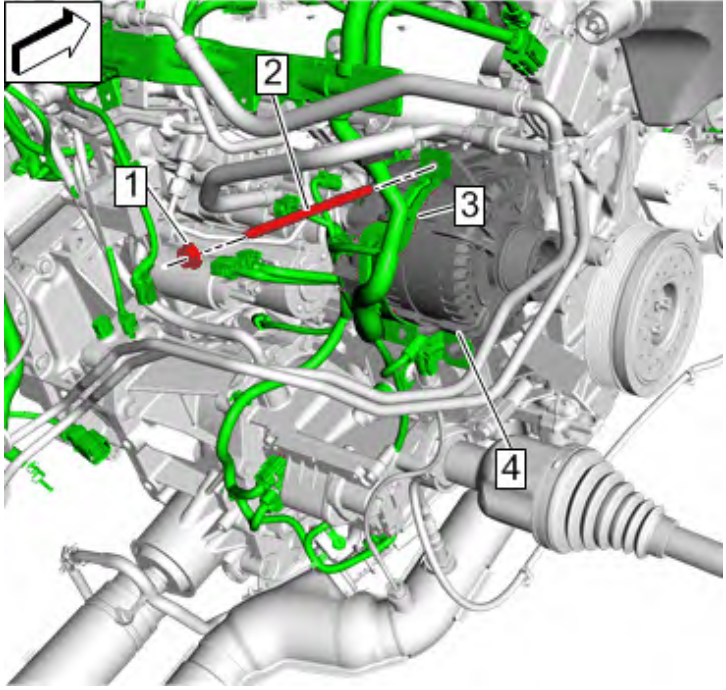


Fig. 264: Generator And Engine Wiring Harness Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Install Generator (4)
2. Install Engine Wiring Harness Bracket (3)

CAUTION: **Fastener Caution**

3. Install Generator Mounting Stud (2) and tighten 9 N.m (80 lb in)
4. Generator Mounting Nut (1) and tighten 22 N.m (16 lb ft)

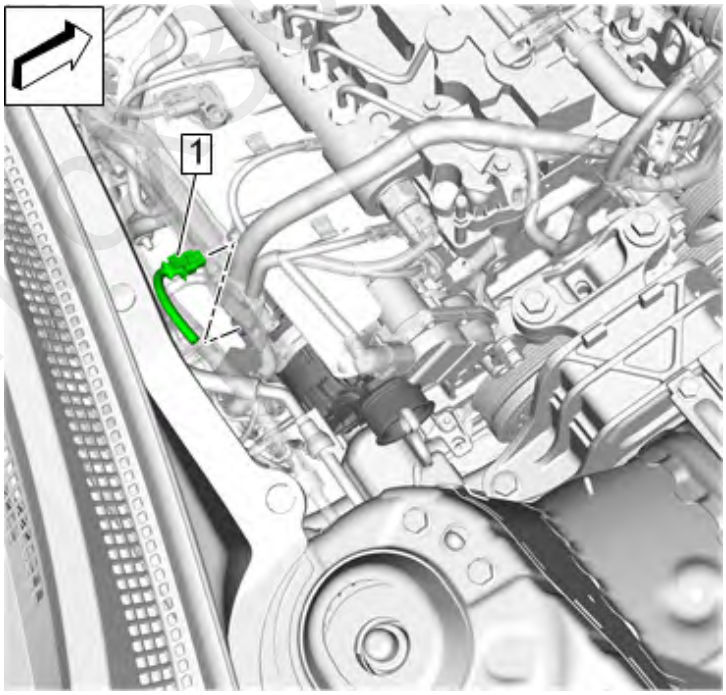


Fig. 265: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Connect Electrical Connector (1).
6. Install the intake manifold cover.
7. Raise and support the vehicle. **Lifting and Jacking the Vehicle**

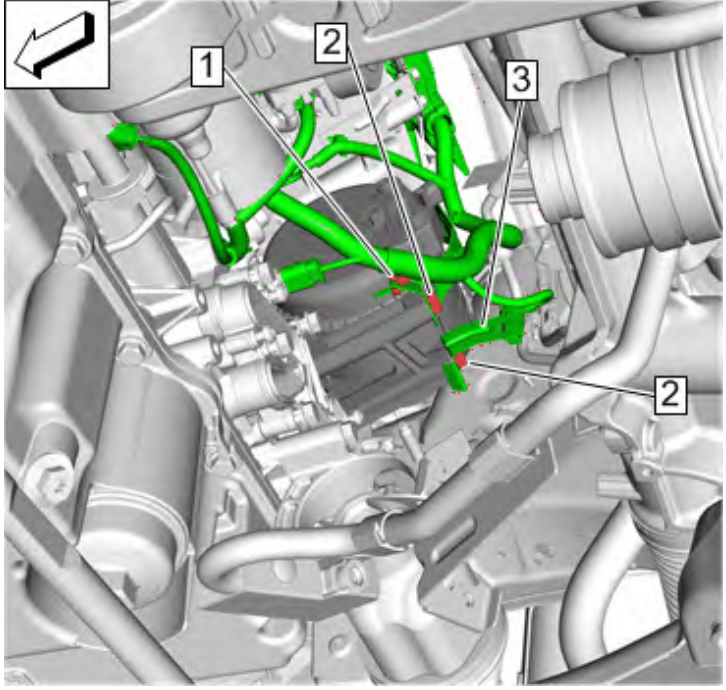


Fig. 266: Generator Mounting Bolt, Retainer And Exhaust Temperature Sensor Bracket
Courtesy of GENERAL MOTORS COMPANY

8. Install Exhaust Temperature Sensor Bracket (3).
9. Install Generator Mounting Bolt (2) and tighten [2x] 22 N.m (16 lb ft)

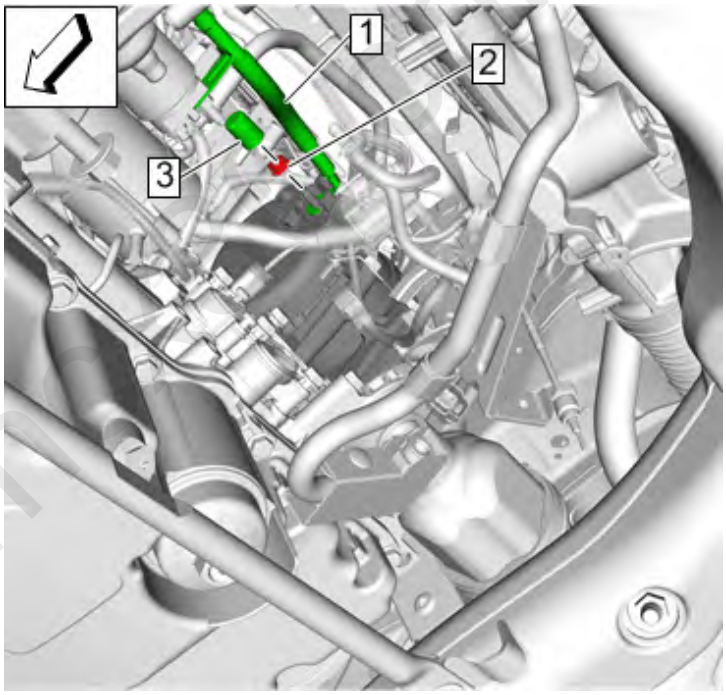


Fig. 267: Protective Cap
Courtesy of GENERAL MOTORS COMPANY

10. Install Starter Solenoid Cable (1).
11. Install Battery Positive Cable Nut (2) and tighten 15 N.m (11 lb ft)
12. Install Protective Cap (3).
13. Install the upper stabilizer shaft link nut. **Stabilizer Shaft Link Replacement (Equinox)** **Stabilizer Shaft Link Replacement (Terrain)**
14. Install Generator and Air Conditioning Compressor Belt - **Generator and Air Conditioning Compressor Belt Replacement**

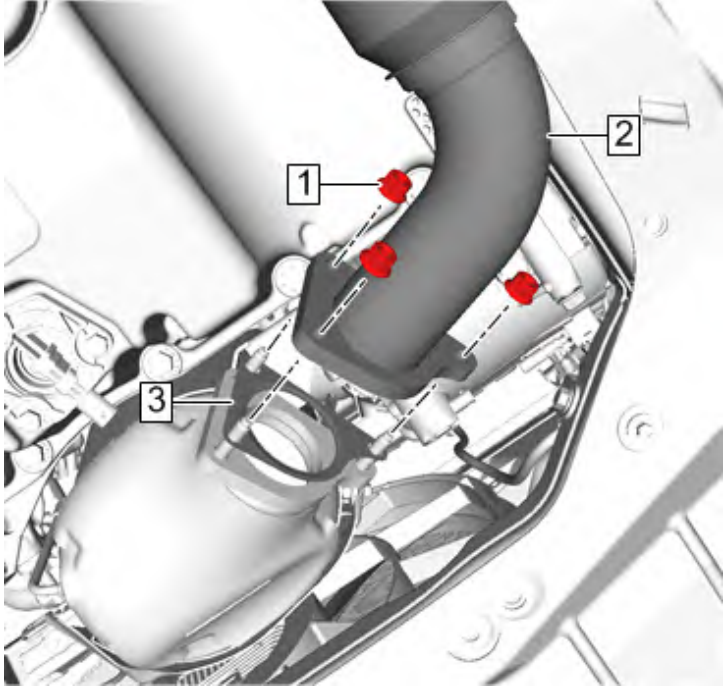


Fig. 268: Exhaust Front Pipe
Courtesy of GENERAL MOTORS COMPANY

15. Install Exhaust Front Pipe (2) - **Exhaust Front Pipe Replacement (LH7)**
16. Lower the vehicle.
17. Install the intake manifold cover. **Intake Manifold Cover Replacement**
18. Connect Battery Negative Cable -**Battery Negative Cable Disconnection and Connection (KL9)**

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.**

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.

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

The body control module (BCM) monitors battery positive voltage to determine battery state of charge. If one or more of the BCM battery positive voltage terminals measure less than approximately 11.6V compared to the BCM ground circuits, 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
- Amperage hours

When a battery is replaced use a battery with similar ratings. See battery specification label on the original battery.

Amperage Hours

The amperage hour rating tells you how much amperage is available when discharged evenly over a 20 hour period. The amperage hour rating is cumulative, so in order to know how many constant amperage the battery will output for 20 h, you have to divide the amperage hour rating by 20. Example: If a battery has an amperage 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 amperage 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 -18Ã‚Â°C (0Ã‚Â°F) while maintaining at least 7.2 V. See battery label for the cold cranking amperage rating of this battery.

CHARGING SYSTEM DESCRIPTION AND OPERATION

Electrical Power Management Overview

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:

- Monitor the battery voltage and estimate the battery condition
- Take corrective actions by boosting idle speeds, and adjusting the regulated voltage
- Perform diagnostics and driver notification

The battery condition is estimated during ignition/vehicle off and during ignition/vehicle on. During ignition/vehicle 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.

Any time the ignition/vehicle is on, the vehicle algorithm continuously estimates battery state-of-charge based on adjusted net amp hours, battery capacity, initial state-of-charge, and calculated temperature.

While the engine is running, the battery degree of discharge is primarily determined by the integrated battery current sensor, 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.

Charging System Components

Generator

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 fault, the generator defaults to an output voltage of 13.8 V.

The generator is serviced as a complete assembly. If there is a diagnosed fault in the generator, it must be replaced as an assembly.

Generator Pulley

The pulley drives the Generator via the engine drive belt. There are 2 types of pulleys:

1. Conventional solid Pulley which is bolted to the Generator stator shaft. This Pulley can be serviced separately.

2. One Way Clutch Pulley or Overrunning Alternator Decoupler Pulley allows the Generator to spin freely when the engine rapidly slows down on sudden deceleration. This part is not serviceable and the Generator needs to be replaced as an assembly.

Body Control Module (BCM)

The BCM communicates with the Engine Control Module (ECM) and the instrument cluster for electrical power management operation. The 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 the battery current sensor, the battery positive voltage circuit, and estimates battery temperature to determine battery state of charge. The BCM also performs idle boost.

Battery Current Sensor (if applicable)

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%. Normal duty cycle is between 5 - 95%. Between 0 - 5% and 95 - 100% are for diagnostic purposes.

Battery Sensor Module (if applicable)

The BCM monitors the Battery Sensor Module for battery state of current, state of health, and battery charge via serial data. If the battery is determined to be in poor state of health or having a low state of charge, the BCM will not allow the ECM to perform an auto-stop.

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 Cluster

As a means of displaying the charging system functions, some vehicles may be equipped with a voltmeter gauge on the instrument cluster and/or a system voltage display in the driver information center. These will indicate the

current vehicle system voltage.

The instrument cluster also provides customer notification if there is a concern with the charging system. There are two means of notification: a charge indicator on the instrument cluster and/or a service system message displayed on the Driver Information Center (DIC) if equipped.

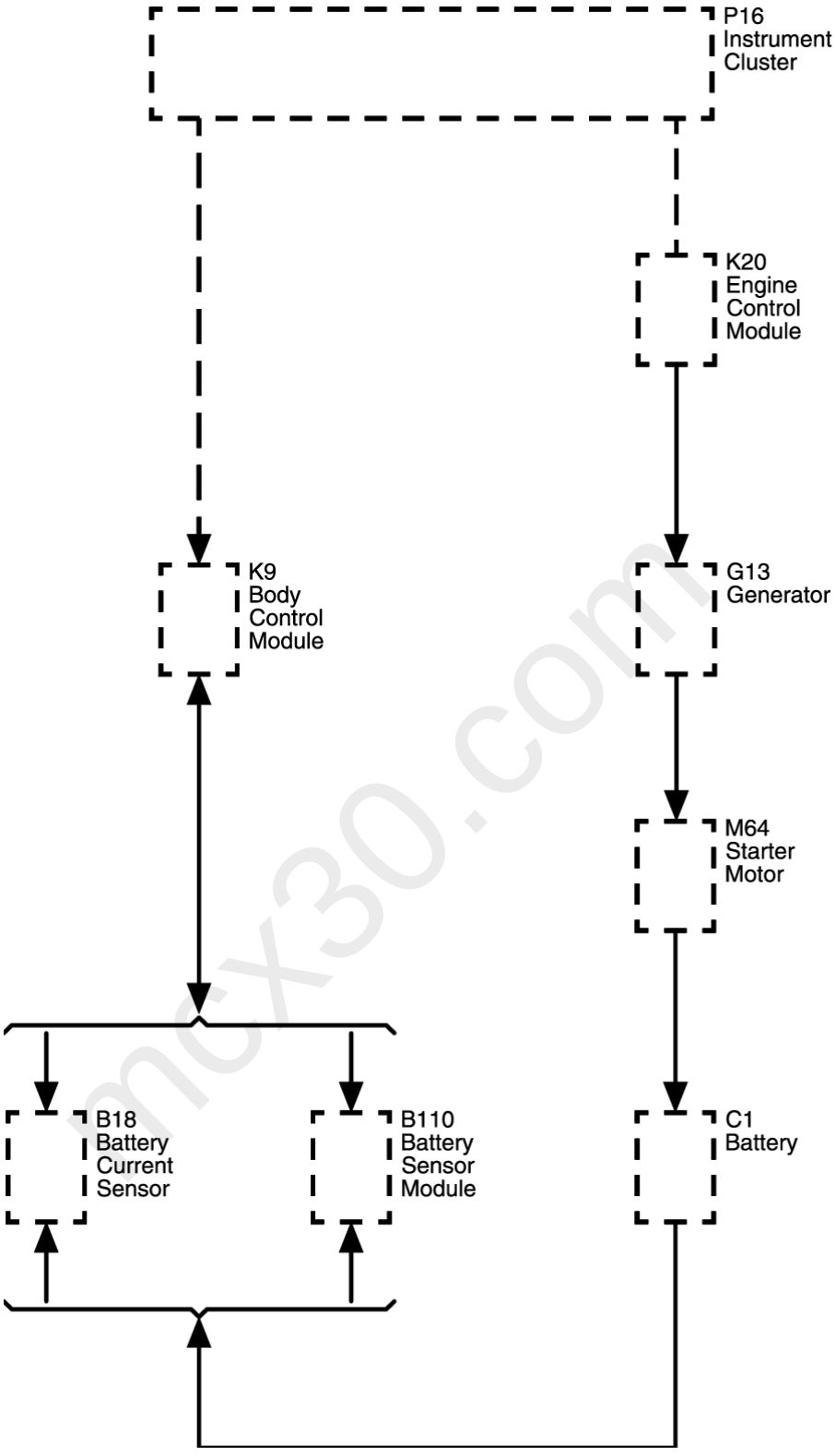


Fig. 269: Charging System Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
P16	P16 Instrument Cluster
K20	K20 Engine Control Module
G13	G13 Generator
M64	M64 Starter Motor
C1	C1 Battery
B18	B18 Battery Current Sensor
K9	K9 Body Control Module

Callout	Component Name
B110	B110 Battery Sensor Module

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
- Head lamp Mode
- Start Up Mode
- Voltage Reduction Mode

The ECM Controls the Generator through the generator turn - on signal circuit, also known as the Generator L-terminal. The ECM monitors the generator performance though the Generator field duty cycle signal circuit, also known as the generator F-terminal.

The Generator turn - on signal (Generator L-terminal) is a Pulse Width Modulation (PWM) signal of 128 Hz with a duty cycle of 0 - 100%. Normal duty cycle is between 5 - 95%. 0 - 5% and 95 - 100% are for diagnostic purposes, with 0 - 5% monitoring for an open circuit and 95 - 100% monitoring for a short to ground at a fixed 13.8 V. The following table shows the commanded duty cycle and output voltage of the Generator:

Commanded Duty Cycle	Generator Output Voltage (+/-.25 V)
0 - 5%	13.8 V
10%	11 V
20%	11.56 V
30%	12.13 V
40%	12.69 V
50%	13.25 V
60%	13.81 V
70%	14.38 V
80%	14.94 V
90%	15.5 V
95 - 100%	13.8 V

The Generator provides a PWM 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 Generator field duty cycle signal (Generator F-terminal) is a PWM signal of 60 - 460 Hz with a duty cycle of 0 - 100%. Normal duty cycle is between 5 - 100%. 0 - 5% is reserved for diagnostic purposes.

As the charging systems works to maintain the battery charge and manage vehicle electrical loads, it is normal for the voltmeter gauge on the instrument cluster or the system voltage displayed in the DIC to fluctuate or change. This does not indicate a malfunction. Depending on the battery state of charge and the vehicle electrical load, these values may be anywhere from 12.5 V to 15.5 V.

Charging System Modes

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:

- Windshield wipers are ON for more than 3 s.

mcx30.com

- Climate Control Voltage Boost Mode Request is true, as sensed by the HVAC control module via serial data. 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 0Ã‚Â°C (32Ã‚Â°F).
- Battery State of Charge is less than 80%.
- Vehicle speed is greater than 145 km/h (90 mph)
- A current sensor malfunction exists.
- System voltage is 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 0Ã‚Â°C (32Ã‚Â°F) but less than or equal to 80Ã‚Â°C (176Ã‚Â°F), the calculated battery current is less than 15 A and greater than -8 A, and the battery state-of-charge is greater than or equal to 80%. Its targeted generator output voltage is the open circuit voltage of the battery and can be between 12.5 - 13.1 V. When fuel economy mode is active, the generator is not charging, only maintaining open circuit battery voltage. 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 head lamps 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 s.

Tow/Haul Mode (if applicable)

Pressing the Tow/Haul Mode button located on the center stack, the vehicle system voltage is raised and the remote (non-vehicle) battery will be charged. Having the headlamps on will raise the system voltage and if the Tow/Haul button is applied it will not serve any purpose. The voltage is regulated between 13.9-14.5 V.

Instrument Cluster Operation

Charge Indicator Operation

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

Driver Information Center Message: BATTERY NOT CHARGING SERVICE CHARGING SYSTEM or SERVICE BATTERY CHARGING SYSTEM

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

Voltmeter Gauge and/or System Voltage Display (if equipped)

As a means of displaying the charging system functions, some vehicles may be equipped with a voltmeter gauge on the instrument cluster and/or a system voltage display in the driver information center. These will indicate the

mcx30.com

current vehicle system voltage.

As the charging systems works to maintain the battery charge and manage vehicle electrical loads, it is normal for the voltmeter gauge on the instrument cluster or the system voltage display in the driver information center to fluctuate or change. This does not indicate a malfunction. Depending on the battery state of charge and the vehicle electrical load, these values may be anywhere from 12.5 V to 15.5 V.

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, 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 activated in incremental steps. For example, 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:

mcx30.com

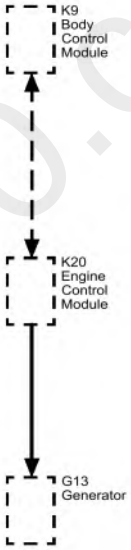


Fig. 270: Electrical Power Management Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
K9	K9 Body Control Module
K20	K20 Engine Control Module
G13	G13 Generator

Idle Boost and Load Shed With Current Sensor

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Idle Boost 1 Start	Less Than -15Ã‚Â°C (5Ã‚Â°F)	Less Than 13 V	-	First level Idle boost requested

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
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 -10Ã‚Â°C (14Ã‚Â°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	-	-	Battery has a net loss greater than 1.6 Ah	Second level Idle boost requested
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
Load Shed 1 Start	-	-	Battery has a net loss of 4 Ah	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 20% of their cycle
Load Shed 1 Start	-	Less Than 11 V	-	Rear Defrost, Heated Mirrors, Heated Seats, HVAC 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 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 6.0 Ah	Third level Idle boost request cancelled
Load Shed 2 Start	-	-	Battery has a net loss greater than 12 Ah	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 Start	-	Less Than 11 V	-	Rear Defrost, Heated Mirrors, Heated Seats, HVAC 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 V	Battery has a net loss of less than 8 Ah	Clear Load Shed 2

mcx30.com

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Load Shed 3 Start	-	Less Than 11.9 V	Battery has a net loss greater than 20 Ah	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 100% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 3 Start	-	Less Than 11 V	-	Rear Defrost, Heated Mirrors, Heated Seats, HVAC 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 13 Ah	Clear Load Shed 3

Idle Boost and Load Shed Without Current Sensor (based on battery voltage)

Function	Battery Temperature Calculation	Battery Voltage Calculation	Action Taken
Idle Boost 1 Start	Less Than -15Ã‚Â°C (5Ã‚Â°F)	Less Than 13 V	First level Idle boost requested
Idle Boost 1 Start	-	Less Than 12.6 V	First level Idle boost requested
Idle Boost 1 End	Greater Than -15Ã‚Â°C (5Ã‚Â°F)	-	First level Idle boost request cancelled
Idle Boost 1 End	-	Greater Than 13 V	First level Idle boost request cancelled
Idle Boost 2 Start	-	Less Than 12.4 V	Second level Idle boost requested
Idle Boost 2 End	-	Greater Than 12.5 V	Second level Idle boost request cancelled
Load Shed 1 Start	-	Less Than 12.3 V	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 20% of their cycle
Load Shed 1 End	-	Greater Than 12.4 V	Clear Load Shed 1
Idle Boost 3 Start	-	Less Than 10 V	Third level Idle boost requested
Idle Boost 3 End	-	Greater Than 12.3 V	Third level Idle boost request cancelled
Load Shed 2 Start	-	Less Than 12.1 V	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 End	-	Greater Than 12.2 V	Clear Load Shed 2

mcx30.com

Function	Battery Temperature Calculation	Battery Voltage Calculation	Action Taken
Load Shed 3 Start	-	Less Than 11.9 V	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 100% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 3 End	-	Greater Than 12.0 V	Clear Load Shed 3

STARTING SYSTEM DESCRIPTION AND OPERATION

Starter Motor Operation (Without KL9)

The starter motors are non-repairable. They have pole pieces that are arranged 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 crank signal is removed, the starter relay opens and battery voltage is removed from the starter solenoid S terminal. 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.

Enhanced Starter Motor Operation (KL9)

The Engine Stop/Start system in GM vehicles automatically turns off the engine when the vehicle comes to a stop under certain driving conditions, and can quickly restart the engine in about 0.3 seconds when commanded to do so.

In order to smoothly restart the engine as quickly as possible while managing the greater number of engine starts, the Stop/Start system uses an enhanced starter motor that operates differently from a conventional starter motor. It has a high performance electric motor and a stronger pinion engagement mechanism than a conventional starter. It also has independent control of the pinion and motor.

The enhanced starter motor continues using the typical pinion engagement mechanism with a starter solenoid that drives the pinion gear to engage or disengage the flywheel of the engine. When engaged, the starter motor can rotate the engine flywheel and, in turn, the crankshaft.

On the enhanced starter of a Stop/Start system the operation is done in two separate functions inside the solenoid, Starter Motor and Pinion Actuator. Each function controlled individually by the ECM. There are two separate relays to control the two separate parts of the enhanced solenoid:

- KR27 Starter Motor Relay
- KR27C Starter Pinion Actuator Relay

The two individually-controlled relays allow for smooth engagement of the pinion gear into the flywheel with minimum noise and wear.

When the vehicle is coming to a stop, just before the engine stops rotating (at approximately 50 RPM) during stop/start operation, the ECM energizes the Starter Pinion Solenoid Actuator Relay to easily push the pinion gear into the flywheel gear without gear clash. (Fig. 8) When the engine stops rotating during Stop/Start operation (Auto

Stop mode), the starter pinion gear is fully engaged, ready for the starter motor to become energized to quickly start the engine again.

A secondary need for the starter pinion to be driven into the flywheel gear before the engine stops rotating is to address quickly changing demands on the engine. For example, when a driver is slowing nearly to a stop - and the Stop/Start system is preparing for Auto Stop mode - but suddenly decides to release the brake and accelerate

In this situation, the engine has already stopped rotating, or nearly so. A conventional starter cannot restart the engine until the engine has completely stopped. However, with the enhanced starter, the starter pinion gear is fully engaged and ready to begin rotating the engine even before it fully stops turning. Otherwise, the engine would actually have to stop rotating before the pinion can engage smoothly to begin a restart.

To prevent a lag in engine operation, the ECM uses predictive speed matching of the flywheel gear speed and the pinion gear speed to engage the pinion gear into the flywheel gear without gear clash before the engine fully stops. By predicting how long it takes the starter motor to spin up using an algorithm, the pinion gear speed can be matched to the flywheel gear speed. The result is an almost instant restart that is possible at extremely low engine speeds.

Circuit Description

Keyless Start

When the Ignition mode switch is placed in the crank position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the crank 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 positive voltage is supplied through the switch side of the crank relay to the S terminal of the starter solenoid.

Key Start

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 or Neutral. If it is, the ECM then supplies 12 V to the control circuit of the crank relay. When this occurs, battery positive voltage is supplied through the switch side of the crank relay to the S terminal of the starter solenoid.

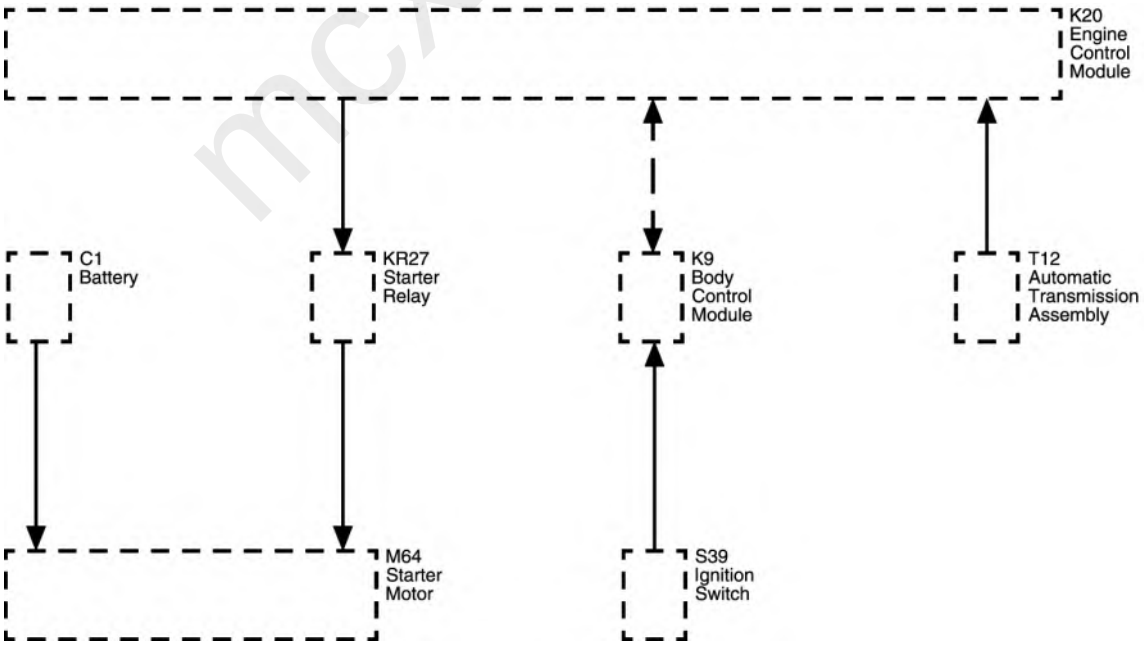


Fig. 271: Starting System Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
K20	K20 Engine Control Module
C1	C1 Battery
KR27	KR27 Starter Relay
K9	K9 Body Control Module

Callout	Component Name
T12	T12 Automatic Transmission Assembly
M64	M64 Starter Motor
S39	S39 Ignition Switch

STOP/START SYSTEM DESCRIPTION AND OPERATION

The Stop/Start System is used to improve fuel efficiency in stop/start driving. The vehicle automatically shuts down the engine in appropriate conditions at a traffic light, for example, resulting in zero tail pipe emissions and saving fuel which otherwise is used idling the engine when stationary. The engine instantly restarts when the driver is ready to move away.

As soon as the driver prepares to move away (by releasing the brake pedal and/or depressing the accelerator pedal), the engine will start; it only takes the system around 0.3 s to start the engine.

To support the increased number of engine starts, the starter motor is upgraded with a high performance electric motor and a stronger pinion engagement mechanism with reduced noise levels.

Along with the upgraded starter motor, advanced battery technology is required to ensure the vehicles battery can handle the frequent charge and discharge cycles common with stop/start operation. There is an intelligent battery sensor connected to the battery which continually monitors the battery charge and healthy state. The engine control module (ECM) uses this information from the intelligent battery sensor to determine if the battery charge and health is sufficient for an Stop/Start condition.

The Stop/Start system can reduce fuel consumption and carbon dioxide (CO2) emissions by up to 5% in mixed driving conditions. In an urban environment and in heavy traffic with frequent stops the savings may increase to as much as 10%.

There are also sophisticated controls in place to help ensure the Stop/Start System does not compromise the needs of either the driver or vehicle. For the engine to shutdown, the vehicle must be below 5 km/h (3 MPH), the selector lever in position D, and brake pedal depressed. To restart, the driver simply releases the brake pedal and the enhanced starter motor engages the engine. When the engine has been shut down by the Stop/Start System, a control indicator will be illuminated in the Driver Information Center (DIC). When the engine is restarted, the control indicator in the DIC extinguishes.

To ensure neither the needs of the driver or vehicle are compromised the engine will not shut down in the following circumstances:

- Ambient and coolant temperature correlation does not match specified values.
- Ambient temperature is less than -10Ã‚Â°C (14Ã‚Â°F)
- Battery temperature is less than 0Ã‚Â°C (32Ã‚Â°F) or greater than 55Ã‚Â°C (131Ã‚Â°F)
- Driver seat belt is not fastened and the drivers door is not fully closed (not applicable to vehicles in North America)
- HVAC system demand is high
- HVAC defrost has been selected
- Battery charge is low
- The learn procedure needs to be completed on the Battery Sensor Module

Likewise the engine will automatically restart if:

- Driver door opened and driver seat belt unbuckled (not applicable to vehicles in North America)
- Engine hood opened
- Battery charge is low
- HVAC demand increases
- Vehicle speed increases
- Brake booster vacuum has been reduced
- Engine coolant temperature is greater than 125Ã‚Â°C (257Ã‚Â°F)
- Economy mode turned OFF by driver
- Autostop time exceeded 2 min

When the Stop/Start System has shut down the engine, and the ambient temperature is below 15Ã‚Â°C (59Ã‚Â°F), the ECM will activate the Stop/Start auxiliary relay which controls the electric engine coolant pump motor to continually circulate the engine coolant through the engine while the engine is off. This is to ensure the engine and passenger compartment temperature is maintained while off. Once the Stop/Start System has restarted the engine, the ECM will turn off the electric coolant pump motor, thus allowing the engines internal coolant pump to circulate the engine coolant. The Stop/Start System is automatically activated each time the ignition switch is turned on

Autostop Criteria

The ECM will send an Autostop state message to the body control module (BCM) and shut down the engine when all of the following criteria is met. The BCM will transmit the Autostop state message to the instrument cluster which will display the Autostop indicator in the tachometer display.

- Economy mode turned ON
- Initial minimum vehicle speed during drive cycle must be 19 km/h (12 MPH) or greater. Subsequent autostop minimum speed may vary from 2-10 km/h (1-6 MPH), depending on vehicle
- Ambient and engine coolant temperature correlation meets specified values.
- Ambient and transmission fluid temperature correlation meets specified values.
- Hood switch status is closed
- Driver door status is closed
- Driver seat belt status is buckled
- Brake booster vacuum is greater than 45 kPa (7 PSI)
- Transmission gear selector is in the Drive position
- Vehicle speed is less than 5 km/h (3 MPH)
- Engine speed is below 1 500 RPM
- Engine coolant temperature is less than 120Ã‚Â°C (248Ã‚Â°F)
- Ambient temperature is greater than -10Ã‚Â°C (14Ã‚Â°F)
- No A/C compressor request from HVAC (A/C or Defrost modes)
- Battery voltage greater than 12 V
- Battery state of charge greater than 75% (changes with state of health)

Autostop Enable Ambient and Engine Coolant Temperature Table

Ambient Temperature	inimum Coolant Temperature	Autostop Enable
-10Ã‚Â°C (14Ã‚Â°F)	60Ã‚Â°C (140Ã‚Â°F)	Yes
0Ã‚Â°C (32Ã‚Â°F)	50Ã‚Â°C (122Ã‚Â°F)	Yes
6Ã‚Â°C (43Ã‚Â°F)	40Ã‚Â°C (104Ã‚Â°F)	Yes
12Ã‚Â°C (54Ã‚Â°F)	30Ã‚Â°C (86Ã‚Â°F)	Yes
20Ã‚Â°C (68Ã‚Â°F)	18Ã‚Â°C (64Ã‚Â°F)	Yes
30Ã‚Â°C (86Ã‚Â°F)	18Ã‚Â°C (64Ã‚Â°F)	Yes

Autostart Criteria

The ECM will send an Autostart state message to the BCM. If all of the following conditions are true the ECM and BCM will restart the vehicle.

Driver Enabled Conditions that will engage Autostart:

- Driver removes pressure from the brake or depresses the accelerator pedal while the vehicle is in the forward Drive gear

System Enabled Conditions that will engage Autostart

NOTE: **If one or more of the following conditions occur, the system will force the engine to restart.**

- Economy mode turned OFF
- Brake booster vacuum is less than 40 kPa (6 PSI)
- HVAC inside air temperature changes than 3Ã‚Â°C (5Ã‚Â°F) (with HVAC Automatic)

- A/C compressor request from HVAC (A/C or Defrost modes)
- Battery voltage less than 11 V,
- Battery state of charge is less than 73% (changes with state of health)
- Driver door status changes to open and driver seat belt status changes to unbuckled (not applicable to vehicles in North America)
- Hood switch status changes to open
- Autostop time exceeded 2 min

If the crank time exceeds 2 s, a manual ignition switch restart will be necessary.

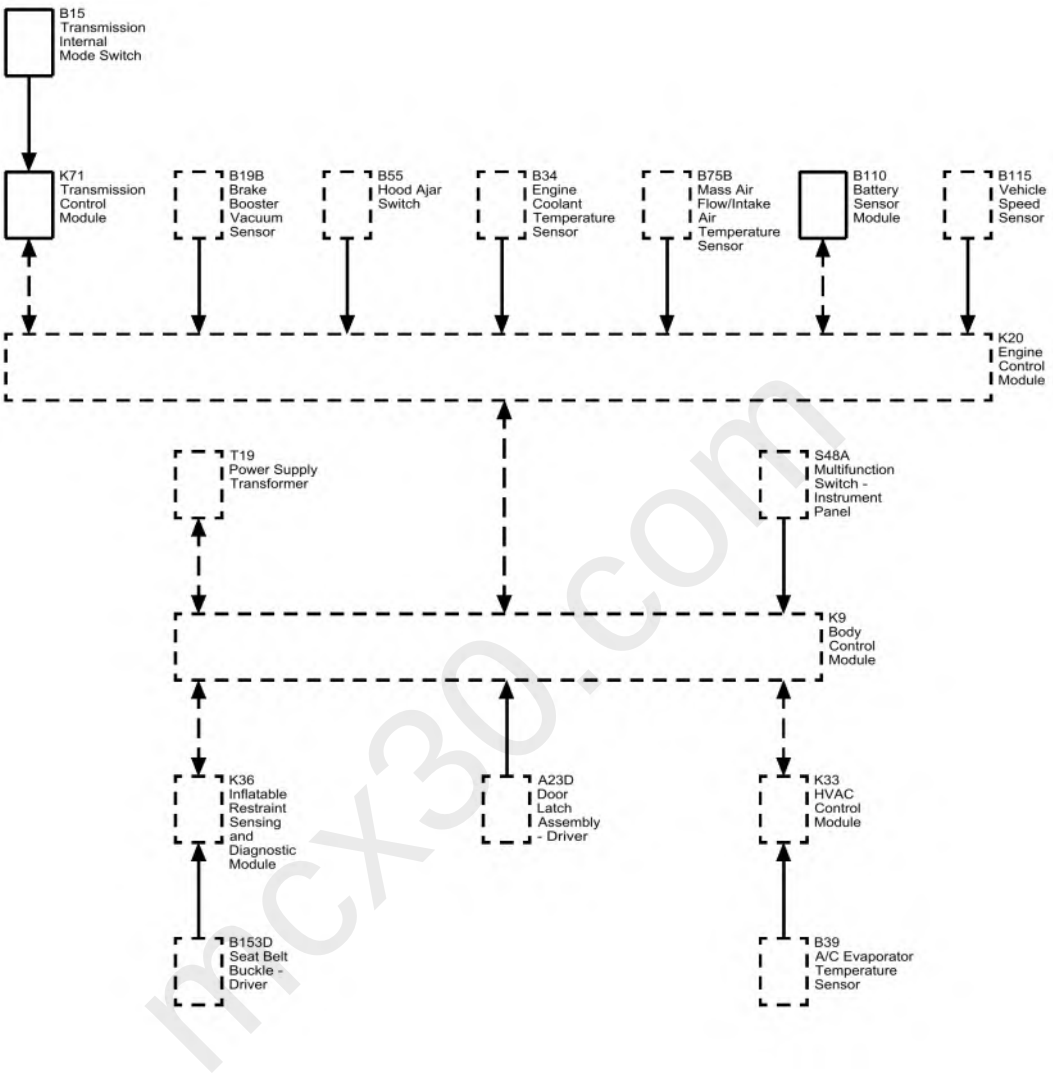


Fig. 272: Autostart System Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
B15	B15 Transmission Internal Mode Switch
K71	K71 Transmission Control Module
B19B	B19B Brake Booster Vacuum Sensor
B55	B55 Hood Ajar Switch
B34	B34 Engine Coolant Temperature Sensor
B75B	B75B Mass Air Flow/Intake Air Temperature Sensor
B110	B110 Battery Sensor Module
B115	B115 Vehicle Speed Sensor
K20	K20 Engine Control Module
T19	T19 Power Supply Transformer
K9	K9 Body Control Module
K33	K33 HVAC Control Module
B39	B39 A/C Evaporator Temperature Sensor
A23D	A23D Door Latch Assembly - Driver

Callout	Component Name
K36	K36 Inflatable Restraint Sensing and Diagnostic Module
B153D	B153D Seat Belt Buckle - Driver
S48A	S48A Multifunction Switch - Instrument Panel

System Components

Engine Control Module (ECM)

The engine control module (ECM) monitors the inputs from the engine coolant temperature (ECT) sensor, vehicle speed sensor (VSS), hood ajar switch, brake booster vacuum sensor, the clutch pedal position sensor, the manual transmission neutral position switch and engine speed to determine Autostart and Autostop conditions. The ECM also controls the auxiliary coolant pump motor.

Transmission Control Module (TCM)

The transmission control module monitors the inputs from the transmission neutral safety switch to determine the driver selected gear. This information is transmitted to the ECM via serial data to support the Auto Stop Start algorithm.

Engine Coolant Temperature sensor

The ECT sensor is used to determine engine operating temperature.

Intake Air Temperature Sensor

The ECM uses this sensor to monitor ambient air temperature. If too cold, the Autostop will not occur.

Inside air temperature sensor

The HVAC control module monitors the passenger compartment temperature sensor to determine the temperature inside the passenger compartment. The HVAC control module sends this temperature reading to the ECM on the data communication circuit. The ECM uses this temperature values to determine if a restart is requires based on the temperature inside the passenger compartment.

Vehicle speed sensor

The vehicle speed sensor is used to determine vehicle speed. If vehicle speed is detected above a calculated value during an Autostop condition, the ECM will start the engine.

Hood Ajar Switch

If the hood switch is in the open position, the vehicle will not Autostop. If the hood is opened during Autostop, the vehicle will automatically restart.

Brake Booster Vacuum Sensor

The ECM monitors vacuum in order to ensure proper power assist for the brake pedal. If the ECM determines vacuum is too low, it will restart the engine.

Brake Pedal Position Sensor & Accelerator Pedal Position Sensor

The ECM monitors both the brake pedal position sensor and the accelerator pedal position sensor to determine the level of activation for each. While the accelerator pedal is in it's at rest position with no pressure applied by the operator, a partially depressed Brake pedal will cause the ECM to prepare the engine for an Autostop event. When the vehicle is in an auto stop event and the status of the brake pedal position sensor changes from meeting the autostop criteria to not meeting this criteria the engine will be restarted provided all of the other conditions to allow an autostart are met. If the Accelerator pedal is moved from its at rest position the vehicle will also enter an auto start event if all other conditions to support an autostart event, except for the brake pedal position, are met.

Transmission Gear Shift Position Switch

The transmission gear shift position switch is used to determine if the transmission is in the proper state to allow an auto stop/start event. The ECM will not allow Autostop until the brake is engaged, the transmission is in the forward

mcx30.com

gear position and then the vehicle slows to below the minimum speed required to allow and autostop while meeting all of the other minimum criteria to support an autostop event.

Coolant Pump Motor

The ECM will turn on the auxiliary coolant pump motor during Autostop to maintain engine operating temperature and also maintain HVAC temperature. Once the engine is running, the ECM will turn off the coolant pump motor.

Body Control Module (BCM)

The body control module (BCM) is the master of the low speed communication bus and transfers the appropriate messages to the instrument cluster and the HVAC.

Battery Sensor Module

The ECM monitors the intelligent battery sensor for battery state of current, state of health, and battery charge via the data communication bus. If the battery is determined to be in poor state of health or having a low charge, the ECM will not allow Autostop to occur.

Power Supply Transformer

The DC to DC converter monitors battery voltage and will maintain operating voltage to the radio, instrument cluster and instrument panel displays. The DC to DC converter will provide a boosted voltage to sensitive loads during Autostart to ensure proper operation of the driver informational displays.

Driver Door Switch

The BCM monitors the driver door switch at all times. The BCM will not allow Autostop if the door is ajar and will Autostart if the driver door is opened and the seat belt unbuckled during Autostop.

Driver Seat Belt Switch

The BCM monitors the driver seat belt switch at all times. The BCM will Autostart if the seat belt is unbuckled and the driver door opened during Autostop.

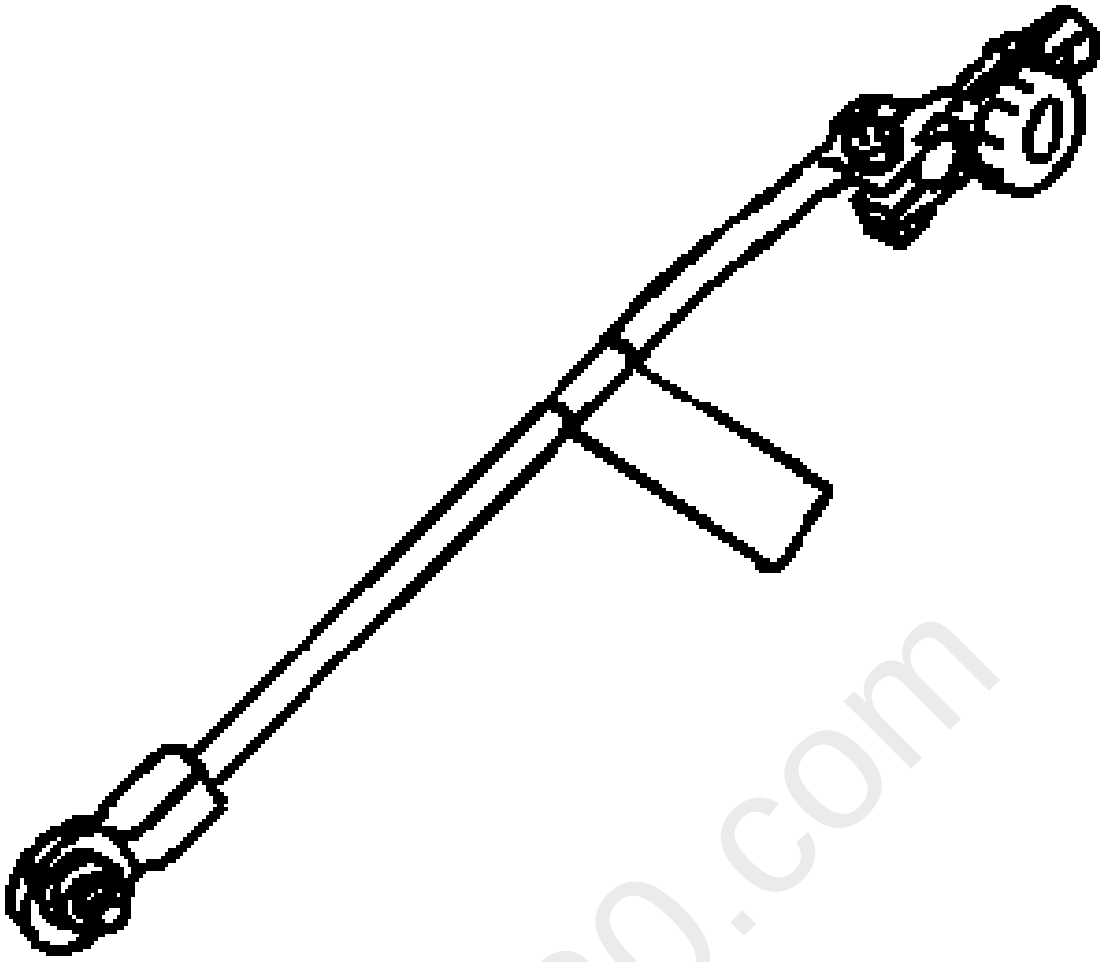
Instrument Cluster

In order to differentiate between a normal engine shut down (engine speed 0 RPM) and when the engine has been shut down by the Stop/Start System, the tachometer needle will rest at the Autostop indicator icon (500 RPM point) indicating the engine has been shut down by the Stop/Start System. Once the engine is restarted, the tachometer will function normally.

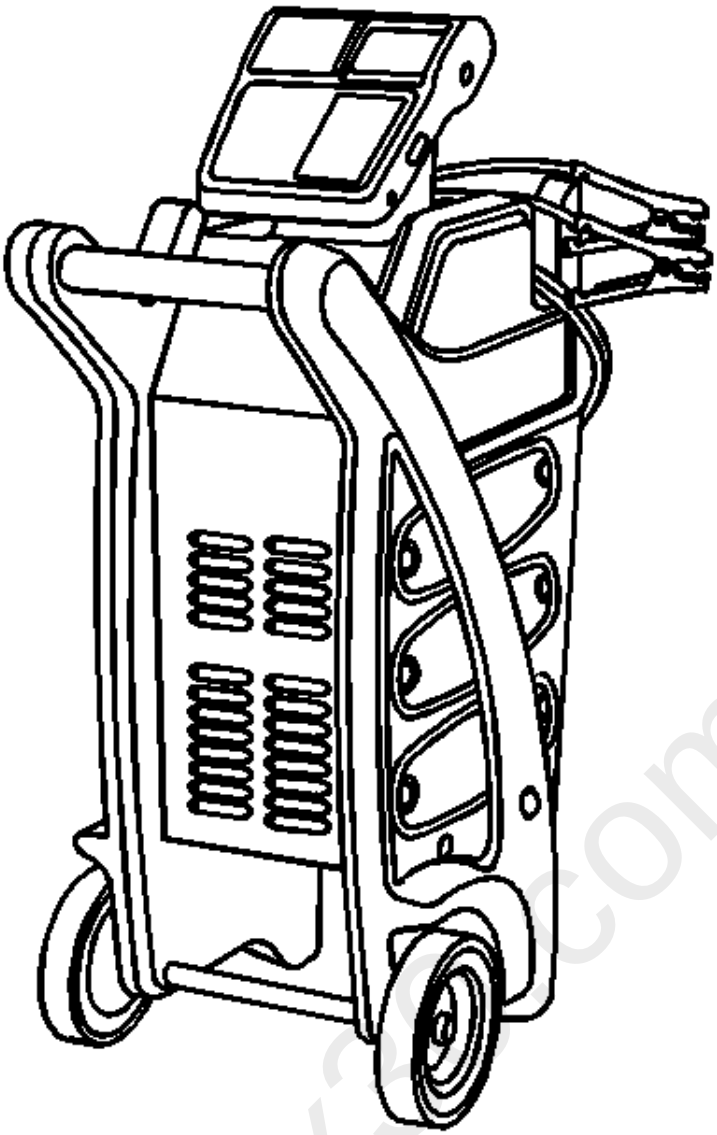
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

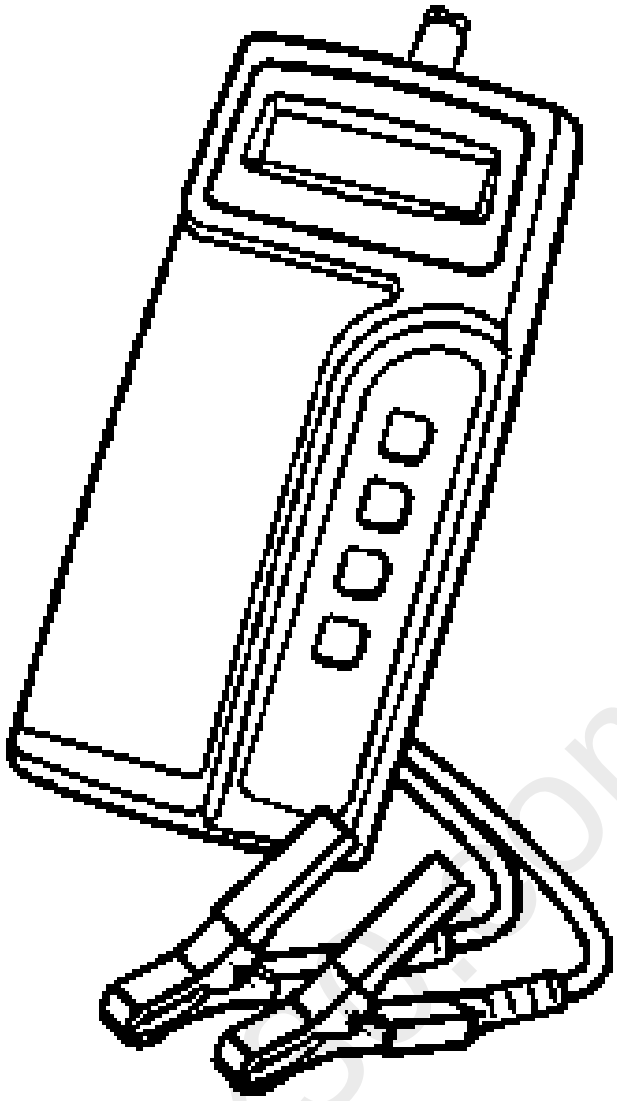
Illustration	Tool Number/Description

Illustration	Tool Number/Description
	EL 38758 EL 50074 J 38758 Parasitic Draw Test Switch

mcx30.com

Illustration	Tool Number/Description
	BC 800 W BC 800 WP EL 50313 EL 42000 EL 50076 Battery Tester
	J 42000 Battery Tester

mcx30.com

Illustration	Tool Number/Description
	

mcx3...com

Back To Article

SPECIFICATIONS

TEMPERATURE VERSUS RESISTANCE

Temperature	Resistance
150Â°C (302Â°F)	42 to 44 Ω
140Â°C (284Â°F)	53 to 57 Ω
130Â°C (266Â°F)	68 to 72 Ω
120Â°C (248Â°F)	88 to 92 Ω
110Â°C (230Â°F)	114 to 120 Ω
100Â°C (212Â°F)	151 to 159 Ω
90Â°C (194Â°F)	203 to 215 Ω
80Â°C (176Â°F)	275 to 293 Ω
70Â°C (158Â°F)	379 to 405 Ω
60Â°C (140Â°F)	532 to 572 Ω
50Â°C (122Â°F)	762 to 824 Ω
45Â°C (113Â°F)	921 to 997 Ω
40Â°C (104Â°F)	1118 to 1212 Ω
35Â°C (95Â°F)	1366 to 1484 Ω
30Â°C (86Â°F)	1683 to 1829 Ω
25Â°C (77Â°F)	2088 to 2266 Ω
20Â°C (68Â°F)	2608 to 2828 Ω
15Â°C (59Â°F)	3289 to 3567 Ω
10Â°C (50Â°F)	4182 to 4532 Ω
5Â°C (41Â°F)	5356 to 5800 Ω
0Â°C (32Â°F)	6914 to 7484 Ω
-5Â°C (23Â°F)	8994 to 9732 Ω
-10Â°C (14Â°F)	11796 to 12762 Ω
-15Â°C (5Â°F)	15589 to 16871 Ω
-20Â°C (-4Â°F)	20791 to 22517 Ω
-30Â°C (-22Â°F)	37991 to 41273 Ω
-40Â°C (-40Â°F)	72230 to 78834 Ω

FASTENER SPECIFICATIONS

Single Use Non-Threaded Fasteners/Components

NOTE:

All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application
Engine Coolant Heater Seal
Engine Coolant Thermostat Housing Gasket
Engine Oil Cooler Gasket
Thermostat Bypass Pipe Gasket
Turbocharger Coolant Feed Pipe Retainer
Turbocharger Coolant Return Pipe Hose Clamp
Water Outlet Seal

NOTE:

All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application
Water Pump Gasket

Reusable Threaded Fastener Tightening Specifications

NOTE:

All fasteners listed in this table can be reused after removal.

Application	Specification
	Metric (English)
Auxiliary Water Pump Bracket Bolt (LTG)	22 N.m (16 lb ft)
Auxiliary Water Pump Bracket Bolt (LYX)	9 N.m (80 lb in)
Auxiliary Water Pump Bracket Nut (LH7)	22 N.m (16 lb ft)
Engine Block Drain Plug	22 N.m (16 lb ft)
Engine Coolant Fan Bolt (LH7, LTG, LYX)	5 N.m (44 lb in)
Engine Coolant Heater (LYX)	50 N.m (37 lb ft)
Engine Coolant Thermostat Housing Bolt (LYX)	10 N.m (89 lb in)
Engine Oil Cooler Large Bolt (LYX)	25 N.m (18 lb ft)
Engine Oil Cooler Small Bolt (LYX)	10 N.m (89 lb in)
Ground Nut	9 N.m (80 lb in)
Radiator Surge Tank Bolt	9 N.m (80 lb in)
Radiator Upper Bracket Bolt	14 N.m (10 lb ft)
Thermostat Bypass Pipe Bolt (LYX)	10 N.m (89 lb in)
Turbocharger Coolant Feed Pipe Hollow Screw (LYX)	35 N.m (26 lb ft)
Turbocharger Coolant Return Pipe Fastener (LYX)	10 N.m (89 lb in)
Turbocharger Coolant Return Pipe Hollow Screw (LYX)	35 N.m (26 lb ft)
Water Outlet Bolt (LYX)	10 N.m (89 lb in)
Water Pump Bolt (LYX)	25 N.m (18 lb ft)

APPROXIMATE FLUID CAPACITIES

Application	Specification	
	Metric	US English
Cooling Systems		
1.4 L (LH7) Engine	7.5 L	7.9 qt
2.0 L (LTG) Engine	7.8 L	8.2 qt
1.5 L (LYX) Engine	6.6 L	7.0 qt

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	
		United States	Canada
DEX-COOLÂ®	Coolant	12346290	10953464
Extended Life Coolant Leak Detection Dye	Dye	89022219	89022220

SCHEMATIC WIRING DIAGRAMS

ENGINE HEATING/COOLING WIRING SCHEMATICS

Cooling Fan

mcx30.com

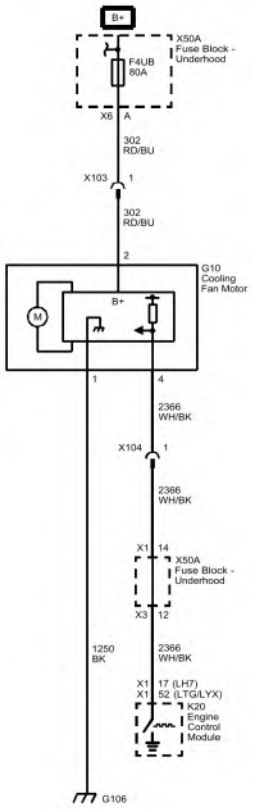


Fig. 1: Cooling Fan
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0480, P0691 OR P0692: COOLING FAN RELAY 1 CONTROL CIRCUIT

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**
- An overview of each diagnostic category can be found here: **Diagnostic Procedure Instructions**

DTC Descriptor

DTC P0480

Cooling Fan Relay 1 Control Circuit

DTC P0691

Cooling Fan Relay 1 Control Circuit Low Voltage

DTC P0692

Cooling Fan Relay 1 Control Circuit High Voltage

Circuit/System Description

For an overview of the component/system, refer to **Cooling Fan Description and Operation**

Circuit	Description
Ground	Chassis Ground
B+	Supplied from a relay.
Control	The output is PWM controlled.

mcx30.com

Component	Description
G10 Cooling Fan Motor	The control module receives a PWM signal from the control module K20 and converts it into another PWM signal which directly supplies the fan motor.
K20 Engine Control Module	The control module contains a microprocessor used to process input data to control outputs. The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Conditions for Running the DTC

- Ignition - On / Vehicle - In Service Mode
- Battery Voltage=Greater than 11 V

Conditions for Setting the DTC

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

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category=Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category=Type B DTC

Reference Information

Schematic Reference

Engine Heating/Cooling Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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

Circuit/System Verification

1. Ignition - On / Vehicle - In Service Mode
2. Perform the scan tool control function:Cooling Fan - 0 to 90%

   Verify the component activates:Cooling Fan Motor

   - **If the component does not activate**

mcx30.com

Refer to Circuit/System Testing below

- **Go to next step: If the component activates**

3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to Circuit/System Testing

   - **Go to next step: If the DTC is not set**

4. All OK.

Circuit/System Testing

NOTE: **It may take up to 2 min for all vehicle systems to power down before an accurate ground or low reference circuit continuity test can be performed.**

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector:@G10 Cooling Fan Motor
3. Connect a test lamp between the test points:Control circuit terminal 4 & B+

   Verify the test lamp does not turn On.

   - **If the test lamp turns On**
   1. Disconnect the electrical connector: X1 @ K20 Engine Control Module
   2. Test for infinite resistance between the test points:Control circuit terminal 52 @ Control module harness & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance - Replace the component:K20 Engine Control Module
   - **Go to next step: If the test lamp does not turn On**

4. Ignition - On / Vehicle - In Service Mode
5. Perform the scan tool control function:Cooling Fan - 0 to 90%

   Verify the test lamp turns On.

   - **If the test lamp does not turn On**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: X1 @ K20 Engine Control Module
   3. Test for less than 2 Ω between the test points:Control circuit terminal 52 @ Control module harness & Terminal 4 @ Control module harness
      - If 2 Ω or greater - Repair the open/high resistance in the circuit.
      - If less than 2 Ω
   4. Connect the electrical connector: X1 @ K20 Engine Control Module
   5. Ignition - On / Vehicle - In Service Mode
   6. Test for less than 1 V between the test points:Terminal 4 @ Control module harness & Ground
      - If 1 V or greater - Repair the short to voltage on the circuit.
      - If less than 1 V - Replace the component:K20 Engine Control Module
   - **Go to next step: If the test lamp turns On**

     Replace the component:G10 Cooling Fan Motor

Repair Instructions

mx30.com

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Engine Coolant Fan Replacement (LYX)Engine Coolant Fan Replacement (LTG)Engine Coolant Fan Replacement (LH7)** - G10 Cooling Fan Motor
- For control module replacement, programming and setup, refer to **Control Module References**

DTC P2600, P2601, P2602, P2603: AUXILIARY COOLANT PUMP

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 P2600

Auxiliary Coolant Pump Relay Control Circuit

DTC P2601

Auxiliary Coolant Pump Performance

DTC P2602

Auxiliary Coolant Pump Relay Control Circuit Low Voltage

DTC P2603

Auxiliary Coolant Pump Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Auxiliary Coolant Pump Relay Coil Ignition Voltage	-	P2600	-	-
Auxiliary Coolant Pump Relay Switched B+	1	1	-	-
Auxiliary Coolant Pump Relay Control	P2602	P2600	P2603	-
Auxiliary Coolant Pump Relay Controlled Output	1	1	2	-

1. Auxiliary coolant pump inoperative.
2. Auxiliary coolant pump always ON

Typical Scan Tool Data

Auxiliary Coolant Pump Relay Control Circuit Open, Low or High Voltage Test Status - Component Commanded OFF

Circuit	Short to Ground	Open	Short to Voltage

mcx80.com

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	Malfunction	-
Auxiliary Coolant Pump Relay Control	Malfunction	Malfunction	Not Run

Auxiliary Coolant Pump Relay Control Circuit Open, Low or High Voltage Test Status - Component Commanded 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	-
Auxiliary Coolant Pump Relay Control	Not Run	Not Run	Malfunction

Circuit/System Description

The auxiliary coolant pump and cooling fan system provides a measure of prevention against fuel vaporization due to excessive engine temperatures. The engine control module (ECM) commands the auxiliary or after boil coolant pump ON when the engine coolant temperature exceeds a calibrated value after engine shut down. The ECM applies ground to the coil side of the auxiliary pump printed circuit board (PCB) relay. This energizes the coil and applies voltage directly to the pump motor through the switch side of the relay. When the auxiliary coolant pump is activated, coolant is drawn from radiator and pumped into the engine through a tee in the engine coolant inlet pipe. As the colder temperature coolant is drawn into the engine warmer coolant is expelled from the engine and back to the radiator. Removing high temperature coolant from the engine after shut down helps prevent vaporization of the fuel that remains in the fuel injectors and fuel rail during a hot soak.

Conditions for Running the DTC

P2600, P2602 or P2603

- The engine speed is greater than 80 RPM.
- The ignition voltage is between 10 - 18 V.
- The ECM has commanded the pump ON and OFF at least once during the ignition cycle.
- The DTCs run continuously once the above conditions are met.

P2601

- DTC P0111, P0112, P0113, P0116, P0117, P0118, P0119, P2600, P2602 or P2603 is not set.
- The ignition is OFF.
- The engine coolant temperature (ECT) at engine shut down is warmer than 110Â°C (230Â°F).
- The auxiliary coolant pump is enabled.
- The DTC runs continuously once the conditions above are met for greater than 30 S.

Conditions for Setting the DTC

P2600

The ECM detects the pump control circuit is open. The condition exists for 4 S or a cumulative of 30 S.

P2601

The ECM detects that the ECT decreases less than 2Â°C (4Â°F) within 60 S. The condition exists for 4 S or a cumulative of 30 S.

P2602

The ECM detects the pump control circuit is shorted to ground. The condition exists for 4 S or a cumulative of 30 S.

P2603

The ECM detects the pump control circuit is shorted to voltage. The condition exists for 4 S or a cumulative of 30 S.

Action Taken When the DTC Sets

The DTCs are Type C DTCs.

Conditions for Clearing the DTC

The DTCs are Type C DTCs.

Diagnostic Aids

- This diagnostic uses a comprehensive approach to the diagnosis of the KR31 auxiliary coolant pump relay and its related circuits. The auxiliary coolant pump relay is a printed circuit board (PCB) relay. The relay is an integral component to the underhood bussed electrical center (UBEC). It cannot be removed and it is not visible.
- Much of the diagnosis is performed at the ECM connectors. Great care should be taken to ensure that the correct terminals are tested and the proper test probes are utilized when performing this diagnostic.
- The test lamp is used to provide a visual aid to observe the integrity of the KR31 relay, the UBEC and the relay control circuit.
- Grounding terminal X2-58 activates the powertrain relay, which will supply power through KR31 relay coil and the relay control circuit. Under normal circumstances the test lamp will illuminate with dim intensity due to the load created by the KR31 relay coil. If the test lamp does not illuminate, or illuminates brightly a condition exists in the KR31 relay control circuit or the UBEC.

Reference Information

Schematic Reference

- **Engine Heating/Cooling Wiring Schematics**
- **Engine Controls Wiring Schematics (1.5L (LYX))**

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Electrical Center Identification Views**

Electrical Information Reference

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

DTC Type Reference

mx30.com

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, verify that DTC P0480, P0691, or P0692, is not set.
   - If a DTC is set, refer to DTC P0480, P0691 or P0692 for further diagnosis.

NOTE: **There is a slight delay before the cooling fan activates and reaches full speed.**

2. Command the cooling fan ON from 20 - 90% with a scan tool. Verify that the cooling fan turns ON and operates as commanded.
   - If the cooling fan does not respond to the commanded states, refer to Cooling Fan Inoperative for further diagnosis.
3. Ignition ON, command the KR31 auxiliary coolant pump relay ON and OFF with the scan tool. An audible click should be heard when changing between the commanded states.
4. Command the KR31 auxiliary coolant pump relay ON and OFF while observing the scan tool parameters listed below:
   - Auxiliary Coolant Pump Relay Control Circuit Open Test Status
   - Auxiliary Coolant Pump Relay Control Circuit Low Voltage Test Status
   - Auxiliary Coolant Pump Relay Control Circuit High Voltage Test Status

   Each of the parameters should display OK or Not Run when changing between the commanded states.
5. Start the engine, observe the DTC information with a scan tool. DTCs P2600, P2602, or P2603 should not set.
   - If a DTC is set, refer to Circuit/System Testing for further diagnosis.
6. 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

CAUTION: **Use the connector test adapter kit EL-35616-F 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.

NOTE: **Refer to Diagnostic Aids before performing the Circuit/System Testing.**

1. Ignition OFF, disconnect harness connector X2 at the K20 engine control module.
2. Connect a test lamp between terminal X2-45 and ground.

NOTE:

- **A DMM connected between the test lamp probe and ground will measure 5 - 6 V if the test lamp illuminates with low intensity. The voltage will measure near B+ if the test lamp illuminates with bright intensity.**

mcx30.com

- **The values listed above are based on the use of the J-35616-210 test lamp, or a comparable test lamp that has approximately 30 Ω of internal resistance.**

3. Ignition ON, connect a fused jumper wire between the powertrain relay control circuit terminal X2-58 and ground. The test lamp should illuminate with low intensity.
    - If the test lamp does not illuminate, test the auxiliary coolant pump relay control circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the X50A fuse block.
    - If the test lamp illuminates with bright intensity, test the auxiliary coolant pump relay control circuit for a short to voltage. If the circuit tests normal, test or replace the X50A fuse block.
4. If all circuits/connections test normal, replace the K20 engine control module.

Repair Instructions

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

- **Battery Distribution Engine Compartment Fuse Block Replacement**
- **Control Module References** for ECM replacement, setup, and programming

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:
    - Engine control module (ECM) and malfunction indicator lamp (MIL) are operating correctly.
    - There are no diagnostic trouble codes (DTCs) 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 EL-35616-F 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:

- Ensure that the control module grounds are clean, tight, and correctly located.
- Inspect cooling system hoses and pipes for splits, kinks, and improper connections. Inspect thoroughly for any type of leak or restriction.

mx30.com

- Inspect for a dirty or restricted radiator or 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 coolant recovery reservoir for proper coolant level.

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:

- Water intrusion in connectors, terminals, or components
- Poor 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 temperatures
- High or low engine coolant temperatures
- High underhood temperatures
- Heat build up in components or circuits 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, or after factory add on accessories

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

Circuit/System Description

The engine cooling fan system is composed of one electric cooling fan and a cooling fan control module. The engine control module (ECM) controls the fan speed by sending a pulse width modulated (PWM) signal to the cooling fan control module. The cooling fan control module varies the voltage drop across the

cooling fan motor in relation to the pulse width modulated signal, which enables cooling fan operation at variable speeds. The ECM will only operate the cooling fan at certain percentages to prevent undesirable noise and vibration. The cooling fan control module is thermally protected to prevent module damage in the case of a short circuit condition in the cooling fan motor.

Diagnostic Aids

- Certain resistance conditions with IAT or ECT sensors may cause unwarranted cooling fan activation. If the ECM is commanding the cooling fan ON for no apparent reason and without any component or system DTCs set, the IAT or ECT sensor may be skewed. If this condition is suspected, refer to the temperature versus resistance tables in the appropriate engine controls subsection.
- The cooling fan will not operate when the scan tool Cooling Fan Motor Command parameter displays less than 4 %. This is a normal condition.

Reference Information

Schematic Reference

Engine Heating/Cooling Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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. Ignition ON.
2. Verify that DTC P0480, P0691, or P0692, is not set.
   - **If a DTC is set**

     Refer to **DTC P0480, P0691, or P0692**.

   - **Go to next step: If no DTC is set.**
3. Verify the scan tool Cooling Fan Motor Command parameter is less than 4 %.
   - **If 4% or greater**

     Refer to **Diagnostic Aids** and **Symptoms - Engine Cooling** for further diagnosis.

   - **Go to next step: If less than 4 %**
4. Verify that the G10 Cooling Fan Motor is not operating.
   - **If the G10 Cooling Fan Motor is operating**

     Test or replace the G10 Cooling Fan Motor.

   - **Go to next step: If the G10 Cooling Fan Motor is not operating**

mcx30.com

5. All OK.

Repair Instructions

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

- **Engine Coolant Fan Replacement (LYX)Engine Coolant Fan Replacement (LTG)Engine Coolant Fan Replacement (LH7)** for G10 Cooling Fan Motor Replacement.
- **Control Module References**

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 is composed of one electric cooling fan and a cooling fan control module. The engine control module (ECM) controls the fan speed by sending a pulse width modulated (PWM) signal to the cooling fan control module. The cooling fan control module varies the voltage drop across the cooling fan motor in relation to the pulse width modulated signal, which enables cooling fan operation at variable speeds. The ECM will only operate the cooling fan at certain percentages to prevent undesirable noise and vibration. The cooling fan control module is thermally protected to prevent module damage in the case of a short circuit condition in the cooling fan motor.

Diagnostic Aids

- During normal operating conditions the ECM may initially activate the cooling fan at 4 or 5 % and then increase, as needed, to satisfy powertrain cooling requirements.

Reference Information

Schematic Reference

Engine Heating/Cooling Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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

Special Tools

EL 36169 - HD Heavy Duty Fused Jumper

Circuit/System Verification

mcx30.com

1. Ignition ON.
2. Verify that DTC P0480, P0691, or P0692, is not set.
    - **If a DTC is set**

      Refer to **DTC P0480, P0691, or P0692**.

    - **Go to next step: If no DTC is set.**

    NOTE: **A slight delay may occur before the cooling fan activates.**

3. Verify the G10 Cooling Fan Motor activates when A/C is On.
    - **The cooling fan does not activate**

      Refer to Circuit/System Testing

    - **Go to next step: The cooling fan activates**
4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the G10 Cooling Fan Motor harness connector.
2. Ignition ON, verify that a test lamp illuminates between ground circuit terminal 1 and B+.
    - **If the test lamp does not illuminate**
    1. Ignition OFF, test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
3. Verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
    2. Test for less than 2 Ω in the B+ circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
    2. Test for infinite resistance between the B+ circuit and ground.
        - If less than infinite resistance, repair the short to ground in the circuit.
        - If infinite resistance, replace the G10 Cooling Fan Motor.
    - **Go to next step: If the test lamp illuminates**

    NOTE: **The cooling fan speed output circuit is pulled-up to a voltage within the ECM, 2-3 volts on the output circuit is normal.**

4. Connect a DMM, set on the diode setting, between the control circuit terminal 4 and ground.
5. Verify the DMM reading is greater than 2.5 V or displays O.L. with the cooling fan commanded OFF.
    - **If 2.5 V or less**
    1. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
    2. Disconnect the harness connector X1 at the K20 Engine Control Module.
    3. Test for infinite resistance between the G10 Cooling Fan Motor control circuit terminal 4 and ground.
        - If less than infinite resistance, repair the short to ground in the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.

mc30.com

- **Go to next step: If greater than 2.5 V or displays O.L.**

6. Activate the cooling fan ON by turning on the A/C.
7. Verify the DMM reading is less than 1 V.
    - **If 1 V or greater**
    1. Ignition OFF.
    2. Disconnect the harness connector X1 at the K20 Engine Control Module, ignition ON.
    3. Test for less than 1 V between the G10 Cooling Fan Motor control circuit terminal 4 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V.
    4. Ignition OFF, and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
    5. Test for less than 2 Ω in the G10 Cooling Fan Motor control circuit end to end.
        - If 2 Ω or greater, repair the open in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **Go to next step: If less than 1 V**
8. Replace the G10 Cooling Fan Motor.

Component Testing

1. Ignition OFF.
2. Disconnect the G10 Cooling Fan Motor harness connector from the G10 Cooling Fan Motor.
3. Connect the **EL 36169 - HD** between the G10 Cooling Fan Motor terminal 1 and B+. Connect a jumper wire between the G10 Cooling Fan Motor terminal 2 and ground.
4. Verify the G10 Cooling Fan Motor operates.
    - **The cooling fan does not operate**

      Replace the G10 Cooling Fan Motor.

    - **Go to next step: The cooling fan operates**
5. All OK.

Repair Instructions

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

- **Engine Coolant Fan Replacement (LYX)Engine Coolant Fan Replacement (LTG)Engine Coolant Fan Replacement (LH7)**
- **Control Module References**

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 surge tank onto the ground while the engine is running.			
1	Check for a loss of coolant. **Loss of Coolant** Is there a loss of coolant?	Go to **Step 2**	Go to **Step 3**
2	Fill the system to the specified level. Does the engine still overheat?	Go to **Step 3**	System OK
3	Check for kinked or pinched surge tank hoses, especially at the radiator. Are any surge tank hoses kinked or pinched?	Go to **Step 4**	Go to **Step 5**

mcx30.com

Step	Action	Yes	No
4	1. Relieve any kinks by rerouting the hoses. 2. Replace the hoses, if necessary. Does the engine still overheat?	Go to **Step 5**	System OK
5	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 6**	Go to **Step 7**
6	Repair or replace any loose, missing, or damaged radiator air seals or deflectors. Does the engine still overheat?	Go to **Step 7**	System OK
7	Check the coolant concentration. Does the coolant concentration test correctly?	Go to **Step 9**	Go to **Step 8**
8	Replace the coolant, if necessary. Does the engine still overheat?	Go to **Step 9**	System OK
9	**NOTE:** **Use the correct pressure cap.** Check the system for loss of pressure. **Pressure Cap Testing**Is there a loss of pressure?	Go to **Step 10**	Go to **Step 11**
10	Repair any leaks, as necessary. Does the engine still overheat?	Go to **Step 11**	System OK
11	Check for a faulty engine coolant temperature sensor. Is the engine coolant temperature sensor faulty?	Go to **Step 12**	Go to **Step 13**
12	Replace the engine coolant temperature sensor. **Engine Coolant Temperature Sensor Replacement** Does the engine still overheat?	Go to **Step 13**	System OK
13	Check the radiator for any air flow obstructions or bent fins. Is there any airflow obstruction or bent fins?	Go to **Step 14**	Go to **Step 15**
14	1. Remove or relocate add-on parts that block air flow to the radiator. 2. Clean any debris from the radiator core. Does the engine still overheat?	Go to **Step 15**	System OK
15	Check for any blocked cooling system passages including inoperative or obstructed in-line auxiliary electric pumps. Are there any blocked cooling system passages?	Go to **Step 16**	Go to **Step 17**
16	1. Remove any obstruction. 2. Flush the cooling system, as required. 3. Refill the coolant. Does the engine still overheat?	Go to **Step 17**	System OK
17	Check for an inoperative cooling fan. Is the cooling fan inoperative?	Go to **Step 18**	Go to **Step 19**
18	Replace the cooling fan. **Engine Coolant Fan Replacement (LYX)Engine Coolant Fan Replacement (LTG)Engine Coolant Fan Replacement (LH7)** Does the engine still overheat?	Go to **Step 19**	System OK

mox30.com

Step	Action	Yes	No
19	Check for a thermostat that is stuck closed. **Thermostat Diagnosis** Is the thermostat stuck closed?	Go to **Step 20**	Go to **Step 21**
20	Replace the thermostat housing. **Engine Coolant Thermostat Housing Replacement (LYX)Engine Coolant Thermostat Housing Replacement (LTG)** Does the engine still overheat?	Go to **Step 21**	System OK
21	Check for a faulty water pump. The impeller blades may be eroded or broken. Is the water pump faulty?	Go to **Step 22**	-
22	Replace the water pump. **Water Pump Replacement (LTG)Water Pump Replacement (LYX)Water Pump Replacement (LH7)** Does the engine still overheat?	-	System OK

LOSS OF COOLANT

Step	Action	Yes	No
DEFINITION: The cooling system is losing 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. **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. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)** 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 23**
6	Engine overheating can cause a loss of coolant. Is the engine overheating?	Go to **Step 24**	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 26**	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 25**	Go to **Step 10**

Step	Action	Yes	No
10	**WARNING:** **Refer to Moving Parts and Hot Surfaces Warning .** With the engine idling, inspect the surge tank.Does the surge tank discharge coolant while the engine is idling?	Go to **Step 14**	Go to **Step 11**
11	Visually inspect the hoses, pipes and hose clamps at the following locations: • Coolant surge tank • Heater core • Radiator Are any of the hoses, clamps or pipes leaking?	Go to **Step 20**	Go to **Step 12**
12	Visually inspect the following components: • The coolant pressure cap • The core plugs • The cylinder head gaskets • The engine block • The intake manifold • The radiator • The thermostat housing • The water pump Are any of the listed components leaking?	Go to **Step 20**	Go to **Step 13**
13	1. Pressure test the cooling system. 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 20**	Go to **Step 14**
14	Pressure test the coolant pressure cap. Pressure Cap Testing Does the coolant pressure cap hold pressure?	Go to **Step 15**	Go to **Step 21**
15	Inspect for the following conditions: • A coolant smell inside of the vehicle • Coolant in the HVAC module drain tube • Coolant on the vehicle floor covering near the HVAC module Is coolant present?	Go to **Step 22**	Go to **Step 16**

mcx30.com

Step	Action	Yes	No
16	1. Add 30 ml (1 oz) of Extended Life Coolant Leak Detection Dye to the cooling system for each 15 liters (4 gallons) of coolant. **Adhesives, Fluids, Lubricants, and Sealers**, and **Approximate Fluid Capacities** 2. Start the vehicle and allow the engine to reach normal operating temperature. 3. Shut the engine off. 4. Use **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 20**	Go to **Step 17**
17	Use **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 22**	Go to **Step 18**
18	Inspect the underside of the engine oil fill cap for a gray/white milky substance. Is there a milky substance on under the oil fill cap?	Go to **Step 19**	Go to **Step 20**
19	Inspect the engine oil fluid level indicator for a gray/white milky substance. Is there a milky substance on the engine oil fluid level indicator?	Go to **Step 25**	System OK
20	Repair or replace the leaking component. Is the repair complete?	Go to **Step 28**	-
21	Replace the coolant pressure cap. Is the repair complete?	Go to **Step 28**	-
22	Replace the heater core. **Heater Core Replacement** Is the repair complete?	Go to **Step 28**	-
23	Repair the engine no crank condition. **Engine Will Not Crank - Crankshaft Will Not Rotate** Is the repair complete?	Go to **Step 28**	-
24	Repair the engine overheating condition. **Engine Overheating** Is the repair complete?	Go to **Step 28**	-
25	Repair the engine internal coolant leak. **Coolant in Combustion Chamber** , or **Coolant in Engine Oil** Is the repair complete?	Go to **Step 28**	-
26	Repair the engine knock. **Lower Engine Noise, Regardless of Engine Speed** Is the repair complete?	Go to **Step 28**	-
27	Repair the combustion pressure in the cooling system problem. **Coolant in Combustion Chamber** Is the repair complete?	Go to **Step 28**	-
28	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to **Step 2**

THERMOSTAT DIAGNOSIS

Special Tools

GE 24731 Tempil Stick

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

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

Thermostat Test Procedure Using Tempil Sticks

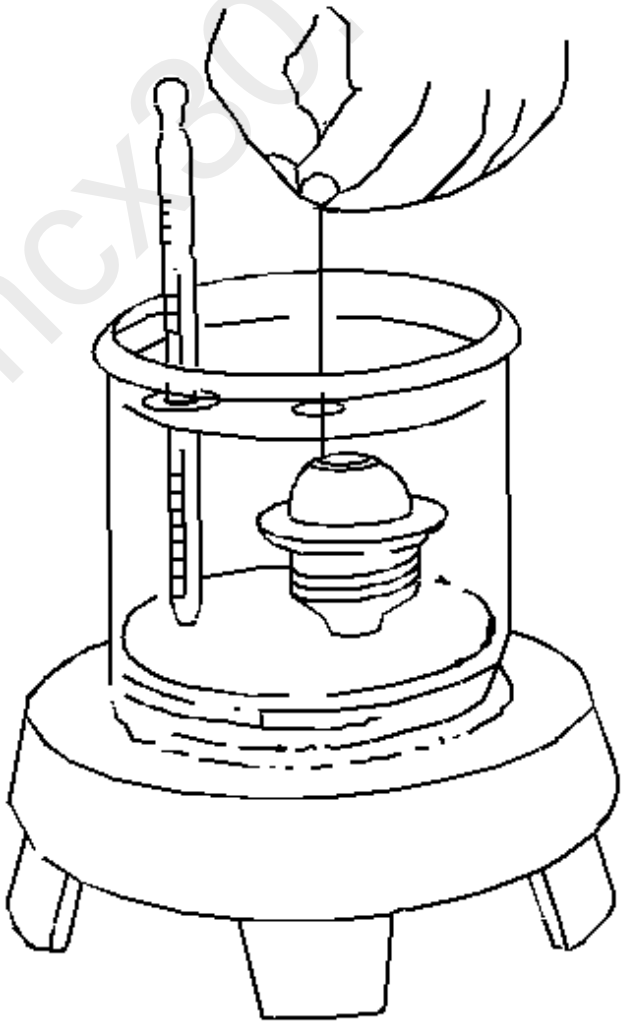
The coolant thermostat can be tested using a temperature (tempil) stick. The temperature stick is a pencil like device. It has a wax material containing certain chemicals which melt at a given temperature. Take a 87Â°C (188Â°F) tempil stick or a 97Â°C (206Â°F) tempil stick and rub it on the thermostat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

1. Use a **GE 24731** Tempil Stick in order to find the opening and the closing temperatures of the coolant thermostat.
    - The 188 tempil stick melts at 87Â°C (188Â°F). The thermostat should begin to open.
    - The 206 tempil stick melts at 97Â°C (206Â°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-COOLÂ® and clean drinkable water.

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



mcx30.com

Fig. 2: View Of Thermostat Test Procedure Using Glycol
Courtesy of GENERAL MOTORS COMPANY

1. Completely submerge the thermostat in the glycol solution. The solution should be 11Â°C (22Â°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:

1. Completely submerge the thermostat in a glycol solution. The solution should be 6Â°C (10Â°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 coolant heater operates using 110 V AC external power and is designed to warm the coolant in the engine block area for improved starting in very cold weather. The coolant heater also helps reduce fuel consumption when a cold engine is warming up. The unit is equipped with a detachable AC power cord. There is an internal thermal switch in the coolant heater cord that prevents operation above -18Â°C (0Â°F). 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 coolant heater cord will read Open due to an internal thermal switch if the ambient temperature is above -18Â°C (0Â°F).**

1. Ignition OFF, disconnect the coolant heater cord from the E19 Coolant Heater.
2. Test for 30 - 40 Ω between the terminals of the E19 Coolant Heater.
   - **If not within 30 - 40 Ω**

     Replace the E19 Coolant Heater.

   - **Go to next step: If within 30 - 40 Ω**
3. Test for infinite resistance between each terminal of the E19 Coolant Heater and ground.
   - **If less than infinite resistance**

     Replace the E19 Coolant Heater.

   - **Go to next step: If infinite resistance**
4. Test for less than 2 Ω between the engine coolant heater cord plug and the engine coolant heater cord connector for each circuit.
   - **If greater than 2 Ω**

mcx30.com

Replace the engine coolant heater cord.

- **Go to next step: If less than 2 Ω**

  All OK.

Repair Instructions

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

- **Coolant Heater Replacement (LTG)Coolant Heater Replacement (LYX)**
- **Coolant Heater Cord Replacement (LYX)Coolant Heater Cord Replacement (LTG)**

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 Inoperative**. 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 housing. Refer to **Engine Coolant Thermostat Housing Replacement (LYX)Engine Coolant Thermostat Housing Replacement (LTG)**. 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

- **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: Identifying Pressure Cap Tester
Courtesy of GENERAL MOTORS COMPANY

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 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** Radiator Cap/Surge Tank Test Adapter

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.

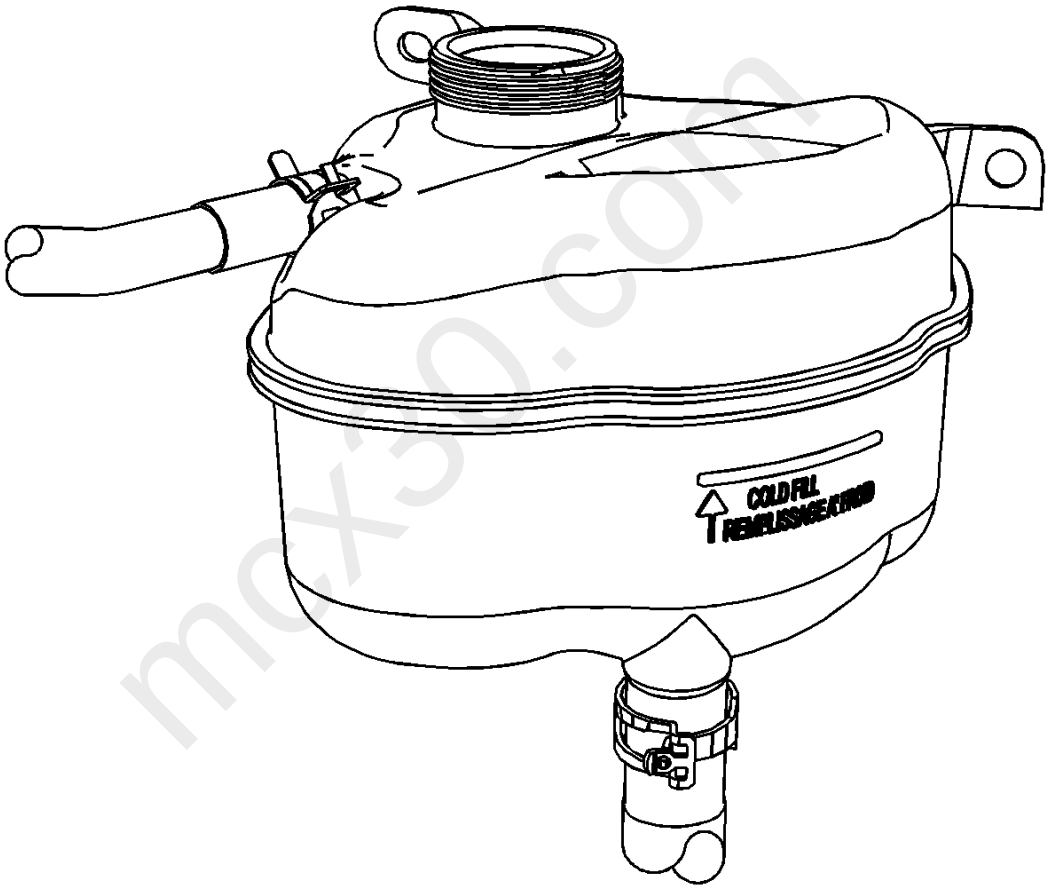


Fig. 4: Applying Pressure To Cooling System
Courtesy of GENERAL MOTORS COMPANY

4. Use the **J 24460-01** Cooling System Pressure Tester with the **J 42401** Radiator Cap/Surge Tank Test Adapter 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

HOSE CLAMP REPLACEMENT GUIDELINES - SPRING TYPE

Special Tools

- **BO-38185** Hose Clamp Pliers
- **GE-47622** Hose Clamp Pliers.

Equivalent regional tools:**Special Tools**

Spring Type Hose Clamp Replacement Guidelines

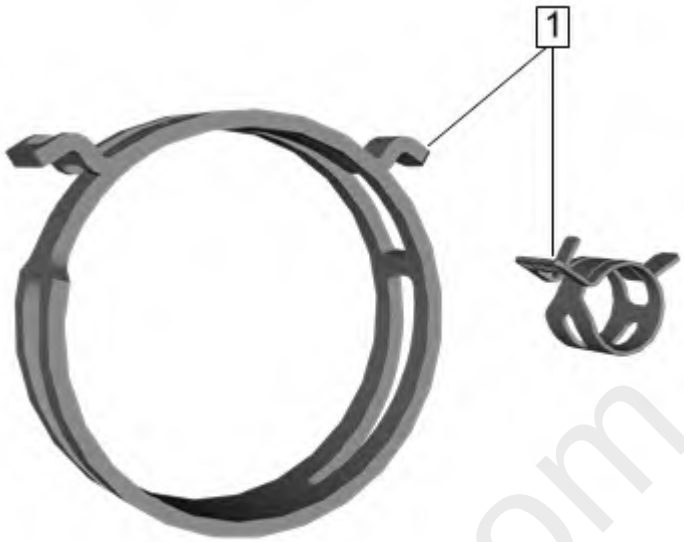


Fig. 5: Spring Type Hose Clamps
Courtesy of GENERAL MOTORS COMPANY

Vehicles utilize spring type hose clamps (1) to secure joints in which fluids, gases, or engine vacuum can travel to various vehicle systems. Spring type hose clamps are engineered to provide the proper amount of tension to maintain a leak & maintenance free joint for the life of the vehicle.

Spring type hose clamps have a special coating applied to the exterior of the clamp that is engineered to resist rust/corrosion, improve durability and increase the life of the hose clamp. If the coating is damaged, rust/corrosion could form resulting in the need to replace the hose clamp.

Many spring type hose clamps within GM utilize a small amount of adhesive placed directly on the hose clamp to secure the clamp to the mating hose for manufacturing purposes. Over time the strength of the adhesive will deteriorate. It is extremely important when a technician is attempting to service a joint or remove the hose clamp, that the clamp is not rotated or repositioned so that is tears and/or damages the hose. In this case, the hose and clamp must both be replaced.

When repairing a vehicle it is very important to observe the condition of both the hose and the spring type hose clamp as well as the orientation of the clamp to the hose.

If the spring type hose clamp(s) have any of the following conditions on any area of the clamp, replace the clamp(s) immediately.

- Rust/Corrosion
- Cracks
- Physical damage
- Leakage attributed to the retention of the clamp

Removing The Spring Type Hose Clamp

While keeping the hose stationary, use BO-38185 Hose Clamp Pliers or GE-47622 Hose Clamp Pliers and release the spring type hose clamp tension while attempting to separate the hose clamp from the hose.

- If the spring type hose clamp will not easily separate from the hose and/or the clamp tears or damages the hose, both the hose and hose clamp must be replaced
- If the spring type hose clamp is easily removed from the hose, the clamp can be reused provided that the clamp does not have any of the conditions as noted above.

If The Spring Type Hose Clamp Is Being Reused

It is extremely important that the spring type hose clamp is orientated to the hose in the exact same position as it was installed during vehicle assembly so that the hose clamp is not damaged or the hose clamp does not contact or damage any adjacent components. Do not use any type of adhesive on the hose clamp prior to installation.

When Reusing The Spring Type Hose Clamp and Replacing The Hose

- The inside and outside hose diameter must be identical between the new hose and the existing hose to guarantee proper hose clamp tension and joint integrity.
- Always place the existing spring type hose clamp in the same orientation as it was positioned prior to separating the joint. The new hose might have a marking on the hose indicating the correct position of a hose clamp, which should re-confirm the correct hose clamp position. The hose clamp should not contact any adjacent components after installation.

When Reusing The Spring Type Hose Clamp with an Existing Hose

Always place the existing spring type hose clamp in the same orientation as it was positioned prior to separating the joint. The existing hose might have an indentation or compression mark on the hose from where the hose clamp was installed previously. The hose clamp should identically overlay this position. The existing hose might also have a marking on the hose indicating the correct position of the hose clamp, which should re-confirm the correct hose clamp position. The hose clamp should not contact any adjacent components after installation.

If The Spring Type Hose Clamp Is Being Replaced

If the hose clamp needs to be replaced, always replace the hose as part of the service repair. It is extremely important that a new spring type hose clamp is orientated to the hose in the exact same position as it was installed during vehicle assembly so that the hose clamp is not damaged or the hose clamp does not contact or damage any adjacent components. Do not use any type of adhesive on the hose clamp prior to installation.

When Replacing The Spring Type Hose Clamp and Replacing The Hose

- The inside and outside hose diameter must be identical between the new hose and the existing hose to guarantee proper hose clamp tension and joint integrity.
- Always place the new spring type hose clamp in the same orientation as it was positioned prior to separating the joint. The new hose might have a marking on the hose indicating the correct position of a hose clamp, which should re-confirm the correct hose clamp position. The hose clamp should not contact any adjacent components after installation.

When Replacing The Spring Type Hose Clamp with an Existing Hose

Always place the new spring type hose clamp in the same orientation as it was positioned prior to separating the joint. The existing hose might have an indentation or compression mark on the hose from where a hose clamp was installed previously. The hose clamp should identically overlay this position. The existing hose might also have a marking on the hose indicating the correct position of the hose clamp, which should re-confirm the correct hose clamp position. The hose clamp should not contact any adjacent components after installation.

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 radiator surge tank cap.
2. Raise and support the vehicle.

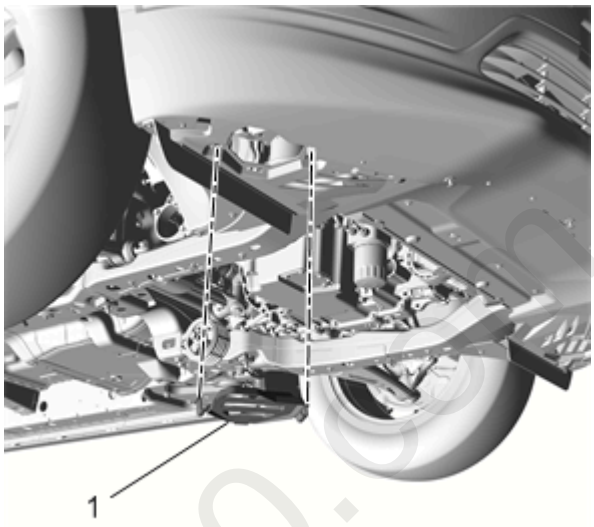


Fig. 6: Lower Deflector Panel Insert
Courtesy of GENERAL MOTORS COMPANY

3. Remove the lower deflector panel insert (1) on the passenger side to gain access to drain cock.
4. Install suitable length of hose to radiator drain nipple, and route hose through opening to allow free drain of coolant.
5. Place a drain pan under the drain cock.
6. Loosen, but do not remove, drain cock until coolant begins to drain from the hose.
7. When cooling system is completely drained, tighten the drain cock by hand.
8. Remove hose segment.

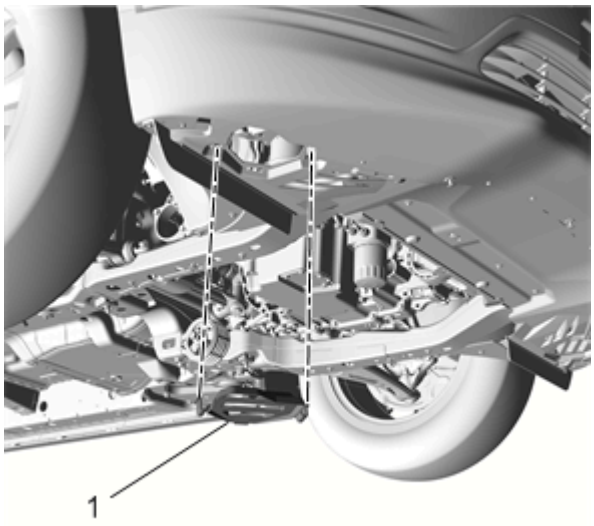


Fig. 7: Lower Deflector Panel Insert
Courtesy of GENERAL MOTORS COMPANY

9. Install lower deflector panel insert (1).
10. Lower the vehicle.
11. Inspect the coolant.
12. 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.

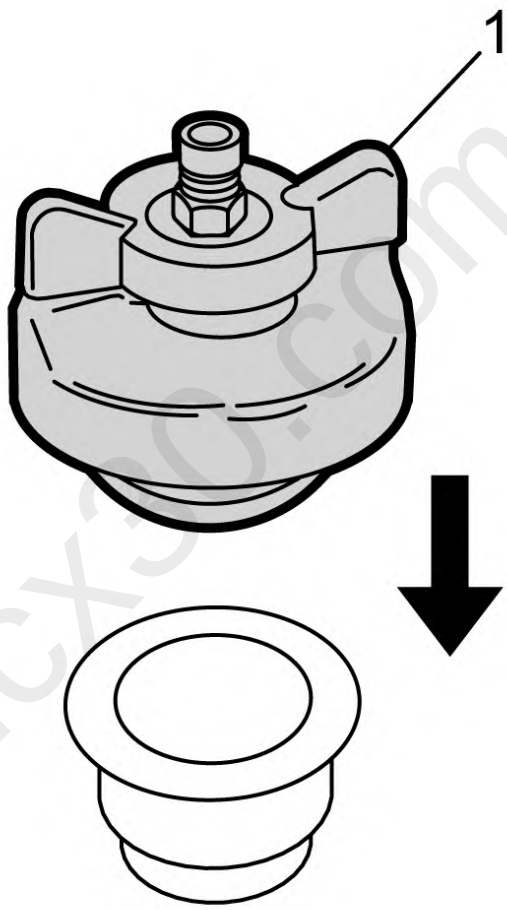


Fig. 8: Radiator Cap & Surge Tank Test Adapter
Courtesy of GENERAL MOTORS COMPANY

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.**

2. Attach the Vac N Fill cap to the **J 42401** Radiator Cap and Surge Tank Test Adapter (1).

mcx30.com

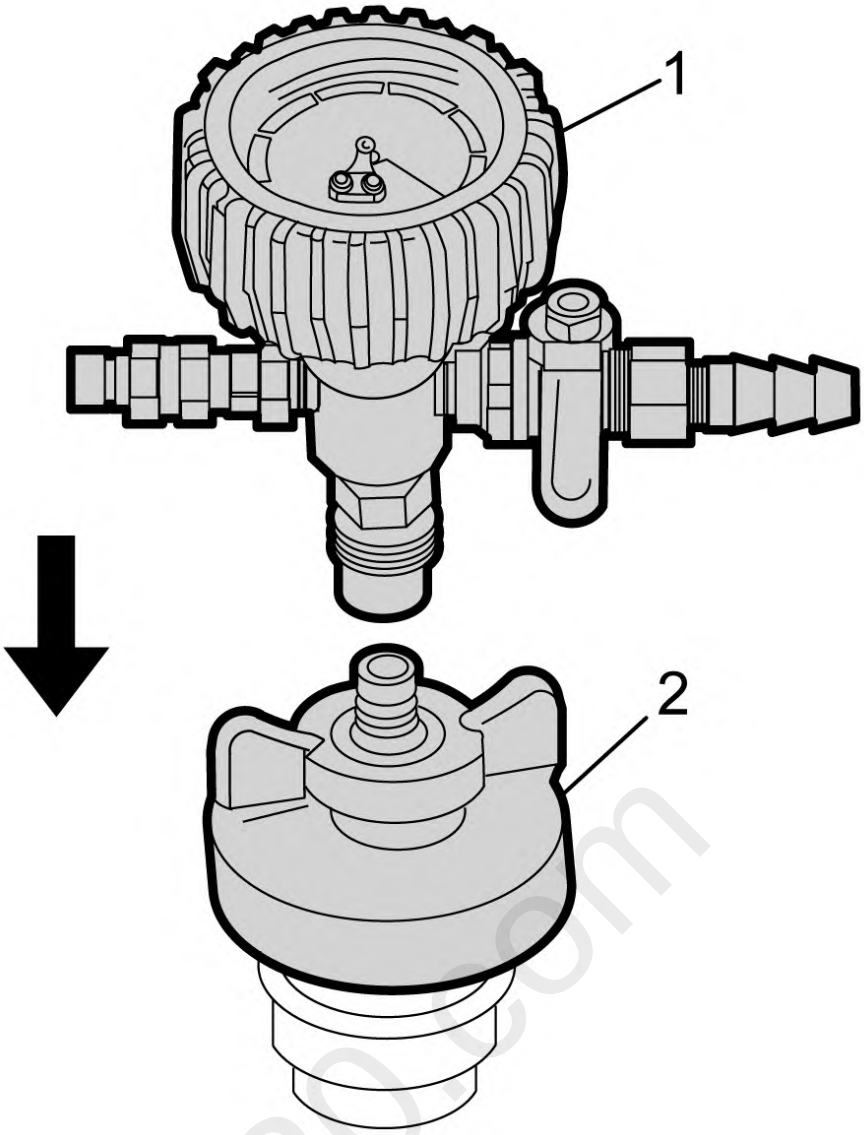


Fig. 9: Vacuum Gauge Assembly & Vac N Fill Cap
Courtesy of GENERAL MOTORS COMPANY

3. Attach the vacuum gauge assembly (1) to the Vac N Fill cap (2).

mcx30.com

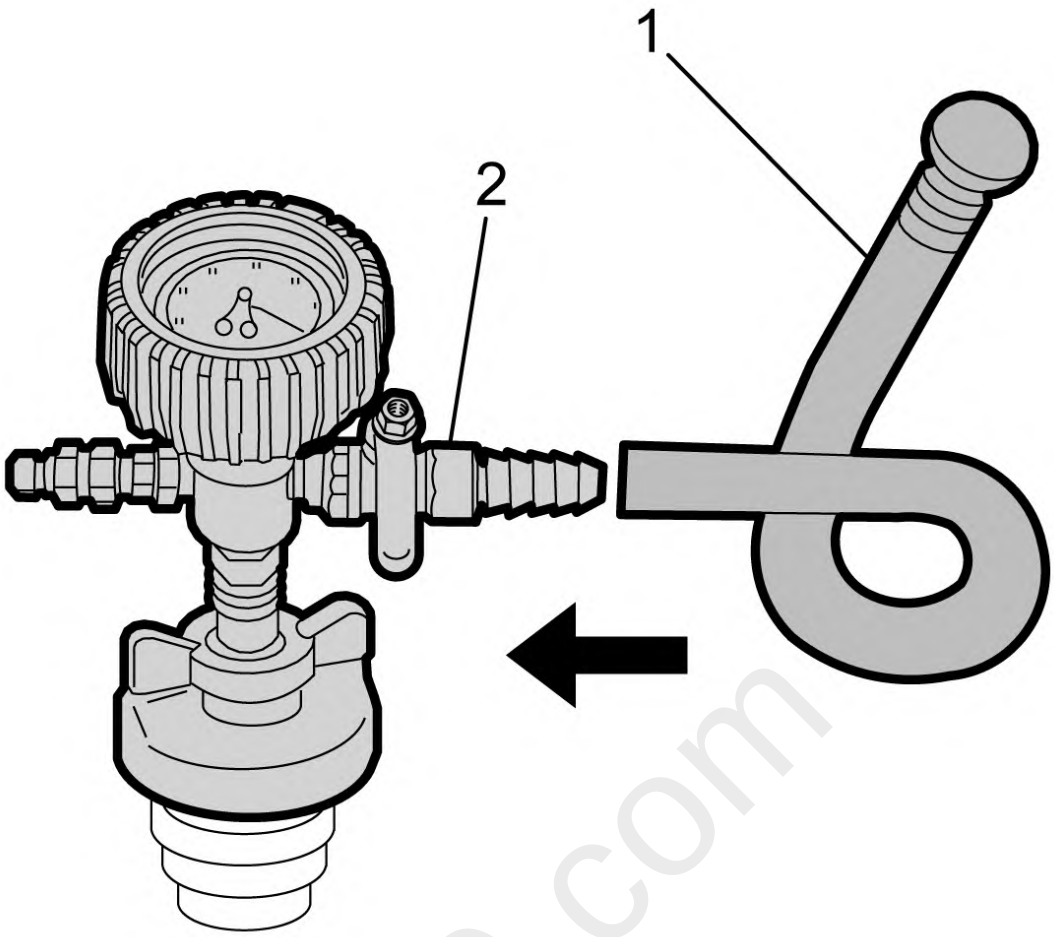


Fig. 10: Vacuum Gauge Assembly & Fill Hose
Courtesy of GENERAL MOTORS COMPANY

4. Attach the fill hose (1) to the barb fitting on the vacuum gauge assembly (2).

   Ensure that the valve is closed.

mcx30.com

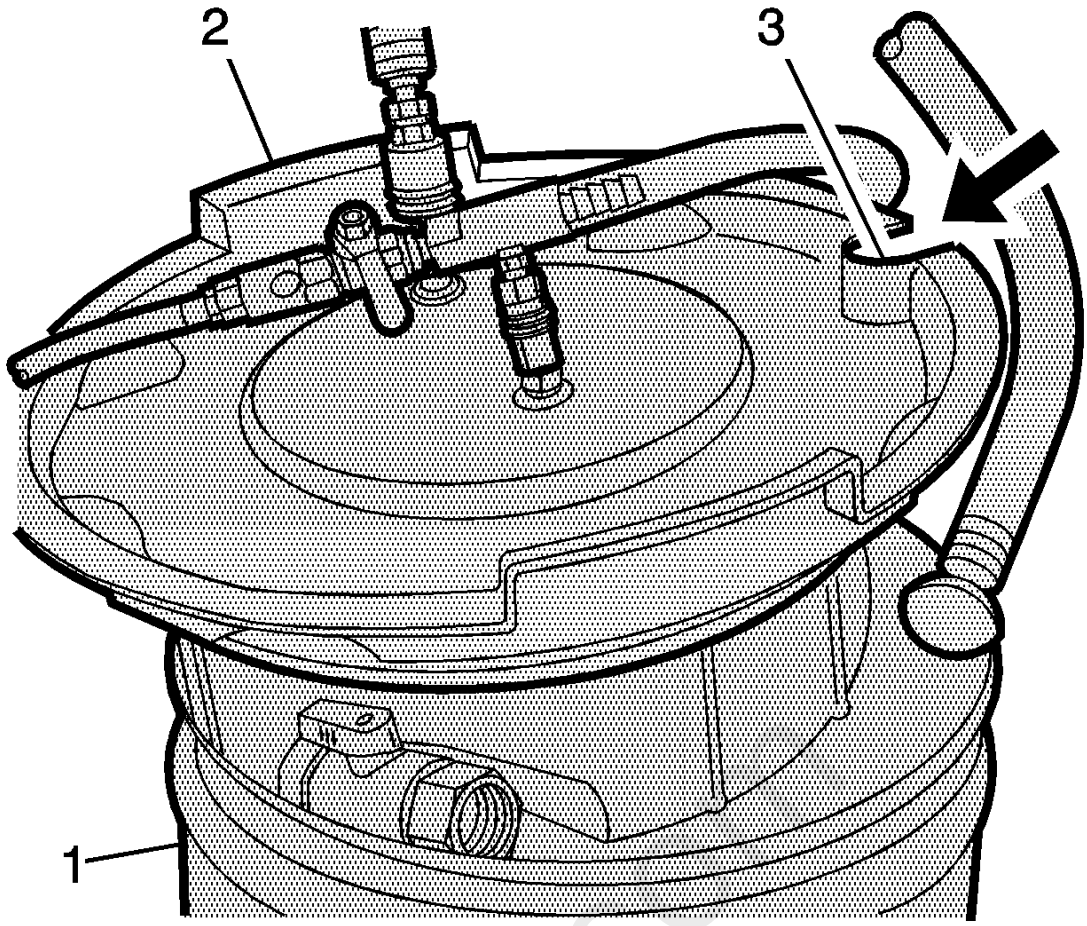


Fig. 11: Graduated Reservoir, Vacuum Tank & Cut-Out Area
Courtesy of GENERAL MOTORS COMPANY

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 (1).
6. Place the fill hose in the graduated reservoir (1).

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 (2) on the graduated reservoir with the fill hose routed through the cut-out area (3) in the vacuum tank.

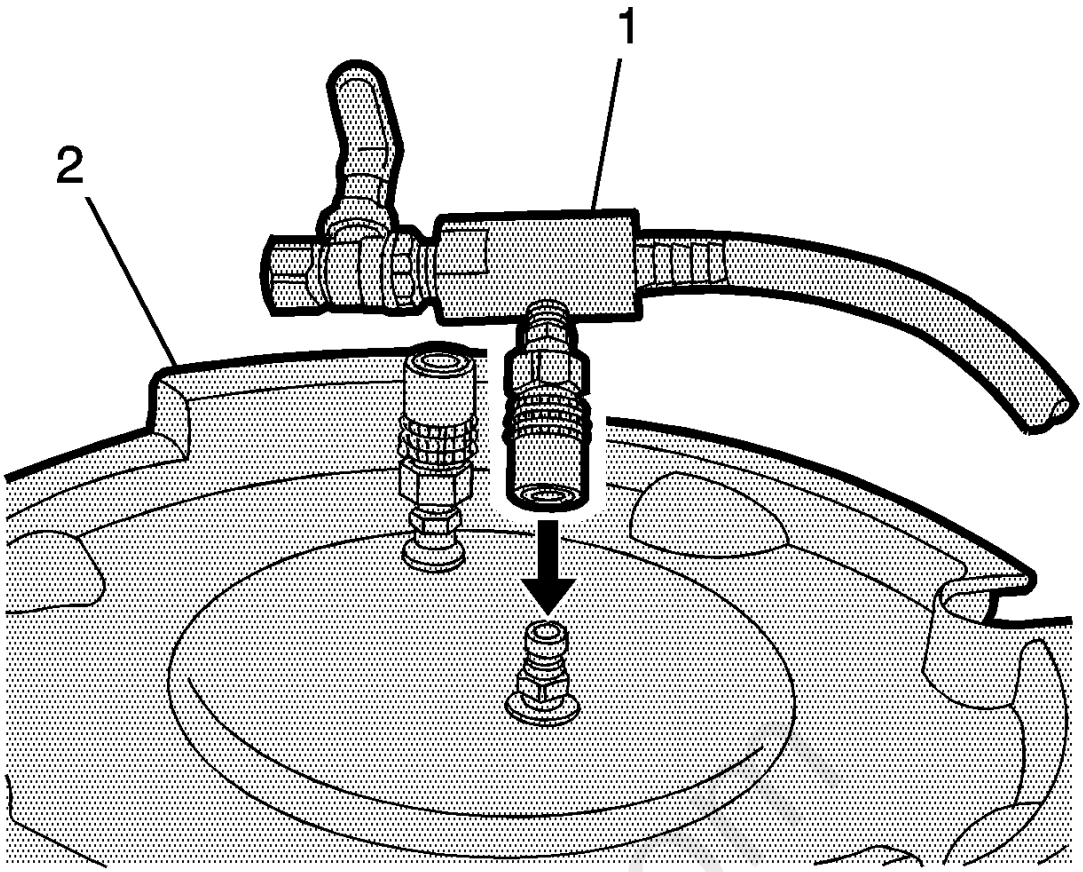


Fig. 12: Vacuum Tank & Venturi Assembly
Courtesy of GENERAL MOTORS COMPANY

8. Attach the venturi assembly (1) to the vacuum tank (2).

mcx30.com

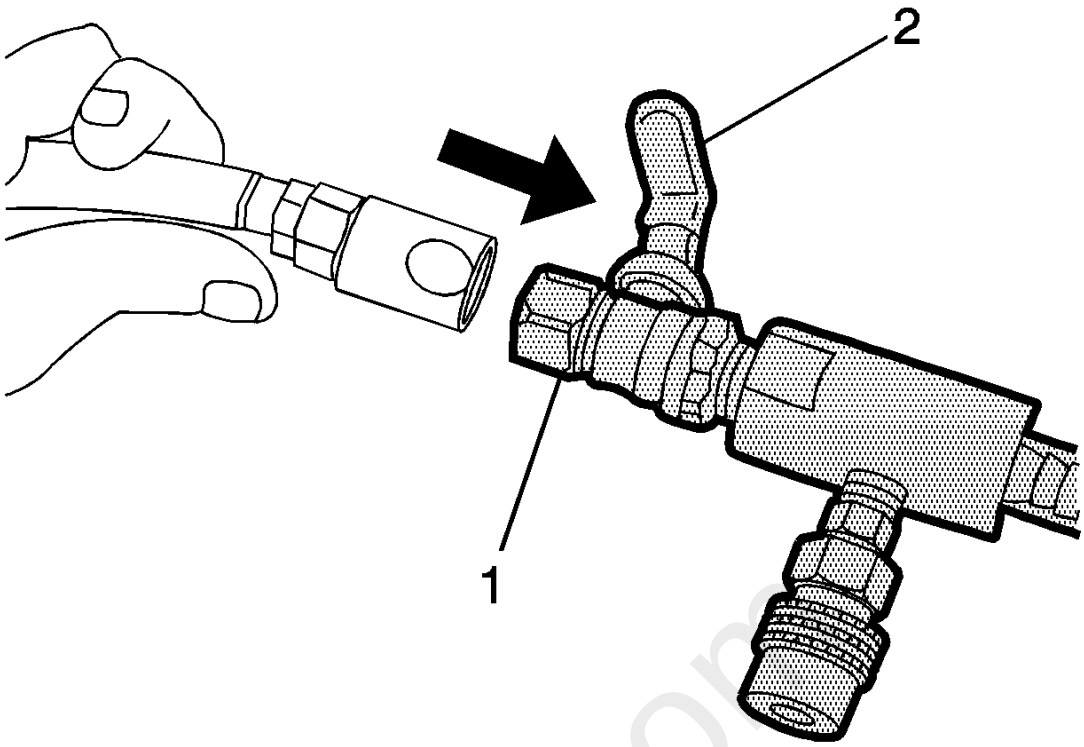


Fig. 13: Venturi Assembly & Valve
Courtesy of GENERAL MOTORS COMPANY

9. Attach a shop air hose to the venturi assembly (1).

   Ensure the valve (2) on the venturi assembly is closed.

mcx30.com

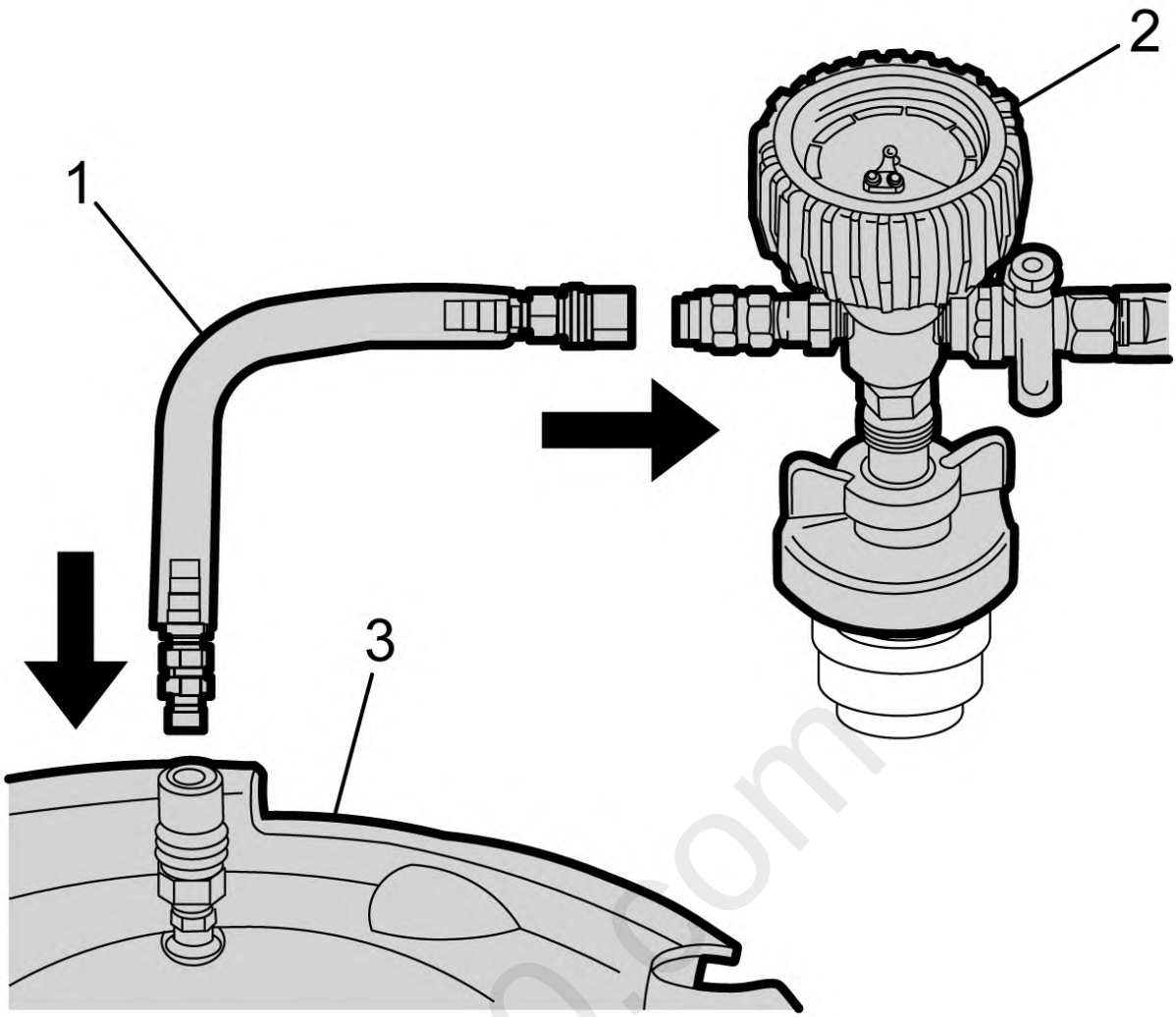


Fig. 14: Vacuum Hose, Gauge Assembly & Tank
Courtesy of GENERAL MOTORS COMPANY

10. Attach the vacuum hose (1) to the vacuum gauge assembly (2) and the vacuum tank (3).

mcx30.com

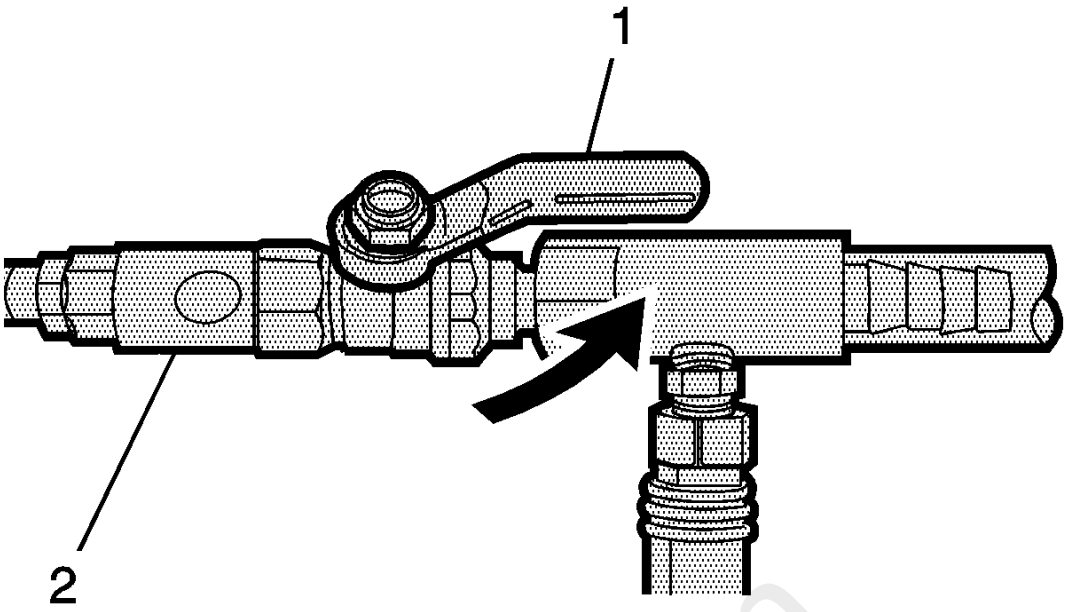


Fig. 15: Valve & Venturi Assembly
Courtesy of GENERAL MOTORS COMPANY

11. Open the valve (1) on the venturi assembly (2). The vacuum gauge will begin to rise and a hissing noise will be present.

mcx30.com

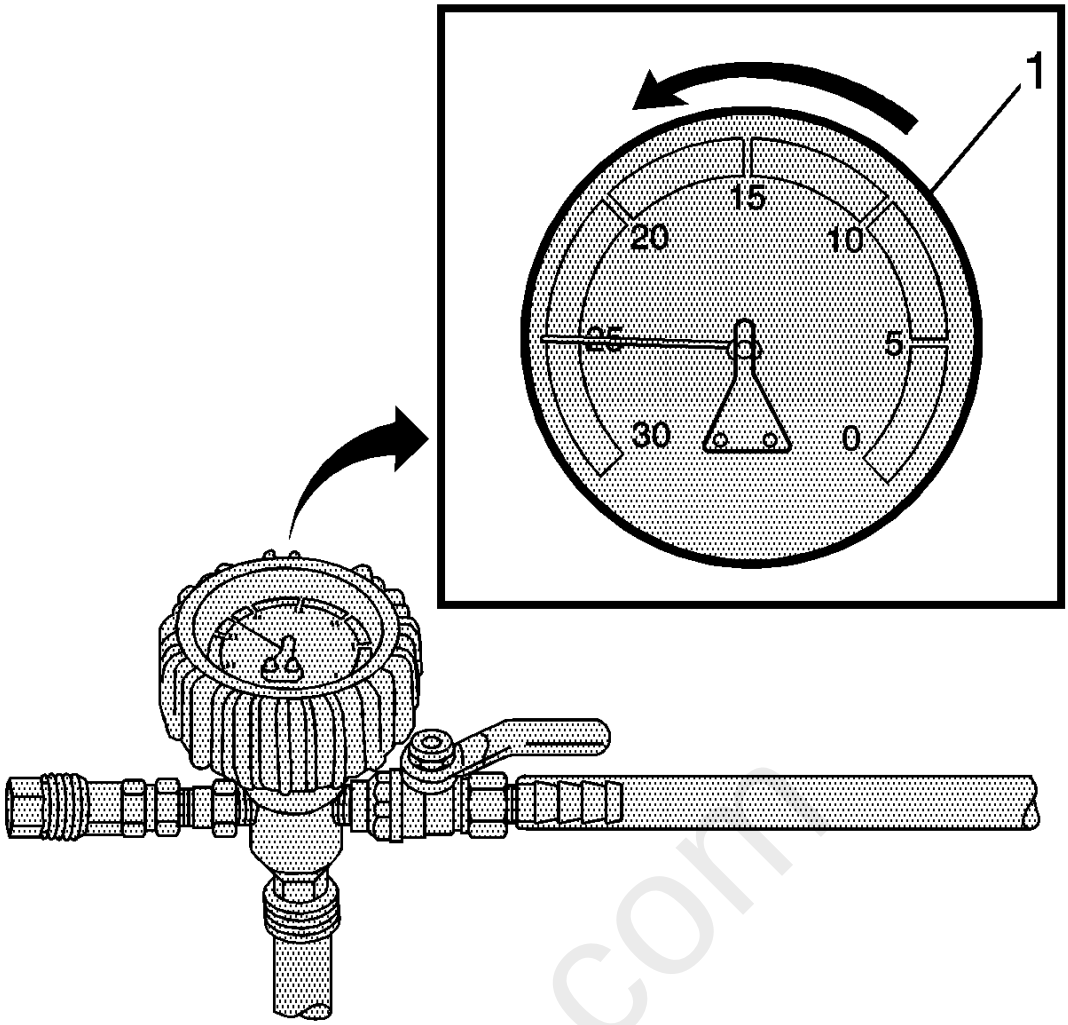


Fig. 16: Vacuum Gauge Needle
Courtesy of GENERAL MOTORS COMPANY

12. Continue to draw vacuum until the needle stops rising (1). 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.

mcx30.com

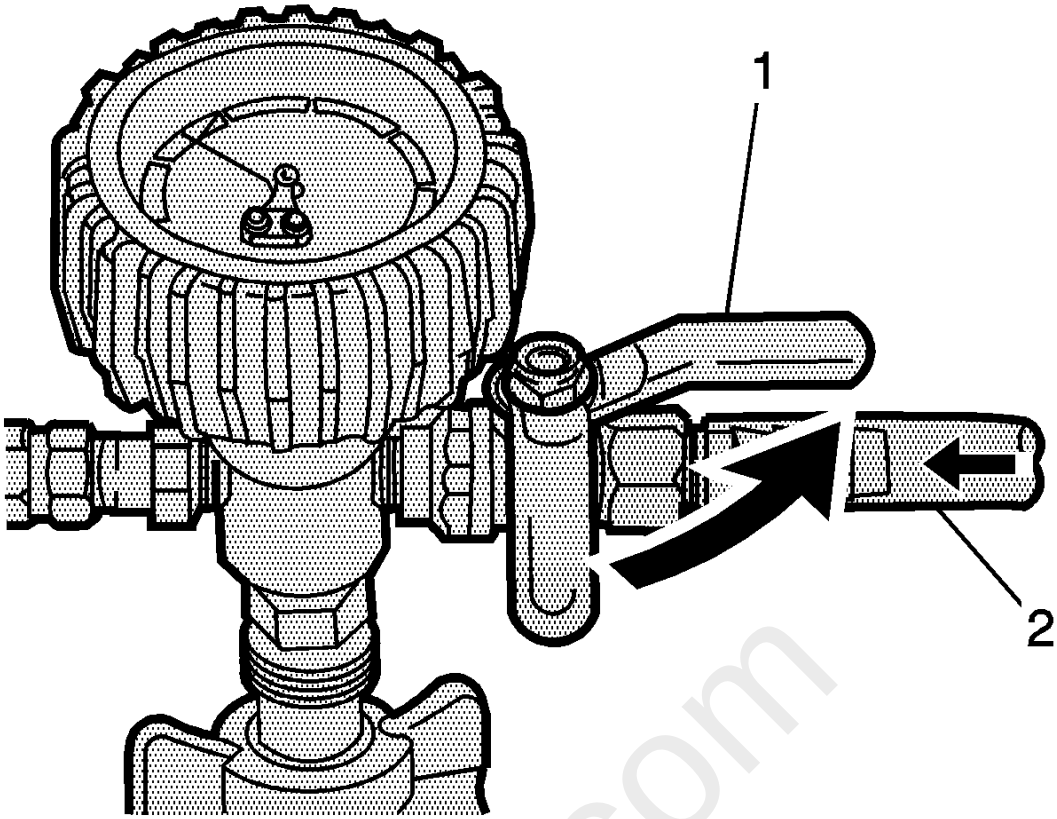


Fig. 17: Vacuum Gauge Assembly & Needle
Courtesy of GENERAL MOTORS COMPANY

14. Slowly open the valve (1) on the vacuum gauge assembly (2). 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.

mcx30.com

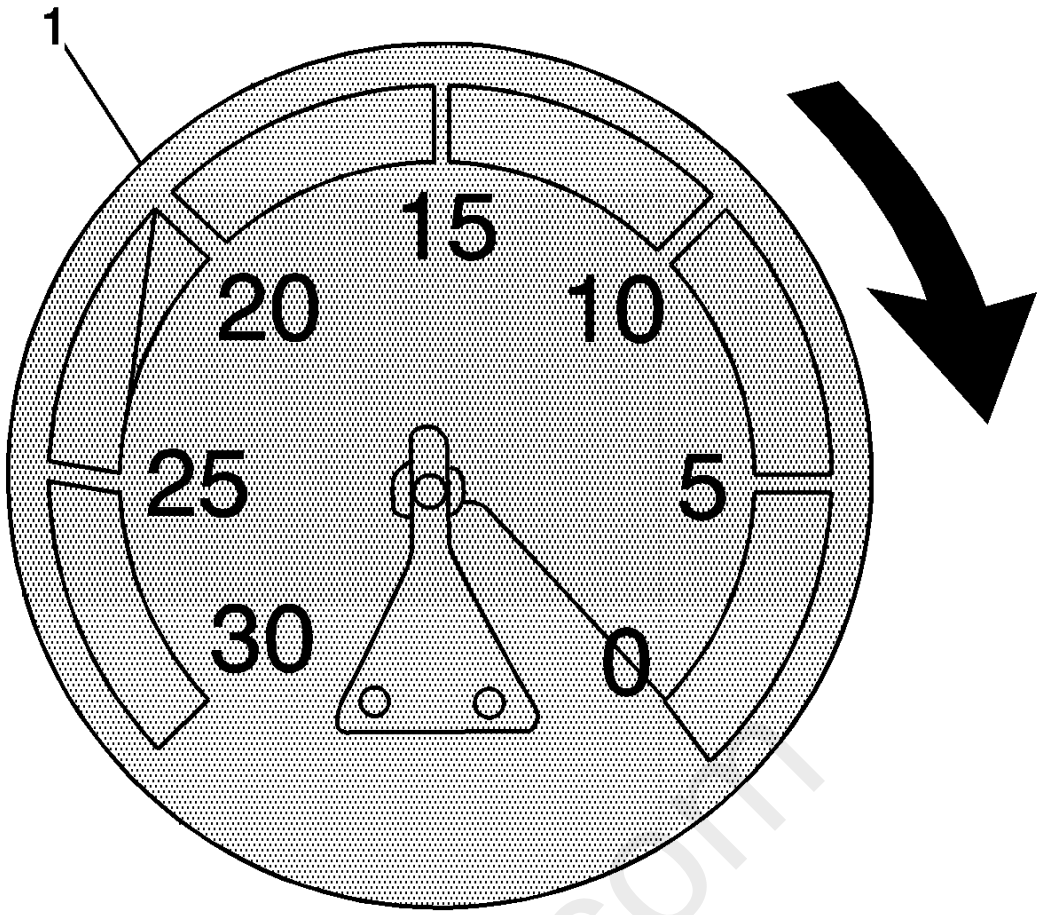


Fig. 18: Vacuum Gauge
Courtesy of GENERAL MOTORS COMPANY

18. Once the vacuum gauge reaches zero (1), 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.

mcx30.com

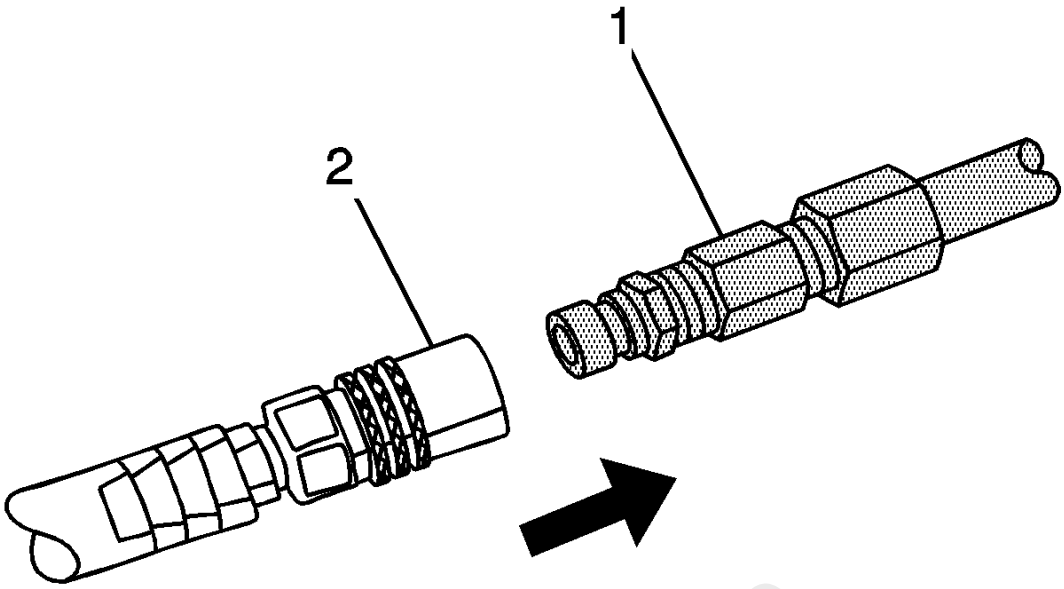


Fig. 19: Vacuum Hose & Extraction Hose
Courtesy of GENERAL MOTORS COMPANY

24. Attach the extraction hose (1) to the vacuum hose (2).

mcx30.com

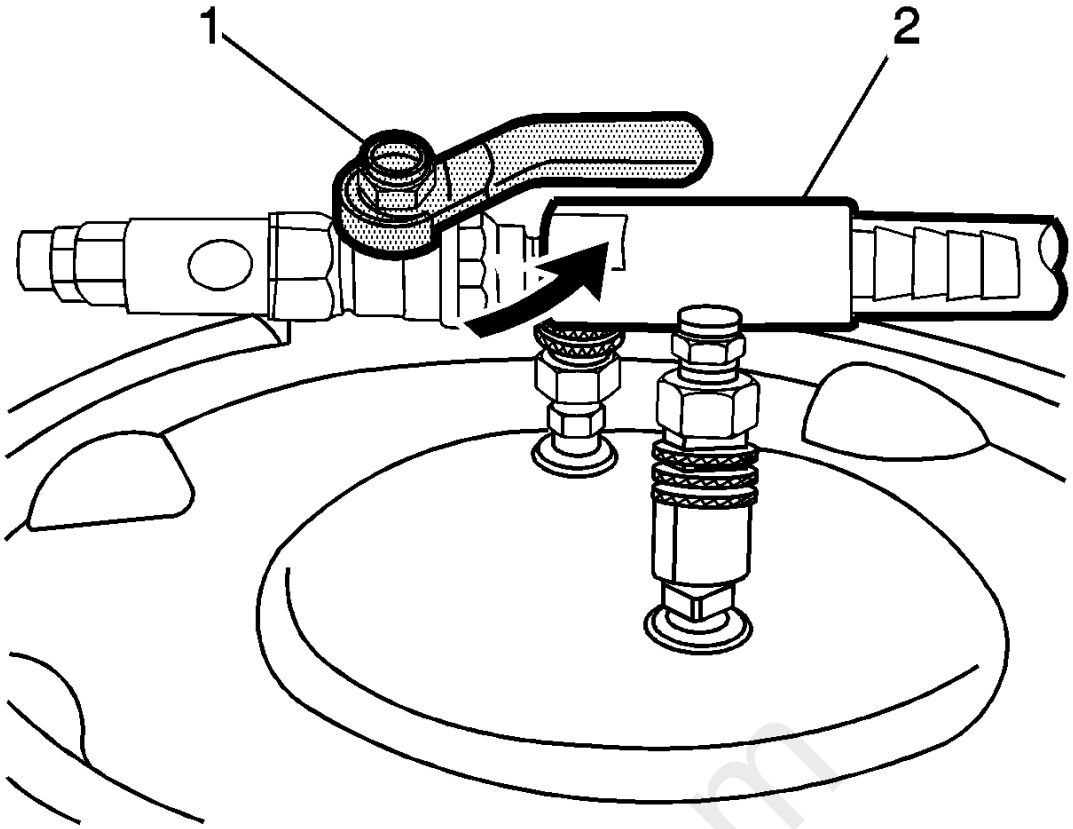


Fig. 20: Venturi Assembly & Valve
Courtesy of GENERAL MOTORS COMPANY

25. Open the valve (1) on the venturi assembly (2) to start a vacuum draw.

mcx30.com

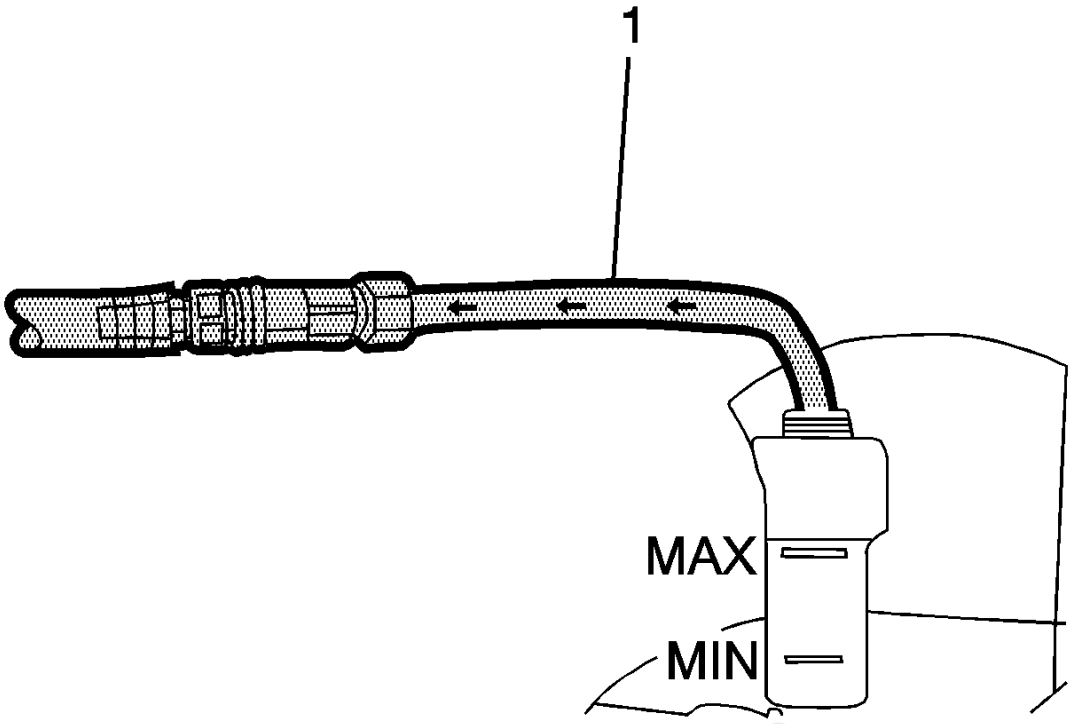


Fig. 21: Coolant Extraction Hose
Courtesy of GENERAL MOTORS COMPANY

26. Use the extraction hose (1) 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 radiator surge tank cap.

COOLING SYSTEM DRAINING AND FILLING (STATIC)

Draining Procedure

Special Tools

J 26568 Coolant and Battery Tester

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.**

NOTE: **Draining the cooling system with the radiator surge tank cap installed will syphon the coolant from the overflow tank.**

1. Remove the radiator surge tank cap.
2. Raise and support the vehicle. Lifting and Jacking the Vehicle

mx30.com

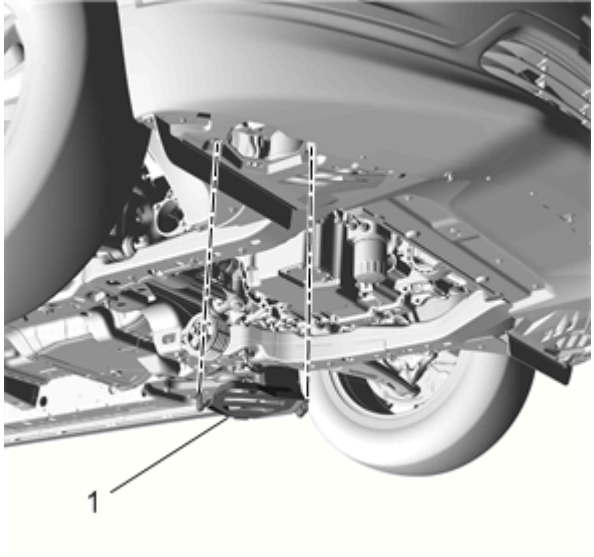


Fig. 22: Lower Deflector Panel Insert
Courtesy of GENERAL MOTORS COMPANY

3. Remove the lower deflector panel insert (1) on the passenger side to gain access to drain cock.
4. Install suitable length of hose to radiator drain nipple, and route hose through opening to allow free drain of coolant.
5. Place a drain pan under the drain cock.
6. Loosen, but do not remove, drain cock until coolant begins to drain from the hose.
7. When cooling system is completely drained, tighten the drain cock by hand.
8. Remove hose segment.

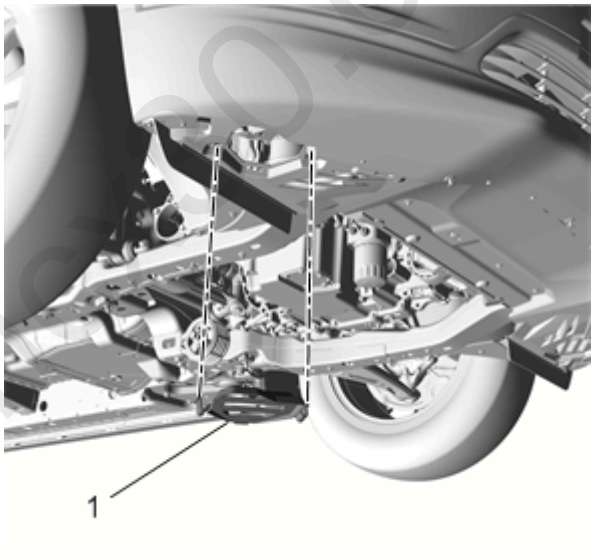


Fig. 23: Lower Deflector Panel Insert
Courtesy of GENERAL MOTORS COMPANY

9. Install lower deflector panel insert (1).
10. Lower the vehicle.
11. Inspect the coolant.
12. 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**.

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.**

1. Lower the vehicle.

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

2. Slowly fill the cooling system with a 50/50 coolant mixture. **Approximate Fluid Capacities**
3. Install Radiator Surge Tank Cap
4. Start the engine.
5. Run the engine at 2, 000 - 2, 500 RPM until the engine reaches normal operating temperature.
6. Allow the engine to idle for 3 minutes.
7. Shut the engine OFF.
8. Allow the engine to cool.
9. Top off the coolant as necessary.
10. Inspect the concentration of the engine coolant, using the **J 26568** coolant and battery tester.
11. Rinse away any excess coolant from the engine and the engine compartment.

FLUSHING

NOTE:

- **When the cooling system becomes contaminated, the cooling system should be flushed thoroughly to remove the contaminants before the engine is seriously damaged.**
- **This procedure is effective in removing contaminants caused by the use of improper coolants, coolant at the end of its life, or some liquid chemical flushing agents. This procedure is NOT effective for removing debris contamination caused by component failure, or the use of 'stop leak' additives. When the system is contaminated by this type of debris, use the system flow diagrams to identify components that may need replacement to restore proper system flow.**
- **Do not use chemical flush agents.**
- **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.**

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**.
2. Remove **Radiator Surge Tank Replacement (LYX without KL9)Radiator Surge Tank Replacement (LTG LYX with KL9)Radiator Surge Tank Replacement (LH7 FWD)Radiator Surge Tank Replacement (LH7 AWD)**
3. Clean and flush the radiator surge tank with clean, drinkable water.
4. Install **Radiator Surge Tank Replacement (LYX without KL9)Radiator Surge Tank Replacement (LTG LYX with KL9)Radiator Surge Tank Replacement (LH7 FWD)Radiator Surge Tank Replacement (LH7 AWD)**
5. Follow the drain and fill procedure using only clean, drinkable water. Refer to **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**.
6. Run the engine for 20 minutes.
7. Stop the engine.
8. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**.
9. Repeat the procedure if necessary, until the fluid is nearly colorless.

10. Fill the cooling system. Refer to Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static).

RADIATOR CLEANING

WARNING: **NEVER spray water on a hot heat exchanger. The resulting steam could cause personal injury.**

CAUTION: **The heat exchanger fins are necessary for good heat transfer. Do not brush the fins. This may cause damage to the fins, reducing heat transfer.**

NOTE: **Remove bugs, leaves, dirt and other debris by blowing compressed air through the engine side of the radiator.**

- Some conditions may require the use of warm water and a mild detergent.
- Clean the A/C condenser fins.
- Clean between the A/C condenser and radiator.
- Clean the radiator cooling fins.
- Straighten any damaged cooling fins.

RADIATOR SURGE TANK REPLACEMENT (LYX WITHOUT KL9)

Removal Procedure

1. Drain the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)

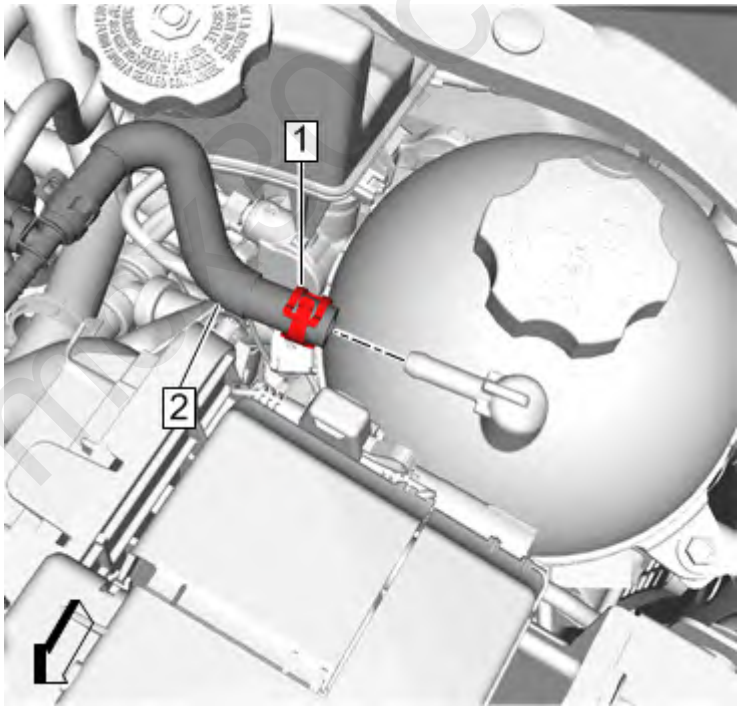


Fig. 24: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

2. Remove Engine Coolant Air Bleed Hose (2) @ Radiator Surge Tank - Engine Coolant Air Bleed Hose Replacement (Turbocharger Coolant Return pipe to Water Outlet, LYX)Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Turbocharger Coolant Return Pipe to Radiator, LYX)

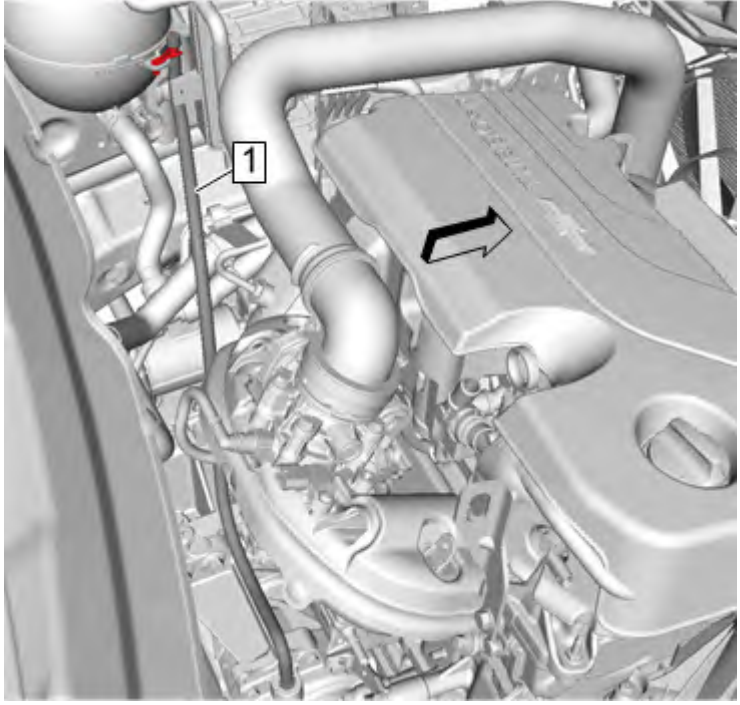


Fig. 25: Power Transfer Unit Vent Hose
Courtesy of GENERAL MOTORS COMPANY

3. Remove {If equipped} Power Transfer Unit Vent Hose (1) @ Radiator Surge Tank - **Power Transfer Unit Vent Hose Replacement**

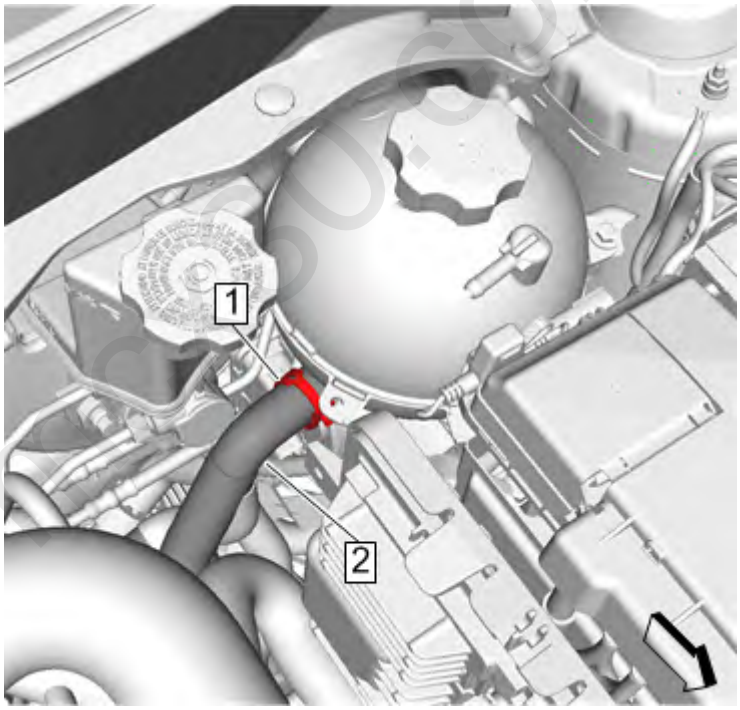


Fig. 26: Heater Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

4. Remove Heater Outlet Hose (2) @ Radiator Surge Tank -**Heater Outlet Hose Replacement (LYX without KL9)**

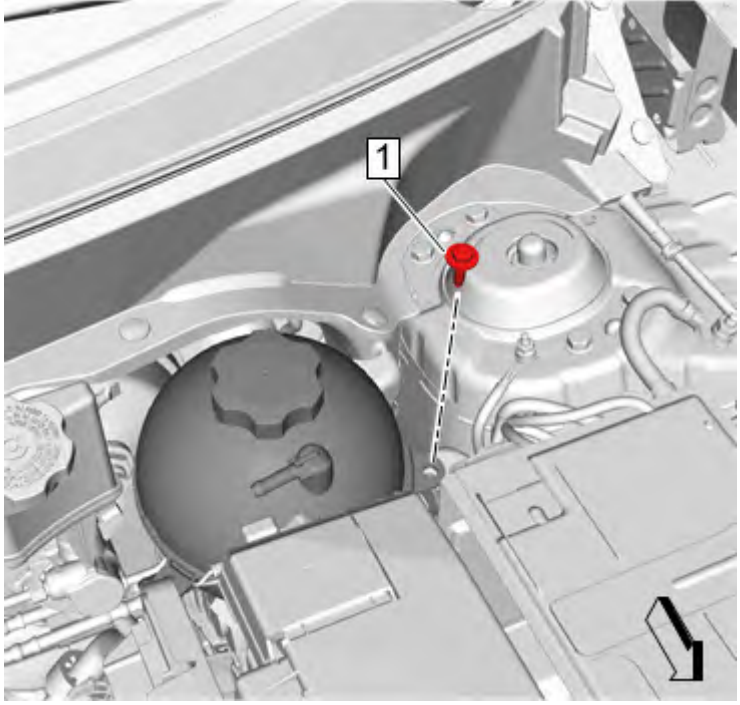


Fig. 27: Radiator Surge Tank Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove Radiator Surge Tank Bolt (1) @ Radiator Surge Tank.
6. Reposition the wiring harness.

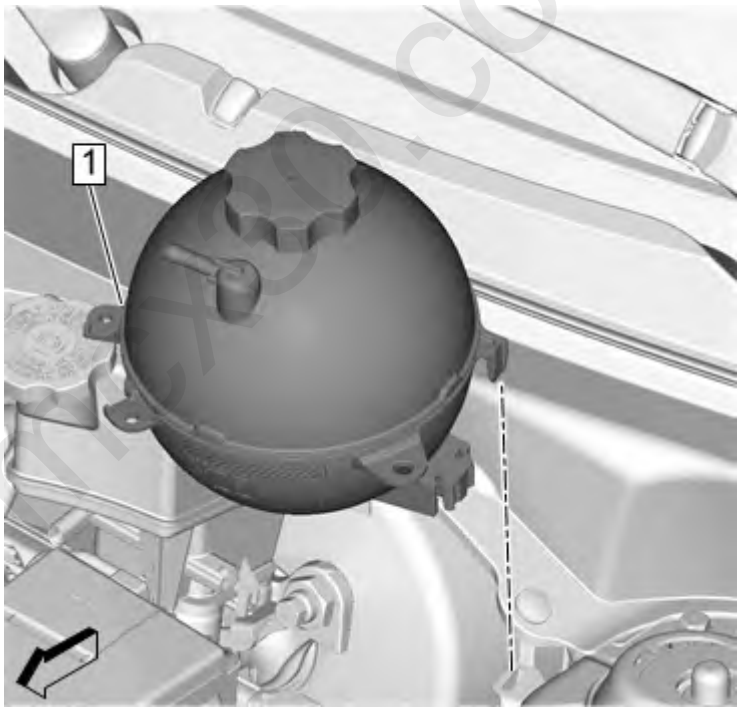


Fig. 28: Radiator Surge Tank
Courtesy of GENERAL MOTORS COMPANY

7. Remove Radiator Surge Tank (1).

Installation Procedure

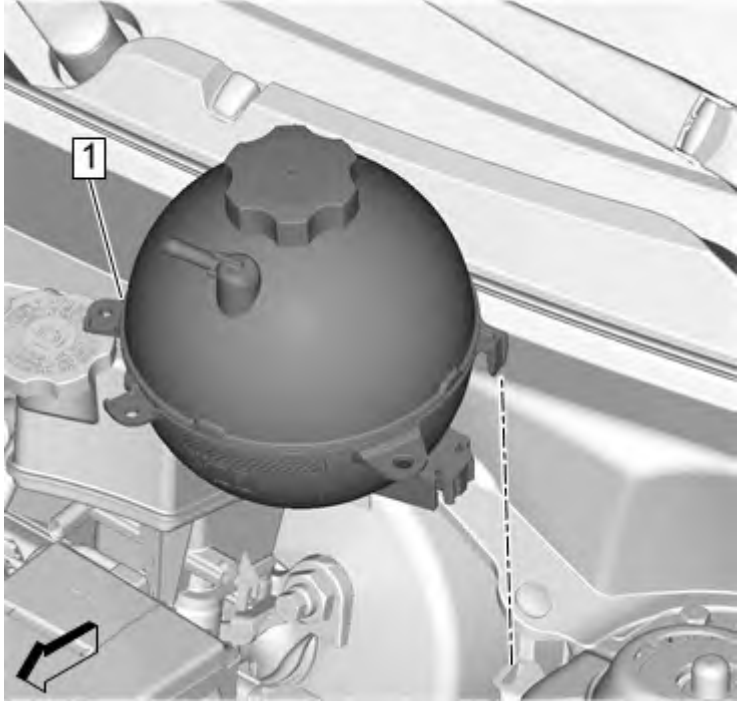


Fig. 29: Radiator Surge Tank
Courtesy of GENERAL MOTORS COMPANY

1. Install Radiator Surge Tank (1).

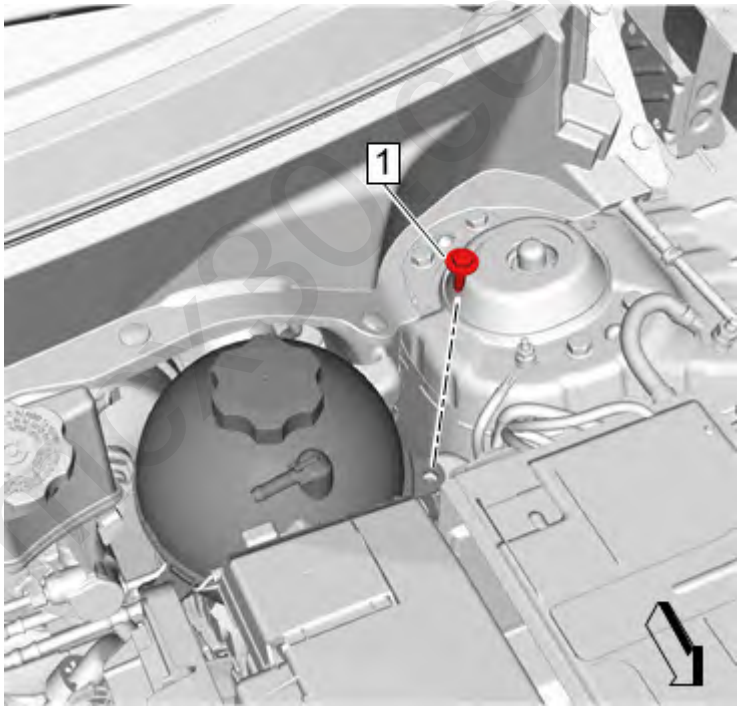


Fig. 30: Radiator Surge Tank Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. Install Radiator Surge Tank Bolt (1) and tighten 9 N.m (80 lb in)
3. Reposition the wiring harness.

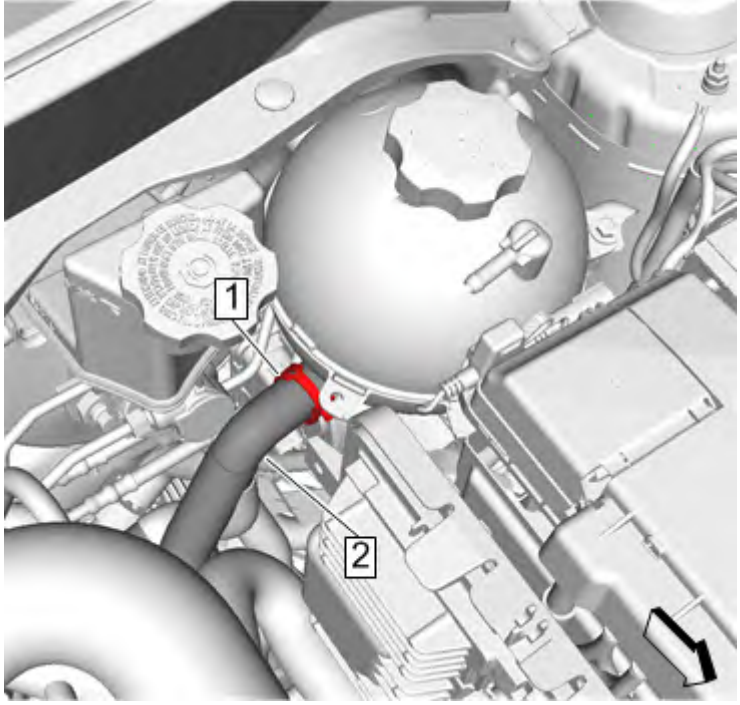


Fig. 31: Heater Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

4. Install Heater Outlet Hose (2) @ Radiator Surge Tank - **Heater Outlet Hose Replacement (LYX without KL9)**

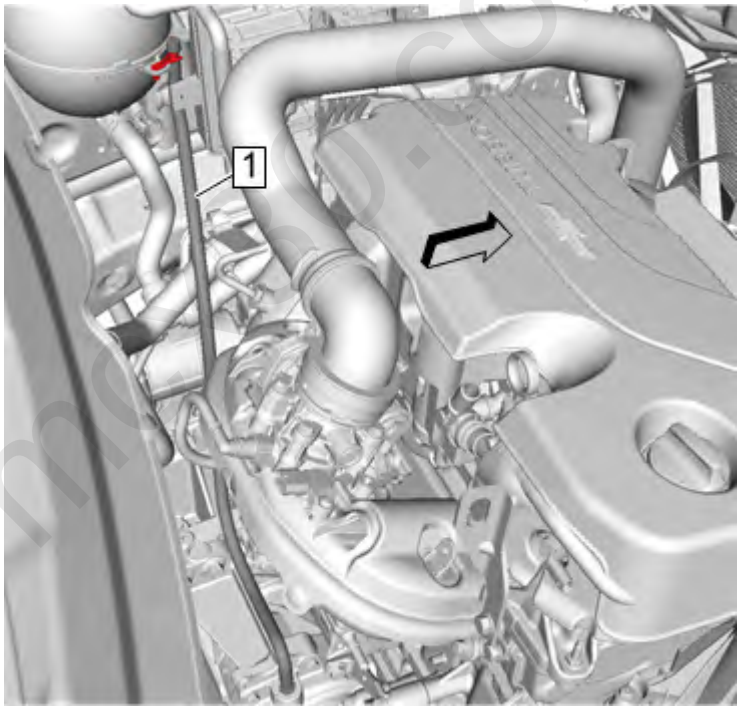


Fig. 32: Power Transfer Unit Vent Hose
Courtesy of GENERAL MOTORS COMPANY

5. Install {If equipped} Power Transfer Unit Vent Hose (1) @ Radiator Surge Tank - **Power Transfer Unit Vent Hose Replacement**

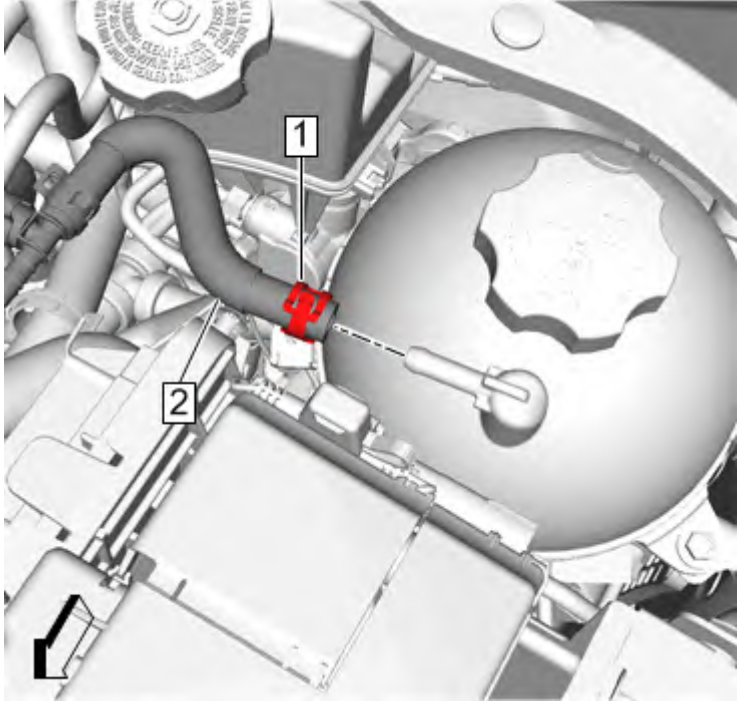


Fig. 33: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

6. Install Engine Coolant Air Bleed Hose (2) @ Radiator Surge Tank - **Engine Coolant Air Bleed Hose Replacement (Turbocharger Coolant Return pipe to Water Outlet, LYX)Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Turbocharger Coolant Return Pipe to Radiator, LYX)**
7. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
8. Check the cooling system for leaks.

RADIATOR SURGE TANK REPLACEMENT (LTG LYX WITH KL9)

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**

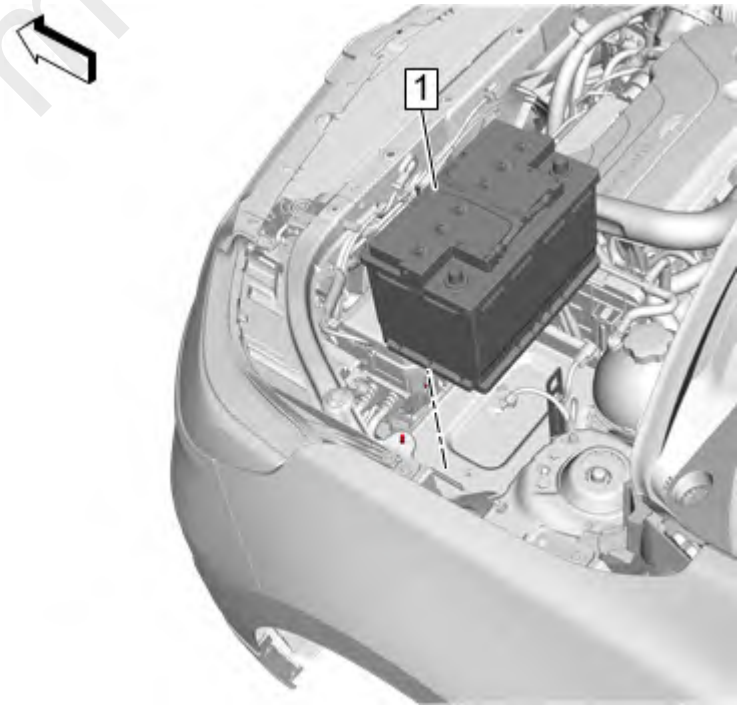


Fig. 34: Battery
Courtesy of GENERAL MOTORS COMPANY

2. Remove Battery (1) - **Battery Replacement**

mex30.com

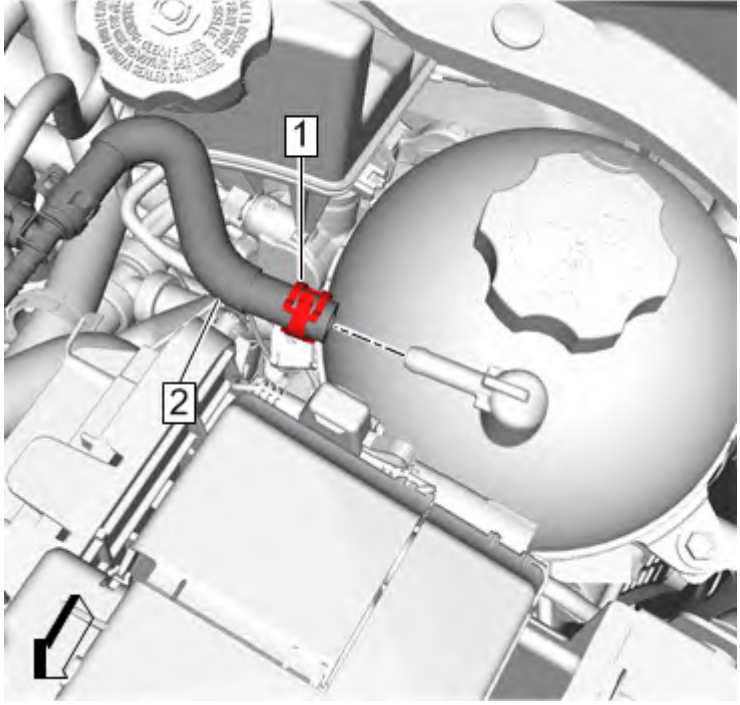


Fig. 35: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

3. Remove Engine Coolant Air Bleed Hose (2) @ Radiator Surge Tank - **Engine Coolant Air Bleed Hose Replacement (Turbocharger Coolant Return pipe to Water Outlet, LYX)Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Turbocharger Coolant Return Pipe to Radiator, LYX)Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Radiator to Engine Coolant Air Bleed Pipe LTG)**
4. Remove If equipped Power Transfer Unit Vent Hose @ Radiator Surge Tank - **Power Transfer Unit Vent Hose Replacement**

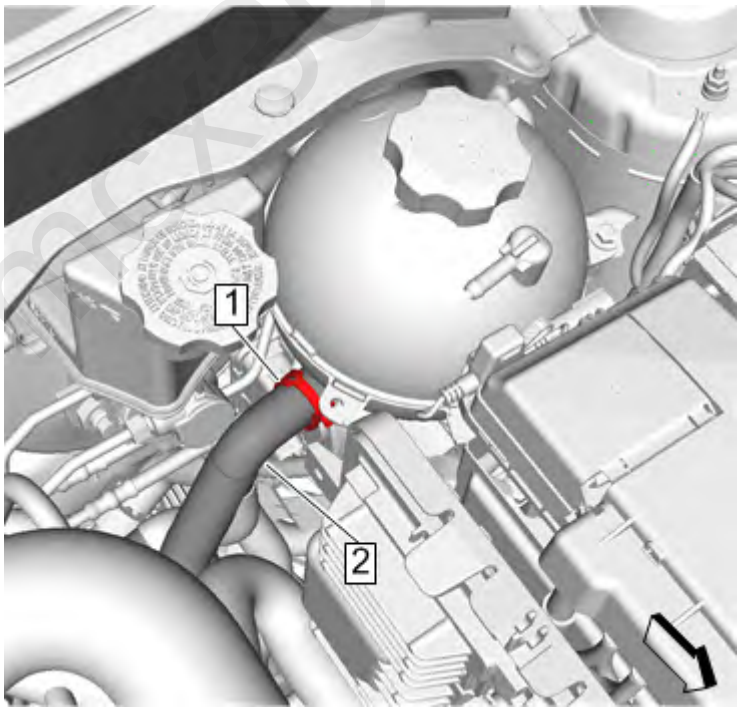


Fig. 36: Heater Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

5. Remove Heater Water Auxiliary Pump Inlet Hose (2) @ Radiator Surge Tank - **Heater Water Auxiliary Pump Inlet Hose Replacement (LYX with KL9) Heater Water Auxiliary Pump Inlet Hose Replacement (LTG with KL9)**

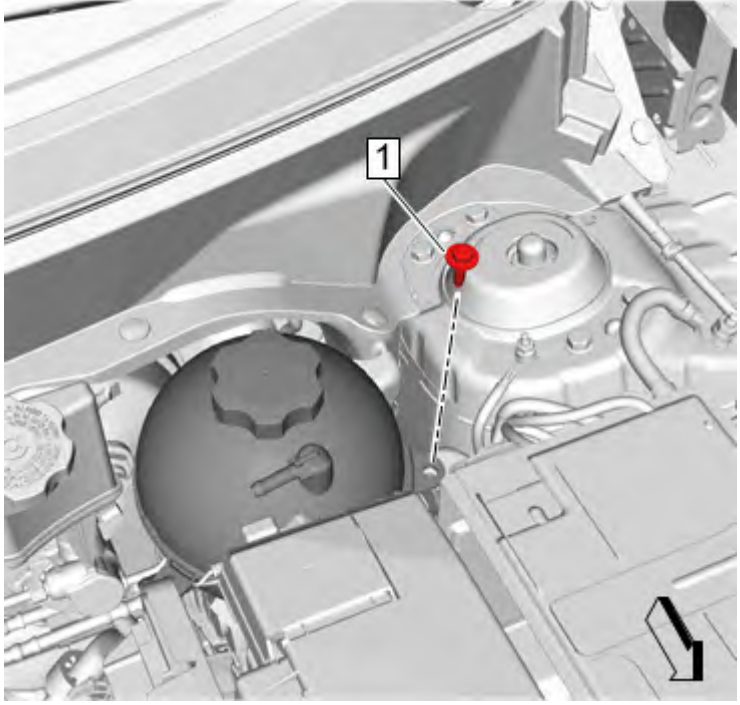


Fig. 37: Radiator Surge Tank Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove Radiator Surge Tank Bolt (1) @ Radiator Surge Tank.
7. Reposition the wiring harness.

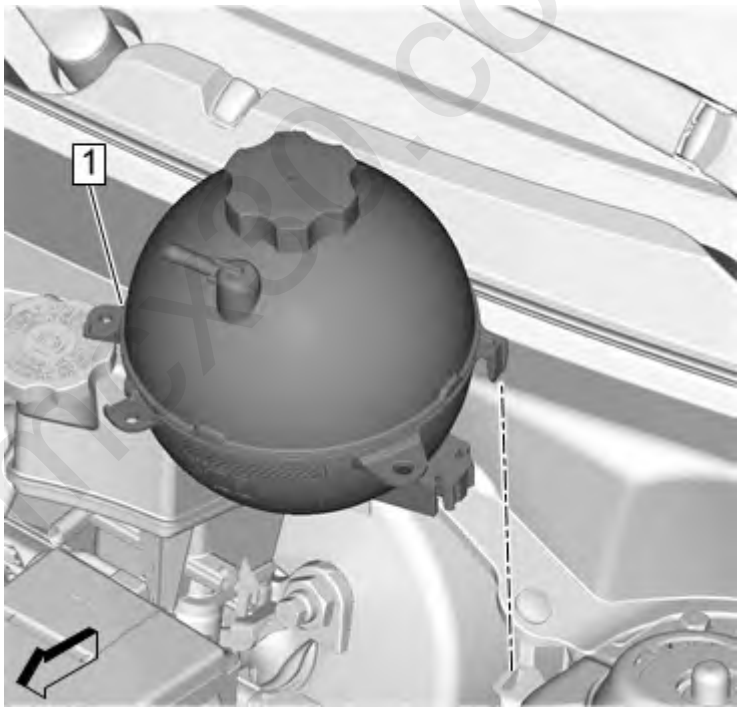


Fig. 38: Radiator Surge Tank
Courtesy of GENERAL MOTORS COMPANY

8. Remove Radiator Surge Tank (1).

Installation Procedure

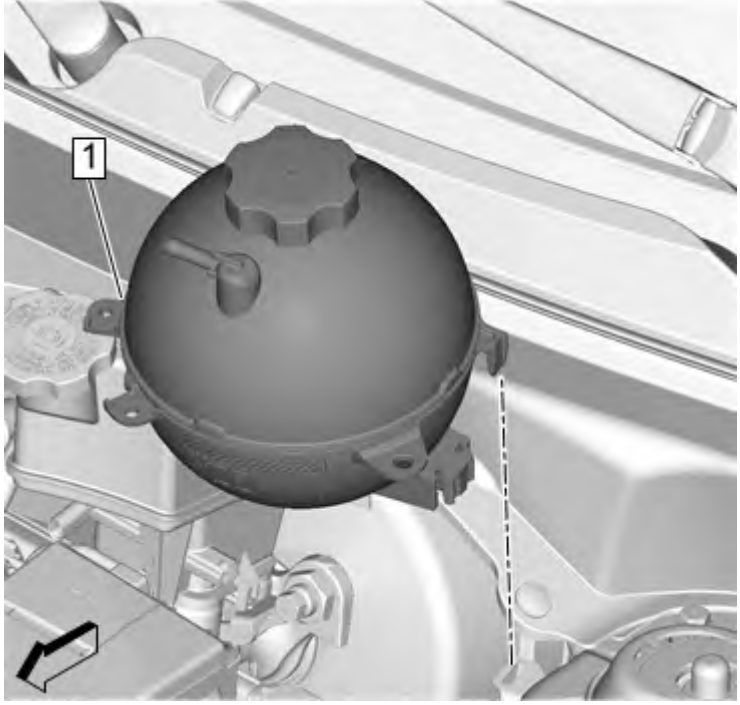


Fig. 39: Radiator Surge Tank
Courtesy of GENERAL MOTORS COMPANY

1. Install Radiator Surge Tank (1).

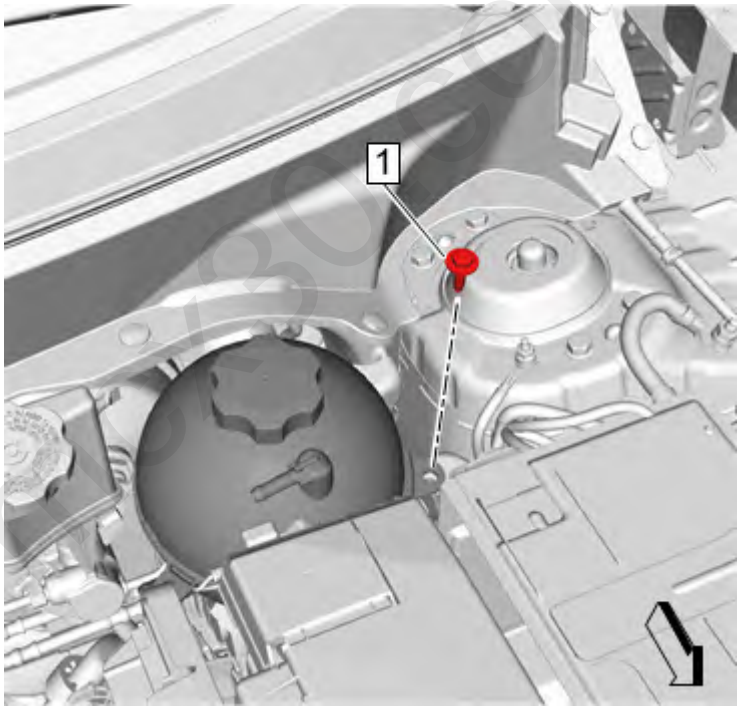


Fig. 40: Radiator Surge Tank Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. Install Radiator Surge Tank Bolt (1) and tighten 9 N.m (80 lb in)
3. Reposition the wiring harness.

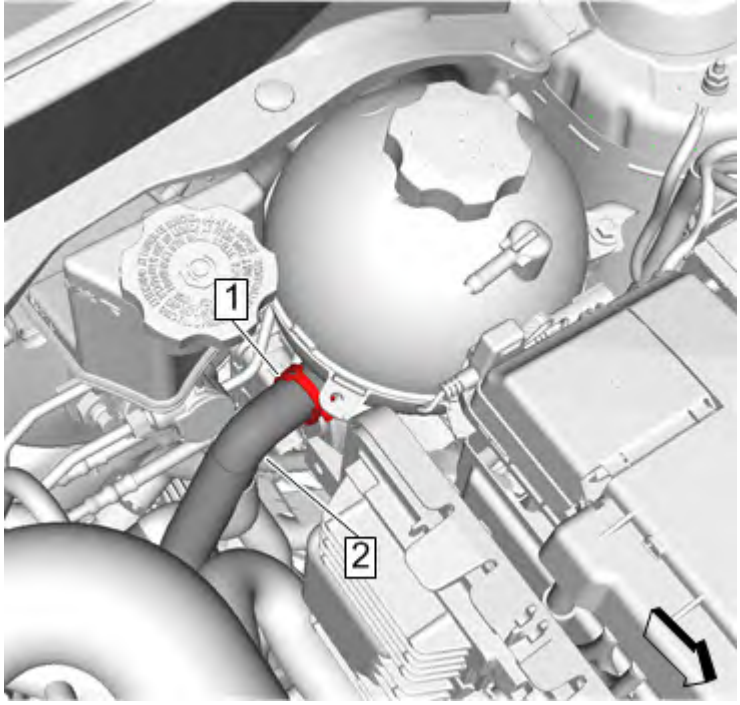


Fig. 41: Heater Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

4. Install Heater Water Auxiliary Pump Inlet Hose (2) @ Radiator Surge Tank - **Heater Water Auxiliary Pump Inlet Hose Replacement (LYX with KL9)** **Heater Water Auxiliary Pump Inlet Hose Replacement (LTG with KL9)**
5. Install If equipped Power Transfer Unit Vent Hose (1) @ Radiator Surge Tank - **Power Transfer Unit Vent Hose Replacement**

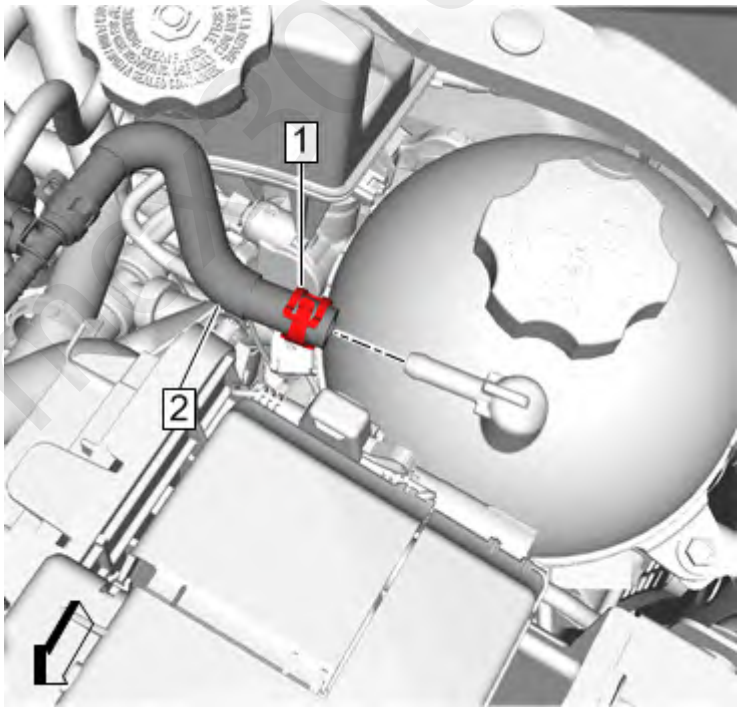


Fig. 42: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

6. Install Engine Coolant Air Bleed Hose (2) @ Radiator Surge Tank - **Engine Coolant Air Bleed Hose Replacement (Turbocharger Coolant Return pipe to Water Outlet, LYX)Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Turbocharger Coolant Return Pipe to Radiator, LYX)Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Radiator to Engine Coolant Air Bleed Pipe LTG)**

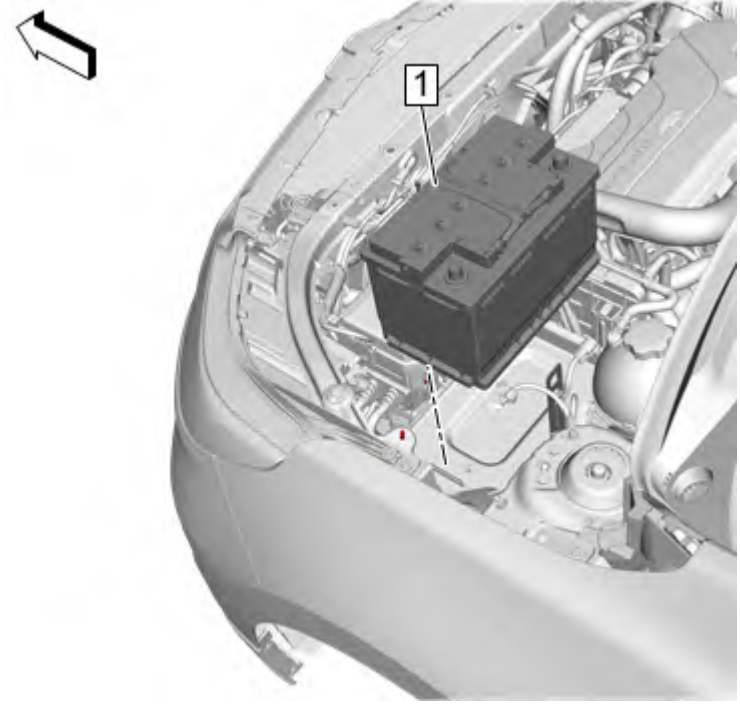


Fig. 43: Battery
Courtesy of GENERAL MOTORS COMPANY

7. Install Battery (1) - **Battery Replacement**
8. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
9. Check the cooling system for leaks.

RADIATOR SURGE TANK REPLACEMENT (LH7 FWD)

Removal Procedure

1. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**

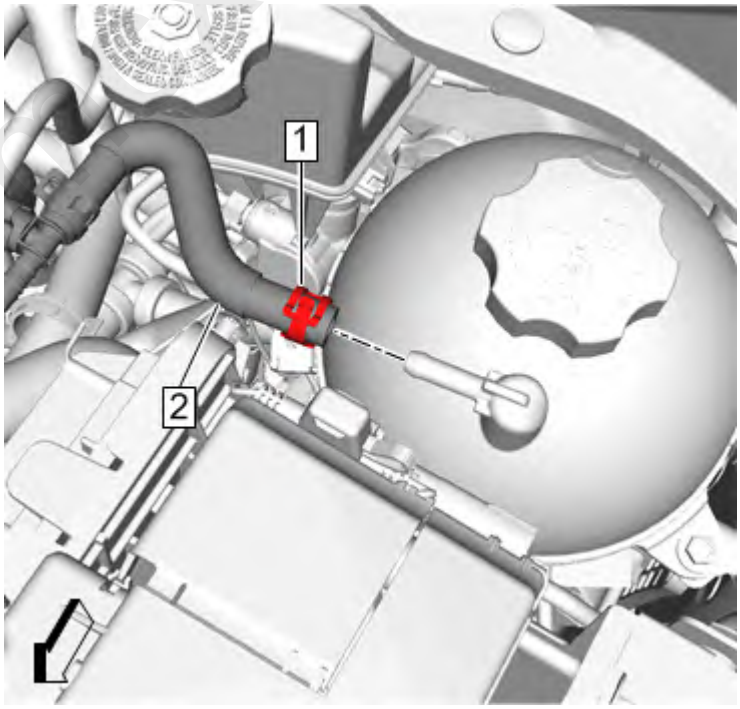


Fig. 44: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

2. Remove Engine Coolant Air Bleed Hose (2) @ Radiator Surge Tank - **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Exhaust Gas Recirculation Cooler Housing and Radiator LH7)**

3. Remove {If equipped} Power Transfer Unit Vent Hose@Radiator Surge Tank - **Power Transfer Unit Vent Hose Replacement**

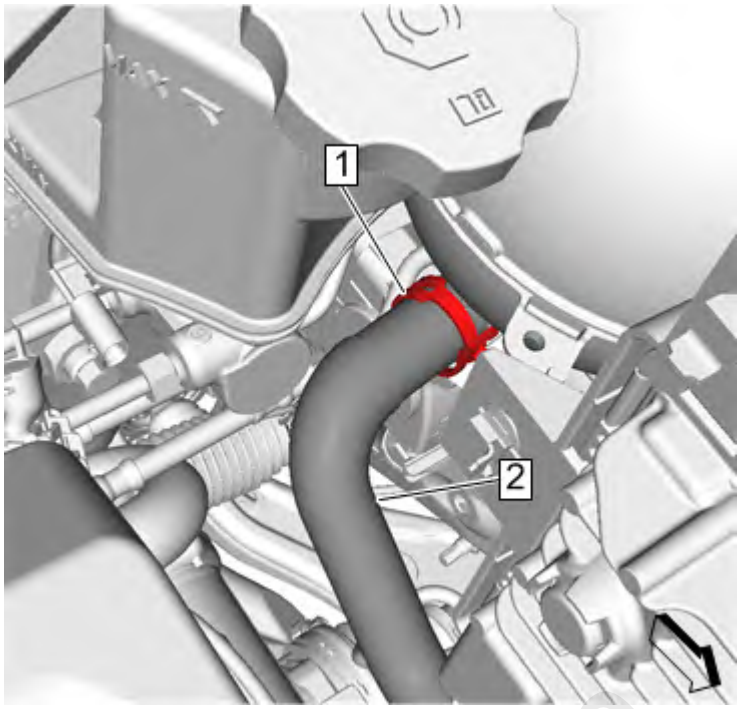


Fig. 45: Radiator Surge Tank Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

4. Remove Radiator Surge Tank Outlet Hose (2) @ Radiator Surge Tank - **Radiator Surge Tank Outlet Hose Replacement (LH7)**

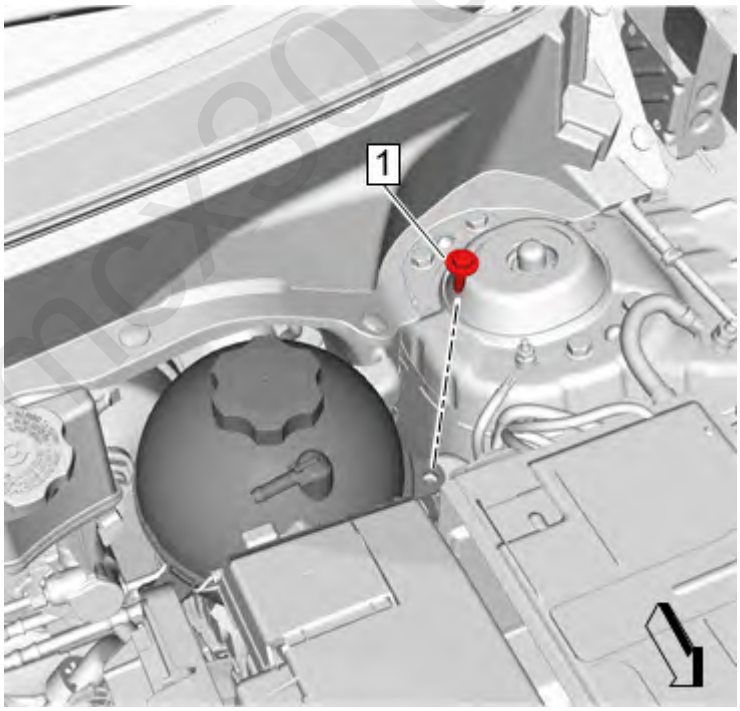


Fig. 46: Radiator Surge Tank Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove Radiator Surge Tank Bolt (1) @ Radiator Surge Tank.
6. Reposition the wiring harness.

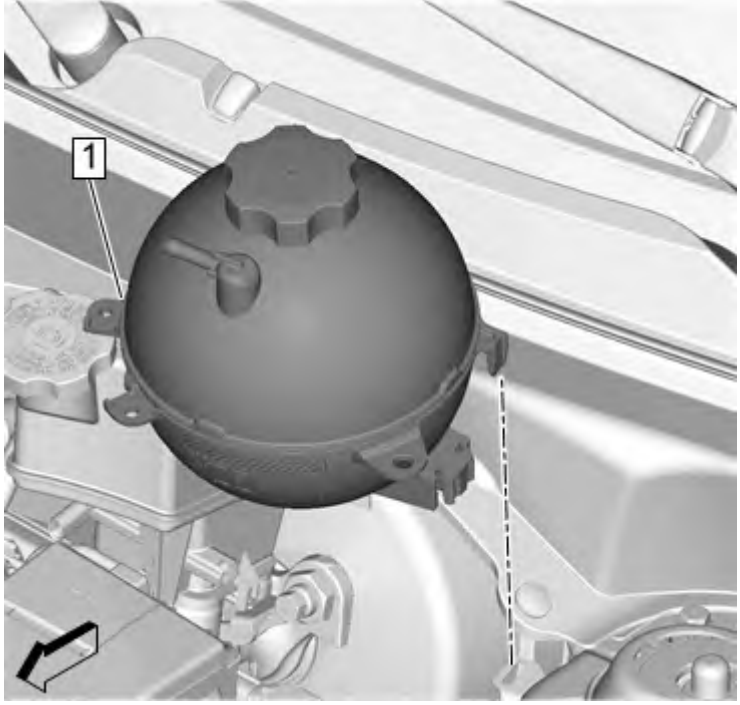


Fig. 47: Radiator Surge Tank
Courtesy of GENERAL MOTORS COMPANY

7. Remove Radiator Surge Tank (1).

Installation Procedure

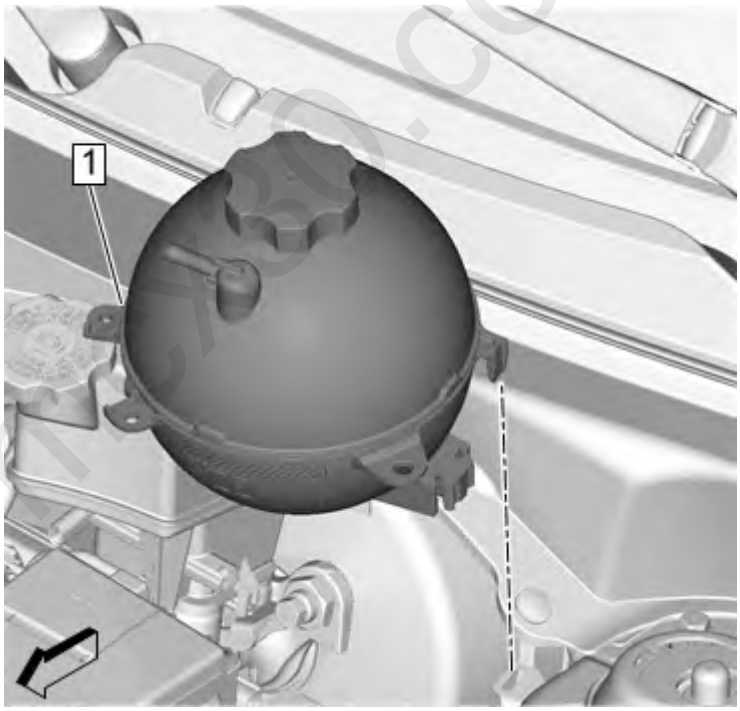


Fig. 48: Radiator Surge Tank
Courtesy of GENERAL MOTORS COMPANY

1. Install Radiator Surge Tank (1).

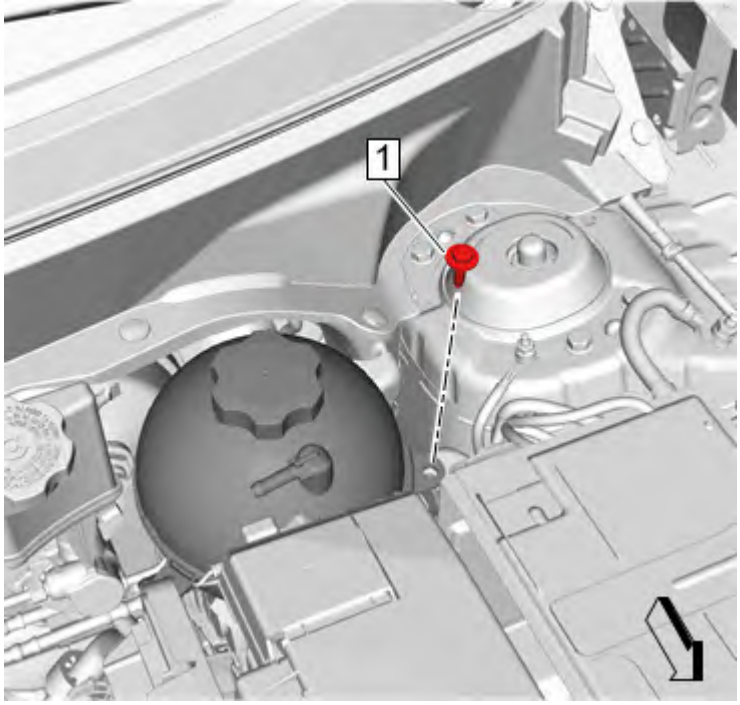


Fig. 49: Radiator Surge Tank Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. Install Radiator Surge Tank Bolt (1) and tighten 9 N.m (80 lb in)
3. Reposition the wiring harness.

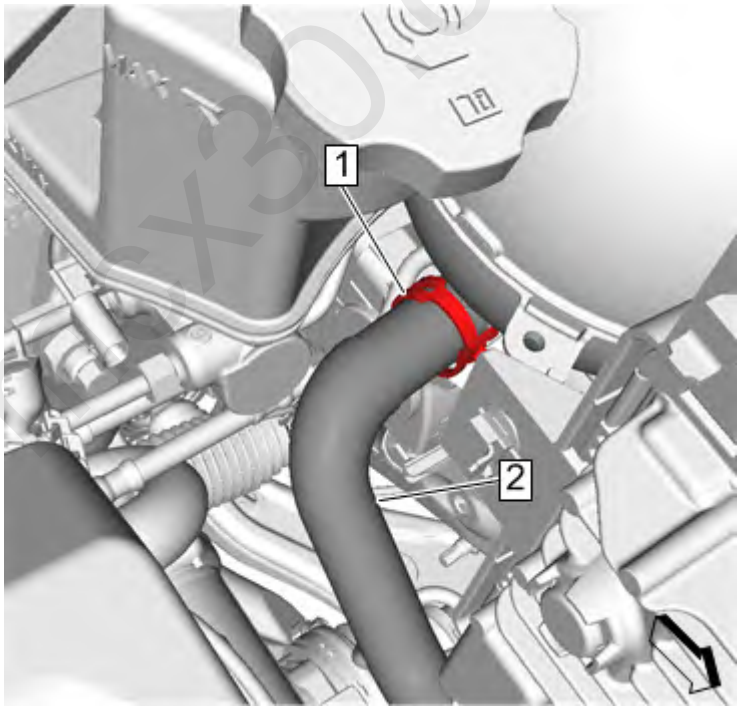


Fig. 50: Radiator Surge Tank Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

4. Install Radiator Surge Tank Outlet Hose (2) @ Radiator Surge Tank - **Radiator Surge Tank Outlet Hose Replacement (LH7)**
5. Install {If equipped} Power Transfer Unit Vent Hose @ Radiator Surge Tank - **Power Transfer Unit Vent Hose Replacement**

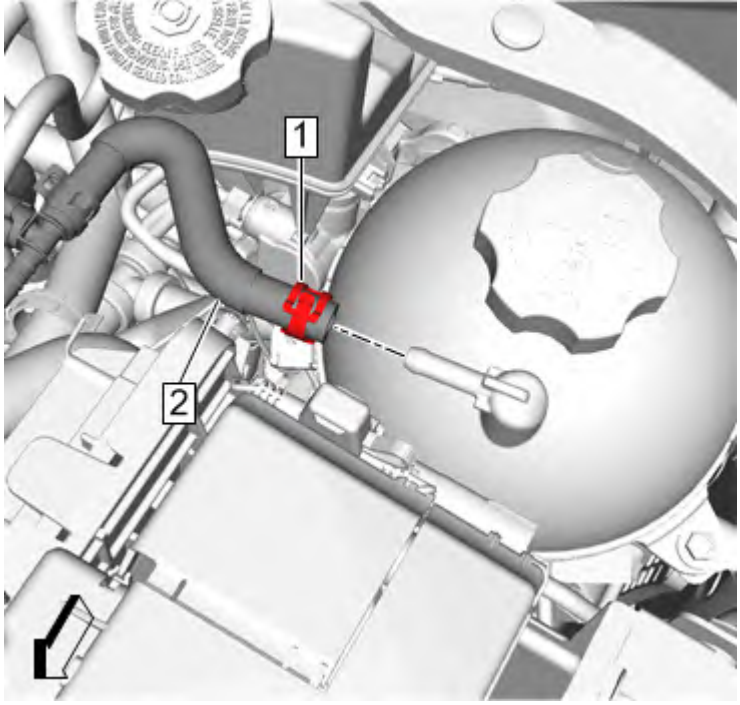


Fig. 51: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

6. Install Engine Coolant Air Bleed Hose (2) @ Radiator Surge Tank - **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Exhaust Gas Recirculation Cooler Housing and Radiator LH7)**
7. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
8. Check the cooling system for leaks.

RADIATOR SURGE TANK REPLACEMENT (LH7 AWD)

Removal Procedure

1. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**

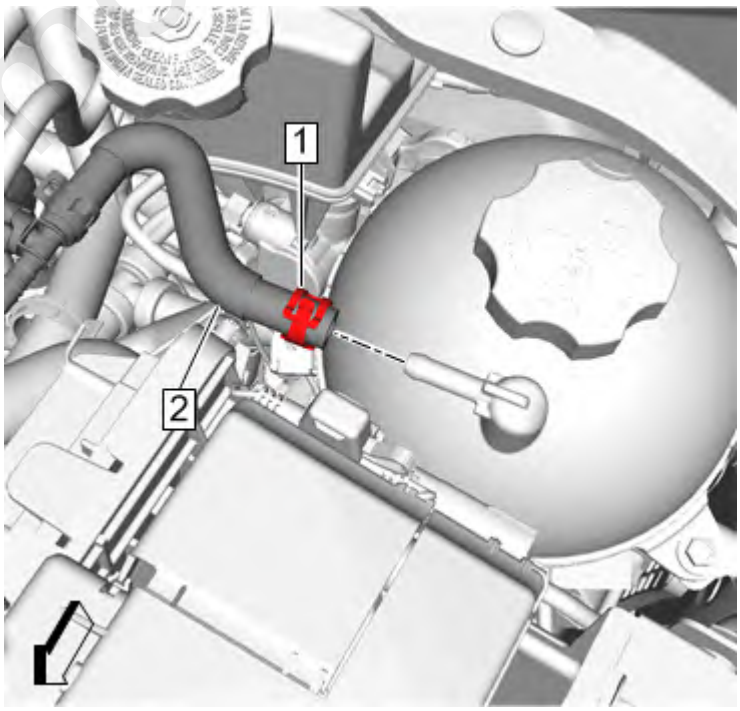


Fig. 52: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

2. Remove Engine Coolant Air Bleed Hose (2) @ Radiator Surge Tank - **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Exhaust Gas Recirculation Cooler Housing and**

Radiator LH7)

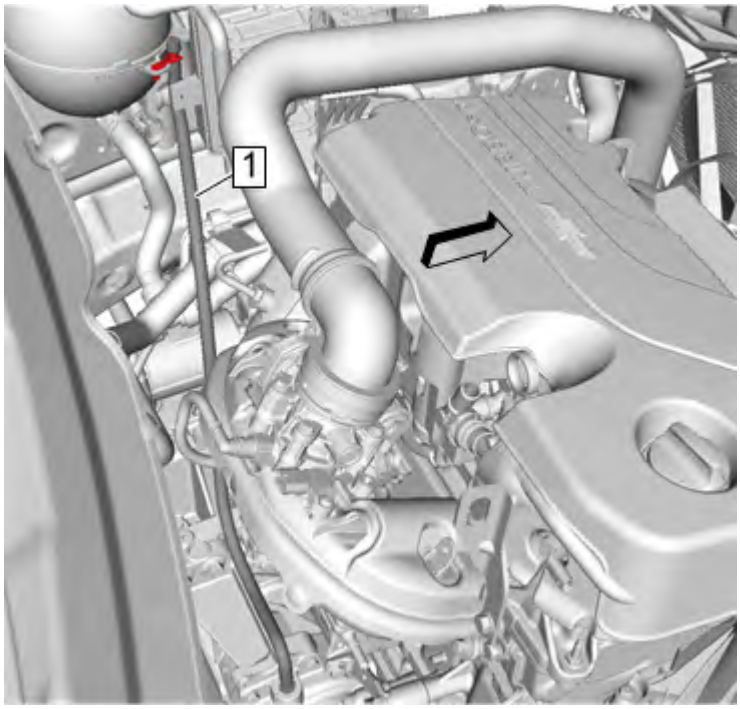


Fig. 53: Power Transfer Unit Vent Hose
Courtesy of GENERAL MOTORS COMPANY

3. Remove Power Transfer Unit Vent Hose (1) @ Radiator Surge Tank - Power Transfer Unit Vent Hose Replacement

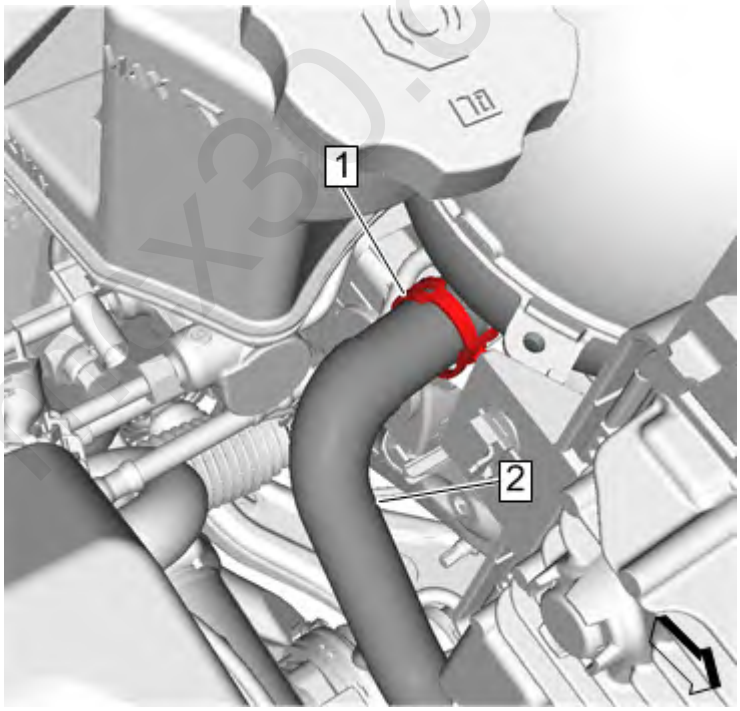


Fig. 54: Radiator Surge Tank Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

4. Remove Radiator Surge Tank Outlet Hose (2) @ Radiator Surge Tank - Radiator Surge Tank Outlet Hose Replacement (LH7)

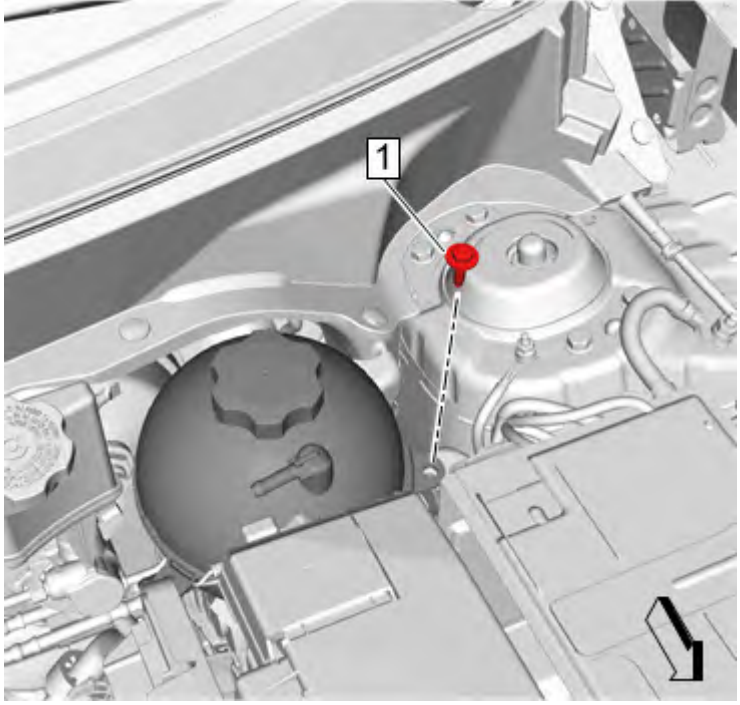


Fig. 55: Radiator Surge Tank Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove Radiator Surge Tank Bolt (1) @ Radiator Surge Tank.
6. Reposition the wiring harness.

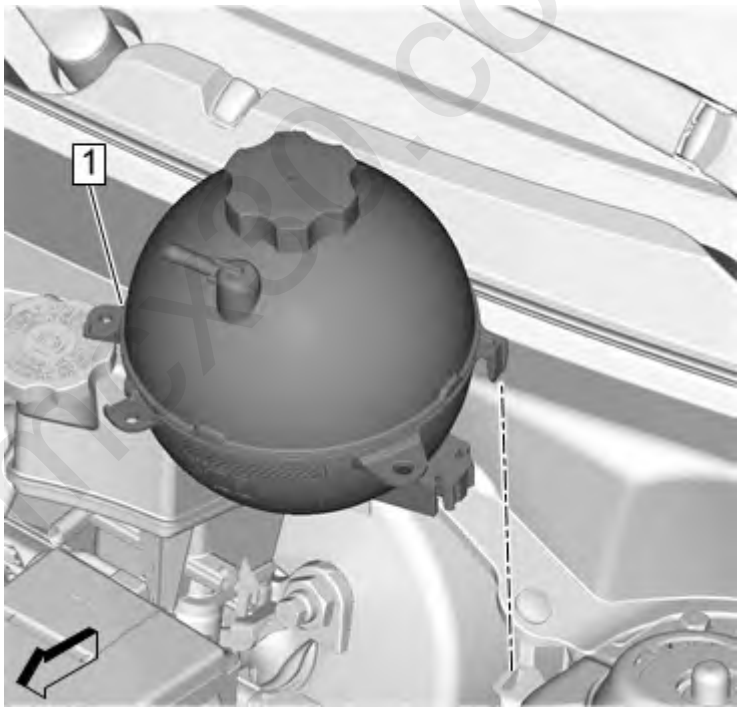


Fig. 56: Radiator Surge Tank
Courtesy of GENERAL MOTORS COMPANY

7. Remove Radiator Surge Tank (1).

Installation Procedure

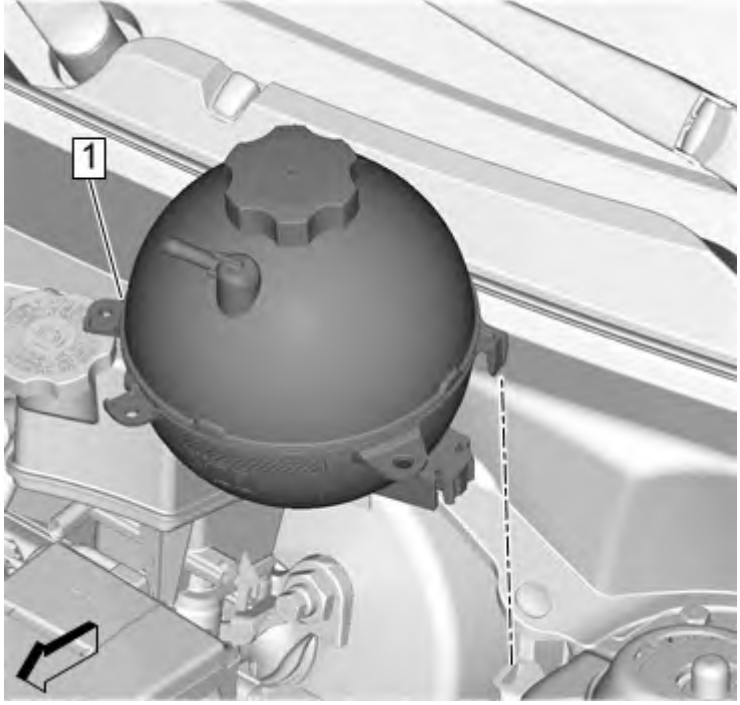


Fig. 57: Radiator Surge Tank
Courtesy of GENERAL MOTORS COMPANY

1. Install Radiator Surge Tank (1).

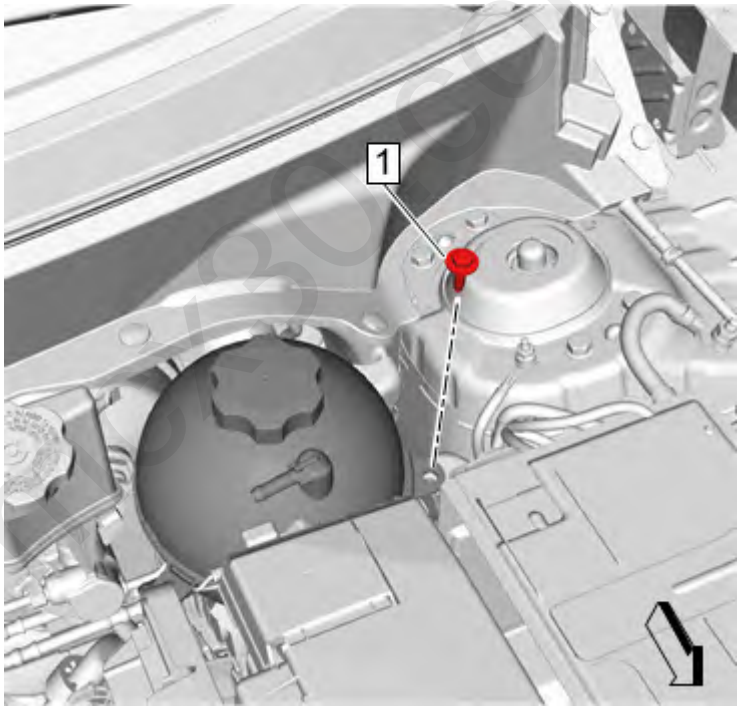


Fig. 58: Radiator Surge Tank Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. Install Radiator Surge Tank Bolt (1) and tighten 9 N.m (80 lb in)
3. Reposition the wiring harness.

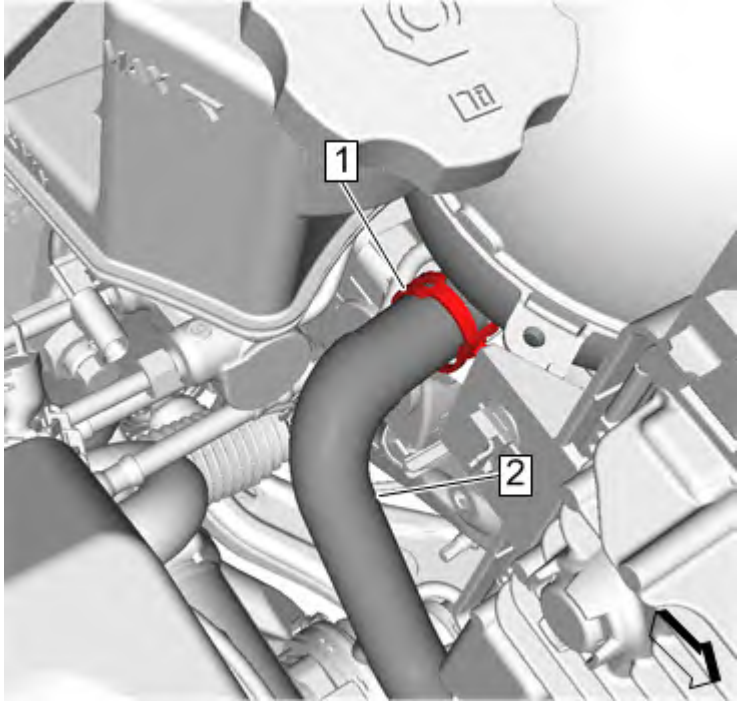


Fig. 59: Radiator Surge Tank Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

4. Install Radiator Surge Tank Outlet Hose (2) @ Radiator Surge Tank - **Radiator Surge Tank Outlet Hose Replacement (LH7)**

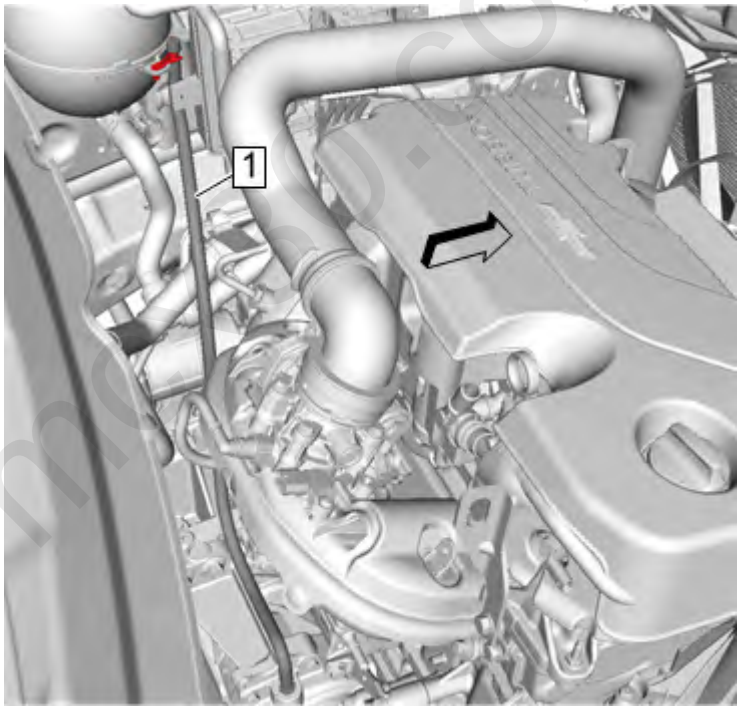


Fig. 60: Power Transfer Unit Vent Hose
Courtesy of GENERAL MOTORS COMPANY

5. Install Power Transfer Unit Vent Hose (1) @ Radiator Surge Tank - **Power Transfer Unit Vent Hose Replacement**

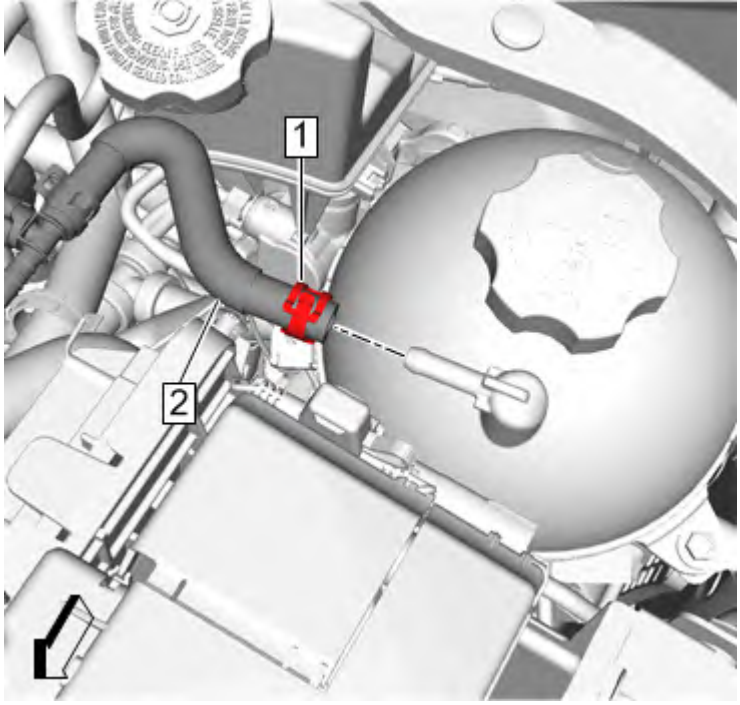


Fig. 61: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

6. Install Engine Coolant Air Bleed Hose (2) @ Radiator Surge Tank - **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Exhaust Gas Recirculation Cooler Housing and Radiator LH7)**
7. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
8. Check the cooling system for leaks.

RADIATOR SURGE TANK OUTLET HOSE REPLACEMENT (LH7)

Removal Procedure

1. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**

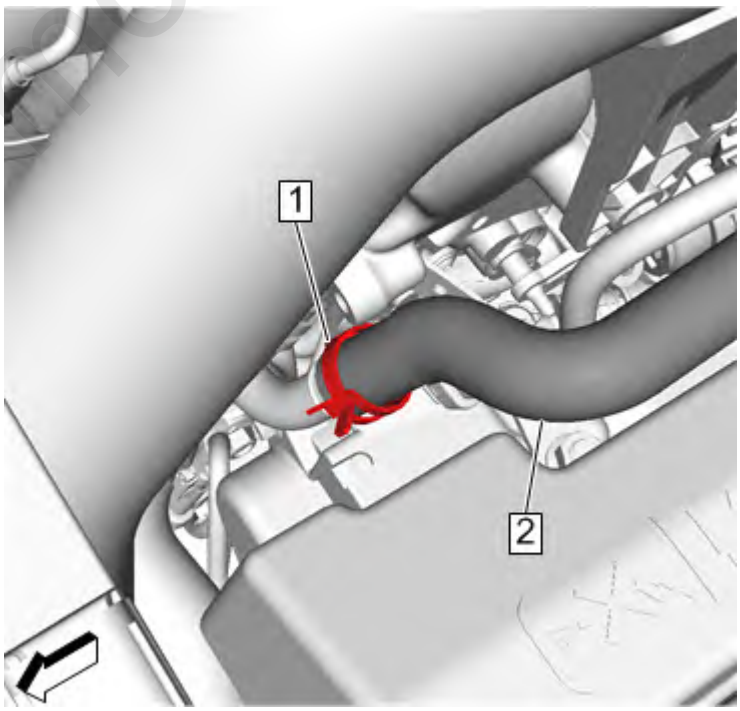


Fig. 62: Radiator Surge Tank Outlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

2. Disengage Radiator Surge Tank Outlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**

3. Remove Radiator Surge Tank Outlet Hose (2) @ Thermostat Bypass Pipe.
4. Reposition the wiring harness.
5. Reposition Engine Coolant Air Bleed Hose - **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Exhaust Gas Recirculation Cooler Housing and Radiator LH7)**

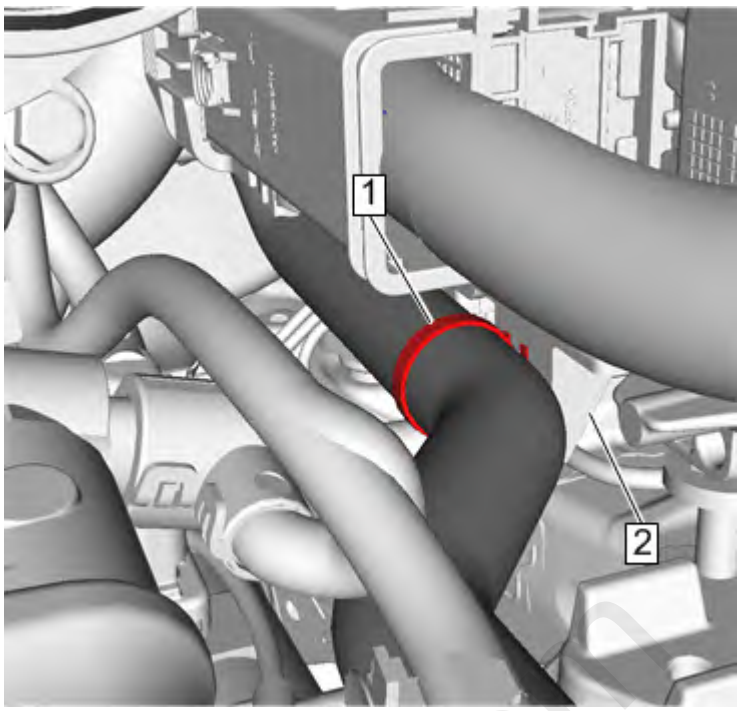


Fig. 63: Radiator Surge Tank Outlet Hose Strap
Courtesy of GENERAL MOTORS COMPANY

6. Remove Radiator Surge Tank Outlet Hose Strap (1) @ Engine Control Module Bracket (2).

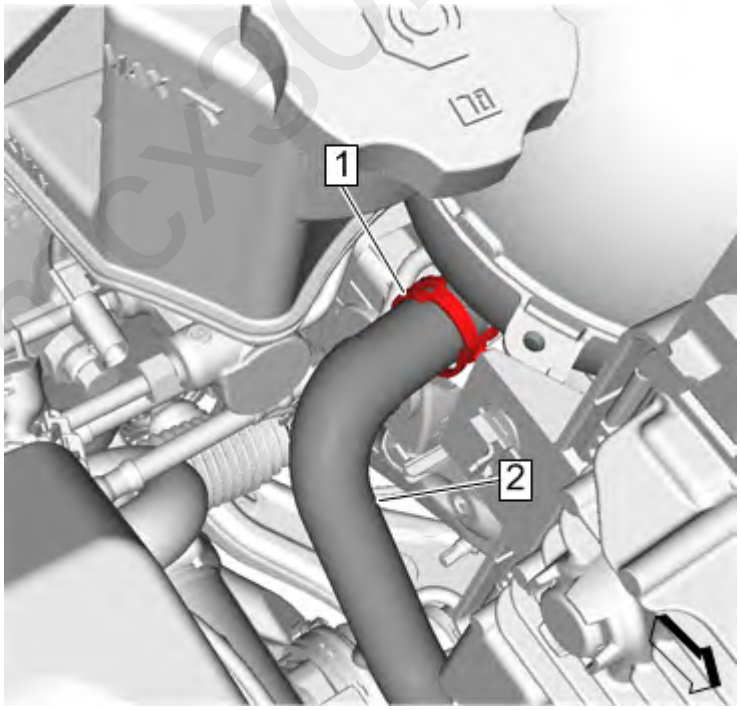


Fig. 64: Radiator Surge Tank Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

7. Disengage Radiator Surge Tank Outlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
8. Remove Radiator Surge Tank Outlet Hose (2) @ Radiator Surge Tank.
9. Remove Radiator Surge Tank Outlet Hose (2).

Installation Procedure

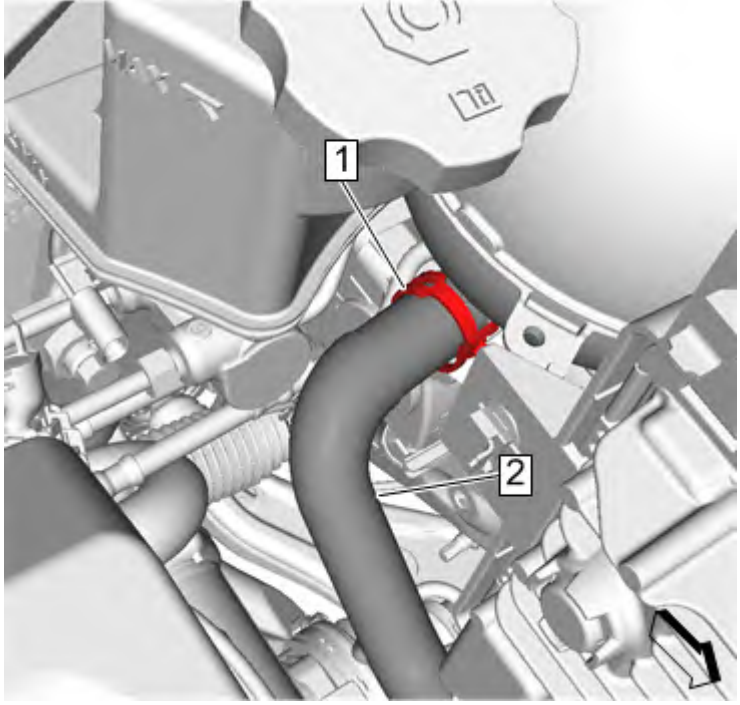


Fig. 65: Radiator Surge Tank Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

1. Install Radiator Surge Tank Outlet Hose (2) @ Radiator Surge Tank.
2. Engage Radiator Surge Tank Outlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**

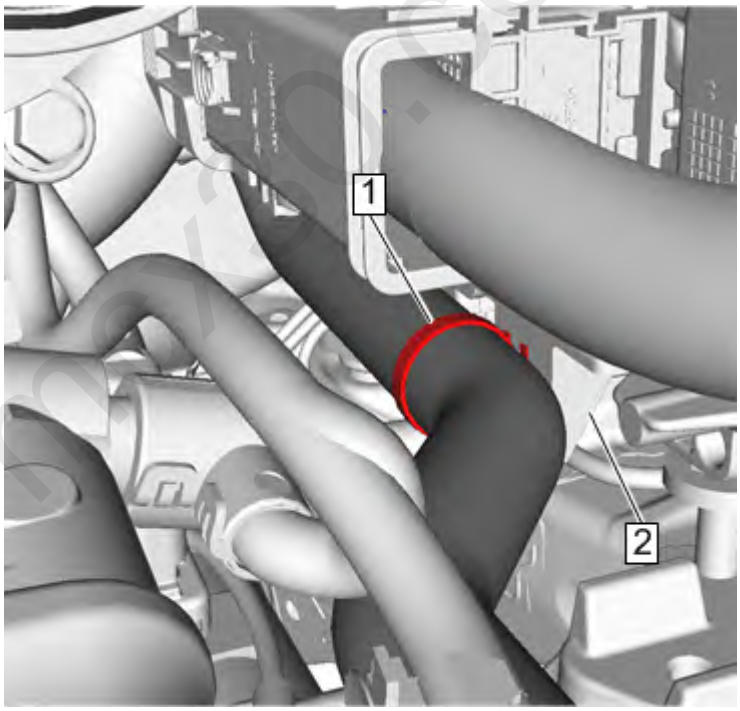


Fig. 66: Radiator Surge Tank Outlet Hose Strap
Courtesy of GENERAL MOTORS COMPANY

3. Install Radiator Surge Tank Outlet Hose Strap (1) @ Engine Control Module Bracket (2).
4. Reposition Engine Coolant Air Bleed Hose - **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Exhaust Gas Recirculation Cooler Housing and Radiator LH7)**
5. Reposition the wiring harness.

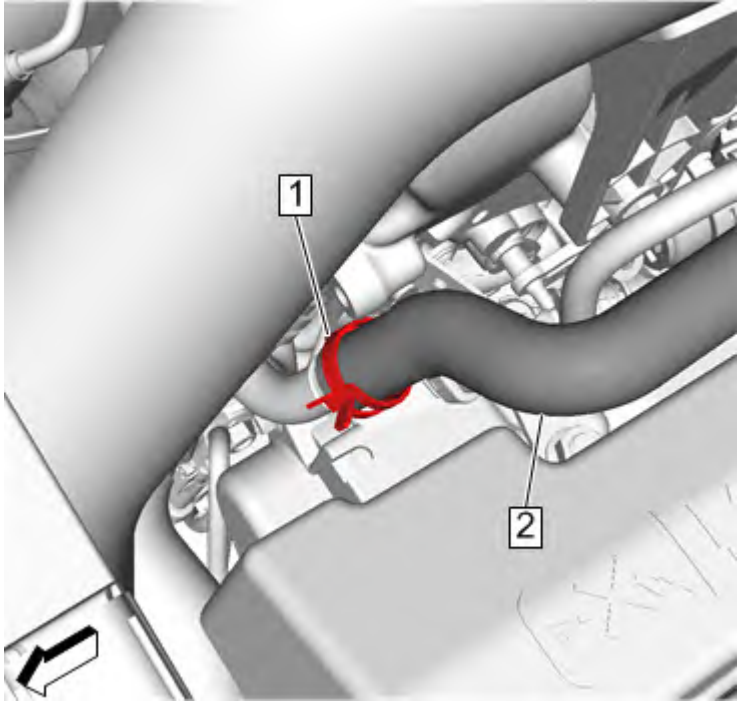


Fig. 67: Radiator Surge Tank Outlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

6. Install Radiator Surge Tank Outlet Hose (2) @ Thermostat Bypass Pipe.
7. Engage Radiator Surge Tank Outlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
8. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
9. Check the cooling system for leaks.

RADIATOR INLET HOSE REPLACEMENT (LYX)

Removal Procedure

1. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**

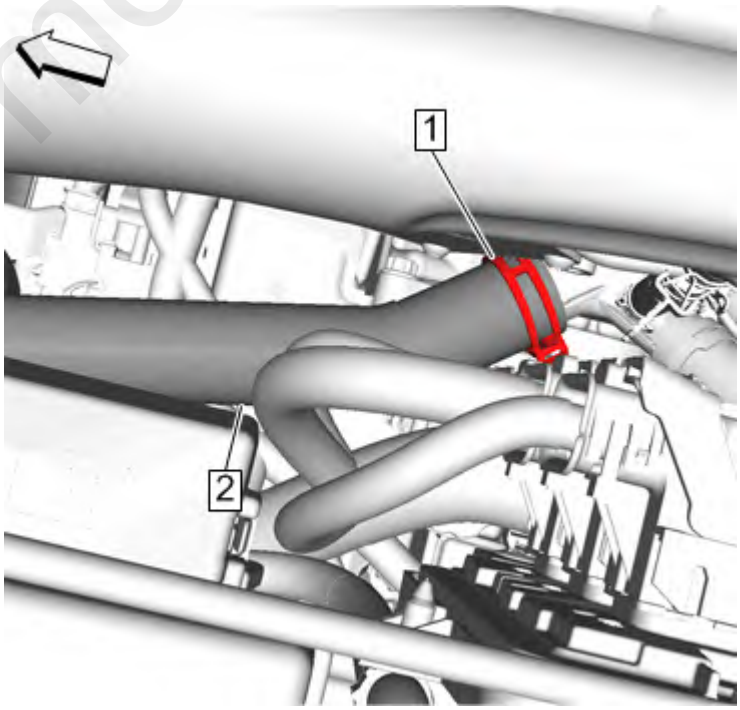


Fig. 68: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

2. Disengage Radiator Inlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**

mcx30.com

3. Remove Radiator Inlet Hose (2) @ Water Outlet.

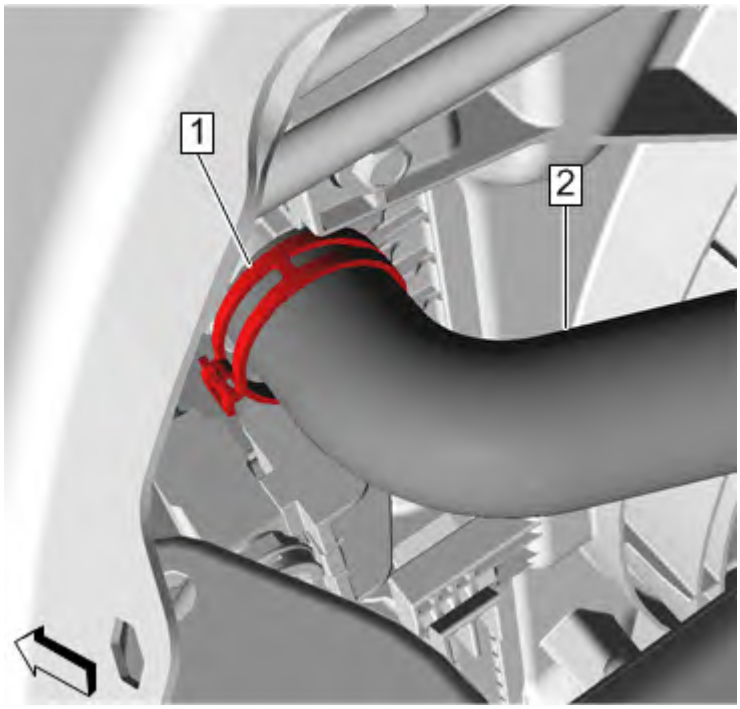


Fig. 69: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

4. Disengage Radiator Inlet Hose Clamp (1) -**Hose Clamp Replacement Guidelines - Spring Type**
5. Remove Radiator Inlet Hose (2) @ - Radiator
6. Remove Radiator Inlet Hose (2).

Installation Procedure

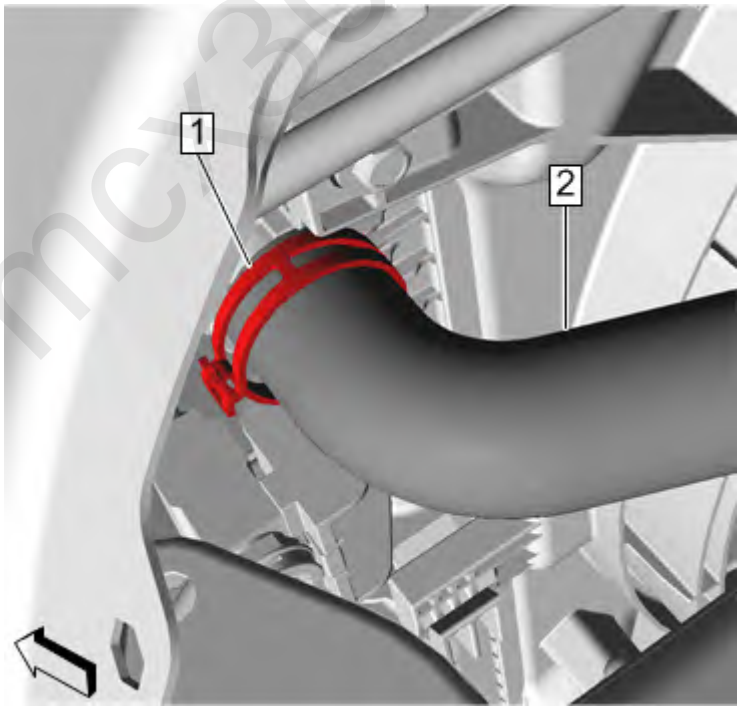


Fig. 70: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

1. Install Radiator Inlet Hose (2) @ - Radiator.
2. Engage Radiator Inlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**

mcx30.com

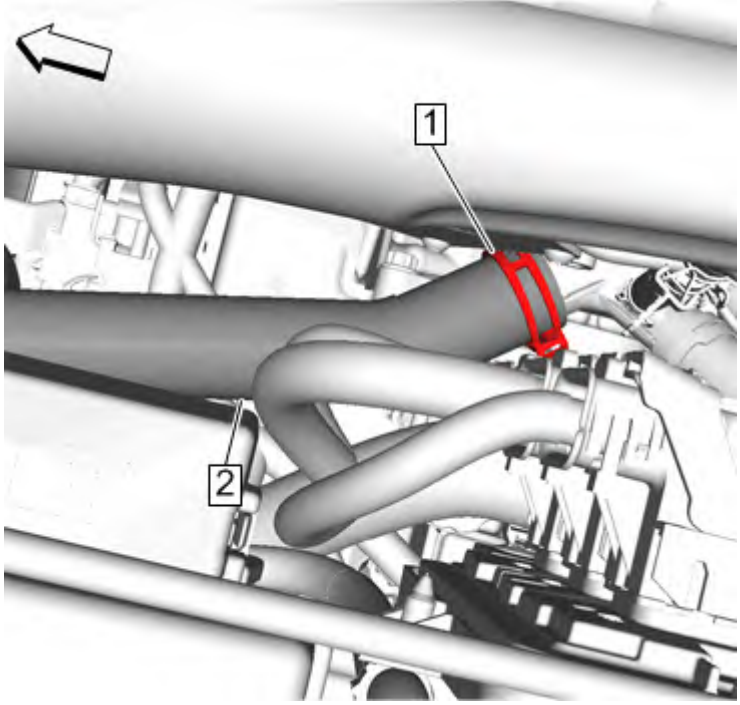


Fig. 71: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

3. Install Radiator Inlet Hose (2) @Water Outlet.
4. Engage Radiator Inlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
5. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
6. Start the engine and inspect for leaks.

RADIATOR INLET HOSE REPLACEMENT (LH7)

Removal Procedure

1. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**

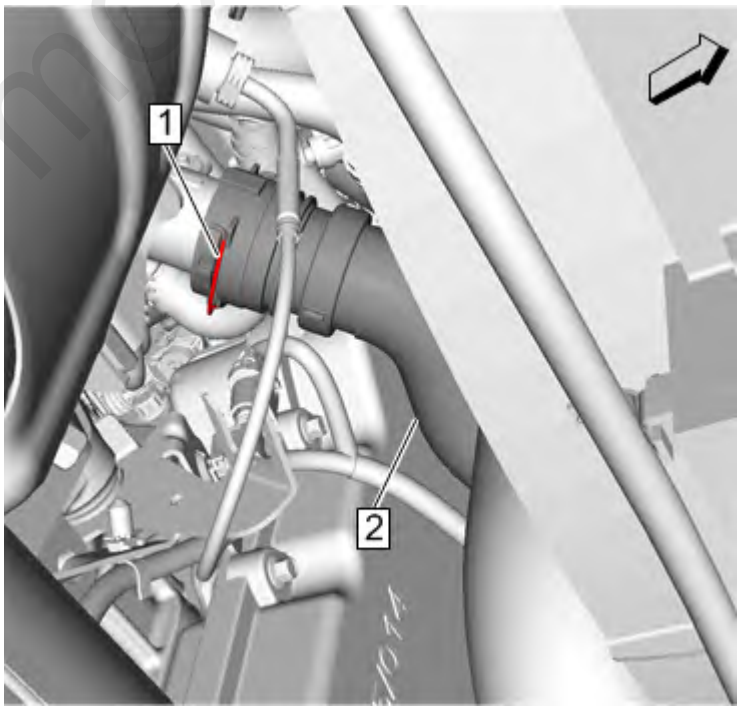


Fig. 72: Radiator Inlet Hose Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Disengage Radiator Inlet Hose Retainer (1).
3. Remove Radiator Inlet Hose (2) @ Water Outlet.

mcx30.com

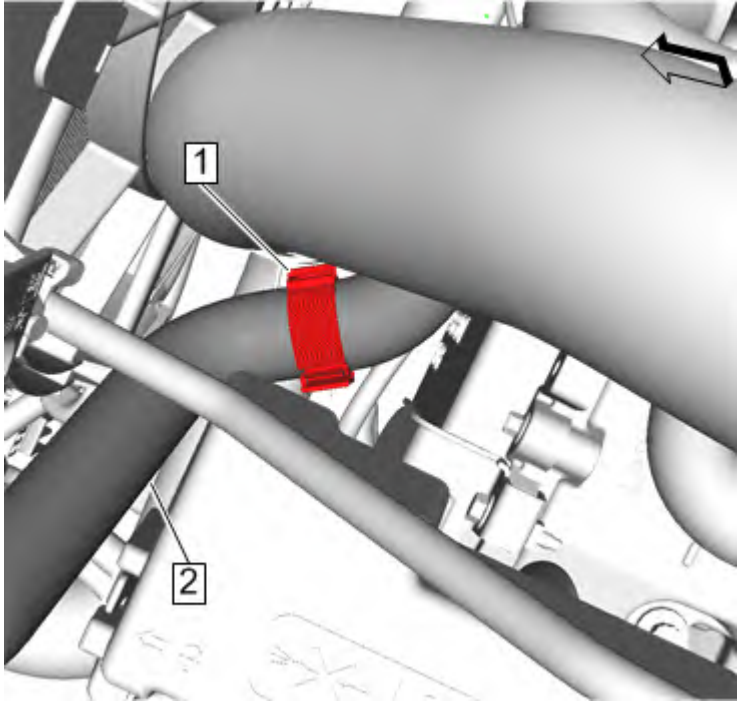


Fig. 73: Radiator Outlet Hose Clip And Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

4. Remove Radiator Outlet Hose Clip (1) @ Radiator Inlet Hose (2).

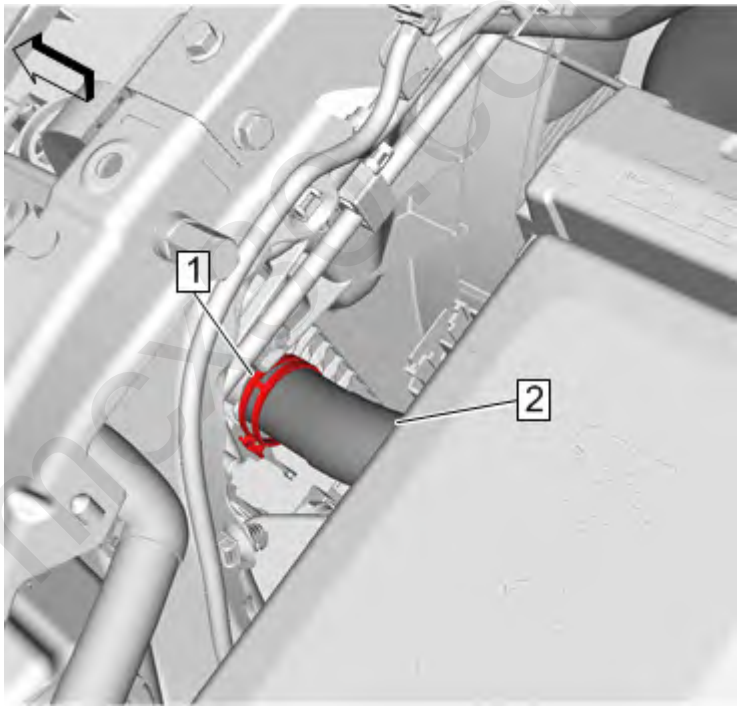


Fig. 74: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Disengage Radiator Inlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
6. Remove Radiator Inlet Hose (2) @ - Radiator.
7. Remove Radiator Inlet Hose (2).

Installation Procedure

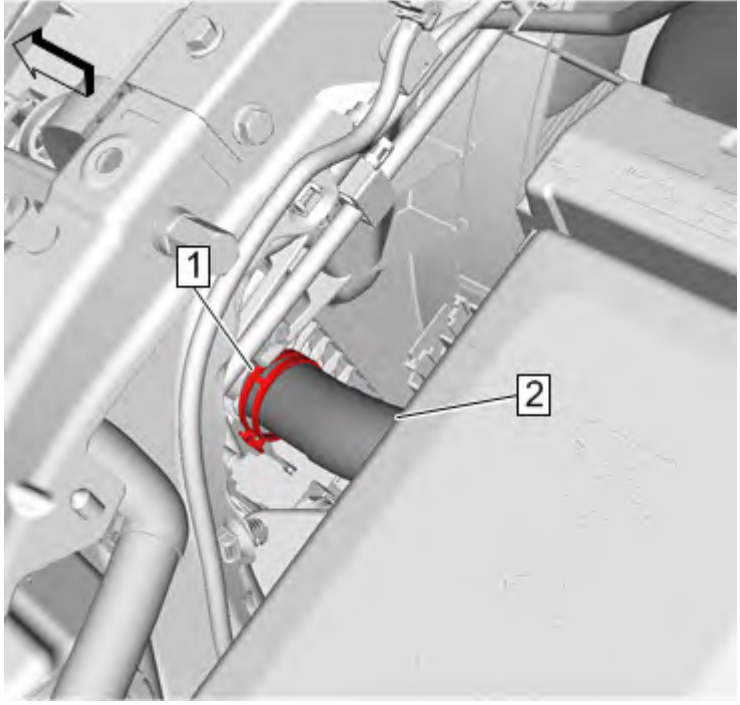


Fig. 75: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

1. Install Radiator Inlet Hose (2) @ - Radiator.
2. Engage Radiator Inlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**

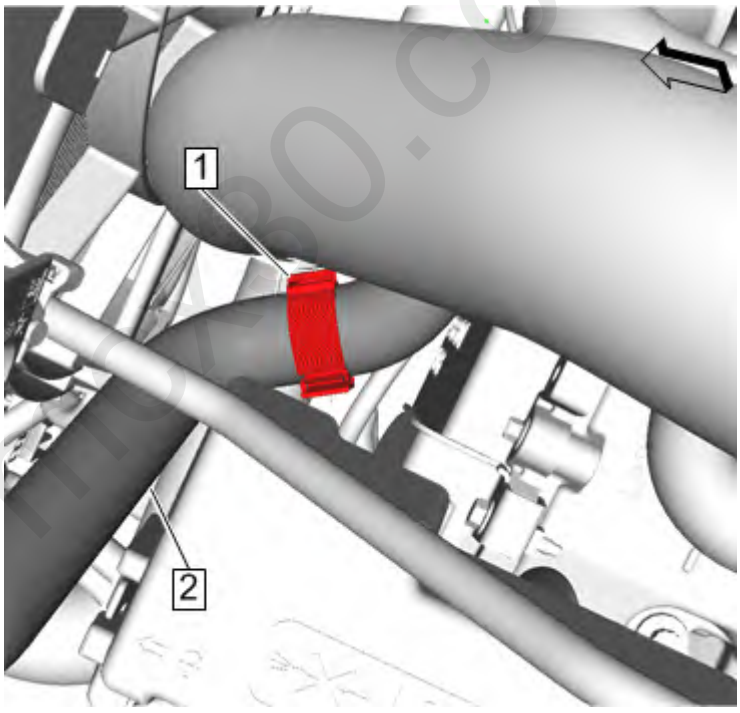


Fig. 76: Radiator Outlet Hose Clip And Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

3. Install Radiator Outlet Hose Clip (1) @ Radiator Inlet Hose (2).

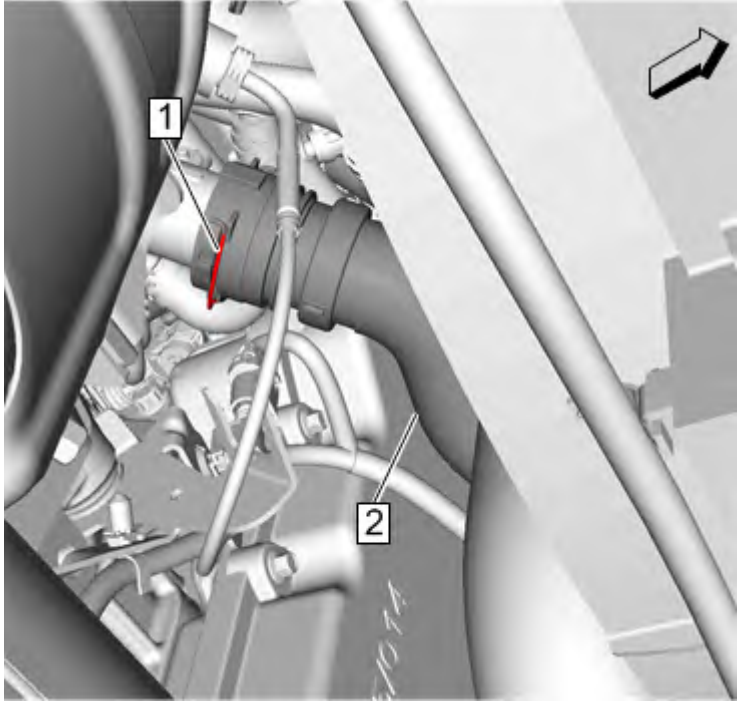


Fig. 77: Radiator Inlet Hose Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install Radiator Inlet Hose (2) @ Water Outlet.
5. Engage Radiator Inlet Hose Retainer (1).
6. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
7. Start the engine and inspect for leaks.

RADIATOR INLET HOSE REPLACEMENT (LTG WITH KL9)

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
2. Reposition Wiring Harnesses.

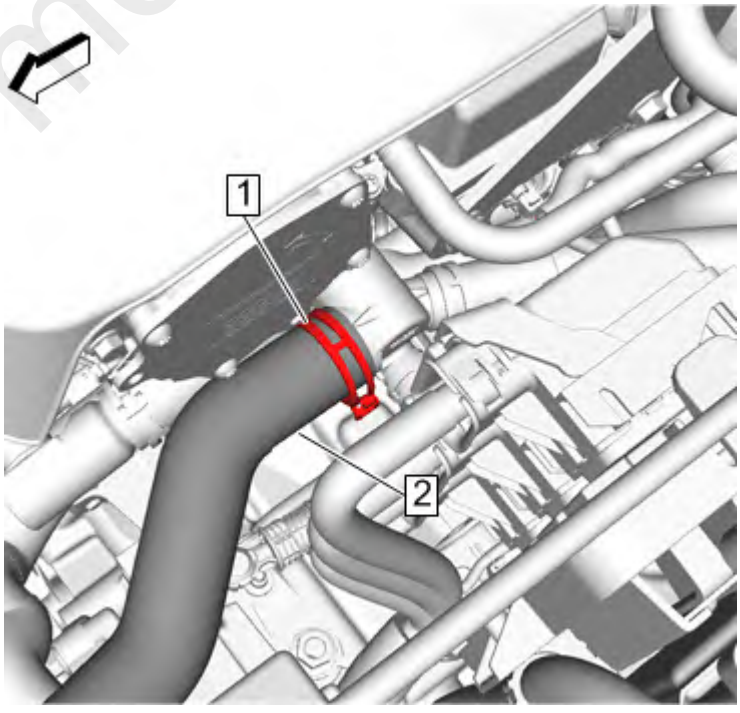


Fig. 78: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

3. Disengage Radiator Inlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**

mcx30.com

4. Remove Radiator Inlet Hose (2) @ Water Outlet.

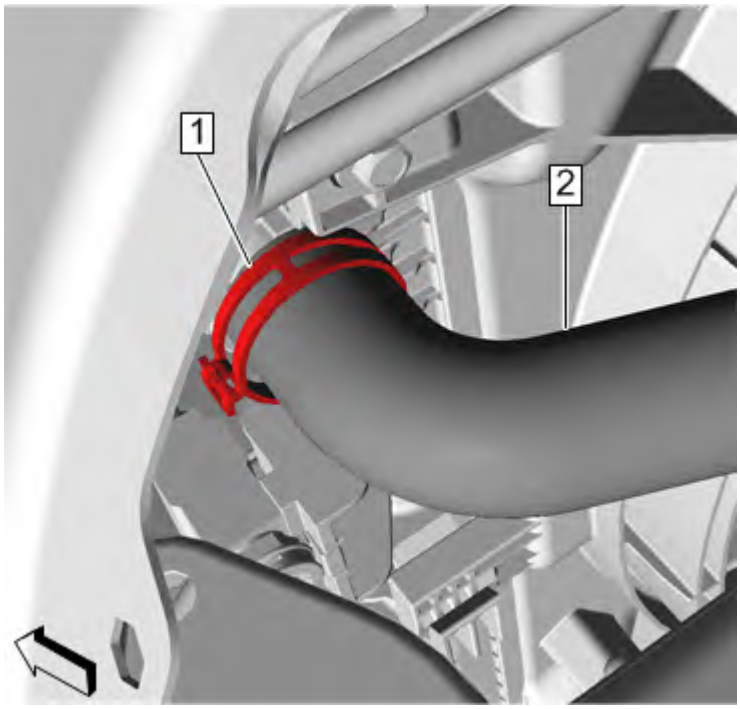


Fig. 79: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Disengage Radiator Inlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
6. Remove Radiator Inlet Hose (2) @ - Radiator.
7. Remove Radiator Inlet Hose (2).

Installation Procedure

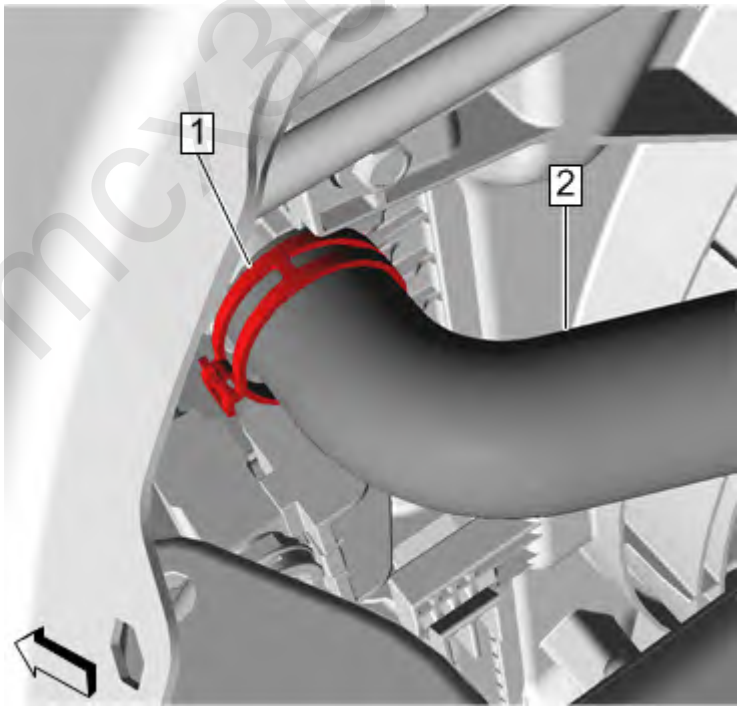


Fig. 80: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

1. Install Radiator Inlet Hose (2) @ - Radiator.
2. Engage Radiator Inlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**

mcx30.com

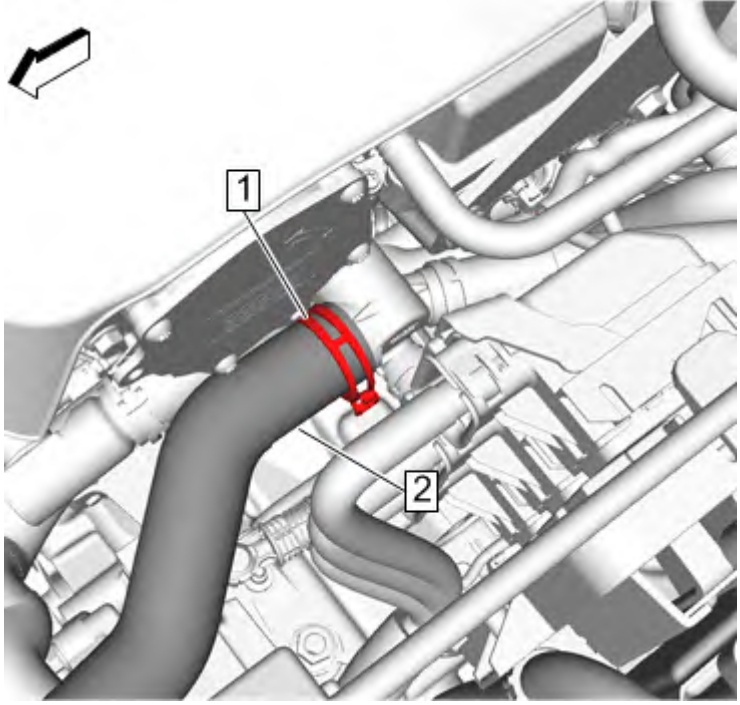


Fig. 81: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

3. Install Radiator Inlet Hose (2) @ Water Outlet.
4. Engage Radiator Inlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
5. Reposition Wiring Harnesses.
6. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
7. Start the engine and inspect for leaks.

RADIATOR OUTLET HOSE REPLACEMENT (LYX)

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
2. Remove Front Bumper Fascia - **Front Bumper Fascia Replacement (Equinox) Front Bumper Fascia Replacement (Terrain)**

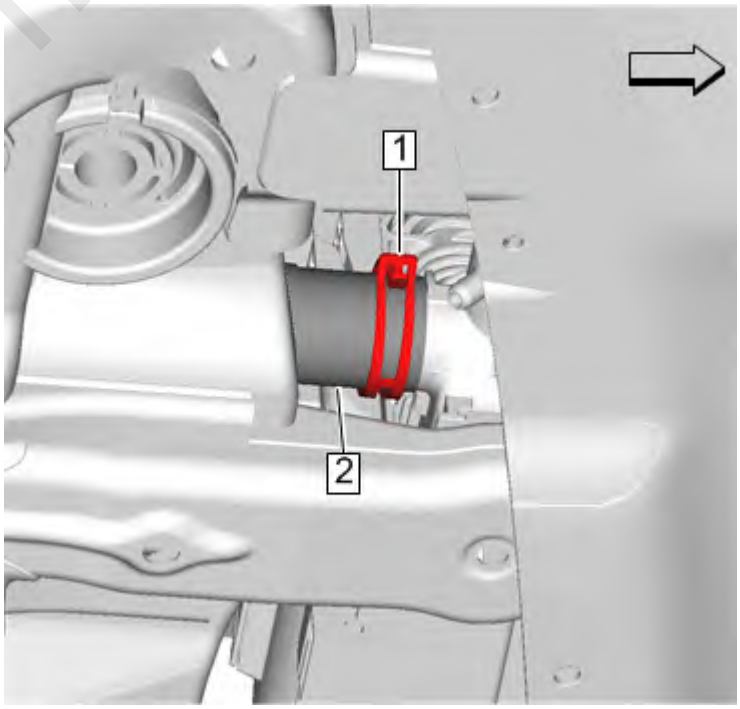


Fig. 82: Radiator Outlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

lnx30.com

3. Disengage Radiator Outlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
4. Remove Radiator Outlet Hose (2) @ Radiator.

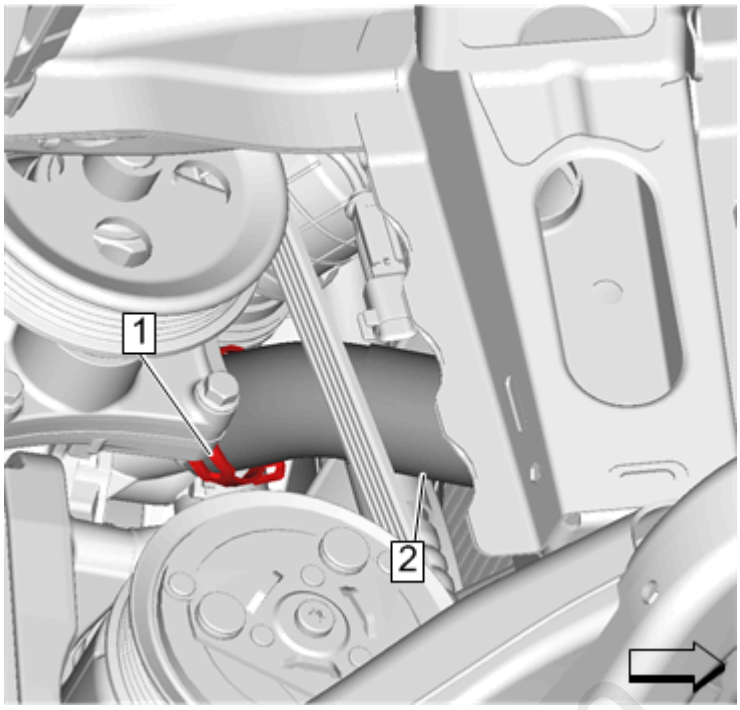


Fig. 83: Radiator Outlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Disengage Radiator Outlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
6. Remove Radiator Outlet Hose (2) @ Engine Coolant Thermostat Housing.
7. Remove Radiator Outlet Hose (2).

Installation Procedure

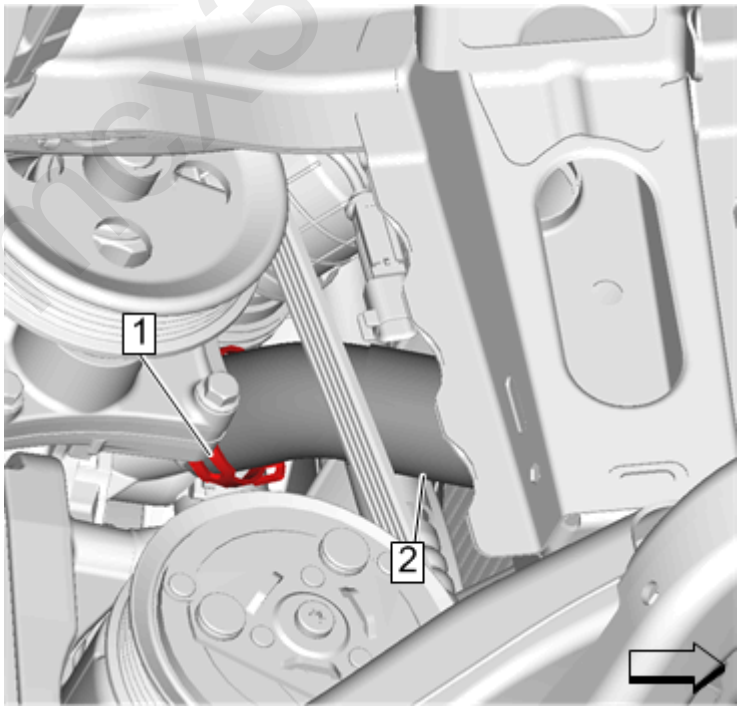


Fig. 84: Radiator Outlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

1. Install Radiator Outlet Hose (2) @ Engine Coolant Thermostat Housing.
2. Engage Radiator Outlet Hose Clamp (1) -**Hose Clamp Replacement Guidelines - Spring Type**

hgx30.com

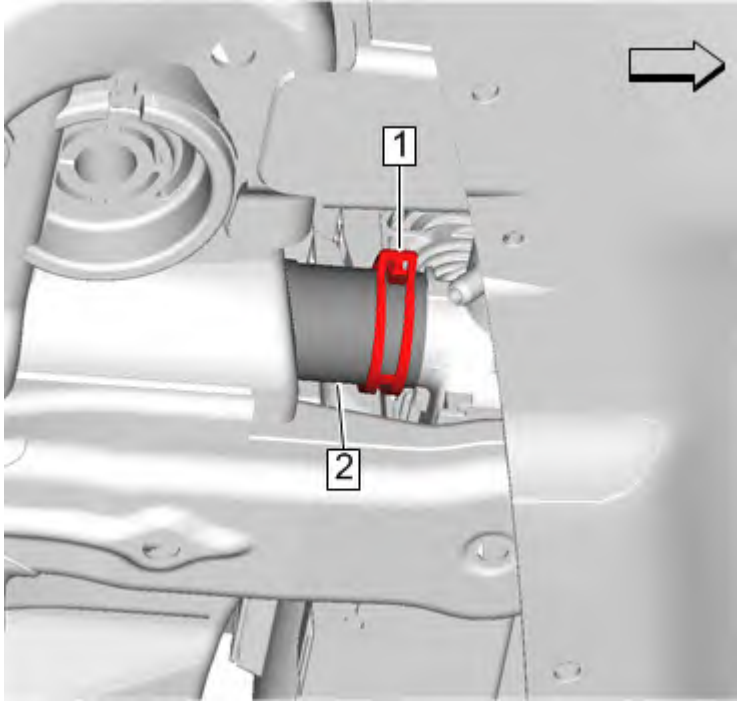


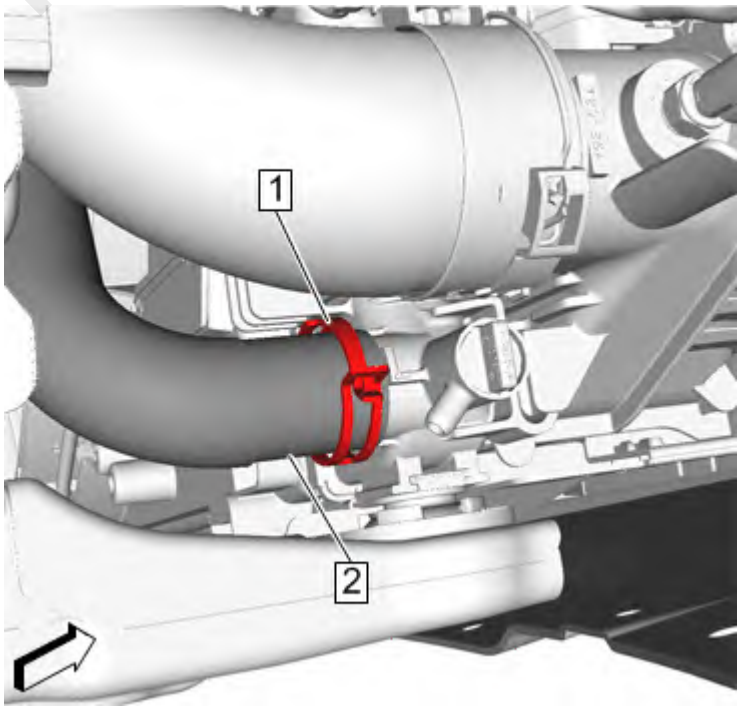
Fig. 85: Radiator Outlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

3. Install Radiator Outlet Hose (2) @ Radiator.
4. Engage Radiator Outlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
5. Install Front Bumper Fascia - **Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**
6. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
7. Start the engine and check for coolant leaks.

RADIATOR OUTLET HOSE REPLACEMENT (LH7)

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
2. Remove Underbody Front Air Deflector - **Underbody Front Air Deflector Replacement (Equinox)** **Underbody Front Air Deflector Replacement (Terrain)**



mcx30.com

Fig. 86: Radiator Outlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

3. Disengage Radiator Outlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
4. Remove Radiator Outlet Hose (2) @ Radiator.

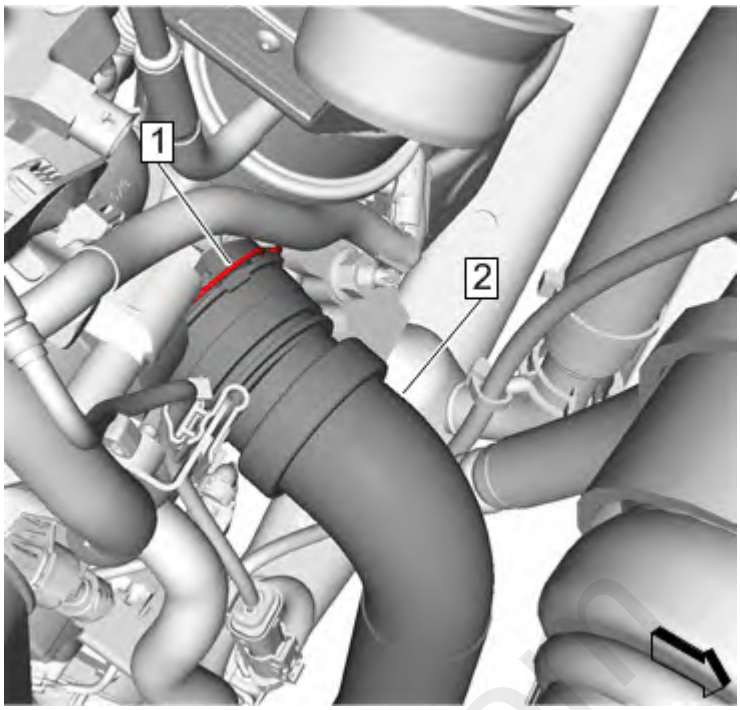


Fig. 87: Radiator Outlet Hose Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Disengage Radiator Outlet Hose Retainer (1).
6. Remove Radiator Outlet Hose (2) @ Engine Coolant Thermostat Housing.
7. Remove Radiator Outlet Hose (2).

Installation Procedure

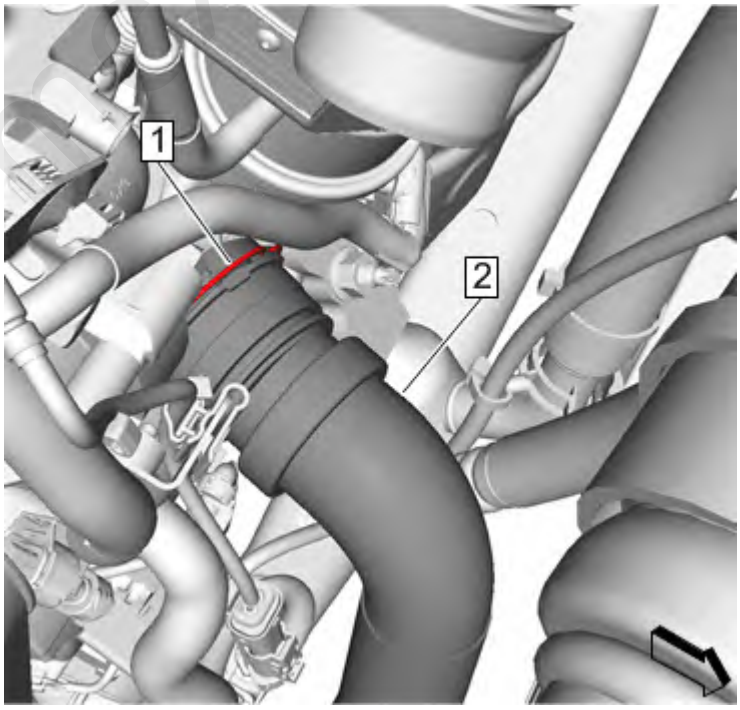


Fig. 88: Radiator Outlet Hose Retainer
Courtesy of GENERAL MOTORS COMPANY

1. Install Radiator Outlet Hose (2) @ Engine Coolant Thermostat Housing.
2. Engage Radiator Outlet Hose Retainer (1).

mox30.com

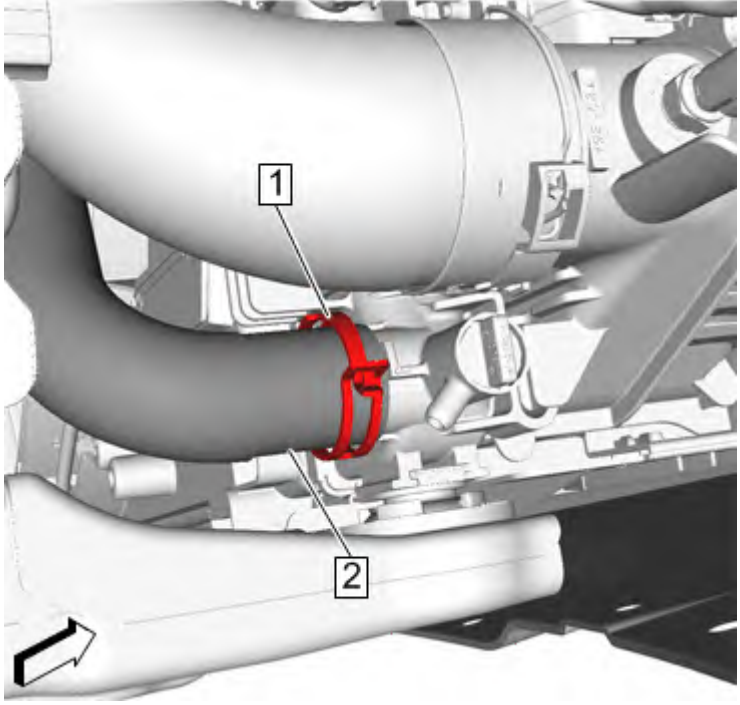


Fig. 89: Radiator Outlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

3. Install Radiator Outlet Hose (2) @ Radiator.
4. Engage Radiator Outlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
5. Install Underbody Front Air Deflector - **Underbody Front Air Deflector Replacement (Equinox)** **Underbody Front Air Deflector Replacement (Terrain)**
6. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
7. Start the engine and check for coolant leaks.

RADIATOR OUTLET HOSE REPLACEMENT (LTG WITH KL9)

Removal Procedure

1. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**

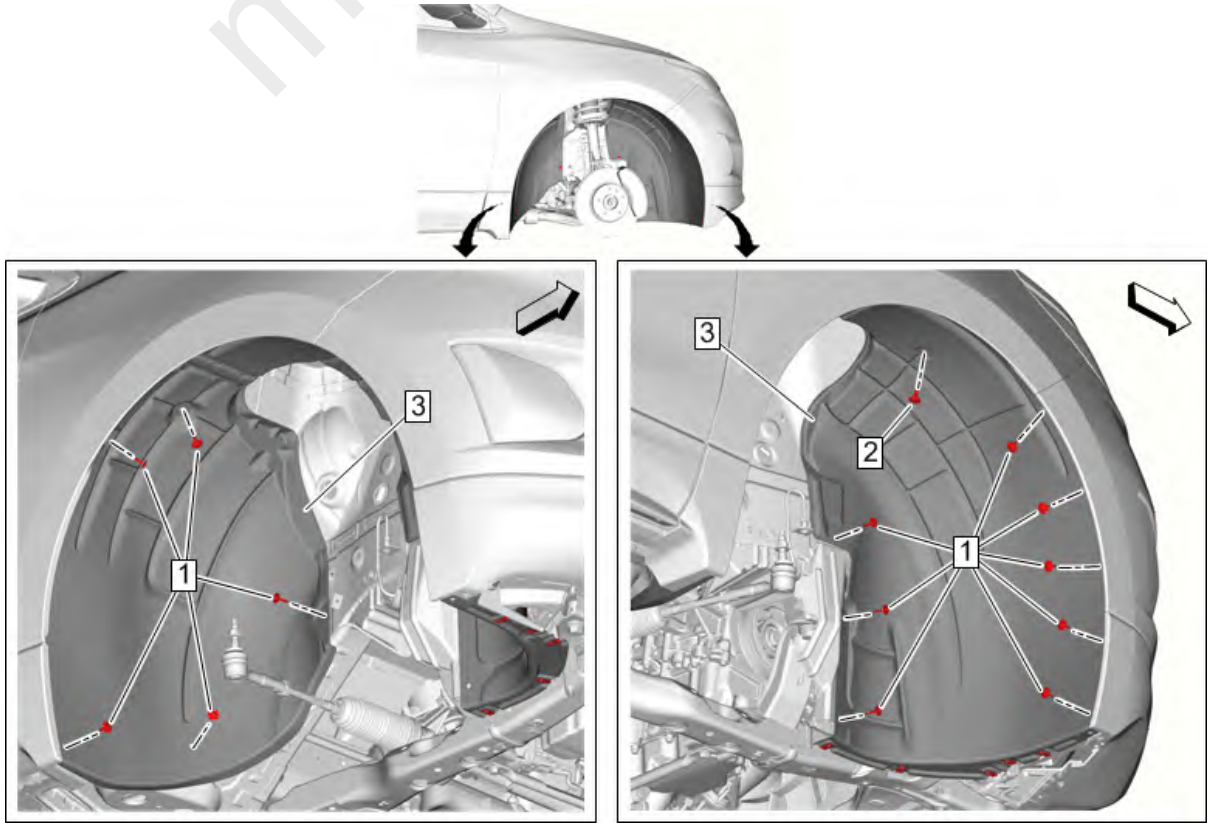


Fig. 90: Front Wheelhouse Liner - Right Side
Courtesy of GENERAL MOTORS COMPANY

2. Remove Front Wheelhouse Liner-Right Side (3) - Front Wheelhouse Liner Replacement - Right Side (Equinox) Front Wheelhouse Liner Replacement - Right Side (Terrain)

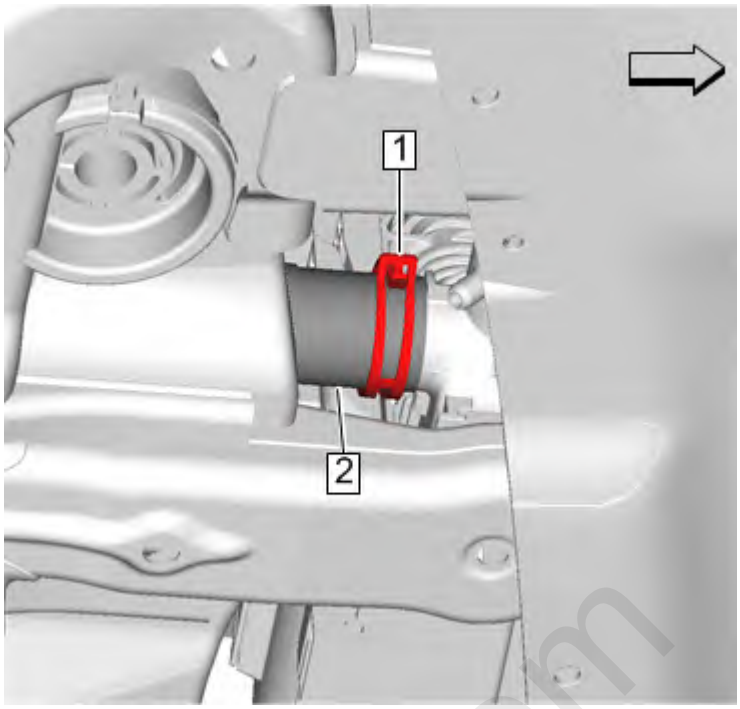


Fig. 91: Radiator Outlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

3. Disengage Radiator Outlet Hose Clamp (1) - Hose Clamp Replacement Guidelines - Spring Type
4. Remove Radiator Outlet Hose (2) @Radiator.
5. Lower the vehicle.

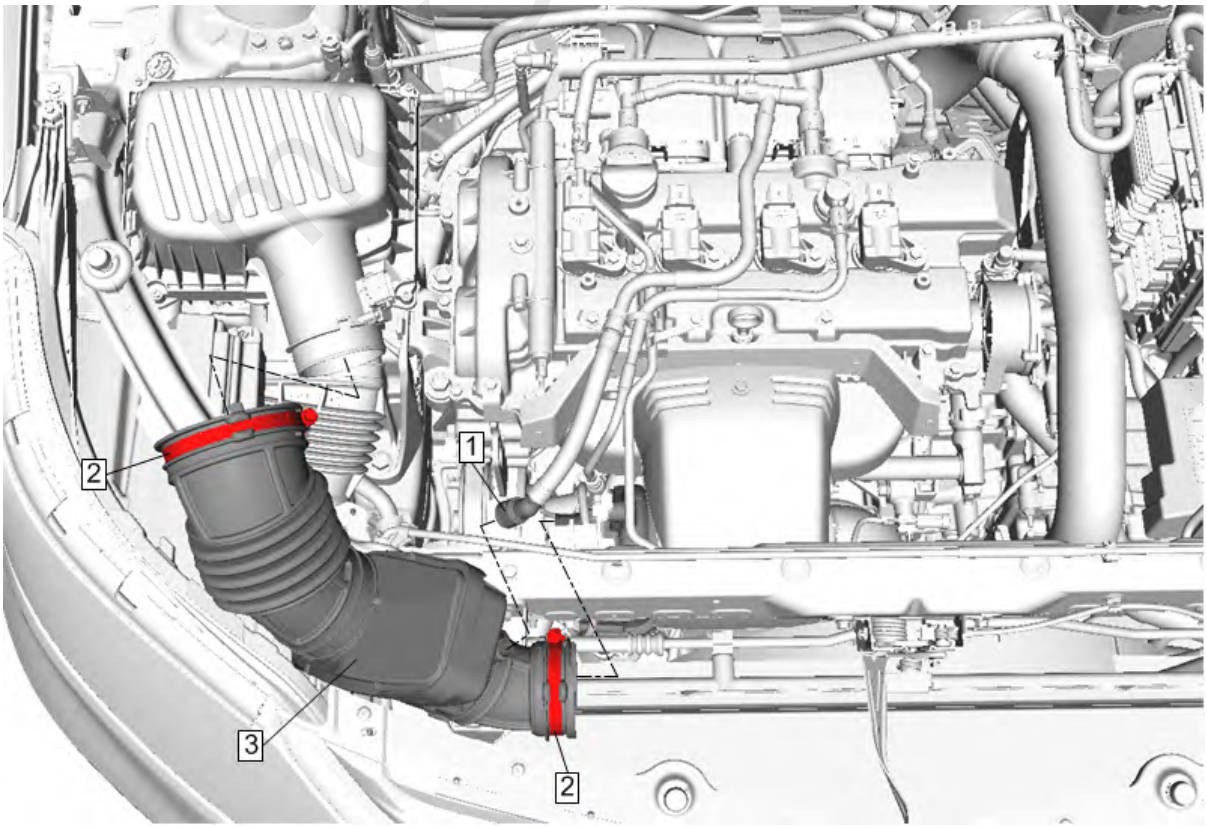


Fig. 92: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

6. Remove Air Cleaner Outlet Duct (3) - Air Cleaner Outlet Duct Replacement (Non-Tamperproof) Air Cleaner Outlet Duct Replacement (Tamperproof)

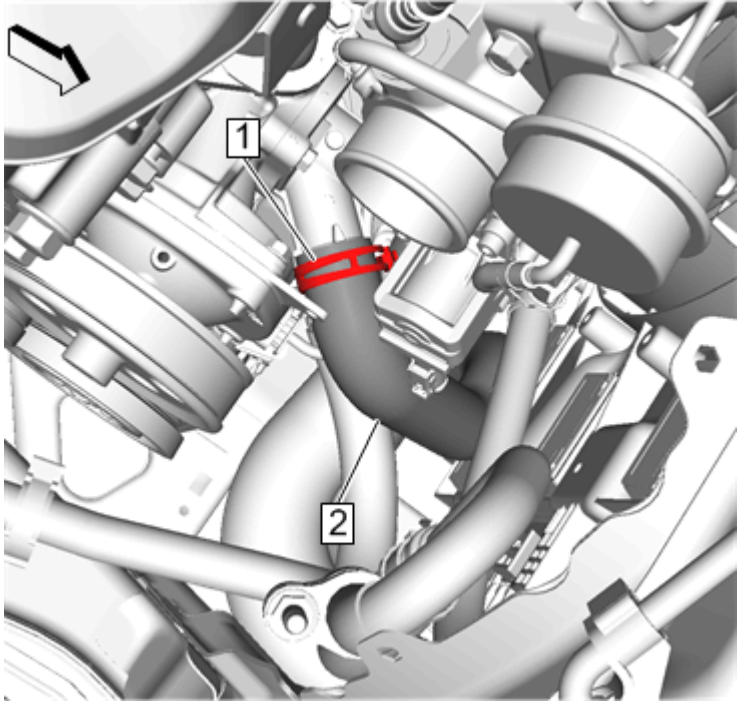


Fig. 93: Radiator Outlet Hose Clamp And Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

7. Disengage Radiator Outlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
8. Remove Radiator Outlet Hose (2) @ Engine Coolant Thermostat Housing.
9. Remove Radiator Outlet Hose (2).

Installation Procedure

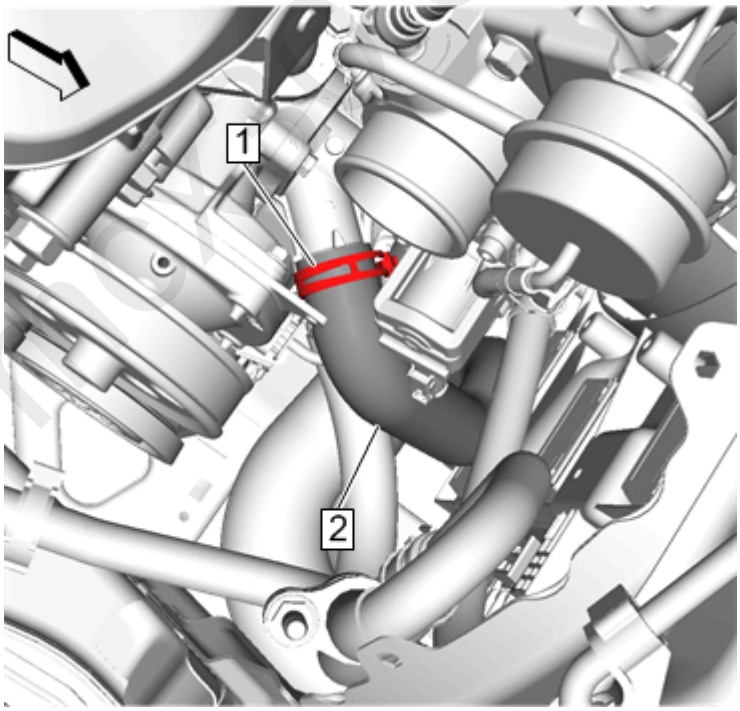


Fig. 94: Radiator Outlet Hose Clamp And Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

1. Install Radiator Outlet Hose (2) @ Engine Coolant Thermostat Housing.
2. Engage Radiator Outlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**

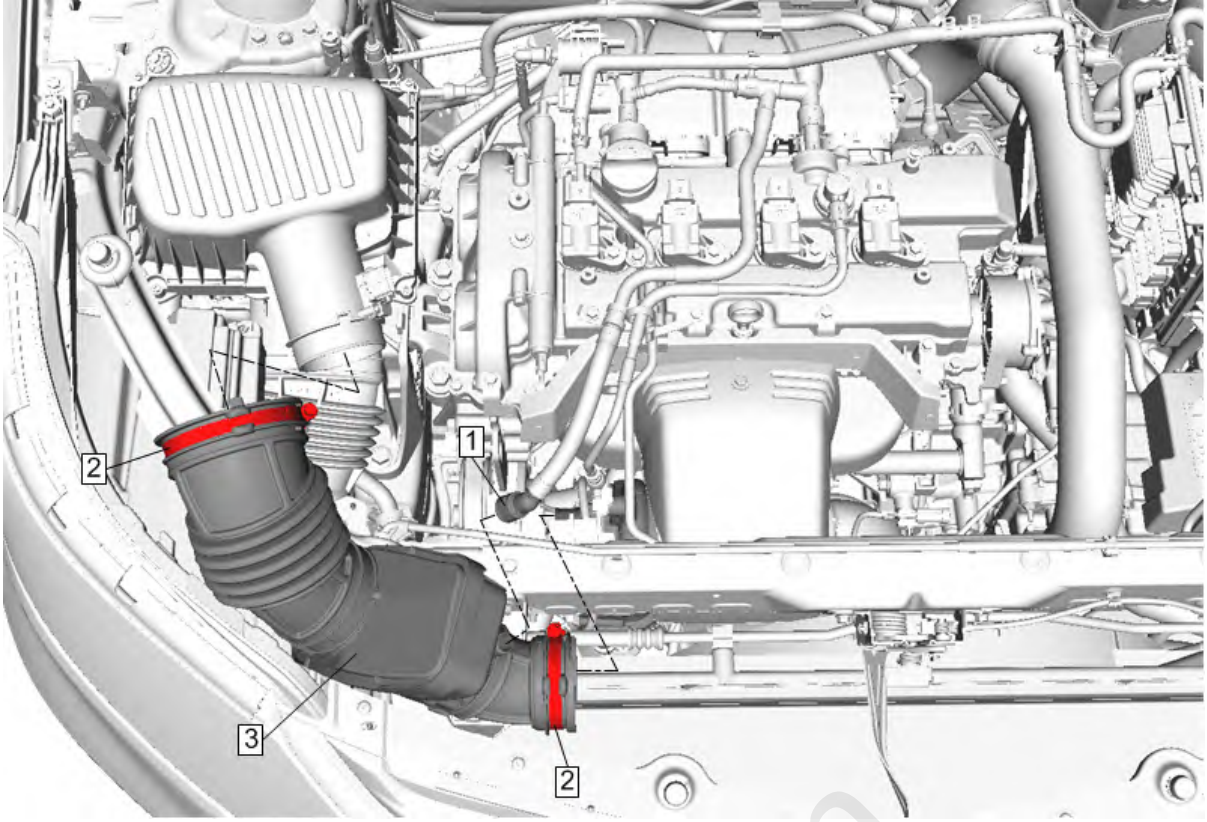


Fig. 95: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

3. Install Air Cleaner Outlet Duct (3). **Air Cleaner Outlet Duct Replacement (Non-Tamperproof)** **Air Cleaner Outlet Duct Replacement (Tamperproof)**
4. Raise and support the vehicle. **Lifting and Jacking the Vehicle**

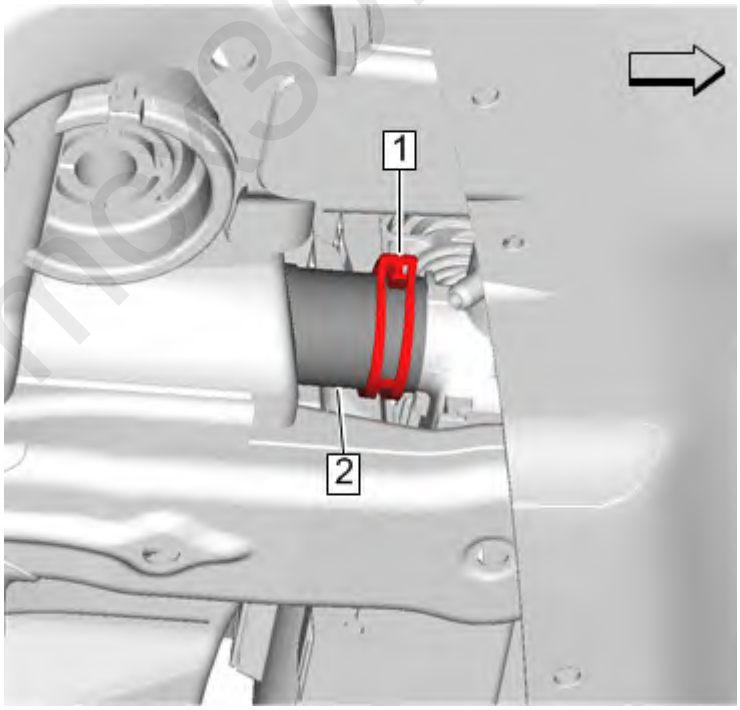


Fig. 96: Radiator Outlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Install Radiator Outlet Hose (2) @Radiator.
6. Engage Radiator Outlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**

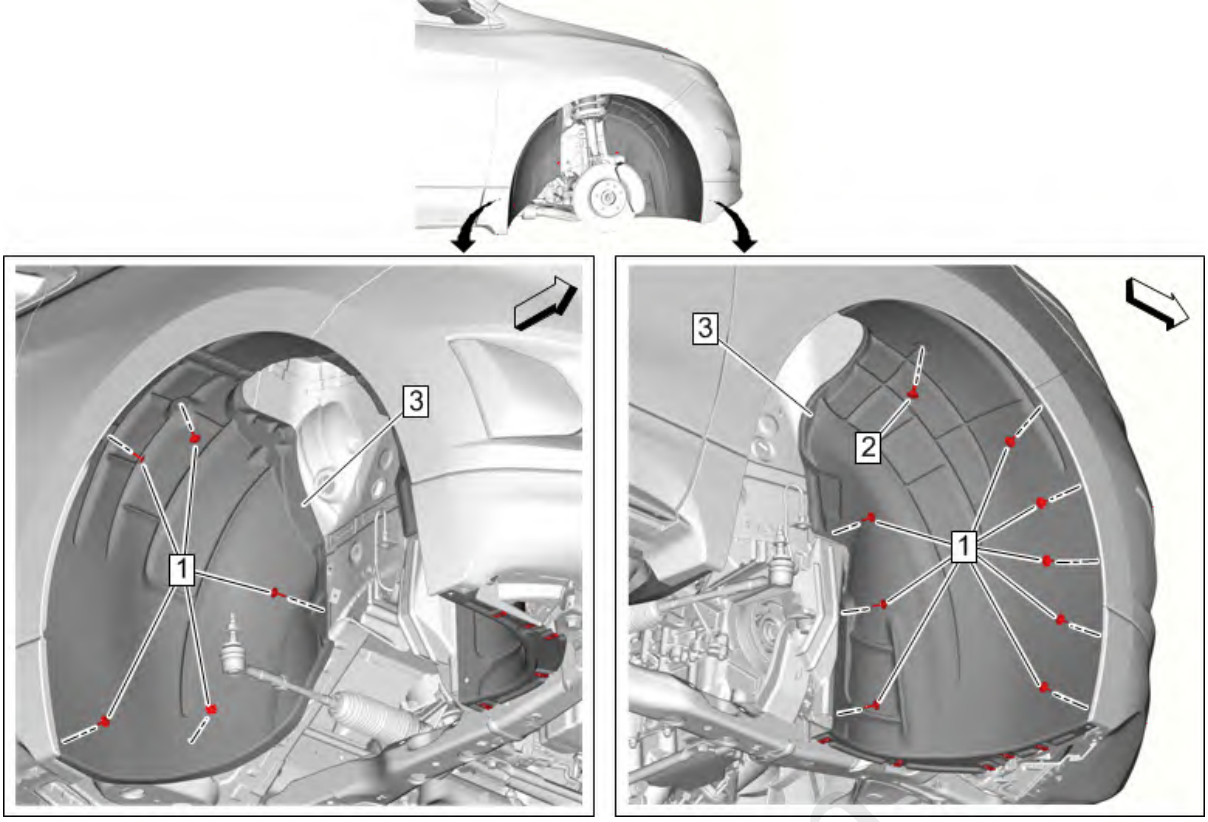


Fig. 97: Front Wheelhouse Liner - Right Side
Courtesy of GENERAL MOTORS COMPANY

7. Install Front Wheelhouse Liner-Right Side (3) - Front Wheelhouse Liner Replacement - Right Side (Equinox) Front Wheelhouse Liner Replacement - Right Side (Terrain)
8. Fill the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)
9. Start the engine and check for coolant leaks.

RADIATOR SLEEVE REPLACEMENT - UPPER (LEFT)

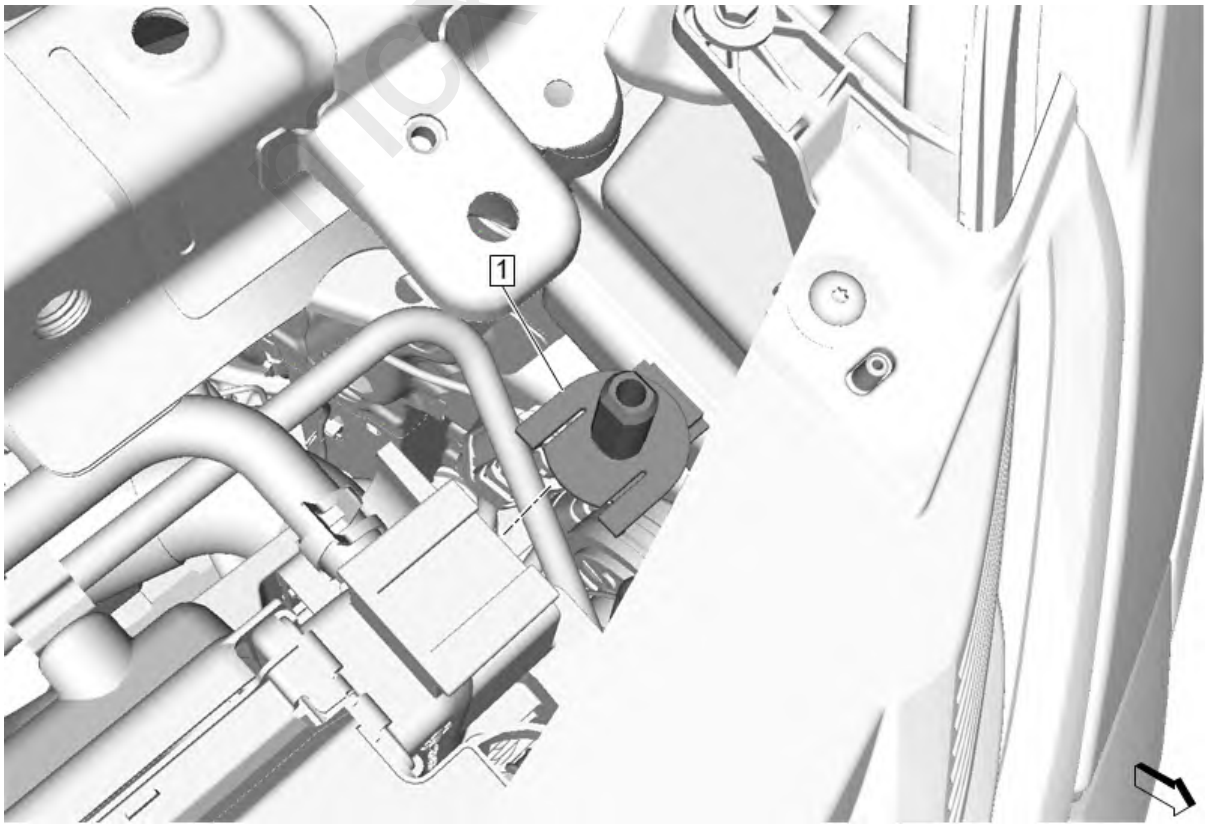


Fig. 98: Radiator Sleeve - Upper (Left)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Radiator Upper Bracket Replacement - Left Side	
1	Radiator Sleeve **Procedure** Lift the retaining tabs on the radiator sleeve to remove.

RADIATOR SLEEVE REPLACEMENT - UPPER (RIGHT)

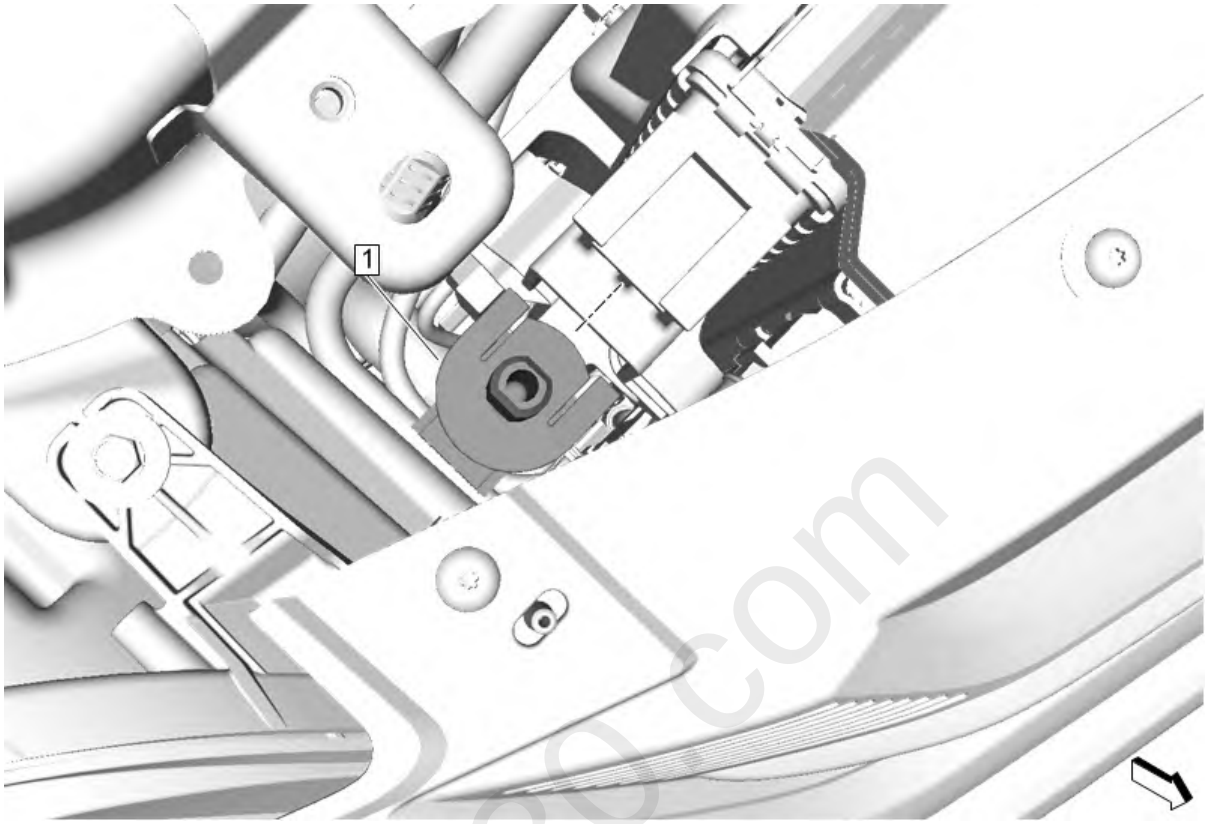


Fig. 99: Radiator Sleeve - Upper (Right)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Radiator Upper Bracket Replacement - Right Side	
1	Radiator Sleeve **Procedure** Lift the retaining tabs on the radiator sleeve to remove.

RADIATOR SLEEVE REPLACEMENT - LOWER (LEFT)

mcx30.com

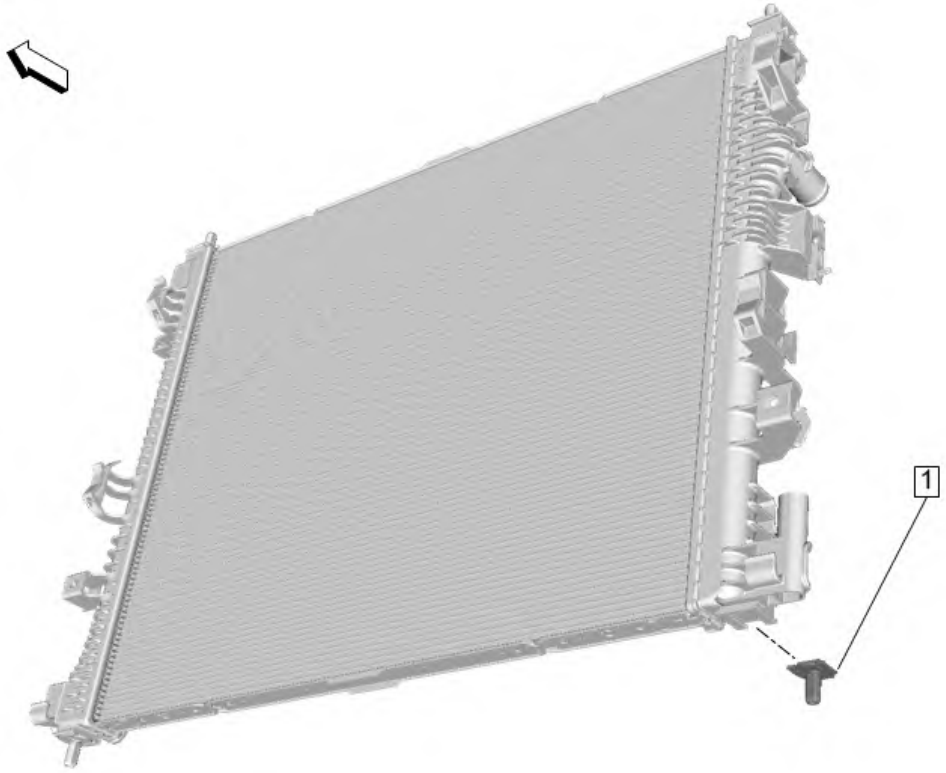


Fig. 100: Radiator Sleeve - Lower (Left)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove Front Bumper Fascia - Front Bumper Fascia Replacement (Equinox) Front Bumper Fascia Replacement (Terrain) 2. Drain the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static) 3. Remove Radiator - Radiator Replacement (LYX)Radiator Replacement (LTG)Radiator Replacement (LH7)	
1	Radiator Sleeve **Procedure** Lift the retaining tabs on the radiator sleeve to remove.

RADIATOR SLEEVE REPLACEMENT - LOWER (RIGHT)

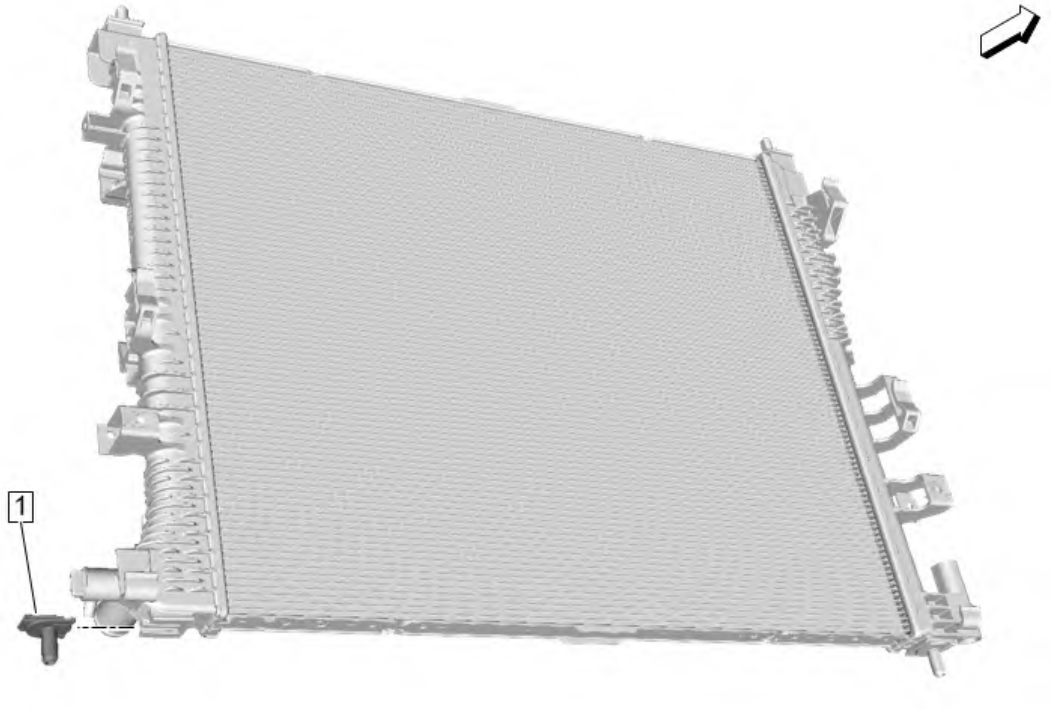


Fig. 101: Radiator Sleeve - Lower (Right)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove Front Bumper Fascia - Front Bumper Fascia Replacement (Equinox) Front Bumper Fascia Replacement (Terrain) 2. Drain the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static) 3. Remove Radiator - Radiator Replacement (LYX)Radiator Replacement (LTG)Radiator Replacement (LH7)	
1	Radiator Sleeve **Procedure** Lift the retaining tabs on the radiator sleeve to remove.

ENGINE COOLANT FAN WIRING HARNESS REPLACEMENT (LTG LYX)

Removal Procedure

NOTE: **Typical wiring harness shown, individual harness may be different due to option content. Various components may need to be removed to access the harness depending on content options.**

1. Remove Front Bumper Fascia - Front Bumper Fascia Replacement (Equinox) Front Bumper Fascia Replacement (Terrain)

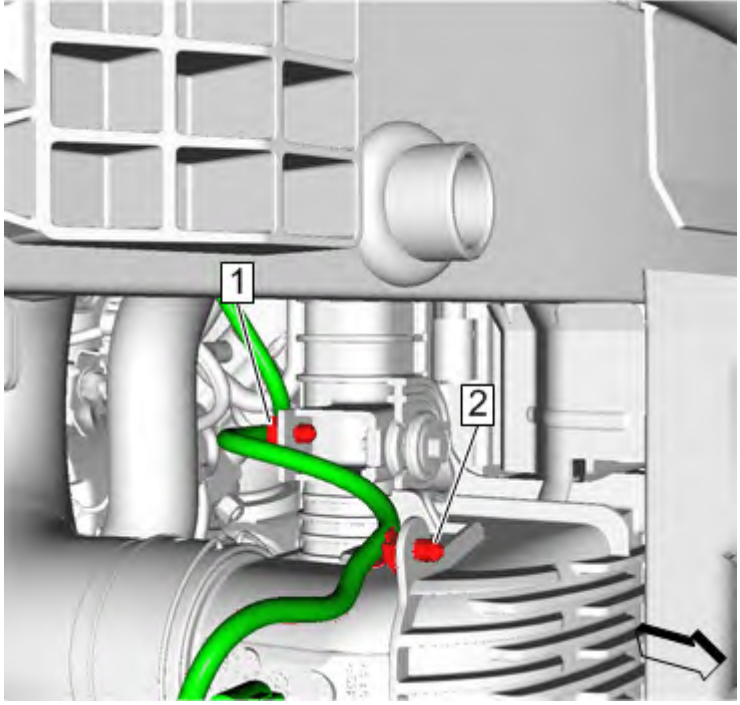


Fig. 102: Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Remove Wiring Harness Retainer (1) @ Radiator.
3. Remove Wiring Harness Retainer (2) @ Charge Air Cooler.

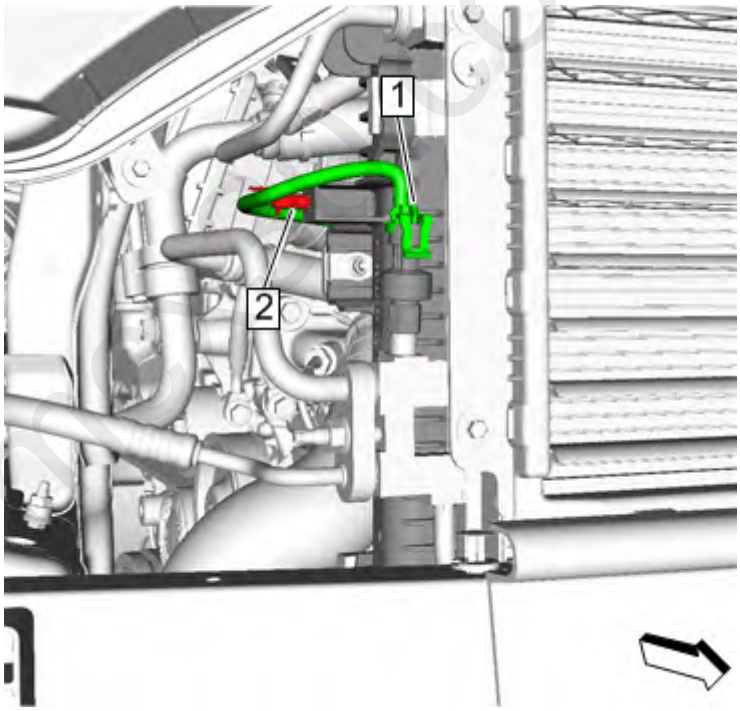


Fig. 103: Wiring Harness Retainer And Connector
Courtesy of GENERAL MOTORS COMPANY

4. Remove Wiring Harness Retainer (2) @ Radiator.
5. Remove Wiring Harness Connector (1) @ Air Conditioning Cycling and Fan Control Refrigerant Pressure Sensor.

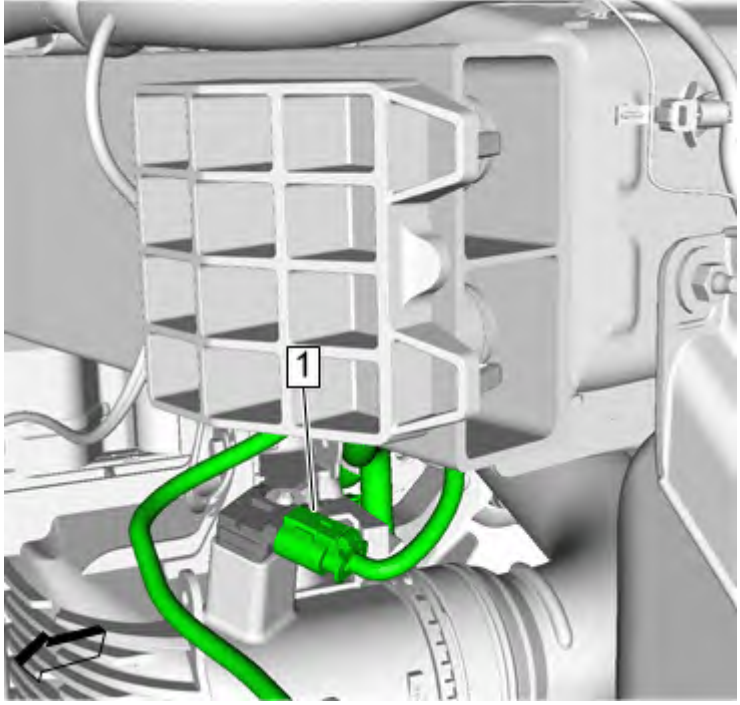


Fig. 104: Wiring Harness Connector
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect Wiring Harness Connector (1) @ Turbocharger Air Pressure Sensor.

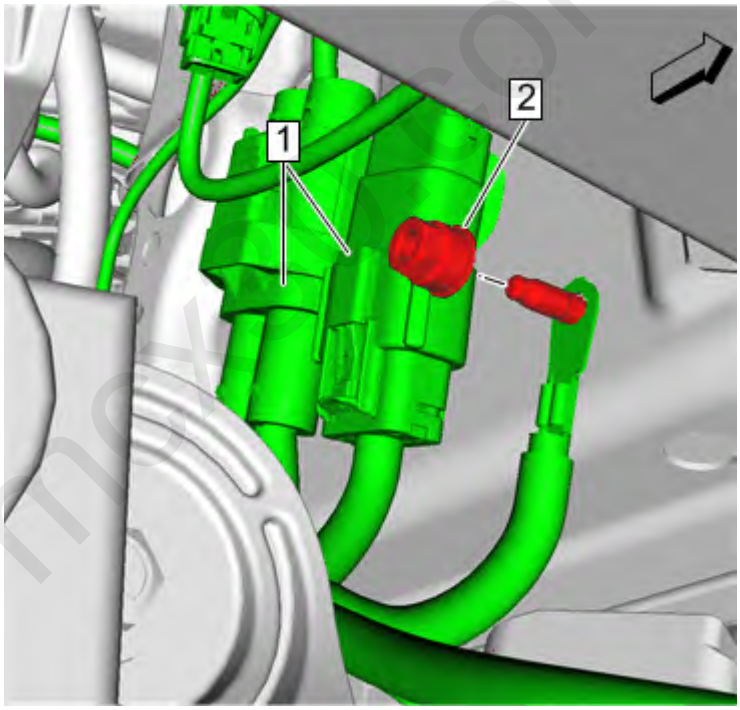


Fig. 105: Electrical Connector And Ground Nut
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect Electrical Connector (1) @ Engine Wiring Harness - [2x]
8. Remove Ground Nut (2) - @ Stud.

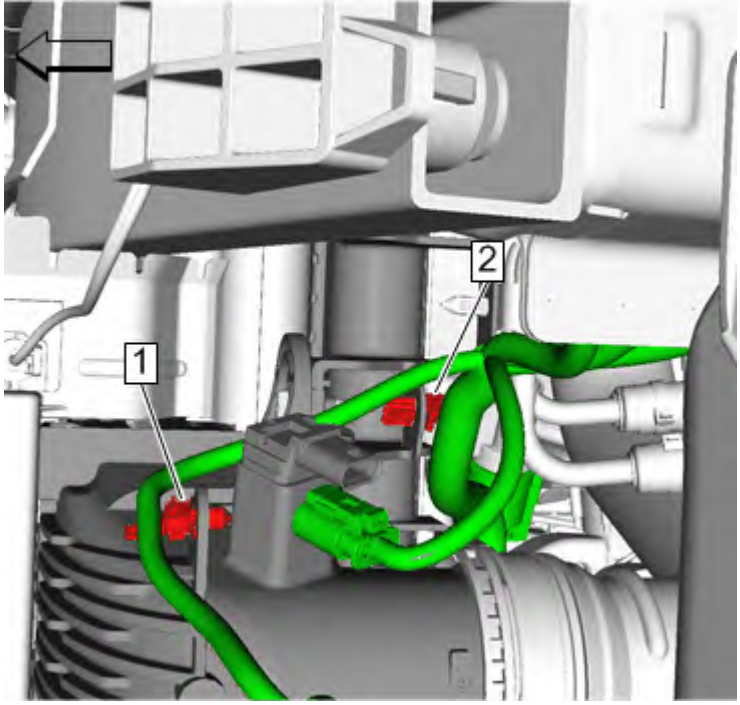


Fig. 106: Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

9. Remove Wiring Harness Retainer (1) @ Charge Air Cooler.
10. Remove Wiring Harness Retainer (2) @ Radiator.

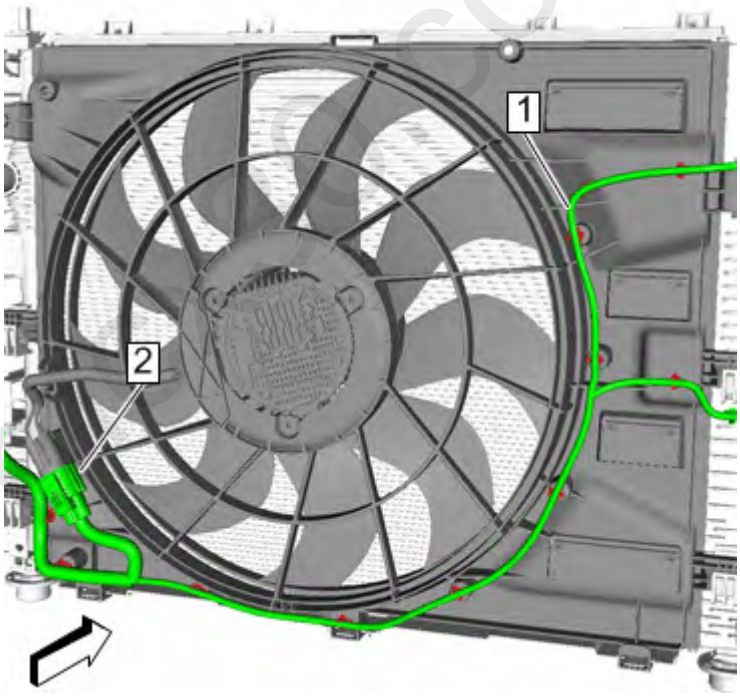


Fig. 107: Engine Coolant Fan Wiring Harness And Retainer
Courtesy of GENERAL MOTORS COMPANY

11. Disconnect Engine Coolant Fan Wiring Harness (2) @ Engine Coolant Fan.
12. Remove Wiring Harness Retainer (1) @ Engine Coolant Fan - [10x]
13. Remove Engine Coolant Fan Wiring Harness (1).
14. Transfer components as necessary.

Installation Procedure

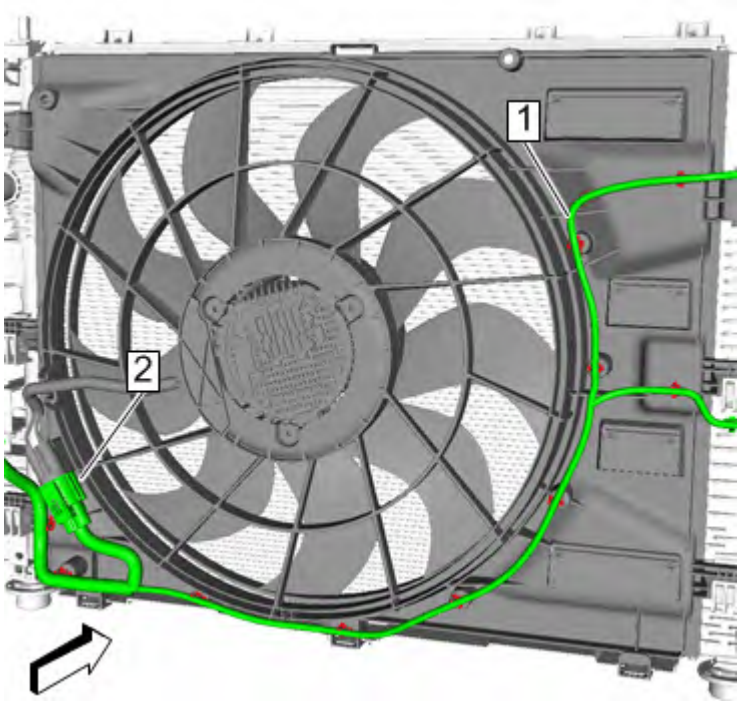


Fig. 108: Engine Coolant Fan Wiring Harness And Retainer
Courtesy of GENERAL MOTORS COMPANY

1. Install Wiring Harness Retainer (1) @ Engine Coolant Fan - [10x]
2. Connect Engine Coolant Fan Wiring Harness (2) @ Engine Coolant Fan.

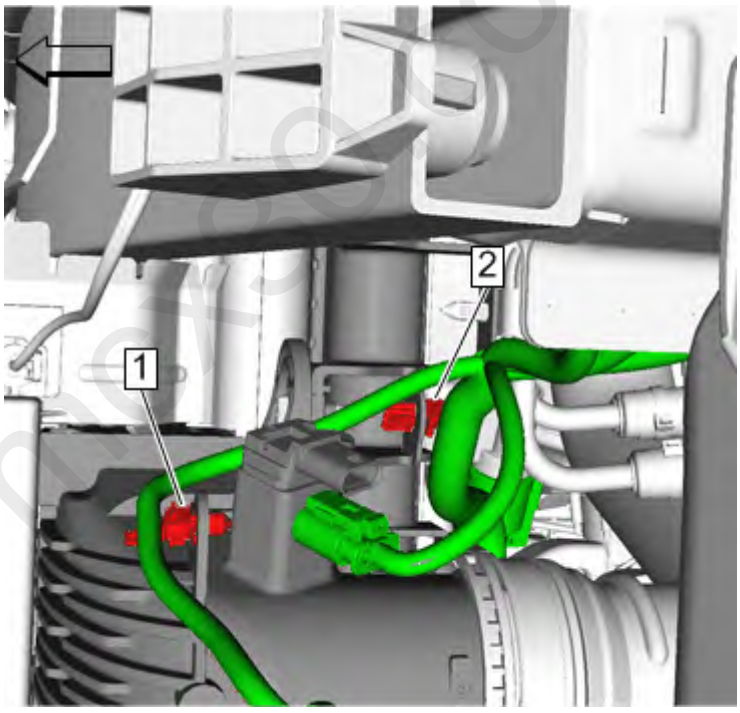


Fig. 109: Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Install Wiring Harness Retainer (2) @ Radiator.
4. Install Wiring Harness Retainer (1) @ Charge Air Cooler.

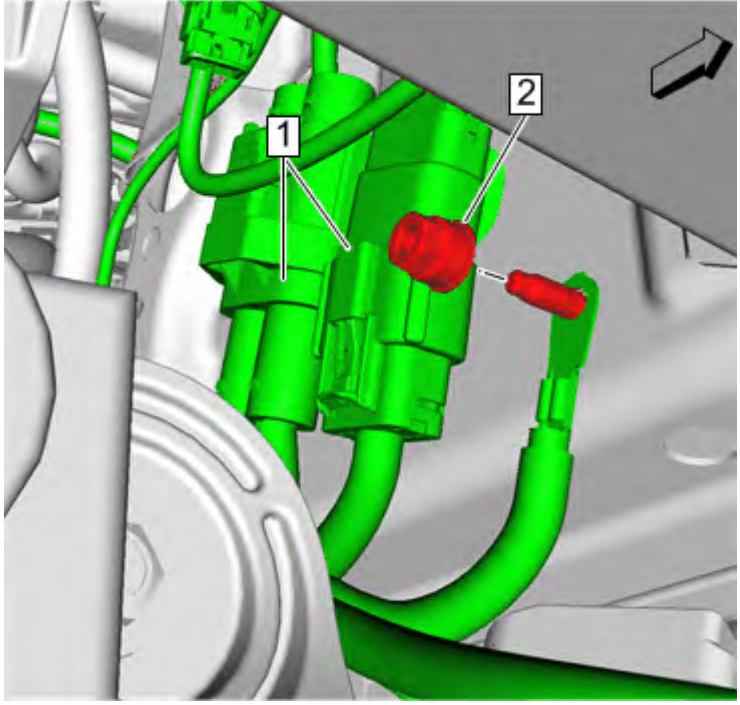


Fig. 110: Electrical Connector And Ground Nut
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

5. Install Ground Nut (2) - @ Stud and tighten 9 N.m (80 lb in)
6. Connect Electrical Connector (1) @ Engine Wiring Harness [2x]

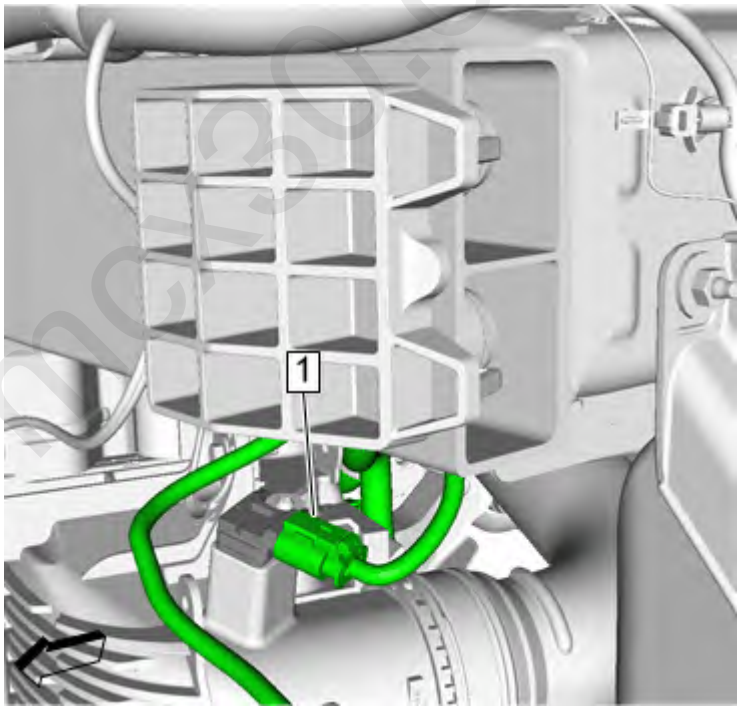


Fig. 111: Wiring Harness Connector
Courtesy of GENERAL MOTORS COMPANY

7. Connect Wiring Harness Connector (1) @ Turbocharger Air Pressure Sensor.

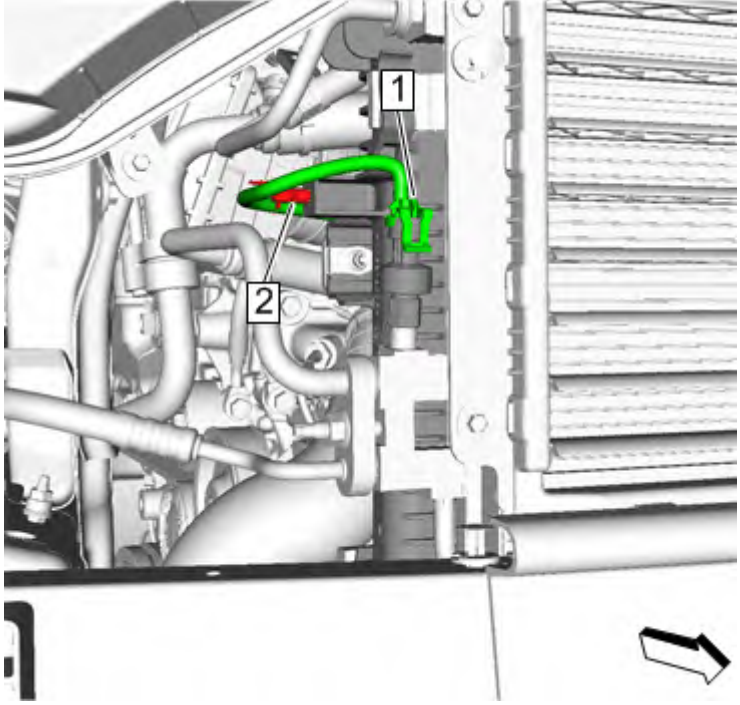


Fig. 112: Wiring Harness Retainer And Connector
Courtesy of GENERAL MOTORS COMPANY

8. Install Wiring Harness Retainer (2) @ Radiator.
9. Install Wiring Harness Connector (1) @ Air Conditioning Cycling and Fan Control Refrigerant Pressure Sensor.

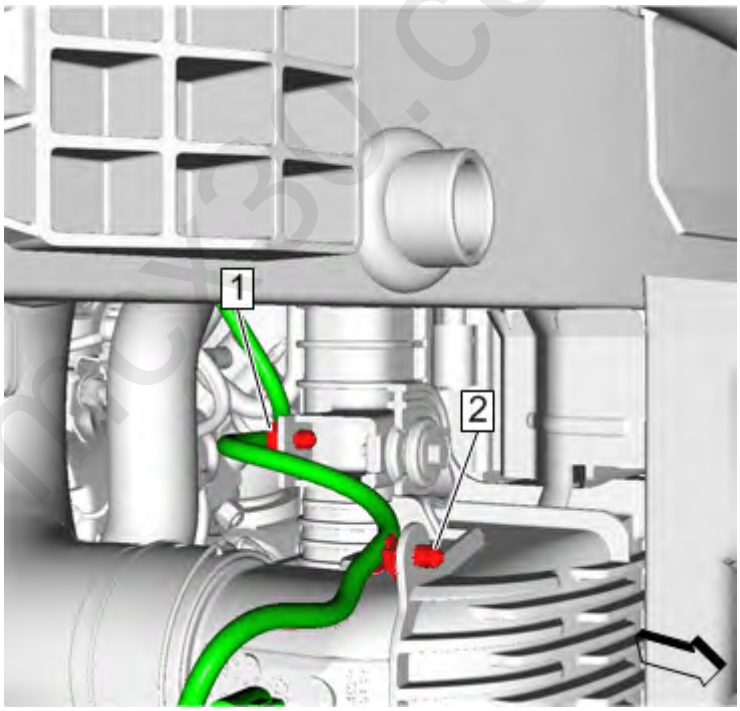


Fig. 113: Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

10. Install Wiring Harness Retainer (2) @ Charge Air Cooler.
11. Install Wiring Harness Retainer (1) @ Radiator.
12. Install Front Bumper Fascia -**Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**

ENGINE COOLANT FAN WIRING HARNESS REPLACEMENT (LH7)

Removal Procedure

NOTE: **Typical wiring harness shown, individual harness may be different due to option content. Various components may need to be removed to**

access the harness depending on content options.

1. Remove Front Bumper Fascia - **Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**

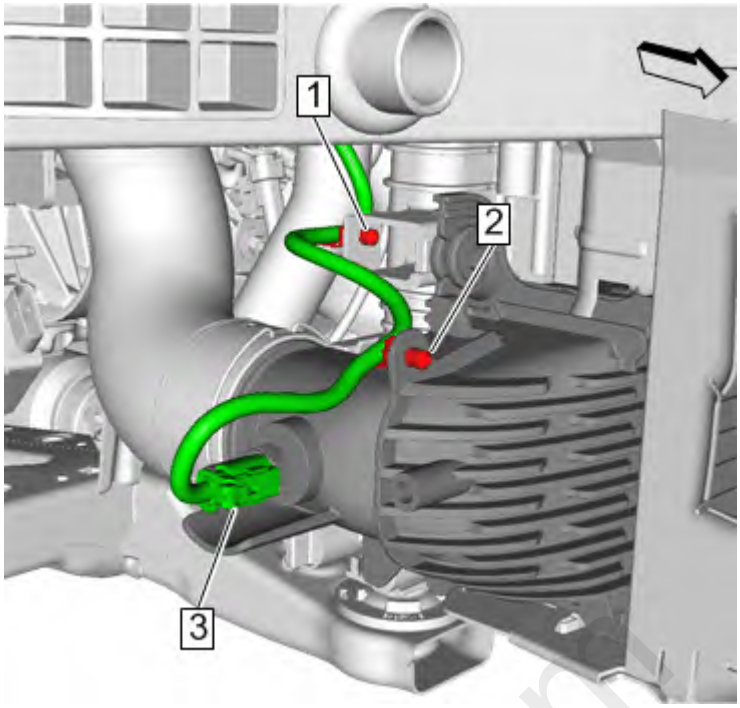


Fig. 114: Wiring Harness Retainer And Connector
Courtesy of GENERAL MOTORS COMPANY

2. Remove Wiring Harness Retainer (1) @ Radiator.
3. Remove Wiring Harness Retainer (2) @ Charge Air Cooler.
4. Disconnect Wiring Harness Connector (3) @ Charge Air Temperature Sensor.

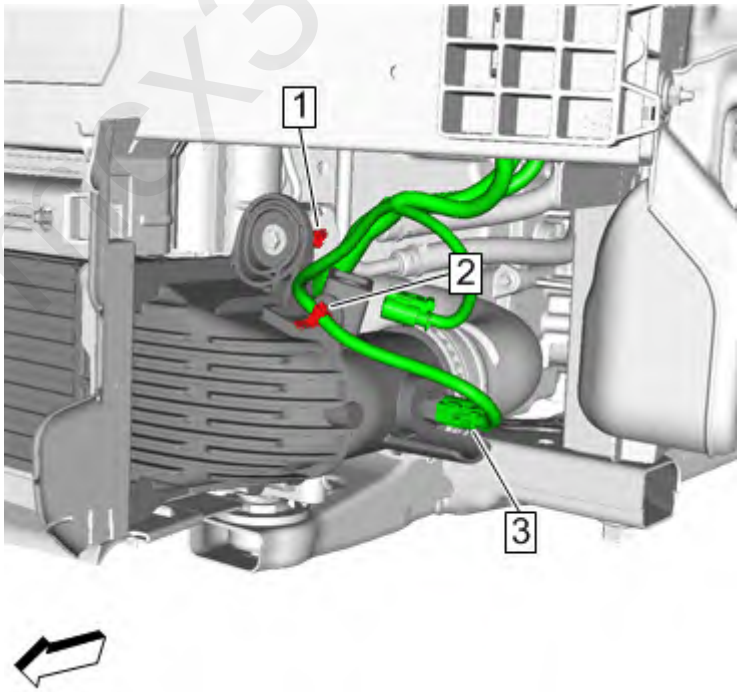


Fig. 115: Wiring Harness Retainer And Connector
Courtesy of GENERAL MOTORS COMPANY

5. Remove Wiring Harness Retainer (1) @ Radiator.
6. Remove Wiring Harness Retainer (2) @ Charge Air Cooler.
7. Disconnect Wiring Harness Connector (3) @ Charge Air Temperature Sensor.

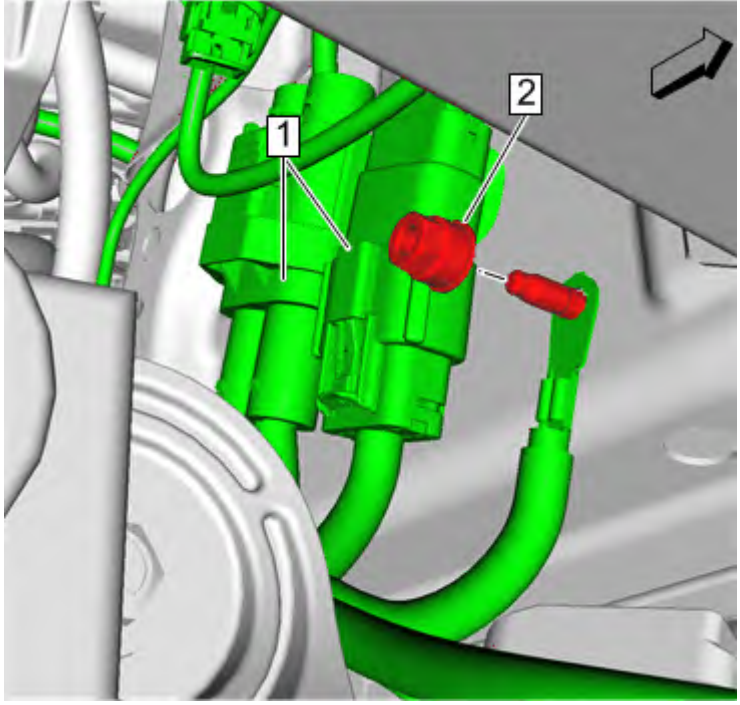


Fig. 116: Electrical Connector And Ground Nut
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect Electrical Connector (1) @ Engine Wiring Harness - [2x]
9. Remove Ground Nut (2) @ Stud.

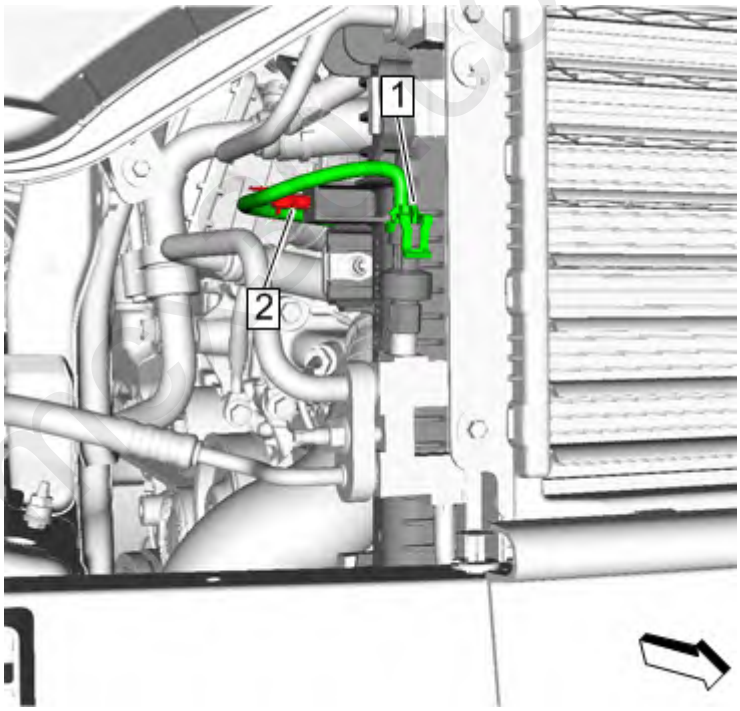


Fig. 117: Wiring Harness Retainer And Connector
Courtesy of GENERAL MOTORS COMPANY

10. Remove Wiring Harness Retainer (1) @ Radiator.
11. Disconnect Wiring Harness Connector (2) @ Air Conditioning Cycling and Fan Control Refrigerant Pressure Sensor.

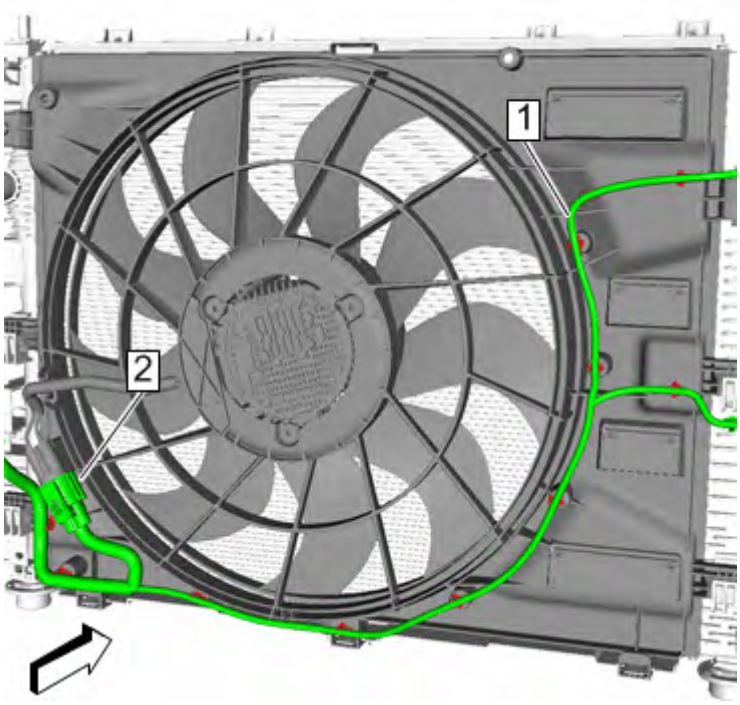


Fig. 118: Engine Coolant Fan Wiring Harness And Retainer
Courtesy of GENERAL MOTORS COMPANY

12. Disconnect Engine Coolant Fan Wiring Harness (2) @ Engine Coolant Fan.
13. Remove Wiring Harness Retainer (1) @ Engine Coolant Fan - [10x]
14. Remove Engine Coolant Fan Wiring Harness (1).
15. Transfer components as necessary.

Installation Procedure

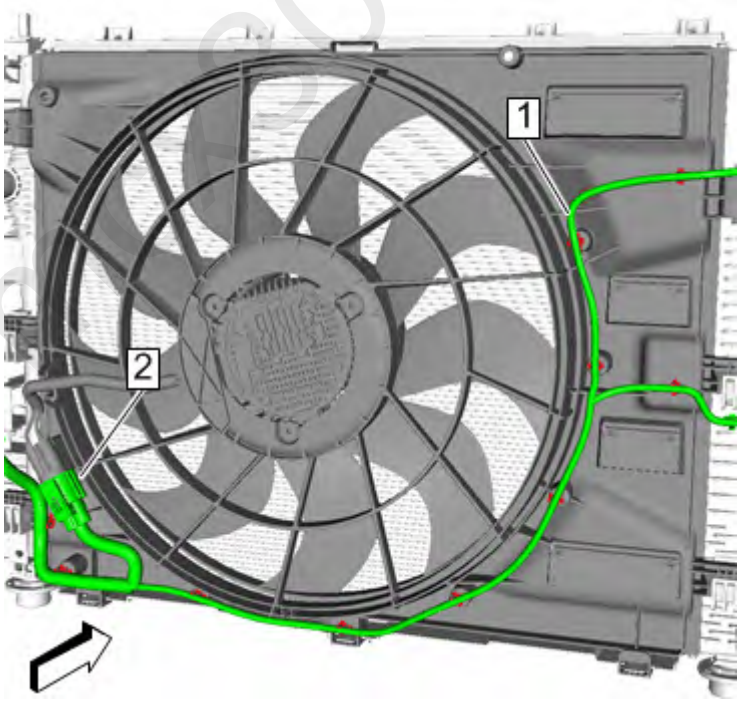


Fig. 119: Engine Coolant Fan Wiring Harness And Retainer
Courtesy of GENERAL MOTORS COMPANY

1. Install Wiring Harness Retainer (1) @ Engine Coolant Fan - [10x]
2. Connect Engine Coolant Fan Wiring Harness (2) @ Engine Coolant Fan.

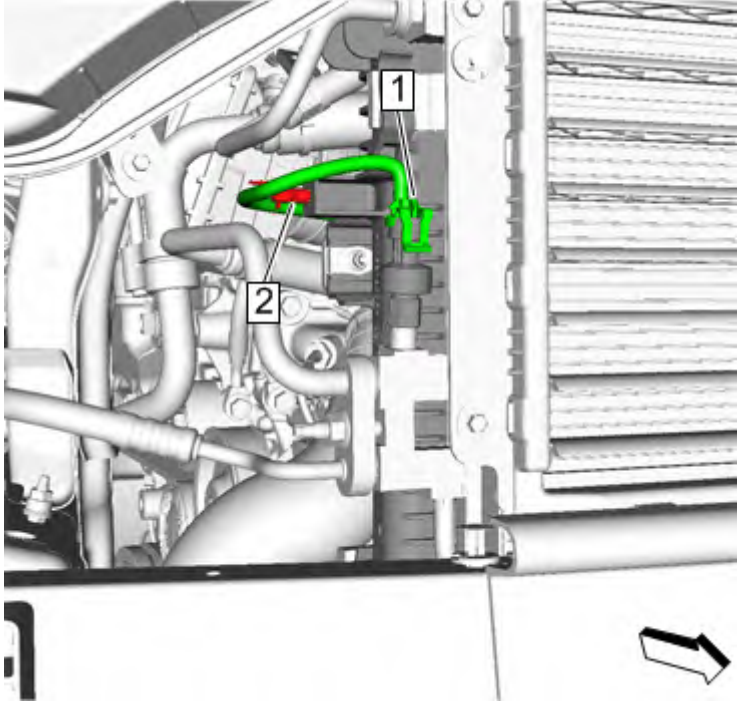


Fig. 120: Wiring Harness Retainer And Connector
Courtesy of GENERAL MOTORS COMPANY

3. Connect Wiring Harness Connector (2) @ Air Conditioning Cycling and Fan Control Refrigerant Pressure Sensor.
4. Install Wiring Harness Retainer (1) @ Radiator.

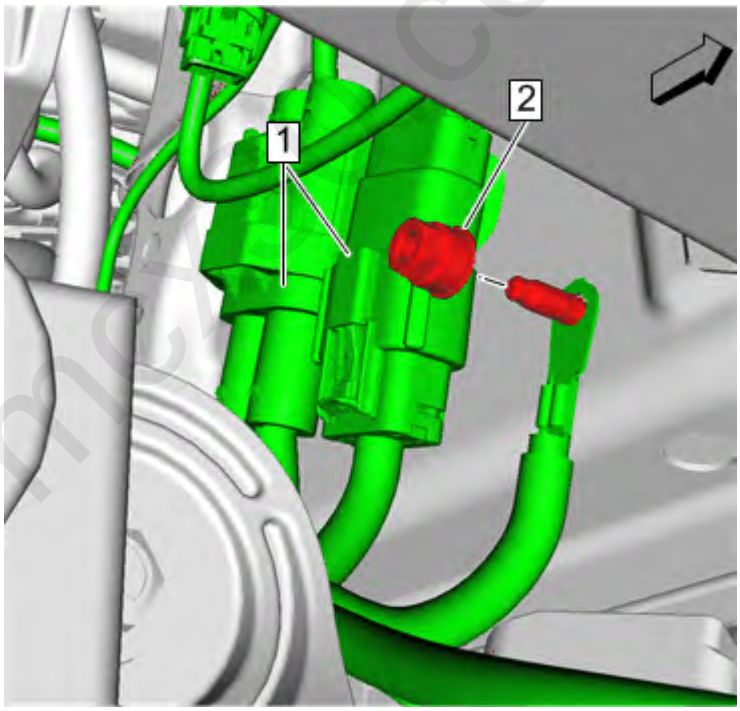


Fig. 121: Electrical Connector And Ground Nut
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

5. Install Ground Nut (2) @ Stud and tighten 9 N.m (80 lb in)
6. Connect Electrical Connector (1) @ Engine Wiring Harness - [2x]

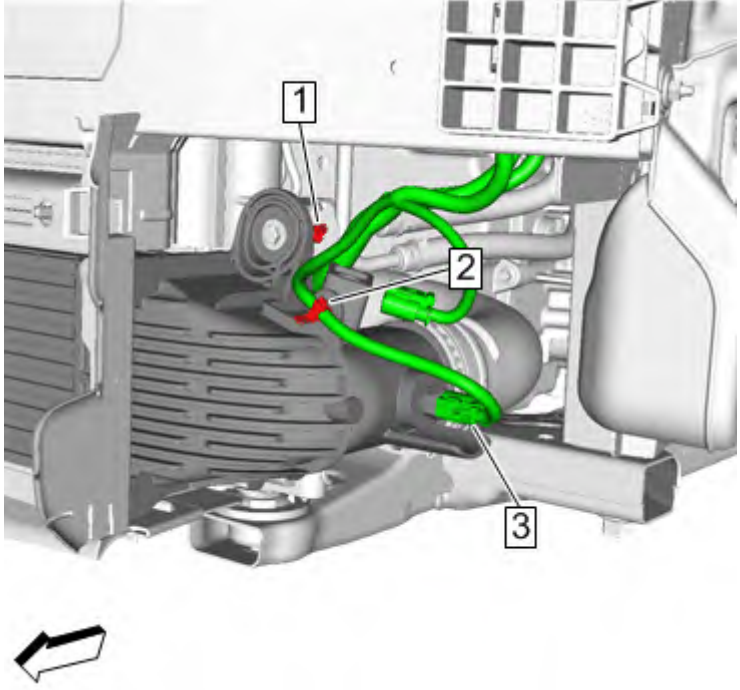


Fig. 122: Wiring Harness Retainer And Connector
Courtesy of GENERAL MOTORS COMPANY

7. Connect Wiring Harness Connector (3) @ Charge Air Temperature Sensor.
8. Install Wiring Harness Retainer (2) @ Charge Air Cooler and tighten
9. Install Wiring Harness Retainer (1) @ Radiator and tighten

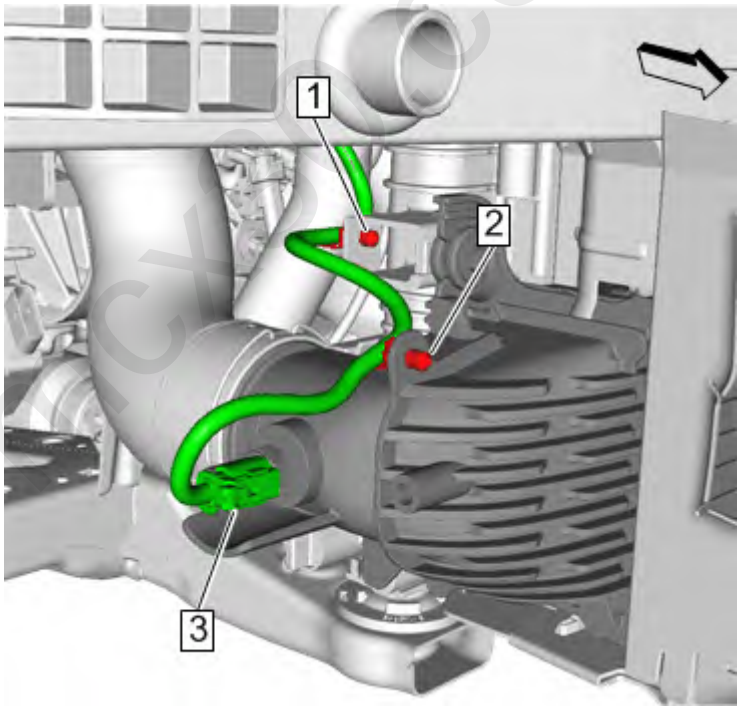


Fig. 123: Wiring Harness Retainer And Connector
Courtesy of GENERAL MOTORS COMPANY

10. Connect Wiring Harness Connector (3) @ Charge Air Temperature Sensor.
11. Install Wiring Harness Retainer (2) @ Charge Air Cooler.
12. Install Wiring Harness Retainer (1) @ Radiator.
13. Install Front Bumper Fascia -**Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**

RADIATOR UPPER BRACKET REPLACEMENT - LEFT SIDE

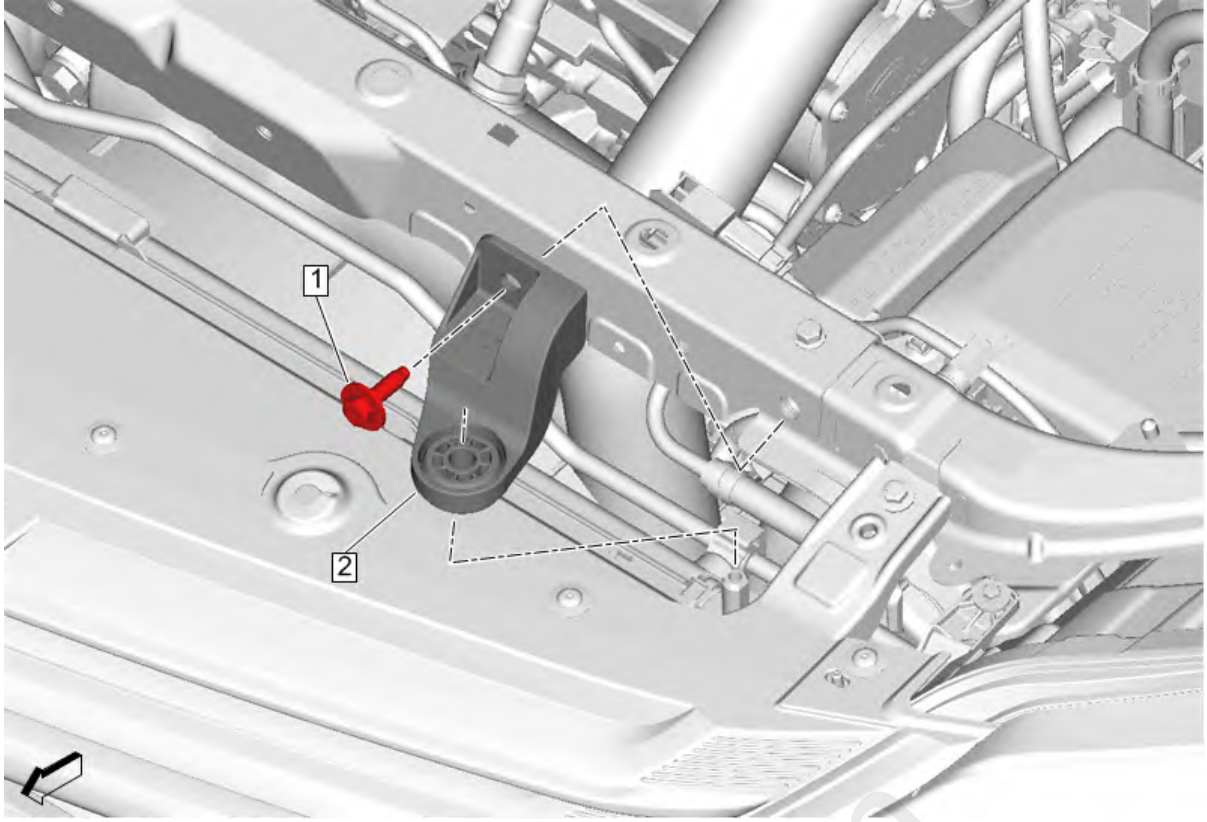


Fig. 124: Radiator Upper Bracket-Left Side
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Radiator Upper Bracket Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 14 N.m (10 lb ft)
2	Radiator Upper Bracket

RADIATOR UPPER BRACKET REPLACEMENT - RIGHT SIDE

mcx30.com

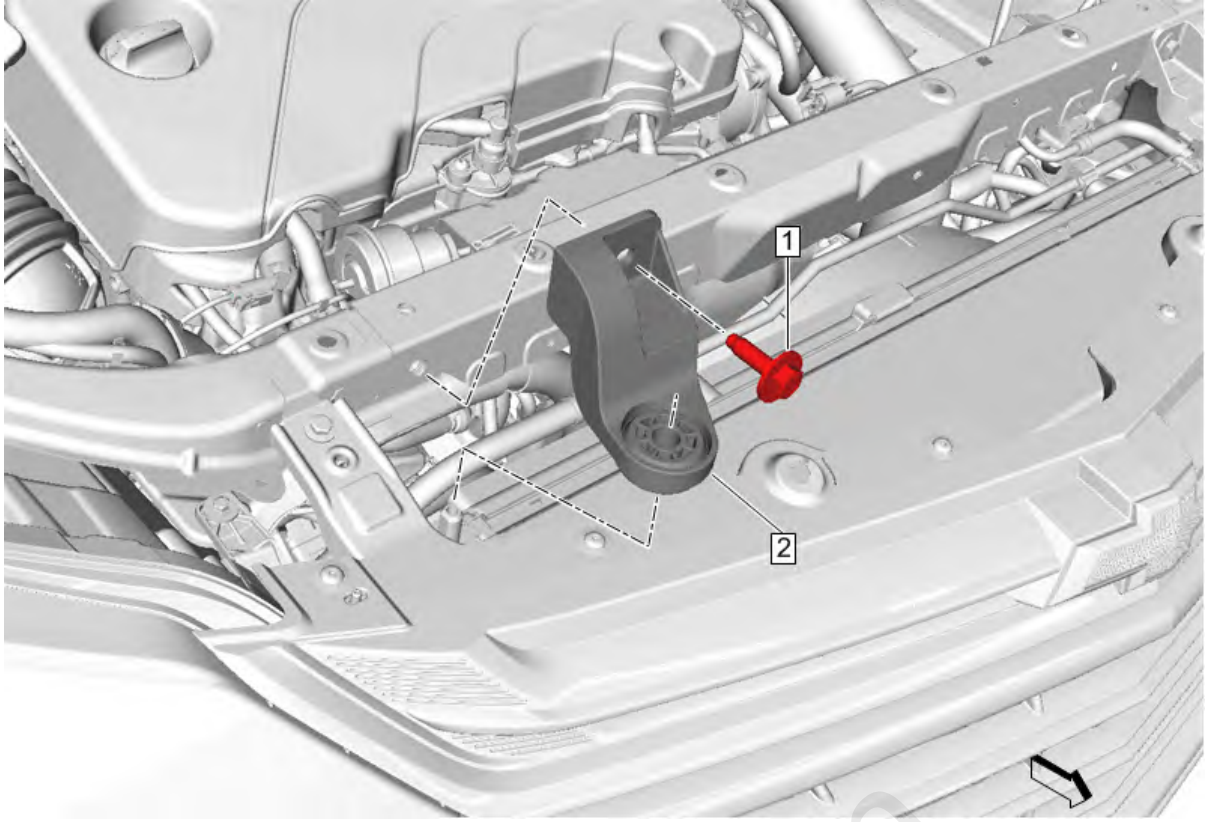


Fig. 125: Radiator Upper Bracket-Right Side
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Radiator Upper Bracket Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 14 N.m (10 lb ft)
2	Radiator Upper Bracket

ENGINE OIL COOLER REPLACEMENT (LYX)

mcx30.com

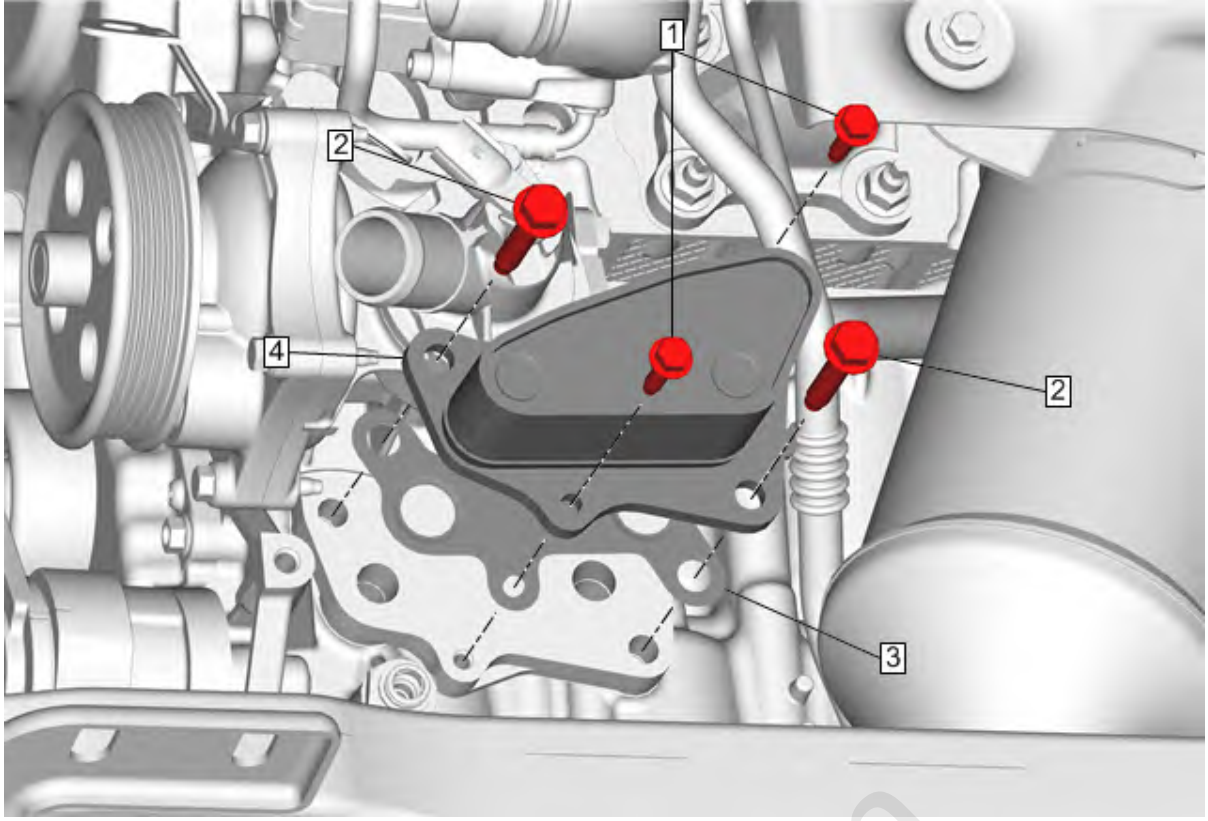


Fig. 126: Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Drain the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static) 2. Drain the engine oil. Engine Oil and Oil Filter Replacement 3. Air Conditioning Compressor Bracket Replacement (LYX)	
1	Engine Oil Cooler Bolt [2x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Engine Oil Cooler Bolt [2x] **Tighten** 25 N.m (18 lb ft)
3	Gasket **Procedure** Install a NEW engine oil cooler gasket.
4	Engine Oil Cooler

ENGINE OIL COOLER REPLACEMENT (LH7)

Removal Procedure

1. Drain the cooling system. Refer to Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)
2. Remove Exhaust Front Pipe Replacement (LH7)

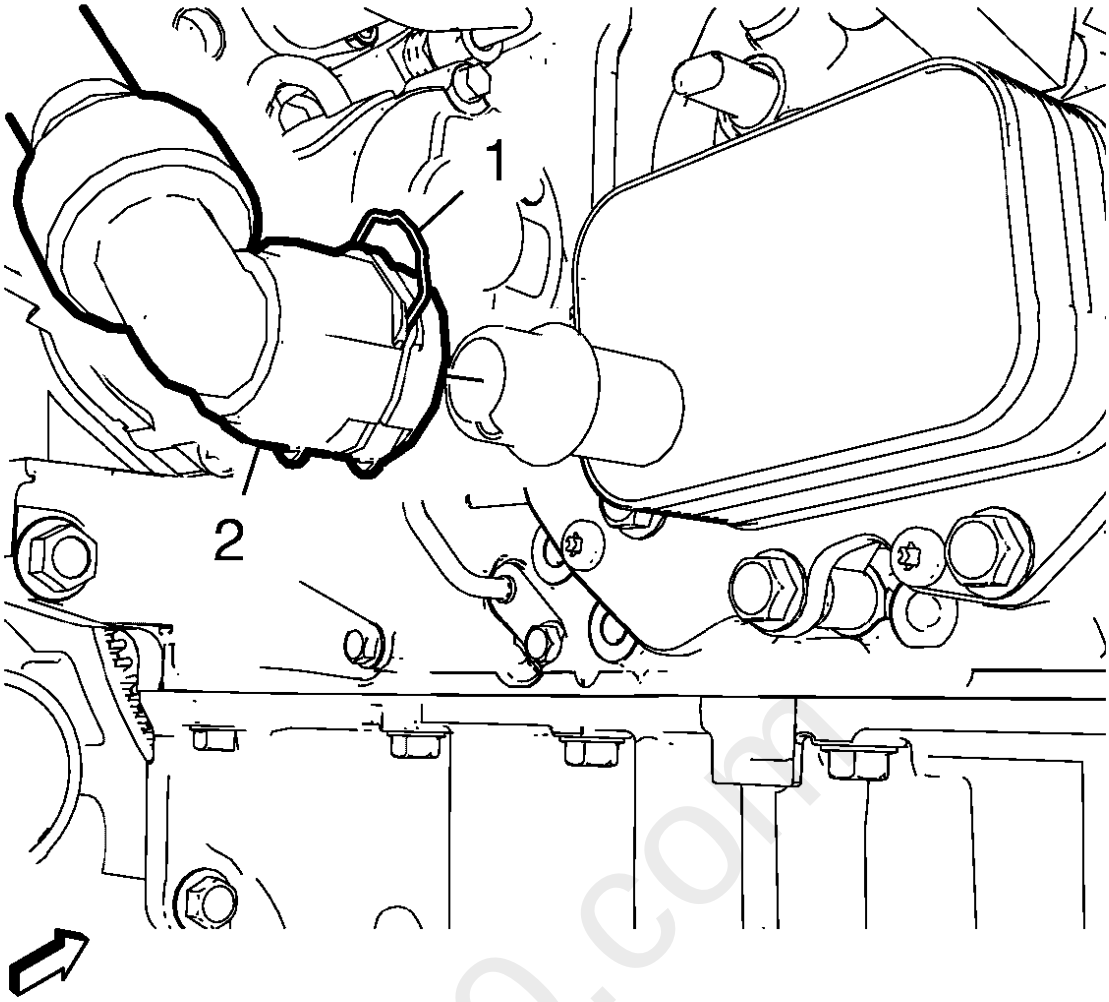


Fig. 127: Quick Connector Clamp
Courtesy of GENERAL MOTORS COMPANY

3. Unlock the quick connector clamp (1) and disconnect the heater inlet hose (2) from the oil cooler.
4. Place a drain pan below the vehicle.

mcx30.com

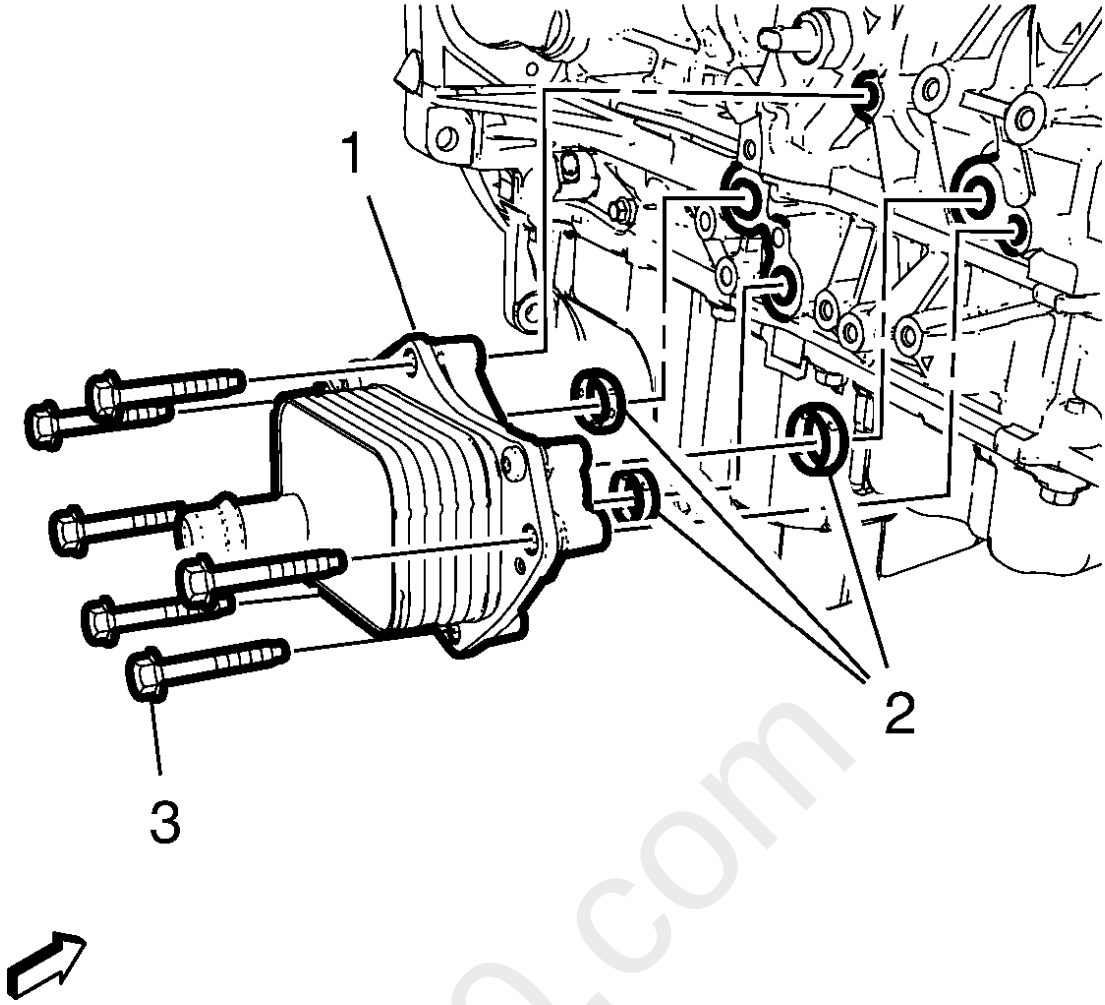


Fig. 128: Engine Oil Cooler, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

5. Remove Engine Oil Cooler Bolt (3) [6x]

NOTE: **A small quantity of oil will drop off the cooler interface.**

6. Remove the oil cooler with oil cooler adapter (1).
7. Remove and DISCARD the 3 oil cooler adapter gaskets (2).

Installation Procedure

1. Clean the engine block and sealant surfaces, if some oil drained on the cooler mating surfaces.

mcx30.com

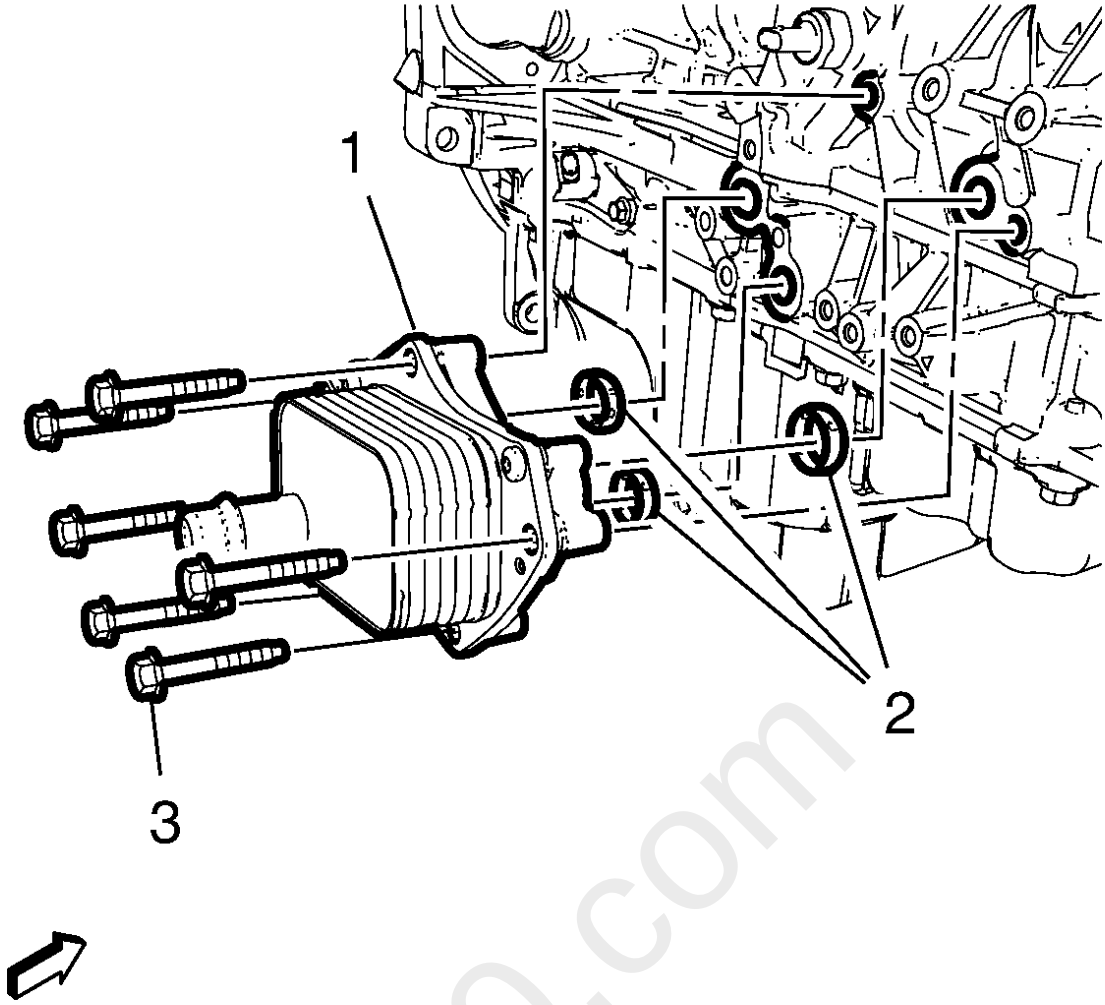


Fig. 129: Engine Oil Cooler, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

2. Install 3 New oil cooler adapter gaskets (2).
3. Install the oil cooler with oil cooler adapter (1).

CAUTION: **Refer to Fastener Caution .**

4. Install Engine Oil Cooler Bolt (3) and tighten 25 N.m (18 lb ft) [6x]

mdx30.com

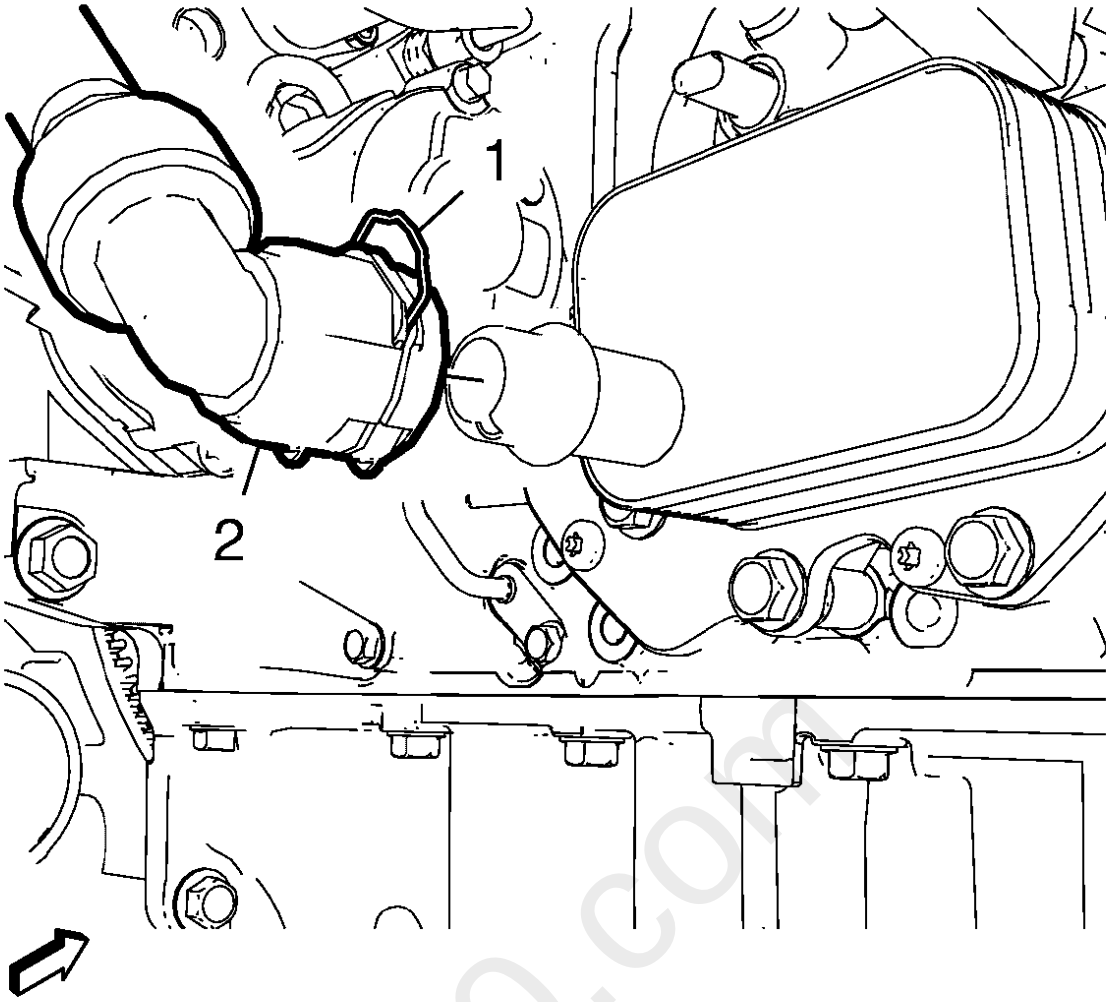


Fig. 130: Quick Connector Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Connect the heater inlet hose (2) to the oil cooler. Ensure the quick connector clamp (1) engages audible.
6. Install **Exhaust Front Pipe Replacement (LH7)**
7. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
8. Check and correct the engine oil level.

ENGINE OIL COOLER REPLACEMENT (LTG)

Removal Procedure

1. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
2. Remove the engine oil filter. **Engine Oil and Oil Filter Replacement**
3. Remove Oil Pump Flow Control Valve Heat Shield - **Oil Pump Flow Control Valve Heat Shield Replacement**

mcx30.com

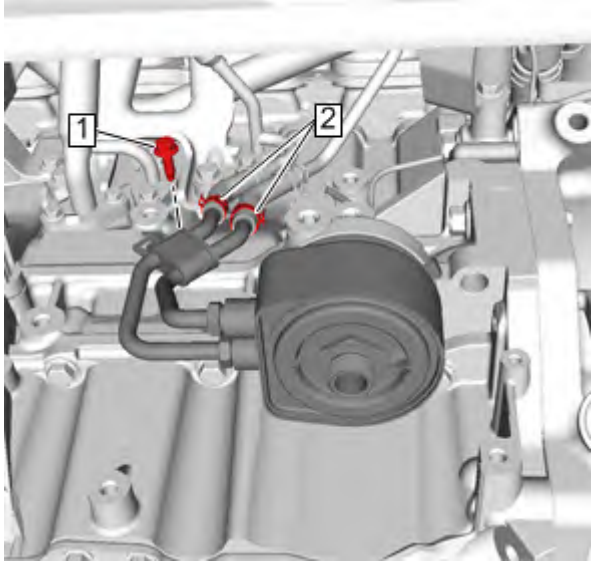


Fig. 131: Engine Oil Cooler Pipe Fastener
Courtesy of GENERAL MOTORS COMPANY

4. Remove Engine Oil Cooler Pipe Fastener (1).
5. Disengage Engine Oil Cooler Hose Clamp (2) - [2x]**Hose Clamp Replacement Guidelines - Spring Type**

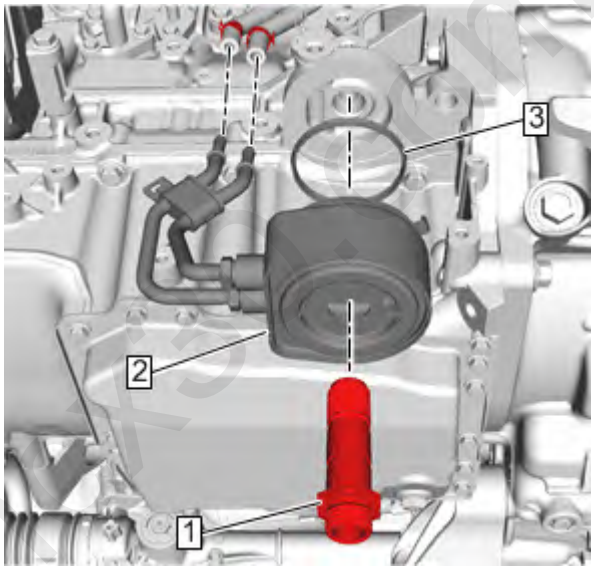


Fig. 132: Engine Oil Cooler Connector
Courtesy of GENERAL MOTORS COMPANY

6. Remove Engine Oil Cooler Core Bolt (1).
7. Remove Engine Oil Cooler (2).
8. Remove Engine Oil Cooler Seal (3) and DISCARD

Installation Procedure

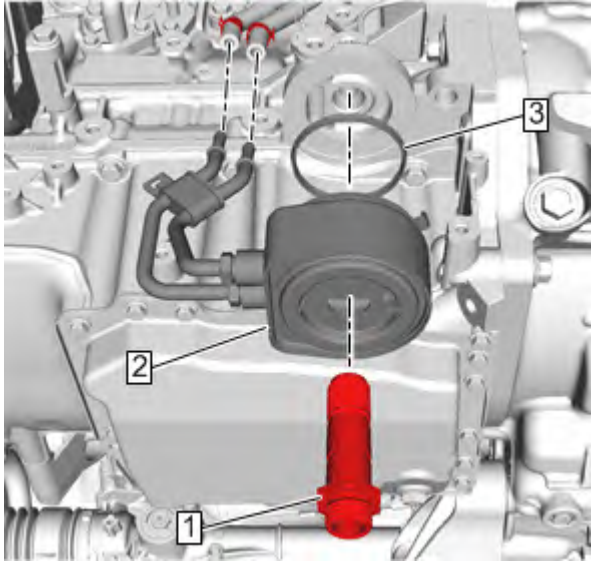


Fig. 133: Engine Oil Cooler Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install a NEW seal.**

1. Install Engine Oil Cooler Seal (3).
2. Install Engine Oil Cooler (2).
3. Engine Oil Cooler Core Bolt (1) - Hand tighten

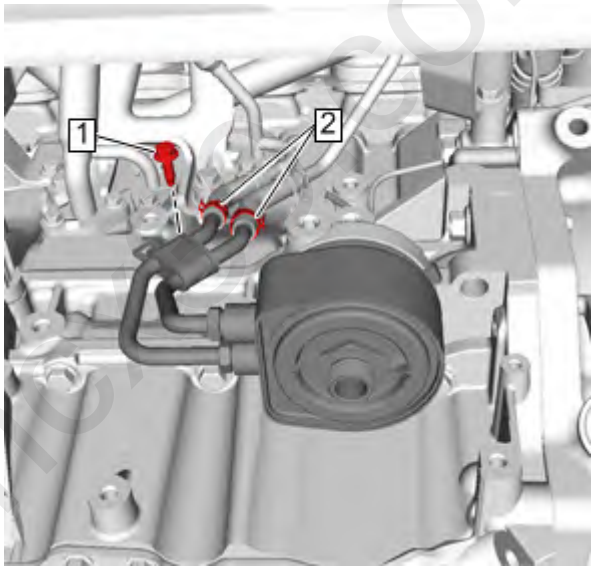


Fig. 134: Engine Oil Cooler Pipe Fastener
Courtesy of GENERAL MOTORS COMPANY

4. Engage Engine Oil Cooler Hose Clamp (2) - [2x]**Hose Clamp Replacement Guidelines - Spring Type**

CAUTION: **Refer to Fastener Caution .**

5. Install Engine Oil Cooler Pipe Fastener (1) and tighten 10 N.m (89 lb in)

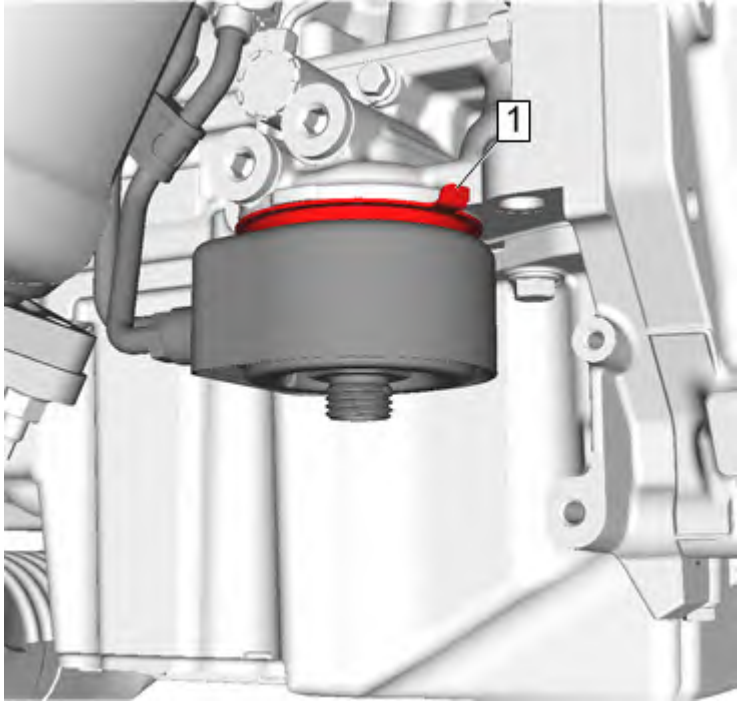


Fig. 135: Engine Oil Cooler Locating Tab
Courtesy of GENERAL MOTORS COMPANY

6. Ensure that the engine oil cooler locating tab (1) is positioned against the engine block.

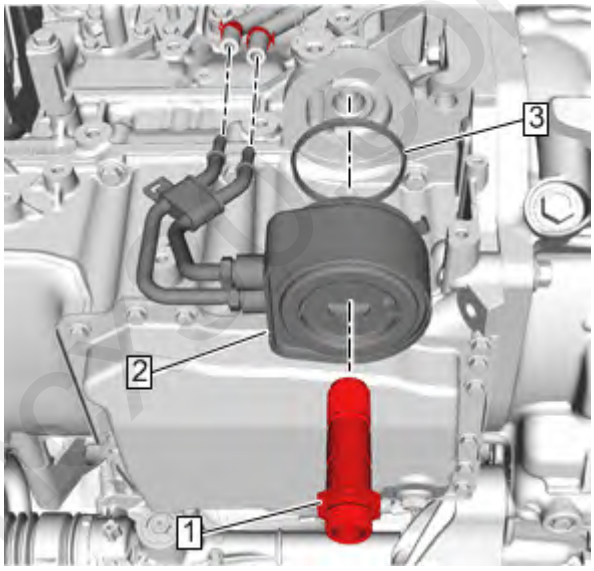


Fig. 136: Engine Oil Cooler Connector
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Component Fastener Tightening Caution .**

7. Engine Oil Cooler Core Bolt (1) - Tighten 50 N.m (37 lb ft)
8. Install Oil Pump Flow Control Valve Heat Shield - **Oil Pump Flow Control Valve Heat Shield Replacement**
9. Change the engine oil and filter. **Engine Oil and Oil Filter Replacement**
10. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**

ENGINE COOLANT FAN REPLACEMENT (LYX)

Removal Procedure

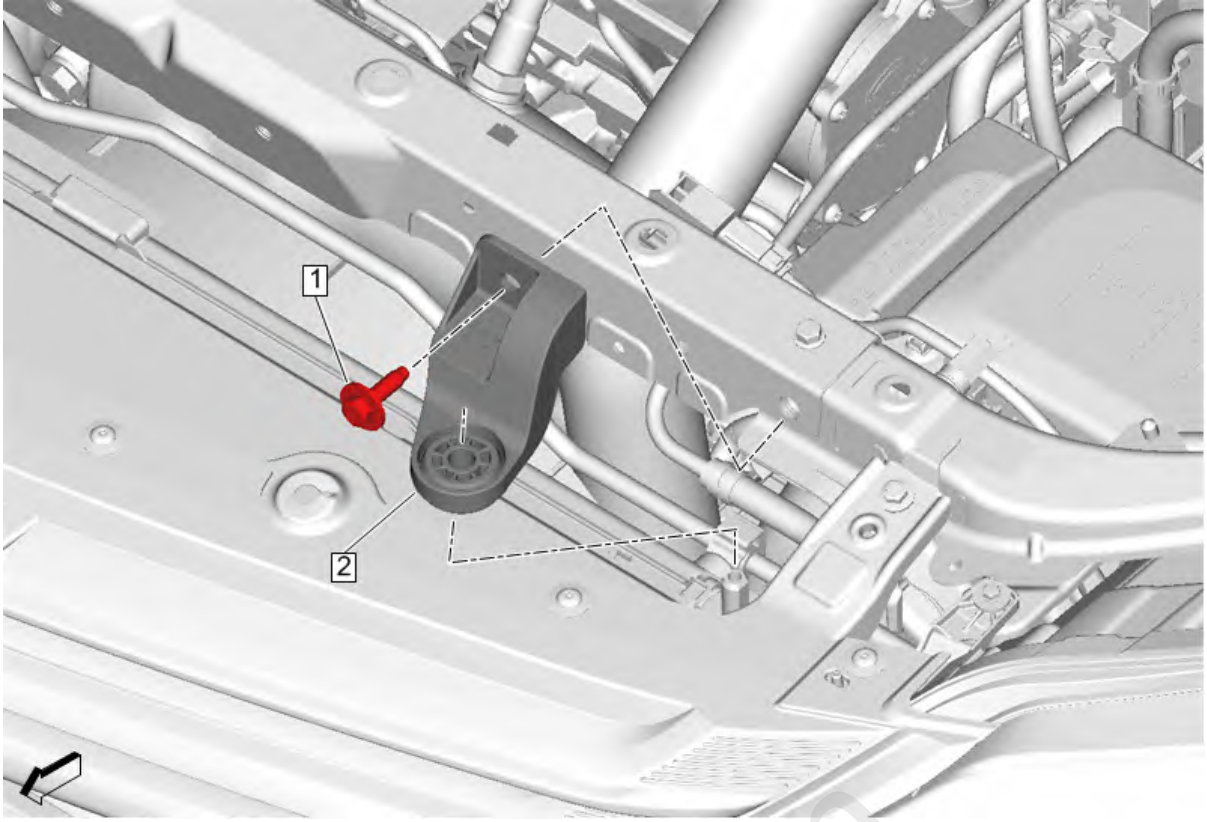


Fig. 137: Radiator Upper Bracket-Left Side
Courtesy of GENERAL MOTORS COMPANY

1. Remove Radiator Upper Bracket-Left Side (2) - **Radiator Upper Bracket Replacement - Left Side**

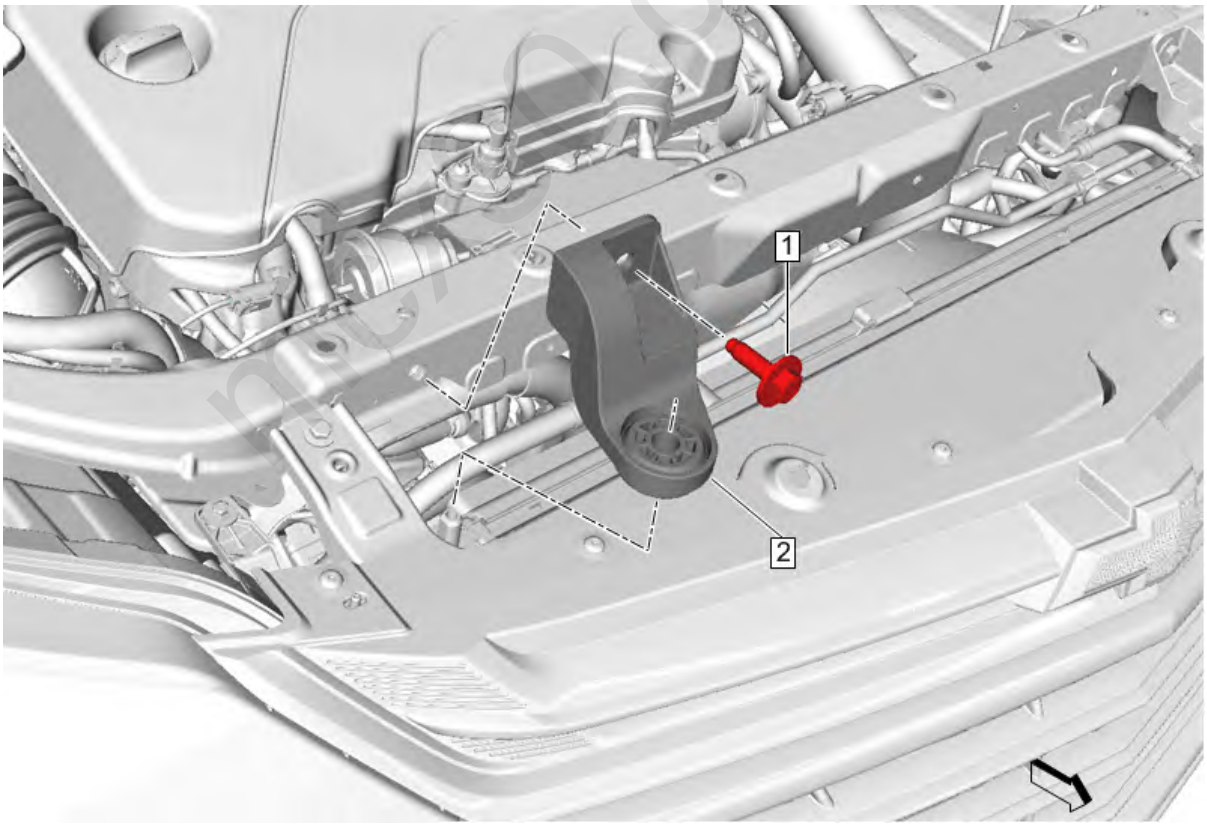


Fig. 138: Radiator Upper Bracket-Right Side
Courtesy of GENERAL MOTORS COMPANY

2. Remove Radiator Upper Bracket-Right Side (2) - **Radiator Upper Bracket Replacement - Right Side**
3. Remove Front End Upper Tie Bar - **Front End Upper Tie Bar Replacement (Equinox)** **Front End Upper Tie Bar Replacement (Terrain)**
4. Remove Front Bumper Fascia - **Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**

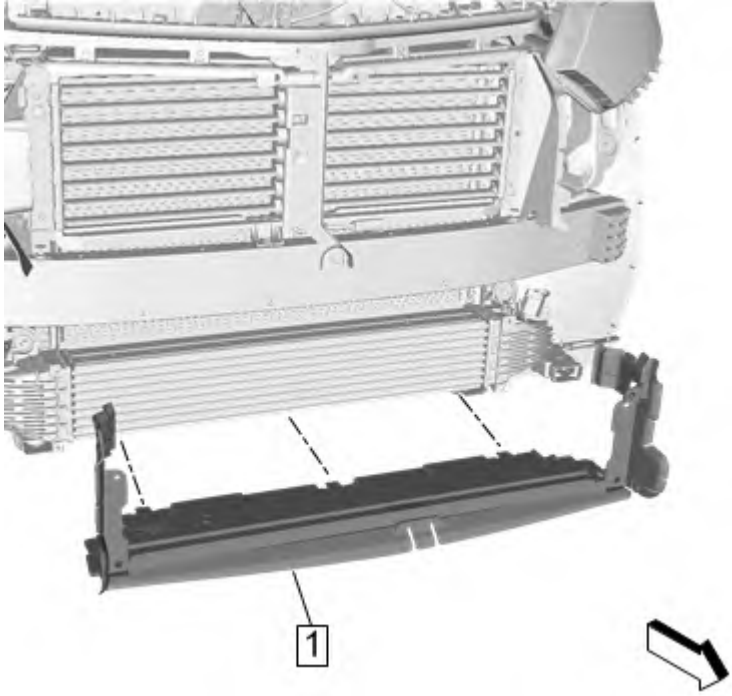


Fig. 139: Radiator Air Lower Baffle
Courtesy of GENERAL MOTORS COMPANY

5. Remove Radiator Air Lower Baffle (1) - **Radiator Air Lower Baffle Replacement (LH7 LTG LYX)**

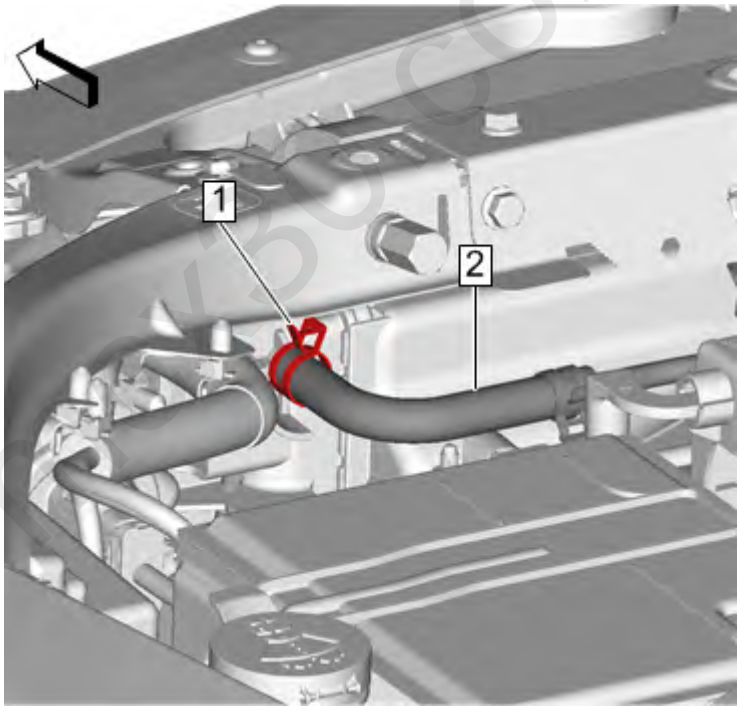


Fig. 140: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

6. Remove Engine Coolant Air Bleed Hose (2) @ Radiator - **Engine Coolant Air Bleed Hose Replacement (Turbocharger Coolant Return pipe to Water Outlet, LYX)Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Turbocharger Coolant Return Pipe to Radiator, LYX)**

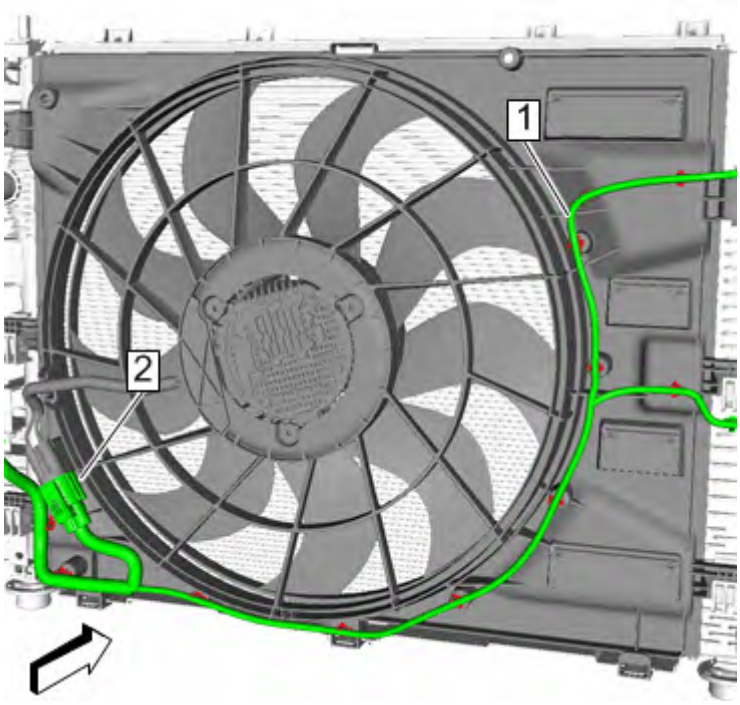


Fig. 141: Engine Coolant Fan Wiring Harness And Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Remove Engine Coolant Fan Wiring Harness (1) @ Engine Coolant Fan.
8. Disconnect Engine Coolant Fan Wiring Harness (2) @ Engine Coolant Fan.
9. Remove Transmission Fluid Cooler Pipe - **Transmission Fluid Cooler Pipe Replacement**

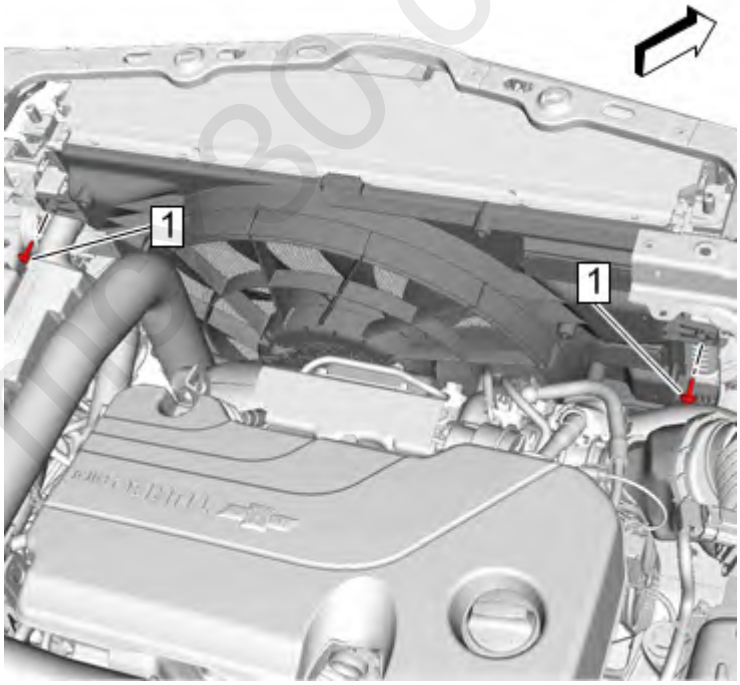


Fig. 142: Engine Coolant Fan Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Remove Engine Coolant Fan Bolt (1) - [2x]

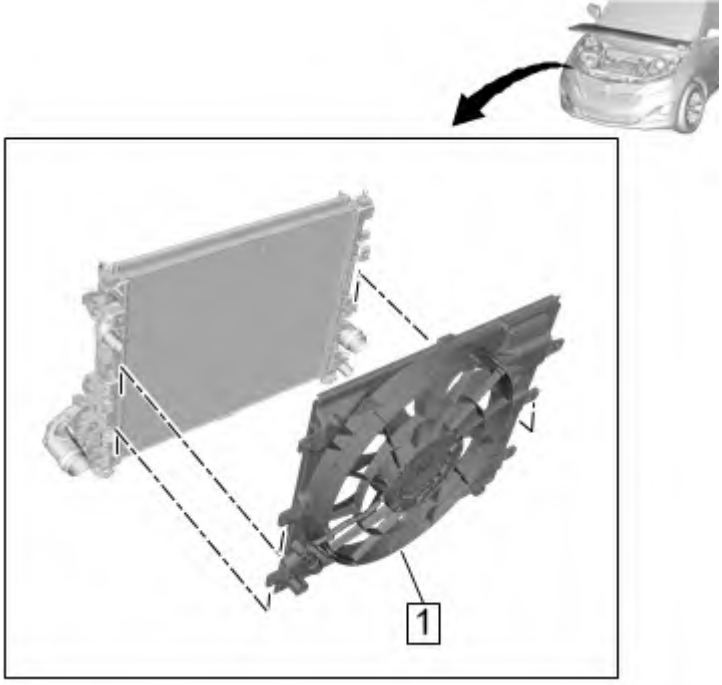


Fig. 143: Engine Coolant Fan
Courtesy of GENERAL MOTORS COMPANY

11. Remove Engine Coolant Fan (1).
12. Transfer components as necessary.

Installation Procedure

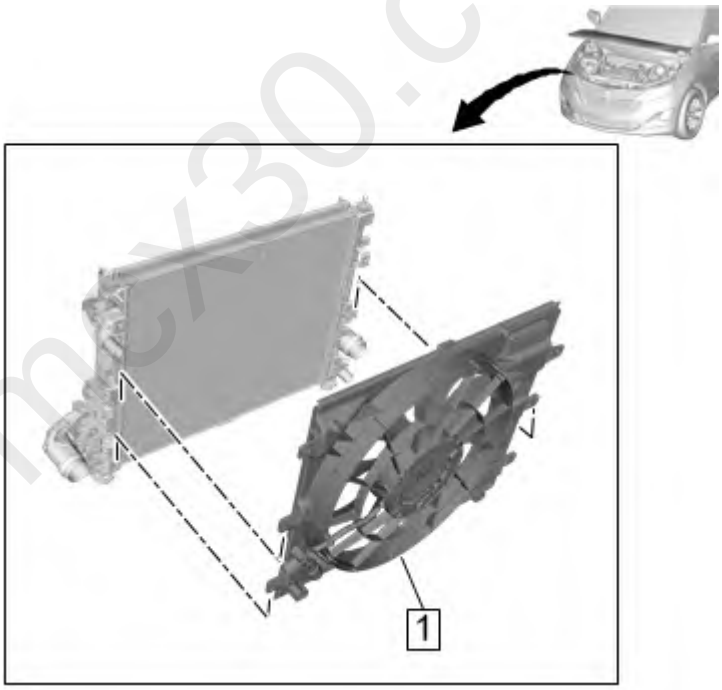


Fig. 144: Engine Coolant Fan
Courtesy of GENERAL MOTORS COMPANY

1. Install Engine Coolant Fan (1).

mcx30.com

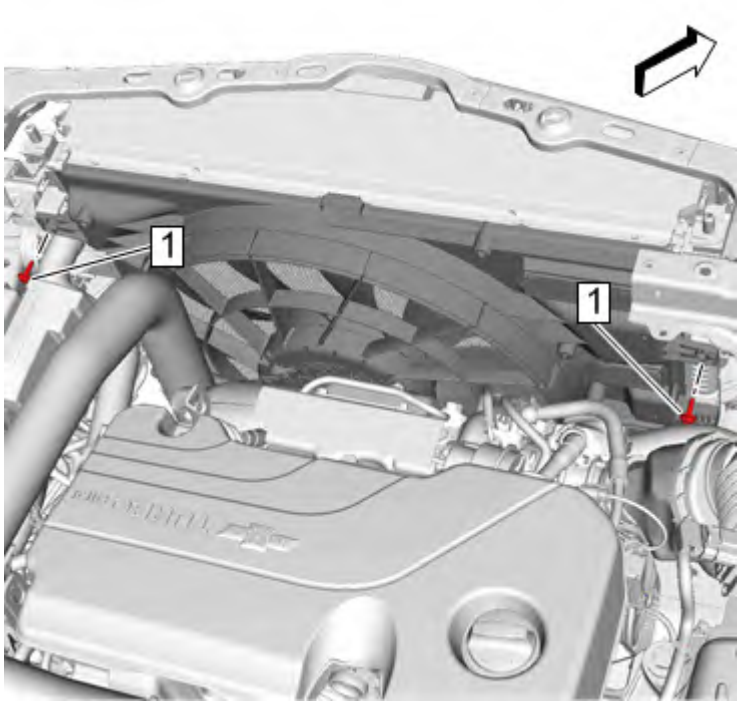


Fig. 145: Engine Coolant Fan Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. Install Engine Coolant Fan Bolt (1) and tighten [2x] 5 N.m (44 lb in)
3. Install Transmission Fluid Cooler Pipe - **Transmission Fluid Cooler Pipe Replacement**

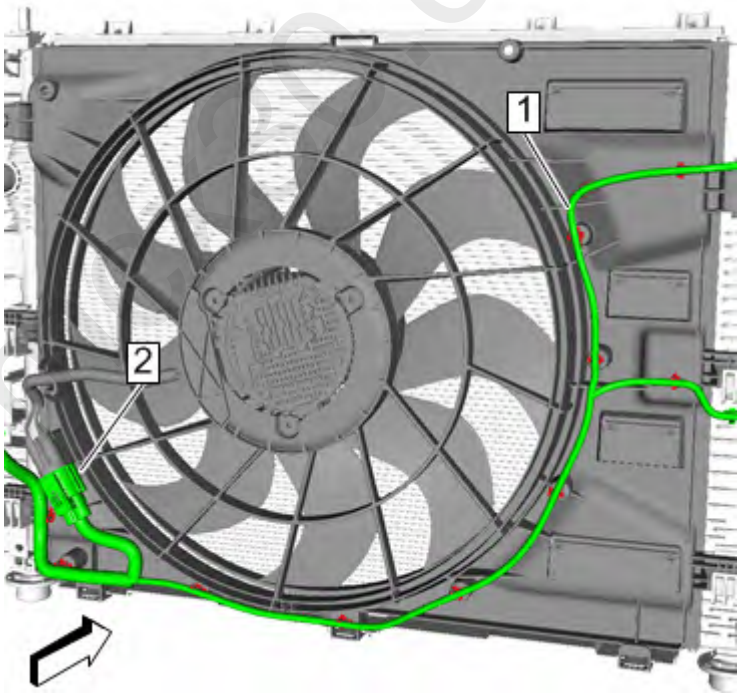


Fig. 146: Engine Coolant Fan Wiring Harness And Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Connect Engine Coolant Fan Wiring Harness (2) @ Engine Coolant Fan
5. Install Engine Coolant Fan Wiring Harness (1) @ Engine Coolant Fan.

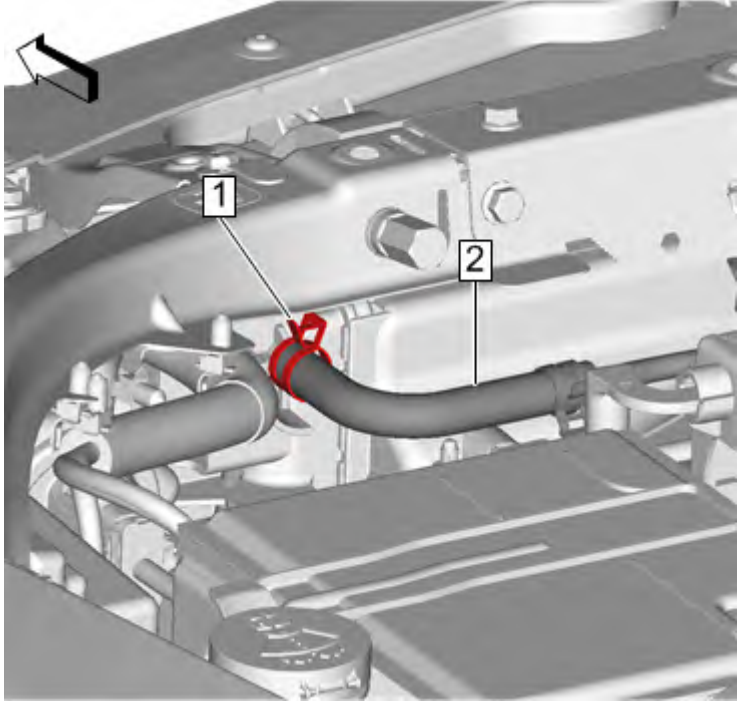


Fig. 147: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

6. Install Engine Coolant Air Bleed Hose (2) @ Radiator - **Engine Coolant Air Bleed Hose Replacement (Turbocharger Coolant Return pipe to Water Outlet, LYX)** **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Turbocharger Coolant Return Pipe to Radiator, LYX)**

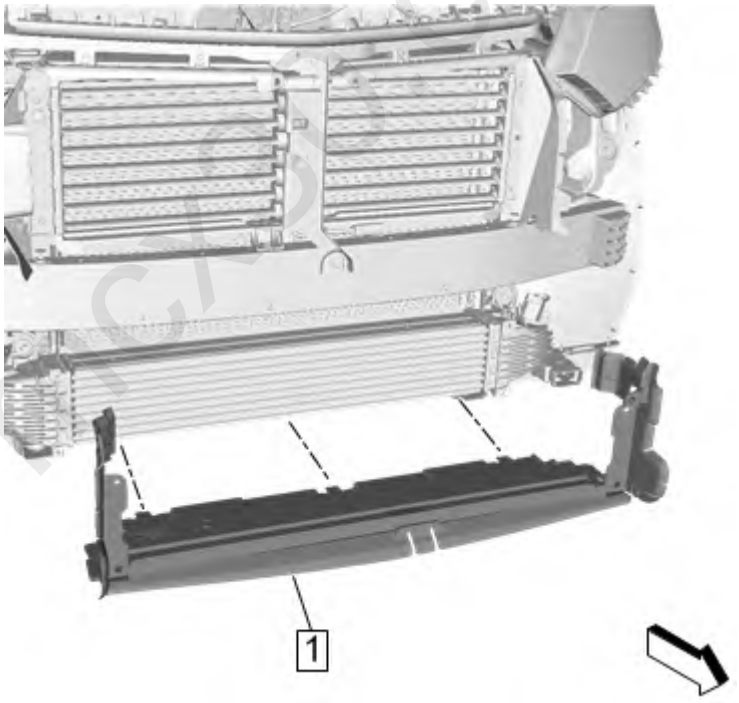


Fig. 148: Radiator Air Lower Baffle
Courtesy of GENERAL MOTORS COMPANY

7. Install Radiator Air Lower Baffle (1) - **Radiator Air Lower Baffle Replacement (LH7 LTG LYX)**
8. Install Front Bumper Fascia -**Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**
9. Install Front End Upper Tie Bar -**Front End Upper Tie Bar Replacement (Equinox)** **Front End Upper Tie Bar Replacement (Terrain)**

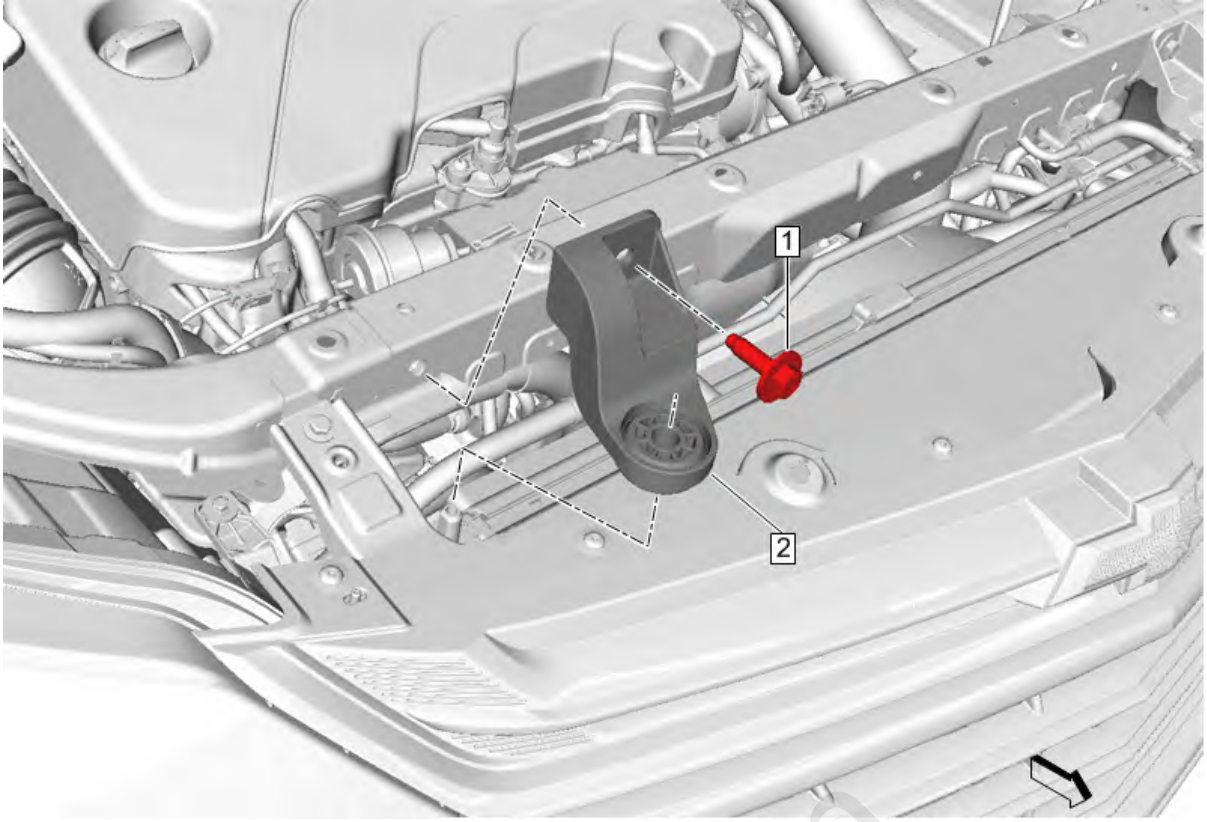


Fig. 149: Radiator Upper Bracket-Right Side
Courtesy of GENERAL MOTORS COMPANY

10. Install Radiator Upper Bracket-Right Side (2) - Radiator Upper Bracket Replacement - Right Side

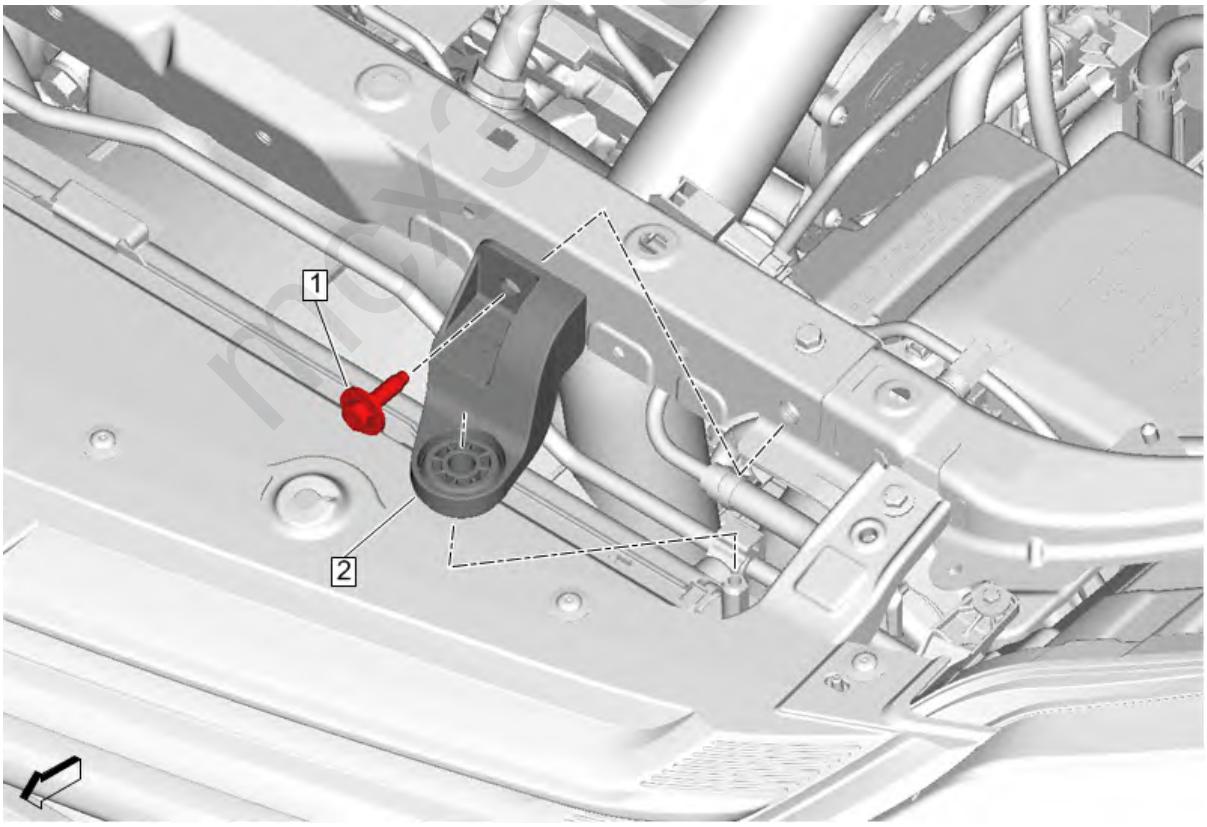


Fig. 150: Radiator Upper Bracket-Left Side
Courtesy of GENERAL MOTORS COMPANY

11. Install Radiator Upper Bracket-Left Side (2) - Radiator Upper Bracket Replacement - Left Side

ENGINE COOLANT FAN REPLACEMENT (LTG)

Removal Procedure

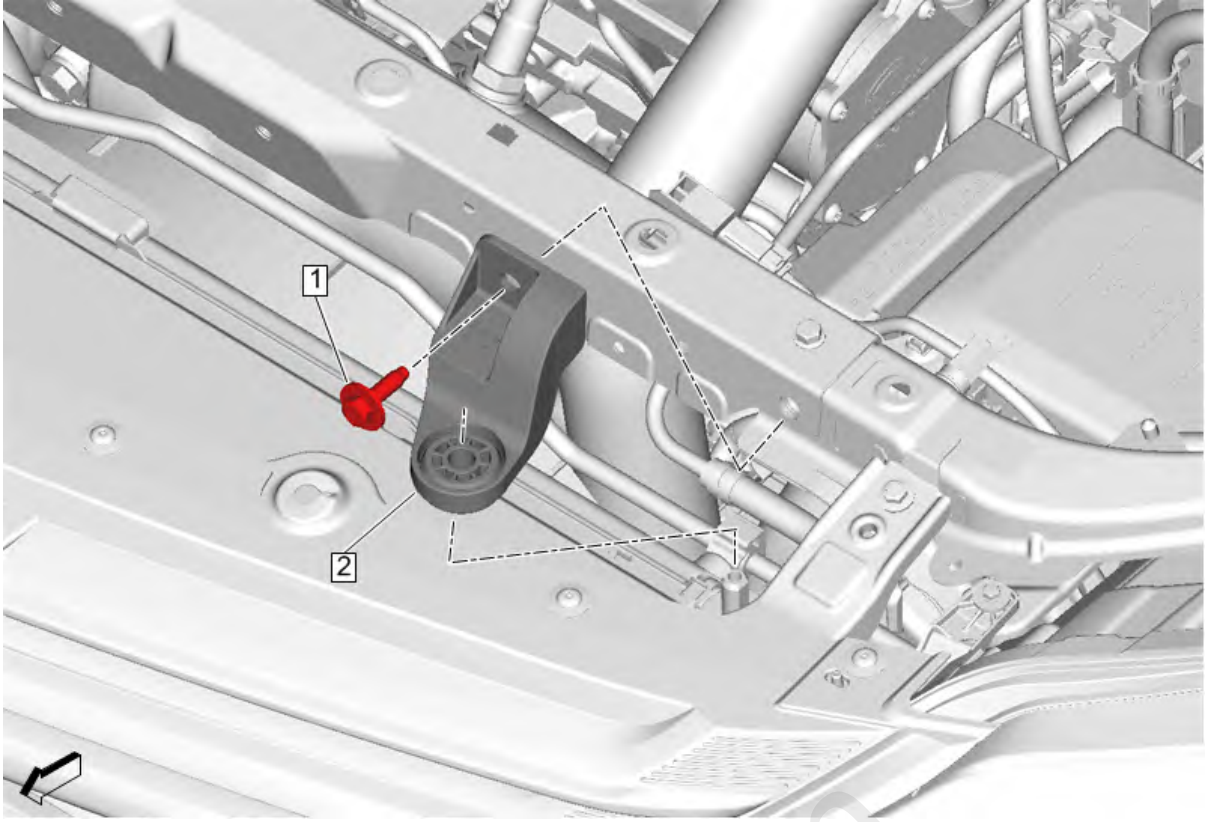


Fig. 151: Radiator Upper Bracket-Left Side
Courtesy of GENERAL MOTORS COMPANY

1. Remove Radiator Upper Bracket-Left Side (2) - **Radiator Upper Bracket Replacement - Left Side**

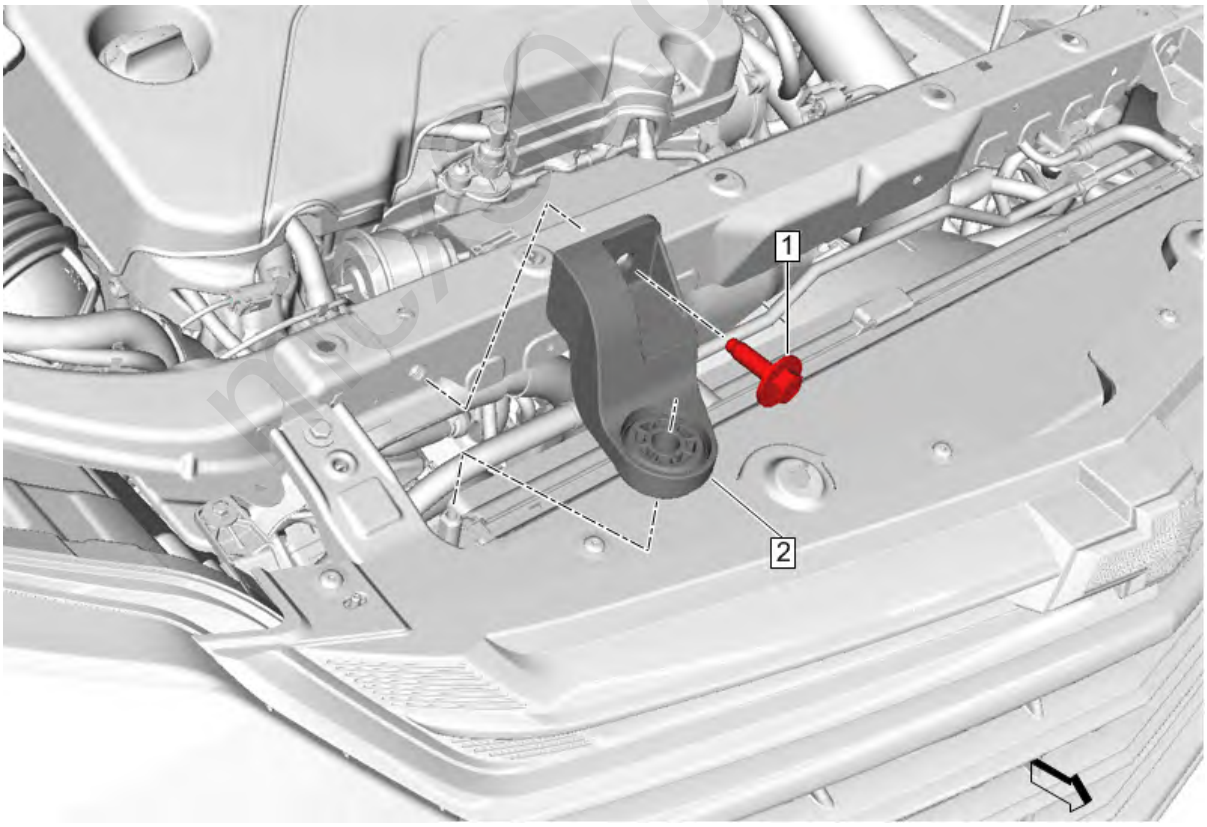


Fig. 152: Radiator Upper Bracket-Right Side
Courtesy of GENERAL MOTORS COMPANY

2. Remove Radiator Upper Bracket-Right Side (2) - **Radiator Upper Bracket Replacement - Right Side**
3. Remove Front End Upper Tie Bar - **Front End Upper Tie Bar Replacement (Equinox)** **Front End Upper Tie Bar Replacement (Terrain)**
4. Remove Front Bumper Fascia - **Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**

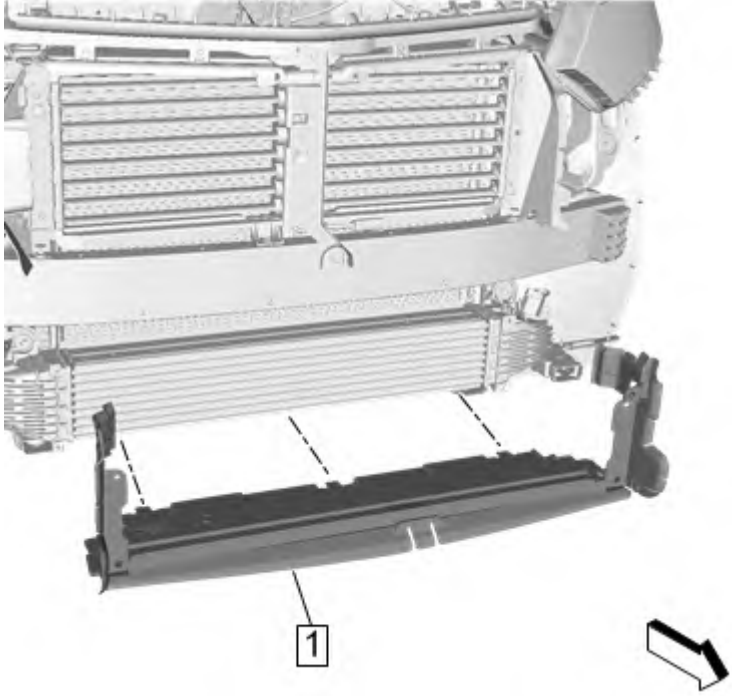


Fig. 153: Radiator Air Lower Baffle
Courtesy of GENERAL MOTORS COMPANY

5. Remove Radiator Air Lower Baffle (1) - **Radiator Air Lower Baffle Replacement (LH7 LTG LYX)**

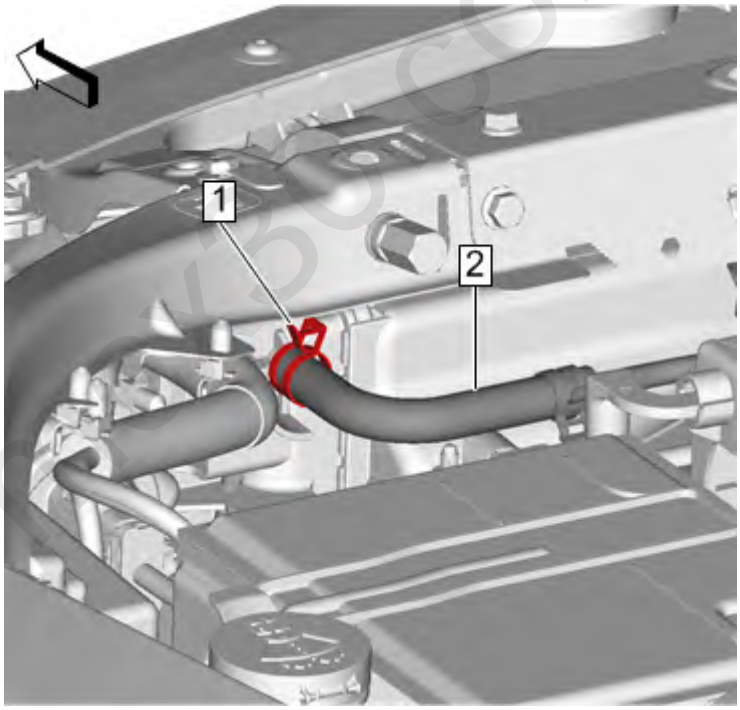


Fig. 154: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

6. Remove Engine Coolant Air Bleed Hose (2) @ Radiator - **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Radiator to Engine Coolant Air Bleed Pipe LTG)**

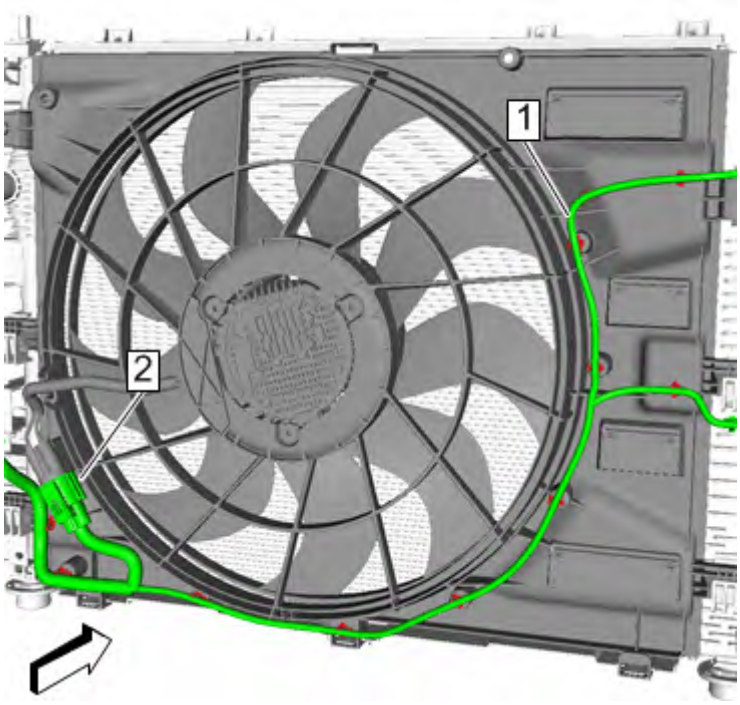


Fig. 155: Engine Coolant Fan Wiring Harness And Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Remove Engine Coolant Fan Wiring Harness (1) @ Engine Coolant Fan.
8. Disconnect Engine Coolant Fan Wiring Harness (2) @ Engine Coolant Fan.
9. Remove Transmission Fluid Cooler Pipe - **Transmission Fluid Cooler Pipe Replacement**

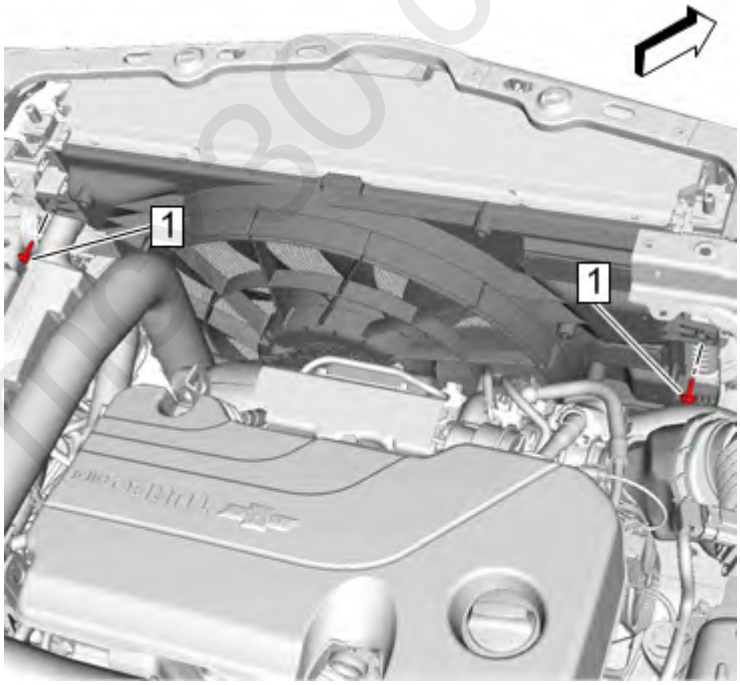


Fig. 156: Engine Coolant Fan Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Remove Engine Coolant Fan Bolt (1) - [2x]

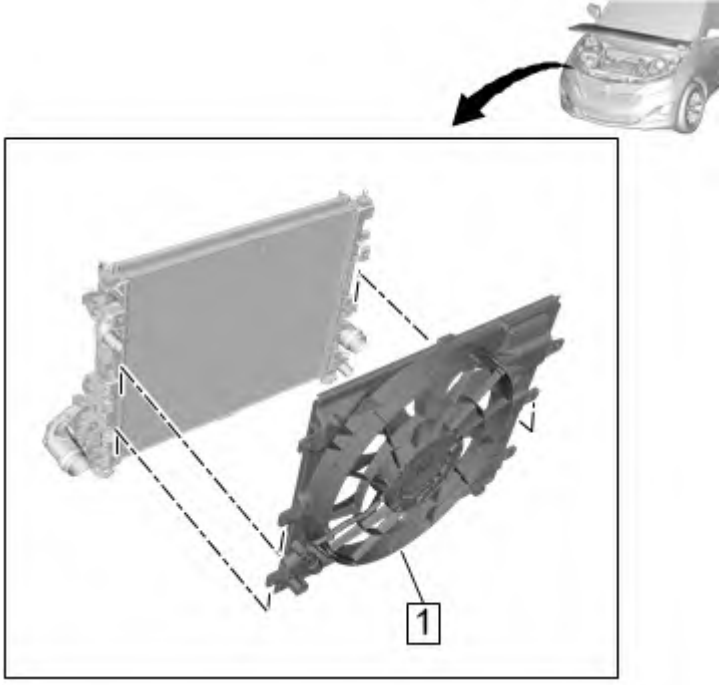


Fig. 157: Engine Coolant Fan
Courtesy of GENERAL MOTORS COMPANY

11. Remove Engine Coolant Fan (1).
12. Transfer components as necessary.

Installation Procedure

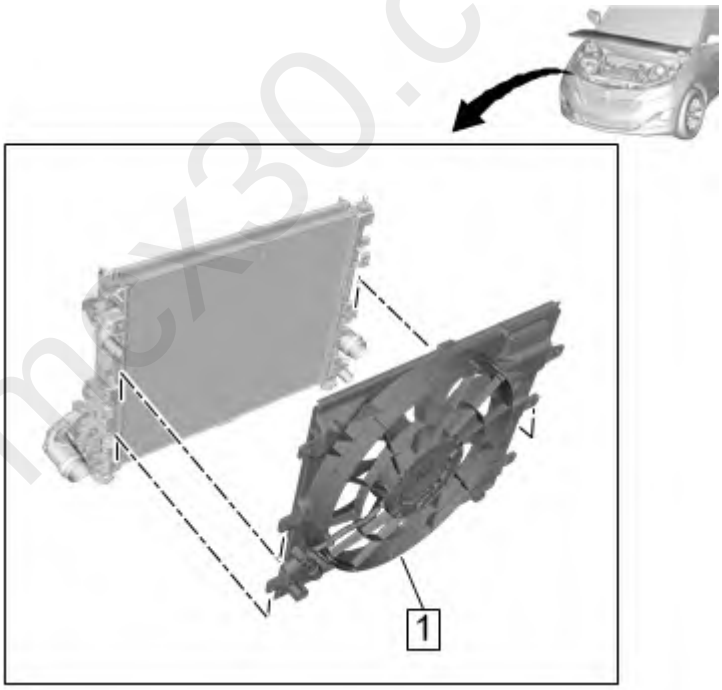


Fig. 158: Engine Coolant Fan
Courtesy of GENERAL MOTORS COMPANY

1. Install Engine Coolant Fan (1).

mcx30.com

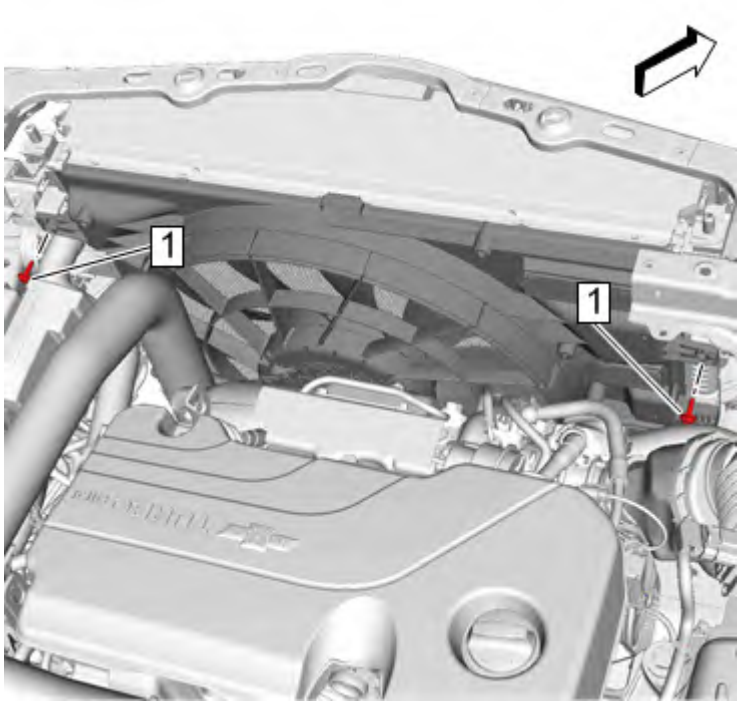


Fig. 159: Engine Coolant Fan Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. Install Engine Coolant Fan Bolt (1) and tighten [2x] 5 N.m (44 lb in)
3. Install Transmission Fluid Cooler Pipe - **Transmission Fluid Cooler Pipe Replacement**

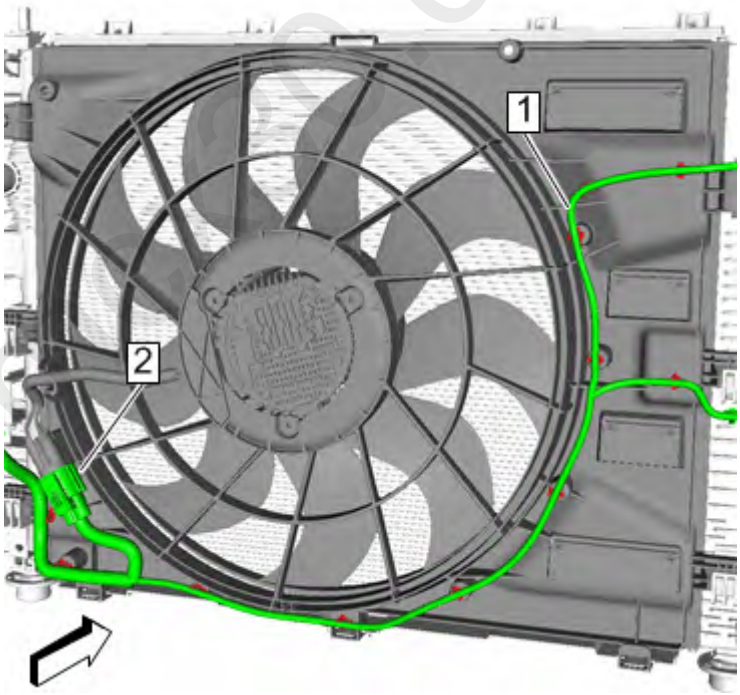


Fig. 160: Engine Coolant Fan Wiring Harness And Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Connect Engine Coolant Fan Wiring Harness (2) @ Engine Coolant Fan.
5. Install Engine Coolant Fan Wiring Harness (1) @ Engine Coolant Fan.

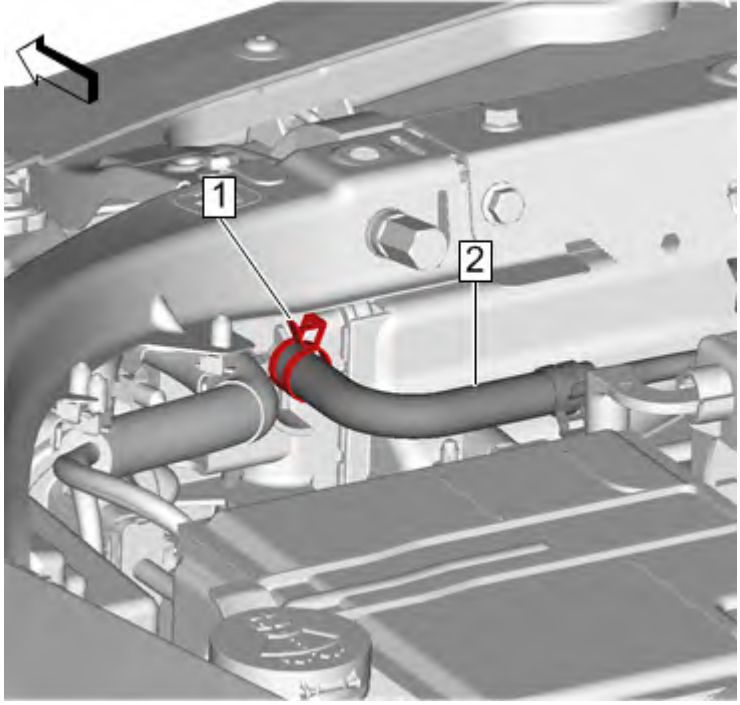


Fig. 161: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

6. Install Engine Coolant Air Bleed Hose (2) @ Radiator - **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Radiator to Engine Coolant Air Bleed Pipe LTG)**

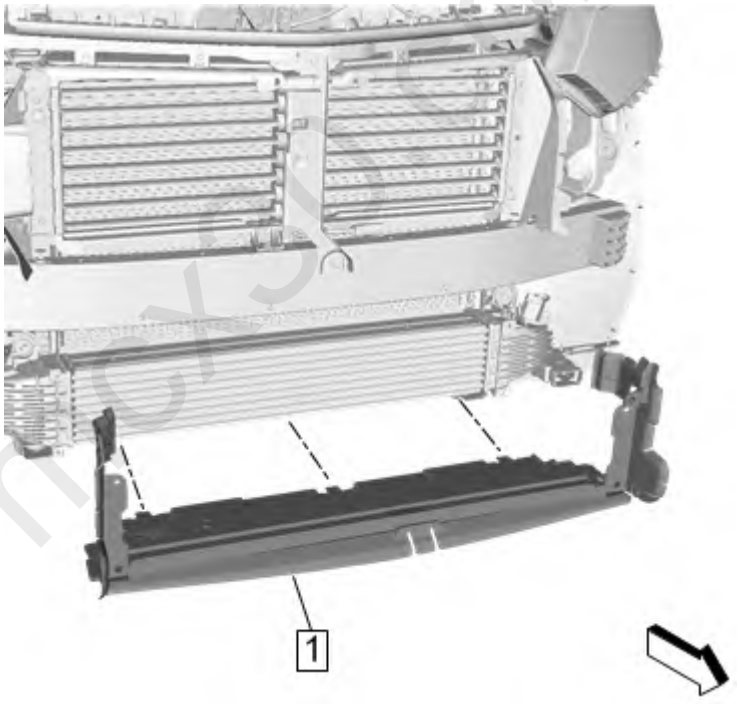


Fig. 162: Radiator Air Lower Baffle
Courtesy of GENERAL MOTORS COMPANY

7. Install Radiator Air Lower Baffle (1) - **Radiator Air Lower Baffle Replacement (LH7 LTG LYX)**
8. Install Front Bumper Fascia - **Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**
9. Install Front End Upper Tie Bar -**Front End Upper Tie Bar Replacement (Equinox)** **Front End Upper Tie Bar Replacement (Terrain)**

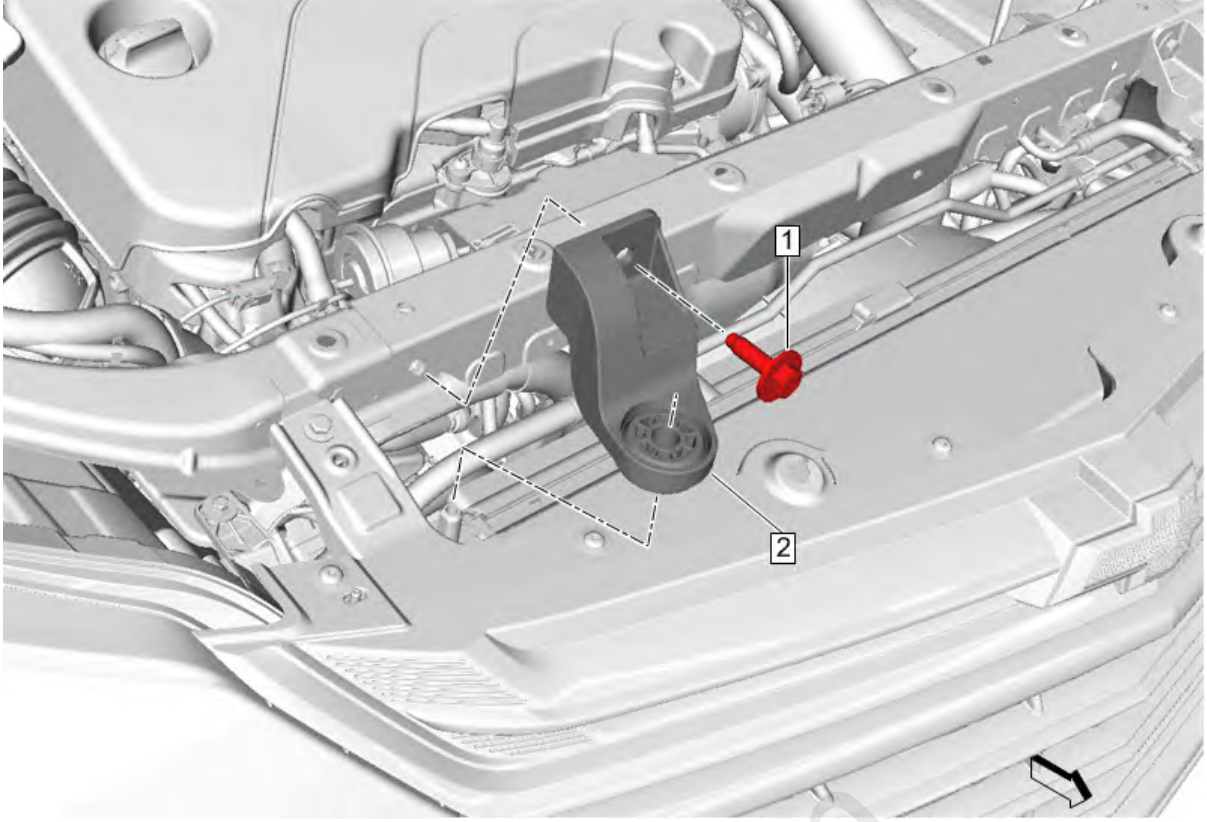


Fig. 163: Radiator Upper Bracket-Right Side
Courtesy of GENERAL MOTORS COMPANY

10. Install Radiator Upper Bracket-Right Side (2) -Radiator Upper Bracket Replacement - Right Side

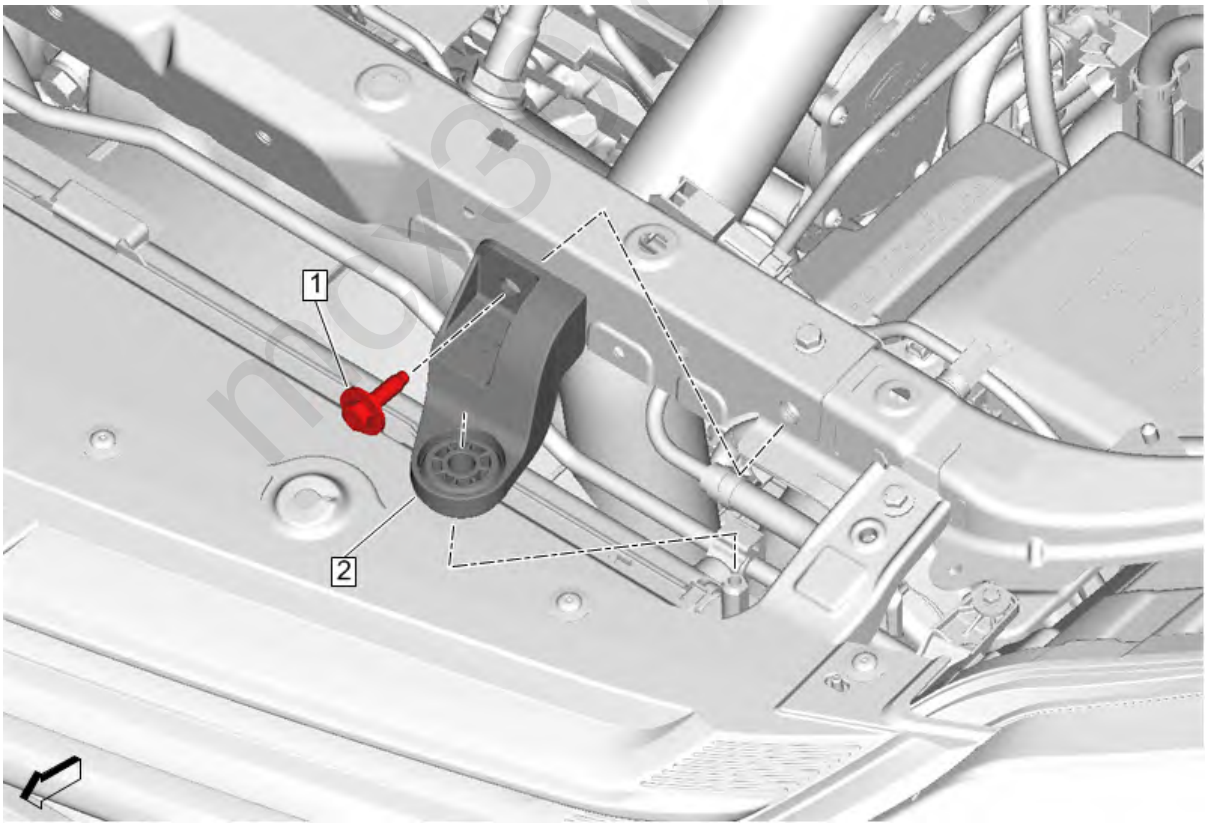


Fig. 164: Radiator Upper Bracket-Left Side
Courtesy of GENERAL MOTORS COMPANY

11. Install Radiator Upper Bracket-Left Side (2) - Radiator Upper Bracket Replacement - Left Side

ENGINE COOLANT FAN REPLACEMENT (LH7)

Removal Procedure

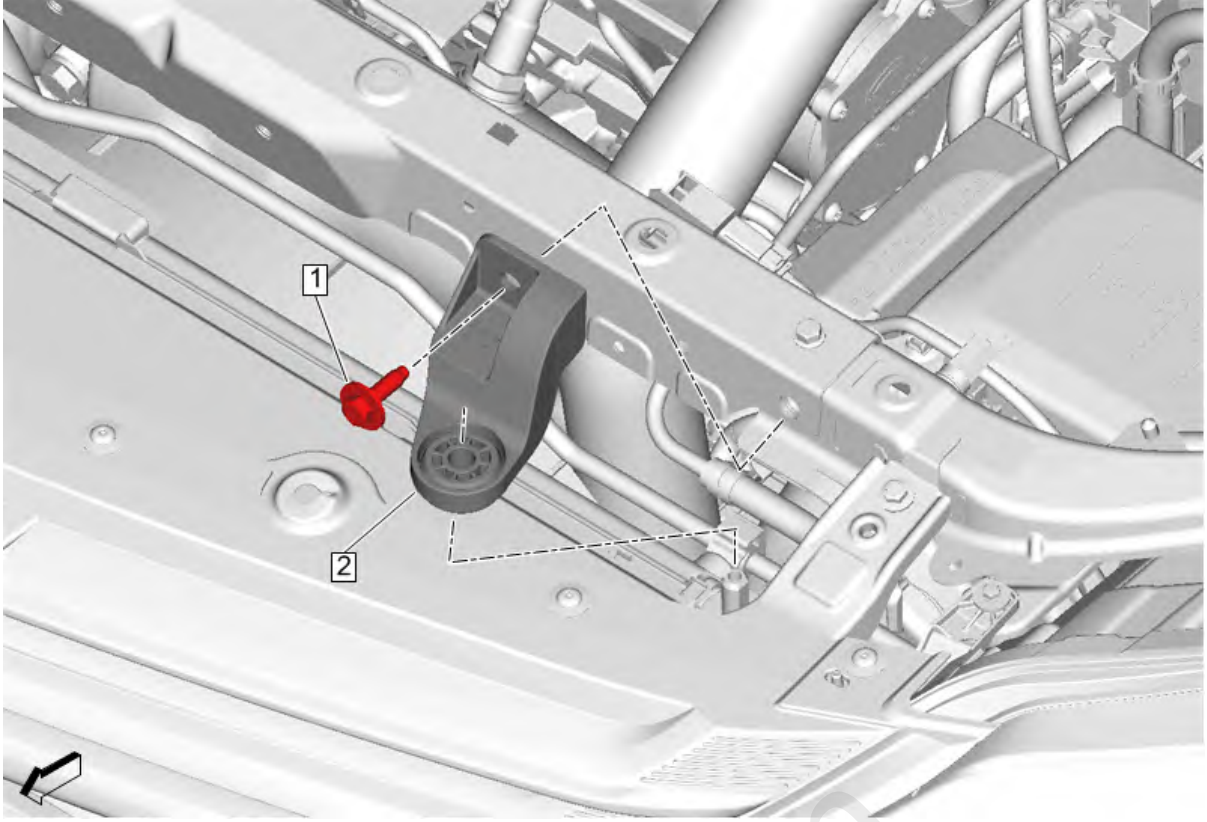


Fig. 165: Radiator Upper Bracket-Left Side
Courtesy of GENERAL MOTORS COMPANY

1. Remove Radiator Upper Bracket-Left Side (2) - Radiator Upper Bracket Replacement - Left Side

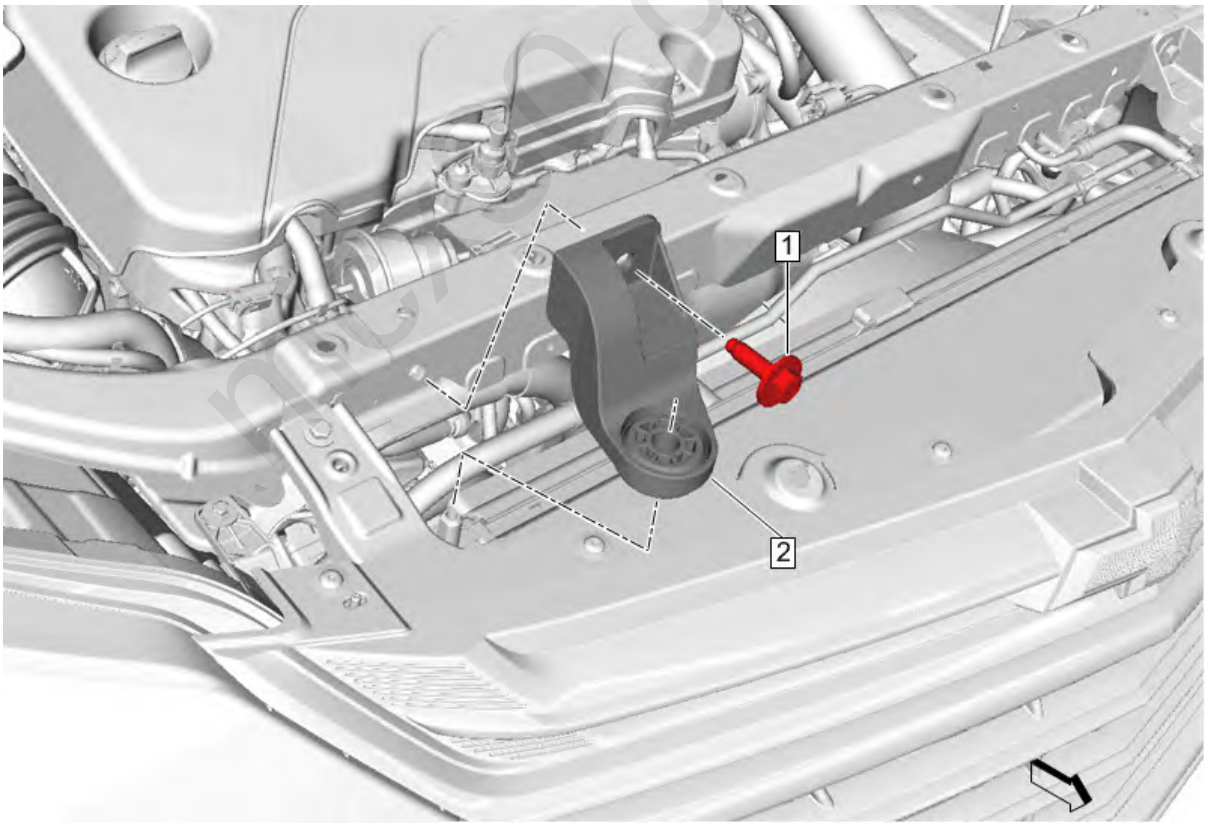


Fig. 166: Radiator Upper Bracket-Right Side
Courtesy of GENERAL MOTORS COMPANY

2. Remove Radiator Upper Bracket-Right Side (2) - Radiator Upper Bracket Replacement - Right Side
3. Remove Front End Upper Tie Bar - Front End Upper Tie Bar Replacement (Equinox) Front End Upper Tie Bar Replacement (Terrain)
4. Remove Front Bumper Fascia - Front Bumper Fascia Replacement (Equinox) Front Bumper Fascia Replacement (Terrain)

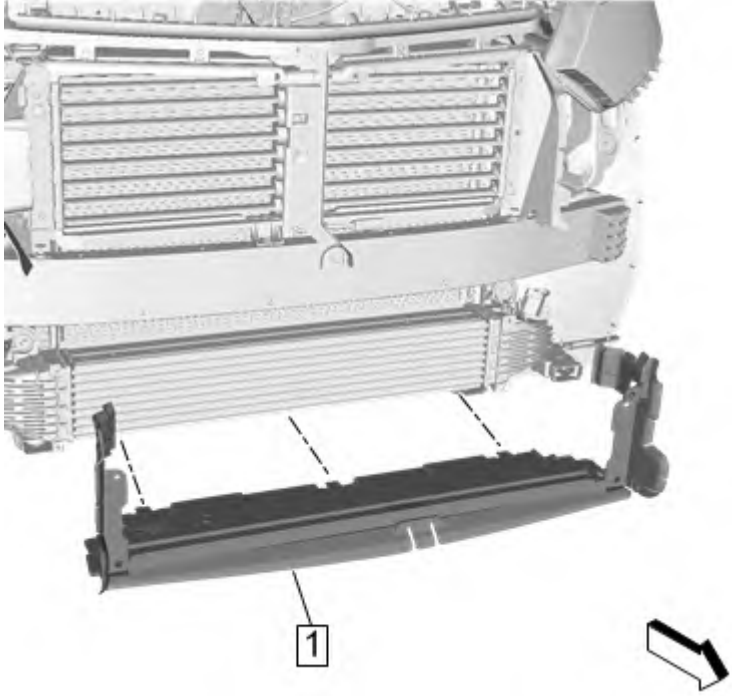


Fig. 167: Radiator Air Lower Baffle
Courtesy of GENERAL MOTORS COMPANY

5. Remove Radiator Air Lower Baffle (1) - **Radiator Air Lower Baffle Replacement (LH7 LTG LYX)**

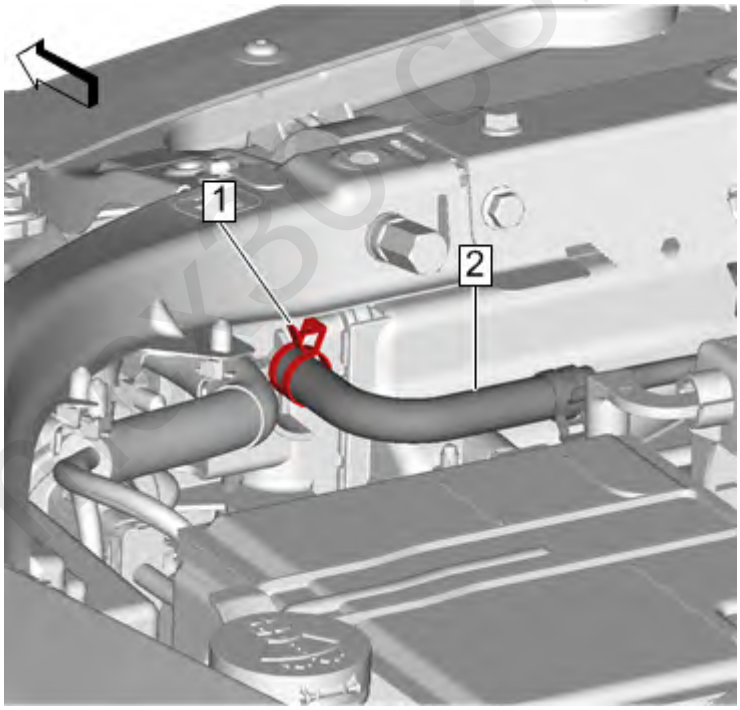


Fig. 168: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

6. Remove Engine Coolant Air Bleed Hose (2) @ Radiator - **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Exhaust Gas Recirculation Cooler Housing and Radiator LH7)**

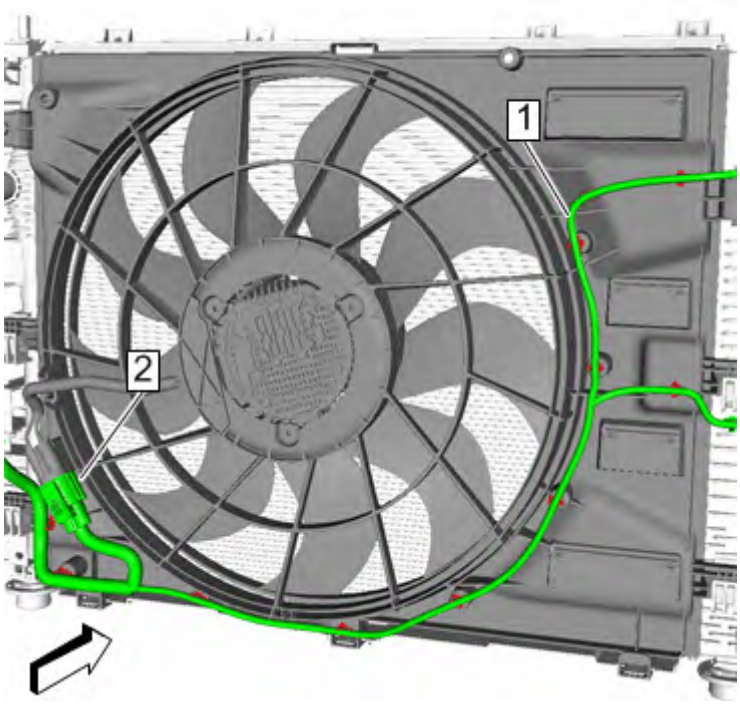


Fig. 169: Engine Coolant Fan Wiring Harness And Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Remove Engine Coolant Fan Wiring Harness (1) @ Engine Coolant Fan.
8. Disconnect Engine Coolant Fan Wiring Harness (2) @ Engine Coolant Fan.
9. Remove Transmission Fluid Cooler Pipe - **Transmission Fluid Cooler Pipe Replacement**

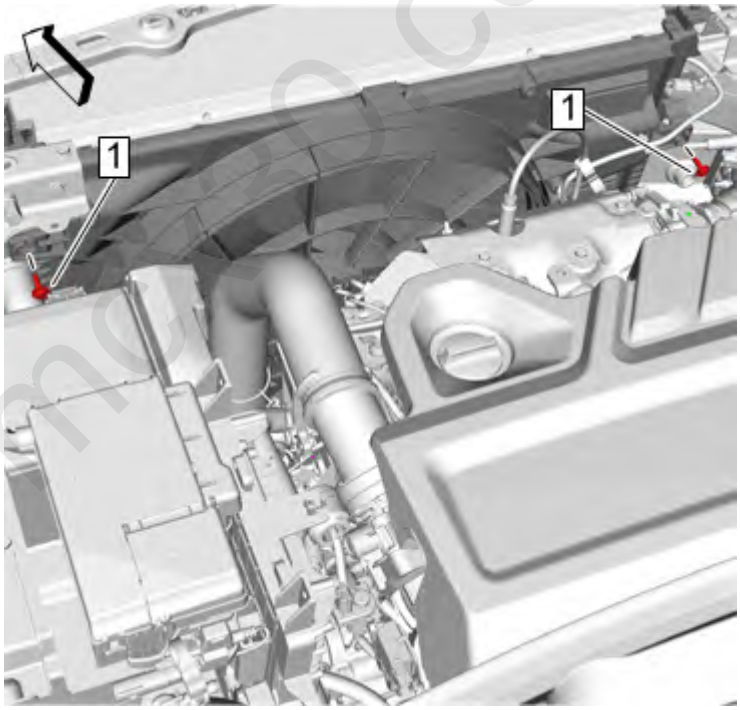


Fig. 170: Engine Coolant Fan And Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Remove Engine Coolant Fan Bolt (1) - [2x]

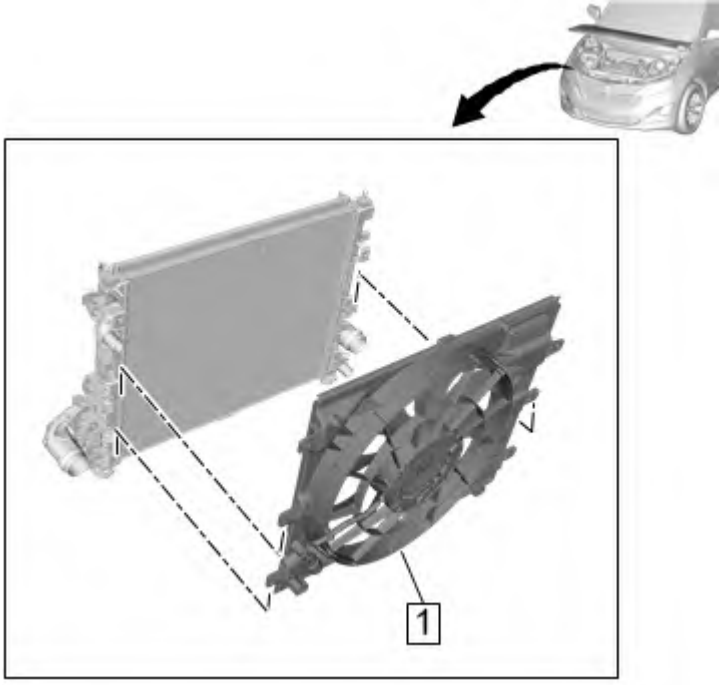


Fig. 171: Engine Coolant Fan
Courtesy of GENERAL MOTORS COMPANY

11. Remove Engine Coolant Fan (1).
12. Transfer components as necessary.

Installation Procedure

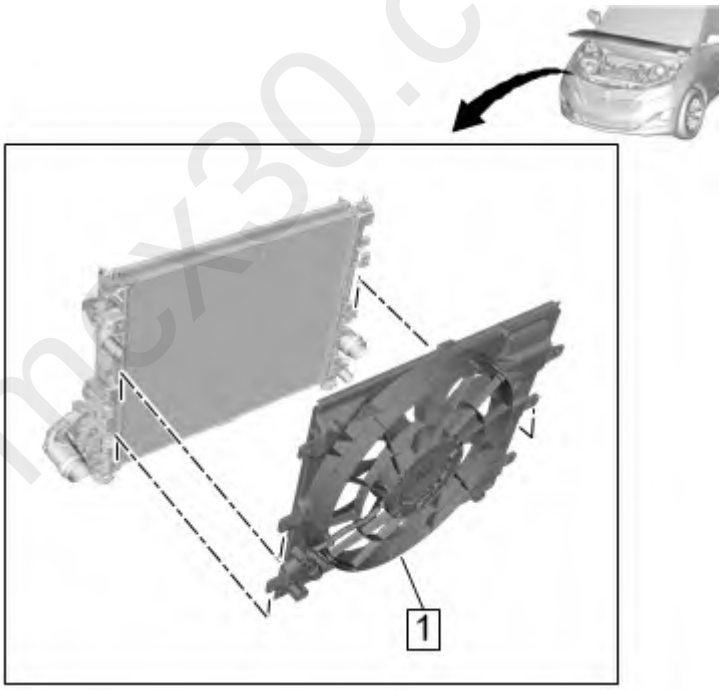


Fig. 172: Engine Coolant Fan
Courtesy of GENERAL MOTORS COMPANY

1. Install Engine Coolant Fan (1).

mcx30.com

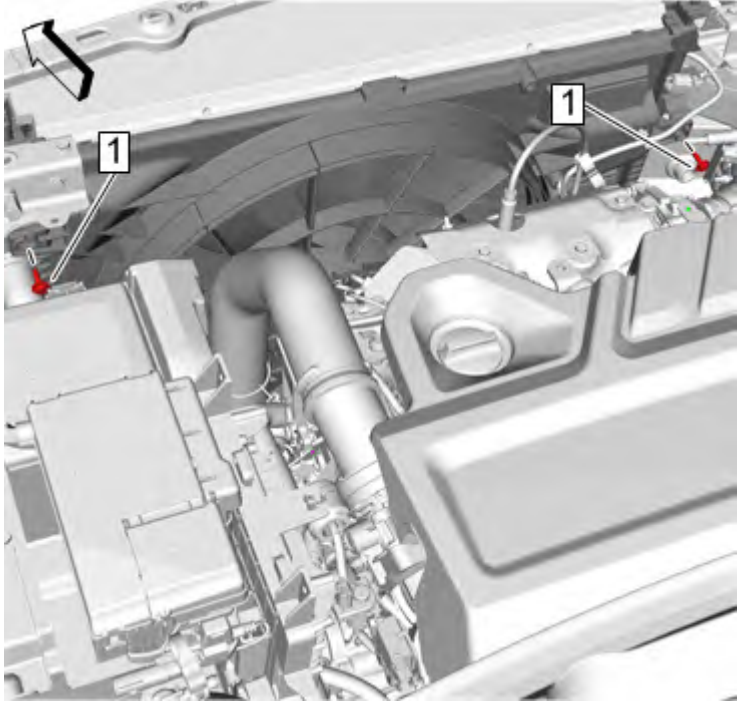


Fig. 173: Engine Coolant Fan And Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. Install Engine Coolant Fan Bolt (1) and tighten [2x] 5 N.m (44 lb in)
3. Install Transmission Fluid Cooler Pipe - **Transmission Fluid Cooler Pipe Replacement**

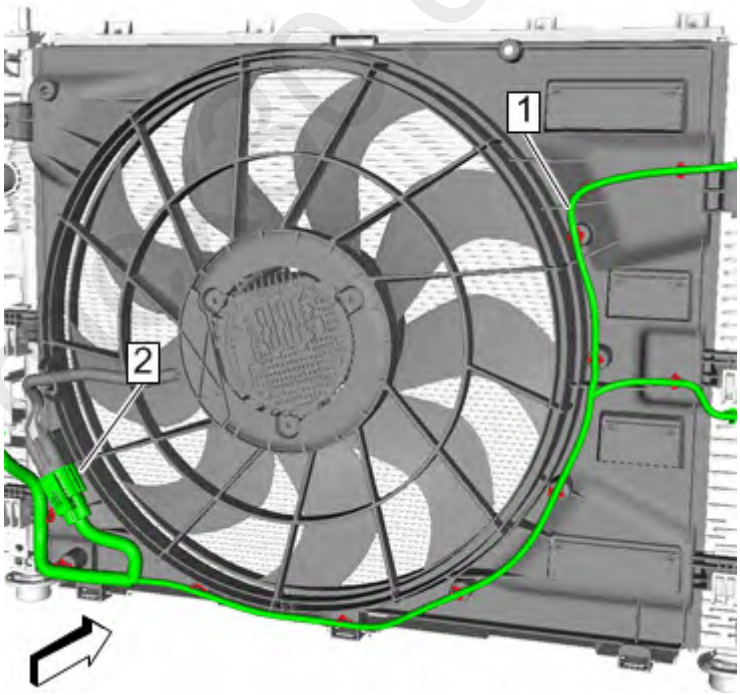


Fig. 174: Engine Coolant Fan Wiring Harness And Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Connect Engine Coolant Fan Wiring Harness (2) @ Engine Coolant Fan.
5. Install Engine Coolant Fan Wiring Harness (1) @ Engine Coolant Fan.

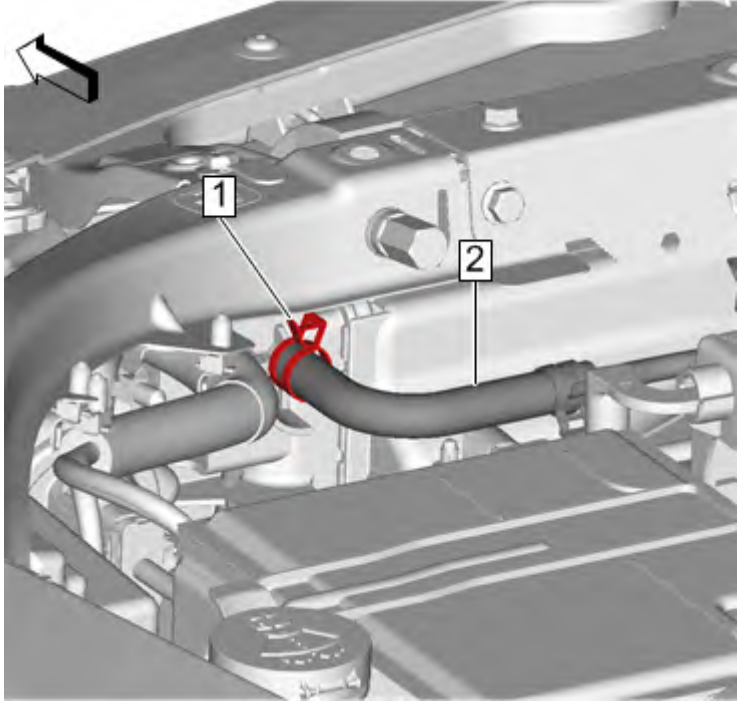


Fig. 175: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

6. Install Engine Coolant Air Bleed Hose (2) @ Radiator - **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Exhaust Gas Recirculation Cooler Housing and Radiator LH7)**

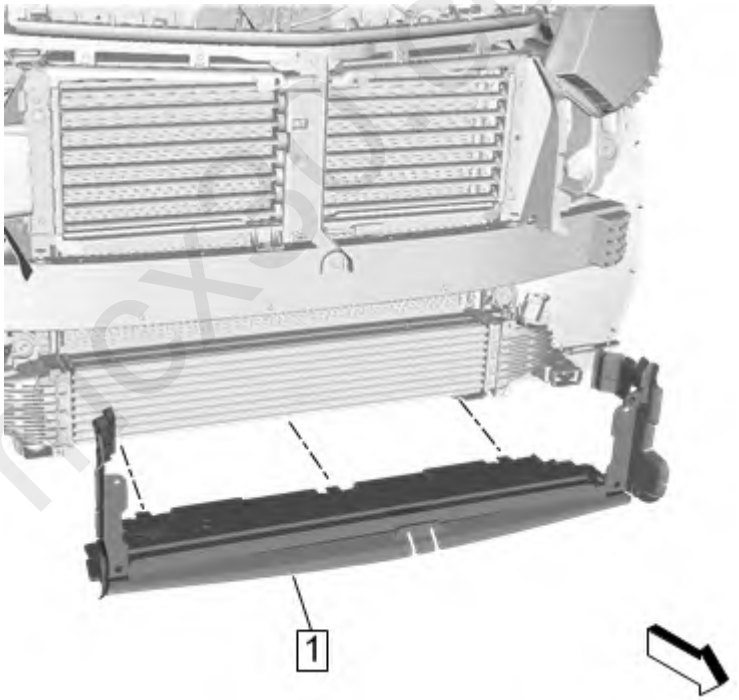


Fig. 176: Radiator Air Lower Baffle
Courtesy of GENERAL MOTORS COMPANY

7. Install Radiator Air Lower Baffle (1) - **Radiator Air Lower Baffle Replacement (LH7 LTG LYX)**
8. Install Front Bumper Fascia - **Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**
9. Install Front End Upper Tie Bar - **Front End Upper Tie Bar Replacement (Equinox)** **Front End Upper Tie Bar Replacement (Terrain)**

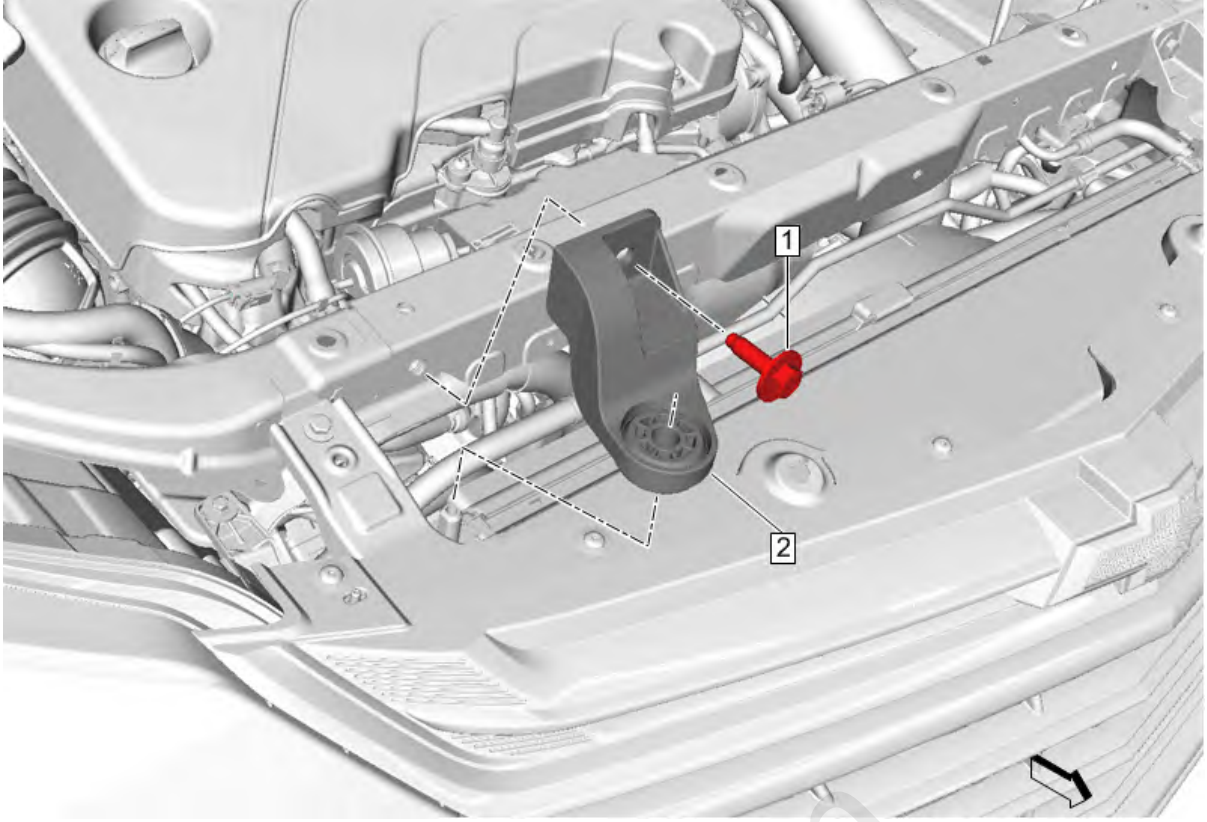


Fig. 177: Radiator Upper Bracket-Right Side
Courtesy of GENERAL MOTORS COMPANY

10. Install Radiator Upper Bracket-Right Side (2) - Radiator Upper Bracket Replacement - Right Side

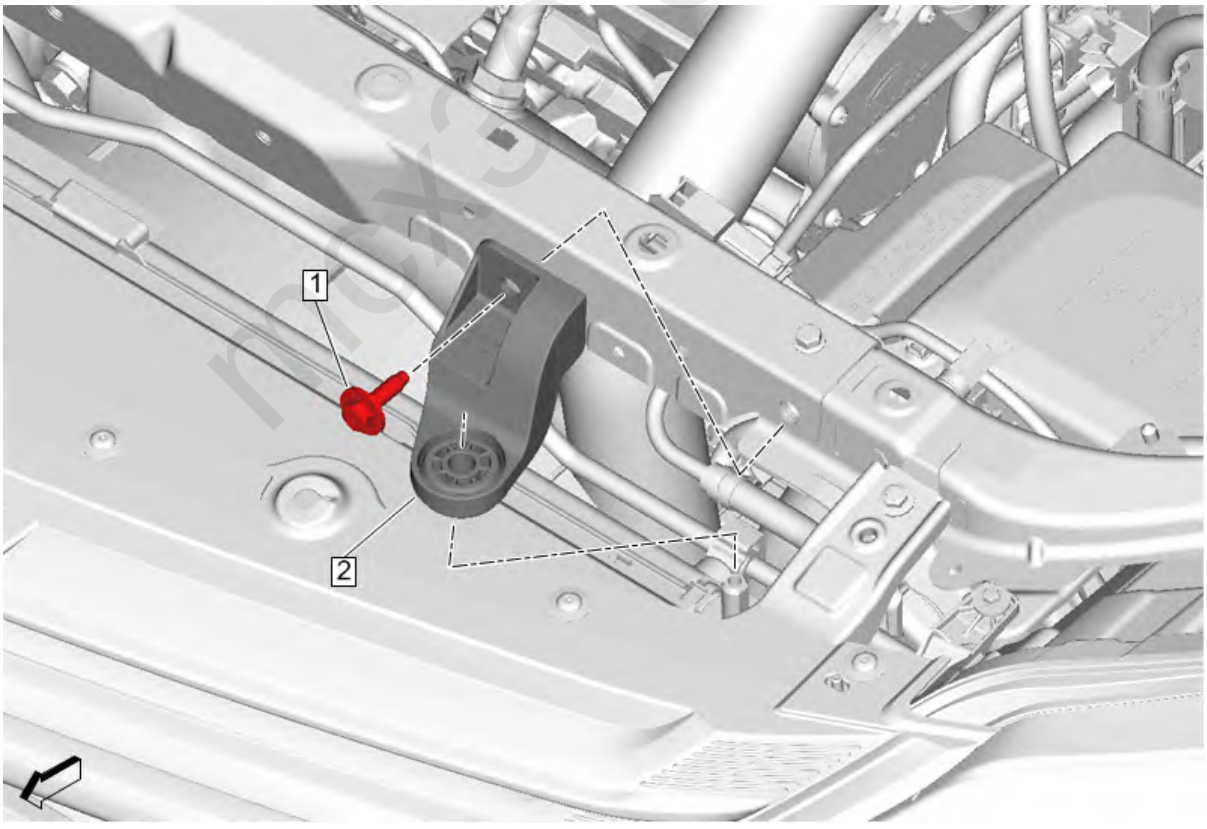


Fig. 178: Radiator Upper Bracket-Left Side
Courtesy of GENERAL MOTORS COMPANY

11. Install Radiator Upper Bracket-Left Side (2) Radiator Upper Bracket Replacement - Left Side

TURBOCHARGER COOLANT FEED PIPE REPLACEMENT (LH7)

Removal Procedure

1. Remove the turbocharger. Refer to Turbocharger Replacement .

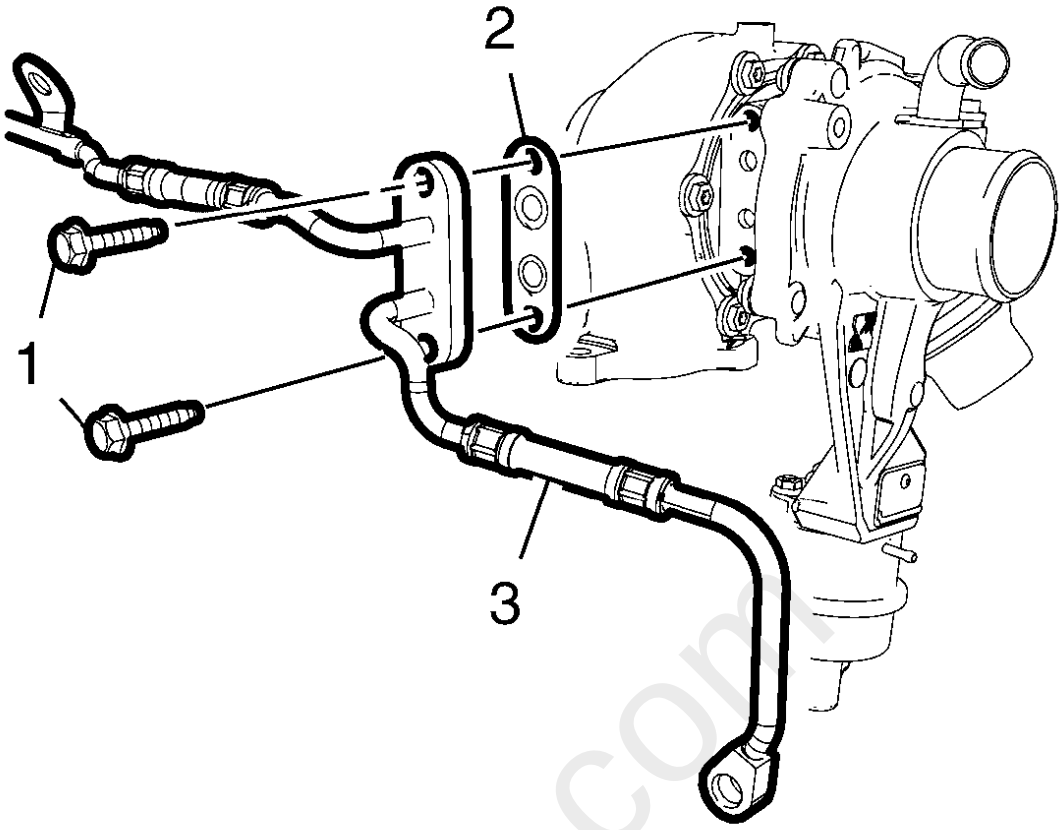


Fig. 179: 2 Turbocharger Coolant Feed And Return Pipe Assembly Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the 2 turbocharger coolant feed and return pipe assembly bolts (1).
3. Remove the turbocharger coolant feed and return pipe assembly (3) and the gasket (2).

Installation Procedure

mcx30.com

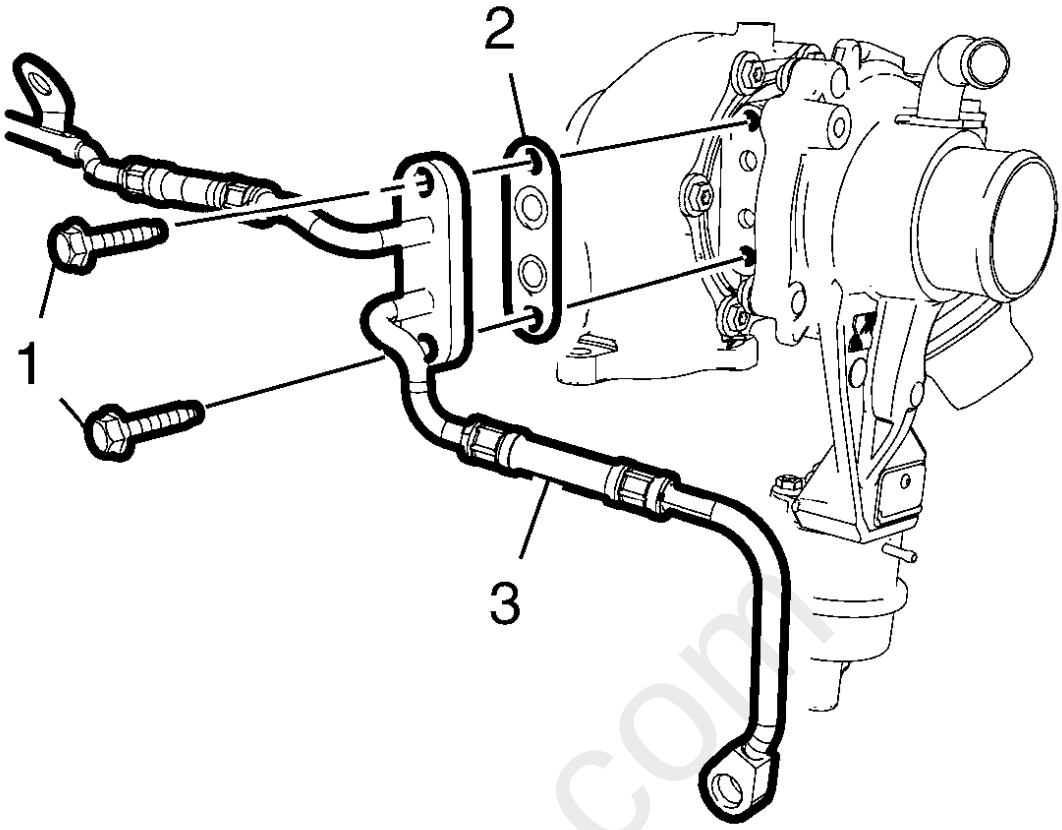


Fig. 180: 2 Turbocharger Coolant Feed And Return Pipe Assembly Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the turbocharger coolant feed and return pipe assembly (3) and a NEW gasket (2).

CAUTION: **Refer to Fastener Caution .**

2. Install the 2 turbocharger coolant feed and return pipe assembly bolts (1) and tighten to 10 N.m (89 lb in).
3. Install the turbocharger. Refer to **Turbocharger Replacement** .

TURBOCHARGER COOLANT FEED PIPE REPLACEMENT (LYX)

mox30.com

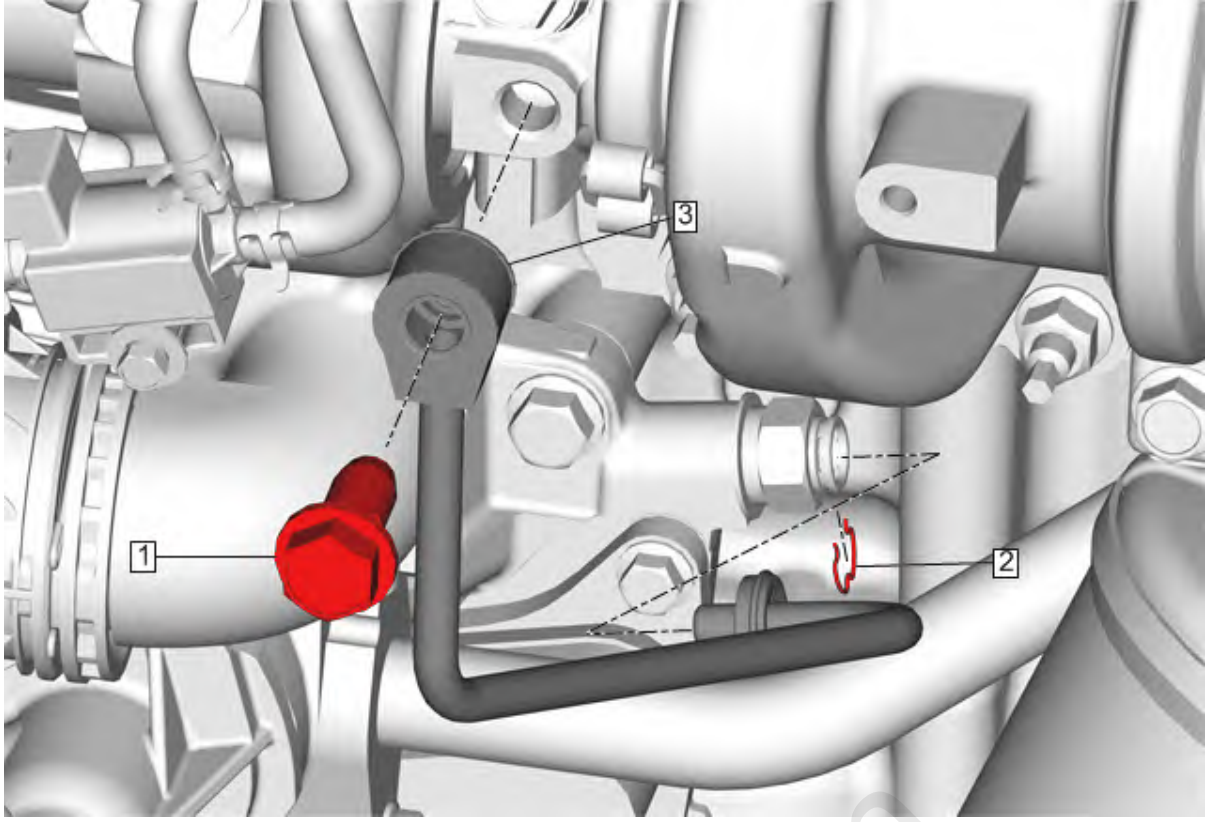


Fig. 181: Turbocharger Coolant Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static) 2. Turbocharger Heat Shield Replacement 3. Warm Up Three-Way Catalytic Converter Replacement (LYX)	
1	Turbocharger Coolant Feed Pipe Hollow Screw **CAUTION:** **Refer to Fastener Caution .** **Tighten** 35 N.m (26 lb ft)
2	Retainer **Procedure** Install a NEW retainer.
3	Turbocharger Coolant Feed Pipe

TURBOCHARGER COOLANT FEED PIPE REPLACEMENT (LTG)

Removal Procedure

1. Drain the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)
2. Remove Warm Up Three-Way Catalytic Converter - Warm Up Three-Way Catalytic Converter Replacement (LTG)

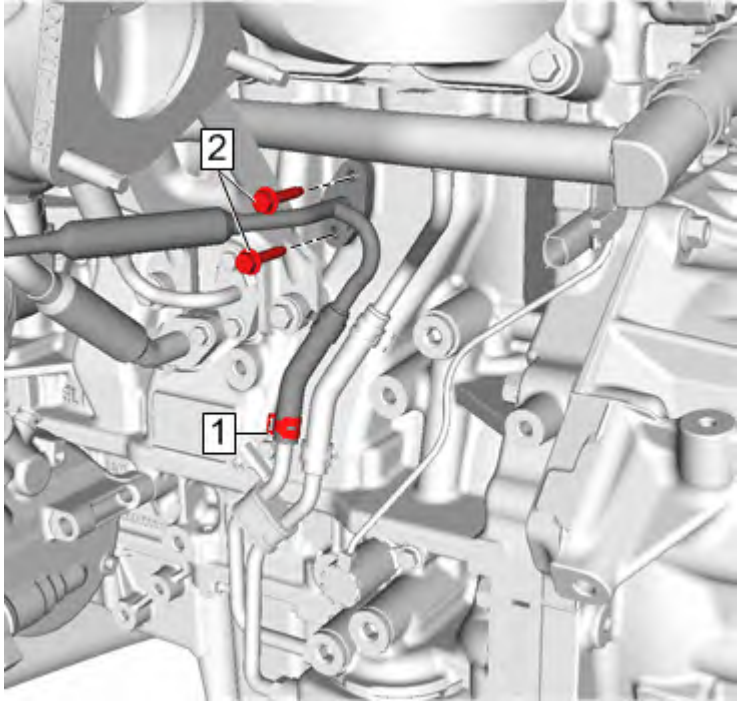


Fig. 182: Turbocharger Coolant Feed Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

3. Disengage Turbocharger Coolant Feed Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
4. Turbocharger Coolant Feed Pipe Bolt (2) - [2x]

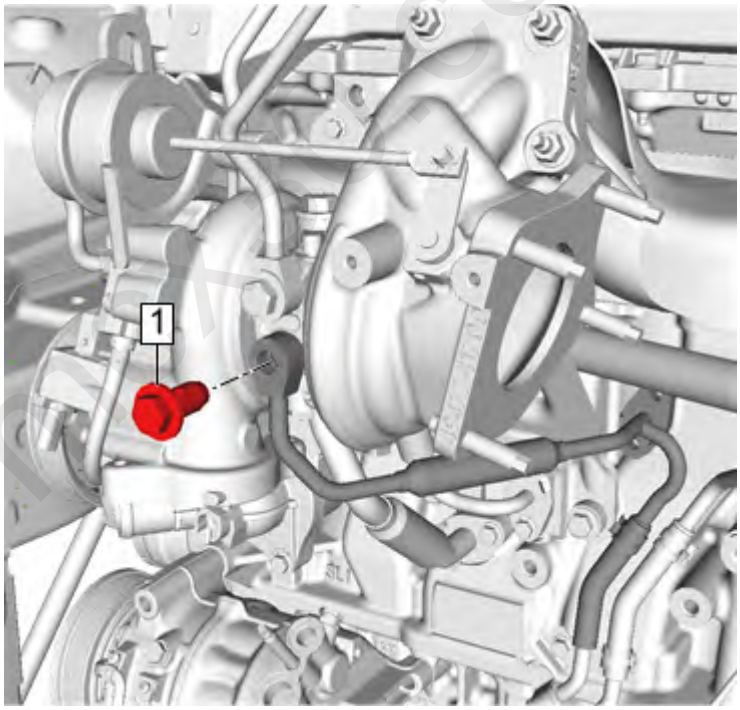


Fig. 183: Turbocharger Coolant Feed Pipe Hollow Screw
Courtesy of GENERAL MOTORS COMPANY

5. Remove Turbocharger Coolant Feed Pipe Hollow Screw (1).

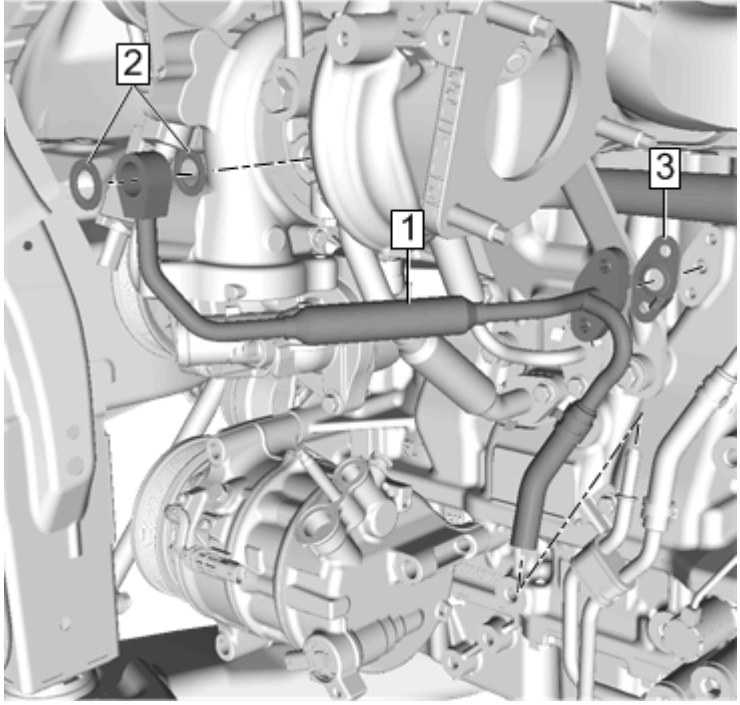


Fig. 184: Turbocharger Coolant Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

6. Remove Turbocharger Coolant Feed Pipe (1).
7. Remove Turbocharger Coolant Feed Pipe Washer (2) and DISCARD [2x]
8. Remove Turbocharger Coolant Feed Pipe Gasket (3) and DISCARD

Installation Procedure

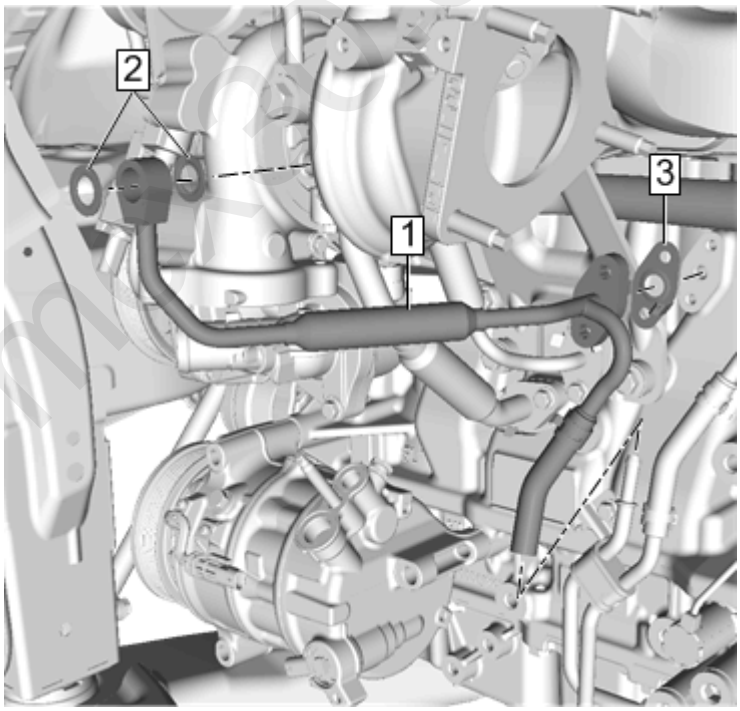


Fig. 185: Turbocharger Coolant Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

NOTE: Install a NEW gasket.

1. Install Turbocharger Coolant Feed Pipe Gasket (3).

NOTE: Install a NEW washer.

2. Install Turbocharger Coolant Feed Pipe Washer (2) - [2x]
3. Install Turbocharger Coolant Feed Pipe (1).

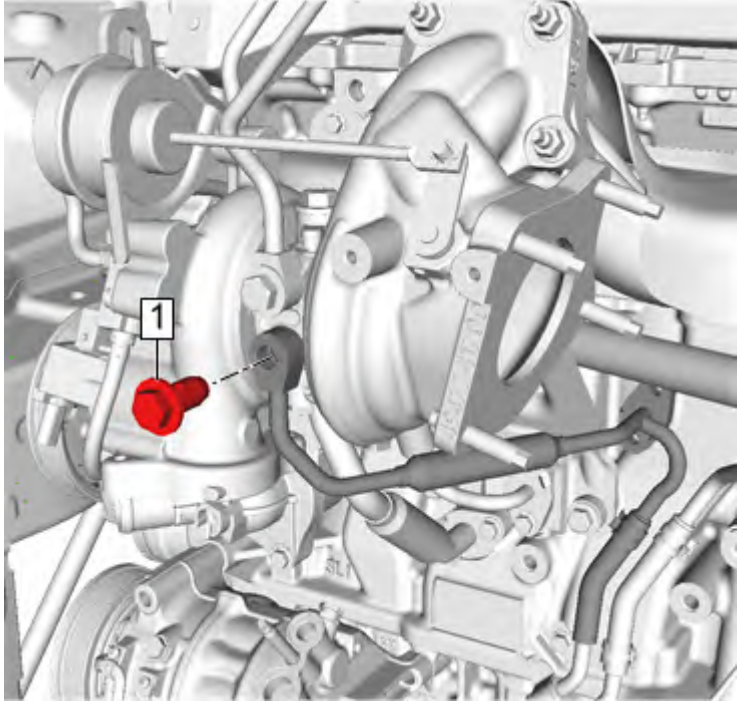


Fig. 186: Turbocharger Coolant Feed Pipe Hollow Screw
Courtesy of GENERAL MOTORS COMPANY

4. Turbocharger Coolant Feed Pipe Hollow Screw (1) - Hand tighten

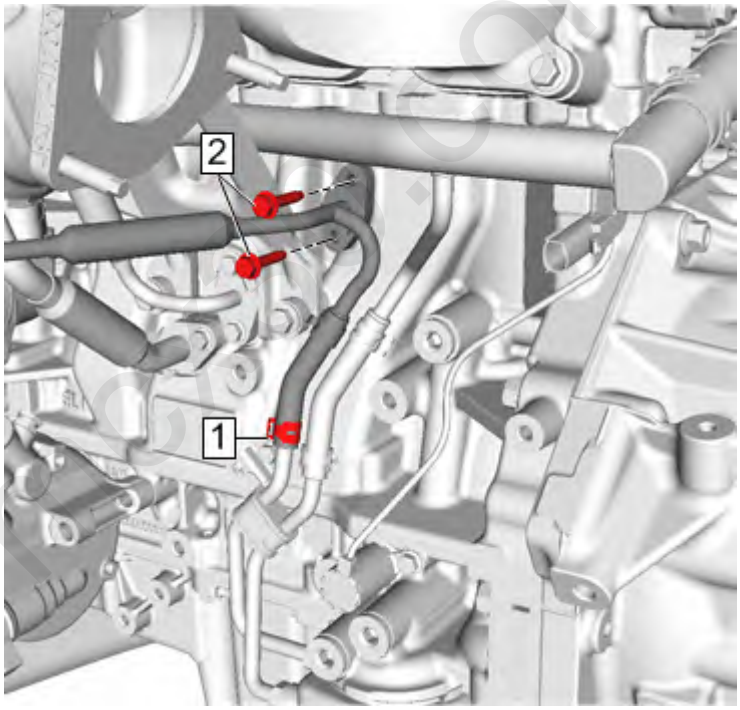


Fig. 187: Turbocharger Coolant Feed Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

5. Install Turbocharger Coolant Feed Pipe Bolt (2) and tighten [2x] 10 N.m (89 lb in)
6. Engage Turbocharger Coolant Feed Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**

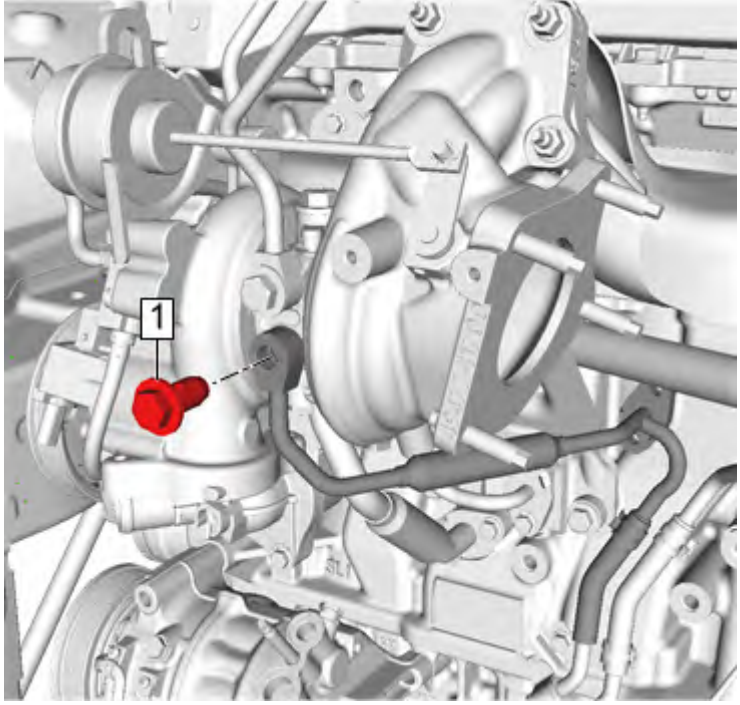


Fig. 188: Turbocharger Coolant Feed Pipe Hollow Screw
Courtesy of GENERAL MOTORS COMPANY

7. Turbocharger Coolant Feed Pipe Hollow Screw (1) - Tighten 35 N.m (26 lb ft)
8. Install Warm Up Three-Way Catalytic Converter - **Warm Up Three-Way Catalytic Converter Replacement (LTG)**
9. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
10. Start the engine and check for leaks.

TURBOCHARGER COOLANT RETURN PIPE REPLACEMENT (LYX)

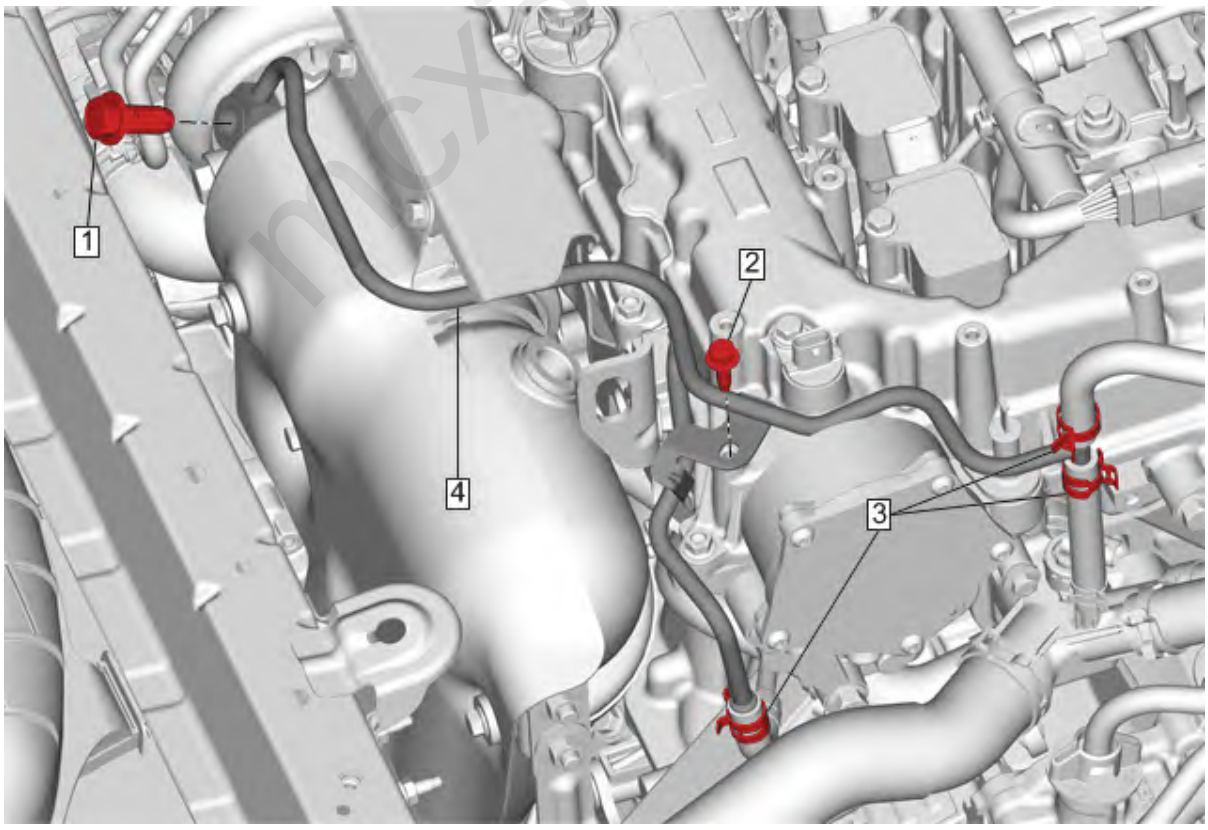


Fig. 189: Turbocharger Coolant Return Pipe
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

Callout	Component Name
Preliminary Procedures 1. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static) 2. Intake Manifold Cover Replacement 3. Disconnect the heated oxygen sensor electrical connector. 4. Reposition Charge Air Cooler Outlet Air Tube Replacement	
1	Turbocharger Coolant Return Pipe Hollow Screw **CAUTION:** **Refer to Fastener Caution .** **Tighten** 35 N.m (26 lb ft)
2	Turbocharger Coolant Return Pipe Fastener **Tighten** 10 N.m (89 lb in)
3	Clamp [3x] **Procedure** Install a NEW clamp. Hose Clamp Replacement Guidelines - Spring Type
4	Turbocharger Coolant Return Pipe

TURBOCHARGER COOLANT RETURN PIPE REPLACEMENT (LTG)

Removal Procedure

1. Drain the cooling system. Refer to Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)
2. Remove Intake Manifold Cover - Intake Manifold Cover Replacement
3. Remove Turbocharger Heat Shield - Turbocharger Heat Shield Replacement

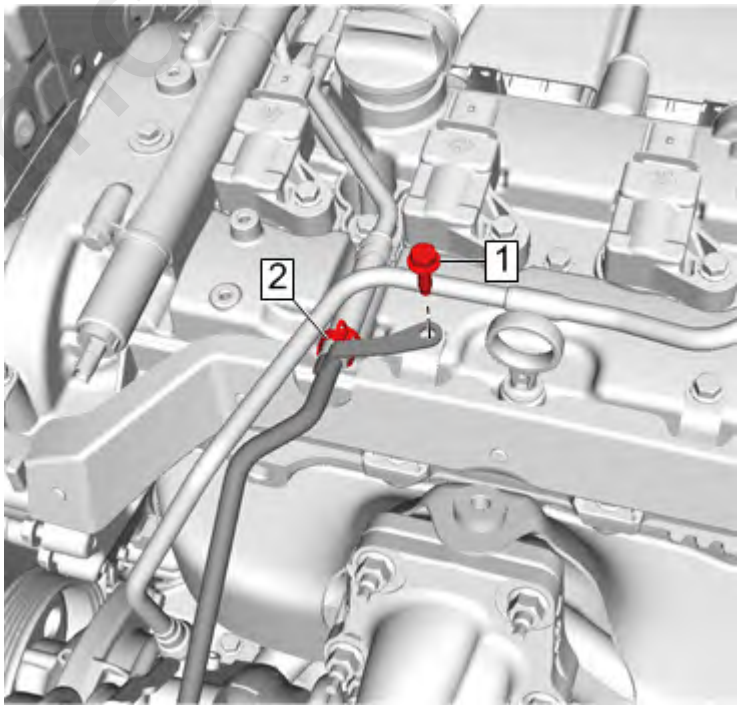


Fig. 190: Turbocharger Coolant Return Pipe Clamp
Courtesy of GENERAL MOTORS COMPANY

4. Disengage Turbocharger Coolant Return Pipe Clamp (2) - Hose Clamp Replacement Guidelines - Spring Type

5. Remove Turbocharger Coolant Return Pipe Bolt (1).

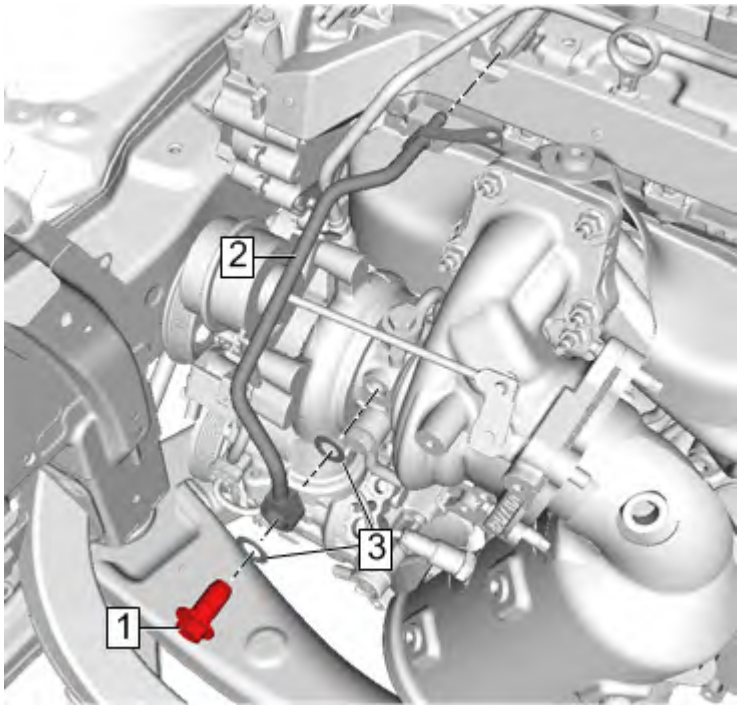


Fig. 191: Turbocharger Coolant Return Pipe Hollow Screw
Courtesy of GENERAL MOTORS COMPANY

6. Remove Turbocharger Coolant Return Pipe Hollow Screw (1).
7. Remove Turbocharger Coolant Return Pipe (2).
8. Remove Turbocharger Coolant Return Pipe Washer (3) and DISCARD [2x]

Installation Procedure

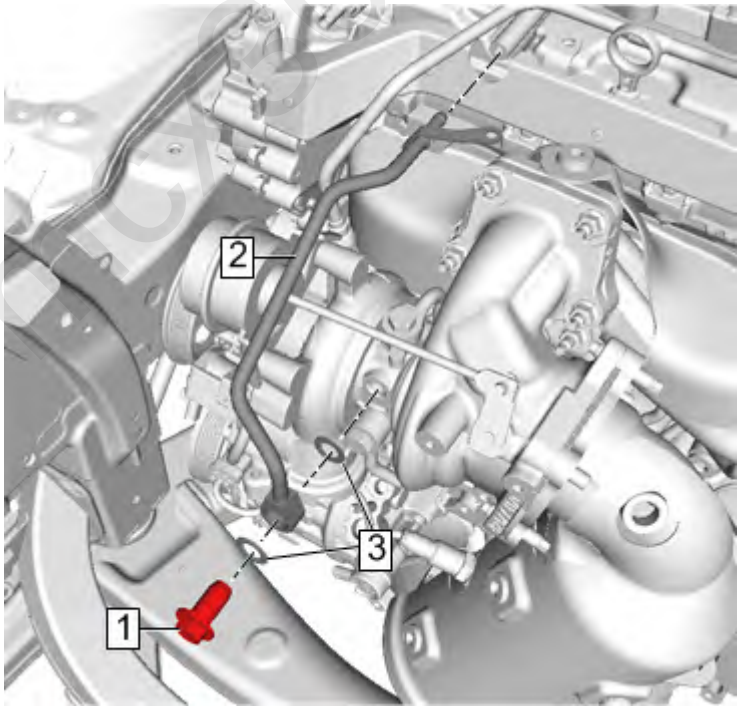


Fig. 192: Turbocharger Coolant Return Pipe Hollow Screw
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install a NEW washer.**

1. Install Turbocharger Coolant Return Pipe Washer (3) - [2x]
2. Install Turbocharger Coolant Return Pipe (2).
3. Turbocharger Coolant Return Pipe Hollow Screw (1) - Hand tighten

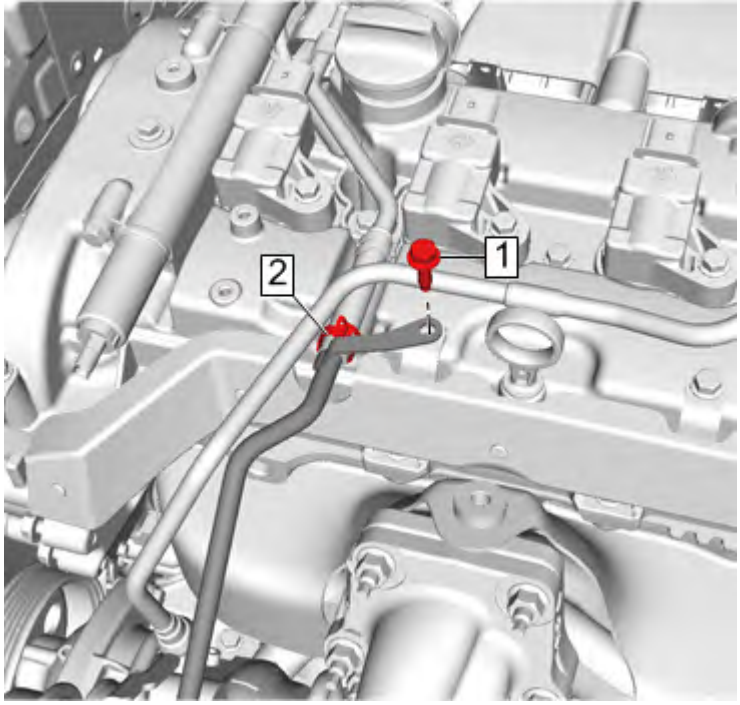


Fig. 193: Turbocharger Coolant Return Pipe Clamp
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

4. Install Turbocharger Coolant Return Pipe Bolt (1) and tighten 10 N.m (89 lb in)
5. Engage Turbocharger Coolant Return Pipe Clamp (2) - **Hose Clamp Replacement Guidelines - Spring Type**

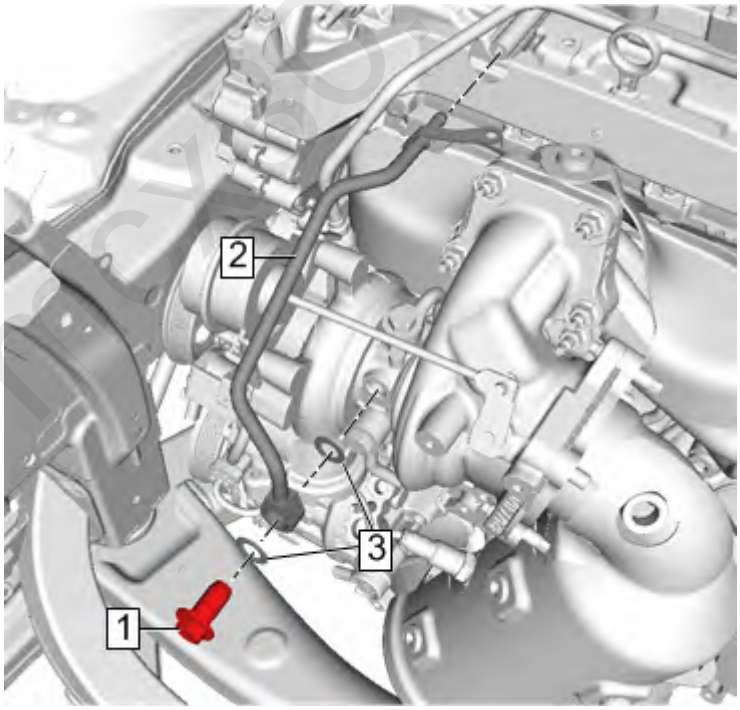


Fig. 194: Turbocharger Coolant Return Pipe Hollow Screw
Courtesy of GENERAL MOTORS COMPANY

6. Turbocharger Coolant Return Pipe Hollow Screw (1) - Tighten 35 N.m (26 lb ft)
7. Remove Turbocharger Heat Shield - **Turbocharger Heat Shield Replacement**
8. Remove Intake Manifold Cover - **Intake Manifold Cover Replacement**
9. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
10. Start the engine and check for leaks.

THERMOSTAT BYPASS HOSE REPLACEMENT (LYX)

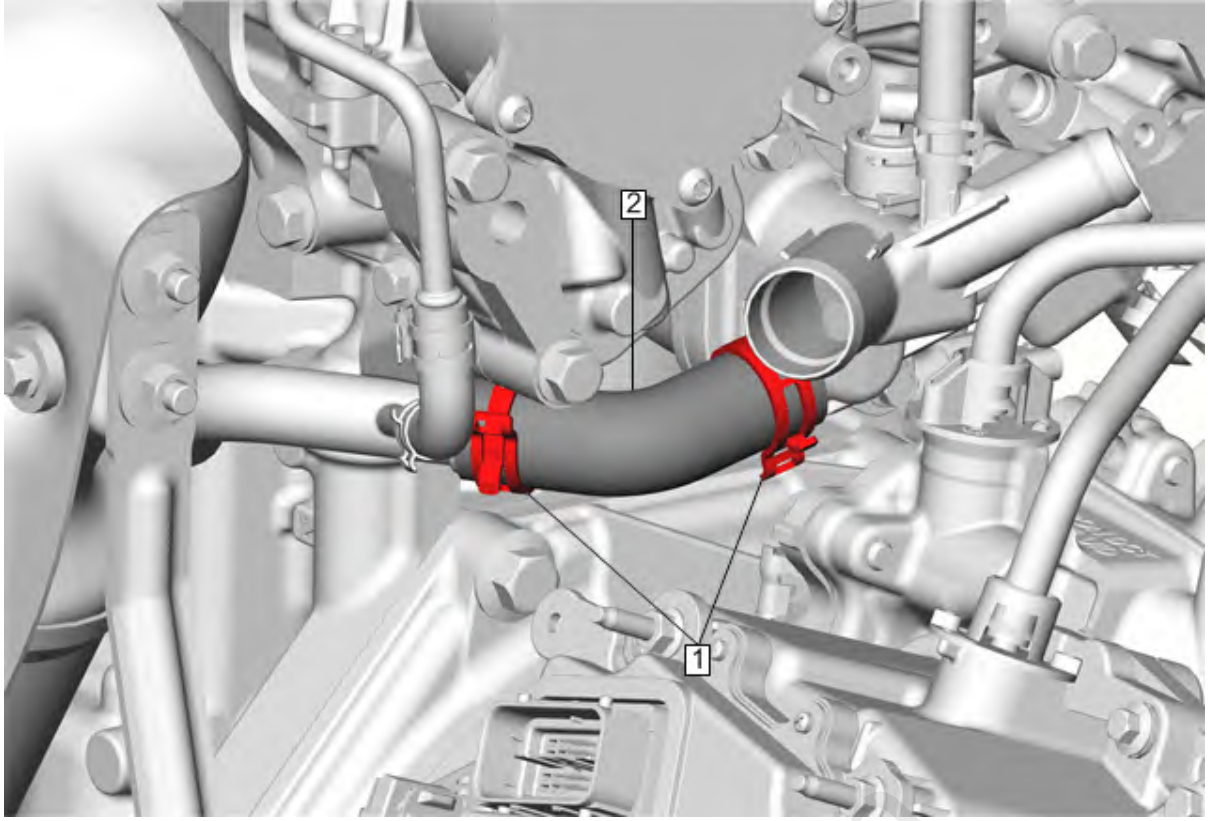


Fig. 195: Thermostat Bypass Hose
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Radiator Inlet Hose Replacement (LYX)	
1	Clamp [2x]
2	Thermostat Bypass Hose

ENGINE COOLANT THERMOSTAT HOUSING REPLACEMENT (LYX)

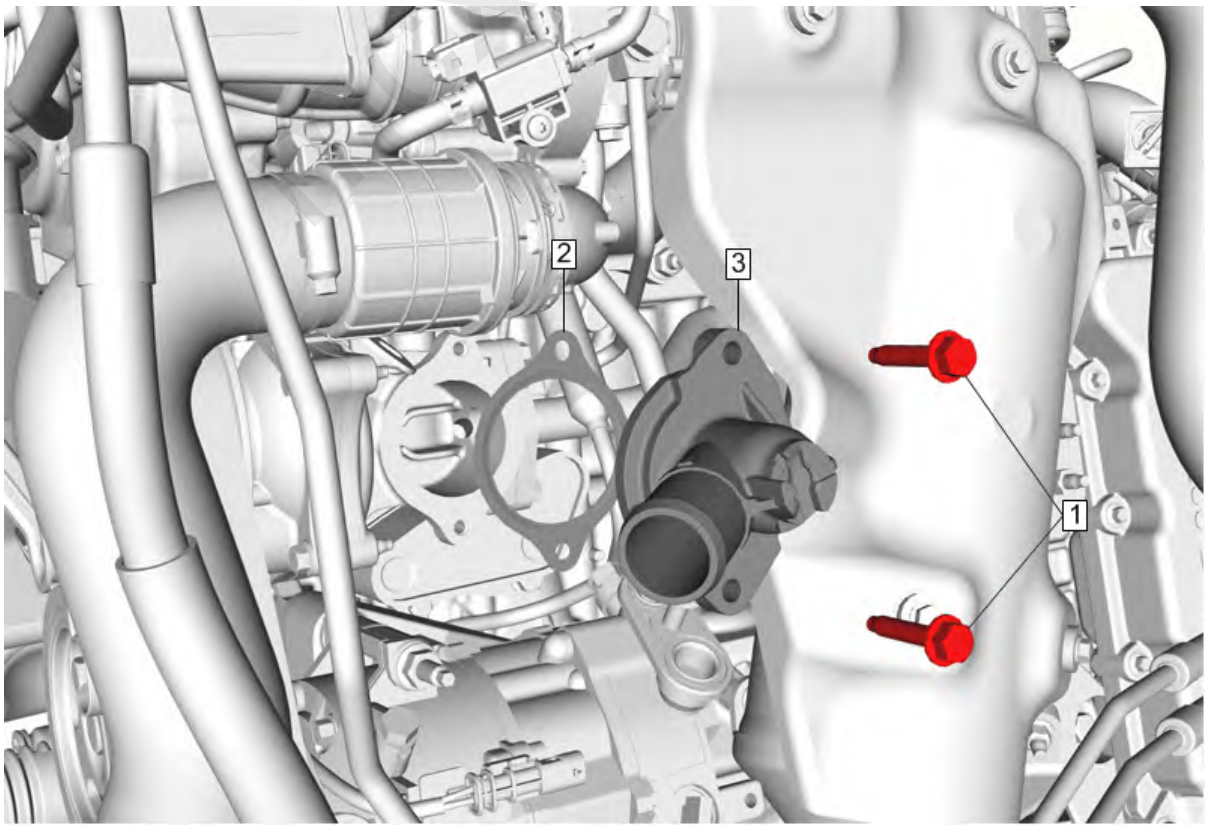


Fig. 196: Engine Coolant Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Radiator Outlet Hose Replacement (LYX)@Engine Coolant Thermostat Housing - Disconnect	
1	Engine Coolant Thermostat Housing Bolt [2x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Gasket **Procedure** Install a NEW gasket.
3	Engine Coolant Thermostat Housing

ENGINE COOLANT THERMOSTAT HOUSING REPLACEMENT (LTG)

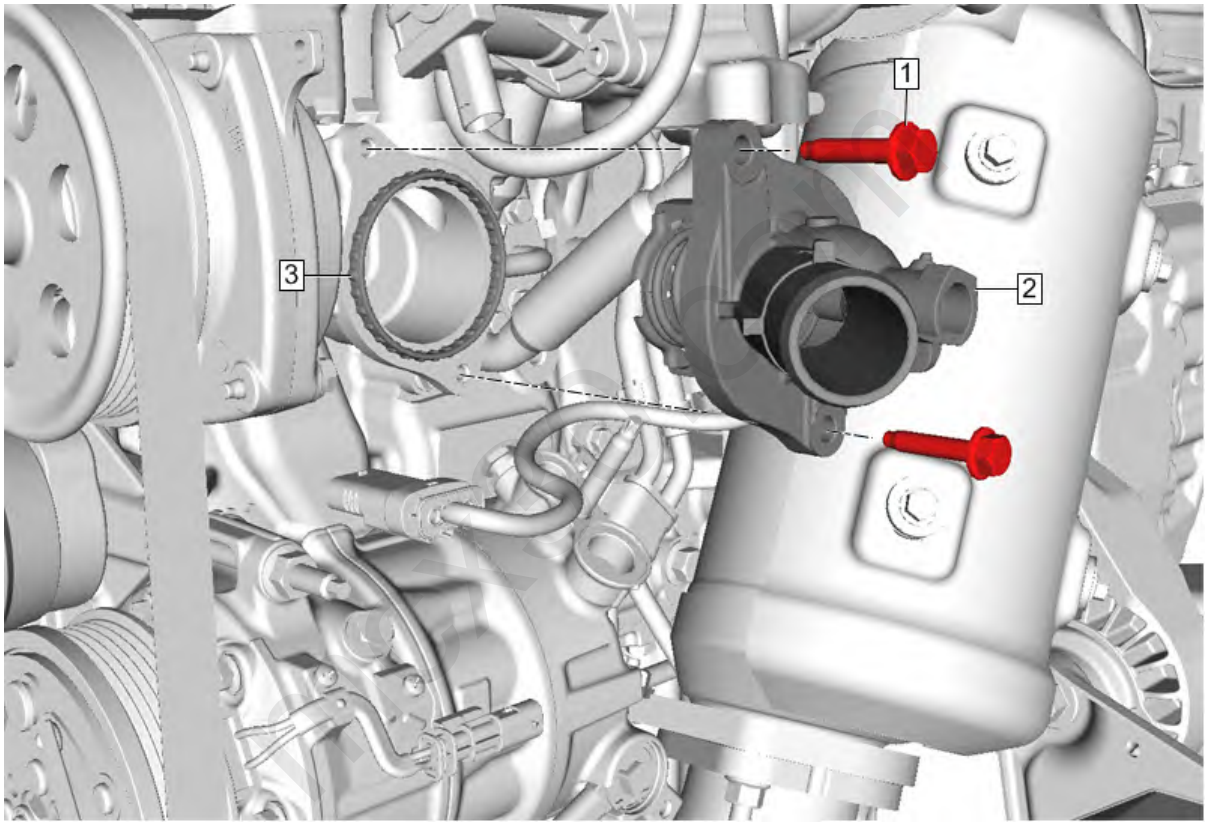


Fig. 197: Engine Coolant Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Air Cleaner Outlet Duct Replacement (Non-Tamperproof) Air Cleaner Outlet Duct Replacement (Tamperproof) 2. Radiator Outlet Hose Replacement (LYX)	
1	Engine Coolant Thermostat Housing Bolt [2x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)

Callout	Component Name
2	Engine Coolant Thermostat Housing
3	Engine Coolant Thermostat Housing Seal **Procedure** Install a NEW engine coolant thermostat housing seal.

ENGINE COOLANT THERMOSTAT REPLACEMENT (LH7)

Removal Procedure

1. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
2. Remove **Water Pump Replacement (LYX)**

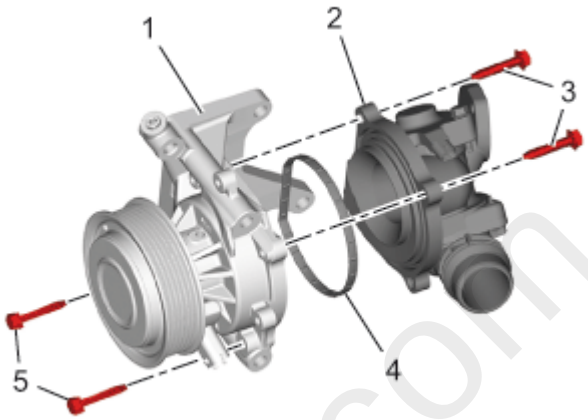


Fig. 198: Engine Coolant Thermostat Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove Engine Coolant Thermostat Bolt (3, 5) - [4x]
4. Remove Engine Coolant Thermostat (2) @ Water Pump (1).
5. Remove Engine Coolant Thermostat Gasket (4) and DISCARD

Installation Procedure

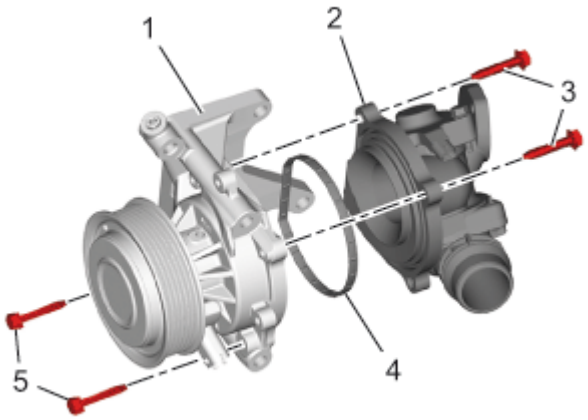


Fig. 199: Engine Coolant Thermostat Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW gasket. (4)
2. Install Engine Coolant Thermostat (2) @ Water Pump (1).

CAUTION: **Refer to Fastener Caution .**

3. Install Engine Coolant Thermostat Bolt (3, 5) and tighten [4x] 10 N.m (89 lb in)
4. Install -Water Pump Replacement (LH7)
5. Fill the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)

ENGINE COOLANT AIR BLEED PIPE REPLACEMENT (LTG)

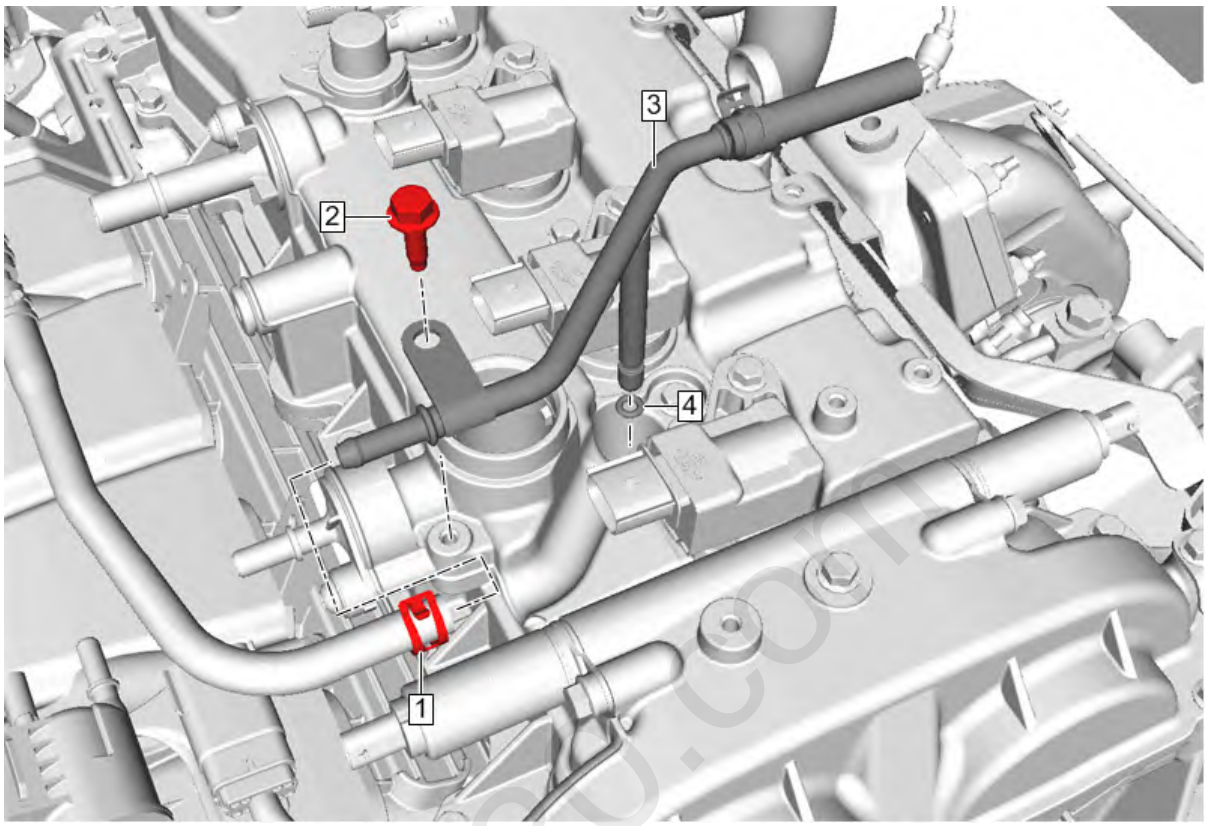


Fig. 200: Engine Coolant Air Bleed Pipe (LTG)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Turbocharger Coolant Return Pipe Replacement (LTG) 2. Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Inlet) 3. Disconnect the electrical wiring harness connector from the ignition coil.	
1	Radiator Surge Tank Inlet Hose Clamp Hose Clamp Replacement Guidelines - Spring Type
2	Engine Coolant Air Bleed Pipe Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
3	Engine Coolant Air Bleed Pipe
4	Engine Coolant Air Bleed Pipe O-Ring **Procedure** Install a NEW O-ring seal.

ENGINE COOLANT AIR BLEED HOSE REPLACEMENT (TURBOCHARGER COOLANT RETURN PIPE TO WATER OUTLET, LYX)

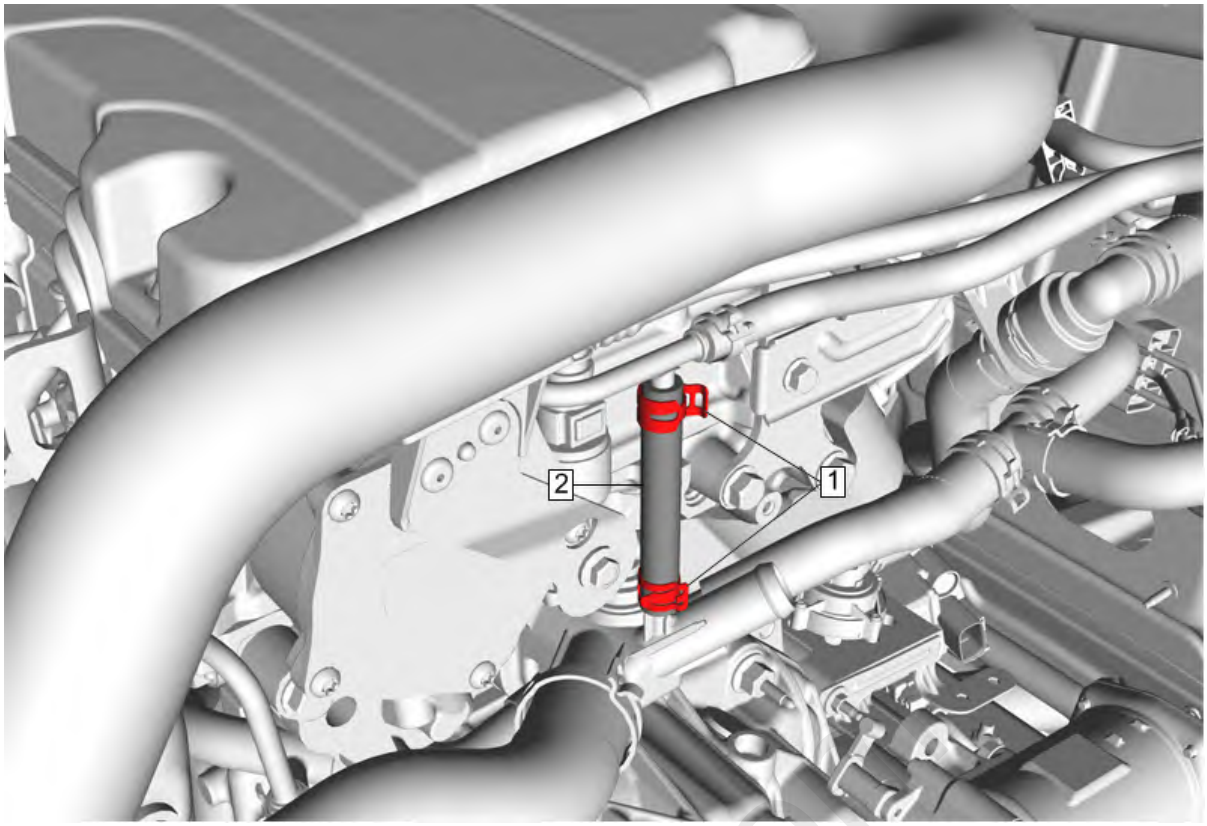


Fig. 201: Engine Coolant Air Bleed Hose (Turbocharger Coolant Return Pipe to Water Outlet
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)	
1	Clamp [2x]
2	Engine Coolant Air Bleed Hose

ENGINE COOLANT AIR BLEED HOSE REPLACEMENT (RADIATOR SURGE TANK TO TURBOCHARGER COOLANT RETURN PIPE TO RADIATOR, LYX)

Removal Procedure

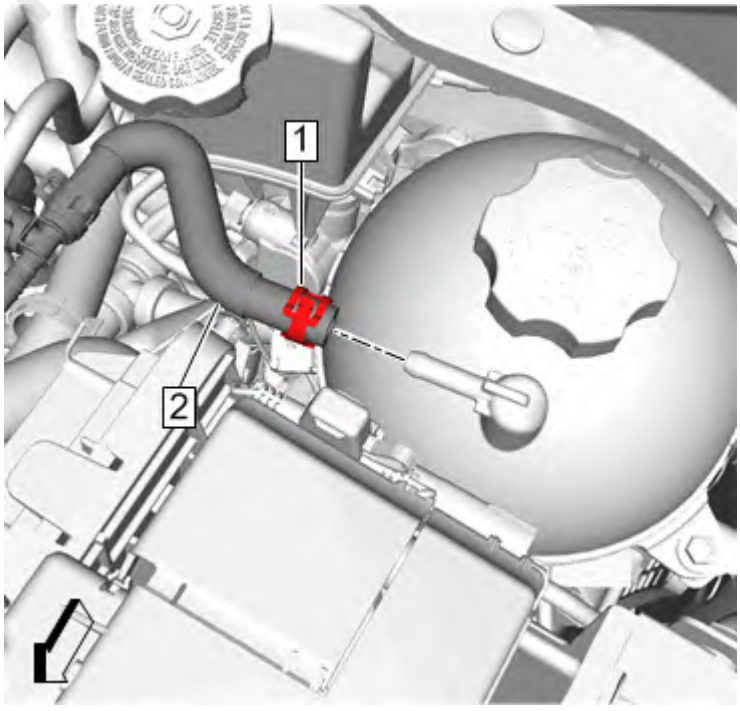


Fig. 202: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

1. Disengage Engine Coolant Air Bleed Hose Clamp (1) - Hose Clamp Replacement Guidelines - Spring Type
2. Remove Engine Coolant Air Bleed Hose (2) @ Radiator Surge Tank.

Fig. 203: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

3. Remove Engine Coolant Air Bleed Hose (1) @ Engine Control Module Bracket.

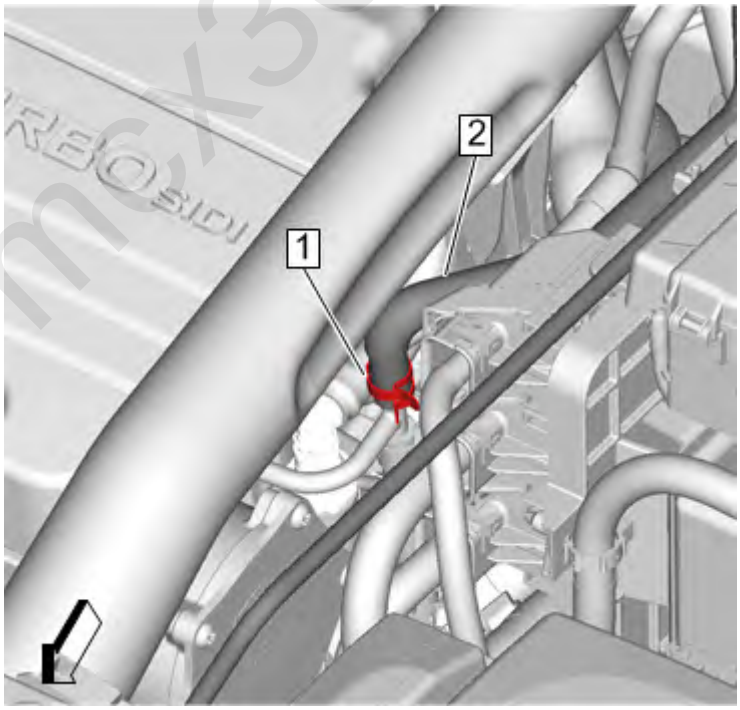


Fig. 204: Engine Coolant Air Bleed Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

4. Disengage Engine Coolant Air Bleed Hose Clamp (1) - Hose Clamp Replacement Guidelines - Spring Type
5. Remove Engine Coolant Air Bleed Hose (2) @ Turbocharger Coolant Return Pipe.

mcx30.com

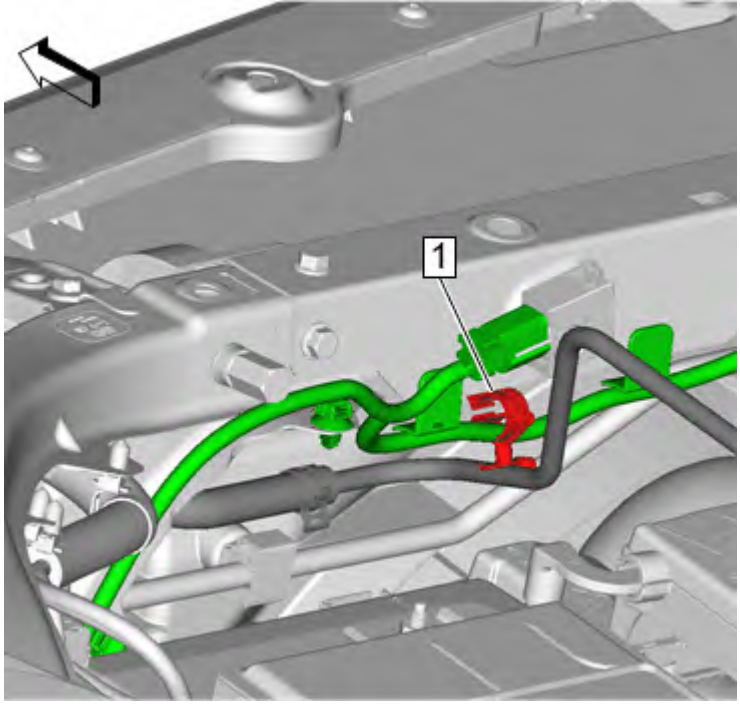


Fig. 205: Engine Coolant Air Bleed Pipe Clip
Courtesy of GENERAL MOTORS COMPANY

6. Remove Engine Coolant Air Bleed Pipe Clip (1) @ Wiring Harness Wire.

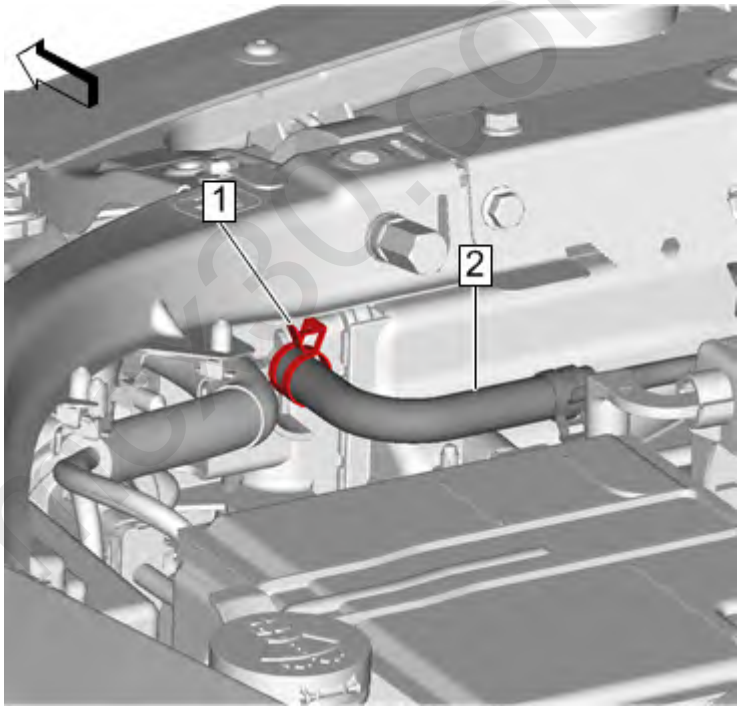


Fig. 206: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

7. Disengage Engine Coolant Air Bleed Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
8. Remove Engine Coolant Air Bleed Hose (2) @ Radiator.
9. Remove Engine Coolant Air Bleed Hose (2).

Installation Procedure

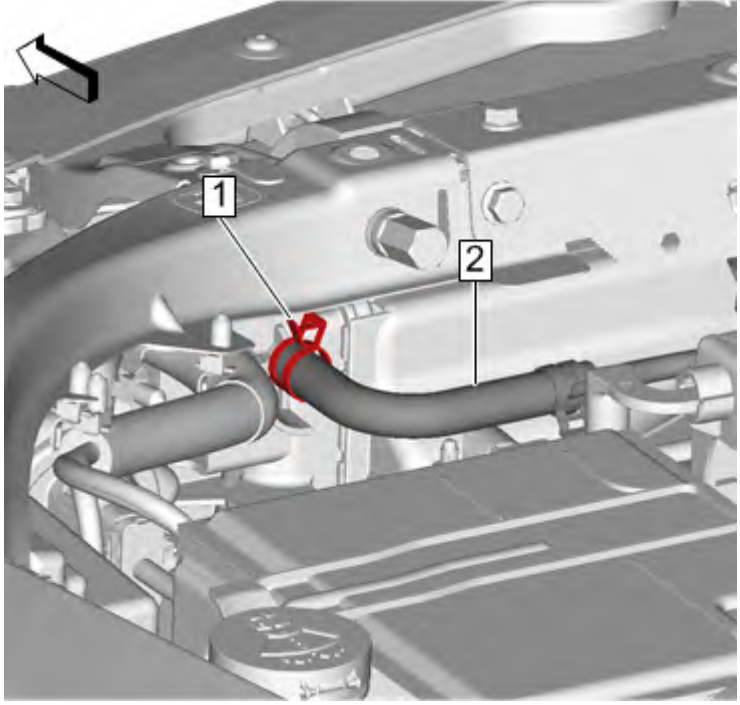


Fig. 207: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

1. Install Engine Coolant Air Bleed Hose (2) @ Radiator.
2. Engage Engine Coolant Air Bleed Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**

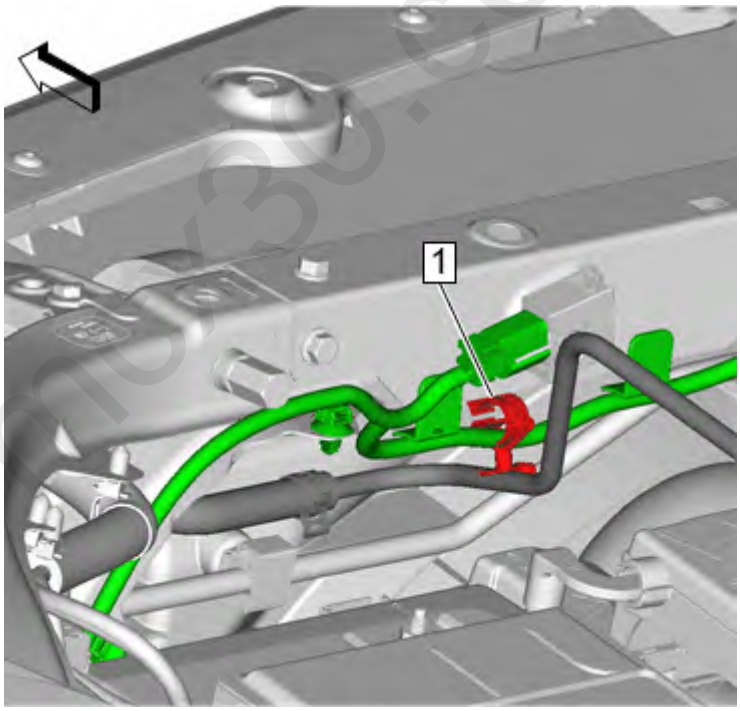


Fig. 208: Engine Coolant Air Bleed Pipe Clip
Courtesy of GENERAL MOTORS COMPANY

3. Install Engine Coolant Air Bleed Pipe Clip (1) @ Wiring Harness Wire.

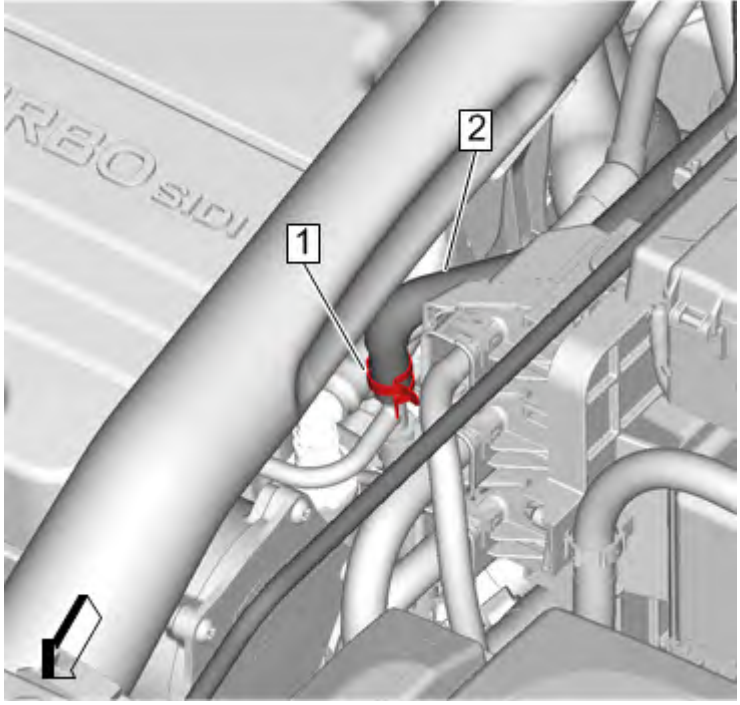


Fig. 209: Engine Coolant Air Bleed Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

4. Install Engine Coolant Air Bleed Hose (2) @ Turbocharger Coolant Return Pipe.
5. Engage Engine Coolant Air Bleed Hose Clamp (1) -**Hose Clamp Replacement Guidelines - Spring Type**

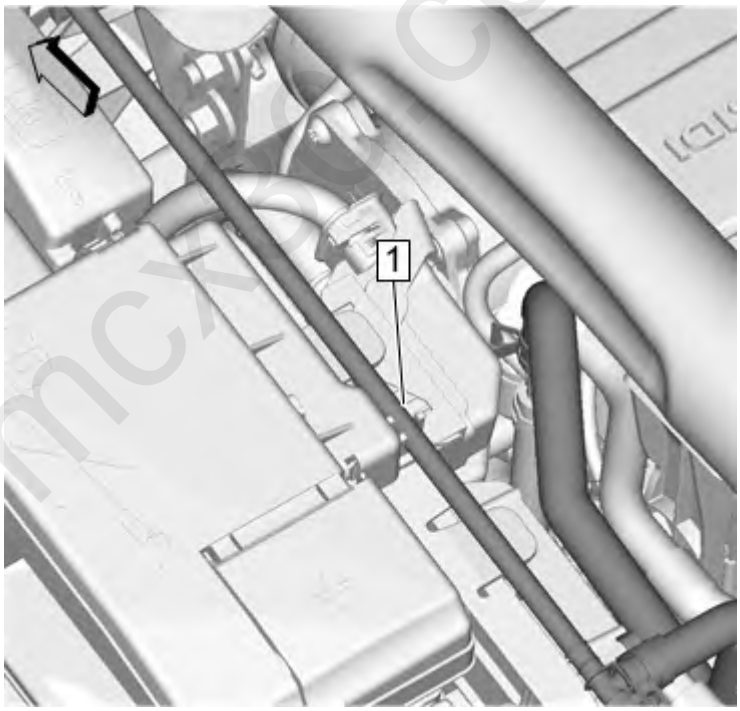


Fig. 210: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

6. Install Engine Coolant Air Bleed Hose (1) @ Engine Control Module Bracket.

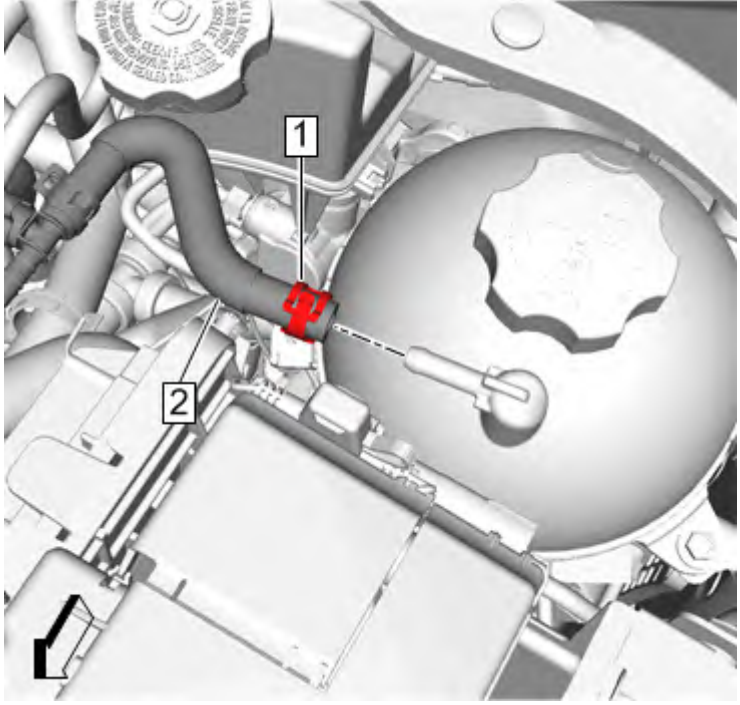


Fig. 211: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

7. Install Engine Coolant Air Bleed Hose (2) @ Radiator Surge Tank.
8. Engage Engine Coolant Air Bleed Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
9. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
10. Check the cooling system for leaks.

ENGINE COOLANT AIR BLEED HOSE REPLACEMENT (RADIATOR SURGE TANK TO RADIATOR TO ENGINE COOLANT AIR BLEED PIPE LTG)

Removal Procedure

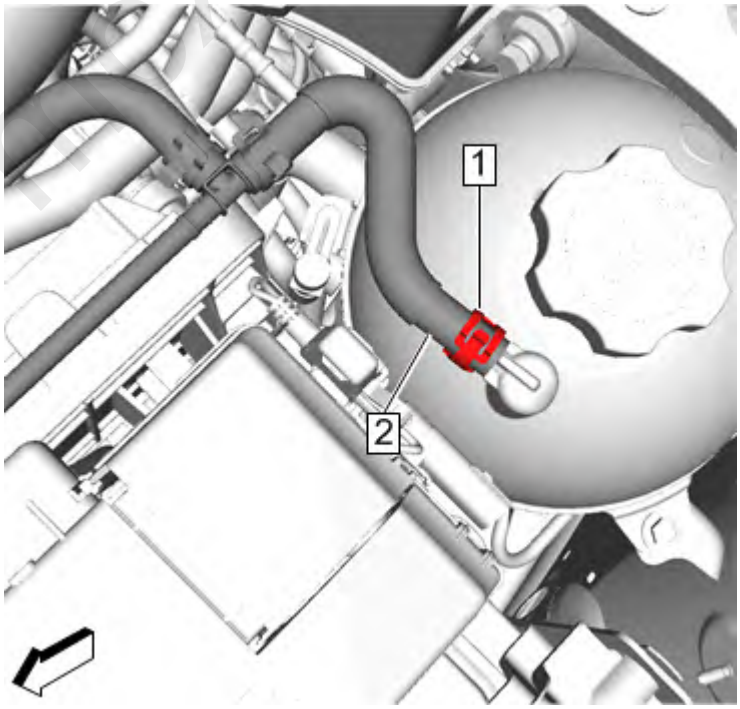


Fig. 212: Engine Coolant Air Bleed Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

1. Disengage Engine Coolant Air Bleed Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
2. Remove Engine Coolant Air Bleed Hose (2) @ Radiator Surge Tank.

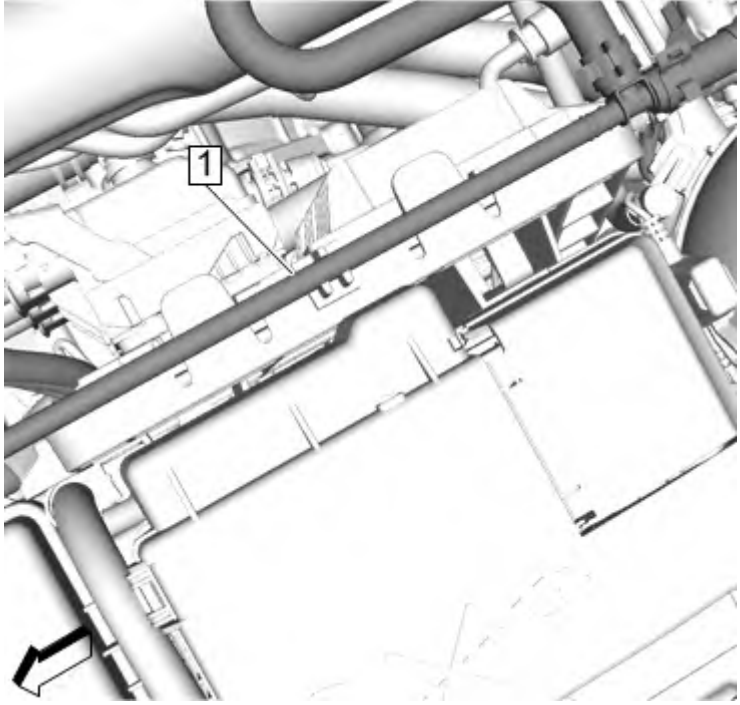


Fig. 213: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

3. Remove Engine Coolant Air Bleed Hose (1) @ Engine Control Module Bracket.

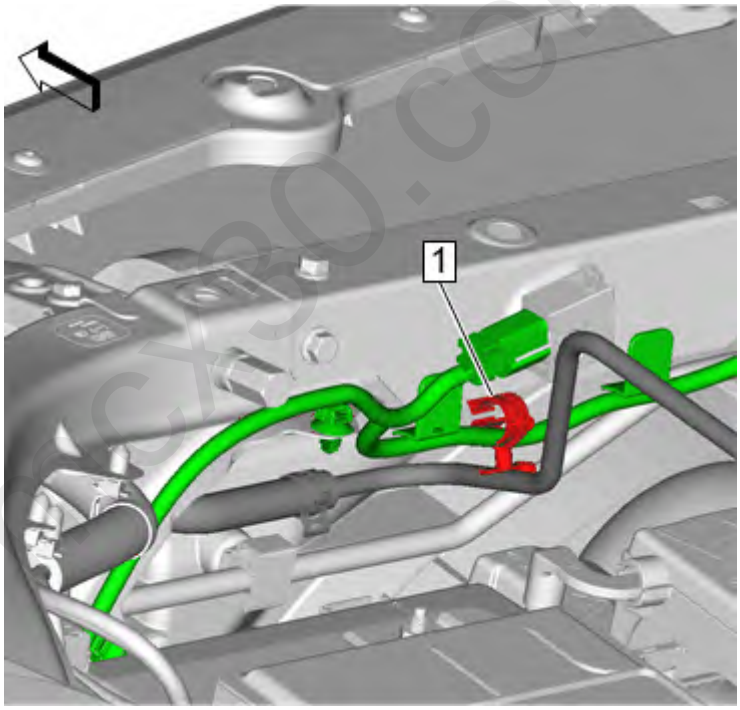


Fig. 214: Engine Coolant Air Bleed Pipe Clip
Courtesy of GENERAL MOTORS COMPANY

4. Remove Engine Coolant Air Bleed Pipe Clip (1) @ Wiring Harness Wire.

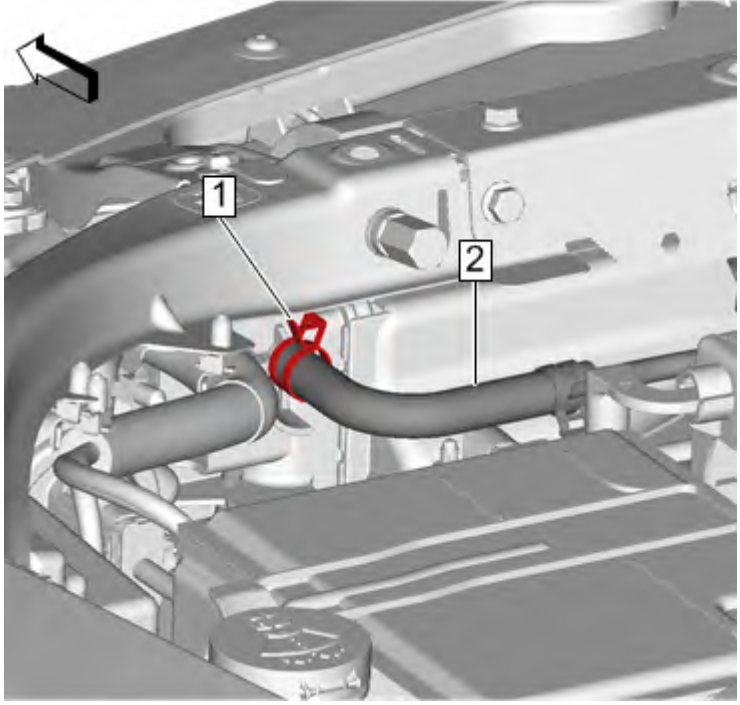


Fig. 215: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

5. Disengage Engine Coolant Air Bleed Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
6. Remove Engine Coolant Air Bleed Hose (2) @ Radiator.
7. Remove Intake Manifold Cover -**Intake Manifold Cover Replacement**

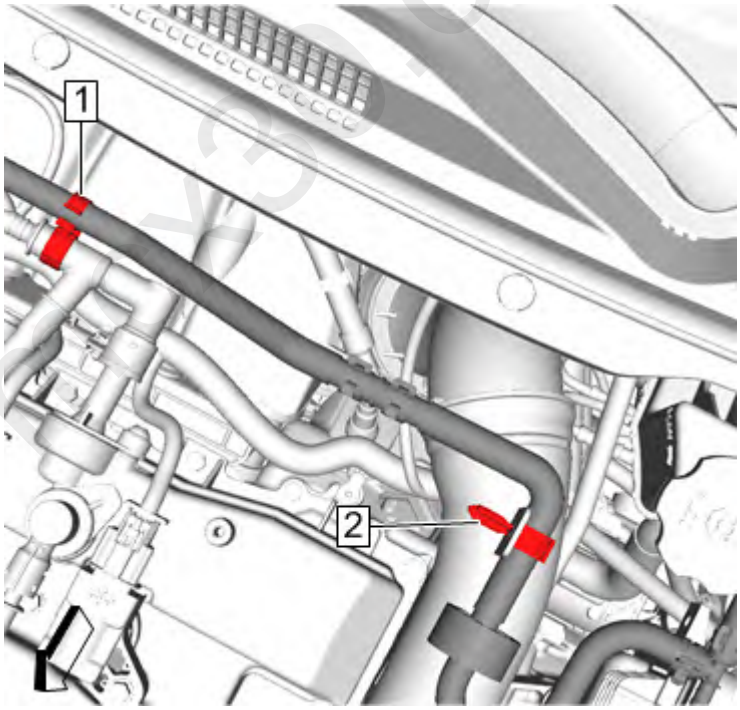


Fig. 216: Engine Coolant Air Bleed Pipe Clip
Courtesy of GENERAL MOTORS COMPANY

8. Remove Engine Coolant Air Bleed Pipe Clip (2) @ Charge Air Cooler Outlet Air Tube.
9. Remove Engine Coolant Air Bleed Pipe Clip (1) @ Positive Crankcase Ventilation Tube.

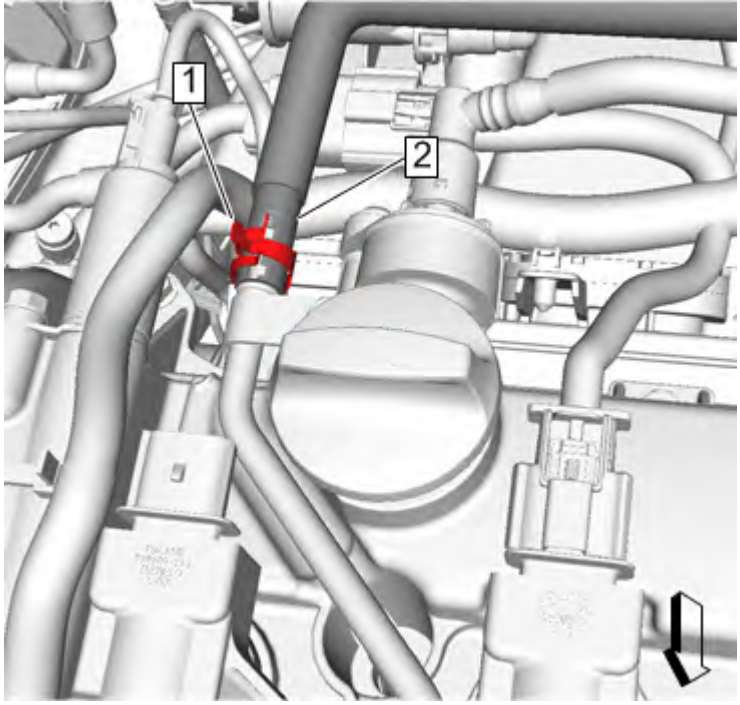


Fig. 217: Engine Coolant Air Bleed Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

10. Disengage Engine Coolant Air Bleed Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
11. Remove Engine Coolant Air Bleed Hose@Engine Coolant Air Bleed Pipe.
12. Remove Engine Coolant Air Bleed Hose (2).

Installation Procedure

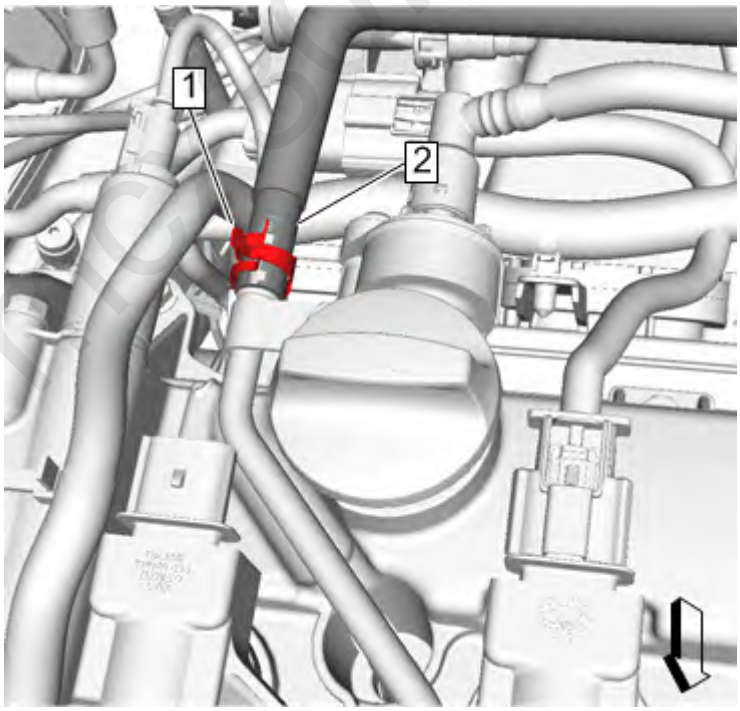


Fig. 218: Engine Coolant Air Bleed Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

1. Install Engine Coolant Air Bleed Hose@Engine Coolant Air Bleed Pipe.
2. Engage Engine Coolant Air Bleed Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**

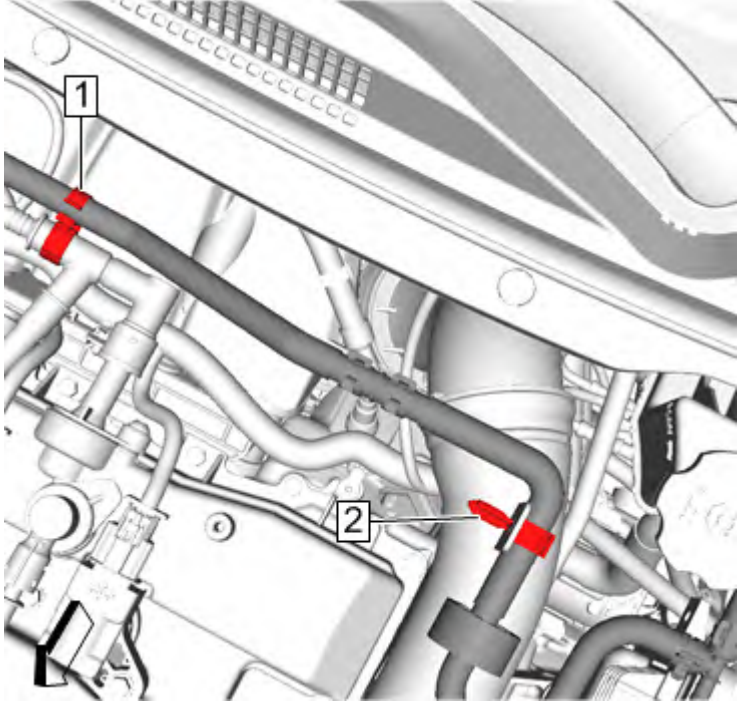


Fig. 219: Engine Coolant Air Bleed Pipe Clip
Courtesy of GENERAL MOTORS COMPANY

3. Install Engine Coolant Air Bleed Pipe Clip (1) @ Positive Crankcase Ventilation Tube.
4. Install Engine Coolant Air Bleed Pipe Clip (2) @ Charge Air Cooler Outlet Air Tube.
5. Install Intake Manifold Cover - **Intake Manifold Cover Replacement**

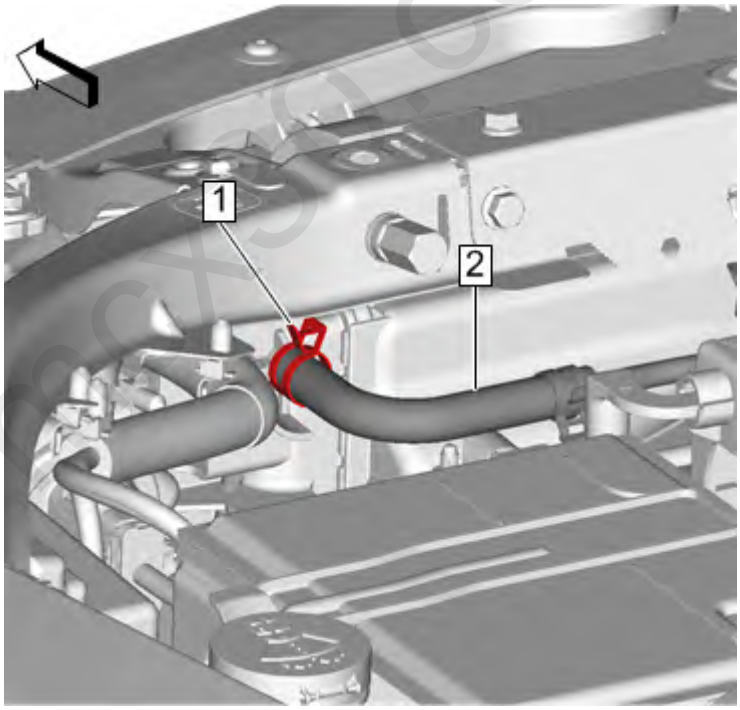


Fig. 220: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

6. Install Engine Coolant Air Bleed Hose (2) @ Radiator.
7. Engage Engine Coolant Air Bleed Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**

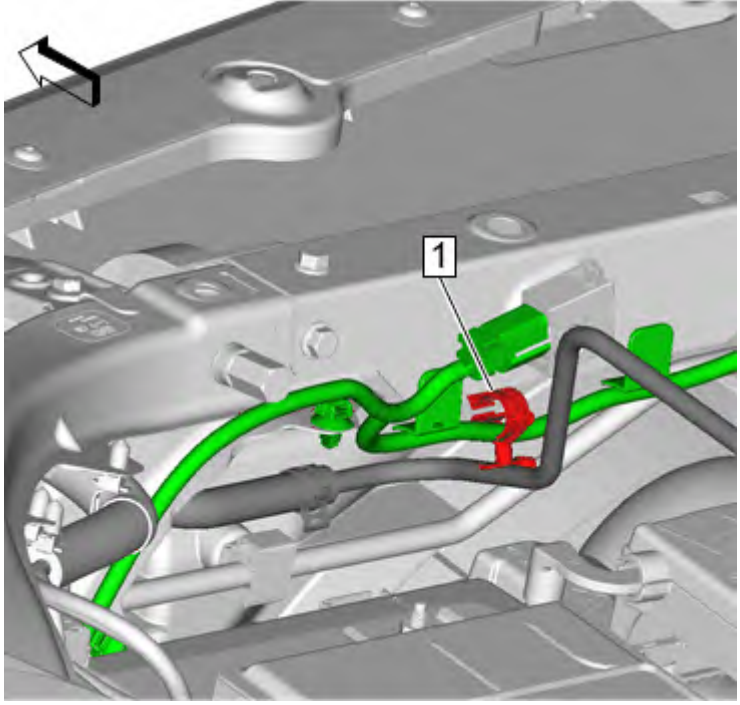


Fig. 221: Engine Coolant Air Bleed Pipe Clip
Courtesy of GENERAL MOTORS COMPANY

8. Install Engine Coolant Air Bleed Pipe Clip (1) @ Wiring Harness Wire.

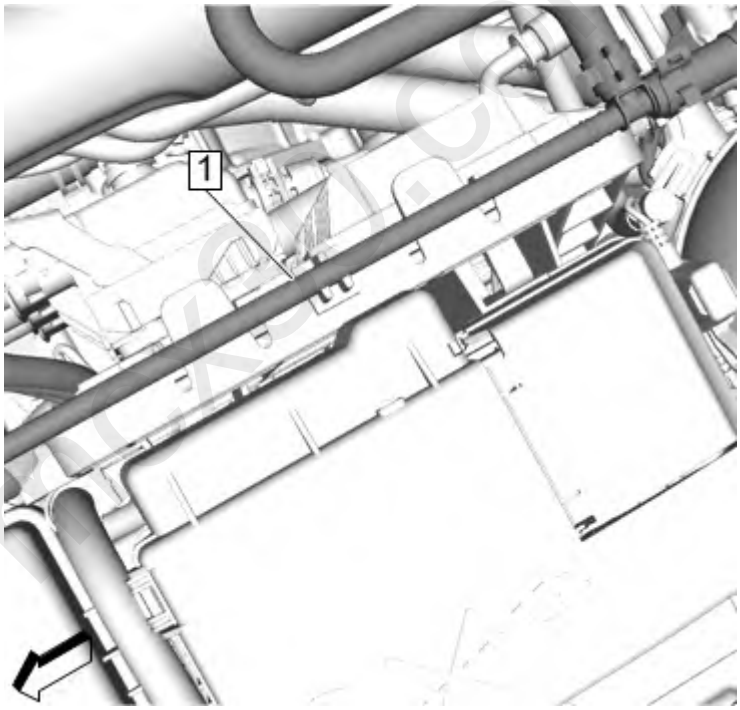


Fig. 222: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

9. Install Engine Coolant Air Bleed Hose (1) @ Engine Control Module Bracket.

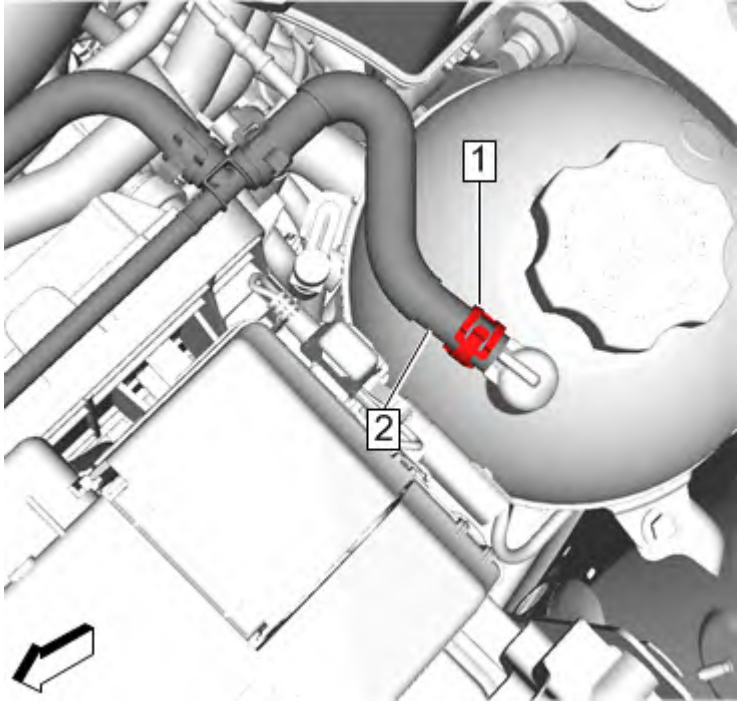


Fig. 223: Engine Coolant Air Bleed Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

10. Install Engine Coolant Air Bleed Hose (2) @ Radiator Surge Tank.
11. Engage Engine Coolant Air Bleed Hose Clamp (1) - Hose Clamp Replacement Guidelines - Spring Type
12. Fill the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)
13. Check the cooling system for leaks.

ENGINE COOLANT AIR BLEED HOSE REPLACEMENT (RADIATOR SURGE TANK TO EXHAUST GAS RECIRCULATION COOLER HOUSING AND RADIATOR LH7)

Removal Procedure

1. Drain the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)
2. Remove Intake Manifold Cover - Intake Manifold Cover Replacement

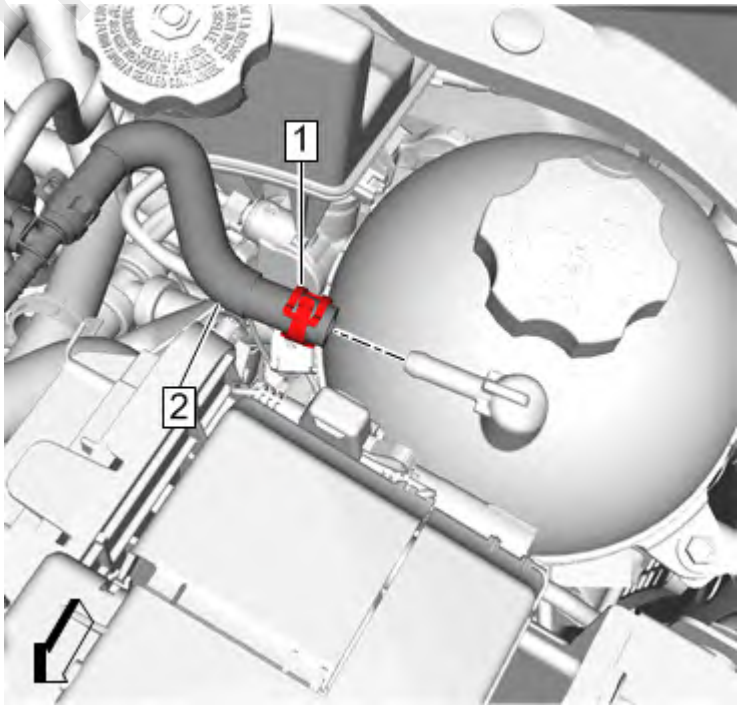


Fig. 224: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

3. Disengage Engine Coolant Air Bleed Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
4. Remove Engine Coolant Air Bleed Hose (2) @ Radiator Surge Tank.

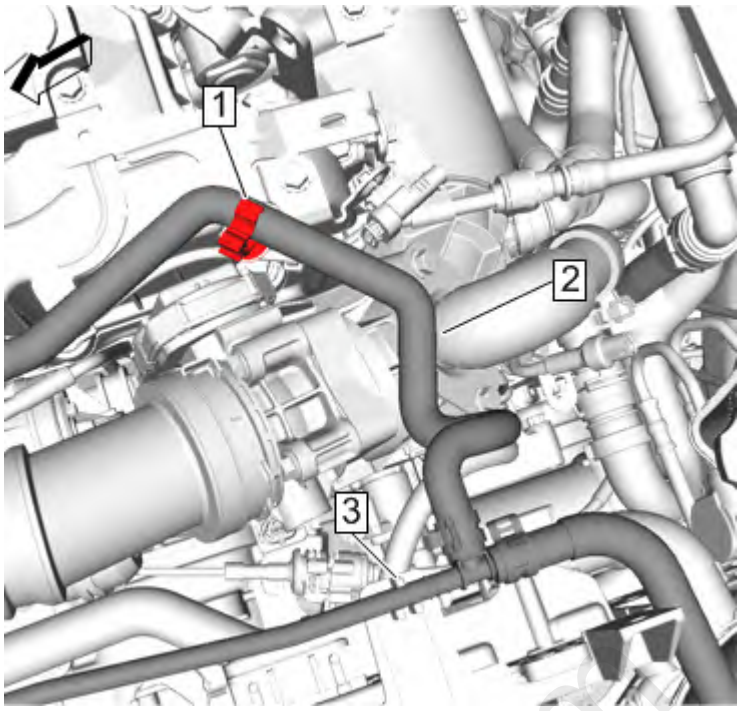


Fig. 225: Engine Coolant Air Bleed Hose, Clip And Bracket
Courtesy of GENERAL MOTORS COMPANY

5. Remove Engine Coolant Air Bleed Hose (2) @Engine Coolant Air Bleed Hose Clip (1).
6. Remove Engine Coolant Air Bleed Hose (2) @Engine Control Module Bracket (3).

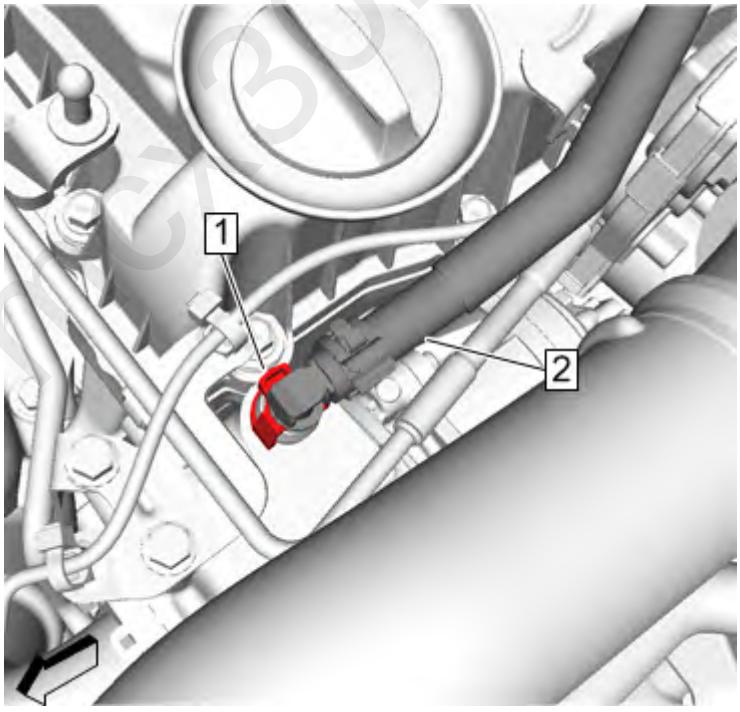


Fig. 226: Engine Coolant Air Bleed Hose Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Disengage Engine Coolant Air Bleed Hose Retainer (1).
8. Remove Engine Coolant Air Bleed Hose (2) @ Exhaust Gas Recirculation Cooler Housing.

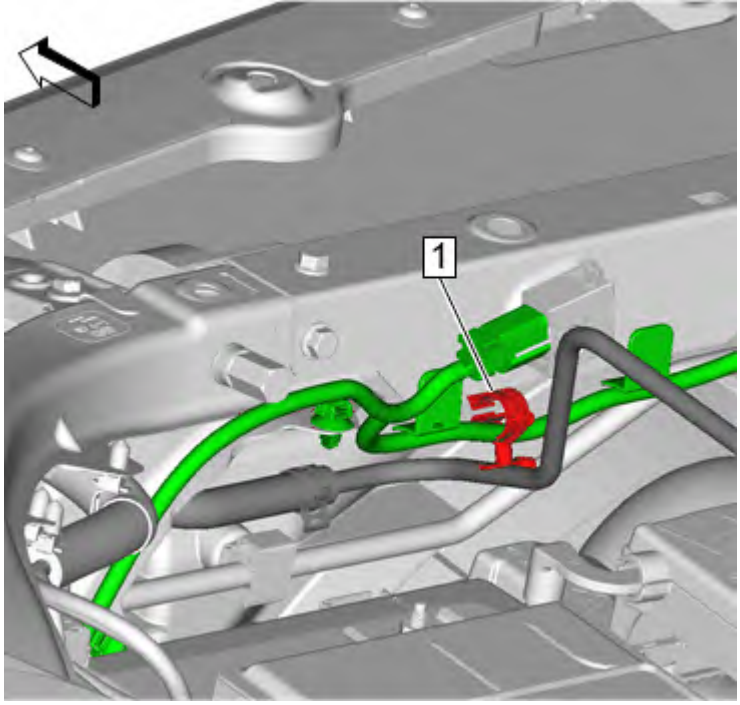


Fig. 227: Engine Coolant Air Bleed Pipe Clip
Courtesy of GENERAL MOTORS COMPANY

9. Remove Engine Coolant Air Bleed Pipe Clip (1) @ Wiring Harness Wire.

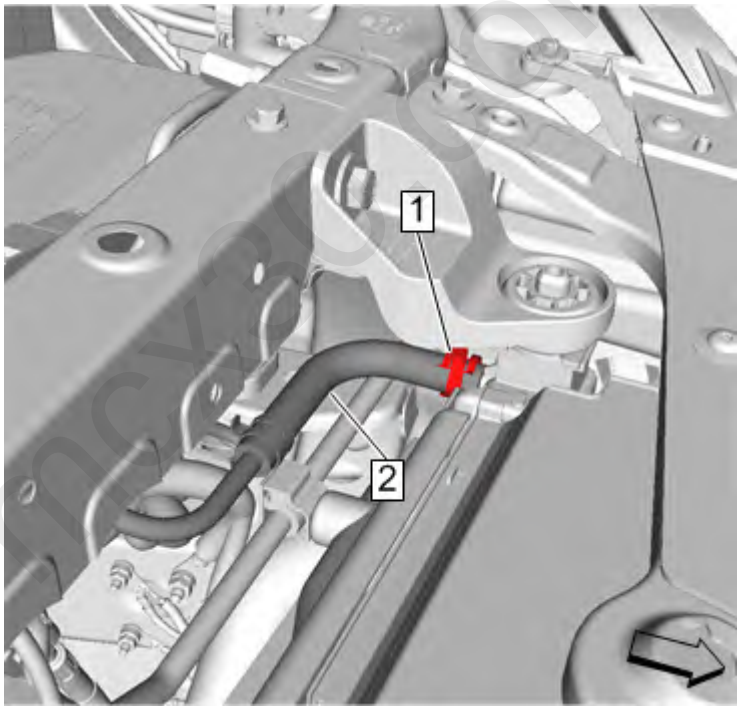


Fig. 228: Engine Coolant Air Bleed Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

10. Disengage Engine Coolant Air Bleed Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
11. Remove Engine Coolant Air Bleed Hose (2) @ Radiator.
12. Remove Engine Coolant Air Bleed Hose (2).

Installation Procedure

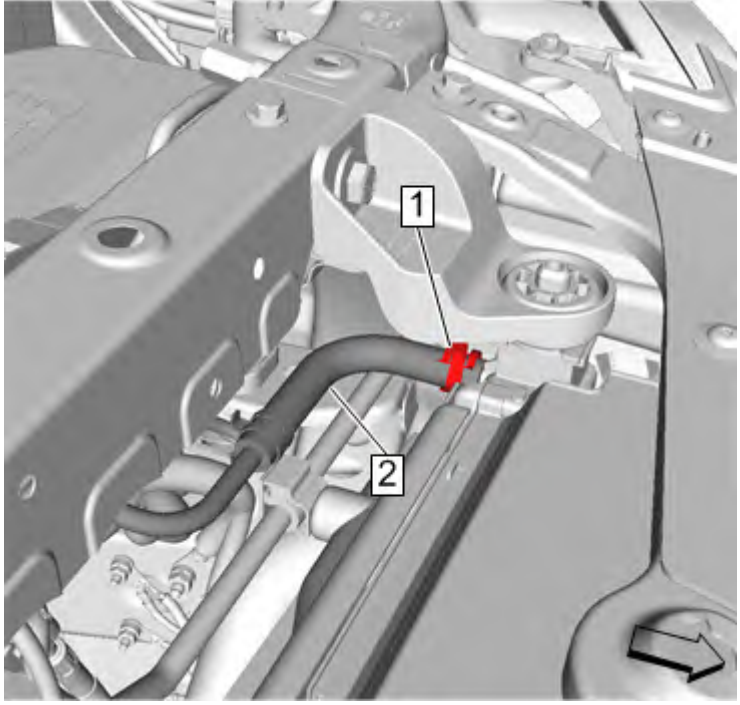


Fig. 229: Engine Coolant Air Bleed Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

1. Install Engine Coolant Air Bleed Hose (2) @ Radiator.
2. Engage Engine Coolant Air Bleed Hose Clamp (1) -**Hose Clamp Replacement Guidelines - Spring Type**

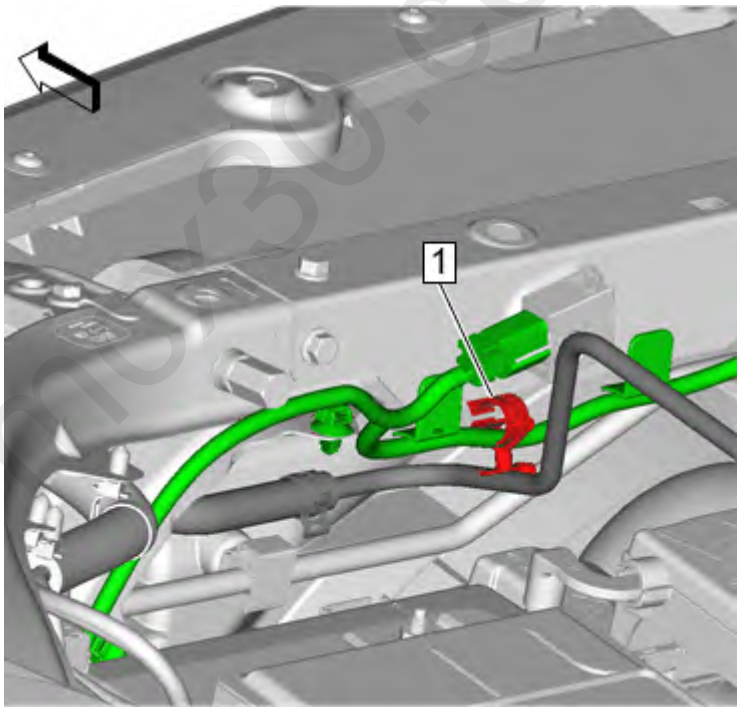


Fig. 230: Engine Coolant Air Bleed Pipe Clip
Courtesy of GENERAL MOTORS COMPANY

3. Install Engine Coolant Air Bleed Pipe Clip (1) @ Wiring Harness Wire.

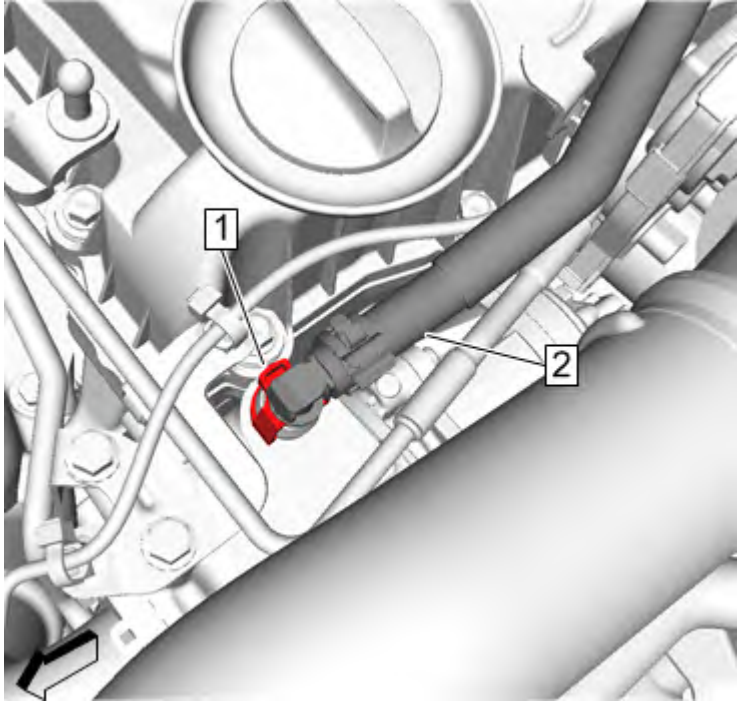


Fig. 231: Engine Coolant Air Bleed Hose Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Install Engine Coolant Air Bleed Hose (2) @ Exhaust Gas Recirculation Cooler Housing.
5. Engage Engine Coolant Air Bleed Hose Retainer (1).

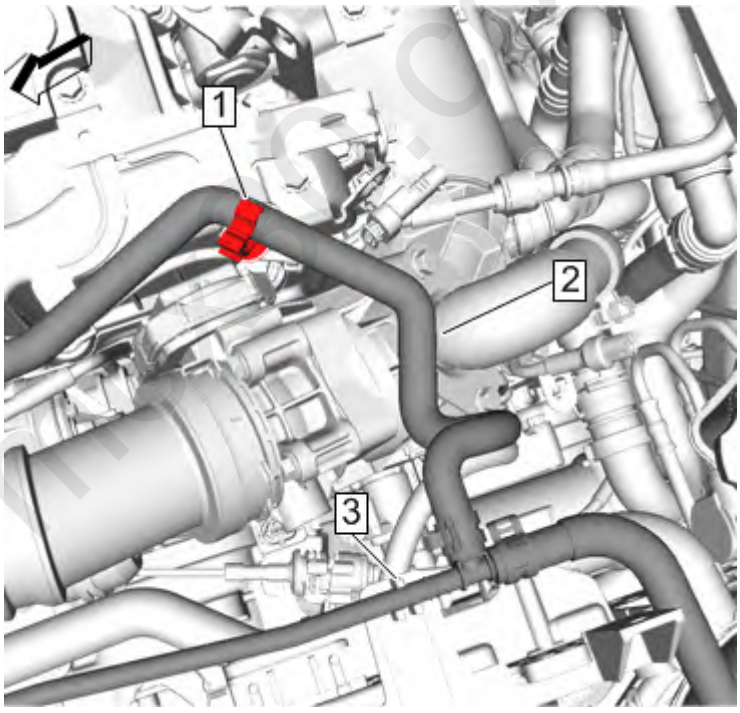


Fig. 232: Engine Coolant Air Bleed Hose, Clip And Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Install Engine Coolant Air Bleed Hose (2) @ Engine Control Module Bracket (3).
7. Install Engine Coolant Air Bleed Hose (2) @ Engine Coolant Air Bleed Hose Clip (1).

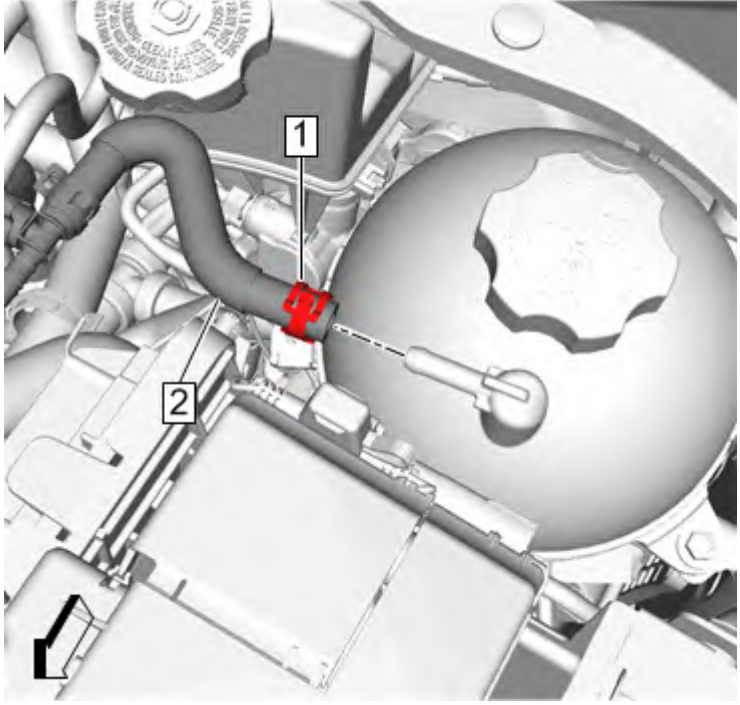


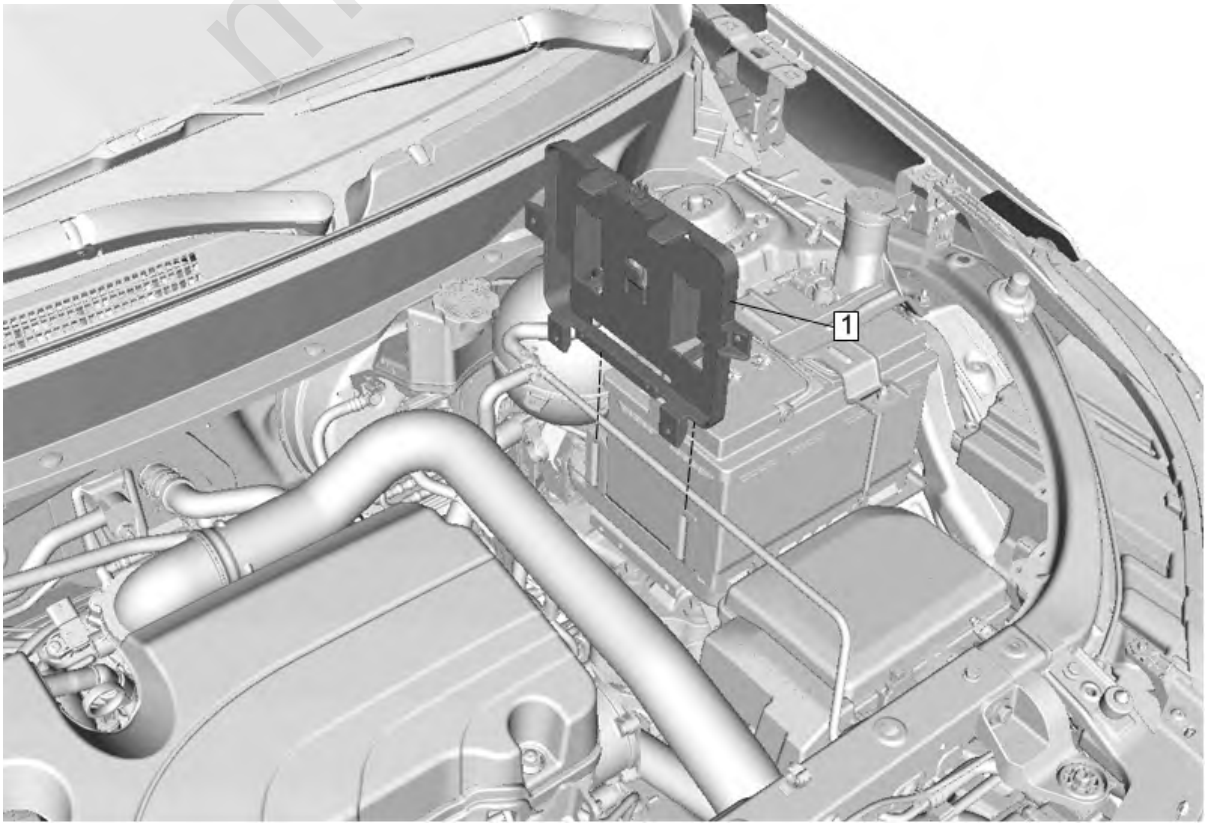
Fig. 233: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

8. Install Engine Coolant Air Bleed Hose (2) @ Radiator Surge Tank.
9. Engage Engine Coolant Air Bleed Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
10. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
11. Check the cooling system for leaks.

WATER OUTLET REPLACEMENT (LYX)

Removal Procedure

1. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
2. Remove **Charge Air Cooler Outlet Air Tube Replacement** .



mcx30.com

Fig. 234: Engine Control Module Bracket
Courtesy of GENERAL MOTORS COMPANY

3. Remove Engine Control Module Bracket (1) - Engine Control Module Bracket Replacement

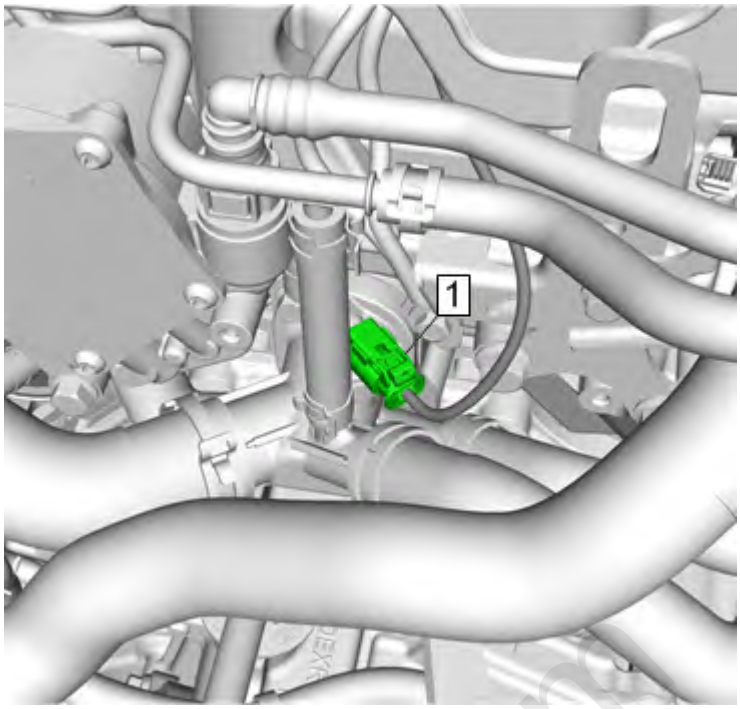


Fig. 235: Engine Coolant Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect Engine Coolant Temperature Sensor Electrical Connector (1).

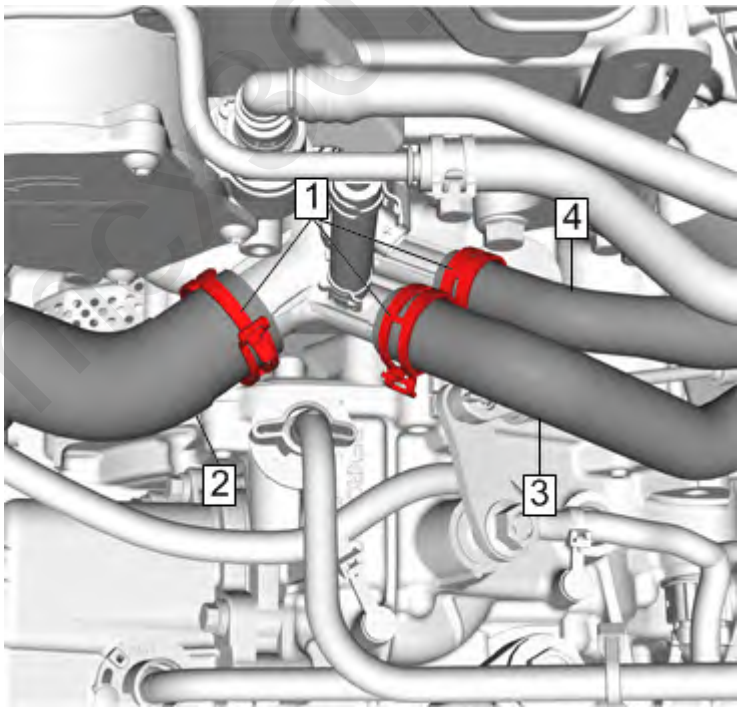


Fig. 236: Hoses And Clamps
Courtesy of GENERAL MOTORS COMPANY

5. Disengage Hose Clamp (1) - [3x]
6. Remove Radiator Inlet Hose (2).
7. Remove Heater Inlet Hose (3).
8. Remove Heater Outlet Hose (4).

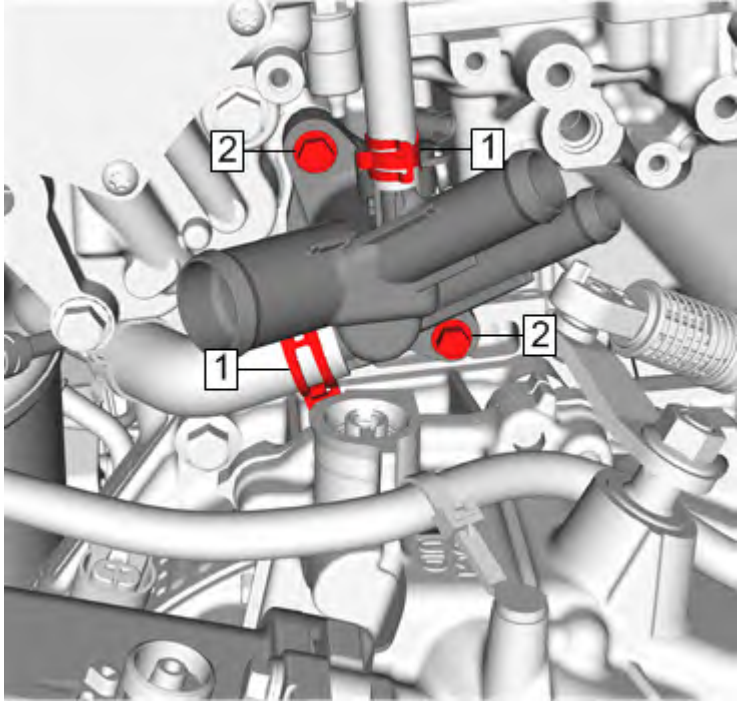


Fig. 237: Water Outlet
Courtesy of GENERAL MOTORS COMPANY

9. Disengage Hose Clamp (1) - [2x]
10. Remove Water Outlet Bolt (2) - [2x]

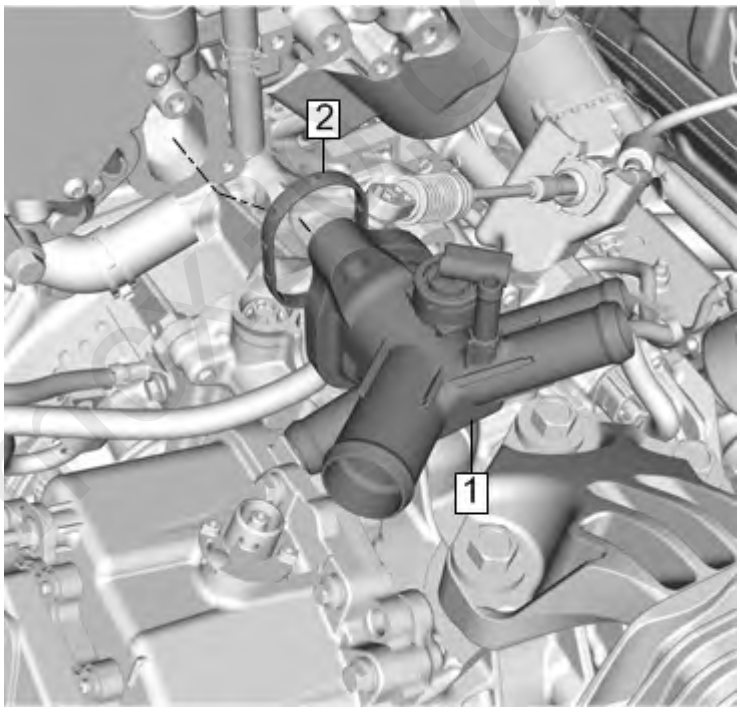


Fig. 238: Water Outlet Seal
Courtesy of GENERAL MOTORS COMPANY

11. Remove Water Outlet (1).
12. Remove Water Outlet Seal (2) and DISCARD

Installation Procedure

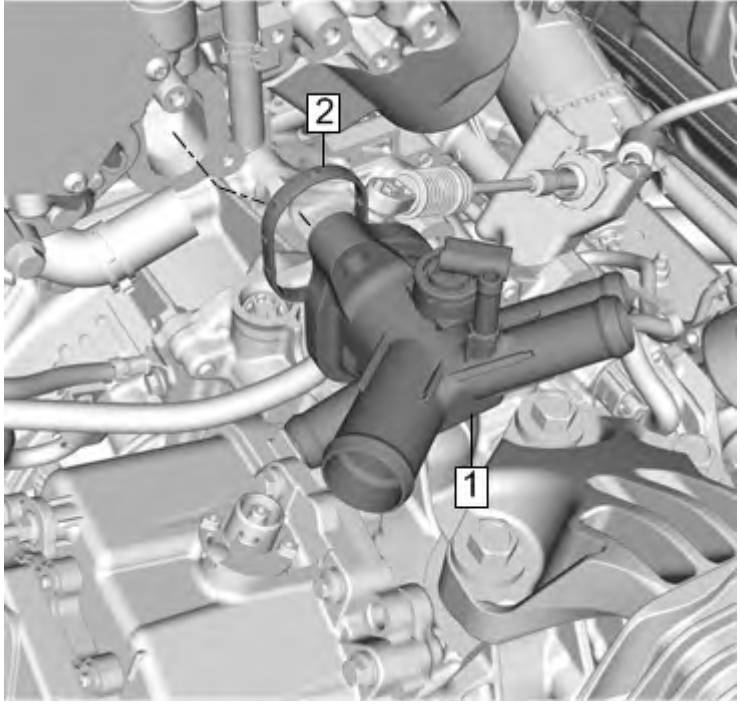


Fig. 239: Water Outlet Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install a NEW seal.**

1. Install Water Outlet Seal (2).
2. Install Water Outlet (1).

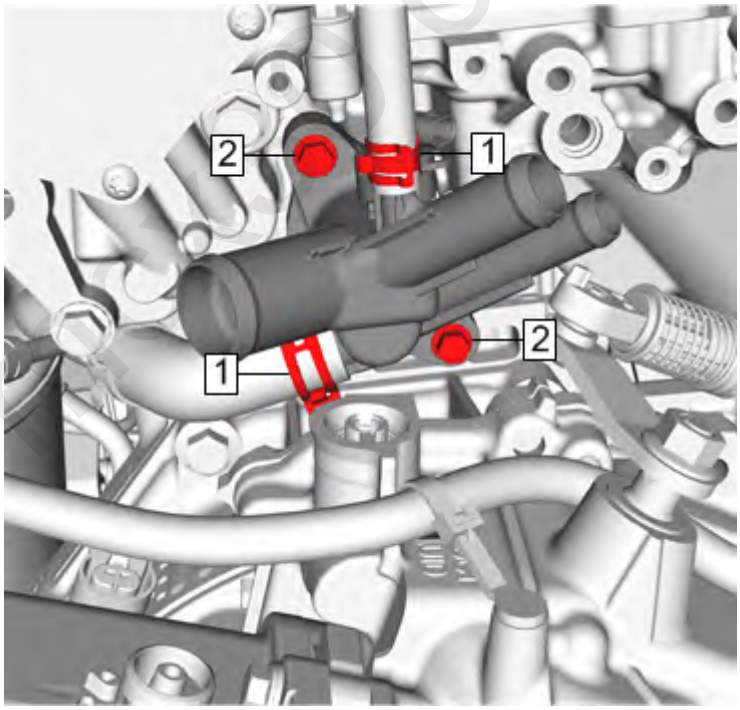


Fig. 240: Water Outlet
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

3. Install Water Outlet Bolt (2) and tighten [2x] 10 N.m (89 lb in)
4. Engage Hose Clamp (1) - [2x]

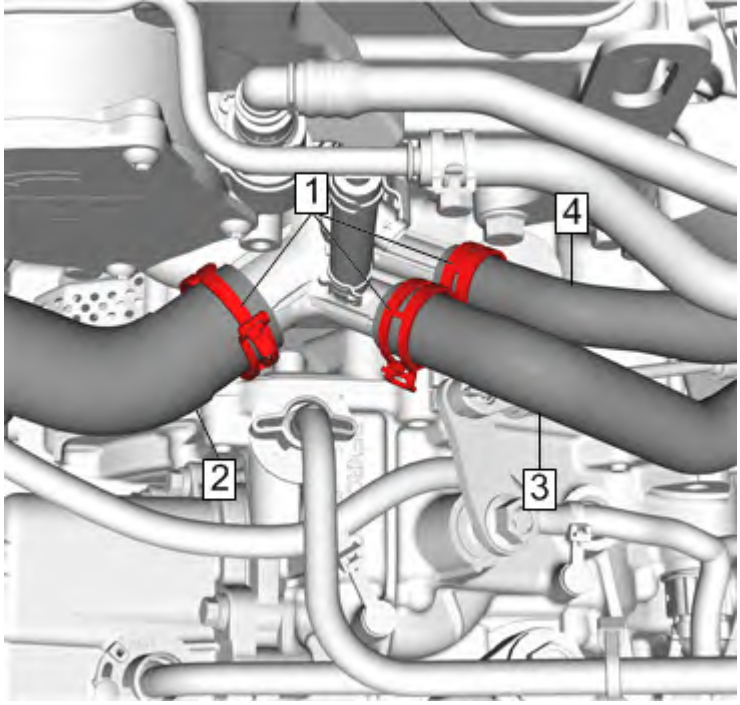


Fig. 241: Hoses And Clamps
Courtesy of GENERAL MOTORS COMPANY

5. Connect Heater Outlet Hose (4).
6. Connect Heater Inlet Hose (3).
7. Connect Radiator Inlet Hose (2).
8. Engage Hose Clamp (1) - [3x]

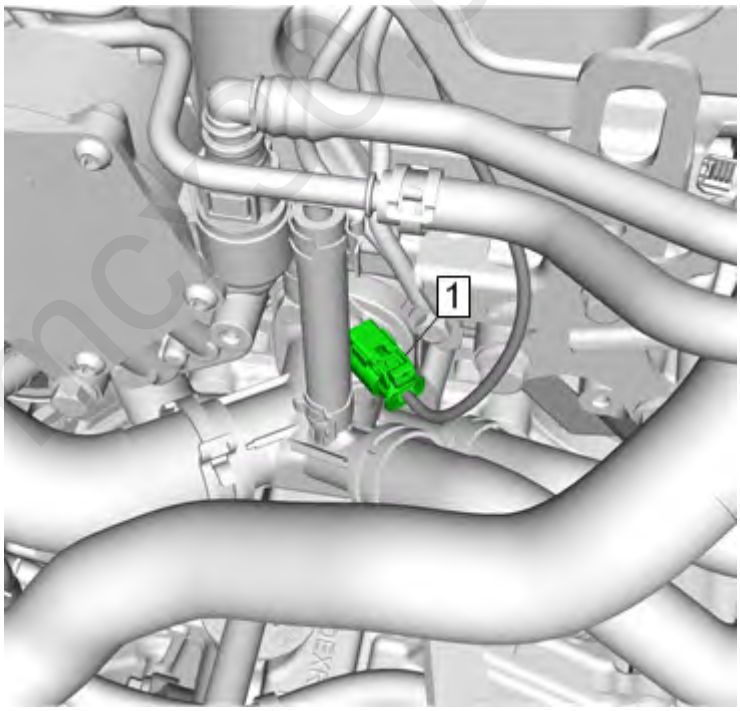


Fig. 242: Engine Coolant Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

9. Connect Engine Coolant Temperature Sensor Electrical Connector (1).

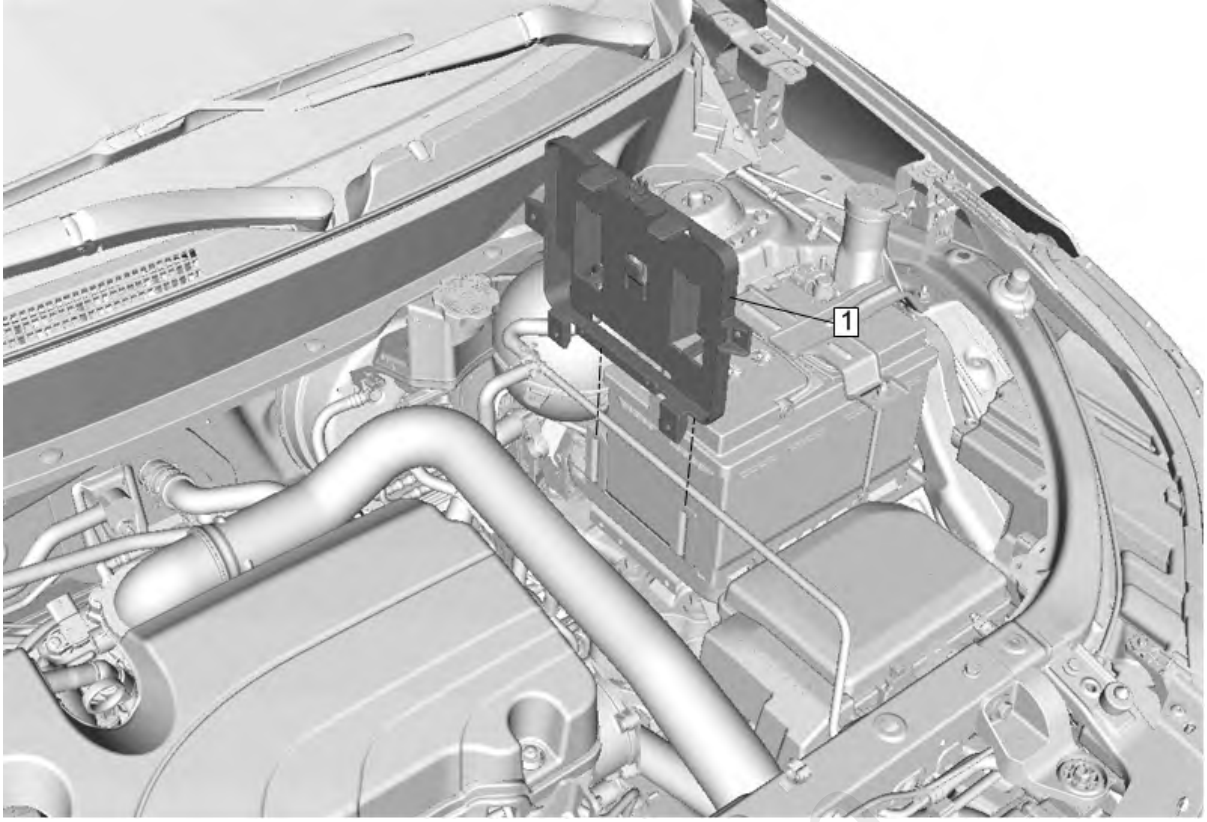


Fig. 243: Engine Control Module Bracket
Courtesy of GENERAL MOTORS COMPANY

10. Install Engine Control Module Bracket (1) -**Engine Control Module Bracket Replacement**
11. Install -**Charge Air Cooler Outlet Air Tube Replacement**
12. Fill the cooling system. Reference **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**

WATER OUTLET REPLACEMENT (LTG)

Removal Procedure

1. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**

   NOTE: **Reposition the engine control module with the wiring harness attached.**

2. Remove Engine Control Module - and position aside - **Engine Control Module Replacement**
3. Remove Battery Tray - **Battery Tray Replacement**

mcx30.com

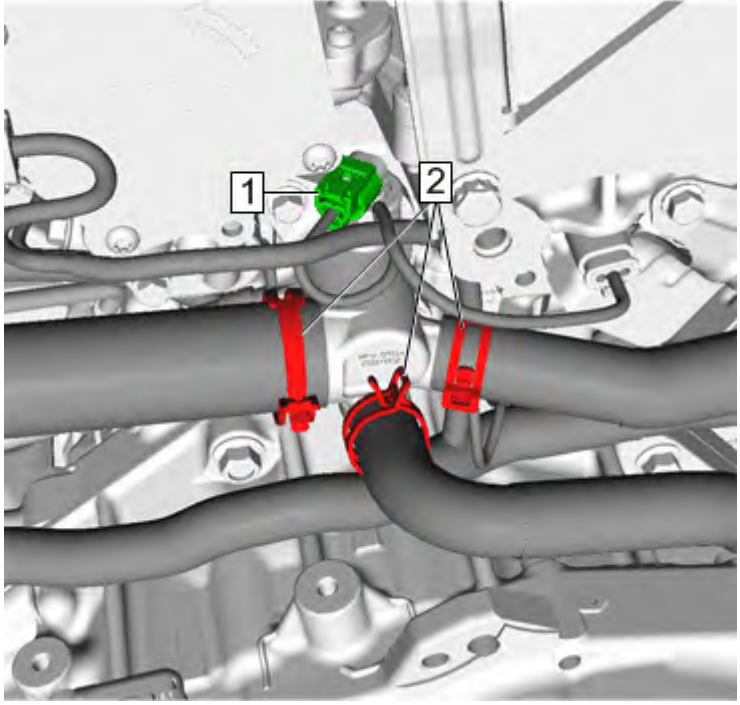


Fig. 244: Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect Engine Coolant Temperature Sensor (1).
5. Disengage Hose Clamp (2) - [3x] - **Hose Clamp Replacement Guidelines - Spring Type**

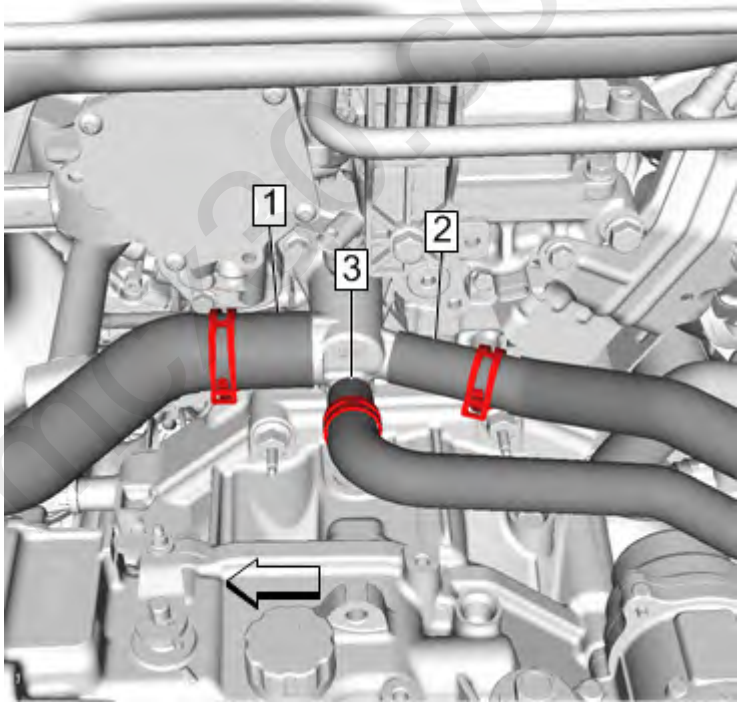


Fig. 245: Radiator Inlet Hose And Heater Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect Radiator Inlet Hose (1) @ Water Outlet.
7. Disconnect Heater Inlet Hose (2) @ Water Outlet.
8. Disconnect Heater Water Auxiliary Pump Inlet Hose (3) @ Water Outlet.

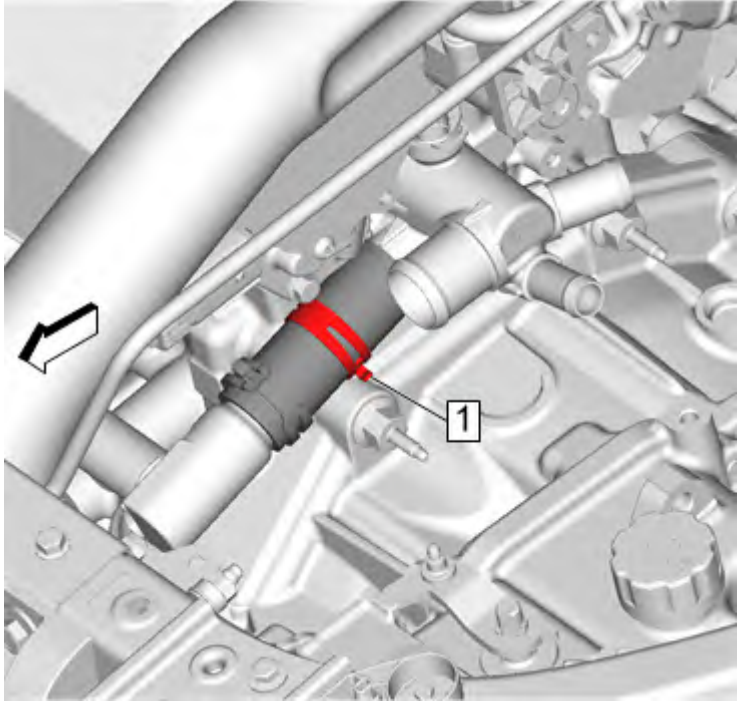


Fig. 246: Thermostat Bypass Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

9. Disengage Thermostat Bypass Hose Clamp (1) @ Water Outlet -**Hose Clamp Replacement Guidelines - Spring Type**

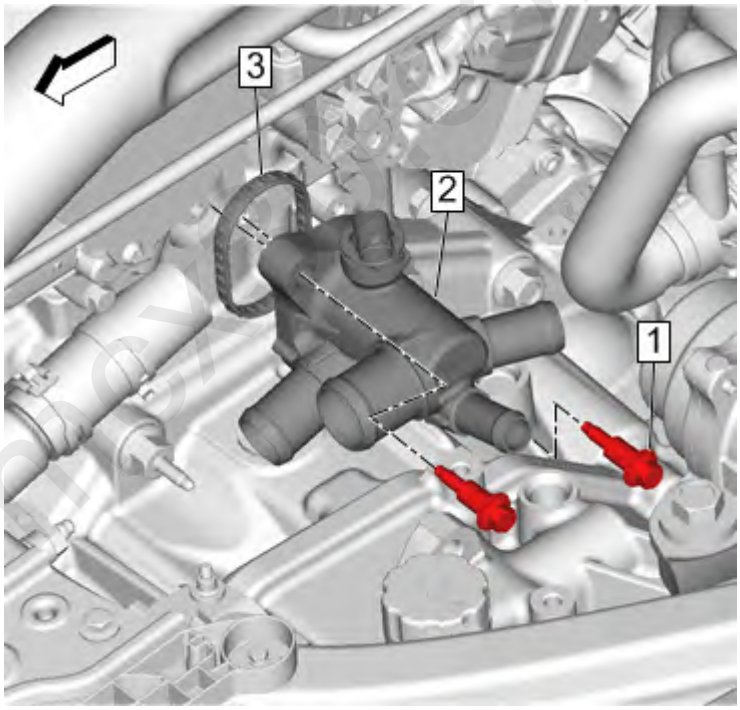


Fig. 247: Water Outlet, Bolt And Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Separate the thermostat bypass hose from the water outlet during removal.**

10. Remove Water Outlet Bolt (1) - [2x]
11. Remove Water Outlet (2).
12. Remove Water Outlet Seal (3) and DISCARD

Installation Procedure

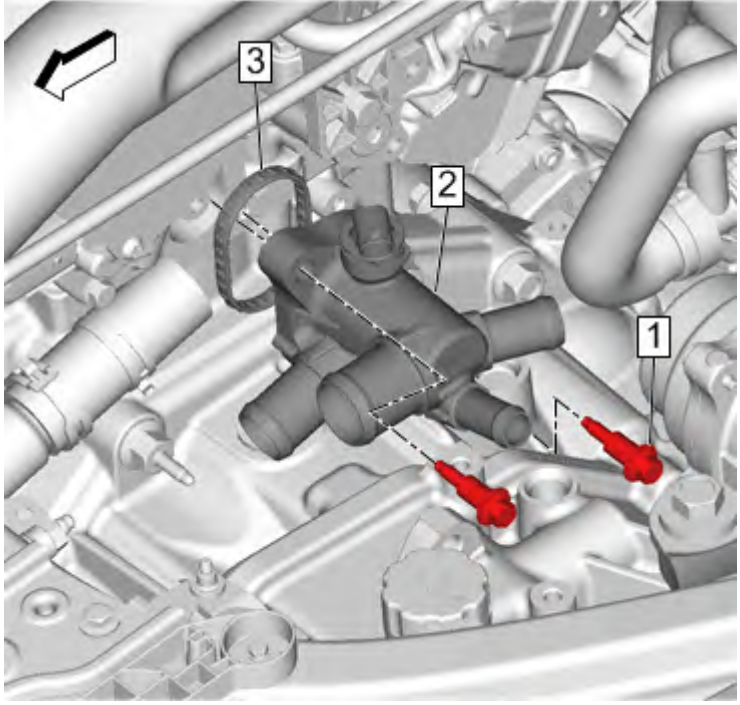


Fig. 248: Water Outlet, Bolt And Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install the thermostat bypass hose onto the water outlet during installation.**

1. Install NEW Water Outlet Seal (3).
2. Install Water Outlet (2).

CAUTION: **Refer to Fastener Caution .**

3. Install Water Outlet Bolt (1) and tighten [2x] 10 N.m (89 lb in)

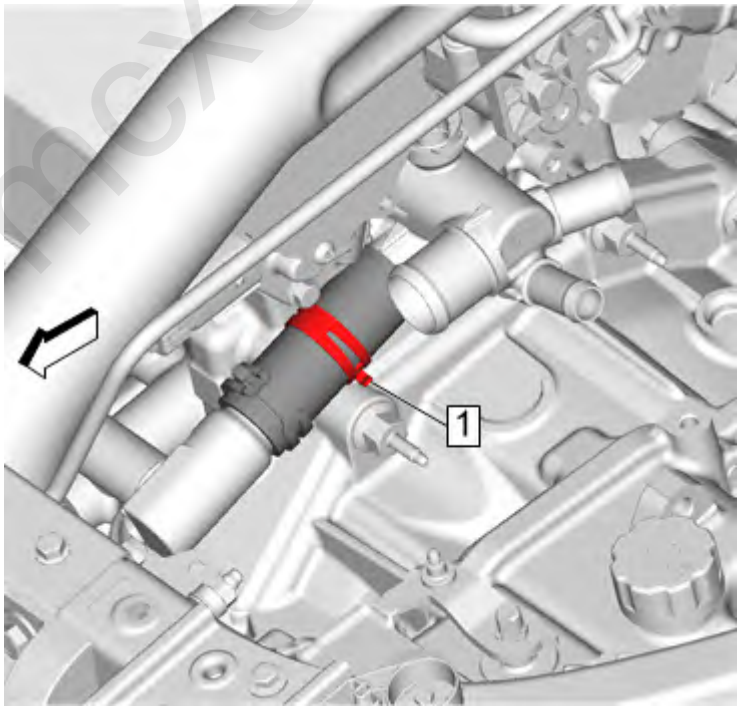


Fig. 249: Thermostat Bypass Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

4. Engage Thermostat Bypass Hose Clamp (1) @ Water Outlet - **Hose Clamp Replacement Guidelines - Spring Type**

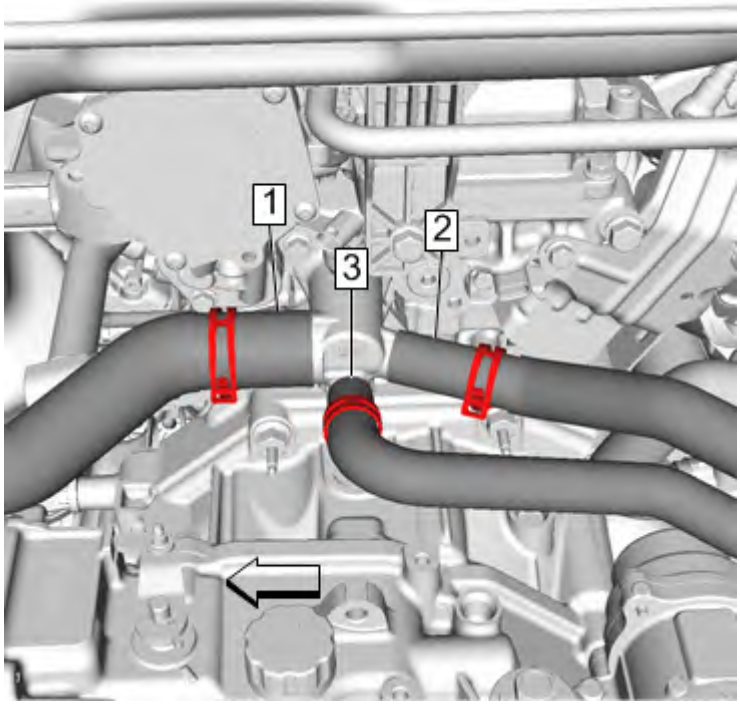


Fig. 250: Radiator Inlet Hose And Heater Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

5. Connect Heater Water Auxiliary Pump Inlet Hose (3) @ Water Outlet.
6. Connect Heater Inlet Hose @ (2) Water Outlet.
7. Connect Radiator Inlet Hose (1) @ Water Outlet.

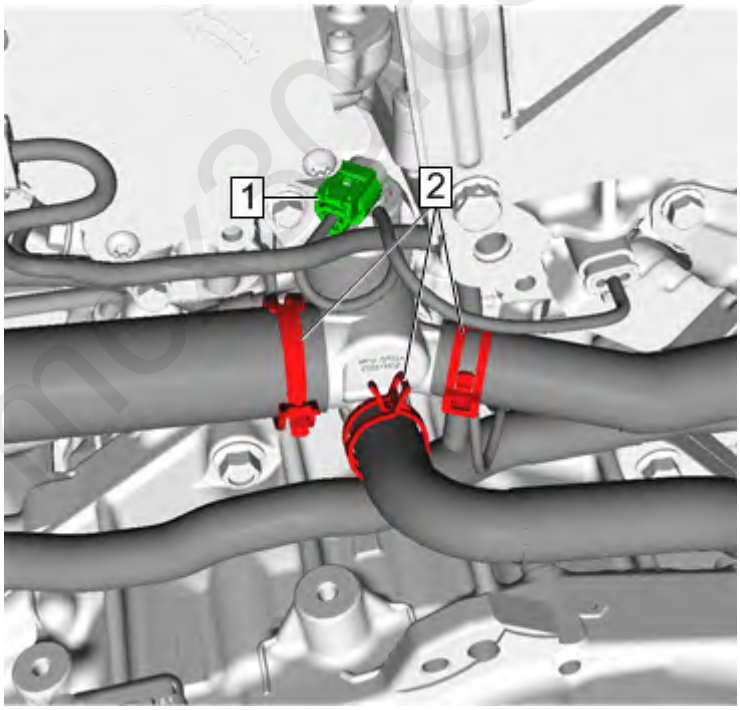


Fig. 251: Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

8. Engage Hose Clamp (2) - [3x] **Hose Clamp Replacement Guidelines - Spring Type**
9. Connect Engine Coolant Temperature Sensor (1).
10. Install Battery Tray - **Battery Tray Replacement**
11. Install Engine Control Module - **Engine Control Module Replacement**
12. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
13. Start the engine and check for leaks.

WATER OUTLET REPLACEMENT (LH7)

Removal Procedure

1. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**

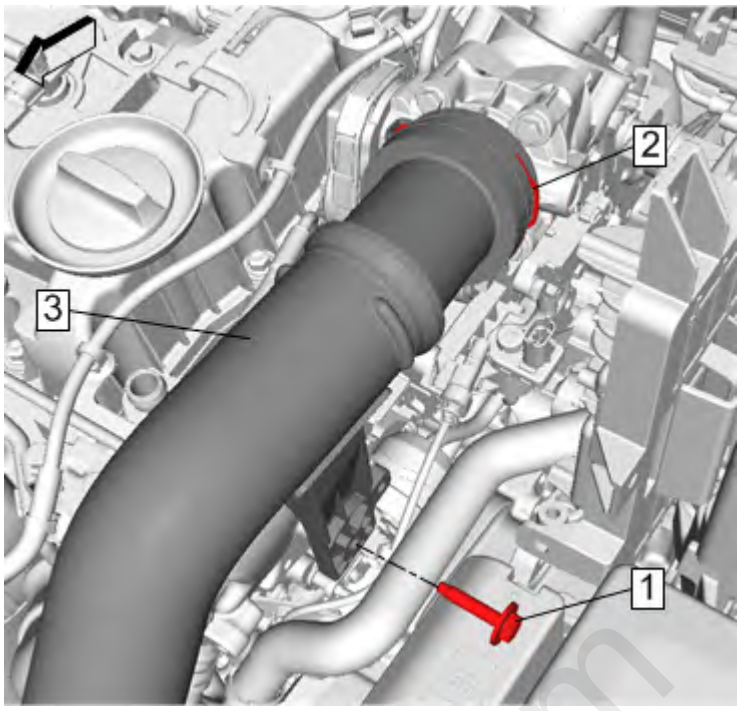


Fig. 252: Charge Air Cooler Outlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

2. Remove Charge Air Cooler Outlet Air Tube (3) - **Charge Air Cooler Outlet Air Tube Replacement**

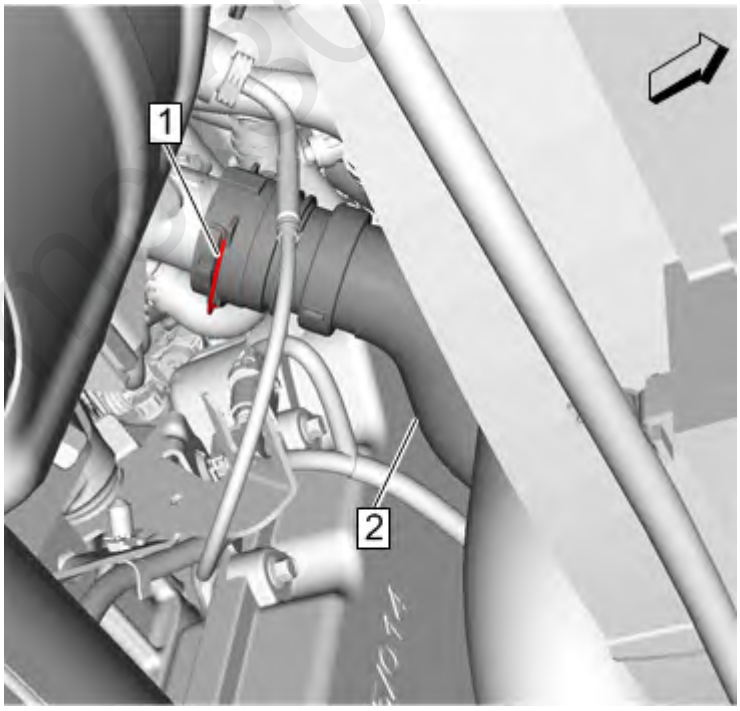


Fig. 253: Radiator Inlet Hose Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Remove Radiator Inlet Hose (2) @ Water Outlet - **Radiator Inlet Hose Replacement (LH7)**

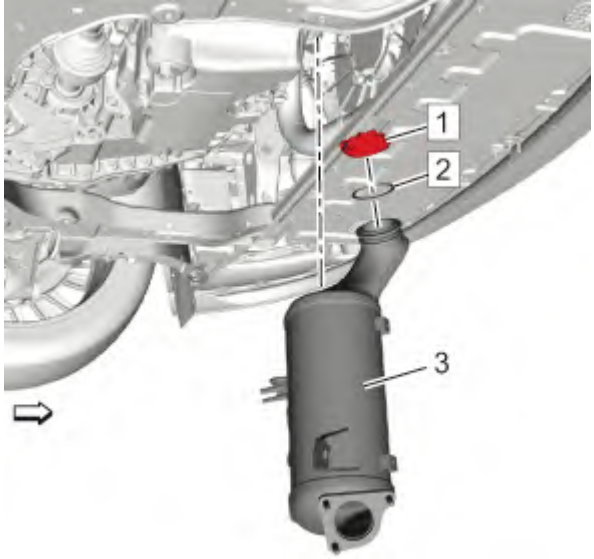


Fig. 254: Catalytic Converter, Clamp And Gasket
Courtesy of GENERAL MOTORS COMPANY

4. Remove Oxidation Catalytic Converter (3) - **Oxidation Catalytic Converter Replacement (LH7)**

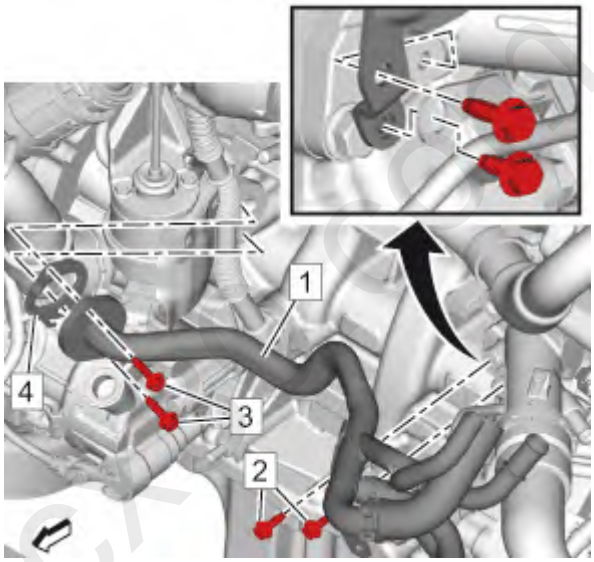


Fig. 255: Thermostat Bypass Pipe, Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove Thermostat Bypass Pipe (1) - **Thermostat Bypass Pipe Replacement (LH7)**
6. Remove Power Brake Booster Inlet Hose Connector Fitting - **Power Brake Booster Inlet Hose Connector Fitting Replacement**

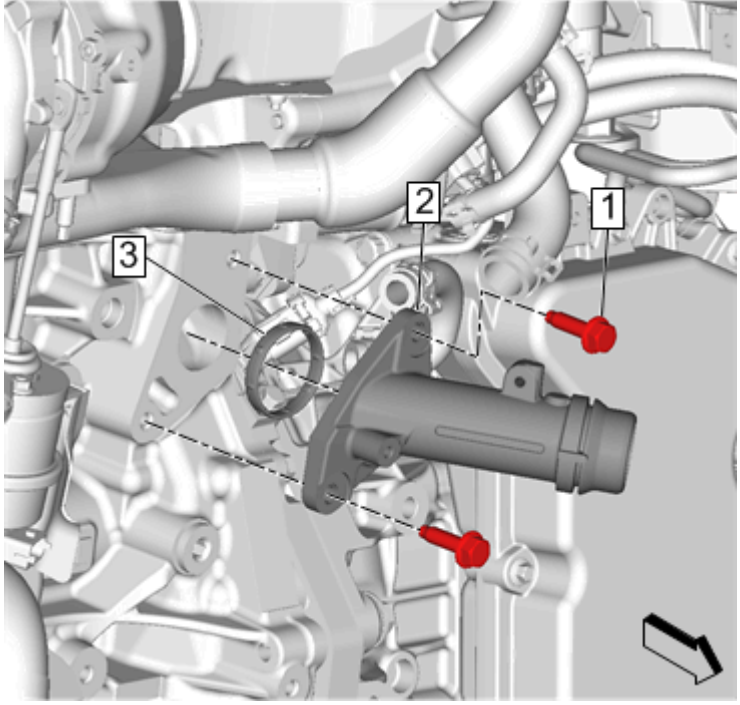


Fig. 256: Water Outlet, Bolt And Seal
Courtesy of GENERAL MOTORS COMPANY

7. Remove Water Outlet Bolt (1) - [2x]
8. Remove Water Outlet (2).
9. Remove Water Outlet Seal (3) and DISCARD

Installation Procedure

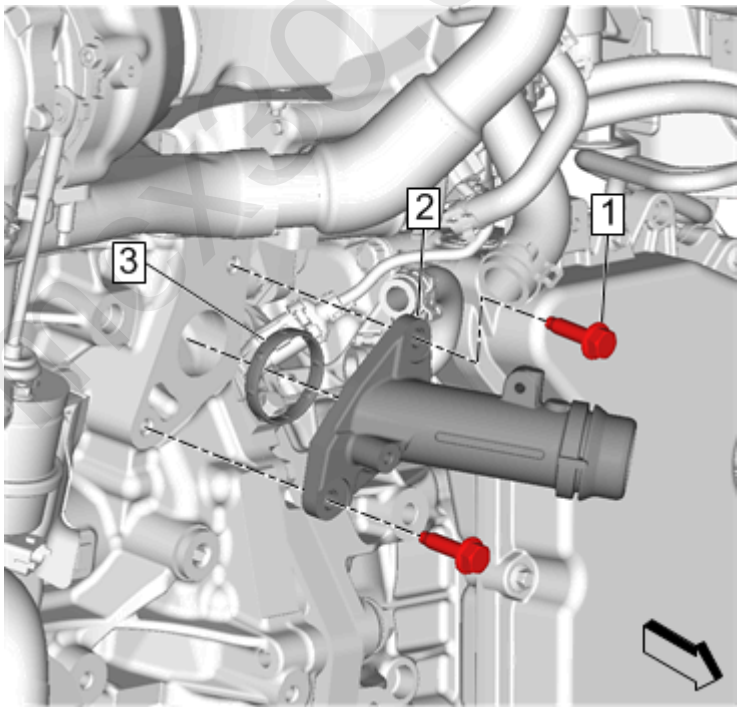


Fig. 257: Water Outlet, Bolt And Seal
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW Water Outlet Seal (3).
2. Install Water Outlet (2).

CAUTION: **Refer to Fastener Caution .**

3. Install Water Outlet Bolt (1) and tighten [2x] 25 N.m (18 lb ft)
4. Install Power Brake Booster Inlet Hose Connector Fitting -**Power Brake Booster Inlet Hose Connector Fitting Replacement**

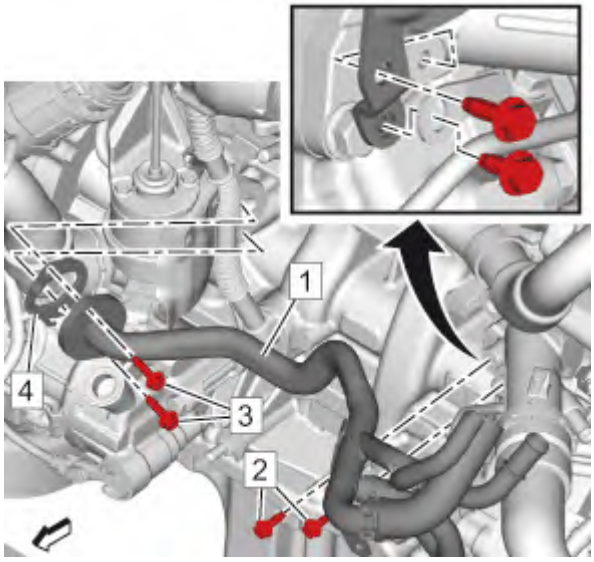


Fig. 258: Thermostat Bypass Pipe, Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install Thermostat Bypass Pipe (1) - **Thermostat Bypass Pipe Replacement (LH7)**

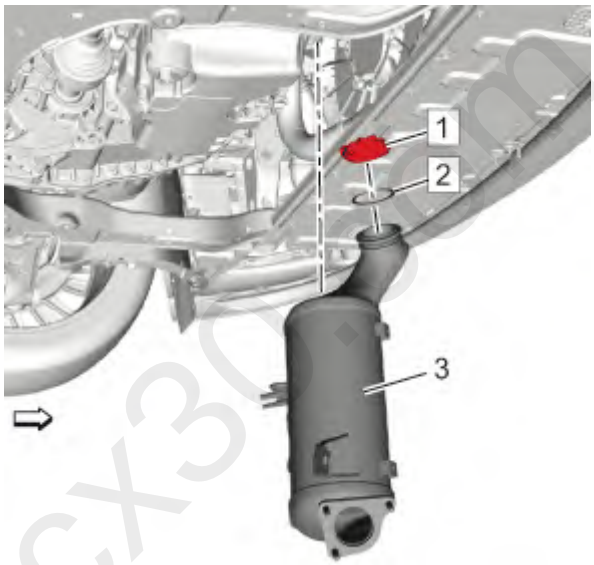


Fig. 259: Catalytic Converter, Clamp And Gasket
Courtesy of GENERAL MOTORS COMPANY

6. Install Oxidation Catalytic Converter (3) - **Oxidation Catalytic Converter Replacement (LH7)**

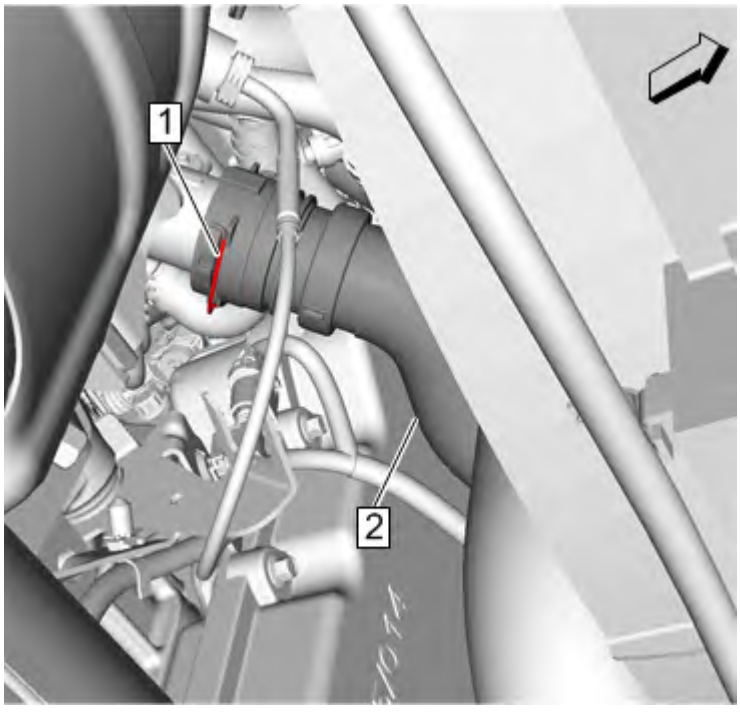


Fig. 260: Radiator Inlet Hose Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Install Radiator Inlet Hose (2) @ Water Outlet - Radiator Inlet Hose Replacement (LH7)

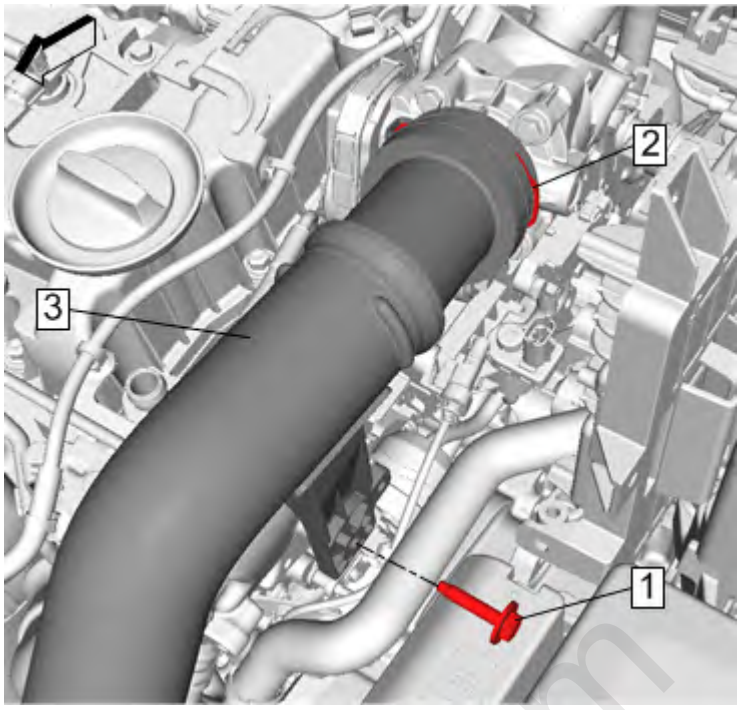


Fig. 261: Charge Air Cooler Outlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

8. Install Charge Air Cooler Outlet Air Tube (3) - Charge Air Cooler Outlet Air Tube Replacement
9. Fill the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)

THERMOSTAT BYPASS PIPE REPLACEMENT (LYX)

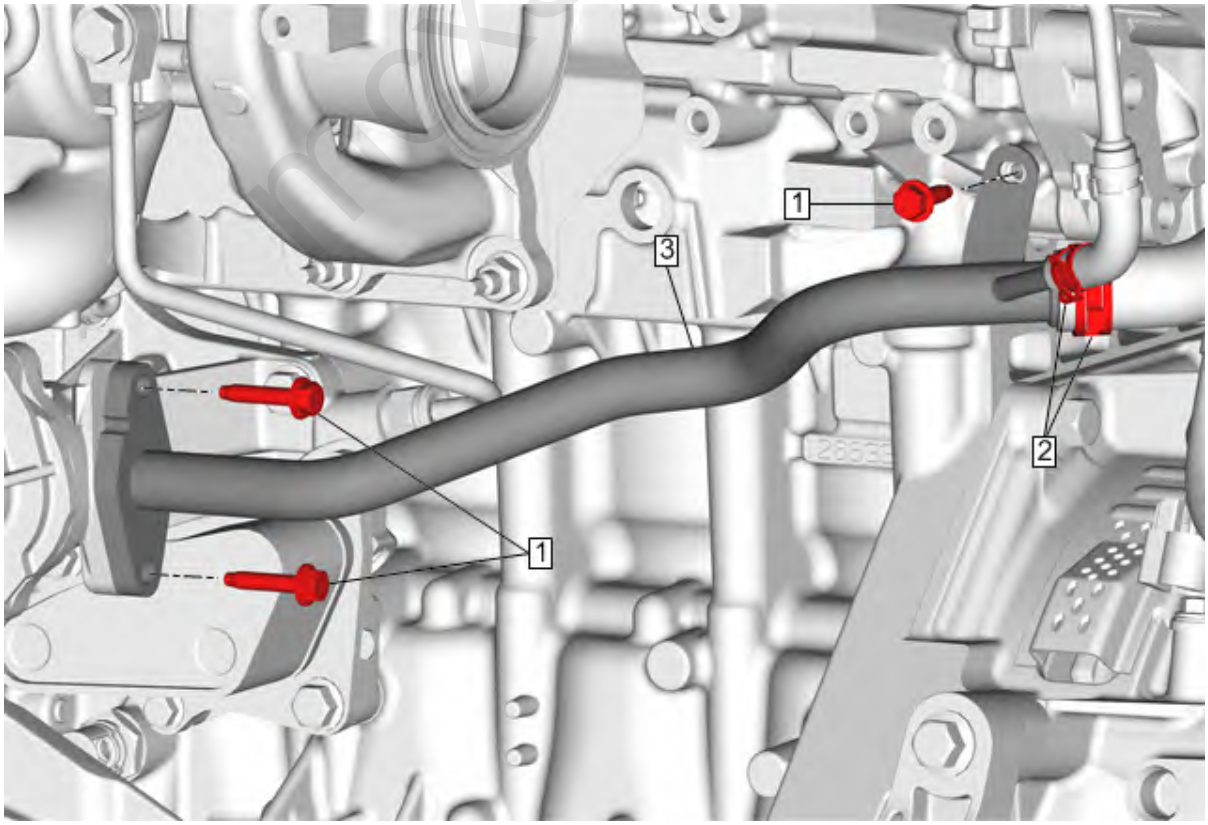


Fig. 262: Thermostat Bypass Pipe
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

Callout	Component Name
Preliminary Procedures 1. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static). 2. Warm Up Three-Way Catalytic Converter Replacement (LYX)	
1	Thermostat Bypass Pipe Bolt [3x] **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Clamp [2x]
3	Thermostat Bypass Pipe **Procedure** Install a NEW gasket.

THERMOSTAT BYPASS PIPE REPLACEMENT (LTG)

Removal Procedure

1. Drain the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)
2. Remove Exhaust Manifold Brace - Exhaust Manifold Brace Replacement (LTG)

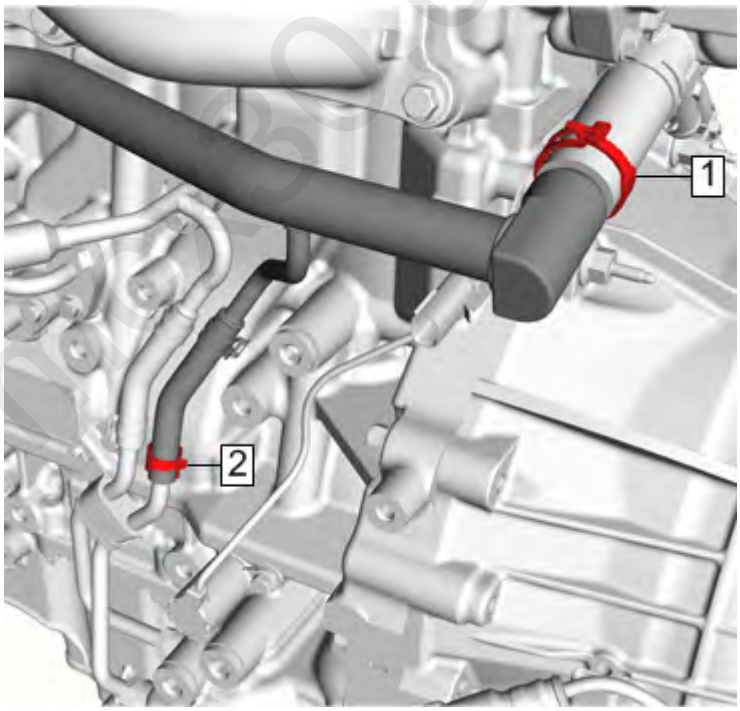


Fig. 263: Clamps
Courtesy of GENERAL MOTORS COMPANY

3. Disengage Thermostat Bypass Hose Clamp (1).
4. Disengage Engine Oil Cooler Inlet Hose Clamp (2).

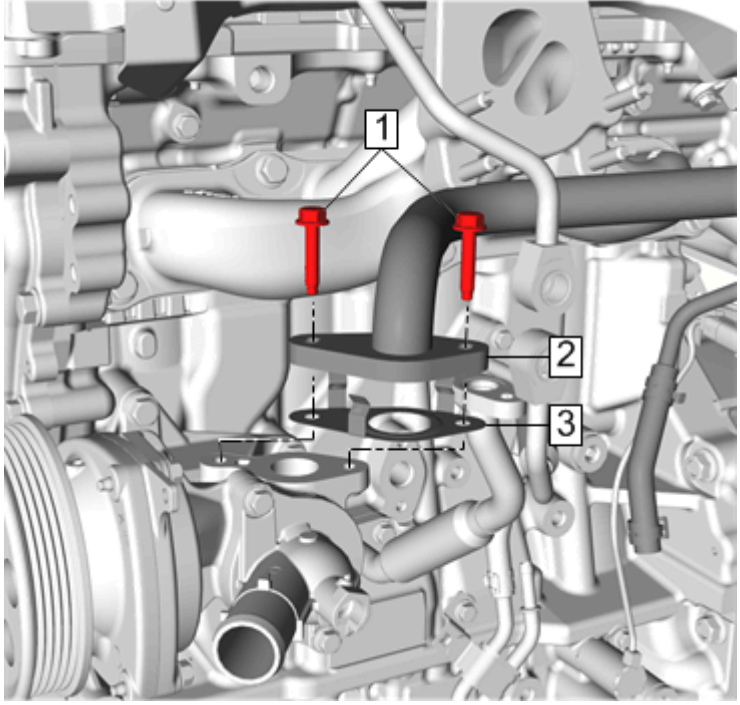


Fig. 264: Thermostat Bypass Pipe, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

5. Remove Thermostat Bypass Pipe Bolt (1) - [2x]
6. Remove Thermostat Bypass Pipe (2)
7. Remove Thermostat Bypass Pipe Gasket (3) and DISCARD

Installation Procedure

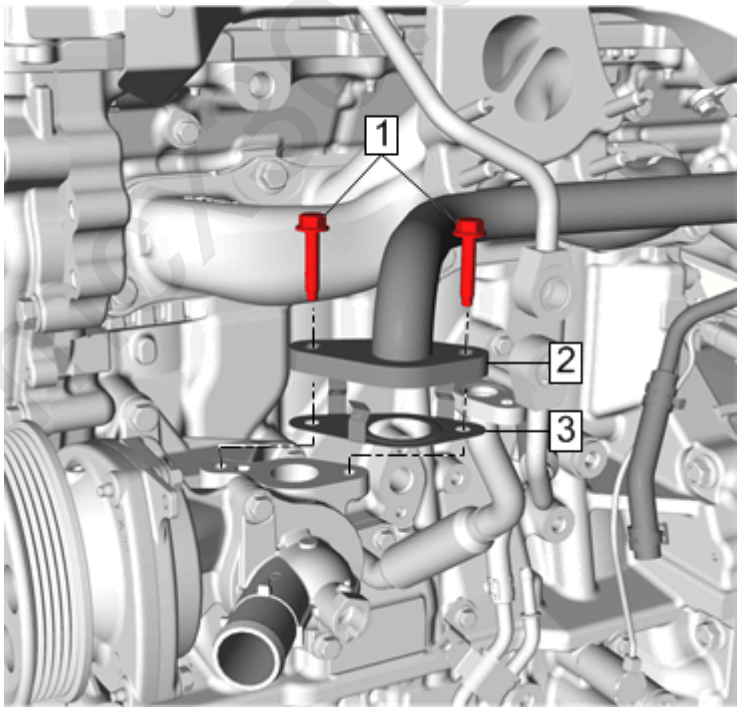


Fig. 265: Thermostat Bypass Pipe, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install a NEW thermostat bypass pipe gasket.**

1. Install Thermostat Bypass Pipe Gasket (3).
2. Install Thermostat Bypass Pipe (2).

CAUTION: **Refer to Fastener Caution .**

3. Install Thermostat Bypass Pipe Bolt (1) and tighten [2x] 10 N.m (89 lb in)

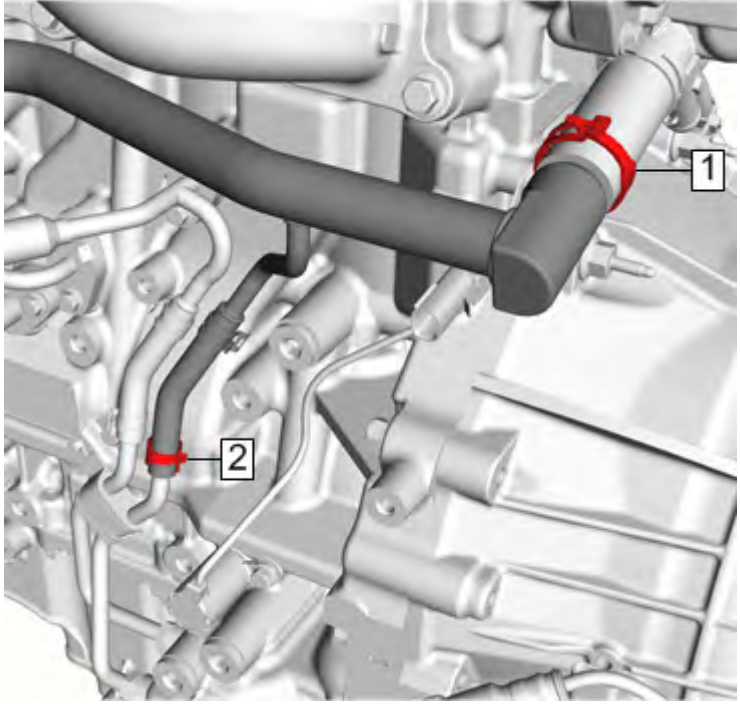


Fig. 266: Clamps
Courtesy of GENERAL MOTORS COMPANY

4. Engage Engine Oil Cooler Inlet Hose Clamp (2).
5. Engage Thermostat Bypass Hose Clamp (1).
6. Install Exhaust Manifold Brace -**Exhaust Manifold Brace Replacement (LTG)**
7. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
8. Start the engine and check for leaks.

THERMOSTAT BYPASS PIPE REPLACEMENT (LH7)

Removal Procedure

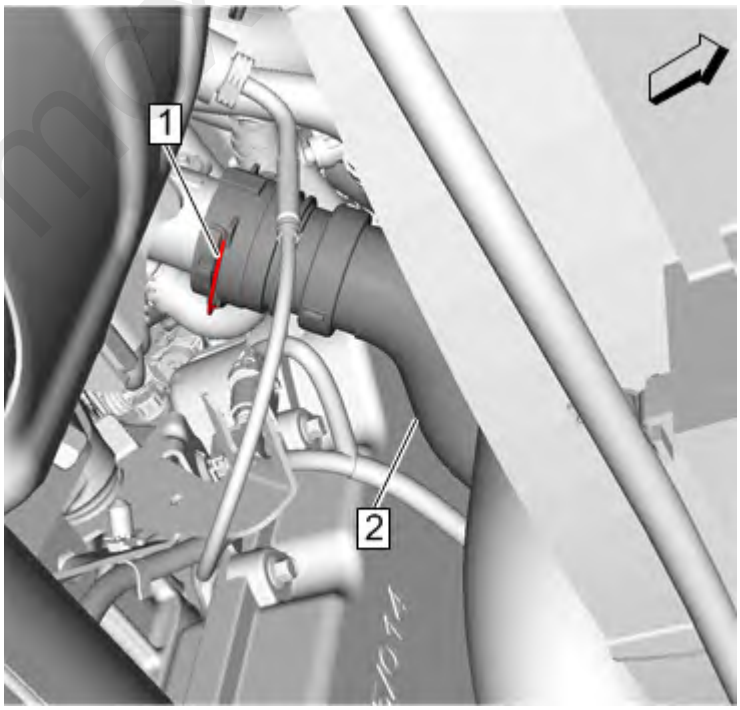


Fig. 267: Radiator Inlet Hose Retainer
Courtesy of GENERAL MOTORS COMPANY

1. Remove Radiator Inlet Hose (2) @ Water Outlet - **Radiator Inlet Hose Replacement (LH7)**
2. Remove Oxidation Catalytic Converter - **Oxidation Catalytic Converter Replacement (LH7)**
3. Remove Charge Air Cooler Outlet Air Tube - **Charge Air Cooler Outlet Air Tube Replacement**

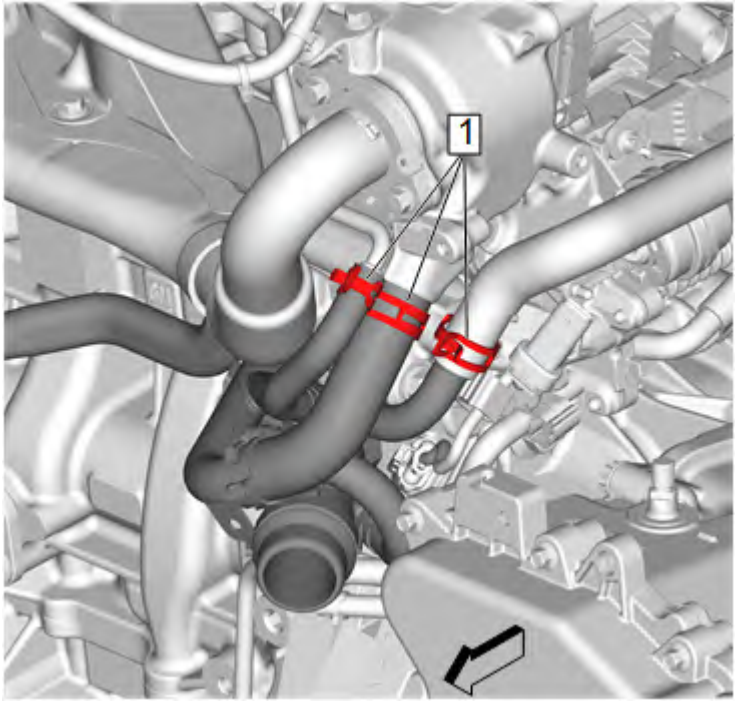


Fig. 268: Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

4. Remove Hose Clamp (1) - [3x] **Hose Clamp Replacement Guidelines - Spring Type**

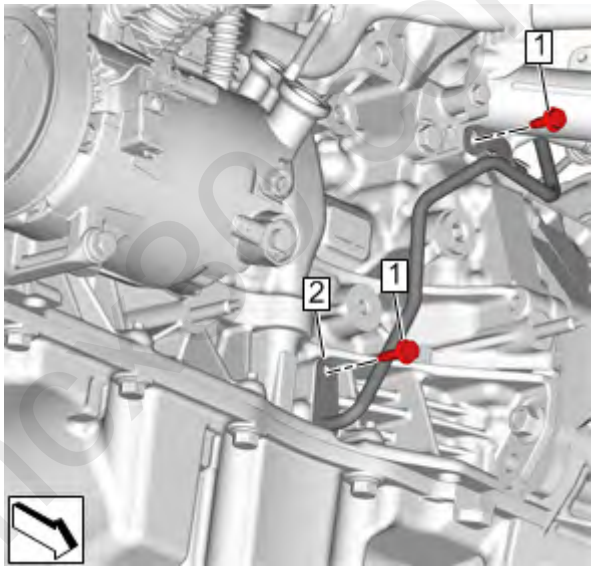


Fig. 269: Power Brake Booster Inlet Hose Connector Fitting Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove Power Brake Booster Inlet Hose Connector Fitting Bolt (1) - [2x] **Power Brake Booster Inlet Hose Connector Fitting Replacement**
6. Power Brake Booster Inlet Hose Connector Fitting (2) - Position aside

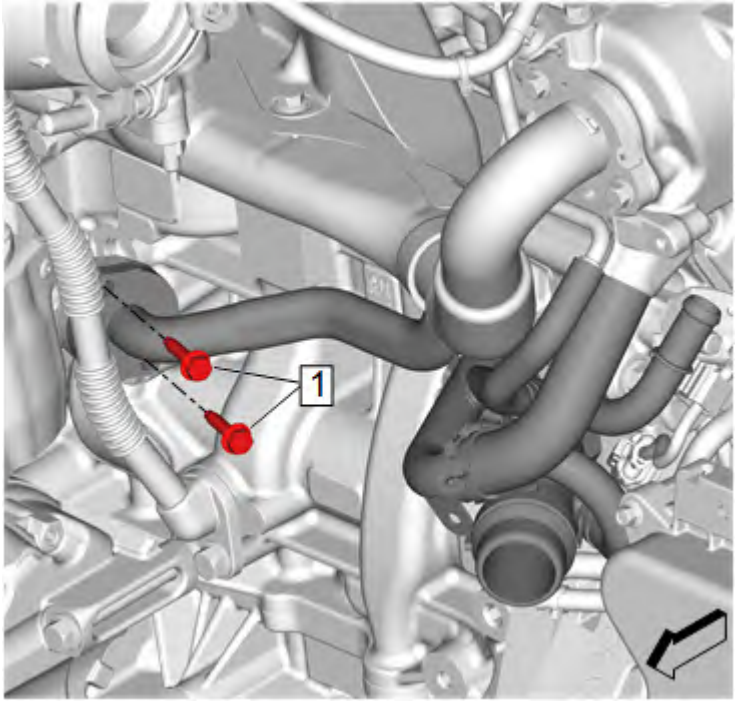


Fig. 270: Thermostat Bypass Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Remove Thermostat Bypass Pipe Bolt (1) - [2x]

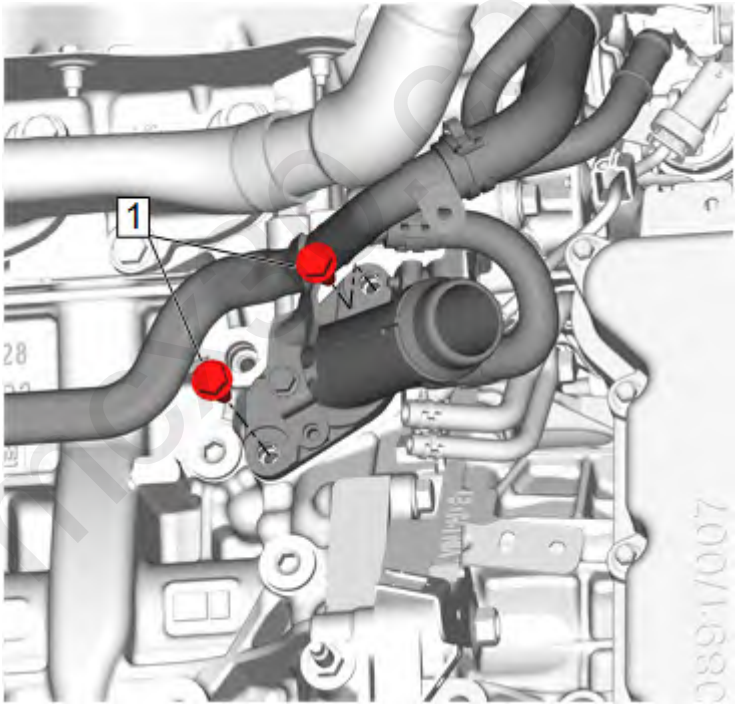


Fig. 271: Water Outlet Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove Water Outlet Bolt (1) - [2x]

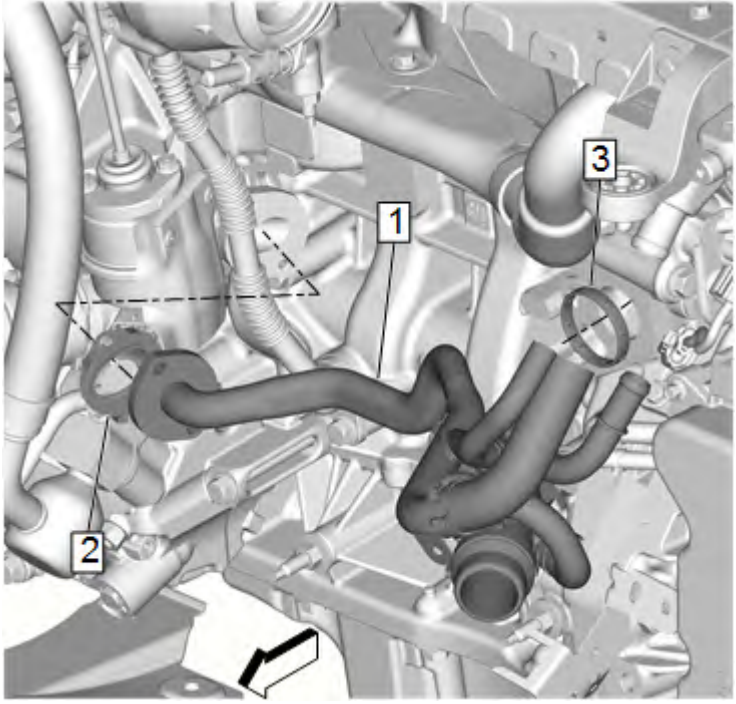


Fig. 272: Water Outlet Seal, Thermostat By-Pass Pipe And Water Outlet
Courtesy of GENERAL MOTORS COMPANY

9. Remove the thermostat by-pass pipe and the water outlet (1) as an assembly.
10. Remove Thermostat Bypass Pipe Gasket (2) and DISCARD
11. Remove Water Outlet Seal (3) and DISCARD

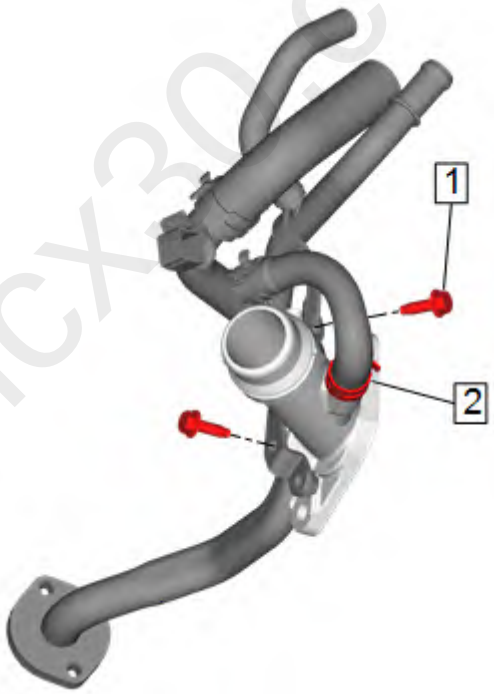


Fig. 273: Thermostat Bypass Pipe Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

12. Remove Thermostat Bypass Pipe Bracket Bolt (1) - [2x]
13. Remove Hose Clamp (2) - **Hose Clamp Replacement Guidelines - Spring Type**

mcx30.com

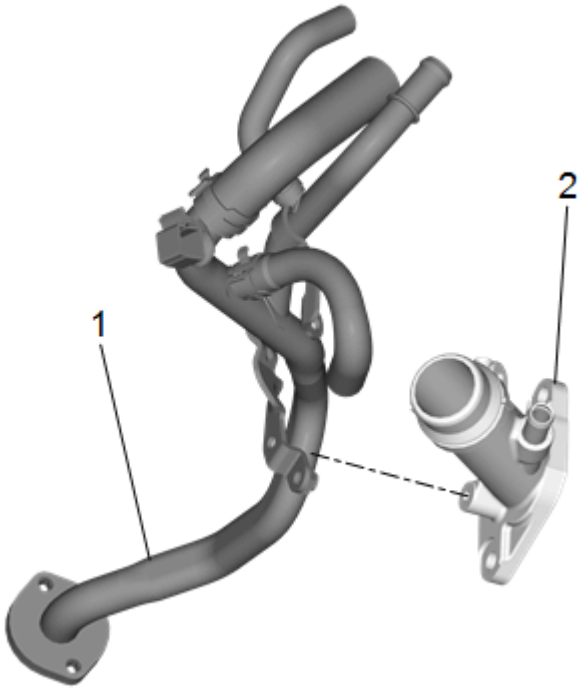


Fig. 274: Thermostat Bypass Pipe And Water Outlet
Courtesy of GENERAL MOTORS COMPANY

14. Separate the thermostat bypass pipe (1) from the water outlet (2).
15. Transfer components as necessary.

Installation Procedure

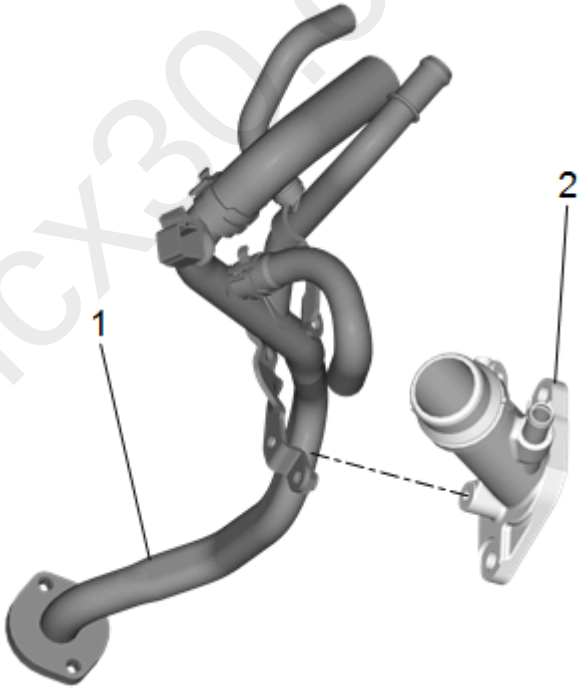


Fig. 275: Thermostat Bypass Pipe And Water Outlet
Courtesy of GENERAL MOTORS COMPANY

1. Join the thermostat bypass pipe (1) to the water outlet (2).

mcx30.com

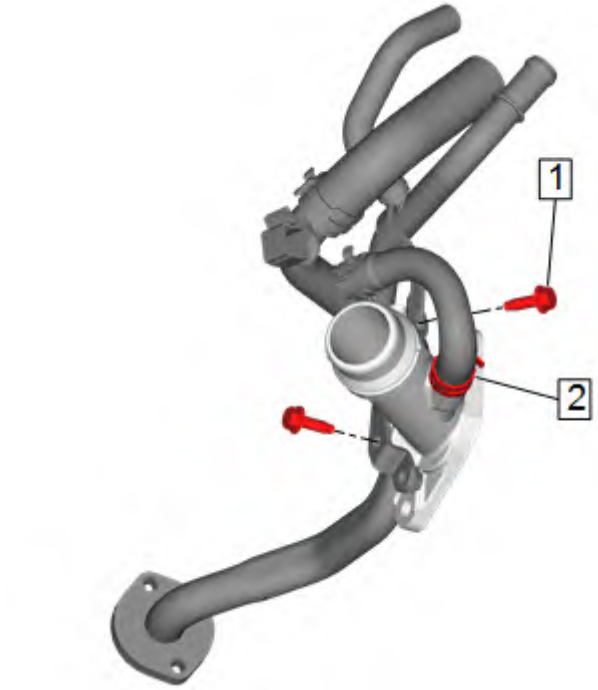


Fig. 276: Thermostat Bypass Pipe Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution**

2. Install Thermostat Bypass Pipe Bracket Bolt (1) and tighten [2x] 10 N.m (89 lb in)
3. Install Hose Clamp (2) -**Hose Clamp Replacement Guidelines - Spring Type**

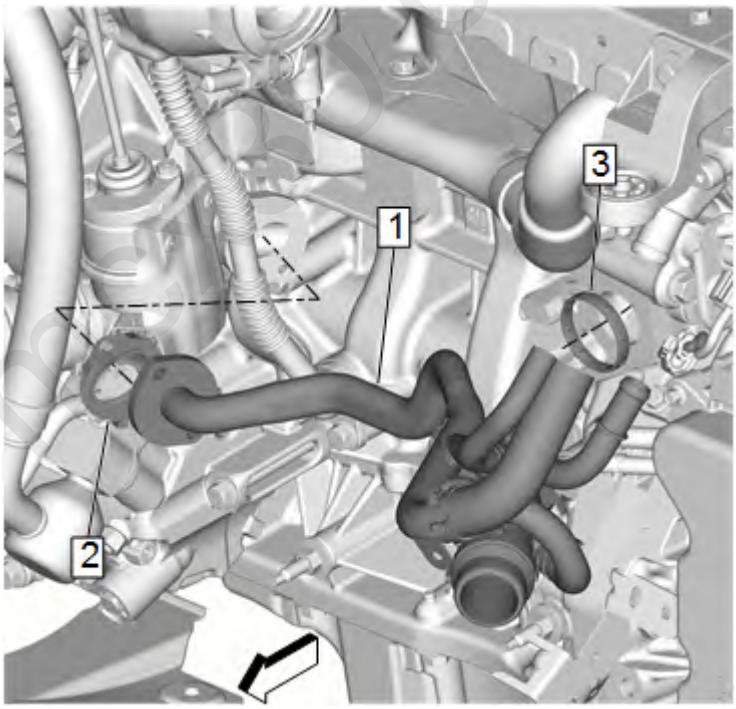


Fig. 277: Water Outlet Seal, Thermostat By-Pass Pipe And Water Outlet
Courtesy of GENERAL MOTORS COMPANY

4. Install New Water Outlet Seal (3).
5. Install a NEW Thermostat Bypass Pipe Gasket (2).
6. Install the thermostat by-pass pipe and the water outlet (1) as an assembly.

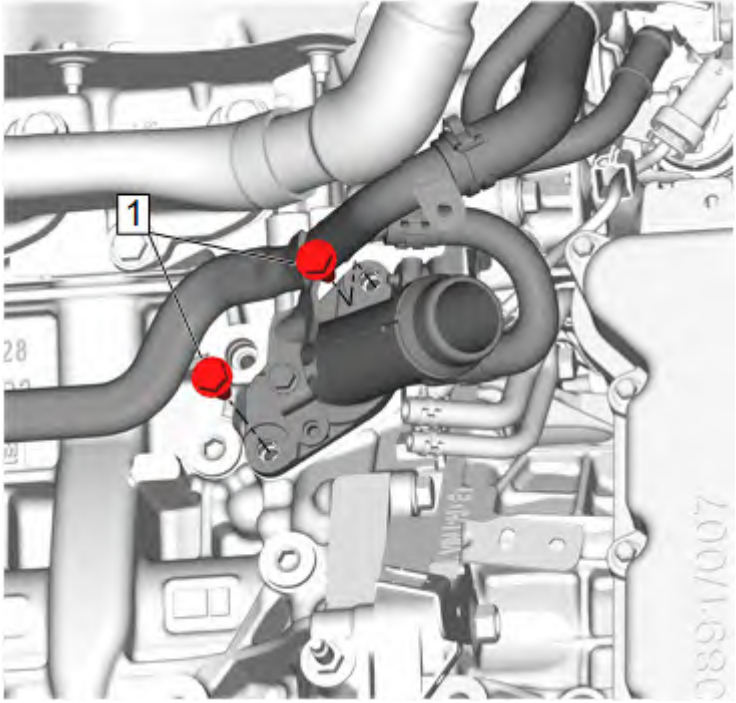


Fig. 278: Water Outlet Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Install Water Outlet Bolt (1) [2x] - **Water Outlet Replacement (LH7)**

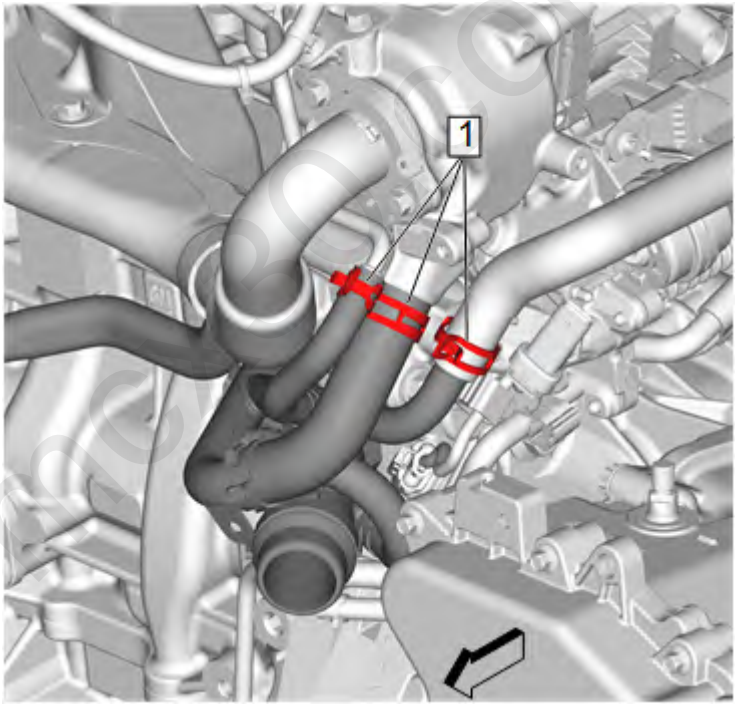


Fig. 279: Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

8. Install Thermostat Bypass Pipe Bolt (1) and tighten [2x] 10 N.m (89 lb in)

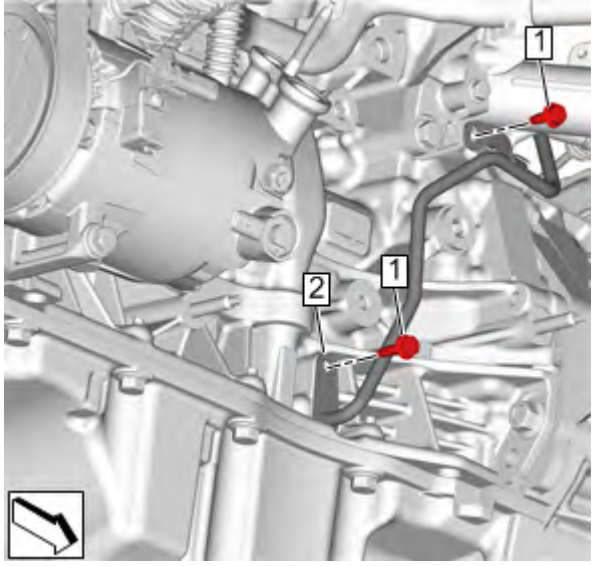


Fig. 280: Power Brake Booster Inlet Hose Connector Fitting Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Install Power Brake Booster Inlet Hose Connector Fitting (2)
10. Install Power Brake Booster Inlet Hose Connector Fitting Bolt (1) - [2x] - **Power Brake Booster Inlet Hose Connector Fitting Replacement**
11. Install Hose Clamp (1) - [3x] - **Hose Clamp Replacement Guidelines - Spring Type**
12. Install Charge Air Cooler Outlet Air Tube - **Charge Air Cooler Outlet Air Tube Replacement**
13. Install Oxidation Catalytic Converter - **Oxidation Catalytic Converter Replacement (LH7)**

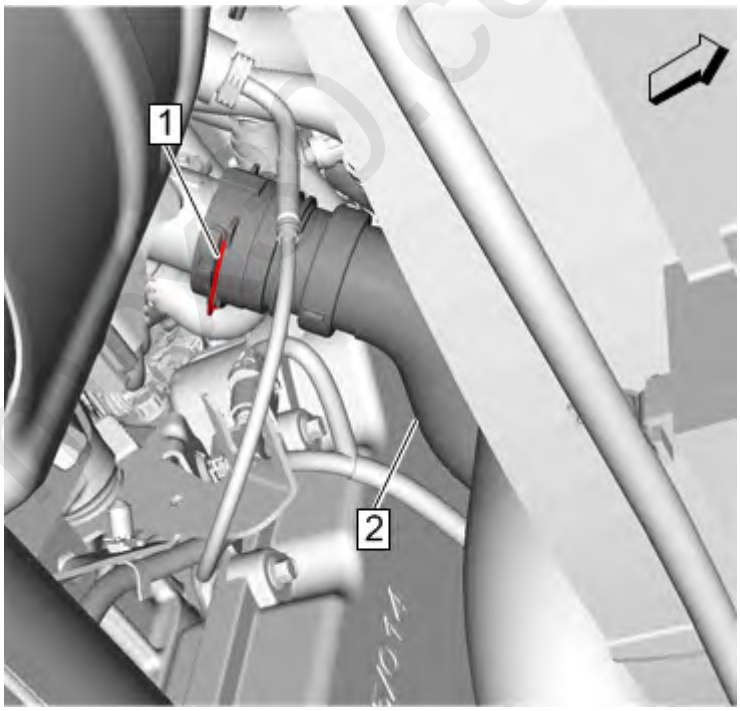


Fig. 281: Radiator Inlet Hose Retainer
Courtesy of GENERAL MOTORS COMPANY

14. Remove Radiator Inlet Hose (2) @ Water Outlet -**Radiator Inlet Hose Replacement (LYX)Radiator Inlet Hose Replacement (LH7)Radiator Inlet Hose Replacement (LTG with KL9)**

WATER PUMP REPLACEMENT (LTG)

Special Tools

BO-38185 Hose Clamp Pliers

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

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**.
2. Remove the drive belt. Refer to **Drive Belt Replacement** .
3. Remove the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LTG)** .

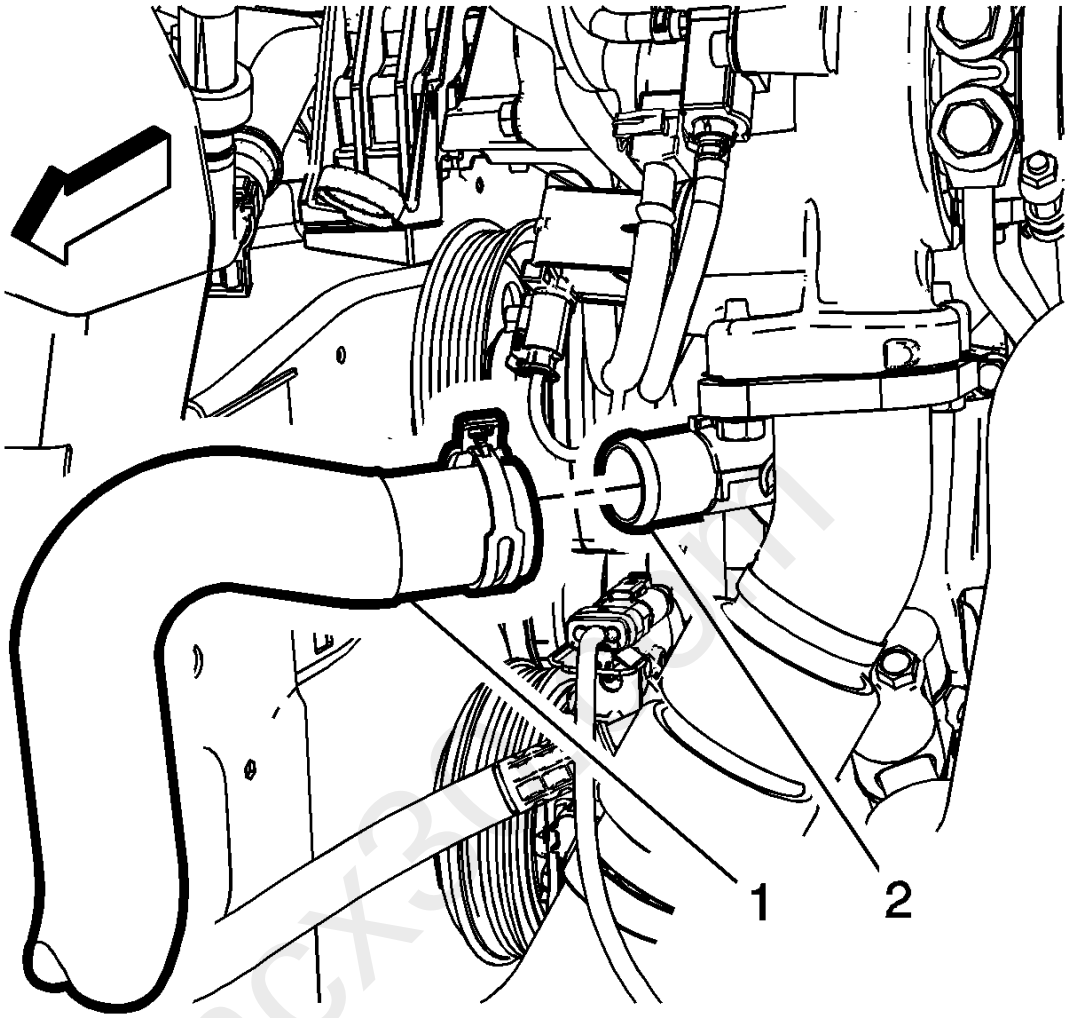


Fig. 282: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

4. Using the BO-38185 hose clamp pliers, remove the radiator outlet hose (1) from the water outlet (2).

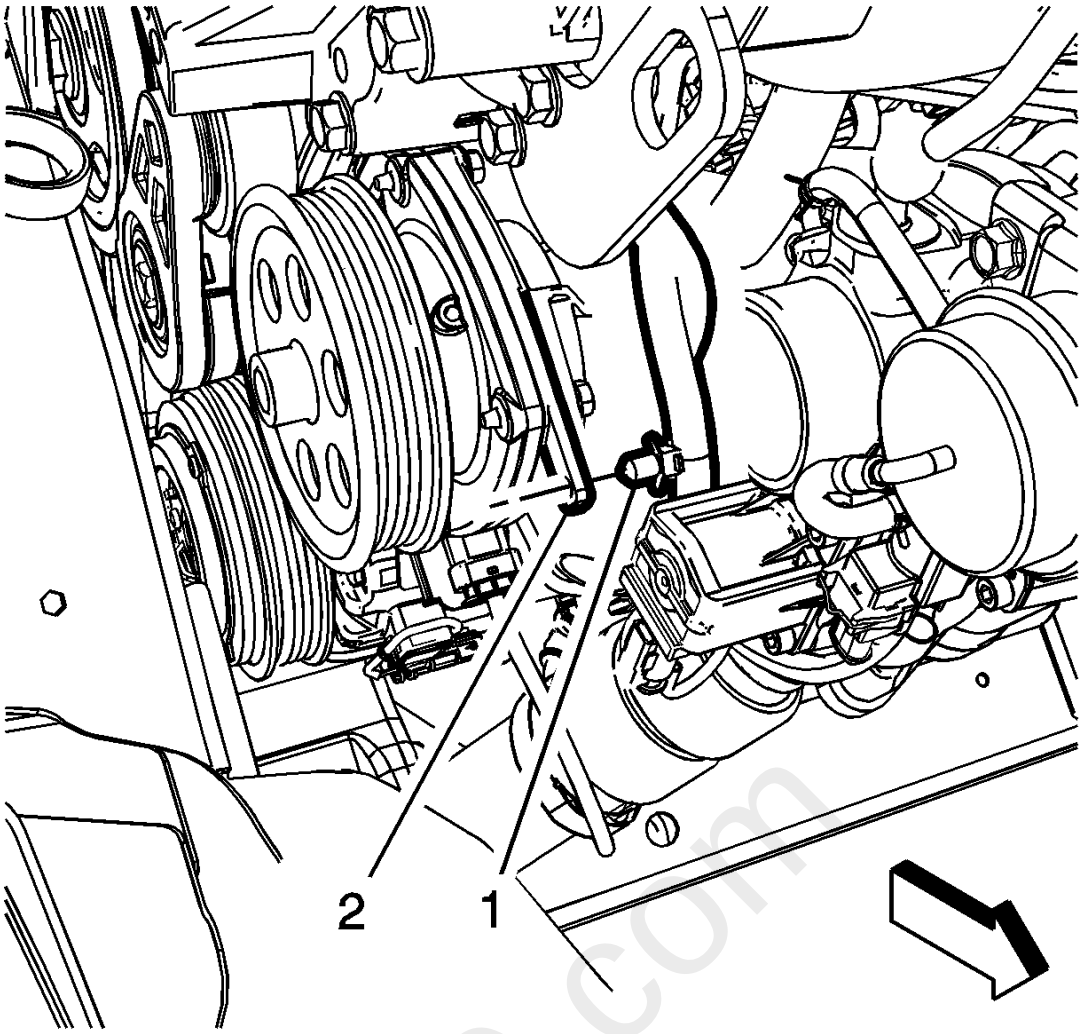


Fig. 283: Engine Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Remove the engine harness retainer (1) from the water pump (2).

mcx30.com

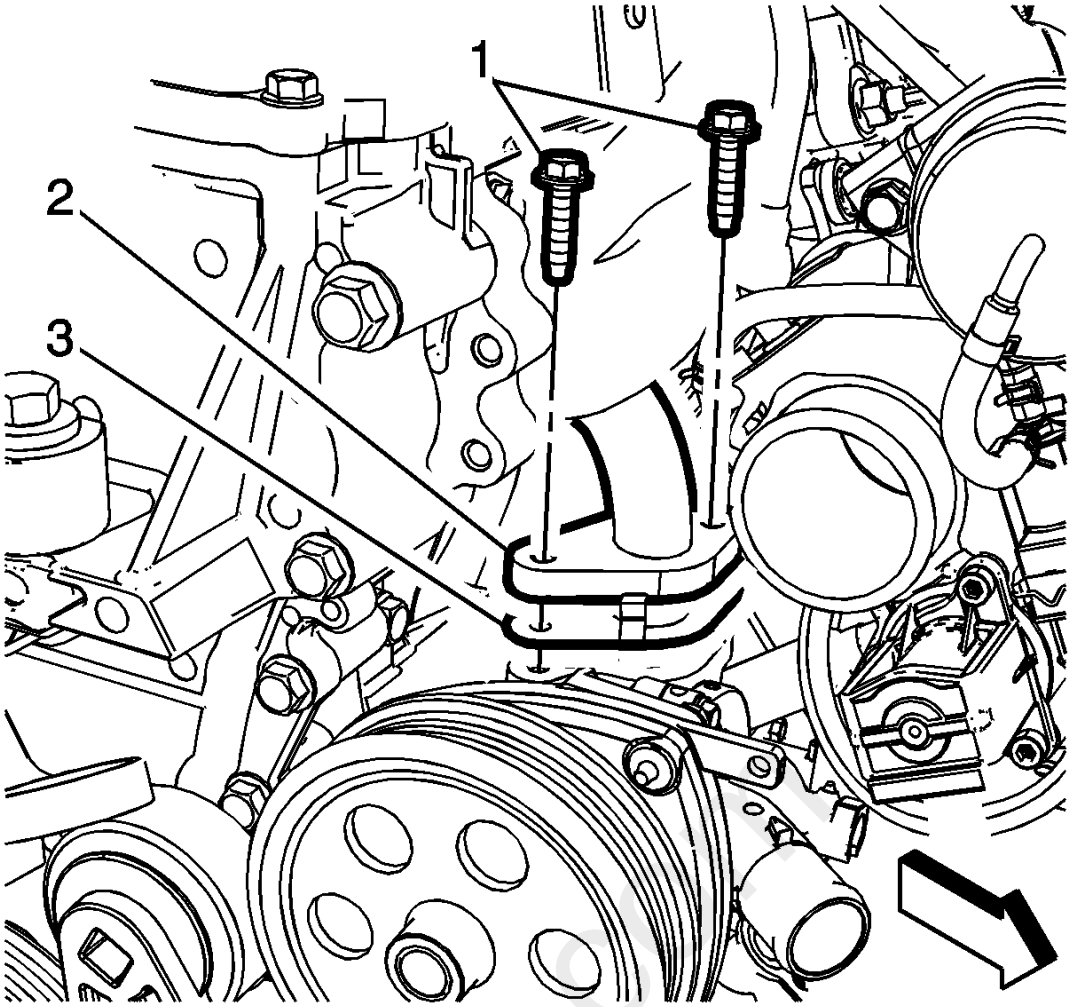


Fig. 284: Thermostat Bypass Pipe Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Remove the thermostat bypass pipe fasteners (1) and remove the thermostat bypass pipe (2) from the water pump.
7. Discard the thermostat bypass pipe gasket (3).

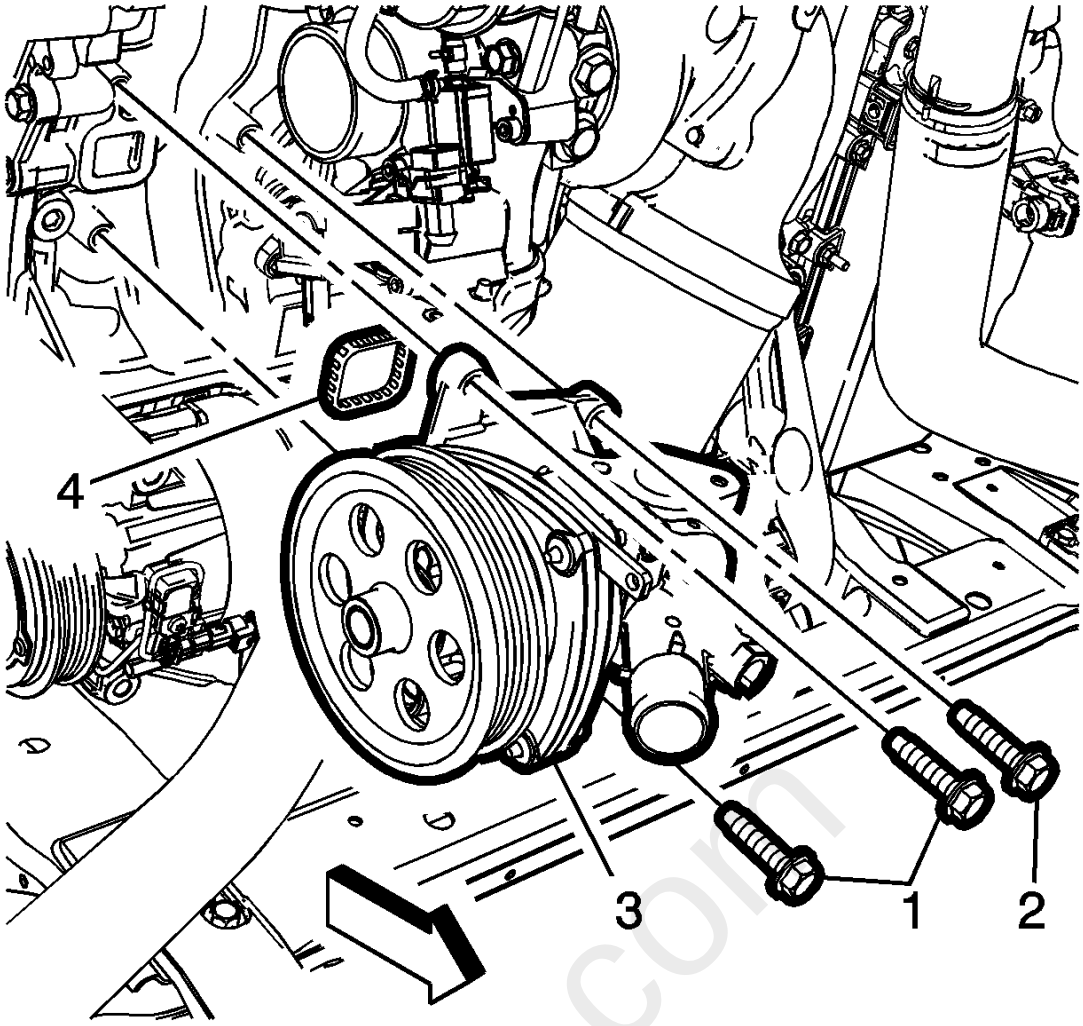


Fig. 285: Water Pump Fasteners
Courtesy of GENERAL MOTORS COMPANY

8. Remove the water pump fasteners (1) and (2) remove the water pump (3).
9. Discard the water pump seal (4).

Installation Procedure

mcx30.com

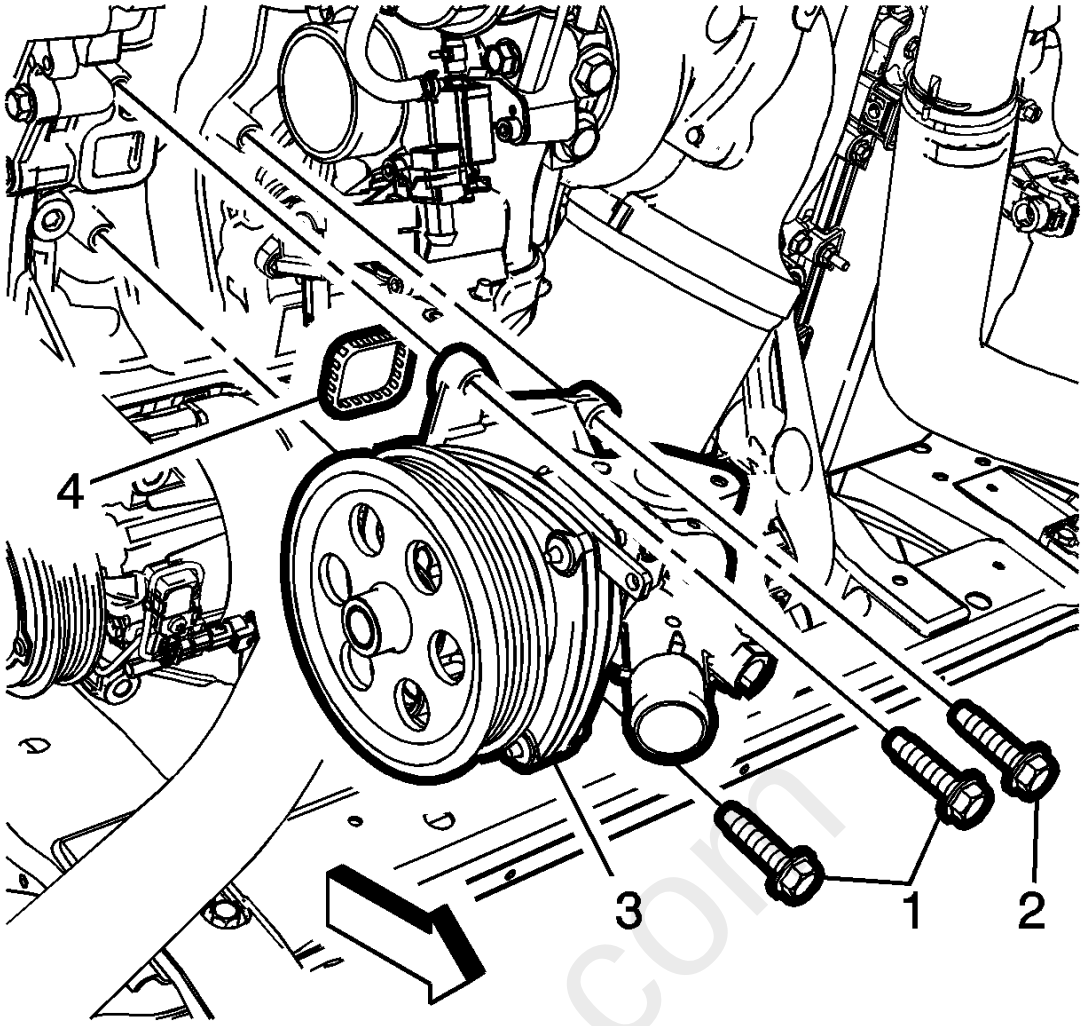


Fig. 286: Water Pump Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

1. Install the water pump (3) into position with a NEW water pump seal (4) and hand tighten the bolts.
2. Tighten (1) bolts to 25 N.m (18 lb ft).
3. Tighten (2) bolt to 25 N.m (18 lb ft).

mcx30.com

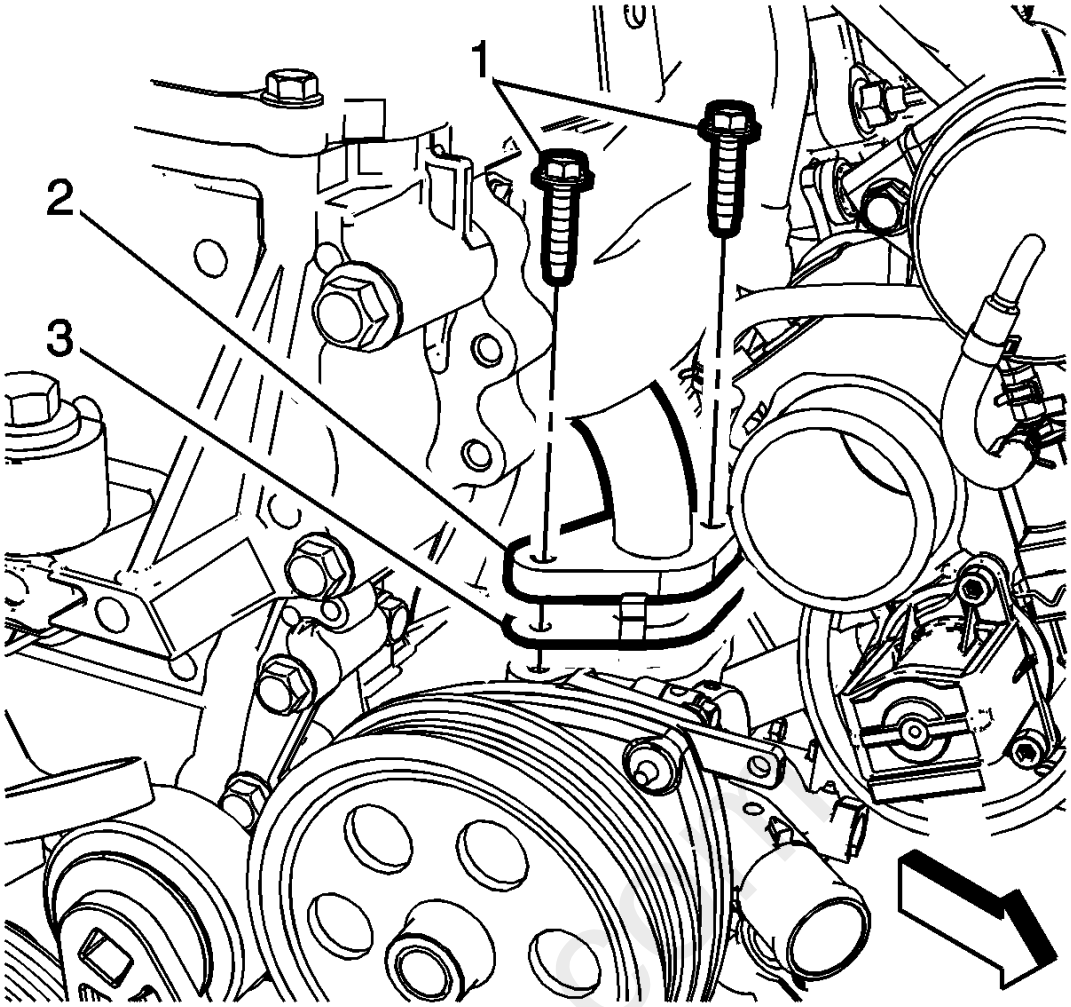


Fig. 287: Thermostat Bypass Pipe Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Install the thermostat bypass pipe (2) to the water pump with a NEW gasket (3) and tighten the fasteners (1) to 10 N.m (89 lb in).

mcx30.com

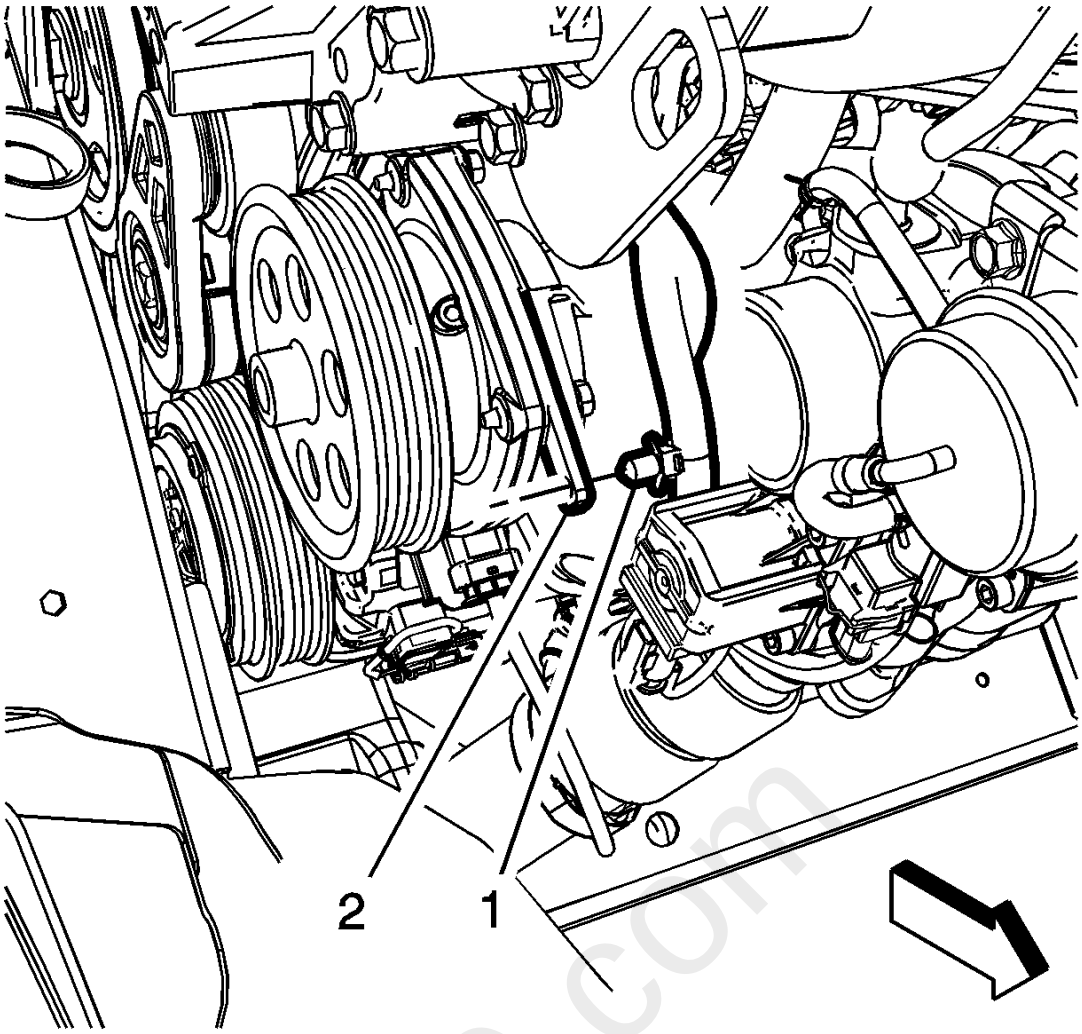


Fig. 288: Engine Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Install the engine wiring harness retainer (1) to the water pump (2).

mcx30.com

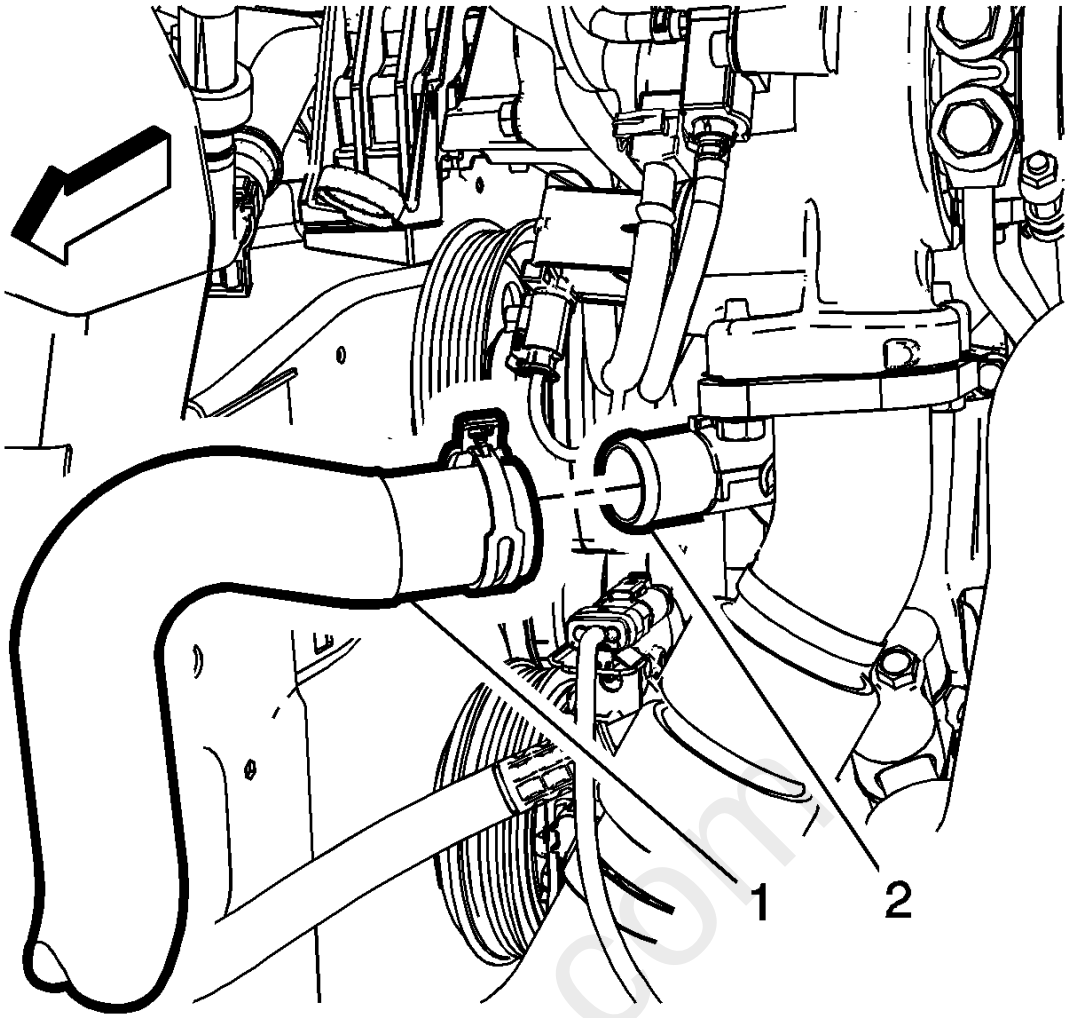


Fig. 289: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

6. Using the BO-38185 hose clamp pliers, install the radiator outlet hose (1) to the water outlet (2).
7. Install the drive belt. Refer to **Drive Belt Replacement** .
8. Install the exhaust manifold heat shield. Refer to **Exhaust Manifold Heat Shield Replacement (LTG)** .
9. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**.
10. Start the engine and check for coolant leaks.

WATER PUMP REPLACEMENT (LYX)

Removal Procedure

1. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**

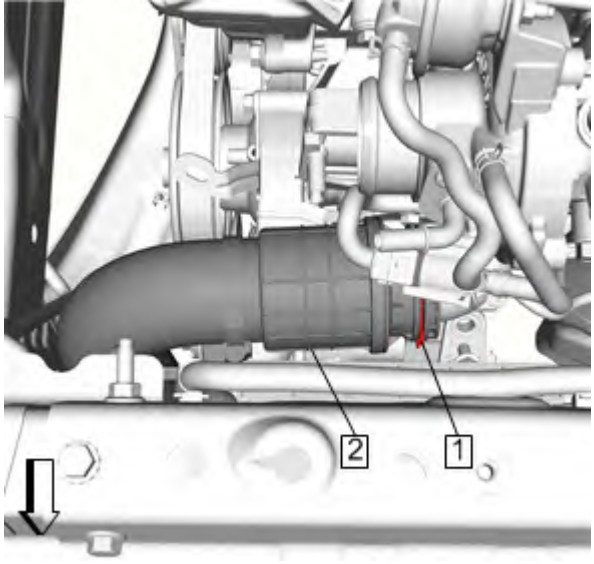


Fig. 290: Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

2. Remove Charge Air Cooler Inlet Air Tube (2) - **Charge Air Cooler Inlet Air Tube Replacement**

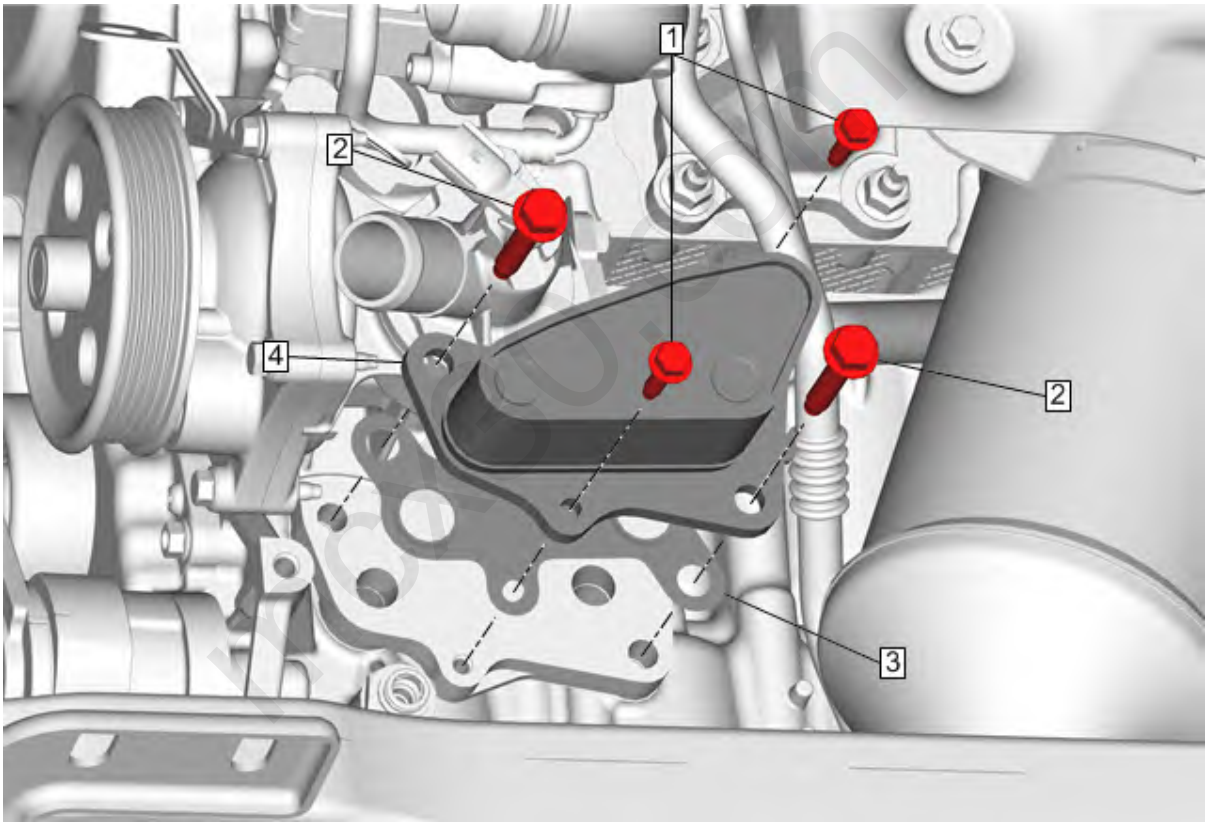


Fig. 291: Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

3. Remove Engine Oil Cooler (4) -

Engine Oil Cooler Replacement (LYX)

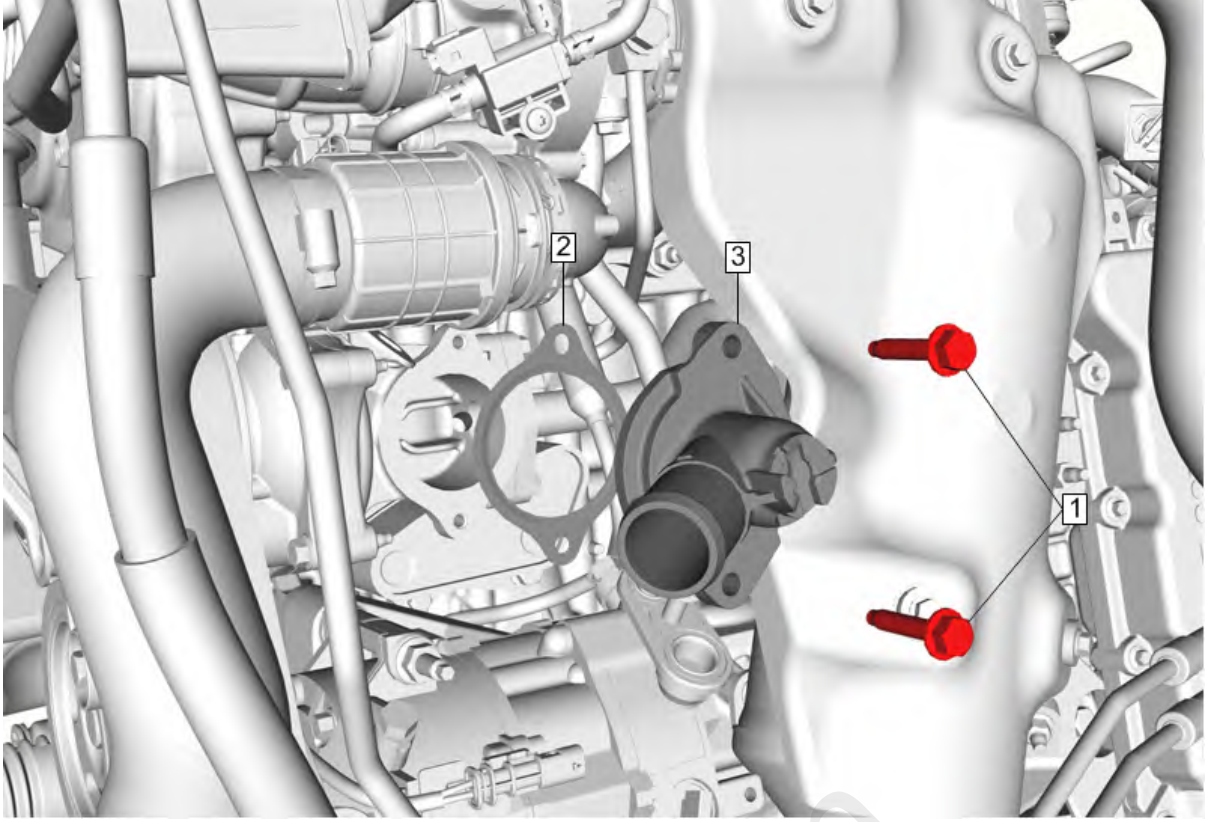


Fig. 292: Engine Coolant Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

4. Remove Engine Coolant Thermostat Housing (3) - **Engine Coolant Thermostat Housing Replacement (LYX)**

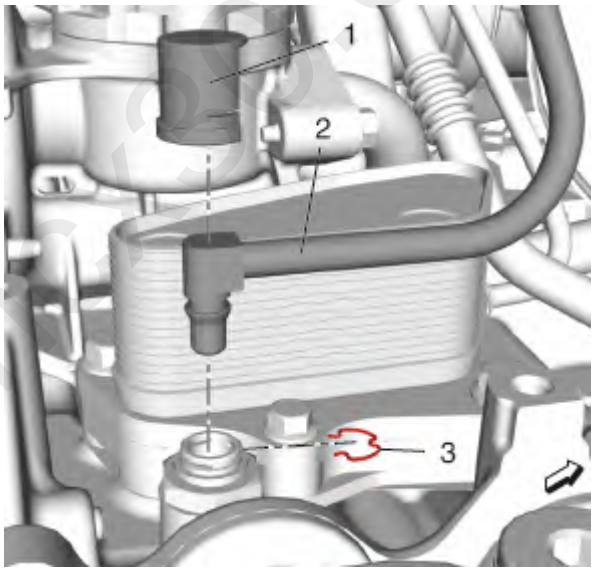


Fig. 293: Turbocharger Oil Feed Pipe, Clip And Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Reposition Turbocharger Oil Feed Pipe (2) - **Turbocharger Oil Feed Pipe Replacement**

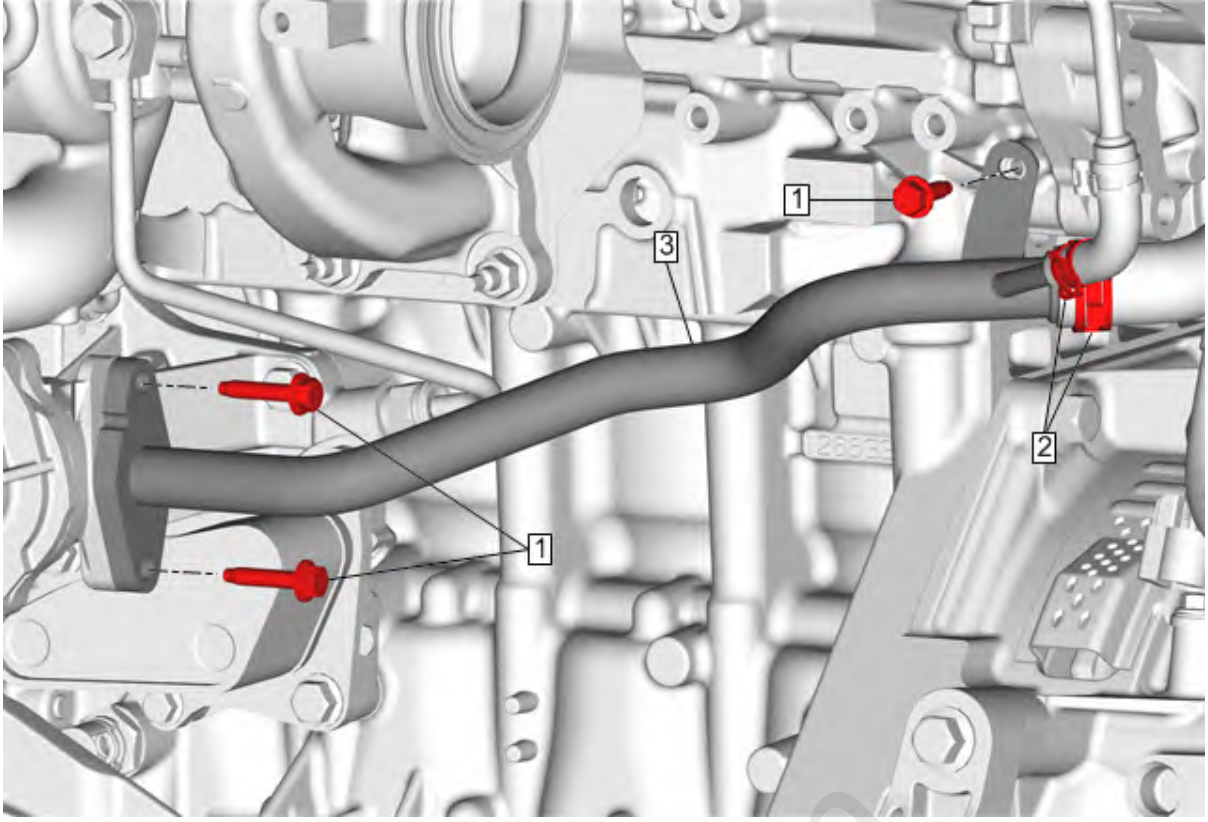


Fig. 294: Thermostat Bypass Pipe
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect Thermostat Bypass Pipe (3) @ Water Pump **Thermostat Bypass Pipe Replacement (LYX)**

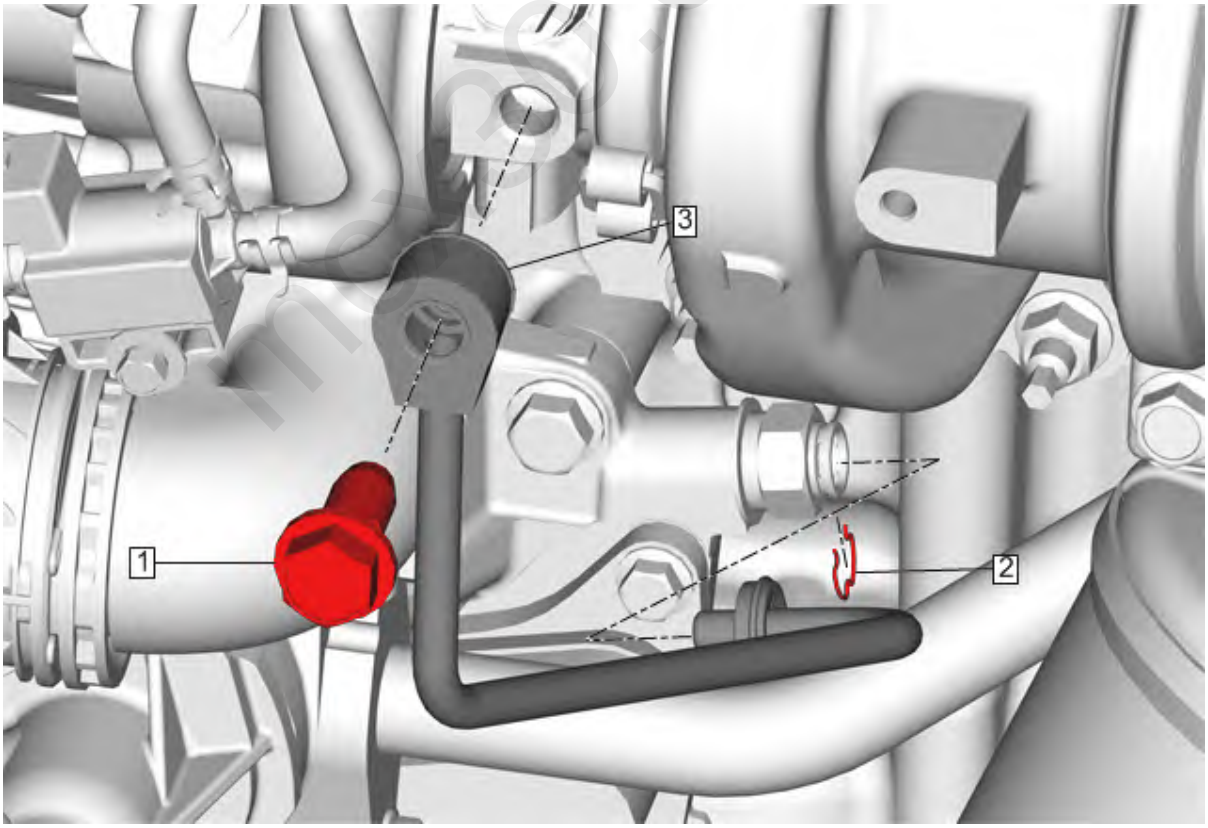


Fig. 295: Turbocharger Coolant Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

7. Remove Turbocharger Coolant Feed Pipe (3) - **Turbocharger Coolant Feed Pipe Replacement (LYX)**

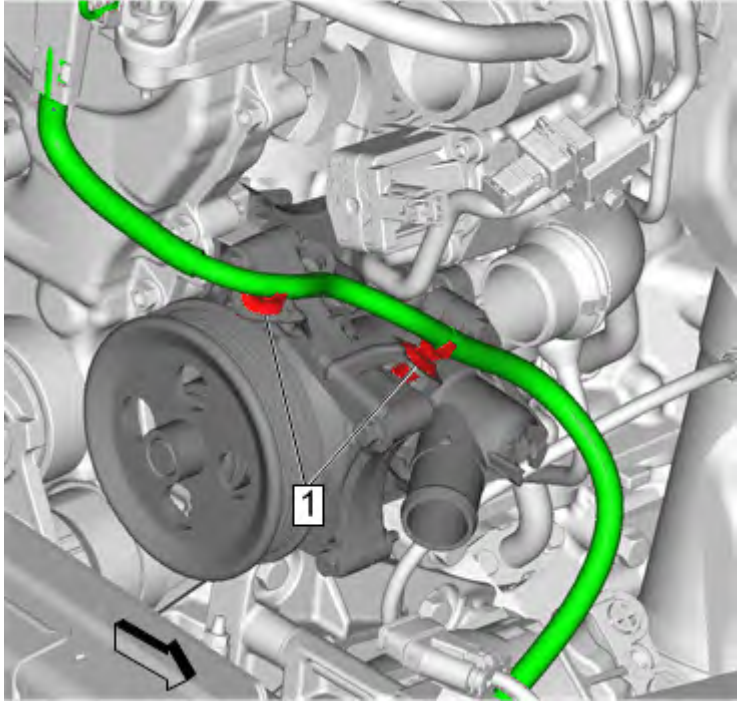


Fig. 296: Engine Wiring Harness Retainers
Courtesy of GENERAL MOTORS COMPANY

8. Separate Engine Wiring Harness Retainer (1) @ Engine Wiring Harness Bracket - [2x]

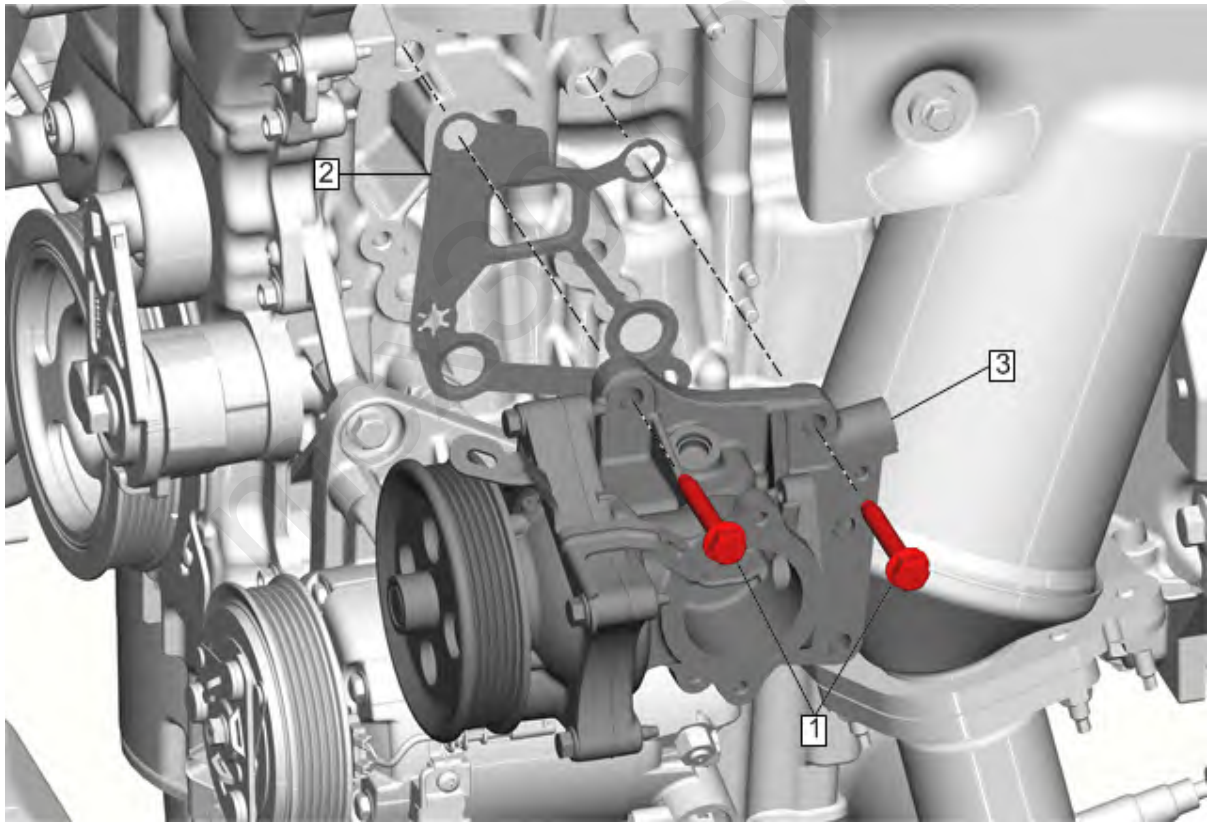


Fig. 297: Water Pump Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Remove Water Pump Bolt (1) - [2x]
10. Remove Water Pump (3).
11. Remove Water Pump Gasket (2) and DISCARD

Installation Procedure

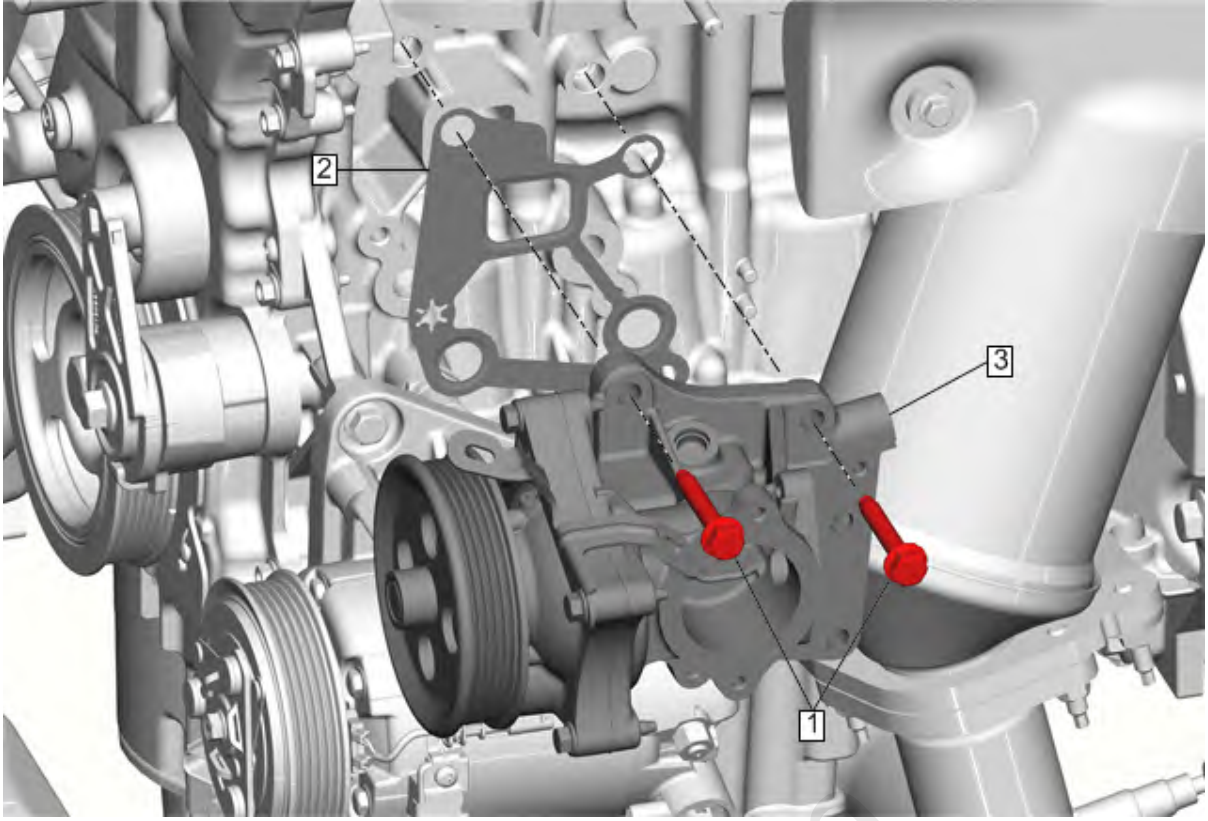


Fig. 298: Water Pump Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW Water Pump Gasket (2).
2. Install Water Pump (3).

CAUTION: **Refer to Fastener Caution .**

3. Install Water Pump Bolt (1) and tighten [2x] 25 N.m (18 lb ft)

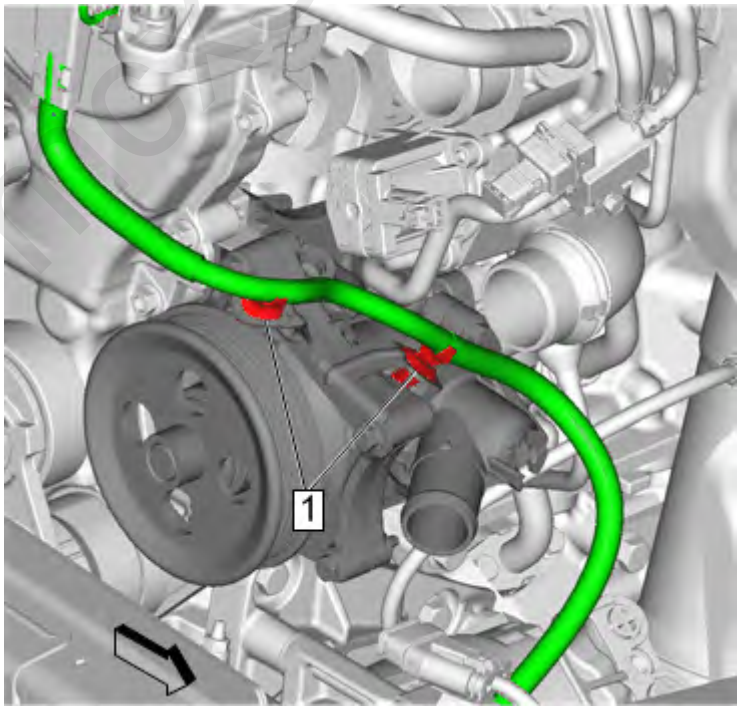


Fig. 299: Engine Wiring Harness Retainers
Courtesy of GENERAL MOTORS COMPANY

4. Install Engine Wiring Harness Retainer (1) @ Engine Wiring Harness Bracket - [2x]

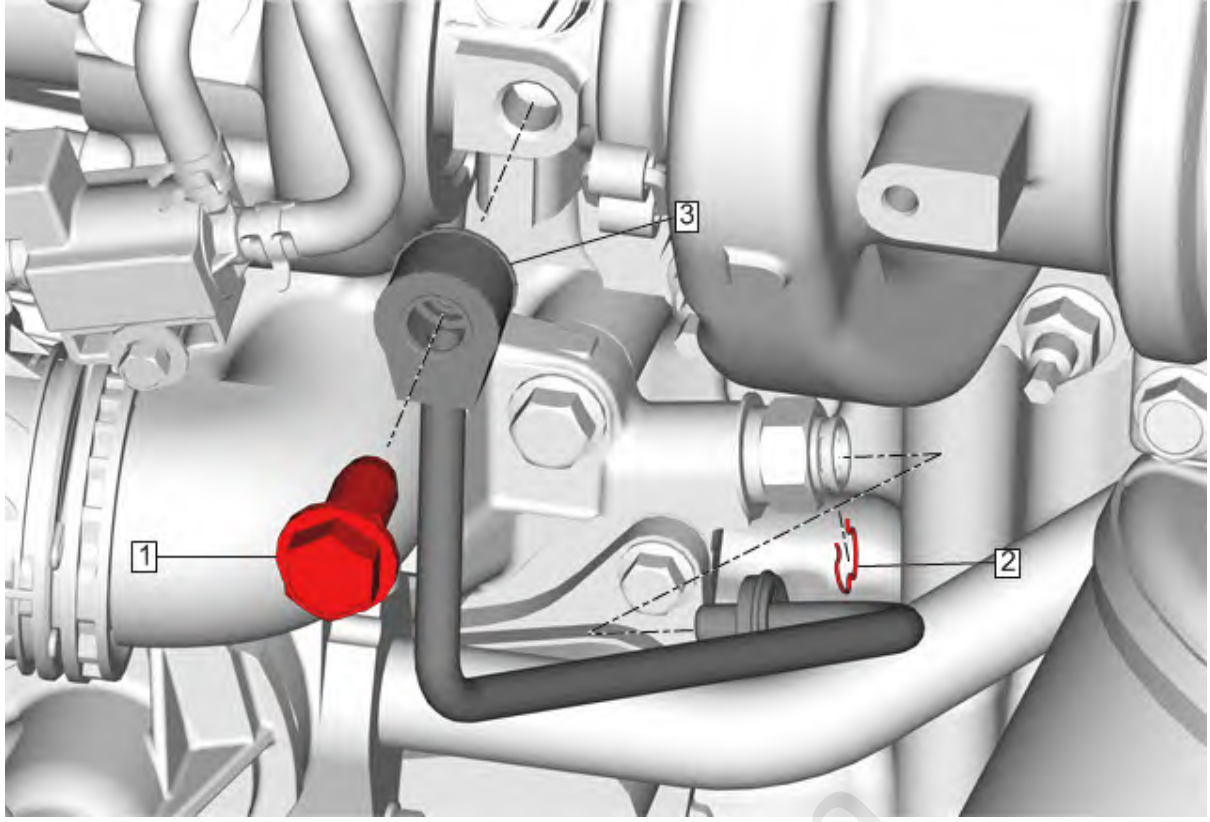


Fig. 300: Turbocharger Coolant Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

5. Install Turbocharger Coolant Feed Pipe (3) - **Turbocharger Coolant Feed Pipe Replacement (LYX)**

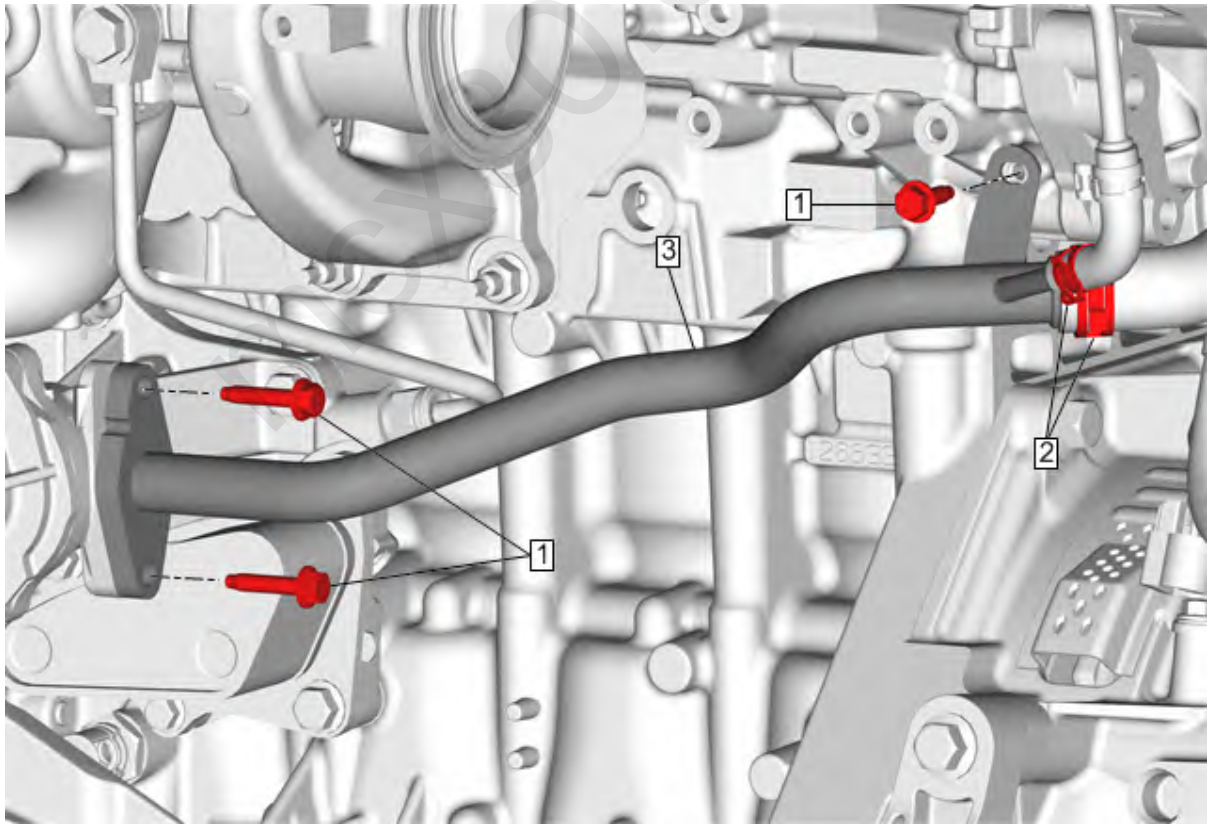


Fig. 301: Thermostat Bypass Pipe
Courtesy of GENERAL MOTORS COMPANY

6. Connect Thermostat Bypass Pipe (3) @ Water Pump - **Thermostat Bypass Pipe Replacement (LYX)**

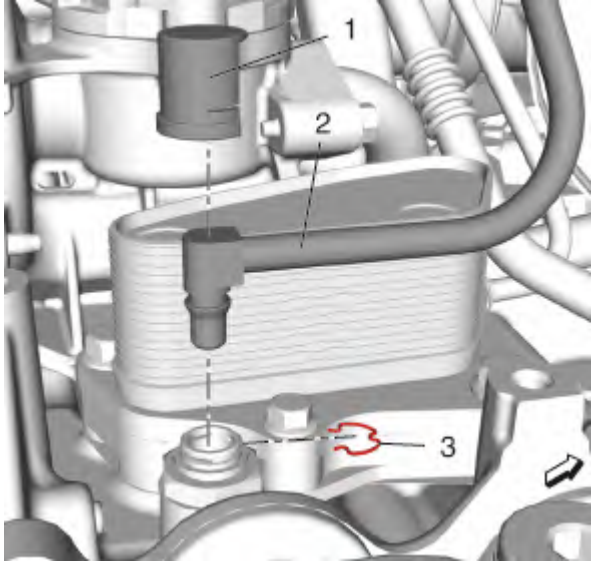


Fig. 302: Turbocharger Oil Feed Pipe, Clip And Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Install Turbocharger Oil Feed Pipe (2) - **Turbocharger Oil Feed Pipe Replacement**

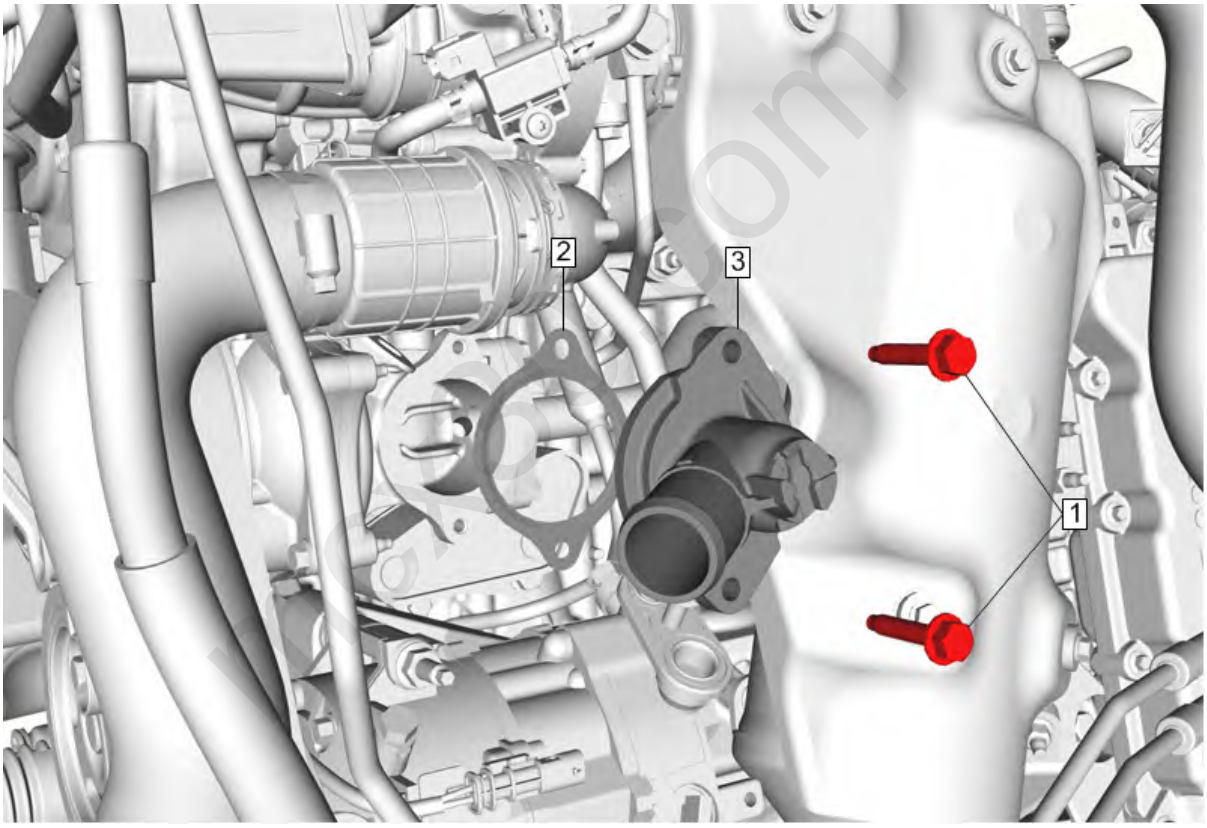


Fig. 303: Engine Coolant Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

8. Install Engine Coolant Thermostat Housing (3) - **Engine Coolant Thermostat Housing Replacement (LYX)**

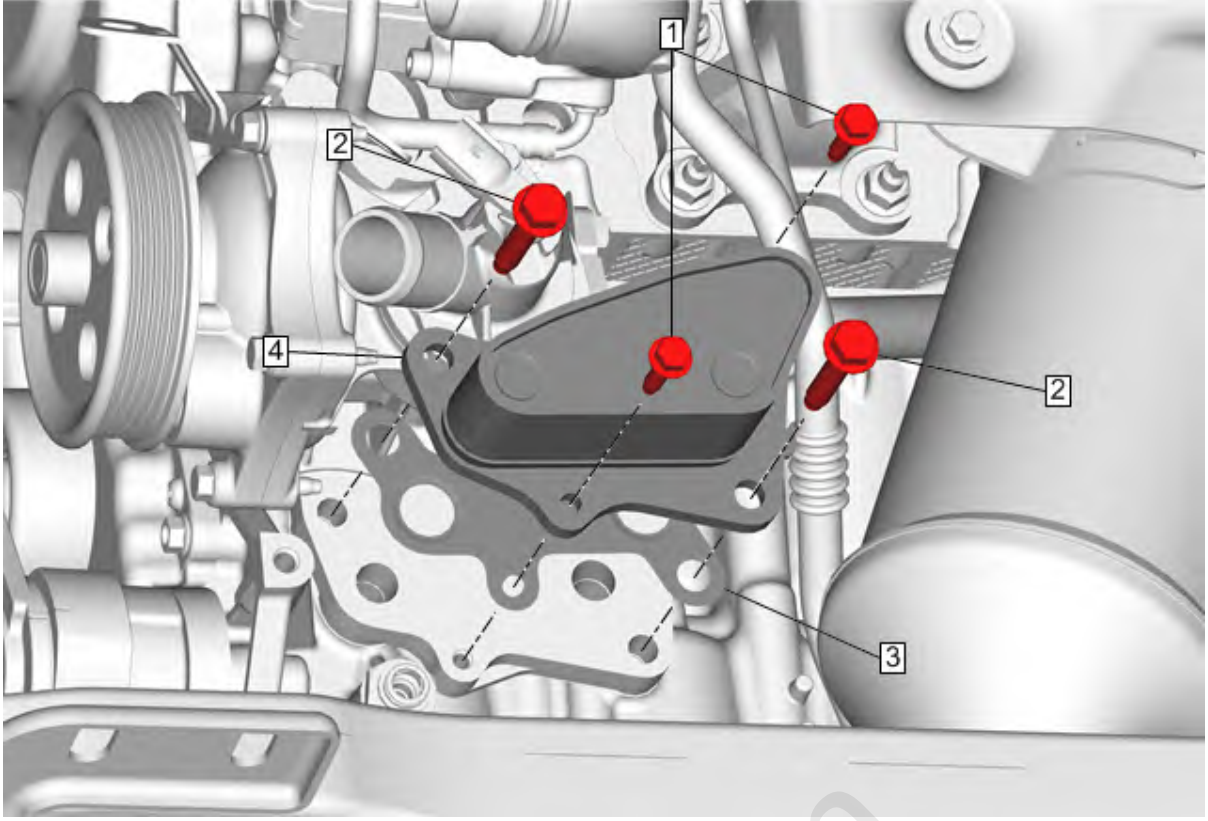


Fig. 304: Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

9. Install Engine Oil Cooler (4) -

   Engine Oil Cooler Replacement (LYX)

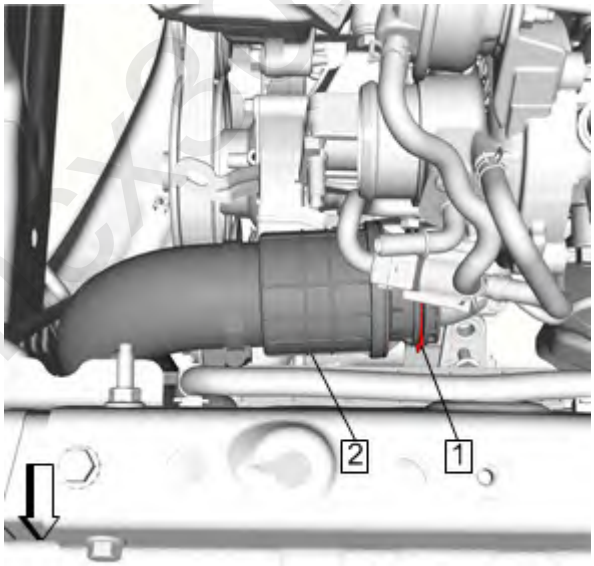


Fig. 305: Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

10. Install Charge Air Cooler Inlet Air Tube (2) - Charge Air Cooler Inlet Air Tube Replacement
11. Fill the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)
12. Start the engine and check for leaks.

WATER PUMP REPLACEMENT (LH7)

Removal Procedure

1. Drain the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)
2. Remove Air Cleaner Outlet Duct - Air Cleaner Outlet Duct Replacement

3. Remove Air Cleaner Assembly - **Air Cleaner Assembly Replacement**
4. Remove Oxidation Catalytic Converter - **Oxidation Catalytic Converter Replacement (LH7)**
5. Remove Charge Air Cooler Inlet Air Tube - **Charge Air Cooler Inlet Air Tube Replacement**
6. Remove Radiator Outlet Hose@Water Pump - **Radiator Outlet Hose Replacement (LH7)**
7. Remove Generator and Air Conditioning Compressor Belt - **Generator and Air Conditioning Compressor Belt Replacement**

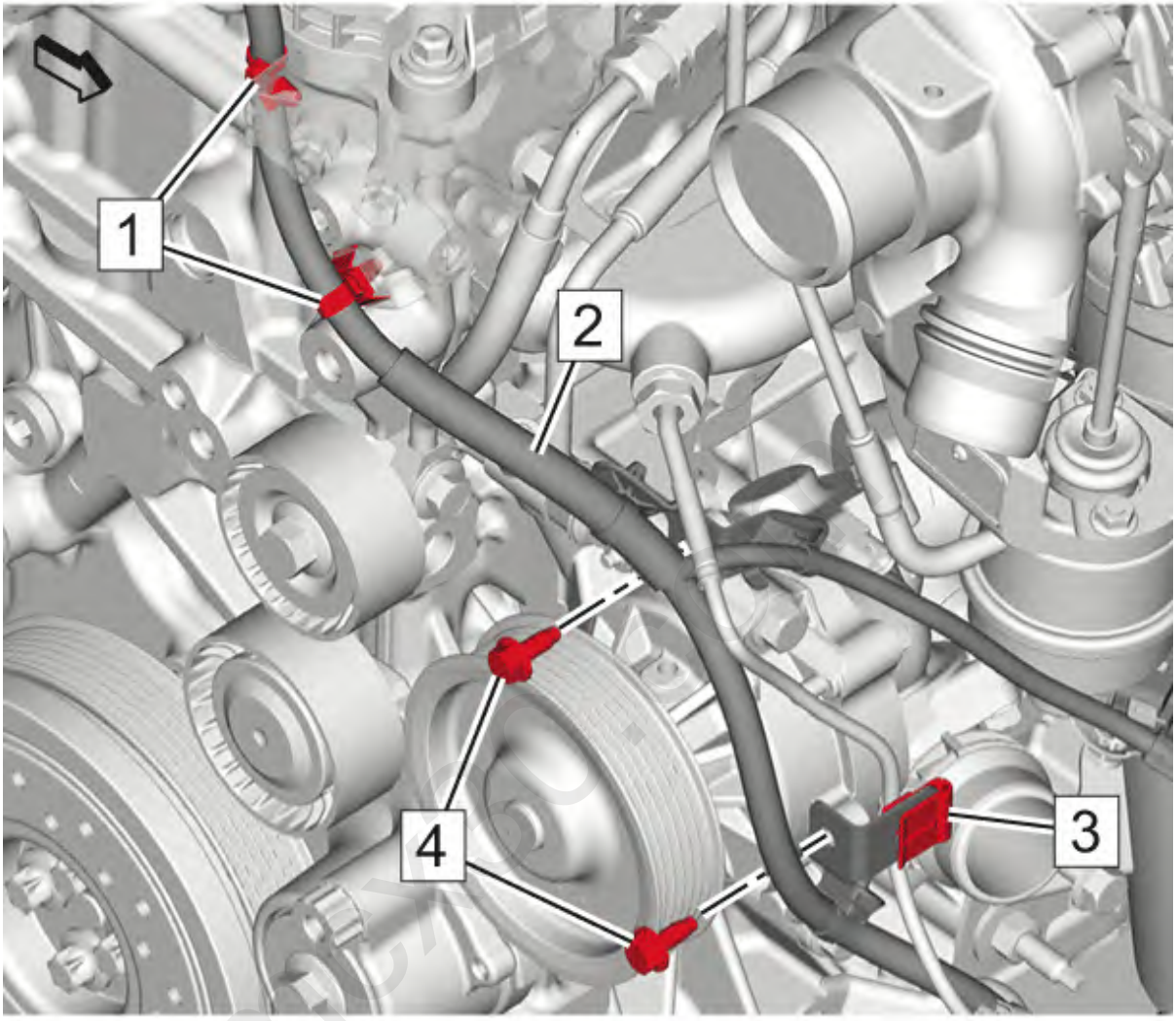


Fig. 306: Wiring Harness Clip And Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Unclip Wiring Harness Clip (1) - [2x]
9. Remove the 2 engine control module and engine wiring harness bracket bolts (4).
10. Unclip Retainer (3).
11. Lay the engine control module wiring harness (2) aside.

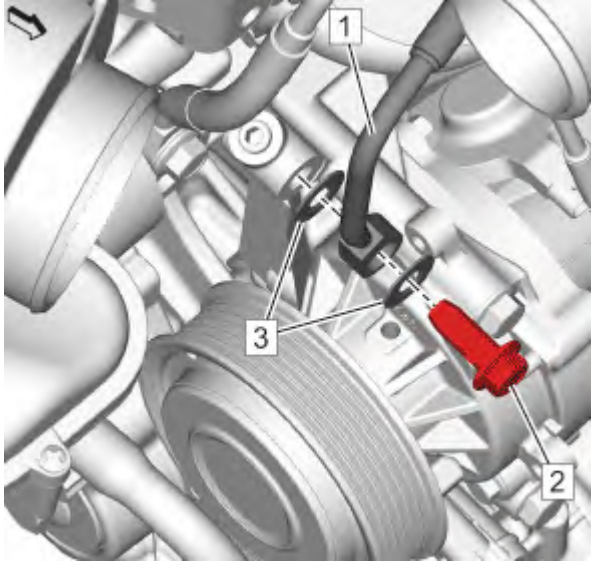


Fig. 307: Turbocharger Coolant Feed Pipe Hollow Screw And Seal Rings
Courtesy of GENERAL MOTORS COMPANY

12. Remove the turbocharger coolant feed pipe hollow screw (2) and DISCARD the 2 seal rings (3). Hang the turbocharger coolant feed pipe (1) aside.

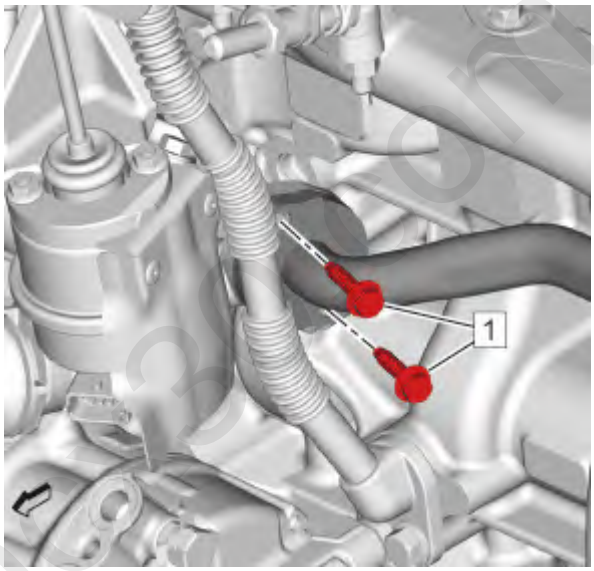


Fig. 308: Thermostat Bypass Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

13. Remove Thermostat Bypass Pipe Bolt (1) - [2x]

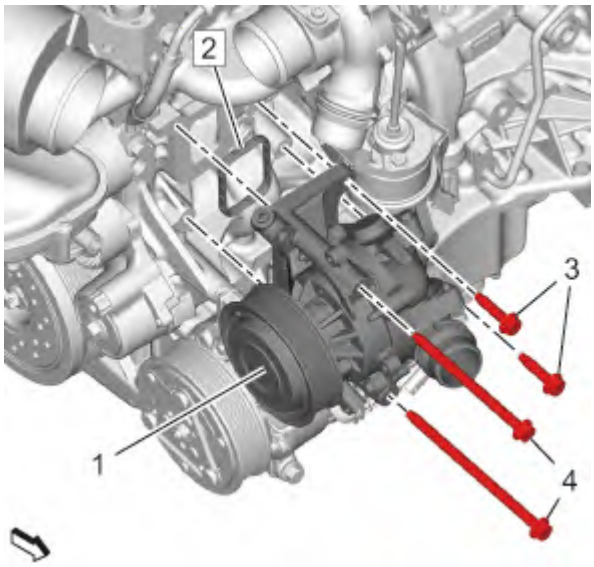


Fig. 309: Gasket, Water Pump And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Take note that there are different bolt lengths.**

14. Remove the water pump bolts. (3, 4) [4x]
15. Remove the water pump. (1)
16. Remove and DISCARD the gasket. (2)

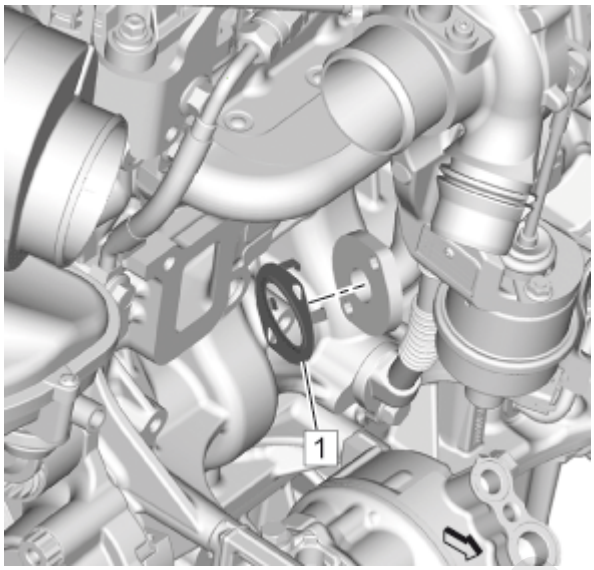


Fig. 310: Thermostat Bypass Pipe Gasket
Courtesy of GENERAL MOTORS COMPANY

17. Remove Thermostat Bypass Pipe Gasket (1) and DISCARD

Installation Procedure

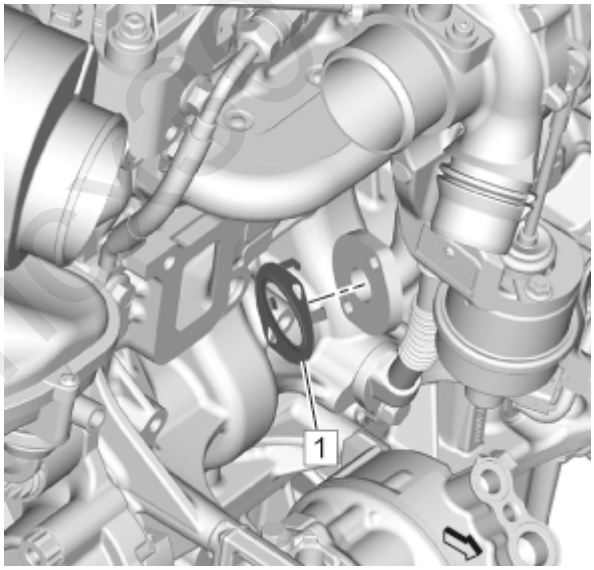


Fig. 311: Thermostat Bypass Pipe Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW Thermostat Bypass Pipe Gasket (1)
2. Clean the sealing surfaces of the water pump and the engine block.

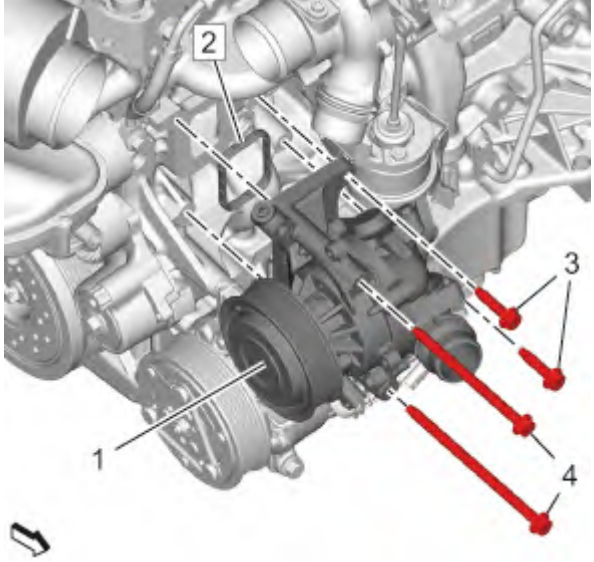


Fig. 312: Gasket, Water Pump And Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW water pump gasket. (2)
4. Install the water pump. (1)

CAUTION: **Fastener Caution**

NOTE: **Take note that there are different bolt lengths.**

5. Install Water Pump Bolt (3, 4) and tighten [4x] 25 N.m (18 lb ft).

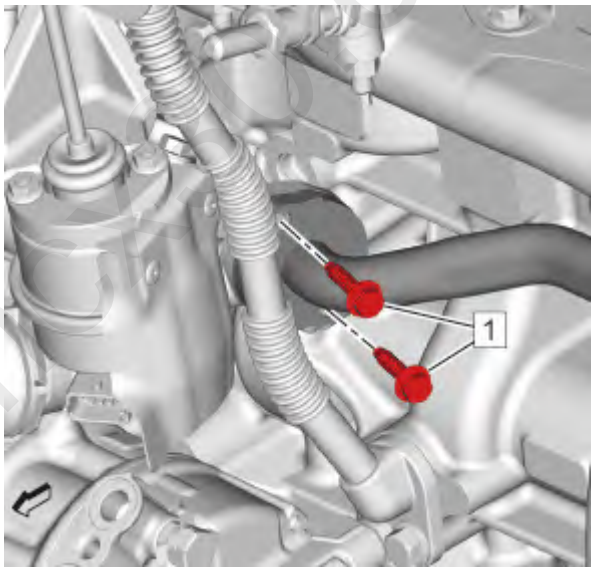


Fig. 313: Thermostat Bypass Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Install Thermostat Bypass Pipe Bolt (1) and tighten [2x] - Thermostat Bypass Pipe Replacement

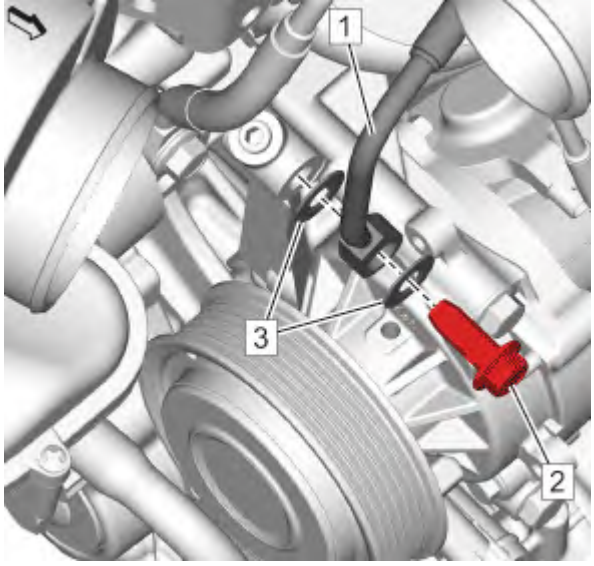


Fig. 314: Turbocharger Coolant Feed Pipe Hollow Screw And Seal Rings
Courtesy of GENERAL MOTORS COMPANY

7. Reposition the turbocharger coolant feed pipe (1) and install the turbocharger coolant feed pipe hollow screw (2) with 2 NEW seal rings (3). Tighten the turbocharger coolant feed pipe hollow screw. **Turbocharger Coolant Feed Pipe Replacement (LH7)**

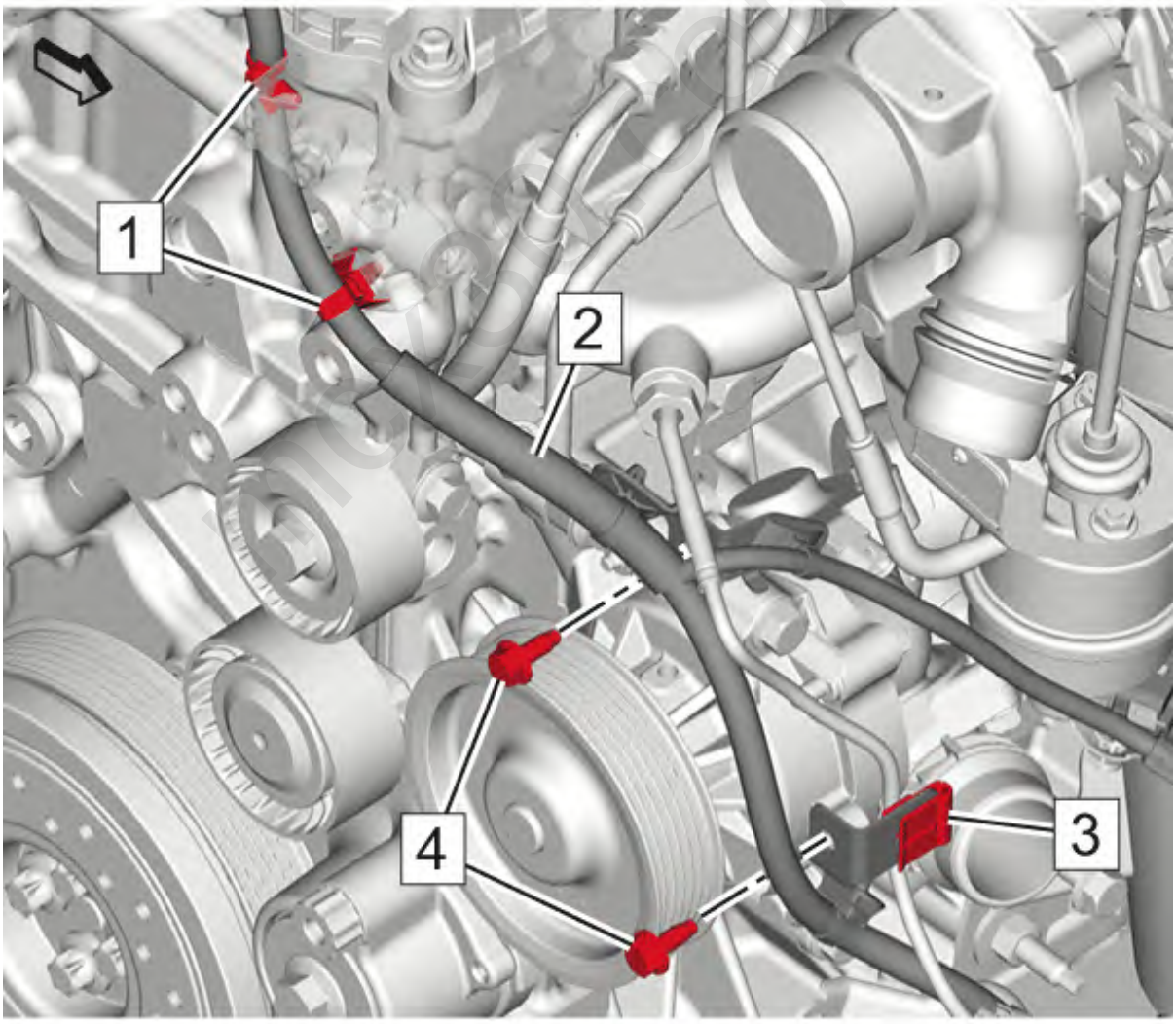


Fig. 315: Wiring Harness Clip And Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Reposition the engine control module wiring harness (2).
9. Install Retainer (3).

10. Install the 2 engine control module and engine wiring harness bracket bolts (4) and tighten to 9 N.m (80 lb in).
11. Clip in the 2 wiring harness clips (1).
12. Install Generator and Air Conditioning Compressor Belt - **Generator and Air Conditioning Compressor Belt Replacement**
13. Install Radiator Outlet Hose@Water Pump - **Radiator Outlet Hose Replacement (LH7)**
14. Install Charge Air Cooler Inlet Air Tube - **Charge Air Cooler Inlet Air Tube Replacement**
15. Install Oxidation Catalytic Converter - **Oxidation Catalytic Converter Replacement (LH7)**
16. Install Air Cleaner Assembly - **Air Cleaner Assembly Replacement**
17. Install Air Cleaner Outlet Duct -**Air Cleaner Outlet Duct Replacement**
18. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**

WATER PUMP HOUSING REPLACEMENT (LYX)

Removal Procedure

1. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
2. Remove Air Cleaner Assembly - **Air Cleaner Assembly Replacement**

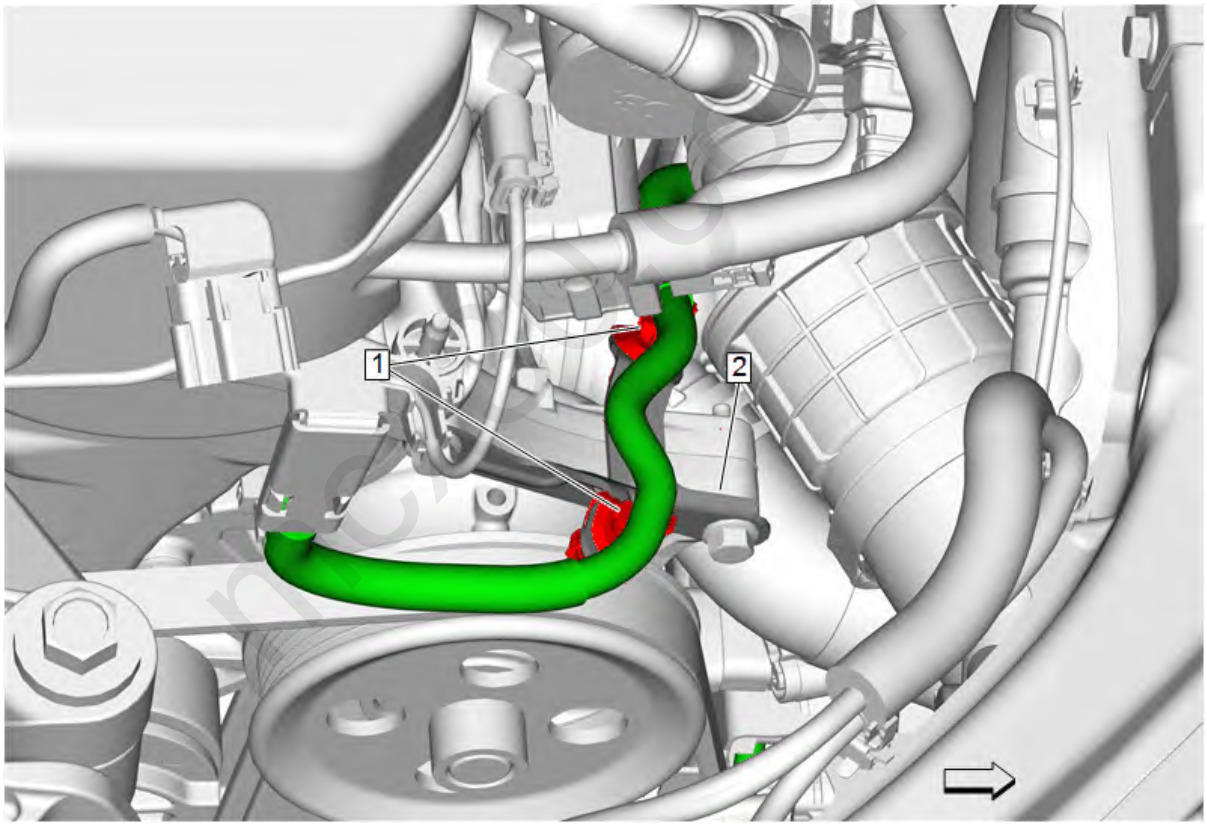


Fig. 316: Engine Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Separate Engine Wiring Harness Retainer (1) @ Engine Wiring Harness Bracket (2) - [2x]

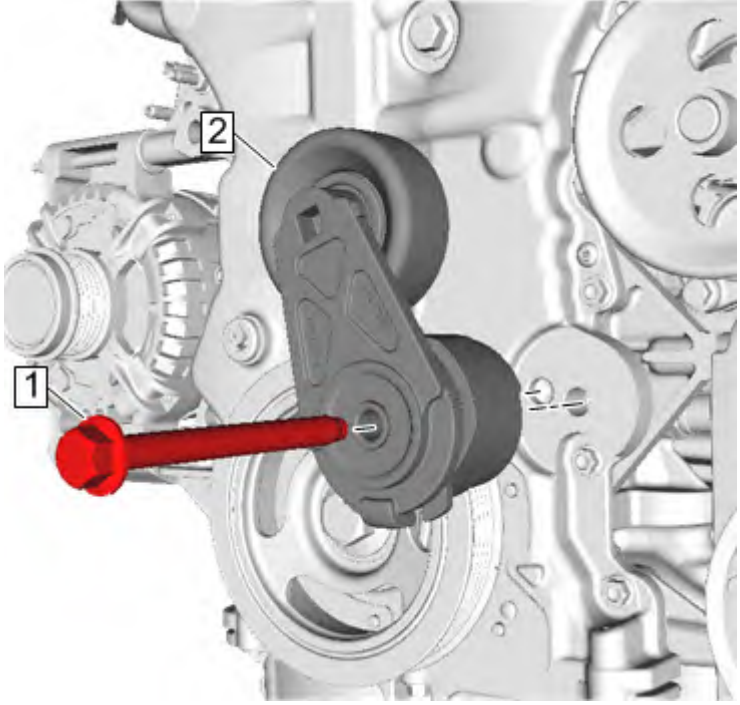


Fig. 317: Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

4. Remove Drive Belt Tensioner (2) - **Drive Belt Tensioner Replacement**

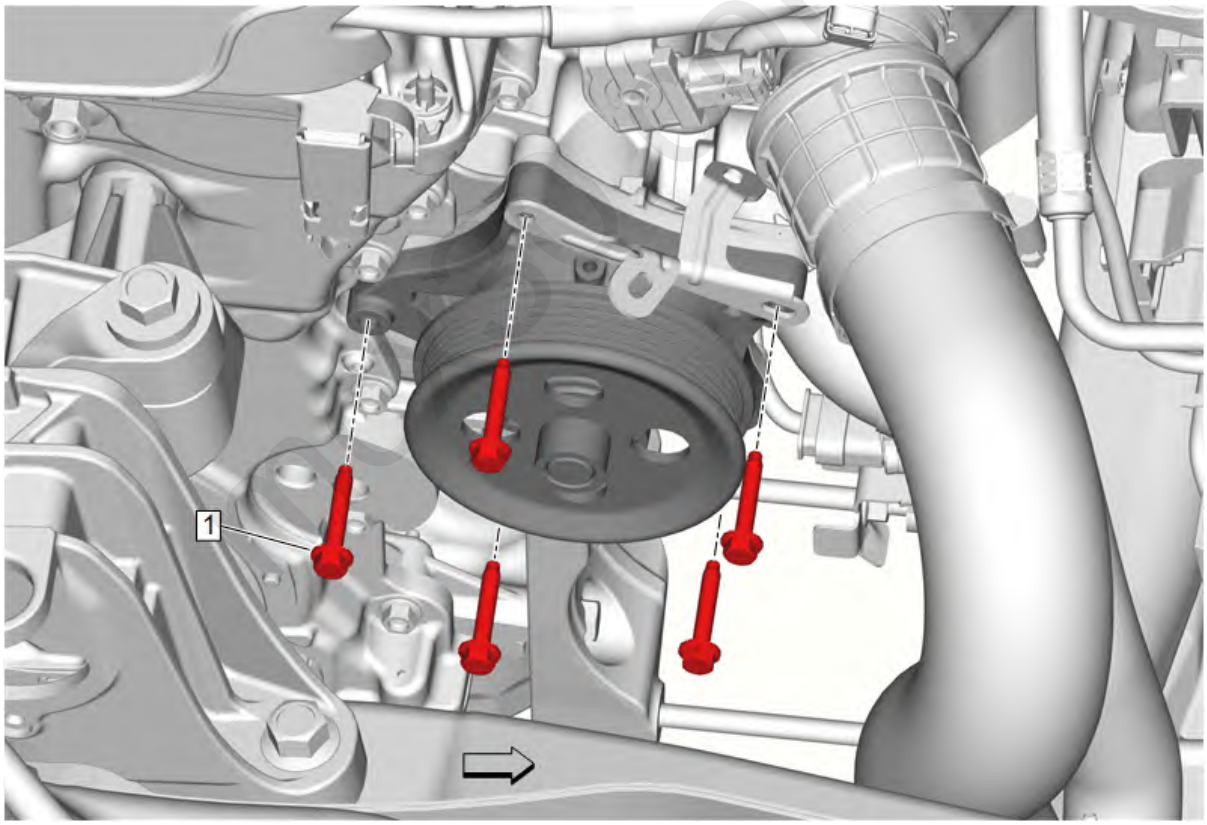


Fig. 318: Water Pump Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove Water Pump Bolt (1) - [5x]

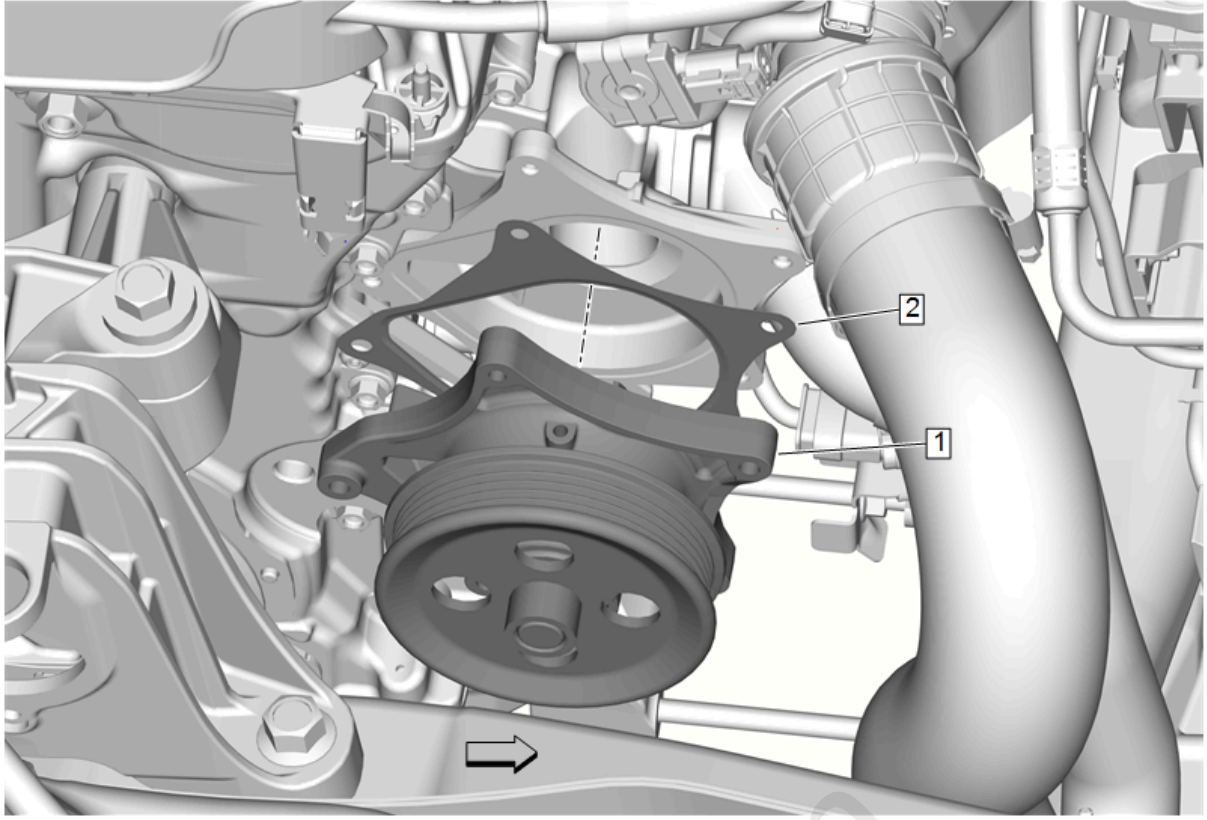


Fig. 319: Water Pump Housing
Courtesy of GENERAL MOTORS COMPANY

6. Remove Water Pump Housing (1).
7. Remove Water Pump Housing Gasket (2) and DISCARD

Installation Procedure

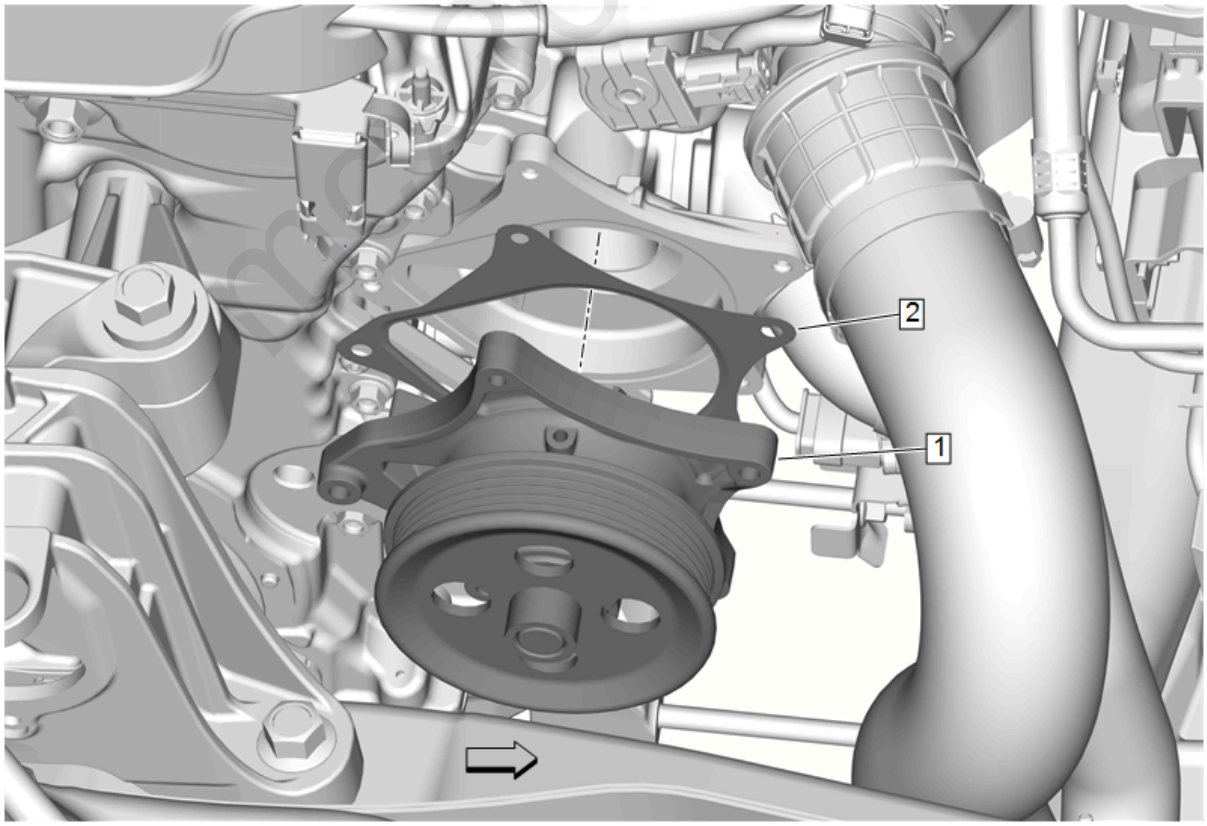


Fig. 320: Water Pump Housing
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW Water Pump Housing Gasket (2).
2. Install Water Pump Housing (1).

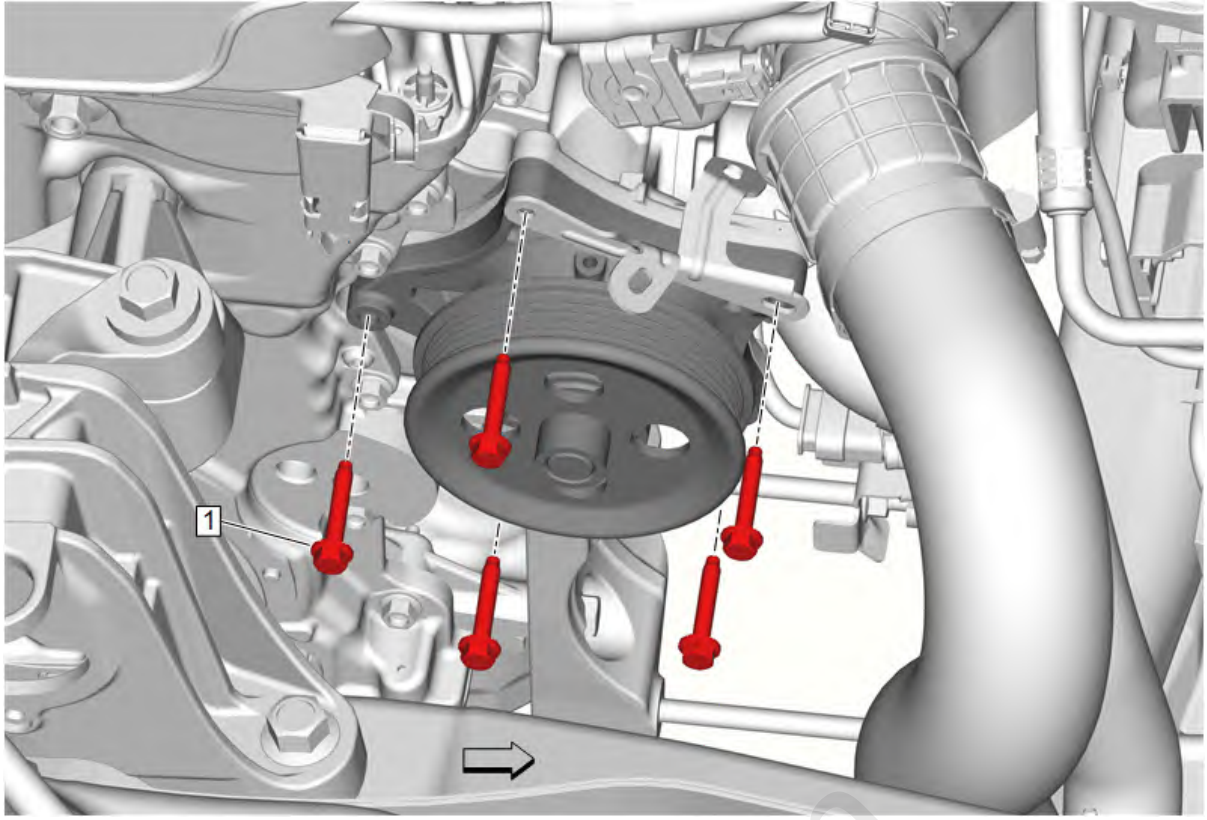


Fig. 321: Water Pump Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

3. Install Water Pump Bolt (1) and tighten [5x] 10 N.m (89 lb in)

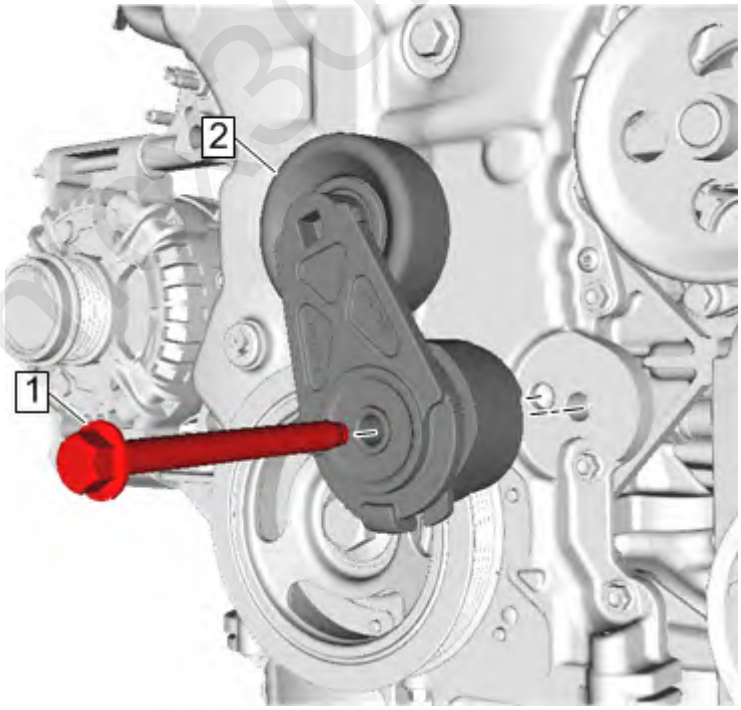


Fig. 322: Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

4. Install Drive Belt Tensioner (2) - **Drive Belt Tensioner Replacement**

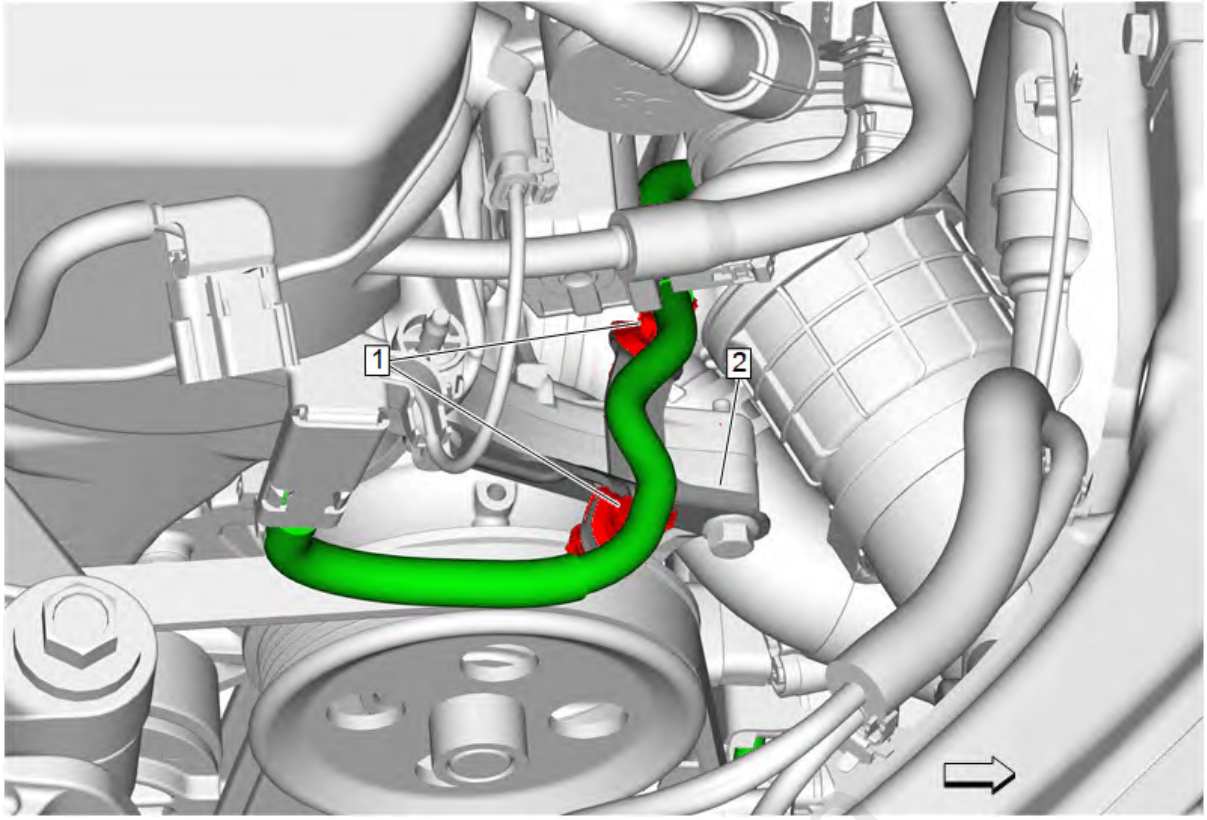


Fig. 323: Engine Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Install Engine Wiring Harness Retainer (1) @ Engine Wiring Harness Bracket (2) - [2x]
6. Install Air Cleaner Assembly - Air Cleaner Assembly Replacement
7. Fill the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)
8. Start the engine and check for leaks.

AUXILIARY WATER PUMP REPLACEMENT (LYX WITH KL9)

Removal Procedure

1. Drain the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)

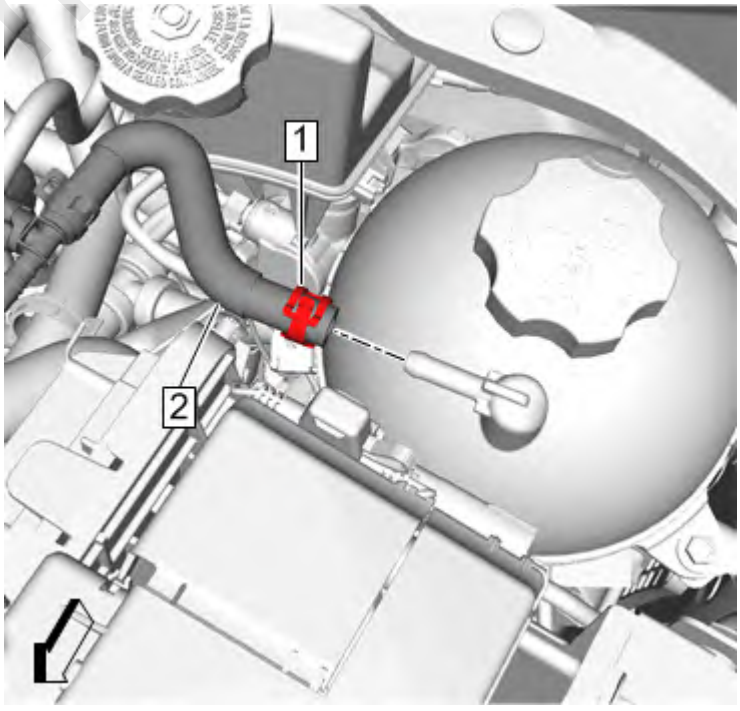


Fig. 324: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

2. Remove Engine Coolant Air Bleed Hose (2) @ Radiator Surge Tank - **Engine Coolant Air Bleed Hose Replacement (Turbocharger Coolant Return pipe to Water Outlet, LYX)Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Turbocharger Coolant Return Pipe to Radiator, LYX)**

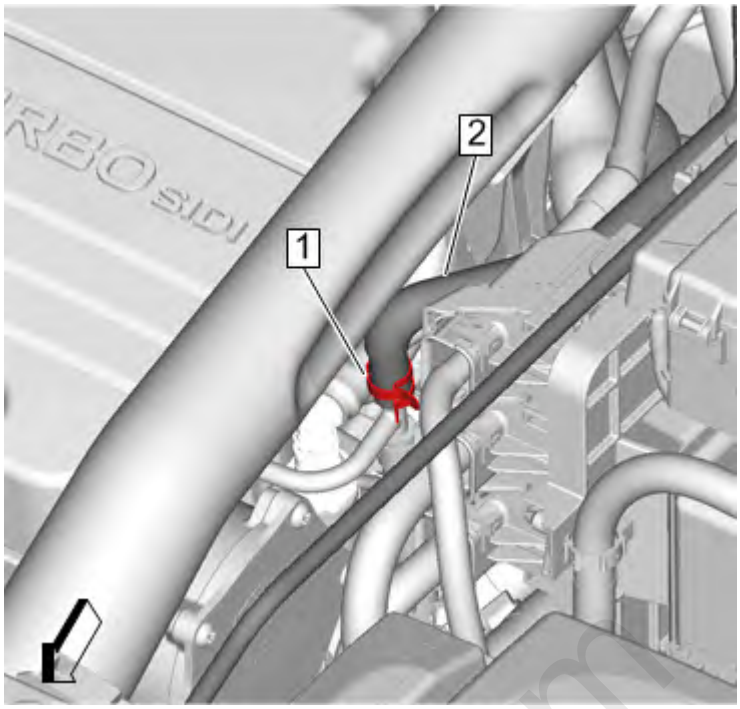


Fig. 325: Engine Coolant Air Bleed Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

3. Remove Engine Coolant Air Bleed Hose (2) @ Turbocharger Coolant Return Pipe -**Engine Coolant Air Bleed Hose Replacement (Turbocharger Coolant Return pipe to Water Outlet, LYX)Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Turbocharger Coolant Return Pipe to Radiator, LYX)**

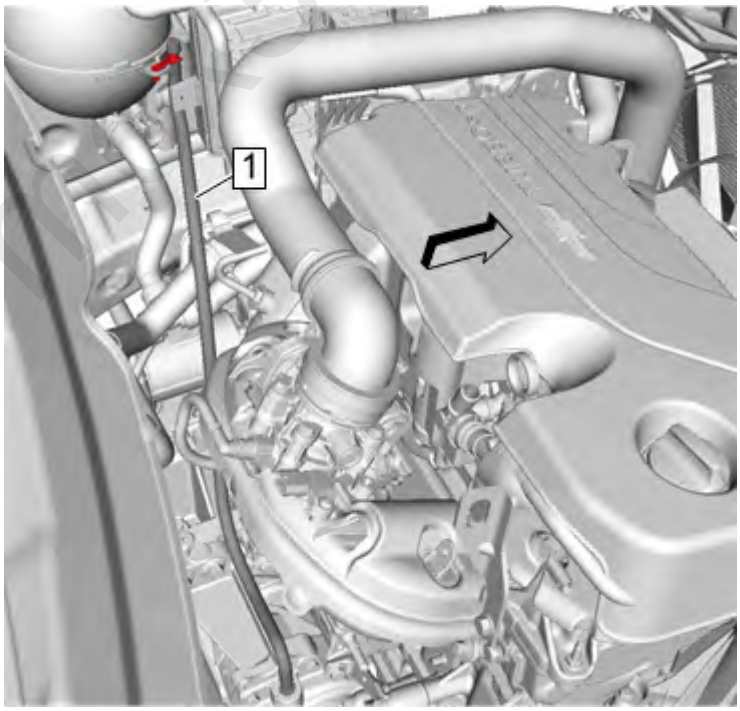


Fig. 326: Power Transfer Unit Vent Hose
Courtesy of GENERAL MOTORS COMPANY

4. Remove { If equipped }Power Transfer Unit Vent Hose (1) @ Radiator Surge Tank - **Power Transfer Unit Vent Hose Replacement**
5. Wiring Harnesses - Reposition

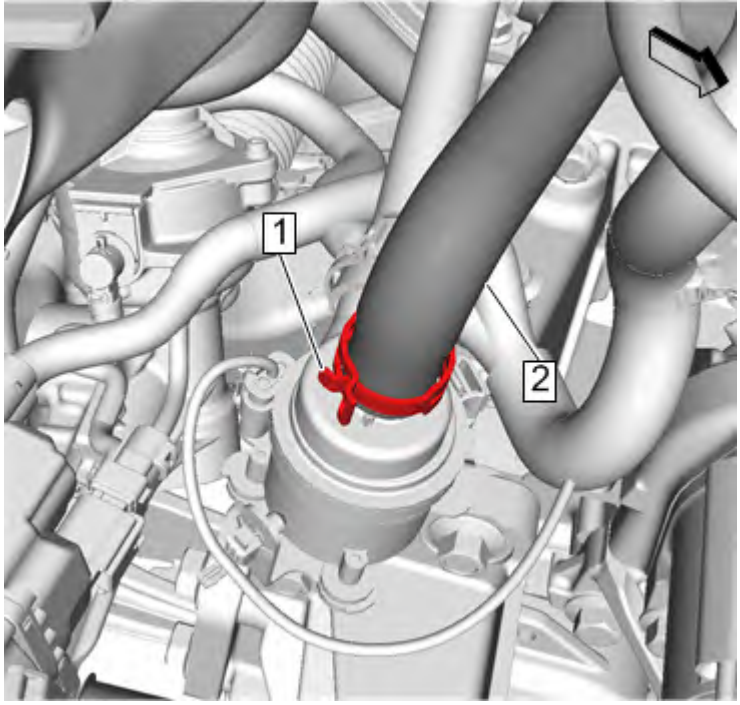


Fig. 327: Heater Water Auxiliary Pump Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

6. Remove Heater Water Auxiliary Pump Inlet Hose (2) @ Auxiliary Water Pump - **Heater Water Auxiliary Pump Inlet Hose Replacement (LYX with KL9)**

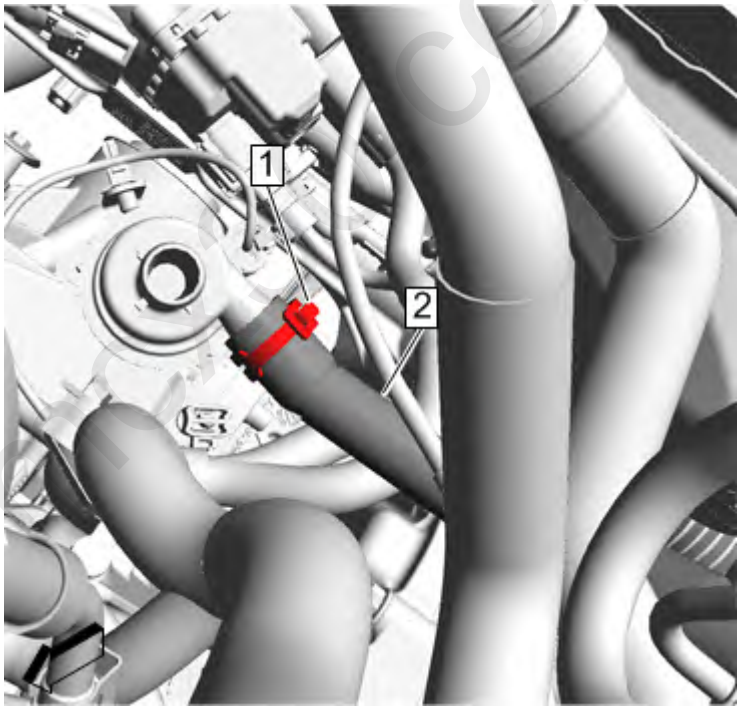


Fig. 328: Auxiliary Heater Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

7. Remove Auxiliary Heater Outlet Hose (2) @ Auxiliary Water Pump - **Auxiliary Heater Outlet Hose Replacement (LYX with KL9)**

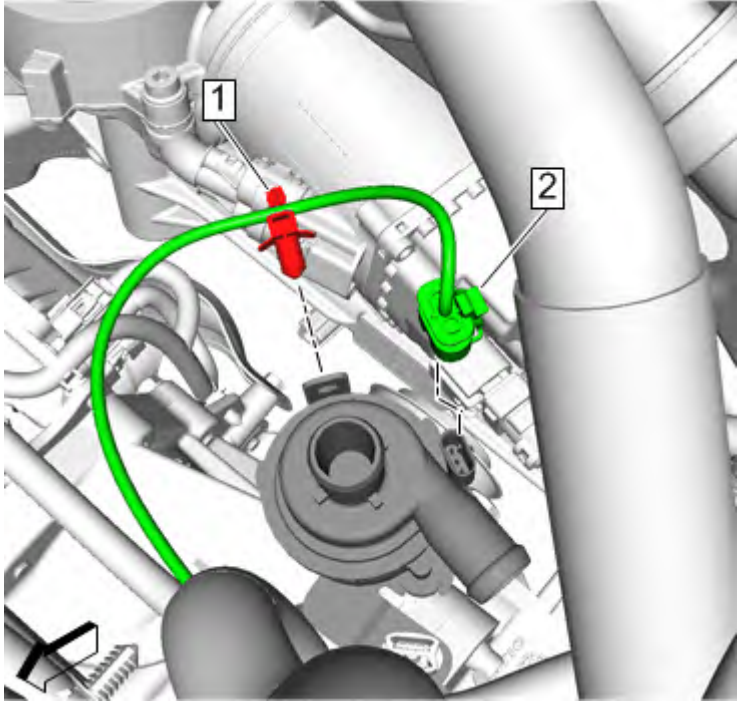


Fig. 329: Engine Wiring Harness Retainer And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

8. Remove Engine Wiring Harness Retainer (1) @ Auxiliary Water Pump
9. Disconnect Electrical Connector (2) @ Auxiliary Water Pump

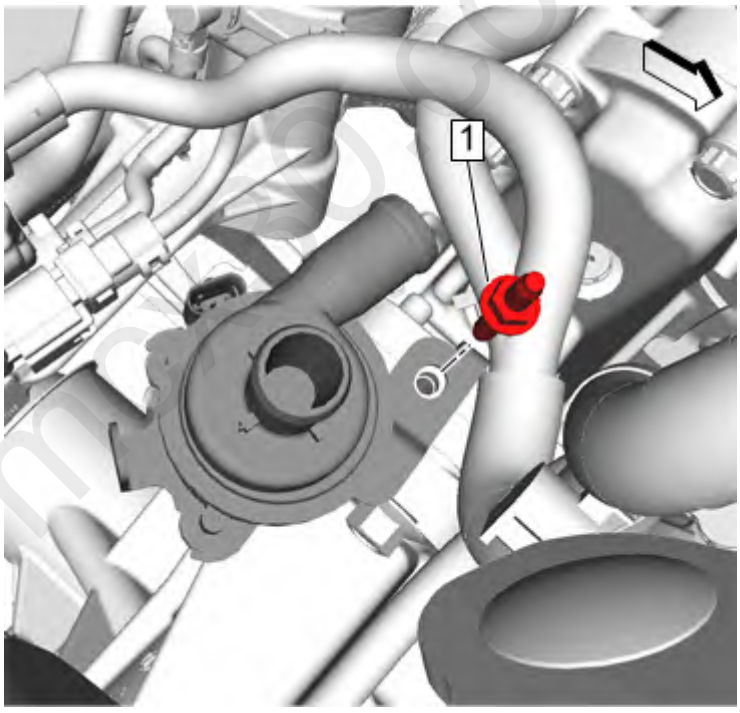


Fig. 330: Auxiliary Water Pump Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Remove Auxiliary Water Pump Bracket Bolt (1) @ Auxiliary Water Pump

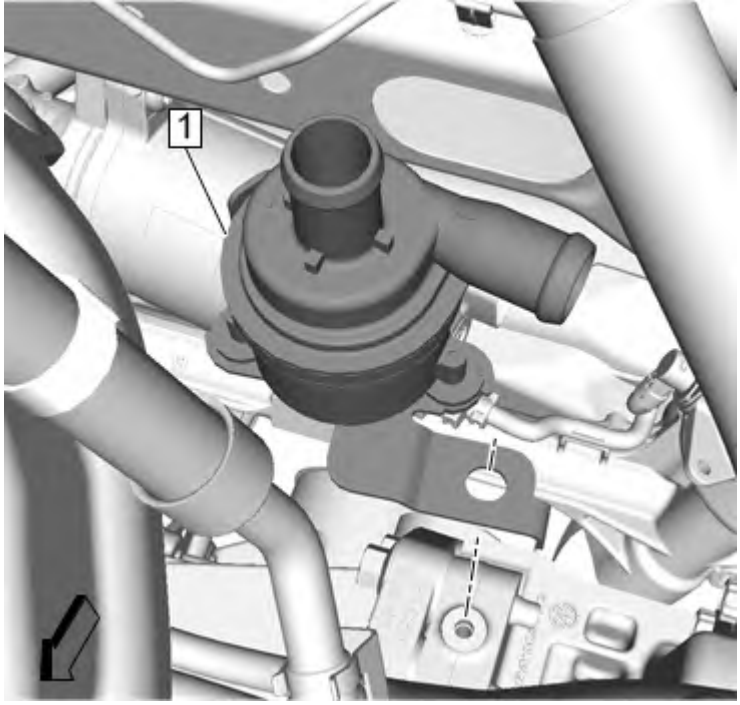


Fig. 331: Auxiliary Water Pump
Courtesy of GENERAL MOTORS COMPANY

11. Remove Auxiliary Water Pump (1).

Installation Procedure

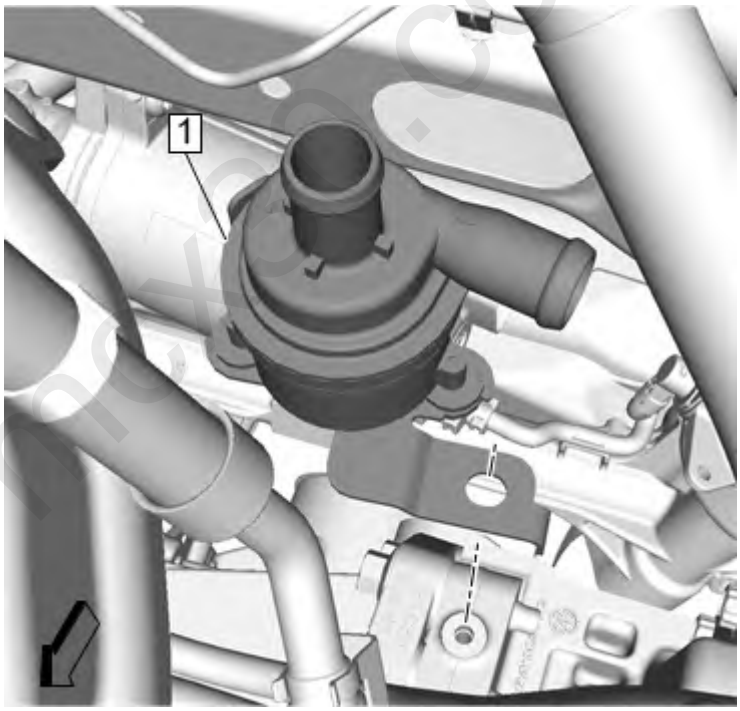


Fig. 332: Auxiliary Water Pump
Courtesy of GENERAL MOTORS COMPANY

1. Install Auxiliary Water Pump (1).

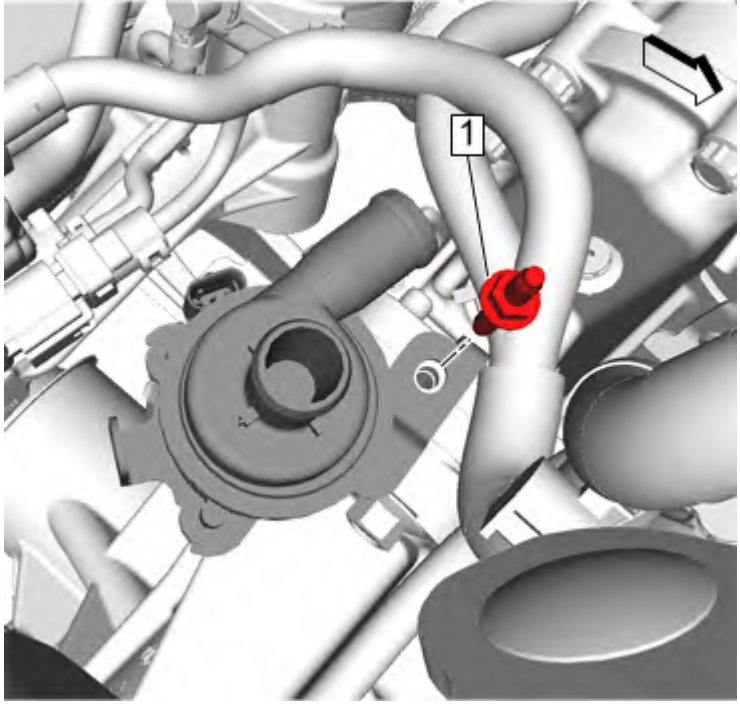


Fig. 333: Auxiliary Water Pump Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. Install Auxiliary Water Pump Bracket Bolt (1) @ Auxiliary Water Pump and tighten 9 N.m (80 lb in)

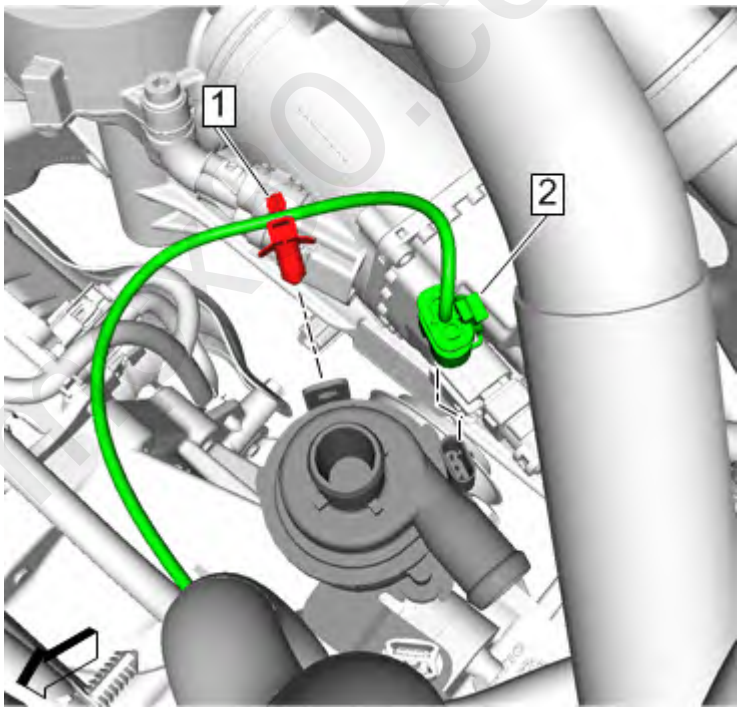


Fig. 334: Engine Wiring Harness Retainer And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Connect Electrical Connector (2) @ Auxiliary Water Pump
4. Install Engine Wiring Harness Retainer (1) @ Auxiliary Water Pump

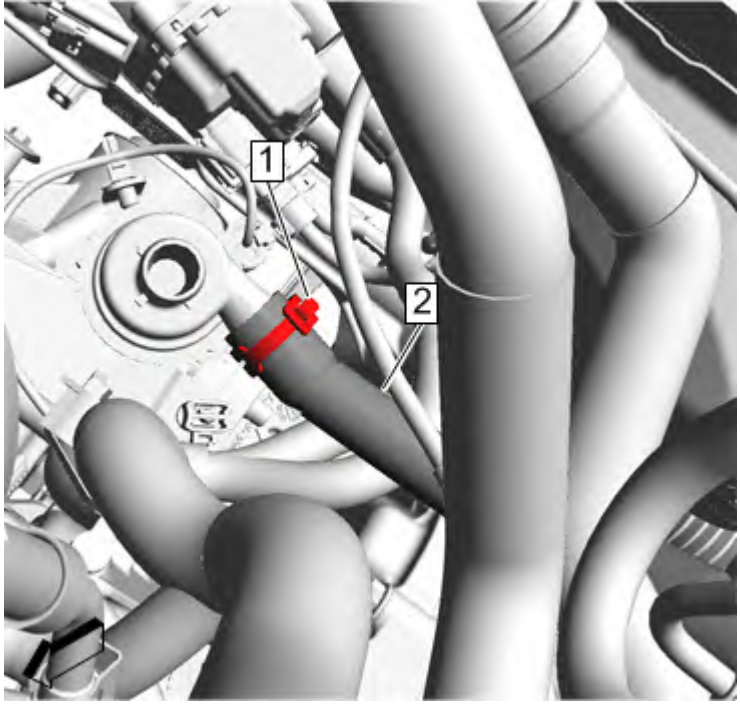


Fig. 335: Auxiliary Heater Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

5. Install Auxiliary Heater Outlet Hose (2) @ Auxiliary Water Pump - **Auxiliary Heater Outlet Hose Replacement (LYX with KL9)**

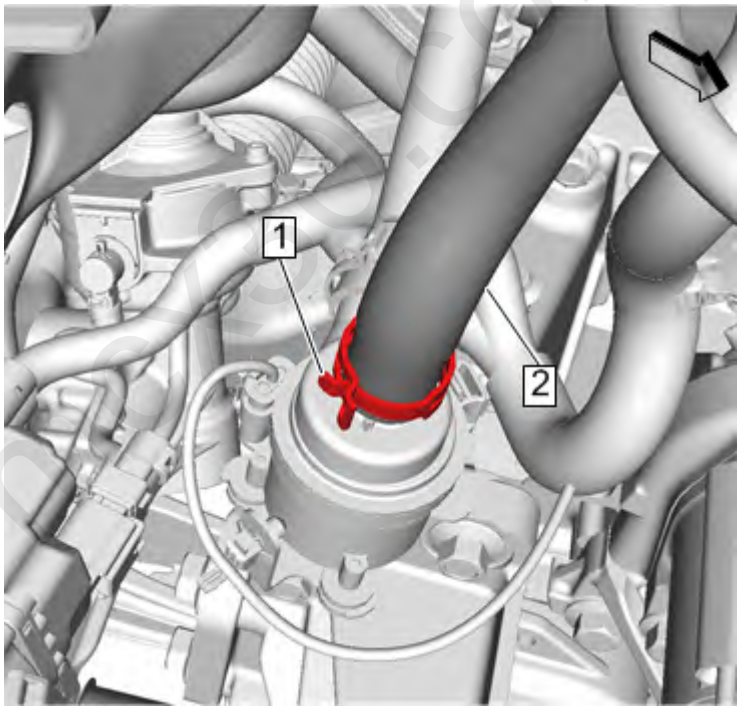


Fig. 336: Heater Water Auxiliary Pump Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

6. Install Heater Water Auxiliary Pump Inlet Hose (2) @ Auxiliary Water Pump -**Heater Water Auxiliary Pump Inlet Hose Replacement (LYX with KL9)**
7. Wiring Harnesses - Reposition

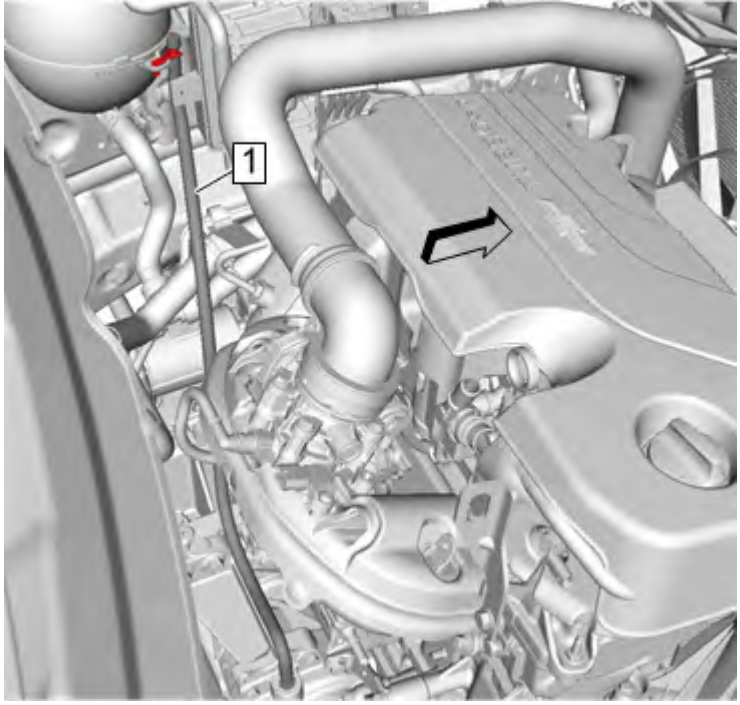


Fig. 337: Power Transfer Unit Vent Hose
Courtesy of GENERAL MOTORS COMPANY

8. Install {If equipped} Power Transfer Unit Vent Hose (1) @ Radiator Surge Tank - **Power Transfer Unit Vent Hose Replacement**

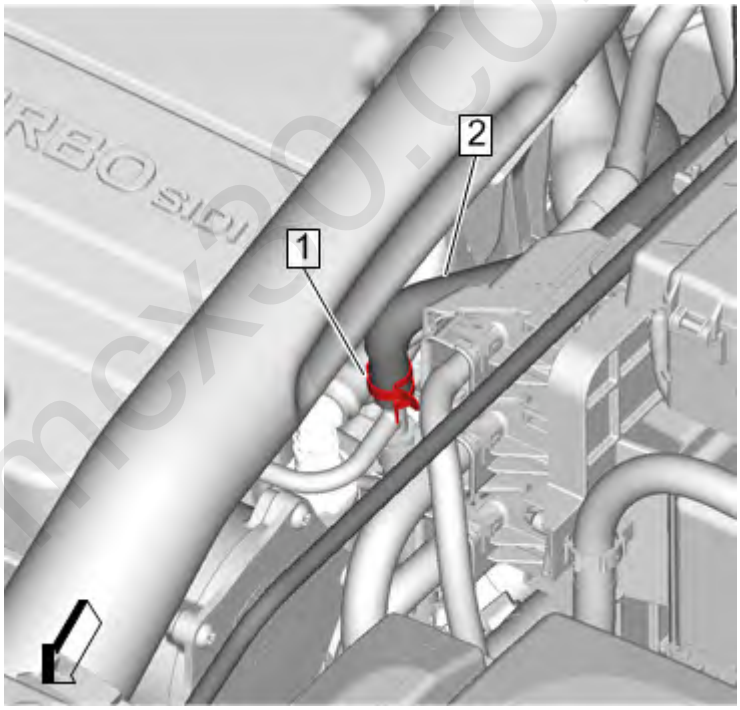


Fig. 338: Engine Coolant Air Bleed Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

9. Install Engine Coolant Air Bleed Hose (2) @ Turbocharger Coolant Return Pipe - **Engine Coolant Air Bleed Hose Replacement (Turbocharger Coolant Return pipe to Water Outlet, LYX)Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Turbocharger Coolant Return Pipe to Radiator, LYX)**

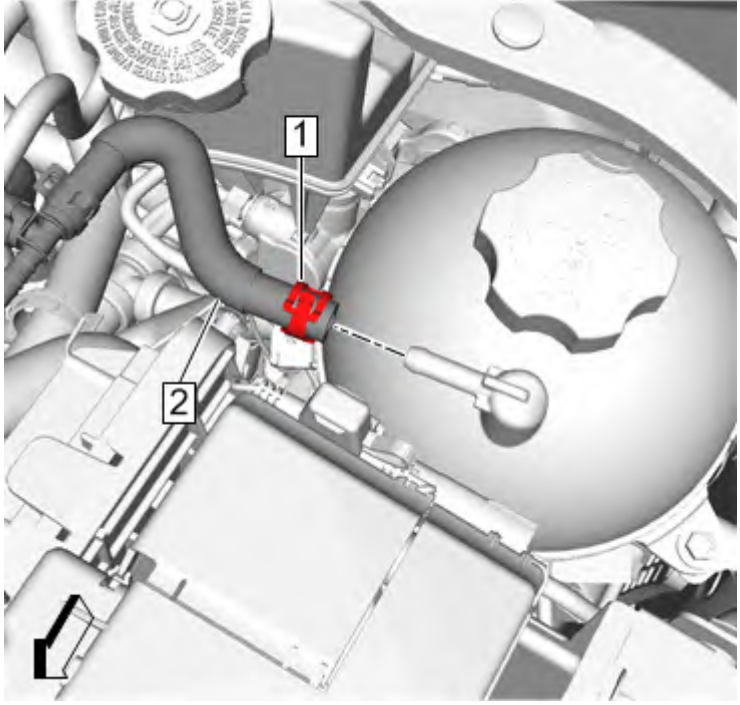


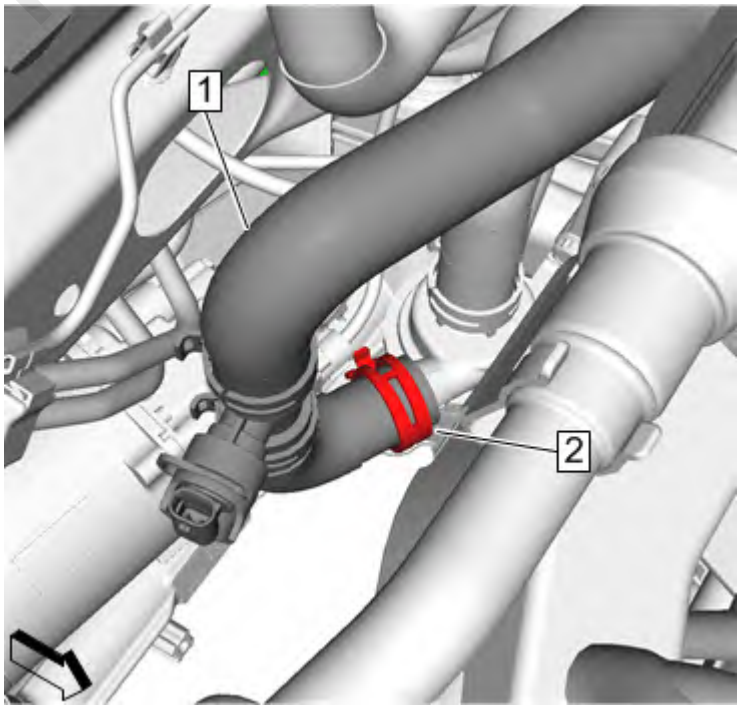
Fig. 339: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

10. Install Engine Coolant Air Bleed Hose (2) @ Radiator Surge Tank - **Engine Coolant Air Bleed Hose Replacement (Turbocharger Coolant Return pipe to Water Outlet, LYX)Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Turbocharger Coolant Return Pipe to Radiator, LYX)**
11. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
12. Check the cooling system for leaks.

AUXILIARY WATER PUMP REPLACEMENT (LH7 EQUINOX)

Removal Procedure

1. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
2. Remove Intake Manifold Cover - **Intake Manifold Cover Replacement**
3. Remove Heater Inlet Hose -**Heater Inlet Hose Replacement (LH7 Equinox)**



nlcx30.com

Fig. 340: Heater Water Auxiliary Pump Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

4. Disengage Heater Water Auxiliary Pump Hose Clamp (2) - **Hose Clamp Replacement Guidelines - Spring Type**
5. Remove Heater Water Auxiliary Pump Hose (1) @ Auxiliary Water Pump -**Heater Water Auxiliary Pump Hose Replacement (LH7 Equinox)**

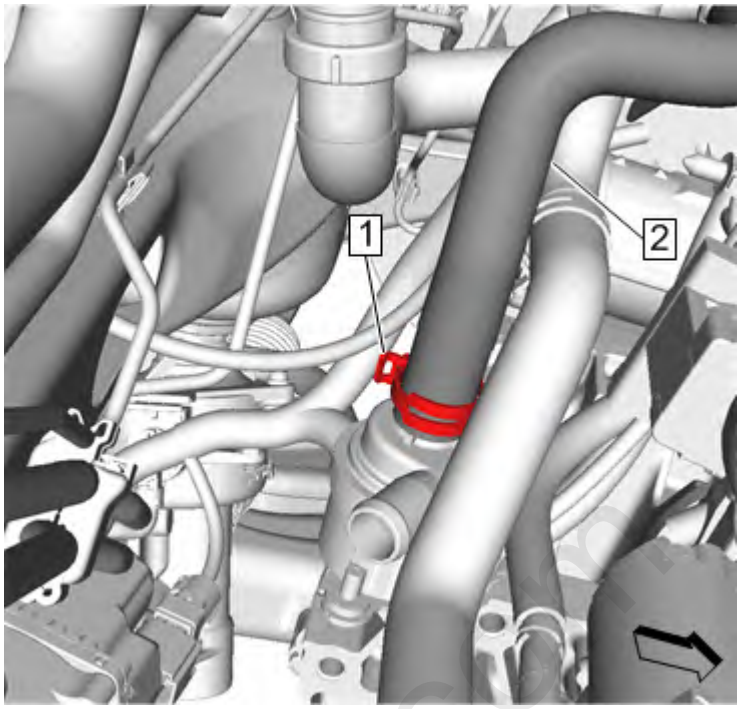


Fig. 341: Heater Water Auxiliary Pump Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

6. Disengage Heater Water Auxiliary Pump Inlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
7. Remove Heater Water Auxiliary Pump Inlet Hose (2) @ Auxiliary Water Pump

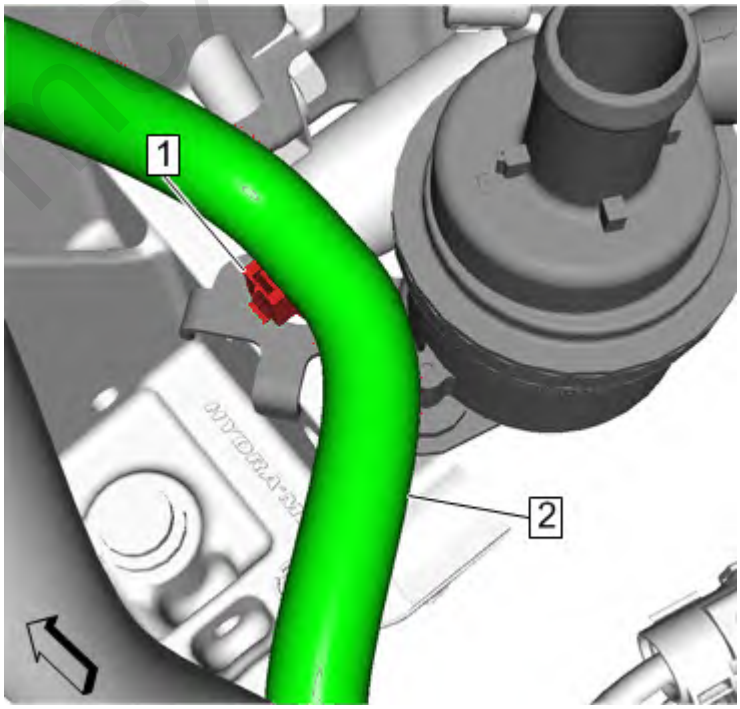


Fig. 342: Engine Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

8. Remove Engine Wiring Harness Retainer (1) @ Auxiliary Water Pump
9. Reposition the wiring harness. (2)

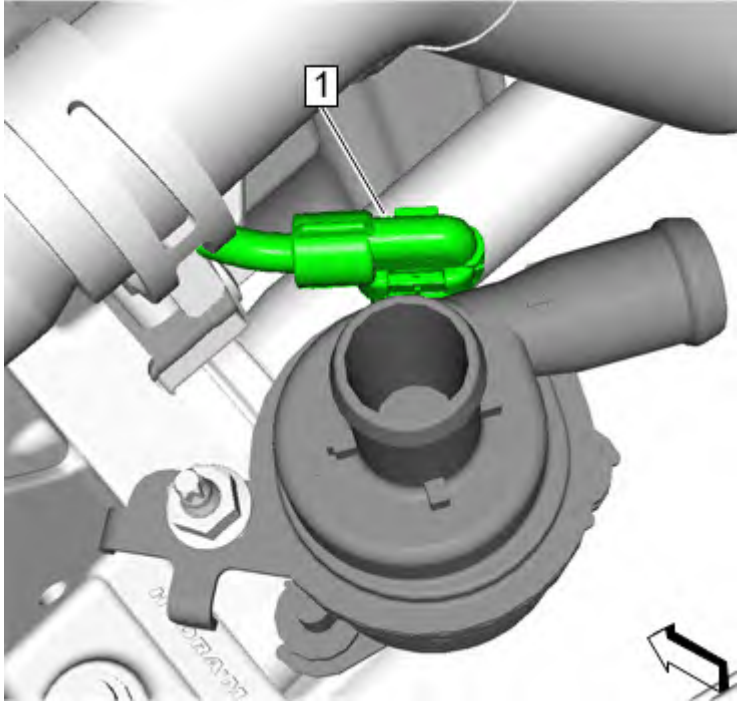


Fig. 343: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

10. Disconnect Electrical Connector@Auxiliary Water Pump

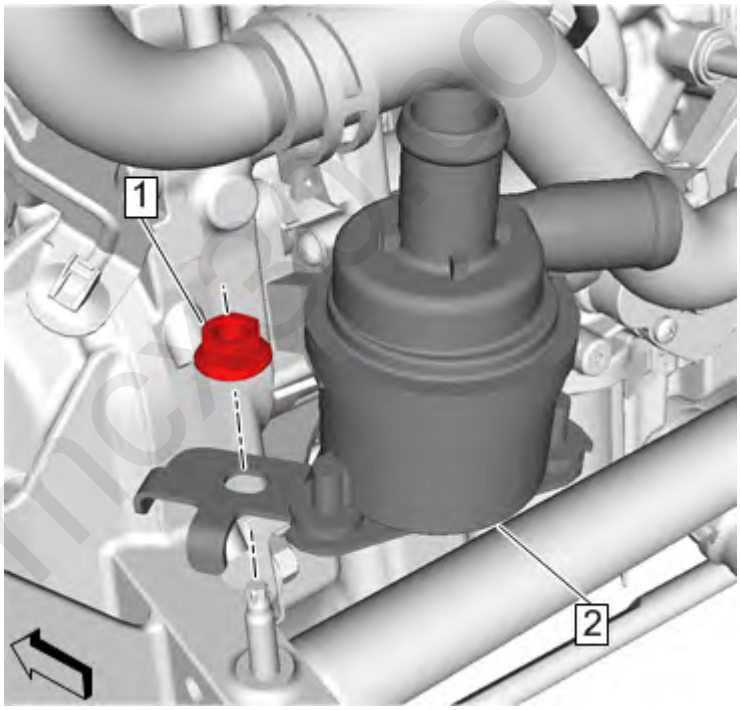


Fig. 344: Auxiliary Water Pump And Bracket Nut
Courtesy of GENERAL MOTORS COMPANY

11. Remove Auxiliary Water Pump Bracket Nut (1)
12. Remove Auxiliary Water Pump (2)

Installation Procedure

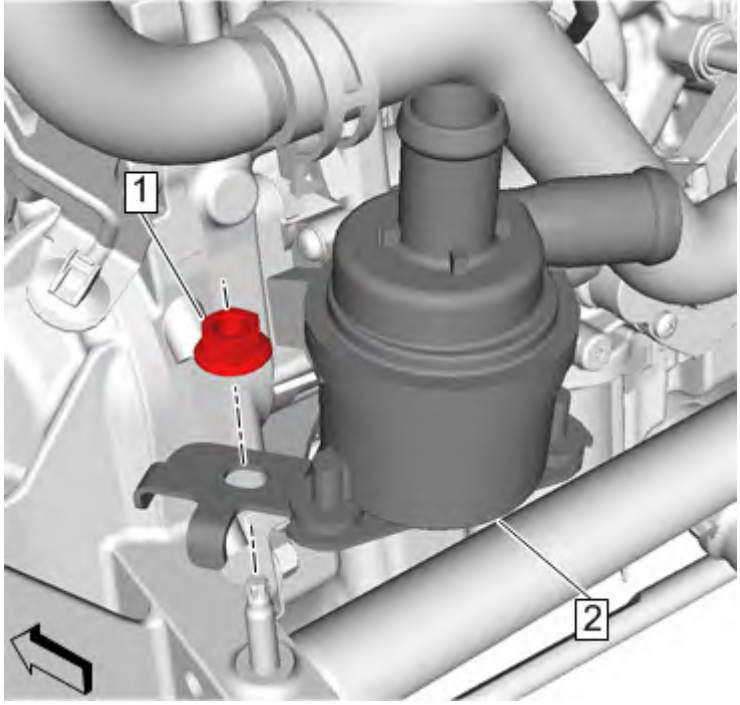


Fig. 345: Auxiliary Water Pump And Bracket Nut
Courtesy of GENERAL MOTORS COMPANY

1. Install Auxiliary Water Pump (2)

CAUTION: **Refer to Fastener Caution .**

2. Install Auxiliary Water Pump Bracket Nut (1) and tighten 22 N.m (16 lb ft)

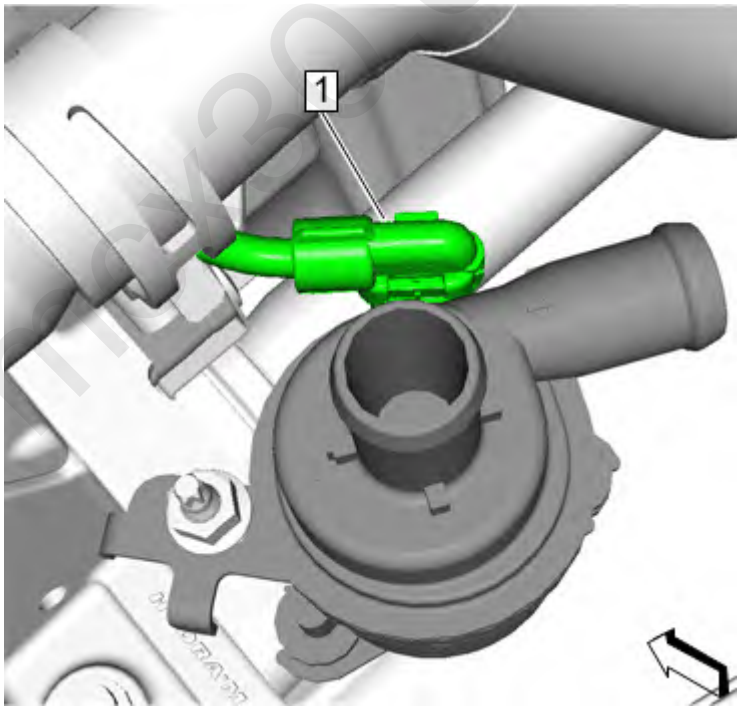


Fig. 346: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Connect Electrical Connector (1) @ Auxiliary Water Pump

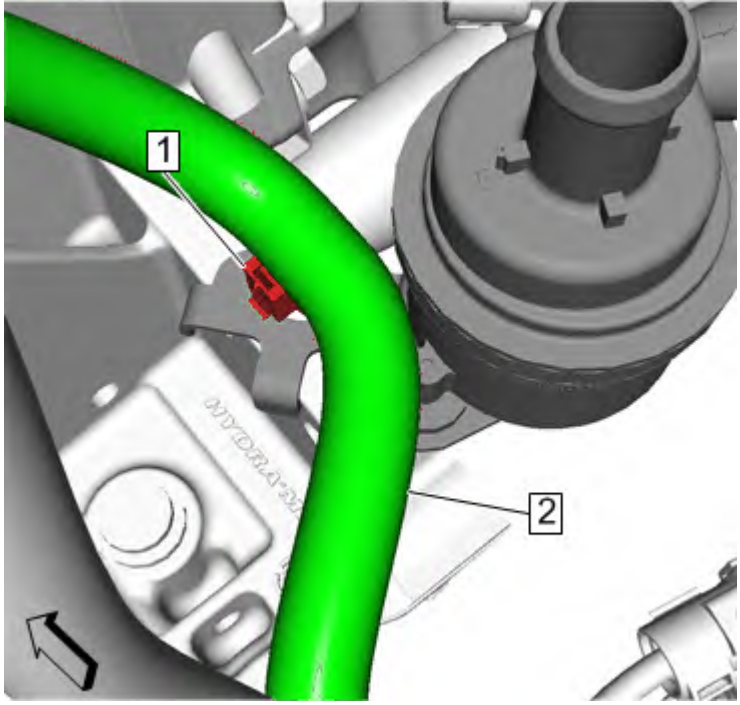


Fig. 347: Engine Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Reposition the wiring harness. (2)
5. Install Engine Wiring Harness Retainer (1) @ Auxiliary Water Pump.

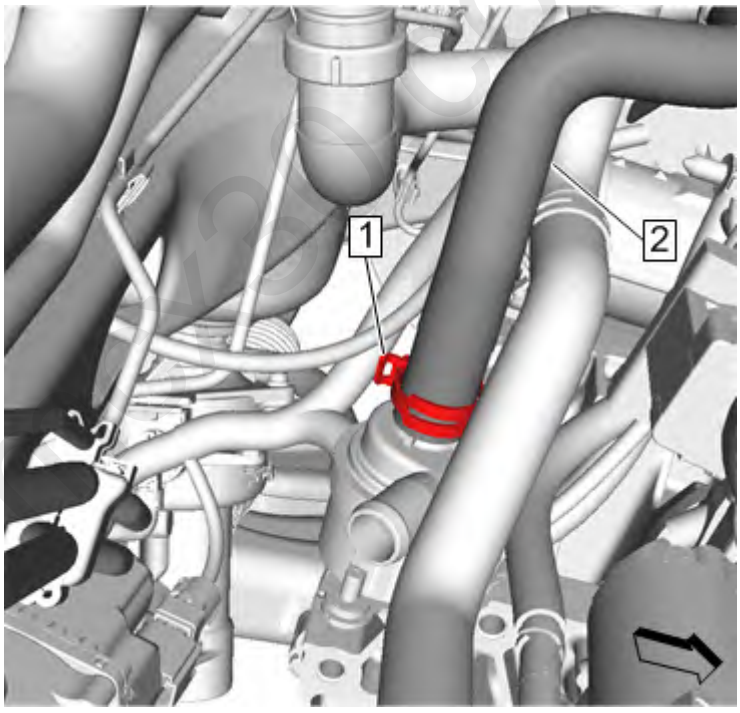


Fig. 348: Heater Water Auxiliary Pump Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

6. Install Heater Water Auxiliary Pump Inlet Hose (2) @ Auxiliary Water Pump.
7. Engage Heater Water Auxiliary Pump Inlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**

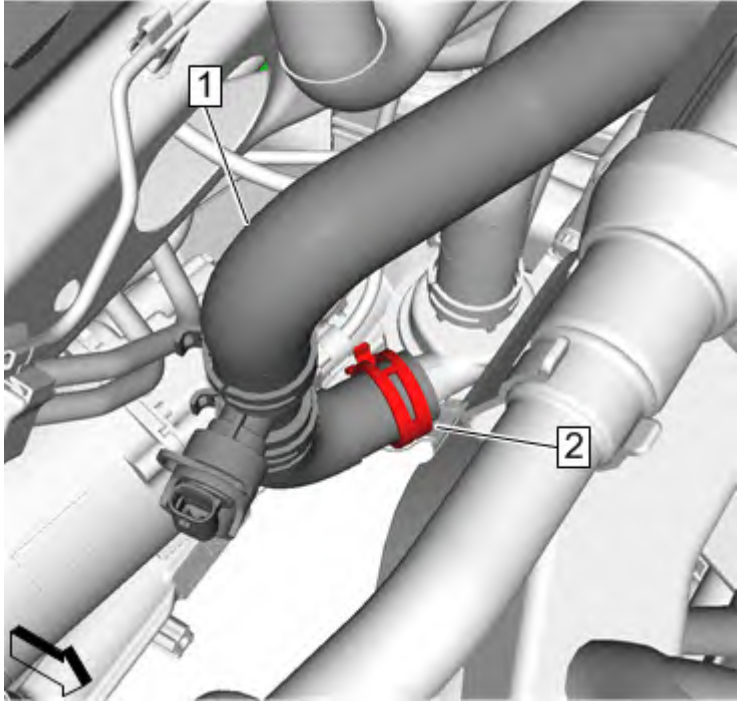


Fig. 349: Heater Water Auxiliary Pump Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

8. Install Heater Water Auxiliary Pump Hose (1) @ Auxiliary Water Pump - **Heater Water Auxiliary Pump Hose Replacement (LH7 Equinox)**
9. Engage Heater Water Auxiliary Pump Hose Clamp (2) - **Hose Clamp Replacement Guidelines - Spring Type**
10. Install Heater Inlet Hose -**Heater Inlet Hose Replacement (LH7 Equinox)**
11. Install Intake Manifold Cover -**Intake Manifold Cover Replacement**
12. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
13. Check the cooling system for leaks.

AUXILIARY WATER PUMP REPLACEMENT (LTG WITH KL9)

Removal Procedure

1. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
2. Reposition Engine Coolant Air Bleed Hose - **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Radiator to Engine Coolant Air Bleed Pipe LTG)**
3. Reposition Power Transfer Unit Vent Hose -**Power Transfer Unit Vent Hose Replacement**
4. Reposition Wiring Harnesses.

mc730.com

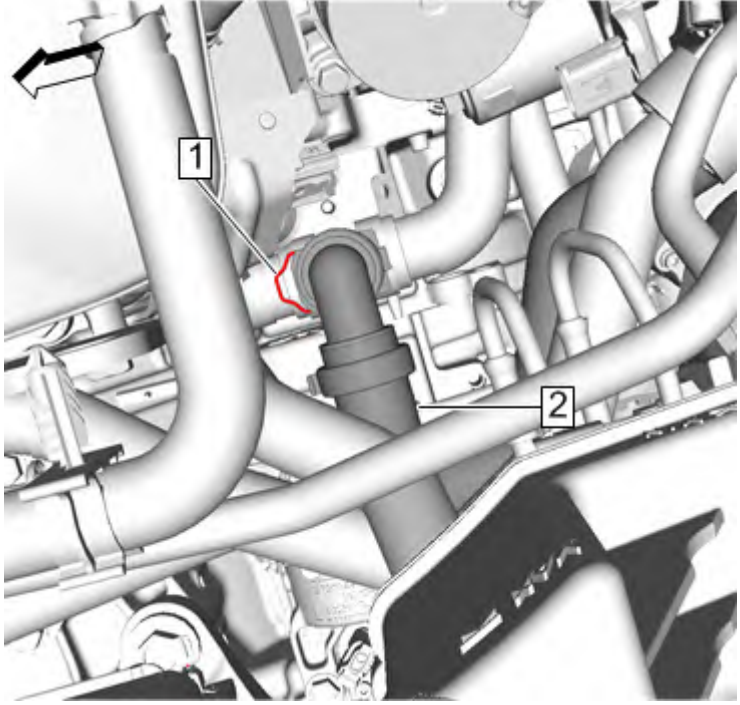


Fig. 350: Heater Water Auxiliary Pump Hose
Courtesy of GENERAL MOTORS COMPANY

5. Remove Heater Water Auxiliary Pump Hose (2) @ Heater Water Auxiliary Pump Inlet Hose - and position aside - **Heater Water Auxiliary Pump Hose Replacement (LTG with KL9)**
6. Remove Heater Water Auxiliary Pump Inlet Hose **Heater Water Auxiliary Pump Inlet Hose Replacement (LTG with KL9)**
7. Remove Auxiliary Heater Outlet Hose - **Auxiliary Heater Outlet Hose Replacement (LTG with KL9)**

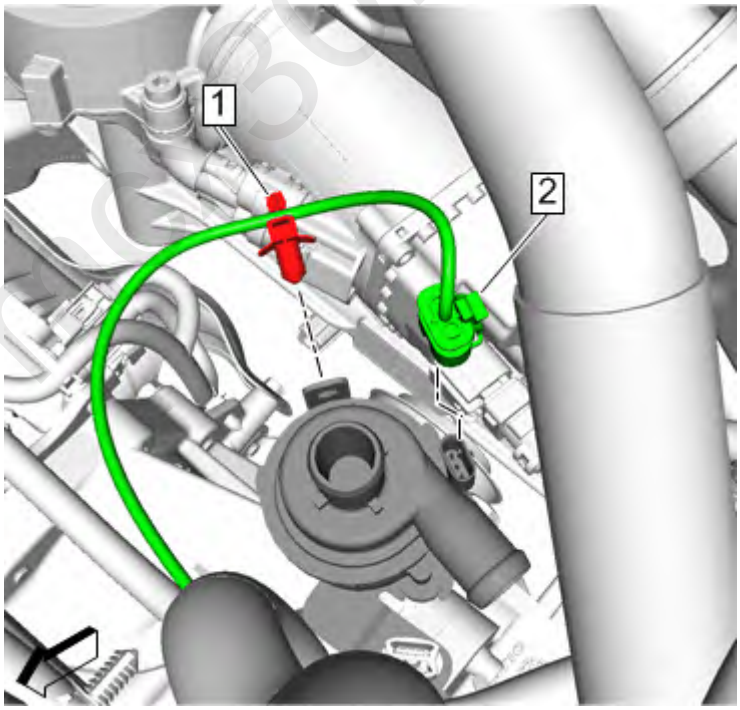


Fig. 351: Engine Wiring Harness Retainer And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

8. Remove Engine Wiring Harness Retainer (1) @ Auxiliary Water Pump
9. Disconnect Electrical Connector (2) @ Auxiliary Water Pump

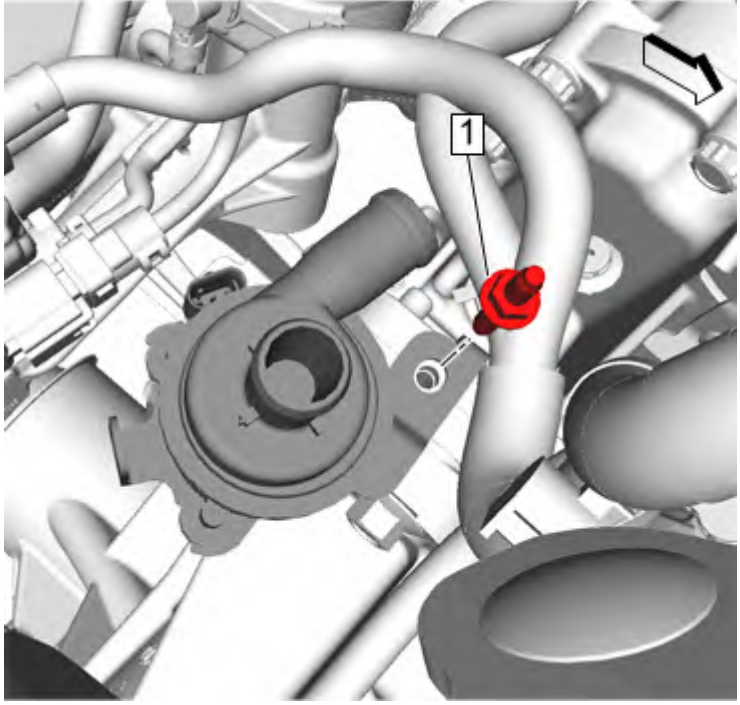


Fig. 352: Auxiliary Water Pump Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Remove Auxiliary Water Pump Bracket Bolt (1) @ Auxiliary Water Pump.

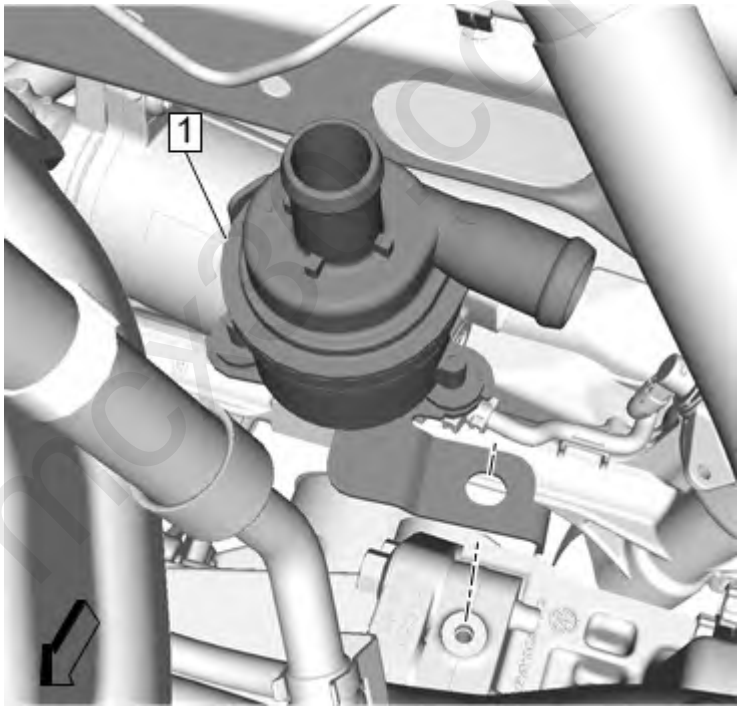


Fig. 353: Auxiliary Water Pump
Courtesy of GENERAL MOTORS COMPANY

11. Remove Auxiliary Water Pump (1).

Installation Procedure

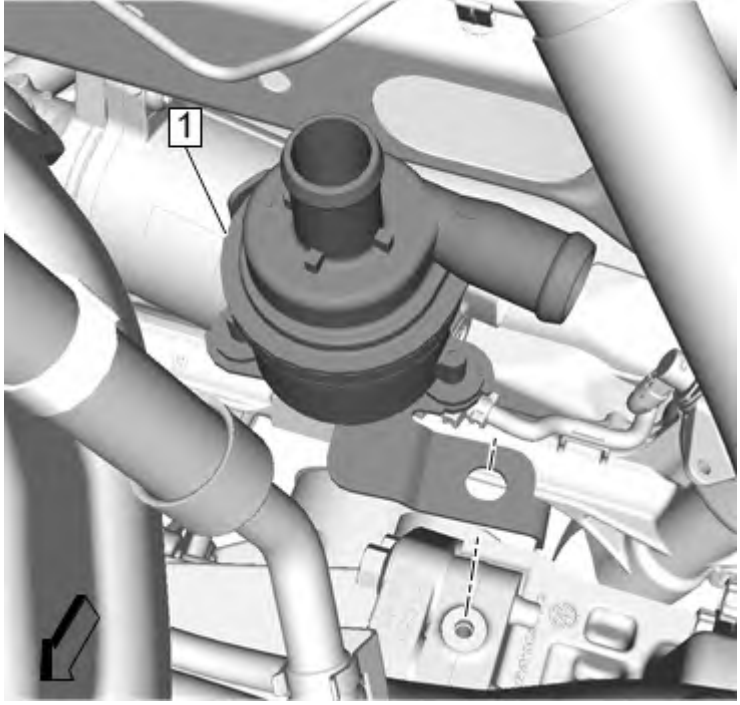


Fig. 354: Auxiliary Water Pump
Courtesy of GENERAL MOTORS COMPANY

1. Install Auxiliary Water Pump (1).

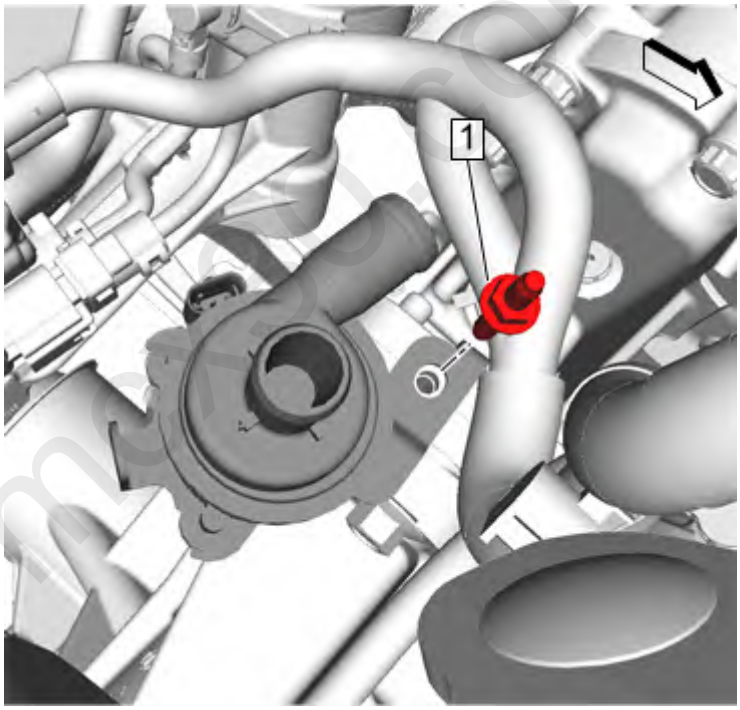


Fig. 355: Auxiliary Water Pump Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. Install Auxiliary Water Pump Bracket Bolt (1) @ Auxiliary Water Pump and tighten 22 N.m (16 lb ft)

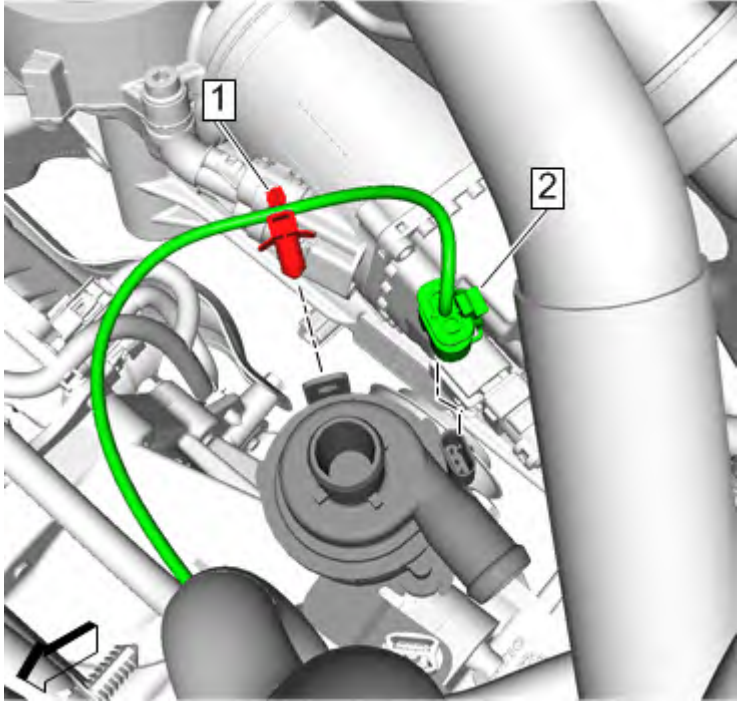


Fig. 356: Engine Wiring Harness Retainer And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Connect Electrical Connector (2) @ Auxiliary Water Pump
4. Install Engine Wiring Harness Retainer (1) @ Auxiliary Water Pump
5. Install Auxiliary Heater Outlet Hose **Auxiliary Heater Outlet Hose Replacement (LTG with KL9)**
6. Install Heater Water Auxiliary Pump Inlet Hose - **Heater Water Auxiliary Pump Inlet Hose Replacement (LTG with KL9)**

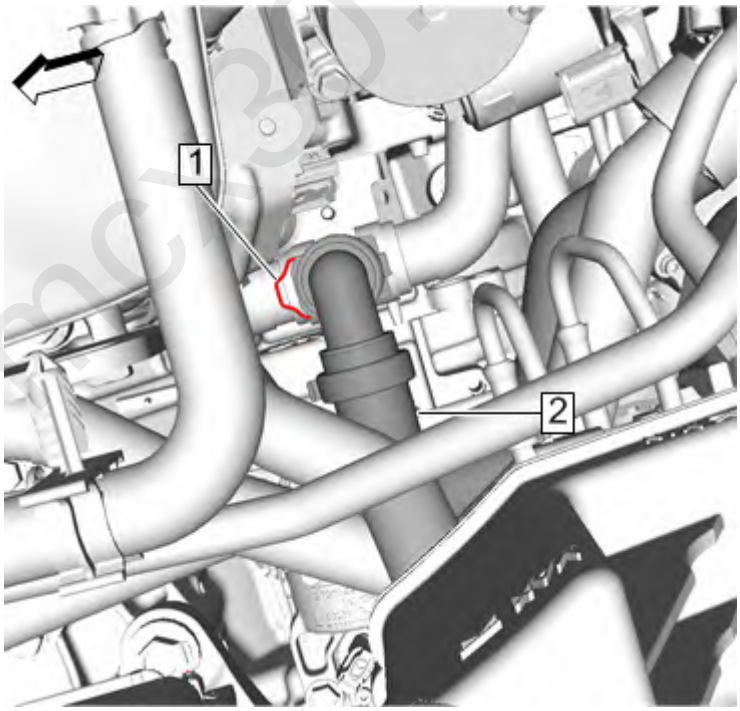


Fig. 357: Heater Water Auxiliary Pump Hose
Courtesy of GENERAL MOTORS COMPANY

7. Install Heater Water Auxiliary Pump Hose (2) @ Heater Water Auxiliary Pump Inlet Hose - **Heater Water Auxiliary Pump Hose Replacement (LTG with KL9)**
8. Position the wiring harness.
9. Install Power Transfer Unit Vent Hose - **Power Transfer Unit Vent Hose Replacement**
10. Install Engine Coolant Air Bleed Hose - **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Radiator to Engine Coolant Air Bleed Pipe LTG)**
11. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**

12. Check the cooling system for leaks.

AUXILIARY WATER PUMP REPLACEMENT (LH7 TERRAIN)

Removal Procedure

1. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
2. Lower the vehicle.
3. Remove Intake Manifold Cover - **Intake Manifold Cover Replacement**

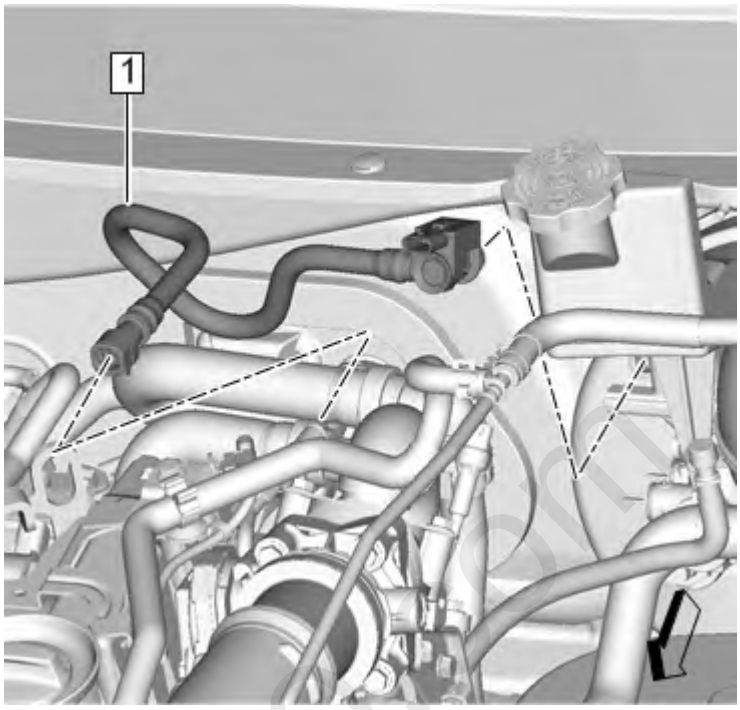


Fig. 358: Power Brake Booster Vacuum Pipe
Courtesy of GENERAL MOTORS COMPANY

4. Remove Power Brake Booster Vacuum Pipe (1).**Power Brake Booster Vacuum Pipe Replacement (LH7)**

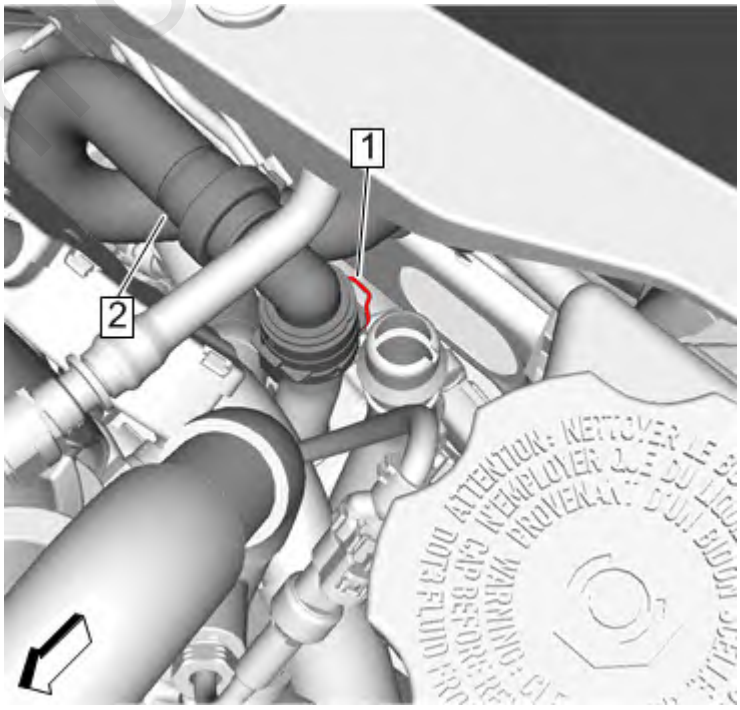


Fig. 359: Auxiliary Heater Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

5. Remove Auxiliary Heater Outlet Hose (2) -**Auxiliary Heater Outlet Hose Replacement (LH7 Terrain)**

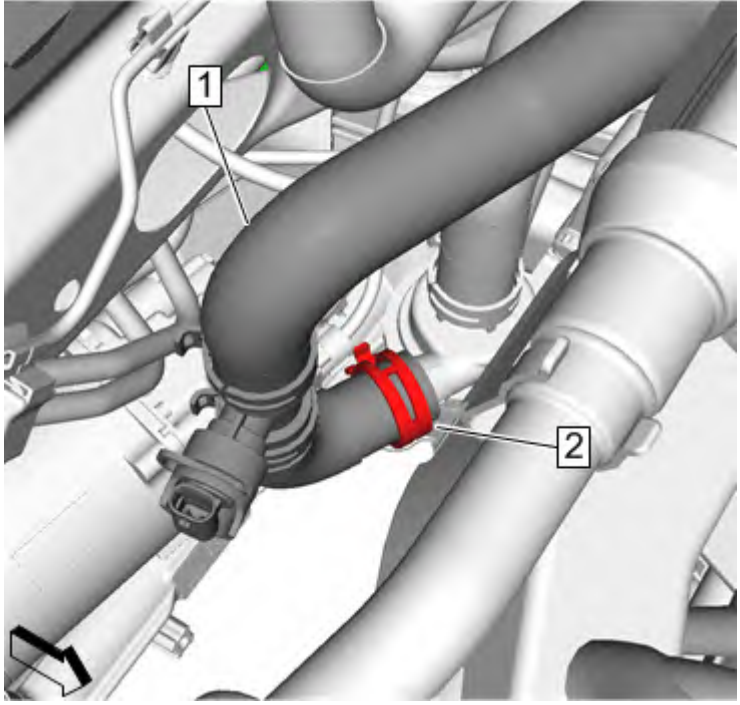


Fig. 360: Heater Water Auxiliary Pump Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

6. Remove Heater Water Auxiliary Pump Hose (1) @ Auxiliary Water Pump - **Heater Water Auxiliary Pump Hose Replacement (LH7 Terrain)**

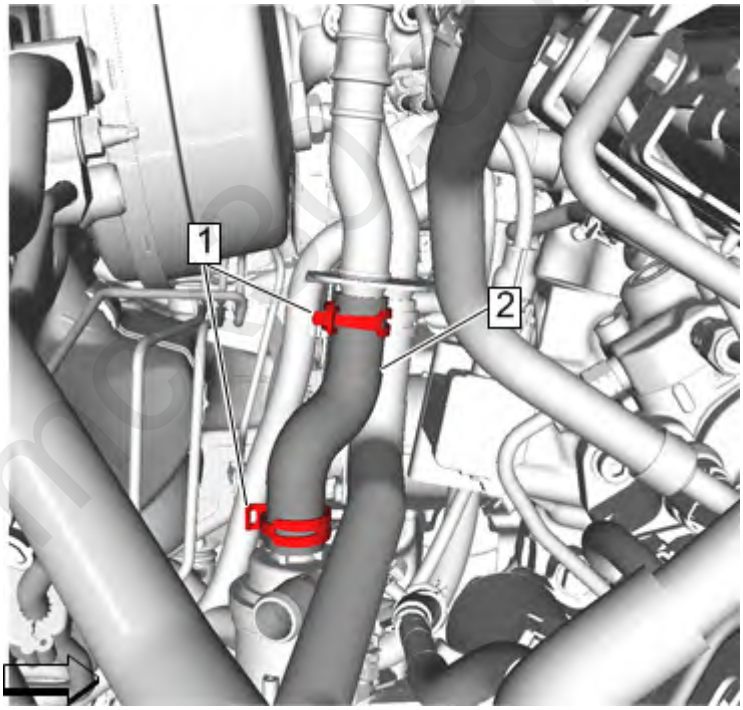


Fig. 361: Heater Water Auxiliary Pump Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

7. Remove Heater Water Auxiliary Pump Inlet Hose (2) @ Heater Inlet and Outlet Bracket - **Heater Water Auxiliary Pump Inlet Hose Replacement (LH7 Terrain)**

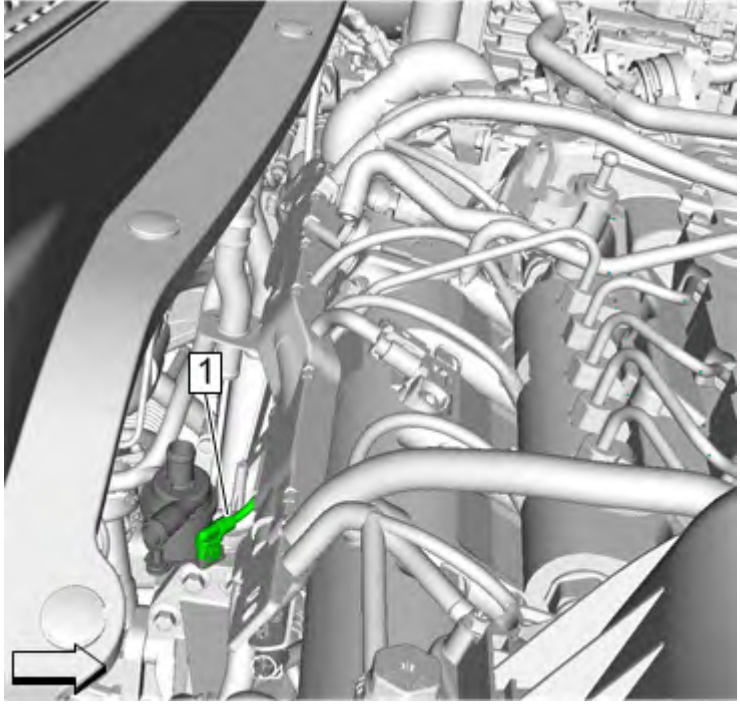


Fig. 362: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

8. Remove Electrical Connector (1) @ Auxiliary Water Pump.

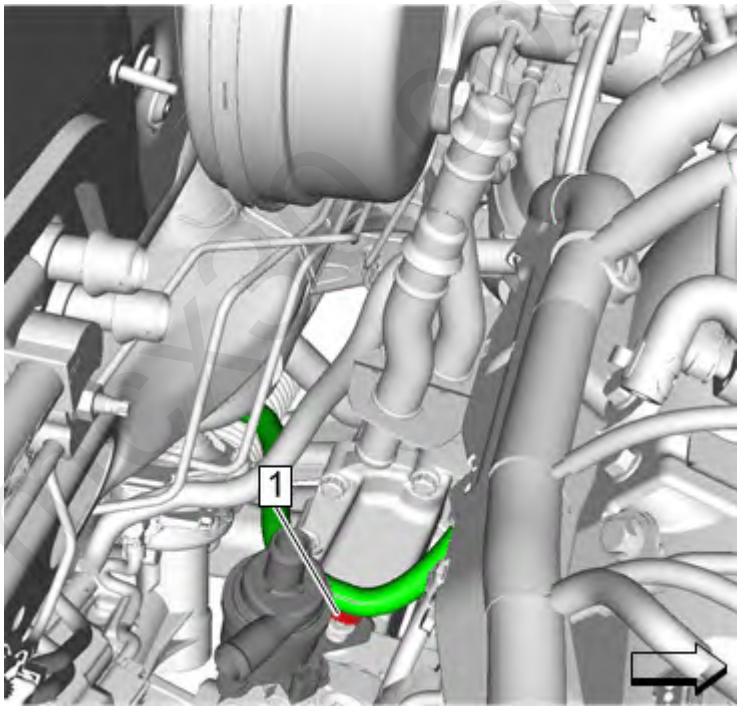


Fig. 363: Engine Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

9. Remove Engine Wiring Harness Retainer (1).

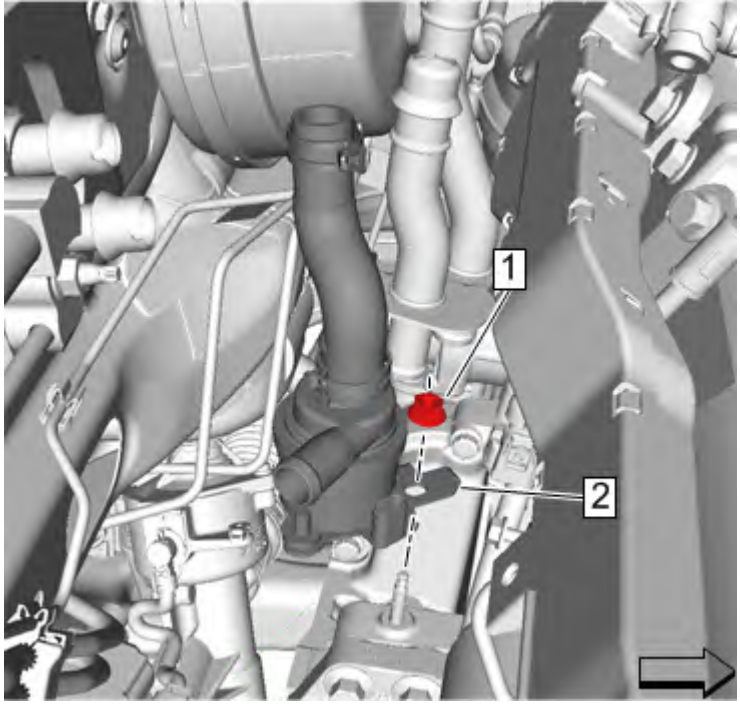


Fig. 364: Auxiliary Water Pump Bracket Nut And Auxiliary Water Pump
Courtesy of GENERAL MOTORS COMPANY

10. Remove Auxiliary Water Pump Bracket Nut (1).
11. Remove Auxiliary Water Pump (2).

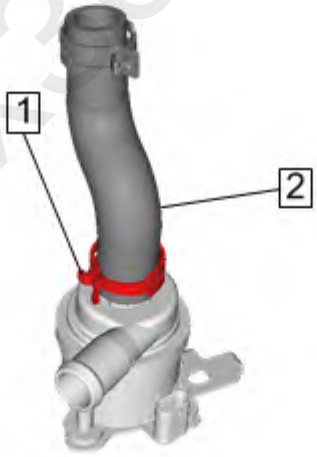


Fig. 365: Heater Water Auxiliary Pump Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

12. Disengage Heater Water Auxiliary Pump Inlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**
13. Remove Heater Water Auxiliary Pump Hose (2) @ Auxiliary Water Pump.

Installation Procedure

mcx30.com

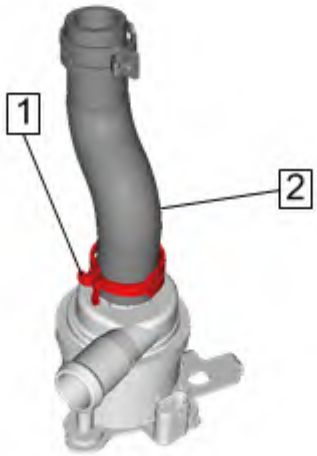


Fig. 366: Heater Water Auxiliary Pump Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

1. Install Heater Water Auxiliary Pump Hose (2) @ Auxiliary Water Pump
2. Engage Heater Water Auxiliary Pump Inlet Hose Clamp (1) - **Hose Clamp Replacement Guidelines - Spring Type**

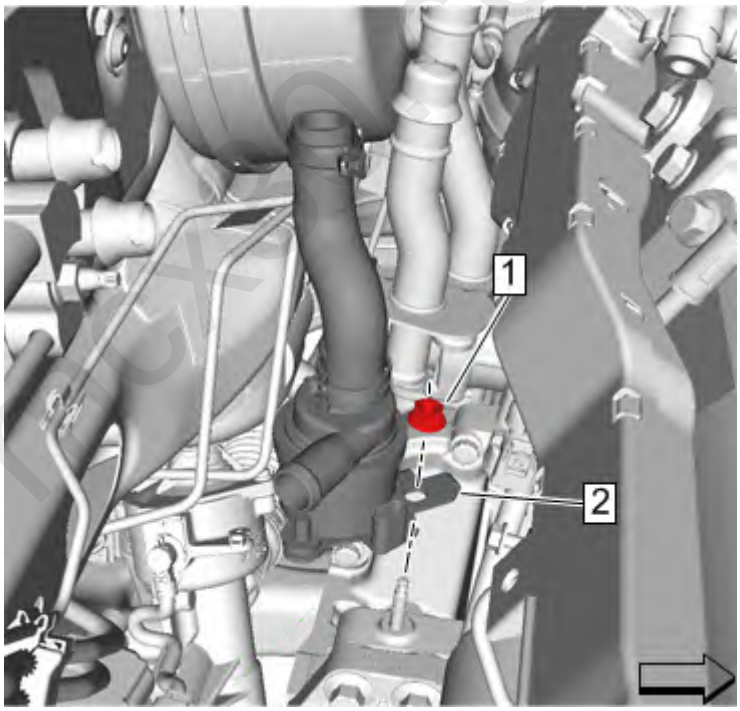


Fig. 367: Auxiliary Water Pump Bracket Nut And Auxiliary Water Pump
Courtesy of GENERAL MOTORS COMPANY

3. Install Auxiliary Water Pump (2)

CAUTION: **Refer to Fastener Caution .**

4. Install Auxiliary Water Pump Bracket Nut (1) and tighten 22 N.m (16 lb ft)

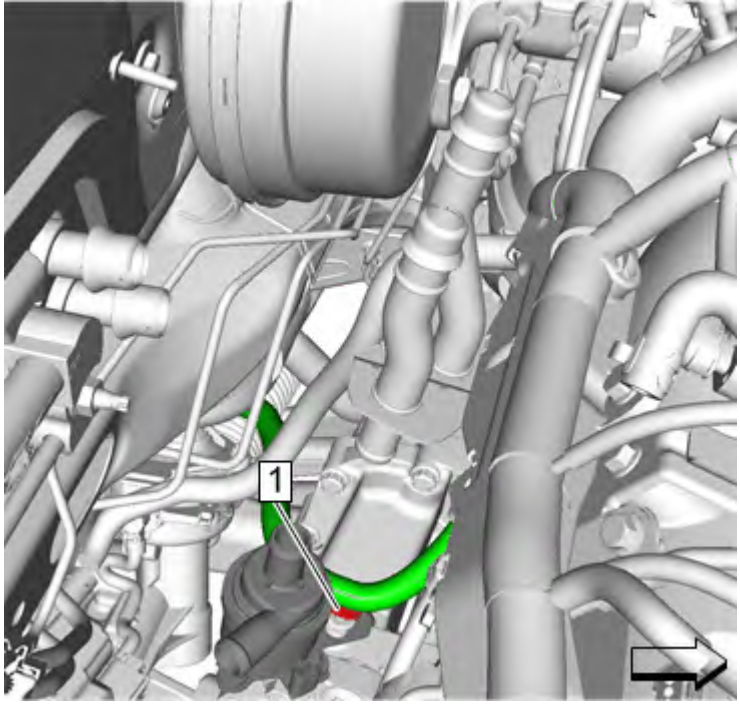


Fig. 368: Engine Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Install Engine Wiring Harness Retainer (1)

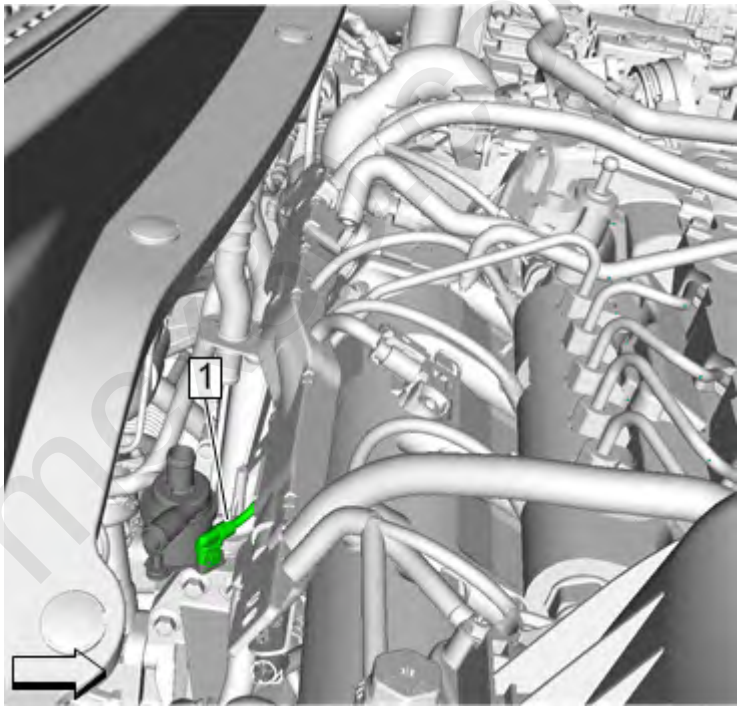


Fig. 369: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Install Electrical Connector (1) @ Auxiliary Water Pump

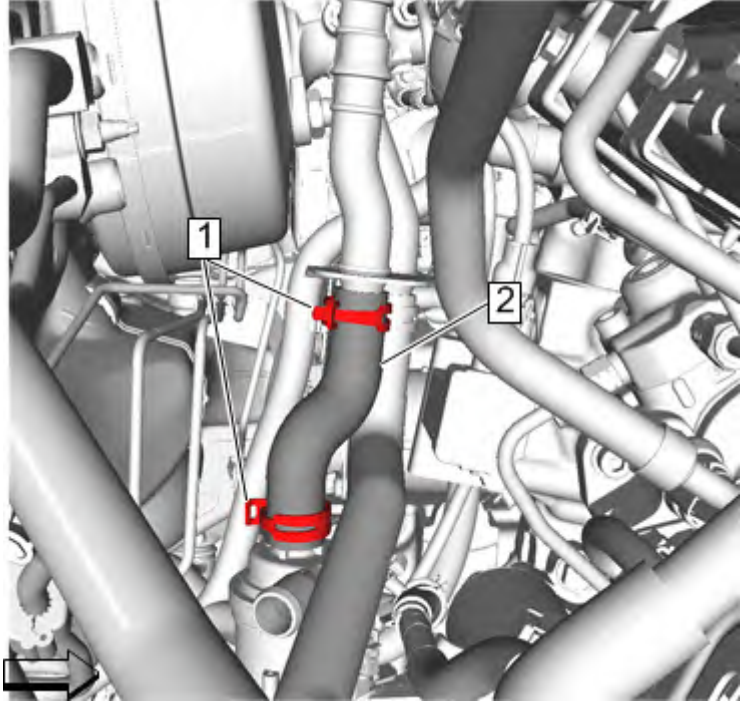


Fig. 370: Heater Water Auxiliary Pump Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

7. Install Heater Water Auxiliary Pump Inlet Hose (2) @ Heater Inlet and Outlet Bracket -**Heater Water Auxiliary Pump Inlet Hose Replacement (LH7 Terrain)**

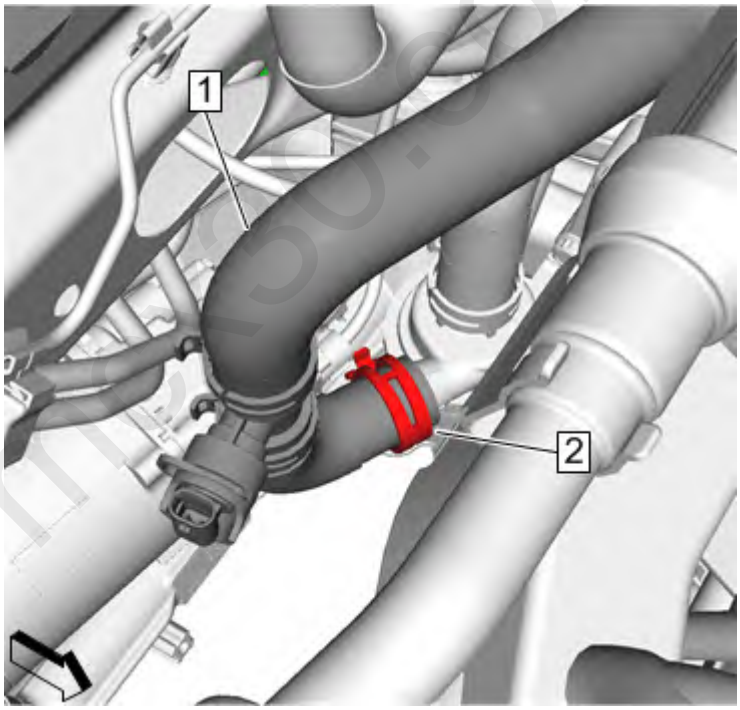


Fig. 371: Heater Water Auxiliary Pump Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

8. Install Heater Water Auxiliary Pump Hose (1) @ Auxiliary Water Pump -**Heater Water Auxiliary Pump Hose Replacement (LH7 Terrain)**

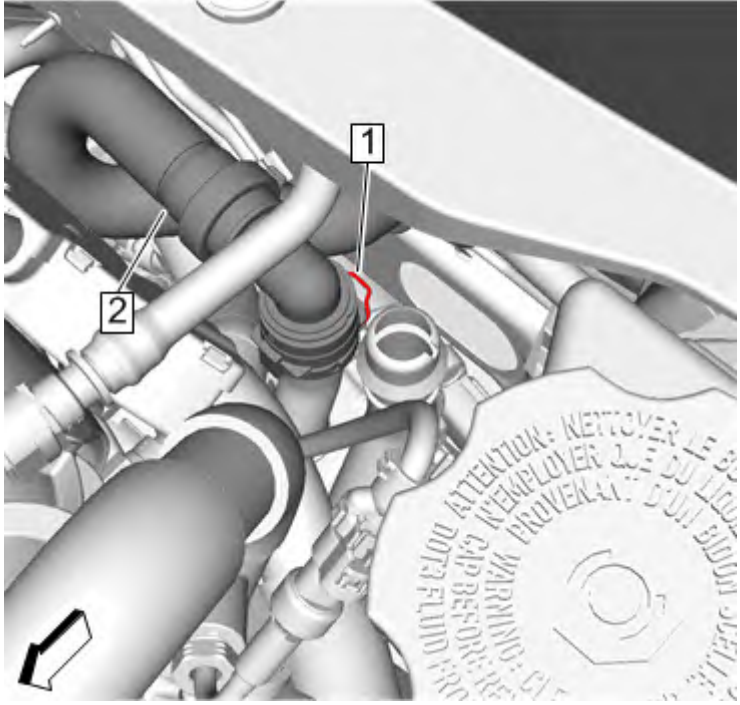


Fig. 372: Auxiliary Heater Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

9. Install Auxiliary Heater Outlet Hose (2) -**Auxiliary Heater Outlet Hose Replacement (LH7 Terrain)**

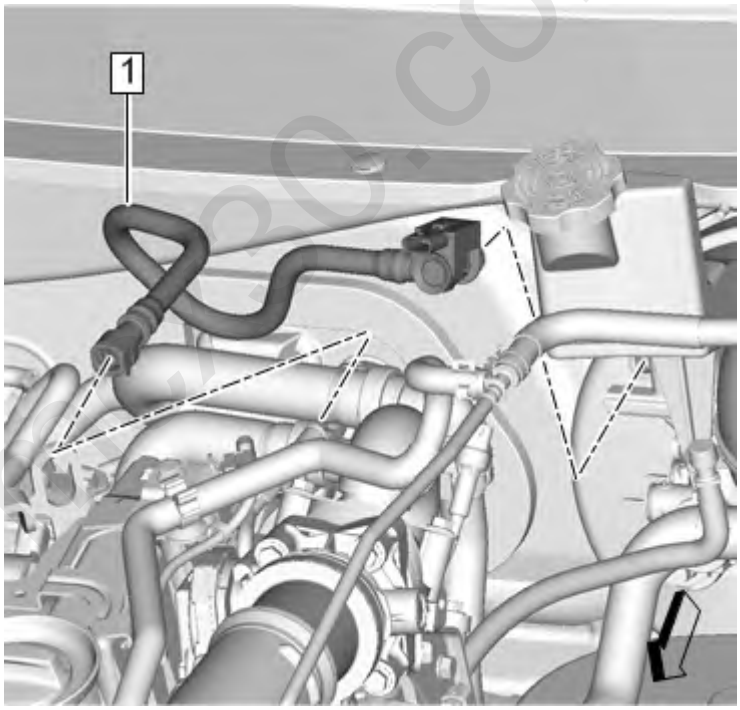


Fig. 373: Power Brake Booster Vacuum Pipe
Courtesy of GENERAL MOTORS COMPANY

10. Install Power Brake Booster Vacuum Pipe (1) **Power Brake Booster Vacuum Pipe Replacement (LH7)**
11. Install Intake Manifold Cover - **Intake Manifold Cover Replacement**
12. Fill the cooling system to the proper level. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
13. Check the cooling system for leaks.

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT (LH7)

Removal Procedure

1. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
2. Lower the vehicle.
3. Remove Intake Manifold Cover - **Intake Manifold Cover Replacement**

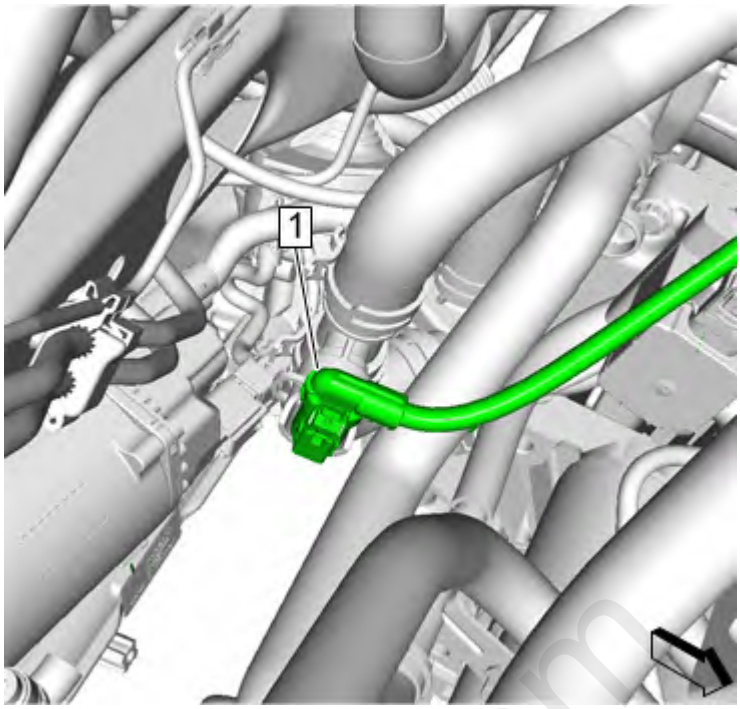


Fig. 374: Engine Coolant Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect Engine Coolant Temperature Sensor Electrical Connector (1) @ Engine Coolant Temperature Sensor.

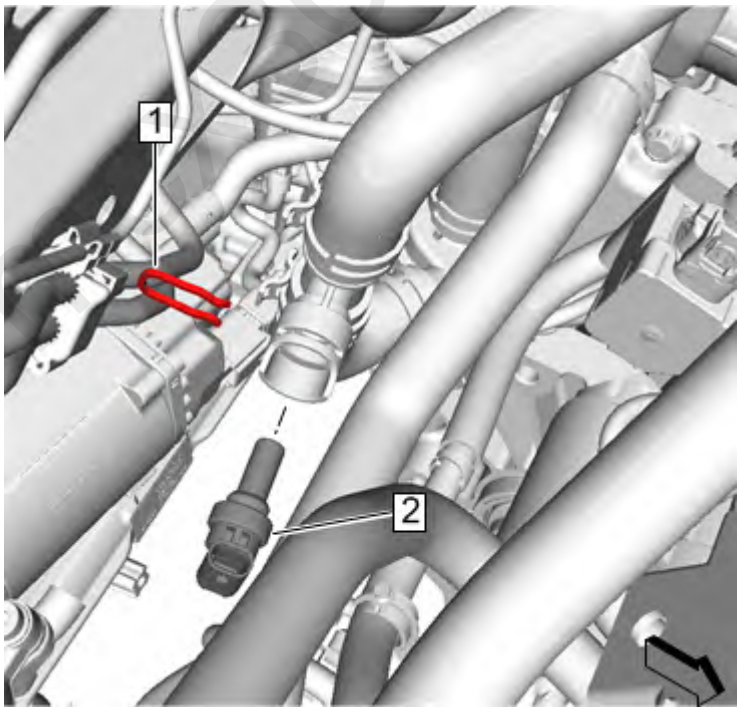


Fig. 375: Engine Coolant Temperature Sensor Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Remove Engine Coolant Temperature Sensor Retainer (1)
6. Remove Engine Coolant Temperature Sensor (2) @ Heater Water Auxiliary Pump Hose

Installation Procedure

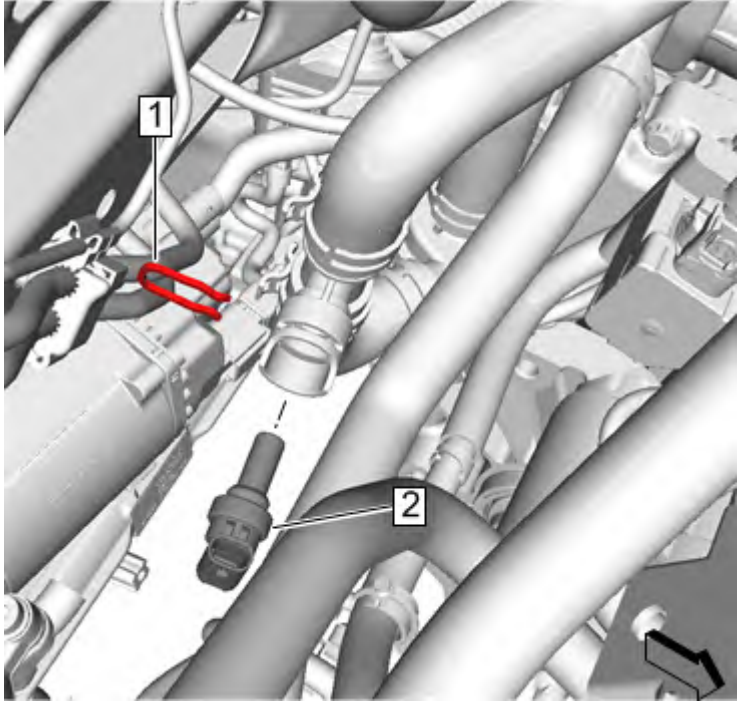


Fig. 376: Engine Coolant Temperature Sensor Retainer
Courtesy of GENERAL MOTORS COMPANY

1. Install Engine Coolant Temperature Sensor (2) @ Heater Water Auxiliary Pump Hose
2. Install Engine Coolant Temperature Sensor Retainer (1).

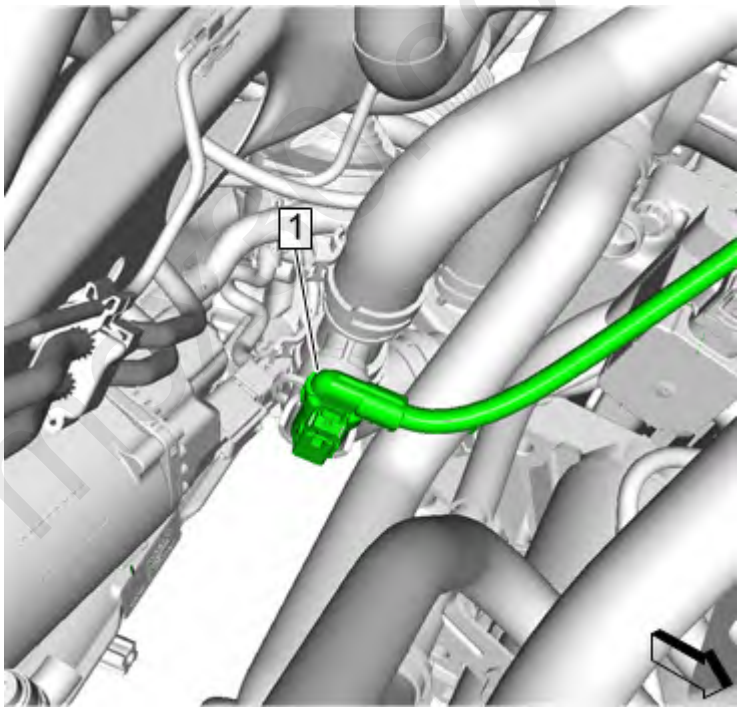


Fig. 377: Engine Coolant Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Connect Engine Coolant Temperature Sensor Electrical Connector (1) @ Engine Coolant Temperature Sensor
4. Install Intake Manifold Cover -**Intake Manifold Cover Replacement**
5. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
6. Check the cooling system for leaks.

RADIATOR DRAIN COCK REPLACEMENT

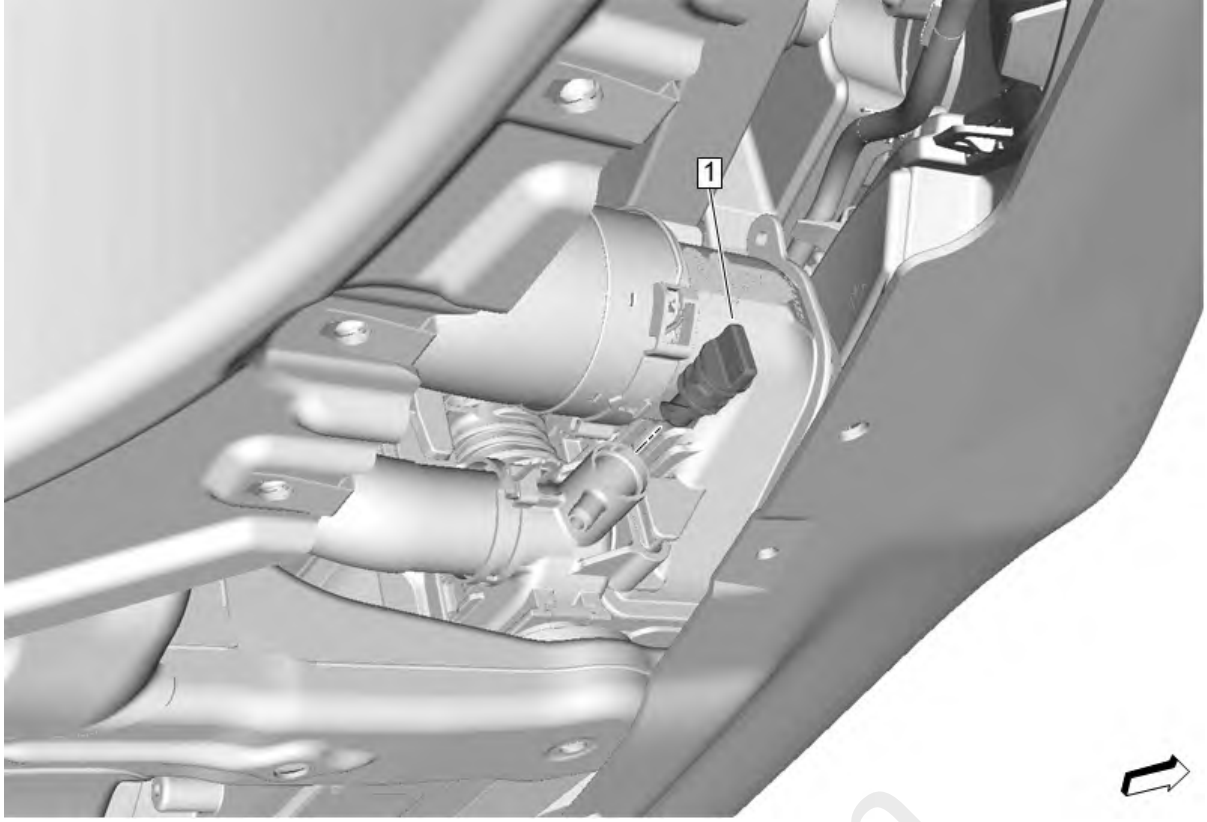


Fig. 378: Radiator Drain Cock
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Underbody Front Air Deflector Replacement (Equinox) Underbody Front Air Deflector Replacement (Terrain) 2. Place a drain pan under the vehicle. 3. Attach a rubber hose to the radiator drain port to guide the coolant into the drain pan.	
1	Radiator Drain Cock **CAUTION:** **Refer to Fastener Caution .** **Procedures** 1. Remove the drain pan. 2. Fill the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static) 3. Start the engine and check for coolant leaks.

RADIATOR REPLACEMENT (LYX)

Removal Procedure

1. Remove Front Bumper Fascia - Front Bumper Fascia Replacement (Equinox) Front Bumper Fascia Replacement (Terrain)
2. Drain the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)

mcx30.com

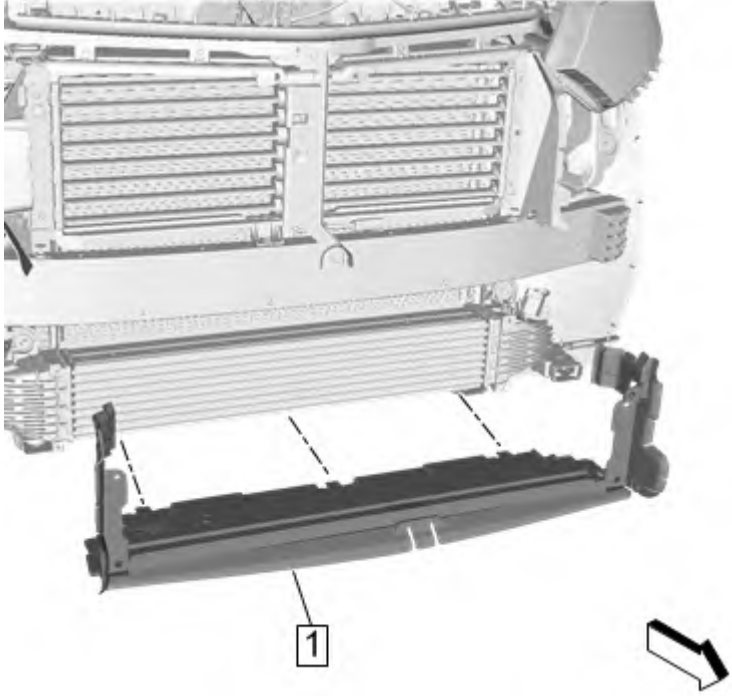


Fig. 379: Radiator Air Lower Baffle
Courtesy of GENERAL MOTORS COMPANY

3. Remove Radiator Air Lower Baffle (1) -**Radiator Air Lower Baffle Replacement (LH7 LTG LYX)**

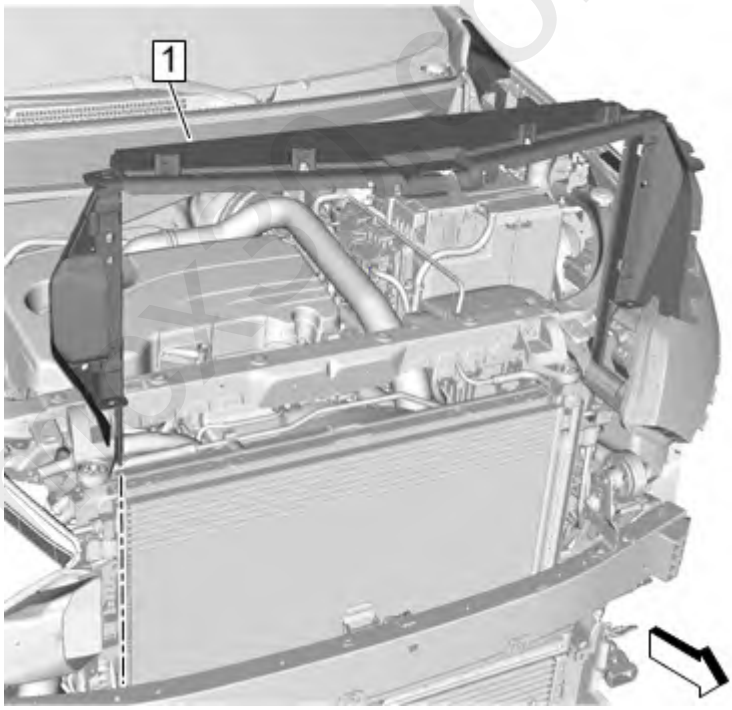


Fig. 380: Radiator Air Upper Baffle
Courtesy of GENERAL MOTORS COMPANY

4. Remove Radiator Air Upper Baffle (1) - **Radiator Air Upper Baffle Replacement (LH7 LTG LYX)**
5. Disconnect the electrical connectors.
6. Remove Air Conditioning Condenser - **Air Conditioning Condenser Replacement**
7. Remove Charge Air Cooler -**Charge Air Cooler Replacement**

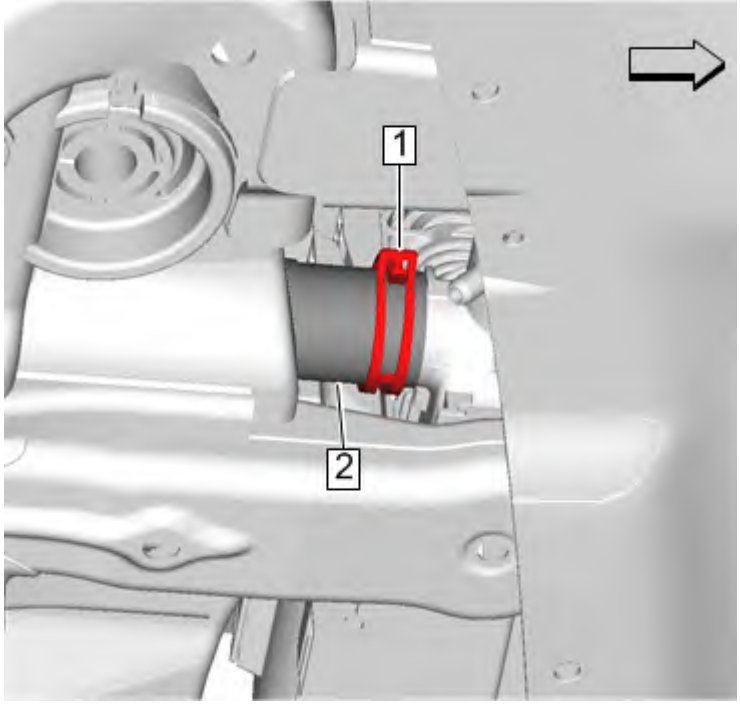


Fig. 381: Radiator Outlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

8. Remove Radiator Outlet Hose (2) @ Radiator **Radiator Outlet Hose Replacement (LYX)**

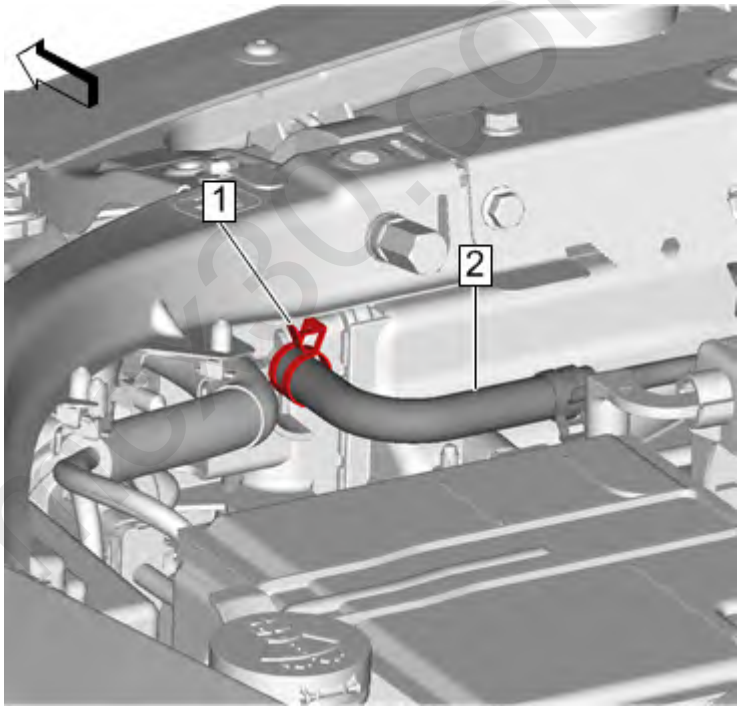


Fig. 382: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

9. Remove Engine Coolant Air Bleed Hose (2) @ Radiator - **Engine Coolant Air Bleed Hose Replacement (Turbocharger Coolant Return pipe to Water Outlet, LYX)Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Turbocharger Coolant Return Pipe to Radiator, LYX)**

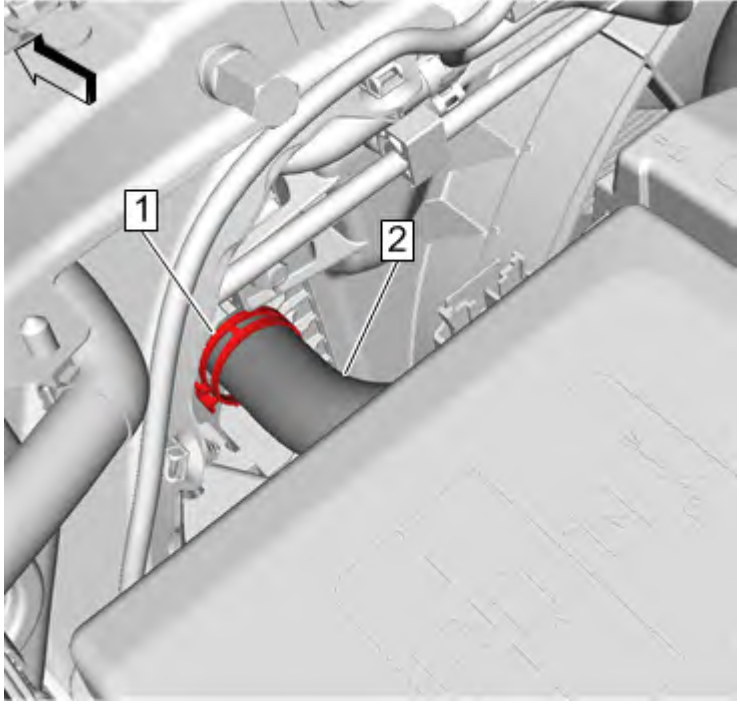


Fig. 383: Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

10. Remove Radiator Inlet Hose (2) @ - Radiator **Radiator Inlet Hose Replacement (LYX)**

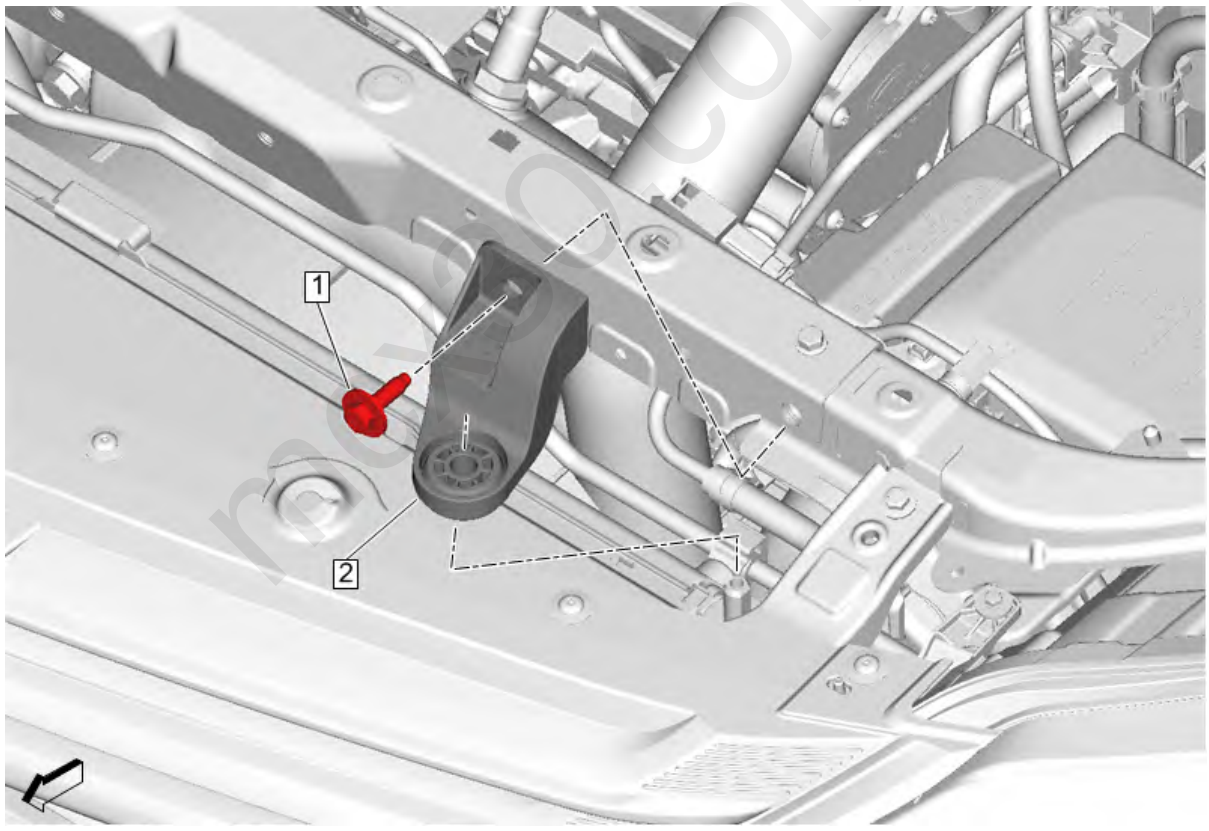


Fig. 384: Radiator Upper Bracket-Left Side
Courtesy of GENERAL MOTORS COMPANY

11. Remove Radiator Upper Bracket - Left Side (2) -**Radiator Upper Bracket Replacement - Left Side**

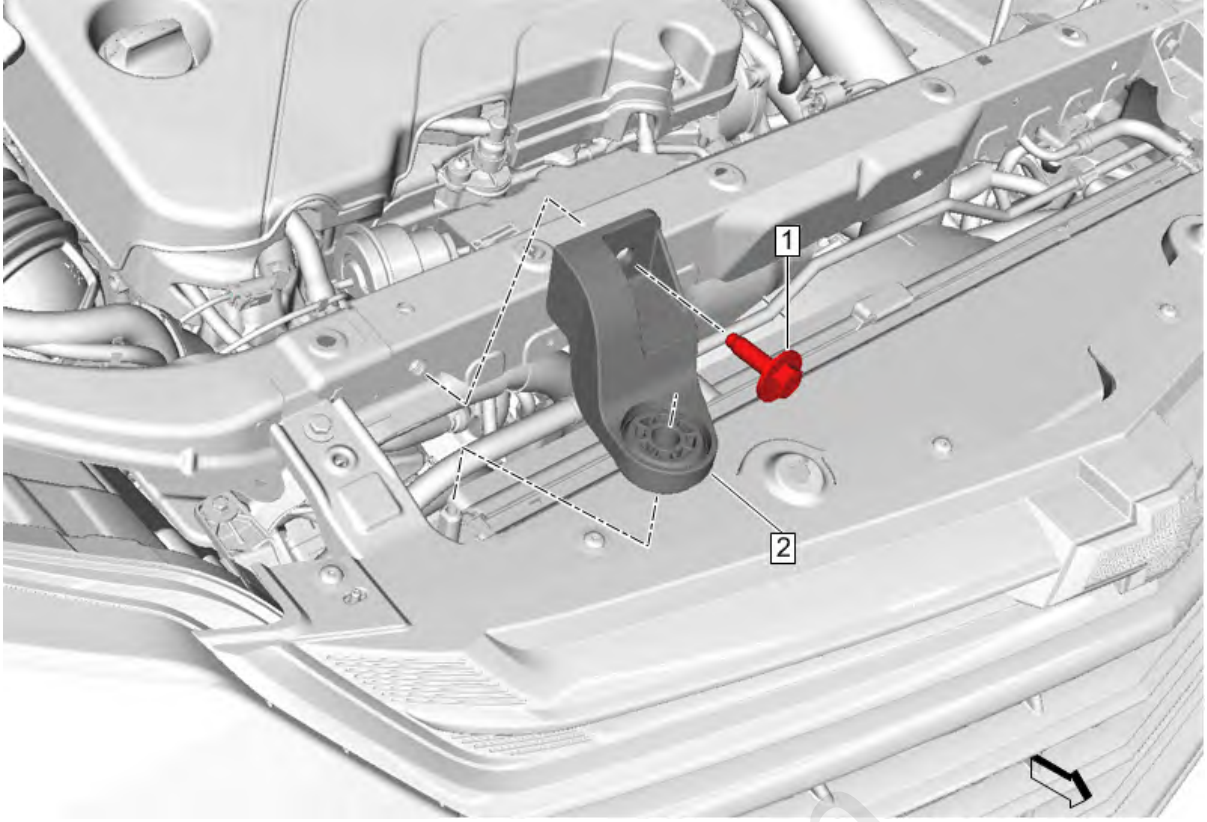


Fig. 385: Radiator Upper Bracket-Right Side
Courtesy of GENERAL MOTORS COMPANY

12. Remove Radiator Upper Bracket - Right Side (2) - **Radiator Upper Bracket Replacement - Right Side**

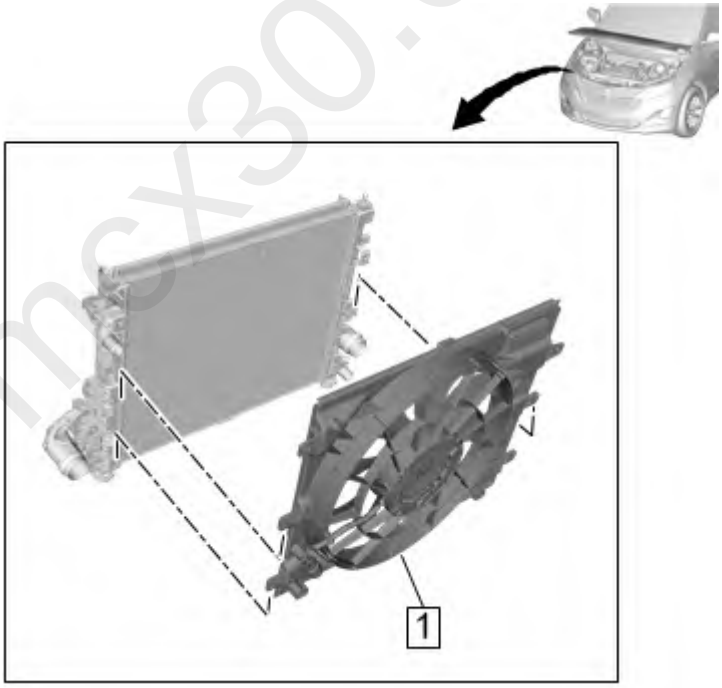


Fig. 386: Engine Coolant Fan
Courtesy of GENERAL MOTORS COMPANY

13. Remove Engine Coolant Fan (1) @ Radiator -**Engine Coolant Fan Replacement (LYX)**

mcx30.com

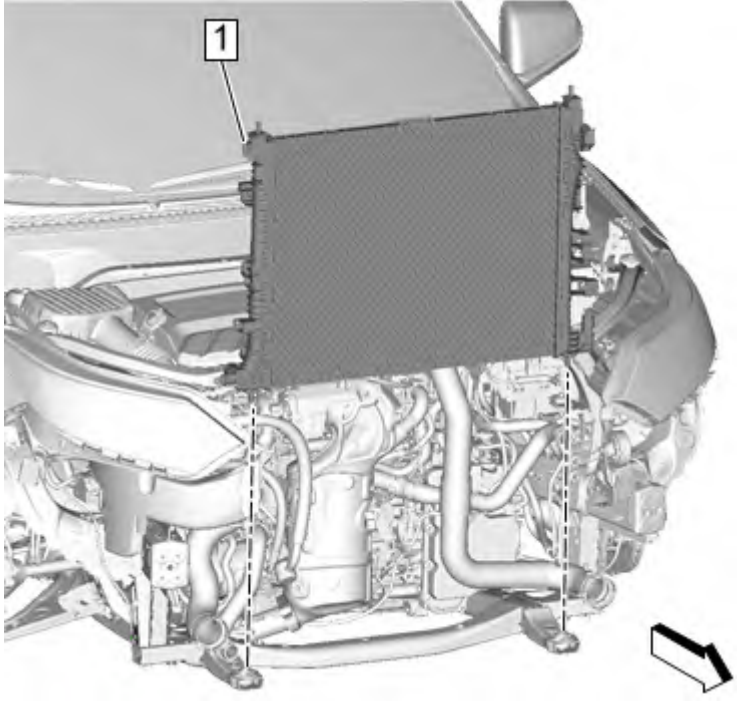


Fig. 387: Radiator
Courtesy of GENERAL MOTORS COMPANY

14. Remove Radiator (1)
15. Transfer components as necessary.

Installation Procedure

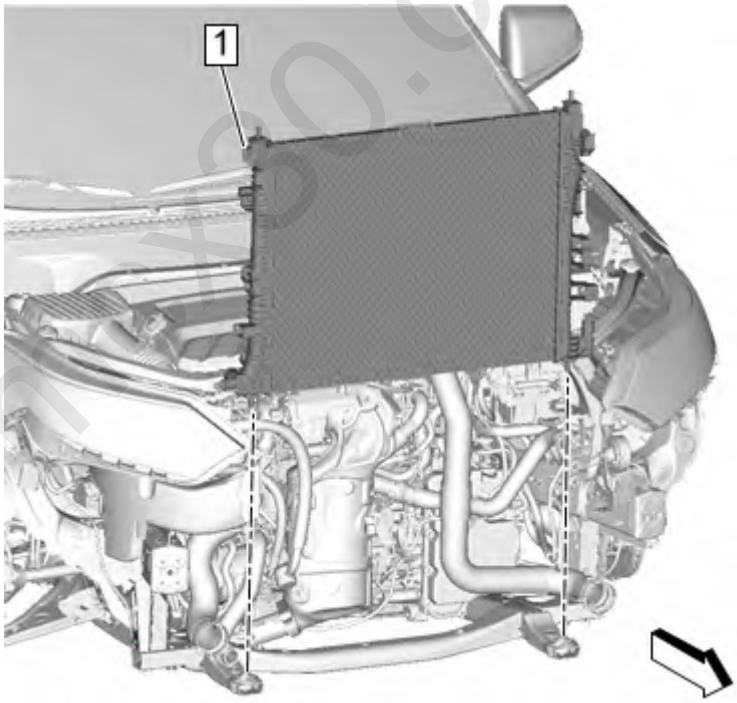


Fig. 388: Radiator
Courtesy of GENERAL MOTORS COMPANY

1. Install Radiator (1)

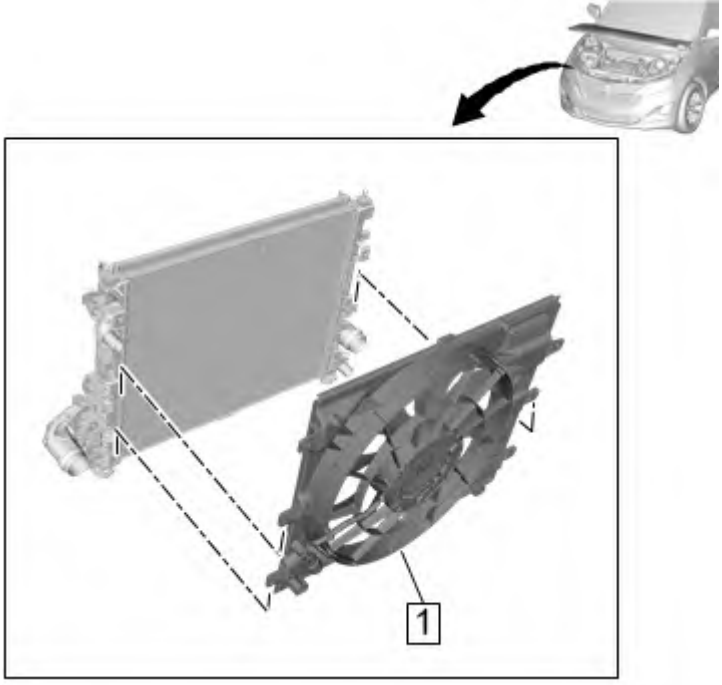


Fig. 389: Engine Coolant Fan
Courtesy of GENERAL MOTORS COMPANY

2. Install Engine Coolant Fan (1) @ Radiator - **Engine Coolant Fan Replacement (LYX)**

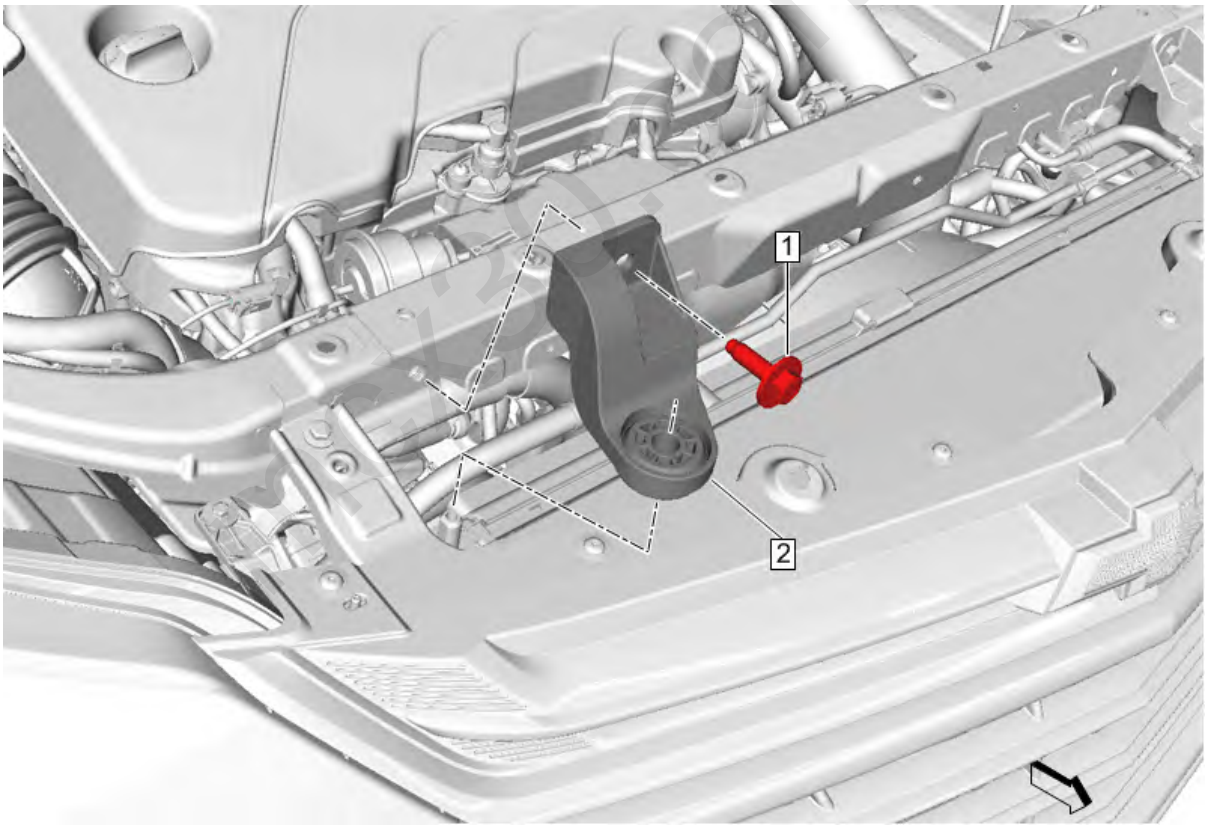


Fig. 390: Radiator Upper Bracket-Right Side
Courtesy of GENERAL MOTORS COMPANY

3. Install Radiator Upper Bracket-Right Side (2) - **Radiator Upper Bracket Replacement - Right Side**

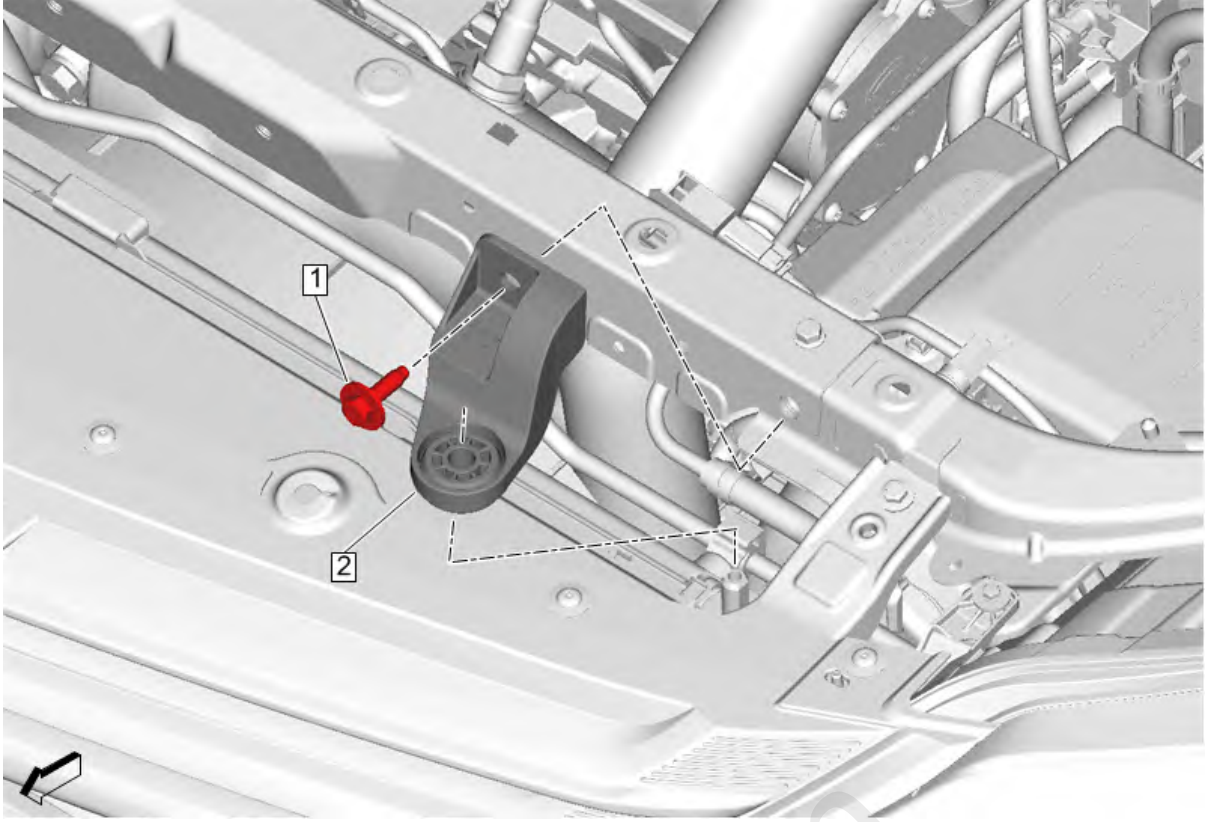


Fig. 391: Radiator Upper Bracket-Left Side
Courtesy of GENERAL MOTORS COMPANY

4. Install Radiator Upper Bracket-Left Side (2) - **Radiator Upper Bracket Replacement - Left Side**

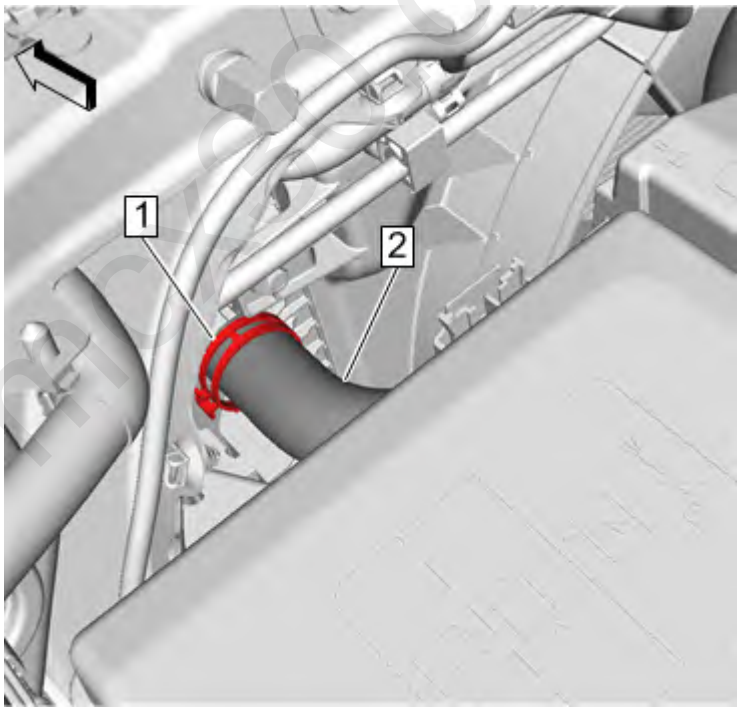


Fig. 392: Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

5. Install Radiator Inlet Hose (2) @ Radiator -**Radiator Inlet Hose Replacement (LYX)**

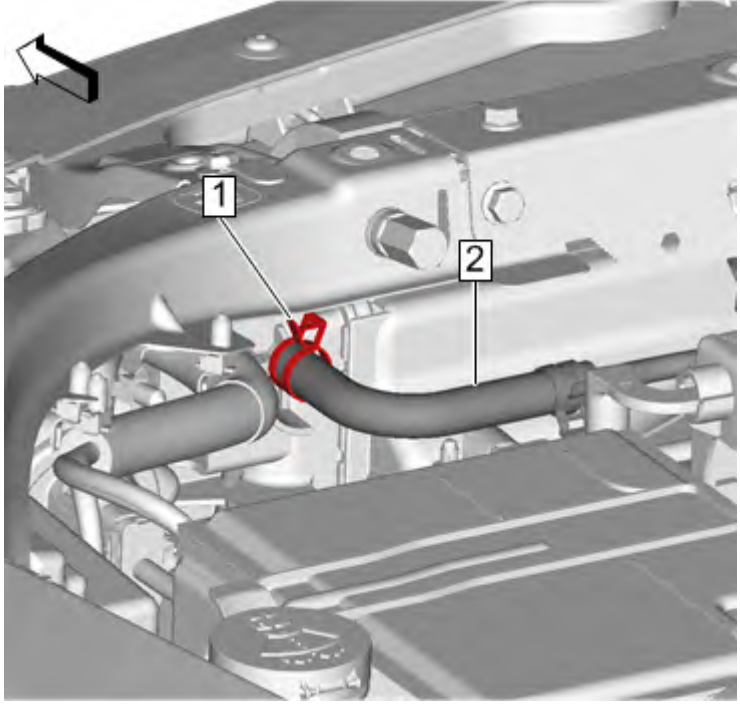


Fig. 393: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

6. Install Engine Coolant Air Bleed Hose (2) @ Radiator - **Engine Coolant Air Bleed Hose Replacement (Turbocharger Coolant Return pipe to Water Outlet, LYX)Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Turbocharger Coolant Return Pipe to Radiator, LYX)**

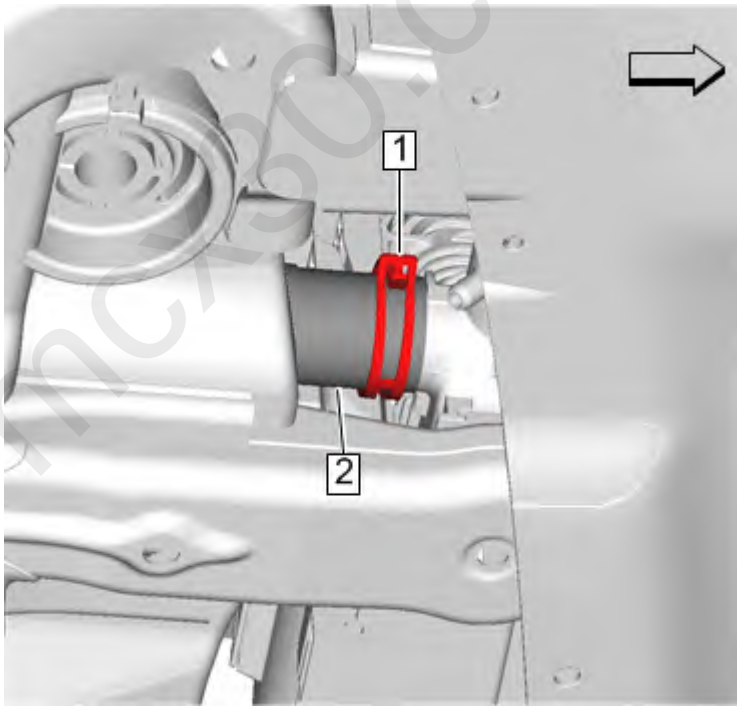


Fig. 394: Radiator Outlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

7. Install Radiator Outlet Hose (2) @ Radiator - **Radiator Outlet Hose Replacement (LYX)**
8. Install Charge Air Cooler - **Charge Air Cooler Replacement**
9. Install Air Conditioning Condenser -**Air Conditioning Condenser Replacement**
10. Connect the electrical connectors.

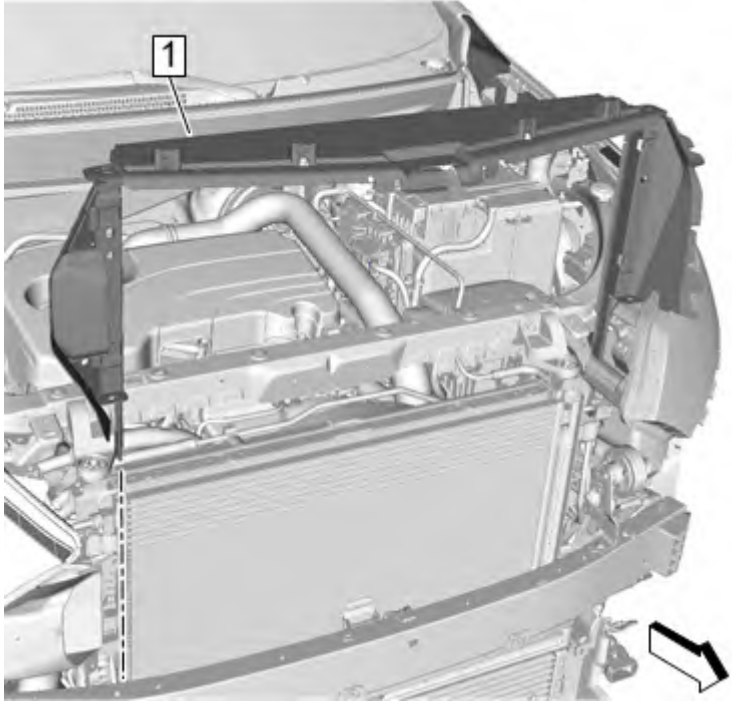


Fig. 395: Radiator Air Upper Baffle
Courtesy of GENERAL MOTORS COMPANY

11. Install Radiator Air Upper Baffle (1) - **Radiator Air Upper Baffle Replacement (LH7 LTG LYX)**

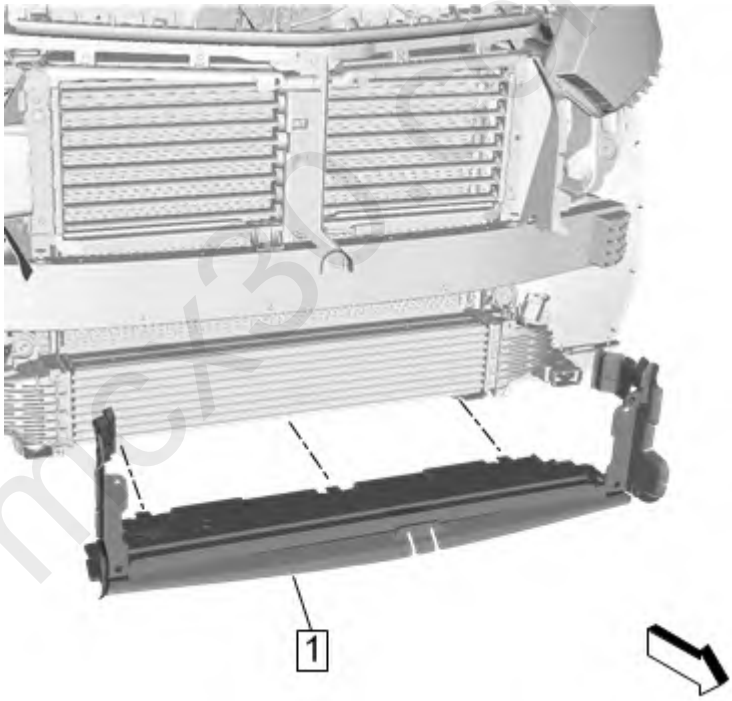


Fig. 396: Radiator Air Lower Baffle
Courtesy of GENERAL MOTORS COMPANY

12. Install Radiator Air Lower Baffle (1) - **Radiator Air Lower Baffle Replacement (LH7 LTG LYX)**
13. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)**
14. Start the engine and check for coolant leaks.
15. Install Front Bumper Fascia - **Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**

RADIATOR REPLACEMENT (LTG)

Removal Procedure

1. Remove Front Bumper Fascia - **Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**

2. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**

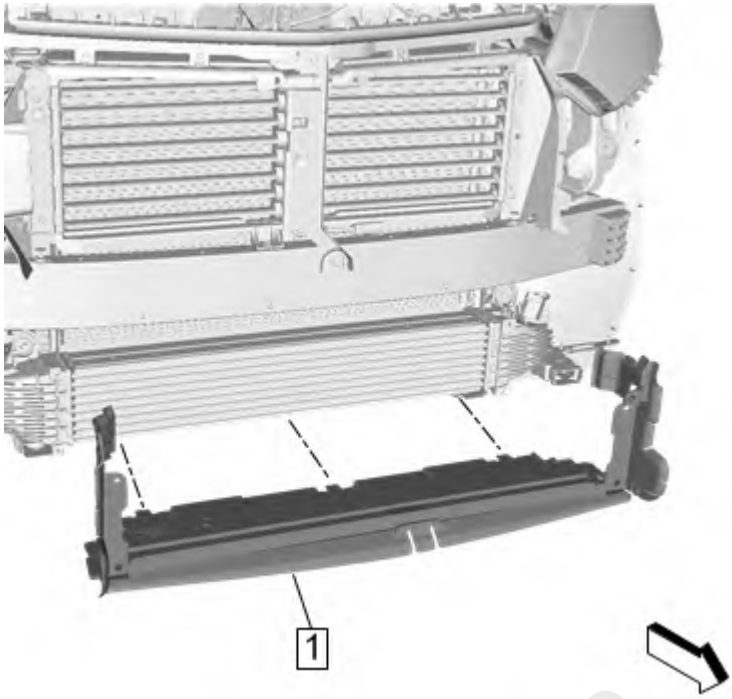


Fig. 397: Radiator Air Lower Baffle
Courtesy of GENERAL MOTORS COMPANY

3. Remove Radiator Air Lower Baffle (1) -**Radiator Air Lower Baffle Replacement (LH7 LTG LYX)**

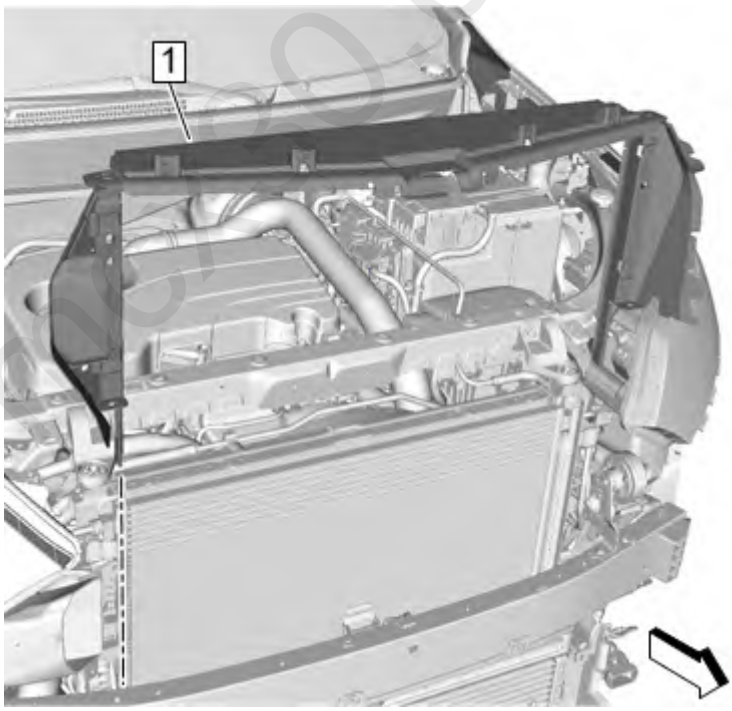


Fig. 398: Radiator Air Upper Baffle
Courtesy of GENERAL MOTORS COMPANY

4. Remove Radiator Air Upper Baffle (1) - **Radiator Air Upper Baffle Replacement (LH7 LTG LYX)**
5. Disconnect the electrical connectors.
6. Remove Air Conditioning Condenser - **Air Conditioning Condenser Replacement**

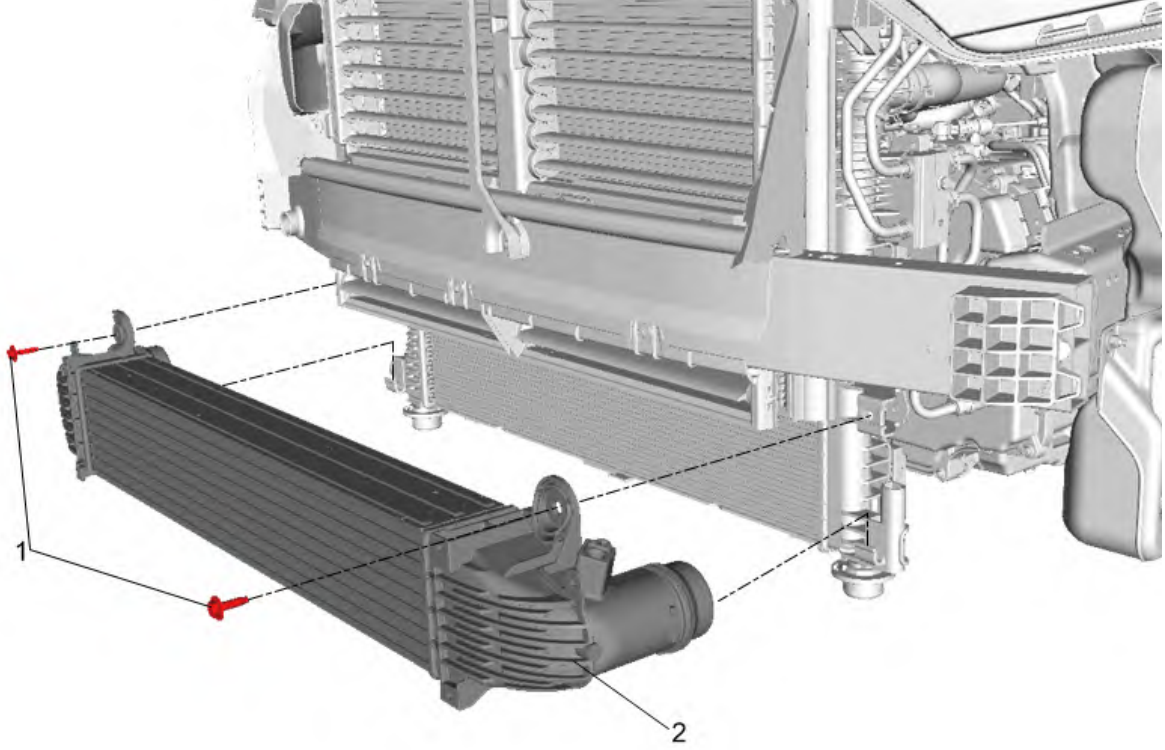


Fig. 399: Charge Air Cooler
Courtesy of GENERAL MOTORS COMPANY

7. Remove Charge Air Cooler (2) **Charge Air Cooler Replacement**

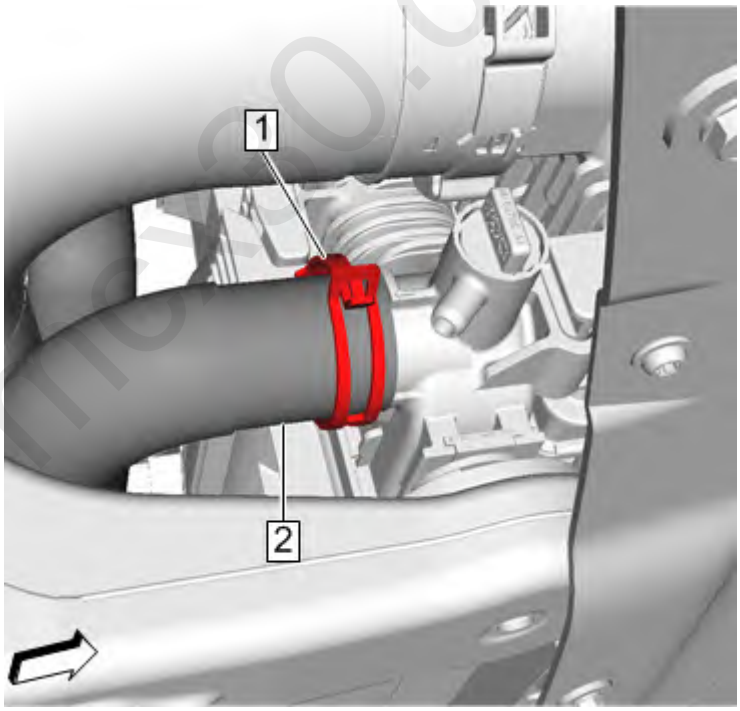


Fig. 400: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

8. Remove Radiator Outlet Hose (2) @ Radiator - **Radiator Outlet Hose Replacement (LTG with KL9)**

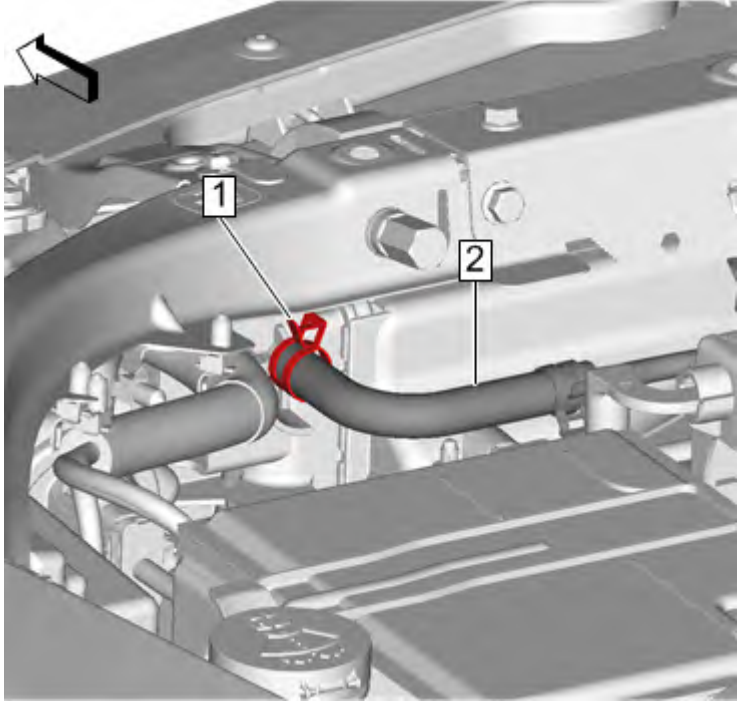


Fig. 401: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

9. Remove Engine Coolant Air Bleed Hose (2) @ Radiator - **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Radiator to Engine Coolant Air Bleed Pipe LTG)**

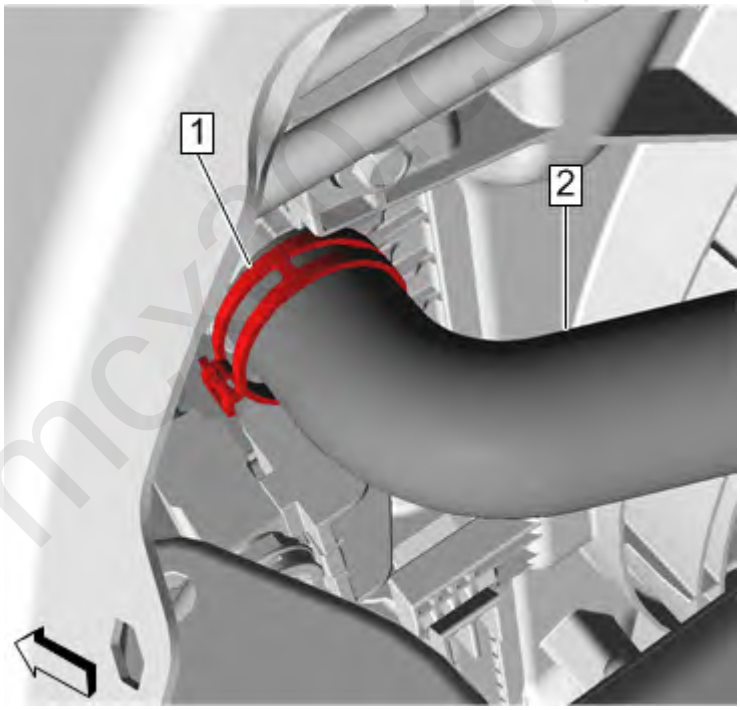


Fig. 402: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

10. Remove Radiator Inlet Hose (2) @ - Radiator - **Radiator Inlet Hose Replacement (LTG with KL9)**

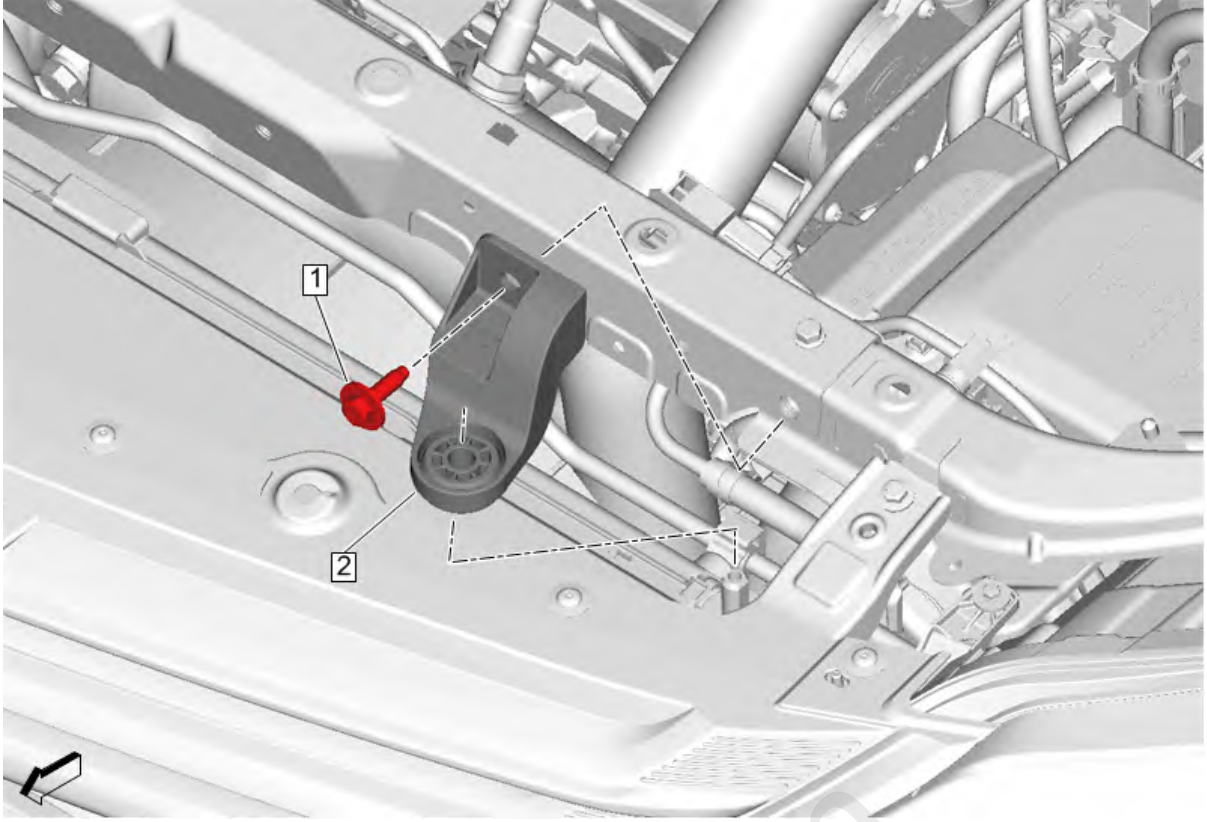


Fig. 403: Radiator Upper Bracket-Left Side
Courtesy of GENERAL MOTORS COMPANY

11. Remove Radiator Upper Bracket - Left Side (2) - **Radiator Upper Bracket Replacement - Left Side**

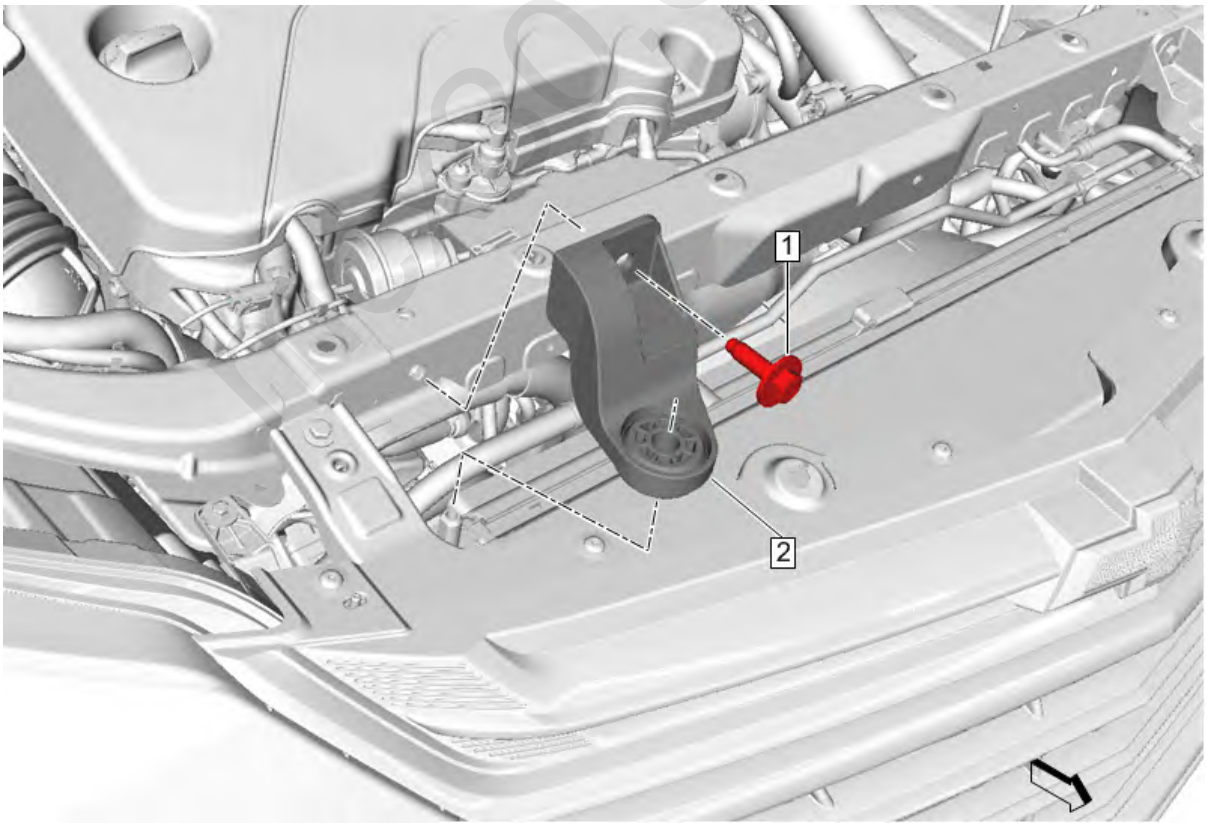


Fig. 404: Radiator Upper Bracket-Right Side
Courtesy of GENERAL MOTORS COMPANY

12. Remove Radiator Upper Bracket - Right Side (2) - **Radiator Upper Bracket Replacement - Right Side**

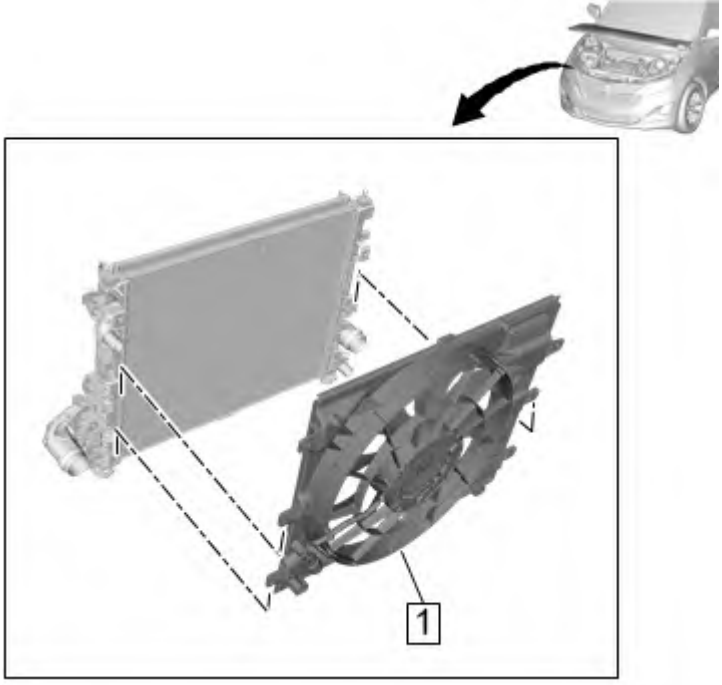


Fig. 405: Engine Coolant Fan
Courtesy of GENERAL MOTORS COMPANY

13. Remove Engine Coolant Fan (1) @ Radiator - **Engine Coolant Fan Replacement (LTG)**

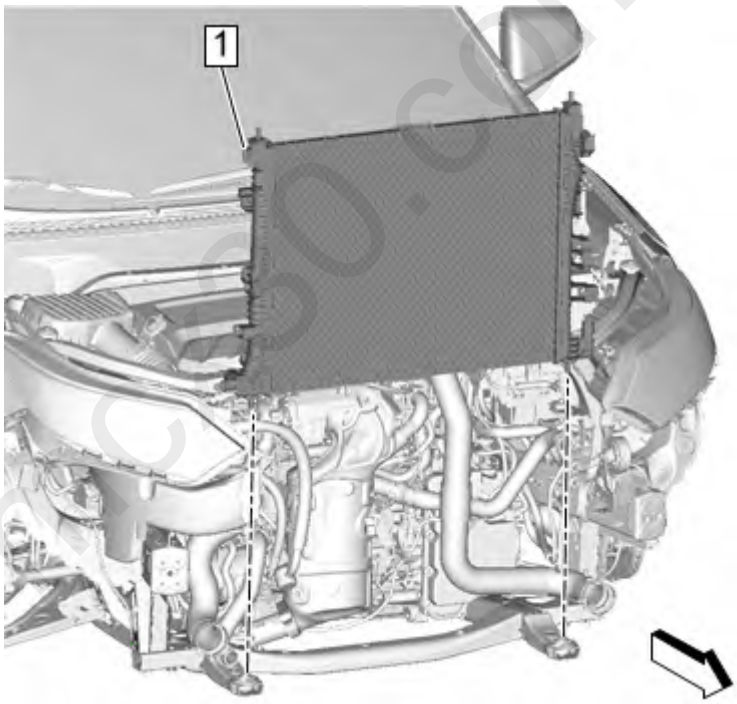


Fig. 406: Radiator
Courtesy of GENERAL MOTORS COMPANY

14. Remove Radiator (1)
15. Transfer components as necessary.

Installation Procedure

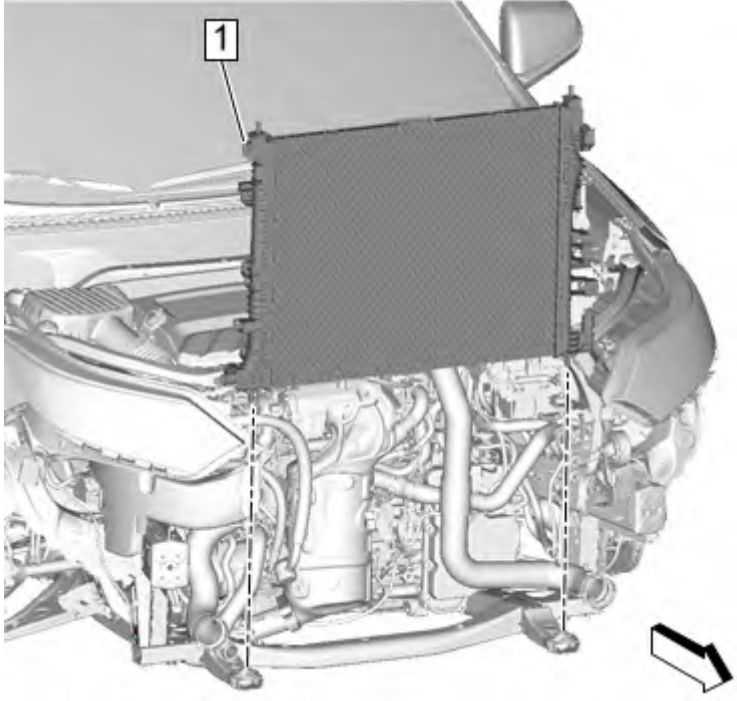


Fig. 407: Radiator
Courtesy of GENERAL MOTORS COMPANY

1. Install Radiator (1)

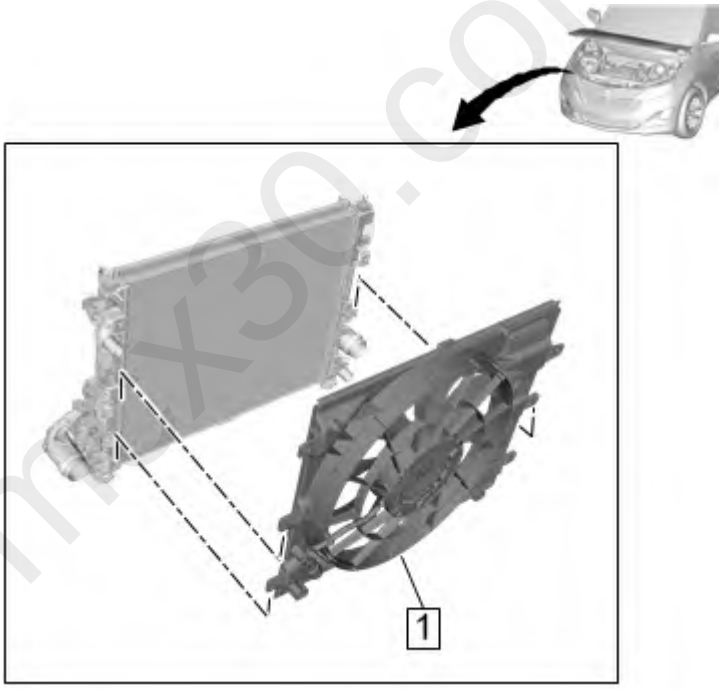


Fig. 408: Engine Coolant Fan
Courtesy of GENERAL MOTORS COMPANY

2. Install Engine Coolant Fan (1) @ Radiator - **Engine Coolant Fan Replacement (LTG)**

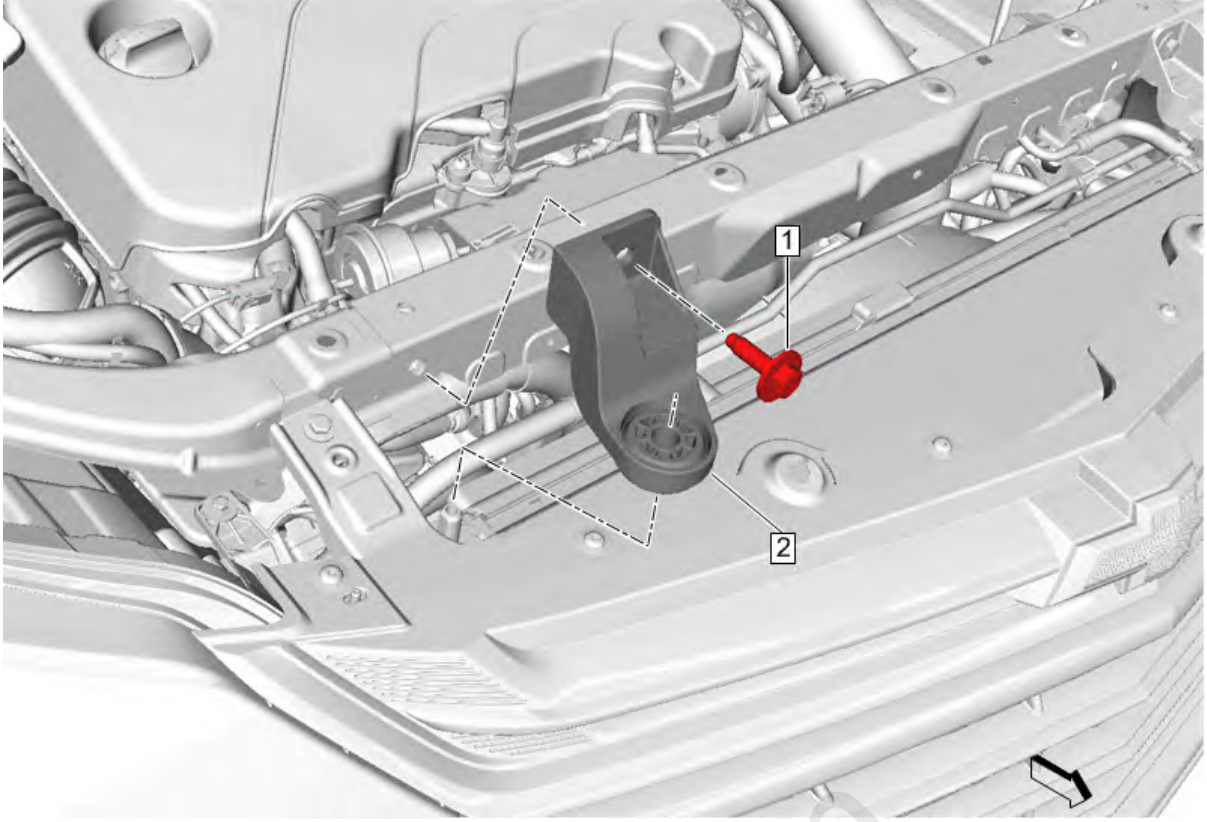


Fig. 409: Radiator Upper Bracket-Right Side
Courtesy of GENERAL MOTORS COMPANY

3. Install Radiator Upper Bracket - Right Side (2) - **Radiator Upper Bracket Replacement - Right Side**

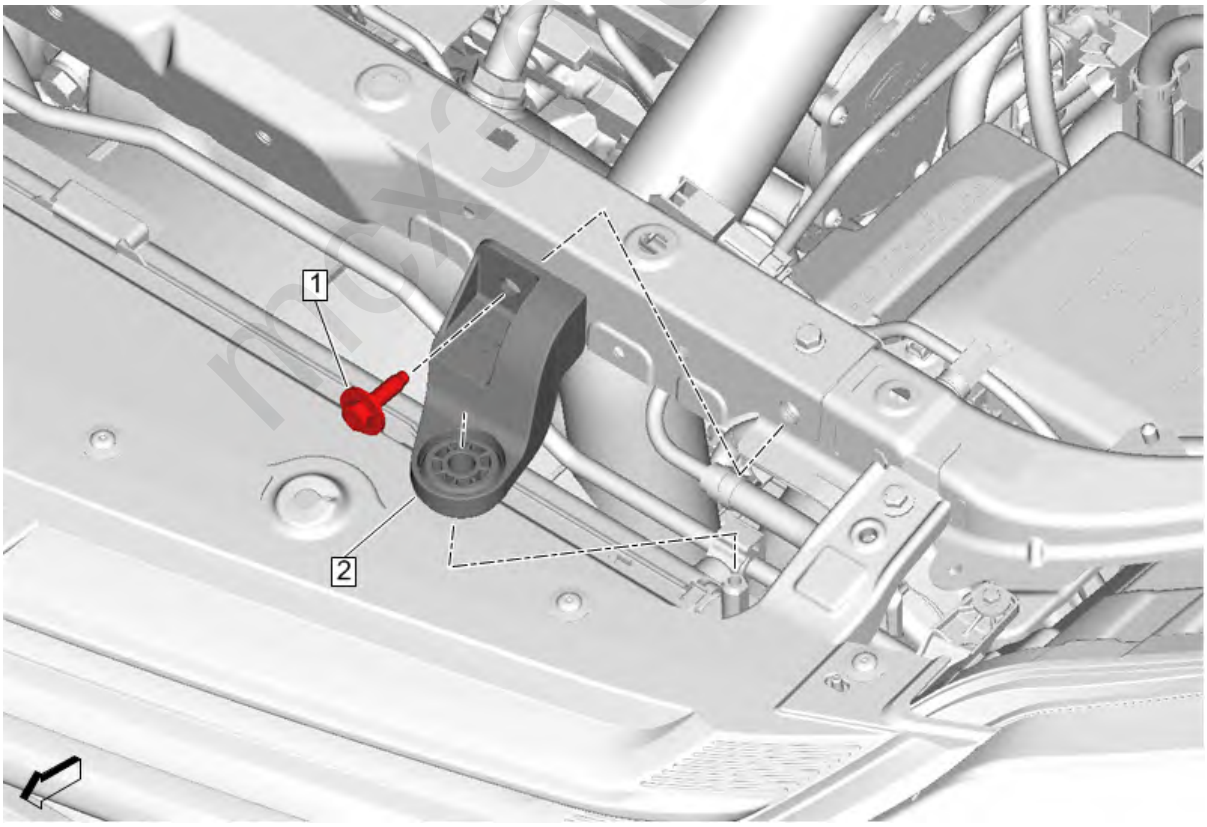


Fig. 410: Radiator Upper Bracket-Left Side
Courtesy of GENERAL MOTORS COMPANY

4. Install Radiator Upper Bracket - Left Side (2) -**Radiator Upper Bracket Replacement - Left Side**

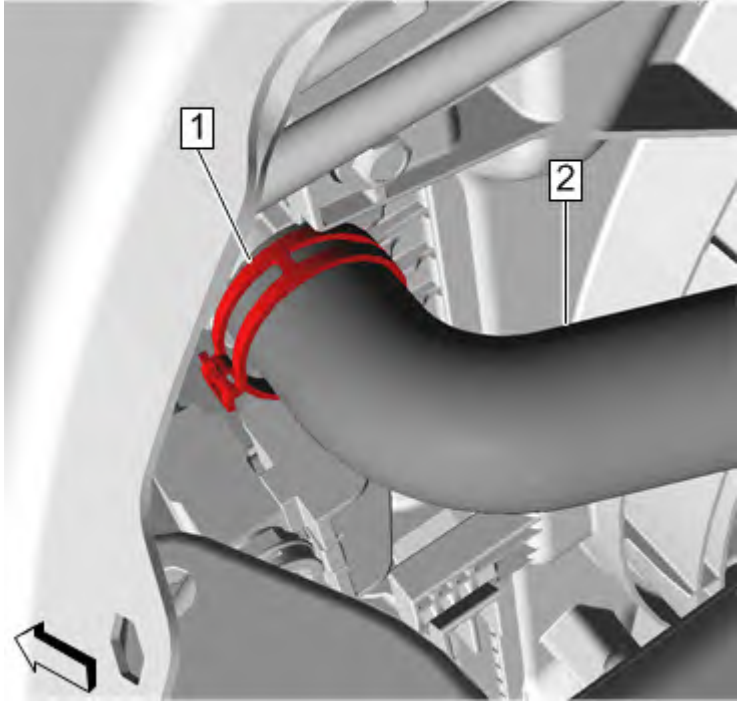


Fig. 411: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Install Radiator Inlet Hose (2) @ Radiator - **Radiator Inlet Hose Replacement (LTG with KL9)**

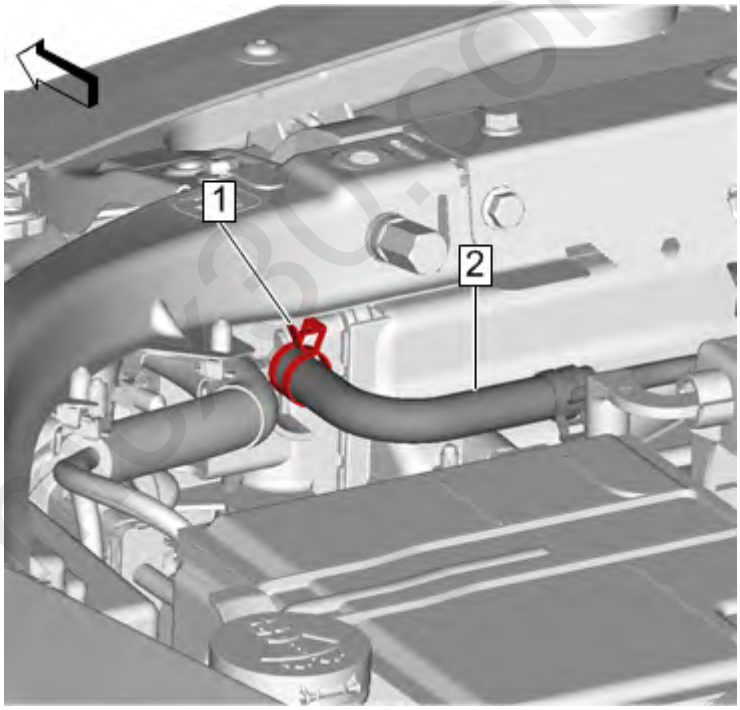


Fig. 412: Engine Coolant Air Bleed Hose
Courtesy of GENERAL MOTORS COMPANY

6. Install Engine Coolant Air Bleed Hose (2) @ Radiator - **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Radiator to Engine Coolant Air Bleed Pipe LTG)**

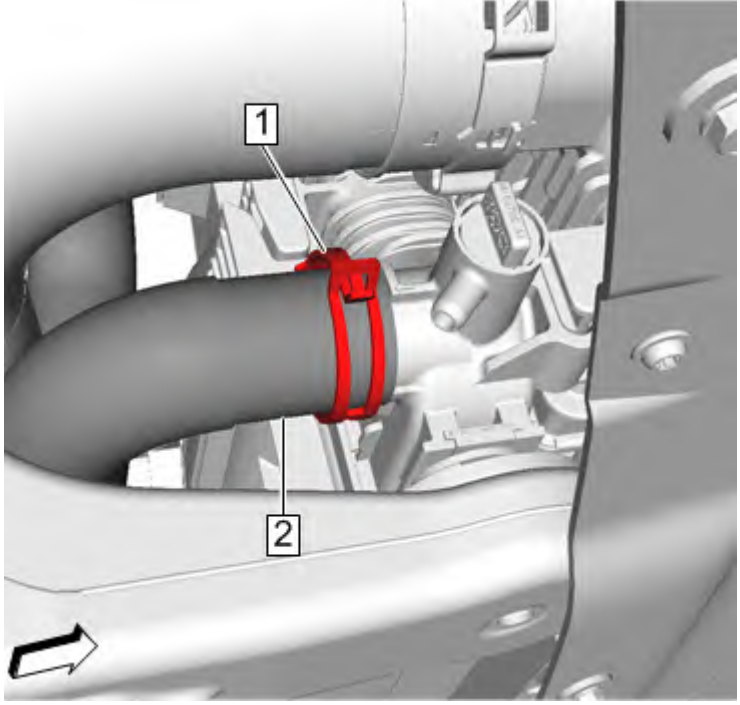


Fig. 413: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

7. Install Radiator Outlet Hose (2) @ Radiator - **Radiator Outlet Hose Replacement (LTG with KL9)**

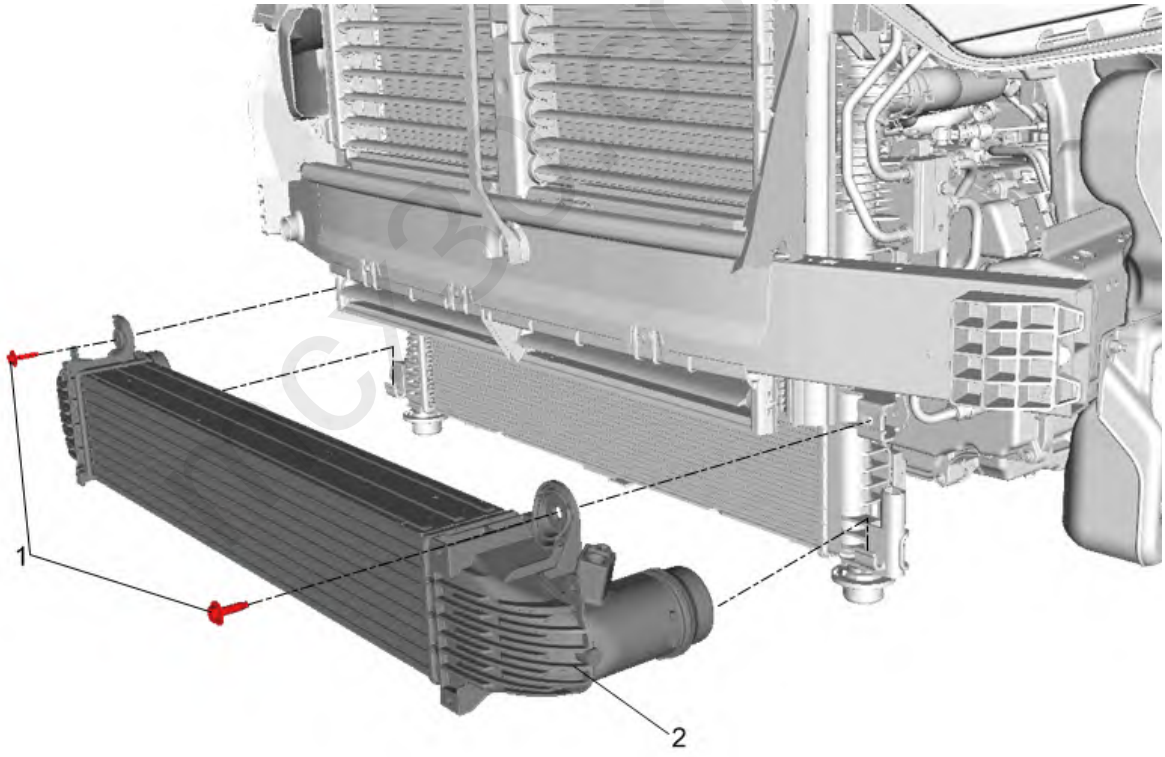


Fig. 414: Charge Air Cooler
Courtesy of GENERAL MOTORS COMPANY

8. Install Charge Air Cooler (2) -**Charge Air Cooler Replacement**
9. Install Air Conditioning Condenser - **Air Conditioning Condenser Replacement**
10. Connect the electrical connectors.

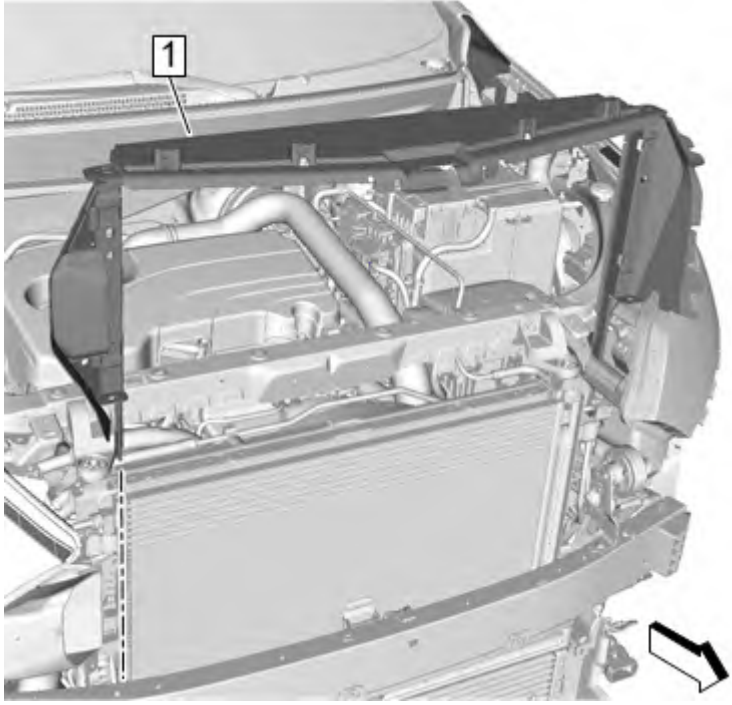


Fig. 415: Radiator Air Upper Baffle
Courtesy of GENERAL MOTORS COMPANY

11. Install Radiator Air Upper Baffle (1) - **Radiator Air Upper Baffle Replacement (LH7 LTG LYX)**

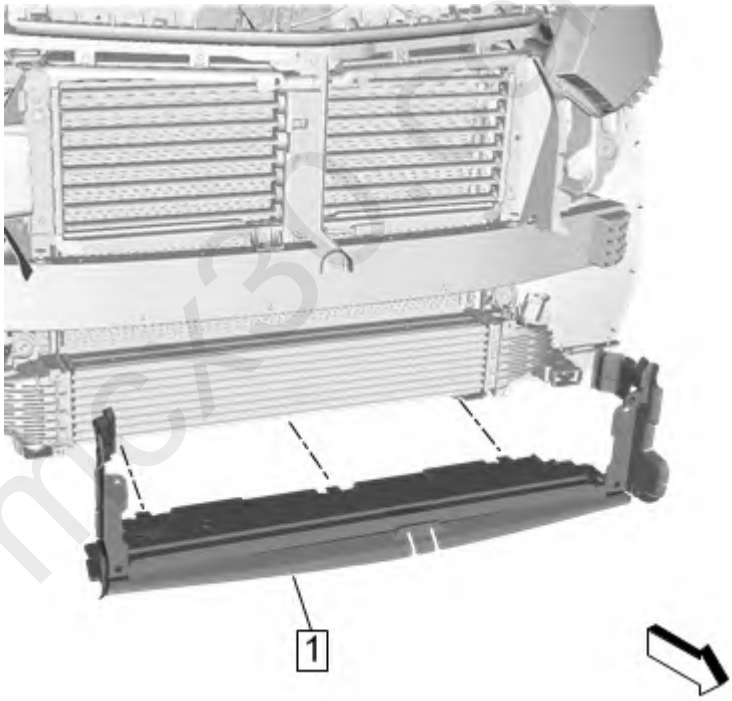


Fig. 416: Radiator Air Lower Baffle
Courtesy of GENERAL MOTORS COMPANY

12. Install Radiator Air Lower Baffle (1) - **Radiator Air Lower Baffle Replacement (LH7 LTG LYX)**
13. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)**
14. Start the engine and check for coolant leaks.
15. Install Front Bumper Fascia - **Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**

RADIATOR REPLACEMENT (LH7)

Removal Procedure

1. Remove Front Bumper Fascia - **Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**

2. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**

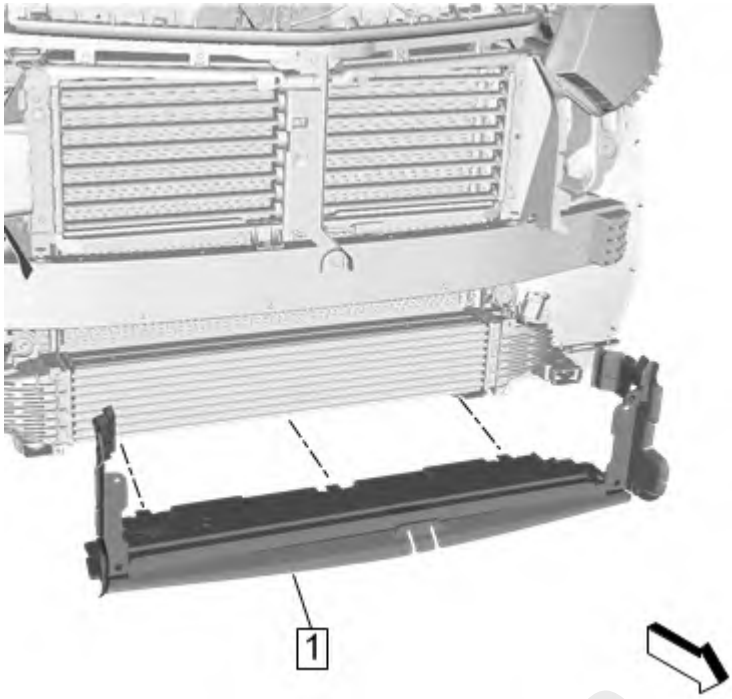


Fig. 417: Radiator Air Lower Baffle
Courtesy of GENERAL MOTORS COMPANY

3. Remove Radiator Air Lower Baffle (1) - **Radiator Air Lower Baffle Replacement (LH7 LTG LYX)**

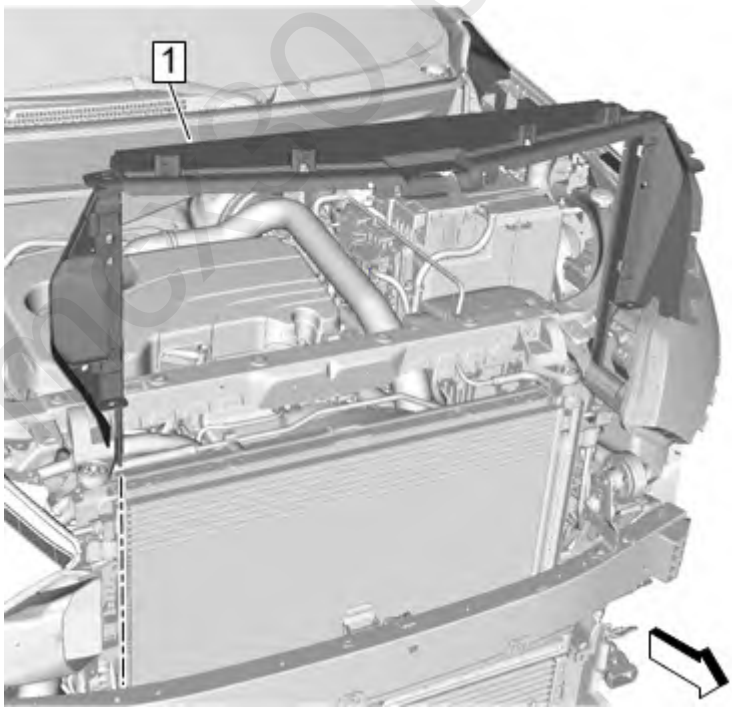


Fig. 418: Radiator Air Upper Baffle
Courtesy of GENERAL MOTORS COMPANY

4. Remove Radiator Air Upper Baffle (1) - **Radiator Air Upper Baffle Replacement (LH7 LTG LYX)**
5. Disconnect the electrical connectors.
6. Remove Air Conditioning Condenser - **Air Conditioning Condenser Replacement**
7. Remove Charge Air Cooler - **Charge Air Cooler Replacement**

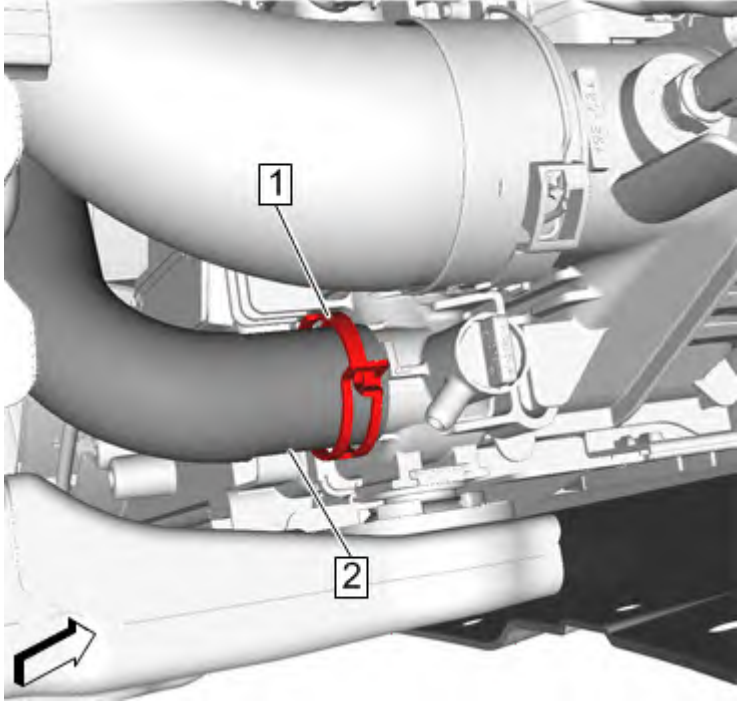


Fig. 419: Radiator Outlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

8. Remove Radiator Outlet Hose (2) @ Radiator **Radiator Outlet Hose Replacement (LH7)**

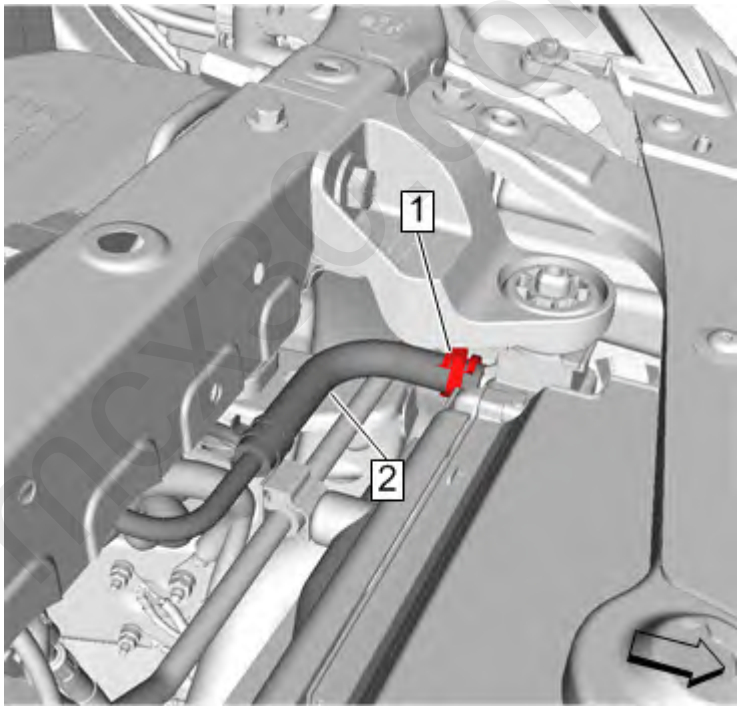


Fig. 420: Engine Coolant Air Bleed Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

9. Remove Engine Coolant Air Bleed Hose (2) @ Radiator - **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Exhaust Gas Recirculation Cooler Housing and Radiator LH7)**

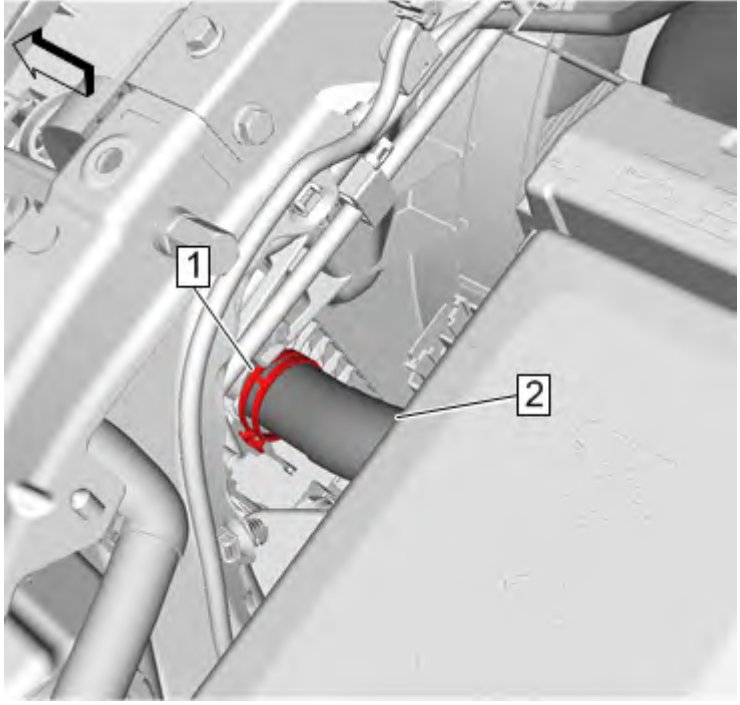


Fig. 421: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

10. Remove Radiator Inlet Hose (2) @ - Radiator - **Radiator Inlet Hose Replacement (LH7)**

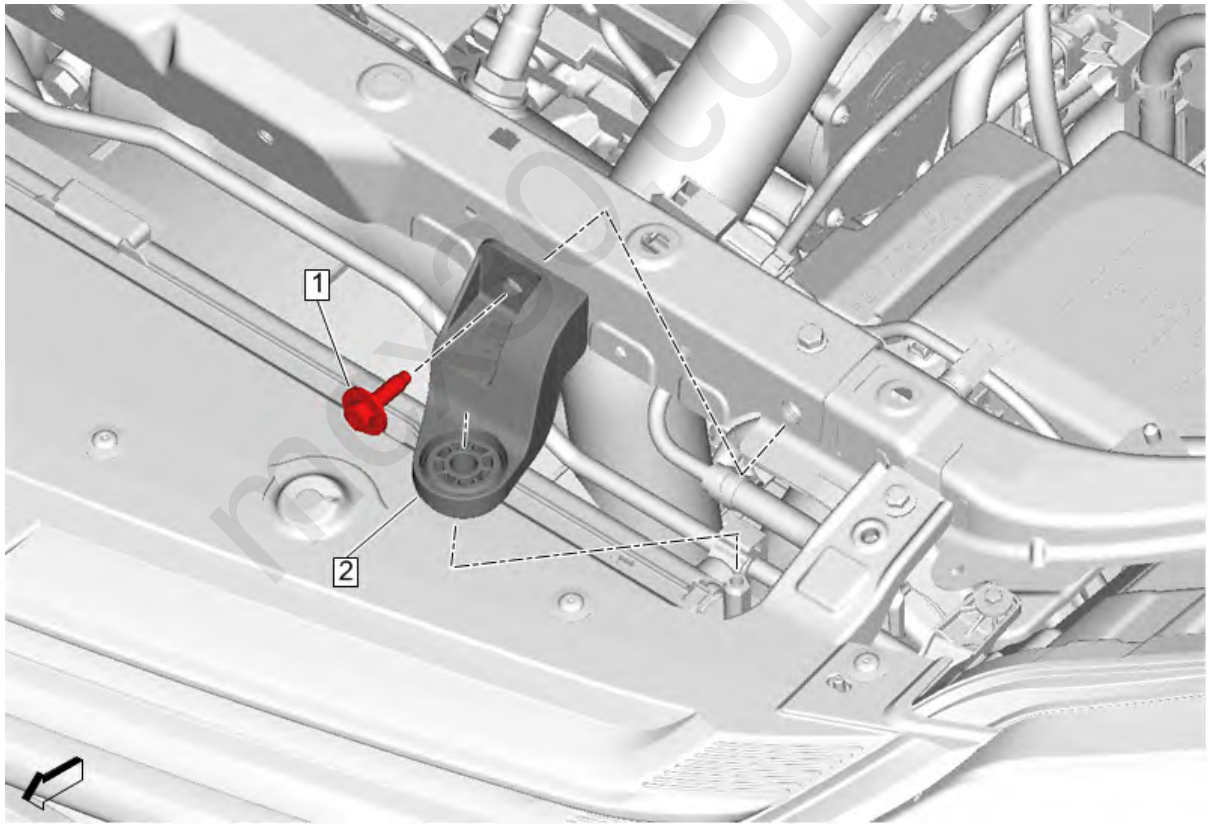


Fig. 422: Radiator Upper Bracket-Left Side
Courtesy of GENERAL MOTORS COMPANY

11. Remove Radiator Upper Bracket-Left Side (2) - **Radiator Upper Bracket Replacement - Left Side**

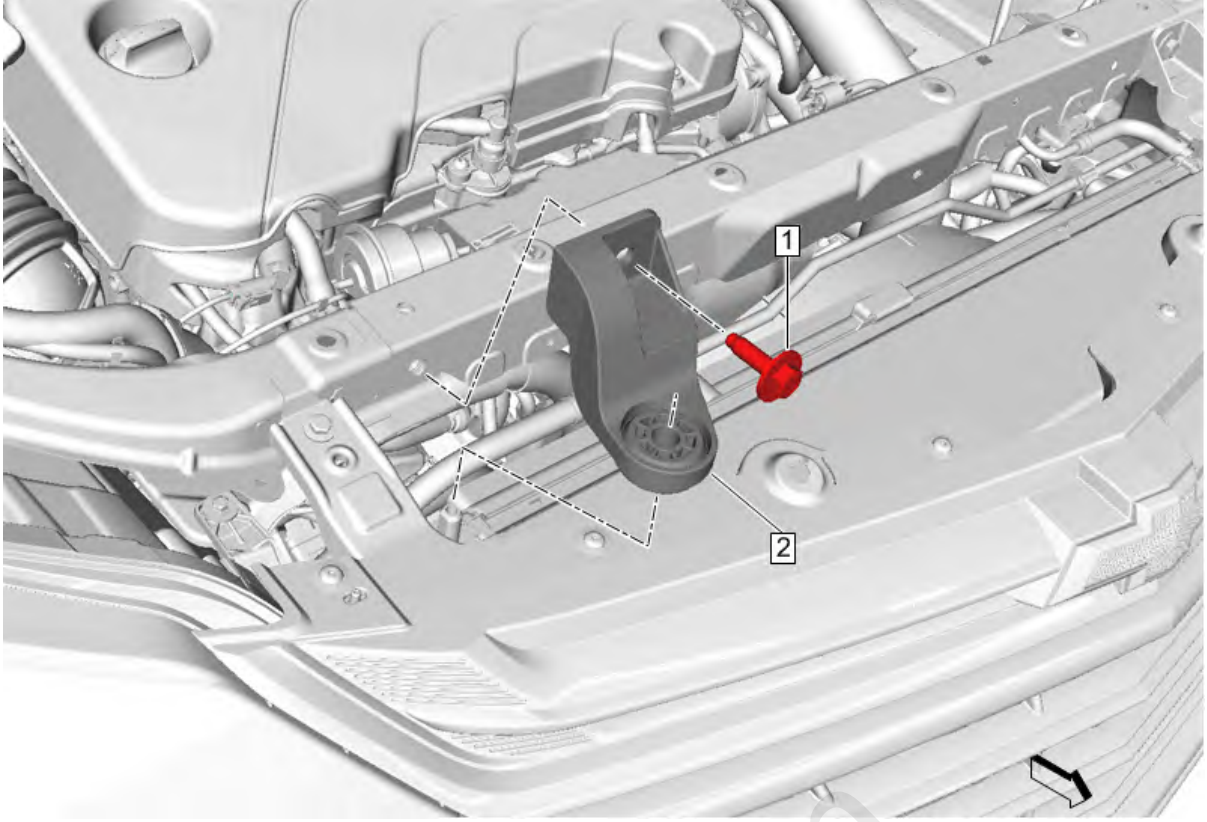


Fig. 423: Radiator Upper Bracket-Right Side
Courtesy of GENERAL MOTORS COMPANY

12. Remove Radiator Upper Bracket-Right Side (2) - **Radiator Upper Bracket Replacement - Right Side**

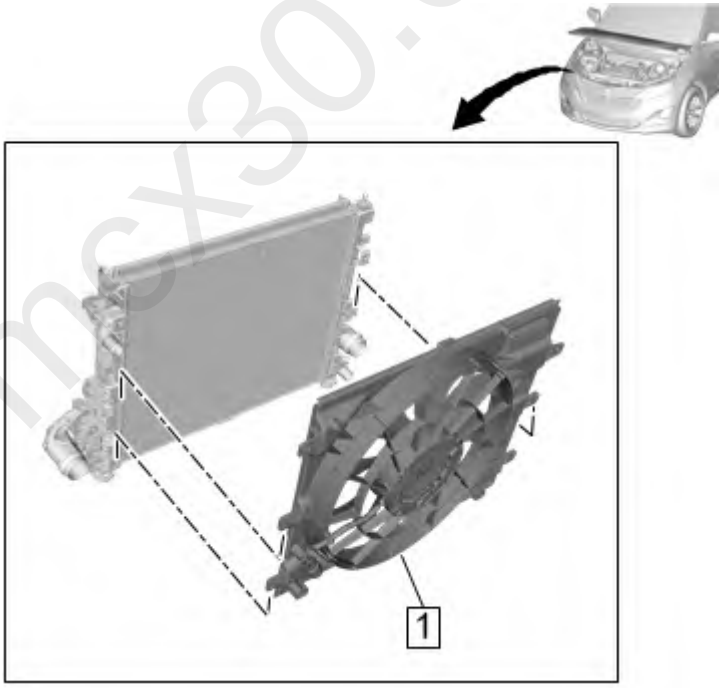


Fig. 424: Engine Coolant Fan
Courtesy of GENERAL MOTORS COMPANY

13. Remove Engine Coolant Fan (1) @ Radiator -**Engine Coolant Fan Replacement (LH7)**

mcx30.com

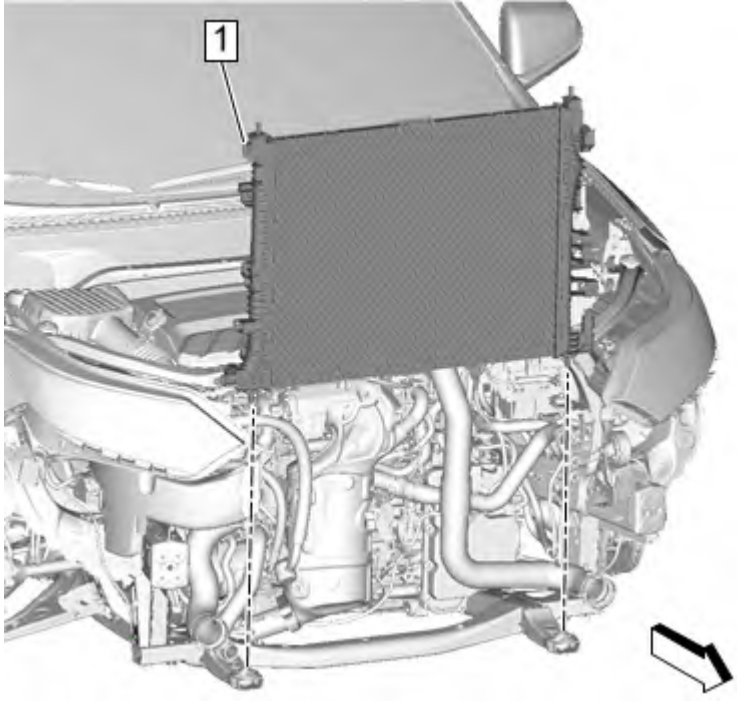


Fig. 425: Radiator
Courtesy of GENERAL MOTORS COMPANY

14. Remove Radiator (1)
15. Transfer components as necessary.

Installation Procedure

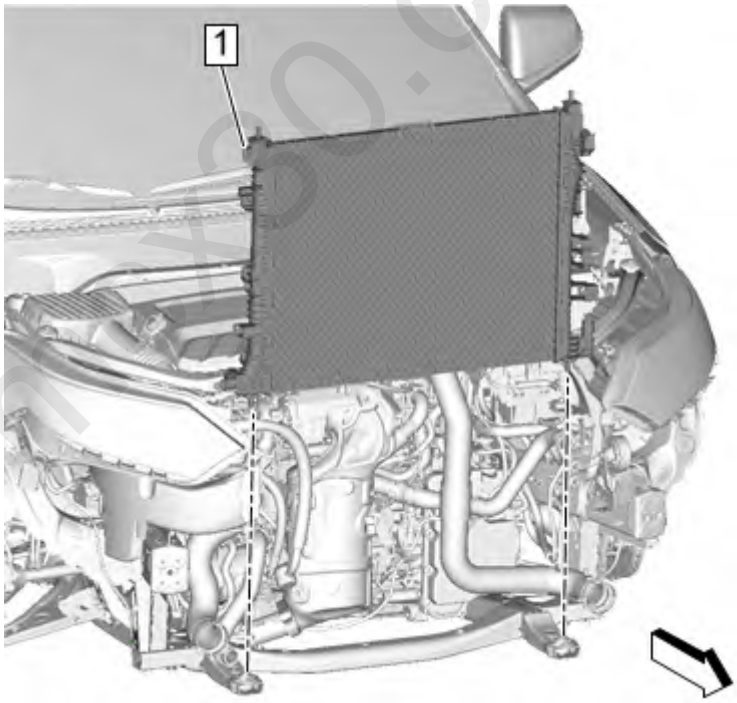


Fig. 426: Radiator
Courtesy of GENERAL MOTORS COMPANY

1. Install Radiator (1)

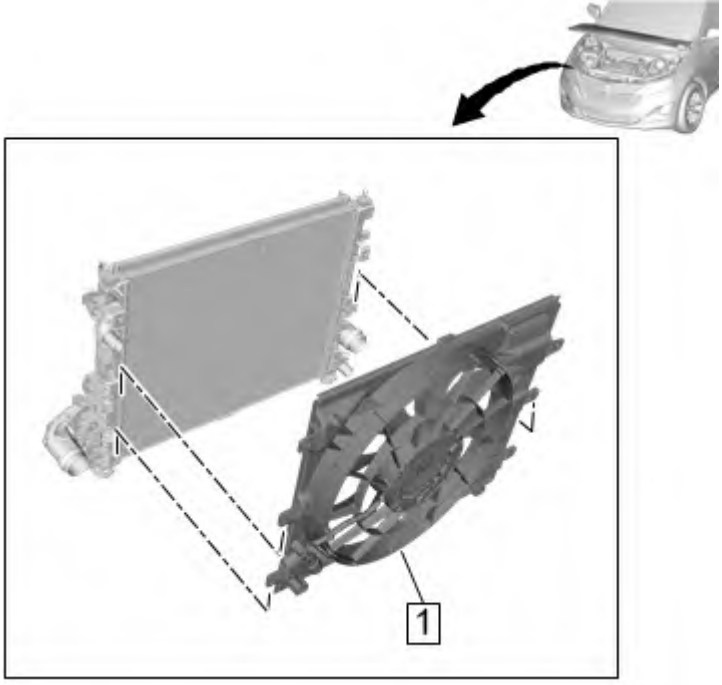


Fig. 427: Engine Coolant Fan
Courtesy of GENERAL MOTORS COMPANY

2. Install Engine Coolant Fan (1) @ Radiator - **Engine Coolant Fan Replacement (LH7)**

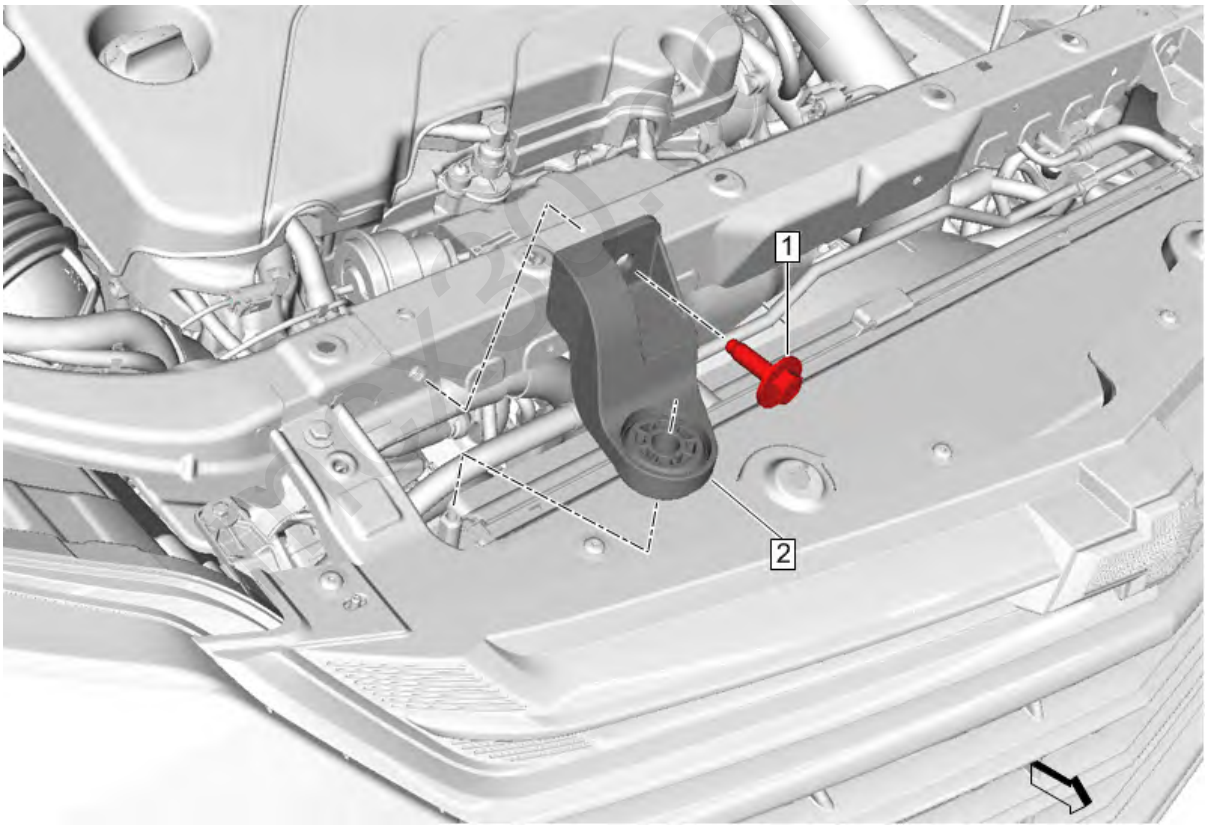


Fig. 428: Radiator Upper Bracket-Right Side
Courtesy of GENERAL MOTORS COMPANY

3. Install Radiator Upper Bracket - Right Side (2) - **Radiator Upper Bracket Replacement - Right Side**

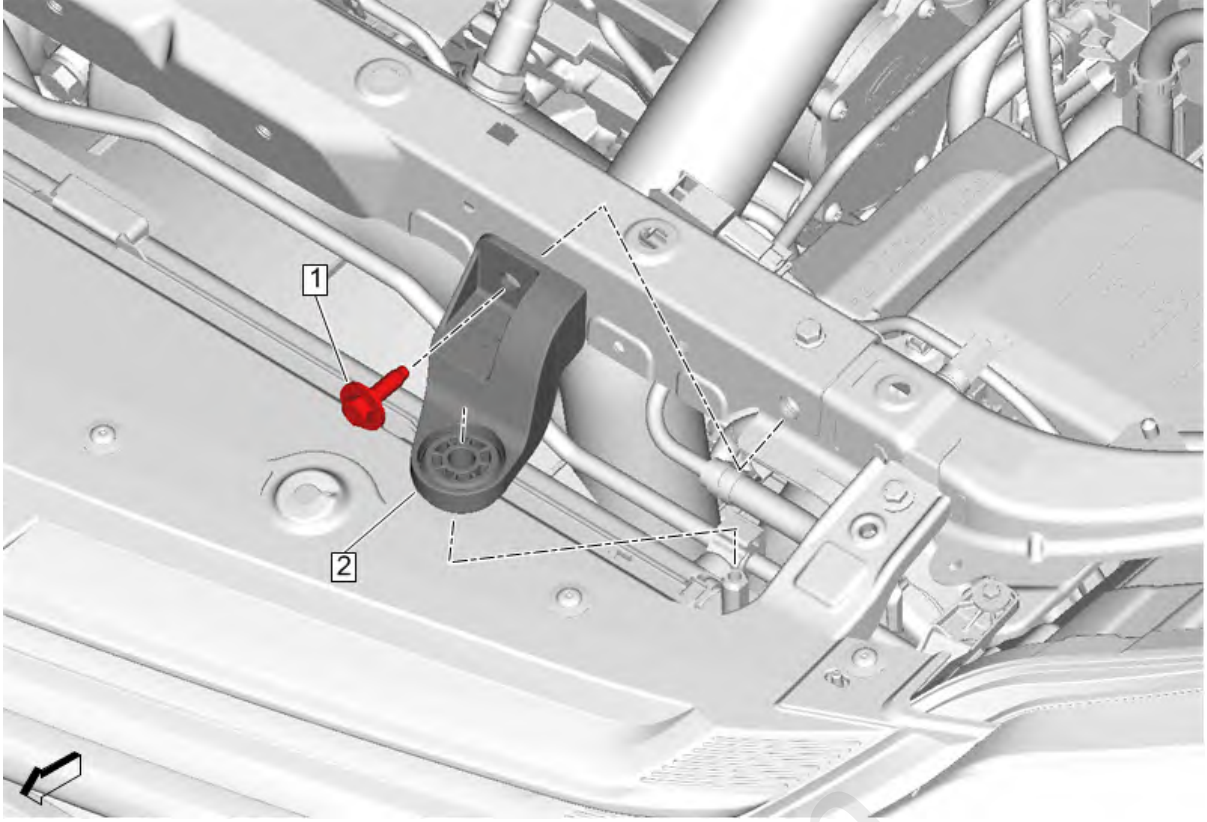


Fig. 429: Radiator Upper Bracket-Left Side
Courtesy of GENERAL MOTORS COMPANY

4. Install Radiator Upper Bracket - Left Side (2) - **Radiator Upper Bracket Replacement - Left Side**

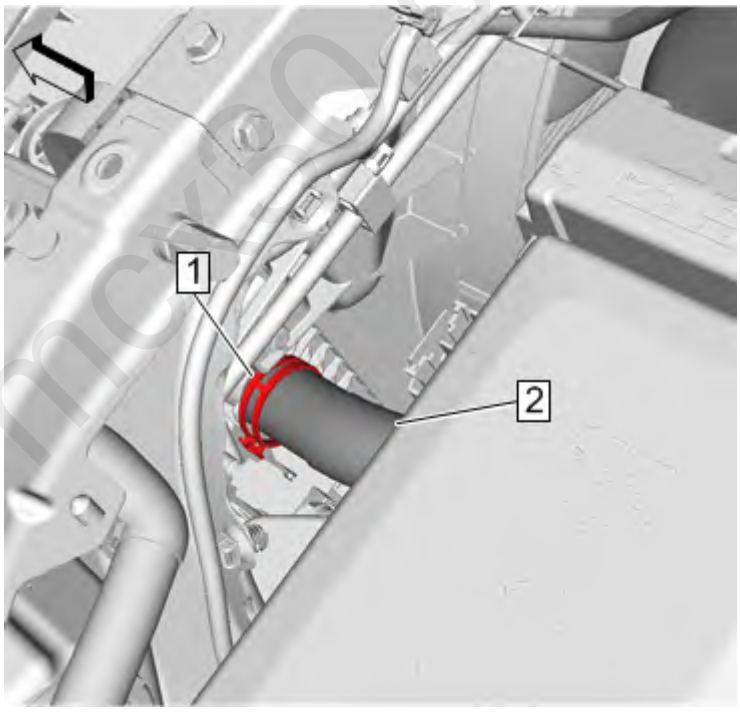


Fig. 430: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Install Radiator Inlet Hose (2) @ Radiator - **Radiator Inlet Hose Replacement (LH7)**

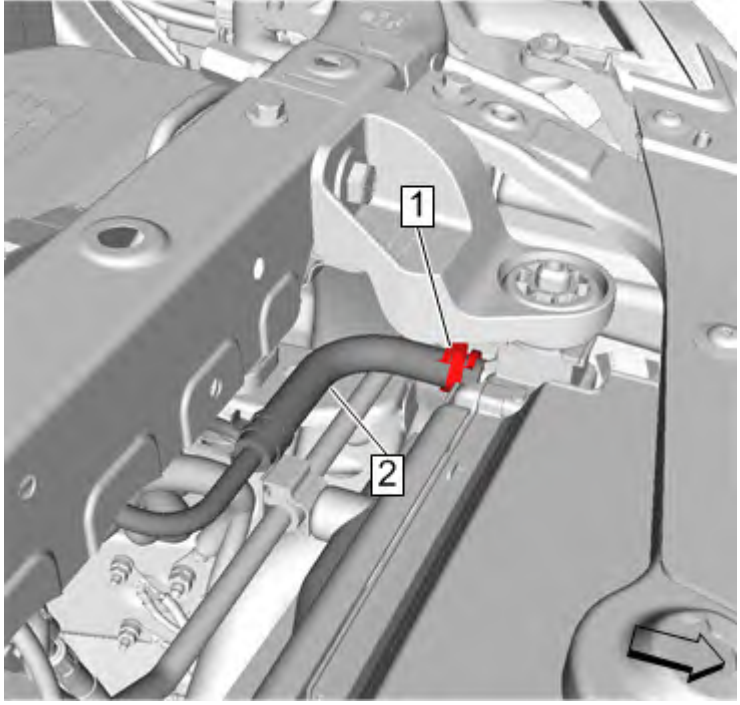


Fig. 431: Engine Coolant Air Bleed Hose And Clamp
Courtesy of GENERAL MOTORS COMPANY

6. Install Engine Coolant Air Bleed Hose (2) @ Radiator - **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Exhaust Gas Recirculation Cooler Housing and Radiator LH7)**

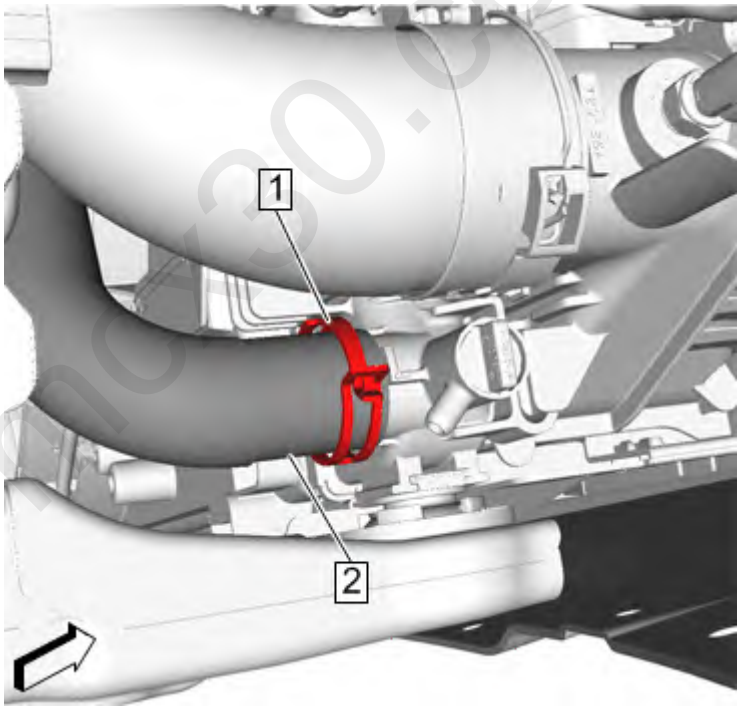


Fig. 432: Radiator Outlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

7. Install Radiator Outlet Hose (2) @ Radiator - **Radiator Outlet Hose Replacement (LH7)**
8. Install Charge Air Cooler - **Charge Air Cooler Replacement**
9. Install Air Conditioning Condenser - **Air Conditioning Condenser Replacement**
10. Connect the electrical connectors.

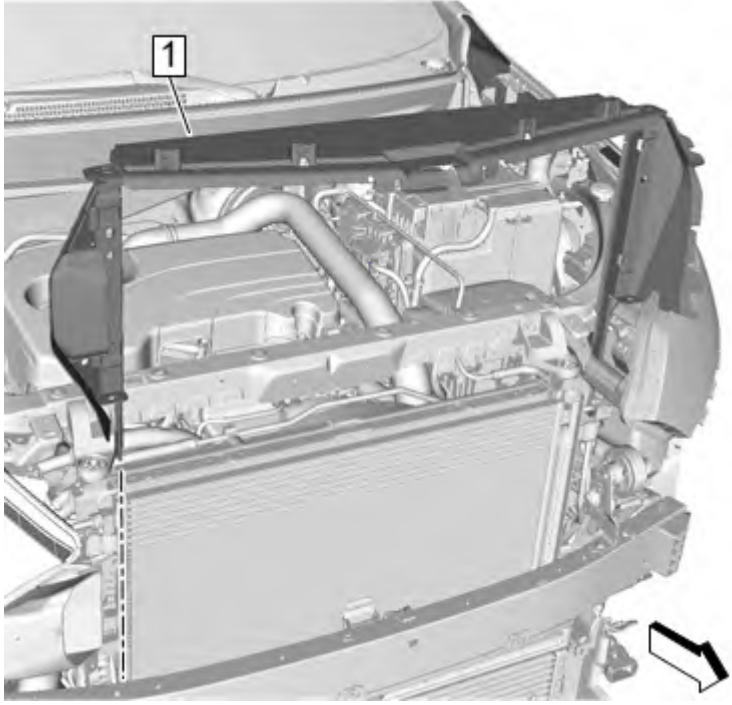


Fig. 433: Radiator Air Upper Baffle
Courtesy of GENERAL MOTORS COMPANY

11. Install Radiator Air Upper Baffle (1) -**Radiator Air Upper Baffle Replacement (LH7 LTG LYX)**

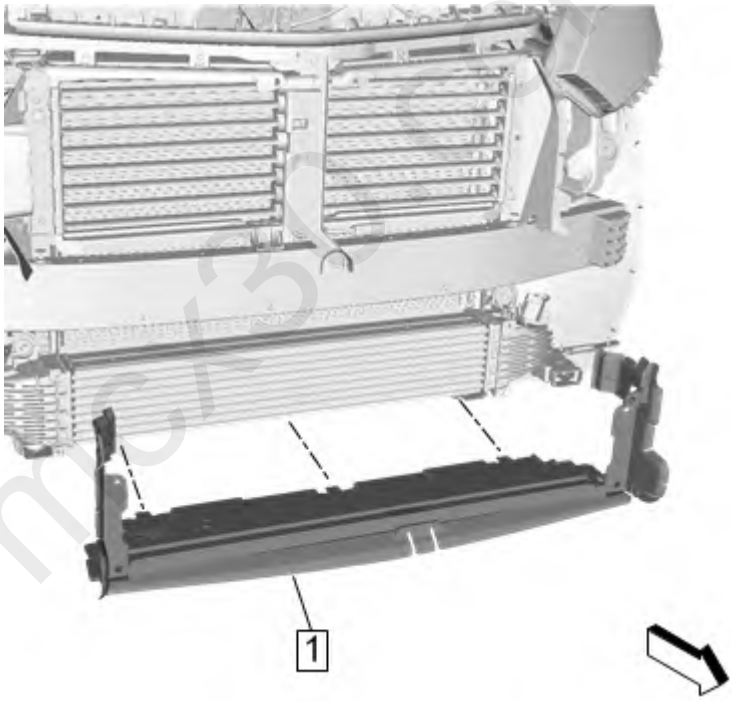


Fig. 434: Radiator Air Lower Baffle
Courtesy of GENERAL MOTORS COMPANY

12. Install Radiator Air Lower Baffle (1) - **Radiator Air Lower Baffle Replacement (LH7 LTG LYX)**
13. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)**
14. Start the engine and check for coolant leaks.
15. Install Front Bumper Fascia - **Front Bumper Fascia Replacement (Equinox) Front Bumper Fascia Replacement (Terrain)**

RADIATOR LOWER INSULATOR REPLACEMENT

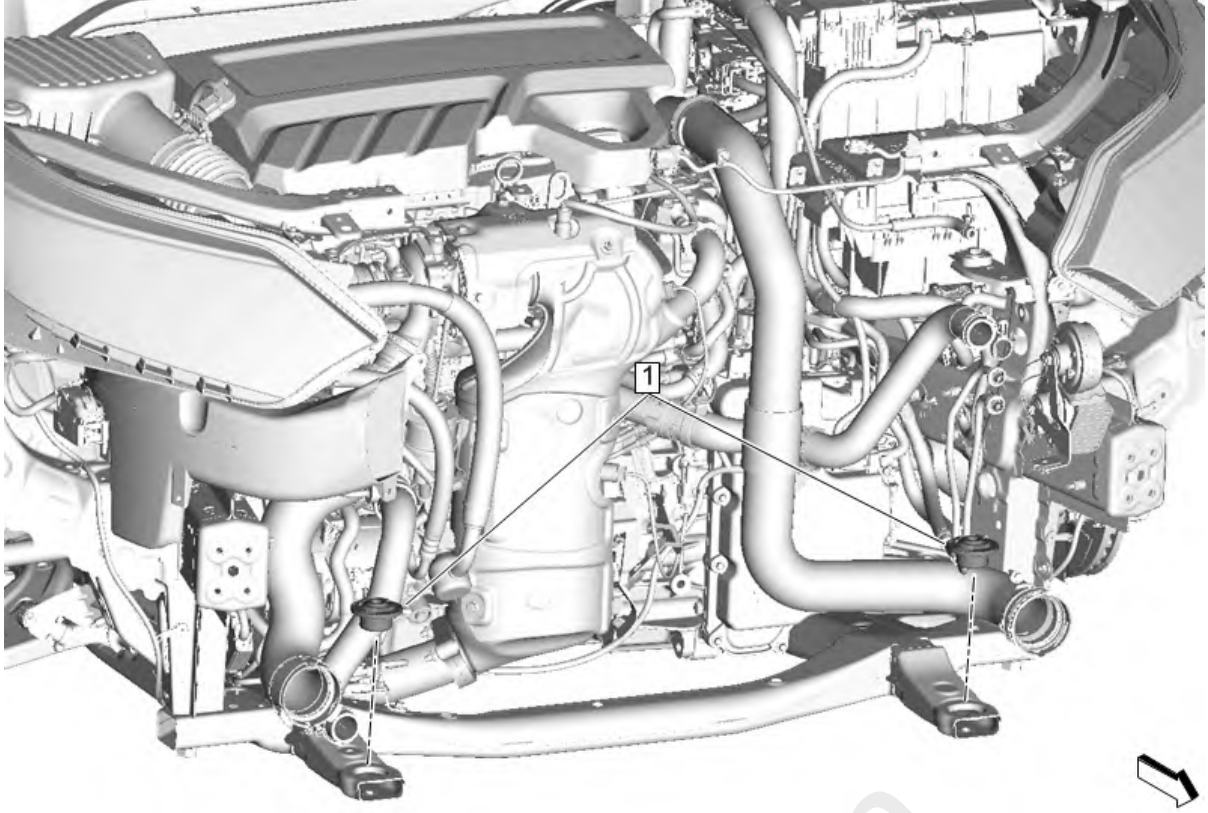


Fig. 435: Radiator Lower Insulator
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove Radiator - **Radiator Replacement (LYX)** **Radiator Replacement (LTG)** **Radiator Replacement (LH7)**	
1	Radiator Lower Insulator [2x]

RADIATOR AIR LOWER BAFFLE REPLACEMENT (LH7/ LTG/LYX)

Removal Procedure

1. Remove Front Bumper Fascia - **Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**
2. Disconnect the electrical connectors.

nicx30.com

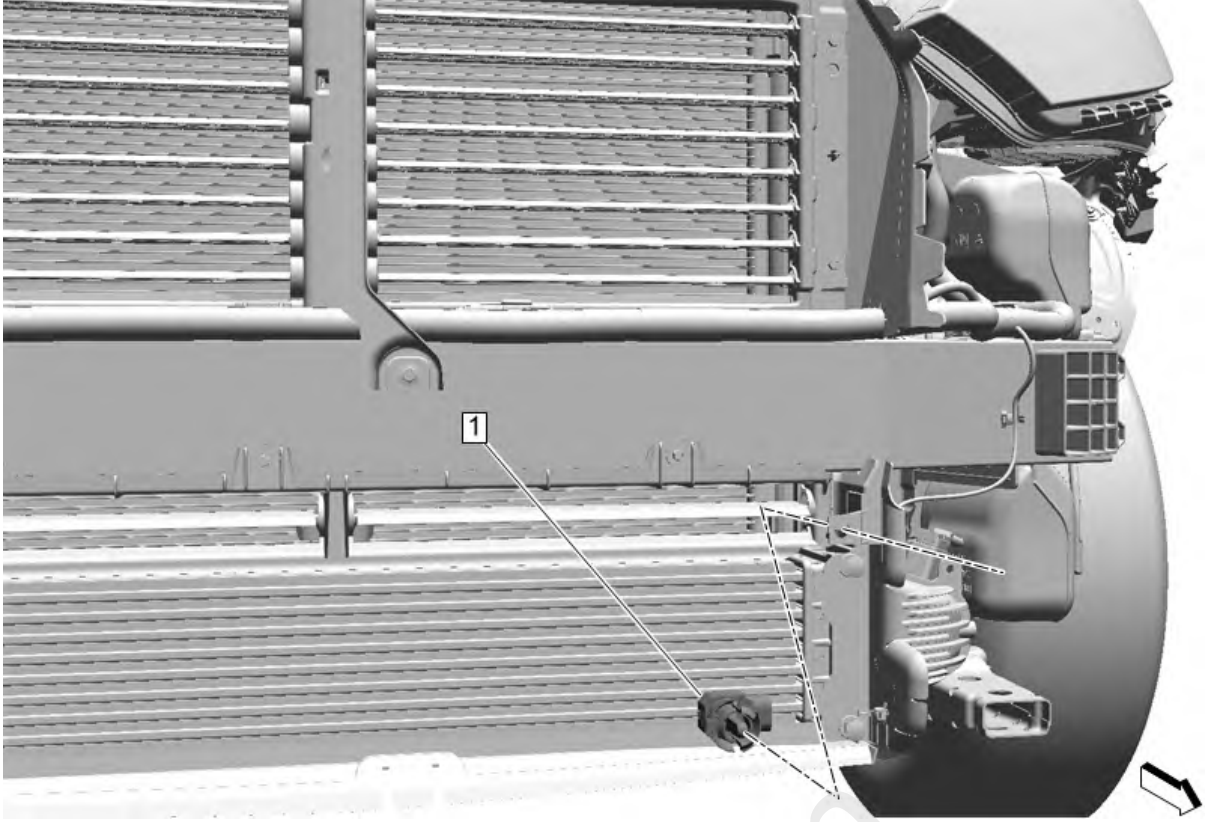


Fig. 436: Ambient Air Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

3. Remove Ambient Air Temperature Sensor (1) - **Ambient Air Temperature Sensor Replacement**
4. Remove {If equipped} Front Bumper Secondary Shutter -**Front Bumper Secondary Shutter Replacement**

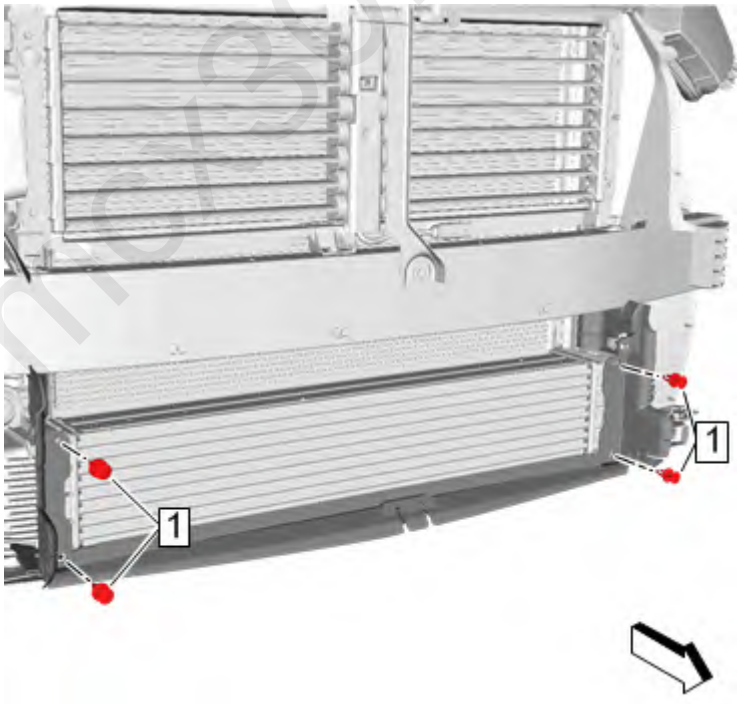


Fig. 437: Radiator Air Lower Baffle Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Remove Radiator Air Lower Baffle Retainer (1) - [4x]

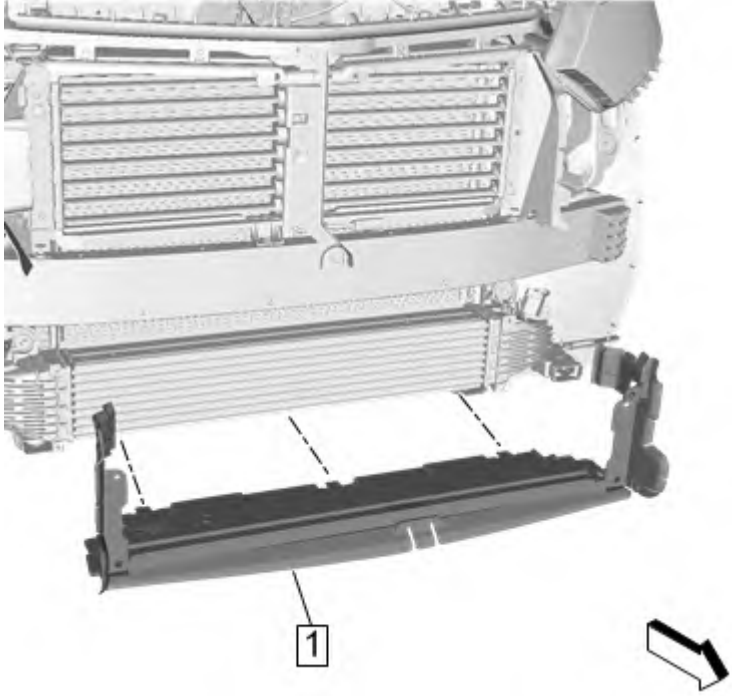


Fig. 438: Radiator Air Lower Baffle
Courtesy of GENERAL MOTORS COMPANY

6. Remove Radiator Air Lower Baffle (1).

Installation Procedure

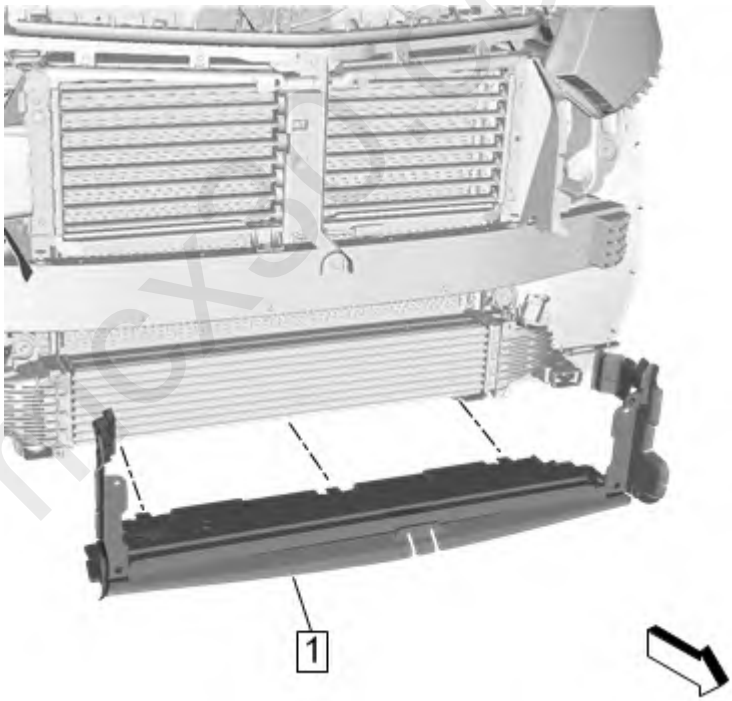


Fig. 439: Radiator Air Lower Baffle
Courtesy of GENERAL MOTORS COMPANY

1. Install Radiator Air Lower Baffle (1)

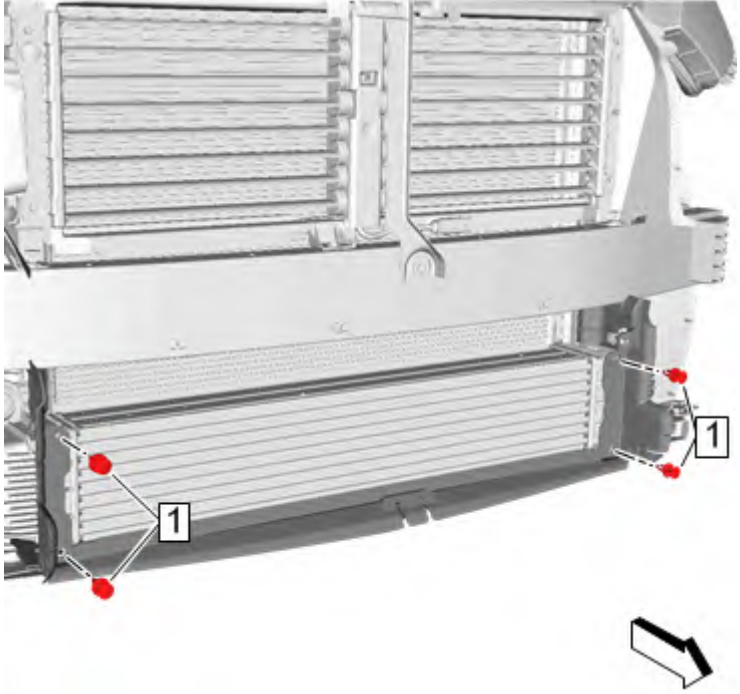


Fig. 440: Radiator Air Lower Baffle Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Install Radiator Air Lower Baffle Retainer (1) - [4x]
3. Install {If equipped} Front Bumper Secondary Shutter - Front Bumper Secondary Shutter Replacement

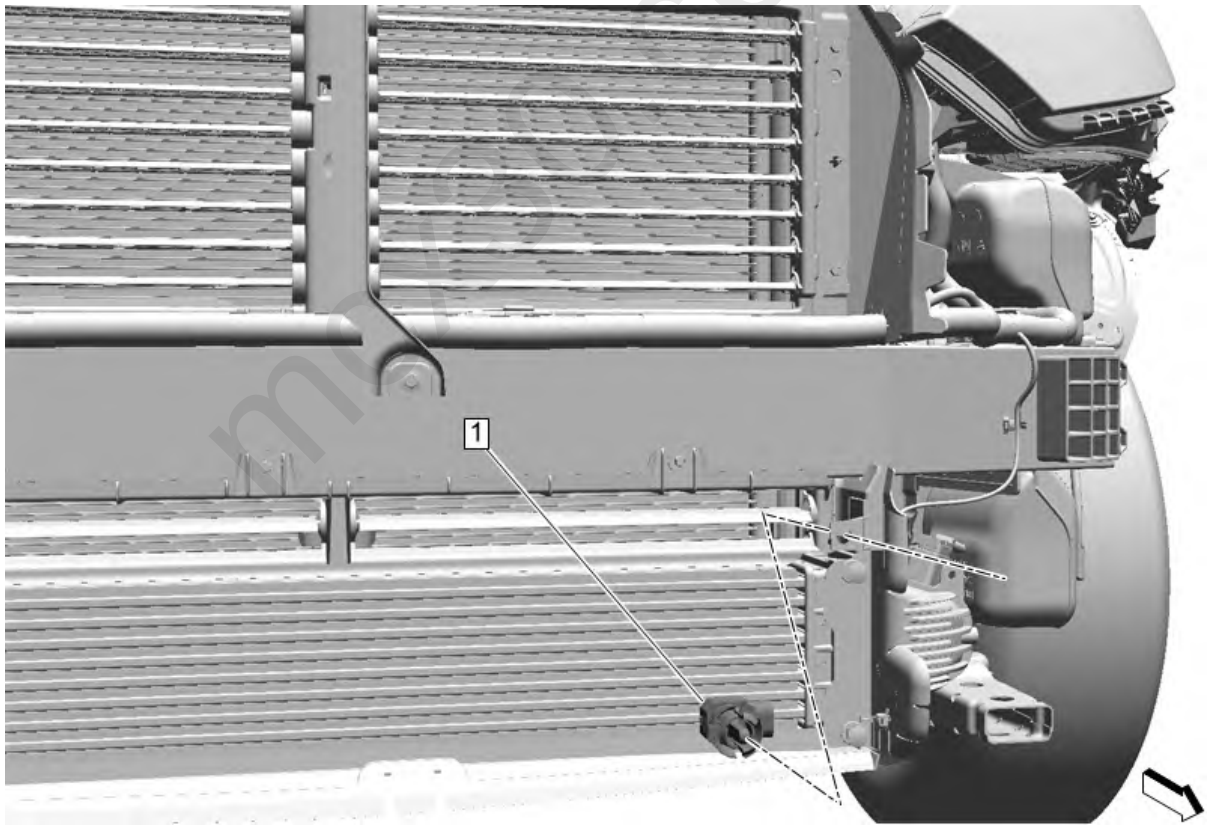


Fig. 441: Ambient Air Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

4. Install Ambient Air Temperature Sensor (1) - Ambient Air Temperature Sensor Replacement
5. Connect the electrical connectors.
6. Install Front Bumper Fascia - Front Bumper Fascia Replacement (Equinox) Front Bumper Fascia Replacement (Terrain)

RADIATOR AIR UPPER BAFFLE REPLACEMENT (LH7/LTG/LYX)

Removal Procedure

1. Remove Front Bumper Fascia - **Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**

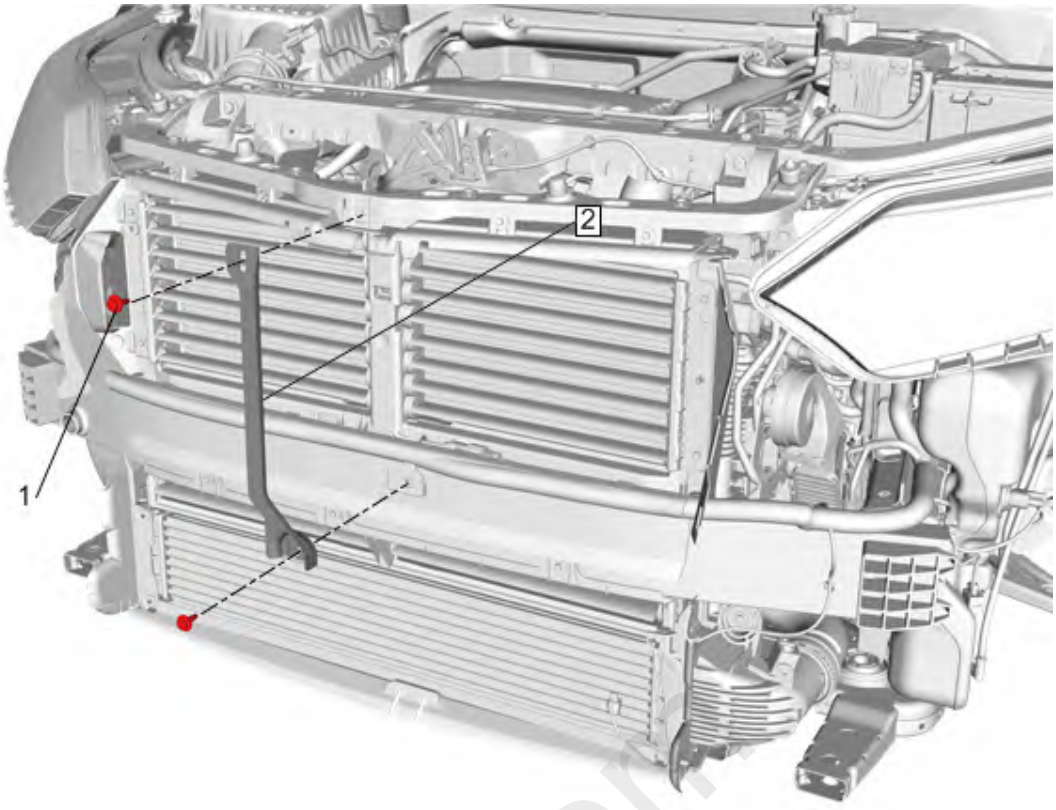


Fig. 442: Front Bumper Fascia Support Brace
Courtesy of GENERAL MOTORS COMPANY

2. Remove Front Bumper Fascia Support Brace (2) - **Front Bumper Fascia Support Brace Replacement**

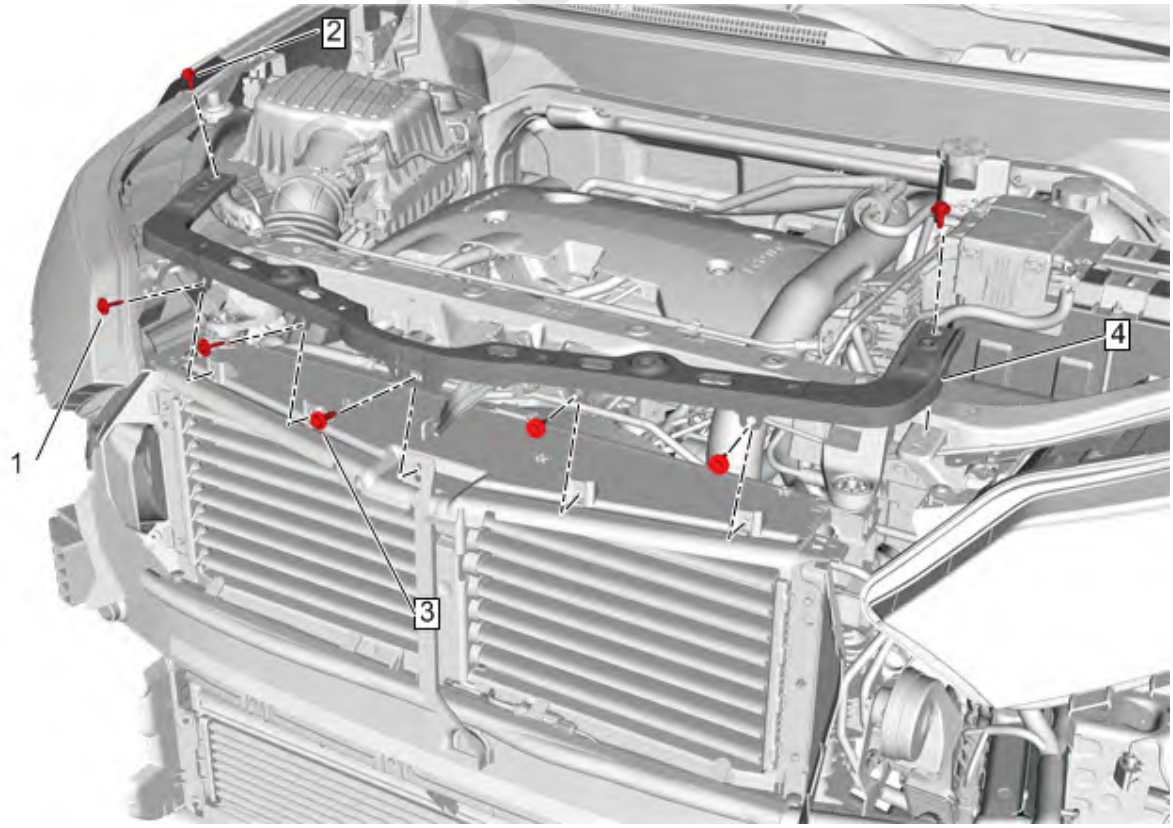


Fig. 443: Front Bumper Fascia Center Support
Courtesy of GENERAL MOTORS COMPANY

3. Remove Front Bumper Fascia Center Support (3) - **Front Bumper Fascia Center Support Replacement**
4. Disconnect the electrical connectors.

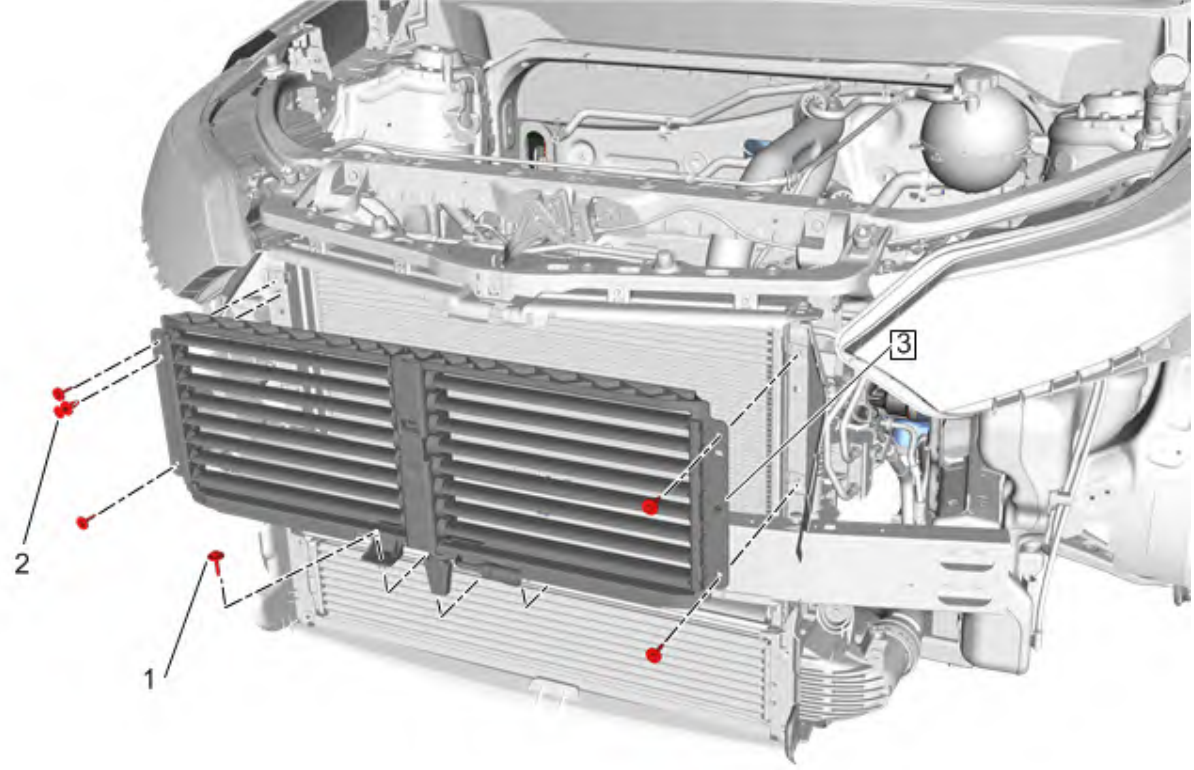


Fig. 444: Front Bumper Shutter
Courtesy of GENERAL MOTORS COMPANY

5. Remove Front Bumper Shutter (2) - **Front Bumper Shutter Replacement**

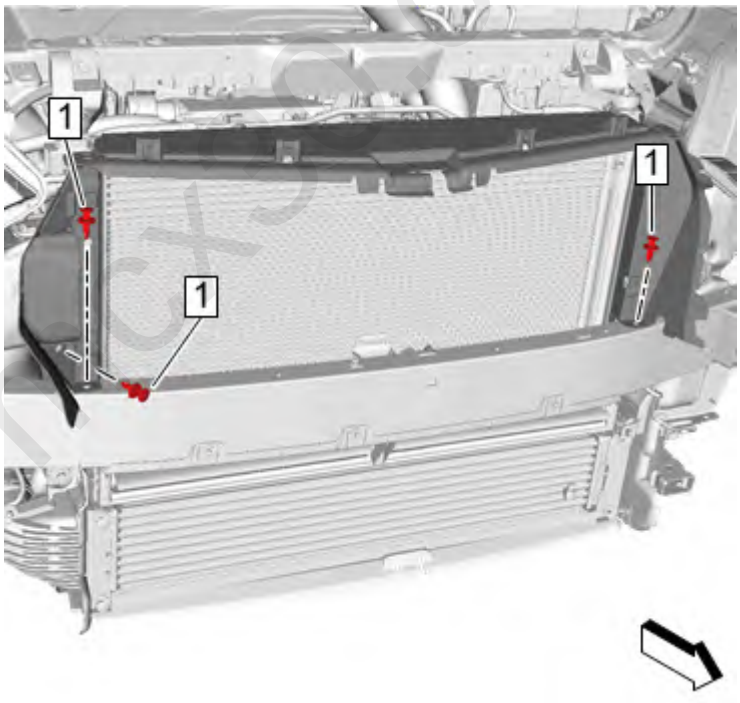


Fig. 445: Radiator Air Upper Baffle Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Remove Radiator Air Upper Baffle Retainer (1) - [3x]

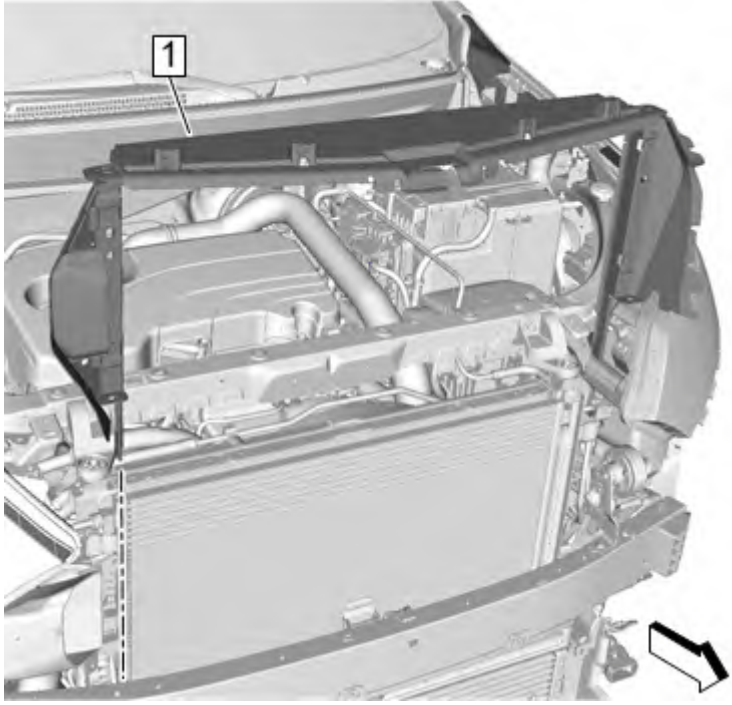


Fig. 446: Radiator Air Upper Baffle
Courtesy of GENERAL MOTORS COMPANY

7. Remove Radiator Air Upper Baffle (1)

Installation Procedure

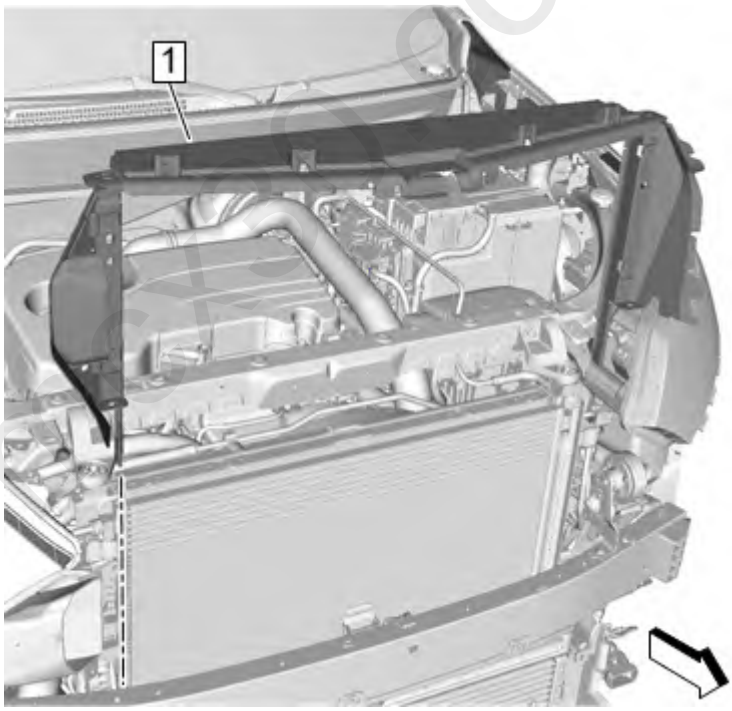


Fig. 447: Radiator Air Upper Baffle
Courtesy of GENERAL MOTORS COMPANY

1. Install Radiator Air Upper Baffle (1)

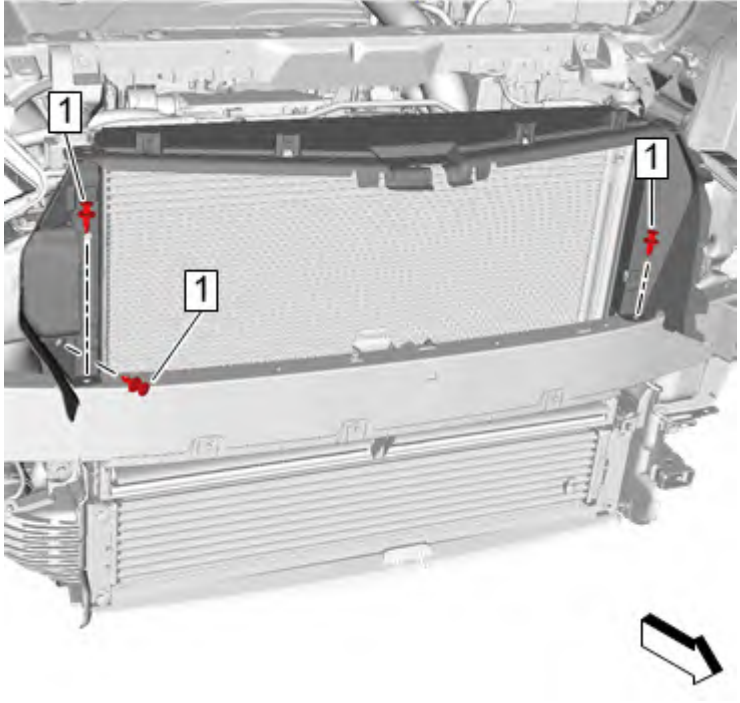


Fig. 448: Radiator Air Upper Baffle Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Install Radiator Air Upper Baffle Retainer (1) - [3x]

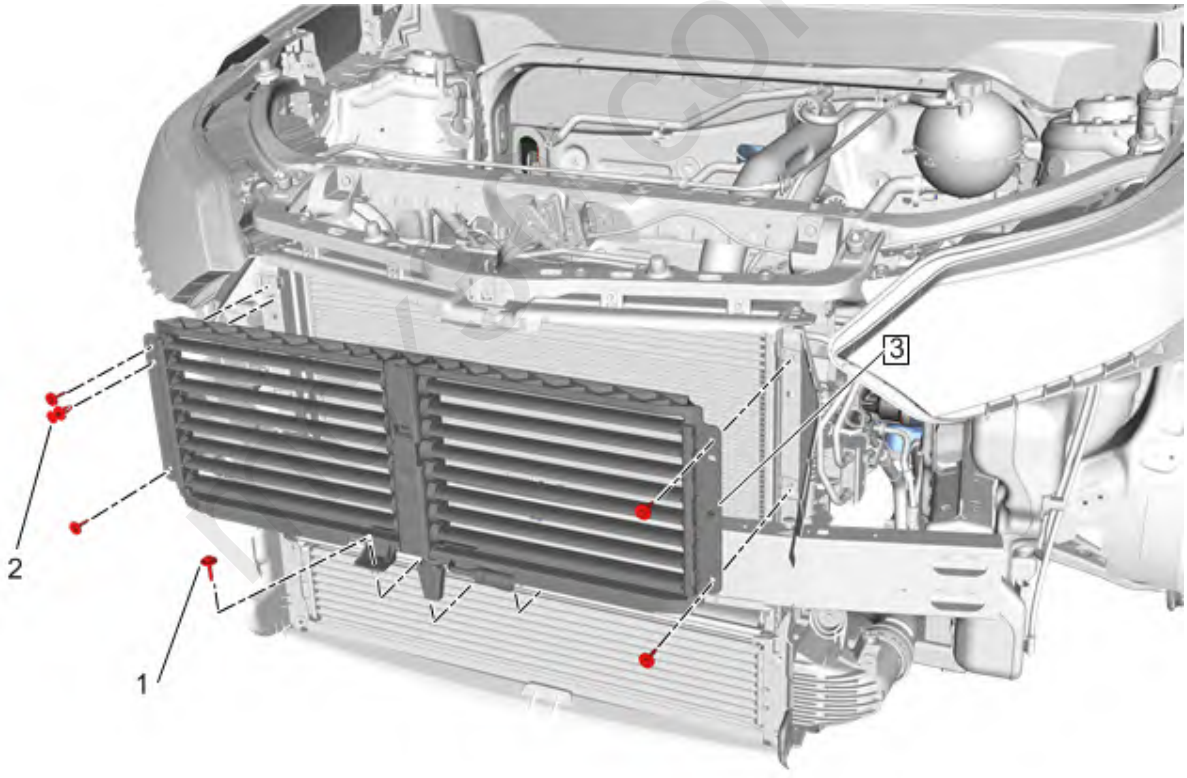


Fig. 449: Front Bumper Shutter
Courtesy of GENERAL MOTORS COMPANY

3. Install Front Bumper Shutter (2) - **Front Bumper Shutter Replacement**
4. Connect the electrical connectors.

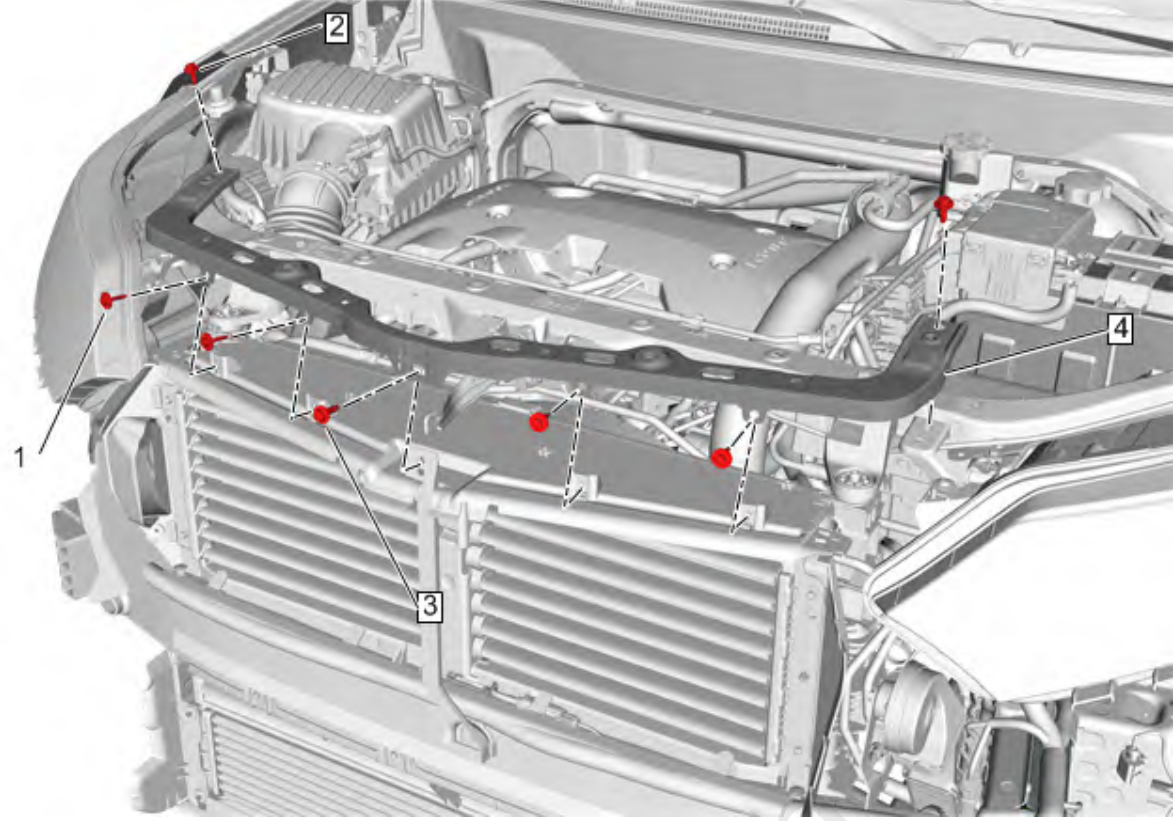


Fig. 450: Front Bumper Fascia Center Support
Courtesy of GENERAL MOTORS COMPANY

5. Install Front Bumper Fascia Center Support (3) - **Front Bumper Fascia Center Support Replacement**

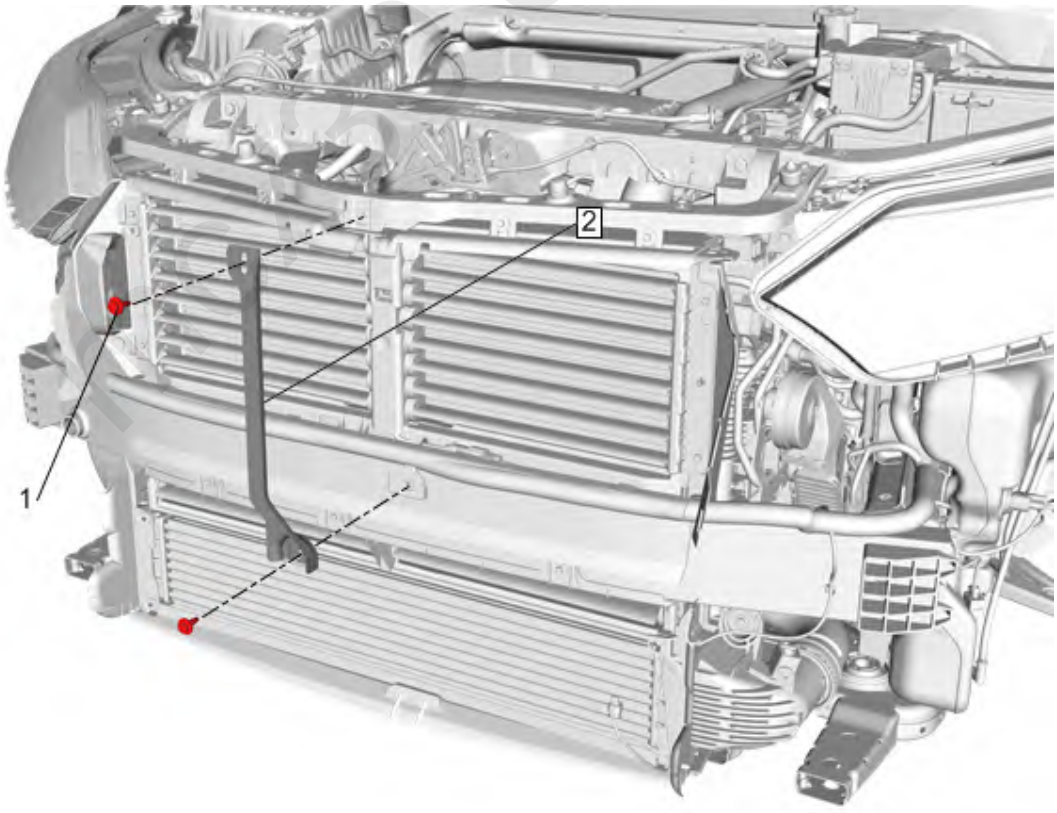


Fig. 451: Front Bumper Fascia Support Brace
Courtesy of GENERAL MOTORS COMPANY

6. Install Front Bumper Fascia Support Brace (2) - **Front Bumper Fascia Support Brace Replacement**
7. Install Front Bumper Fascia - **Front Bumper Fascia Replacement (Equinox)** **Front Bumper Fascia Replacement (Terrain)**

COOLANT HEATER REPLACEMENT (LTG)

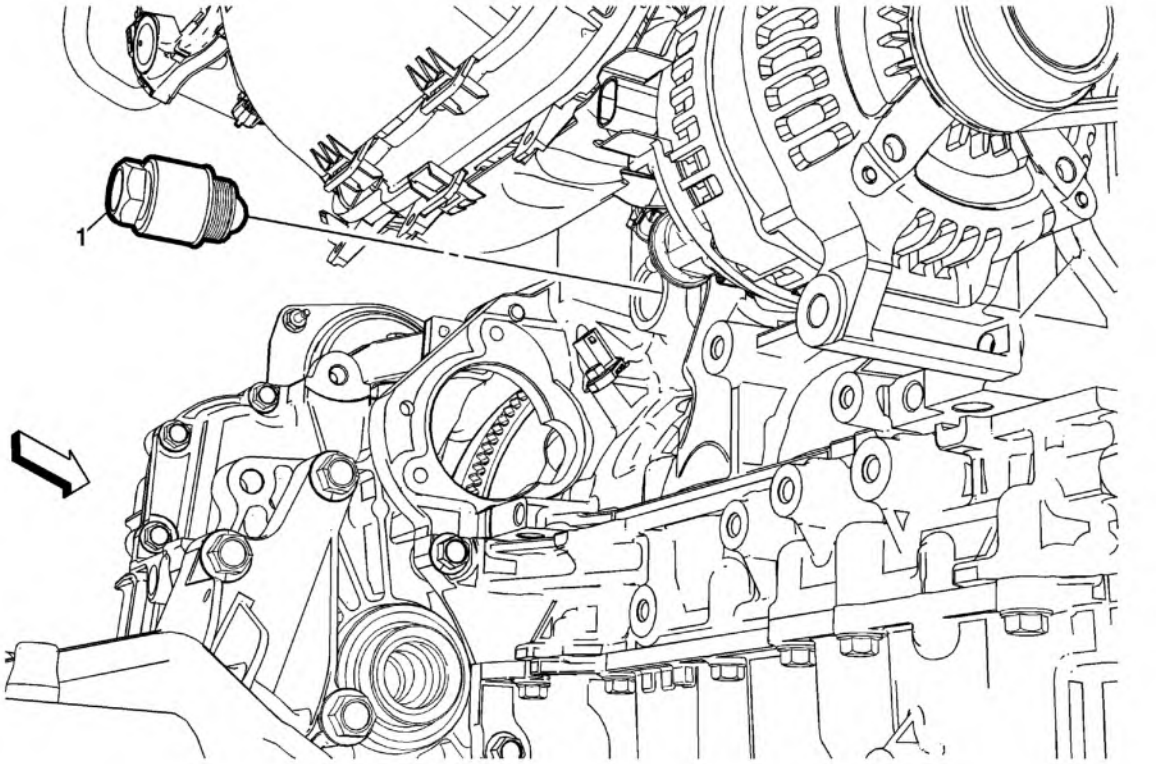


Fig. 452: Coolant Heater (LTG)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Drain the cooling system. Refer to Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static). 2. Remove the starter. Refer to Starter Replacement (LTG - All Wheel Drive) Starter Replacement (LTG - Front Wheel Drive) .	
1	Engine Coolant Heater **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Procedure** Disconnect the engine coolant heater cord. **Tighten** 50 N.m (37 lb ft)

COOLANT HEATER REPLACEMENT (LYX)

Removal Procedure

1. Drain the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static).
2. Remove Starter - Starter Replacement (LYX - All Wheel Drive) Starter Replacement (LYX - Front Wheel Drive)

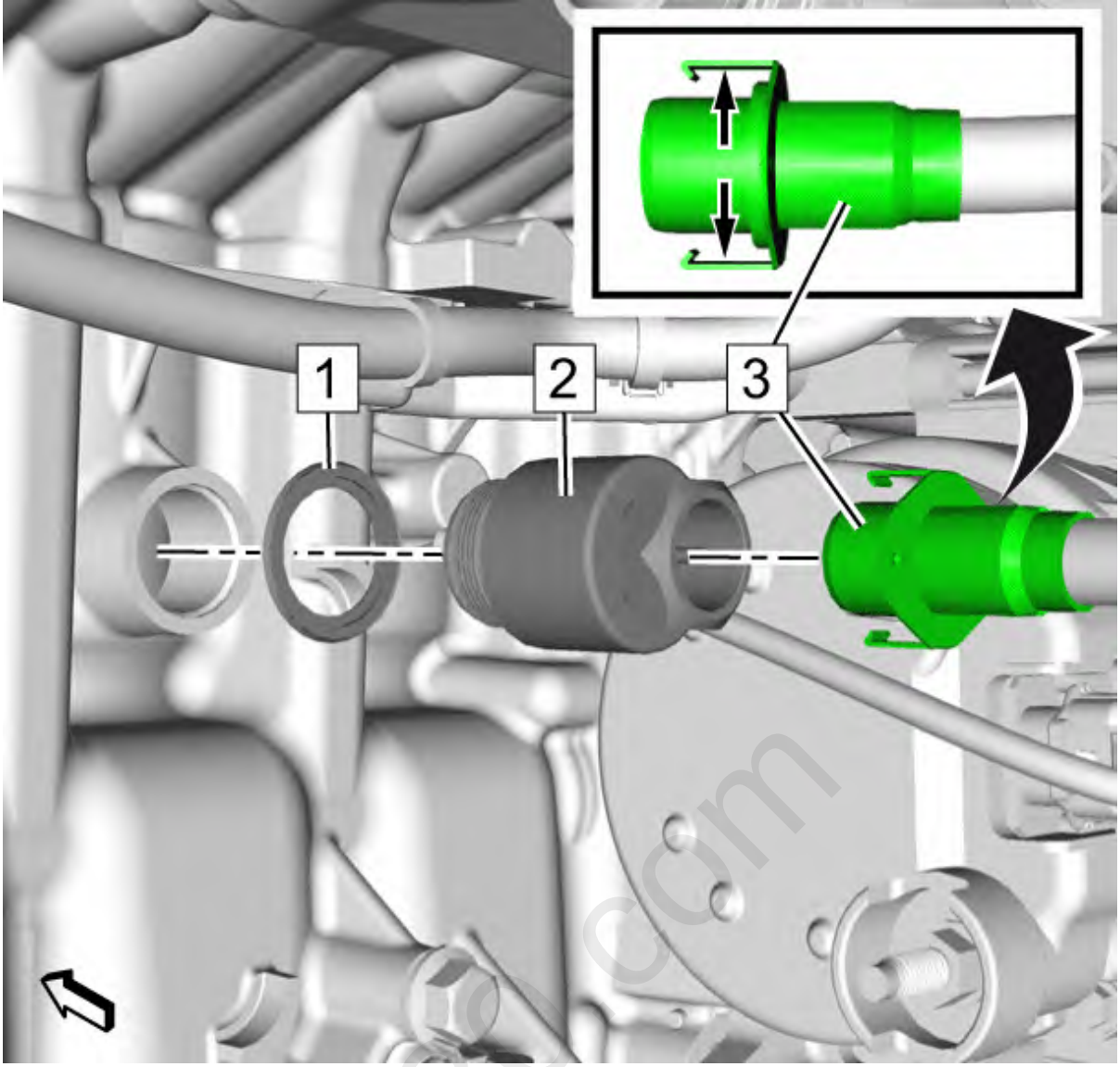


Fig. 453: Engine Coolant Heater, Seal And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the electrical connector. (3)
4. Remove Engine Coolant Heater (2)
5. Remove Engine Coolant Heater Seal (1) and DISCARD

Installation Procedure

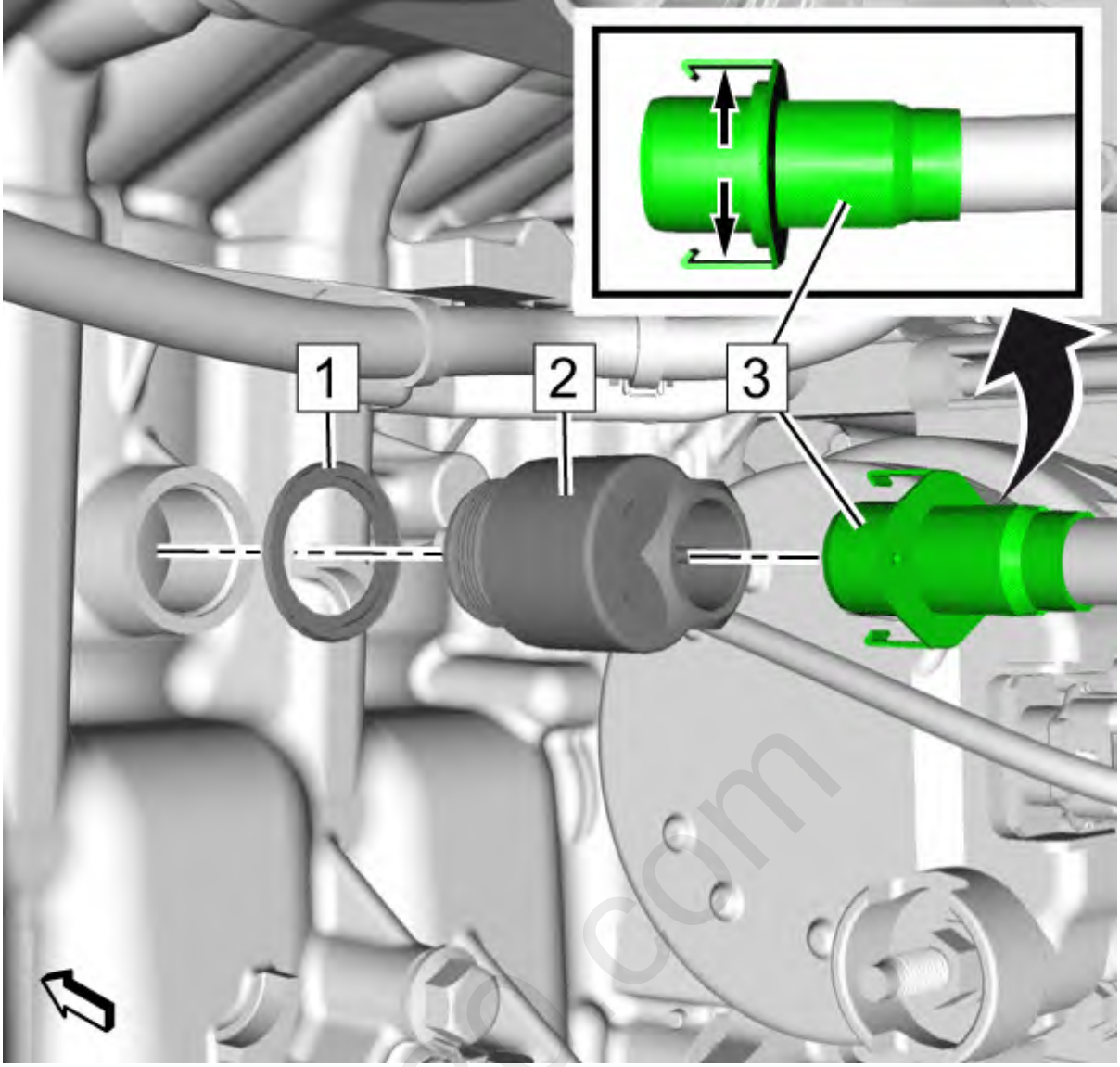


Fig. 454: Engine Coolant Heater, Seal And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW Engine Coolant Heater Seal (1).

CAUTION: Fastener Caution

2. Install Engine Coolant Heater (2) and tighten 50 N.m (37 lb ft)
3. Connect the electrical connector. (3)
4. Install Starter - Starter Replacement (LYX - All Wheel Drive) Starter Replacement (LYX - Front Wheel Drive)
5. Fill the cooling system. Cooling System Draining and Filling (GE 47716)Cooling System Draining and Filling (Static)
6. Inspect for coolant leaks.

COOLANT HEATER CORD REPLACEMENT (LYX)

Removal Procedure

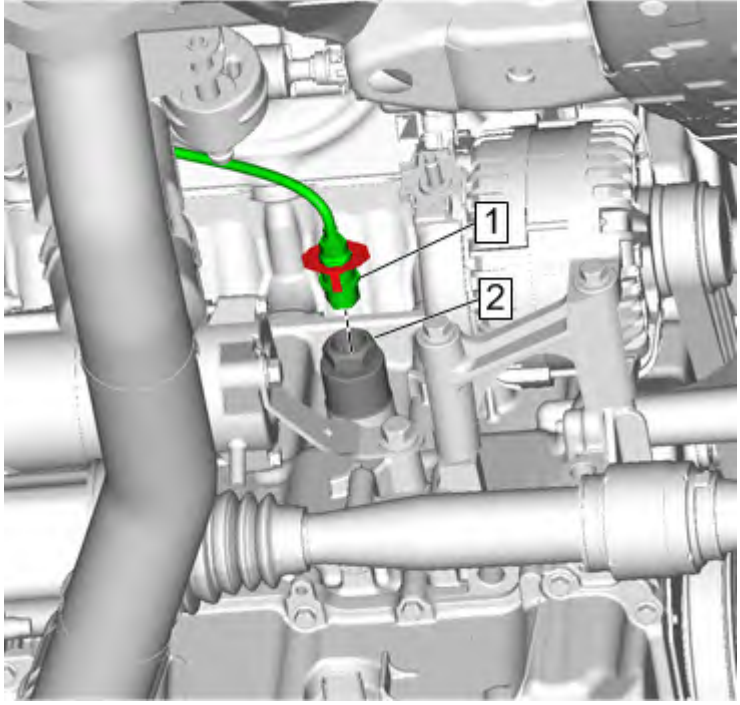


Fig. 455: Coolant Heater Cord
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect Coolant Heater Cord (1) @ Coolant Heater (2)

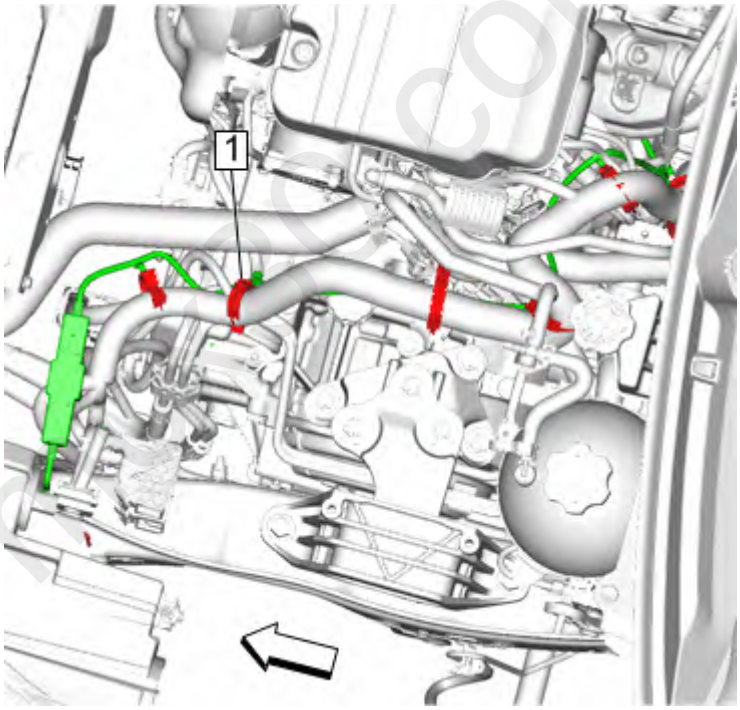


Fig. 456: Coolant Heater Cord Clip
Courtesy of GENERAL MOTORS COMPANY

2. Separate Coolant Heater Cord Clip (1) @ Wiring Harness - [7x]

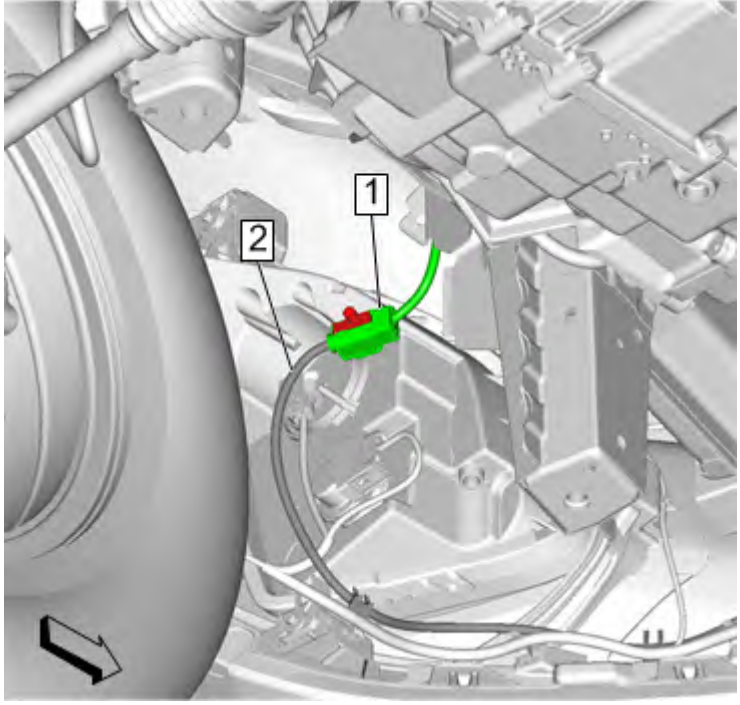


Fig. 457: Coolant Heater Cord
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect Coolant Heater Cord (1) @ Engine Coolant Heater Wiring Extension Harness (2).
4. Remove Coolant Heater Cord.

Installation Procedure

1. Install Coolant Heater Cord.

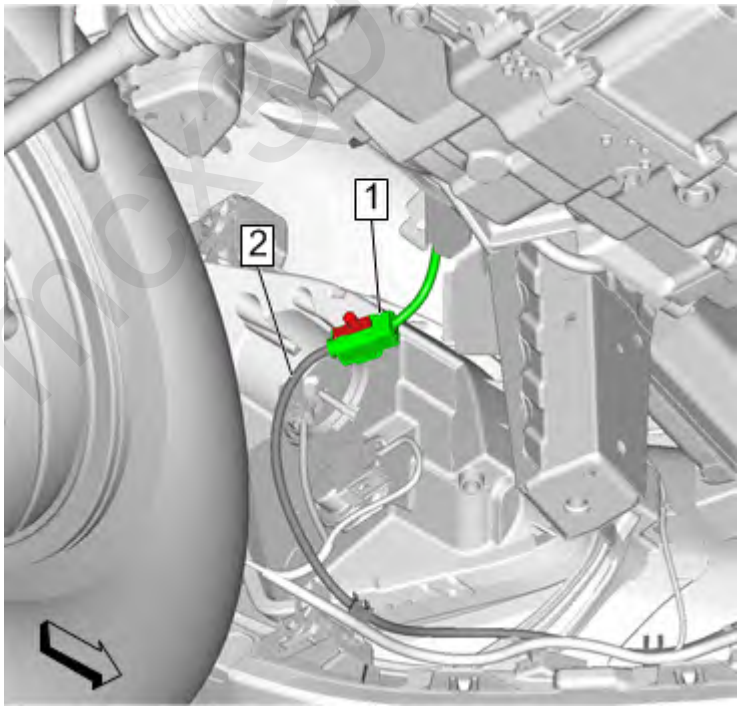


Fig. 458: Coolant Heater Cord
Courtesy of GENERAL MOTORS COMPANY

2. Connect Coolant Heater Cord (1) @ Engine Coolant Heater Wiring Extension Harness (2).

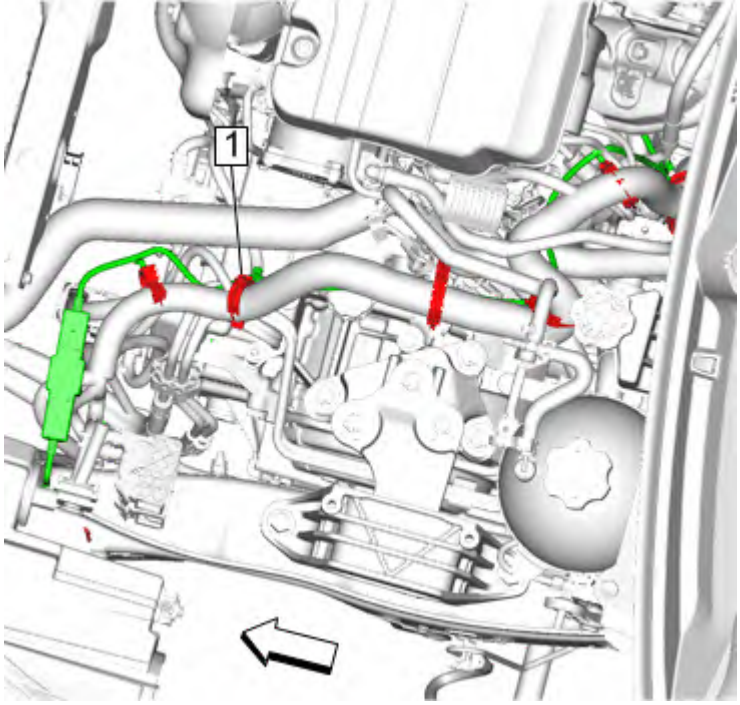


Fig. 459: Coolant Heater Cord Clip
Courtesy of GENERAL MOTORS COMPANY

3. Install Coolant Heater Cord Clip (1) @ Wiring Harness.[7x]

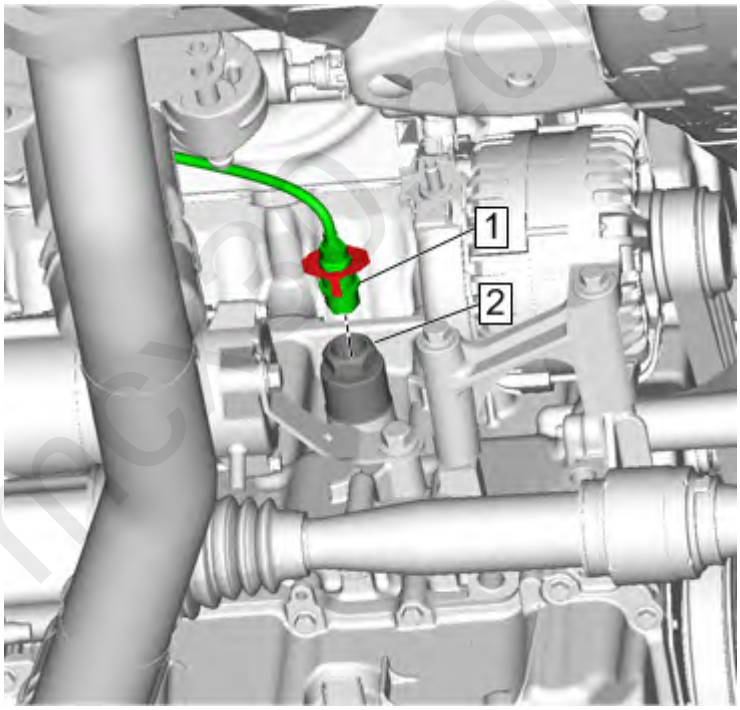


Fig. 460: Coolant Heater Cord
Courtesy of GENERAL MOTORS COMPANY

4. Connect Coolant Heater Cord (1) @ Coolant Heater (2).

COOLANT HEATER CORD REPLACEMENT (LTG)

Removal Procedure

1. Remove Starter - **Starter Replacement (LTG - All Wheel Drive)** **Starter Replacement (LTG - Front Wheel Drive)**

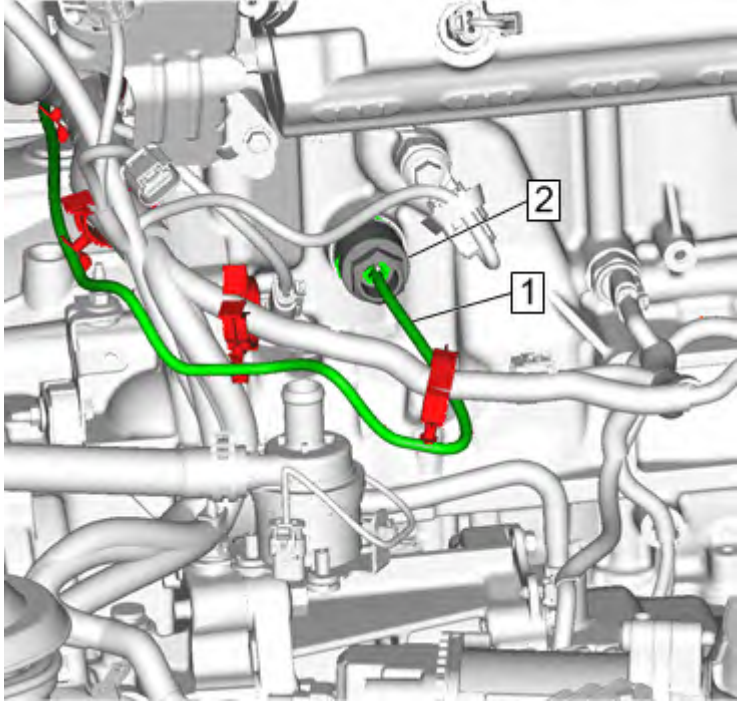


Fig. 461: Coolant Heater Cord
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Coolant Heater Cord (1) @ Coolant Heater (2)

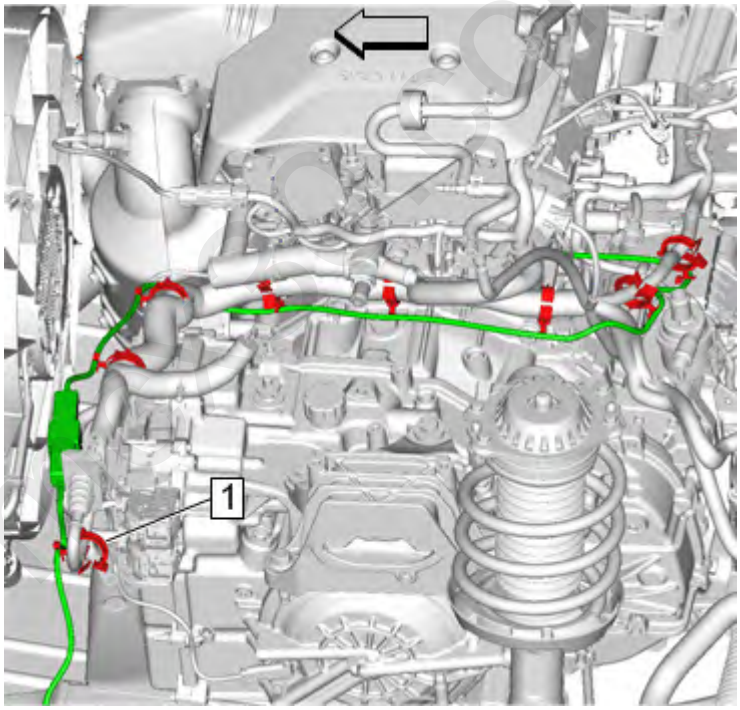


Fig. 462: Coolant Heater Cord Clip
Courtesy of GENERAL MOTORS COMPANY

3. Separate Coolant Heater Cord Clip (1) @ Wiring Harness - [8x]

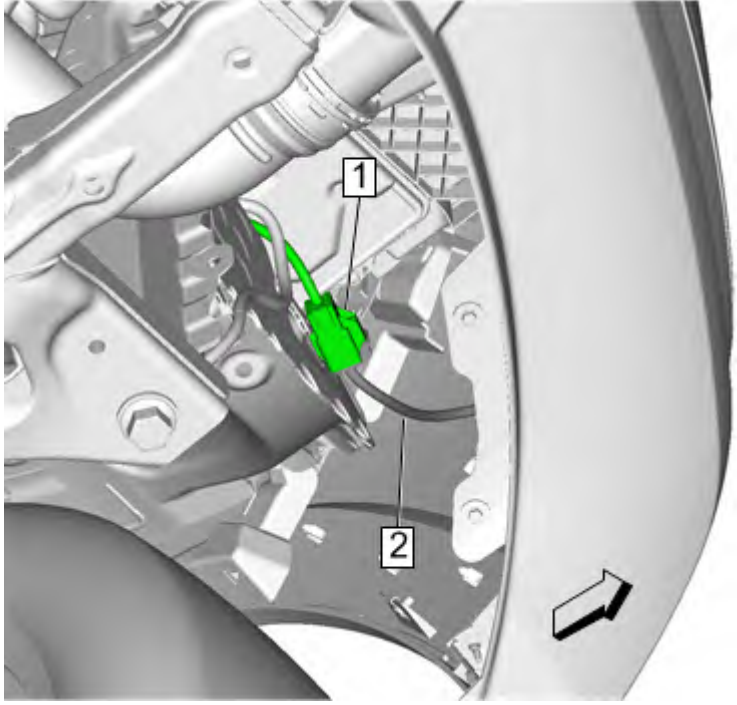


Fig. 463: Coolant Heater Cord
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect Coolant Heater Cord (1) @ Engine Coolant Heater Wiring Extension Harness (2).
5. Remove Coolant Heater Cord

Installation Procedure

1. Install Coolant Heater Cord.

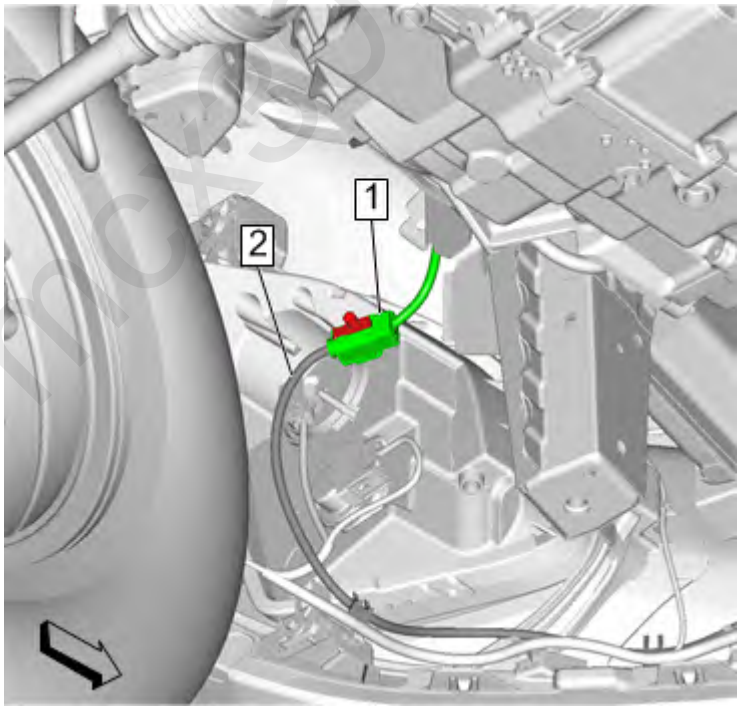


Fig. 464: Coolant Heater Cord
Courtesy of GENERAL MOTORS COMPANY

2. Connect Coolant Heater Cord (1) @ Engine Coolant Heater Wiring Extension Harness (2).

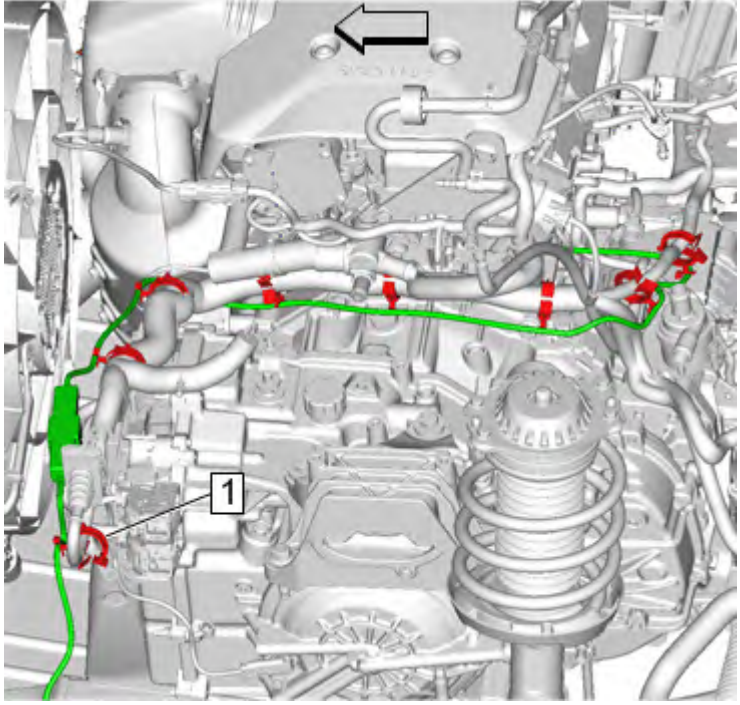


Fig. 465: Coolant Heater Cord Clip
Courtesy of GENERAL MOTORS COMPANY

3. Connect Coolant Heater Cord Clip (1) @ Wiring Harness - [8x]

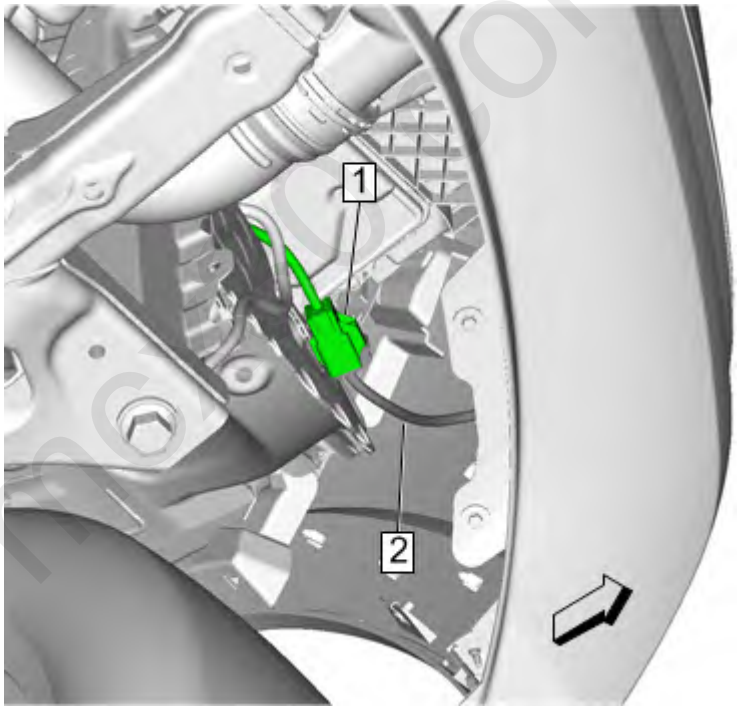


Fig. 466: Coolant Heater Cord
Courtesy of GENERAL MOTORS COMPANY

4. Connect Coolant Heater Cord (1) @ Coolant Heater (2)
5. Install Starter - **Starter Replacement (LTG - All Wheel Drive)** **Starter Replacement (LTG - Front Wheel Drive)**

ENGINE COOLANT HEATER WIRING EXTENSION HARNESS REPLACEMENT

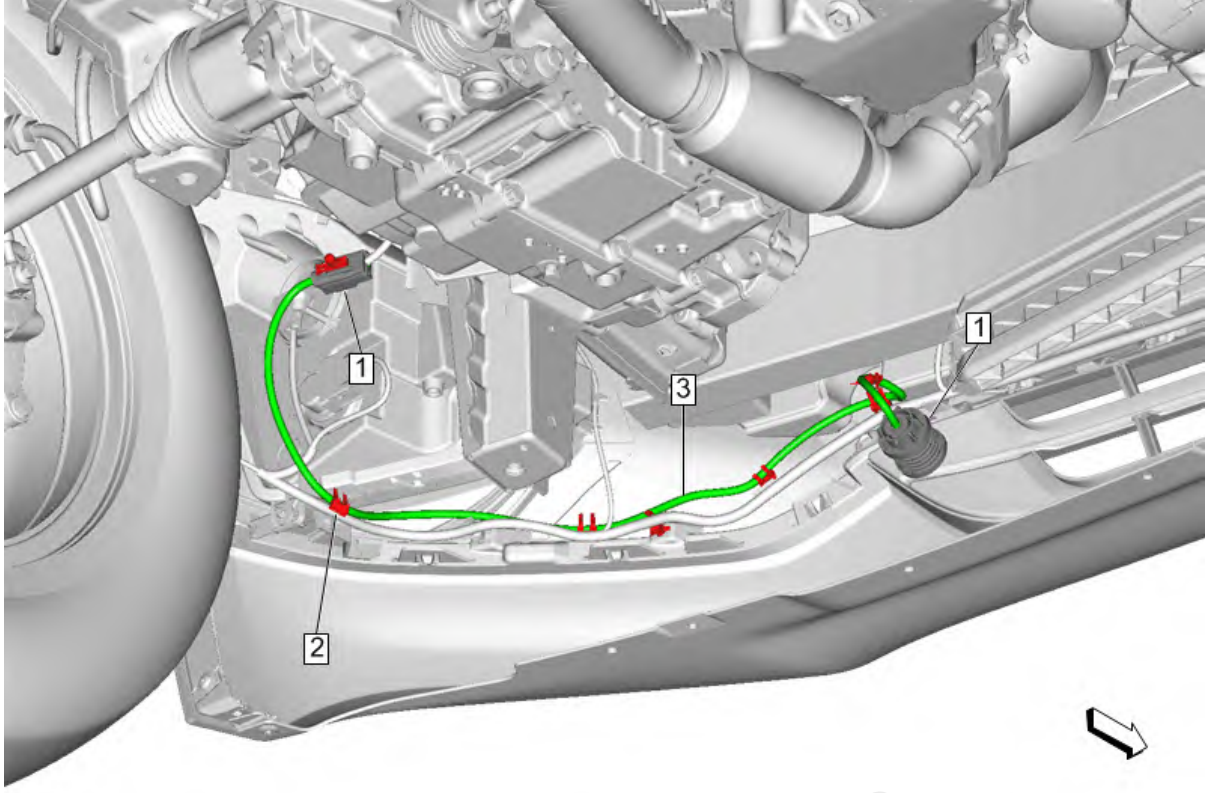


Fig. 467: Engine Coolant Heater Wiring Extension Harness
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Coolant Heater Wiring Extension Harness Electrical Connector [2x]
2	Engine Coolant Heater Wiring Extension Harness Double Tie Strap Clip [6x]
3	Engine Coolant Heater Wiring Extension Harness

DESCRIPTION AND OPERATION

COOLING FAN DESCRIPTION AND OPERATION

Cooling Fan Control

The engine cooling fan system is composed of one electric cooling fan and a cooling fan control module. The engine control module (ECM) controls the fan speed by sending a pulse width modulated (PWM) signal to the cooling fan control module. The cooling fan control module varies the voltage drop across the cooling fan motor in relation to the pulse width modulated signal, allowing the cooling fan to operate at variable speeds. The cooling fan speed is effected by many different operating conditions and the ECM will adjust the duty cycle based on cooling system requirements.

This system is unique in that the ECM will not operate the cooling fan at every speed within a 0 - 90 percent range. The cooling fan calibration is designed to operate the cooling fan at 5 specific percentages in order to avoid the speed regions that create undesirable noise and vibration. During normal operating conditions the ECM may initially activate the cooling fan at 4 or 5 % and then increase to the desired percentages to satisfy powertrain cooling requirements. Generally, the ECM will operate the cooling fan at specific percentages but, may scale the percentages either higher or lower in response to generator demand. The percentages at which the cooling fan operates may vary between vehicle lines and engines.

The cooling fan control module is thermally protected to prevent module damage in the case of a short circuit condition in the cooling fan motor. The scan tool output control is only capable of operating the cooling fan in the speed percentages allowed by the ECM. When multiple cooling fan speed requests are received, the ECM operates the fan at the highest of the speed requests. The ECM commands the fan(s) ON under the following conditions:

- The engine coolant temperature is warmer than a predetermined temperature.
- The engine oil temperature is warmer than a predetermined temperature.
- The A/C pressure reaches a predetermined pressure.

- If the engine coolant temperature at key-off is warmer than a predetermined value, or the A/C pressure is greater than a predetermined value, the cooling fan will operate at a low speed. The fan will shut OFF if the temperature or pressure drops below the predetermined value, but will only operate for 2 minutes, regardless of the coolant temperature or A/C pressure.

Cooling System Electronic Component Description and Operation

Coolant Heater

The coolant heater operates using 110 V AC external power and is designed to warm the coolant in the engine block area for improved starting in very cold weather. The coolant heater also 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.

Engine or Radiator Coolant Temperature Sensor

The engine coolant temperature (ECT) sensor or radiator coolant temperature (RCT) sensor is a variable resistor that measures the temperature of the engine or radiator coolant. The ECM supplies 5 V to the sensor signal circuit and a ground for the low reference circuit.

Engine Coolant Thermostat Heater

The ECM controls the pulse width modulated (PWM) thermostat heater circuit. The engine coolant thermostat heater helps control coolant flow and regulates the engine operating temperature. The ignition relay supplies 12 V to the thermostat through a fuse. The ECM controls the engine coolant thermostat heater by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Electronic Coolant Pump

The switchable water pump is always ON in the default position. When commanded, an actuator disengages a clutch that decouples the pump from the engine. An Engine Material Sensor has been introduced on the engine head for the switchable water pump control and engine protection purposes. The engine metal temperature (EMT) sensor is present only if the switchable water pump is present in the specific application.

Engine Metal Temperature Sensor/Cylinder Head Temperature Sensor

The cylinder head temperature sensor is a variable resistor that measures the temperature of the cylinder head. The engine control module (ECM) supplies 5 V to the cylinder head temperature sensor signal circuit and a ground for the low reference circuit.

Electro-Viscous (EV) Fan Clutch

The ECM controls the EV fan clutch operation. The ECM regulates a 12-volt pulse width modulated signal (PWM) to the cooling fan relay. The PWM signal determines the ON time of the relay. As the ECM command increases, so does the ON time of the relay. The relay ON time directly controls the amount of time the solenoid, which is internal to the fan clutch, is energized. When the solenoid in the fan clutch is energized, it opens the spring loaded valve and allows fluid to flow from the storage chamber to the fluid coupling of the cooling fan clutch, which increases the fan speed. When the solenoid is de-energized, the spring loaded valve closes, and allows the fluid in the coupling of the fan clutch to drain back to the storage chamber, which reduces fan speed. The rapid modulation of the fan clutch solenoid valve gives the ECM the ability to precisely control the amount of fluid that remains in the fluid coupler, allowing more effective regulation of the fan speed and powertrain cooling requirements.

COOLING SYSTEM DESCRIPTION AND OPERATION

The cooling systems 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 coolant does not flow to the radiator until the thermostat opens. This allows the engine to warm quickly.

Cooling Cycle

Coolant is drawn from the radiator outlet to the thermostat. The flow of coolant will be stopped at the thermostat until the engine is warmed; while the thermostat is closed the water pump circulates coolant through the engine block and heater core. An electric auxiliary water pump is used on the heater core outlet circuit to aid in flow through the heater loop with KL9. This auxiliary water pump is enabled when the heater control is set to request heat, and the vehicle is in the STOP mode of the AUTOSTOP feature. Coolant is returned to the water pump through the engine bypass and the heater core outlet hose. This provides the passenger compartment with heat and defrost.

After the thermostat opens, the coolant is pumped through the water pump outlet and into the engine block and heater core. 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 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-COOLÂ® and suitable drinking 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 consisting of a core and 2 tanks. The aluminum core is a tube and fin cross-flow design that extends from the inlet tank to the outlet tank. Fins are placed around the outside of the tubes to improve heat transfer to the atmosphere. The inlet and outlet tanks are a molded, high temperature, nylon reinforced plastic material. A high temperature rubber gasket seals the tank flange edge to the aluminum core. 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 located in the bottom of the right hand tank. The drain cock unit includes the drain cock and drain cock seal. The radiator removes heat from the coolant passing through it. The fins on the core transfer heat from the coolant passing through the tubes. As air passes between the fins, it absorbs heat and cools the coolant.

Thermostat

The thermostat controls the flow of coolant and is mounted to the cylinder head. The thermostat contains a wax pellet that expands and contracts based on the coolant temperature, which will mechanically move the main spring and a sealing disc to control the flow of coolant. It is assisted by electric power in order to open the main valve earlier than original opening temperature.

Surge Tank

The surge tank is a plastic tank with a threaded pressure cap. The tank is mounted at a point higher than all other coolant passages. The surge tank provides an air space in the cooling system that allows the coolant to expand and contract. The surge tank provides a coolant fill point and a central air bleed location. During vehicle use, the coolant heats and expands. The increased coolant volume flows into the surge tank. As the coolant circulates, any air is allowed to bubble out. Coolant without air 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 cooling system capability. Deflectors are installed under the vehicle to redirect airflow beneath the vehicle and through the radiator to increase engine cooling. Air baffles are also used to direct airflow through the radiator and increase cooling capability. Air seals prevent air from bypassing the radiator and A/C condenser, and prevent recirculation of hot air for better hot weather cooling and A/C condenser performance.

LTG, LYX, LH7 Engine

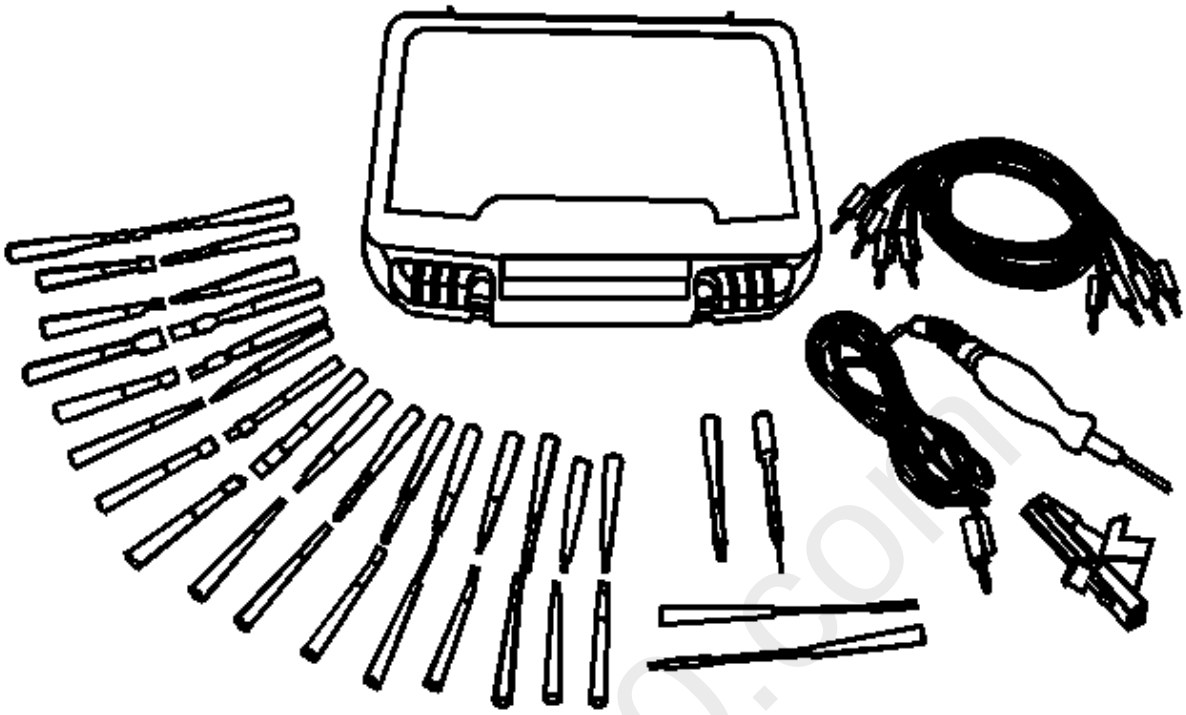
The transmission oil cooler is an air-to-oil heat exchanger integrated with the A/C condenser, occupying the top seven rows. Transmission fluid is supplied to the cooler inlet, where it passes through a series of tubes and is returned to the transmission sump. Transmission fluid temperature is regulated by air passing through the cooler fins, between the tubes, carrying away heat to the atmosphere.

A temperature/pressure fluid bypass valve is mounted to the end of the cooler. By design, transmission fluid bypasses the cooler to provide quick transmission warm-up where efficient shift schedules can be achieved. As the transmission fluid achieves proper operating temperature, the thermostatic bypass valve closes, and fluid is routed through the cooler to manage fluid temperature. When a pressure drop (due to cooler blockage) is present, the bypass valve will open to bypass the cooler, returning the fluid to the transmission sump.

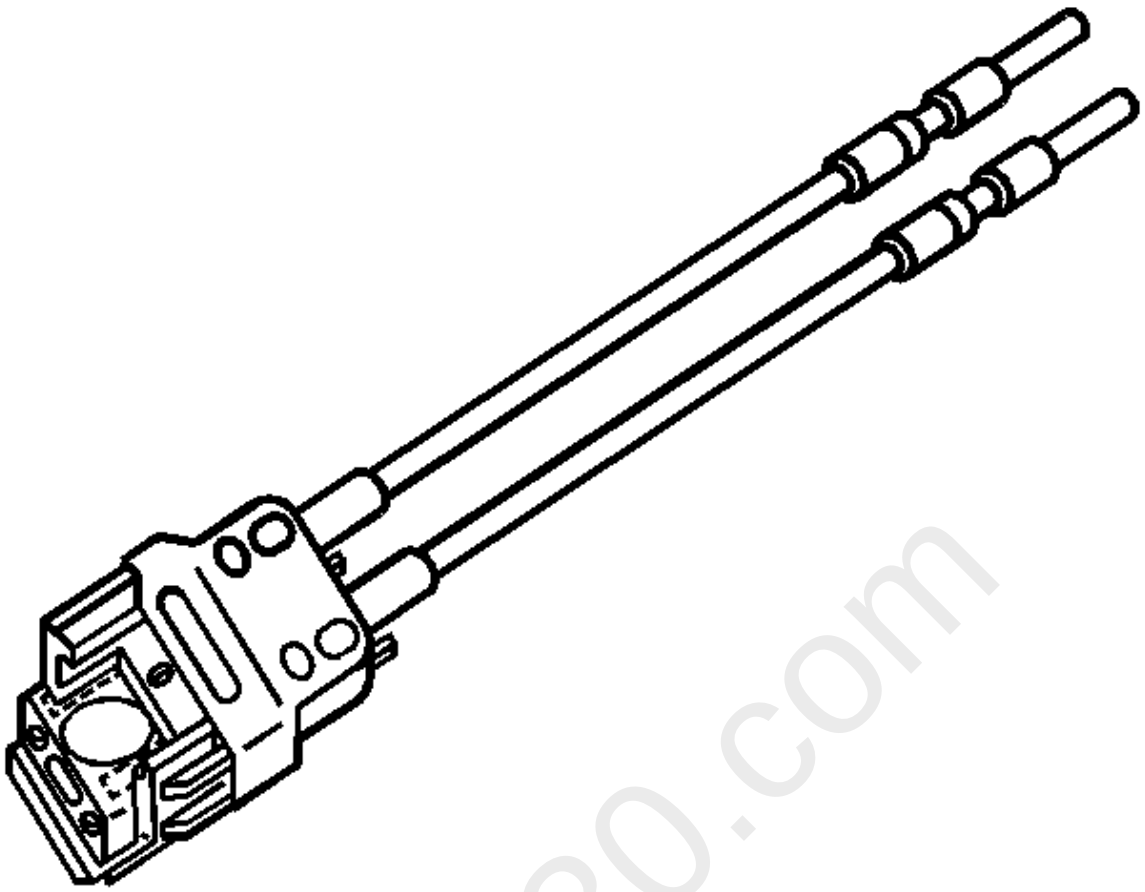
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

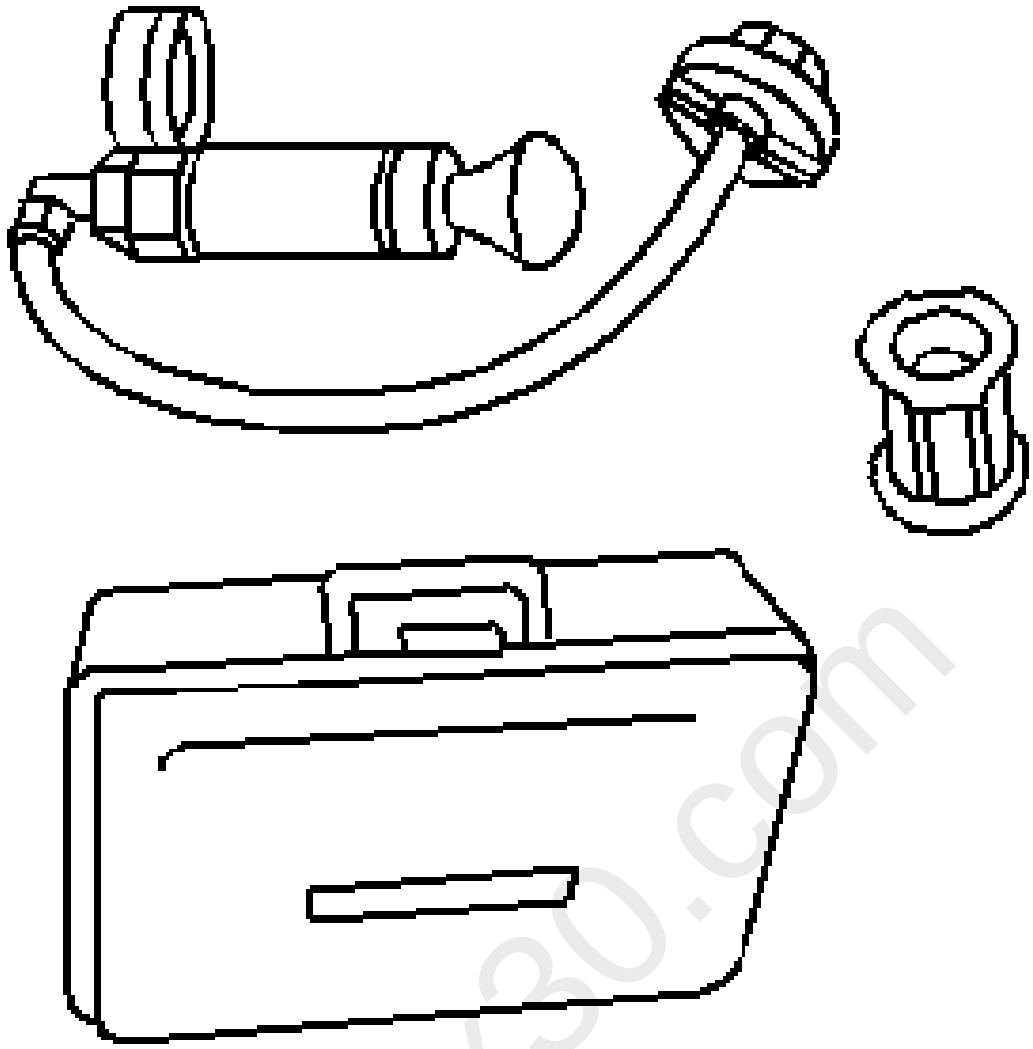
Illustration	Tool Number/ Description
	BO 38185 J 38185 Hose Clamp Pliers

Illustration	Tool Number/ Description
	EL 35616-F J 35616-F Terminal Test Kit

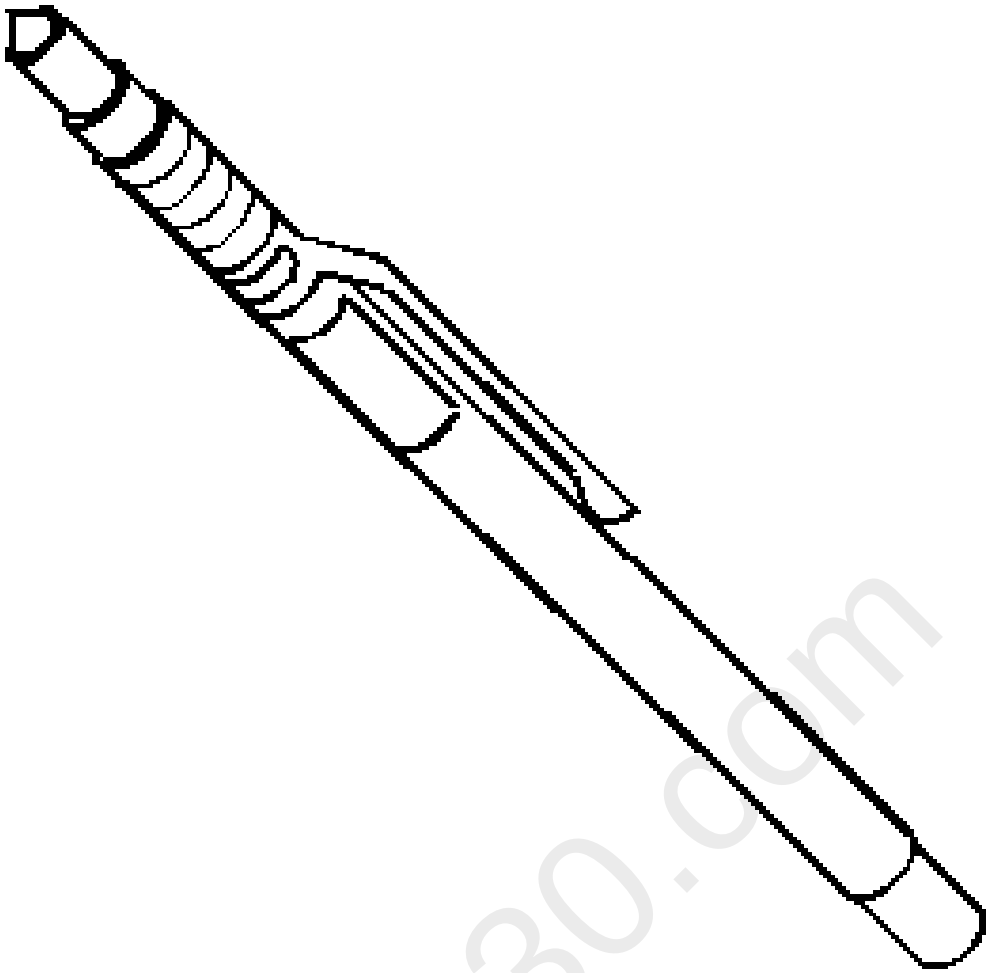
mcx30.com

Illustration	Tool Number/ Description
	EL 36169-HD J 36169-HD Heavy Duty Fused Jumper
	EN 24460-A J 24460-01 Cooling System Pressure Tester

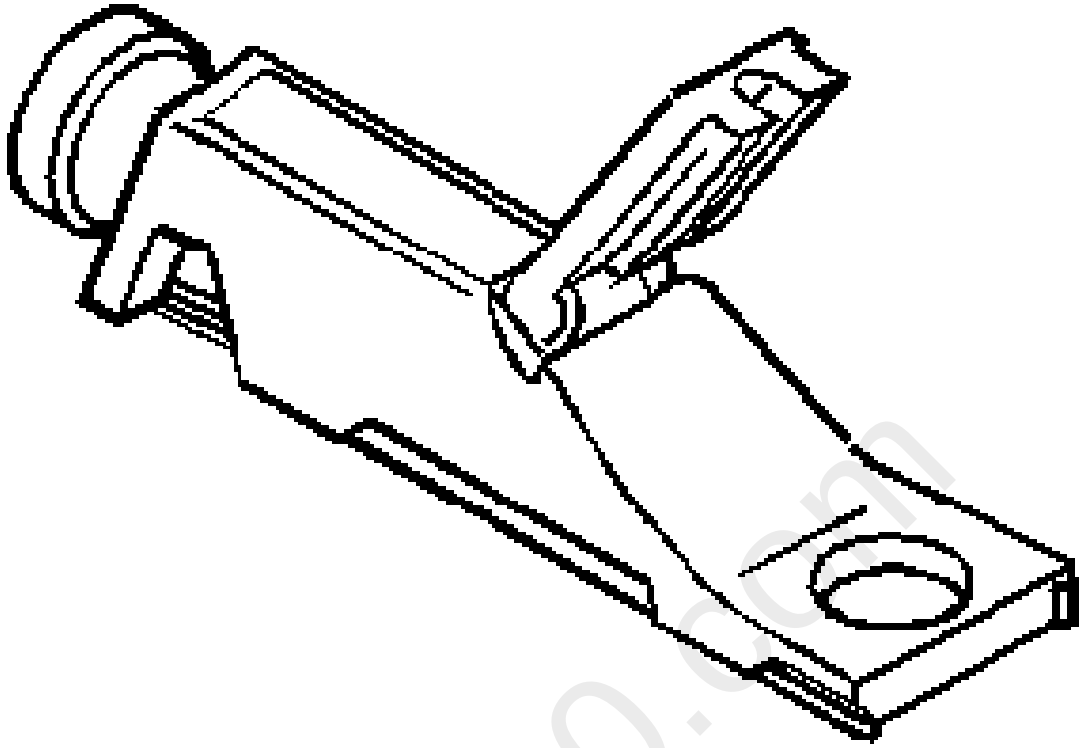
mcx30.com

Illustration	Tool Number/ Description
	

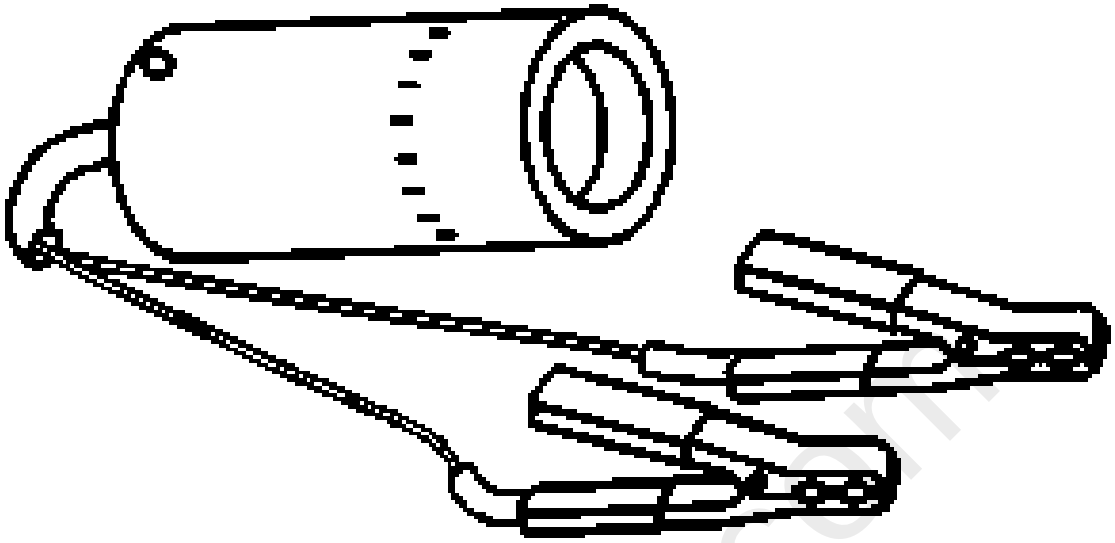
mcx30.com

Illustration	Tool Number/ Description
	GE 24731 J 24731 Tempilstick

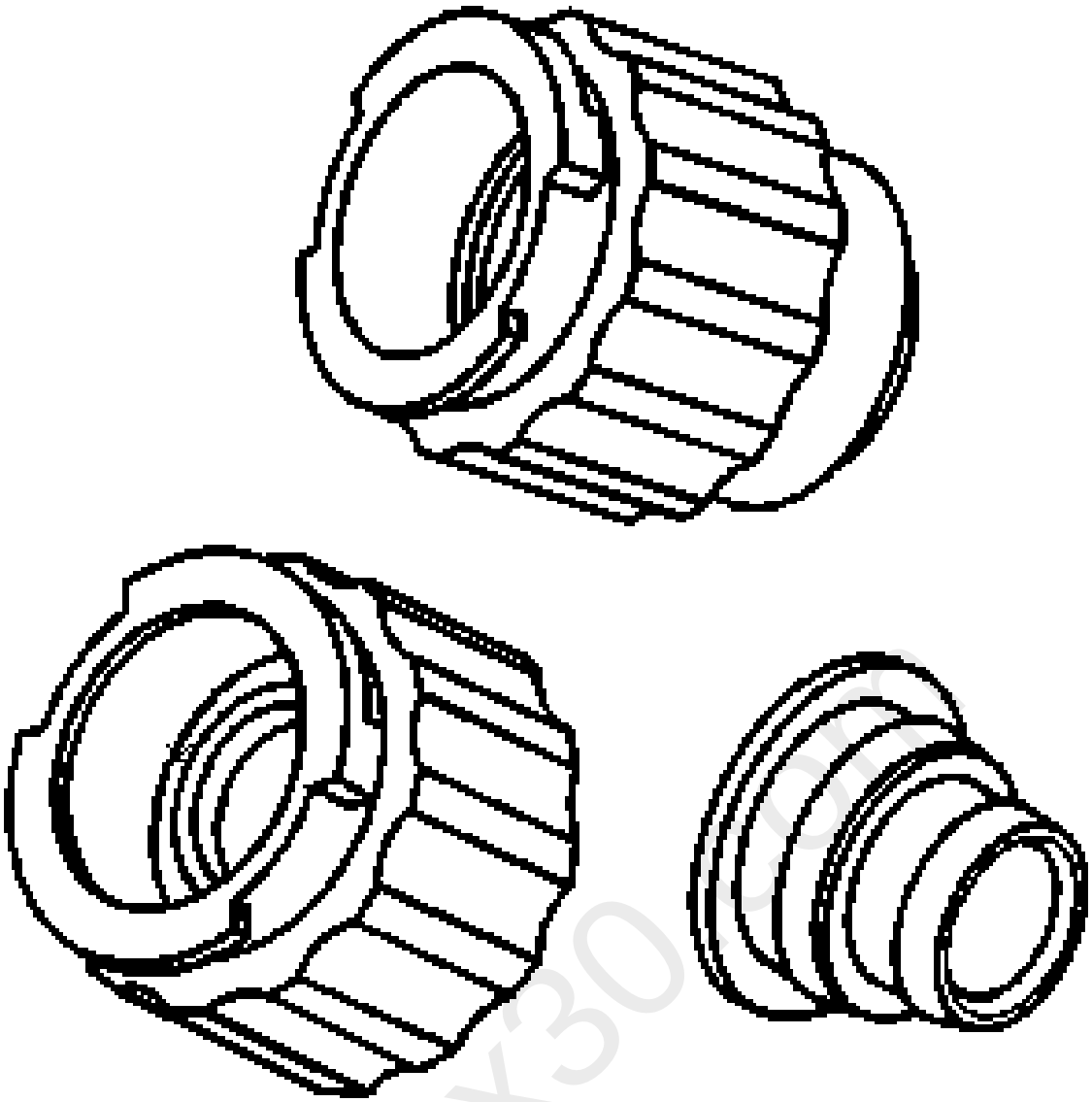
mcx30.com

Illustration	Tool Number/ Description
	GE 26568 J 26568 Coolant and Battery Fluid Tester

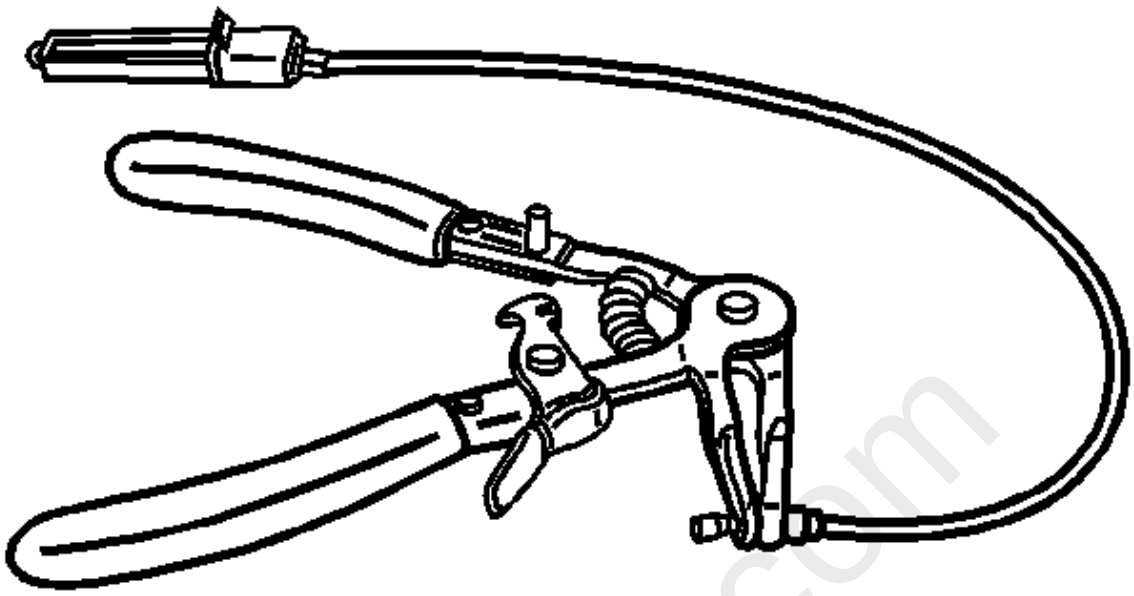
mcx30.com

Illustration	Tool Number/ Description
	GE 42220 J 42220 Universal 12V Leak Detection Lamp
	GE 42401 - A J 42401 Radiator Cap and Surge Tank Test Adapter

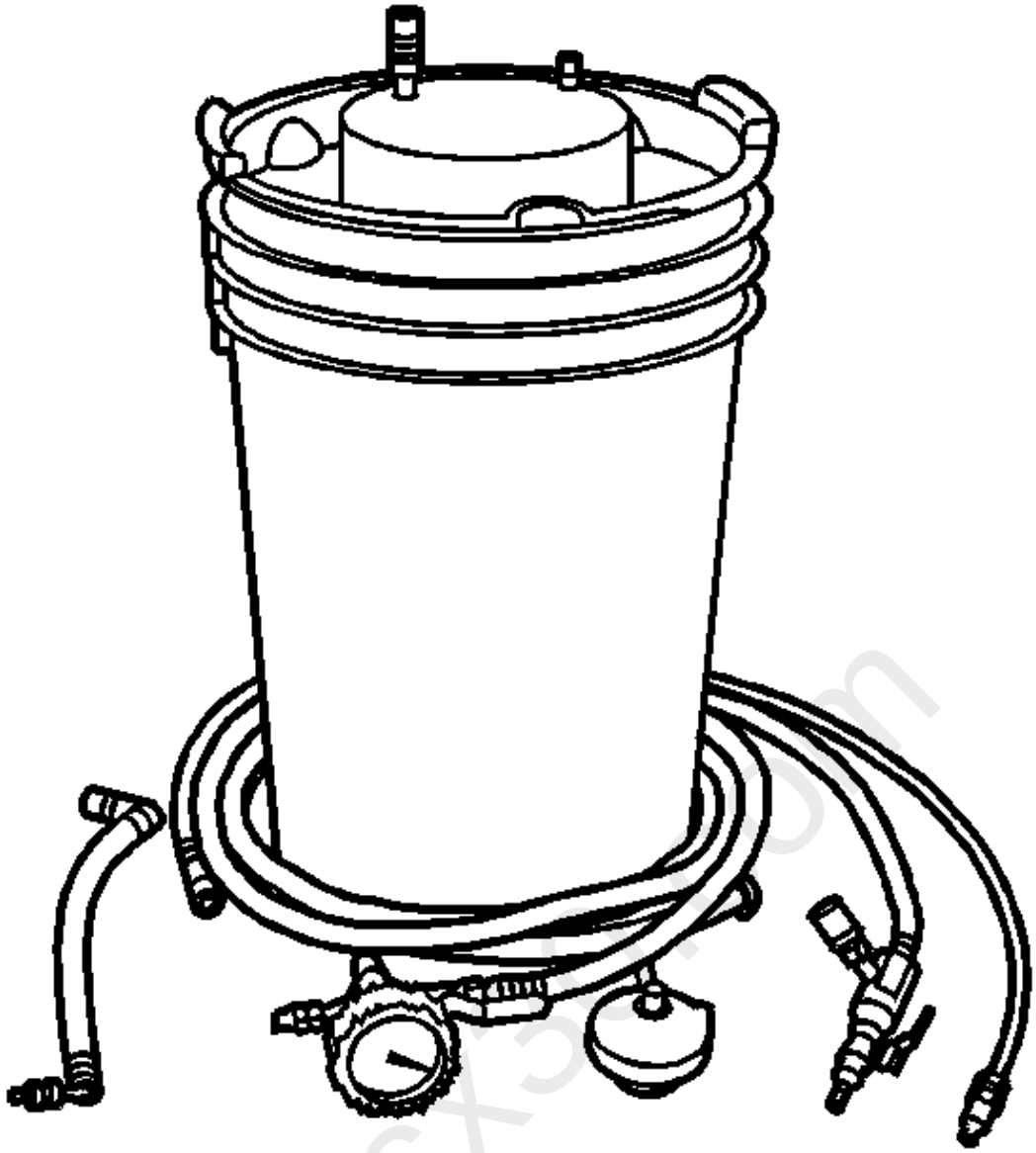
mcx30.com

Illustration	Tool Number/ Description
	

mcx30.com

Illustration	Tool Number/ Description
	GE 47622 Hose Clamp Pliers

mcx30.com

Illustration	Tool Number/ Description
	GE 47716 Vac N Fill Coolant Refill Tool

mcx30.com

2018 ENGINE

Engine Mechanical - 1.5L (LYX) - Equinox & Terrain

SPECIFICATIONS

FASTENER SPECIFICATIONS

Single Use Non-Threaded Fasteners/Components

Application
NOTE: ***All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.***
Camshaft Cover Gasket
Camshaft Housing Gasket
Combustion Fuel Injector Seal
Connecting Rod Bearing
Crankshaft Front Oil Seal
Cylinder Head Core Hole Plug
Cylinder Head Gasket
Engine Oil Cooler Gasket
Engine Oil Manifold Check Valve
Fuel Injector
Fuel Pump Housing Seal
Intake Manifold Gasket
Lower Oil Pan
Oil Pan Drain Plug Seal
Oil Pump Seal
Positive Crankcase Ventilation Tube
Positive Crankcase Ventilation Valve
Throttle Body Gasket
Timing Chain Oil Nozzle
Turbocharger Coolant Feed Pipe Seal
Turbocharger Coolant Return Pipe Fitting
Turbocharger Coolant Return Pipe Seal
Turbocharger Gasket
Turbocharger Oil Feed Pipe Washer
Turbocharger Oil Return Pipe Gasket
Turbocharger Pipe Fitting
Vacuum Pump Gasket
Vacuum Pump Seal
Valve Stem Oil Seal
Water Outlet Gasket
Water Pump Housing Gasket

Single Use Threaded Fastener/Component Tightening Specifications

NOTE: ***All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.***

mcx30.com

NOTE:
All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application	Specification Metric (English)
Automatic Transmission Flex Plate Bolt	
• First Pass:	20 N.m (15 lb ft)
• Second Pass:	30 N.m (22 lb ft)
• Final Pass:	70 degrees
Camshaft Position Actuator Bolt	
• First Pass:	20 N.m (15 lb ft)
• Final Pass:	90 degrees
Connecting Rod Bolt	
• First Pass:	25 N.m (18 lb ft)
• Final Pass:	75 degrees
Crankshaft Balancer Bolt	
• First Pass:	100 N.m (74 lb ft)
• Final Pass:	180 degrees
Cylinder Head Bolt	
• First Pass:	30 N.m (22 lb ft)
• Final Pass:	240 degrees
Cylinder Head Core Hole Plug	75 N.m (55 lb ft)
Cylinder Head Core Hole Plug	25 N.m (18 lb ft)
Engine Mount Bracket Engine Side Bolt	
• First Pass:	58 N.m (43 lb ft)
• Final Pass:	60-75 degrees
Engine Mount Engine Side Bolt Refer to procedure for tightening sequence and torque values.	**Engine Mount Replacement**
Fuel Feed Intermediate Pipe	30 N.m (22 lb ft)
Fuel Injector Bolt	5 N.m (44 lb in)
Fuel Pump Bolt	25 N.m (18 lb ft)

mcx30.com

NOTE:

All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application	Specification Metric (English)
Lower Crankcase Bolt	
• First Pass:	15 N.m (11 lb ft)
• Final Pass:	180 degrees
Oil Filter	3/4 to 1 full turn after gasket makes contact with the sealing surface on the filter mounting flange
Positive Crankcase Ventilation Valve Bolt	10 N.m (89 lb in)
Turbocharger Nut	
• First Pass:	15 N.m (11 lb ft)
• Second Pass:	20 N.m (15 lb ft)
• Final Pass:	60 degrees
Turbocharger Coolant Return Pipe Fitting	35 N.m (26 lb ft)
Turbocharger Oil Feed Pipe Fitting	35 N.m (26 lb ft)
Turbocharger Stud	10 N.m (89 lb in)

Reusable Threaded Fastener Tightening Specifications

NOTE:

All fasteners listed in this table can be reused after removal.

Application	Specification Metric (English)
Camshaft Bearing Cap Bolt	12 N.m (106 lb in)
Camshaft Cover Bolt	15 N.m (11 lb ft)
Camshaft Cover Opening Plug	12 N.m (106 lb in)
Camshaft Cover Stud [2x]	15 N.m (11 lb ft)
Camshaft Cover Stud	10 N.m (89 lb in)
Camshaft Housing Bolt	10 N.m (89 lb in)
Camshaft Position Actuator Solenoid Valve Bolt	10 N.m (89 lb in)
Camshaft Position Sensor Bolt	10 N.m (89 lb in)
Charge Air Bypass Valve Bolt	8 N.m (71 lb in)
Crankshaft Oil Deflector Bolt	10 N.m (89 lb in)
Crankshaft Position Sensor Bolt	10 N.m (89 lb in)
Engine Block Oil Gallery Plug	65 N.m (48 lb ft)
Engine Coolant Heater Hole Plug	60 N.m (44 lb ft)
Engine Front Cover Bolt [11x]	15 N.m (133 lb in)
Engine Front Cover Bolt [1x]	15 N.m (133 lb in)
Engine Front Cover Bolt [1x]	58 N.m (43 lb ft)
Engine Front Cover Hole Plug	50 N.m (37 lb ft)
Engine Front Cover Stud	15 N.m (133 lb in)

mc30.com

NOTE:

All fasteners listed in this table can be reused after removal.

Application	Specification Metric (English)
Engine Lift Front Bracket Bolt - Model Dependent	25 N.m (18 lb ft)
Engine Lift Rear Bracket Bolt	25 N.m (18 lb ft)
Engine Mount Bolt	100 N.m (74 lb ft)
Engine Mount Brace Bolt	22 N.m (16 lb ft)
Engine Oil Cooler Bolt [2x]	10 N.m (89 lb in)
Engine Oil Cooler Bolt [2x]	25 N.m (18 lb ft)
Engine Oil Pressure Sensor	35 N.m (26 lb ft)
Fuel Feed Front Pipe Bracket Bolt	10 N.m (89 lb in)
Fuel Feed Intermediate Pipe Bolt	10 N.m (89 lb in)
Fuel Injection Fuel Rail Bolt	10 N.m (89 lb in)
Ignition Coil Bolt	10 N.m (89 lb in)
Intake Air Pressure and Temperature Sensor Bolt	5 N.m (44 lb in)
Intake Manifold Bolt	12 N.m (106 lb in)
Intake Manifold Cover Fastener	9 N.m (80 lb in)
Knock Sensor Bolt	25 N.m (18 lb ft)
Lower Crankcase Bolt	
• First Pass:	5 N.m (44 lb in)
• Final Pass:	10 N.m (89 lb in)
Lower Oil Pan Bolt	10 N.m (89 lb in)
Oil Filter Fitting	55 N.m (41 lb ft)
Oil Pan Drain Plug	25 N.m (18 lb ft)
Oil Pump Bolt	10 N.m (89 lb in)
Oil Pump Drive Chain Tensioner Bolt	10 N.m (89 lb in)
Piston Oil Nozzle Bolt	10 N.m (89 lb in)
Positive Crankcase Ventilation Hose Fitting Bolt	10 N.m (89 lb in)
Positive Crankcase Ventilation Oil Separator Drain Pipe Bolt	10 N.m (89 lb in)
Spark Plug	17 N.m (13 lb ft)
Thermostat Bypass Pipe Bolt	10 N.m (89 lb in)
Throttle Body Bolt	10 N.m (89 lb in)
Timing Chain Guide Bolt	10 N.m (89 lb in)
Timing Chain Guide Bolt	10 N.m (89 lb in)
Timing Chain Oil Nozzle	15 N.m (11 lb ft)
Timing Chain Tensioner Bolt	25 N.m (18 lb ft)
Timing Chain Tensioner Shoe Bolt	25 N.m (18 lb ft)
Turbocharger Bypass Valve Solenoid Bolt	10 N.m (89 lb in)
Turbocharger Coolant Feed Pipe Bolt	35 N.m (26 lb ft)
Turbocharger Coolant Return Pipe Bolt	35 N.m (26 lb ft)
Turbocharger Coolant Return Pipe Bracket Bolt	10 N.m (89 lb in)
Turbocharger Heat Shield Bolt	10 N.m (89 lb in)
Turbocharger Oil Feed Pipe Bolt	32 N.m (24 lb ft)
Turbocharger Oil Return Pipe Bolt	10 N.m (89 lb in)
Turbocharger Wastegate Actuator Nut	10 N.m (89 lb in)
Upper Oil Pan Bolt	10 N.m (89 lb in)
Vacuum Pump Bolt	

mcx30.com

NOTE:
All fasteners listed in this table can be reused after removal.

Application	Specification
	Metric (English)
• First Pass:	15 N.m (11 lb ft)
• Final Pass:	25 N.m (18 lb ft)
Water Outlet Bolt	10 N.m (89 lb in)
Water Pump Bolt	25 N.m (18 lb ft)
Wiring Harness Bracket Bolt	10 N.m (89 lb in)
Wiring Harness Connector Bolt	10 N.m (89 lb in)

APPROXIMATE FLUID CAPACITIES

Application	Specification	
	Metric	English
LFV, LYX		
Oil Capacity - AWD	5.0L	5.3 quarts
Oil Capacity - FWD	4.0L	4.2 quarts

ENGINE MECHANICAL SPECIFICATIONS

Application	Specification	
	Metric	English
General Data		
• Engine Type	4-Cylinder Inline	
• Displacement	1.5L	92 CID
• RPO	LYX	
• Valves	16	
• Bore	74 mm	2.91 in
• Stroke	86.6 mm	3.409 in
• Compression Ratio	10.0:1	
• Spark Plug Gap	0.60 - 0.70 mm	0.024 - 0.028 in
• Firing Order	1 - 3 - 4 - 2	
Block		

mcx30.com

Application	Specification	
	Metric	English
• Crankshaft Main Bearing Bore Diameter	51.868 - 51.882	2.0420 - 2.0426 in
• Cylinder Bore Diameter	73.992 - 74.008 mm	2.913 - 2.914 in
• Cylinder Bore Out-of-Round - Maximum	0.013 mm	0.0005 in
• Cylinder Head Deck Surface Flatness - over 25 mm length	0.025 mm	0.0010 in
• Cylinder Head Deck Surface Flatness - over 150 mm length	0.050 mm	0.0020 in
Engine Block to Bedplate Flatness - overall	0.1 mm	0.004 in
Engine Block to Bedplate Flatness - straightness	0.050 - 0.100 mm	0.0020 - 0.0040 in
Piston Deck Height - Below Deck	0.74 - 0.94 mm	0.029 - 0.037 in
Camshaft		
• Camshaft End Play	0.040 - 0.660 mm	0.0016 - 0.0260 in
• Camshaft Journal Clearance	0.040 - 0.085 mm	0.0016 - 0.0033 in
• Camshaft Journal Diameter - Journal 1	30.935 - 30.960 mm	1.2179 - 1.2189 in
• Camshaft Journal Diameter - Journal 2 - 6	23.935 - 23.960 mm	0.9423 - 0.9433 in
• Camshaft Thrust Width - Camshaft with Phaser installed	33.175 - 33.525 mm	1.3061 - 1.3199 in
• Camshaft Thrust Width - Cylinder Head	32.865 - 33.135 mm	1.2939 - 1.3045 in
Connecting Rod		
• Connecting Rod Bearing to Crankpin Clearance	0.013 - 0.068 mm	0.0005 - 0.0027 in
• Connecting Rod Bore Diameter - Bearing End	47.186 - 47.202 mm	1.8577 - 1.8583 in
• Connecting Rod Bore Diameter - Pin End w/Bushing	18.007 - 18.017 mm	0.7089 - 0.7093 in
• Connecting Rod Side Clearance	0.090 - 0.350 mm	0.0035 - 0.0138 in
• Connecting Rod Straightness - Bend - Maximum	0.017 mm	0.0007 in
• Connecting Rod Straightness - Twist - Maximum	0.040 mm	0.0016 in

mcx30.com

Application	Specification	
	Metric	English
Crankshaft		
• Connecting Rod Journal Diameter	43.992 - 44.008 mm	1.7320 - 1.7326 in
• Connecting Rod Journal Out-of-Round	0.005 mm	0.0002 in
• Crankshaft End Play	0.15 - 0.38	0.0059 - 0.0150 in
• Crankshaft Main Bearing Clearance #1 Bearing	0.011 - 0.070	0.0004 - 0.0028
• Crankshaft Main Bearing Clearance # 2, 3, 4 and 5 Bearings	0.012 - 0.067	0.0005 - 0.0026
• Crankshaft Main Journal Diameter	46.992 - 47.008	1.8501 - 1.8507 in
• Crankshaft Main Journal Out-of-Round	0.005 mm	0.0002 in
Cylinder Head		
• Surface Flatness - Block Deck - in 25 mm	0.025 mm	0.0010 in
• Surface Flatness - Block Deck - in 150 mm	0.050 mm	0.0020 in
• Surface Flatness - Block Deck - between bolts	0.030 mm	0.0012 in
• Surface Flatness - Block Deck - Overall	0.100 mm	0.0039 in
• Valve Guide Bore - Exhaust	5.000 - 5.020 mm	0.1968 - 0.1976 in
• Valve Guide Bore - Intake	5.000 - 5.020 mm	0.1968 - 0.1976 in
• Valve Lifter Bore Diameter - Stationary Lash Adjusters	12.008 - 12.030 mm	0.4728 - 0.4736 in
• Valve Seat Angle - Relief Surface	50 Degrees	
• Valve Seat Angle - Seating Surface	90 Degrees	
• Valve Seat Angle - Undercut Surface	120 Degrees	
• Valve Seat Runout - Maximum	0.080 mm	0.0031 in
Lubrication System		

mcx30.com

Application	Specification	
	Metric	English
• Oil Pressure - @1500 RPM 100Â°C	200 - 250 kPa	29 - 36 psi
Piston Rings		
• Piston Ring End Gap - Top	0.25 - 0.40 mm	0.010 - 0.016 in
• Piston Ring End Gap - Second	0.40 - 0.60 mm	0.016 - 0.024 in
• Piston Ring End Gap - Oil Control	0.25 - 0.75 mm	0.010 - 0.030 in
• Piston Ring to Groove Clearance - Top	0.03 - 0.08 mm	0.001 - 0.003 in
• Piston Ring to Groove Clearance - Second	0.03 - 0.07 mm	0.001 - 0.003 in
• Piston Ring to Groove Clearance - Oil Control	0.050 - 0.190 mm	0.0020 - 0.0075 in
• Piston Ring Thickness - Top	1.17 - 1.19 mm	0.046 - 0.047 in
• Piston Ring Thickness - Second	1.17 - 1.19 mm	0.046 - 0.047 in
• Piston Ring Thickness - Oil Control - Rail	0.045 - 0.47 mm	0.0018 - 0.0019 in
• Piston Ring Thickness - Oil Control - Spacer	1.67 - 1.79 mm	0.066 - 0.071 in
Pistons and Pins		
• Pin - Piston Pin Clearance to Connecting Rod Bore	0.007 - 0.020 mm	0.0003 - 0.0008 in
• Pin - Piston Pin Clearance to Piston Pin Bore	0.002 - 0.010 mm	0.0001 - 0.0004 in
• Pin - Piston Pin Diameter	17.997 - 18.000 mm	0.7085 - 0.7087 in
• Pin - Piston Pin End Play	0.18 - 0.79 mm	0.0071 - 0.0311 in
• Piston - Piston Diameter - @38 mm up from crown	73.957 - 73.971 mm	2.9117 - 2.9122 in
• Piston - Piston Pin Bore Diameter	18.002 - 18.010 mm	0.7087 - 0.7091 in
• Piston - Piston Ring Groove Width - Top	1.23 - 1.25 mm	0.0484 - 0.0492 in

mcx30.com

Application	Specification	
	Metric	English
• Piston - Piston Ring Groove Width - Second	1.23 - 1.25 mm	0.0484 - 0.0492 in
• Piston - Piston Ring Groove Width - Oil Control	2.03 - 2.05 mm	0.0799 - 0.0807 in
• Piston - Piston to Bore Clearance - w/Polymer	-0.017 mm to +0.029 mm	-0.0007 in to +0.0011 in
Valve System		
• Valves - Valve Face Angle	90 Degrees	
• Valves - Valve Face Runout - Maximum	0.050 mm	0.0020 in
• Valves - Valve Seat Runout - Maximum	0.080 mm	0.0031 in
• Valves - Valve Seat Gauge Ball Height - Exhaust	8.85 - 9.09 mm	0.3484 - 0.3579 in
• Valves - Valve Seat Gauge Ball Height - Intake	9.47 - 9.71 mm	0.3728 - 0.3823 in
• Valves - Valve Stem Diameter - Exhaust	4.945 - 4.965 mm	0.1947 - 0.1955 in
• Valves - Valve Stem Diameter - Intake	4.955 - 4.975 mm	0.1951 - 0.1959 in
• Valves - Valve Stem Installed Height	Check and Record	
• Valves - Valve Stem to Guide Clearance - Exhaust	0.035 - 0.075 mm	0.0014 - 0.0030 in
• Valves - Valve Stem to Guide Clearance - Intake	0.025 - 0.065 mm	0.0010 - 0.0026 in
• Valve Lash Adjusters - Valve Lash Adjuster Diameter - Stationary Lash Adjuster	11.986 - 12.000 mm	0.4719 - 0.4724 in
• Valve Lash Adjusters - Valve Lash-Adjuster-to-Bore Clearance - Stationary Lash Adjuster	0.008 - 0.044 mm	0.0003 - 0.0017 in
• Valve Springs - Valve Spring Installed Height	34.50 - 35.50 mm	1.358 - 1.398 in
• Valve Springs - Valve Spring Load - Closed - @35 mm	225 - 245 N	51 - 55 lb
• Valve Springs - Valve Spring Load - Open - @26.5 mm	405 - 445 N	91 - 100 lb

mcx30.com

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	
		United States	Canada
Camshaft Cover[1]	Sealant	12378521	88901148
Camshaft Cover Opening Plug	Threadlocker	19333511	10953489
Camshaft Lobes	0W-20	19352900	-
Crankshaft Sensor O-Ring	0W-20	19352900	-
Cylinder Bores	0W-20	19352900	-
Cylinder Head Plugs	Threadlocker	19333511	10953489
Engine Block Plugs	Sealant	12346004	10953480
Engine Front Cover[1]	Sealant	12378521	88901148
Engine Oil	0W-20	19352900	-
Fuel Injector O-Rings	0W-20	19352900	-
Hydraulic Valve Lash Adjuster Arm	0W-20	19352900	-
Hydraulic Valve Lash Adjuster	0W-20	19352900	-
Ignition Coil	Lubricant	19260901	19260902
Intake and Exhaust Valve Stems	0W-20	19352900	-
Lower Crankcase[1]	Sealant	12378521	88901148
Lower Crankcase Bolt	Threadlocker	19333511	10953489
Main Bearings	0W-20	19352900	-
Oil Filter	0W-20	19352900	-
Oil Level Indicator Tube O-Ring	Lubricant	88862586	88862827
Oil Pan[1]	Sealant	12378521	88901148
Oil Pan Bolt	Threadlocker	19333511	10953489
Oil Pump - Pump Elements	0W-20	19352900	-
Oxygen Sensor	Anti-seize	88862477	88862478
Piston Pin to Piston/Rod - Pin Bores of Piston and Rod	0W-20	19352900	-
Rod Bearings - Rod Pins of Crankshaft	0W-20	19352900	-
Thread Repair Cutting Oil	Lubricant	1052864	992881
Thread Repair	Cleaner	88862650	88901247
Timing Chain Guide Bolt Access Hole Plug	Threadlocker	19333511	10953489
Valves	Parts Immersion Solvent	12345368	10953514
Water Feed Tube O-Rings	Lubricant	19260901	19260902
Water Pump Drain Plug	Sealant	12346004	10953480

[1] Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**

THREAD REPAIR SPECIFICATIONS

Engine Block - Front View

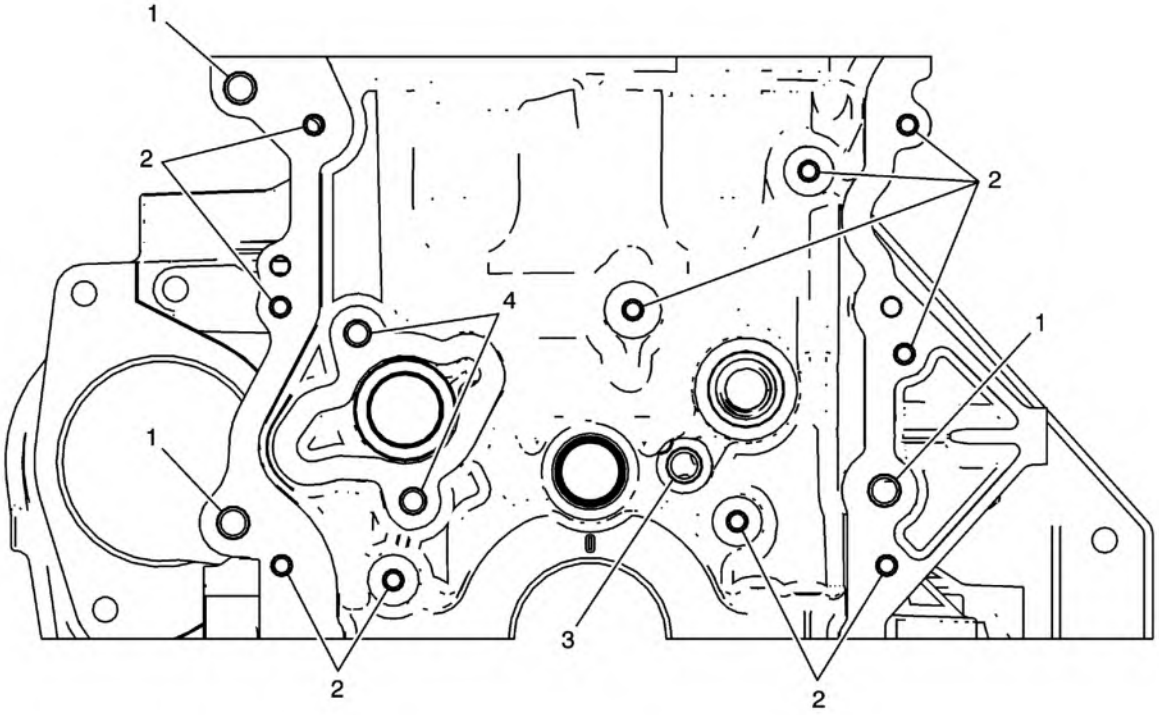


Fig. 1: Engine Block -- Front View
Courtesy of GENERAL MOTORS COMPANY

Engine Block - Front View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-400							MM	(IN)	MM	(IN)
1	M10x1.5	420	211	212	213	214	27.0	1.063	27.0	1.063
2	M6x1.0	205	201	202	203	204	20.0	0.787	20.0	0.787
3	Not Serviced									
4	M8x1.25	61	206	207	208	209	29.0	1.142	29.0	1.142

Engine Block - Rear View

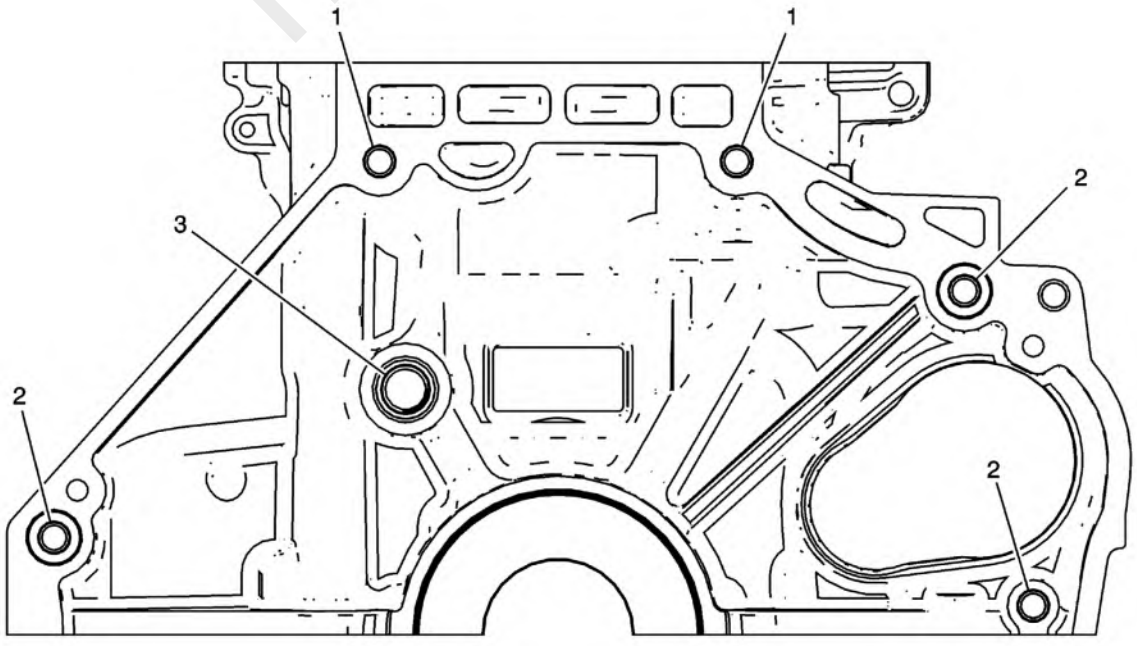


Fig. 2: Engine Block -- Rear View
Courtesy of GENERAL MOTORS COMPANY

Engine Block - Rear View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-400							MM	(IN)	MM	(IN)
1	M10x1.5	904	211	212	213	903	36.0	1.417	36.0	1.417
2	M10x1.5	215	211	212	213	214	25.0	0.984	25.0	0.984
3	Not Serviced									

Engine Block - Right Side View

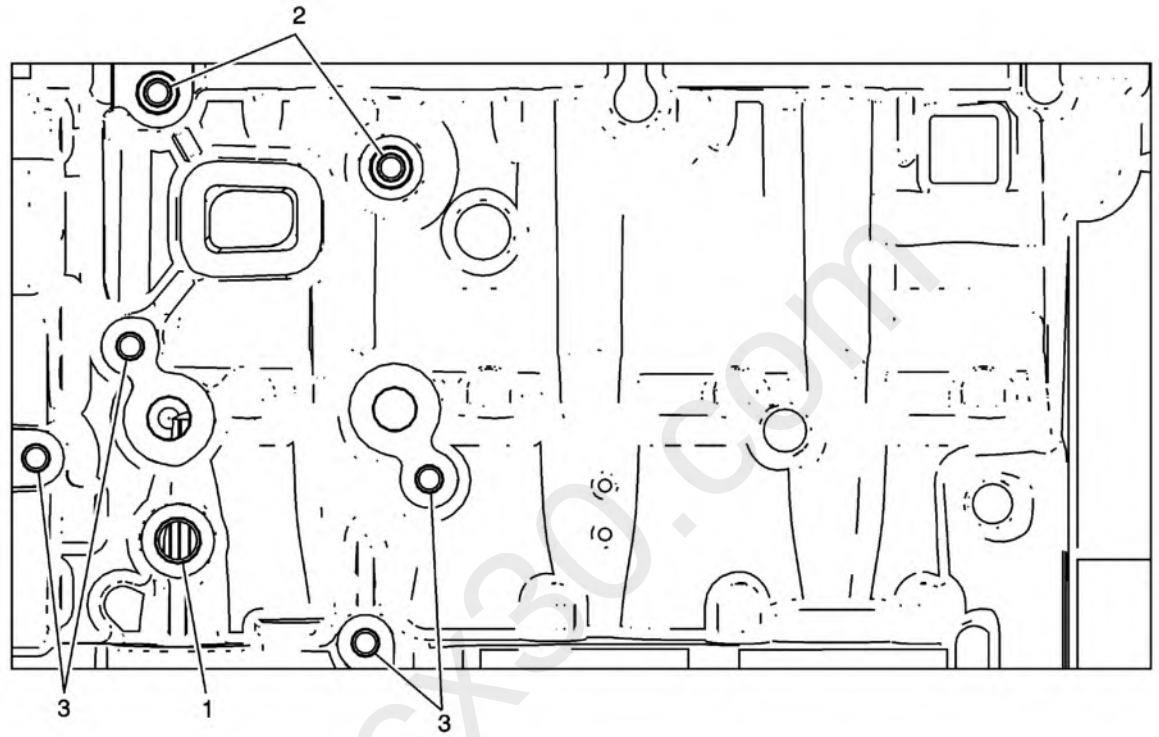


Fig. 3: Engine Block -- Right Side View
Courtesy of GENERAL MOTORS COMPANY

Engine Block - Right Side View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-400							MM	(IN)	MM	(IN)
1	M14x1.5	735	409	410	411	412	20.0	0.787	20.0	0.787
2	M8x1.25	210	206	207	208	209	37.0	1.457	37.0	1.457
3	M8x1.25	61	206	207	208	209	29.0	1.141	29.0	1.141

Engine Block - Left Side View

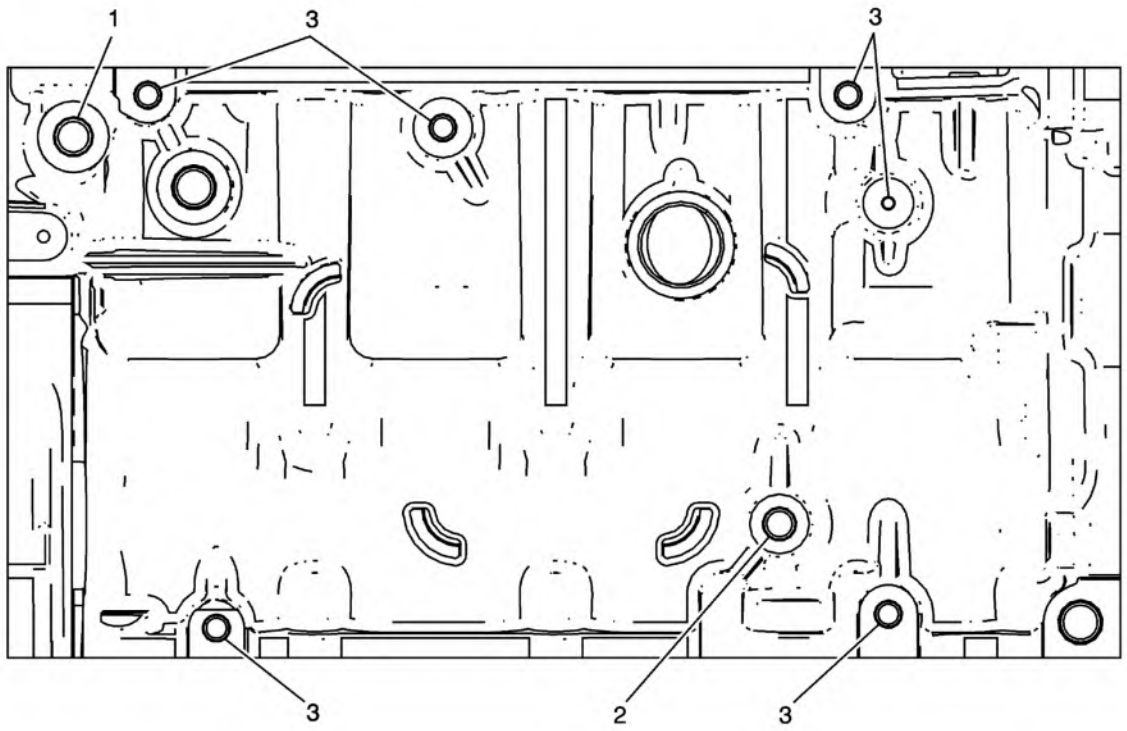


Fig. 4: Engine Block -- Left Side View
Courtesy of GENERAL MOTORS COMPANY

Engine Block - Left Side View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-400							MM	(IN)	MM	(IN)
1	M12x1.75	865	856	857	858	859	24.0	0.944	24.0	0.944
2	M10x1.5	420	211	212	213	214	34.0	1.338	34.0	1.338
3	M8x1.25	61	206	207	208	209	29.0	1.142	29.0	1.142

Engine Block - Bottom View

mcx30.com

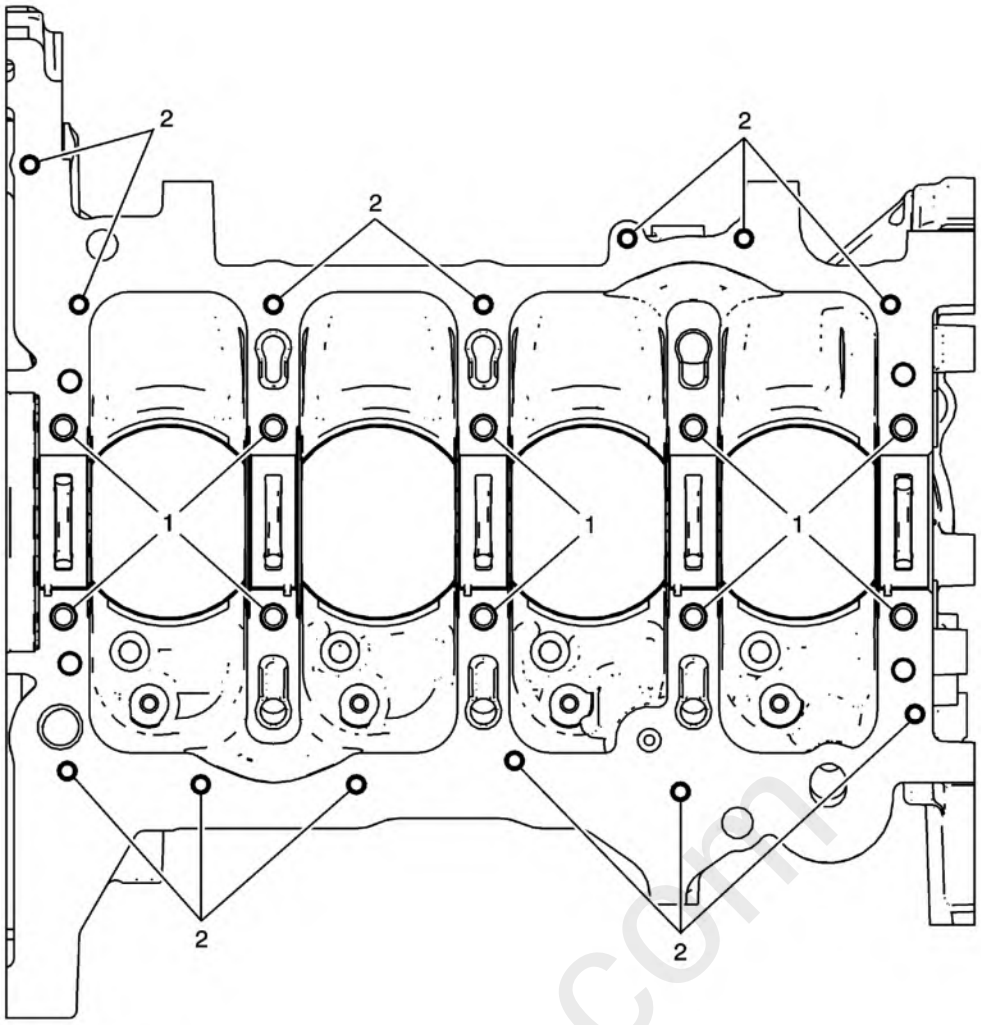


Fig. 5: Engine Block -- Bottom View
Courtesy of GENERAL MOTORS COMPANY

Engine Block - Bottom View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-400							MM	(IN)	MM	(IN)
1	Not Serviceable									
2	M6x1.0	205	201	202	203	204	22.0	0.866	22.0	0.866

Engine Block - Top View

mcx30.com

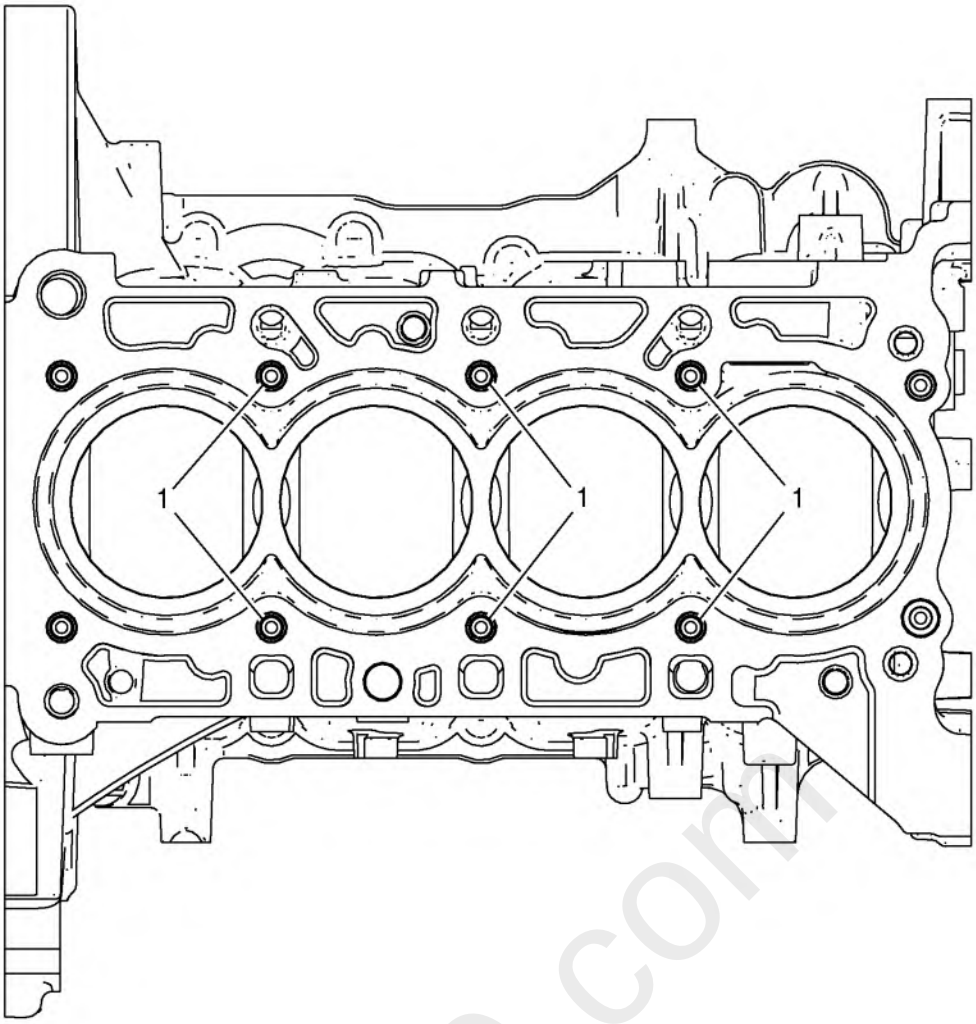


Fig. 6: Engine Block -- Top View
Courtesy of GENERAL MOTORS COMPANY

Engine Block - Top View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-900							MM	(IN)	MM	(IN)
1	M10x1.5	904	901	901	903	904	86.38	3.40	86.38	3.40

Lower Crankcase - Front View

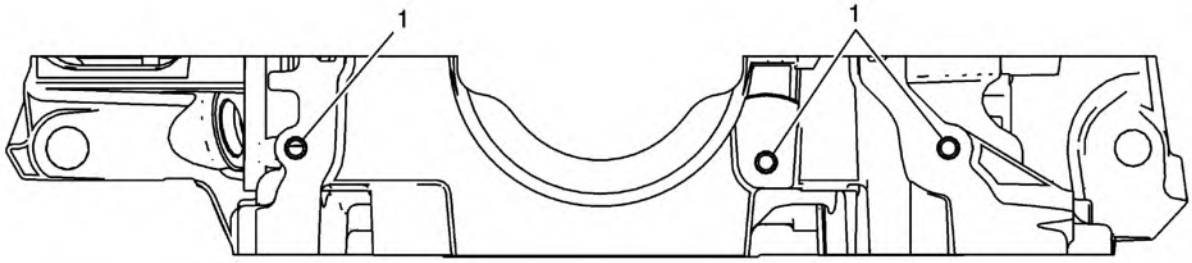


Fig. 7: Lower Crankcase -- Front View
Courtesy of GENERAL MOTORS COMPANY

Lower Crankcase - Front View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-400							MM	(IN)	MM	(IN)
1	M6x1.0	63	201	202	203	204	20.0	0.787	20.0	0.787

Lower Crankcase - Bottom View

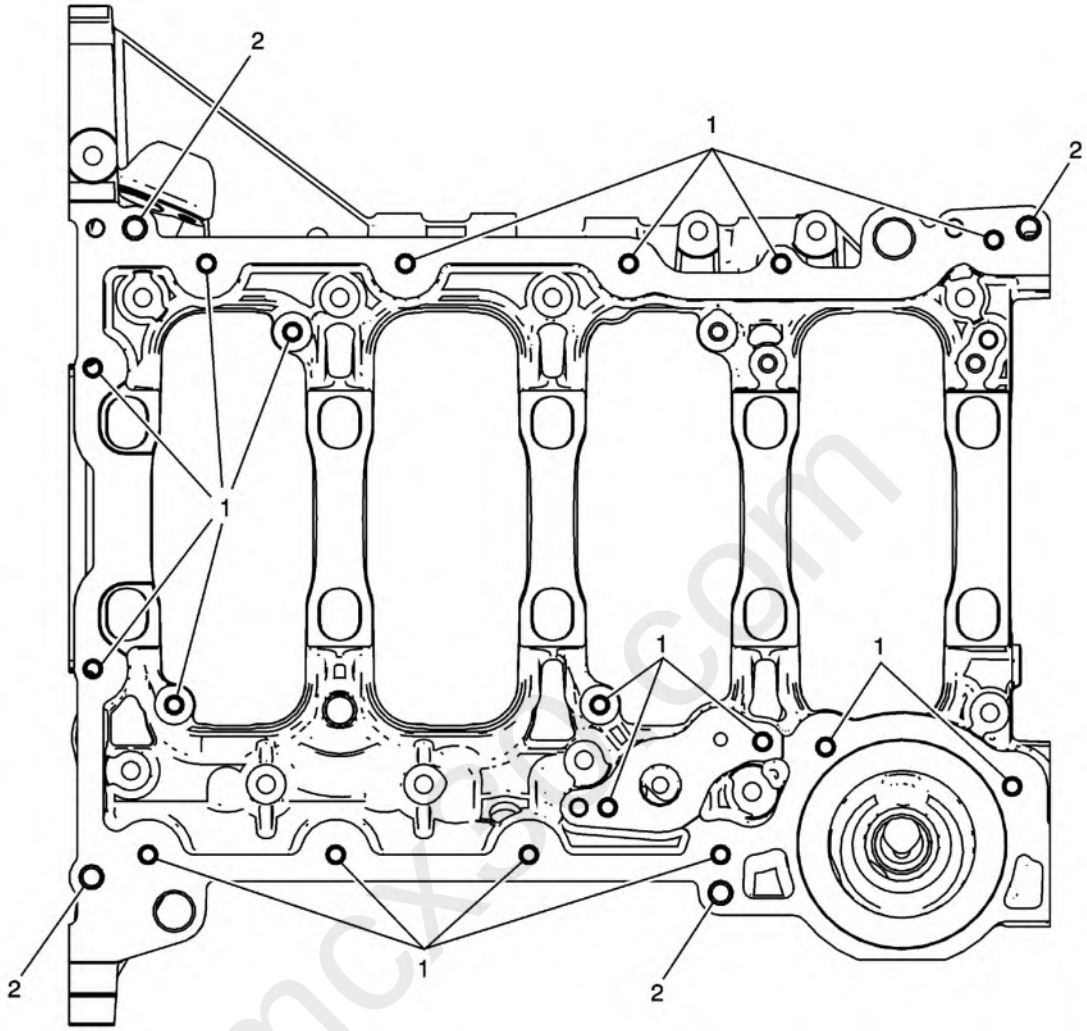


Fig. 8: Lower Crankcase -- Bottom View
Courtesy of GENERAL MOTORS COMPANY

Lower Crankcase - Bottom View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-400							MM	(IN)	MM	(IN)
1	M6x1.0	63	201	202	203	204	23.0	0.905	23.0	0.905
2	M8x1.25	210	206	207	208	209	24.0	0.945	24.0	0.945

Lower Crankcase - Right Side View

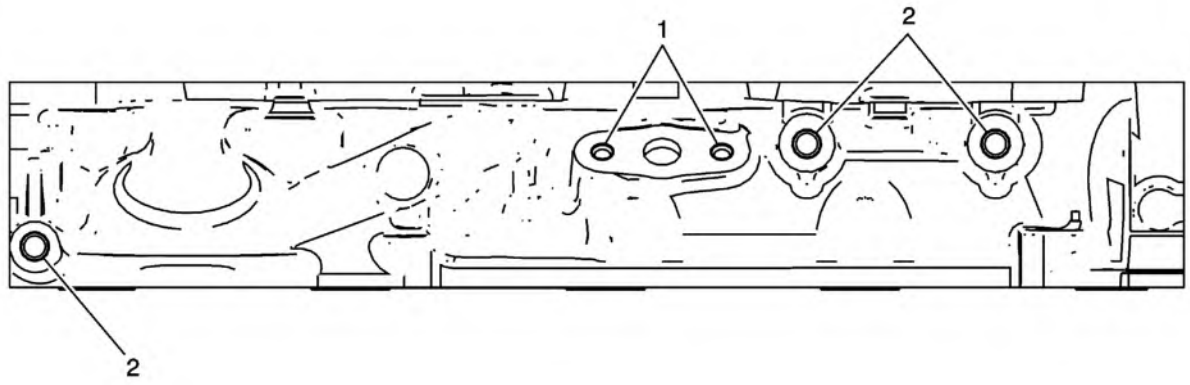


Fig. 9: Lower Crankcase -- Right Side View
Courtesy of GENERAL MOTORS COMPANY

Lower Crankcase - Right Side View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-400							MM	(IN)	MM	(IN)
1	M6x1.0	63	201	202	203	204	22.0	0.865	22.0	0.865
2	M8x1.25	61	206	207	208	209	29.0	1.142	29.0	1.142

Lower Crankcase - Left Side View

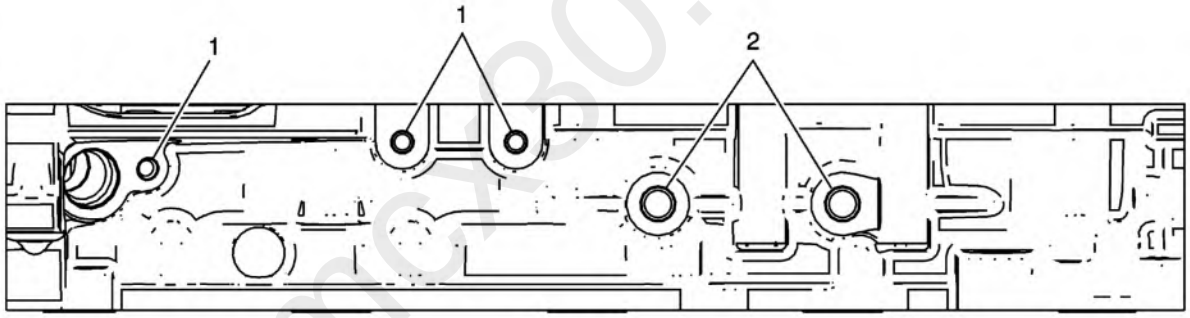


Fig. 10: Lower Crankcase -- Left Side View
Courtesy of GENERAL MOTORS COMPANY

Lower Crankcase - Left Side View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-400							MM	(IN)	MM	(IN)
1	M6x1.0	63	201	202	203	204	22.0	0.865	22.0	0.865
2	M10x1.5	420	211	212	213	214	34.0	1.338	34.0	1.338

Cylinder Head - Top View

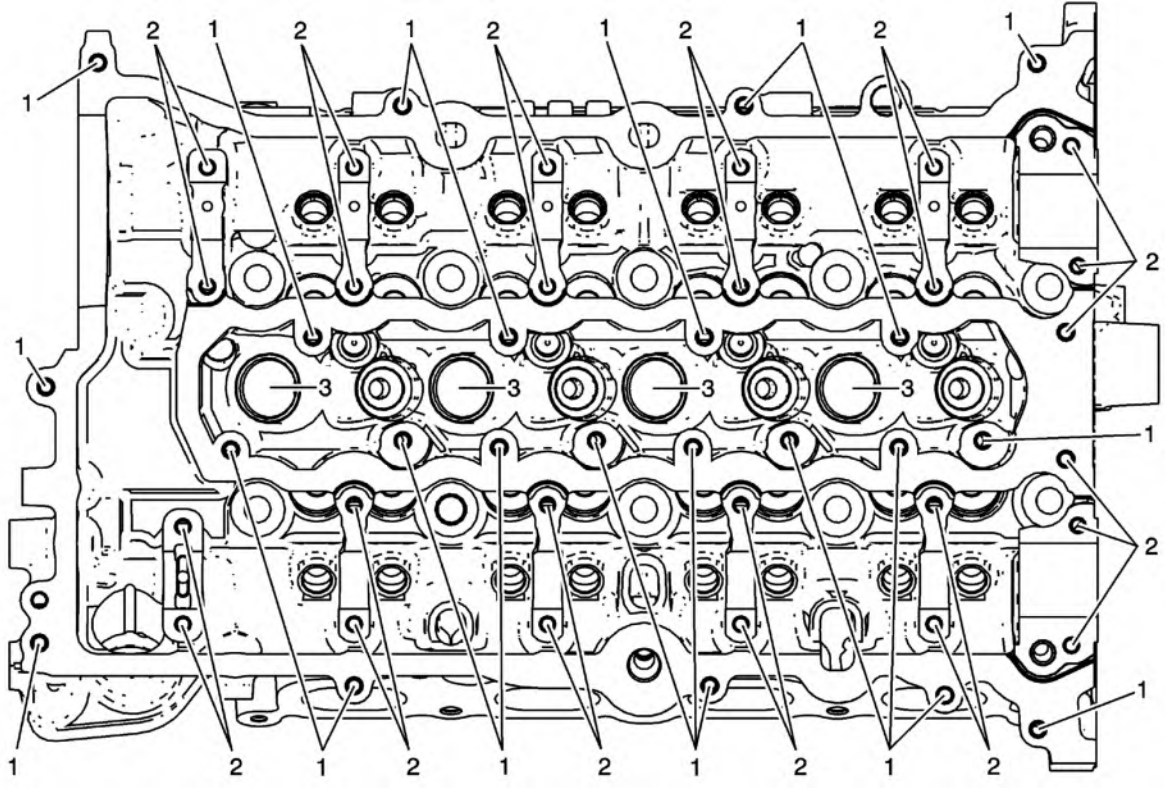


Fig. 11: Cylinder Head -- Top View
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head - View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-400							MM	(IN)	MM	(IN)
1	M6x1.0	205	201	202	203	204	22.0	0.865	22.0	0.865
2	M6x1.0	63	201	852 core drill as c bore	203	204	22.0	0.865	22.0	0.865
3	Not Serviceable									

Cylinder Head - Intake Manifold Deck View

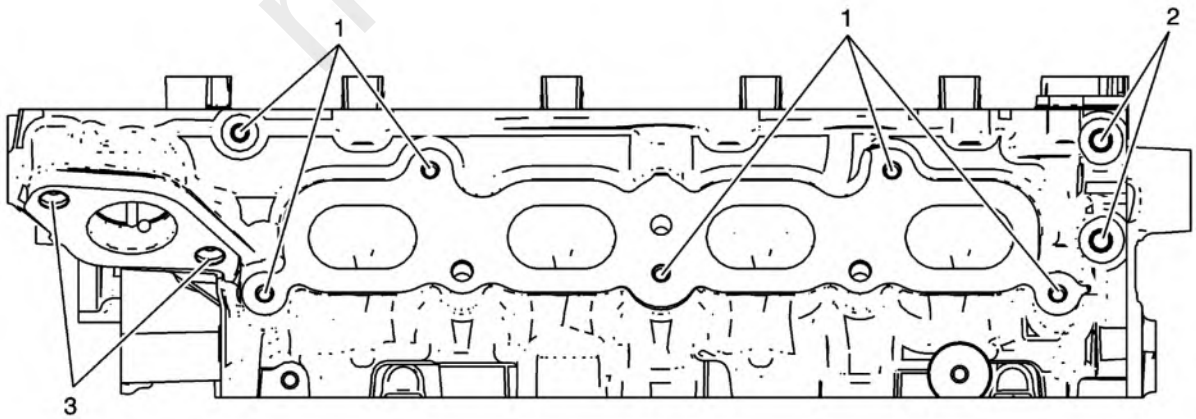


Fig. 12: Cylinder Head -- Intake Manifold Deck View
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head - Intake Manifold Deck View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-400							MM	(IN)	MM	(IN)

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
1	M6x1.0	63	201	202	203	204	22.0	0.865	22.0	0.865
2	M8x1.25	61	206	207	208	209	29.0	1.142	29.0	1.142
3	M8x1.25	210	206	207	208	209	29.0	1.142	29.0	1.142

Cylinder Head - Exhaust Side View

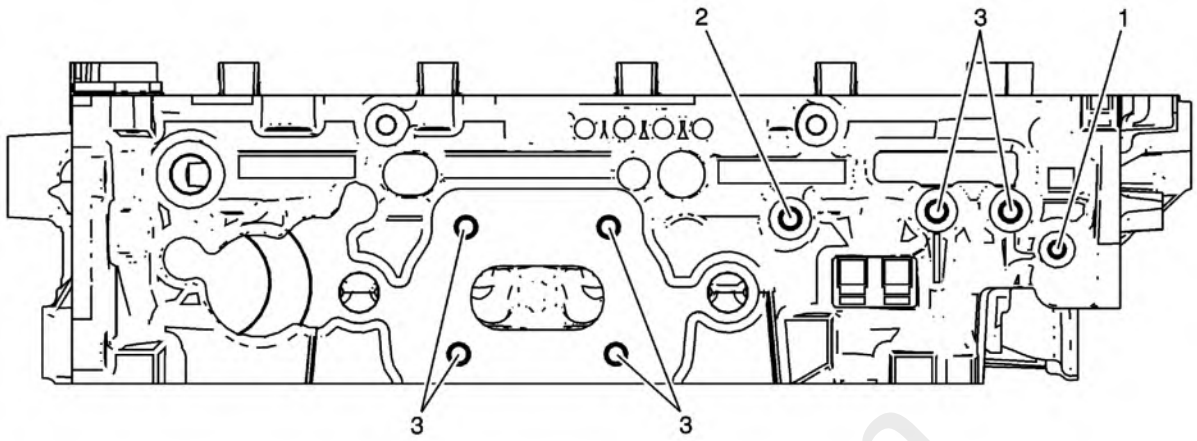


Fig. 13: Cylinder Head -- Exhaust Side View
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head - Exhaust Side View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-400							MM	(IN)	MM	(IN)
1	M6x1.0	63	201	202	203	204	22.0	0.865	22.0	0.865
2	M8x1.25	906	206	207	208	209	29.0	1.142	29.0	1.142
3	M8x1.25	61	206	207	208	209	29.0	1.142	29.0	1.142

Cylinder Head - Front View

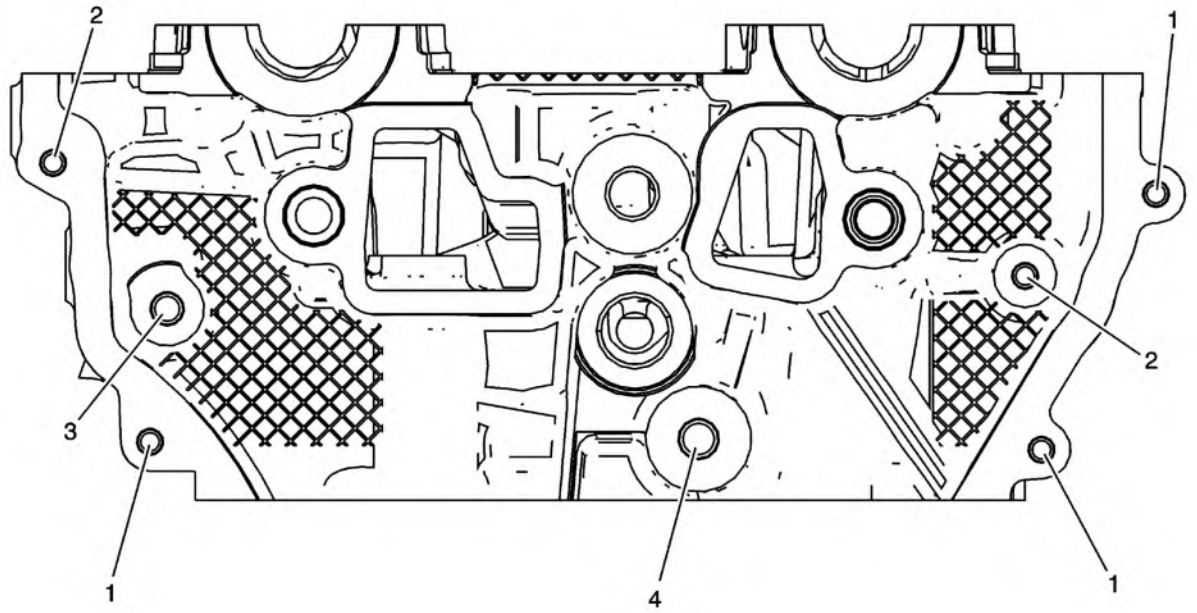


Fig. 14: Cylinder Head -- Front View
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head - Front View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-400							MM	(IN)	MM	(IN)
1	M6x1.0	205	201	202	203	204	19.0	0.747	19.0	0.747
2	M6x1.0	63	201	202	203	204	22.0	0.865	22.0	0.865
3	M8x1.25	61	206	207	208	209	29.0	1.142	29.0	1.142
4	M10x1.5	420	211	212	213	214	32.0	1.260	32.0	1.260

Cylinder Head - Back View

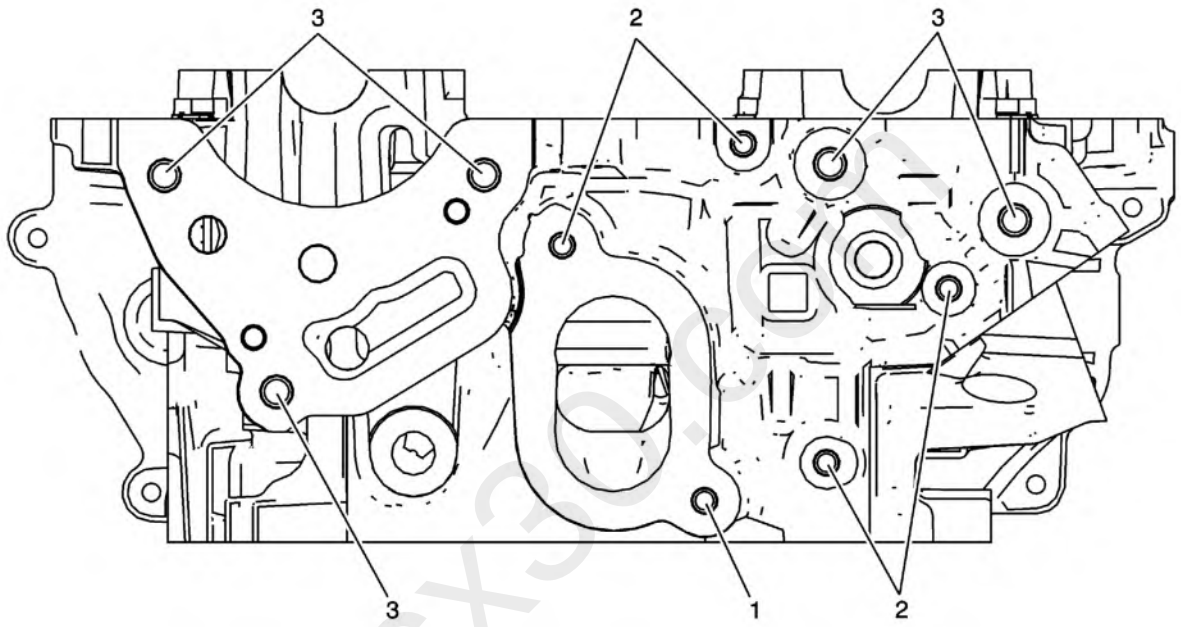


Fig. 15: Cylinder Head -- Back View
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head - Back View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385-400							MM	(IN)	MM	(IN)
1	M6x1.0	205	201	202	203	204	19.0	0.747	19.0	0.747
2	M6x1.0	63	201	202	203	204	22.0	0.865	22.0	0.865
3	M8x1.25	61	206	207	208	209	29.0	1.142	29.0	1.142

SCHEMATIC WIRING DIAGRAMS

ENGINE MECHANICAL WIRING SCHEMATICS (1.5L (LYX))

Oil Pressure Control (LYX)

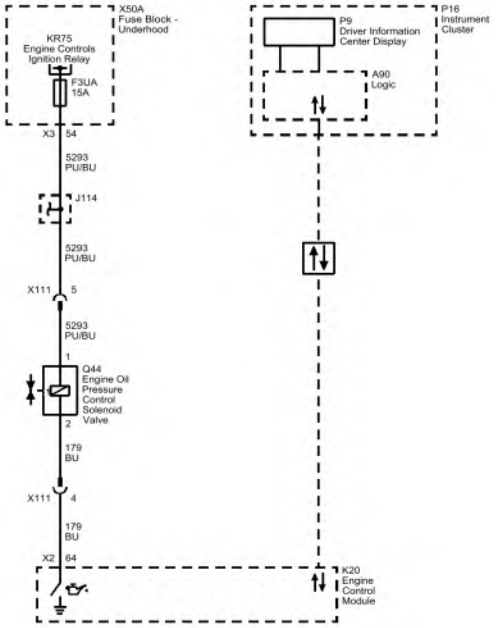


Fig. 16: Oil Pressure Control (LYX)
Courtesy of GENERAL MOTORS COMPANY

COMPONENT LOCATOR

DISASSEMBLED VIEWS

Camshaft Cover and Components

mcx30.com

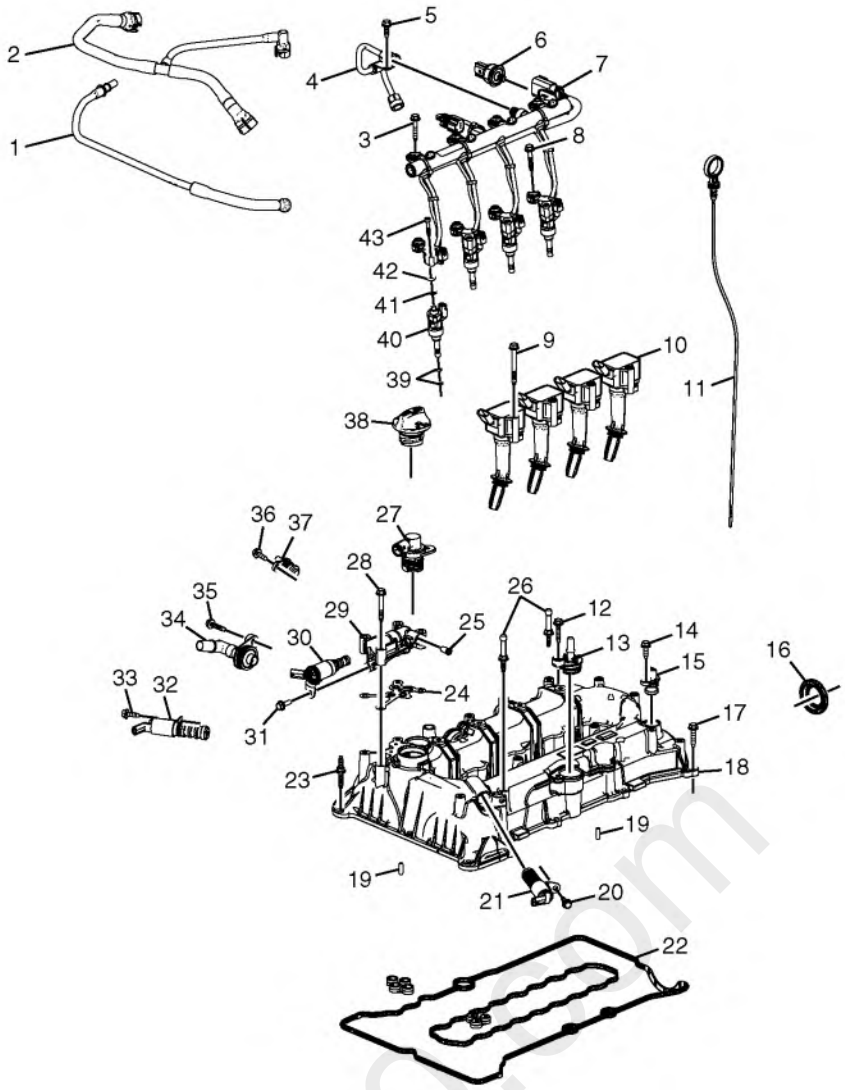


Fig. 17: View Of Camshaft Cover and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Positive Crankcase Ventilation Tube
2	Positive Crankcase Ventilation Tube
3	Fuel Injection Fuel Rail Bolt- Upper[4x]
4	Fuel Feed Intermediate Pipe
5	Fuel Feed Intermediate Pipe Bolt
6	Fuel Injection Fuel Rail Fuel Pressure Sensor
7	Fuel Injection Fuel Rail
8	Fuel Injection Fuel Rail Bolt- Lower[4x]
9	Ignition Coil Bolt[4x]
10	Ignition Coil[4x]
11	Oil Level Indicator
12	Positive Crankcase Ventilation Valve Bolt
13	Positive Crankcase Ventilation Valve
14	Camshaft Position Sensor Bolt
15	Camshaft Position Sensor
16	Vacuum Pump Seal
17	Camshaft Cover Bolt[18x]
18	Camshaft Cover
19	Camshaft Cover Locating Pin[2x]
20	Camshaft Position Actuator Solenoid Valve Bolt
21	Camshaft Position Actuator Solenoid Valve
22	Camshaft Cover Gasket

Callout	Component Name
23	Camshaft Cover Stud[2x]
24	Camshaft Housing Gasket
25	Camshaft Cover Opening Plug
26	Camshaft Housing Cover Stud[2x]
27	Positive Crankcase Ventilation Valve
28	Camshaft Housing Bolt[4x]
29	Camshaft Housing
30	Camshaft Position Actuator Locating Pin Control Valve
31	Camshaft Position Actuator Solenoid Valve Bolt
32	Camshaft Position Actuator Solenoid Valve
33	Camshaft Position Actuator Solenoid Valve Bolt
34	Positive Crankcase Ventilation Valve
35	Positive Crankcase Ventilation Valve Bolt
36	Camshaft Position Sensor Bolt
37	Camshaft Position Sensor
38	Oil Filler Cap
39	Combustion Fuel Injector Seal[8x]
40	Direct Fuel Injector[4x]
41	Fuel Injector Seal Retainer
42	Fuel Injector Seal Ring
43	Fuel Injector Bolt[8x]

Cylinder Head and Components

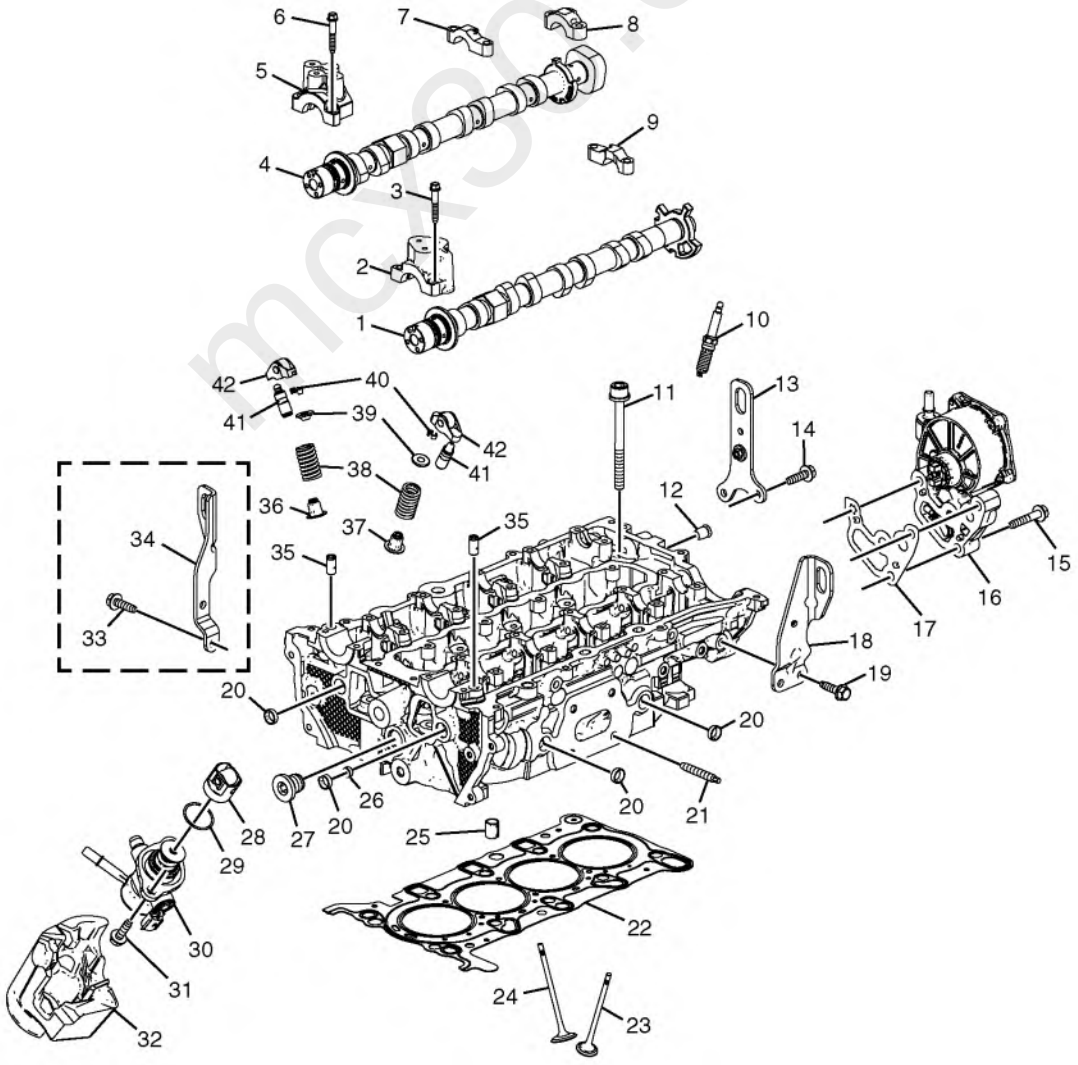


Fig. 18: View Of Cylinder Head and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Exhaust Camshaft
2	Camshaft Bearing Front Exhaust Cap
3	Camshaft Bearing Cap Bolt[12x]
4	Intake Camshaft
5	Camshaft Bearing Front Intake Cap
6	Camshaft Bearing Cap Bolt[12x]
7	Camshaft Bearing Cap[4x]
8	Camshaft Bearing Rear Cap
9	Camshaft Bearing Cap[5x]
10	Spark Plug[4x]
11	Cylinder Head Bolt[10x]
12	Cylinder Head Core Hole Plug[5x]
13	Engine Lift Rear Bracket
14	Engine Lift Rear Bracket Bolt[2x]
15	Vacuum Pump Bolt[3x]
16	Vacuum Pump
17	Vacuum Pump Gasket
18	Engine Lift Rear Bracket
19	Engine Lift Rear Bracket Bolt[2x]
20	Cylinder Head Core Hole Plug[4x]
21	Turbocharger Stud[4x]
22	Cylinder Head Gasket
23	Exhaust Valve[8x]
24	Intake Valve[8x]
25	Cylinder Head Locating Pin[2x]
26	Cylinder Head Oil Gallery Restrictor
27	Cylinder Head Core Hole Plug
28	Valve Lifter Follower
29	Fuel Pump Housing Seal
30	Fuel Pump
31	Fuel Pump Bolt[2x]
32	Fuel Pump Insulator
33	Engine Lift Front Bracket Bolt[2x]-Model Dependent
34	Engine Lift Front Bracket - Model Dependent
35	Engine Oil Manifold Check Valve[2x]
36	Valve Stem Oil Seal[8x]
37	Valve Stem Oil Seal[8x]
38	Valve Spring[16x]
39	Valve Spring Retainer[16x]
40	Valve Stem Key[32x]
41	Hydraulic Valve Lash Adjuster[16x]
42	Hydraulic Valve Lash Adjuster Arm[16x]

Drive Belt Accessory Components

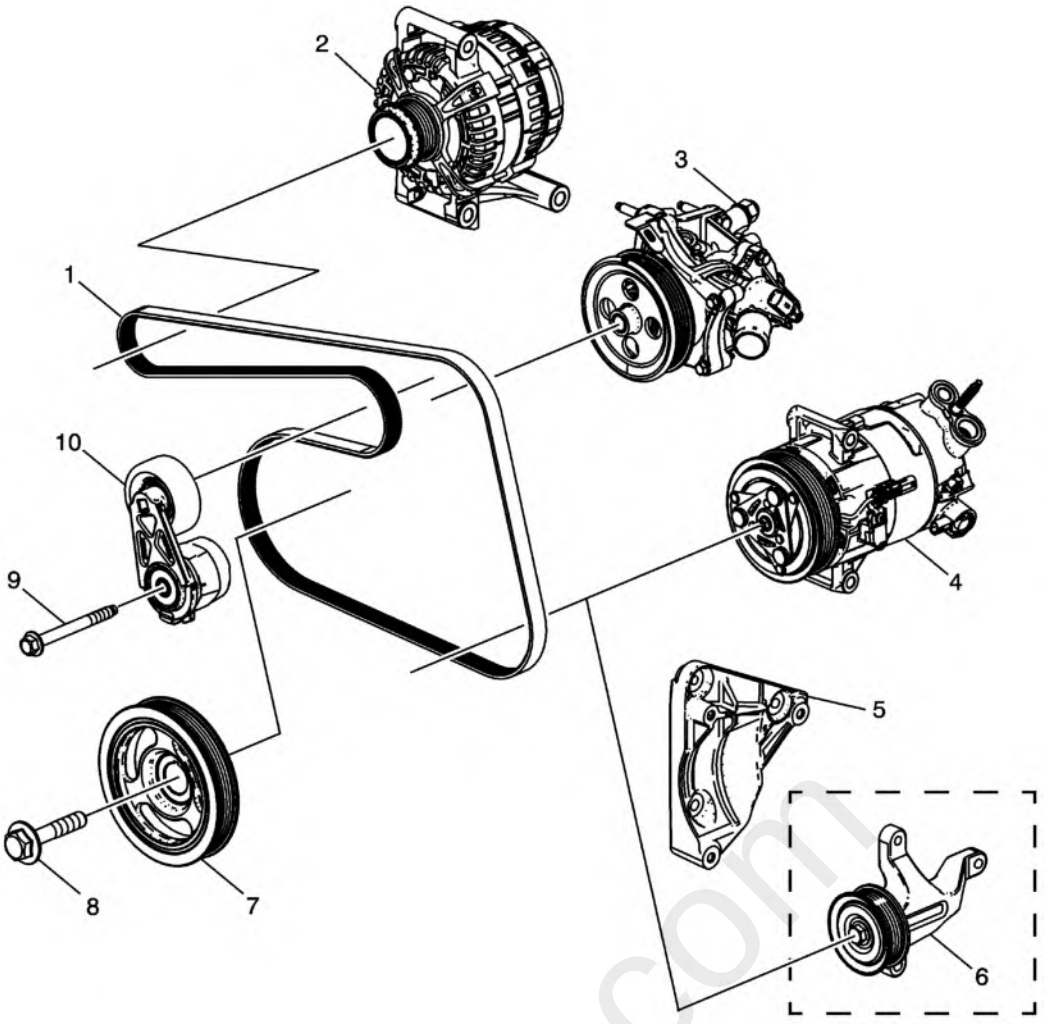


Fig. 19: View Of Drive Belt Accessory Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Drive Belt
2	Generator
3	Water Pump
4	A/C Compressor
5	A/C Compressor Bracket
6	Belt Idler Bracket Assembly, Some Models
7	Crankshaft Balancer
8	Crankshaft Balancer Bolt
9	Drive Belt Tensioner Bolt
10	Drive Belt Tensioner

Engine Block and Components

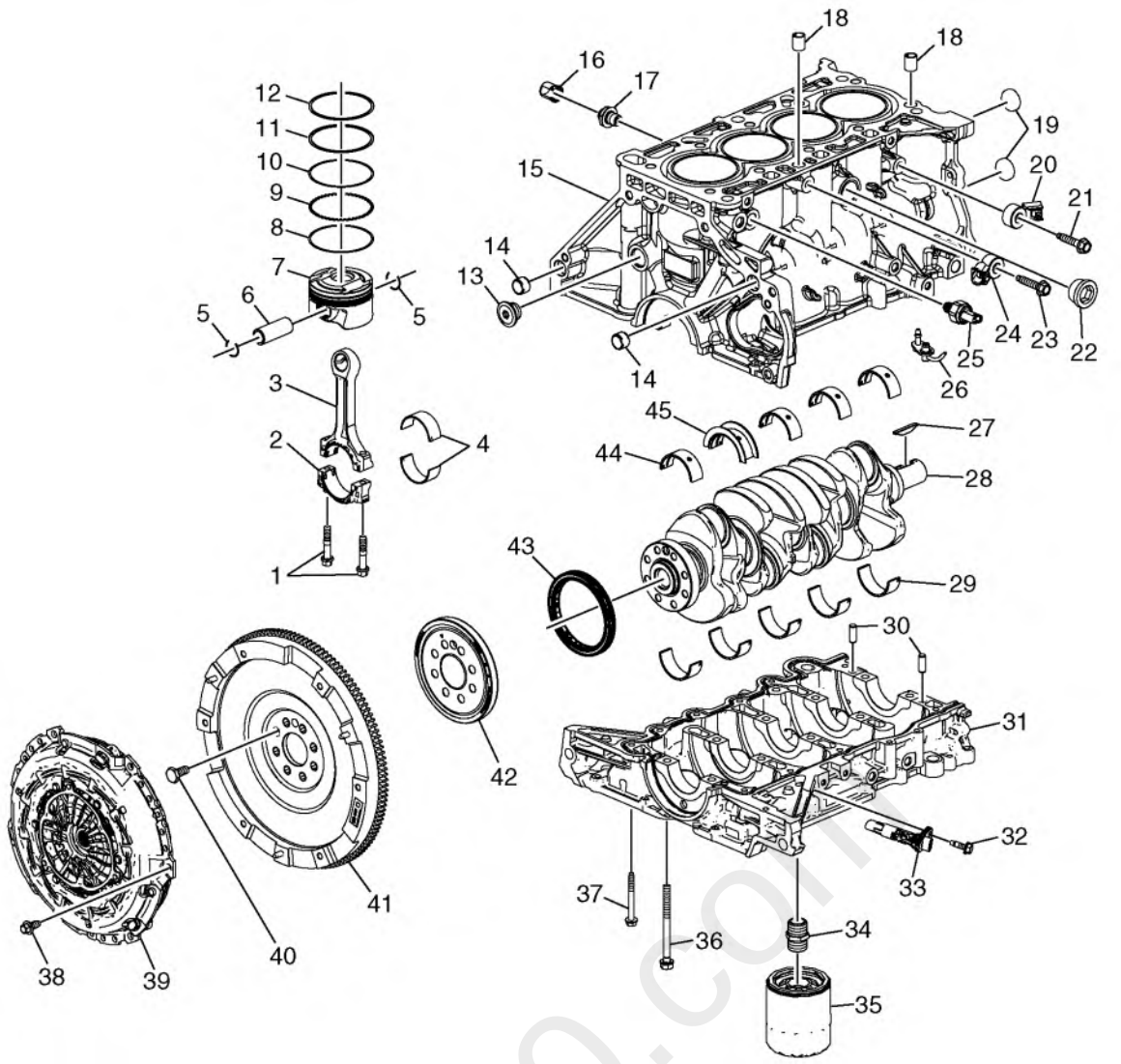
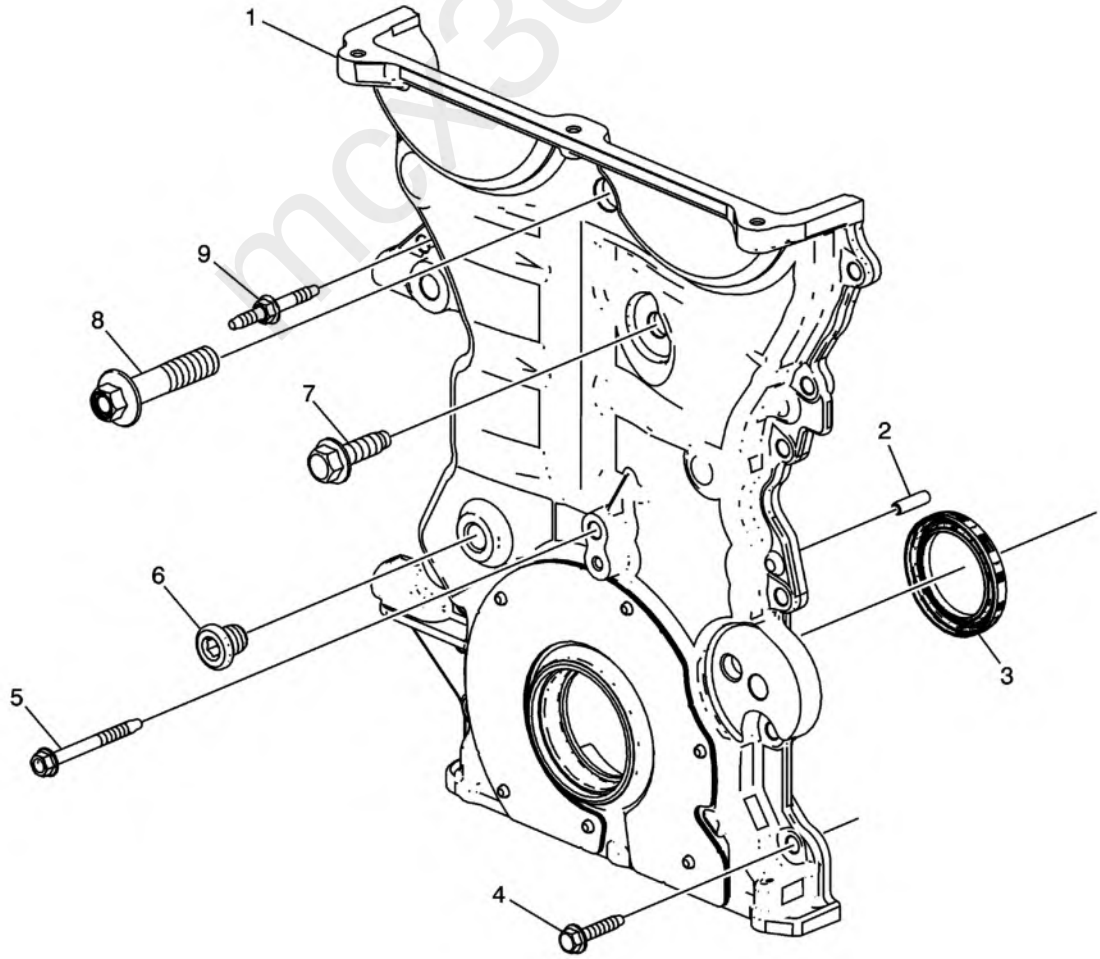


Fig. 20: Engine Block and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Connecting Rod Bolt[8x]
2	Connecting Rod Cap[4x]
3	Connecting Rod[4x]
4	Connecting Rod Bearing[4x]
5	Piston Pin Retainer [8x]
6	Piston Pin[4x]
7	Piston[4x]
8	Piston Oil Ring Rail[4x]
9	Piston Oil Ring Rail Spacer[4x]
10	Piston Oil Ring Rail[4x]
11	Piston Compression Lower Ring[4x]
12	Piston Compression Upper Ring [4x]
13	Engine Block Oil Gallery Plug
14	Transmission Locating Pin[2x]
15	Engine Block
16	Turbocharger Oil Feed Pipe Clip
17	Turbocharger Pipe Fitting
18	Cylinder Head Locating Pin[2x]
19	Engine Block Core Hole Plug[2x]
20	Knock Sensor
21	Knock Sensor Bolt
22	Engine Coolant Heater Hole Plug

Callout	Component Name
23	Knock Sensor Bolt
24	Knock Sensor
25	Engine Oil Pressure Sensor
26	Piston Oil Nozzle[4x]
27	Crankshaft Balancer Key
28	Crankshaft
29	Crankshaft Lower Bearing[5x]
30	Lower Crankcase Locating Pin[4x]
31	Lower Crankcase
32	Crankshaft Position Sensor Bolt
33	Crankshaft Position Sensor
34	Oil Filter Fitting
35	Oil Filter
36	Lower Crankcase Bolt[10x]
37	Lower Crankcase Bolt[13x]
38	Clutch Pressure Plate Bolt[6x]
39	Clutch Pressure Plate
40	Engine Flywheel Bolt[8x]
41	Engine Flywheel
42	Crankshaft Position Sensor Reluctor Ring
43	Crankshaft Rear Oil Seal
44	Crankshaft Upper Bearing[4x]
45	Crankshaft Thrust Upper Bearing

Engine Front Cover and Components



mg30.com

Fig. 21: Engine Front Cover and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Front Cover
2	Engine Front Cover Locating Pin
3	Crankshaft Front Oil Seal
4	Engine Front Cover Bolt - M6 (Qty: 11)
5	Engine Front Cover Bolt - M6 (Qty: 1)
6	Engine Front Cover Hole Plug
7	Engine Front Cover Bolt - M14 (Qty: 1)
8	Engine Front Cover Bolt - M14 (Qty: 1)
9	Engine Front Cover Stud (Qty: 1)

Turbocharger and Components

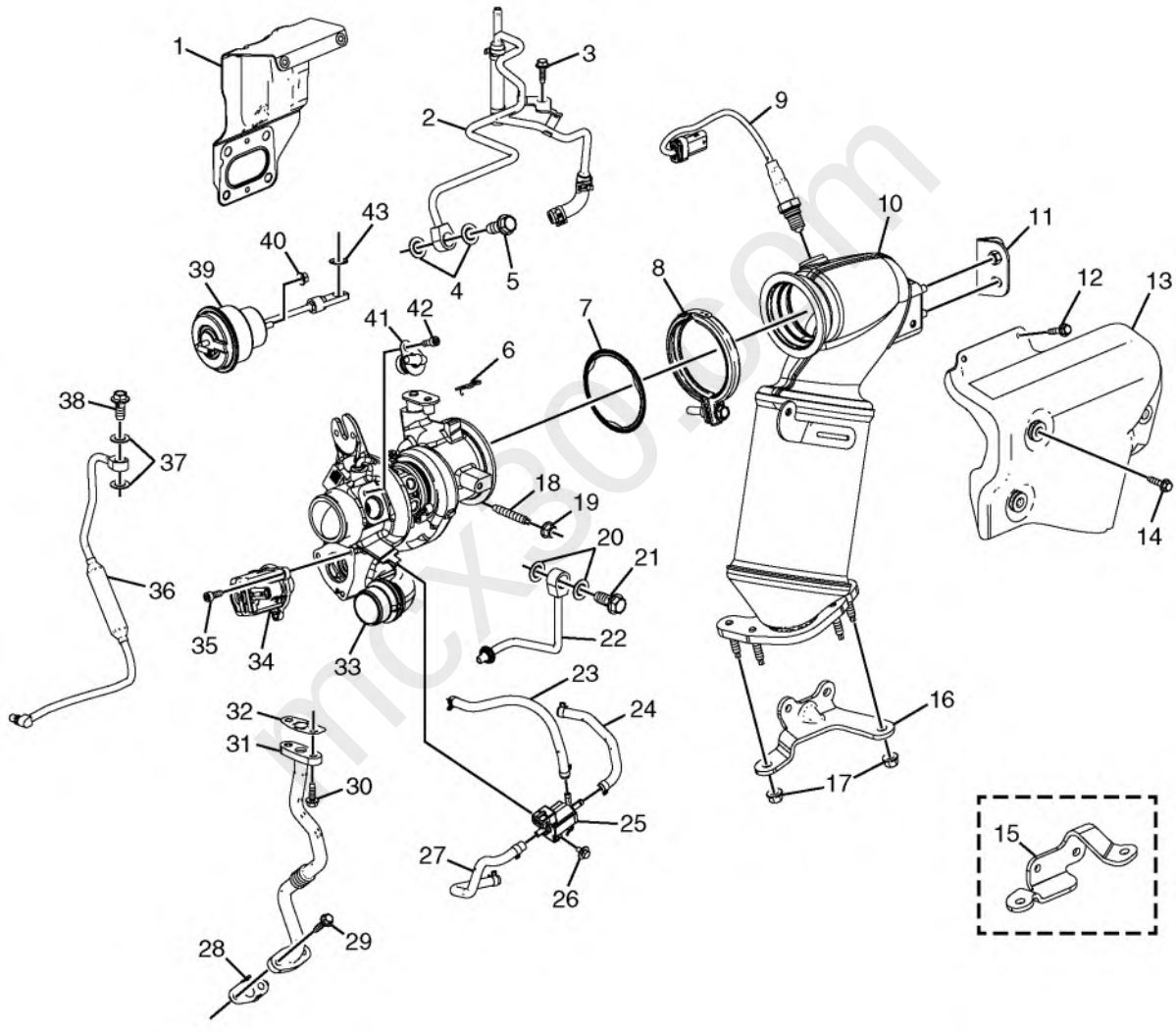


Fig. 22: Turbocharger and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Turbocharger Heat Shield
2	Turbocharger Coolant Return Pipe
3	Turbocharger Coolant Return Pipe Bracket Bolt
4	Turbocharger Coolant Return Pipe Seal[2x]
5	Turbocharger Coolant Return Pipe Bolt
6	Turbocharger Wastegate Actuator Arm Retainer
7	Catalytic Converter Gasket

Callout	Component Name
8	Exhaust Pipe Clamp
9	Oxygen Sensor
10	Catalytic Converter
11	Catalytic Converter Bracket
12	Catalytic Converter Heat Shield Bolt
13	Catalytic Converter Heat Shield
14	Catalytic Converter Heat Shield Bolt
15	Catalytic Converter Bracket - Model Dependent
16	Catalytic Converter Bracket
17	Catalytic Converter Bracket Nut[2x]
18	Turbocharger Stud[4x]
19	Turbocharger Nut[4x]
20	Turbocharger Coolant Feed Pipe Seal [2x]
21	Turbocharger Coolant Feed Pipe Bolt
22	Turbocharger Coolant Feed Pipe
23	Turbocharger Wastegate Regulator Solenoid Valve Hose
24	Turbocharger Wastegate Regulator Solenoid Valve Hose
25	Turbocharger Wastegate Regulator Solenoid Valve
26	Turbocharger Wastegate Regulator Solenoid Valve Bolt
27	Turbocharger Wastegate Regulator Solenoid Valve Hose
28	Turbocharger Oil Return Pipe Gasket
29	Turbocharger Oil Return Pipe Bolt[2x]
30	Turbocharger Oil Return Pipe Bolt[2x]
31	Turbocharger Oil Return Pipe
32	Turbocharger Oil Return Pipe Gasket
33	Turbocharger
34	Turbocharger Bypass Valve Solenoid
35	Charge Air Bypass Valve Bolt[3x]
36	Turbocharger Oil Feed Pipe
37	Turbocharger Oil Feed Pipe Washer[2x]
38	Turbocharger Oil Feed Pipe Bolt
39	Turbocharger Wastegate Actuator
40	Turbocharger Wastegate Actuator Nut[2x]
41	Positive Crankcase Ventilation Hose Fitting
42	Positive Crankcase Ventilation Hose Fitting Bolt
43	Turbocharger Wastegate Actuator Rod Spring

Water Pump and Components

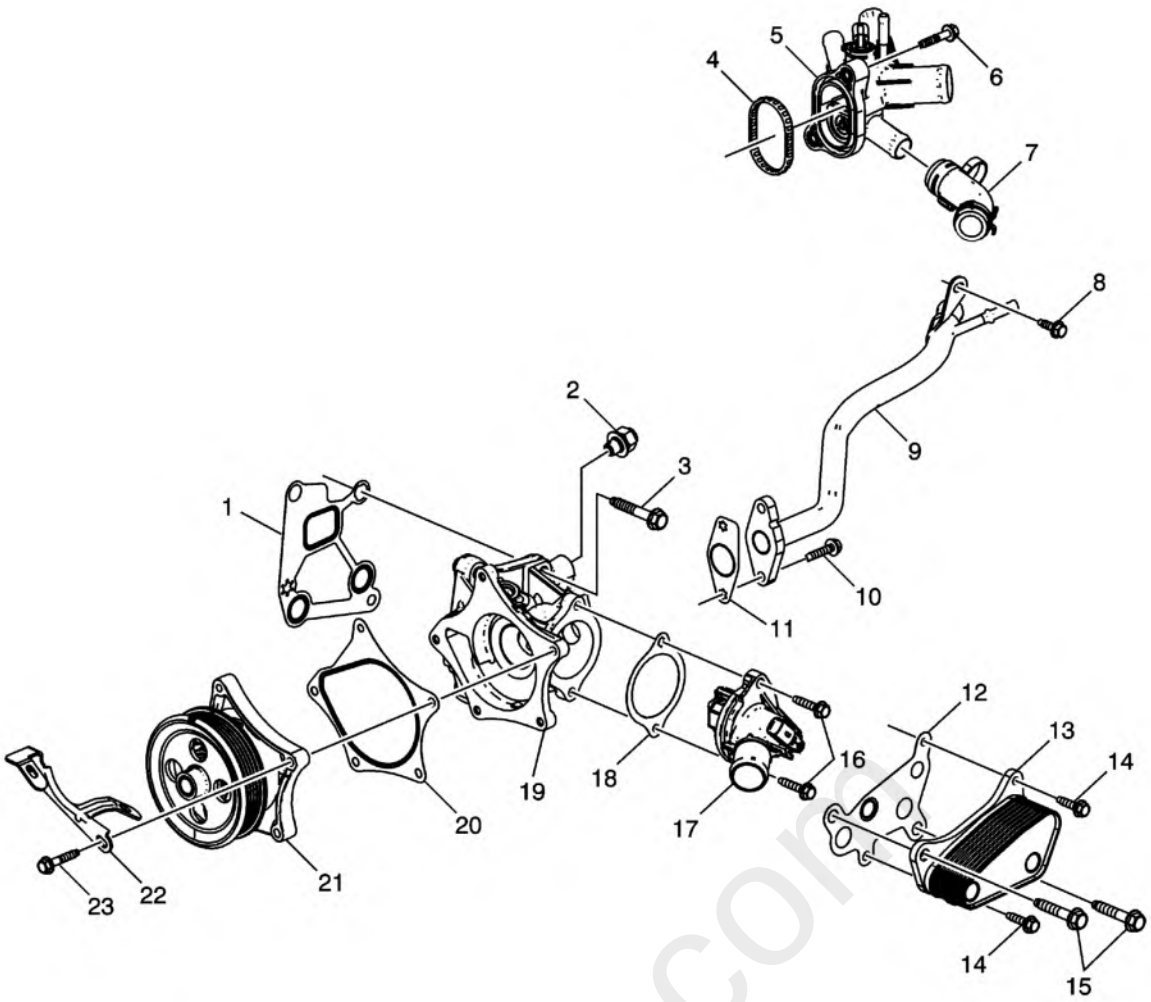


Fig. 23: Water Pump and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Water Pump Housing Gasket
2	Turbocharger Oil Feed Pipe Fitting
3	Water Pump Rear Housing Bolt (Qty: 2)
4	Water Outlet Gasket
5	Water Outlet Assembly
6	Water Outlet Assembly Bolt (Qty: 2)
7	Thermal Bypass Hose
8	Thermal Bypass Pipe Assembly Bolt (Qty: 1)
9	Thermal Bypass Pipe Assembly
10	Thermal Bypass Pipe Assembly Bolt (Qty: 2)
11	Thermal Bypass Pipe Gasket
12	Engine Oil Cooler Gasket
13	Engine Oil Cooler Assembly
14	Engine Oil Cooler Assembly Bolt (Qty: 2)
15	Engine Oil Cooler Assembly Bolt (Qty: 2)
16	Engine Coolant Thermostat Housing Bolt
17	Engine Coolant Thermostat Housing Assembly
18	Engine Coolant Thermostat Housing Gasket
19	Water Pump Rear Housing
20	Water Pump Gasket
21	Water Pump Housing Assembly
22	ECM Engine Wiring Harness Bracket
23	Water Pump Housing Assembly Bolt (Qty: 5)

Intake Manifold and Components

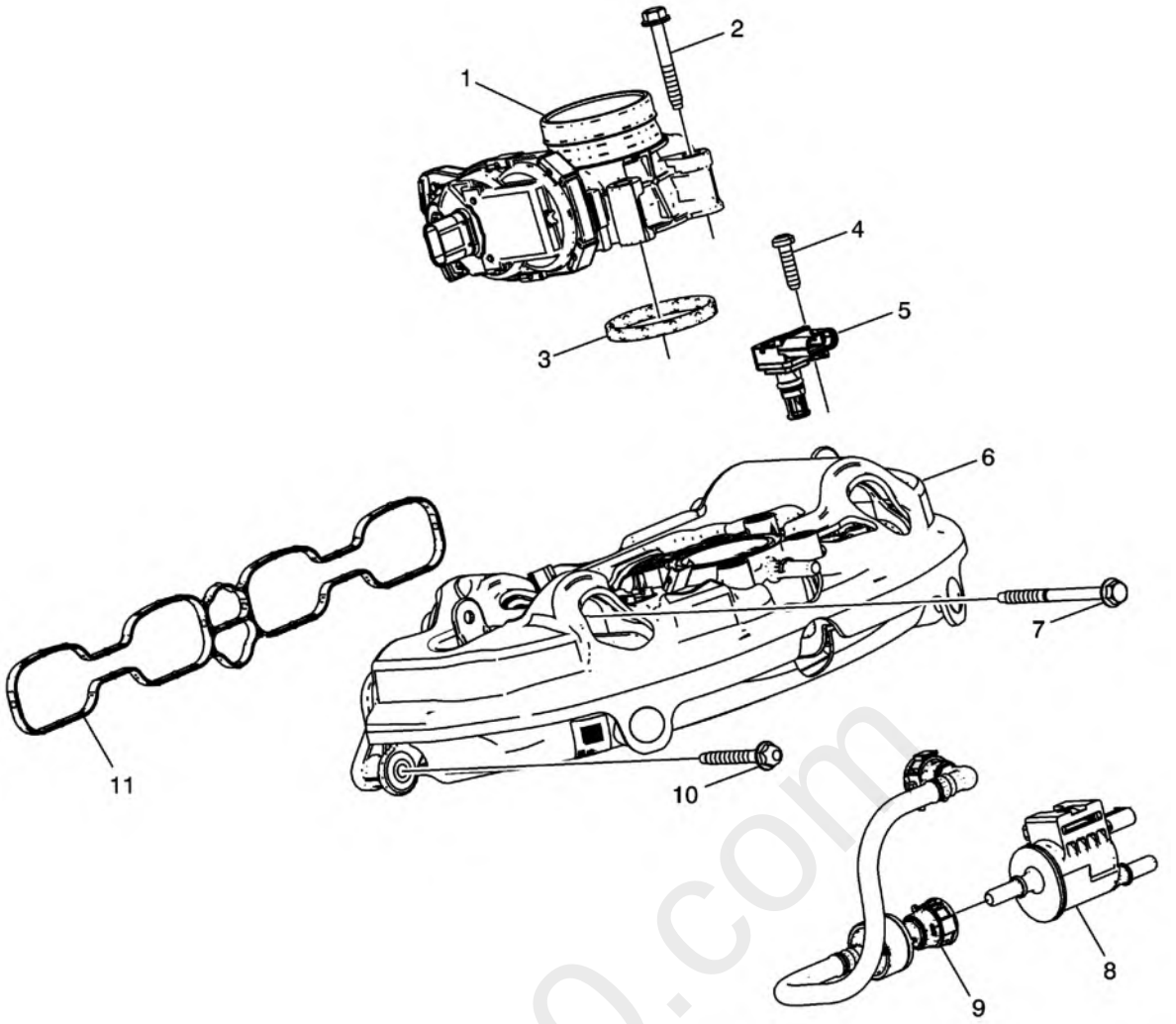


Fig. 24: Intake Manifold and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Throttle Body Assembly
2	Throttle Body Assembly Bolt (Qty: 4)
3	Throttle Body Gasket
4	Intake Air Pressure and Temperature Sensor Bolt
5	Intake Air Pressure and Temperature Sensor
6	Intake Manifold Assembly
7	Intake Manifold Assembly Bolt (Qty: 3)
8	Evaporative Emission Canister Purge Valve
9	Evaporative Emission Canister Purge Tube Assembly
10	Intake Manifold Assembly Bolt (Qty: 2)
11	Intake Manifold Gasket

Oil Pan and Components - FWD

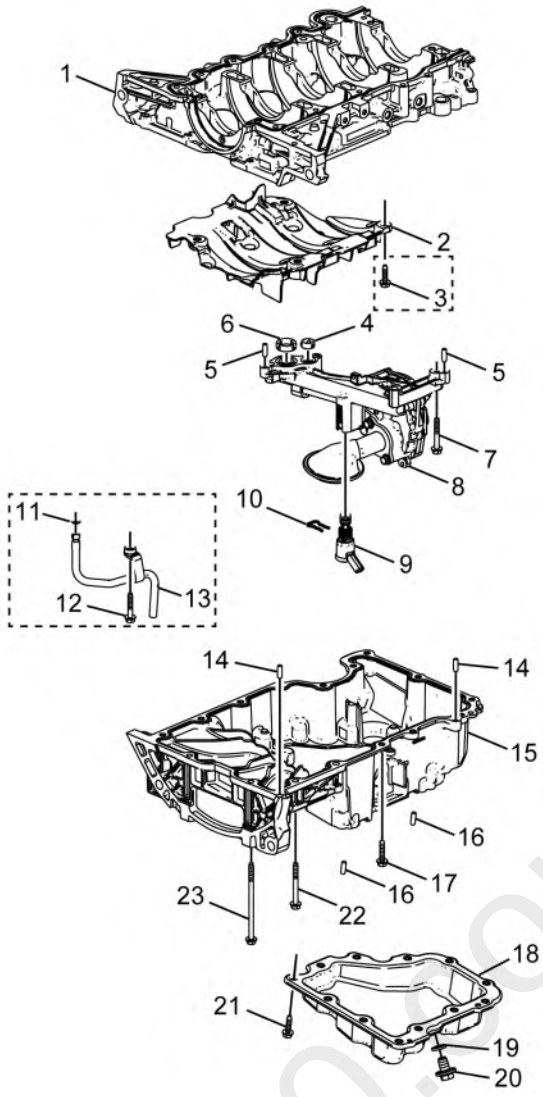


Fig. 25: Oil Pan and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Lower Crankcase
2	Crankshaft Oil Deflector
3	Crankshaft Oil Deflector Bolt [3x]
4	Oil Pump Gasket
5	Oil Pump Locating Pin
6	Oil Pump Gasket
7	Oil Pump Bolt [4x]
8	Oil Pump
9	Oil Pump Flow Control Solenoid Valve
10	Oil Pump Flow Control Solenoid Valve Retainer
11	Positive Crankcase Ventilation Oil Separator Seal
12	Positive Crankcase Ventilation Oil Separator Drain Pipe Bolt
13	Positive Crankcase Ventilation Oil Separator Drain Pipe
14	Oil Pan Locating Pin [2x]
15	Upper Oil Pan
16	Oil Pan Locating Pin [2x]
17	Oil Pan Bolt [12x]
18	Lower Oil Pan
19	Oil Pan Drain Plug Seal
20	Oil Pan Drain Plug
21	Lower Oil Pan Bolt [12x]
22	Oil Pan Bolt [2x]

Callout	Component Name
23	Oil Pan Bolt [2x]

Timing Chain and Components

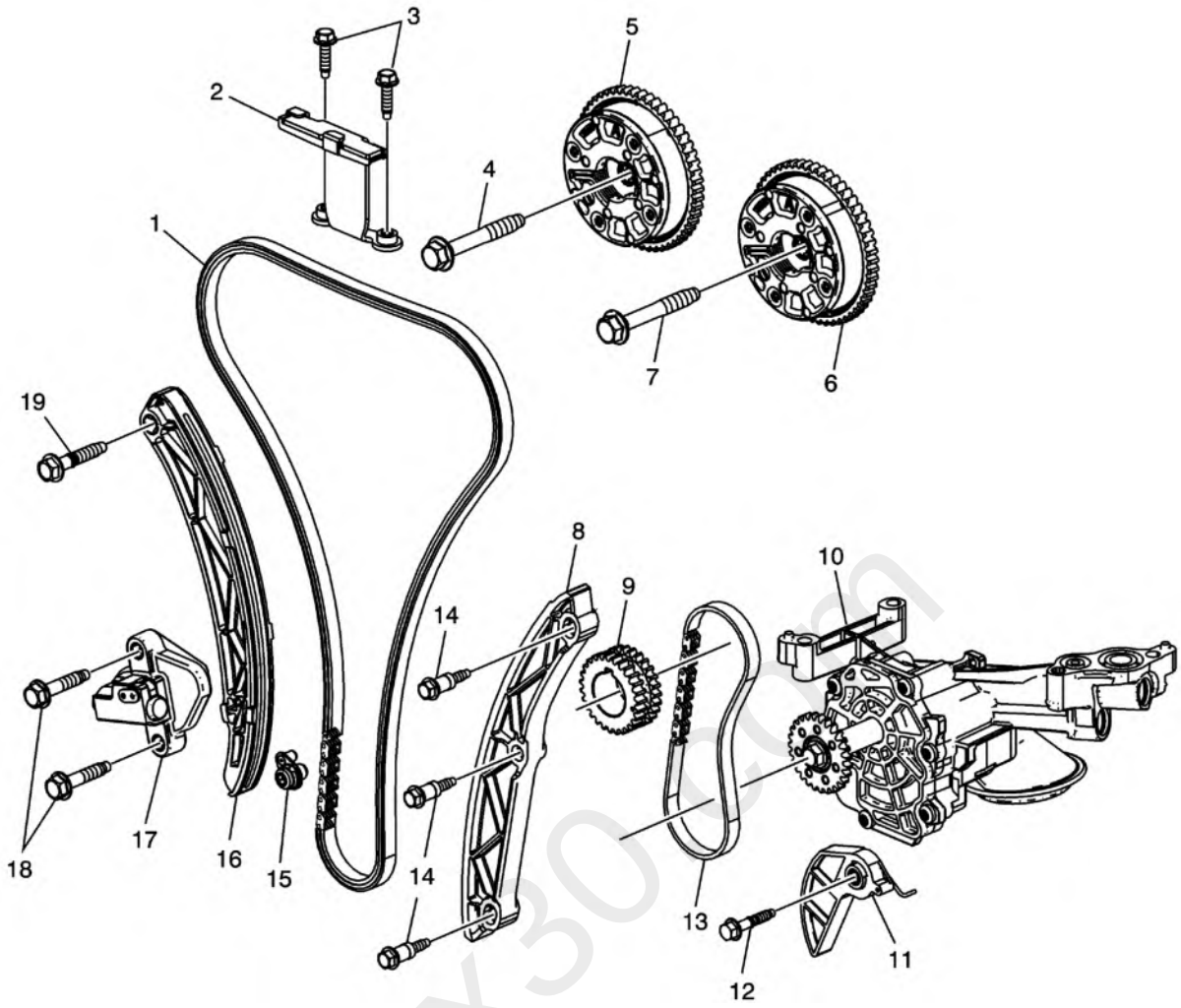


Fig. 26: Timing Chain and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Timing Chain
2	Timing Chain Guide - to Cylinder Head
3	Timing Chain Guide Bolt
4	Camshaft Position Actuator Bolt
5	Camshaft Position Actuator Assembly - Intake
6	Camshaft Position Actuator Assembly - Exhaust
7	Camshaft Position Actuator Bolt
8	Timing Chain Guide - Exhaust Side
9	Crankshaft Sprocket
10	Oil Pump Assembly
11	Oil Pump Drive Chain Tensioner Assembly
12	Oil Pump Drive Chain Tensioner Bolt
13	Oil Pump Drive Chain
14	Timing Chain Guide Bolt (Qty: 3)
15	Timing Chain Oil Nozzle
16	Timing Chain Tensioner Shoe Assembly
17	Timing Chain Tensioner Assembly
18	Timing Chain Tensioner Bolt
19	Timing Chain Tensioner Shoe Bolt

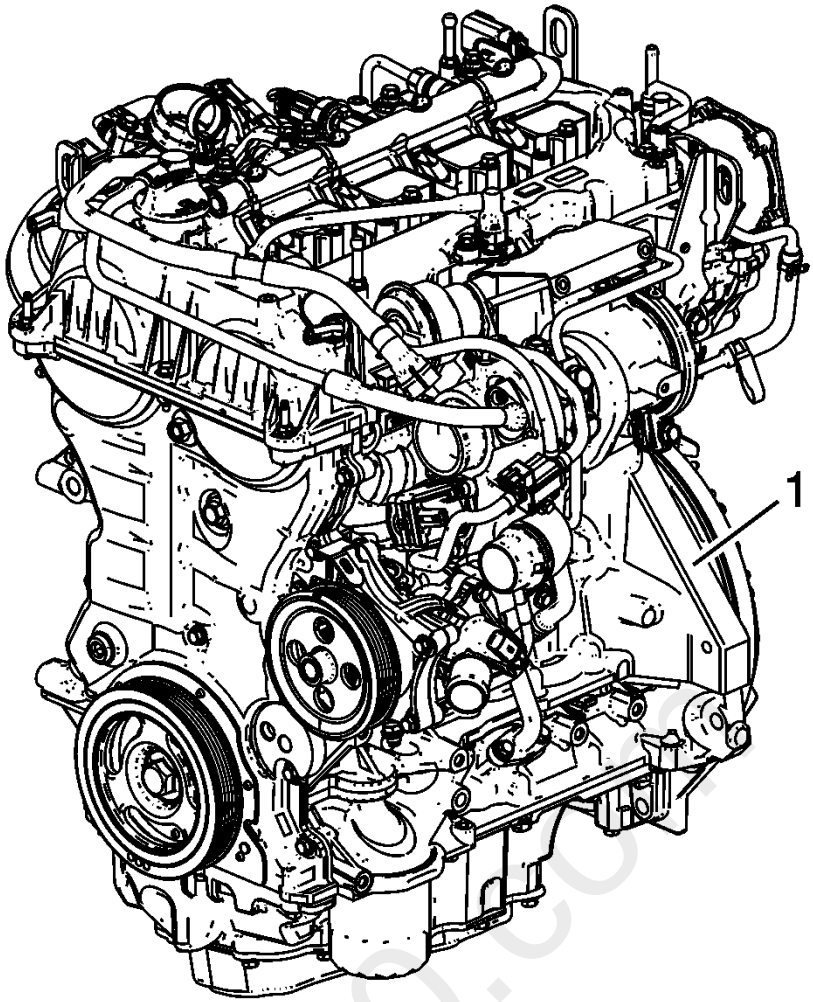


Fig. 27: Engine Identification Code
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The engine identification number must be stamped to the cylinder block in case of engine replacement.**

The engine identification code (1) is stamped on the flattened area of the cylinder block, at the transmission side.

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P06DA-P06DE: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: Diagnostic System Check - Vehicle
- Review the description of Strategy Based Diagnosis: Strategy Based Diagnosis
- An overview of each diagnostic category can be found here: Diagnostic Procedure Instructions

DTC Descriptor

DTC P06DA

Engine Oil Pressure Control Solenoid Valve Control Circuit

DTC P06DA

Engine Oil Pressure Control Solenoid Valve Control Circuit Low Voltage

DTC P06DC

Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage

DTC P06DD

Engine Oil Pressure Control Solenoid Valve Stuck Off

DTC P06DE

Engine Oil Pressure Control Solenoid Valve Stuck On

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P06DA, P06DB*	P06DA, P06DB	-	-
Control	P06DB	P06DA	P06DC	P06DD, P06DE
* Additional DTCs may set.				

Circuit/System Description

Circuit	Description
Ignition	Supplied from a fuse.
Control	The output circuit is switched to ground to activate the component.

Component	Description
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.
Q44 Engine Oil Pressure Control Solenoid Valve	A solenoid valve is an electro-mechanically operated valve. The valve is controlled by an electric current through the solenoid.

The engine oil pressure control solenoid valve is used to control engine oil pressure inside the mechanical engine oil pump.The control module controls the commanded state of the solenoid valve based on the following inputs:

- Engine Speed
- Calculated Engine Oil Temperature
- Engine Oil Pressure
- Engine Run Time

When the solenoid valve is commanded Off, oil pressure is higher.When the solenoid valve is commanded On, oil pressure is lower.

Conditions for Running the DTC

DTC P06DA, P06DB, P06DC

- Ignition Voltage = Greater than 11 V
- Engine=Running

DTCs run continuously when the above conditions are met.

DTC P06DD

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0335, P0336, P0521, P0522, P0523, P06DA, P06DB, P06DC, P06DD, P06DE, P111E, P2227, P2228, P2229, P2230 = Not set
- Engine Speed = 1, 500 to 2, 500 RPM

DTCs run continuously when the above conditions are met.

DTC P06DE

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0335, P0336, P0521, P0522, P0523, P06DA, P06DB, P06DC, P06DD, P06DE, P111E, P2227, P2228, P2229, P2230 = Not set
- Engine = Running - For greater than 1.5s
- Engine Speed = 1, 500 to 2, 500 RPM
- Engine Oil Pressure Control Solenoid Valve = On - For greater than 1.5s

DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

DTC P06DA, P06DB, P06DC

Control Circuit = Commanded state does not match the actual state - For 1 s

DTC P06DD

Engine Oil Pressure = Less than a predefined threshold

DTC P06DE

Engine Oil Pressure = Greater than a predefined threshold

Actions Taken When the DTC Sets

- DTCs P06DB, P06DE are Type A DTCs.
- DTCs P06DA, P06DC, P06DD are Type B DTCs.
- Engine Oil Pressure Control Solenoid Valve = Off
- Reduced Engine Power = Active

Conditions for Clearing the DTC

- DTCs P06DA, P06DC, P06DD are Type B DTCs.
- DTCs P06DB, P06DE are Type A DTCs.

Reference Information

Schematic Reference

Engine Mechanical Schematics (1.5L (LYX))

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

mcx30.com

- 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

Circuit/System Verification

NOTE: **The engine oil level and condition is critical to the correct operation of the system.**

1. Ignition - On / Vehicle - In Service Mode
2. Verify there are no DTCs set related to the following system/component:
   - B35B Engine Oil Level Sensor
   - B37B Engine Oil Pressure Sensor
   - B37 Engine Oil Pressure Switch
   - **If other DTCs are set**

     Refer to:Diagnostic Trouble Code (DTC) List - Vehicle

   - **Go to next step: If no other DTCs are set**
3. Verify the condition does not exist:
   - Low Engine Oil Level
   - Dirty or contaminated oil
   - **If a condition exists**

     Repair as necessary

   - **Go to next step: If no condition exists**
4. Perform the scan tool control function:Engine Oil Pressure Control Solenoid Valve - Low Pressure - High Pressure

   Verify the scan tool parameter:

   - Engine Oil Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status = OK or Not Run
   - Engine Oil Pressure Control Solenoid Valve Control Circuit Open Test Status = OK or Not Run
   - Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status = OK or Not Run
   - **If not the specified state**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified state**
5. Engine running.
6. Perform the following steps:
   1. Increase the engine speed slowly to 1, 800 RPM.

      NOTE: **Using the scan tool line graph function may make it easier to identify if the value changes.**

mcx30.com

2. Perform the scan tool control function:Engine Oil Pressure Control Solenoid Valve - Low Pressure

   Verify the scan tool parameter: Engine Oil Pressure = Change is greater than 30 kPa (4 PSI)

   - If the change is 30 kPa (4 PSI) or less Â» Replace the component: Q44 Engine Oil Pressure Control Solenoid Valve
   - If the change is greater than 30 kPa (4 PSI)

7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to: Circuit/System Testing

   - **Go to next step: If the DTC is not set**

8. All OK.

Circuit/System Testing

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the appropriate electrical connector:Inline Harness Connector
3. Ignition - On / Vehicle - In Service Mode

NOTE: **Testing for steps 4 to 9 is performed on the control module K20 side of the inline harness connector.**

4. Verify a test lamp turns On between the test points: Ignition circuit terminal 5 & Ground
   - **If the test lamp does not turn On and the circuit fuse is OK**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Test for less than 2 Ω between the test points: Ignition circuit terminal 5 & Fuse
      - If 2 Ω or greater Â» Repair the open/high resistance in the circuit.
      - If less than 2 Ω Â» Verify the fuse is OK and there is voltage at the fuse.
   - **If the test lamp does not turn On and the circuit fuse is open**
   1. Ignition/Vehicle - Off & Remove - Test lamp

      NOTE: **The ignition circuit supplies voltage to other components. Test all circuits for a short to ground or test all components for being shorted.**

   2. Test for infinite resistance between the test points: Ignition circuit terminal 5 & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance Refer to: Step 10
   - **Go to next step: If the test lamp turns On**
5. Verify a test lamp does not turn On between the test points: Control circuit terminal 4 & B+
   - **If the test lamp turns On**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Disconnect the electrical connector: K20 Engine Control Module
   3. Test for infinite resistance between the test points: Inline Harness Connector Control circuit terminal 4 & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance - Replace the component: K20 Engine Control Module
   - **Go to next step: If the test lamp does not turn On**
6. Remove - Test Lamp

mbx30.com

7. Perform the scan tool control function: Engine Oil Pressure Control Solenoid Valve - Low Pressure

   Verify the scan tool parameter: Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status = OK or Not Run

   - **If not the specified state**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: K20 Engine Control Module
   3. Test for less than 2 Ω between the test points: Inline Harness Connector Control circuit terminal 4 & The other end of the circuit
      - If 2 Ω or greater Â» Repair the open/high resistance in the circuit.
      - If less than 2 Ω Â» Replace the component: K20 Engine Control Module
   - **Go to next step: If the specified state**
8. Connect a 3 A fused jumper wire between the test points: Control circuit terminal 4 & Ignition circuit terminal 5
9. Perform the scan tool control function: Engine Oil Pressure Control Solenoid Valve - Low Pressure.

   Verify the scan tool parameter: Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status = Malfunction

   - **If not the specified state**
   1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
   2. Disconnect the electrical connector: K20 Engine Control Module
   3. Test for less than 2 Ω between the test points: Inline Harness Connector Control circuit terminal 4 & The other end of the circuit
      - If 2 Ω or greater Â» Repair the open/high resistance in the circuit.
      - If less than 2 Ω Â» Replace the component: K20 Engine Control Module
   - **Go to next step: If the specified state**

NOTE: **Testing for steps 10 to 12 is performed on the component side of the inline harness connector: Q44 Engine Oil Pressure Control Solenoid Valve**

10. Test for 10 to 30 Ω between the test points: Control circuit terminal 4 & Ignition circuit terminal 5
    - **If not between 10 and 30 Ω**
    1. Disconnect the electrical connector: Q44 Engine Oil Pressure Control Solenoid Valve
    2. Test for less than 2 Ω between the test points:
       - Ignition circuit terminal 5 & The other end of the circuit
       - Control circuit terminal 4 & The other end of the circuit
       - If 2 Ω or greater Â» Repair the open/high resistance in the circuit.
       - If less than 2 Ω Â» Test or replace the component: Q44 Ω Engine Oil Pressure Control Solenoid Valve
    - **Go to next step: If between 10 and 30 Ω**
11. Test for infinite resistance between the test points:
    - Ignition circuit terminal 5 & Ground
    - Control circuit terminal 4 & Ground
    - **If less than infinite resistance**

      Repair the short to ground on the circuit.

    - **Go to next step: If infinite resistance**
12. Test for less than 1 V between the test points:
    - Ignition circuit terminal 5 & Ground

mcx30.com

- Control circuit terminal 4 & Ground
- **If 1 V or greater**

  Repair the short to voltage on the circuit.

- **Go to next step: If less than 1 V**

13. Test or replace the component:Q44 Engine Oil Pressure Control Solenoid Valve

Component Testing

Static Test

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector:Q44 Engine Oil Pressure Control Solenoid Valve
3. Test for 10 to 30 ohm between the test points: Control terminal 2/B & Ignition terminal 1/A
   - **If not between 10 and 30ohm**

     Replace the component:Q44 Engine Oil Pressure Control Solenoid Valve

   - **Go to next step: If between 10 and 30ohm**
4. Test for infinite resistance between the test points:Each terminal of the component & The component's housing
   - **If less than infinite resistance**

     Replace the component:Q44 Engine Oil Pressure Control Solenoid Valve

   - **Go to next step: If infinite resistance**
5. All OK.

Dynamic Test

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector:Q44 Engine Oil Pressure Control Solenoid Valve
3. Connect a 10 A fused jumper wire between the test points: Ignition terminal 1/A & 12 V

   CAUTION: **Complete the testing as quickly as possible in order to prevent overheating and damaging the component.**

4. Momentarily connect a jumper wire between the test points: Control terminal 2/B & Ground

   Verify the component turns On and Off when connecting and disconnecting the jumper wire:Q44 Engine Oil Pressure Control Solenoid Valve

   - **If the component does not turn On and Off**

     Replace the component:Q44 Engine Oil Pressure Control Solenoid Valve

   - **Go to next step: If the component turns On and Off**
5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- **Oil Pump Flow Control Solenoid Valve Replacement** - Q44 Engine Oil Pressure Control Solenoid Valve
- For control module replacement, programming, and setup refer to: **Control Module References**

SYMPTOMS - ENGINE MECHANICAL

Strategy Based Diagnostics

mcx30.com

Perform the **Diagnostic System Check - Vehicle** .

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.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the engine.
- 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 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:

- **Engine Noise Under Load**
- **Base Engine Misfire without Internal Engine Noises**
- **Base Engine Misfire with Abnormal Internal Lower Engine Noises**
- **Base Engine Misfire with Abnormal Valve Train Noise**
- **Base Engine Misfire with Coolant Consumption**
- **Base Engine Misfire with Excessive Oil Consumption**
- **Engine Noise on Start-Up, but Only Lasting a Few Seconds**
- **Upper Engine Noise, Regardless of Engine Speed**
- **Lower Engine Noise, Regardless of Engine Speed**
- **Engine Will Not Crank - Crankshaft Will Not Rotate**
- **Coolant in Engine Oil**
- **Engine Compression Test**
- **Oil Consumption Diagnosis**
- **Oil Pressure Diagnosis and Testing**
- **Oil Leak Diagnosis**
- **Drive Belt Chirping, Squeal, and Whine Diagnosis**
- **Drive Belt Rumbling and Vibration Diagnosis**
- **Drive Belt Falls Off and Excessive Wear Diagnosis**
- **Drive Belt Tensioner Diagnosis**

OIL PRESSURE DIAGNOSIS AND TESTING

Special Tools

- **CH-48027** Digital Pressure Gauge
- **EN-21867-850** Oil Pressure Gauge Adapter

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

Procedure

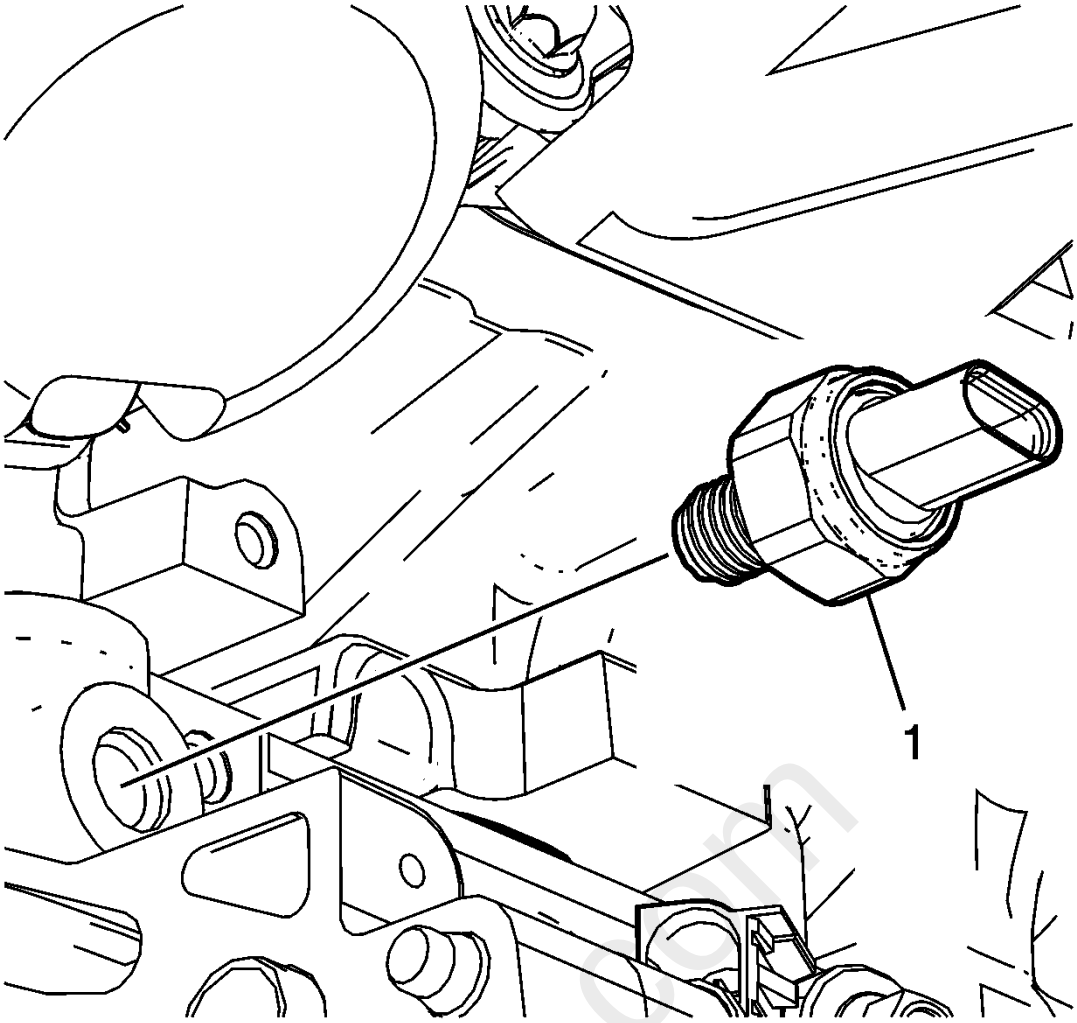


Fig. 28: Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine oil pressure sensor (1).

mcx30.com

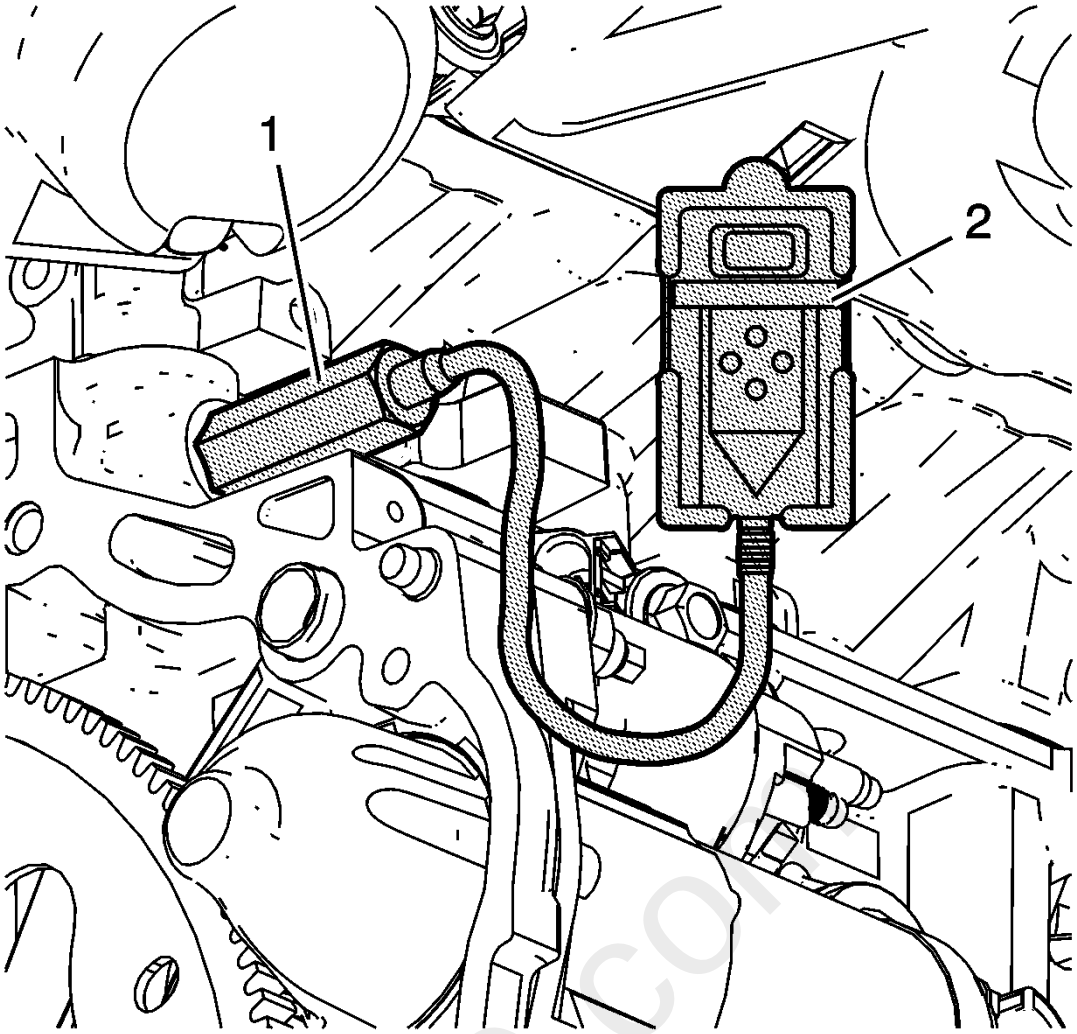


Fig. 29: Adapter And Gauge
Courtesy of GENERAL MOTORS COMPANY

2. Install the **EN-21867-850** adapter (1).
3. Install the **CH-48027** gauge (2).
4. Start the engine.
5. Check oil pressure.
6. At idling speed, the oil pressure must be greater than 180 kPa (26.11 psi) and the oil temperature must be 85Â°C (185Â°F) or more.
7. Remove the **CH-48027** gauge (2).
8. Remove the **EN-21867-850** adapter (1).
9. Turn off the engine.

mcx30.com

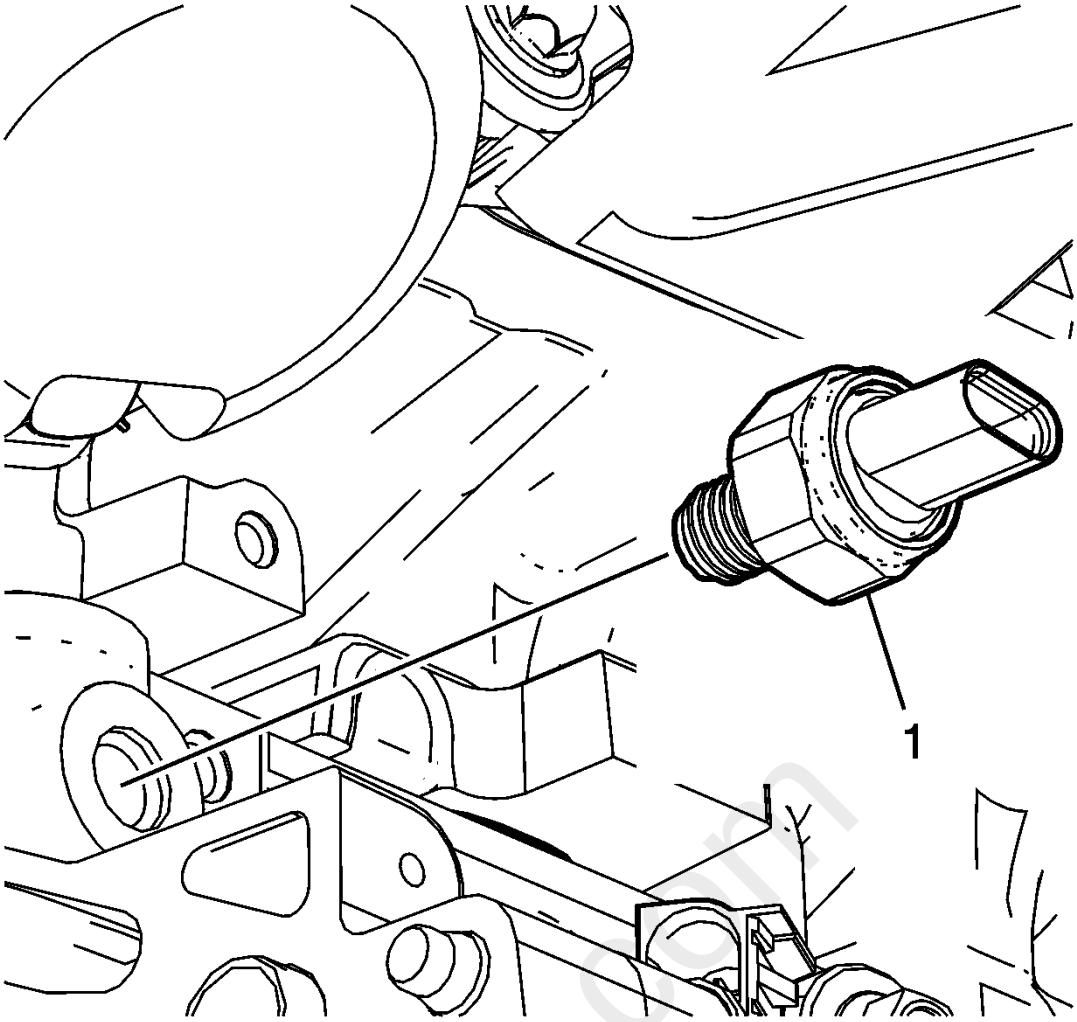


Fig. 30: Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

10. Install the engine oil pressure sensor (1).
11. Tighten the sensor to 35 N.m (26 lb ft).
12. Check the engine oil level.

OIL LEAK DIAGNOSIS

Step	Action	Yes	No
DEFINITION: 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 leak and the cause of the leak.			
1	1. Operate the vehicle until it reaches normal operating temperature. Refer to **Engine Mechanical Specifications**. 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**

mck30.com

Step	Action	Yes	No
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 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, for example, baby powder or foot powder, to the suspected area. 3. Operate the vehicle for several miles at normal operating temperature and at varying speeds. 4. Identify the type of fluid and the approximate location of the leak from the discolorations in the powder surface. Can you identify the type of fluid and the approximate location of the leak?	Go to **Step 10**	Go to **Step 7**

mcx30.com

Step	Action	Yes	No
7	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. 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	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 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 interest should be shown to the following areas: • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves • Plugged or malfunctioning engine ventilation system • Improperly tightened or damaged fasteners • Cracked or porous components • Improper sealants or gaskets, where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals • Damaged or worn sealing surfaces 2. Inspect the engine for customer modifications. Is there mechanical damage or customer modifications to the engine?	Go to **Step 11**	System OK
11	Repair or replace all damaged or modified components. Did you complete the repair?	Go to **Step 1**	-

mcx30.com

OIL CONSUMPTION DIAGNOSIS

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

- External oil leaks

  Tighten bolts and/or replace gaskets and oil seals as necessary.

- Incorrect oil level or improper reading of oil level indicator

  With the vehicle on a level surface, allow adequate drain down time and inspect for the correct oil level.

- Improper oil viscosity

  Use recommended SAE viscosity for the prevailing temperatures.

- Continuous high speed driving and/or severe usage
- Crankcase ventilation system restrictions or malfunctioning components
- Valve guides and/or valve stem oil seals worn, or the seal omitted

  Ream guides and install oversize service valves and/or new valve stem oil seals.

- Piston rings broken, improperly installed, worn, or not seated properly

  Allow adequate time for rings to seat. Replace broken or worn rings, as necessary.

- Piston improperly installed or mis-fitted.

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 overheating condition which may cause engine component damage. **NOTE:** **While not always conclusive, use of hydrocarbon block test kits may reveal hydrocarbons indicating combustion chamber gases in cooling system. It is important to follow the kit instructions. This is not a substitute for service information. Combustion leak tests are available from a wide variety of aftermarket suppliers.** 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 Replacement**.
Warped cylinder head	Replace the cylinder head and gasket. Refer to **Cylinder Head Replacement**.
Cracked cylinder head	Replace the cylinder head and gasket. Refer to **Cylinder Head Replacement**.

Cause	Correction
Cracked cylinder liner	Replace the components as required.
Cylinder head or block porosity	Replace the components as required.

COOLANT IN ENGINE OIL

Cause	Correction
DEFINITION: Foamy or discolored oil or an engine oil overfill condition may indicate coolant entering the engine crankcase. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an overtemperature condition which may cause engine component damage. Contaminated engine oil and oil filter should be changed. 1. Inspect the oil for excessive foaming or an overfill condition. Oil diluted by coolant may not properly lubricate the crankshaft bearings and may lead to component damage. Refer to **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 cylinder head gasket	Replace the head gasket and components as required. Refer to **Cylinder Head Replacement**.
Warped cylinder head	Replace the cylinder head and gasket. Refer to **Cylinder Head Replacement**.
Cracked cylinder head	Replace the cylinder head and gasket. Refer to **Cylinder Head Replacement**.
Cracked cylinder liner	Replace the components as required.
Cylinder head or block porosity	Replace the components 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. Refer to **Symptoms - Engine Controls** .
Loose torque converter bolts	1. Inspect the torque converter bolts and flywheel. 2. Repair as required.
Cracked flywheel - automatic transmission	1. Inspect the flywheel bolts and flywheel. 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

mcx30.com

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

Cause	Correction
Incorrect oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	1. Drain the oil. 2. Install the correct viscosity oil.
High valve lash adjuster leak down rate	Replace the lash adjusters as required.
Worn crankshaft thrust bearing	1. Inspect the thrust bearing and crankshaft. 2. Repair or replace as required.
Damaged or faulty oil filter by-pass valve	1. Inspect the oil filter by-pass valve for proper operation. 2. Repair or replace as required.
Malfunctioning camshaft position actuators - improper oil viscosity or contamination. The result is camshaft actuator locking pin does not lock	1. Verify correct engine oil viscosity by changing the engine oil and filter. Reevaluate the concern. 2. Isolate the noise to a specific camshaft position actuator. 3. Replace the camshaft actuator, oil and filter.

BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

Cause	Correction
Abnormalities, severe cracking, bumps, or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations and lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Replace the drive belt.
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout may lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Inspect the components, and repair or replace as required.
A loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required.

mcx30.com

Cause	Correction
Restricted exhaust system A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.	Repair or replace as required.
Improperly installed or damaged vacuum hoses	Repair or replace as required.
Improper sealing between the intake manifold and cylinder heads or throttle body	Replace the intake manifold, gaskets, cylinder heads, and/or throttle body as required.
Improperly installed or damaged manifold absolute pressure (MAP) sensor The sealing grommet of the MAP sensor should not be torn or damaged.	Repair or replace the MAP sensor as required.
Damage to the MAP sensor housing	Replace the intake manifold.
Worn rocker arms	Replace the 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	Replace the timing chain and sprockets as required.
Worn camshaft lobes	Replace the camshaft and valve lifters.
Excessive oil pressure A lubrication system with excessive oil pressure may lead to excessive valve lifter pump up and loss of compression.	• Perform an oil pressure test. Refer to **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 Coolant consumption may or may not cause the engine to overheat.	• Inspect for spark plugs saturated by coolant. • Inspect the cylinder heads, engine block, and/or head gaskets. • Repair or replace as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. • Inspect the cylinders for a loss of compression. Refer to **Engine Compression Test**. • Perform cylinder leak down and compression testing to identify the cause. • Repair or replace as required.

mcx30.com

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

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

Cause	Correction
Abnormalities, severe cracking, bumps or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine, and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.	Replace the drive belt.
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout A misfire code may be present without an actual misfire condition.	Inspect the components, repair or replace as required.
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. • Inspect the cylinders for a loss of compression. 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.

mcx30.com

BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

Cause	Correction
Abnormalities, severe cracking, bumps or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine, and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.	Replace the drive belt.
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout A misfire code may be present without an actual misfire condition.	Inspect the components, repair or replace as required.
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. • Inspect the cylinders for a loss of compression. 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 COOLANT CONSUMPTION

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

BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION

Cause	Correction
Worn valves, valve guides, and/or valve stem oil seals	• Inspect the spark plugs for oil deposits. • Repair or replace as required.

mcx30.com

Cause	Correction
Worn piston rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. • Inspect the cylinders for a loss of compression. Refer to **Engine Compression Test**. • Perform cylinder leak down and compression testing to determine the cause. • Repair or replace as required.

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Low oil pressure	• Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. • Repair or replace as required.
Worn valve rocker arm	Replace the valve rocker arm.
Improper lubrication to the valve rocker arms	Inspect the following components and repair or replace as required: • The valve rocker arm • The valve lifter • The oil filter bypass valve • The oil pump and pump screen • The engine block oil galleries
Broken valve spring	Replace the valve spring.
Worn or dirty valve lifters	Replace the valve lifters.
Stretched timing chain and/or damaged sprocket teeth	Replace the timing chain and sprockets.
Worn, damaged, or faulty timing chain tensioner	Replace the tensioner.
Worn engine camshaft lobes	• Inspect the engine camshaft lobes. • Replace the camshaft and valve lifters as required.
Worn valve guides or valve stems	Inspect the following components, and repair as required: • The valves • The valve guides
Stuck valves Carbon on the valve stem or valve seat may cause the valve to stay open.	Inspect the following components and repair as required: • The valves • The valve guides

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction

mcx30.com

Cause	Correction
Low oil pressure	• Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. • Repair or replace damaged components as required.
Worn accessory drive components - abnormalities, such as severe cracking, bumps, or missing areas in the accessory drive belt and/or misalignment of system components	1. Inspect the accessory drive system. 2. Repair or replace as required.
Loose or damaged crankshaft balancer	1. Inspect the crankshaft balancer. 2. Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the ignition system. Refer to **Symptoms - Engine Controls** .
Loose torque converter bolts	1. Inspect the torque converter bolts and flywheel. 2. Repair or replace as required.
Loose or damaged flywheel	Repair or replace the flywheel.
Damaged oil pan, contacting the oil pump screen An oil pan that has been damaged, may improperly position the oil pump screen, preventing proper oil flow to the oil pump.	1. Inspect the oil pan. 2. Inspect the oil pump screen. 3. Repair or replace as required.
Oil pump screen loose, damaged or restricted	1. Inspect the oil pump screen. 2. Repair or replace as required.
Excessive piston-to-cylinder bore clearance	1. Inspect the piston and cylinder bore. 2. Repair as required.
Excessive piston pin-to-bore clearance	1. Inspect the piston, piston pin, and the connecting rod. 2. Repair or replace as required.
Excessive connecting rod bearing clearance	Inspect the following components and repair as required: • The connecting rod bearings • The connecting rods • The crankshaft • The crankshaft journals
Excessive crankshaft bearing clearance	Inspect the following components and repair as required: • The crankshaft bearings • The crankshaft journals

mcx30.com

Cause	Correction
Incorrect piston, piston pin, and connecting rod installation Pistons must be installed with the mark, or dimple, on the top of the piston, facing the front of the engine. Piston pins must be centered in the connecting rod pin bore.	1. Verify the pistons, piston pins and connecting rods are installed correctly. 2. Repair as required.

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Cause	Correction
Seized accessory drive system component	1. Remove accessory drive belts. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Hydraulically locked cylinder • Coolant/antifreeze in cylinder • Oil in cylinder • Fuel in cylinder	1. Remove spark plugs and check for fluid. 2. Inspect for broken head gasket. 3. Inspect for cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector. 5. Inspect for cracked cylinder wall.
Seized automatic transmission torque converter	1. Remove the torque converter bolts. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Seized manual transmission	1. Disengage the clutch. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Broken timing chain and/or gears	• Inspect timing chain and gears. • Repair as required.
Seized balance shaft	• Inspect balance shaft. • Repair as required.
Material in cylinder • Broken valve • Piston material • Foreign material • Cracked cylinder wall	• Inspect cylinder for damaged components and/or foreign materials. • Inspect for fallen cylinder wall. • Repair or replace as required.
Seized crankshaft or connecting rod bearings	• Inspect crankshaft and connecting rod bearings. • Inspect for fallen cylinder wall. • Repair as required.

mcx30.com

Cause	Correction
Bent or broken connecting rod	• Inspect connecting rods. • Repair as required.
Broken crankshaft	• Inspect crankshaft. • Repair as required.

ENGINE COMPRESSION TEST

Special Tools

EN-51749 Compression Gauge Tester Kit

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

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

Removal Procedure

NOTE: **The battery must be at or near full charge.**

1. Connect a battery charger to the battery for the duration of the test to maintain an adequate battery level.
2. Engine OFF.
3. Remove the spark plugs. Refer to **Spark Plug Replacement** .
4. Interrupt the fuel supply.

Measurement Procedure

1. Connect the GDS2 to the vehicle and select "Compression Test". Enabling the Compression Test will disable the fuel pump, fuel injectors, and spark. The throttle body is opened to a Wide Open Throttle (WOT) position. The GDS2 will also automatically control the cranking procedure for many applications. If cranking control is not available use a remote start switch in place of the Starter Relay to control cranking.

mc30.com

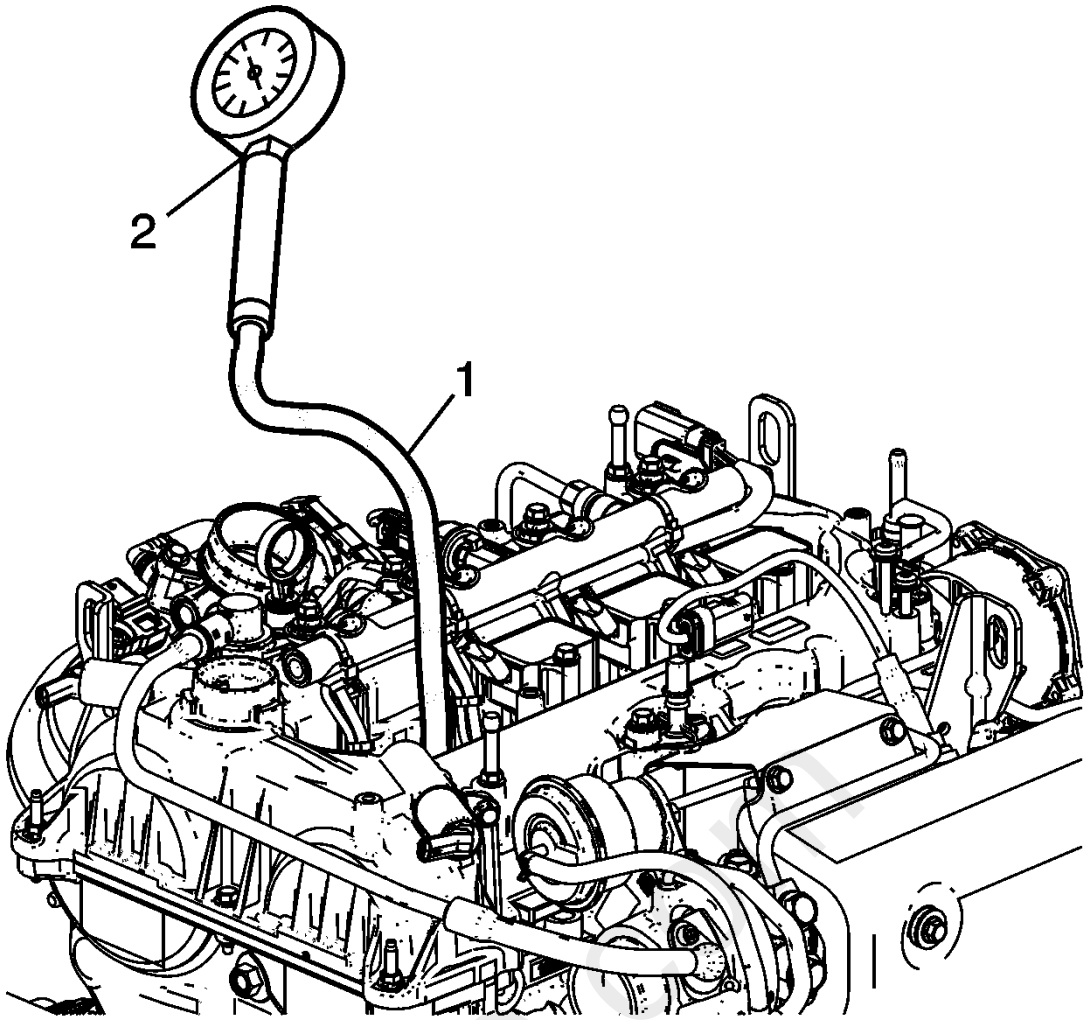


Fig. 31: Compression Gauge
Courtesy of GENERAL MOTORS COMPANY

2. Install the **EN-51749** gauge (1, 2) into the spark plug hole for the cylinder that is being checked.

NOTE: **Engine should be operated at least 300 revolutions per minute (RPM).**

NOTE: **When the compression measurement is normal, the compression builds up quickly and evenly to the specified compression on each cylinder.**

3. Use a remote start switch to crank the engine. If cranking function exists via GDS2, this can be used as an alternative method. Record the reading after the cranking cycle completes.
4. Repeat the compression test for each cylinder.
5. Compare the compression readings from all of the cylinders. Maximum pressure differential 100 kPa (14.5 psi).
6. The following are indicators of potential problems:
    - 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 to the cylinder. Use approximately 3 squirts of oil from a plunger-type oiler into the cylinder and replace the gauge and measure again.
    - 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.
7. Disconnect GDS2 diagnostic tool or remote start switch.

Installation Procedure

1. Restore the fuel supply.
2. Install the spark plugs. Refer to **Spark Plug Replacement** .

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

mcx30.com

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: • 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

mcx30.com

Step	Action	Yes	No
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, 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 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. If diagnosing a whine noise and the condition still exist, 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 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
18	Replace the bent pulley. Did you complete the repair?	Go to **Step 20**	Go to **Step 19**

mcx30.com

Step	Action	Yes	No
19	Replace the drive belt. Refer to **Drive Belt Replacement**. Did you complete the repair?	Go to **Step 20**	Go to Diagnostic Aids
20	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

DRIVE BELT RUMBLING AND VIBRATION DIAGNOSIS

Diagnostic Aids

The accessory drive components can have an affect on engine vibration. Vibration from the engine operating may cause a body component or another part of the vehicle to make rumbling noise. Vibration can be caused by, but not limited to the A/C system over charged, the power steering system restricted or the incorrect fluid, or an extra load on the generator. To help identify an intermittent or an improper condition, vary the loads on the accessory drive components.

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

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

Test Description

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

2

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

3

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

4

Inspecting the drive belts is to ensure that they are not causing the noise. Small cracks across the ribs of the drive belt will not cause the noise. Belt separation is identified by the plys of the belt separating and may be seen at the edge of the belt or felt as a lump in the belt.

5

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

9

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

11

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

mx30.com

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:
  • Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove
  • The separation of the drive belt
  • A damaged drive belt
  • A worn drive belt idler pulley
 	
DEFINITION: The following items are indications of drive belt vibration:
• The vibration is engine-speed related.
• The vibration may be sensitive to accessory load.			

1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to **Step 2**	Go to **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**	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**
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**

mcx30.com

Step	Action	Yes	No
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	**CAUTION:** **Refer to Fastener Caution .** 1. Tighten any loose fasteners. Refer to **Fastener 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 (LYX)** . 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**

CYLINDER LEAKAGE TEST

Special Tools

EN-51749 Compression Gauge Tester Kit

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 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 **EN-51749** gauge according to the manufacturers instructions.

NOTE: **It may be necessary to hold the crankshaft balancer bolt to prevent**

mc30.com

the crankshaft from rotating.

5. Apply shop air pressure 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.

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 FALLS OFF AND EXCESSIVE WEAR DIAGNOSIS

Diagnostic Aids

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

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

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

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

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

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

mcy30.com

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 false positioning the drive belt by one groove on a pulley.

14

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

15

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

Step	Action	Yes	No
CAUTION: **Refer to 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**

mex30.com

Step	Action	Yes	No
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
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 correct the condition?	Go to **Step 12**	Go to **Step 6**
6	Inspect for a bent or a cracked bracket. Did you find and correct 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 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 correct 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 correct 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

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

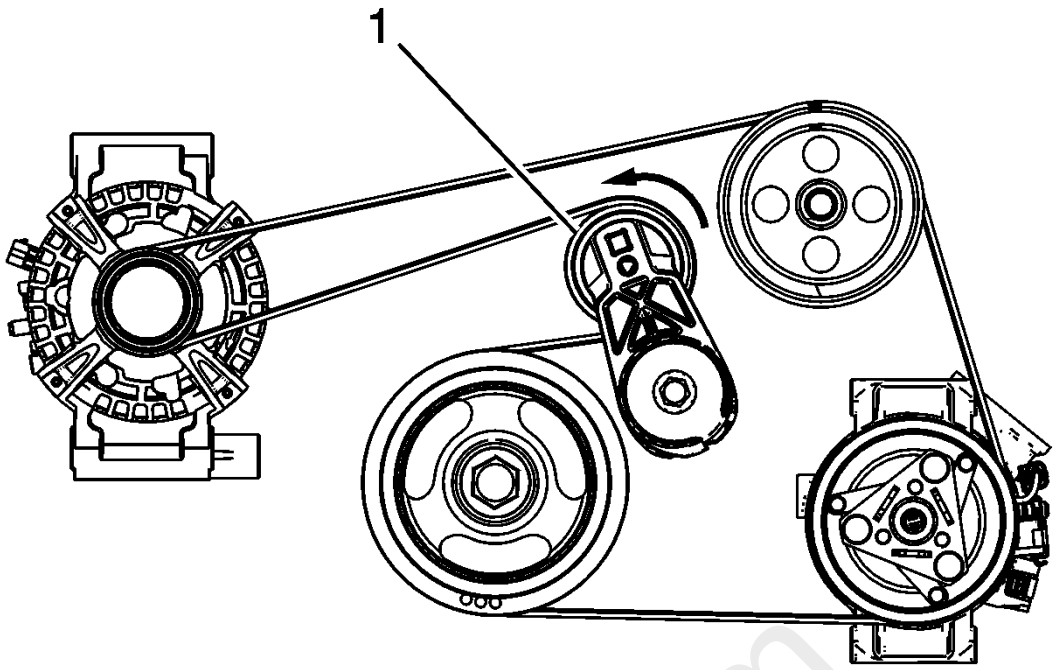


Fig. 32: Applying Tension To Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

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

REPAIR INSTRUCTIONS - ON VEHICLE

DRIVE BELT REPLACEMENT

Removal Procedure

1. Remove Front Wheelhouse Liner-Right Side - **Front Wheelhouse Liner Replacement - Right Side (Equinox)** **Front Wheelhouse Liner Replacement - Right Side (Terrain)**

mcx30.com

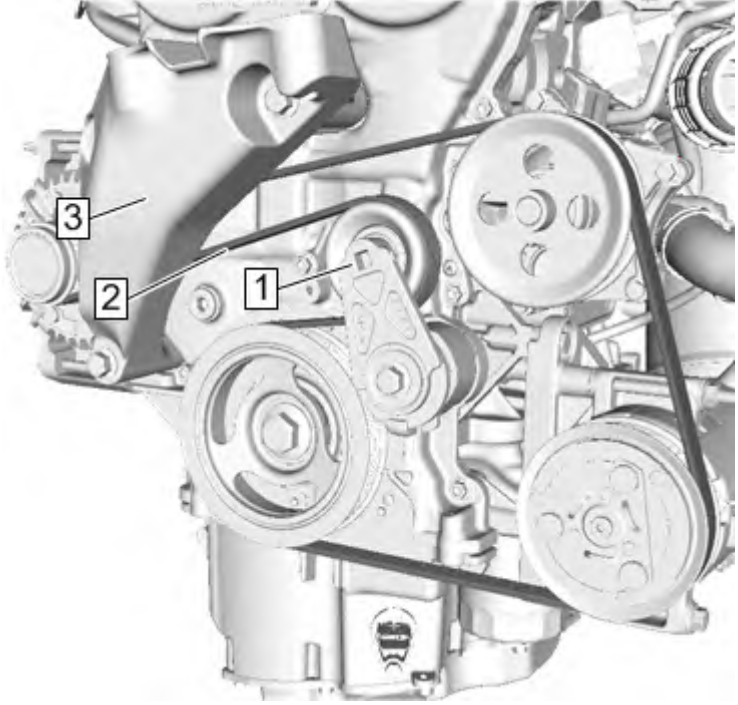


Fig. 33: Drive Belt Diagram
Courtesy of GENERAL MOTORS COMPANY

2. Rotate the drive belt tensioner (1) counterclockwise and hold tension.

NOTE: **It is NOT necessary to remove the engine mount bracket (3) to remove the belt. Once the drive belt has been removed from the pulleys, navigate the belt past the engine mount bracket to remove.**

3. Remove Drive Belt (2).
4. Slowly release the tension on the drive belt tensioner.(1)

Installation Procedure

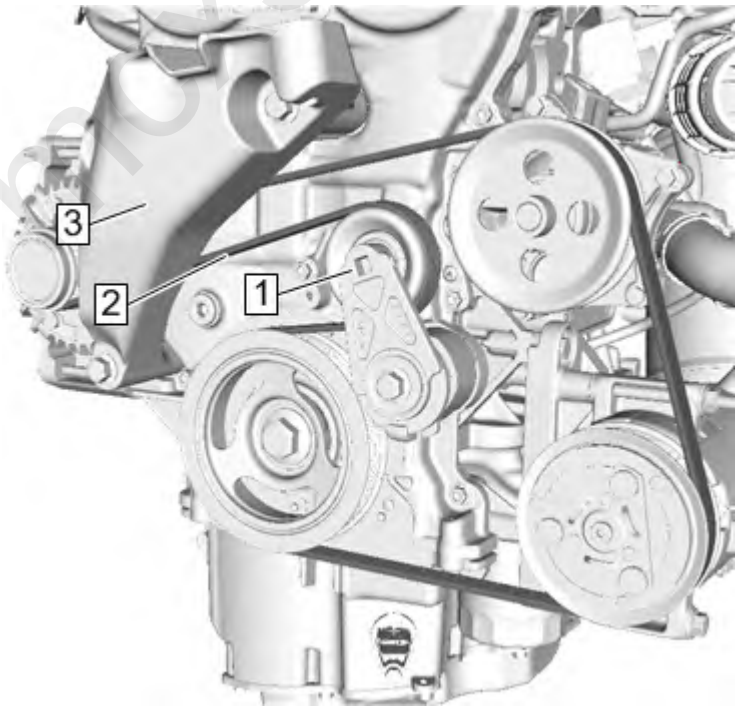


Fig. 34: Drive Belt Routing
Courtesy of GENERAL MOTORS COMPANY

1. Apply tension to the drive belt tensioner (1) by rotating counterclockwise and hold tension.

NOTE: **Navigate the belt (2) past the engine mount bracket (3) and properly install.**

2. Install Drive Belt (2).
3. Slowly release the tension on the drive belt tensioner.(1)
4. Inspect the drive belt for proper installation and alignment.
5. Install Front Wheelhouse Liner-Right Side - **Front Wheelhouse Liner Replacement - Right Side (Equinox)** **Front Wheelhouse Liner Replacement - Right Side (Terrain)**
6. Lower the vehicle.

DRIVE BELT TENSIONER REPLACEMENT

Removal Procedure

1. Remove Drive Belt - **Drive Belt Replacement**

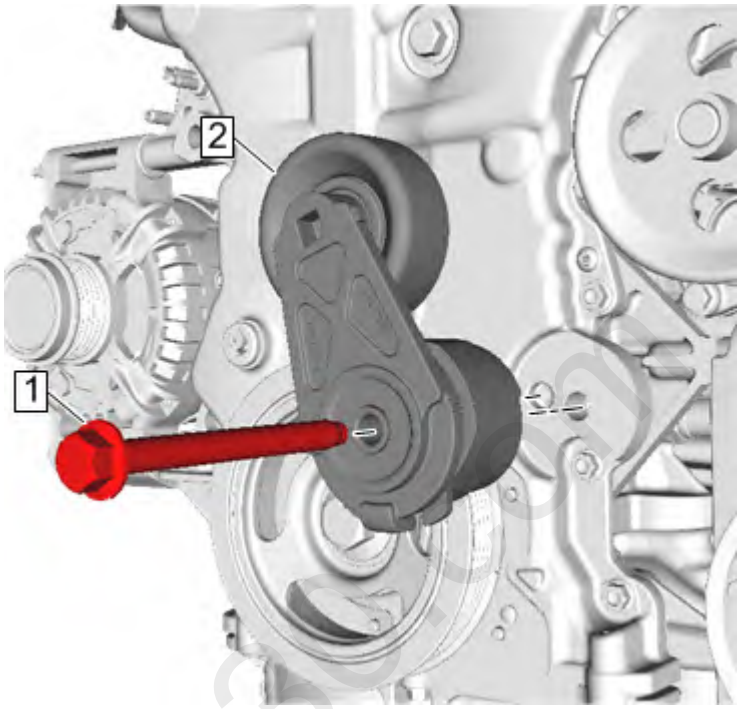


Fig. 35: Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

2. Remove Drive Belt Tensioner Fastener (1).
3. Remove Drive Belt Tensioner (2).

Installation Procedure

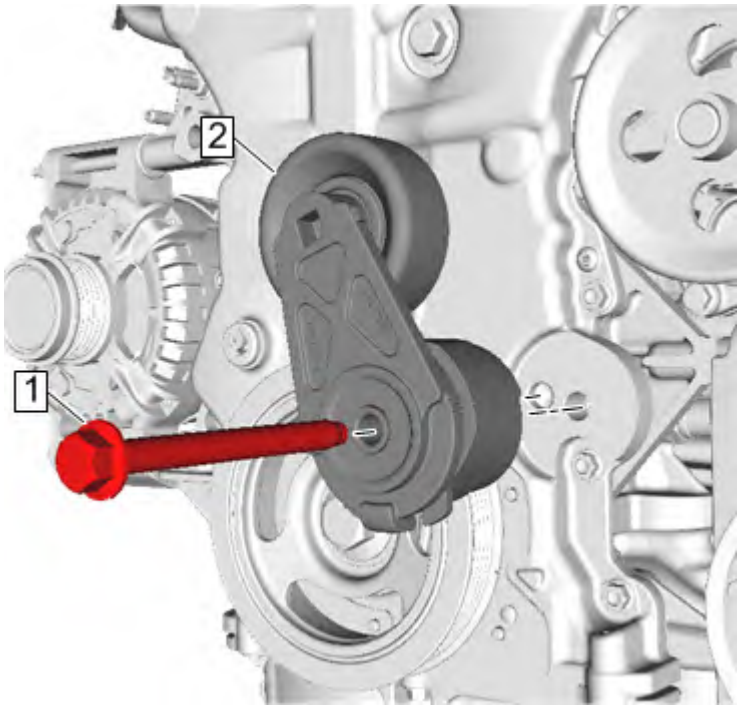


Fig. 36: Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that the drive belt tensioner pin engages the engine front cover hole.**

1. Install Drive Belt Tensioner(2)

CAUTION: **Refer to Fastener Caution .**

2. Install Drive Belt Tensioner Fastener(1) and tighten 58 N.m (43 lb ft)
3. Install Drive Belt - **Drive Belt Replacement**

CAMSHAFT COVER REPLACEMENT

Removal Procedure

1. Remove Air Cleaner Assembly -**Air Cleaner Assembly Replacement**
2. Remove Fuel Injection Fuel Rail Assembly -**Fuel Injection Fuel Rail Assembly Replacement**
3. Remove Vacuum Pump Assembly - **Vacuum Pump Assembly Replacement**

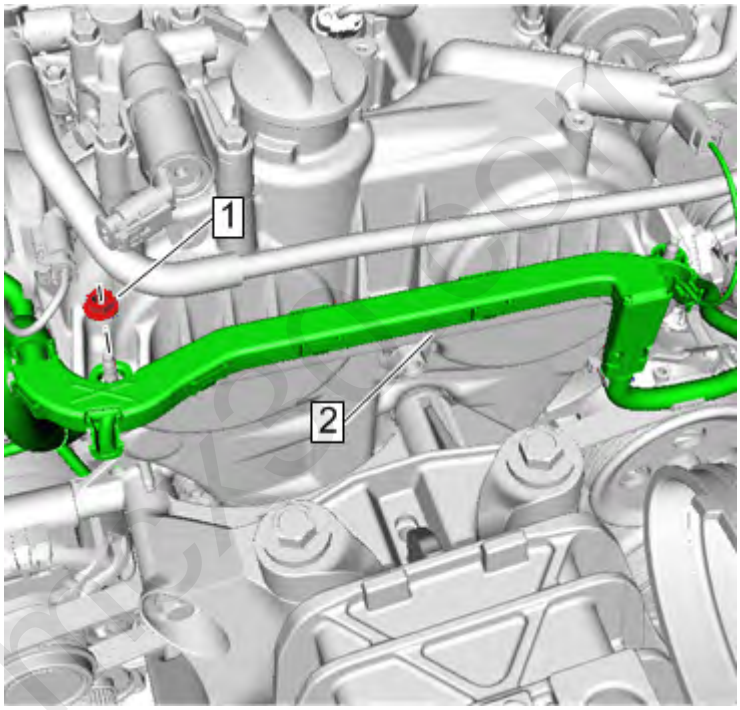


Fig. 37: Wiring Harness And Fastener
Courtesy of GENERAL MOTORS COMPANY

4. Remove the wiring harness fastener (1) then reposition the wiring harness (2) as needed.

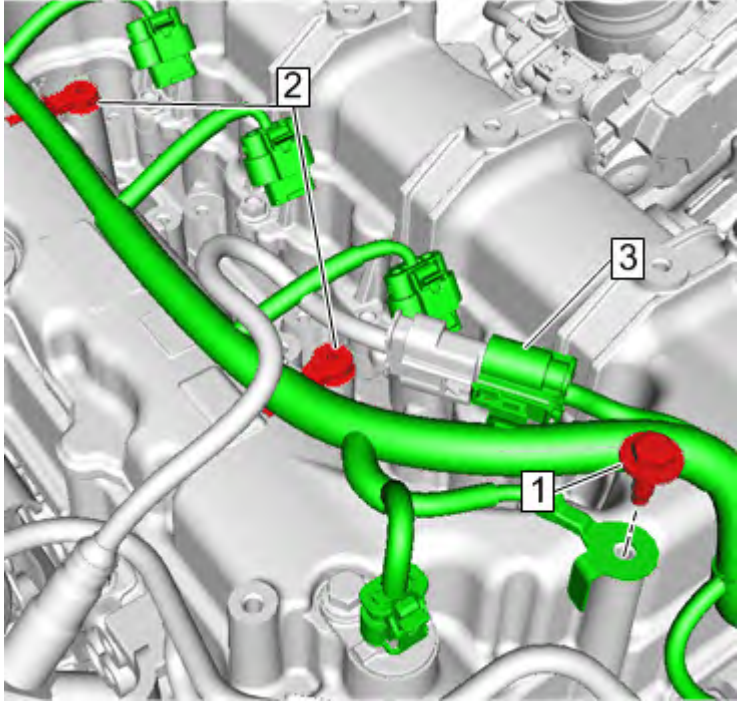


Fig. 38: Engine Wiring Harness Bolt And Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Remove Engine Wiring Harness Bolt.
6. Remove Engine Wiring Harness Retainer (2) - [2x]
7. Disconnect Electrical Connector (3).
8. Remove Air Cleaner Outlet Duct@Turbocharger - **Air Cleaner Outlet Duct Replacement**

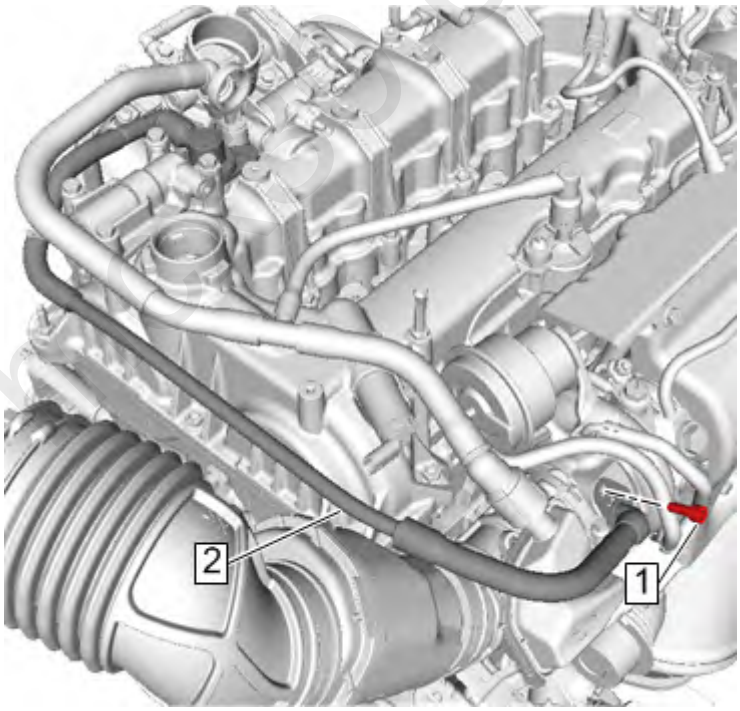


Fig. 39: PCV Valve Tube And Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The positive crankcase ventilation valve and tube assembly (2) are not reusable. If reinstalling the camshaft cover, do not remove the PCV valve and tube assembly (2) from the camshaft cover.**

9. Remove the PCV valve tube fastener (1).
10. Remove Turbocharger Coolant Return Pipe - **Turbocharger Coolant Return Pipe Replacement (LYX)**
11. Remove Engine Lift Rear Bracket - **Engine Lift Rear Bracket Replacement**
12. Remove the oil level indicator.

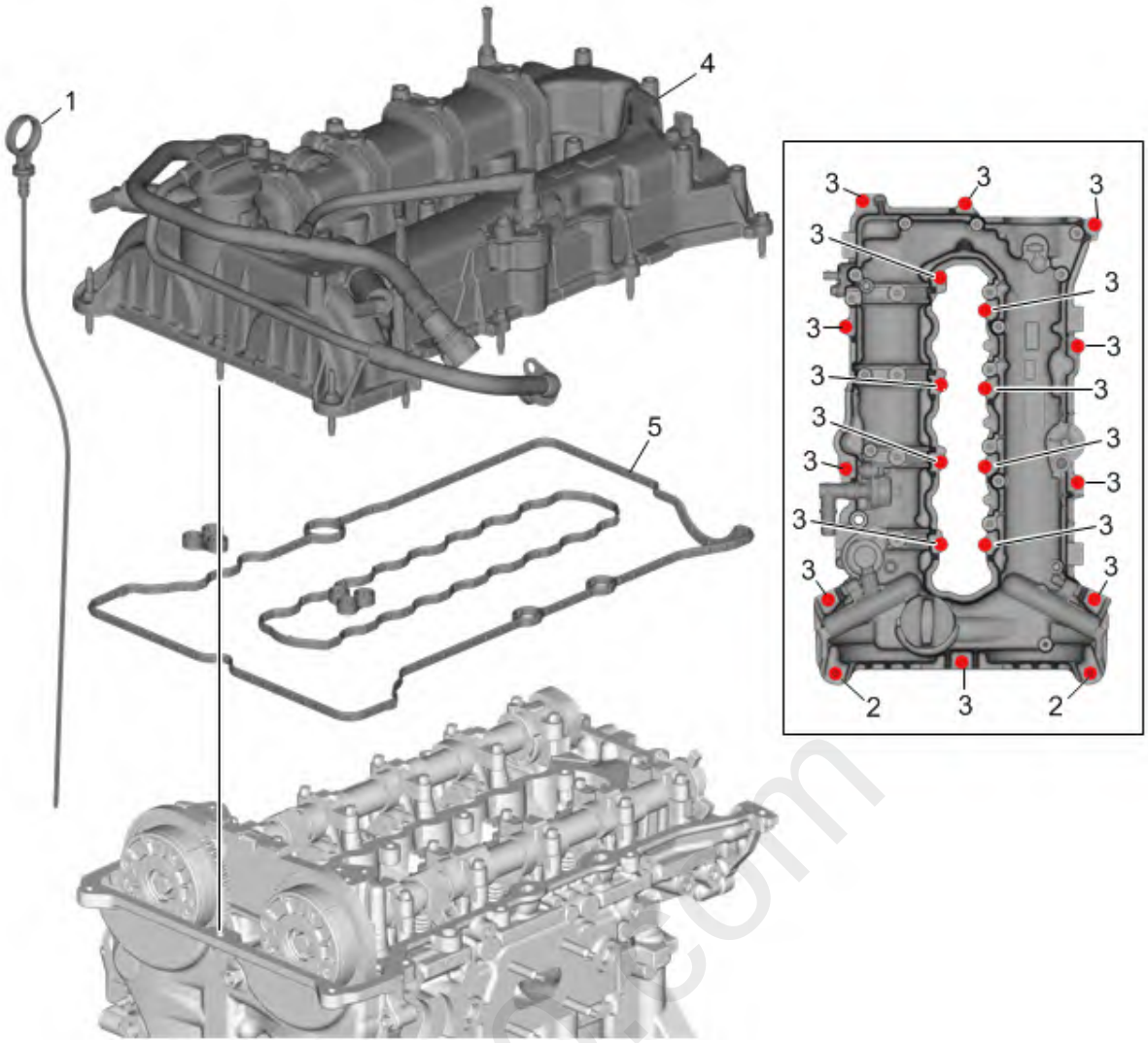


Fig. 40: Camshaft Cover and Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Remove the camshaft cover with the PCV tubes attached.**

13. Remove Camshaft Cover (4) -**Camshaft Cover Removal**
14. If reinstalling the camshaft cover, clean and inspect the cover, replace seals, gaskets and transfer components as needed.
15. If replacing the camshaft cover, remove the following:
    1. Remove Camshaft Position Actuator Solenoid Valve - Intake - **Camshaft Position Actuator Solenoid Valve Replacement - Intake**
    2. Remove Camshaft Position Actuator Solenoid Valve - Exhaust - **Camshaft Position Actuator Solenoid Valve Replacement - Exhaust**
    3. Remove Camshaft Position Sensor - **Camshaft Position Sensor Replacement - Intake**
    4. Remove Camshaft Position Sensor - **Camshaft Position Sensor Replacement - Exhaust**
    5. Remove Camshaft Position Actuator Locating Pin Control Valve -**Camshaft Position Actuator Locating Pin Control Valve Replacement**

Installation Procedure

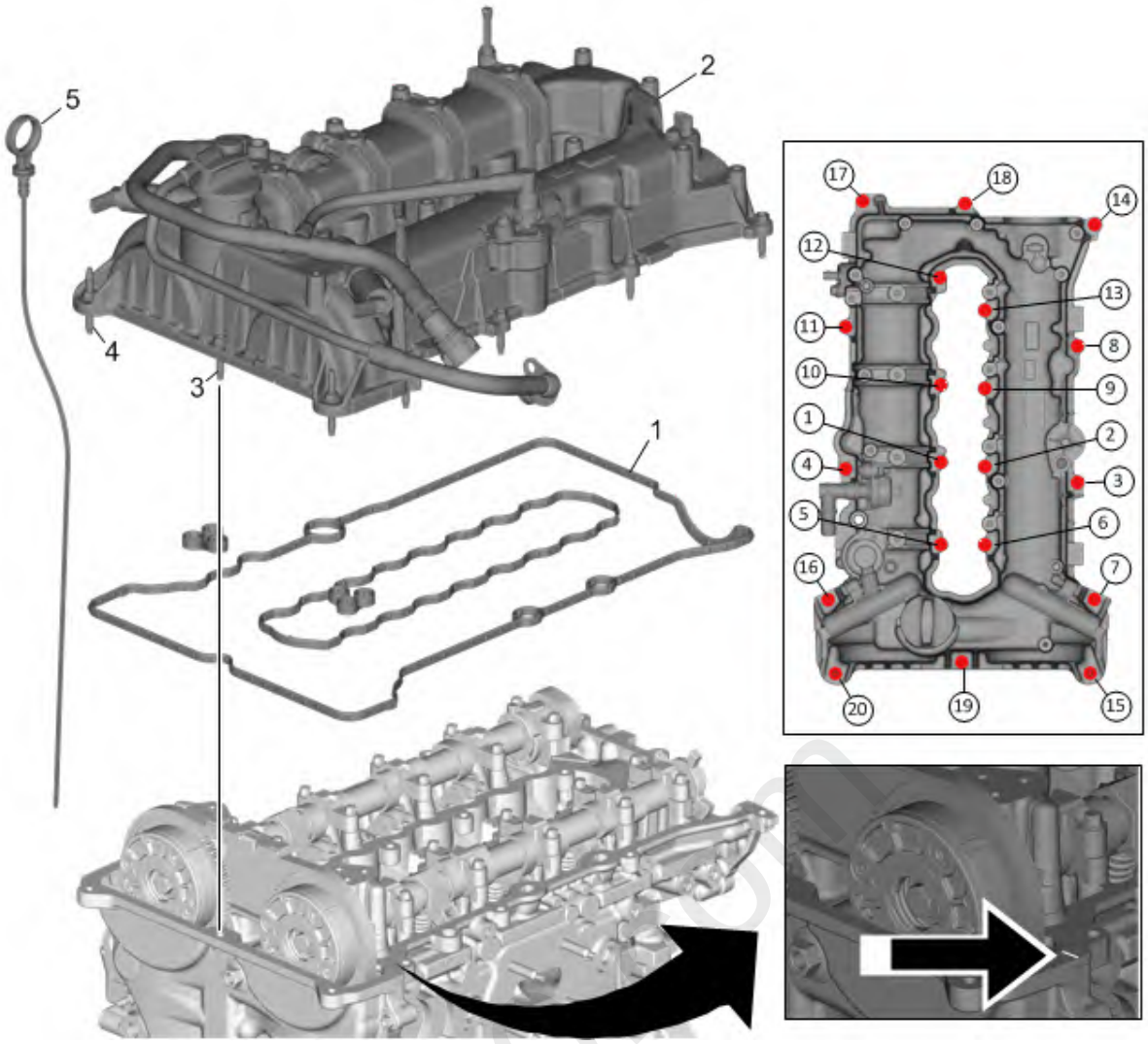


Fig. 41: Camshaft Cover With Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

1. Install Camshaft Cover (2) **Camshaft Cover Installation**
2. If replacing the camshaft cover, install the following:
    1. Remove Camshaft Position Actuator Solenoid Valve - Intake - **Camshaft Position Actuator Solenoid Valve Replacement - Intake**
    2. Remove Camshaft Position Actuator Solenoid Valve - Exhaust -**Camshaft Position Actuator Solenoid Valve Replacement - Exhaust**
    3. Remove Camshaft Position Sensor - **Camshaft Position Sensor Replacement - Intake**
    4. Remove Camshaft Position Sensor - **Camshaft Position Sensor Replacement - Exhaust**
    5. Remove Camshaft Position Actuator Locating Pin Control Valve - **Camshaft Position Actuator Locating Pin Control Valve Replacement**
3. Install the oil level indicator.
4. Install Engine Lift Rear Bracket - **Engine Lift Rear Bracket Replacement**
5. Install Turbocharger Coolant Return Pipe - **Turbocharger Coolant Return Pipe Replacement (LYX)**

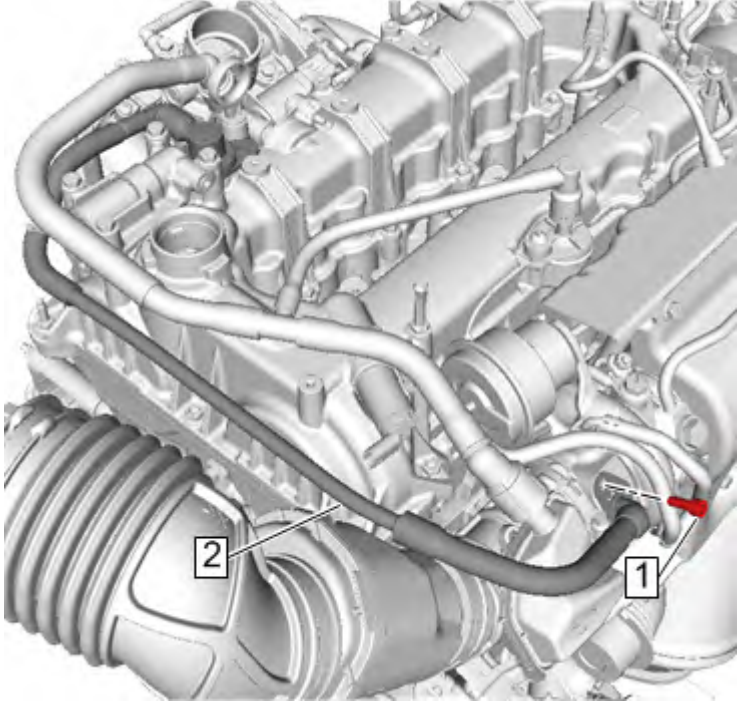


Fig. 42: PCV Valve Tube And Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the PCV valve has been removed from the valve cover, replace the valve and tube assembly (2).**

6. Install the PCV valve tube fastener (1). Tighten to 10 N.m (89 lb in)

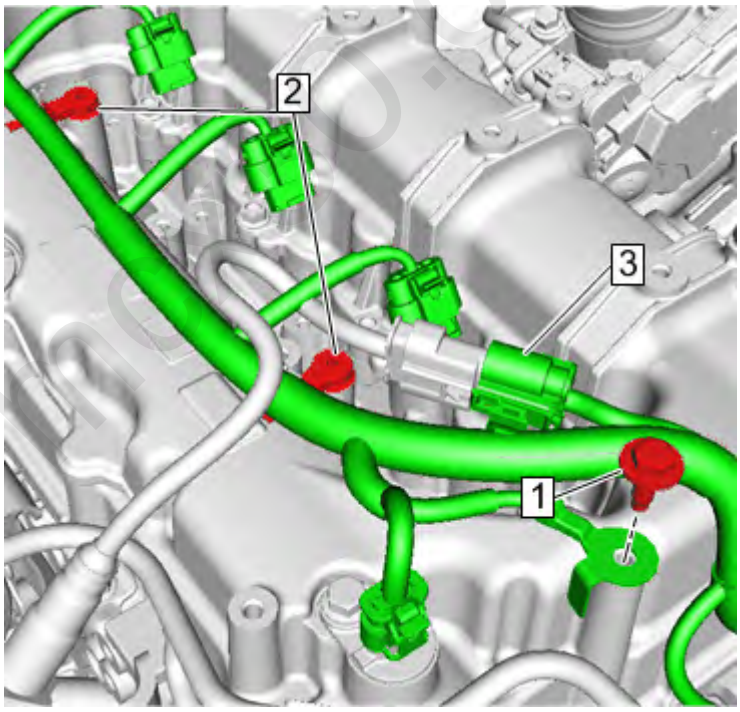


Fig. 43: Engine Wiring Harness Bolt And Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Install Engine Wiring Harness Retainer (2)
8. Connect Electrical Connector (3)
9. Install Engine Wiring Harness Bolt (1) and tighten 9 N.m (80 lb in)
10. Install Air Cleaner Outlet Duct@Turbocharger - **Air Cleaner Outlet Duct Replacement**

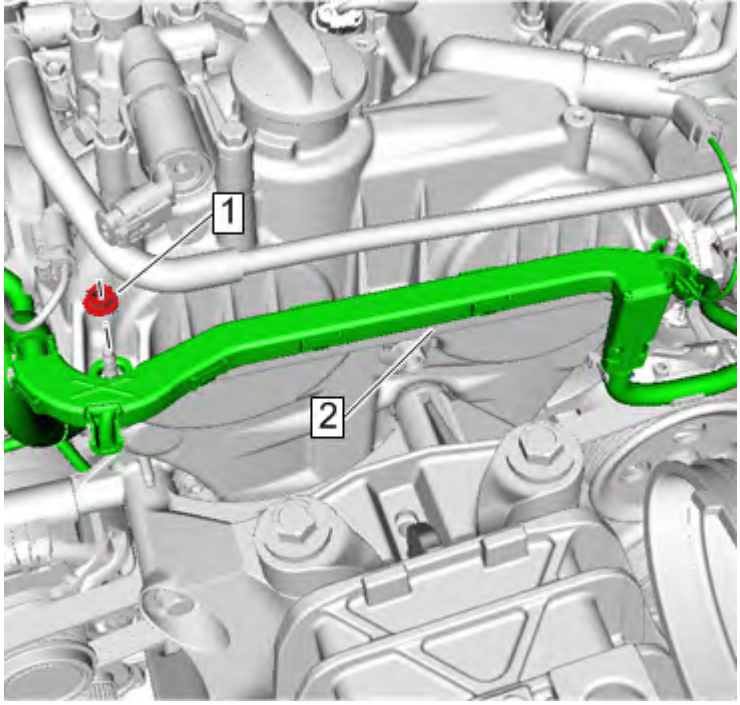


Fig. 44: Wiring Harness And Fastener
Courtesy of GENERAL MOTORS COMPANY

11. Reposition the wiring harness (2) then install and tighten the engine wiring harness bolt (1). 10 N.m (89 lb in)
12. Install Fuel Injection Fuel Rail Assembly - **Fuel Injection Fuel Rail Assembly Replacement**
13. Install Vacuum Pump Assembly - **Vacuum Pump Assembly Replacement**
14. Install Air Cleaner Assembly - **Air Cleaner Assembly Replacement**

CAMSHAFT POSITION ACTUATOR REPLACEMENT

Special Tools

- **EN-45059** Torque Angle Sensor Kit
- **EN-51367** Camshaft Locking Tool
- **EN-51397** Timing Chain Retainer

Equivalent regional tools:**Special Tools**

Removal Procedure

1. Remove Air Cleaner Assembly - **Air Cleaner Assembly Replacement**
2. Remove Camshaft Cover - **Camshaft Cover Replacement**

NOTE: **Perform step 3 if the Intake camshaft position actuator is being removed.**

3. Remove Fuel Pump - **Fuel Pump Replacement**

mcx30.com

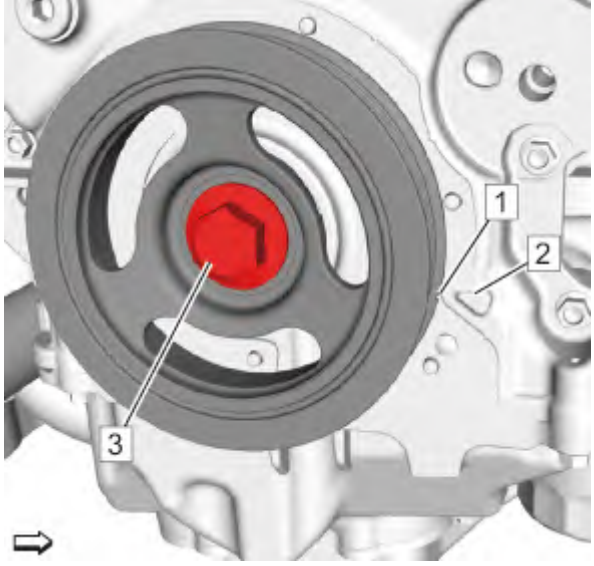


Fig. 45: Crankshaft Balancer Markings
Courtesy of GENERAL MOTORS COMPANY

4. Adjust the engine to cylinder 1 top dead center (TDC) of the combustion stroke. Using the crankshaft balancer bolt (3), rotate the crankshaft in direction of engine rotation until the markings (1, 2) line up.

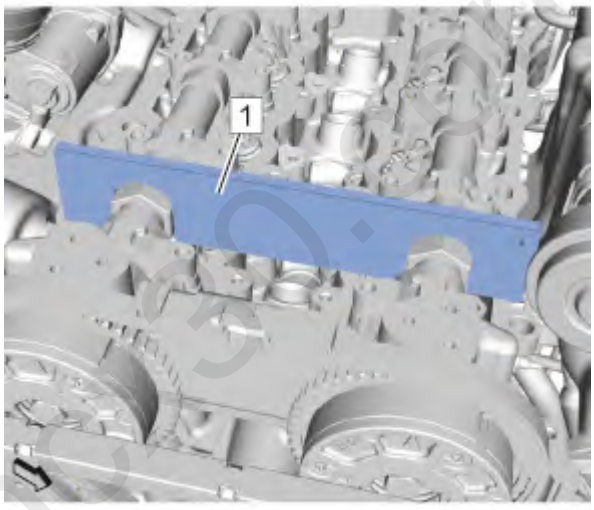


Fig. 46: Camshaft Holder
Courtesy of GENERAL MOTORS COMPANY

5. Install the **EN-51367** Camshaft Locking Tool (1).
6. Remove Timing Chain Upper Guide - **Timing Chain Upper Guide Replacement**

Fig. 47: Camshaft Position Actuator Marks And Timing Chain Marks
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The actuator marks (2) should be at the 12 O'clock position when cylinder 1 is at top dead center.**

7. Mark the camshaft timing chain (1) at the corresponding actuator marks (2).

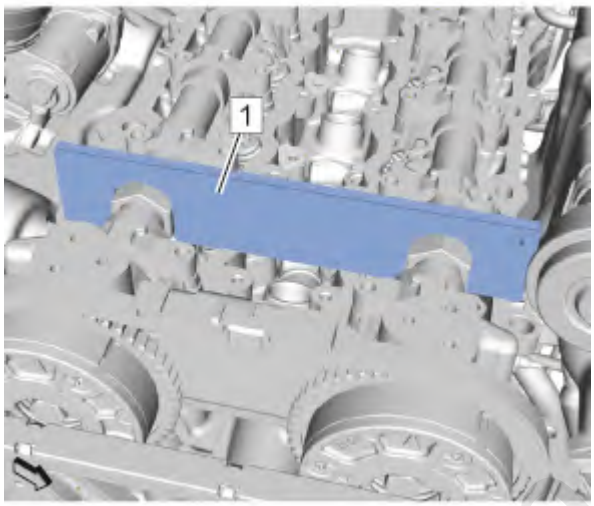


Fig. 48: Camshaft Holder
Courtesy of GENERAL MOTORS COMPANY

8. Remove **EN-51367** Camshaft Locking Tool
9. Using a wrench rotate the intake camshaft clockwise, then release. Repeat this three times to relieve oil pressure from the tensioner.

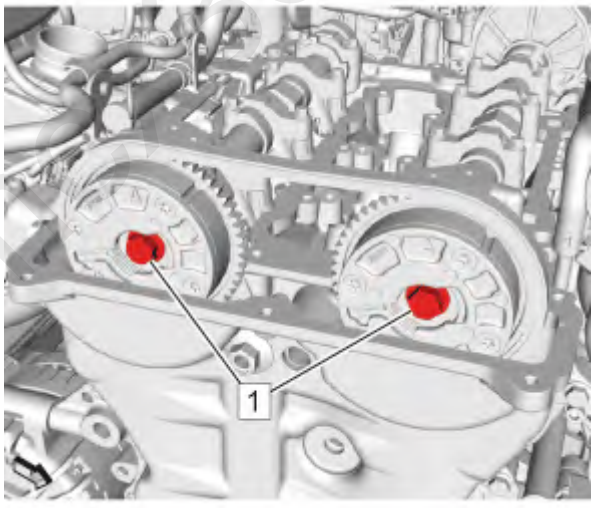


Fig. 49: Camshaft Position Actuator Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do NOT remove or back out the camshaft position actuator bolt(s). Break them loose from their fully-torqued position. The position actuators must stay firmly attached until the retaining tools are in place, they should be broken loose while the chain is still tight and in position.**

10. Loosen Camshaft Position Actuator Bolt (1)@Camshaft Position Actuator - [2x]

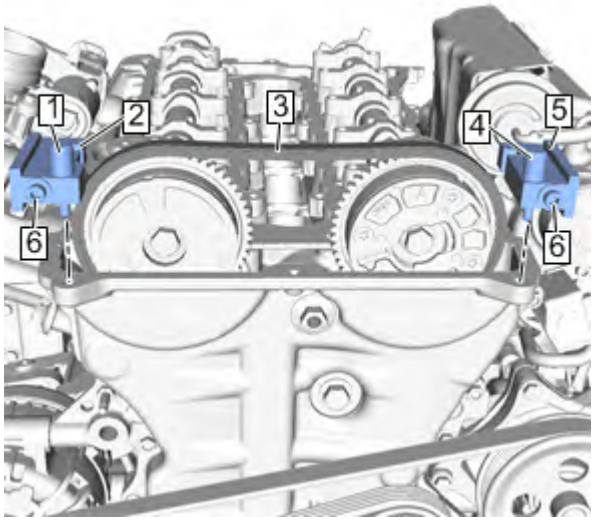


Fig. 50: Timing Chain Retainer And Camshaft Timing Chain
Courtesy of GENERAL MOTORS COMPANY

11. Pre-Install the **EN-51397-2** Timing Chain Retainer (2) to the intake side of the camshaft timing chain (3).
12. Pre-Install the **EN-51397-1** Timing Chain Retainer (5) to the exhaust side of the camshaft timing chain.
13. Hand tighten the thumb wheels (1, 4) securely.

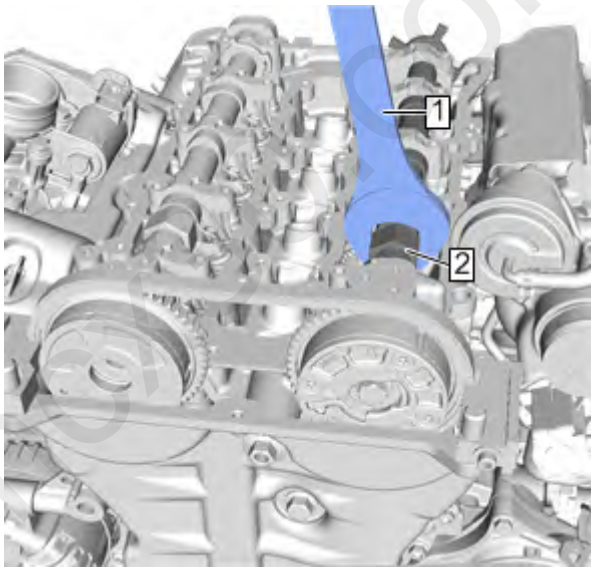


Fig. 51: Exhaust Camshaft And Wrench
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **The tightening force must be applied gently to the wrench. Using too much force will lead to an overlap of the timing chain that will cause severe engine damages.**

14. Install a suitable wrench (1) at the exhaust camshaft (2).
15. Apply tension to the chain tensioner by rotating the exhaust camshaft counter-clockwise.

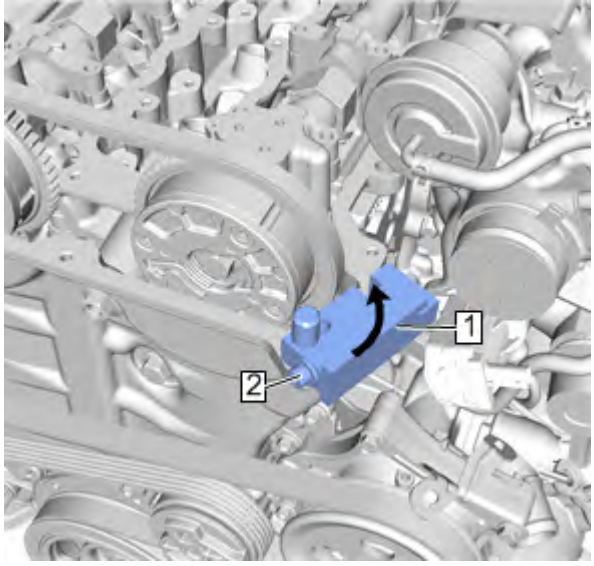


Fig. 52: Timing Chain Retainer And Bolt
Courtesy of GENERAL MOTORS COMPANY

16. While maintaining tension against the exhaust camshaft, install the **EN-51397-1** Timing Chain Retainer(1) to the exhaust side of the camshaft timing chain.

CAUTION: **Refer to Fastener Caution .**

17. Tighten bolt (2) of the **EN-51397-1** Timing Chain Retainer (1) to 5 N.m (44 lb in).
18. Remove the wrench from the exhaust camshaft, and apply to the intake camshaft.
19. Apply tension to the chain tensioner by slightly rotating the intake camshaft clockwise.

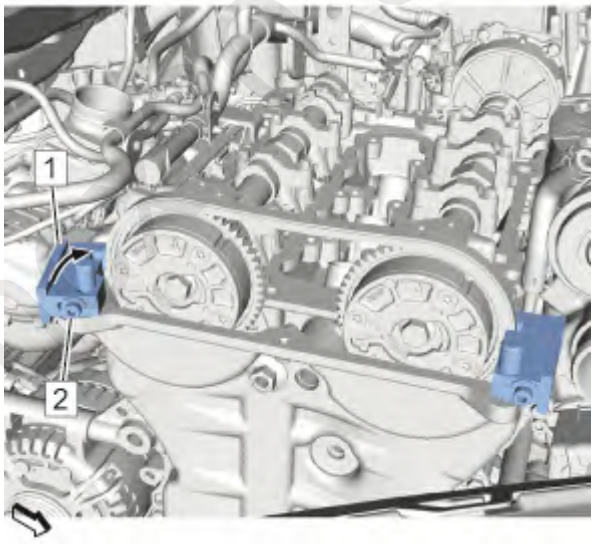


Fig. 53: Bolt And Retainer
Courtesy of GENERAL MOTORS COMPANY

20. While maintaining tension against the intake camshaft, install the **EN-51397-2** Timing Chain Retainer (1) to the intake side of the camshaft timing chain.
21. Tighten the bolt (2) of the **EN-51397-2** Timing Chain Retainer to N.m (lb in).
22. If removing the exhaust camshaft position actuator, proceed to step 28.

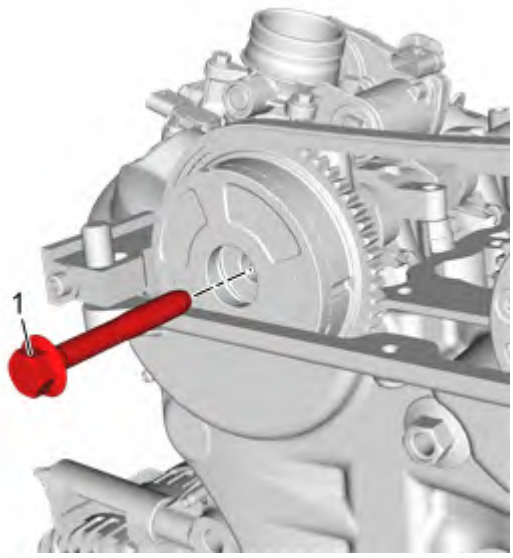


Fig. 54: Intake Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

23. Remove and DISCARD the intake camshaft position actuator bolt (1).

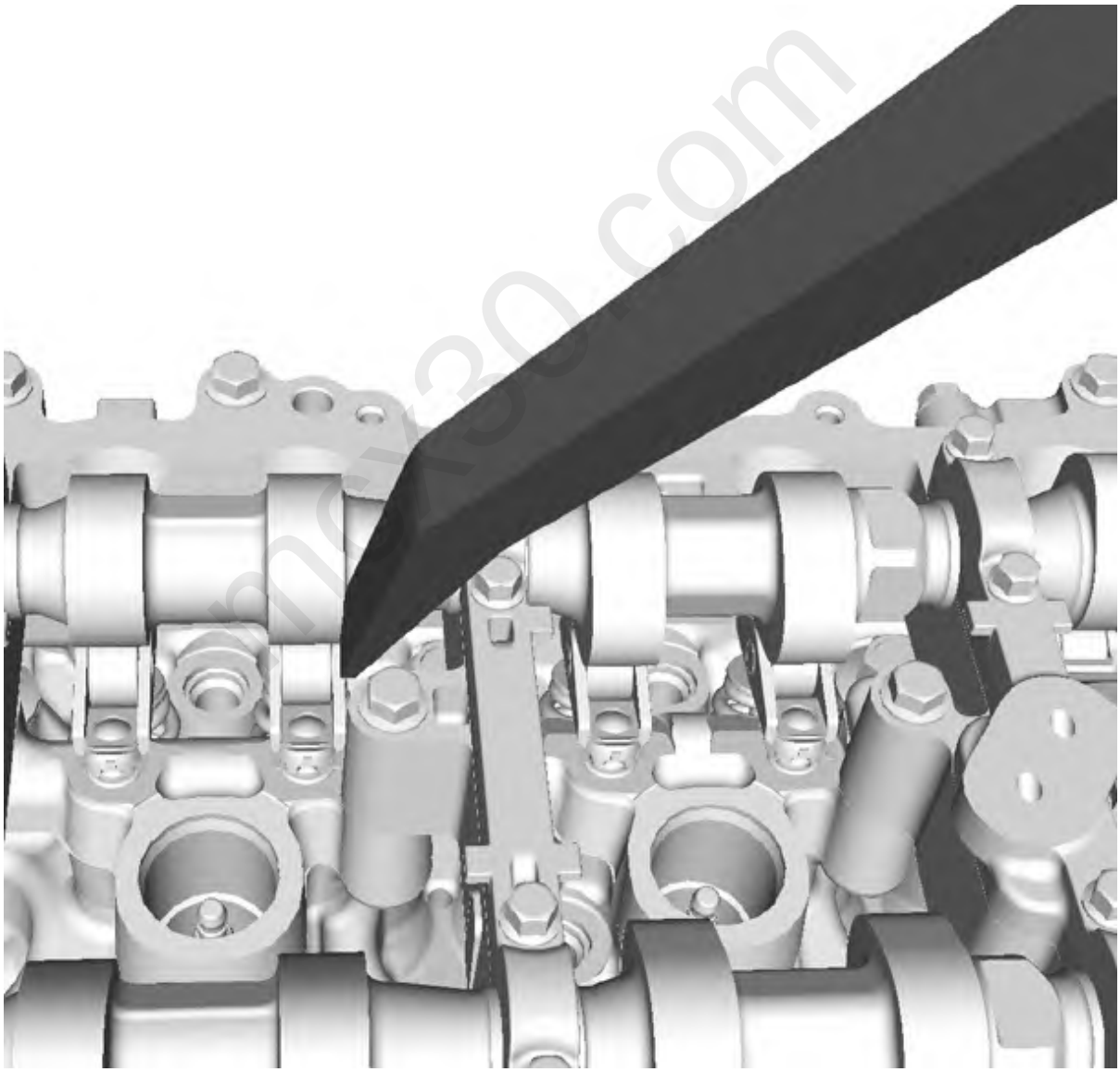


Fig. 55: Prying Camshaft Toward Rear/Flywheel End Of Engine
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Do not pry against the face of the camshaft position actuators or the position actuator retaining bolts as the position actuators will be damaged.**

24. Position a screwdriver or small pry bar between a camshaft cap and camshaft lobe. Carefully pry the camshaft to move as far as possible toward the rear/flywheel end of the engine to help gain clearance for actuator removal.

NOTE: **The camshaft timing chain will be held by the EN-51397 Timing Chain Retainers.**

25. Pull the camshaft actuator straight back and off the nose of the camshaft, leaving it in place temporarily with the timing chain.

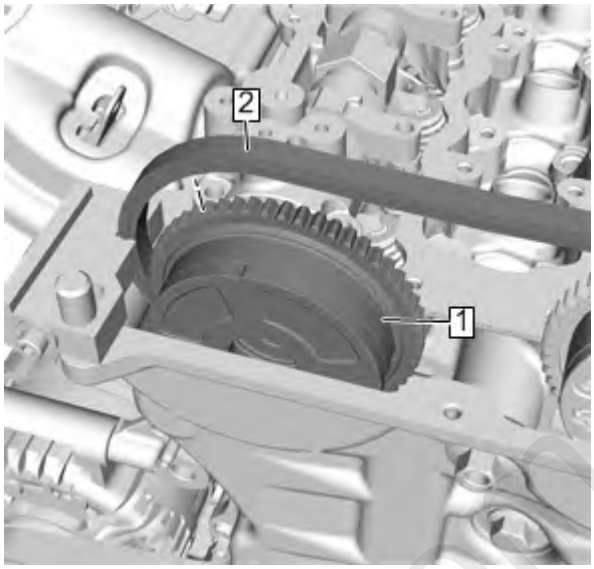


Fig. 56: Intake Camshaft Position Actuator And Timing Chain
Courtesy of GENERAL MOTORS COMPANY

26. Disengage and lower the intake camshaft position actuator (1) from the timing chain (2).

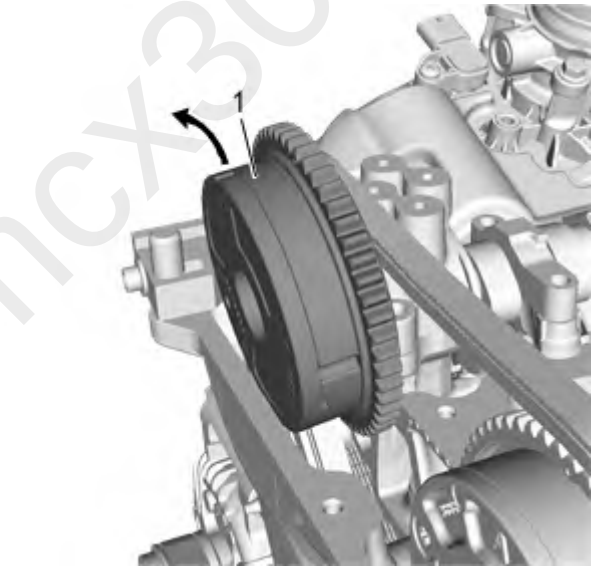


Fig. 57: Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

27. Remove Camshaft Position Actuator (1)

mcx30.com

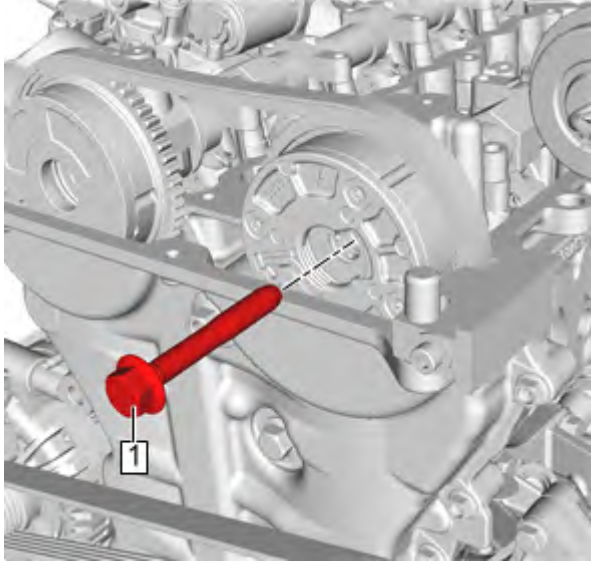


Fig. 58: Exhaust Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

28. Remove and DISCARD the exhaust camshaft position actuator bolt (1).

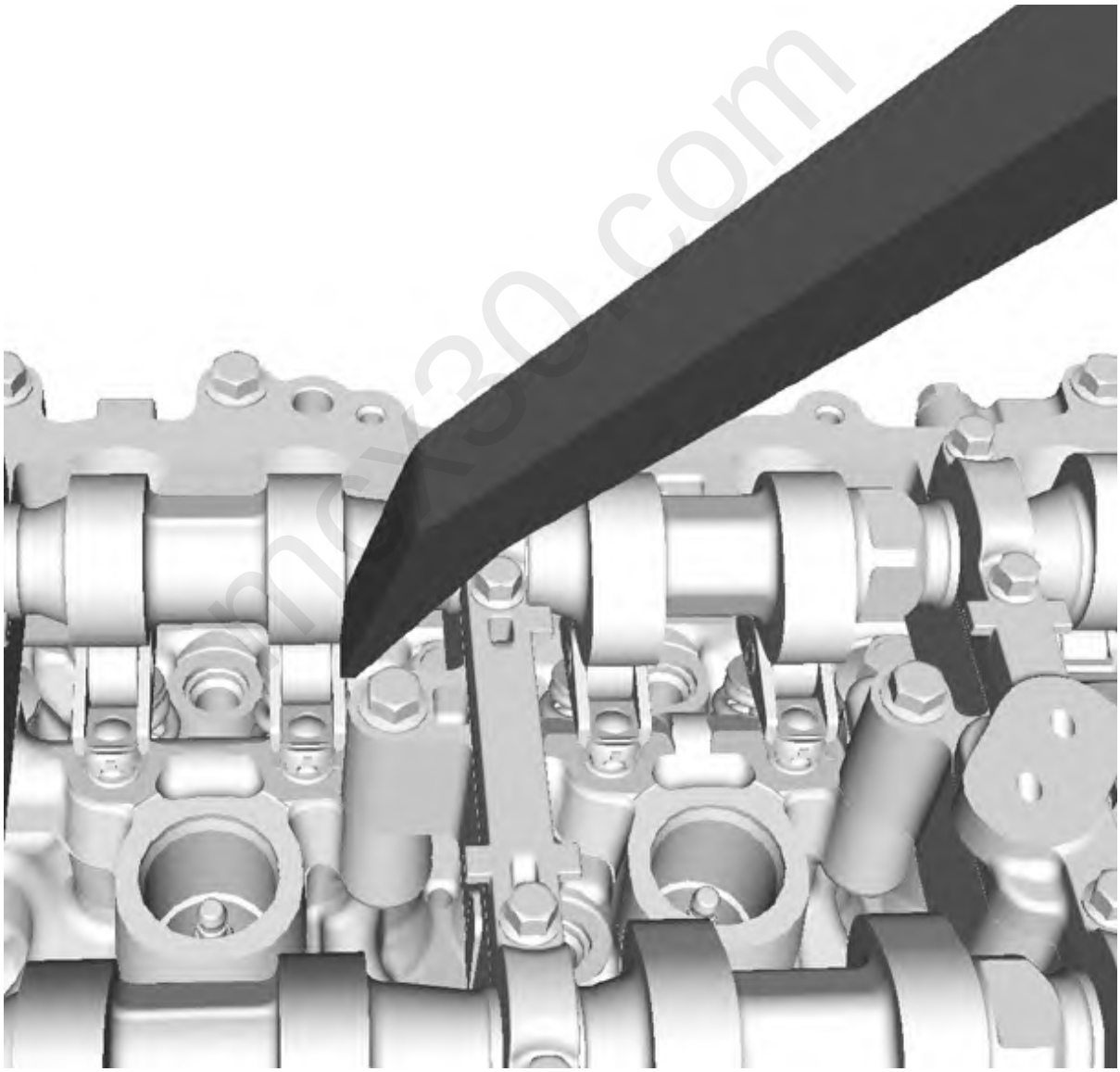


Fig. 59: Prying Camshaft Toward Rear/Flywheel End Of Engine
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Do not pry against the face of the camshaft position actuators or the position actuator retaining bolts as the position actuators will be damaged.**

29. Position a screwdriver or small pry bar between a camshaft cap and camshaft lobe. Carefully pry the camshafts to move as far as possible toward the rear/flywheel end of the engine to help gain clearance for actuator removal.

NOTE: **The camshaft timing chain will be held by the EN-51397 Timing Chain Retainers.**

30. Pull the camshaft actuator straight back and off the nose of the camshaft, leaving it in place temporarily with the timing chain.

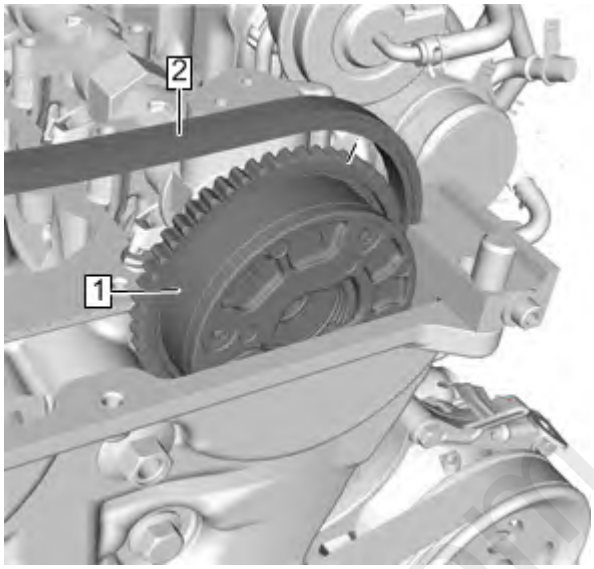


Fig. 60: Exhaust Camshaft Position Actuator And Timing Chain
Courtesy of GENERAL MOTORS COMPANY

31. Disengage and lower the exhaust camshaft position actuator (1) from the timing chain (2)

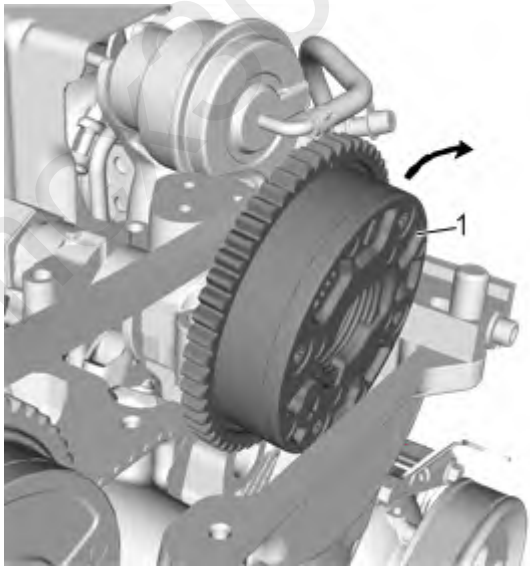


Fig. 61: Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

32. Remove Camshaft Position Actuator (1)

Installation Procedure

1. Apply lubricant to the back of the camshaft position actuators and front of the camshaft bearing cap. **Adhesives, Fluids, Lubricants, and Sealers**
2. If installing the intake camshaft position actuator, proceed to step 9.

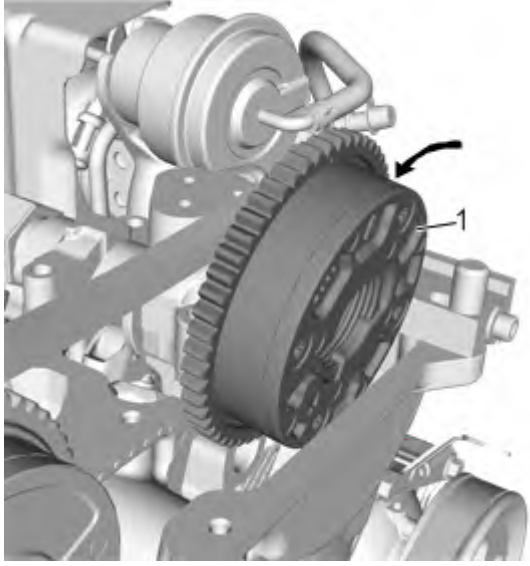


Fig. 62: Exhaust Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

NOTE: **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.**

3. Lower the exhaust camshaft position actuator (1) into place below the timing chain (2)

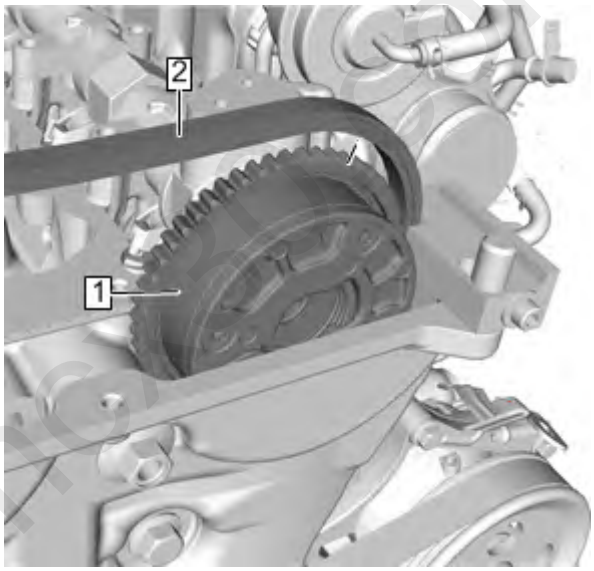


Fig. 63: Exhaust Camshaft Position Actuator And Timing Chain
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The timing mark on the camshaft position actuator needs to be aligned to the corresponding timing mark that was applied to the timing chain prior to removal of the camshaft position actuator.**

4. Raise the exhaust camshaft position actuator (1) to engage the timing chain (2).

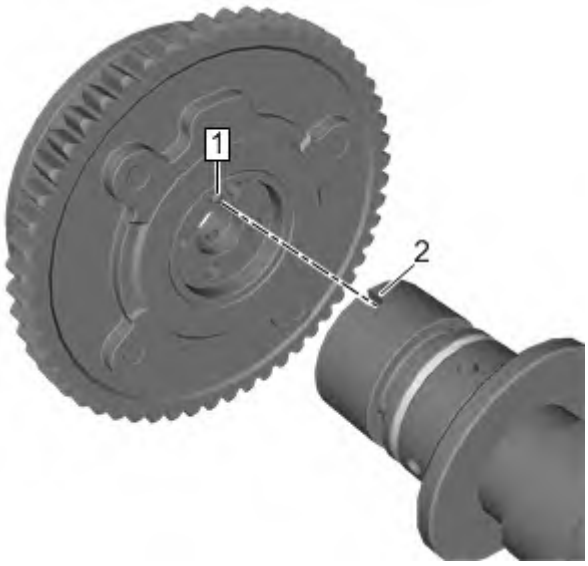


Fig. 64: Dowel Pin And Camshaft Slot
Courtesy of GENERAL MOTORS COMPANY

5. Adjust the camshaft until the dowel pin (1) aligns with the camshaft slot (2).

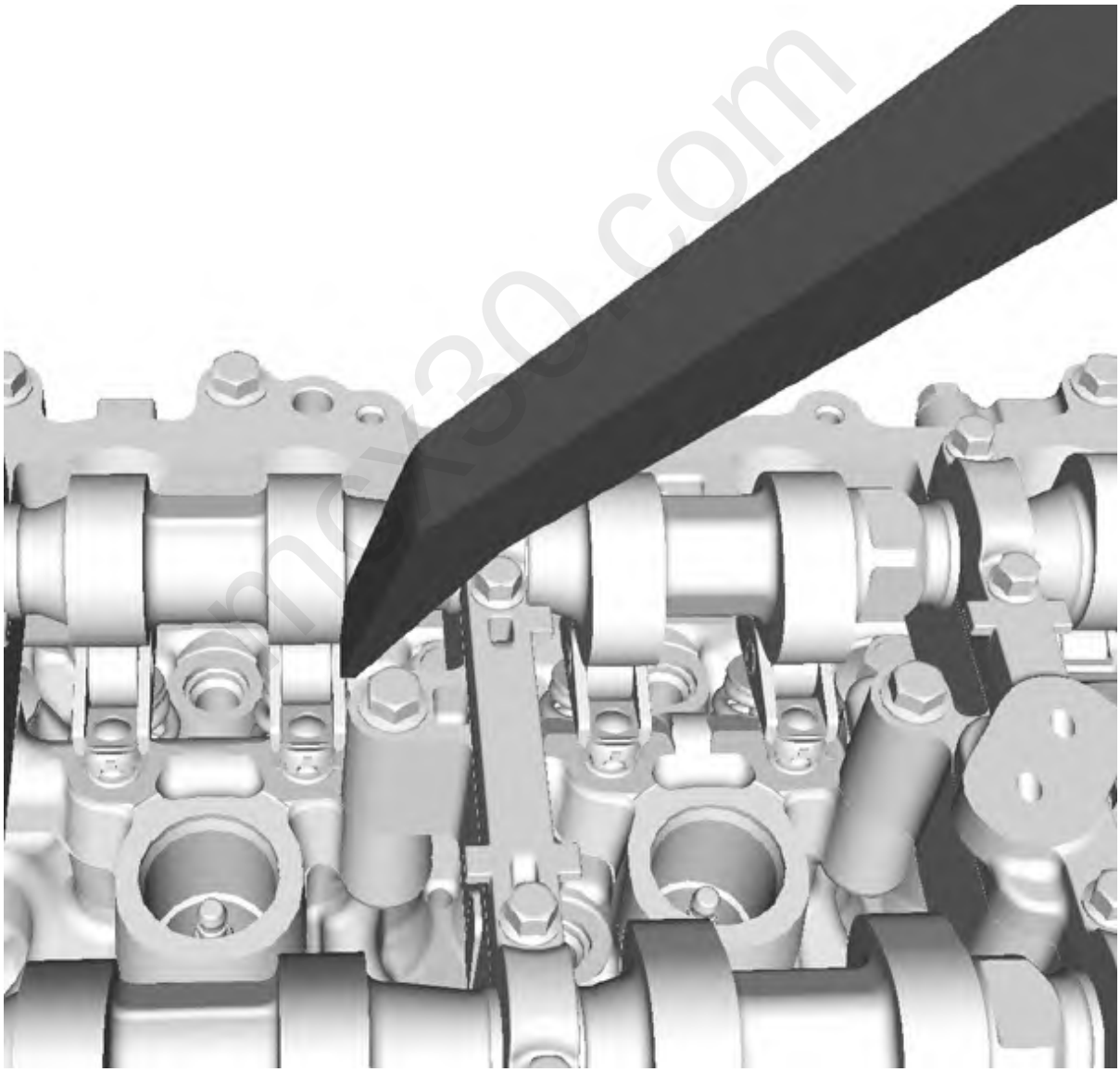


Fig. 65: Prying Camshaft Toward Rear/Flywheel End Of Engine
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Do not pry against the face of the camshaft position actuators or the position actuator retaining bolts as the position actuators will be damaged.**

6. Position a screwdriver or small pry bar between a camshaft cap and camshaft lobe. Carefully pry the camshaft forward.
7. Ensure the exhaust camshaft position actuator is seated properly on the end of the camshaft.

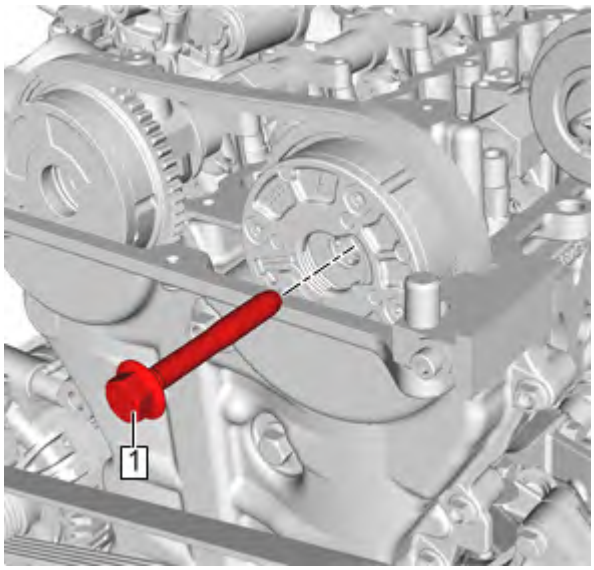


Fig. 66: Exhaust Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install the camshaft position actuator bolt snugly but to not torque at this step.**

8. Install the NEW exhaust camshaft position actuator bolt (1).

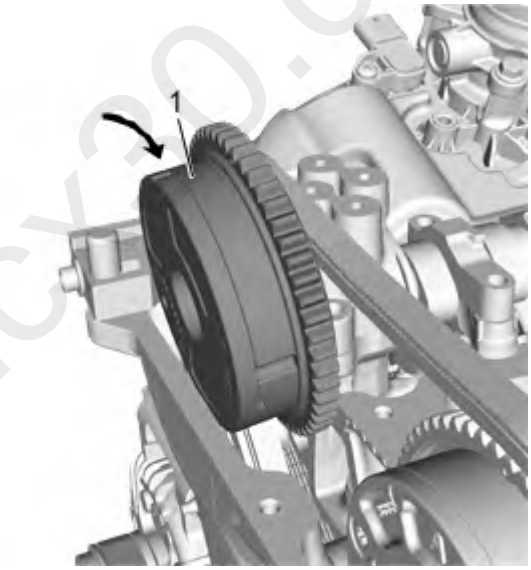


Fig. 67: Intake Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

NOTE: **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.**

9. Lower the intake camshaft position actuator (1) into place below the timing chain.

mcy30.com

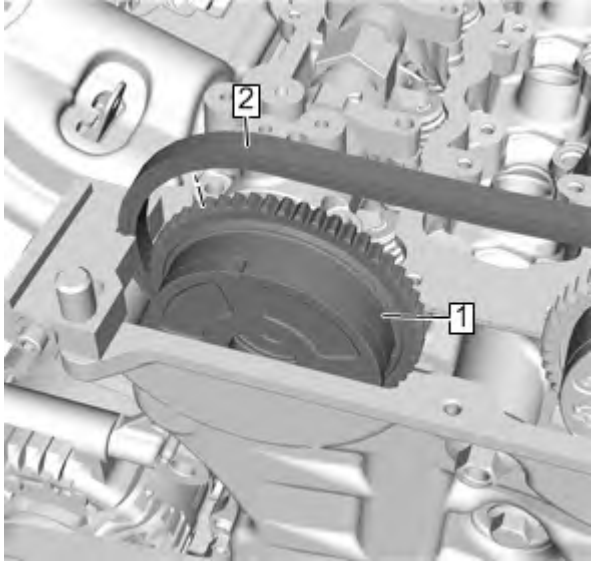


Fig. 68: Intake Camshaft Position Actuator And Timing Chain
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The timing mark on the camshaft position actuator needs to be aligned to the corresponding timing mark that was applied to the timing chain prior to removal of the camshaft position actuator.**

10. Raise the intake camshaft position actuator (1) to engage the timing chain (2).

Fig. 69: Dowel Pin And Camshaft Slot
Courtesy of GENERAL MOTORS COMPANY

11. Adjust the camshaft until the dowel pin (1) aligns with the camshaft slot (2).

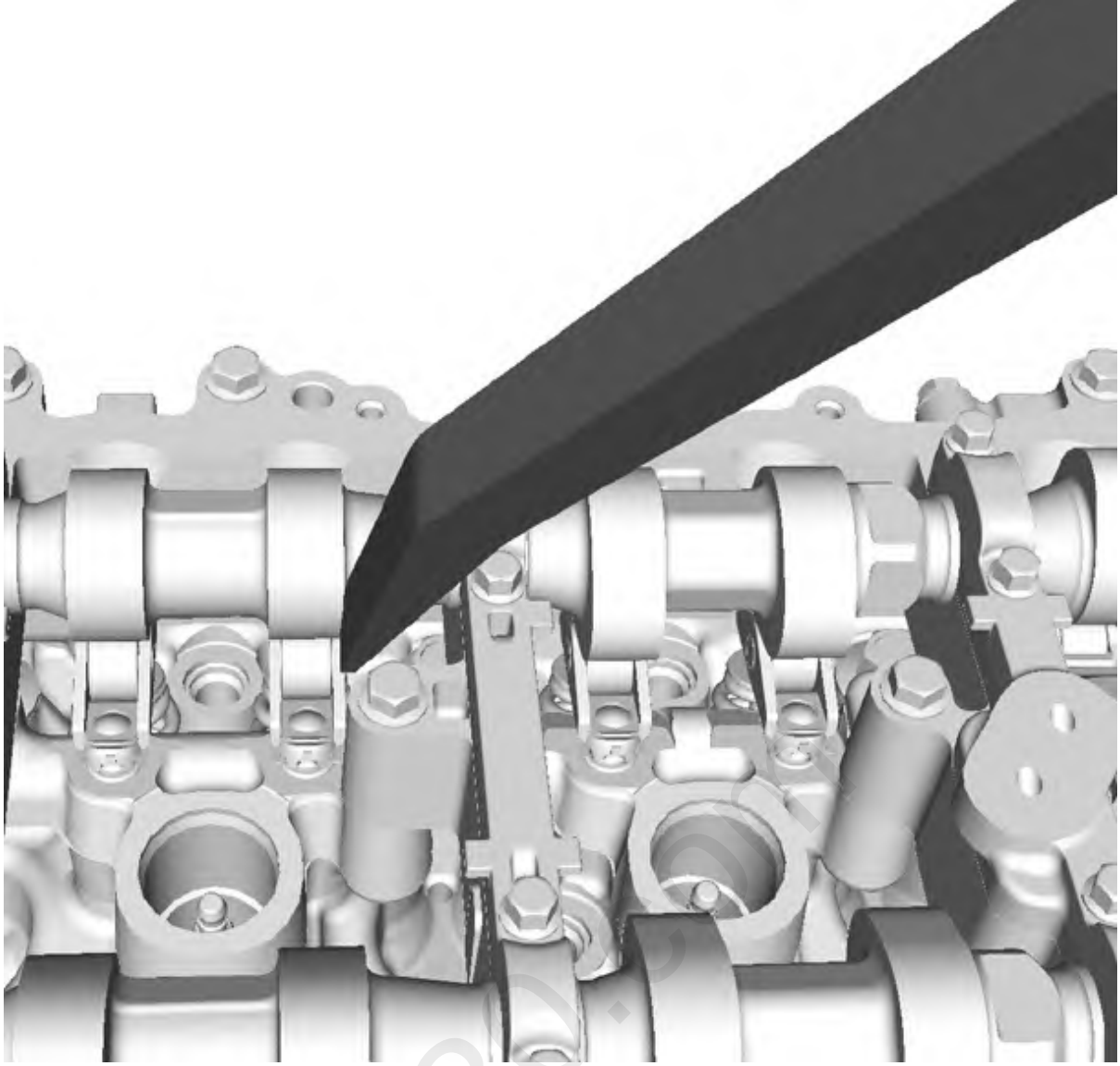


Fig. 70: Prying Camshaft Toward Rear/Flywheel End Of Engine
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Do not pry against the face of the camshaft position actuators or the position actuator retaining bolts as the position actuators will be damaged.**

12. Position a screwdriver or small pry bar between a camshaft cap and camshaft lobe. Carefully pry the camshaft forward.
13. Ensure the intake camshaft position actuator is seated properly on the end of the camshaft.

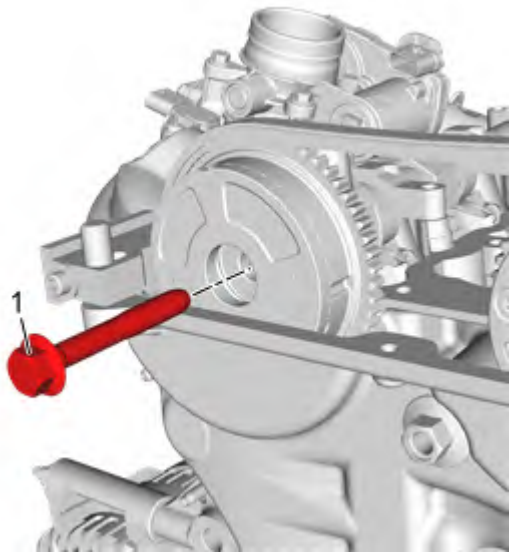


Fig. 71: Intake Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install the camshaft position actuator bolt snugly but to not torque at this step.**

14. Install the NEW intake camshaft position actuator bolt (1).

Fig. 72: Camshaft Position Actuator Marks And Timing Chain Marks
Courtesy of GENERAL MOTORS COMPANY

15. Ensure the marks of the camshaft position actuators (2) are matched to the marks of the camshaft timing chain (1).

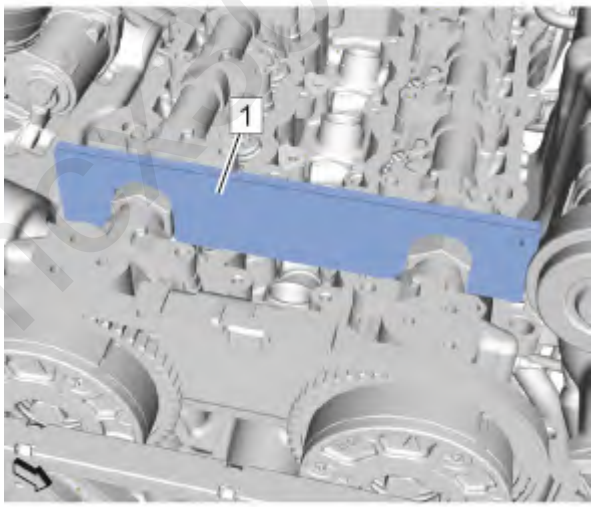


Fig. 73: Camshaft Holder
Courtesy of GENERAL MOTORS COMPANY

16. Install the **EN-51367** Camshaft Locking Tool (1).

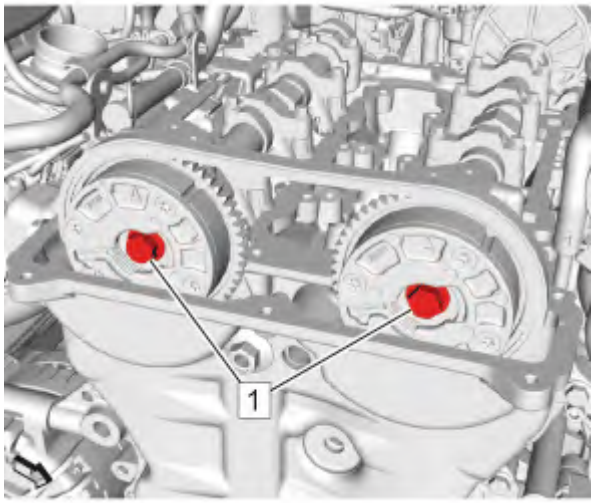


Fig. 74: Camshaft Position Actuator Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Torque-to-Yield Fastener Caution .**

NOTE: **Counterhold the camshaft with a suitable tool.**

17. Camshaft Position Actuator Bolt (1) - Tighten

Tighten

1. First pass to 20 N.m (15 lb ft)
2. Final pass to an additional 90 degrees using the **EN-45059** Torque Angle Sensor Kit

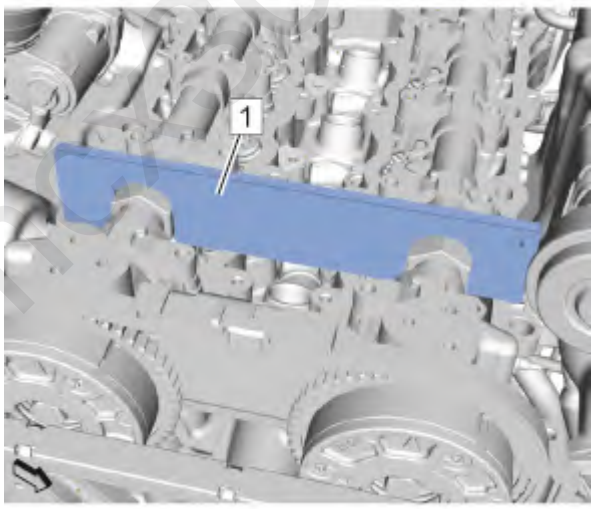


Fig. 75: Camshaft Holder
Courtesy of GENERAL MOTORS COMPANY

18. Remove the **EN-51367** Camshaft Locking Tool (1).

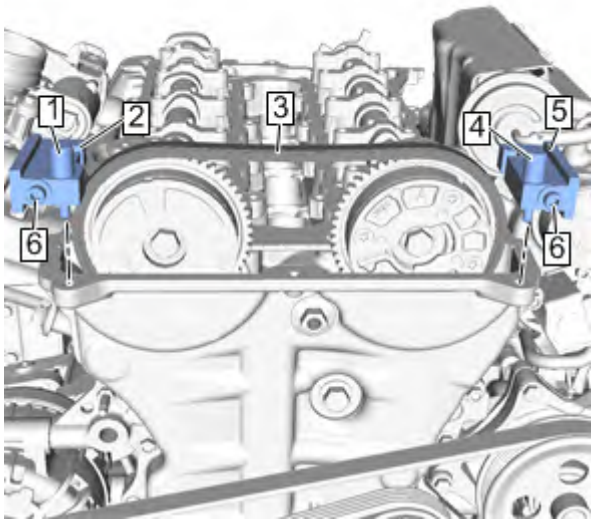


Fig. 76: Timing Chain Retainer And Camshaft Timing Chain
Courtesy of GENERAL MOTORS COMPANY

19. Loosen the bolt.(6)[2x]
20. Loosen the bolt.(1, 4)[2x]
21. Remove **EN-51397-2** Timing Chain Retainer (2).
22. Remove **EN-51397-1** Timing Chain Retainer (5).
23. Install Timing Chain Upper Guide - **Timing Chain Upper Guide Replacement**
24. Check the position of the crankshaft, camshaft and camshaft position actuator.

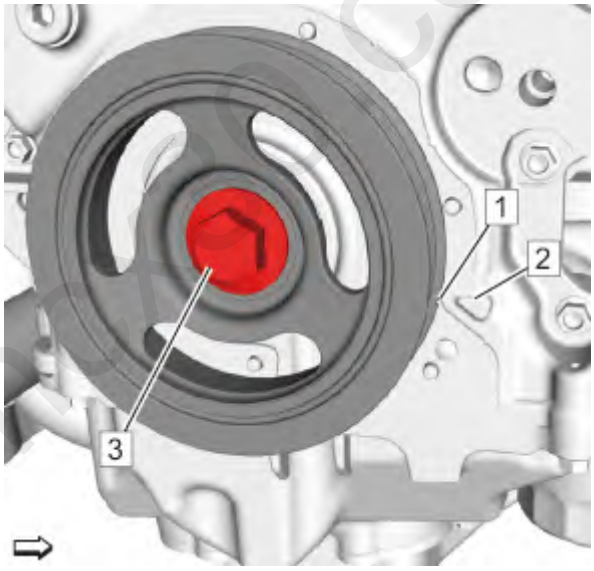


Fig. 77: Crankshaft Balancer Markings
Courtesy of GENERAL MOTORS COMPANY

25. Turn crankshaft 720 degrees in the direction of engine rotation using the crankshaft balancer bolt (3).
26. Adjust the engine to cylinder 1 TDC of combustion stroke. Using the crankshaft balancer bolt (3), rotate the crankshaft in direction of engine rotation until the markings (1, 2) line up.

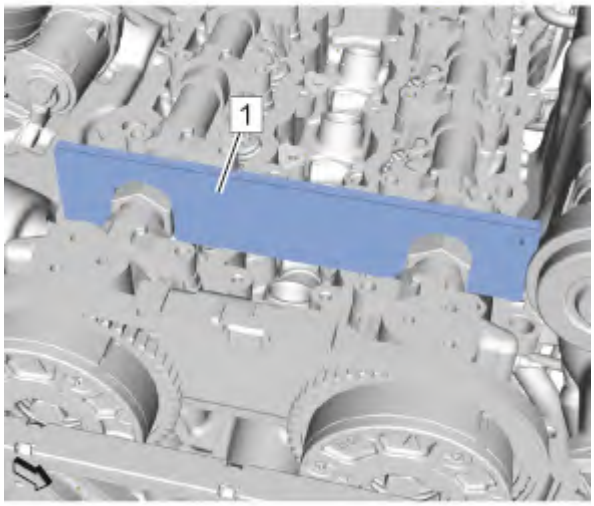


Fig. 78: Camshaft Holder
Courtesy of GENERAL MOTORS COMPANY

27. Install the **EN-51367** Camshaft Locking Tool.
28. If the **EN-51367** Camshaft Locking Tool can be installed, the engine timing is properly adjusted.
29. Remove the **EN-51367** Camshaft Locking Tool

NOTE: **Perform step 19 if the Intake camshaft position actuator was removed.**

30. Install Fuel Pump - Fuel Pump Replacement
31. Install Camshaft Cover - Camshaft Cover Replacement
32. Install Air Cleaner Assembly - Air Cleaner Assembly Replacement

EXHAUST CAMSHAFT REPLACEMENT

Removal Procedure

1. Remove Camshaft Position Actuator - Camshaft Position Actuator Replacement

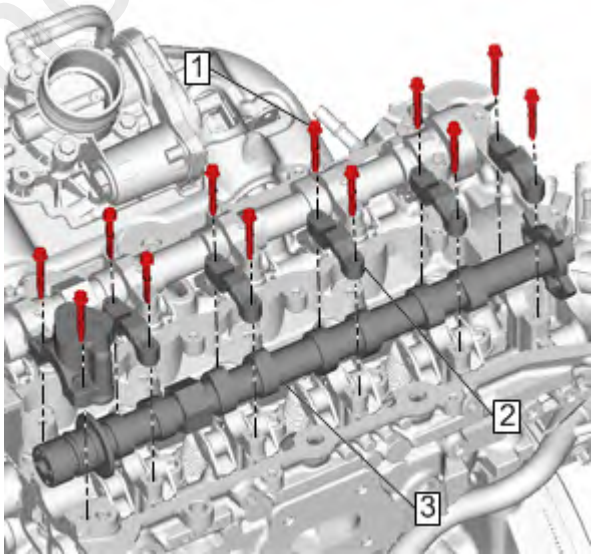


Fig. 79: Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Many internal engine components will develop specific wear patterns on their friction surfaces. Components MUST be separated, marked, or organized in a way to ensure installation to their original location and position. Take precautions in order to prevent interchanging of parts.**

mcx30.com

2. Tag or mark each part immediately after removal. Indicate location, direction, and orientation when necessary.
3. Loosen the 12 camshaft bearing cap bolts (1) 1/2 turn working from outside to inside in a spiral in direction.

NOTE: **Observe the markings on the bearing caps. Ensure that each bearing cap is marked in order to identify its location and direction.**

4. Remove the camshaft bearing cap bolts.(1)[12x]
5. Remove the camshaft bearing caps.(2)[6x]
6. Remove the exhaust camshaft.(3)

Installation Procedure

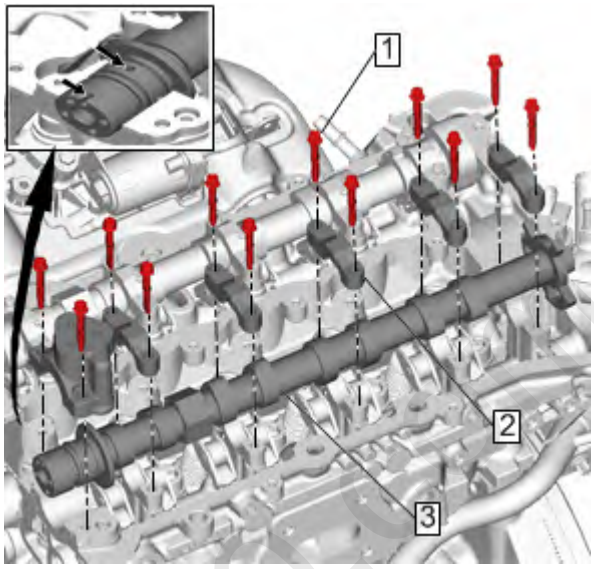


Fig. 80: Exhaust Camshaft
Courtesy of GENERAL MOTORS COMPANY

1. Coat the exhaust camshaft with engine oil. **Adhesives, Fluids, Lubricants, and Sealers**

NOTE: **Ensure that the camshaft notch at the front of the camshaft indicated by arrow is in the 12 O ' clock position before installing the camshaft caps.**

2. Install the exhaust camshaft (3) in the cylinder head.
3. Prior to installing the camshaft bearing caps, rotate the oil seal in the groove of the number one camshaft journal so that the split line is approximately at the 12 O ' clock position as indicated by the arrow.

NOTE: **Ensure the caps are installed in the original location and position.**

4. Lubricate the camshaft bearing caps (2) and the bolts (1) with clean engine oil. **Adhesives, Fluids, Lubricants, and Sealers**
5. Install the camshaft bearing caps.(2)[6x]
6. Hand start the 12 camshaft bearing cap bolts (1).

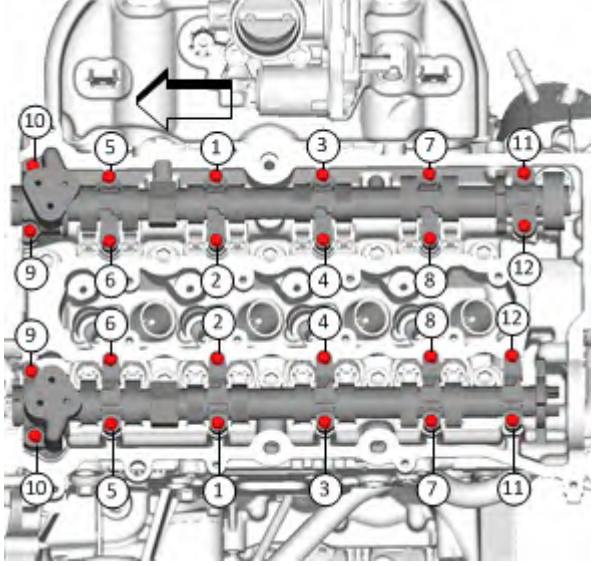


Fig. 81: Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

7. Tighten the bearing cap bolts (1) in sequence three turns each until the caps are seated.
8. Tighten the bearing cap bolts (1) in sequence as shown to 12 N.m (106 lb in).
9. Install Camshaft Position Actuator - Camshaft Position Actuator Replacement

INTAKE CAMSHAFT REPLACEMENT

Removal Procedure

1. Remove Camshaft Position Actuator Replacement.

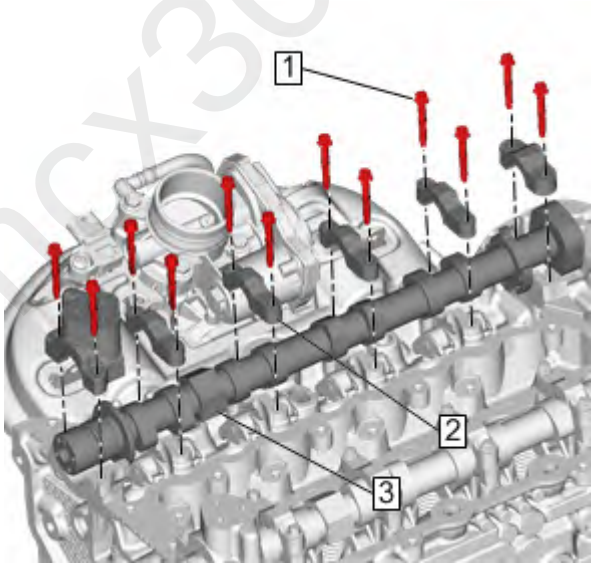


Fig. 82: Camshaft Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Many internal engine components will develop specific wear patterns on their friction surfaces. Components MUST be separated, marked, or organized in a way to ensure installation to their original location and position. Take precautions in order to prevent interchanging of parts.**

2. Tag or mark each part immediately when removed. Indicate location, direction, or orientation when necessary.
3. Loosen the 12 camshaft bearing cap bolts (1) 1/2 turn working from outside to inside in spiral steps.

mcx30.com

NOTE: **Observe the markings on the bearing caps. Ensure that each bearing cap is marked in order to identify its location and direction.**

4. Remove the camshaft bearing cap bolts.(1)[12x]
5. Remove the camshaft bearing caps.(2)[6x]
6. Remove the intake camshaft.(3)

Installation Procedure

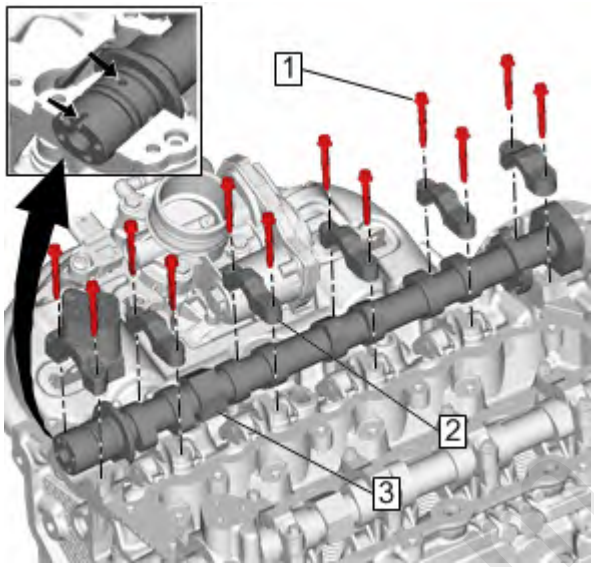


Fig. 83: Intake Camshaft
Courtesy of GENERAL MOTORS COMPANY

1. Coat the intake camshaft with engine oil. Refer to:**Adhesives, Fluids, Lubricants, and Sealers**

NOTE: **Ensure that the camshaft notch at the front of the camshaft indicated by arrow is in the 12 O ' clock position before installing the camshaft caps.**

2. Install the intake camshaft (3) in the cylinder head.
3. Prior to installing the camshaft bearing caps, rotate the oil seal in the groove of the number one camshaft journal so that the split line is approximately at the 12 O ' clock position as indicated by the arrow

NOTE: **Ensure the caps are installed in the original location and position.**

4. Lubricate the camshaft bearing caps (2) and the bolts (1) with clean engine oil. Refer to:**Adhesives, Fluids, Lubricants, and Sealers**
5. Install the camshaft bearing caps.(2)[6x]
6. Hand start the 12 camshaft bearing cap bolts (1).

mx30.com

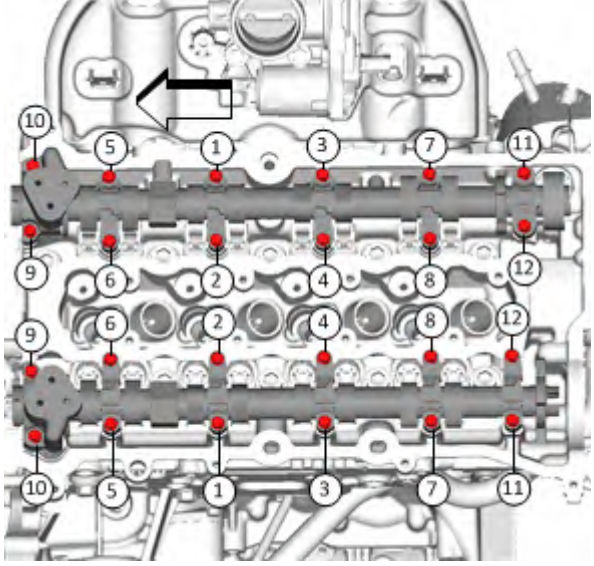


Fig. 84: Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

7. Tighten the bearing cap bolts (1) in sequence three turns each until the caps are seated.
8. Tighten the bearing cap bolts in sequence as shown to 12 N.m (106 lb in).
9. Install Camshaft Position Actuator Replacement.

CAMSHAFT TIMING CHAIN REPLACEMENT

Special Tools

EN-51367 Camshaft Holder

Equivalent regional tools:Special Tools

Removal Procedure

1. Remove Camshaft Cover Replacement.

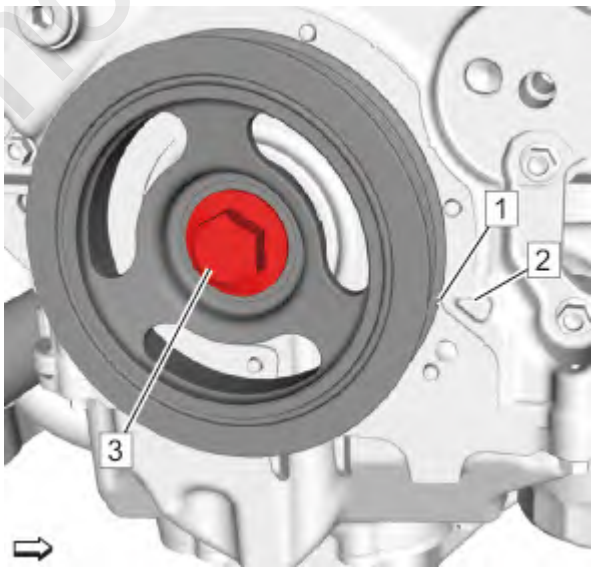


Fig. 85: Crankshaft Balancer Markings
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Adjust the engine to cylinder 1 top dead center (TDC) of combustion stroke. Set crankshaft in direction of engine rotation until the markings (1, 2) line up.**

2. Rotate at the crankshaft balancer bolt (3).

mcx30.com

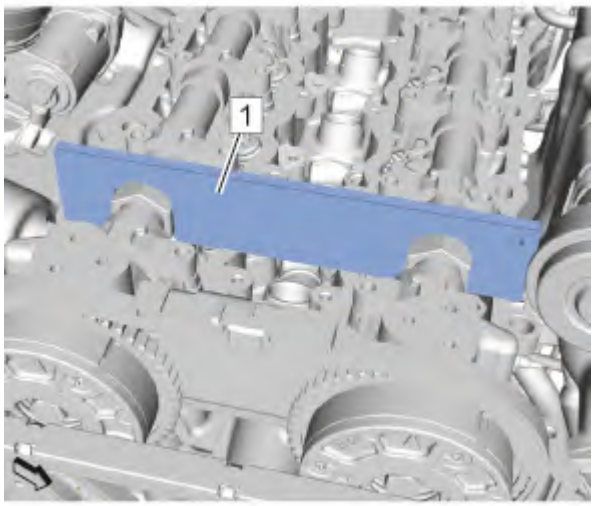


Fig. 86: Camshaft Holder
Courtesy of GENERAL MOTORS COMPANY

3. Install the **EN-51367** holder (1).
4. Remove **Engine Front Cover Replacement**
5. Remove **Timing Chain Upper Guide Replacement**

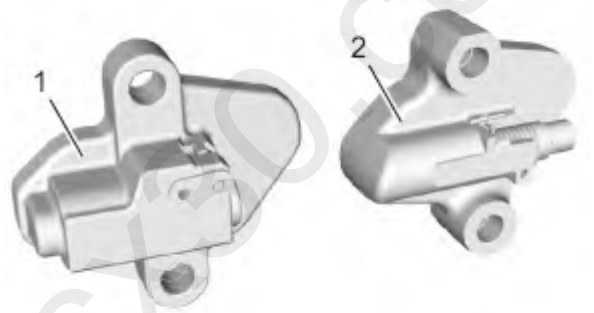


Fig. 87: Tensioner Designs
Courtesy of GENERAL MOTORS COMPANY

6. The engine has one of the two tensioner designs (1, 2). Each design has a different release mechanism and position.

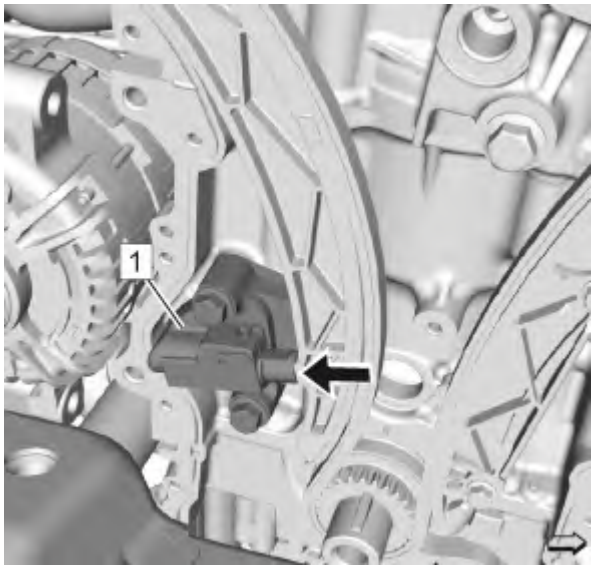


Fig. 88: Timing Chain Tensioner In Service Position
Courtesy of GENERAL MOTORS COMPANY

7. Fix the timing chain tensioner with design 1 (1) in service position:

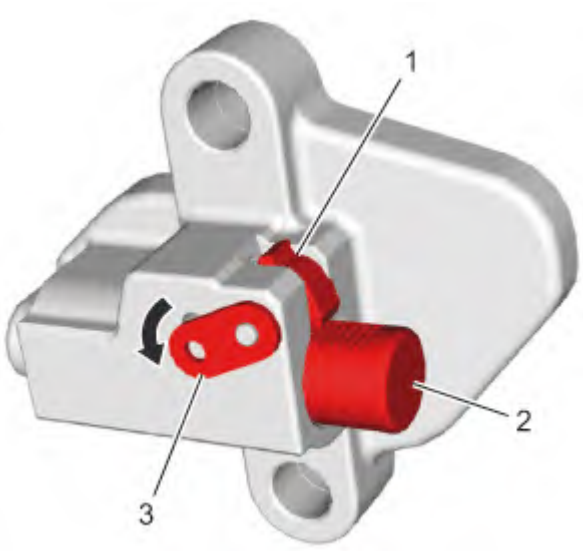


Fig. 89: Releasing Tension From Piston
Courtesy of GENERAL MOTORS COMPANY

1. Slightly release tension from the piston (2) until bar (1) can be unlocked by rotating the lever (3) in direction of arrow.

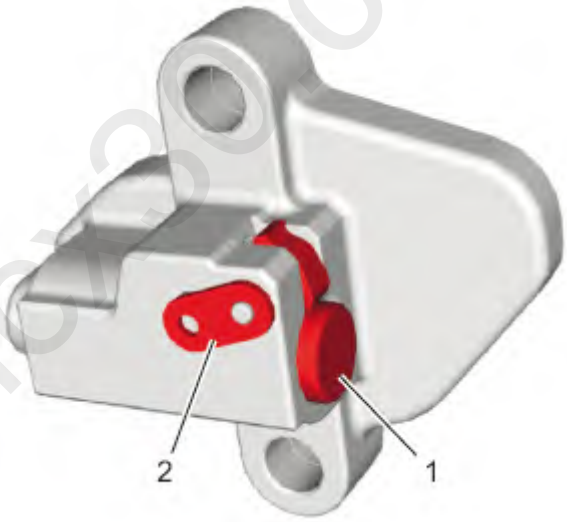


Fig. 90: Pushing Back Piston
Courtesy of GENERAL MOTORS COMPANY

2. Entirely push back the piston (1) until the tensioner lever (2) cannot be locked in this position.

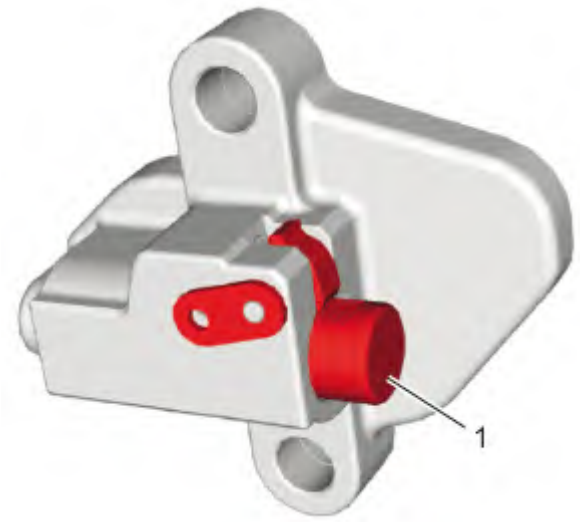


Fig. 91: Piston
Courtesy of GENERAL MOTORS COMPANY

3. Release tension from the piston (1) until it releases for three ratchets. The three ratchets can be noticed by the click noises.

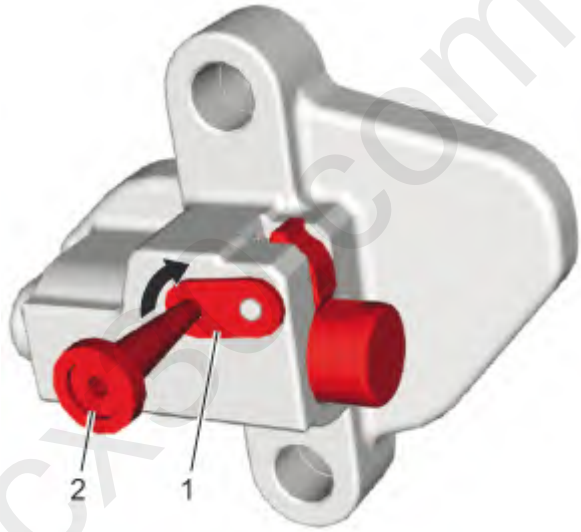


Fig. 92: Lever And Fixing Pin
Courtesy of GENERAL MOTORS COMPANY

4. Apply tension to the piston until the lever (1) is rotated back into the locking position where the bore in the lever aligns with the bore in the tensioner housing.
5. Fix the lever in this position with a suitable fixing pin (2).

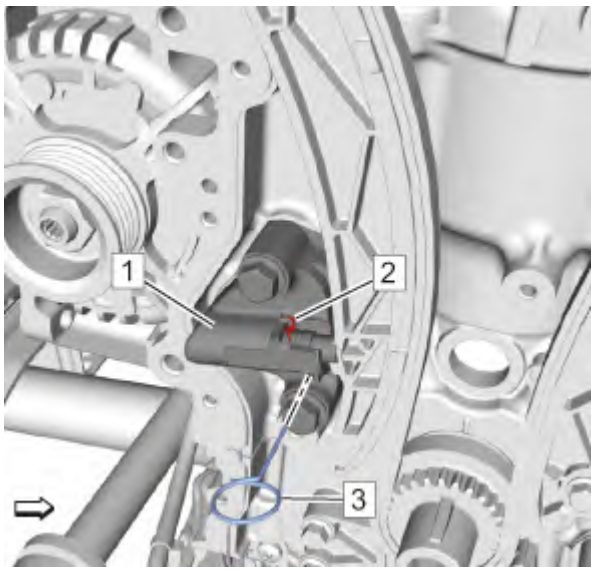


Fig. 93: Tensioner Design 2
Courtesy of GENERAL MOTORS COMPANY

6. The style of tensioner design 2 (1) can be released by using a punch and pressing on the release clip (2).
7. Secure the timing chain tensioner with suitable sized drill bit (3).

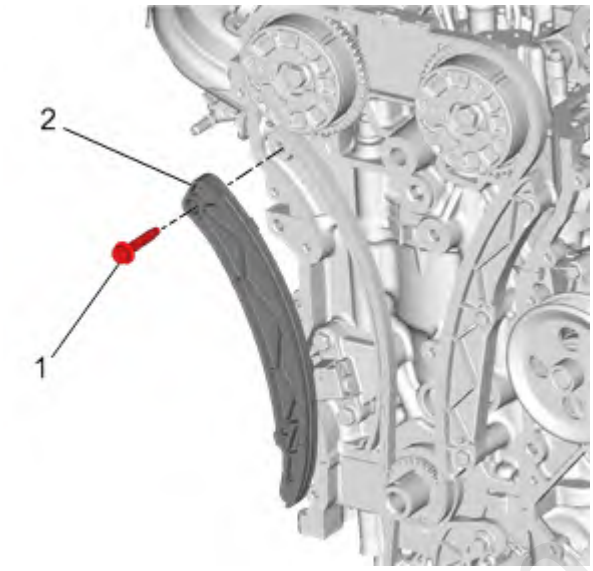


Fig. 94: Timing Chain Tensioner Shoe Fastener
Courtesy of GENERAL MOTORS COMPANY

8. Remove Timing Chain Tensioner Shoe Bolt(1)
9. Remove Timing Chain Tensioner Shoe(2)

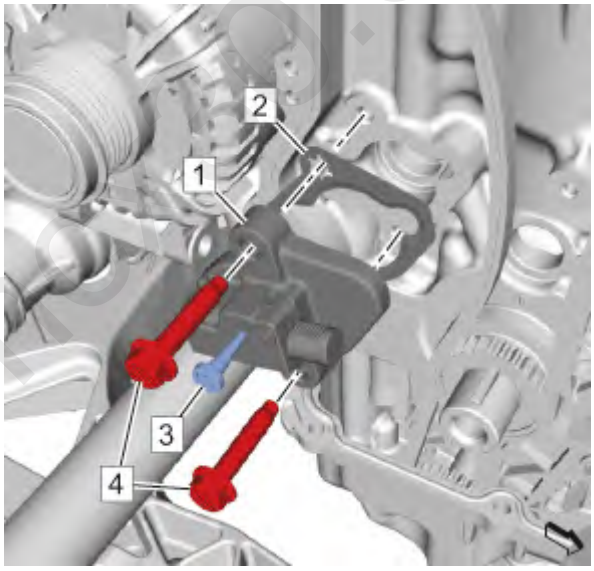


Fig. 95: Timing Chain Tensioner Tool, Timing Chain Tensioner, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Both tensioner designs have the same removal procedure. Each tensioner design uses a different fixing procedure and fixing tool see steps 7.1 - 7.7.**

10. Ensure the correct fixation of the tool (3) is used.
11. Remove Timing Chain Tensioner Bolt (4)
12. Remove Timing Chain Tensioner (1)
13. Remove and DISCARD the gasket. (2)

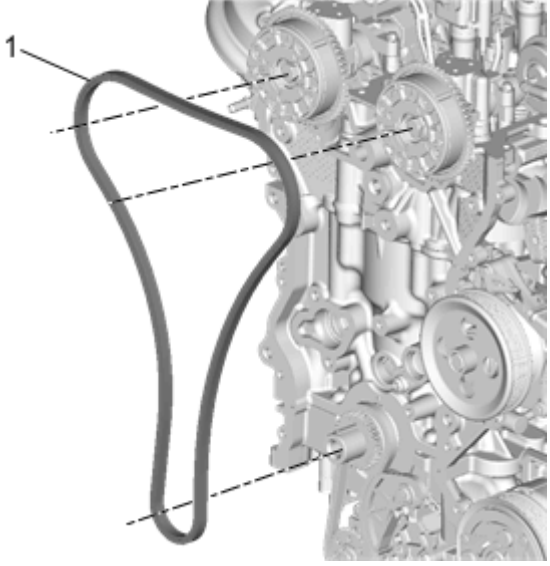


Fig. 96: Timing Chain
Courtesy of GENERAL MOTORS COMPANY

14. Remove Timing Chain (1)
15. If reinstalling timing components, clean and inspect as needed prior to reinstalling. **Camshaft Timing Chain and Sprocket Cleaning and Inspection**

Installation Procedure

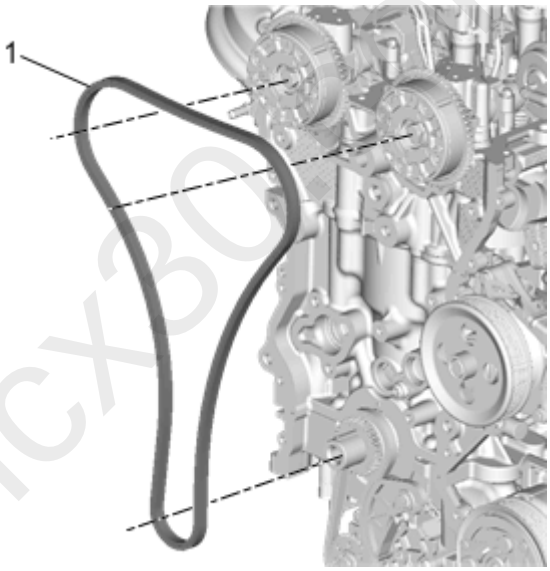


Fig. 97: Timing Chain
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the actuator timing marks are approximately the 12 O'clock position.**

1. Install Timing Chain (1).

mcx30.com

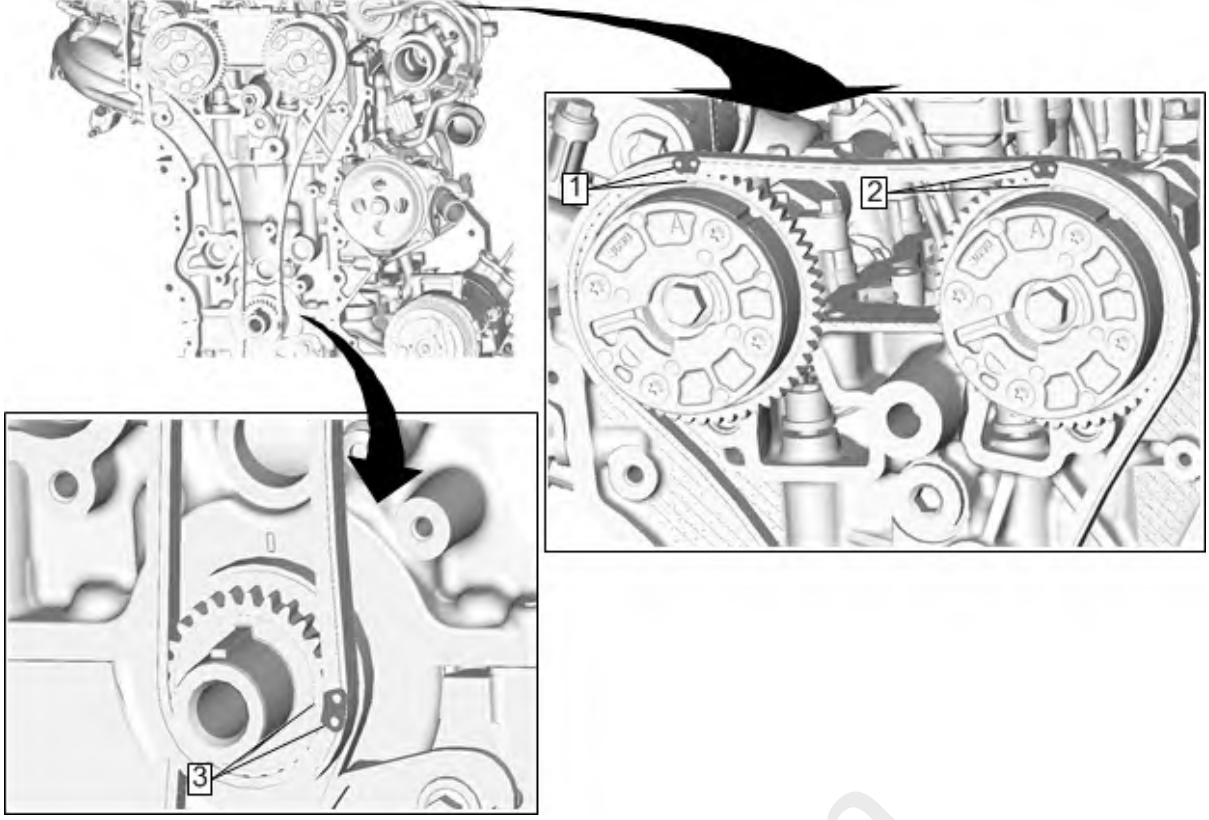


Fig. 98: Timing Chain Marks
Courtesy of GENERAL MOTORS COMPANY

2. Ensure that the colored link (3) matches to the arrow on the crankshaft sprocket.
3. Ensure that the colored links (1, 2) match to the marks on the camshaft position adjuster actuators.

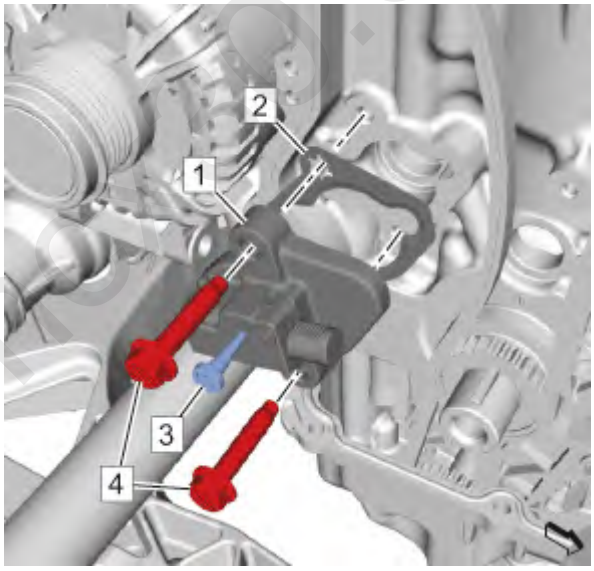


Fig. 99: Timing Chain Tensioner Tool, Timing Chain Tensioner, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

4. Install a NEW gasket.(2)
5. Install Timing Chain Tensioner(1).

CAUTION: **Refer to Fastener Caution .**

6. Install Timing Chain Tensioner Bolt (4) and tighten 25 N.m (18 lb ft)[2x].

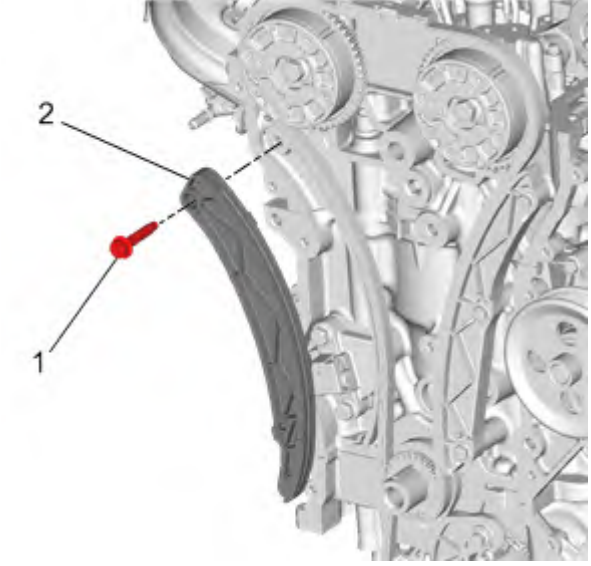


Fig. 100: Timing Chain Tensioner Shoe Fastener
Courtesy of GENERAL MOTORS COMPANY

7. Install Timing Chain Tensioner Shoe (2)
8. Install Timing Chain Tensioner Shoe Bolt (1) and tighten 25 N.m (18 lb ft)
9. Remove the suitable tool from the timing chain tensioner.

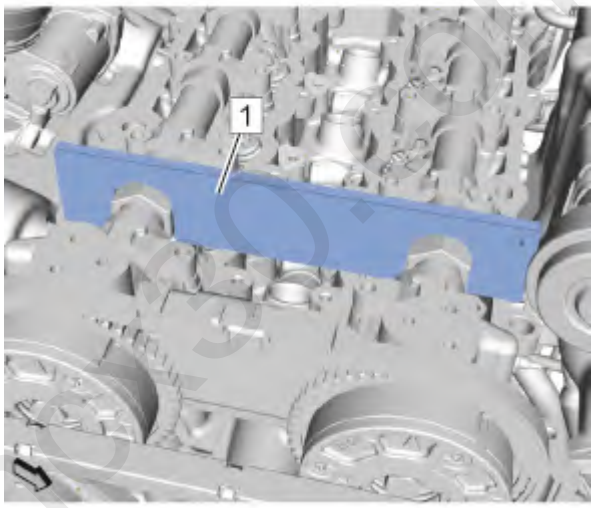


Fig. 101: Camshaft Holder
Courtesy of GENERAL MOTORS COMPANY

10. Remove the **EN-51367** holder (1).
11. Install **Timing Chain Upper Guide Replacement**.
12. Check the position of the crankshaft, camshaft and camshaft position actuator adjuster.
    1. Install the engine front cover with 4 bolts and the crankshaft balancer.

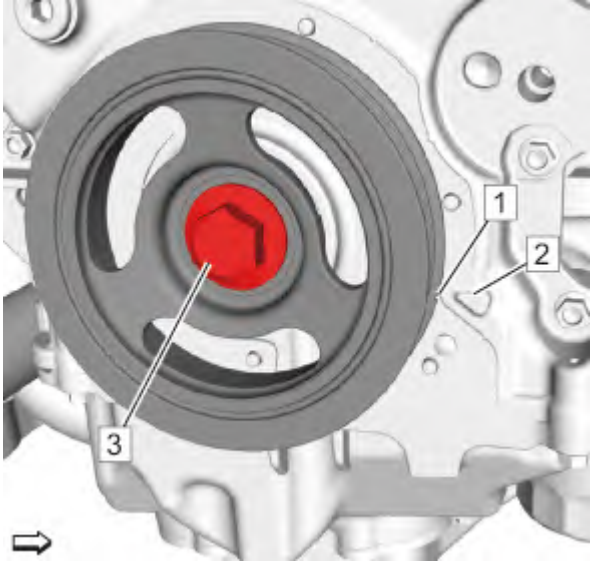


Fig. 102: Crankshaft Balancer Markings
Courtesy of GENERAL MOTORS COMPANY

2. Turn crankshaft 720 degrees in the direction of engine rotation by the crankshaft balancer bolt (2).

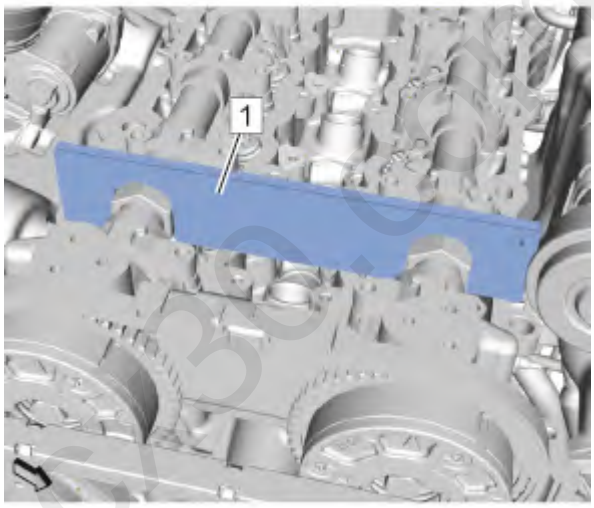


Fig. 103: Camshaft Holder
Courtesy of GENERAL MOTORS COMPANY

13. Install the **EN-51367** holder (1).
14. If the **EN-51367** holder (1) can be installed, the engine timing is properly adjusted.
15. Remove the **EN-51367** holder.
16. Remove the engine front cover and crankshaft balancer.
17. Install **Engine Front Cover Replacement**
18. Install **Camshaft Cover Replacement**

CAMSHAFT TIMING CHAIN INSPECTION

Special Tools

EN-51367 Camshaft Holder

Equivalent regional tools:**Special Tools**

1. Remove Camshaft Cover - **Camshaft Cover Replacement**
2. Remove Front Wheelhouse Liner-Right Side - **Front Wheelhouse Liner Replacement - Right Side (Equinox)** **Front Wheelhouse Liner Replacement - Right Side (Terrain)**

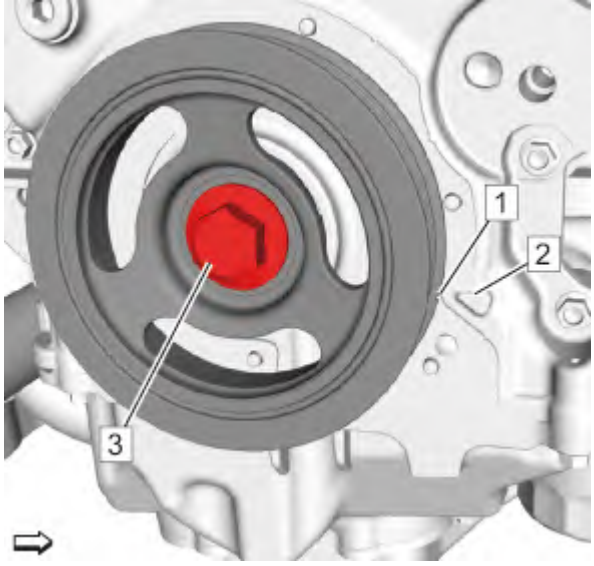


Fig. 104: Crankshaft Balancer Markings
Courtesy of GENERAL MOTORS COMPANY

3. Adjust the engine to cylinder 1 top dead center (TDC) of combustion stroke. Using the balancer bolt (3) rotate the crankshaft in direction of engine rotation until the markings (1, 2) line up.

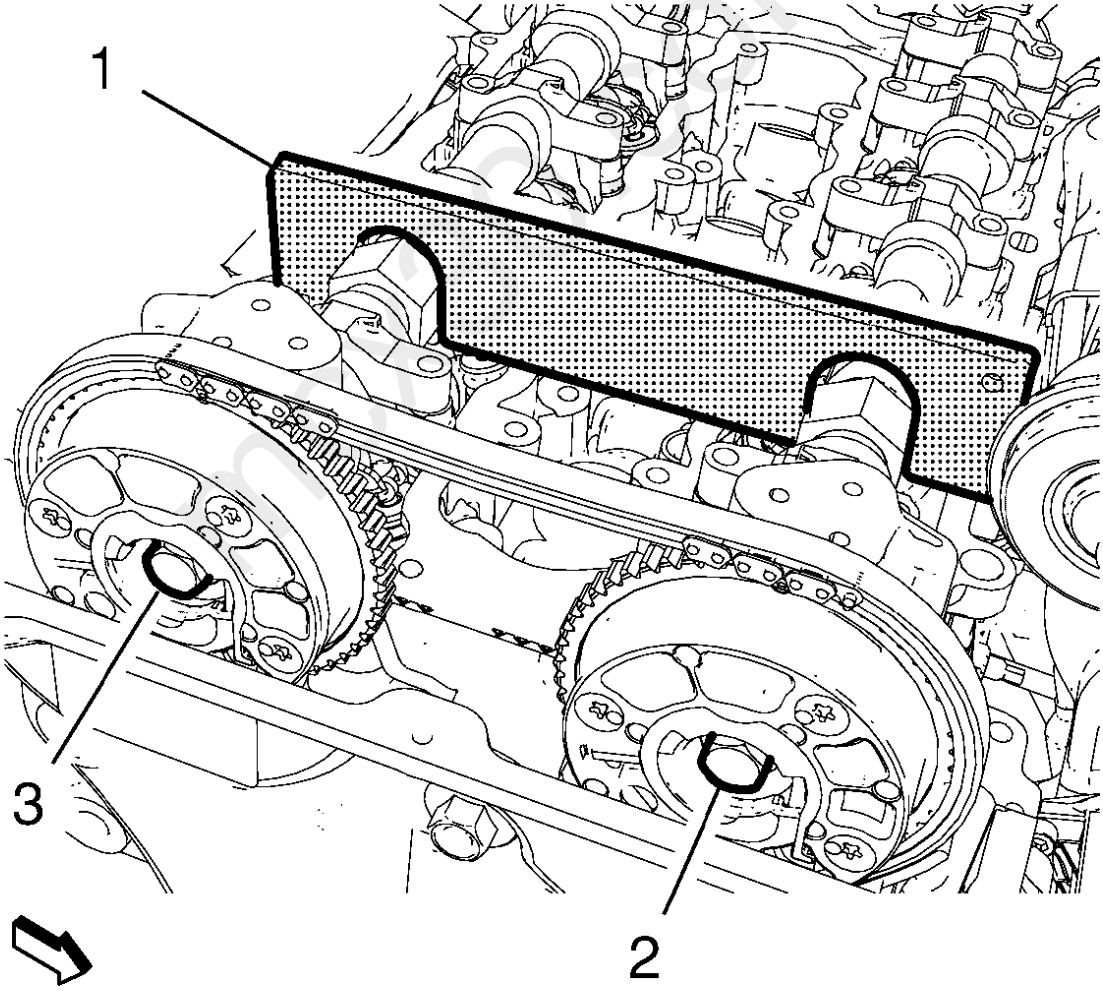


Fig. 105: Holder
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-51367** holder (1).

NOTE: **The marks of the camshaft position actuators must be at the 12 O'clock position.**

5. If the **EN-51367** holder (1) can be installed, the engine timing is properly adjusted.
6. If the **EN-51367** holder (1) can't be installed, inspect for wear, damage and proper installation of the timing chain components and replace as necessary. **Camshaft Timing Chain Replacement**
7. Remove the **EN-51367** holder (1).
8. Install Camshaft Cover - **Camshaft Cover Replacement**
9. Install Front Wheelhouse Liner-Right Side - **Front Wheelhouse Liner Replacement - Right Side (Equinox)** **Front Wheelhouse Liner Replacement - Right Side (Terrain)**

TIMING CHAIN OIL NOZZLE REPLACEMENT

Removal Procedure

1. Remove the engine front cover. **Engine Front Cover Replacement**
2. Reset the tensioner plunger and inspect for proper operation. **Camshaft Timing Chain and Sprocket Cleaning and Inspection**

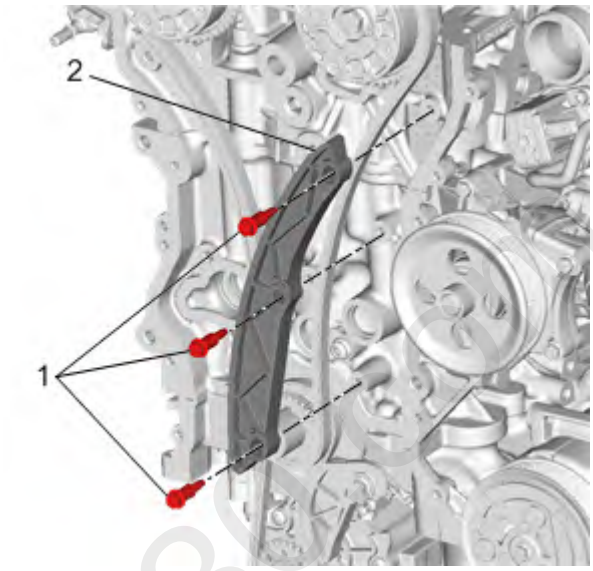


Fig. 106: Timing Chain Guide And Fasteners
Courtesy of GENERAL MOTORS COMPANY

3. Remove the timing chain guide fasteners (1) then remove the timing chain guide (2). **Timing Chain Upper Guide Replacement**

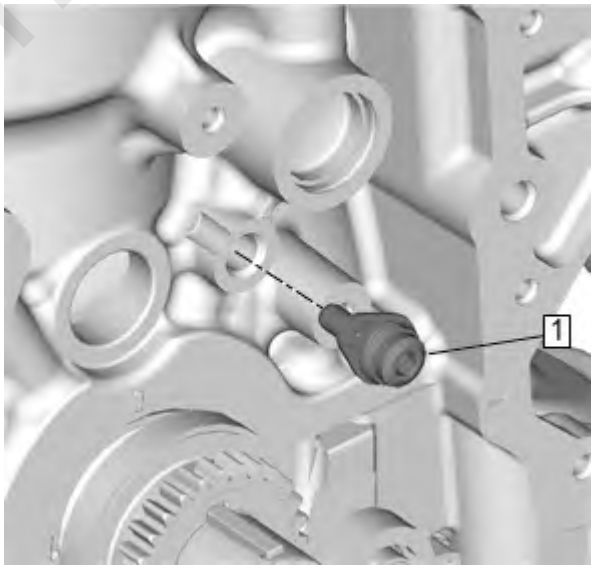


Fig. 107: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

4. Remove the timing chain oil nozzle (1).
5. For camshaft timing chain, oil nozzle, sprocket and tensioner cleaning and inspection, refer to **Camshaft Timing Chain and Sprocket Cleaning and Inspection**.

Installation Procedure

1. Ensure that the timing chain oil nozzle is clean and free of debris. **Camshaft Timing Chain and Sprocket Cleaning and Inspection**

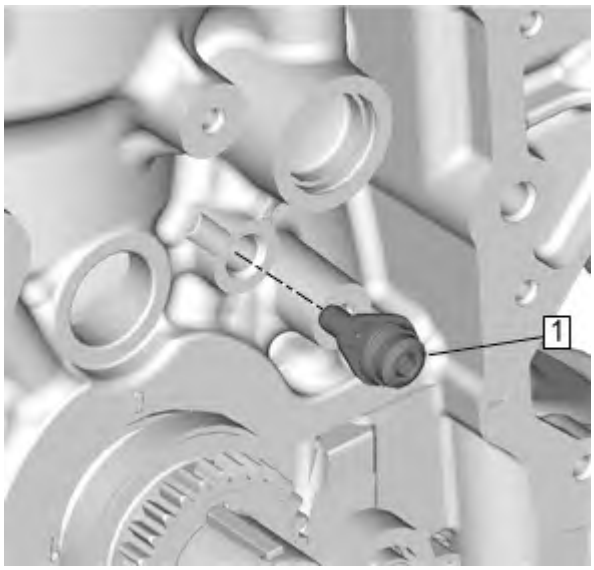


Fig. 108: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Component Fastener Tightening Caution .**

2. Install the timing chain oil nozzle (1). Tighten to 15 N.m (11 lb ft).

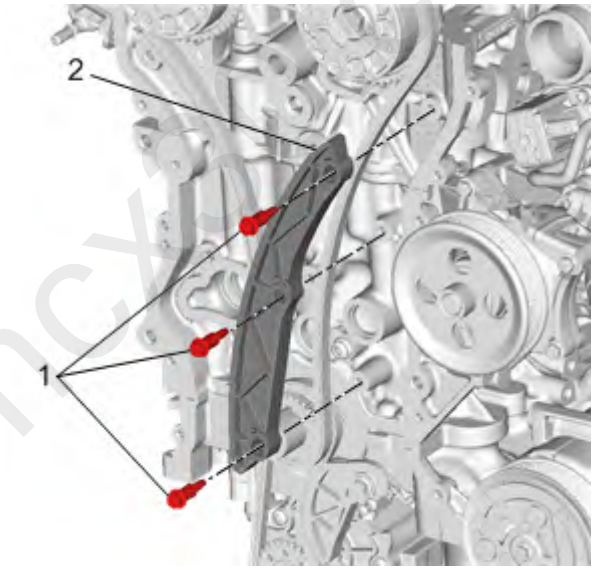


Fig. 109: Timing Chain Guide And Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

3. Install the timing chain guide (2) and bolts (1). **Timing Chain Upper Guide Replacement**

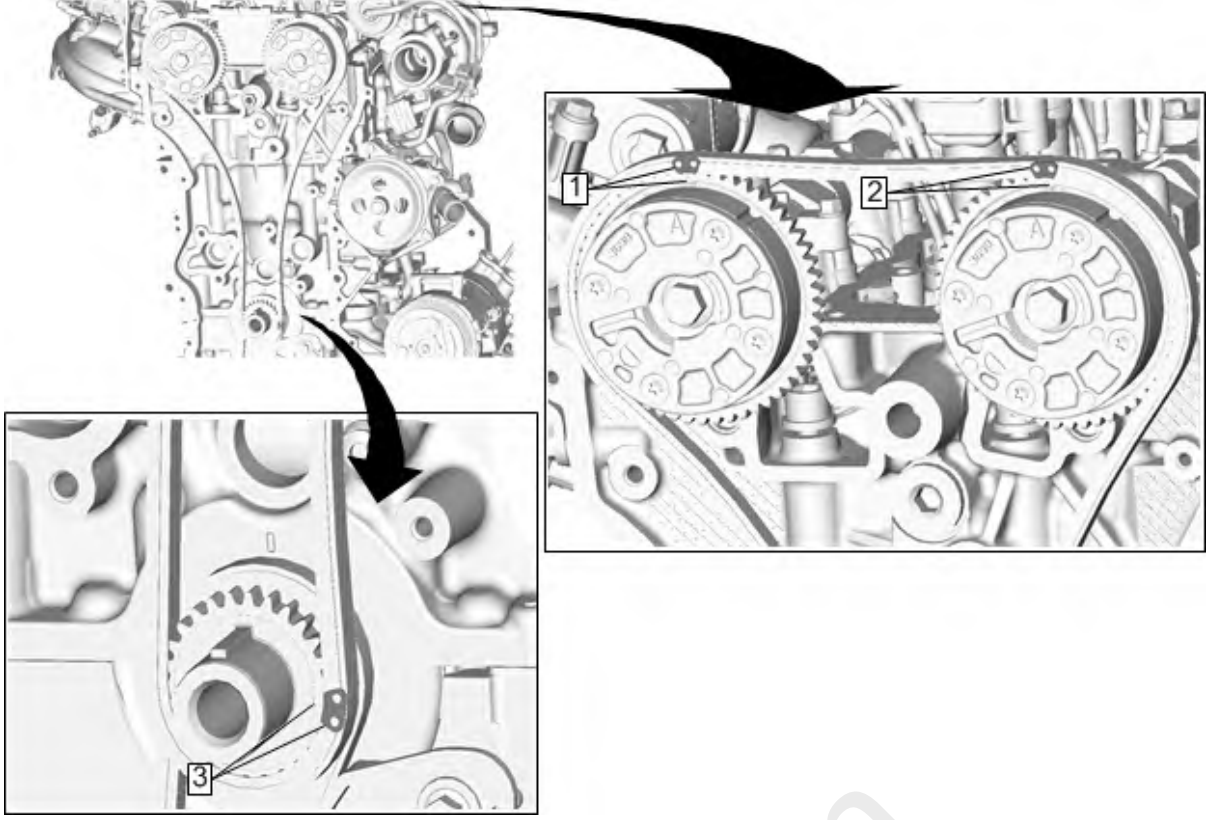


Fig. 110: Timing Chain Marks
Courtesy of GENERAL MOTORS COMPANY

4. Inspect the timing chain marks to confirm they remained aligned after engaging the timing chain tensioner.
5. Using a suitable tool, rotate the crankshaft one complete engine cycle then verify the timing chain marks (1, 2 and 3) are aligned properly.
6. Install the engine front cover. **Engine Front Cover Replacement**

HYDRAULIC VALVE LASH ADJUSTER ARM REPLACEMENT

Removal Procedure

1. Remove **Intake Camshaft Replacement**
2. Remove **Exhaust Camshaft Replacement**

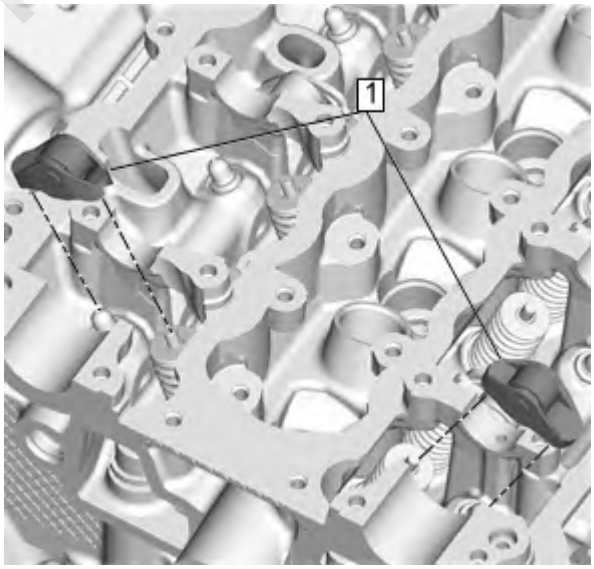


Fig. 111: Hydraulic Valve Lash Adjuster Arm
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Many internal engine components will develop specific wear patterns on their friction surfaces.**

mcx30.com

NOTE: **Components MUST be separated, marked, or organized in a way to ensure installation to their original location and position. Take precautions in order to prevent interchanging of parts. Tag or mark each part immediately when removed. Indicate location, direction, or orientation when necessary.**

3. Remove Hydraulic Valve Lash Adjuster Arm (1)[16x]

Installation Procedure

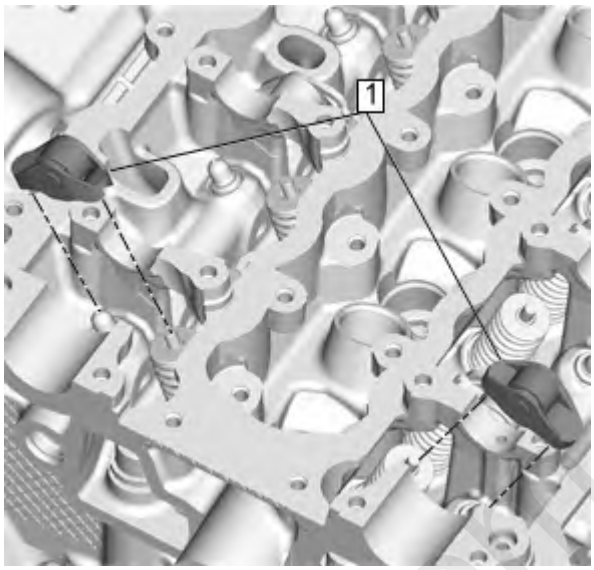


Fig. 112: Hydraulic Valve Lash Adjuster Arm
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Used lash adjuster arms must be returned to the original position on the camshaft. If the camshaft is being replaced, the lash adjuster arms actuated by the camshaft must also be replaced.**

1. Apply lubricant to the valve tips. **Adhesives, Fluids, Lubricants, and Sealers**
2. Position the 16 hydraulic lash adjuster arms (1) on the tip of the valve stems and on the lash adjusters.
3. Apply lubricant to the 16 hydraulic lash adjuster arms (1). **Adhesives, Fluids, Lubricants, and Sealers**
4. Install **Exhaust Camshaft Replacement**.
5. Install **Intake Camshaft Replacement**.

HYDRAULIC VALVE LASH ADJUSTER REPLACEMENT

Removal Procedure

1. Remove **Hydraulic Valve Lash Adjuster Arm Replacement**

mc730.com

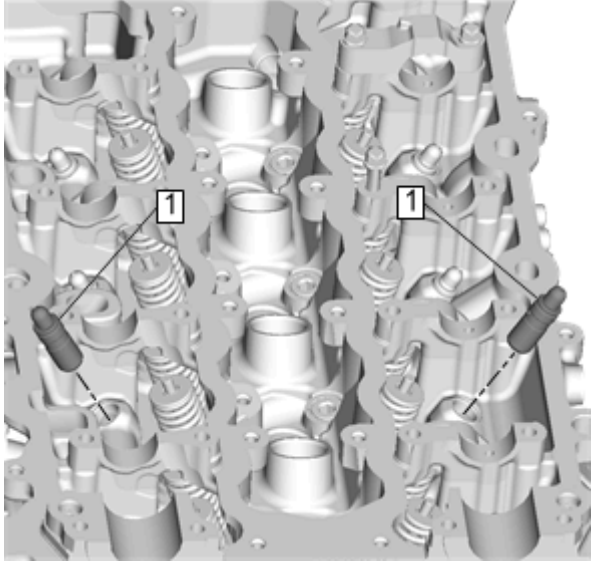


Fig. 113: Hydraulic Valve Lash Adjuster
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Many internal engine components will develop specific wear patterns on their friction surfaces. Components MUST be separated, marked, or organized in a way to ensure installation to their original location and position. Take precautions in order to prevent interchanging of parts.**

2. Tag or mark each part immediately when removed. Indicate location, direction, or orientation when necessary.
3. Remove Hydraulic Valve Lash Adjuster (1)[16x]

Installation Procedure

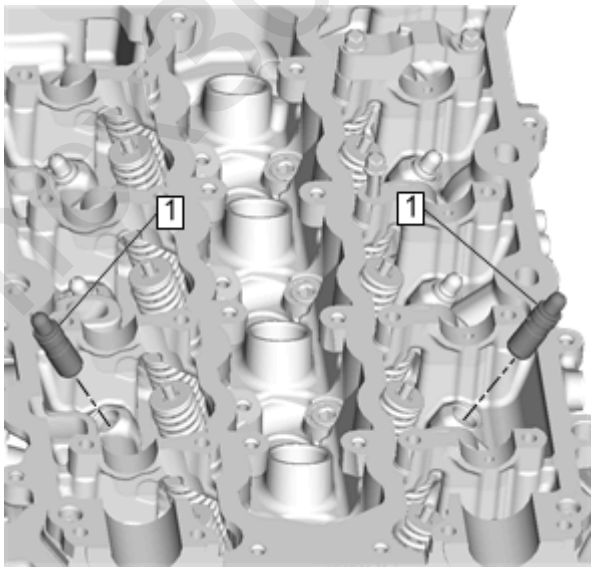


Fig. 114: Hydraulic Valve Lash Adjuster
Courtesy of GENERAL MOTORS COMPANY

1. Install the 16 hydraulic valve lash adjusters (1) in the bores in the cylinder head.
2. Apply lubricant to the 16 hydraulic valve lash adjusters (1). Adhesives, Fluids, Lubricants, and Sealers.
3. Install Hydraulic Valve Lash Adjuster Arm Replacement

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

Special Tools

- **EN-46116** Valve Stem Seal Remover
- **EN-50717** Universal Valve Spring Compressor Kit

- **EN-51511** Injector Port Service Plug

Equivalent regional tools:**Special Tools**.

Removal Procedure

1. Remove **Spark Plug Replacement**
2. Remove **Hydraulic Valve Lash Adjuster Arm Replacement**

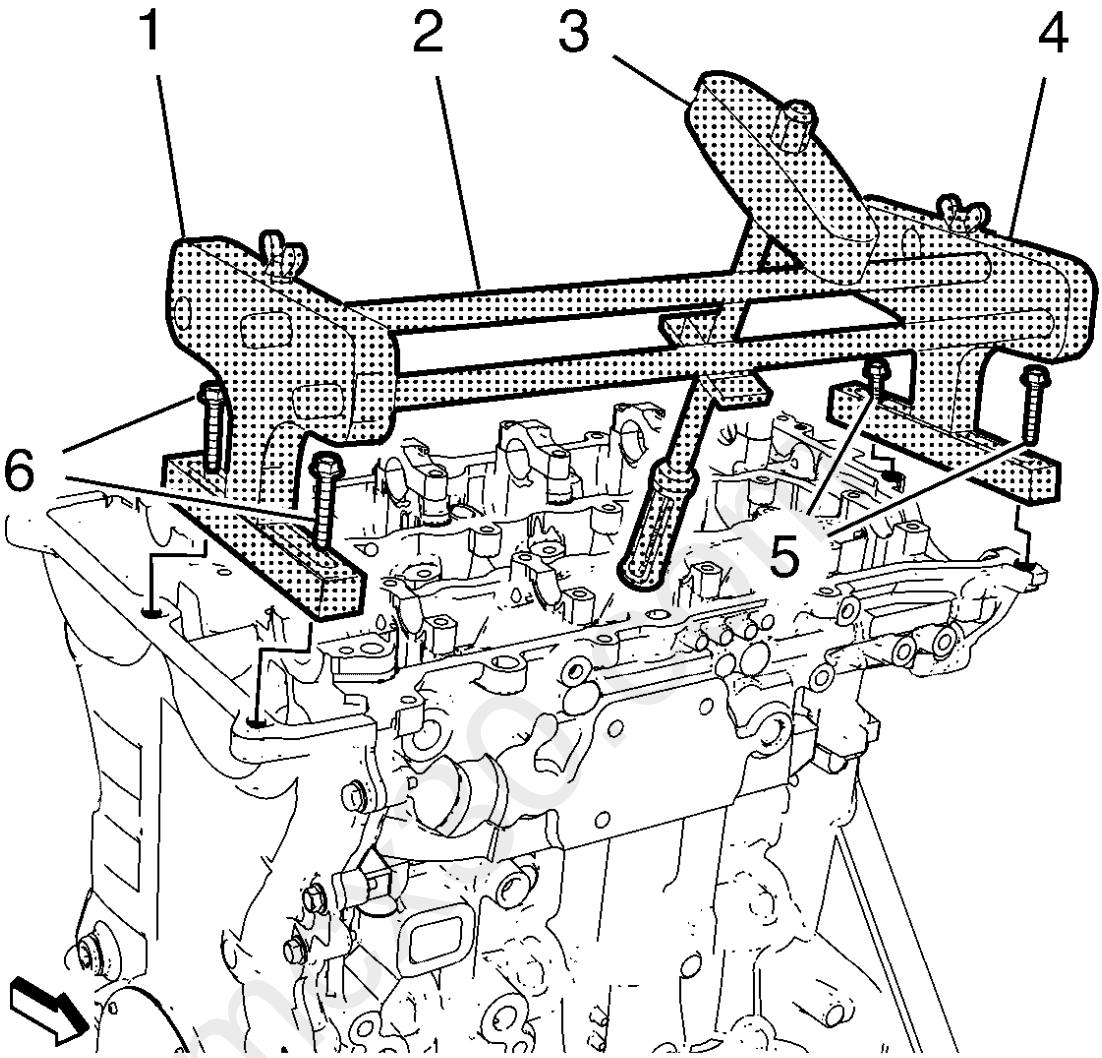


Fig. 115: Valve Stem Oil Seal and Valve Spring Tools
Courtesy of GENERAL MOTORS COMPANY

3. Install the 2 **EN-50717-1** stands (1, 4) to the cylinder head and fix them with the screws (5, 6).
4. Install the 2 **EN-50717-3** rods (2) to the **EN-50717-1** stands (1, 4).
5. Install the **EN-50717-2** compressor (3) to the **EN-50717-3** rods (2).
6. Plug the injector bores, using the **EN-51511** plug.
7. Install a suitable air pressure adapter to the spark plug hole.

NOTE: **To keep the valve seated in the valve seat, ensure that air pressure is always applied to the combustion chamber of the treated cylinder.**

8. Apply air pressure to the corresponding cylinder.
9. Position the **EN-50717-2** compressor (3) so that its adapter properly contacts the valve spring retainer then pretension the compressor.

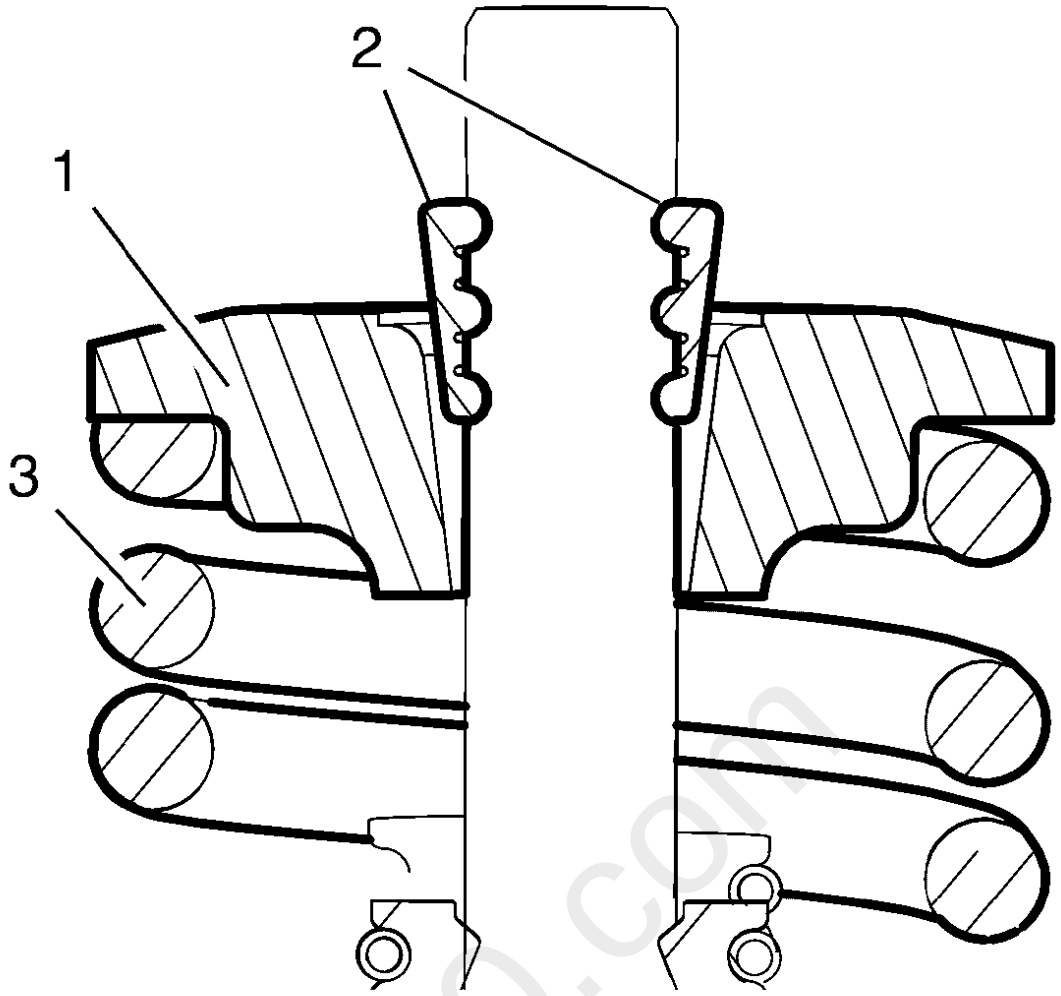


Fig. 116: Valve Spring Retainer And Valve Spring
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Valve springs can be tightly compressed. Use care when removing the retainers and plugs. Personal injury could result.**

NOTE: **Mark all components to ensure they are returned to their original location upon installation.**

10. Apply pressure to the **EN-50717-2** compressor to push down the vale spring retainer (1) and compress the valve spring (3) until the valve keys (2) are free from tension.
11. Carefully remove the valve keys (2).
12. Release the tension from the **EN-50717-2** compressor.

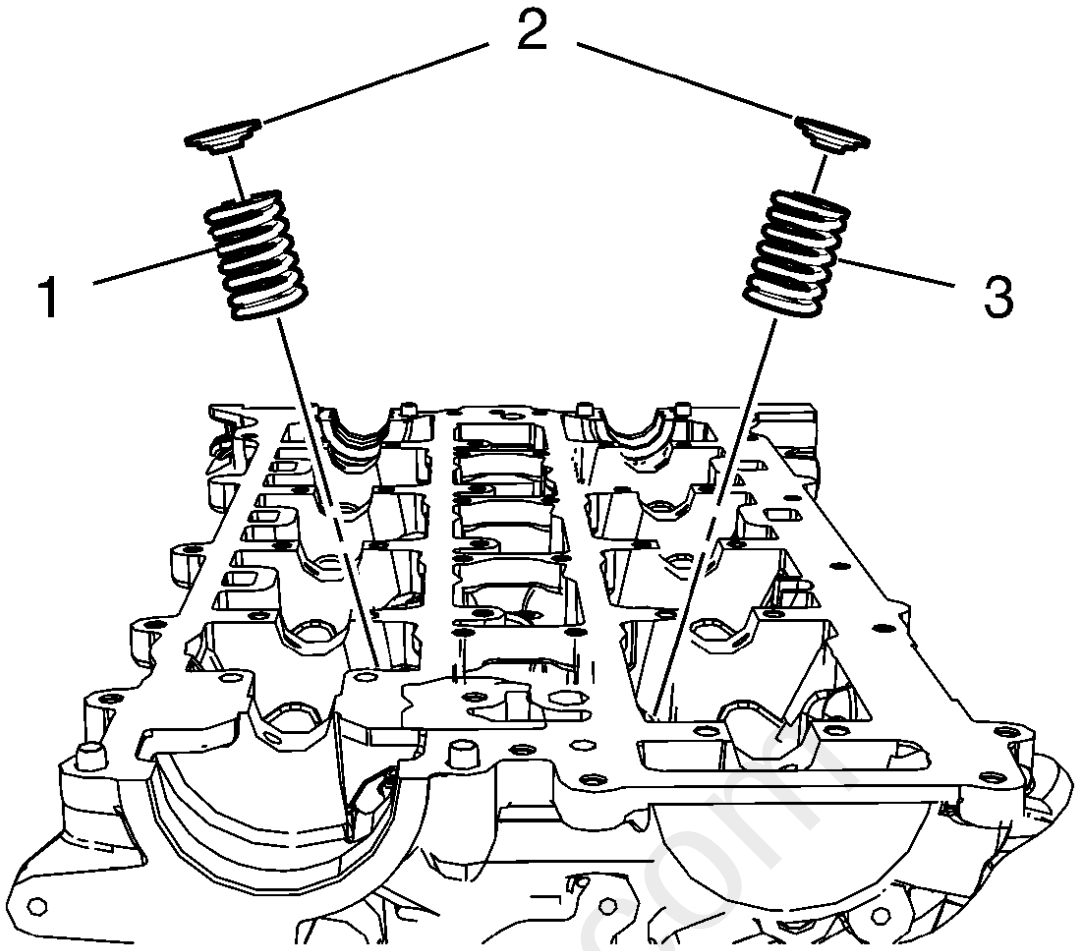


Fig. 117: Valve Springs And Retainers
Courtesy of GENERAL MOTORS COMPANY

13. Remove the valve spring retainer (2) and the exhaust valve spring (1) or intake valve spring (3).

mcx30.com

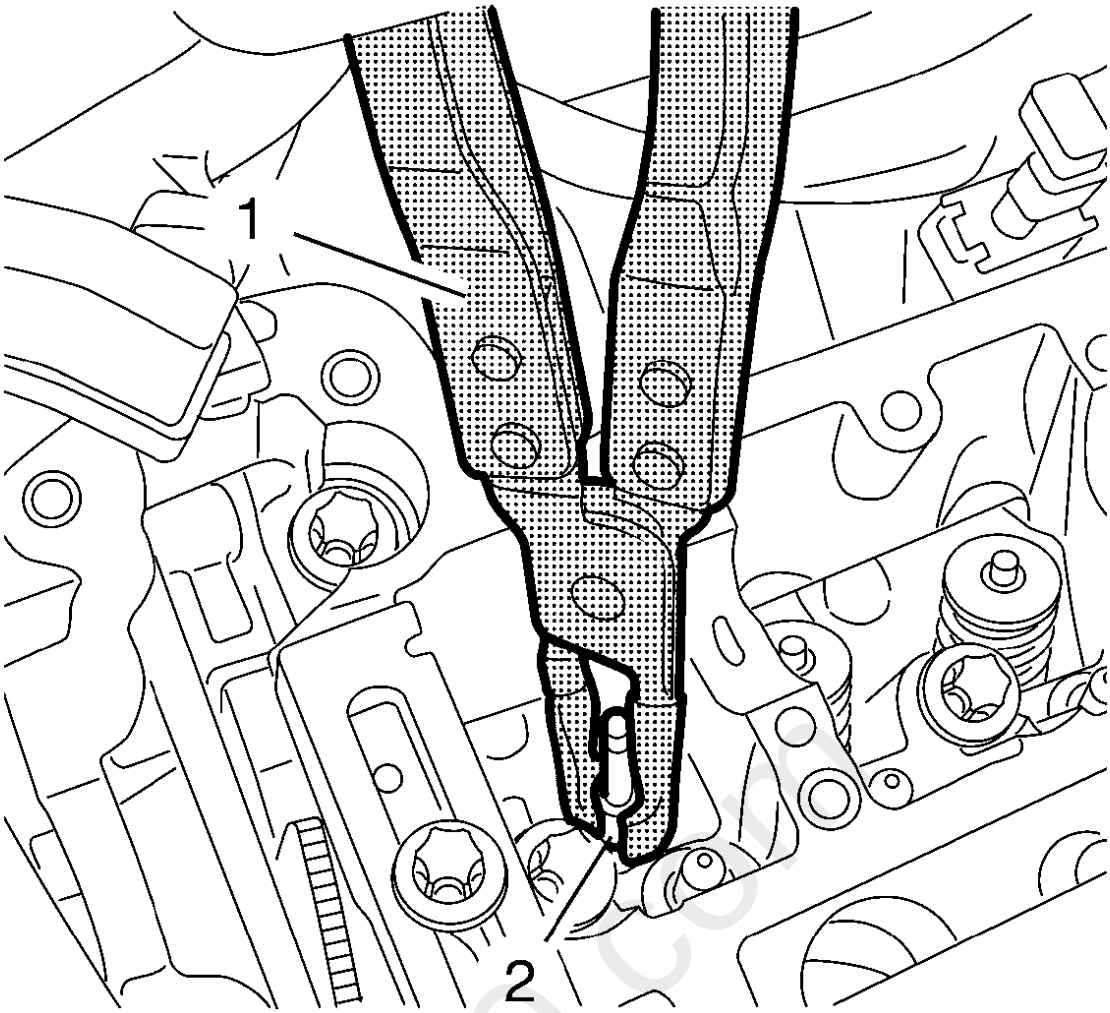


Fig. 118: Pliers And Intake Valve Stem Oil Seals
Courtesy of GENERAL MOTORS COMPANY

14. Using **EN-46116** remover (1), remove and DISCARD the valve stem oil seal (2).

Installation Procedure

mox30.com

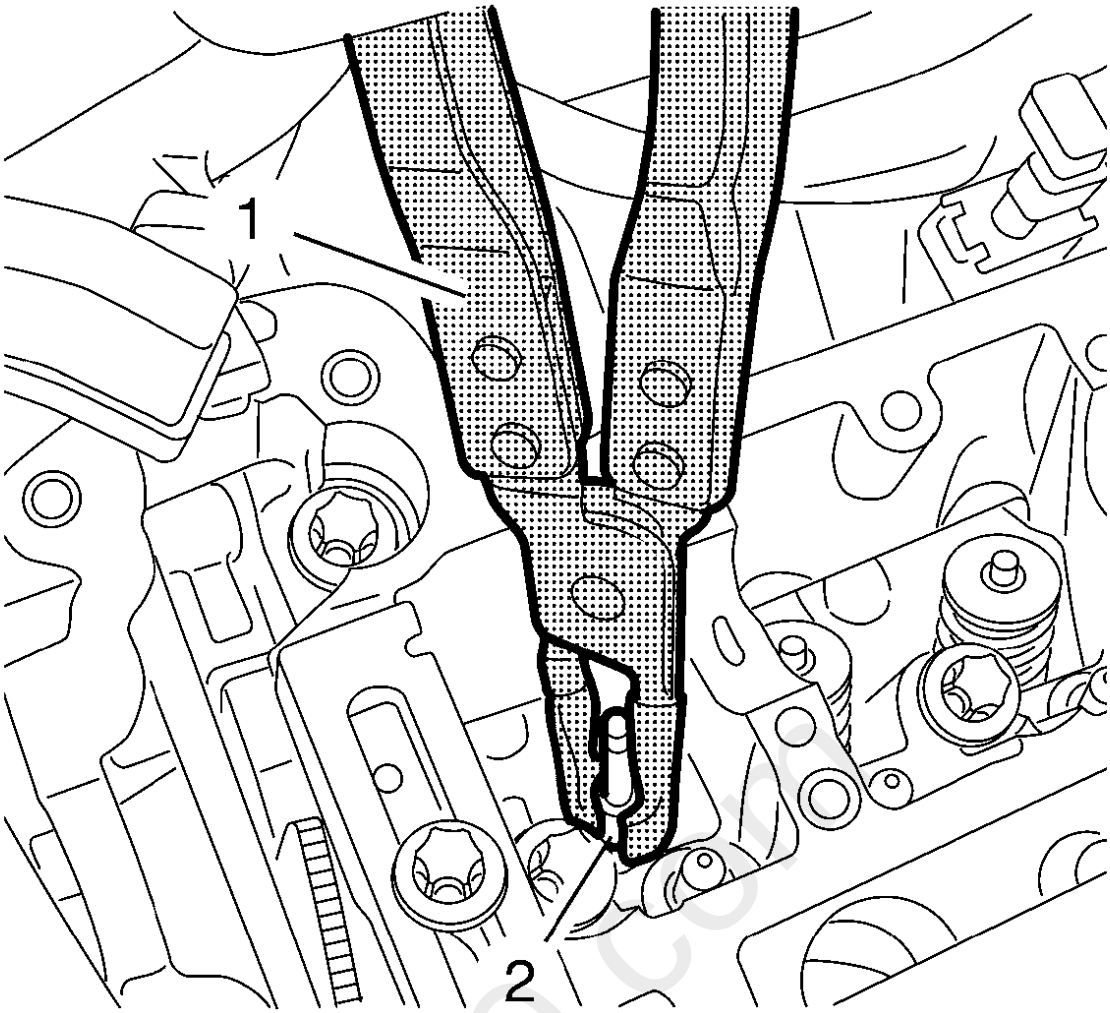


Fig. 119: Pliers And Intake Valve Stem Oil Seals
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Valve stem oil seal sets will contain 2 different colored seals, black and green. The set of 8 seals that are green should be installed onto the exhaust valves.**

1. Using the **EN-46116** installer (1), install NEW valve stem oil seal (2).

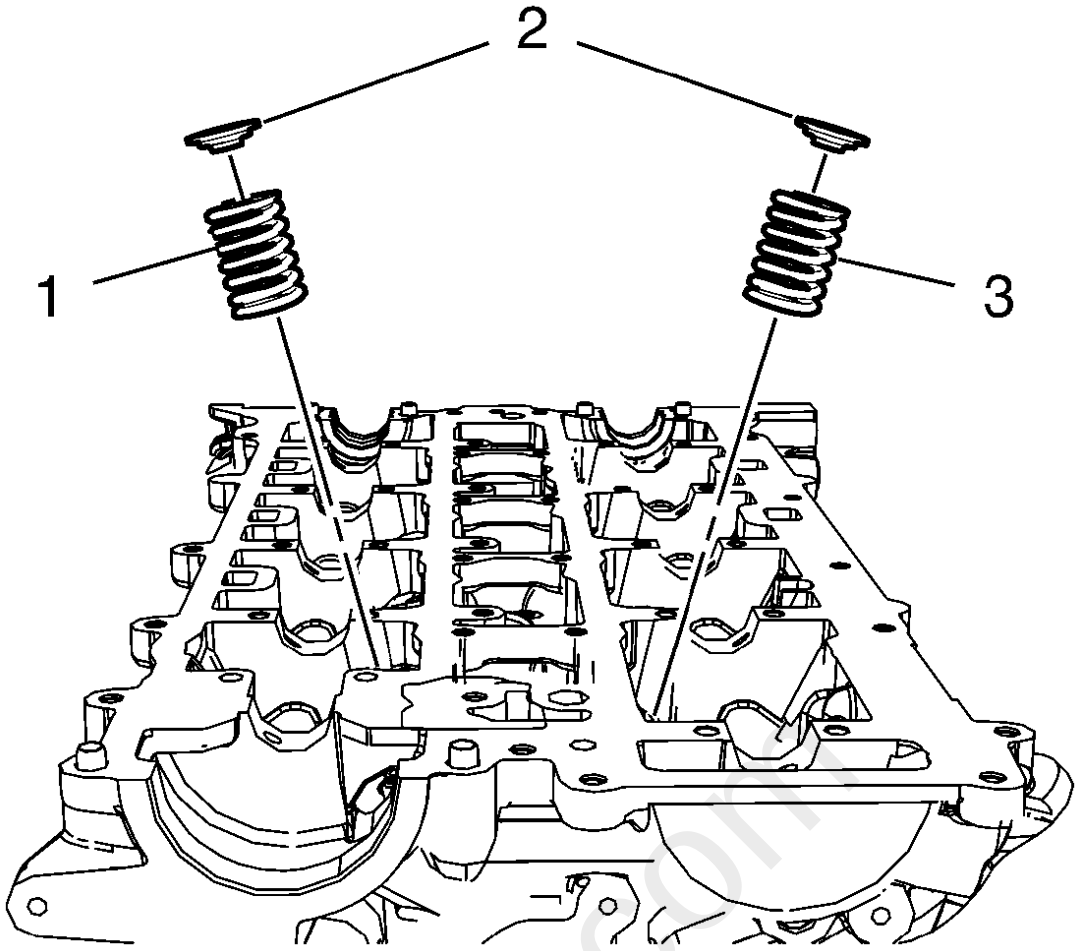


Fig. 120: Valve Springs And Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Make sure that the valve springs and the valve spring retainers are installed in their original position.**

2. Install the exhaust valve spring (1), or the intake valve spring (3) and the upper valve spring retainer (2).

mcx30.com

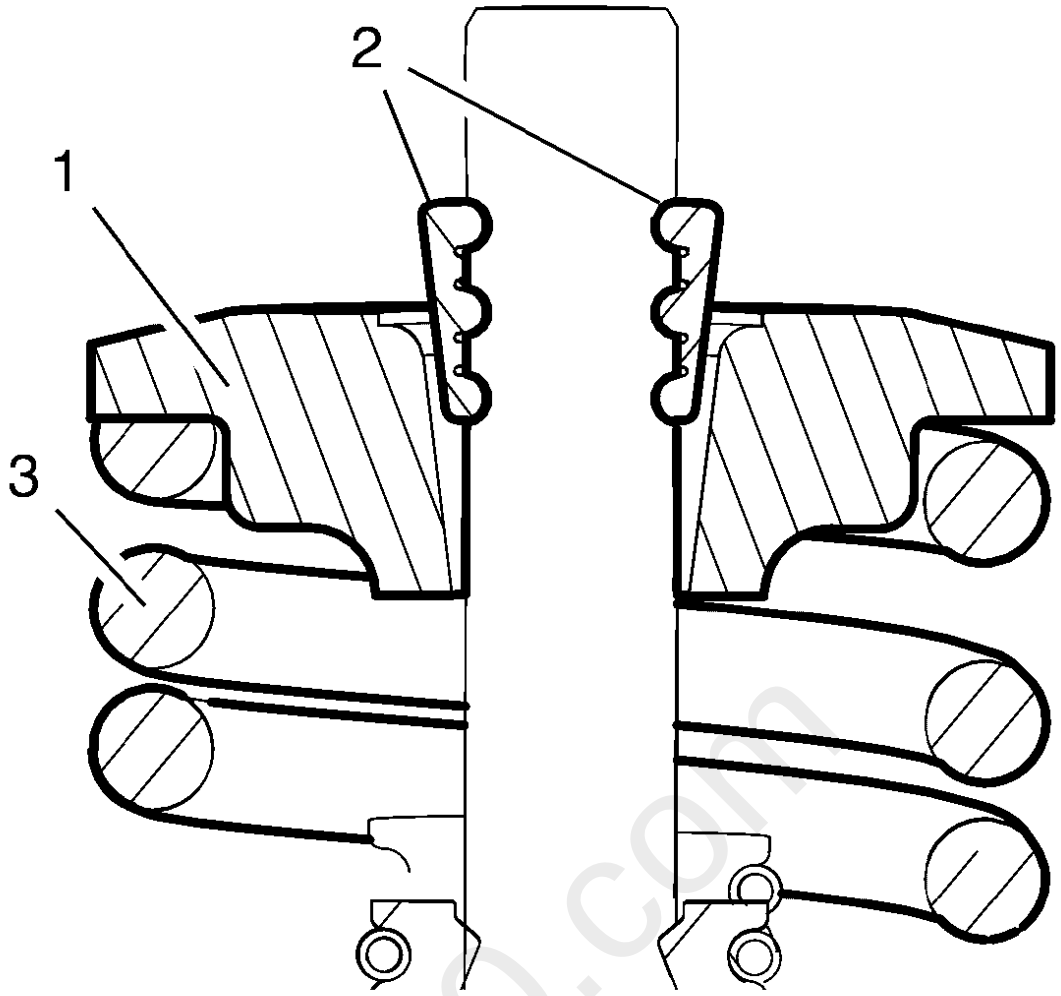


Fig. 121: Valve Spring Retainer And Valve Spring
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **The valve stem keys must correctly seat in the valve spring cap. Engine damage may occur by not installing properly.**

3. Using the **EN-50717-2** compressor, push down the valve spring retainer (1) and compress the valve spring (3) until the valve keys (2) can be inserted.
4. Carefully insert the valve keys (2), so that they are properly installed into the valve stem grooves.
5. Carefully release the tension from the **EN-50717-2** compressor.
6. Inspect the valve keys (2) and valve spring retainer (1) for proper seat.

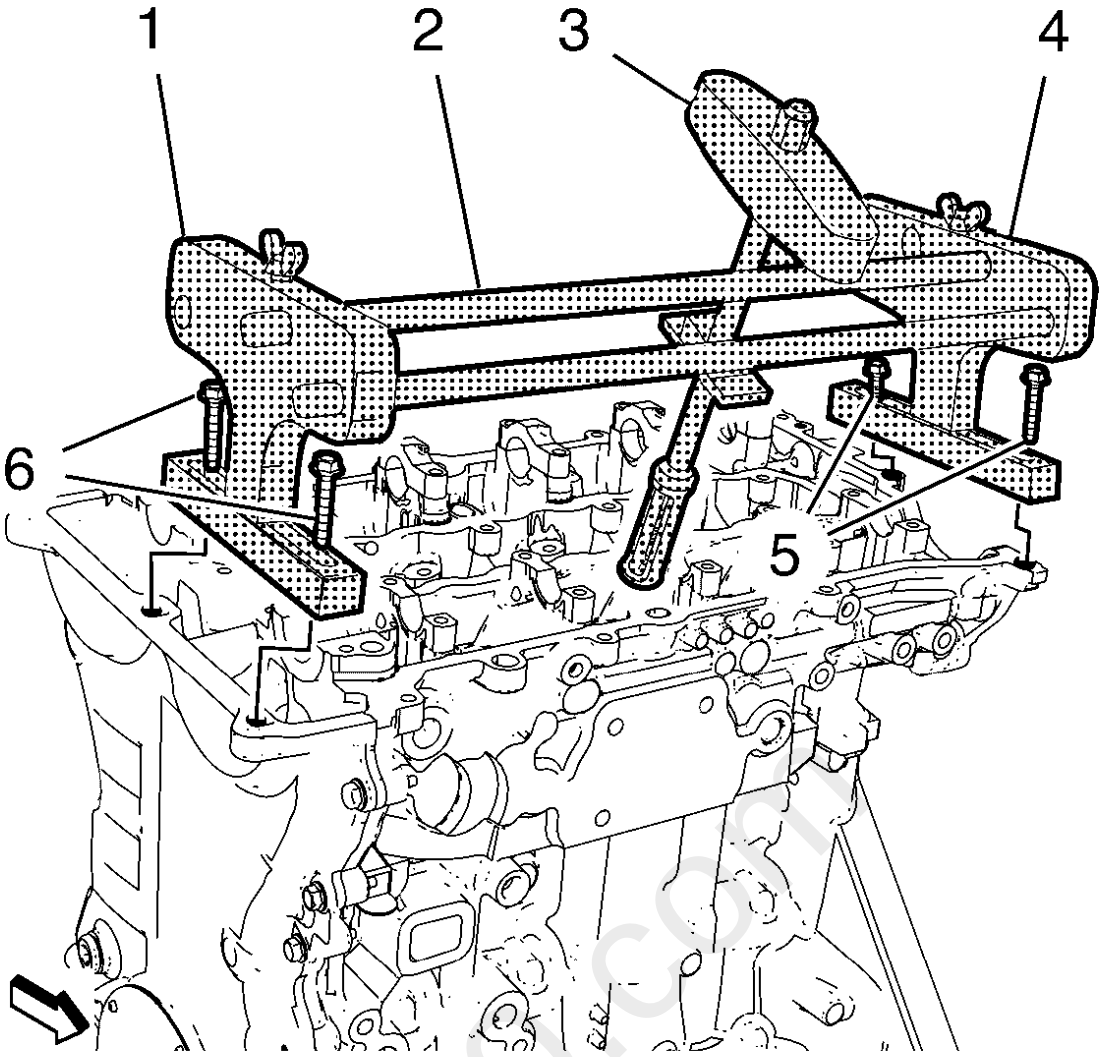


Fig. 122: Valve Stem Oil Seal and Valve Spring Tools
Courtesy of GENERAL MOTORS COMPANY

NOTE: **To keep the valve seated in the valve seat, ensure that air pressure is always applied to the combustion chamber of the treated cylinder.**

7. Repeat the procedure with the remaining valves and cylinders.
8. Transfer the **EN-50717-1** stands, **EN-51511** plug and the **EN-50717-2** compressor (1 - 6) as needed.
9. Remove the **EN-51511** plug from the injector bores.
10. Remove **EN-50717-1** stands and the **EN-50717-2** compressor from the cylinder head.
11. Install **Hydraulic Valve Lash Adjuster Arm Replacement**
12. Install **Spark Plug Replacement**

VALVE LIFTER FOLLOWER REPLACEMENT

Special Tools

EN-51365 High Pressure Fuel Pump Installation Alignment Gauge

Equivalent regional tools:**Special Tools**

Removal Procedure

1. Remove Fuel Pump -**Fuel Pump Replacement**

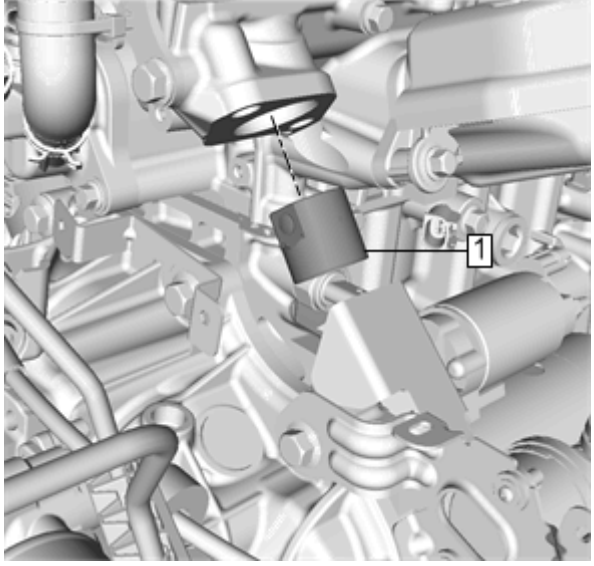


Fig. 123: Valve Lifter Follower
Courtesy of GENERAL MOTORS COMPANY

2. Remove the valve lifter follower (1) from the cylinder head bore.

Installation Procedure

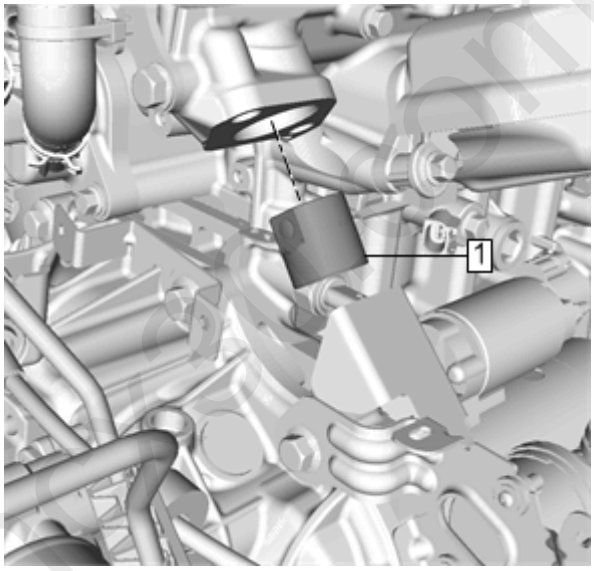


Fig. 124: Valve Lifter Follower
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the valve lifter follower (1) with engine oil. **Adhesives, Fluids, Lubricants, and Sealers**
2. Install the valve lifter follower into the cylinder head bore.

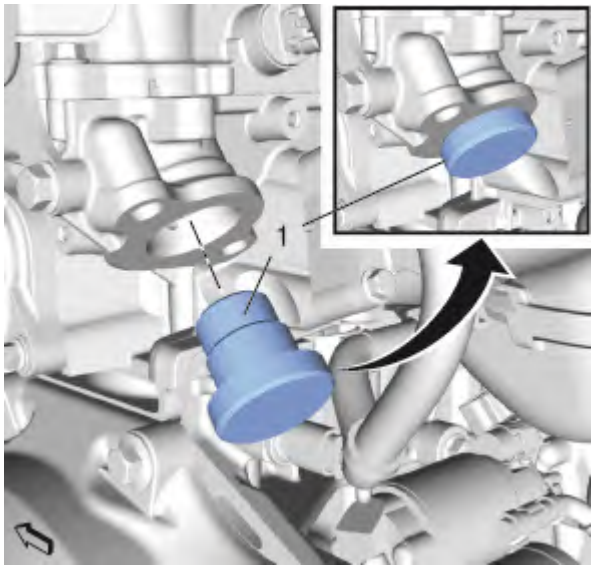


Fig. 125: Gauge
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The camshaft must be in the base circle position before the high pressure fuel pump is installed.**

3. Install the **EN-51365** gauge (1).
4. Rotate the crankshaft until the **EN-51365** gauge (1) is flush with the cylinder head. This indicates the camshaft lobe is at base circle position.
5. Remove the **EN-51365** gauge (1).
6. Install Fuel Pump - Fuel Pump Replacement

POSITIVE CRANKCASE VENTILATION TUBE REPLACEMENT (FRESH AIR)

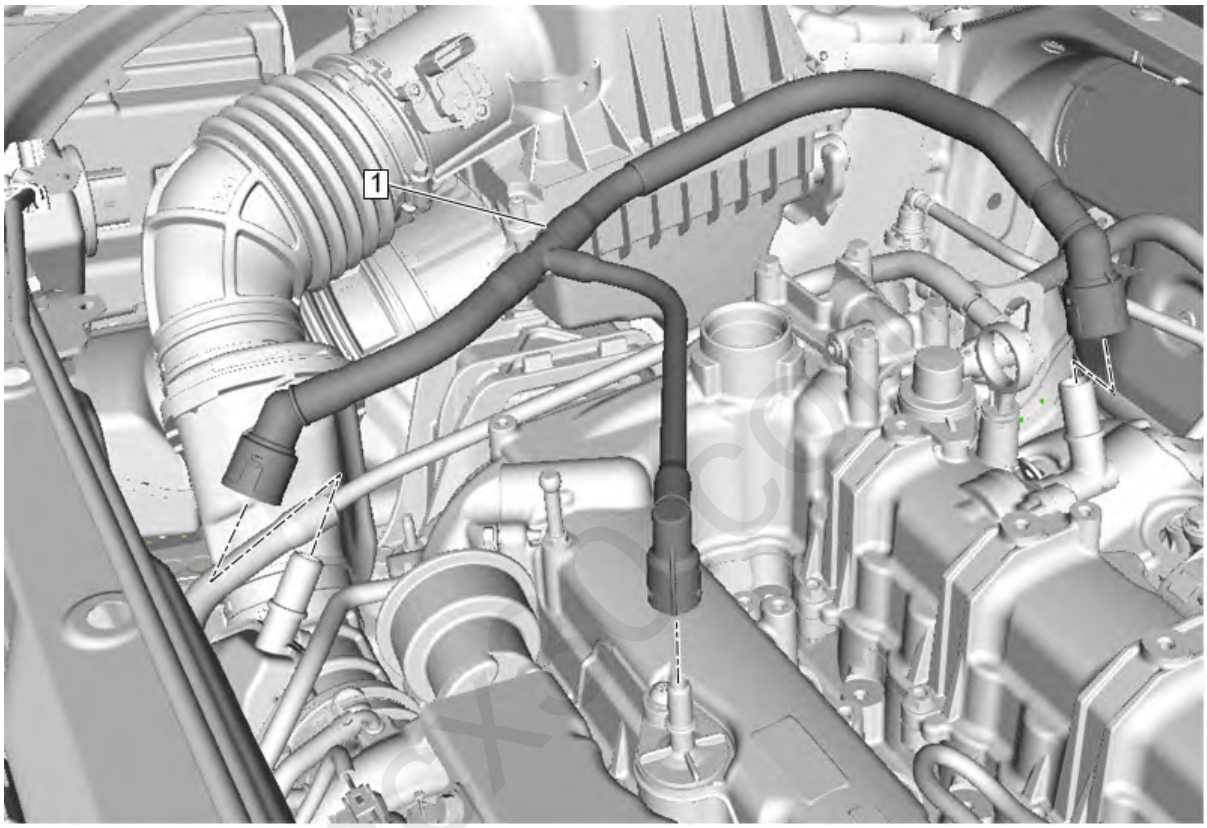


Fig. 126: Positive Crankcase Ventilation Tube
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures Intake Manifold Cover Replacement	
1	Positive Crankcase Ventilation Tube **CAUTION:** **The Positive Crankcase Ventilation (PCV) line is tamper resistant and must always be replaced once it is removed. The fittings connected to the PCV line must also be replaced if they are damaged when the PCV line is removed. To reduce the risk of damage to the fittings, use a suitable cutting tool and carefully cut the connections away.** **Procedure** Using a suitable cutting tool, carefully cut the PCV tube away from the fittings at the air cleaner outlet rear duct and the camshaft cover. If any damage occurs to either the air intake tube or camshaft cover fitting, they must be replaced. Air Cleaner Outlet Duct Replacement

POSITIVE CRANKCASE VENTILATION TUBE REPLACEMENT (FOUL AIR)

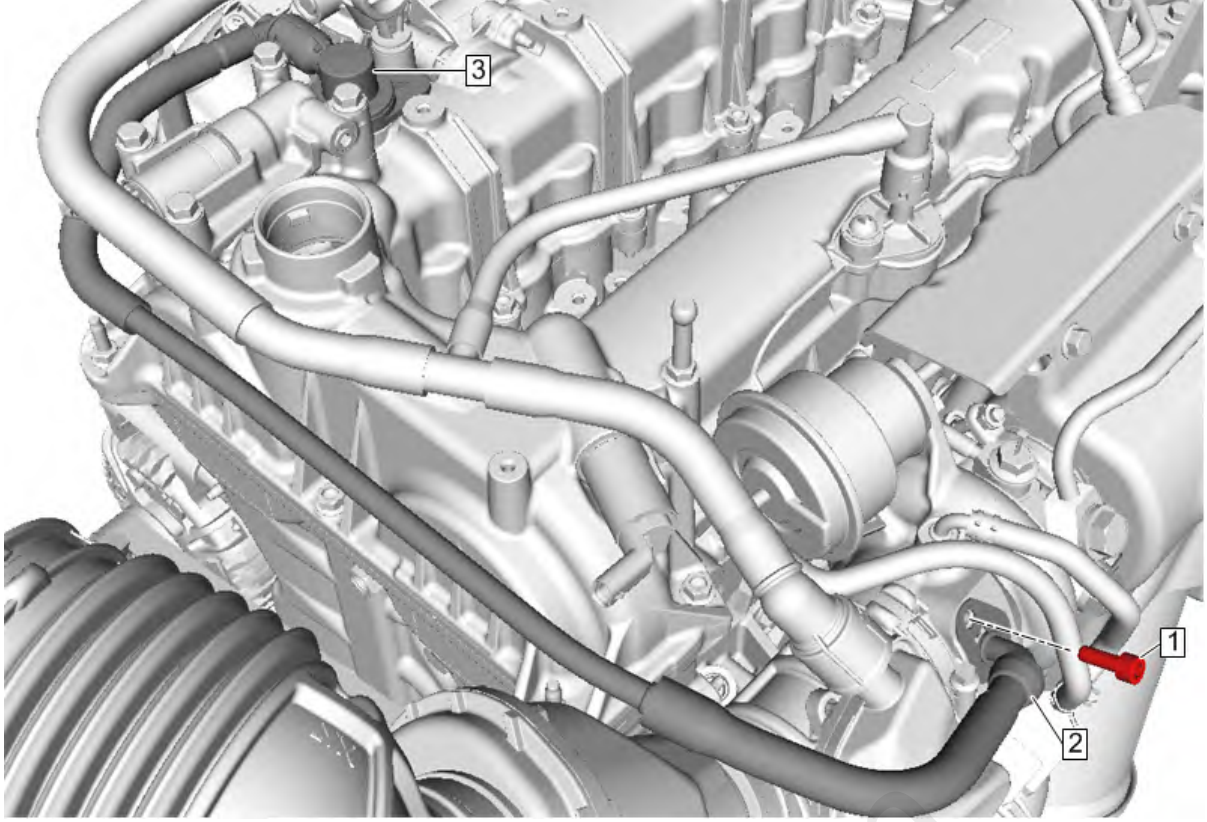


Fig. 127: Positive Crankcase Ventilation Tube
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Intake Manifold Cover Replacement **NOTE:** **Inspect each component while attached to the camshaft cover. Do not remove the PCV components unless inspection indicates a suspect component. Replace the PCV valve, PCV tube assembly, and PCV hose fitting as an assembly. The connections between these components are permanent.**	
1	Positive Crankcase Ventilation Valve Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 8 N.m (71 lb in)
2	Positive Crankcase Ventilation Valve Fitting
3	Positive Crankcase Ventilation Valve **Procedure** Inspect the PCV valve. If the PCV valve is suspect, use a suitable tool to pry the valve off of the cover. Retrieve any particles that fall onto the baffle in the cover. DISCARD the valve and particles. **NOTE:** **When the PCV valve is removed, small particles of the valve will break and fall into the cover.**

POSITIVE CRANKCASE VENTILATION VALVE REPLACEMENT - FRESH AIR

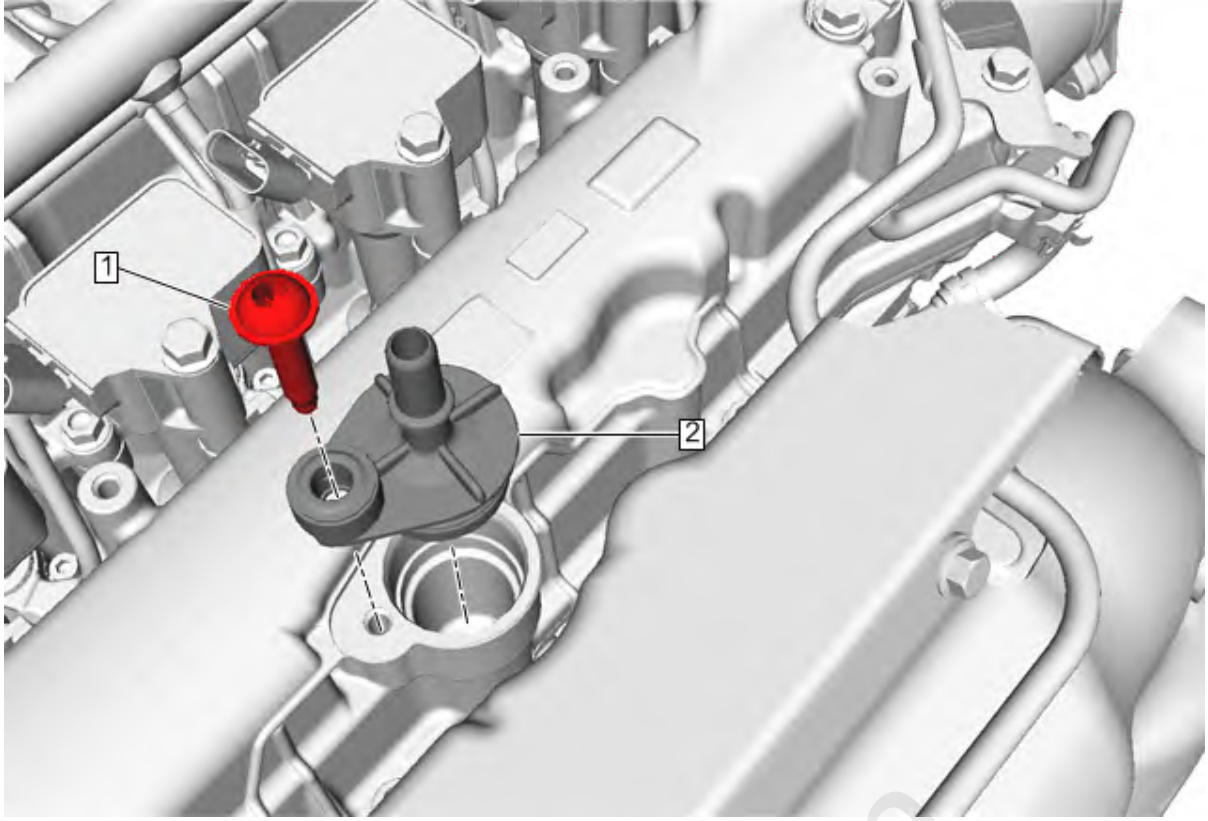


Fig. 128: Positive Crankcase Ventilation Valve (Fresh Air)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Positive Crankcase Ventilation Tube Replacement (Fresh Air)	
1	Positive Crankcase Ventilation Valve Bolt **CAUTION:** **Refer to Fastener Caution .** **CAUTION:** **The Positive Crankcase Ventilation (PCV) line is tamper resistant and must always be replaced once it is removed. The fittings connected to the PCV line must also be replaced if they are damaged when the PCV line is removed. To reduce the risk of damage to the fittings, use a suitable cutting tool and carefully cut the connections away.** **Procedure** Using a suitable tool, cut a slot in the tamper-resistant positive crankcase ventilation (PCV) bolt heads and remove with a flat-bladed tool. Discard bolts. **NOTE:** **Bolt is a one-time use ONLY, will need to be slotted then removed and replaced** **Tighten** 10 N.m (89 lb in) **Special Tools** **EN-50956** Tamper Proof Drive Bit Equivalent regional tools:Special Tools
2	Positive Crankcase Ventilation Valve

POSITIVE CRANKCASE VENTILATION VALVE REPLACEMENT - SECONDARY

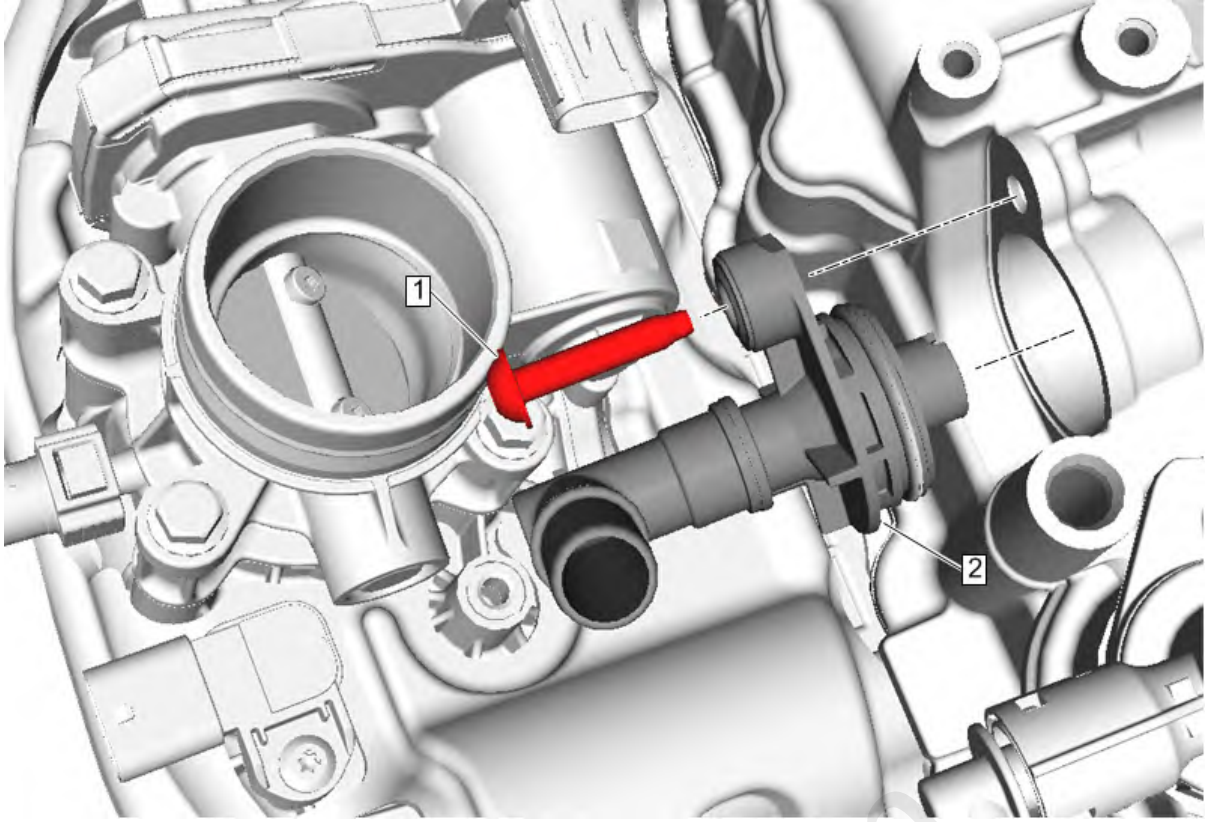


Fig. 129: Positive Crankcase Ventilation Valve
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Positive Crankcase Ventilation Tube Replacement (Fresh Air)Positive Crankcase Ventilation Tube Replacement (Foul Air)	
1	Positive Crankcase Ventilation Valve Bolt **CAUTION:** **Refer to Fastener Caution .** **CAUTION:** **The Positive Crankcase Ventilation (PCV) line is tamper resistant and must always be replaced once it is removed. The fittings connected to the PCV line must also be replaced if they are damaged when the PCV line is removed. To reduce the risk of damage to the fittings, use a suitable cutting tool and carefully cut the connections away.** **Procedure** Using a suitable tool, cut a slot in the tamper-resistant positive crankcase ventilation (PCV) bolt heads and remove with a flat-bladed tool. DISCARD bolt. **NOTE:** **Bolt is a one-time use ONLY, will need to be slotted then removed and replaced** **Tighten** 10 N.m (89 lb in) **Special Tools** **EN-50956** Tamper Proof Drive Bit Equivalent regional tools:Special Tools
2	Positive Crankcase Ventilation Valve

TIMING CHAIN UPPER GUIDE REPLACEMENT

mc730.com

Removal Procedure

1. Remove Camshaft Cover - **Camshaft Cover Replacement**

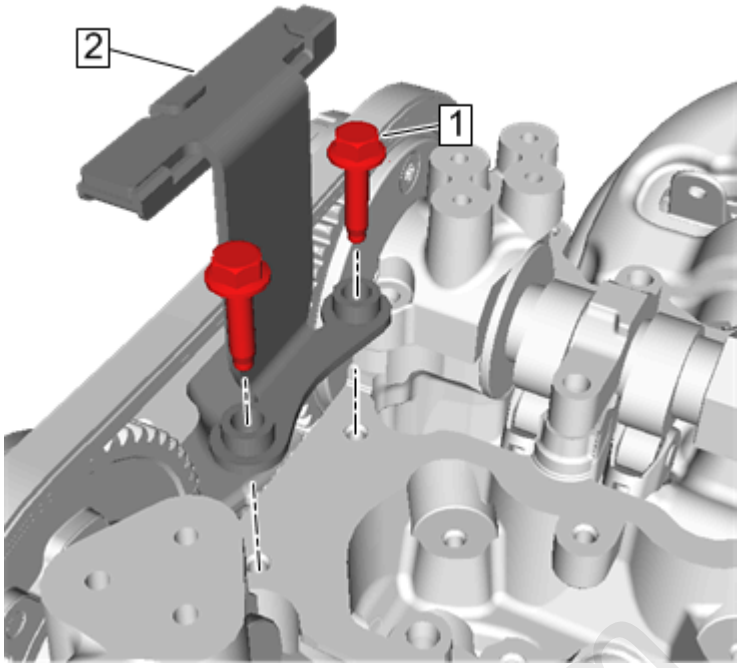


Fig. 130: Timing Chain Upper Guide And Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove Timing Chain Upper Guide Bolt (1)
3. Remove Timing Chain Upper Guide (2)
4. Inspect the timing chain components for damage or excessive wear. **Camshaft Timing Chain and Sprocket Cleaning and Inspection**

Installation Procedure

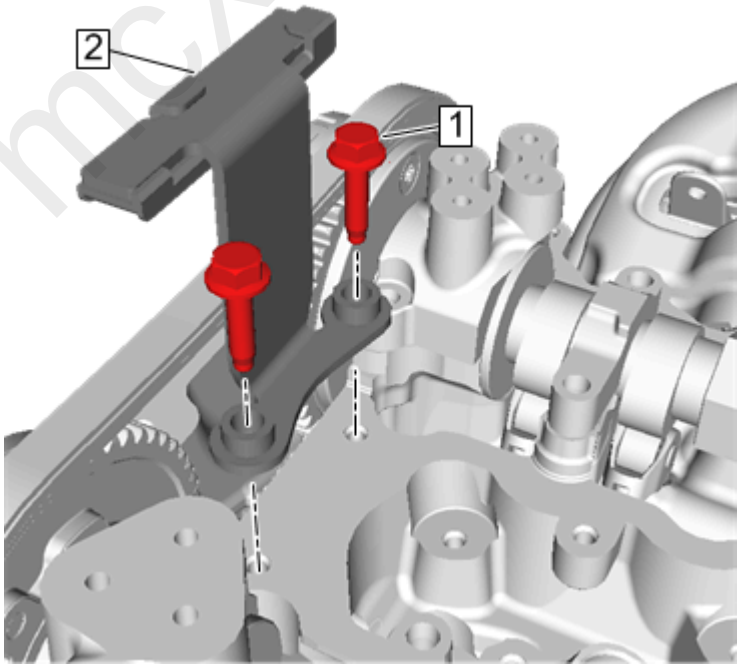


Fig. 131: Timing Chain Upper Guide And Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

1. Install Timing Chain Upper Guide (2)
2. Install Timing Chain Upper Guide Bolt (1) and tighten 10 N.m (89 lb in)

mcx30.com

3. Install Camshaft Cover - **Camshaft Cover Replacement**

TIMING CHAIN GUIDE REPLACEMENT - LEFT SIDE (EXHAUST)

Special Tools

EN-51367 Camshaft Holder

Equivalent regional tools:**Special Tools**

Removal Procedure

1. Remove **Engine Front Cover Replacement**
2. Set the engine to top dead center (TDC).

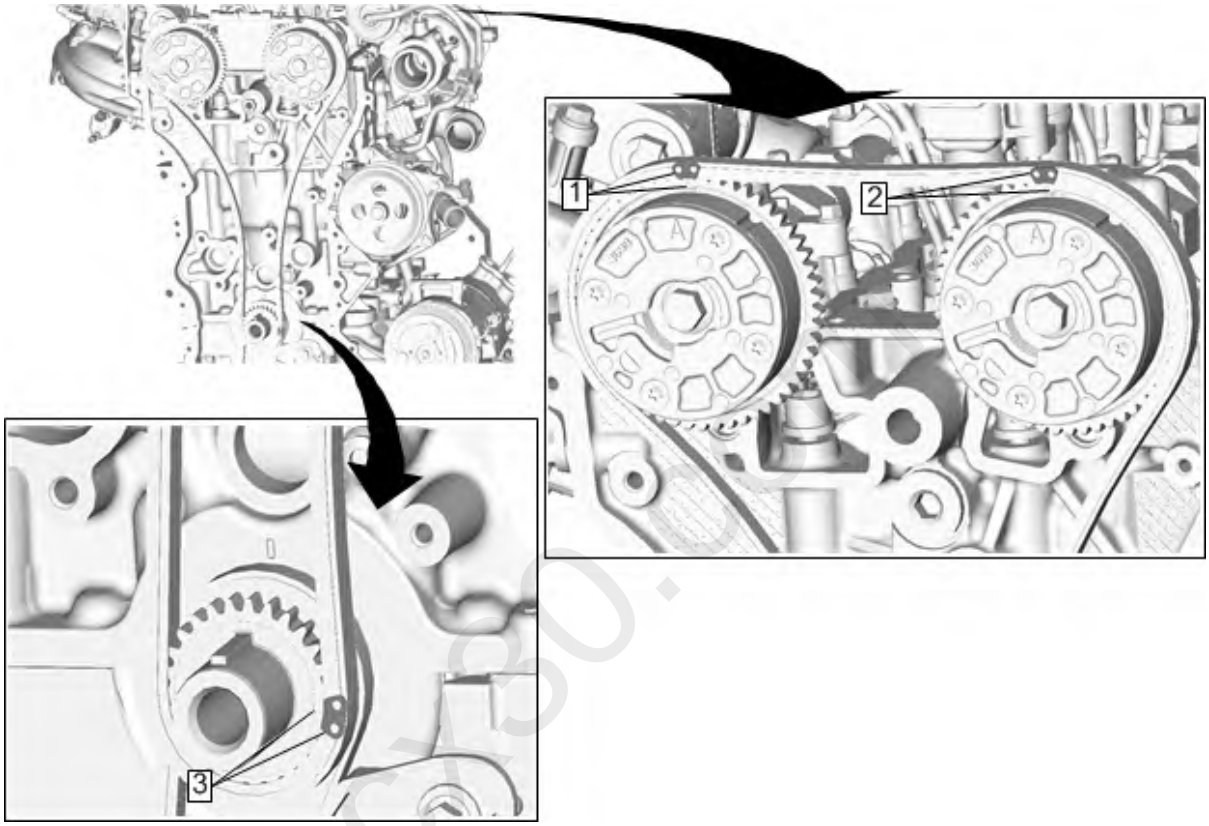


Fig. 132: Timing Chain Marks
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the timing chain marks (1, 2, and 3) to confirm they are properly aligned.

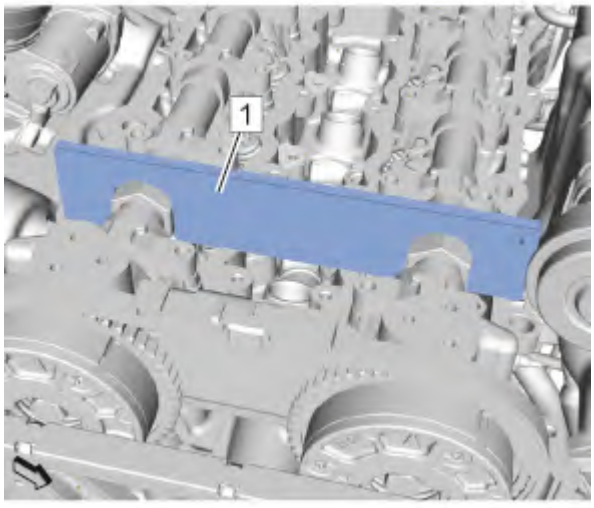


Fig. 133: Camshaft Holder
Courtesy of GENERAL MOTORS COMPANY

4. Install camshaft holding tool **EN-51367** (1).

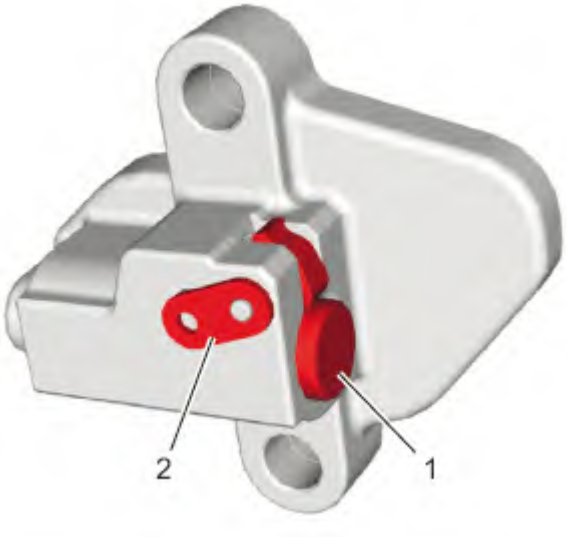


Fig. 134: Pushing Back Piston
Courtesy of GENERAL MOTORS COMPANY

5. Reset the tensioner plunger (1). **Timing Chain Tensioner Replacement**

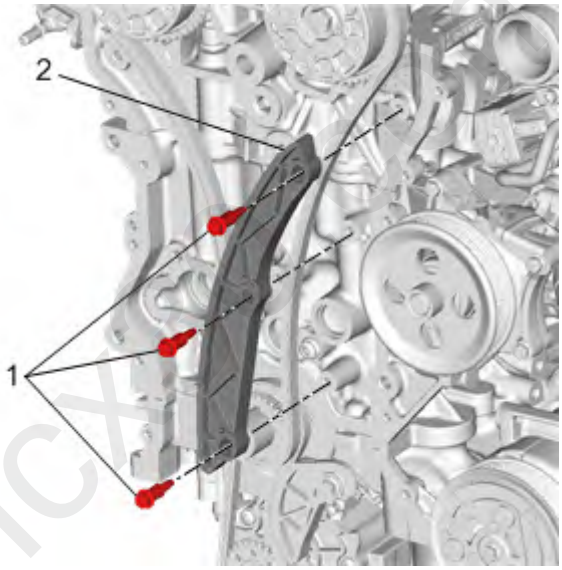


Fig. 135: Timing Chain Guide And Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Remove Timing Chain Guide Fastener (1)
7. Remove Timing Chain Guide (2)

NOTE: **It is not necessary to remove the timing chain from the sprockets.**

8. Inspect, timing components as necessary. For camshaft timing chain, oil nozzle, sprocket and tensioner cleaning and inspection. **Camshaft Timing Chain and Sprocket Cleaning and Inspection**.

Installation Procedure

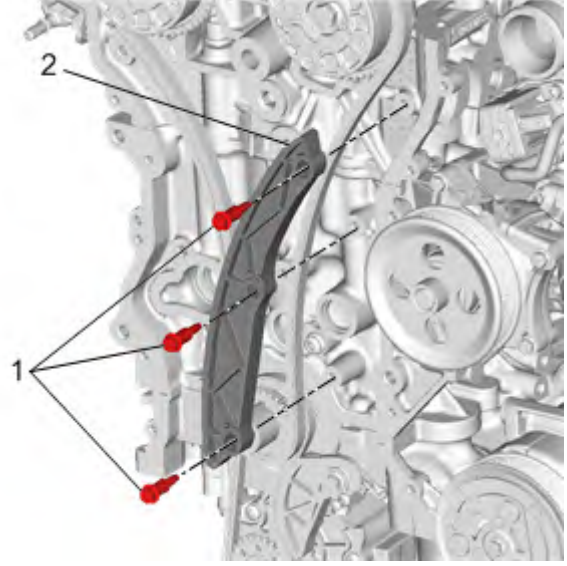


Fig. 136: Timing Chain Guide And Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

1. Install Timing Chain Guide (2)
2. Install Timing Chain Guide Fastener (1) and tighten 10 N.m (89 lb in)

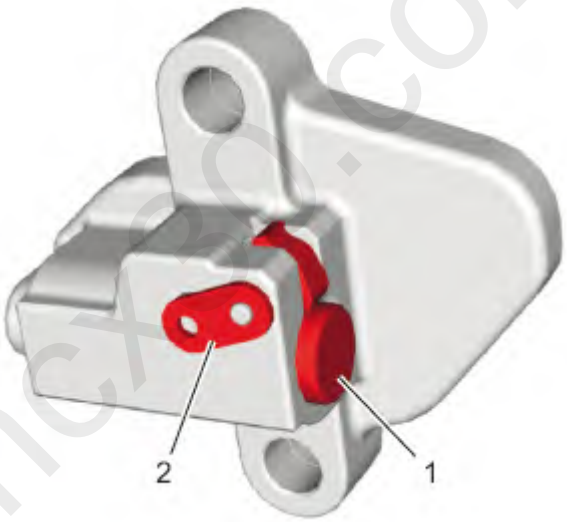


Fig. 137: Pushing Back Piston
Courtesy of GENERAL MOTORS COMPANY

3. Release the tensioner plunger (1). **Timing Chain Tensioner Replacement**

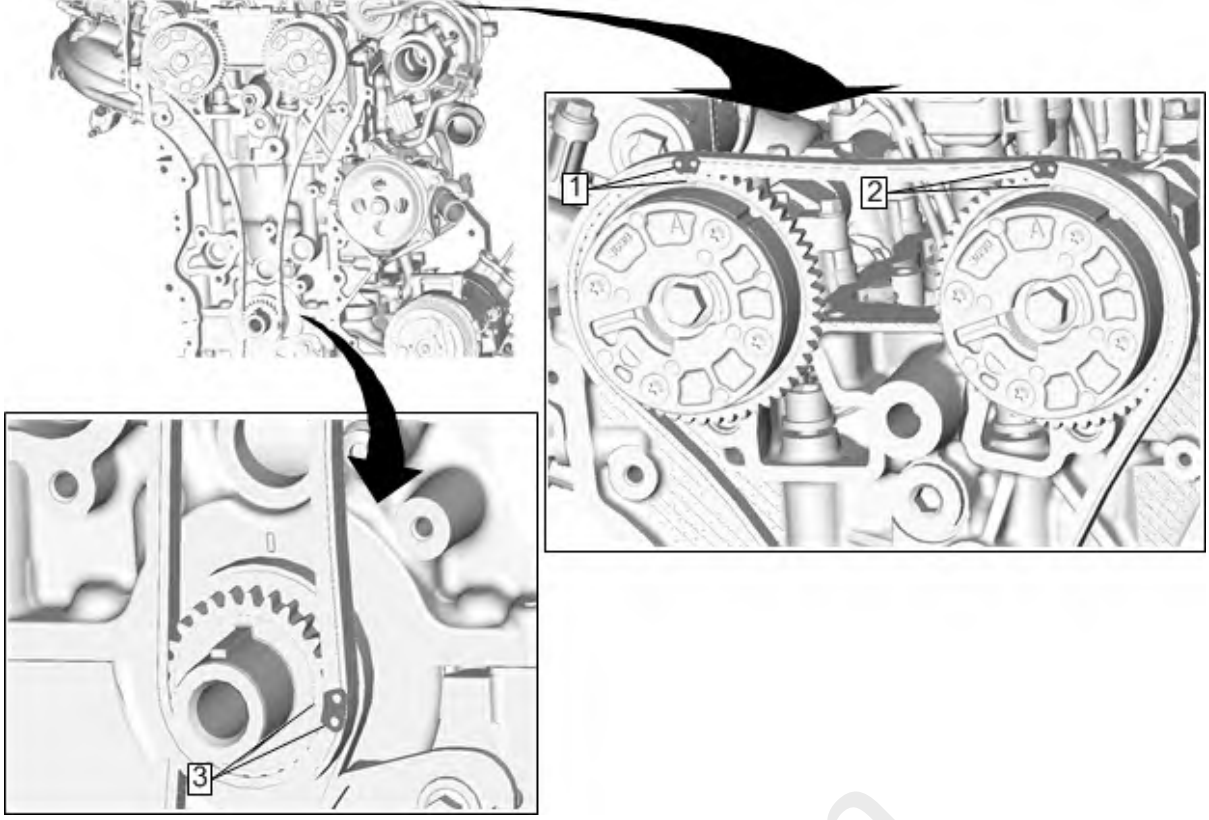


Fig. 138: Timing Chain Marks
Courtesy of GENERAL MOTORS COMPANY

4. Inspect the timing chain marks (1, 2, and 3) to confirm they remained aligned after engaging the timing chain tensioner.

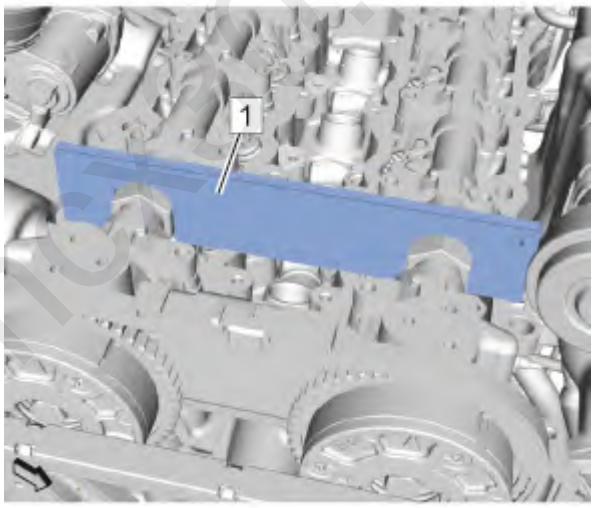


Fig. 139: Camshaft Holder
Courtesy of GENERAL MOTORS COMPANY

5. Remove camshaft holding tool **EN-51367** (1).
6. Using a suitable tool, rotate the crankshaft one complete engine cycle then verify the timing chain marks are aligned properly.
7. Install **Engine Front Cover Replacement**

TIMING CHAIN TENSIONER REPLACEMENT

Special Tools

EN-51367 Camshaft Holder

Equivalent regional tools:**Special Tools**

Removal Procedure

1. Remove Camshaft Cover **Camshaft Cover Replacement**
2. Remove Front Wheelhouse Liner-Right Side **Front Wheelhouse Liner Replacement - Right Side (Equinox)** **Front Wheelhouse Liner Replacement - Right Side (Terrain)**

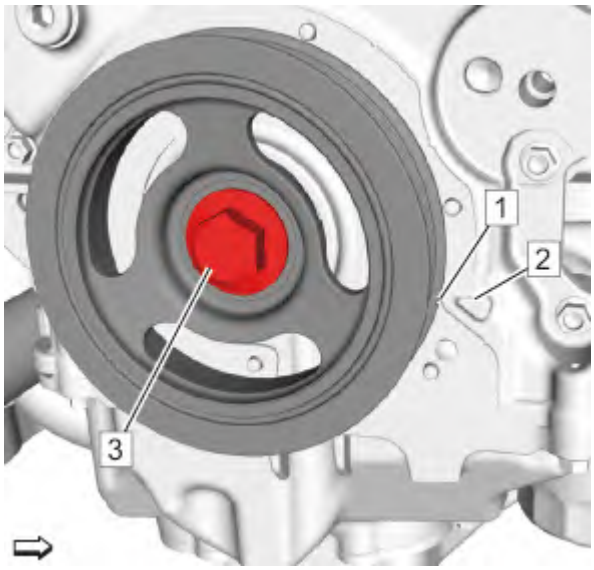


Fig. 140: Crankshaft Balancer Markings
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Adjust the engine to cylinder 1 top dead center (TDC) of combustion stroke. Turn the crankshaft in direction of engine rotation until the markings (1, 2) line up.**

3. Rotate at the crankshaft balancer bolt (3).

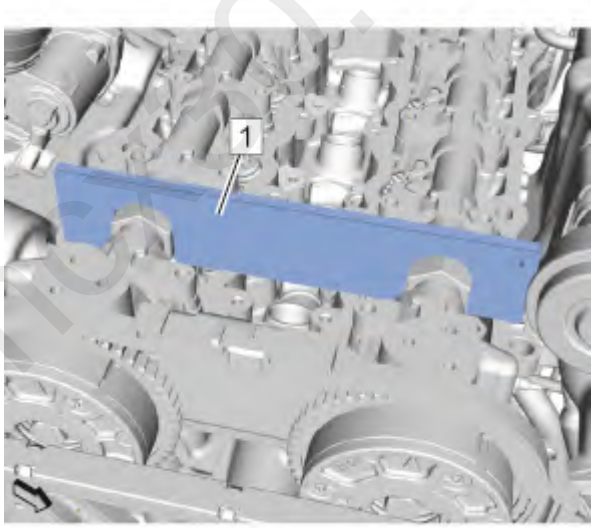


Fig. 141: Camshaft Holder
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-51367** holder (1).
5. Remove Engine Front Cover - **Engine Front Cover Replacement**
6. Remove Timing Chain Upper Guide - **Timing Chain Upper Guide Replacement**

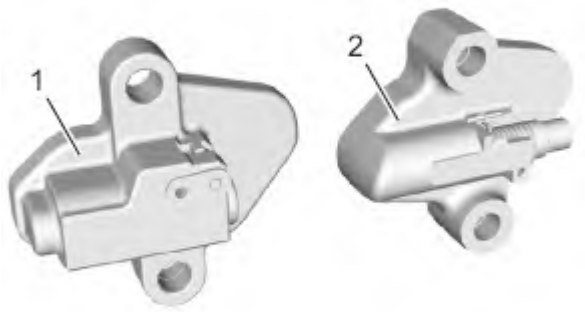


Fig. 142: Tensioner Designs
Courtesy of GENERAL MOTORS COMPANY

7. The engine has one of the two tensioner designs (1, 2). Each design has a different release mechanism and position.

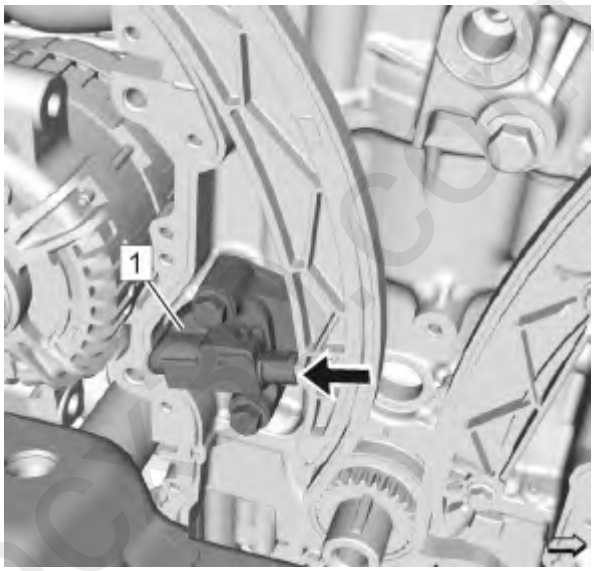


Fig. 143: Timing Chain Tensioner In Service Position
Courtesy of GENERAL MOTORS COMPANY

8. Fix the timing chain tensioner with design 1 (1) in service position:

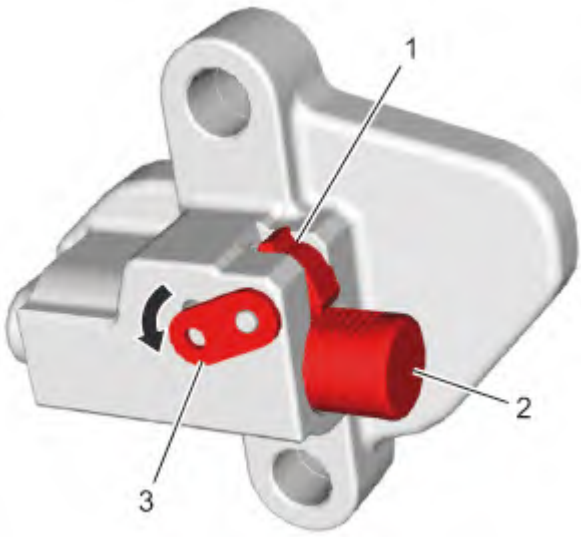


Fig. 144: Releasing Tension From Piston
Courtesy of GENERAL MOTORS COMPANY

1. Slightly release tension from the piston (2) until bar (1) can be unlocked by rotating the lever (3) in direction of arrow.

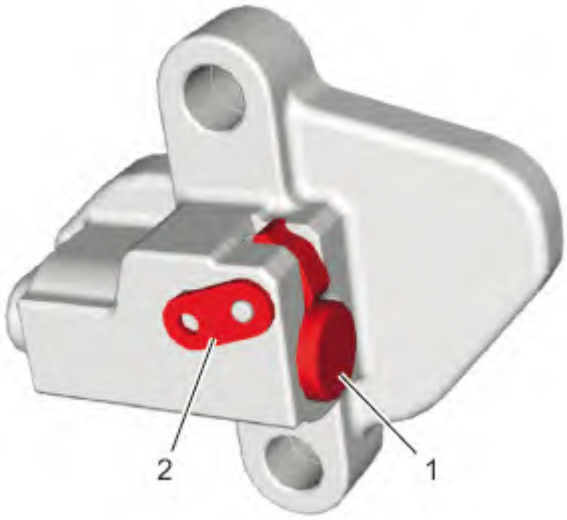


Fig. 145: Pushing Back Piston
Courtesy of GENERAL MOTORS COMPANY

2. Entirely push back the piston (1) until the tensioner lever (2) cannot be locked in this position.

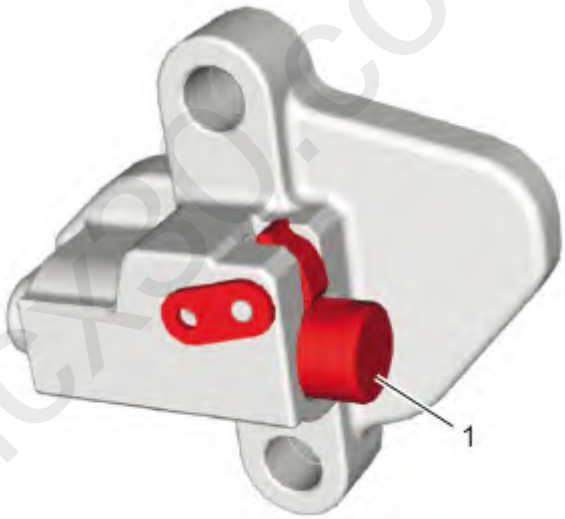


Fig. 146: Piston
Courtesy of GENERAL MOTORS COMPANY

3. Release tension from the piston (1) until it releases for three ratchets. The three ratchets can be noticed by the click noises.

mcx30.com

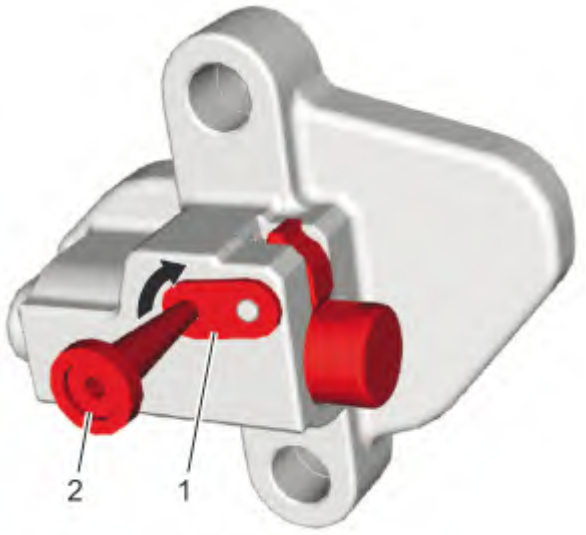


Fig. 147: Lever And Fixing Pin
Courtesy of GENERAL MOTORS COMPANY

4. Apply tension to the piston until the lever (1) is rotated back into the locking position where the bore in the lever aligns with the bore in the tensioner housing.
5. Fix the lever in this position with a suitable fixing pin (2).

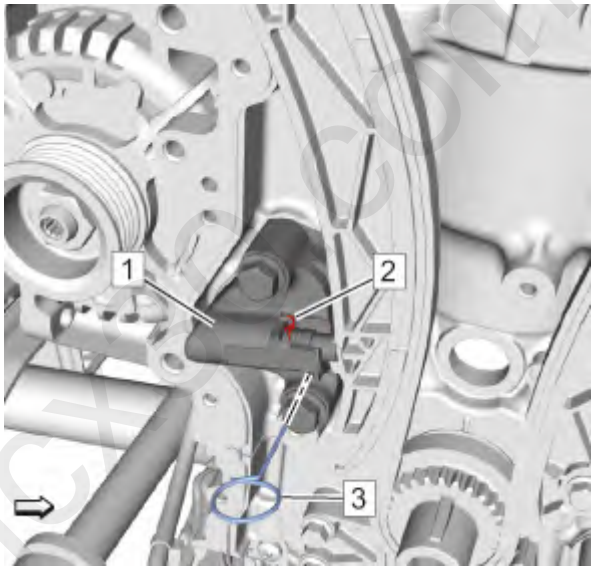


Fig. 148: Tensioner Design 2
Courtesy of GENERAL MOTORS COMPANY

6. The style of tensioner design 2 (1) can be released by using a punch and pressing on the release clip (2).
7. Secure the timing chain tensioner with suitable sized drill bit (3).

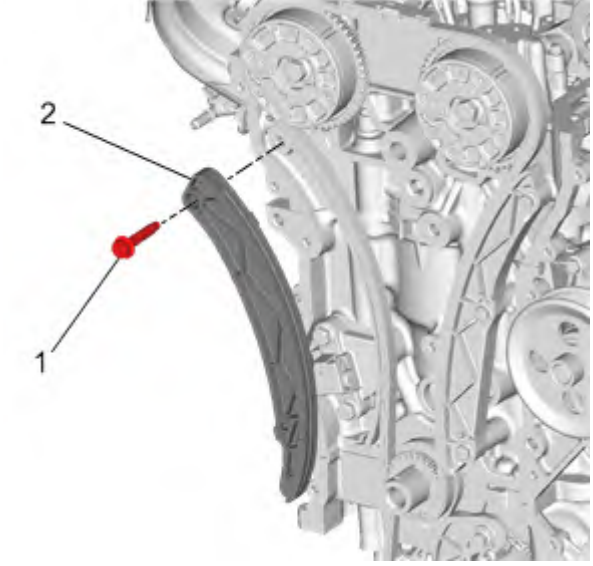


Fig. 149: Timing Chain Tensioner Shoe Fastener
Courtesy of GENERAL MOTORS COMPANY

9. Remove Timing Chain Tensioner Shoe Bolt (1)
10. Remove Timing Chain Tensioner Shoe (2)

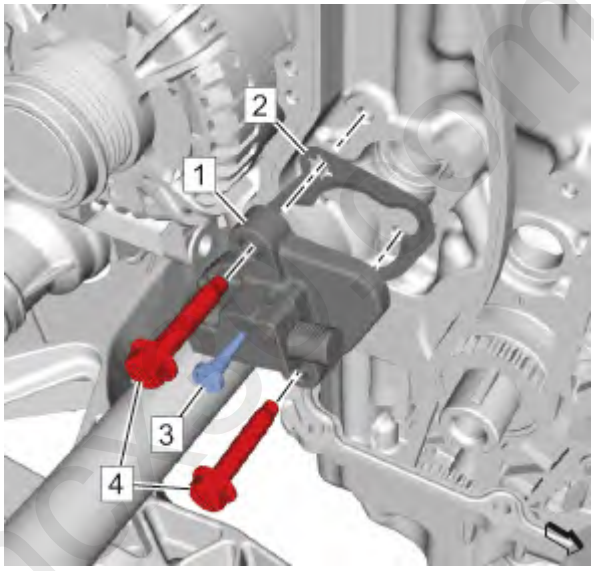


Fig. 150: Timing Chain Tensioner Tool, Timing Chain Tensioner, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Both tensioner designs have the same removal procedure. Each tensioner design uses a different fixing procedure and fixing tool see steps 7 - 8.7.**

11. Ensure the correct fixation of the tool (3) is used.
12. Remove Timing Chain Tensioner Bolt (4) - [2x]
13. Remove Timing Chain Tensioner (1)
14. Remove and DISCARD the gasket.(2)

Installation Procedure

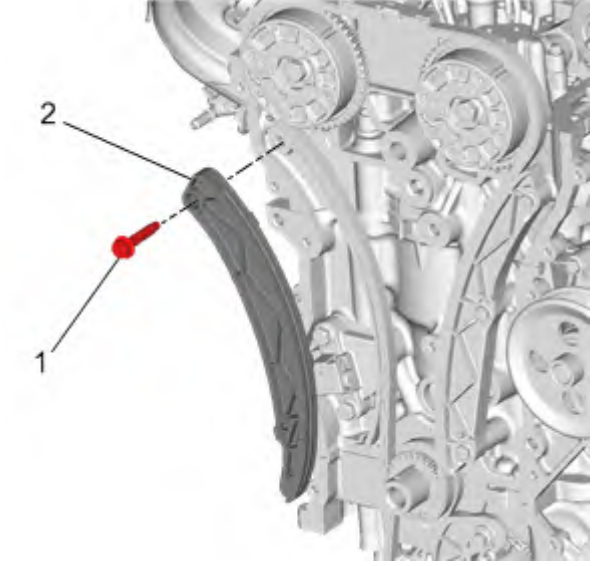


Fig. 151: Timing Chain Tensioner Shoe Fastener
Courtesy of GENERAL MOTORS COMPANY

1. Install Timing Chain Tensioner Shoe (2).

CAUTION: **Refer to Fastener Caution .**

2. Install Timing Chain Tensioner Shoe Bolt (1) and tighten 25 N.m (18 lb ft)

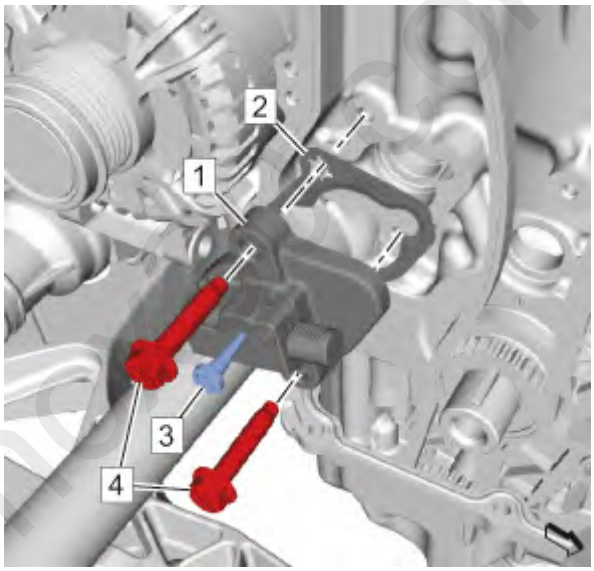


Fig. 152: Timing Chain Tensioner Tool, Timing Chain Tensioner, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW gasket.(2)
4. Install Timing Chain Tensioner(1)
5. Install Timing Chain Tensioner Bolt (4) - and tighten 25 N.m (18 lb ft).
6. Remove the suitable tool (3) from the timing chain tensioner.

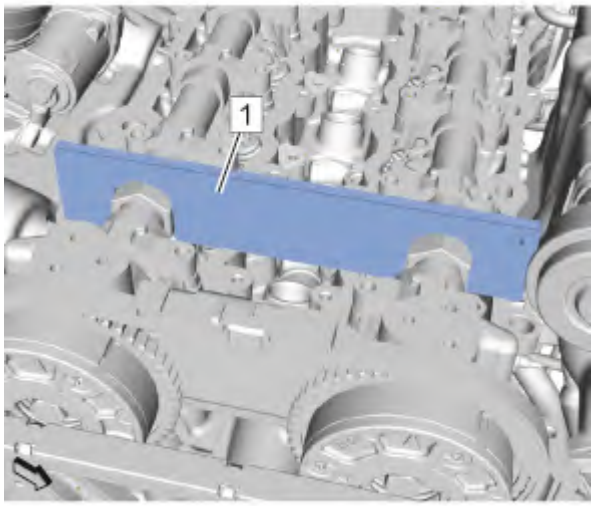


Fig. 153: Camshaft Holder
Courtesy of GENERAL MOTORS COMPANY

7. Remove the **EN-51367** holder (1).
8. Install Timing Chain Upper Guide - **Timing Chain Upper Guide Replacement**
9. Check the position of the crankshaft, camshaft and camshaft position actuator adjuster.
    1. TEMPORARILY install the engine front cover with 4 bolts and the crankshaft balancer.

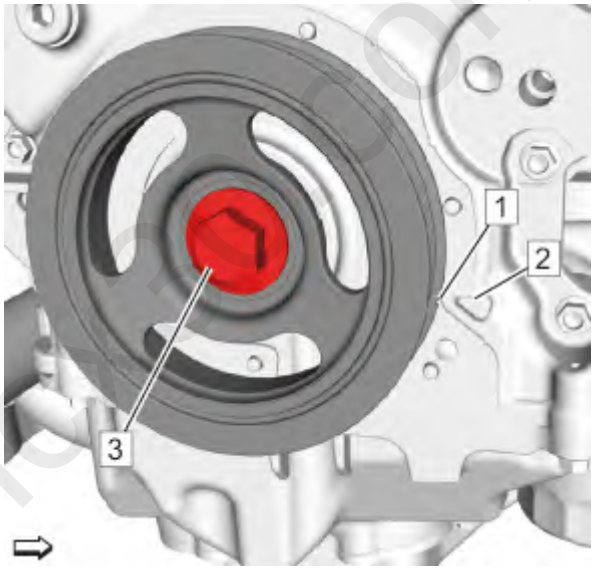


Fig. 154: Crankshaft Balancer Markings
Courtesy of GENERAL MOTORS COMPANY

    2. Turn crankshaft 720 degrees in the direction of engine rotation by the crankshaft balancer bolt (3).

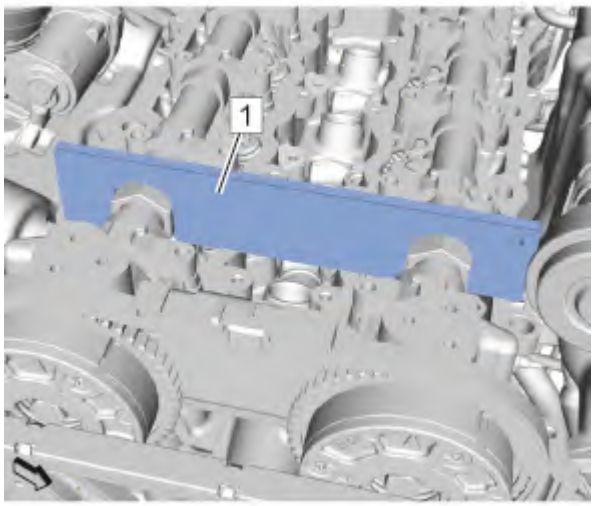


Fig. 155: Camshaft Holder
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the EN-51367 holder (1) can be installed, the engine timing is properly adjusted. If the EN-51367 holder (1) can not be installed, confirm the engine is set to cylinder 1 top dead center (TDC) of combustion stroke.**

10. Install the **EN-51367** holder (1).
11. Remove the **EN-51367** holder.
12. Remove the TEMPORARILY installed engine front cover and crankshaft balancer.
13. Install Engine Front Cover - **Engine Front Cover Replacement**

NOTE: **Right Side**

14.
15. Install Front Wheelhouse Liner-Right Side - **Front Wheelhouse Liner Replacement - Right Side (Equinox)** **Front Wheelhouse Liner Replacement - Right Side (Terrain)**
16. Install Camshaft Cover - **Camshaft Cover Replacement**

TIMING CHAIN TENSIONER SHOE REPLACEMENT

Special Tools

EN-51367 Camshaft Holder

Equivalent regional tools:**Special Tools**

Removal Procedure

1. Remove **Engine Front Cover Replacement**
2. Set the engine to top dead center (TDC).

mcx30.com

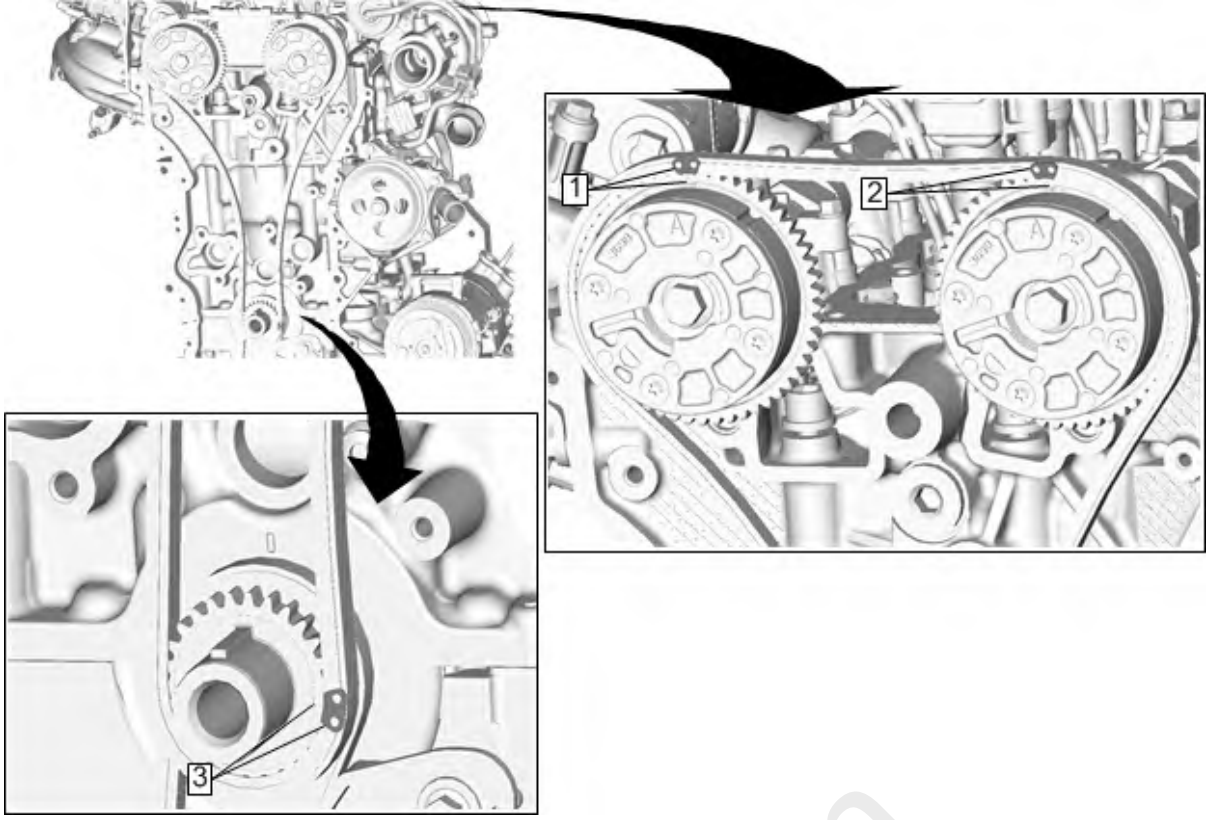


Fig. 156: Timing Chain Marks
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the timing chain marks (1, 2, and 3) to confirm they are properly aligned.

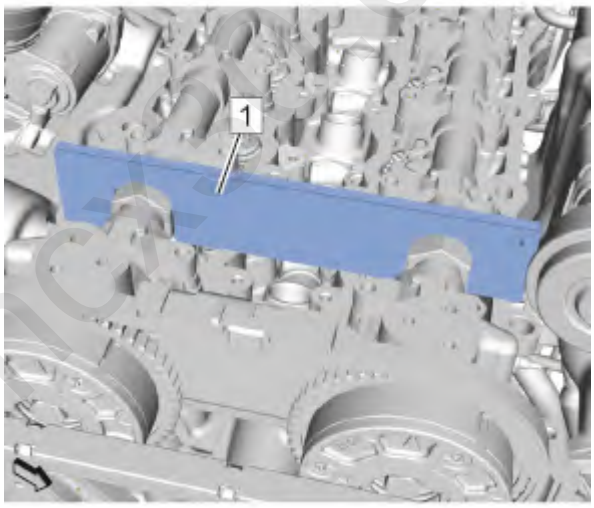


Fig. 157: Camshaft Holder
Courtesy of GENERAL MOTORS COMPANY

4. Install camshaft holding tool **EN-51367** (1).

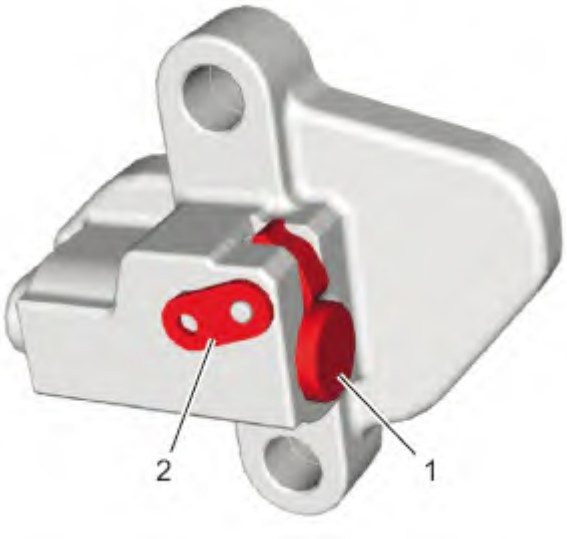


Fig. 158: Pushing Back Piston
Courtesy of GENERAL MOTORS COMPANY

5. Reset the tensioner plunger (1). **Timing Chain Tensioner Replacement**

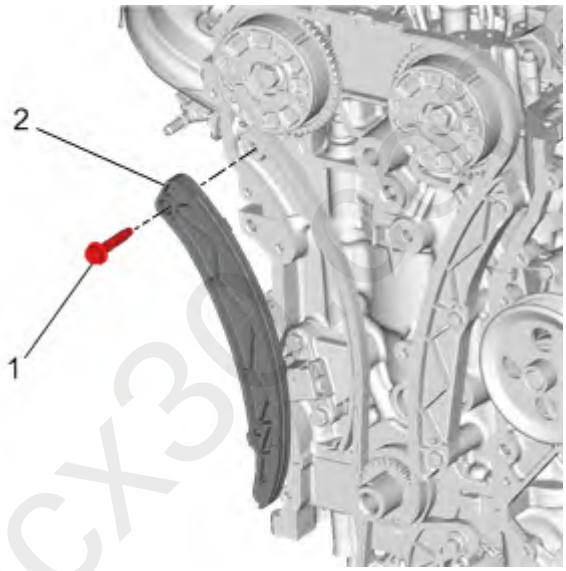


Fig. 159: Timing Chain Tensioner Shoe Fastener
Courtesy of GENERAL MOTORS COMPANY

6. Remove Timing Chain Tensioner Shoe Bolt (1)
7. Remove Timing Chain Tensioner Shoe (2)

NOTE: **It is not necessary to remove the timing chain from the sprockets.**

8. Inspect, timing components as necessary. For camshaft timing chain, oil nozzle, sprocket and tensioner cleaning and inspection. **Camshaft Timing Chain and Sprocket Cleaning and Inspection**

Installation Procedure

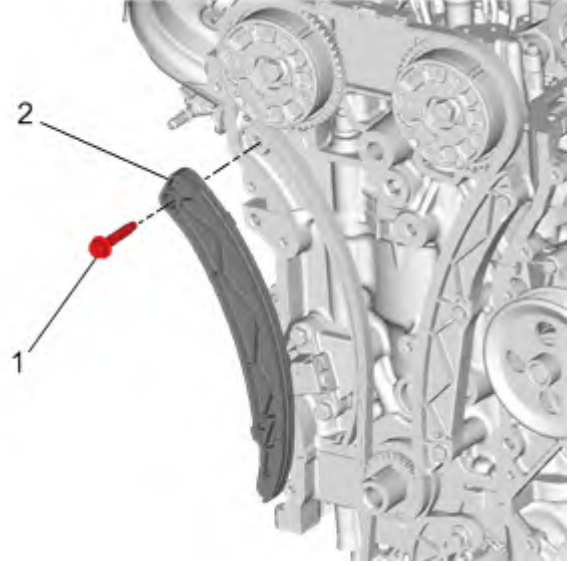


Fig. 160: Timing Chain Tensioner Shoe Fastener
Courtesy of GENERAL MOTORS COMPANY

1. Install Timing Chain Tensioner Shoe (2)

CAUTION: **Refer to Fastener Caution .**

2. Install Timing Chain Tensioner Shoe Bolt (1) and tighten 25 N.m (18 lb ft)

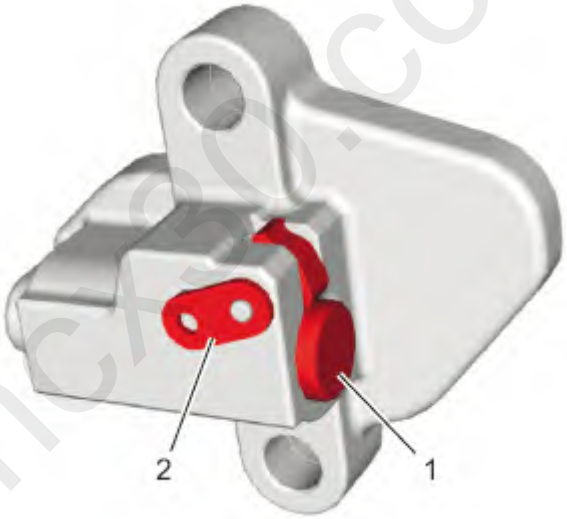


Fig. 161: Pushing Back Piston
Courtesy of GENERAL MOTORS COMPANY

3. Release the tensioner plunger (1). **Timing Chain Tensioner Replacement**

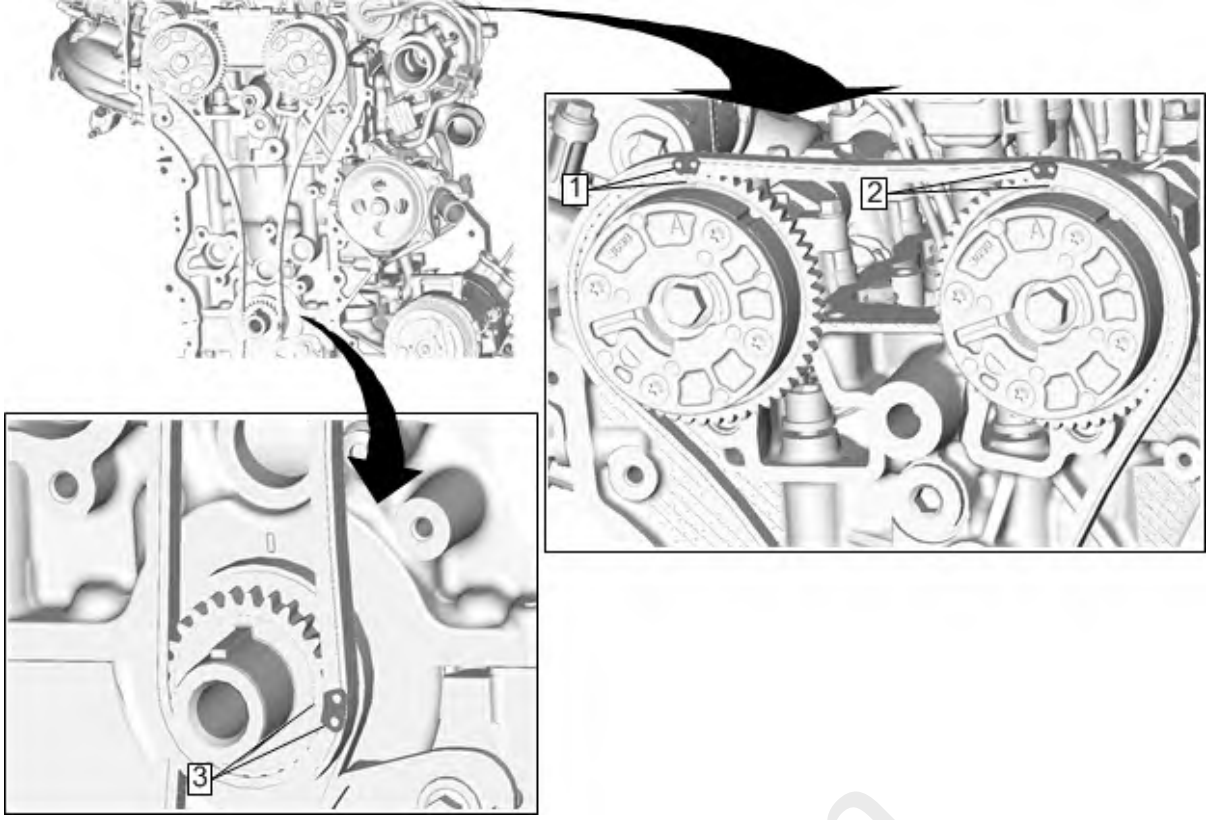


Fig. 162: Timing Chain Marks
Courtesy of GENERAL MOTORS COMPANY

4. Inspect the timing chain marks to confirm they remained aligned after engaging the timing chain tensioner.

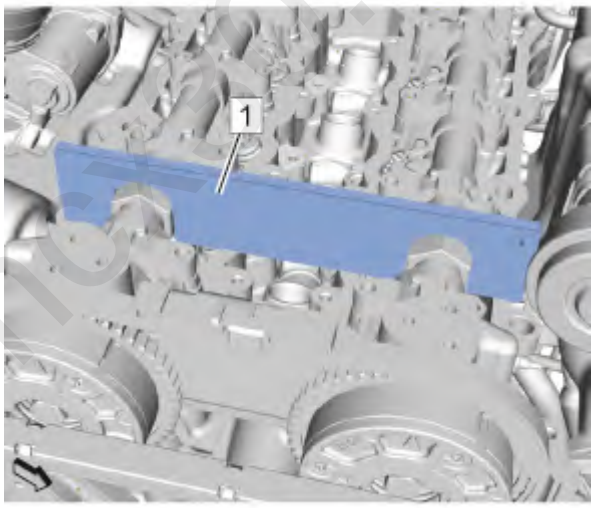


Fig. 163: Camshaft Holder
Courtesy of GENERAL MOTORS COMPANY

5. Remove camshaft holding tool **EN-51367** (1).
6. Using a suitable tool, rotate the crankshaft one complete engine cycle then verify the timing chain marks (1, 2 and 3) are aligned properly.
7. Install **Engine Front Cover Replacement**

TURBOCHARGER HEAT SHIELD REPLACEMENT

Removal Procedure

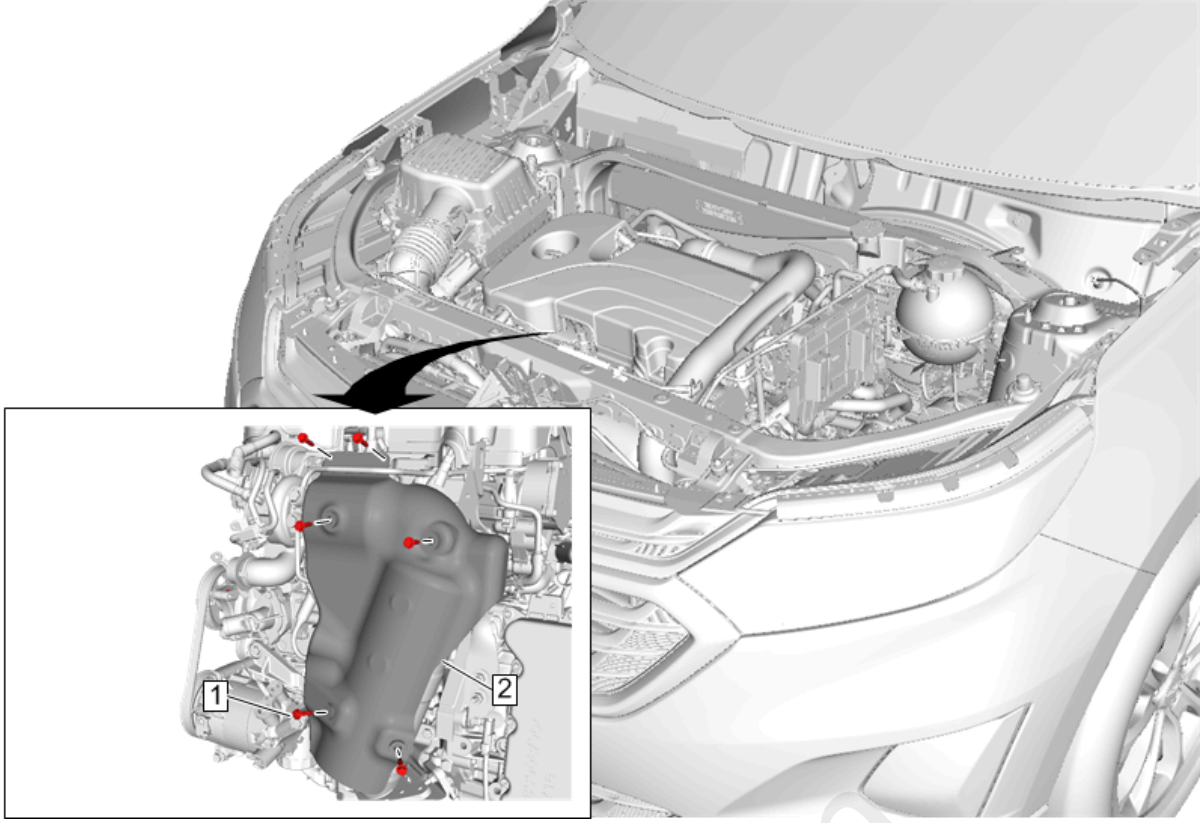


Fig. 164: Turbocharger Heat Shield And Fastener
Courtesy of GENERAL MOTORS COMPANY

1. Remove Turbocharger Heat Shield Fastener (1)
2. Remove Turbocharger Heat Shield (2)

Installation Procedure

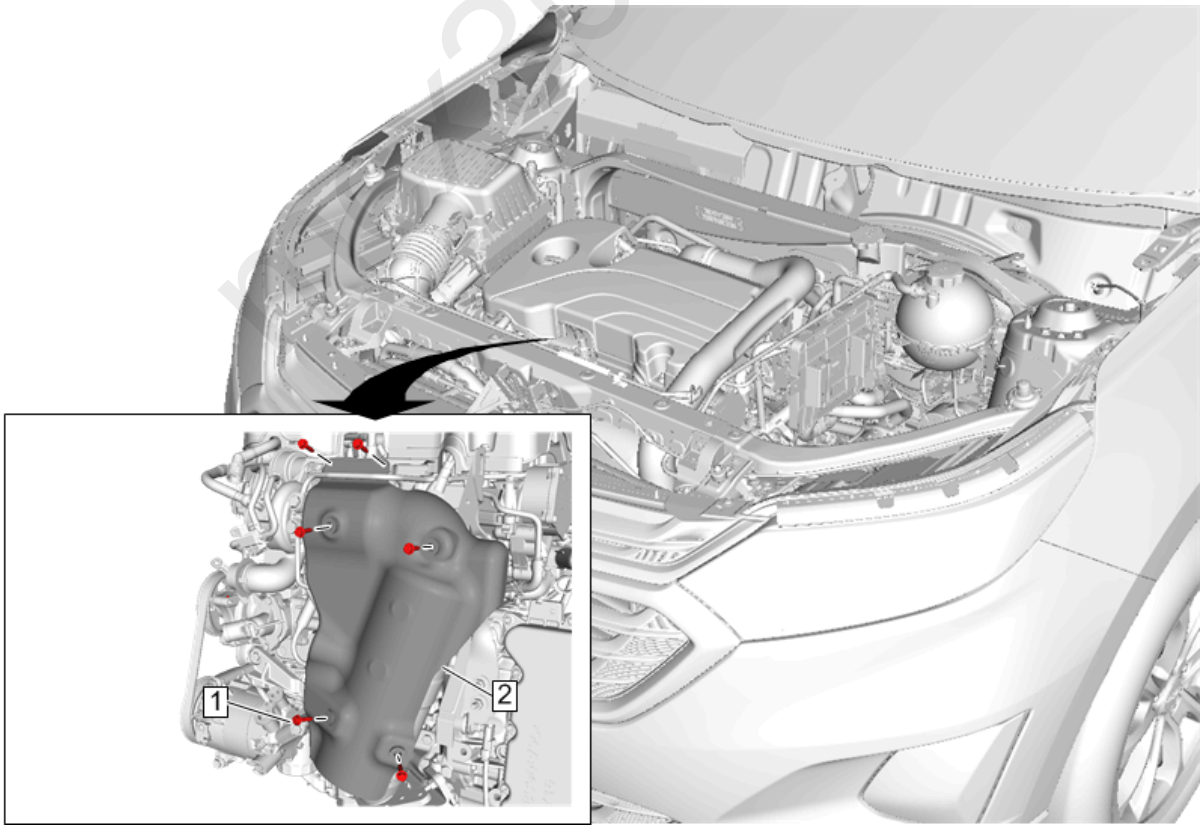


Fig. 165: Turbocharger Heat Shield And Fastener
Courtesy of GENERAL MOTORS COMPANY

1. Install Turbocharger Heat Shield (2)

CAUTION: **Refer to Fastener Caution .**

2. Install Turbocharger Heat Shield Fastener (1) and tighten 10 N.m (89 lb in)

TURBOCHARGER OIL FEED PIPE REPLACEMENT

Removal Procedure

1. Remove **Air Conditioning Compressor Bracket Replacement (LYX)**

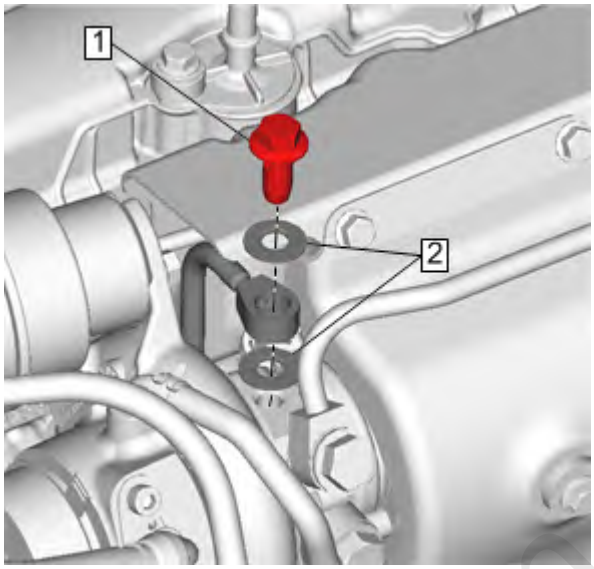


Fig. 166: Turbocharger Oil Feed Pipe Bolt And Gaskets
Courtesy of GENERAL MOTORS COMPANY

2. Remove the turbocharger oil feed pipe bolt (1).
3. Remove and DISCARD the 2 turbocharger oil feed pipe gaskets (2).
4. Raise and support the vehicle. **Lifting and Jacking the Vehicle**

NOTE: **It is necessary to remove the catalytic converter to gain more space for the turbocharger oil feed pipe removal.**

5.

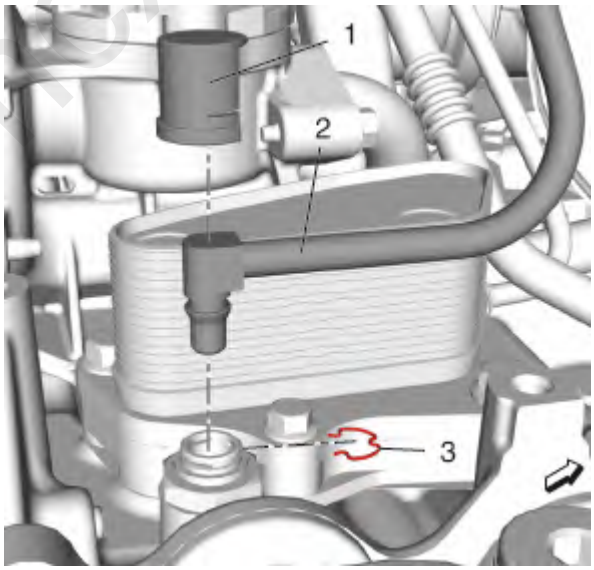


Fig. 167: Turbocharger Oil Feed Pipe, Clip And Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Remove the turbocharger oil feed pipe clip (1).
7. Remove and DISCARD the turbocharger oil feed pipe retainer (3).
8. Remove the turbocharger oil feed pipe (2).

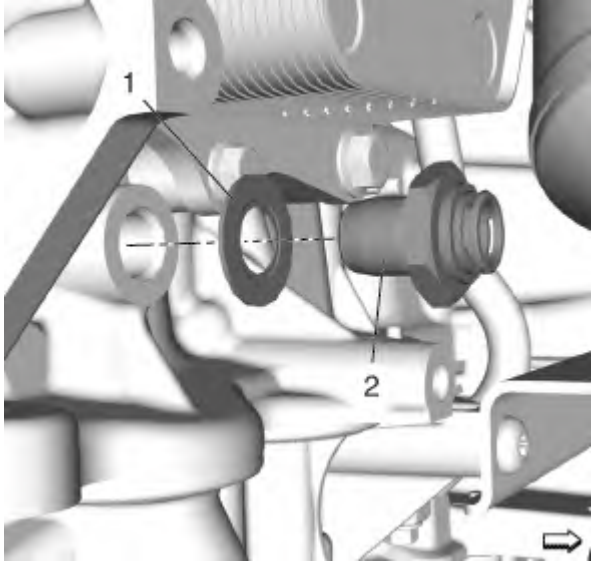


Fig. 168: Turbocharger Oil Feed Pipe Fitting Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The turbocharger oil feed pipe fitting is not reusable.**

9. Remove and DISCARD the turbocharger oil feed pipe fitting (2).
10. Remove and DISCARD the turbocharger oil feed pipe fitting gasket (1).

Installation Procedure

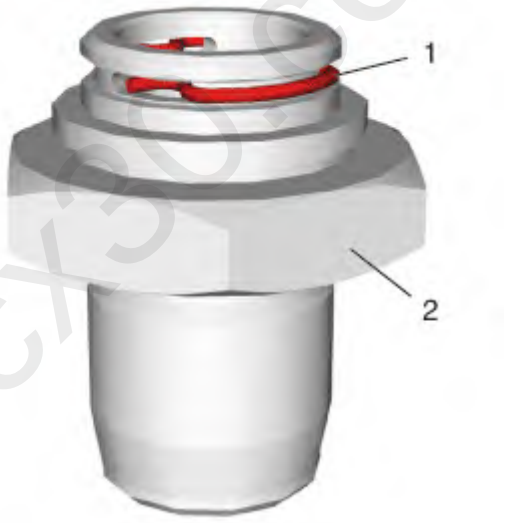


Fig. 169: Turbocharger Oil Feed Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

1. The retainer (1) of the turbocharger oil feed pipe fitting (2) is pre-installed.

mcx30.com

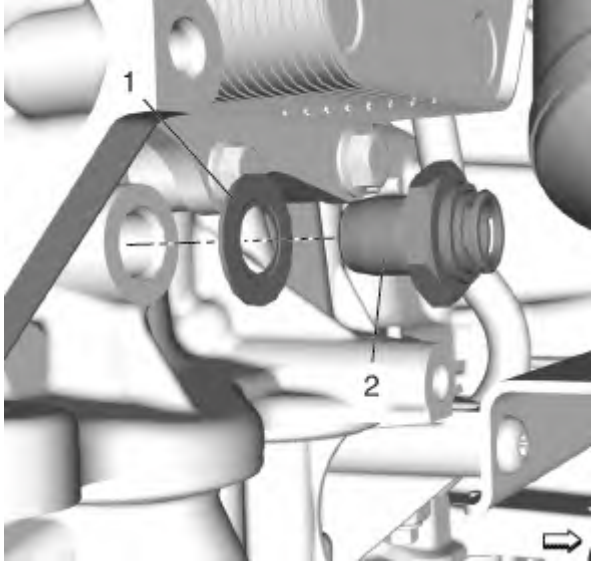


Fig. 170: Turbocharger Oil Feed Pipe Fitting Gasket
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW turbocharger oil feed pipe fitting gasket (1).

CAUTION: **Refer to Component Fastener Tightening Caution .**

3. Install a NEW turbocharger oil feed pipe fitting (2) and tighten to 35 N.m (26 lb ft).

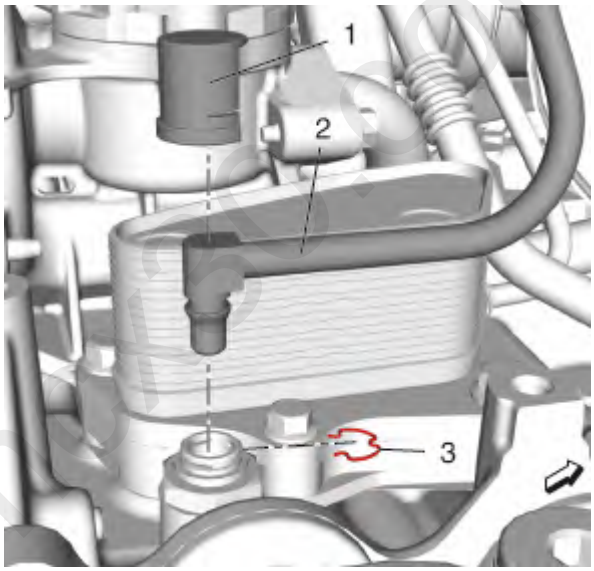


Fig. 171: Turbocharger Oil Feed Pipe, Clip And Retainer
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **When installing a quick-connect turbocharger oil feed pipe, ensure that the oil feed pipe is fully secured into the oil feed pipe fitting. An audible click will be heard when the oil feed pipe is seated. If the oil feed pipe is not fully seated, an oil leak can occur in certain RPM ranges and will cause significant component and/or vehicle damage. Due to the possibility of significant component and/or vehicle damage from an oil feed pipe leak, it is necessary to start the engine and inspect for signs of leakage around the connections after performing the repair.**

NOTE: **The retainer (3) is pre-installed in the fitting. Therefore the pipe can be snapped into the fitting but cannot be removed once installed.**

4. Install the turbocharger oil feed pipe (2).
5. Install the turbocharger oil feed pipe clip (1).

6. Pull back on turbocharger oil feed pipe (2) to be sure the retainer (3) properly retains the pipe in the fitting.
7. Lower the vehicle.

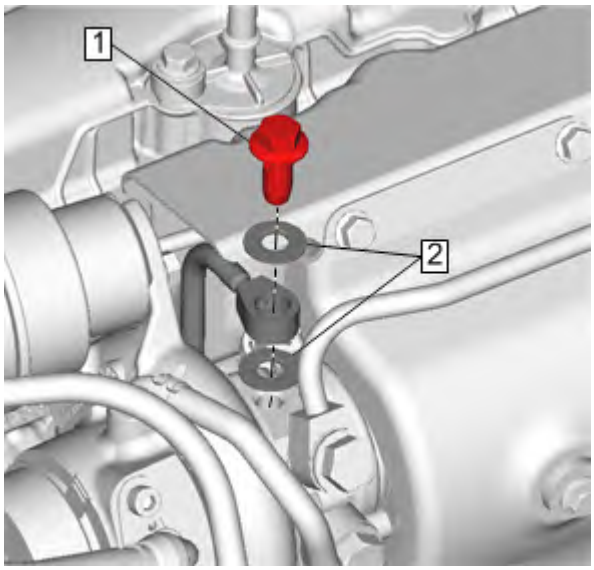


Fig. 172: Turbocharger Oil Feed Pipe Bolt And Gaskets
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Ensure that the turbocharger oil feed pipe does not rotate while torquing it. There should be a minimum 10 mm gap between the oil feed pipe and the v-band clamp. Failure to perform this could result in damage to the oil feed pipe and create an oil leak.**

8. Install 2 NEW turbocharger oil feed pipe gaskets (2).
9. Install the turbocharger oil feed pipe bolt (1) and tighten to 32 N.m (24 lb ft)
10. Install **Air Conditioning Compressor Bracket Replacement (LYX)** .

TURBOCHARGER OIL RETURN PIPE REPLACEMENT

Removal Procedure

1. Remove Warm Up Three-Way Catalytic Converter - **Warm Up Three-Way Catalytic Converter Replacement (LYX)**

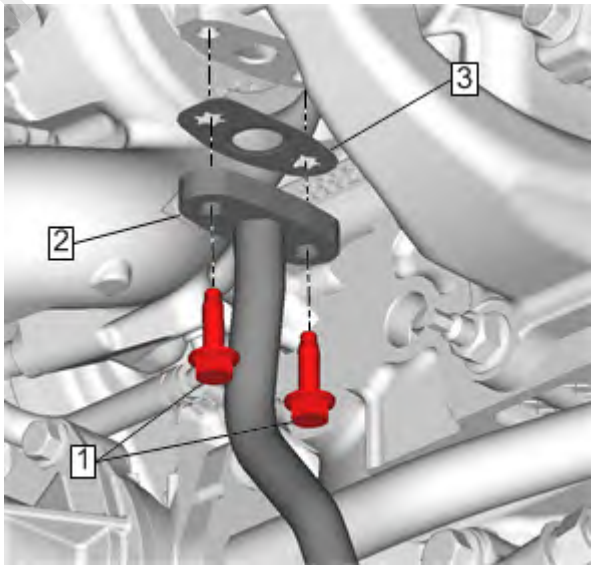


Fig. 173: Turbocharger Oil Return Pipe, Fasteners And Gasket
Courtesy of GENERAL MOTORS COMPANY

2. Remove the short turbocharger oil return pipe fasteners (1).
3. Remove and DISCARD the gasket (3) from the turbocharger oil return pipe (2).

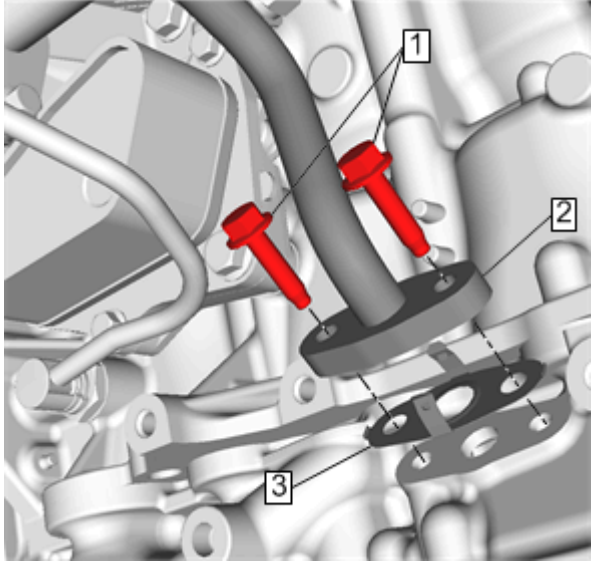


Fig. 174: Turbocharger Oil Return Pipe, Fasteners And Gasket
Courtesy of GENERAL MOTORS COMPANY

4. Remove the long turbocharger oil return pipe fasteners (1) then remove the pipe (2).
5. Remove and DISCARD the turbocharger oil return pipe gasket (3).

Installation Procedure

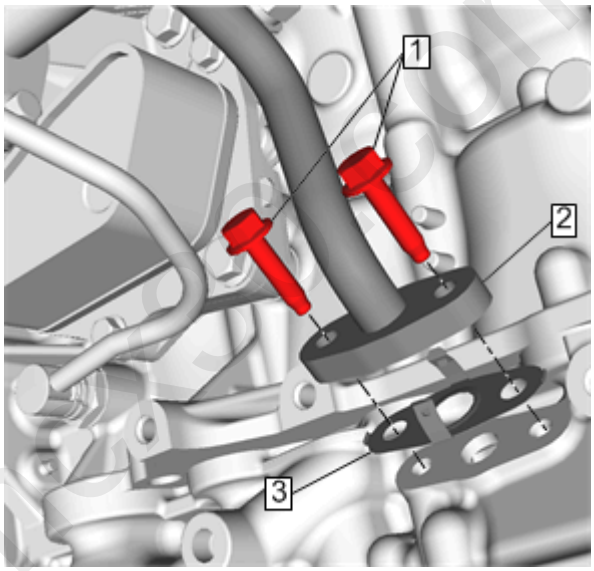


Fig. 175: Turbocharger Oil Return Pipe, Fasteners And Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW turbocharger return pipe gasket (3).

CAUTION: **Refer to Fastener Caution .**

2. Position the turbocharger oil return pipe (2) then hand start the long turbocharger oil return pipe to engine block fasteners (1). Tighten to 10 N.m (89 lb in).

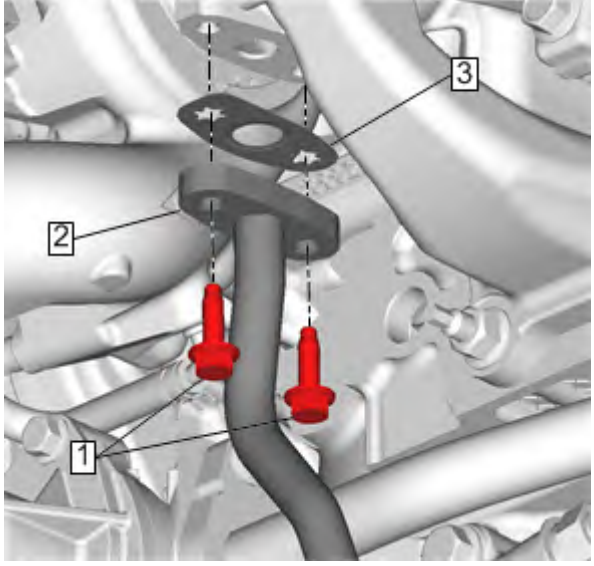


Fig. 176: Turbocharger Oil Return Pipe, Fasteners And Gasket
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW turbocharger oil return pipe gasket (3).
4. Hand start the short turbocharger oil return pipe to turbocharger fasteners (1). Tighten to 10 N.m (89 lb in).
5. Install Warm Up Three-Way Catalytic Converter - **Warm Up Three-Way Catalytic Converter Replacement (LYX)**

TURBOCHARGER REPLACEMENT

Special Tools

- **EN-45059** Angle Meter

Equivalent regional tools:**Special Tools**

Removal Procedure

CAUTION: **If a turbocharger has failed, clean any turbocharger debris or excessive oil from the charge air cooler system before installing the new turbocharger. Failure to clean debris from the charge air cooler system will cause severe turbocharger and engine damage upon startup.**

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Turbocharger Heat Shield -**Turbocharger Heat Shield Replacement**
3. Disconnect Air Cleaner Outlet Duct@Turbocharger - **Air Cleaner Outlet Duct Replacement**
4. Disconnect Air Cleaner Outlet Duct@Air Cleaner Assembly - **Air Cleaner Outlet Duct Replacement**

mx30.com

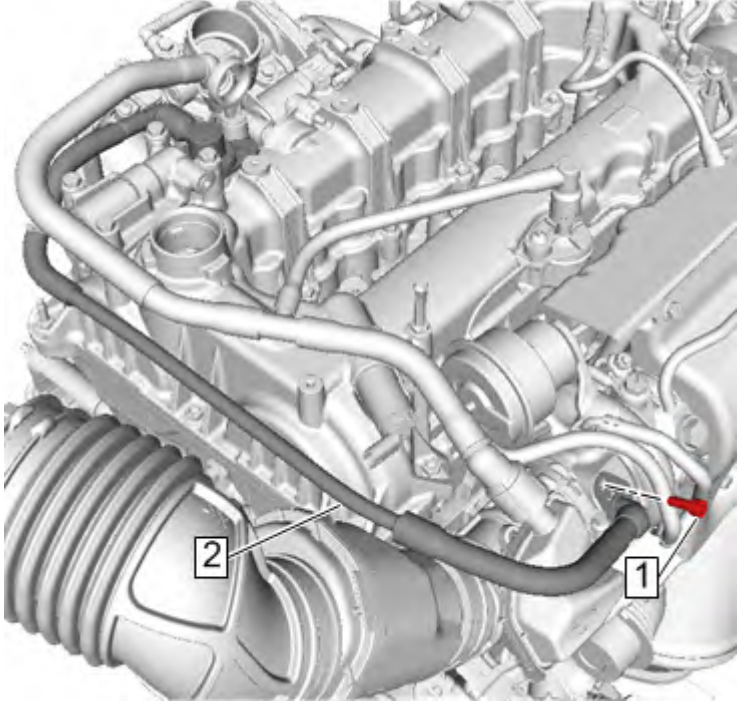


Fig. 177: PCV Valve Tube And Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The positive crankcase ventilation valve and tube assembly (2) are not reusable. If reinstalling the camshaft cover, do not remove the PCV valve and tube assembly (2) from the camshaft cover.**

5. Disconnect Positive Crankcase Ventilation Tube with Positive Crankcase Ventilation Valve - Foul Air@Turbocharger - **Positive Crankcase Ventilation Tube Replacement (Fresh Air)Positive Crankcase Ventilation Tube Replacement (Foul Air)**
6. Remove Charge Air Cooler Inlet Hose - **Charge Air Cooler Inlet Air Tube Replacement**
7. Remove Warm Up Three-Way Catalytic Converter - **Warm Up Three-Way Catalytic Converter Replacement (LYX)**

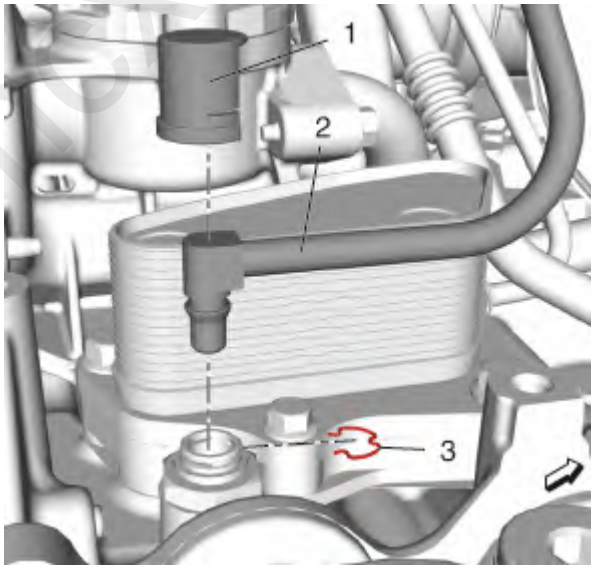


Fig. 178: Turbocharger Oil Feed Pipe, Clip And Retainer
Courtesy of GENERAL MOTORS COMPANY

8. Remove Turbocharger Oil Feed Pipe - **Turbocharger Oil Feed Pipe Replacement**
9. Remove Turbocharger Coolant Return Pipe -**Turbocharger Coolant Return Pipe Replacement (LYX)**
10. Remove Turbocharger Coolant Feed Pipe - **Turbocharger Coolant Feed Pipe Replacement (LYX)**

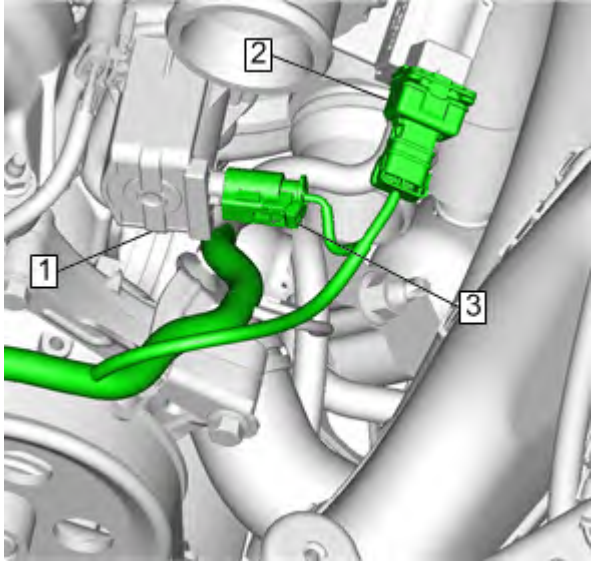


Fig. 179: Turbocharger Bypass Valve Solenoid And Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

11. Disconnect Electrical Connector (3)@Turbocharger Bypass Valve Solenoid (1)
12. Disconnect the turbocharger wastegate regulator solenoid valve electrical connector (2).
13. Raise the vehicle. **Lifting and Jacking the Vehicle**

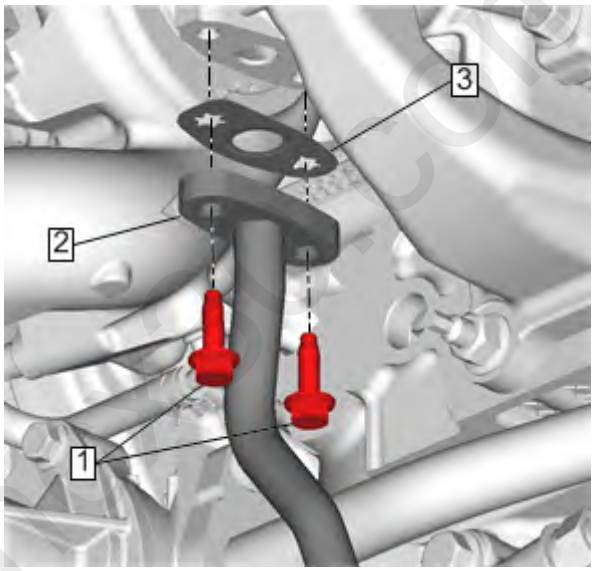


Fig. 180: Turbocharger Oil Return Pipe, Fasteners And Gasket
Courtesy of GENERAL MOTORS COMPANY

14. Remove the turbocharger oil return pipe bolts (1) and carefully separate the pipe (2).
15. Remove Remove Turbocharger Oil Return Pipe Gasket (3) and DISCARD
16. Lower the vehicle. **Lifting and Jacking the Vehicle**

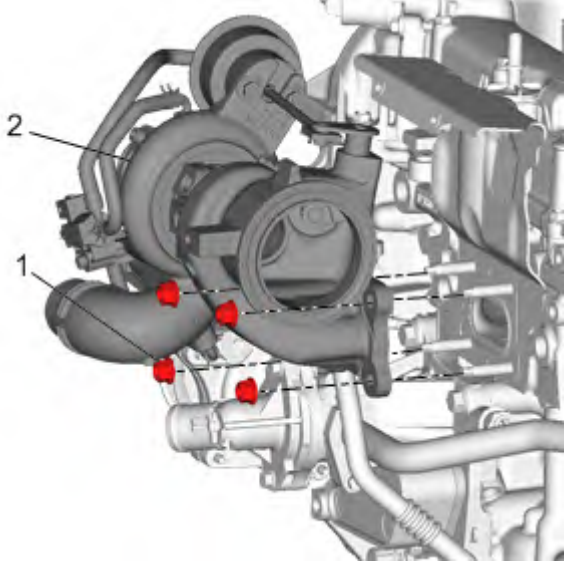


Fig. 181: Turbocharger And Nuts
Courtesy of GENERAL MOTORS COMPANY

17. Remove Turbocharger Nut (1) and DISCARD[4x]
18. Remove Turbocharger (2).

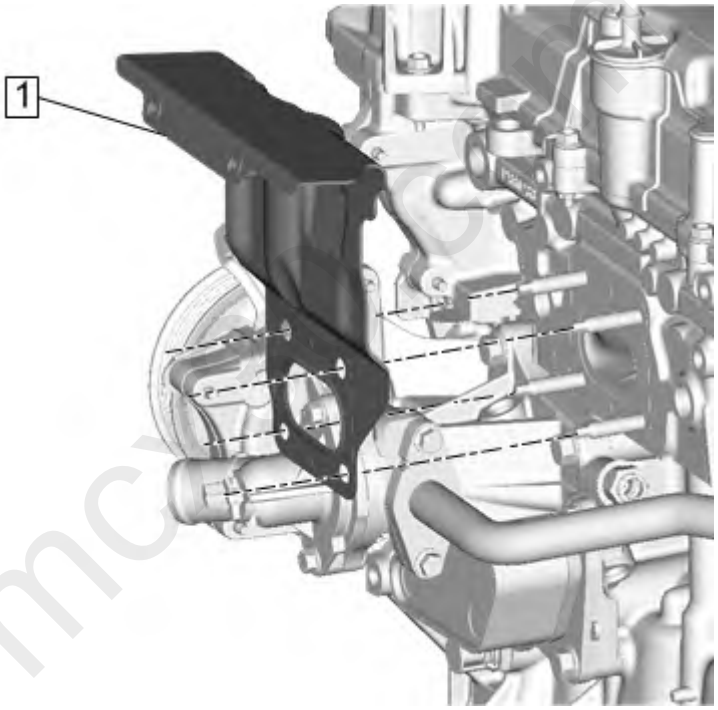


Fig. 182: Turbocharger Heat Shield
Courtesy of GENERAL MOTORS COMPANY

19. Remove and DISCARD the turbocharger heat shield with gasket (1).
20. Clean the exhaust manifold sealing surface at the cylinder head.
21. Clean the 4 turbocharger studs at the cylinder head.
22. Clean and inspect the turbocharger and transfer remaining components as needed. **Turbocharger Cleaning and Inspection**

Installation Procedure

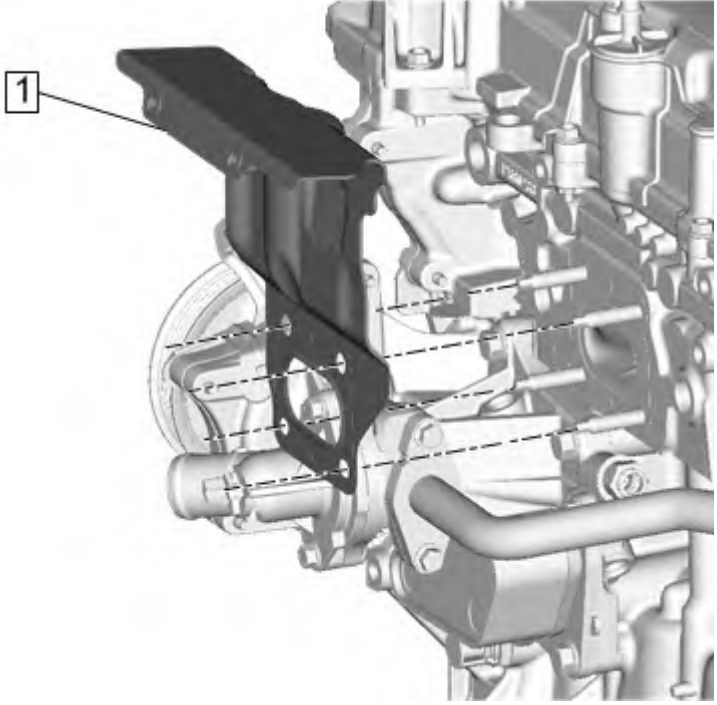


Fig. 183: Turbocharger Heat Shield
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW turbocharger heat shield with gasket (1).

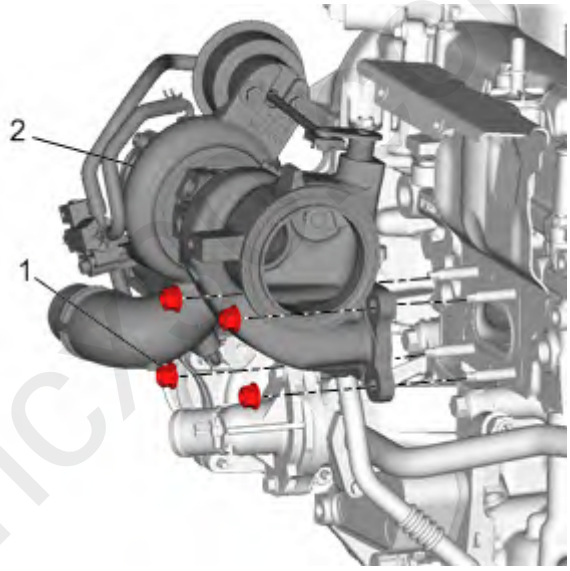


Fig. 184: Turbocharger And Nuts
Courtesy of GENERAL MOTORS COMPANY

2. Install Turbocharger (2)
3. Raise the vehicle.
4. Install and hand tighten the 4 NEW turbocharger nuts (1).

CAUTION: **Refer to Torque-to-Yield Fastener Caution .**

5. Turbocharger Nut (1) - Tighten in sequence [4x] - **Turbocharger Installation**

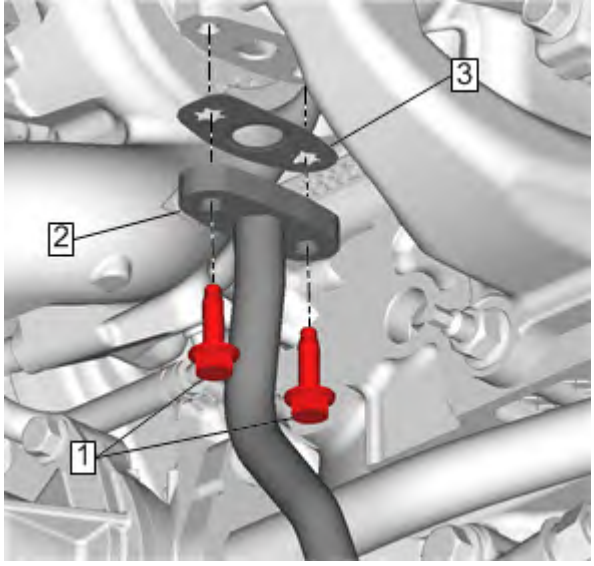


Fig. 185: Turbocharger Oil Return Pipe, Fasteners And Gasket
Courtesy of GENERAL MOTORS COMPANY

6. Install a NEW Turbocharger Oil Return Pipe Gasket (3).
7. Position the pipe (2) then install the turbocharger oil return pipe bolts (1). **Turbocharger Oil Return Pipe Replacement**
8. Lower the vehicle.

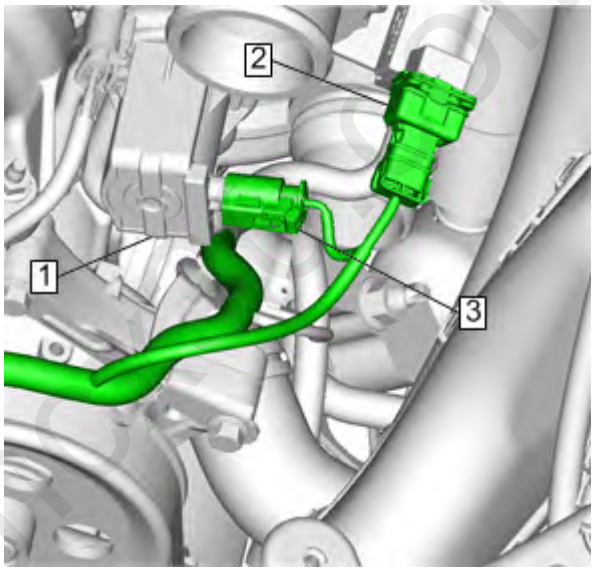


Fig. 186: Turbocharger Bypass Valve Solenoid And Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

9. Connect the turbocharger wastegate regulator solenoid valve electrical connector (2).
10. Connect Electrical Connector (3) @Turbocharger Bypass Valve Solenoid (1)
11. Install Turbocharger Coolant Feed Pipe - **Turbocharger Coolant Feed Pipe Replacement (LYX)**
12. Install Turbocharger Coolant Return Pipe - **Turbocharger Coolant Return Pipe Replacement (LYX)**

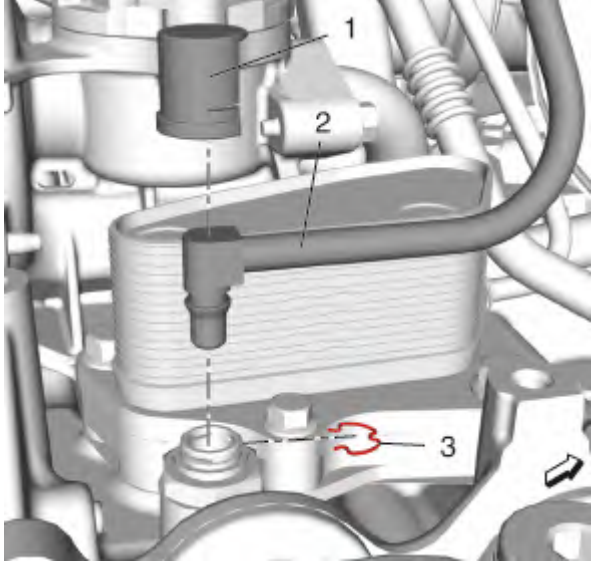


Fig. 187: Turbocharger Oil Feed Pipe, Clip And Retainer
Courtesy of GENERAL MOTORS COMPANY

13. Install Turbocharger Oil Feed Pipe (2) - **Turbocharger Oil Feed Pipe Replacement**
14. Install Warm Up Three-Way Catalytic Converter - **Warm Up Three-Way Catalytic Converter Replacement (LYX)**

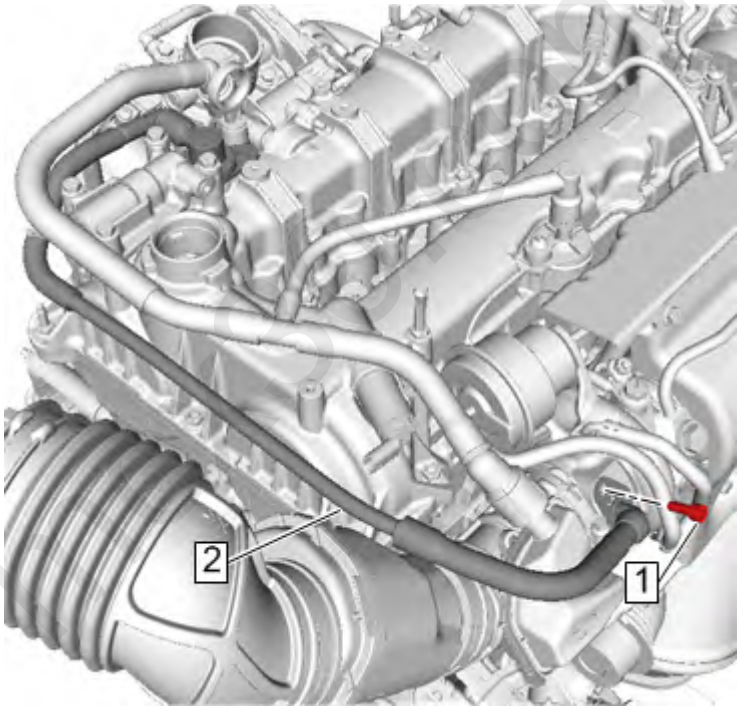


Fig. 188: PCV Valve Tube And Fastener
Courtesy of GENERAL MOTORS COMPANY

15. Connect Positive Crankcase Ventilation Tube with Positive Crankcase Ventilation Valve - Foul Air (2) @Turbocharger -**Positive Crankcase Ventilation Tube Replacement (Fresh Air)Positive Crankcase Ventilation Tube Replacement (Foul Air)**
16. Install Charge Air Cooler Inlet Hose - **Charge Air Cooler Inlet Air Tube Replacement**
17. Install Turbocharger Heat Shield - **Turbocharger Heat Shield Replacement**
18. Connect Air Cleaner Outlet Duct@Turbocharger -**Air Cleaner Outlet Duct Replacement**
19. Connect Air Cleaner Outlet Duct@Air Cleaner Assembly - **Air Cleaner Outlet Duct Replacement**
20. Connect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**
21. Perform the Intake System Learned Values Reset. **Intake System Learned Values Reset**

INTAKE MANIFOLD COVER REPLACEMENT

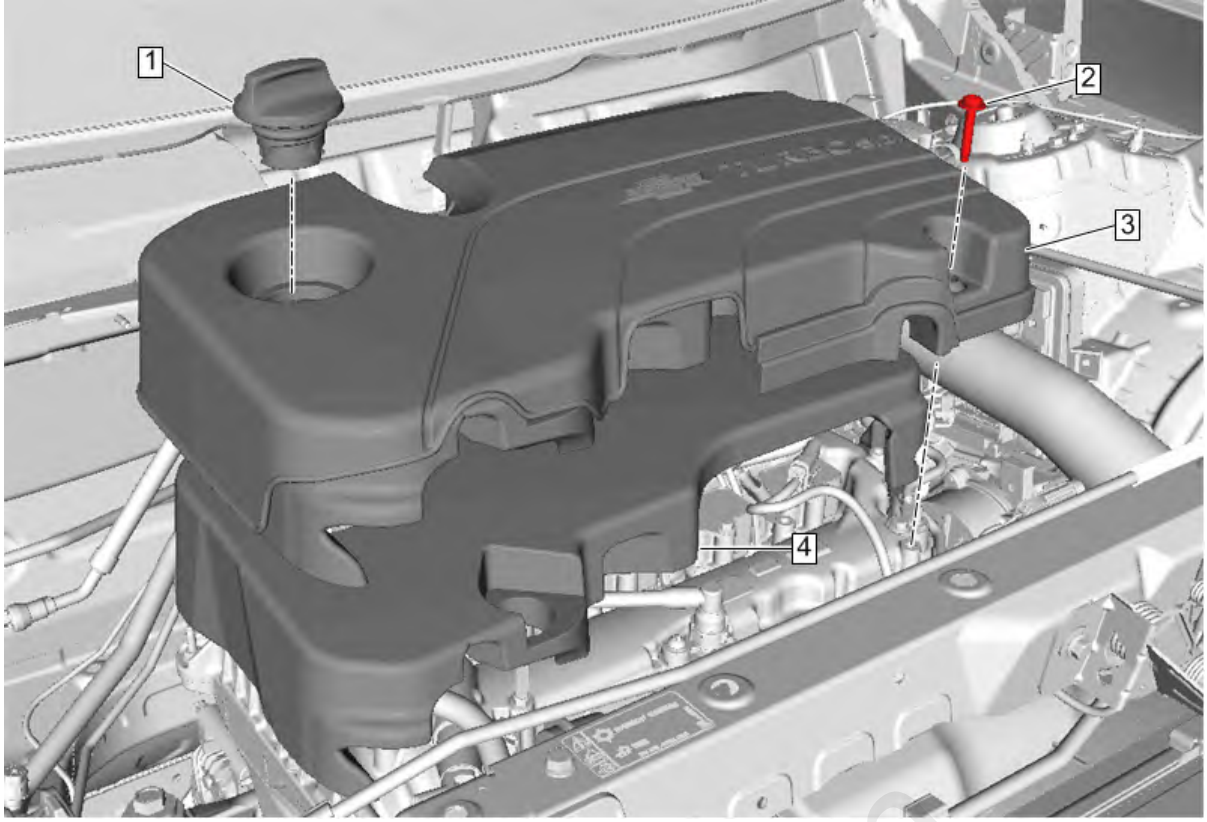


Fig. 189: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Oil Filler Cap
2	Intake Manifold Cover Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
3	Intake Manifold Cover **Procedure** Release the intake manifold cover retainers by pulling the intake manifold cover upwards.
4	Intake Manifold Cover Insulator

INTAKE MANIFOLD REPLACEMENT

Removal Procedure

1. Remove Intake Manifold Cover -Intake Manifold Cover Replacement
2. Reposition away Fuel Feed Front Pipe -Fuel Feed Front Pipe Replacement
3. Remove Evaporative Emission Canister Purge Solenoid Valve -Evaporative Emission Canister Purge Solenoid Valve Replacement

mcx30.com

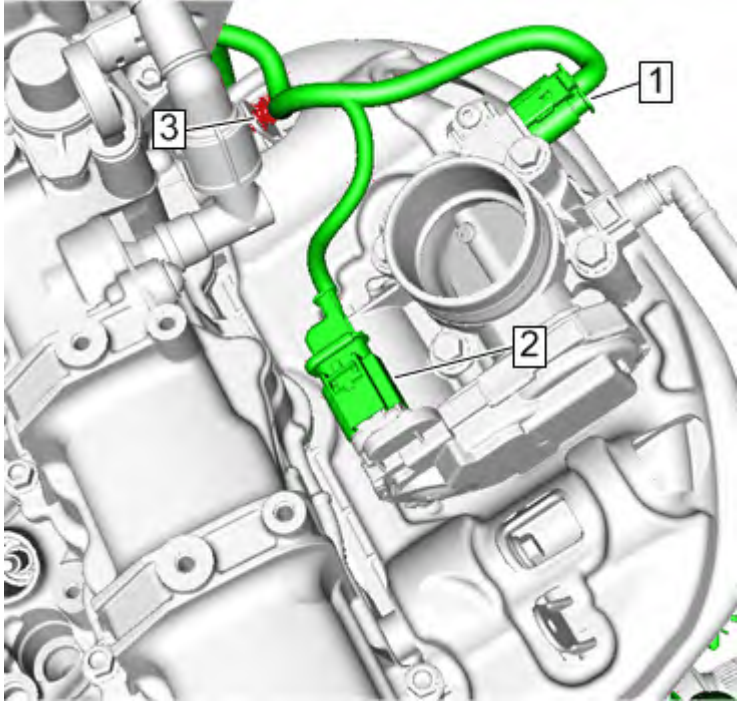


Fig. 190: Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the electrical connectors (1, 2)
5. Remove Wiring Harness Retainer (3)
6. Remove Throttle Body Assembly - **Throttle Body Assembly Replacement**

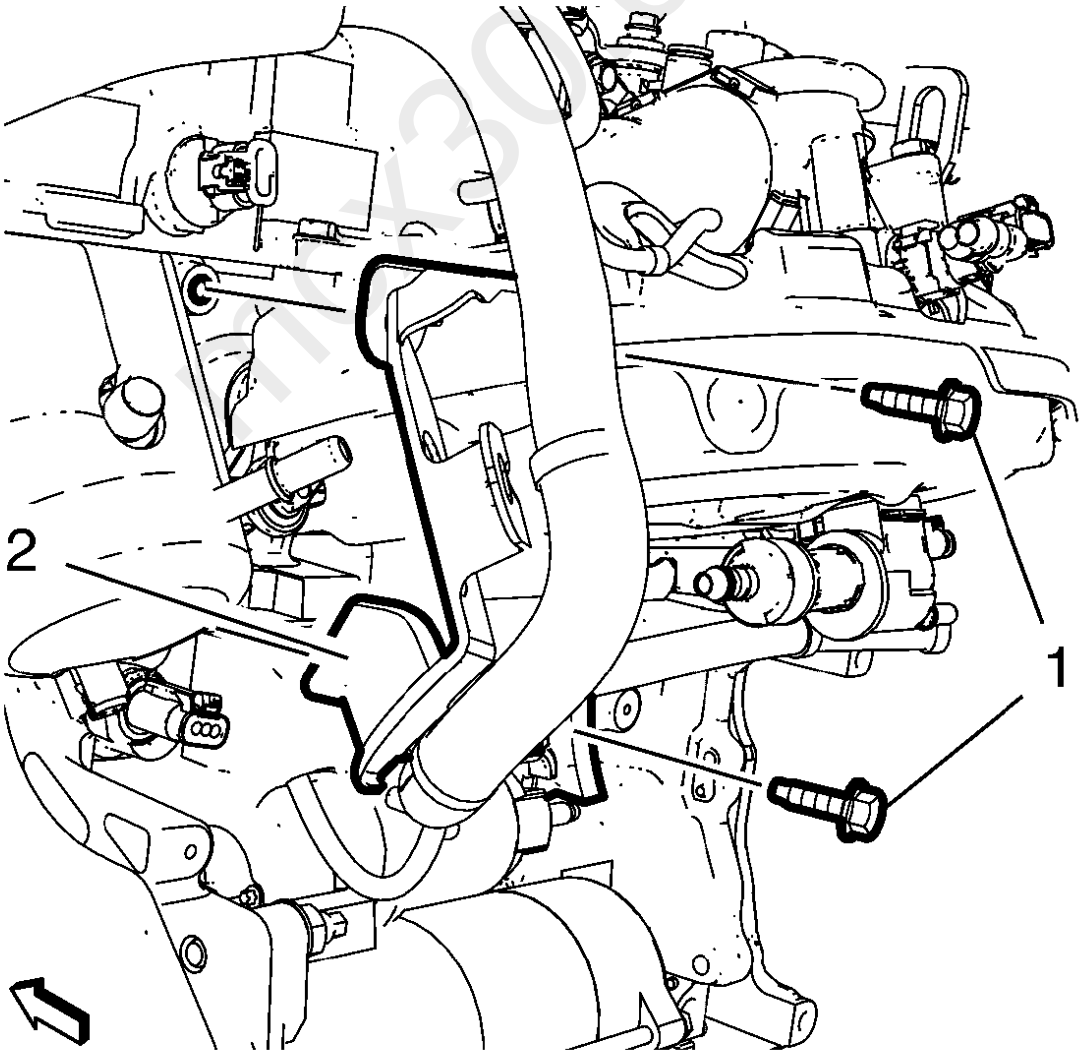


Fig. 191: Engine Wiring Harness Bracket
Courtesy of GENERAL MOTORS COMPANY

7. Remove Engine Wiring Harness Bracket Bolt (1)
8. Reposition away Engine Wiring Harness Bracket (2)

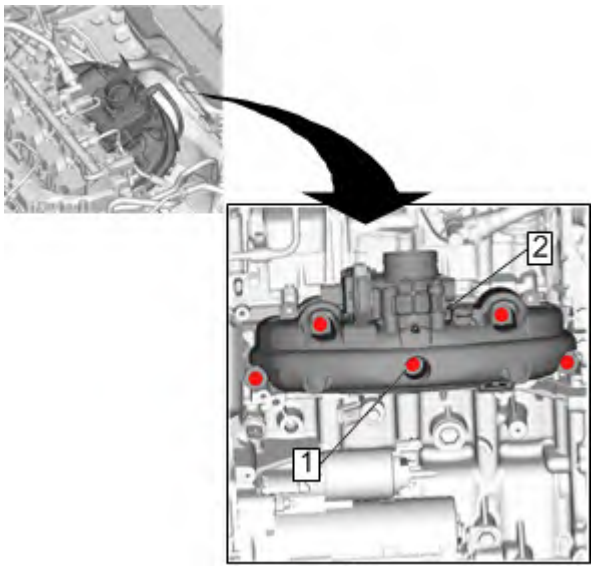


Fig. 192: Intake Manifold And Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Bolt retainers keep the bolts in position on the assembly. If the bolts are removed from the assembly, the 2 shorter bolts go to the outside lower locations.**

9. Fully loosen the intake manifold fasteners (1) then remove the intake manifold (2).

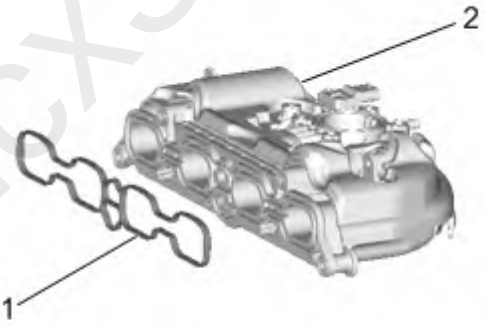


Fig. 193: Intake Manifold Gasket
Courtesy of GENERAL MOTORS COMPANY

10. Remove Intake Manifold Gasket (2) and DISCARD
11. Clean and inspect the intake manifold. Intake Manifold Cleaning and Inspection
12. If replacing the intake manifold, transfer all necessary parts.

Installation Procedure

mcx30.com

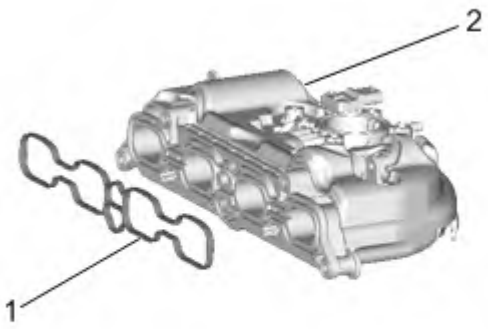


Fig. 194: Intake Manifold Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Upon installation of the intake manifold, ensure the gasket remains properly seated into the intake manifold (2).**

1. Install a NEW intake manifold gasket.

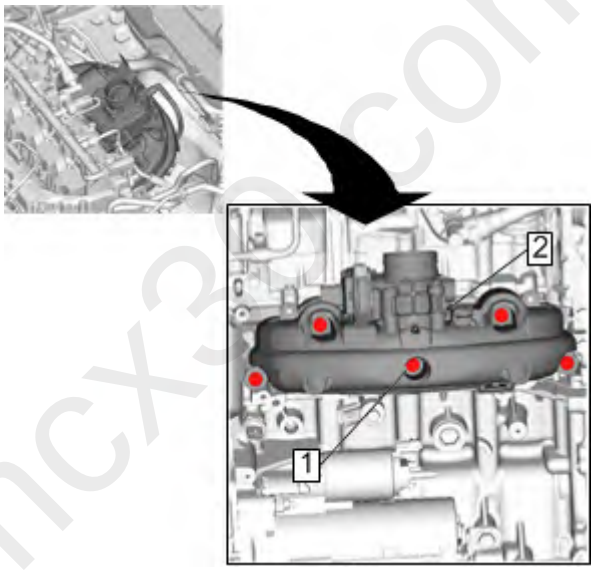


Fig. 195: Intake Manifold And Fasteners
Courtesy of GENERAL MOTORS COMPANY

2. Install the intake manifold (2).
3. Hand tighten the bolts.

mcx30.com

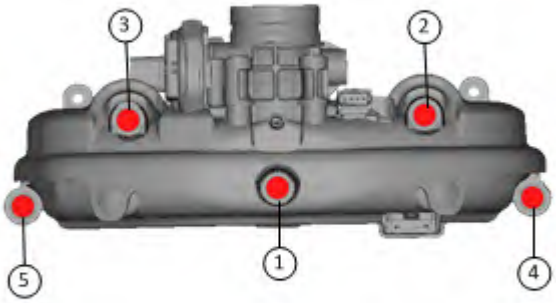


Fig. 196: Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

4. Tighten the bolts in sequence. 12 N.m (106 lb in)

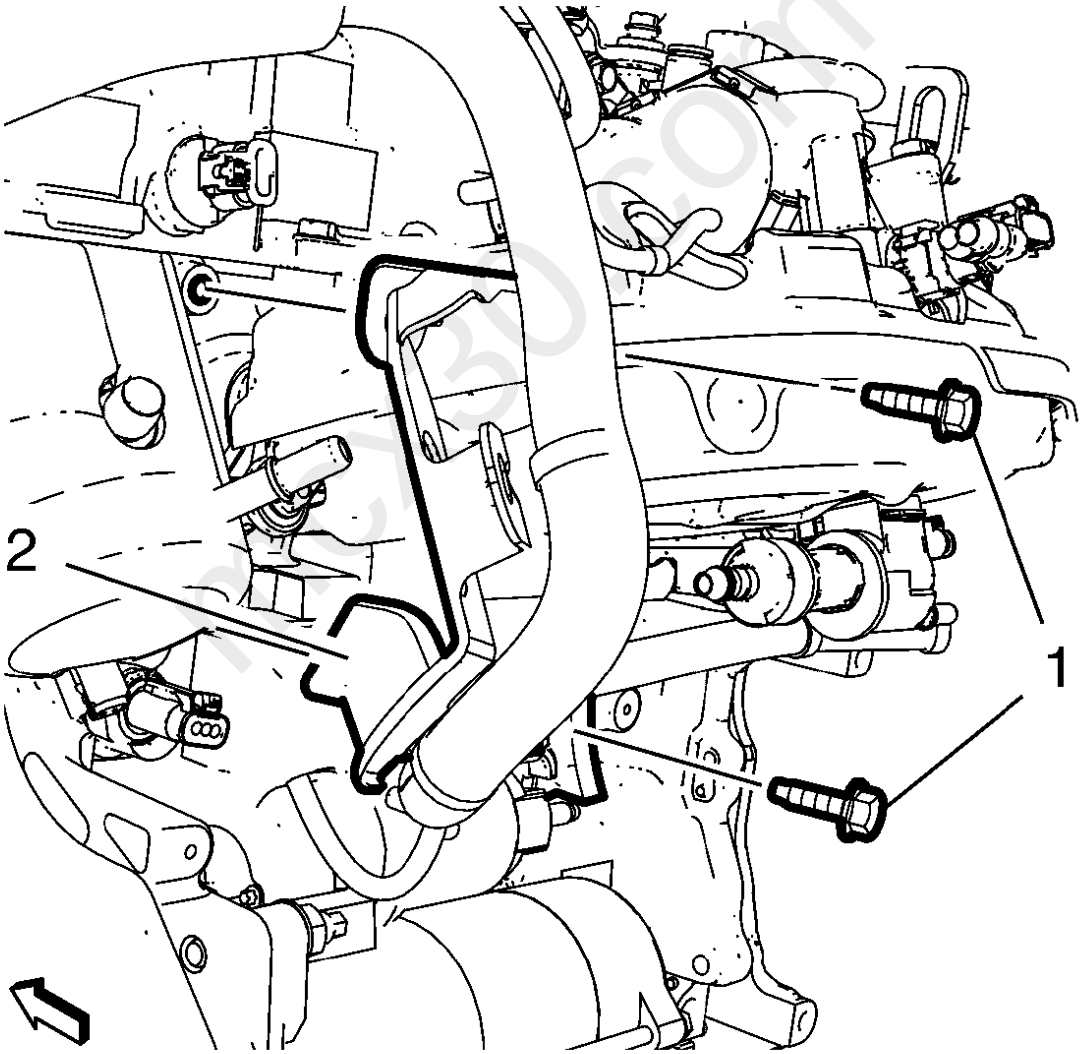


Fig. 197: Engine Wiring Harness Bracket
Courtesy of GENERAL MOTORS COMPANY

5. Install Engine Wiring Harness Bracket (2).
6. Install Engine Wiring Harness Bracket Bolt (1) - and tighten 9 N.m (80 lb in) [2x]
7. Install Fuel Feed Front Pipe - **Fuel Feed Front Pipe Replacement**
8. Install Throttle Body Assembly - **Throttle Body Assembly Replacement**

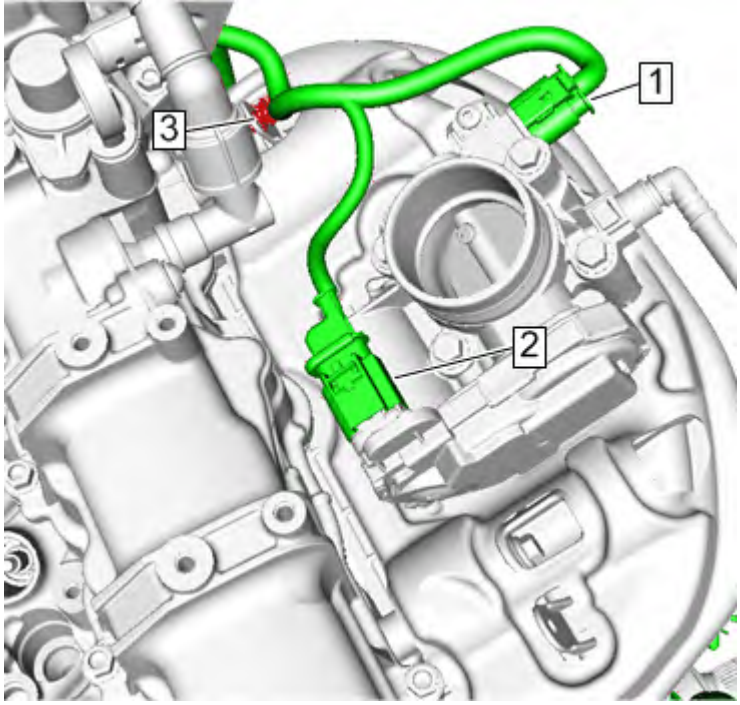


Fig. 198: Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

9. Connect the electrical connectors.(1, 2)
10. Install Wiring Harness Retainer (3)
11. Install Evaporative Emission Canister Purge Solenoid Valve - **Evaporative Emission Canister Purge Solenoid Valve Replacement**
12. Install Intake Manifold Cover - **Intake Manifold Cover Replacement**

CRANKSHAFT BALANCER REPLACEMENT

Special Tools

- **EN-44226** Crankshaft Balancer Remover
- **EN-44226-5** Crankshaft Protector
- **EN-45059** Angle Meter
- **EN-51368** Front Crankshaft Seal Installer

Equivalent regional tools:**Special Tools**

Removal Procedure

1. Remove **Drive Belt Replacement**

mcx30.com

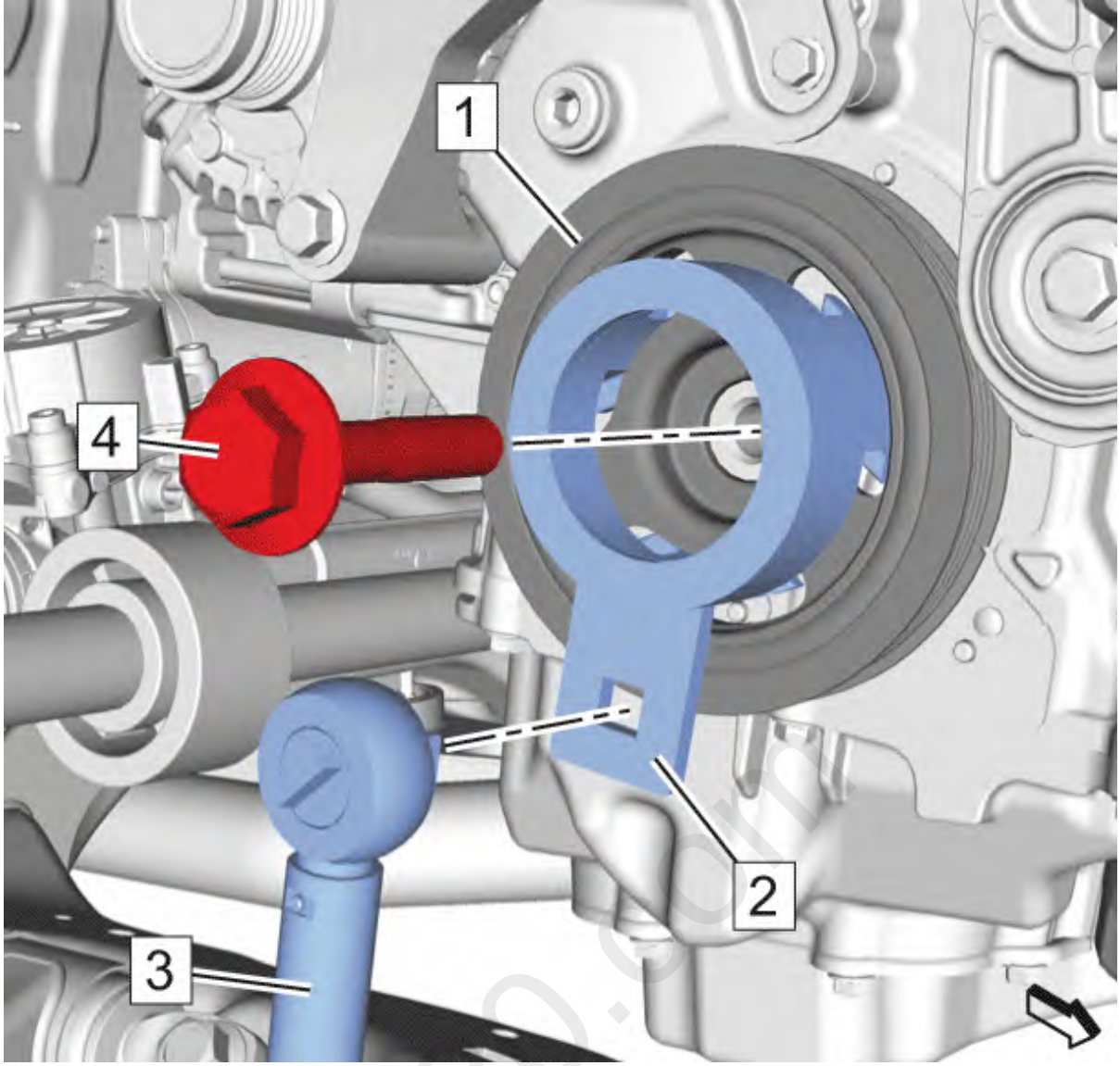


Fig. 199: Crankshaft Balancer, Special Tools And Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Install the **EN-44226-1** remover (2) to the crankshaft balancer (1).
3. Loosen the crankshaft balancer bolt (3) by counter holding the crankshaft balancer (1) with the **EN-44226-1** remover (3) and suitable tool.
4. Remove the **EN-44226-1** remover.
5. Remove the crankshaft balancer bolt.

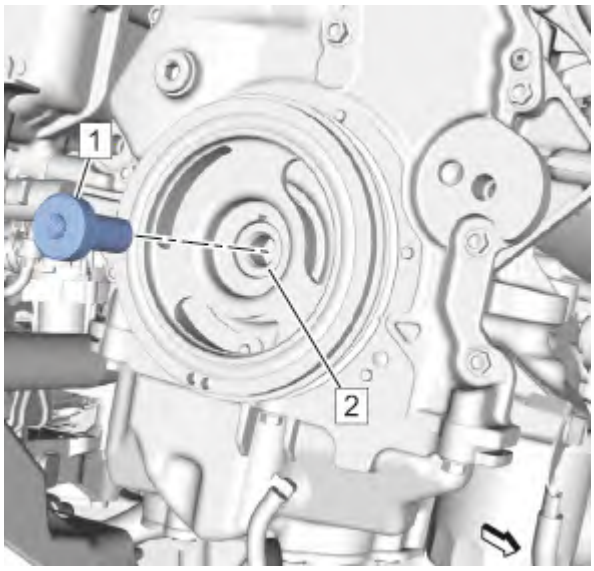


Fig. 200: Protector And Crankshaft
Courtesy of GENERAL MOTORS COMPANY

6. Install the **EN-44226-5** protector (1) to the crankshaft (2).

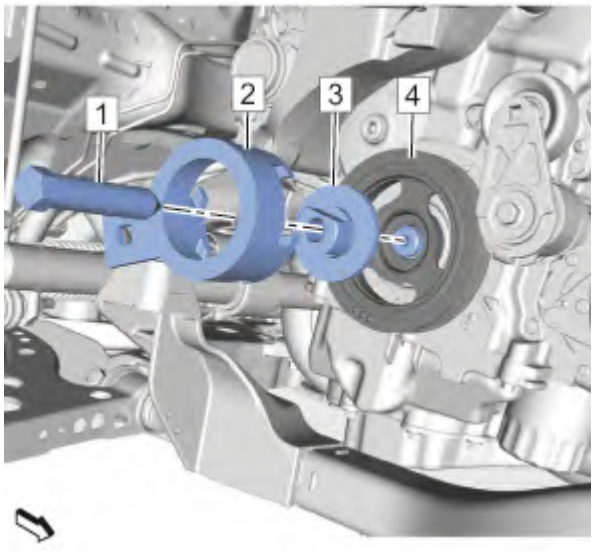


Fig. 201: Remover Plate Assembly And Balancer
Courtesy of GENERAL MOTORS COMPANY

7. Install **EN-44226-1** remover (2) and **EN-44226-2** remover plate (3) onto the balancer (4).
8. Install the **EN-44226-3** remover screw (1) through the **EN-44226-2** remover plate and against the **EN-44226-5** protector.
9. Counter hold the **EN-44226-2** remover plate and turn the **EN-51368** installer screw to remove the balancer.
10. Remove the **EN-44226** remover.
11. Remove the crankshaft balancer (4).
12. Remove the **EN-44226-5** protector.

Installation Procedure

mcx30.com

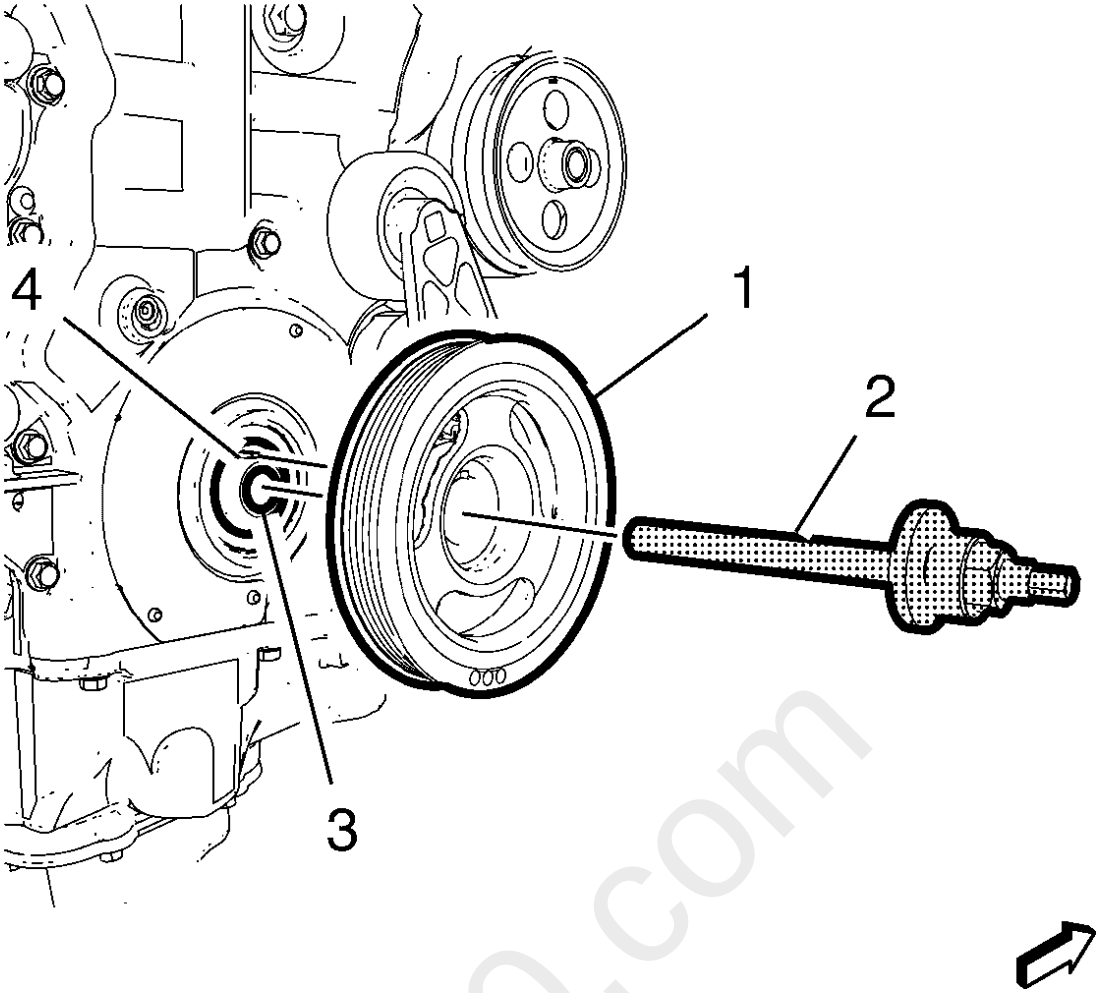


Fig. 202: Crankshaft Balancer, Key And Special Tool
Courtesy of GENERAL MOTORS COMPANY

1. Install Crankshaft Balancer (1) @Crankshaft (3).
2. Make sure that the key is properly seated (4) on crankshaft balancer notch.
3. Install the **EN-51368** installer (2)
4. Install the crankshaft balancer by screwing the flange from **EN-51368** installer.
5. Remove the **EN-51368** installer (2)

mdx30.com

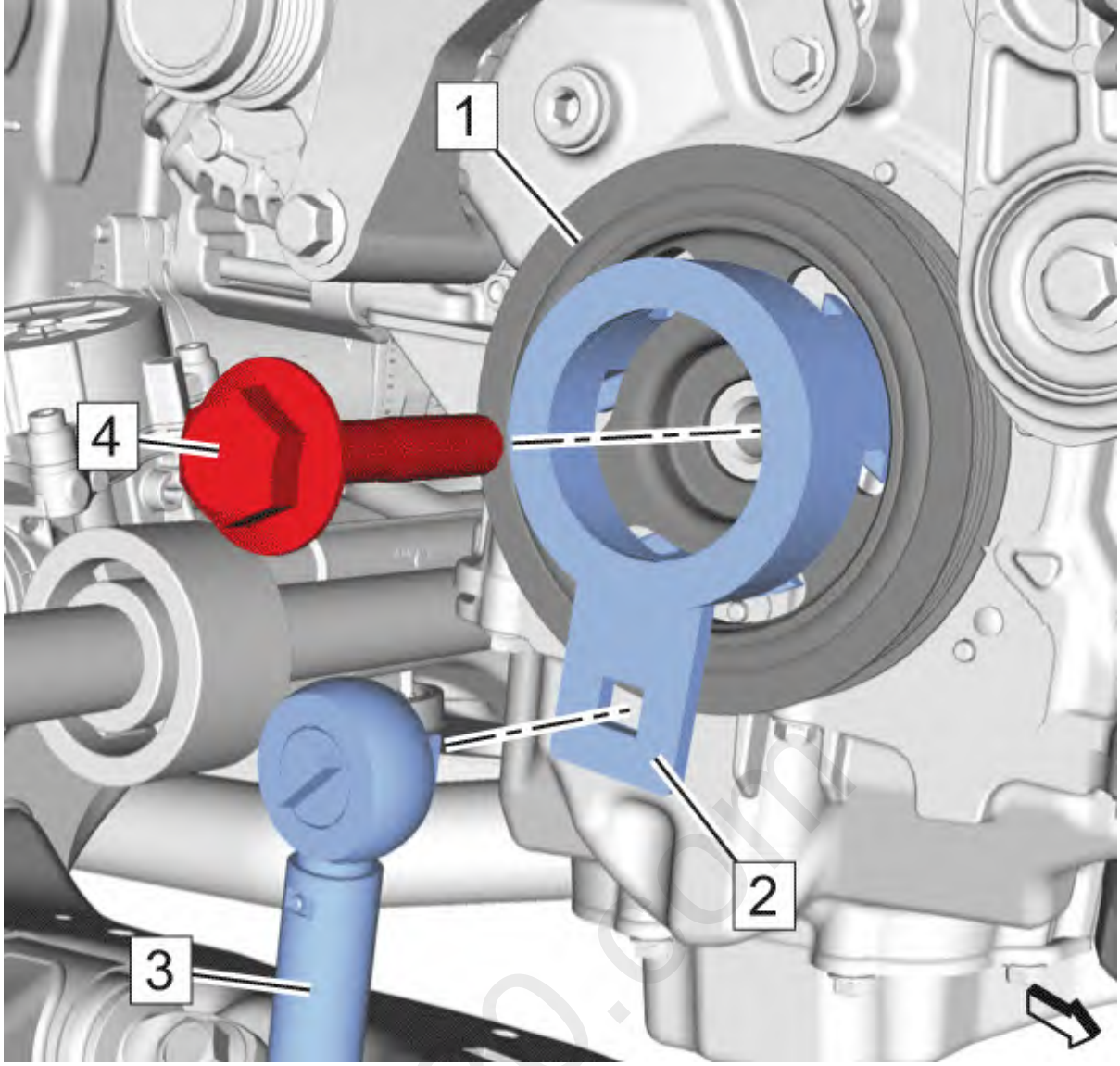


Fig. 203: Crankshaft Balancer, Special Tools And Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Install and handtighten the crankshaft balancer bolt (3).
7. Install the **EN-44226-1** remover (2) to the crankshaft balancer (1).

CAUTION: **Refer to Torque-to-Yield Fastener Caution .**

8. Tighten the crankshaft balancer bolt (3) by counter holding the crankshaft balancer (1) with the **EN-44226-1** (3) and torque wrench.
    1. First pass to 100 N.m (74 lb ft)
    2. Loosen the bolt to 360 degrees
    3. Final pass to an additional 180 degress, using the **EN-45059** meter
9. Remove **EN-44226-1** remover (2) from the crankshaft balancer (1).
10. Install **Drive Belt Replacement**.

CRANKSHAFT POSITION SENSOR RELUCTOR RING REPLACEMENT

Removal Procedure

1. Remove **Automatic Transmission Flex Plate Replacement**

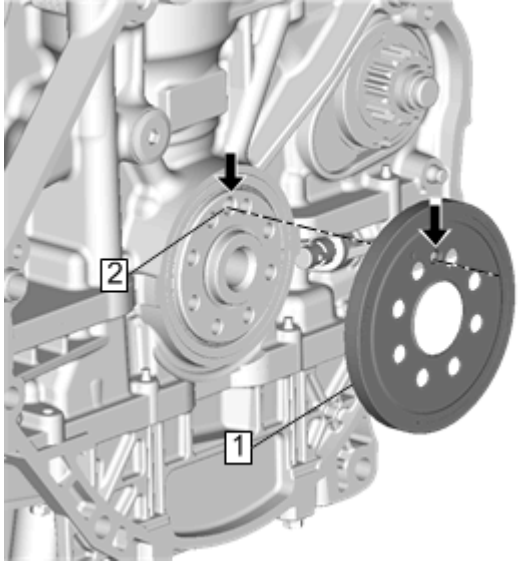


Fig. 204: Crankshaft Position Sensor Reluctor Ring
Courtesy of GENERAL MOTORS COMPANY

2. Remove the crankshaft position sensor reluctor ring.(1)

Installation Procedure

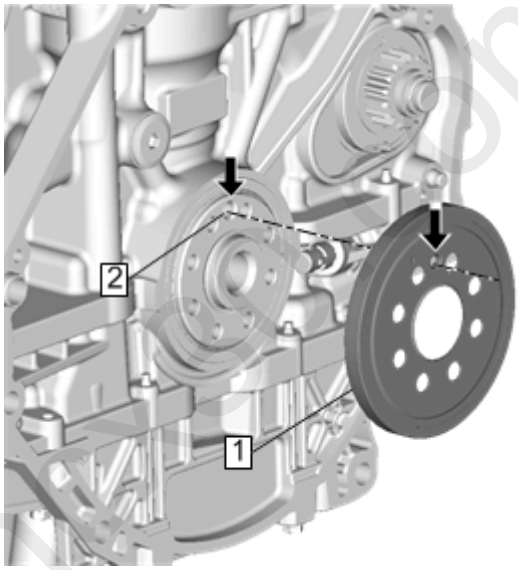


Fig. 205: Crankshaft Position Sensor Reluctor Ring
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Do not allow the crankshaft position sensor reluctor ring to come into contact with external magnetic fields or sharp metal objects. Do not drop the crankshaft position sensor reluctor ring. Do not damage the rubberized encoder track. Failure to follow these precautions may cause damage to the component.**

NOTE: **Ensure that the crankshaft reluctor ring alignment hole indicated by arrows properly aligns with the hole in the crankshaft (2).**

1. Install the crankshaft position sensor reluctor ring.(1)
2. Install Automatic Transmission Flex Plate Replacement

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Special Tools

- **EN-51368** Front Crankshaft Seal Installer
- **DT-6125-1B** Slide Hammer
- **DT-23129** Seal Remover

Equivalent regional tools:**Special Tools**

Removal Procedure

1. Remove **Crankshaft Balancer Replacement**

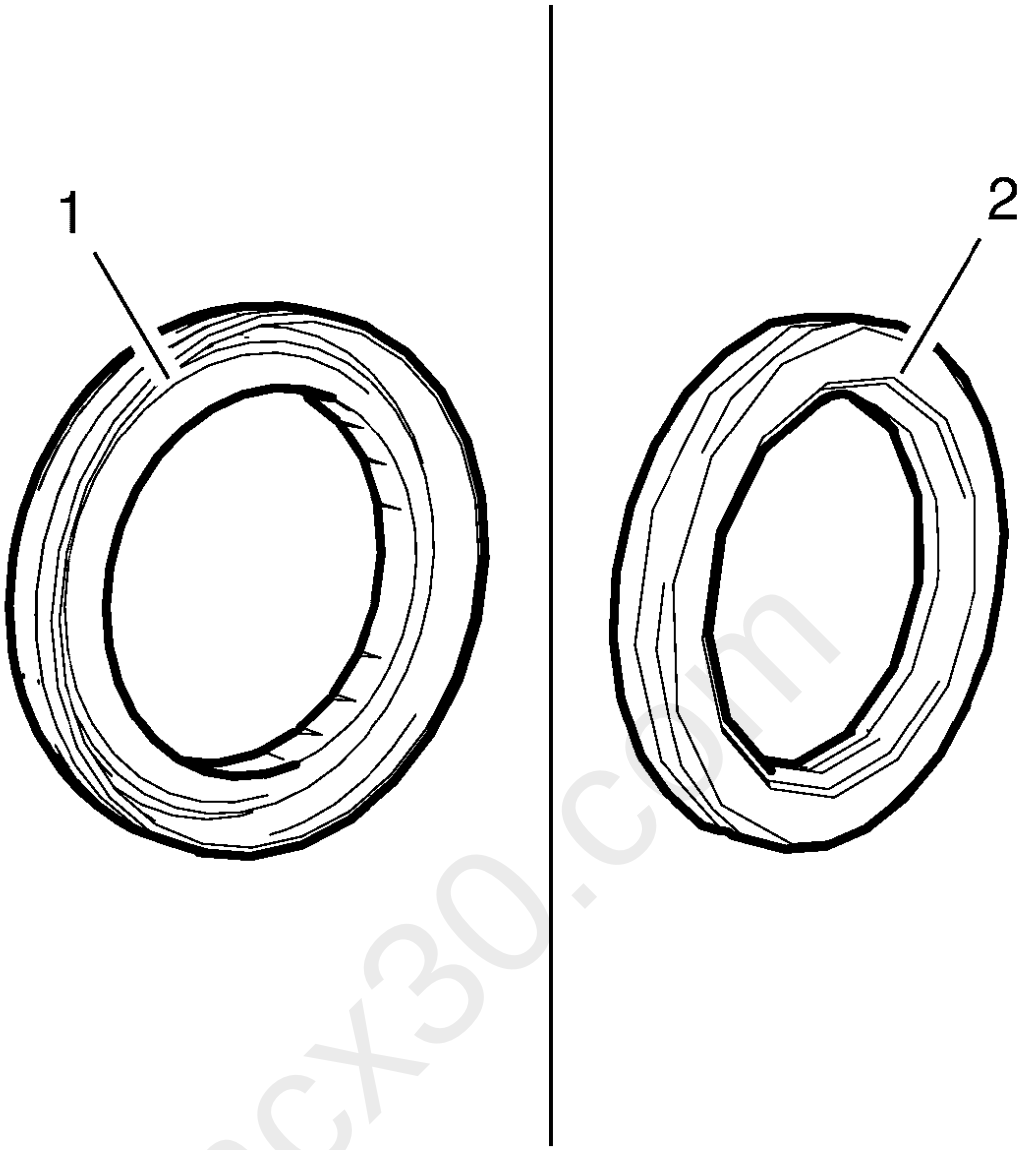


Fig. 206: Identifying Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The engine can be equipped with two different front oil seal designs.**

2. Check the seal to confirm which crankshaft front oil seal (1, 2) is installed.

mcx30.com

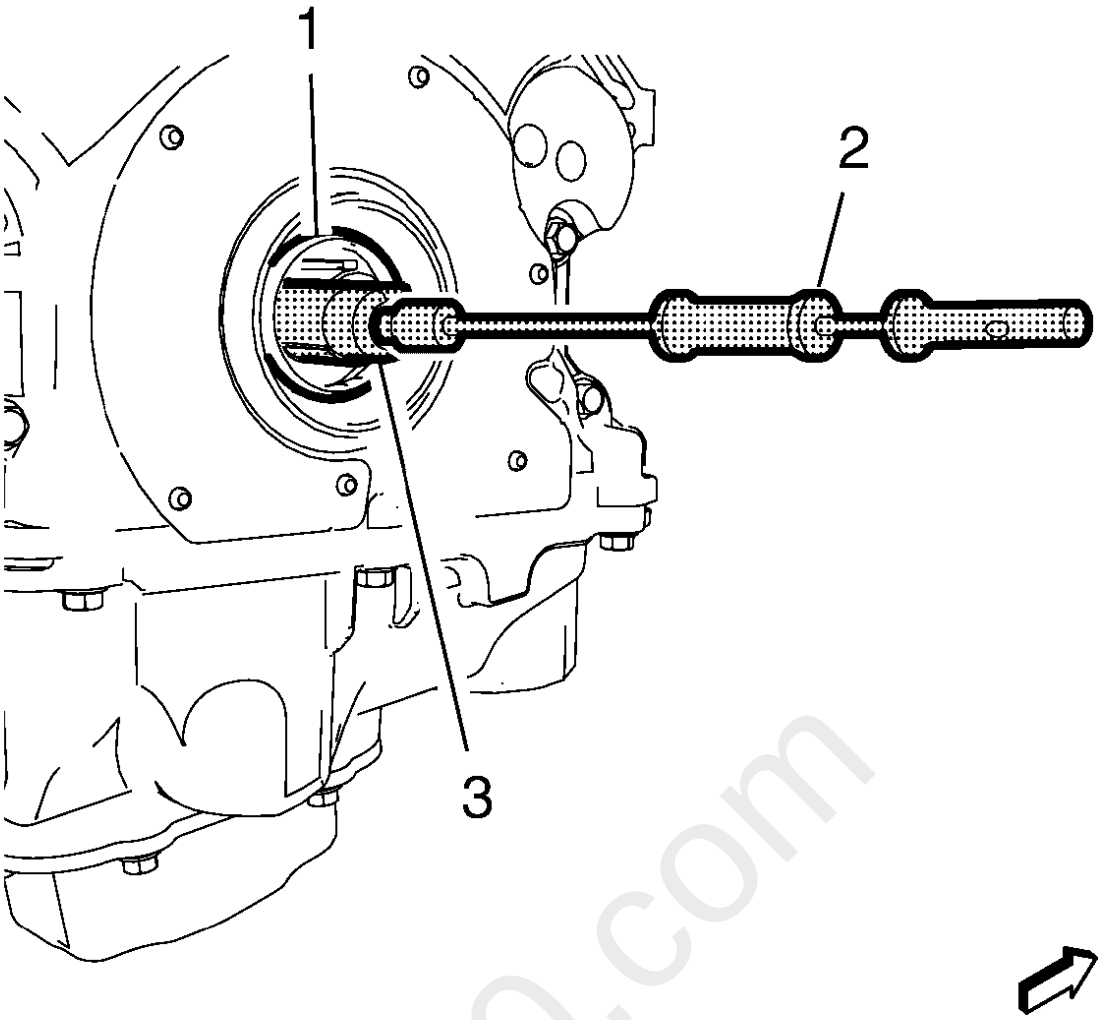


Fig. 207: Removing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

3. Install the **DT-6125-B** hammer (2) to **DT-23129** seal remover (3).
4. Install the **DT-2165-B** hammer with the **DT-23129** seal remover behind the crankshaft front oil seal (1).
5. Remove the crankshaft front oil seal (1), with the **DT-6125-B** hammer (2).

Installation Procedure

mcx30.com

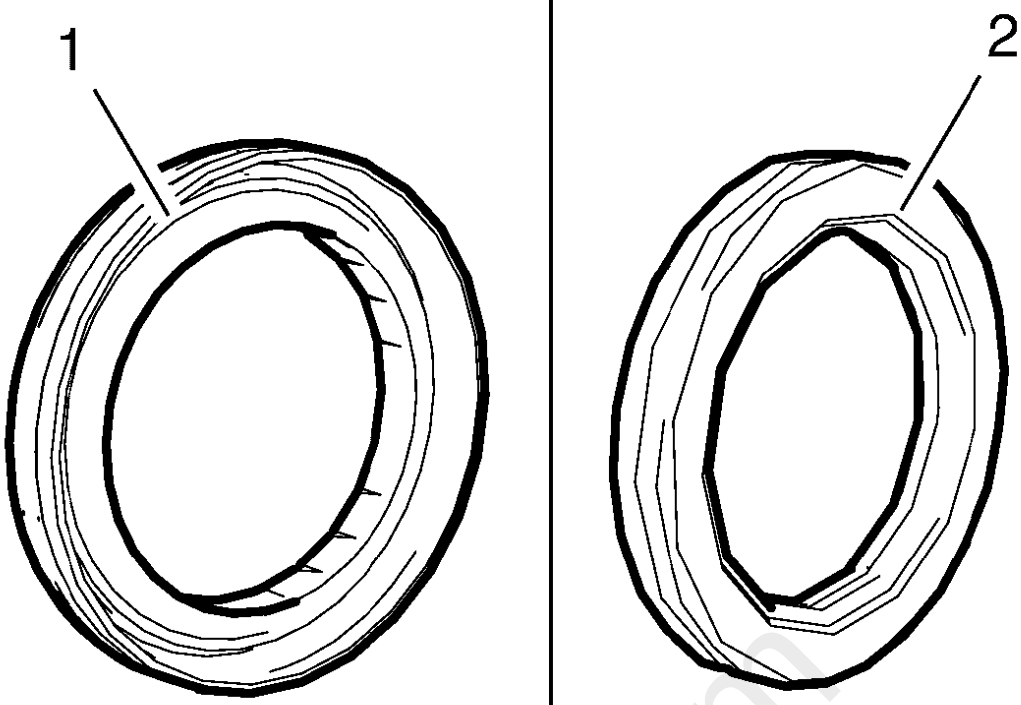


Fig. 208: Identifying Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The engine can be equipped with two different front oil seal designs.**

1. Check the seal to confirm which crankshaft front oil seal (1, 2) is installed.

mcx30.com

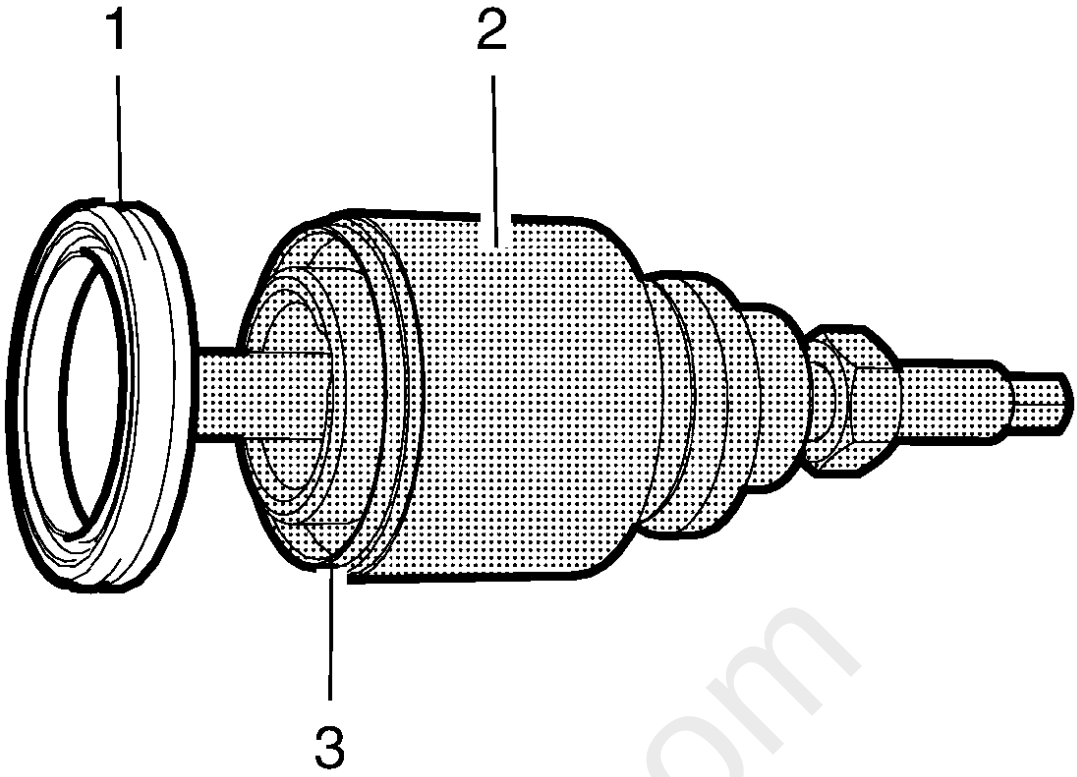


Fig. 209: Installing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

2. For front oil seal first design, use the following procedure:

NOTE: **The special tool EN-51368 seal installer can be used in two positions, depending which crankshaft front oil seal type is used.**

3. Install the crankshaft front oil seal (1) to the **EN-51368** seal installer (2) with the notch on the surface. (3).

mcx30.com

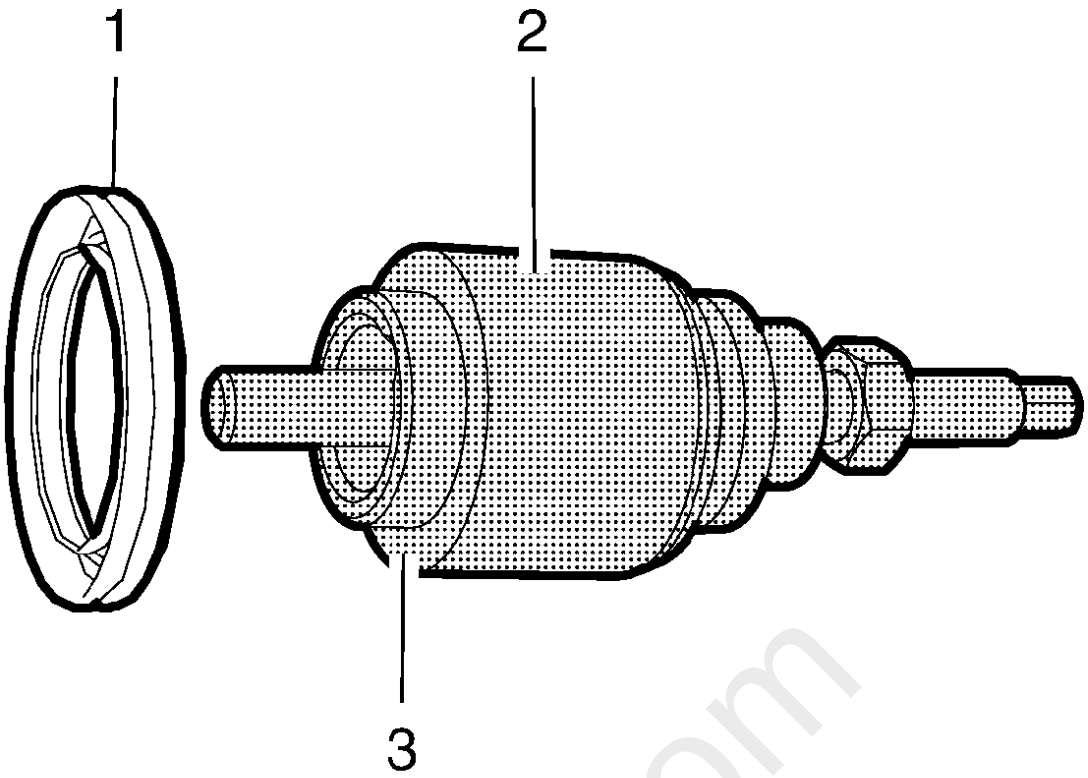


Fig. 210: Front Oil Seal Second Design Procedure
Courtesy of GENERAL MOTORS COMPANY

4. For front oil seal second design, use the following procedure:

NOTE: **The special tool EN-51368 seal installer can be used in two positions, depending which crankshaft front oil seal type is used.**

5. Install the crankshaft front oil seal (1) to the **EN-51368** seal installer (2) with the plain surface (3).

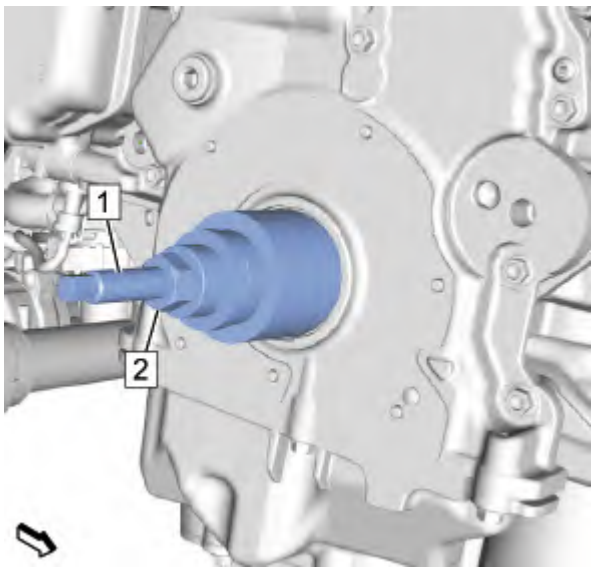


Fig. 211: Installing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

mcx30.com

CAUTION: **Be careful that the crankshaft front oil seal does not deform while installing. Failing to do so may reduce the leak-tightness and could cause damage to the crankshaft.**

6. Press the crankshaft front oil seal into the correct seat, by tightening the nut (2) from the **EN-51368** seal installer (1).
7. Remove the **EN-51368** seal installer
8. Check to ensure that the crankshaft front oil seal is properly seated.
9. Install **Crankshaft Balancer Replacement**

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Special Tool

EN-51369 Rear Crankshaft Seal Installer

Equivalent regional tools:**Special Tools**

Removal Procedure

1. Remove **Crankshaft Position Sensor Reluctor Ring Replacement**

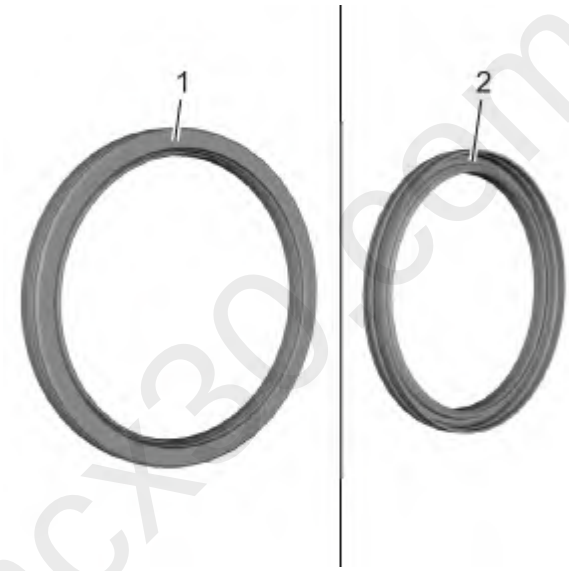


Fig. 212: Identifying Crankshaft Rear Oil Seals
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The engine could be equipped with two different rear oil seal designs.**

2. Check which of the crankshaft rear oil seals (1, 2) is installed.

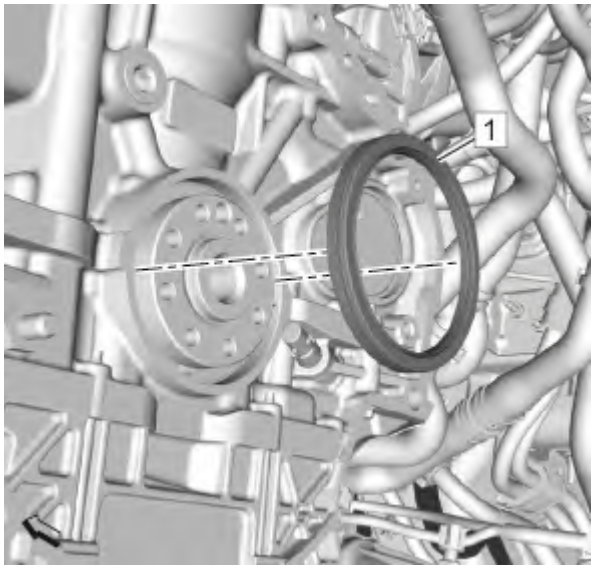


Fig. 213: Removing Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Be careful that the crankshaft will not be damaged while the crankshaft rear oil seal is pulled out. Failing to do so may reduce the leak-tightness and could cause damage to the crankshaft.**

NOTE: **Use a suitable tool to remove the seal.**

3. Remove Crankshaft Rear Oil Seal (2) @Crankshaft (1)

Installation Procedure

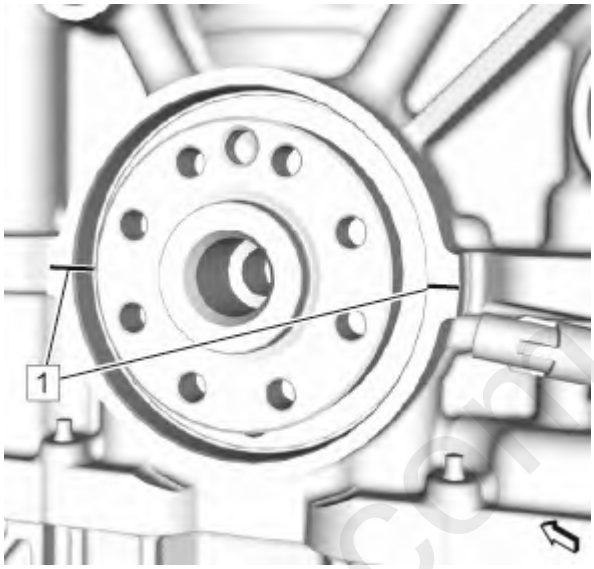


Fig. 214: RTV Sealant Application Points
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the seal recess (1) for excess sealer material at the lower crankcase to engine block mating location.
2. Remove excess sealer, if present.
3. Add RTV sealer at the 2 locations (1) where the bedplate and block join prior to installing the oil seal. **Adhesives, Fluids, Lubricants, and Sealers**

mx30.com

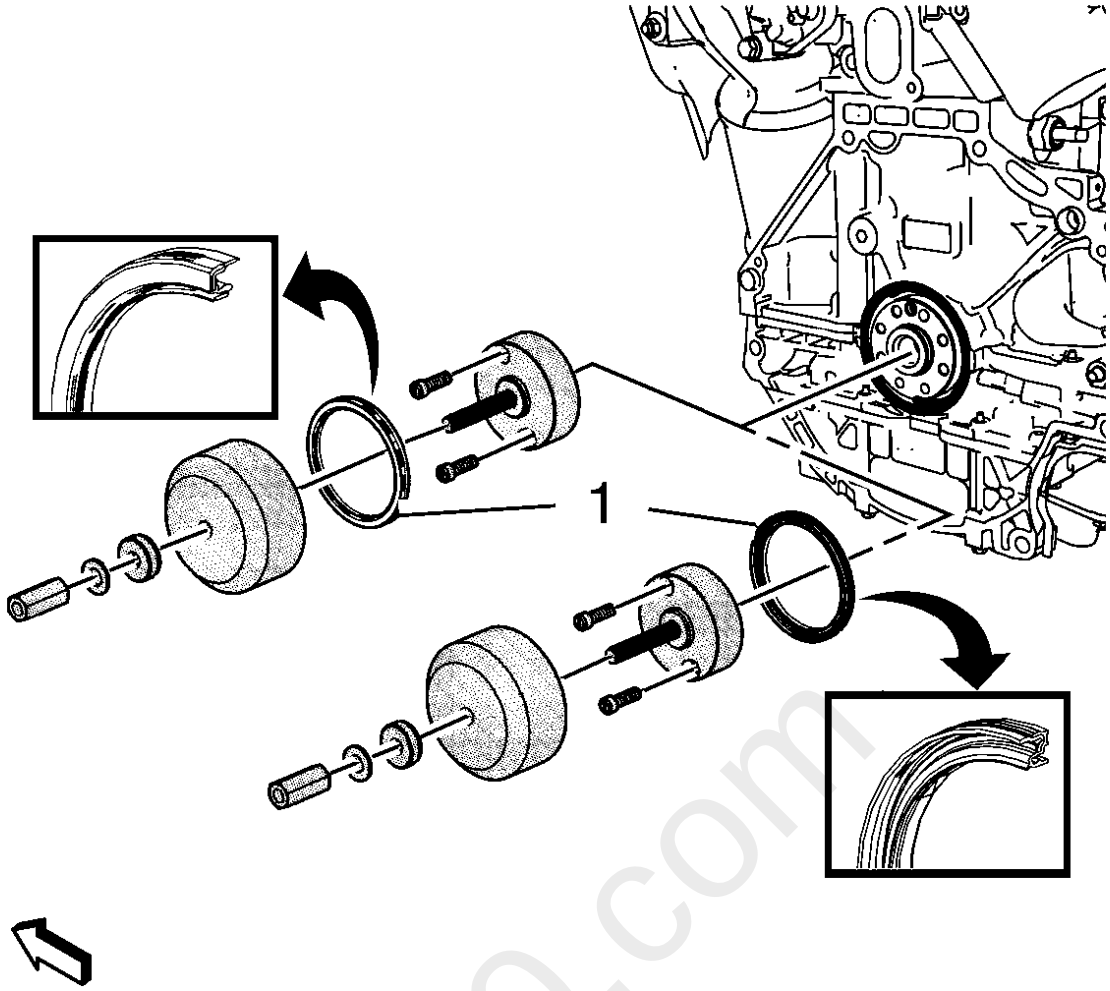


Fig. 215: Installing Oil Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The oil seal must be installed in the correct direction. The side that faces out will have "this side out" printed on it. Depending on seal design, the way the seal is installed on the EN-51369 installer is opposite. Either the seal is installed over the back of the installer, or the seal is installed over the front of the installer. Match the seal design as shown above and install the seal onto the installer in the correct direction.**

4. Install the oil seal (1) in the correct direction on the **EN-51369** installer.

NOTE: **If the seal is improperly installed on the special tool, it will not install correctly.**

5. Inspect the seal on **EN-51369** installer, and ensure that the seal lip is not deformed. If necessary, remove the seal and reinstall on the special tool.

NOTE: **The special tool installs and establishes the proper depth of the seal in the crankshaft seal bore.**

6. Use **EN-51369** installer to press the new crankshaft seal into the housing.
7. Ensure that the seal is installed in the crankshaft seal bore flush to 0.5 mm (0.2 in) depth.
8. Install Crankshaft Position Sensor Reluctor Ring Replacement

CRANKSHAFT SPROCKET REPLACEMENT

Removal Procedure

isuzx30.com

1. Remove **Camshaft Timing Chain Replacement**
2. Remove **Oil Pump Drive Chain Replacement**

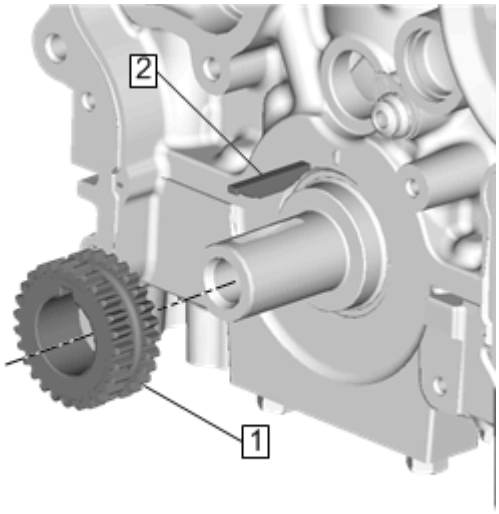


Fig. 216: Crankshaft Sprocket And Balancer Key
Courtesy of GENERAL MOTORS COMPANY

3. Remove Crankshaft Sprocket (1)
4. Remove the crankshaft balancer key.(2)

Installation Procedure

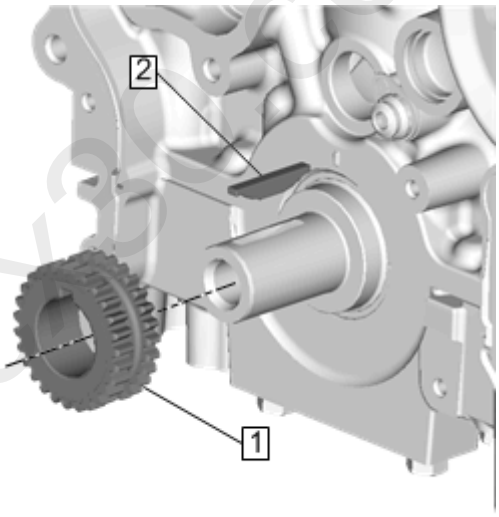


Fig. 217: Crankshaft Sprocket And Balancer Key
Courtesy of GENERAL MOTORS COMPANY

1. Install the crankshaft balancer key (2).
2. Align the keyway of the crankshaft sprocket with the crankshaft balancer key.
3. Install Crankshaft Sprocket (1)
4. Install **Oil Pump Drive Chain Replacement**
5. Install **Camshaft Timing Chain Replacement**

CRANKSHAFT OIL DEFLECTOR REPLACEMENT

Removal Procedure

1. Remove the upper oil pan. Refer to **Upper Oil Pan Replacement**.

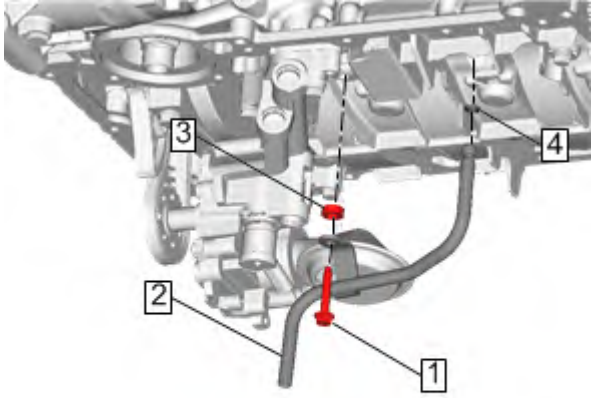


Fig. 218: Crankcase Ventilation Oil Separator Drain Pipe, Fastener, Retainer And Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the position of the retainer (3) for proper installation.**

2. Remove the positive crankcase ventilation oil separator drain pipe fastener (1) then remove the pipe (2).

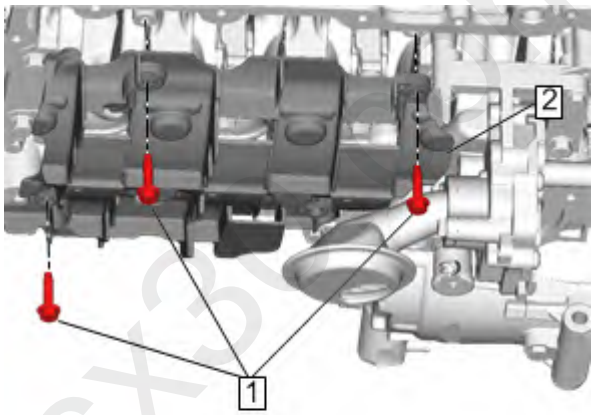


Fig. 219: Oil Deflector And Fasteners
Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil deflector fasteners (1) then remove the oil deflector (2).

Installation Procedure

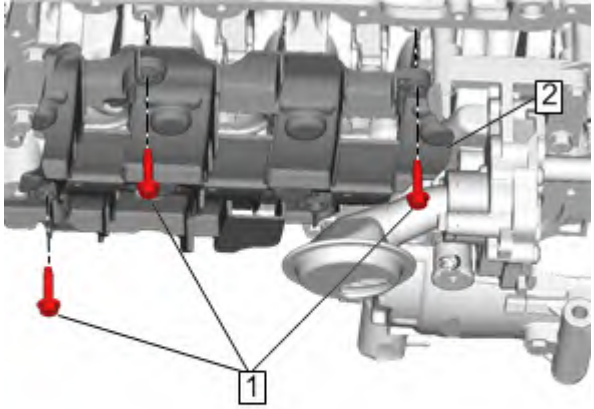


Fig. 220: Oil Deflector And Fasteners
Courtesy of GENERAL MOTORS COMPANY

1. Position the oil deflector (2) then hand start the oil deflector fasteners (1).

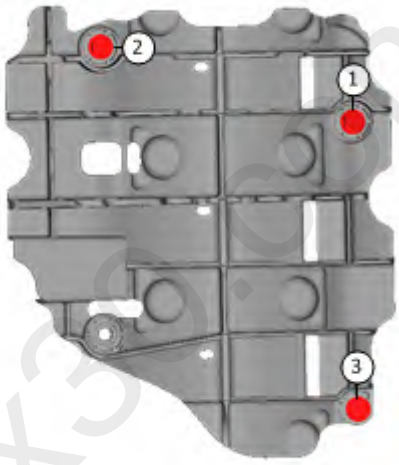


Fig. 221: Oil Deflector Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. Tighten the fasteners in sequence as shown to 10 N.m (89 lb in).

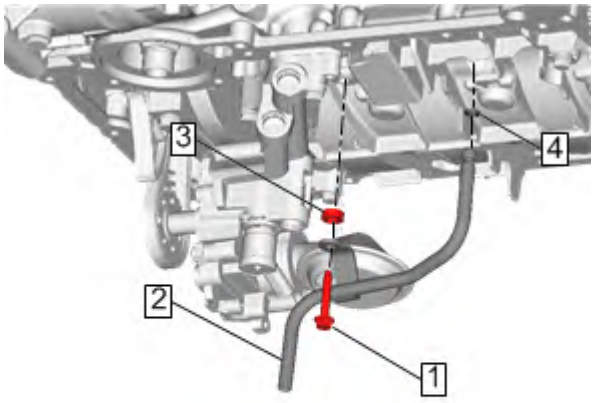


Fig. 222: Crankcase Ventilation Oil Separator Drain Pipe, Fastener, Retainer And Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that the retainer (3) is properly installed.**

NOTE: **Inspect the seal (4) and install NEW if necessary.**

3. Position the positive crankcase ventilation oil separator drain pipe (2) then hand start the fastener (1). Tighten to 10 N.m (89 lb in).
4. Install the upper oil pan. Refer to **Upper Oil Pan Replacement**.

ENGINE LIFT FRONT BRACKET REPLACEMENT

Removal Procedure

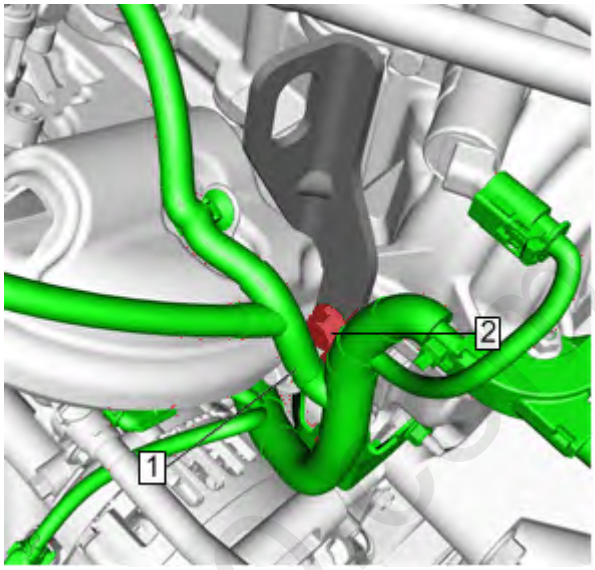


Fig. 223: Wiring Harness And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Slight repositioning of the wiring harness will gain enough clearance to access the bolts (2)**

1. Reposition the wiring harness (1)

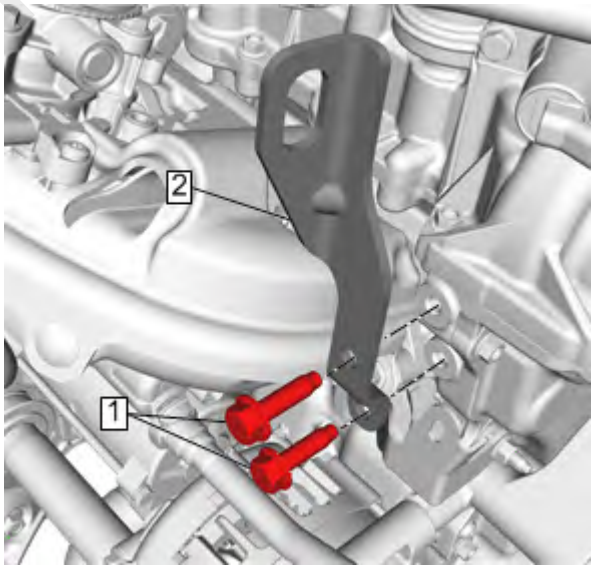


Fig. 224: Engine Lift Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove Engine Lift Bracket Bolt (1)
3. Remove Engine Lift Bracket (2)

Installation Procedure

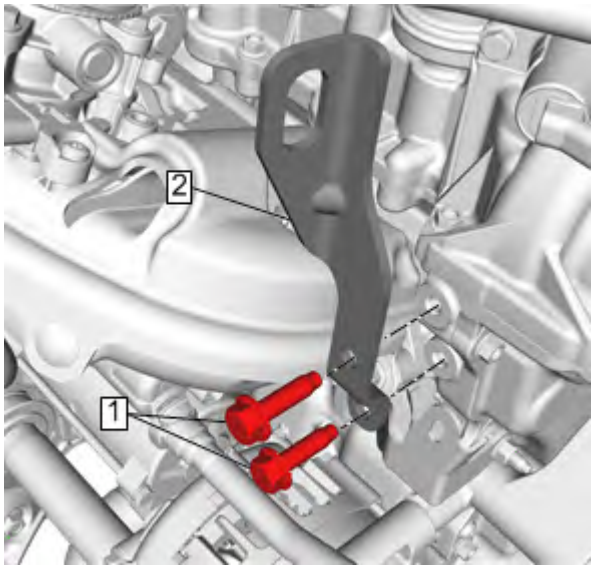


Fig. 225: Engine Lift Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install Engine Lift Bracket (2)

CAUTION: **Refer to Fastener Caution .**

2. Install Engine Lift Bracket Bolt (1) and tighten 25 N.m (18 lb ft)

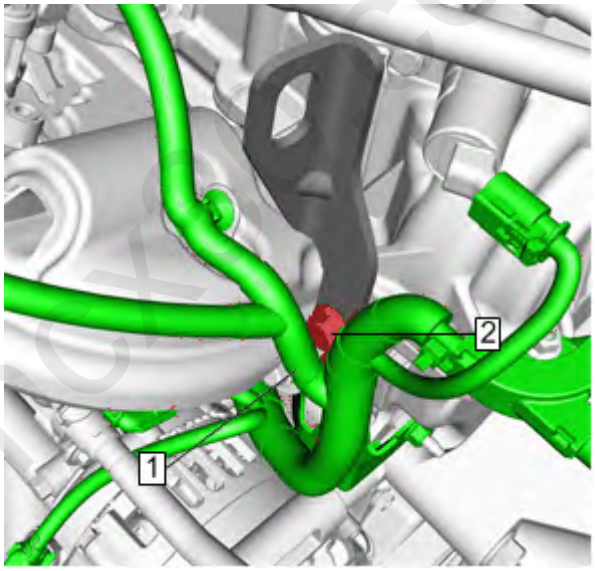


Fig. 226: Wiring Harness And Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Properly position wiring harness (1) after tightening bolts (2)

ENGINE LIFT REAR BRACKET REPLACEMENT

Removal Procedure

1. Remove Charge Air Cooler Outlet Air Tube - **Charge Air Cooler Outlet Air Tube Replacement**

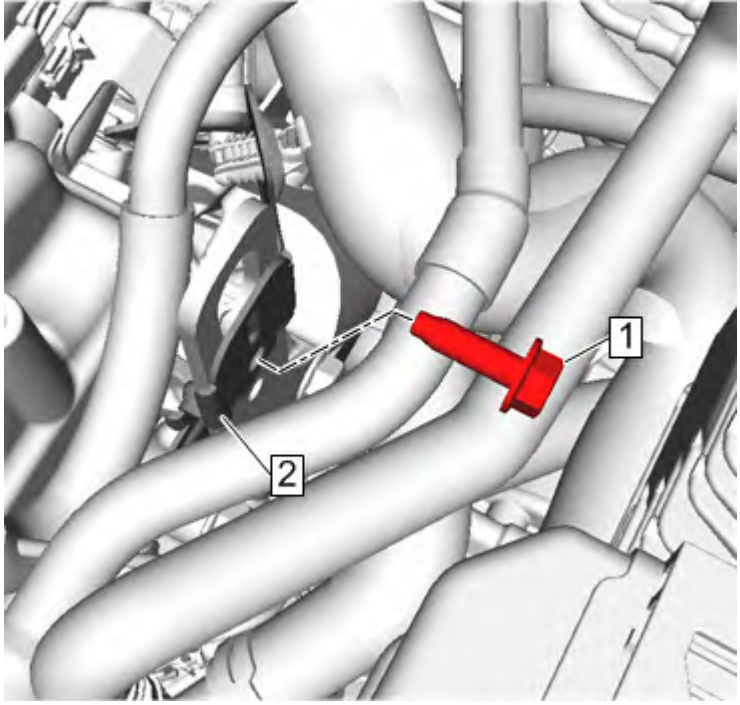


Fig. 227: Engine Wiring Harness Bracket Bolt And Charge Air Cooler Outlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

2. Remove Engine Wiring Harness Bracket Bolt (1).

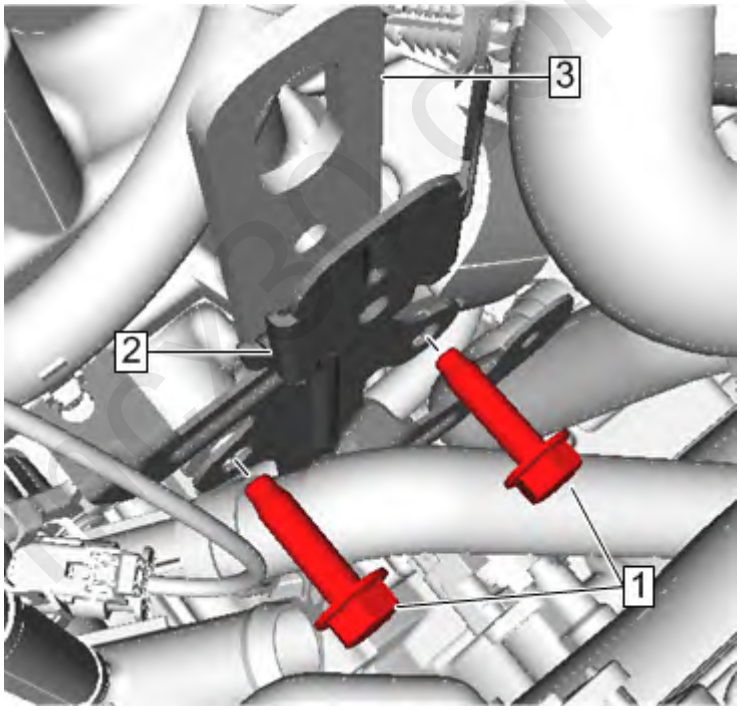


Fig. 228: Engine Wiring Harness Bracket And Engine Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

3. Remove Engine Lift Bracket Bolt (1)
4. Separate the engine wiring harness bracket (2) from the engine lift bracket then remove the engine lift bracket (3).

Installation Procedure

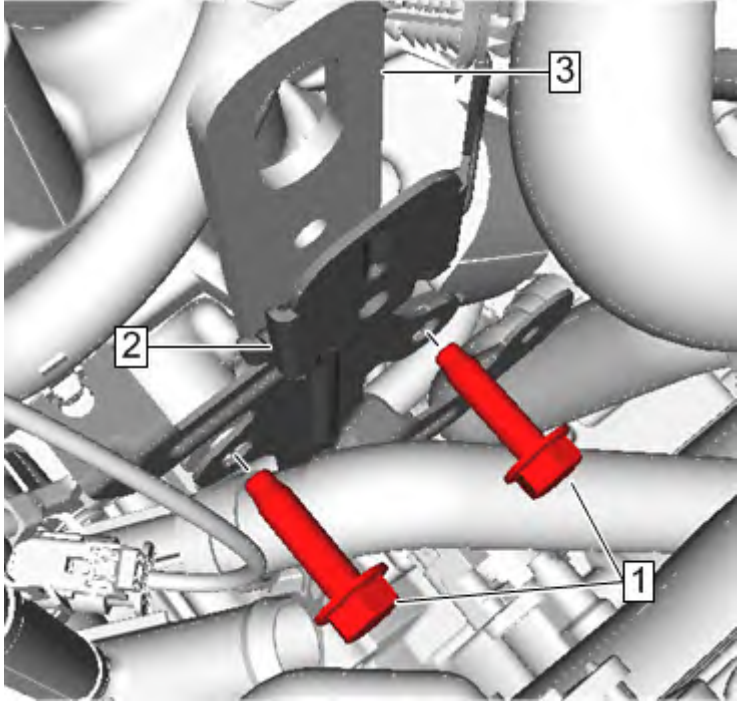


Fig. 229: Engine Wiring Harness Bracket And Engine Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine lift bracket (3) then install the engine wiring harness bracket (2).

CAUTION: **Refer to Fastener Caution .**

2. Install Engine Lift Bracket Bolt (1) and tighten 25 N.m (18 lb ft)

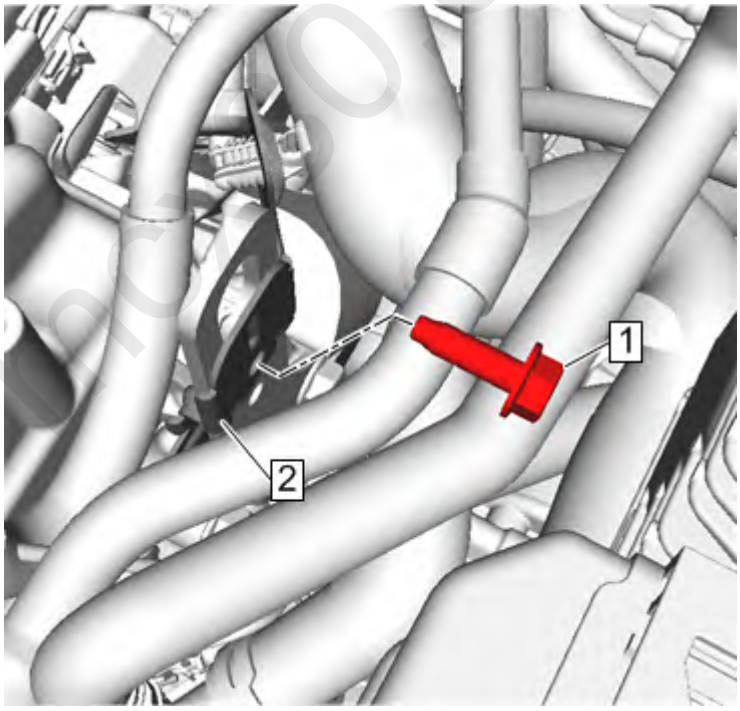


Fig. 230: Engine Wiring Harness Bracket Bolt And Charge Air Cooler Outlet Air Tube
Courtesy of GENERAL MOTORS COMPANY

3. Install Engine Wiring Harness Bracket Bolt and tighten 10 N.m (89 lb in)
4. Install Charge Air Cooler Outlet Air Tube - **Charge Air Cooler Outlet Air Tube Replacement**

CYLINDER HEAD REPLACEMENT

Special Tools

- **EN 38188** Cylinder Head Broken Bolt Extractor Kit - or equivalent aftermarket tool
- **EN 45059** Angle Meter

- **EN-36857** Engine Lift Bracket

Equivalent regional tools:**Special Tools**

Removal Procedure

1. Relieve the fuel system pressure. **Fuel Pressure Relief**
2. Drain the engine oil. **Engine Oil and Oil Filter Replacement**
3. Drain the coolant. **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)**

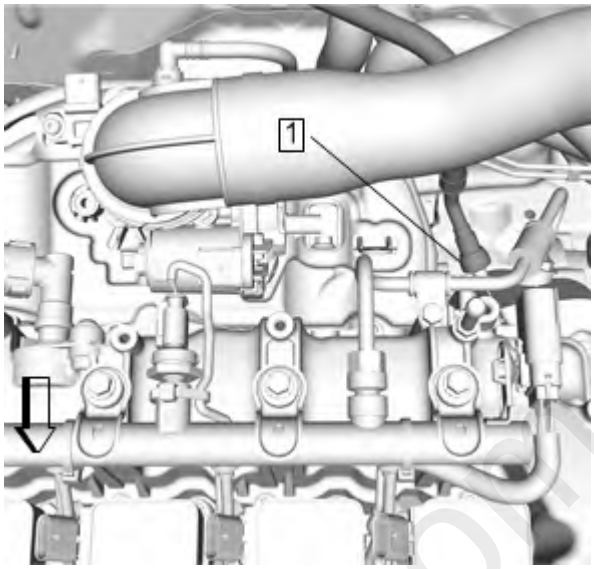


Fig. 231: Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect Fuel Feed Hose (1) **Metal Collar Quick Connect Fitting Service**
5. Remove Camshaft Timing Chain - **Camshaft Timing Chain Replacement**
6. Remove Intake Manifold - **Intake Manifold Replacement**

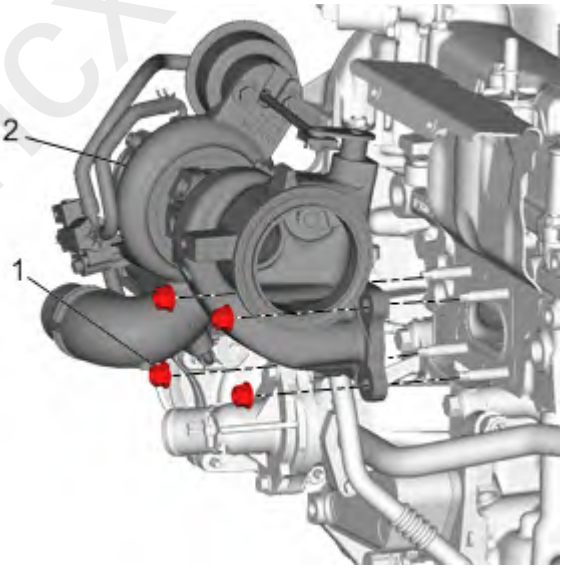


Fig. 232: Turbocharger And Nuts
Courtesy of GENERAL MOTORS COMPANY

7. Remove Turbocharger (2) - **Turbocharger Replacement**
8. Remove Fuel Pump - **Fuel Pump Replacement**
9. Remove Water Outlet -**Water Outlet Replacement (LYX)**
10. Remove Vacuum Pump Assembly - **Vacuum Pump Assembly Replacement**

mcx30.com

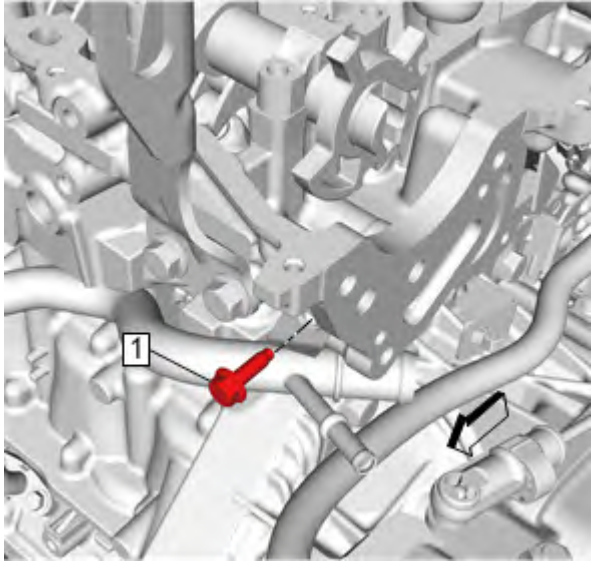


Fig. 233: Thermostat Bypass Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

11. Remove Thermostat Bypass Pipe Bolt (1)

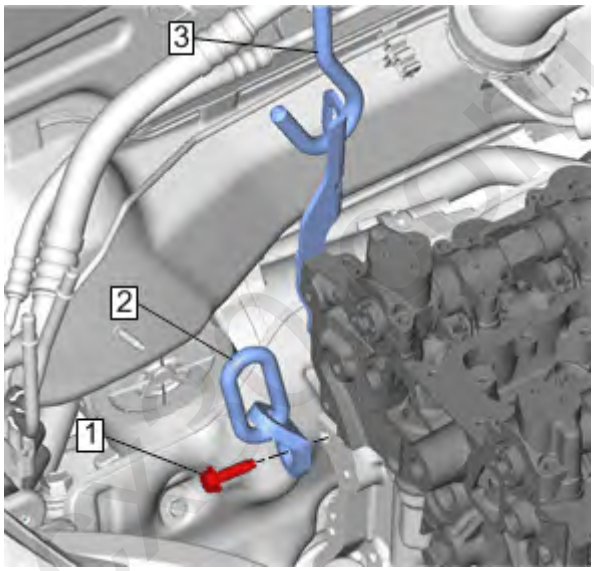


Fig. 234: Engine Lift Bracket, Fixture Hook And Bolt
Courtesy of GENERAL MOTORS COMPANY

12. Insall the **EN-36857** Engine Lift Bracket (2) then install the bolt (1).

NOTE: **Use a suitable device to support the engine while repositioning the lift hook.**

13. Reposition the engine support fixture hook (3) to the newly installed **EN-36857** engine lift bracket (2).

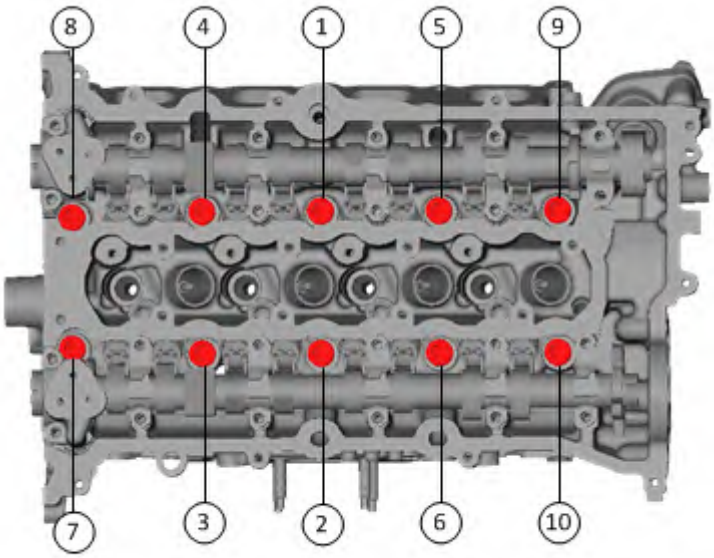


Fig. 235: Cylinder Head Bolt Loosening/Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

14. Loosen the cylinder head bolts in sequence shown.

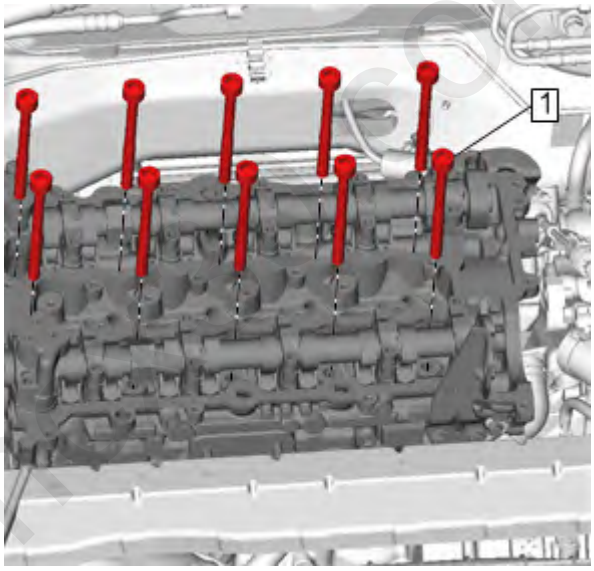


Fig. 236: Cylinder Head Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Remove any broken bolts using the EN 38188 Cylinder Head Broken Bolt Extractor Kit or equivalent.**

15. Remove and DISCARD the cylinder head bolts (1)

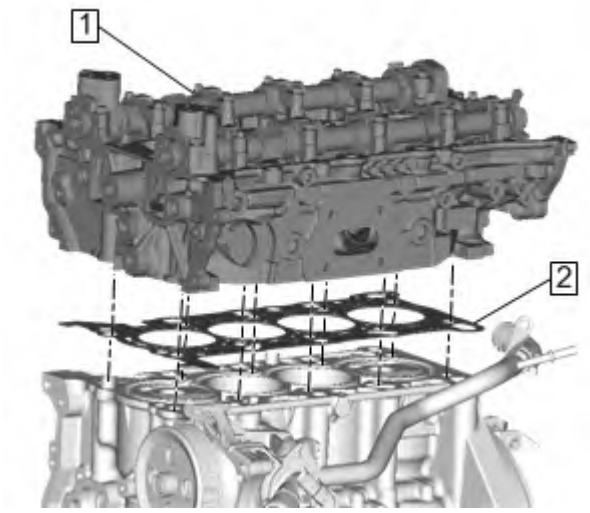


Fig. 237: Cylinder Head And Gasket
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **In order to prevent damage to the valves and injectors during cylinder head removal, set the cylinder head on blocks.**

16. Remove the cylinder head (1)
17. Remove and DISCARD the cylinder head gasket (2)

NOTE: **A nylon bristle brush should be used to clean the bolt holes. Do not use a tap to clean the cylinder head bolt holes.**

18. Clean the old sealer/lube and dirt from the bolt holes.
19. Remove any broken cylinder head bolts using the **EN 38188** kit or equivalent.

WARNING: **Wear safety glasses to avoid injury when using compressed air or any cleaning solvent. Bodily injury may occur if fumes are inhaled or if skin is exposed to chemicals.**

NOTE:

- **When cleaning the engine block cylinder head bolt holes use a suitable commercial spray liquid solvent and compressed air from an extended-tip blow gun to reach the bottom of the holes.**
- **Use a gasket scraper to clean the cylinder head and block surfaces.**
- **Be careful not to gouge or scratch the gasket surfaces. Do not gouge or scrape the combustion chamber surfaces. The feel of the gasket surface is important, not the appearance. There will be indentations from the gasket left in the cylinder head after all of the gasket material is removed. These small indentations will be filled in by the new gasket.**
- **Do not use a tap to clean the cylinder head bolt holes.**

20. Clean the mating surfaces at the engine block.
21. If not replacing the cylinder head, clean and inspect the cylinder head. Cylinder Head Cleaning and Inspection
22. If replacing cylinder head, swap components as needed. Cylinder Head Disassemble
    1. Remove timing components as needed. Intake and Exhaust Camshaft, Bearing Cap, and Lash Adjuster Removal

Installation Procedure

1. If replacing cylinder head, swap components as needed. **Cylinder Head Assemble**
    1. Install timing components as needed. **Intake and Exhaust Camshaft, Bearing Cap, and Lash Adjuster Installation**

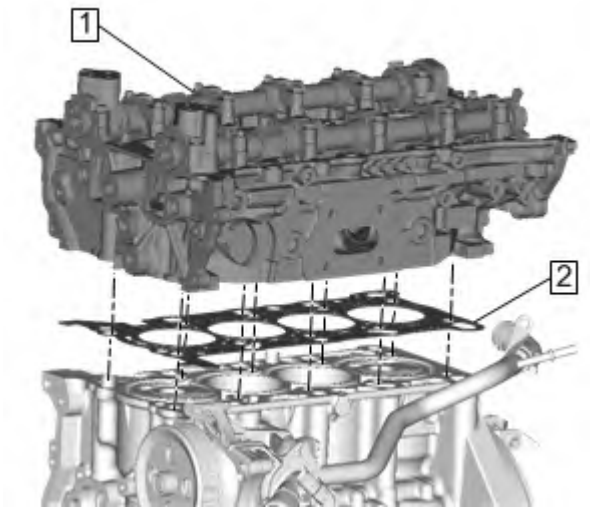


Fig. 238: Cylinder Head And Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that the cylinder head and the cylinder block sealing surfaces are clear of oil, grease and old gasket material.**

2. Install the NEW cylinder head gasket (2)
3. Install the cylinder head (1)

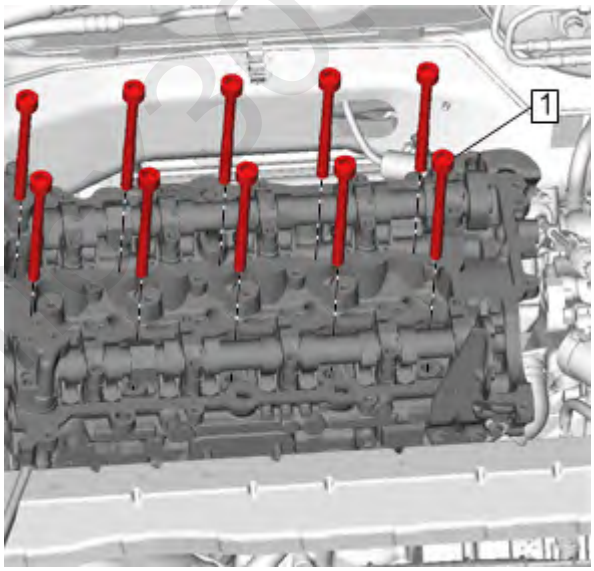


Fig. 239: Cylinder Head Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Loosely install Cylinder Head Bolt (1)

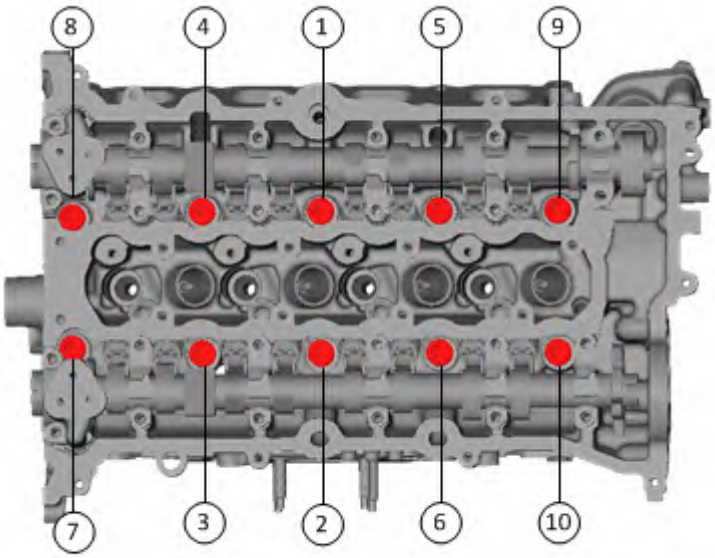


Fig. 240: Cylinder Head Bolt Loosening/Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Torque-to-Yield Fastener Caution .**

CAUTION: **Refer to Fastener Caution .**

5. Tighten the NEW bolts in sequence shown.

Tighten

1. Tighten the bolts a first pass to 30 N.m (22 lb ft).
2. Using the **EN-45059** angle meter, tighten the bolts a final pass to 240 degrees.

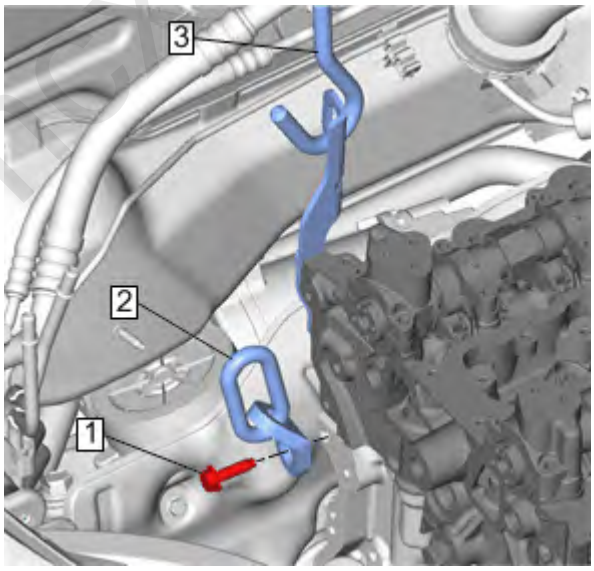


Fig. 241: Engine Lift Bracket, Fixture Hook And Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Use a suitable device to support the engine while repositioning the lift hook.**

6. Reposition the lift hook from the **EN-36857** Engine Lift Bracket to the cylinder head lift bracket.
7. Remove the **EN-36857** Engine Lift Bracket (2).
8. Remove the suitable device holding the engine during lift hook repositioning.
9. Install Water Outlet - Water Outlet Replacement (LYX)

mlx30.com

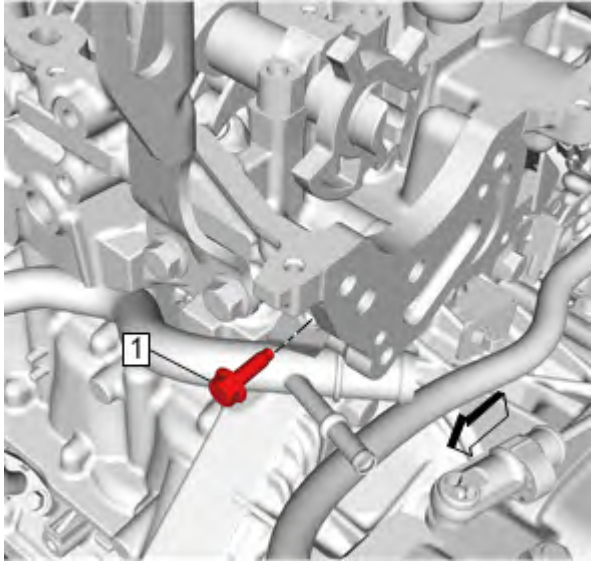


Fig. 242: Thermostat Bypass Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Install Thermostat Bypass Pipe Bolt and tighten - **Thermostat Bypass Pipe Replacement (LYX)**
11. Install Camshaft Timing Chain - **Camshaft Timing Chain Replacement**
12. Install Fuel Pump - **Fuel Pump Replacement**
13. Install Intake Manifold - **Intake Manifold Replacement**
14. Install Vacuum Pump Assembly - **Vacuum Pump Assembly Replacement**

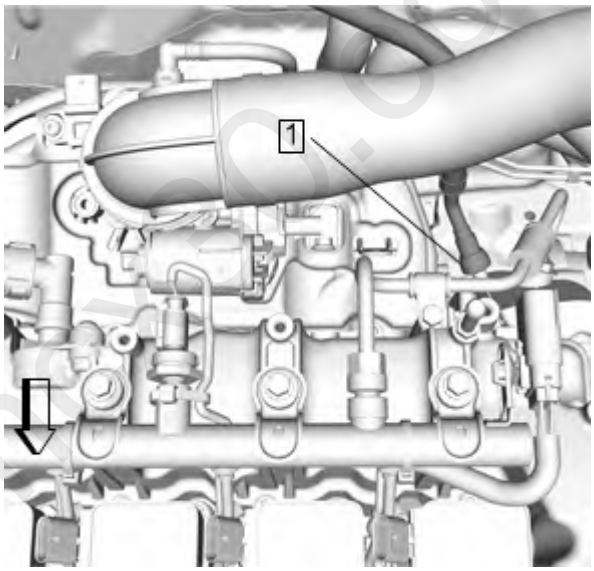


Fig. 243: Fuel Feed Hose
Courtesy of GENERAL MOTORS COMPANY

15. Connect Fuel Feed Hose - **Metal Collar Quick Connect Fitting Service**

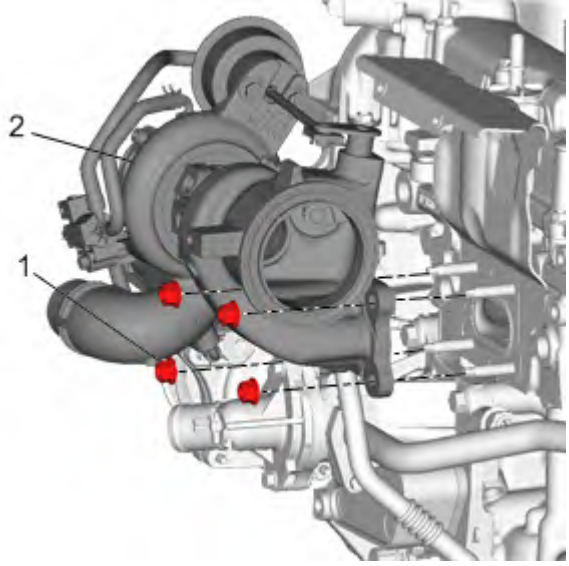


Fig. 244: Turbocharger And Nuts
Courtesy of GENERAL MOTORS COMPANY

16. Install Turbocharger - Turbocharger Replacement
17. Change the engine oil and filter. Engine Oil and Oil Filter Replacement
18. Fill the cooling system to the proper level. Cooling System Draining and Filling (GE 47716) Cooling System Draining and Filling (Static)

ENGINE FRONT COVER REPLACEMENT

Removal Procedure

1. Remove Camshaft Cover Replacement
2. Remove Engine Mount Bracket Replacement
3. Remove Crankshaft Balancer Replacement
4. Remove Drive Belt Tensioner Replacement
5. Remove Generator Replacement (LYX)
6. Drain the engine oil. Engine Oil and Oil Filter Replacement
7. Remove Upper Oil Pan Replacement

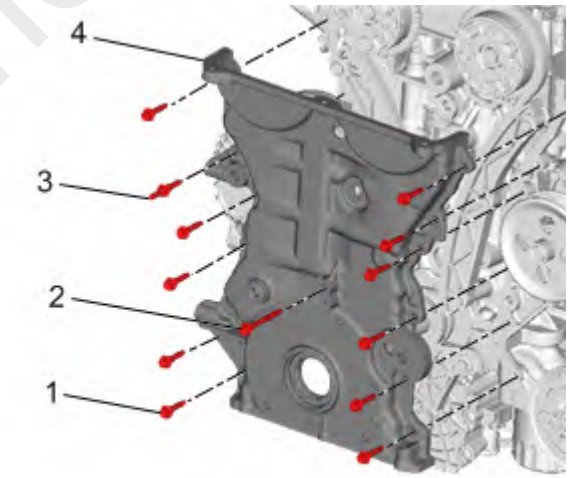


Fig. 245: Identifying Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the location of the long fastener (2), short fasteners (1) and stud fastener (3) for correct installation.**

8. Remove Engine Front Cover (4)Engine Front Cover Removal

9. Transfer parts as needed.
10. Install a NEW seal. **Crankshaft Front Oil Seal Replacement**

Installation Procedure

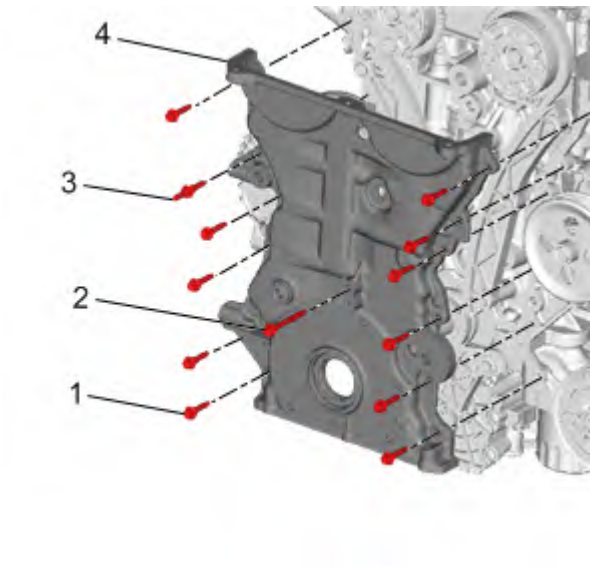


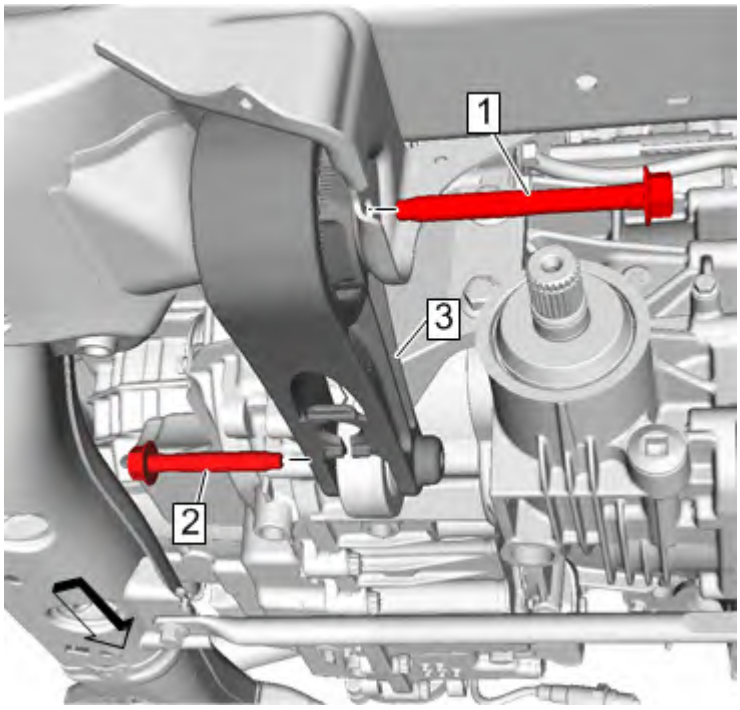
Fig. 246: Identifying Fasteners
Courtesy of GENERAL MOTORS COMPANY

1. Install Engine Front Cover (4)**Engine Front Cover Installation**
2. Install **Upper Oil Pan Replacement**
3. Install **Crankshaft Balancer Replacement**
4. Install **Camshaft Cover Replacement**
5. Install **Engine Mount Bracket Replacement**
6. Install **Generator Replacement (LYX)**
7. Install **Drive Belt Tensioner Replacement**
8. Fill the engine oil to the proper level with NEW engine oil. **Engine Oil and Oil Filter Replacement**

POWERTRAIN MOUNT BALANCING (ALL WHEEL DRIVE)

Removal Procedure

1. Raise the vehicle. **Lifting and Jacking the Vehicle**



mcx30.com

Fig. 247: Transmission Mount Strut Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Loosen the transmission mount strut bolt (2) at the transmission mount strut (3). **Transmission Mount Strut Replacement (All Wheel Drive)** **Transmission Mount Strut Replacement (Front Wheel Drive)**
3. Position two floor jacks with wood blocks under the engine and transaxle in order to support the powertrain assembly.
4. Lower the vehicle. **Lifting and Jacking the Vehicle**

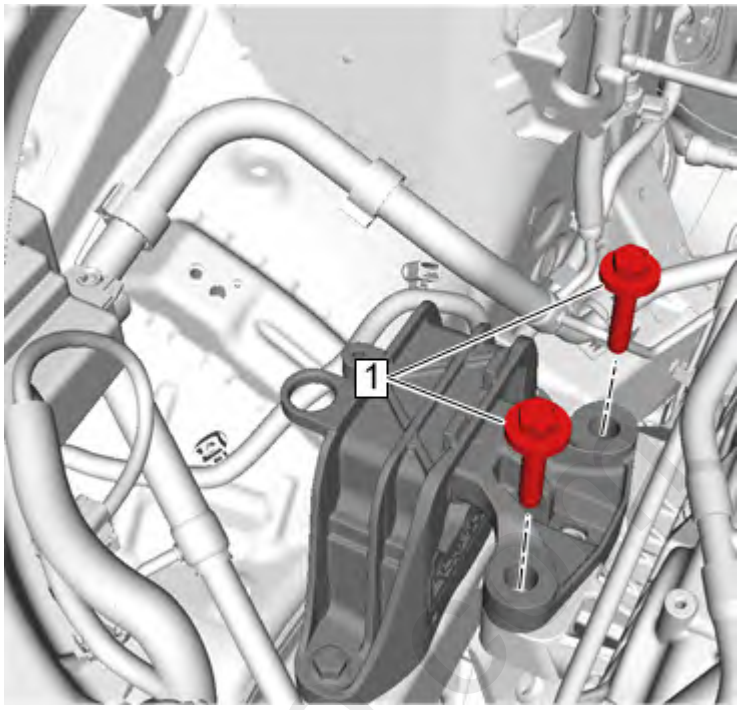


Fig. 248: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Loosen ONLY the engine mount to engine mount bracket bolts (1). **Engine Mount Replacement**

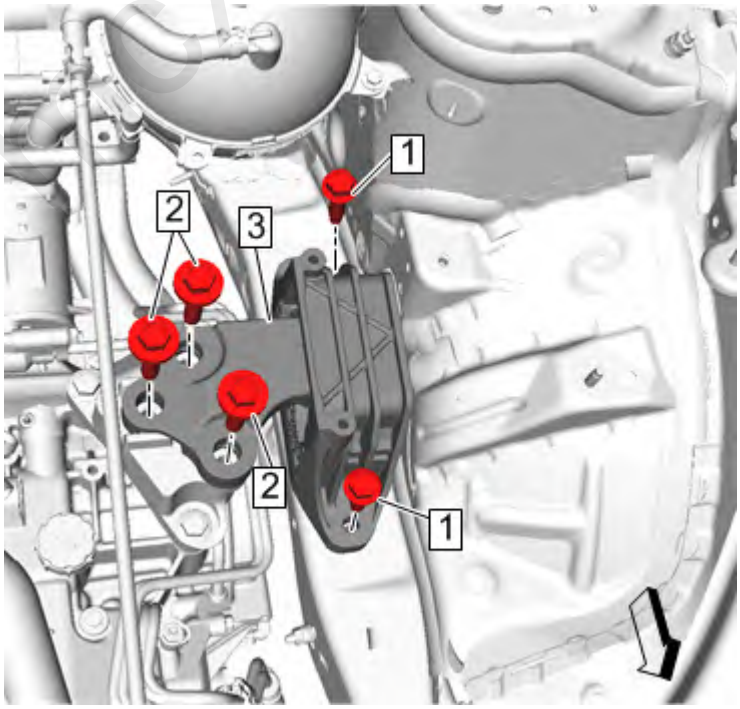


Fig. 249: Transmission Mount Bolts And Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Only the transmission mount to transmission bolts should be loosened. Bolts (1) should remain tightened during the balancing procedure.**

6. Loosen ONLY bolts (2) at the left transmission mount (3). **Transmission Mount Replacement - Left Side**

Installation Procedure

1. Reposition both floor jacks and blocks of wood in order to allow a 1/8 inch gap between the mount and bracket.
2. Shake the powertrain vigorously by hand from front to rear and allow the powertrain to settle.

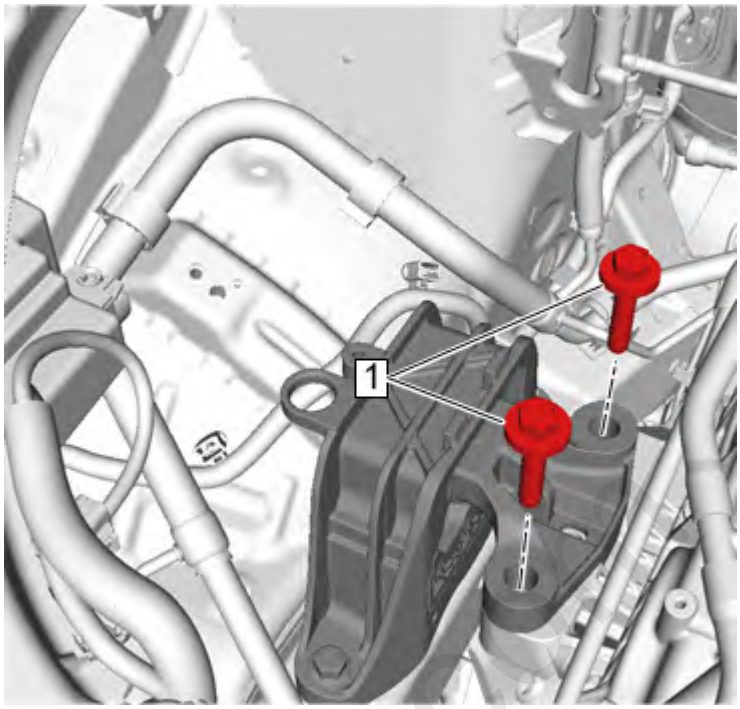


Fig. 250: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Tighten the engine mount to engine mount bracket bolts (1). **Engine Mount Replacement**

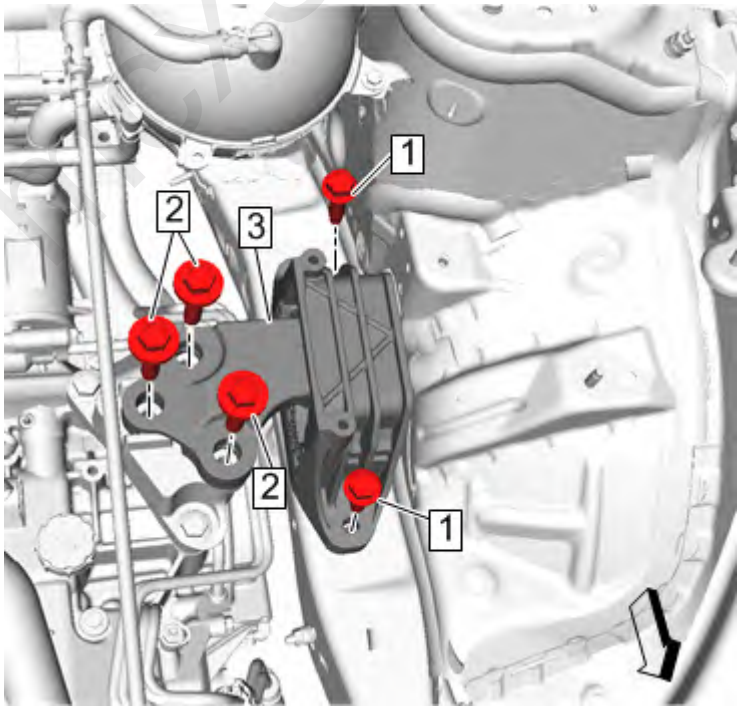


Fig. 251: Transmission Mount Bolts And Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Bolts (1) should remain tightened during the balancing procedure.**

4. Tighten bolts (2) at the left transmission mount (3). **Transmission Mount Replacement - Left Side**

5. Raise the vehicle. **Lifting and Jacking the Vehicle**

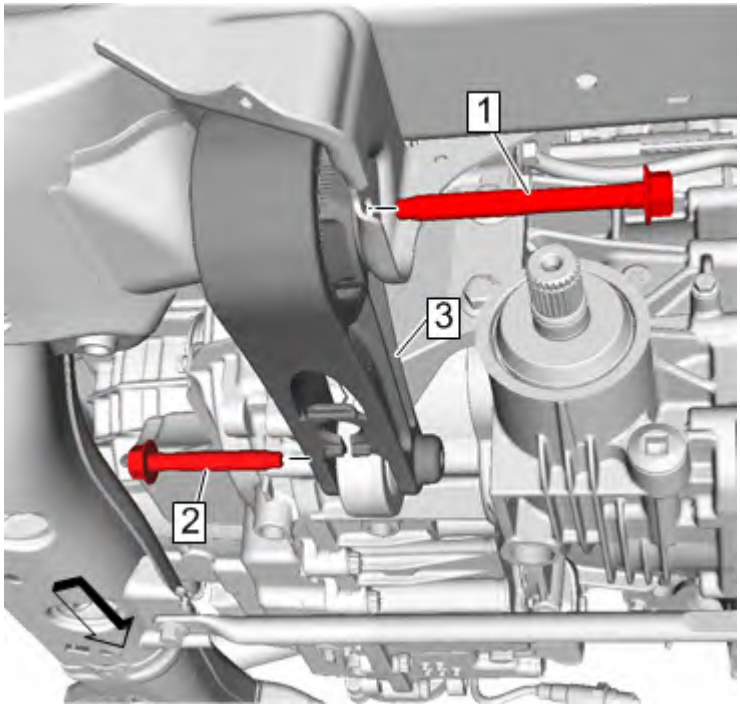


Fig. 252: Transmission Mount Strut Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Tighten the transmission mount strut bolt (2) at the transmission mount strut (3). **Transmission Mount Strut Replacement (All Wheel Drive)** **Transmission Mount Strut Replacement (Front Wheel Drive)**
7. Remove the jack stands and wood blocks supporting the engine and transaxle from underneath the powertrain.
8. Lower the vehicle. **Lifting and Jacking the Vehicle**

POWERTRAIN MOUNT BALANCING (FRONT WHEEL DRIVE)

Removal Procedure

1. Raise the vehicle. **Lifting and Jacking the Vehicle**

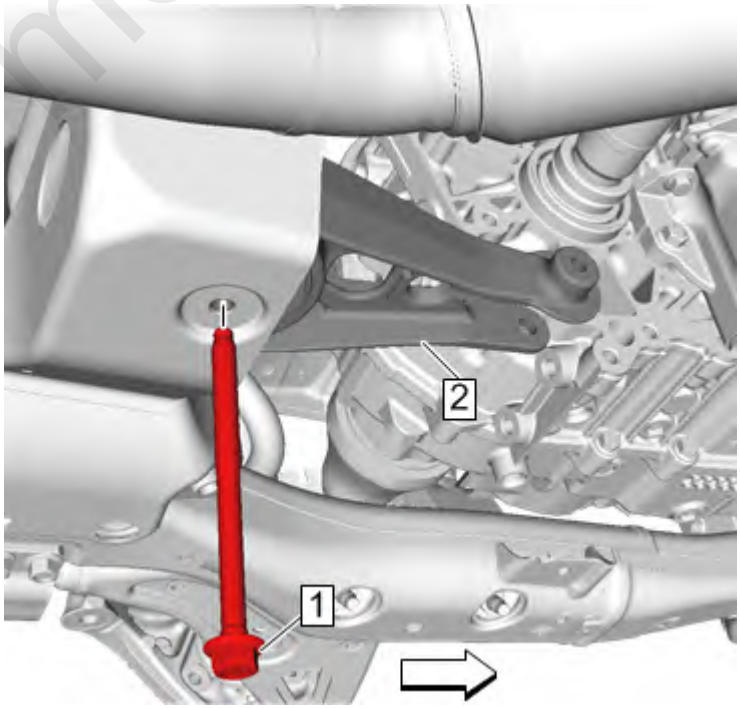


Fig. 253: Transmission Mount Strut Bolt
Courtesy of GENERAL MOTORS COMPANY

mcx30.com

2. Loosen the transmission mount strut bolt (1) at the transmission mount strut (2). **Transmission Mount Strut Replacement (All Wheel Drive) Transmission Mount Strut Replacement (Front Wheel Drive)**
3. Position two floor jacks with wood blocks under the engine and transaxle in order to support the powertrain assembly.
4. Lower the vehicle. **Lifting and Jacking the Vehicle**

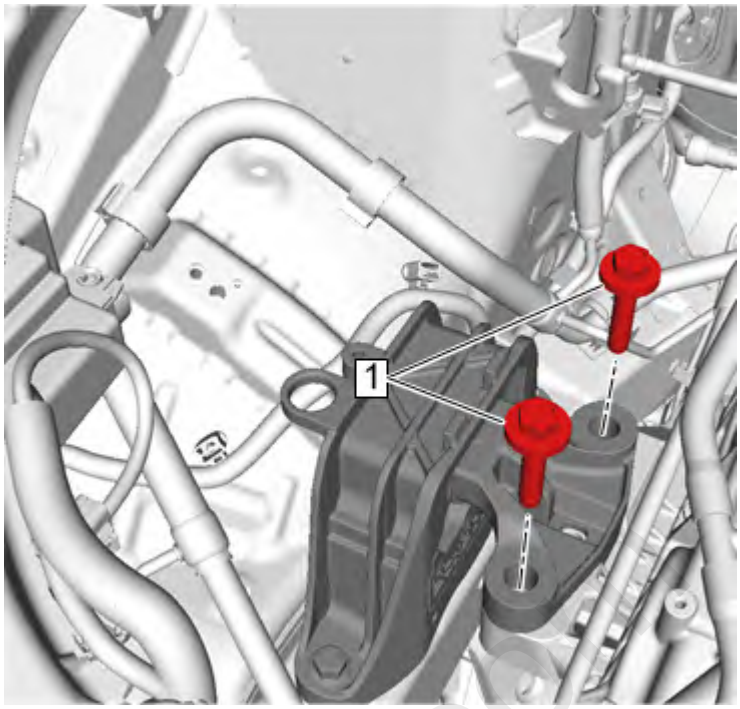


Fig. 254: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Loosen ONLY the engine mount to engine mount bracket bolts (1). **Engine Mount Replacement**

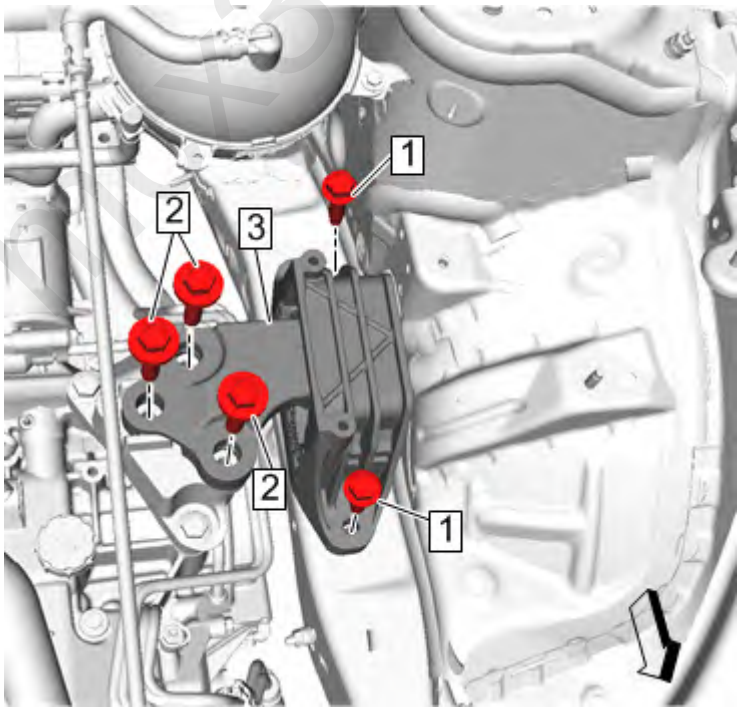


Fig. 255: Transmission Mount Bolts And Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Only the transmission mount to transmission bolts should be loosened. Bolts (1) should remain tightened during the balancing procedure.**

6. Loosen ONLY bolts (2) at the left transmission mount (3). **Transmission Mount Replacement - Left Side**

Installation Procedure

1. Reposition both floor jacks and blocks of wood in order to allow a 1/8 inch gap between the mount and bracket.
2. Shake the powertrain vigorously by hand from front to rear and allow the powertrain to settle.

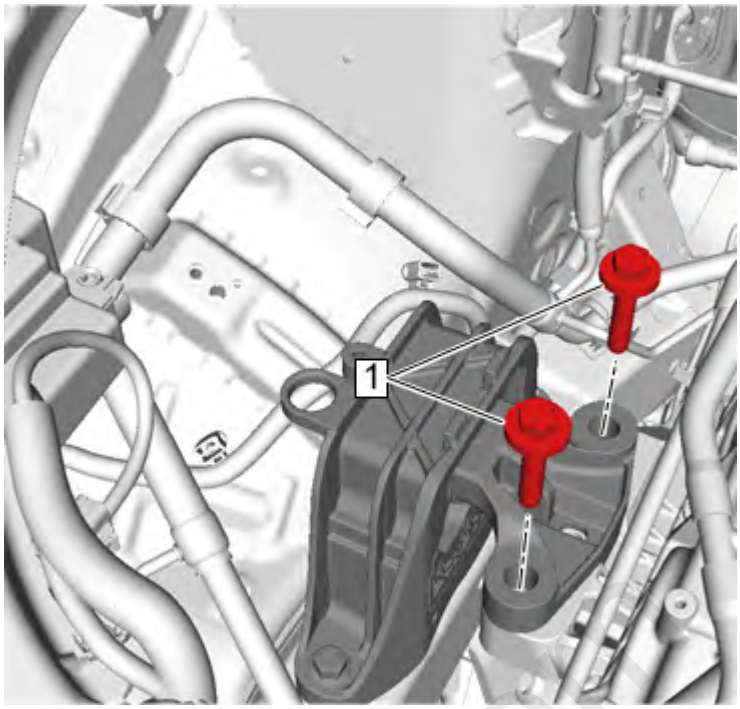


Fig. 256: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Tighten the engine mount to engine mount bracket bolts (1). **Engine Mount Replacement**

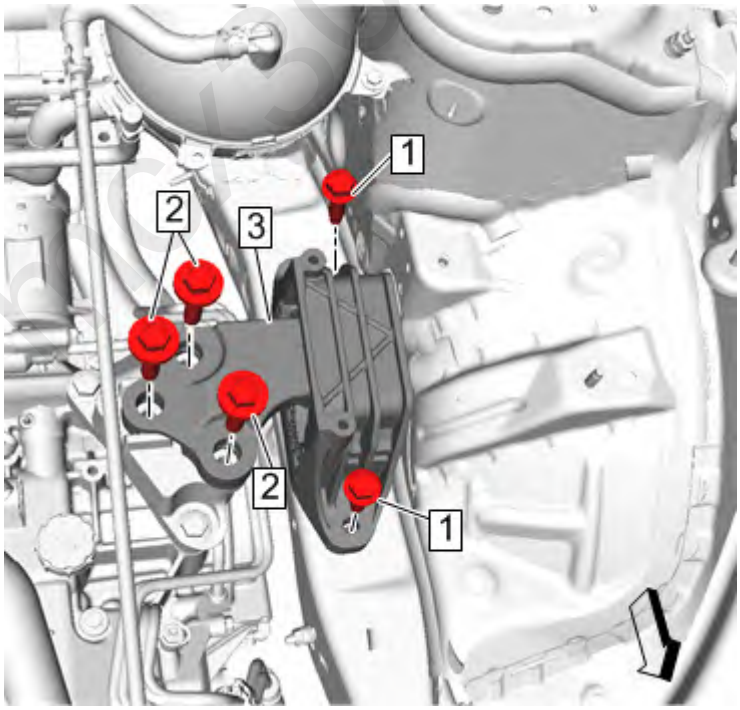


Fig. 257: Transmission Mount Bolts And Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Bolts (1) should remain tightened during the balancing procedure.**

4. Tighten bolts (2) at the left transmission mount (3). **Transmission Mount Replacement - Left Side**
5. Raise the vehicle. **Lifting and Jacking the Vehicle**

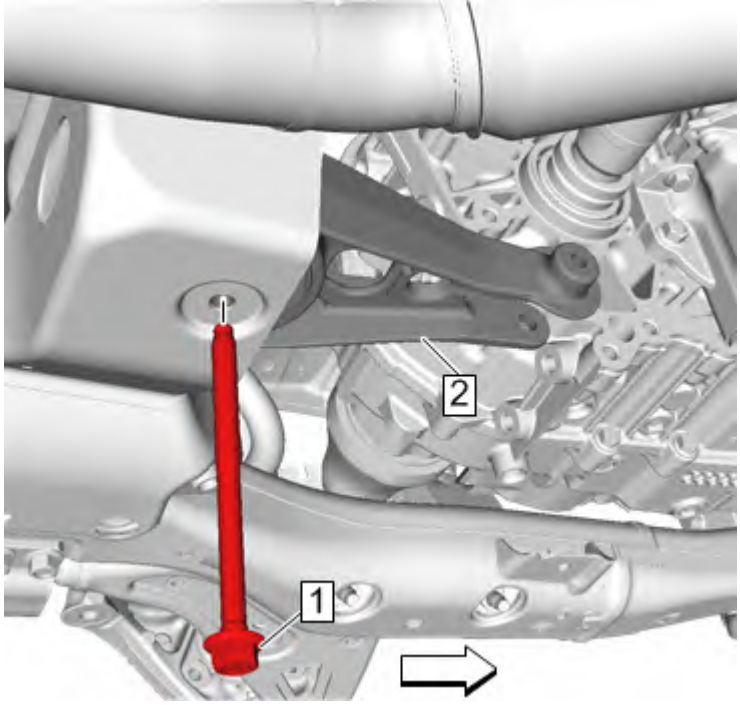


Fig. 258: Transmission Mount Strut Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Tighten the transmission mount strut bolt (1) at the transmission mount strut (2). **Transmission Mount Strut Replacement (All Wheel Drive)** **Transmission Mount Strut Replacement (Front Wheel Drive)**
7. Remove the jack stands and wood blocks supporting the engine and transaxle from underneath the powertrain.
8. Lower the vehicle. **Lifting and Jacking the Vehicle**

ENGINE MOUNT BRACKET REPLACEMENT

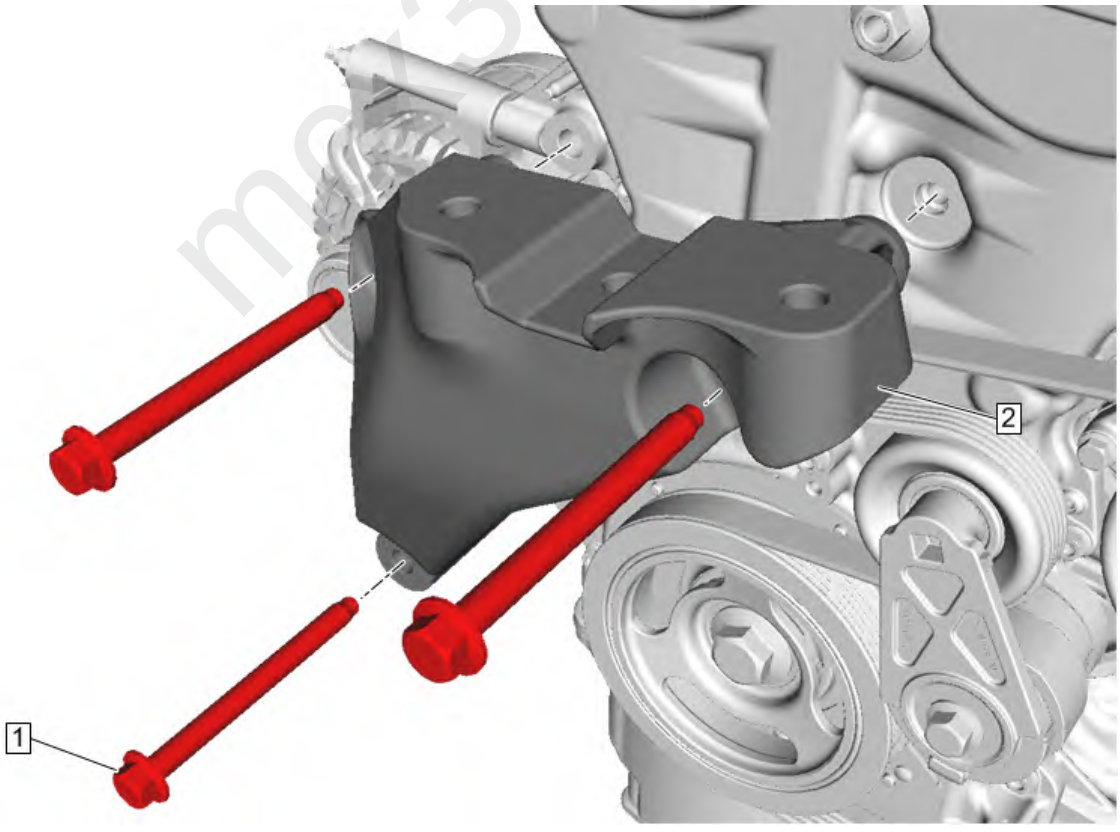


Fig. 259: Engine Mount Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

Callout	Component Name
Preliminary Procedure Engine Mount Replacement	
1	Engine Mount Bracket Engine Side Bolt [3x] **CAUTION:** **Refer to Fastener Caution .** **Procedure** Remove and DISCARD the fasteners. **NOTE:** **Install NEW engine mount bracket fasteners.** **Tighten** **First Pass:** 58 N.m (43 lb ft) **Final Pass:** 60 - 75 degrees
2	Engine Mount Bracket

ENGINE MOUNT REPLACEMENT

Special Tools

EN-45059 Angle Meter

Equivalent regional tools:Special Tools

Removal Procedure

1. Remove Intake Manifold Cover - Intake Manifold Cover Replacement
2. Remove Air Cleaner Assembly -Air Cleaner Assembly Replacement
3. Install Engine Support Fixture - Engine Support Fixture

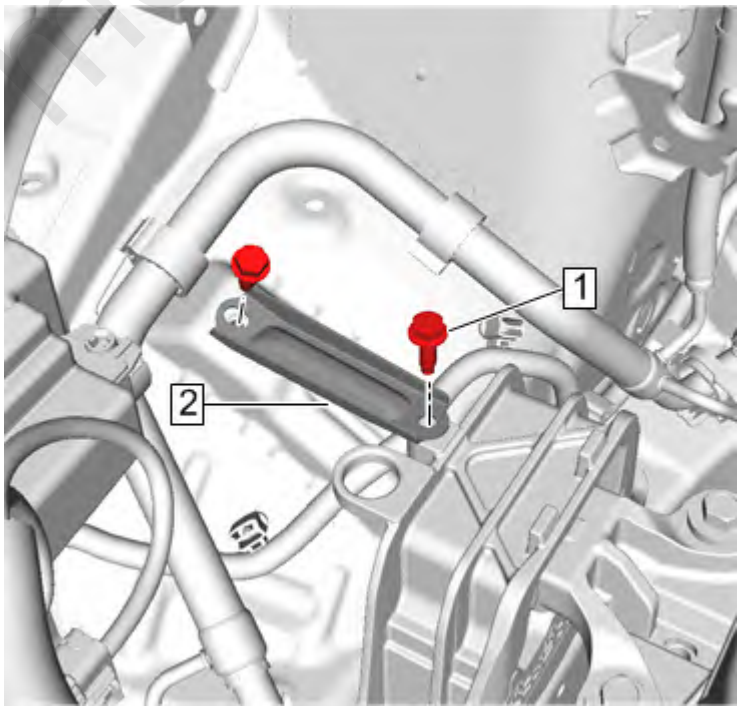


Fig. 260: Engine Mount Brace And Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove Engine Mount Brace Bolt (1)

mcx30.com

5. Remove Engine Mount Brace (2)

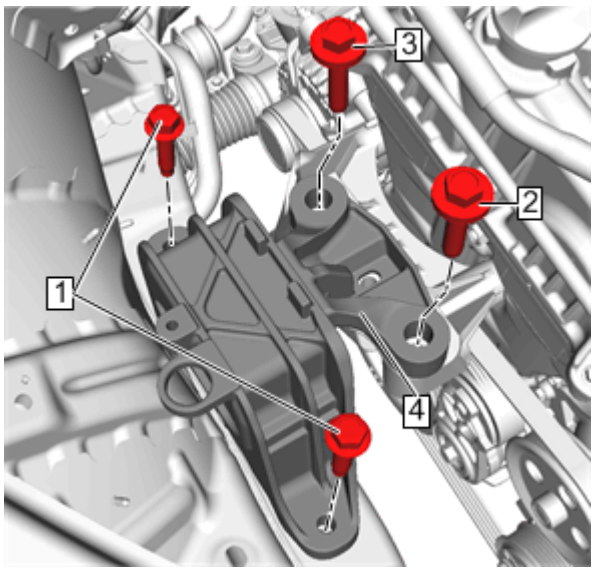


Fig. 261: Engine Mount Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove Engine Mount Bolt (1)
7. Remove Engine Mount Engine Side Bolt (2) and DISCARD
8. Remove Engine Mount Engine Side Bolt (3) and DISCARD
9. Remove Engine Mount (4)

Installation Procedure

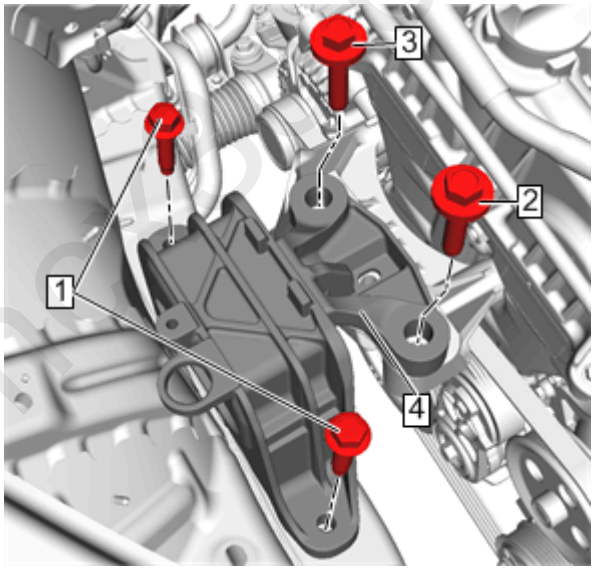


Fig. 262: Engine Mount Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install Engine Mount (4)

CAUTION: Fastener Caution

2. Install Engine Mount Bolt (1) and tighten 100 N.m (74 lb ft)

CAUTION: Torque-to-Yield Fastener Caution

3. Install NEW Engine Mount Engine Side Bolt (2, 3)
4. Engine Mount Engine Side Bolt (2) - Tighten
    1. First Pass:35 N.m (26 lb ft)
5. Engine Mount Engine Side Bolt (3) - Tighten

1. First Pass:35 N.m (26 lb ft)

6. Engine Mount Engine Side Bolt (2, 3) - Tighten
    1. Second Pass:100 N.m (74 lb ft)
    2. Final Pass:60 - 75 degrees - **EN-45059** Angle Meter

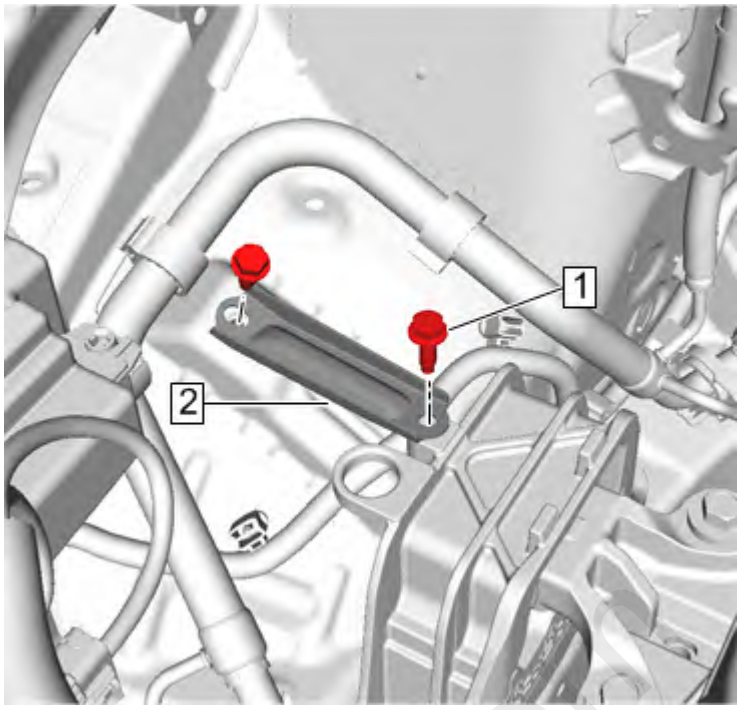


Fig. 263: Engine Mount Brace And Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Install Engine Mount Brace (2)
8. Install Engine Mount Brace Bolt (1) and tighten 22 N.m (16 lb ft)
9. Install Engine Support Fixture - **Engine Support Fixture**
10. Install Air Cleaner Assembly - **Air Cleaner Assembly Replacement**
11. Install Intake Manifold Cover - **Intake Manifold Cover Replacement**

UPPER OIL PAN REPLACEMENT

Removal Procedure

1. Remove Engine Oil Level Indicator Control Module Wiring Harness - **Engine Oil Level Indicator Control Module Wiring Harness Replacement**
2. Remove Exhaust Front Pipe - **Exhaust Front Pipe Replacement (LYX)**

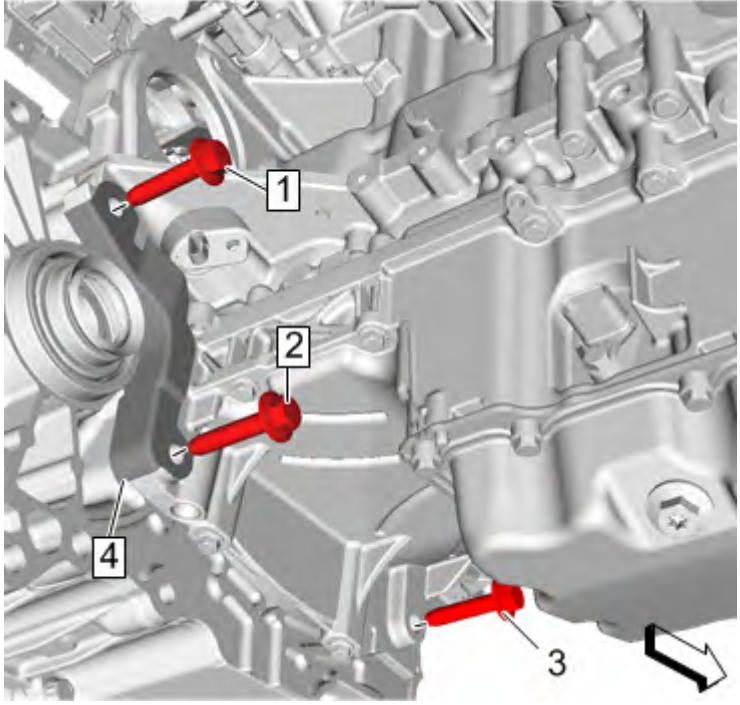


Fig. 264: Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the transmission bolts (1, 2, 3)**Transmission Replacement (Front Wheel Drive except Diesel Engine)** **Transmission Replacement (All Wheel Drive except Diesel Engine)**
4. Remove Torque Converter Cover (4)

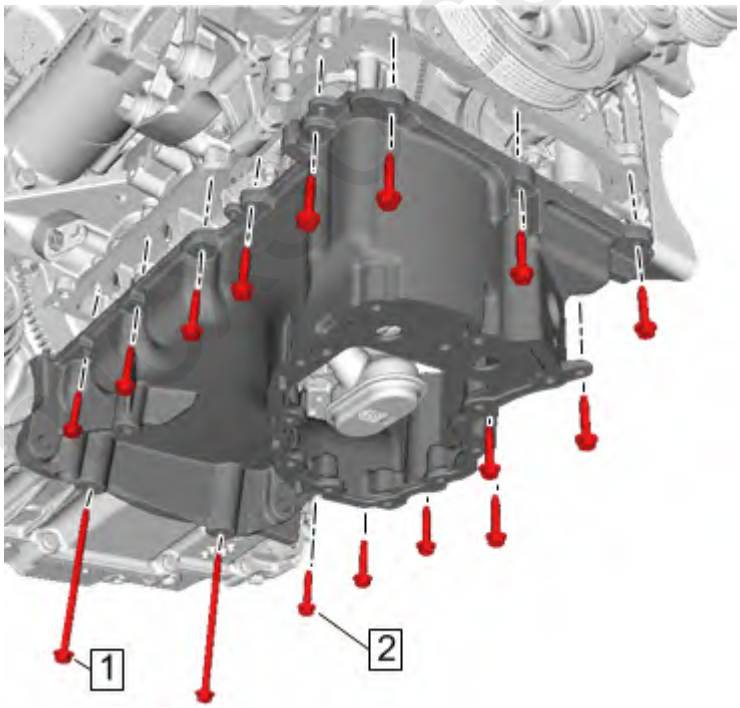


Fig. 265: Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Mark the position of the oil pan bolts because of different length.**

5. Remove the oil pan bolts (1, 2)
6. Carefully pry the oil pan loose and remove.
7. For part transfer, cleaning and inspection **Oil Pan Cleaning and Inspection**.

Installation Procedure

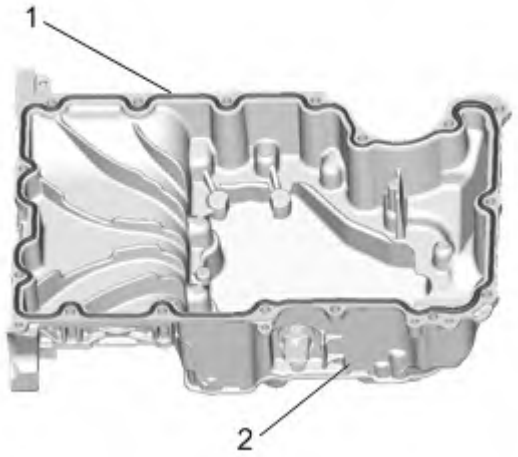


Fig. 266: Sealant Application Points
Courtesy of GENERAL MOTORS COMPANY

1. Apply sealer (1) around the perimeter of the oil pan (2). **Oil Pan Installation**

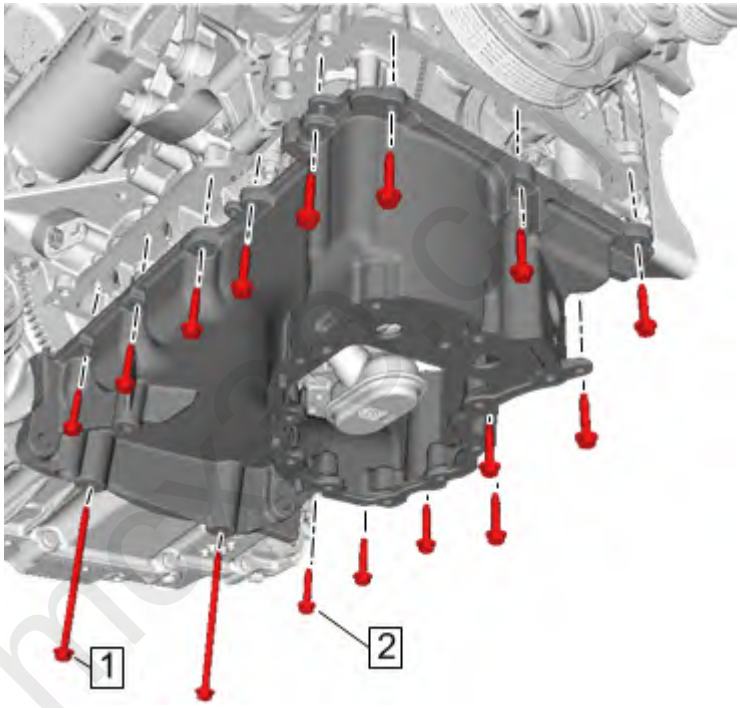


Fig. 267: Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that the different length bolts are installed in the same positions from which they were removed.**

NOTE: **When installing the oil pan, carefully align the oil pan to the locating pins and install the pan onto the lower crankcase.**

2. Coat the oil pan bolts (1) and (2) with sealant prior to installation. **Adhesives, Fluids, Lubricants, and Sealers**
3. Loosely install the oil pan bolts.

NOTE: **Inspect for excessive sealer around the oil filter mounting area. If extra sealer is present remove and clean**

accordingly.

4. Tighten the oil pan bolts in sequence. **Oil Pan Installation**

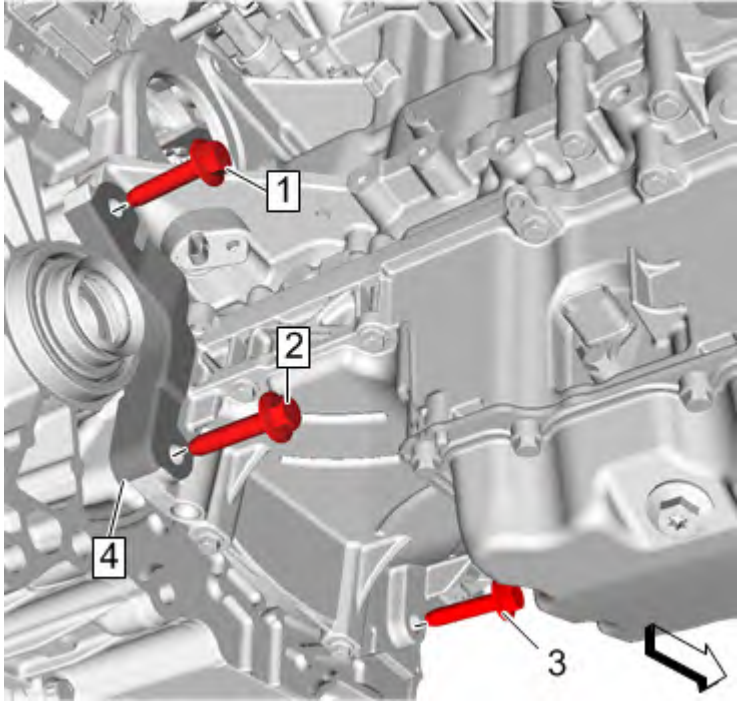


Fig. 268: Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install Torque Converter Cover (4)
6. Install the transmission bolts. **Transmission Replacement (Front Wheel Drive except Diesel Engine)** **Transmission Replacement (All Wheel Drive except Diesel Engine)**
7. Install Exhaust Front Pipe - **Exhaust Front Pipe Replacement (LYX)**
8. Install Engine Oil Level Indicator Control Module Wiring Harness - **Engine Oil Level Indicator Control Module Wiring Harness Replacement**
9. Change the engine oil and filter. **Engine Oil and Oil Filter Replacement**

LOWER OIL PAN REPLACEMENT

Removal Procedure

1. Drain the engine oil. **Engine Oil and Oil Filter Replacement**

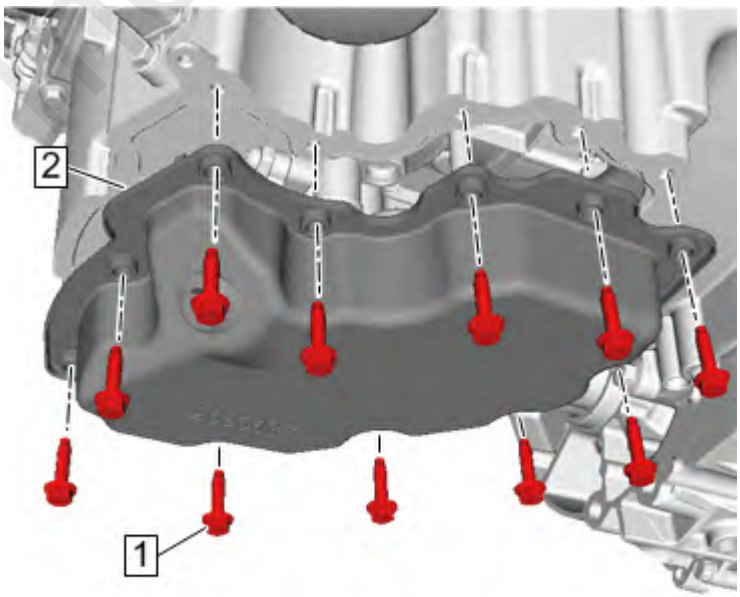


Fig. 269: Lower Oil Pan Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove Lower Oil Pan Bolt (1)

CAUTION: **Always replace the used oil pan with a new oil pan. The lower oil pan becomes damaged during removal and oil leaks may occur if it is not replaced with a new oil pan.**

3. Remove Lower Oil Pan (2) and DISCARD
4. Clean and inspect the lower oil pan locating pins and the lower oil pan to upper oil pan mating surfaces. **Oil Pan Cleaning and Inspection**

Installation Procedure

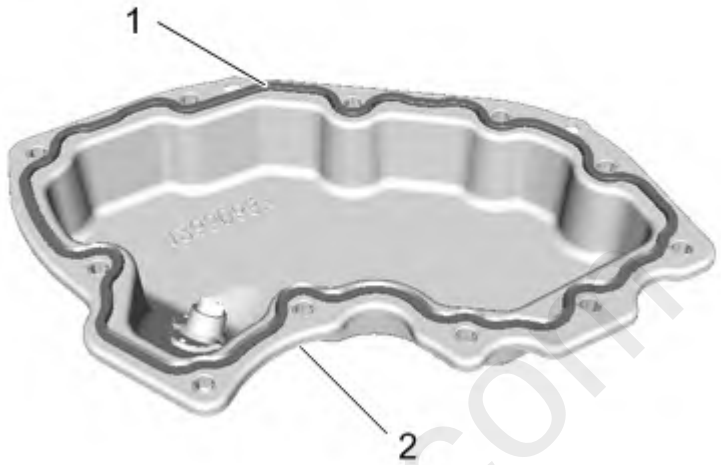


Fig. 270: Sealer
Courtesy of GENERAL MOTORS COMPANY

1. Apply bead of sealer (1) on the level part of the flange around the perimeter of the NEW oil pan (2). **Oil Pan Installation**

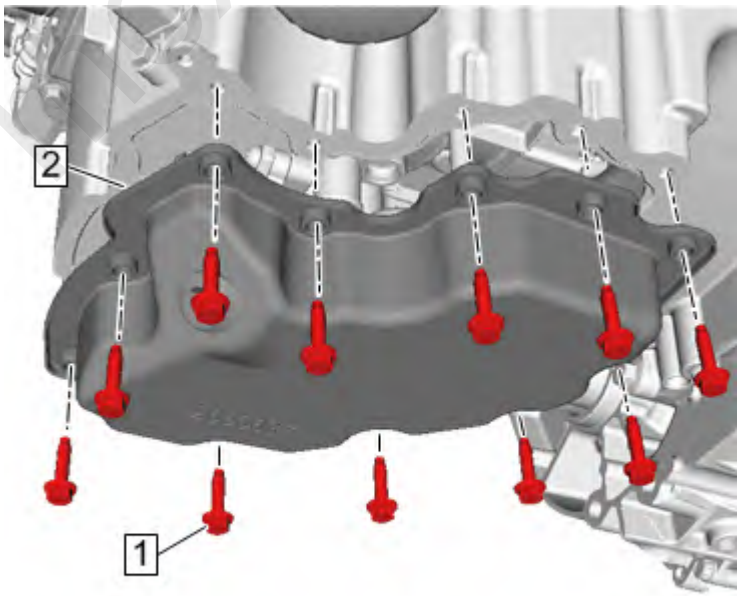


Fig. 271: Lower Oil Pan Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Install NEW Lower Oil Pan (2)
3. Loosely install Lower Oil Pan Bolt (1)

4. Lower Oil Pan Bolt (1) - Tighten in sequence - **Oil Pan Installation**
5. Change the engine oil and filter. **Engine Oil and Oil Filter Replacement**

ENGINE OIL LEVEL INDICATOR CONTROL MODULE WIRING HARNESS REPLACEMENT

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Lower Oil Pan - **Lower Oil Pan Replacement**

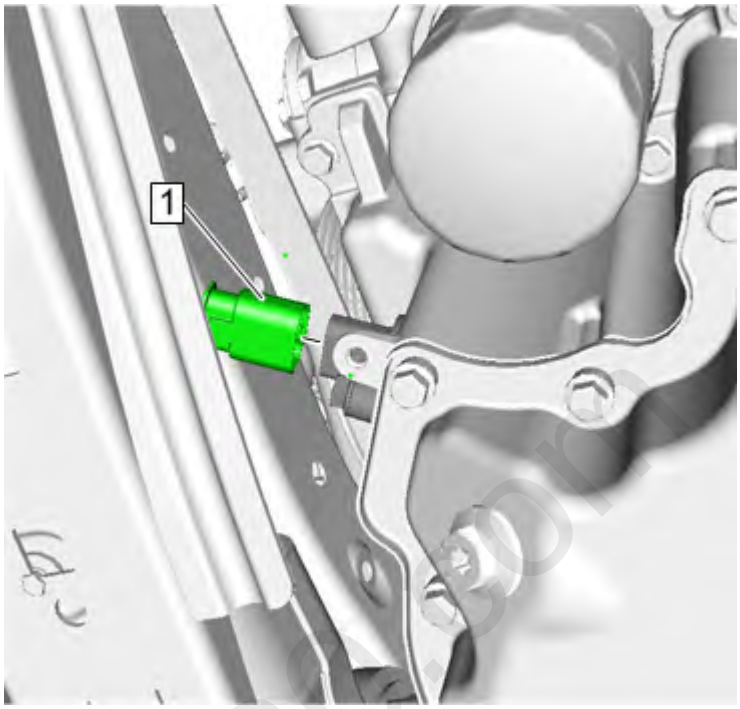


Fig. 272: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect Electrical Connector (1) @Engine Oil Level Indicator Control Module Wiring Harness

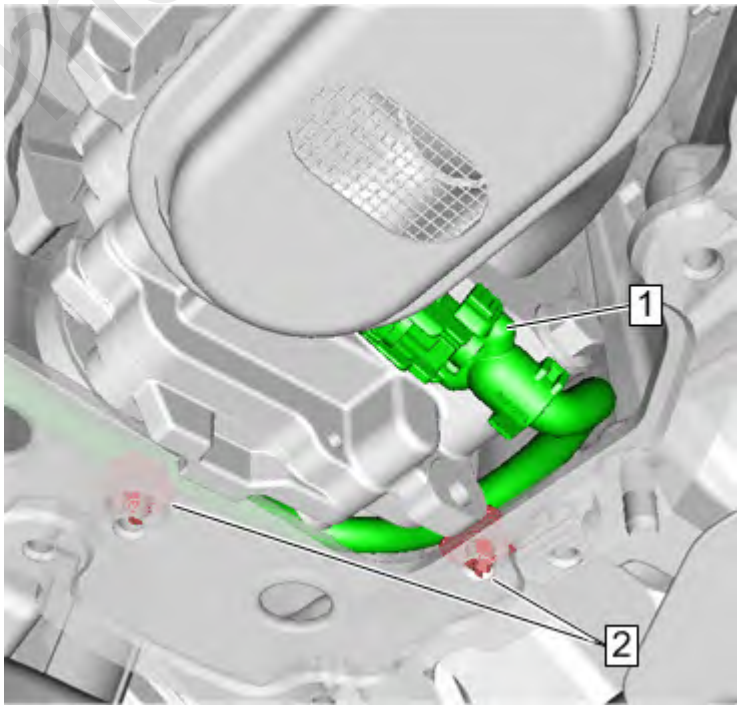


Fig. 273: Electrical Connector And Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect Electrical Connector (1) @ Oil Pump Flow Control Solenoid Valve

5. Remove { If equipped }Wiring Harness Retainer (2)

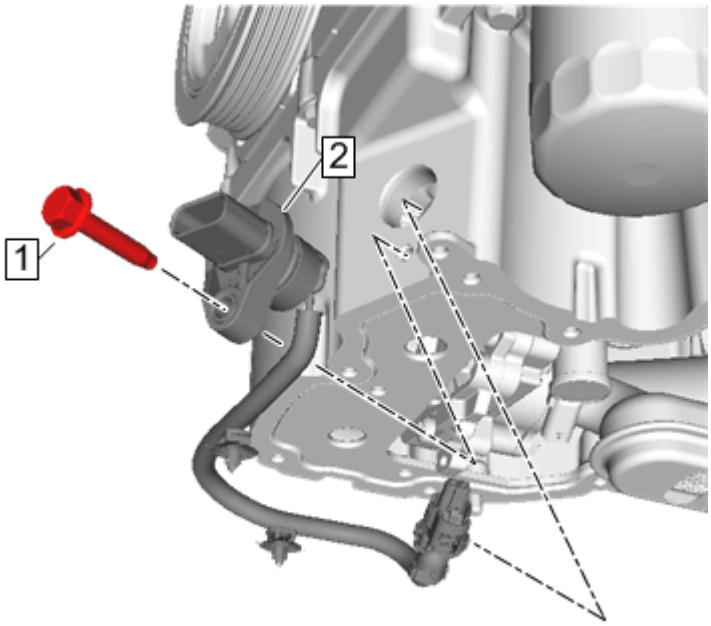


Fig. 274: Wiring Harness Connector Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove Wiring Harness Connector Bolt (1)
7. Remove Engine Oil Level Indicator Control Module Wiring Harness

Installation Procedure

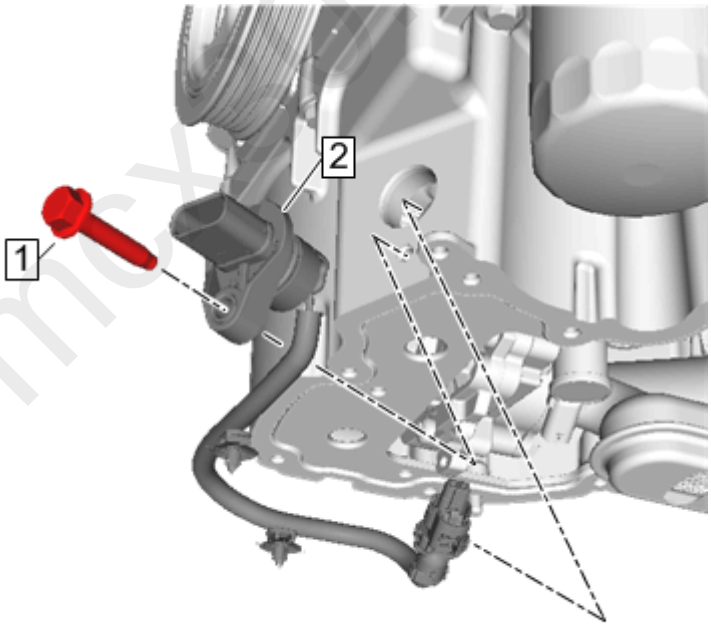


Fig. 275: Wiring Harness Connector Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install Engine Oil Level Indicator Control Module Wiring Harness (2)

CAUTION: **Fastener Caution**

2. Install Wiring Harness Connector Bolt (1) and tighten 10 N.m (89 lb in)

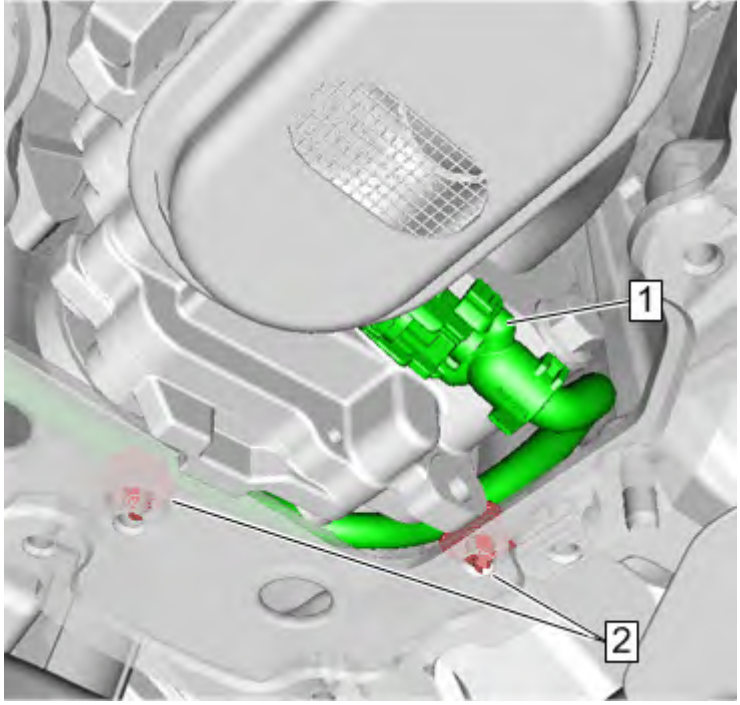


Fig. 276: Electrical Connector And Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Install { If equipped } Wiring Harness Retainer (2)
4. Connect Electrical Connector (1) @Oil Pump Flow Control Solenoid Valve (1).

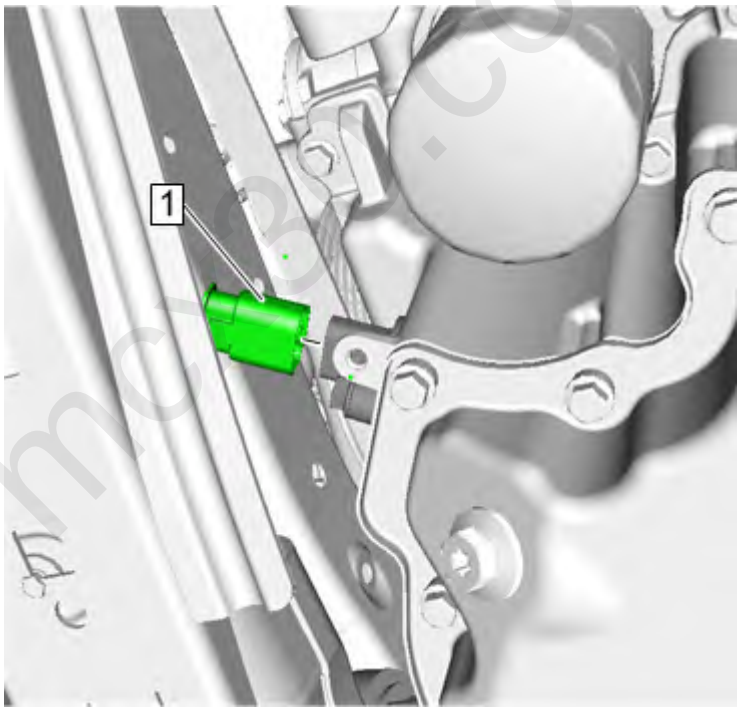


Fig. 277: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Connect Electrical Connector (1) @Engine Oil Level Indicator Control Module Wiring Harness
6. Install Lower Oil Pan - **Lower Oil Pan Replacement**
7. Connect the battery negative cable. **Battery Negative Cable Disconnection and Connection (KL9)**

ENGINE OIL AND OIL FILTER REPLACEMENT

Removal Procedure

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Place a drain pan under the oil drain plug.

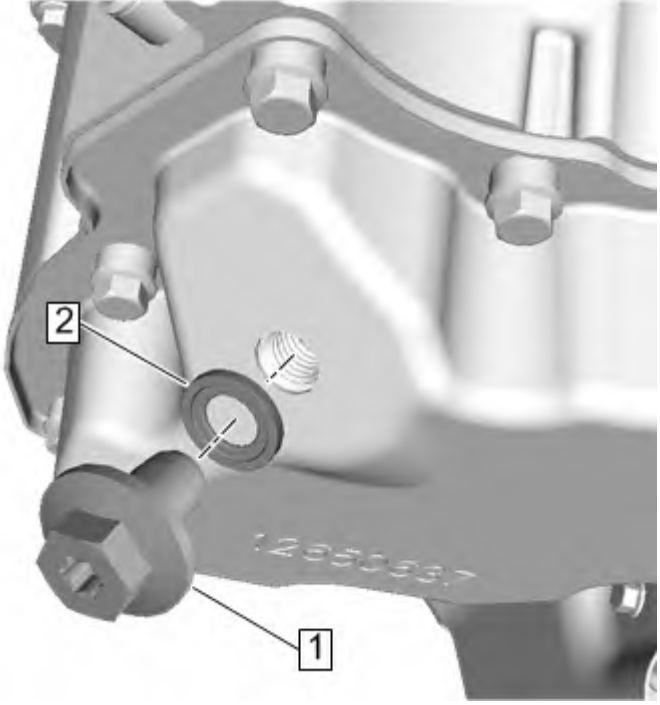


Fig. 278: Oil Pan Drain Plug
Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil pan drain plug (1)
4. Allow the oil to drain completely.

CAUTION: **Refer to Component Fastener Tightening Caution .**

NOTE: **Inspect the oil drain plug (1) and ring seal (2), replace only if damaged.**

5. Install the oil pan drain plug (1) Tighten 25 N.m (18 lb ft).

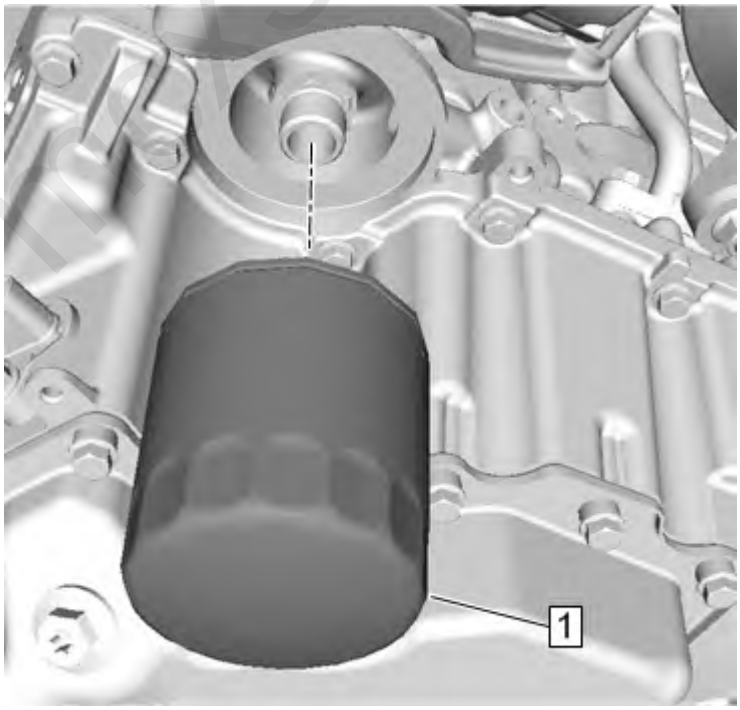


Fig. 279: Oil Filter
Courtesy of GENERAL MOTORS COMPANY

6. Place the drain pan under the oil filter.
7. Remove and DISCARD the oil filter (1)
8. Ensure that the old oil filter seal has been removed.

Installation Procedure

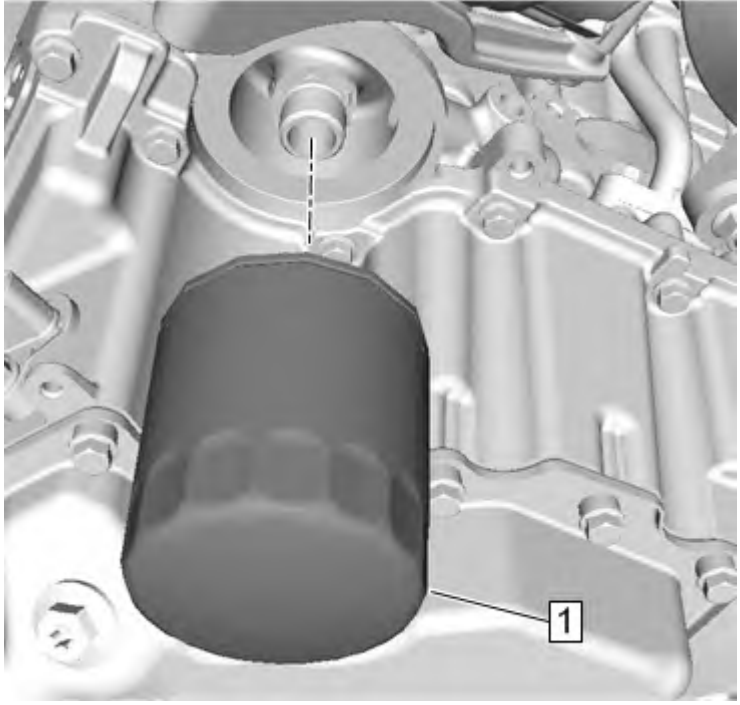


Fig. 280: Oil Filter
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the NEW oil filter gasket with clean engine oil.
2. Install a NEW oil filter and tighten 3/4 to 1 full turn after the gasket makes contact with the sealing surface on the filter mounting flange.
3. Remove the drain pan.
4. Lower the vehicle.
5. Fill the engine oil to the proper level using the appropriate oil type. Approximate Fluid Capacities, Adhesives, Fluids, Lubricants, and Sealers
6. Start the engine and inspect for leaks.

OIL PUMP FLOW CONTROL SOLENOID VALVE REPLACEMENT

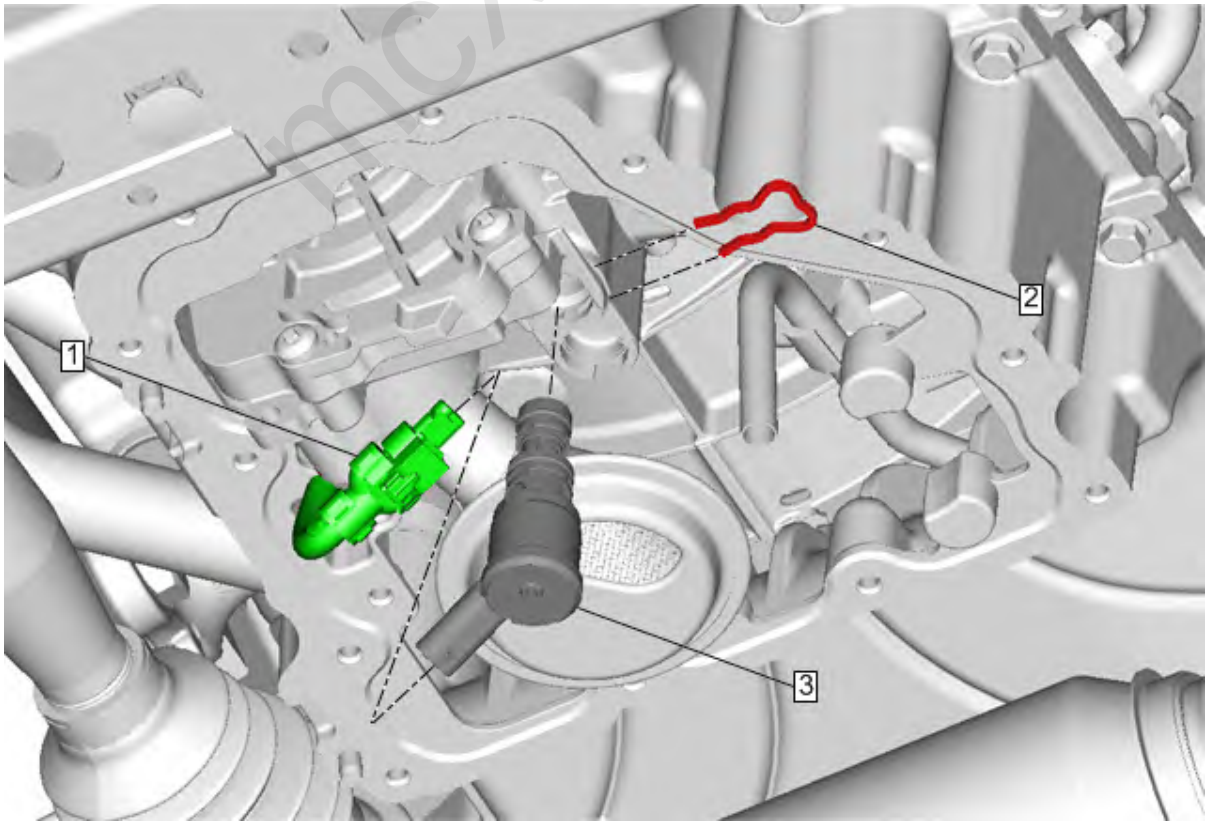


Fig. 281: Oil Pump Flow Control Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Lower Oil Pan Replacement	
1	Oil Pump Flow Control Solenoid Valve Electrical Connector
2	Oil Pump Flow Control Solenoid Valve Retainer **Procedure** Using a suitable tool, remove the retainer.
3	Oil Pump Flow Control Solenoid Valve

OIL PUMP DRIVE CHAIN REPLACEMENT

Removal Procedure

1. Remove Oil Pump Drive Chain Tensioner Replacement
2. Remove Camshaft Timing Chain Replacement
3. Remove Oil Pump Replacement.

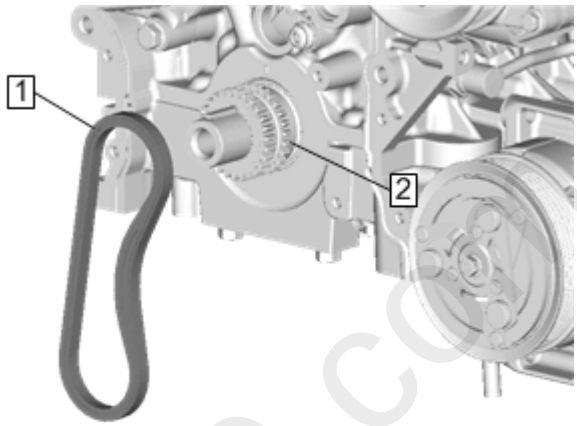


Fig. 282: Oil Pump Drive Chain And Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

4. Remove the oil pump drive chain (1) from the crankshaft sprocket (2).

Installation Procedure

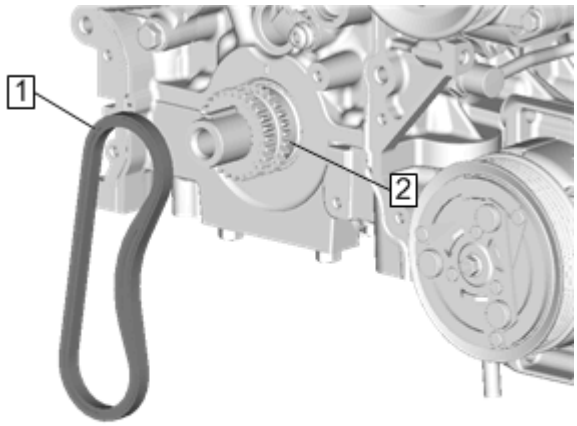


Fig. 283: Oil Pump Drive Chain And Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

1. Install the oil pump drive chain (1) onto the crankshaft sprocket (2).

mcx30.com

2. Install **Oil Pump Replacement**.
3. Install **Oil Pump Drive Chain Tensioner Replacement**.
4. Install **Camshaft Timing Chain Replacement**.

OIL PUMP DRIVE CHAIN TENSIONER REPLACEMENT

Removal Procedure

1. Remove **Engine Front Cover Replacement**

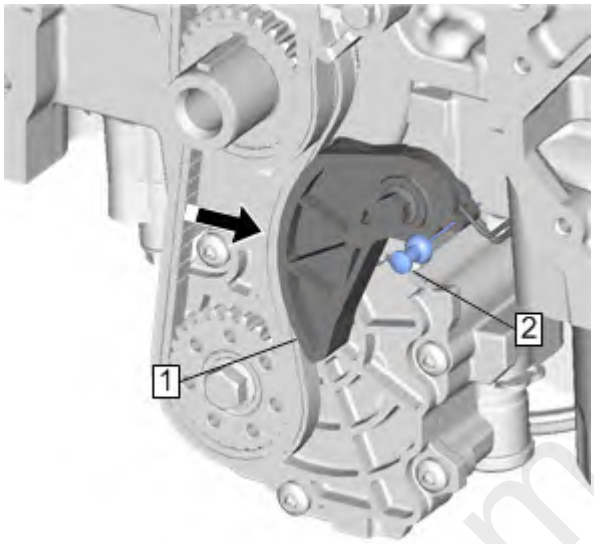


Fig. 284: Pushing Oil Pump Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

2. Push the oil pump drive chain tensioner (1) in direction of arrow.
3. Lock the tensioner using a suitable tool (2).

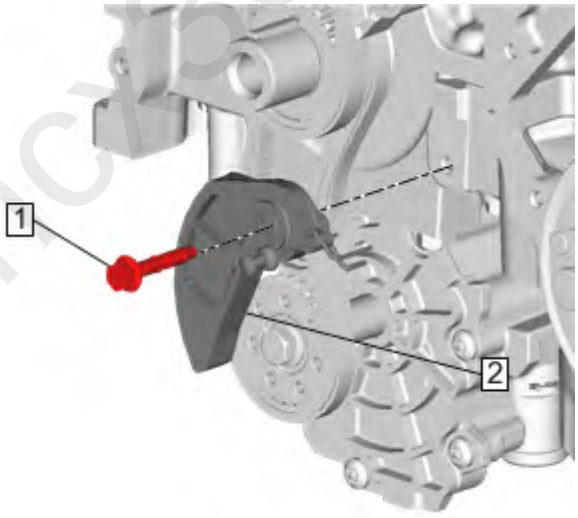


Fig. 285: Oil Pump Drive Chain Tensioner And Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the oil pump drive chain tensioner bolt (1).
5. Remove the oil pump drive chain tensioner (2).

Installation Procedure

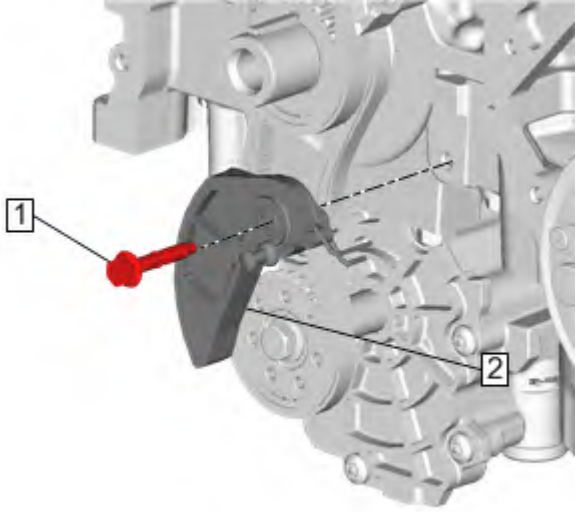


Fig. 286: Oil Pump Drive Chain Tensioner And Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the tensioner spring is retained in the correct position prior to installation.**

1. Install the oil pump drive chain tensioner (2).

CAUTION: **Refer to Fastener Caution .**

2. Install the oil pump drive chain tensioner bolt (1) and tighten to 10 N.m (89 lb in).

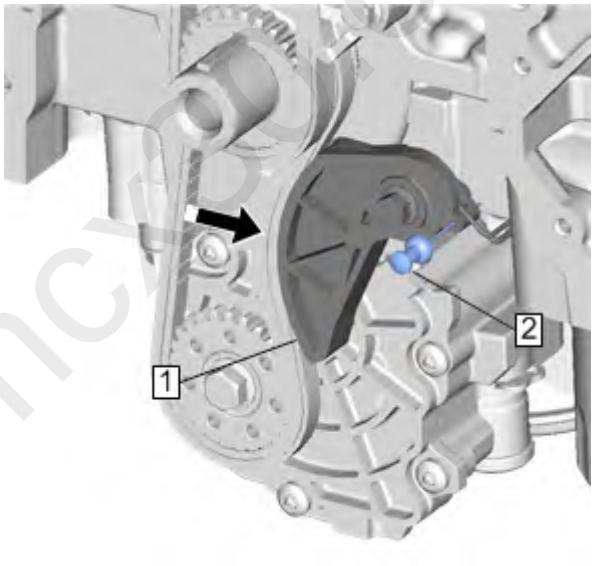


Fig. 287: Pushing Oil Pump Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

3. Remove the suitable tool (2) from the oil pump drive chain tensioner (1).
4. Install Engine Front Cover Replacement.

OIL PUMP REPLACEMENT

Removal Procedure

1. Remove Upper Oil Pan Replacement

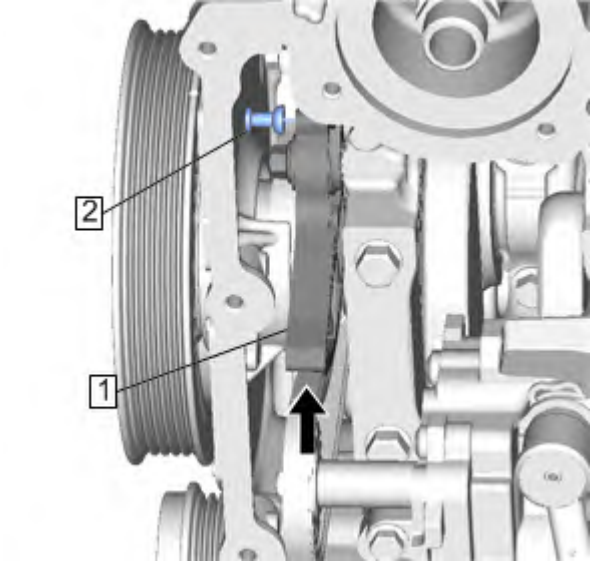


Fig. 288: Unlocking Tensioner
Courtesy of GENERAL MOTORS COMPANY

2. Push the oil pump drive chain tensioner (1) in direction of arrow.
3. Lock the tensioner using a suitable tool (2).
4. If replacing the oil pump, remove the oil pump flow control solenoid valve. **Oil Pump Flow Control Solenoid Valve Replacement**

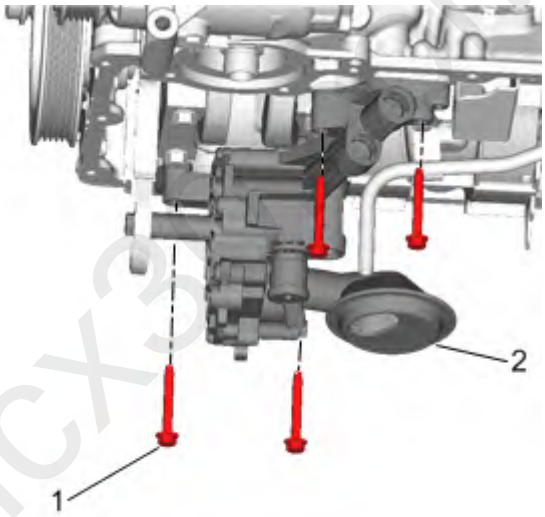


Fig. 289: Oil Pump Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: **It may be necessary to leave one fastener in the pump assembly to secure the pump prior to removing it from the engine.**

5. Remove all EXCEPT one of the oil pump fasteners (1) securing the oil pump (2).

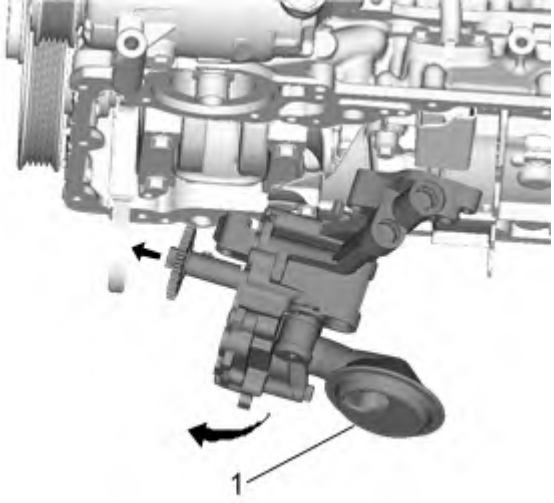


Fig. 290: Oil Pump
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The last oil pump fastener should be removed while simultaneously tilting the pump in the direction of the arrow.**

6. Remove the remaining oil pump fastener.
7. Remove the oil pump (1).

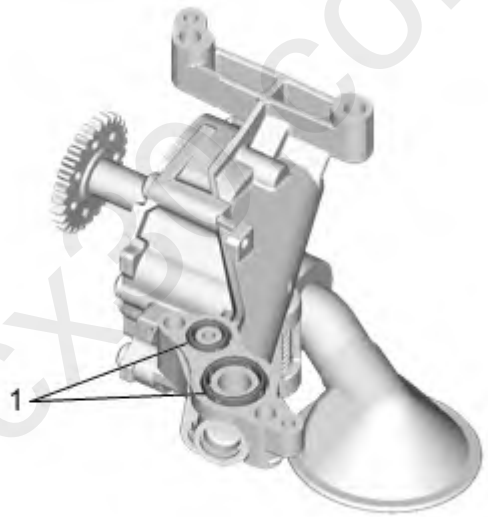


Fig. 291: Oil Pump Seals
Courtesy of GENERAL MOTORS COMPANY

8. Remove and DISCARD the oil pump seals (1).

Installation Procedure

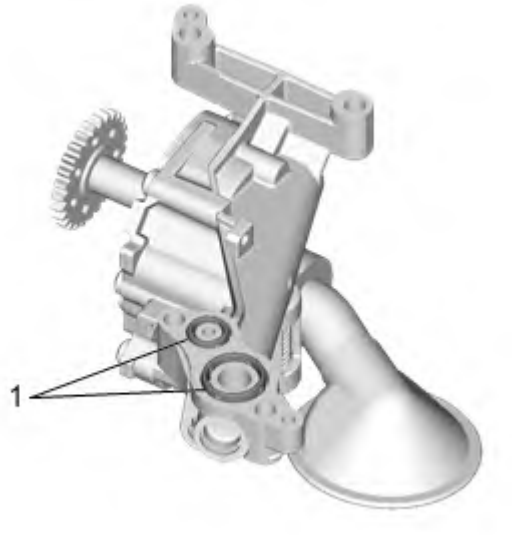


Fig. 292: Oil Pump Seals
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW oil pump seals (1).

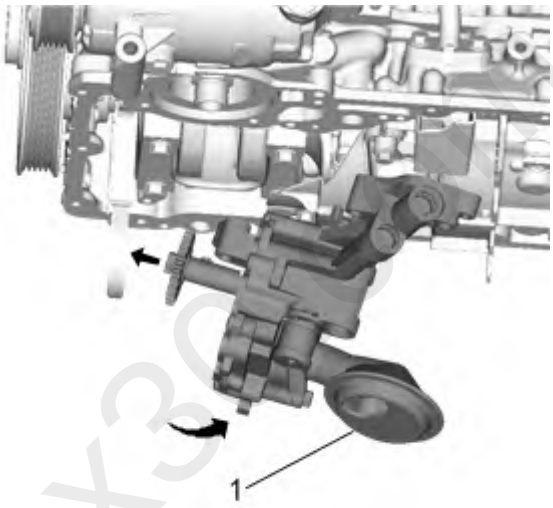


Fig. 293: Oil Pump Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Tilt the oil pump assembly (1) in order to install the drive chain over the oil pump shaft sprocket.

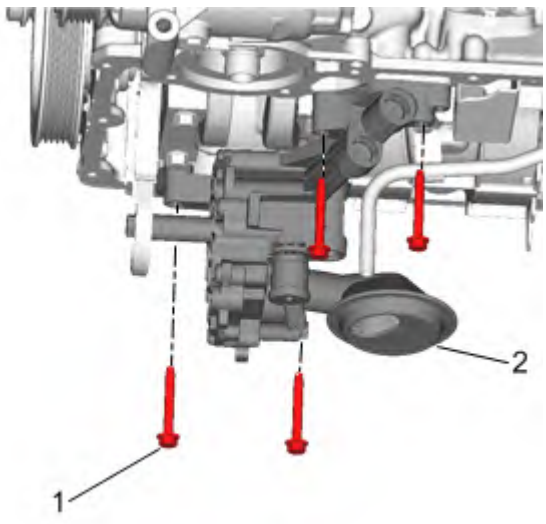


Fig. 294: Oil Pump Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

NOTE: **Ensure the oil pump assembly (2) is properly positioned. The fasteners should only be installed and tightened after the drive chain is correctly positioned on the sprocket.**

3. Install the oil pump fasteners (1). Tighten to 10 N.m (89 lb in)
4. If replacing the oil pump, install the oil pump flow control solenoid valve. **Oil Pump Flow Control Solenoid Valve Replacement**

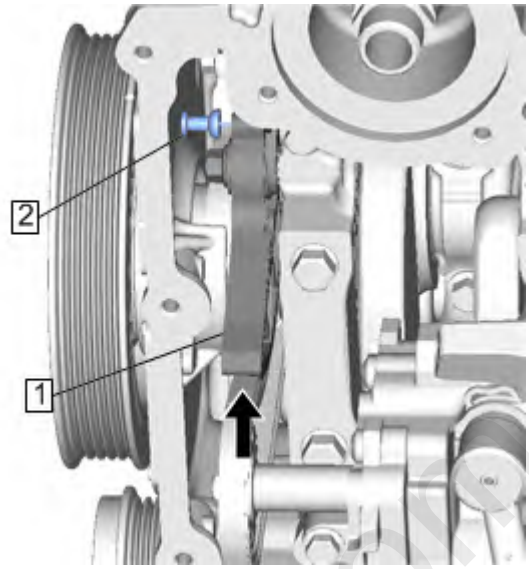


Fig. 295: Unlocking Tensioner
Courtesy of GENERAL MOTORS COMPANY

5. Remove the suitable tool (2) to unlock the tensioner (1).
6. Install **Upper Oil Pan Replacement**.

ENGINE REPLACEMENT (ALL WHEEL DRIVE)

Special Tools

- **BO-38185** Hose Clamp Pliers

Equivalent regional tools:**Special Tools**

Removal Procedure

1. Relieve the fuel system pressure. **Fuel Pressure Relief**

mcx30.com

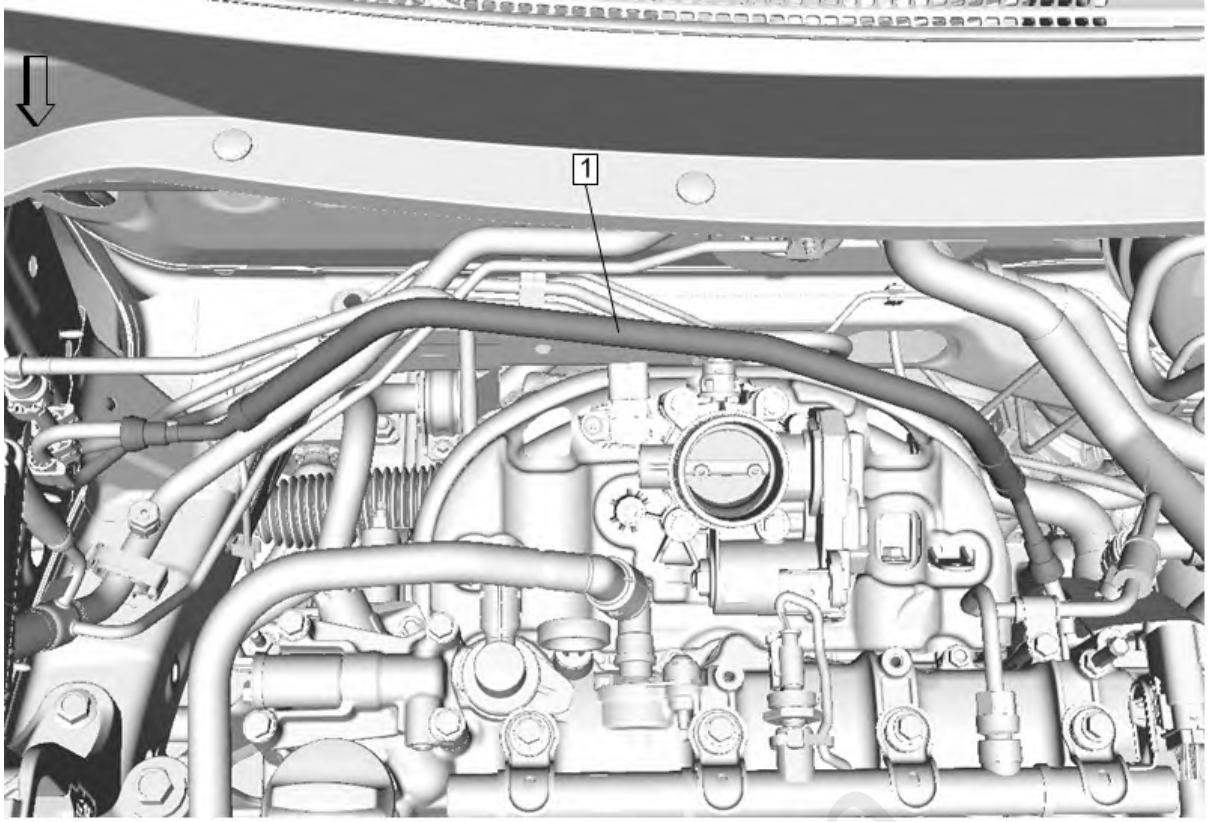


Fig. 296: Fuel Feed Front Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Fuel Feed Front Pipe (1) @ Engine **Fuel Feed Front Pipe Replacement**
3. Recover the refrigerant. **Refrigerant Recovery and Recharging (R-134a)** **Refrigerant Recovery and Recharging (R-1234yf)**

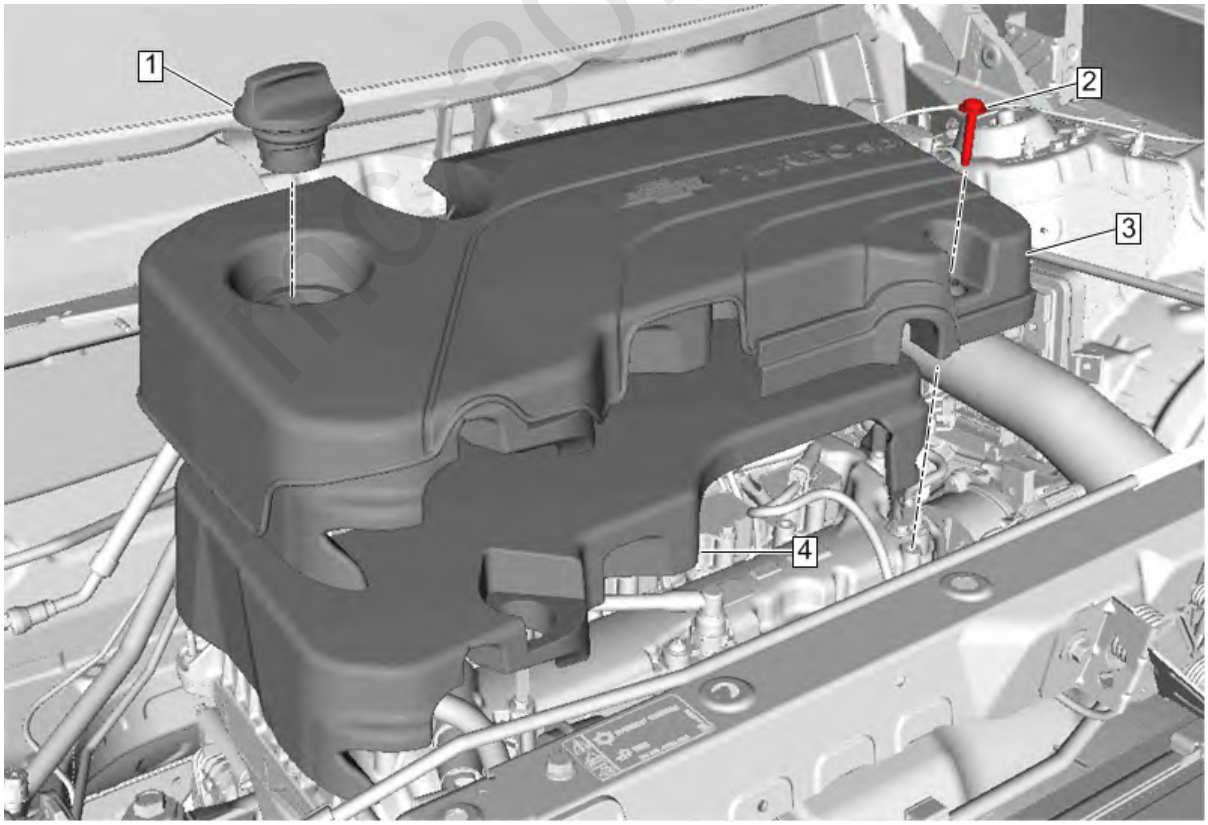


Fig. 297: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

4. Remove Intake Manifold Cover (3) - **Intake Manifold Cover Replacement**
5. Remove Charge Air Cooler Inlet Air Tube - **Charge Air Cooler Inlet Air Tube Replacement**
6. Remove Charge Air Cooler Outlet Air Tube - **Charge Air Cooler Outlet Air Tube Replacement**
7. Remove Air Cleaner Assembly - **Air Cleaner Assembly Replacement**

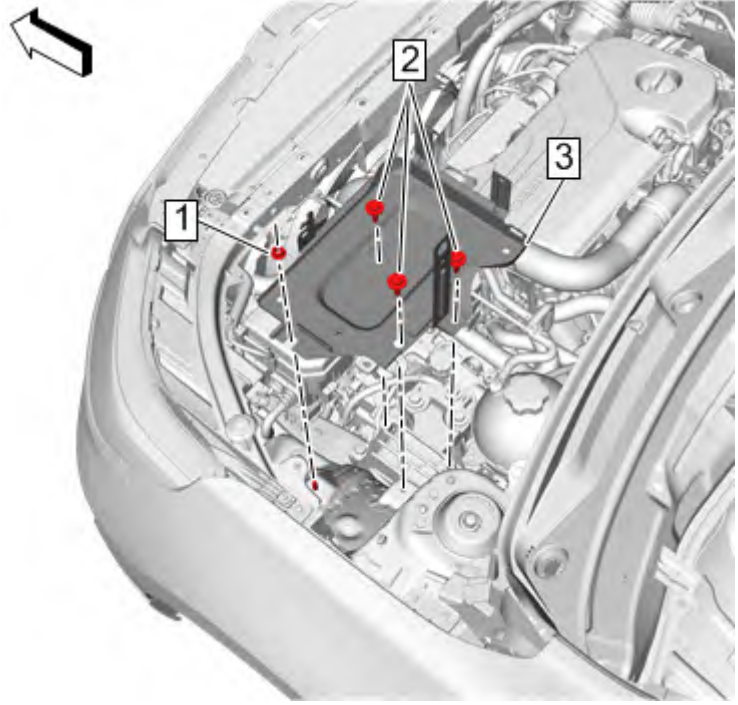


Fig. 298: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

8. Remove Battery Tray (3)**Battery Tray Replacement**
9. Remove Radiator Inlet Hose - **Radiator Inlet Hose Replacement (LYX)**
10. Remove Radiator Outlet Hose - **Radiator Outlet Hose Replacement (LYX)**

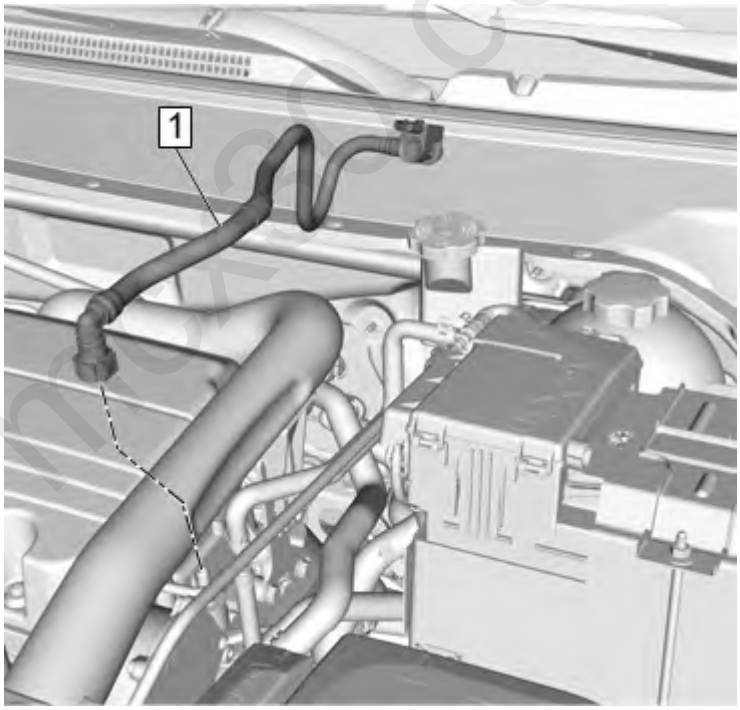


Fig. 299: Power Brake Booster Vacuum Pipe
Courtesy of GENERAL MOTORS COMPANY

11. Remove Power Brake Booster Vacuum Pipe (1)**Power Brake Booster Vacuum Pipe Replacement (LYX)**
12. Remove Heater Inlet Hose - **Heater Inlet Hose Replacement (LYX AWD without KL9)** **Heater Inlet Hose Replacement (LYX with KL9)**
13. Remove Heater Outlet Hose - **Heater Outlet Hose Replacement (LYX without KL9)**

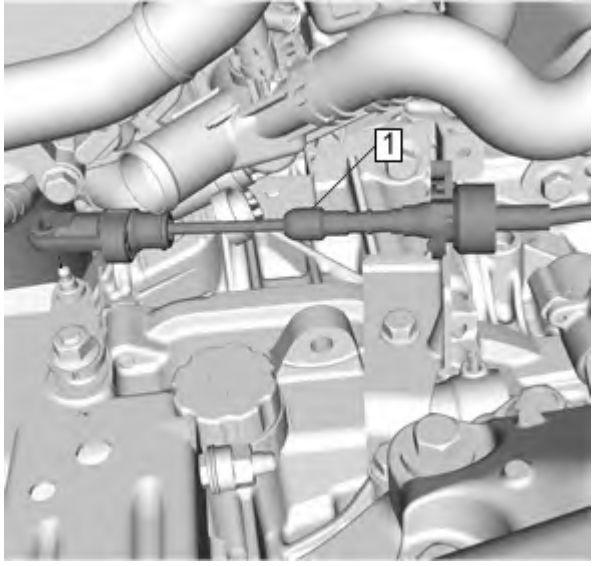


Fig. 300: Range Selector Lever Cable
Courtesy of GENERAL MOTORS COMPANY

14. Disconnect Range Selector Lever Cable (1) @Transmission - **Range Selector Lever Cable Replacement**
15. Remove Underbody Front Air Deflector -**Underbody Front Air Deflector Replacement (Equinox)** **Underbody Front Air Deflector Replacement (Terrain)**
16. Remove Exhaust Front Pipe - **Exhaust Front Pipe Replacement (LYX)**
17. Disconnect Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose@Air Conditioning Compressor - **Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose Replacement (LYX)**

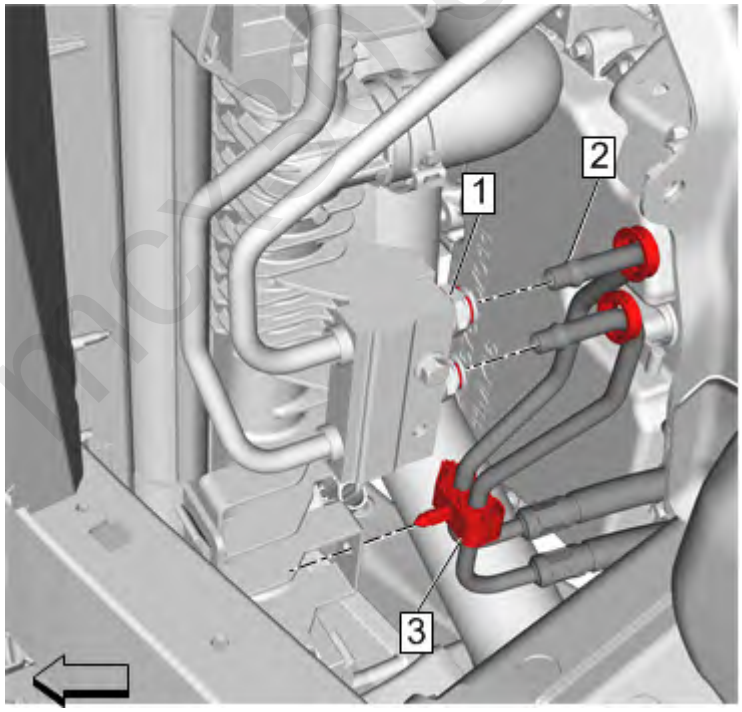


Fig. 301: Transmission Fluid Cooler Inlet and Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

18. Disconnect Transmission Fluid Cooler Inlet and Outlet Pipe@Radiator Assembly - **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (MNH, MHG)** **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (M3D, M3H, M3U)**
19. Remove Front Wheel Drive Half Shaft-Left Side - **Front Wheel Drive Half Shaft Replacement - Left Side**
20. Remove Front Wheel Drive Half Shaft-Right Side - **Front Wheel Drive Half Shaft Replacement - Right Side (AWD)** **Front Wheel Drive Half Shaft Replacement - Right Side (M3U, MHG, MNH, MNK with FWD)** **Front Wheel Drive Half Shaft Replacement - Right Side (M3D, M3H with FWD)**

21. Remove Propeller Shaft -**Two-Piece Propeller Shaft Replacement**

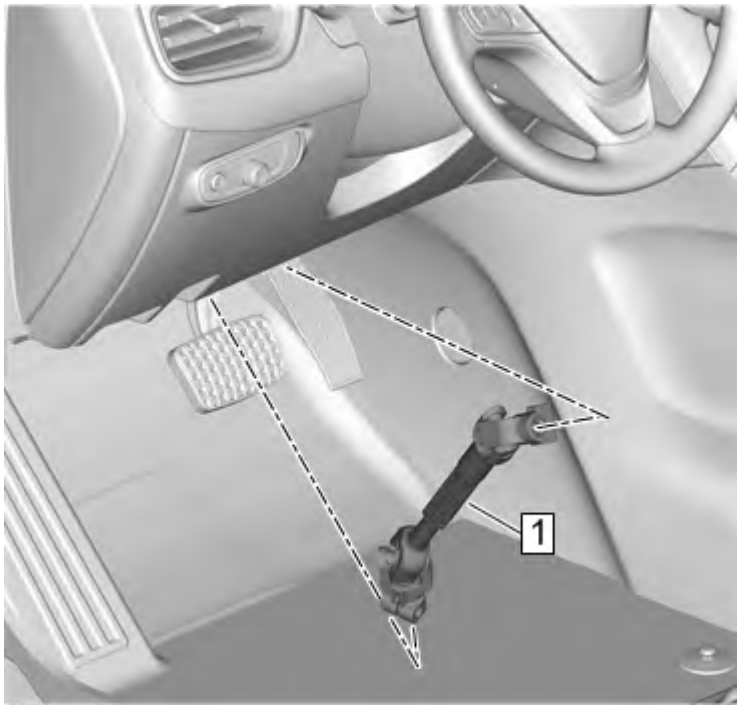


Fig. 302: Intermediate Steering Shaft
Courtesy of GENERAL MOTORS COMPANY

22. Remove Intermediate Steering Shaft - **Intermediate Steering Shaft Replacement (Equinox)** **Intermediate Steering Shaft Replacement (Terrain)**

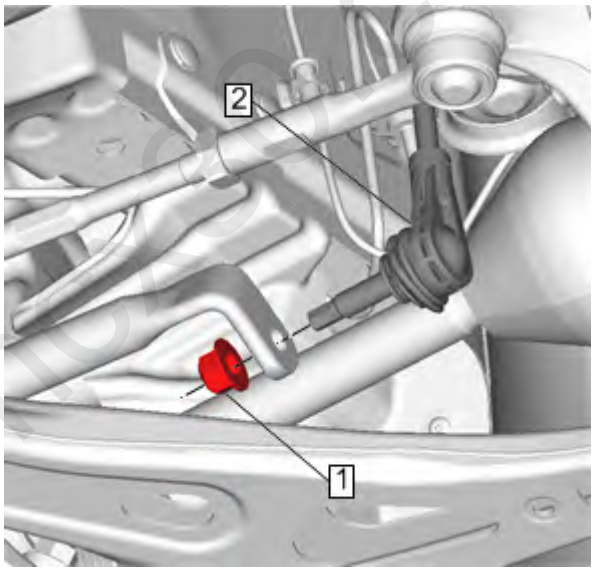


Fig. 303: Stabilizer Link Nuts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Right side shown, left side is similar.**

23. Remove left and right side the stabilizer link nuts (1) then disconnect the links at the stabilizer. **Stabilizer Shaft Link Replacement (Equinox)** **Stabilizer Shaft Link Replacement (Terrain)**

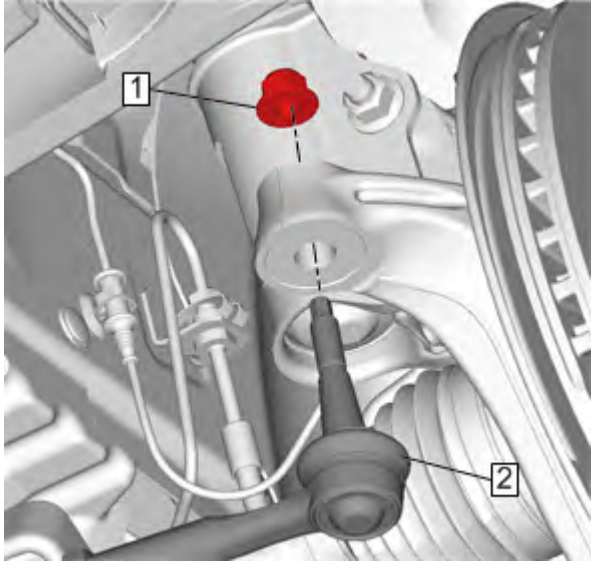


Fig. 304: Tie Rods And Nuts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Right side shown, left side is similar.**

24. Remove the left and right side tie rod nuts (1), then disconnect the tie rods (2) from the steering knuckles. **Steering Linkage Outer Tie Rod Replacement**

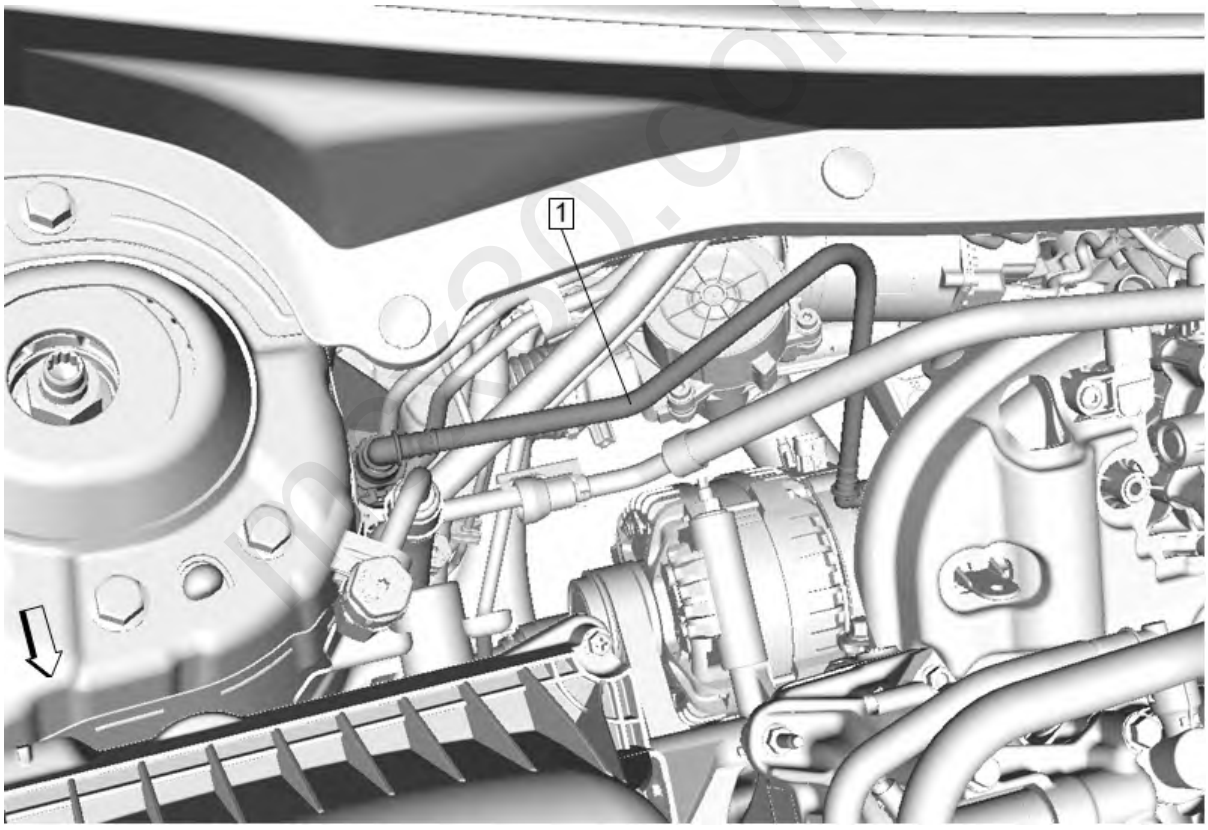


Fig. 305: Evaporative Emission Front Hose
Courtesy of GENERAL MOTORS COMPANY

25. Remove Evaporative Emission Front Hose - **Evaporative Emission Front Hose Replacement**
26. Position a suitable engine table or equivalent under the cradle to support the cradle and powertrain.

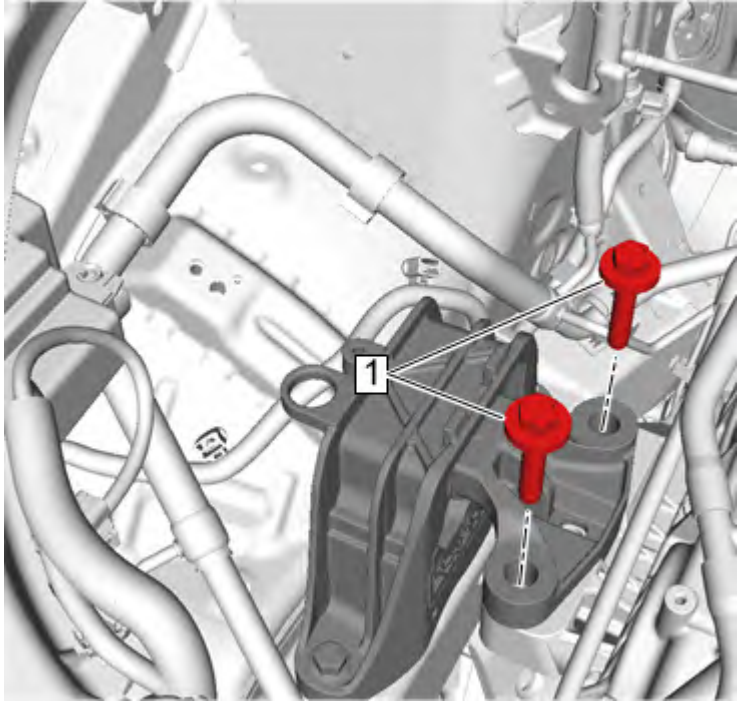


Fig. 306: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

27. Remove Engine Mount Fastener - and DISCARD - **Engine Mount Replacement**

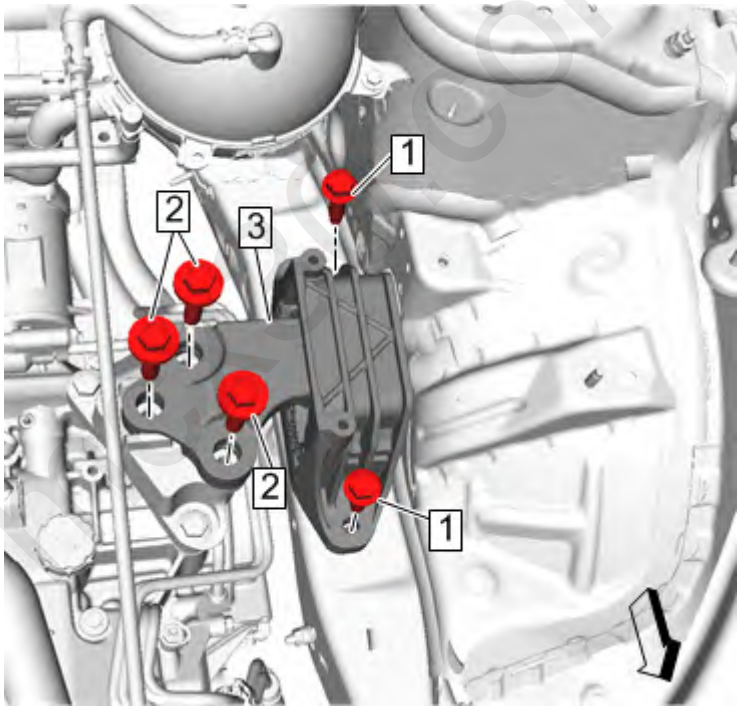


Fig. 307: Transmission Mount Bolts And Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: **ONLY the fasteners (2) should be removed and DISCARDED**

28. Remove Transmission Mount Fastener (2) and DISCARD [3x] - **Transmission Mount Replacement - Left Side**

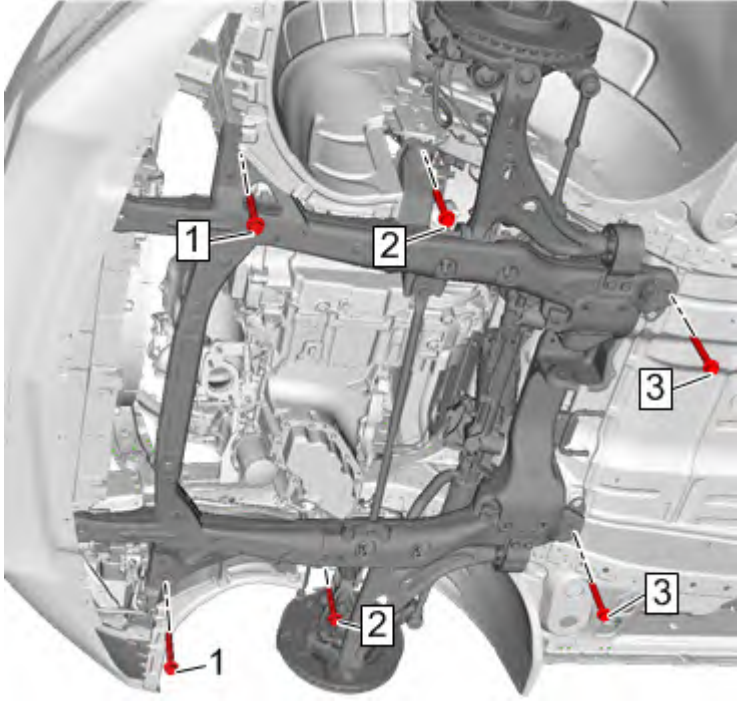


Fig. 308: Front Cradle Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Use a suitable device to hold the cradle while removing the fasteners.**

NOTE: **Remove ONLY the body to frame bolts as the powertrain will be removed while still bolted to the frame.**

29. Remove bolts necessary to remove the cradle (1) (2) and (3). **Drivetrain and Front Suspension Cradle Replacement (Front Wheel Drive)** **Drivetrain and Front Suspension Cradle Replacement (All Wheel Drive)**
30. Disconnect electrical connections and reposition harnesses as needed.
31. Carefully lower the engine table and raise the body on the hoist until the engine/transaxle and frame are separated from the vehicle.
32. Separate the engine from the transmission. **Transmission Replacement (Front Wheel Drive except Diesel Engine)** **Transmission Replacement (All Wheel Drive except Diesel Engine)** **Transmission Replacement (All Wheel Drive with Diesel Engine, Equinox)** **Transmission Replacement (Front Wheel Drive with Diesel Engine)** **Transmission Replacement (All Wheel Drive with Diesel Engine, Terrain)**
33. Install the engine to a suitable engine stand.

Installation Procedure

1. Install the transmission to the engine. **Transmission Replacement (Front Wheel Drive except Diesel Engine)** **Transmission Replacement (All Wheel Drive except Diesel Engine)** **Transmission Replacement (All Wheel Drive with Diesel Engine, Equinox)** **Transmission Replacement (Front Wheel Drive with Diesel Engine)** **Transmission Replacement (All Wheel Drive with Diesel Engine, Terrain)**
2. Position the powertrain and support table under the vehicle.
3. Raise the powertrain into position under the vehicle.
4. With the table positioned, if required, lower the vehicle over the powertrain.

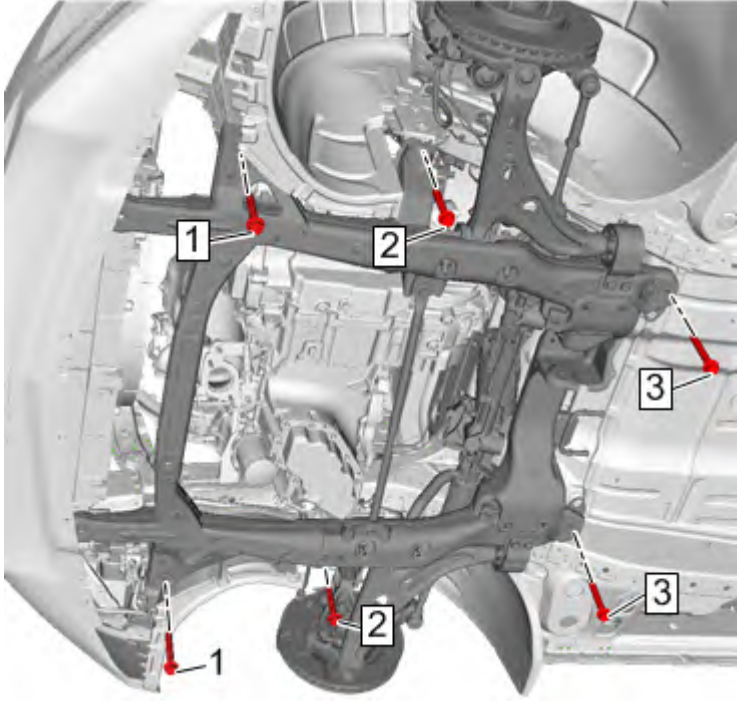


Fig. 309: Front Cradle Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install the previously removed body to frame bolts to secure the frame and powertrain.**

5. Install bolts (1) (2) and frame (3). **Drivetrain and Front Suspension Cradle Replacement (Front Wheel Drive)** **Drivetrain and Front Suspension Cradle Replacement (All Wheel Drive)**

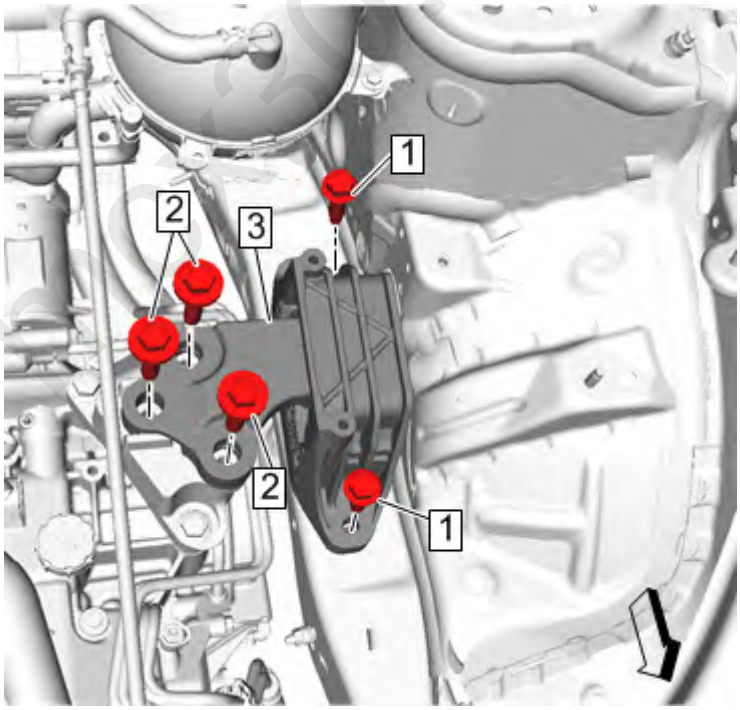


Fig. 310: Transmission Mount Bolts And Fastener
Courtesy of GENERAL MOTORS COMPANY

6. Install Transmission Mount Fastener (2) - [3x] - **Transmission Mount Replacement - Left Side**

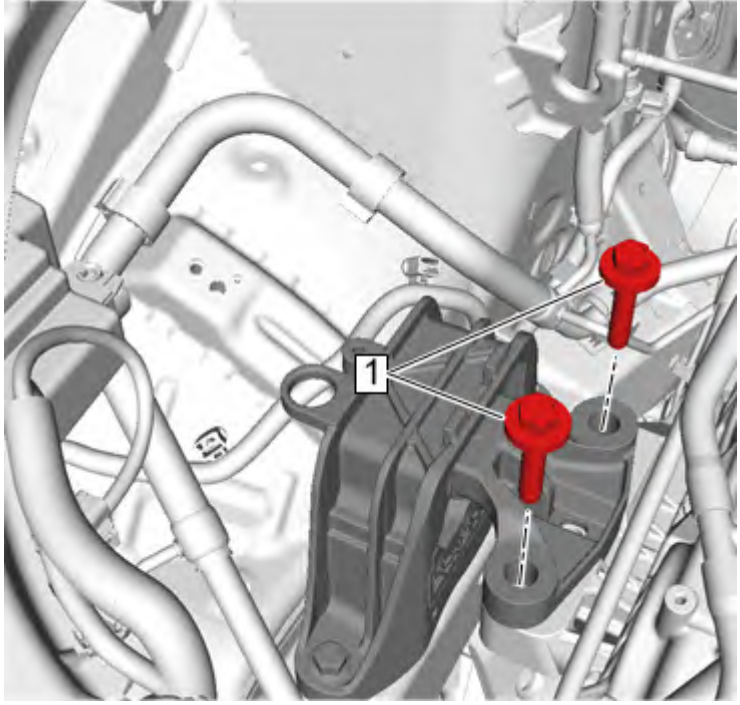


Fig. 311: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **ONLY the fasteners (1) should be removed and DISCARDED**

7. Install NEW Engine Mount Fastener - **Engine Mount Replacement**
8. Remove the suitable engine table or equivalent from under the powertrain and cradle.
9. Install Front Wheel Drive Half Shaft-Left Side - **Front Wheel Drive Half Shaft Replacement - Left Side**
10. Install Front Wheel Drive Half Shaft-Right Side - **Front Wheel Drive Half Shaft Replacement - Right Side (AWD)** **Front Wheel Drive Half Shaft Replacement - Right Side (M3U, MHG, MNH, MNK with FWD)** **Front Wheel Drive Half Shaft Replacement - Right Side (M3D, M3H with FWD)**
11. Install Propeller Shaft - **Two-Piece Propeller Shaft Replacement**

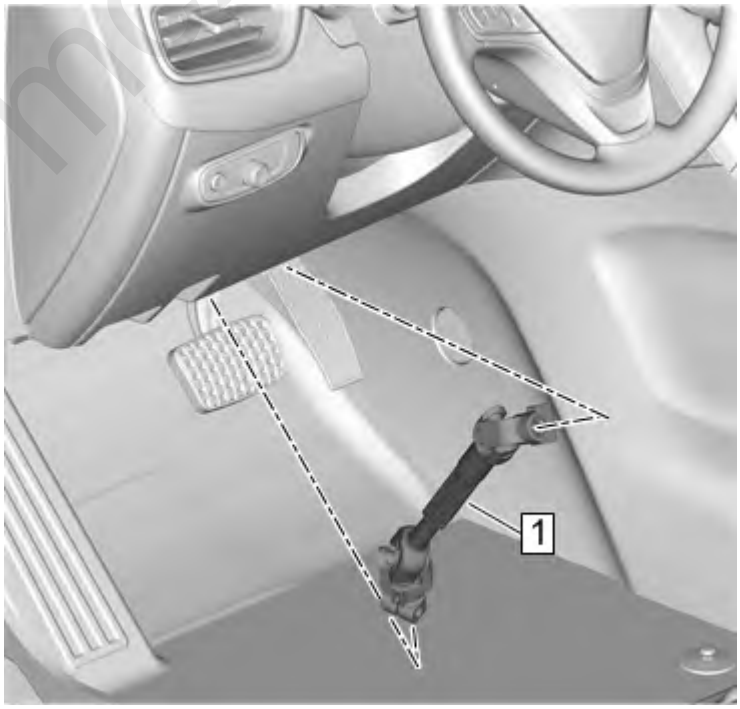


Fig. 312: Intermediate Steering Shaft
Courtesy of GENERAL MOTORS COMPANY

12. Connect Intermediate Steering Shaft@Steering Gear - **Intermediate Steering Shaft Replacement (Equinox)** **Intermediate Steering Shaft Replacement (Terrain)**

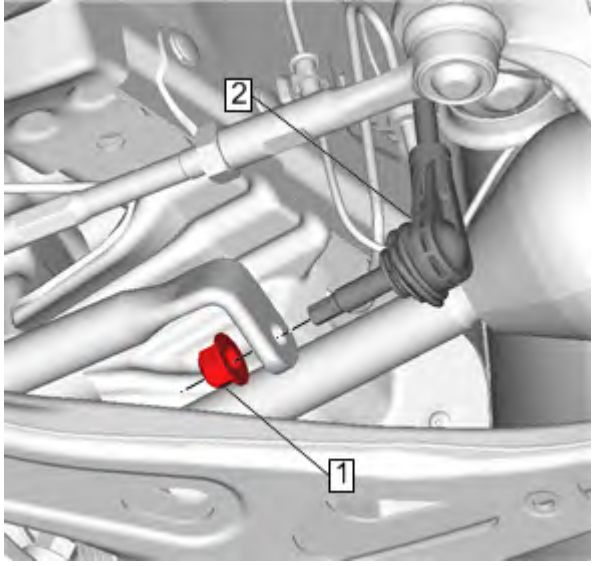


Fig. 313: Stabilizer Link Nuts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Right side shown, left side is similar.**

13. Connect the stabilizer links (2) and install nuts (1). **Stabilizer Shaft Link Replacement (Equinox)** **Stabilizer Shaft Link Replacement (Terrain)**

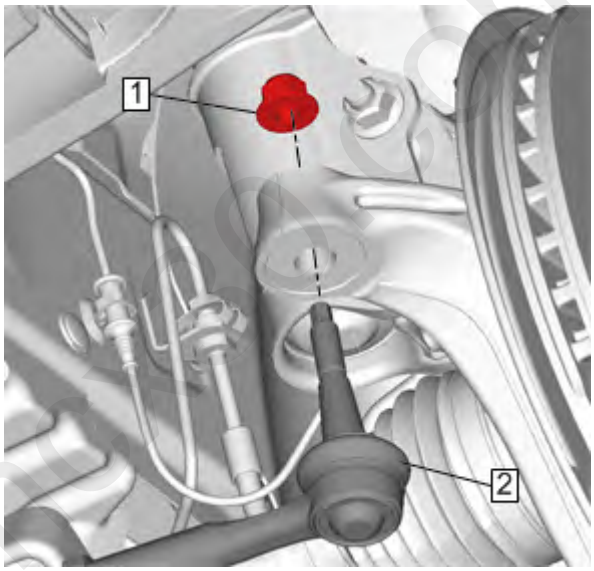


Fig. 314: Tie Rods And Nuts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Right side shown, left side is similar.**

14. Install the tie rod ends (2) then install nuts (1). **Steering Linkage Outer Tie Rod Replacement**

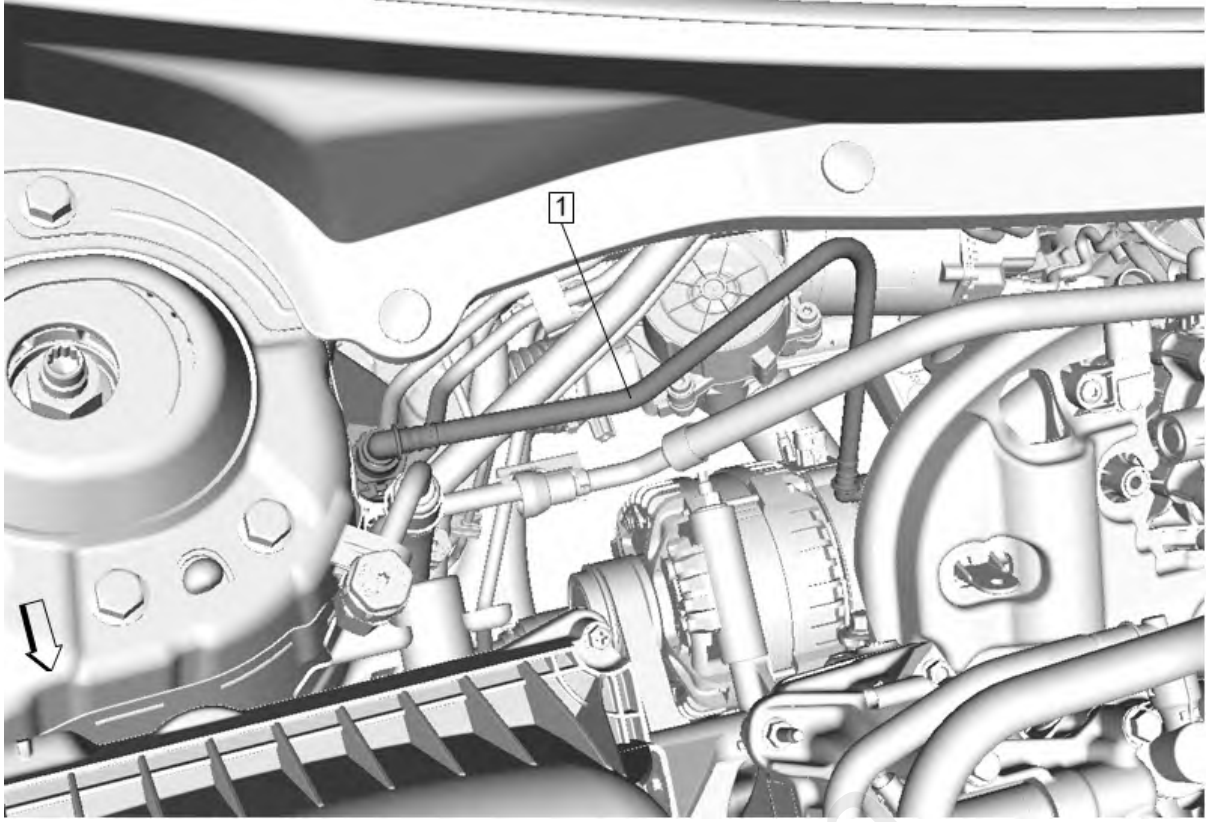


Fig. 315: Evaporative Emission Front Hose
Courtesy of GENERAL MOTORS COMPANY

15. Install Evaporative Emission Front Hose - **Evaporative Emission Front Hose Replacement**

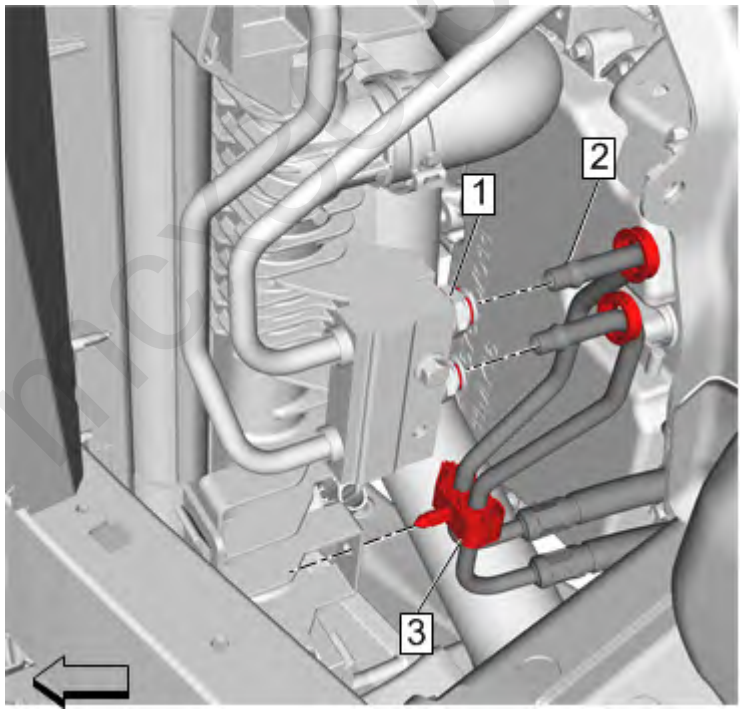


Fig. 316: Transmission Fluid Cooler Inlet and Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

16. Connect Transmission Fluid Cooler Inlet and Outlet Pipe@Radiator Assembly - **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (MNH, MHG)** **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (M3D, M3H, M3U)**
17. Connect Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose@Air Conditioning Compressor - **Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose Replacement (LYX)**

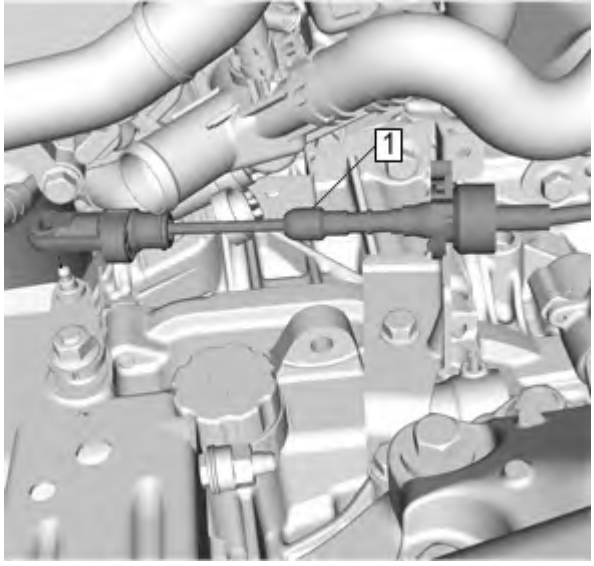


Fig. 317: Range Selector Lever Cable
Courtesy of GENERAL MOTORS COMPANY

18. Connect Range Selector Lever Cable@Transmission - **Range Selector Lever Cable Replacement**
19. Install Heater Inlet Hose - **Heater Inlet Hose Replacement (LYX AWD without KL9)** **Heater Inlet Hose Replacement (LYX with KL9)**
20. Install Heater Outlet Hose - **Heater Outlet Hose Replacement (LYX without KL9)**
21. Install Radiator Inlet Hose - **Radiator Inlet Hose Replacement (LYX)**
22. Install Radiator Outlet Hose - **Radiator Outlet Hose Replacement (LYX)**

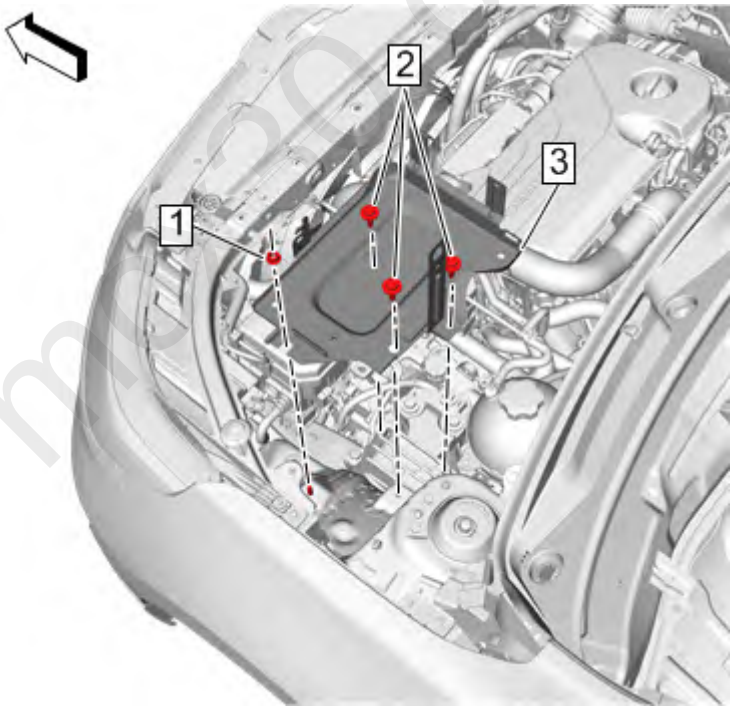


Fig. 318: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

23. Install Battery Tray - **Battery Tray Replacement**

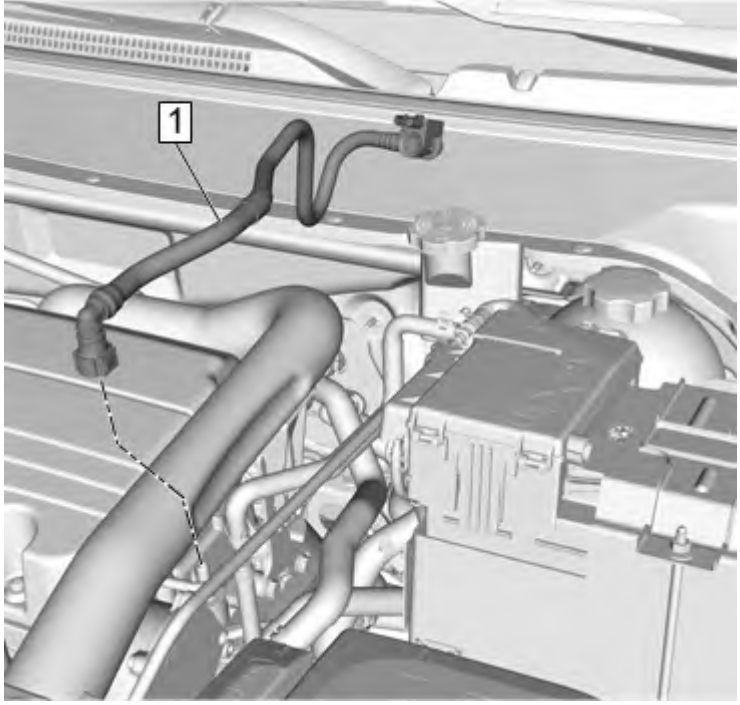


Fig. 319: Power Brake Booster Vacuum Pipe
Courtesy of GENERAL MOTORS COMPANY

24. Install Power Brake Booster Vacuum Pipe - **Power Brake Booster Vacuum Pipe Replacement (LYX)**
25. Install Air Cleaner Assembly - **Air Cleaner Assembly Replacement**

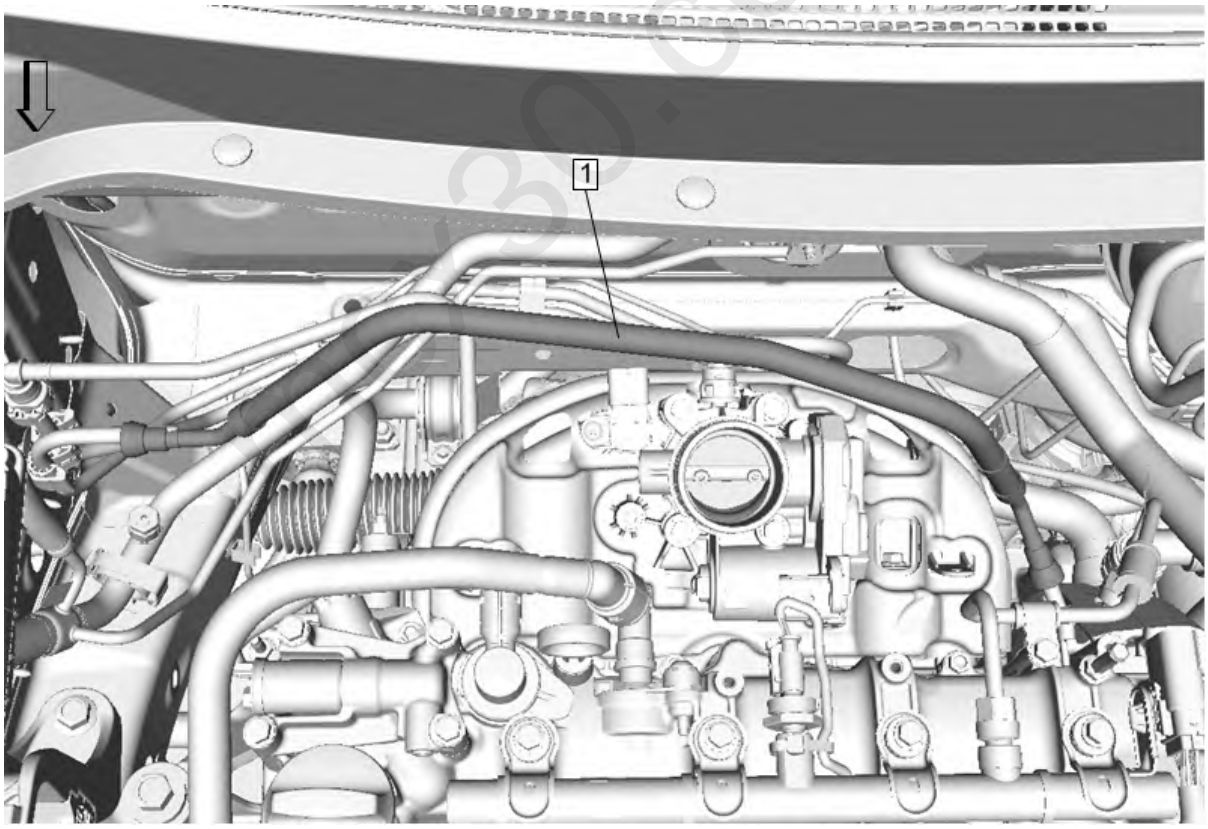


Fig. 320: Fuel Feed Front Pipe
Courtesy of GENERAL MOTORS COMPANY

26. Connect Fuel Feed Front Pipe @ Engine - **Fuel Feed Front Pipe Replacement**
27. Install Charge Air Cooler Outlet Air Tube - **Charge Air Cooler Outlet Air Tube Replacement**
28. Install Exhaust Front Pipe - **Exhaust Front Pipe Replacement (LYX)**
29. Install Underbody Front Air Deflector - **Underbody Front Air Deflector Replacement (Equinox)** **Underbody Front Air Deflector Replacement (Terrain)**
30. Install Charge Air Cooler Inlet Air Tube - **Charge Air Cooler Inlet Air Tube Replacement**

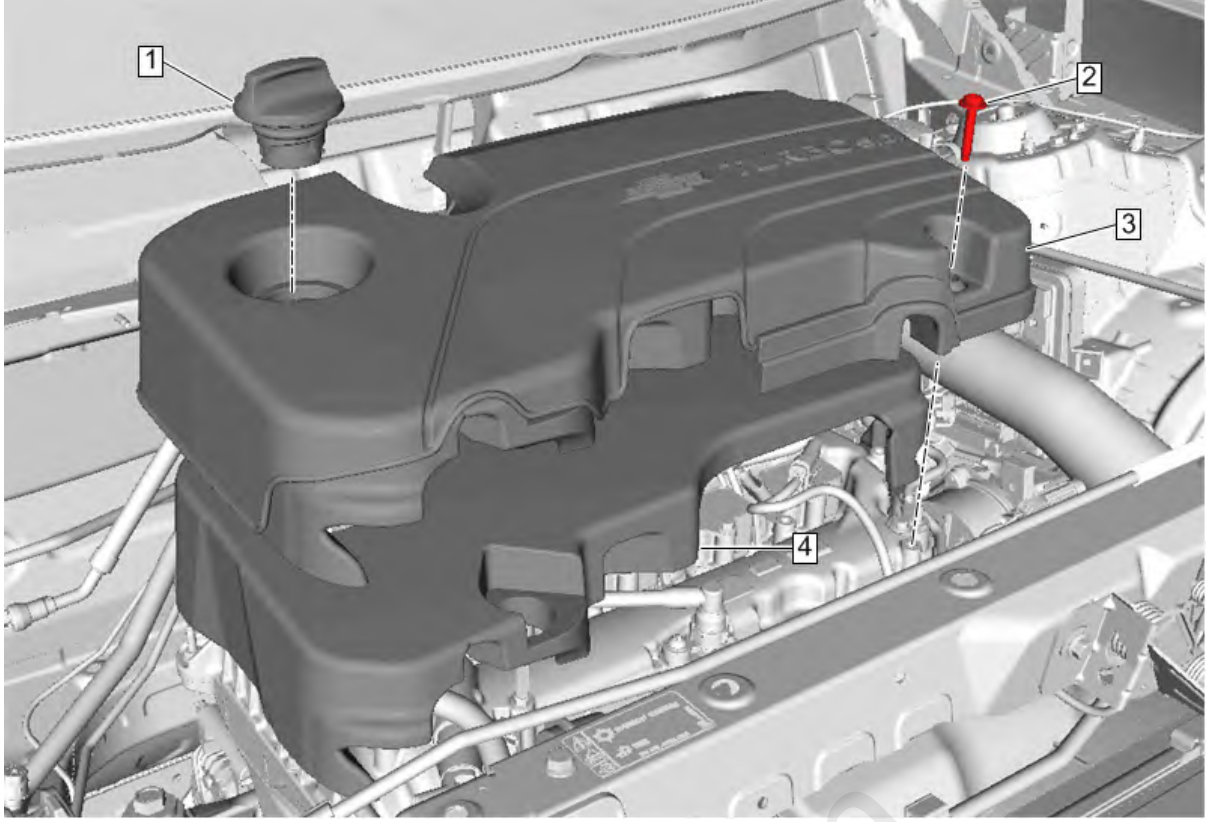


Fig. 321: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

31. Install Intake Manifold Cover - Intake Manifold Cover Replacement
32. Recharge the refrigerant. Refrigerant Recovery and Recharging (R-134a) Refrigerant Recovery and Recharging (R-1234yf)
33. Fill the cooling system to the proper level. Cooling System Draining and Filling (GE 47716) Cooling System Draining and Filling (Static)

NOTE: **Prelube is necessary if the engine is replaced or overhauled.**

34. If the engine is replaced with a new engine or has been overhauled, perform the engine prelubing procedure. Engine Prelubing
35. If the engine has not been replaced or overhauled, check and correct engine oil level as needed. Engine Oil and Oil Filter Replacement
36. Perform the crankshaft position variation learn. Crankshaft Position Variation Learn

ENGINE REPLACEMENT (FRONT WHEEL DRIVE)

Special Tools

- **BO-38185** Hose Clamp Pliers

Equivalent regional tools:Special Tools

Removal Procedure

1. Relieve the fuel system pressure. Fuel Pressure Relief

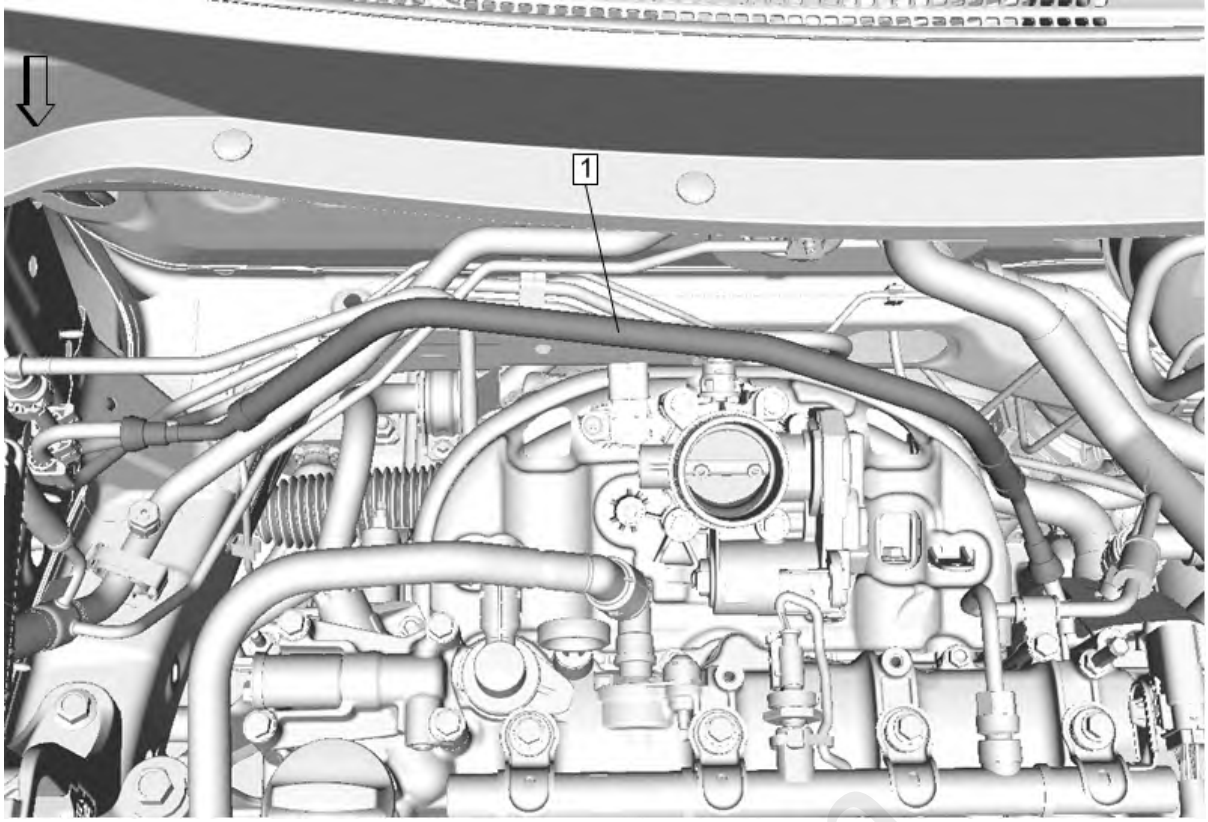


Fig. 322: Fuel Feed Front Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Fuel Feed Front Pipe (1) @ Engine -Fuel Feed Front Pipe Replacement
3. Recover the refrigerant. Refrigerant Recovery and Recharging (R-134a) Refrigerant Recovery and Recharging (R-1234yf)

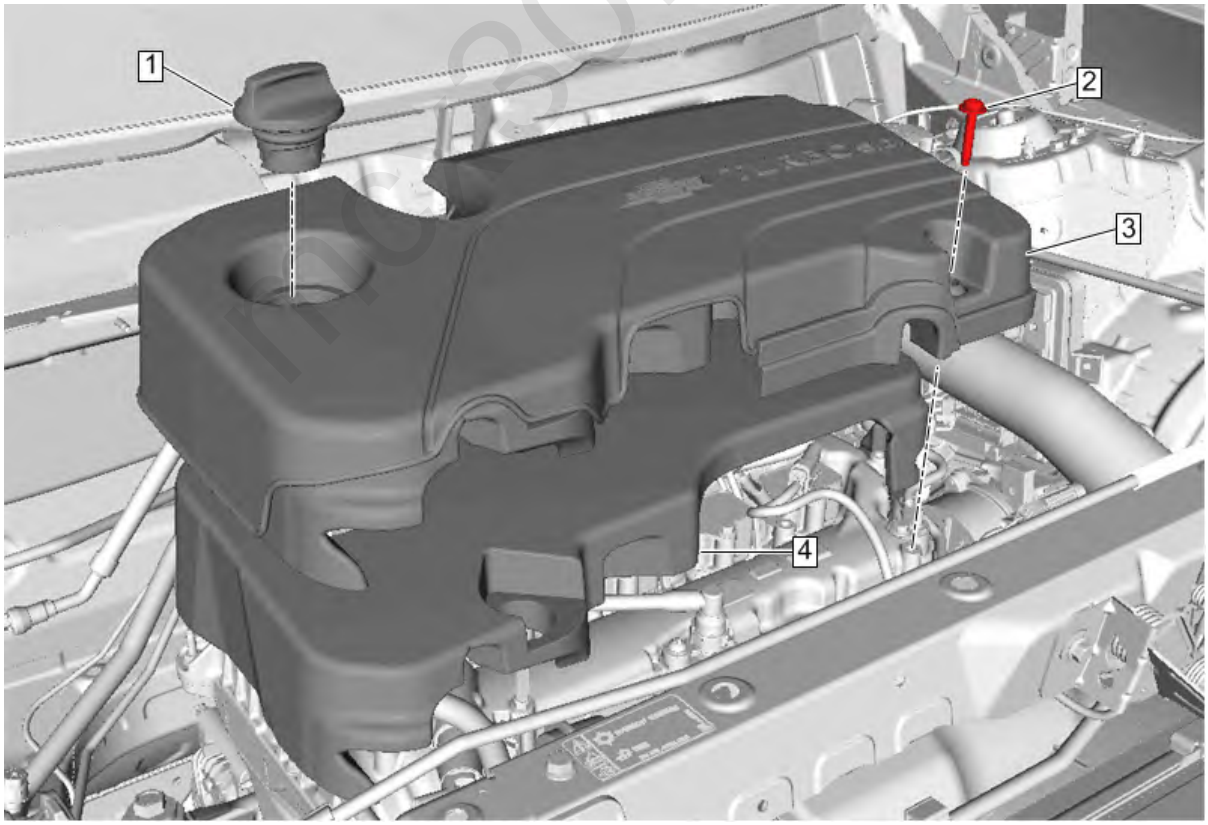


Fig. 323: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

4. Remove Intake Manifold Cover (3)Intake Manifold Cover Replacement
5. Remove Charge Air Cooler Inlet Air Tube - Charge Air Cooler Inlet Air Tube Replacement
6. Remove Charge Air Cooler Outlet Air Tube -Charge Air Cooler Outlet Air Tube Replacement
7. Remove Air Cleaner Assembly Air Cleaner Assembly Replacement

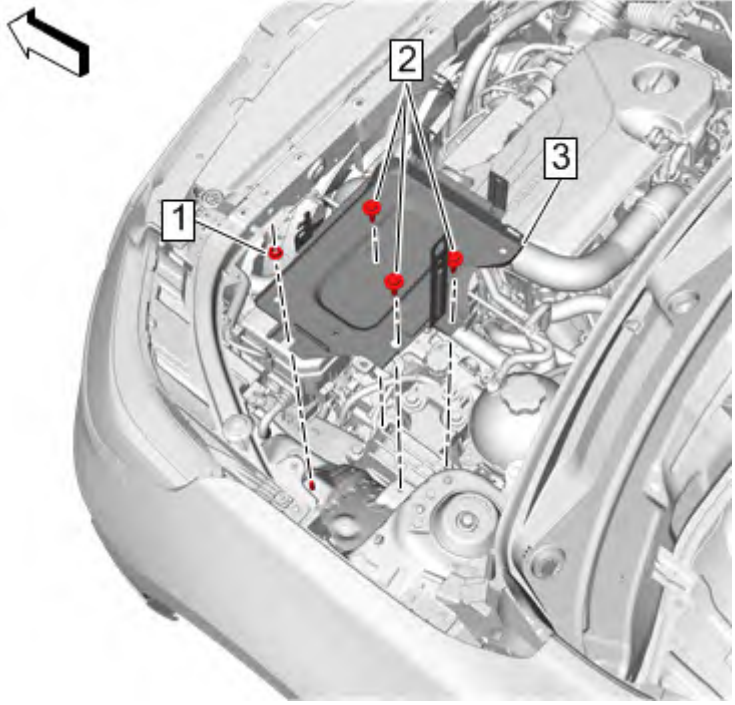


Fig. 324: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

8. Remove Battery Tray (3) **Battery Tray Replacement**
9. Remove Radiator Inlet Hose - **Radiator Inlet Hose Replacement (LYX)**
10. Remove Radiator Outlet Hose -**Radiator Outlet Hose Replacement (LYX)**

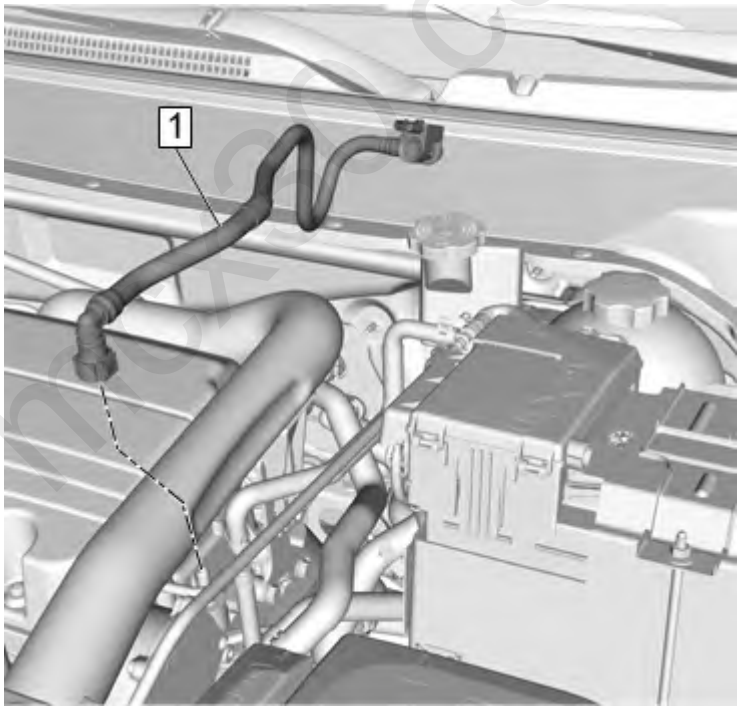


Fig. 325: Power Brake Booster Vacuum Pipe
Courtesy of GENERAL MOTORS COMPANY

11. Remove Power Brake Booster Vacuum Pipe (1) **Power Brake Booster Vacuum Pipe Replacement (LYX)**
12. Remove Heater Inlet Hose - **Heater Inlet Hose Replacement (LYX AWD without KL9)** **Heater Inlet Hose Replacement (LYX with KL9)** **Heater Inlet Hose Replacement (LH7 Terrain)** **Heater Inlet Hose Replacement (LH7 Equinox)** **Heater Inlet Hose Replacement (LTG with KL9)**
13. Remove Heater Outlet Hose -**Heater Outlet Hose Replacement (LYX without KL9)** **Heater Outlet Hose Replacement (LH7)**

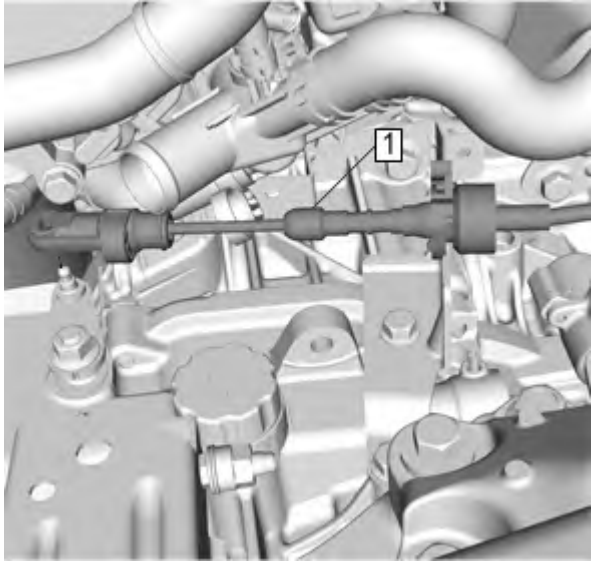


Fig. 326: Range Selector Lever Cable
Courtesy of GENERAL MOTORS COMPANY

14. Disconnect Range Selector Lever Cable (1) @Transmission - **Range Selector Lever Cable Replacement**
15. Remove Underbody Front Air Deflector -**Underbody Front Air Deflector Replacement (Equinox)** **Underbody Front Air Deflector Replacement (Terrain)**
16. Remove Exhaust Front Pipe - **Exhaust Front Pipe Replacement (LYX)**
17. Disconnect Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose@Air Conditioning Compressor - **Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose Replacement (LYX)**

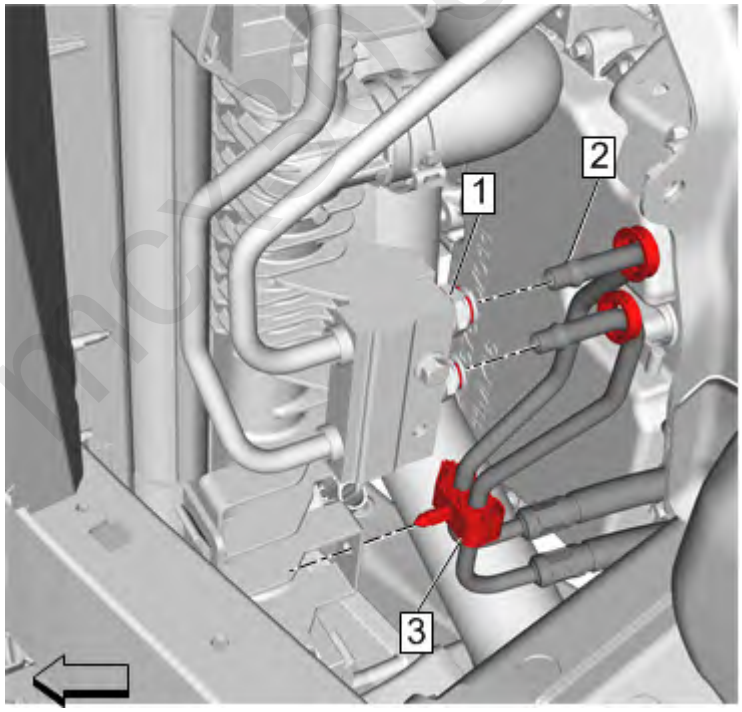


Fig. 327: Transmission Fluid Cooler Inlet and Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

18. Disconnect Transmission Fluid Cooler Inlet and Outlet Pipe@Radiator Assembly - **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (MNH, MHG)** **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (M3D, M3H, M3U)**
19. Disconnect electrical connections and reposition harnesses as needed.
20. Remove Front Wheel Drive Half Shaft-Left Side - **Front Wheel Drive Half Shaft Replacement - Left Side**
21. Remove Front Wheel Drive Half Shaft-Right Side - **Front Wheel Drive Half Shaft Replacement - Right Side (AWD)** **Front Wheel Drive Half Shaft Replacement - Right Side (M3U, MHG,**

MNH, MNK with FWD) Front Wheel Drive Half Shaft Replacement - Right Side (M3D, M3H with FWD)

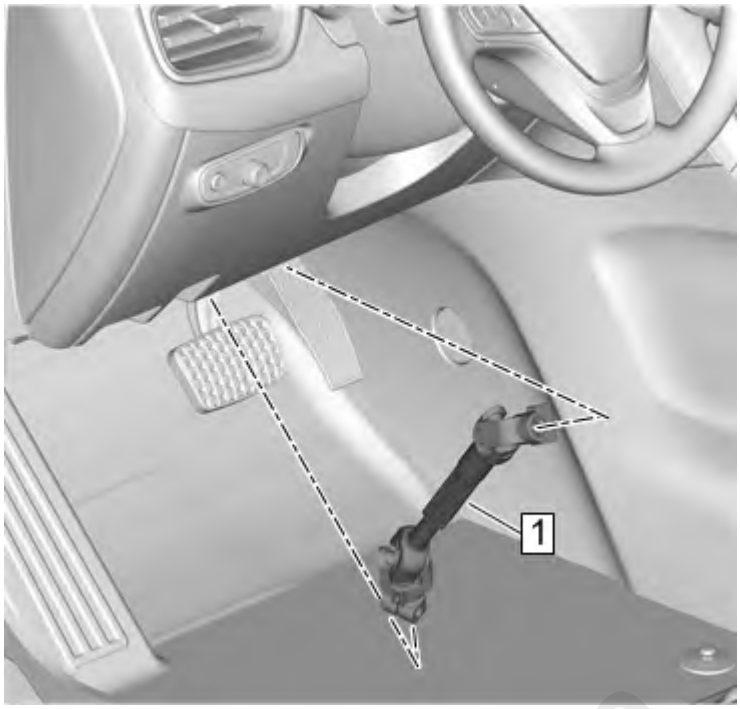


Fig. 328: Intermediate Steering Shaft
Courtesy of GENERAL MOTORS COMPANY

22. Remove Intermediate Steering Shaft (1)Intermediate Steering Shaft Replacement (Equinox) Intermediate Steering Shaft Replacement (Terrain)

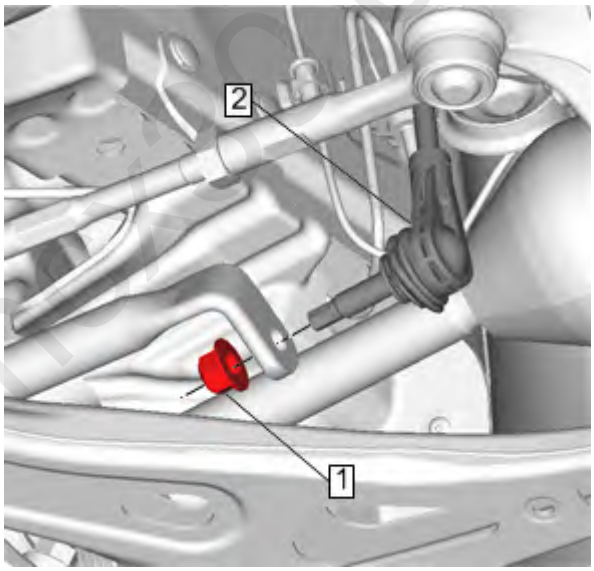


Fig. 329: Stabilizer Link Nuts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Right side shown, left side is similar.**

23. Remove left and right side the stabilizer link nuts (1) then disconnect the links at the stabilizer. Stabilizer Shaft Link Replacement (Equinox) Stabilizer Shaft Link Replacement (Terrain)

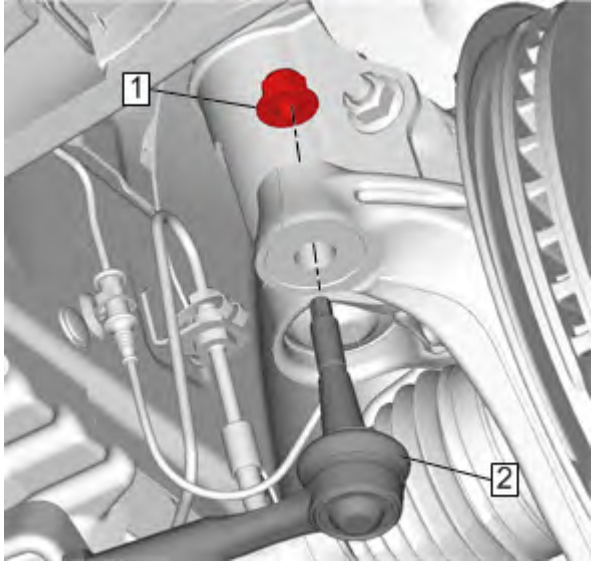


Fig. 330: Tie Rods And Nuts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Right side shown, left side is similar.**

24. Remove the left and right side tie rod nuts (1), then disconnect the tie rods (2) from the steering knuckles. **Steering Linkage Outer Tie Rod Replacement**

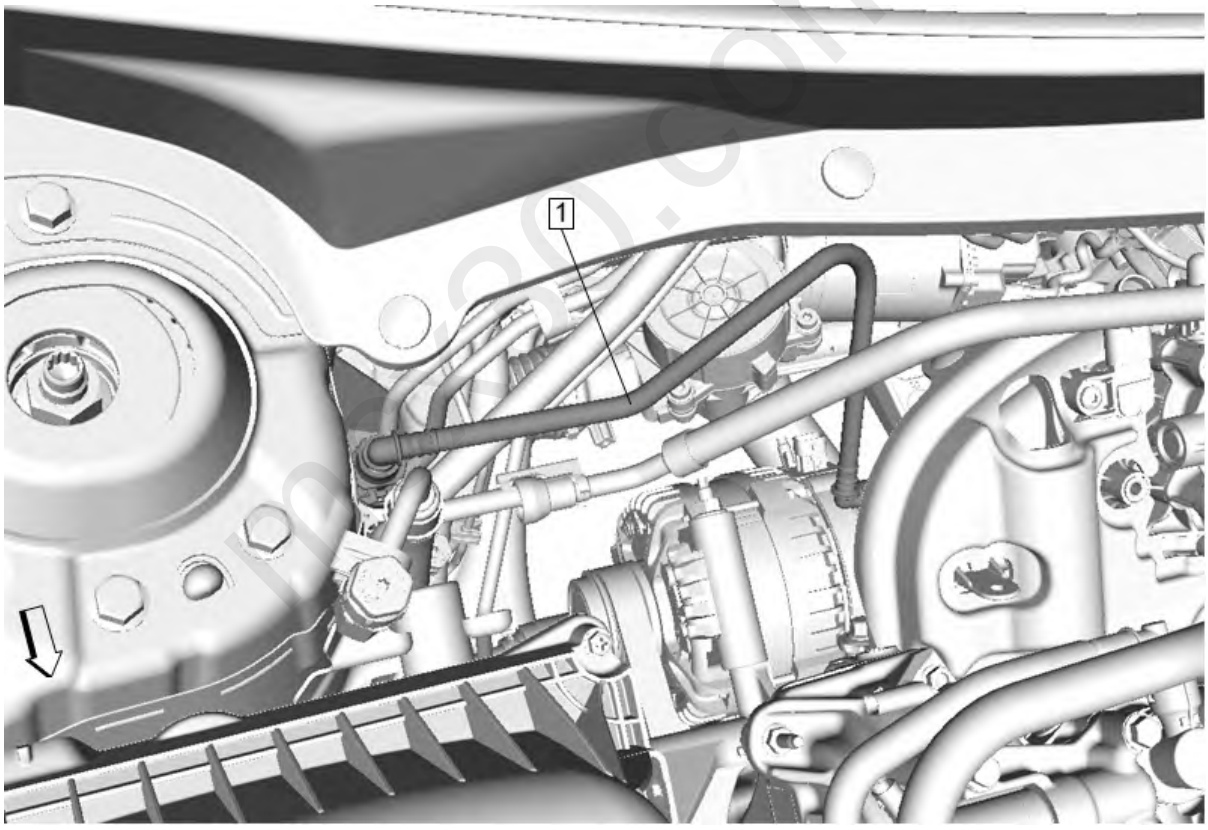


Fig. 331: Evaporative Emission Front Hose
Courtesy of GENERAL MOTORS COMPANY

25. Remove Evaporative Emission Front Hose (1)**Evaporative Emission Front Hose Replacement**
26. Position a suitable engine table or equivalent under the cradle to support the cradle and powertrain.

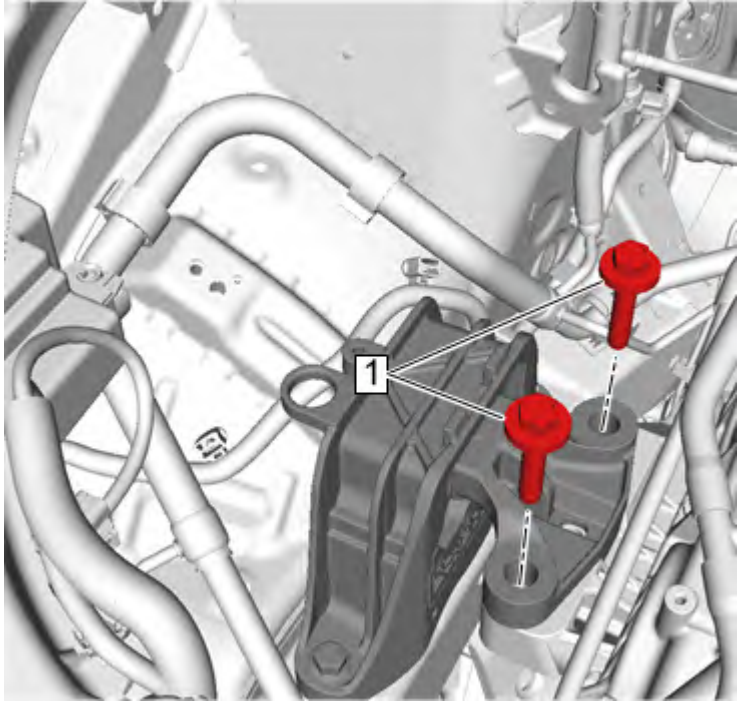


Fig. 332: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

27. Remove Engine Mount Fastener (1) and DISCARD - **Engine Mount Replacement**

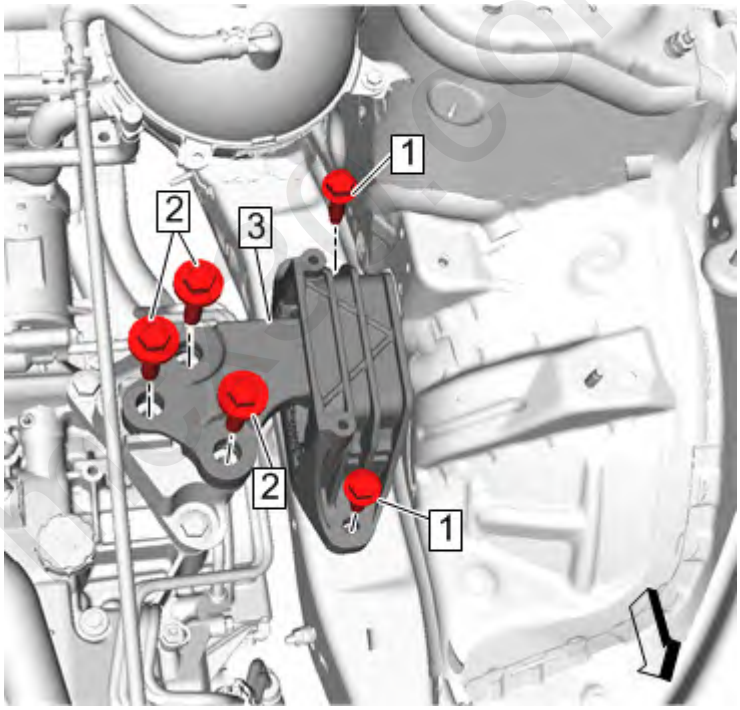


Fig. 333: Transmission Mount Bolts And Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: **ONLY the fasteners (2) should be removed and DISCARDED**

28. Remove Transmission Mount Fastener (2) and DISCARD - **Transmission Mount Replacement - Left Side**

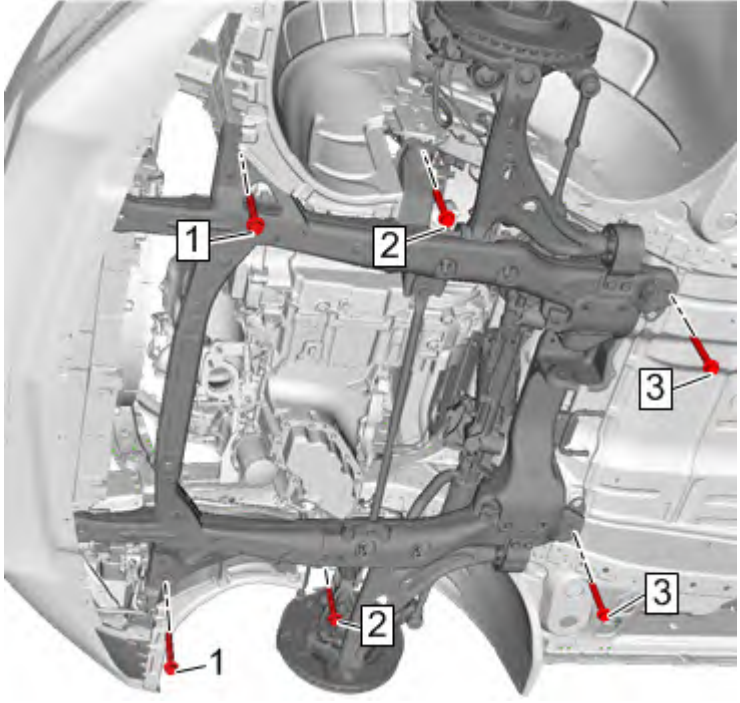


Fig. 334: Front Cradle Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Use a suitable device to hold the cradle while removing the fasteners.**

NOTE: **Remove ONLY the body to frame bolts as the powertrain will be removed while still bolted to the frame.**

29. Remove bolts necessary to remove the cradle (1) (2) and (3). Drivetrain and Front Suspension Cradle Replacement (Front Wheel Drive) Drivetrain and Front Suspension Cradle Replacement (All Wheel Drive)
30. Carefully lower the engine table and raise the body on the hoist until the engine/transaxle and frame are separated from the vehicle.
31. Separate the engine from the transmission. Transmission Replacement (Front Wheel Drive except Diesel Engine) Transmission Replacement (All Wheel Drive except Diesel Engine) Transmission Replacement (All Wheel Drive with Diesel Engine, Equinox) Transmission Replacement (Front Wheel Drive with Diesel Engine) Transmission Replacement (All Wheel Drive with Diesel Engine, Terrain)
32. Install the engine to a suitable engine stand.
33. Transfer components as necessary.

Installation Procedure

1. Install the transmission to the engine. Transmission Replacement (Front Wheel Drive except Diesel Engine) Transmission Replacement (All Wheel Drive except Diesel Engine) Transmission Replacement (All Wheel Drive with Diesel Engine, Equinox) Transmission Replacement (Front Wheel Drive with Diesel Engine) Transmission Replacement (All Wheel Drive with Diesel Engine, Terrain)
2. Position the powertrain and support table under the vehicle.
3. Raise the powertrain into position under the vehicle.
4. With the table positioned, if required, lower the vehicle over the powertrain.

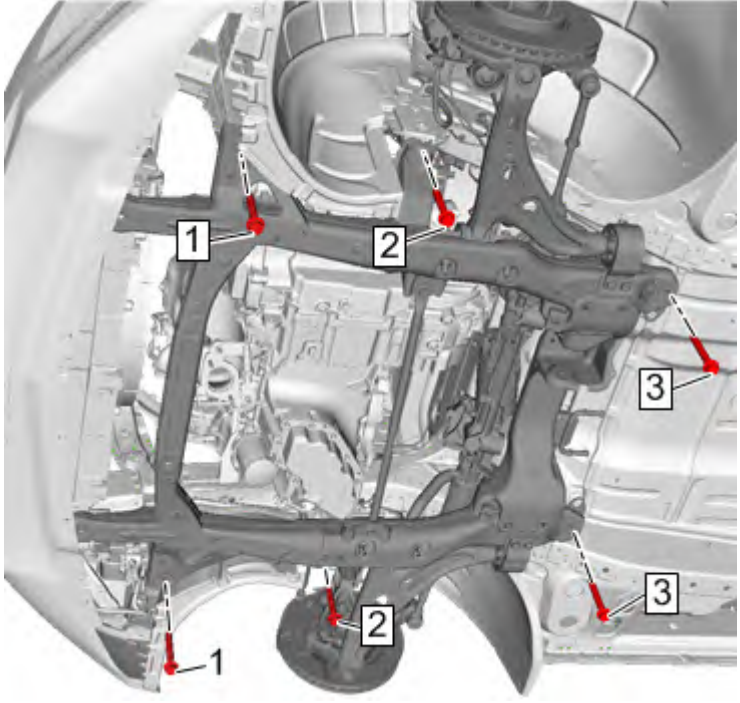


Fig. 335: Front Cradle Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install the previously removed body to frame bolts to secure the frame and powertrain.**

5. Install bolts (1) (2) and frame (3). **Drivetrain and Front Suspension Cradle Replacement (Front Wheel Drive)** **Drivetrain and Front Suspension Cradle Replacement (All Wheel Drive)**

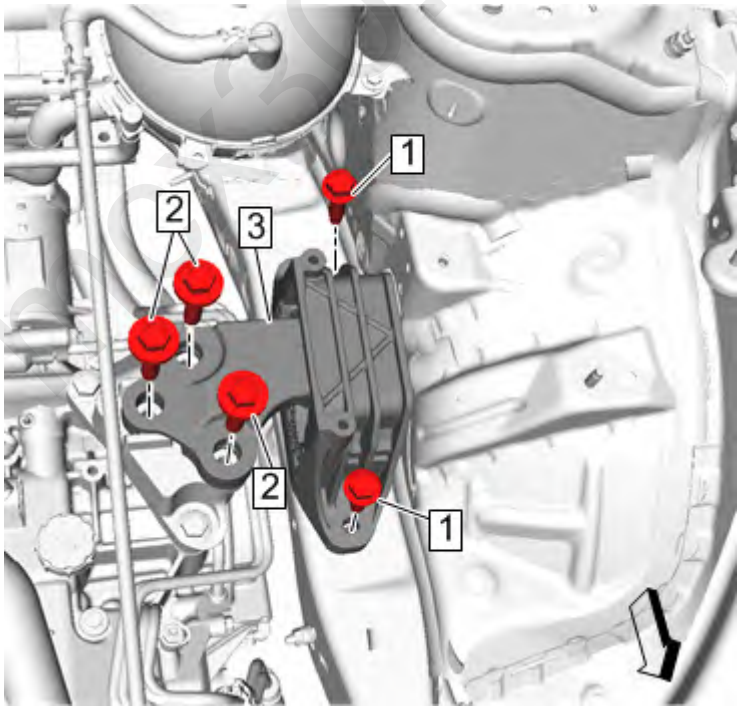


Fig. 336: Transmission Mount Bolts And Fastener
Courtesy of GENERAL MOTORS COMPANY

6. Install Transmission Mount Fastener **Transmission Mount Replacement - Left Side**

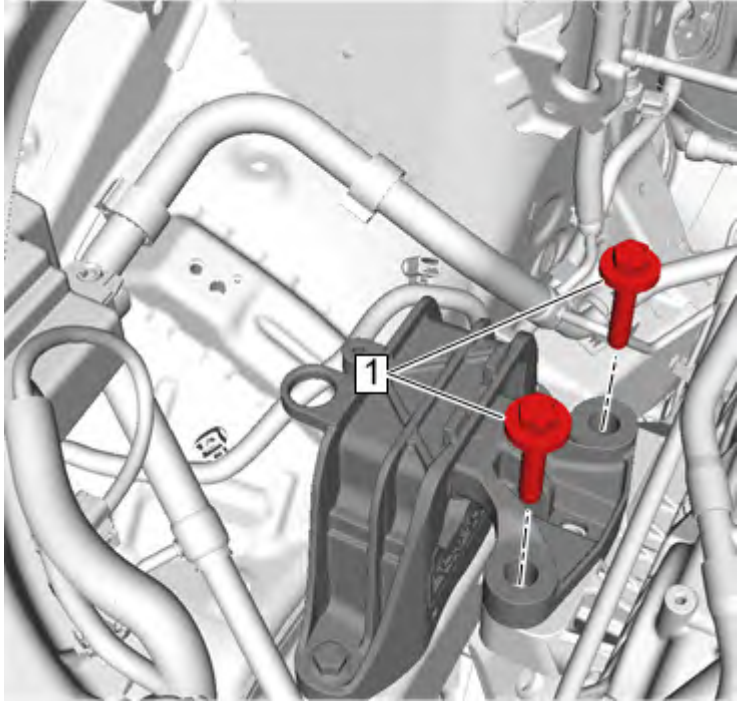


Fig. 337: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install Engine Mount Fastener - **Engine Mount Replacement**
8. Remove the suitable engine table or equivalent from under the powertrain and cradle.
9. Reconnect electrical connections and reposition harnesses as needed.
10. Install Front Wheel Drive Half Shaft-Left Side - **Front Wheel Drive Half Shaft Replacement - Left Side**
11. Install Front Wheel Drive Half Shaft-Right Side - **Front Wheel Drive Half Shaft Replacement - Right Side (AWD)**, **Front Wheel Drive Half Shaft Replacement - Right Side (M3U, MHG, MNH, MNK with FWD)**, **Front Wheel Drive Half Shaft Replacement - Right Side (M3D, M3H with FWD)**

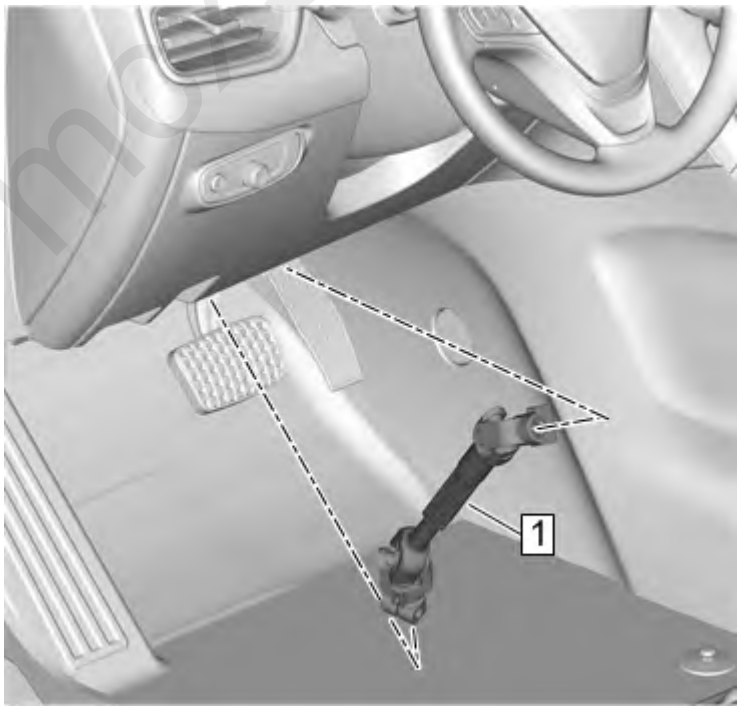


Fig. 338: Intermediate Steering Shaft
Courtesy of GENERAL MOTORS COMPANY

12. Install Intermediate Steering Shaft -**Intermediate Steering Shaft Replacement (Equinox)**, **Intermediate Steering Shaft Replacement (Terrain)**

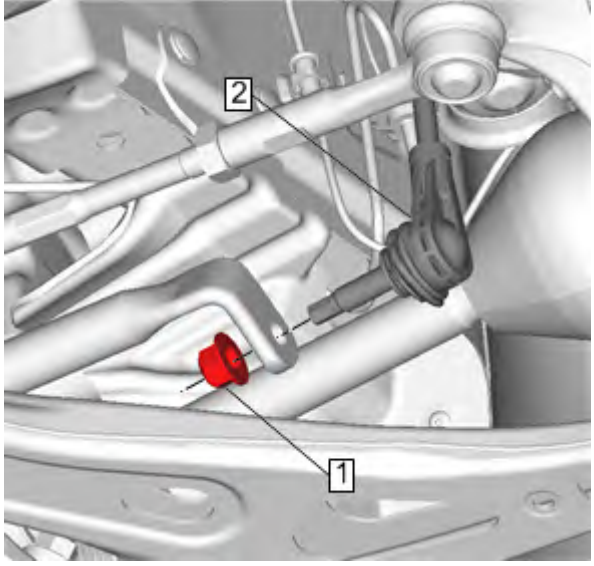


Fig. 339: Stabilizer Link Nuts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Right side shown, left side is similar.**

13. Connect the stabilizer links (2) and install nuts (1). **Stabilizer Shaft Link Replacement (Equinox)** **Stabilizer Shaft Link Replacement (Terrain)**

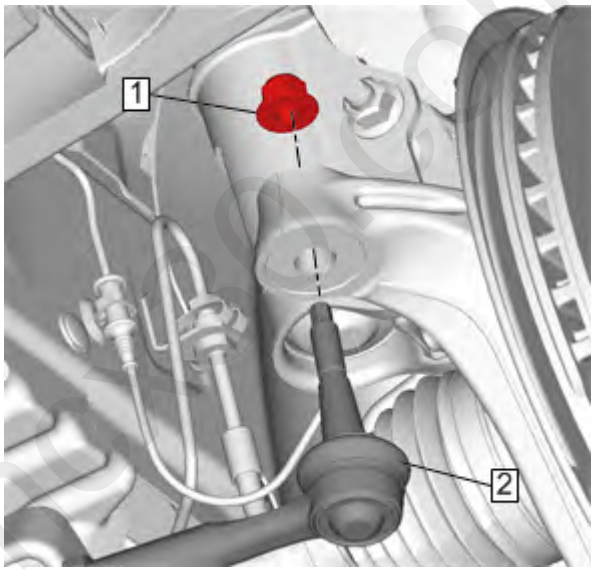


Fig. 340: Tie Rods And Nuts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Right side shown, left side is similar.**

14. Install the tie rod ends (2) then install nuts (1). **Steering Linkage Outer Tie Rod Replacement**

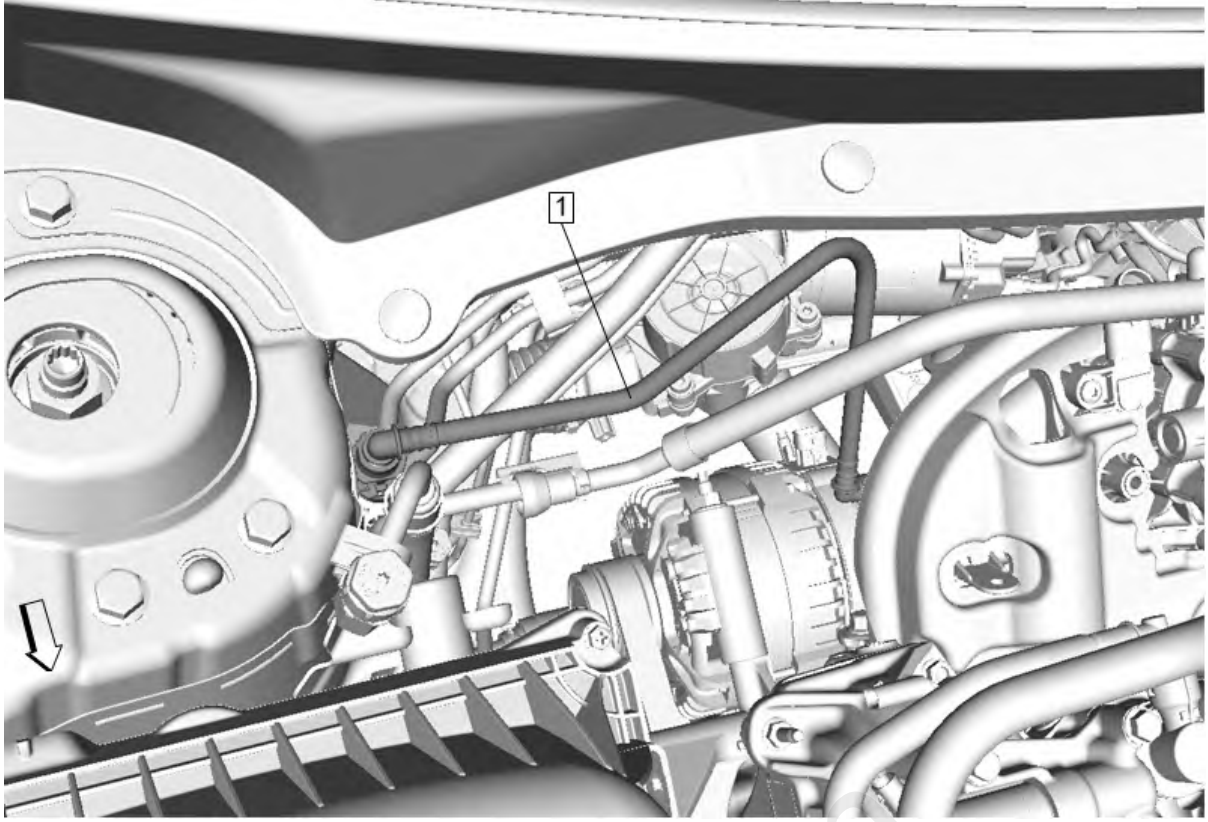


Fig. 341: Evaporative Emission Front Hose
Courtesy of GENERAL MOTORS COMPANY

15. Install Evaporative Emission Front Hose - **Evaporative Emission Front Hose Replacement**

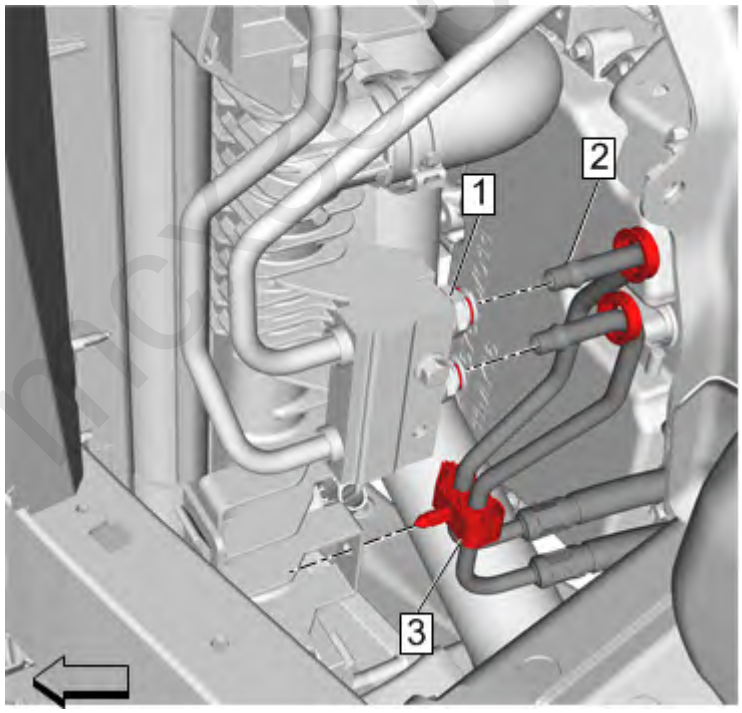


Fig. 342: Transmission Fluid Cooler Inlet and Outlet Pipe
Courtesy of GENERAL MOTORS COMPANY

16. Connect Transmission Fluid Cooler Inlet and Outlet Pipe@Radiator Assembly - **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (MNH, MHG)** **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (M3D, M3H, M3U)**
17. Connect Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose@Air Conditioning Compressor - **Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose Replacement (LYX)**

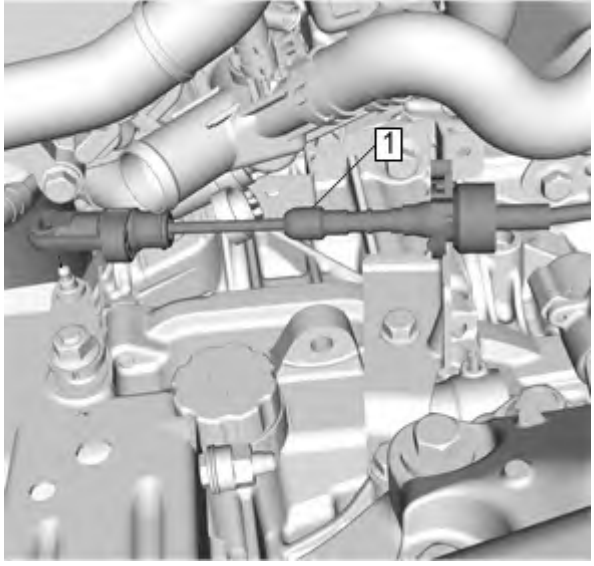


Fig. 343: Range Selector Lever Cable
Courtesy of GENERAL MOTORS COMPANY

18. Connect Range Selector Lever Cable@Transmission - **Range Selector Lever Cable Replacement**
19. Install Heater Inlet Hose - **Heater Inlet Hose Replacement (LYX AWD without KL9)** **Heater Inlet Hose Replacement (LYX with KL9)**
20. Install Heater Outlet Hose - **Heater Outlet Hose Replacement (LYX without KL9)**
21. Install Radiator Inlet Hose -**Radiator Inlet Hose Replacement (LYX)**
22. Install Radiator Outlet Hose - **Radiator Outlet Hose Replacement (LYX)**

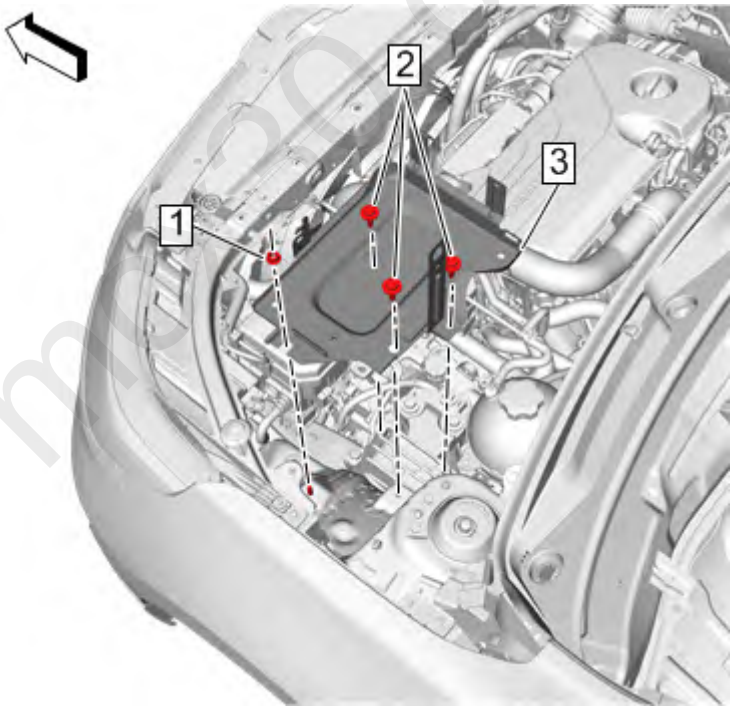


Fig. 344: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

23. Install Battery Tray - **Battery Tray Replacement**

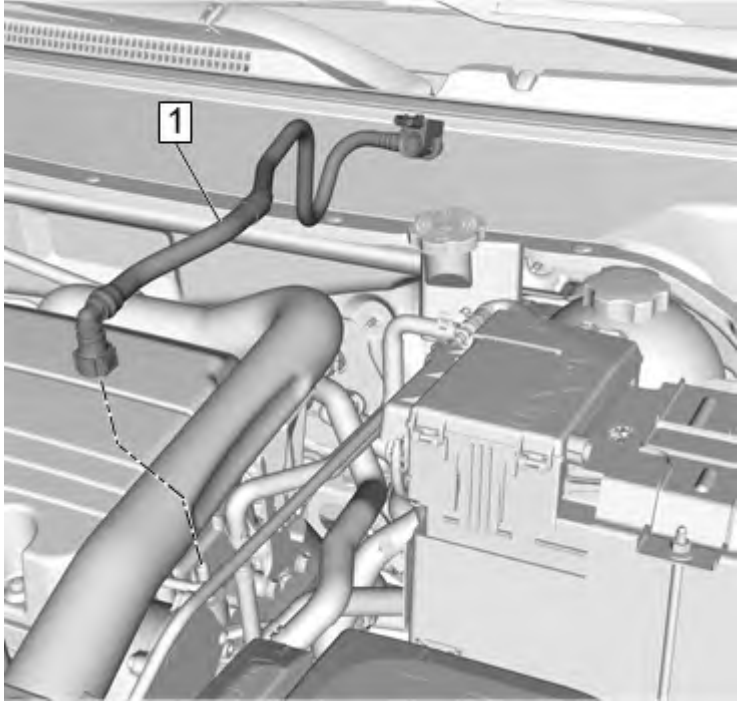


Fig. 345: Power Brake Booster Vacuum Pipe
Courtesy of GENERAL MOTORS COMPANY

24. Install Power Brake Booster Vacuum Pipe - **Power Brake Booster Vacuum Pipe Replacement (LYX)**
25. Install Air Cleaner Assembly - **Air Cleaner Assembly Replacement**

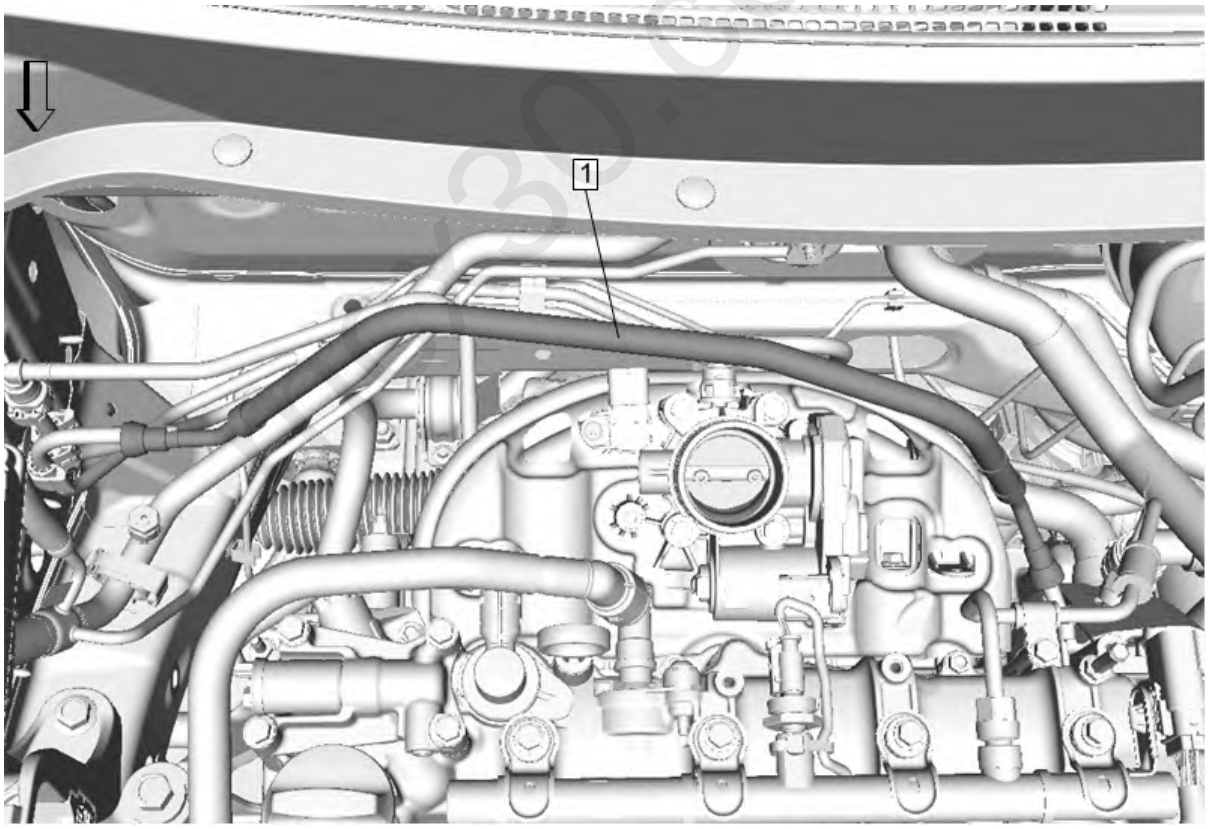


Fig. 346: Fuel Feed Front Pipe
Courtesy of GENERAL MOTORS COMPANY

26. Connect Fuel Feed Front Pipe @ Engine - **Fuel Feed Front Pipe Replacement**
27. Install Charge Air Cooler Outlet Air Tube - **Charge Air Cooler Outlet Air Tube Replacement**
28. Install Exhaust Front Pipe - **Exhaust Front Pipe Replacement (LYX)**
29. Install Underbody Front Air Deflector - **Underbody Front Air Deflector Replacement (Equinox)** **Underbody Front Air Deflector Replacement (Terrain)**
30. Install Charge Air Cooler Inlet Air Tube - **Charge Air Cooler Inlet Air Tube Replacement**

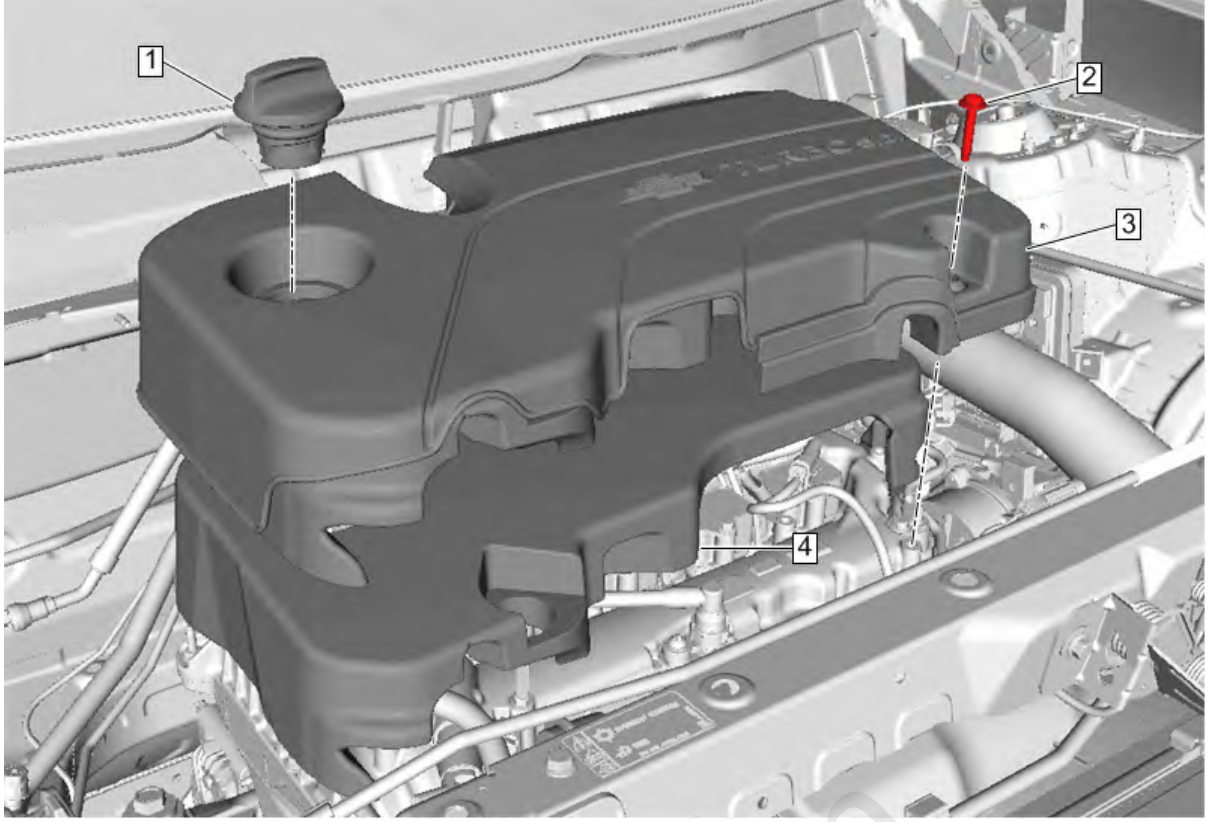


Fig. 347: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

31. Install Intake Manifold Cover - **Intake Manifold Cover Replacement**
32. Recharge the refrigerant. **Refrigerant Recovery and Recharging (R-134a)** **Refrigerant Recovery and Recharging (R-1234yf)**
33. Fill the cooling system to the proper level. **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)**

NOTE: **Prelube is necessary if the engine is replaced or overhauled.**

34. If the engine is replaced with a new engine or has been overhauled, perform the engine prelubing procedure. **Engine Prelubing**
35. If the engine has not been replaced or overhauled, check and correct engine oil level as needed. **Engine Oil and Oil Filter Replacement**
36. Perform the crankshaft position variation learn. **Crankshaft Position Variation Learn**

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

Special Tools

- **EN-45059** Angle Meter
- **EN-51760** Flywheel Holding Tool

Equivalent regional tools:**Special Tools**

Removal Procedure

1. Remove Transmission - **Transmission Replacement (Front Wheel Drive except Diesel Engine)** **Transmission Replacement (All Wheel Drive except Diesel Engine)** **Transmission Replacement (All Wheel Drive with Diesel Engine, Equinox)** **Transmission Replacement (Front Wheel Drive with Diesel Engine)** **Transmission Replacement (All Wheel Drive with Diesel Engine, Terrain)**
2. Install the **EN-51760** Holding Tool.

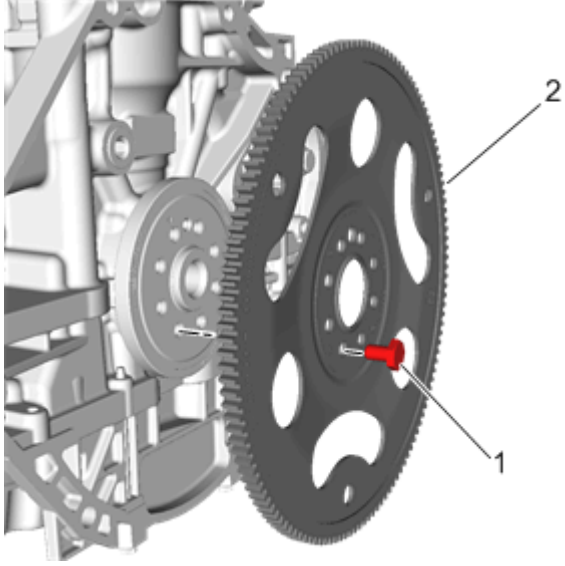


Fig. 348: Automatic Transmission Flex Plate Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove Automatic Transmission Flex Plate Bolt (1) and DISCARD
4. Remove Automatic Transmission Flex Plate (2)

Installation Procedure

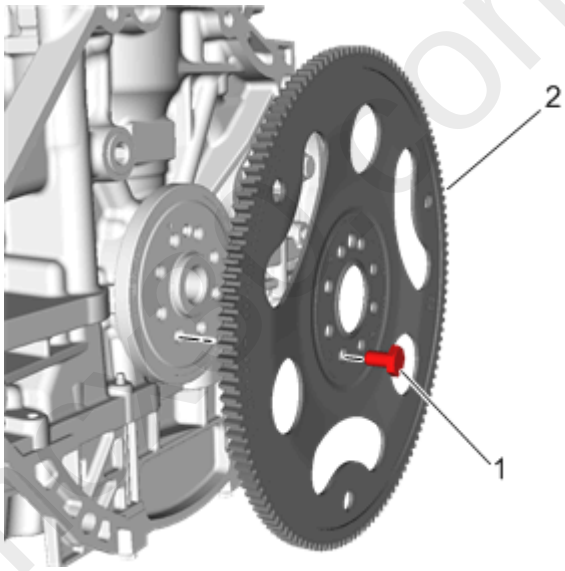


Fig. 349: Automatic Transmission Flex Plate Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install Engine Flywheel (2)

NOTE: **Install NEW bolts.**

NOTE: **Bolts have adhesive patch and must be tightened to final torque within 5 minutes.**

2. Loosely install Automatic Transmission Flex Plate Bolt (1)

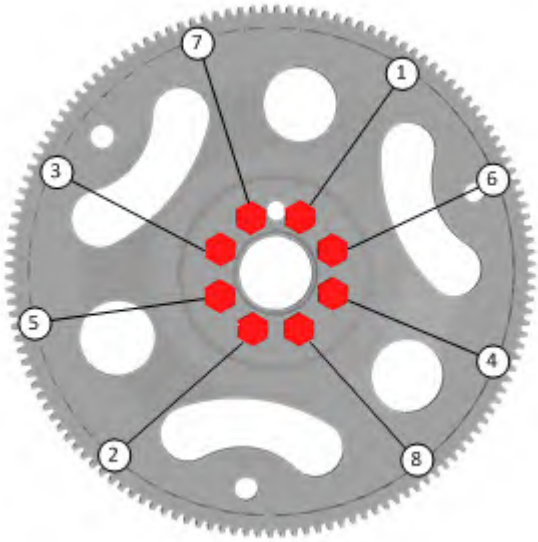


Fig. 350: Flywheel Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

CAUTION: Refer to Torque-to-Yield Fastener Caution .

3. Tighten the flywheel bolts in the sequence shown.

   Tighten

   1. First Pass:20 N.m (15 lb ft)
   2. Second Pass:30 N.m (22 lb ft)
   3. Final Pass:70 degrees, using the **EN-45059** angle meter
4. Remove the **EN-51760** Holding tool.
5. Install Transmission - Transmission Replacement (Front Wheel Drive except Diesel Engine), Transmission Replacement (All Wheel Drive except Diesel Engine), Transmission Replacement (All Wheel Drive with Diesel Engine, Equinox), Transmission Replacement (Front Wheel Drive with Diesel Engine), Transmission Replacement (All Wheel Drive with Diesel Engine, Terrain).

ENGINE SUPPORT FIXTURE

mo630.com

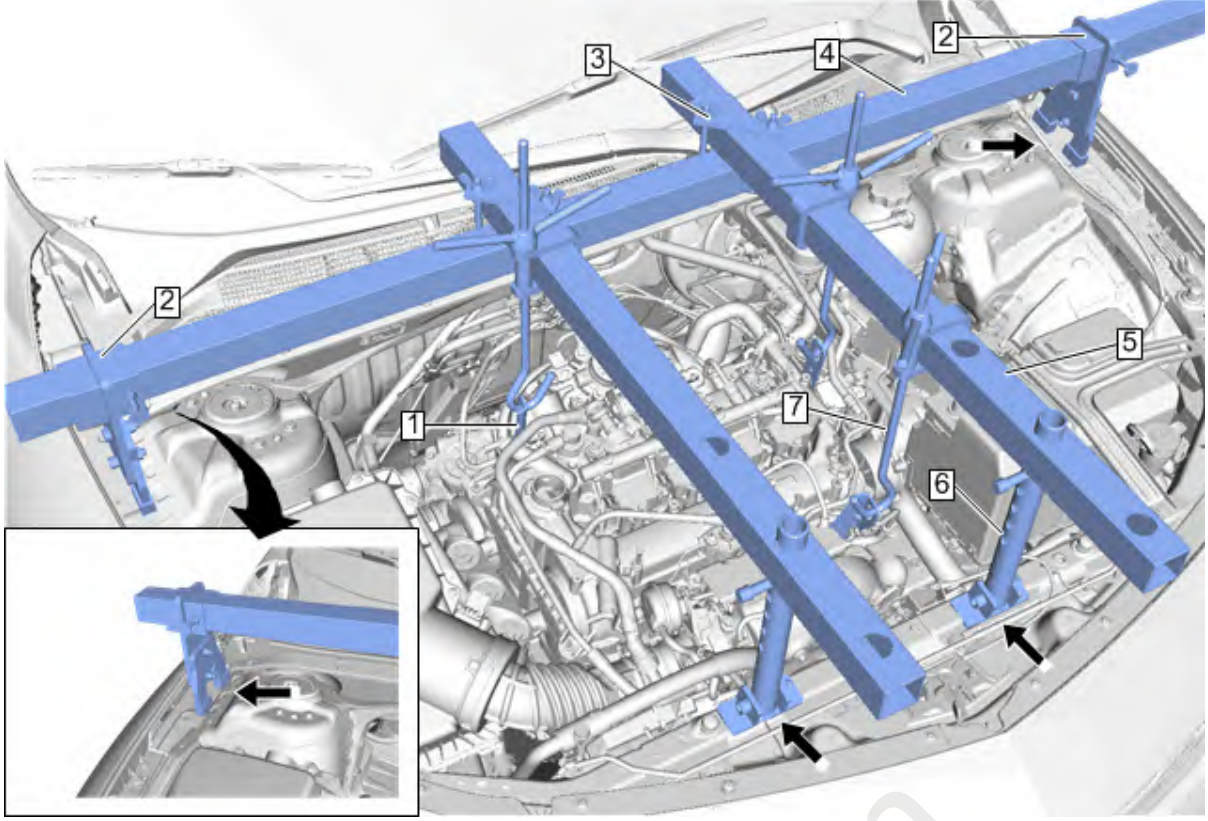


Fig. 351: Engine Support Fixture
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Intake Manifold Cover Replacement 2. Charge Air Cooler Outlet Air Tube Replacement **Special Tools** • **EN-51007-1** Main Support Beam • **EN-51007-3** Radiator Support Beam • **EN-51007-4** Clamp • **EN-51007-5** Support Leg, Front • **EN-51007-6** Hook • **EN-51007-7** Support Leg, Side • **EN-36857** Engine Lift Bracket Equivalent regional tools: Special Tools (Diagnostic Tools) Special Tools (Mechanical Tools) .	
1	**EN-36857** Engine Lift Bracket **Procedure** **NOTE:** **The engine support fixture and lift brackets can be repositioned to either lift bracket to lift in desired lift points.** If engine lift brackets are not present, install **EN-36857** engine lift brackets as needed.

mcx30.com

Callout	Component Name
2	**EN-51007-7** Support Leg, Side **Procedure** **NOTE:** **Ensure that the engine support fixture only contacts the frame in the area indicated by arrows. Do not install on top of fender lip.** Install the **EN-51007-7** Support Leg, Side to frame as shown.
3	**EN-51007-4** Clamp
4	**EN-51007-1** Main Support Beam
5	Z **EN-51007-3** Radiator Support Beam
6	**EN-51007-5** Support Leg, Front
7	**EN-51007-6** Hook

REPAIR INSTRUCTIONS - OFF VEHICLE

DRAINING FLUIDS AND OIL FILTER REMOVAL

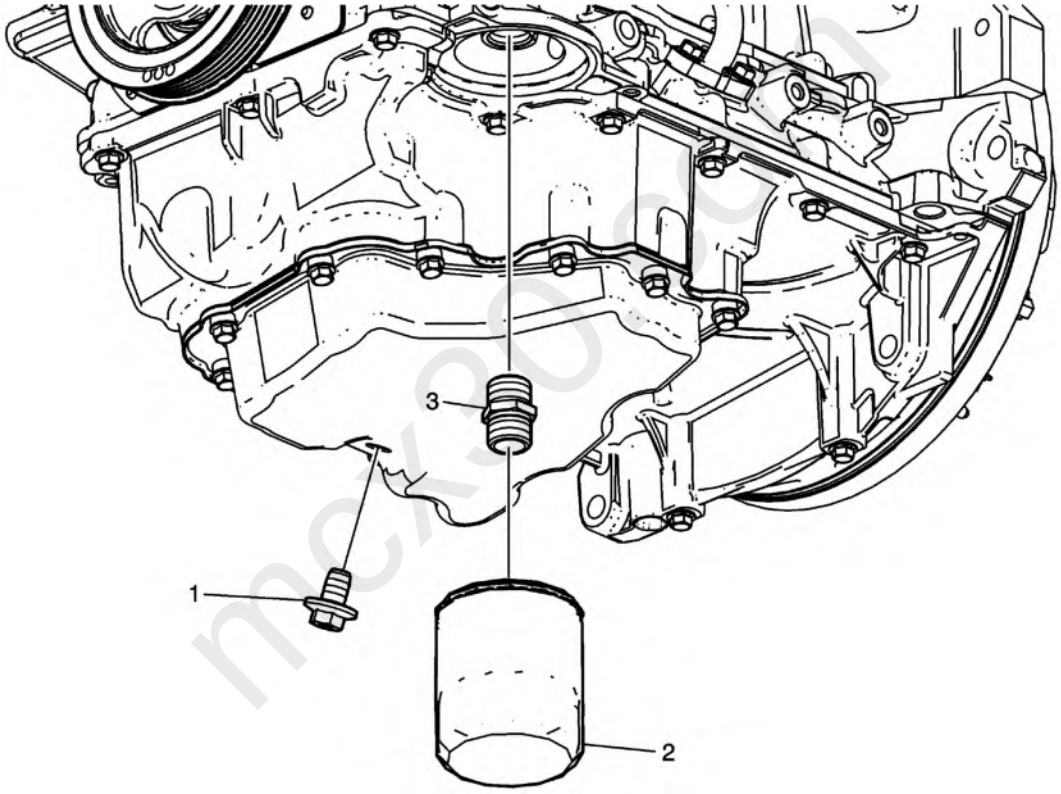


Fig. 352: Draining Fluids and Oil Filter
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Pan Drain Plug **CAUTION:** **Refer to Fastener Caution .** **NOTE:** **Place a drip pan underneath. Allow the oil to drain completely.**
2	Oil Filter **Special Tools** **EN-726-A** Oil Filter Wrench For equivalent regional tools, refer to Special Tools.

Callout	Component Name
3	Oil Filter Fitting

CRANKSHAFT BALANCER REMOVAL

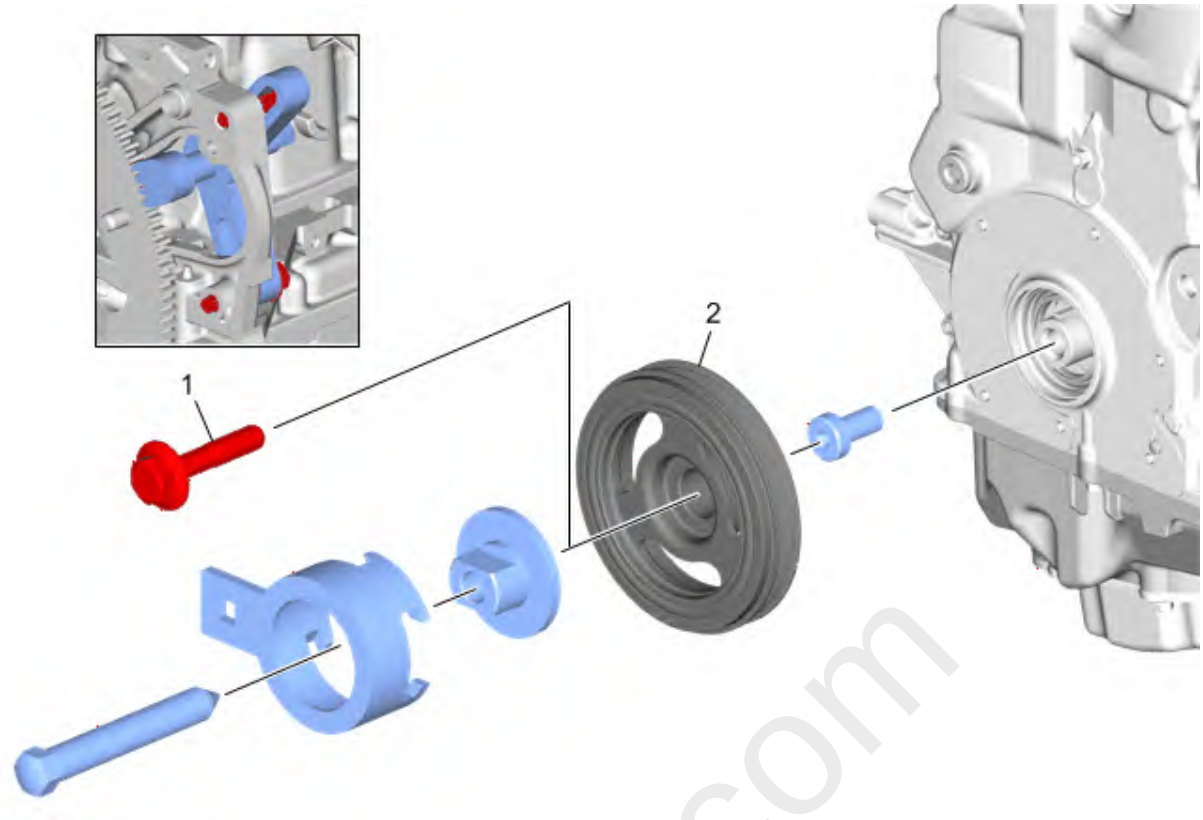


Fig. 353: Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Install the **EN-51760** holder, lock the automatic transmission flex plate via the starter ring gear. **Special Tools EN-51760** Flywheel HolderFor equivalent regional tools, refer to **Special Tools**.	
1	Crankshaft Balancer Bolt
2	Crankshaft Balancer **Procedure** 1. Install the **EN-44226-5** protector onto the crankshaft. 2. Install **EN-44226-1** holding body and **EN-44226-2** remover plate with remover bolt onto the balancer. 3. Counter hold the **EN-44226-2** remover plate and turn the remover screw to remove the balancer. **Special Tools** • **EN-44226** Crankshaft Balancer Remover • **EN-44226-5** Crankshaft Protector

AUTOMATIC TRANSMISSION FLEX PLATE REMOVAL

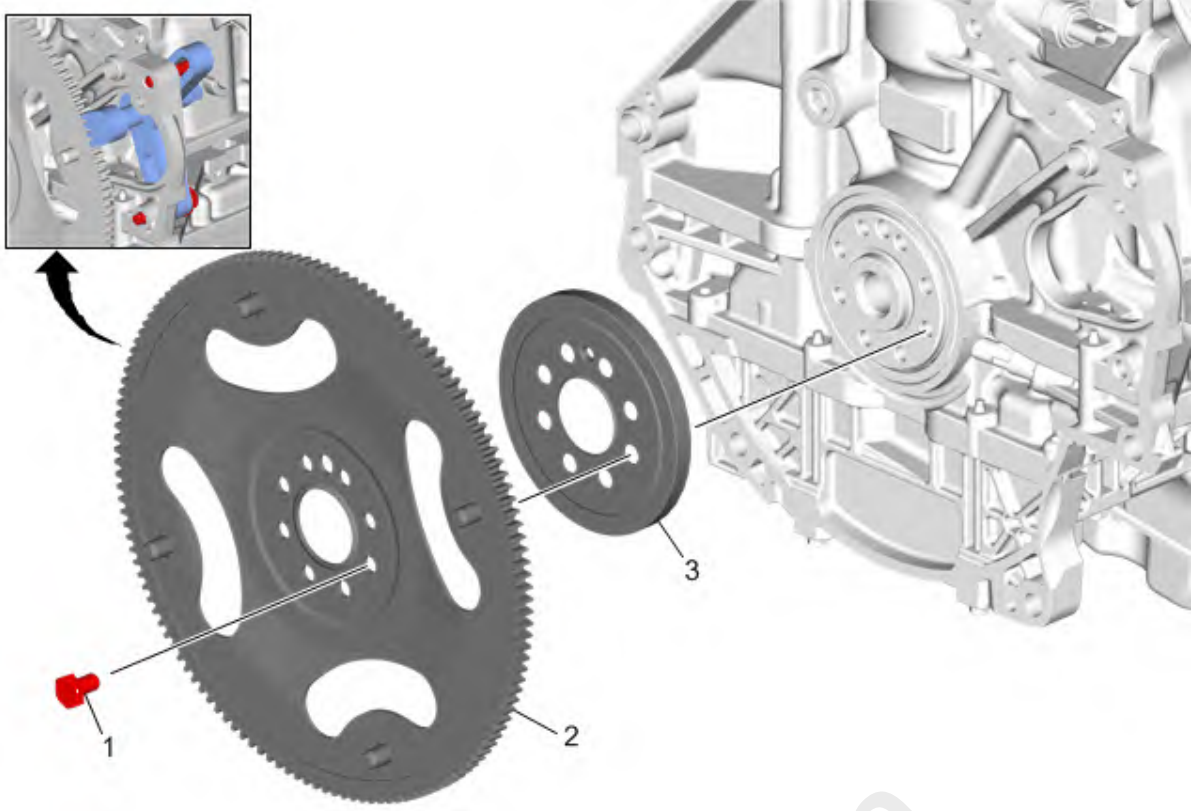


Fig. 354: Automatic Transmission Flex Plate
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Install **EN-51760** holder, lock the automatic transmission flex plate via the starter ring gear. **Special Tools** **EN-51760** Flywheel Holder For equivalent regional tools, refer to Special Tools.	
1	Automatic Transmission Flex Plate Bolt (Qty: 8) **NOTE:** **Discard the bolts.**
2	Automatic Transmission Flex Plate
3	Crankshaft Position Sensor Reluctor Ring **CAUTION:** **Refer to Crankshaft Position Sensor Reluctor Ring Caution .**

TURBOCHARGER REMOVAL

mcx30.com

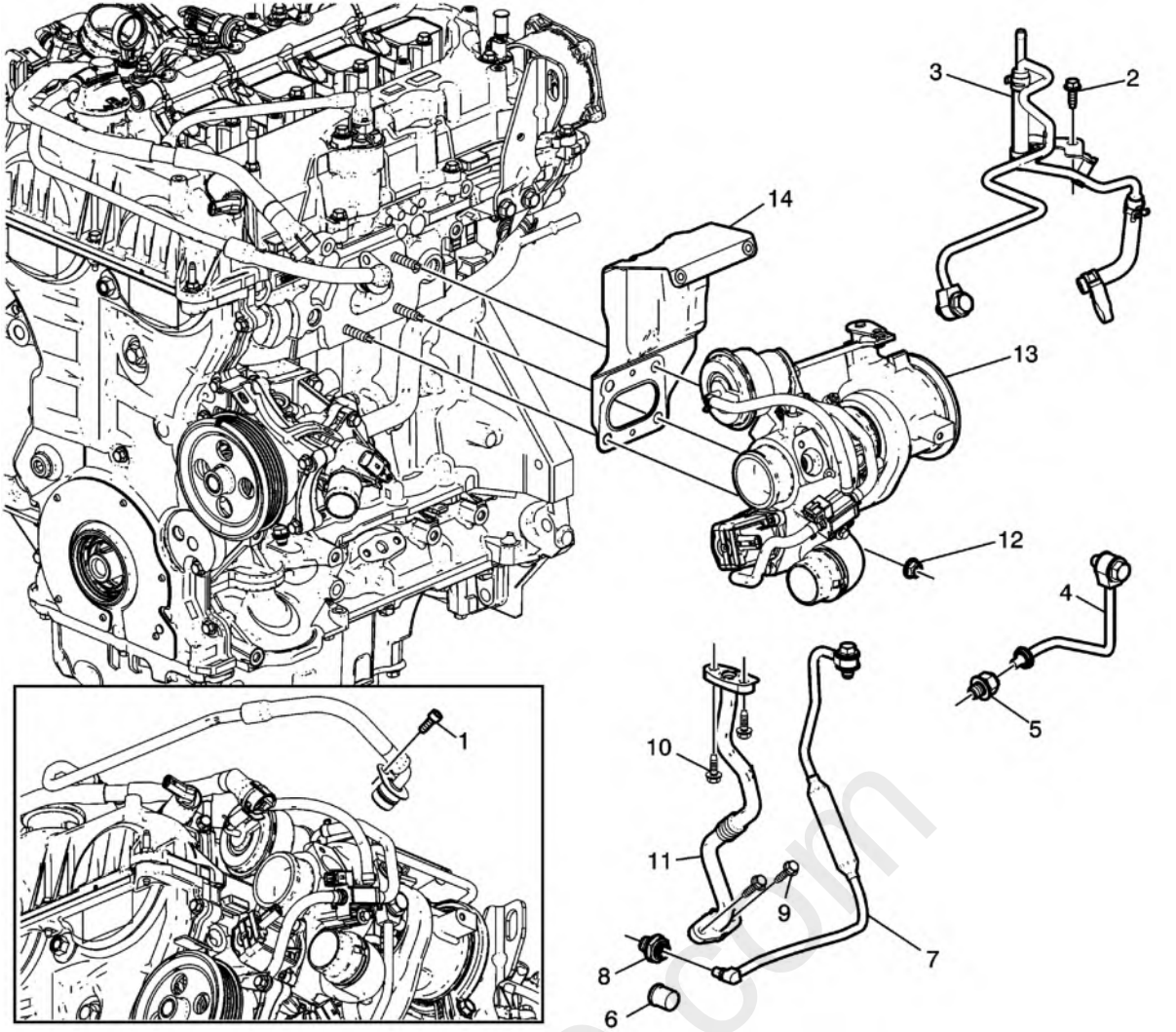


Fig. 355: Turbocharger
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Positive Crankcase Ventilation Hose Fitting Bolt **NOTE:** **The connection between the PCV hose and PCV hose fitting at the turbocharger is a permanent connection and cannot be disassembled. Disconnect the PCV fitting, with the PCV hose attached, from the turbocharger.**
2	Turbocharger Coolant Return Pipe Bracket Bolt
3	Turbocharger Coolant Return Pipe **NOTE:** **Discard the two gaskets for the bolt at the turbocharger connection.**
4	Turbocharger Coolant Feed Pipe **Procedure:** 1. Loosen the bolt and rotate the pipe downward. Discard the two gaskets for the bolt at the turbocharger connection. 2. Remove and discard the turbocharger coolant feed pipe clamp at the turbocharger pipe fitting. 3. Remove the turbocharger coolant feed pipe.

Callout	Component Name
5	Turbocharger Pipe Fitting **NOTE:** **Discard the turbocharger pipe fitting, including the pipe fitting gasket.**
6	Turbocharger Oil Feed Pipe Clip
7	Turbocharger Oil Feed Pipe Assembly **Procedure:** 1. Remove the turbocharger oil feed pipe bolt. Discard the two gaskets for the bolt at the turbocharger connection. 2. Remove and discard the turbocharger oil feed pipe clamp at the turbocharger pipe fitting. 3. Remove the turbocharger coolant feed pipe.
8	Turbocharger Pipe Fitting **NOTE:** **Discard the turbocharger pipe fitting, including the pipe fitting gasket.**
9	Turbocharger Oil Return Pipe Bolt - Flange to Block (Qty: 2)
10	Turbocharger Oil Return Pipe Bolt - Flange to Turbocharger (Qty: 2)
11	Turbocharger Oil Return Pipe Assembly **NOTE:** **Remove and discard the two turbocharger oil return pipe gaskets.**
12	Turbocharger Nut (Qty: 4) **NOTE:** **Remove and discard the turbocharger nuts.**
13	Turbocharger
14	Turbocharger Heat Shield **NOTE:** **Remove and discard the turbocharger heat shield with gasket.**

ENGINE OIL COOLER REMOVAL

mcx30.com

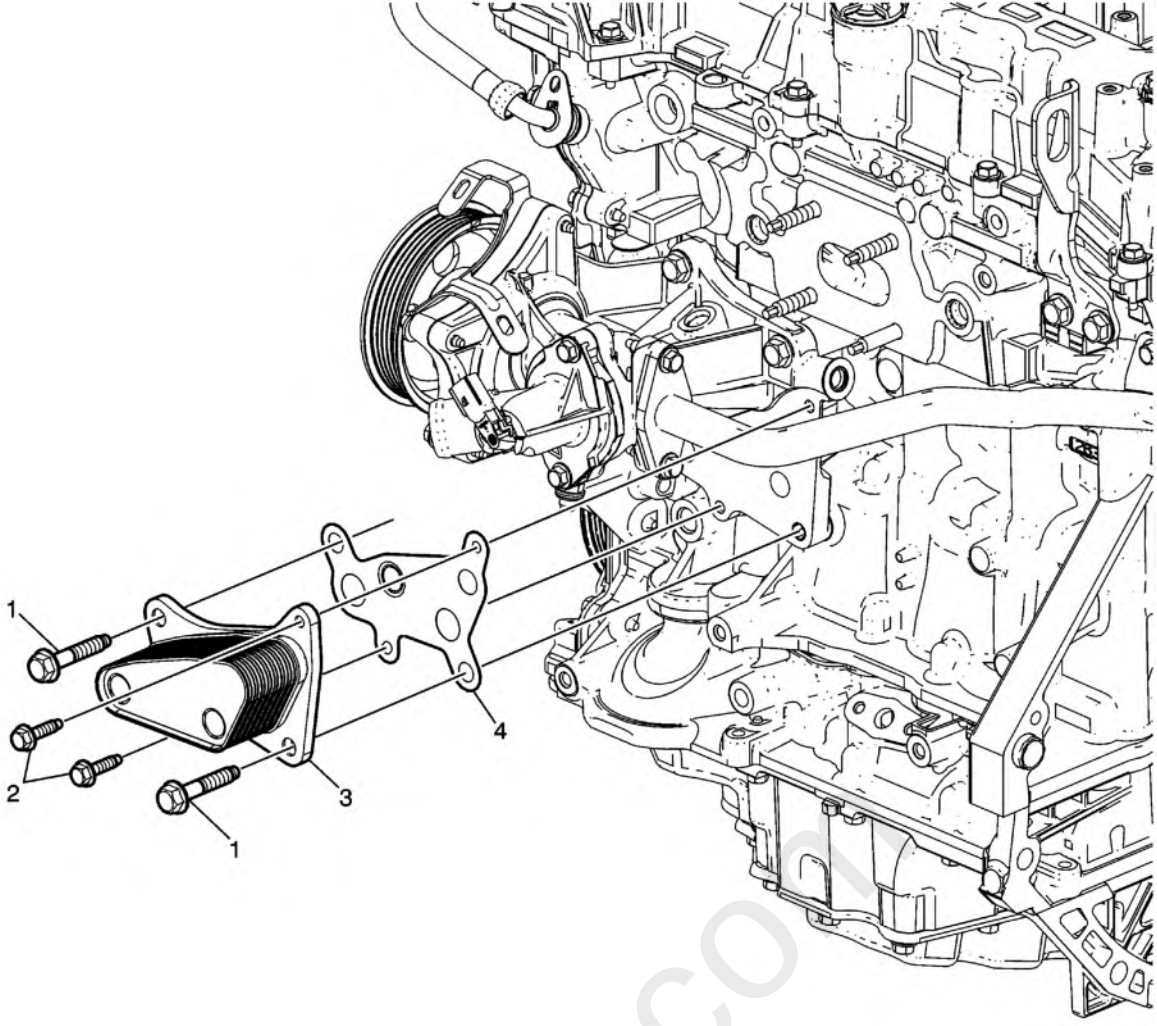


Fig. 356: Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Oil Cooler Assembly Bolt (Qty: 2)
2	Engine Oil Cooler Assembly Bolt (Qty: 2)
3	Engine Oil Cooler Assembly
4	Engine Oil Cooler Gasket

WATER PUMP REMOVAL

mnv30.com

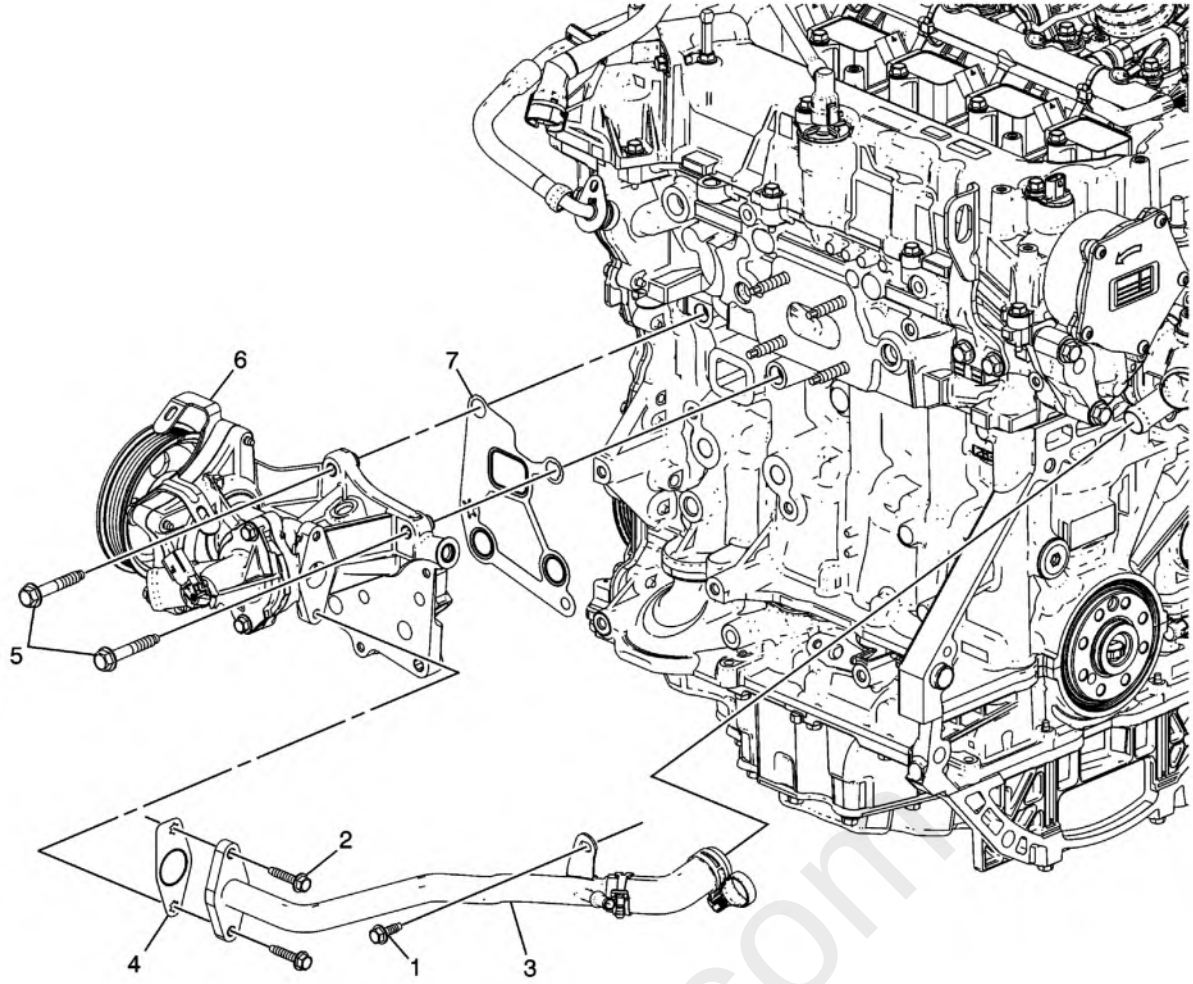


Fig. 357: Water Pump
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Thermostat Bypass Pipe Bolt (Qty: 1)
2	Thermostat Bypass Pipe Bolt (Qty: 2)
3	Thermostat Bypass Pipe Assembly
4	Thermostat Bypass Pipe Gasket
5	Water Pump Bolt (Qty: 2)
6	Water Pump
7	Water Pump Housing Gasket

THROTTLE BODY ASSEMBLY REMOVAL

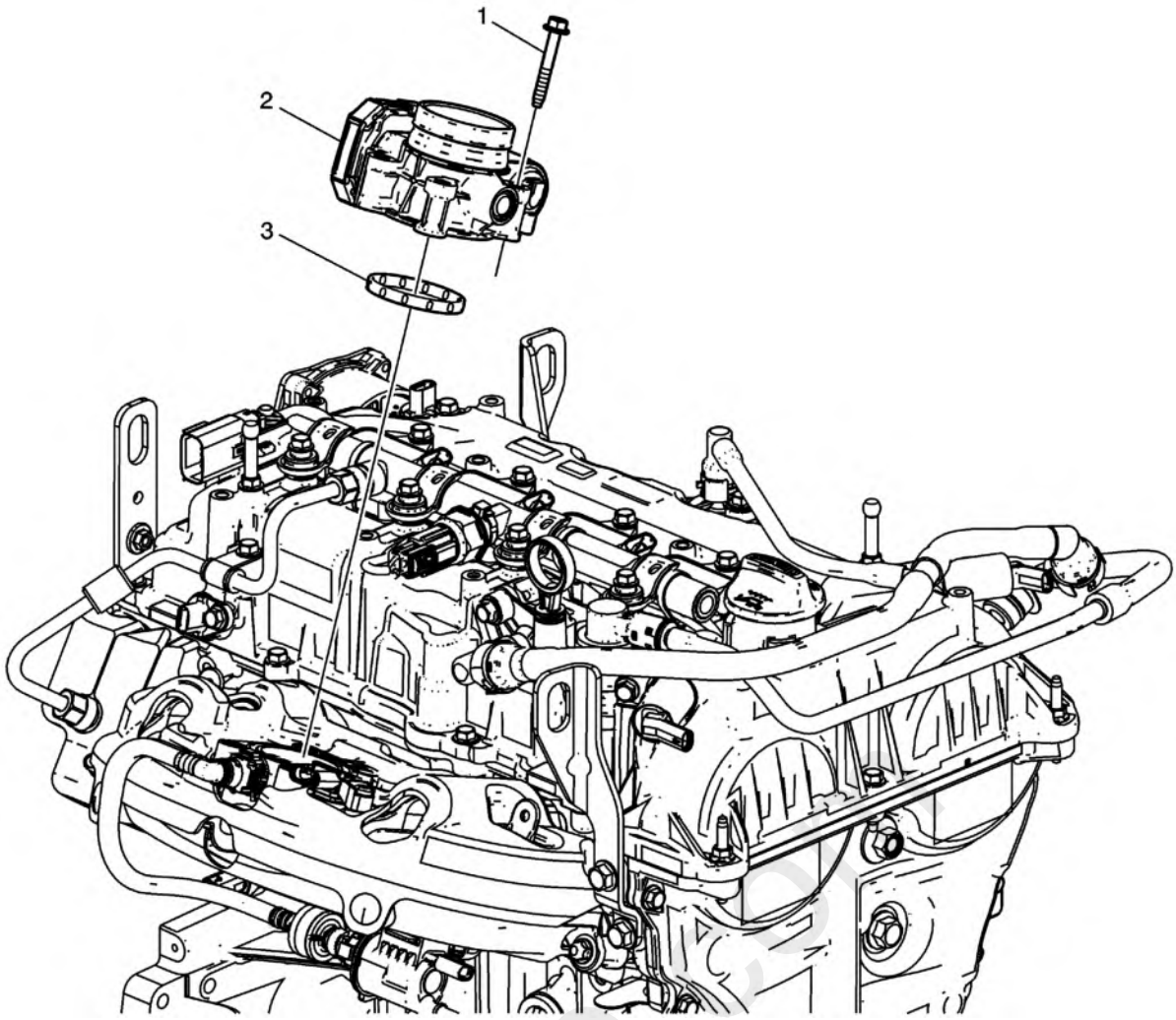


Fig. 358: Throttle Body
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Throttle Body Assembly Bolt (Qty: 4)
2	Throttle Body Assembly
3	Throttle Body Gasket

INTAKE MANIFOLD REMOVAL

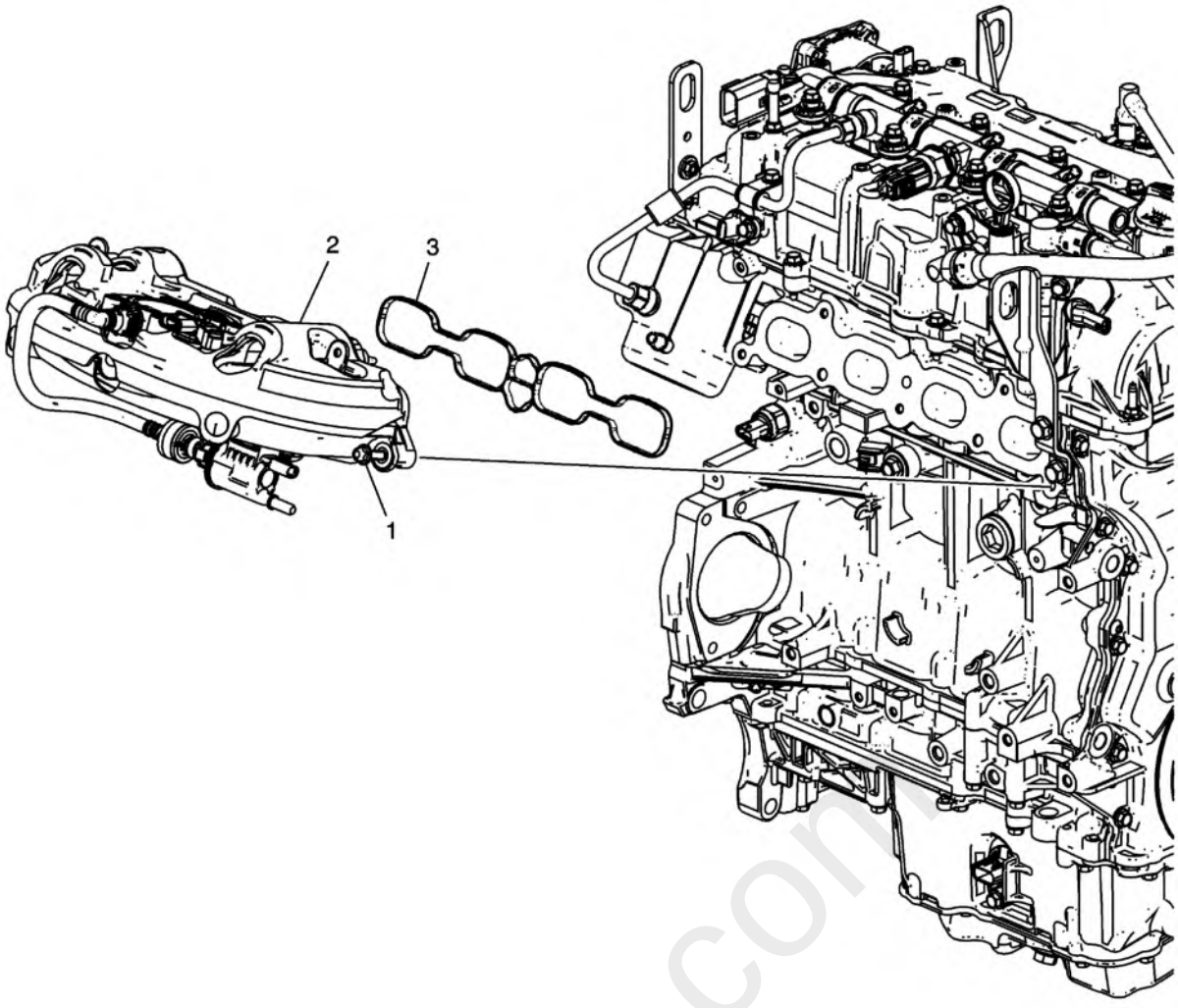


Fig. 359: Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Intake Manifold Assembly Bolt (Qty: 5) **NOTE:** **Bolt retainers keep the bolts in position on the assembly. If the bolts are removed from the assembly, the 2 shorter bolts go to the outside lower locations.** **Procedure** Loosen bolts until disengaged from mount location.
2	Intake Manifold Assembly
3	Intake Manifold Gasket

FUEL PUMP REMOVAL

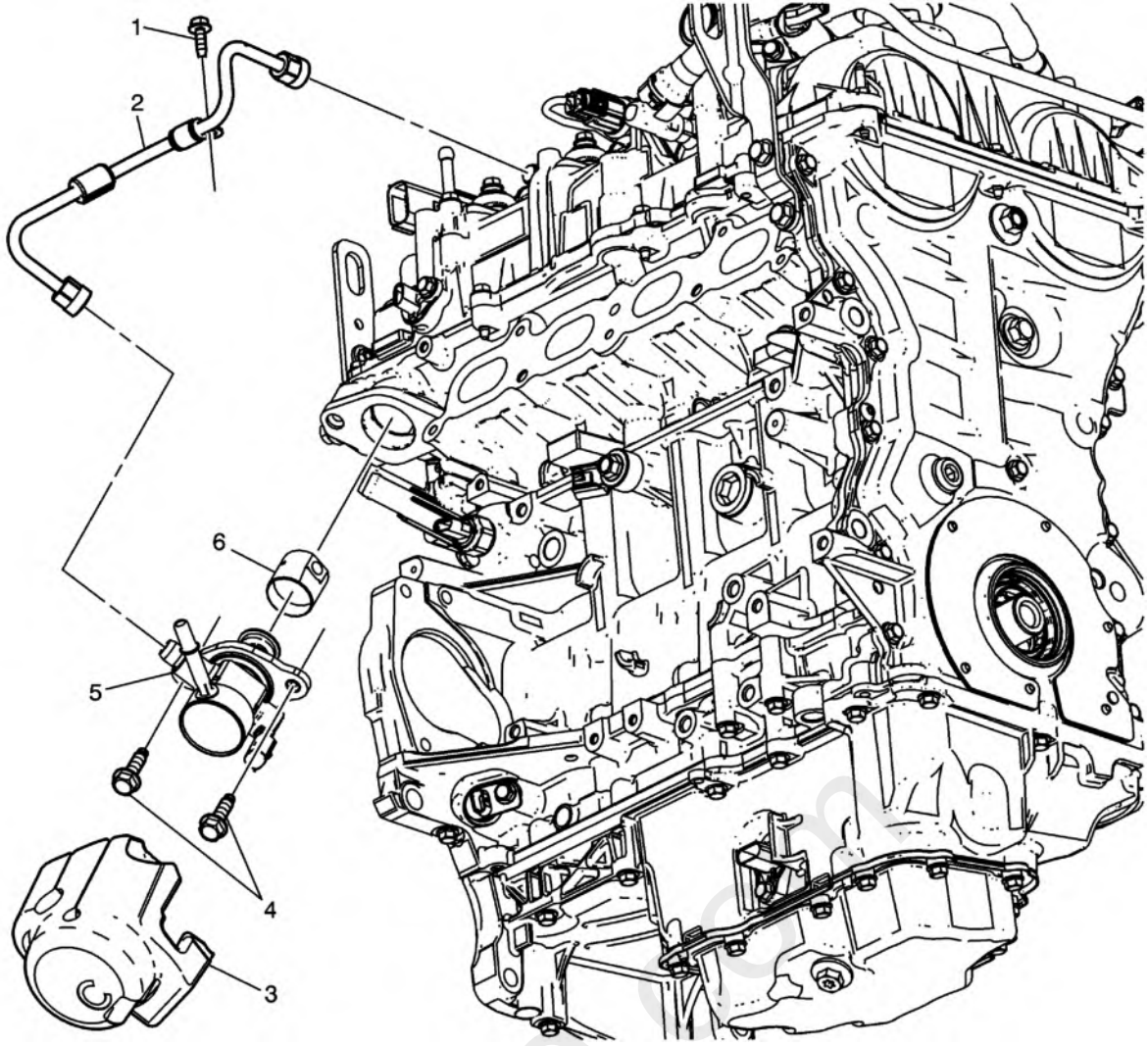


Fig. 360: Fuel Pump
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Fuel Feed Intermediate Pipe Bolt (Qty: 1)
2	Fuel Feed Intermediate Pipe **WARNING:** **Fuel that flows out at high pressure can cause serious injury to the skin and eyes. ALWAYS depressurize the fuel system before removing components that are under high fuel pressure.** **NOTE:** **Discard the pipe.**
3	Fuel Pump Insulator **WARNING:** **The noise cancelling foam component MUST be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.**

Callout	Component Name
4	Fuel Pump Bolt (Qty: 2) **CAUTION:** **Alternately loosen the fuel pump bolts one turn at a time until the pump is fully disengaged from fuel pump lifter follower. Trying to remove the pump bolts without even side-to-side loosening may result in pump plunger damage** **Procedure:** Remove the fuel injection pump bolts alternating in steps of one turn each. **NOTE:** **Discard the bolts.**
5	Fuel Pump
6	Valve Lifter Follower

ENGINE LIFT AND SIGHT SHIELD BRACKET REMOVAL

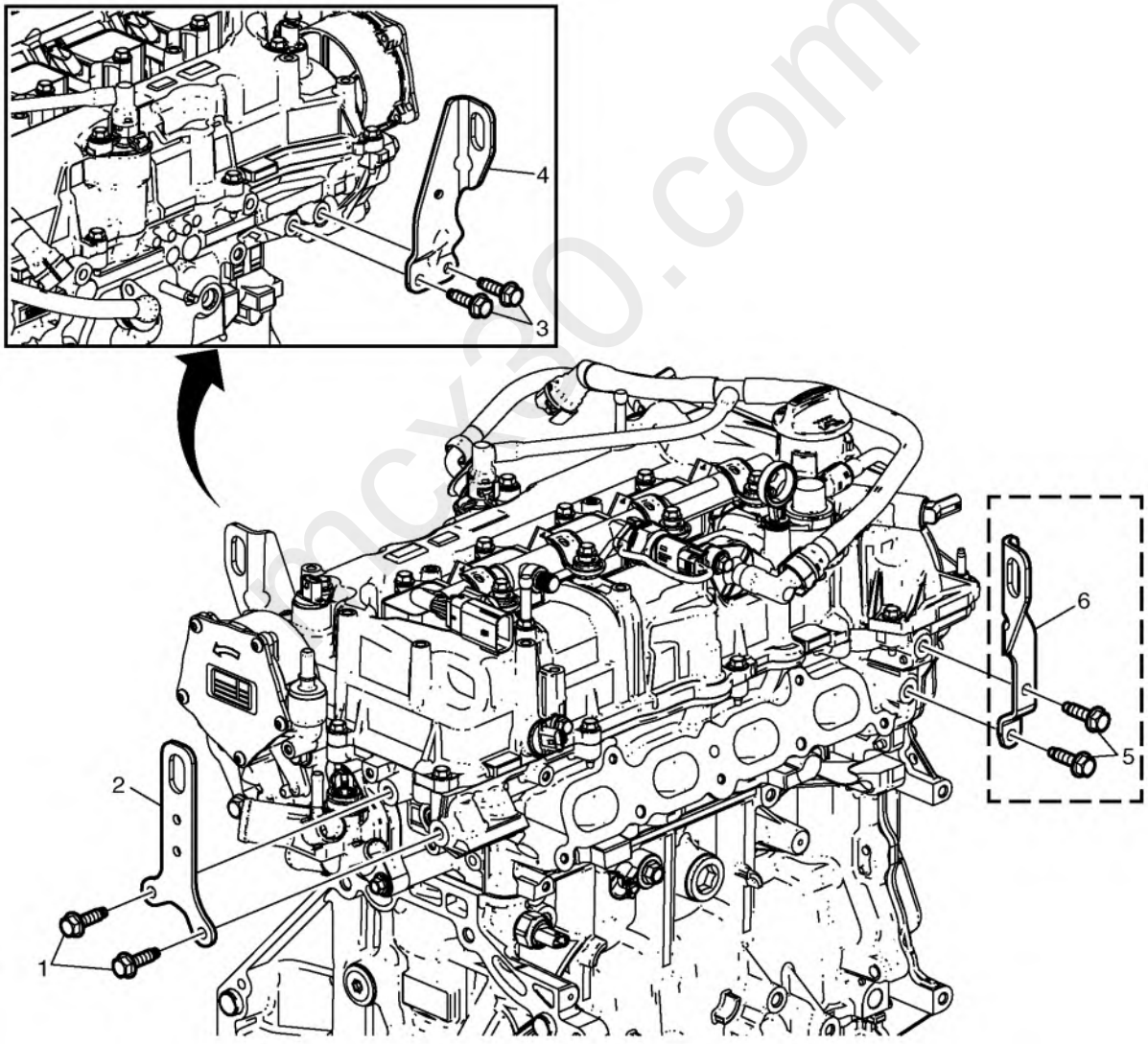


Fig. 361: Engine Lift and Sight Shield Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Lift Rear Bracket Bolt [2x]
2	Engine Lift Rear Bracket
3	Engine Lift Rear Bracket Bolt [2x]

Callout	Component Name
4	Engine Lift Rear Bracket
5	Engine Lift Front Bracket Bolt [2x] - Model Dependent
6	Engine Lift Front Bracket - Model Dependent

WATER OUTLET REMOVAL

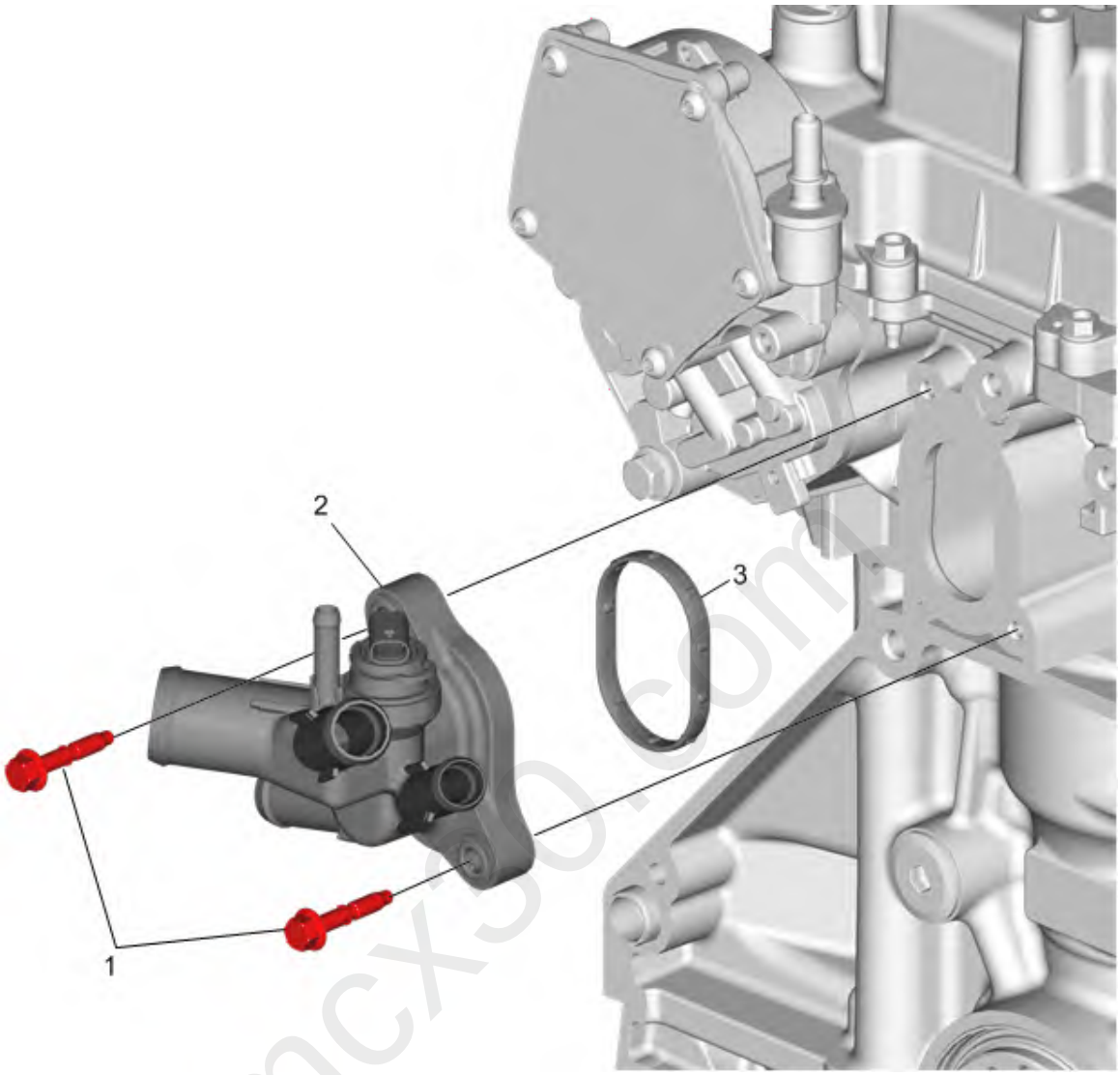


Fig. 362: Water Outlet
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Water Outlet Assembly Bolt (Qty: 2)
2	Water Outlet Assembly
3	Water Outlet Gasket

VACUUM PUMP REMOVAL

mcx30.com

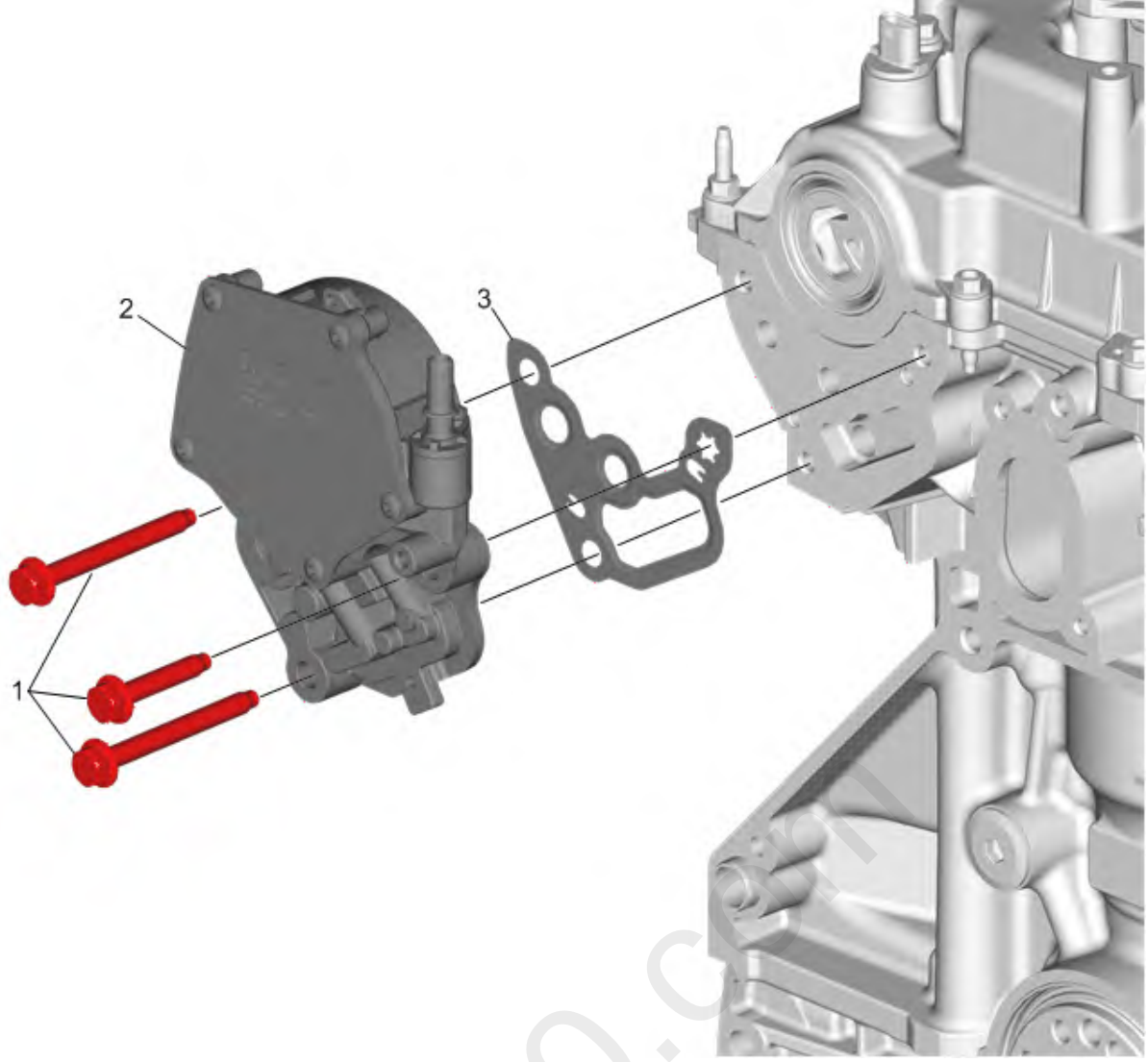


Fig. 363: Vacuum Pump
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Vacuum Pump Assembly Bolt (Qty: 3)
2	Vacuum Pump Assembly
3	Vacuum Pump Gasket

IGNITION COIL REMOVAL

mox30.com

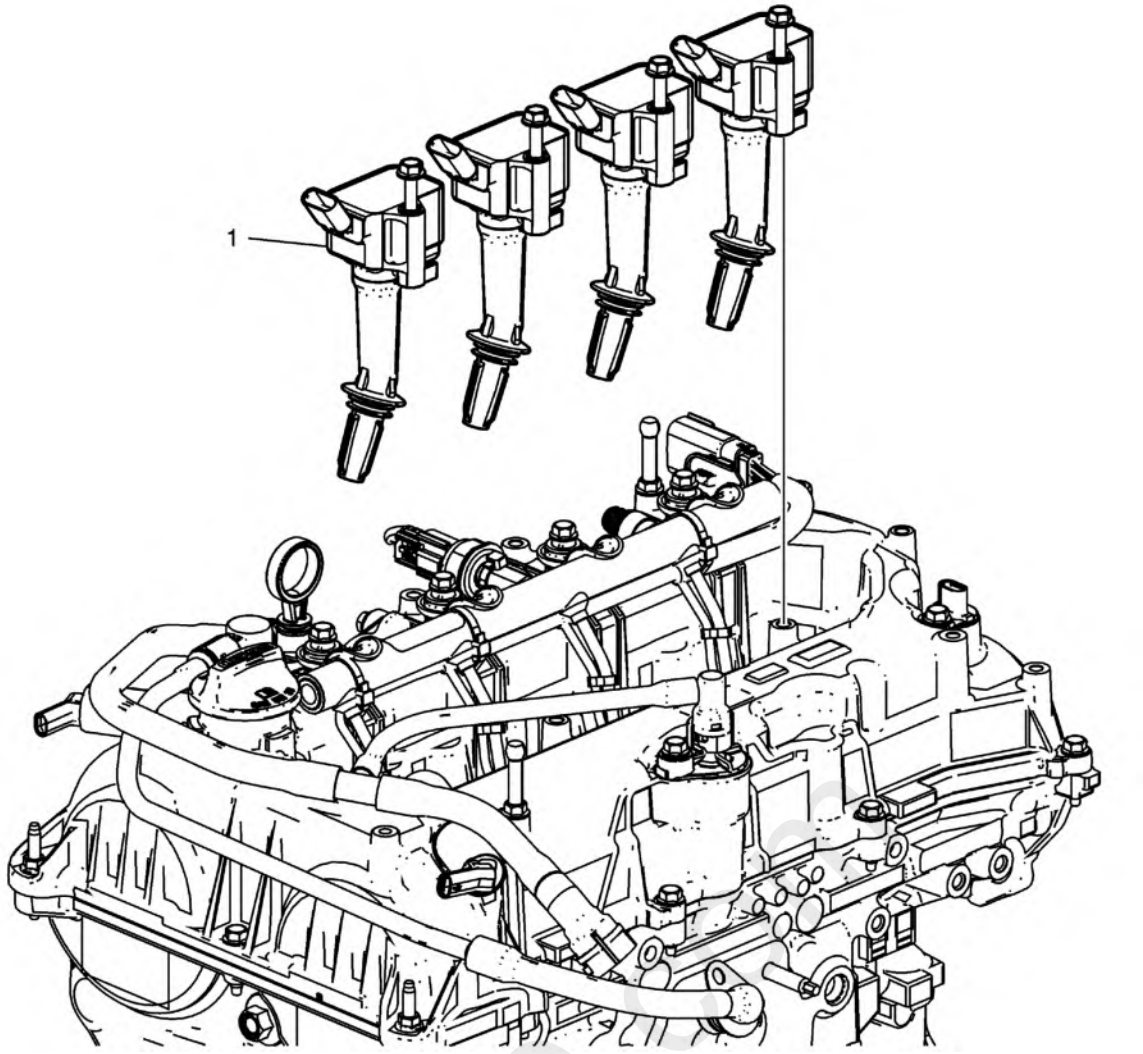


Fig. 364: Ignition Coil
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Ignition Coil Assembly (Qty: 4)

FUEL RAIL AND INJECTORS REMOVAL

Special Tools

- **EN-51146** Fuel Injector Removal/Installation Kit
- **EN-51146-100** Fuel Injector Removal Plate

For equivalent regional tools, refer to Special Tools.

WARNING: **Refer to Diesel/Gasoline Vapors Warning .**

WARNING: **Refer to Safety Goggles and Fuel Warning .**

NOTE: **Maintain a clean work surface when working with fuel rail and fuel injectors. Use care to avoid contaminants on the injector seals.**

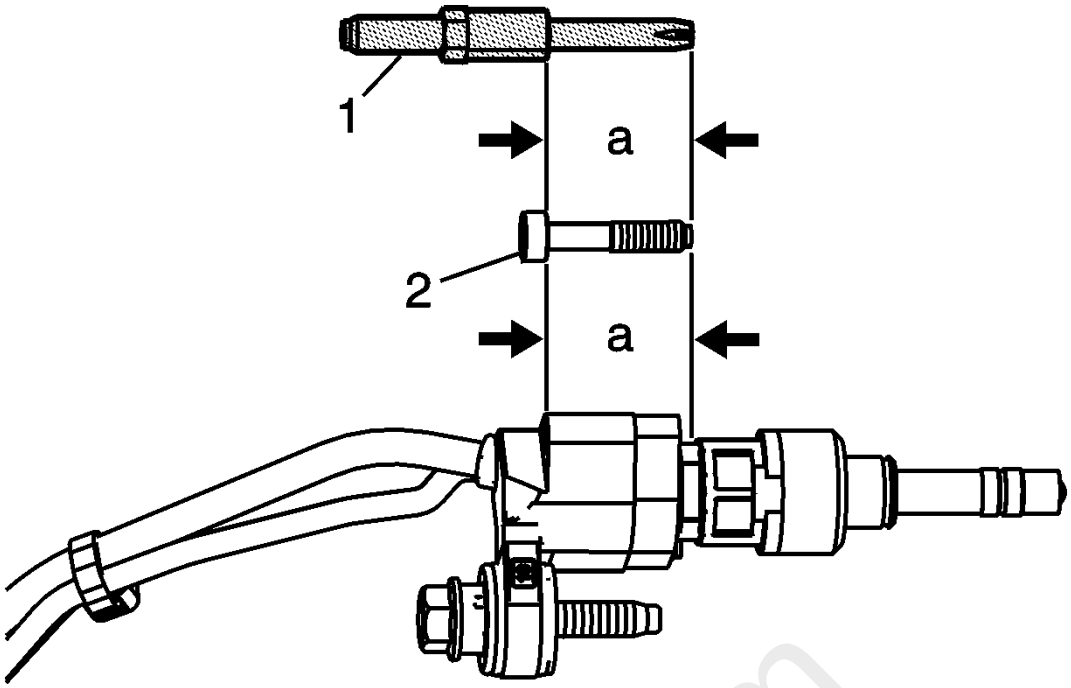


Fig. 365: Fuel Injector Screw
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Remove only one fuel injector screw (2) to perform the length check.**

1. Ensure the **EN-51146-1-6** demounting screws (1) are used with turbocharger equipped applications. Match the length (a) of the **EN-51146-1-6** demounting screws (1) to the length of the fuel injector screw (2). If the length does not match, refer to the Non-Turbocharger procedure.

mcx30.com

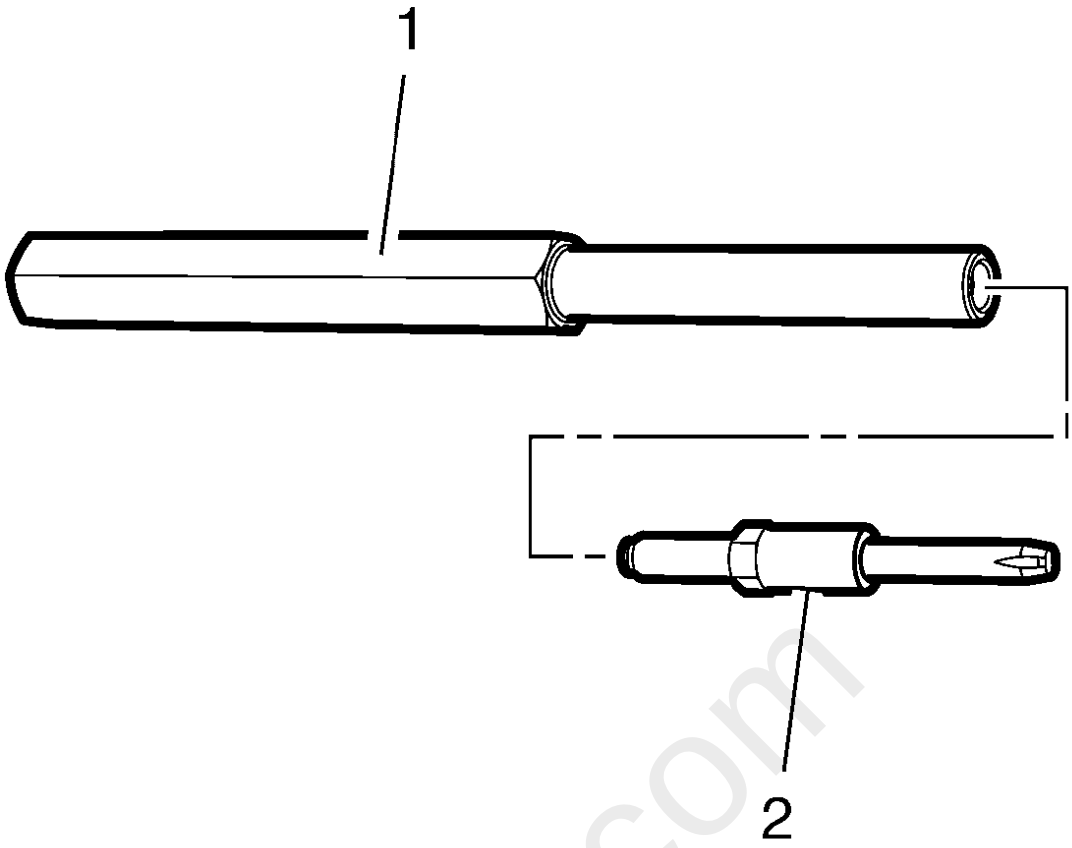


Fig. 366: Continental MGE Demounting Screw
Courtesy of GENERAL MOTORS COMPANY

2. Install the **EN-51146-1-6** demounting screws (2) to the **EN-51146-1-1** supports (1) and tighten to 7 N.m (62 lb in).

mcx30.com

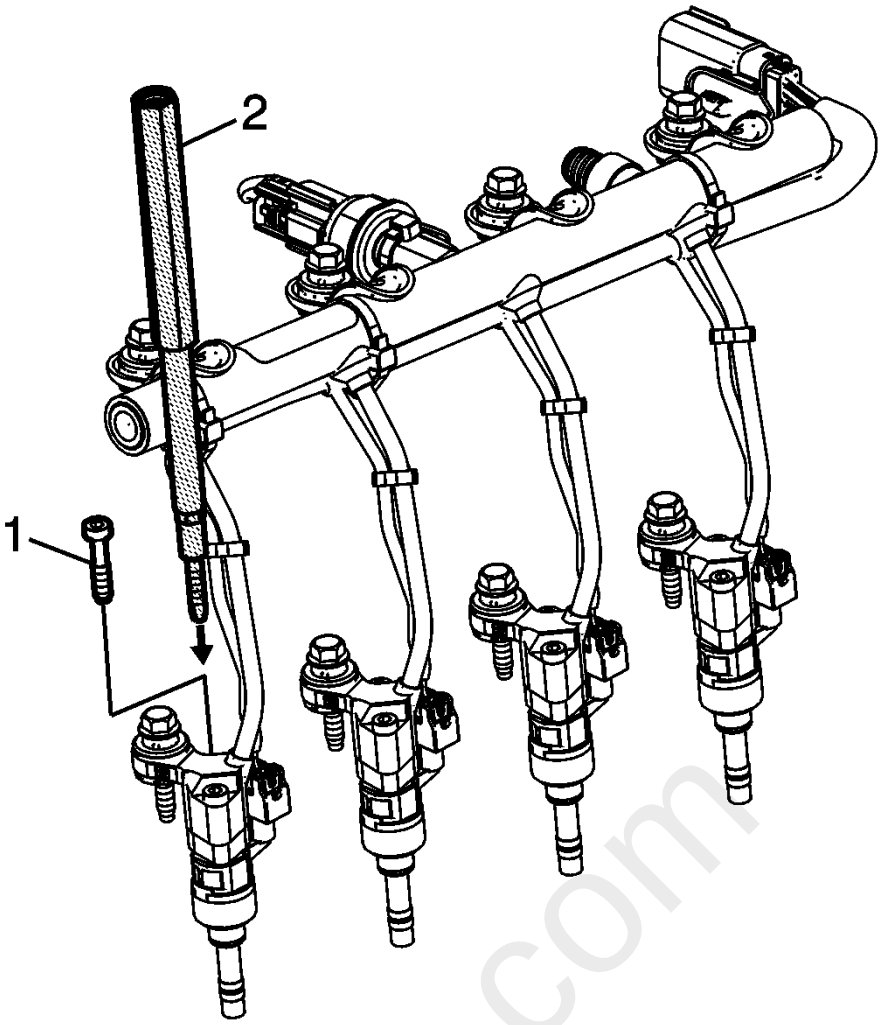


Fig. 367: Inner Fuel Injector Screw
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not loosen or remove both fuel injector screws for an individual fuel injector at the same time. Ensure the EN-51146-1-6 demounting screw and EN-51146-1-1 support is properly installed on the inner fuel injector screw location before removing the remaining outer fuel injector screw. Ensure the screws do not fall into the cylinder head slot.**

3. Remove the inner fuel injector screw (1).
4. Install one **EN-51146-1-6** demounting screws and **EN-51146-1-1** support (2) and tighten to 5 N.m (44 lb in).

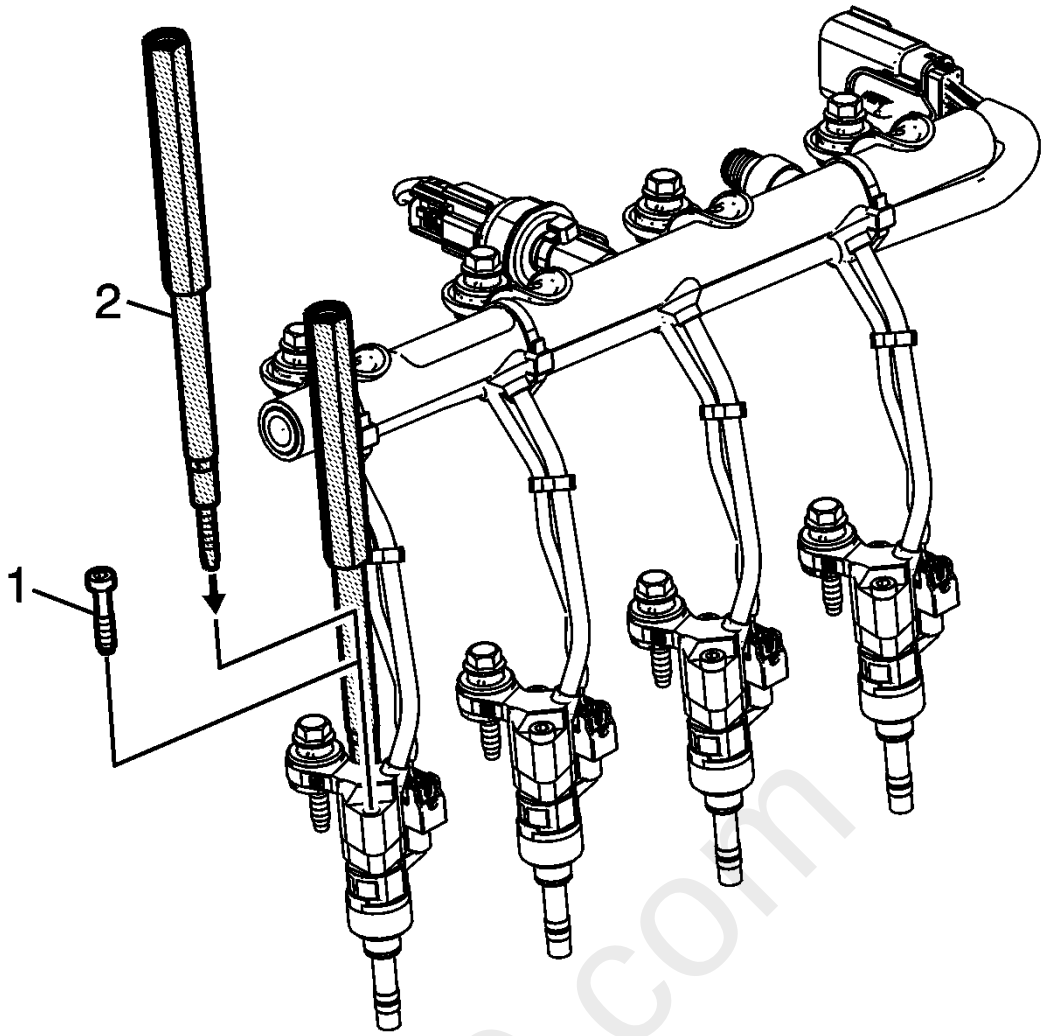


Fig. 368: Outer Fuel Injector Screw
Courtesy of GENERAL MOTORS COMPANY

5. Remove the outer fuel injector screw (1).
6. Install a second **EN-51146-1-6** demounting screws and **EN-51146-1-1** support (2) and tighten to 5 N.m (44 lb in).

mcx30.com

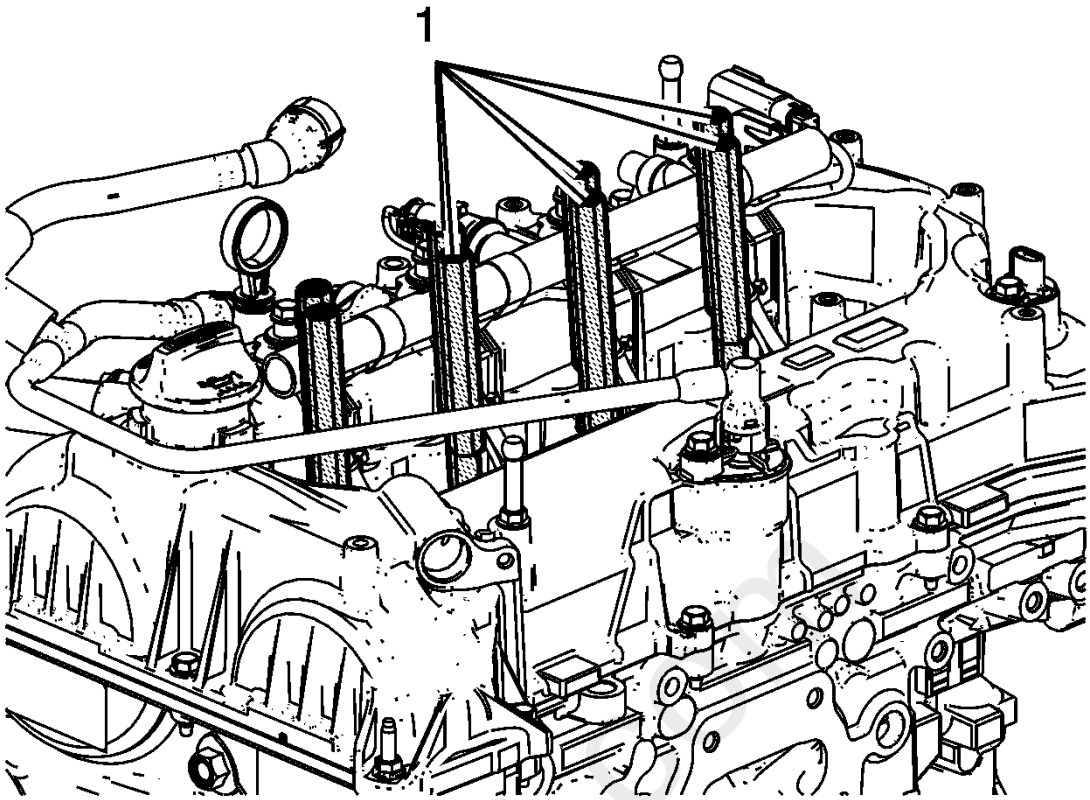


Fig. 369: Supports
Courtesy of GENERAL MOTORS COMPANY

7. Using the same procedure, install the remaining **EN-51146-1-6** demounting screws and **EN-51146-1-1** supports (1) for each fuel injector and tighten to 5 N.m (44 lb in).

mcx30.com

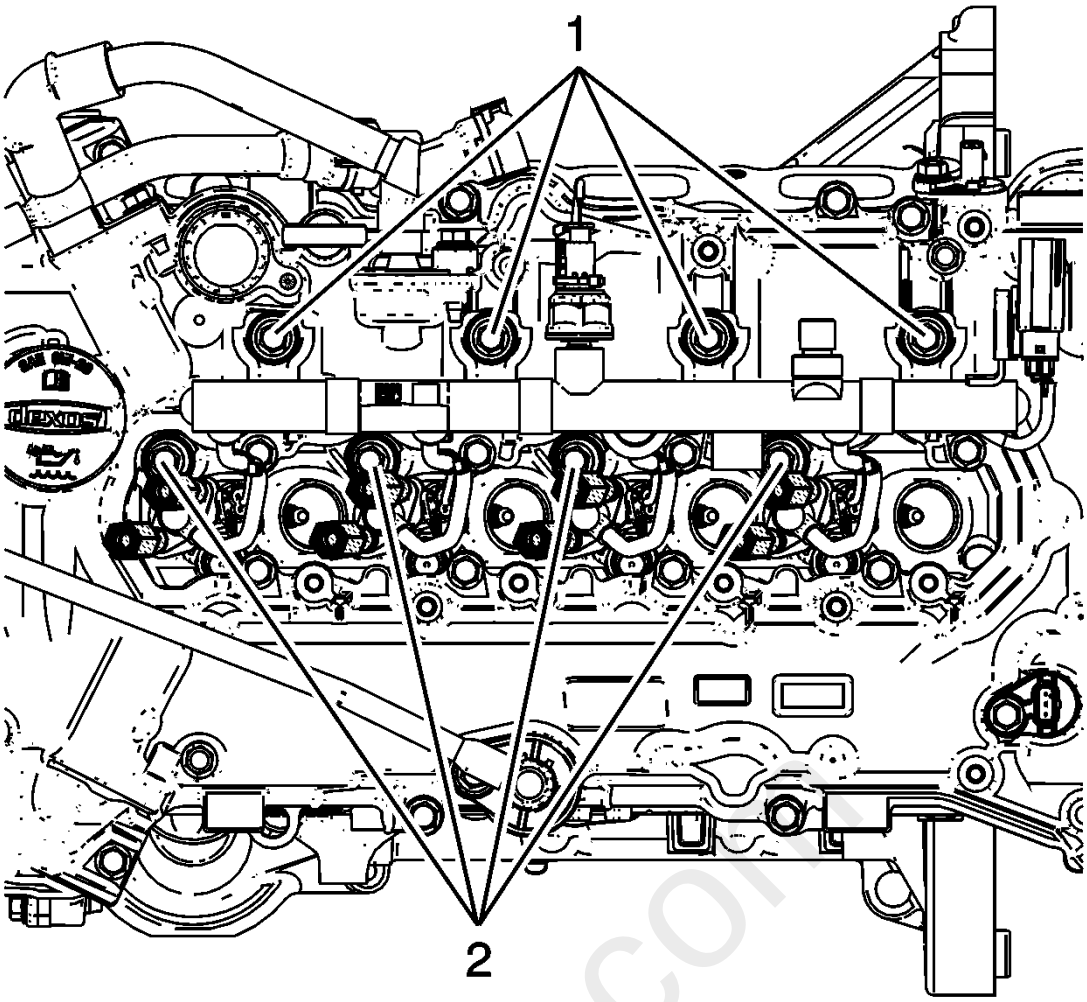


Fig. 370: Upper And Lower Fuel Rail Assembly Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The fuel rail bolts may remain with the decoupling elements and retainer at the fuel rail assembly.**

8. Loosen the 4 upper fuel rail assembly bolts (1) completely from the cylinder head, but do not remove the bolts.
9. Loosen the 4 lower fuel rail assembly bolts (2) completely from the cylinder head, but do not remove the bolts.

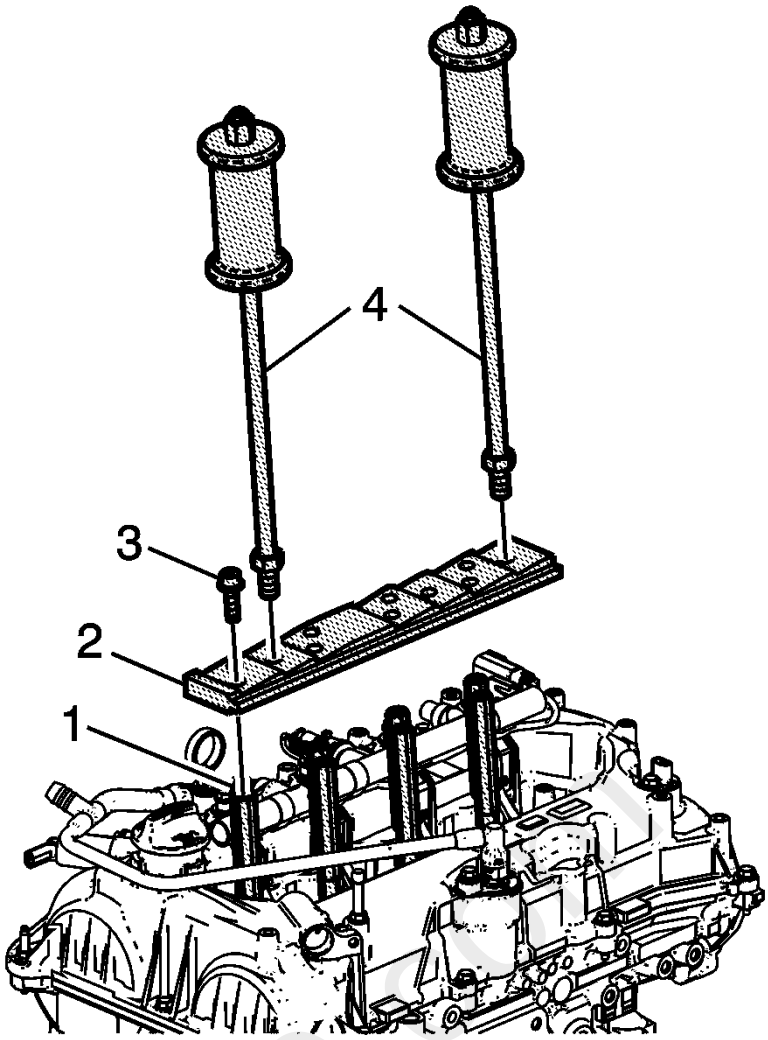


Fig. 371: Plate, Supports, Bolts And Slide Hammers
Courtesy of GENERAL MOTORS COMPANY

10. Install **EN-51146-100** plate (2) to the **EN-51146-1-1** supports (1) using the eight plate bolts (3). Counterhold each support with a wrench while tightening the bolt.
11. Install the **EN-51146-1-3** slide hammers (4) onto the **EN-51146-100** plate (2) using the outer holes.

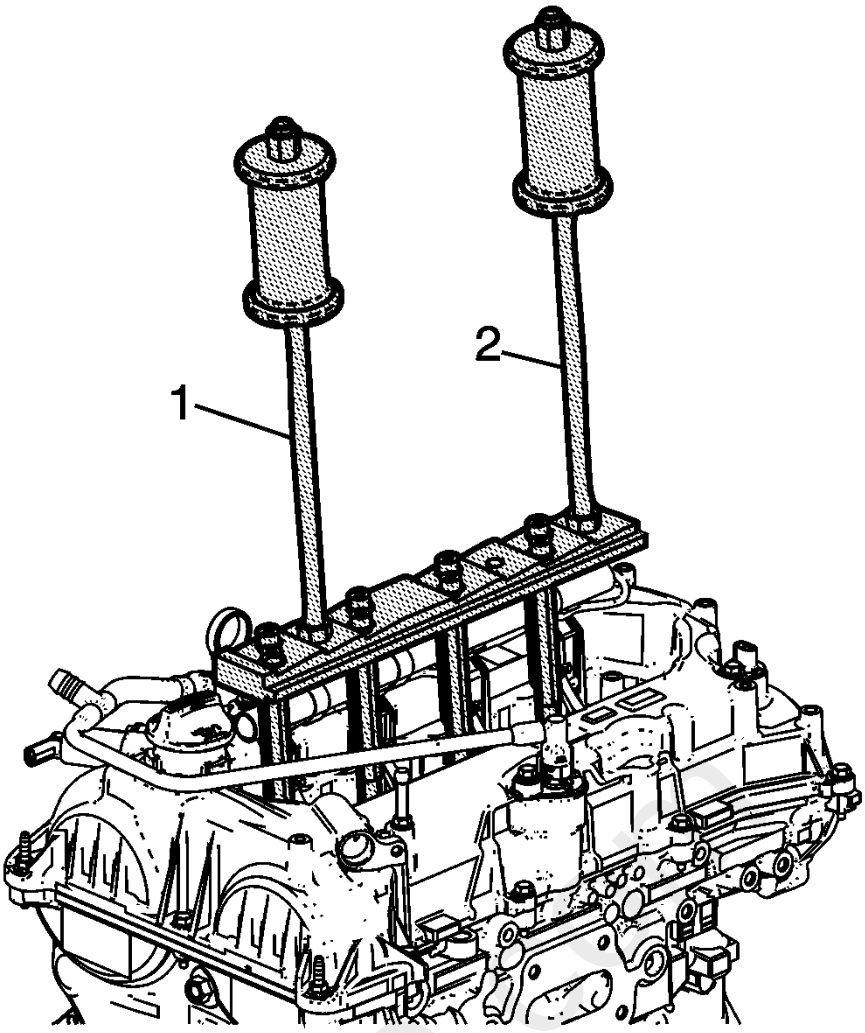


Fig. 372: Removing Fuel Injectors
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The alignment of the fuel injectors within the cylinder bores is critical for fuel injection system function. Use equal force on each slide hammer to ensure the fuel injectors are removed without tilting in the injector bore.**

12. Using the **EN-51146-1-3** slide hammers (1, 2), begin to remove the fuel injectors by applying slight force equally on both hammers. Observe the alignment of the fuel injectors, and allocate force on the hammers as necessary.

NOTE: **After removing the fuel rail and injector assembly, position the assembly on a clean work surface with the fuel injectors on top. Do not allow the weight of the assembly to rest on the fuel injectors.**

13. Complete the removal of the fuel rail and injector assembly with the **EN-51146** remover. The slide hammers may then be removed from the plate.
14. Install the **EN-51146-2-5** calibration tools onto the fuel injector tips to protect the injectors.
15. Cover the fuel injector bores at the cylinder head to prevent contamination.

CAMSHAFT COVER REMOVAL

Camshaft Cover and Gasket Removal

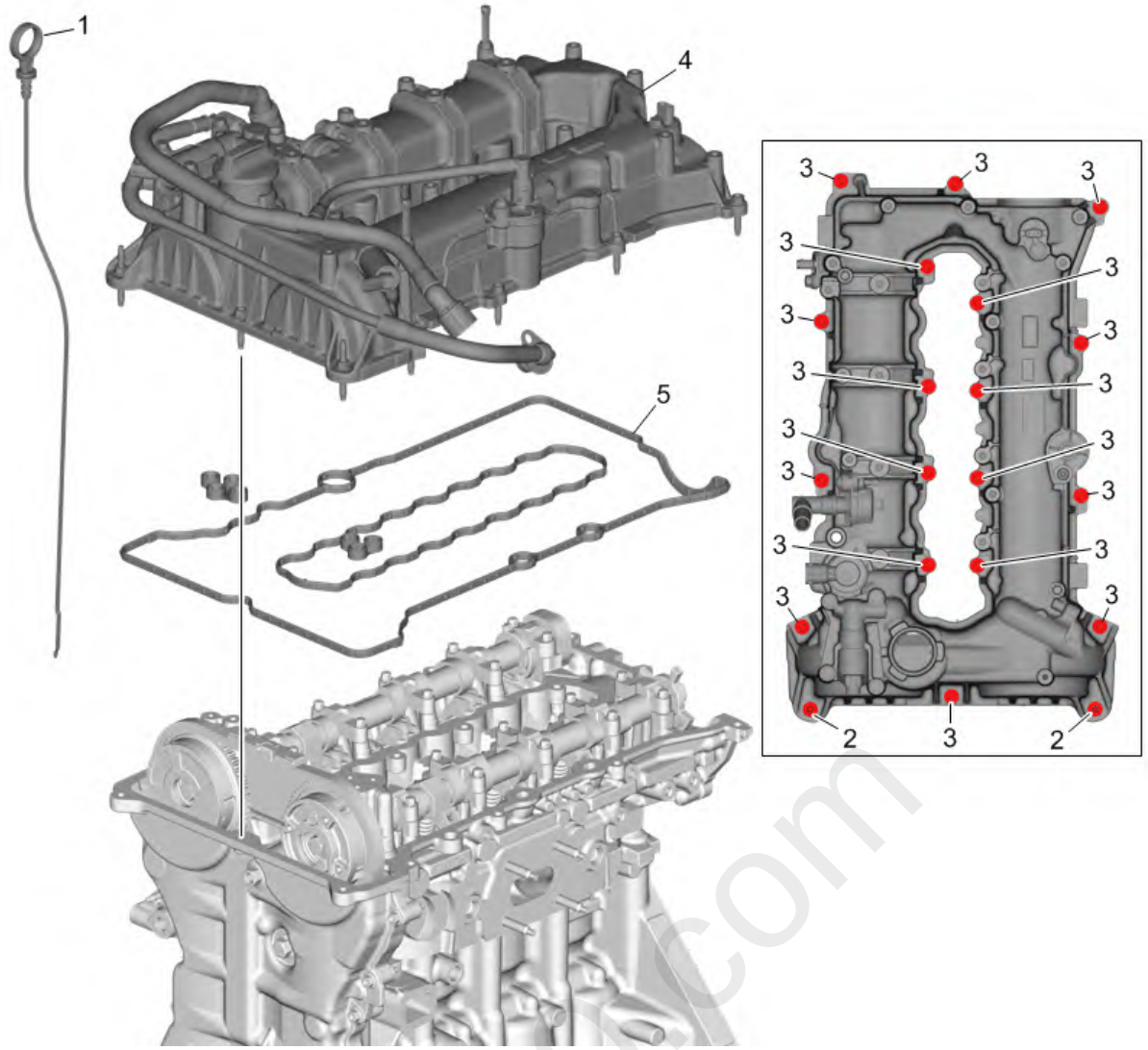


Fig. 373: Camshaft Cover and Gasket
Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover and Gasket Removal

Callout	Component Name
1	Oil Level Indicator
2	Camshaft Cover Stud [2x]
3	Camshaft Cover Bolt [18x]
4	Camshaft Cover **Procedure** Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**
5	Camshaft Cover Gasket **NOTE:** **Discard the gasket.**

Camshaft Cover Positive Crankcase Ventilation Components Removal

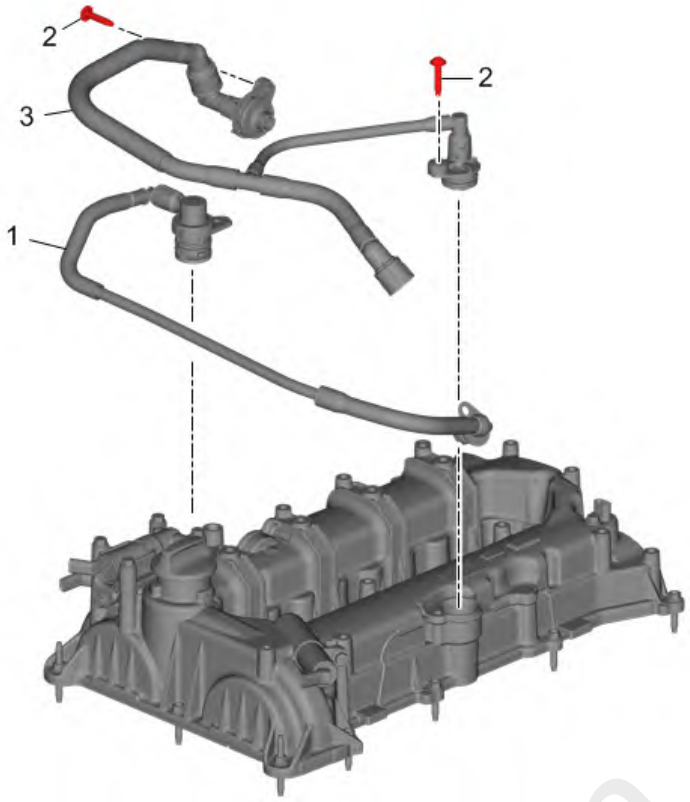


Fig. 374: Camshaft Cover Positive Crankcase Ventilation Components
Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover Positive Crankcase Ventilation Components Removal

Callout	Component Name
1	Positive Crankcase Ventilation Tube with Positive Crankcase Ventilation Valve - Foul Air **NOTE:** **These components have tamper-proof connections and cannot be disassembled. Remove this component only if inspection indicates replacement is necessary.** **Procedure** 1. Inspect all positive crankcase ventilation (PCV) components prior to removal. Do not remove the PCV components unless a diagnostic or inspection procedure indicates replacement is necessary. 2. Complete all camshaft cover inspections prior to inspecting or removing PCV components. If inspection indicates the camshaft cover requires replacement, all PCV components will be replaced with the cover. 3. Remove the PCV valve from the cover by twisting and breaking the connection. Retrieve any particles that fall onto the baffle in the cover. Discard the valve and particles.
2	Positive Crankcase Ventilation Valve Bolt [2x] **NOTE:** **Bolts are tamper-proof. Remove the bolts only if inspection of the PCV tube or valves indicates replacement is necessary.** **Procedure** 1. Using a suitable tool, cut a slot in the tamper-proof PCV bolt heads and remove with a flat-bladed tool. 2. Discard the bolts.

Callout	Component Name
3	Positive Crankcase Ventilation Tube with Positive Crankcase Ventilation Valve - Fresh Air **NOTE:** **These components have tamper-proof connections and cannot be disassembled. Remove this component only if inspection indicates replacement is necessary. The PCV tube to fresh air inlet duct connection is tamper-proof, and the inlet duct must be replaced when servicing PCV valve components.** **Procedure** 1. Inspect all PCV components and the fresh air inlet duct prior to removal. Do not remove the PCV components or inlet duct unless a diagnostic or inspection procedure indicates replacement is necessary. 2. Complete all camshaft cover inspections prior to inspecting or removing PCV components. If inspection indicates the camshaft cover requires replacement, all PCV components and inlet duct will be replaced with the cover.

Camshaft Cover Components Removal

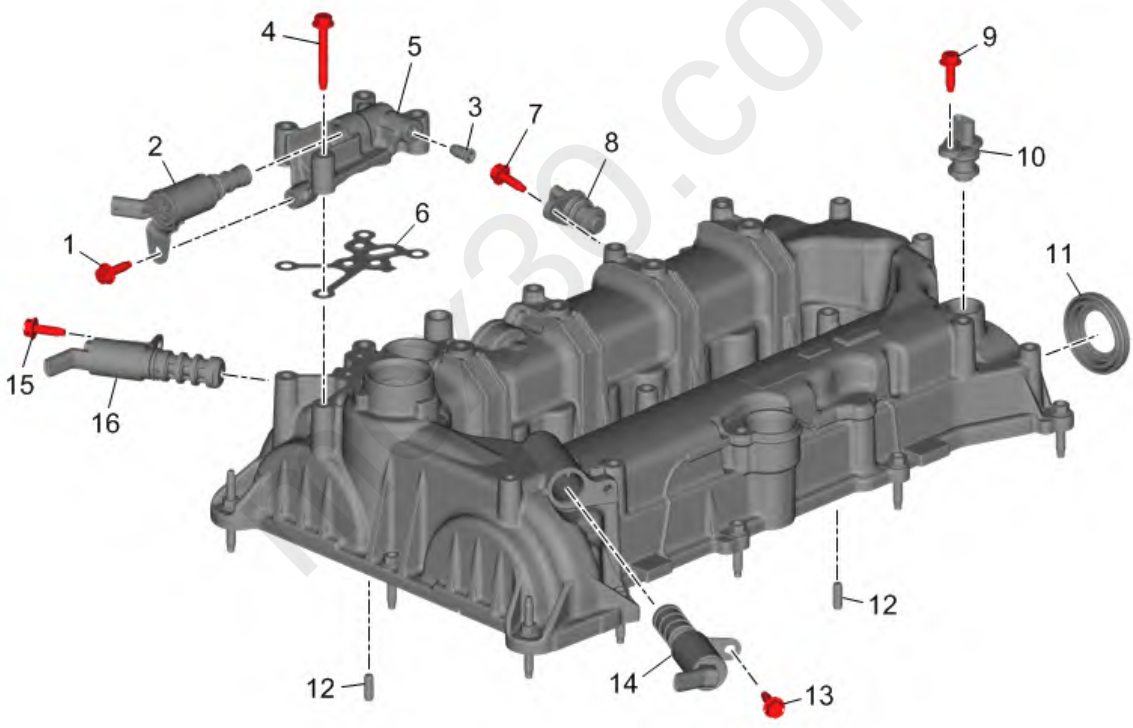


Fig. 375: Camshaft Cover Components
Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover Components Removal

Callout	Component Name
1	Camshaft Position Actuator Solenoid Valve Bolt
2	Camshaft Position Actuator Locating Pin Control Valve
3	Camshaft Cover Opening Plug
4	Camshaft Housing Bolt [4x]
5	Camshaft Housing

Callout	Component Name
6	Camshaft Housing Gasket **NOTE:** **Discard the gasket.**
7	Camshaft Position Sensor Bolt
8	Camshaft Position Sensor
9	Camshaft Position Sensor Bolt
10	Camshaft Position Sensor
11	Vacuum Pump Seal **Special Tools** **EN-51096** Seal Remover Equivalent regional tools: **Special Tools**.
12	Camshaft Cover Locating Pin [2x]
13	Camshaft Position Actuator Solenoid Valve Bolt
14	Exhaust Camshaft Position Actuator Solenoid Valve
15	Camshaft Position Actuator Solenoid Valve Bolt
16	Intake Camshaft Position Actuator Solenoid Valve

OIL PAN REMOVAL

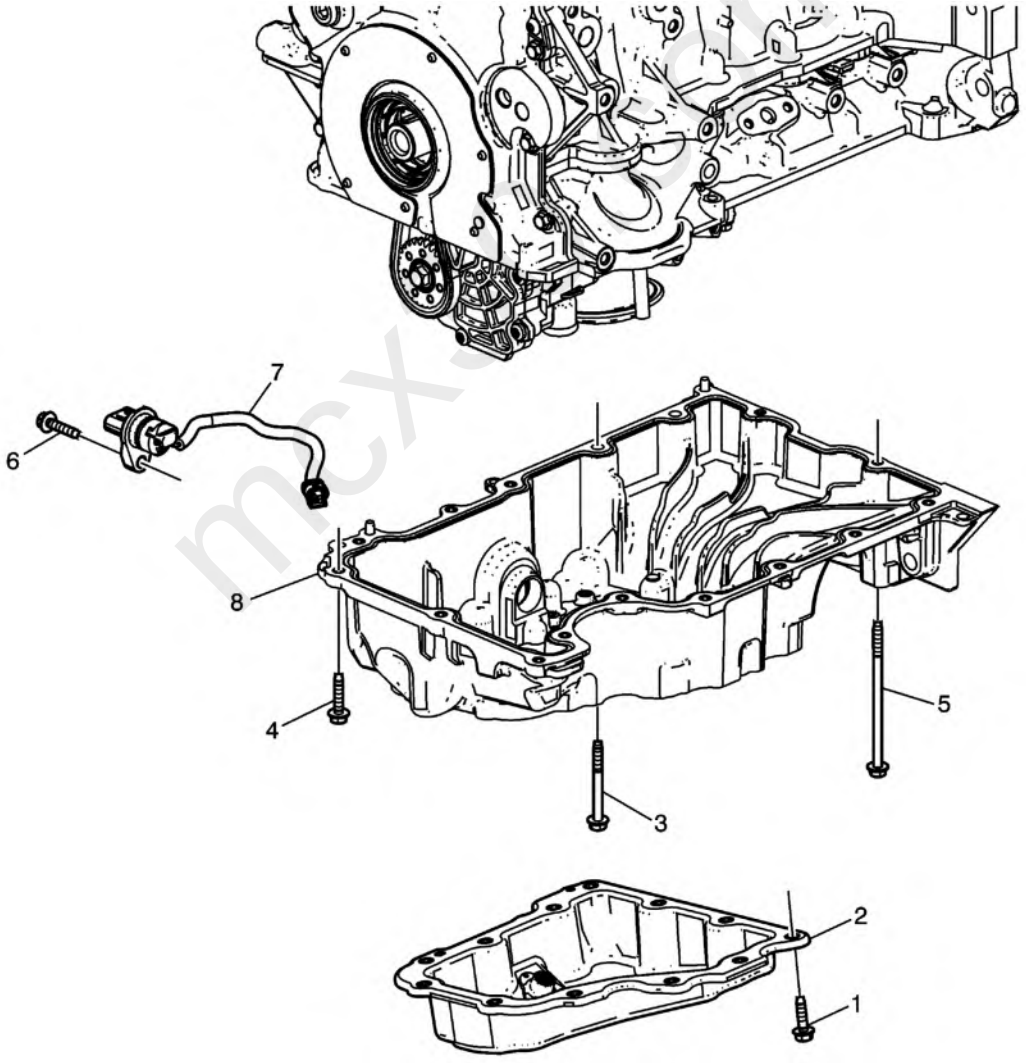


Fig. 376: Oil Pan
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Lower Oil Pan Bolt (Qty: 12)

Callout	Component Name
2	Lower Oil Pan **Procedure** Remove the oil pan drain plug, if applicable. Discard the lower oil pan.
3	Oil Pan Bolt (Qty: 2)
4	Oil Pan Bolt (Qty: 12)
5	Oil Pan Bolt (Qty: 2)
6	Wiring Harness Connector Bolt
7	Wiring Harness Connector **Procedure** Disconnect the oil pump control valve connector, then remove through the upper oil pan.
8	Upper Oil Pan Assembly

ENGINE FRONT COVER REMOVAL

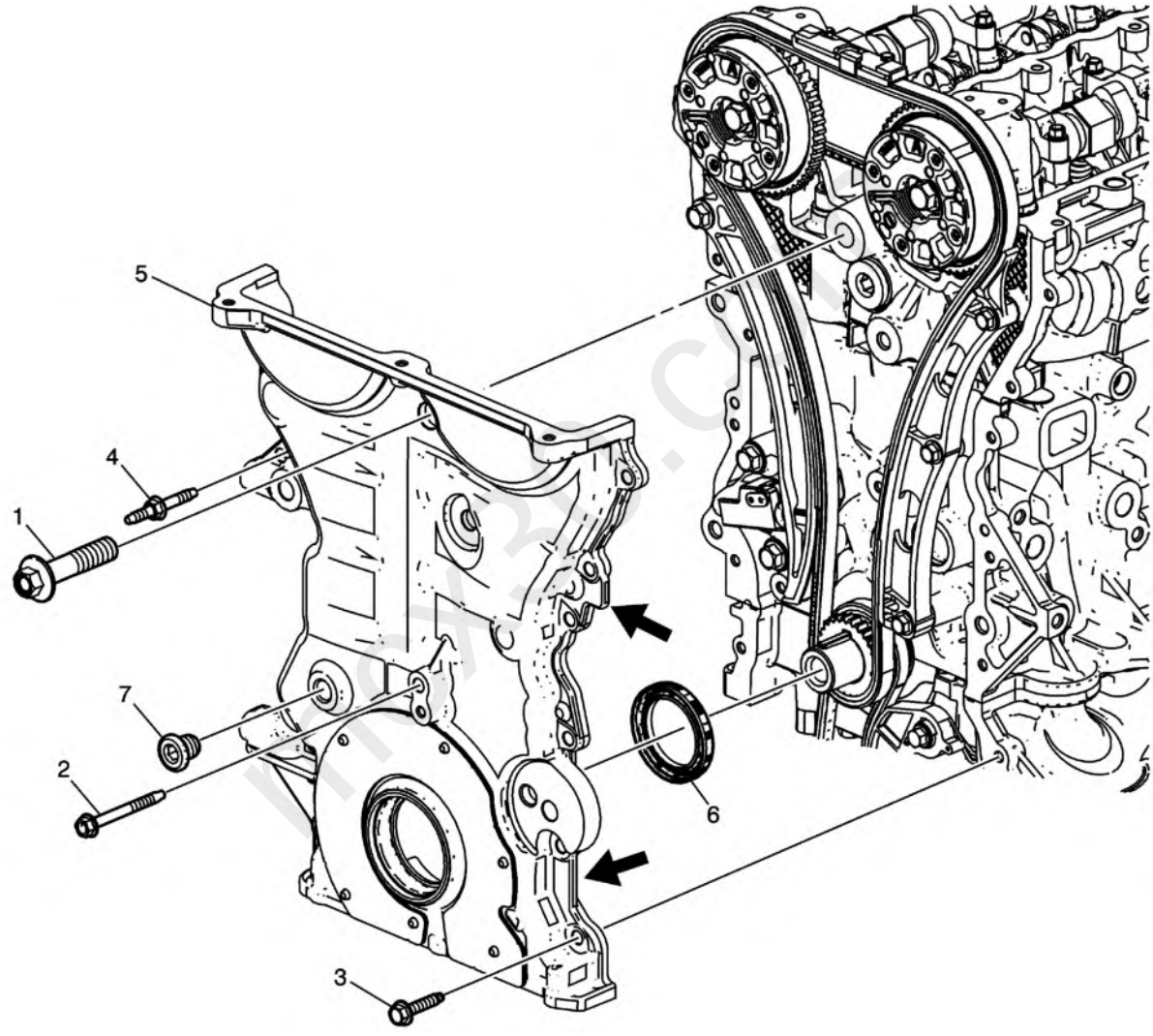


Fig. 377: Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Front Cover Bolt (Qty: 1)
2	Engine Front Cover Bolt (Qty: 1)
3	Engine Front Cover Bolt (Qty: 11)
4	Engine Front Cover Stud (Qty: 1)

Callout	Component Name
5	Engine Front Cover **Procedure** 1. Locate pry-points on the engine front cover to loosen the cover from the engine block. 2. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant** 3. Clean and inspect the engine front cover mating surface.
6	Crankshaft Front Oil Seal **Procedure** Discard the seal. **Special Tools** **EN-51096** Crankshaft Seal Remover For equivalent regional tools, refer to **Special Tools**.
7	Engine Front Cover Hole Plug

CAMSHAFT TIMING CHAIN REMOVAL

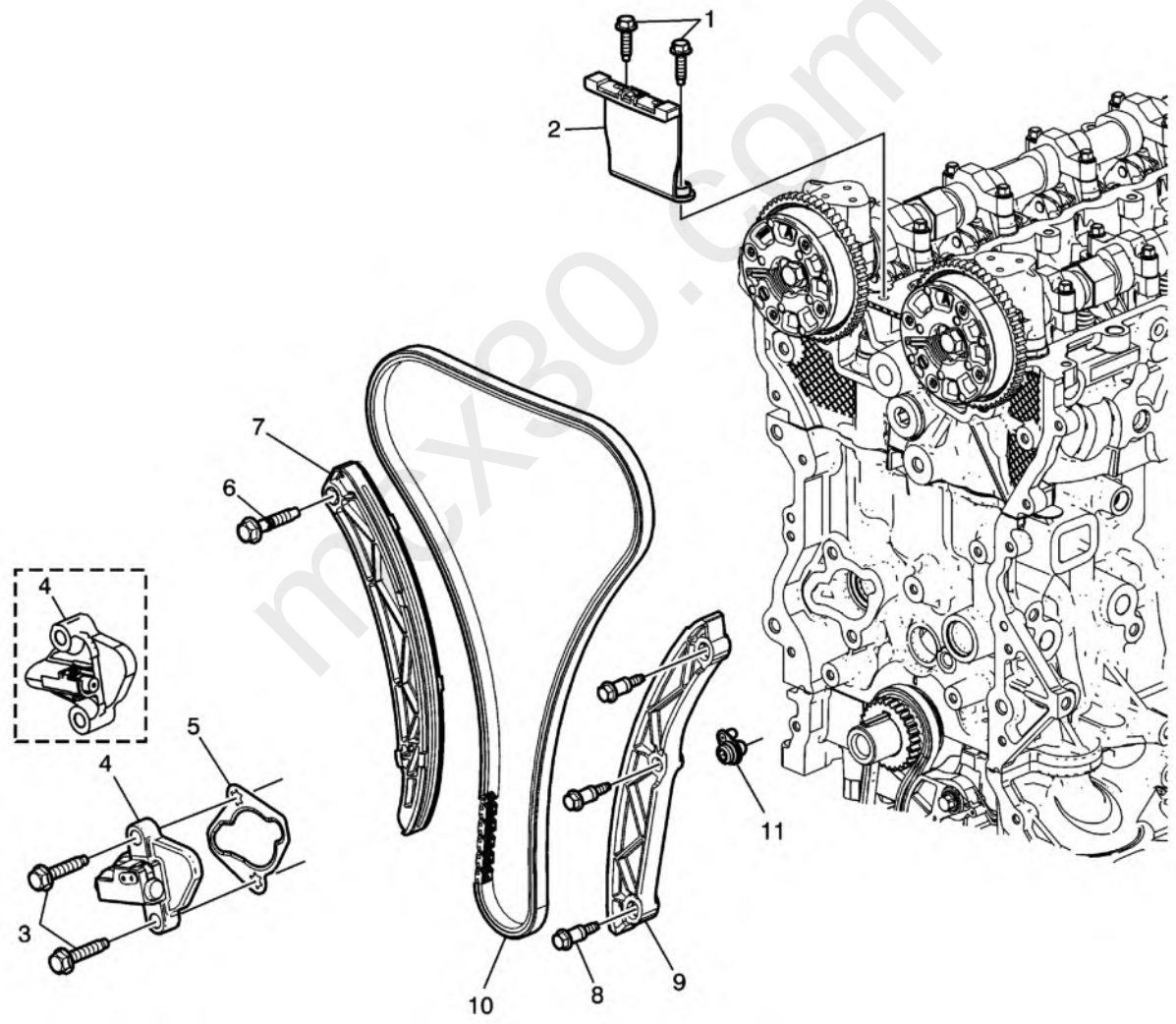


Fig. 378: Camshaft Timing Chain
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Timing Chain Guide Bolt (Qty: 2)
2	Timing Chain Guide - to Cylinder Head
3	Timing Chain Tensioner Bolt (Qty: 2)
4	Timing Chain Tensioner Assembly
5	Timing Chain Tensioner Gasket

Callout	Component Name
6	Timing Chain Tensioner Shoe Bolt (Qty: 1)
7	Timing Chain Tensioner Shoe Assembly
8	Timing Chain Guide Bolt (Qty: 3)
9	Timing Chain Guide - Exhaust Side
10	Timing Chain
11	Timing Chain Oil Nozzle

INTAKE AND EXHAUST CAMSHAFT, BEARING CAP, AND LASH ADJUSTER REMOVAL

Camshaft Actuator Removal

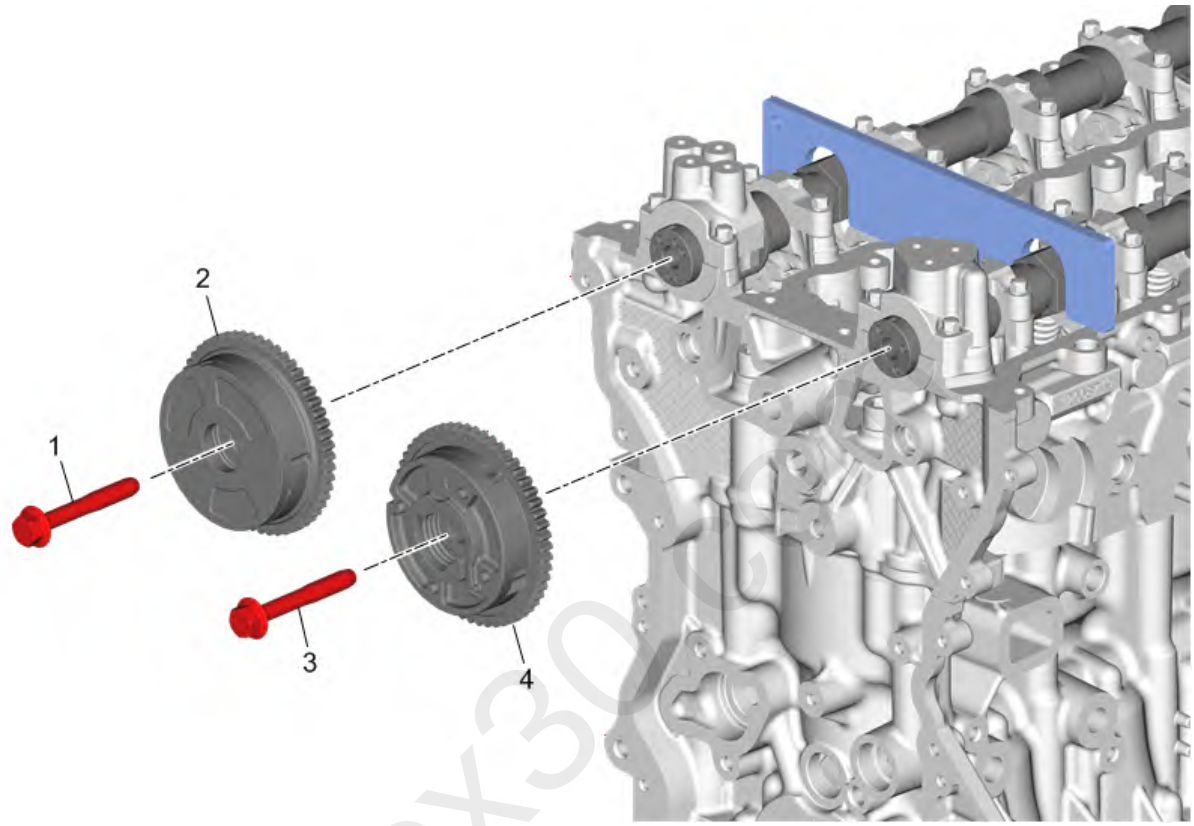


Fig. 379: Camshaft Actuator
Courtesy of GENERAL MOTORS COMPANY

Camshaft Actuator Removal

Callout	Component Name
Preliminary Procedure Install the **EN-51367** camshaft locking tool. **Special Tools** **EN-51367** Camshaft Locking Tool Equivalent regional tools: Special Tools.	
1	Camshaft Position Actuator Bolt **NOTE:** **Discard the bolt.**
2	Camshaft Position Actuator
3	Camshaft Position Actuator Bolt **NOTE:** **Discard the bolt.**
4	Camshaft Position Actuator

Camshaft Bearings and Camshaft Removal

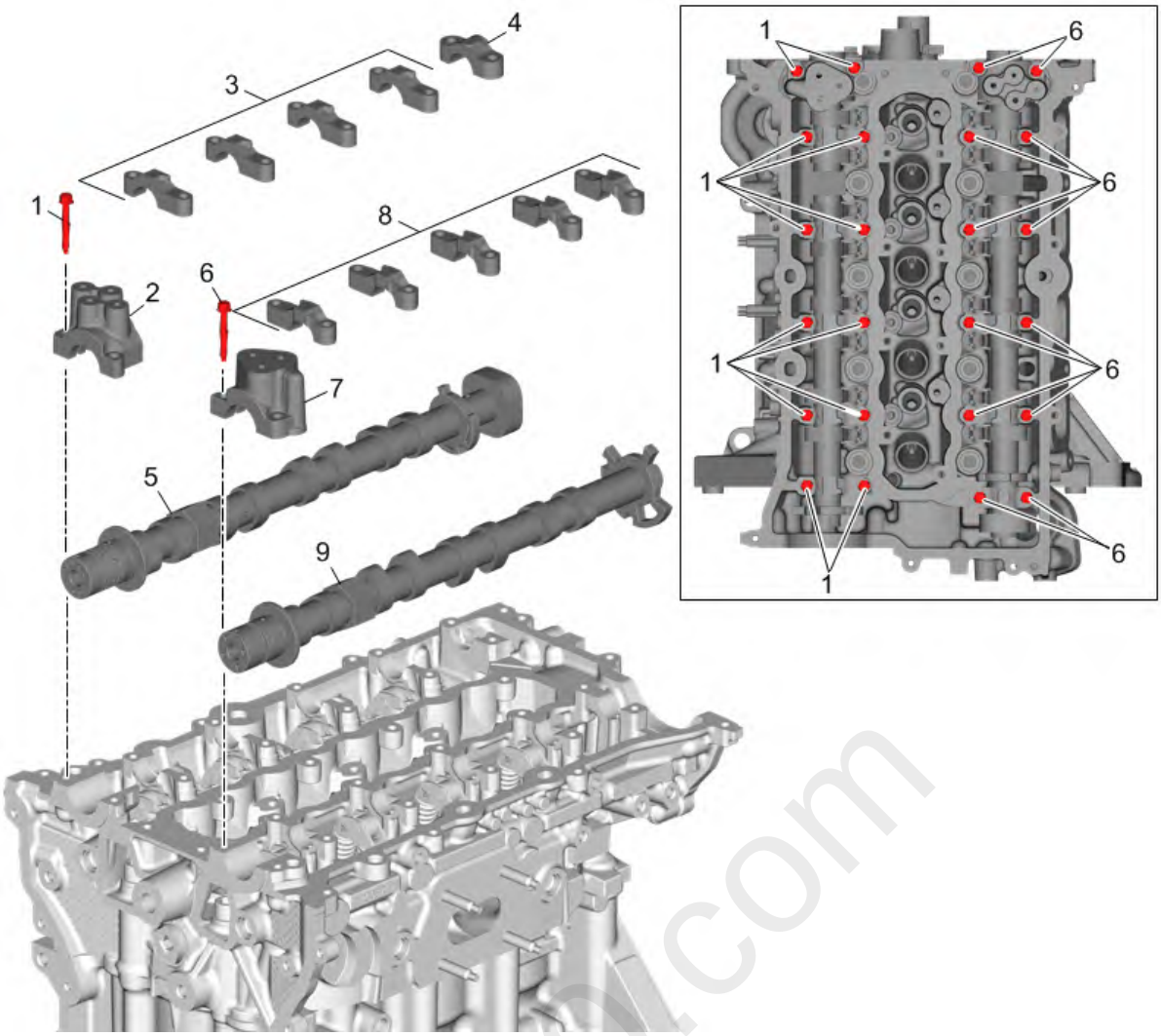


Fig. 380: Camshaft Bearings and Camshaft
Courtesy of GENERAL MOTORS COMPANY

Camshaft Bearings and Camshaft Removal

Callout	Component Name
Preliminary Procedure **NOTE:** **Many internal engine components will develop specific wear patterns on their friction surfaces.** 1. Components MUST be separated, marked, or organized in a way to ensure installation to their original location and position. Take precautions in order to prevent interchanging of parts. 2. Tag or mark each part immediately when removed. Indicate location, direction, or orientation when necessary.	
1	Camshaft Bearing Cap Bolt [12x] **Procedure** Loosen each bolt 1/2 turn to reduce spring pressure.
2	Camshaft Bearing Front Intake Cap
3	Camshaft Bearing Cap [4x] **NOTE:** **Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location.**
4	Camshaft Bearing Rear Cap

Callout	Component Name
5	Intake Camshaft
6	Camshaft Bearing Cap Bolt [12x] **Procedure** Loosen each bolt 1/2 turn to reduce spring pressure.
7	Camshaft Bearing Front Exhaust Cap
8	Camshaft Bearing Cap [5x] **NOTE:** **Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location.**
9	Exhaust Camshaft

Valve Rocker Arm and Lash Adjuster Removal

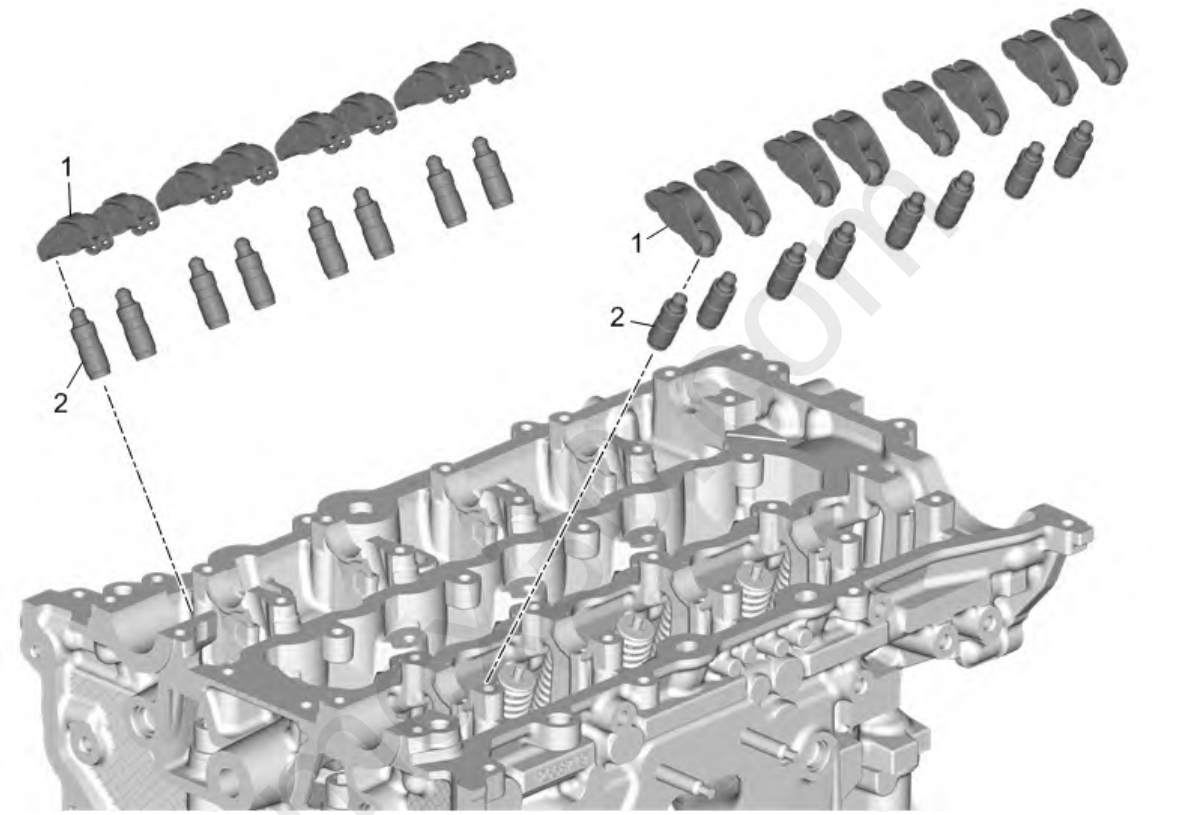


Fig. 381: Valve Rocker Arm and Lash Adjuster
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm and Lash Adjuster Removal

Callout	Component Name
Preliminary Procedure **NOTE:** **Many internal engine components will develop specific wear patterns on their friction surfaces.** 1. Components MUST be separated, marked, or organized in a way to ensure installation to their original location and position. Take precautions in order to prevent interchanging of parts. 2. Tag or mark each part immediately when removed. Indicate location, direction, or orientation when necessary.	
1	Hydraulic Valve Lash Adjuster Arm [16x]
2	Hydraulic Valve Lash Adjuster [16x]

CYLINDER HEAD REMOVAL

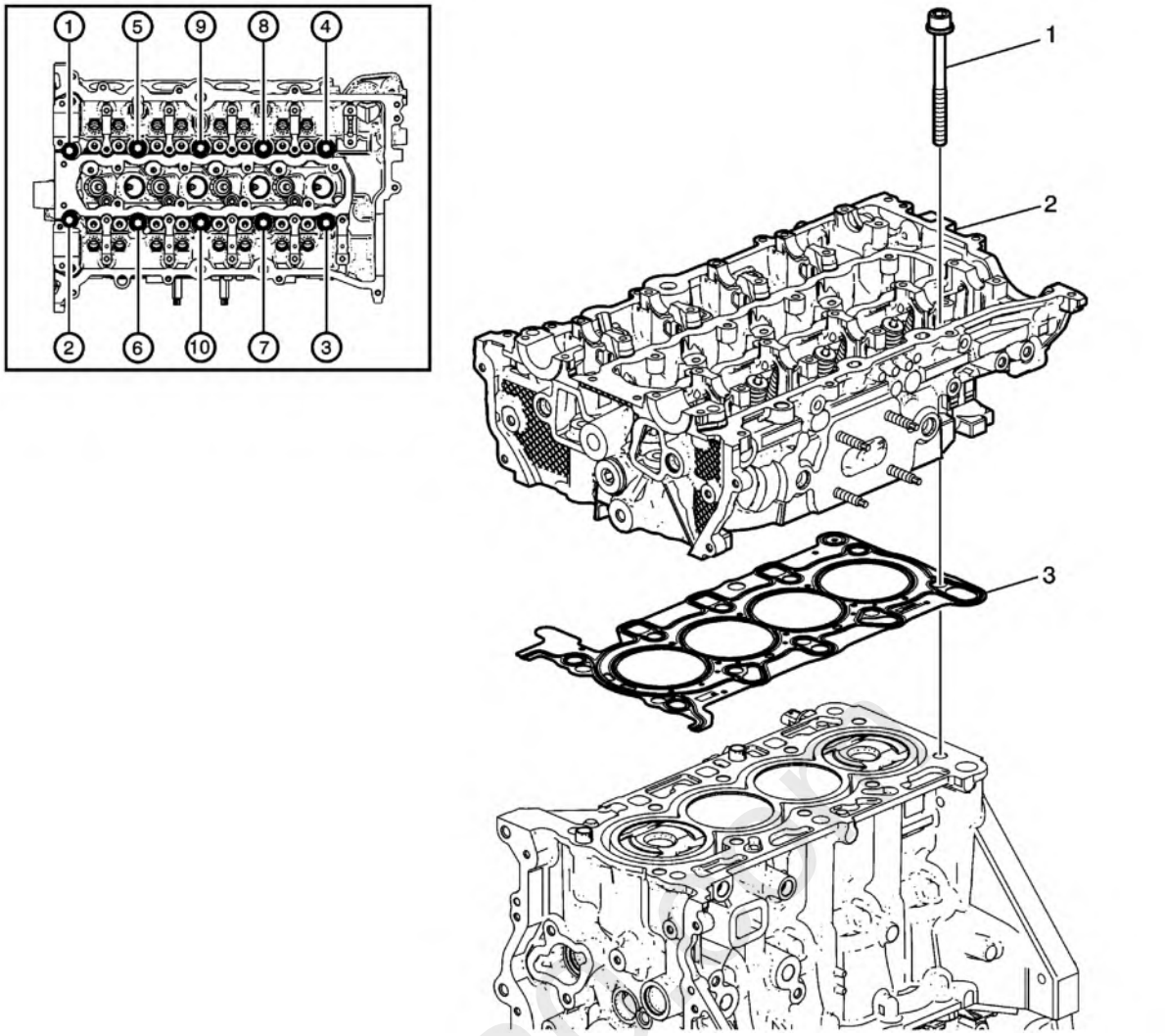


Fig. 382: Cylinder Head (With Loosening/Tightening Sequence)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Cylinder Head Bolt (Qty: 10) **Procedure** Remove the bolts in sequence. Discard the bolts.
2	Cylinder Head Assembly
3	Cylinder Head Gasket

OIL PUMP DRIVE CHAIN AND OIL PUMP REMOVAL

Oil Pump Drive Chain and Crankshaft Sprocket Removal

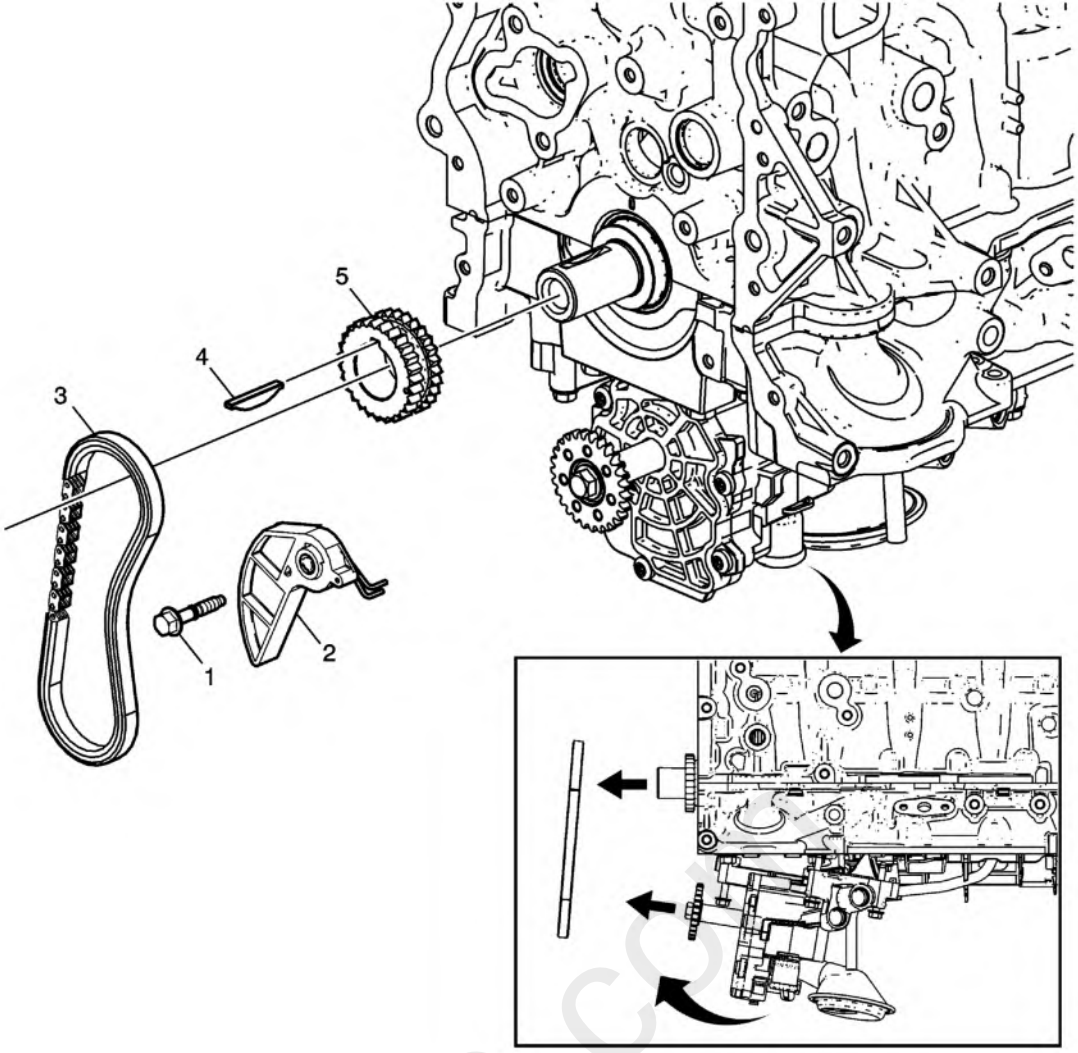


Fig. 383: Oil Pump Drive Chain and Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

Oil Pump Drive Chain and Crankshaft Sprocket Removal

Callout	Component Name
1	Oil Pump Drive Chain Tensioner Bolt
2	Oil Pump Drive Chain Tensioner
3	Oil Pump Drive Chain **Procedure** Loosen the oil pump assembly bolts and tilt the oil pump assembly in order to remove the drive chain.
4	Crankshaft Balancer Key
5	Crankshaft Sprocket

Oil Pump Assembly Removal

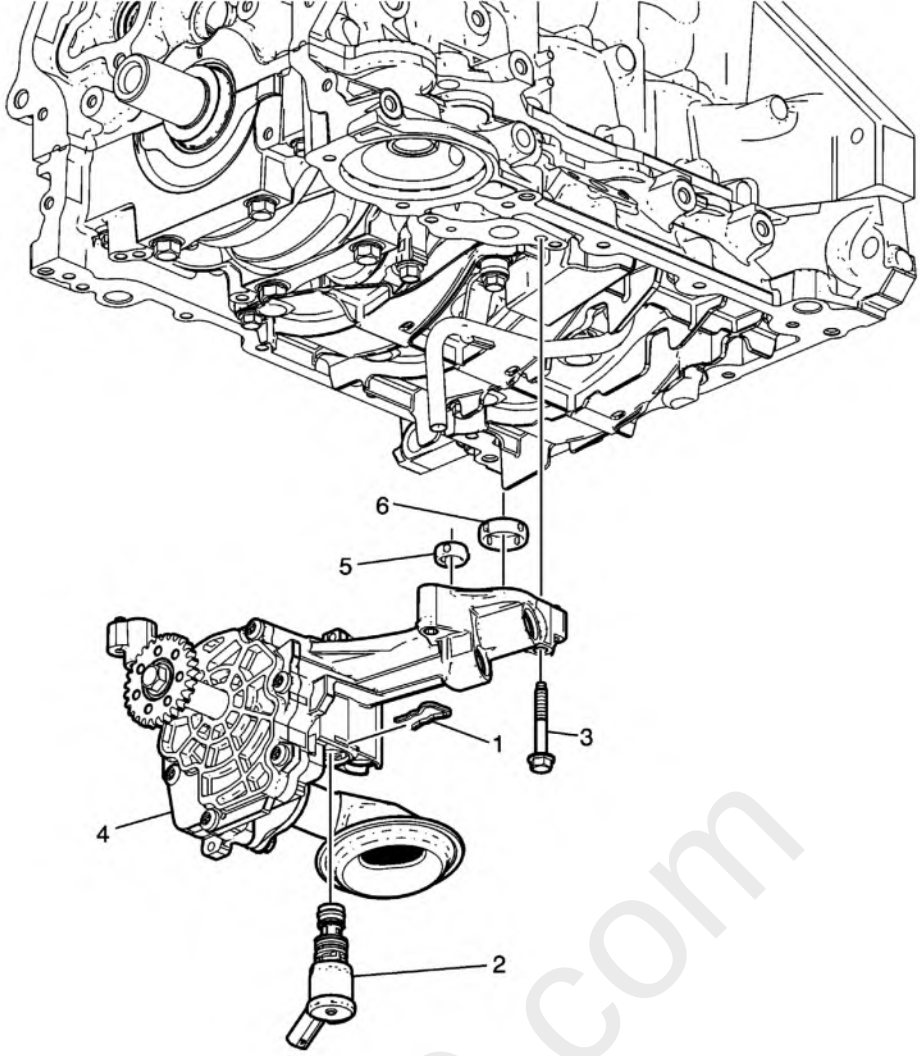


Fig. 384: Oil Pump Assembly
Courtesy of GENERAL MOTORS COMPANY

Oil Pump Assembly Removal

Callout	Component Name
1	Oil Pump Flow Control Solenoid Valve Retainer
2	Oil Pump Flow Control Solenoid Valve
3	Oil Pump Assembly Bolt (Qty: 4)
4	Oil Pump Assembly
5	Oil Pump Gasket
6	Oil Pump Gasket

CRANKSHAFT OIL DEFLECTOR REMOVAL

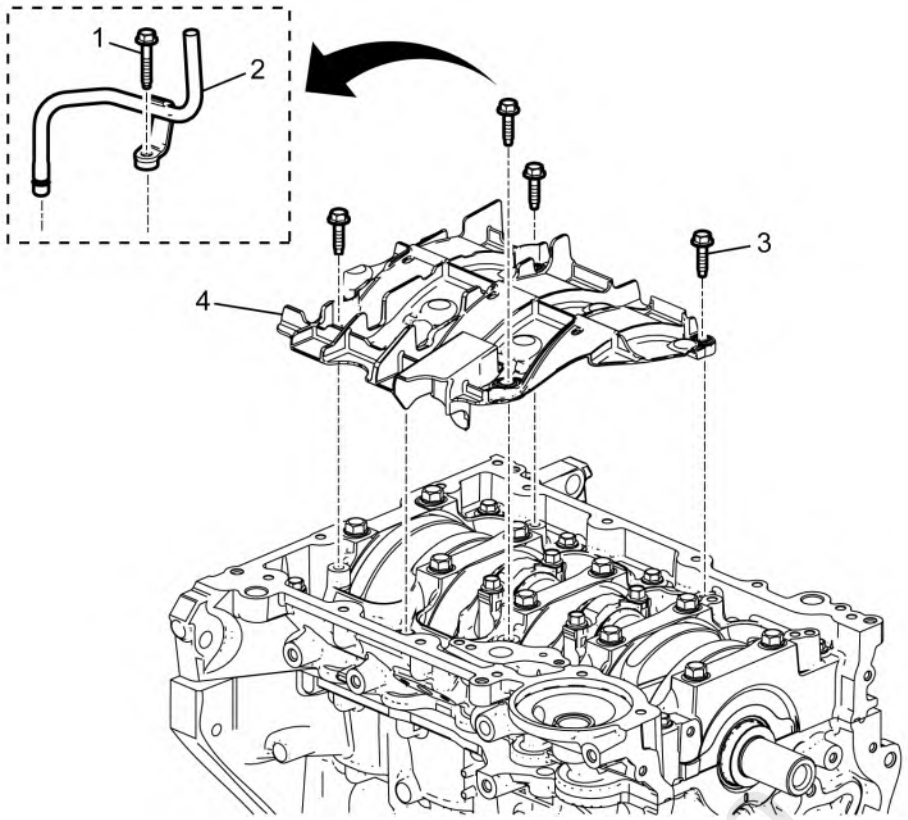


Fig. 385: Crankshaft Oil Deflector
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Positive Crankcase Ventilation Oil Separator Drain Pipe Bolt
2	Positive Crankcase Ventilation Oil Separator Drain Pipe
3	Crankshaft Oil Deflector Bolt (Qty: 3)
4	Crankshaft Oil Deflector

LOWER CRANKCASE REMOVAL

mcx30.com

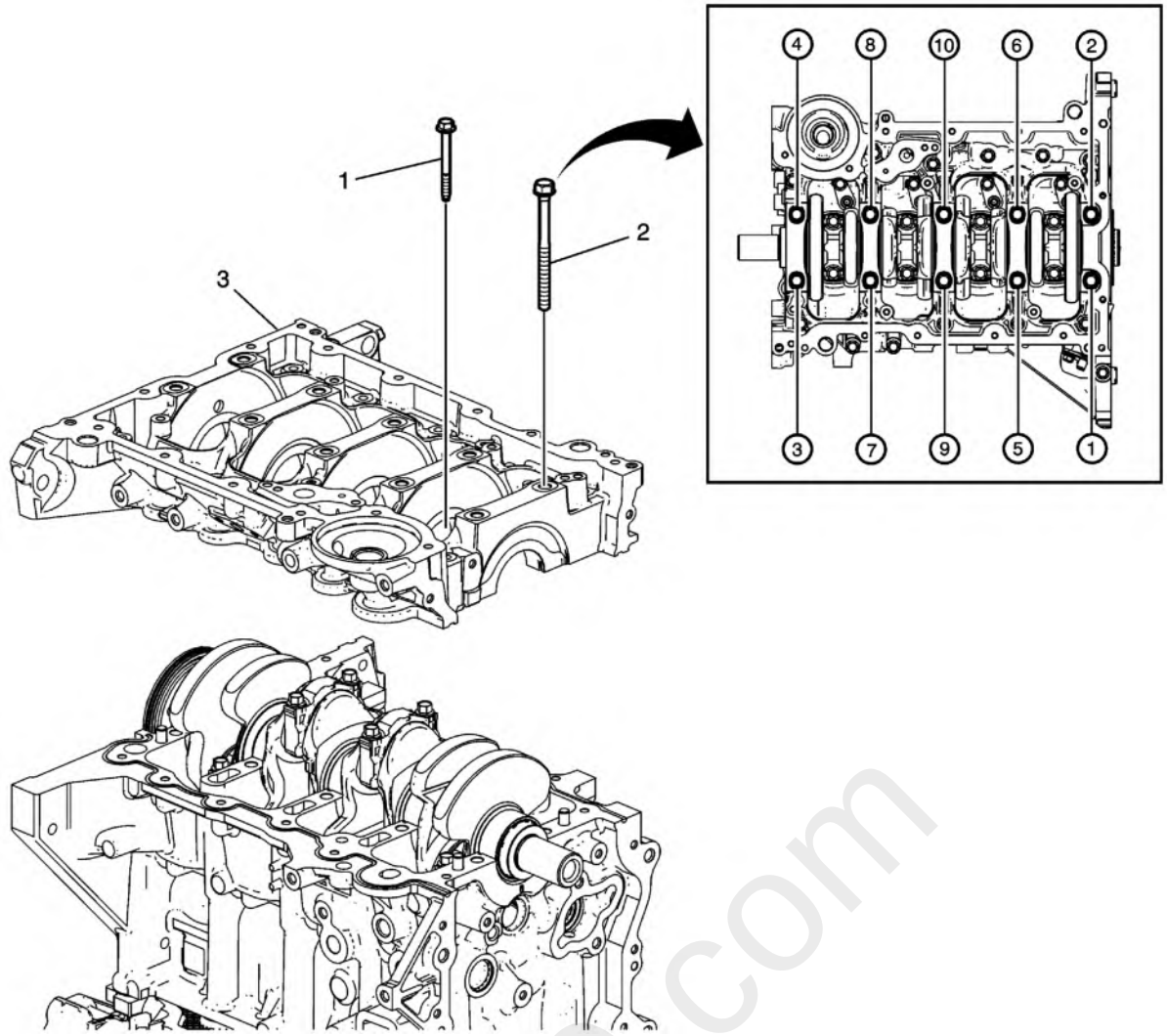


Fig. 386: Lower Crankcase (With Bolt Removal Sequence)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Lower Crankcase Bolt - Perimeter (Qty: 13)
2	Lower Crankcase Bolt (Qty: 10) **Procedure** Remove bolts in sequence. Discard the bolts.
3	Lower Crankcase

PISTON, CONNECTING ROD, AND BEARING REMOVAL

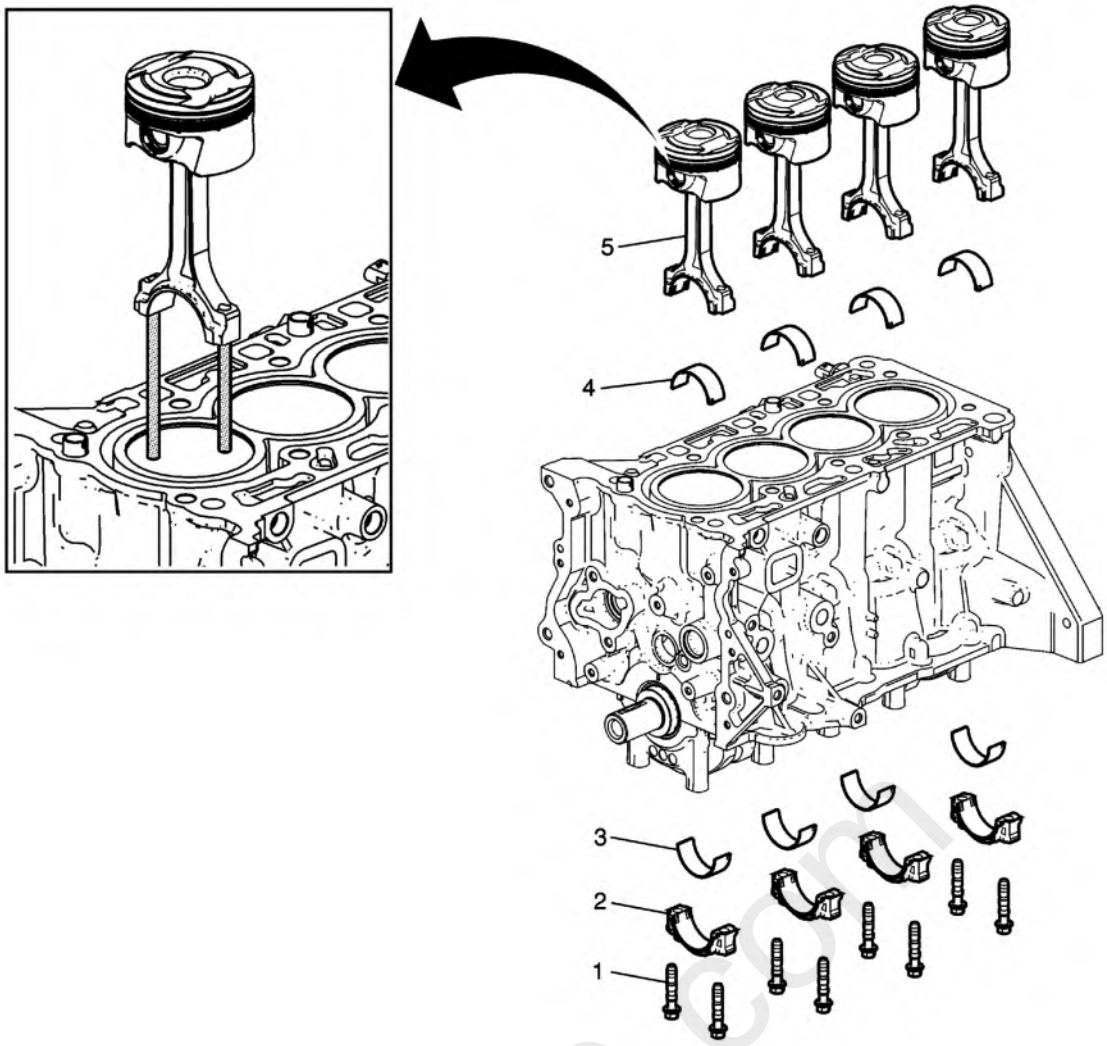


Fig. 387: Piston, Connecting Rod, and Bearing
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

mcx30.com

Callout	Component Name

Preliminary Procedure

NOTE:

Many internal engine components will develop specific wear patterns on their friction surfaces.

1. Components MUST be separated, marked, or organized in a way to ensure installation to their original location and position. Take precautions in order to prevent interchanging of parts.
2. Tag or mark each part immediately when removed. Indicate location, direction, or orientation when necessary.
3. 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**
    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.

NOTE:

An arrow/dot showing proper piston orientation is located on the top of the piston.

4. 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.

5. Mark the cylinder number on the connecting rod and the connecting rod cap with a scribe, paint stick or permanent marker.

1	Connecting Rod Bolt (Qty: 8) **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.** **Procedure** DO NOT use the bolts for reinstallation. The bolts may be used to keep the parts together and for inspection and specification measurements.

Callout	Component Name
2	Connecting Rod Assembly (Qty: 4) **NOTE:** **The connecting rod caps must remain with the original connecting rod. The caps must be oriented identical to original installation.** **Procedure** Mark the side of the rod with a line that crosses the interface of the rod and cap. Use this line to ensure that the cap and rod are reinstalled in the same orientation.
3	Connecting Rod Bearing (Qty: 4) **NOTE:** **If the connecting rod bearings have been used in a running engine, you must replace them with NEW connecting rod bearings for reassembly.**
4	Connecting Rod Bearing (Qty: 4) **NOTE:** **If the connecting rod bearings have been used in a running engine, you must replace them with NEW connecting rod bearings for reassembly.**
5	Connecting Rod Assembly (Qty: 4) **NOTE:** **Piston assembly attached.** **Procedure** Using the **EN-51454** guides, 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. **Special Tools** **EN-51454** Connecting Rod Guides For equivalent regional tools, refer to **Special Tools**.

CRANKSHAFT AND BEARING REMOVAL

mx30.com

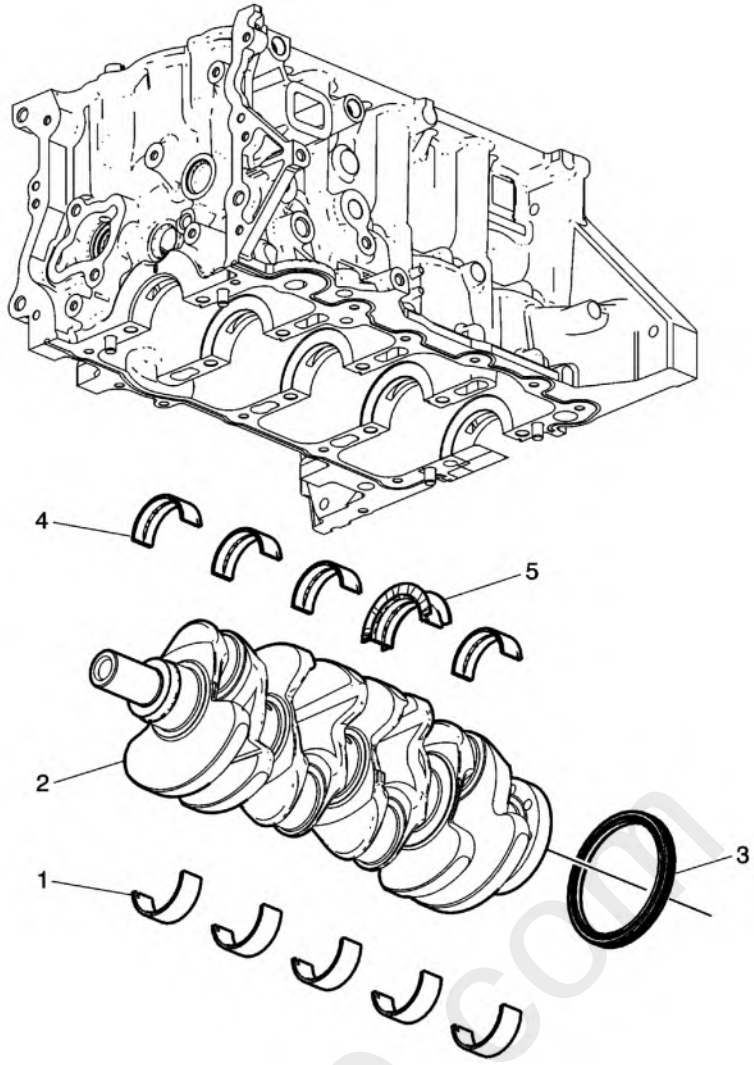


Fig. 388: Crankshaft and Bearing
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Crankshaft Lower Bearing (Qty: 5) **NOTE:** • **Crankshaft bearings MUST be separated, marked, or organized in a way to ensure installation to their original location and position, when suitable for use.** • **If the lower half of the bearing is worn or damaged, both upper and lower halves should be replaced.**
2	Crankshaft Assembly
3	Crankshaft Rear Oil Seal
4	Crankshaft Upper Bearing (Qty: 4)
5	Crankshaft Thrust Upper Bearing

CYLINDER HEAD DISASSEMBLE

Intake and Exhaust Valve Removal

mcx30.com

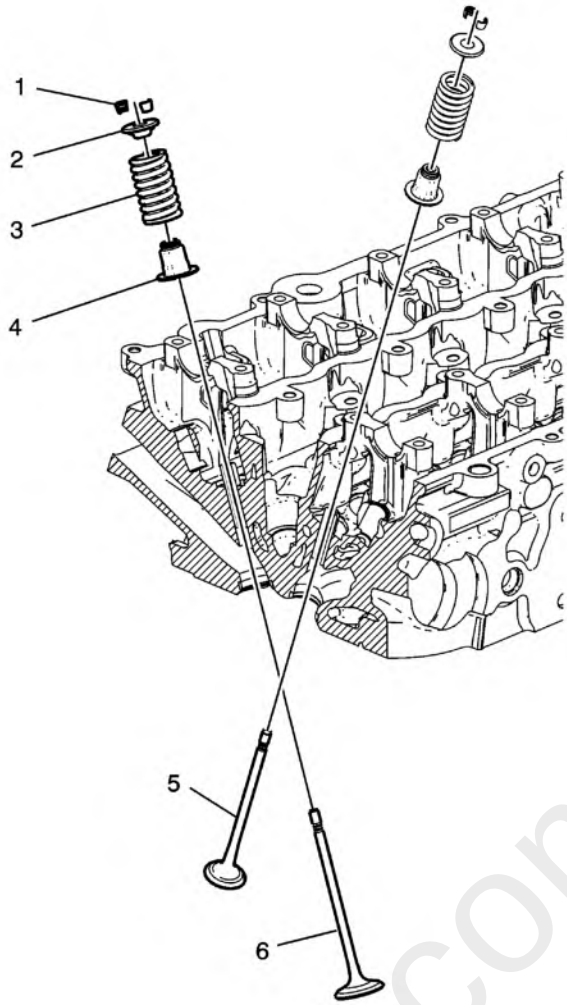


Fig. 389: Intake and Exhaust Valve
Courtesy of GENERAL MOTORS COMPANY

Intake and Exhaust Valve Removal

Callout	Component Name
Preliminary Procedure	

NOTE:
Many internal engine components will develop specific wear patterns on their friction surfaces.

1. Components MUST be separated, marked, or organized in a way to ensure installation to their original location and position. Take precautions in order to prevent interchanging of parts.
2. Tag or mark each part immediately when removed. Indicate location, direction, or orientation when necessary.

mcx30.com

Callout	Component Name
1	Valve Stem Key - Intake, Exhaust (Qty: 32) **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 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 less than 25.0 mm (0.984 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.** **Procedure** 1. Using the **EN-8062** compressor and the **EN-43963** compressor adapter, compress the valve spring. 2. Remove the valve stem keys. **Special Tools** • **EN-8062** Valve Spring Compressor • **EN-43963** Valve Spring Compressor - Off-Car Adapter • **EN-50717** Compressor Adapter For equivalent regional tools, refer to **Special Tools**.
2	Valve Spring Retainer (Qty: 16) **Procedure** 1. Slowly release the **EN-8062** compressor and the **EN-43963** compressor adapter from the valve spring assembly. 2. Remove the valve spring retainer.
3	Valve Springs (Qty: 16)
4	Valve Stem Oil Seal (Qty: 16) **CAUTION:** **Do not damage the valve guide. Remove any burrs that have formed at the key groove by chamfering the valve stem with an oil stone or a file.** **Procedure** Using **EN-46116** remover, remove the seals. Discard all used seals and replace with new. **Special Tools** **EN-46116** Valve Seal Remover For equivalent regional tools, refer to **Special Tools**.
5	Exhaust Valve (Qty: 8)
6	Intake Valve (Qty: 8)

mcx30.com

Cylinder Head Oil Gallery Plugs, Turbocharger Studs, Spark Plugs, and Engine Oil Manifold Check Valve Removal

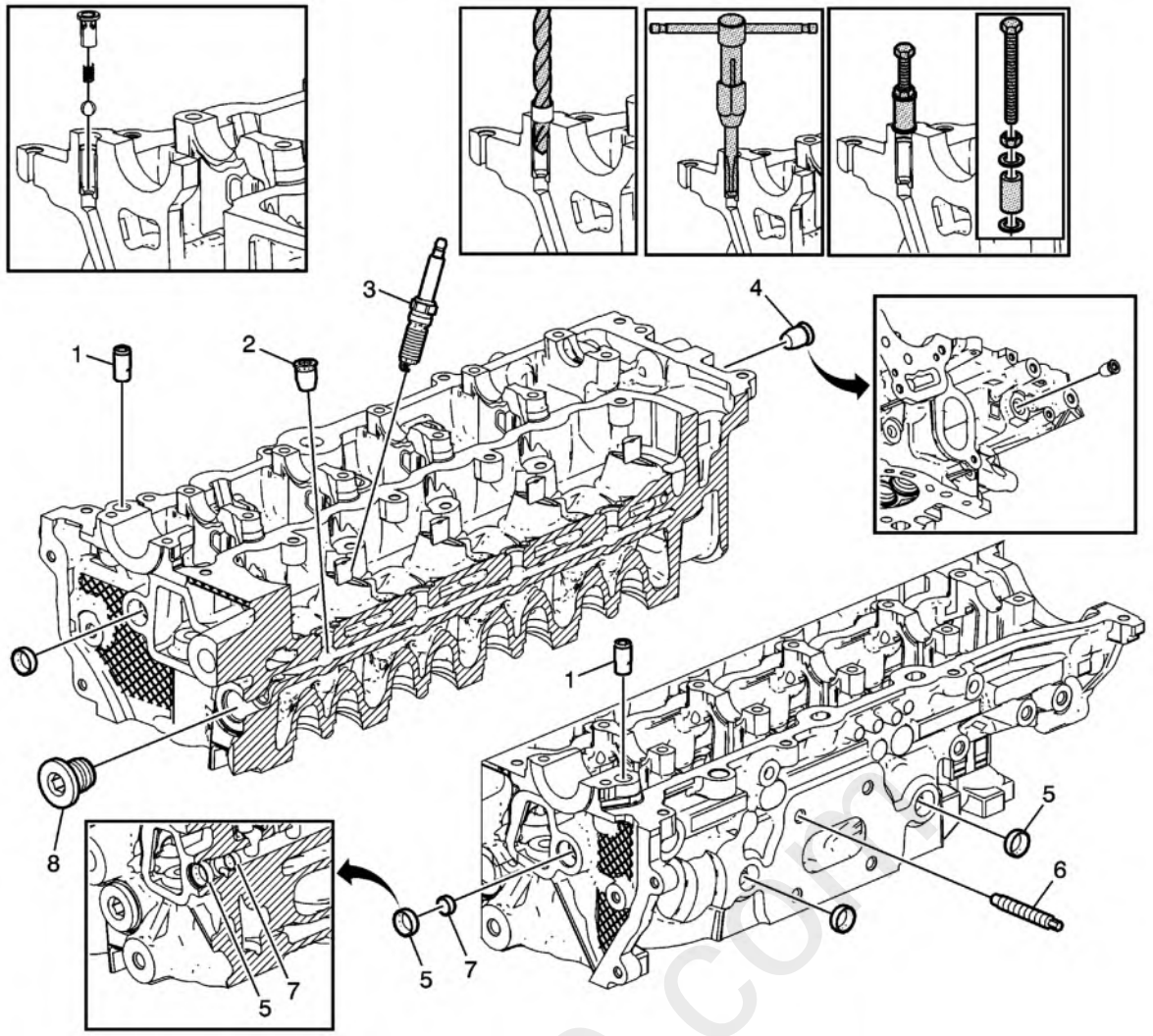


Fig. 390: Cylinder Head Oil Gallery Plugs, Turbocharger Studs, Spark Plugs, and Engine Oil Manifold Check Valve
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head Oil Gallery Plugs, Turbocharger Studs, Spark Plugs, and Engine Oil Manifold Check Valve Removal

Callout	Component Name

mc30.com

Callout	Component Name
1	Engine Oil Manifold Check Valve (Qty: 2) **Procedure** 1. Inspect the oil feed check valves. Damaged, restricted or clogged check valves must be replaced. If check valves are OK, disregard remaining steps which detail replacing the check valves. 2. Insert a punch or drift into the check valve. With moderate pressure, seat the punch into the inner body of the check valve, and remove the upper part of the valve. 3. Remove check ball and check ball spring from inside of check valve. 4. Using **EN-46122-3** drill bit, drill the remainder of check valve sleeve to a depth of approximately 19 mm (0.75 in) 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. 5. Lubricate **EN-46122-4** tap with lubricant. Tap drilled out portion of check valve remaining in cylinder head. Tap to full depth possible until tap bottoms out in head. 6. Assemble **EN-46122-2** bolt, nut, washers, and collar. Position collar with slightly-larger inside diameter DOWN toward the cylinder head. 7. Screw bolt by hand fully down into threaded check valve sleeve, then lightly tighten nut against washer. 8. Hold bolt with one wrench, and use another to tighten the nut until the check valve sleeve is removed from the cylinder head. 9. Clean check valve bore and related passages thoroughly to remove any drilling chips or other debris. **Special Tools** **EN-46122** Camshaft Position Actuator Check-Ball Valve Remover/Installer For equivalent regional tools, refer to **Special Tools**.
2	Cylinder Head Core Hole Plug (Qty: 4)
3	Spark Plug (Qty: 4)
4	Cylinder Head Core Hole Plug
5	Cylinder Head Core Hole Plug (Qty: 4)
6	Double End Stud - Cylinder Head to Turbocharger (Qty:4)
7	Cylinder Head Oil Restrictor Plug
8	Cylinder Head Core Hole Plug

CYLINDER HEAD CLEANING AND INSPECTION

Special Tools

- **EN-22738-B** Valve Spring Tester
- **EN-28410** Gasket Remover
- **GE-7872** Magnetic Base Dial Indicator

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

Cylinder Head and Gasket Surface Cleaning and Inspection

1. Inspect the cylinder head gasket and mating surfaces for leaks, corrosion and blow-by. If the gasket has failed, use the following faults to determine the cause:
    1. Improper installation
    2. Loose or warped cylinder head
    3. Missing, off location or not fully seated dowel pins
    4. Corrosion in the seal area around the coolant passages

5. Chips or debris in the cylinder head bolt holes
6. Bolt holes in the cylinder block not drilled or tapped deep enough

2. Inspect the fuel injector bores and clean, if required. Refer to **Fuel Injector and Fuel Injector Bore Cleaning and Inspection**.
3. Inspect the cylinder head gasket surface.
   - Cylinder head may be reused if corrosion is found only outside a 4 mm (0.375 in) band around each combustion chamber (1).
   - Replace the cylinder head if the area between the valve seats is cracked (2).
   - Replace the cylinder head if corrosion has been found inside a 4 mm (0.375 in) band around each combustion chamber (3).
4. Ensure proper use of room temperature vulcanizing (RTV) sealant.Properly clean all RTV surfaces, Refer to **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**.

NOTE: **Do not use a wire brush on any gasket sealing surface.**

5. Clean the cylinder head. Remove all varnish, soot and carbon to the bare metal.
6. Remove any old thread sealant, gasket material or sealant using **EN-28410** remover.
7. Clean all cylinder head surfaces with non-corrosive solvent.
8. Blow out all the oil galleries using compressed air.
9. Clean any debris or build-up from the lifter pockets.
10. Clean the valve guides.
11. Clean the threaded holes. Use a nylon bristle brush.
12. Clean the remains of the sealer from the plug holes.
13. Inspect the cylinder head for cracks. Check between the valve seats and in the exhaust ports.

NOTE: **Do not attempt to weld the cylinder head, replace it.**

14. Inspect the cylinder head deck for corrosion, sand inclusions and blow holes.
15. Inspect all the threaded holes for damage. Threads may be reconditioned with thread inserts.
16. Inspect the sealing surfaces.
17. Inspect the cylinder head plugs and verify the oil orifice is clear and free of debris.

Valve Cleaning and Inspection

mcx30.com

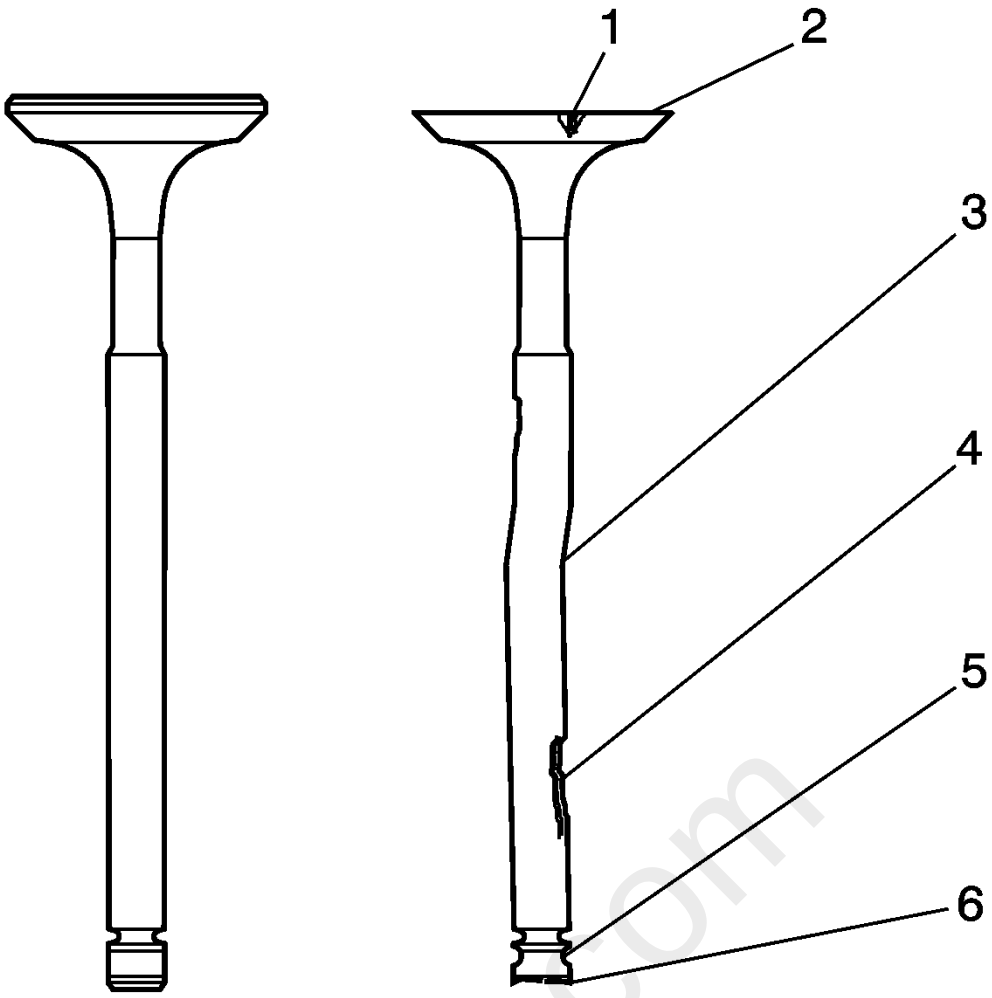


Fig. 391: Valve Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not use a wire brush on any part of the valve stem.**

NOTE: **Do not grind or condition the intake valve. If the intake valve is out of specification, replace the valve.**

1. Clean the valves of carbon, oil and varnish. Use a soft bristle wire brush to clean any carbon build-up from the valve head. Varnish can be removed by soaking in Parts Immersion Solvent or equivalent. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
2. Clean the valve guides.
3. Inspect the valve stem for pitting or wear (4).
4. Inspect the valve key groove for chipping or wear (5). Replace the valve if chipped or worn.
5. Inspect the valve face for burning or cracking (1). If pieces are broken off, inspect the corresponding piston and cylinder head area for damage.
6. Inspect the valve stem for burrs and scratches. Burrs and minor scratches may be removed with an oil stone.
7. Inspect the valve stem for straightness (3) and the valve head for bending or distortion using V blocks. Bent or distorted valves must be replaced.
8. Clean the deposits from the valve face. Inspect the valve face for grooving.
9. Replace the valve if the face is grooved. Valve faces cannot be machined. If worn, or damaged, the valves must be replaced.
10. Replace the valve if the valve head O.D. and chamfer (2) is worn or out of specification. Refer to **Valve and Seat Grinding**.
11. The valves may be lightly lapped to the valve seats.
12. Replace the valve if the valve tip (6) is worn.

mcx30.com

13. If no apparent wear, pitting, grooving, or distortion is present, perform the valve measurement and reconditioning procedure to verify valve specification. Refer to **Valve and Seat Grinding**.

Valve Guide Measurement

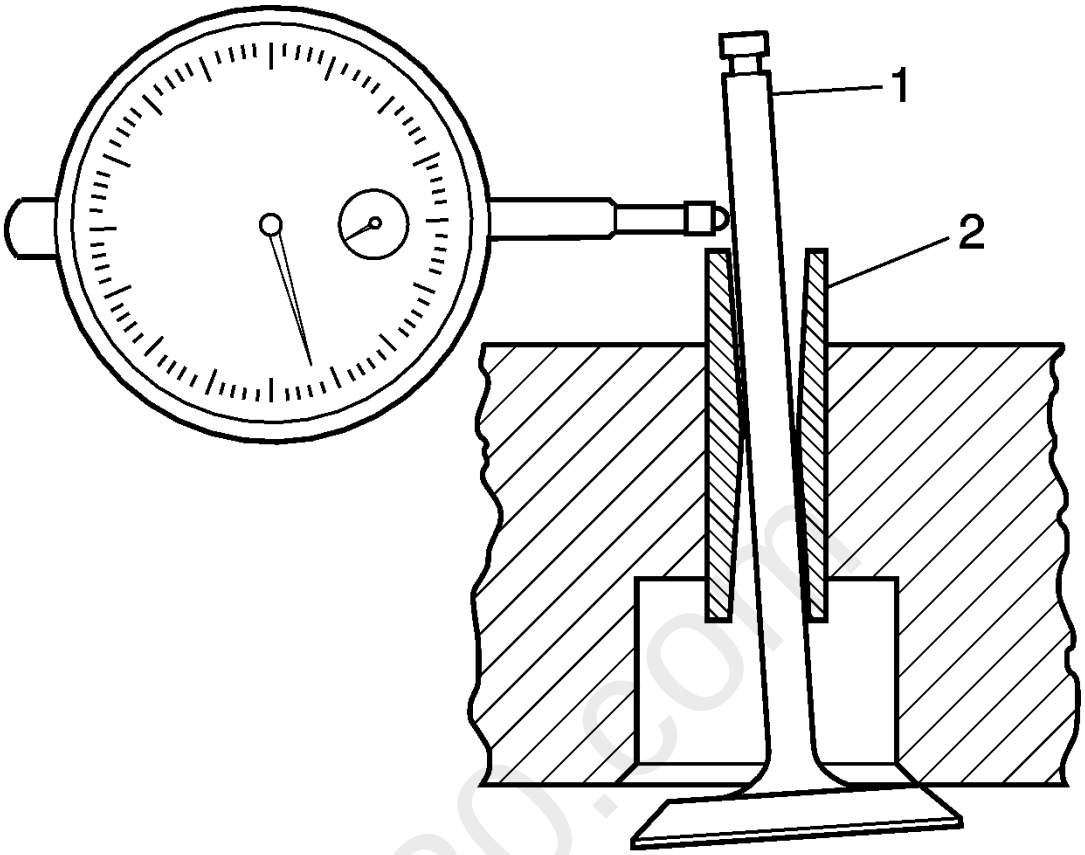


Fig. 392: Inspecting For Excessive Valve Stem To Guide Clearance
Courtesy of GENERAL MOTORS COMPANY

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 **GE-7872** indicator 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** for proper clearance.

NOTE: **Valve guide wear at the bottom 10 mm (0.390 in) of the valve guide is not significant to normal operation.**

6. If the clearance for the valve is greater than specifications and a new standard diameter valve stem will not bring the clearance within specifications, replace the cylinder head.

Valve Spring Cleaning and Inspection

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.

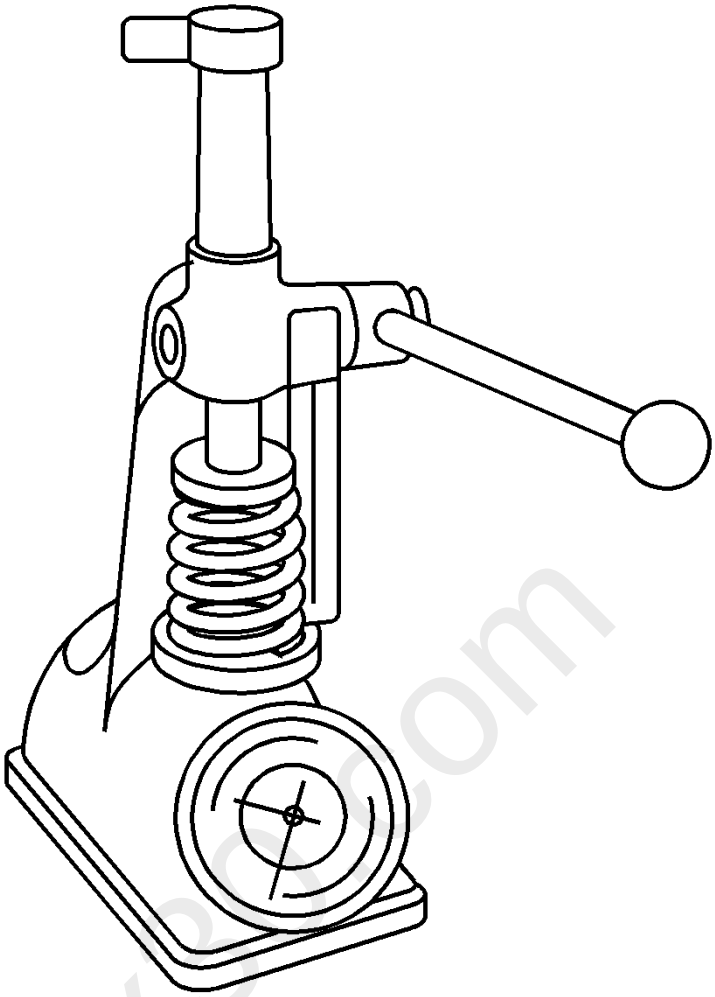


Fig. 393: Measuring Valve Spring Tension
Courtesy of GENERAL MOTORS COMPANY

4. Measure the valve spring tension using the **EN-22738-B** tester. Refer to **Engine Mechanical Specifications**
5. 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.

Valve Rocker Arm Cleaning and Inspection

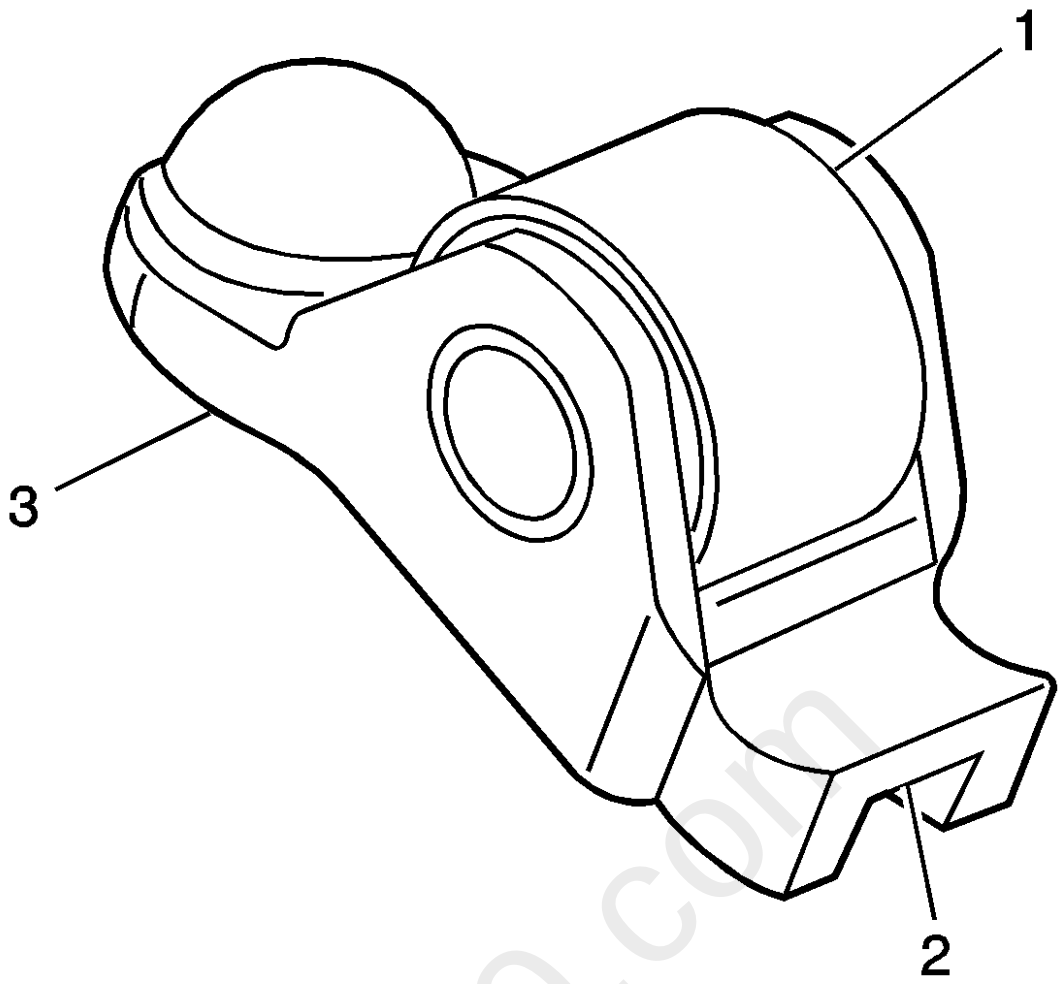


Fig. 394: Inspecting Valve Rocker Arms
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the camshaft follower roller (1) for the following:
    - Flat spots
    - 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.

Cylinder Head Deck Flatness Inspection

mcx30.com

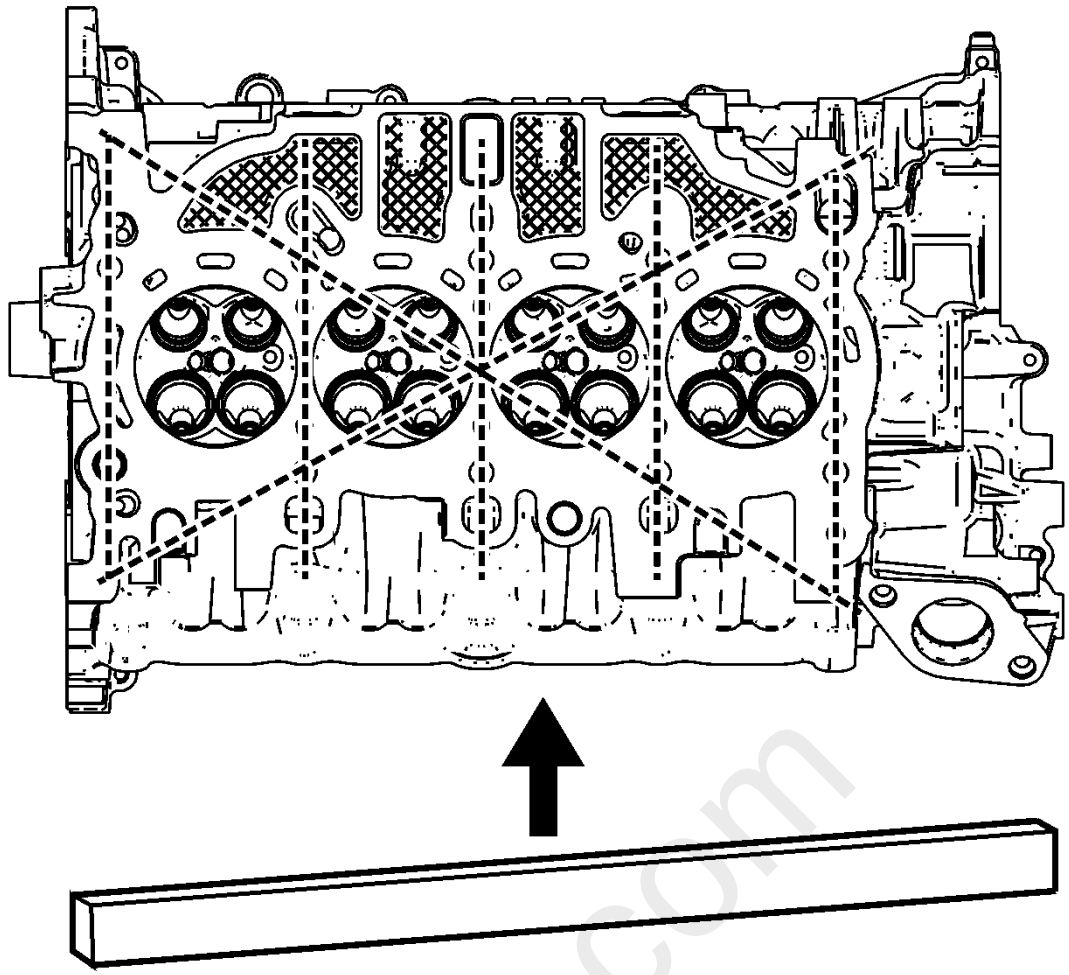


Fig. 395: Inspecting Cylinder Head Deck Surface For Flatness
Courtesy of GENERAL MOTORS COMPANY

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 sealing.
3. Using a straight-edge placed diagonally across the deck surface, measure the cylinder head deck surface for flatness using a feeler gauge. Refer to **Engine Mechanical Specifications**.
4. If the cylinder head deck flatness is more than the specified amount, replace the cylinder head.

Cylinder Head Deck Height Measurement

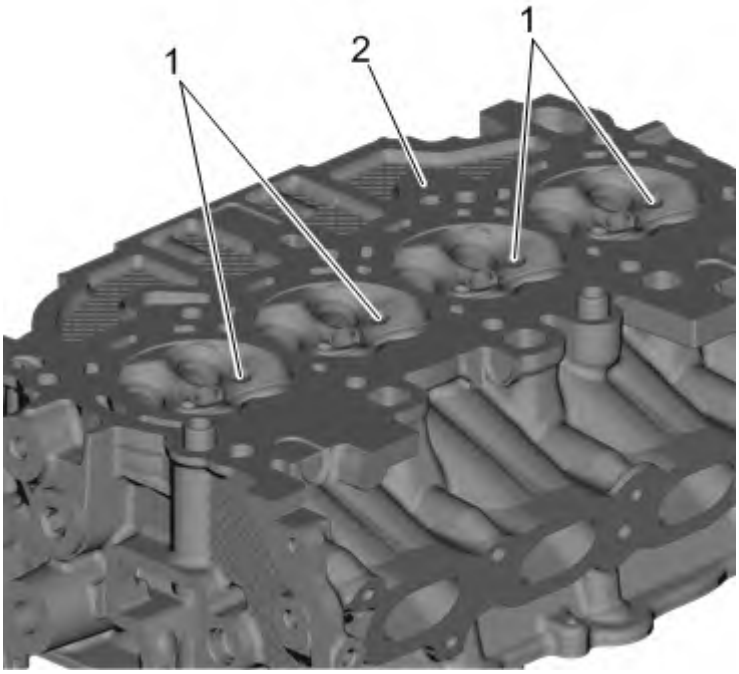


Fig. 396: Cylinder Head Deck Height
Courtesy of GENERAL MOTORS COMPANY

Overall deck height is measured by calculating the average deck height measurement from the 4 pad locations (1) to the deck surface (2), refer to **Engine Mechanical Specifications** for deck height specification.

Camshaft Cap Bore Measurement

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 cap bores using an inside micrometer, refer to **Engine Mechanical Specifications** for camshaft cap bore diameter.
4. If camshaft cap bores do not meet specification the cylinder head must be replaced.

Camshaft Cap Bore Alignment

1. Ensure the camshafts are serviceable. Refer to **Camshaft Cleaning and Inspection**.
2. Inspect the cylinder head camshaft bore surfaces for any imperfections or scratches that could inhibit proper camshaft clearances.
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 turn freely, the cylinder head must be replaced.

VALVE AND SEAT GRINDING

Valve Measurement and Reconditioning Overview

- Proper valve service is critical to engine performance. Therefore, all detailed measurement procedures must be followed to identify components that are out of specification.
- 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

mc30.com

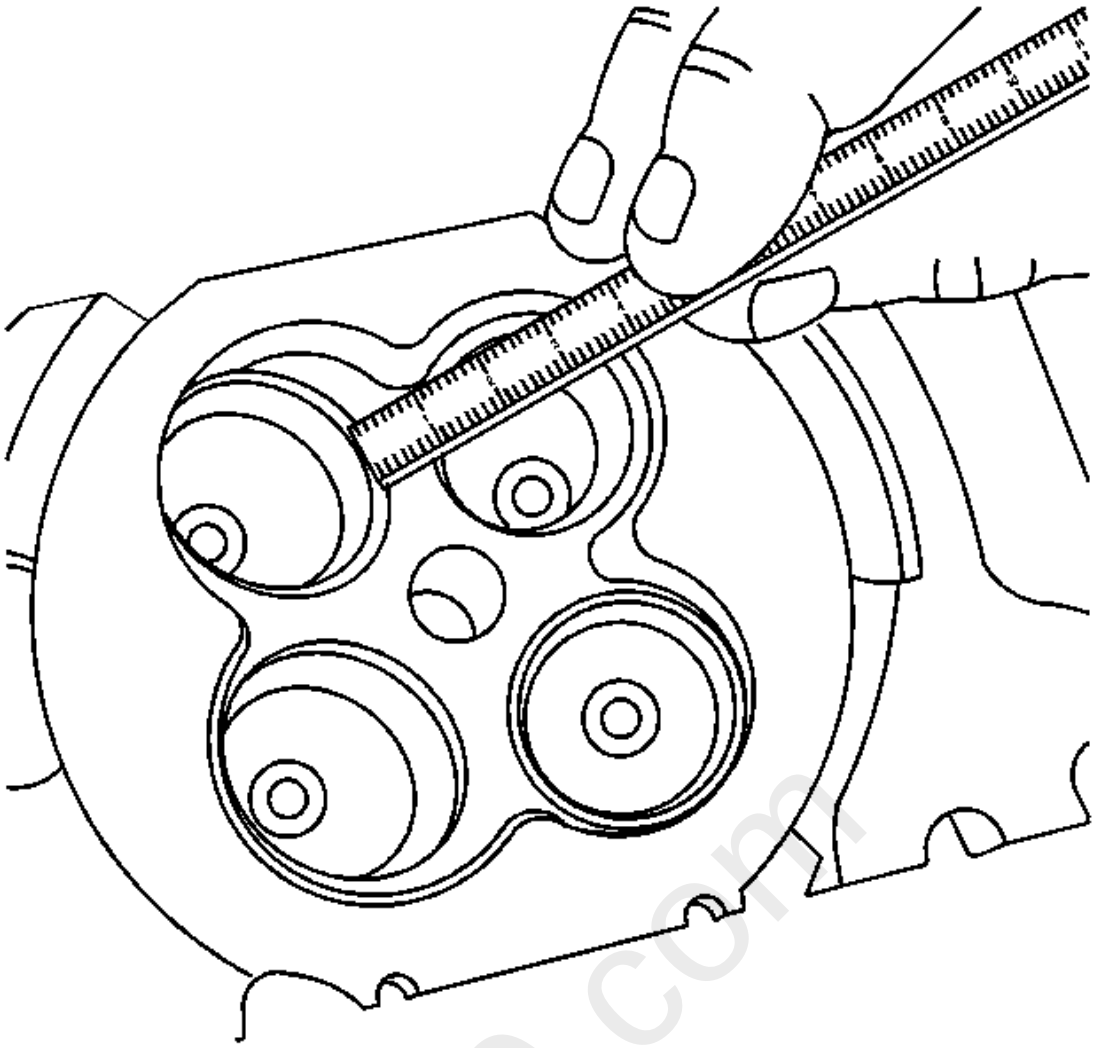


Fig. 397: Checking Valve Seat Width
Courtesy of GENERAL MOTORS COMPANY

1. Measure the valve seat width in the cylinder head using a proper scale.

mcx30.com

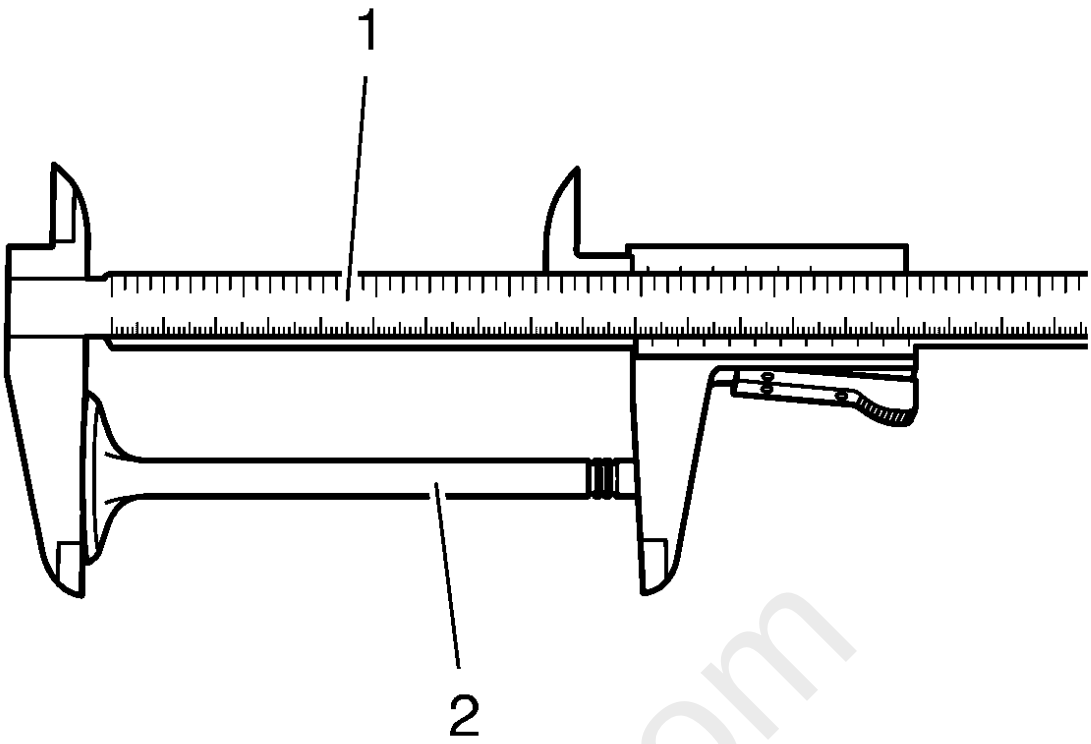


Fig. 398: Measuring Valve Length Using Slide Gauge
Courtesy of GENERAL MOTORS COMPANY

2. Measure the valve length (2). Use a slide gauge (1). Refer to **Engine Mechanical Specifications**.

mcx30.com

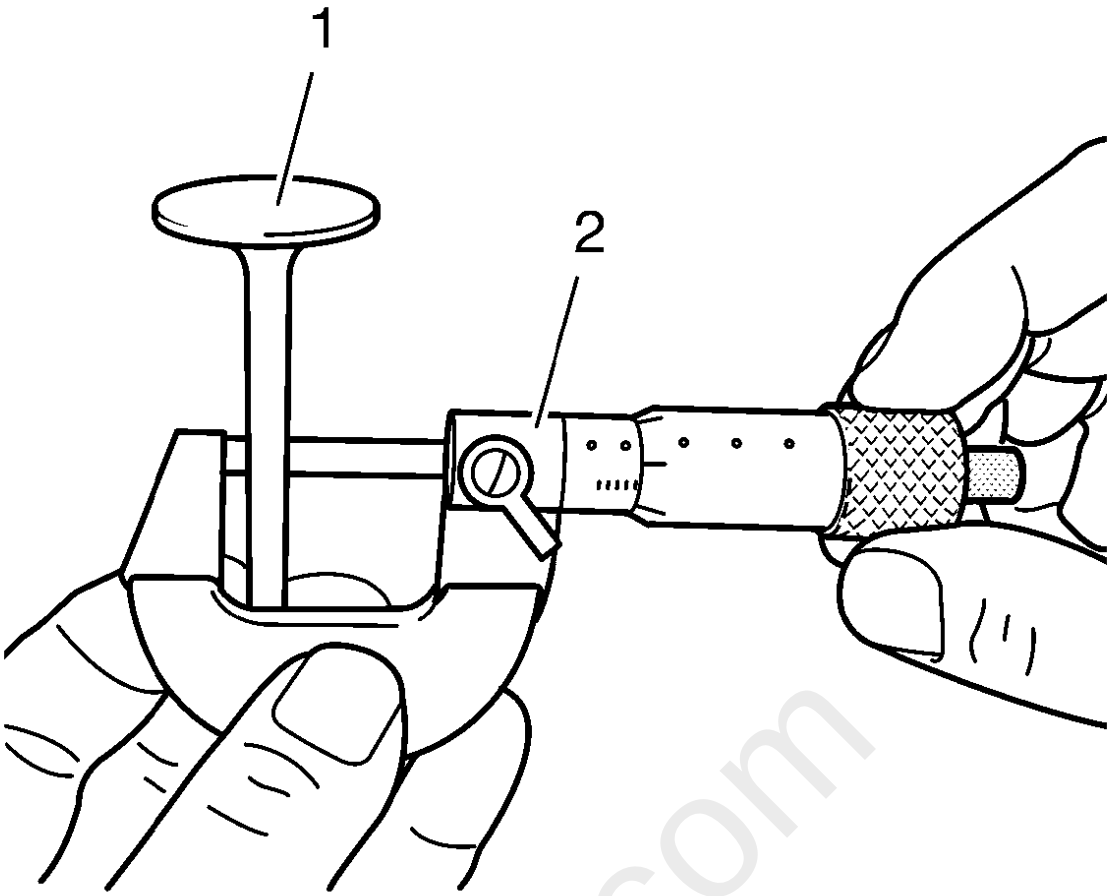


Fig. 399: Measuring Valve Stem Diameter Using Micrometer Gauge
Courtesy of GENERAL MOTORS COMPANY

3. Measure the valve stem diameter (1). Use a micrometer gauge (2). Refer to **Engine Mechanical Specifications**.

mcx30.com

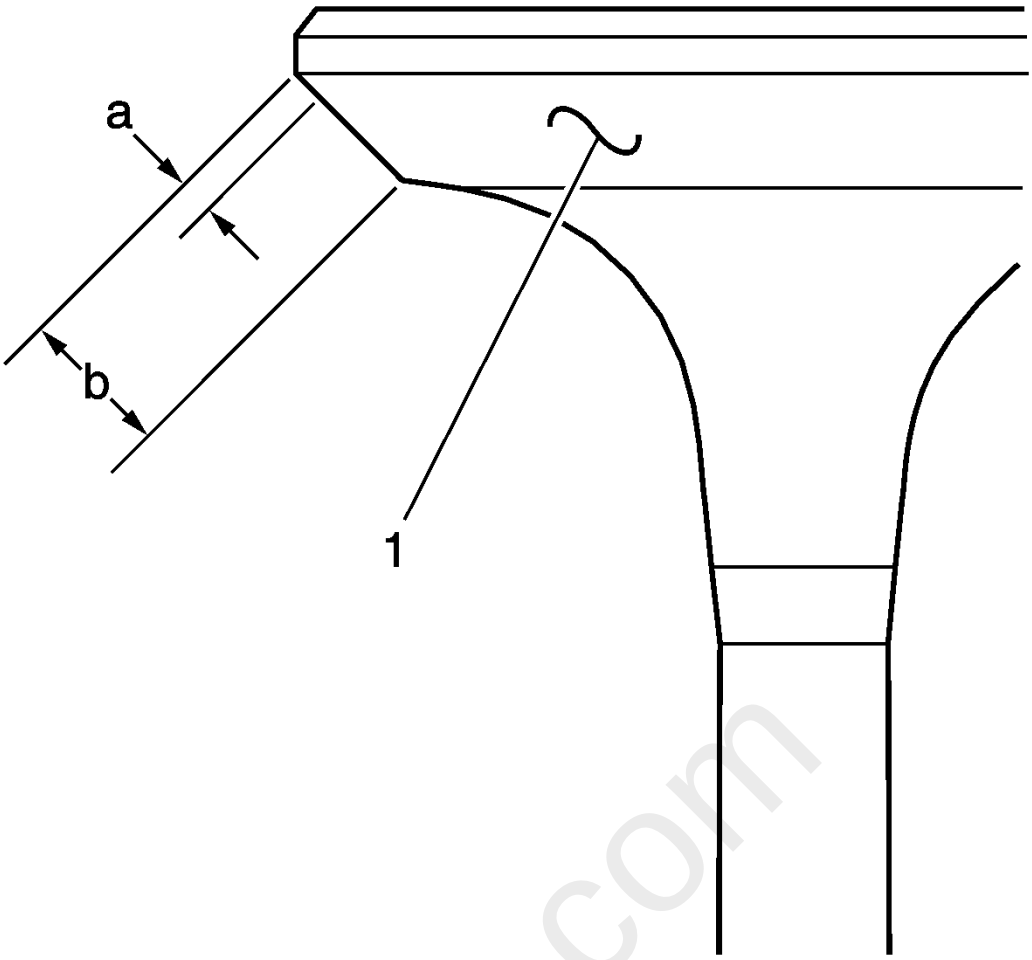


Fig. 400: Valve Face Seat Width
Courtesy of GENERAL MOTORS COMPANY

4. Measure the seat width (b) 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 (a), 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.**

5. Compare your measurements with the specifications listed in **Engine Mechanical Specifications**.
6. If the seat widths are acceptable, check the valve seat roundness using the Valve Seat Roundness Measurement Procedure.
7. 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.

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**.
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).

mcx30.com

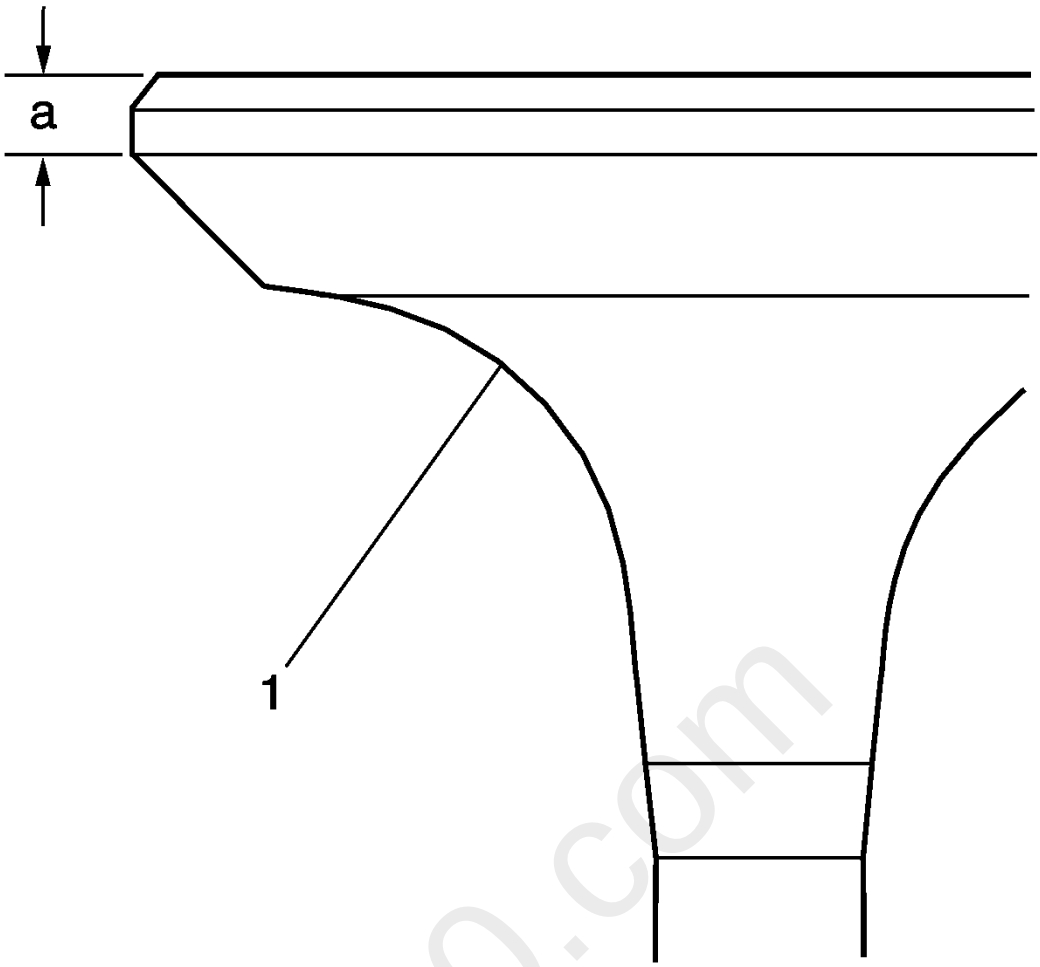


Fig. 401: View Of Valve Head O.D. & Chamfer
Courtesy of GENERAL MOTORS COMPANY

1. Measure the valve head O.D. and chamfer (a) using an appropriate scale. Refer to **Engine Mechanical Specifications**.
2. If the valve head O.D. and chamfer is within specification, test the valve (1) for seat concentricity using the Valve-to-Seat Concentricity Measurement Procedure. Reinspect the valve head O.D. and chamfer after completing the concentricity measurement if valve seat reconditioning is performed.

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.**

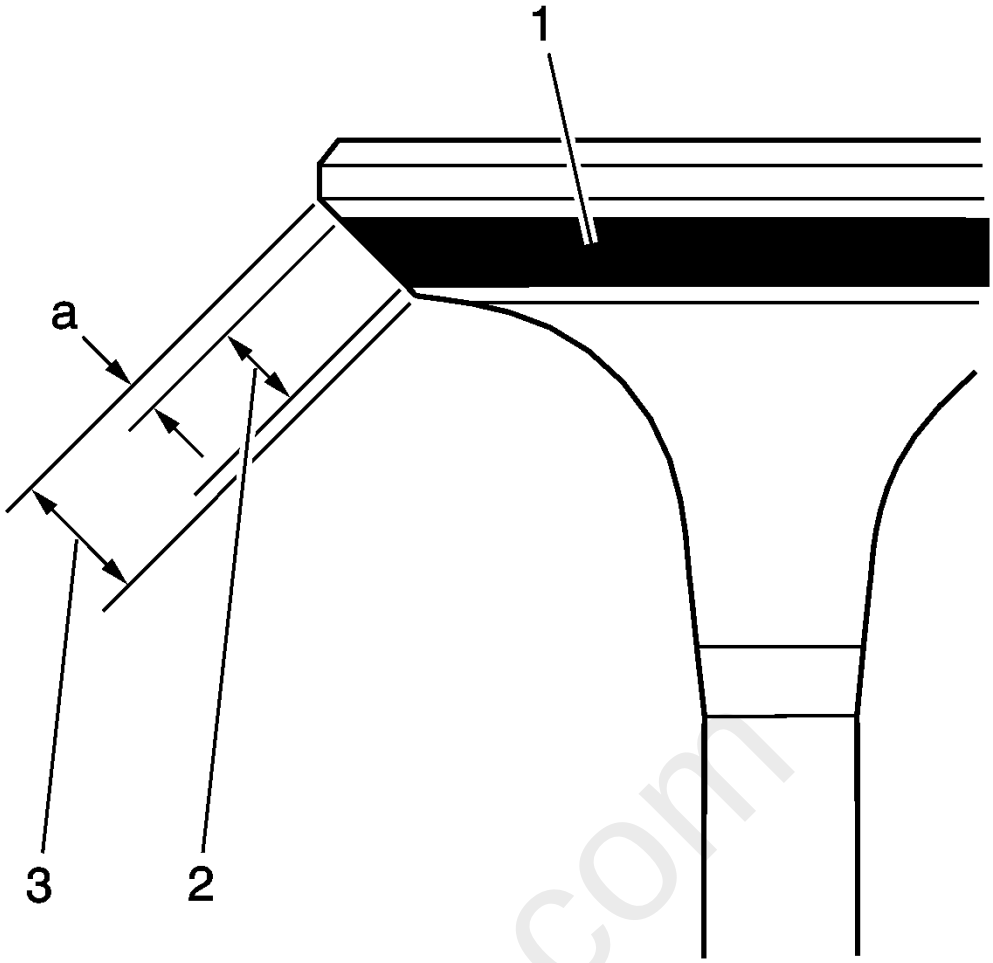


Fig. 402: Inspecting Valve Face
Courtesy of GENERAL MOTORS COMPANY

1. Coat the valve face (3) lightly with blue dye (1).
2. Install the valve in the cylinder head.
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 (2) will be made around the entire face.

NOTE: **The wear mark MUST be at least 0.5 mm (0.020 in) from the outer diameter, the margin (a), 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.**

NOTE: **Do not grind or condition the intake valve. If the intake valve is out of specification, replace the valve.**

- 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

mcx30.com

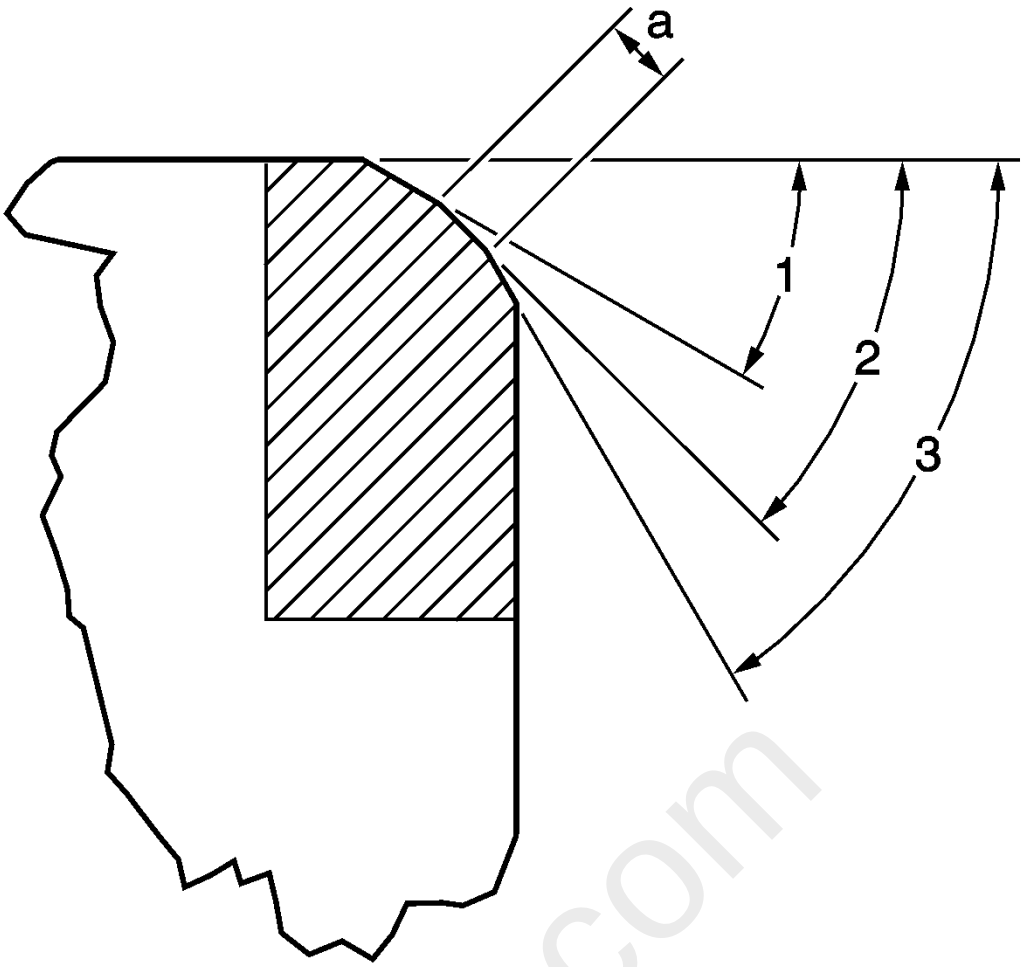


Fig. 403: Valve Seating Surface Angle
Courtesy of GENERAL MOTORS COMPANY

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 seating surface (a) to the proper angle specification (2). Refer to **Engine Mechanical Specifications**.
2. Grind the valve relief surface to the proper angle specification (1) to correctly position the valve seating surface (a) to the valve. Refer to **Engine Mechanical Specifications**.
3. Grind the valve undercut surface to the proper angle specification (3) to narrow the valve seating surface width (a). Refer to **Engine Mechanical Specifications**.

NOTE: **Do not grind or condition the intake valve. If the intake valve seat has been reconditioned, replace the corresponding intake valve.**

4. Replace the intake valve if it is out of specification. Refer to **Engine Mechanical Specifications**.
5. If the original exhaust valve is being used, grind the valve to the specifications listed in **Engine Mechanical Specifications**. Measure the valve head O.D. and chamfer again after grinding using the Valve Head O.D. and Chamfer Measurement Procedure. Replace the exhaust valve if it is out of specification. New valves do not require grinding.
6. When grinding the valves and seats, grind off as little material as possible. Cutting valve seat results in lowering the valve spring pressure.
7. Install the valve in the cylinder head.

- If you are using refaced exhaust 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.
- Be sure to clean any remaining lapping compound from the valve and seat with solvent and compressed air prior to final assembly.

8. 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.
9. 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

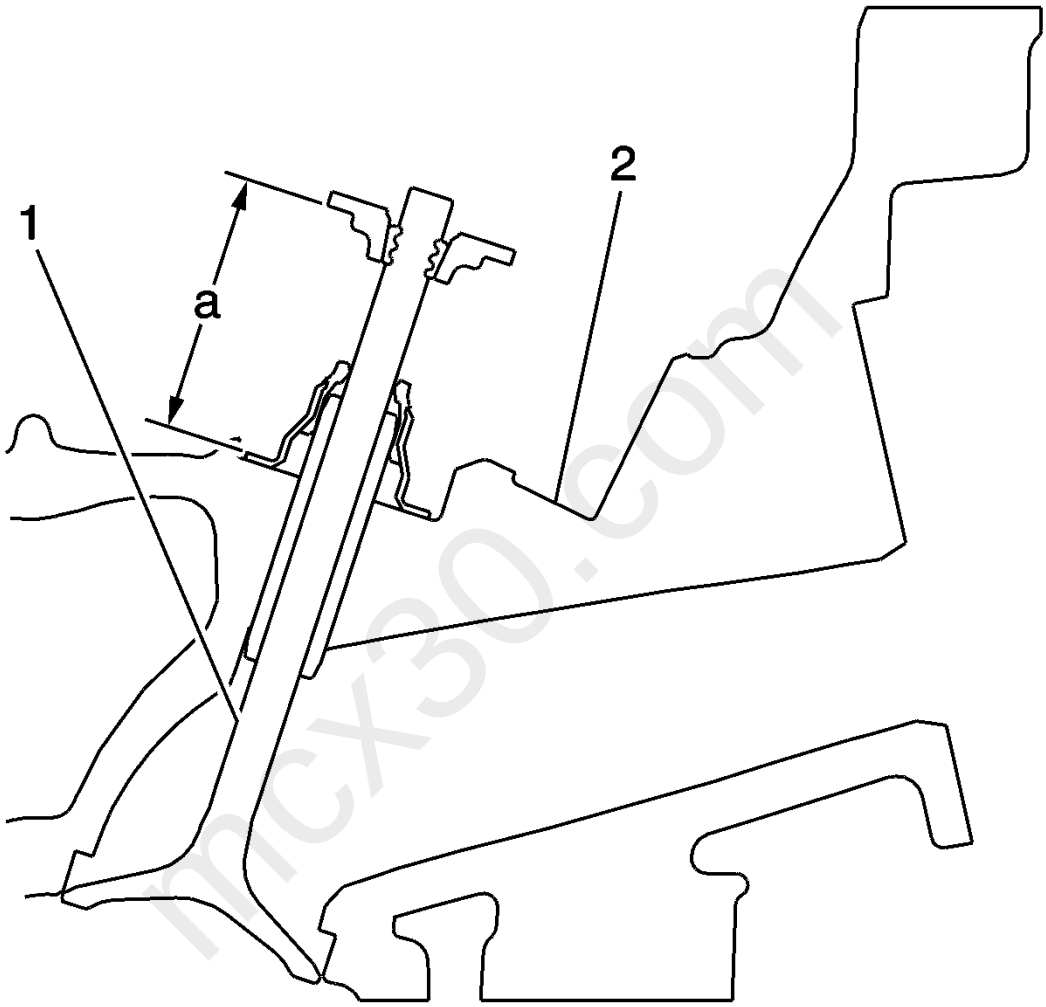


Fig. 404: Valve Stem Height Measurement
Courtesy of GENERAL MOTORS COMPANY

NOTE: **To determine the valve stem height measurement, measure from the valve spring seat to the valve spring retainer.**

1. Install the valve (1) into the valve guide in the cylinder head (2).
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.
5. Measure the distance (a) between the valve seal lip to the bottom of the valve spring retainer. Refer to **Engine Mechanical Specifications**.
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**

mcx30.com

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.

CYLINDER HEAD ASSEMBLE

Cylinder Head Oil Gallery Plugs, Turbocharger Studs, Spark Plugs, and Engine Oil Manifold Check Valve Installation

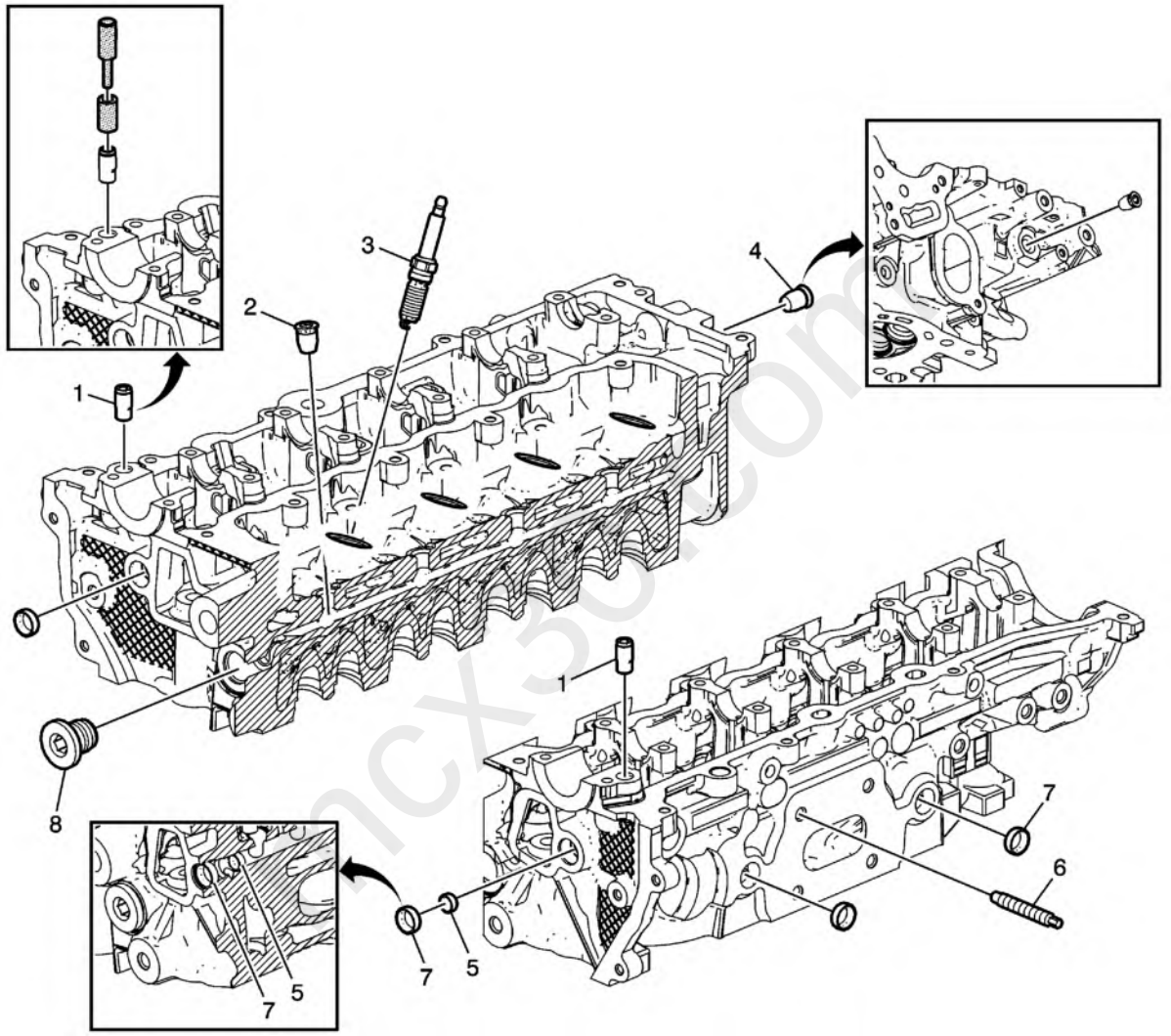


Fig. 405: Cylinder Head Oil Gallery Plugs, Turbocharger Studs, Spark Plugs, and Engine Oil Manifold Check Valve
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head Oil Gallery Plugs, Turbocharger Studs, Spark Plugs, and Engine Oil Manifold Check Valve Installation

Callout	Component Name
Preliminary Procedure Apply sealant to all plugs prior to installation. Refer to Adhesives, Fluids, Lubricants, and Sealers.	

Callout	Component Name
1	Engine Oil Manifold Check Valve (Qty: 2) 1. Use lubricant included with **EN-46122** remover/installer to lubricate the outside of the new check valve. 2. With the check ball end of the check valve facing DOWN, towards the head, insert the NEW check valve into the check valve bore in the cylinder head. 3. Place **EN-46122-2** collar over the new check valve with the slightly-larger inside diameter of the collar DOWN toward the cylinder head. 4. Using the **EN-46122-1** driver, lightly tap the new check valve into place until the driver stops against the top of the collar. **Special Tools** **EN-46122** Camshaft Position Actuator Check-Ball Valve Remover/Installer For equivalent regional tools, refer to **Special Tools**.
2	Cylinder Head Core Hole Plug (Qty: 4) **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Procedure** Install NEW cylinder head plugs. **Tighten** 25 N.m (18 lb ft)
3	Spark Plug (Qty: 4) **CAUTION:** **In order to avoid damage, install the spark plugs after the cylinder head has been installed on the engine.** **Tighten** 17 N.m (13 lb ft)
4	Cylinder Head Core Hole Plug **Procedure** Install NEW cylinder head plug. **Tighten** 25 N.m (18 lb ft)
5	Cylinder Head Oil Restrictor Plug (Qty: 1) **Procedure** Install a NEW cylinder head plug.
6	Double End Stud - Cylinder Head to Turbocharger (Qty:4) **CAUTION:** **Refer to Torque-to-Yield Fastener Caution .** **Tighten** 10 N.m (89 lb in)
7	Cylinder Head Core Hole Plug (Qty: 4) **Procedure** Install NEW cylinder head plugs.
8	Cylinder Head Core Hole Plug **Procedure** Install NEW cylinder head plug. **Tighten** 75 N.m (55 lb ft)

mcx30.com

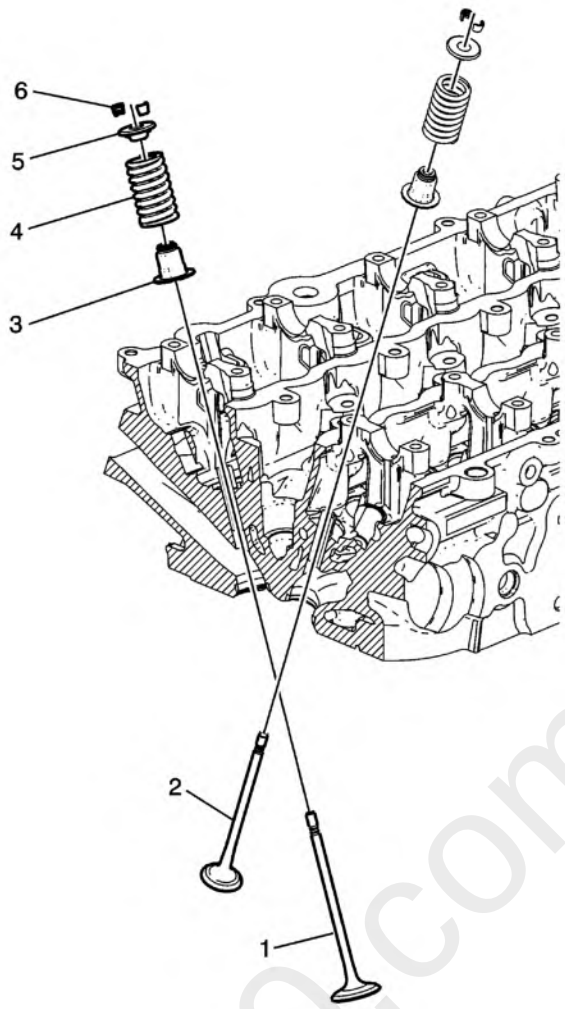


Fig. 406: Intake and Exhaust Valve
Courtesy of GENERAL MOTORS COMPANY

Intake and Exhaust Valve Installation

Callout	Component Name
Preliminary Procedure Ensure that the valve train components will be installed in their original position.	
1	Intake Valve (Qty: 8) **NOTE:** **Lubricate the valve guides and the valve stems with engine oil.**
2	Exhaust Valve (Qty: 8) **NOTE:** **Lubricate the valve guides and the valve stems with engine oil.**

mcx30.com

Callout	Component Name
3	Valve Stem Oil Seal (Qty: 16) **NOTE:** **Valve stem oil seal sets will contain 2 different colored seals, black and green. The set of 8 seals that are green go on the exhaust valves.** **Procedure** 1. Place the valve stem oil seals onto the guides. **NOTE:** **Always use NEW seals when assembling the cylinder head.** 2. 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.** 3. 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. 4. Lubricate the valve stem and valve guide ID with clean engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers**. **Special Tools** **EN-46116** Valve Stem Seal Remover/Installer For equivalent regional tools, refer to **Special Tools**.
4	Valve Springs (Qty: 16)
5	Valve Spring Retainer (Qty: 16)

mcx30.com

Callout	Component Name
6	Valve Stem Key - Intake, Exhaust (Qty: 32) **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 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 less than 25.0 mm (0.984 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.** **Procedure** 1. Using the **EN-8062** compressor and the **EN-43963** compressor adapter, compress the valve spring. 2. Install the valve stem keys. 3. Slowly release the tension. 4. Inspect for proper valve key seating. **Special Tools** • **EN-8062** Valve Spring Compressor • **EN-43963** Valve Spring Compressor - Off-Car Adapter For equivalent regional tools, refer to **Special Tools**.

ENGINE BLOCK DISASSEMBLE

Upper Engine Block Disassemble

mcx30.com

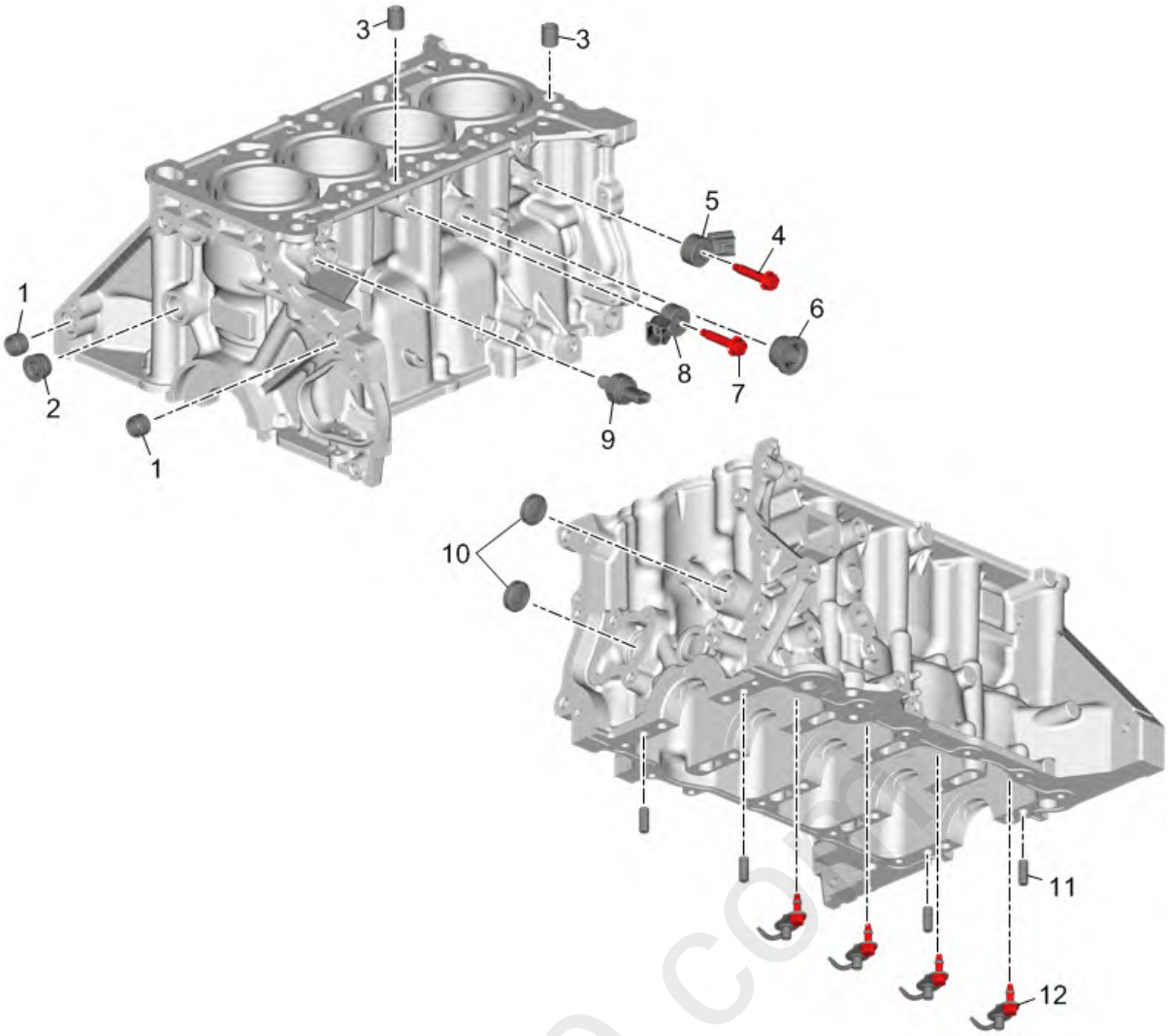


Fig. 407: Upper Engine Block
Courtesy of GENERAL MOTORS COMPANY

Upper Engine Block Disassemble

Callout	Component Name
1	Transmission Locating Pin [2x]
2	Engine Block Oil Gallery Plug
3	Cylinder Head Locating Pin [2x]
4	Knock Sensor Bolt
5	Knock Sensor
6	Engine Coolant Heater Hole Plug
7	Knock Sensor Bolt
8	Knock Sensor
9	Engine Oil Pressure Sensor
10	Engine Block Core Hole Plug [2x]
11	Lower Crankcase Locating Pin [4x]
12	Piston Oil Nozzle [4x]

Lower Crankcase Disassemble

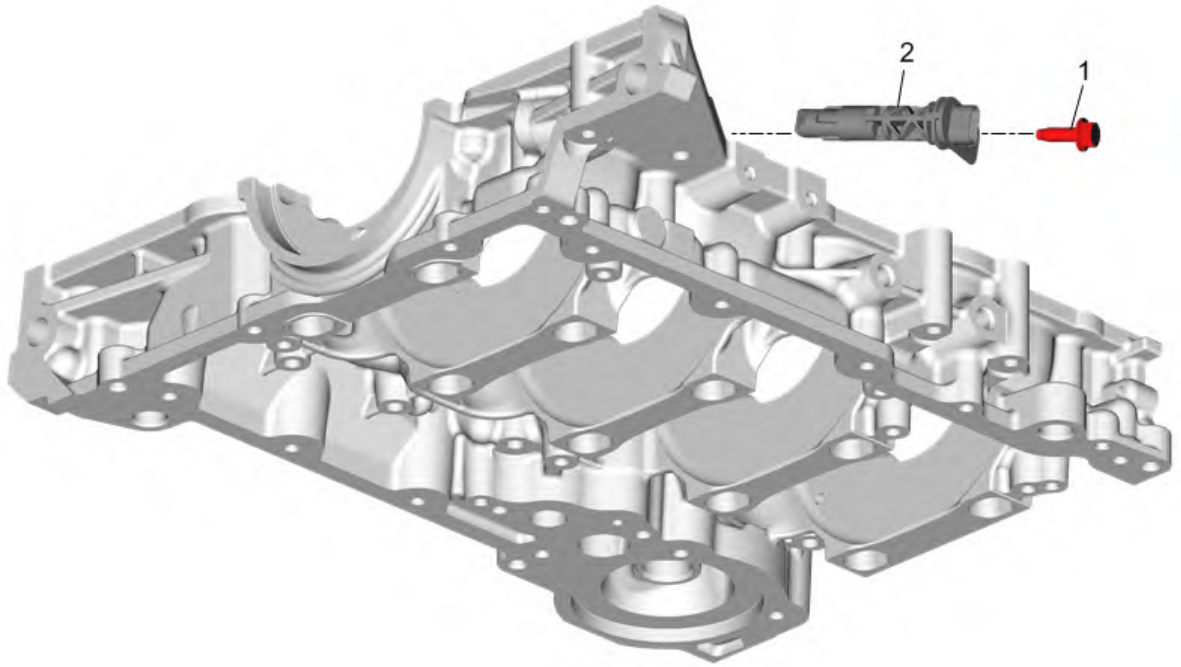


Fig. 408: Lower Crankcase
Courtesy of GENERAL MOTORS COMPANY

Lower Crankcase Disassemble

Callout	Component Name
1	Crankshaft Position Sensor Bolt
2	Crankshaft Position Sensor

ENGINE BLOCK CLEANING AND INSPECTION

Special Tools

- **EN-8087** Cylinder Bore Gauge
- **EN-28410** Gasket Remover

For equivalent regional tools, refer to Special Tools.

Cleaning Procedure

1. Ensure proper use of room temperature vulcanizing (RTV) sealant.Properly clean all RTV surfaces, Refer to Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant.
2. Remove any old thread sealant, gasket material or sealant using **EN-28410** remover.
3. Clean all the following areas with solvent:
    - Sealing surfaces
    - Cooling passages
    - Oil passages
    - Bearing journals
4. Clean all threaded and through holes with solvent.

    WARNING: **Refer to Safety Glasses Warning .**

5. Dry the engine block with compressed air.

Visual Inspection

mcx30.com

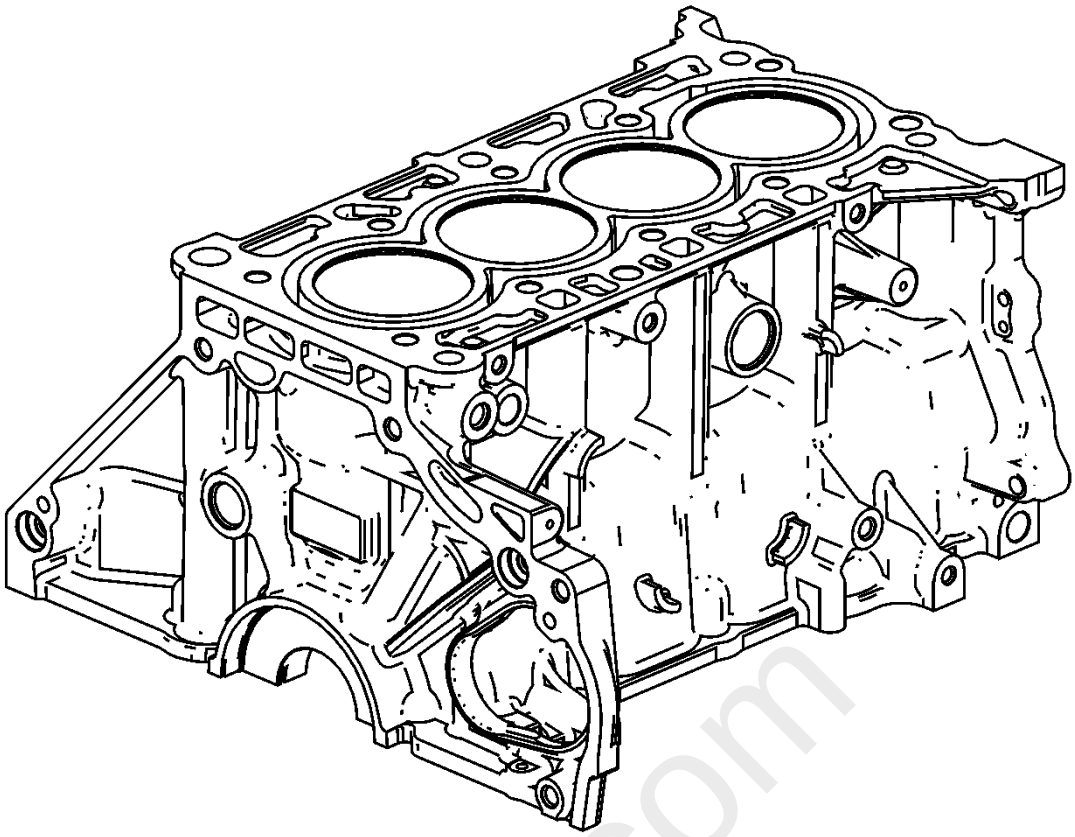


Fig. 409: Block
Courtesy of GENERAL MOTORS COMPANY

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. Check the cylinder condition. Some light vertical marks may be visible on the cylinder wall. In these areas, check that the honing marks are still visible in this marked area. If they are, the cylinder surface has not been compromised and the engine block can be used.
7. 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.
8. Inspect the engine block for cracks. Do not repair any cracks. If cracks are found, the cylinder block assembly must be replaced.
9. Repair any damaged threaded holes. Refer to **Thread Repair Specifications**, and **Thread Repair**.

Measuring Cylinder Bore Diameter

mcx30.com

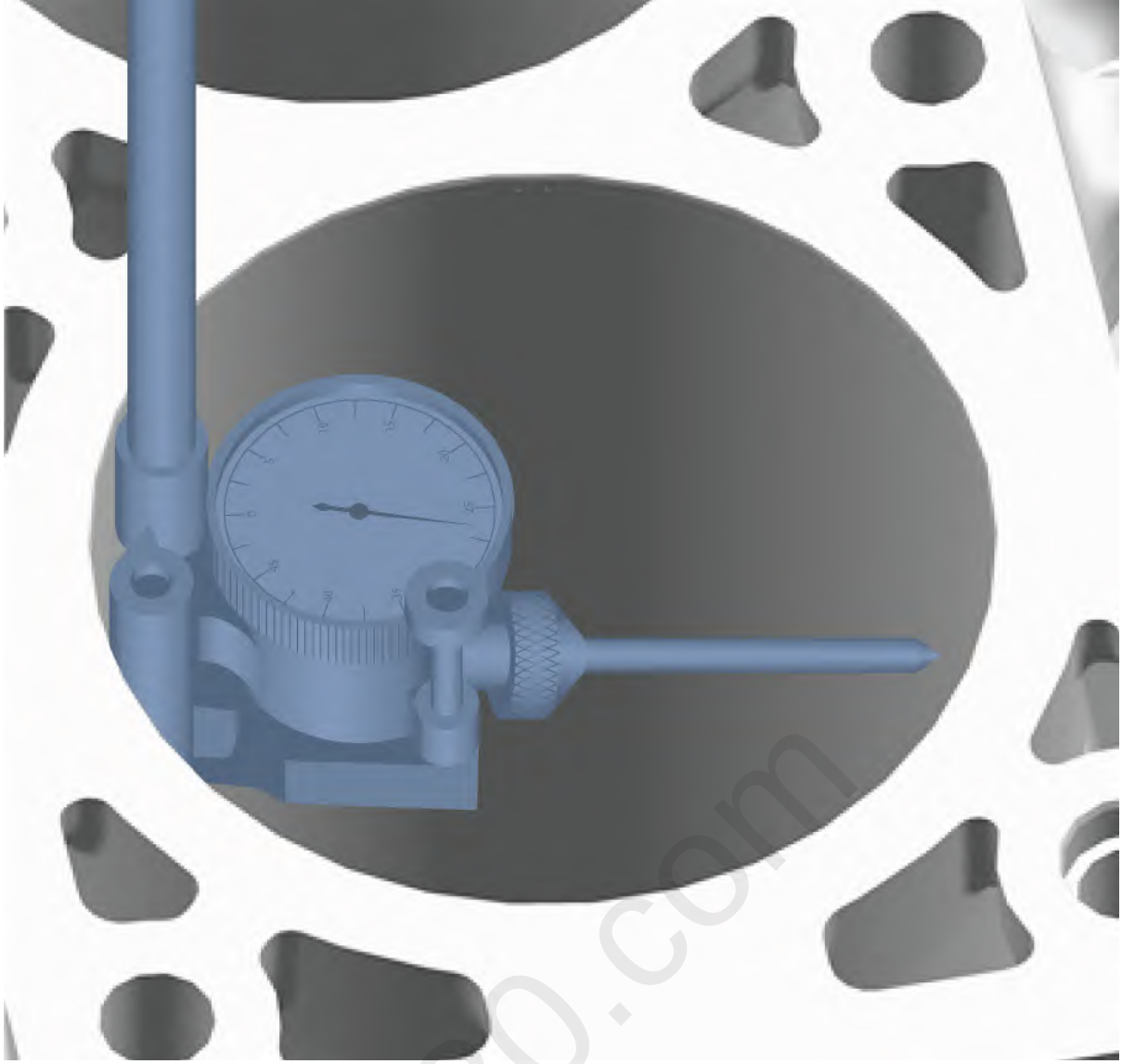


Fig. 410: Measuring Cylinder Bore
Courtesy of GENERAL MOTORS COMPANY

1. Using **EN-8087** gauge, measure the cylinder bore diameter 35 mm (1.378 in) down from deck face perpendicular to the crankshaft centerline. Refer to **Engine Mechanical Specifications**.
2. In the cylinder bore diameter is outside the specification the engine block must be replaced.

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**. If the cylinder bores exceed the specifications, the engine block must be replaced.

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.

mex30.com

5. Compare your results with the **Engine Mechanical Specifications**. If the cylinder bores exceed these specifications, the engine block must be replaced.

Engine Block Deck Flatness Inspection

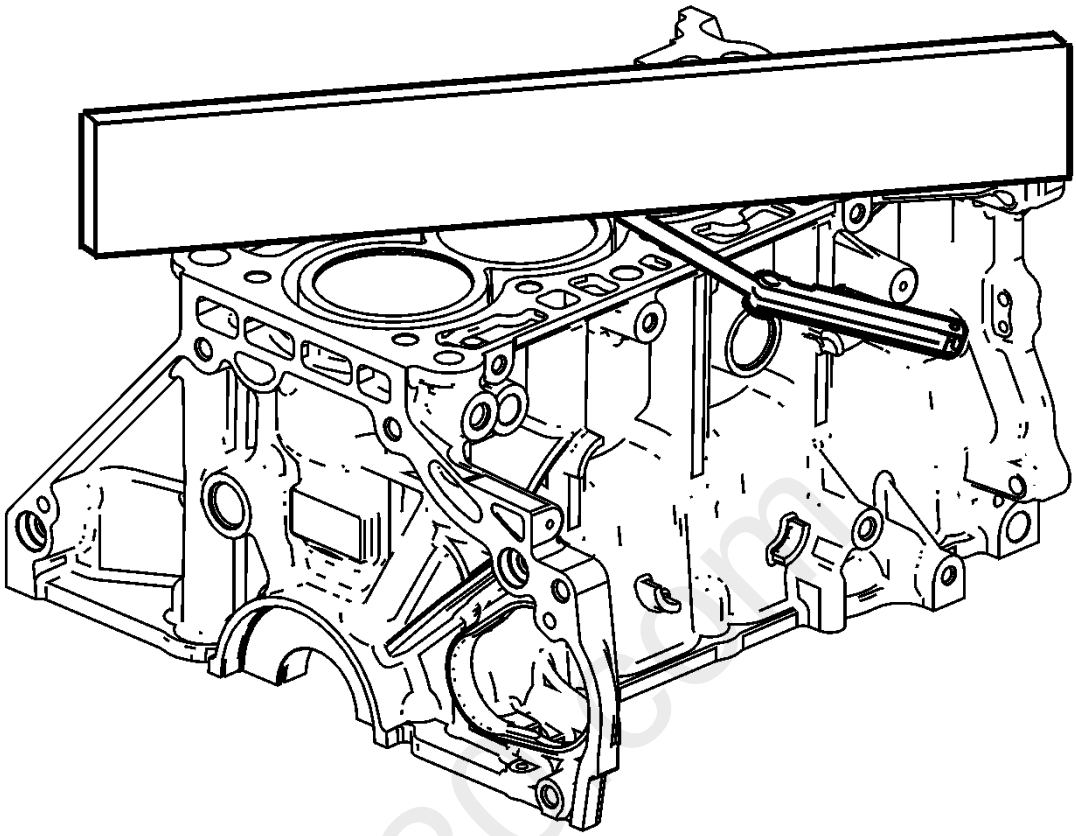


Fig. 411: Checking Deck Flatness
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the engine block deck surface is clean and free of gasket material.
2. Inspect the surface for any imperfections or scratches that could inhibit proper cylinder head gasket sealing.
3. Using a straight-edge placed diagonally across the deck surface, measure the engine block - cylinder head deck surface for flatness using a feeler gauge. Refer to **Engine Mechanical Specifications**.
4. If the cylinder head deck surface flatness is more than the specified amount, replace the engine.

Engine Block Deck Height Measurement

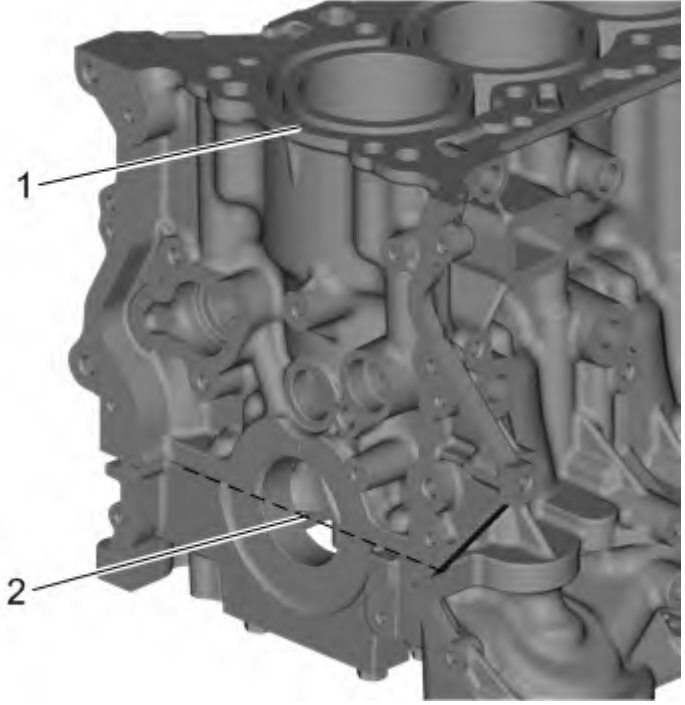


Fig. 412: Engine Block Deck Height
Courtesy of GENERAL MOTORS COMPANY

Engine block deck height is measured from deck face surface (1) to crankshaft center bore (2). Measure at front and rear of the engine block. Refer to **Engine Mechanical Specifications** for engine block deck height specification.

ENGINE BLOCK ASSEMBLE

Lower Crankcase Assemble

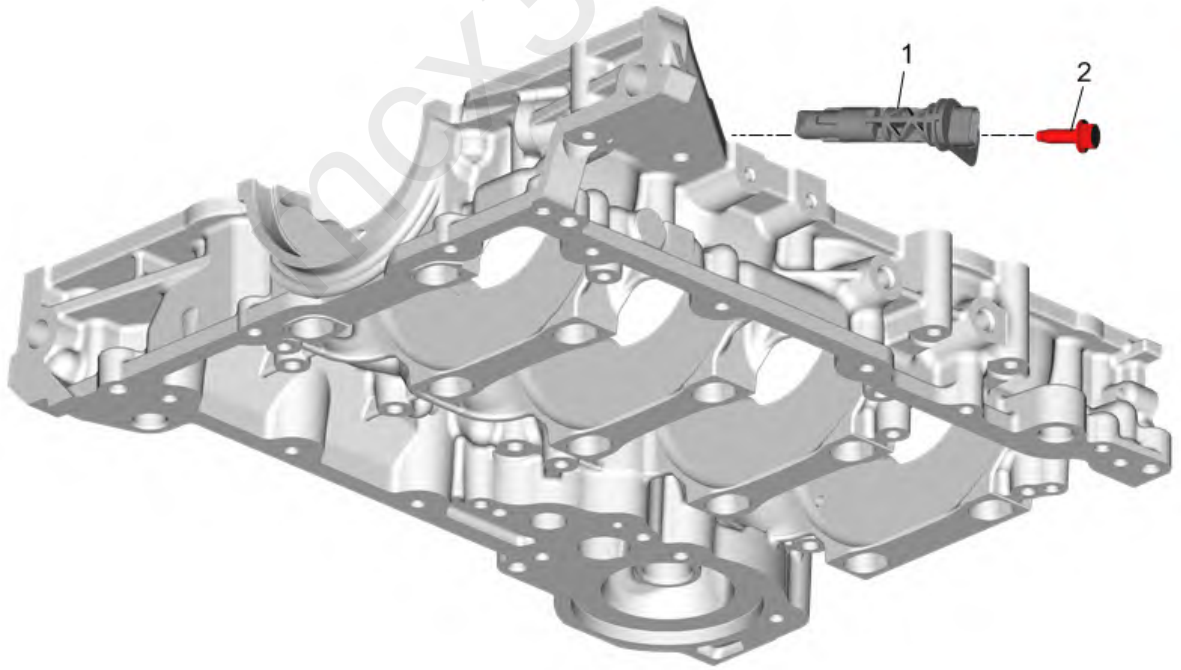


Fig. 413: Lower Crankcase
Courtesy of GENERAL MOTORS COMPANY

Lower Crankcase Assemble

Callout	Component Name
1	Crankshaft Position Sensor

Callout	Component Name
2	Crankshaft Position Sensor Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)

Upper Engine Block Assemble

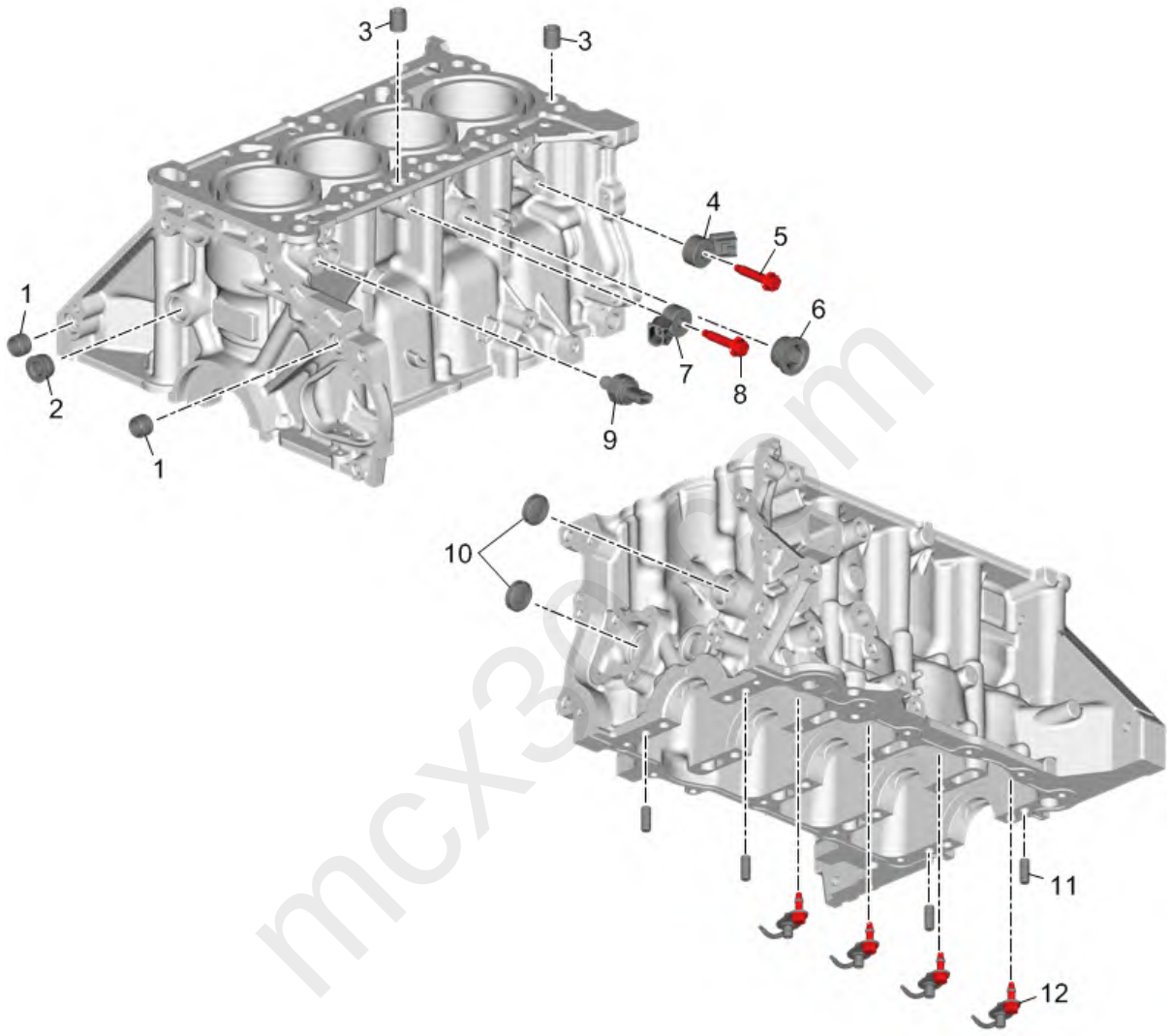


Fig. 414: Upper Engine Block
Courtesy of GENERAL MOTORS COMPANY

Upper Engine Block Assemble

Callout	Component Name
Preliminary Procedure Apply sealant to all plugs prior to installation. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.	
1	Transmission Locating Pin [2x] **Procedure** Ensure Transmission locating pins are properly seated and not damaged.

Callout	Component Name
2	Engine Block Oil Gallery Plug **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Tighten** 65 N.m (48 lb ft)
3	Cylinder Head Locating Pin [2x]
4	Knock Sensor
5	Knock Sensor Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)
6	Engine Coolant Heater Hole Plug **Tighten** 60 N.m (44 lb ft)
7	Knock Sensor
8	Knock Sensor Bolt **Tighten** 25 N.m (18 lb ft)
9	Engine Oil Pressure Sensor **Tighten** 35 N.m (26 lb ft)
10	Engine Block Core Hole Plug [2x]
11	Lower Crankcase Locating Pin [4x]
12	Piston Oil Nozzle [4x] **Tighten** 10 N.m (89 lb in)

FUEL INJECTOR AND FUEL INJECTOR BORE CLEANING AND INSPECTION

mcx30.com

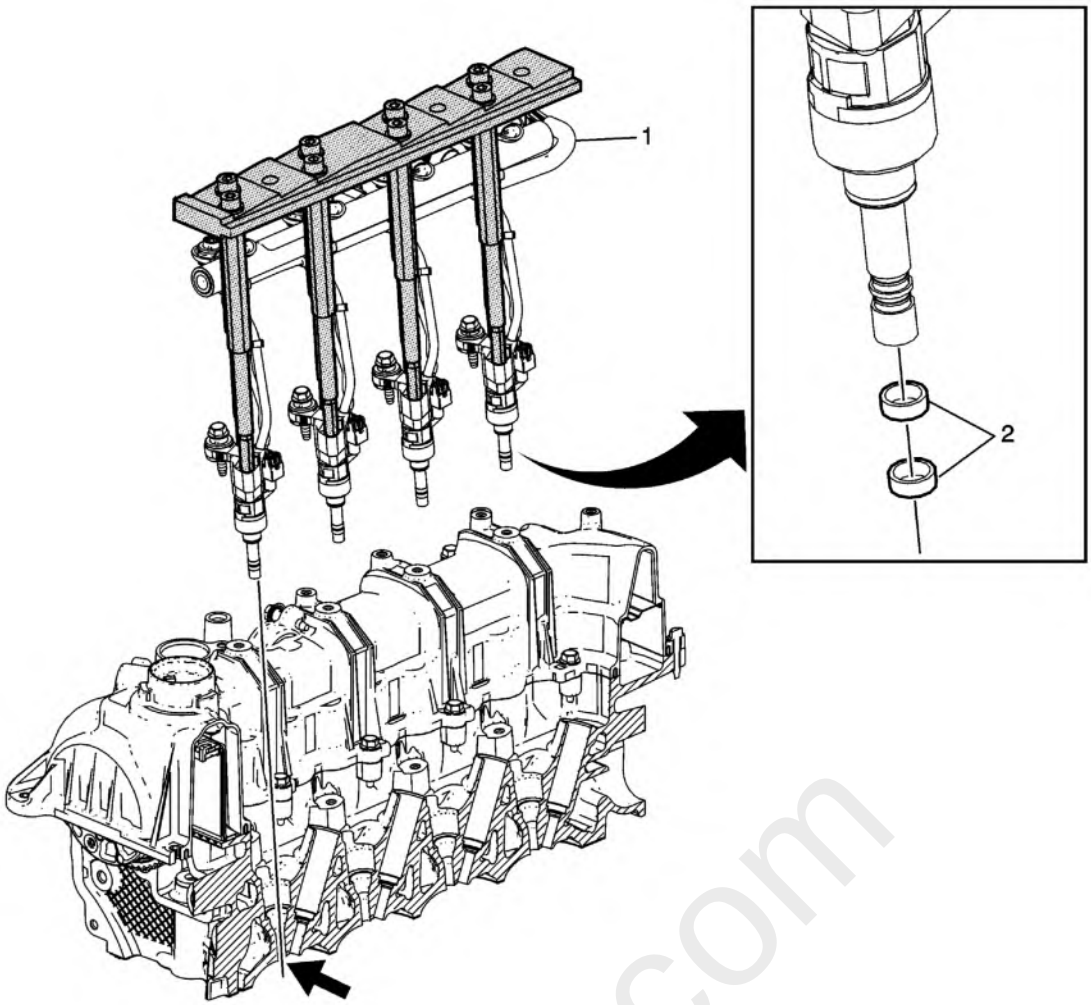


Fig. 415: Fuel Injector and Fuel Injector Bore
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Use **EN-47909** cleaning kit to clean the fuel injector bores. **NOTE:** **Do not soak or immerse the fuel rail or injectors in solvent.** 2. Clean the exterior of the fuel rail and injectors with solvent. **Special Tools EN-47909** Injector Bore and Sleeve Cleaning KitFor equivalent regional tools, refer to **Special Tools**.	

mcx30.com

Callout	Component Name
1	Fuel Rail Assembly **NOTE:** **Do not remove the EN-51146 remover unless fuel injector replacement is necessary.** **Procedure** 1. Inspect for damage, debris, or restrictions to the fuel rail and fuel ports. 2. Inspect for damage to the mounting area for the fuel rail. 3. Inspect for damage to the fuel rail mounting bolts. 4. Inspect for damage to the threads on the fuel rail fuel feed fitting. 5. Inspect the fuel rail pressure sensor for damage. 6. Inspect the fuel injector for damage to the harness connector. 7. Inspect the fuel injector tip, tolerance ring, and seal locations.
2	Fuel Injector Combustion Seal **NOTE:** **Discard the seals and use NEW seals upon installation.** **Procedure** 1. If present, remove the calibration tool on the fuel injector tip. 2. Remove and discard the fuel injector combustion seals. 3. Reinspect each fuel injector tip once the seals are removed.

PISTON AND CONNECTING ROD DISASSEMBLE

mcx30.com

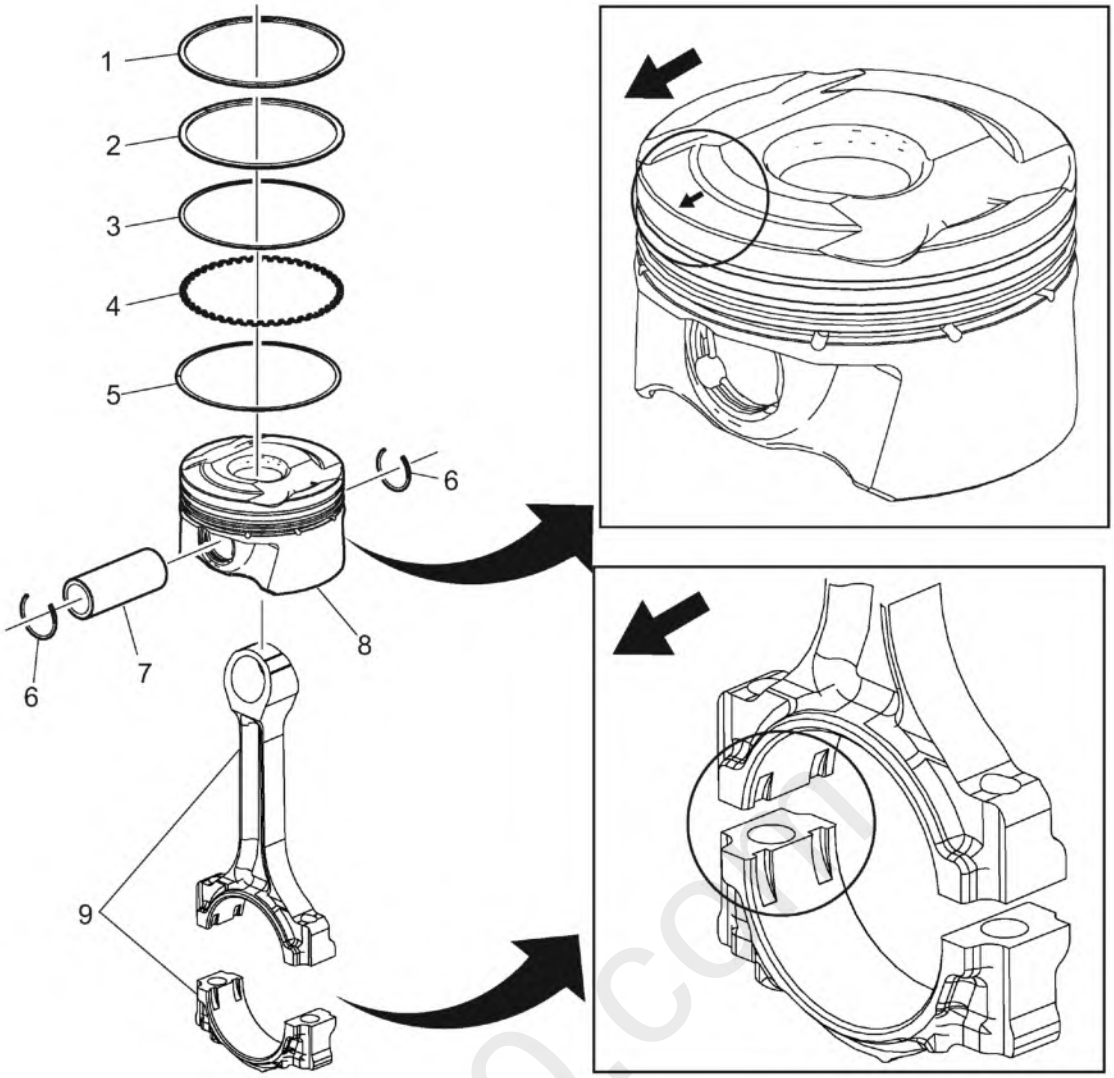


Fig. 416: Piston and Connecting Rod
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure **NOTE:** **Many internal engine components will develop specific wear patterns on their friction surfaces.** 1. Components MUST be separated, marked, or organized in a way to ensure installation to their original location and position. Take precautions in order to prevent interchanging of parts. 2. Tag or mark each part immediately when removed. Indicate location, direction, or orientation when necessary.	
1	Piston Compression Upper Ring **WARNING:** **Handle the piston carefully. Worn piston rings are sharp and may cause bodily injury.** **NOTE:** **Use a suitable tool to expand the rings. The piston rings must not be reused.**
2	Piston Compression Lower Ring
3	Piston Oil Ring Rail

Callout	Component Name
4	Piston Oil Ring Spacer
5	Piston Oil Ring Rail
6	Piston Pin Retainer **WARNING:** **Use extreme care when removing snap rings. Always wear adequate eye protection in order to avoid personal injury.** **NOTE:** **Two retainers hold the piston pins in place. Ensure that the piston pin is not damaged. Do not reuse the retainers.** **Procedure** Remove the piston pin retainers using the **EN-49941** remover. **Special Tools** **EN-49941** Piston Pin Retainer Remover and Installer For equivalent regional tools, refer to **Special Tools**.
7	Piston Pin
8	Piston **NOTE:** **An arrow/dot showing proper piston orientation is located on the top of the piston.**
9	Connecting Rod **NOTE:** **Features such as a raised section on the connecting rod may help identify the correct orientation relative to the front of the engine. Ensure that each connecting rod has been clearly marked upon removal to identify the cylinder, orientation, and direction of both the rod and cap.**

PISTON, CONNECTING ROD, AND BEARING CLEANING AND INSPECTION

Piston Cleaning Procedure

NOTE: **DO NOT wire brush any part of the piston.**

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

mc750.com

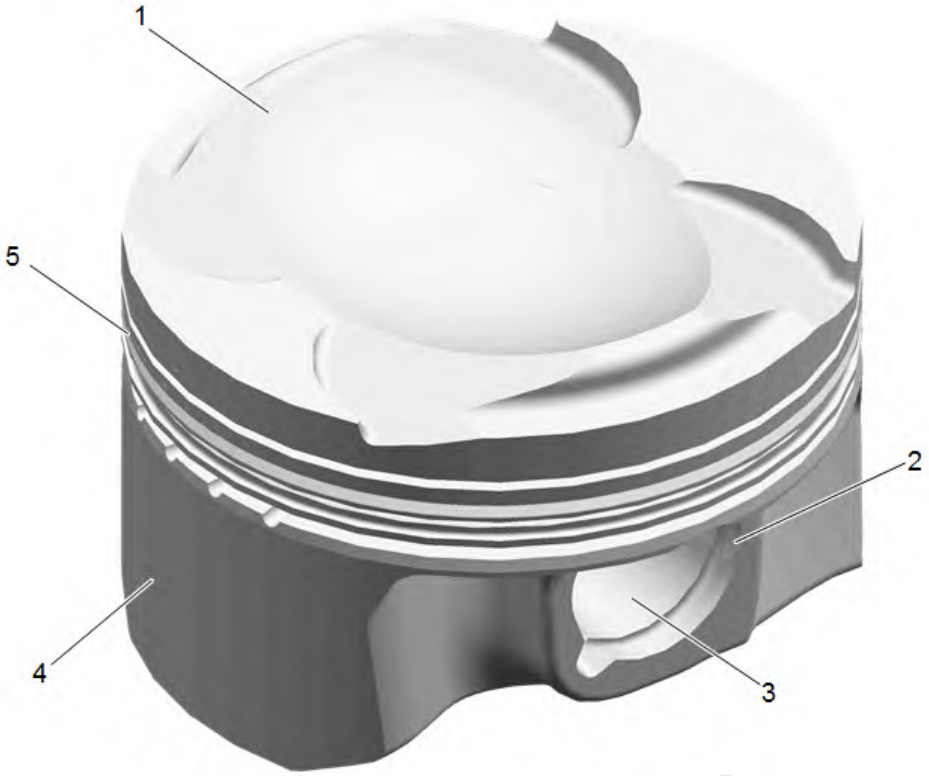


Fig. 417: Identifying Piston Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the pistons for the following conditions:
    - 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

mc30.com

Fig. 418: Measuring Piston Width
Courtesy of GENERAL MOTORS COMPANY

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 the cylinder diameter.
    3. Check your measurements. Refer to **Engine Mechanical Specifications**.
    4. If the clearance obtained through measurement is greater than the provided specifications and the cylinder bores are within specification, replace the piston.

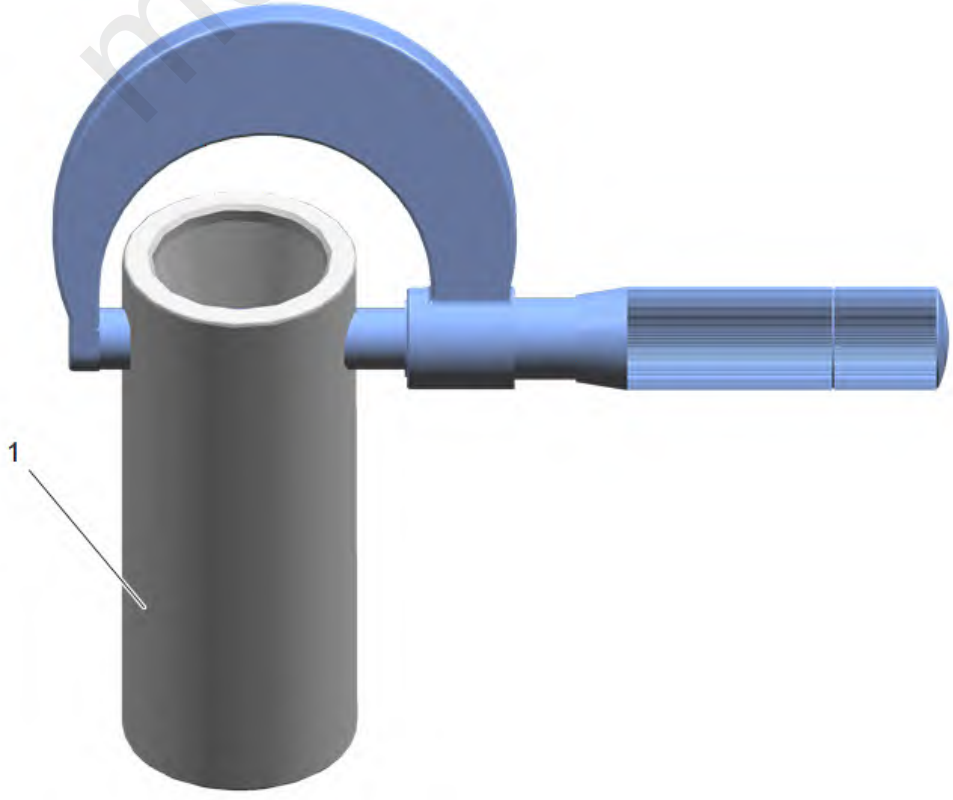


Fig. 419: Measuring Piston Pin Diameter
Courtesy of GENERAL MOTORS COMPANY

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.

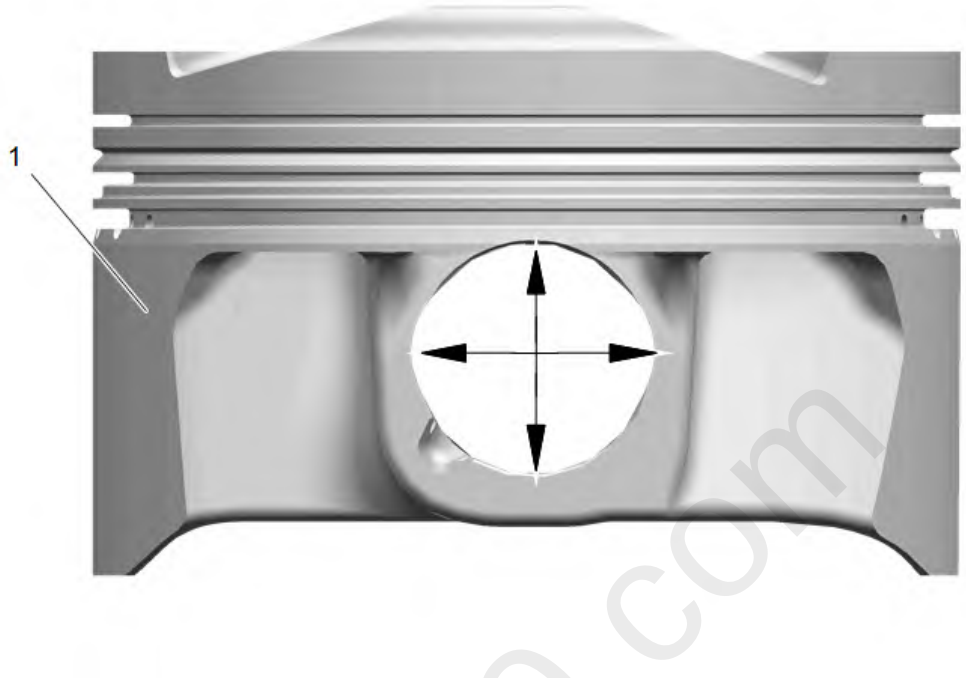


Fig. 420: Measuring Piston Pin Bore
Courtesy of GENERAL MOTORS COMPANY

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 specification. Refer to **Engine Mechanical Specifications**.
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

mcx30.com

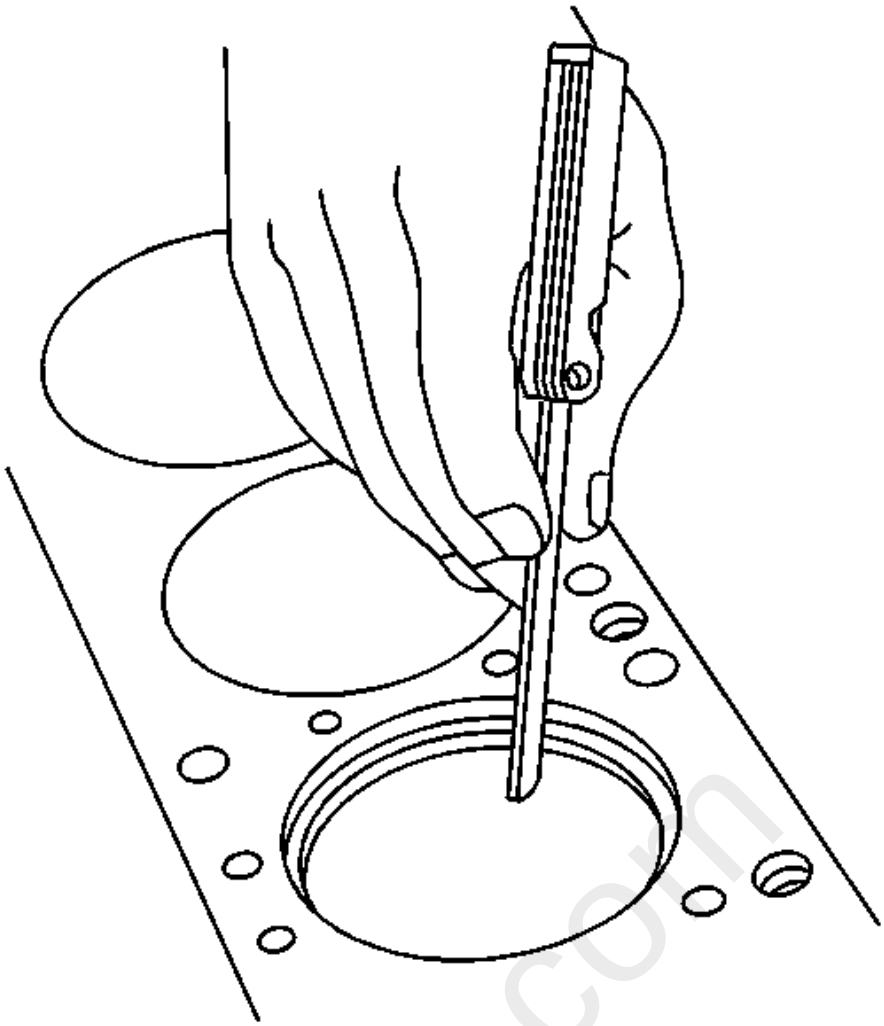


Fig. 421: Measuring Piston Ring End Gap
Courtesy of GENERAL MOTORS COMPANY

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.
    2. Measure the end gap of the piston ring with feeler gauges. Refer to **Engine Mechanical Specifications**.
    3. If the clearance exceeds the provided specifications, the piston rings must be replaced.
    4. Repeat the procedure for all the piston rings.

mgx80.com

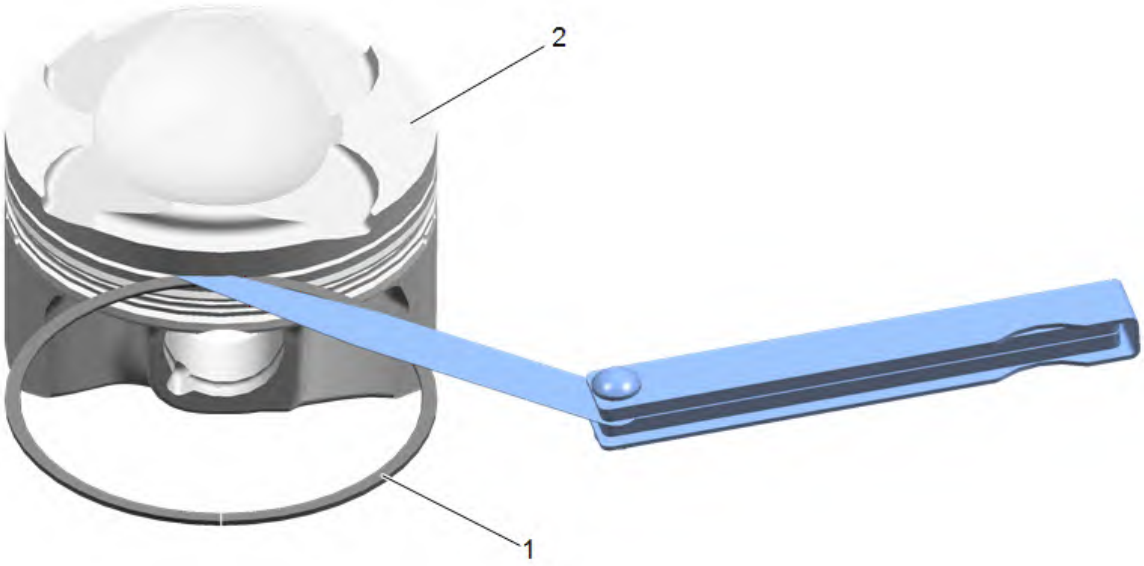


Fig. 422: Measuring Piston Ring Side Clearance
Courtesy of GENERAL MOTORS COMPANY

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 specification. Refer to **Engine Mechanical Specifications**.
    4. If the clearance is greater than specifications, replace the piston rings.

mox30.com

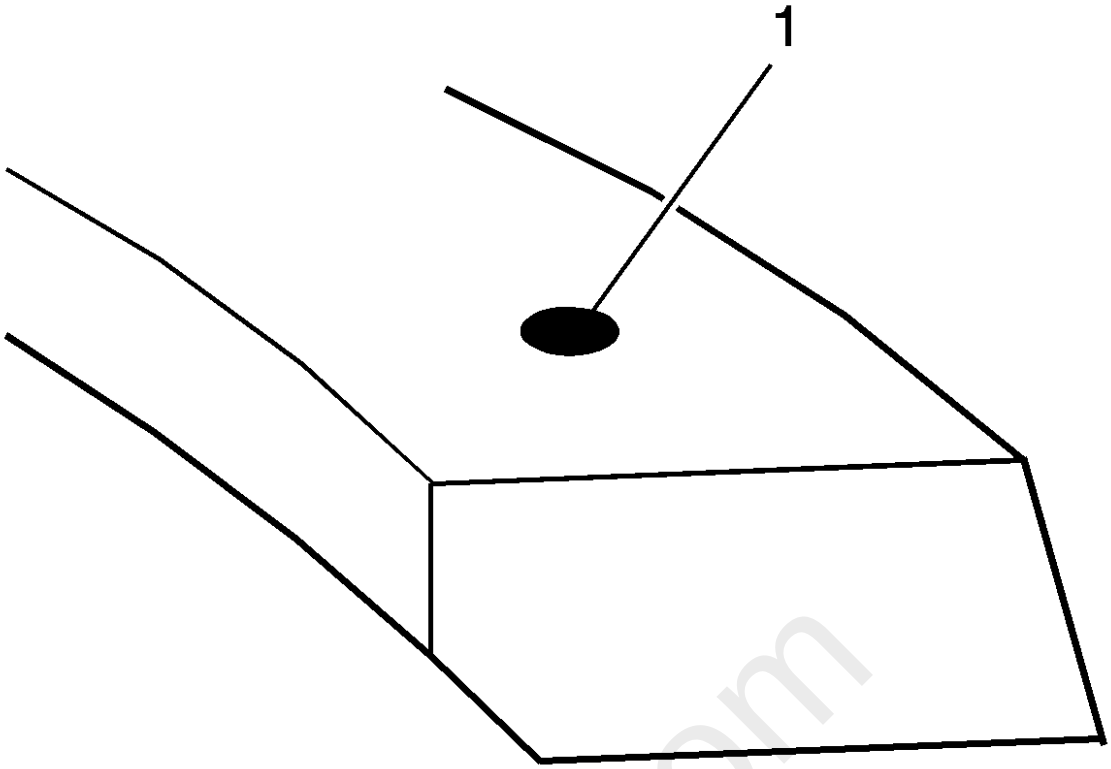


Fig. 423: View Of Lower Compression Piston Ring Mark
Courtesy of GENERAL MOTORS COMPANY

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 1 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 engine.

Connecting Rod Visual Inspection Procedure

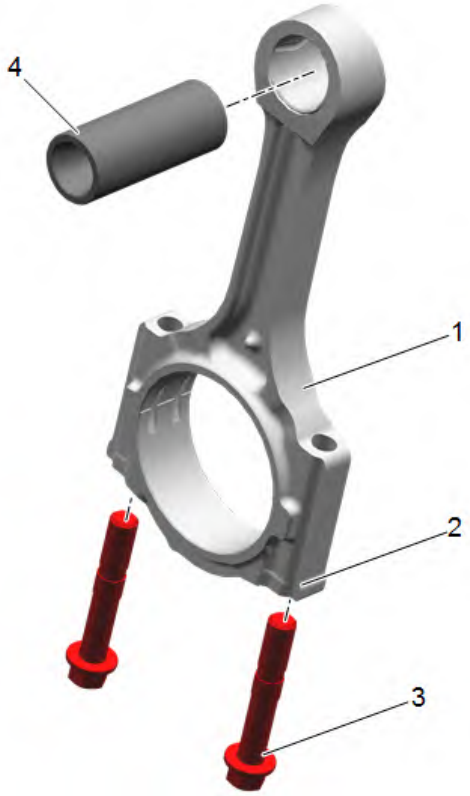


Fig. 424: Inspecting Connecting Rod Components
Courtesy of GENERAL MOTORS COMPANY

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. Thoroughly clean the parts and perform a high-pressure wash if an abrasive is used on the bores.

Connecting Rod Measurement Procedure

Piston Pin End

mcy30.com

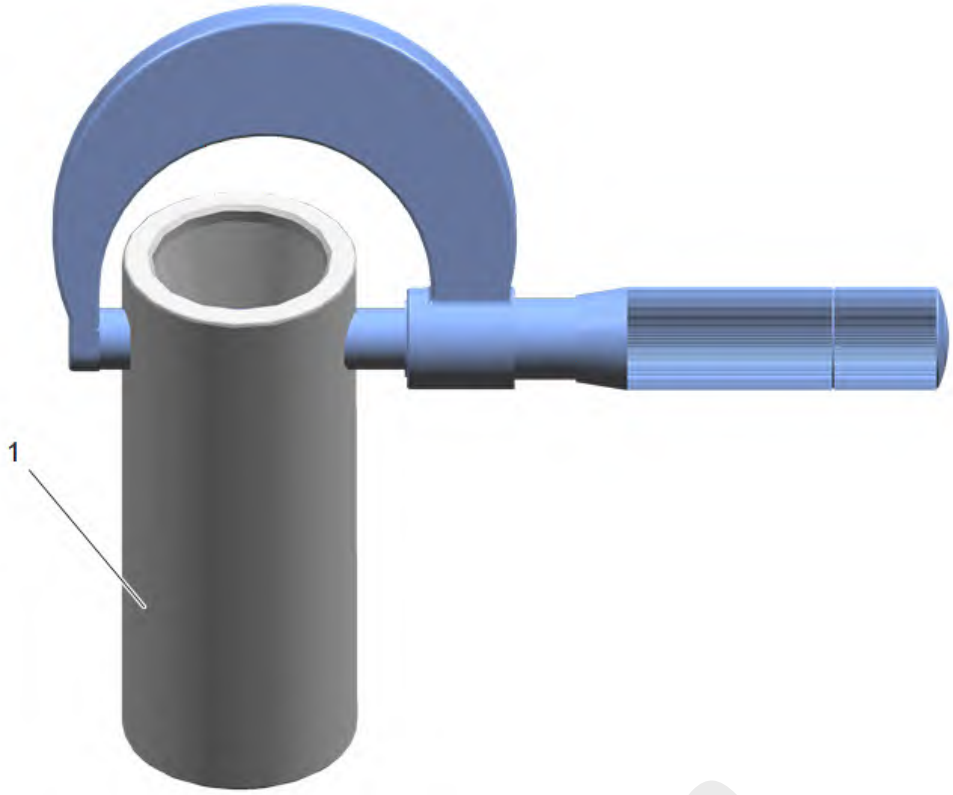


Fig. 425: Measuring Piston Pin Diameter
Courtesy of GENERAL MOTORS COMPANY

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.

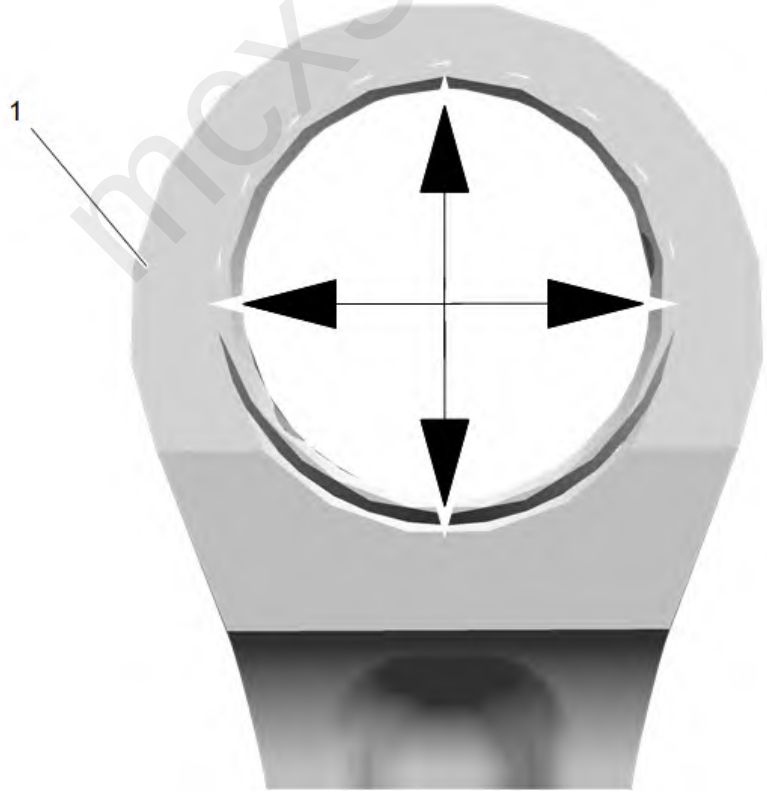


Fig. 426: Checking Connecting Rod Piston Pin Bore Dimensions
Courtesy of GENERAL MOTORS COMPANY

2. Using an inside micrometer, measure the connecting rod piston pin bore.
3. Subtract the piston pin diameter from the piston pin bore.

mcx30.com

4. Compare the clearance measurements to the proper specifications. Refer to **Engine Mechanical Specifications**.
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

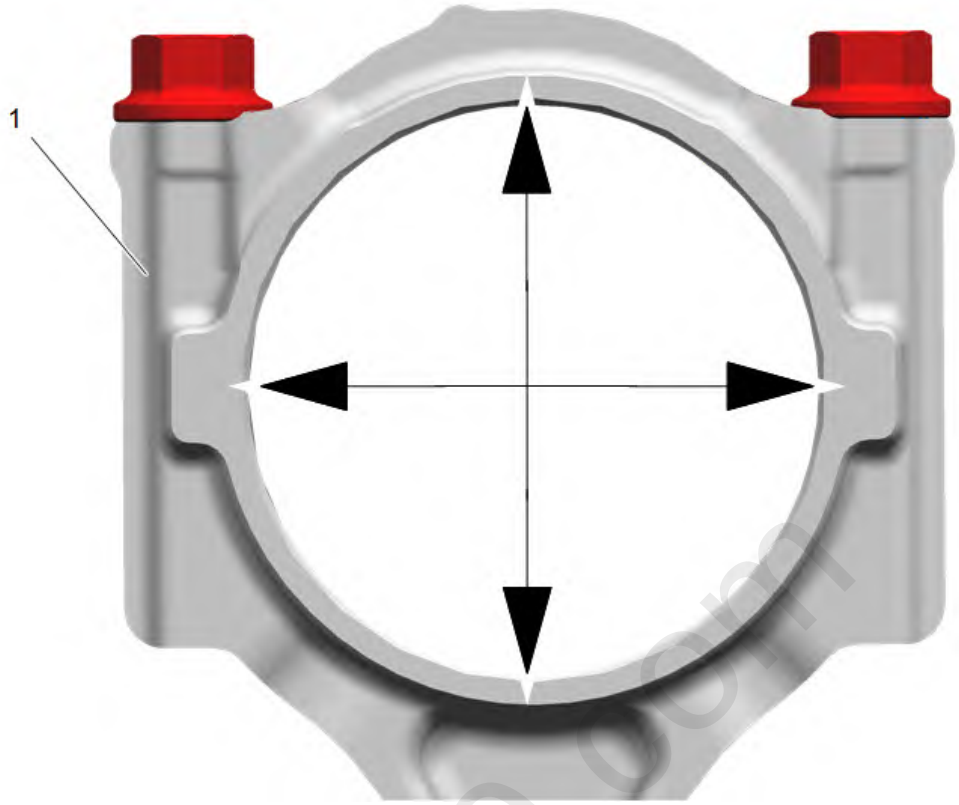


Fig. 427: Measuring Connecting Rod Crankshaft Bearing Bore
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Measurements of all components should be taken with the components at normal room temperature.**

NOTE: **The bore specifications are based on connecting rod bolts at full torque specification.**

1. Using the old bolts, tighten the connecting rod cap bolts to 25 N.m (18 lb ft) plus 75 degrees.
2. Using an inside micrometer, measure the connecting rod crankshaft bearing bore.
3. Compare the bore measurements to the proper specifications. Refer to **Engine Mechanical Specifications**.
4. Replace the connecting rod if the bore is out of specifications. DO NOT recondition the connecting rod.

PISTON AND CONNECTING ROD ASSEMBLE

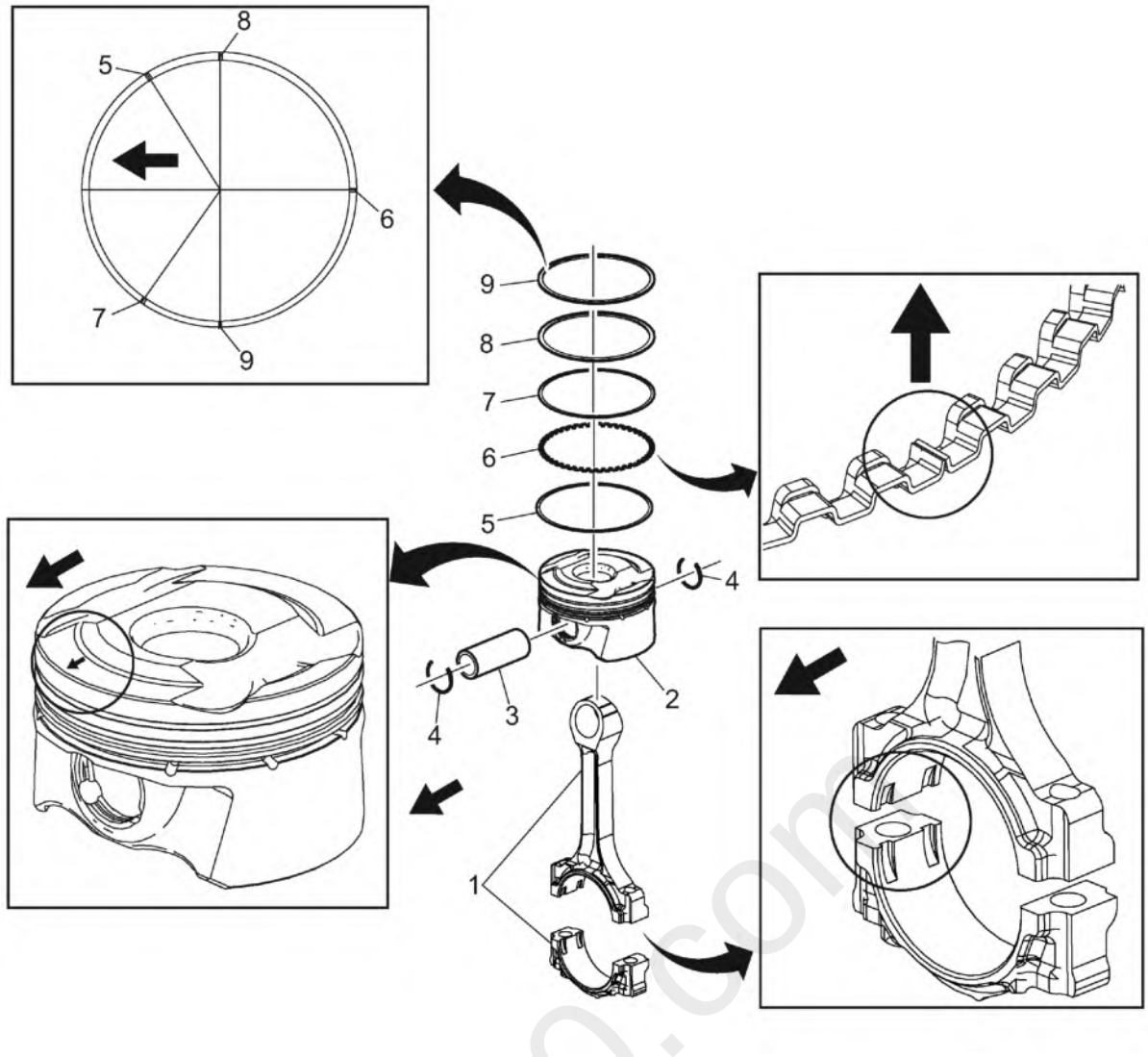


Fig. 428: Piston and Connecting Rod
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Connecting Rod **NOTE:** **Align the connecting rod and piston with the features used to identify the orientation of the component relative to the front of the engine.**
2	Piston **Procedure** 1. Locate the alignment feature or marks on the connecting rod. 2. Locate the alignment feature or marks on the piston. 3. Ensure that the alignment features are in the correct location when assembling the components.
3	Piston Pin

mcx30.com

Callout	Component Name
4	Piston Pin Retainer **CAUTION:** **Install the piston pin retainers correctly in the retaining groove during assembly in order to avoid engine damage.** **Procedure** 1. Coat the piston pin with oil. 2. Install one side of one piston pin retainer into the retaining groove using **EN-49941** installer. Rotate the retainer until it is fully seated in the groove. 3. Install the piston pin. Push the piston pin until it bottoms in the previously installed retainer. 4. Install the second piston pin retainer, using **EN-49941** installer. 5. Ensure that the piston moves freely. **Special Tools** **EN-49941** Piston Pin Retainer Remover and Installer For equivalent regional tools, refer to **Special Tools**.
5	Piston Oil Ring Rail **CAUTION:** **Use a piston ring expander to install the piston rings. The rings may be damaged if expanded more than necessary.**
6	Piston Oil Ring Spacer **NOTE:** **Properly orient the oil ring spacer as shown before installation. The ends of the spacer must be facing toward the top of the piston.**
7	Piston Oil Ring Rail
8	Piston Compression Lower Ring
9	Piston Compression Upper Ring **Procedure** Once the rings are installed, set the ring gaps as shown. Use the piston location arrow for reference.

CAMSHAFT CLEANING AND INSPECTION

Special Tools

GE-7872 Magnetic Base Dial Indicator

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

mcx30.com

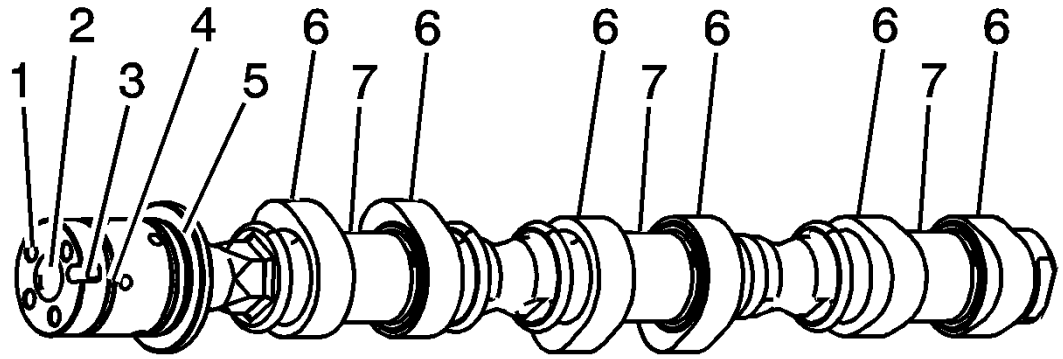


Fig. 429: Identifying Camshaft Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

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

mcx30.com

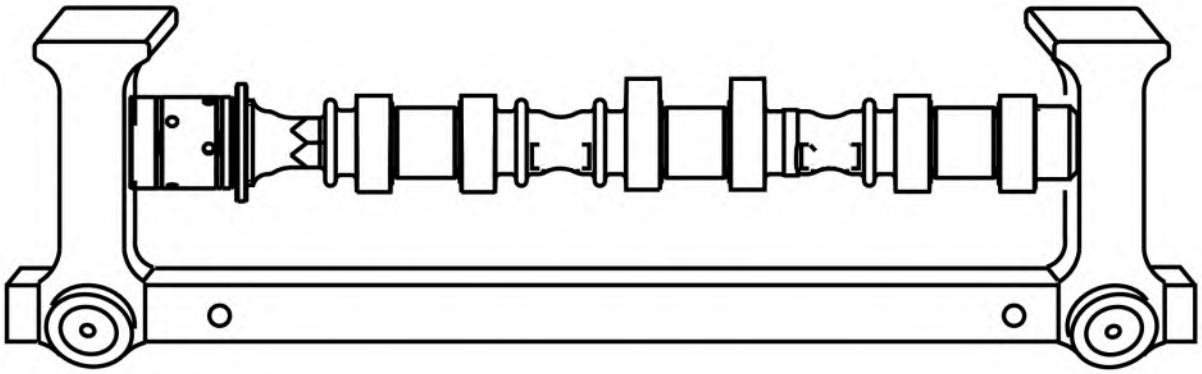


Fig. 430: Supporting Camshaft In Fixture
Courtesy of GENERAL MOTORS COMPANY

1. With the camshaft in a suitable fixture, measure the camshaft for wear.

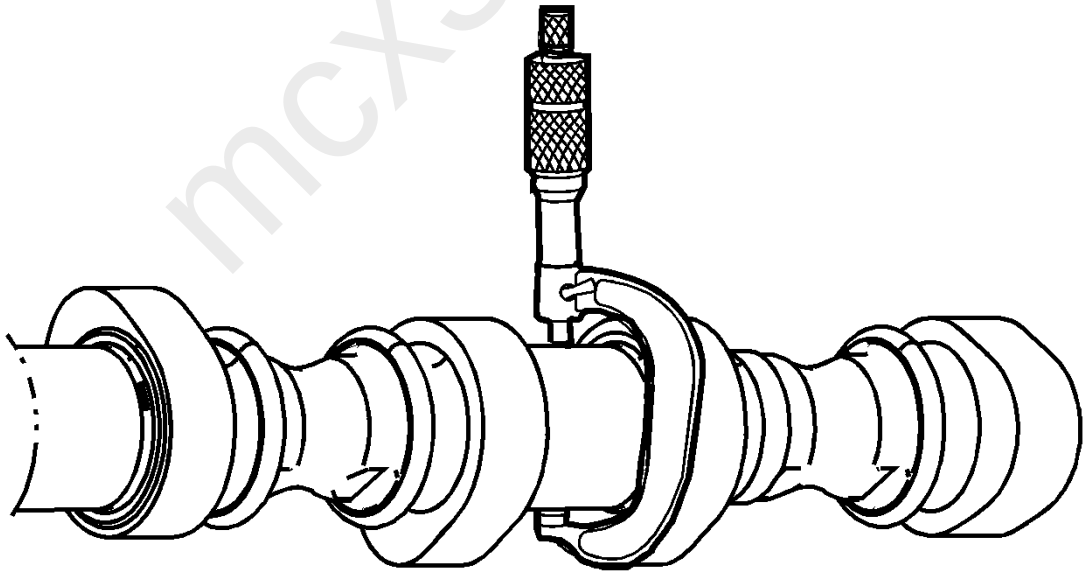


Fig. 431: Measuring Camshaft Journals
Courtesy of GENERAL MOTORS COMPANY

mcx30.com

2. Measure the camshaft journals for diameter and out-of-round using an outside micrometer. Refer to **Engine Mechanical Specifications**.
    - If the diameter is smaller than specifications, replace the camshaft.
    - If the out-of-round exceeds specifications, replace the camshaft.

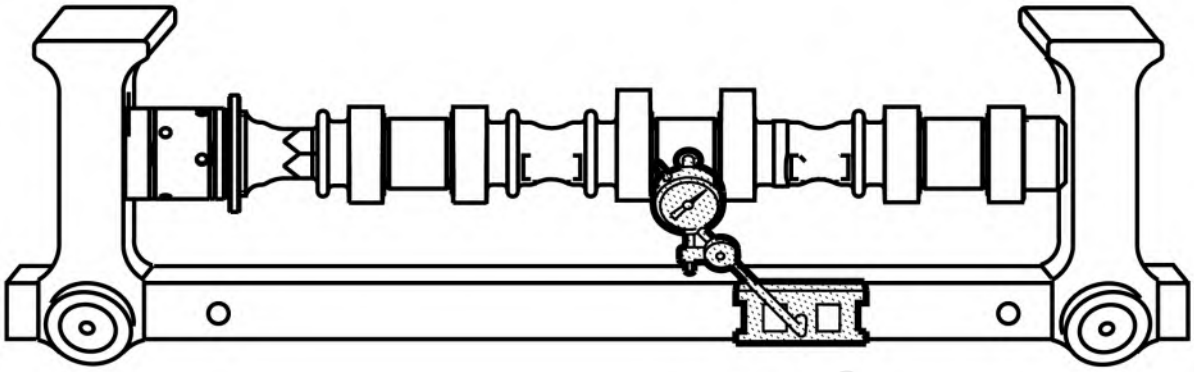


Fig. 432: Checking Camshaft Runout
Courtesy of GENERAL MOTORS COMPANY

3. Measure the camshaft runout using the **GE-7872** indicator. Refer to **Engine Mechanical Specifications**.

mcx30.com

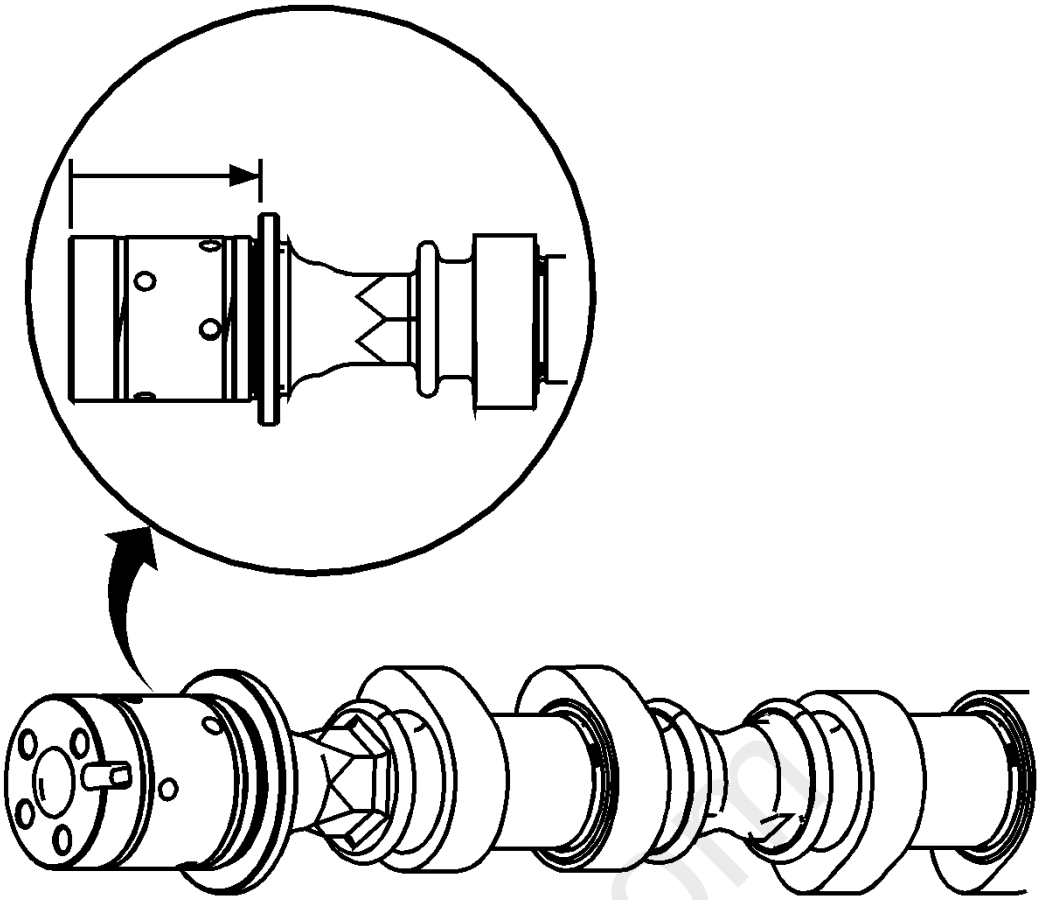


Fig. 433: Measuring Camshaft Thrust Width
Courtesy of GENERAL MOTORS COMPANY

4. Measure the camshaft thrust width for wear using a depth micrometer. Refer to **Engine Mechanical Specifications**.

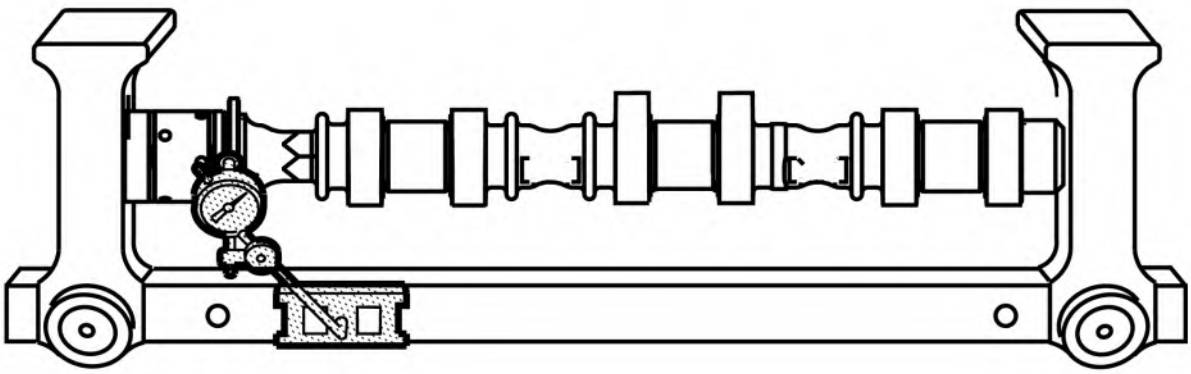


Fig. 434: Measuring Camshaft
Courtesy of GENERAL MOTORS COMPANY

mcx30.com

5. Measure the camshaft thrust wall surface for runout using **GE-7872** indicator. Refer to **Engine Mechanical Specifications**.
6. If the camshaft is damaged or worn beyond specifications, replace the camshaft. No machining of the camshaft is allowed.

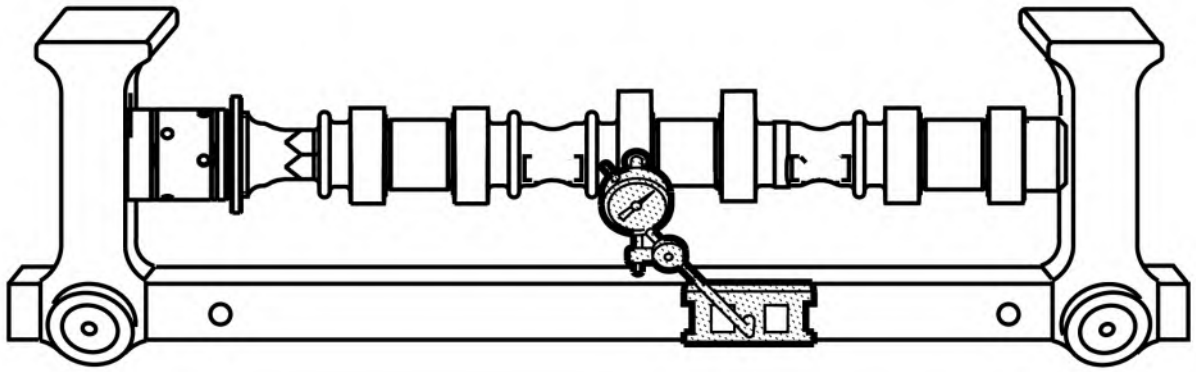


Fig. 435: Measuring Camshaft Lobes For Wear
Courtesy of GENERAL MOTORS COMPANY

7. Measure the camshaft lobes for wear using the **GE-7872** indicator.

mcx30.com

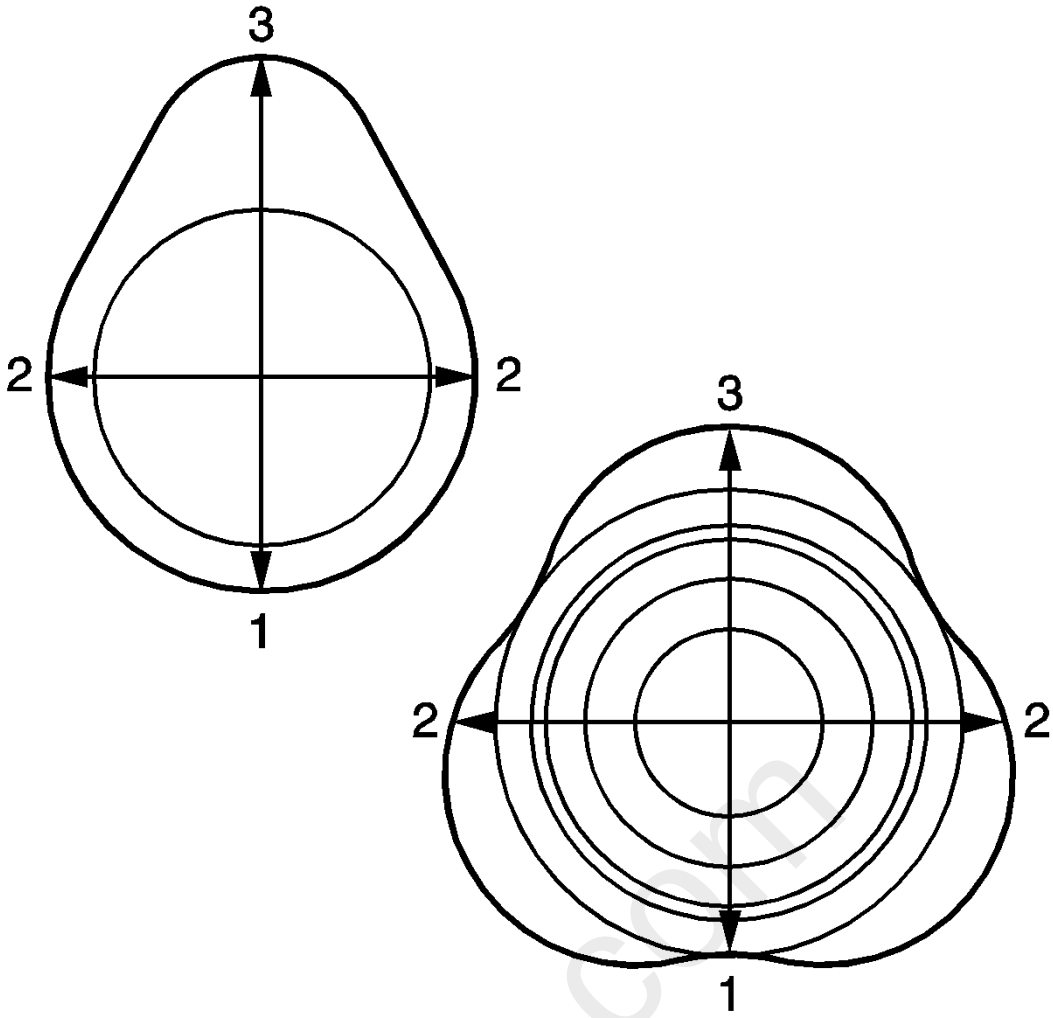


Fig. 436: View of Lobe Diagram
Courtesy of GENERAL MOTORS COMPANY

8. Place the **GE-7872** indicator with the indicator tip on the base circle (1) of the camshaft lobe.
    1. Place the **GE-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**.
    3. If the indicated measurement is significantly lower than these specifications, replace the camshaft or engine performance will be reduced.

CAMSHAFT TIMING CHAIN AND SPROCKET CLEANING AND INSPECTION

nick30.com

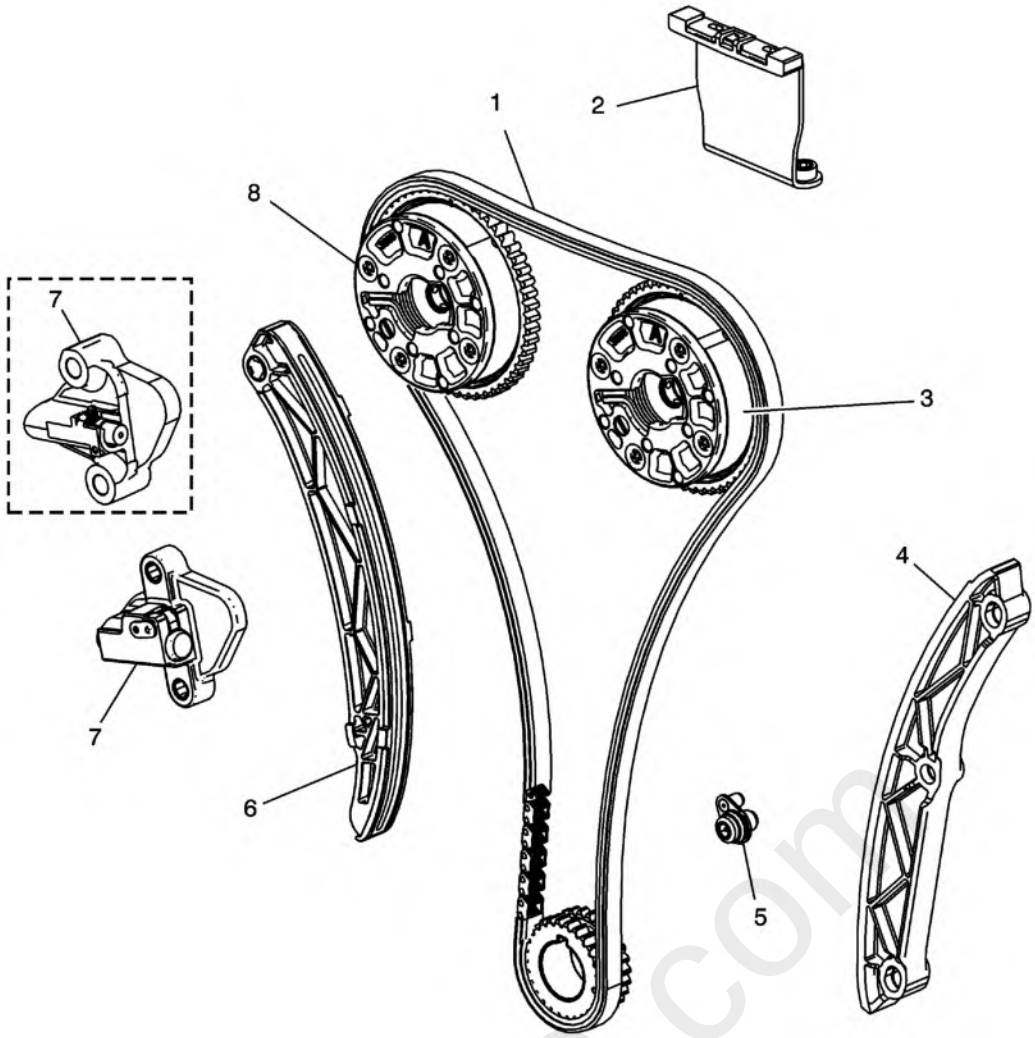


Fig. 437: Camshaft Timing Chain and Sprocket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Timing Chain **Procedure** 1. Inspect the timing chain for binding or worn links. 2. Inspect the timing chain for loose links. 3. Inspect the timing chain for loose pins. 4. Replace the timing chain if binding, excessive wear, or a loose condition is present.
2	Timing Chain Guide **Procedure** 1. Inspect the guide for worn guide surface. Replace the timing chain guides if wear exceeds 1.12 mm (0.045 in) depth on the chain guide surface. 2. Inspect the guide for a cracked or broken guide surface. 3. Inspect the guide for a cracked or damaged guide base. 4. Replace the guide if damage is present.

mcx30.com

Callout	Component Name
3	Camshaft Position Actuator Assembly - Exhaust **Procedure** 1. Inspect the camshaft actuator faces for signs of movement. 2. Inspect the camshaft actuator for sprocket damage. 3. Inspect the actuator bolt seating and sealing inner hub flange for damage. 4. Inspect the back of the actuator for locating pin damage. 5. Ensure the actuator housing bolts are not loose or missing. 6. Inspect the back of the actuator for blockage to the oil passages. 7. Replace the actuator if any of these conditions are present.
4	Timing Chain Guide **Procedure** 1. Inspect the guide for wear to the guide surface. 2. Inspect the guide for cracked or broken guide surface or base. 3. Replace the guide if these conditions are present.
5	Timing Chain Oil Nozzle **Procedure** 1. Inspect the oil nozzle body for collapse or cracks at the bolt boss. Discard and replace the oil nozzle body if it is damaged. 2. Verify oil nozzle oil flow with compressed air. 3. Replace the nozzle if damage or oil flow restriction is present.
6	Timing Chain Tensioner Shoe **Procedure** 1. Inspect for worn, cracked, or broken shoe surface. 2. Inspect the shoe for wear at the tensioner contact pad. 3. Replace the shoe if any of these conditions are present.
7	Timing Chain Tensioner **Procedure** 1. Inspect the tensioner for damage to the plunger-to-shoe contact surface. 2. Inspect the tensioner for a locked or binding condition. Reset the plunger and ensure the plunger moves freely in and out of the tensioner body. • If the tensioner has a lever on the front, press down on the lever and depress the plunger. Insert a suitable tool into the hole in the tensioner body to hold the plunger in the retracted position. • If the tensioner has a retaining clip, press the clip and depress the plunger. Insert a suitable tool into the hole in the tensioner body to hold the plunger in the retracted position. 3. Inspect the timing chain tensioner gasket for damage. 4. Replace the tensioner if any of these conditions are present.

mcx30.com

Callout	Component Name
8	Camshaft Position Actuator Assembly - Intake **Procedure** 1. Inspect the camshaft actuator faces for signs of movement. 2. Inspect the camshaft actuator for sprocket damage. 3. Inspect the actuator bolt seating and sealing inner hub flange for damage. 4. Inspect the back of the actuator for locating pin damage. 5. Ensure the actuator housing bolts are not loose or missing. 6. Inspect the back of the actuator for blockage to the oil passages. 7. Replace the actuator if any of these conditions are present.

INTAKE MANIFOLD CLEANING AND INSPECTION

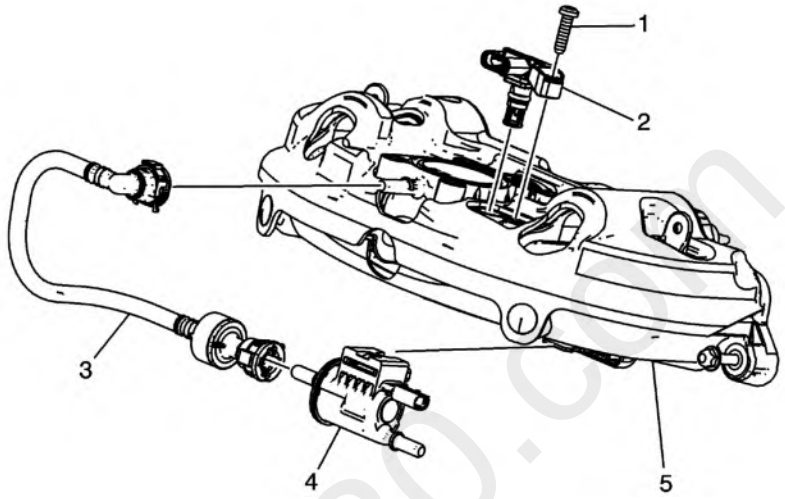


Fig. 438: Intake Manifold Cleaning and Inspection
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove all components prior to cleaning and inspection. 2. Inspect each component.	
1	Intake Air Pressure and Temperature Sensor Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 5 N.m (44 lb in)
2	Intake Air Pressure and Temperature Sensor
3	Evaporative Emission Canister Purge Tube Assembly
4	Evaporative Emission Canister Purge Valve
5	Intake Manifold

CRANKSHAFT AND BEARING CLEANING AND INSPECTION

Special Tools

- **EN-8087** Cylinder Bore Checking Gauge
- **EN-45059** Angle Meter

- **GE-7872** Magnetic Base Dial Indicator Set

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

Crankshaft Cleaning and Inspection

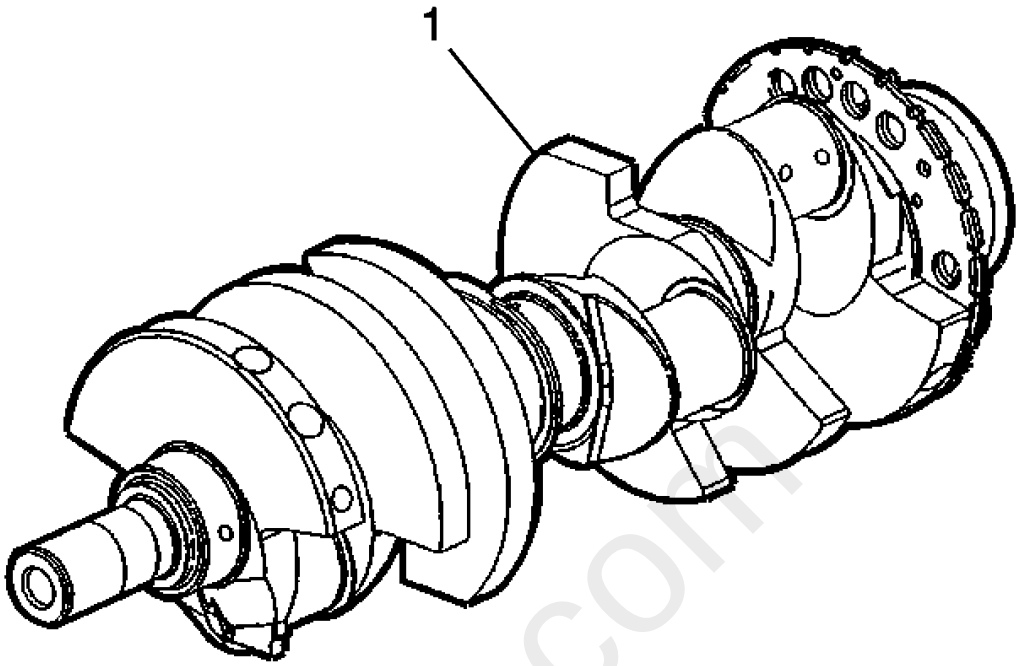


Fig. 439: Clean Crankshaft With Solvent
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Use care when handling the crankshaft. Avoid damage to the bearing surfaces or the lobes of the crankshaft position reluctor ring. Damage to the teeth of the crankshaft position reluctor ring may affect on-board diagnostic (OBD) II system performance.**

1. Clean the crankshaft (1) with solvent.
2. Thoroughly clean all oil passages and inspect for restrictions or burrs.

WARNING: **Refer to Safety Glasses Warning .**

3. Dry the crankshaft with compressed air.

NOTE: **Reluctor ring teeth should not have imperfections on the rising or falling edges. Imperfections of the reluctor ring teeth may effect OBD II system performance.**

4. Perform a visual inspection of the crankshaft for damage.

mcx30.com

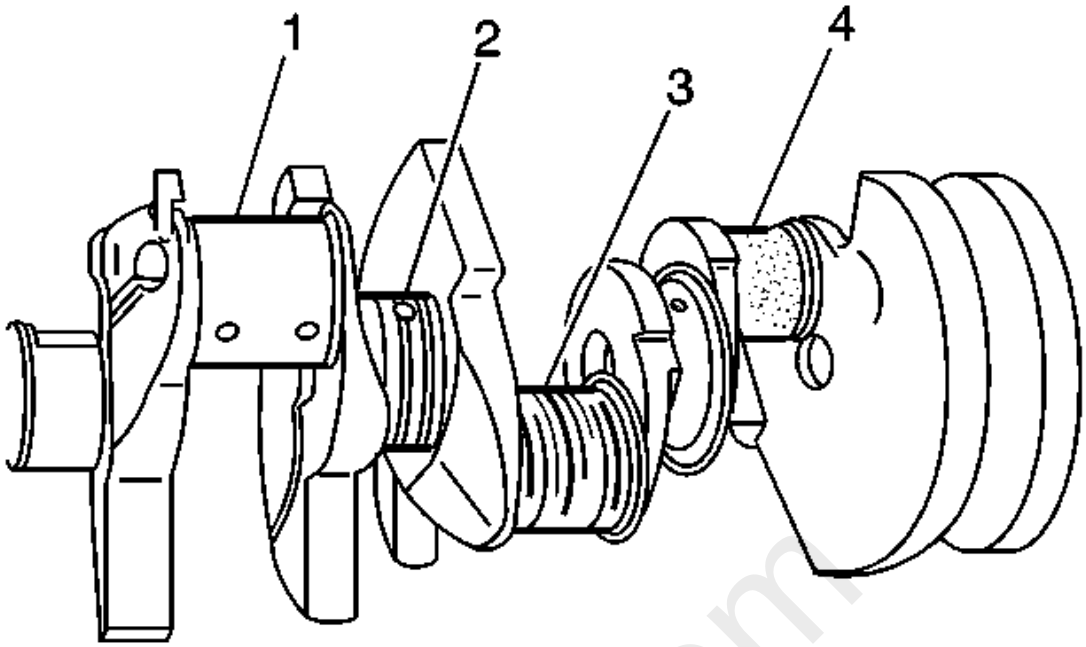


Fig. 440: Identifying Different Crankshaft Journal Wear Patterns
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the crankshaft journals for wear (1). The journals should be smooth, with no signs of scoring, wear, or damage.
6. Inspect the crankshaft journals for grooves or scoring (2).
7. Inspect the crankshaft journals for scratches or wear (3).
8. Inspect the crankshaft journals for pitting or imbedded bearing material (4).

Crankshaft Measurements

mcx80.com

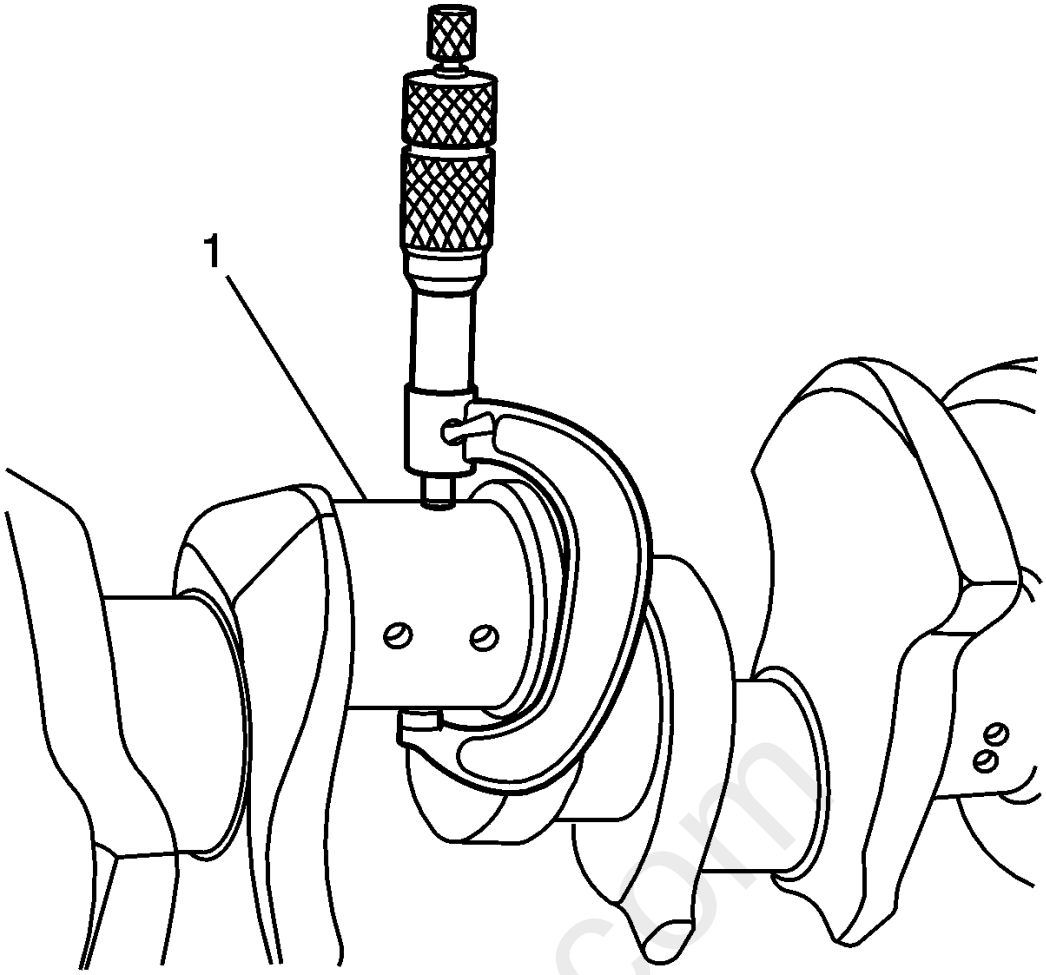


Fig. 441: Measure Crankshaft Journals For Out-Of-Round
Courtesy of GENERAL MOTORS COMPANY

1. Measure the crankshaft journals (1) for out-of-round.
2. Measure the crankshaft journals for taper.

mexeo.com

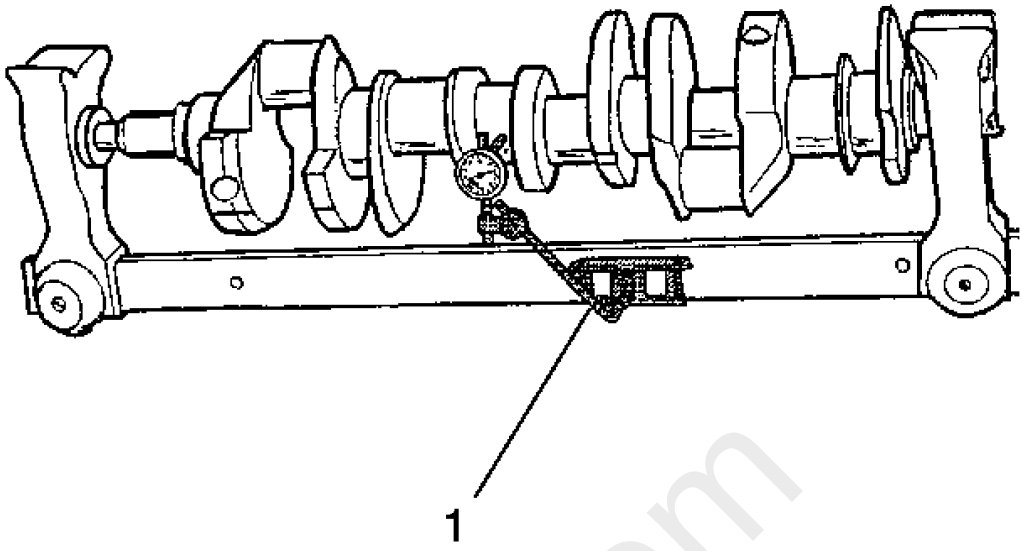


Fig. 442: Measuring The Crankshaft Runout
Courtesy of GENERAL MOTORS COMPANY

3. Measure the crankshaft runout.

   Using wooden V-blocks, support the crankshaft on the front and rear journals.

4. Use the **GE-7872** indicator (1) in order to measure the crankshaft runout at the front and rear intermediate journals.
5. Use the **GE-7872** indicator in order to measure the runout of the crankshaft rear flange.
6. Replace the crankshaft if the measurements are not within specifications. Refer to **Engine Mechanical Specifications**.

Crankshaft Bearings Cleaning and Inspection

mcx30.com

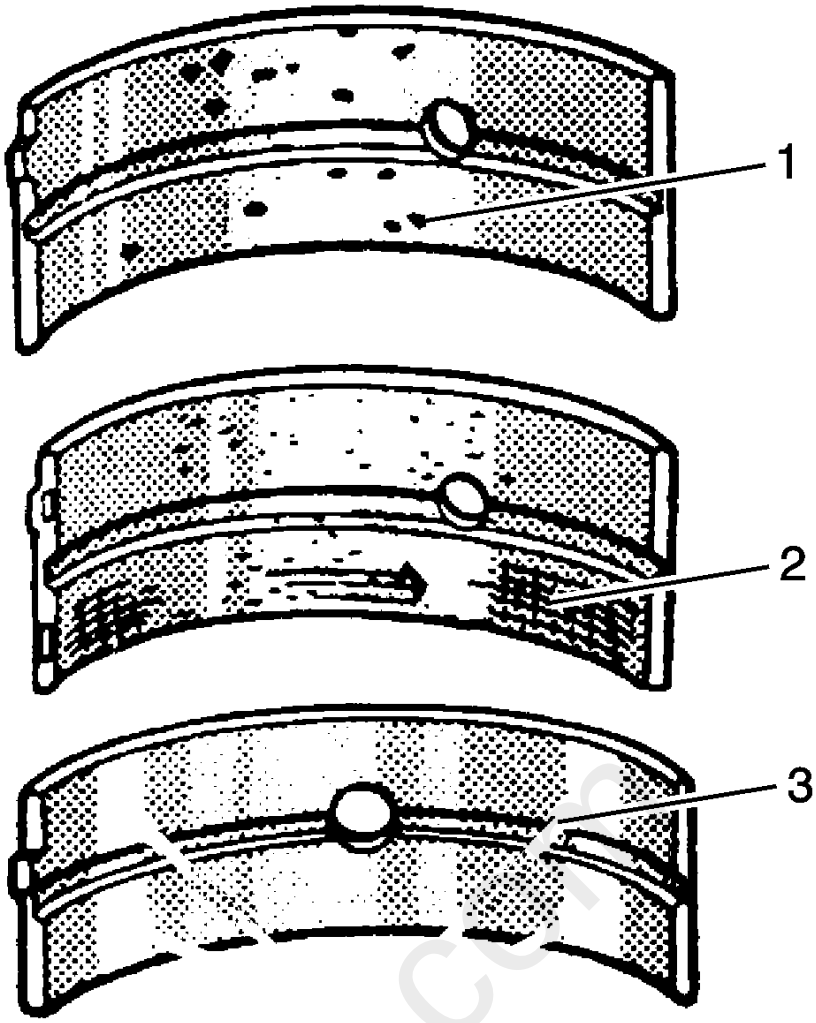


Fig. 443: Identifying Crankshaft Bearings For Craters Or Pockets
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Crankshaft bearings MUST be separated, marked, or organized in a way to ensure installation to their original location and position, when suitable for use.**
- **If crankshaft bearing failure is due to other than normal wear, investigate the cause. Inspect the crankshaft or connecting rod bearing bores.**

1. Inspect crankshaft bearings for craters or pockets (1). Flattened sections on the bearing halves also indicate fatigue.
2. Inspect the crankshaft bearings for excessive scoring or discoloration (2).
3. Inspect the crankshaft bearings for dirt or debris imbedded into the bearing material.
4. Inspect the crankshaft bearings for improper seating indicated by bright, polished sections of the bearing (3).

   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.

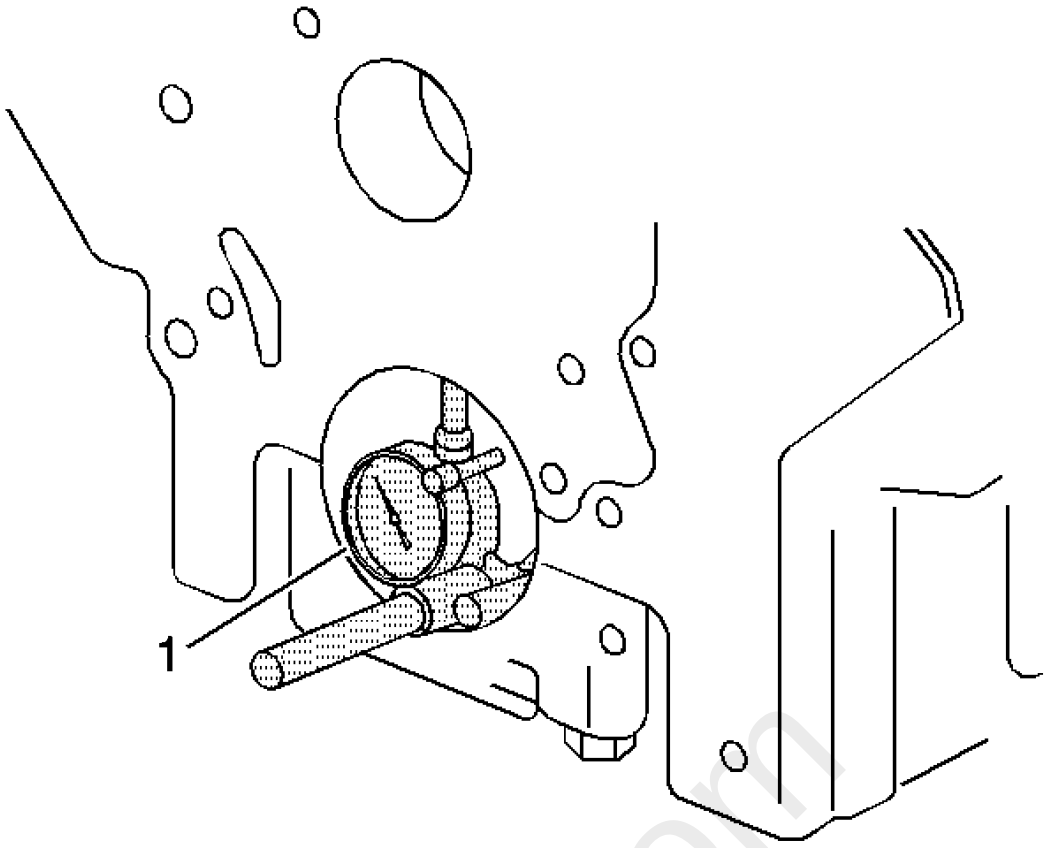


Fig. 444: Measuring Bearing Bore
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the connecting rod bearing bores or crankshaft main bearing bores using the following procedure:
    1. Tighten the bedplate to specification using the **EN-45059** meter.
    2. Measure the bearing bore for taper and out-of-round using the **EN-8087** gauge (1).
    3. No taper or out-of-round should exist.

Bearing Selection

1. Measure the bearing clearance to determine the correct replacement bearing insert size. There are 2 methods to measure bearing clearance. Method A gives more reliable results and is preferred.
    - Method A yields measurement from which the bearing clearance can be computed.
    - Method B yields the bearing clearance directly. Method B does not give any indication of bearing run-out.

mcx30.com

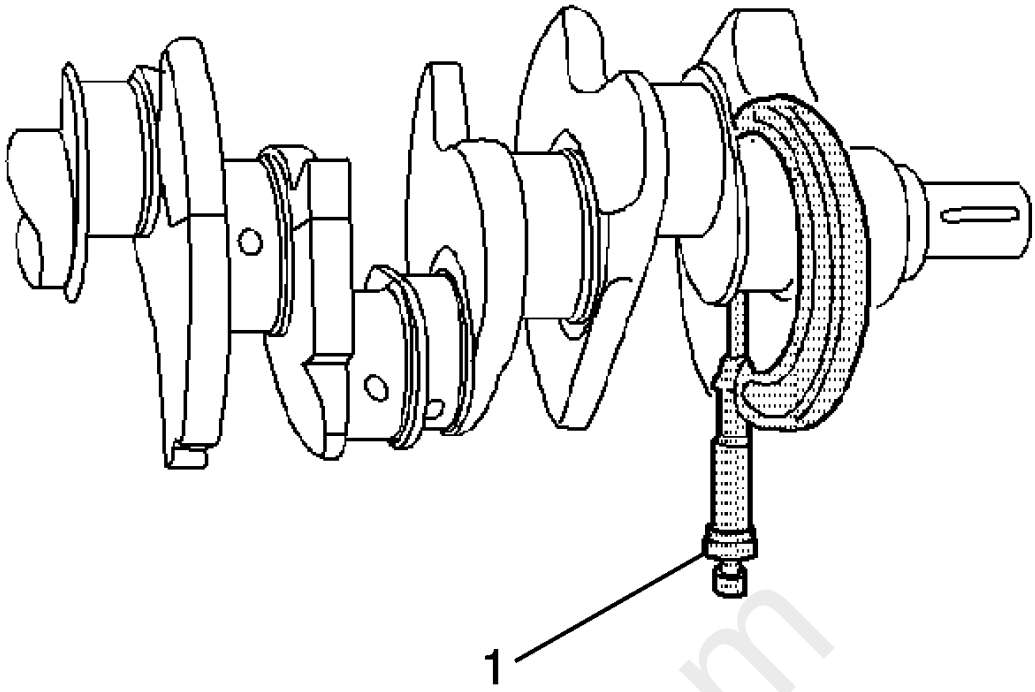


Fig. 445: View of Measuring Crankshaft Bearing Journal Using Method A
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not mix inserts of different nominal size in the same bearing bore.**

2. To measure bearing clearance using Method A, use the following procedure:
    1. Measure the crankshaft bearing journal diameter with a micrometer (1) in several places, 90 degrees apart. Average the measurements.
    2. Measure the crankshaft bearing journal taper and runout.
    3. Install the lower crankcase and tighten the bearing cap bolts to specification.
    4. Measure bearing inside diameter (ID) in several places 90 degrees apart, average measurements.
    5. Subtract journal measurement from bearing ID measurement to determine clearance.
    6. Determine whether clearance is within specification.
    7. If out of specification, choose different inserts.
    8. Measure the connecting rod inside diameter in the same direction as the length of the rod with an inside micrometer.
    9. Measure the crankshaft main bearing inside diameter with an inside micrometer.

mcx30.com

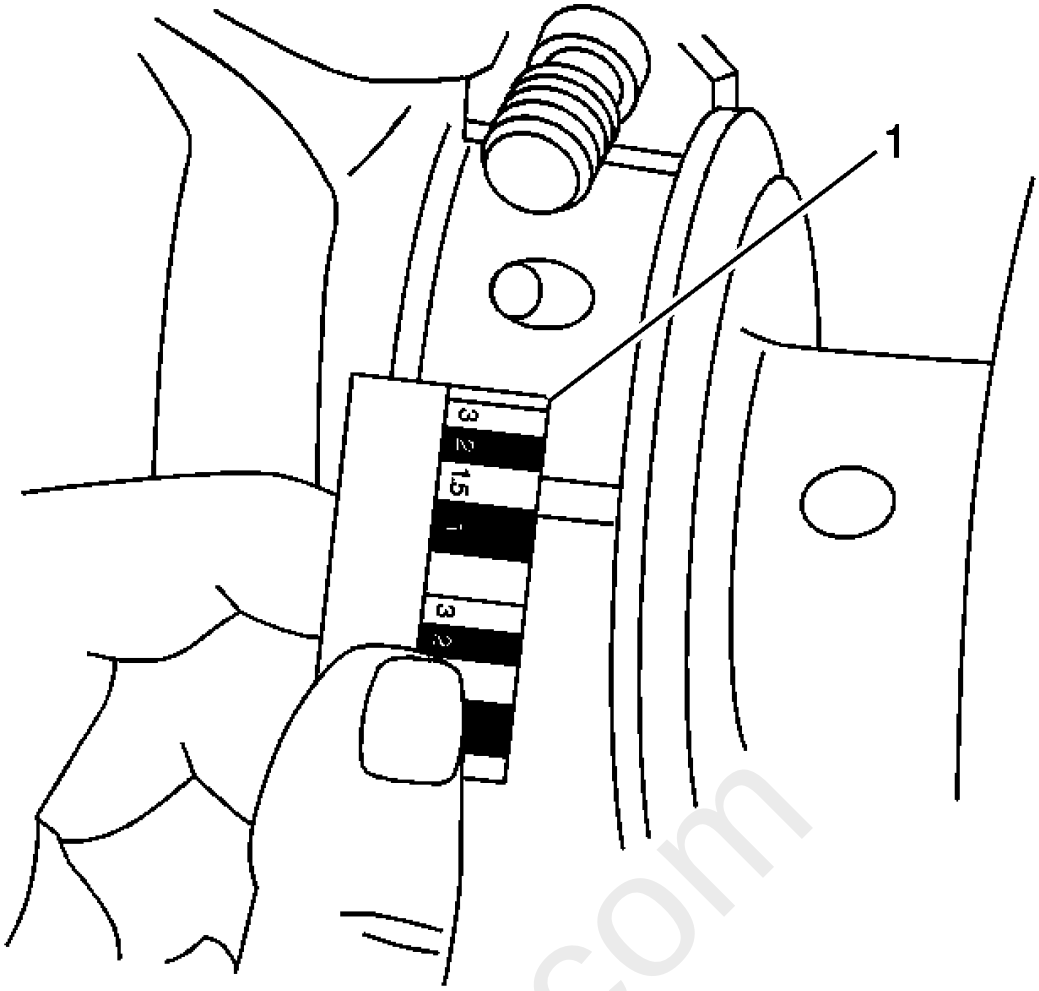


Fig. 446: Measuring Bearing Clearance Using Method B
Courtesy of GENERAL MOTORS COMPANY

3. To measure bearing clearance using Method B, use the following procedure:
    1. Clean the used bearing inserts.
    2. Install the used bearing inserts.
    3. Place a piece of gaging plastic across the entire bearing width.
    4. Install the bearing caps.

CAUTION: **In order to prevent the possibility of cylinder block or crankshaft bearing cap damage, the crankshaft bearing caps are tapped into the cylinder block cavity using a brass, lead, or a leather mallet before the attaching bolts are installed. Do not use attaching bolts to pull the crankshaft bearing caps into the seats. Failure to use this process may damage a cylinder block or a bearing cap.**

    5. Install the bearing cap bolts to specification.

NOTE: **Do not rotate the crankshaft.**

    6. Remove the bearing cap, leaving the gauging plastic in place. It does not matter whether the gauging plastic adheres to the journal or to the bearing cap.
    7. Measure the gauging plastic at its widest point with the scale (1) printed on the gauging plastic package.
    8. Remove the gauging plastic.

OIL PUMP DRIVE CHAIN TENSIONER AND OIL PUMP DRIVE CHAIN CLEANING AND INSPECTION

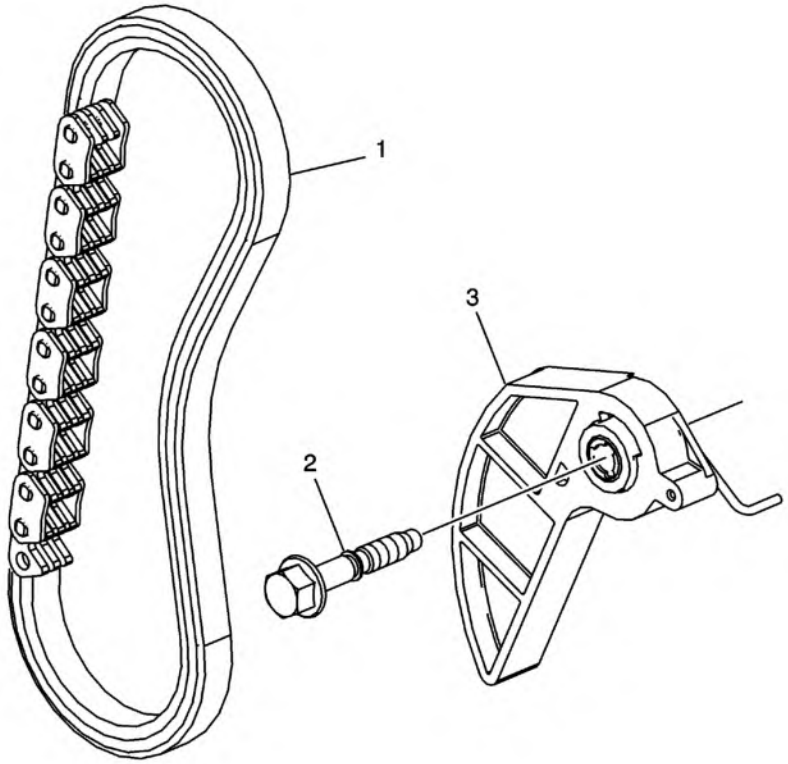


Fig. 447: Oil Pump Drive Chain Tensioner And Oil Pump Drive Chain
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Clean all components. 2. Inspect each component.	
1	Oil Pump Drive Chain
2	Oil Pump Drive Chain Tensioner Bolt
3	Oil Pump Drive Chain Tensioner

OIL PUMP CLEANING AND INSPECTION

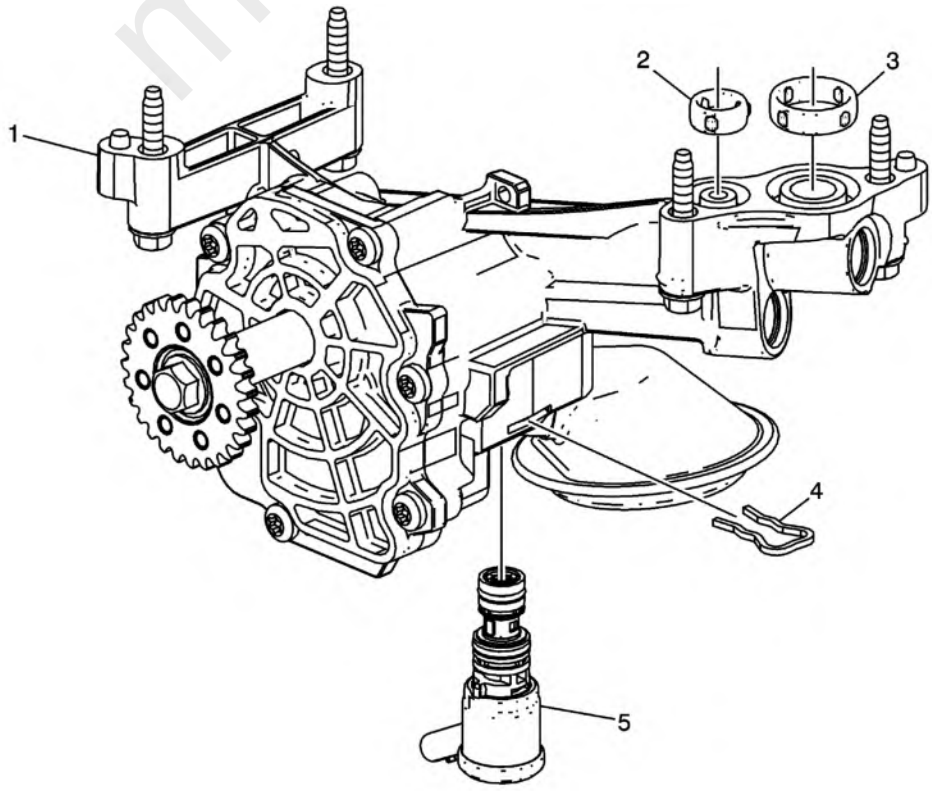


Fig. 448: Oil Pump
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Clean all components. 2. Inspect each component.	
1	Oil Pump
2	Oil Pump Gasket
3	Oil Pump Gasket
4	Oil Pump Flow Control Solenoid Valve Retainer
5	Oil Pump Flow Control Solenoid Valve

TURBOCHARGER CLEANING AND INSPECTION

Turbocharger and Components Cleaning and Inspection

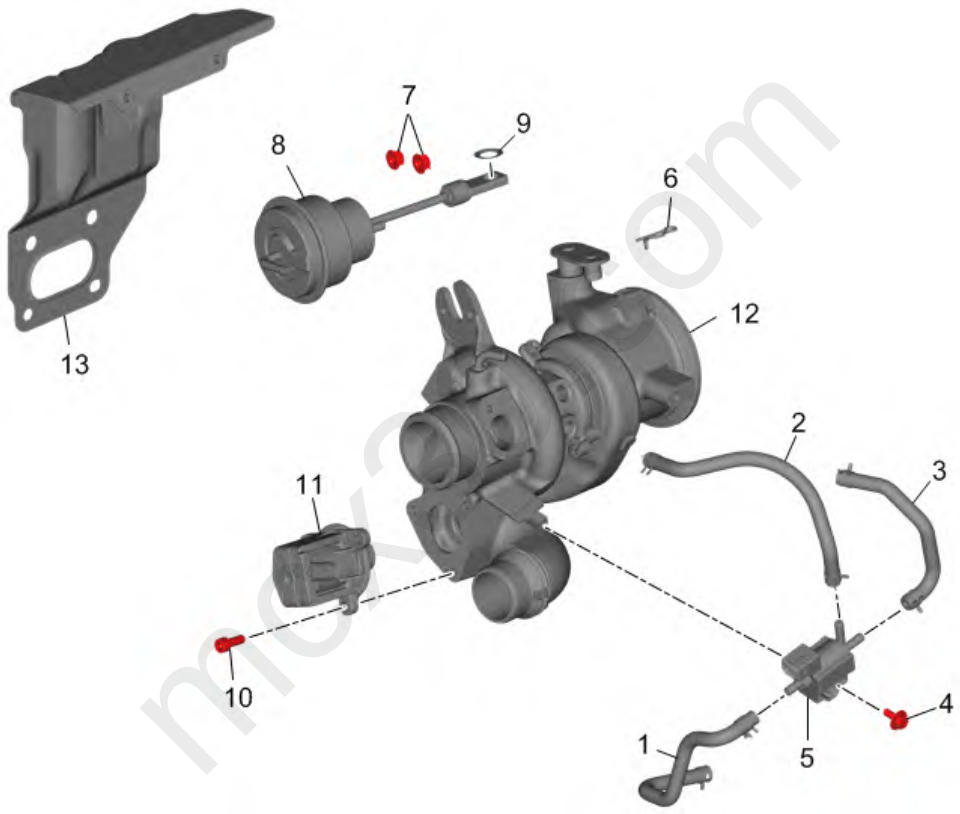


Fig. 449: Turbocharger and Components
Courtesy of GENERAL MOTORS COMPANY

Turbocharger and Components Cleaning and Inspection

Callout	Component Name
Preliminary Procedure 1. Remove all components. 2. Completely inspect the turbocharger and all other engine components that may cause similar conditions before replacing the turbocharger. Refer to **Symptoms - Engine Mechanical**. 3. Clean all mating surfaces. 4. Inspect all threaded holes for damage.	
1	Turbocharger Wastegate Regulator Solenoid Valve Hose
2	Turbocharger Wastegate Regulator Solenoid Valve Hose
3	Turbocharger Wastegate Regulator Solenoid Valve Hose

Callout	Component Name
4	Turbocharger Wastegate Regulator Solenoid Valve Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 8 N.m (71 lb in)
5	Turbocharger Wastegate Regulator Solenoid Valve
6	Turbocharger Wastegate Actuator Arm Retainer **NOTE:** **Slight force may be needed to compress the turbocharger wastegate actuator rod spring at the wastegate actuator arm enough to install the actuator arm retainer. Be sure to provide only enough force, as needed, to slide the retainer into the slot. Too much force can result in crushing or deforming the washer.**
7	Turbocharger Wastegate Actuator Nut [2x] **Tighten** 10 N.m (89 lb in)
8	Turbocharger Wastegate Actuator **Procedure** Inspect the wastegate regulator mechanism for functionality.
9	Turbocharger Wastegate Actuator Rod Spring **NOTE:** **Ensure the spring washer is installed in the correct orientation, with the widest side facing up. Do not over-compress the wastegate actuator arm against the spring washer when installing the actuator arm retainer.**
10	Charge Air Bypass Valve Bolt [3x] **Tighten** 10 N.m (89 lb in)
11	Turbocharger Bypass Valve Solenoid
12	Turbocharger **Procedure** 1. Inspect the compressor and turbine for bent or broken blades and foreign material. PCV fluids and combustion product buildup are common and not a sign of failure. 2. Inspect the mating surfaces for flatness. 3. Replace the turbocharger if damage is found.
13	Turbocharger Heat Shield

Turbocharger Coolant Feed/Return Pipe Assemblies Cleaning and Inspection

mcx30.com

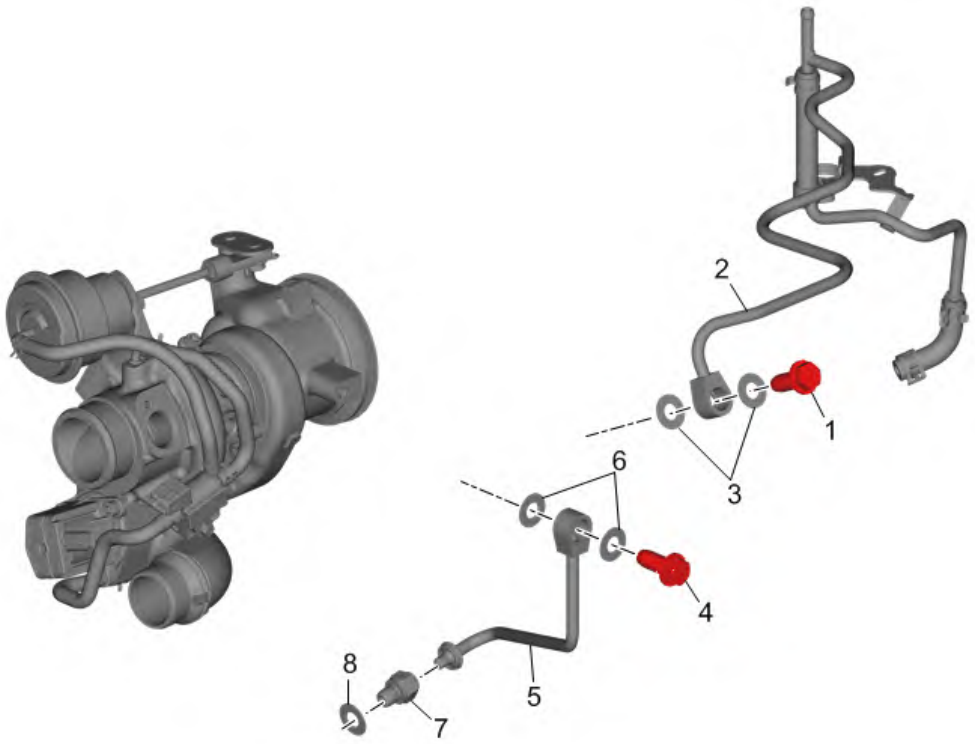


Fig. 450: Turbocharger Coolant Feed/Return Pipe Assemblies
Courtesy of GENERAL MOTORS COMPANY

Turbocharger Coolant Feed/Return Pipe Assemblies Cleaning and Inspection

Callout	Component Name
Preliminary Procedure 1. Clean all components. 2. Inspect each component.	
1	Turbocharger Coolant Return Pipe Bolt
2	Turbocharger Coolant Return Pipe
3	Turbocharger Coolant Return Pipe Seal [2x] **NOTE:** **Discard the seals. Use NEW seals upon installation.**
4	Turbocharger Coolant Feed Pipe Bolt
5	Turbocharger Coolant Feed Pipe
6	Turbocharger Coolant Feed Pipe Seal **NOTE:** **Discard the seals. Use NEW seals upon installation.**
7	Turbocharger Coolant Return Pipe Fitting **NOTE:** **Discard the pipe fitting. Use a NEW fitting upon installation.**
8	Turbocharger Oil Feed Pipe Washer **NOTE:** **Discard the washer. Use a NEW washer upon installation.**

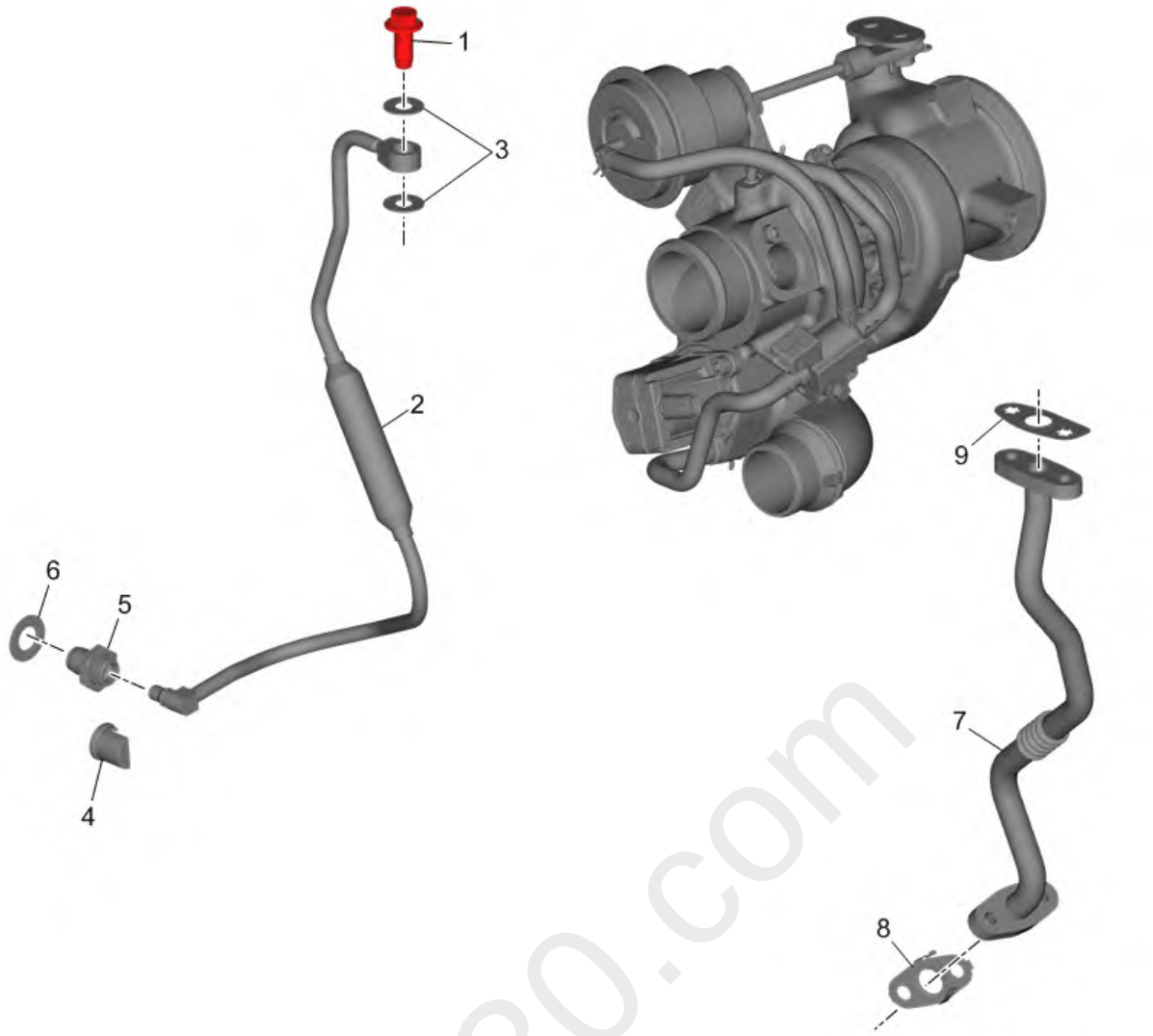


Fig. 451: Turbocharger Oil Feed/Return Pipe Assemblies
Courtesy of GENERAL MOTORS COMPANY

Turbocharger Oil Feed/Return Pipe Assemblies Cleaning and Inspection

Callout	Component Name
Preliminary Procedure 1. Clean all components. 2. Inspect each component.	
1	Turbocharger Oil Feed Pipe Bolt
2	Turbocharger Oil Feed Pipe
3	Turbocharger Oil Feed Pipe Washer [2x] **NOTE:** **Discard the washers. Use NEW washers upon installation.**
4	Turbocharger Oil Feed Pipe Clip
5	Turbocharger Pipe Fitting **NOTE:** **Discard the pipe fitting. Use a NEW fitting upon installation.**

mc30.com

Callout	Component Name
6	Turbocharger Oil Feed Pipe Washer **NOTE:** **Discard the washer. Use a NEW washer upon installation.**
7	Turbocharger Oil Return Pipe
8	Turbocharger Oil Return Pipe Gasket **NOTE:** **Discard the used gasket. Use a NEW gasket upon installation.**
9	Turbocharger Oil Return Pipe Gasket **NOTE:** **Discard the used gasket. Use a NEW gasket upon installation.**

OIL PAN CLEANING AND INSPECTION

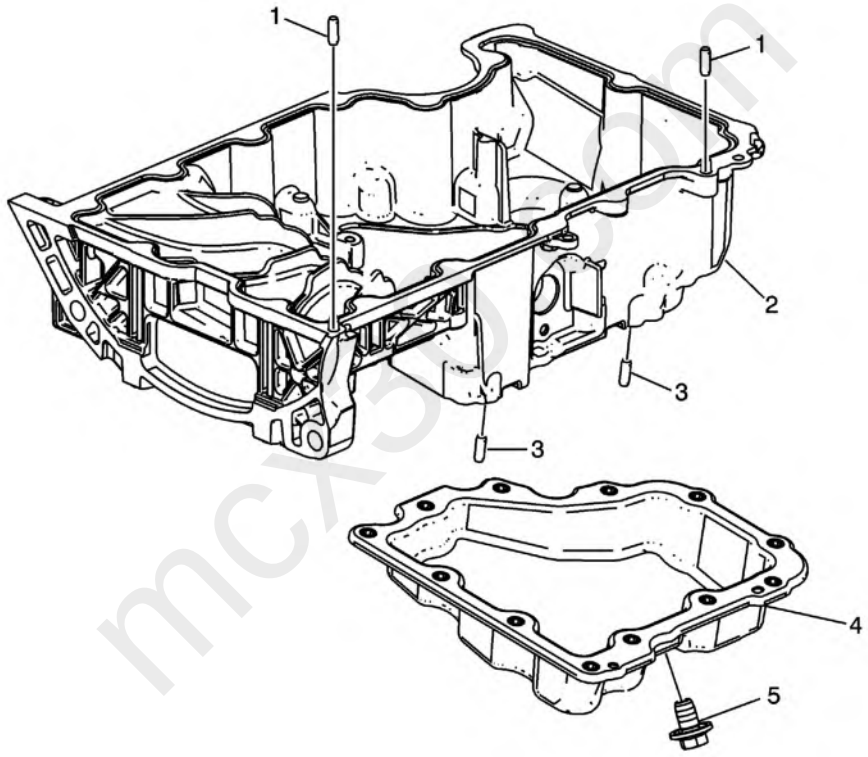


Fig. 452: Oil Pan
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove all components prior to cleaning. 2. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant** 3. Clean all components. 4. Inspect each component.	
1	Upper Oil Pan Locating Pin (Qty: 2)
2	Upper Oil Pan
3	Lower Oil Pan Locating Pin (Qty: 2)

Callout	Component Name
4	Lower Oil Pan **NOTE:** **Use a NEW lower oil pan.**
5	Oil Pan Drain Plug

THREAD REPAIR

Special Tools

- **EN 42385 - 307** Drill Busing
- **EN 42385 - 308** Alignment PIn
- **EN 42385 - 510** Main Attachment Bolt
- **EN 42385 - 900** Head Bolt Thread Repair Kit
- **EN 42385 - 904** Thread Insert

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

General Thread Repair

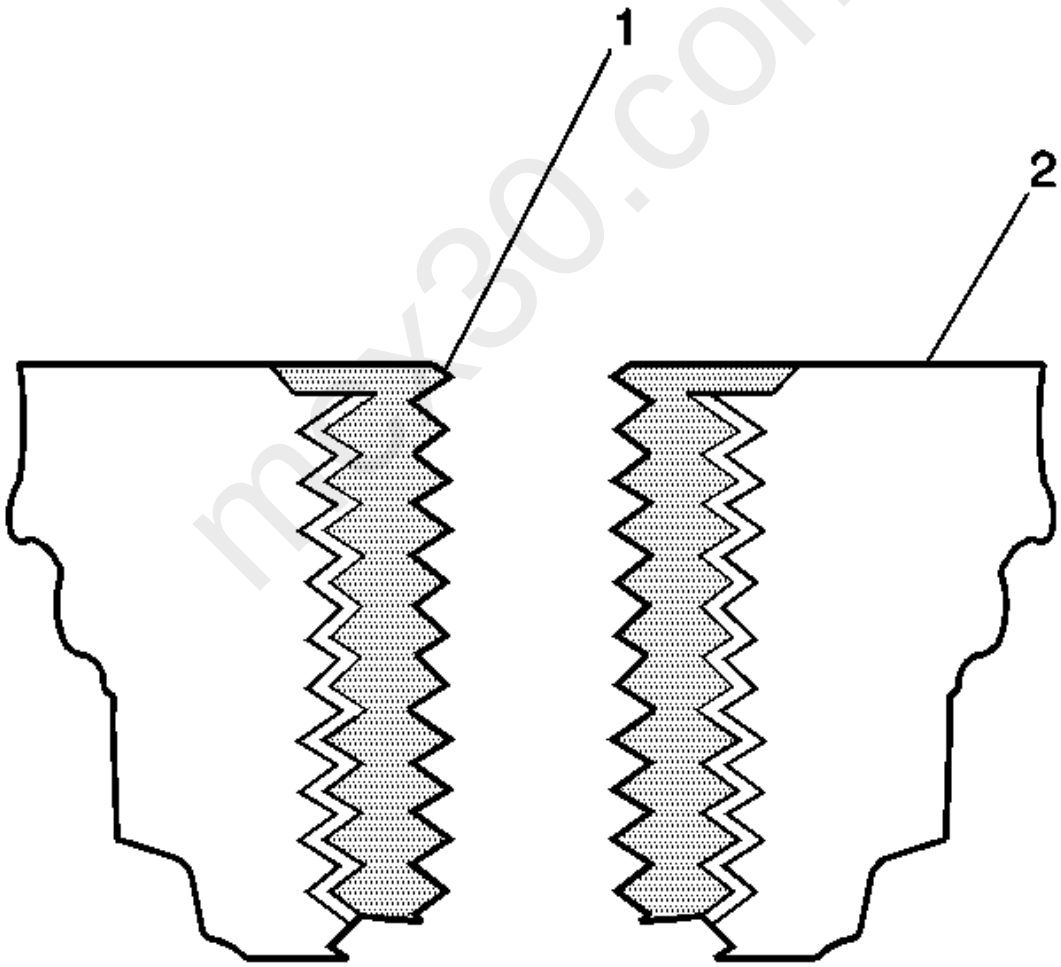


Fig. 453: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS COMPANY

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, the flange of the insert will be seated against the counterbore of the repaired hole.

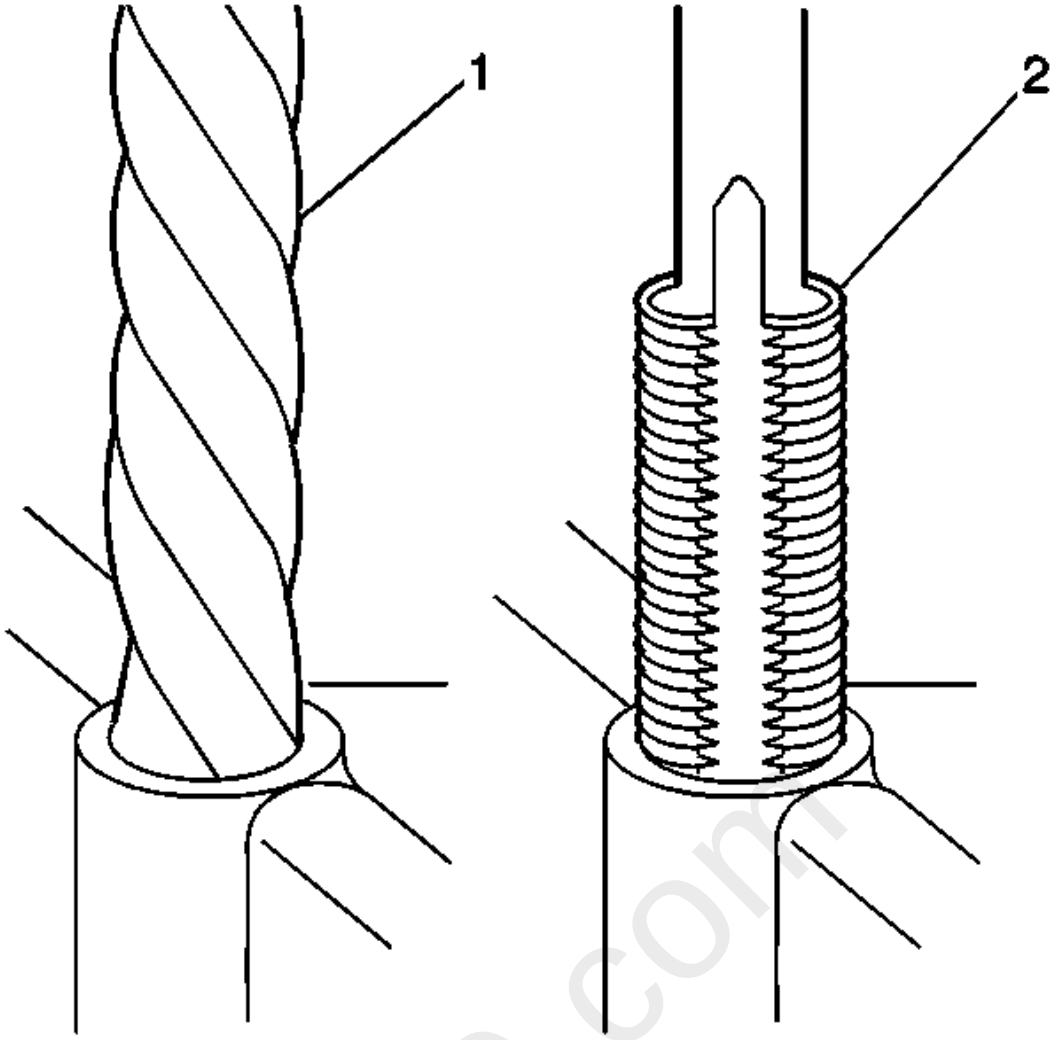


Fig. 454: Drilling & Tapping Threads
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The use of a cutting fluid, WD 40Â®, or equivalent, is recommended when performing the drilling, counterboring, and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers.**

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).

WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

2. Using compressed air, clean out any chips.

mex30.com

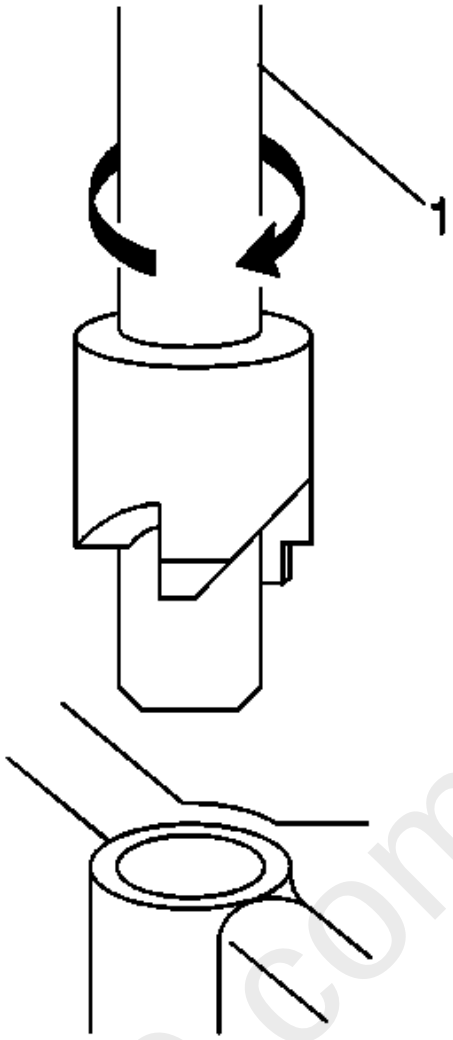


Fig. 455: Identifying Tool Used To Counterbore The Hole
Courtesy of GENERAL MOTORS COMPANY

3. Counterbore the hole to the full depth permitted by the tool (1).
4. Using compressed air, clean out any chips.

mcx80.com

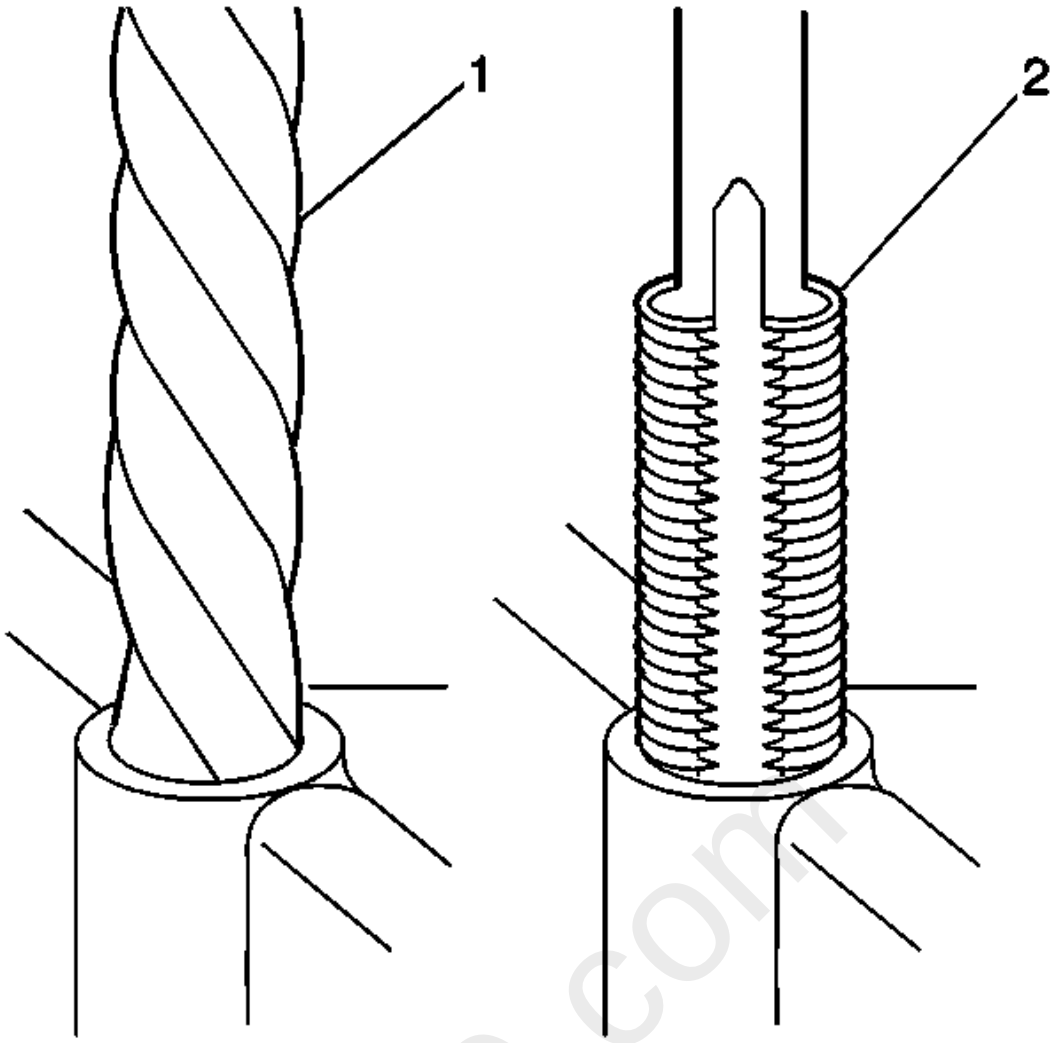


Fig. 456: Drilling & Tapping Threads
Courtesy of GENERAL MOTORS COMPANY

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).

WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

WARNING: **Refer to Cleaning Solvent Warning .**

6. Using compressed air, clean out any chips.
7. Spray cleaner into the hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
8. Using compressed air, clean any cutting oil and chips out of the hole.

mcx30.com

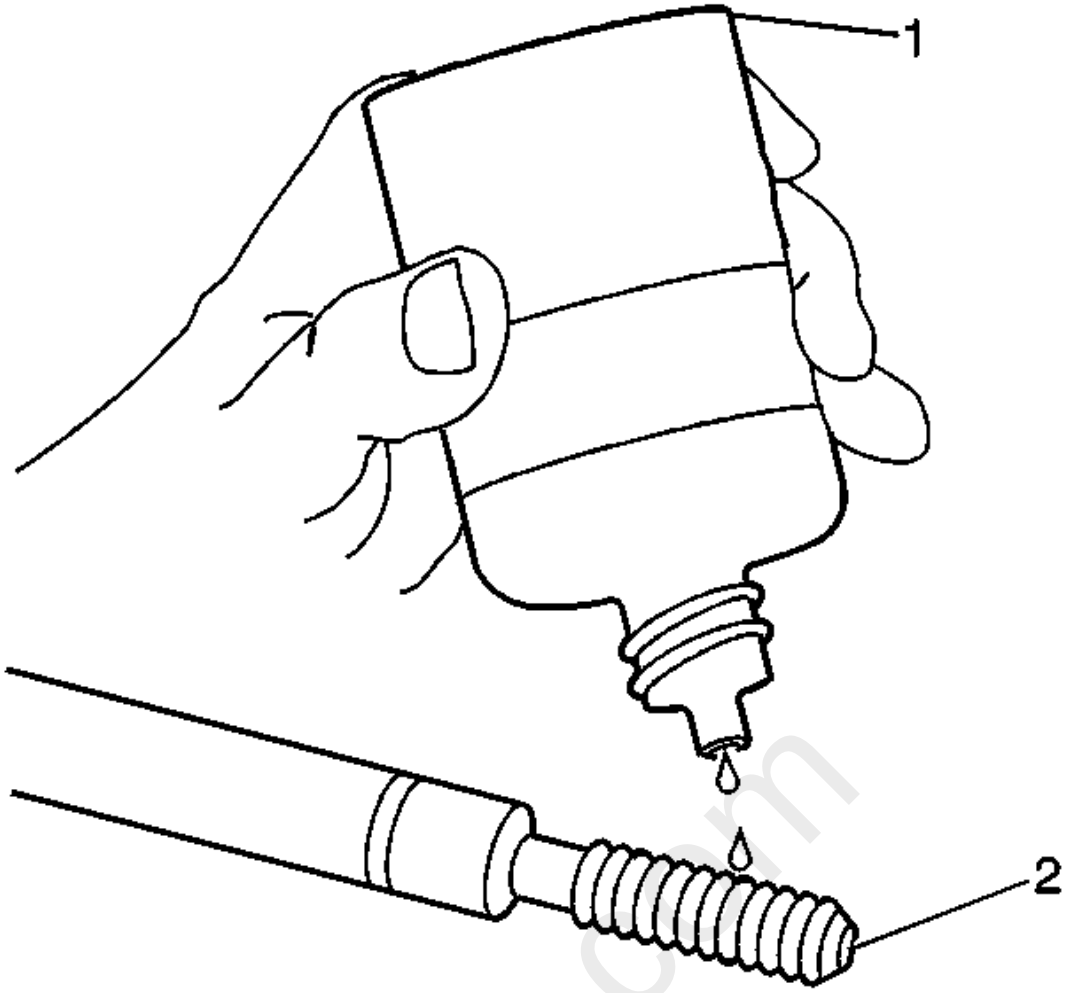


Fig. 457: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

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).

mexico.com

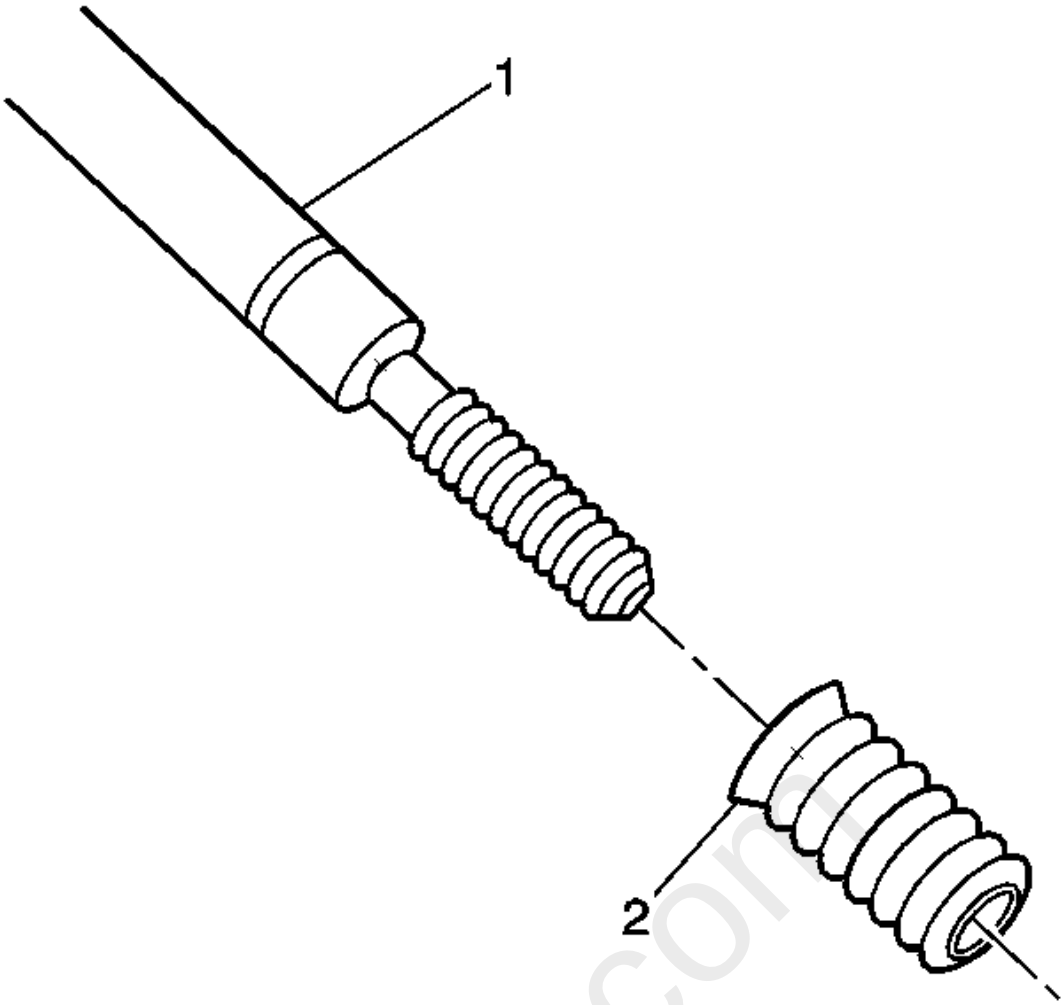


Fig. 458: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

10. Install the insert (2) onto the driver tool (1).

mcx30.com

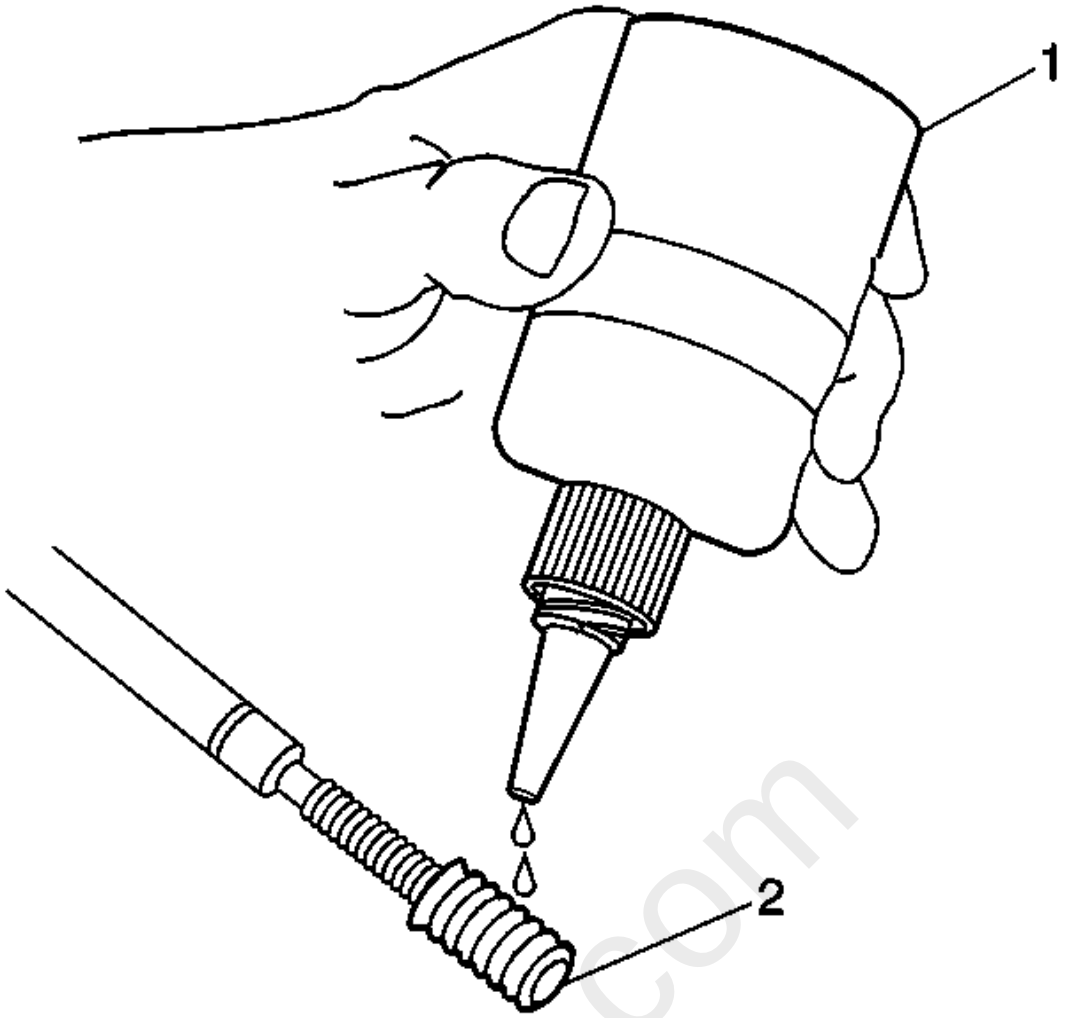


Fig. 459: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

11. Apply threadlock LOCTITE™ 277, **EN 42385 - 109 (1)** loctite, or equivalent to the insert OD threads (2).

mcx80.com

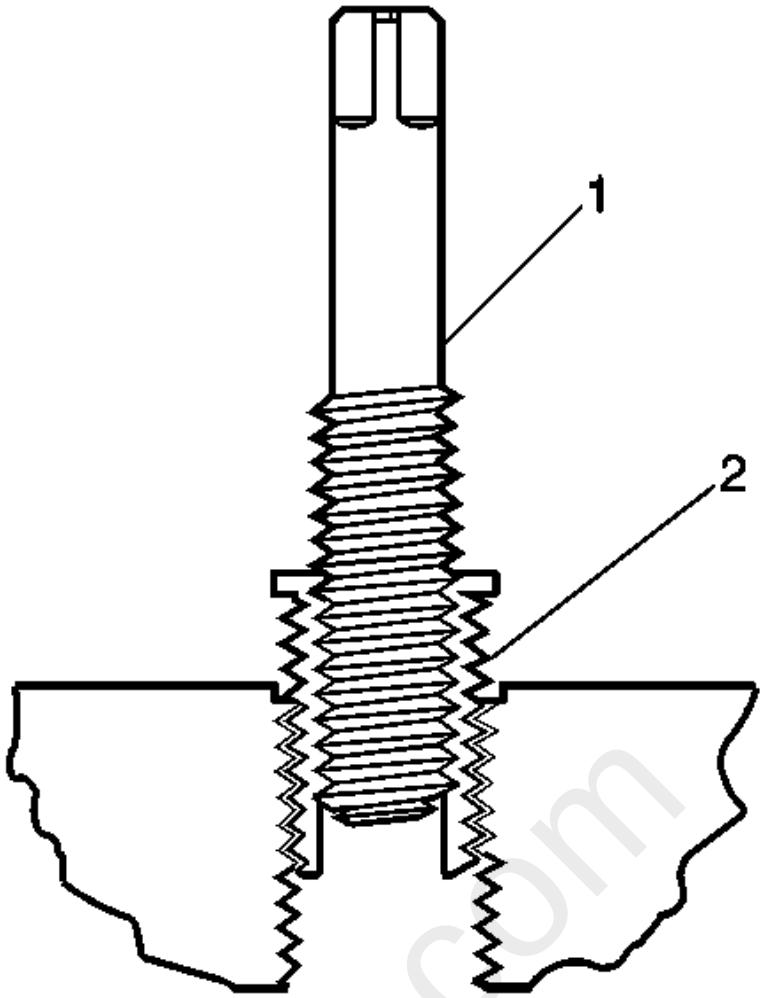


Fig. 460: View Of Insert In Tapped Bolt Hole
Courtesy of GENERAL MOTORS COMPANY

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.

    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.

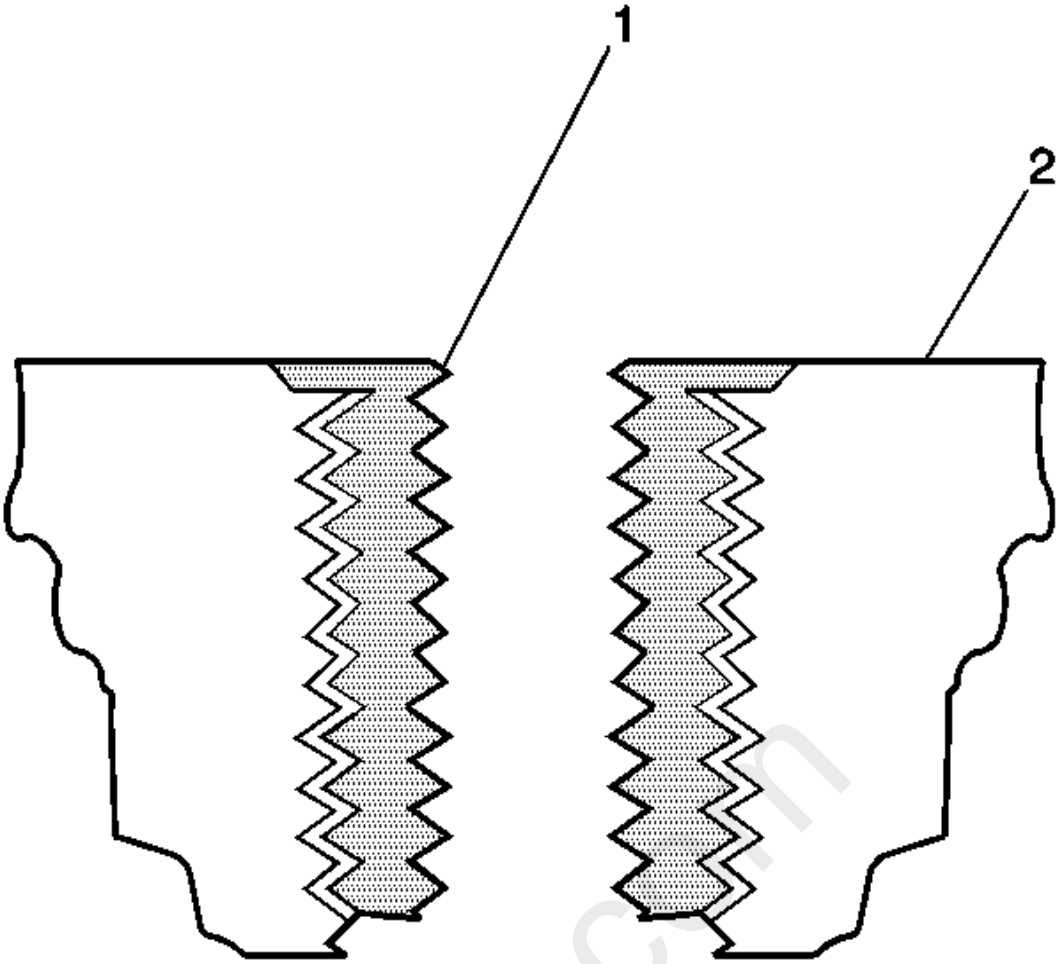


Fig. 461: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS COMPANY

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

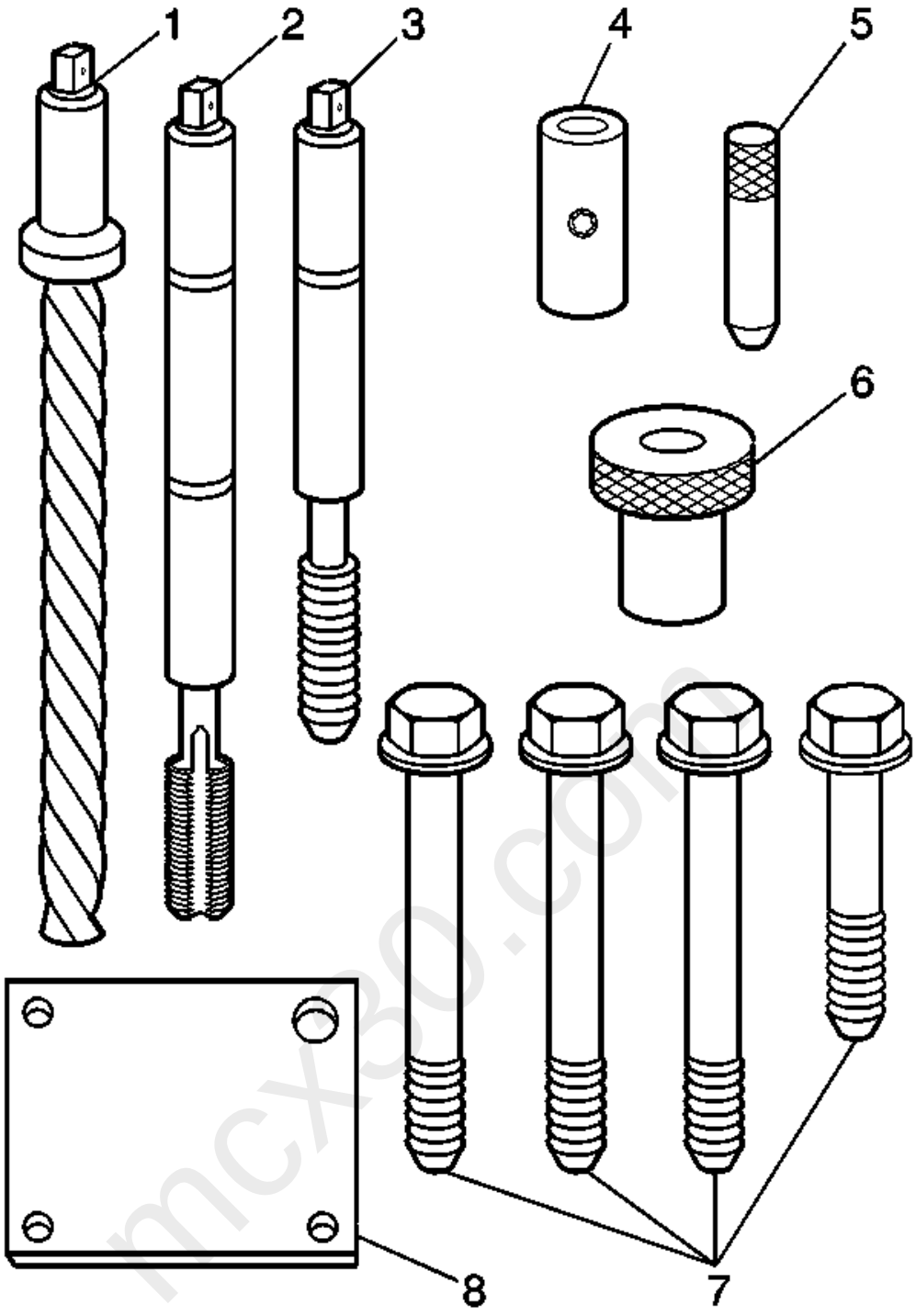


Fig. 462: Identifying Thread Repair Kit Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The tools listed may not necessarily represent the exact tools used for the procedure.**

1. The cylinder head bolt hole thread repair kit consists of the following items:
    - Drill (1)
    - Tap (2)
    - Installer (3)
    - Sleeve (4)
    - Alignment Pin (5)
    - Bushing (6)
    - Bolts (7)

- Fixture Plate (8)

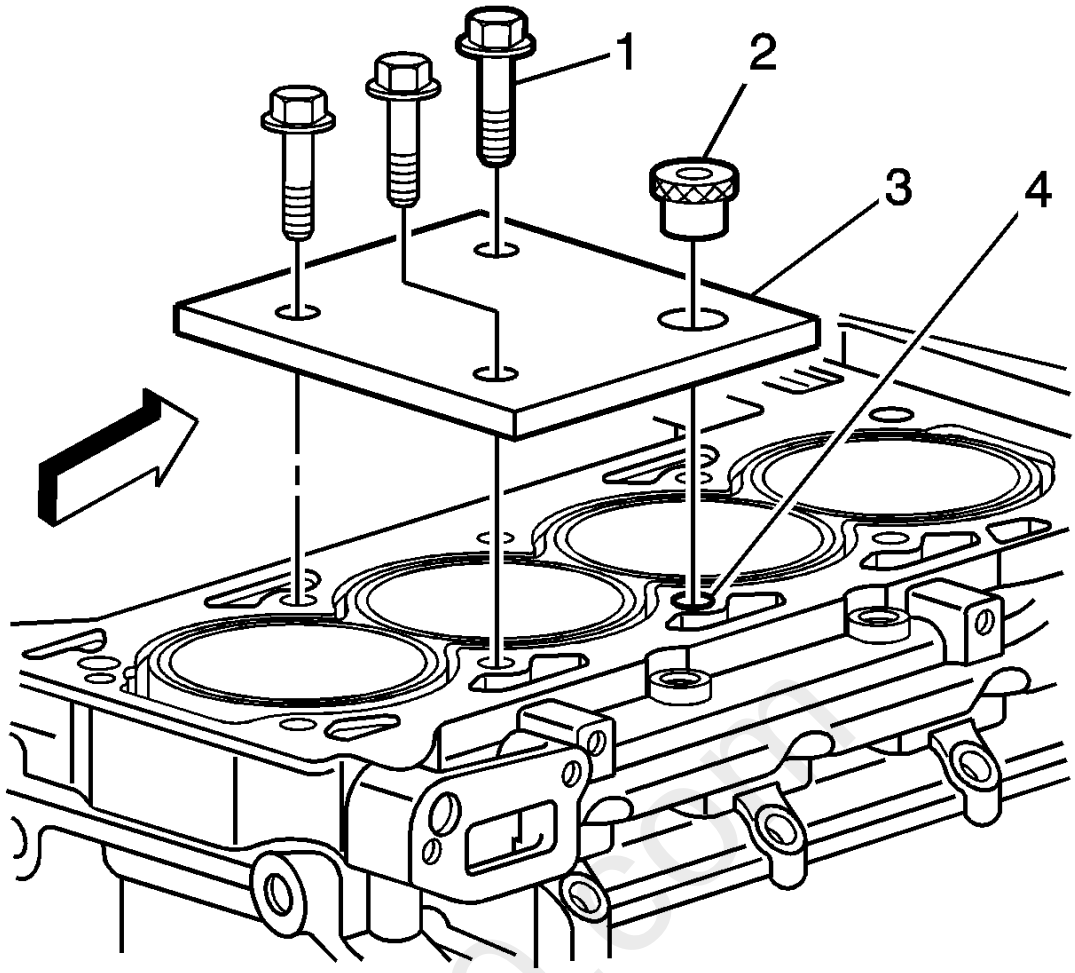


Fig. 463: Identifying Fixture Plate, Bolts, & Bushing
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

NOTE: **The use of a cutting fluid, WD 40Â®, or equivalent, is recommended when performing the drilling and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers.**

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).

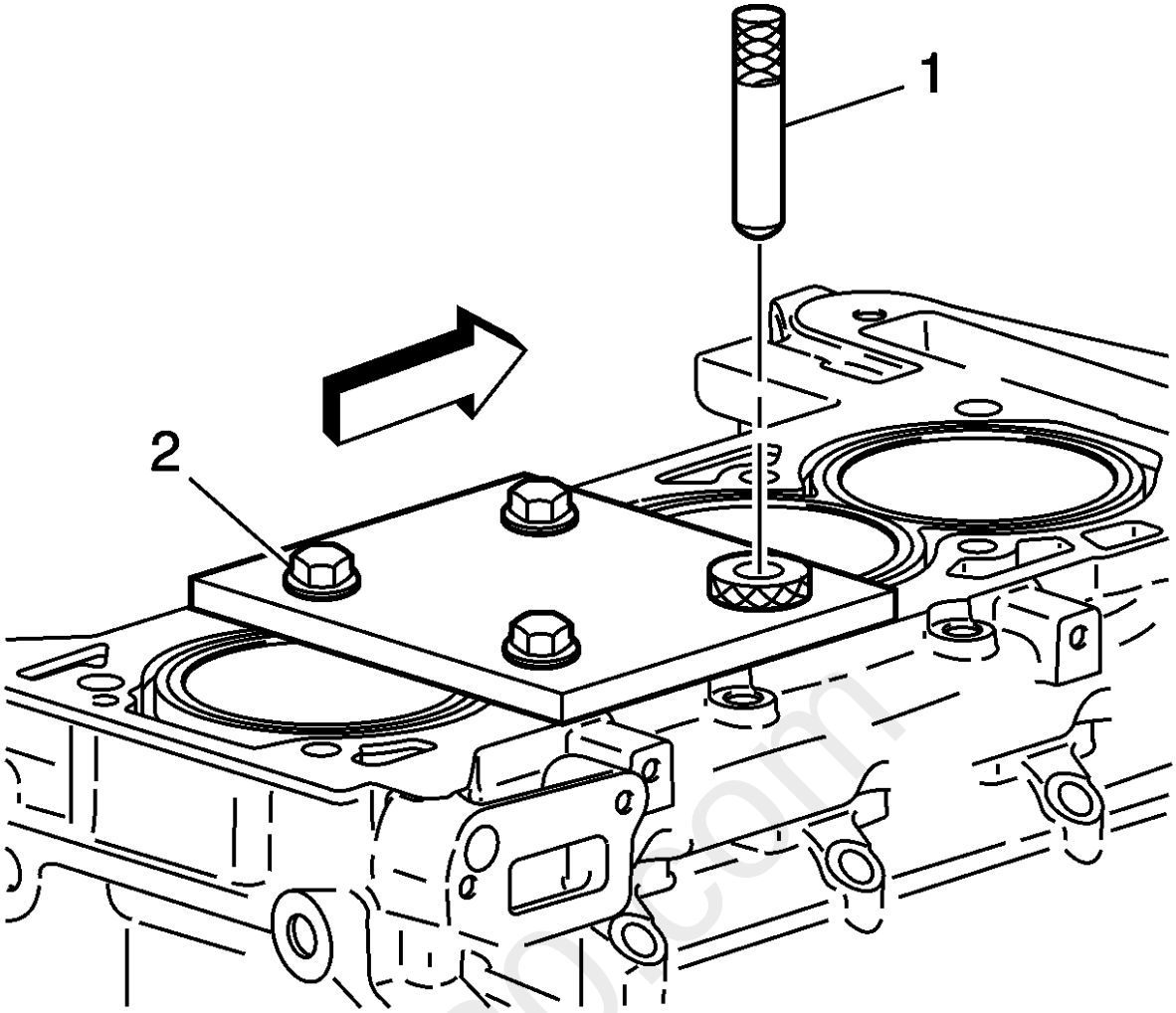


Fig. 464: Identifying Alignment Pin
Courtesy of GENERAL MOTORS COMPANY

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.

mcx30.com

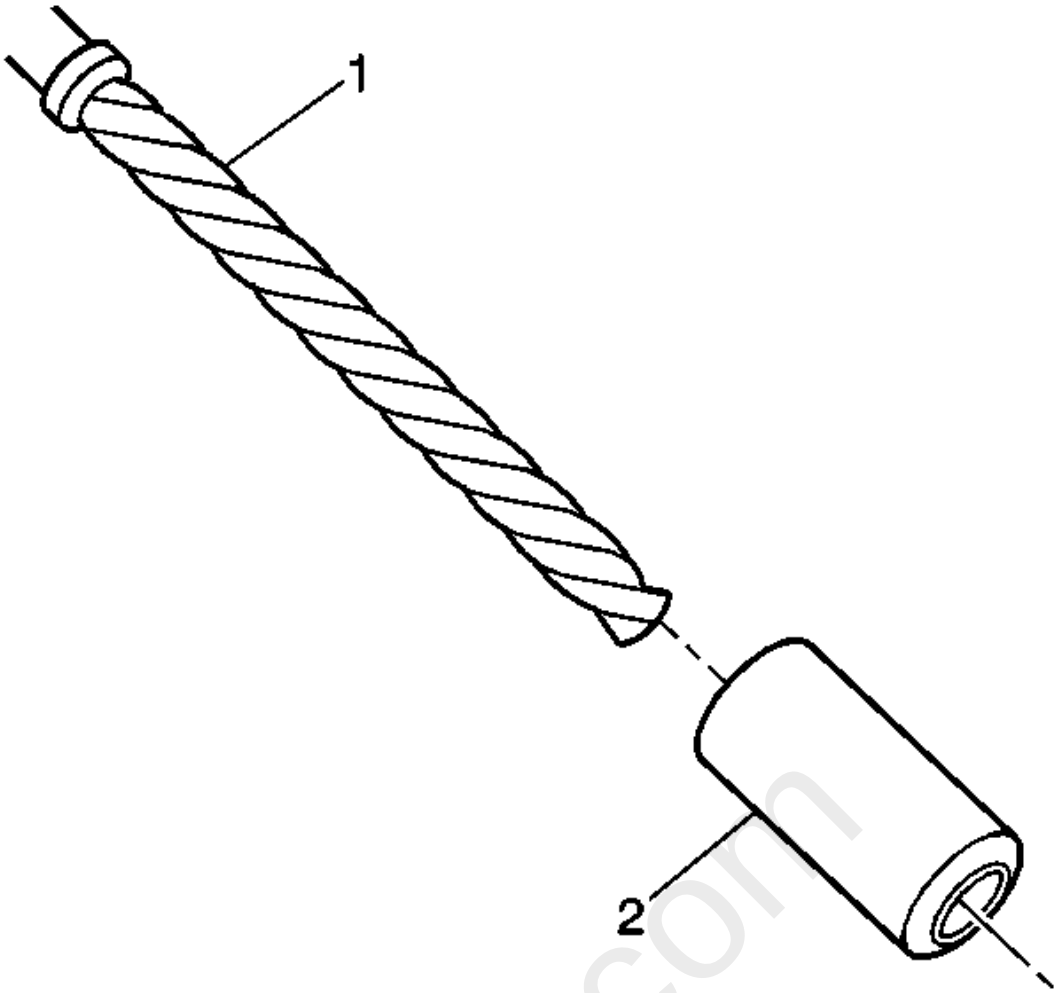


Fig. 465: View Of Stop Collar & Counterbore Drill
Courtesy of GENERAL MOTORS COMPANY

6. Install the sleeve (2) onto the drill (1), if required.

mcx80.com

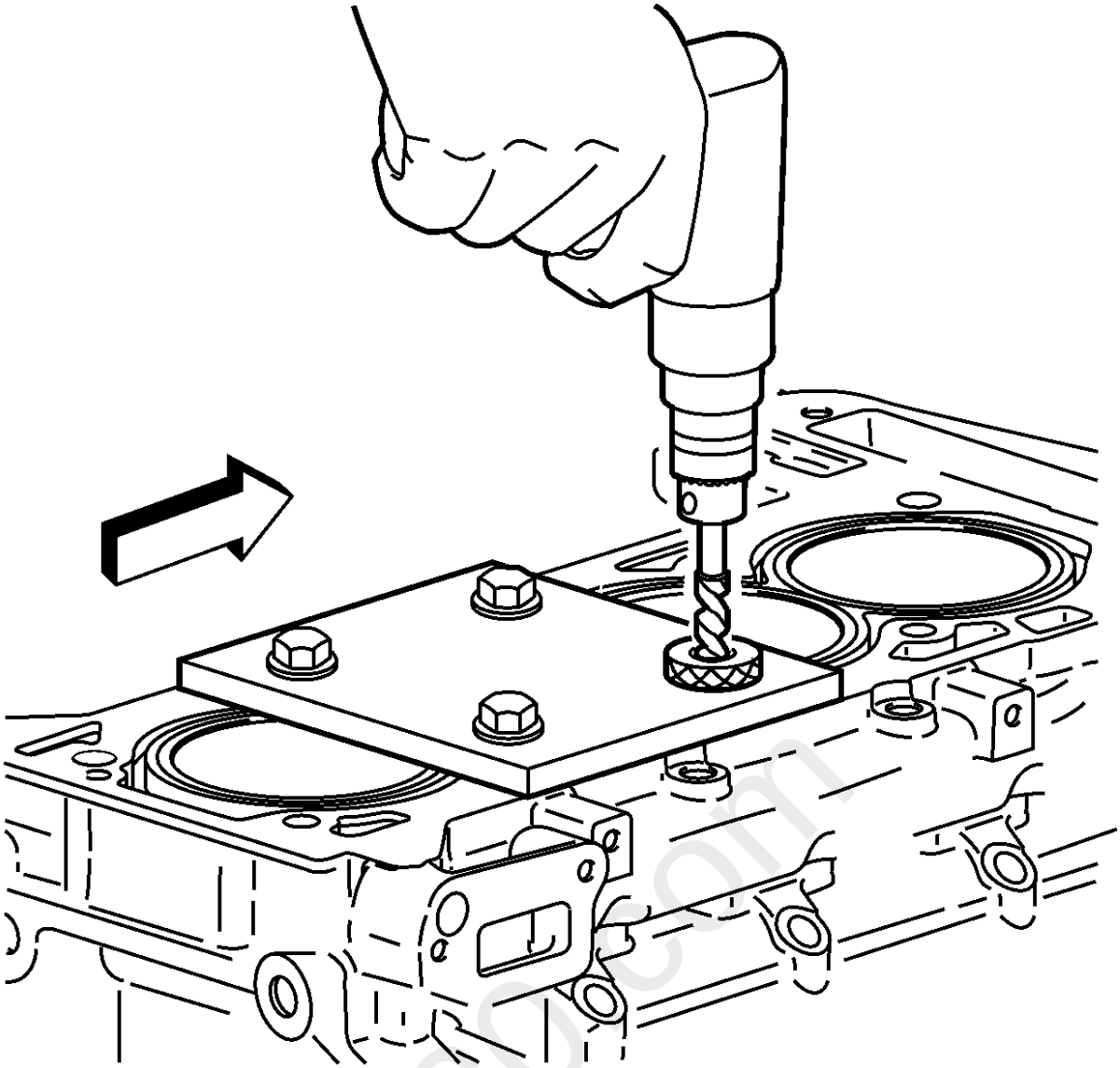


Fig. 466: Drilling Out Threads Of Damaged Hole
Courtesy of GENERAL MOTORS COMPANY

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.

   WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

8. Using compressed air, clean out any chips.

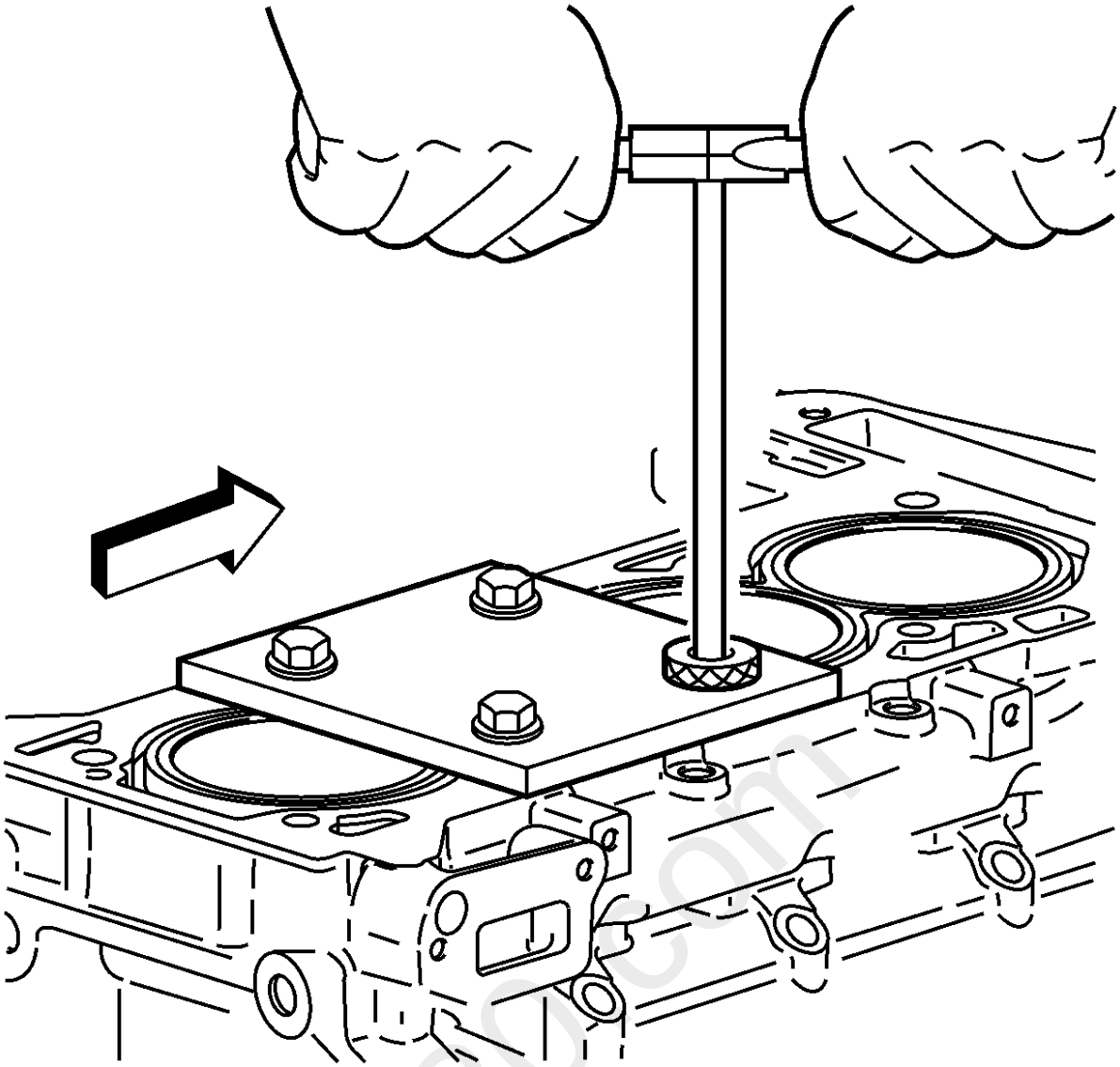


Fig. 467: Tapping Threads Of Drilled Hole With Tap Wrench
Courtesy of GENERAL MOTORS COMPANY

9. Using a tap wrench, tap the threads of the drilled hole.

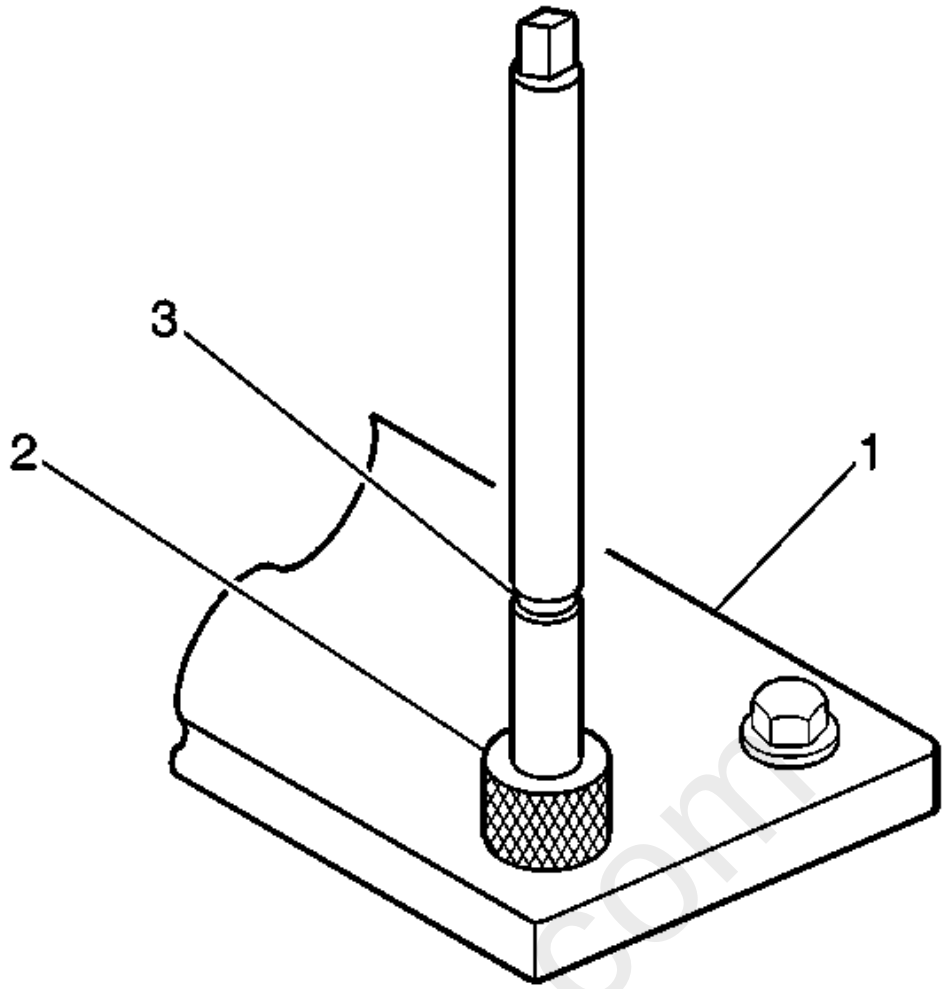


Fig. 468: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS COMPANY

10. 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 (3) on the tap align with the top of the drill bushing (2).

11. Remove the fixture plate (1), bushing (2), and bolts.

    WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

    WARNING: **Refer to Cleaning Solvent Warning .**

12. Using compressed air, clean out any chips.
13. Spray cleaner into the hole. Refer to Adhesives, Fluids, Lubricants, and Sealers.
14. Using compressed air, clean any cutting oil and chips out of the hole.

mcx80.com

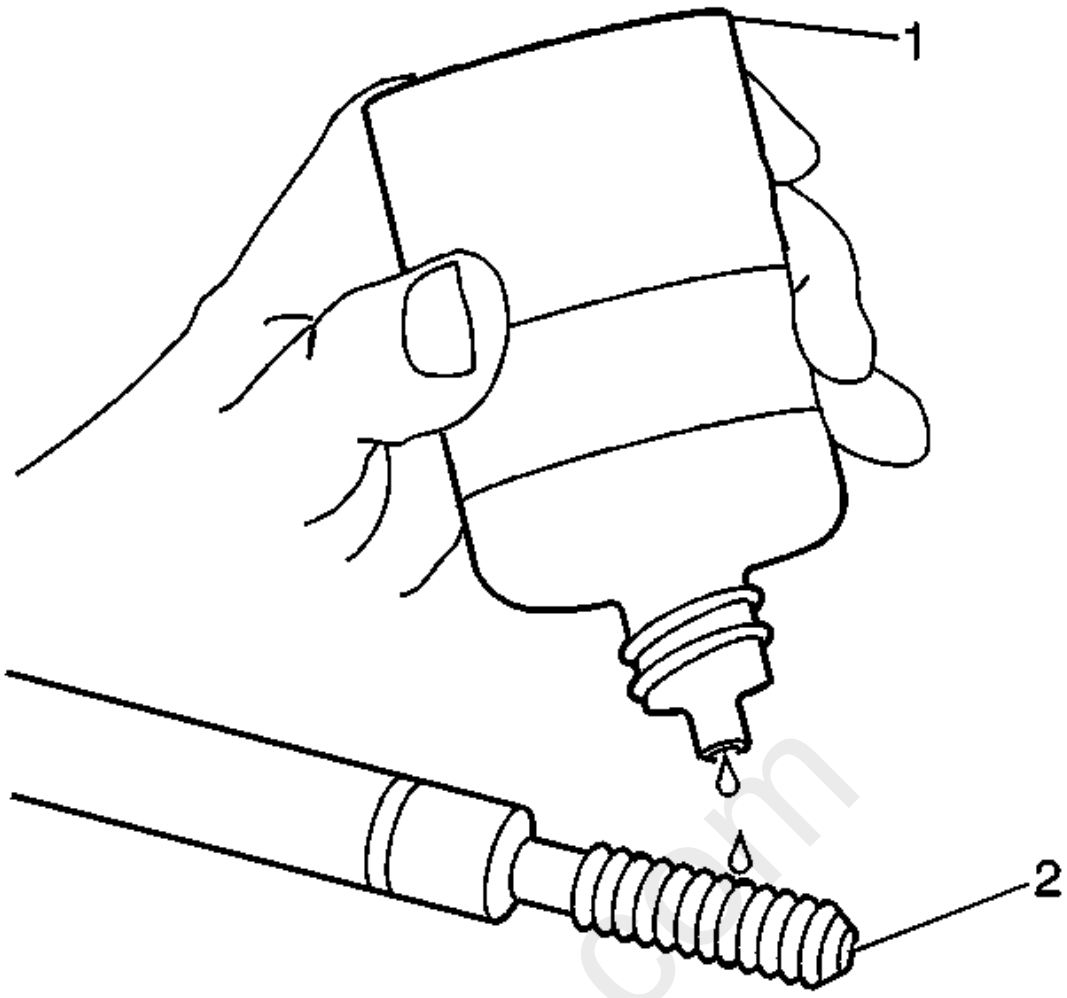


Fig. 469: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.**

15. Lubricate the threads of the installer tool (2) with the driver oil (1).

mexa0.com

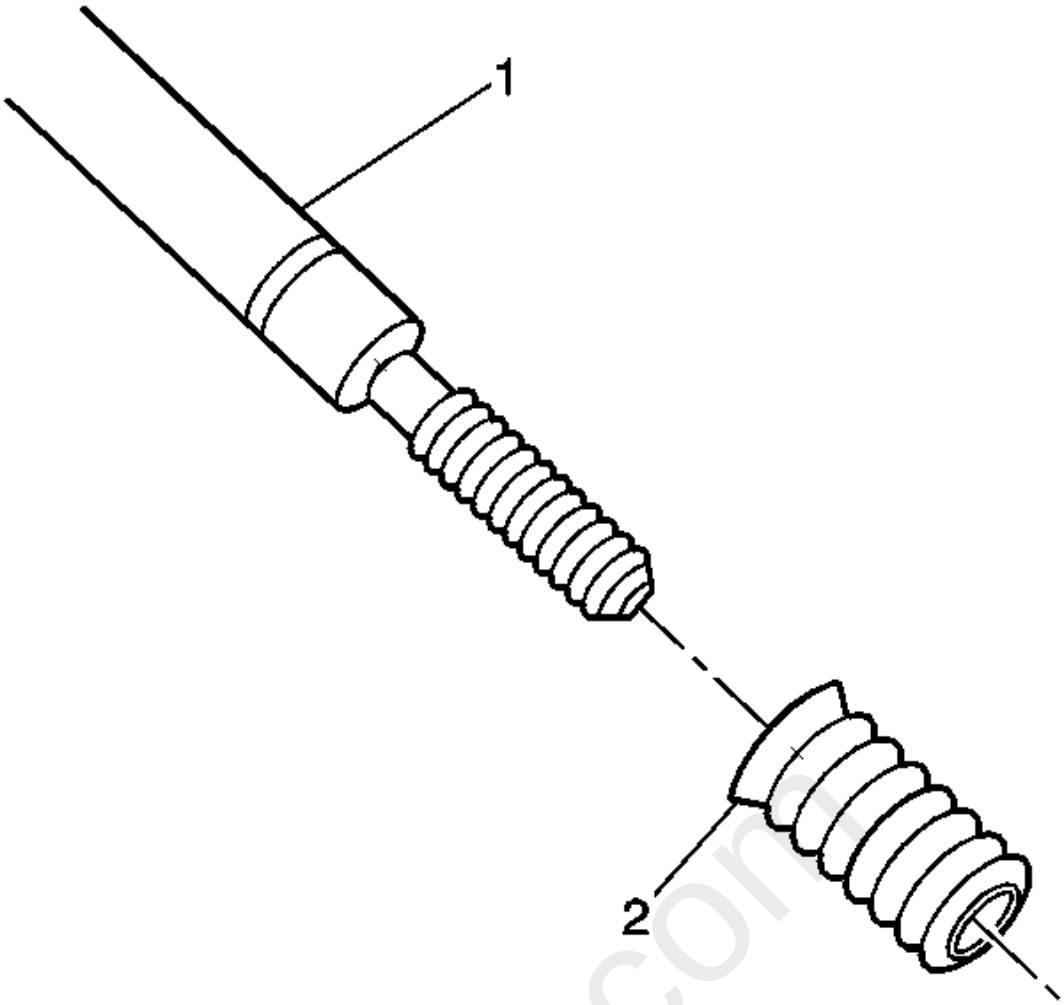


Fig. 470: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

16. Install the insert (2) onto the driver tool (1).

mcx30.com

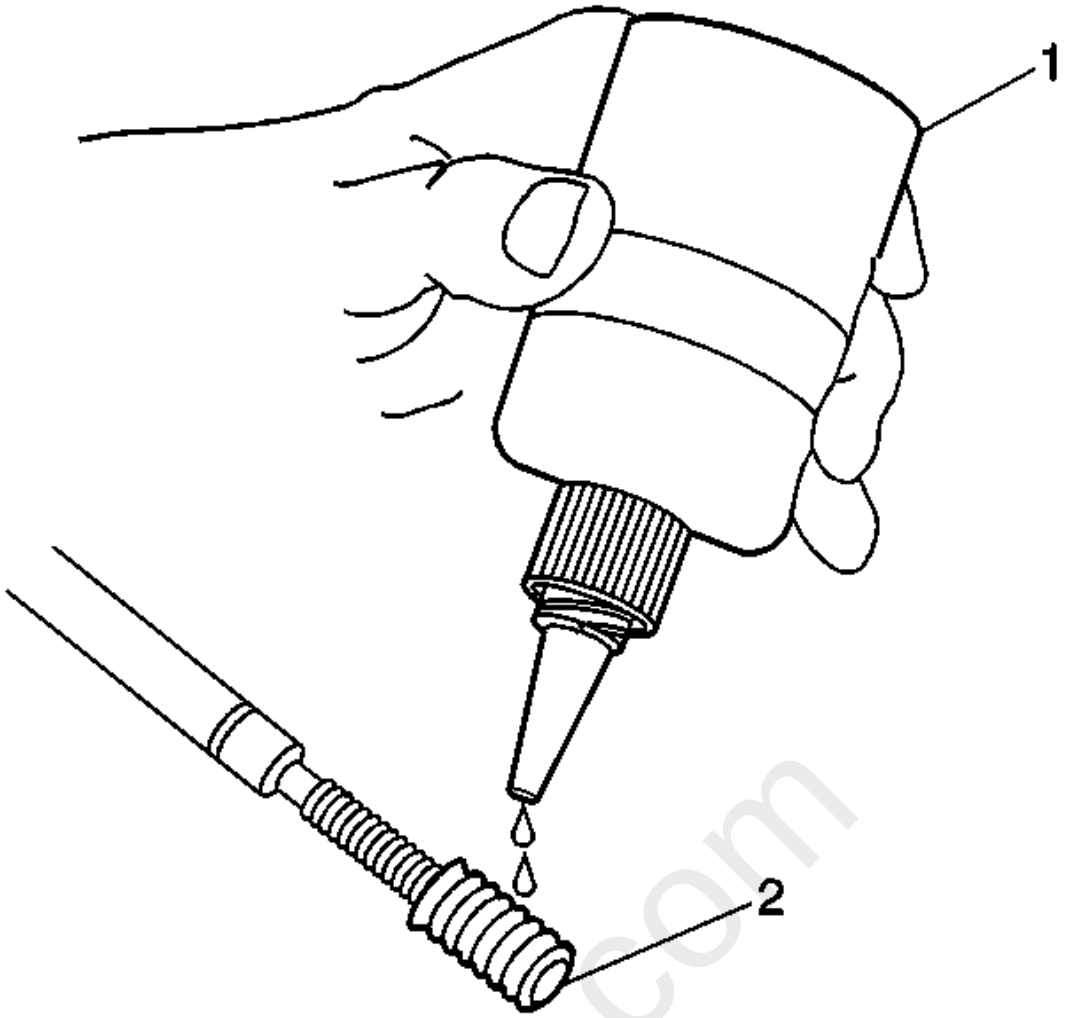


Fig. 471: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

17. Apply threadlock LOCTITE™ 277, **EN 42385 - 109** loctite (1), or equivalent to the insert OD threads (2).

mcx80.com

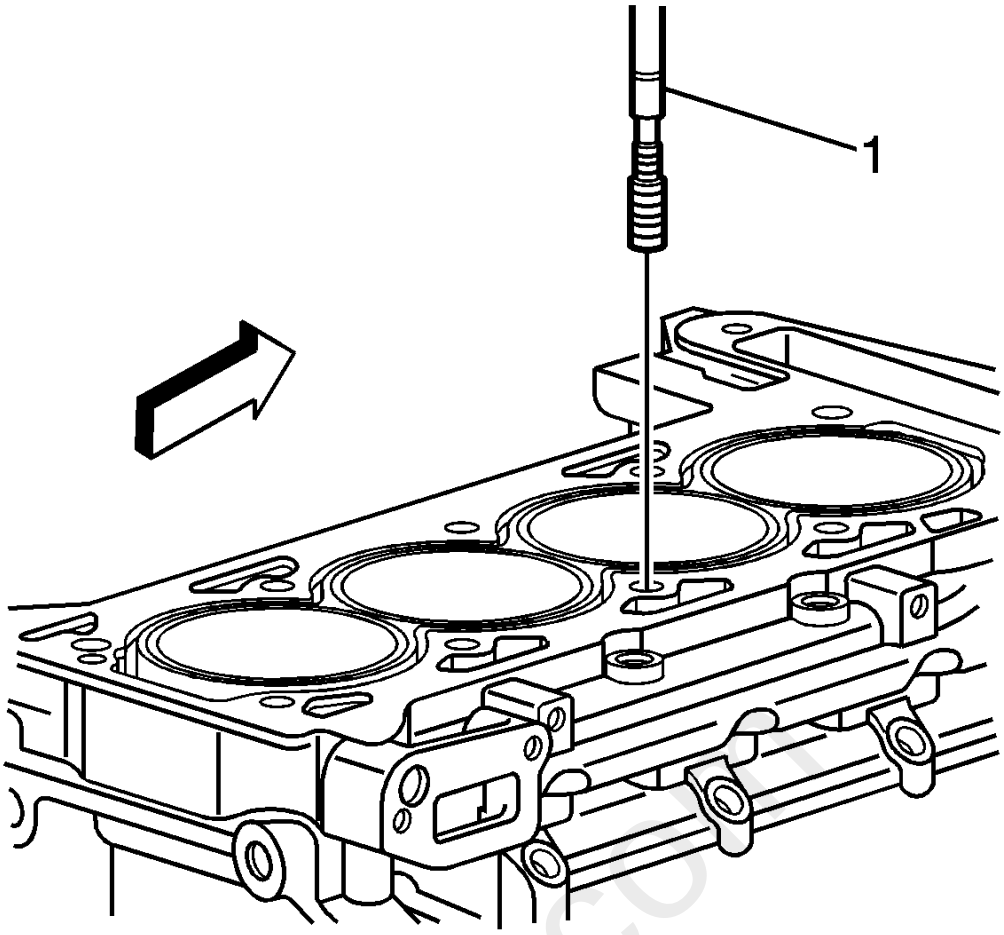


Fig. 472: Installing & Inserting Driver Into Hole
Courtesy of GENERAL MOTORS COMPANY

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.

SERVICE PRIOR TO ASSEMBLY

The importance of cleanliness during assembly cannot be overstated. Dirt or debris will cause engine damage. An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in ten thousandths of an inch. When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of engine oil should be applied to friction areas during assembly in order to protect and lubricate the surfaces on initial operation. Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas are part of the repair procedure. This is considered standard shop practice even if not specifically stated.

Lubricate all moving parts with engine oil or a specified assembly lubricant. This will provide lubrication for initial start up.

CRANKSHAFT AND BEARING INSTALLATION

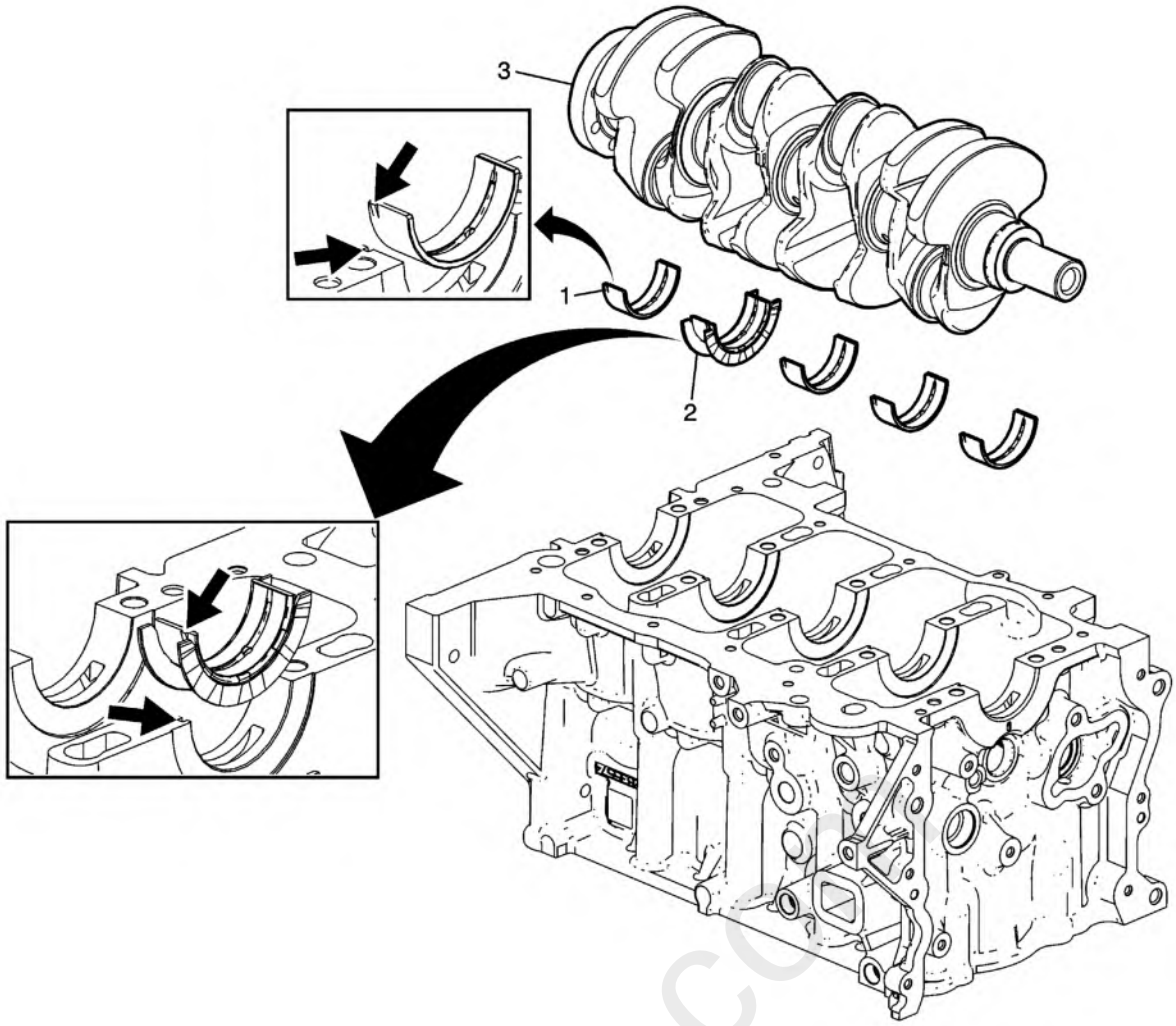


Fig. 473: Crankshaft and Bearing
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Crankshaft Upper Bearing (Qty: 4) **NOTE:** • **Crankshaft bearings MUST be separated, marked, or organized in a way to ensure installation to their original location and position, when suitable for use.** • **For vehicles equipped with Start/Stop and Hybrid vehicles, the #1 upper bearing is specifically coated for durability and has a blue coloration.** **Procedure** Ensure that the guide lug on the bearing is properly seated to the notch in the engine block for each bearing. Coat the crankshaft bearing shell with engine oil.
2	Crankshaft Thrust Bearing **Procedure** Ensure that the guide lug on the bearing is properly seated to the notch in the engine block. Coat the crankshaft bearing shell with engine oil.
3	Crankshaft

LOWER CRANKCASE INSTALLATION

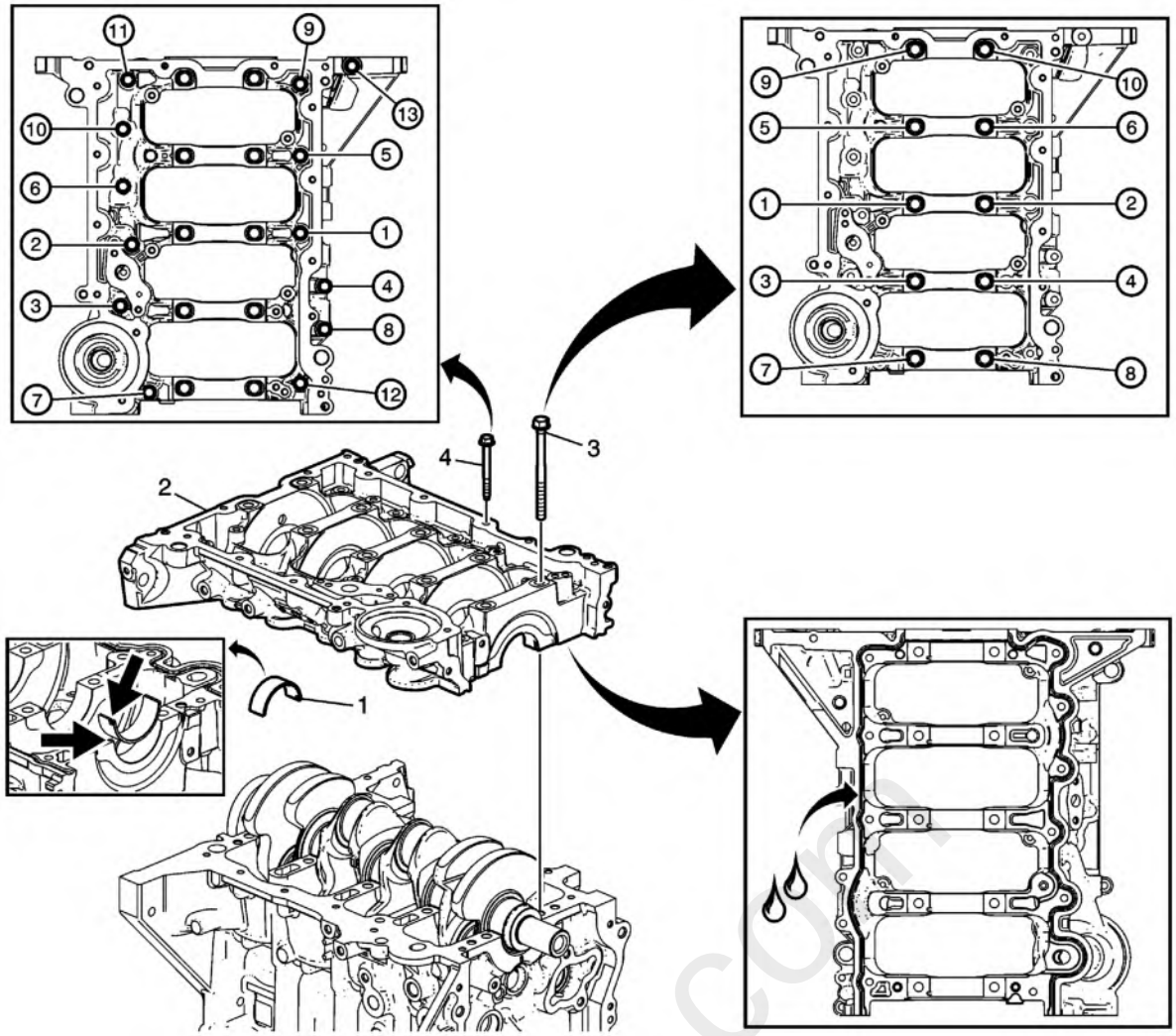


Fig. 474: Lower Crankcase With Bolt Tightening Sequences
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Crankshaft Lower Bearing (Qty: 5) **Procedure** Install the bearings in the lower crankcase, and ensure that the guide lug on the bearing is properly seated to the notch in the lower crankcase for each bearing. Coat the crankshaft bearing shell with engine oil.
2	Lower Crankcase **Procedure** 1. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant** **NOTE:** • **The block assembly surface must be free of contamination prior to applying the sealer.** • **Install and align the bedplate to block within 20 minutes of applying the sealer.** • **The bedplate must be fastened to final torque specification within 60 minutes of applying the sealer.** 2. Apply a 3 mm bead of sealer directly in the groove of the block to bedplate mating surfaces. Refer to **Adhesives, Fluids, Lubricants, and Sealers**. 3. Install the lower crankcase, ensure the lower crankcase is aligned properly on the dowels. Tap gently into place with a suitable tool, if necessary.

Callout	Component Name
3	Lower Crankcase Bolts (Qty: 10) **CAUTION:** **Refer to Fastener Caution .** **CAUTION:** **Refer to Torque-to-Yield Fastener Caution .** **Procedure** Tighten the NEW lower crankcase bolts in the sequence shown. 1. Tighten the bolts in sequence a first pass to 15 N.m (11 lb ft). 2. Using the **EN 45059** angle meter, tighten the bolts in sequence a final pass to 180 degrees. **Special Tools** **EN-45059** Angle Meter For equivalent regional tools, refer to **Special Tools**.
4	Lower Crankcase Bolts (Qty: 13) **Procedure** 1. Apply sealant to the lower crankcase perimeter bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers**. 2. Tighten the lower crankcase bolts in the sequence shown. 3. Tighten the bolts in sequence a first pass to 5 N.m (44 lb in). 4. Tighten the bolts in sequence a final pass to 10 N.m (89 lb in).

PISTON, CONNECTING ROD, AND BEARING INSTALLATION

mcx30.com

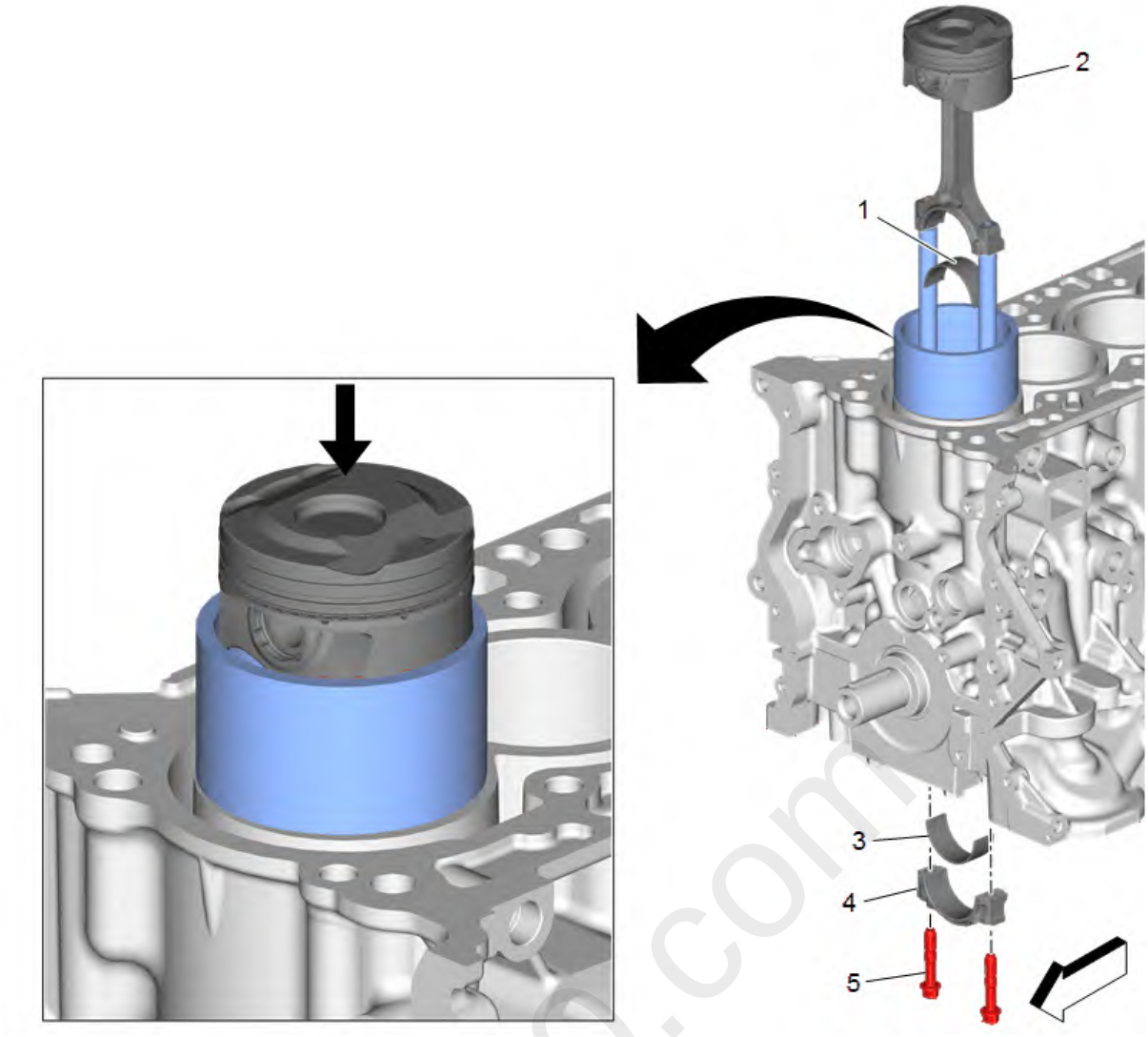


Fig. 475: Piston, Connecting Rod, and Bearing
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure **NOTE:** **Many internal engine components will develop specific wear patterns on their friction surfaces.** 1. Components MUST be separated, marked, or organized in a way to ensure installation to their original location and position. Take precautions in order to prevent interchanging of parts. 2. Ensure all components are adequately marked with location, direction, or orientation when necessary.	
1	Connecting Rod Bearing [4x] **NOTE:** **The connecting rod bearing anti-rotation tab grooves are to point toward the right-hand side of the engine.** **Procedure** Install NEW bearings to the connecting rods and lubricate each bearing with engine oil.
2	Piston and Connecting Rod Assembly [4x] **NOTE:**

mcx30.com

Callout	Component Name
	The connecting rods and caps must be installed in the same order and orientation in which they were removed. If new connecting rods are required, the connecting rod is provided as an assembly, and the upper rod will need to be disassembled from the lower cap. **Procedure** 1. Install the **EN-51454** guides into the connecting rod bolt holes. This protects the crankshaft journal during piston and connecting rod installation. **NOTE:** **Ensure to stagger each piston ring end gap equally around the piston.** **NOTE:** **When installing a piston into a cylinder, use a ring compressor sleeve, such as EN-52490-74 or equivalent for best results. The following features should be looked for when selecting a ring compressor sleeve:** • **Hard anodized and Teflon coated for low friction and prolonged wear resistance.** • **Smooth radius that tapers down to the specific bore size.** • **Sleeve should compress the piston rings smoothly and evenly.** • **Using a ring compressor sleeve greatly reduces the difficulty with installing thin high-performance oil rings.** **If a ring compressor sleeve is unavailable, a universal ring compressor will work, but is more difficult to use.** 2. Install the **EN-52490-74** ring compressor or equivalent on the piston. 3. Ensure each piston ring end gap is spaced equally around the piston, refer to **Piston and Connecting Rod Assemble**. 4. Lubricate the piston and the piston rings with engine oil. Do not disturb the piston ring end gap location. 5. Lubricate the correct engine bore for the piston. **NOTE:** **The piston must be installed oriented correctly to the front of the engine.** 6. Position the piston so that the arrow mark on the top of the piston points to the front of the engine. 7. Install the ring compressor, the piston, and the connecting rod to the correct bore. 8. Tap the piston into the bore with a hammer handle. Guide the connecting rod to the connecting rod journal while tapping the piston into place. 9. Hold the ring compressor against the engine block until all the rings have entered the cylinder bore. 10. Remove the connecting rod guides from the connecting rod bolt holes. **Special Tools** • **EN-51454** Connecting Rod Guides • **EN-52490-74** Piston Ring Compressor

mx5.com

Callout	Component Name
	Equivalent regional tools: **Special Tools**.
3	Connecting Rod Bearing [4x] **Procedure** Install NEW bearings to the connecting rod caps and lubricate each bearing with engine oil.
4	Connecting Rod Cap [4x] **Procedure** Ensure that the connecting rod cap is properly oriented on the connecting rod.
5	Connecting Rod Bolt [8x] **CAUTION:** **Refer to Fastener Caution .** **CAUTION:** **Refer to Torque-to-Yield Fastener Caution .** **Procedure** 1. Install NEW connecting rod bolts and tighten using the **EN-45059** angle meter. 1. Tighten the bolts a first pass to 25 N.m (18 lb ft). 2. Tighten the bolts a final pass 75 degrees using **EN-45059** angle meter. **NOTE:** **Rotate the crankshaft to ensure that it moves freely and does not bind.** 2. Measure the connecting rod side clearance with a feeler gauge. Refer to **Engine Mechanical Specifications**. 3. Measure the piston deck height. Refer to **Engine Mechanical Specifications**. **Special Tools** **EN-45059** Angle Meter Equivalent regional tools: **Special Tools**.

CRANKSHAFT OIL DEFLECTOR INSTALLATION

mcx30.com

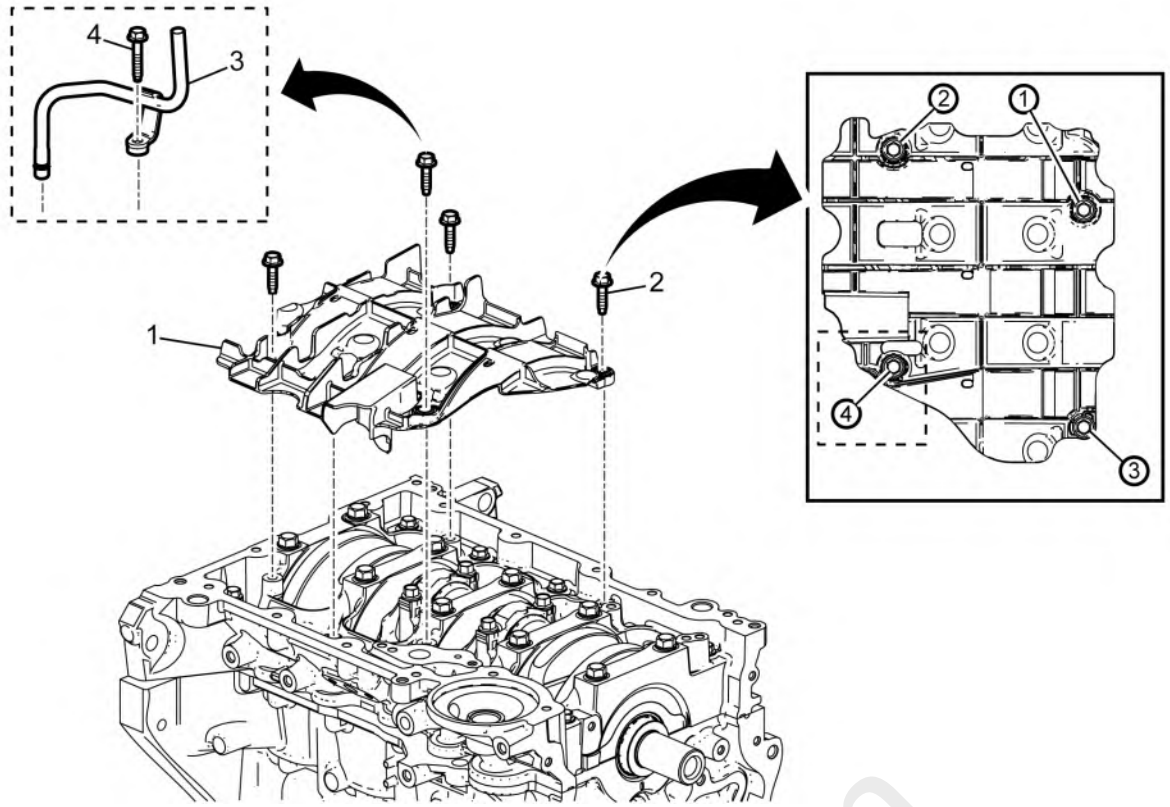


Fig. 476: Crankshaft Oil Deflector (With Bolt Tightening Sequence)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Crankshaft Oil Deflector
2	Crankshaft Oil Deflector Bolt (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Procedure** Tighten the bolts in the sequence shown. **Tighten** 10 N.m (89 lb in)
3	Positive Crankcase Ventilation Oil Separator Drain Pipe
4	Positive Crankcase Ventilation Oil Separator Drain Pipe Bolt **Tighten** 10 N.m (89 lb in)

CRANKSHAFT REAR OIL SEAL INSTALLATION

mcx30.com

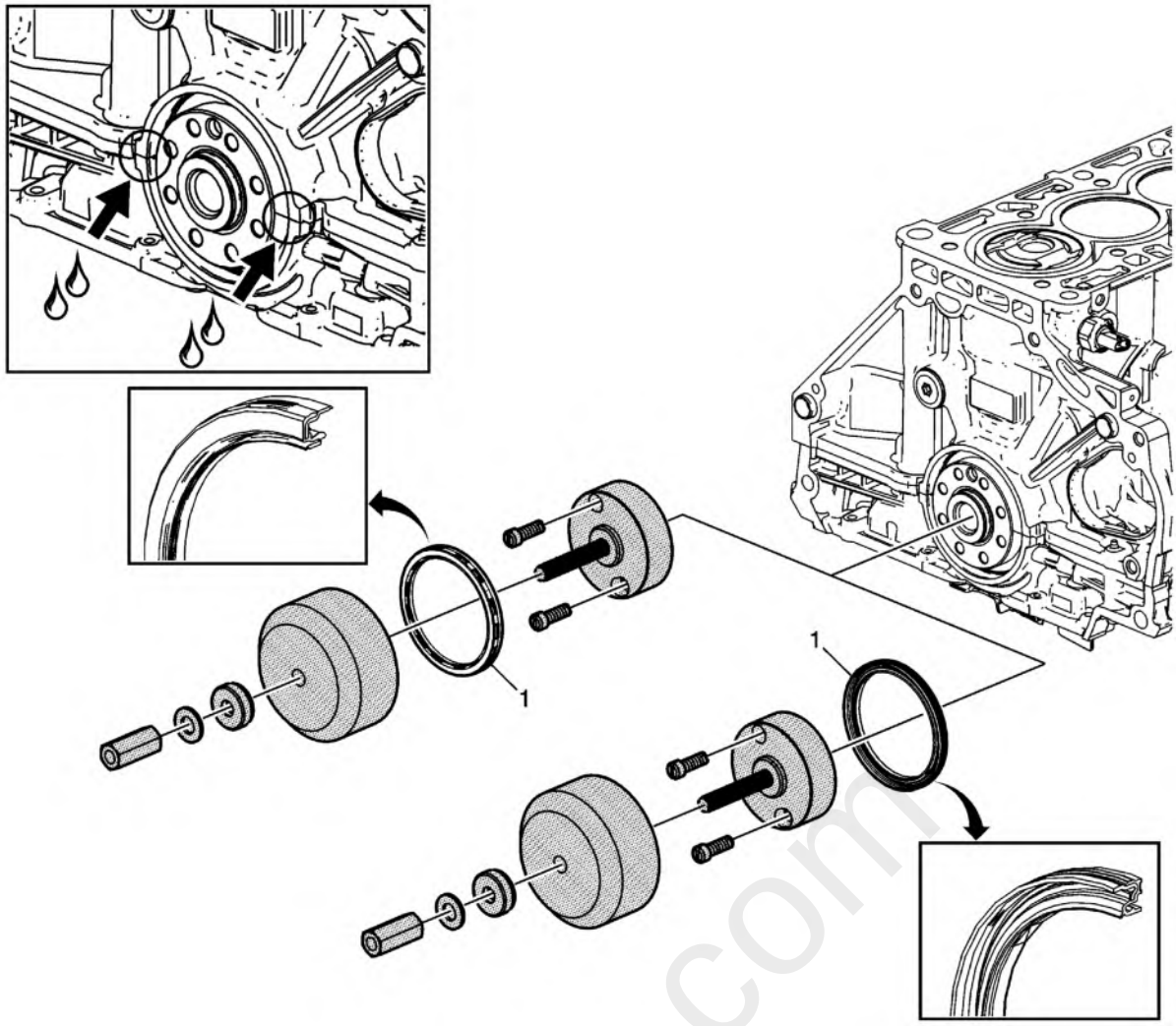


Fig. 477: Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

mcx30.com

Callout	Component Name
1	Crankshaft Rear Oil Seal **Procedure** 1. Inspect the seal recess for excess sealer material at the lower crankcase to engine block mating location. Remove excess sealer, if present. 2. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant** 3. Add RTV sealer at 2 locations where the bedplate and block join prior to installing the oil seal. Refer to **Adhesives, Fluids, Lubricants, and Sealers**. **NOTE:** **The oil seal must be installed in the correct direction. The side that faces out will have "this side out" printed on it. Depending on seal design, the way the seal is installed on the EN-51369 installer is opposite. Either the seal is installed over the back of the installer, or the seal is installed over the front of the installer. Match the seal design as shown above and install the seal onto the installer in the correct direction.** 4. Install the oil seal in the correct direction on **EN-51369** seal installer. **NOTE:** **If the seal is improperly installed on the special tool, it will not install correctly.** 5. Inspect the seal on **EN-51369** seal installer, and ensure that the seal lip is not deformed. If necessary, remove the seal and reinstall on the special tool. 6. Assemble the **EN-51369** seal installer components. **NOTE:** **The special tool installs and establishes the proper depth of the seal in the crankshaft seal bore.** 7. Use **EN-51369** seal installer to press the new crankshaft seal into the housing. Ensure that the seal is installed in the crankshaft seal bore flush to 0.5 mm depth. **Special Tools** **EN-51369** Seal Installer For equivalent regional tools, refer to **Special Tools**.

OIL PUMP DRIVE CHAIN AND OIL PUMP INSTALLATION

Oil Pump Assembly Installation

mcx30.com

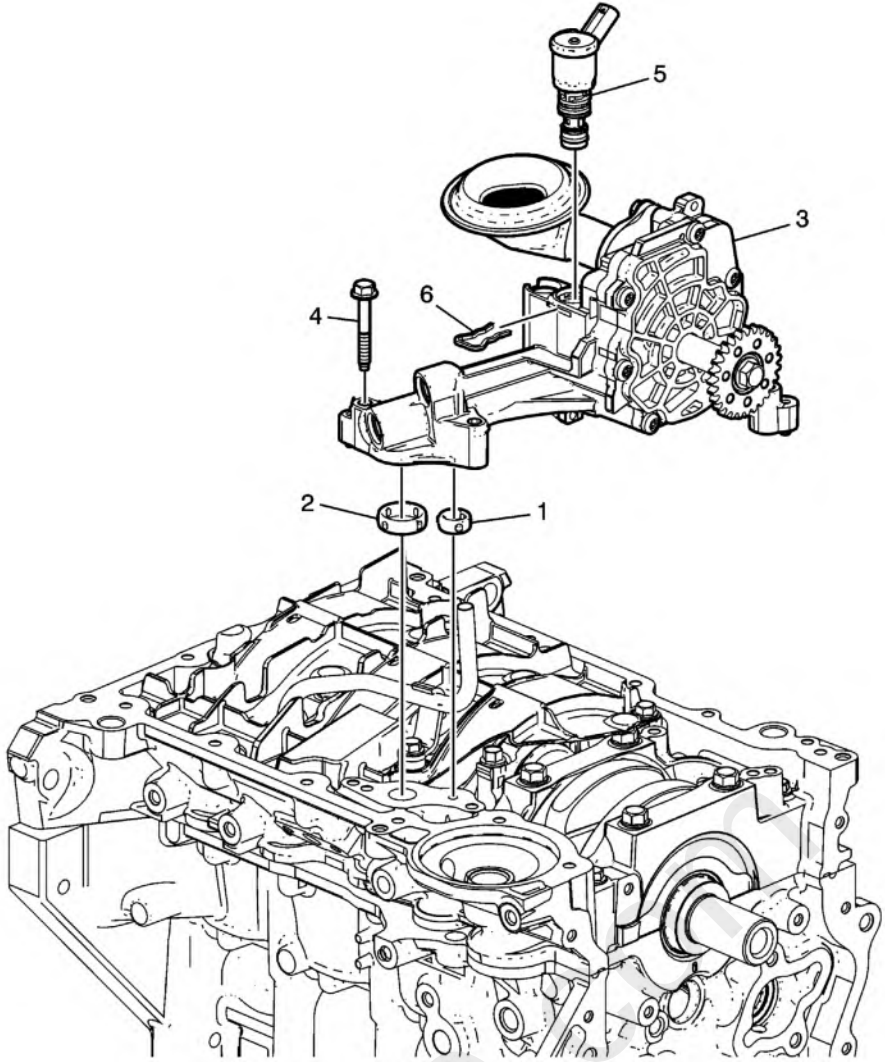


Fig. 478: Oil Pump Assembly
Courtesy of GENERAL MOTORS COMPANY

Oil Pump Assembly Installation

Callout	Component Name
1	Oil Pump Gasket
2	Oil Pump Gasket
3	Oil Pump Assembly
4	Oil Pump Assembly Bolt (Qty: 4) **NOTE:** **Install the oil pump assembly and bolts loosely onto the engine block. Final torque must be performed after the drive chain is installed.**
5	Oil Pump Flow Control Solenoid Valve
6	Oil Pump Flow Control Solenoid Valve Retainer

Crankshaft Sprocket and Oil Pump Drive Chain Installation

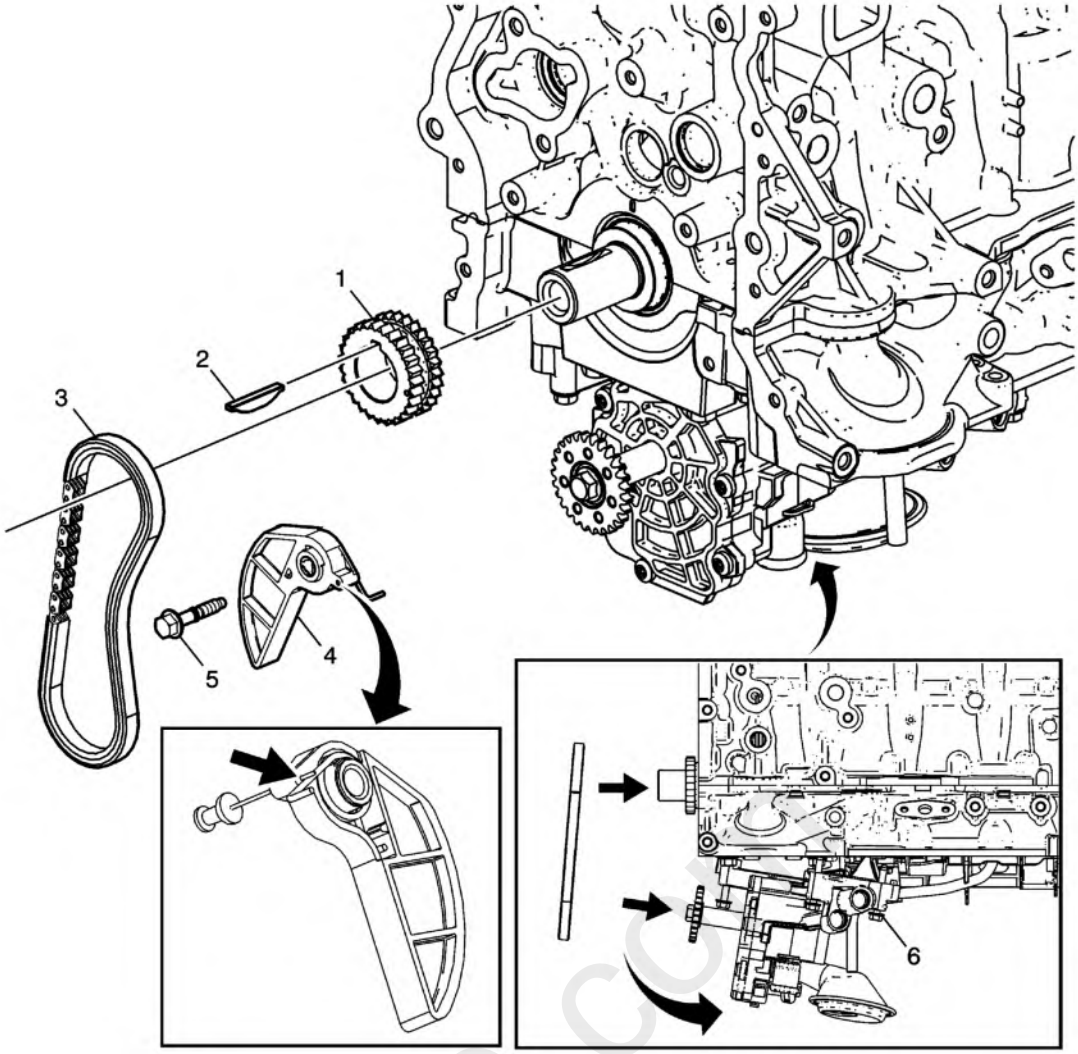


Fig. 479: Crankshaft Sprocket and Oil Pump Drive Chain
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Sprocket and Oil Pump Drive Chain Installation

Callout	Component Name
1	Crankshaft Sprocket
2	Crankshaft Balancer Key
3	Oil Pump Drive Chain **CAUTION:** **Refer to Fastener Caution .** **Procedure** 1. Tilt the oil pump assembly in order to install the drive chain over the oil pump and crankshaft sprockets. 2. Once the drive chain is correctly positioned on the sprockets, tighten the oil pump assembly bolts to 10 N.m (89 lb in).
4	Oil Pump Drive Chain Tensioner Assembly **NOTE:** **Ensure the tensioner spring is retained in the correct position prior to installation.**
5	Oil Pump Drive Chain Tensioner Bolt **Tighten** 10 N.m (89 lb in)

Callout	Component Name
6	Oil Pump Assembly Bolt **Tighten** 10 N.m (89 lb in)

CYLINDER HEAD INSTALLATION

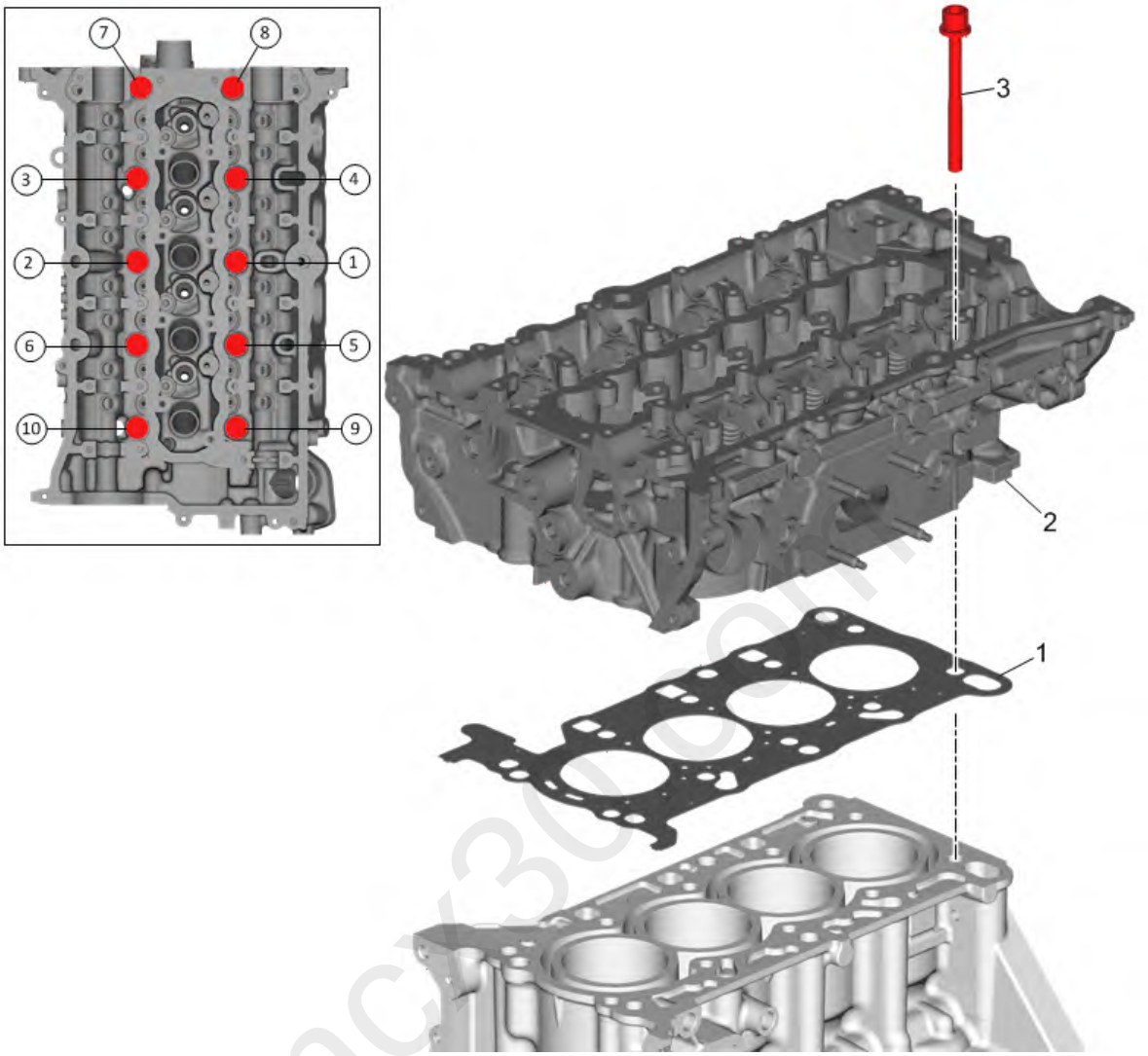


Fig. 480: Cylinder Head With Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Cylinder Head Gasket **NOTE:** **Ensure that the cylinder head and the engine block sealing surfaces are clear of oil, grease, and old gasket material.**
2	Cylinder Head Assembly

Callout	Component Name
3	Cylinder Head Bolt (Qty: 10) **CAUTION:** **Refer to Fastener Caution .** **CAUTION:** **Refer to Torque-to-Yield Fastener Caution .** **Procedure** Tighten the NEW cylinder head bolts in the sequence shown. 1. Tighten the bolts a first pass to 30 N.m (22 lb ft). 2. Using the **EN-45059 - A** angle meter, tighten the bolts a final pass to 240 degrees. **Special Tools** **EN-45059 - A** Angle Meter For equivalent regional tools, refer to **Special Tools**.

INTAKE AND EXHAUST CAMSHAFT, BEARING CAP, AND LASH ADJUSTER INSTALLATION

Valve Rocker Arm and Lash Adjuster Installation

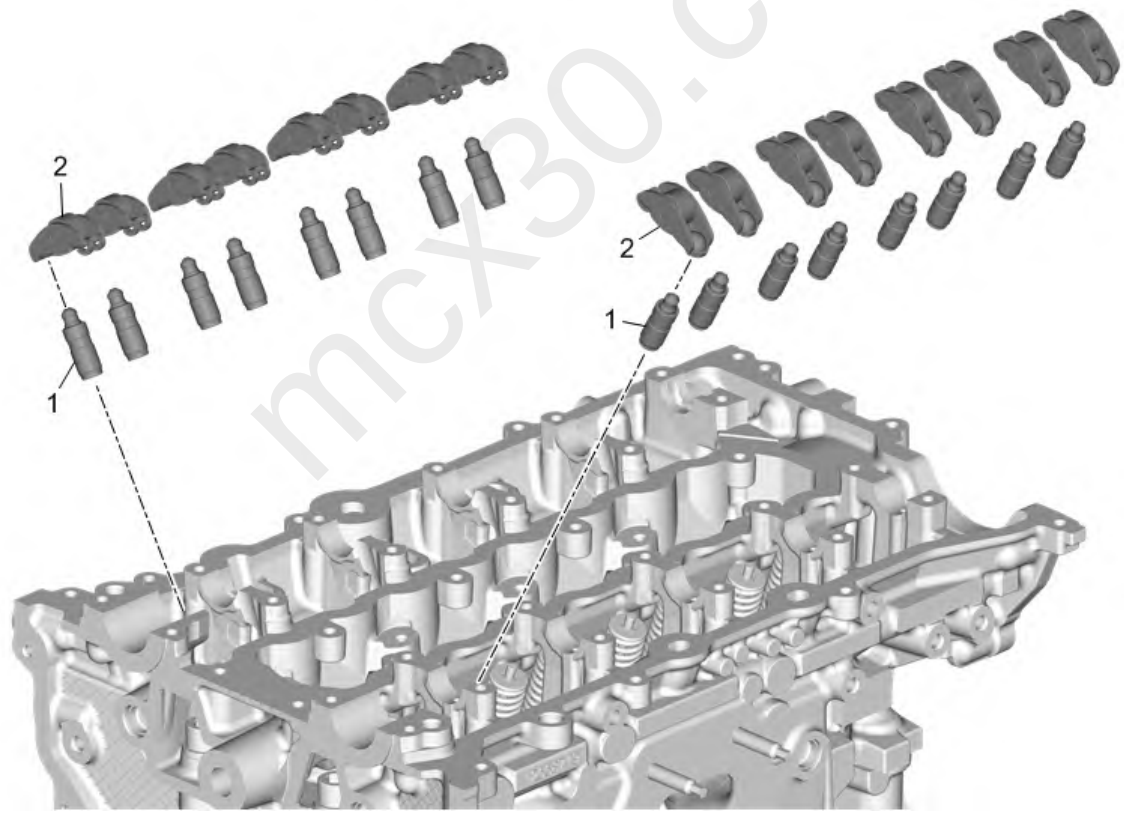


Fig. 481: Valve Rocker Arm and Lash Adjuster
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm and Lash Adjuster Installation

Callout	Component Name
1	Hydraulic Valve Lash Adjuster [16x] **Procedure** Install the lash adjusters in the bores in the cylinder head. Apply lubricant to the lash adjusters, refer to **Adhesives, Fluids, Lubricants, and Sealers**.

mcx30.com

Callout	Component Name
2	Hydraulic Valve Lash Adjuster Arm [16x] **NOTE:** **Used lash adjuster arms must be returned to the original position on the camshaft. If the camshaft is being replaced, the lash adjuster arms actuated by the camshaft must also be replaced.** **Procedure** 1. Apply lubricant to the valve tips, refer to **Adhesives, Fluids, Lubricants, and Sealers**. 2. Position the lash adjuster arm on the tip of the valve stem and on the lash adjuster. 3. Apply lubricant to the lash adjuster arms, refer to **Adhesives, Fluids, Lubricants, and Sealers**.

Camshaft Bearings and Camshaft Installation

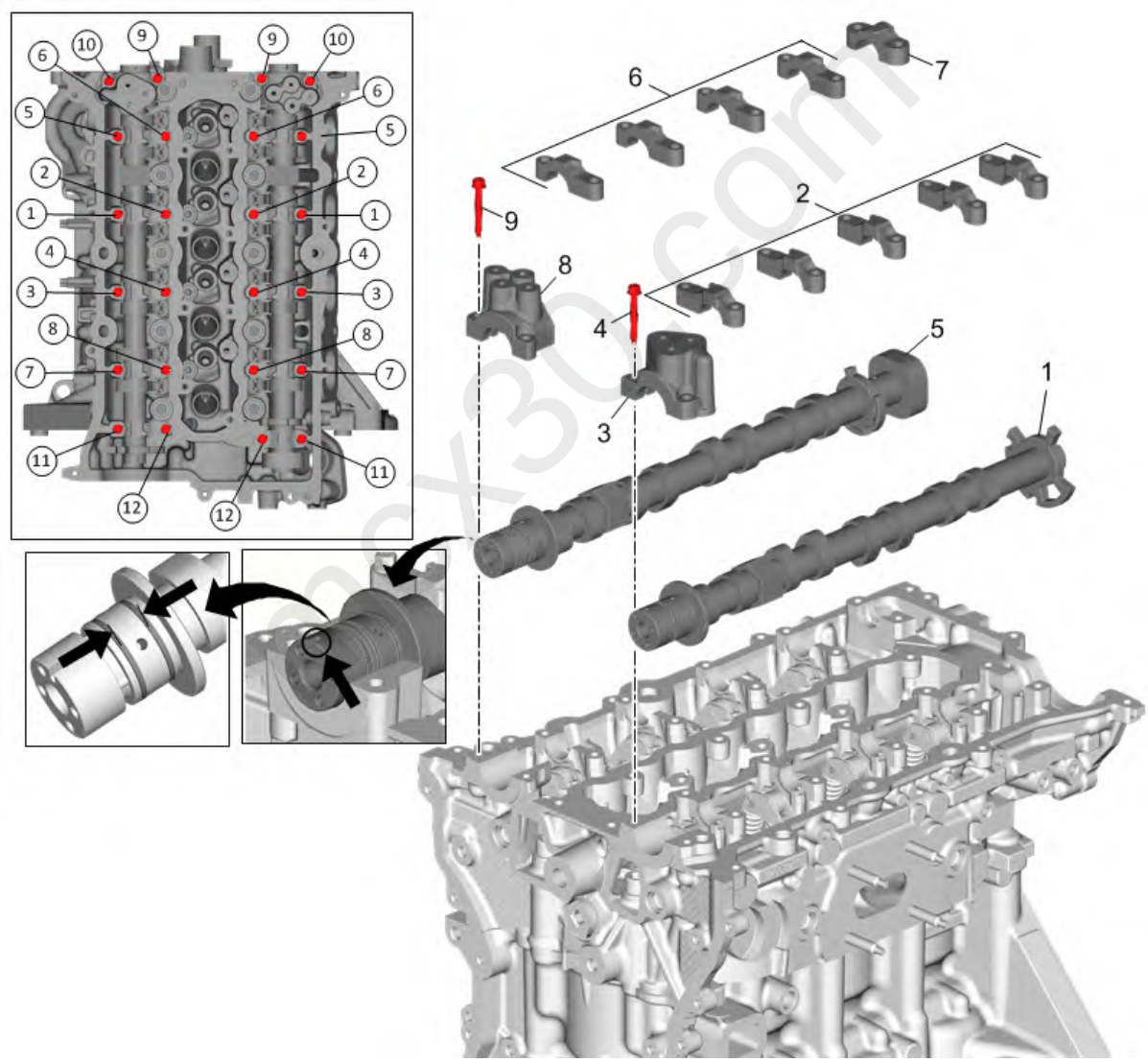


Fig. 482: Camshaft Bearings and Camshaft
Courtesy of GENERAL MOTORS COMPANY

Camshaft Bearings and Camshaft Installation

Callout	Component Name

Callout	Component Name
1	Exhaust Camshaft **Procedure** 1. Coat the exhaust camshaft with lubricant. Refer to **Adhesives, Fluids, Lubricants, and Sealers**. 2. Install the exhaust camshaft in the cylinder head. 3. Ensure that the camshaft notch at the front of the camshaft is in the 12 O'clock position. 4. Rotate the oil seals in the groove of the number one camshaft journal so the split line is at approximately the 12 O'clock position before installing the camshaft caps.
2	Camshaft Bearing Cap [5x] **NOTE:** **Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location. Ensure the caps are installed in the original location and position.** **Procedure** Install the cap and start the cap bolts by hand.
3	Camshaft Bearing Front Exhaust Cap **Procedure** Install the cap and start the cap bolts by hand.
4	Camshaft Bearing Cap Bolt [12x] **CAUTION:** **Refer to Fastener Caution .** **Procedure** 1. Lubricate the bearing cap bolts. 2. Tighten the bearing cap bolts in sequence three turns each until the caps are seated. **Tighten** 12 N.m (106 lb in)
5	Intake Camshaft **Procedure** 1. Coat the intake camshaft with lubricant. Refer to **Adhesives, Fluids, Lubricants, and Sealers**. 2. Install the intake camshaft in the cylinder head. 3. Ensure that the camshaft notch at the front of the camshaft is in the 12 O'clock position. 4. Rotate the oil seals in the groove of the number one camshaft journal so the split line is at approximately the 12 O'clock position before installing the camshaft caps.

mrx30.com

Callout	Component Name
6	Camshaft Bearing Cap [4x] **NOTE:** **Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location. Ensure the caps are installed in the original location and position.** **Procedure** Install the cap and start the cap bolts by hand.
7	Camshaft Bearing Rear Cap **Procedure** Install the cap and start the cap bolts by hand.
8	Camshaft Bearing Front Intake Cap **Procedure** Install the cap and start the cap bolts by hand.
9	Camshaft Bearing Cap Bolt [12x] **Procedure** 1. Lubricate the bearing cap bolts. 2. Tighten the bearing cap bolts in sequence three turns each until the caps are seated. **Tighten** 12 N.m (106 lb in)

Camshaft Actuator Installation

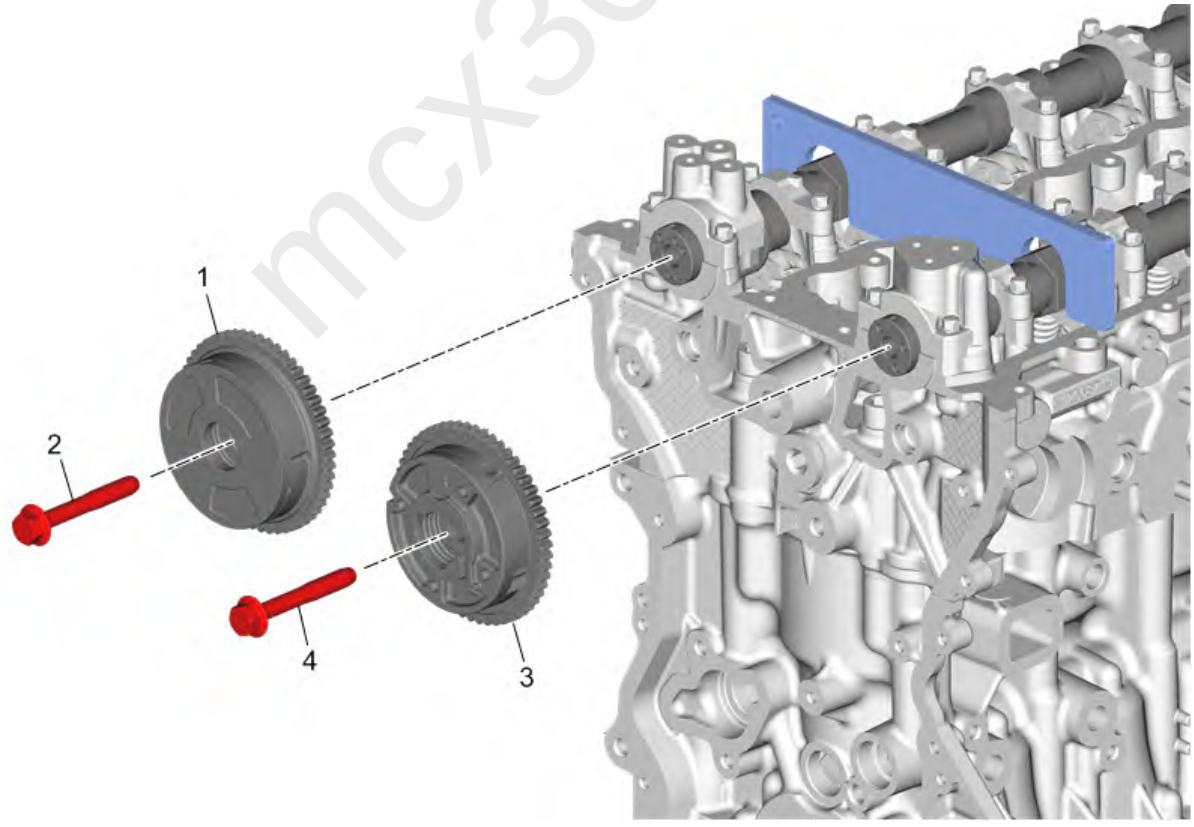


Fig. 483: Camshaft Actuator
Courtesy of GENERAL MOTORS COMPANY

Camshaft Actuator Installation

Callout	Component Name

mcx30.com

Callout	Component Name
Preliminary Procedure Install the **EN-51367** camshaft locking tool. Remove when the camshaft actuator bolts are tightened to specification. **Special Tools** **EN-51367** Camshaft Locking Tool Equivalent regional tools: **Special Tools**.	
1	Camshaft Position Actuator **NOTE:** **Align the actuator with the notch in the camshaft.**
2	Camshaft Position Actuator Bolt **CAUTION:** **Refer to Fastener Caution .** **CAUTION:** **Refer to Torque-to-Yield Fastener Caution .** **Procedure** Tighten the NEW camshaft position actuator bolt in the sequence shown. 1. Tighten the bolt a first pass to 20 N.m (15 lb ft). 2. Using the **EN 45059** angle meter, tighten the bolt a final pass to 90 degrees. **Special Tools** **EN-45059** Angle Meter Equivalent regional tools: **Special Tools**.
3	Camshaft Position Actuator **NOTE:** **Align the actuator with the notch in the camshaft.**
4	Camshaft Position Actuator Bolt **Procedure** Tighten the NEW camshaft position actuator bolt in the sequence shown. 1. Tighten the bolt a first pass to 20 N.m (15 lb ft). 2. Using the **EN-45059** angle meter, tighten the bolt a final pass to 90 degrees. **Special Tools** **EN-45059** Angle Meter Equivalent regional tools: **Special Tools**.

CAMSHAFT TIMING CHAIN INSTALLATION

mcx30.com

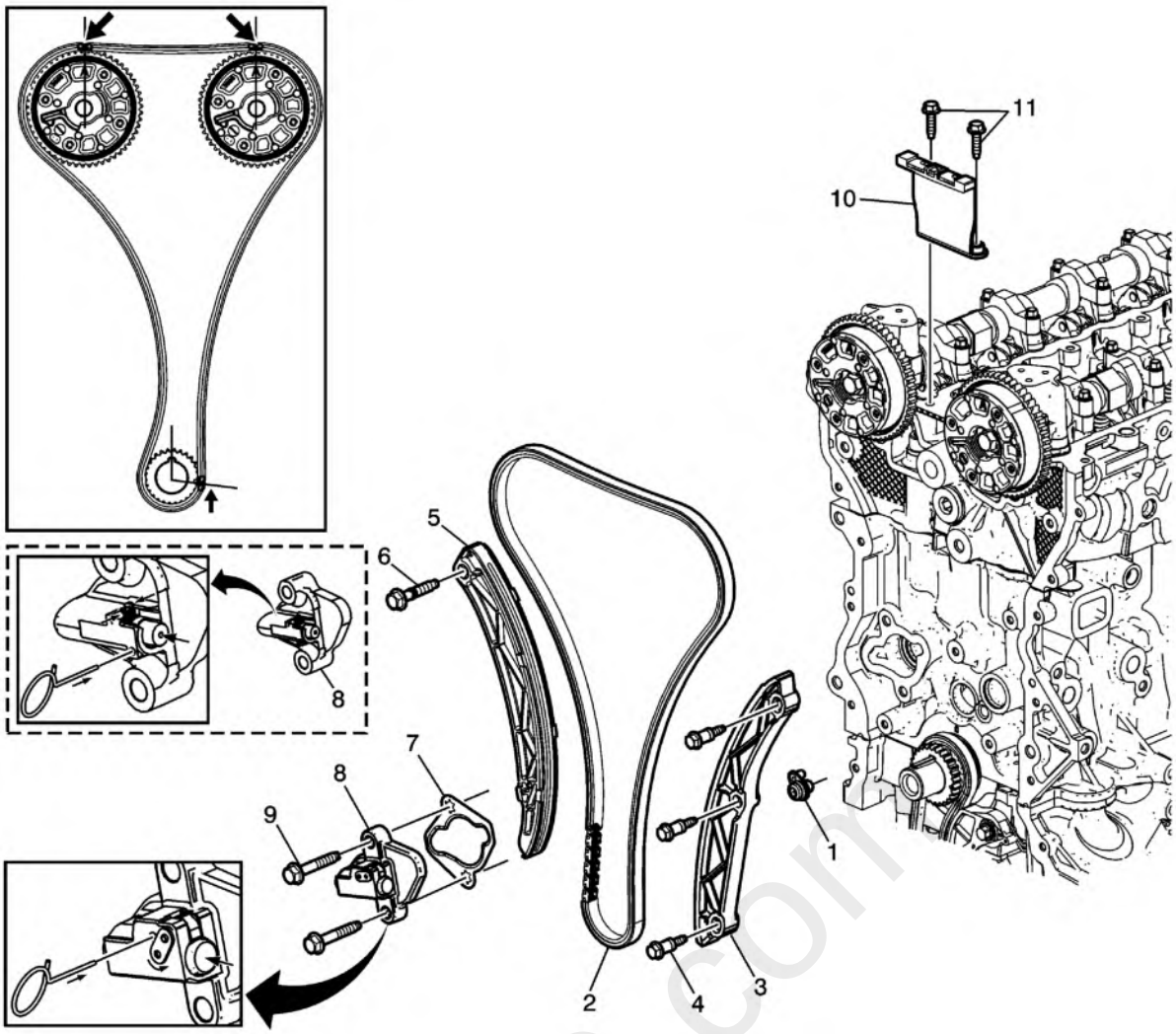


Fig. 484: Camshaft Timing Chain Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Timing Chain Oil Nozzle **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Tighten** 15 N.m (11 lb ft)
2	Timing Chain **NOTE:** **Ensure the actuator timing marks and the crankshaft sprocket keyway are at the 12 O'Clock position.** **Procedure** **NOTE:** **Ensure the correct timing link is aligned with the timing mark. The color of the actuator timing links are the same, and the color of the crankshaft sprocket timing link is unique.** 1. Align the first timing chain link with the intake actuator timing mark. 2. Align the second timing chain link with the exhaust actuator timing mark. 3. Align the final timing chain link with the crankshaft sprocket timing mark.

mcx30.com

Callout	Component Name
3	Timing Chain Guide - Exhaust Side
4	Timing Chain Guide Bolt (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
5	Timing Chain Tensioner Shoe Assembly
6	Timing Chain Tensioner Shoe Bolt **Tighten** 25 N.m (18 lb ft)
7	Timing Chain Tensioner Gasket
8	Timing Chain Tensioner Assembly **NOTE:** **Ensure the tensioner is fully retracted prior to installation. Depending on tensioner model, the procedure to depress and lock the plunger is different.** **Procedure** 1. If the tensioner has a lever on the front, press down on the lever and depress the plunger. Insert a suitable tool into the hole in the tensioner body to hold the plunger in the retracted position. 2. If the tensioner has a retaining clip, press the clip and depress the plunger. Insert a suitable tool into the hole in the tensioner body to hold the plunger in the retracted position.
9	Timing Chain Tensioner Bolt (Qty: 2) **Tighten** 25 N.m (18 lb ft)
10	Timing Chain Upper Guide - to Cylinder Head
11	Timing Chain Upper Guide Bolt (Qty: 2) **Tighten** 10 N.m (89 lb in)

ENGINE FRONT COVER INSTALLATION

Engine Front Cover and Components Installation

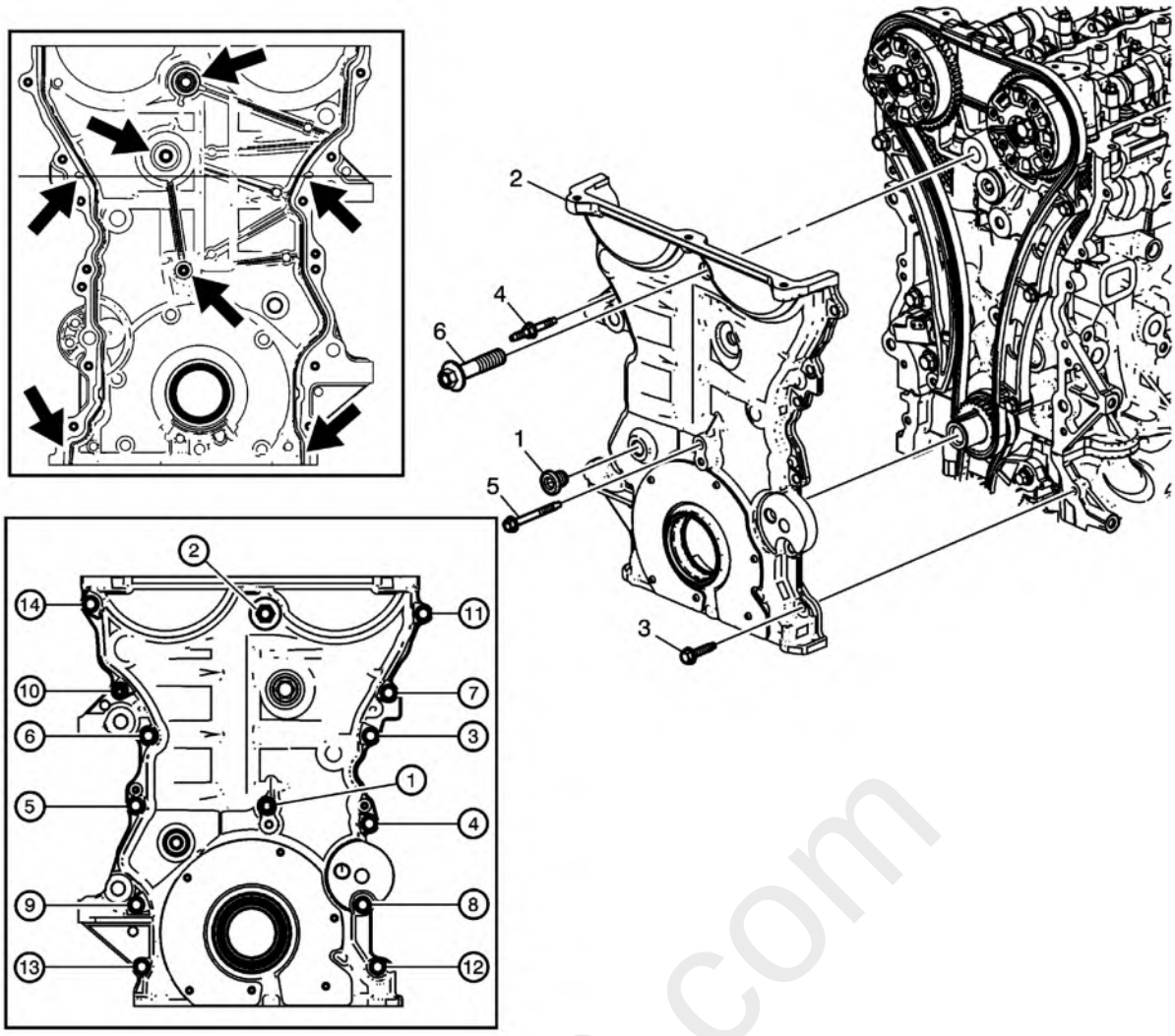


Fig. 485: Engine Front Cover and Components With Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

Engine Front Cover and Components Installation

Callout	Component Name
1	Engine Front Cover Hole Plug **CAUTION:** **Refer to Fastener Caution .** **Tighten** 50 N.m (37 lb ft)

mox30.com

Callout	Component Name
2	Engine Front Cover **Procedure** 1. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant** **NOTE:** • **The engine front cover surface must be free of contamination prior to applying the sealer.** • **Install and align the cover within 20 minutes of applying the sealer.** • **The cover must be fastened to final torque specification within 20 minutes of applying the sealer.** • **Additional sealant is necessary to reduce the possibility of leakage where the cylinder head to engine block interface along the bead path flange on the front cover.** 2. Apply a 4 mm bead of sealer directly in the flange of the engine front cover perimeter mating surface. 3. Apply a 3 mm bead of sealer circling 3 locations on the interior of the engine front cover. 4. Apply a 3 mm bead of sealant at the 2 horizontal groove locations along the flange where the cylinder head and engine block mate. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
3	Engine Front Cover Bolt - M6 (Qty: 11) **NOTE:** **Hand start the engine front cover bolts. Torque to specification when all front cover bolts and the stud are installed hand-tight.** **Tighten** 15 N.m (11 lb ft)
4	Engine Front Cover Stud (Qty: 1) **Tighten** 15 N.m (11 lb ft)
5	Engine Front Cover Bolt - M6 (Qty: 1) **NOTE:** **This interior M6 bolt is longer than the perimeter M6 bolts.** **Tighten** 15 N.m (11 lb ft)
6	Engine Front Cover Bolt - M14 (Qty: 1) **Tighten** 58 N.m (43 lb ft) **Procedure** Tighten all the engine front cover bolts in the sequence shown. 1. Tighten the bolts a first pass to 5 N.m (44 lb in). 2. Tighten the bolts a final pass to final torque specification.

mcx30.com

Crankshaft Front Oil Seal Installation

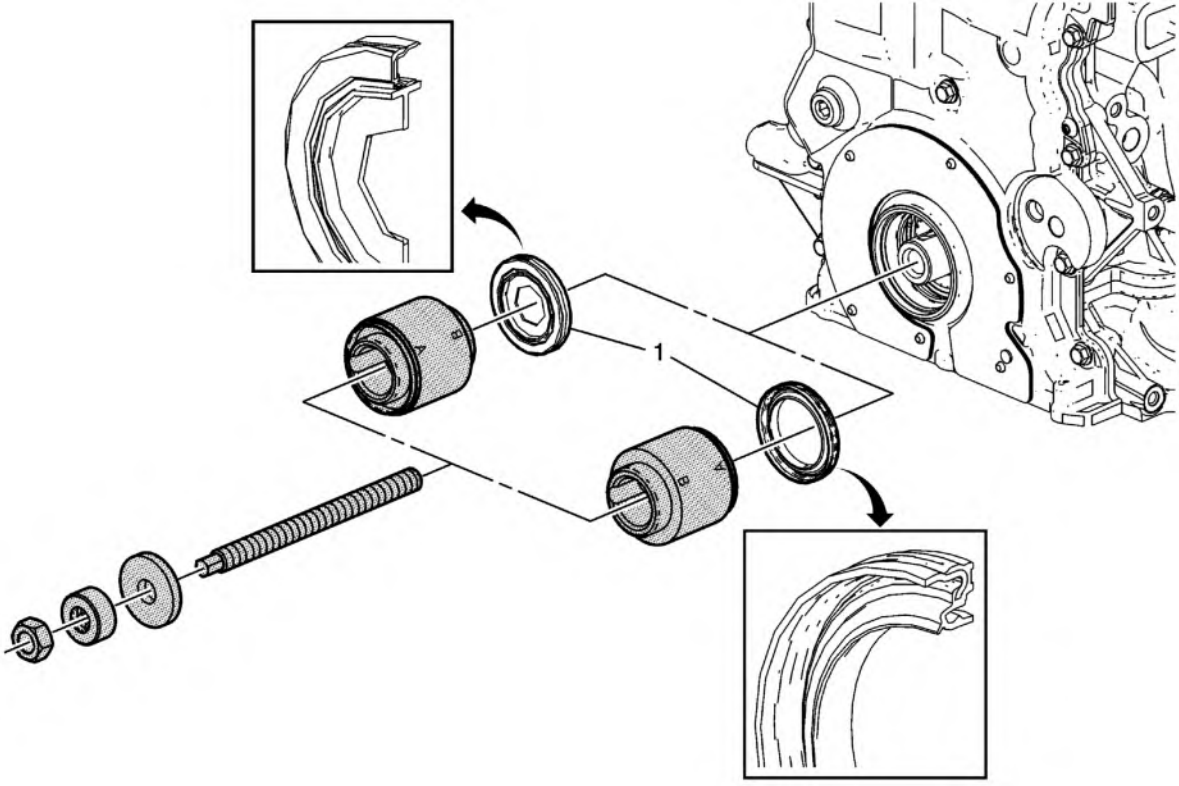


Fig. 486: Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Front Oil Seal Installation

Callout	Component Name
1	Crankshaft Front Oil Seal **Procedure** **NOTE:** **The oil seal must be installed in the correct direction. The side that faces out will have "this side out" printed on it. The design of the seal determines which end of the EN 51368 installer is used. Use the end of the installer that matches the design of the seal, as shown.** 1. Lubricate the outside diameter of the new crankshaft seal with clean engine oil. 2. Determine which end of the **EN-51368** installer will be used and install the seal on it. 3. Install the **EN-51368** installer over the crankshaft. 4. Install the **EN-51368** screw, large washer, bearing, and nut. 5. Counter-hold the screw, and tighten the nut to install the seal. **Special Tools** **EN-51368** Front Crankshaft Seal Installer For equivalent regional tools, refer to Special Tools.

OIL PAN INSTALLATION

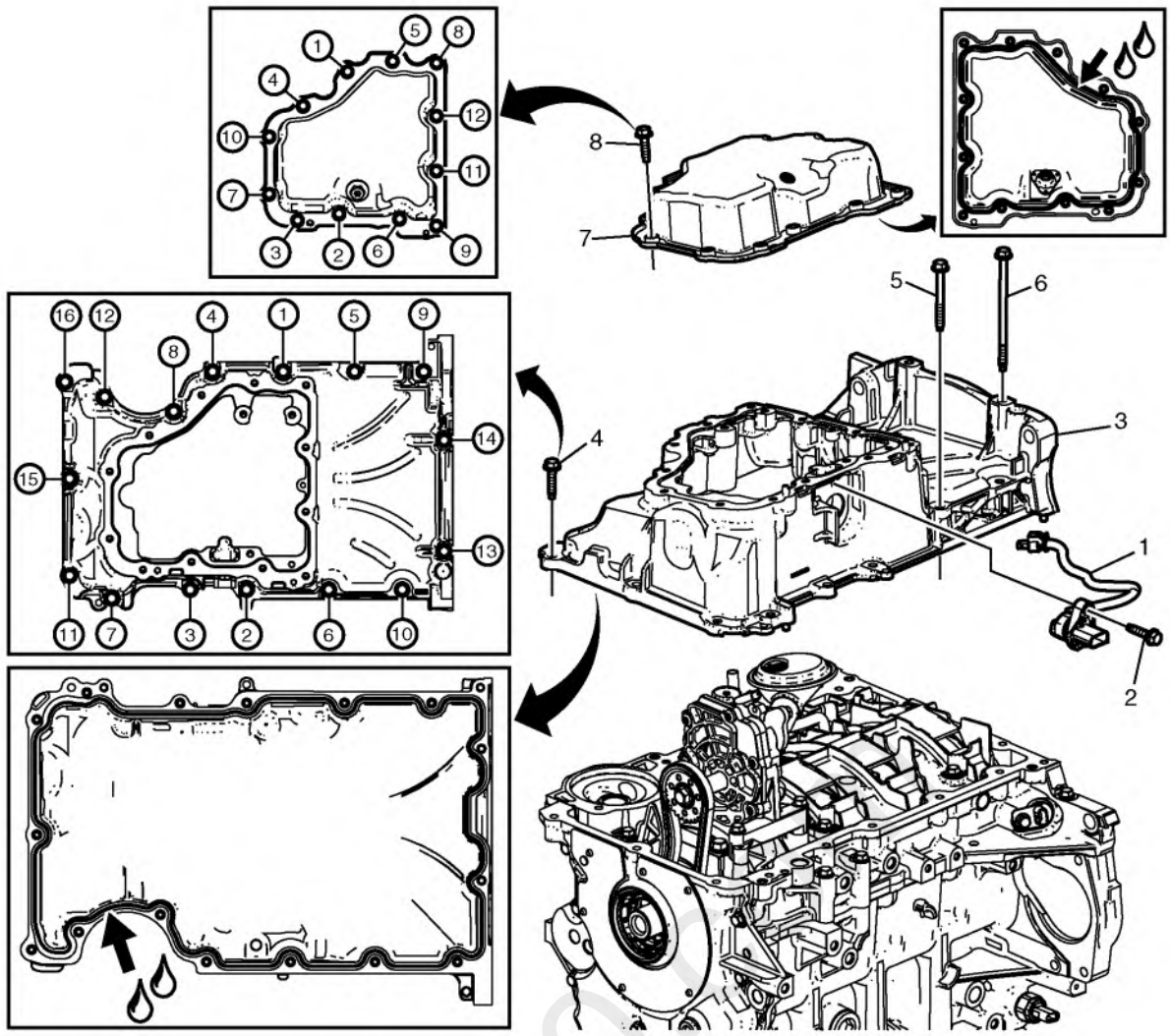


Fig. 487: Oil Pan With Bolt Tightening Sequences
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Oil Level Indicator Control Wiring Harness
2	Wiring Harness Connector Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)

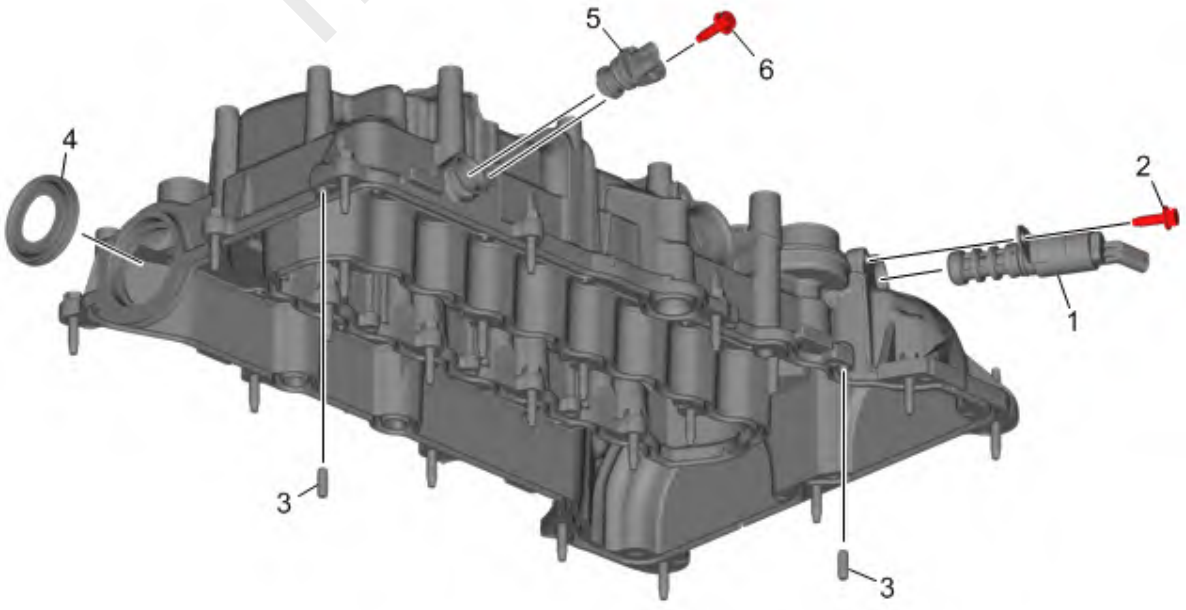
Callout	Component Name
3	Upper Oil Pan Assembly **Procedure** 1. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant** **NOTE:** • **The lower crankcase and oil pan mating surfaces must be free of contamination prior to applying the sealer.** • **Install and align the oil pan to block within 20 minutes of applying the sealer.** • **The oil pan must be fastened to final torque specification within 60 minutes of applying the sealer.** • **Additional sealant is necessary to reduce the possibility of leakage where the cylinder head to engine block interface along the bead path flange on the front cover.** 2. Apply a 3 mm bead of sealer around the perimeter of the oil pan. Refer to **Adhesives, Fluids, Lubricants, and Sealers**. 3. Install the oil pan on the lower crankcase, ensure the oil pan locating pins align with the lower crankcase.
4	Oil Pan Bolt (Qty: 12) **Procedure** 1. Apply sealant to the oil pan bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers**. 2. Hand start the oil pan bolts. Torque to specification when all oil pan bolts are installed hand-tight. **Tighten** 10 N.m (89 lb in)
5	Oil Pan Bolt (Qty: 2) **Procedure** 1. Apply sealant to the oil pan bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers**. 2. Hand start the oil pan bolts. Torque to specification when all oil pan bolts are installed hand-tight. **Tighten** 10 N.m (89 lb in)

mcx30.com

Callout	Component Name
6	Oil Pan Bolt (Qty: 2) **Procedure** 1. Apply sealant to the oil pan bolts. Refer to **Adhesives, Fluids, Lubricants, and Sealers**. 2. Tighten all the oil pan bolts in sequence. 3. Inspect for excessive sealer around the oil filter mounting area when final torque is achieved. If extra sealer is present, remove and clean accordingly. **Tighten** 10 N.m (89 lb in)
7	Lower Oil Pan **Procedure** 1. Connect the oil pump control valve wiring harness connector. 2. Use a NEW lower oil pan. 3. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant** 4. Apply a 5 mm bead of sealer around the perimeter of the lower oil pan. Refer to **Adhesives, Fluids, Lubricants, and Sealers**. 5. Install the lower oil pan on the upper oil pan, ensure the oil pan locating pins align with the lower oil pan.
8	Lower Oil Pan Bolt (Qty: 12) **Procedure** Tighten the oil pan bolts in sequence. **Tighten** 10 N.m (89 lb in)

CAMSHAFT COVER INSTALLATION

Camshaft Cover Components Installation - Bottom



mcx30.com

Fig. 488: Camshaft Cover Components -- Bottom
Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover Components Installation - Bottom

Callout	Component Name
1	Camshaft Position Actuator Solenoid Valve
2	Camshaft Position Actuator Solenoid Valve Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
3	Camshaft Cover Locating Pin [2x]
4	Vacuum Pump Seal **NOTE:** **Use NEW seal.** **Special Tools** **EN-45866** Seal Installer Equivalent regional tools: Special Tools.
5	Camshaft Position Sensor
6	Camshaft Position Sensor Bolt **Tighten** 10 N.m (89 lb in)

Camshaft Cover Components Installation - Top

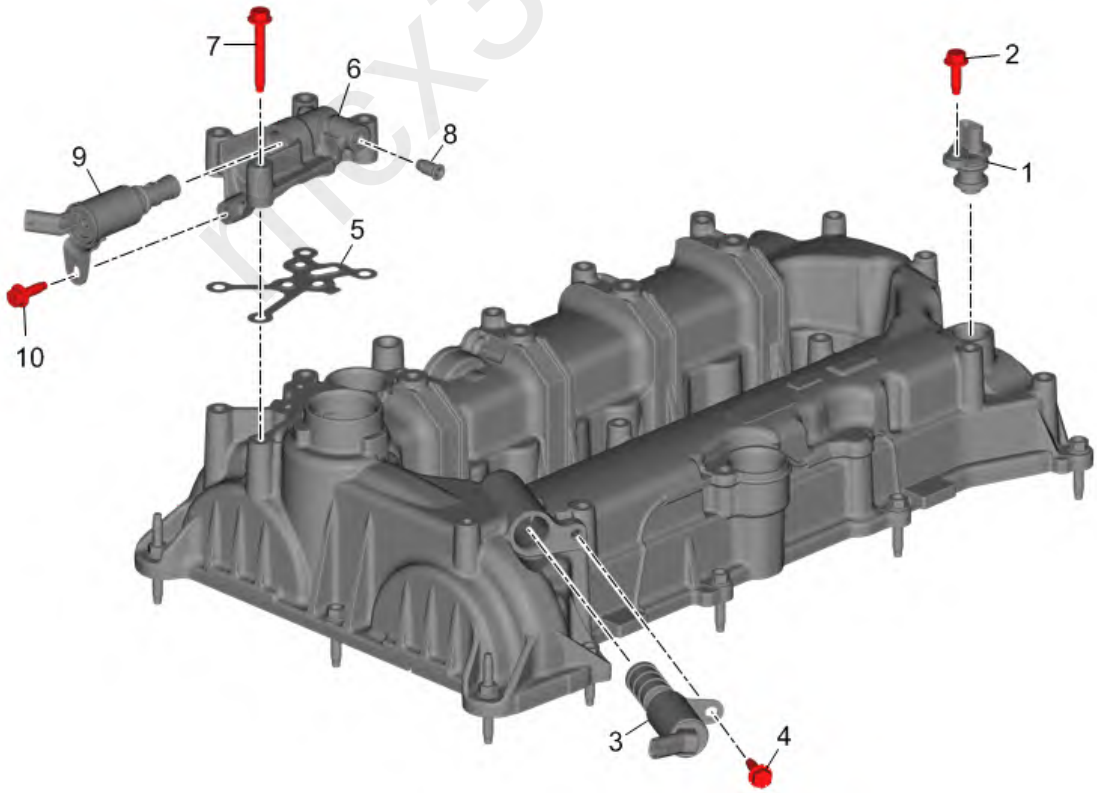


Fig. 489: Camshaft Cover Components - Top
Courtesy of GENERAL MOTORS COMPANY

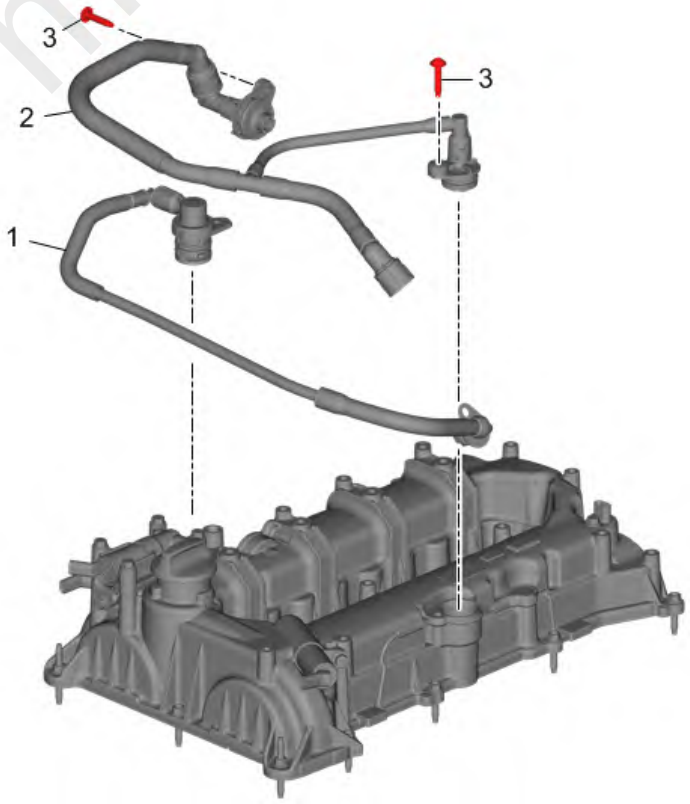
Camshaft Cover Components Installation - Top

Callout	Component Name

mex30.com

Callout	Component Name
1	Camshaft Position Sensor
2	Camshaft Position Sensor Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
3	Camshaft Position Actuator Solenoid Valve
4	Camshaft Position Actuator Solenoid Valve Bolt **Tighten** 10 N.m (89 lb in)
5	Camshaft Housing Gasket **NOTE:** **Use a NEW gasket.**
6	Camshaft Housing
7	Camshaft Housing Bolt [4x] **Tighten** 10 N.m (89 lb in)
8	Camshaft Cover Opening Plug **Procedure** Apply sealant to the plug prior to installation. Refer to Adhesives, Fluids, Lubricants, and Sealers. **Tighten** 12 N.m (106 lb in)
9	Camshaft Position Actuator Locating Pin Control Valve
10	Camshaft Position Actuator Solenoid Valve Bolt **Tighten** 10 N.m (89 lb in)

Camshaft Cover Positive Crankcase Ventilation Components Installation



mcx30.com

Fig. 490: Camshaft Cover Positive Crankcase Ventilation Components
Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover Positive Crankcase Ventilation Components Installation

Callout	Component Name
1	Positive Crankcase Ventilation Tube with Positive Crankcase Ventilation Valve - Foul Air **NOTE:** **These components have tamper-proof connections and cannot be disassembled.** **Procedure** 1. Assemble a NEW PCV Tube, NEW PCV valve, and NEW PCV Hose fitting. 2. Install the PCV valve to the camshaft cover. The valve is retained by snapping into the camshaft cover.
2	Positive Crankcase Ventilation Tube with Positive Crankcase Ventilation Valve - Fresh Air **NOTE:** **These components have tamper-proof connections and cannot be disassembled. The fresh air inlet duct is connected to the PCV Tube with a tamper-proof connection. All components must be replaced once removed.** **Procedure** 1. Assemble a NEW PCV tube with NEW PCV valves and a NEW fresh air inlet duct. 2. Install the PCV valves to the camshaft cover.
3	Positive Crankcase Ventilation Valve Bolt [2x] **CAUTION:** **Refer to Fastener Caution .** **NOTE:** **Bolts are tamper-proof.** **Procedure** Using **EN-50956** bit, install NEW bolts. **Tighten** 10 N.m (89 lb in) **Special Tools** **EN-50956** Tamper-Proof Drive Bit Equivalent regional tools: Special Tools.

Camshaft Cover Installation

mc30.com

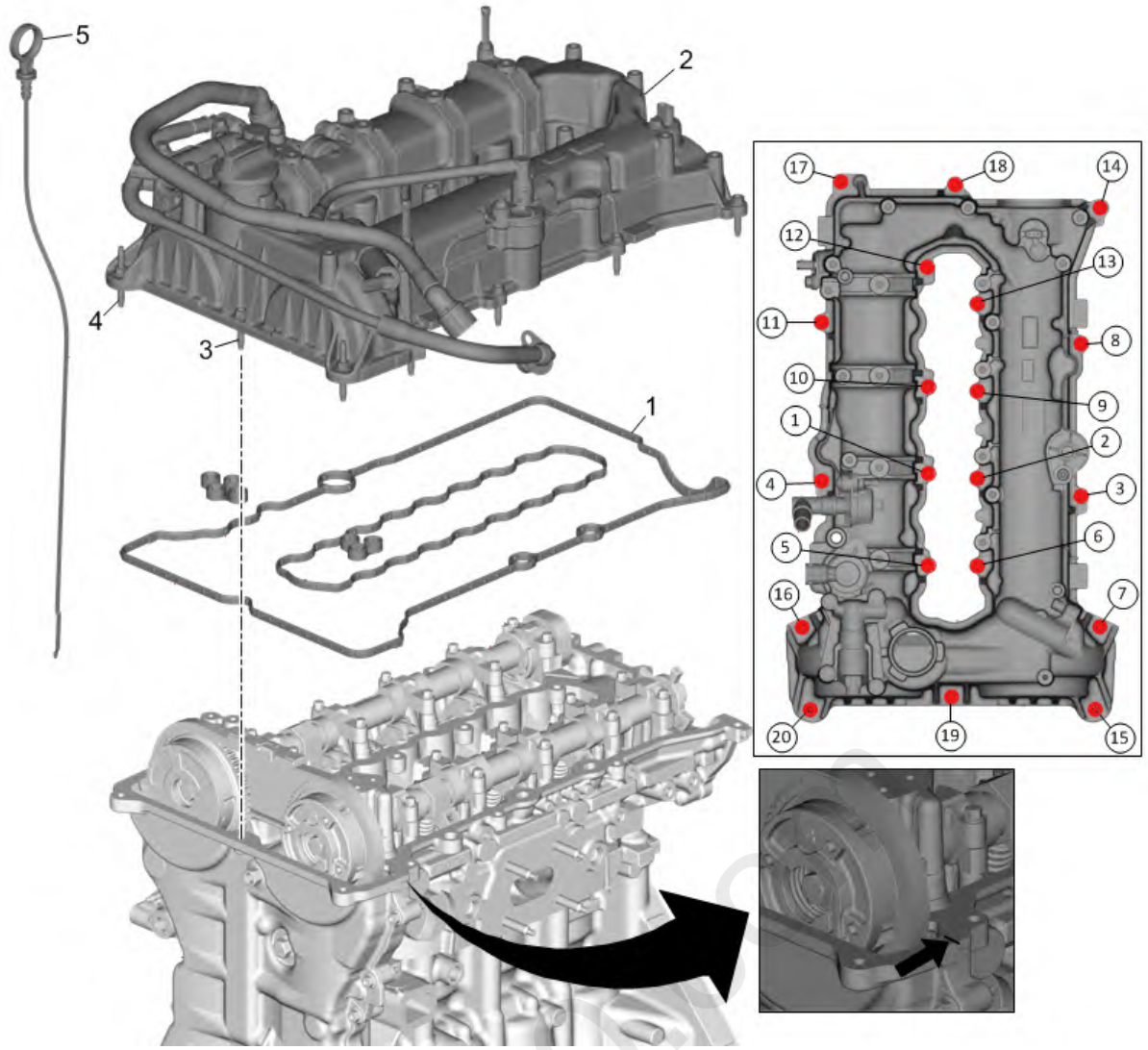


Fig. 491: Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover Installation

Callout	Component Name
1	Camshaft Cover Gasket **NOTE:** **Use a NEW gasket.** **Procedure** Assemble the camshaft cover and a NEW gasket. Ensure that the gasket is located in the retaining groove in the camshaft cover.
2	Camshaft Cover **Procedure** 1. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant** 2. Apply approximately a 5 mm (0.2 in) thick bead of camshaft cover sealant on both sides between the cylinder head and the engine front cover. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
3	Camshaft Cover Bolt [18x] **Procedure** Start the bolts by hand. Tighten the engine front cover bolts and studs in sequence.

Callout	Component Name
4	Camshaft Cover Stud [2x] **Procedure** Tighten the engine front cover bolts and studs in sequence. **CAUTION:** **Refer to Fastener Caution .** **Tighten** 15 N.m (11 lb ft)
5	Oil Level Indicator

FUEL RAIL AND INJECTORS INSTALLATION

Special Tools

- **EN-49245** Fuel Injector Seal Installer/Sizer
- **EN-51105** Injector Seal Installer Adapters
- **EN-51146** Fuel Injector Removal/Installation Kit
- **EN-51146-100** Fuel Injector Removal Plate

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

Fuel Injector Installation Procedure

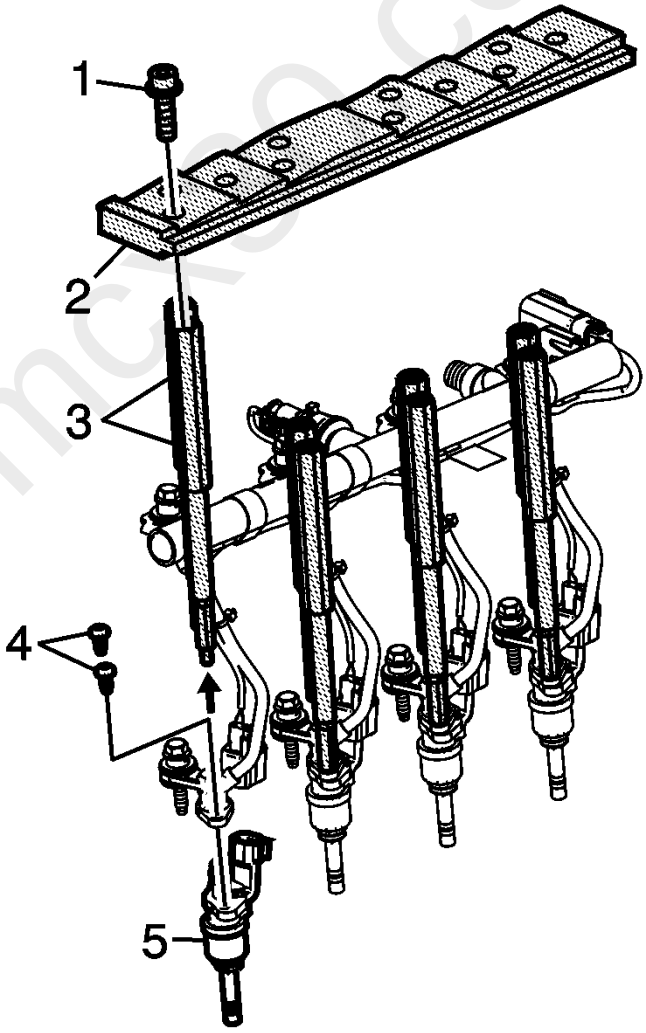


Fig. 492: Installing Fuel Injectors Using Removal/Installation Kit
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not remove the fuel injectors unless inspection indicates**

replacement is necessary. Do not remove the EN-51146-1-6 demounting screw and EN-51146-1-1 support unless the fuel injector is being replaced.

1. If one or more fuel injectors are being replaced, remove the bolts (1) and **EN-51146-100** plate (2).
2. Remove the **EN-51146-1-6** demounting screws and **EN-51146-1-1** supports (3) for all fuel injectors that are being replaced.
3. Remove and discard the fuel injectors (5) that are being replaced.
4. Lubricate the O-ring with one drop of clean engine oil. Install a new fuel injector (5).

CAUTION: **Refer to Fastener Caution .**

5. Install the NEW fuel injector screws (4) to the NEW fuel injectors (5) and tighten to 5 N.m (44 lb in).
6. Connect the fuel injector wiring harness plugs.

Fuel Injector Combustion Seal Installation Procedure

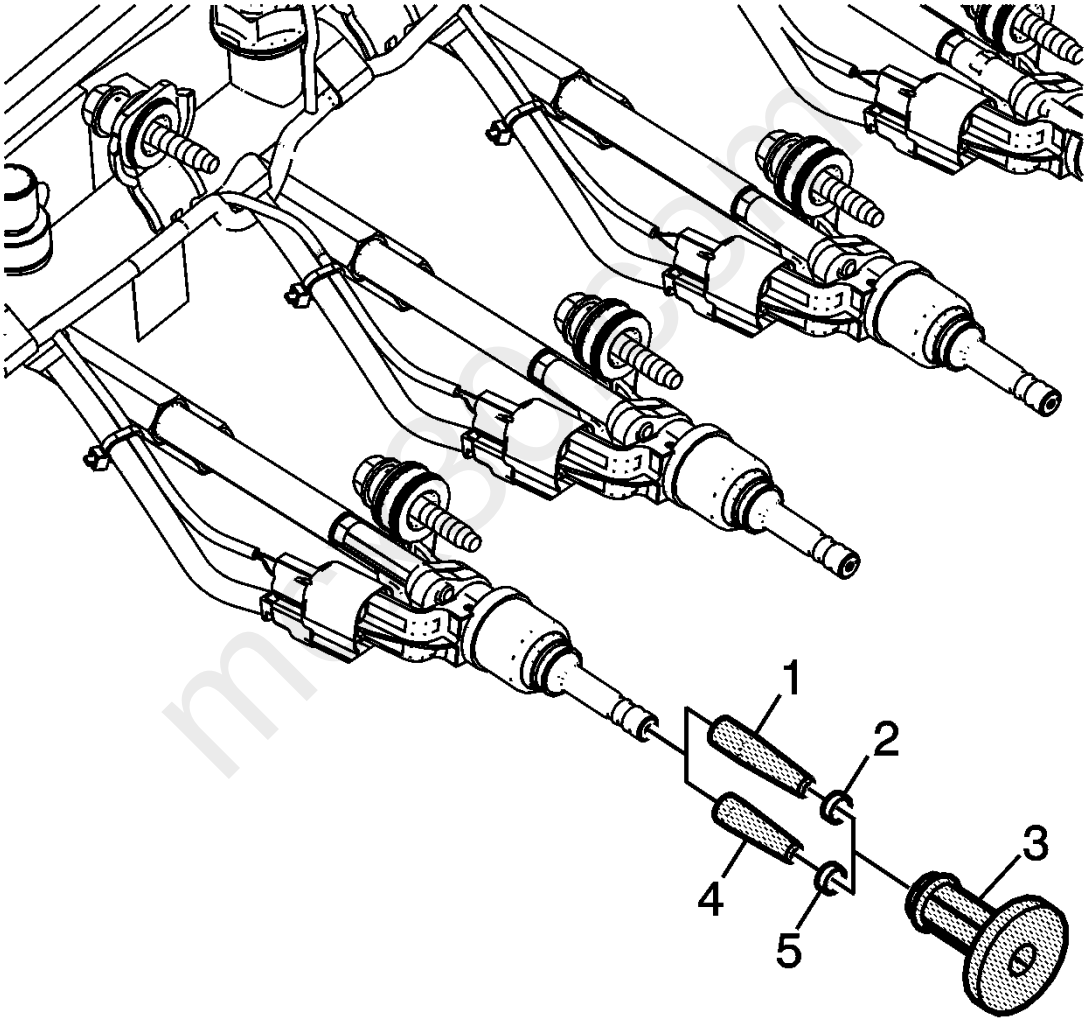


Fig. 493: Installing Combustion Seals
Courtesy of GENERAL MOTORS COMPANY

NOTE: **DO NOT use any type of lubricant when installing the NEW combustion seals on the fuel injector tip.**

NOTE: **The injector tip protectors in the EN-49245 set are too small for some injectors. Ensure EN-51105 is used on injector tips during seal installation. The pusher and final sizer work for all injectors.**

1. Install **EN-51105-1** long protector (1) onto the fuel injector tip, covering the first recessed area closest to the tip. Place a NEW seal (2) on **EN-51105-1** long protector (1).

2. Using **EN-49245-3** pusher (3), install the seal (2) into the recessed area of the fuel injector.
3. Compress the seal (2) with your fingers.
4. Install **EN-51105-2** short protector (4) onto the fuel injector tip. Place a NEW seal (5) on **EN-51105-2** short protector (4).
5. Using **EN-49245-3** pusher (3), install the seal (5) into the last recessed area of the fuel injector.
6. Compress the seal (5) with your fingers.

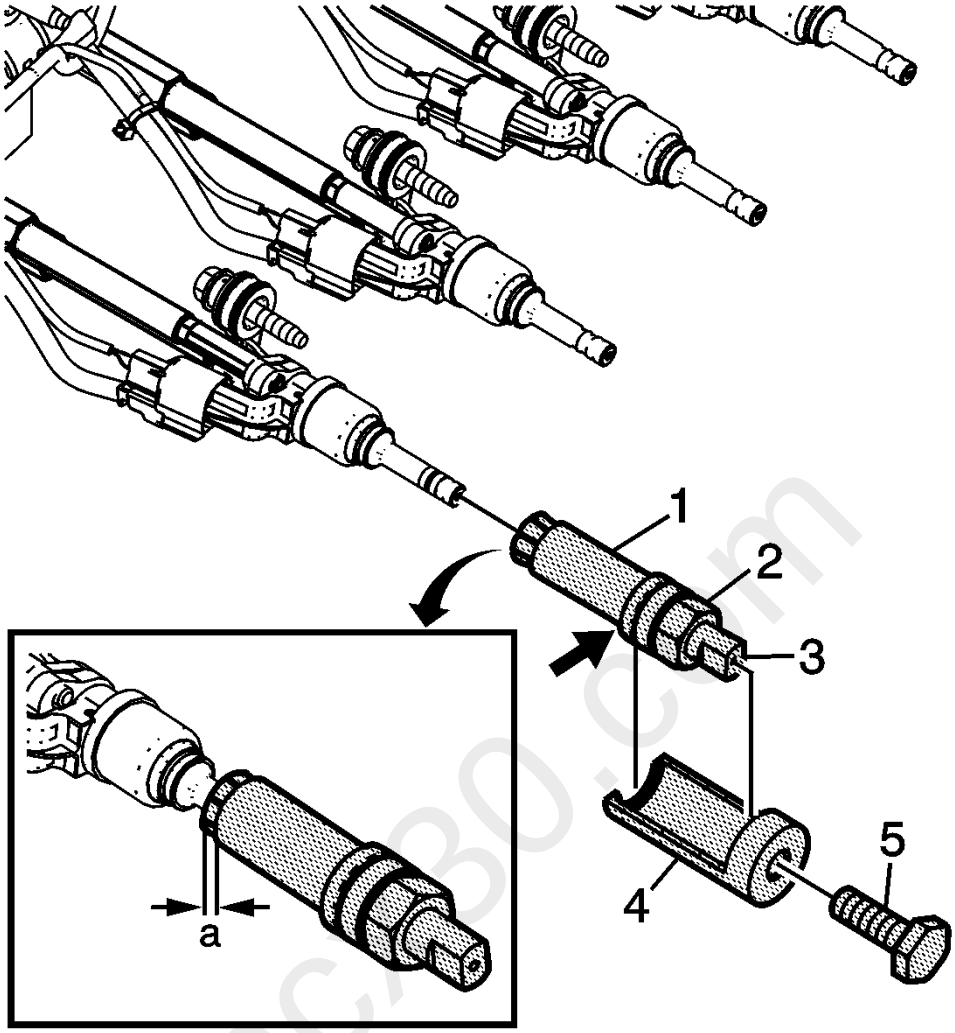


Fig. 494: Pre-Sizing Tool
Courtesy of GENERAL MOTORS COMPANY

7. Push the **EN-51146-2-4** pre-sizing tool (1) over the fuel injector tip.
8. Tighten the nut (2) and counterhold at the spanner flat (3) of the **EN-51146-2-4** pre-sizing tool (1) until the measure (a) of 4.5 mm (0.177 in) is reached.
9. Loosen the nut (2) of the **EN-51146-2-4** pre-sizing tool.
10. Install the **EN-51146-2-4-7** take off chassis (4) to the **EN-51146-2-4** pre-sizing tool (1).
11. Install the **EN-51146-2-4-6** screw M10 (5) to the **EN-51146-2-4-7** take off chassis (4) and tighten until the **EN-51146-2-4** pre-sizing tool (1) is loosened.

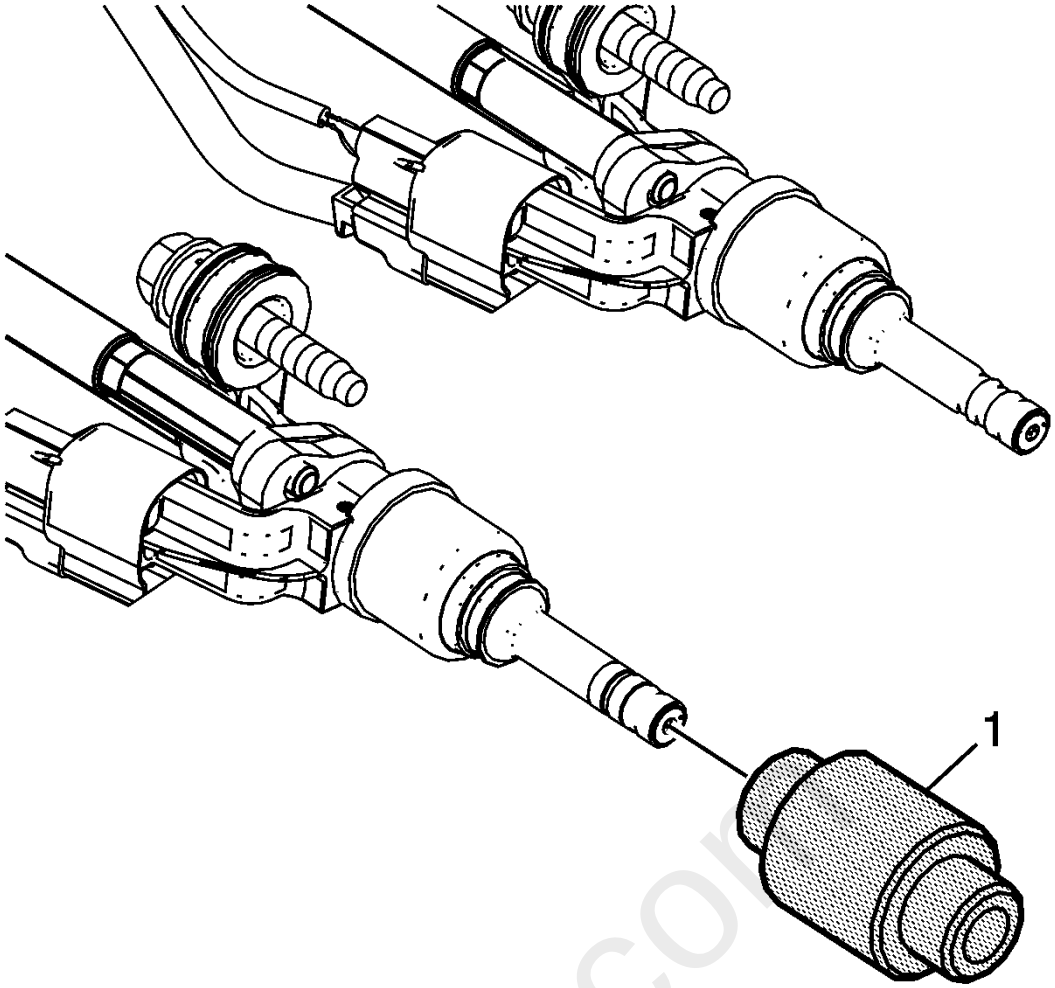


Fig. 495: Sizer
Courtesy of GENERAL MOTORS COMPANY

12. Install the **EN-49245-4** sizer (1) in a rotary motion to the fuel injector tip in order to complete the combustion seal final sizing.

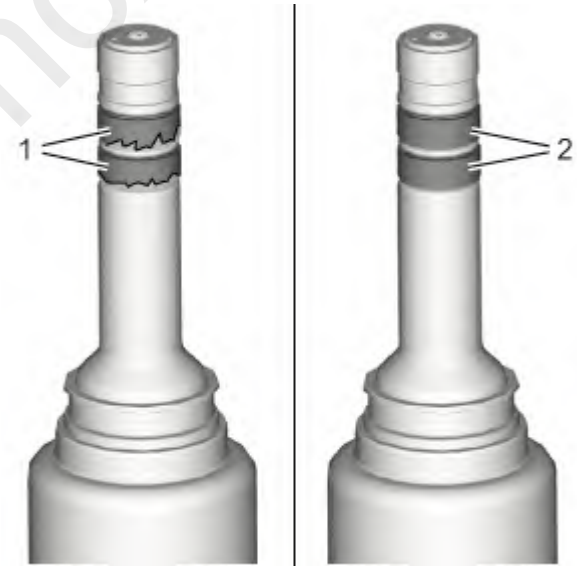


Fig. 496: Installing Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The fuel injector seals must fit properly in the relative groove. Overlapping of the fuel injector seals with the external surface of the injector must be avoided.**

13. Check both of the fuel injector combustion seals on each fuel injector for correct seat:

- The seal must not be too large, buckled, or corrugated (1)
- The seal must be fixed tight and accurate (2)

14. If the seals are not installed correctly, remove the incorrect seal and replace with a NEW seal.

Fuel Rail Assembly Installation Procedure

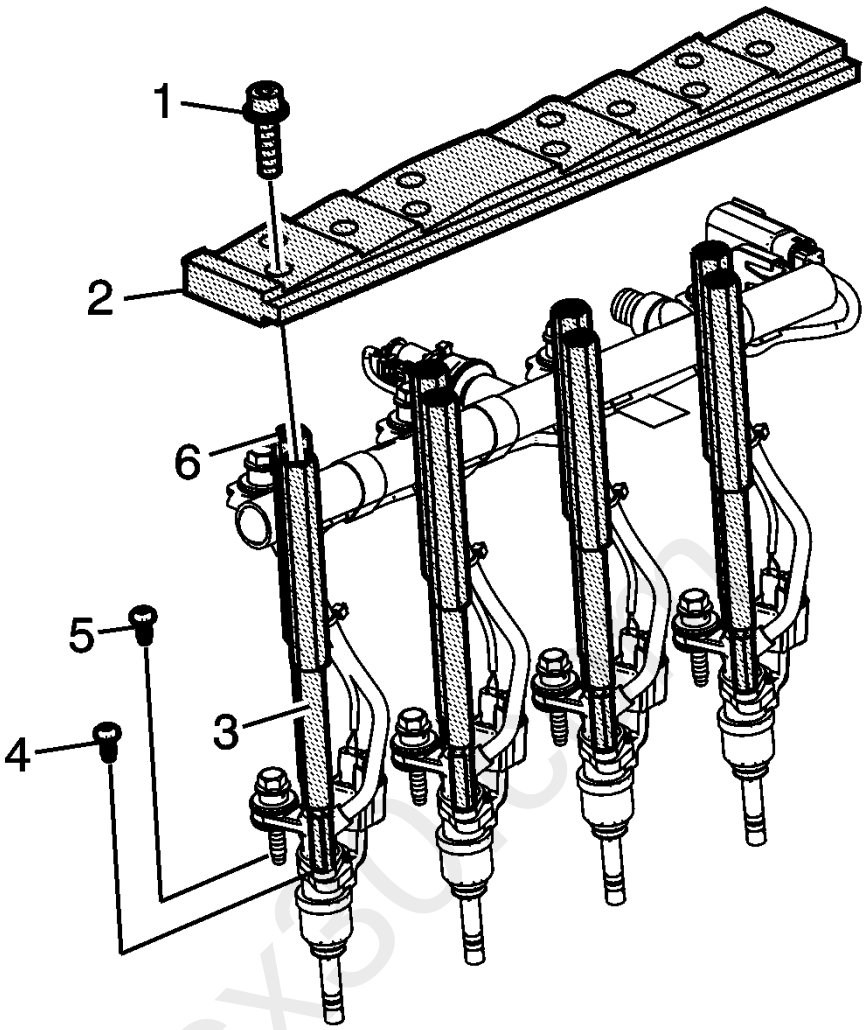


Fig. 497: Plate And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. If any components of **EN-51146** remover are installed to the fuel rail, perform the following procedure:

NOTE: **If the plate is not installed on the supports, it is likely one or more fuel injectors have been replaced. Disregard the following steps for fuel injectors that have already been replaced.**

1. Remove the bolts (1) and **EN-51146-100** plate (2).
2. Clean the fuel injector screws of any residual threadlock agent.
3. Remove only the front **EN-51146-1-6** demounting screw and **EN-51146-1-1** support (3) for the first fuel injector.
4. Apply one drop of threadlock agent onto the screw (4). Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

CAUTION: **Refer to Fastener Caution .**

5. Install the fuel injector screw (4) and tighten to 5 N.m (44 lb in).
6. Remove the rear **EN-51146-1-6** demounting screw and **EN-51146-1-1** support (6) for the first fuel injector.

7. Apply one drop of threadlock agent onto the screw (5). Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
8. Install the fuel injector screw (5) and tighten to 5 N.m (44 lb in).
9. Repeat the same procedure for the remaining fuel injectors with **EN-51146-1-6** demounting screw and **EN-51146-1-1** supports still attached.
10. Connect the fuel injector wiring harness plugs, if necessary.

2. Ensure the fuel rail assembly and fuel injector bores have been cleaned prior to installation.

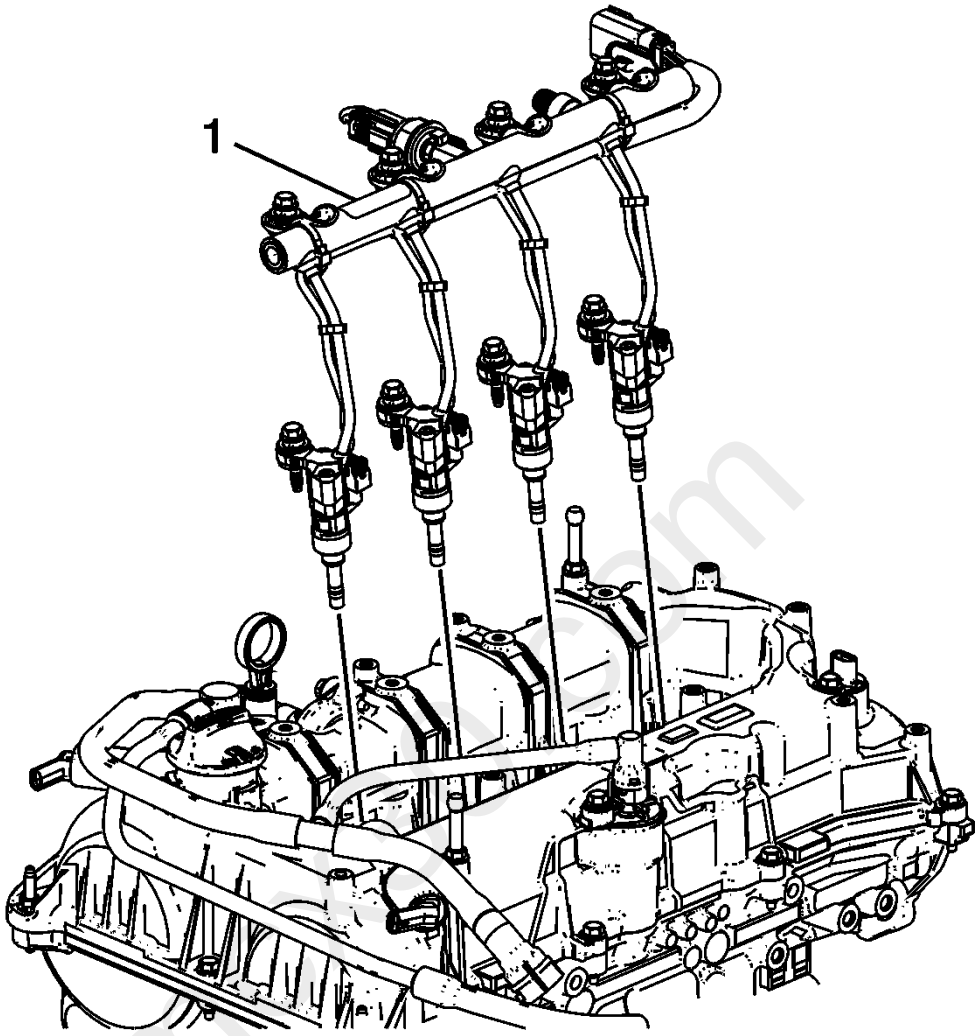


Fig. 498: Fuel Rail Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: **During the installation of the fuel rail and injector assembly, ensure that the fuel injectors are positioned straight into the injector opening. Failure to follow this caution can tilt or bend the injectors and could cause leaks or malfunction after installation.**

3. Carefully install the fuel rail assembly (1).
4. Push the fuel injectors slightly in their seats.

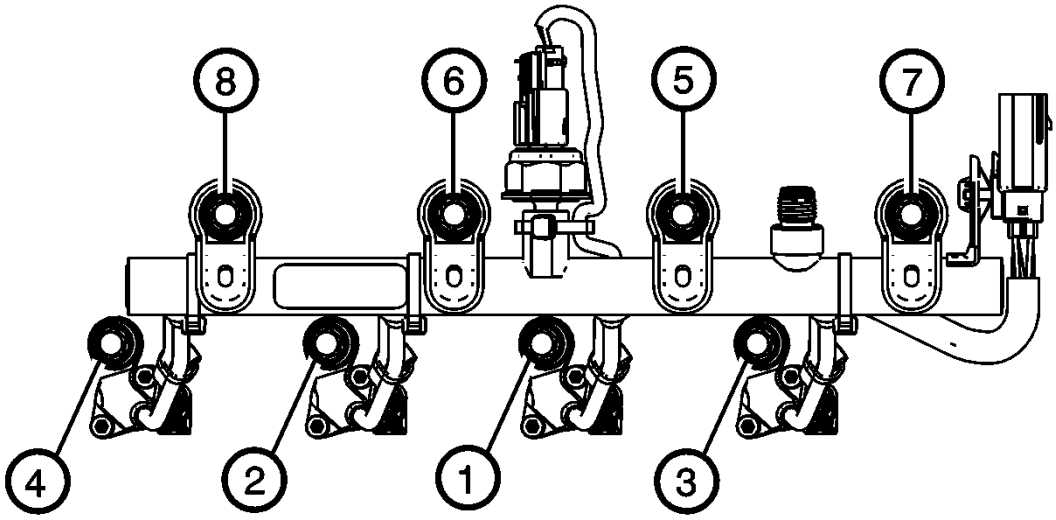


Fig. 499: Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

5. Tighten the 4 lower fuel rail bolts in increments of 1 turn until they are seated.
6. Tighten the 4 lower fuel rail bolts in sequence to 10 N.m (89 lb in).
7. Tighten the 4 upper fuel rail bolts in sequence to 10 N.m (89 lb in).

IGNITION COIL INSTALLATION

mcx30.com

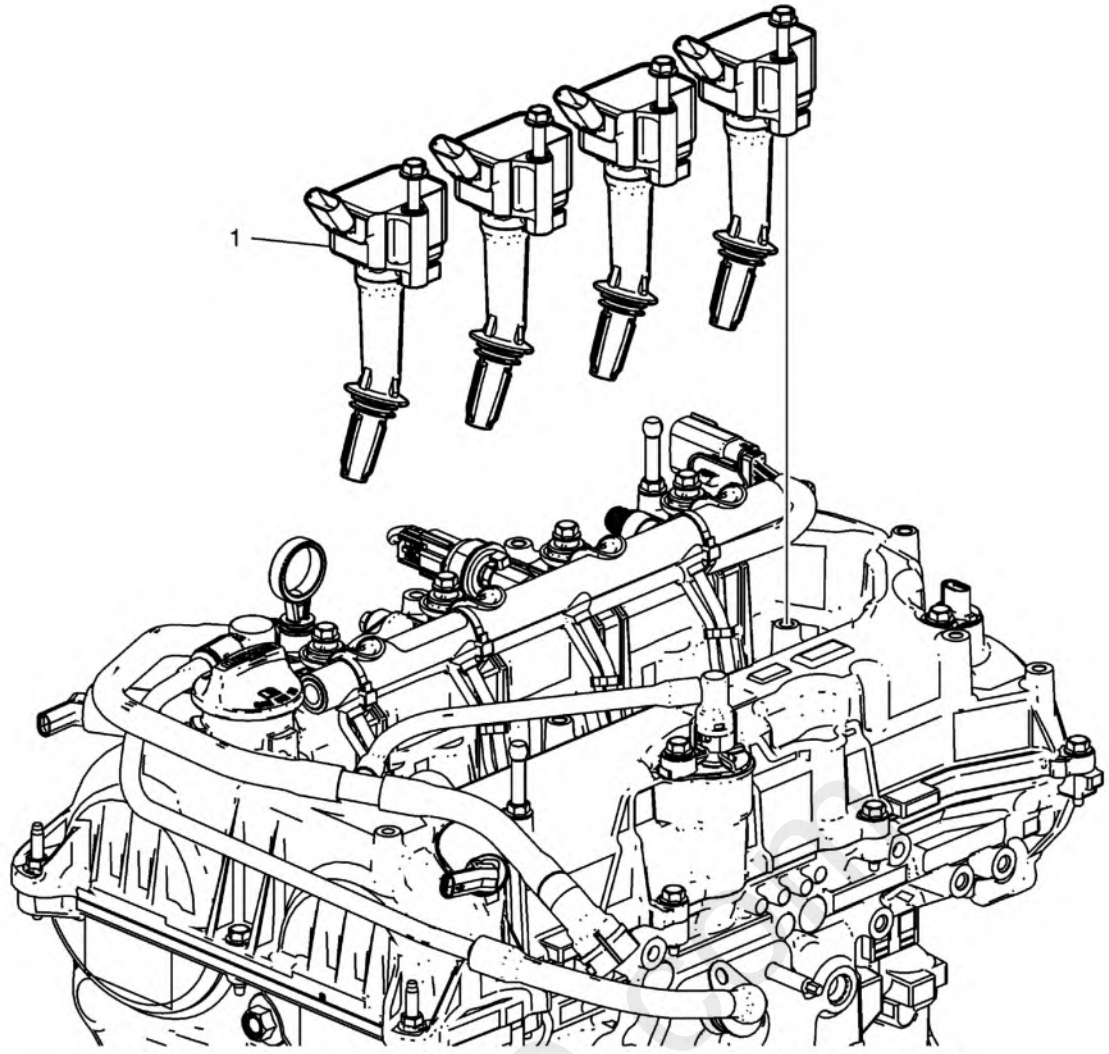


Fig. 500: Ignition Coil
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Inspect the inside of the ignition coil rubber boot for a thin, even coat of grease. 2. If there is no grease present or additional grease is necessary, apply a thin coating of dielectric grease evenly to the inside of the ignition coil rubber boot, up to a depth of 15 mm from the end of the boot. Refer to **Adhesives, Fluids, Lubricants, and Sealers**. 3. Remove any excess grease from around the end of the boot, and ensure there is not an excessive amount within the boot.	
1	Ignition Coil Assembly (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)

VACUUM PUMP INSTALLATION

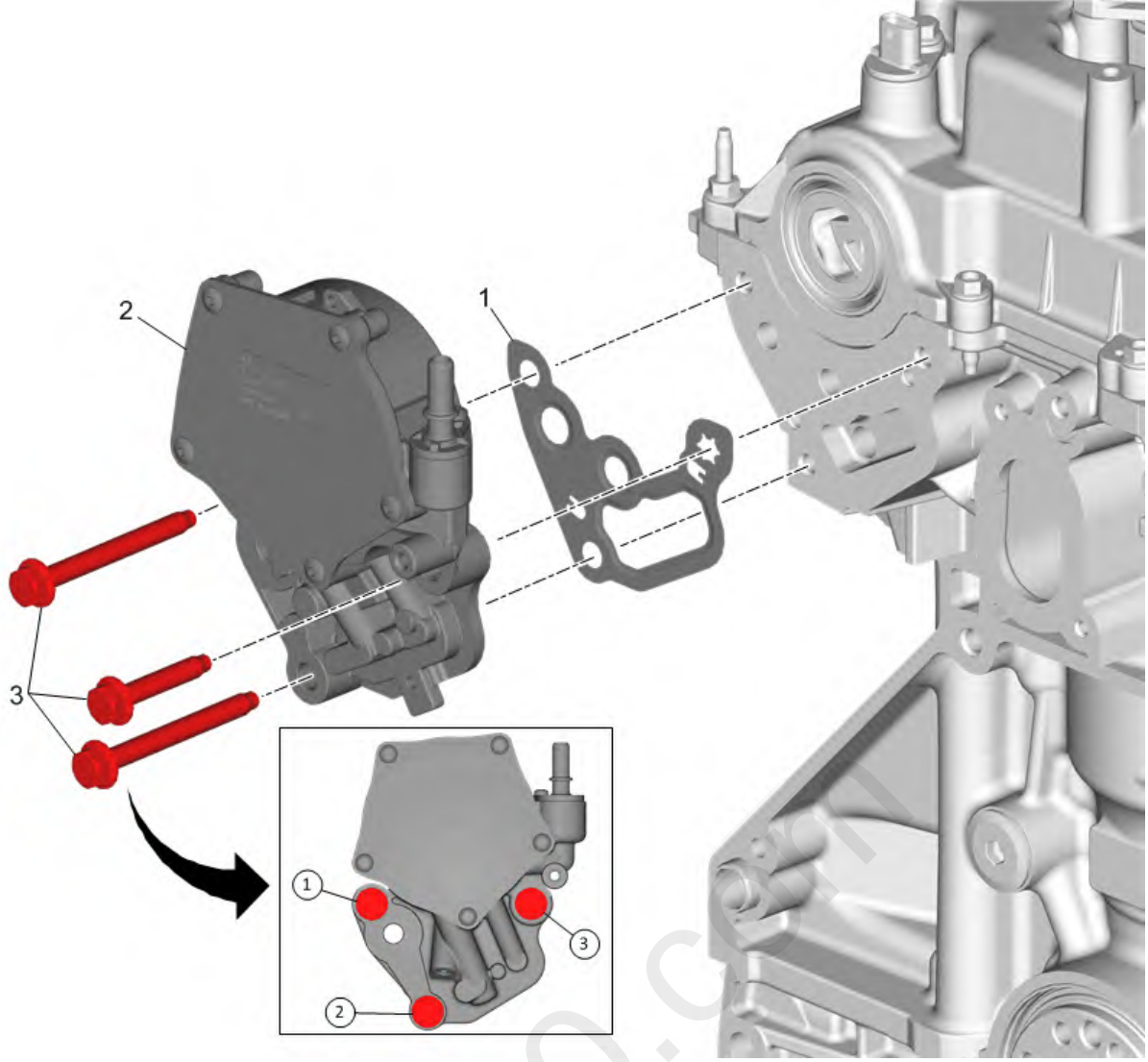


Fig. 501: Vacuum Pump (With Bolt Tightening Sequence)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Ensure all passages of the vacuum pump are clean and free of debris prior to installation.	
1	Vacuum Pump Gasket **NOTE:** **Use a NEW gasket. Ensure the mating surfaces are clean and free of debris.**
2	Vacuum Pump Assembly **NOTE:** • **Ensure the 2 locating pins are present and aligned to the cylinder head during installation.** • **Ensure the vacuum pump drive is aligned with the end of the camshaft. The pump should sit flush to the cylinder head before installing the bolts.**

Callout	Component Name
3	Vacuum Pump Assembly Bolt (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Procedure** Tighten the vacuum pump bolts in the sequence shown. 1. Tighten the vacuum pump bolts a first pass to 15 N.m (11 lb ft). 2. Tighten the vacuum pump bolts a final pass to 25 N.m (18 lb ft).

WATER OUTLET INSTALLATION

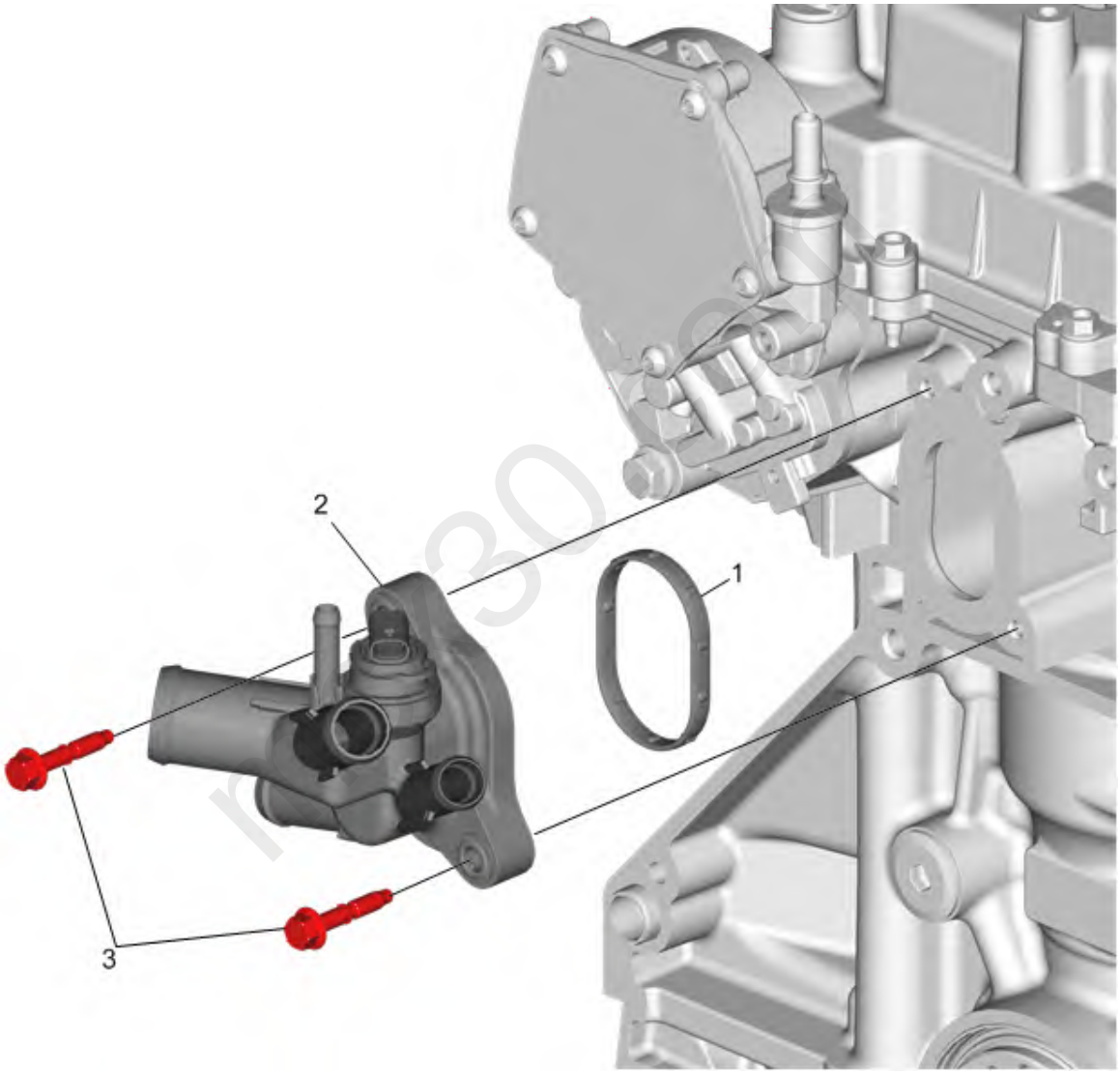


Fig. 502: Water Outlet Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Water Outlet Gasket **NOTE:** **Use a NEW gasket. Ensure the mating surfaces are clean and free of debris.**
2	Water Outlet Assembly

Callout	Component Name
3	Water Outlet Assembly Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)

ENGINE LIFT AND SIGHT SHIELD BRACKET INSTALLATION

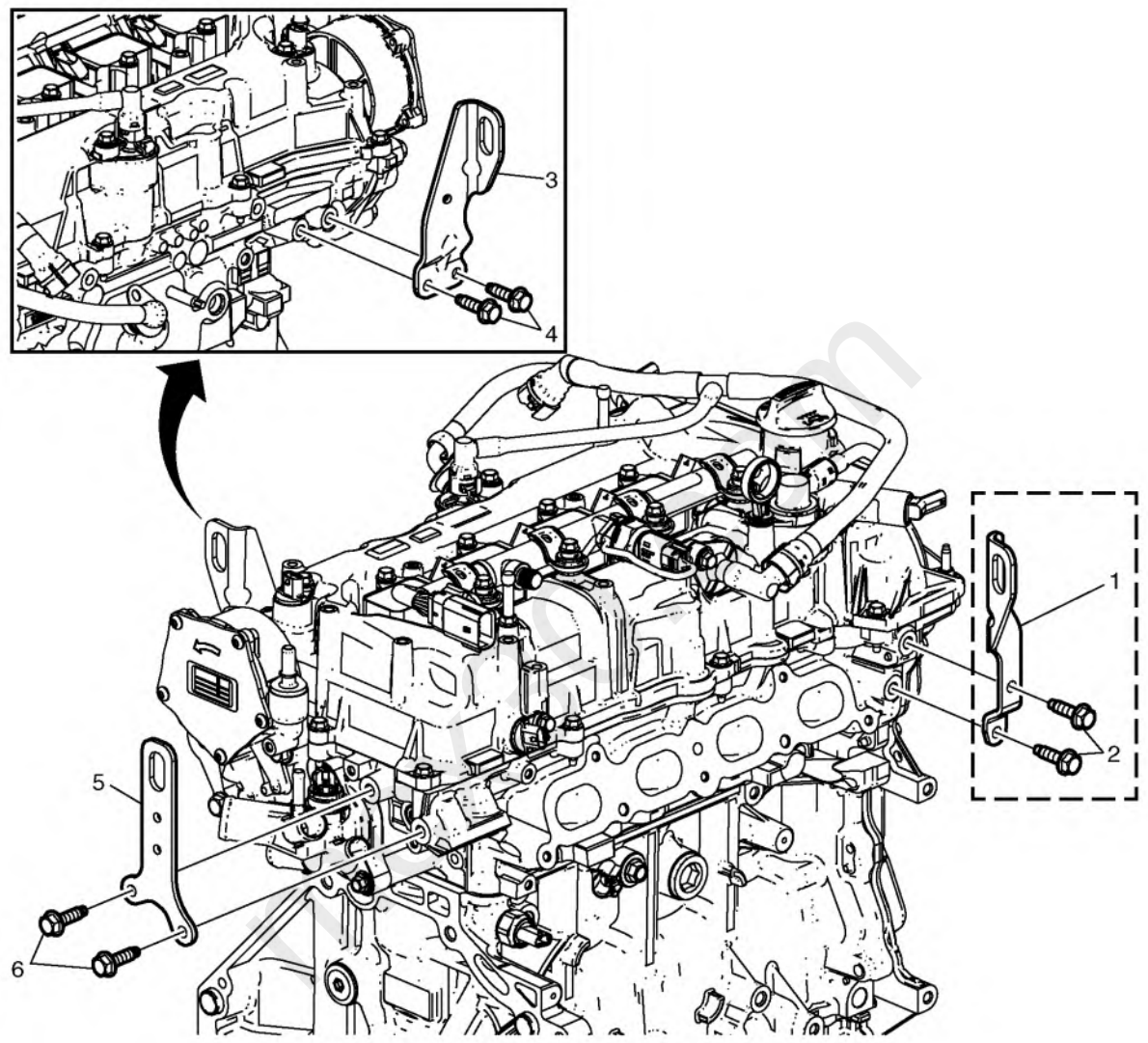


Fig. 503: Engine Lift and Sight Shield Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Lift Front Bracket - Model Dependent
2	Engine Lift Front Bracket Bolt [2x] - Model Dependent **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)
3	Engine Lift Rear Bracket
4	Engine Lift Rear Bracket Bolt [2x] **Tighten** 25 N.m (18 lb ft)

Callout	Component Name
5	Engine Lift Rear Bracket
6	Engine Lift Rear Bracket Bolt [2x] **Tighten** 25 N.m (18 lb ft)

FUEL PUMP INSTALLATION

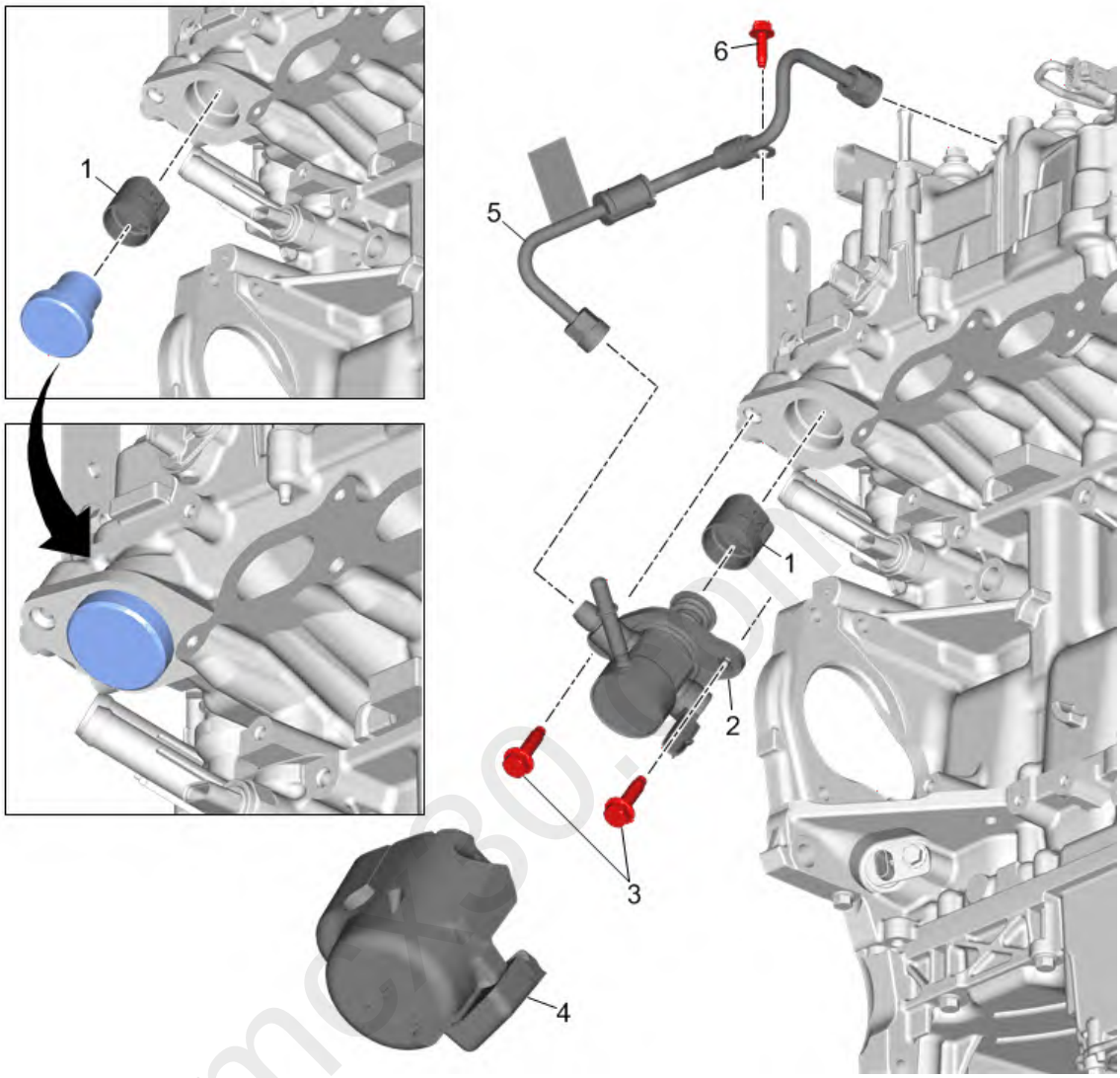


Fig. 504: Fuel Pump
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

Callout	Component Name
1	Valve Lifter Follower **NOTE:** **The camshaft must be in the base circle position before the high pressure fuel pump is installed.** **Procedure** 1. Lubricate the valve lifter follower with engine oil, refer to **Adhesives, Fluids, Lubricants, and Sealers**. **NOTE:** **At the base circle position, the EN-51365 alignment gauge will sit flush with the cylinder head.** 2. Install the valve lifter follower. Ensure that the guide pin on the follower is aligned with the groove in the fuel pump bore. Install **EN-51365** alignment gauge and rotate the camshaft until the special tool is flush with the cylinder head. This indicates the camshaft lobe is at base circle position. 3. Remove **EN-51365** alignment gauge and the valve lifter follower. 4. Lubricate the valve lifter follower again with engine oil. 5. Install the valve lifter follower. Ensure that the guide pin on the follower is aligned with the groove in the fuel pump bore. **Special Tools** **EN-51365** Fuel Pump Installation Gauge For equivalent regional tools, refer to **Special Tools**.
2	Fuel Pump **NOTE:** **If the fuel pump is not new, replace the fuel pump O-ring seal. Lubricate the O-ring with one drop of clean engine oil.**
3	Fuel Pump Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **CAUTION:** **Refer to Torque-to-Yield 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.** **Procedure** Install NEW fuel injection pump bolts alternating in steps of one turn each until seated to specified torque. **Tighten** 25 N.m (18 lb ft)

mc730.com

Callout	Component Name
4	Fuel Pump Insulator **WARNING:** **The noise cancelling foam component MUST be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.**
5	Fuel Feed Intermediate Pipe **NOTE:** **Use a NEW pipe.** **Procedure** **NOTE:** **Do not remove shipping caps from the fuel rail fitting or fuel pump fitting until installation of pipe. Do not remove the fuel pump inlet shipping cap at any time.** 1. Remove any fuel pipe shipping caps, if applicable. 2. Finger start the fuel pipe nuts to pump and fuel rail. 3. Finger start the fuel feed intermediate pipe assembly bolt through the pipe bracket. 4. Snug the fuel pipe nut at the pump by hand, 5 full turns minimum. 5. Snug the fuel pipe nut at the fuel rail by hand, 5 full turns minimum. **NOTE:** **Tightening the bracket bolt prior to final torque for the pipe nuts helps to align the fuel feed pipe.** 6. Tighten the fuel feed intermediate pipe assembly bracket bolt to 10 N.m (22 lb ft). 7. Torque the pipe nut to fuel rail to specification. 8. Torque the pipe nut to pump to specification. **Tighten** 30 N.m (22 lb ft)
6	Fuel Feed Intermediate Pipe Bolt (Qty: 1) **Tighten** 10 N.m (89 lb in)

INTAKE MANIFOLD INSTALLATION

mcx30.com

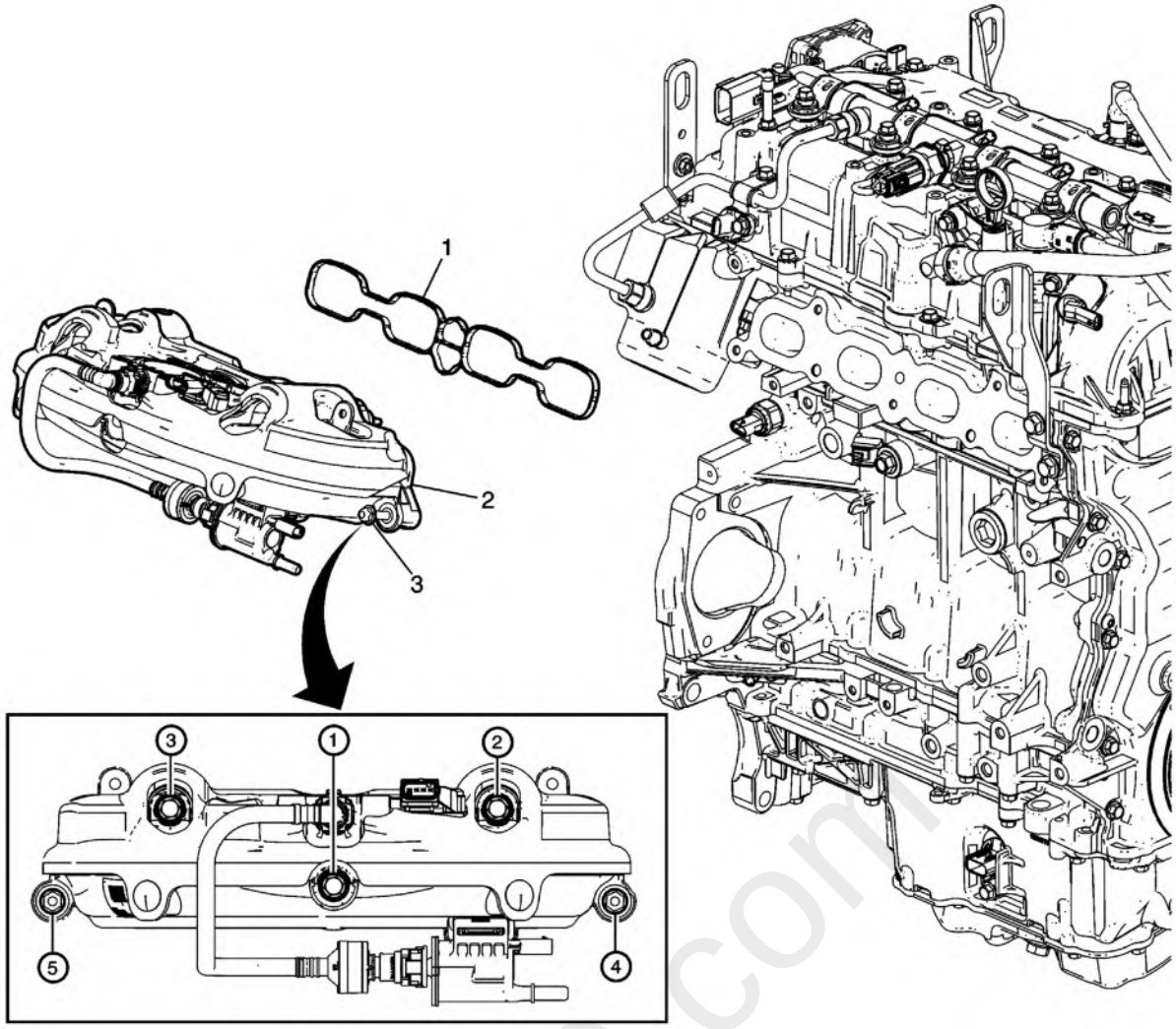


Fig. 505: Intake Manifold With Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Intake Manifold Gasket **NOTE:** **Use a NEW gasket. Ensure the mating surfaces are clean and free of debris.**
2	Intake Manifold Assembly
3	Intake Manifold Assembly Bolt (Qty: 5) **CAUTION:** **Refer to Fastener Caution .** **NOTE:** **Bolt retainers keep the bolts in position on the assembly.** **Procedure** Tighten the bolts in sequence. **Tighten** 12 N.m (106 lb in)

THROTTLE BODY ASSEMBLY INSTALLATION

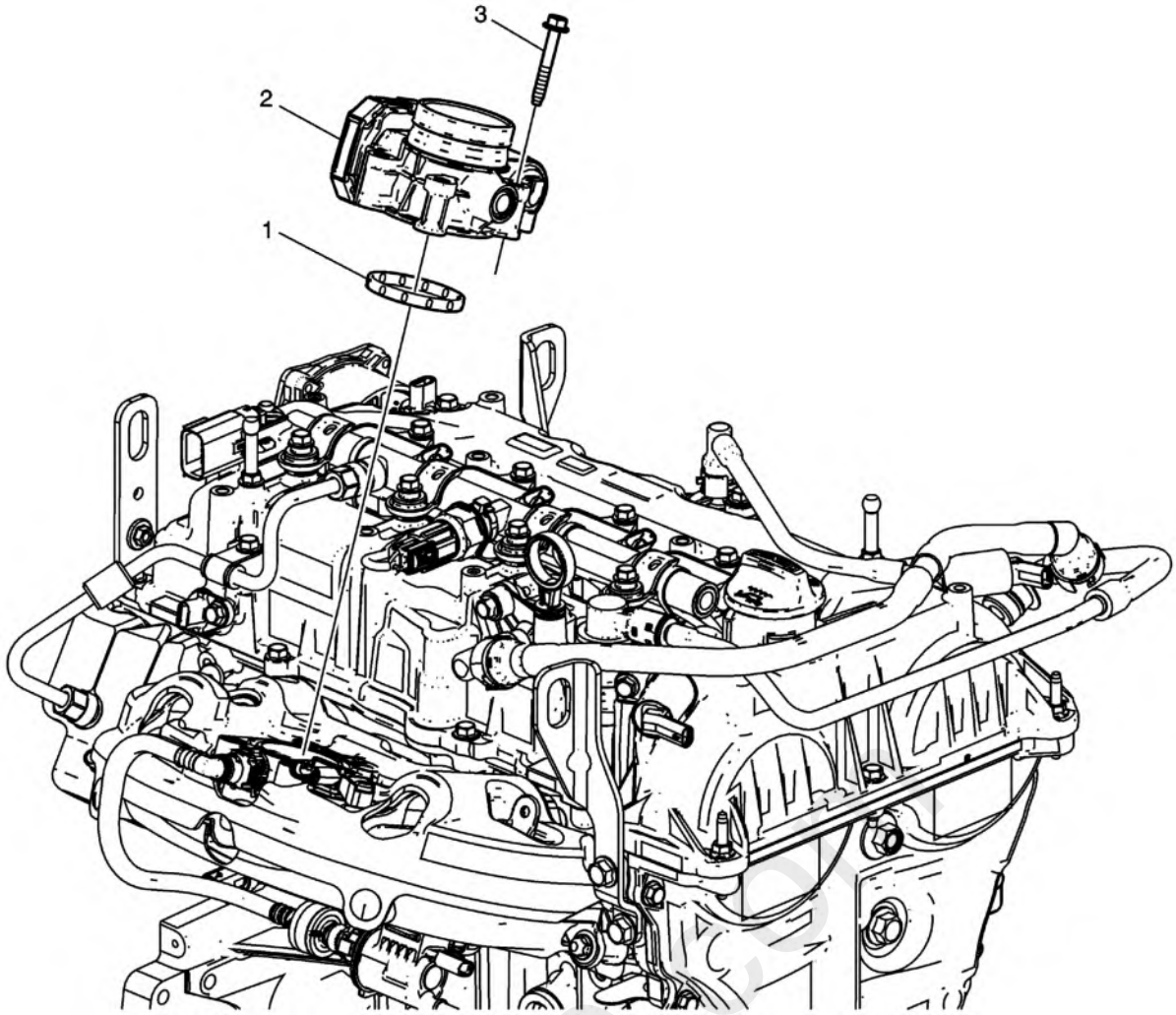


Fig. 506: Throttle Body
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Throttle Body Gasket **NOTE:** **Use a NEW gasket. Ensure the mating surfaces are clean and free of debris.**
2	Throttle Body Assembly
3	Throttle Body Assembly Bolt (Qty: 4) **NOTE:** **Tighten the 4 bolts in a criss-cross pattern.** **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)

WATER PUMP INSTALLATION

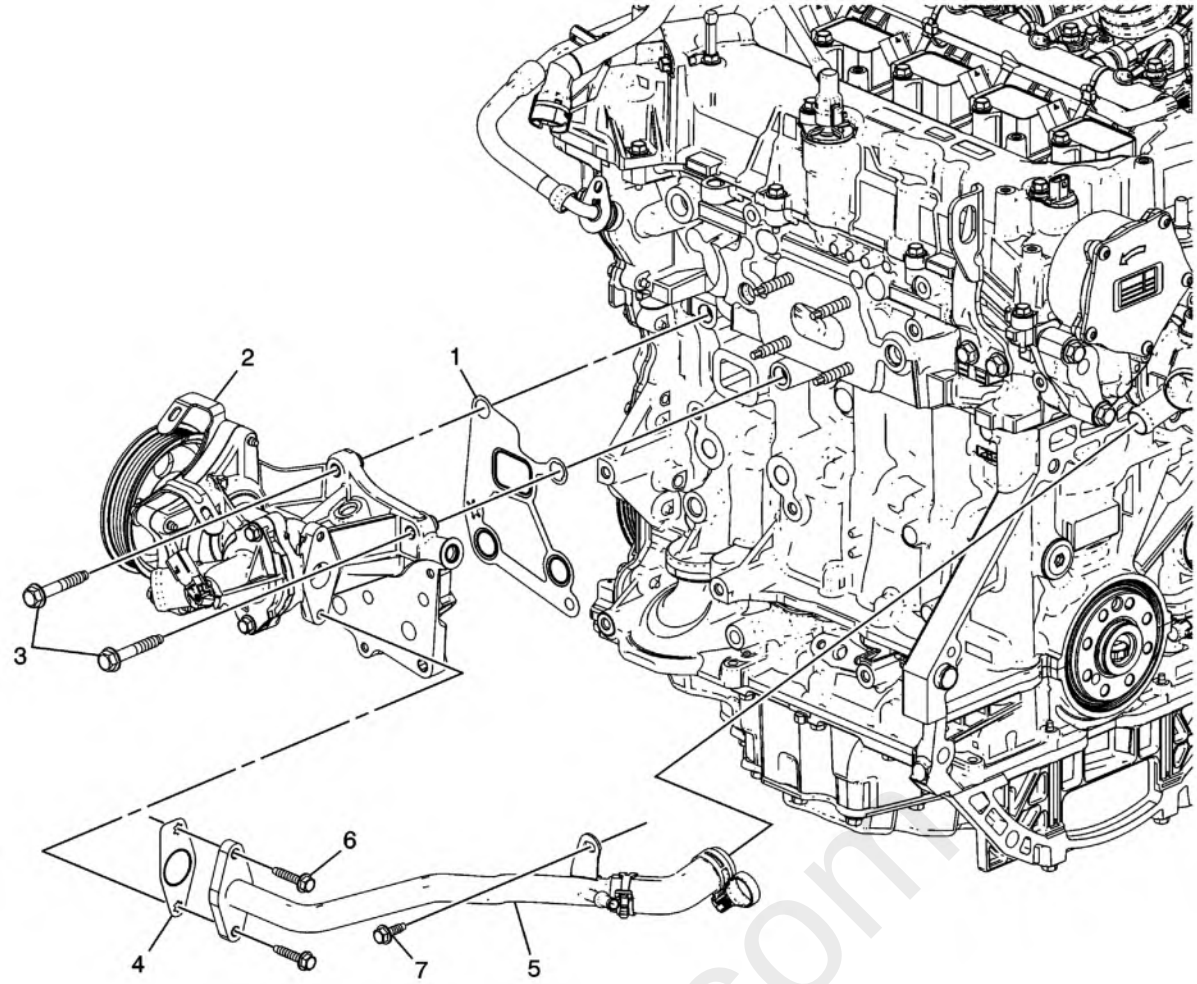


Fig. 507: Water Pump
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Water Pump Housing Gasket **NOTE:** **Use a NEW gasket. Ensure the mating surfaces are clean and free of debris.**
2	Water Pump
3	Water Pump Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)
4	Thermostat Bypass Pipe Gasket
5	Thermostat Bypass Pipe Assembly
6	Thermostat Bypass Pipe Bolt (Qty: 2) **Tighten** 10 N.m (89 lb in)
7	Thermostat Bypass Pipe Bolt (Qty: 1) **Tighten** 10 N.m (89 lb in)

ENGINE OIL COOLER INSTALLATION

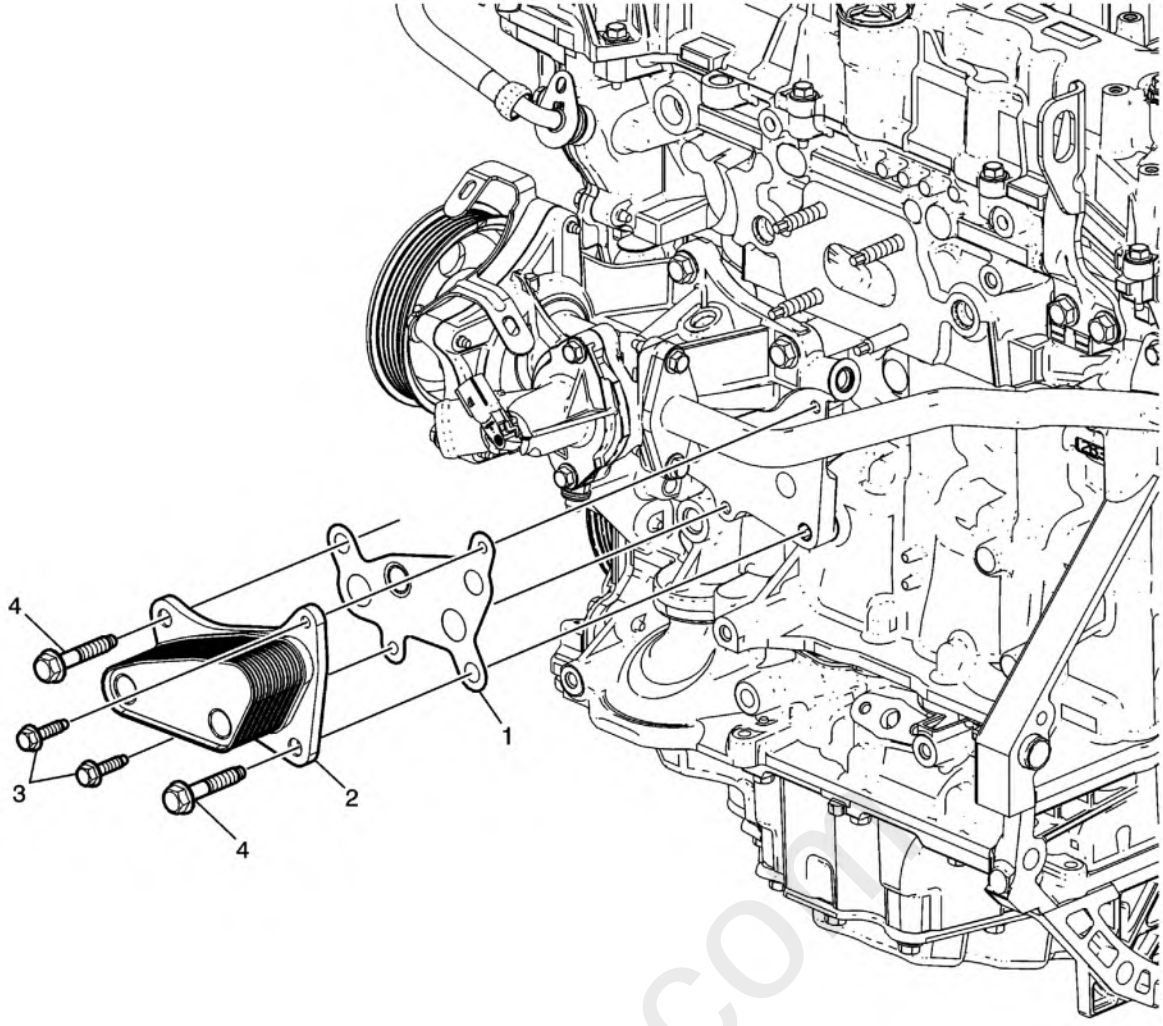


Fig. 508: Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Oil Cooler Gasket **NOTE:** **Use a NEW gasket. Ensure the mating surfaces are clean and free of debris.**
2	Engine Oil Cooler Assembly
3	Engine Oil Cooler Assembly Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
4	Engine Oil Cooler Assembly Bolt (Qty: 2) **Tighten** 25 N.m (18 lb ft)

TURBOCHARGER INSTALLATION

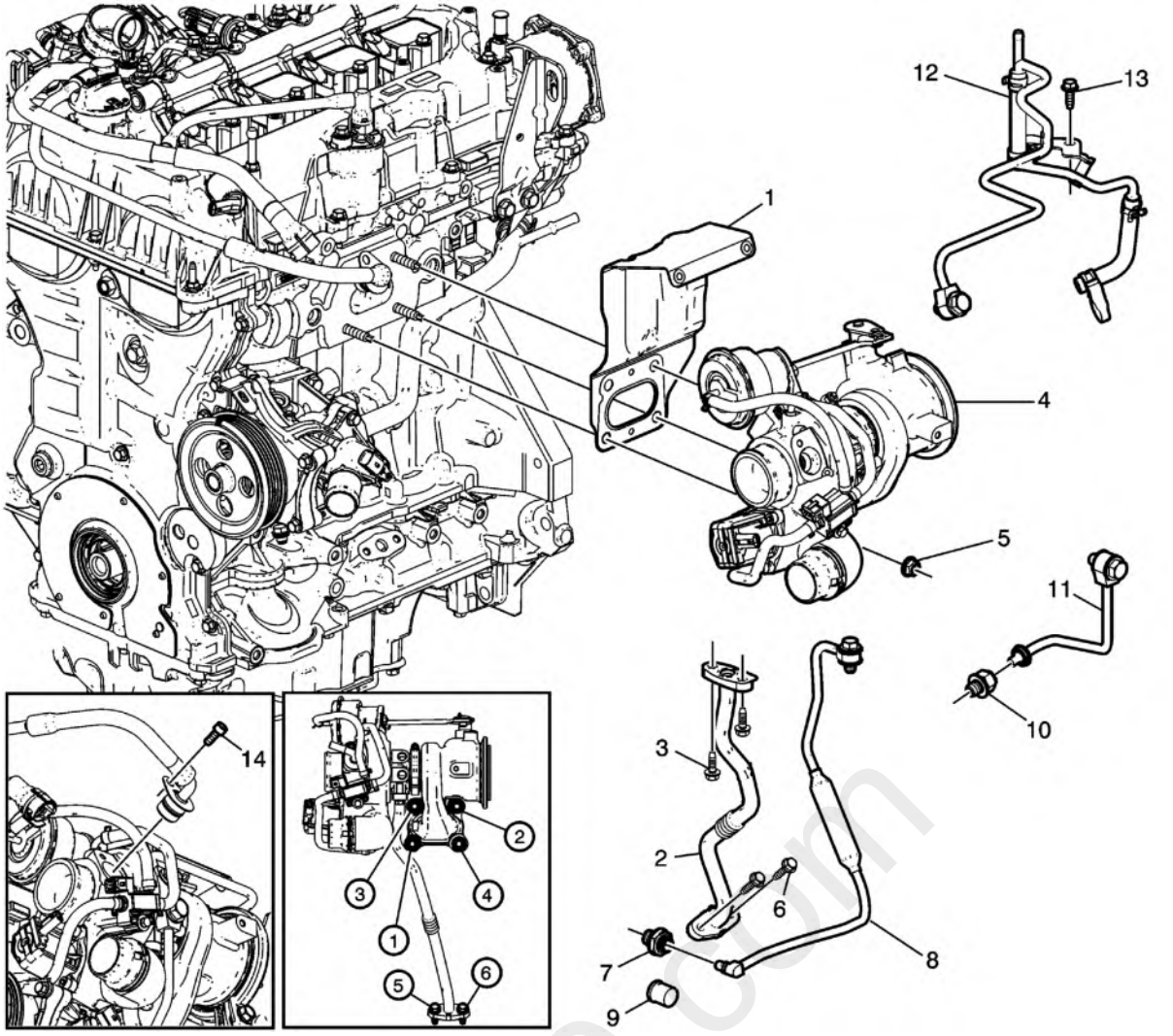


Fig. 509: Turbocharger
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Turbocharger Heat Shield **NOTE:** **Use a NEW heat shield with gasket.**
2	Turbocharger Oil Return Pipe **NOTE:** **Use NEW turbocharger oil return pipe gaskets on the oil return pipe.**
3	Turbocharger Oil Return Pipe Bolt - Flange to Turbocharger (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
4	Turbocharger

mcx30.com

Callout	Component Name
5	Turbocharger Nut (Qty: 4) **CAUTION:** **Refer to Torque-to-Yield Fastener Caution .** **Procedure** Tighten the NEW turbocharger nuts in sequence. 1. Tighten the nuts a first pass to 15 N.m (11 lb ft). 2. Tighten the nuts a second pass to 20 N.m (15 lb ft). 3. Using the **EN-45059** angle meter, tighten the bolt a final pass 60 Degrees. **Special Tools** **EN-45059** Angle Meter For equivalent regional tools, refer to **Special Tools**.
6	Turbocharger Oil Return Pipe Bolt - Flange to Block (Qty: 2) **Tighten** 10 N.m (89 lb in)
7	Turbocharger Pipe Fitting **NOTE:** **Use a NEW fitting and gasket.** **Tighten** 35 N.m (26 lb ft)

mcx30.com

Callout	Component Name
8	Turbocharger Oil Feed Pipe **CAUTION:** **When installing a quick-connect turbocharger oil feed pipe, ensure that the oil feed pipe is fully secured into the oil feed pipe fitting. An audible click will be heard when the oil feed pipe is seated. If the oil feed pipe is not fully seated, an oil leak can occur in certain RPM ranges and will cause significant component and/or vehicle damage. Due to the possibility of significant component and/or vehicle damage from an oil feed pipe leak, it is necessary to start the engine and inspect for signs of leakage around the connections after performing the repair.** **CAUTION:** **Ensure that the turbocharger oil feed pipe does not rotate while torquing it. There should be a minimum 10 mm gap between the oil feed pipe and the v-band clamp. Failure to perform this could result in damage to the oil feed pipe and create an oil leak.** **Procedure** **NOTE:** • **Use NEW turbocharger oil feed pipe gaskets on the bolt at the turbocharger connection.** • **A suitable tool can be used to ensure there is a 10 mm gap between the feed pipe and turbine housing while tightening the turbocharger oil feed pipe.** 1. Install the pipe with the bolt at the turbocharger. 2. Attached the bottom of the pipe to the turbocharger pipe fitting at the engine block. 3. Ensure that the oil feed pipe is fully secured into the turbocharger pipe fitting. An audible click will be heard when the oil feed pipe is seated. **Tighten** 32 N.m (24 lb ft)
9	Turbocharger Oil Feed Pipe Clip
10	Turbocharger Pipe Fitting **NOTE:** **Use a NEW fitting and gasket.** **Tighten** 35 N.m (26 lb ft)

mcx30.com

Callout	Component Name
11	Turbocharger Coolant Feed Pipe **Procedure:** 1. Attach the coolant feed pipe at the pipe fitting. 2. Ensure that the coolant feed pipe is fully secured into the turbocharger pipe fitting. An audible click will be heard when the coolant feed pipe is seated. **NOTE:** **Use NEW turbocharger coolant feed pipe gaskets on the bolt at the turbocharger connection.** 3. Rotate the coolant feed pipe upwards to attach the bolt at the turbocharger. **Tighten** 35 N.m (26 lb ft)
12	Turbocharger Coolant Return Pipe **Procedure** **NOTE:** **Use NEW turbocharger coolant return pipe gaskets on the bolt at the turbocharger connection.** 1. Set the coolant return pipe in place and hand tighten the bolt at the turbocharger. 2. Attach the hose to the thermal bypass pipe. 3. Attach the hose at the water outlet assembly. **Tighten** 35 N.m (26 lb ft)
13	Turbocharger Coolant Return Pipe Bracket Bolt **Tighten** 10 N.m (89 lb in)
14	Positive Crankcase Ventilation Hose Fitting Bolt **NOTE:** **The PCV hose and fitting assembly connection is permanent. Reinstall these components as an assembly unless new components are being used.** **Tighten** 10 N.m (89 lb in)

mcx30.com

AUTOMATIC TRANSMISSION FLEX PLATE INSTALLATION

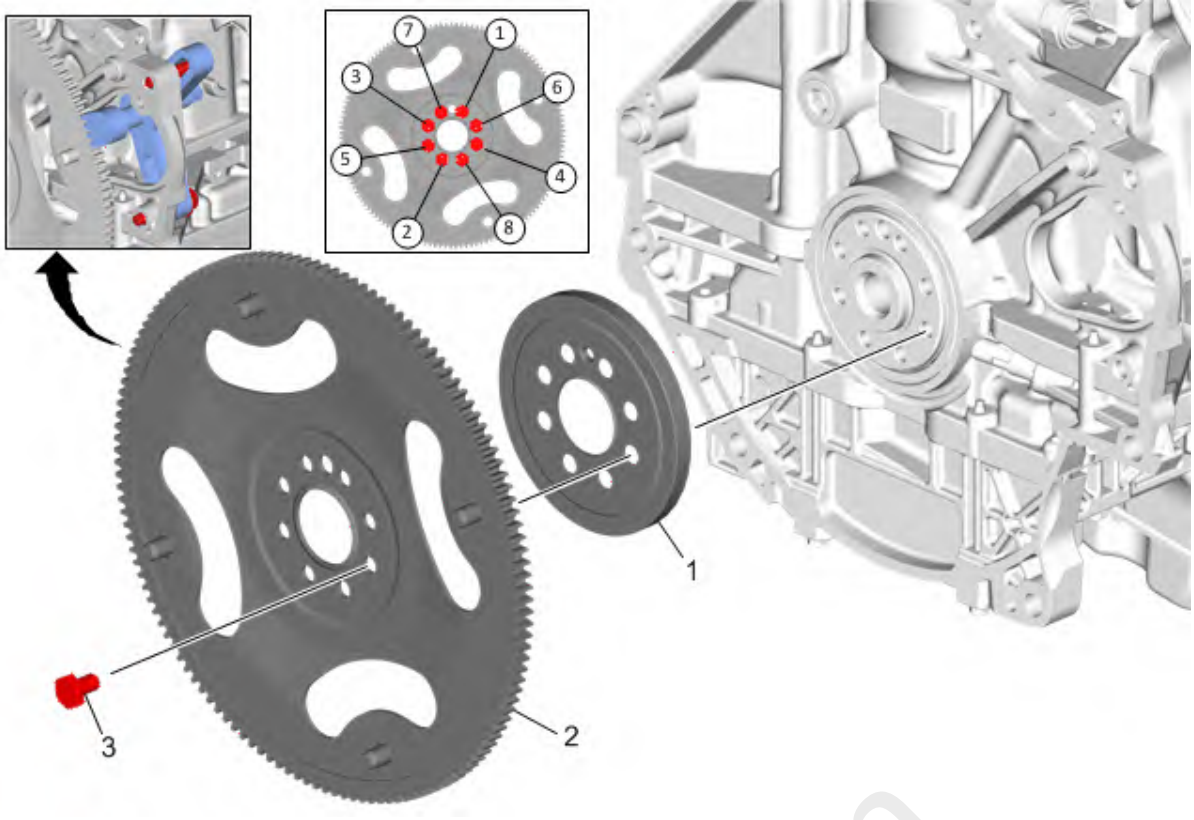


Fig. 510: Automatic Transmission Flex Plate With Bolt Tightening Sequence (North America)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Crankshaft Position Sensor Reluctor Ring **CAUTION:** **Refer to Crankshaft Position Sensor Reluctor Ring Caution .**
2	Automatic Transmission Flex Plate **Procedure** 1. Install the flex plate, and install the flex plate bolts hand tight to hold in place. 2. Install **EN-51760** holder to lock the flywheel via the starter ring gear. **Special Tools** **EN-51760** Flywheel Holder For equivalent regional tools, refer to Special Tools.

mcx30.com

Callout	Component Name
3	Automatic Transmission Flex Plate Bolt (Qty: 8) **CAUTION:** **Refer to Fastener Caution .** **CAUTION:** **Refer to Torque-to-Yield Fastener Caution .** **NOTE:** **Bolts have adhesive patch and must be tightened to final torque within 5 minutes.** **Procedure** Tighten the NEW flex plate bolts in the sequence shown. 1. Tighten the bolts a first pass to 20 N.m (15 lb ft). 2. Tighten the bolts a second pass to 30 N.m (22 lb ft). 3. Using the **EN-45059** angle meter, tighten the bolt a final pass 70 degrees. 4. Remove **EN-51760** holder once final torque is achieved. **Special Tools** **EN-45059** Angle Meter For equivalent regional tools, refer to Special Tools.

CRANKSHAFT BALANCER INSTALLATION

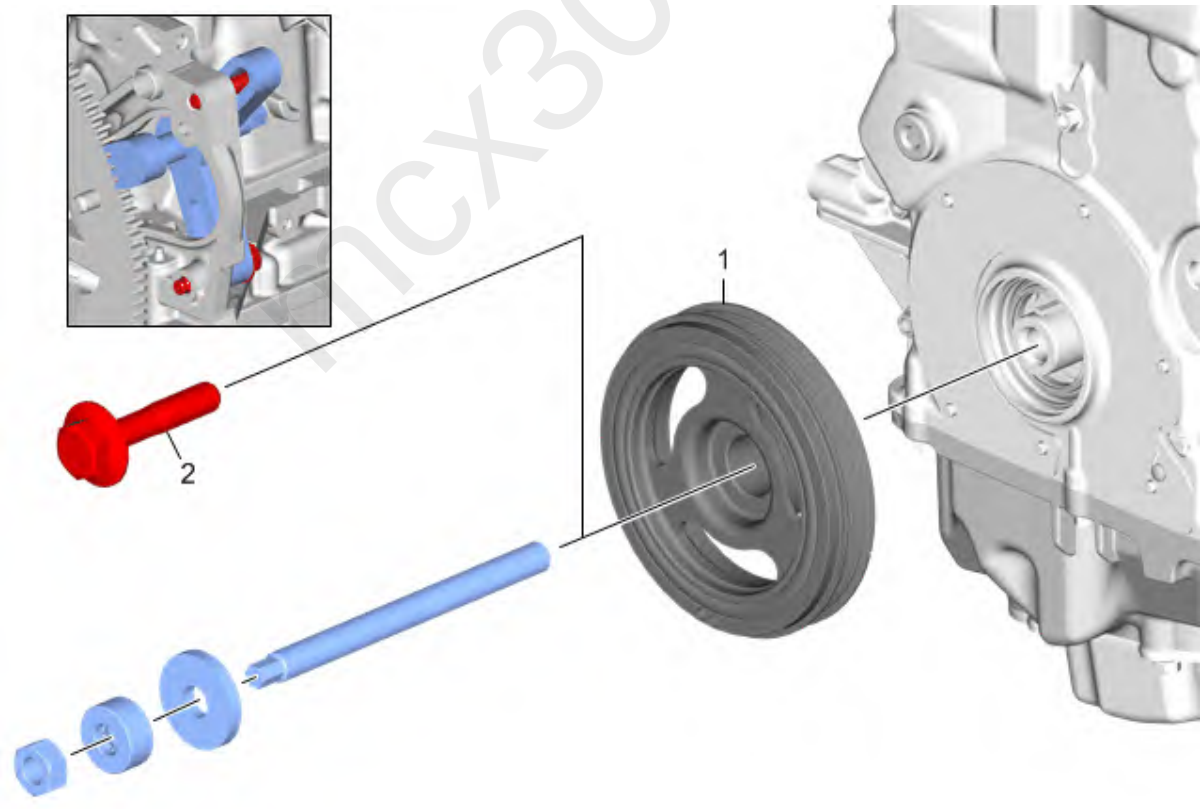


Fig. 511: Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

mcx30.com

Callout	Component Name
Preliminary Procedure Install the **EN-51760** holder, lock the automatic transmission flex plate via the starter ring gear. **Special Tools** **EN-51760** Flywheel Holder For equivalent regional tools, refer to **Special Tools**.	
1	Crankshaft Balancer **Procedure** Using the screw, washer, bearing, and nut from the **EN-51368** installer, seat the crankshaft balancer. **Special Tools** **EN-51368** Front Crankshaft Seal Installer For equivalent regional tools, refer to **Special Tools**.
2	Crankshaft Balancer Bolt **CAUTION:** **Refer to Fastener Caution .** **CAUTION:** **Refer to Torque-to-Yield Fastener Caution .** **Procedure** Tighten the NEW crankshaft balancer bolt in the sequence shown. 1. Tighten the bolt a first pass to 100 N.m (74 lb ft). 2. Loosen the bolt 360 degrees. 3. Tighten the bolt a second pass to 100 N.m (74 lb ft). 4. Tighten the bolt a final pass 180 degrees using **EN-45059** angle meter. 5. Remove **EN-51760** holder once final torque is achieved. **Special Tools** **EN-45059** Angle Meter For equivalent regional tools, refer to **Special Tools**.

OIL FILTER INSTALLATION

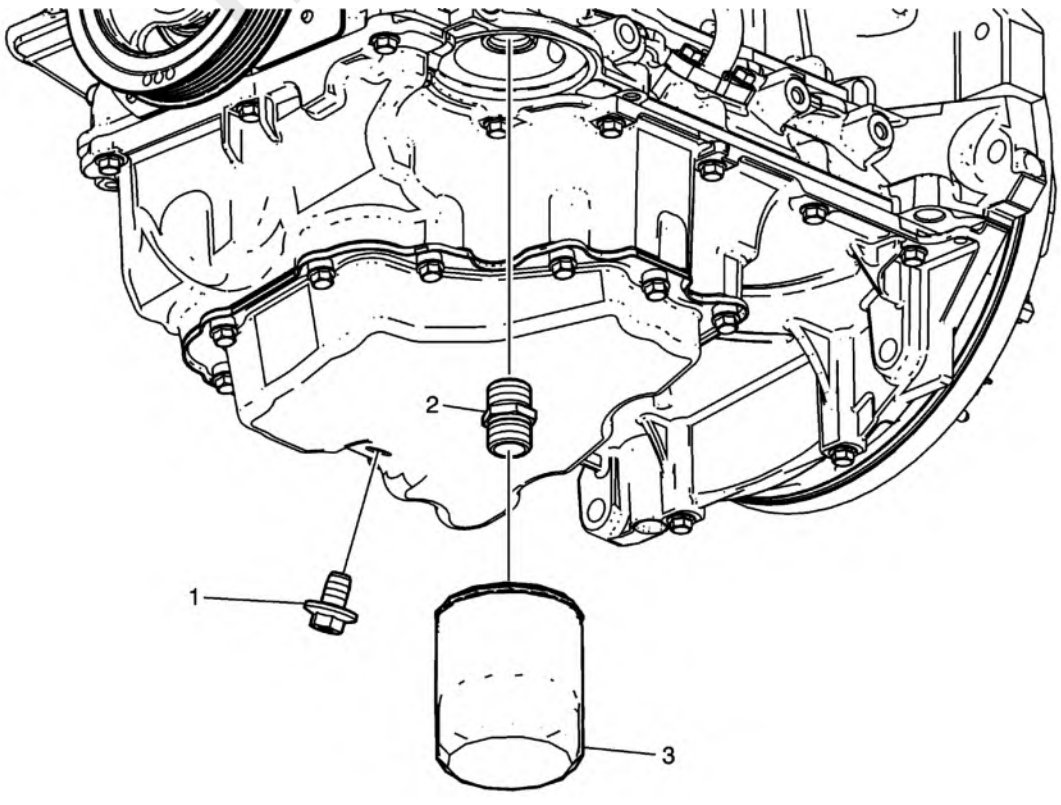


Fig. 512: Oil Filter, Fitting Adapter And Drain Plug
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Pan Drain Plug **CAUTION:** **Refer to Component Fastener Tightening Caution .** **NOTE:** **Use a NEW gasket.** **Tighten** 25 N.m (18 lb ft)
2	Oil Filter Fitting **Tighten** 55 N.m (41 lb ft)
3	Oil Filter **Tighten** 3/4 to 1 full turn after gasket makes contact with the sealing surface on the filter mounting flange. **Special Tools** **EN-726-A** Oil Filter Wrench For equivalent regional tools, refer to Special Tools.

ENGINE PRELUBING

Special Tools

EN-45299 Engine Preluber

For equivalent regional tools, refer to Special Tools.

mcx30.com

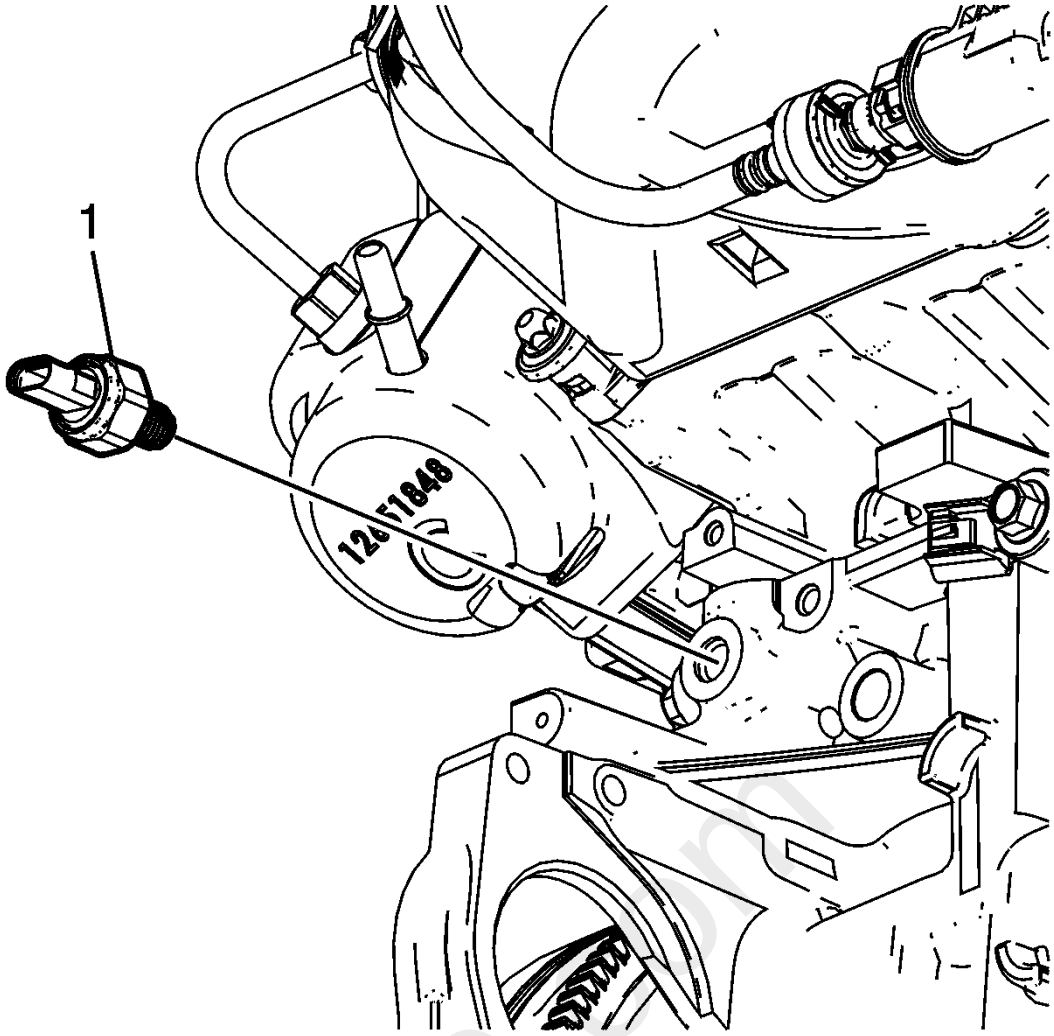


Fig. 513: Oil Pressure Switch
Courtesy of GENERAL MOTORS COMPANY

NOTE: **A constant and continuous flow of clean engine oil is required in order to properly prime the engine. Ensure an approved engine oil is used, as specified in the owners manual.**

1. Remove the oil pressure switch.
2. Install the M12 x 1.75 adapter (1) P/N 509376.

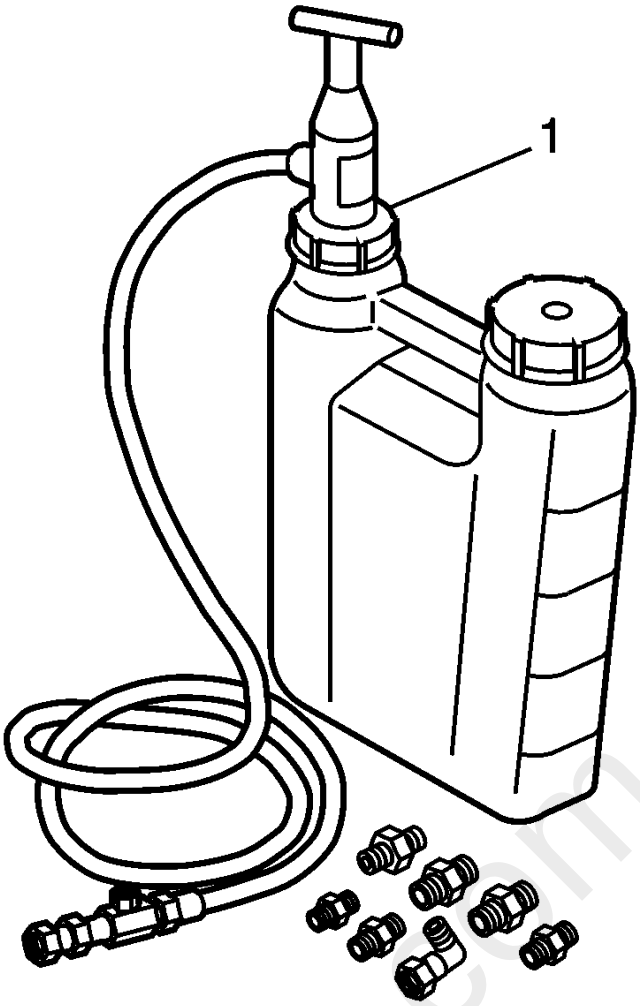


Fig. 514: View of Flexible Hose, Adapter and Preluber
Courtesy of GENERAL MOTORS COMPANY

3. Install the flexible hose to the adapter and open the valve.
4. Pump the handle on the **EN-45299** preluber (1) 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.
5. Close the valve and remove the flexible hose and adapter from the engine.

CAUTION: **Refer to Fastener Caution .**

6. Install the oil pressure switch to the engine and tighten to 26 N.m (19 lb ft).
7. Top-off the engine oil to the proper level.

DESCRIPTION AND OPERATION

CRANKCASE VENTILATION SYSTEM DESCRIPTION

Positive Crankcase Ventilation System

The crankcase ventilation system is used to consume crankcase vapors in the combustion process instead of venting vapors to the atmosphere. Fresh air from the intake system is supplied to the crankcase and mixed with blow-by gases inside the crankcase. Blow-by gases rise to the top of the engine and are picked up into the oil separation chamber in the camshaft cover, where oil is separated from the gases. Blow-by gases are then passed to the intake manifold to be consumed by normal combustion, through a calibrated orifice inside of the camshaft cover.

Operation

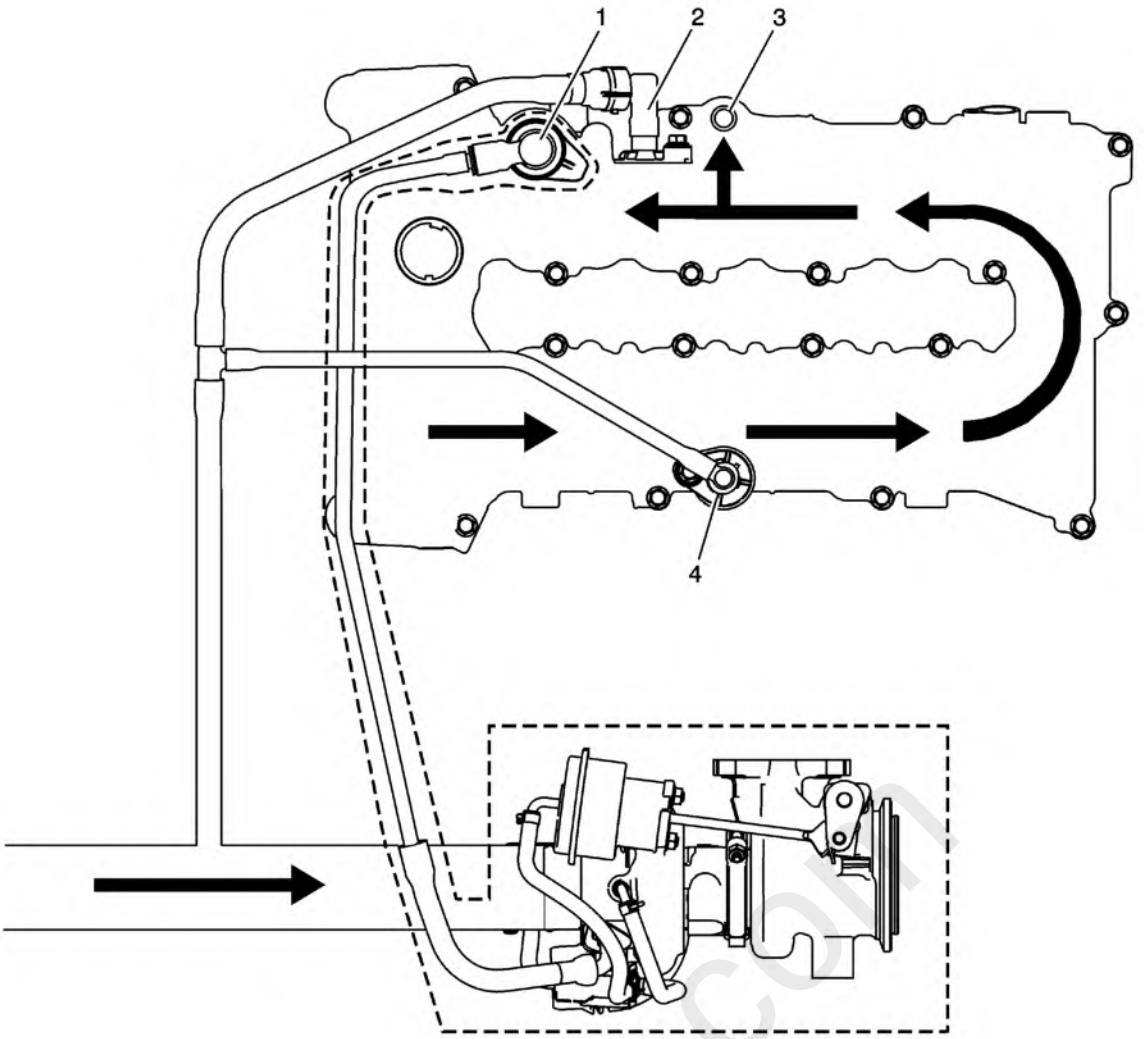


Fig. 515: Crankcase Ventilation System Diagram
Courtesy of GENERAL MOTORS COMPANY

Fresh air is brought into the engine through the positive crankcase ventilation (PCV) valve (4) as long as the crankcase is under vacuum. The primary control is through the PCV orifice (3) which meters the flow into intake manifold, at a rate depending on manifold vacuum. The PCV orifice is an integral part of the camshaft cover. Under certain operating conditions, the system is designed to allow excessive amounts of blow by gases to flow through the PCV valves (1 or 2) depending on if the engine is in boost mode or excessive crankcase pressure is detected and then routed into the intake system to be consumed by normal combustion.

Turbo Applications:

During normal operating conditions the PCV gases are routed using PCV valve (3) and the internal passage within the camshaft cover. When the Turbo is active, check valve (3) is closed and check valve (1) opens and PCV gases are routed back to the turbocharger to be consumed by normal combustion. If the engine sees excessive positive crankcase pressure check valve (2) opens and the pressure is routed to the air inlet to be reintroduced into the engine.

Non-Turbo Applications:

During normal operating conditions the PCV gases are routed using check valve (3) and the internal passage within the camshaft cover. If the engine sees excessive positive crankcase pressure check valve (2) opens and the pressure is routed to the air inlet. Also for non-turbo applications check valve (1) does not exist.

In any application check valve (2) is only used if the engine sees excessive crankcase pressure.

Results of Incorrect Operation

A plugged orifice may cause the following conditions:

- Rough idle

- Stalling or slow idle speed
- Oil leaks
- Sludge in engine

A leaking orifice may cause the following conditions:

- Rough idle
- Stalling
- High idle speed

ENGINE COMPONENT DESCRIPTION

Engine Description

Cylinder Block

The cylinder block is constructed of aluminum alloy by high-pressure die casting with 4 cast-in-place iron cylinder liners arranged in-line. The block has 5 crankshaft bearings with the thrust bearing located on the second bearing from the rear of the engine. The cylinder block incorporates a bedplate design that forms an upper and lower crankcase. This design promotes cylinder block rigidity and reduced noise and vibration.

Crankshaft

The crankshaft is forged micro alloy steel. It is supported in 5 main journals with main bearings which have oil clearance for lubricating. The thrust bearing is located in the 4th position which controls proper crankshaft axial end play. The crankshaft is also comprised of 8 counterweights that have been scalloped for mass reduction and topped for precise engine balance. A harmonic balancer is used to control torsional vibration.

Piston and Connecting Rod

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 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.

Upper Oil Pan

The oil pan is a structural aluminum oil pan with transmission attachment. It includes the oil suction pipe, this pipe is connected with the oil pump. The oil pan is attached at the lower crankcase.

Oil Pump

The oil pump is a crankshaft driven oil pump integrated in pump module. The oil pump draws engine oil from the oil pan and feeds it under pressure to the various parts of the engine. An oil strainer is mounted before the inlet of the oil pump to remove impurities which could clog or damage the oil pump or other engine components. When the crankshaft rotates, the oil pump driven gear rotates. This causes the space between the gears to constantly open and narrow, pulling oil in from the oil pan when the space opens and pumping the oil out to the engine as it narrows. At high engine speeds, the oil pump supplies a much higher amount of oil than required for lubrication of the engine. The oil pressure regulator prevents too much oil from entering the engine lubrication passages.

Cylinder Head

This cylinder head is double over head camshaft (DOHC) type and has 2 camshafts that open 4 valves per cylinder with hydraulic valve lash adjuster. The camshaft sprocket wheels are installed in front of the camshafts. The cylinder head is made of cast aluminum alloy for better strength in hardness with light weight. The combustion chamber of the cylinder head is designed for increasing of squish and swirl efficiency and then this is maximized to gasoline combustion efficiency. The exhaust manifold is integrated into the cylinder head.

mo330.com

Valves

There are 2 intake and 2 exhaust valves per cylinder. Positive valve stem seals are used on all valves.

Valve Lash Adjusters

The valve train uses a roller finger follower acted on by a hydraulic lash adjuster. The roller finger follower reduces friction and noise.

Camshaft Cover

The camshaft cover has a steel crankcase ventilation baffling incorporated. The camshaft cover has mounting locations for the ignition system.

Camshaft/Camshaft Drive

Two camshafts are used, one for all intake valves, the other for all exhaust valves. The camshafts are assembled with steel lobes.

This engine design uses a chain to drive the dual overhead camshafts. The chain is an inverted tooth or silent design with a 6.35 mm pitch to ensure quiet operation and is hydraulically tensioned to be maintenance-free. The tensioner has a ratchet mechanism to reduce chain movement during engine starts to eliminate noise. The lightweight plastic/composite chain guides have a unique grooved face design to reduce friction for optimum efficiency. Both the crank sprocket and cam sprockets are hardened to prevent wear even with extended oil change intervals.

Intake Manifold

The intake manifold is the air flow passage to the cylinder combustion chamber through the throttle body and has an effect on engine torque, power, noise, drivability, emission, fuel economy and performance. It is made of composite plastic. The intake manifold incorporates a distribution and control system for positive crankcase ventilation (PCV) gases.

Turbocharger, If Equipped

The turbocharger consists of turbine and compressor on a common shaft. The shaft bearing is constructed to higher rotation speed and lubricated by engine oil. The turbocharger is water cooled for improved durability. The turbine wheel is driven by exhaust emissions. The compressor wheel compresses the intake air. A wastegate bypass valve regulates the charging pressure for generating a high pressure at low speed as well. At a defined charging pressure it regulates the way of the exhaust emission on bypassing the turbine wheel. The wastegate valve is controlled pneumatic and electric from the pressure in the intake manifold. The pressure of exhaust emission is reduced by opening the wastegate thereby reducing the intake pressure.

Fuel Injection System

The engine is equipped with a central direct injection system. The fuel system consists of 4 separate direct injection fuel injectors, one high pressure fuel rail, and a high pressure fuel feed pipe that connects the high pressure fuel pump to the fuel rail. The injectors are each seated into their individual bores in the cylinder head with two combustion seals to provide sealing. The high pressure fuel pump mounts to the rear of the cylinder head and is driven by the intake camshaft. Motion is transmitted to the pump from a tri-lobe on the rear of the camshaft through a hydraulic roller lifter. Due to the location of the central direct injection system injector location this provides an increase in fuel economy and performance.

TURBOCHARGER SYSTEM DESCRIPTION

Turbocharger Description and Operation

A turbocharger is a compressor that is used to increase the power output of an engine by increasing the mass of the oxygen and therefore the fuel entering the engine. The single-scroll turbocharger is mounted either to the exhaust manifold or directly to the head. The turbine is driven by the energy generated by the flow of the exhaust gases. The turbine is connected by a shaft to the compressor which is mounted in

the induction system of the engine. The centrifugal compressor blades compress the intake air above atmospheric pressure, thereby increasing the density of the air entering the engine.

The turbocharger incorporates a wastegate that is controlled by the ECM, by means of a pulse width modulated (PWM) solenoid, to control boost pressure. A turbocharger bypass valve (compressor recirculation valve), controlled by the ECM, and is used to prevent compressor surging and damage by opening during abrupt closed throttle conditions. The bypass valve opens during closed throttle deceleration conditions, which allows the air to recirculate to the turbocharger compressor inlet. During a wide open throttle command, the bypass valve closes to optimize turbo response.

The turbocharger is connected to the engine oiling system by a supply and drain pipe. The oil is required for the bearing system function and also serves to carry some heat from the turbocharger. There is a cooling system circuit in the turbocharger that further reduces operating temperatures and passively dissipates bearing housing heat away from the turbocharger on shut down.

Wastegate Solenoid Valve

The wastegate valve opens and closes a bypass passage beside the turbine wheel. A spiral spring works in the closing direction while the pressure in the diaphragm works in the opening direction. The ECM supplies a PWM signal to the solenoid valve, which then allows pressure from the turbo to come through. When the pressure overcomes the spring force the actuator rod begins to move, opening the wastegate valve to a corresponding degree. The ECM changes wastegate valve opening by varying the PWM signal, which regulates the turbine speed.

At low loads, the wastegate valve is closed. All the exhaust gas then passes through the turbine. At high loads, the volume of exhaust gas is greater, which makes the turbine wheel rotate faster. This delivers a greater air displacement mass flow to the engine.

When the air displacement mass flow becomes so large that the current air mass per combustion cannot be controlled with the throttle alone, the turbo must be regulated. This is done by opening the wastegate valve so that some of the exhaust gas passes through the wastegate. Consequently, this gas does not contribute to driving the turbine and the turbine speed will be regulated so that the turbo air displacement mass flow will be correct.

When certain DTCs are set the ECM will limit the amount of available boost pressure. Limiting boost pressure is accomplished by the ECM controlling the wastegate actuator solenoid valve and maintaining the duty cycle at 0%. This means that the ECM will not actively open the wastegate during greater engine loads. The system at this point is limited to mechanical boost. Mechanical boost means that the wastegate will still move, but the amount of motion is limited by the mechanical properties of the return spring within the diaphragm valve, the pneumatic properties of the actuator, and the physics of the exhaust gas flow in the exhaust system.

The following diagrams illustrate the turbocharger wastegate closed and open conditions:

Turbocharger Wastegate Closed

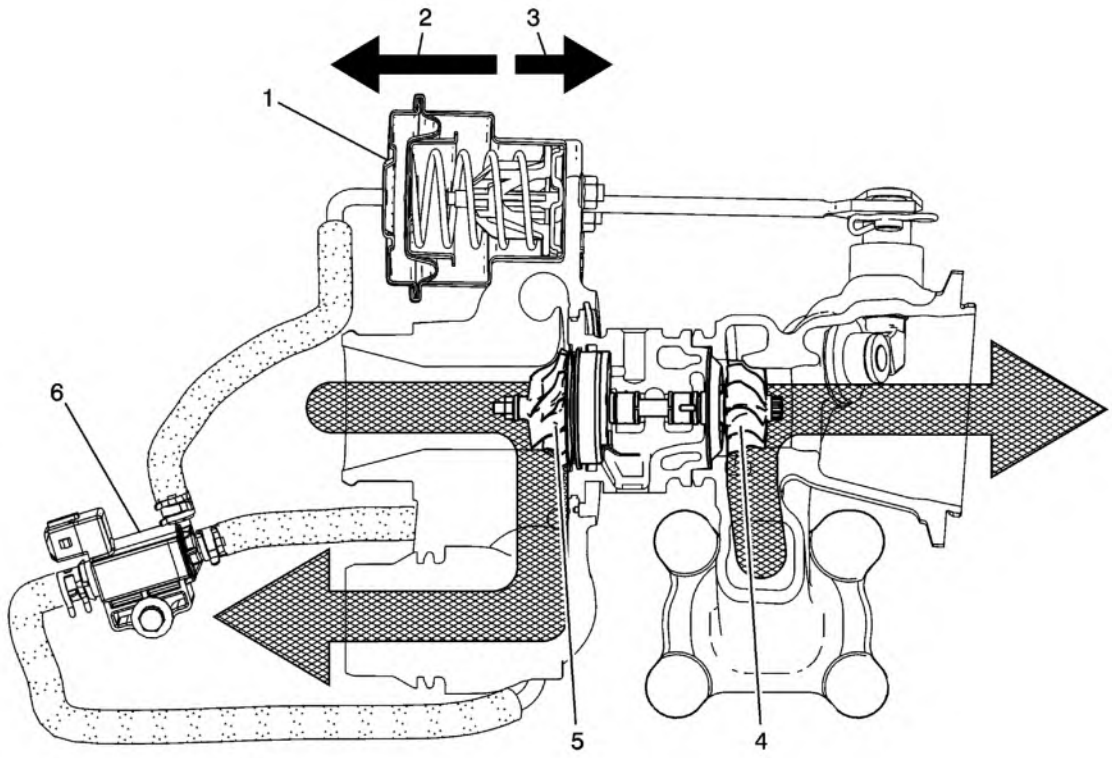


Fig. 516: Turbocharger Wastegate Actuator Solenoid Valve Closed
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Turbocharger Wastegate Diaphragm Valve
2	Spring Force
3	Exhaust Gas Pressure
4	Turbine
5	Compressor
6	Turbocharger Wastegate Actuator Solenoid Valve with Duty Cycle at 100 percent

Turbocharger Wastegate Open

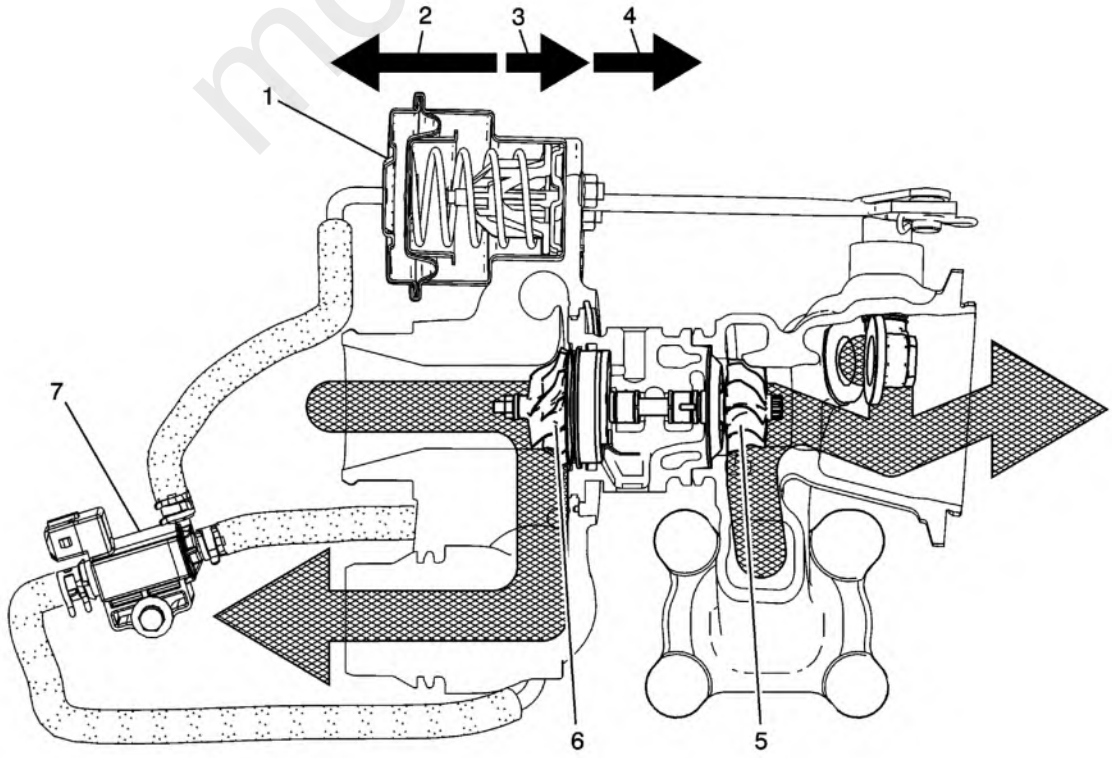


Fig. 517: Turbocharger Wastegate Actuator Solenoid Valve Open
Courtesy of GENERAL MOTORS COMPANY

mcx30.com

Callout	Component Name
1	Turbocharger Wastegate Diaphragm Valve
2	Spring Force
3	Exhaust Gas Pressure
4	Regulating Pressure
5	Turbine
6	Compressor
7	Turbocharger Wastegate Actuator Solenoid Valve with Duty Cycle at 0 percent

The wastegate is completely closed at idle. All of the exhaust energy is passing through the turbine.

During normal operation, when wide open throttle is requested at lower engine speeds, the ECM commands the wastegate solenoid with a duty cycle of 100% to minimize any turbo lag. During engine loads in the middle and upper RPM ranges, the ECM commands the solenoid with a duty cycle of 65 - 80%.

Bypass Solenoid Valve (Compressor Recirculation Valve)

The turbocharger bypass valve prevents the turbo from exceeding the surge limit of the compressor at low flow and high pressure. This occurs when the engine is running with a load and the throttle suddenly closes. In this case, flow is almost null and pressure is very high. This not only is damaging to the turbocharger, but also generates noise and decelerates turbine speed. The ECM supplies a voltage signal to the solenoid valve output driver, which regulates the open or closed valve position.

Accelerator Pedal Depressed

The bypass valve is closed. The force in the return spring integrated in the valve presses the valve cone against its seat in the turbo housing. The valve is turned OFF.

Accelerator Pedal Released

In order to avoid pressure spikes in the intake manifold and unloading or overrunning the turbo, the ECM sends a voltage signal to the bypass valve, which will then open. The compressed air on the pressure side of the turbo is led to the intake via the open valve. When the pressure drops, the turbine speed can be kept relatively high and the turbocharger is prevented from exceeding the surge limit of the compressor.

Charge Air Cooler

The turbocharger intake system is supported by an air-to-air charge air cooler system, which uses fresh air drawn through a heat exchanger to reduce the temperature of the hot compressed air exiting the turbo compressor, prior to delivery to the engine combustion system. Inlet air temperature can be reduced by up to 100Â°C (180Â°F), which enhances performance. This is due to the higher density of oxygen in the cooled air, which promotes optimal combustion. The charge air cooler is connected to the turbocharger and to the throttle body by flexible ductwork that requires the use of special high torque fastening clamps. In order to prevent any type of air leak when servicing the ductwork, the tightening specifications, cleanliness and proper positioning of the clamps is critical, and must be strictly adhered to.

SEPARATING PARTS

NOTE:

- **Disassembly of the piston, press fit design piston pin, and connecting rod may create scoring or damage to the piston pin and piston pin bore. If the piston, pin, and connecting rod have been disassembled, replace the components as an assembly.**
- **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 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 lash adjusters
- Valve lash adjusters, lash adjuster guides, pushrods and rocker arm assemblies
- Valve to the valve guide
- Valve spring and shim to the cylinder head location
- Engine block main bearing cap location and direction
- Oil pump drive and driven gears

LUBRICATION DESCRIPTION

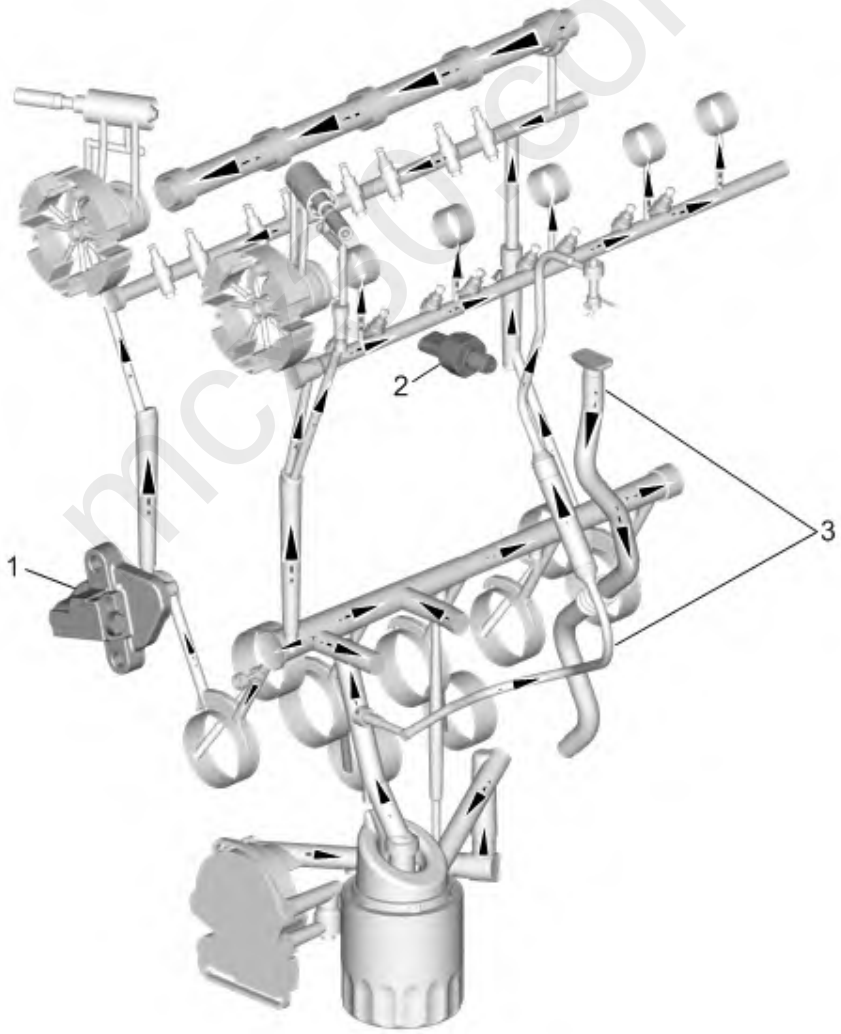


Fig. 518: Cutaway View Of Lubrication System
Courtesy of GENERAL MOTORS COMPANY

Engine lubrication is supplied by a variable displacement two-stage vane-type oil pump assembly. An oil control solenoid valve, controlled by the engine control module (ECM), mounted to the oil pump provides two stage functionality. The oil pump is mounted off-axis on the front of the engine.

All oil passing through the oil pump goes through the oil filter, where contaminants are removed. The oil filter is located on the left front side of the engine block. The oil filter is a spin-on type that mounts directly to the engine block. A bypass valve is incorporated into the oil filter, which permits oil flow in the event the filter becomes restricted.

Oil then enters the gallery where it is distributed to the crankshaft, piston oil nozzles, and timing chain oil nozzle. For turbo applications, oil is also distributed through the turbocharger oil feed and return pipes (3) and engine oil cooler. The connecting rod bearings are oiled by passages through the crankshaft connecting the main journals to the rod journals. A groove around each upper main bearing furnishes oil to the drilled crankshaft passages. The pressurized oil passes through the cylinder head restrictor orifice into the cylinder head and then into each camshaft feed gallery. Passages feed each hydraulic lash adjuster.

The front feed off the main oil gallery also feeds the timing chain tensioner (1) and the intake and exhaust side phasers and oil control valves.

NOTE: **A mechanical vacuum pump is not used on hybrid engine.**

On the exhaust side, drilled passages feed each camshaft journal surface and the exhaust side head gallery feeds the mechanical vacuum pump. On the intake side, the oil is fed through the hollow camshaft to each camshaft journal surface, and a separate connected gallery feeds the intake side hydraulic lash adjusters.

An engine oil pressure sensor (2) is located on the intake rear side of the engine just below the head gasket interface. Oil returns to the oil pan through passages cast into the cylinder head. The phasers and timing chain drive lubrication drains directly into the oil pan behind the front cover.

CLEANLINESS AND CARE

An automobile engine is a combination of many machined, honed, polished, and lapped surfaces with tolerances that are measured in ten thousandths of an inch. When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of engine oil should be applied to friction areas during assembly to protect and lubricate the surfaces during initial operation. Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas are part of the repair procedure. This is considered standard shop practice even if not specifically stated.

When valve train components are removed for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed.

REPLACING ENGINE GASKETS

Special Tools

J 28410 Gasket Remover

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

Gasket Use and Applying Sealants

- 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

Cleaning Mating Part Surfaces for RTV Joints

RTV sealant depends greatly on adhesion to the mating parts in order to form and maintain a robust sealed joint. As with any adhesion system, proper surface preparation of the bonded parts is extremely important to ensure good adhesion over the life of the product.

CAUTION: **When cleaning the sealing surfaces of engine components, DO NOT use bristle discs, abrasive pads, wire wheels or surface conditioning discs. These types of devices should not be used because they produce a very fine grit that is abrasive and known to cause internal engine damage. The bristle discs and pads are embedded with abrasive material and wear down as they clean, continually exposing fresh abrasive to the surface of the component.**

Abrasive pads, wire wheels and bristle discs can remove enough metal to affect the engine front cover, cylinder head, engine block, oil pan rail, and intake manifold runner surface flatness, which can then result in engine coolant leaks, engine oil leaks and air leaks. It takes about 15 seconds to remove 0.203 mm (0.008 in) of metal with an abrasive pad.

Abrasive pads, wire wheels and bristle discs used with high speed grinders produce airborne debris that can travel throughout the shop contaminating other work being performed outside of the immediate work area.

When cleaning engine gasket sealing surfaces and/or cleaning parts from an engine that are to be reused, surface conditioning discs, typically constructed of woven fiber or molded bristles that contain abrasives, such as a high amount of aluminum oxide, should NOT be used. The use of such surface conditioning discs dislodges aluminum oxide from the disk and metal component particles, which can lead to premature engine bearing failure. The presence of aluminum oxide in engine oil has been shown to cause premature engine bearing failure. In some cases, this failure occurs in as little as 1, 600 km (1, 000 mi) or less after the repair has been made.

Surface conditioning discs may grind the component material and embed it into the disc. This can result when more aggressive grinding of the gasket surface takes place.

General Motors strongly recommends using a plastic razor blade, plastic gasket scraper, a wood scraper or a non-metallic scraper to remove all sealer/gasket material on the surface of engine components that are to be reused. Do not use any other method or technique to remove the sealant or the gasket material from a part.

- Do not gouge or scratch any engine sealing surface during the cleaning process.
- It is not necessary to remove every speck of the old sealer.

To remove the old RTV sealant from the sealing surface, spray GM Low VOC Cleaner or an equivalent, on the mating surfaces and allow it to soak to loosen the old gasket material. Use care to avoid getting GM Low VOC Cleaner in any area other than the mating surface to be cleaned.

Use a plastic razor blade, that mounts in a scraper device or a hand held plastic razor blade, to remove old RTV sealant from a sealing surface. Use a new blade for each corresponding engine component surface. Hold the blade as parallel to the flat surface as possible.

To properly clean the sealing surfaces prior to reassembly, spray GM Low VOC Cleaner on a folded lint free shop cloth. Wipe the mating surfaces on the engine and front cover and rotate the shop cloth until there are no more visible signs of contamination on the cloth.

After the final cleaning of the parts, allow up to 5 minutes for the components to dry before applying new RTV sealant.

NOTE: **After the final cleaning with GM Low VOC Cleaner and before reassembly, DO NOT touch the cleaned surfaces with your hand. Oils from your skin WILL CONTAMINATE the surface and prevent proper bonding of the new RTV sealant.**

Typical Applications

This procedure is intended for use in the following operations:

- Building of engines in a manual low volume build process where the use of assembly lubricants and other typical conditions exist which may contaminate the component sealing surfaces in an RTV joint.
- Cleaning of surfaces contaminated with oil or other substance during the assembly operation as a special case event.

In the typical situation, both the part being assembled, and the assembly to which it is to be sealed will be cleaned. An example is an oil pan assembled to a block/front cover/rear cover assembly using an RTV seal applied to the pan or the block. Both the pan and the block assembly should be cleaned prior to RTV application.

Any loose gaskets that are part of the RTV joint should not be cleaned unless it is known that they have been contaminated during the build process. Examples of loose gaskets are intake side and end seals which contact RTV used to seal a T-joint.

Assemblies supplied to GM with gaskets in place should not be cleaned unless they are known to be contaminated during the build process. Examples are rocker/cam covers with press in place gaskets using RTV at corners or T-joints.

Materials Needed

Use clean dry lint free cloths to wipe surface with approved solvent based cleaner. Examples are:

- GM Good Wrench Service Low VOC Brake Parts Cleaner
- AC Delco Non-Chlorinated Brake Parts Cleaner
- Loctite ODC - Free Cleaner & Degreaser

Procedure:

1. Identify the surfaces to which the RTV will come into contact in the assembled joint.
2. Using an approved solvent based cleaner, thoroughly soak an appropriate portion of a clean, dry cloth. Immediately wipe the surfaces with the cloth to remove any residue of oil, soap, etc.
3. Repeat step 2 using a clean portion of the cloth as many times as required until the cleanliness of the cloth after wiping the surface becomes constant in appearance. There is typically some

mcx30.com

discoloration of the cloth after wiping however a clean surface should produce the same level of discoloration with successive wiping with a clean cloth and solvent.

4. If crevices exist in the joint such that wiping the surface would not be sufficient to clean the crevice, the approved solvent based cleaner should be directly sprayed on the joint to ensure wetting of the surfaces and removal of the contaminant. DO NOT spray rubber components directly. Care must be used to avoid getting solvent in areas other than necessary to clean the joint. Then continue with step 3.
5. Allow the surfaces to dry for a minimum of 1 minute or longer if necessary for the solvent to evaporate from the surface.
6. Do not touch the cleaned surface with anything prior to RTV application.
7. The surface is now prepared for RTV application.

Sealant Types

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 two major types of sealant are commonly used in engines:

- Room Temperature Vulcanizing (RTV)
- Anaerobic sealant, which include the following:
  - Gasket Eliminator
  - Pipe Sealant
  - Threadlock

Room Temperature Vulcanizing (RTV) Sealer

This type of sealant is used where two 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
- Do not use RTV sealant unless the ambient air temperature is at least 18Â°C (65Â°F) degrees or higher.
- 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.

NOTE: **The bead size is critical and is easier to maintain consistency and**

mcx30.com

application with a RTV dispensing tool. This also helps to eliminate waste.

- 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.**

- Assemble the components while the RTV sealant is still wet to the touch, within 10 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 two rigid parts, such as castings, are assembled together. When two rigid parts are disassembled and no sealant or gasket is readily noticeable, then the two 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.**

- Do not allow the gasket eliminator sealed joint to cure more than 5 minutes before torquing to specification. This will result in an incorrect clamp load of assembled components.
- 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 two 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.
- The threaded surfaces to be sealed must be clean and dry.
- Apply the threadlock sealant as specified on the threadlock sealant container.

NOTE:

- **Do not allow the threadlock sealant to cure more than 5 minutes before torquing to specification. This will result in an 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 two 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.**

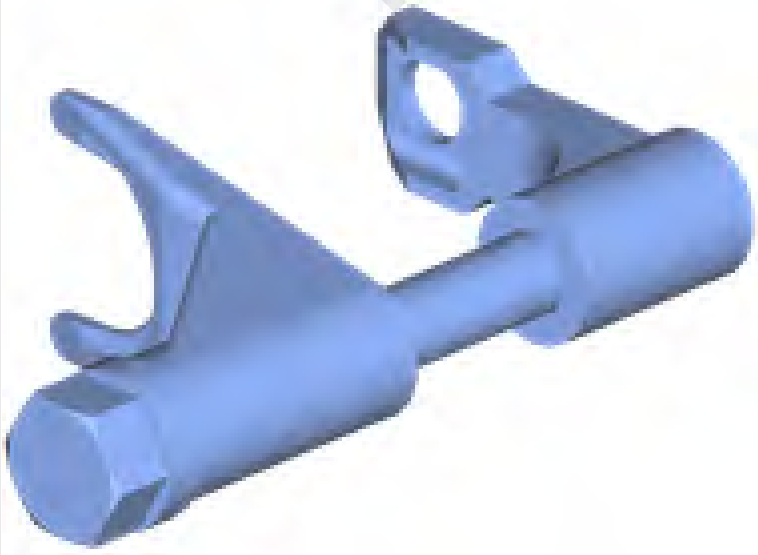
- Apply the pipe sealant bead to the inside of any bolt hole areas.
- Apply a continuous bead of pipe sealant to one sealing surface.

NOTE: **Do not overtighten the fasteners.**

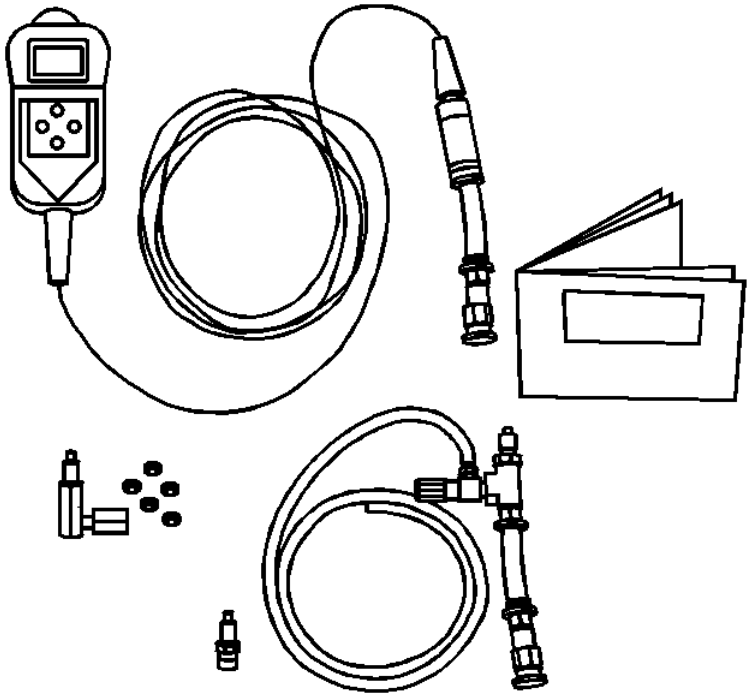
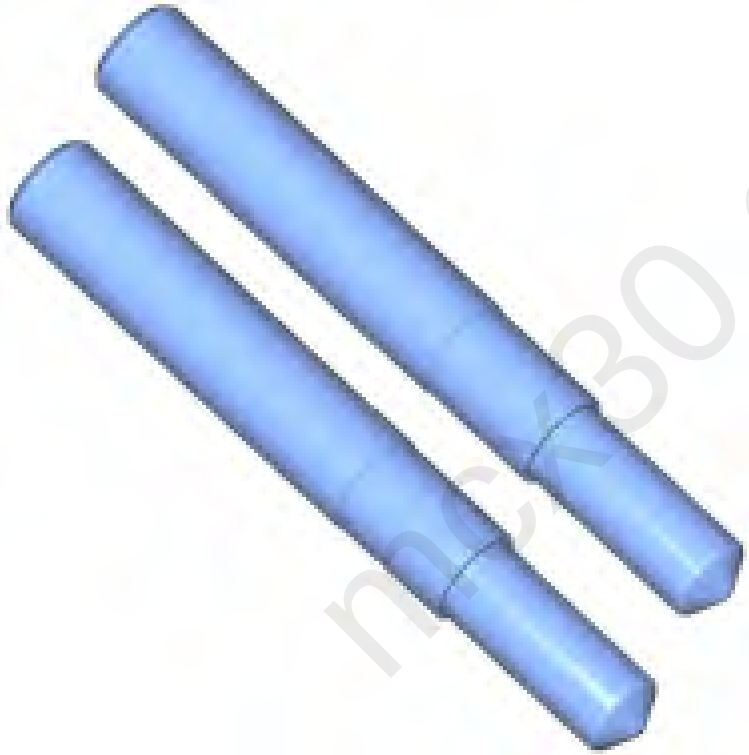
- Tighten the fasteners in sequence, if specified, and to the proper torque specifications.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/Description
	CH-42188-B J-42188-B Ball Joint Separator

mcx30.com

Illustration	Tool Number/Description
	CH-48027 7-0006833 Digital Pressure Gauge
	CH-51034 Cradle Alignment Guide Pins

mc130.com

Illustration	Tool Number/Description
	DT-6125-1B J-6125-1B Slide Hammer with Adapter
	DT-23129 J-23129 KM-586 T-0207928 Universal Seal Remover

mgx30.com

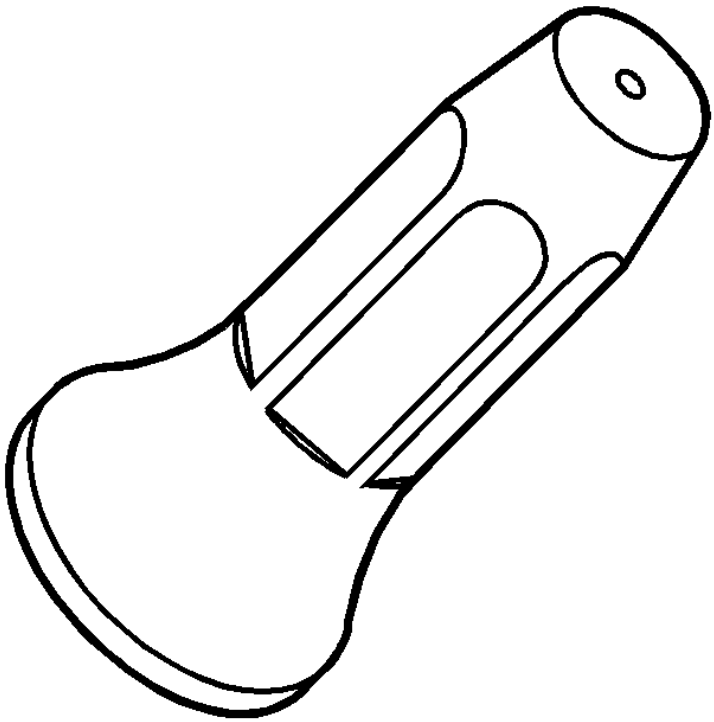
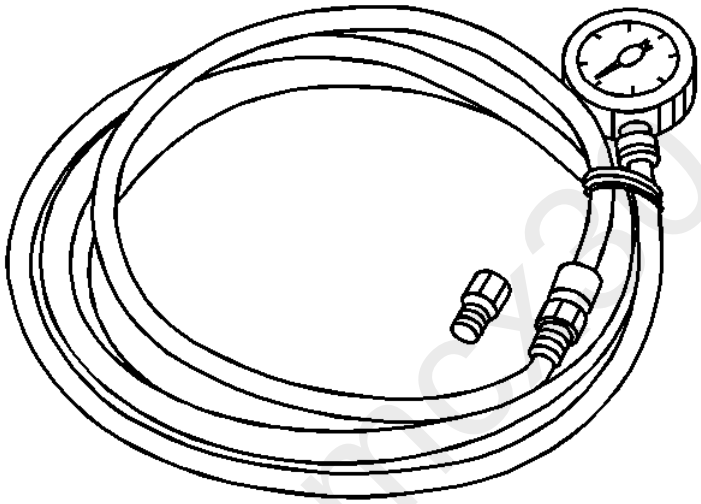
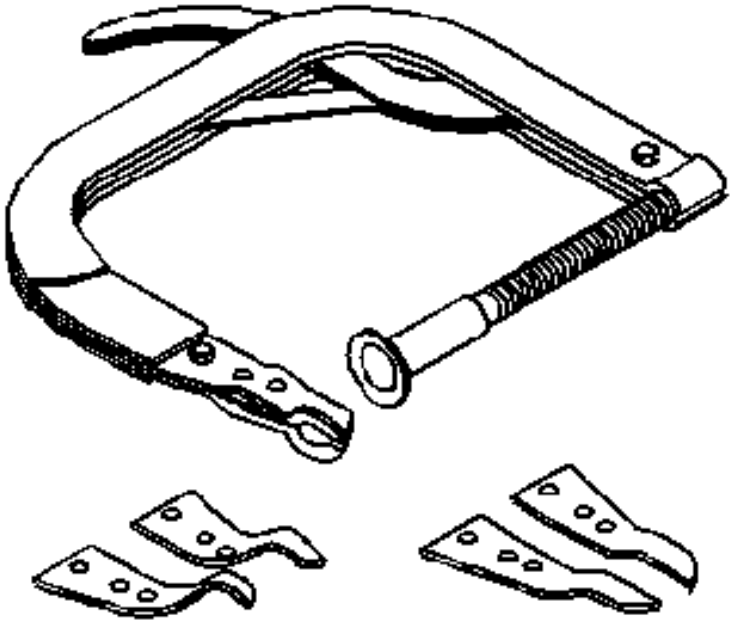
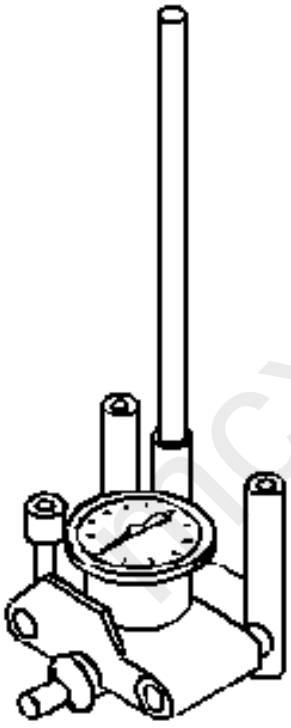
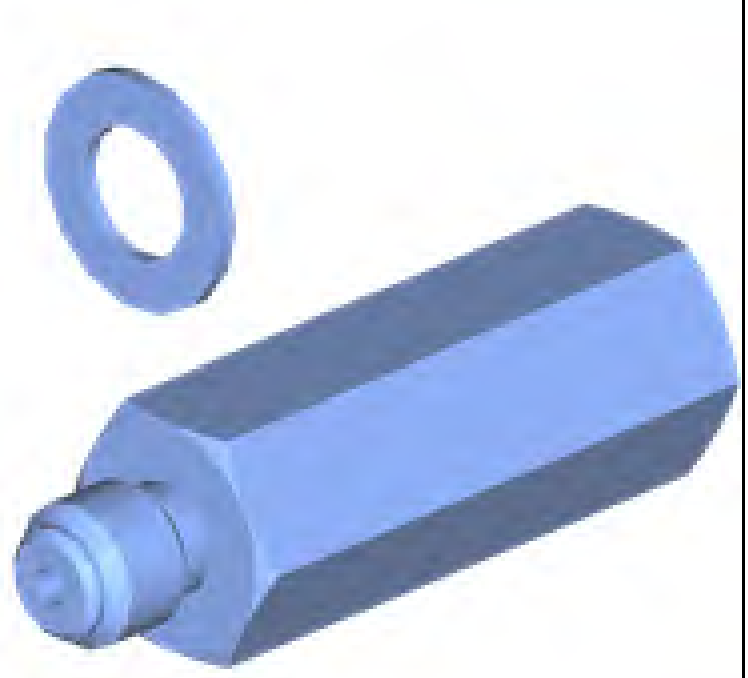
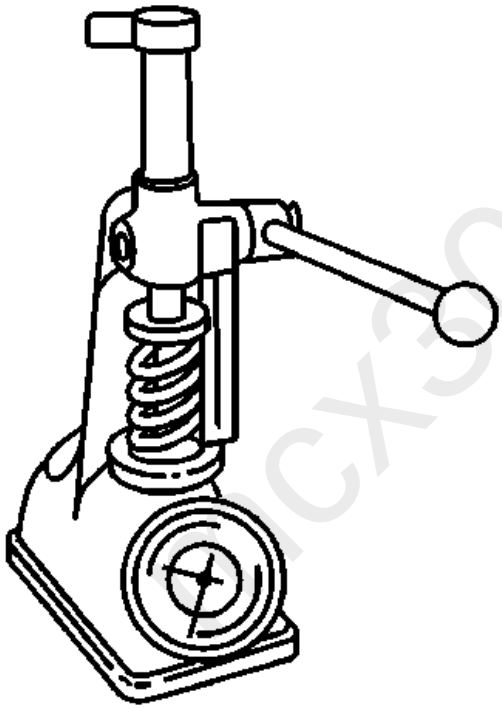
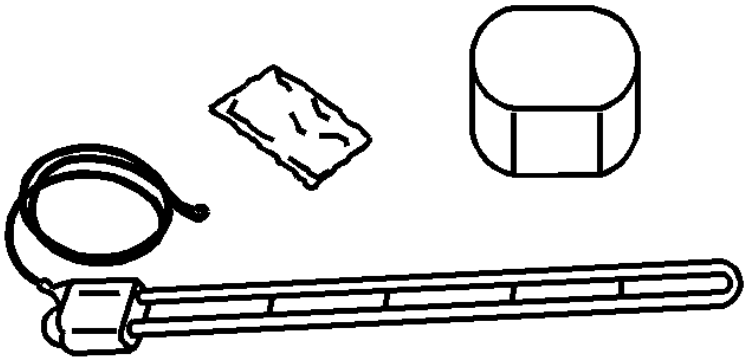
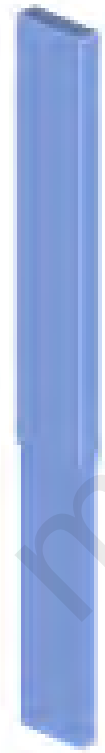
Illustration	Tool Number/Description
	DT-45866 J-45866 7-0007829 Input Shaft Seal Installer
	EN-498-B KM-498-B KM-6106 83 93 852 7-0006833 Oil Pressure Gauge

Illustration	Tool Number/Description
	EN-8062 J-8062 KM-348 Valve Spring Compressor - Head Off
	EN-8087 J-8087 Cylinder Bore Gauge

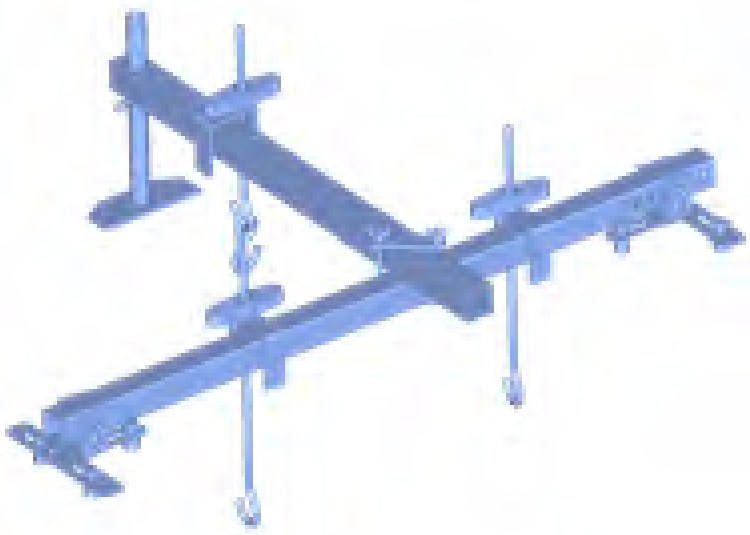
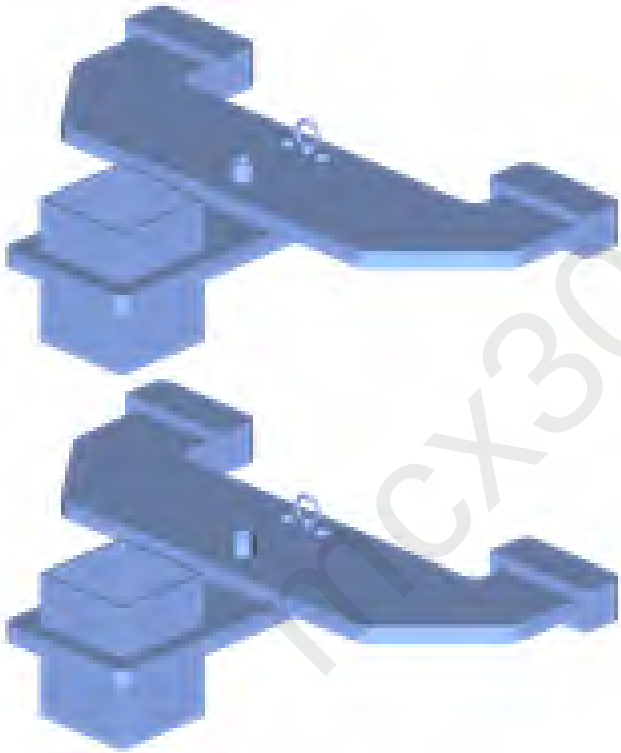
mcx30.com

Illustration	Tool Number/Description
	EN-21867-850 J-21867-850 KM-498-B KM-6106 83 93 852 Oil Pressure Gauge Adapter
	EN-22738-B GE-22738-B J-22738-B J-9666 Valve Spring Tester

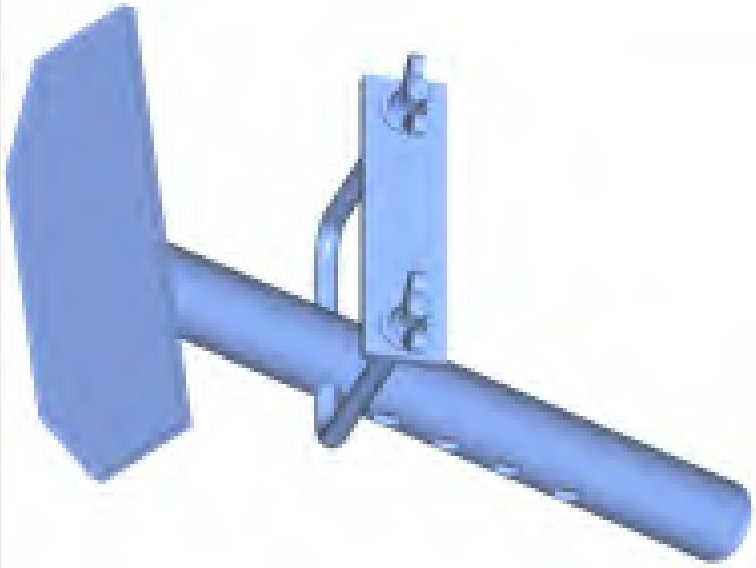
mcx30.com

Illustration	Tool Number/Description
	EN-23951 J-23951 Valve Manometer
	EN-28410 J-28410 Gasket Remover

mcx30.com

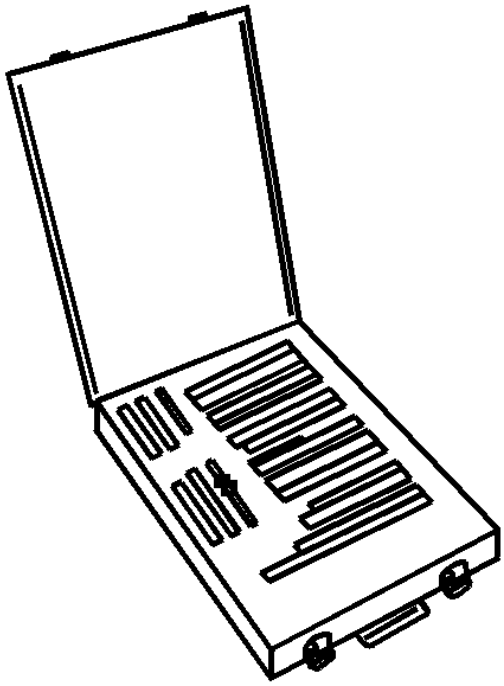
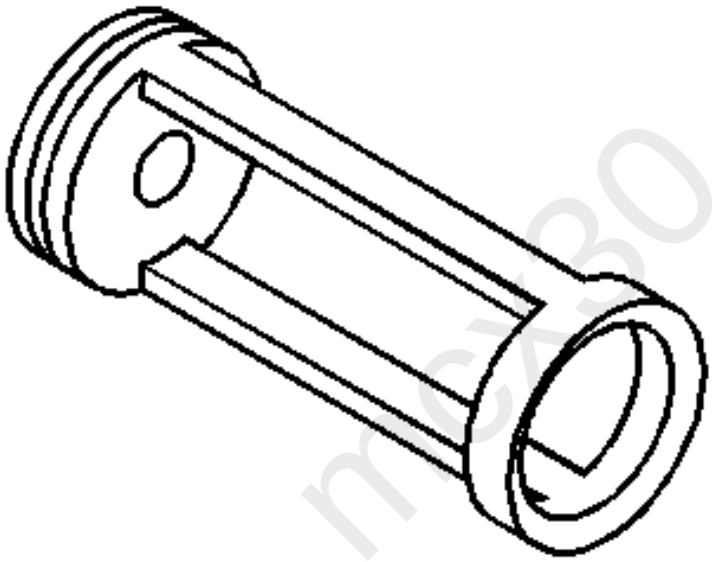
Illustration	Tool Number/Description
	EN-28467-B J-28467-B Universal Engine Support Fixture
	EN-28467-501 J-28467-501 Engine Support Fixture Adapters

mcx30.com

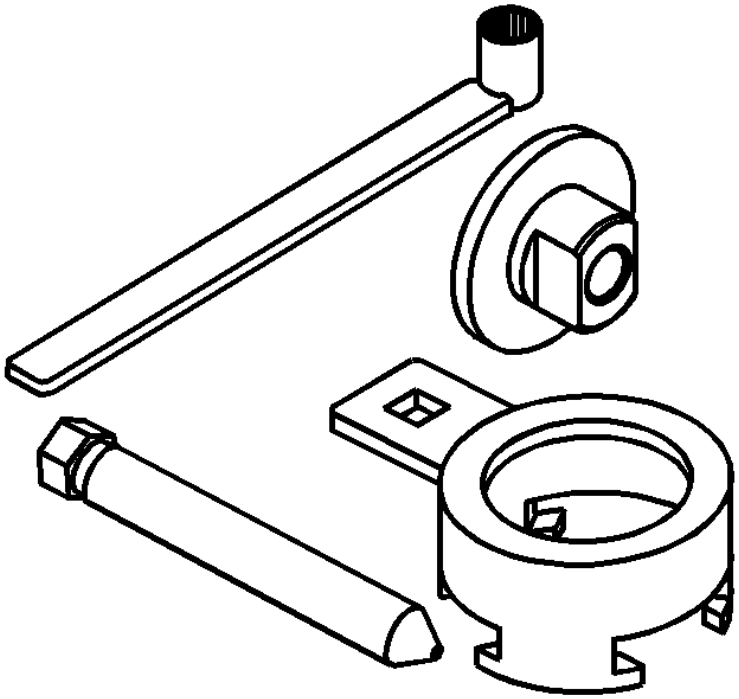
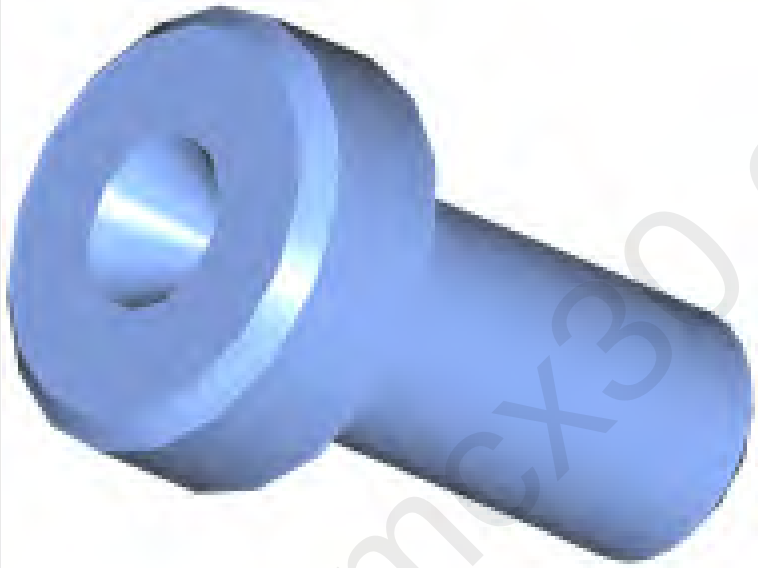
Illustration	Tool Number/Description
	EN-36462-A J-36462-A Engine Support Adapter Leg Set
	EN-36857 J-36857 Engine Lift Bracket

mcy30.com

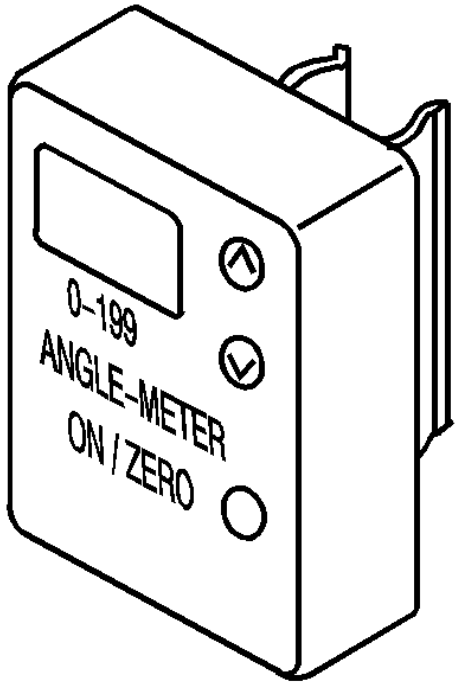
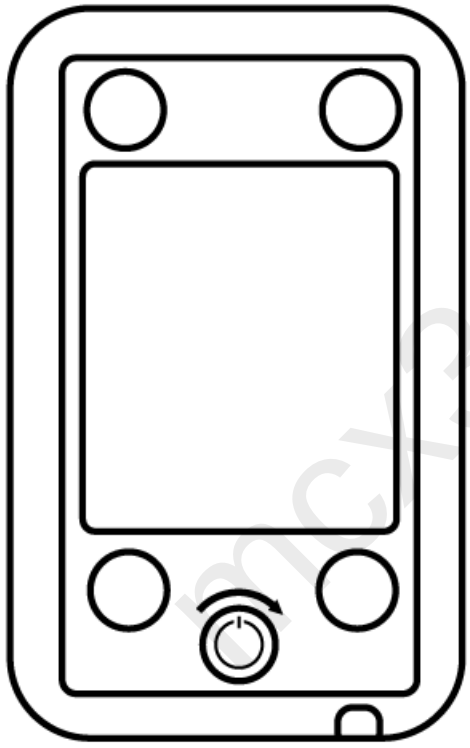
Illustration	Tool Number/Description
	EN-38185 Hose Clamp Pliers
	EN-41816 J-41816 Crankshaft Balancer Remover

Illustration	Tool Number/Description
	EN-42385-850 J-42385-850 Thread Repair Kit
	EN-43963 J-43963 KM-6149 Valve Spring Compressor (off car)

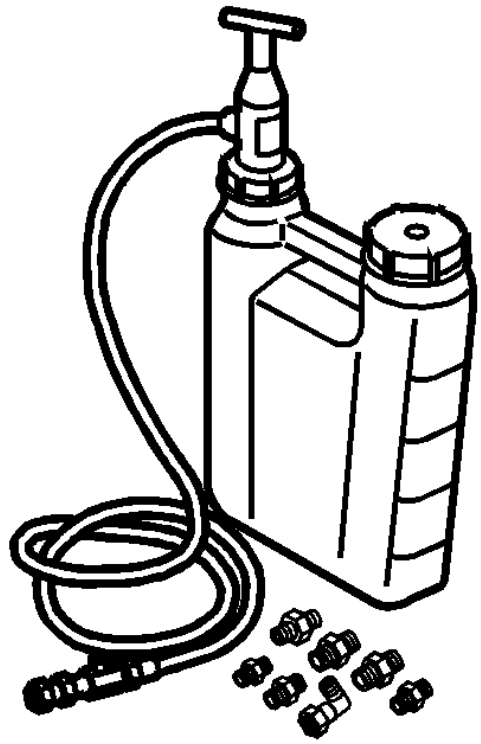
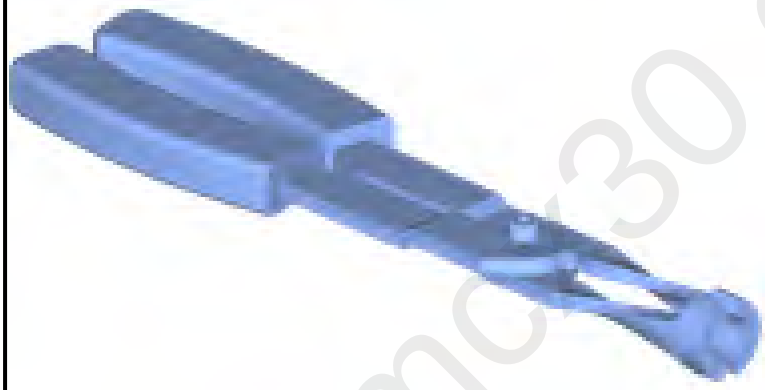
mCA30.com

Illustration	Tool Number/Description
	EN-44226 J-44226 J-44226-BR Crankshaft Balancer Remover
	EN-44226-5 J-44226-BR Crankshaft Protector

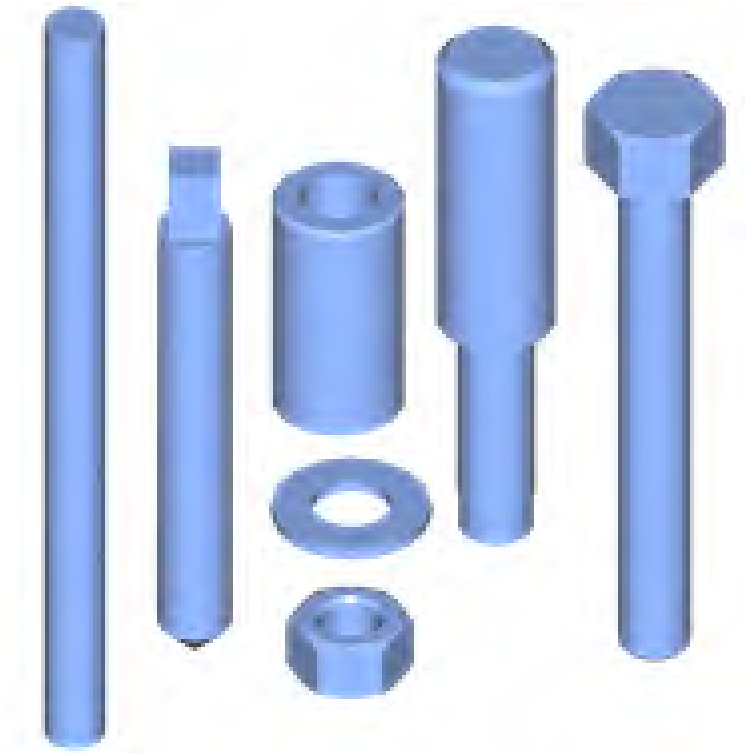
mcx30.com

Illustration	Tool Number/Description
	EN-45059 J-45059 KM-470-B J-840902 Angle Meter
	EN-45059 - A Angle Meter

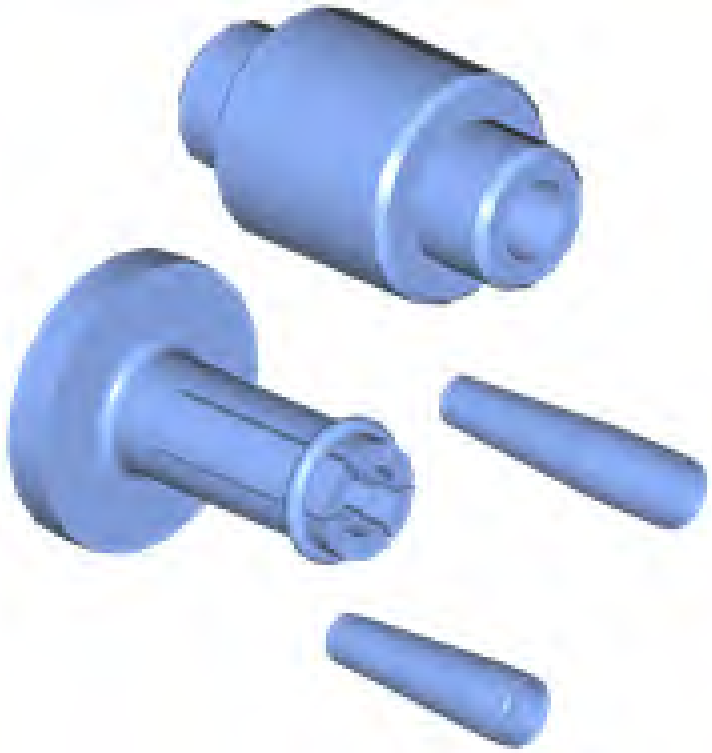
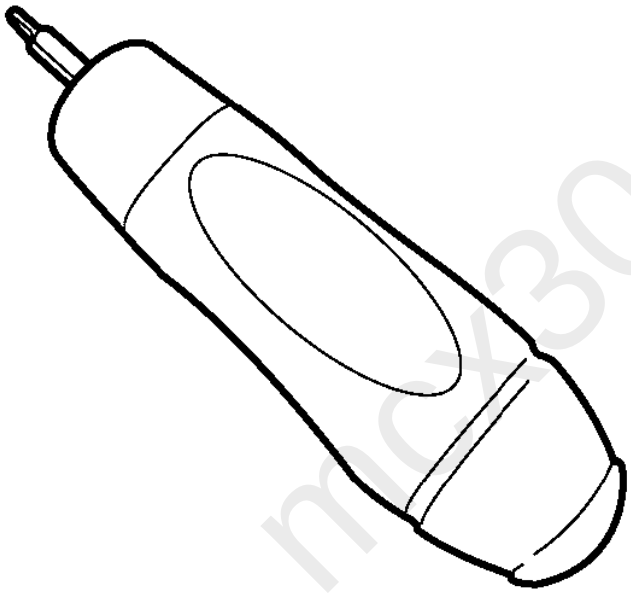
mcy30.com

Illustration	Tool Number/Description
	EN-45299 J-45299 Engine Pre-Luber
	EN-46116 X-0606051 Valve Stem Seal Remover

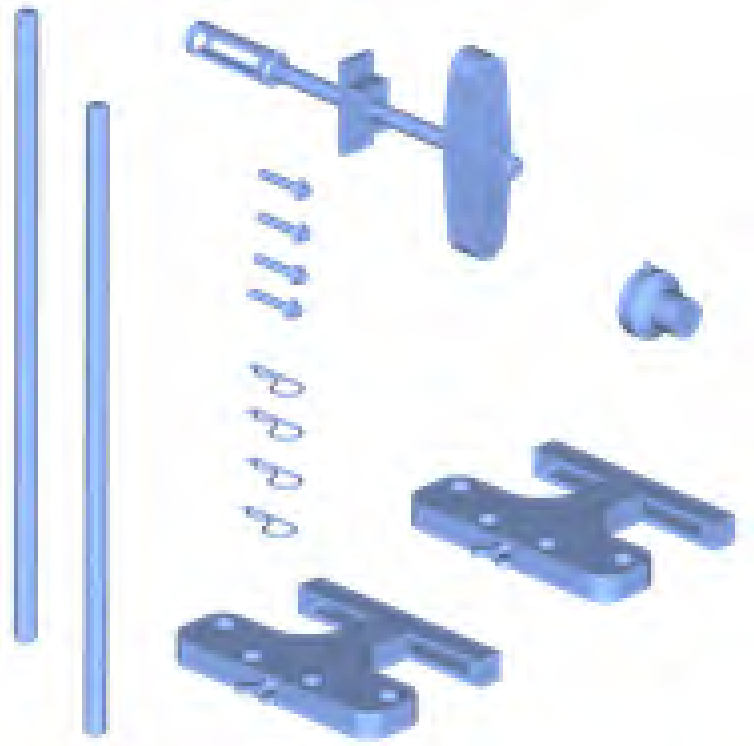
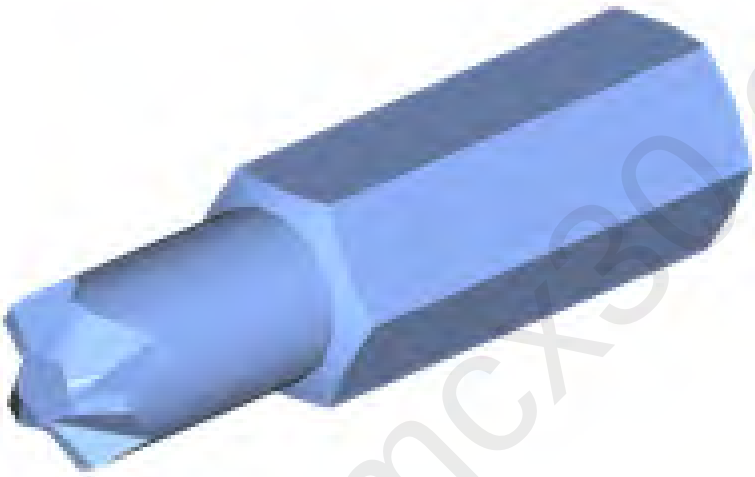
mc30.com

Illustration	Tool Number/Description
	EN-46122 Camshaft Position Actuator Check-Ball Valve Remover/Installer
	EN-47909 Injector Bore and Sleeve Cleaning Kit

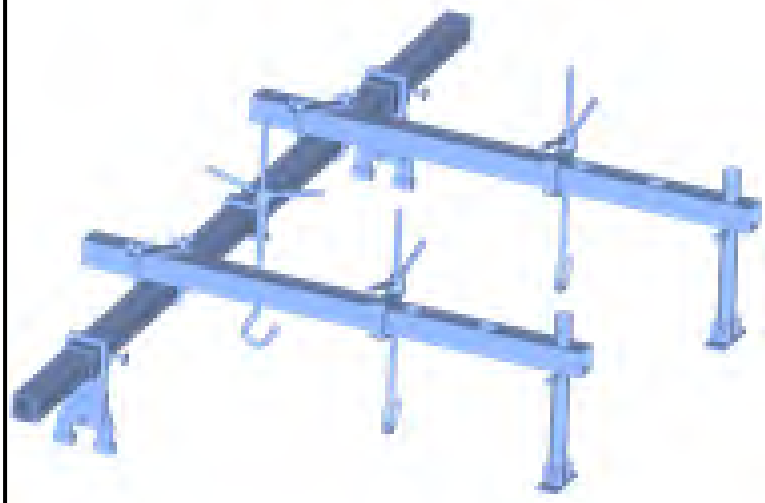
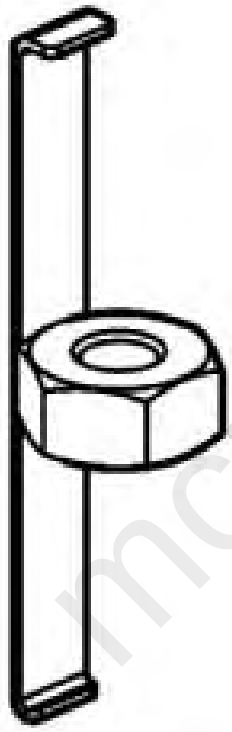
mex30.com

Illustration	Tool Number/Description
	EN-49245 Fuel Injector Seal Installer/Sizer
	EN-49941 Piston Pin Clip Remover/Installer

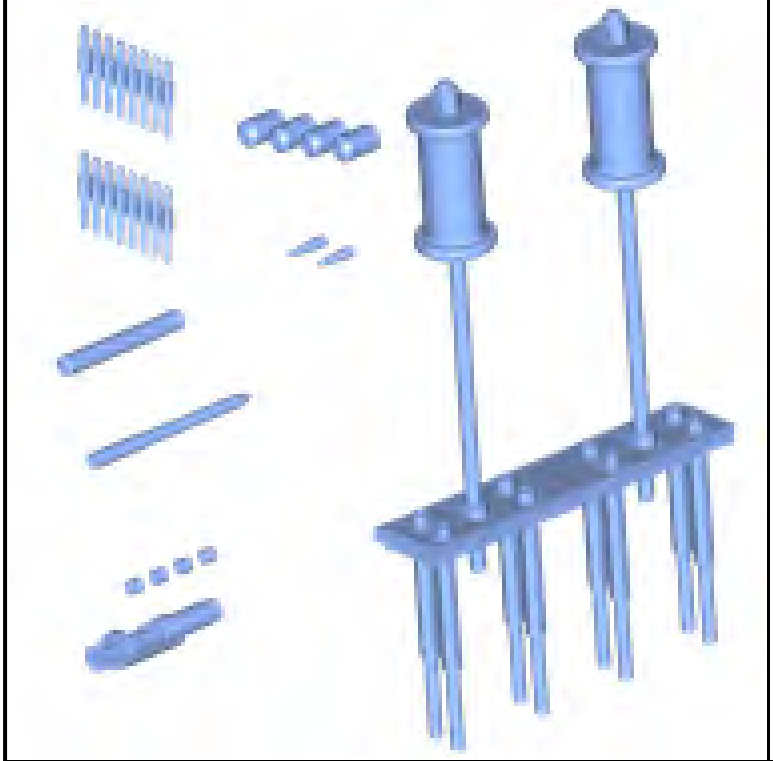
mcx30.com

Illustration	Tool Number/Description
	EN-50717 7-0006798 Valve Spring Compressor - Head On
	EN-50956 Tamper Proof Drive Bit

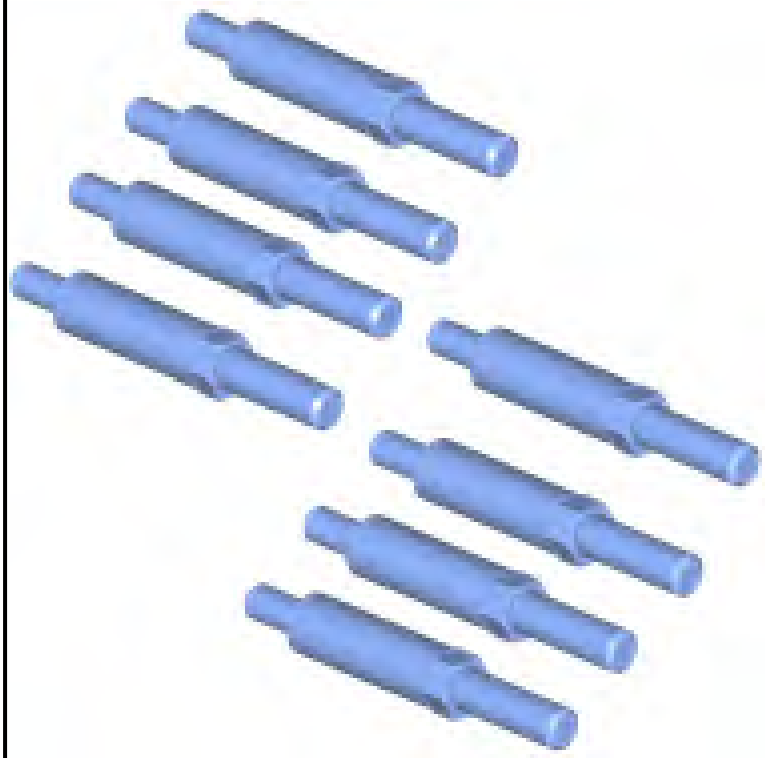
mcx30.com

Illustration	Tool Number/Description
	EN-51007 Engine Support Fixture
	EN-51096 Crankshaft Rear Oil Seal Remover

mcx30.com

Illustration	Tool Number/Description
	EN-51146 EN-51146-BR Injector Remover/Installer
	EN-51146-100 Fuel Injector Removal Plate

mcx30.com

Illustration	Tool Number/Description
	EN-51146-150 Injector Remover/Installer Adapters
	EN-51365 Fuel Pump Installation Gauge

mcx30.com

Illustration	Tool Number/Description
	EN-51367 Camshaft Locking Tool
	EN-51368 Front Crankshaft Seal Installer

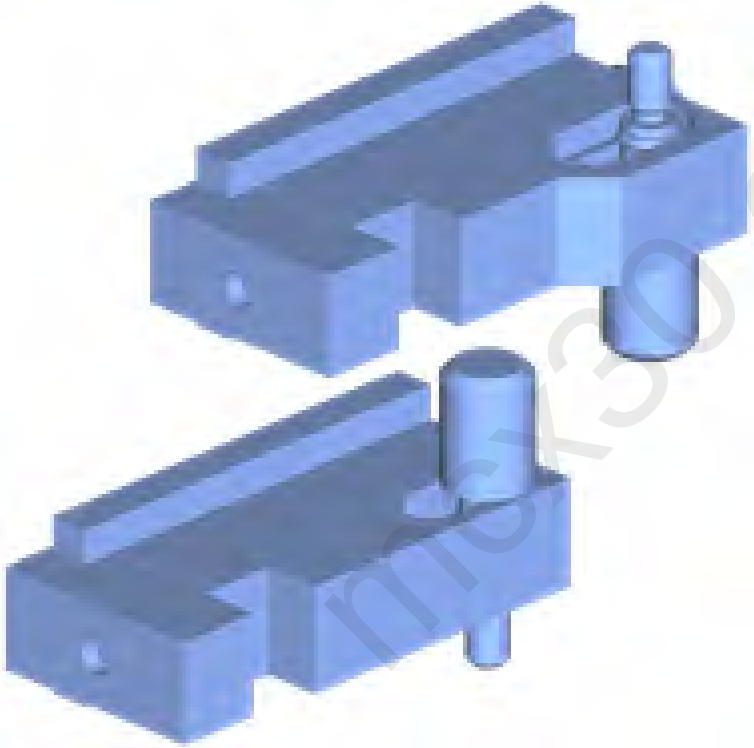
Illustration	Tool Number/Description
	EN-51369 Rear Crankshaft Seal Installer
	EN-51397 Timing Chain Retainer

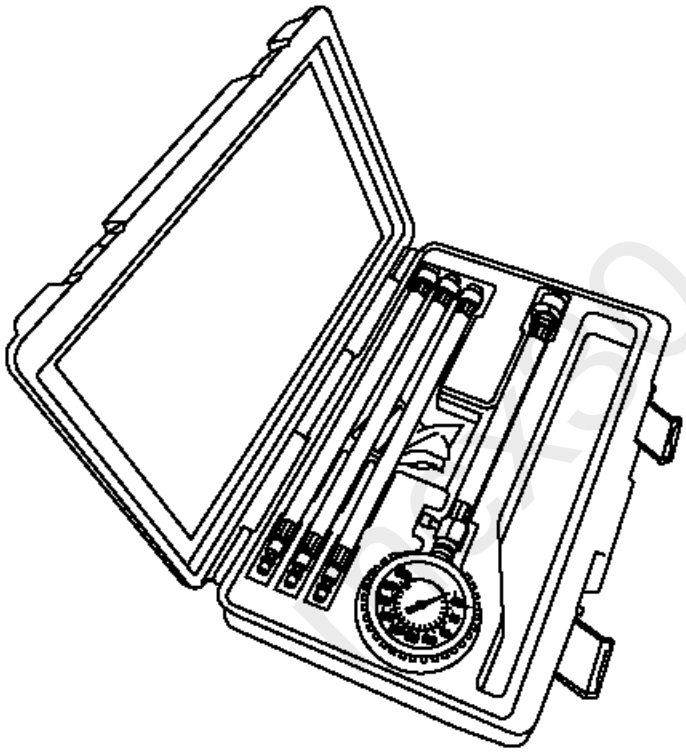
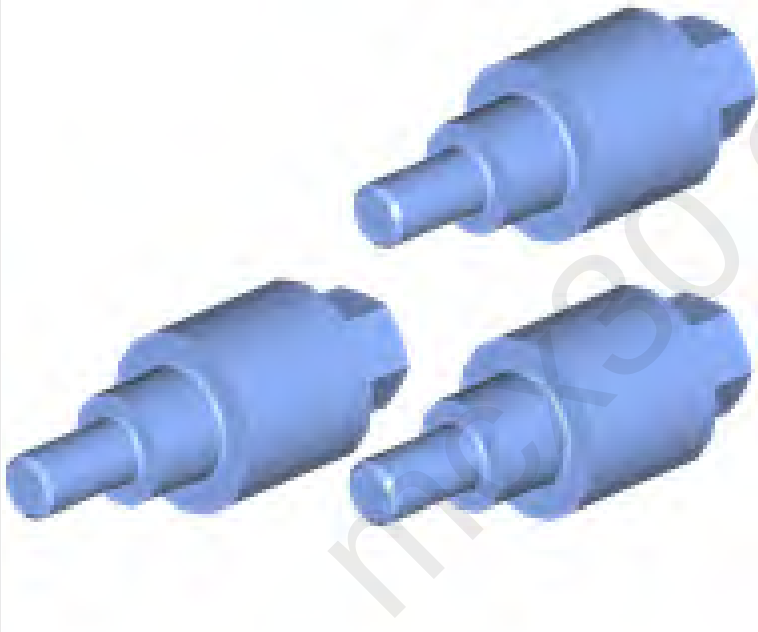
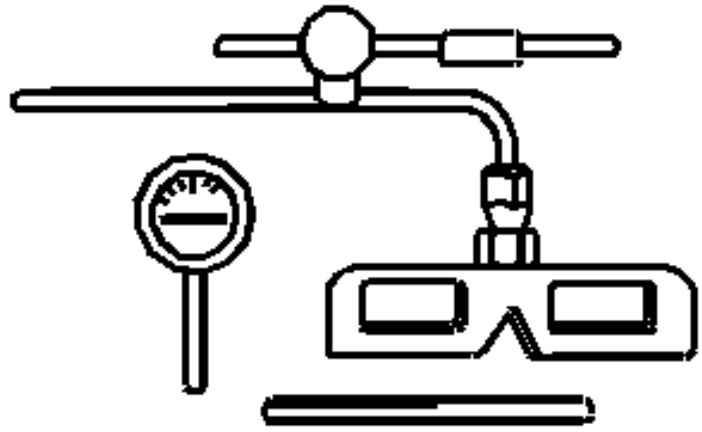
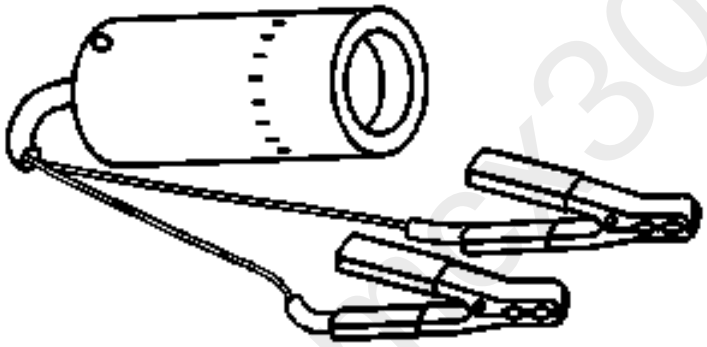
Illustration	Tool Number/Description
	EN-51454 Connecting Rod Guides
	EN-51749 3-0006784 Compression Gauge Tester Kit

Illustration	Tool Number/Description
	EN-51760 Flywheel Holding Tool
	EN-51768 Engine Support Fixture Adapter Bolts M8

mx30.com

Illustration	Tool Number/Description
	EN-52059 Engine Support Fixture Adapter Bolts M10
	EN-52490-74 Piston Ring Compressor

mcx30.com

Illustration	Tool Number/Description
	GE-7872 J-7872 Magnetic Base Dial Indicator Set
	GE-42220 J-28428-E J-42220 Universal 12V Leak Detection Lamp

mcv30.com

Back To Article

SPECIFICATIONS

FASTENER SPECIFICATIONS

Single Use Non-Threaded Fasteners/Components

NOTE:

All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application
Air Conditioning Compressor Hose Seal
Camshaft Housing Gasket
Catalytic Converter Gasket
Charge Air Bypass Valve Vacuum Hose Seal
Crankshaft Front Oil Seal
Crankshaft Rear Oil Seal
Cylinder Head Gasket
Engine Cooler Outlet Pipe Seal
Engine Core Hole Plug
Engine Oil Level Indicator Switch O-Ring Seal
Exhaust Gas Recirculation Cooler Housing Gasket
Exhaust Gas Recirculation Cooler Outlet Pipe Seal
Exhaust Gas Recirculation Cooler Pipe Gasket
Exhaust Gas Recirculation Valve Gasket
Exhaust Gas Recirculation Valve Seat Gasket
Exhaust Manifold Gasket
Exhaust Pressure Differential Sensor Pipe Clamp
Fuel Injection Fuel Return Hose Clamp
Fuel Injection Pump Seal Ring
Fuel Injector Fuel Return Hose Clamp
Fuel Injector Gasket
Fuel Injector Return Hose Clip
Fuel Return Hose Clamp
Intake Manifold Gasket
Oil Cooler Adapter Gasket
Oil Filter Cap Bolt Gasket
Oil Filter Cap O-Ring
Oil Filter Cap Seal
Oil Filter Seal
Oil Pan Drain Plug Gasket
Power Brake Booster Inlet Hose Connector Fitting Seal
Throttle Body Assembly Gasket
Timing Chain Lower Cover Gasket
Turbocharger Coolant Feed And Return Pipe Bracket Gasket
Turbocharger Coolant Feed Pipe Clamp
Turbocharger Coolant Feed Pipe Gasket
Turbocharger Gasket
Turbocharger Oil Feed Pipe Gasket

NOTE:

All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application
Turbocharger Oil Return Pipe Gasket
Valve Stem Oil Seal
Water Pump Seal

Single Use Threaded Fastener/Component Tightening Specifications

NOTE:

All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application	Specification Metric (English)
Automatic Transmission Flex Plate Bolt	
• First Pass:	60 N.m (44 lb ft)
• Final Pass:	45 degrees
Catalytic Converter Clamp	
• First Pass:	6 N.m (53 lb in)
• Final Pass:	25 N.m (18 lb ft)
Connecting Bearing Cap Bolt	
• First Pass:	25 N.m (18 lb ft)
• Final Pass:	110 degrees
Crankshaft Pulley Bolt	
• First Pass:	50 N.m (37 lb ft)
• Final Pass:	45 degrees
Cylinder Head Bolt	
• First Pass:	50 N.m (37 lb ft)
• Second Pass:	90 degrees
• Third Pass:	90 degrees
• Final Pass:	90 degrees
Cylinder Head Outer Bolt	
• First Pass:	20 N.m (15 lb ft)

mcx30.com

NOTE:
All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application	Specification Metric (English)
• Final Pass:	45 degrees
Engine Mount Bracket Bolt	
• First Pass:	58 N.m (43 lb ft)
• Final Pass:	60 - 75 degrees
Exhaust Manifold Bolt	
• First Pass:	27 N.m (20 lb ft)
• Second Pass:	27 N.m (20 lb ft)
• Final Pass:	27 N.m (20 lb ft)
Fuel Injector Bracket Bolt	
• First Pass:	10 N.m (89 lb in)
• Final Pass:	60 degrees
Fuel Injection Fuel Feed Pipe - Fuel Injection Pump To Fuel Rail	28 N.m (21 lb ft)
Fuel Injection Fuel Feed Pipe - Fuel Rail To Fuel Injector	28 N.m (21 lb ft)
Fuel Injection Fuel Rail Fuel Pressure Sensor	35 N.m (26 lb ft)
Main Bearing Bolt	
• First Pass:	50 N.m (37 lb ft)
• Second Pass:	90 degrees
• Final Pass:	90 degrees
Oil Pump Sprocket Bolt	
• First Pass:	25 N.m (18 lb ft)
• Final Pass:	60 degrees

Reusable Threaded Fastener Tightening Specifications

NOTE:
All fasteners listed in this table can be reused after removal.

Application	Specification Metric (English)

mx30.com

NOTE:

All fasteners listed in this table can be reused after removal.

Application	Specification
	Metric (English)
Air Cleaner Outlet Duct Clamp	3.5 N.m (31 lb in)
Air Conditioning Compressor Bolt	22 N.m (16 lb ft)
Air Conditioning Compressor Hose Bolt	22 N.m (16 lb ft)
Air Conditioning Compressor Nut	22 N.m (16 lb ft)
Camshaft Housing Bolt	10 N.m (89 lb in)
Camshaft Position Sensor Bolt	10 N.m (89 lb in)
Camshaft Rear Cap Bolt	25 N.m (18 lb ft)
Camshaft Sprocket Bolt	25 N.m (18 lb ft)
Catalytic Converter Bracket Nut	22 N.m (16 lb ft)
Catalytic Converter Heat Shield Bolt	9 N.m (80 lb in)
Charger Air Bypass Valve Vacuum Hose Bracket Bolt	10 N.m (89 lb in)
Crankshaft Position Sensor Bolt	10 N.m (89 lb in)
Diesel Fuel Separator Bolt	10 N.m (89 lb in)
Drive Belt Idler Pulley Bolt	58 N.m (43 lb ft)
Drive Belt Tensioner Bolt	55 N.m (41 lb ft)
Engine Block Coolant Drain Hole Plug	65 N.m (48 lb ft)
Engine Block Oil Gallery Plug	65 N.m (48 lb ft)
Engine Block Stud	20 N.m (15 lb ft)
Engine Coolant Temperature Sensor	33 N.m (24 lb ft)
Engine Cooler Outlet Pipe Bolt	25 N.m (18 lb ft)
Engine Lift Bracket Bolt	58 N.m (43 lb ft)
Engine Oil Heater Bolt	9 N.m (80 lb in)
Engine Oil Level Indicator Switch Bolt	10 N.m (89 lb in)
Engine Oil Pressure Sensor	35 N.m (26 lb ft)
Engine Oil Pressure Switch	35 N.m (26 lb ft)
Exhaust Camshaft Bearing Cap Bolt	10 N.m (89 lb in)
Exhaust Gas Recirculation Cooler Bolt	25 N.m (18 lb ft)
Exhaust Gas Recirculation Cooler Outlet Pipe Bolt	10 N.m (89 lb in)
Exhaust Gas Recirculation Cooler Temperature Sensor	45 N.m (33 lb ft)
Exhaust Gas Recirculation Pipe Bolt	10 N.m (89 lb in)
Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve Bolt	7 N.m (62 lb in)
Exhaust Gas Recirculation Valve Bolt	10 N.m (89 lb in)
Exhaust Particulate Sensor Control Module Bracket Bolt	9 N.m (80 lb in)
Exhaust Pressure Differential Sensor Bolt	9 N.m (80 lb in)
Exhaust Pressure Differential Sensor Pipe Bracket Bolt	9 N.m (80 lb in)
Exhaust Temperature Sensor	45 N.m (33 lb ft)
Exhaust Temperature Sensor Electrical Connector Bracket Bolt	9 N.m (80 lb in)
Exhaust Temperature Wiring Harness Bracket Bolt	10 N.m (89 lb in)
Fuel Injection Fuel Feed Pipe Bracket Bolt	9 N.m (80 lb in)
Fuel Injection Fuel Pump Bolt	25 N.m (18 lb ft)
Fuel Injection Fuel Rail Bolt	25 N.m (18 lb ft)
Fuel Injection Fuel Rail Fuel Pressure Sensor Wire Bracket Bolt	9 N.m (80 lb in)
Fuel Injection Fuel Rail Pressor Sensor Wiring Harness Bracket Bolt	9 N.m (80 lb in)
Fuel Injection Fuel Return Pipe Bracket Bolt	7 N.m (62 lb in)
Fuel Injection Pipe Bracket Bolt	9 N.m (80 lb in)
Fuel Injection Pump Driven Sprocket Nut	64 N.m (47 lb ft)

mcx30.com

NOTE:

All fasteners listed in this table can be reused after removal.

Application	Specification
	Metric (English)
Generator Bolt	22 N.m (16 lb ft)
Glow Plug	16.5 N.m (12 lb ft)
Heated Oxygen Sensor	45 N.m (33 lb ft)
Intake Air Pressure and Temperature Sensor Bolt	1.6 N.m (14 lb in)
Intake Camshaft Bearing Cap Bolt	10 N.m (89 lb in)
Intake Manifold Bolt	12 N.m (106 lb in)
Intake Manifold Brace Bolt	10 N.m (89 lb in)
Lower Crankcase Bolt	34 N.m (25 lb ft)
Nitrogen Oxides Sensor	50 N.m (37 lb ft)
Nitrogen Oxides Sensor Control Module Nut	9 N.m (80 lb in)
Oil Cooler Bolt	25 N.m (18 lb ft)
Oil Filter Cap	25 N.m (18 lb ft)
Oil Filter Cap Bolt	10 N.m (89 lb in)
Oil Pan Baffle Bolt	10 N.m (89 lb in)
Oil Pan Bolt	25 N.m (18 lb ft)
Oil Pan Drain Plug	25 N.m (18 lb ft)
Oil Pump Bolt	25 N.m (18 lb ft)
Oil Pump Drive Chain Tensioner Bolt (M6)	10 N.m (89 lb in)
Oil Pump Drive Chain Tensioner Bolt (M8)	25 N.m (18 lb ft)
Piston Oil Nozzle Bolt	10 N.m (89 lb in)
Piston Oil Nozzle Oil Control Solenoid Valve Bolt	10 N.m (89 lb in)
Power Brake Booster Inlet Hose Connector Fitting Bolt	10 N.m (89 lb in)
Starter Bolt	22 N.m (16 lb ft)
Thermostat Bypass Pipe Bolt	10 N.m (89 lb in)
Thermostat Bypass Pipe Bracket Bolt	10 N.m (89 lb in)
Throttle Body Assembly Bolt	10 N.m (89 lb in)
Timing Chain Idler Sprocket Bolt	25 N.m (18 lb ft)
Timing Chain Lower Cover Bolt	25 N.m (18 lb ft)
Timing Chain Lower Guide Bolt	10 N.m (89 lb in)
Timing Chain Tensioner Bolt	10 N.m (89 lb in)
Timing Chain Tensioner Shoe Bolt	25 N.m (18 lb ft)
Timing Chain Upper Cover Bolt	25 N.m (18 lb ft)
Timing Chain Upper Cover Sleeve	25 N.m (18 lb ft)
Timing Chain Upper Cover Sleeve Bolt	25 N.m (18 lb ft)
Timing Chain Upper Guide Bolt	11 N.m (97 lb in)
Turbocharger Coolant Feed Pipe Bolt	10 N.m (89 lb in)
Turbocharger Coolant Feed Pipe Bracket Nut	10 N.m (89 lb in)
Turbocharger Coolant Feed Pipe Hollow Bolt	25 N.m (18 lb ft)
Turbocharger Heat Shield Bolt	9 N.m (80 lb in)
Turbocharger Heat Shield Nut	9 N.m (80 lb in)
Turbocharger Nut	30 N.m (22 lb ft)
Turbocharger Oil Feed Pipe Bolt	10 N.m (89 lb in)
Turbocharger Oil Feed Pipe Bracket Bolt	10 N.m (89 lb in)
Turbocharger Oil Feed Pipe Hollow Bolt	25 N.m (18 lb ft)
Turbocharger Oil Return Pipe Bolt (M6)	10 N.m (89 lb in)
Turbocharger Oil Return Pipe Bolt (M8)	25 N.m (18 lb ft)
Turbocharger Wastegate Actuator Pipe Bracket Bolt	10 N.m (89 lb in)
Turbocharger Wastegate Actuator Pipe Nut	10 N.m (89 lb in)
Water Pump Bolt	25 N.m (18 lb ft)

mcx30.com

APPROXIMATE FLUID CAPACITIES

Application	Specification	
	Metric	English
Engine Cooling System Capacity	5.9 liters	6.23 quarts
Engine Oil Capacity	5 liters	5.28 quarts

ENGINE MECHANICAL SPECIFICATIONS

Application	Specification	
	Metric	English
General Data		
• RPO	LH7	
• Engine Type	4-Cylinder Inline	
• Displacement	1598 ccm	97.5 cu in
• Bore Diameter	79.7 mm	3.14 in
• Stroke	80.1 mm	3.15 in
• Bore Distance	88.7 mm	3.49 in
• Compression Ratio	16.0:1	
• Output @ Engine Speed	100 kW / 4000 RPM	
• Torque @ Engine Speed	320 N.m / 2000 RPM	236 lb ft / 2000 RPM
• Idle Speed	800 RPM	
• No-Load max. Speed	5500 RPM	
• Compression	2000 kPa	290 PSI
• Leakage of Pressure	< 25% per Cylinder	
• Injection Pressure of the Common Rail System	200 MPa	29008 PSI
Engine Management		
• ECM Type	E98 D1P	
• Injection Pressure Pump Type	D1P	

mcx30.com

Application	Specification	
	Metric	English
• Injector Type	Denso - G3.5S	
• Firing Order	1 - 3 - 4 - 2	
• Glow Plug Type	without Pressure Sensor	
• Glow Plug Voltage	4.4 Volt	
Oil Circulation System		
• Engine Oil Filling with Oil Filter	Refer to **Approximate Fluid Capacities**	
• Engine Oil Filling between "min." and "max."	1.0 L	1.06 quarts
• Engine Oil Quality	ACEA C3 or A3/B4	
• Engine Oil Viscosity	0W-30, 5W-30, 0W-40, 5W-40	
• Disposal of Engine Oil	For disposal the engine oil follow safety regulations and national legislation.	
• Oil Consumption / 1000 km	max 0.6 L	max 0.63 quarts
Oil Pump		
• Oil Pump Type	2 Steps Variable Displacement Oil Pump with Solenoid Control	
• Oil Pressure with Idle Speed and under hot running conditions		
• Solenoid: On	> 100 kPa / 800 RPM	
• Solenoid: Off	> 100 kPa / 800 RPM	
• Oil Pressure with 4000 RPM under hot running conditions		
• Solenoid: On	260-280 kPa / 4000 RPM	
• Solenoid: Off	660-680 kPa / 4000 RPM	
Coolant System		
• Type of Coolant Pump	Non Switchable Water Pump	
• Filling	Refer to **Approximate Fluid Capacities**	

mcx30.com

Application	Specification	
	Metric	English
• Coolant Flow Cylinder Block inlet with 4000 RPM	167 L / min	44.12 gal / min
• Coolant Flow Radiator Flow with 4000 RPM	130 L / min	34.34 gal / min
Coolant pressurization	240 kPa	34.8 PSI
Thermostat		
• Type	Thermal Controlled Thermostat	
• Start to Opening	88Â°C	190.4Â°F
• Fully Open	102Â°C	215.6Â°F
Cylinder Head Gasket		
• Cylinder Head Gasket Thickness / Piston Projection Dimension (identification mark on Position I)	1.06-1.20 mm / 0.193 - 0.350 mm	0.042-0.047 in / 0.008 - 0.014 in
• Cylinder Head Gasket Thickness / Piston Projection Dimension (identification mark on Position II)	1.155-1.305 mm / 0.350 - 0.450 mm	0.045-0.051 in / 0.014 - 0.018 in
• Cylinder Head Gasket Thickness / Piston Projection Dimension (identification mark on Position III)	1.255-1.405 mm / 0.450 - 0.565 mm	0.049-0.055 in / 0.018 - 0.022 in
Cylinder Head		
• Cylinder Head Height	127 Â± 0.15 mm	5.000 Â± 0.006 in
• Maximum Sag of Cylinder Head	0.10 mm	0.0039 in
• Valve Seat Angle at Valve Head	45 degrees Â± 20 minutes	45 degrees Â± 0.33 degrees
• Valve Guide External Diameter Standard	9.528-9.539 mm	0.3751-0.3756 in
Valves		
• Valve Stem Diameter - Intake	4.969-4.985 mm	0.1956-0.1963 in
• Valve Stem Diameter - Exhaust	4.959-4.975 mm	0.1952-0.1959 in
• Valve Spring Length - Unstressed	42.87 mm	1.688 in
• Valve Spring Length - 22.8 - 25.2 daN	32.0 mm	1.260 in
• Valve Spring Length - 44.2 - 44.7 daN	24.0 mm	0.945 in

mcx30.com

Application	Specification	
	Metric	English
• Valve Diameter Intake	26.54-26.8 mm	1.0449-1.0551 in
• Valve Diameter Exhaust	24.24-24.5 mm	0.9543-0.9646 in
Engine Block		
• Engine Block Height	220.25 mm	8.67 in
• Conrod Length	135 mm	5.32 in
• Compression Height	46.65 mm	1.84 in
Cylinder Bore		
• Cylinder Bore Diameter	79.692-79.708 mm	3.1375-3.1381 in
• Oval Diameter Range	Â± 0.013 mm	Â± 0.0005 in
• Oversize Cylinder Bore Diameter	0.25 mm	0.0098 in
Camshaft		
• Camshaft Bearing Journal Diameter - 1-4 Bearing Journal	23.948 Â± 0.012 mm	0.9428 Â± 0.0005 in
• Camshaft Bearing Journal Diameter - Rear Bearing Journal	28.448 Â± 0.012 mm	1.1200 Â± 0.0005 in
• Camshaft Axial Clearance	0.090-0.190 mm	0.0035-0.0075 in
Camshaft Bearing		
• Camshaft Bearing Diameter - 1-4 Bearing Journal	24.000-24.020 mm	0.9448-0.9457 mm
• Camshaft Bearing Diameter - Rear Bearing Journal	28.500-28.520 mm	1.1220-1.1228 in
Connecting Rod		
• Con Rod Bearing Bushing Internal Diameter	29.017-29.031 mm	1.1424-1.1429 in
• Con Rod Big End Bore Diameter	52.992-53.008 mm	2.0863-2.0869 in
Connecting Rod Bearing	Â	Â
• Con Rod Bearing Shell Thickness (Upper Shell - Blue - Class B)	1.469-1.473 mm	0.0578-0.0580 in
• Con Rod Bearing Shell Thickness (Lower Shell - Blue - Class B)	1.469-1.473 mm	0.0578-0.0580 in

mcx30.com

Application	Specification	
	Metric	English
• Con Rod Bearing Shell Thickness (Upper Shell - Yellow - Class C)	1.473-1.477 mm	0.0580-0.0581 in
• Con Rod Bearing Shell Thickness (Lower Shell - Yellow - Class C)	1.473-1.477 mm	0.0580-0.0581 in
• Con Rod Bearing Shell Thickness (Upper Shell - Green - Class D)	1.477-1.481 mm	0.0581-0.0583 in
• Con Rod Bearing Shell Thickness (Lower Shell - Green - Class D)	1.477-1.481 mm	0.0581-0.0583 in
• Con Rod Bearing Shell Thickness (Upper Shell - Black - Class E)	1.481-1.485 mm	0.0583-0.0585 in
• Con Rod Bearing Shell Thickness (Lower Shell - Black - Class E)	1.481-1.485 mm	0.0583-0.0585 in
• Con Rod Bearing Shell Thickness Oversize (Upper Shell)	1.535-1.545 mm	0.0604-0.0608 in
• Con Rod Bearing Shell Thickness Oversize (Lower Shell)	1.535-1.541 mm	0.0604-0.0607 in
• Con Rod Bearing Clearance	0.072-0.02 mm	0.0028-0.0008 in
Crankshaft		
• Main Bearing Journal Diameter Standard Size	52.982-52.998 mm	2.0859-2.0865 in
• Main Bearing Journal Diameter Undersize	52.855-52.871 mm	2.0809-2.0815 in
• Crankshaft Journal Width for Thrust Bearing	25.810-25.890 mm	1.0161-1.0193 in
• Connecting Rod Bearing Journal Diameter	49.992-50.008 mm	1.9682-1.9688 in
Main Bearing		
• Main Bearing Shell Thickness Standard Size	2.261-2.269 mm	0.0890-0.0893 in
• Main Bearing Shell Thickness Oversize	2.324-2.332 mm	0.0915-0.0918 in
• Axial Thrust Washers Thickness	2.000-2.030 mm	0.0787-0.0799 in
• Axial Clearance	0.110-0.330 mm	0.0043-0.0130 in

mcx30.com

Application	Specification	
	Metric	English
• Main Bearing Clearance	0.038-0.086 mm	0.0015-0.0034 in
Engine Block		
• Bearing Bore Diameter in Cylinder Block	57.551 Â± 0.007 mm	2.2658 Â± 0.00028 in
Piston		
• Piston Diameter	79.655 Â± 0.007 mm	3.1360 Â± 0.00028 in
• Piston Projection Dimension	0.193-0.565 mm	0.0076-0.0222 in
• Piston Pin Diameter	28.997-29.000 mm	1.1416-1.1417 in
• Piston Pin Eye Diameter	29.008-29.013 mm	1.1420-1.1422 in
• Clearance Piston Pin in Piston	0.008-0.016 mm	0.0003-0.0006 in
• Clearance Piston Pin in Con Rod	0.017-0.034 mm	0.0007-0.0013 in
• Piston Weight Difference	Â± 0.005 kg	
Piston Rings		
• Compression Ring 1 - Thickness	1.47-1.495 mm	0.0579-0.0589 in
• Compression Ring 2 - Thickness	1.47-1.495 mm	0.0579-0.0589 in
• Oil Scraper Ring - Thickness	1.97-1.99 mm	0.0776-0.0783 in
• Compression Ring 1 - Axial Clearance	0.115-0.16 mm	0.0045-0.0063 in
• Compression Ring 2 - Axial Clearance	0.095-0.14 mm	0.0037-0.0055 in
• Oil Scraper Ring - Axial Clearance	0.025-0.065 mm	0.0010-0.0026 in
• Compression Ring 1 - Gap	0.20-0.35 mm	0.0079-0.0137 in
• Compression Ring 2 - Gap	0.5-0.7 mm	0.0197-0.0276 in
• Oil Scraper Ring - Gap	0.25-0.5 mm	0.0098-0.0197 in

mcx30.com

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number

Application	Type of Material	GM Part Number	
		United States	Canada
Anti-Seize Compound	Lubricant	88862477	88862478
Bolt Connections	Threadlocker	12345382	10953489
Engine Oil	DEXOS2, 5W-30	19354306	19354309
Exhaust Emission Reduction Fluid	Fluid	19286291	88865654
Oil Pan Sealant	Sealant	12378521	10953476
Top Engine Cleaner	Cleaner	1052626	993026

SCHEMATIC WIRING DIAGRAMS

ENGINE MECHANICAL WIRING SCHEMATICS (1.6L (LH7))

Oil Pressure Control (LH7)

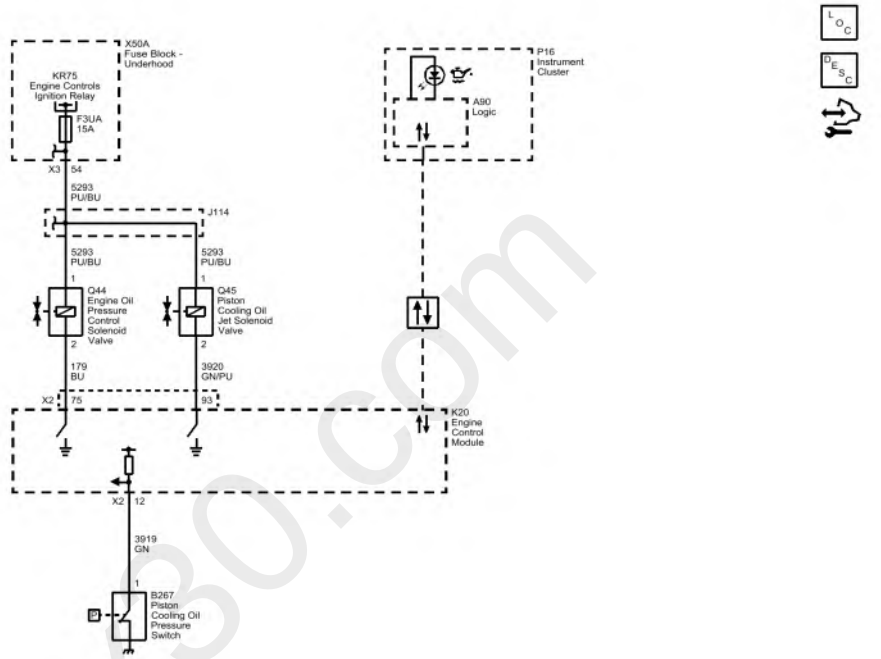


Fig. 1: Oil Pressure Control (LH7)
Courtesy of GENERAL MOTORS COMPANY

COMPONENT LOCATOR

DISASSEMBLED VIEWS

Intake Manifold

mcx30.com

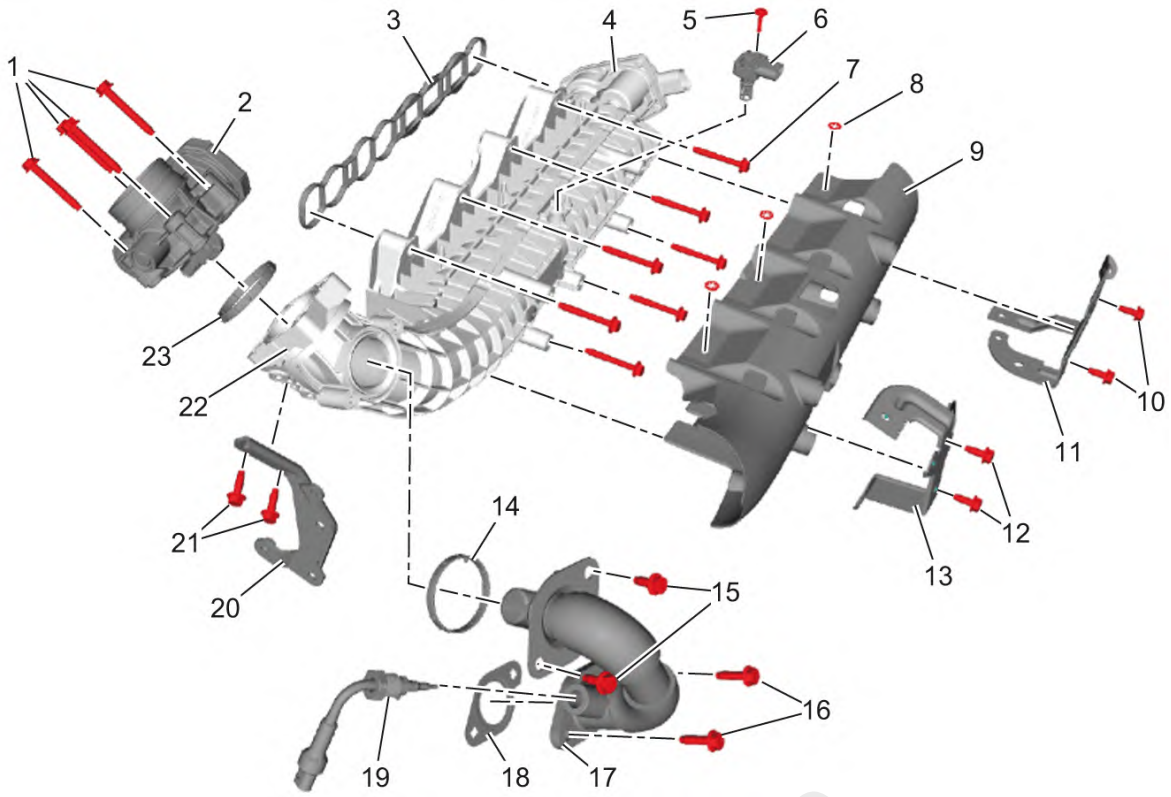


Fig. 2: Intake Manifold Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Throttle Body Bolt
2	Throttle Body
3	Intake Manifold Gasket
4	Intake Manifold Runner Control Valve Actuator
5	Intake Air Pressure and Temperature Sensor Bolt
6	Intake Air Pressure and Temperature Sensor
7	Intake Manifold Bolt
8	Intake Manifold Cover Washer
9	Intake Manifold Cover
10	Fuel Injection Fuel Return Pipe Bracket Bolt
11	Fuel Injection Fuel Return Pipe Bracket
12	Fuel Injection Fuel Rail Pressure Sensor Wiring Harness Bracket Bolt
13	Fuel Injection Fuel Rail Pressure Sensor Wiring Harness Bracket
14	Exhaust Gas Recirculation Cooler Outlet Pipe Seal
15	Exhaust Gas Recirculation Cooler Outlet Pipe Bolt
16	Exhaust Gas Recirculation Cooler Outlet Pipe Bolt
17	Exhaust Gas Recirculation Cooler Outlet Pipe
18	Exhaust Gas Recirculation Cooler Outlet Pipe Gasket
19	Exhaust Gas Recirculation Cooler Temperature Sensor-Position 2
20	Intake Manifold Brace
21	Intake Manifold Brace Bolt
22	Intake Manifold
23	Throttle Body Seal

Turbocharger

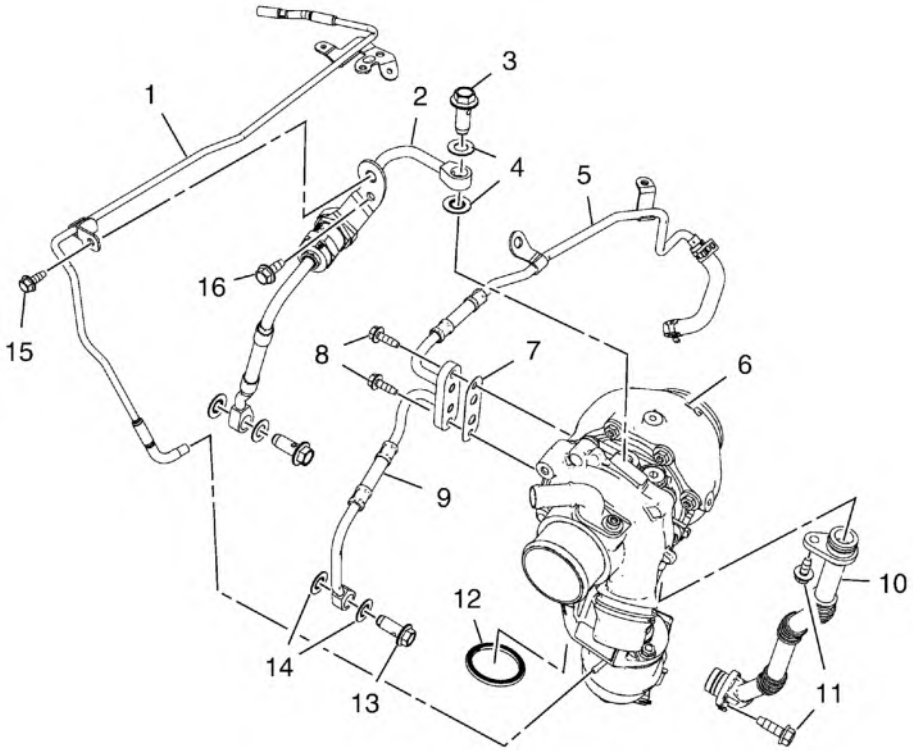


Fig. 3: Turbocharger Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Turbocharger Wastegate Actuator Pipe
2	Turbocharger Oil Feed Pipe
3	Turbocharger Oil Feed Pipe Bolt
4	Turbocharger Oil Feed Pipe Gaskets
5	Turbocharger Coolant Return Pipe
6	Turbocharger
7	Turbocharger Coolant Feed and Return Pipe Gasket
8	Turbocharger Coolant Feed and Return Pipe Bolts
9	Turbocharger Coolant Feed Pipe
10	Turbocharger Oil Return Pipe
11	Turbocharger Oil Return Pipe Bolts
12	Turbocharger Gasket
13	Turbocharger Coolant Feed Pipe Bolt
14	Turbocharger Coolant Feed Pipe Gaskets
15	Turbocharger Wastegate Actuator Pipe Bracket Bolt
16	Turbocharger Oil Feed Pipe Bracket Bolt

Exhaust Manifold

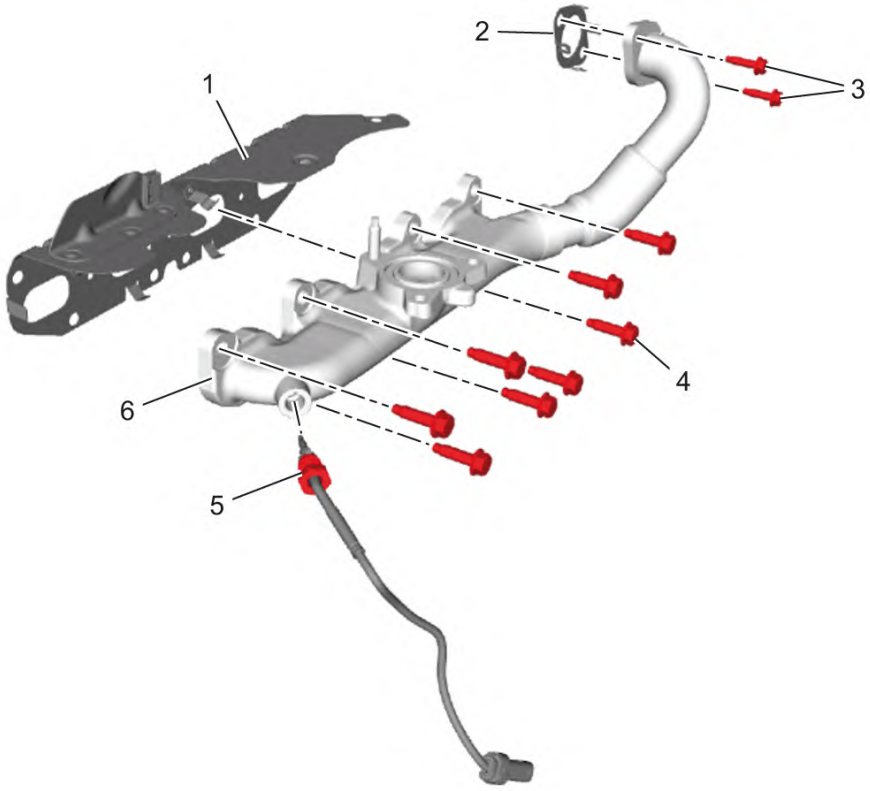


Fig. 4: Exhaust Manifold Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Exhaust Manifold Gasket
2	Exhaust Gas Recirculation Pipe Gasket
3	Exhaust Gas Recirculation Pipe Bolt
4	Exhaust Manifold Bolt
5	Exhaust Gas Recirculation Cooler Temperature Sensor-Position 1
6	Exhaust Manifold

Fuel Injection Fuel System

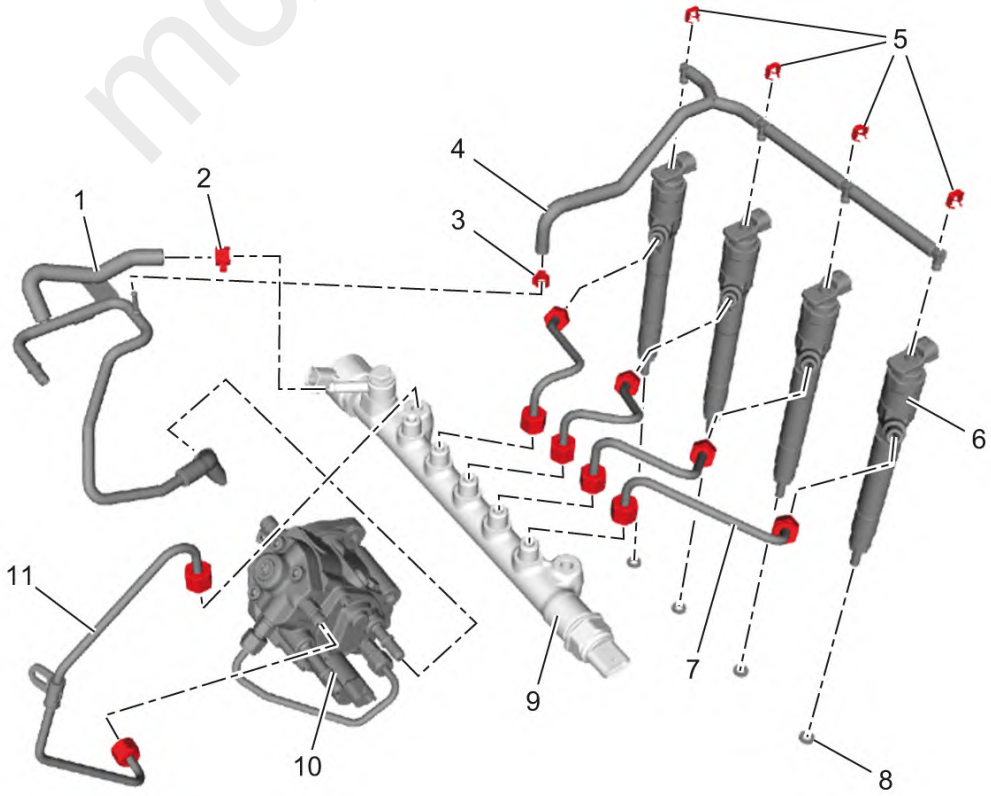


Fig. 5: Fuel Injection Fuel System Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Diesel Fuel Separator
2	Diesel Fuel Separator Hose Clamp
3	Fuel Return Hose Clamp
4	Fuel Return Hose
5	Fuel Return Hose Clip
6	Fuel Injector
7	Fuel Injection Fuel Feed Pipe - Fuel Rail to Fuel Injector
8	Fuel Injector Seal Ring
9	Fuel Rail
10	Fuel Injection Pump
11	Fuel Injection Fuel Feed Pipe - Fuel Injection Pump to Fuel Rail

Timing Chain System

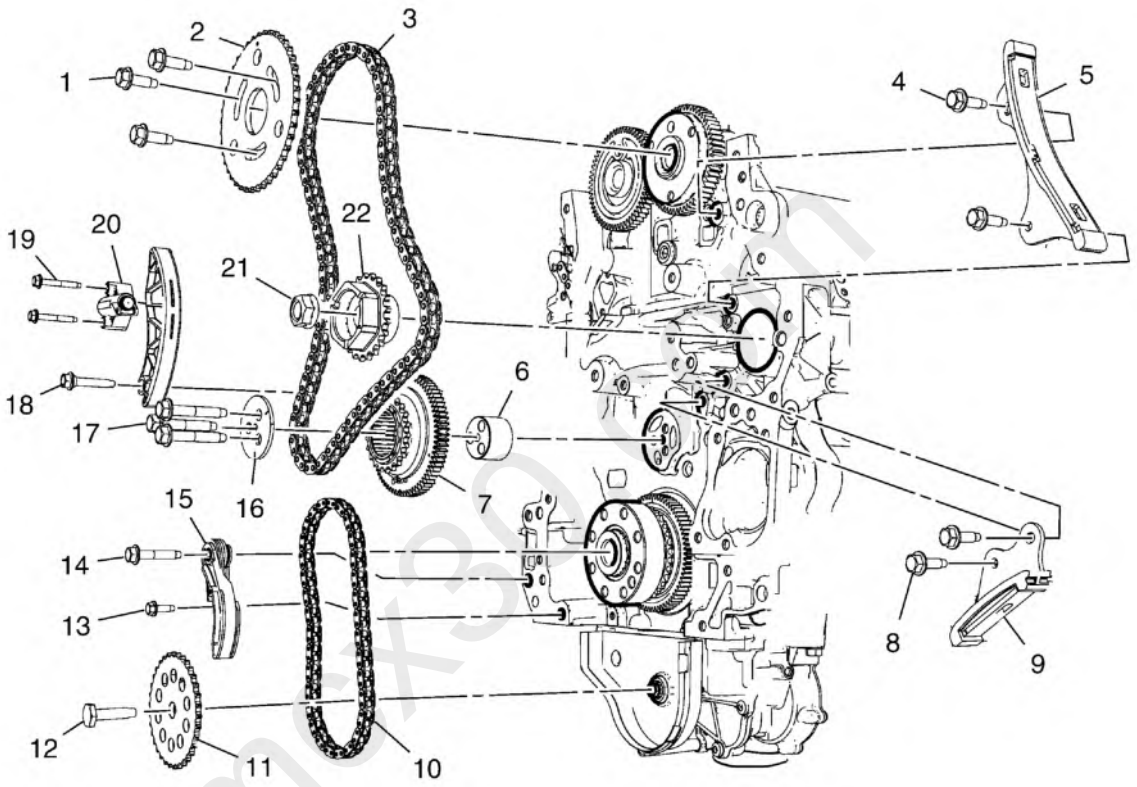


Fig. 6: Timing Chain System Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Sprocket Bolts
2	Camshaft Sprocket
3	Timing Chain
4	Timing Chain Upper Guide Bolts
5	Timing Chain Upper Guide
6	Gear Shaft Distributor
7	Timing Chain Idler Sprocket
8	Timing Chain Lower Guide Bolts
9	Timing Chain Lower Guide
10	Oil Pump Drive Chain
11	Oil pump Sprocket
12	Oil Pump Sprocket Bolt
13	Oil Pump Drive Chain Tensioner Bolts
14	Oil Pump Drive Chain Tensioner Shoe Bolt
15	Oil Pump Drive Chain Tensioner
16	Timing Chain Idler Sprocket Bearing Plate

Callout	Component Name
17	Timing Chain Idler Sprocket Bolts
18	Timing Chain Tensioner Shoe Bolt
19	Timing Chain Tensioner Bolts
20	Timing Chain Tensioner
21	Fuel Injection Fuel Pump Sprocket Bolt
22	Fuel Injection Fuel Pump Sprocket

Camshaft Housing

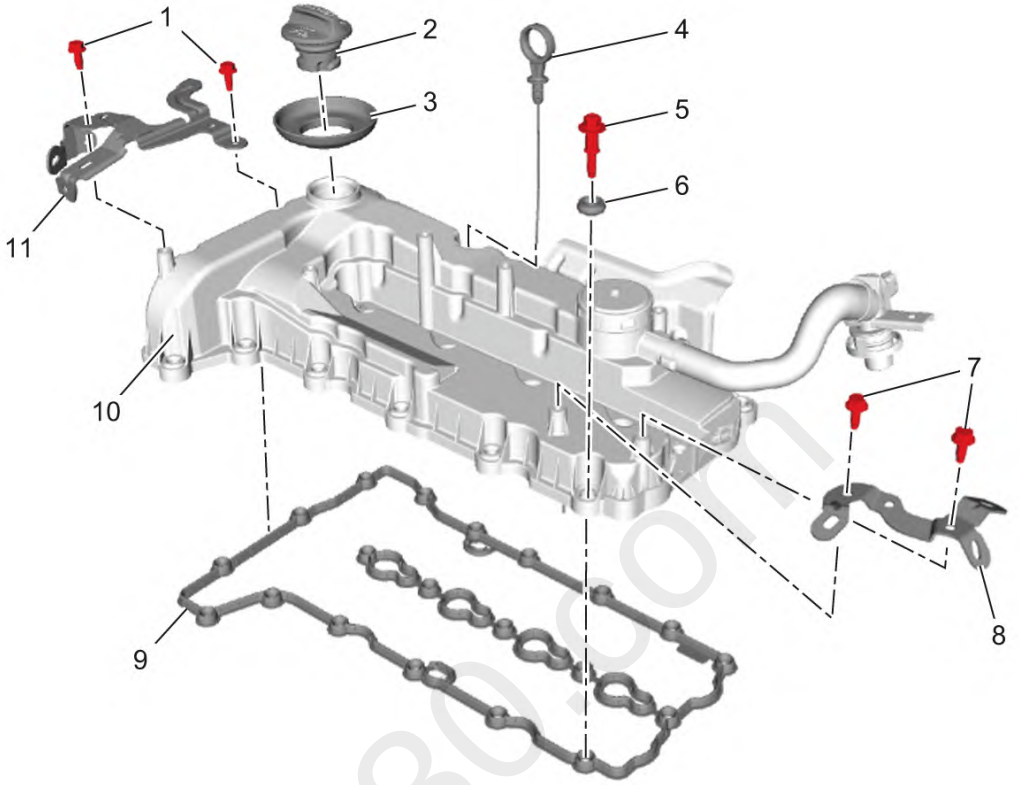


Fig. 7: Camshaft Housing Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Wiring Harness Bracket Bolt
2	Oil Filler Cap
3	Oil Filler Tube Gasket
4	Oil Level Indicator
5	Camshaft Housing Cover Bolt
6	Camshaft Housing Cover Insulator
7	Wiring Harness Bracket Bolt
8	Wiring Harness Bracket
9	Camshaft Housing Cover Gasket
10	Camshaft Housing
11	Wiring Harness Bracket

Cylinder Head

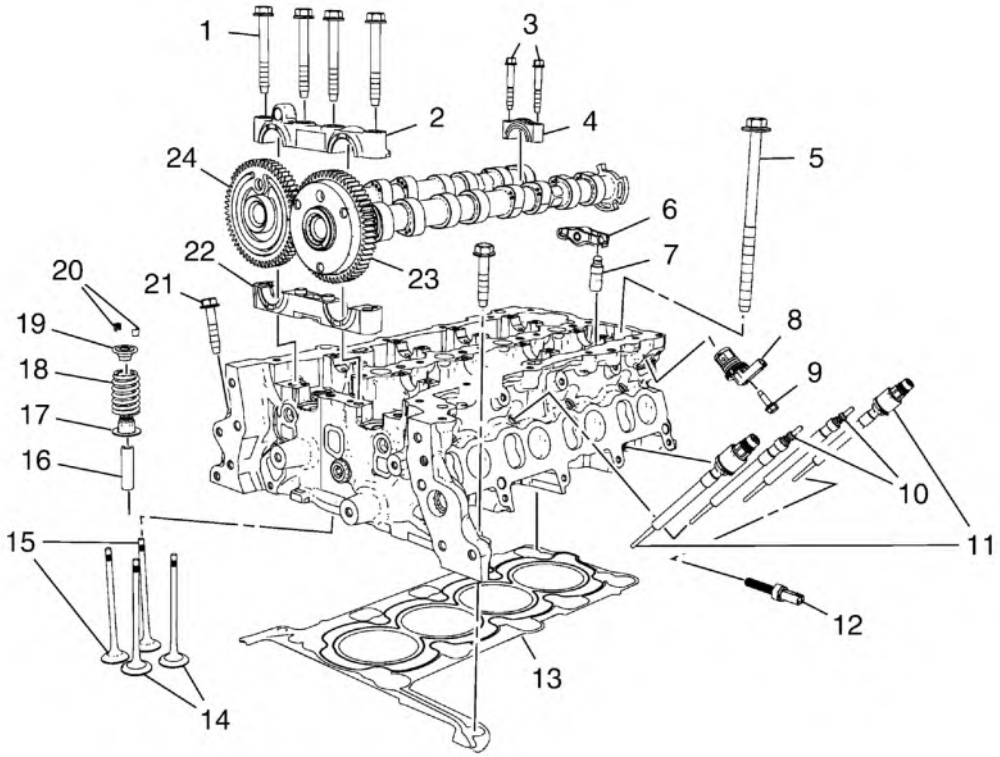


Fig. 8: Cylinder Head Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Bearing Rear Cap Bolts
2	Camshaft Bearing Rear Cap
3	Camshaft Bearing Cap Bolts
4	Camshaft Bearing Cap
5	Cylinder Head Bolts
6	Valve Lifter Roller
7	Valve Lifter
8	Camshaft Position Sensor
9	Camshaft Position Sensor Bolt
10	Glow Plugs without Pressure Sensor
11	Glow Plugs with Pressure Sensor
12	Engine Metal Temperature Sensor
13	Cylinder Head Gasket
14	Intake Valves
15	Exhaust Valves
16	Valve Guides
17	Valve Stem Oil Seal
18	Valve Spring
19	Valve Spring Retainer
20	Valve Stem Keys
21	Cylinder Head Outer Bolts
22	Camshaft Lower Rear Bearing
23	Intake Camshaft
24	Exhaust Camshaft

Engine Block

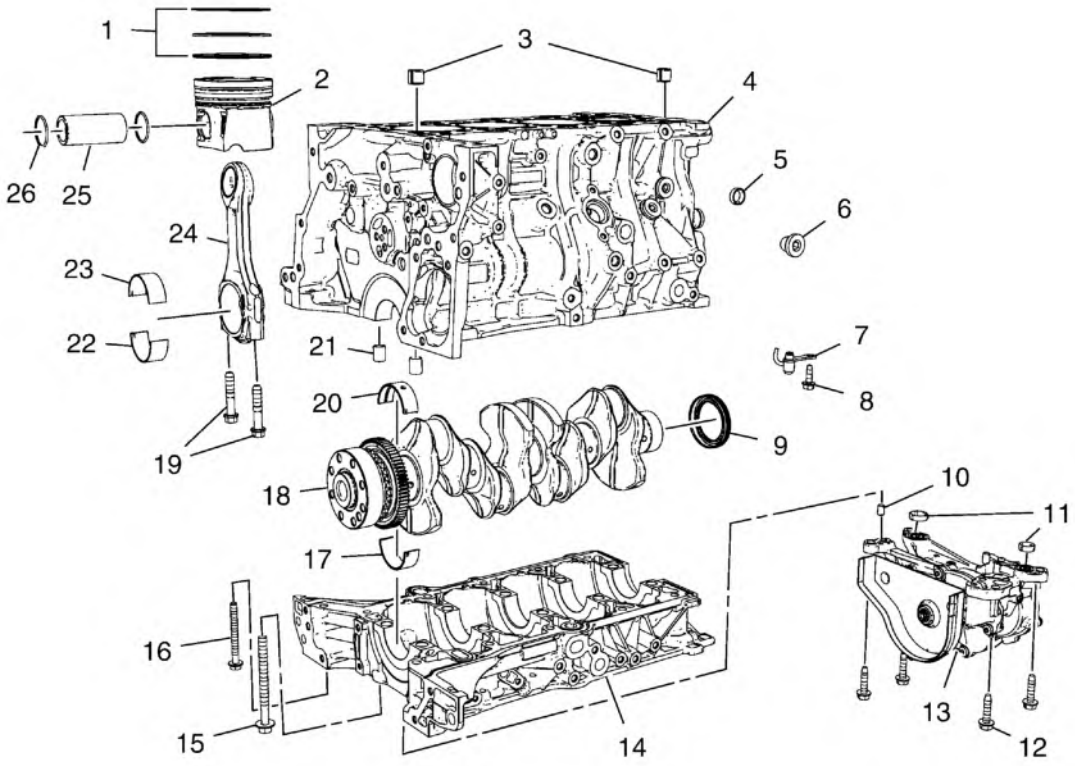


Fig. 9: Engine Block Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Piston Rings
2	Piston
3	Cylinder Head Locating Pins
4	Engine Block
5	Oil Gallery Plug
6	Oil Gallery Plug Bolt
7	Piston Oil Nozzle
8	Piston Oil Nozzle Bolt
9	Crankshaft Front Oil Seal
10	Oil Pump Locating Pin
11	Oil and Power Brake Booster Pump Gasket
12	Oil and Power Brake Booster Pump Bolts
13	Oil and Power Brake Booster Pump
14	Lower Crankcase
15	Lower Crankcase Bearing Bolts
16	Lower Crankcase Bolts
17	Crankshaft Lower Bearing
18	Crankshaft
19	Connecting Rod Bearing Cap Bolts
20	Crankshaft Upper Bearing
21	Crankcase Locating Pins
22	Connecting Rod Lower Bearings
23	Connecting Rod Upper Bearings
24	Connecting Rod
25	Piston Pin
26	Piston Pin Retainer

ENGINE IDENTIFICATION

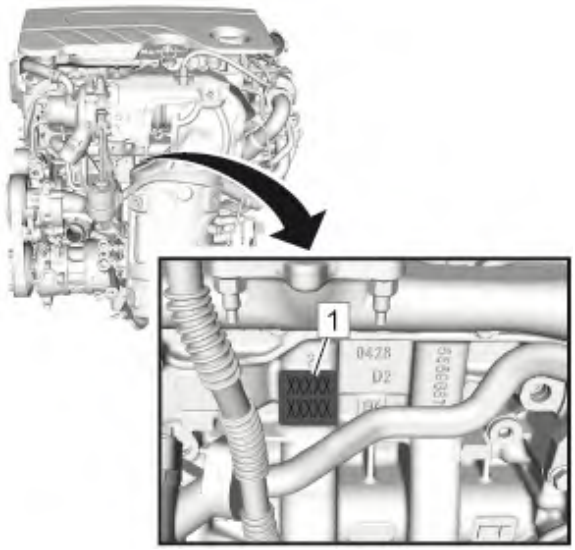


Fig. 10: Broadcast Code Label
Courtesy of GENERAL MOTORS COMPANY

1. Identification can be made through the use of the broadcast code label (1) on the engine.

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P06DA-P06DE: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CONTROL CIRCUIT/ENGINE OIL PRESSURE CONTROL SOLENOID VALVE STUCK

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**
- An overview of each diagnostic category can be found here: **Diagnostic Procedure Instructions**

DTC Descriptor

DTC P06DA

Engine Oil Pressure Control Solenoid Valve Control Circuit

DTC P06DB

Engine Oil Pressure Control Solenoid Valve Control Circuit Low Voltage

DTC P06DC

Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage

DTC P06DD

Engine Oil Pressure Control Solenoid Valve Stuck Off

DTC P06DE

Engine Oil Pressure Control Solenoid Valve Stuck On

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P06DA, P06DB*	P06DA, P06DB	-	-
Control	P06DB	P06DA	P06DC	P06DD, P06DE
* Additional DTCs may set.				

mcx30.com

Circuit/System Description

Circuit	Description
Ignition	Supplied from a fuse.
Control	The output circuit is switched to ground to activate the component.

Component	Description
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.
Q44 Engine Oil Pressure Control Solenoid Valve	A solenoid valve is an electro-mechanically operated valve. The valve is controlled by an electric current through the solenoid.

The engine oil pressure control solenoid valve is used to control engine oil pressure inside the mechanical engine oil pump. The control module controls the commanded state of the solenoid valve based on the following inputs:

- Engine Speed
- Calculated Engine Oil Temperature
- Engine Oil Pressure
- Engine Run Time

When the solenoid valve is commanded Off, oil pressure is higher. When the solenoid valve is commanded On, oil pressure is lower.

Conditions for Running the DTC

DTC P06DA, P06DB, P06DC

- Ignition Voltage = Greater than 11 V
- Engine = Running

Frequency the DTC runs = Continuously

DTC P06DD, P06DE

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0335, P0336, P0521, P0522, P0523, P06DA, P06DB, P06DC, P06DE, P111E, P2227, P2228, P2229, P2230 = Not set
- Engine = Running - For greater than 10 s
- Engine Speed = 1, 400 to 2, 640 RPM
- Barometric Pressure = Greater than 70 kPa (10 PSI)
- Engine Oil Temperature = 50 to 100Â°C (122 to 212Â°F)
- Engine Oil Pressure Control Solenoid Valve = On - For greater than 1.6 s

Frequency the DTC runs = Continuously

Conditions for Setting the DTC

DTC P06DA, P06DB, P06DC

Control Circuit = Commanded state does not match the actual state - For greater than 1 s

DTC P06DD, P06DE

Engine Oil Pressure = Less than a predefined threshold

Actions Taken When the DTC Sets

- DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below

mcx30.com

DTC P06DB, P06DD, P06DE = Type A DTC

- Engine Oil Pressure Control Solenoid Valve = Off
- Reduced Engine Power = Active

Conditions for Clearing the DTC

- DTCs listed in the DTC Descriptor Category = Type B DTC - Exceptions listed below
- DTC P06DB, P06DD, P06DE = Type A DTC

Reference Information

Schematic Reference

Engine Mechanical Wiring Schematics (1.6L (LH7))

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

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

Circuit/System Verification

NOTE: **The engine oil level and condition is critical to the correct operation of the system.**

1. Ignition - On/Vehicle - In Service Mode
2. Verify there are no DTCs set related to the following system/component:
   - B35B Engine Oil Level Sensor
   - B37B Engine Oil Pressure Sensor
   - B37 Engine Oil Pressure Switch
   - **If other DTCs are set**

     Refer to: **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If no other DTCs are set**
3. Verify the condition does not exist: Engine Oil - Contaminated/Dirty/Fill Level = Low
   - **If a condition exists**

     Repair as necessary

   - **Go to next step: If no condition exists**
4. Perform the scan tool control function: Engine Oil Pressure Control Solenoid Valve - Low Pressure - High Pressure

mcx30.com

Verify the scan tool parameter:

- Engine Oil Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status = OK or Not Run
- Engine Oil Pressure Control Solenoid Valve Control Circuit Open Test Status = OK or Not Run
- Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status = OK or Not Run
- **If not the specified state**

  Refer to: Circuit/System Testing

- **Go to next step: If the specified state**

5. Ignition - On/Vehicle - In Service Mode
6. Verify the scan tool parameter:
   - Engine Oil Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status = OK or Not Run
   - Engine Oil Pressure Control Solenoid Valve Control Circuit Open Test Status = OK or Not Run
   - Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status = OK or Not Run
   - Perform the action while monitoring the parameter:
   - Wiggle the harness and connector: Q44 Engine Oil Pressure Control Solenoid Valve
   - Wiggle the harness and connector: K20 Engine Control Module
   - **If not the specified state**

     Repair as necessary - Wiring/Terminal(s)/Electrical Connector(s)

   - **Go to next step: If the specified state**
7. Engine running.
8. Perform the following steps:
   1. Increase the engine speed slowly to 1, 800 RPM.

      NOTE: Using the scan tool line graph function may make it easier to identify if the value changes.

   2. Perform the scan tool control function: Engine Oil Pressure Control Solenoid Valve - Low Pressure

      Verify the scan tool parameter: Engine Oil Pressure = Change is greater than 30 kPa (4 PSI)

      - If the change is 30 kPa (4 PSI) or less - Replace the component: Q44 Engine Oil Pressure Control Solenoid Valve
      - If the change is greater than 30 kPa (4 PSI)
9. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

   - **If the DTC sets**

     Refer to: Circuit/System Testing

   - **Go to next step: If the DTC is not set**
10. All OK.

Circuit/System Testing

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: Q44 Engine Oil Pressure Control Solenoid Valve
3. Ignition - On/Vehicle - In Service Mode
4. Verify a test lamp turns On between the test points: Ignition circuit terminal 1 & Ground
   - **If the test lamp does not turn On and the circuit fuse is OK**
   1. Ignition/Vehicle - Off & Remove - Test lamp
   2. Test for less than 2 ohms between the test points: Ignition circuit terminal 1 & Output terminal @ Fuse

nicx30.com

- If 2 ohms or greater - Repair the open/high resistance in the circuit.
- If less than 2 ohms - Verify the fuse is OK and there is voltage at the fuse.

- **If the test lamp does not turn On and the circuit fuse is open**

1. Ignition/Vehicle - Off & Remove - Test lamp

NOTE: **The ignition circuit supplies voltage to other components. Test all circuits for a short to ground or test all components for being shorted.**

2. Test for infinite resistance between the test points: Ignition circuit terminal 1 & Ground
   - If less than infinite resistance - Repair the short to ground on the circuit.
   - If infinite resistance - Replace the component: Q44 Engine Oil Pressure Control Solenoid Valve

- **Go to next step: If the test lamp turns On**

5. Verify a test lamp does not turn On between the test points: Control circuit terminal 2 & B+

- **If the test lamp turns On**

1. Ignition/Vehicle - Off & Remove - Test lamp
2. Disconnect the electrical connector: K20 Engine Control Module
3. Test for infinite resistance between the test points: Control circuit terminal 2 @ Component harness & Ground
   - If less than infinite resistance - Repair the short to ground on the circuit.
   - If infinite resistance - Replace the component: K20 Engine Control Module

- **Go to next step: If the test lamp does not turn On**

6. Remove - Test Lamp
7. Perform the scan tool control function: Engine Oil Pressure Control Solenoid Valve - Low Pressure

   Verify the scan tool parameter: Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status = OK or Not Run

- **If not the specified state**

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: K20 Engine Control Module
3. Ignition - On/Vehicle - In Service Mode
4. Test for less than 1 V between the test points: Control circuit terminal 2 @ Component harness & Ground
   - If 1 V or greater - Repair the short to voltage on the circuit.
   - If less than 1 V - Replace the component: K20 Engine Control Module

- **Go to next step: If the specified state**

8. Connect a 3 A fused jumper wire between the test points: Control circuit terminal 2 & Ignition circuit terminal 1/A
9. Perform the scan tool control function: Engine Oil Pressure Control Solenoid Valve - Low Pressure

   Verify the scan tool parameter: Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status = Malfunction

- **If not the specified state**

1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
2. Disconnect the electrical connector: K20 Engine Control Module
3. Test for less than 2 ohms between the test points: Control circuit terminal 2 @ Component harness & The other end of the circuit @ Control module harness
   - If 2 ohms or greater - Repair the open/high resistance in the circuit.
   - If less than 2 ohms - Replace the component: K20 Engine Control Module

- **Go to next step: If the specified state**

10. Test or replace the component: Q44 Engine Oil Pressure Control Solenoid Valve

Component Testing

mx30.com

Static Test

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: Q44 Engine Oil Pressure Control Solenoid Valve
3. Test for 10 to 30 ohms between the test points: Control terminal 2 & Ignition terminal 1
   - **If not between 10 and 30 ohms**

     Replace the component: Q44 Engine Oil Pressure Control Solenoid Valve

   - **Go to next step: If between 10 and 30 ohms**
4. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
   - **If less than infinite resistance**

     Replace the component: Q44 Engine Oil Pressure Control Solenoid Valve

   - **Go to next step: If infinite resistance**
5. All OK.

Dynamic Test

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: Q44 Engine Oil Pressure Control Solenoid Valve
3. Connect a 3 A fused jumper wire between the test points: Ignition terminal 1 & 12 V

   CAUTION: **Complete the testing as quickly as possible in order to prevent overheating and damaging the component.**

4. Momentarily connect a jumper wire between the test points: Control terminal 2 & Ground

   Verify the component turns On and Off when connecting and disconnecting the jumper wire: Q44 Engine Oil Pressure Control Solenoid Valve

   - **If the component does not turn On and Off**

     Replace the component: Q44 Engine Oil Pressure Control Solenoid Valve

   - **Go to next step: If the component turns On and Off**
5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- Refer to **Oil Pump Flow Control Solenoid Valve Replacement (AWD)** **Oil Pump Flow Control Solenoid Valve Replacement (FWD)** - Q44 Engine Oil Pressure Control Solenoid Valve
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P25A9, P25AA, OR P25AB: PISTON COOLING OIL JET SOLENOID VALVE CONTROL CIRCUIT

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**
- An overview of each diagnostic category can be found here: **Diagnostic Procedure Instructions**

DTC Descriptor

DTC P25A9

Piston Cooling Oil Jet Solenoid Valve Control Circuit

mcx30.com

DTC P25AA

Piston Cooling Oil Jet Solenoid Valve Control Circuit Low Voltage

DTC P25AB

Piston Cooling Oil Jet Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P25AA*	P25A9, P25AA, P25AC	-	-
Control	P25AA	P25A9	P25AB	-
* Additional DTCs may set.				

Circuit/System Description

For an overview of the component/system, refer to: **Lubrication Description**

Circuit	Description
Ignition	Supplied from a fuse.
Control	The output circuit is switched to ground to activate the component.

Component	Description
Q45 Piston Cooling Oil Jet Solenoid Valve	A solenoid valve is an electro-mechanically operated valve. The valve is controlled by an electric current through the solenoid.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Conditions for Running the DTC

DTC P25A9, P25AA, P25AB

- Ignition Voltage = Greater than 11 V
- Engine = Running

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

DTC P25A9, P25AA, P25AB

Control Circuit = Commanded state does not match the actual state - For greater than 1 s

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics (1.6L (LH7))

mcx30.com

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

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

Circuit/System Verification

NOTE: The engine oil level and condition is critical to the correct operation of the system.

1. Ignition - On/Vehicle - In Service Mode
2. Perform the scan tool control function: Piston Cooling Oil Jet Solenoid Valve - On and Off

   Verify the scan tool parameter:

   - Piston Cooling Oil Jet Solenoid Valve Control Circuit High Voltage Test Status = OK or Not Run
   - Piston Cooling Oil Jet Solenoid Valve Control Circuit Low Voltage Test Status = OK or Not Run
   - Piston Cooling Oil Jet Solenoid Valve Control Circuit Open Test Status = OK or Not Run
   - **If not the specified state**

     Refer to: Circuit/System Testing

   - **Go to next step: If the specified state**
3. Perform the scan tool control function: Piston Cooling Oil Jet Solenoid Valve - On and Off

   Verify the scan tool parameter:

   - Piston Cooling Oil Jet Solenoid Valve Control Circuit High Voltage Test Status = OK or Not Run
   - Piston Cooling Oil Jet Solenoid Valve Control Circuit Low Voltage Test Status = OK or Not Run
   - Piston Cooling Oil Jet Solenoid Valve Control Circuit Open Test Status = OK or Not Run
   - Perform the action while monitoring the parameter:
   - Wiggle the harness and connector: Q45 Piston Cooling Oil Jet Solenoid Valve
   - Wiggle the harness and connector: K20 Engine Control Module
   - **If not the specified state**

     Repair as necessary - Wiring/Terminal(s)/Electrical Connector(s)

   - **Go to next step: If the specified state**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

   Verify the DTC does not set.

   - **If the DTC sets**

mcx30.com

Refer to: Circuit/System Testing

- **Go to next step: If the DTC is not set**

5. All OK.

Circuit/System Testing

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: Q45 Piston Cooling Oil Jet Solenoid Valve
3. Ignition - On/Vehicle - In Service Mode
4. Verify a test lamp turns On between the test points: Ignition circuit terminal 1 & Ground
    - **If the test lamp does not turn On and the circuit fuse is OK**
    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Test for less than 2 ohms between the test points: Ignition circuit terminal 1 & Output terminal @ Fuse
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Verify the fuse is OK and there is voltage at the fuse.
    - **If the test lamp does not turn On and the circuit fuse is open**
    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Connect the electrical connector: Q45 Piston Cooling Oil Jet Solenoid Valve
    3. Ignition - On/Vehicle - In Service Mode
    4. Replace the component: Fuse
    5. Verify the fuse does not open.
        - If the fuse opens and there are components connected to the circuit - Disconnect a component and repeat step 4.4
        - If the fuse opens with all components disconnected from the circuit - Repair the short to ground on the circuit.
        - If the fuse does not open after disconnecting a component from the circuit - Replace the component disconnected last.
        - If the fuse does not open with all components connected.
    6. Verify the fuse does not open when any of the components are activated.
        - If the fuse opens - Replace the component that caused the fuse to open when activated.
        - If the fuse does not open.
    7. All OK.
    - **Go to next step: If the test lamp turns On**
5. Verify a test lamp does not turn On between the test points: Control circuit terminal 2 & B+
    - **If the test lamp turns On**
    1. Ignition/Vehicle - Off & Remove - Test lamp
    2. Disconnect the electrical connector: K20 Engine Control Module
    3. Test for infinite resistance between the test points: Control circuit terminal 2 @ Component harness & Ground
        - If less than infinite resistance - Repair the short to ground on the circuit.
        - If infinite resistance - Replace the component: K20 Engine Control Module
    - **Go to next step: If the test lamp does not turn On**
6. Remove - Test Lamp
7. Perform the scan tool control function: Piston Cooling Oil Jet Solenoid Valve - On

    Verify the scan tool parameter: Piston Cooling Oil Jet Solenoid Valve Control Circuit High Voltage Test Status = OK or Not Run

    - **If not the specified state**
    1. Ignition/Vehicle - Off
    2. Disconnect the electrical connector: K20 Engine Control Module
    3. Ignition - On/Vehicle - In Service Mode

mcx30.com

4. Test for less than 1 V between the test points: Control circuit terminal 2 @ Component harness & Ground
    - If 1 V or greater - Repair the short to voltage on the circuit.
    - If less than 1 V - Replace the component: K20 Engine Control Module
- **Go to next step: If the specified state**

8. Connect a 3 A fused jumper wire between the test points: Control circuit terminal 2 & Ignition circuit terminal 1
9. Perform the scan tool control function: Piston Cooling Oil Jet Solenoid Valve - On

   Verify the scan tool parameter: Piston Cooling Oil Jet Solenoid Valve Control Circuit High Voltage Test Status = Malfunction

    - **If not the specified state**
    1. Ignition/Vehicle - Off & Remove - Jumper wire(s)
    2. Disconnect the electrical connector: X2 @ K20 Engine Control Module
    3. Test for less than 2 ohms between the test points: Control circuit terminal 2 @ Component harness & The other end of the circuit @ Control module harness
        - If 2 ohms or greater - Repair the open/high resistance in the circuit.
        - If less than 2 ohms - Replace the component: K20 Engine Control Module
    - **Go to next step: If the specified state**
10. Test or replace the component: Q45 Piston Cooling Oil Jet Solenoid Valve

Component Testing

Static Test

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: Q45 Piston Cooling Oil Jet Solenoid Valve
3. Test for 10 to 30 ohms between the test points: Control terminal 2 & Ignition terminal 1
    - **If not between 10 and 30 ohms**

      Replace the component: Q45 Piston Cooling Oil Jet Solenoid Valve

    - **Go to next step: If between 10 and 30 ohms**
4. Test for infinite resistance between the test points: Each terminal of the component & The component's housing
    - **If less than infinite resistance**

      Replace the component: Q45 Piston Cooling Oil Jet Solenoid Valve

    - **Go to next step: If infinite resistance**
5. All OK.

Dynamic Test

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: Q45 Piston Cooling Oil Jet Solenoid Valve
3. Connect a 3 A fused jumper wire between the test points: Ignition terminal 1 & 12 V

   CAUTION: **Complete the testing as quickly as possible in order to prevent overheating and damaging the component.**

4. Momentarily connect a jumper wire between the test points: Control terminal 2 & Ground

   Verify the component turns On and Off when connecting and disconnecting the jumper wire: Q45 Piston Cooling Oil Jet Solenoid Valve

    - **If the component does not turn On and Off**

mx30.com

Replace the component: Q45 Piston Cooling Oil Jet Solenoid Valve

- **Go to next step: If the component turns On and Off**

5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- Refer to **Piston Oil Nozzle Oil Control Solenoid Valve Replacement (AWD)** **Piston Oil Nozzle Oil Control Solenoid Valve Replacement (FWD)** - Q45 Piston Cooling Oil Jet Solenoid Valve
- For control module replacement, programming, and setup refer to: **Control Module References**

DTC P25AC OR P25AD: PISTON COOLING OIL JET STUCK OFF/ON

Diagnostic Instructions

- Perform the Diagnostic System Check prior to using this diagnostic procedure: **Diagnostic System Check - Vehicle**
- Review the description of Strategy Based Diagnosis: **Strategy Based Diagnosis**
- An overview of each diagnostic category can be found here: **Diagnostic Procedure Instructions**

DTC Descriptor

DTC P25AC

Piston Cooling Oil Jet Stuck Off

DTC P25AD

Piston Cooling Oil Jet Stuck On

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P25AD	P25AC	P25AC	-
Ground	-	P25AC	-	-

Circuit/System Description

For an overview of the component/system, refer to: **Lubrication Description**

Circuit	Description
Signal	The control module input circuit has an internal resistance connected to 12 V.
Ground	Chassis Ground

Component	Description
B267 Piston Cooling Oil Pressure Switch	The pressure sensor generates a voltage signal.
K20 Engine Control Module	The control module controls a series of actuators to ensure optimal engine performance. The control module does this by reading values from a variety of sensors, interprets the data and adjusts the engine actuators accordingly.

Conditions for Running the DTC

- Ignition Voltage = Greater than 11 V
- Engine = Running

Frequency the DTC runs = Continuously - After the running conditions are met

Conditions for Setting the DTC

mcx30.com

Commanded state does not match the actual state

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Reference Information

Schematic Reference

Engine Controls Wiring Schematics (1.6L (LH7))

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

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

Circuit/System Verification

NOTE: **The engine oil level and condition is critical to the correct operation of the system.**

1. Ignition - On/Vehicle - In Service Mode
2. Verify there are no DTCs set related to the following system/component:
   - Q45 Piston Cooling Oil Jet Solenoid Valve
   - B35B Engine Oil Level Sensor
   - B37B Engine Oil Pressure Sensor
   - B37 Engine Oil Pressure Switch
   - **If other DTCs are set**

     Refer to: **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **Go to next step: If no other DTCs are set**
3. Verify the condition does not exist: Engine Oil - Contaminated/Dirty/Fill Level = Low
   - **If a condition exists**

     Repair as necessary

   - **Go to next step: If no condition exists**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

mcx30.com

Verify the DTC does not set.

- **If the DTC sets**

  Refer to: Circuit/System Testing

- **Go to next step: If the DTC is not set**

5. All OK.

Circuit/System Testing

NOTE: **It may take up to 2 min for all vehicle systems to power down before an accurate ground or low reference circuit continuity test can be performed.**

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: B267 Piston Cooling Oil Pressure Switch
3. Ignition - On/Vehicle - In Service Mode
4. Test for battery voltage between the test points: Signal circuit terminal 1 & Ground
   - **If less than battery voltage**
   1. Ignition/Vehicle - Off
   2. Disconnect the electrical connector: K20 Engine Control Module
   3. Test for infinite resistance between the test points: Signal circuit terminal 1 & Ground
      - If less than infinite resistance - Repair the short to ground on the circuit.
      - If infinite resistance
   4. Test for less than 2 ohms between the test points: Signal circuit terminal 1 @ Component harness & Terminal 12 X2 @ Control module harness
      - If 2 ohms or greater - Repair the open/high resistance in the circuit.
      - If less than 2 ohms - Replace the component: K20 Engine Control Module
   - **Go to next step: If battery voltage**
5. Ignition/Vehicle - Off
6. Disconnect the electrical connector: K20 Engine Control Module
7. Ignition - On/Vehicle - In Service Mode
8. Test for less than 1 V between the test points: Signal circuit terminal 1 @ Component harness & Ground
   - **If 1 V or greater - Repair the short to voltage on the circuit.**
   - **Go to next step: If less than 1 V**
9. Test or replace the component: B267 Piston Cooling Oil Pressure Switch

Component Testing

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: B267 Piston Cooling Oil Pressure Switch
3. Test for less than 60 ohms between the test points: Signal terminal 1 & The component's housing
   - **If less than infinite resistance**

     Replace the component: B267 Piston Cooling Oil Pressure Switch

   - **Go to next step: If infinite resistance**
4. All OK.

Dynamic Test

1. Ignition/Vehicle - Off
2. Disconnect the electrical connector: B267 Piston Cooling Oil Pressure Switch
3. Connect a DMM between the test points: Signal circuit terminal 1 @ Component & Ground
4. Engine Running
5. Verify the DMM transitions to infinite resistance when above 2650 RPMs.

mx30.com

- **If not in the specified range or does not change**

  Replace the component: B267 Piston Cooling Oil Pressure Switch

- **Go to next step: If infinite resistance**

6. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair: **Diagnostic Repair Verification**

- Refer to **Engine Oil Pressure Switch Replacement** - B267 Piston Cooling Oil Pressure Switch
- For control module replacement, programming, and setup refer to: **Control Module References**

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**, **Engine Component 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 condition. The diagnostic flow is the place to start when repairs are necessary.

Visual/Physical Inspection

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

Intermittent

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

Symptom List

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

- **Base Engine Misfire without Internal Engine Noises**
- **Base Engine Misfire with Abnormal Internal Lower Engine Noises**
- **Base Engine Misfire with Abnormal Valve Train Noise**
- **Base Engine Misfire with Coolant Consumption**
- **Base Engine Misfire with Excessive Oil Consumption**
- **Engine Noise on Start-Up, but Only Lasting a Few Seconds**
- **Upper Engine Noise, Regardless of Engine Speed**
- **Lower Engine Noise, Regardless of Engine Speed**
- **Engine Noise Under Load**
- **Engine Will Not Crank - Crankshaft Will Not Rotate**
- Engine Compression Test
- **Oil Consumption Diagnosis**
- **Oil Pressure Diagnosis and Testing**
- **Oil Leak Diagnosis**

mcx30.com

- Fuel in Engine Oil
- 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
- Turbocharger Lack of Oil Supply
- Turbocharger Oil Leak From Compressor Seal
- Turbocharger Oil Leak From Turbine Seal
- Turbocharger Whine Noise
- Turbocharger Hissing Noise

BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

Cause	Correction
Abnormalities, severe cracking, bumps, or missing areas in the accessory drive belt. Abnormalities in the accessory drive system and/or components may cause engine RPM variations and lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Replace the drive belt.
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout. May lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Inspect the components and repair or replace, as required.
A loose or improperly installed engine flywheel/automatic transmission flex plate or crankshaft balancer. A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel/automatic transmission flex plate and/or balancer, as required.
Restricted exhaust system. A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.	Repair or replace, as required.
Improperly installed or damaged vacuum hoses.	Repair or replace, as required.
Improperly installed or leaking charge air cooler tube.	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 or intake air pressure temp (TMAP) sensor. The sealing grommet of the MAP sensor should not be torn or damaged.	Repair or replace the MAP sensor and/or the TMAP sensor, as required.
Damage to the MAP sensor housing.	Replace the intake manifold.
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact and in the proper position.	Replace the valve rocker arms, as required.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace, as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets, as required.
Worn camshaft lobes	Replace the camshaft and valve lifters.

mr30.com

Cause	Correction
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. 2. Inspect the cylinder heads, engine block, and/or head gaskets. 3. 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. 2. Inspect the cylinders for a loss of compression. 3. Perform cylinder leak down and compression testing to identify the cause. 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 re-sync the crankshaft position. • Systems with electronic communication, DIS or coil per cylinder, and slight reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a DTC P0300 may be set. • Systems with mechanical communications, high voltage switch, and severe reluctor ring damage may cause additional pulses and affect fuel and spark delivery to the point of generating a DTC P0300 or P0336.	Replace the sensor and/or crankshaft reluctor ring, as required.

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

Cause	Correction
Abnormalities, severe cracking, bumps or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine, and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.	Replace the drive belt.
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout A misfire code may be present without an actual misfire condition.	Inspect the components, repair or replace as required.
Loose or improperly installed engine flywheel/automatic transmission flex plate or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel/automatic transmission flex plate and/or balancer as required.

Cause	Correction
Loose torque converter bolts A misfire code may be present without an actual misfire condition.	Inspect the torque converter bolts and automatic transmission flex plate. Repair or replace as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	1. Inspect the cylinders for a loss of compression. 2. Perform cylinder leak down and compression testing to determine the cause. 3. 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 misfire code without an actual misfire condition.	Replace the crankshaft and bearings as required.
Overfilled crankcase	1. Check engine oil level with vehicle on a level surface. 2. Correct any overfilled condition. 3. Inspect for fuel leaks into the crankcase. 4. Repair any fuel leaks.

BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

Cause	Correction
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should intact within the rocker arm assembly.	Replace the valve rocker arms as required.
Stuck valves Carbon buildup on the valve stem can cause the valve to not close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing belt	Replace the timing belt and sprockets as required.
Worn camshaft lobes	Replace the camshaft and valve lash adjusters.
Sticking valve	Replace as required.
Worn or damaged pushrods	1. Inspect the pushrods for excessive wear, bent condition or broken tip. 2. Replace as required.
Broken valve springs	Inspect valve springs and replace as required.
Excessive valve lash	Inspect the valve lash adjusters and replace as required.

BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

Inspection	Action
DEFINITION: Base engine misfire with coolant consumption	
Preliminary Inspection	Verify that there are no external coolant leaks. Refer to **Symptoms - Engine Cooling** .
Isolate Affected Cylinders	• Cylinder balance test with scan tool • Cooling system pressurization • Inspection of glow plugs • Compression test

mcx30.com

Inspection	Action
EGR System Inspection	• Inspect EGR valve and intake system for evidence of coolant leakage. • Replace the EGR cooler if any problem is found.
Cylinder Head Gasket Leakage	• Remove cylinder heads of the affected cylinder bank and inspect for damage. • Replace components as necessary.
Cylinder Head or Engine Block Damage.	• Inspect the cylinder head for cracks. • Inspect the cylinder block for damage. • Inspect the cylinder block to head mating surface for straightness. • Replace components as necessary.

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. 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. 2. Inspect the cylinders for a loss of compression. 3. Perform the 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-drain back feature	Install the correct oil filter.
Incorrect oil viscosity	1. Drain the oil. 2. Install the correct viscosity oil.
High valve lash adjuster leak down rate	Replace the lash adjusters as required.
Worn crankshaft thrust bearing	1. Inspect the thrust bearing and crankshaft. 2. Repair or replace as required.
Damaged or faulty oil filter by-pass valve	1. Inspect the oil filter by-pass valve for proper operation. 2. Repair or replace as required.
Malfunctioning camshaft position actuators - improper oil viscosity or contamination. The result is camshaft actuator locking pin does not lock	1. Verify correct engine oil viscosity by changing the engine oil and filter. Reevaluate the concern. 2. Isolate the noise to a specific camshaft position actuator. 3. Replace the camshaft actuator, oil and filter.

mcx30.com

Cause	Correction
Excessive piston-to-cylinder bore clearance	1. Inspect the piston and piston skirt, connecting rod, and cylinder bore. 2. Repair or replace all damaged components.

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 stud, nut, or bolt. 2. Repair or replace, as required.
Worn valve rocker arm	Replace the valve rocker arm.
Improper lubrication to the valve rocker arms	Inspect the following components and repair or replace, as required: • The valve rocker arm • The valve lifter • The oil filter bypass valve • The oil pump and pump screen • The engine block oil galleries
Broken valve spring	Replace the valve spring.
Worn or dirty valve lifters	Replace the valve lifters.
Stretched or broken timing chain and/or damaged sprocket teeth	Replace the timing chain and sprockets.
Worn, damaged, or faulty timing chain tensioners	Replace the timing chain tensioners.
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

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction

mcx30.com

Cause	Correction
Low oil pressure	• Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. • 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.
Leaking and/or sticking fuel injection nozzle. A stuck fuel injection nozzle can cause a noise similar to a damaged piston, rod or rod bearing.	1. Use the cylinder balance diagnostic procedure to help locate the cylinder that is the source of the noise. 2. If you cannot locate the cylinder that is the source of the noise, diagnose the engine for mechanical damage. 3. If it has been determined that the fuel injection nozzle is causing the noise, replace the fuel injection nozzle.
Loose or damaged crankshaft balancer	1. Inspect the crankshaft balancer. 2. Repair or replace as required.
Loose or damaged flywheel	Repair or replace the flywheel.
Damaged oil pan, contacting the oil pump screen. An oil pan that has been damaged, may improperly position the oil pump screen, preventing proper oil flow to the oil pump.	1. Inspect the oil pan. 2. Inspect the oil pump screen. 3. Repair or replace as required.
Oil pump screen loose, damaged or restricted	1. Inspect the oil pump screen. 2. Repair or replace as required.
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.
Misaligned or bent connecting rod	1. Inspect connecting rod and connecting rod bearings. 2. Repair or replace all damaged components.
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

mcx30.com

Cause	Correction
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.
Oil pump pickup tube or screen bent or loose	1. Inspect the oil pump pickup tube and/or screen. 2. Repair or replace all damaged components.

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.
Loose or damaged flywheel/automatic transmission flex plate	1. Inspect the flywheel/automatic transmission flex plate bolts and flywheel/automatic transmission 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
Excessive piston-to-cylinder bore clearance	1. Inspect the piston rings for low ring tension, broken or worn rings, inspect cylinder bore. 2. Repair or replace all damaged components.
Excessive crankshaft thrust bearing clearance	1. Inspect the crankshaft end play and crankshaft thrust bearings. 2. Repair or replace all damaged components.

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Cause	Correction

mcx30.com

Cause	Correction
Seized accessory drive system component	1. Remove accessory drive belts. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Hydraulically locked cylinder • Coolant/antifreeze in cylinder • Oil in cylinder • Fuel in cylinder	1. Remove glow plugs and check for fluid. 2. Inspect for broken head gasket. 3. Inspect for cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector. 5. Inspect for cracked cylinder wall.
Seized automatic transmission torque converter	1. Remove the torque converter bolts. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Seized manual transmission	1. Disengage the clutch. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Broken timing belt and/or gears	1. Inspect timing belt and gears. 2. Repair as required.
Seized balance shaft	1. Inspect balance shaft. 2. Repair as required.
Material in cylinder • Broken valve • Piston material • Foreign material • Cracked cylinder wall	1. Inspect cylinder for damaged components and/or foreign materials. 2. Inspect for fallen cylinder wall. 3. Repair or replace as required.
Seized crankshaft or connecting rod bearings	1. Inspect crankshaft and connecting rod bearings. 2. Inspect for fallen cylinder wall. 3. Repair as required.
Bent or broken connecting rod	1. Inspect connecting rods. 2. Repair as required.
Broken crankshaft	1. Inspect crankshaft. 2. Repair as required.

COOLANT IN COMBUSTION CHAMBER

Inspection	Action

mcx30.com

Inspection	Action
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 "over temperature" condition which may cause engine component damage.	
Preliminary Inspection	Verify that there are no external coolant leaks. Refer to **Loss of Coolant** .
Isolate Affected Cylinders	1. Cylinder balance test with scan tool 2. Cooling system pressurization 3. Compression test
EGR System Inspection	1. Inspect EGR valve and intake system for evidence of coolant leakage. 2. Replace the EGR cooler if any problem is found.
Cylinder Head Gasket Leakage	Remove cylinder heads of the affected cylinder bank and inspect for damage. Replace components as necessary.
Cylinder Head or Engine Block Damage	1. Inspect the cylinder heads for cracks. 2. Inspect the cylinder block for damage. 3. Inspect the cylinder block to head mating surface for straightness. 4. Replace components as necessary.

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 compression test. Two cylinders "side-by-side" on the engine block with low compression may indicate a failed cylinder head gasket.	
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**.
Warped cylinder head	Replace the cylinder head. Refer to **Cylinder Head Replacement**.
Cracked cylinder head	Replace the cylinder head and gasket. Refer to **Cylinder Head Replacement**.
Cracked cylinder liner or engine block	Replace the components as required.
Cylinder head, block, or manifold porosity	Replace the components as required.

FUEL IN ENGINE OIL

DEFINITION: If fuel is suspected of leaking into the crankcase, the following procedure should be performed to verify the condition.

1. Remove the oil level indicator and allow oil to drop onto a clean white paper towel.
2. If the oil is diluted with fuel, it will become apparent as the towel wicks the fuel away from the drop of oil on the towel. The fuel will expand out in a ring around the oil droplet.

3. If fuel dilution is apparent, inspect the vehicle for aftermarket performance accessories that may cause damage to the injection pump. After repairs are completed, perform the test again to verify the condition is corrected.
4. If no fuel dilution is present, verify the oil level and correct as needed.

ENGINE COMPRESSION TEST

Special Tools

- **EN-51110** Compression and Cylinder Leakdown Test Adapter
- **EN-26999** Compression Gauge

Equivalent regional tools: **Special Tools**

Technical Requirements

- Ensure that the vehicle battery is in good condition, and fully charged or the battery is connected to a battery charger. The battery voltage should be > 12, 5 V.
- Operate the vehicle until the engine is at normal operating temperature. The engine oil temperature should be > 80Â°C (> 176Â°F).

Preliminary Procedures

1. Remove Fuel Injector. Refer to **Fuel Injector Replacement**
2. Remove Fuel Pump Relay
   - For component location refer to **Engine Controls Wiring Schematics (1.6L (LH7))** .
   - For removal procedure refer to **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)** .

   WARNING: **Refer to Eye Protection Warning**
3. Crank the engine with the starter motor for 5 seconds to remove any foreign substances from the cylinders.

Installation Procedure

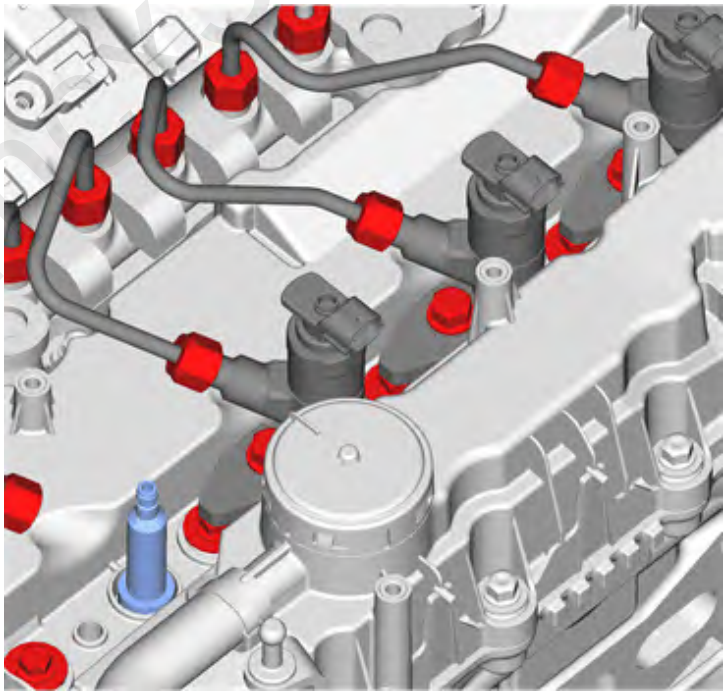


Fig. 11: Compression And Cylinder Leakdown Test Adapter
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-51110** Compression and Cylinder Leakdown Test Adapter into the fuel injector bore.
2. Connect the **EN-26999** gauge to the adapter (1).

Measurement Procedure

1. Check the compression of cylinder 1:

WARNING: **Refer to Eye Protection Warning**

CAUTION: **Do not add oil to any cylinder during a compression test as extensive engine damage may result.**

NOTE:

- **Engine revs at least 300/min.**
- **A second technician is required.**

1. Turn the ignition ON, with the engine OFF.
2. Using the vehicle starter motor to crank the engine.
3. Observe the gauge and note the reading as the compression test is being performed

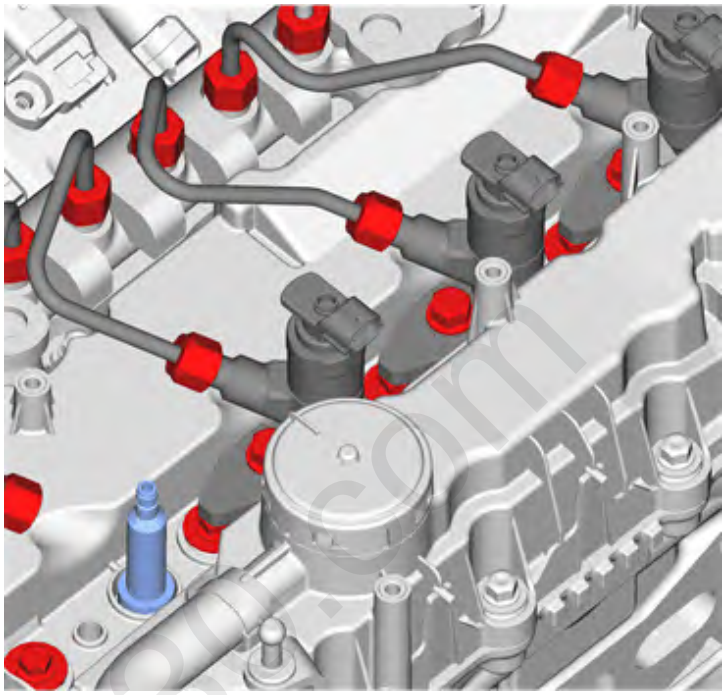


Fig. 12: Compression And Cylinder Leakdown Test Adapter
Courtesy of GENERAL MOTORS COMPANY

4. Remove the assembled compression adapter along with the **EN-51110** Compression and Cylinder Leakdown Test Adapter.

2. Repeat the procedure for all remaining cylinders.
3. Compare the compression value from all cylinders.
4. There should not be more than 10 percent difference between a suspect cylinder and the average compression of all 4 cylinders. For compression values refer to **Engine Mechanical Specifications**.
5. If one or more cylinders fails to meet the specified compression range, refer to **Cylinder Leakage Test** for finding the leakage.

Subsequent Procedures

1. Install Fuel Pump Relay
   - For component location refer to **Engine Controls Wiring Schematics (1.6L (LH7))** .
   - For installation procedure refer to **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)** .
2. Install Fuel Injector. Refer to **Fuel Injector Replacement**

CYLINDER LEAKAGE TEST

WARNING: **Unless directed otherwise, the ignition must be OFF with the key removed, 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 OnStarÂ® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStarÂ® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStarÂ® module). Do not disconnect the main vehicle battery or remove the OnStarÂ® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStarÂ® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStarÂ® Back-Up Battery 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 back-up battery is not rechargeable and once activated the back-up battery must be replaced.

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

- **Worn, burnt, or stuck valves**
- **Damaged piston**
- **Worn piston rings**
- **Worn or scored cylinder bore**
- **Damaged cylinder head gasket**
- **Cracked or damaged cylinder head**
- **Cracked or damaged engine block**

Special Tools

- **EN-35667-A** Cylinder Leakdown Tester
- **EN-51140** Crankshaft Fixing Tool
- **EN-51110** Compression and Cylinder Leakdown Test Adapter

Equivalent regional tools: **Special Tools**

Preliminary Procedures

1. Disconnect Battery Negative Cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Fuel Injector. Refer to **Fuel Injector Replacement**
3. Remove Crankshaft Pulley. Refer to **Crankshaft Pulley Replacement**

Installation Procedure

mcx30.com

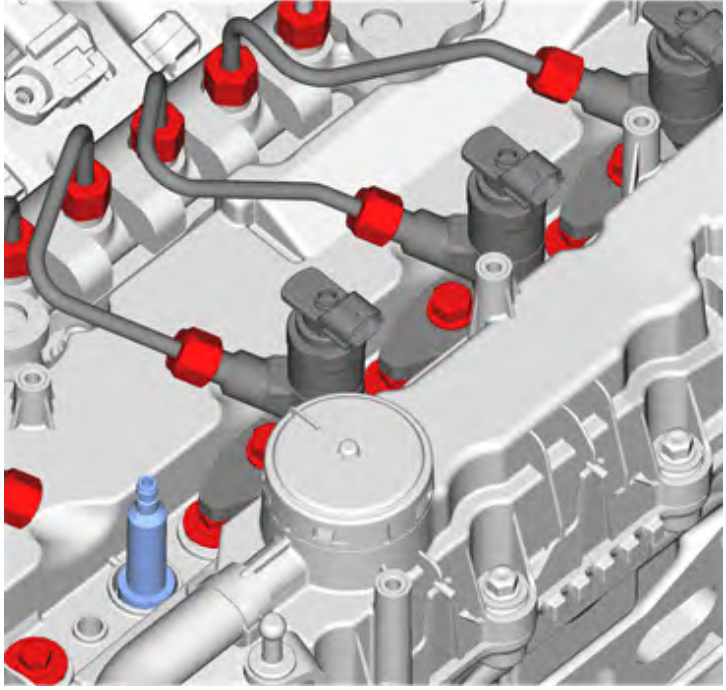


Fig. 13: Compression And Cylinder Leakdown Test Adapter
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-51110** Compression and Cylinder Leakdown Test Adapter into the fuel injector bore.
2. Install the **EN-35667-A** Cylinder Leakdown Tester to the leakage adapter (1).

Measurement Procedure

Cylinder 1:

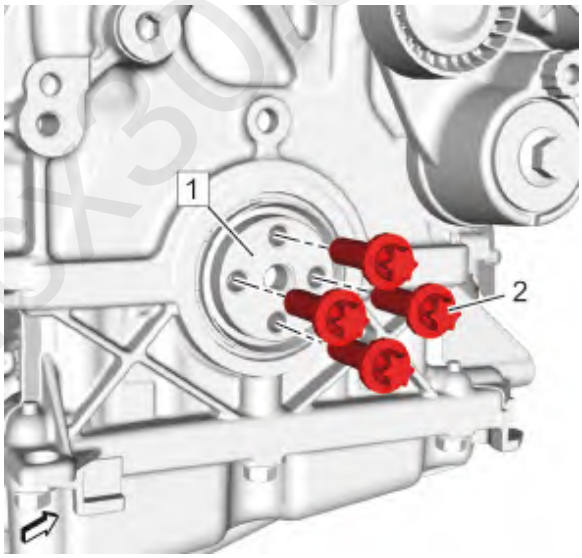


Fig. 14: Crankshaft And Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install Crankshaft Pulley Bolts (2) (Qty: 4) @ Crankshaft (1)

mx30.com

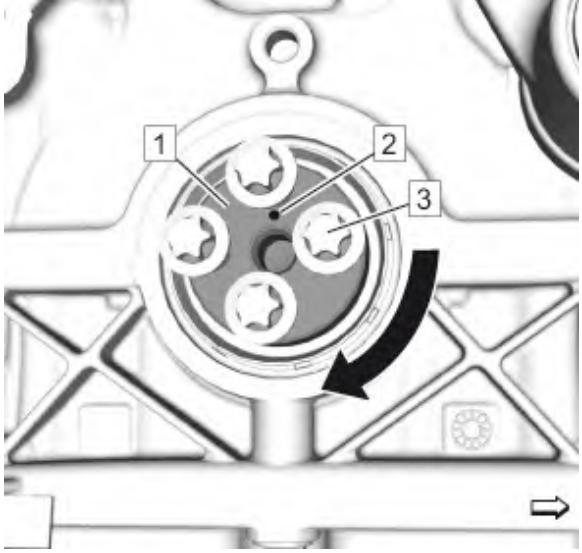


Fig. 15: Rotating Crankshaft Clockwise Until Matching Mark Is At Top
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If air leakage sounds at the intake manifold tube and exhaust system tailpipe rotate the crankshaft 360 degrees.**

2. Adjust the piston of cylinder 1 at top dead center (TDC) of compression stroke.
    1. Rotate the crankshaft (1) in direction of arrow until the matching mark (2) is at the top. Use a pry bar at the 4 crankshaft pulley bolts (3).

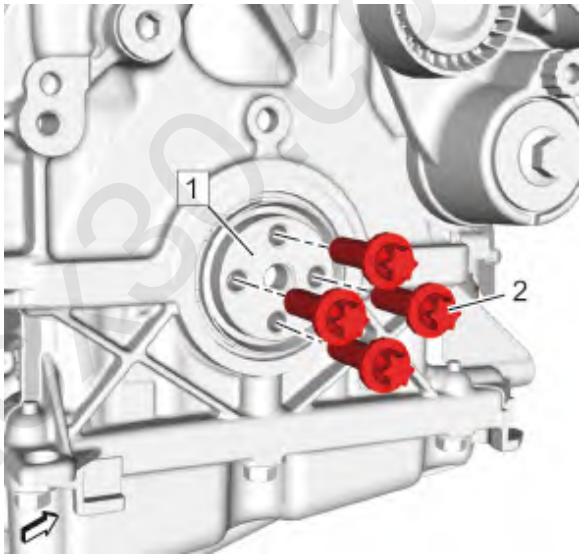


Fig. 16: Crankshaft And Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove Crankshaft Pulley Bolts (2) (Qty: 4) @ Crankshaft (1)

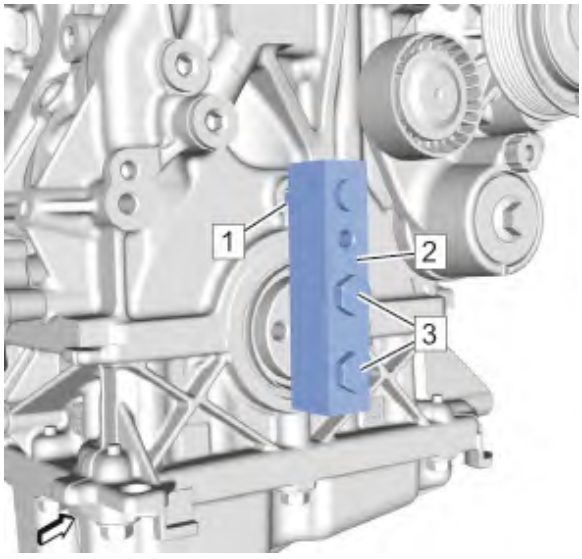


Fig. 17: Crankshaft Fixing Tool, Pin And Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-51140** fixing tool (2).
5. Guide the fixing pin (1) into the engine block bore.
6. Install and tighten Bolts (3) (Qty: 2)
7. Lower the vehicle.
8. Apply shop air pressure to the tester and adjust according to the manufacturers instructions.
9. Record the cylinder leakage value. For cylinder leakage value refer to **Engine Mechanical Specifications**. In excessive leakage situations, inspect for the following conditions:
    - Air leakage sounds at the intake manifold tube, may indicate a worn, stuck or burnt intake valve.
    - Air leakage sounds at the exhaust system tailpipe may indicate a worn, burnt, or stuck exhaust valve, broken valve spring, incorrect valve lash or damaged valve train components.
    - Air leakage sounds from the crankcase, oil level indicator tube, or oil fill tube 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 engine block, cylinder head or gasket.
10. Raise the vehicle.

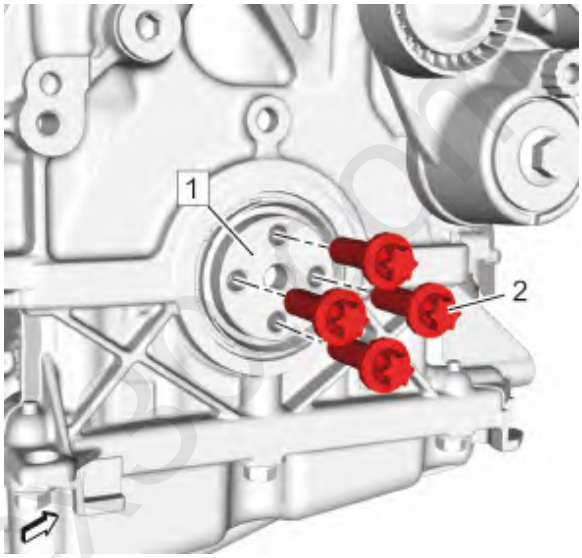


Fig. 18: Crankshaft And Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Remove Bolts (2) (Qty: 4)
12. Remove the **EN-51140** fixing tool (2).

Cylinder 3:

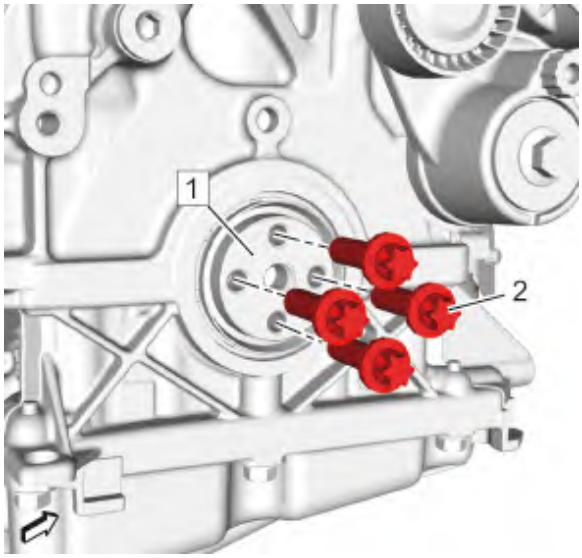


Fig. 19: Crankshaft And Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install Crankshaft Pulley Bolts (2) (Qty: 4) @ Crankshaft (1)

Fig. 20: Rotating Crankshaft 180 Degrees Clockwise Until Matching Mark Is At Bottom
Courtesy of GENERAL MOTORS COMPANY

2. Adjust the piston of cylinder 3 at top dead center (TDC) of compression stroke.
    1. Rotate the crankshaft (1) 180 degrees in direction of arrow until the matching mark (3) is at the bottom. Use a pry bar at the 4 crankshaft pulley bolts (2).
3. Repeat the procedure from cylinder 1 step 2 and perform the leakage test on cylinder 3 and record the value.

Cylinder 4:

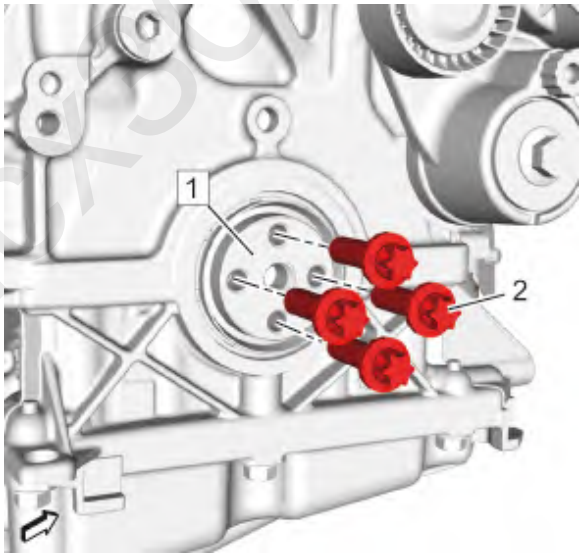


Fig. 21: Crankshaft And Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install Crankshaft Pulley Bolts (2) (Qty: 4) @ Crankshaft (1)

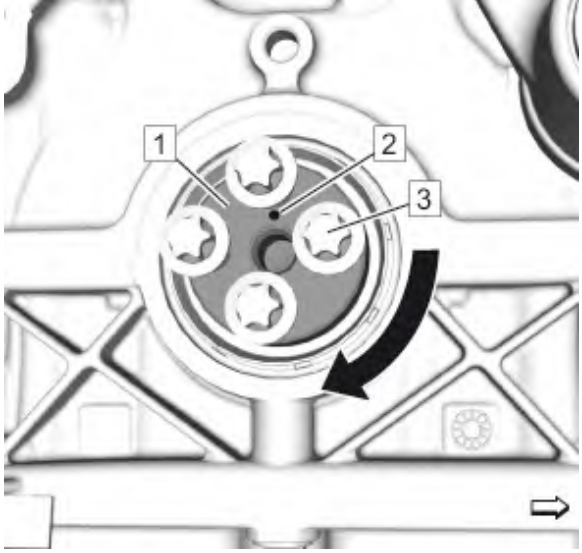


Fig. 22: Rotating Crankshaft Clockwise Until Matching Mark Is At Top
Courtesy of GENERAL MOTORS COMPANY

2. Place the piston of cylinder 4 at top dead center (TDC) of compression stroke.
    1. Rotate the crankshaft (1) 180 degrees in direction of arrow until the matching mark (2) is at the top. Use a pry bar at the 4 crankshaft pulley bolts (3).
3. Repeat the procedure from cylinder 1 step 2 and perform the leakage test on cylinder 4 and record the value.

Cylinder 2:

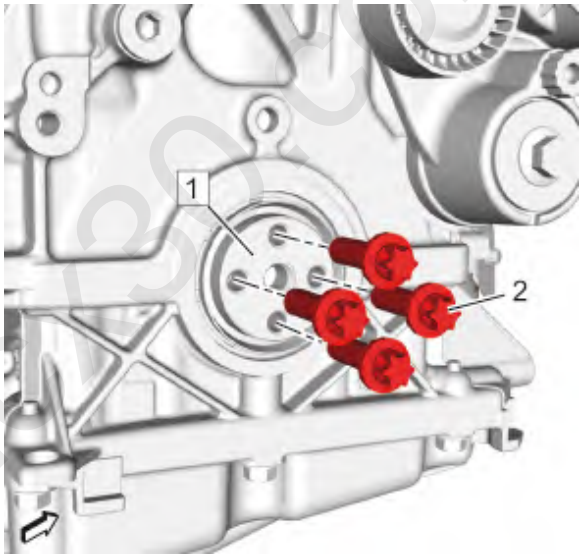


Fig. 23: Crankshaft And Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install Crankshaft Pulley Bolts (2) (Qty: 4) @ Crankshaft (1)

Fig. 24: Rotating Crankshaft 180 Degrees Clockwise Until Matching Mark Is At Bottom
Courtesy of GENERAL MOTORS COMPANY

2. Place the piston of cylinder 2 at top dead center (TDC) of compression stroke.
    1. Rotate the crankshaft (1) 180 degrees in direction of arrow until the matching mark (3) is at the bottom. Use a pry bar at the 4 crankshaft pulley bolts (2).
3. Repeat the procedure from cylinder 1 step 2 and perform the leakage test on cylinder 2 and record the value.

Subsequent Procedures

1. Install Crankshaft Pulley. Refer to **Crankshaft Pulley Replacement**
2. Connect Battery Negative Cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
3. Install Fuel Injector. Refer to **Fuel Injector Replacement**

OIL CONSUMPTION DIAGNOSIS

Explanation

NOTE: **Oil consumption for a combustion engine refers to the amount of oil consumed as a result of the combustion process. Oil consumption is not to be equated with oil loss resulting from leaks from components such as the oil pan and cylinder head cover.**

- The role of the engine oil is to:
    1. Separate surfaces that slide against each other by means of an oil film, i.e. to prevent dry friction.
    2. Dissipate heat generated by friction.
    3. Lead away combustion residue.
- This task involves the consumption of a certain amount of oil. It is therefore wrong to assume that future enhancements of the combustion engine may produce an engine which has zero oil consumption.
- Outside operating conditions, driving style and manufacturing tolerances do, however, have an impact on oil consumption.
- It is imperative that oil be filled when the level has fallen below the "MIN" mark on the dipstick.
- It is also important to ensure that the oil level is not above the "MAX" mark on the dipstick as this could result in increased oil consumption.
- As oil consumption is affected by technical factors, the conclusion is reached that the engine does not consume oil in special operating conditions that lead to oil dilution.
- During conditions such as frequent cold starts and driving before the engine reaches operating temperature, it is only the oil flowing back to the oil pan that carries away scalding fuel components and precipitates. This "dilutes" the oil and leads to the erroneous assumption that the engine consumes no oil.
- Such diluted oil loses its ability to lubricate and could cause engine damage if the prescribed oil change intervals are not observed.
- Driving in predominately urban traffic and frequently running a cold engine at rpms above idle speed are the main causes of oil dilution.
- As oil consumption does not stabilize until after a few thousand kilometers of travel, oil consumption measurements are not reliable until after a distance of about 7, 500 km.
- The oil standard is merely used for monitoring and cannot be used for measurement purposes. In principle, the engine must have stopped for at least 5 minutes or 10 minutes before checking the oil level. If the maximum amount of oil added during an oil change does not agree with the max. on the oil dip stick, then this will be accounted for by the necessary manufacturing tolerances.

Measuring Procedure

NOTE: **All information on permissible engine oil consumption and capacities are found in the Owner's Manual.**

1. Before measuring consumption, ensure that the engine is not losing oil due to leakage.
2. The check is carried out with the vehicle parked on a level surface with the engine at operating temperature (engine oil temperature at least 80Â°C).
3. Drain the engine oil immediately after switching off the engine - drainage time = approx. 30 minutes (this value has been obtain through technical trials).

4. The quantity of drained engine oil is determined via a measuring container. The container is then filled with fresh oil up to the maximum engine oil capacity minus the volume remaining in the unchanged oil filter.
5. With this engine oil quantity, the customer should be able to travel at 1000 km without needing to top up engine oil (the distance profile and customer driving style should be maintained).
6. Then, the preceding procedure (points 1 and 2) should be repeated with the exact same engine drainage time.
7. The oil quantity now "missing" from the measuring container is equal to the engine oil consumption for that distance.
8. Oil consumption is calculated as follows:
    - (filled oil quantity (l) - drained oil quantity (l)) / total distance driven (km) x 1000 = oil consumption (l/1000 km)

CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS

Symptom	Correction
External oil leak	Inspect for any of the following conditions: • Restricted or kinked positive crankcase ventilation (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

OIL PRESSURE DIAGNOSIS AND TESTING

Special Tools

- **GE-498-B** Oil Pressure Gauge
- **EN-21867-850** Oil Pressure Gage Adapter

Equivalent regional tools: **Special Tools**

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**
3. Remove the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LH7)**

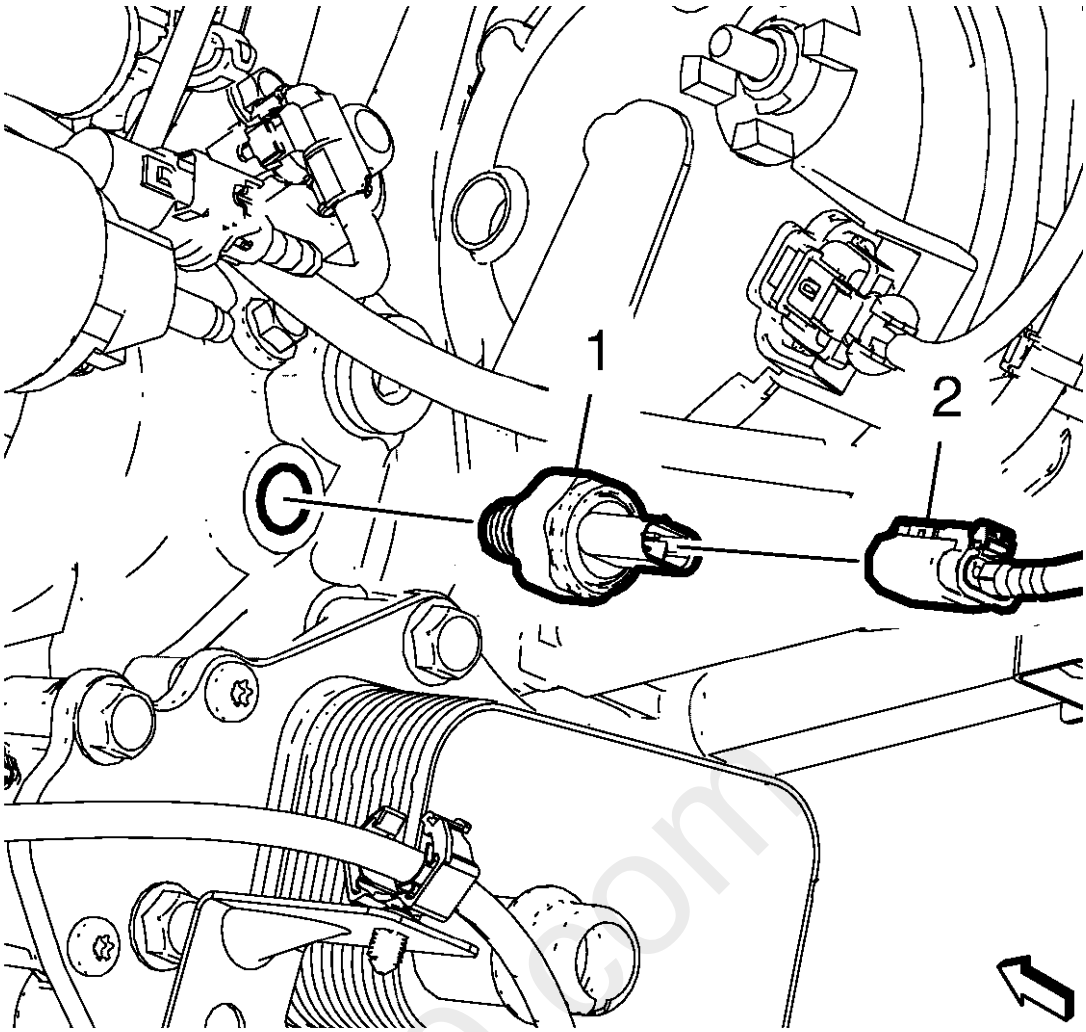


Fig. 25: Oil Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the oil pressure sensor electrical connector (2) from the engine oil pressure sensor (1).
5. Remove the oil pressure sensor (1).

Measuring Procedure

mcx30.com

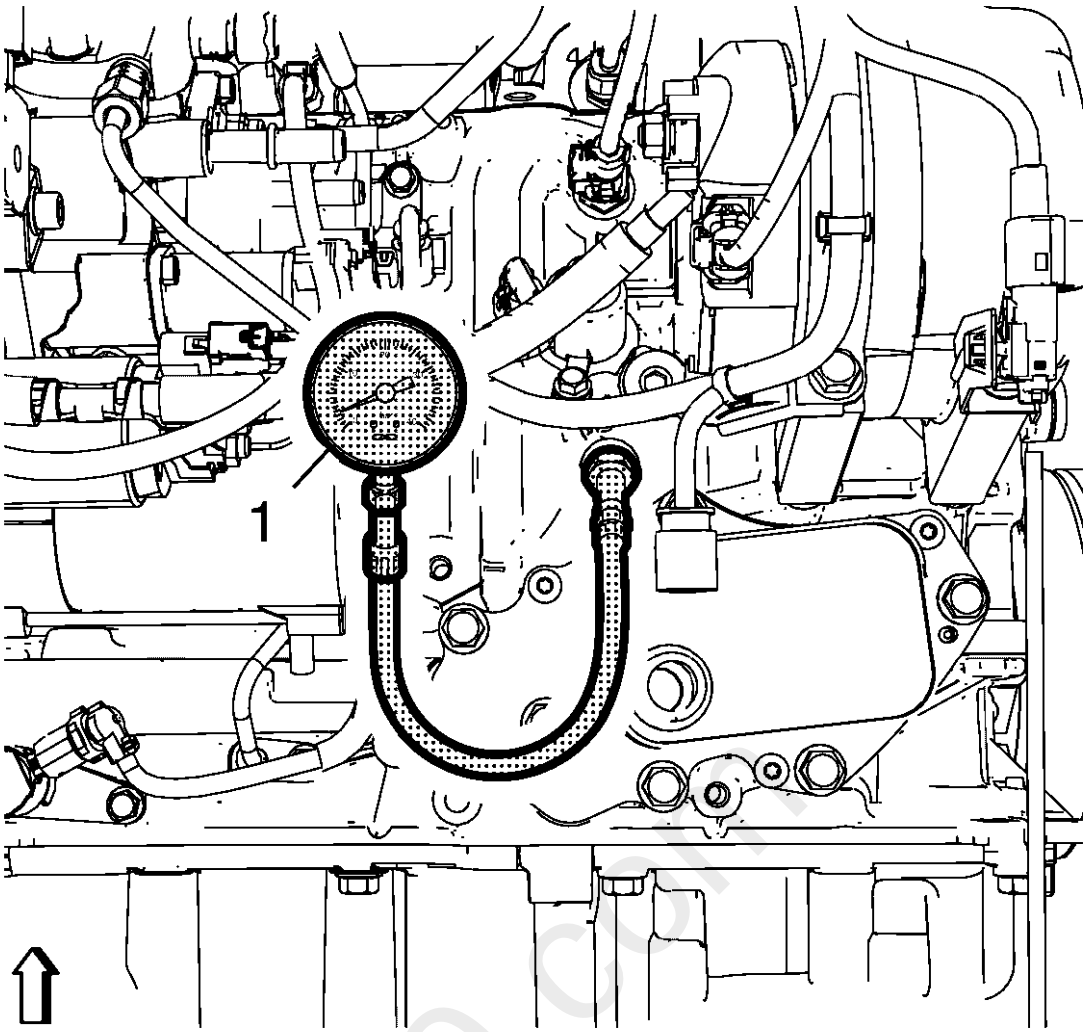


Fig. 26: Oil Pressure Gauge And Adapter
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Component Fastener Tightening Caution .**

1. Install the **EN-21867-850** adapter to the engine block and tighten to 35 N.m (26 lb ft).
2. Install the **GE-498-B** Oil Pressure Gauge (1) to the **EN-21867-850** Oil Pressure Gage Adapter.
3. Install the exhaust front pipe. Refer to Exhaust Front Pipe Replacement (LH7)
4. Lower the vehicle.
5. Connect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection (KL9)
6. Start the engine.

NOTE: **The oil temperature should be between 80Â°C (176Â°F) and 100Â°C (212Â°F).**

7. Measure the oil pressure. Compare the engine oil pressure with the nominal value. Refer to Engine Mechanical Specifications
8. Stop engine.
9. If the engine oil pressure is below specifications, inspect the engine for one or more of the following conditions:
   - Oil pump worn or dirty. Refer to Oil and Power Brake Booster Pump Replacement
   - Oil suction gallery clogged or dirty. Refer to Oil Pan Cleaning and Inspection
   - Cracked, porous or restricted oil galleries.
   - Oil pressure relief valve malfunction.

Installation Procedure

1. Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection (KL9)

2. Raise the vehicle.
3. Remove the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LH7)**
4. Remove the **GE-498-B** Oil Pressure Gauge.
5. Remove the **EN-21867-850** Oil Pressure Gage Adapter.

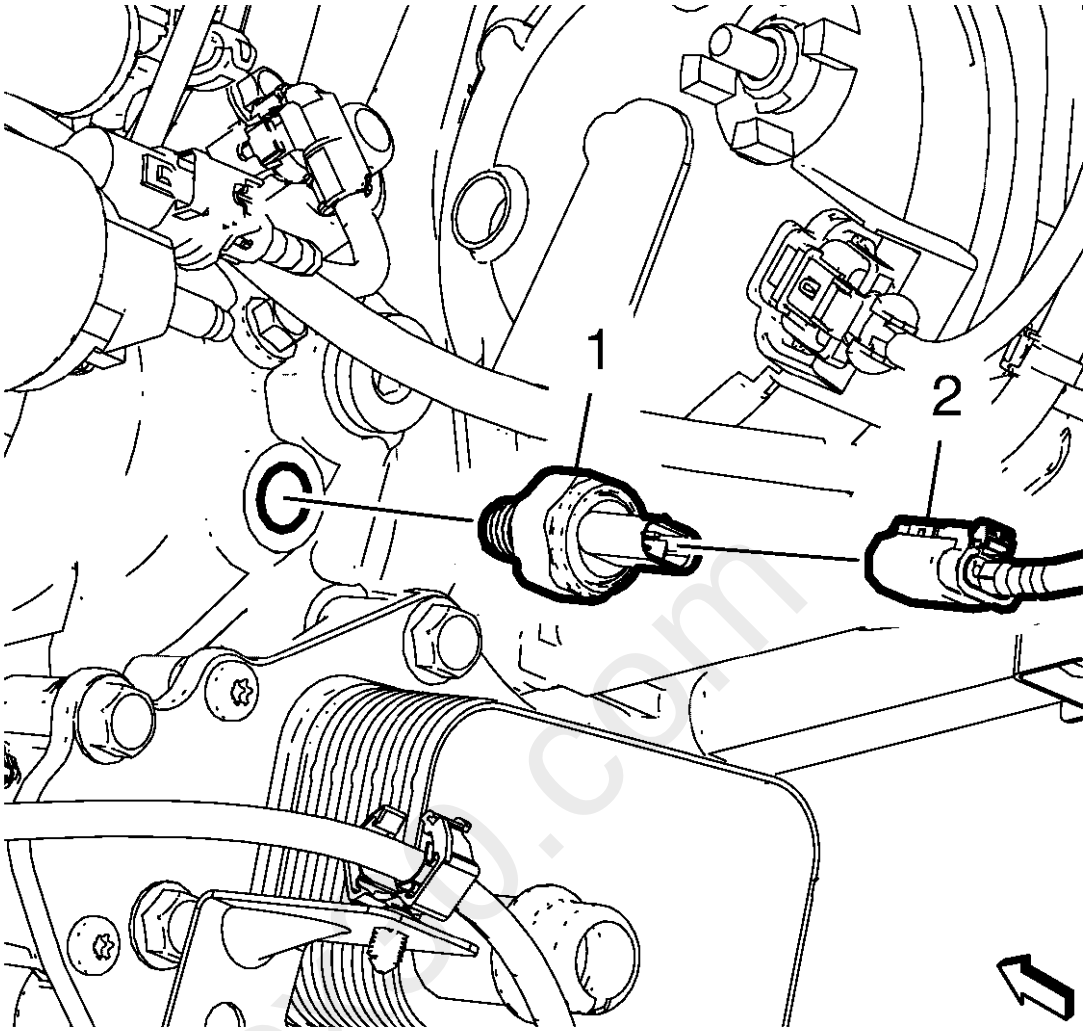


Fig. 27: Oil Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Install the engine oil pressure sensor (1) to the engine block and tighten to 35 N.m (26 lb ft).
7. Connect the electrical connector (2) to the engine oil pressure sensor (1).
8. Install the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LH7)**
9. Lower the vehicle.
10. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

OIL LEAK DIAGNOSIS

Special Tools

BO-42220 Universal Leak Detection Lamp

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

Step	Action	Yes	No

Step	Action	Yes	No
	CAUTION: **Do not use belt dressing on the drive belt. Belt dressing causes the breakdown of the composition of the drive belt. Failure to follow this recommendation will damage the drive belt.** DEFINITION: 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. Refer to **Engine Mechanical Specifications**. 2. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 3. Wait 15 minutes. 4. Check for drippings. Are drippings present?	Go to **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**
3	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard-to-see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to **Step 10**	Go to **Step 4**
4	1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several 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. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to **Step 10**	Go to **Step 6**

mx30.com

Step	Action	Yes	No
6	1. Completely clean the entire engine and surrounding components. 2. Apply an aerosol-type powder, for example, baby powder or foot powder, to the suspected area. 3. Operate the vehicle for several miles at normal operating temperature and at varying speeds. 4. Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface. Can you identify the type of fluid and the approximate location of the leak?	Go to **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. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to **Step 10**	Go to **Step 8**
8	Use the **BO-42220** lamp, 12 Volt UV in order to identify the type of fluid, and the approximate location of the leak. Refer to the manufacturer's instructions when using the tool. Can you identify the type of fluid and the approximate location of the leak?	Go to **Step 10**	Go to **Step 9**
9	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to **Step 10**	System OK
10	1. Inspect the engine for mechanical damage. Special interest should be shown to the following areas: 2. Inspect the engine for customer modifications. • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves • 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 Is there mechanical damage, or customer modifications to the engine?	Go to **Step 11**	System OK

mcx30.com

Step	Action	Yes	No
11	Repair or replace all damaged or modified components. Did you complete the repair?	Go to **Step 1**	--

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

mcx30.com

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: **Do not use belt dressing on the drive belt. Belt dressing causes the breakdown of the composition of the drive belt. Failure to follow this recommendation will damage the drive belt.** 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

mcx30.com

Step	Action	Yes	No
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, 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 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? If diagnosing a whine noise and the condition still exist, proceed to Diagnostic Aids.	Go to **Step 20**	Go to **Step 14**
14	Test the drive belt tensioner for proper operation. 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**

mcx30.com

Step	Action	Yes	No
19	Replace the generator and A/C compressor belt. Refer to **Generator and Air Conditioning Compressor 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 plays of the belt separating and may be seen at the edge of the belt our felt as a lump in the belt.

5

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

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

mx30.com

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

Step	Action	Yes	No

DEFINITION: The following items are indications of drive belt 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**	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**
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**	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**

mcx30.com

Step	Action	Yes	No
10	**CAUTION:** Refer to Fastener Caution . 1. Tighten any loose fasteners. Refer to Fastener Specifications. 2. Replace improper or missing fasteners. Did you complete the repair?	Go to **Step 12**	Go to **Step 11**
11	Inspect for bent or cracked brackets. Did you find and correct 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 3**

DRIVE BELT FALLS OFF AND EXCESSIVE WEAR DIAGNOSIS

Diagnostic Aids

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

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

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

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

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

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

Test Description

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

2

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

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

mcx30.com

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
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 high 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 generator and A/C compressor belt. Refer to **Generator and Air Conditioning Compressor Belt Replacement**. Does the drive belt continue to fall off?	Go to **Step 4**	System OK
4	Inspect for misalignment of the pulleys. Did you find and correct the condition?	Go to **Step 12**	Go to **Step 5**
5	Inspect for a bent or dented pulley. Did you find and correct the condition?	Go to **Step 12**	Go to **Step 6**
6	Inspect for a bent or a cracked bracket. Did you find and correct 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 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 correct 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**

Step	Action	Yes	No
13	Inspect the generator and A/C compressor belt for the proper installation. Refer to **Generator and Air Conditioning Compressor 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 correct the condition?	Go to **Step 17**	Go to Diagnostic Aids
16	Replace the generator and A/C compressor belt. Refer to **Generator and Air Conditioning Compressor 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
CAUTION: **Allowing the drive belt tensioner to snap into the free position may result in damage to the tensioner.**			
1	1. Remove the generator and A/C compressor belt. Refer to **Generator and Air Conditioning Compressor Belt Replacement**. 2. Inspect the drive belt tensioner pulley. Is the drive belt tensioner pulley loose or misaligned?	Go to **Step 4**	Go to **Step 2**
2	Rotate the drive belt tensioner. Does the tensioner rotate without any unusual resistance or binding?	Go to **Step 3**	Go to **Step 4**
3	1. Use a torque wrench in order to measure the torque required to move the tensioner off of the stop. 2. Use a torque wrench on a known good tensioner in order to measure the torque required to move the tensioner off of the stop. Is the first torque reading within 10 percent of the second torque reading?	System OK	Go to **Step 4**
4	Replace the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**. Is the repair complete?	System OK	-

TURBOCHARGER WHINE NOISE

Cause	Correction
NOTE: **Some whine noise is normal. Compare to a known good vehicle.**	
Leaking charge air cooler/pipes/hoses	Inspect for leaks in charge air cooler/pipes/hoses.
Worn turbocharger bearings	Visually inspect for evidence of compressor wheel to housing contact. If the turbocharger bearings are worn or damaged, inspect for a **Turbocharger Lack of Oil Supply**.

Cause	Correction
Intake system leaks or obstructions	1. With the engine off, pressurize the intake system and inspect for intake manifold leaks. 2. Inspect for obstructions in the intake manifolds.

TURBOCHARGER HISSING NOISE

Condition	Action
Air inlet leaks or obstructions	Inspect the turbocharger inlet pipes/hoses for leaks or obstructions.
Leaking charge air cooler/pipes/hoses	Inspect the charge air cooler/pipes/hoses for leaks or obstructions.
Leaking or restricted exhaust system	1. Inspect the exhaust system for a leak. 2. Inspect the exhaust system for a restrictions.
Intake system leaks or obstructions	1. Inspect the intake manifold for a leak. 2. Inspect the intake manifold for restrictions.

TURBOCHARGER OIL LEAK FROM COMPRESSOR SEAL

Condition	Action
NOTE: **Oil in the turbocharger air inlet pipe, oil on the compressor wheel, and oil throughout the charge air cooler system is normal with a closed PCV system. Do not attempt repairs for this condition.**	
Restricted air system	Inspect for clogged air filter element or restricted air inlet system.
Restricted exhaust system	Inspect for a restricted exhaust.
Leaking exhaust system	Inspect for exhaust manifold leaks.
Poor oil drainage from turbocharger	Inspect for restricted turbocharger oil drain pipe.
Restricted crankcase ventilation system	Inspect for restricted crankcase ventilation system.
Worn internal engine components	Inspect for excessive blowby or engine oil consumption.

TURBOCHARGER OIL LEAK FROM TURBINE SEAL

Condition	Action
Poor oil drainage from turbocharger	Inspect for a restricted turbocharger oil drain pipe.
Restricted crankcase ventilation system	Inspect for a restricted crankcase ventilation system.
Worn internal engine components	Inspect for excessive blowby or engine oil consumption.

TURBOCHARGER LACK OF OIL SUPPLY

Condition	Action
Restricted oil supply pipe	Inspect for restricted turbocharger oil feed pipe. Refer to **Turbocharger Oil Feed Pipe Replacement**.
Leakage of oil at the oil supply pipe	Inspect for the turbocharger oil supply pipe.

DUAL MASS FLYWHEEL DIAGNOSIS

Check for Thermal Overload

NOTE: **These quick information shall help to carry out a correct diagnosis in case of a customer complaint.**

Through friction of clutch plate on the friction surface of the dual mass flywheel temperatures up to 200Â°C can arise during normal driving. At sliding clutch or through operating errors much higher temperatures can arise. These temperatures must not cause mandatory a reduced lifetime of the dual mass flywheel.

Possible indications for a high thermal load are:

- Tarnish (bluish) as well as local hotspots on friction surface
- Tarnish (bluish) near of mounting area and riveting area of clutch

If all other checkable features are well, the dual mass flywheel can stay in the vehicle.

Possible indications for a too high thermal load are:

- Cracks
- Fusion zones on friction surface (material smear)
- Scores in friction surface (for example through clutch lining riveting at destroyed or worn clutch plate)
- Tarnish (bluish) which reaches up to bearing area of dual mass flywheel
- Bluish discoloration of locating pins (3 locating pins in outer zone of dual mass flywheel)

In these cases the dual mass flywheel has to be replaced.

Overview Dual Mass Flywheel

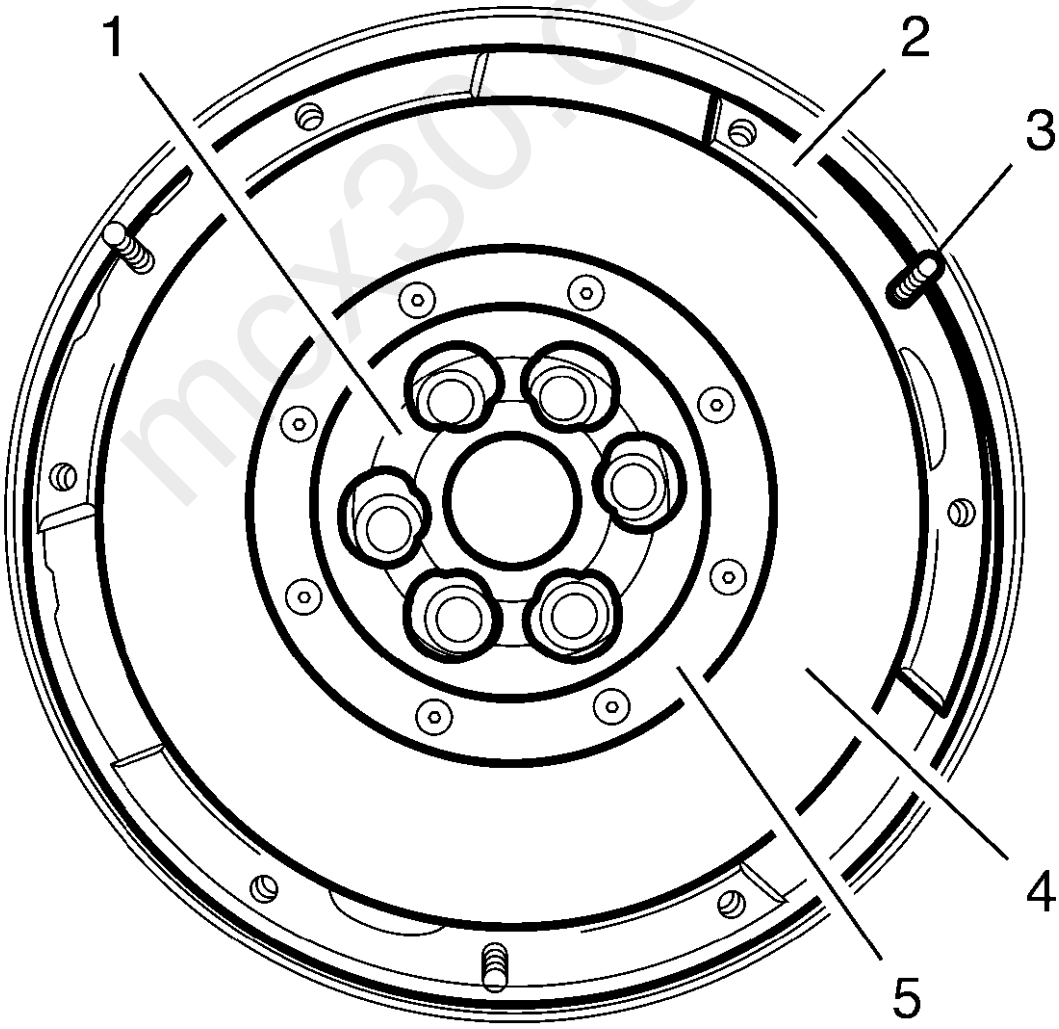


Fig. 28: Dual Mass Flywheel Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

Callout	Component Name
1	Bearing Area
2	Mounting Area Pressure Plate
3	Locating Pins
4	Friction Surface
5	Riveting Area

Exploded View Dual Mass Flywheel with Additional Mass

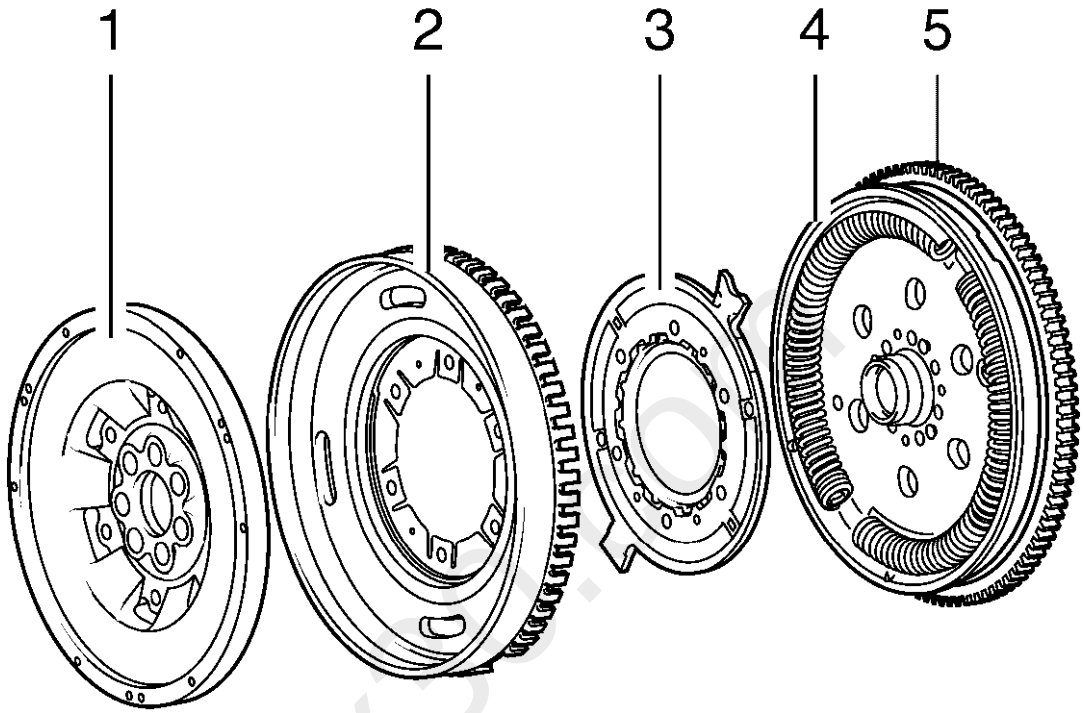


Fig. 29: Dual Mass Flywheel With Additional Mass Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Secondary Flywheel Mass
2	Additional Mass, Coupled with Cover and Pulse-Generator Ring
3	Flange
4	Primary Flywheel Mass with Bowed Springs and Plain Bearing/Bearing Bolt
5	Toothed Ring

Check for Damaged Components

All following checking procedures have to be carried out at installed dual mass flywheel. For visual check at vehicle very bright light and a additional bright and small pocket lamp is necessary. Damages like grease on primary flywheel and loose ore missing balance weights cannot be checked at installed condition. During visual check material alteration can be stated which eliminate a further operating suitability.

For comparison different damages at dual mass flywheel with the corresponding further procedure are presented here.

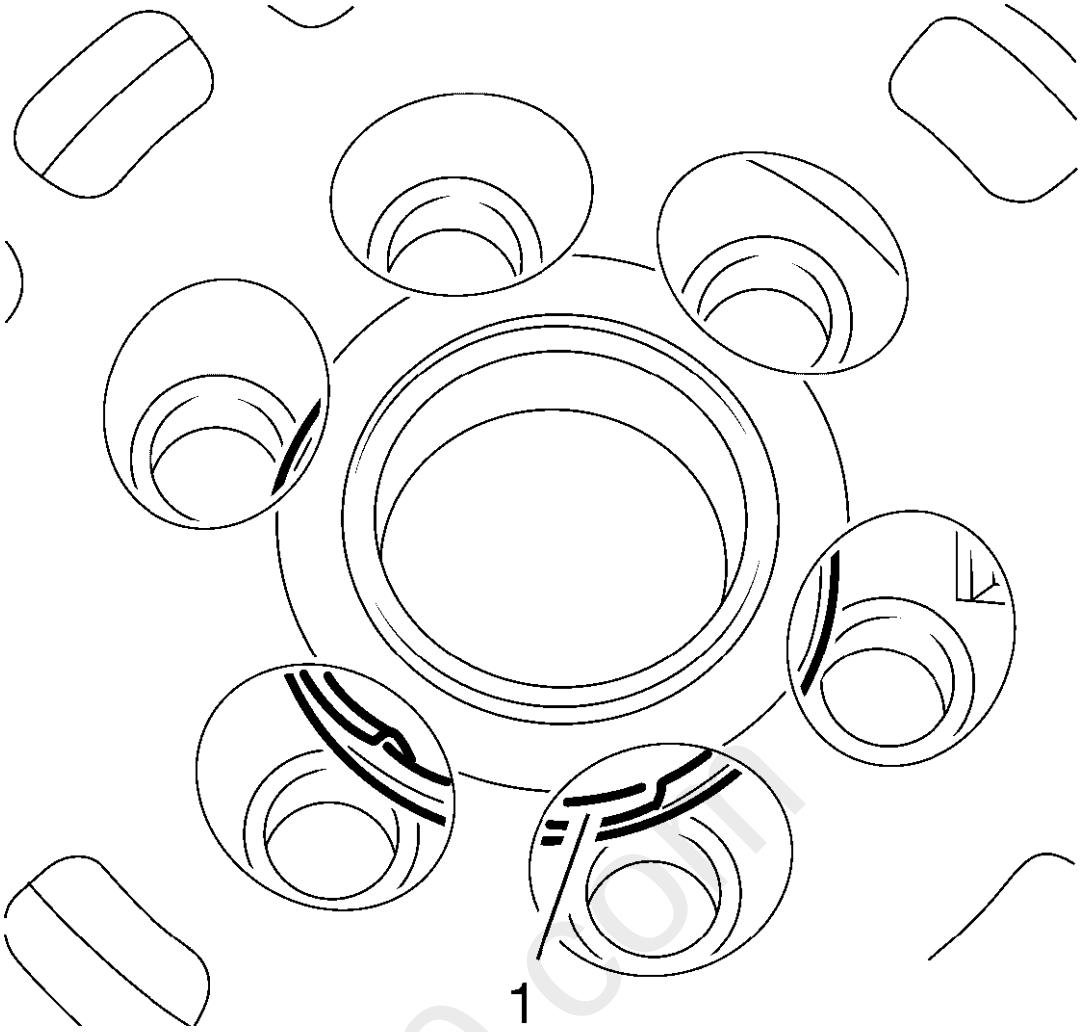


Fig. 30: Plain Bearing
Courtesy of GENERAL MOTORS COMPANY

NOTE: **In case of mechanical damages at plain bearing the dual mass flywheel has to be replaced.**

1. Inspect plain bearing (1) for damages.

   Dependent of the manufacturer damages can be detected through ventilation openings of secondary flywheel. Parts of the bearing (1) are detached or lie loose around the bearing bolt.

mcx30.com

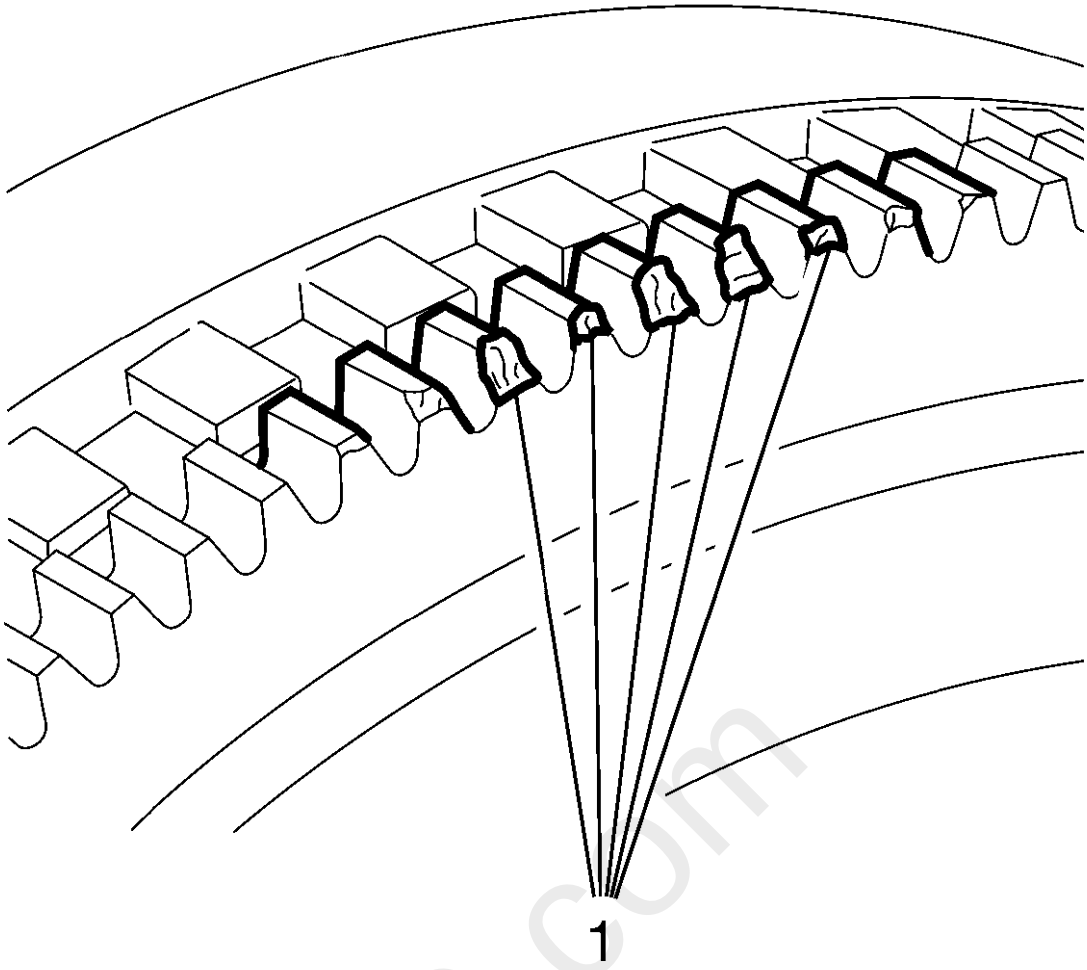


Fig. 31: Toothed Ring
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Light abrasion on frontal areas of teeth is allowed. If problems occur during starting the engine the dual mass flywheel has to be replaced.**

2. Inspect toothed ring (1) for damages.

   The toothed ring is needed to start the engine. Through a lot of starting procedures and/or an incorrect engaging starter signs of abrasion can occur on teeth of the toothed ring. The profile of damages can reach from only low signs of abrasion up to heavy material removal. The installation of a pulse-generator ring depends on the manufacturer.

   The image shows signs of abrasion and mechanical damages at toothed ring (1), they occur through abrasion due to a lot of starting procedures. In this case the dual mass flywheel has to be replaced.

mox30.com

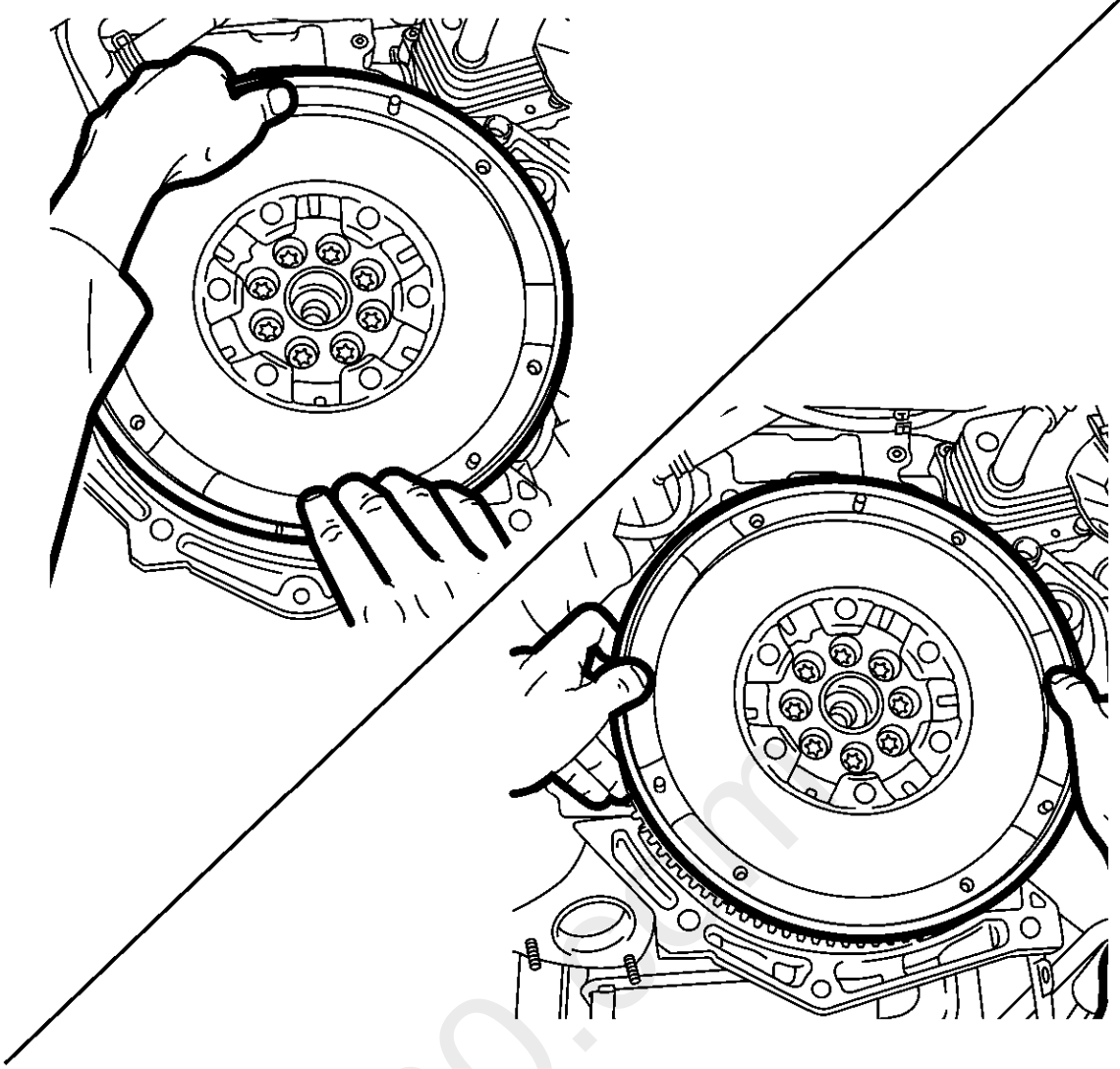


Fig. 32: Inspecting Tilt Clearance
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The check must be carried out only by hand without any tools.**

3. Inspect tilt clearance.

   At dual mass flywheel the additional-mass ring looms over the gap between primary and secondary flywheel.

mcx30.com

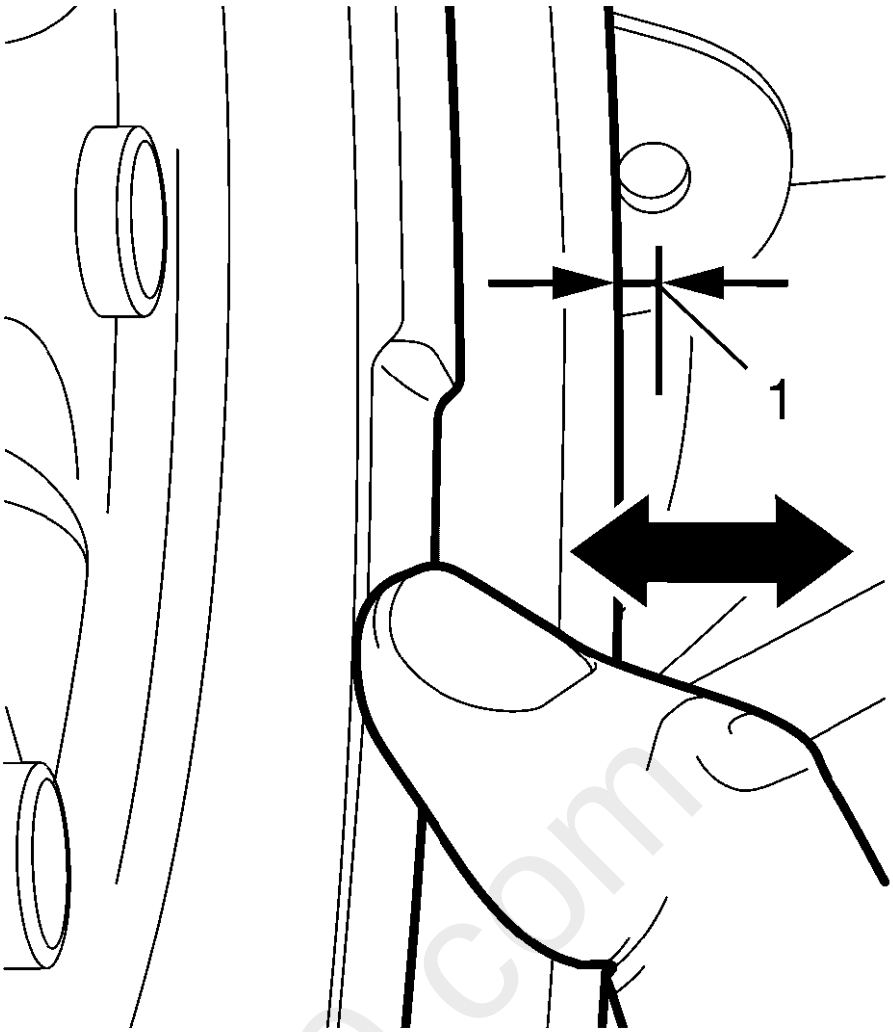


Fig. 33: Tilt Clearance Height
Courtesy of GENERAL MOTORS COMPANY

NOTE: **An absolute clear measurement is not possible with this check due to the different applied forces of the several workshop employees during the check and the different clearance of tilt play between the different suppliers.**

4. Embrace dual mass flywheel and apply thumbs onto the outer radius of secondary flywheel.
5. Apply pressure onto the secondary flywheel alternating on upper, lower, left and right side

During the tilt clearance check a functional metal rattling noise may occur.

A tilt play (1) is normal and does not require a replacement of the DMF, Check whether the free angle and the spring pressure are available on both sides. If the rotation of the flywheel at one or both sides impossible the flywheel is defective and has to be replaced.

mx30.com

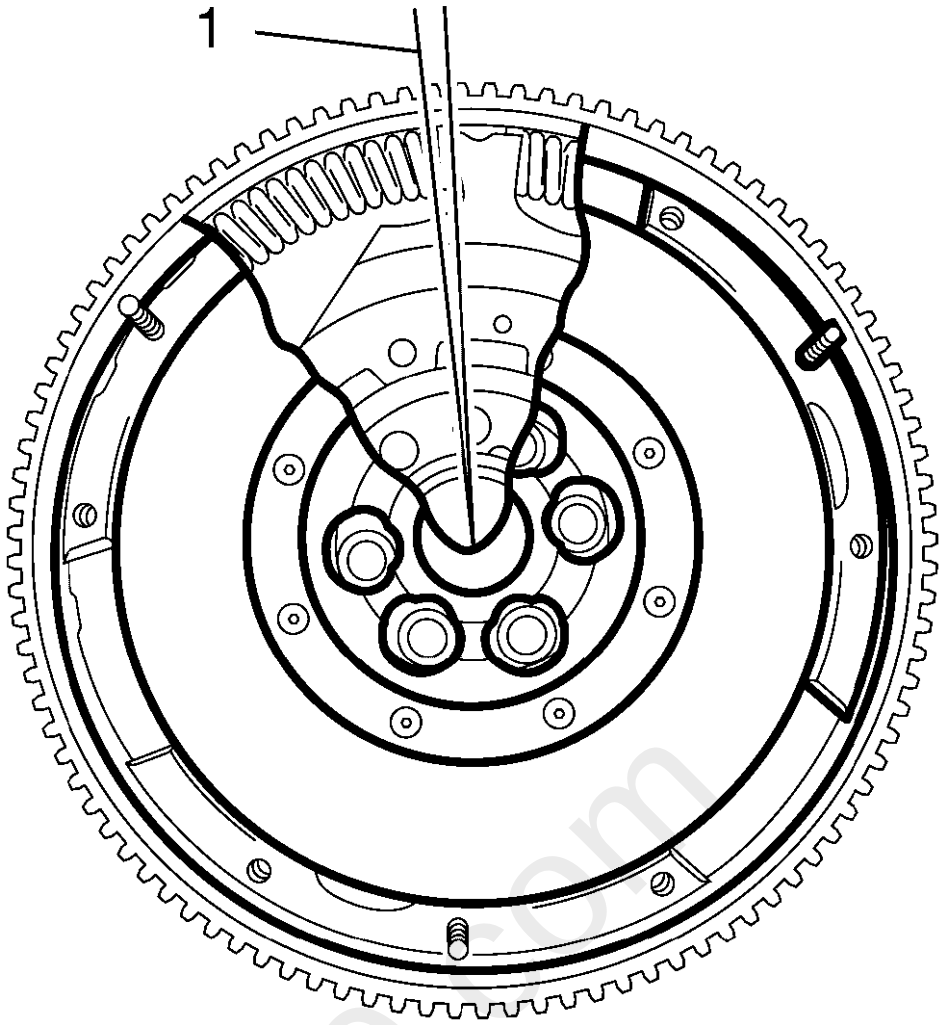


Fig. 34: Tilt Clearance Angle
Courtesy of GENERAL MOTORS COMPANY

mcx30.com

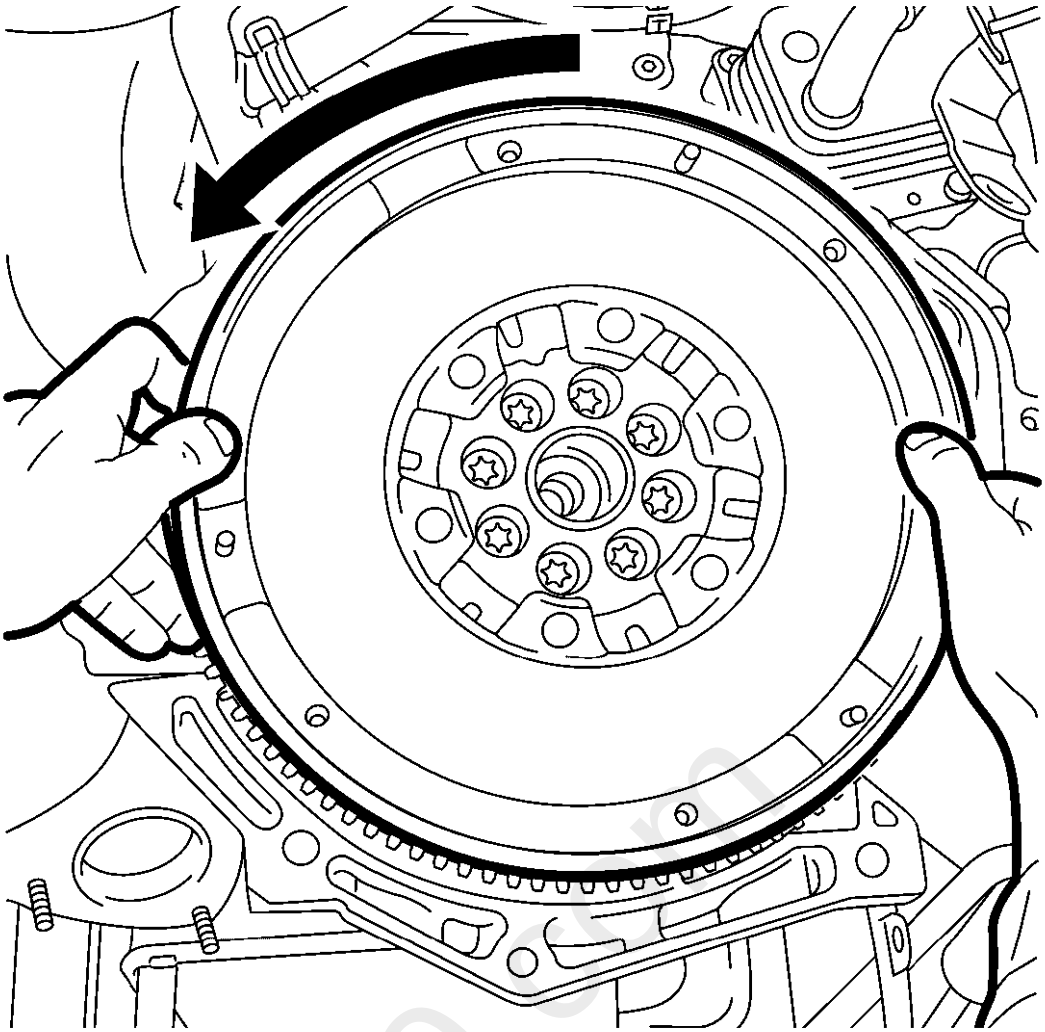


Fig. 35: Rotating Secondary Flywheel Anti-Clockwise
Courtesy of GENERAL MOTORS COMPANY

6. Inspect clearance angle (1).

   Before the inspection of the clearance angle the dual mass flywheel should be rotated several times clockwise and anti-clockwise to receive a feeling for the resistance of the springs. In addition unusual loud clicking noise or possible rattle, crunch, grinding noise can be sounded out during rotating the dual mass flywheel.

   If the rotation of the flywheel is impossible the flywheel is defective and has to be replaced.

   The clearance angle is the angle (1) about the secondary and the primary flywheel can be turned light against each other. Thereby the flange wings are moved in the duct of the bowed springs without adjoining the bowed springs.

   Is the secondary flywheel rotated beyond this point the bowed springs in the duct are moved to spring arrestor in the primary flywheel/cover. Now the both spring are tensioned.

   1. Rotate secondary flywheel anti-clockwise (arrow) until the elastic counterforce (spring force) is clear noticeable.
   2. Release secondary flywheel slowly until the bowed springs are relaxed, so no counterforce acts onto the springs.

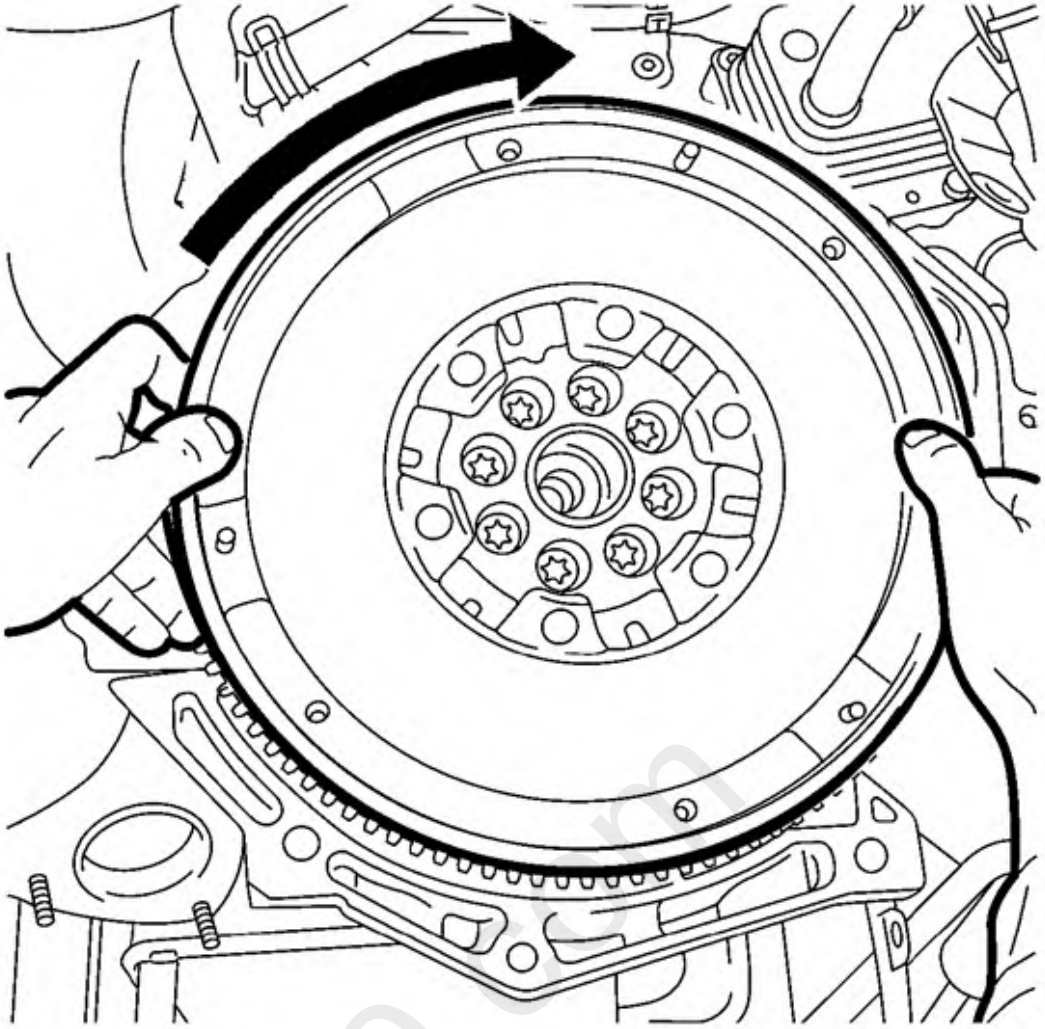


Fig. 36: Rotating Secondary Flywheel Clockwise
Courtesy of GENERAL MOTORS COMPANY

3. Rotate secondary flywheel clockwise until the elastic counterforce is clear noticeable.
4. Release secondary flywheel slowly until the bowed springs are relaxed.

7. ALWAYS replace the engine flywheel if following conditions are given:
   - The dual mass flywheel be rotated in one or both direction with no elastic counterforce.
   - The dual mass flywheel cannot be rotated.
   - During rotating the dual mass flywheel a hard metallic arrestor is audible or noticeable and there is no elastic counterforce.

REPAIR INSTRUCTIONS - ON VEHICLE

GENERATOR AND AIR CONDITIONING COMPRESSOR BELT REPLACEMENT

Removal Procedure

1. Remove Front Wheelhouse Liner Right Side. Refer to **Front Wheelhouse Liner Replacement - Right Side (Equinox)** **Front Wheelhouse Liner Replacement - Right Side (Terrain)**

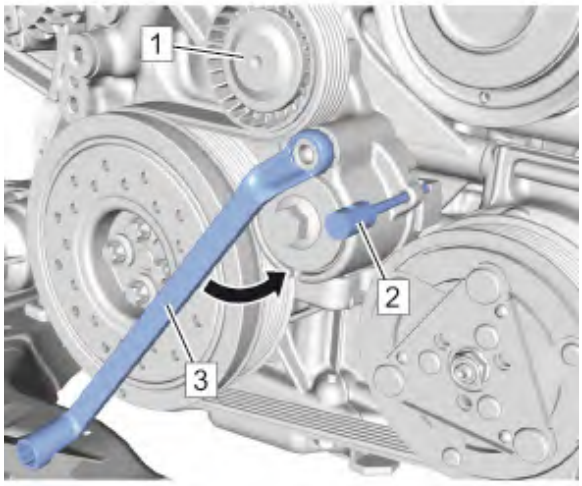


Fig. 37: Drive Belt Tensioner, Wrench And Fixing Pin
Courtesy of GENERAL MOTORS COMPANY

2. Tension the drive belt tensioner (1)
    1. Install a wrench (3) to the drive belt tensioner.
    2. Push the drive belt tensioner in arrow direction until a suitable fixing pin (2) can be installed to the bore.

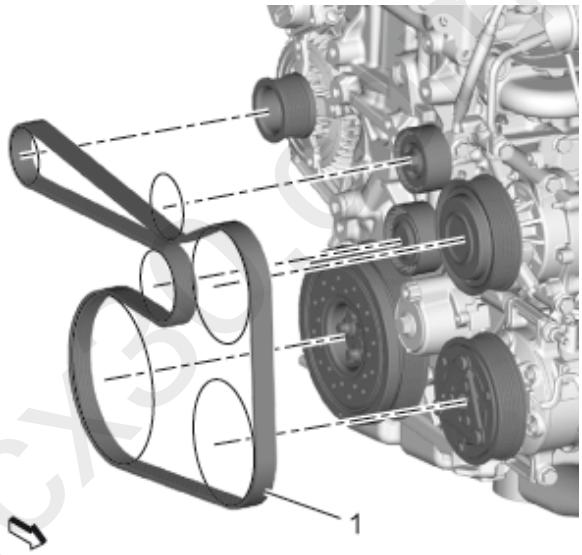


Fig. 38: Generator And Air Conditioning Compressor Belt
Courtesy of GENERAL MOTORS COMPANY

3. Remove Generator and Air Conditioning Compressor Belt (1)

Installation Procedure

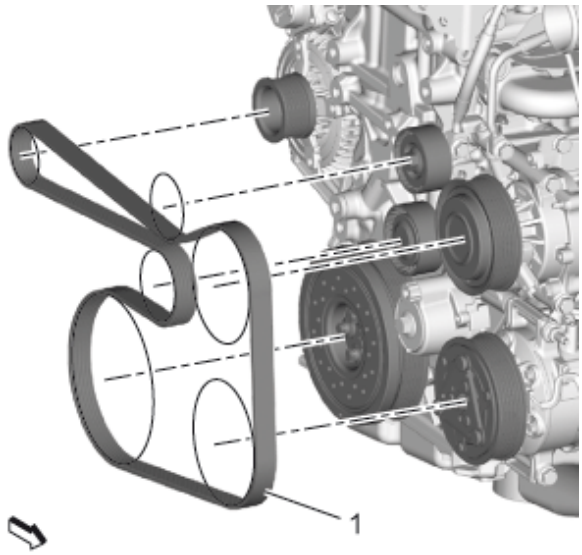


Fig. 39: Generator And Air Conditioning Compressor Belt Routing
Courtesy of GENERAL MOTORS COMPANY

1. Install Generator and Air Conditioning Compressor Belt (1)

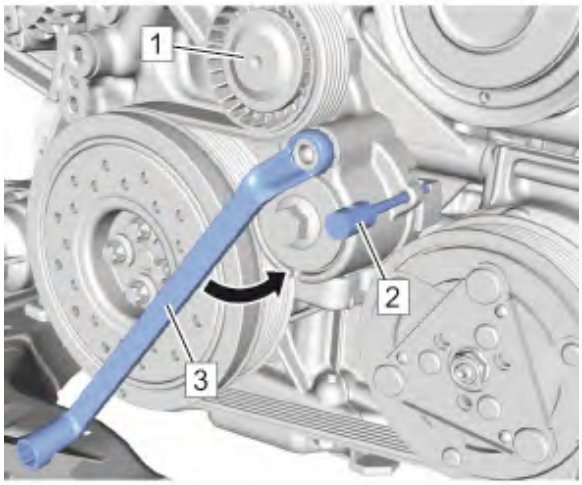


Fig. 40: Drive Belt Tensioner, Wrench And Fixing Pin
Courtesy of GENERAL MOTORS COMPANY

2. Tension the drive belt tensioner (1).
    1. Install a wrench (3) to the drive belt tensioner.
    2. Push the drive belt tensioner in arrow direction until the suitable fixing pin (2) can be removed from the bore.
    3. Release the drive belt tensioner.
3. Install Front Wheelhouse Liner Right Side. Refer to **Front Wheelhouse Liner Replacement - Right Side (Equinox)** **Front Wheelhouse Liner Replacement - Right Side (Terrain)**

BELT IDLER PULLEY REPLACEMENT

Removal Procedure

1. Remove Generator and Air Conditioning Compressor Belt. Refer to **Generator and Air Conditioning Compressor Belt Replacement**

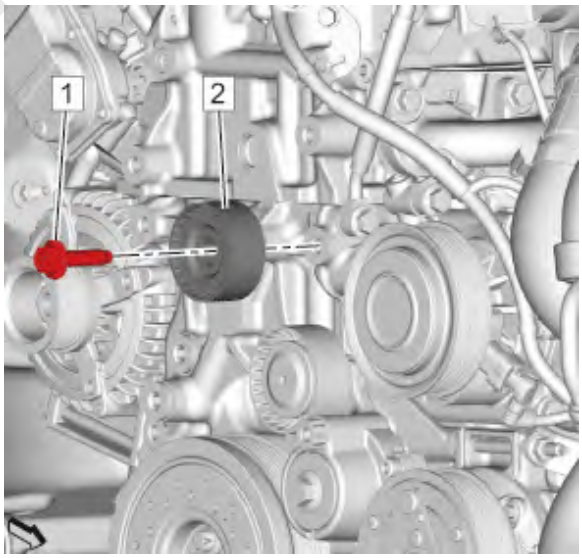


Fig. 41: Belt Idler Pulley And Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove Belt Idler Pulley Bolt (1)
3. Remove Belt Idler Pulley (2)

Installation Procedure

mcx30.com

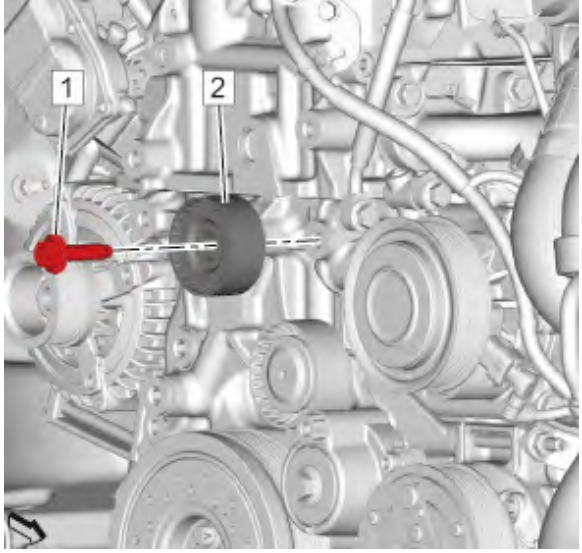


Fig. 42: Belt Idler Pulley And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install Belt Idler Pulley (2)

CAUTION: **Refer to: Fastener Caution**

2. Install and tighten Belt Idler Pulley Bolt (1) to 58 N.m (43 lb ft)
3. Install Generator and Air Conditioning Compressor Belt. Refer to **Generator and Air Conditioning Compressor Belt Replacement**

DRIVE BELT TENSIONER REPLACEMENT

Removal Procedure

1. Remove the drive belt. Refer to **Generator and Air Conditioning Compressor Belt Replacement**

mcx30.com

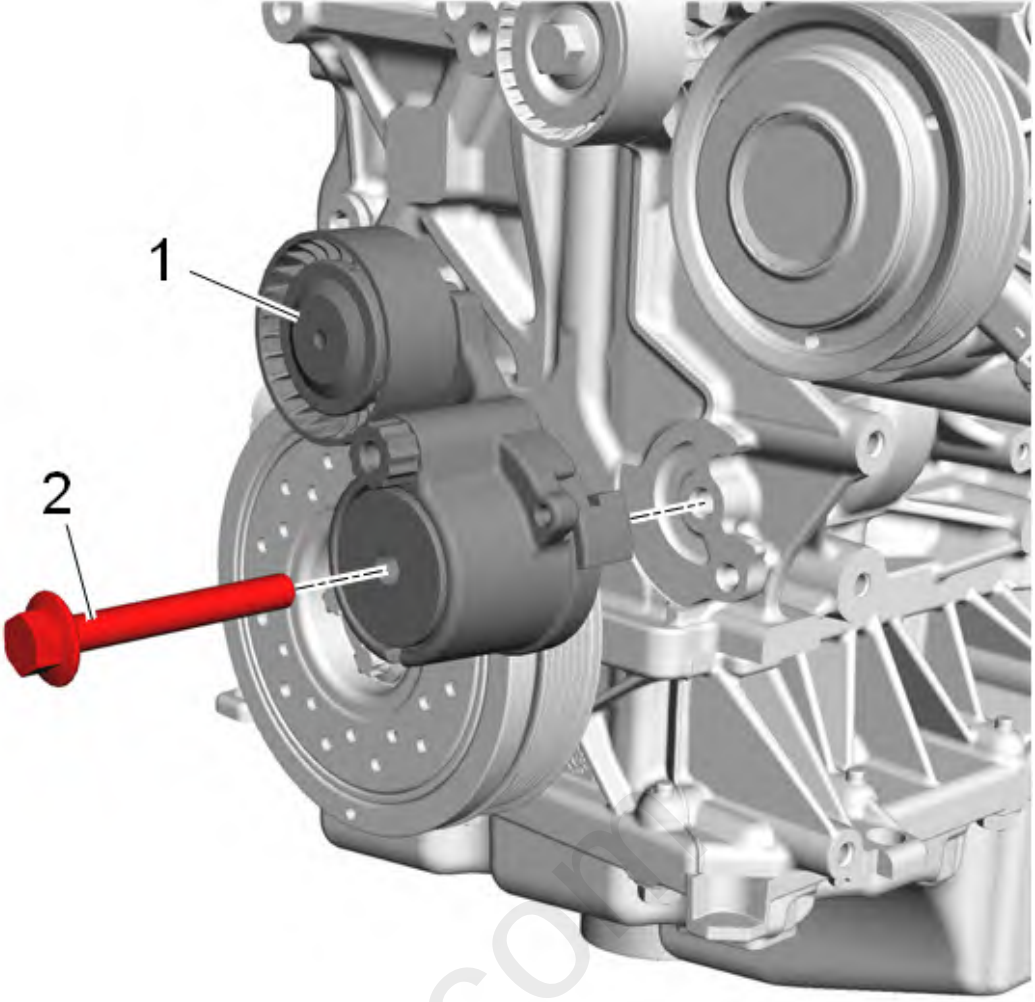


Fig. 43: Drive Belt Tensioner And Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove the drive belt tensioner bolt (2).
3. Remove the drive belt tensioner (1).

Installation Procedure

mcx30.com

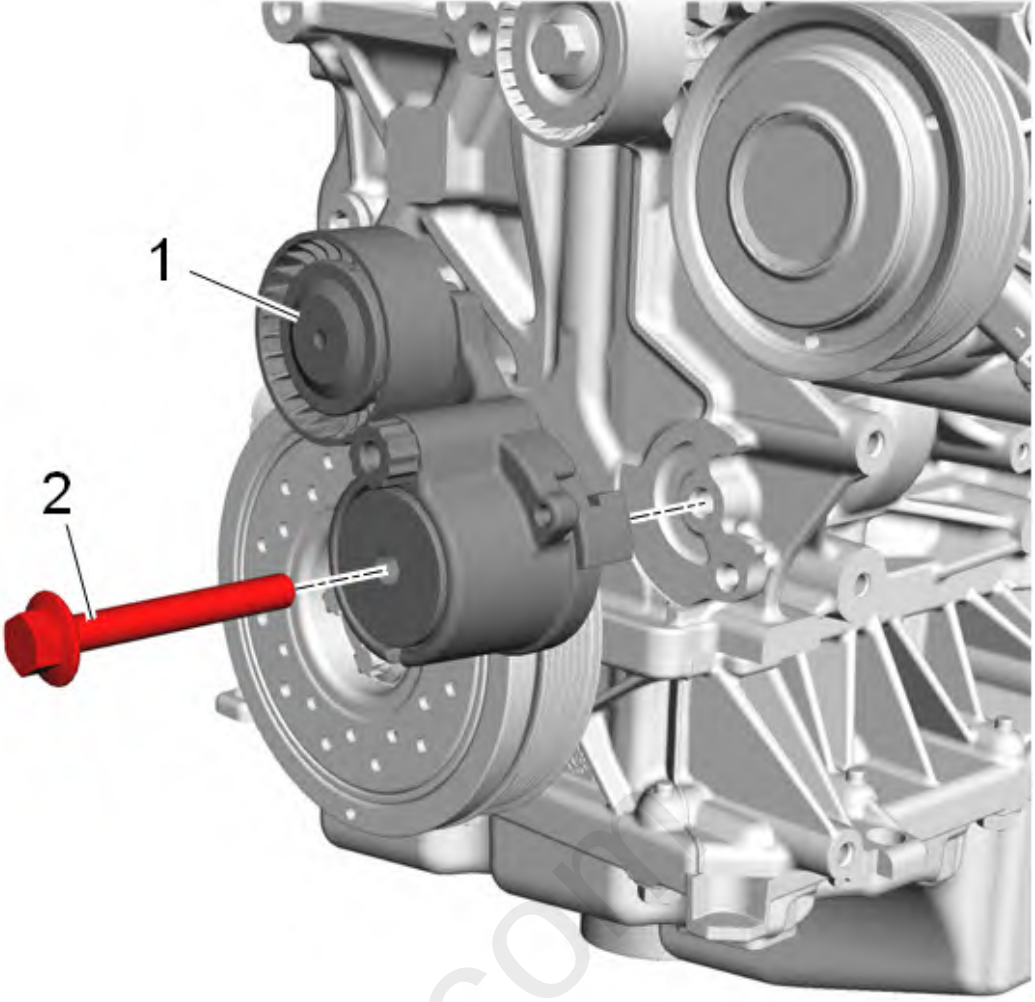


Fig. 44: Drive Belt Tensioner And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the drive belt tensioner (1).

CAUTION: **Refer to Fastener Caution .**

2. Install the drive belt tensioner bolt (2) and tighten to 55 N.m (41 lb ft).
3. Install the drive belt. Refer to **Generator and Air Conditioning Compressor Belt Replacement**

ENGINE MOUNT REPLACEMENT

Special Tools

EN-45059 Angle Meter

Equivalent regional tools: **Special Tools**

Removal Procedure

1. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
2. Remove Air Cleaner Assembly. Refer to **Air Cleaner Assembly Replacement**
3. Install Engine Support Fixture. Refer to **Engine Support Fixture**

mcx30.com

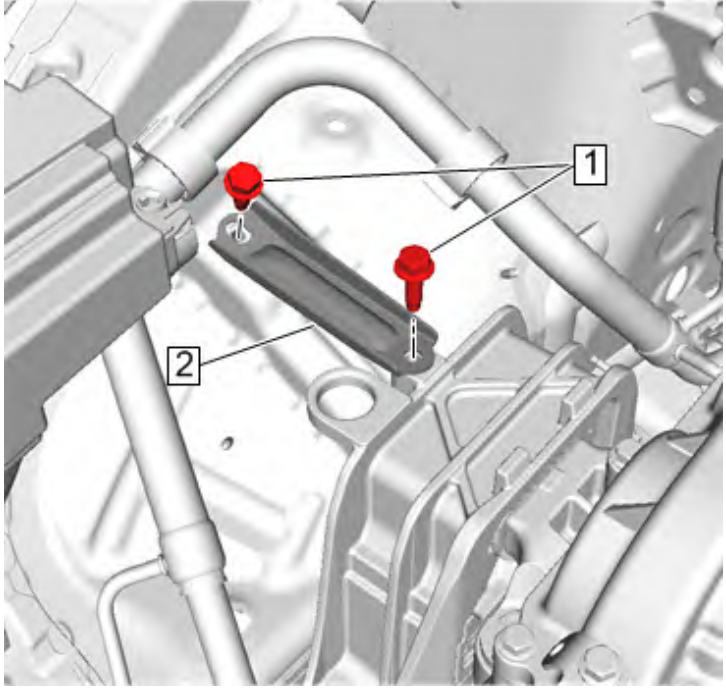


Fig. 45: Engine Mount Brace And Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove Engine Mount Brace Bolts (1) (Qty: 2)
5. Remove Engine Mount Brace (2)

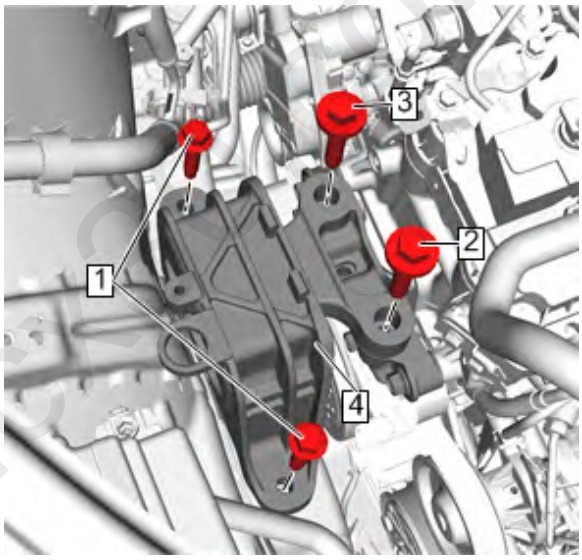


Fig. 46: Engine Mount And Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove Engine Mount Bolts (1) (Qty: 2)
7. Remove and DISCARD Engine Mount Engine Side Bolt (2)
8. Remove and DISCARD Engine Mount Engine Side Bolt (3)
9. Remove Engine Mount (4)

Installation Procedure

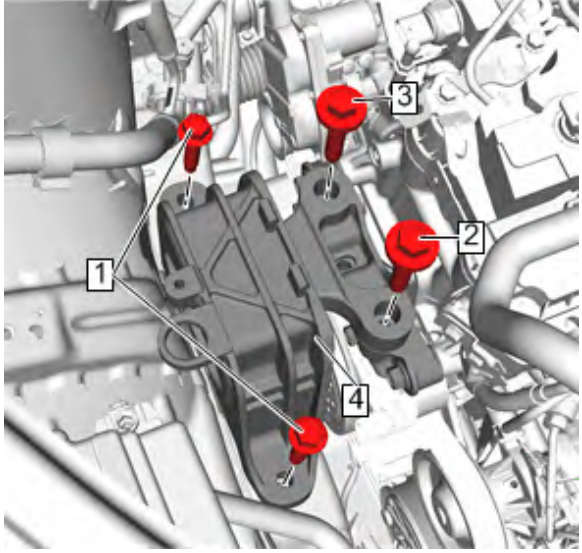


Fig. 47: Engine Mount And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install Engine Mount (4)

CAUTION: **Refer to Fastener Caution**

2. Install and tighten Engine Mount Bolts (1) (Qty: 2) to 100 N.m (74 lb ft)

CAUTION: **Refer to Torque-to-Yield Fastener Caution**

3. Install NEW Engine Mount Engine Side Bolt (2, 3)
4. Tighten Engine Mount Engine Side Bolt (2)
    1. First Pass: 35 N.m (26 lb ft)
5. Tighten Engine Mount Engine Side Bolt (3)
    1. First Pass: 35 N.m (26 lb ft)
6. Tighten Engine Mount Engine Side Bolt (2, 3)
    1. Second Pass: 100 N.m (74 lb ft)
    2. Final Pass: 60 - 75 degrees - **EN-45059** Angle Meter

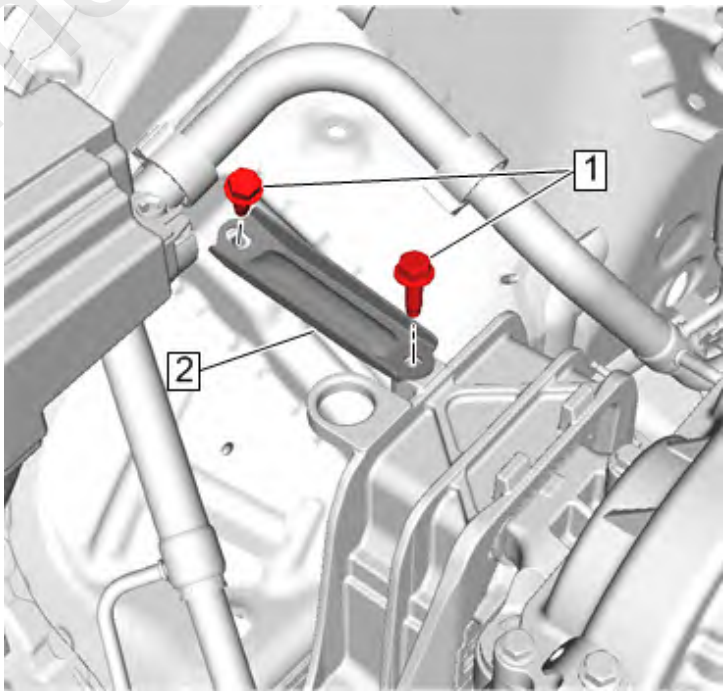


Fig. 48: Engine Mount Brace And Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install Engine Mount Brace (2)

mcx30.com

8. Install and tighten Engine Mount Brace Bolts (1) (Qty: 2) to 22 N.m (16 lb ft)
9. Remove Engine Support Fixture. Refer to **Engine Support Fixture**
10. Install Air Cleaner Assembly. Refer to **Air Cleaner Assembly Replacement**
11. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

ENGINE MOUNT BRACKET REPLACEMENT

Special Tools

EN-45059 Angle Meter

Equivalent regional tools: **Special Tools**

Removal Procedure

1. Remove the engine mount. Refer to **Engine Mount Replacement**

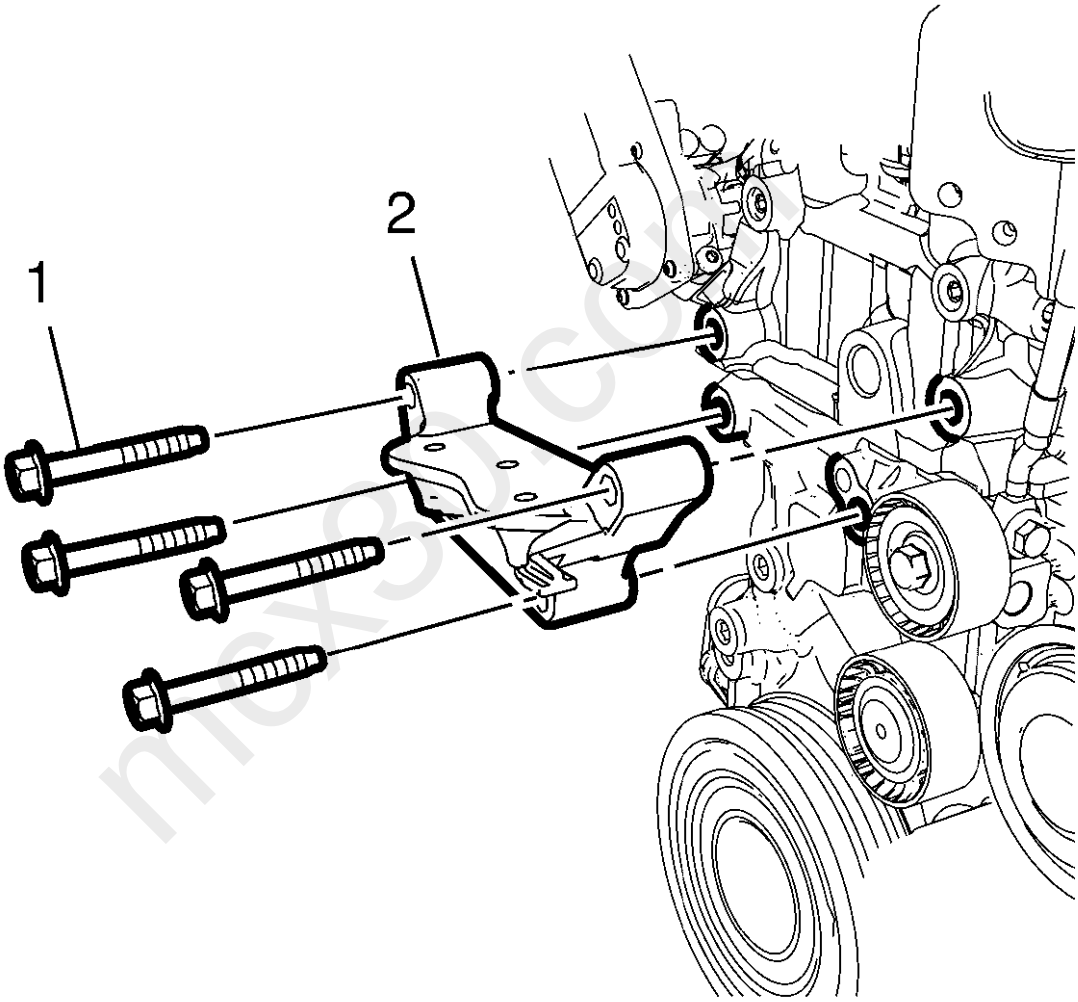


Fig. 49: Engine Mount Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove Engine Mount Bracket Bolts (1) (Qty: 4)
3. Remove Engine Mount Bracket (2)

Installation Procedure

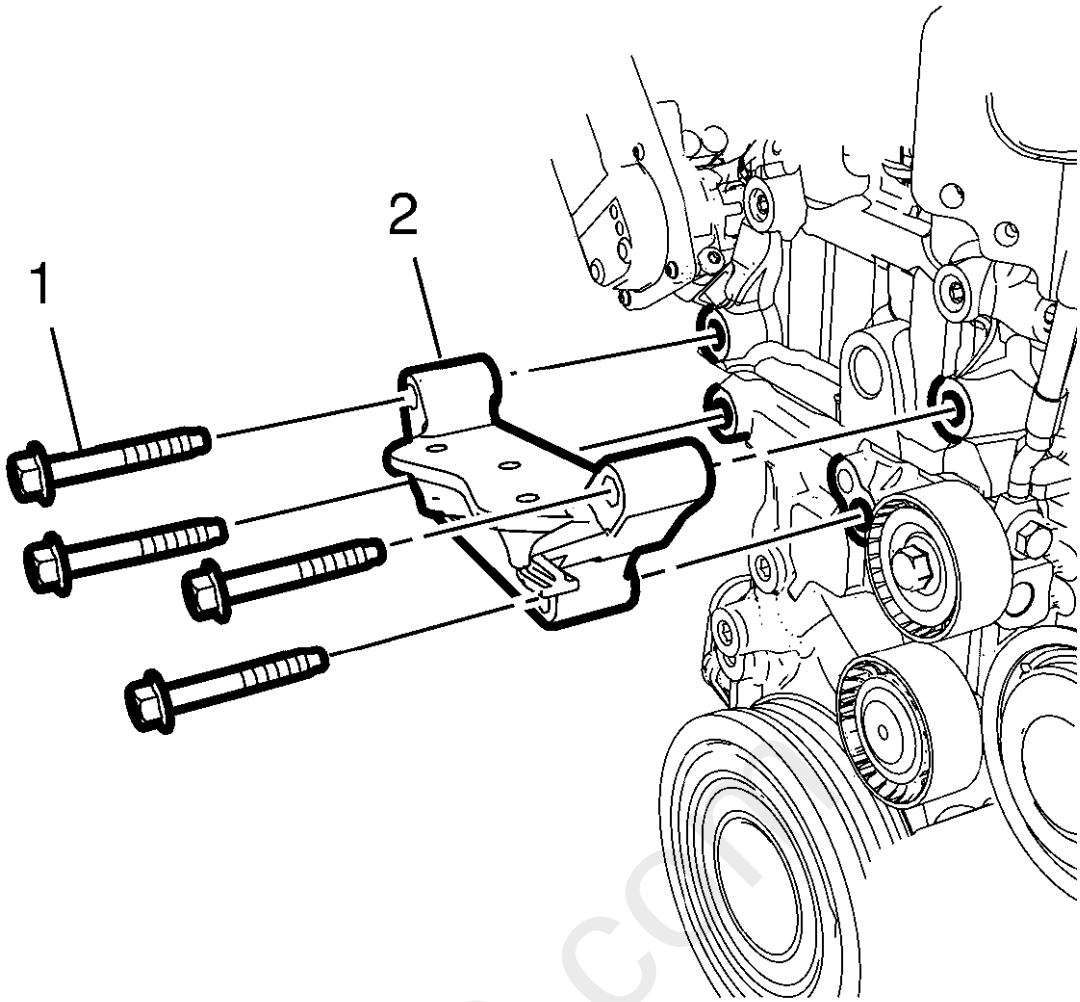


Fig. 50: Engine Mount Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install Engine Mount Bracket (2)

   CAUTION: **Refer to Fastener Caution**

2. Install NEW Engine Mount Bracket Bolts (1) (Qty: 4) and Hand tighten

   CAUTION: **Refer to Torque-to-Yield Fastener Caution**

3. Tighten Engine Mount Bracket Bolts (1) (Qty: 4) in sequence:
   1. First Pass: 58 N.m (43 lb ft)
   2. Final Pass: 60 - 75 degrees - Use the special tool: **EN-45059** Angle Meter
4. Install the engine mount. Refer to **Engine Mount Replacement**

CAMSHAFT HOUSING REPLACEMENT

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Fuel Injectors (Qty: 4). Refer to **Fuel Injector Replacement**

mcx30.com

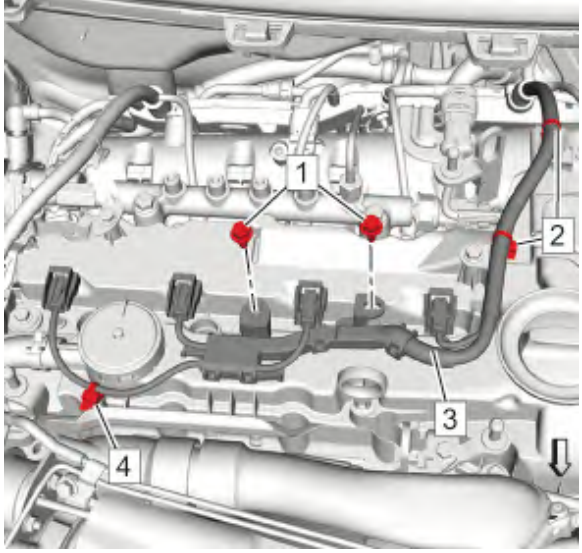


Fig. 51: Engine Wiring Harness, Conduit Bolts And Clips
Courtesy of GENERAL MOTORS COMPANY

3. Remove Engine Wiring Harness Conduit Bolts (1) (Qty: 2)
4. Unclip Wiring Harness Clips (2, 4) (Qty: 3)
5. Position aside Engine Wiring Harness (3)

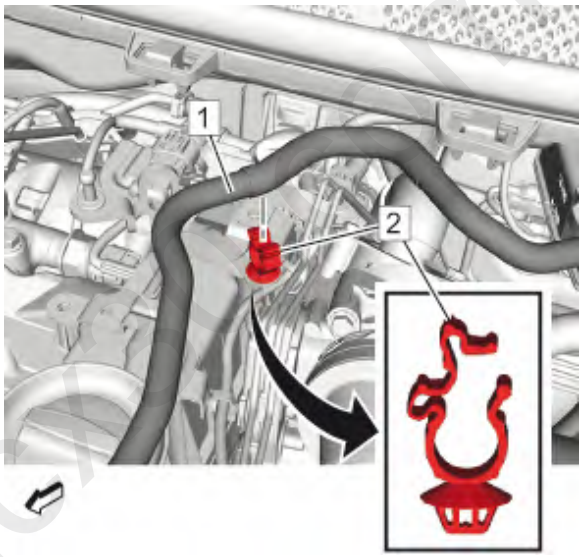


Fig. 52: Engine Coolant Air Bleed Hose And Retainer Clip
Courtesy of GENERAL MOTORS COMPANY

6. Unclip Engine Coolant Air Bleed Hose (1) @ Retainer Clip (2)
7. Position aside Engine Coolant Air Bleed Hose (1)

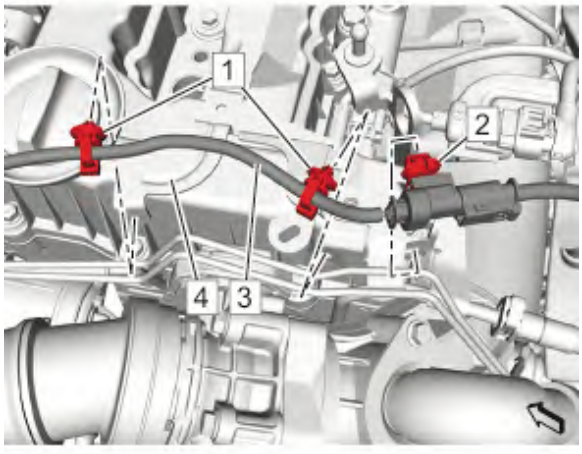


Fig. 53: Wiring Harness, Exhaust Temperature Sensor Bracket And Clips
Courtesy of GENERAL MOTORS COMPANY

8. Unclip Wiring Harness Clips (1) (Qty: 2) @ Exhaust Temperature Sensor Bracket (4)
9. Unclip Clip (2) @ Exhaust Temperature Sensor Bracket (4)
10. Position aside Wiring Harness (3)

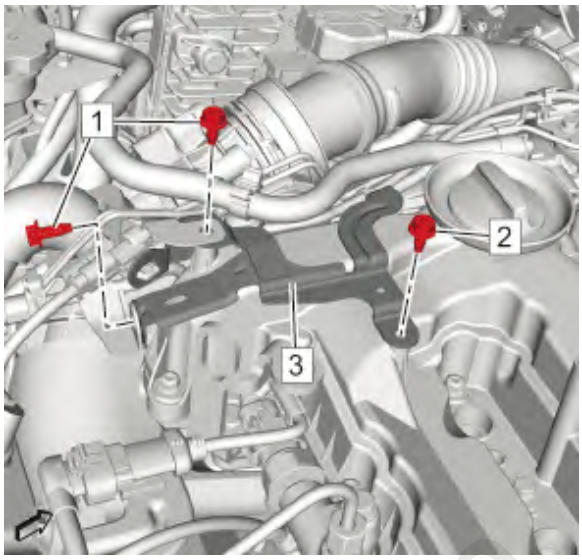


Fig. 54: Exhaust Temperature Sensor Electrical Connector Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Remove Exhaust Temperature Sensor Electrical Connector Bracket Bolts (1, 2) (Qty: 3)
12. Remove Exhaust Temperature Sensor Electrical Connector Bracket (3)

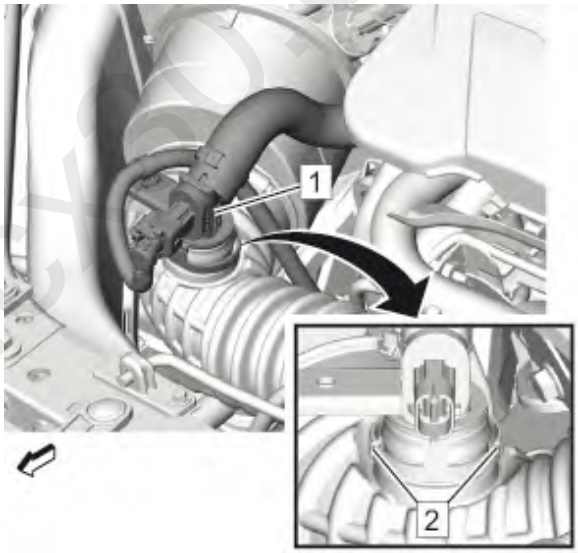


Fig. 55: Positive Crankcase Ventilation Heater And Checkered Places
Courtesy of GENERAL MOTORS COMPANY

13. Remove Positive Crankcase Ventilation Heater (1)
    1. Press the positive crankcase ventilation heater at the 2 checkered places (2).
    2. Pull the positive crankcase ventilation heater up to remove.

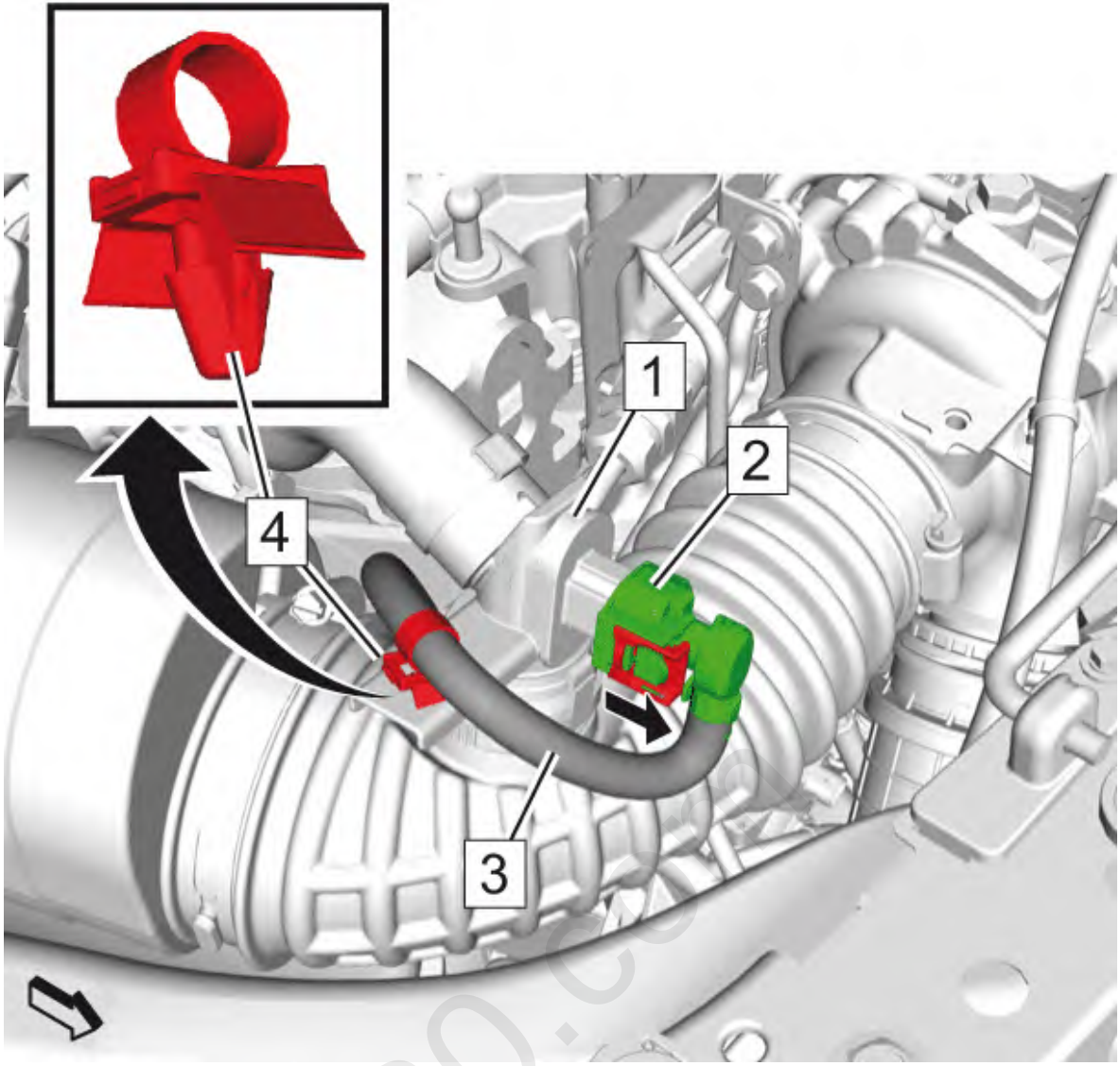


Fig. 56: Electrical Connector, PCV Heater, Wiring Harness And Clip
Courtesy of GENERAL MOTORS COMPANY

14. Disconnect Electrical Connector (2) @ Positive Crankcase Ventilation Heater (1)
15. Unclip Wiring Harness Clip (4)
16. Position aside Wiring Harness (3)

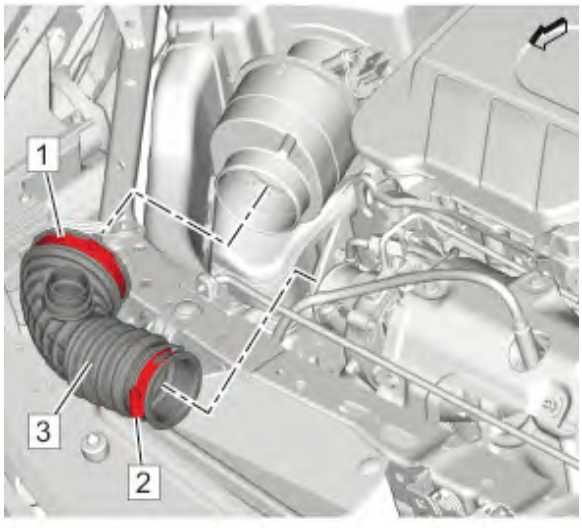


Fig. 57: Air Cleaner Outlet Duct And Clamps
Courtesy of GENERAL MOTORS COMPANY

17. Loosen Air Cleaner Outlet Duct Clamps (1, 2) (Qty: 2)
18. Remove Air Cleaner Outlet Duct (3)

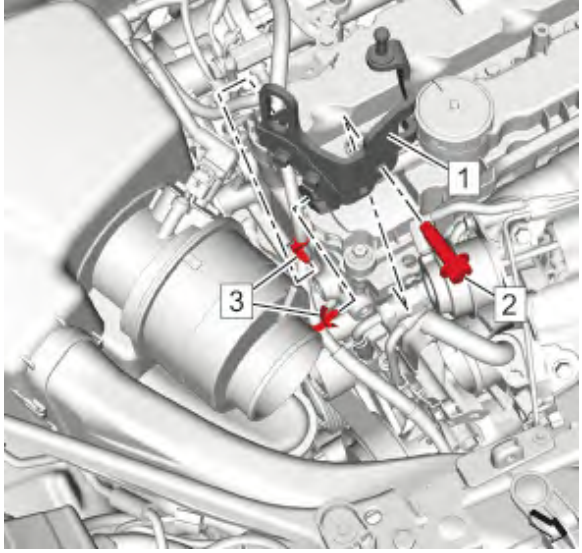


Fig. 58: Engine Lift Bracket, Bolt And Clips
Courtesy of GENERAL MOTORS COMPANY

19. Unclip Wiring Harness Clips (3) (Qty: 2)
20. Remove Engine Lift Bracket Bolt (2)
21. Remove Engine Lift Bracket (1)

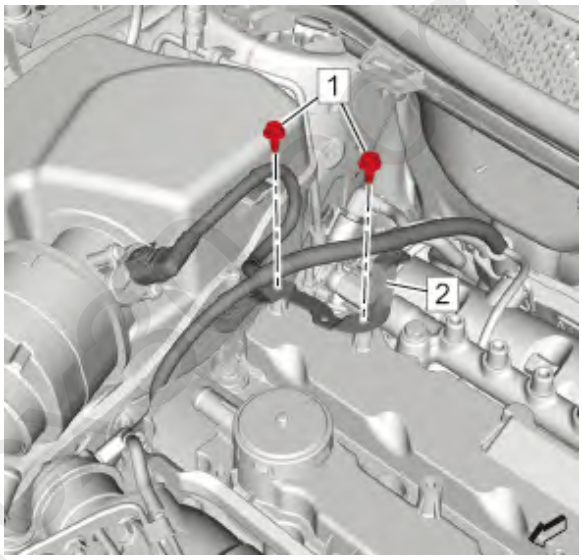


Fig. 59: Engine Control Module Wiring Harness Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

22. Remove Engine Control Module and Engine Wiring Harness Bracket Bolts (1) (Qty: 2)
23. Position aside Engine Control Module Wiring Harness Bracket (2)

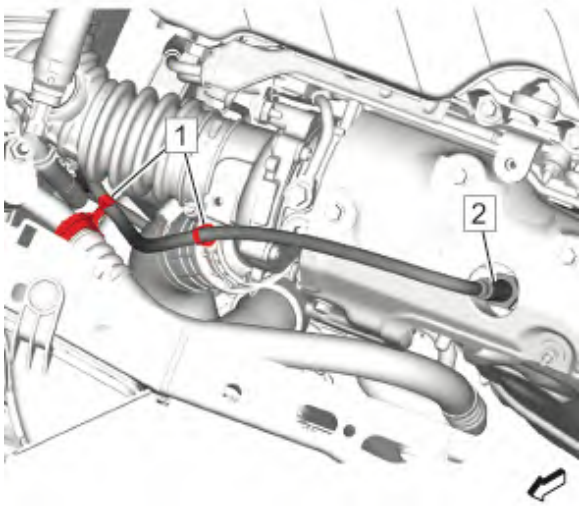


Fig. 60: Nitrogen Oxides Sensor And Wiring Harness Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not bend the cable sharply at the base of either the sensing unit or sensor ECU in the final mounting position.**

24. Remove Nitrogen Oxides Sensor (2)

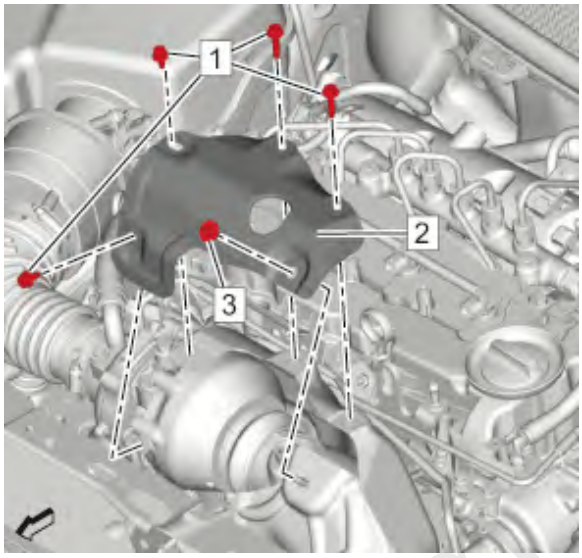


Fig. 61: Turbocharger Heat Shield, Bolts And Nut
Courtesy of GENERAL MOTORS COMPANY

25. Remove Turbocharger Heat Shield Bolts (1) (Qty: 4)
26. Remove Turbocharger Heat Shield Nut (3)
27. Remove Turbocharger Heat Shield (2)

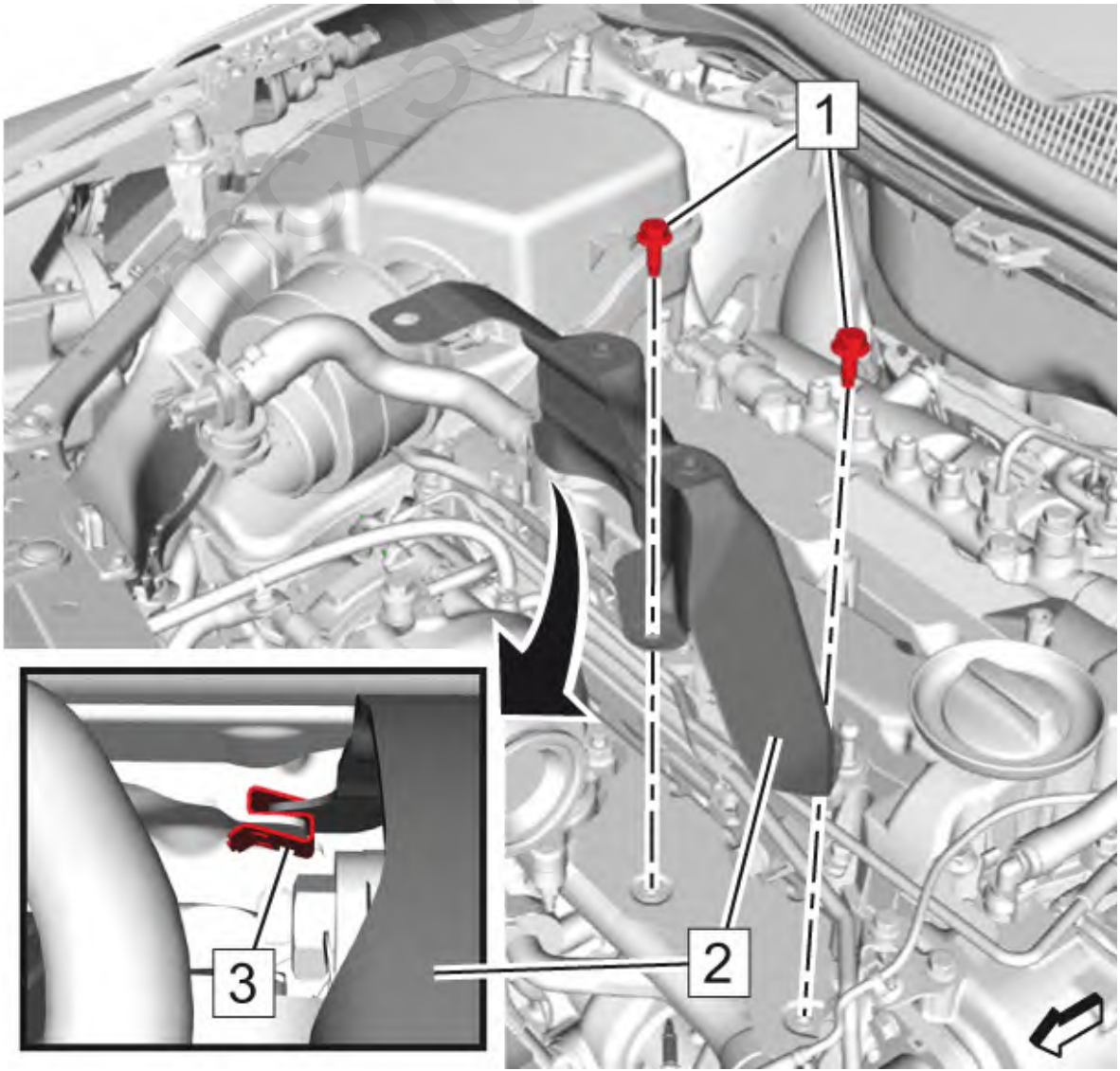


Fig. 62: Turbocharger Heat Shield, Bolts And Clamp
Courtesy of GENERAL MOTORS COMPANY

28. Remove Turbocharger Heat Shield Bolts (1) (Qty: 2)
29. Unclip Turbocharger Heat Shield (2) @ Clamp (3)
30. Remove Turbocharger Heat Shield (2)

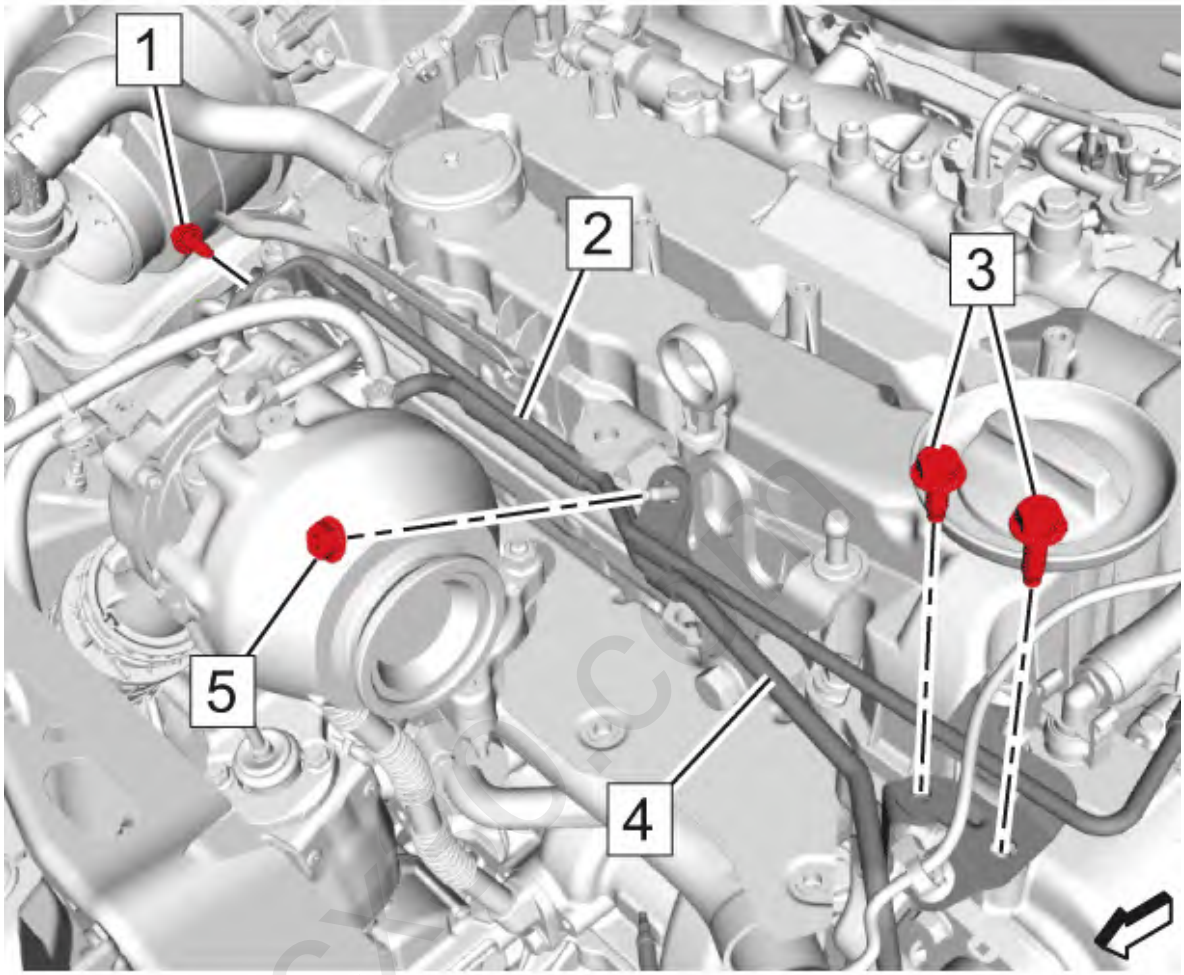


Fig. 63: Turbocharger Wastegate Actuator Pipe, Bolts, Nut And Turbocharger Coolant Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

31. Remove Turbocharger Wastegate Actuator Pipe Bolts (1, 3) (Qty: 3)
32. Remove the turbocharger wastegate actuator pipe nut (5).
33. Position aside Turbocharger Wastegate Actuator Pipe (2)
34. Position aside Turbocharger Coolant Feed Pipe (4)

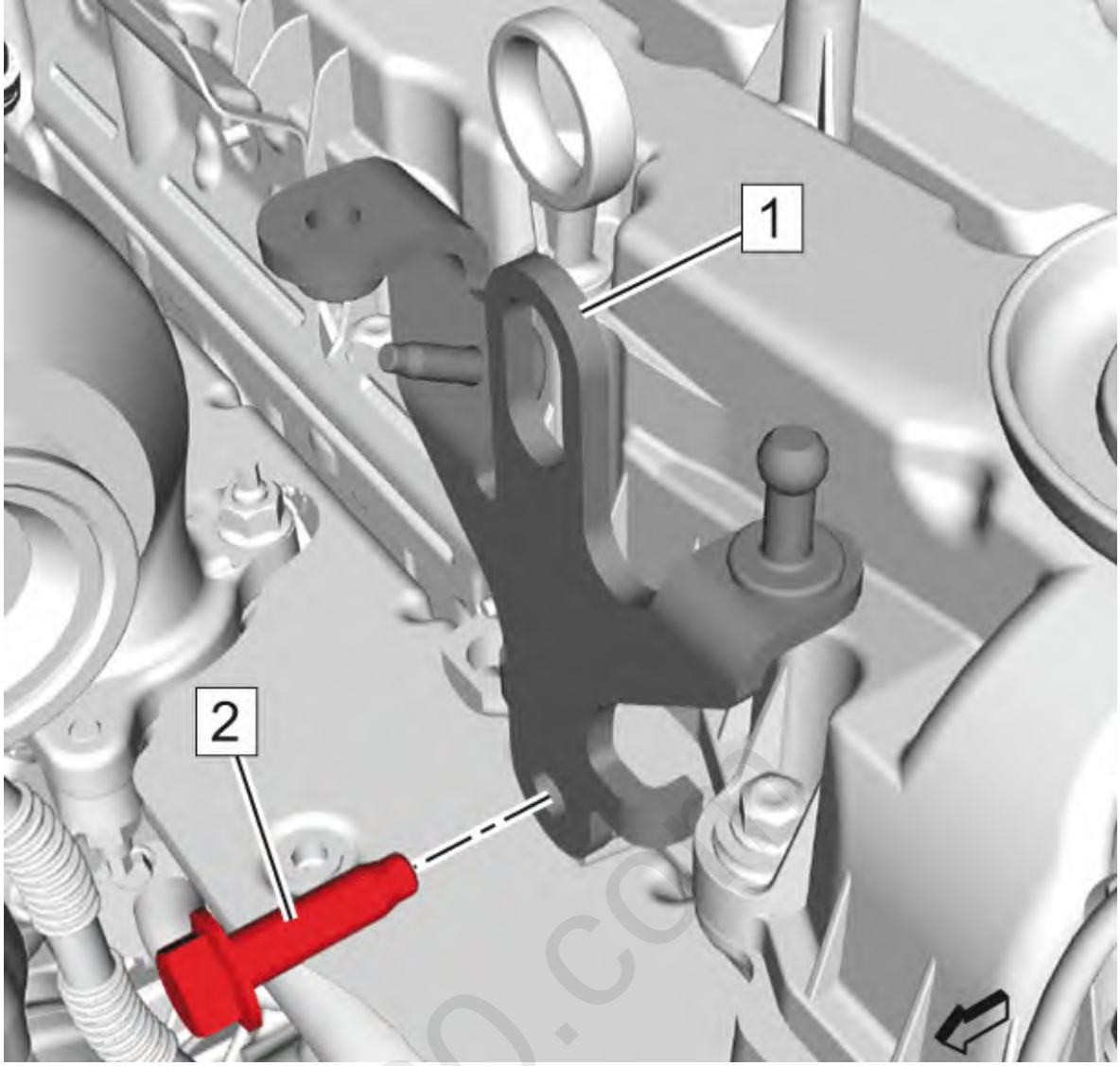


Fig. 64: Engine Lift Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

35. Remove Engine Lift Bracket Bolt (2)
36. Remove Engine Lift Bracket (1)

mcx30.com

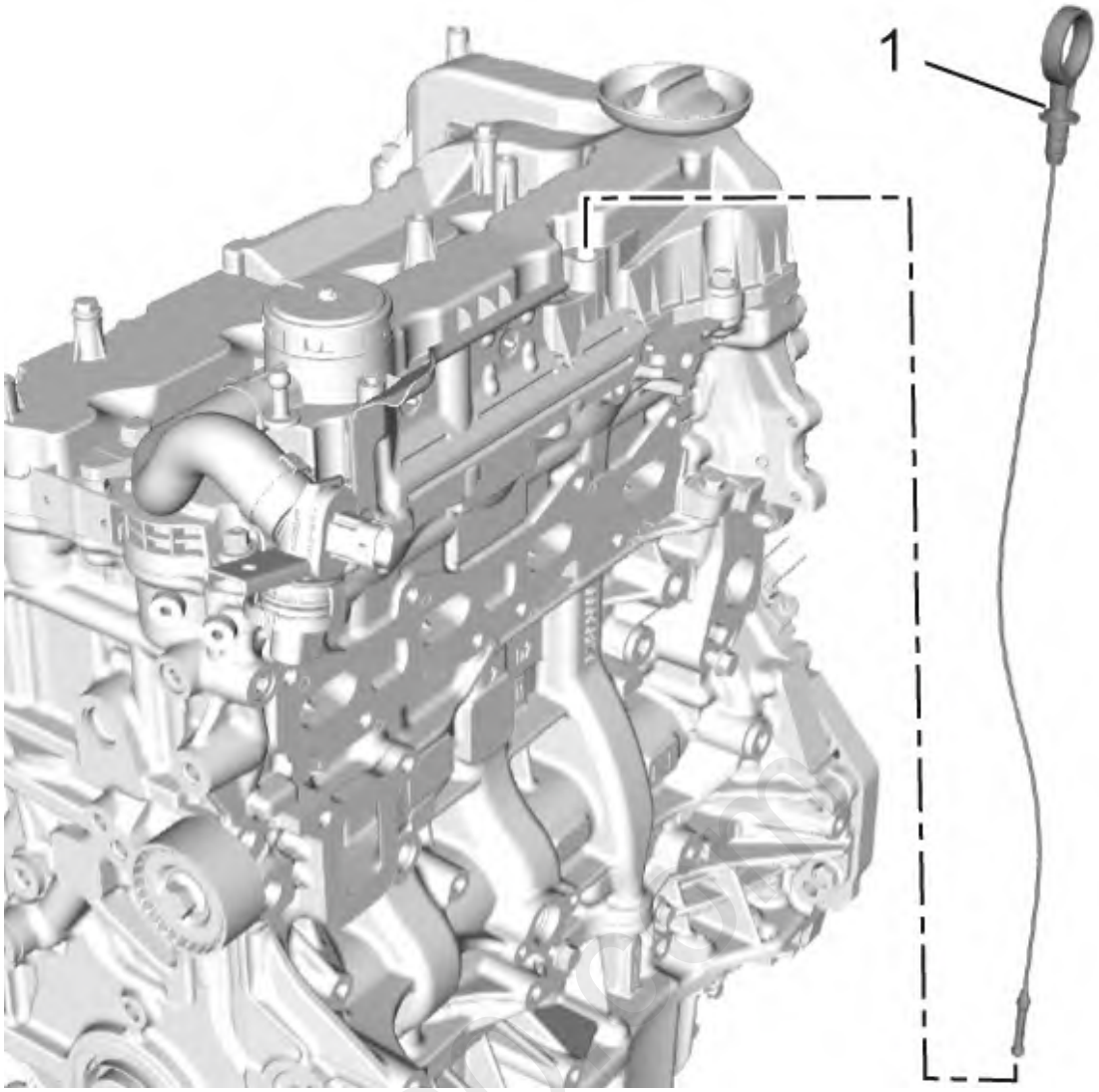


Fig. 65: Engine Oil Level Indicator
Courtesy of GENERAL MOTORS COMPANY

37. Remove Engine Oil Level Indicator (1)

mcx30.com

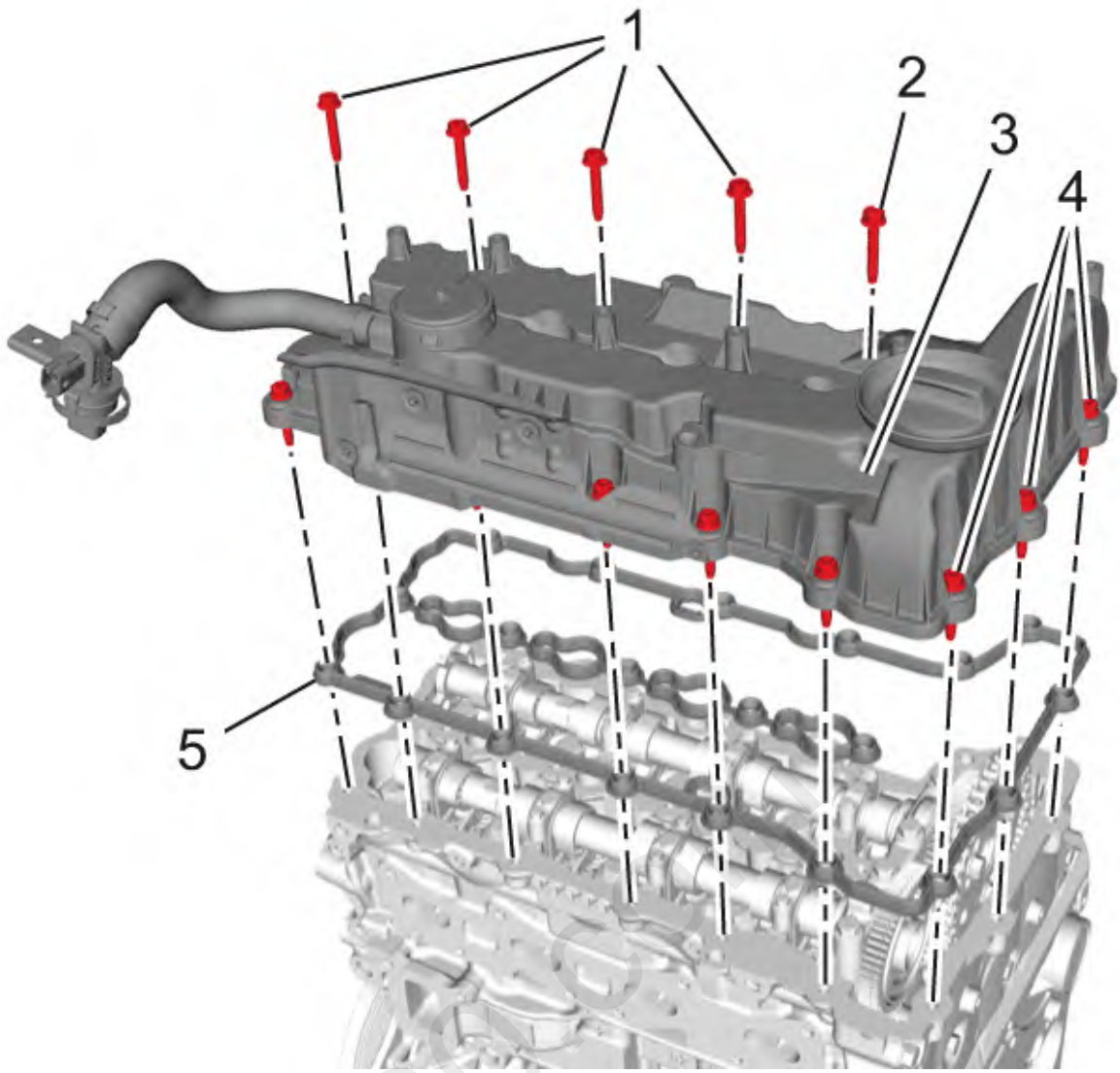


Fig. 66: Camshaft Housing, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Mind the different bolts.**

38. Remove Camshaft Housing Bolt - Outer (4) (Qty: 15)
39. Remove Camshaft Housing Bolt - Inner (1, 2) (Qty: 5)
40. Remove Camshaft Housing (3)
41. Remove and DISCARD Camshaft Housing Gasket (5)

Installation Procedure

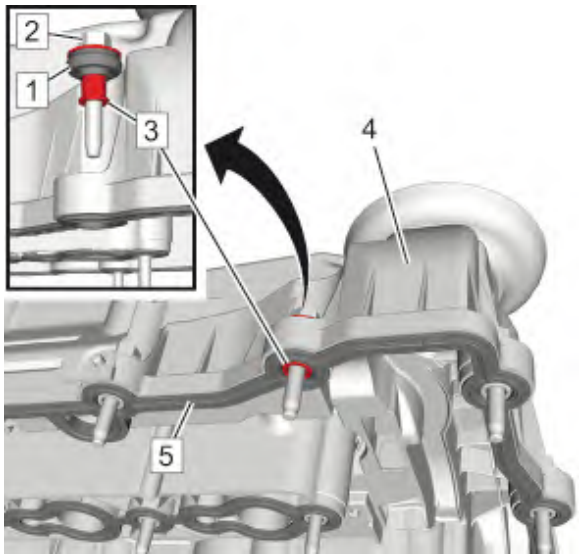


Fig. 67: Camshaft Housing, Gasket, Bolts, Bushings And Insulators
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW Camshaft Housing Gasket (5) @ Camshaft Housing (4)
2. Install Camshaft Housing Bolt (2) (Qty: 20) @ Camshaft Housing (4)
3. Ensure the camshaft housing bolt bushings (3) and the camshaft housing cover insulators (1) are seated properly.

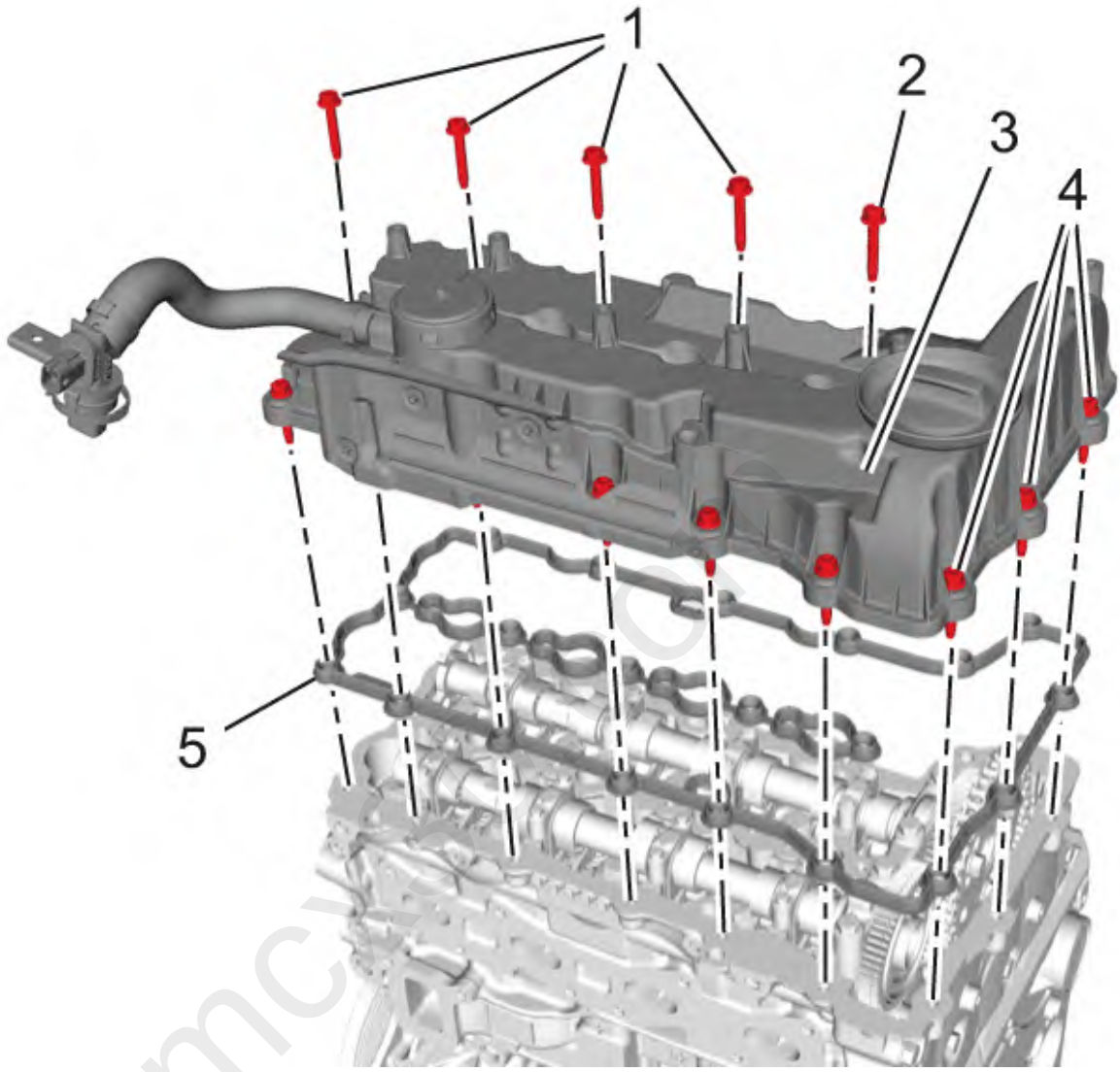


Fig. 68: Camshaft Housing, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Mind the different bolts.**

4. Install the camshaft housing cover (3) along with the camshaft housing gasket (5) and the 20 camshaft housing bolts (1, 2, 4).
5. Hand tighten Camshaft Housing Bolts (1, 2, 4) (Qty: 20)

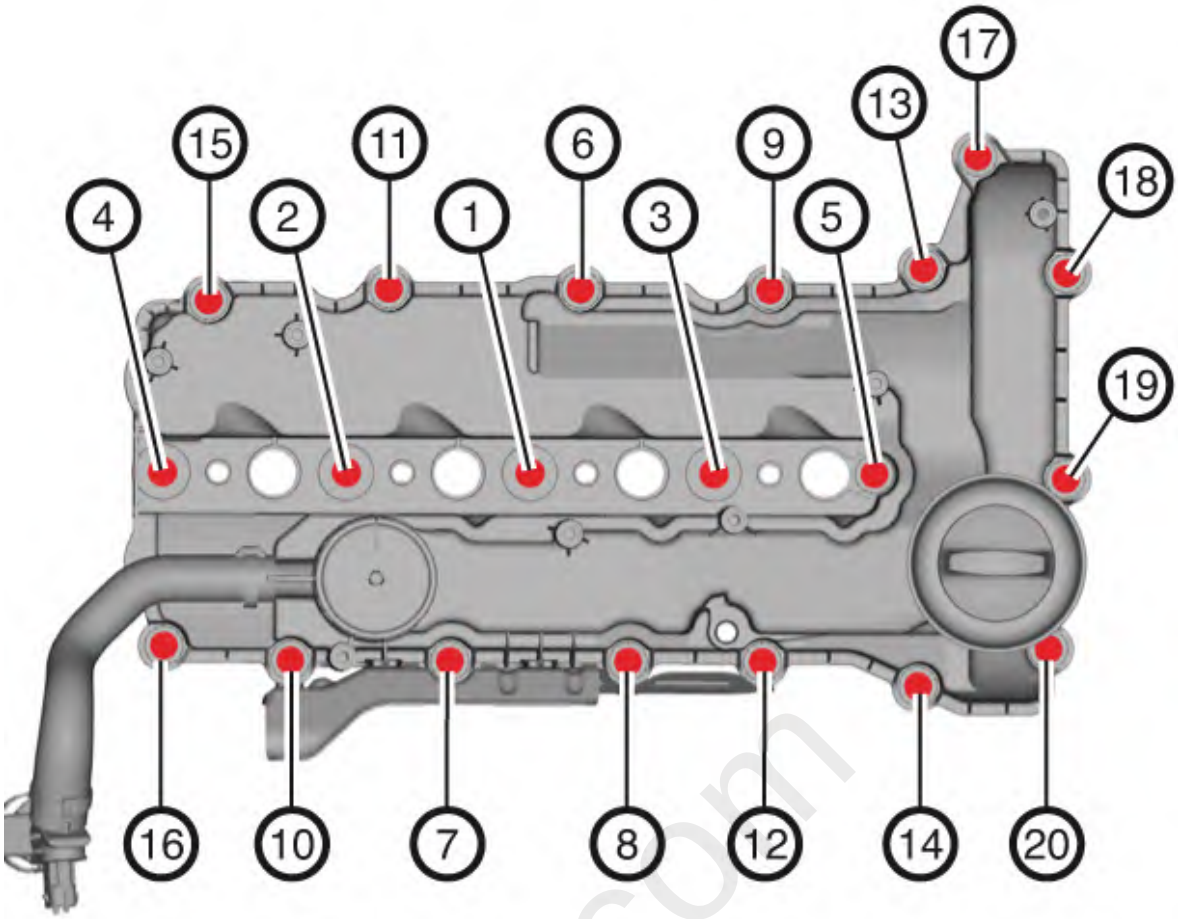


Fig. 69: Camshaft Housing Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution**

6. Tighten Camshaft Housing Bolts in sequence (Qty: 20) to 10 N.m (89 lb in)

mcx30.com

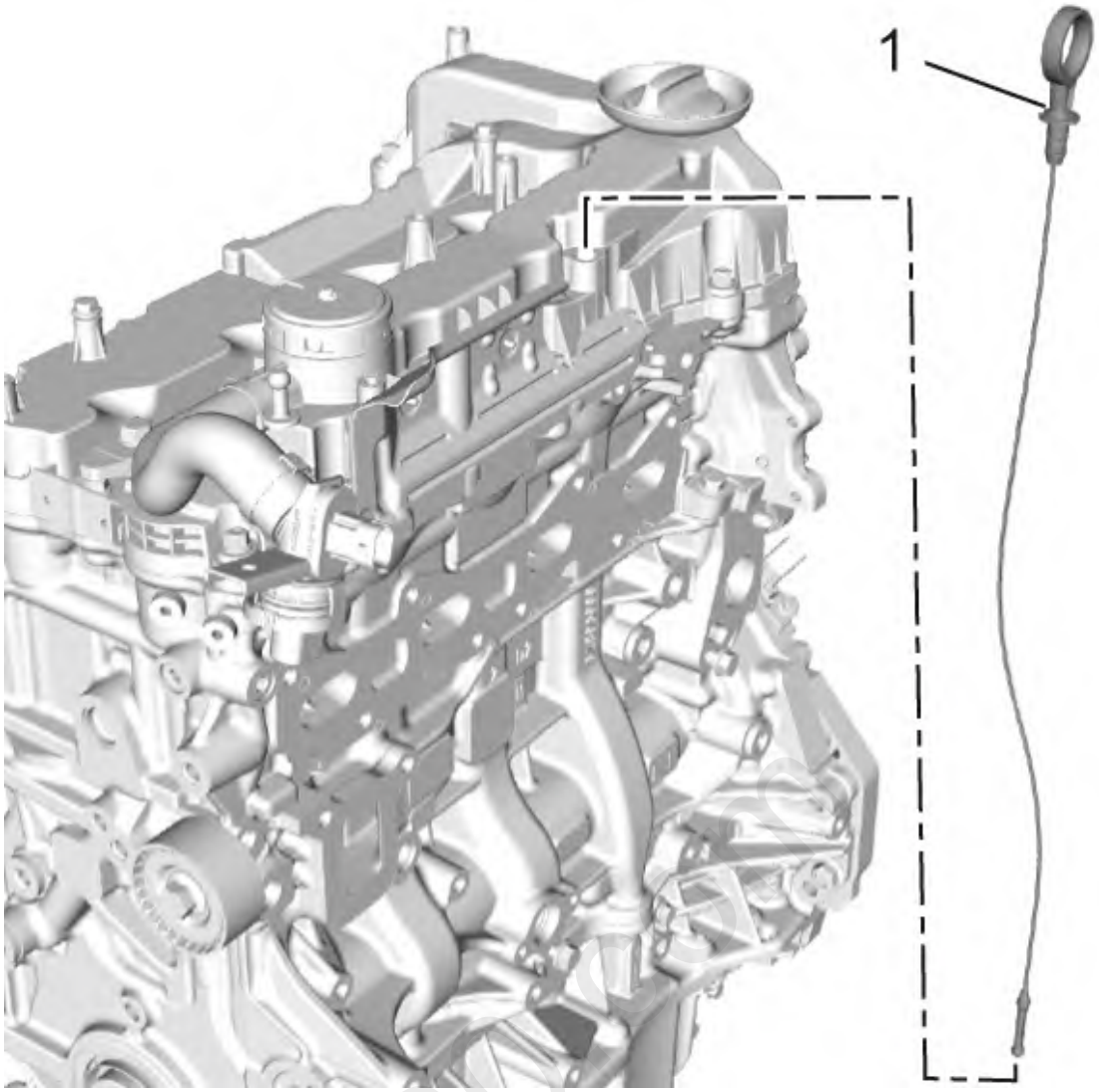


Fig. 70: Engine Oil Level Indicator
Courtesy of GENERAL MOTORS COMPANY

7. Install Engine Oil Level Indicator (1)

mcx30.com

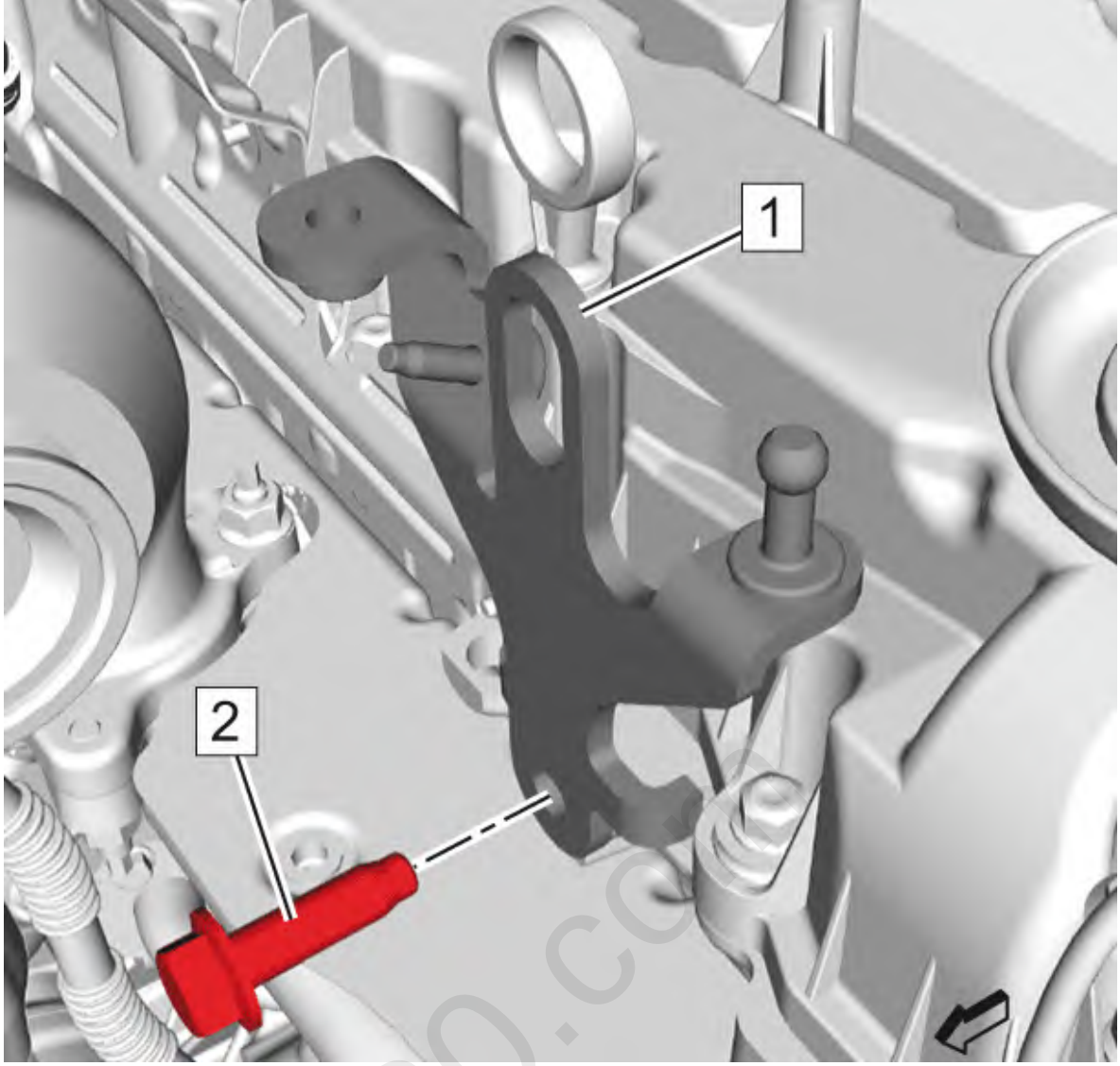


Fig. 71: Engine Lift Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Install Engine Lift Bracket (1)
9. Install and tighten Engine Lift Bracket Bolt (2) to 58 N.m (43 lb ft)

mcx30.com

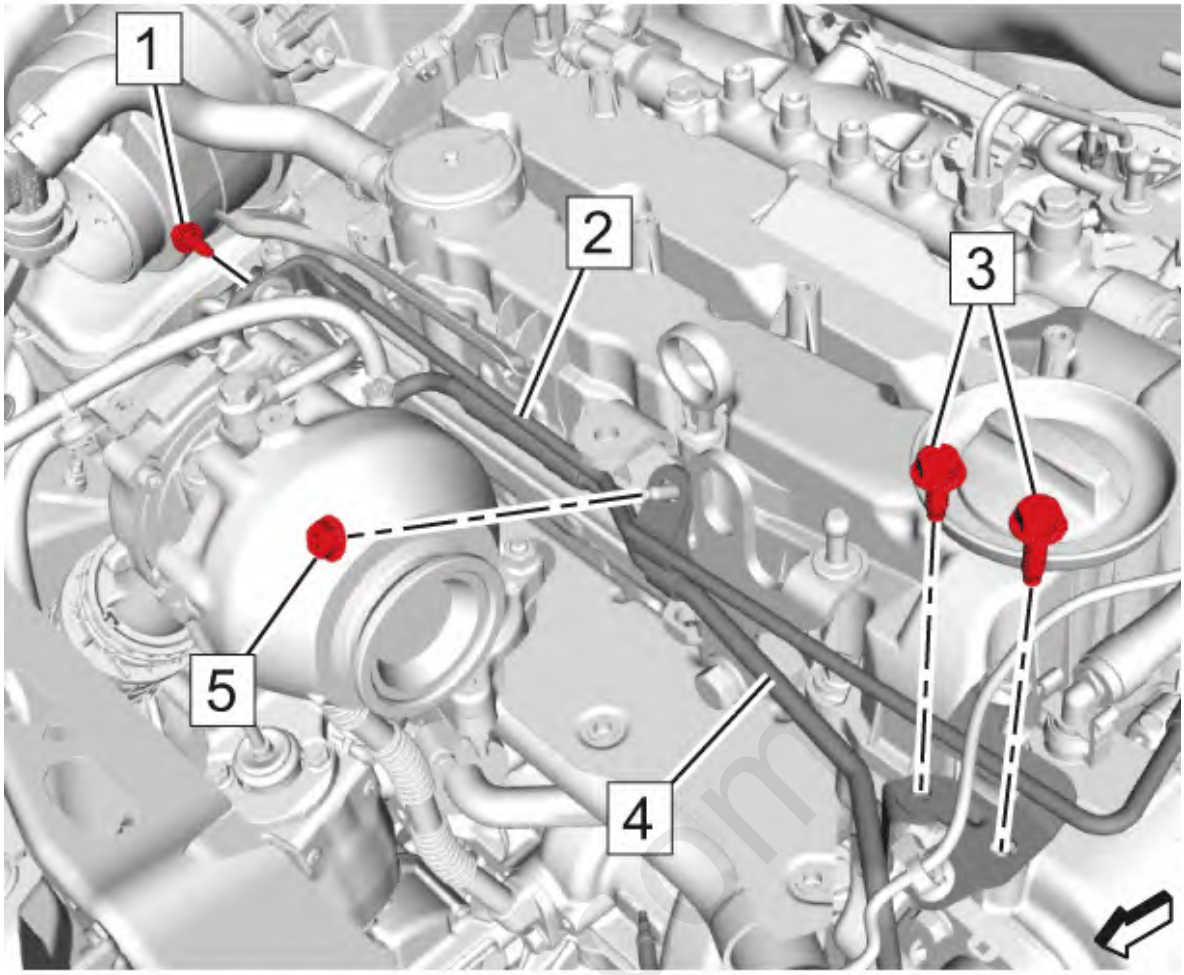


Fig. 72: Turbocharger Wastegate Actuator Pipe, Bolts, Nut And Turbocharger Coolant Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

10. Reposition Turbocharger Coolant Feed Pipe (4)
11. Reposition Turbocharger Wastegate Actuator Pipe (2)
12. Install the turbocharger wastegate actuator pipe nut (5) and tighten to 10 N.m (89 lb in)
13. Install and tighten Turbocharger Wastegate Actuator Pipe Bolts (1, 3) (Qty: 3) to 10 N.m (89 lb in)

mcx30.com

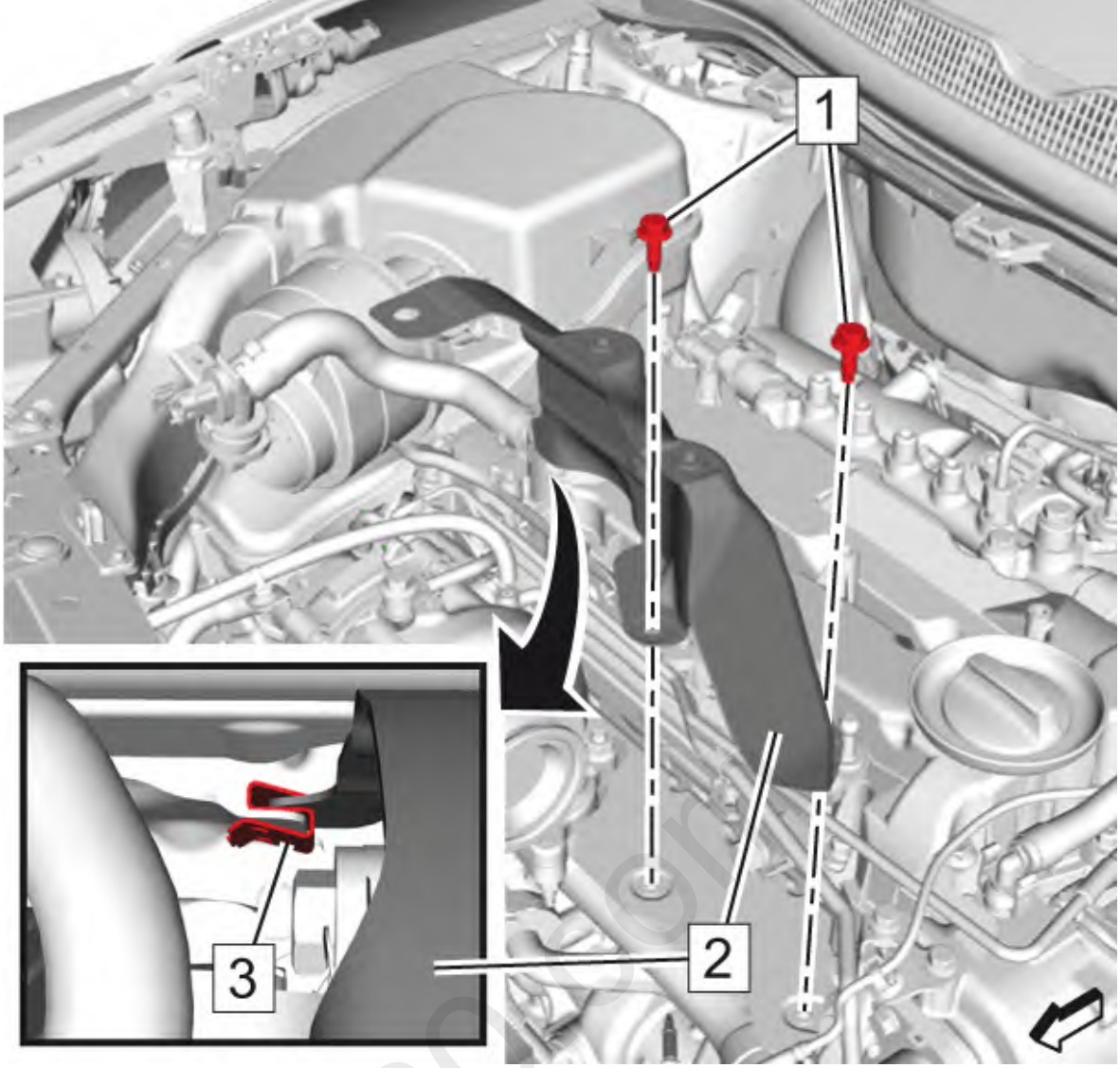


Fig. 73: Turbocharger Heat Shield, Bolts And Clamp
Courtesy of GENERAL MOTORS COMPANY

14. Install Turbocharger Heat Shield (2)
15. Install Turbocharger Heat Shield (2) @ Clamp (3)
16. Install and tighten Turbocharger Heat Shield Bolts (1) (Qty: 2) to 10 N.m (89 lb in)

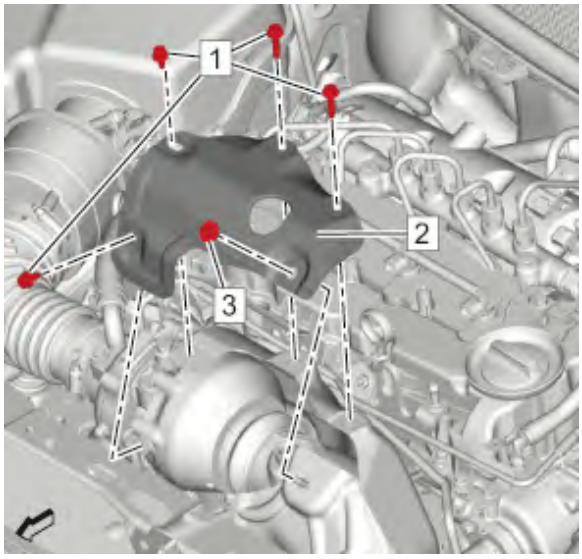


Fig. 74: Turbocharger Heat Shield, Bolts And Nut
Courtesy of GENERAL MOTORS COMPANY

17. Install Turbocharger Heat Shield (2)
18. Install and tighten Turbocharger Heat Shield Nut (3) to 9 N.m (80 lb in)
19. Install and tighten Turbocharger Heat Shield Bolts (1) (Qty: 4) to 9 N.m (80 lb in)

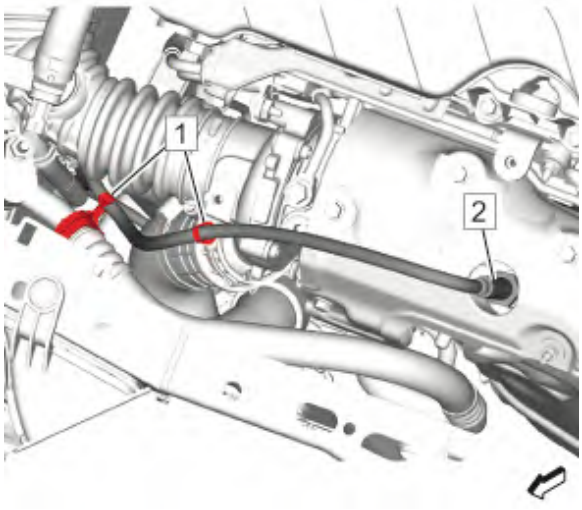


Fig. 75: Nitrogen Oxides Sensor And Wiring Harness Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not bend the cable sharply at the base of either the sensing unit or sensor ECU in the final mounting position**

20. Install and tighten Nitrogen Oxides Sensor (2) to 50 N.m (37 lb ft)

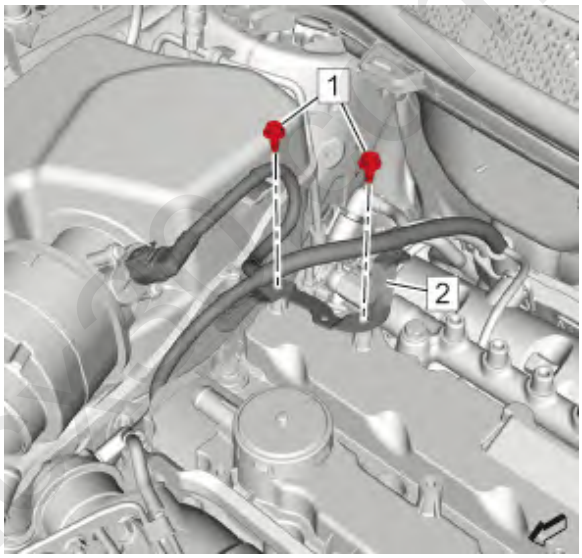


Fig. 76: Engine Control Module Wiring Harness Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

21. Reposition Engine Control Module Wiring Harness Bracket (2)
22. Install and tighten Engine Control Module and Engine Wiring Harness Bracket Bolts (1) (Qty: 2) to 9 N.m (80 lb in)

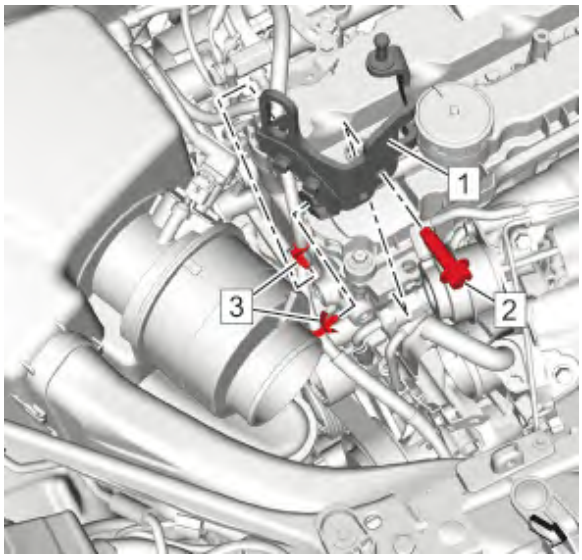


Fig. 77: Engine Lift Bracket, Bolt And Clips
Courtesy of GENERAL MOTORS COMPANY

23. Install Engine Lift Bracket (1)
24. Install and tighten Engine Lift Bracket Bolt (2) to 58 N.m (43 lb ft)
25. Install Wiring Harness Clips (3) (Qty: 2)

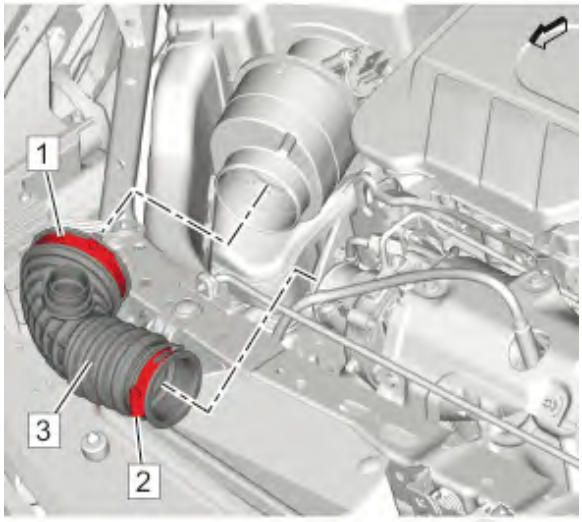


Fig. 78: Air Cleaner Outlet Duct And Clamps
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the outlet duct is fully seated to the mating surfaces before clamping. Verify that the cuff is not rolled under.**

26. Install Air Cleaner Outlet Duct (3)

CAUTION: **Refer to Fastener Caution**

27. Tighten Air Cleaner Outlet Duct Clamps (1, 2) (Qty: 2) to 3.5 N.m (31 lb in)

mcx30.com

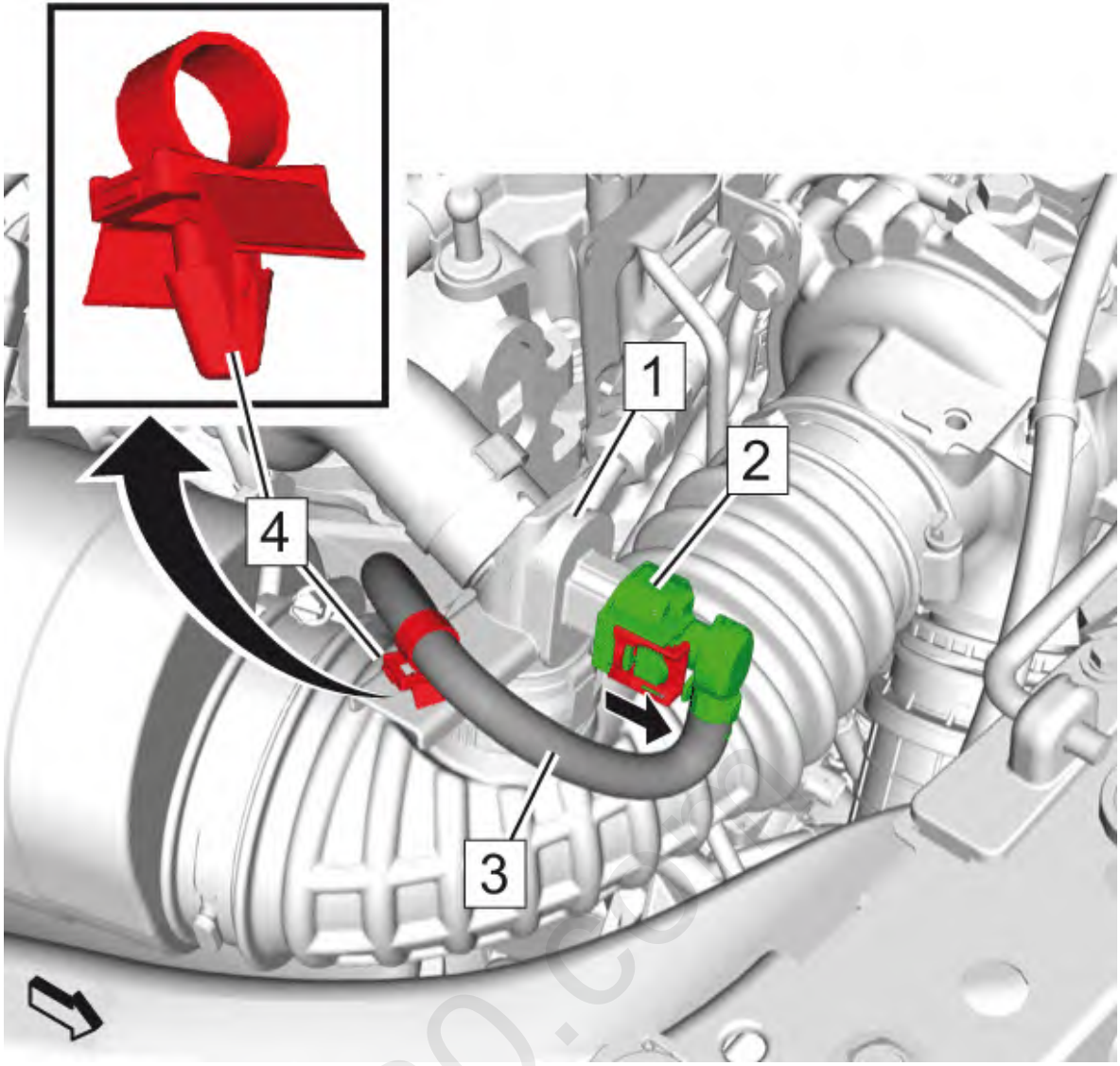


Fig. 79: Electrical Connector, PCV Heater, Wiring Harness And Clip
Courtesy of GENERAL MOTORS COMPANY

28. Reposition Wiring Harness (3)
29. Connect Electrical Connector (2) @ Positive Crankcase Ventilation Heater (1)
30. Install Wiring Harness Clip (4)

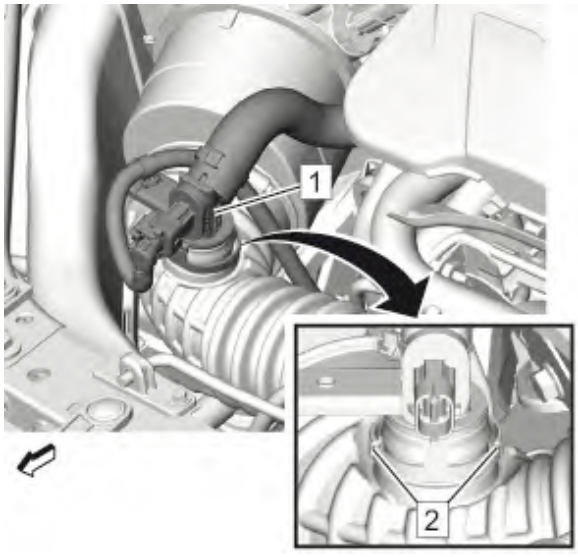


Fig. 80: Positive Crankcase Ventilation Heater And Checkered Places
Courtesy of GENERAL MOTORS COMPANY

NOTE: **There must be a noticeable click noise.**

31. Install Positive Crankcase Ventilation Heater (1)

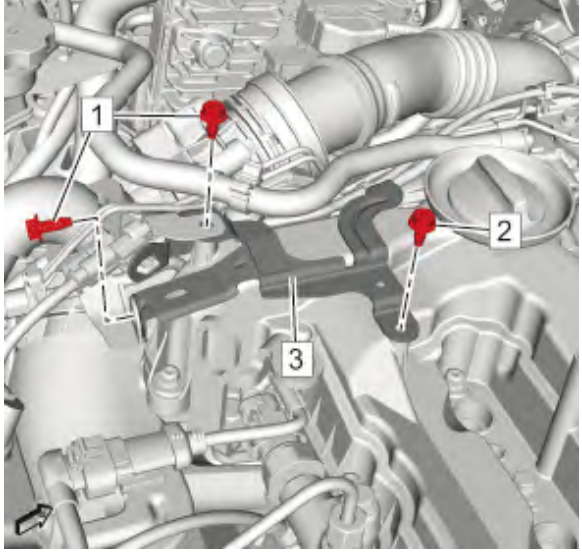


Fig. 81: Exhaust Temperature Sensor Electrical Connector Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

32. Install Exhaust Temperature Sensor Electrical Connector Bracket (3)
33. Install and tighten Exhaust Temperature Sensor Electrical Connector Bracket Bolts (1, 2) (Qty: 3) to 9 N.m (80 lb in)

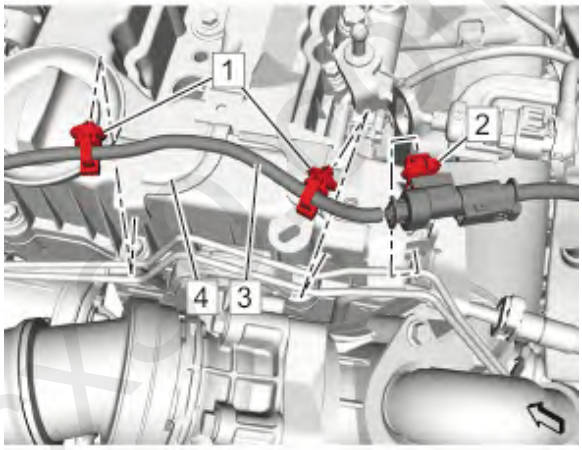


Fig. 82: Wiring Harness, Exhaust Temperature Sensor Bracket And Clips
Courtesy of GENERAL MOTORS COMPANY

34. Reposition Wiring Harness (3)
35. Install Clip (2) @ Exhaust Temperature Sensor Bracket (4)
36. Install Wiring Harness Clips (1) (Qty: 2) @ Exhaust Temperature Sensor Bracket (4)

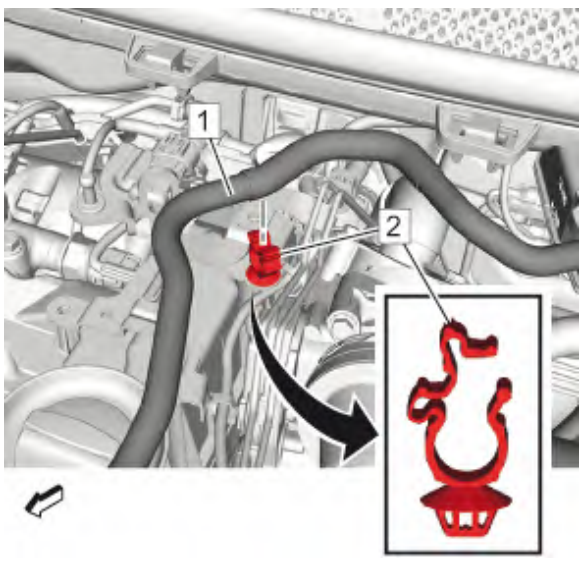


Fig. 83: Engine Coolant Air Bleed Hose And Retainer Clip
Courtesy of GENERAL MOTORS COMPANY

37. Reposition Engine Coolant Air Bleed Hose (1)
38. Install Engine Coolant Air Bleed Hose (1) @ Retainer Clip (2)

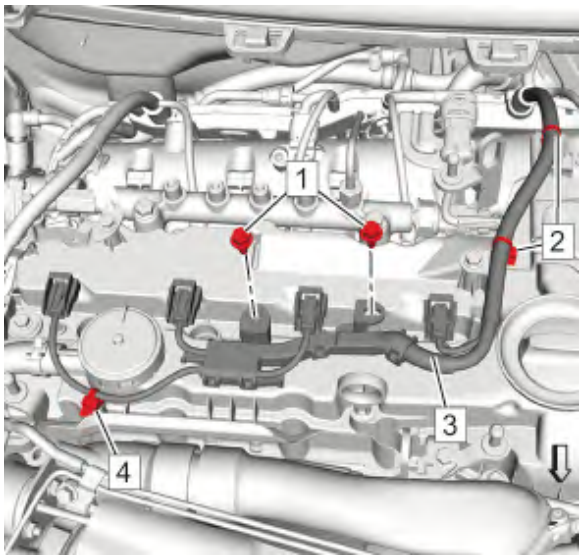


Fig. 84: Engine Wiring Harness, Conduit Bolts And Clips
Courtesy of GENERAL MOTORS COMPANY

39. Reposition Engine Wiring Harness (3)
40. Install Wiring Harness Clips (2, 4) (Qty: 3)
41. Install and tighten Engine Wiring Harness Conduit Bolts (1) (Qty: 2) to 9 N.m (80 lb in)
42. Install Fuel Injectors (Qty: 4). Refer to **Fuel Injector Replacement**
43. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

CAMSHAFT TIMING CHAIN REPLACEMENT

Special Tools

- **EN-50513** Fixing Pin
- **EN-51140** Crankshaft Fixing Tool
- **EN-51143** Camshaft Sprocket Fixing Tool

Equivalent regional tools: **Special Tools**

Removal Procedure

mcx30.com

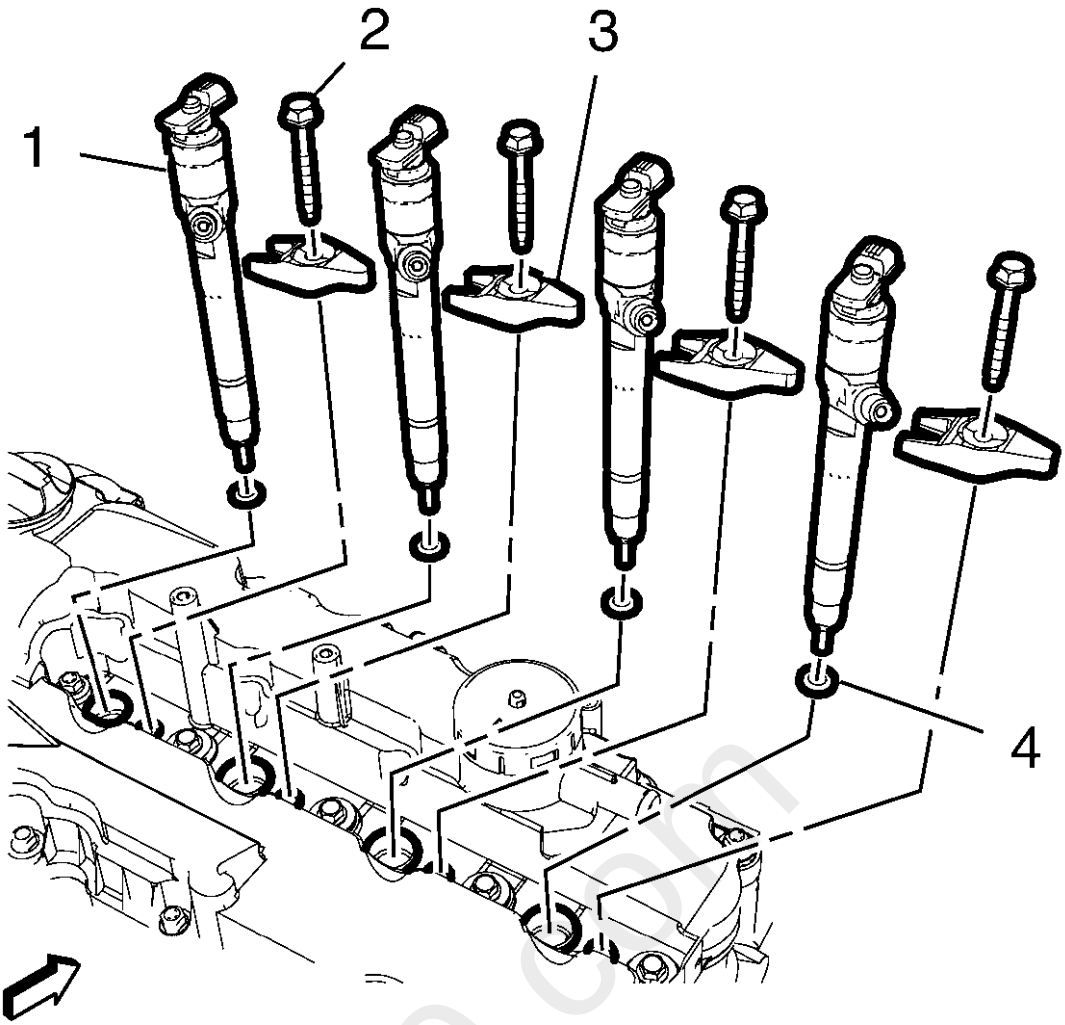


Fig. 85: Fuel Injectors, Bolts And Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Remove Fuel Injectors (1) (Qty: 4). Refer to **Fuel Injector Replacement**

mcx80.com

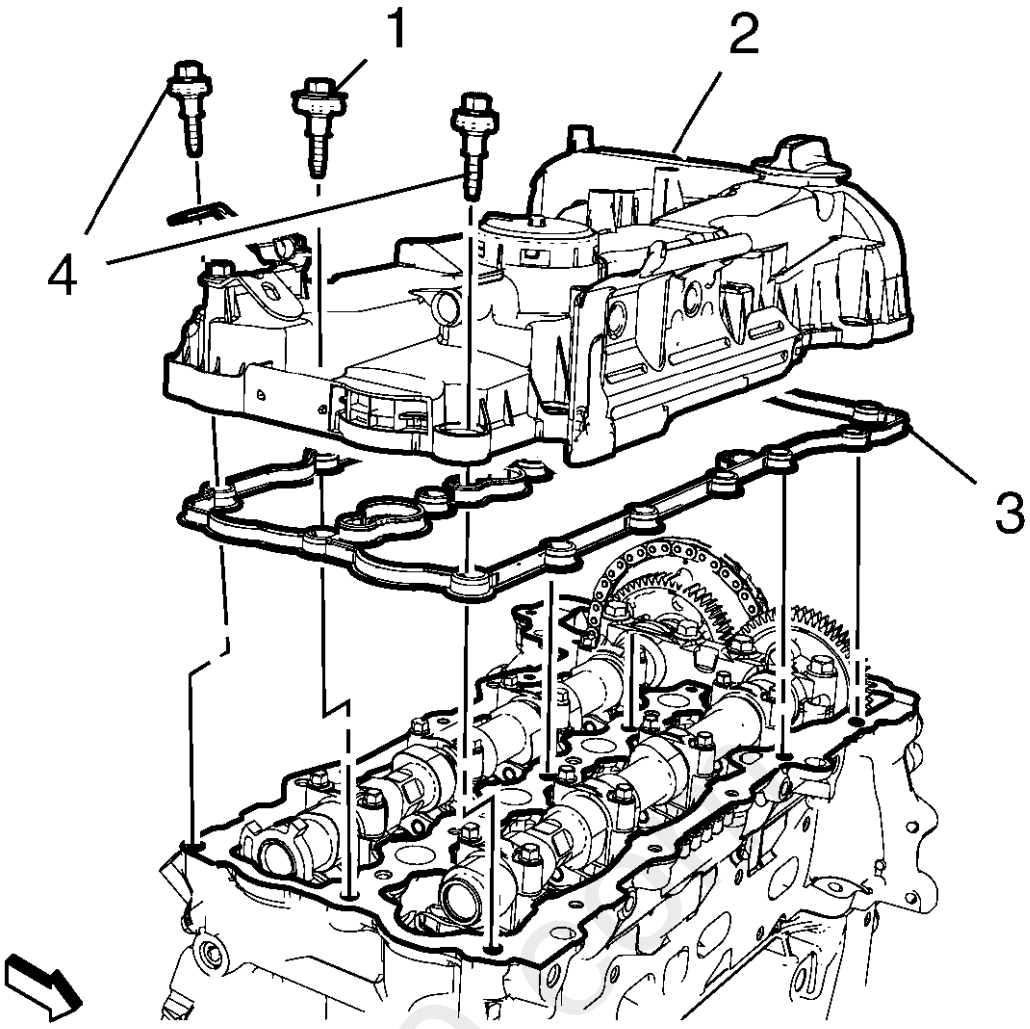


Fig. 86: Camshaft Housing, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

2. Remove Camshaft Housing (2). Refer to **Camshaft Housing Replacement**

mcx30.com

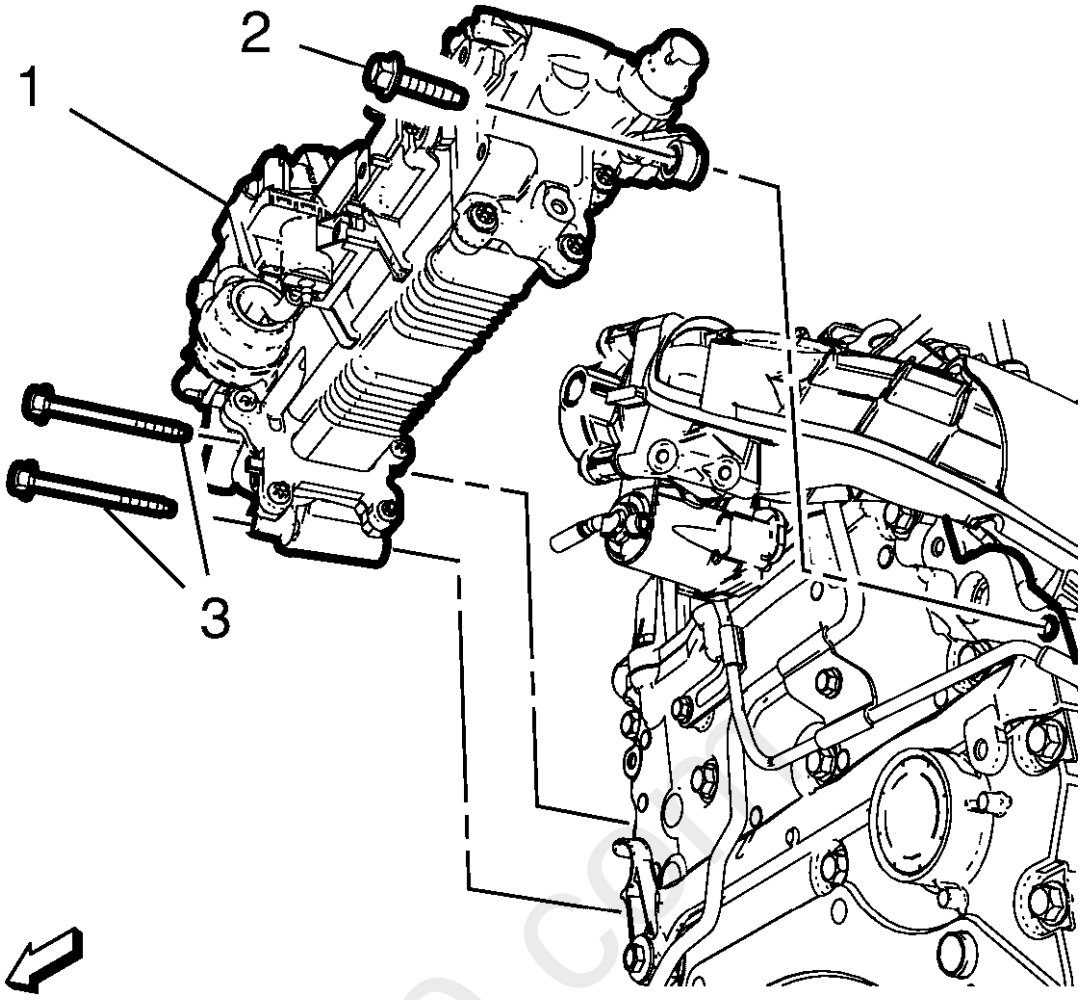


Fig. 87: Exhaust Gas Recirculation Cooler Housing
Courtesy of GENERAL MOTORS COMPANY

3. Remove Exhaust Gas Recirculation Cooler Housing (1). Refer to **Exhaust Gas Recirculation Cooler Housing Replacement**
4. Remove Oxidation Catalytic Converter. Refer to **Oxidation Catalytic Converter Replacement (LH7)**

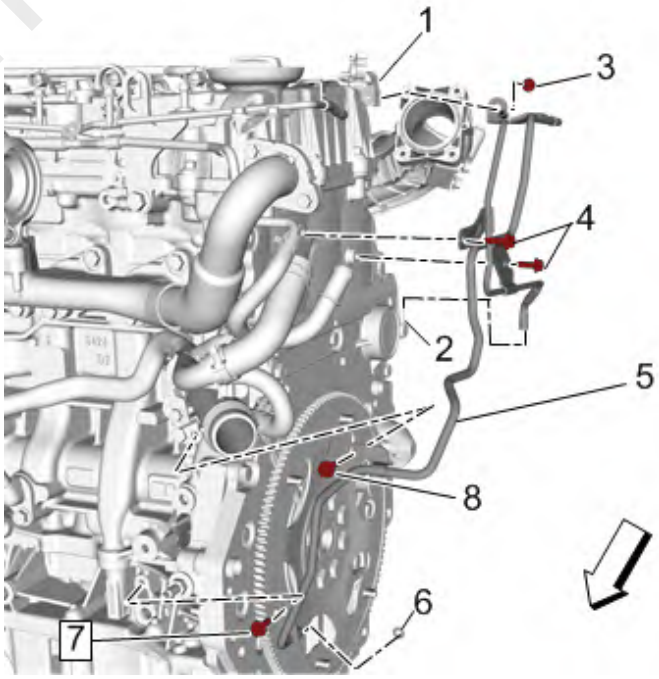


Fig. 88: Power Brake Booster Inlet Hose Connector Fitting And Components
Courtesy of GENERAL MOTORS COMPANY

5. Remove Power Brake Booster Inlet Hose Connector Fitting (5). Refer to **Power Brake Booster Inlet Hose Connector Fitting Replacement**

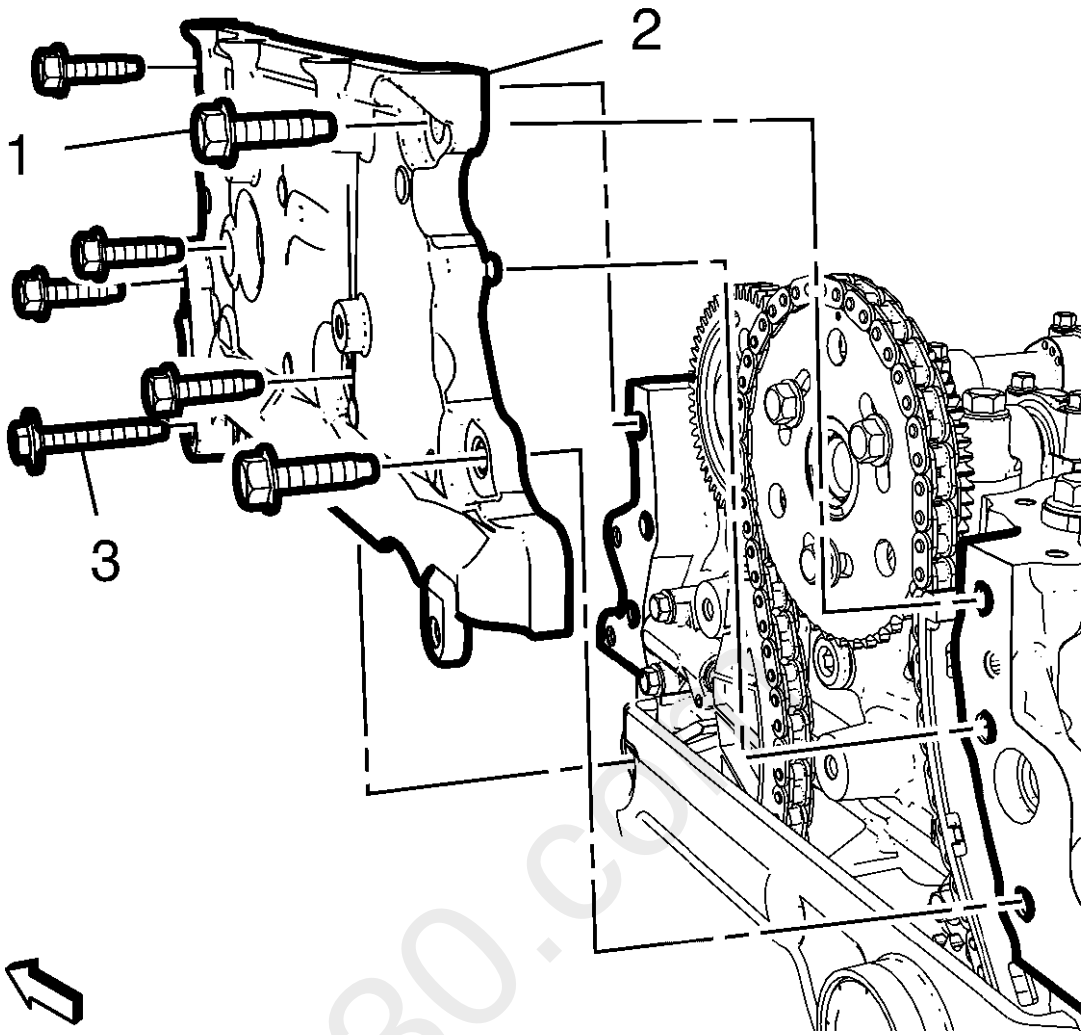


Fig. 89: Timing Chain Upper Cover And Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove Timing Chain Upper Cover (2). Refer to **Timing Chain Upper Cover Replacement**

mox30.com

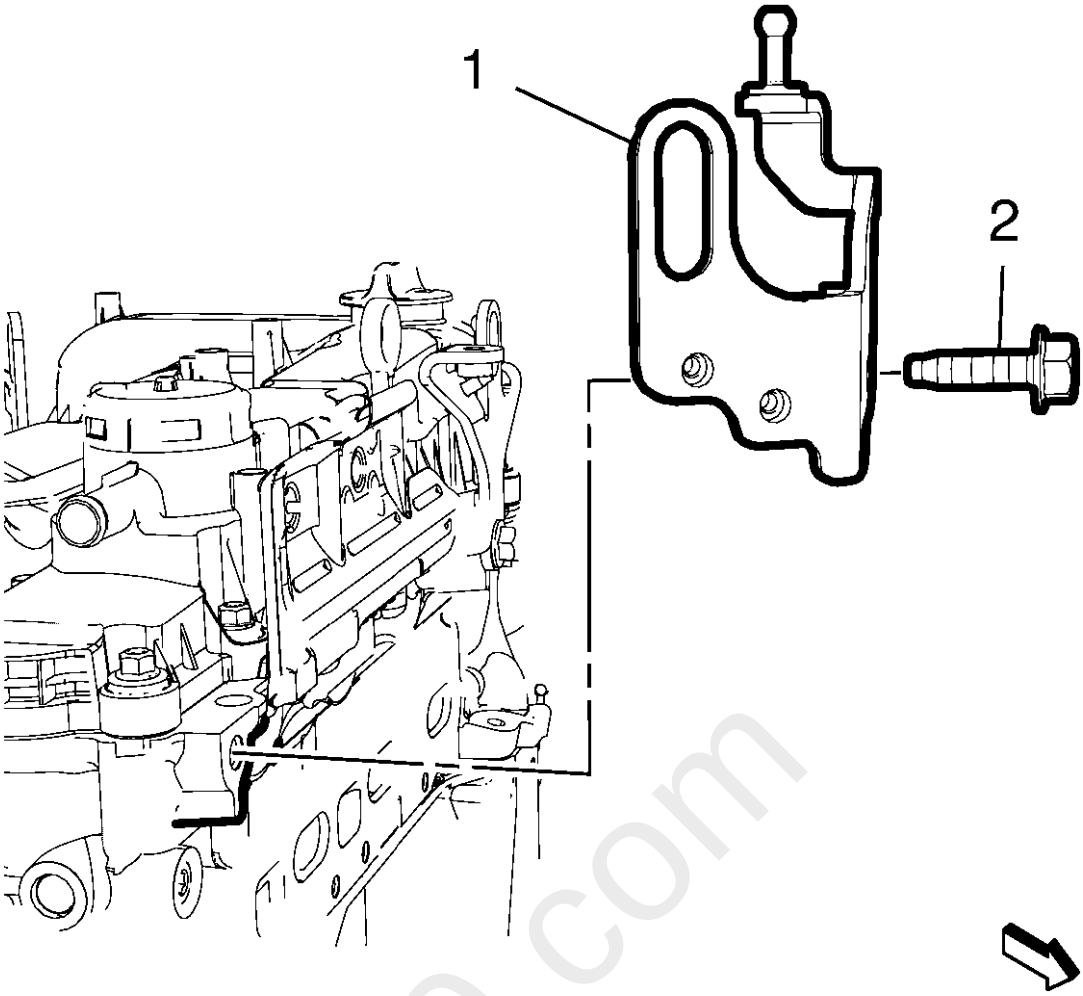


Fig. 90: Engine Lift Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Install Engine Lift Bracket - Right Side (1) @ Cylinder Head

CAUTION: **Refer to Fastener Caution**

8. Install and tighten Engine Lift Bracket Bolt (2) to 58 N.m (43 lb ft)

mcx30.com

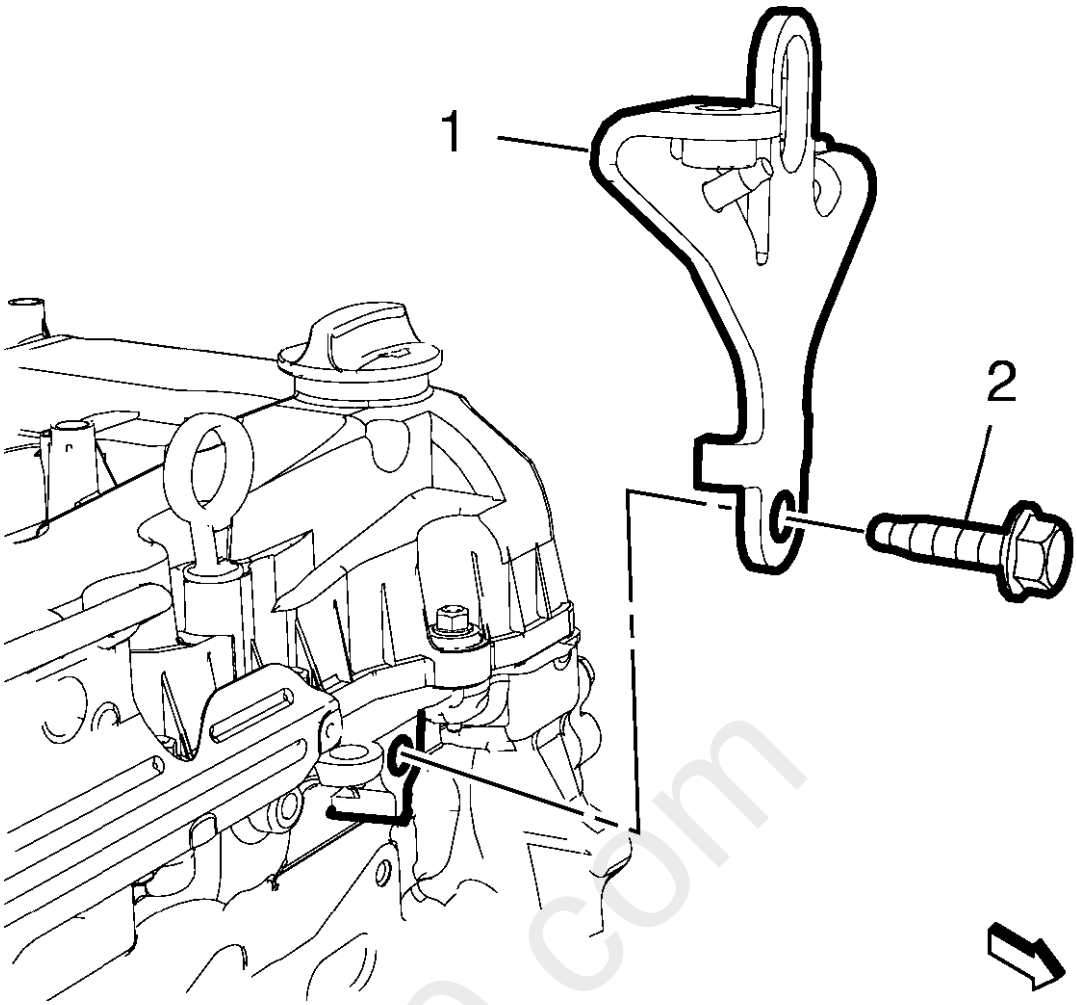


Fig. 91: Engine Lift Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Install Engine Lift Bracket - Left Side (1) @ Cylinder Head
10. Install and tighten Engine Lift Bracket Bolt (2) to 58 N.m (43 lb ft)
11. Remove Transmission. Refer to **Transmission Replacement (Front Wheel Drive)** **Transmission Replacement (All Wheel Drive)**

mcx30.com

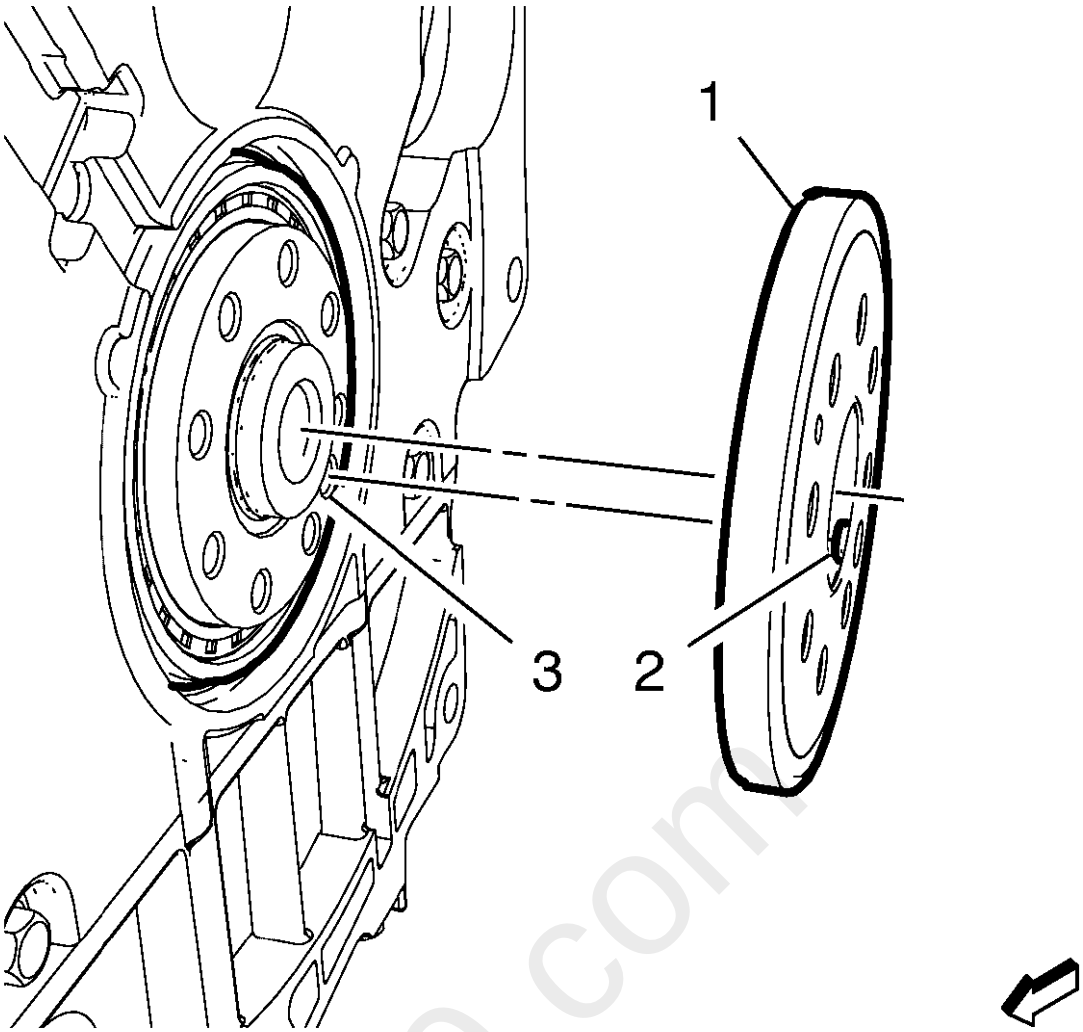


Fig. 92: Crankshaft Position Sensor Reluctor Ring
Courtesy of GENERAL MOTORS COMPANY

12. Remove Crankshaft Position Sensor Reluctor Ring (1). Refer to **Crankshaft Position Sensor Reluctor Ring Replacement**

mcx30.com

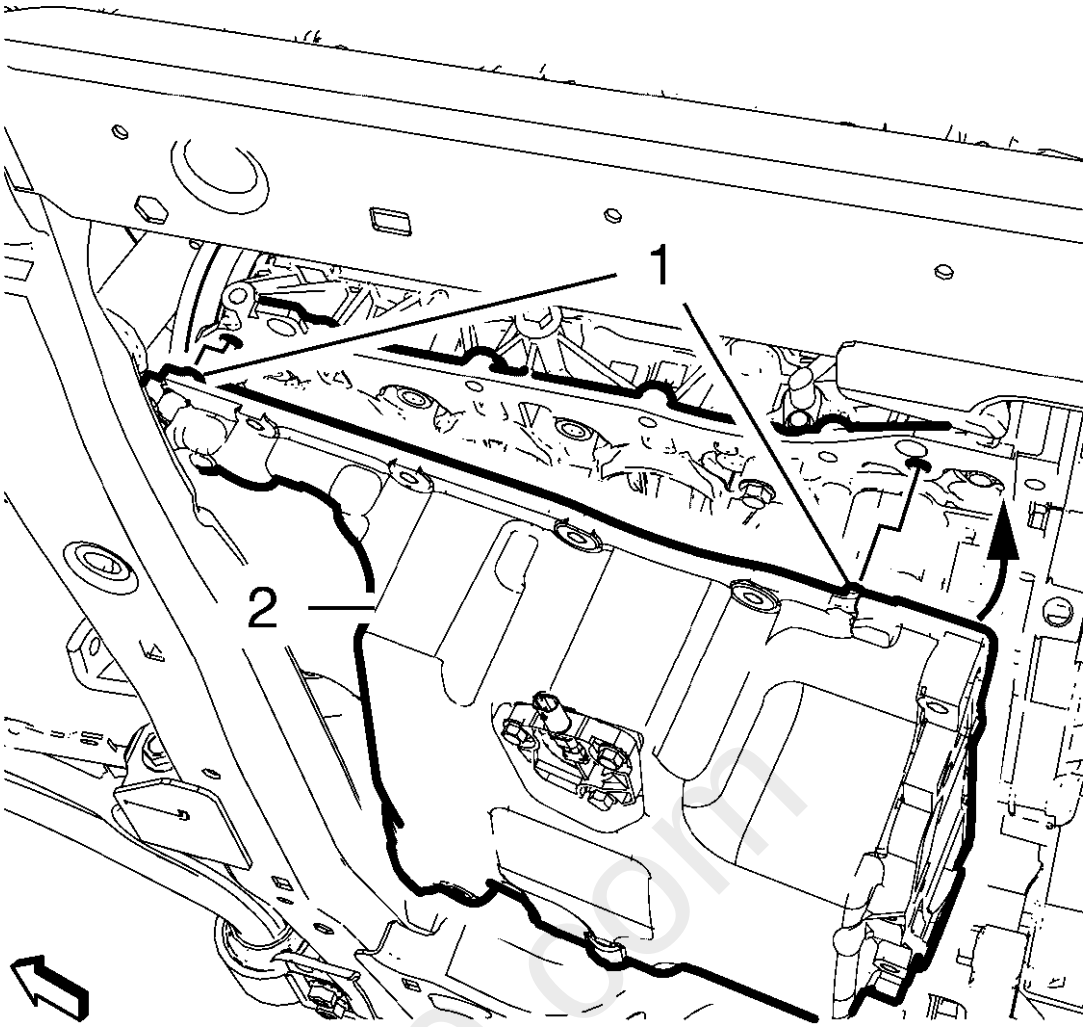


Fig. 93: Oil Pan
Courtesy of GENERAL MOTORS COMPANY

13. Remove Oil Pan (2). Refer to **Oil Pan Replacement**

mcx30.com

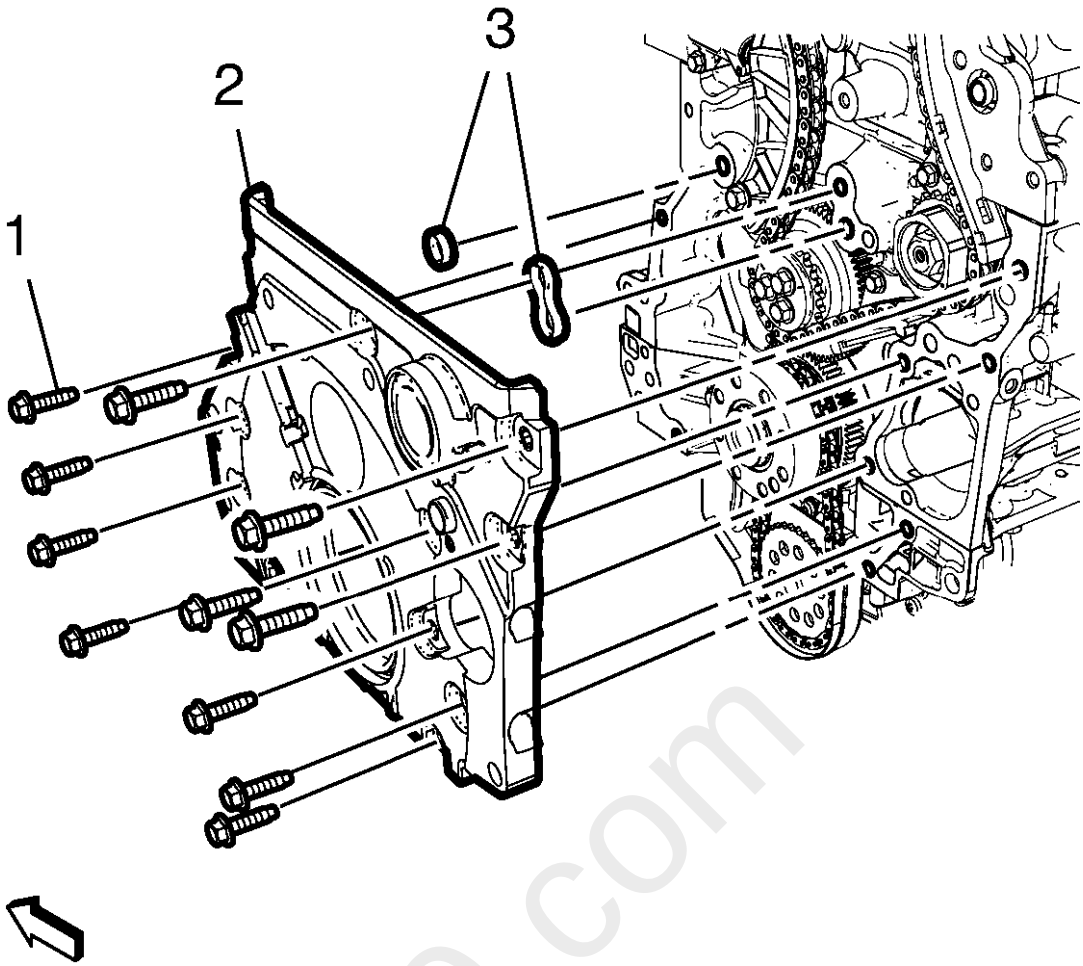


Fig. 94: Timing Chain Lower Cover, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

14. Remove Timing Chain Lower Cover (2). Refer to **Timing Chain Lower Cover Replacement**

mcx30.com

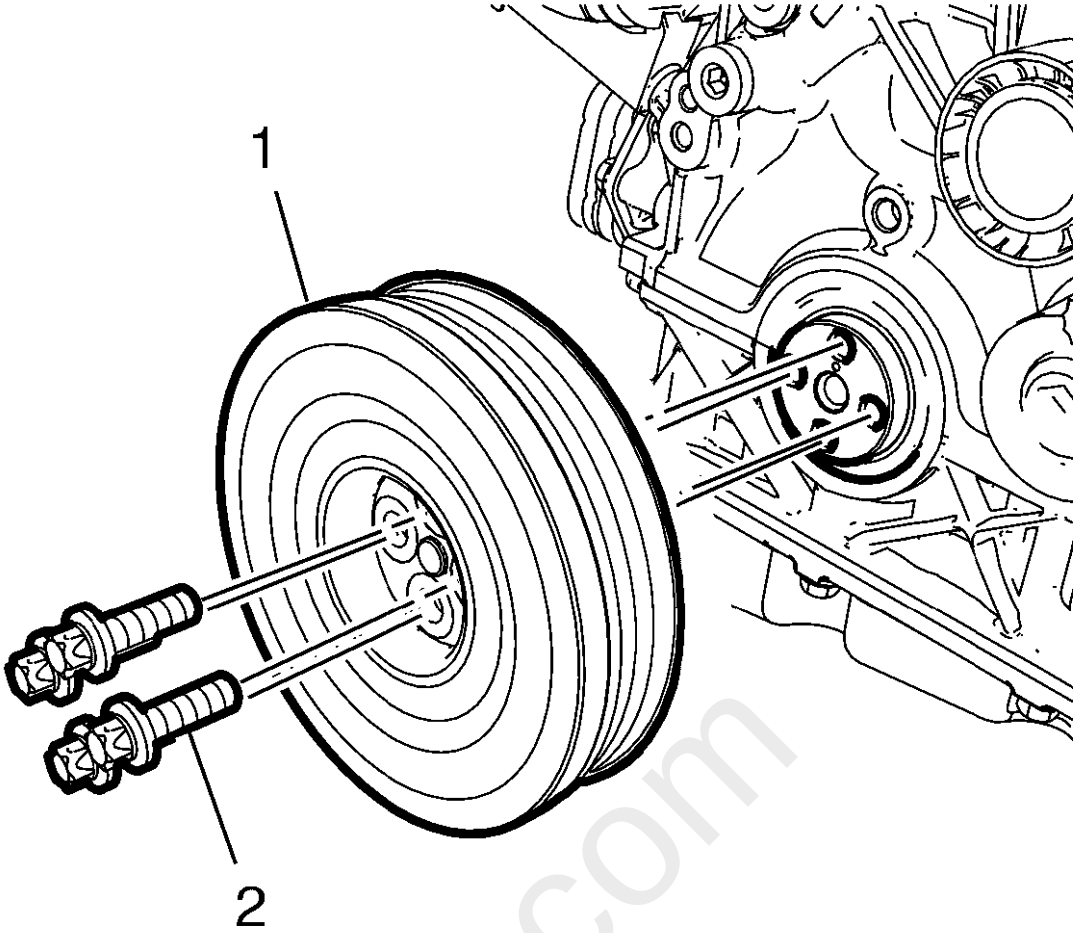


Fig. 95: Crankshaft Pulley And Bolts
Courtesy of GENERAL MOTORS COMPANY

15. Remove Crankshaft Pulley (1). Refer to **Crankshaft Pulley Replacement**

mcx30.com

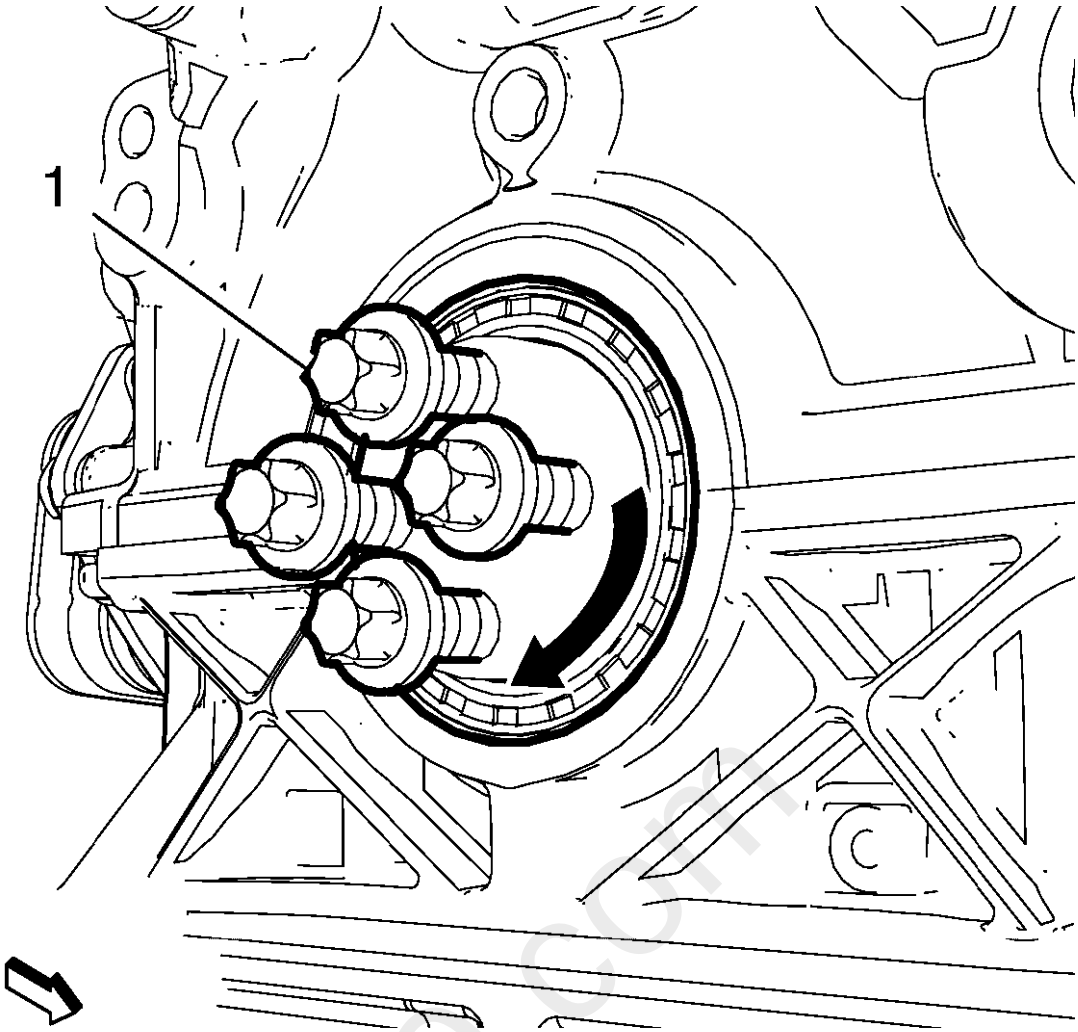


Fig. 96: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

16. Install Crankshaft Pulley Bolts (1) (Qty: 4)
17. Lower the vehicle.

mcx30.com

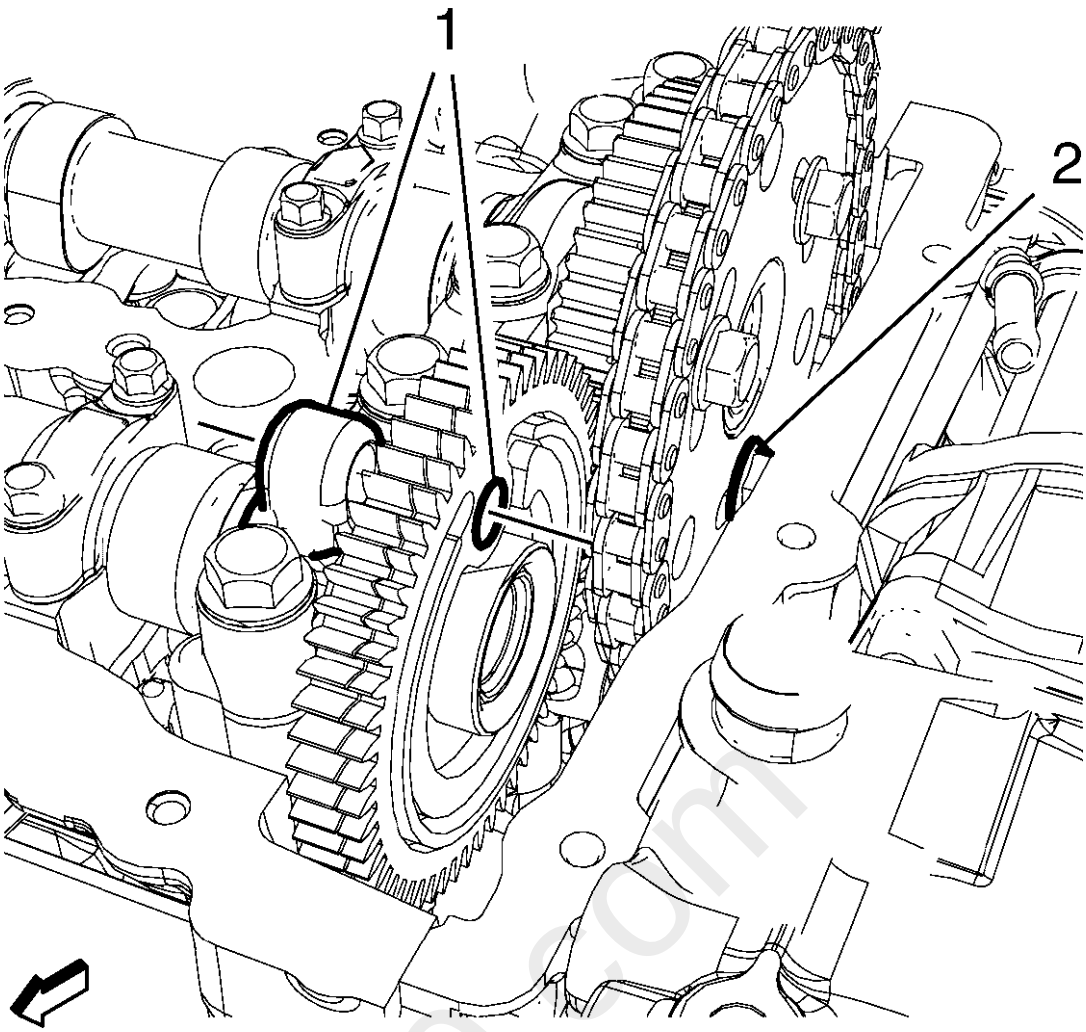


Fig. 97: Aligning Bores
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the bores are not aligned, turn the crankshaft at the crankshaft pulley bolts.**

18. Check if the bores (1) are aligned.

mcx30.com

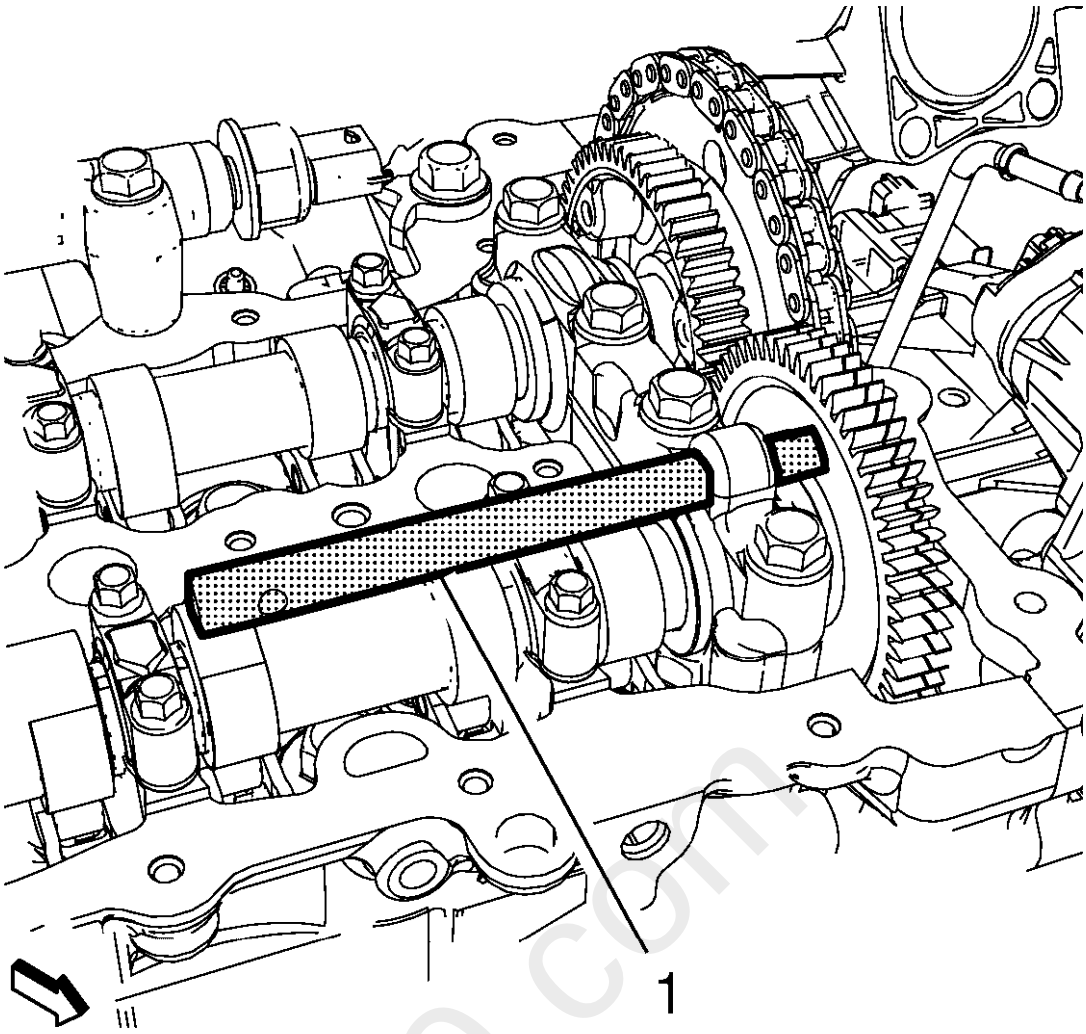


Fig. 98: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

19. Turn the exhaust camshaft at the hexagon so far so that the **EN-51143** fixing tool (1) can be installed.
20. Raise the vehicle.

mcx30.com

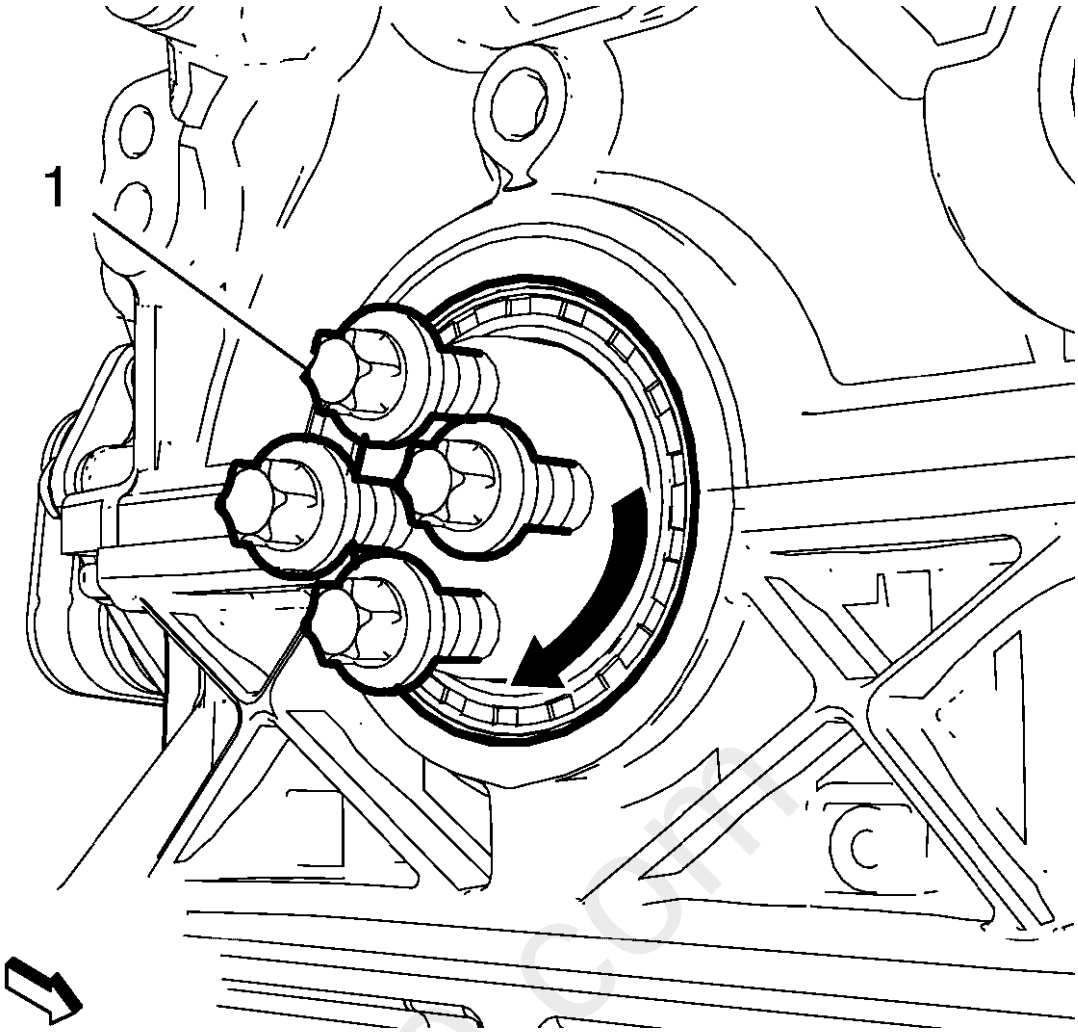


Fig. 99: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

21. Remove Crankshaft Pulley Bolts (1) (Qty: 4)

mcx30.com

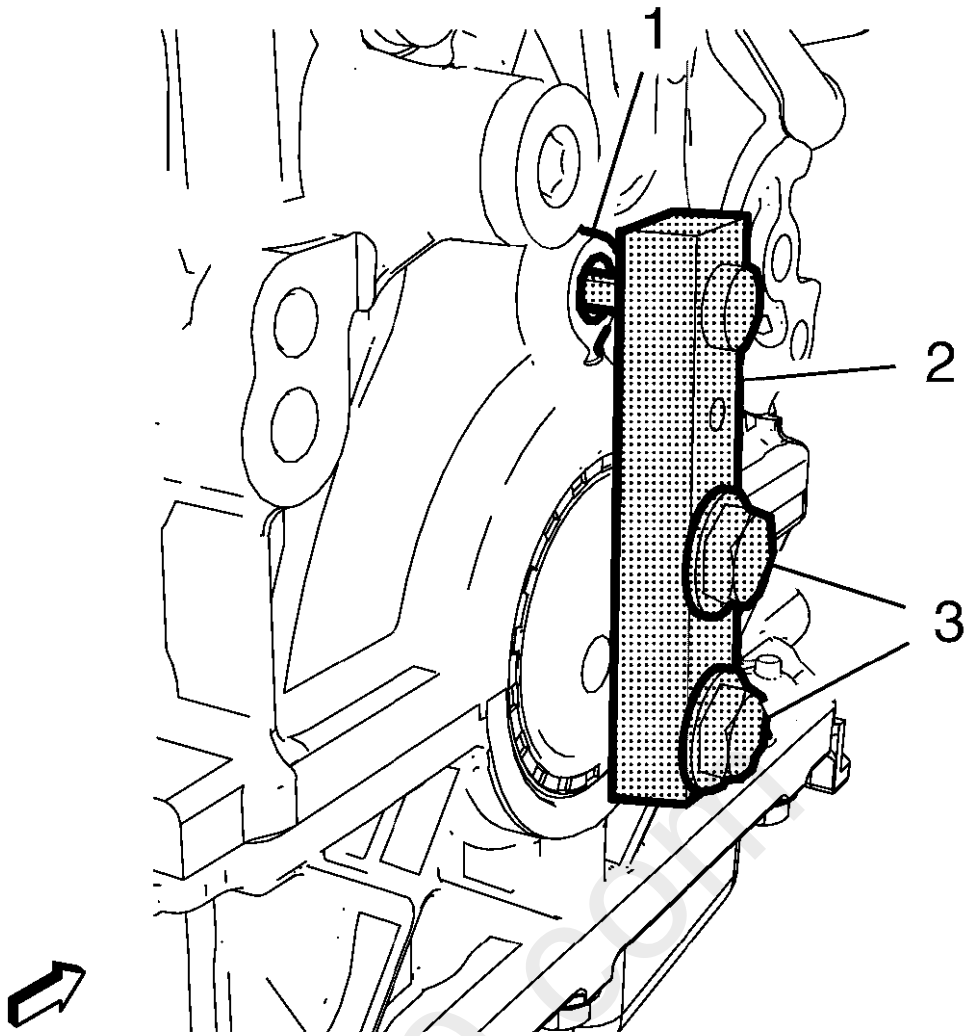


Fig. 100: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

22. Install **EN-51140** Fixing Tool (2)
23. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).
24. If the **EN-51140** fixing tool can not installed. Refer to **Camshaft Timing Chain Adjustment**
25. Lower the vehicle.

mcx30.com

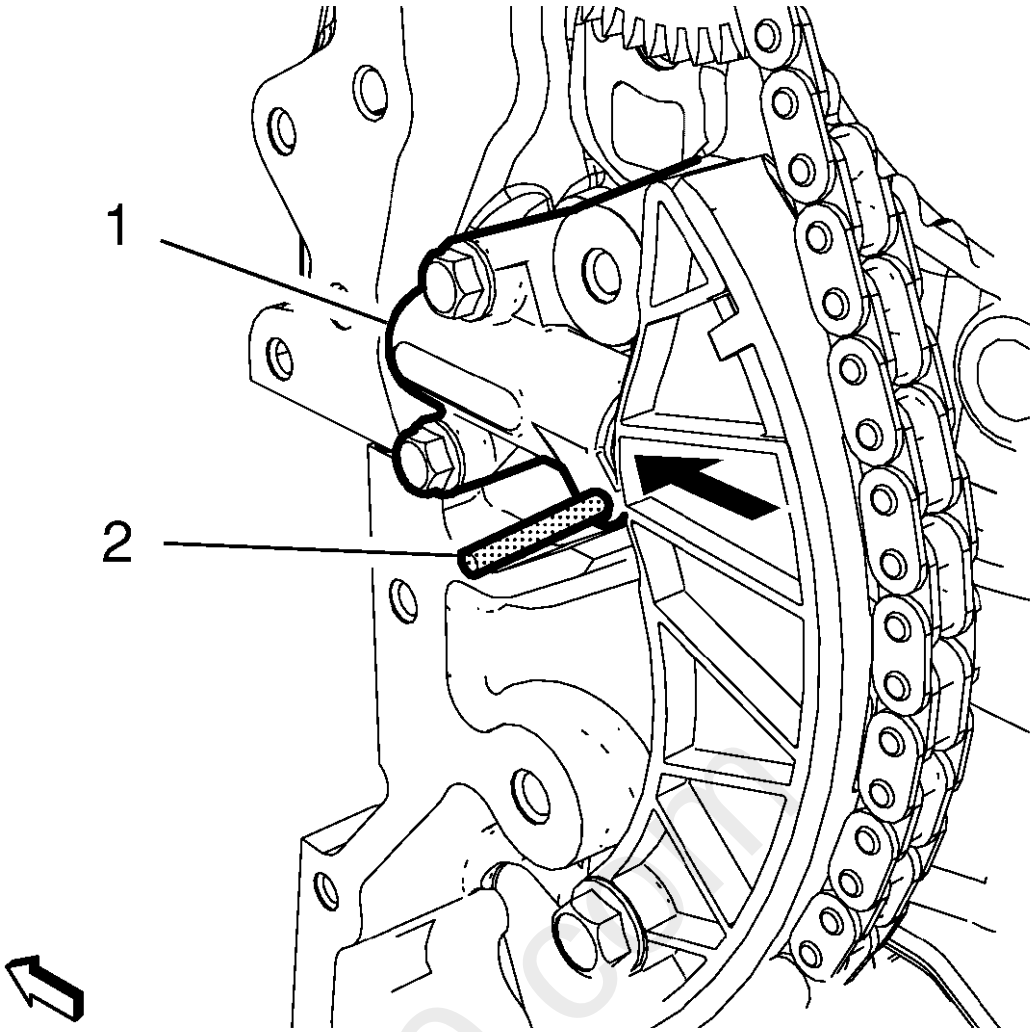


Fig. 101: Timing Chain Tensioner And Pin
Courtesy of GENERAL MOTORS COMPANY

26. Tension the timing chain tensioner (1) in arrow direction.
27. Install **EN-50513** Pin (2)

mcx30.com

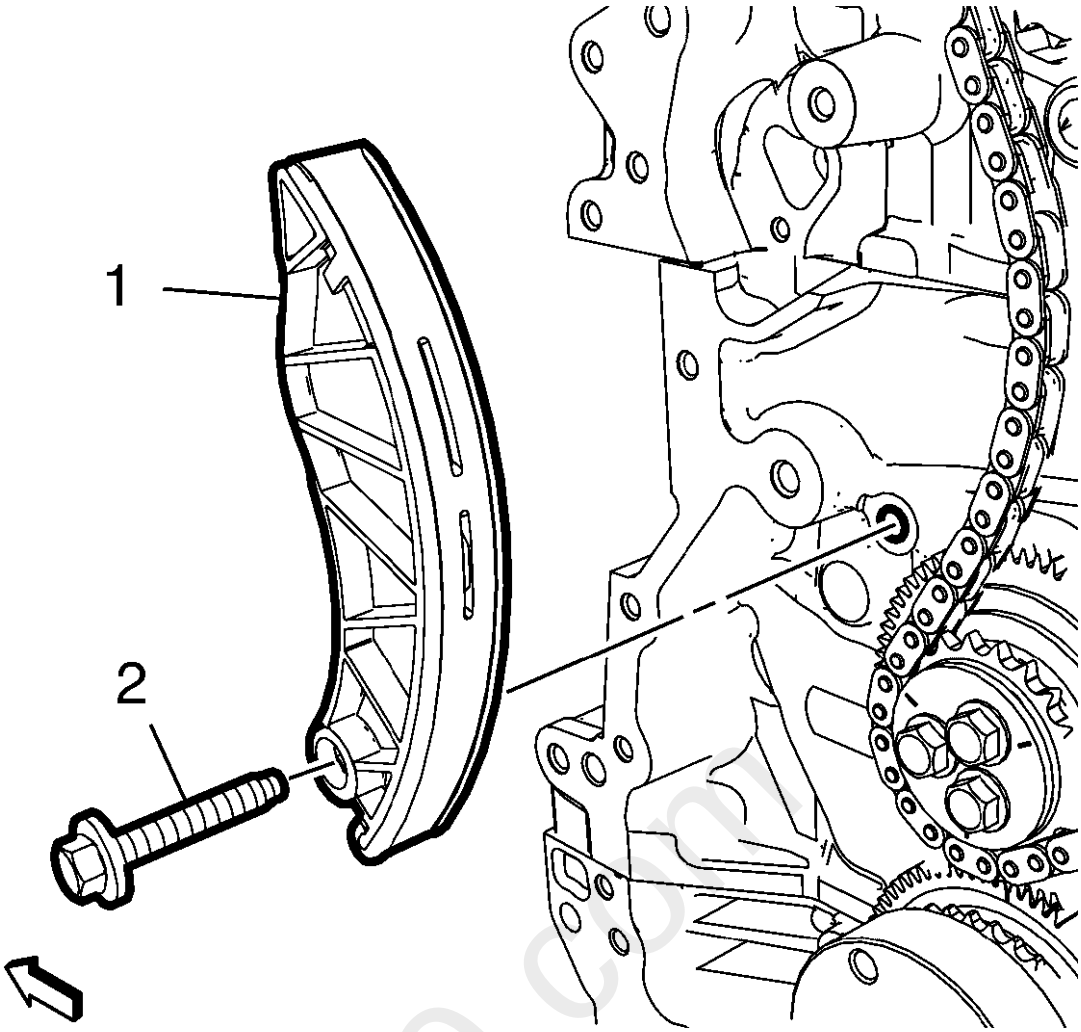


Fig. 102: Timing Chain Tensioner Shoe And Bolt
Courtesy of GENERAL MOTORS COMPANY

28. Remove Timing Chain Tensioner Shoe Bolt (2)
29. Remove Timing Chain Tensioner Shoe (1)

mcx30.com

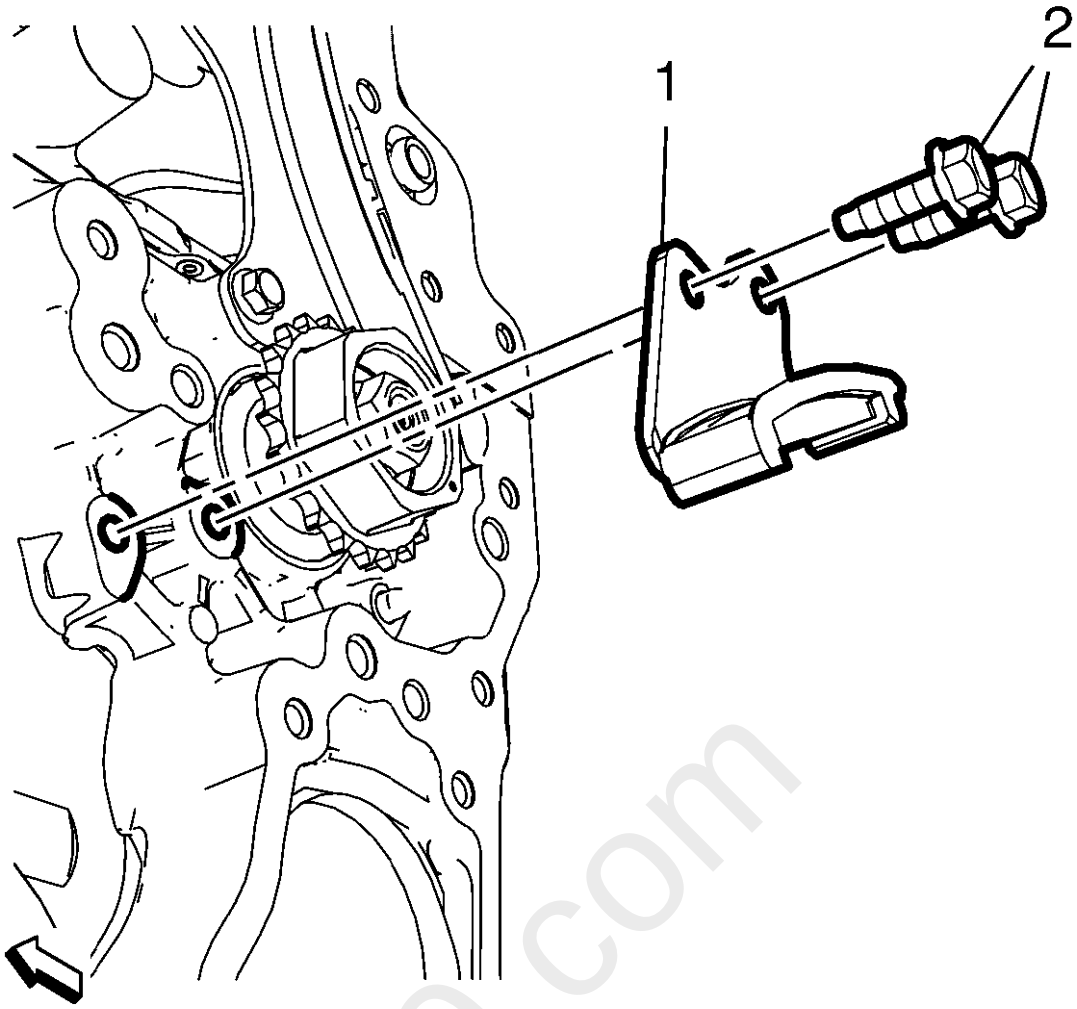


Fig. 103: Timing Chain Lower Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

30. Remove Timing Chain Lower Guide Bolts (2) (Qty: 2)
31. Remove Timing Chain Lower Guide (1)

mcx30.com

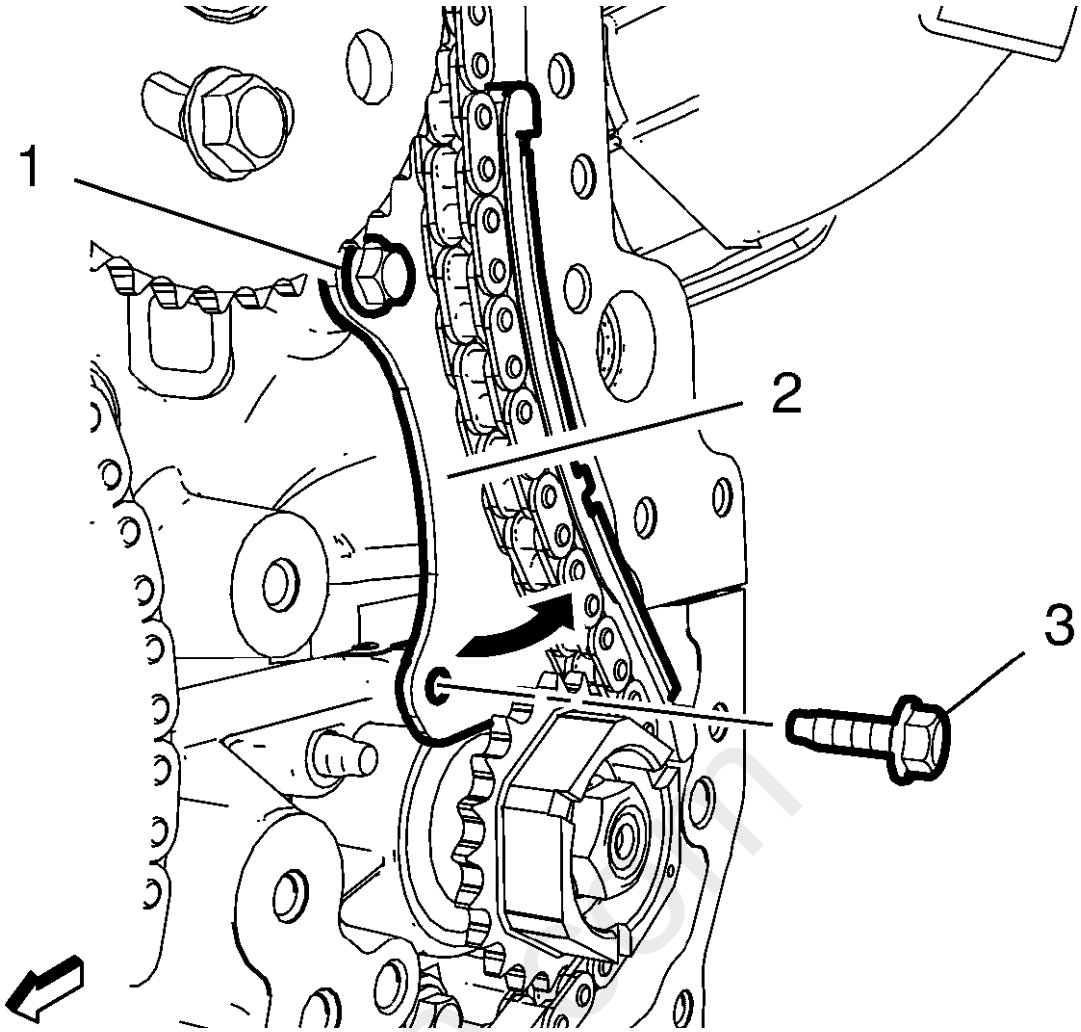


Fig. 104: Timing Chain Upper Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

32. Loosen Timing Chain Upper Guide Bolt (1)
33. Remove Timing Chain Upper Guide Bolt (3)
34. Move the timing chain upper guide in the direction of arrow.

mx30.com

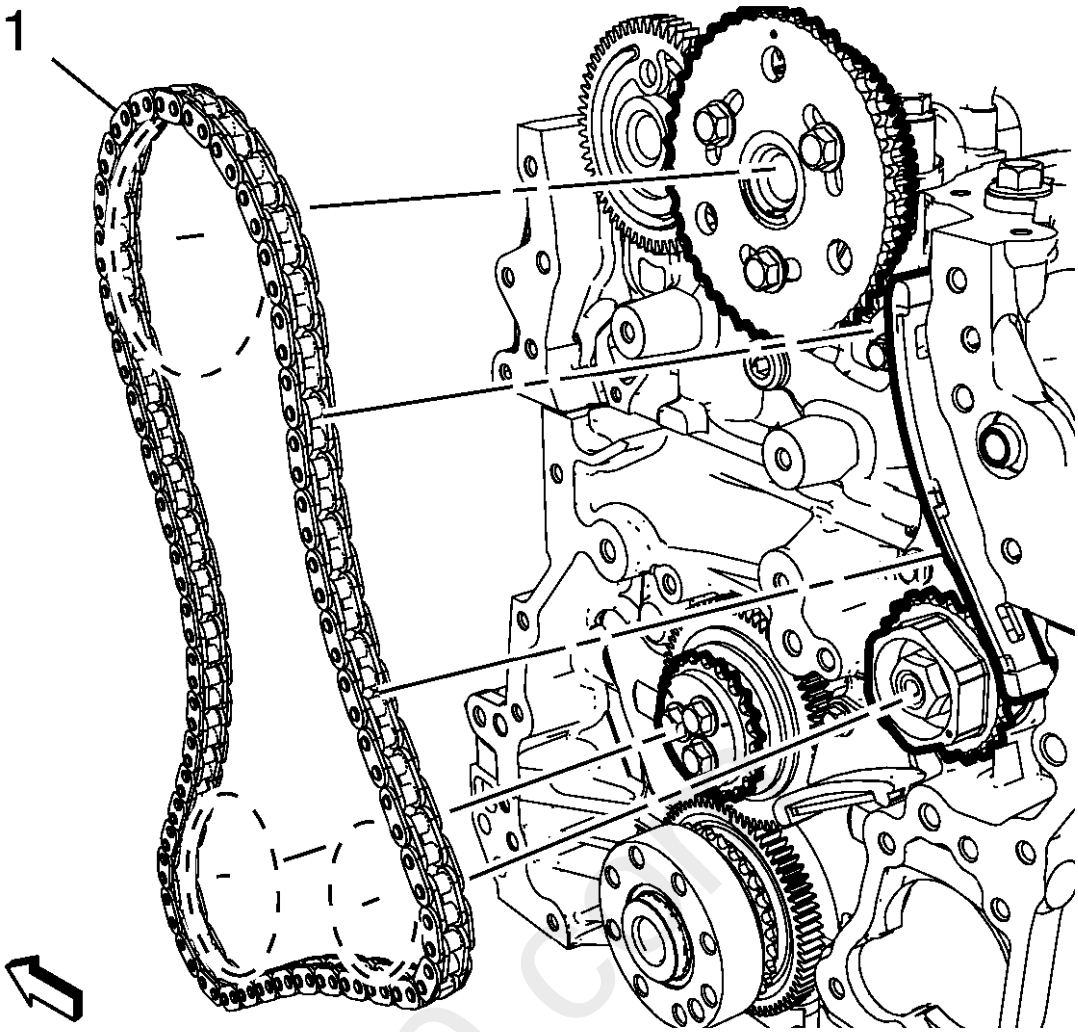


Fig. 105: Timing Chain
Courtesy of GENERAL MOTORS COMPANY

35. Remove Timing Chain (1)

mcx30.com

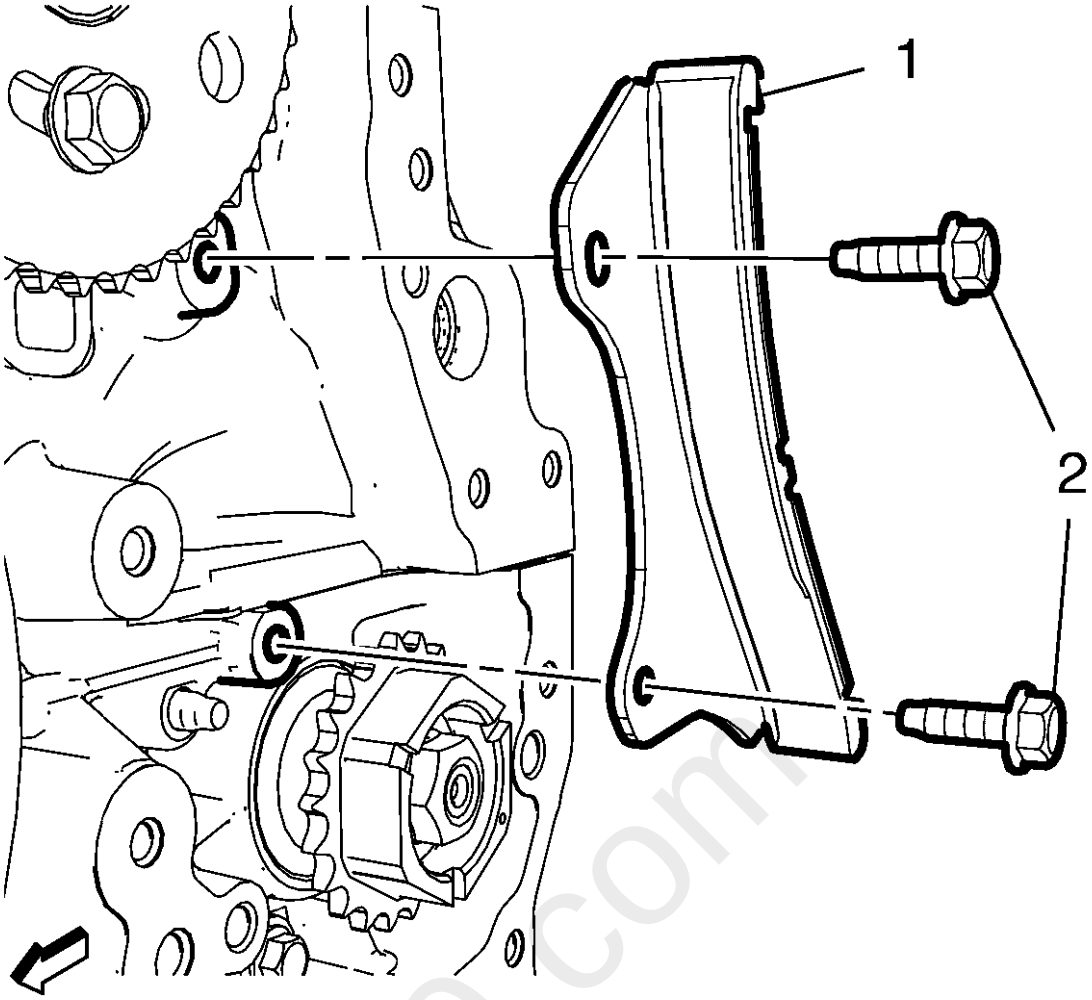


Fig. 106: Timing Chain Upper Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

36. Remove the upper timing chain upper guide bolt (2).
37. Remove Timing Chain Upper Guide (1)

Installation Procedure

NOTE: **Before installing the camshaft timing chain, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

mcx30.com

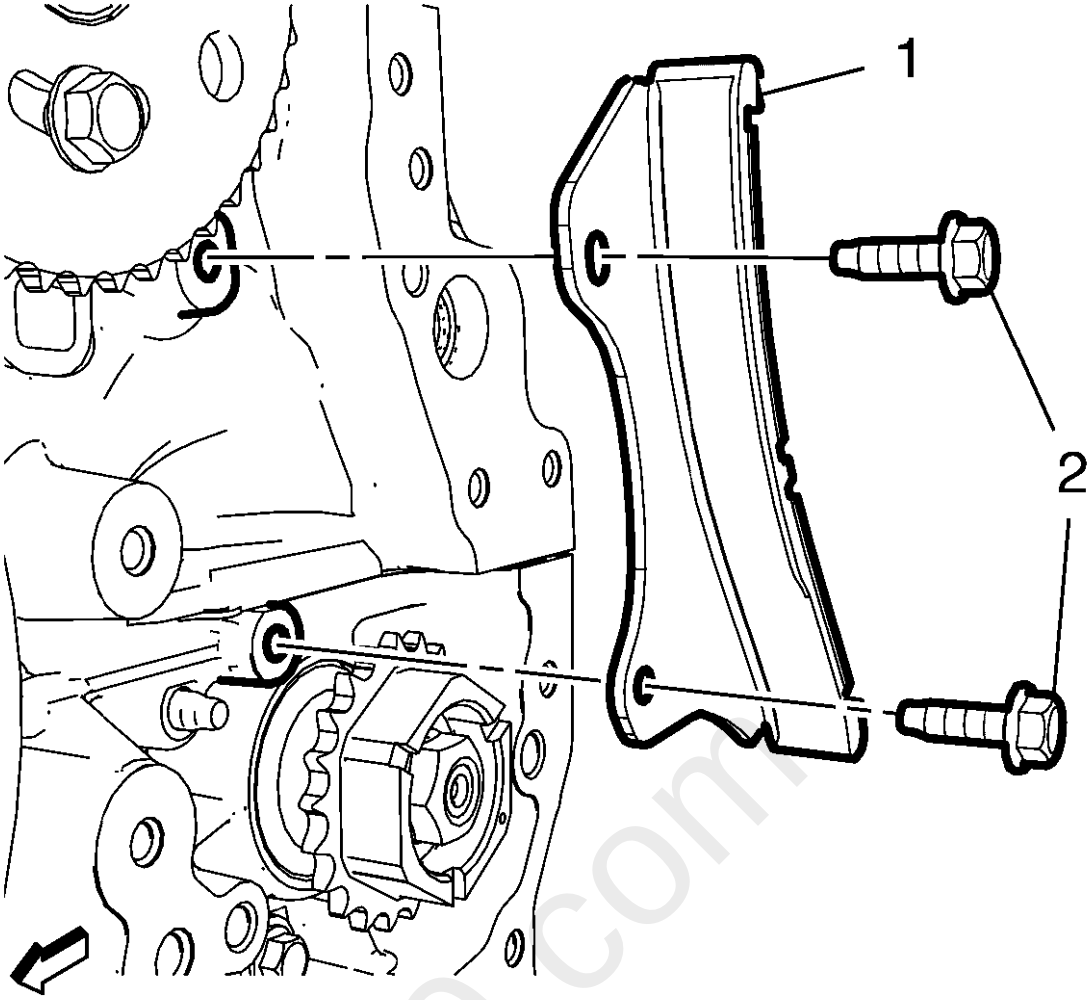


Fig. 107: Timing Chain Upper Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Re-cut thread at cylinder head and engine block for the 2 timing chain upper guide bolts (2).
3. Install Timing Chain Upper Guide (1)

NOTE: **The tightening procedure of the timing chain upper guide bolts should be completed within 10 minutes.**

4. Apply thread lock agent to the upper timing chain upper guide bolt (2).

NOTE: **Do not tighten the upper timing chain upper guide bolt before the camshaft timing chain is installed.**

5. Install the upper timing chain upper guide bolt (2).

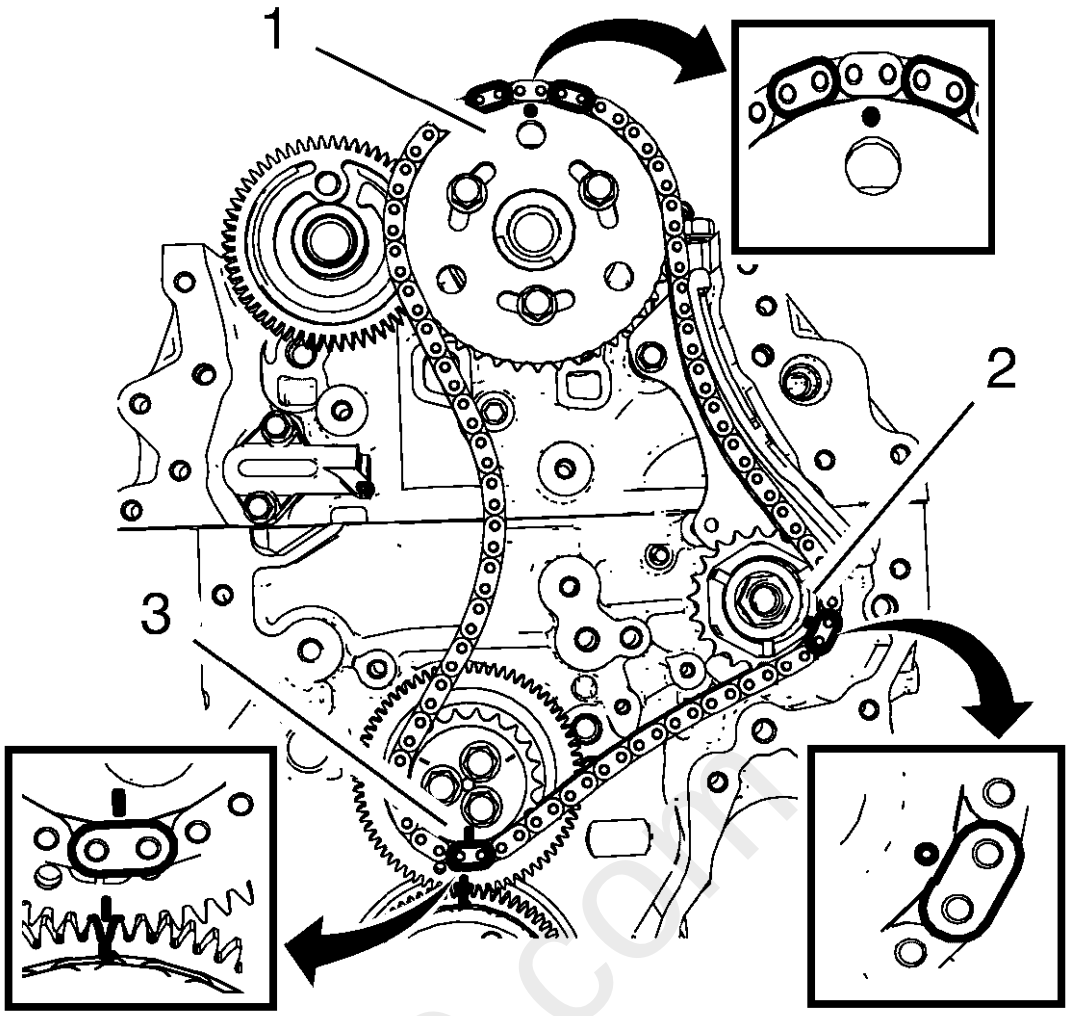


Fig. 108: Aligning Timing Chain Marked Chain Links
Courtesy of GENERAL MOTORS COMPANY

6. Install the timing chain with the marked chain links as shown and follow the installation sequence:
    1. Install the timing chain in the first step to the fuel injection pump sprocket (2).
    2. Install the timing chain in the second step to the camshaft sprocket (1).
    3. Install the timing chain in the final step to the timing chain idler sprocket (3).

mcx30.com

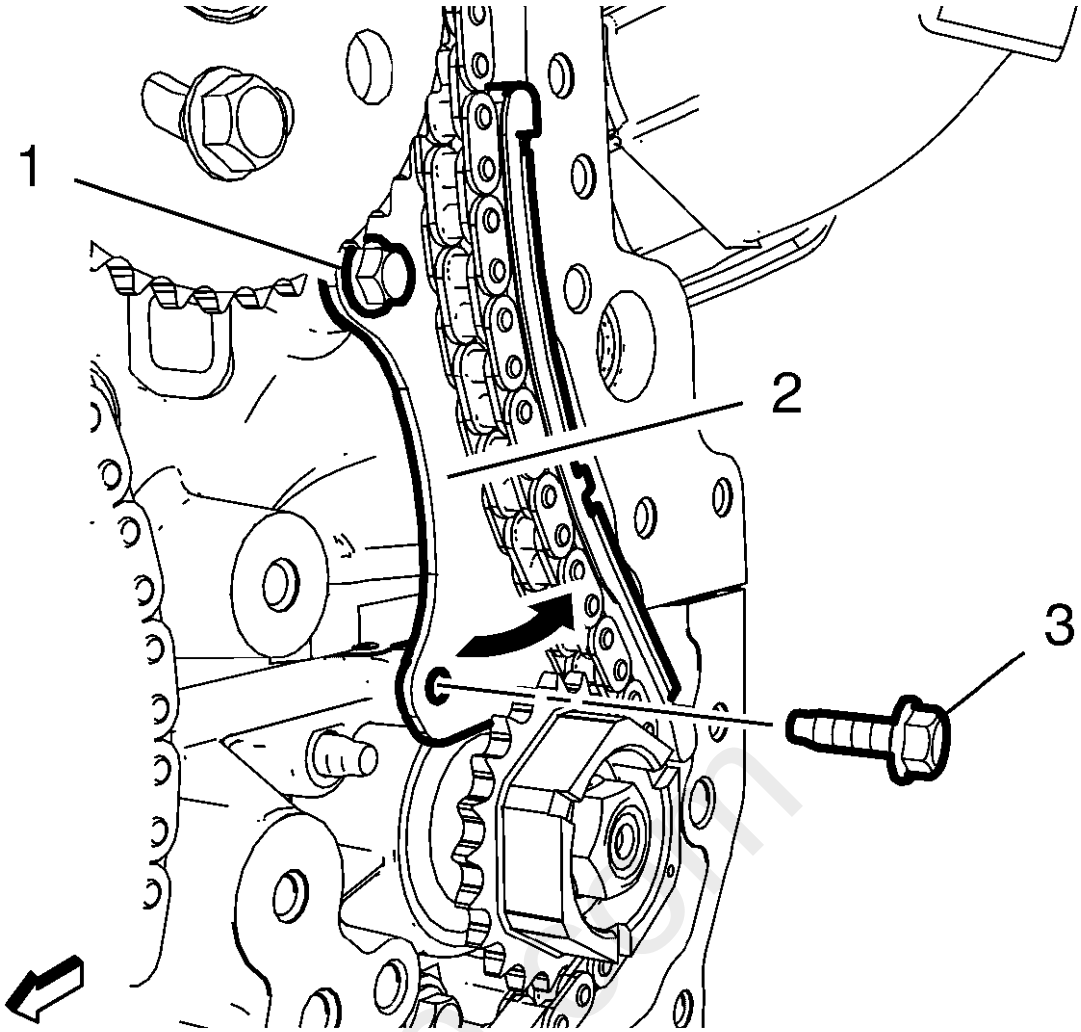


Fig. 109: Timing Chain Upper Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution**

7. Apply thread lock agent to the lower timing chain upper guide bolt (3). Refer to **Adhesives, Fluids, Lubricants, and Sealers**
8. Install and tighten Timing Chain Upper Guide Bolt (3) to 11 N.m (97 lb in)
9. Tighten Timing Chain Upper Guide Bolt (1) to 11 N.m (97 lb in)

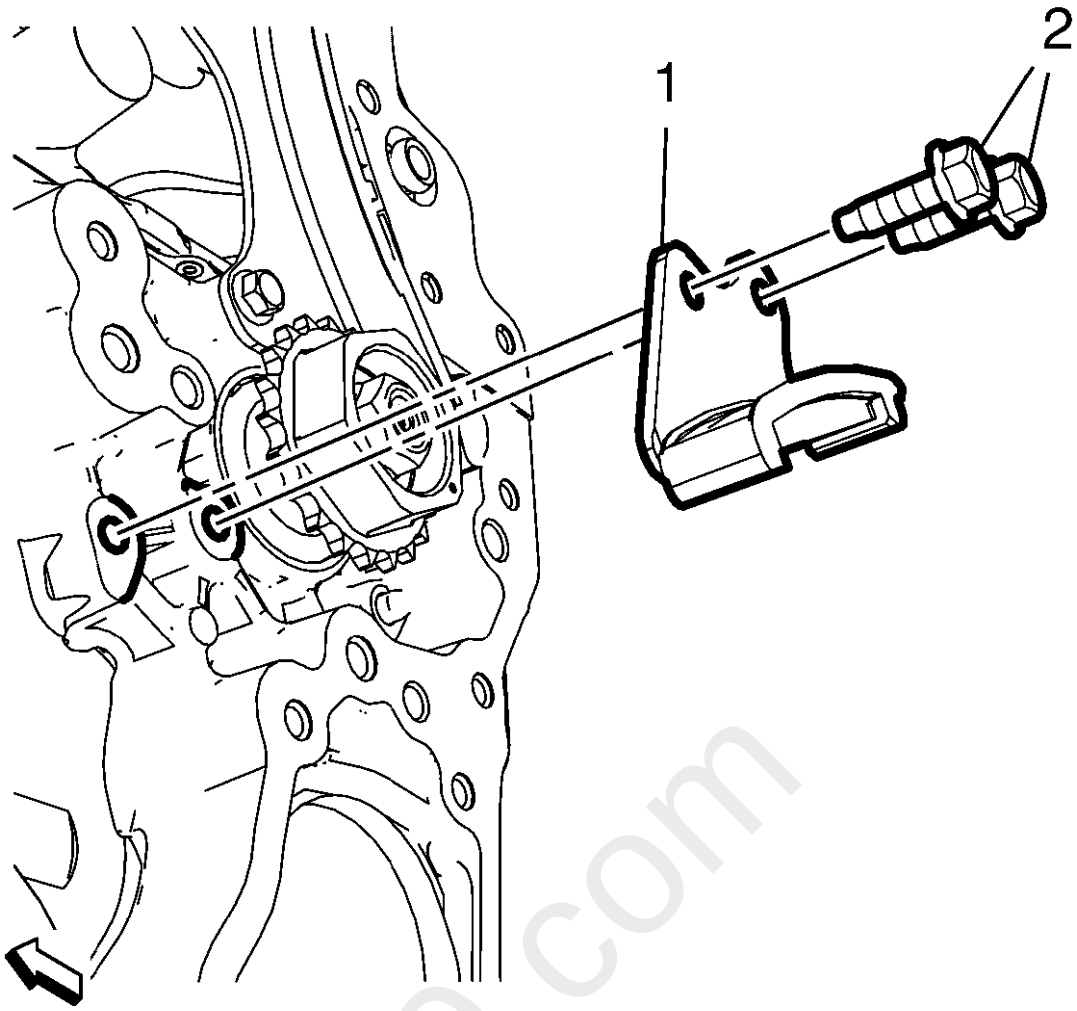


Fig. 110: Timing Chain Lower Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Install Timing Chain Lower Guide (1)
11. Install and tighten Timing Chain Lower Guide Bolts (2) (Qty: 2) to 10 N.m (89 lb in)

mcx30.com

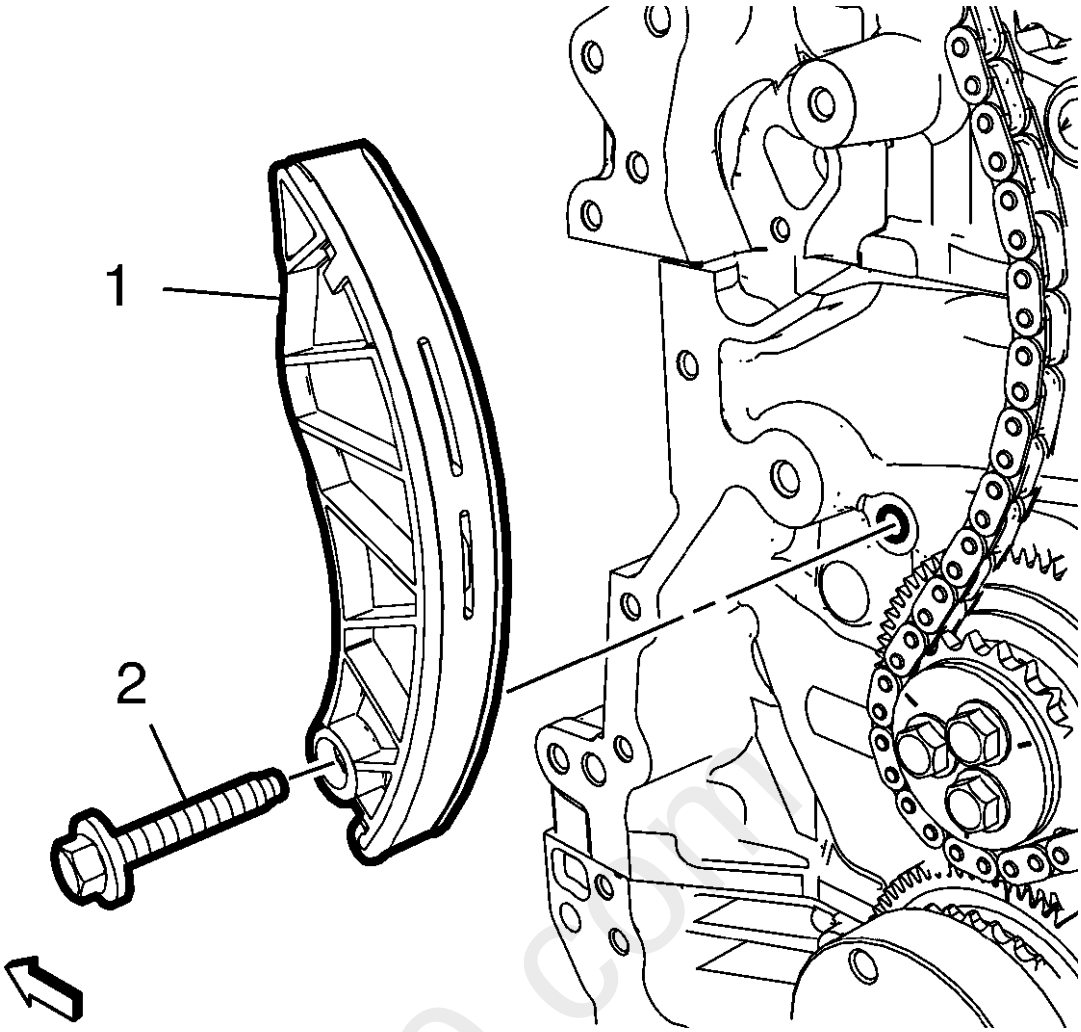


Fig. 111: Timing Chain Tensioner Shoe And Bolt
Courtesy of GENERAL MOTORS COMPANY

12. Install Timing Chain Tensioner Shoe (1)
13. Install and tighten Timing Chain Tensioner Shoe Bolt (2) to 25 N.m (18 lb ft)

mcx30.com

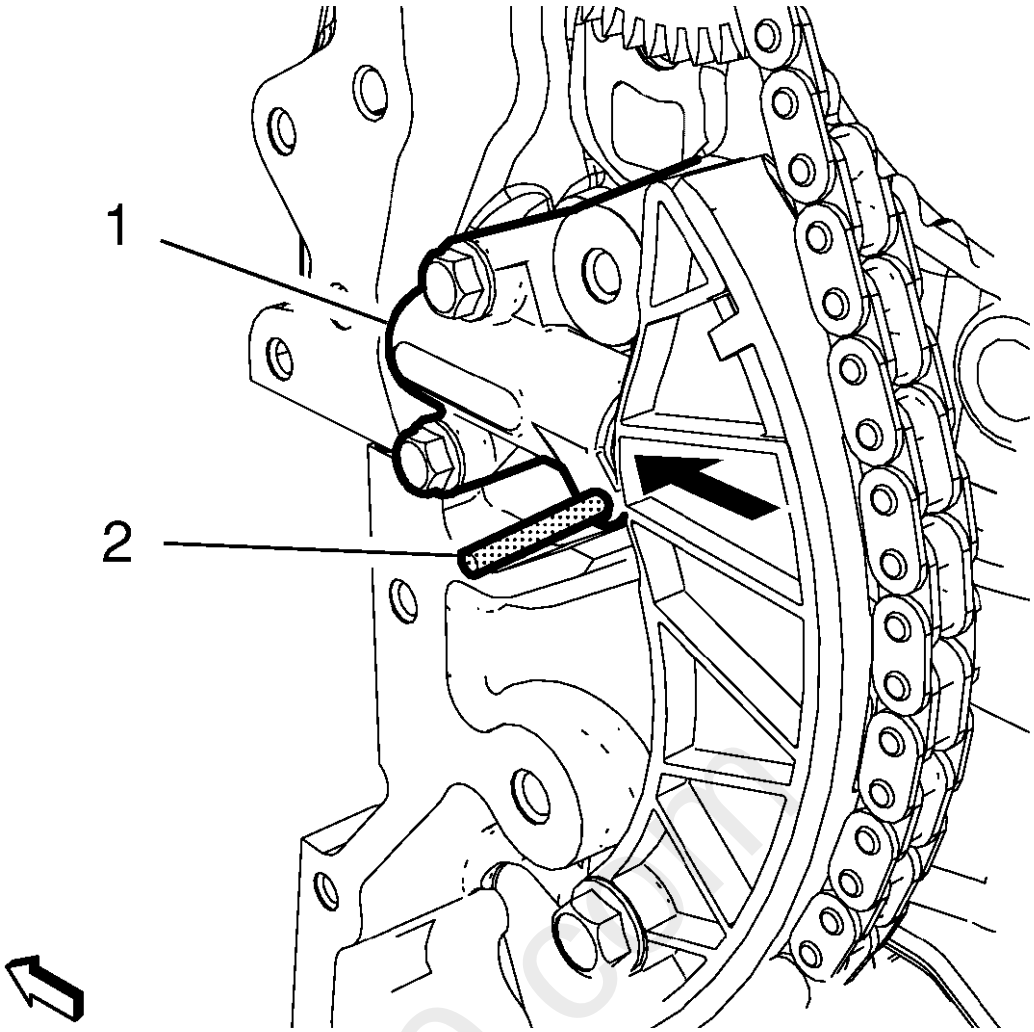


Fig. 112: Timing Chain Tensioner And Pin
Courtesy of GENERAL MOTORS COMPANY

14. Remove **EN-50513** Pin (2)

mcx30.com

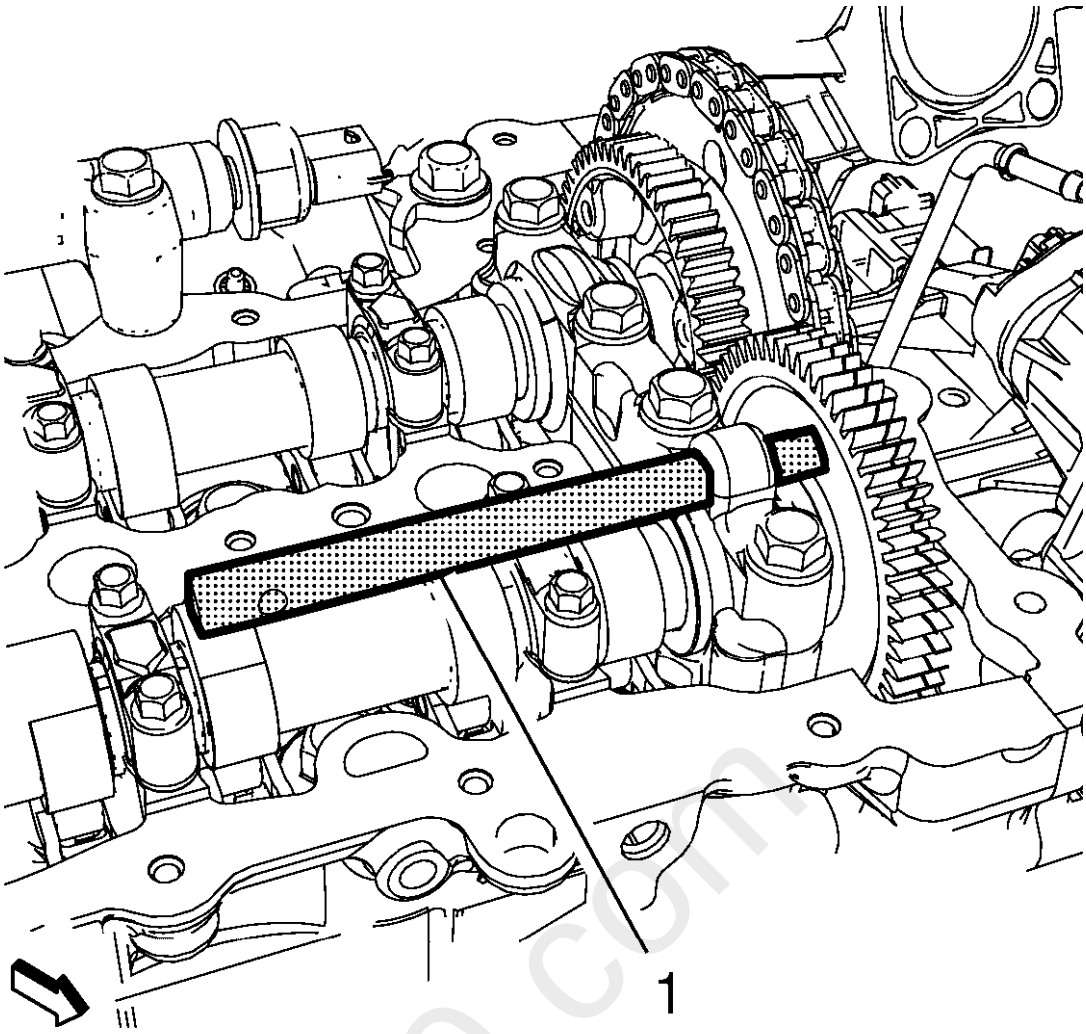


Fig. 113: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

15. Remove **EN-51143** Fixing Tool (1)
16. Raise the vehicle.

mcx30.com

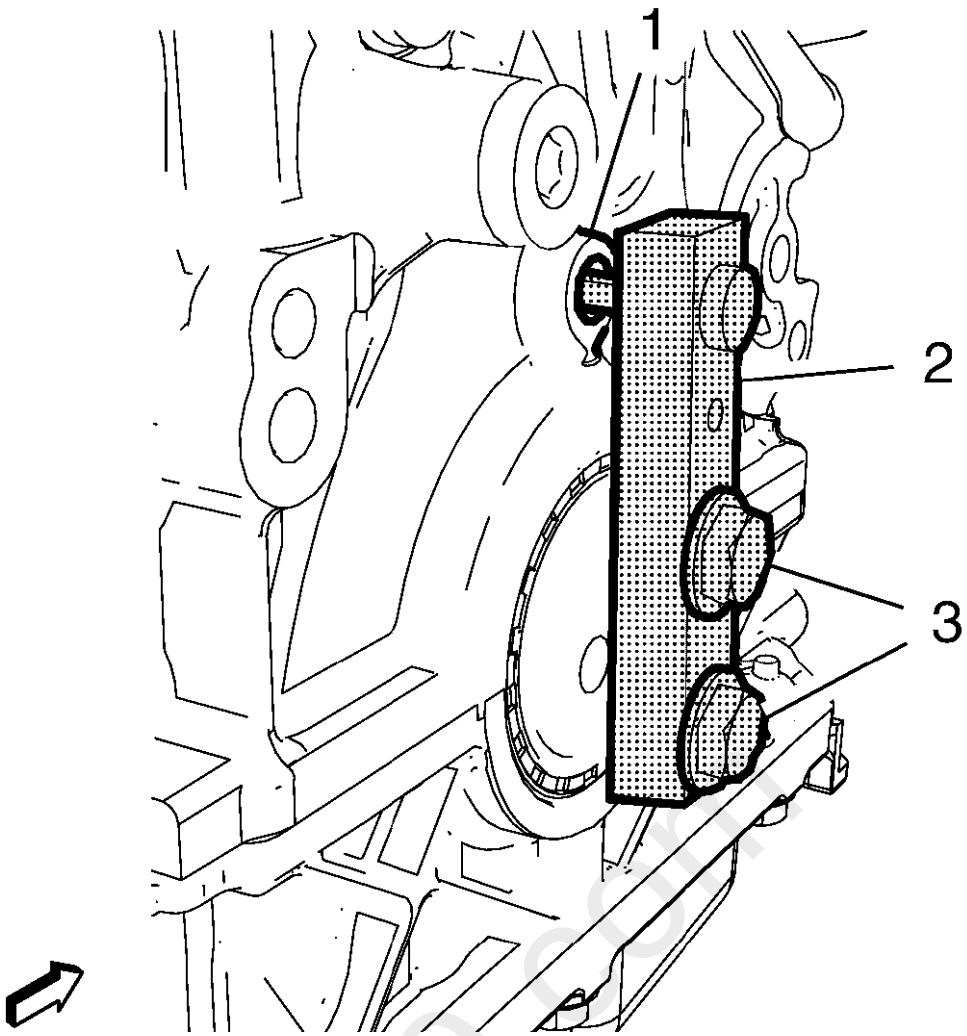


Fig. 114: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

17. Remove Bolts (3) (Qty: 2)
18. Remove **EN-51143** Fixing Tool (2)

mcx30.com

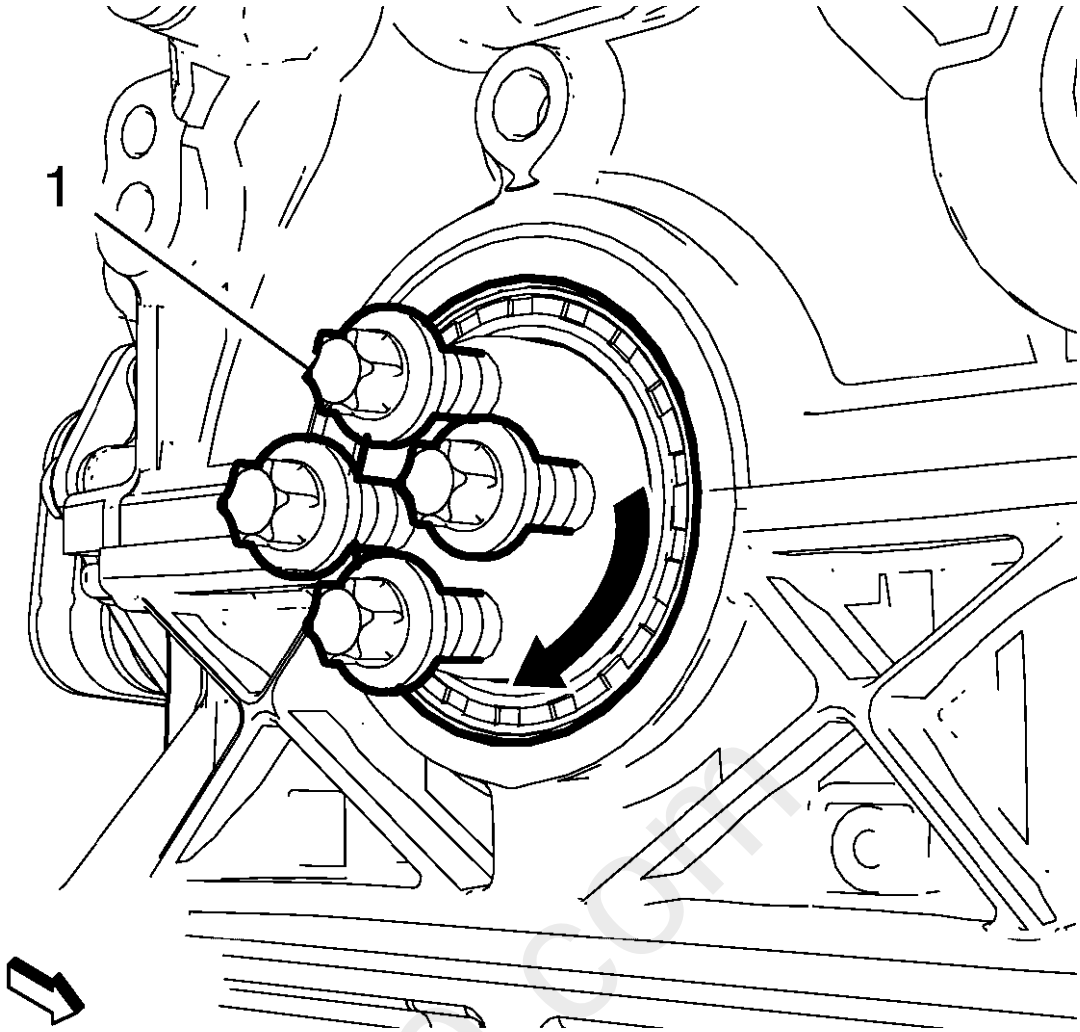


Fig. 115: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

19. Install Crankshaft Pulley Bolts (1) (Qty: 4)

    Rotate the crankshaft 720 degrees in direction of arrow. Use a pry bar at the 4 crankshaft pulley bolts (1).

20. Remove Crankshaft Pulley Bolts (1) (Qty: 4)

mcx30.com

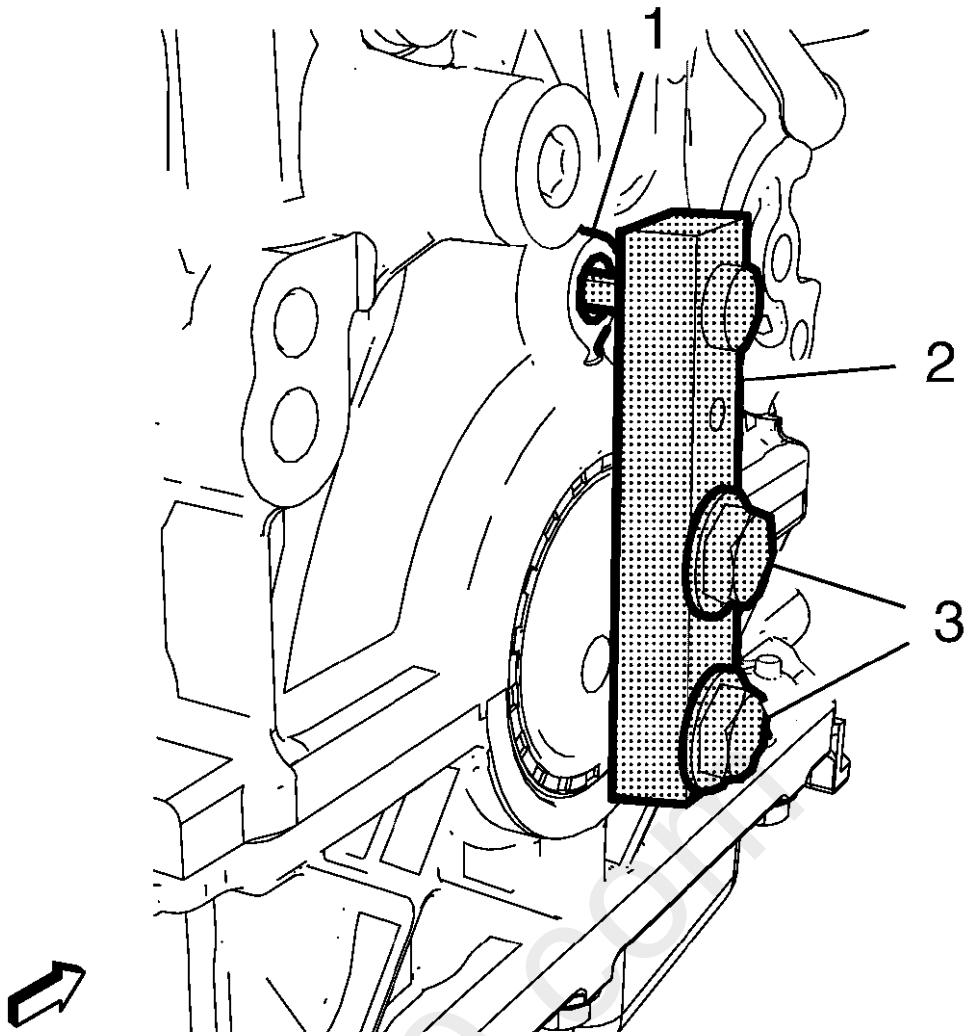


Fig. 116: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

21. Install **EN-51140** Fixing Tool (2)
22. Install Bolts (3) (Qty: 2)
23. Lower the vehicle.

mcx30.com

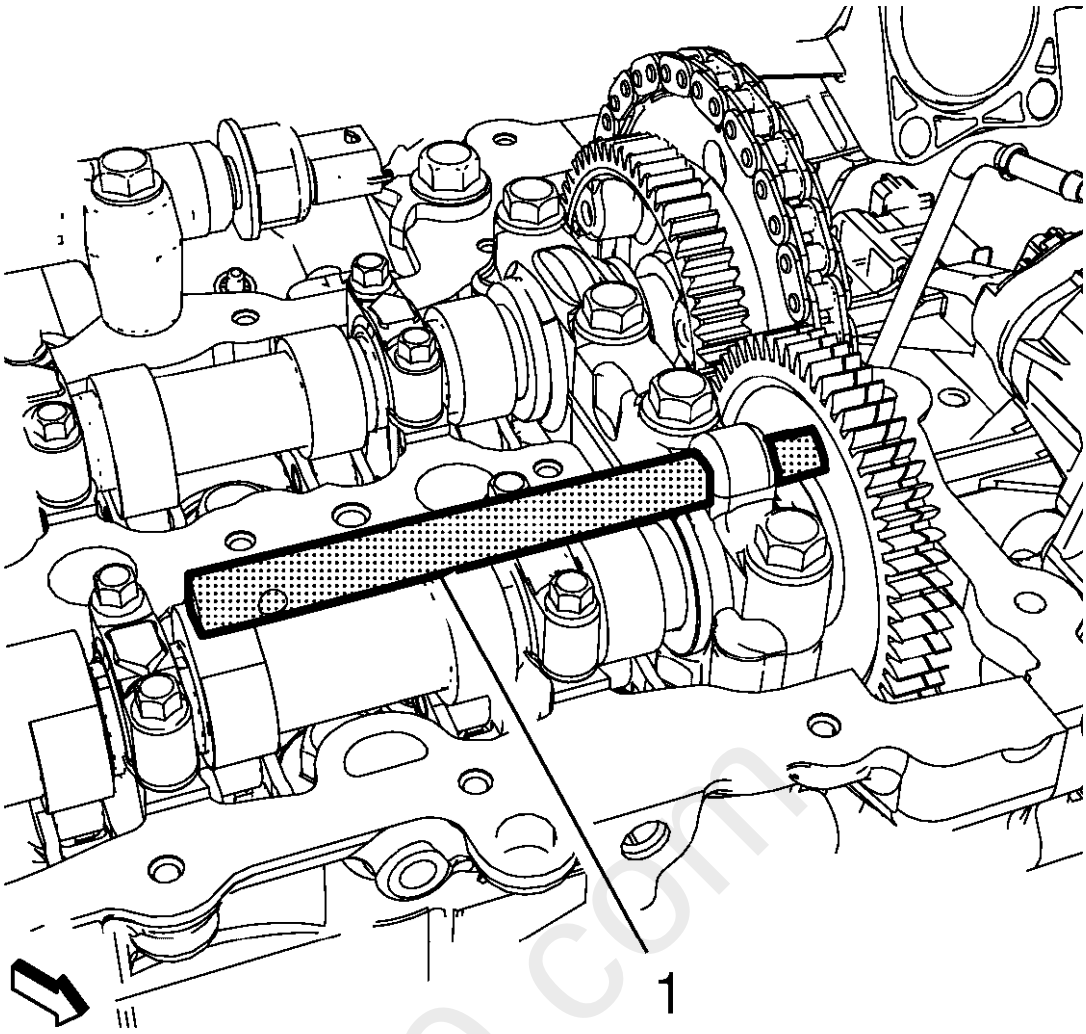


Fig. 117: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

24. Install **EN-51143** Fixing Tool (1)
25. If the fixing pin does not fit into the camshaft sprocket bore, the camshaft timing must be adjusted. Refer to **Camshaft Timing Chain Adjustment**
26. Remove **EN-51143** Fixing Tool (1)
27. Raise the vehicle.

mr-x30.com

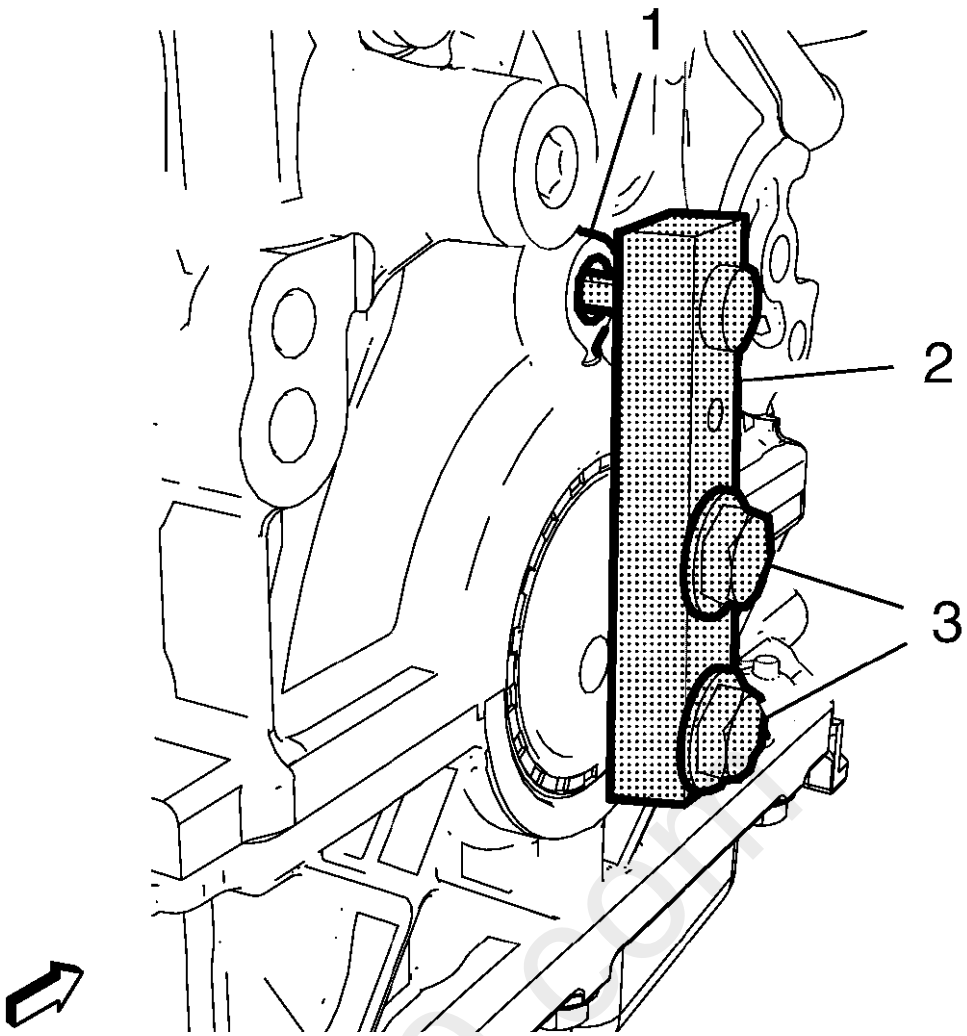


Fig. 118: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

28. Remove Bolts (3) (Qty: 2)
29. Remove **EN-51140** Fixing Tool (2)

mcx30.com

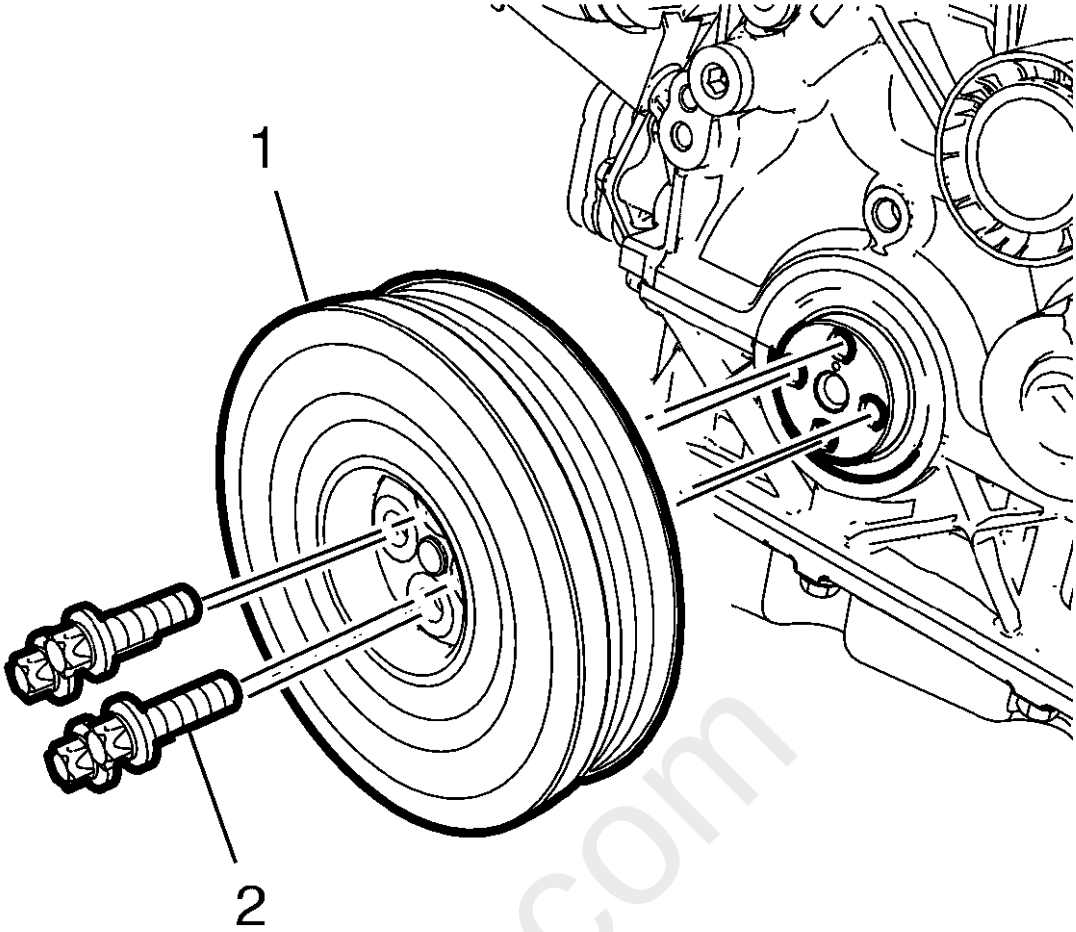


Fig. 119: Crankshaft Pulley And Bolts
Courtesy of GENERAL MOTORS COMPANY

30. Install Crankshaft Pulley (1). Refer to **Crankshaft Pulley Replacement**

mcx30.com

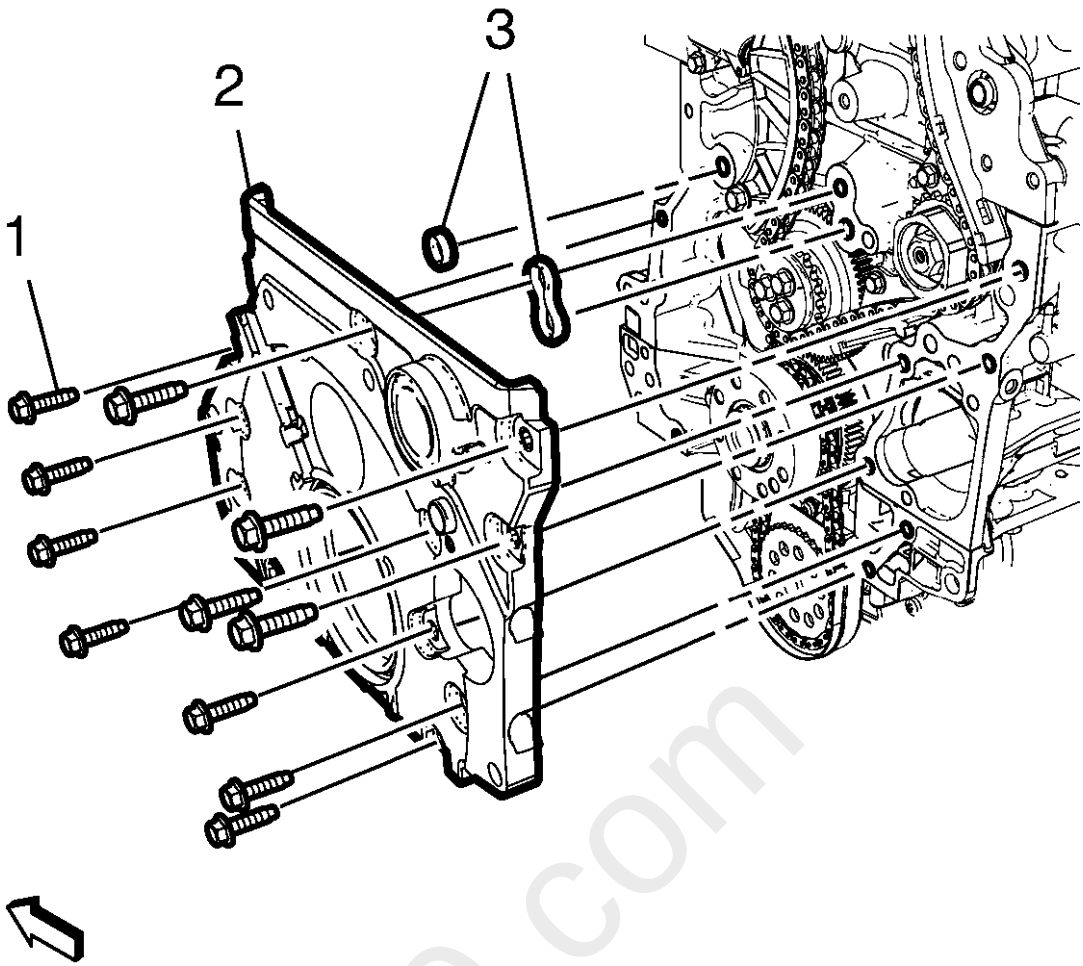


Fig. 120: Timing Chain Lower Cover, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

31. Install Timing Chain Lower Cover (2). Refer to **Timing Chain Lower Cover Replacement**

mcx30.com

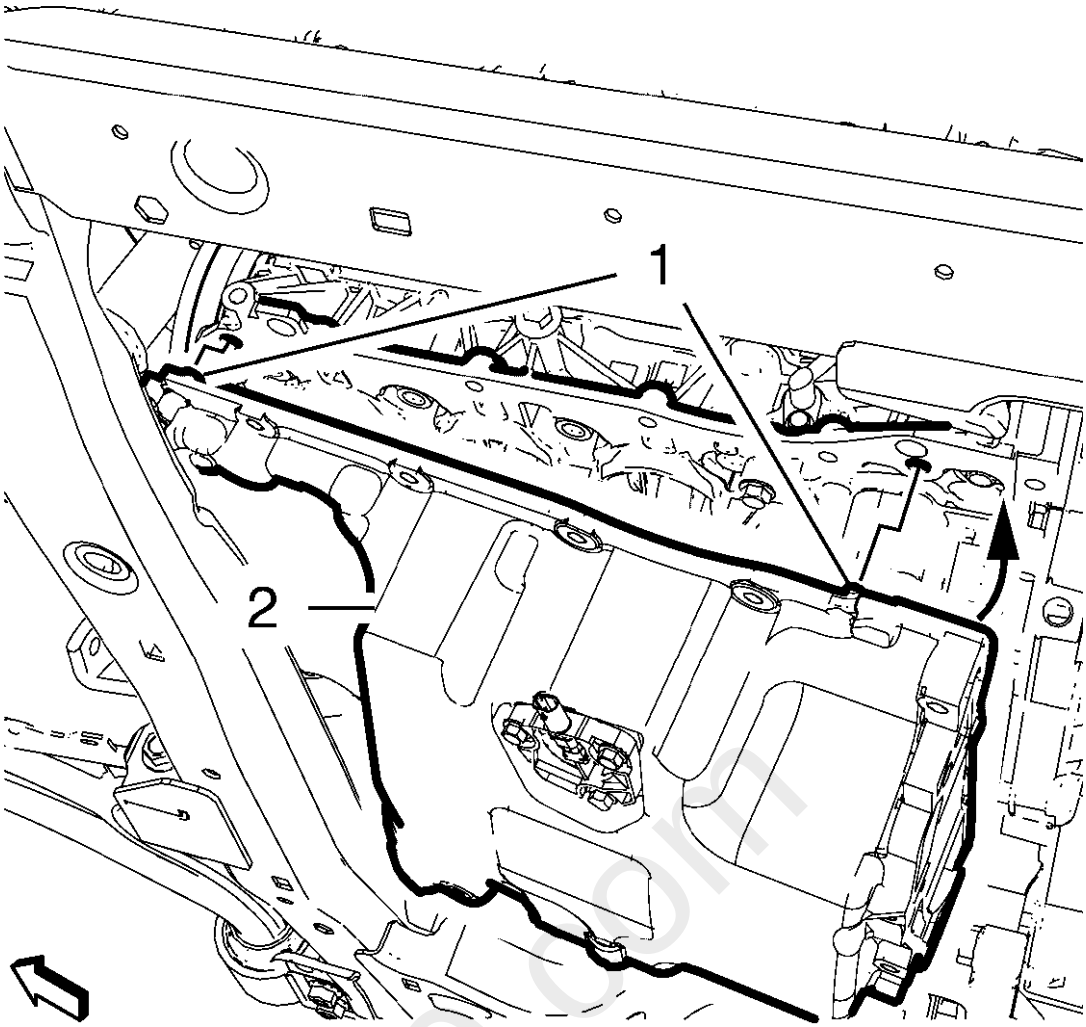


Fig. 121: Oil Pan
Courtesy of GENERAL MOTORS COMPANY

32. Install Oil Pan (2). Refer to **Oil Pan Replacement**

mcx30.com

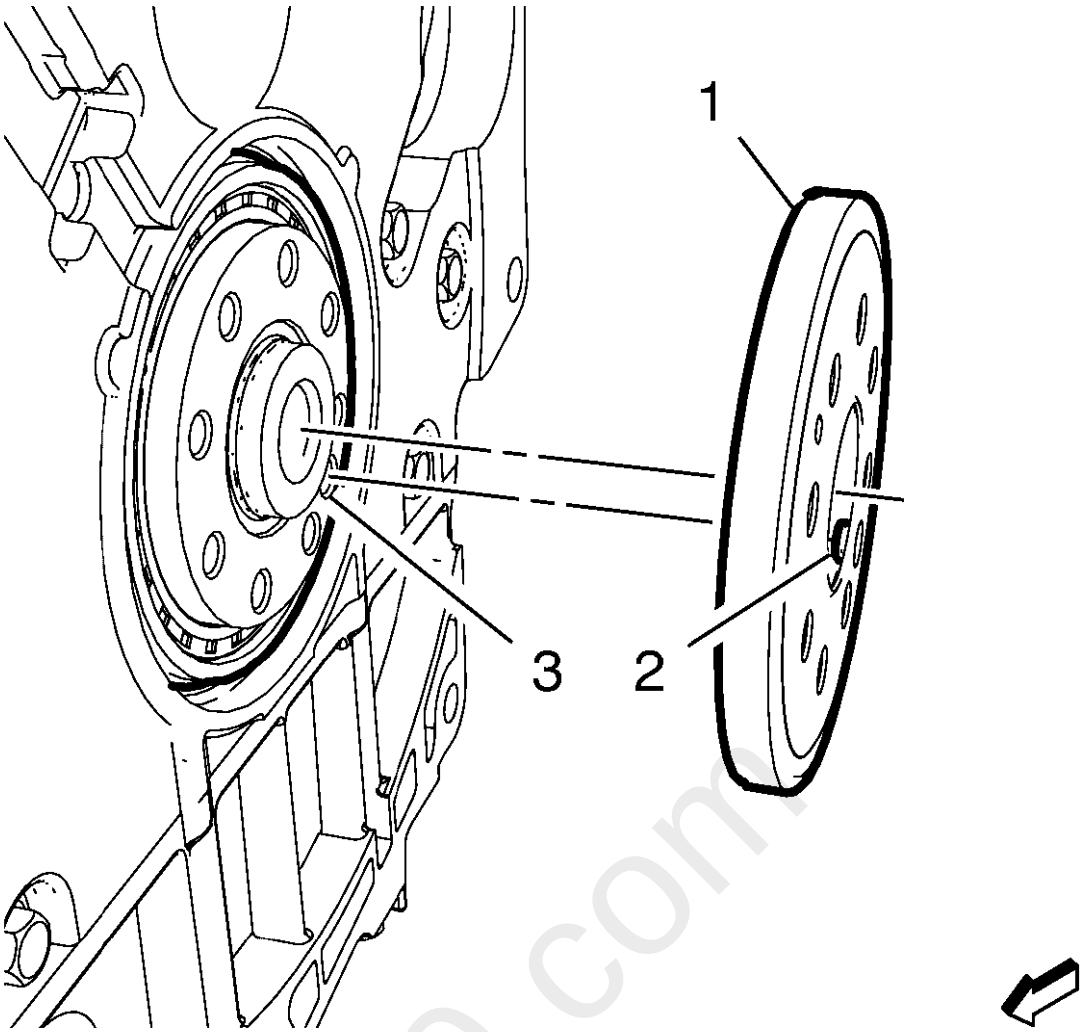


Fig. 122: Crankshaft Position Sensor Reluctor Ring
Courtesy of GENERAL MOTORS COMPANY

33. Install Crankshaft Position Sensor Reluctor Ring (1). Refer to **Crankshaft Position Sensor Reluctor Ring Replacement**
34. Install Transmission. Refer to **Transmission Replacement (Front Wheel Drive)** **Transmission Replacement (All Wheel Drive)**

mcx30.com

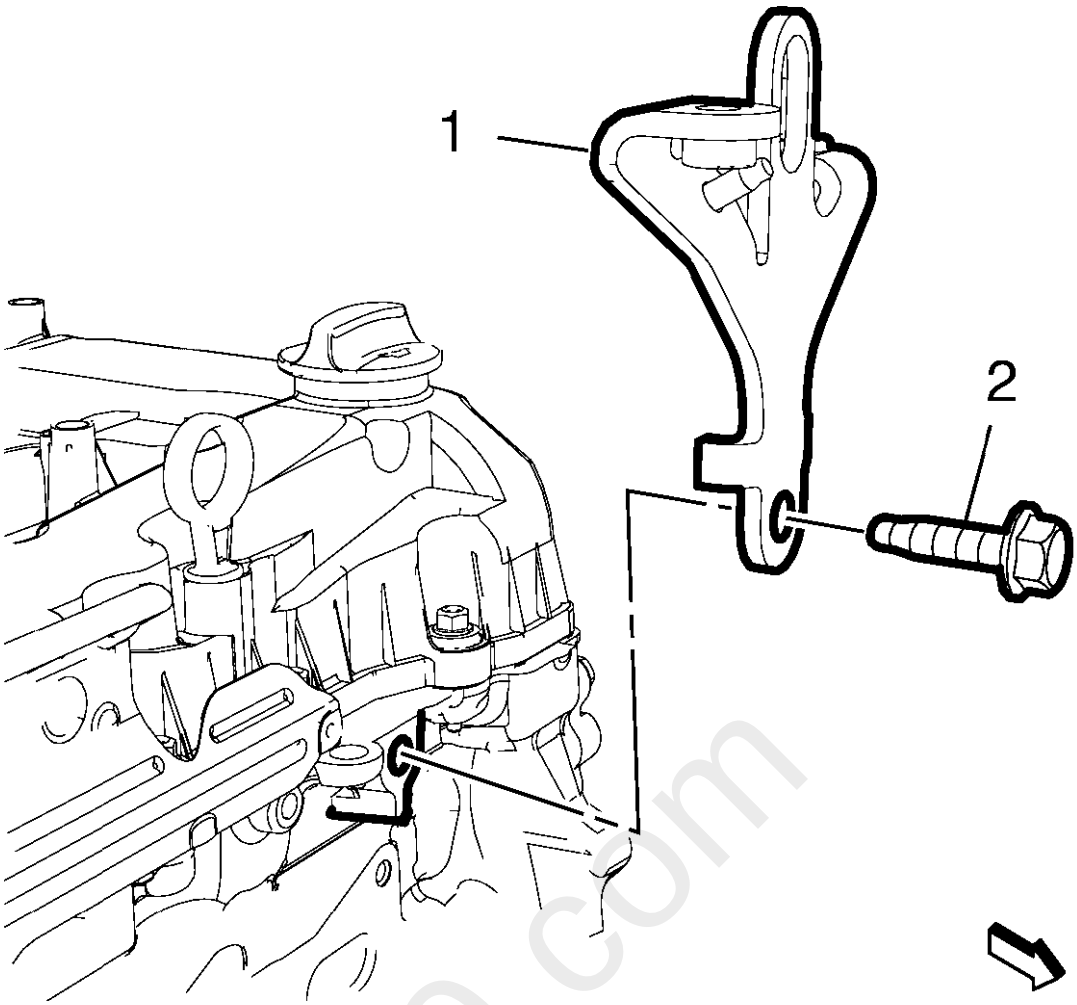


Fig. 123: Engine Lift Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

35. Remove Engine Lift Bracket Bolt (2)
36. Remove Engine Lift Bracket - Left Side (1) @ Cylinder Head

mcx30.com

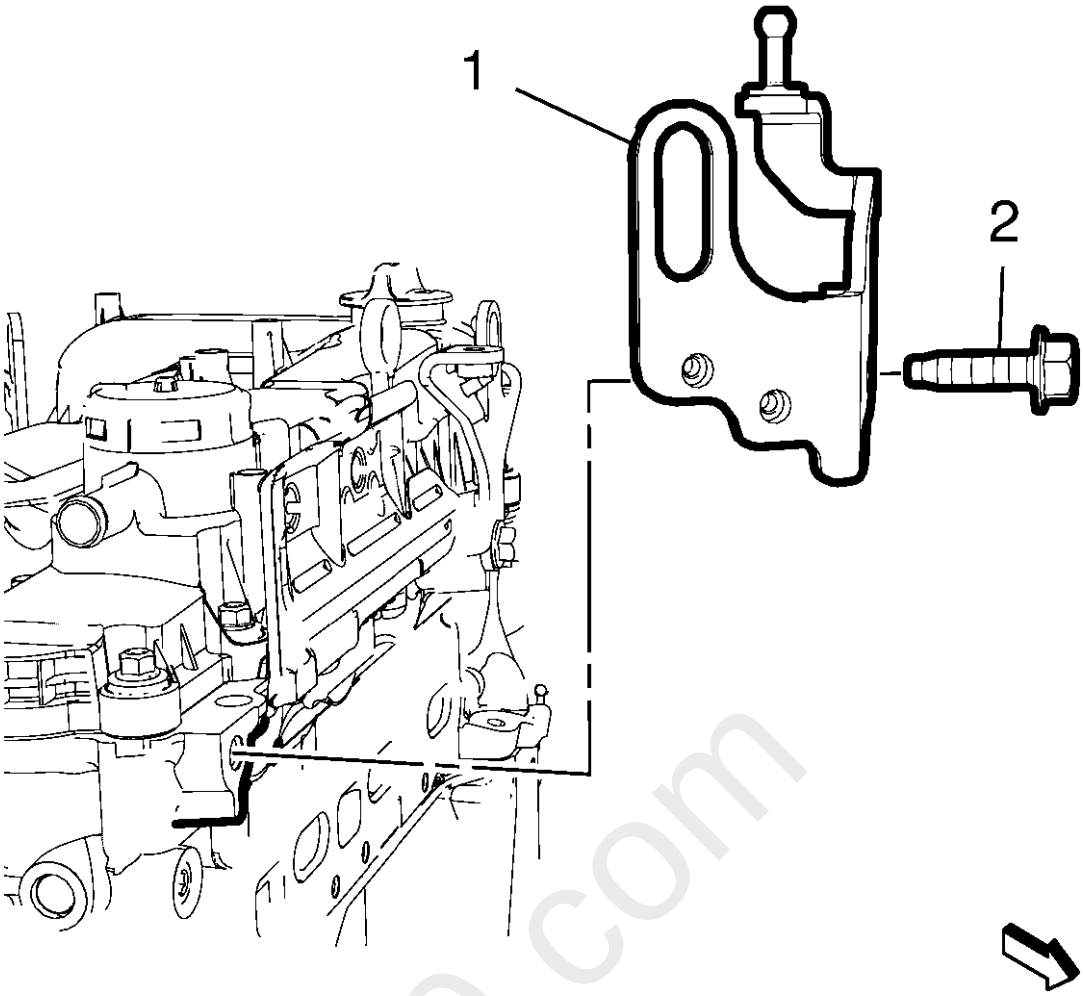


Fig. 124: Engine Lift Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

37. Remove Engine Lift Bracket Bolt (2)
38. Remove Engine Lift Bracket - Right Side (1) @ Cylinder Head

mcx30.com

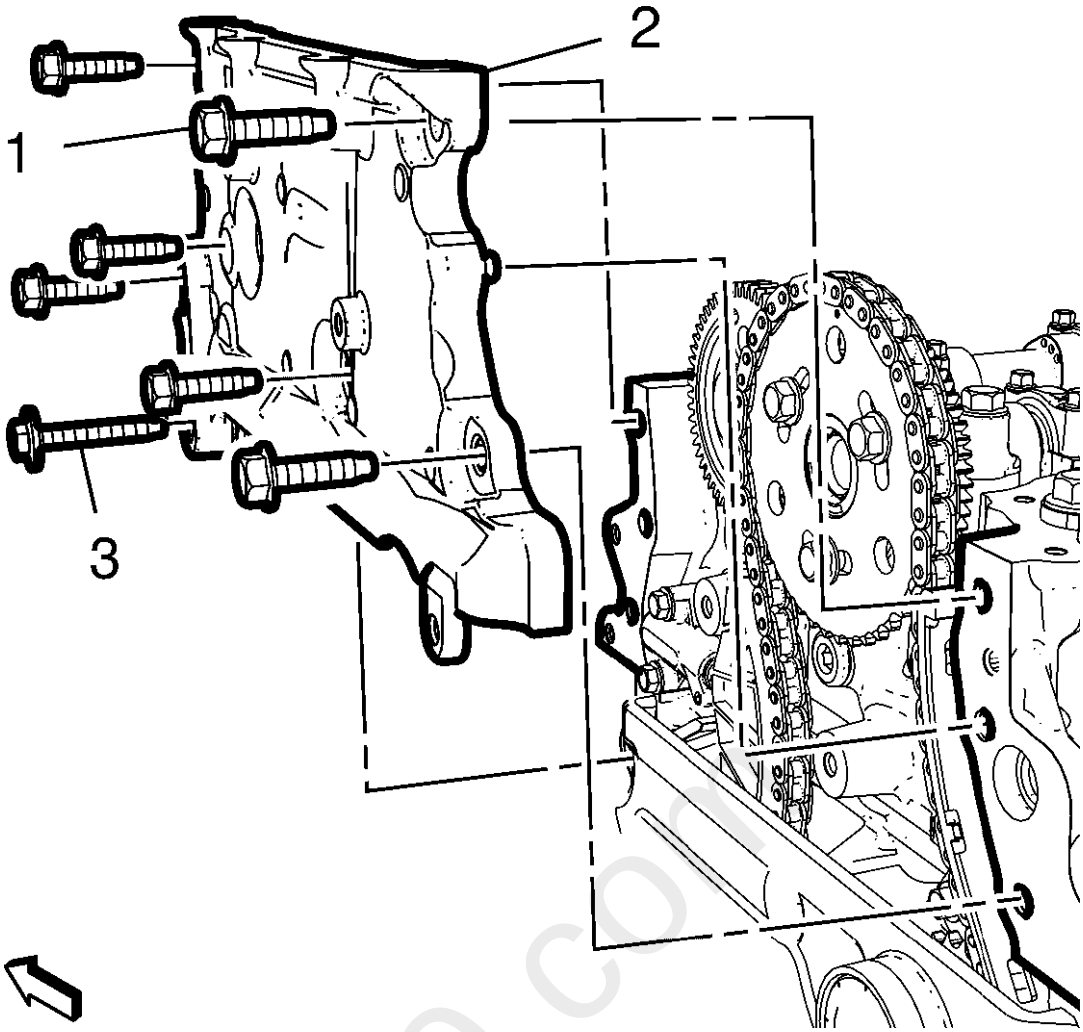


Fig. 125: Timing Chain Upper Cover And Bolts
Courtesy of GENERAL MOTORS COMPANY

39. Install Timing Chain Upper Cover (2). Refer to **Timing Chain Upper Cover Replacement**

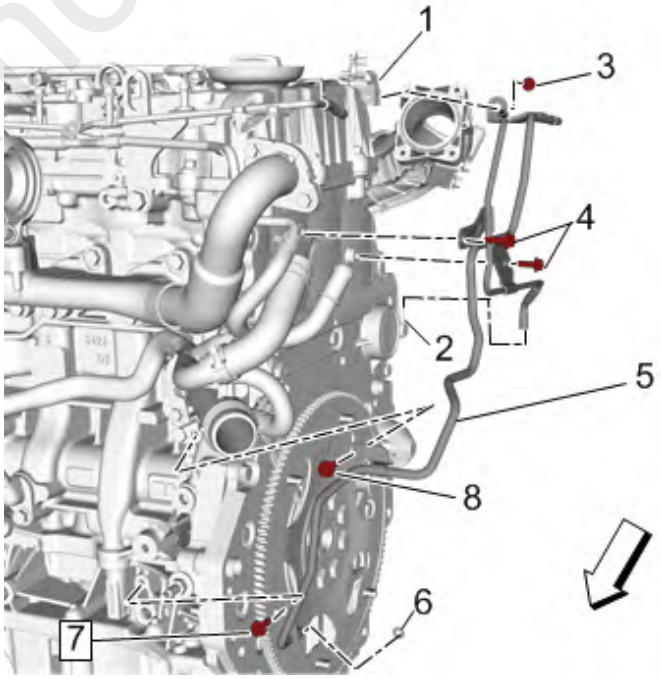


Fig. 126: Power Brake Booster Inlet Hose Connector Fitting And Components
Courtesy of GENERAL MOTORS COMPANY

40. Install Power Brake Booster Inlet Hose Connector Fitting (5). Refer to **Power Brake Booster Inlet Hose Connector Fitting Replacement**

41. Install Oxidation Catalytic Converter. Refer to **Oxidation Catalytic Converter Replacement (LH7)**

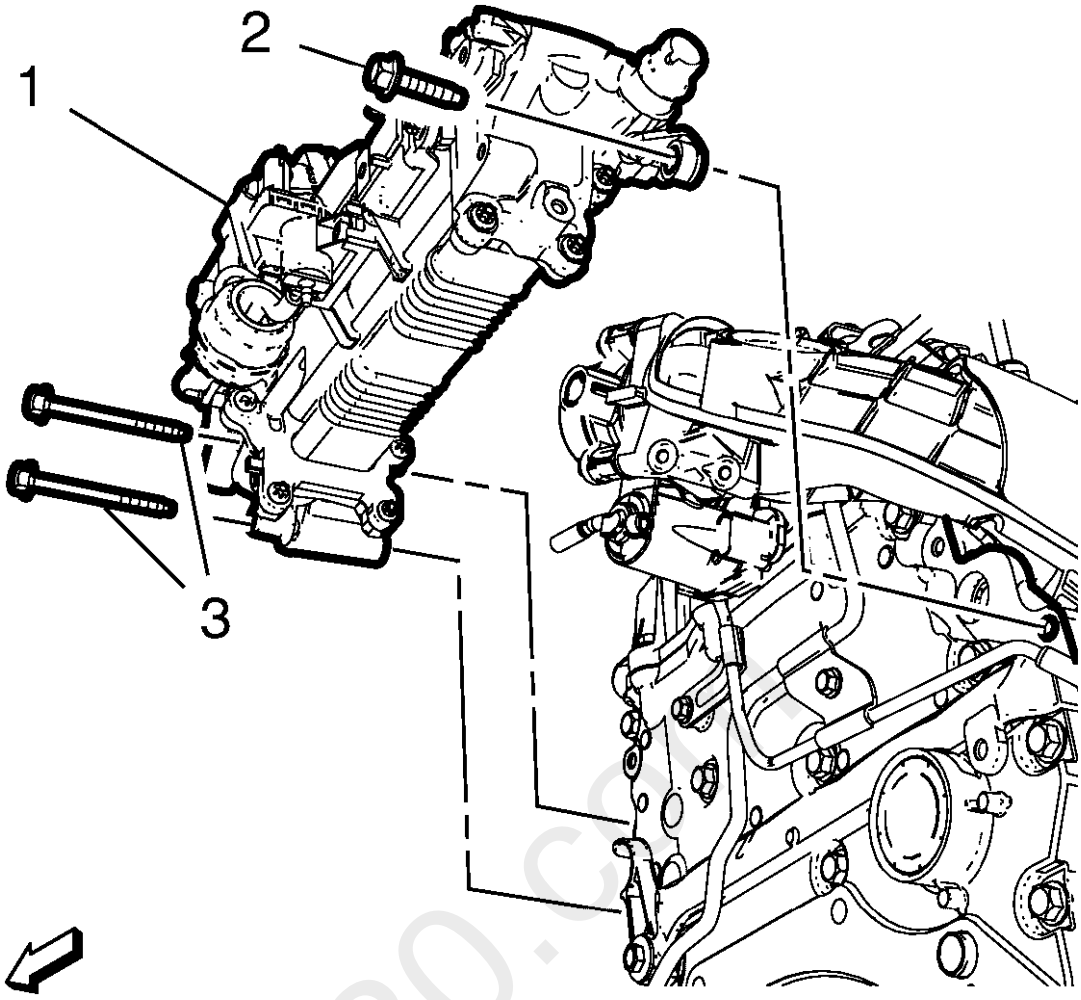


Fig. 127: Exhaust Gas Recirculation Cooler Housing
Courtesy of GENERAL MOTORS COMPANY

42. Install Exhaust Gas Recirculation Cooler Housing (1). Refer to **Exhaust Gas Recirculation Cooler Housing Replacement**

mc730.com

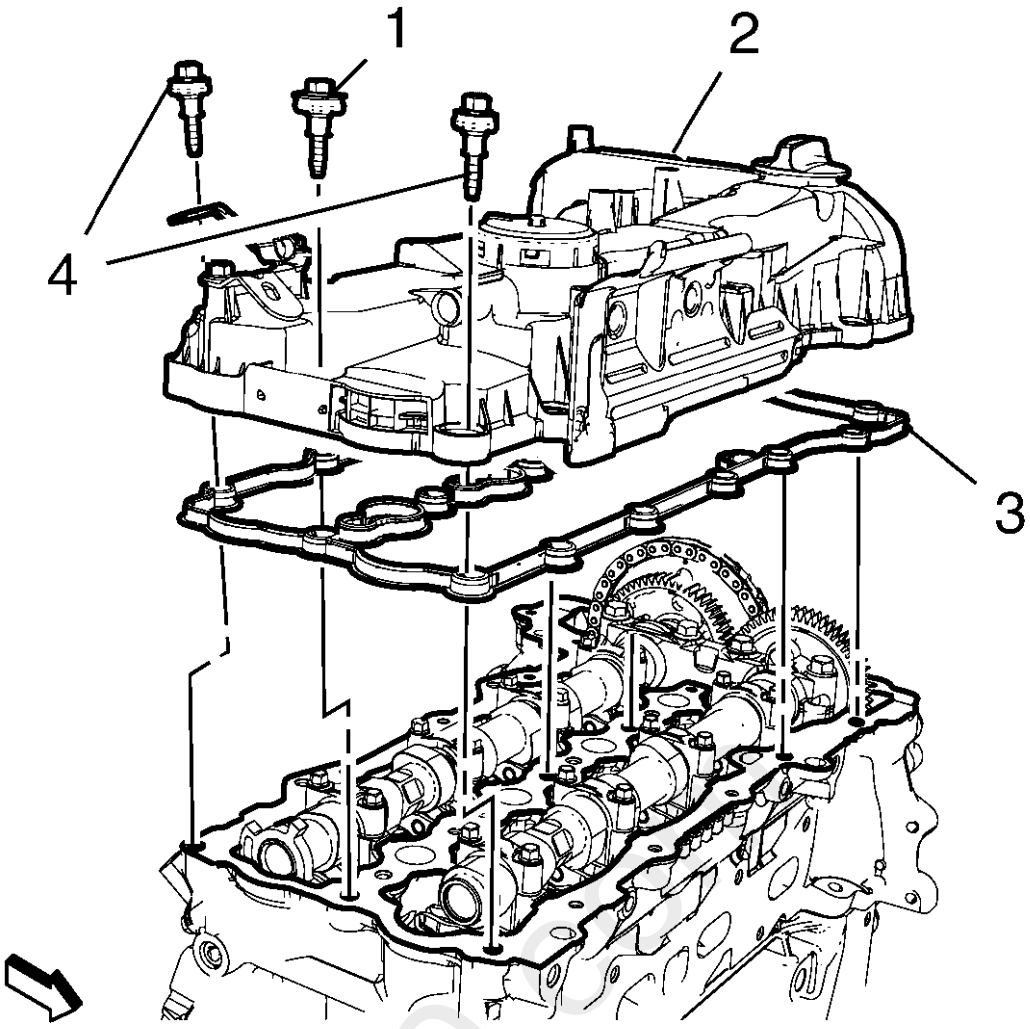


Fig. 128: Camshaft Housing, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

43. Install Camshaft Housing (2). Refer to **Camshaft Housing Replacement**

mcx30.com

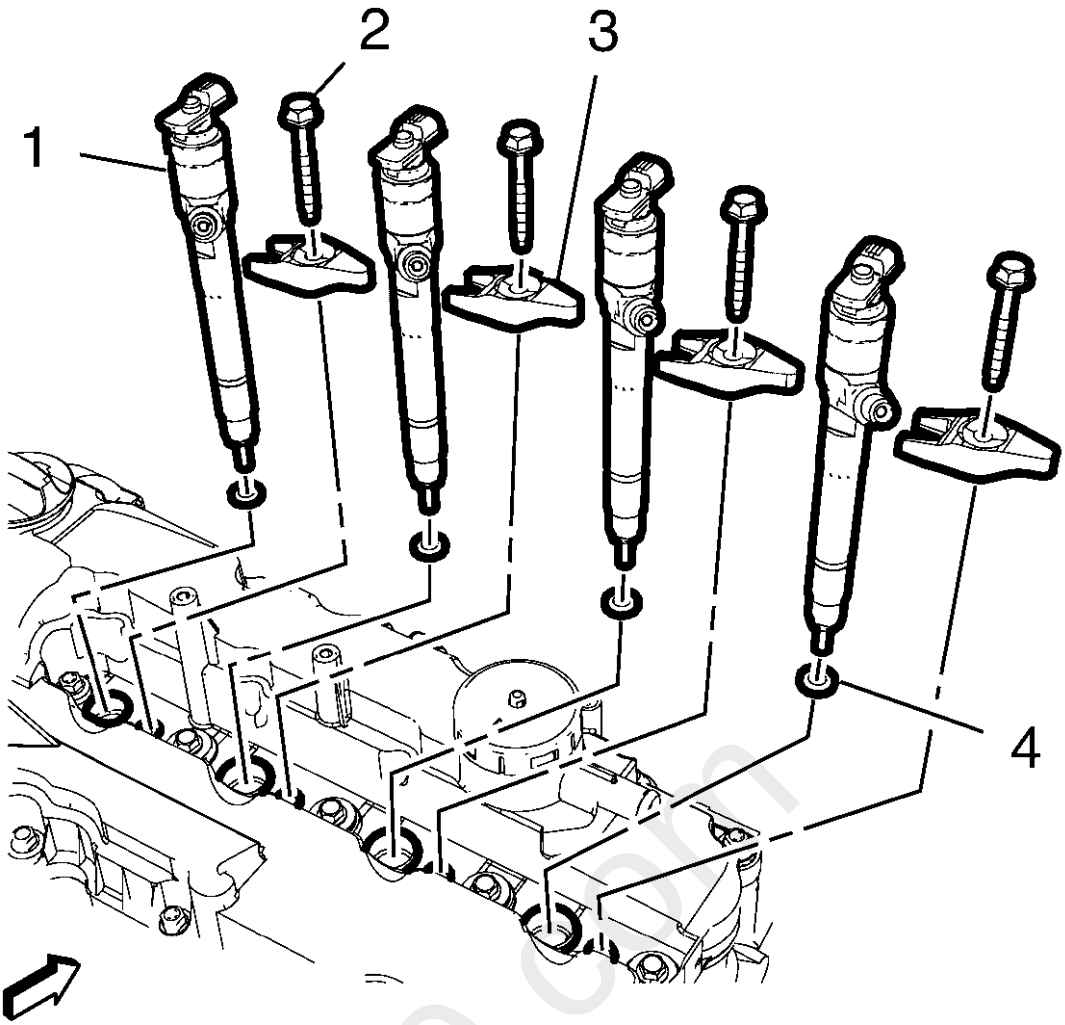


Fig. 129: Fuel Injectors, Bolts And Retainers
Courtesy of GENERAL MOTORS COMPANY

44. Install Fuel Injectors (1) (Qty: 4). Refer to **Fuel Injector Replacement**

CAMSHAFT SPROCKET REPLACEMENT

Special Tools

- **EN-50513** Fixing Pin
- **EN-51140** Crankshaft Fixing Tool
- **EN-51143** Camshaft Sprocket Fixing Tool

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

Removal Procedure

1. Remove the timing chain upper cover. Refer to **Timing Chain Upper Cover Replacement**.
2. Remove the crankshaft pulley. Refer to **Crankshaft Pulley Replacement**.

mcx30.com

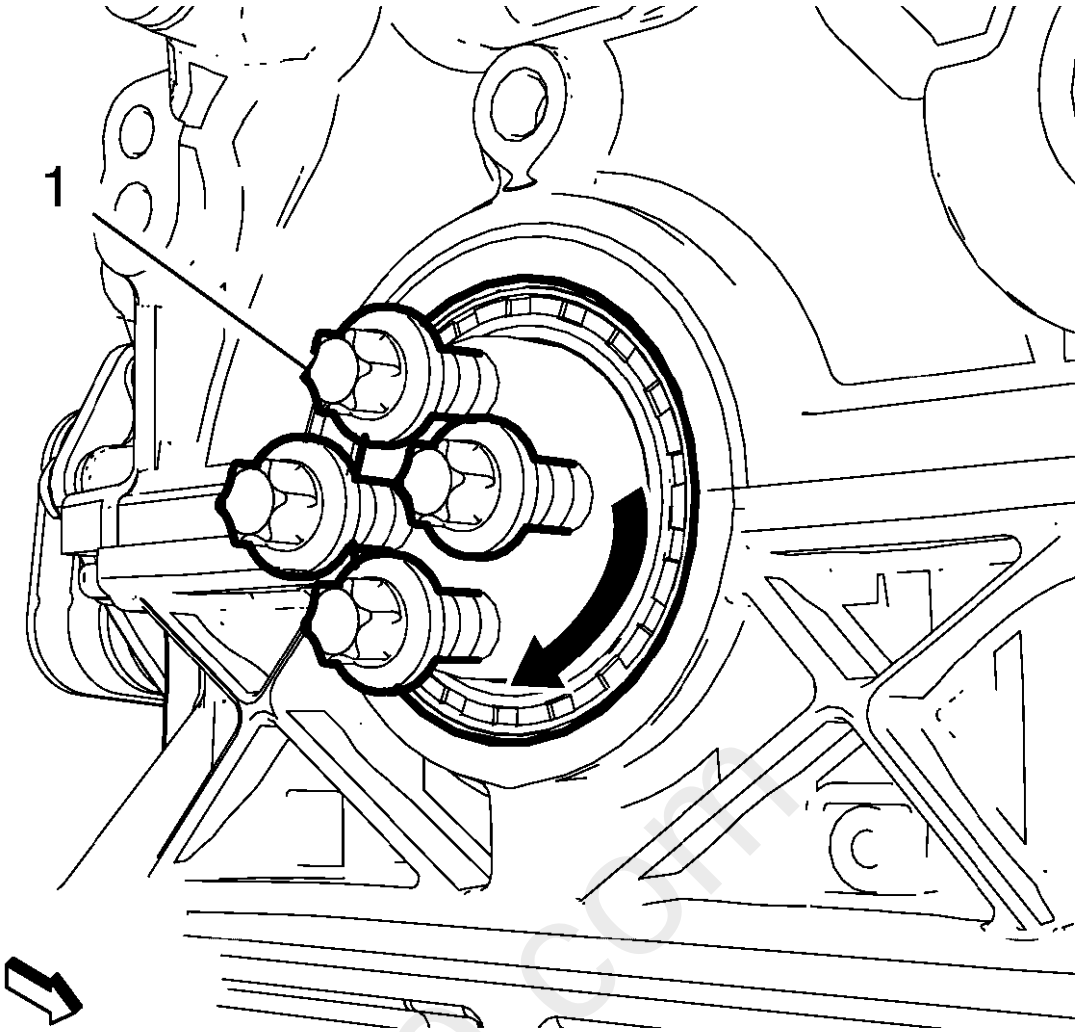


Fig. 130: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the 4 crankshaft pulley bolts (1).

mcx30.com

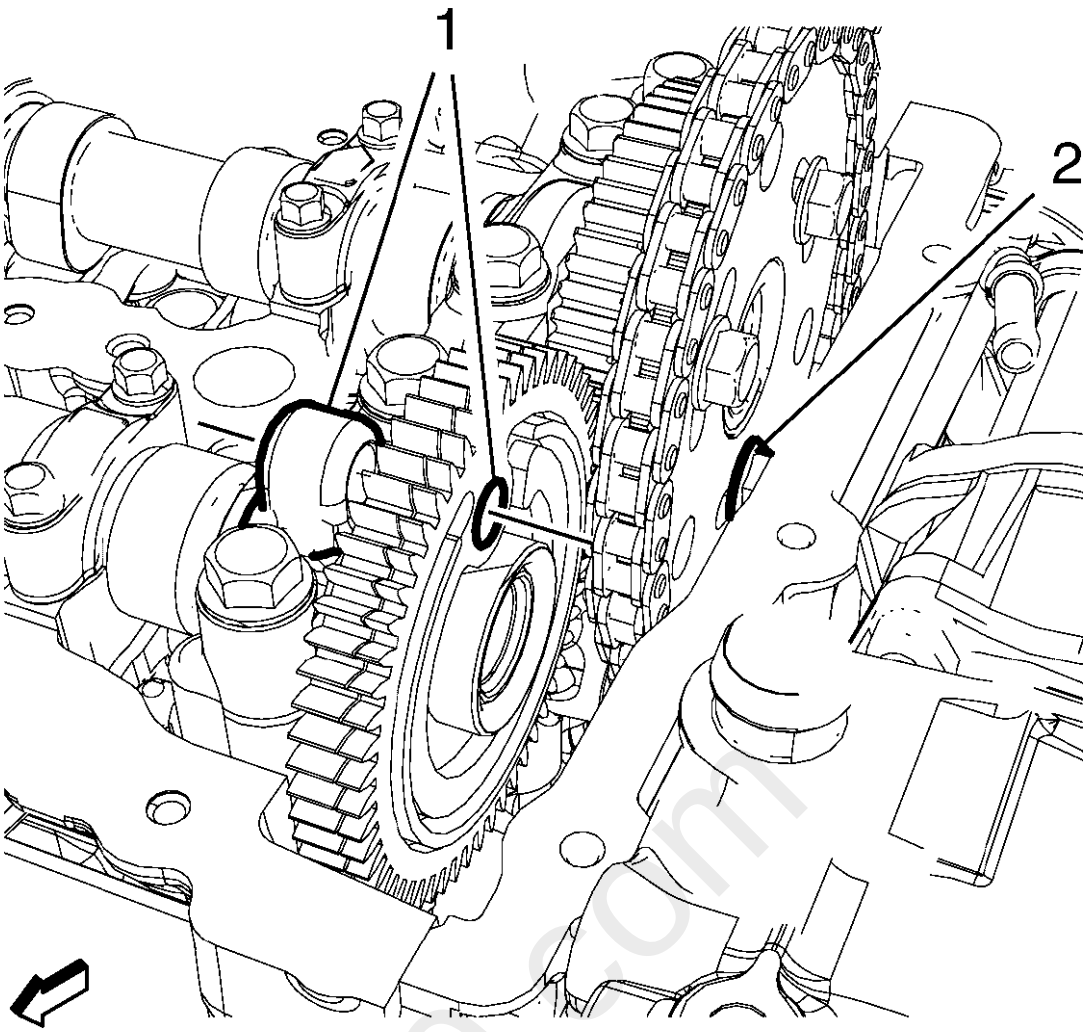


Fig. 131: Aligning Bores
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the bores not aligned turn the crankshaft at the crankshaft pulley bolts.**

mcx30.com

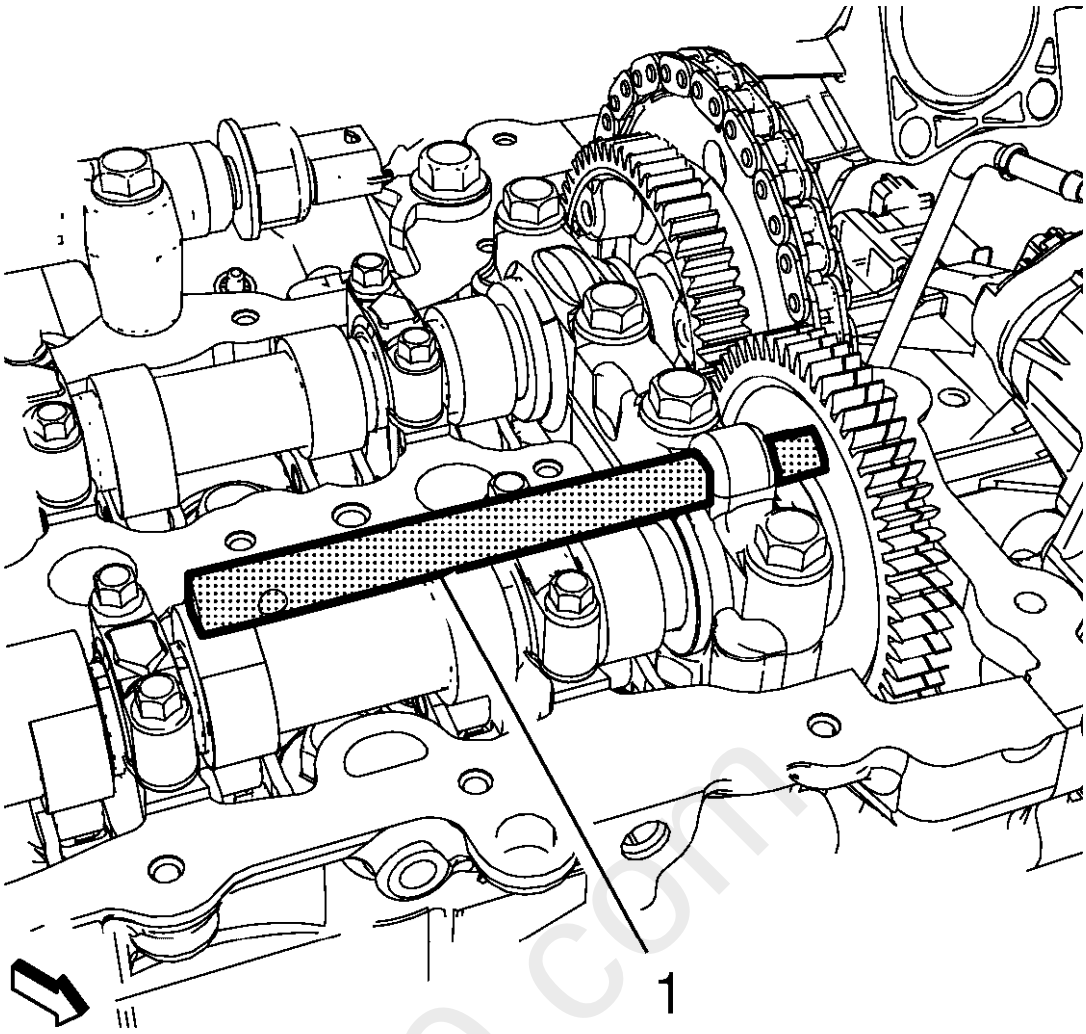


Fig. 132: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

4. Check if the bores (1) are aligned.

   Turn the exhaust camshaft at the hexagon so far if the **EN-51143** fixing tool (1) can be installed.

5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

mcx30.com

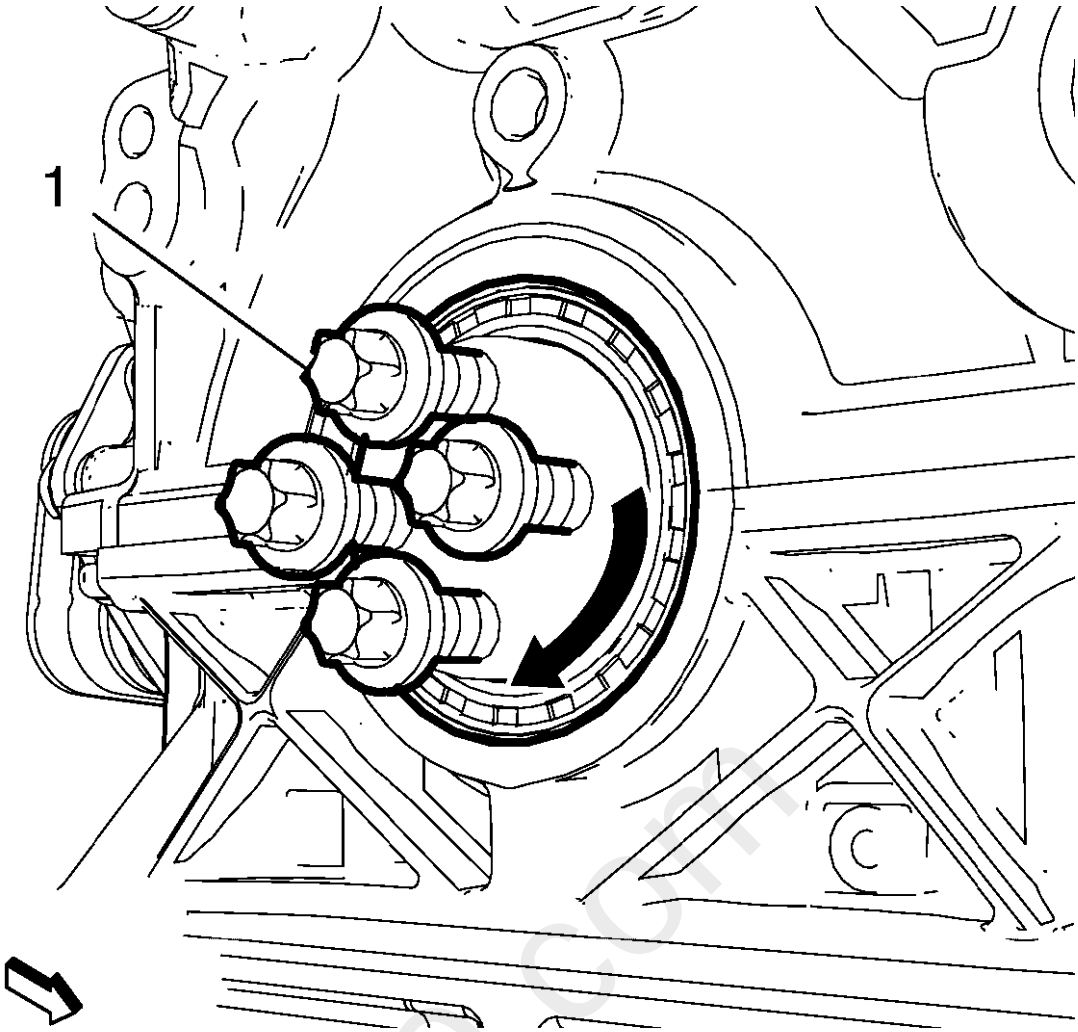


Fig. 133: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the 4 crankshaft pulley bolts (1).

mcx30.com

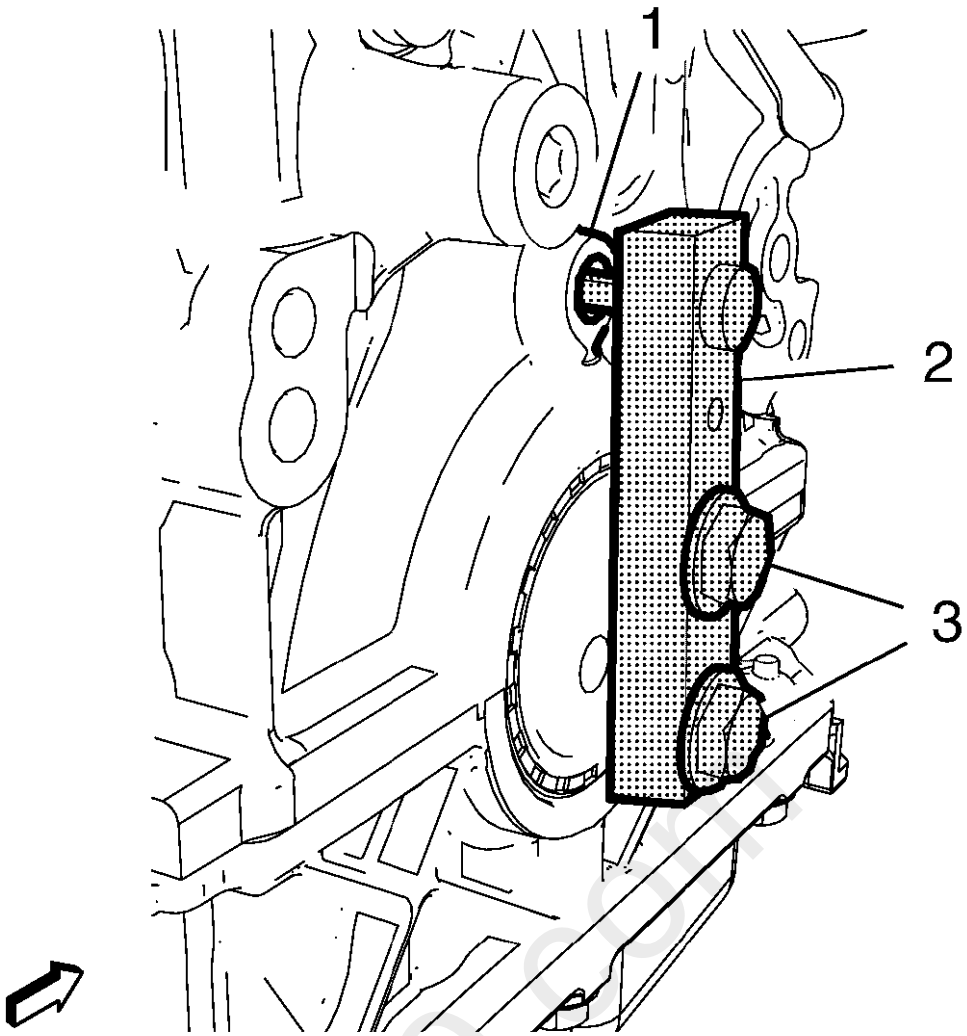


Fig. 134: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

7. Install **EN-51140** fixing tool (2).
8. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).
9. If the **EN-51140** fixing tool can not installed. Refer to **Camshaft Timing Chain Adjustment**.
10. Lower the vehicle.

mtx30.com

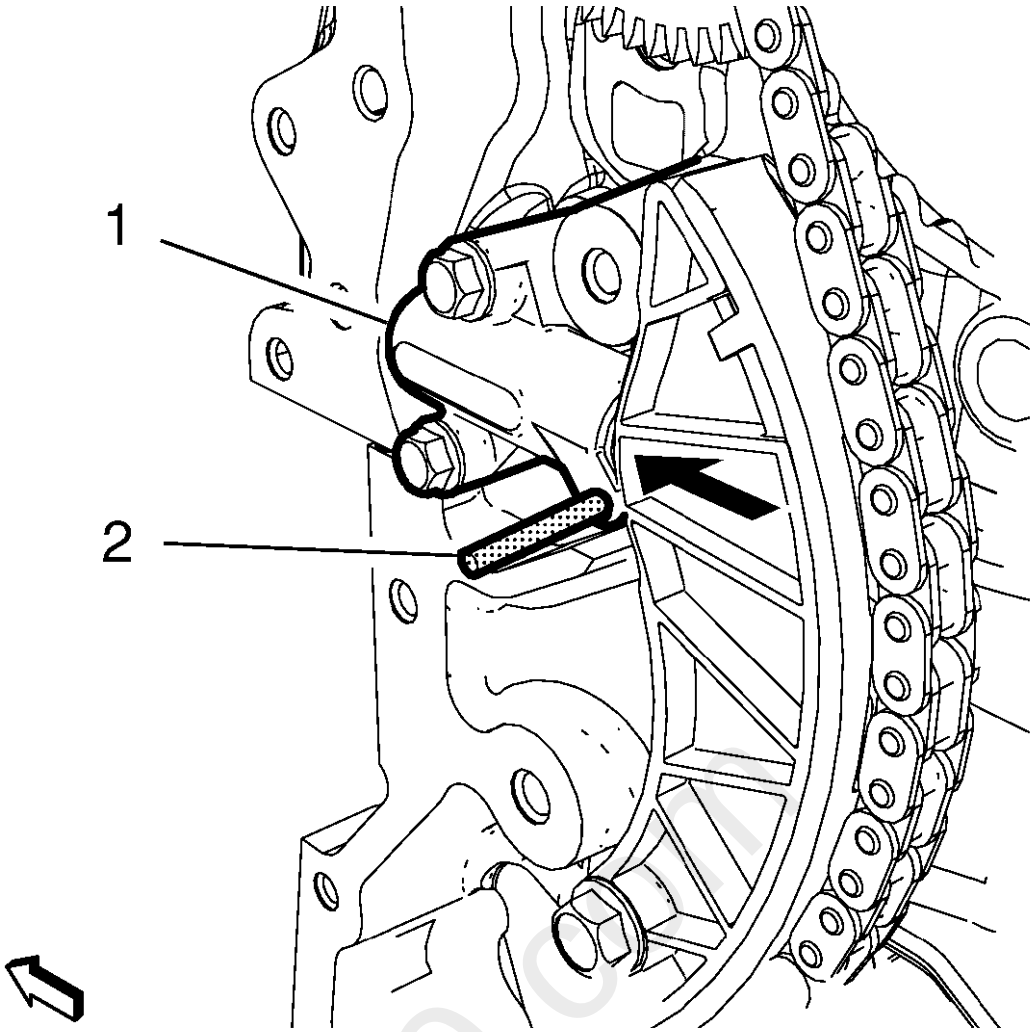


Fig. 135: Timing Chain Tensioner And Pin
Courtesy of GENERAL MOTORS COMPANY

11. Tension the timing chain tensioner (1) in arrow direction.
12. Install the **EN-50513** pin (2).

mcx30.com

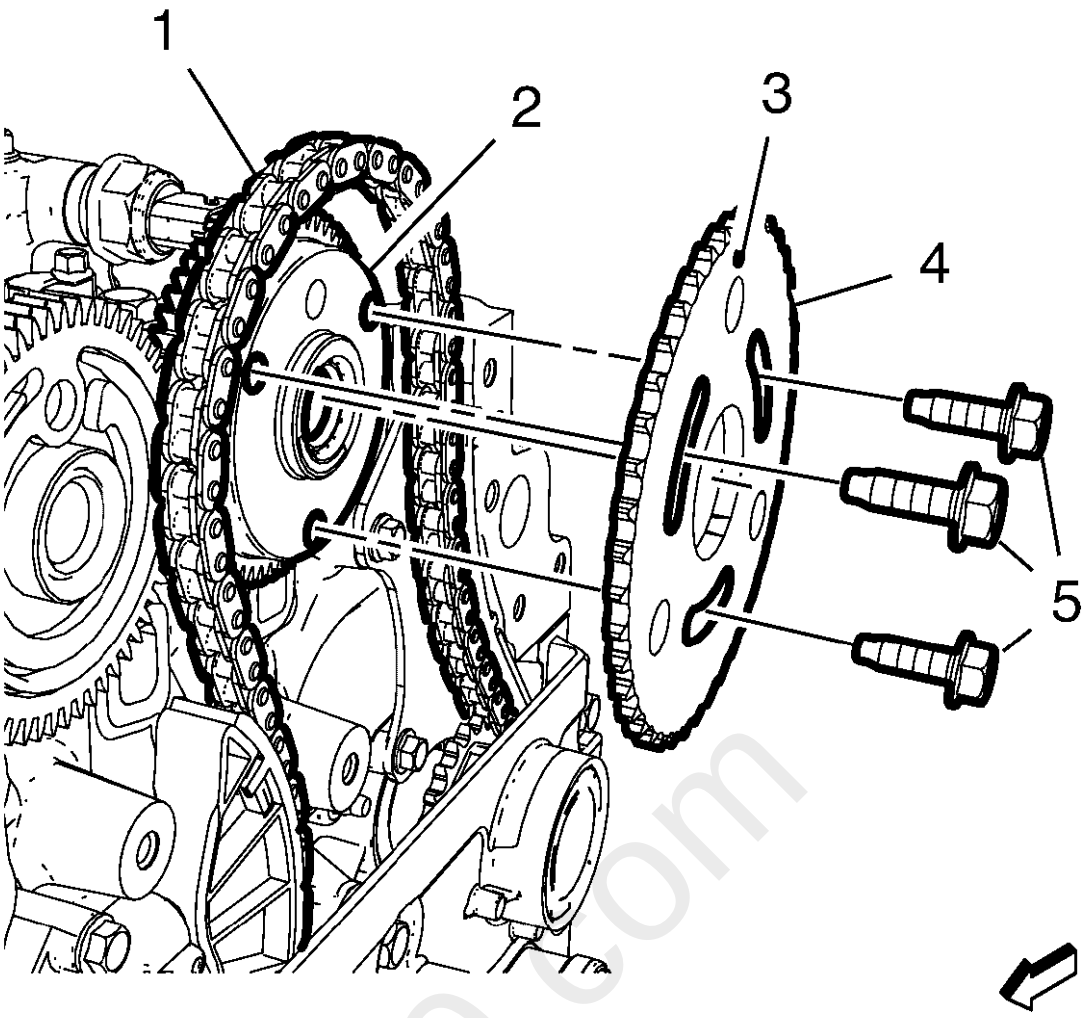


Fig. 136: Camshaft Sprocket, Bolts, Intake Camshaft And Timing Chain
Courtesy of GENERAL MOTORS COMPANY

13. Remove the 3 camshaft sprocket bolts (5), counterhold with a wrench at the camshaft hexagon.
14. Remove the camshaft sprocket (4) from the intake camshaft (2).
15. Deposit the camshaft timing chain (1) onto the upper timing chain cover.

Installation Procedure

NOTE: **Before installing the camshaft sprocket, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

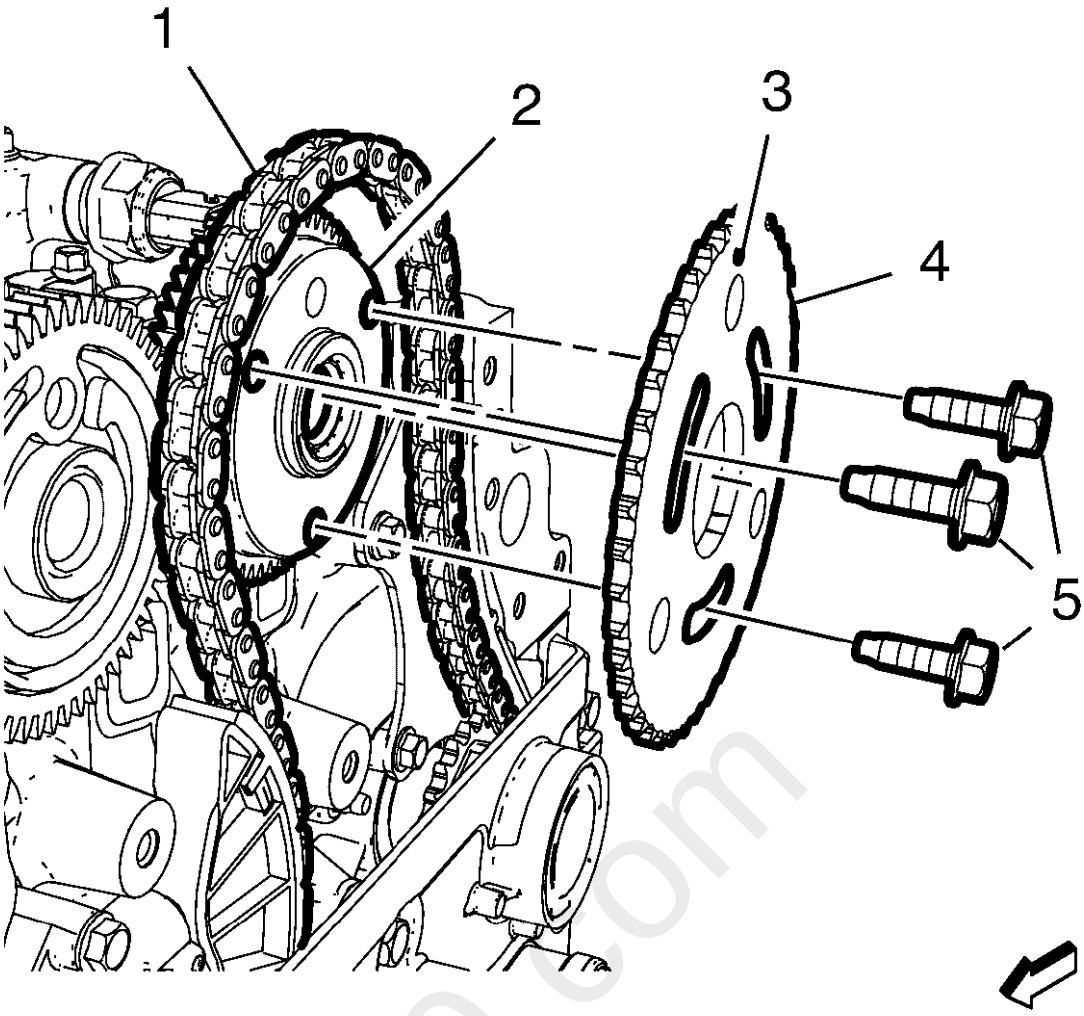


Fig. 137: Camshaft Sprocket, Bolts, Intake Camshaft And Timing Chain
Courtesy of GENERAL MOTORS COMPANY

2. Position the camshaft sprocket mark (3) at a 12 o'clock position and install the camshaft sprocket (4) to the camshaft timing chain (1).
3. Install the camshaft sprocket (3) to intake camshaft (2).

CAUTION: **Refer to Fastener Caution .**

4. Install the 3 camshaft sprocket bolts (5) and tighten to 25 N.m (18 lb ft), counterhold with a wrench at the camshaft hexagon.

mcx30.com

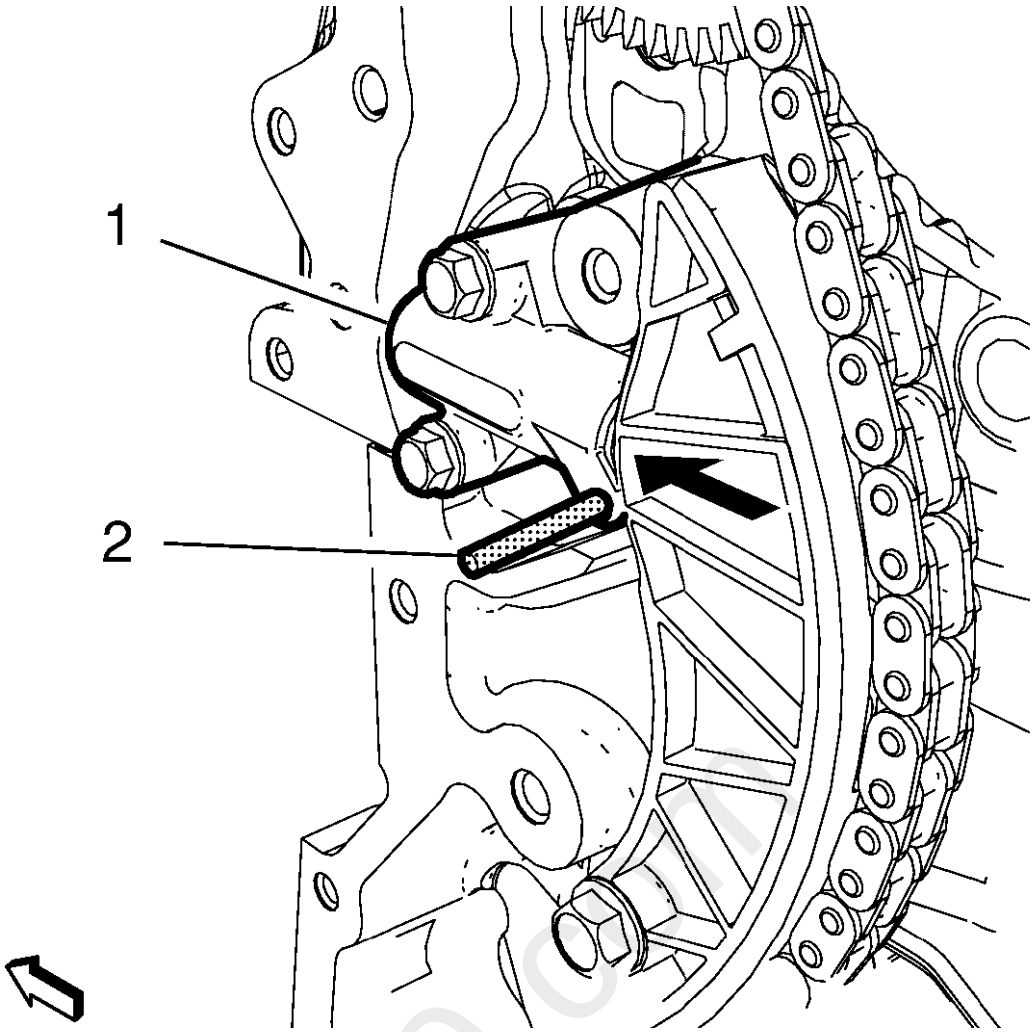


Fig. 138: Timing Chain Tensioner And Pin
Courtesy of GENERAL MOTORS COMPANY

5. Remove the **EN-50513** pin (2).

mcx30.com

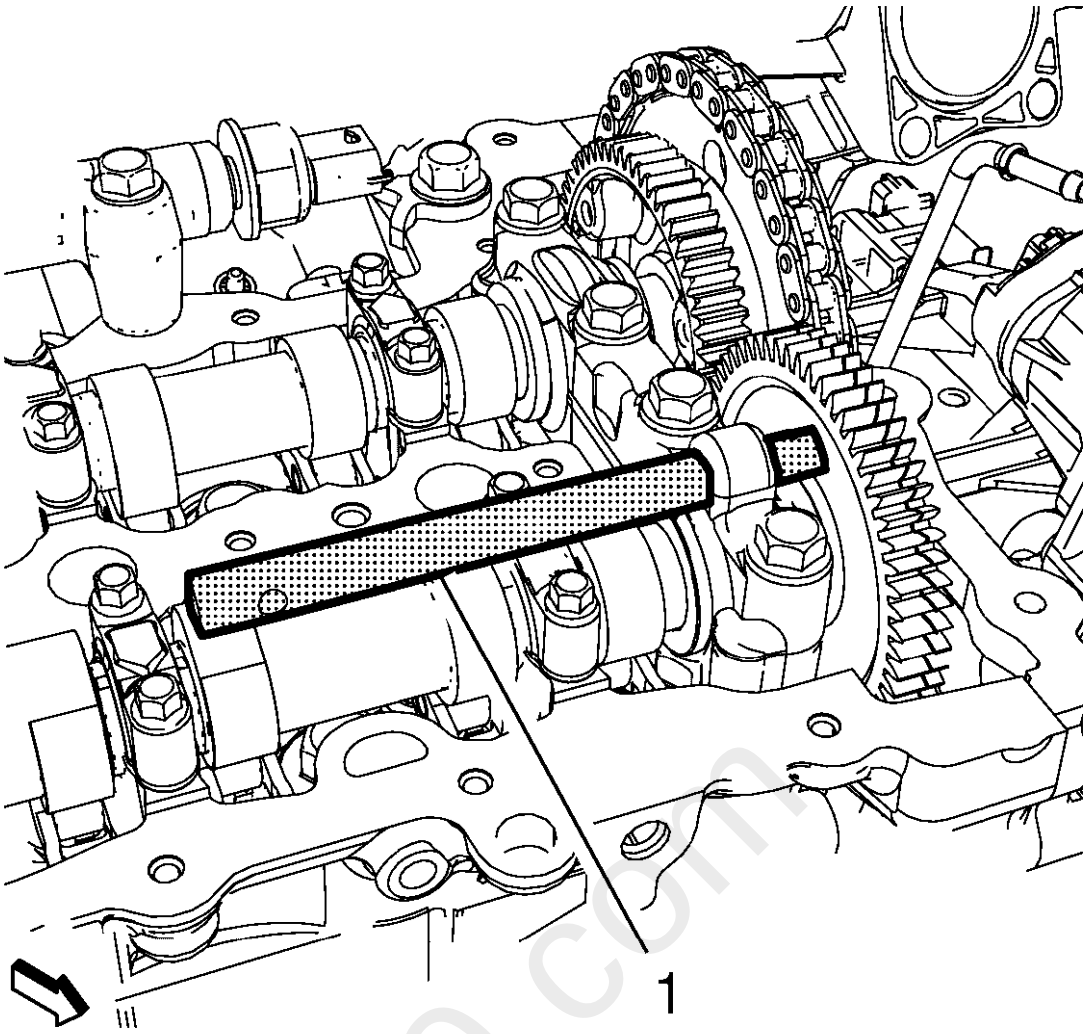


Fig. 139: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

6. Remove the **EN-51143** fixing tool (1).
7. Raise the vehicle.

mcx30.com

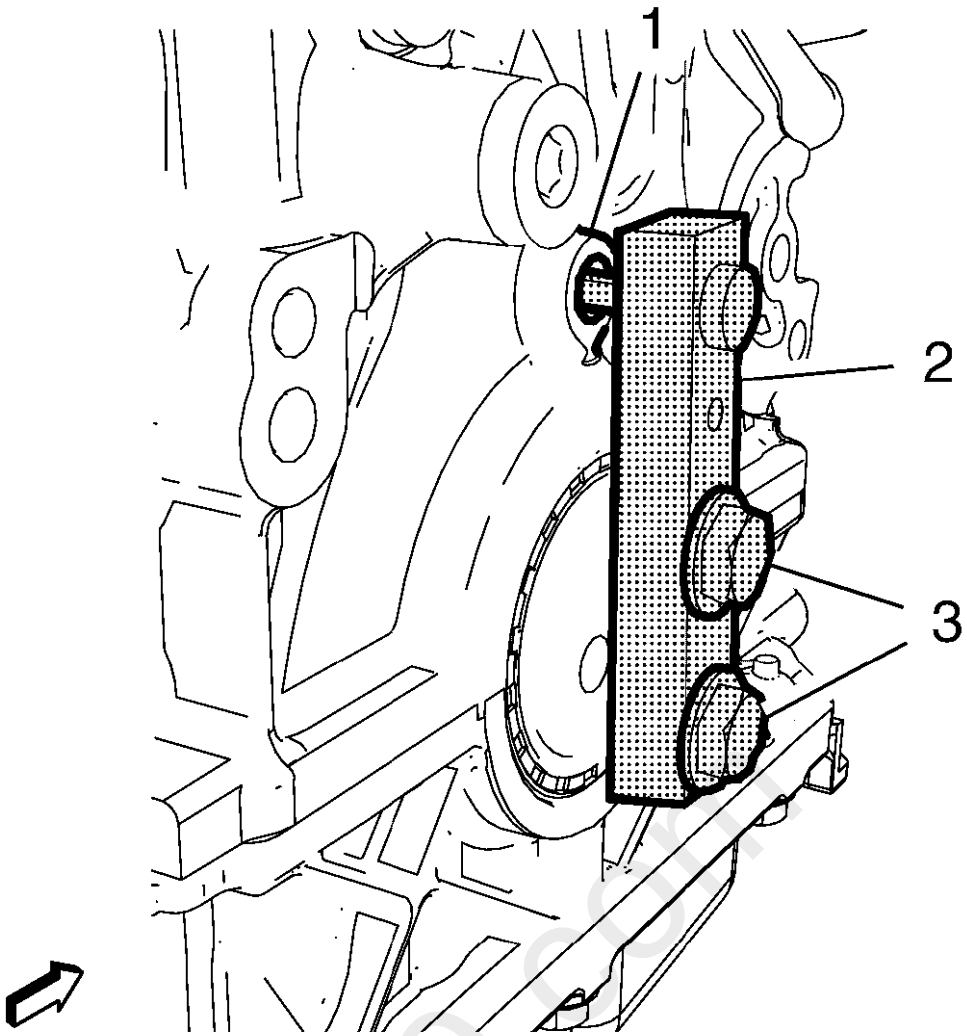


Fig. 140: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

8. Remove the 2 bolts (3).
9. Remove the **EN-51140** fixing tool (2).

mcx30.com

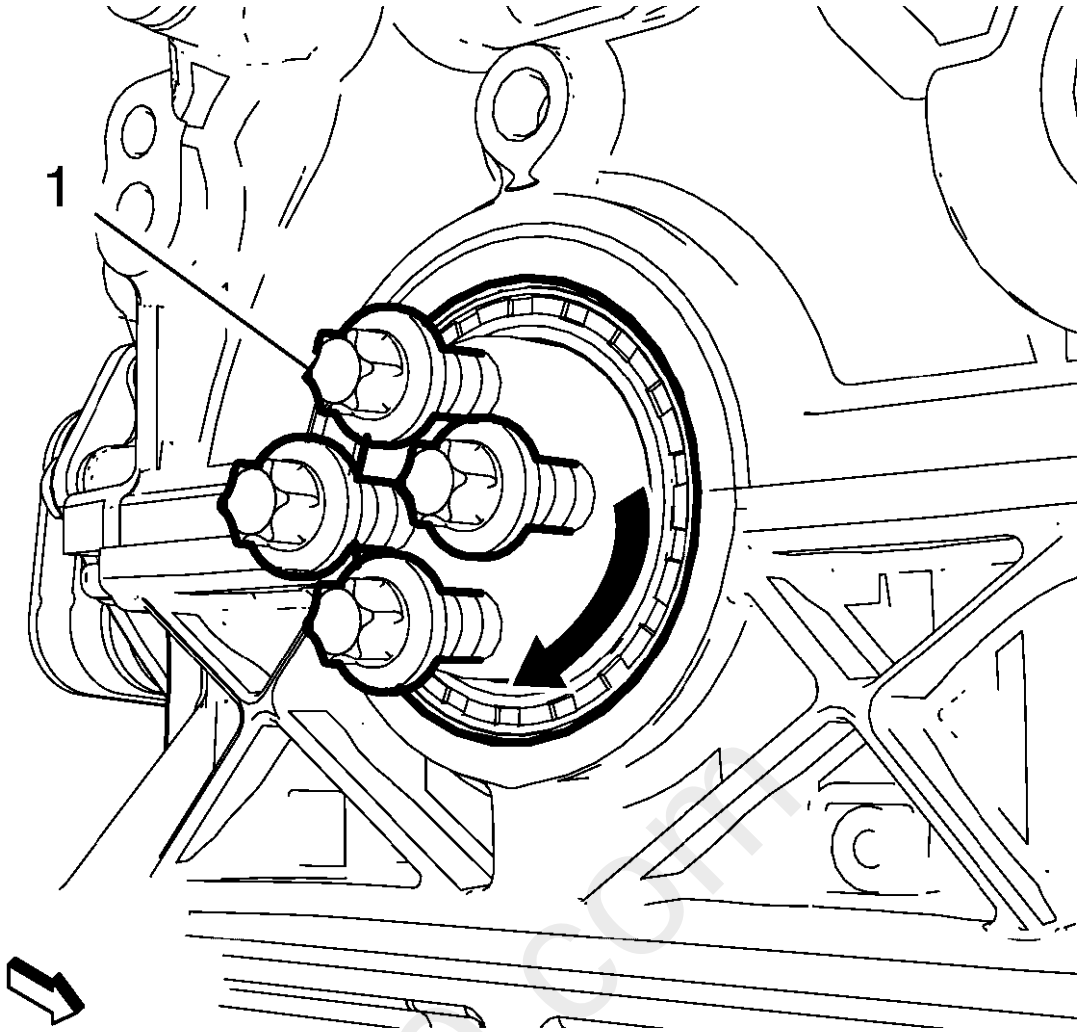


Fig. 141: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Install the 4 crankshaft pulley bolts (1).

    Rotate the crankshaft 720 degrees in direction of arrow. Use a pry bar at the 4 crankshaft pulley bolts (1).

11. Remove the 4 crankshaft pulley bolts (1).
12. Check the camshaft timing. Refer to **Camshaft Timing Chain Inspection**.
13. Install the crankshaft pulley. Refer to **Crankshaft Pulley Replacement**.
14. Install the timing chain upper cover. Refer to **Timing Chain Upper Cover Replacement**

CAMSHAFT REPLACEMENT

Special Tools

- **EN-50509** Split Intake Camshaft Sprocket Fixing Tool
- **EN-51140** Crankshaft Fixing Tool
- **EN-51143** Camshaft Sprocket Fixing Tool
- **EN-51188** Timing Chain Camshaft Sprocket Fixing Tool

Equivalent regional tools: **Special Tools**

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Throttle Body Assembly. Refer to **Throttle Body Assembly Replacement**
3. Remove Camshaft Housing. Refer to **Camshaft Housing Replacement**

mcx30.com

4. Remove Crankshaft Pulley. Refer to **Crankshaft Pulley Replacement**
5. Lower the vehicle. Refer to **Lifting and Jacking the Vehicle**

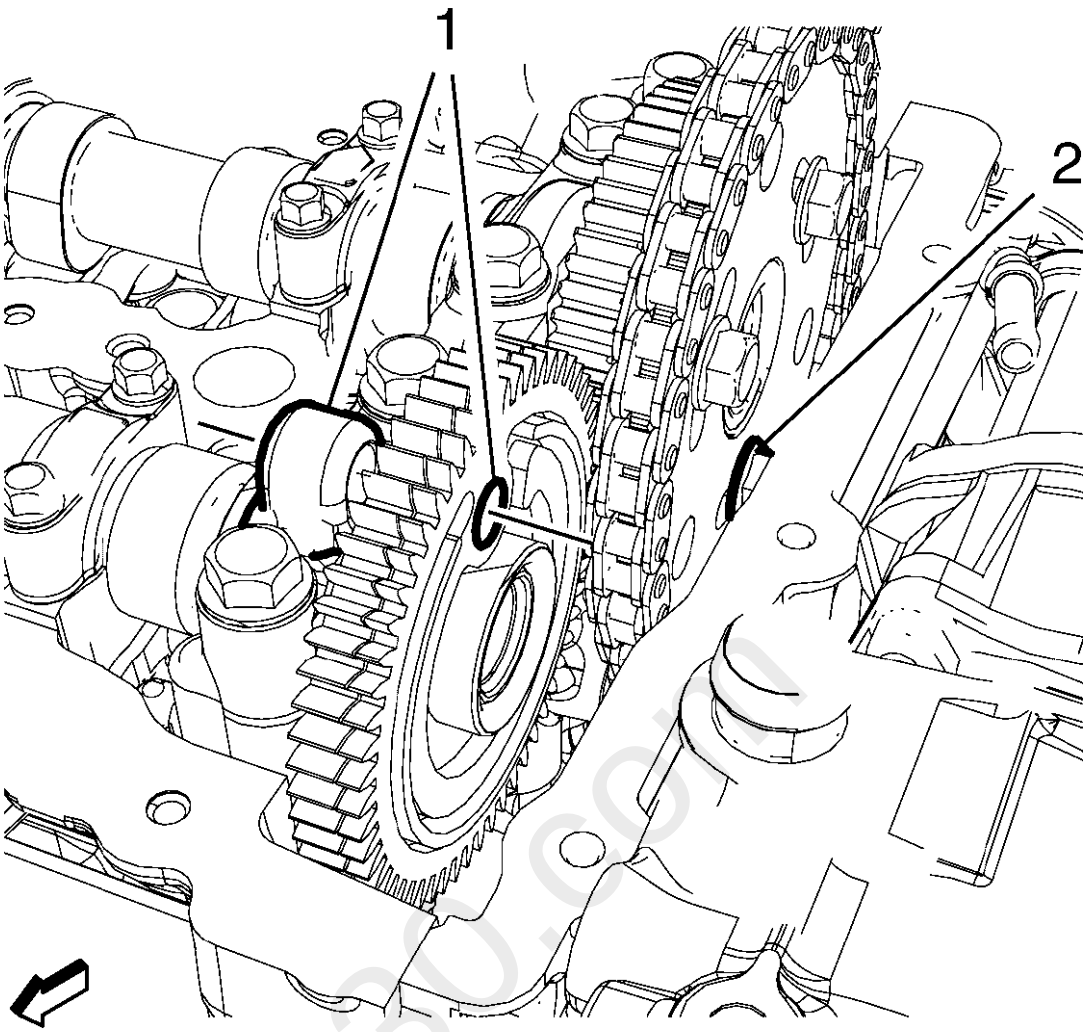


Fig. 142: Aligning Bores
Courtesy of GENERAL MOTORS COMPANY

NOTE: **To locate the correct camshaft sprocket bolt (2) check the TDC position.**

6. Check if the bores (1) are aligned.
7. Raise the vehicle.

mcx30.com

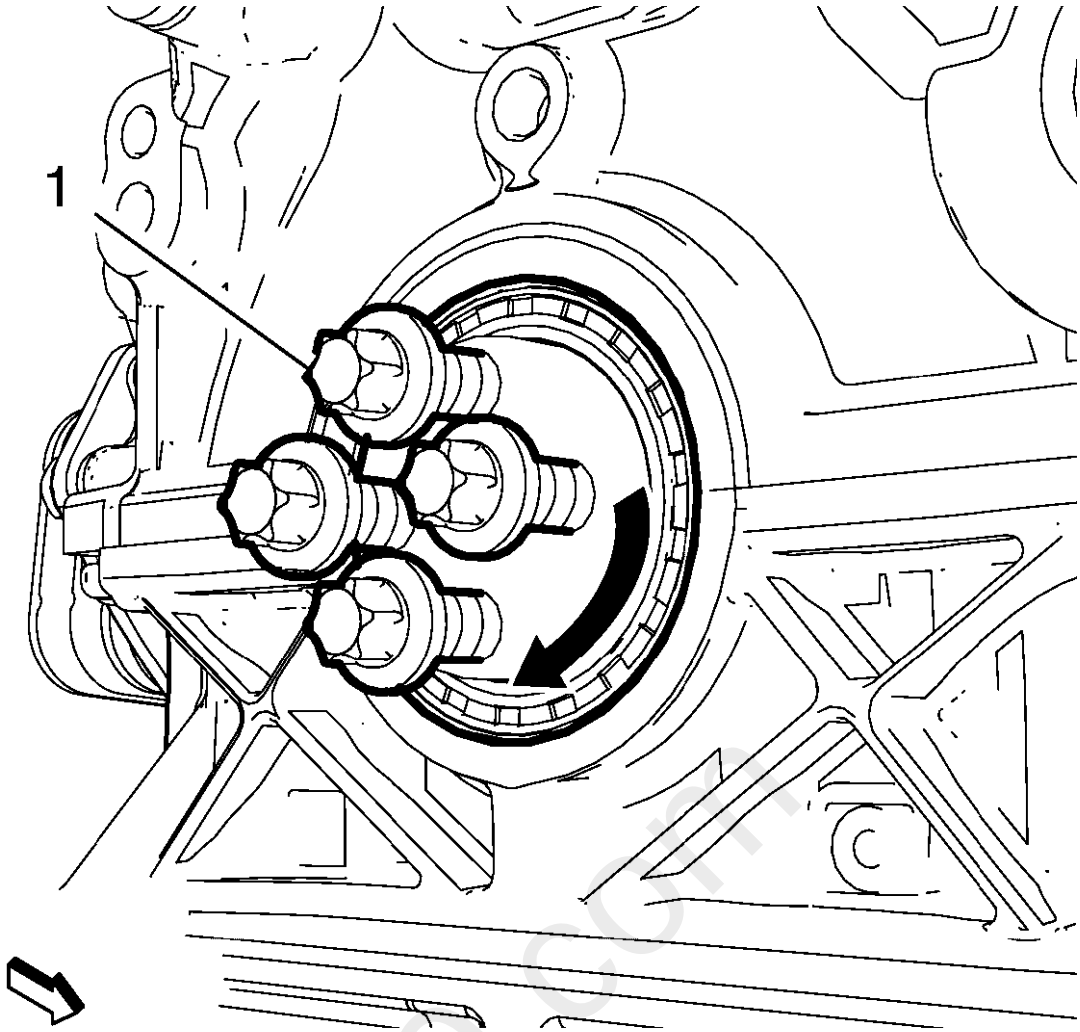


Fig. 143: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the 4 crankshaft pulley bolts (1).
9. Rotate the crankshaft 360 degrees in direction of arrow. Use a pry bar.
10. Lower the vehicle.

mcx30.com

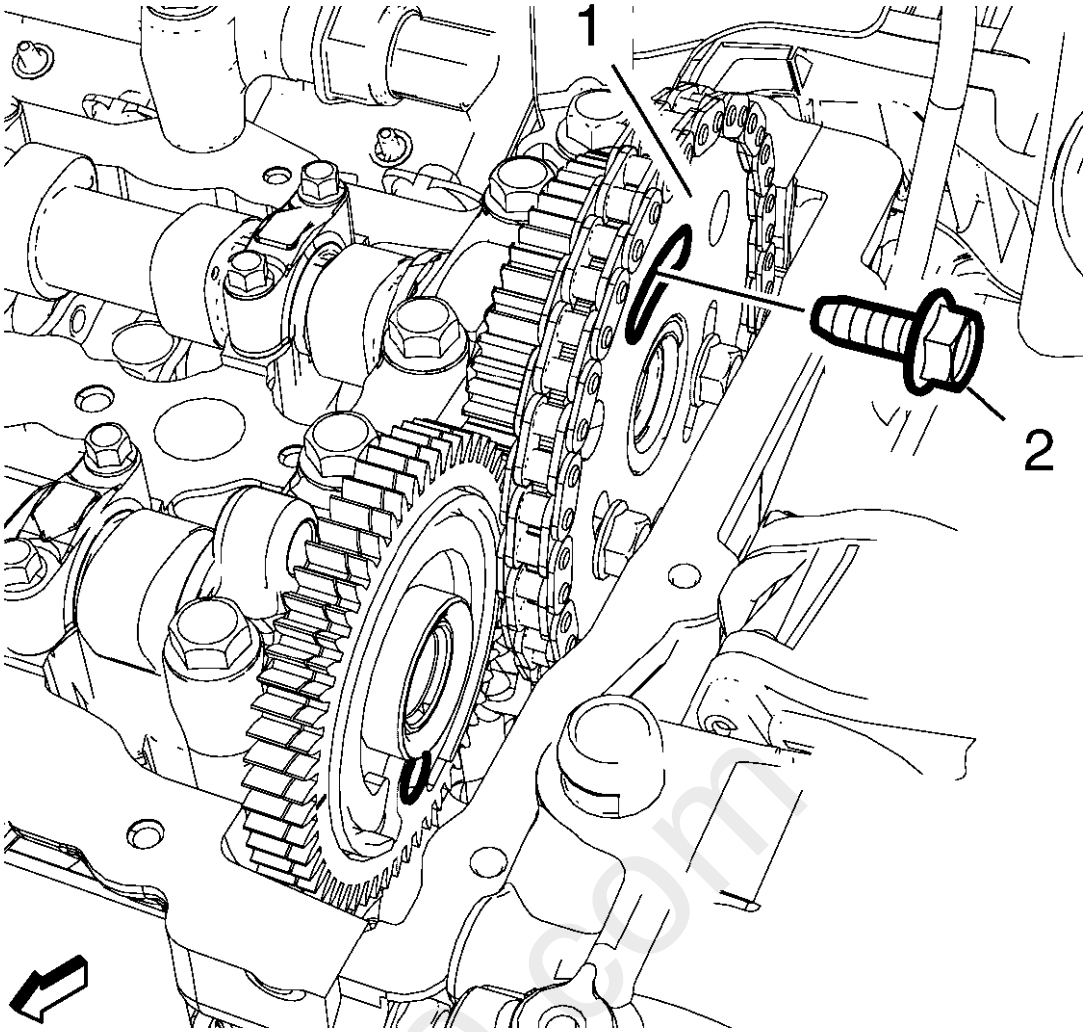


Fig. 144: Camshaft Sprocket And Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Cover the timing case with a lint-free cloth.**

11. Remove the camshaft sprocket bolt (2) from the intake camshaft sprocket (1). Counterhold with a wrench at the camshaft hexagon.
12. Raise the vehicle.

mcx30.com

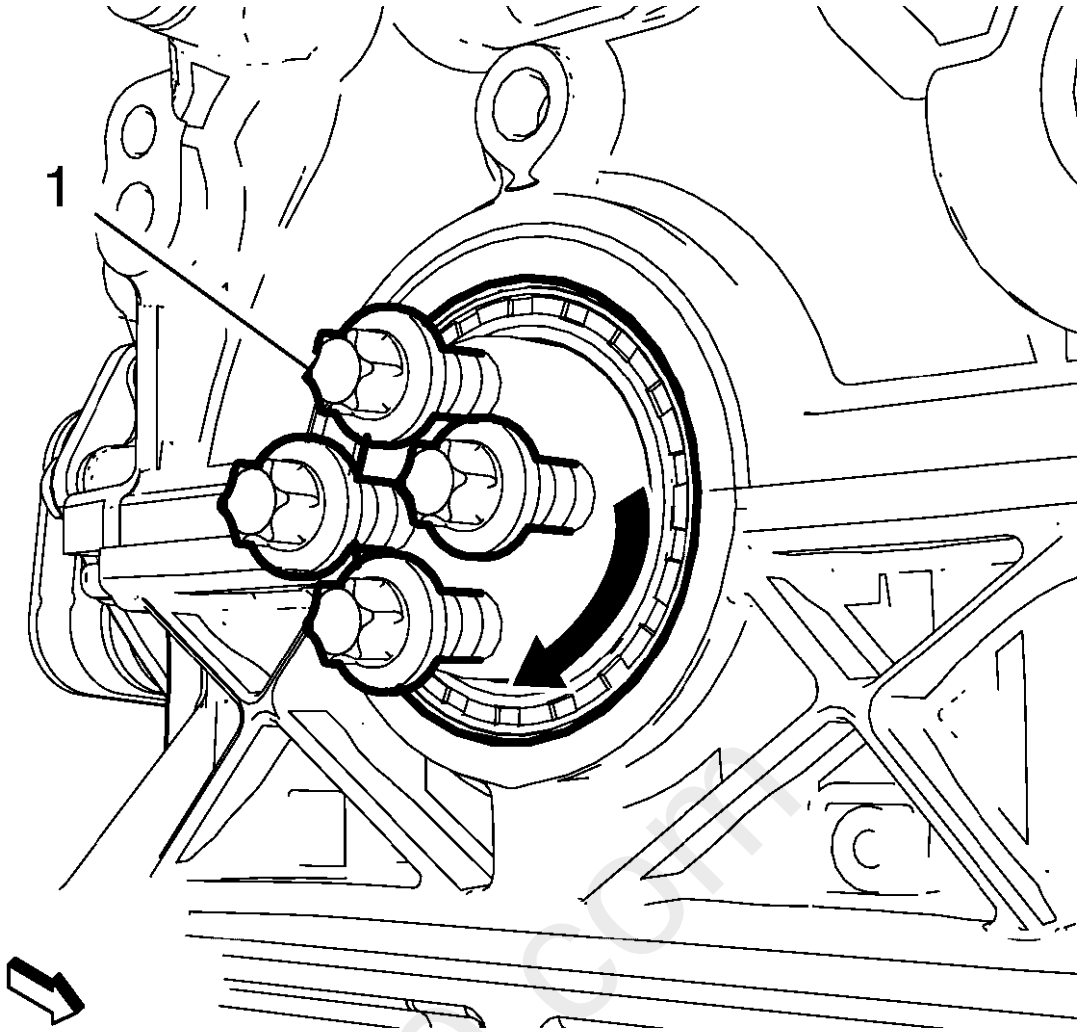


Fig. 145: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Rotate the crankshaft 360 degrees in direction of arrow. Use a pry bar at the 4 crankshaft pulley bolts (1).
14. Remove the 4 crankshaft pulley bolts (1).

mcx30.com

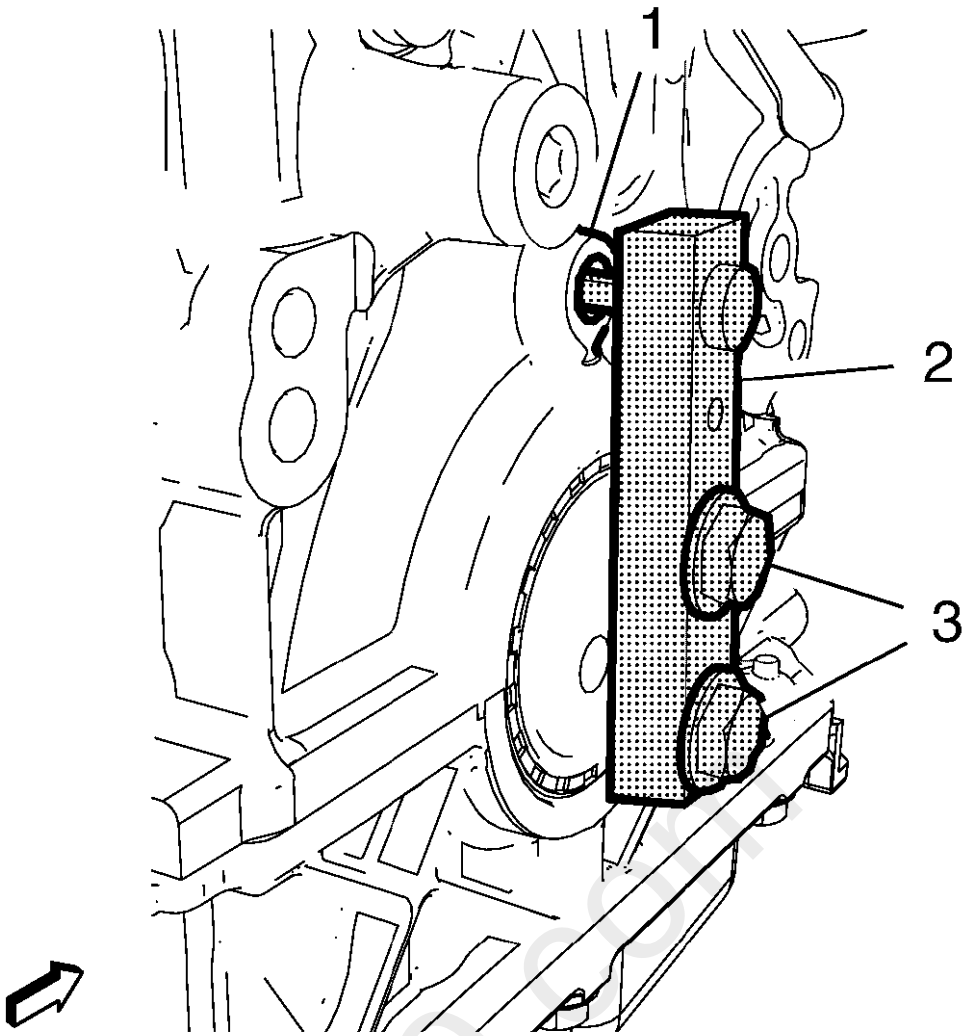


Fig. 146: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

15. Install the **EN-51140** fixing tool (2).
16. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).
17. Lower the vehicle.

mcx30.com

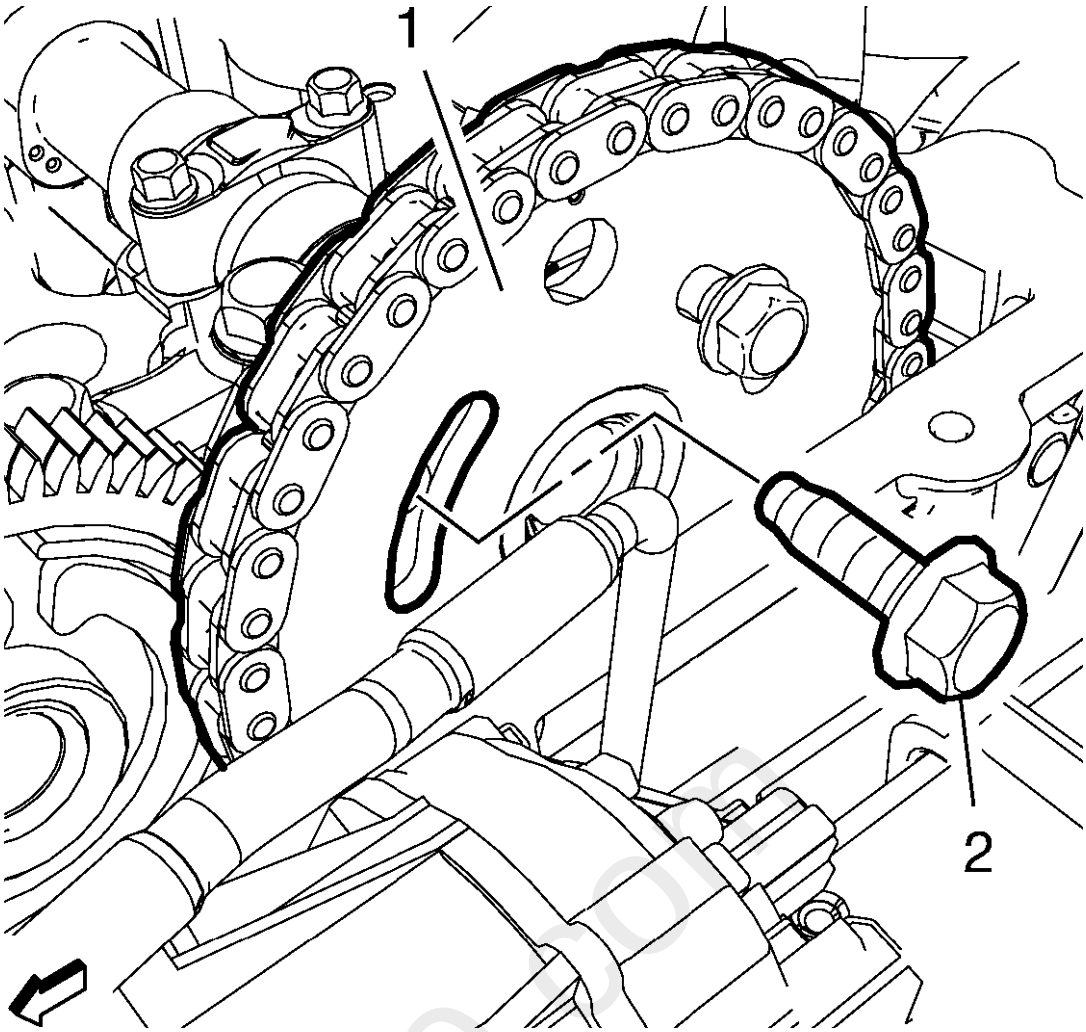


Fig. 147: Camshaft Sprocket And Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Cover the timing case with a lint-free cloth.**

18. Remove the camshaft sprocket bolt (2) from the camshaft sprocket (1). Counterhold with a wrench at the camshaft hexagon.

mcx30.com

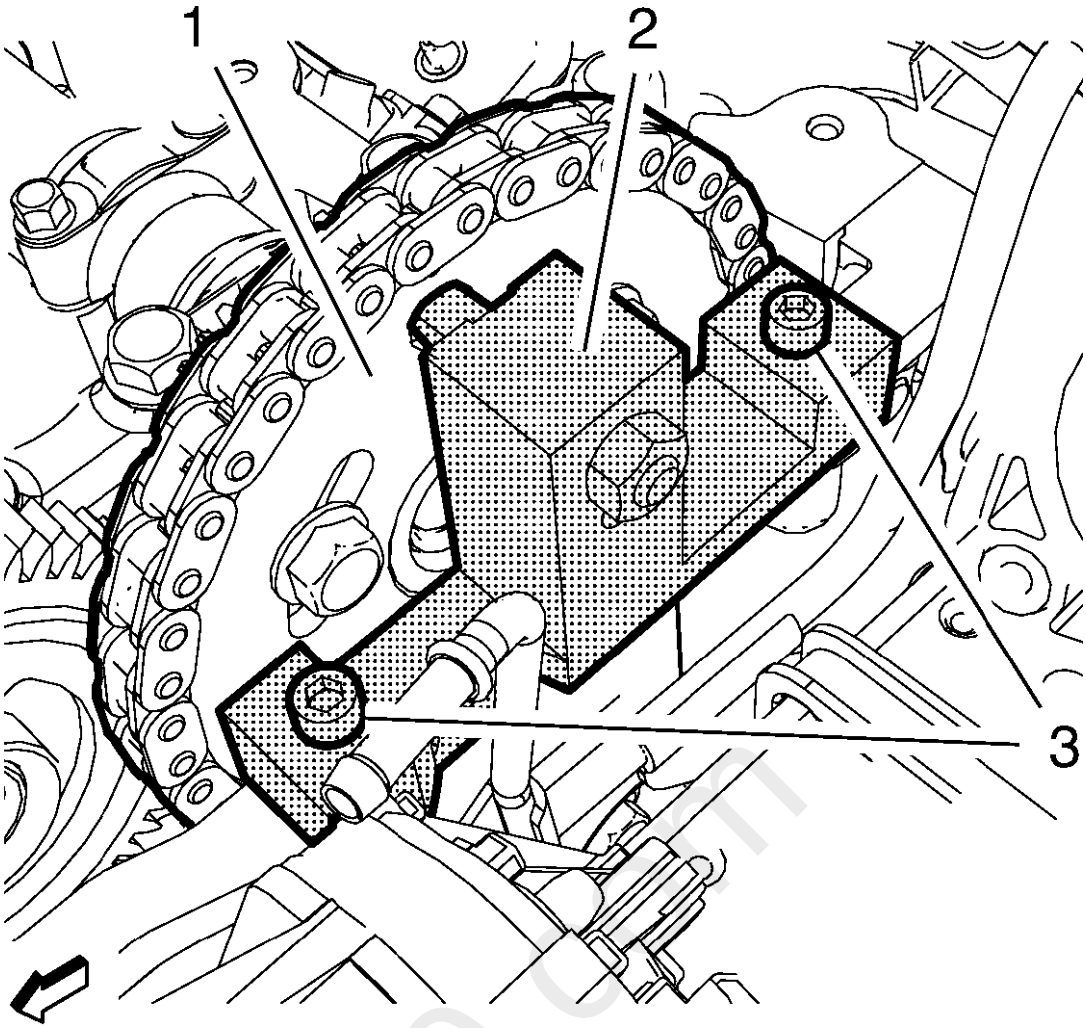


Fig. 148: Timing Chain Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

19. Install the **EN-51188** fixing tool (2) to fix the camshaft sprocket (1).
20. Install the 2 bolts (3).

mcx30.com

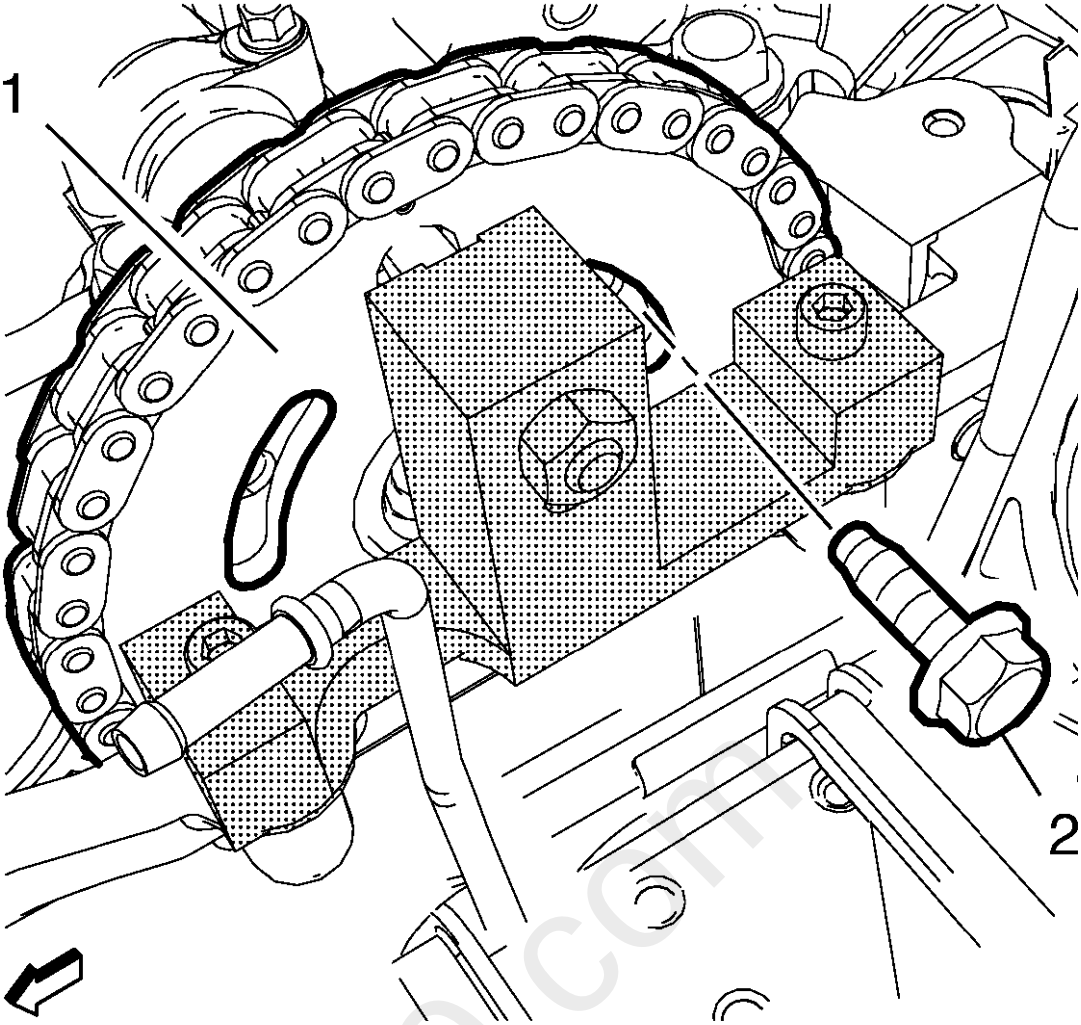


Fig. 149: Camshaft Sprocket And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Cover the timing case with a lint-free cloth.**

21. Remove the camshaft sprocket bolt (2) from the camshaft sprocket (1). Counterhold with a wrench at the camshaft hexagon.

mcx30.com

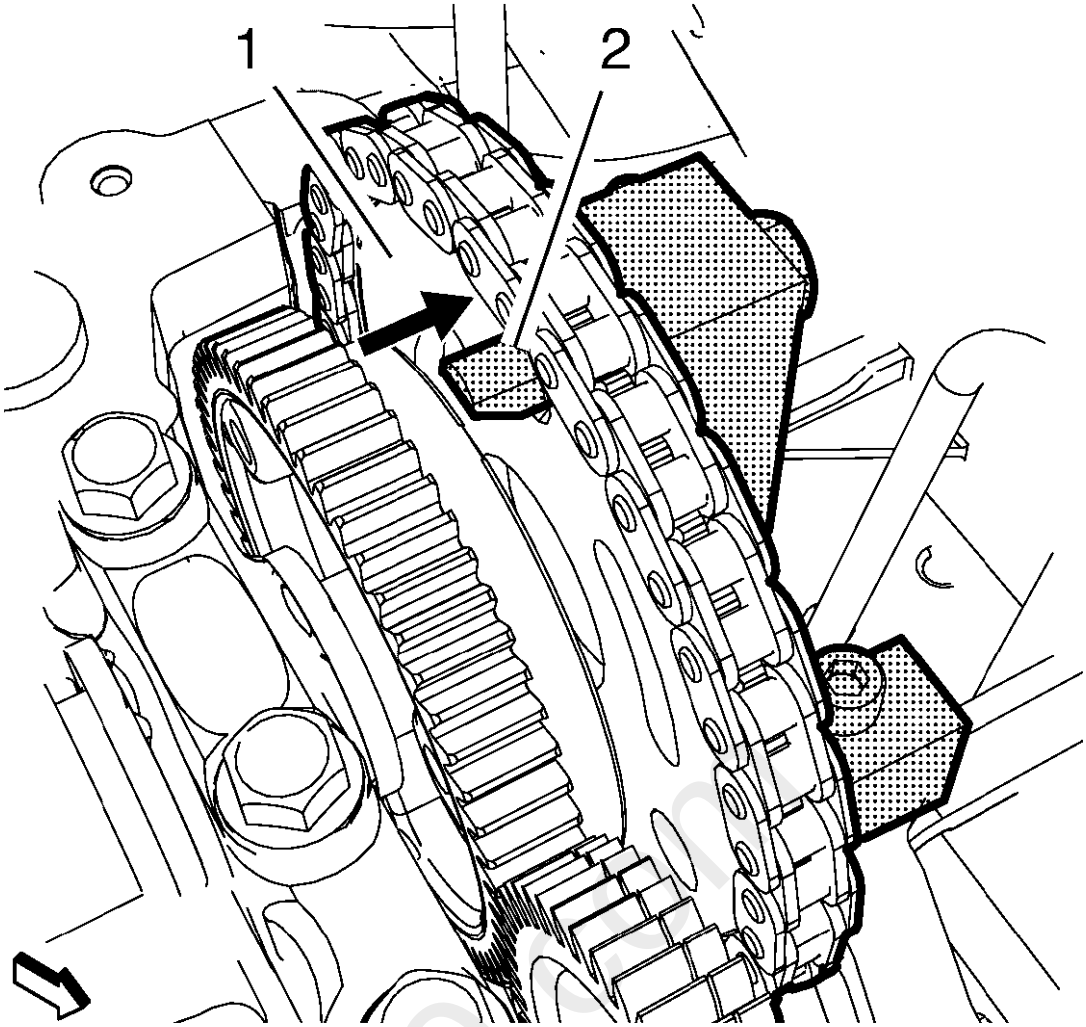


Fig. 150: Camshaft Sprocket Over Pin Of Timing Chain Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not move the camshaft sprocket onto the EN-51188 fixing tool if the intake camshaft was removed.**

22. Slide the camshaft sprocket (1) over the pin (2) of the **EN-51188** fixing tool in arrow direction.

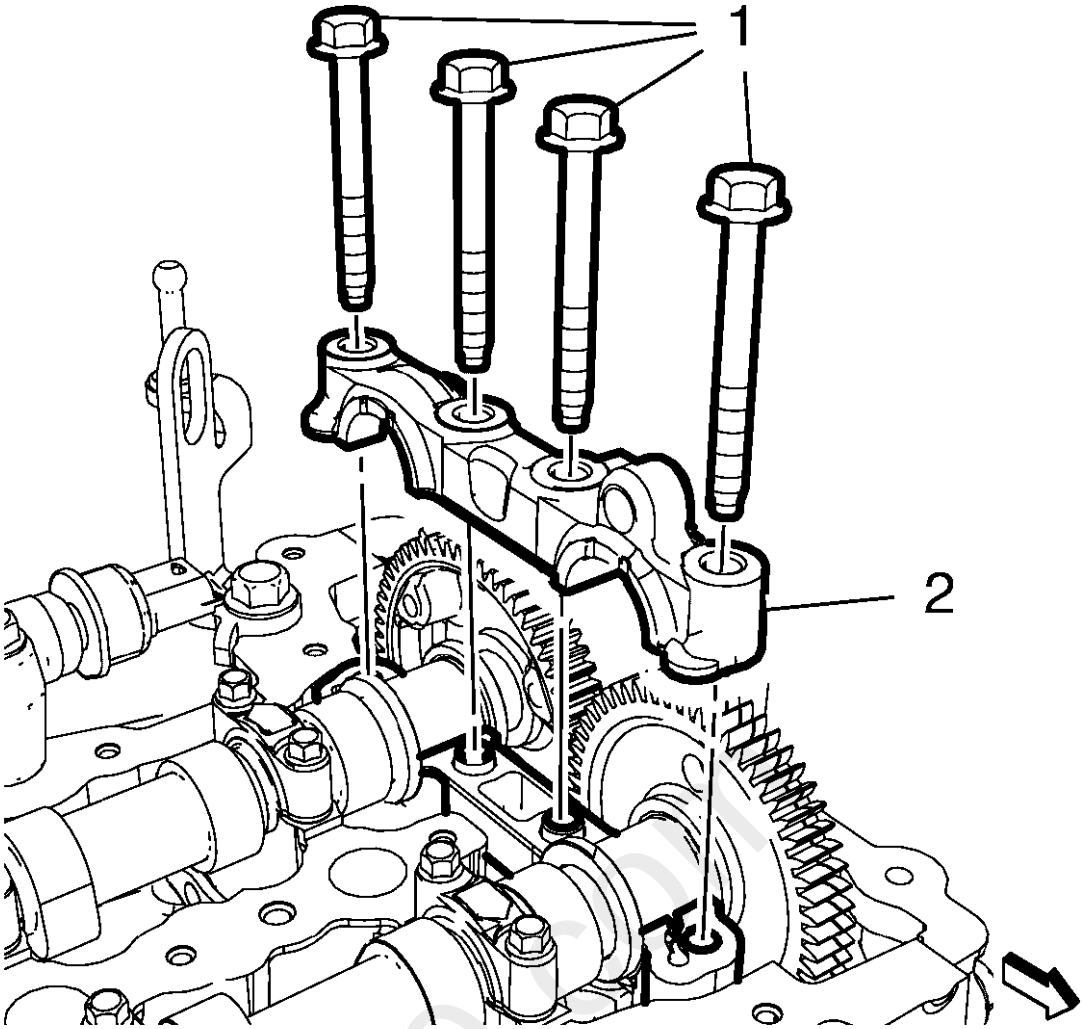


Fig. 151: Camshaft Bearing Rear Cap And Bolts
Courtesy of GENERAL MOTORS COMPANY

23. Remove the 4 camshaft bearing rear cap bolts (1).
24. Remove the camshaft bearing rear cap (2).

mitsubishi

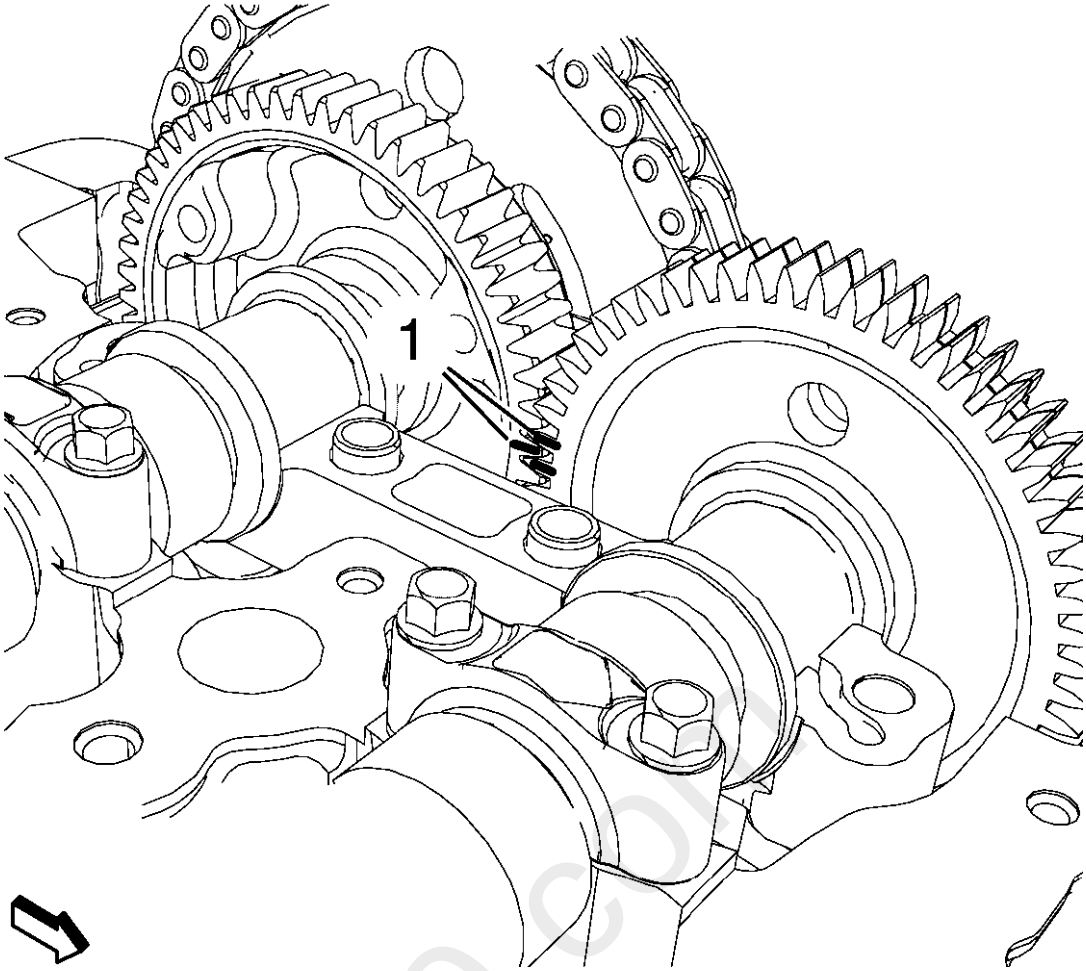


Fig. 152: Marking Exhaust Camshaft Sprocket And Intake Camshaft Sprocket With Paint Marks
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Mark the camshaft sprockets if the camshafts will be reinstalled.**

25. Mark the exhaust camshaft sprocket and intake camshaft sprocket with paint marks (1).

mcx30.com

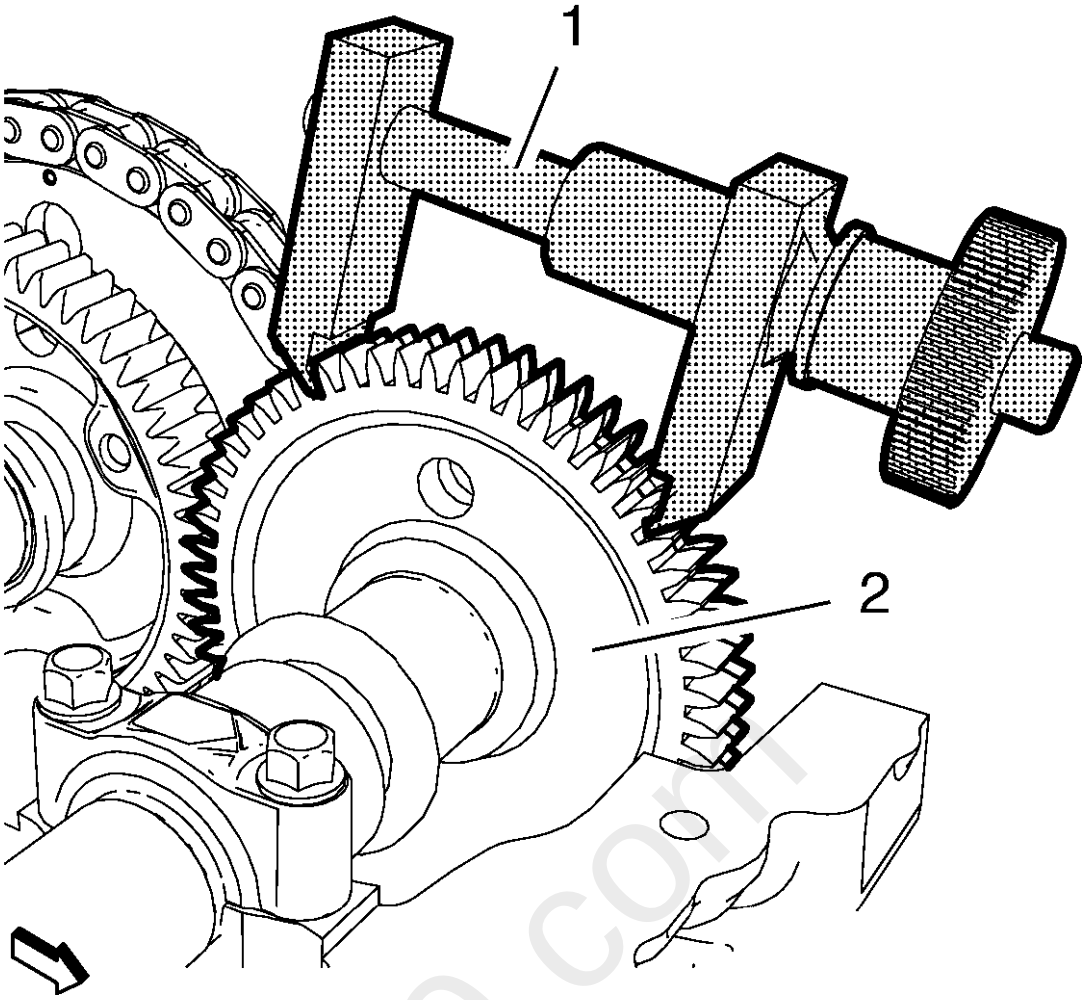


Fig. 153: Split Intake Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

26. Install the **EN-50509** fixing tool (1) to the exhaust camshaft sprocket (2).

mcx30.com

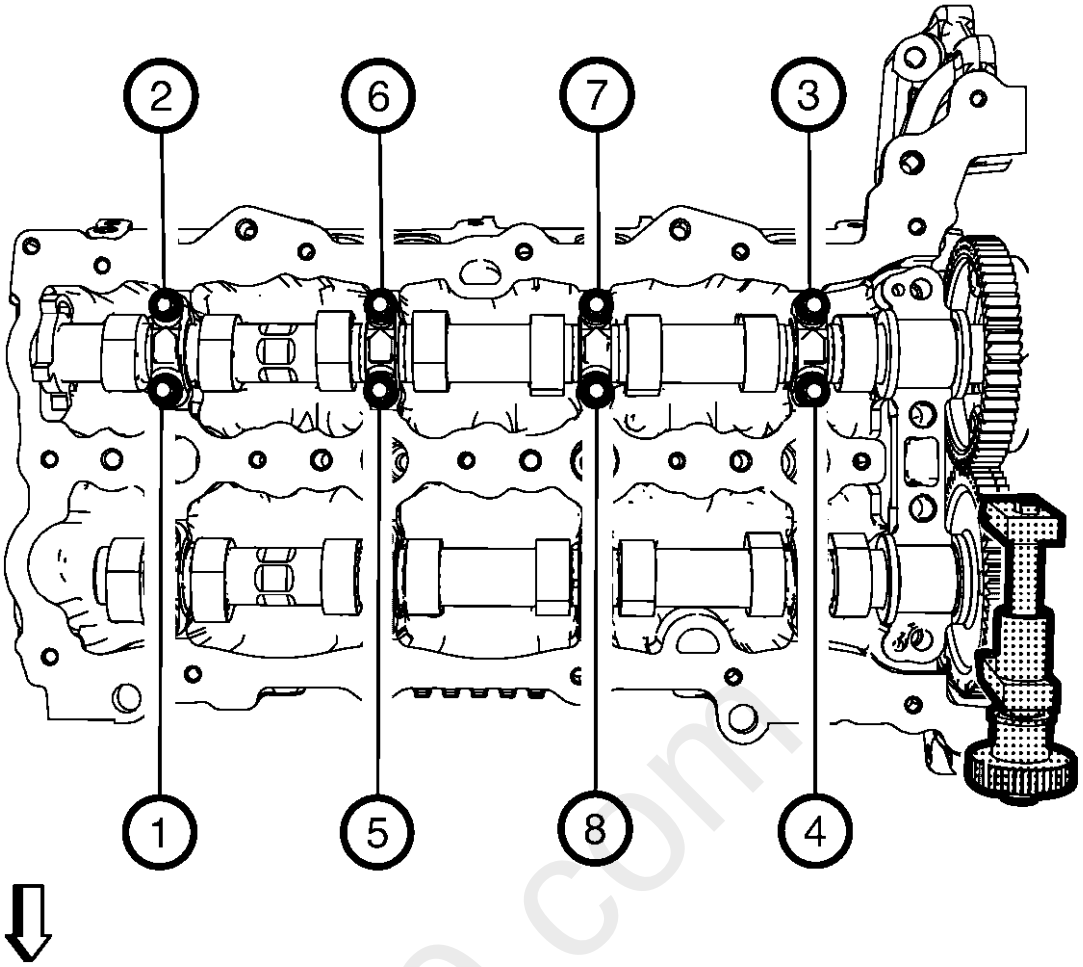


Fig. 154: Intake Camshaft Bearing Cap Bolt Loosening Sequence
Courtesy of GENERAL MOTORS COMPANY

27. Loosen the 8 intake camshaft bearing cap bolts in sequence as shown.

mcx30.com

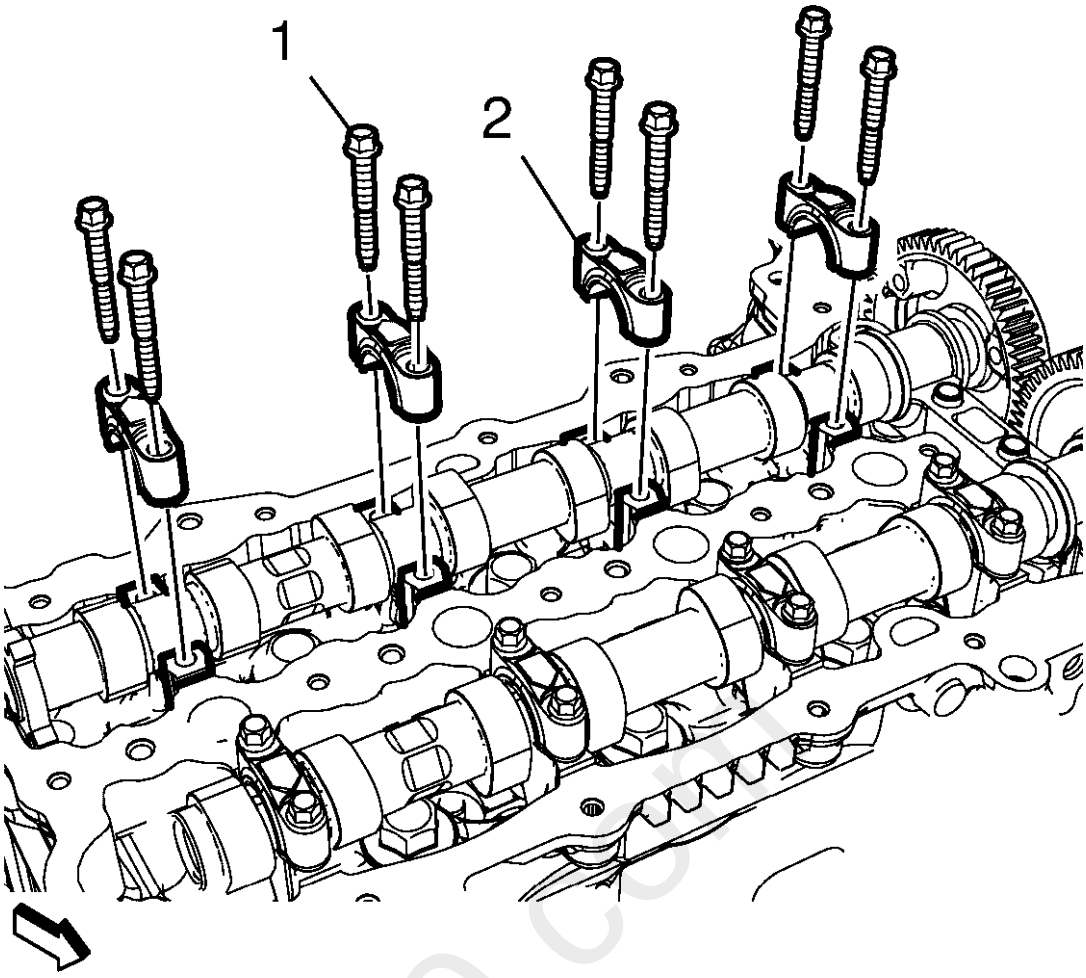


Fig. 155: Intake Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

28. Remove the 8 intake camshaft bearing cap bolts (1).
29. Remove the 4 intake camshaft bearing caps (2) and lay aside in the order they were removed.

mcx30.com

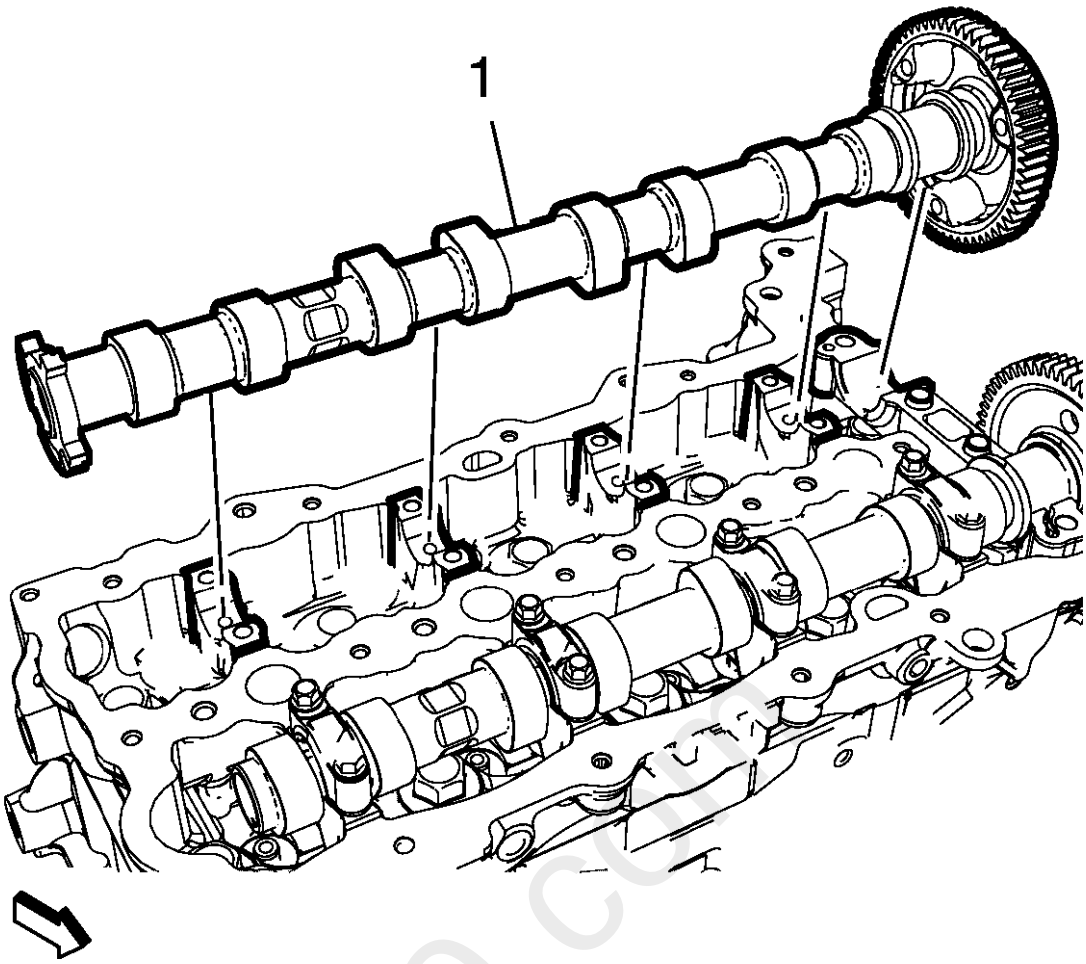


Fig. 156: Intake Camshaft
Courtesy of GENERAL MOTORS COMPANY

30. Remove the intake camshaft (1).

mcx30.com

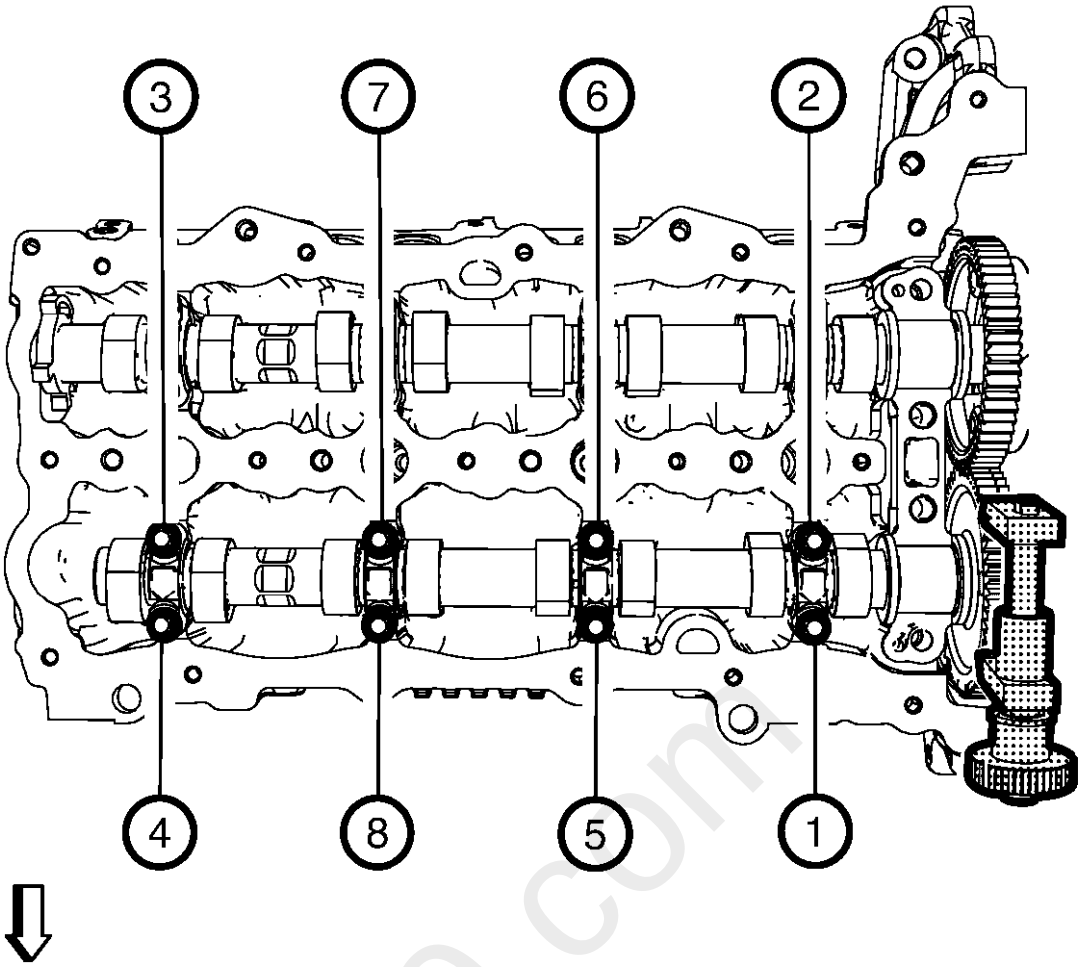


Fig. 157: Exhaust Camshaft Bearing Cap Bolt Loosening Sequence
Courtesy of GENERAL MOTORS COMPANY

31. Loosen the 8 exhaust camshaft bearing cap bolts in sequence as shown.

mcx30.com

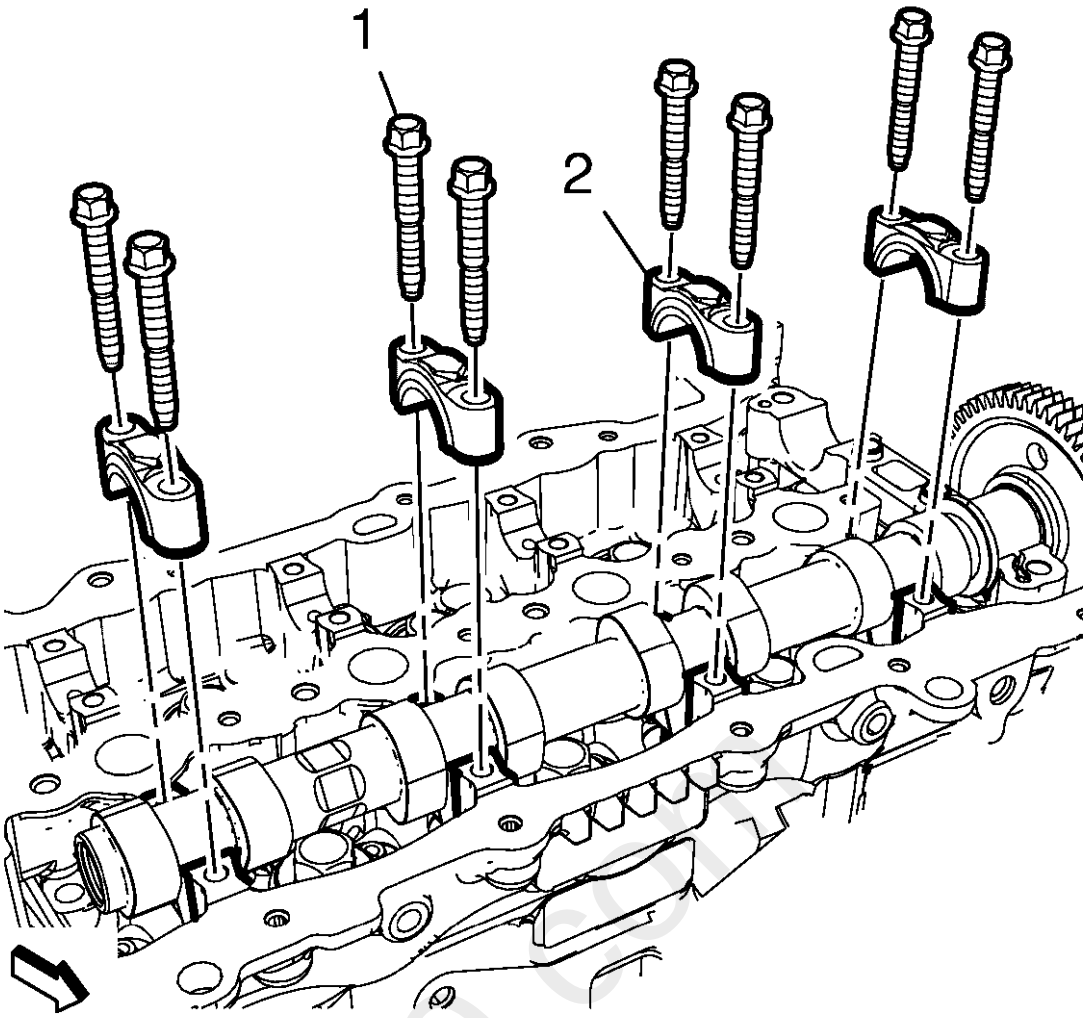


Fig. 158: Exhaust Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

32. Remove the 8 exhaust camshaft bearing cap bolts (1).
33. Remove the 4 exhaust camshaft bearing caps (2) and lay aside in the order they were removed.

mcx30.com

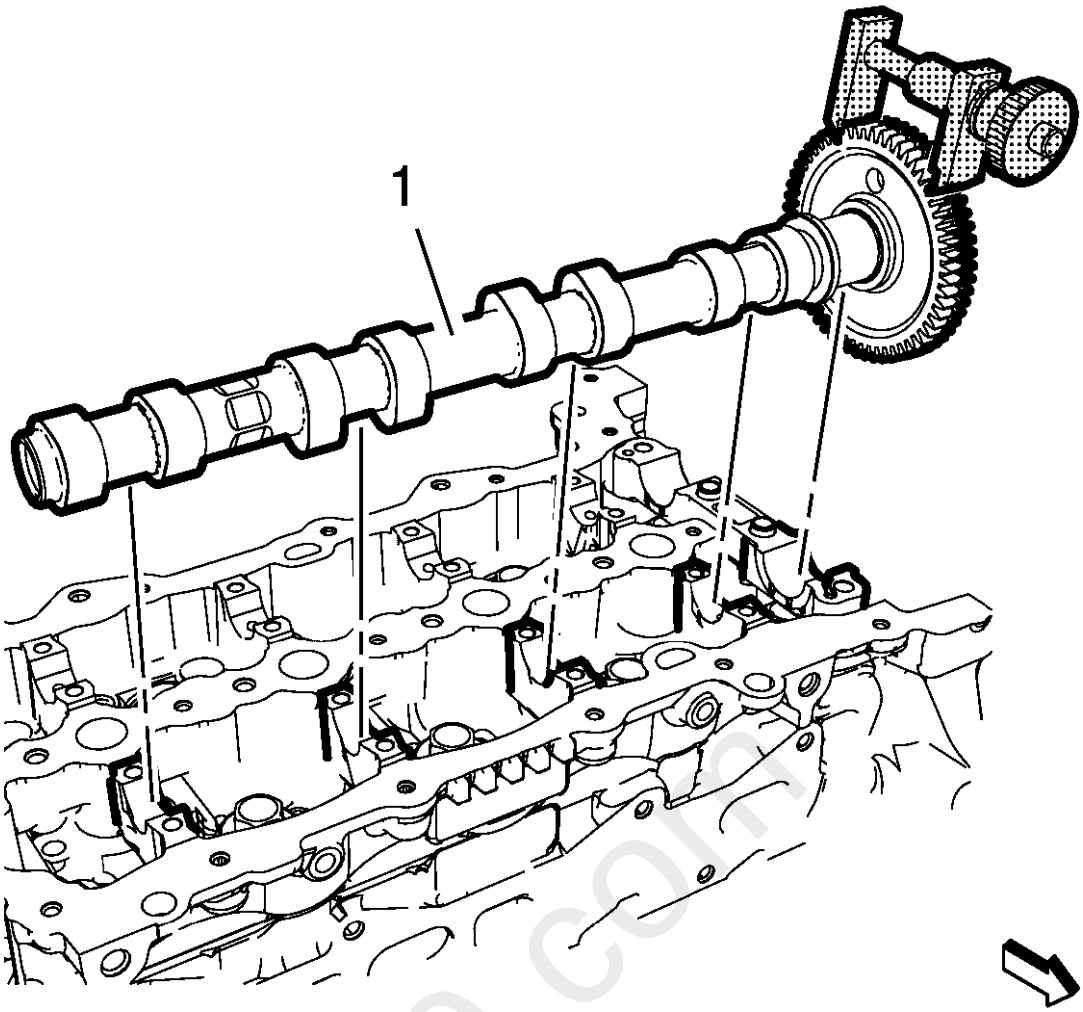


Fig. 159: Exhaust Camshaft
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the exhaust camshaft will be reinstalled, do not remove the EN-50509 fixing tool.**

34. Remove the exhaust camshaft (1).

Installation Procedure

NOTE: **Before installing the camshaft, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

mcx30.com

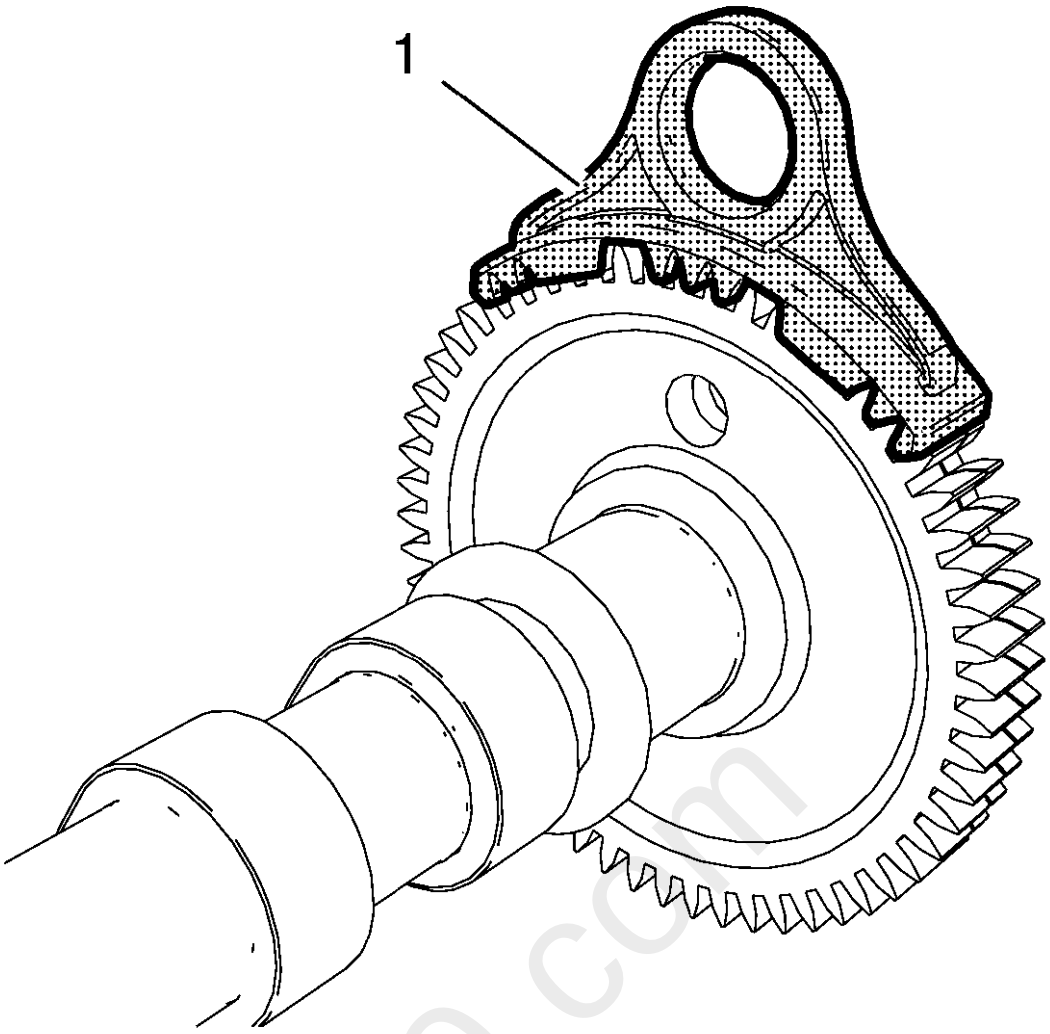


Fig. 160: Transport Lock
Courtesy of GENERAL MOTORS COMPANY

2. When installing a NEW exhaust camshaft do not remove the transport lock (1) before the exhaust camshaft and intake camshaft are installed.

mcx30.com

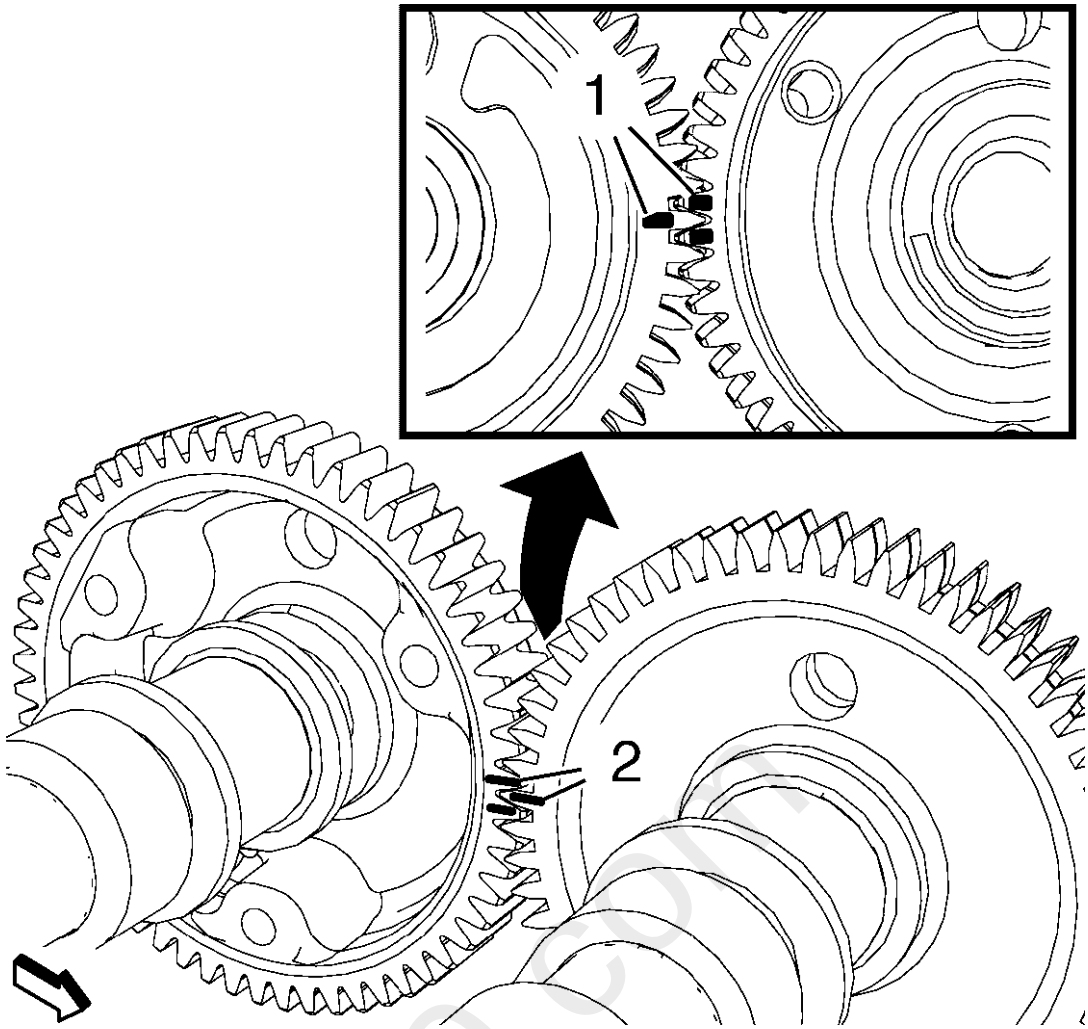


Fig. 161: Marking Camshaft Sprockets With Paint Marks By Transmitting Front Marks
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If new camshafts are used, transfer the front marks (1) to the back.**

3. Mark the exhaust camshaft sprocket and intake camshaft sprocket with paint marks (2), by transferring the front marks (1).

mcx30.com

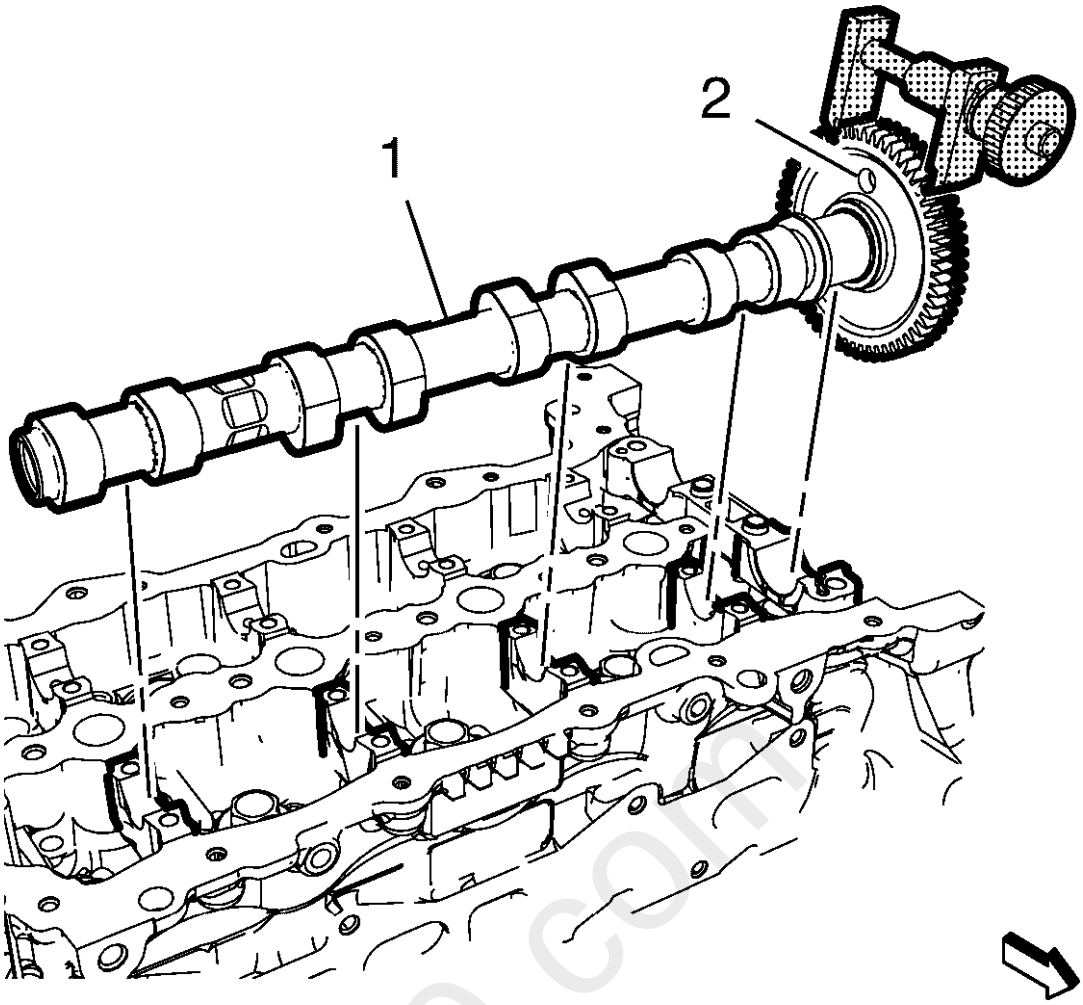


Fig. 162: Exhaust Camshaft With Bore Of Camshaft Sprocket Upwards
Courtesy of GENERAL MOTORS COMPANY

4. Coat all bearing surfaces with engine oil.
5. Install the exhaust camshaft (1). Ensure the bore (2) of the camshaft sprocket is positioned upwards.

mx30.com

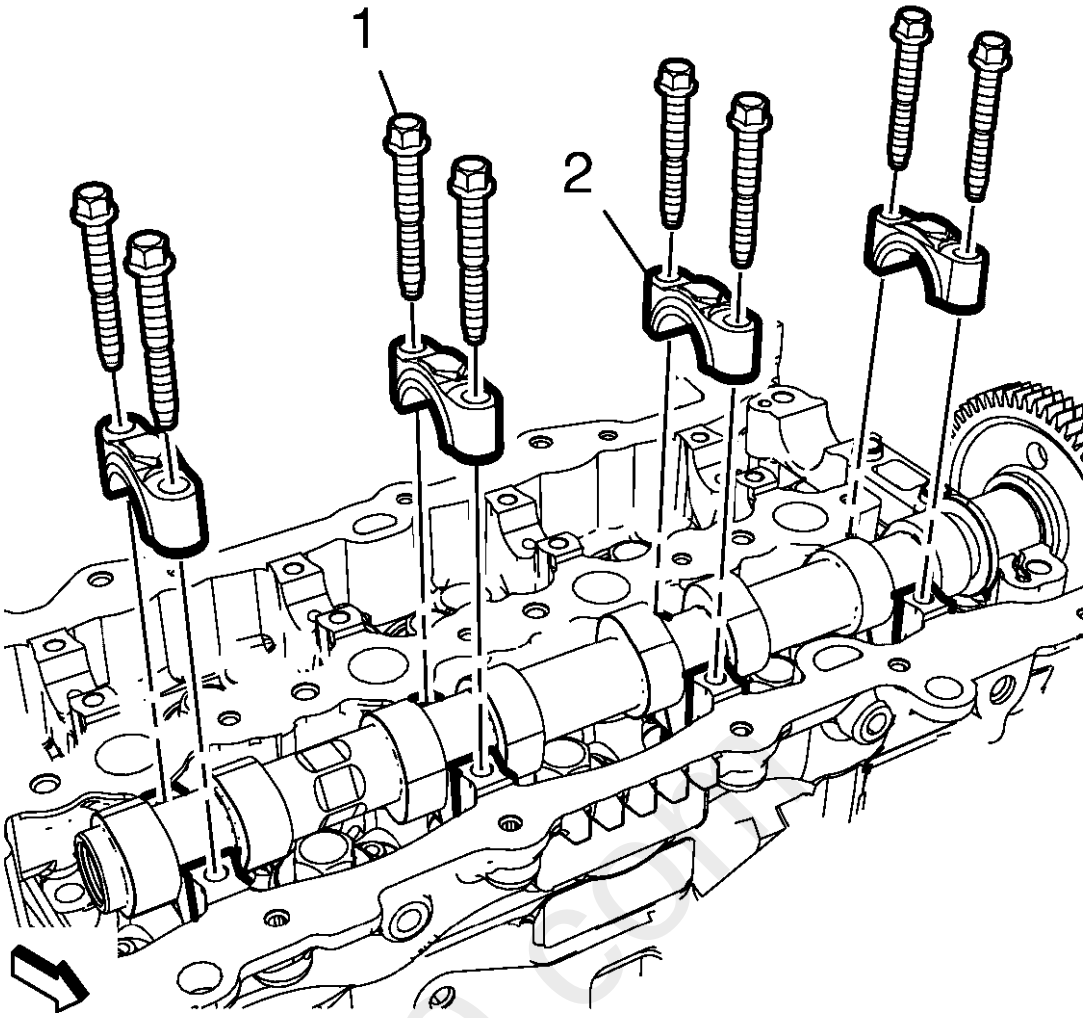


Fig. 163: Exhaust Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the arrows marks on the camshaft bearing caps, which show on the outside of the cylinder head.**

6. Install the exhaust camshaft bearing caps (2) in the order as they were removed.
7. Install the exhaust camshaft bearing cap bolts (1).

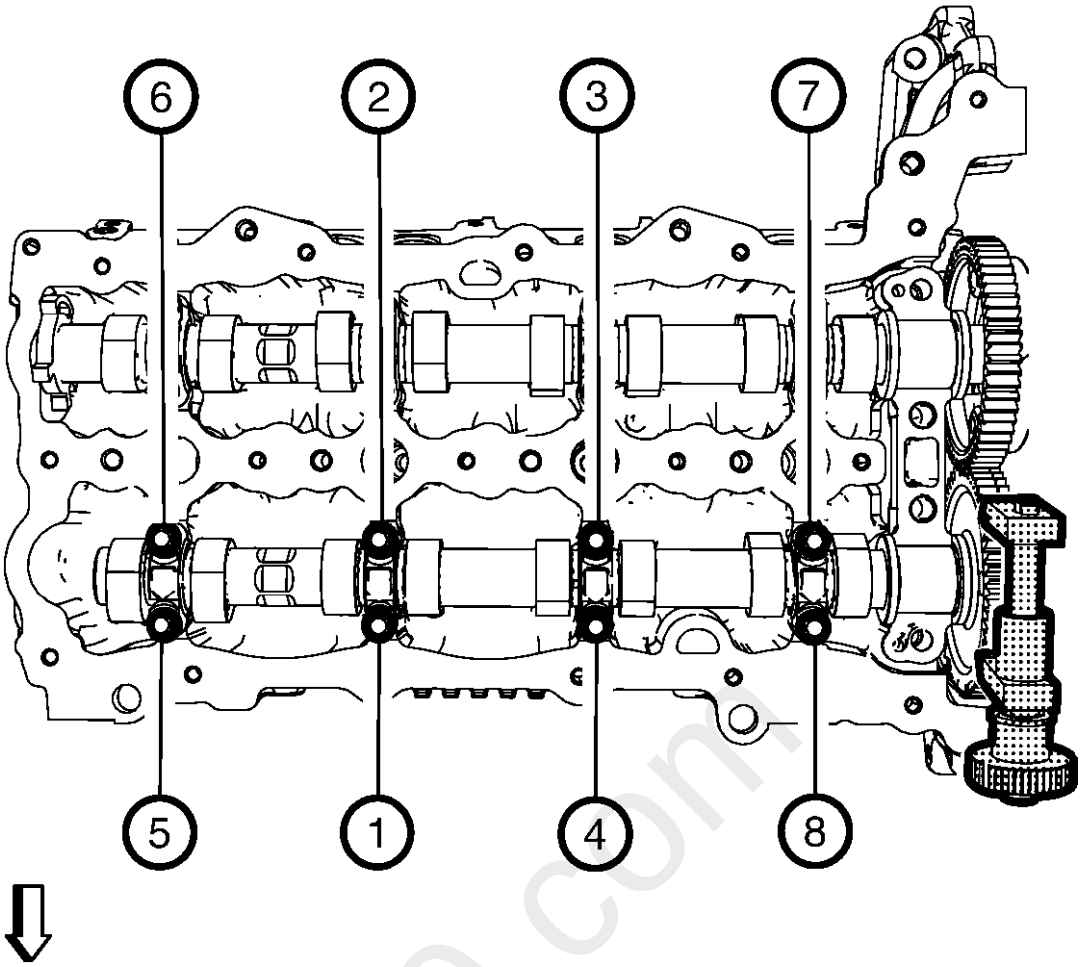


Fig. 164: Exhaust Camshaft Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

8. Tighten the 8 exhaust camshaft bearing cap bolts in the sequence shown to 10 N.m (89 lb in).

mcx30.com

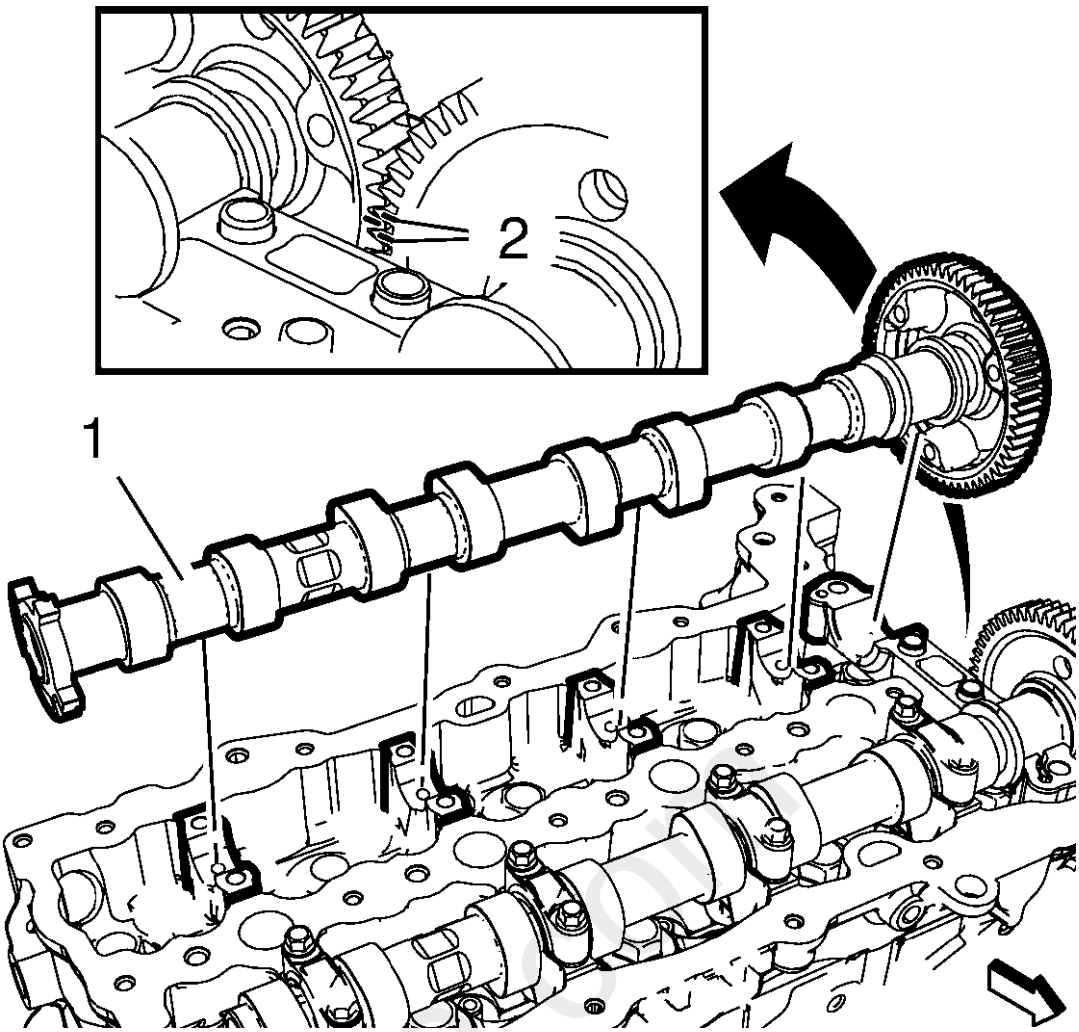


Fig. 165: Intake Camshaft With Camshaft Sprocket Marks Aligned
Courtesy of GENERAL MOTORS COMPANY

9. Coat all bearing surfaces with engine oil.

NOTE: **Ensure the marks (2) of the camshaft sprocket are aligned.**

10. Install the intake camshaft (1).

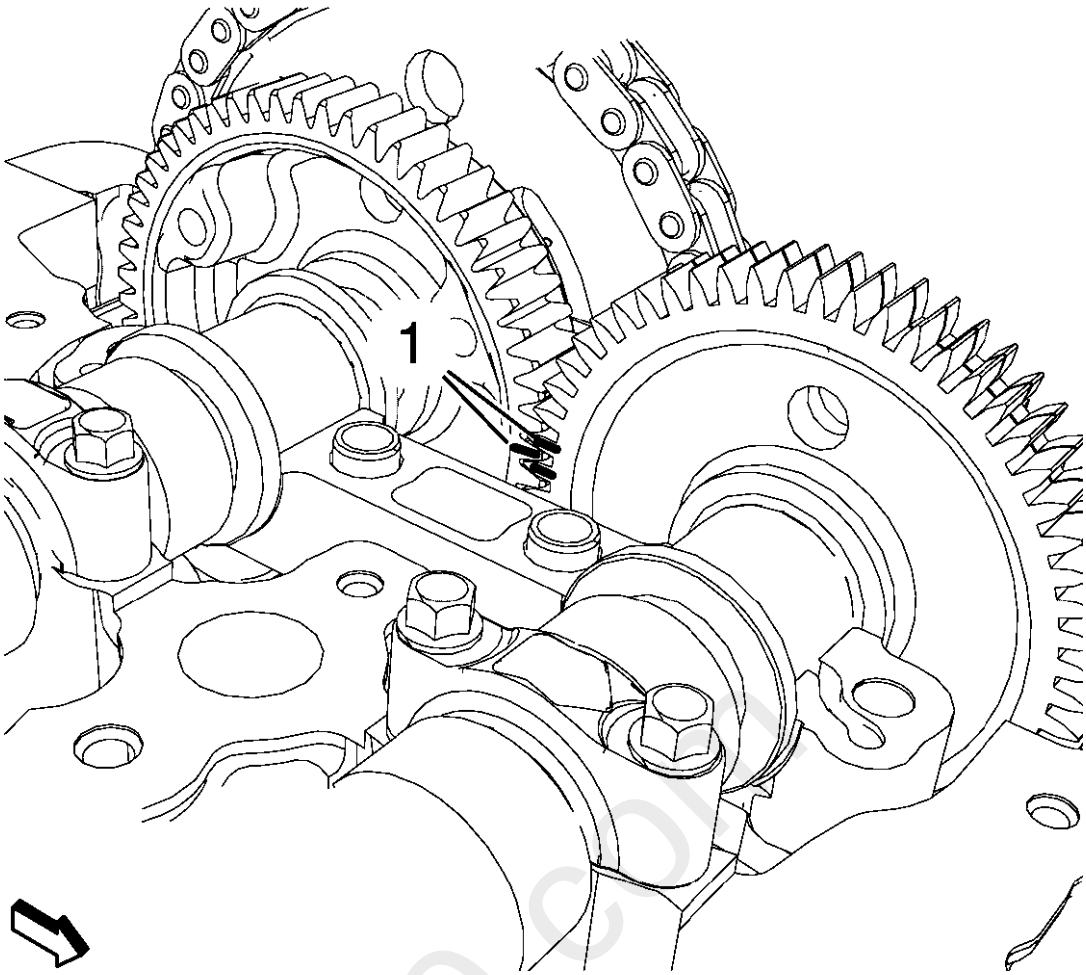


Fig. 166: Marking Exhaust Camshaft Sprocket And Intake Camshaft Sprocket With Paint Marks
Courtesy of GENERAL MOTORS COMPANY

11. Check the marks (1) on the camshaft sprockets to ensure they are aligned.

mcx30.com

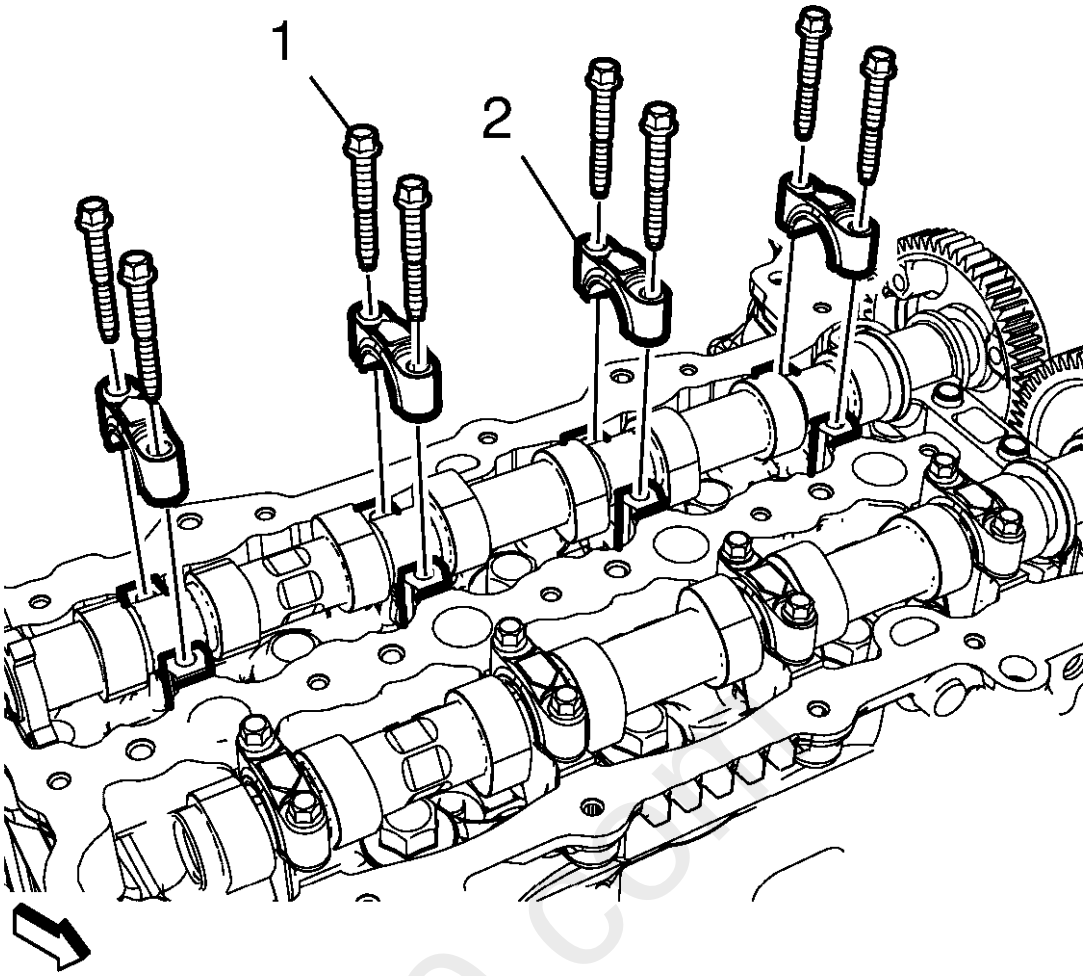


Fig. 167: Intake Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the arrow marks on the camshaft bearing caps, which show the outside of the cylinder head.**

12. Install the 4 intake camshaft bearing caps (2) in the order as they were removed.
13. Install the 8 intake camshaft bearing cap bolts (1).

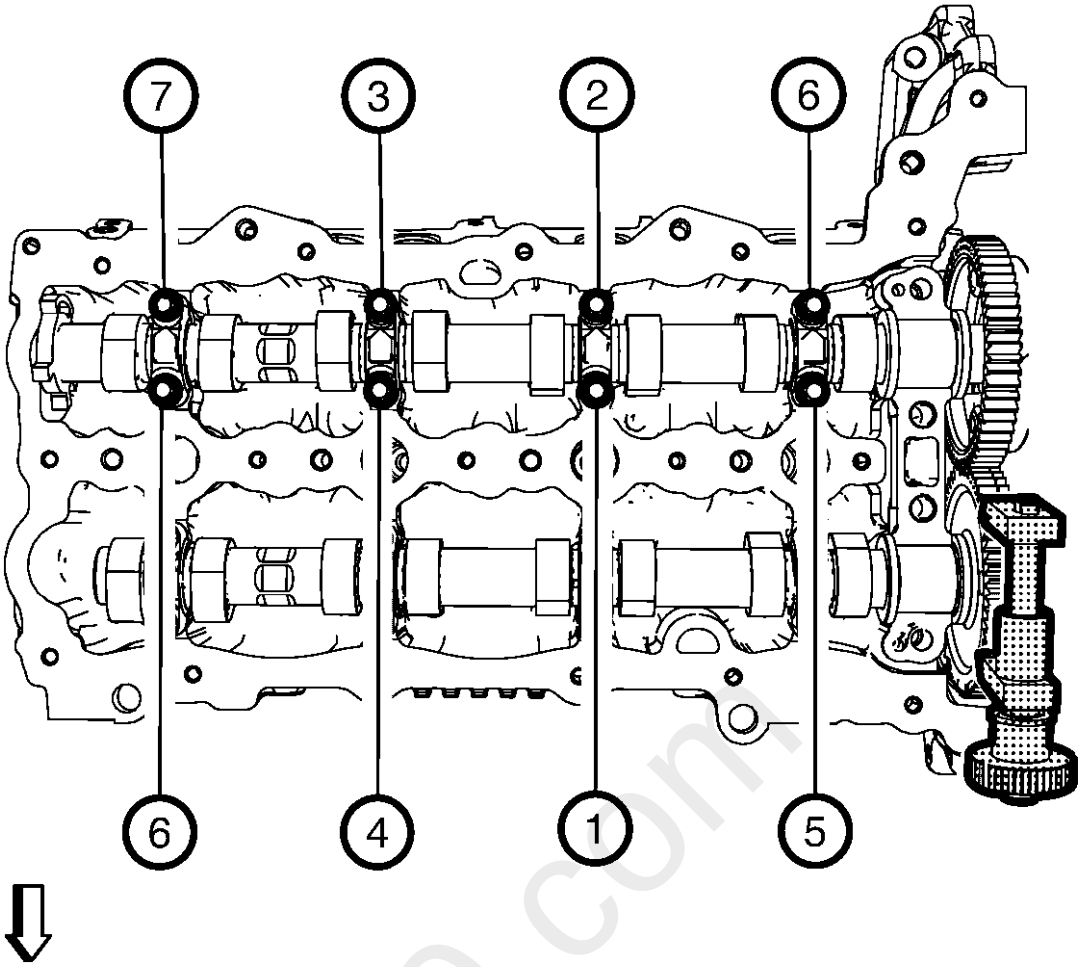


Fig. 168: Intake Camshaft Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

14. Tighten the 8 intake camshaft bearing cap bolts in the sequence shown to 10 N.m (89 lb in).

mcx30.com

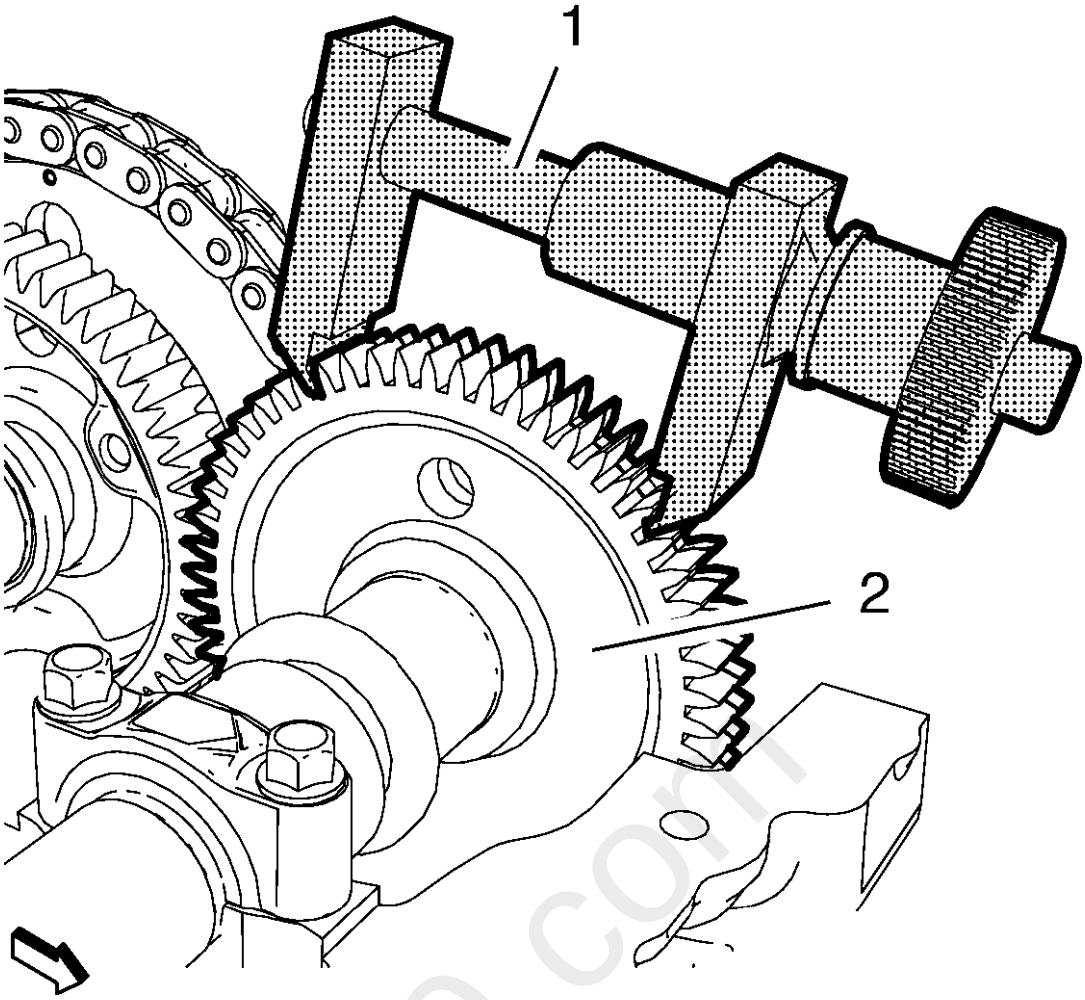


Fig. 169: Split Intake Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

15. Remove the **EN-50509** fixing tool (1) or the transport lock from the exhaust camshaft sprocket (2).

mcx30.com

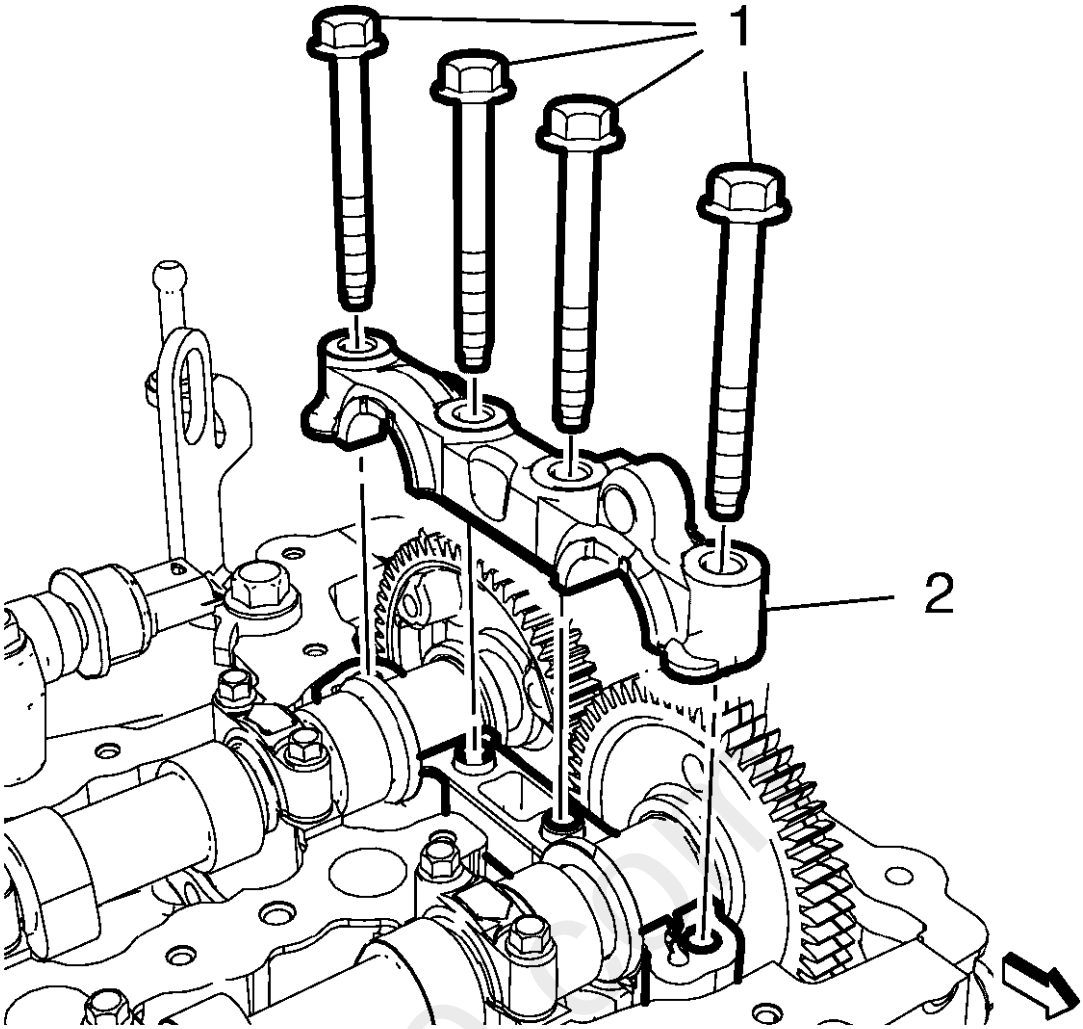


Fig. 170: Camshaft Bearing Rear Cap And Bolts
Courtesy of GENERAL MOTORS COMPANY

16. Coat all bearing surfaces with engine oil.
17. Install the camshaft bearing rear cap (2).
18. Install the 4 camshaft bearing rear cap bolts (1).

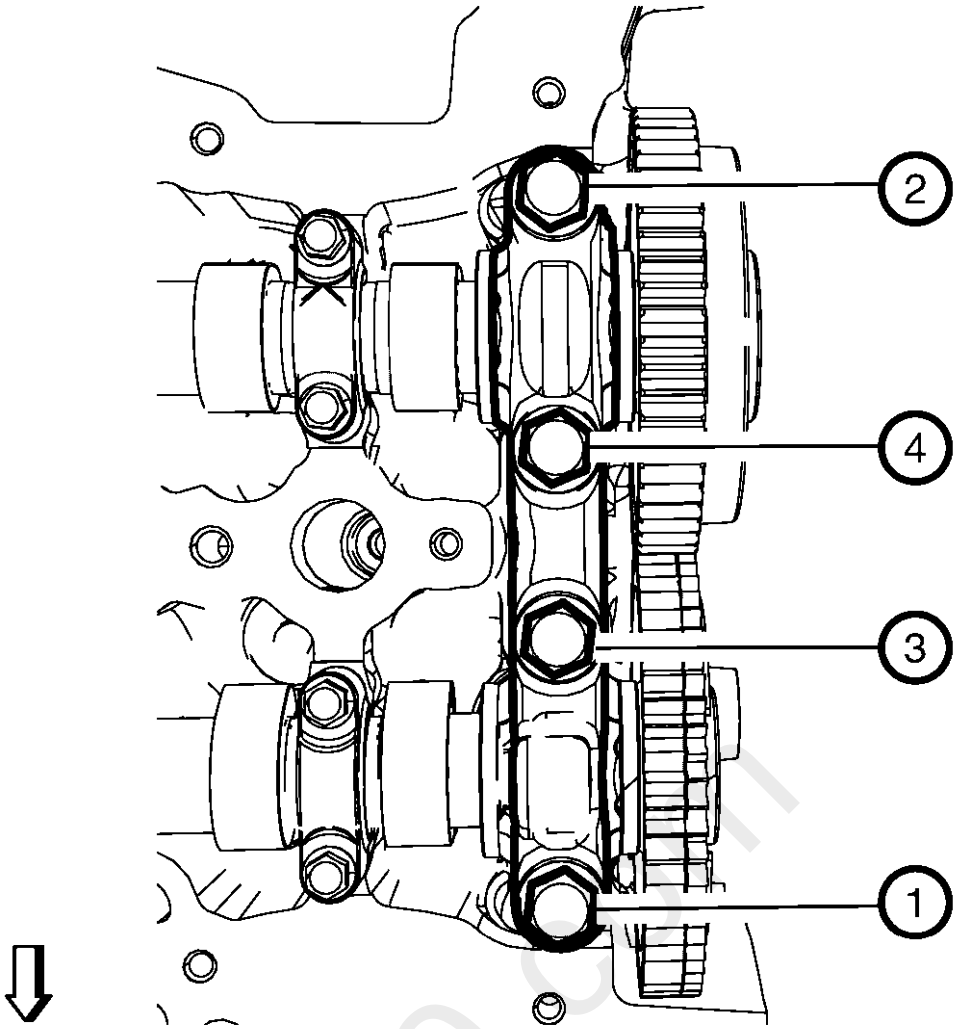


Fig. 171: Camshaft Rear Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

19. Tighten the 4 camshaft rear cap bolts in the sequence shown to 25 N.m (18 lb ft).

mcx30.com

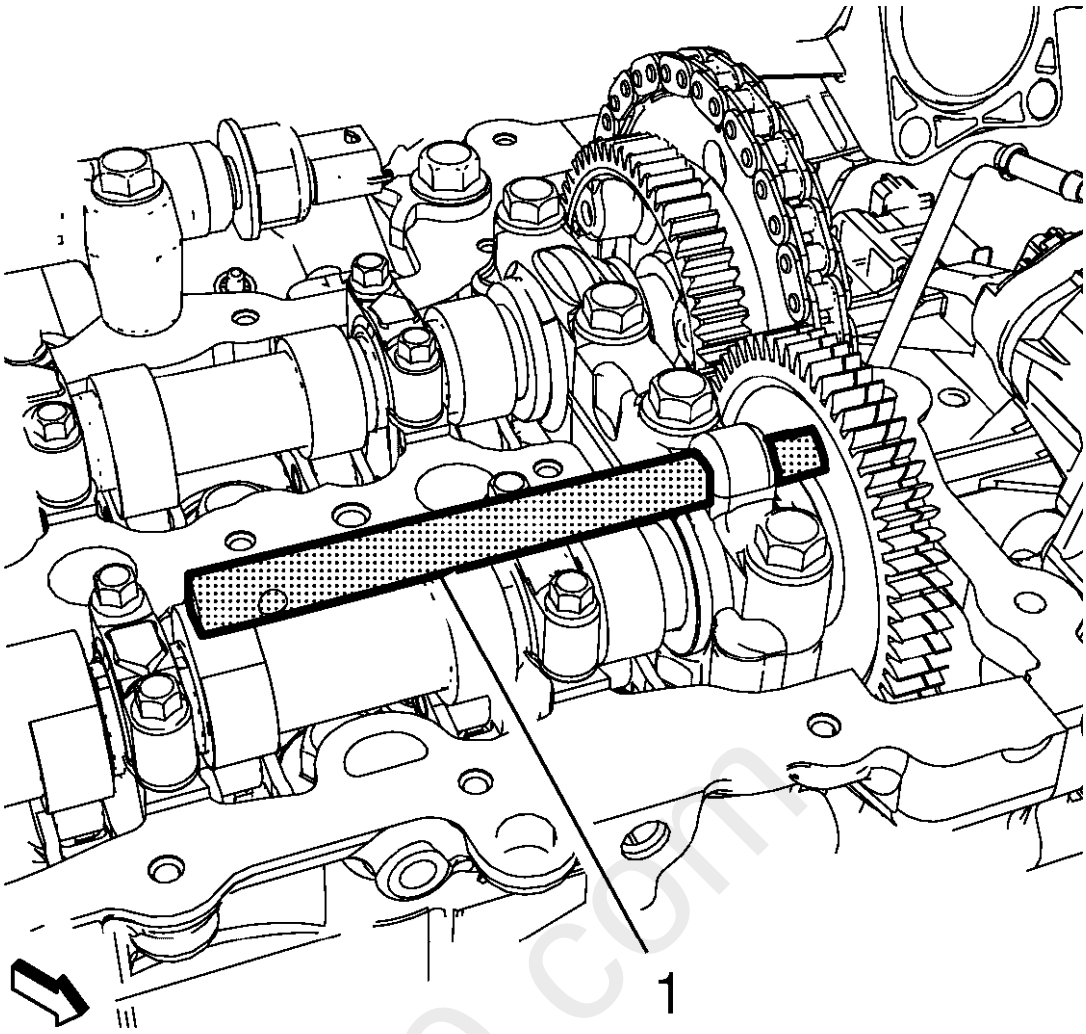


Fig. 172: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

20. Install the **EN-51143** fixing tool (1), by carefully turning the hexagon of the camshaft.

mcx30.com

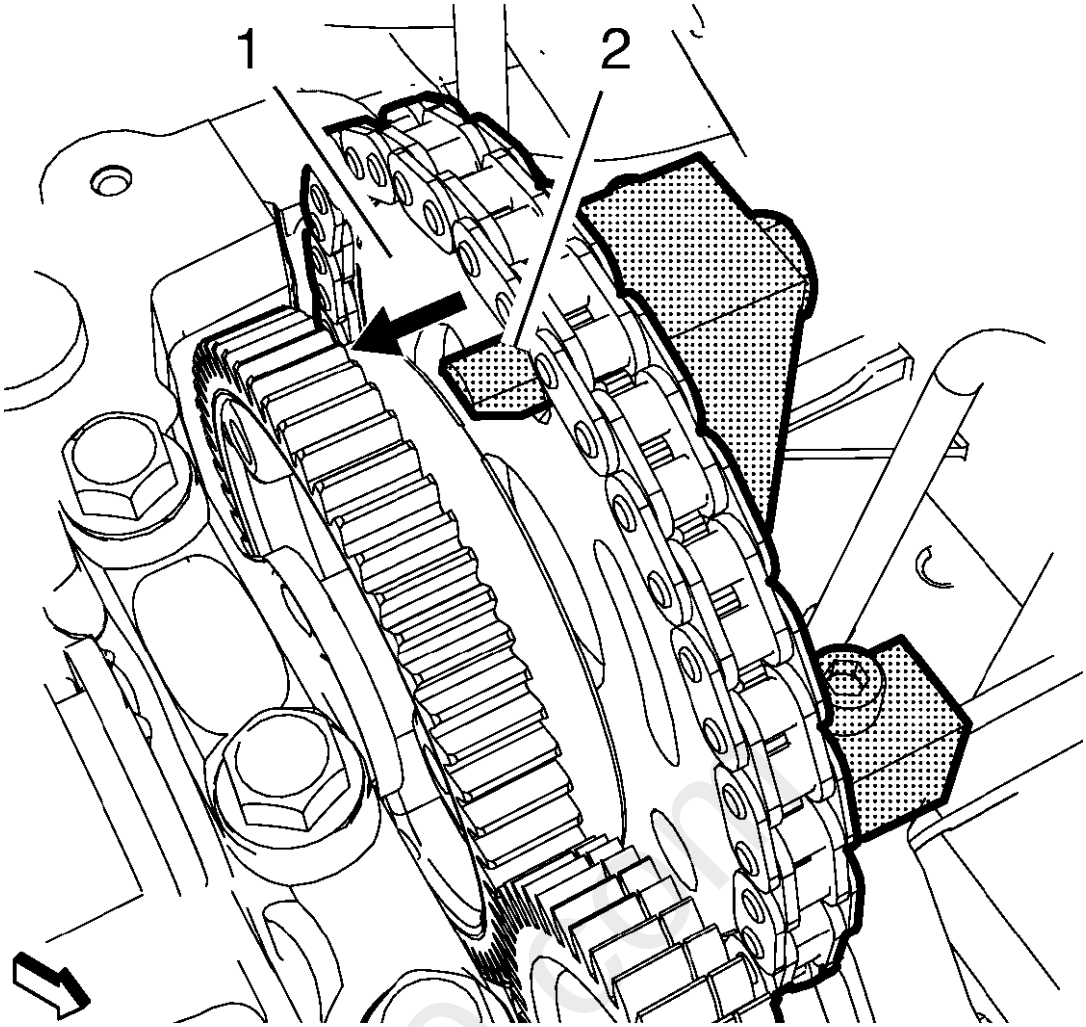


Fig. 173: Camshaft Sprocket Over Pin Of Timing Chain Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

21. Slide the camshaft sprocket (1) over the pin (2) of the **EN-51188** fixing tool in arrow direction.

mcx30.com

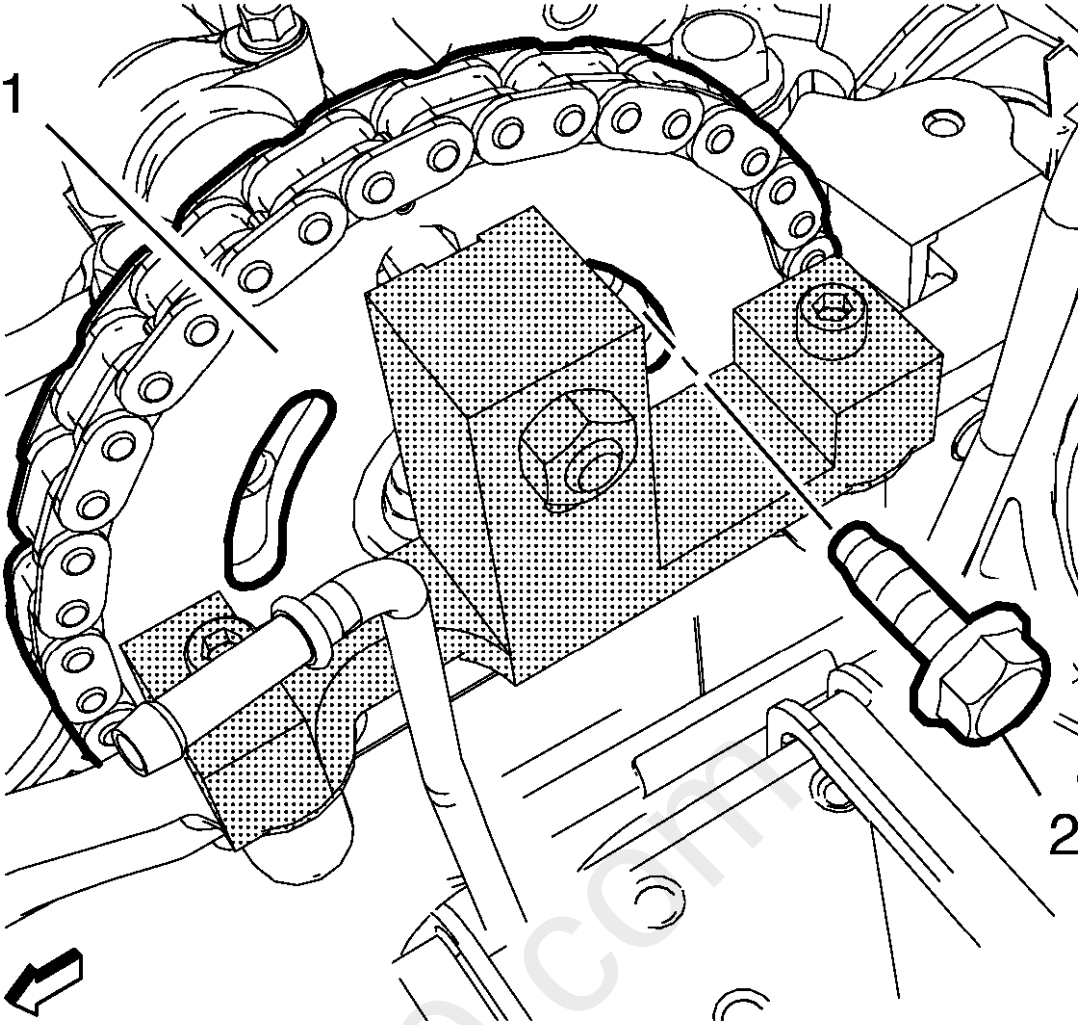


Fig. 174: Camshaft Sprocket And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Cover the timing case with a lint-free cloth.**

22. Check that the camshaft sprocket (1) on the camshaft is properly installed.
23. Install the camshaft sprocket bolts (2), counterhold with a wrench at the camshaft hexagon, and tighten to 25 N.m (18 lb ft).

mcx30.com

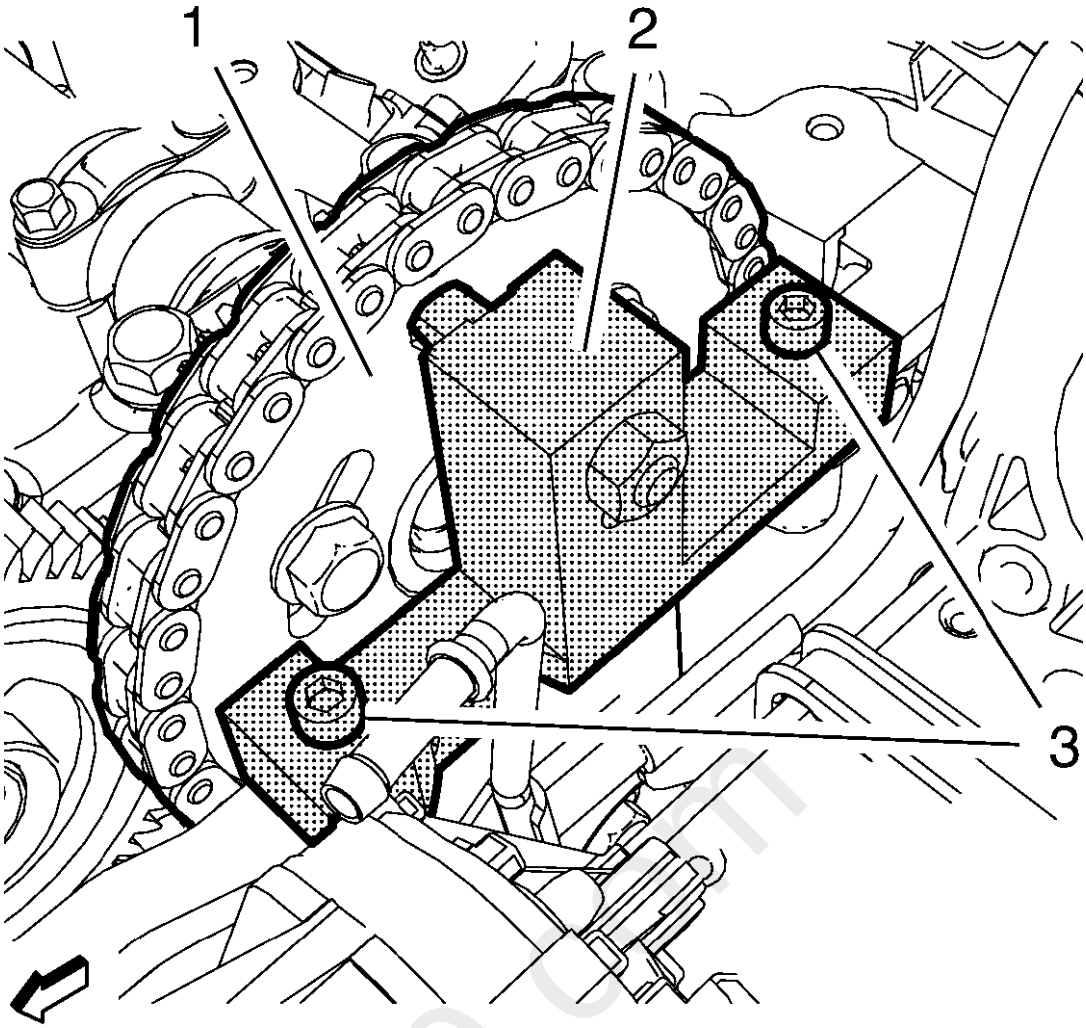


Fig. 175: Timing Chain Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

24. Remove the 2 bolts (3).
25. Remove the **EN-51188** fixing tool (2).

mcx30.com

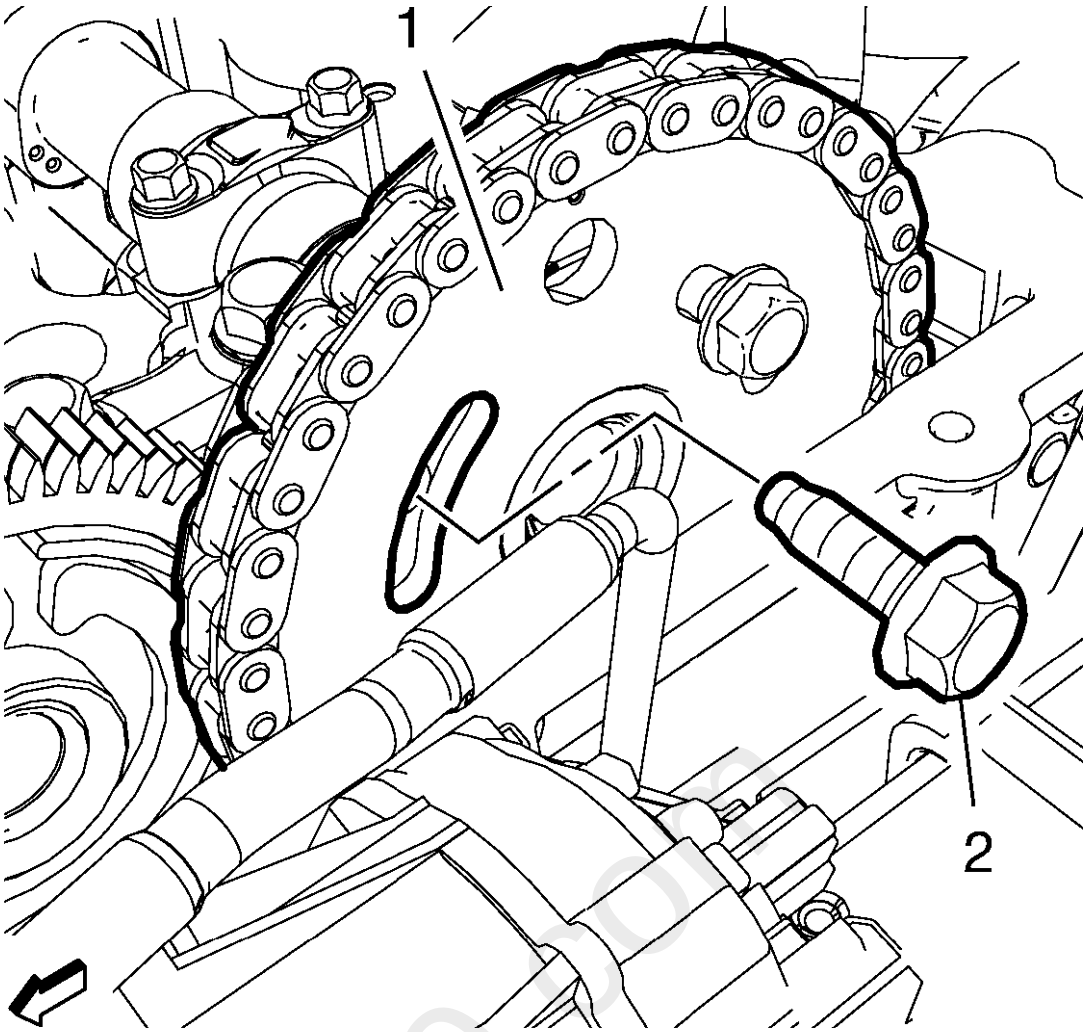


Fig. 176: Camshaft Sprocket And Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Cover the timing case with a lint-free cloth.**

26. Install the camshaft sprocket bolt (2) to the camshaft sprocket (1), counterhold with a wrench at the camshaft hexagon, and tighten to 25 N.m (18 lb ft).

mcx30.com

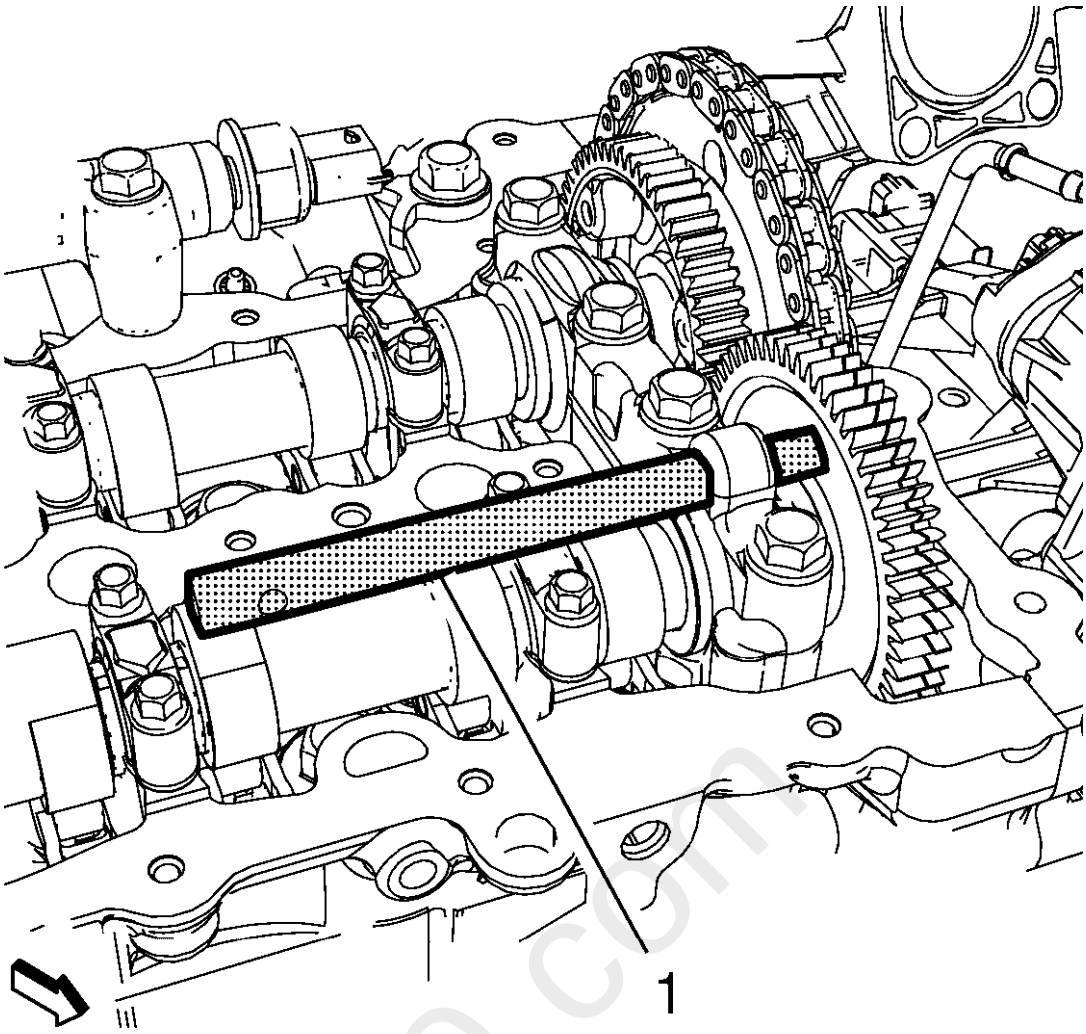


Fig. 177: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

27. Remove the **EN-51143** fixing tool (1).
28. Raise the vehicle.

mcx30.com

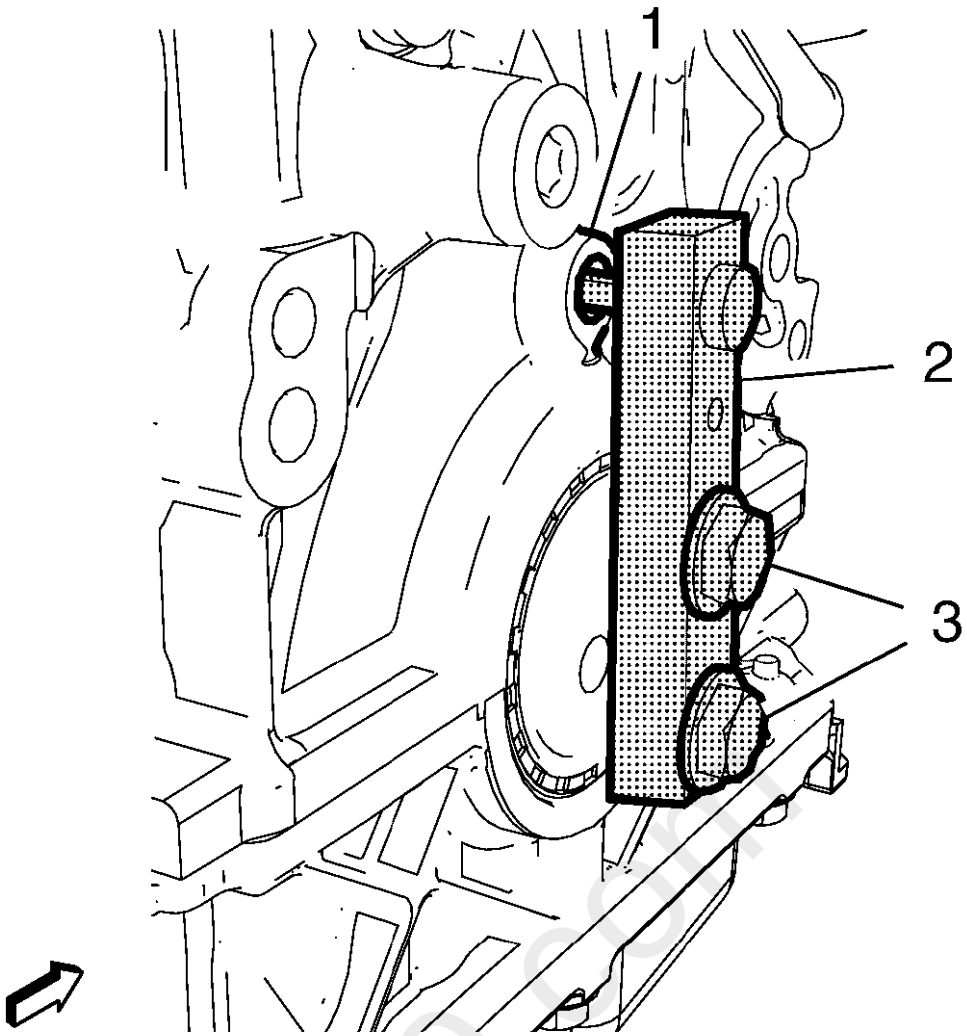


Fig. 178: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

29. Remove the 2 bolts (3).
30. Remove the **EN-51140** fixing tool (2).

mcx30.com

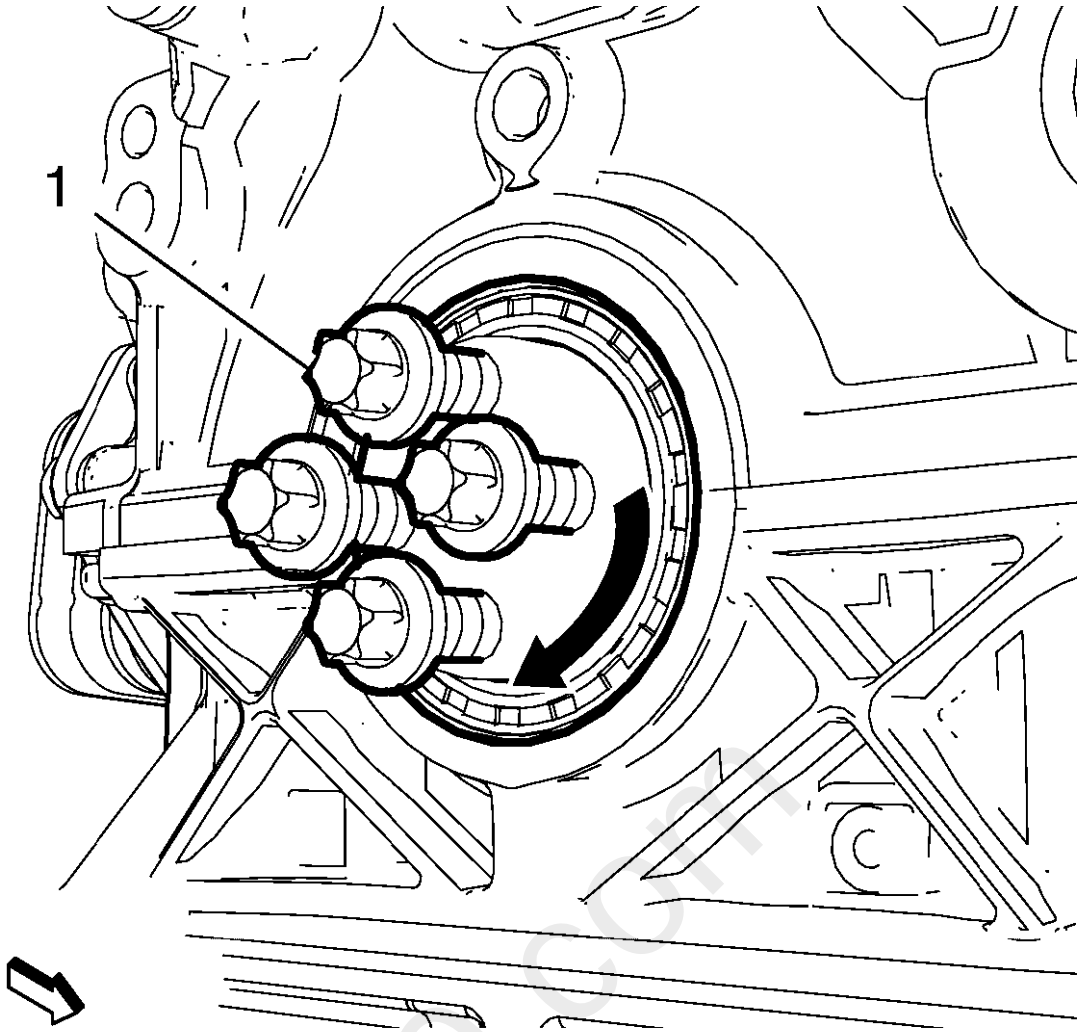


Fig. 179: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

31. Install the 4 crankshaft pulley bolts (1).

    Rotate the crankshaft 360 degrees in direction of arrow. Use a pry bar at the 4 crankshaft pulley bolts (1).

32. Lower the vehicle.

mcx30.com

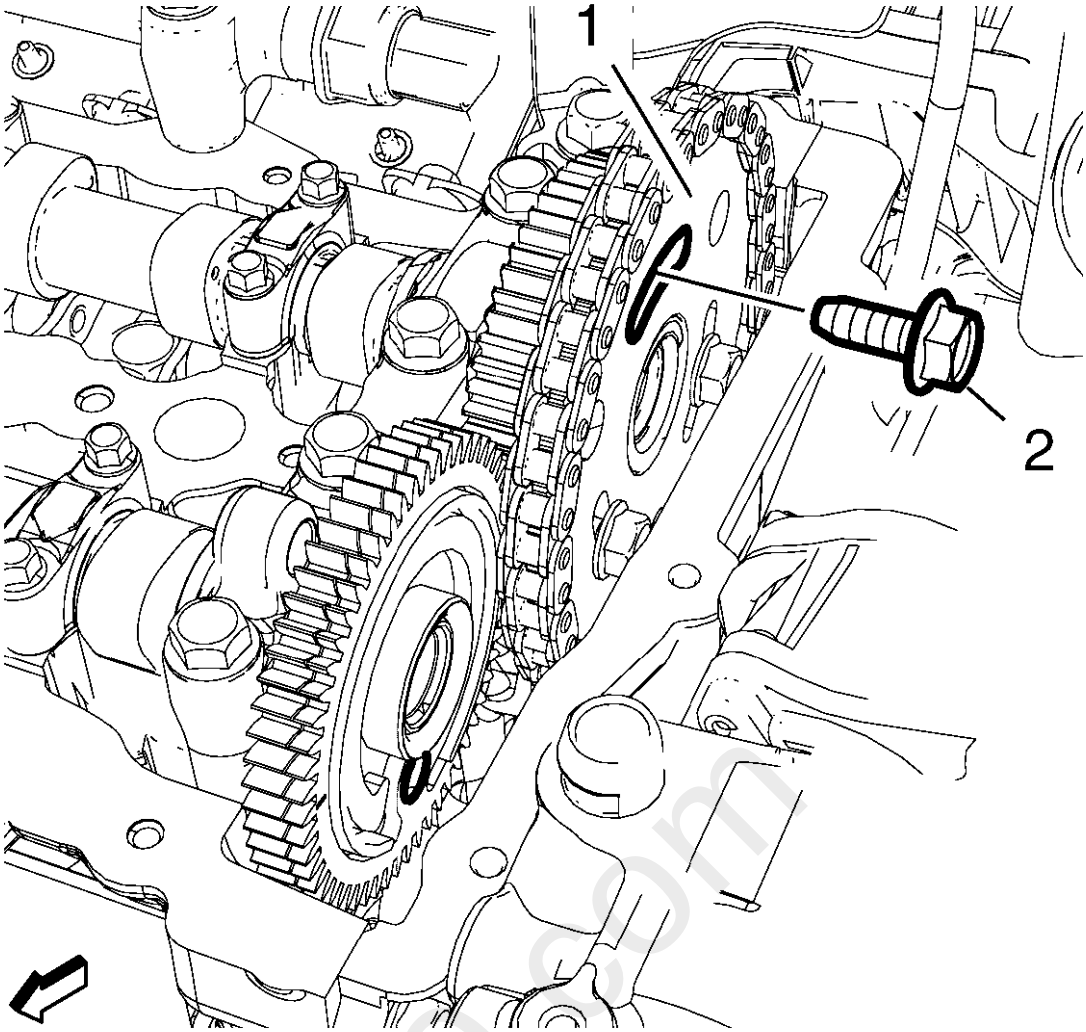


Fig. 180: Camshaft Sprocket And Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Cover the timing case with a lint-free cloth.**

33. Install the camshaft sprocket bolt (2), counterhold with a wrench at the camshaft hexagon, and tighten to 25 N.m (18 lb ft).
34. Raise the vehicle.

mcx30.com

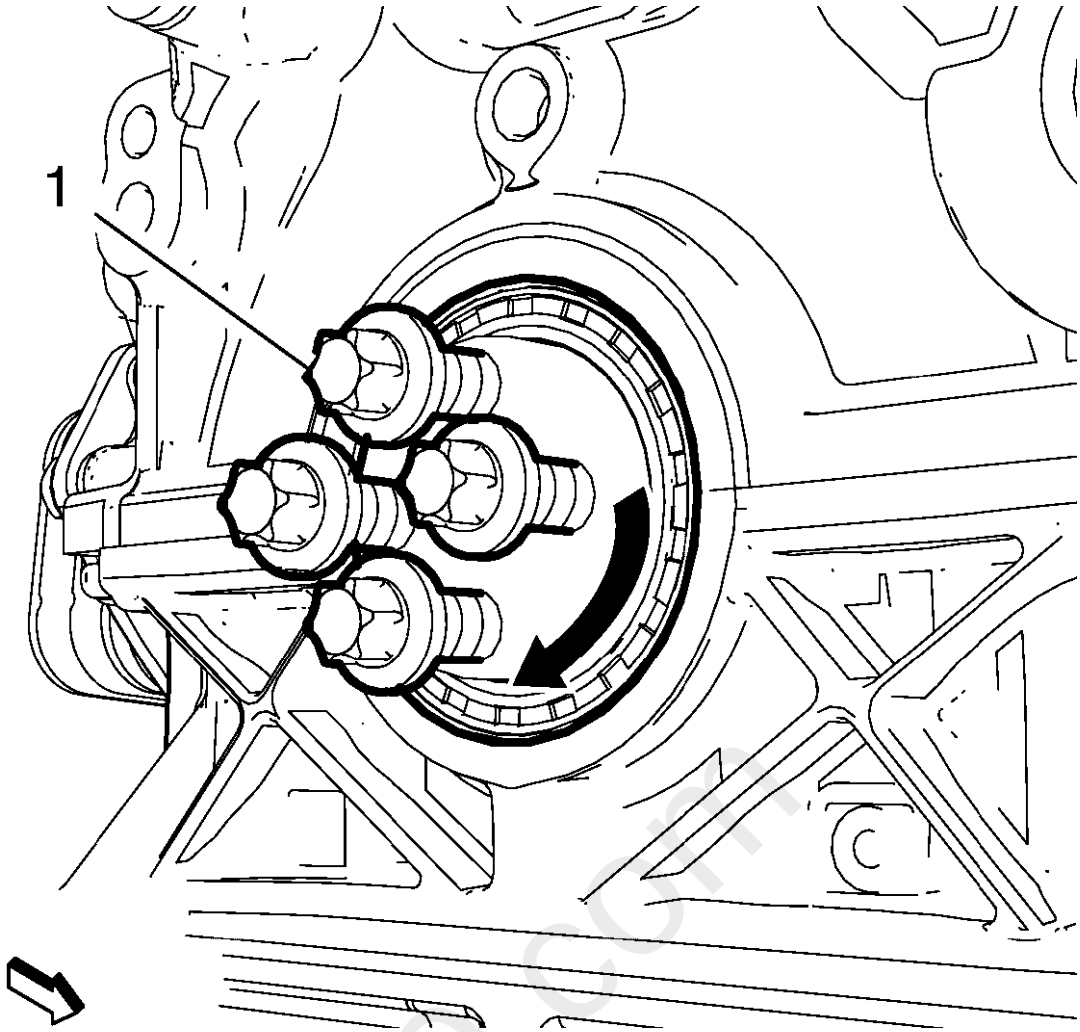


Fig. 181: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

35. Rotate the crankshaft 360 degrees in direction of arrow. Use a pry bar.
36. Remove the 4 crankshaft pulley bolts (1).

mcx30.com

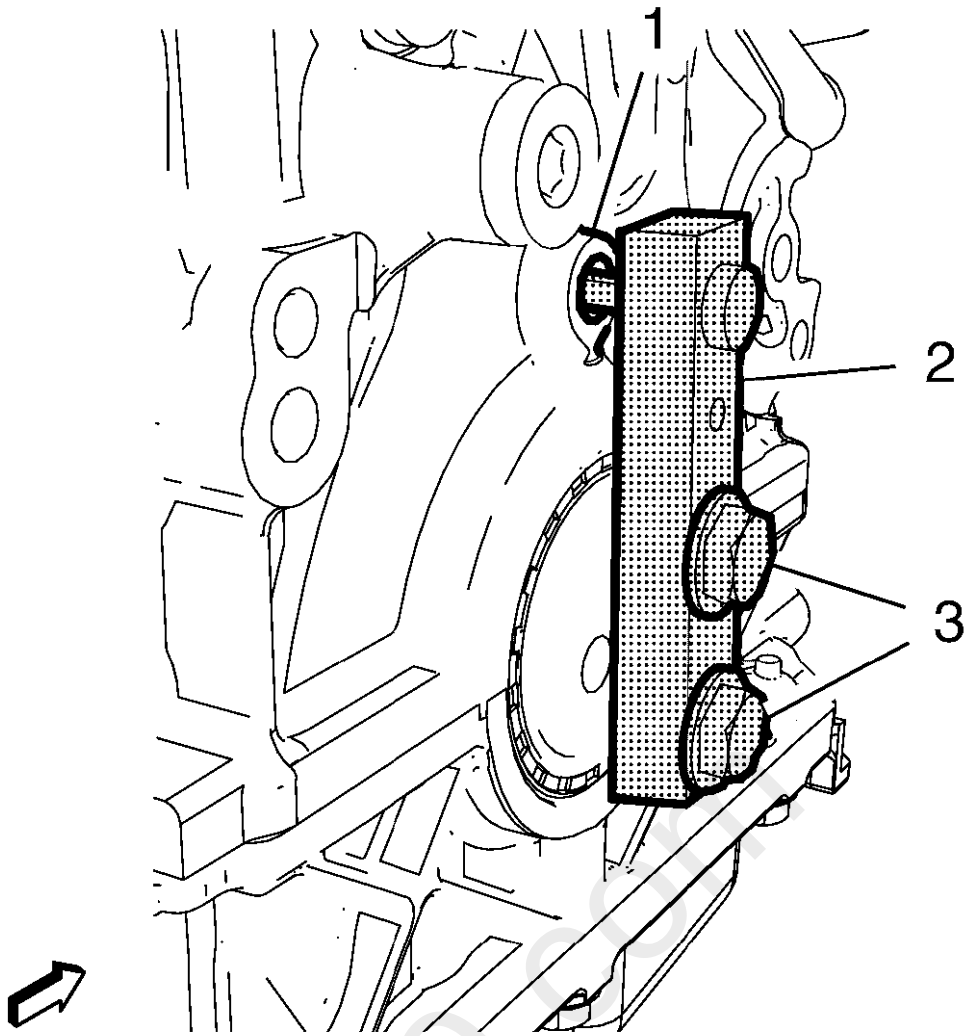


Fig. 182: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

37. Install the **EN-51140** fixing tool (2).
38. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).
39. Lower the vehicle.

mcx30.com

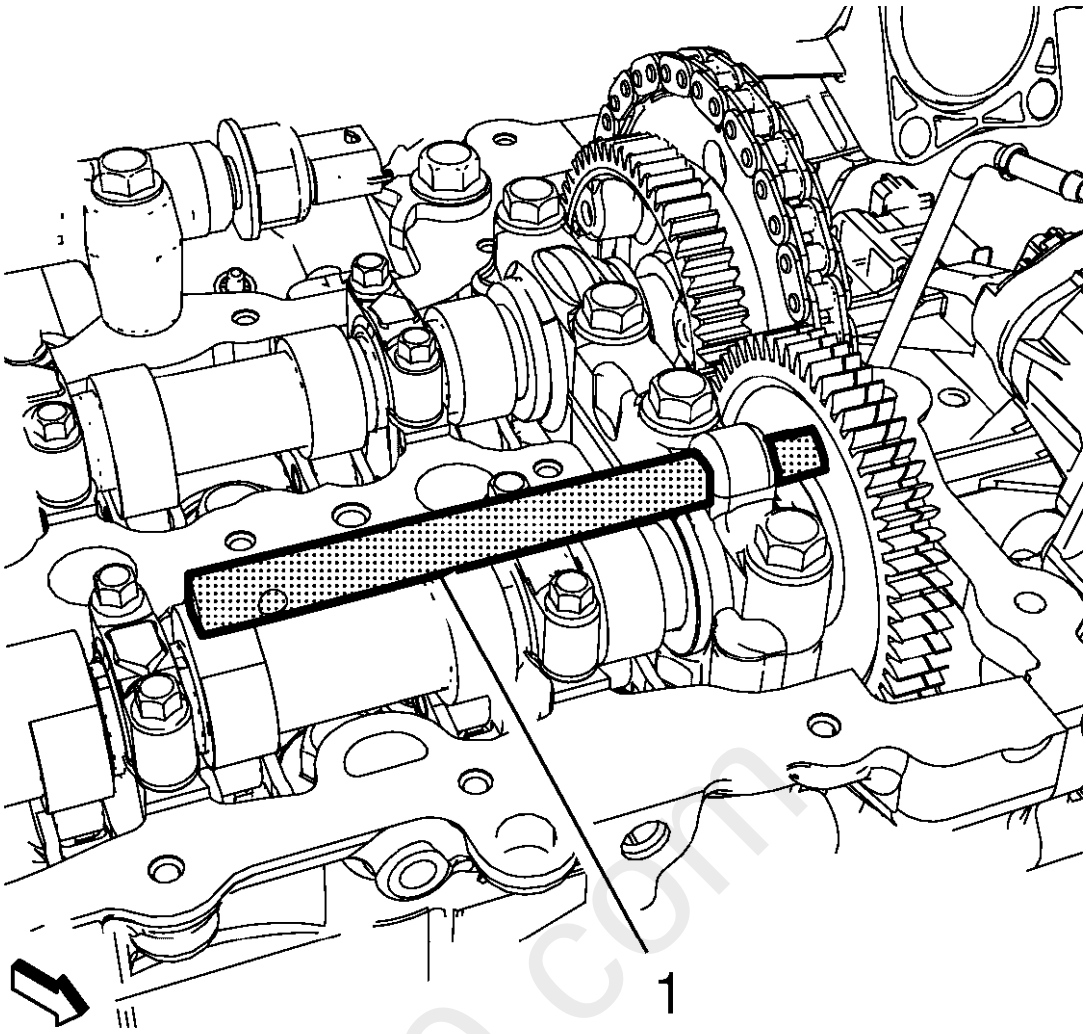


Fig. 183: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the EN-51143 fixing tool does not fit, adjust timing.**

40. Install the **EN-51143** fixing tool (1), by carefully turning the hexagon of the camshaft.
41. Remove the **EN-51143** fixing tool.
42. Raise the vehicle.

mcx30.com

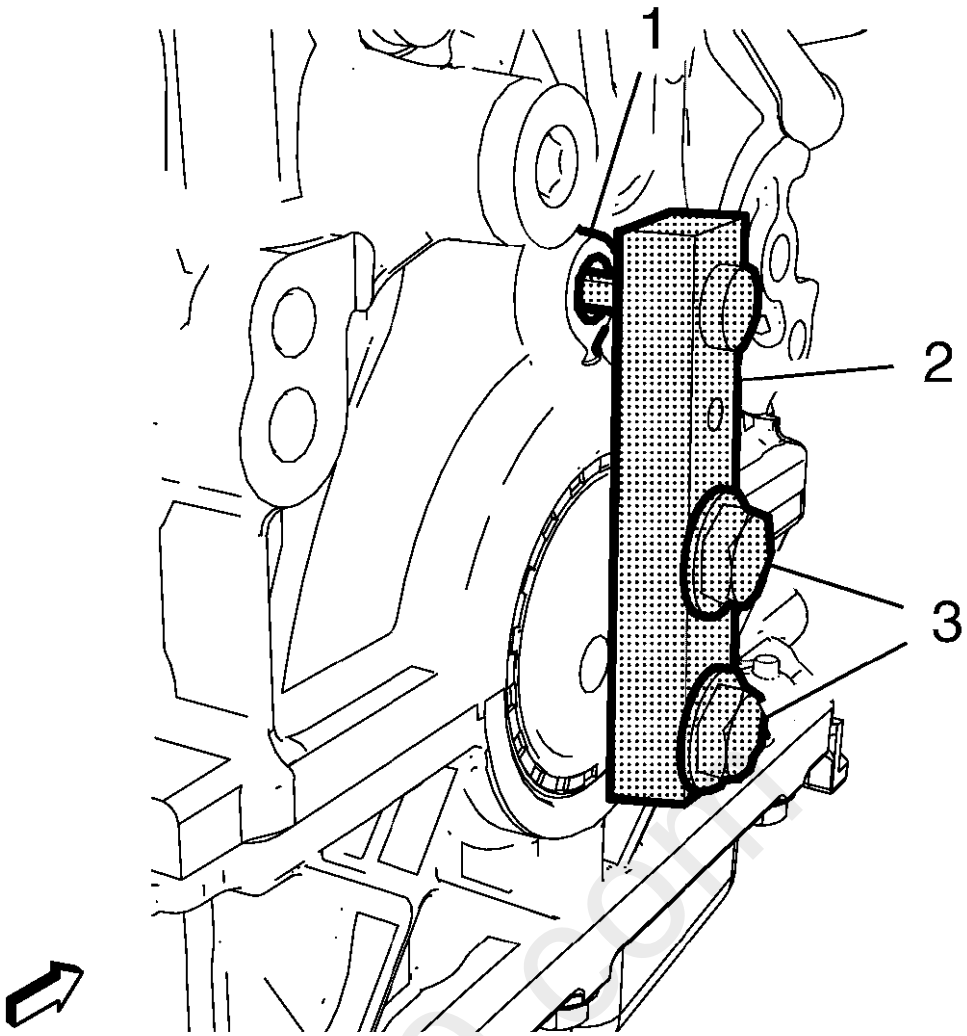


Fig. 184: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

43. Remove the 2 bolts (3).
44. Remove the **EN-51140** fixing tool (2).
45. Install Crankshaft Pulley. Refer to **Crankshaft Pulley Replacement**
46. Install Camshaft Housing. Refer to **Camshaft Housing Replacement**
47. Install Throttle Body Assembly. Refer to **Throttle Body Assembly Replacement**
48. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

INTAKE CAMSHAFT REPLACEMENT

Special Tools

- **EN-50509** Split Intake Camshaft Sprocket Fixing Tool
- **EN-51140** Crankshaft Fixing Tool
- **EN-51143** Camshaft Sprocket Fixing Tool
- **EN-51188** Timing Chain Camshaft Sprocket Fixing Tool

Equivalent regional tools: **Special Tools**

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Throttle Body Assembly. Refer to **Throttle Body Assembly Replacement**
3. Remove Camshaft Housing. Refer to **Camshaft Housing Replacement**
4. Remove Crankshaft Pulley. Refer to **Crankshaft Pulley Replacement**

mcx30.com

5. Lower the vehicle. Refer to **Lifting and Jacking the Vehicle**

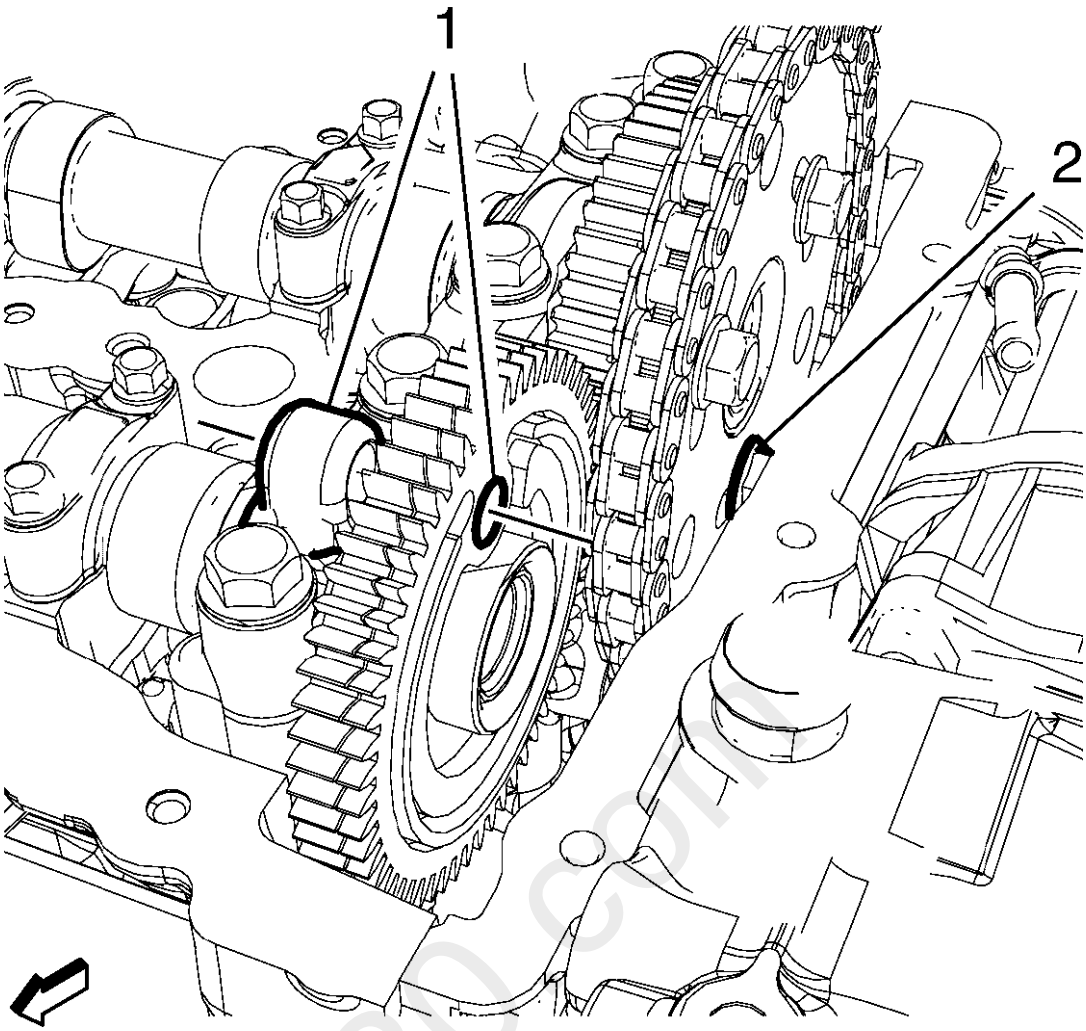


Fig. 185: Aligning Bores
Courtesy of GENERAL MOTORS COMPANY

6. Check the Top Dead Center (TDC) position to locate the correct camshaft sprocket bolt (2) that is to be removed first.
7. Check if the bores (1) are aligned.
8. If the bores are aligned, raise the vehicle.

mcx30.com

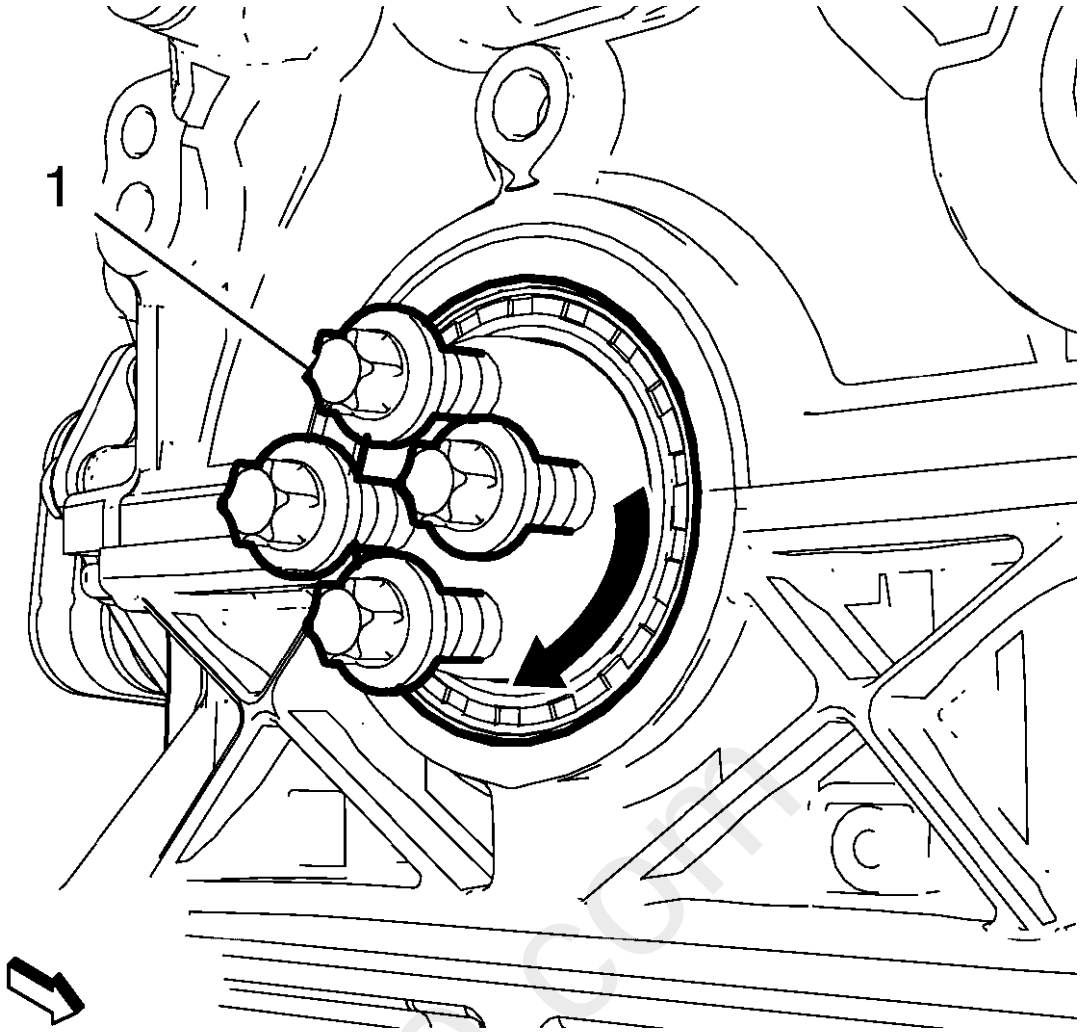


Fig. 186: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Install the 4 crankshaft pulley bolts (1).
10. Rotate the crankshaft 360 degrees in direction of arrow. Use a suitable flat bladed tool.
11. Lower the vehicle.

mcx30.com

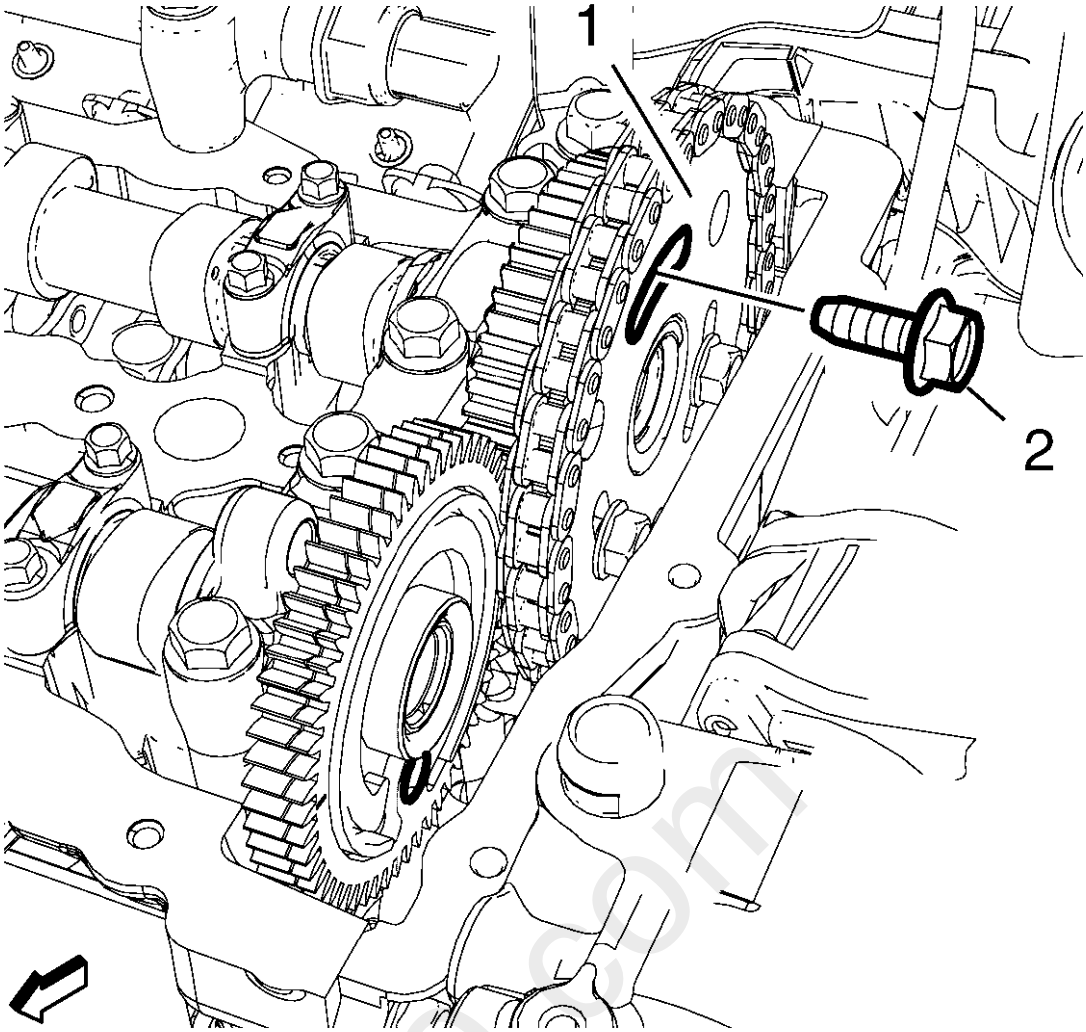


Fig. 187: Camshaft Sprocket And Bolt
Courtesy of GENERAL MOTORS COMPANY

12. Remove the camshaft sprocket bolt (2) from the intake camshaft sprocket (1). Counterhold with a wrench at the camshaft hexagon.
13. Raise the vehicle.

mcx30.com

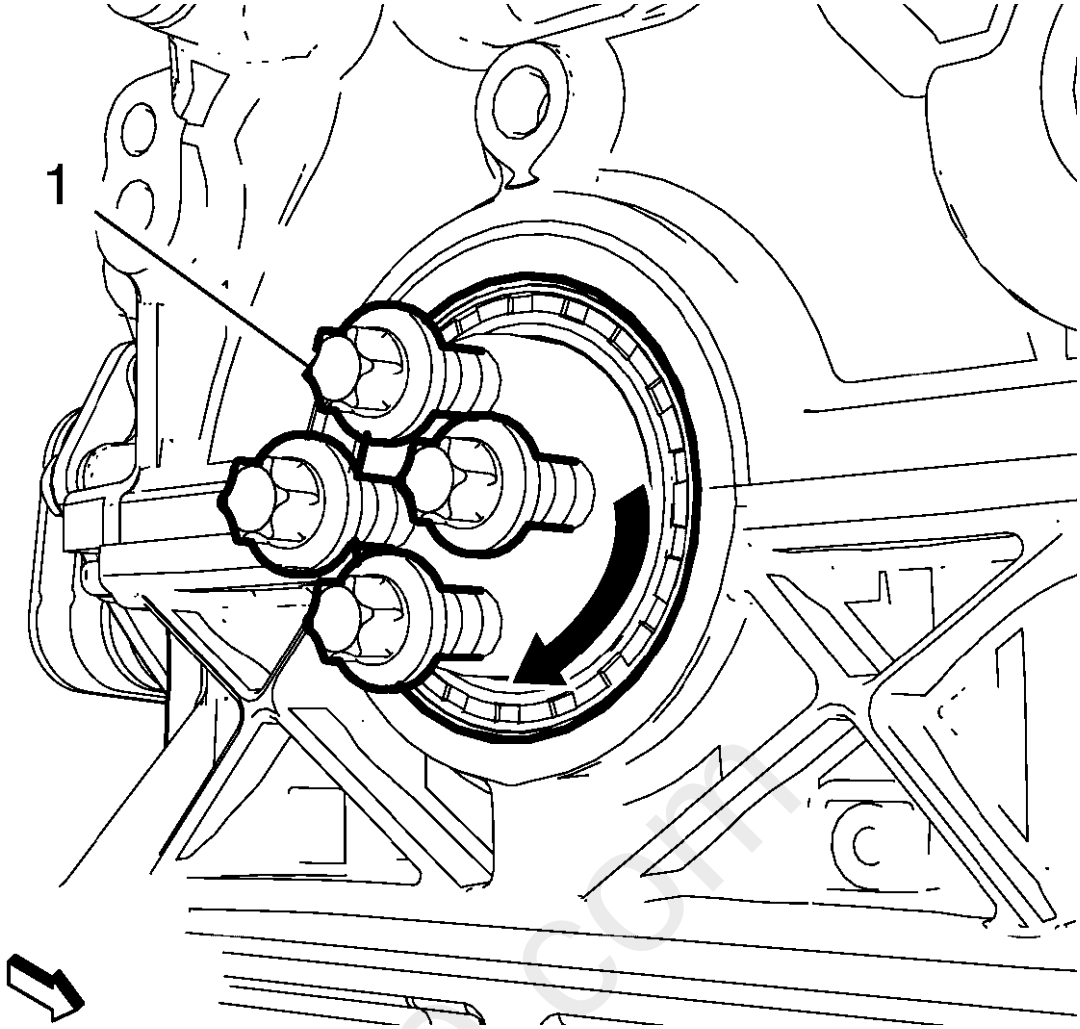


Fig. 188: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

14. Rotate the crankshaft 360 degrees in direction of arrow. Use a suitable flat bladed tool at the 4 crankshaft pulley bolts (1).
15. Remove the 4 crankshaft pulley bolts (1).

mcx30.com

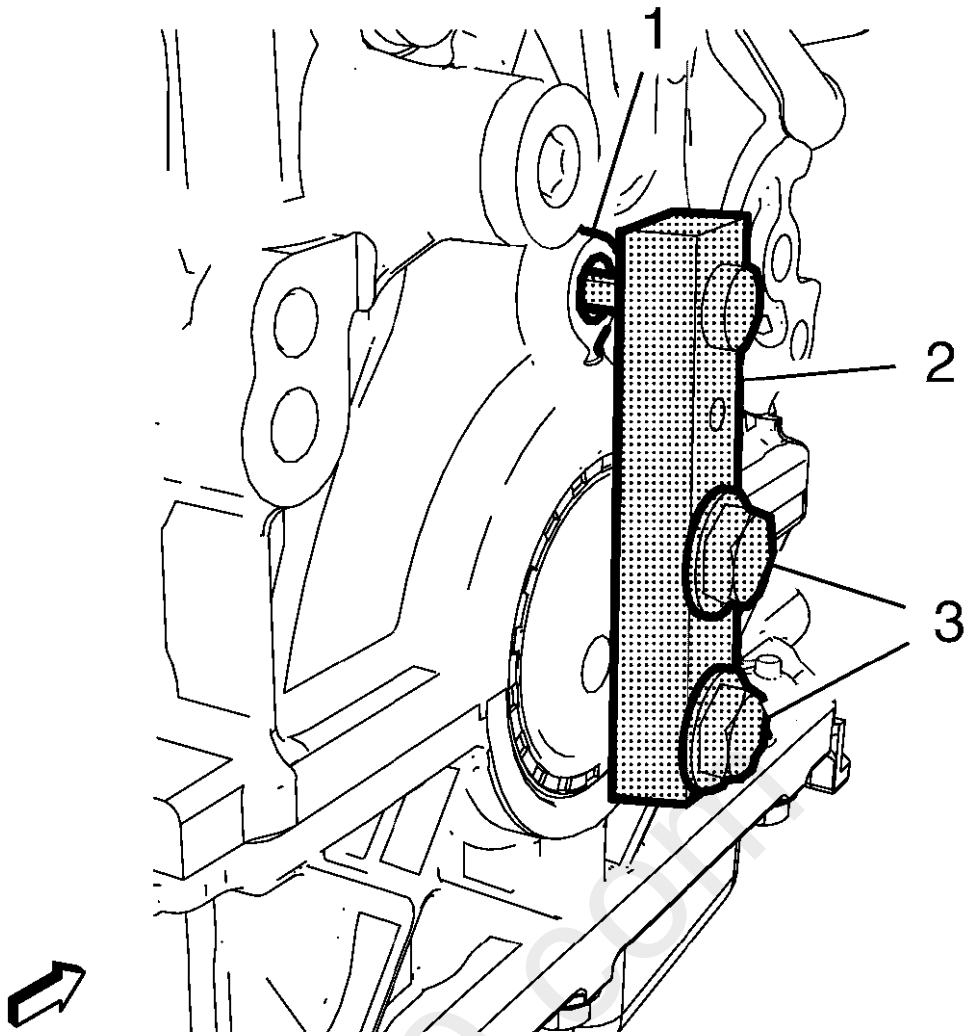


Fig. 189: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

16. Install the **EN-51140** fixing tool (2).
17. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).
18. Lower the vehicle.

mcx30.com

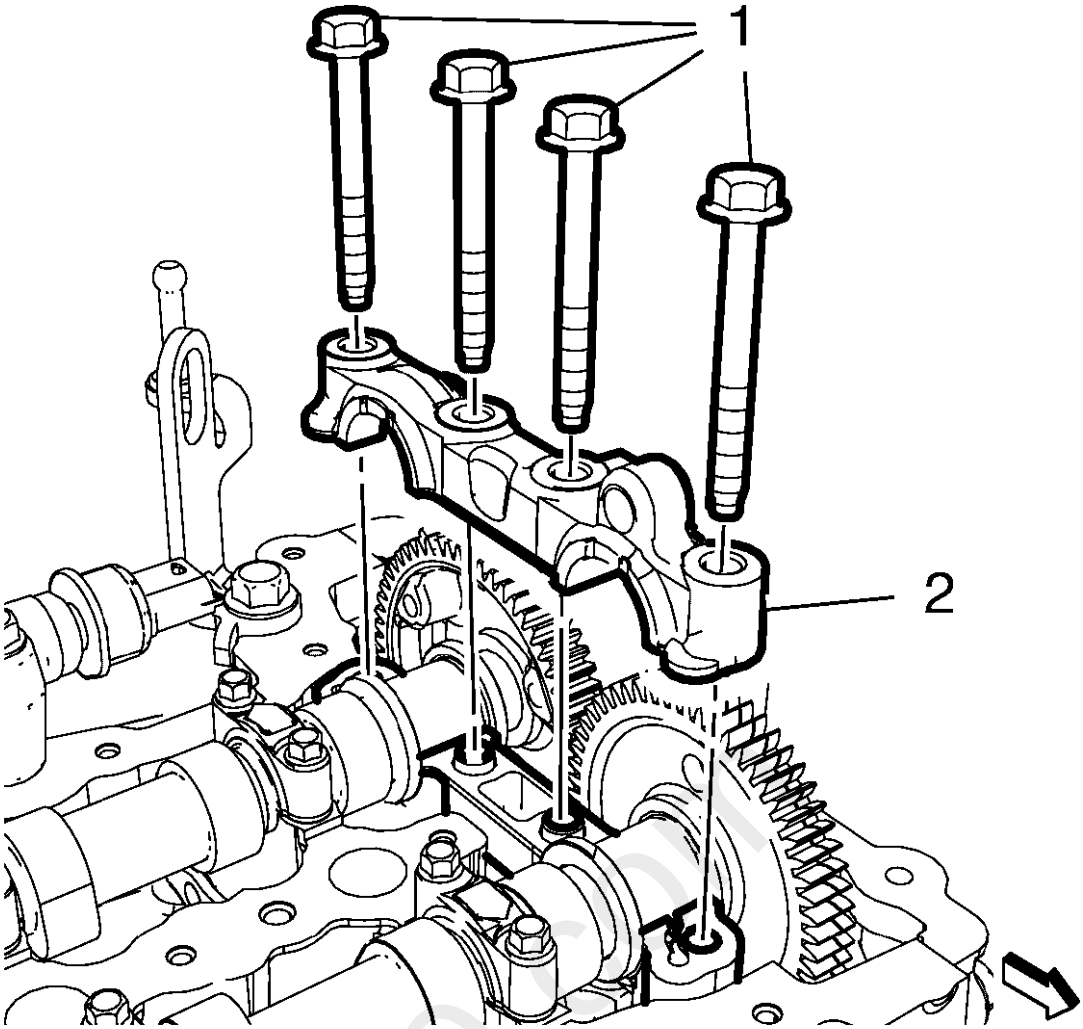


Fig. 190: Camshaft Bearing Rear Cap And Bolts
Courtesy of GENERAL MOTORS COMPANY

19. Remove the 4 camshaft bearing rear cap bolts (1).
20. Remove the camshaft bearing rear cap (2).

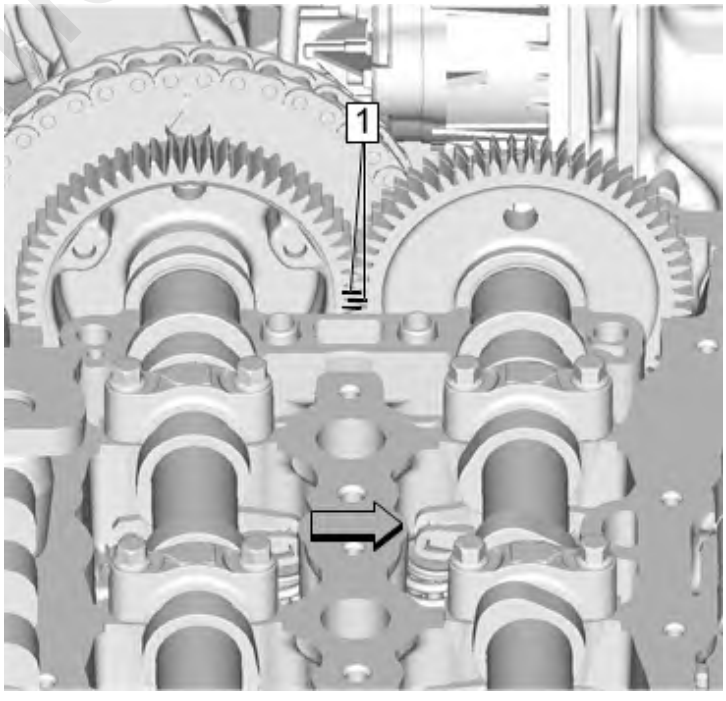


Fig. 191: Mark Backside Of Both Cam Gears With Paint Marks
Courtesy of GENERAL MOTORS COMPANY

21. Mark the backside of both cam gears with paint marks (1).

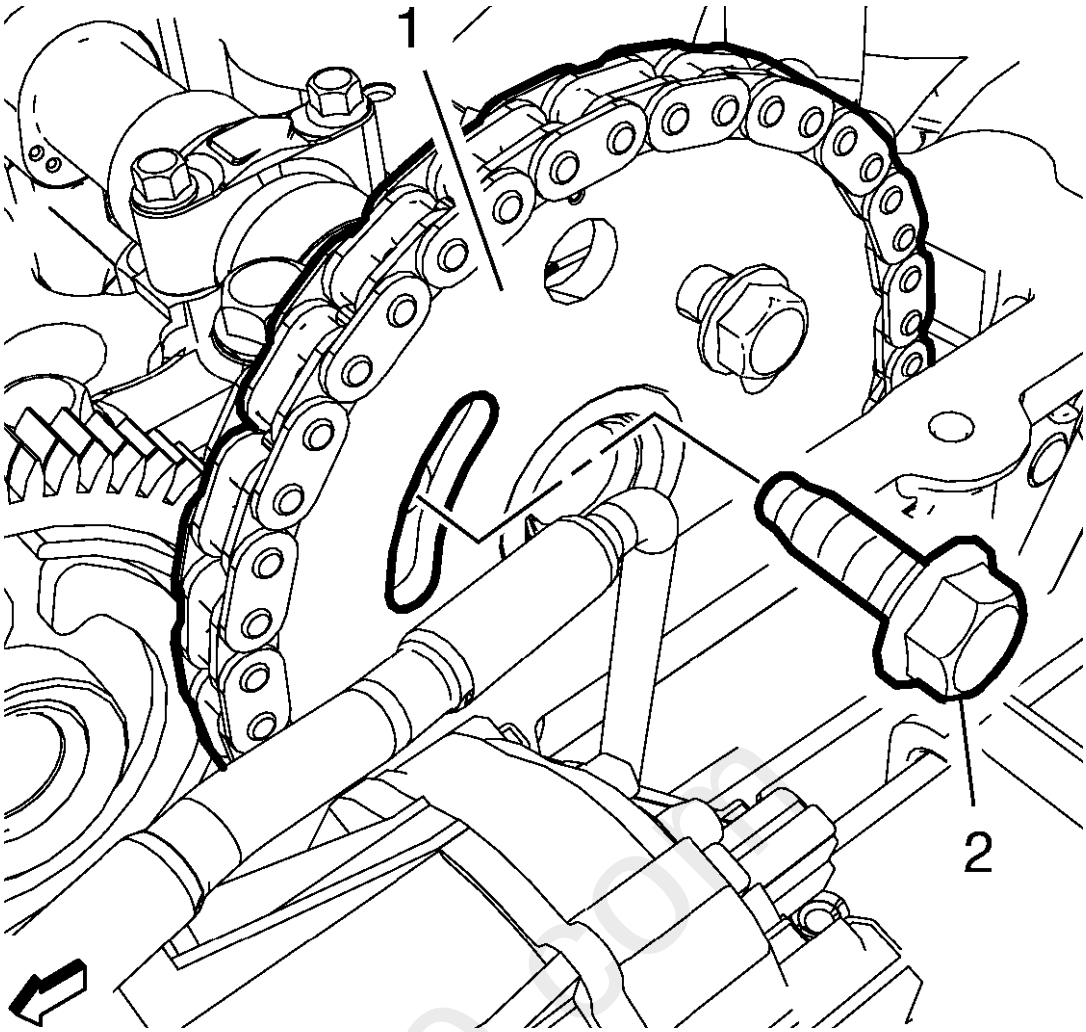


Fig. 192: Camshaft Sprocket And Bolt
Courtesy of GENERAL MOTORS COMPANY

22. Remove the camshaft sprocket bolt (2) from the camshaft sprocket (1). Counterhold with a wrench at the camshaft hexagon.

mcx30.com

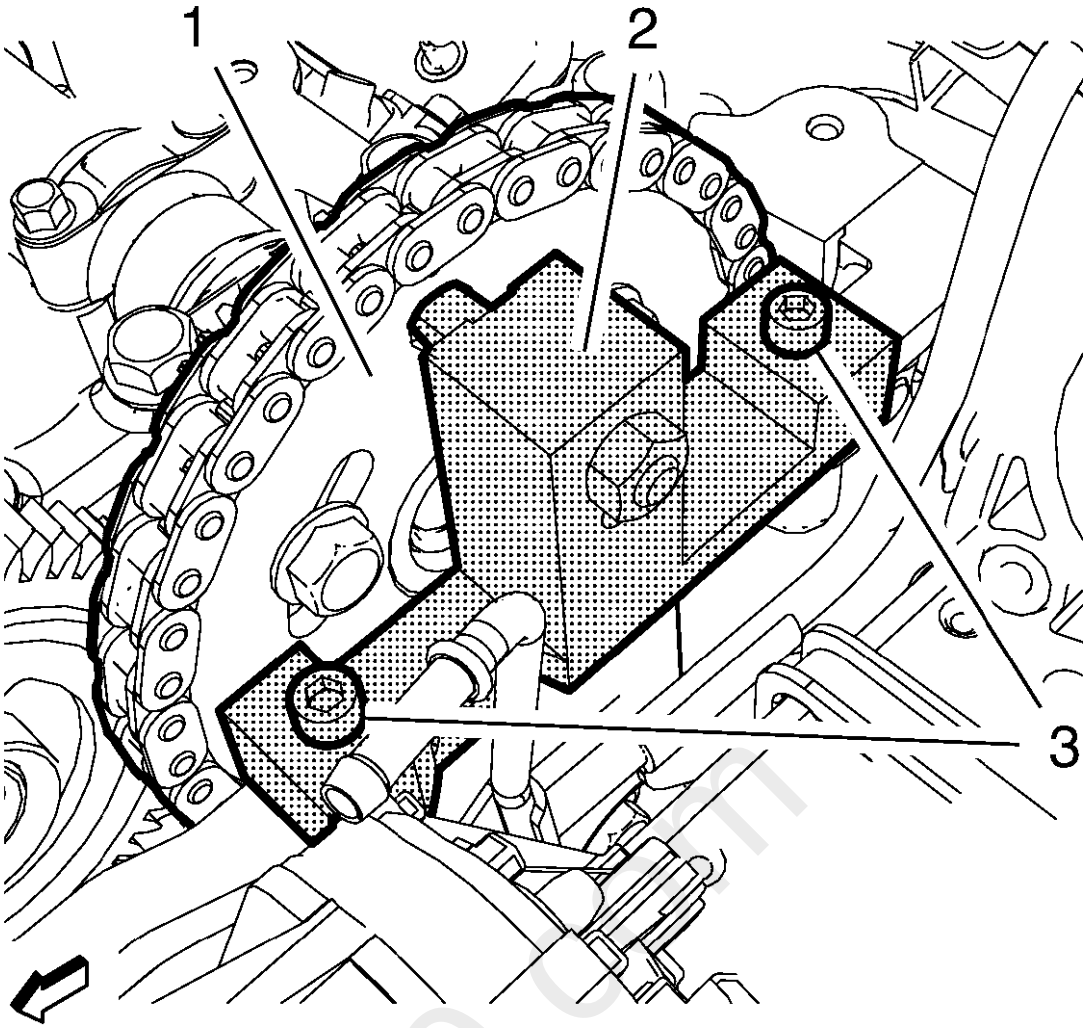


Fig. 193: Timing Chain Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

23. Install the **EN-51188** fixing tool (2) to fix the camshaft sprocket (1).
24. Install the 2 bolts (3).

mcx80.com

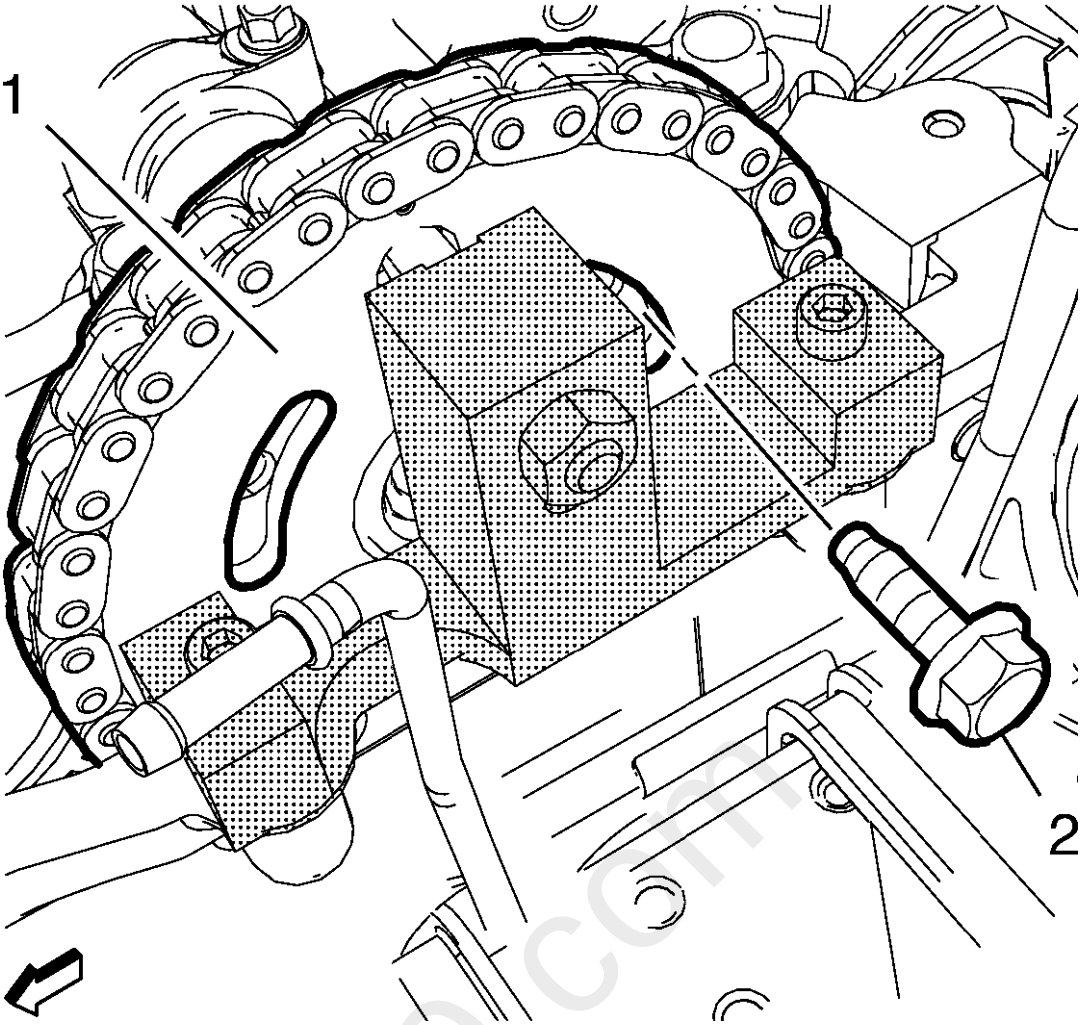


Fig. 194: Camshaft Sprocket And Bolts
Courtesy of GENERAL MOTORS COMPANY

25. Remove the camshaft sprocket bolt (2) from the camshaft sprocket (1). Counterhold with a wrench at the camshaft hexagon.

mcx30.com

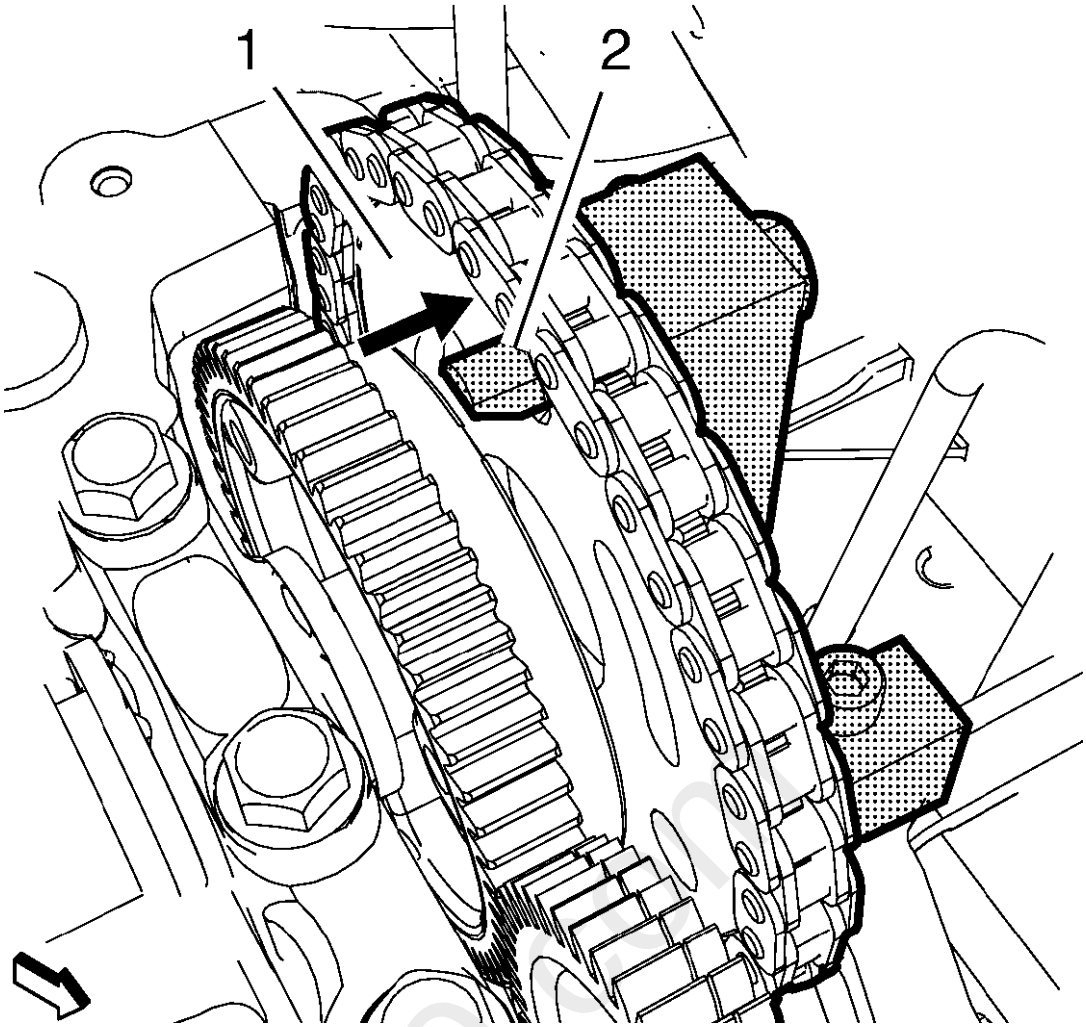


Fig. 195: Camshaft Sprocket Over Pin Of Timing Chain Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

26. Slide the camshaft sprocket (1) over the pin (2) of the **EN-51188** fixing tool in arrow direction.

mcx30.com

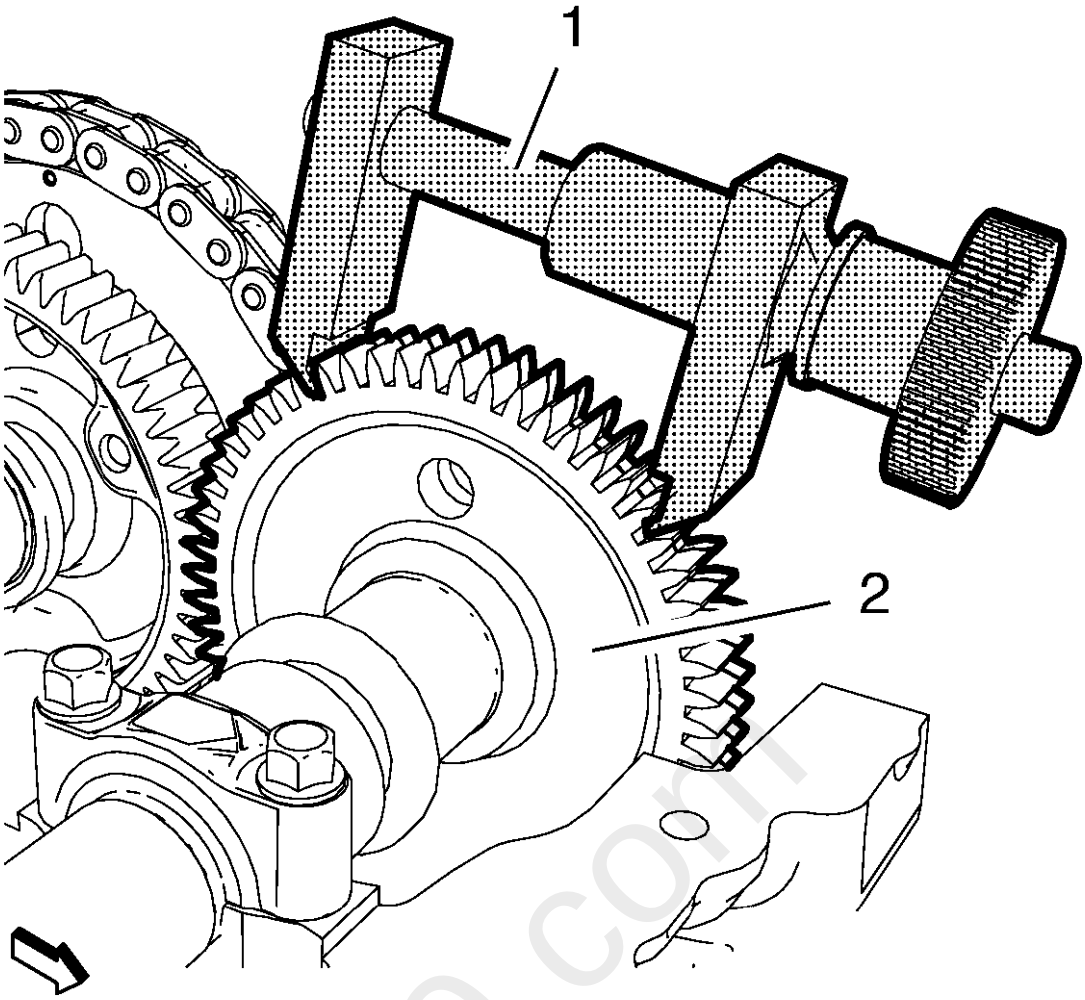


Fig. 196: Split Intake Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

27. Install the **EN-50509** fixing tool (1) to the exhaust camshaft sprocket (2).

mcx30.com

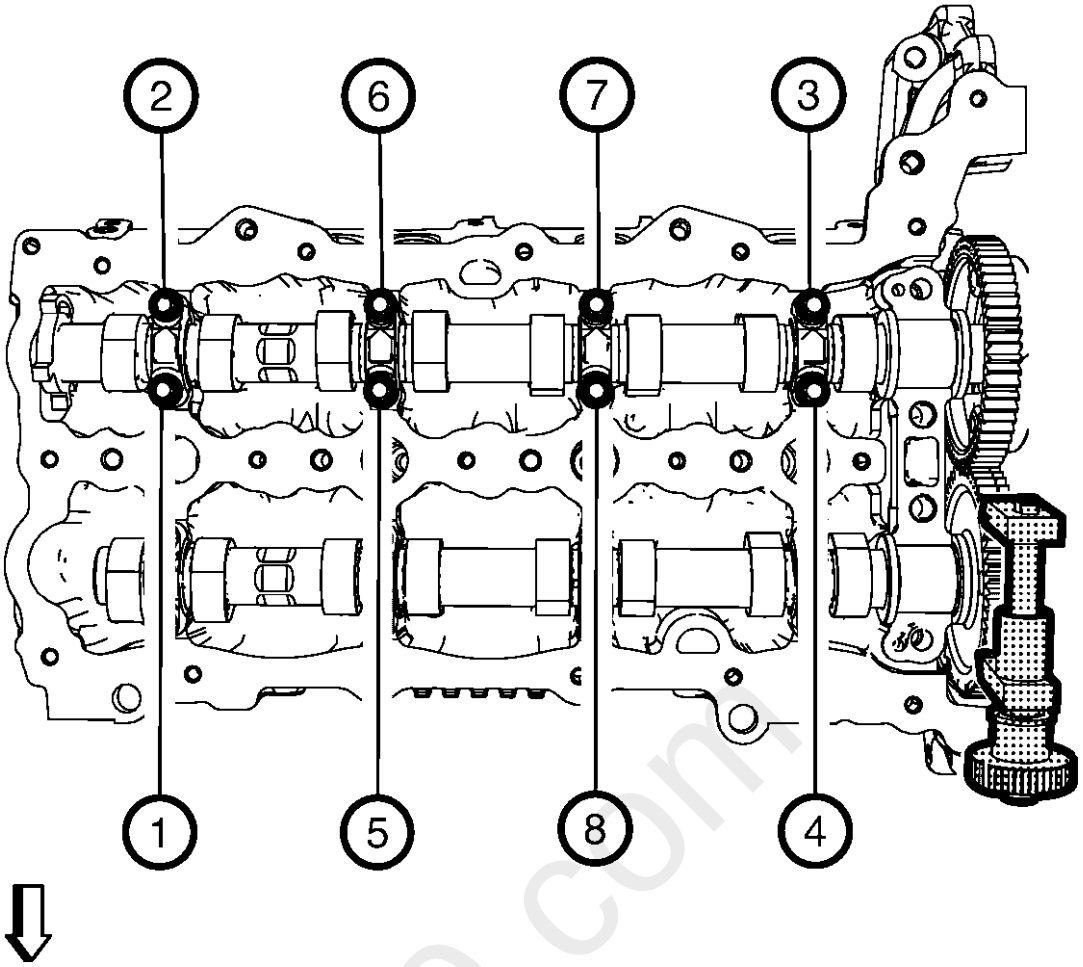


Fig. 197: Intake Camshaft Bearing Cap Bolt Loosening Sequence
Courtesy of GENERAL MOTORS COMPANY

28. Loosen the 8 intake camshaft bearing cap bolts in sequence as shown.

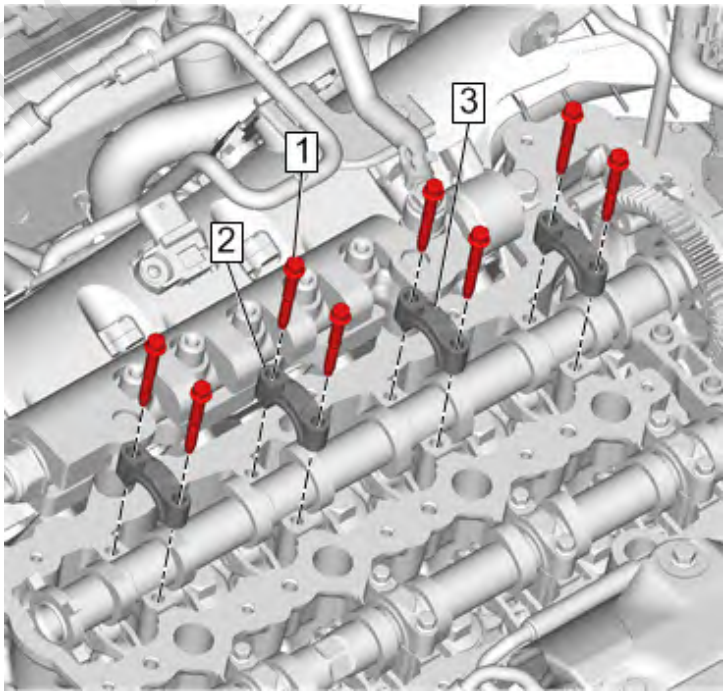


Fig. 198: Intake Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the direction of the arrows (3) on the camshaft bearing caps pointing to outside of the cylinder head.**

29. Remove the 8 intake camshaft bearing cap bolts (1).
30. Remove the 4 intake camshaft bearing caps (2) and lay aside in the order as they were removed.

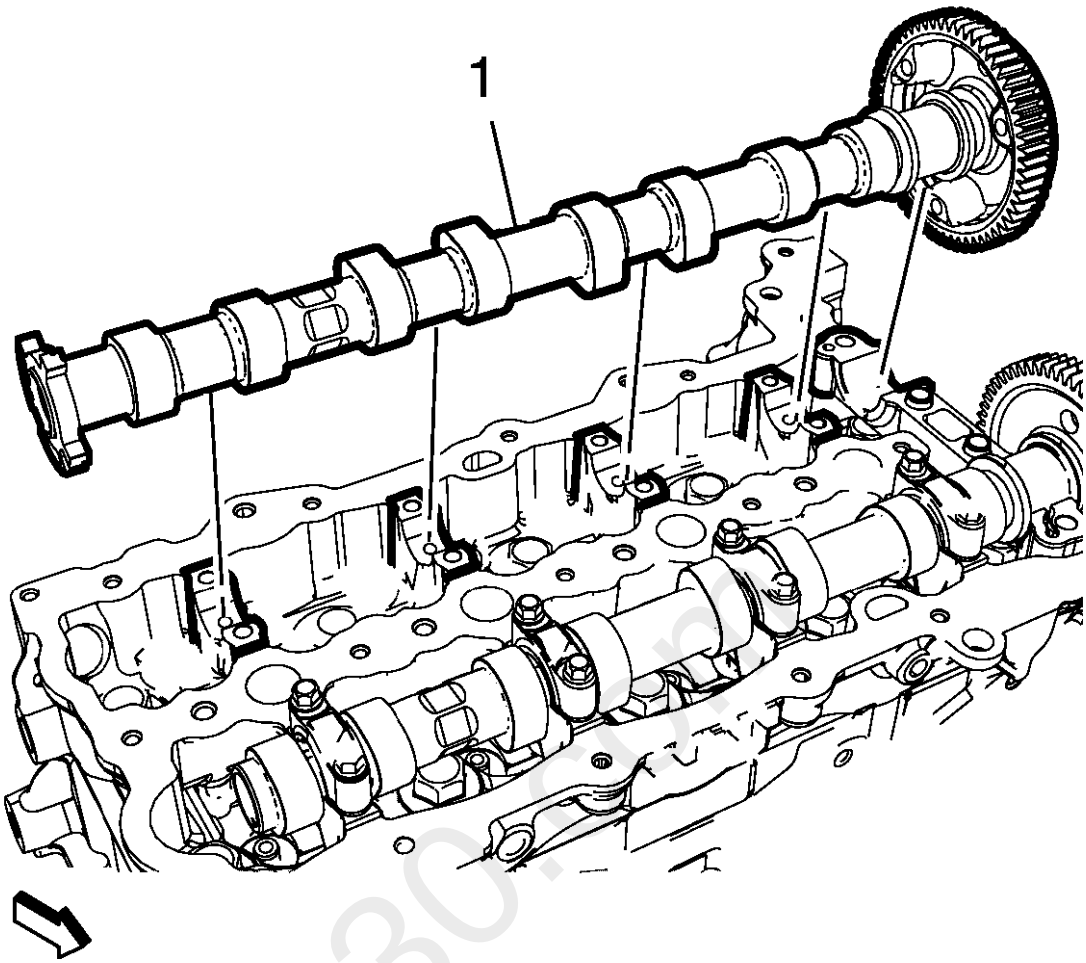


Fig. 199: Intake Camshaft
Courtesy of GENERAL MOTORS COMPANY

31. Remove the intake camshaft (1).
32. Cover the timing case with a lint free cloth.

Installation Procedure

NOTE: **Before installing the intake camshaft, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

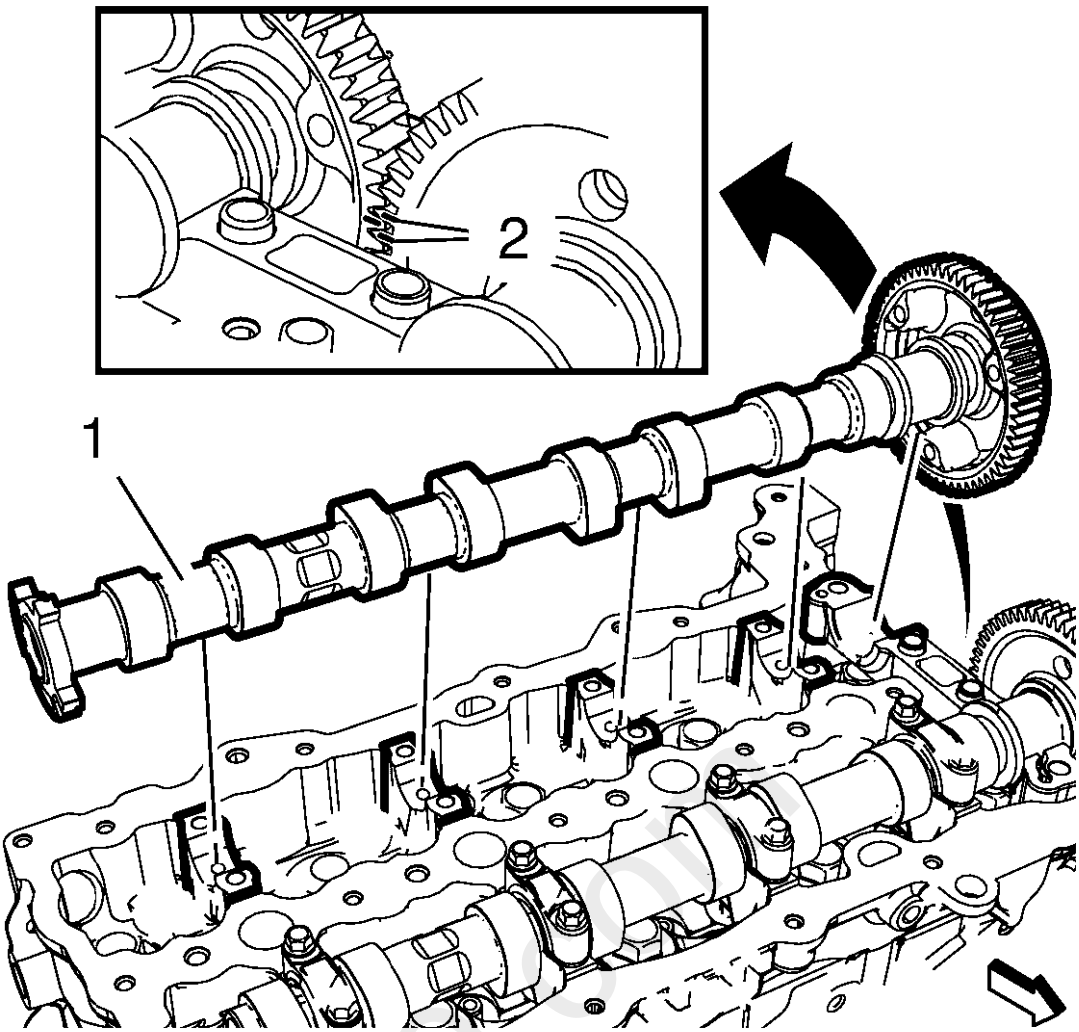


Fig. 200: Intake Camshaft With Camshaft Sprocket Marks Aligned
Courtesy of GENERAL MOTORS COMPANY

2. Coat all bearing surfaces with engine oil.

NOTE: **Ensure the marks (2) of the camshaft sprocket are aligned.**

3. Install the intake camshaft (1).

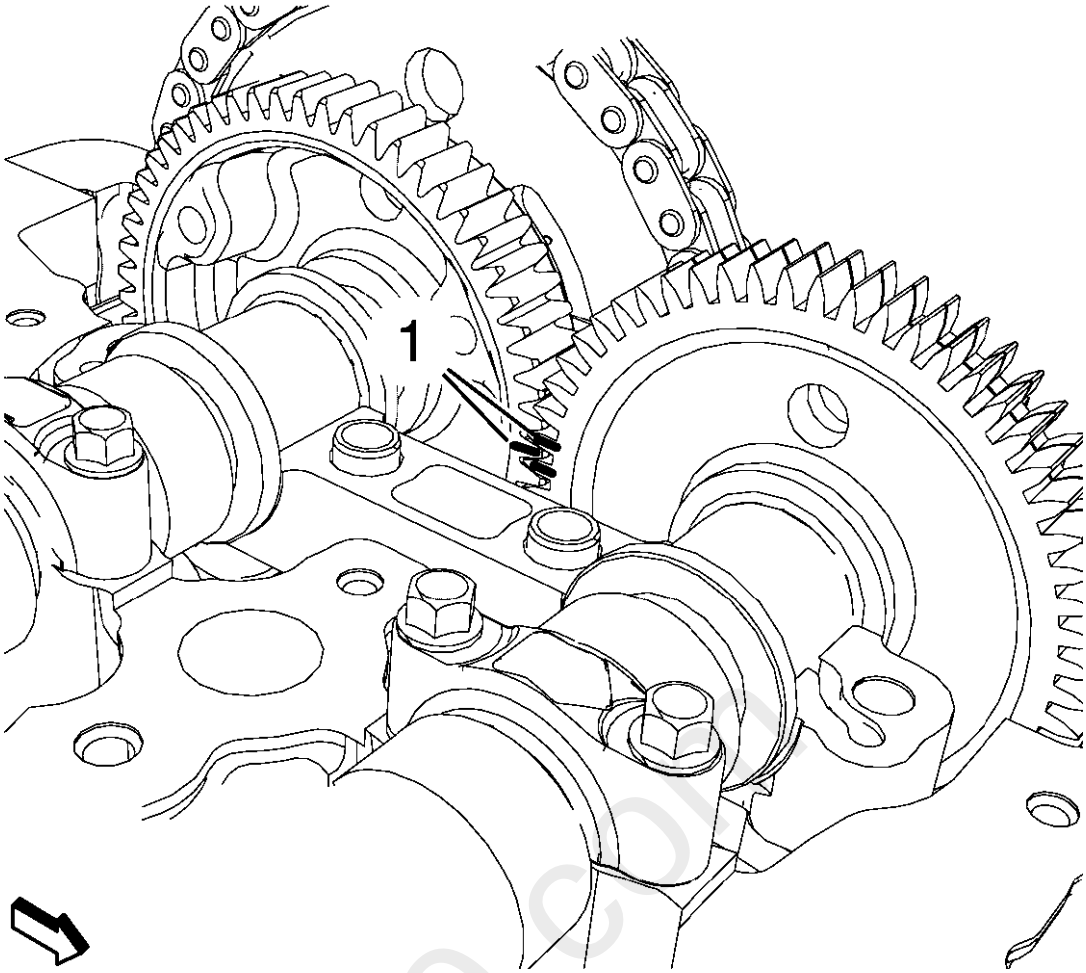


Fig. 201: Marking Exhaust Camshaft Sprocket And Intake Camshaft Sprocket With Paint Marks
Courtesy of GENERAL MOTORS COMPANY

4. Check the marks (1) of the camshaft sprockets to ensure they are aligned.

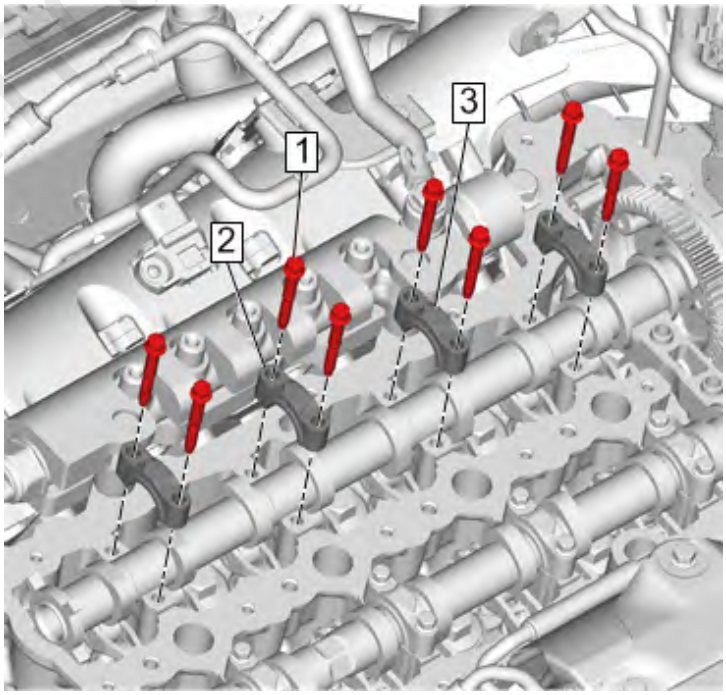


Fig. 202: Intake Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the direction of the arrows (3) on the camshaft bearing caps pointing to outside of the cylinder head.**

5. Install the 4 intake camshaft bearing caps (2) in the order as they were removed.
6. Install the 8 intake camshaft bearing cap bolts (1).

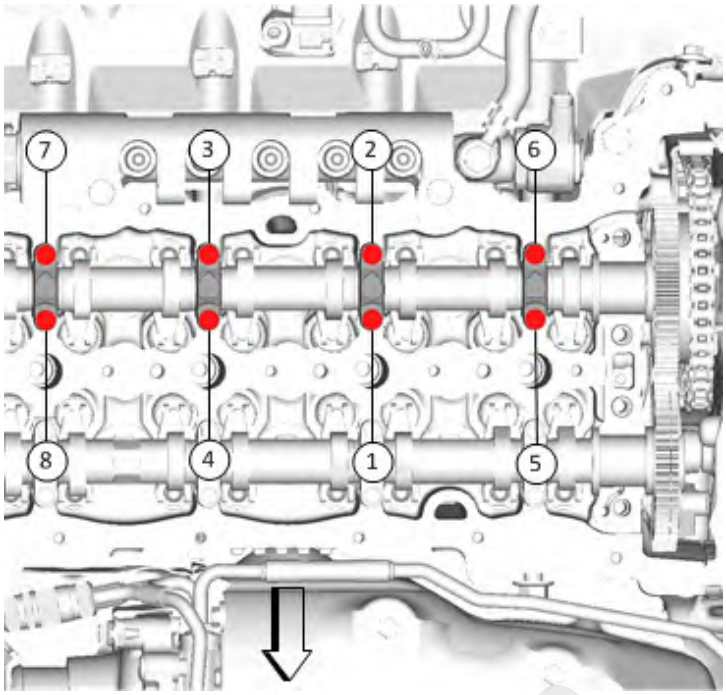


Fig. 203: Intake Camshaft Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

7. Tighten the 8 intake camshaft bearing cap bolts in sequence as shown to 10 N.m (89 lb in).

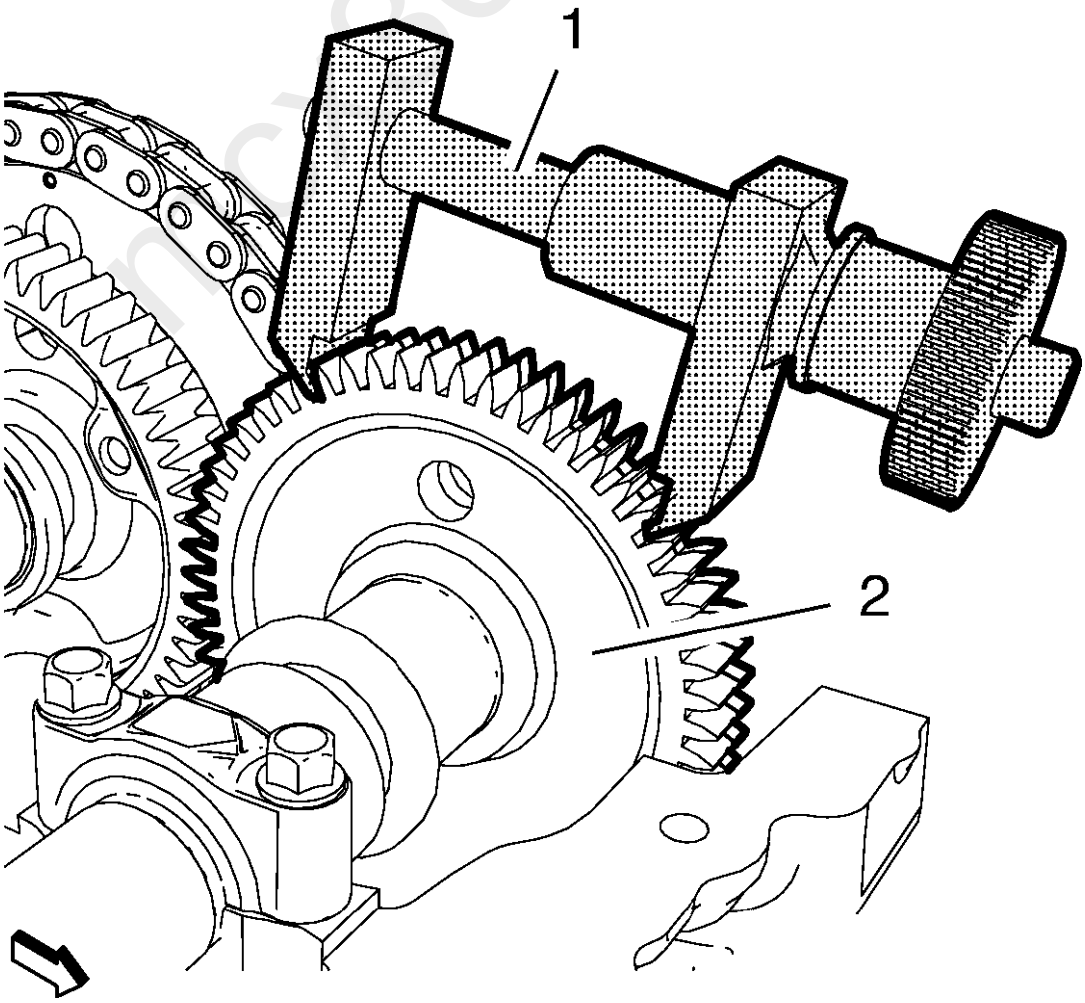


Fig. 204: Split Intake Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

8. Remove the **EN-50509** fixing tool (1) or the transport lock from the exhaust camshaft sprocket (2).

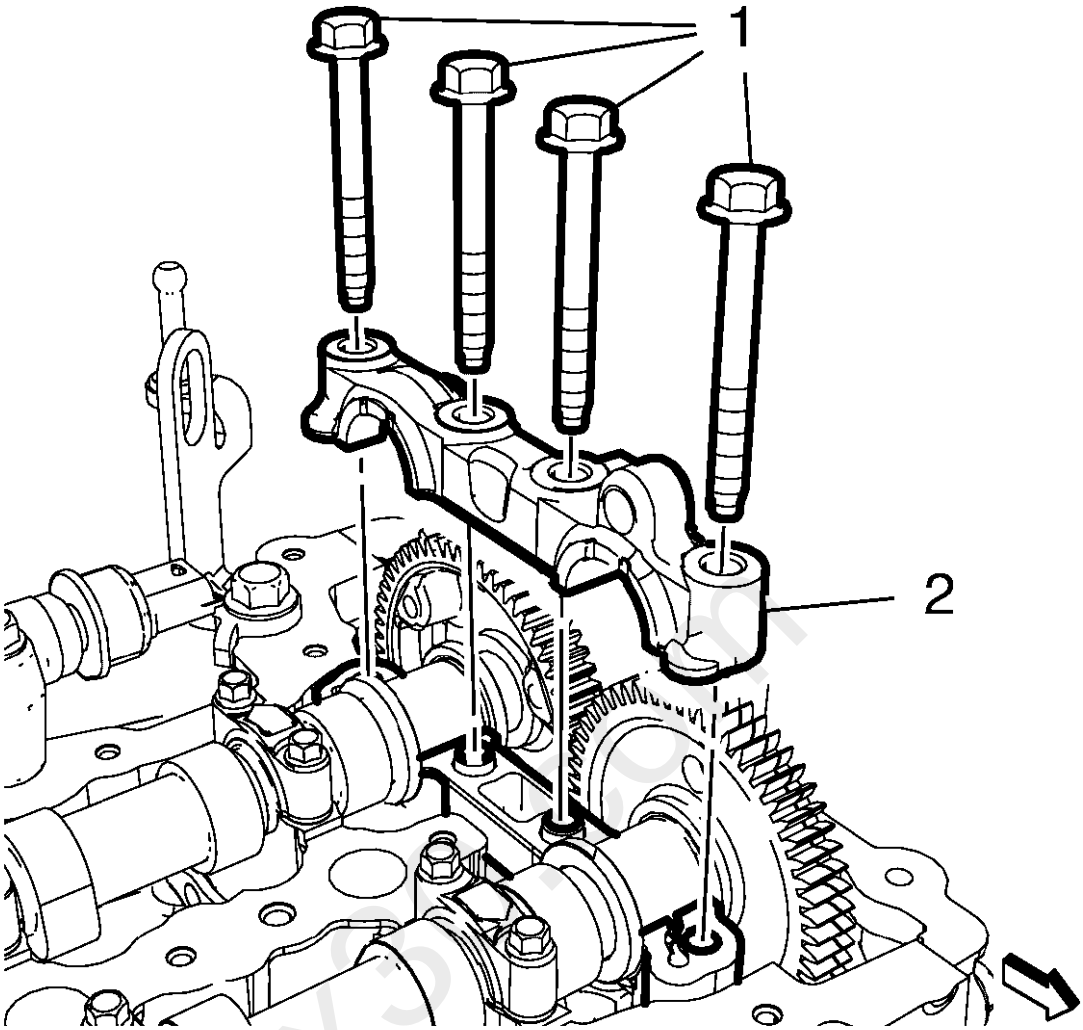


Fig. 205: Camshaft Bearing Rear Cap And Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Coat all bearing surfaces with engine oil.
10. Install the camshaft bearing rear cap (2).
11. Install the 4 camshaft bearing rear cap bolts (1).

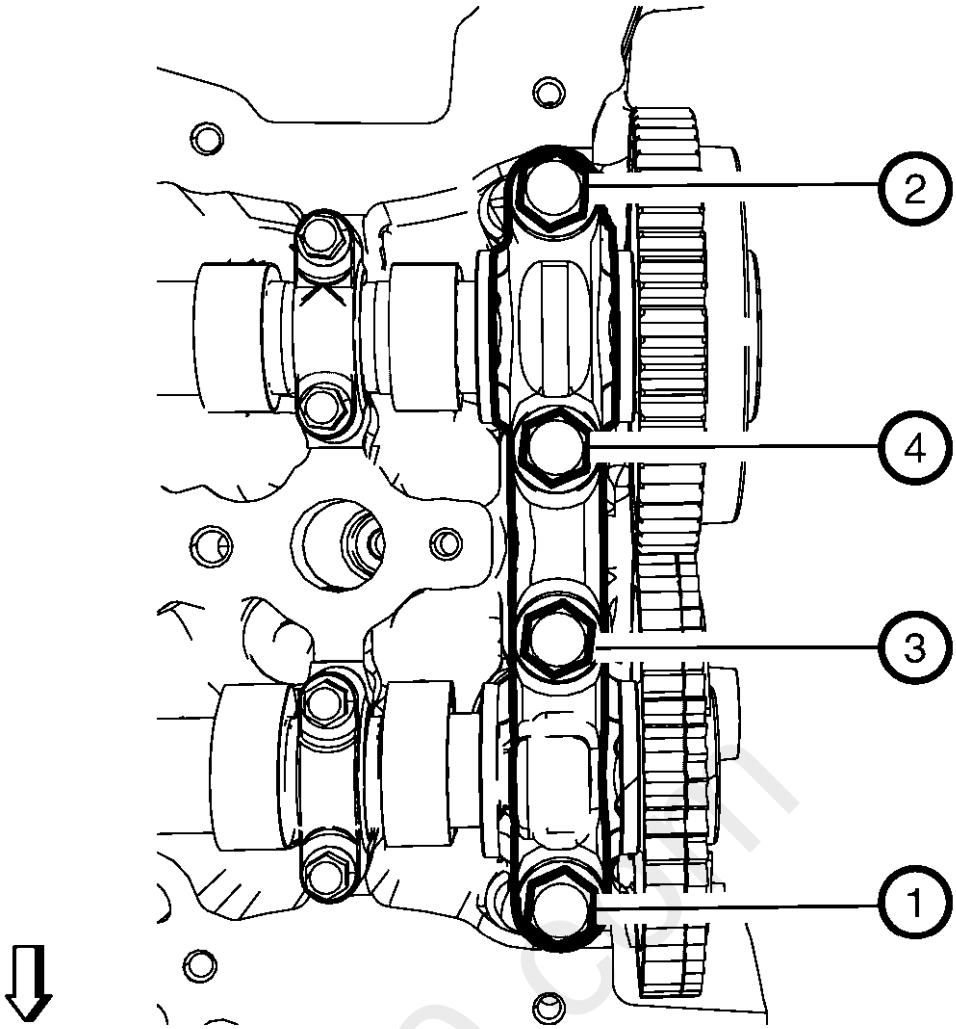


Fig. 206: Camshaft Rear Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

12. Tighten the 4 camshaft rear cap bolts in sequence as shown to 25 N.m (18 lb ft).

mcx30.com

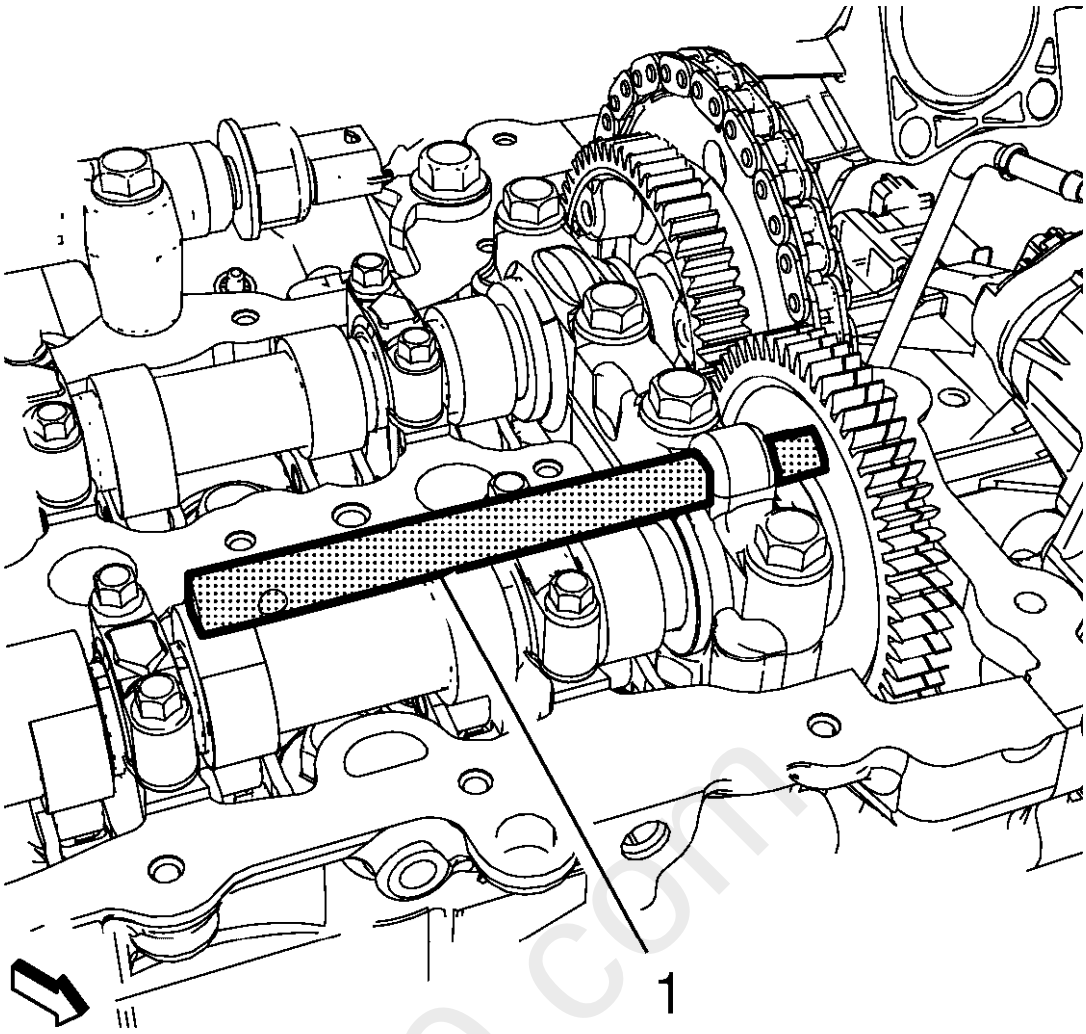


Fig. 207: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

13. To check for proper alignment, install the **EN-51143** fixing tool (1), by carefully turning the hexagon of the camshaft.

mcx30.com

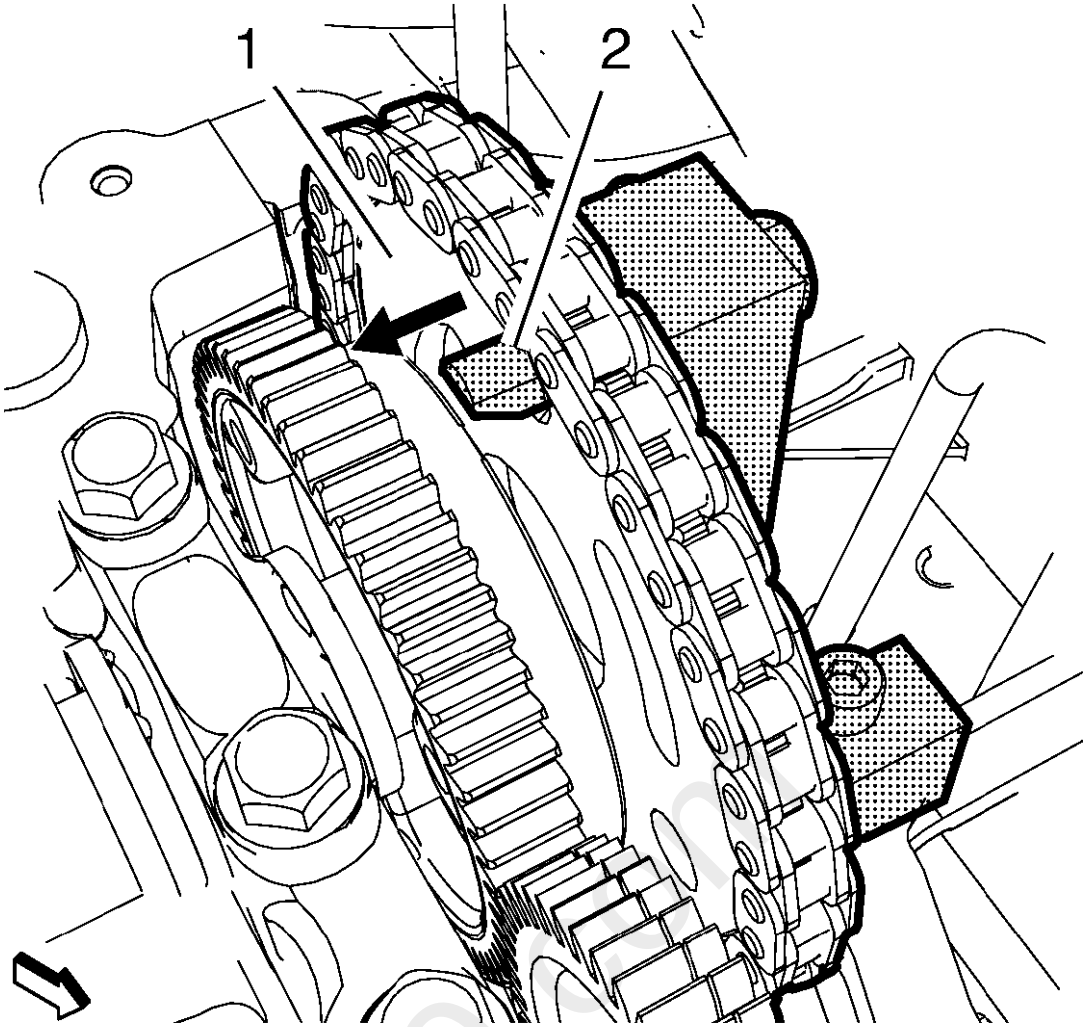


Fig. 208: Camshaft Sprocket Over Pin Of Timing Chain Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

14. Slide the camshaft sprocket (1) over the pin (2) of the **EN-51188** fixing tool in arrow direction.

mcx30.com

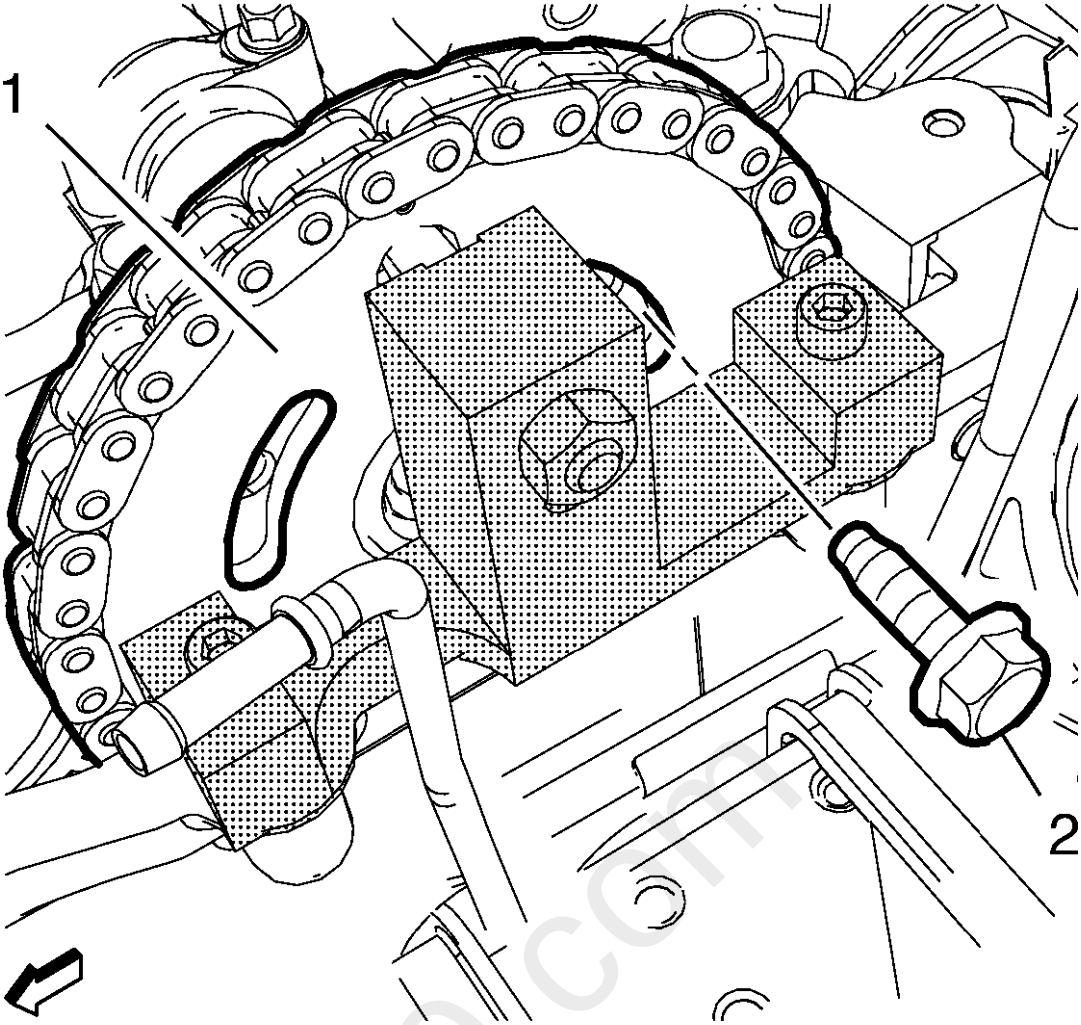


Fig. 209: Camshaft Sprocket And Bolts
Courtesy of GENERAL MOTORS COMPANY

15. Check that the camshaft sprocket (1) on the camshaft is properly applied.
16. Install the camshaft sprocket bolts (2), counterhold with a wrench at the camshaft hexagon, and tighten to 25 N.m (18 lb ft).

mx30.com

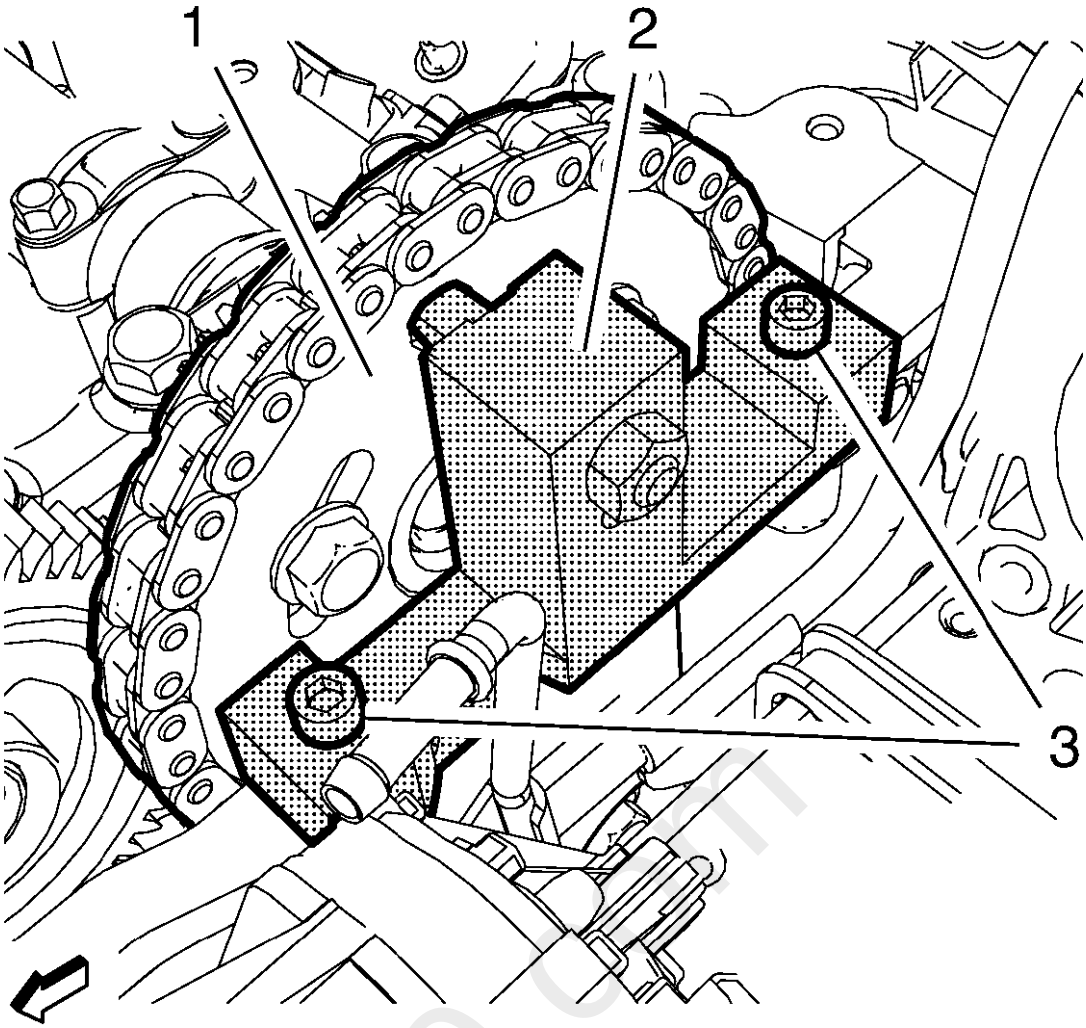


Fig. 210: Timing Chain Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

17. Remove the 2 bolts (3).
18. Remove **EN-51188** fixing tool (2).

mcx30.com

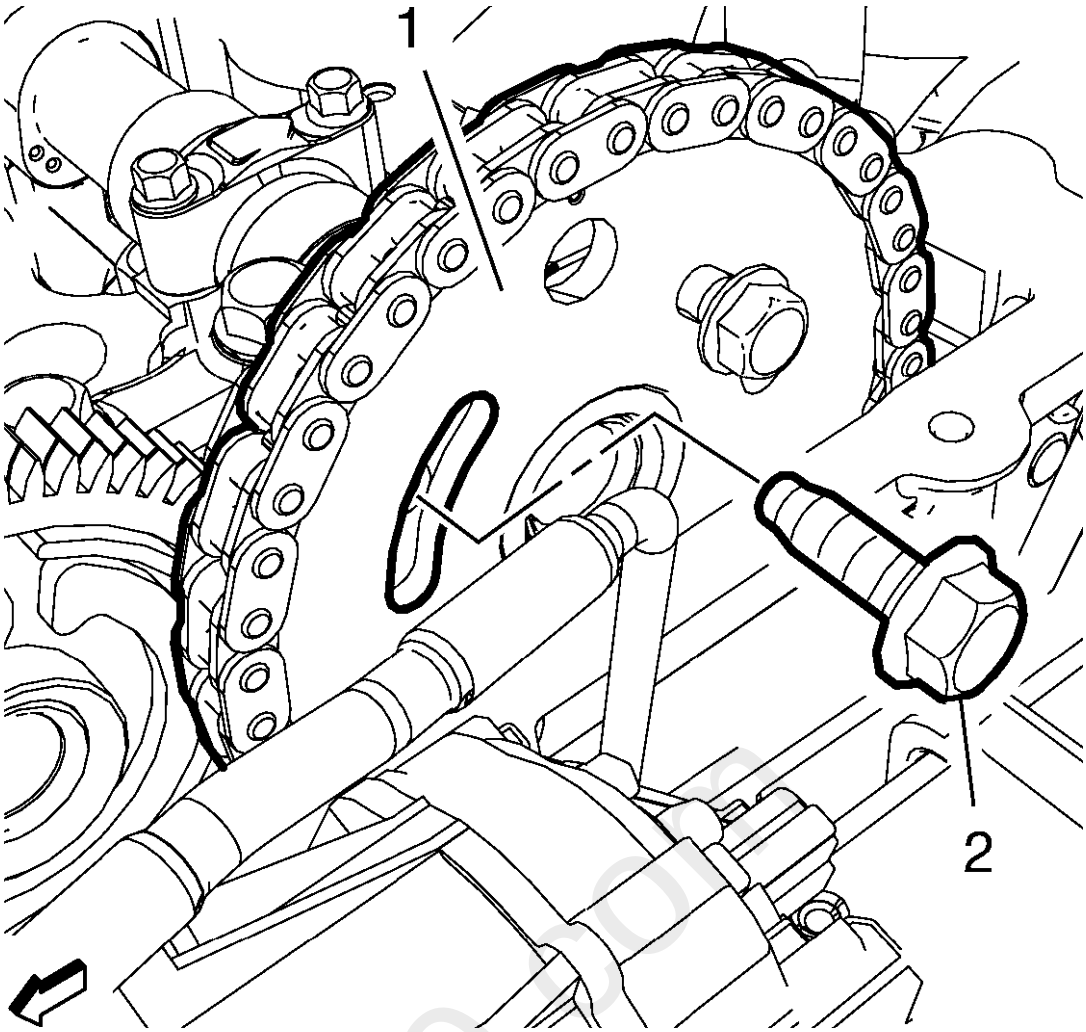


Fig. 211: Camshaft Sprocket And Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Cover the timing case with a lint-free cloth.**

19. Install the camshaft sprocket bolt (2) to the camshaft sprocket (1), counterhold with a wrench at the camshaft hexagon, and tighten to 25 N.m (18 lb ft).

mcx30.com

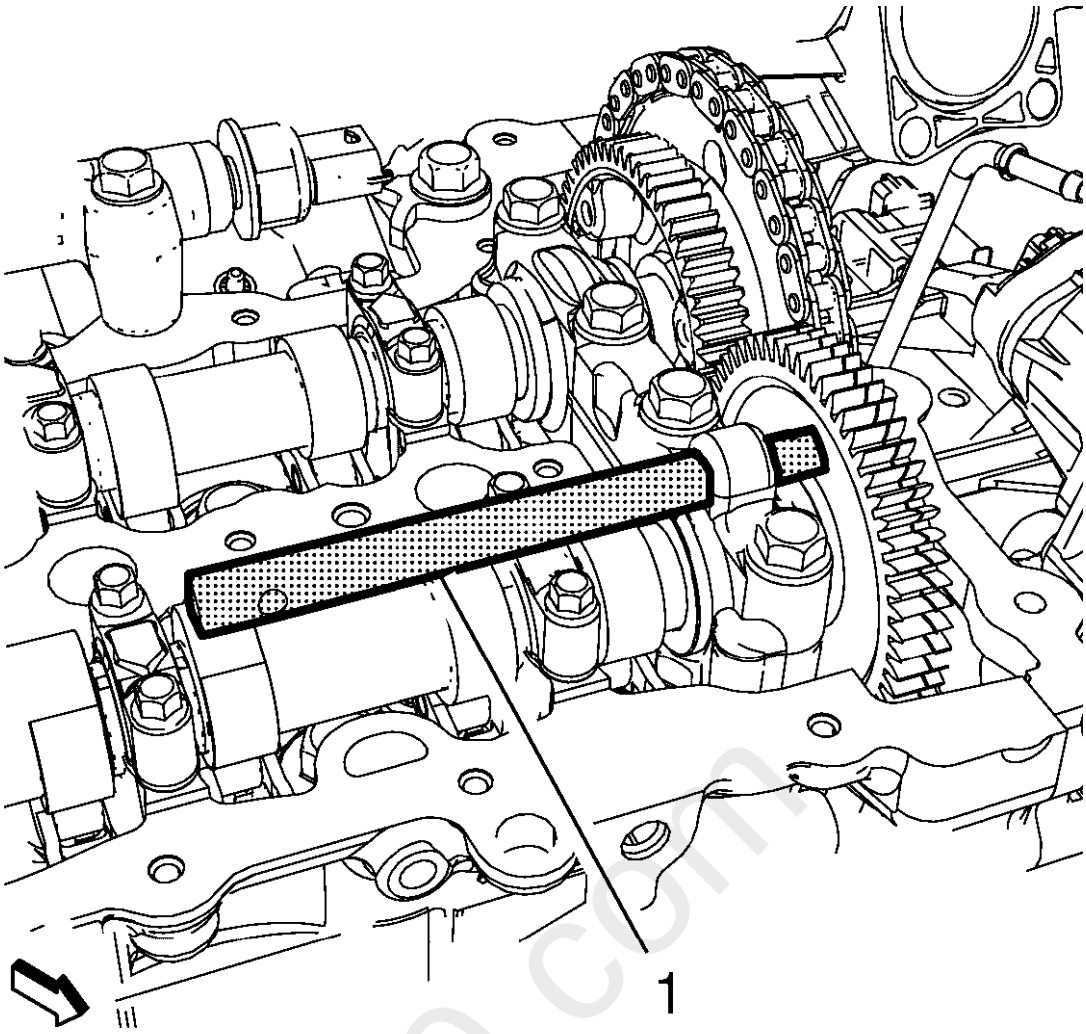


Fig. 212: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

20. Remove the **EN-51143** fixing tool (1).
21. Raise the vehicle.

mcx30.com

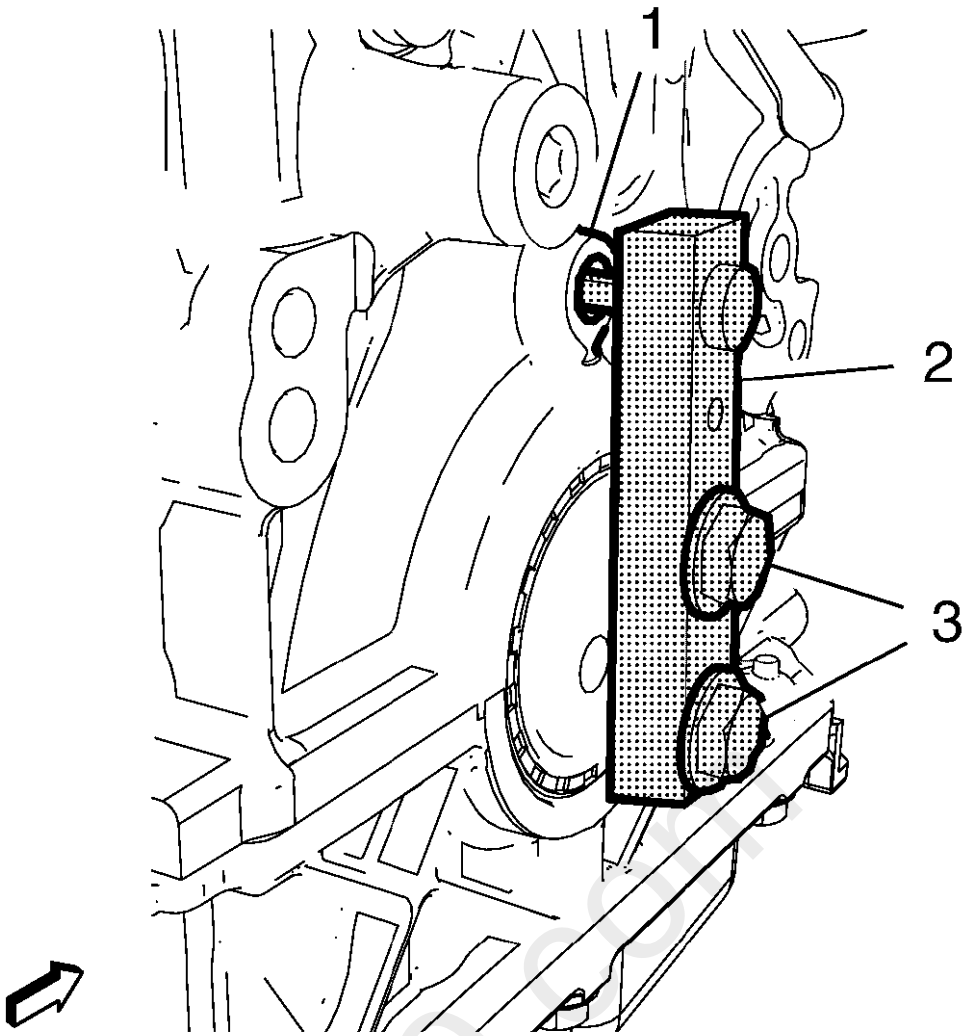


Fig. 213: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

22. Remove the 2 bolts (3).
23. Remove the **EN-51140** fixing tool (2).

mcx30.com

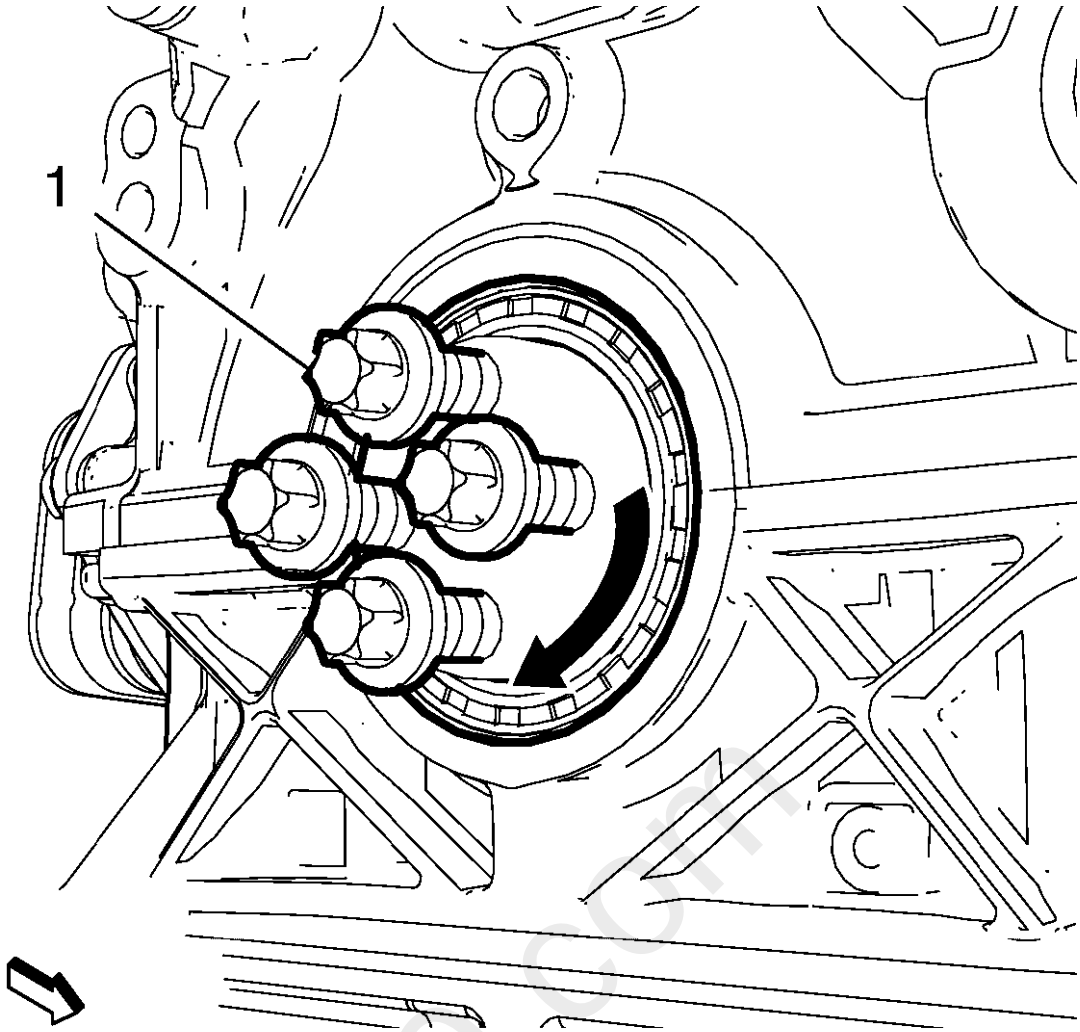


Fig. 214: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

24. Install the 4 crankshaft pulley bolts (1).

    Rotate the crankshaft 360 degrees in direction of arrow. Use a suitable flat bladed tool at the 4 crankshaft pulley bolts (1).

25. Lower the vehicle.

mcx30.com

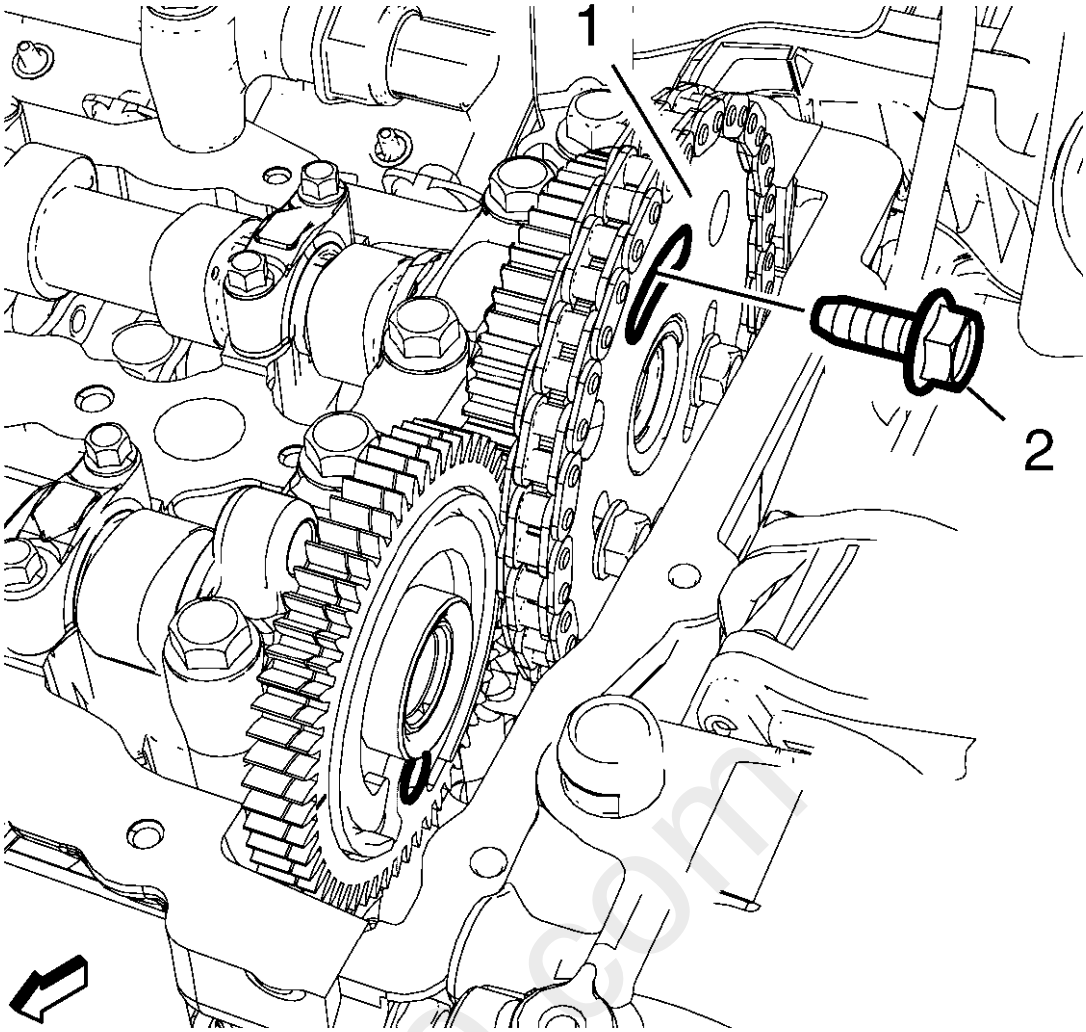


Fig. 215: Camshaft Sprocket And Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Cover the timing case with a lint-free cloth.**

26. Install the camshaft sprocket bolt (2), counterhold with a wrench at the camshaft hexagon, and tighten to 25 N.m (18 lb ft).
27. Raise the vehicle.

mcx30.com

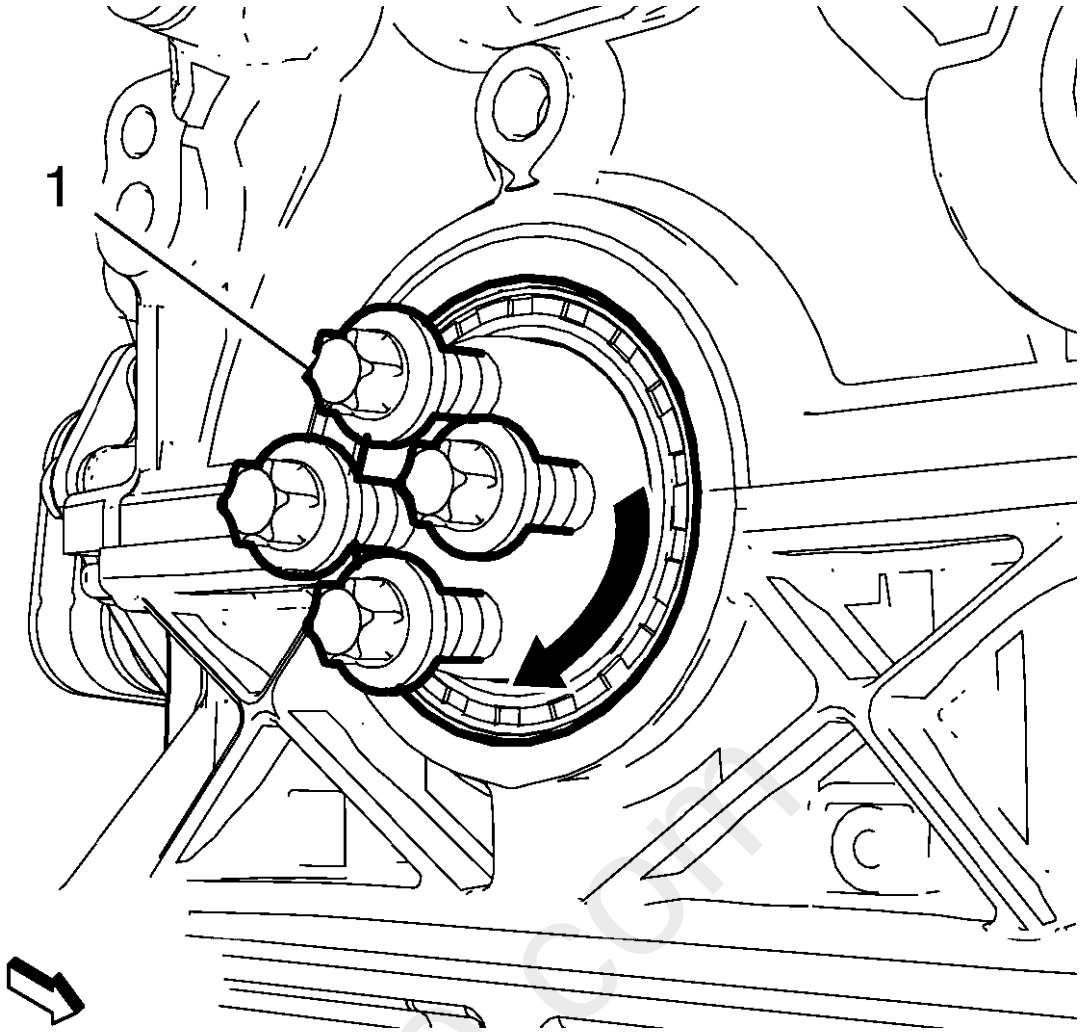


Fig. 216: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

28. Rotate the crankshaft 360 degrees in direction of arrow. Use a suitable flat bladed tool.
29. Remove the 4 crankshaft pulley bolts (1).

mcx30.com

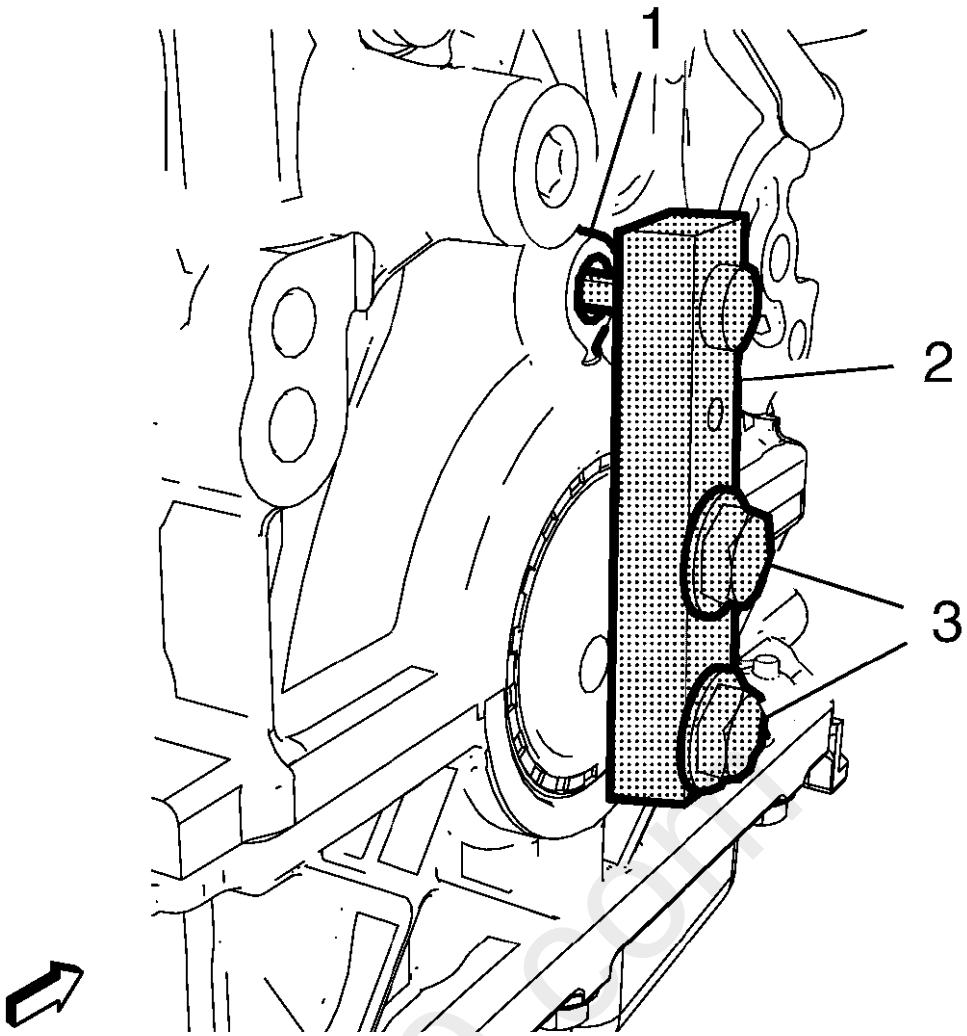


Fig. 217: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

30. Install the **EN-51140** fixing tool (2).
31. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).
32. Lower the vehicle.

mcx30.com

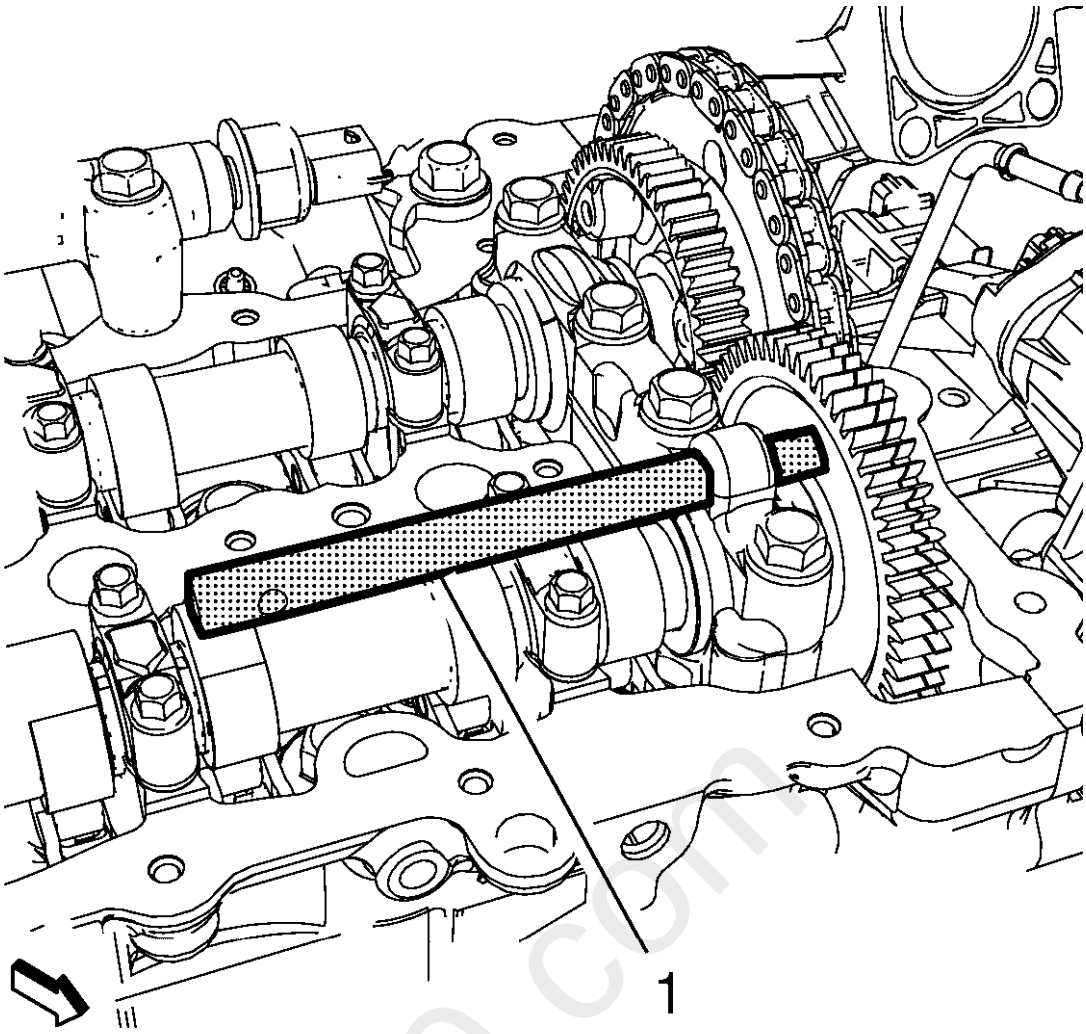


Fig. 218: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the EN-51143 fixing tool does not fit, adjust timing.**

33. Install the **EN-51143** fixing tool (1), by carefully turning the hexagon of the camshaft.
34. Remove the **EN-51143** fixing tool.
35. Raise the vehicle.

mcx30.com

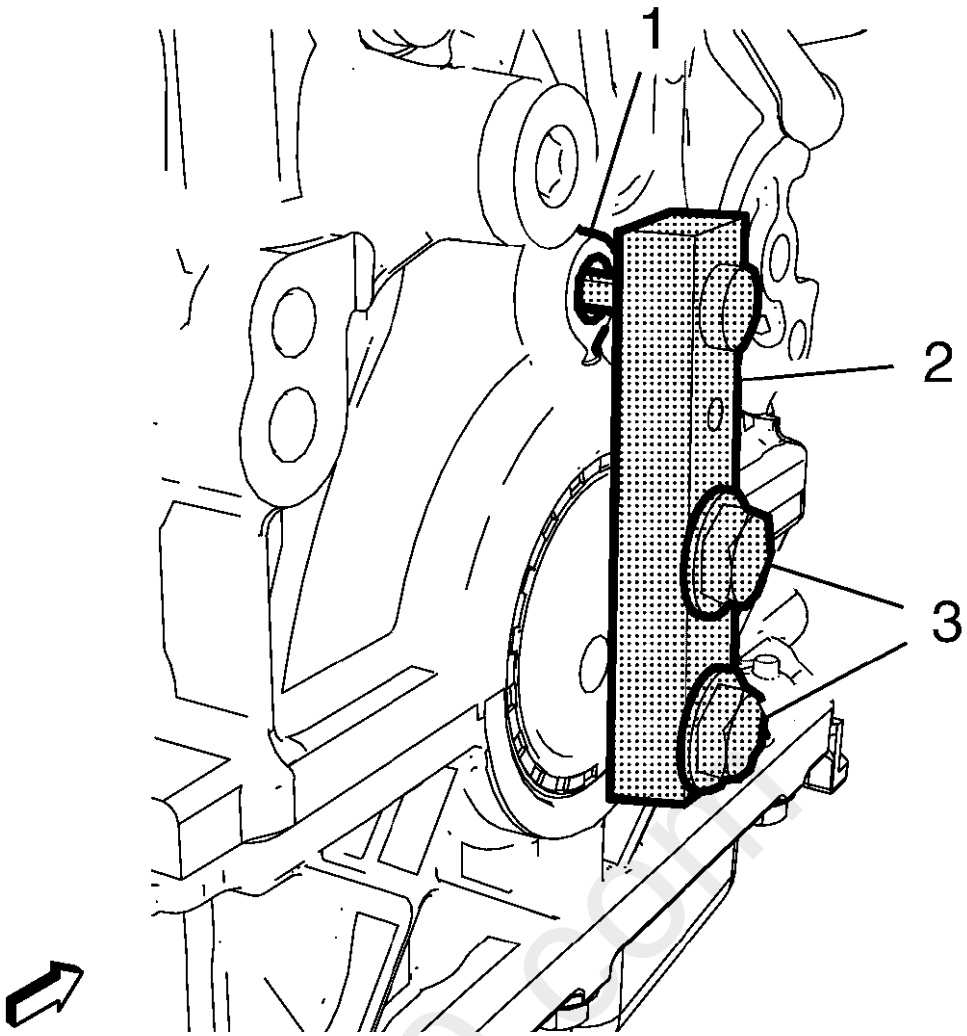


Fig. 219: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

36. Remove the 2 bolts (3).
37. Remove the **EN-51140** fixing tool (2).
38. Install Crankshaft Pulley. Refer to **Crankshaft Pulley Replacement**
39. Install Camshaft Housing. Refer to **Camshaft Housing Replacement**
40. Install Throttle Body Assembly. Refer to **Throttle Body Assembly Replacement**
41. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

EXHAUST CAMSHAFT REPLACEMENT

Special Tools

- **EN-50509** Split Intake Camshaft Sprocket Fixing Tool
- **EN-51140** Crankshaft Fixing Tool
- **EN-51143** Camshaft Sprocket Fixing Tool

Equivalent regional tools: **Special Tools**

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Throttle Body Assembly. Refer to **Throttle Body Assembly Replacement**
3. Remove Camshaft Housing. Refer to **Camshaft Housing Replacement**
4. Remove Crankshaft Pulley. Refer to **Crankshaft Pulley Replacement**
5. Lower the vehicle. Refer to **Lifting and Jacking the Vehicle**

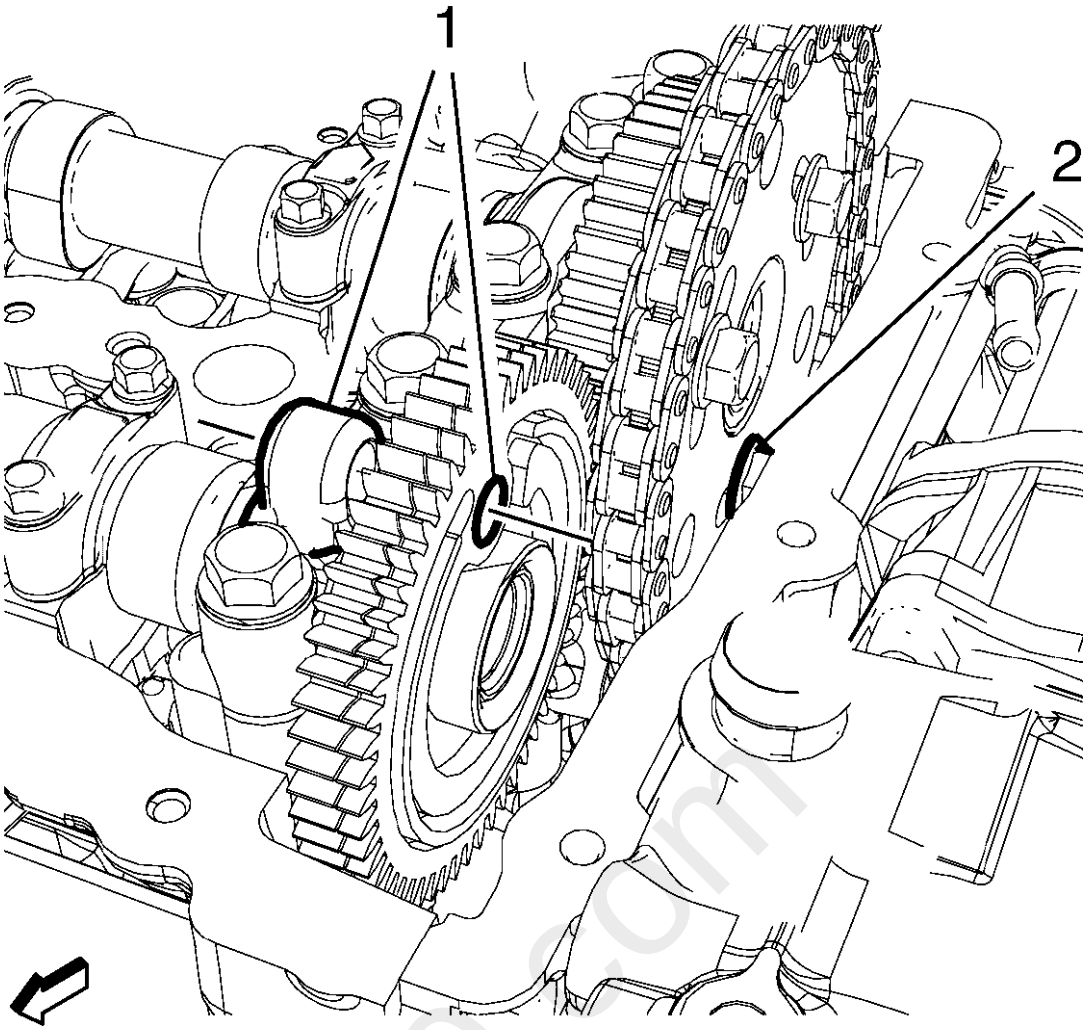


Fig. 220: Aligning Bores
Courtesy of GENERAL MOTORS COMPANY

6. Check if the bores (1) are aligned.
7. Raise the vehicle.

mcx30.com

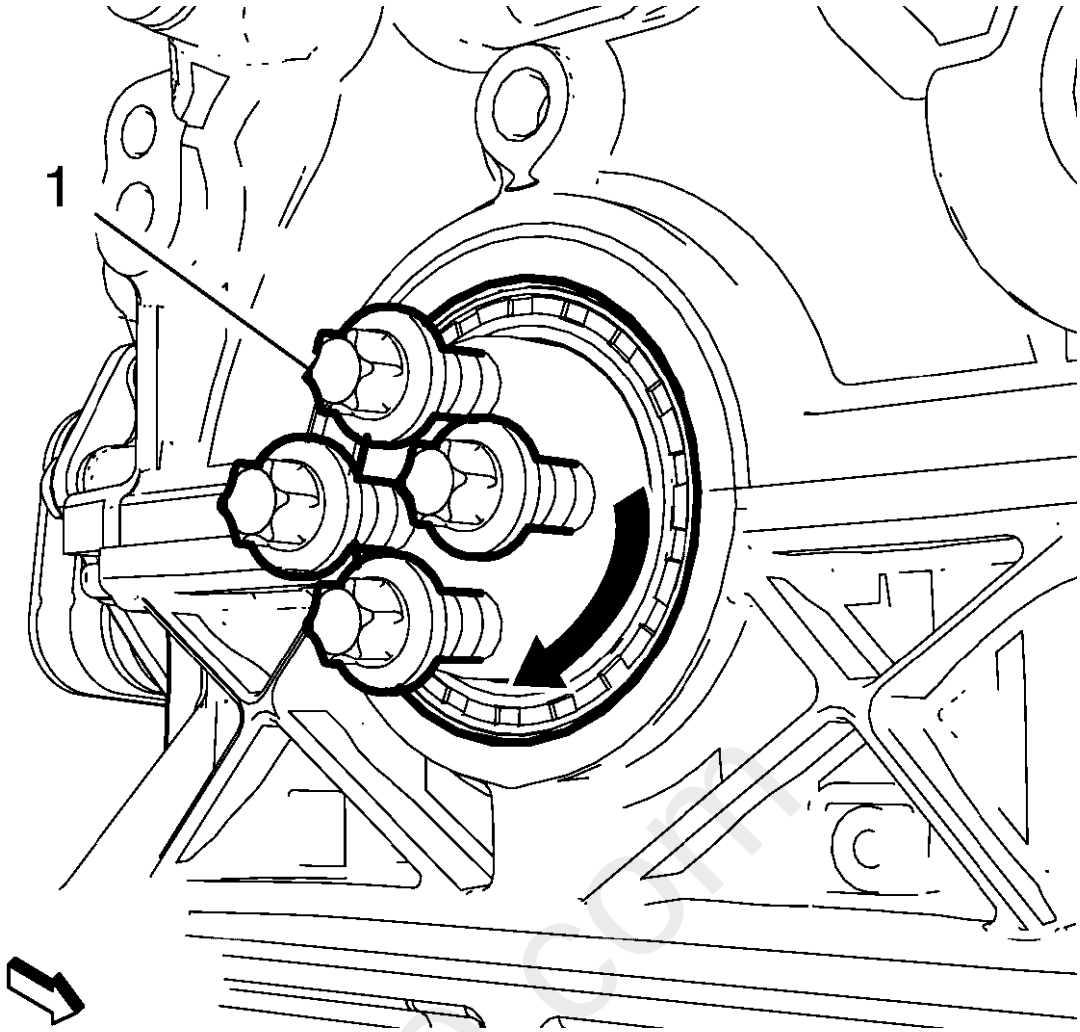


Fig. 221: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the 4 crankshaft pulley bolts (1).
9. Rotate the crankshaft in the direction of the arrow until the exhaust cam bores are aligned. Use a suitable flat bladed tool.
10. Raise the vehicle.

mcx30.com

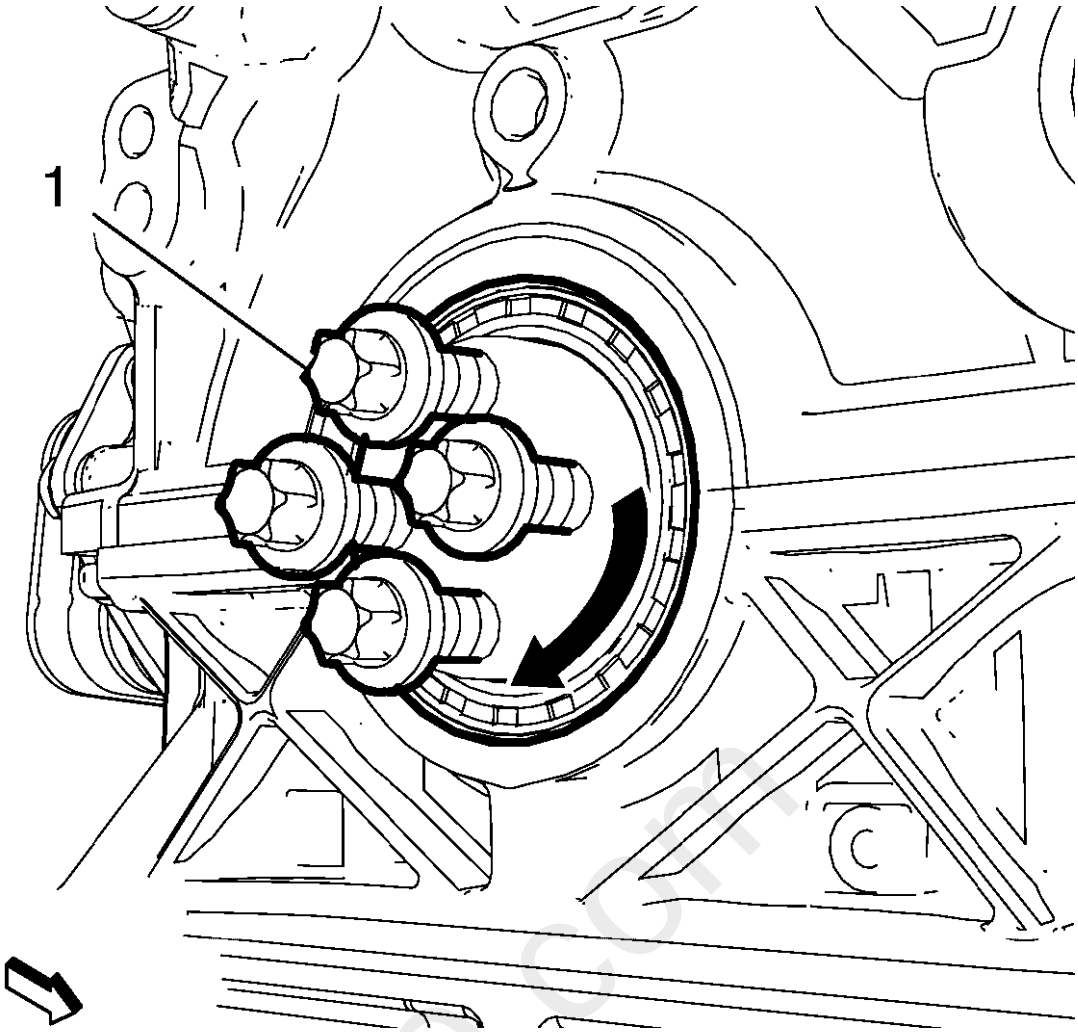


Fig. 222: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Remove the 4 crankshaft pulley bolts (1).

mcx30.com

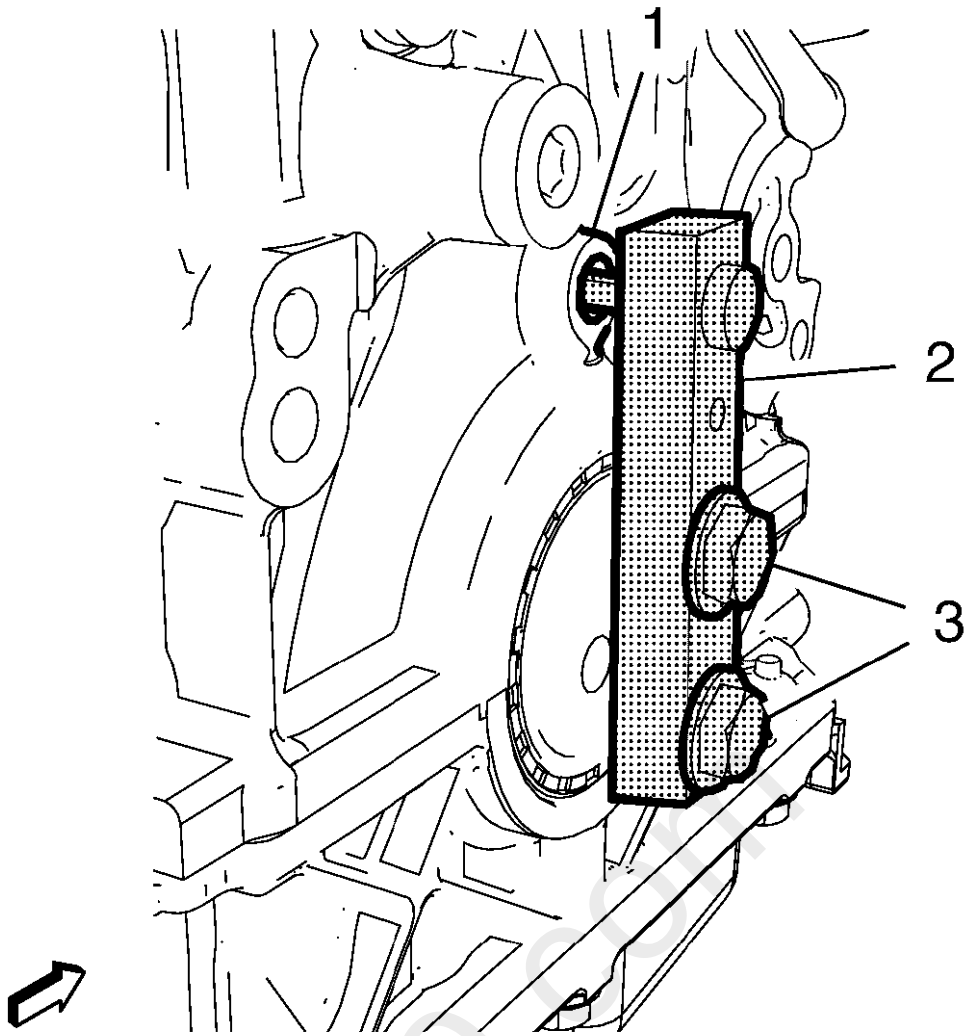


Fig. 223: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

12. Install the **EN-51140** fixing tool (2).
13. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).
14. Lower the vehicle.
15. Install the 2 bolts (3).

mcx30.com

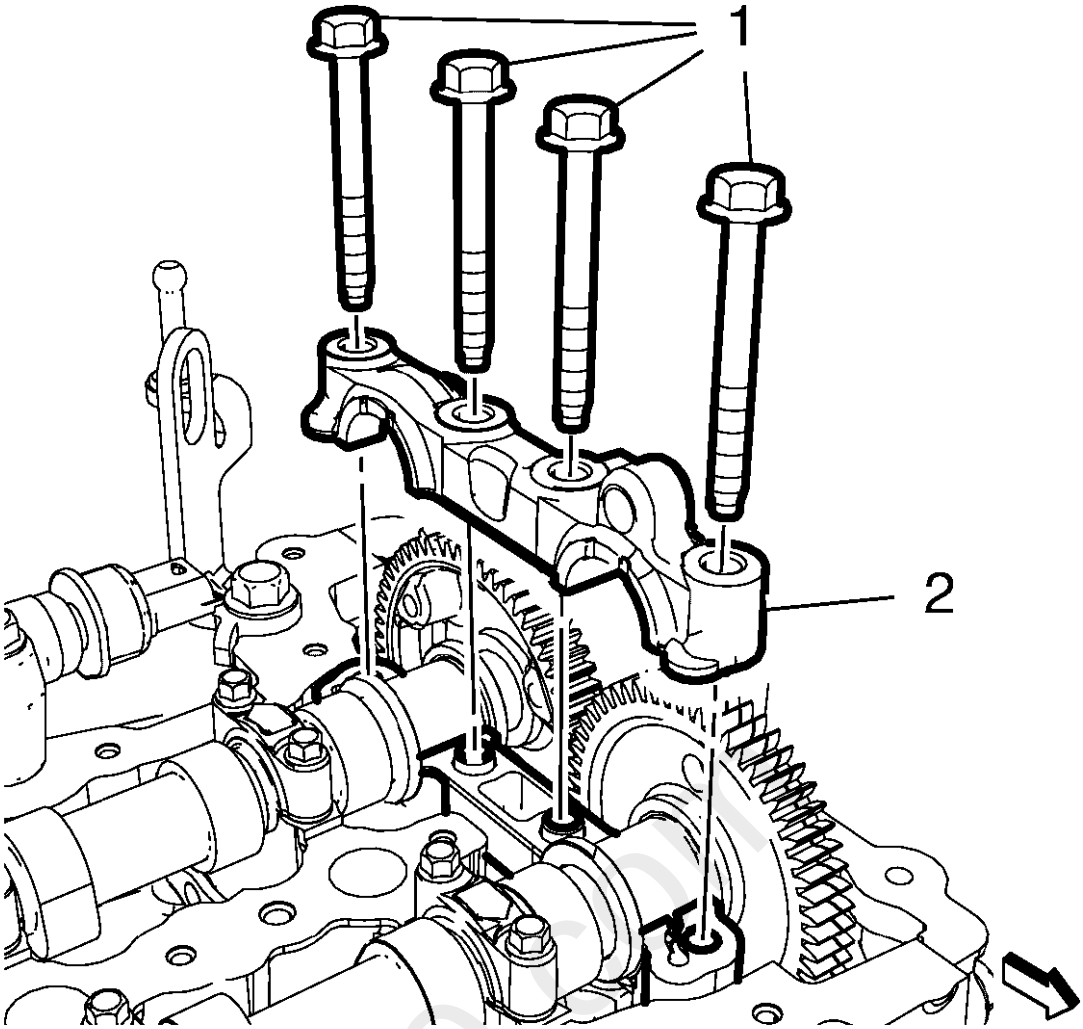


Fig. 224: Camshaft Bearing Rear Cap And Bolts
Courtesy of GENERAL MOTORS COMPANY

16. Remove the 4 camshaft bearing rear cap bolts (1).
17. Remove the camshaft bearing rear cap (2).

mitsubishi

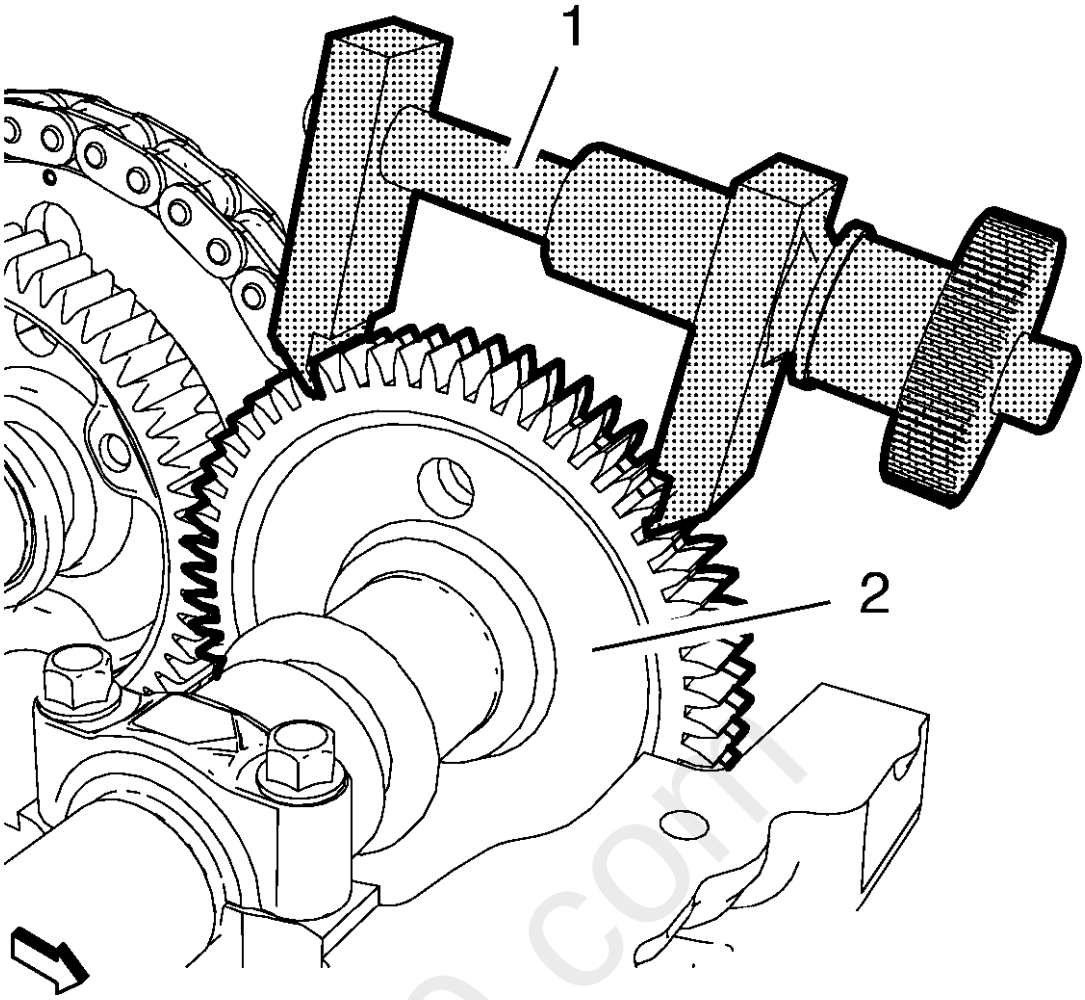


Fig. 225: Split Intake Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

18. Install the **EN-50509** fixing tool (1) to the exhaust camshaft sprocket (2).

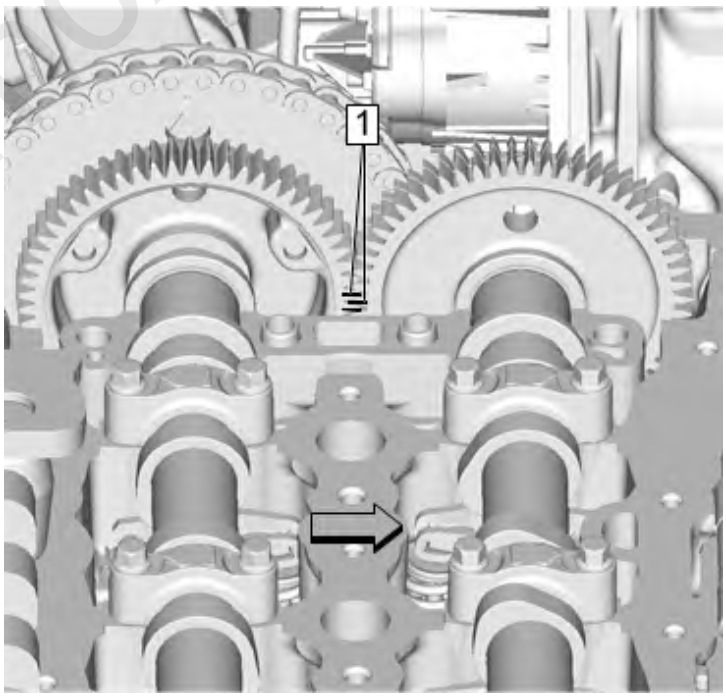


Fig. 226: Mark Backside Of Both Cam Gears With Paint Marks
Courtesy of GENERAL MOTORS COMPANY

19. Mark the backside of both cam gears with paint marks (1).

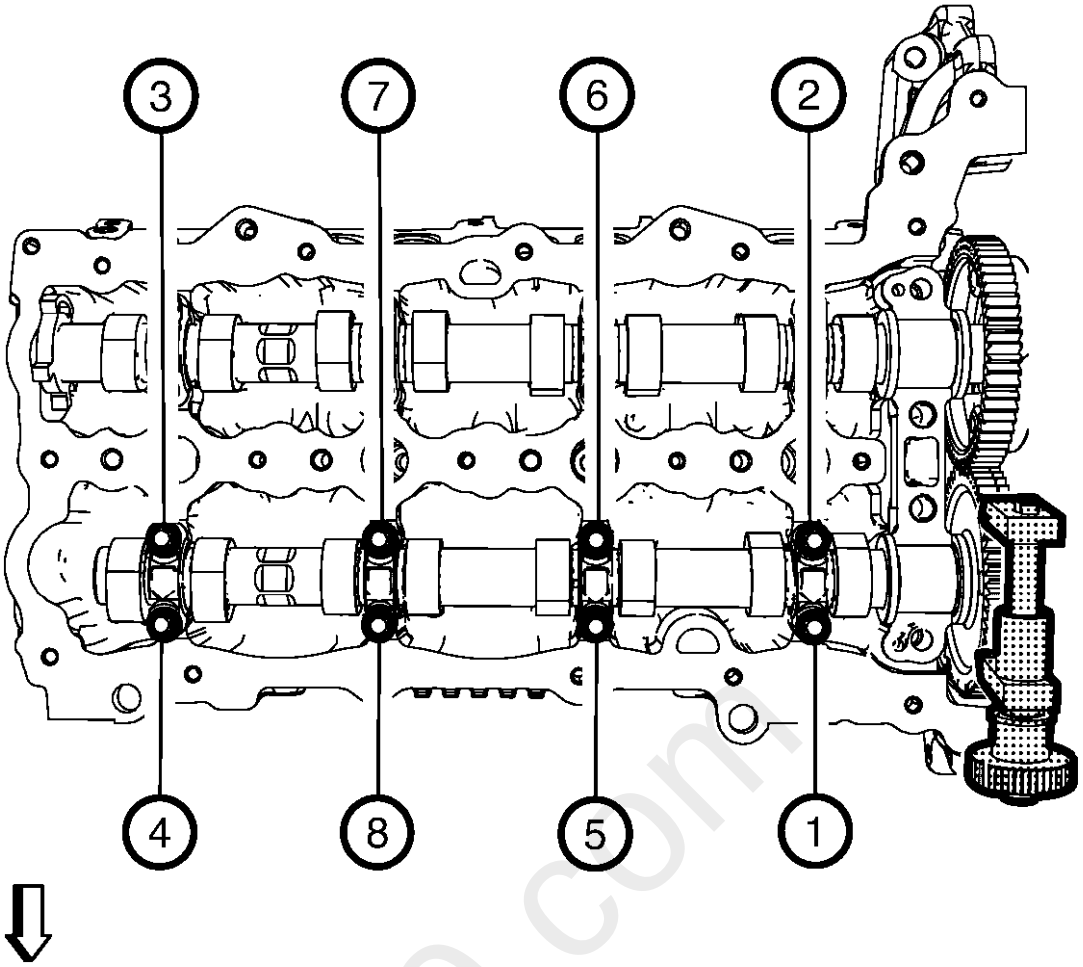


Fig. 227: Exhaust Camshaft Bearing Cap Bolt Loosening Sequence
Courtesy of GENERAL MOTORS COMPANY

20. Loosen the 8 exhaust camshaft bearing cap bolts in sequence shown.

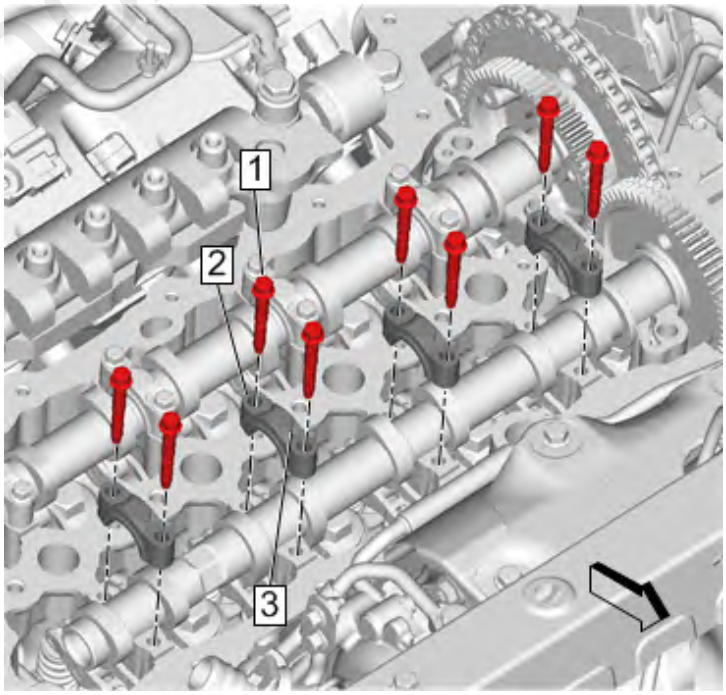


Fig. 228: Exhaust Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the direction of the arrows (3) on the camshaft bearing caps pointing to outside of the cylinder head.**

21. Remove the 8 exhaust camshaft bearing cap bolts (1).
22. Remove the 4 exhaust camshaft bearing caps (2) and lay aside in the order they were removed.

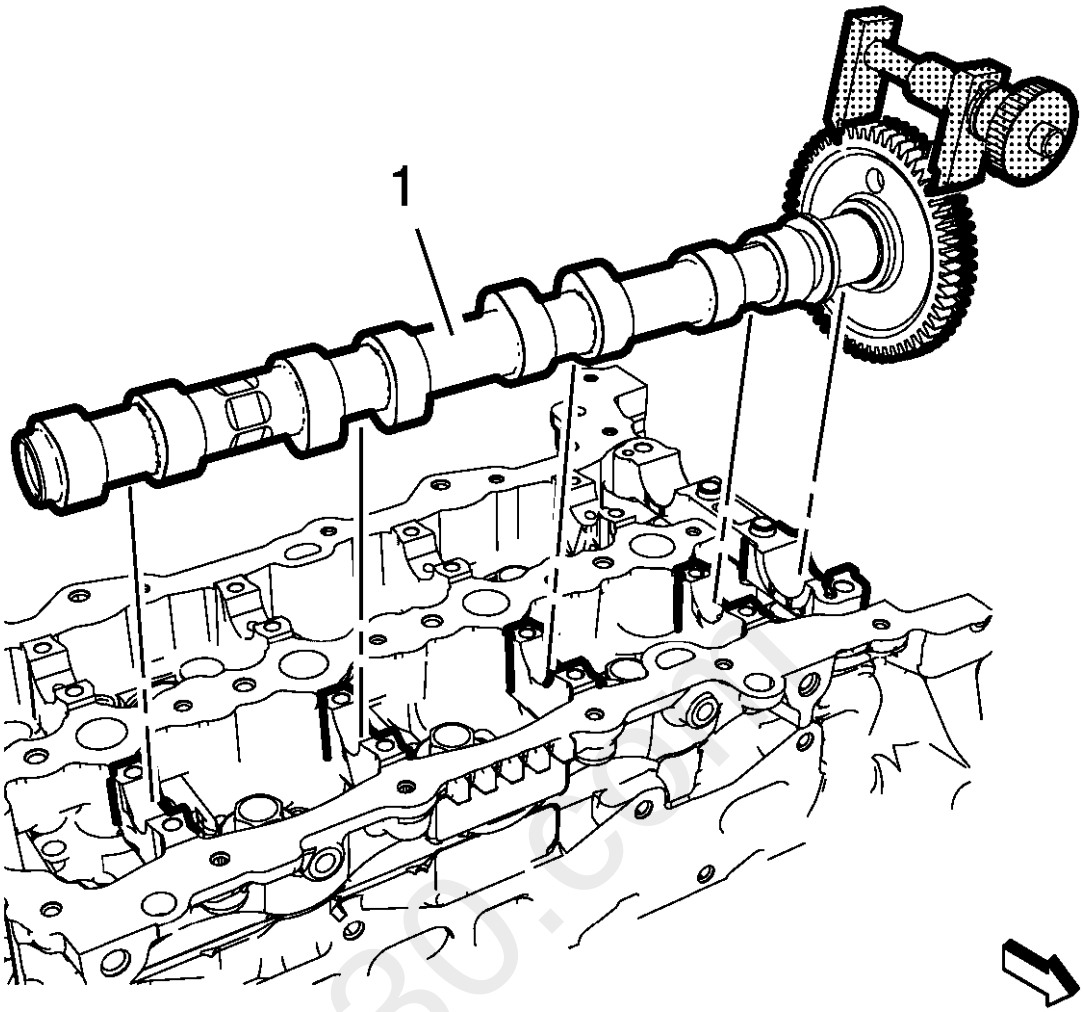


Fig. 229: Exhaust Camshaft
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the exhaust camshaft is to be reinstalled, do not remove the EN-50509 fixing tool.**

23. Remove the exhaust camshaft (1).
24. Cover the timing case with a lint free cloth.

Installation Procedure

NOTE: **Before installing the exhaust camshaft, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
    - Timing chain guides with plastic attachment
    - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
    - Timing chain and all timing chain sprockets
    - Oil pump sprocket
    - Oil pump drive chain tensioner

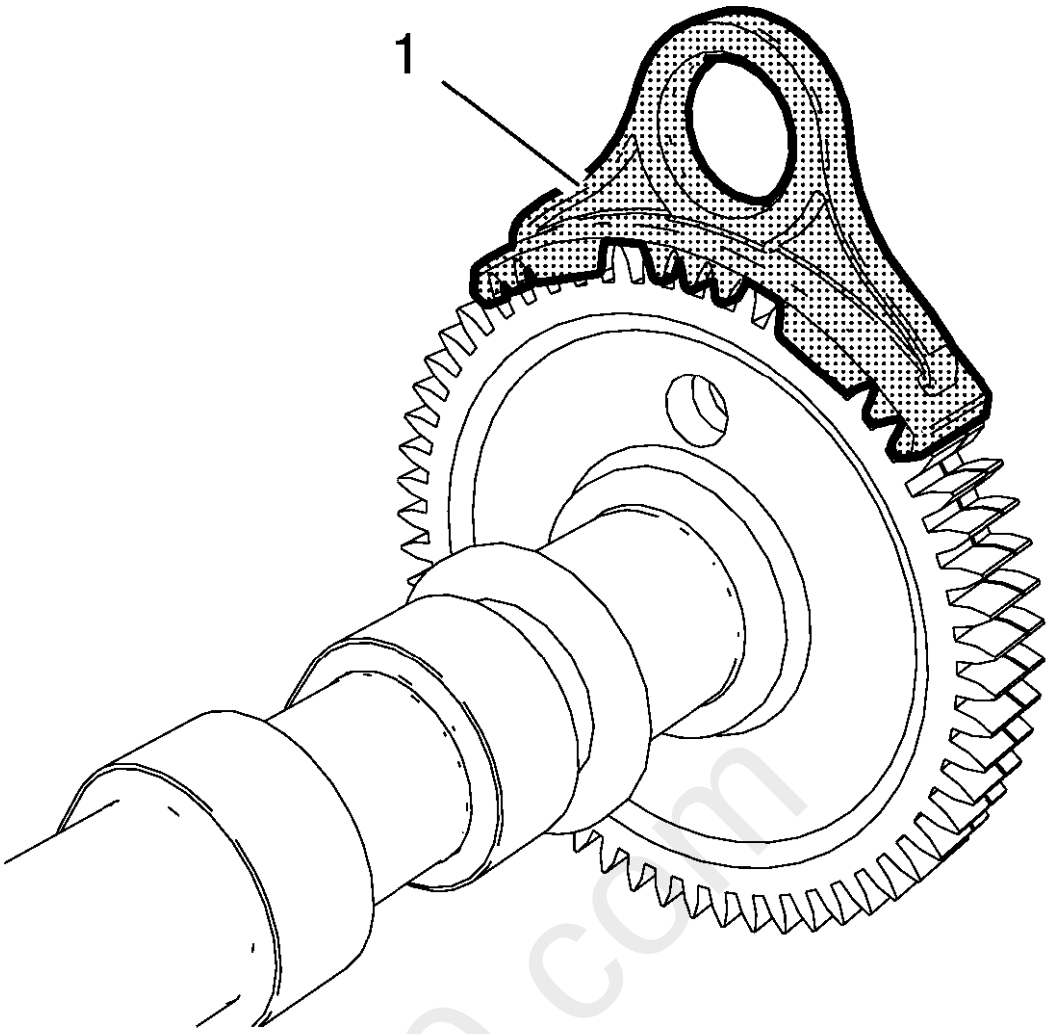


Fig. 230: Transport Lock
Courtesy of GENERAL MOTORS COMPANY

2. For installation of a NEW exhaust camshaft do not remove the transport lock (1) before the exhaust camshaft and intake camshaft are installed.

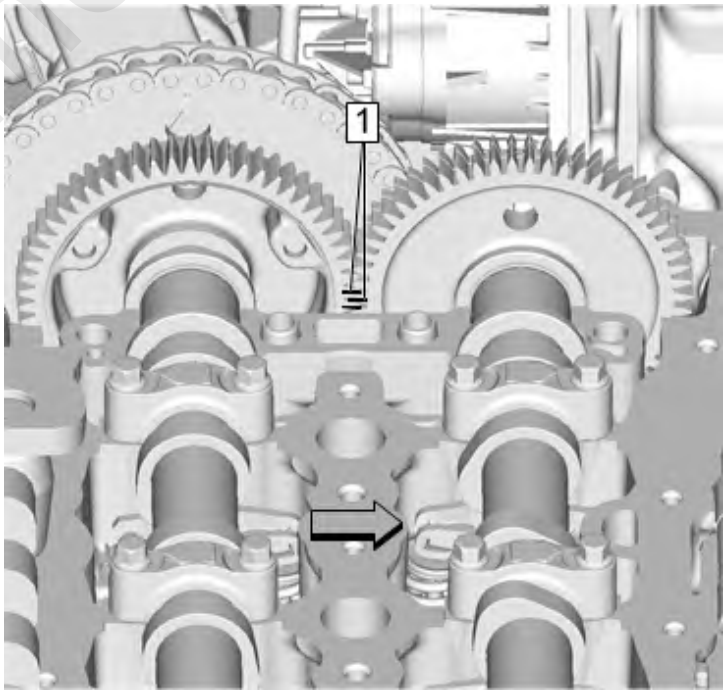


Fig. 231: Mark Backside Of Both Cam Gears With Paint Marks
Courtesy of GENERAL MOTORS COMPANY

3. Transfer the rear marks (1) onto the back of the new camshaft sprocket.

mcx30.com

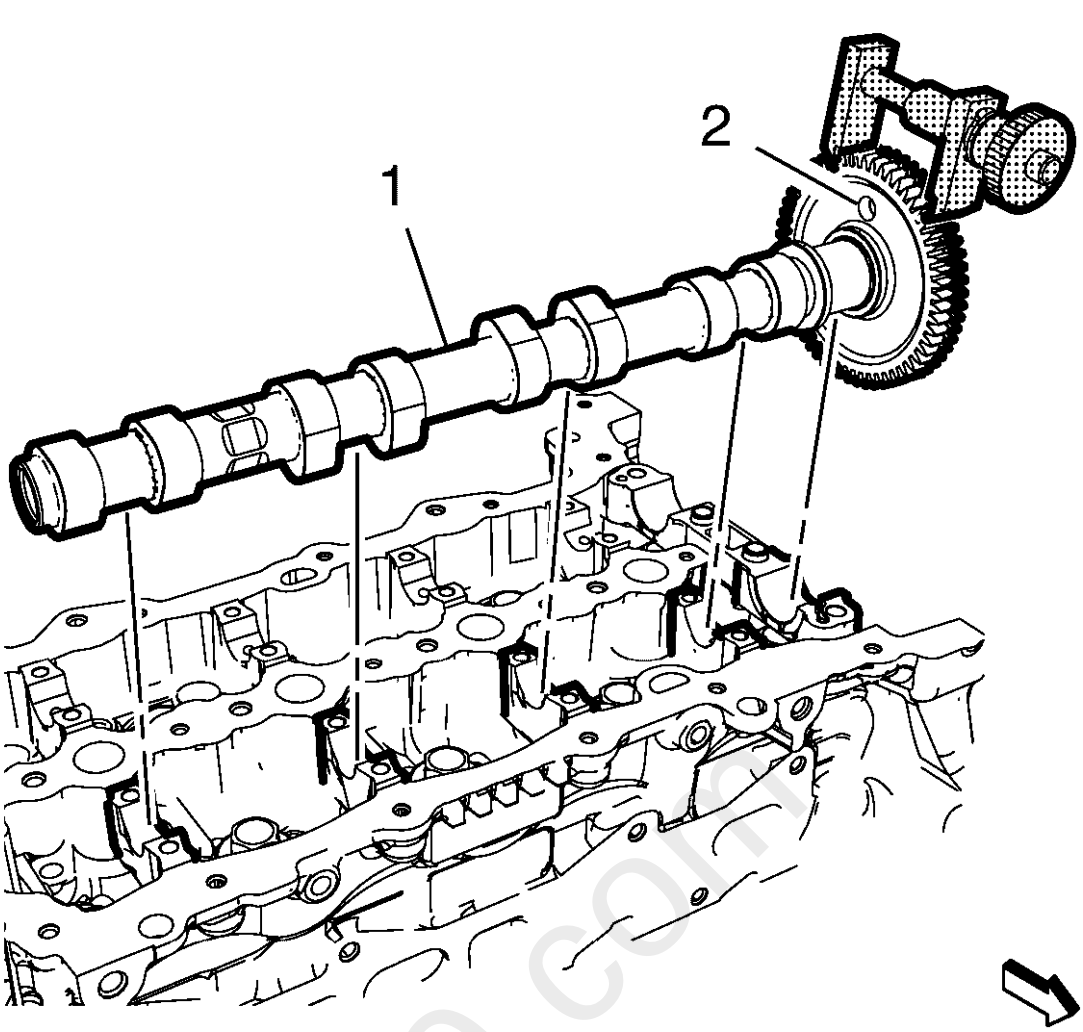


Fig. 232: Exhaust Camshaft With Bore Of Camshaft Sprocket Upwards
Courtesy of GENERAL MOTORS COMPANY

4. Coat all bearing surfaces with engine oil.
5. Install the exhaust camshaft (1), ensure the bore (2) of the camshaft sprocket shows upwards and the marks are aligned.

mx30.com

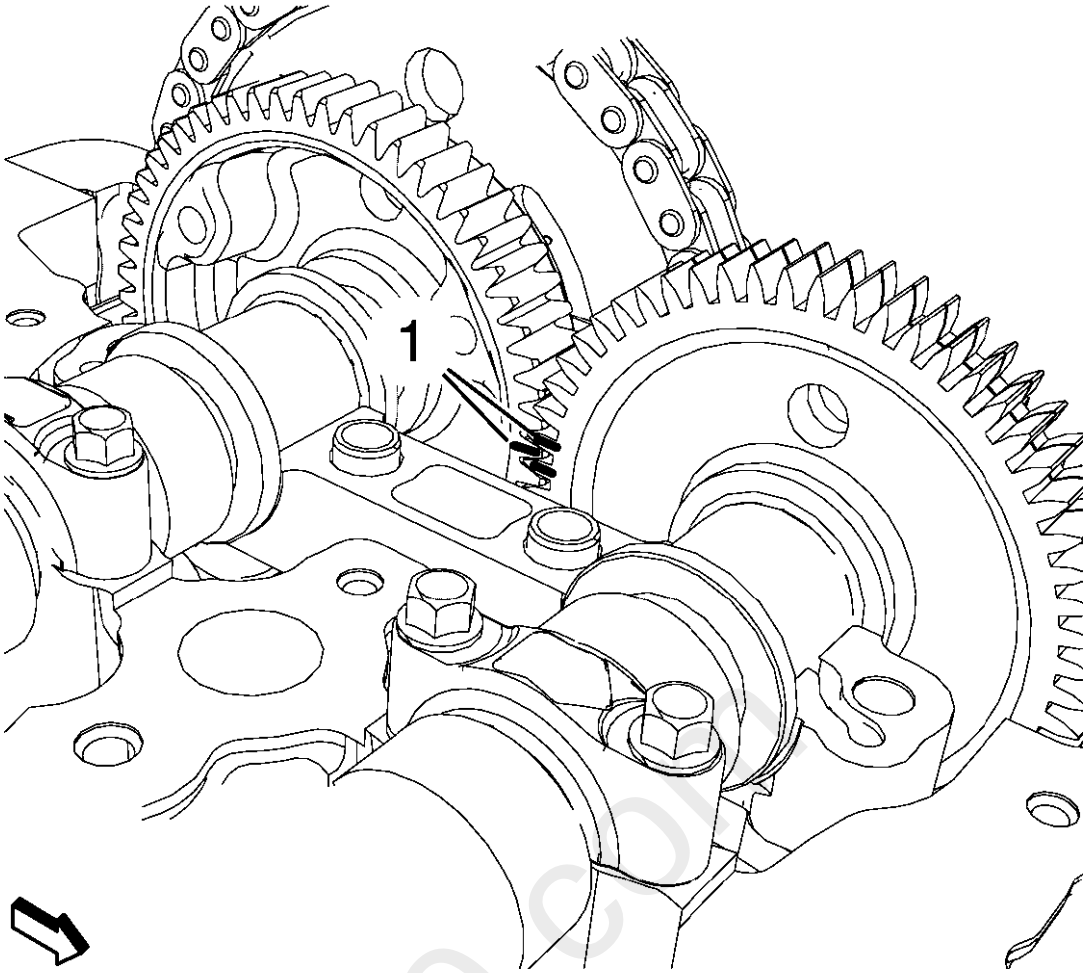


Fig. 233: Marking Exhaust Camshaft Sprocket And Intake Camshaft Sprocket With Paint Marks
Courtesy of GENERAL MOTORS COMPANY

6. Check the marks (1) of the camshaft sprockets whether they are aligned.

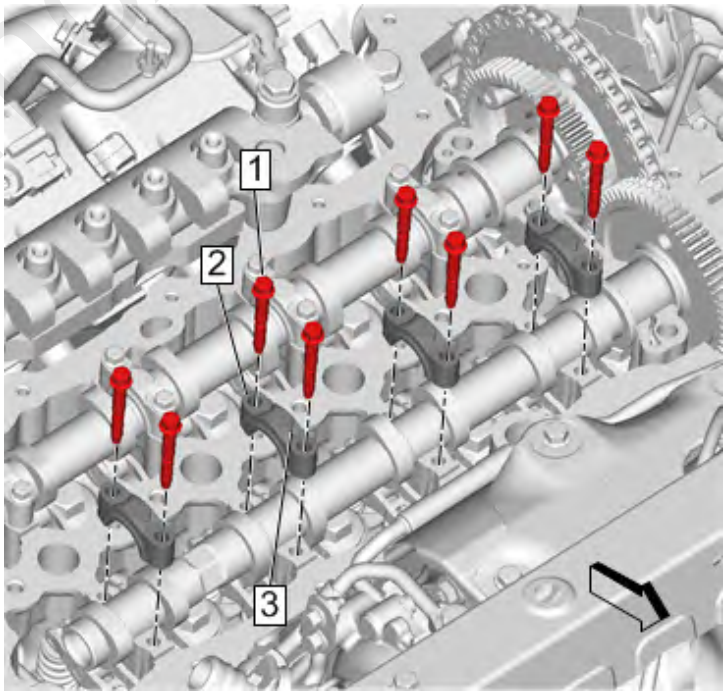


Fig. 234: Exhaust Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the direction of the arrows (3) on the camshaft bearing caps pointing to outside of the cylinder head.**

7. Install the 4 exhaust camshaft bearing caps (2) in the order they were removed.
8. Install the 8 exhaust camshaft bearing cap bolts (1).

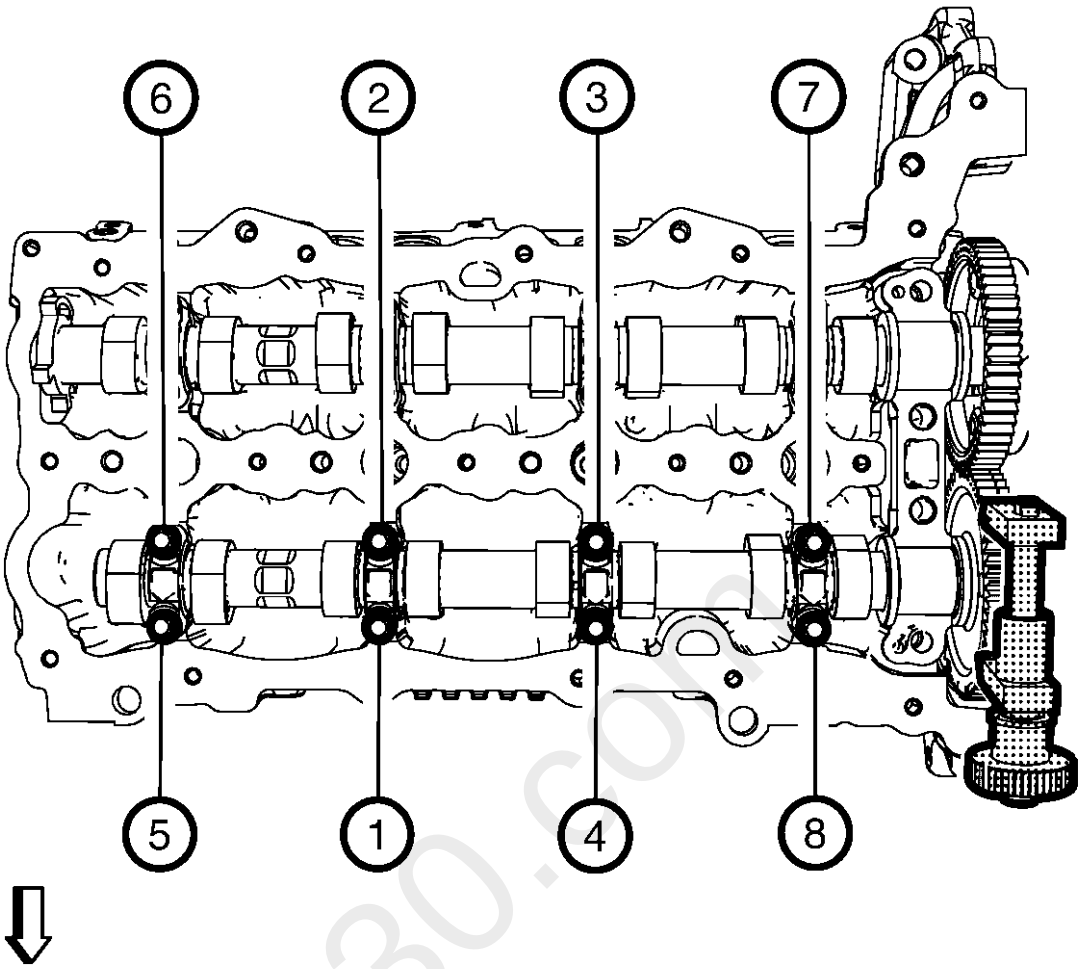


Fig. 235: Exhaust Camshaft Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

9. Tighten the 8 exhaust camshaft bearing cap bolts in sequence shown to 10 N.m (89 lb in).

mox30.com

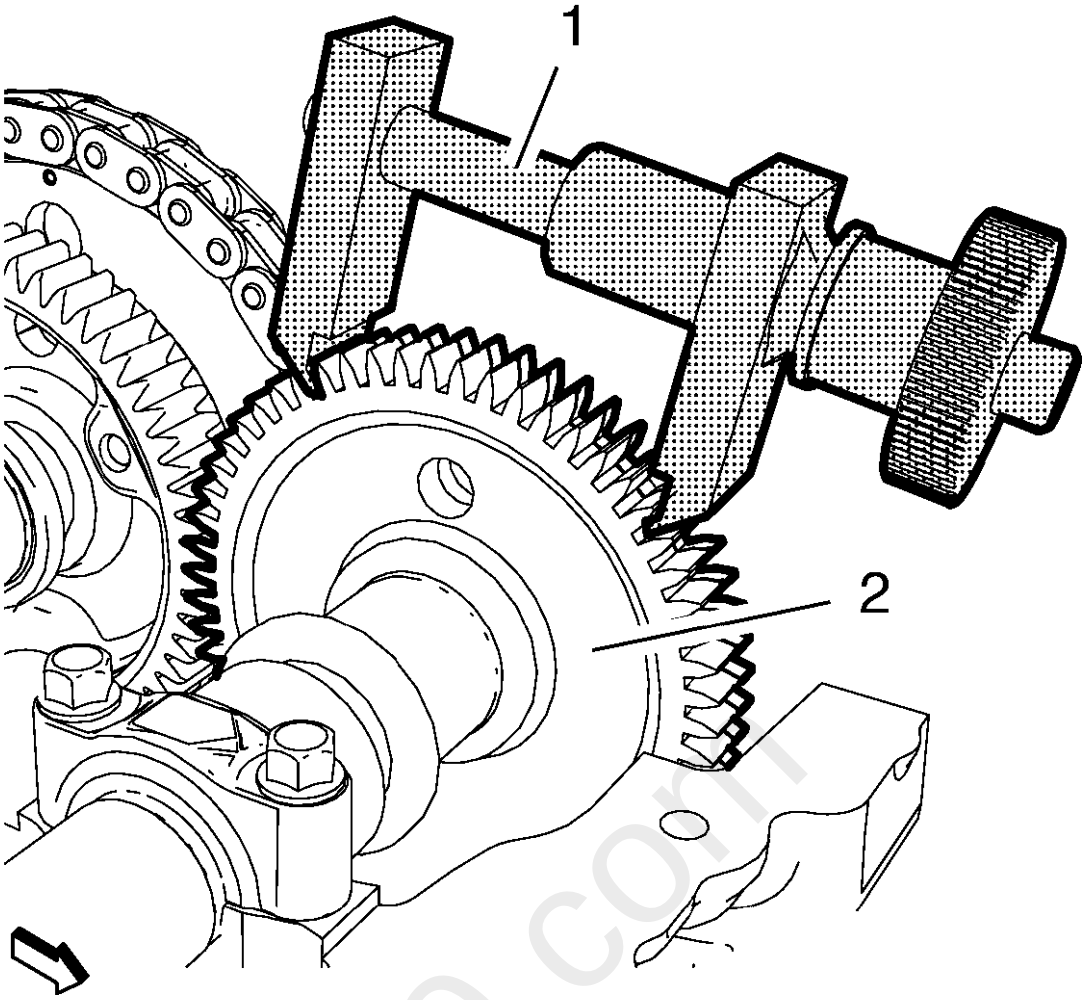


Fig. 236: Split Intake Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

10. Remove the **EN-50509** fixing tool (1) or the transport lock from the exhaust camshaft sprocket (2).

mcx30.com

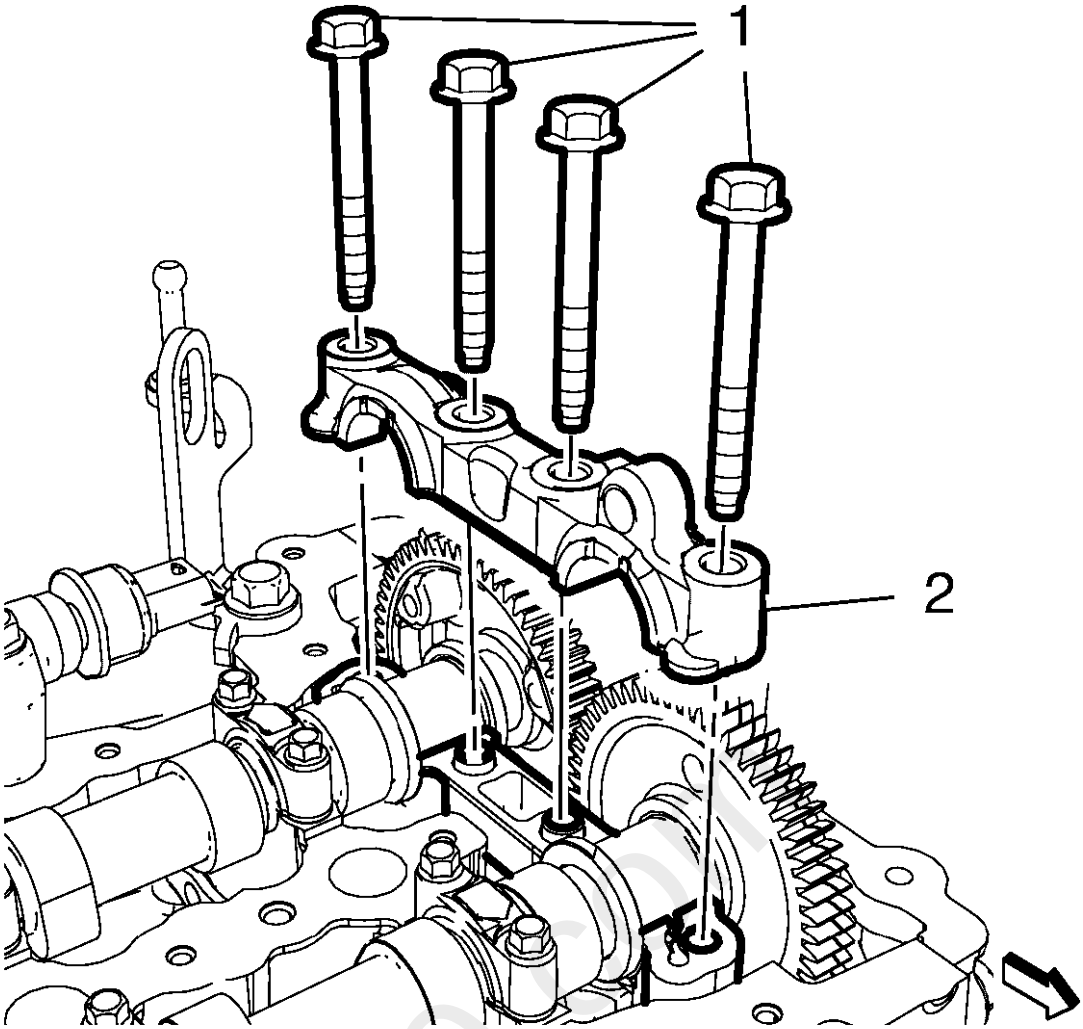


Fig. 237: Camshaft Bearing Rear Cap And Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Coat all bearing surfaces with engine oil.
12. Install the camshaft bearing rear cap (2).
13. Install the 4 camshaft bearing rear cap bolts (1).

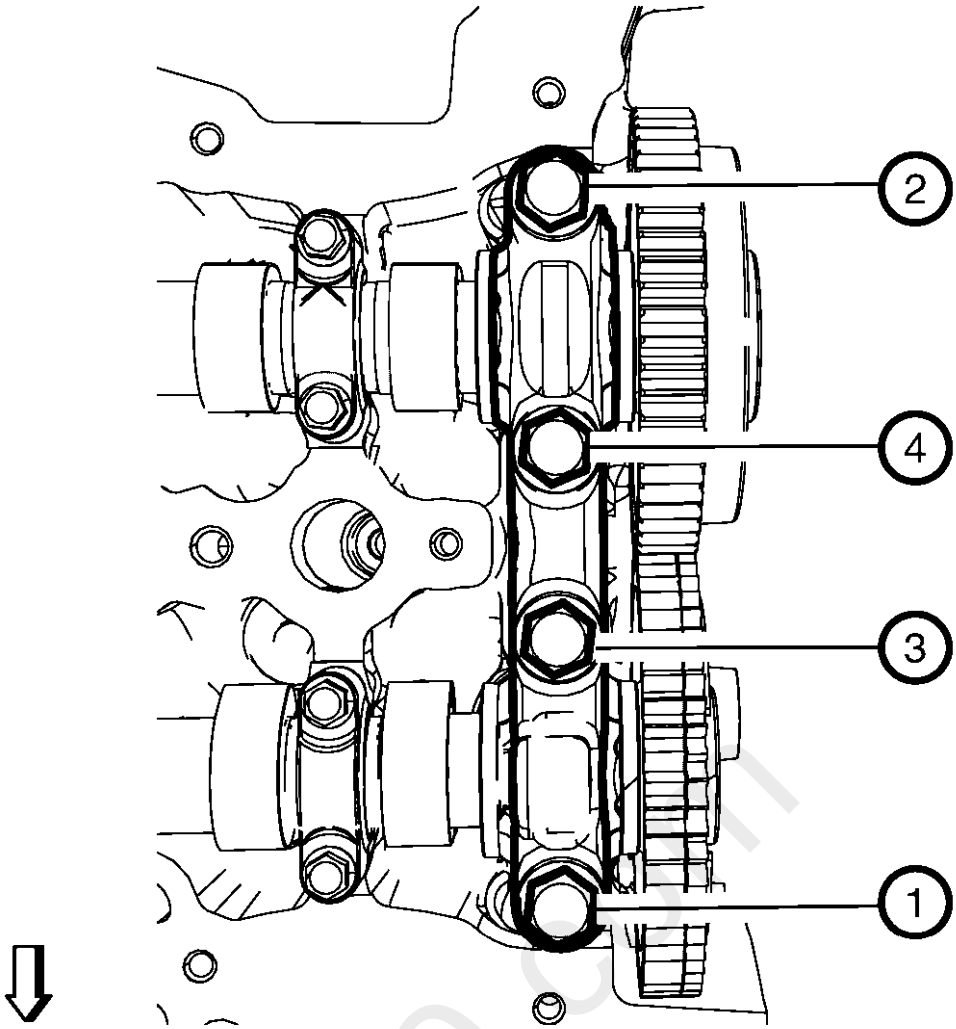


Fig. 238: Camshaft Rear Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

14. Tighten the 4 camshaft rear cap bolts in sequence shown to 25 N.m (18 lb ft).

mcx30.com

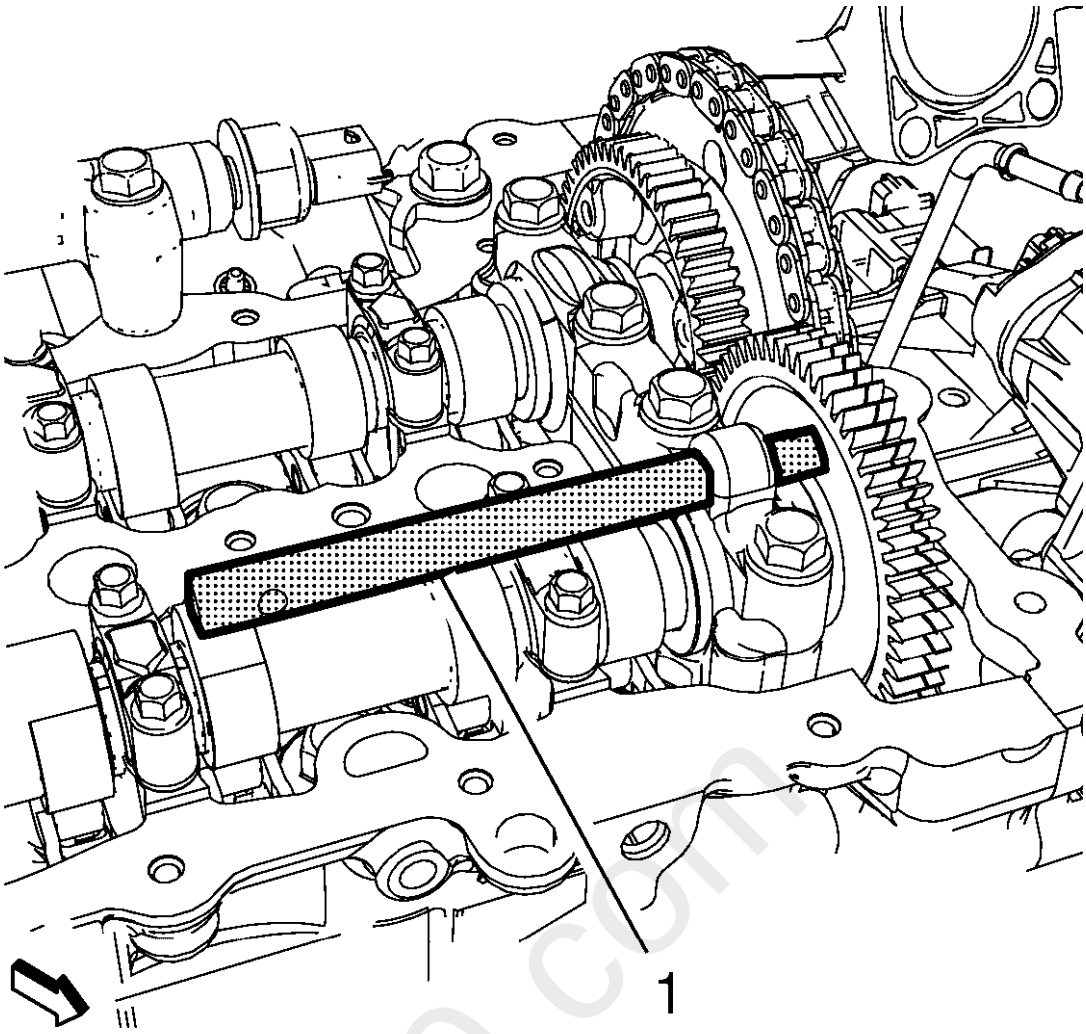


Fig. 239: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

15. To check for proper alignment, install the **EN-51143** fixing tool (1), by carefully turning the hexagon of the camshaft.
16. Remove **EN-51188** fixing tool (2).

mcx30.com

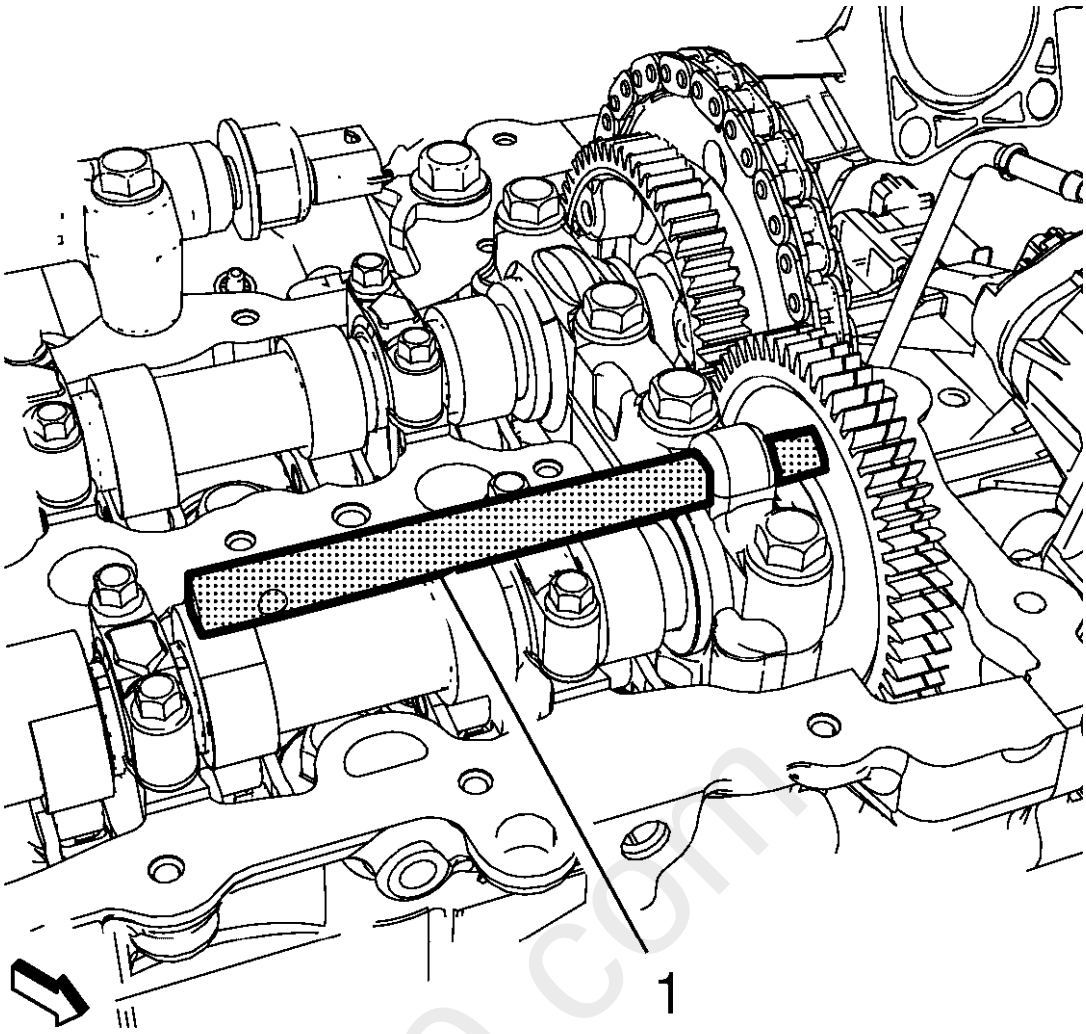


Fig. 240: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

17. Remove the **EN-51143** fixing tool (1).
18. Raise the vehicle.
19. Remove the 4 crankshaft pulley bolts (1).
20. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).
21. Lower the vehicle.

mcx30.com

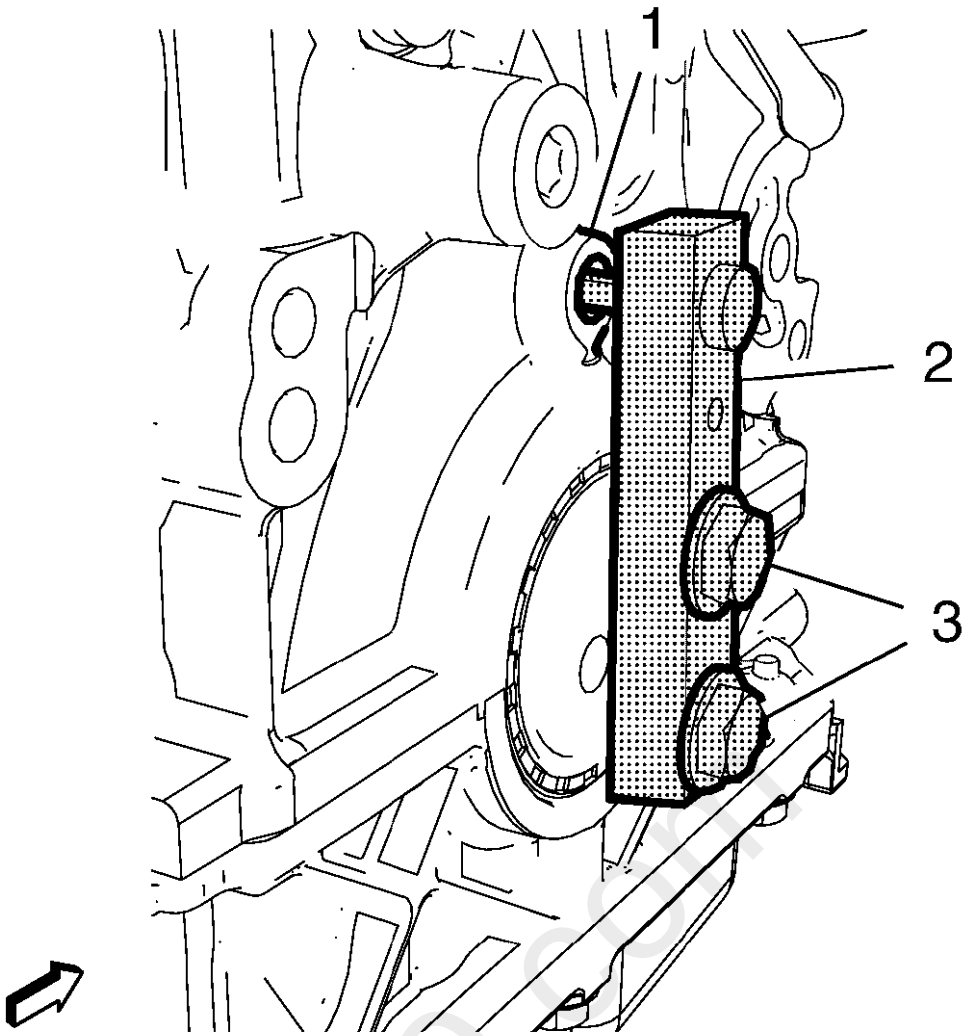


Fig. 241: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

22. Remove the 2 bolts (3).
23. Remove the **EN-51140** fixing tool (2).
24. Install Crankshaft Pulley. Refer to **Crankshaft Pulley Replacement**
25. Install Camshaft Housing. Refer to **Camshaft Housing Replacement**
26. Install Throttle Body Assembly. Refer to **Throttle Body Assembly Replacement**
27. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

TIMING CHAIN IDLER SPROCKET REPLACEMENT

Special Tools

EN-51141 Intermediate Drive Gear Fixing Tool

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

Removal Procedure

1. Remove the camshaft timing chain. Refer to **Camshaft Timing Chain Replacement**

mcx30.com

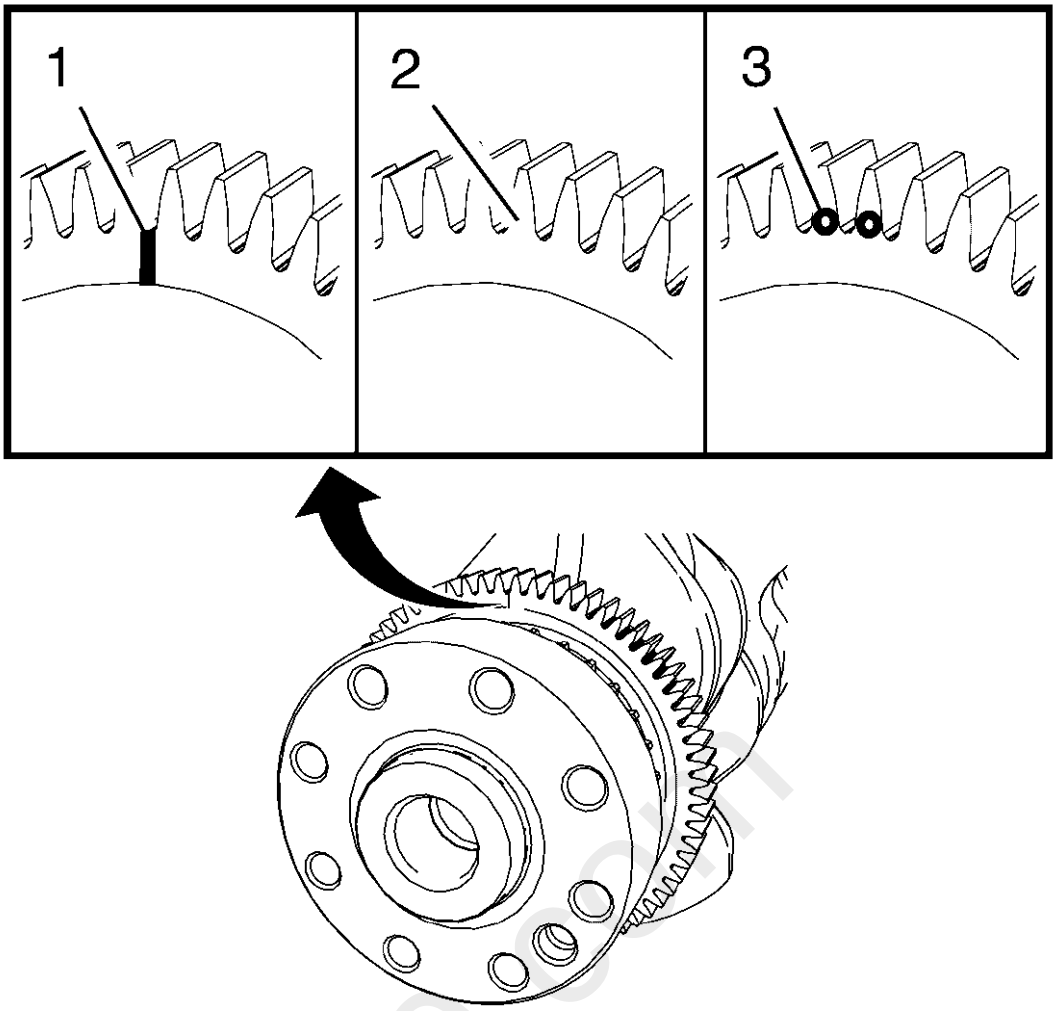


Fig. 242: Crankshaft Sprocket Marks
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Depending on the crankshaft, two different marks (1) and (3) or none (2) can be located on the crankshaft sprocket.**

2. Mark the crankshaft sprocket align with the timing chain idler sprocket if there is no mark.

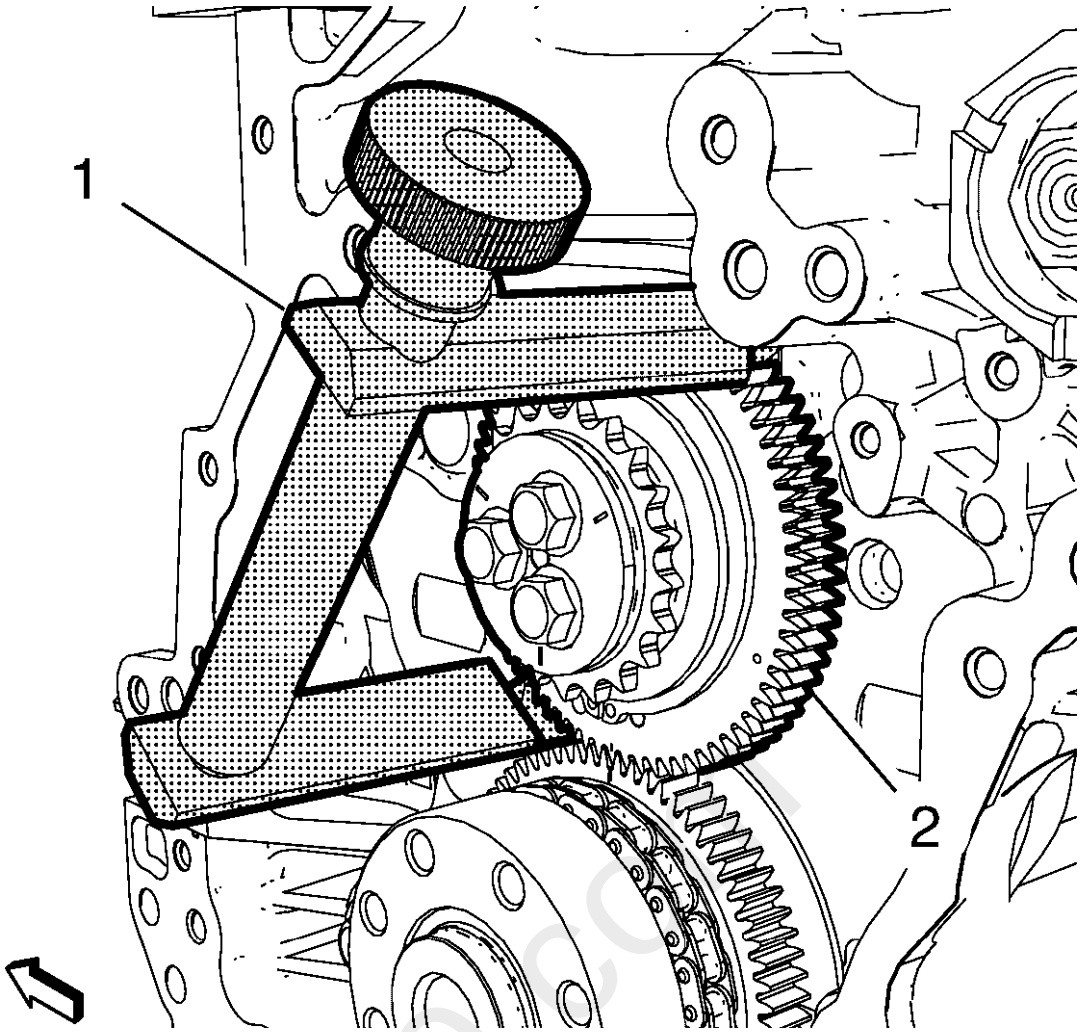


Fig. 243: Intermediate Drive Gear Fixing Tool And Timing Chain Idler Sprocket
Courtesy of GENERAL MOTORS COMPANY

3. Install the **EN-51141** fixing tool (1) to the timing chain idler sprocket (2).

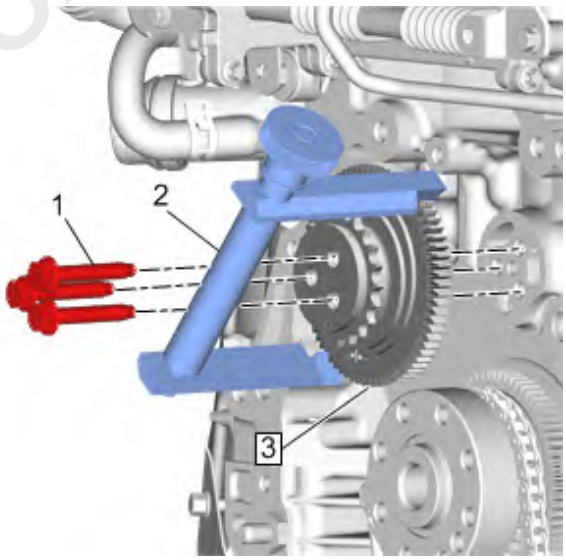


Fig. 244: Timing Chain Idler Sprocket, Bolts And Intermediate Drive Gear Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

4. Remove the 3 timing chain idler sprocket bolts (1).

NOTE: **If the timing chain idler sprocket will be reused, do not remove the EN-51141 fixing tool (2).**

5. Remove the timing chain idler sprocket (3) from the engine block.

Installation Procedure

NOTE: **Before installing the timing chain idler sprocket, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

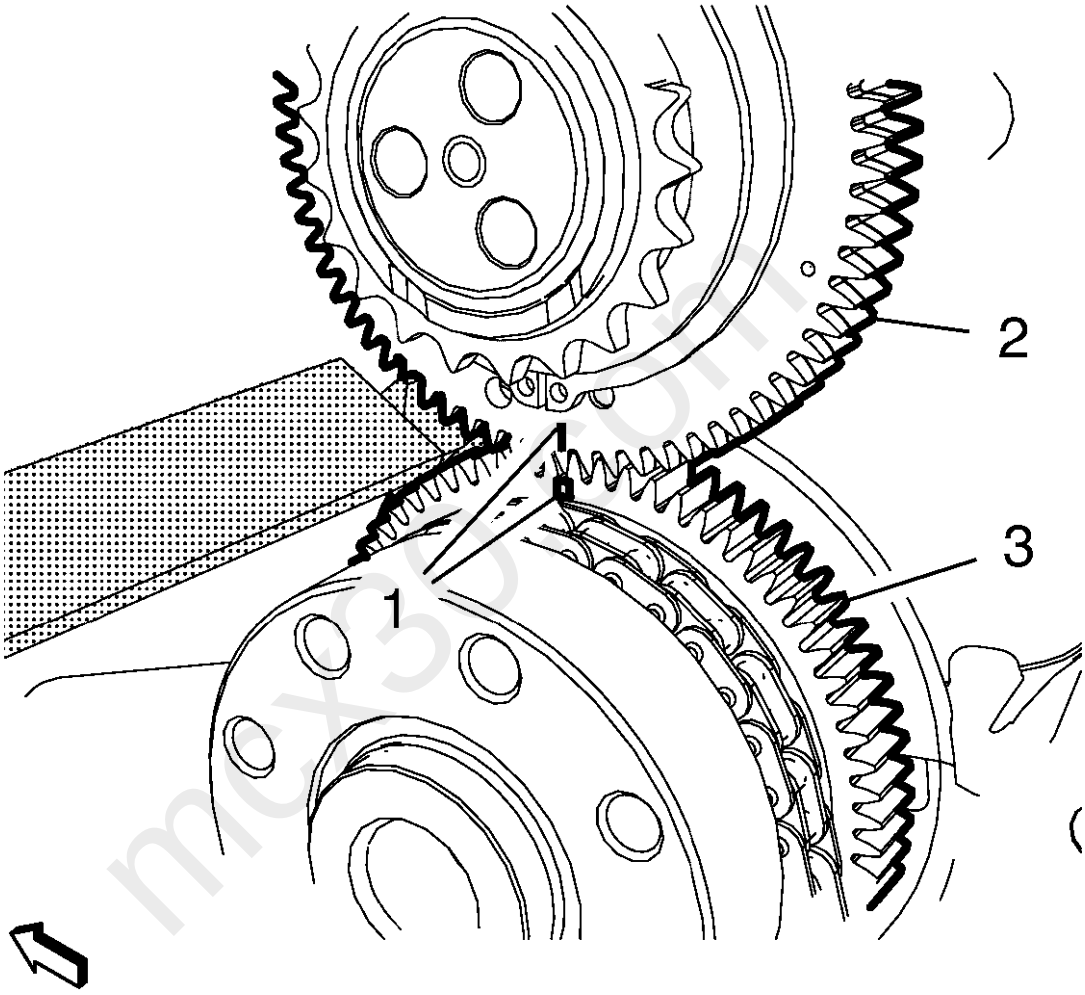


Fig. 245: Timing Chain Idler Sprocket, Alignment Marks And Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

2. Install the timing chain idler sprocket (2), by align the marks (1) with the timing chain idler sprocket and the crankshaft sprocket (3).

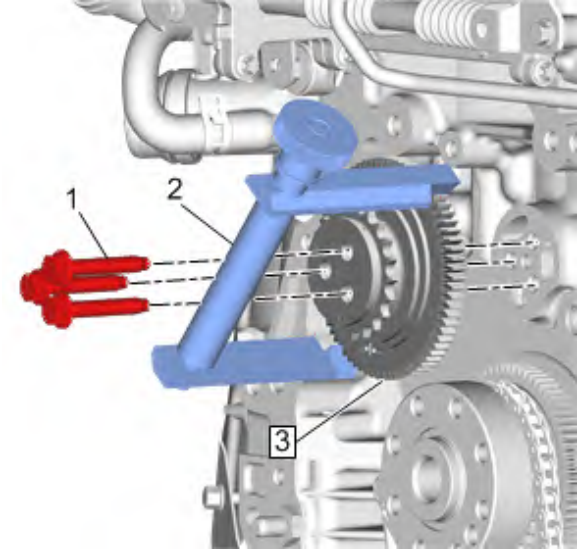


Fig. 246: Timing Chain Idler Sprocket, Bolts And Intermediate Drive Gear Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

3. Install the 3 timing chain idler sprocket bolts (1) and tighten to 25 N.m (18 lb ft).
4. Remove the **EN-51141** fixing tool (2).
5. Install the camshaft timing chain. Refer to **Camshaft Timing Chain Replacement**

TIMING CHAIN LOWER COVER REPLACEMENT

Removal Procedure

1. Remove Timing Chain Upper Cover. Refer to **Timing Chain Upper Cover Replacement**.
2. Remove Oil Pan. Refer to **Oil Pan Replacement**.

mcx30.com

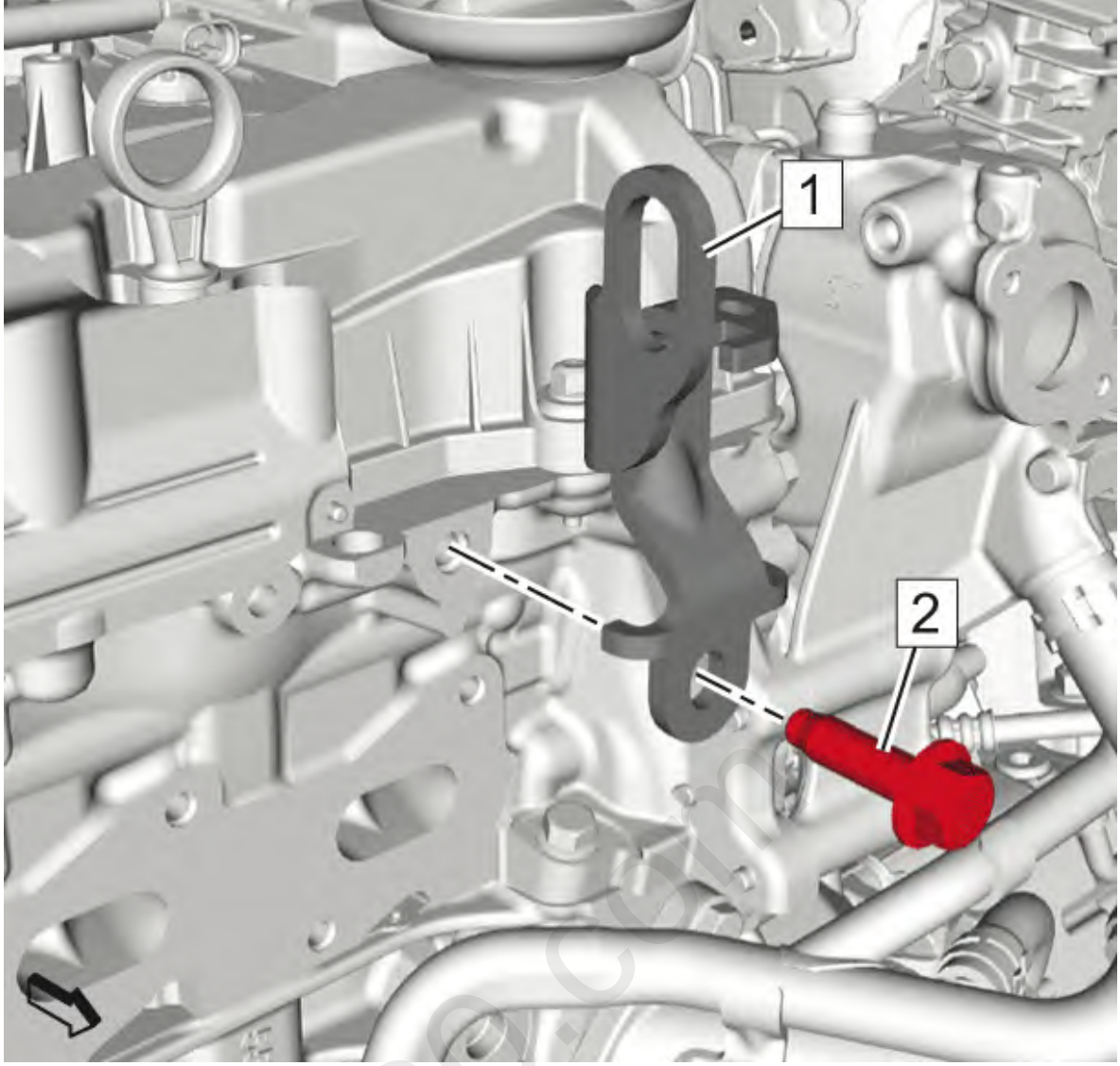


Fig. 247: Engine Lift Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install Engine Lift Bracket-Left Side (1)

CAUTION: **Refer to Fastener Caution**

4. Install and tighten Engine Lift Bracket Bolt (2) to 58 N.m (43 lb ft)

mcx30.com

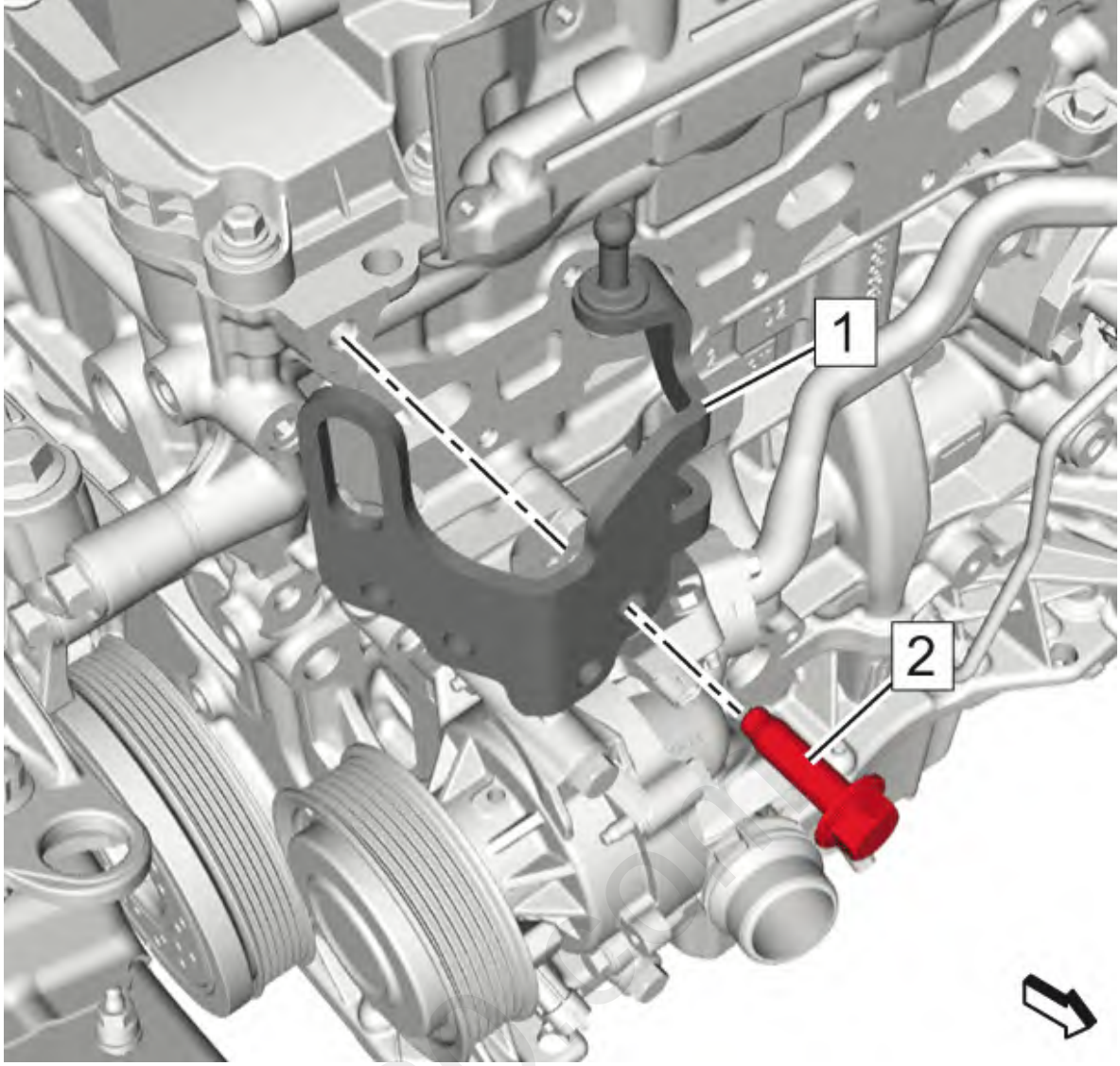


Fig. 248: Engine Lift Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Install Engine Lift Bracket-Right Side (1)
6. Install and tighten Engine Lift Bracket Bolt (2) to 58 N.m (43 lb ft).
7. Remove Crankshaft Position Reluctor Ring. Refer to **Crankshaft Position Sensor Reluctor Ring Replacement**.

mcx30.com

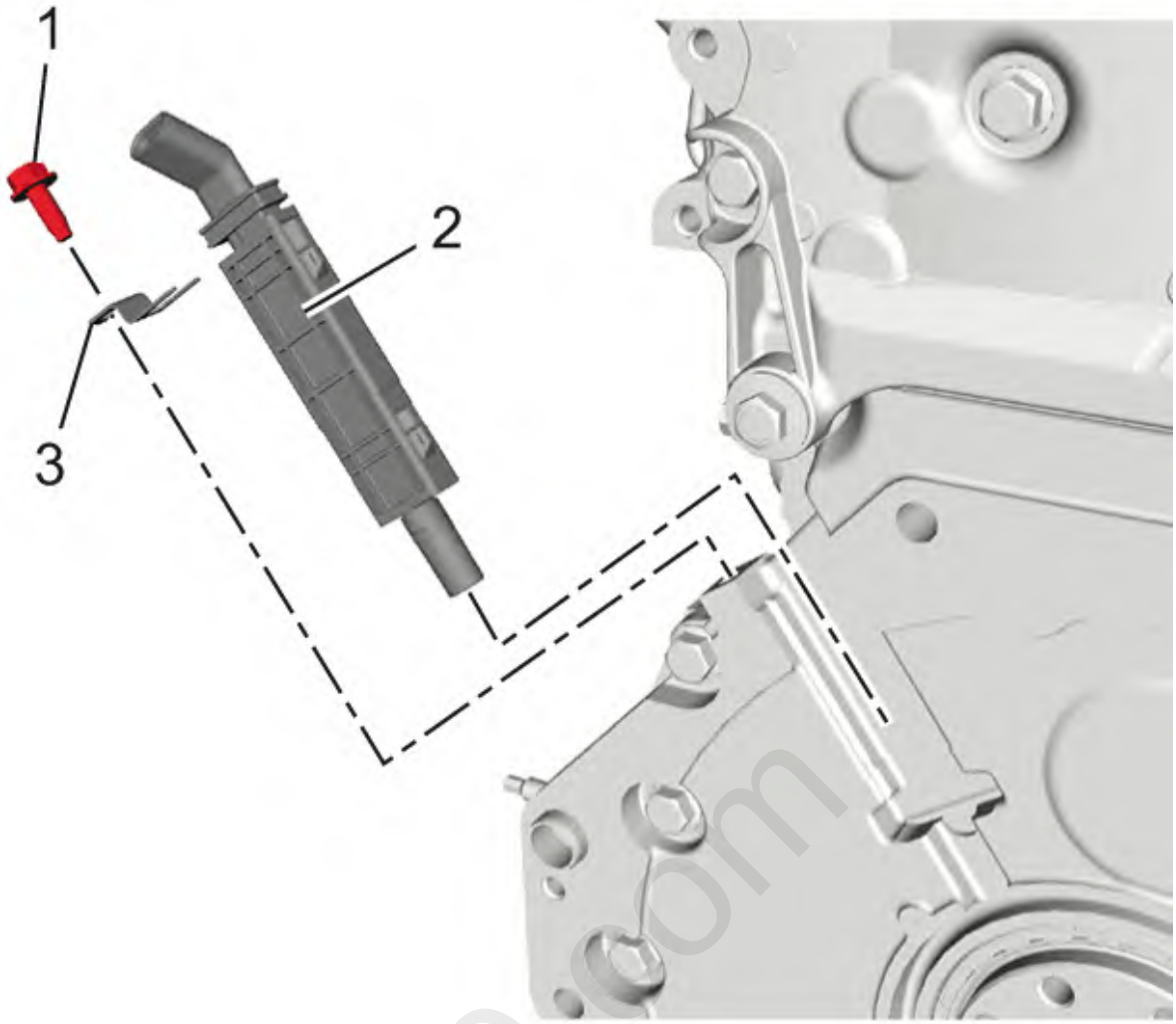


Fig. 249: Crankshaft Position Sensor, Bolt And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

8. Remove Crankshaft Position Sensor Bolt (1)
9. Remove the crankshaft position sensor retainer spring (3).
10. Remove Crankshaft Position Sensor (2)

mcx30.com

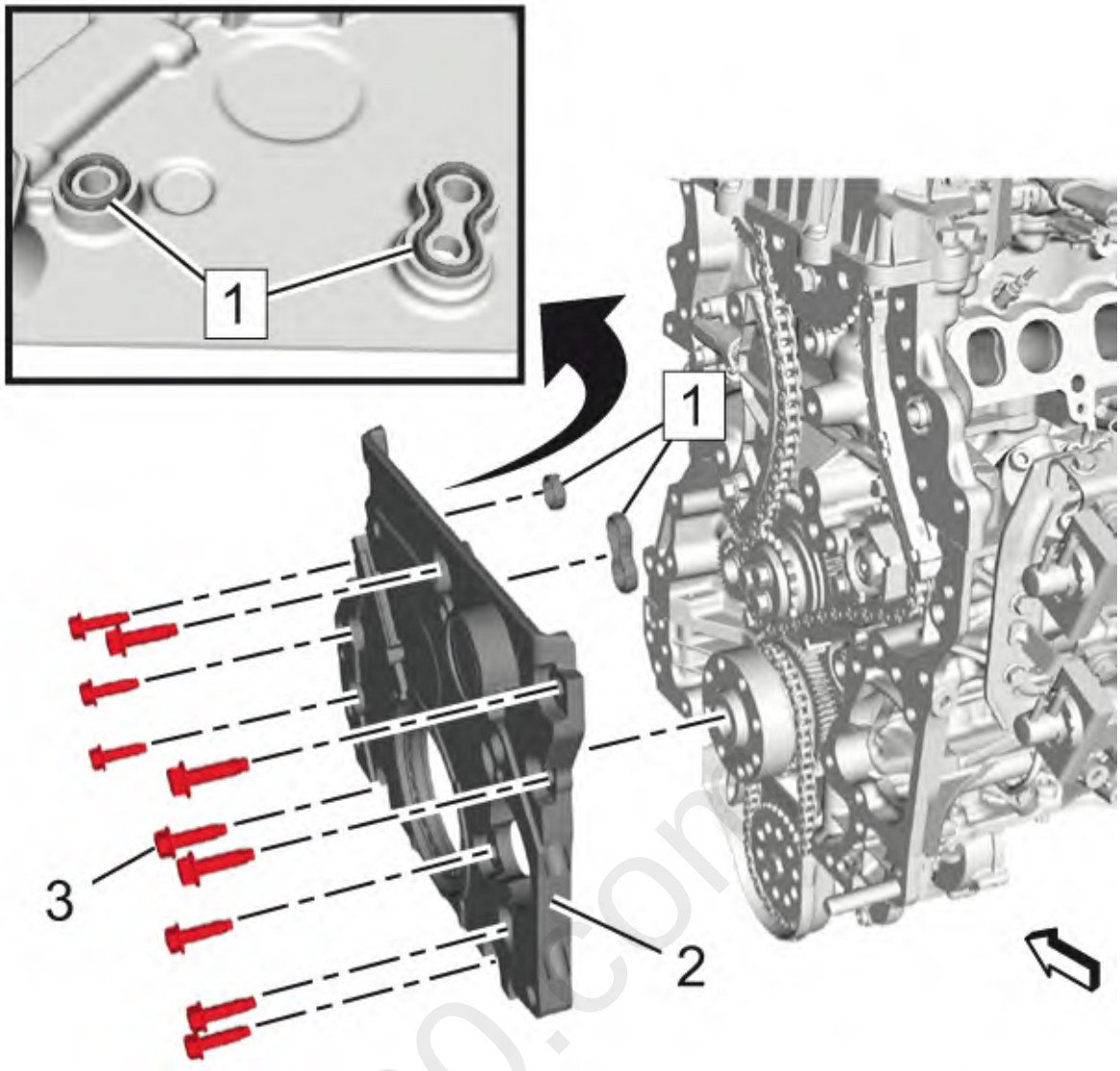


Fig. 250: Timing Chain Lower Cover, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

11. Remove the 11 timing chain lower cover bolts (1).
12. Remove Timing Chain Lower Cover (2) - Use a suitable tool.
13. Remove and DISCARD the gaskets. (3) (Qty: 2)
14. Remove the crankshaft rear oil seal, if the timing chain lower cover reused.

Installation Procedure

NOTE: **Before installing the timing chain lower cover, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner
2. Clean all sealing surfaces.

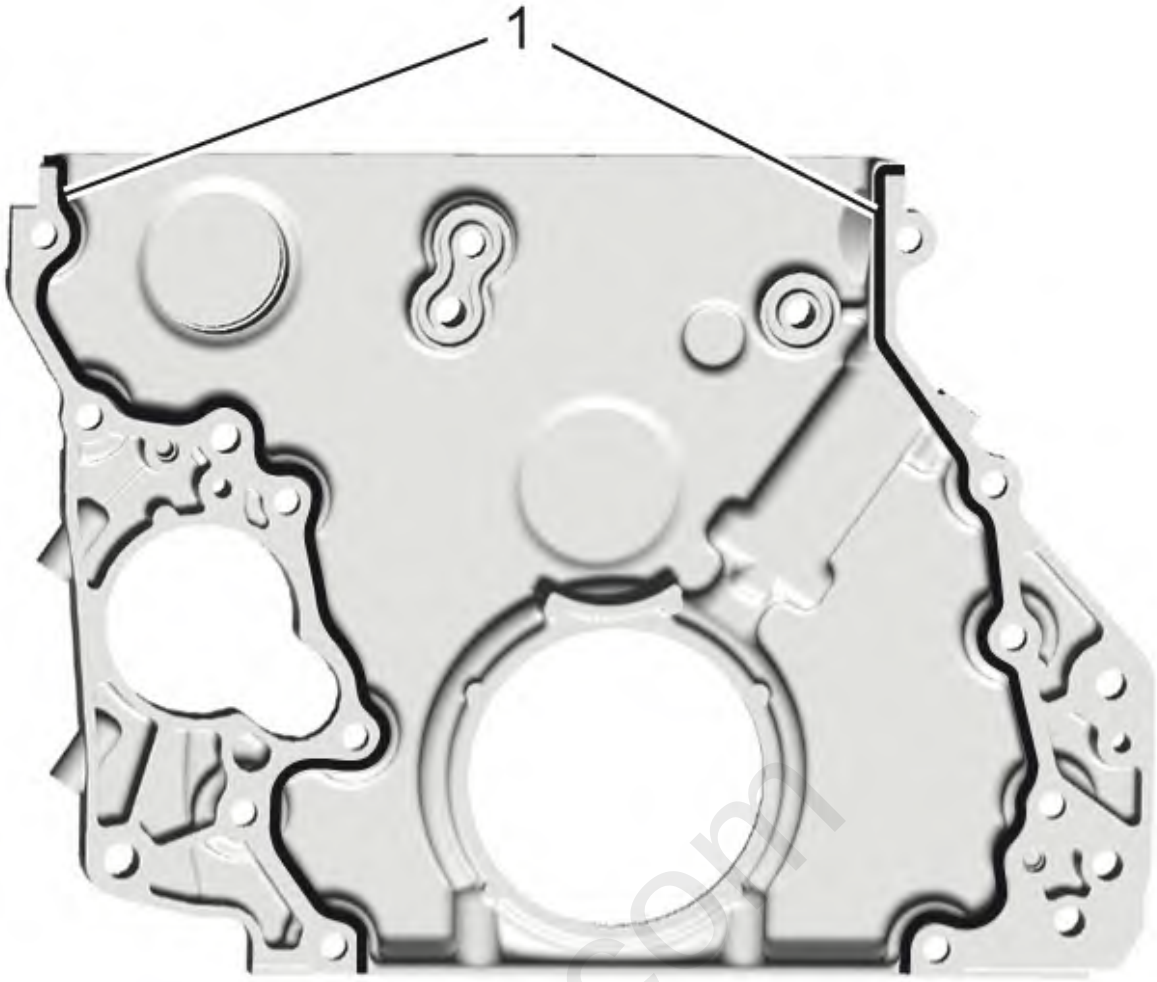


Fig. 251: Silicone Sealing Compound Application Area
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The complete installation procedure of the timing chain lower cover should be done in 20 minutes.**

3. Apply silicone sealing compound (1) to the timing chain lower cover sealing surface. The thickness of the sealing bead should be 2.0 - 3.0 mm (0.079 - 0.118 in)

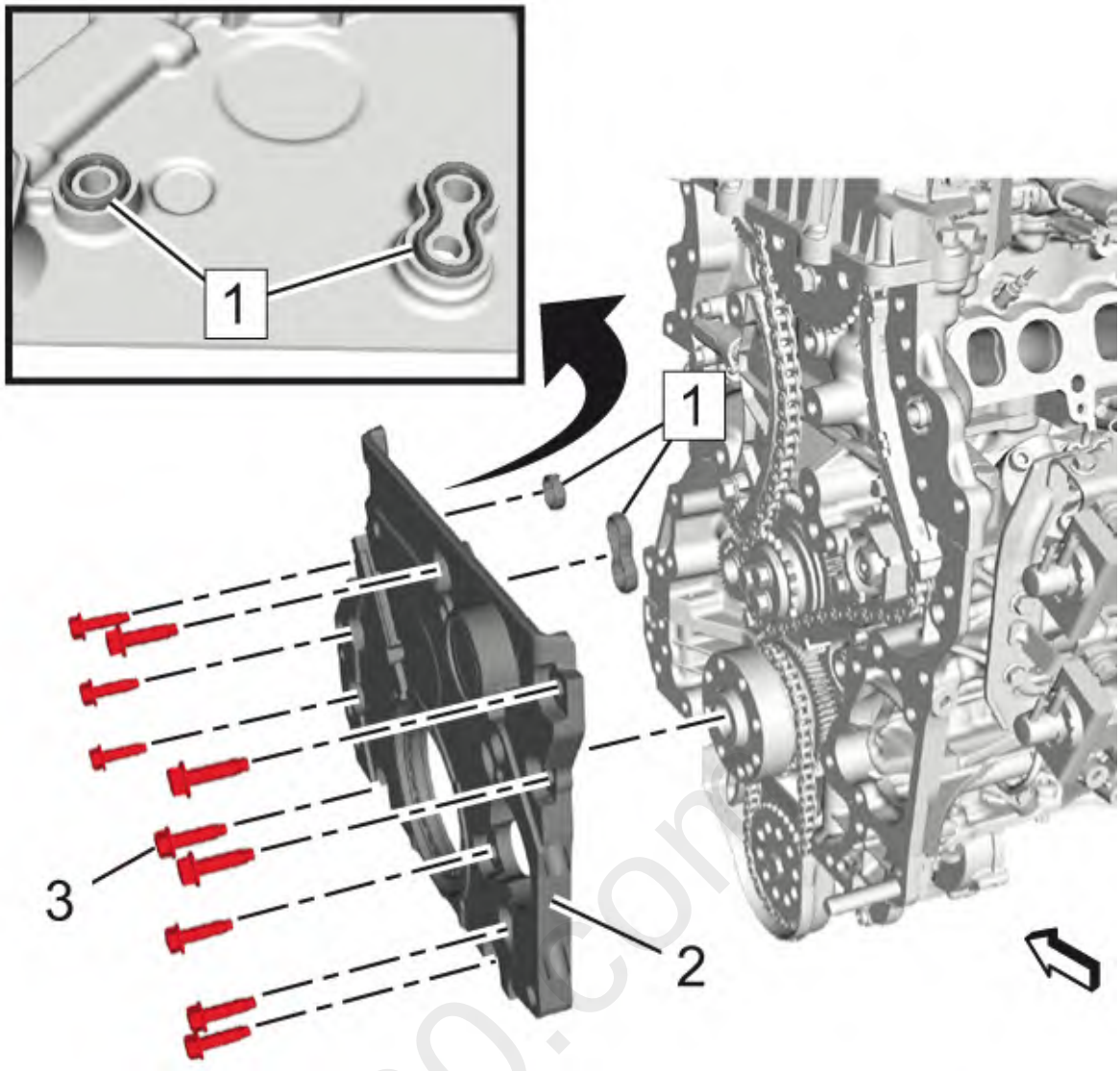


Fig. 252: Timing Chain Lower Cover, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

4. Install NEW gaskets. (3) (Qty: 2)
5. Install Timing Chain Lower Cover (2)
6. Install the 11 timing chain lower cover bolts (1).

mcx30.com

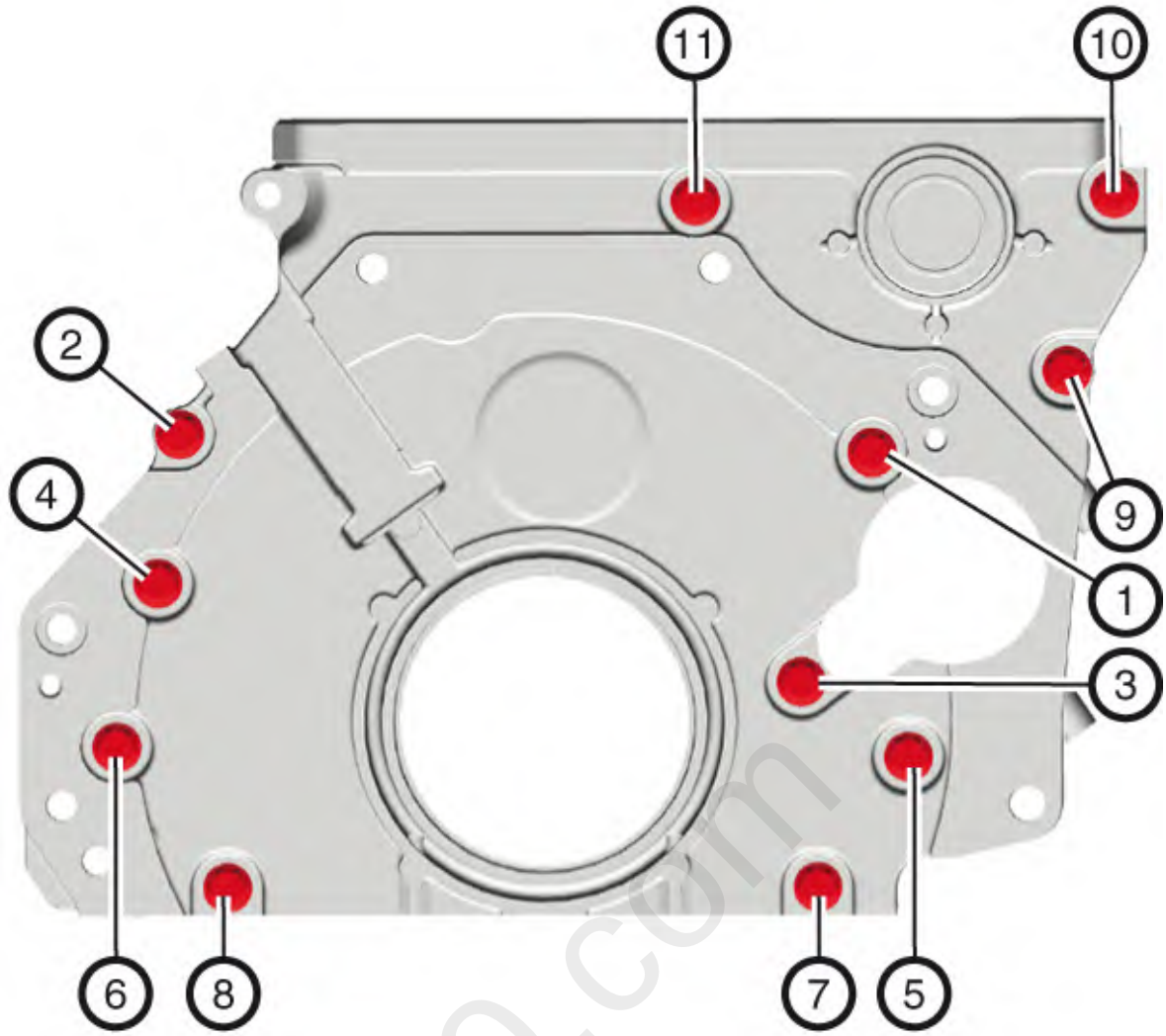


Fig. 253: Timing Chain Lower Cover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

7. Tighten the bolts in the sequence shown. (Qty: 11) to 25 N.m (18 lb ft).

mcx30.com

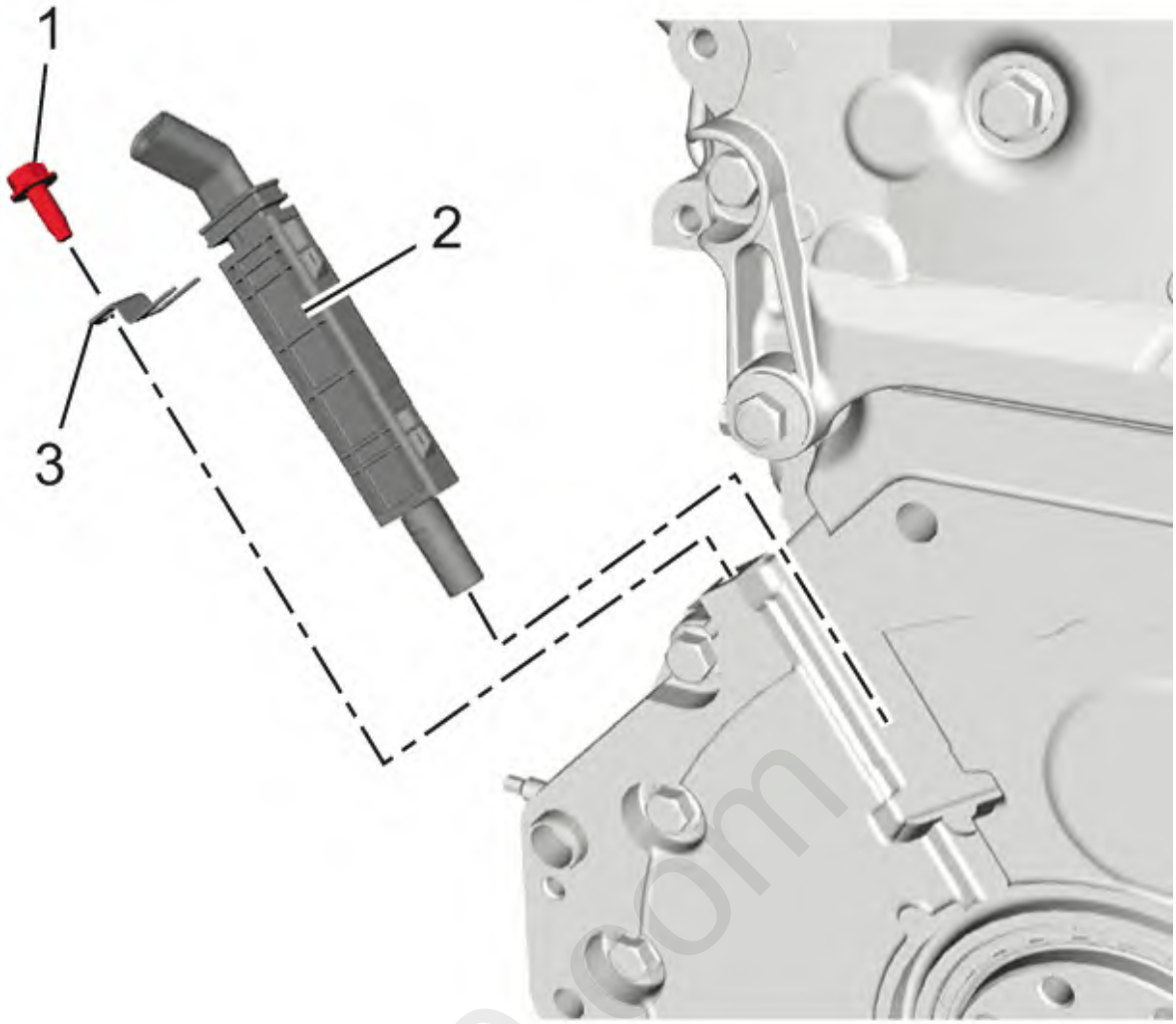


Fig. 254: Crankshaft Position Sensor, Bolt And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

8. Install Crankshaft Position Sensor (2)
9. Install the crankshaft position sensor retainer spring (3).
10. Install and tighten Crankshaft Position Sensor Bolt (1) to 10 N.m (89 lb in)
11. Install Crankshaft Rear Oil Seal. Refer to **Crankshaft Rear Oil Seal Replacement**
12. Install Crankshaft Position Sensor Reluctor Ring. Refer to **Crankshaft Position Sensor Reluctor Ring Replacement**

mcx30.com

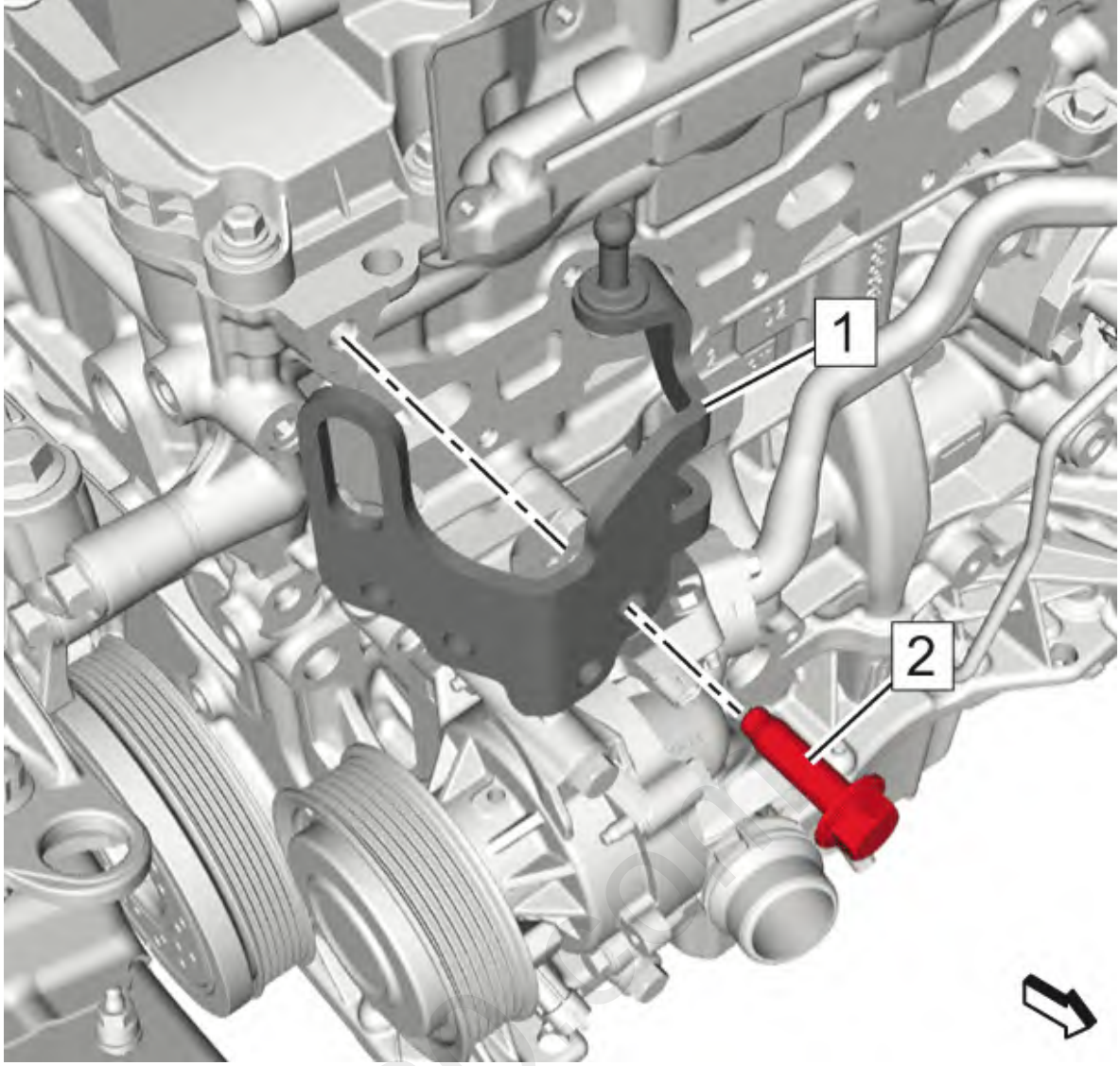


Fig. 255: Engine Lift Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

13. Remove Engine Lift Bracket Bolt (2)
14. Remove Engine Lift Bracket-Right Side (1)

mcx30.com

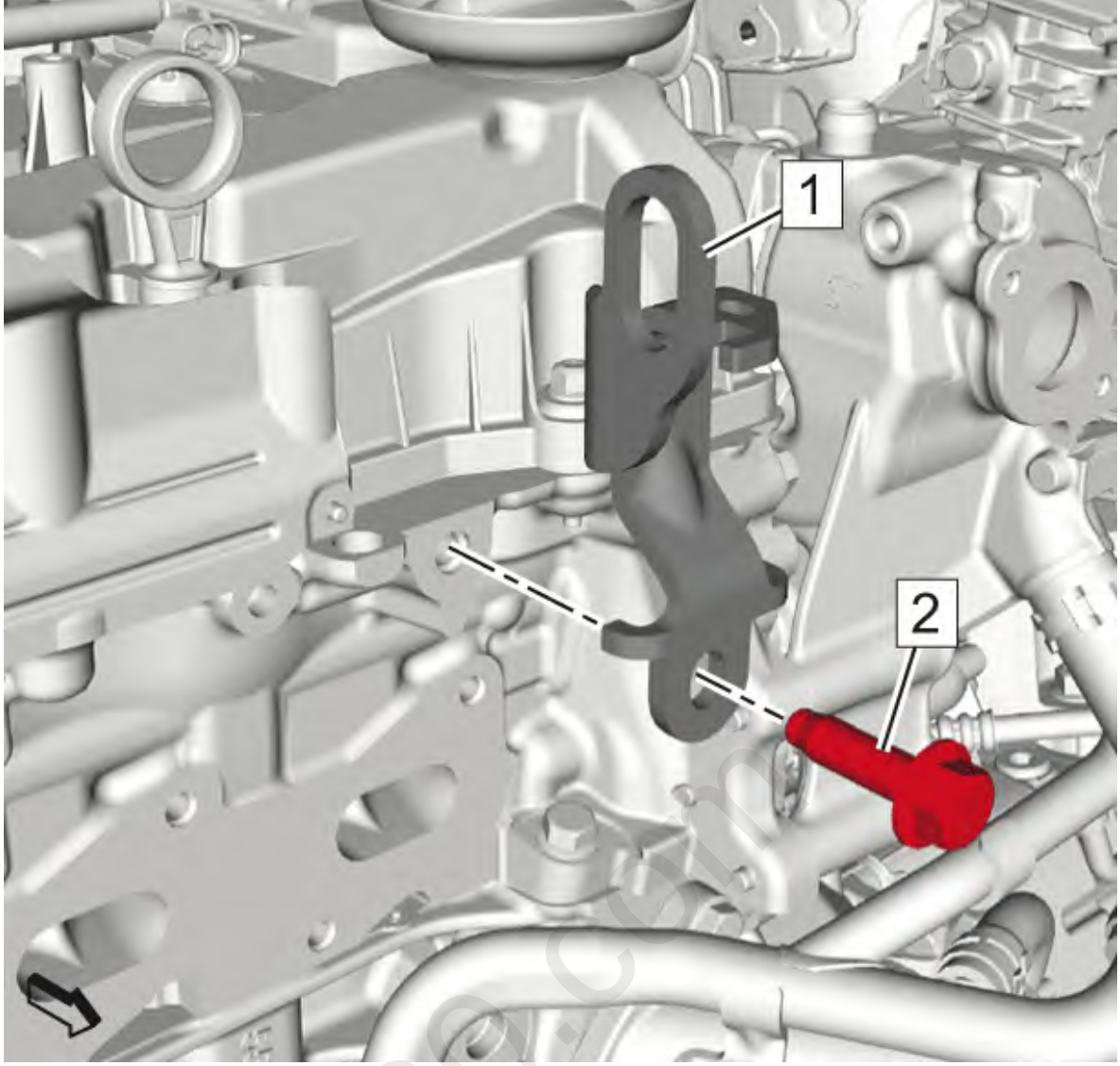


Fig. 256: Engine Lift Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

15. Remove Engine Lift Bracket Bolt (2)
16. Remove Engine Lift Bracket-Left Side (1)
17. Install Oil Pan. Refer to **Oil Pan Replacement**
18. Install Timing Chain Upper Cover. Refer to **Timing Chain Upper Cover Replacement**

TIMING CHAIN LOWER GUIDE REPLACEMENT

Special Tools

- **EN-50513** Fixing Pin
- **EN-51140** Crankshaft Fixing Tool
- **EN-51143** Camshaft Sprocket Fixing Tool

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

Removal Procedure

1. Remove the timing chain lower cover. Refer to **Timing Chain Lower Cover Replacement**.
2. Remove the crankshaft pulley. Refer to **Crankshaft Pulley Replacement**.

mcx30.com

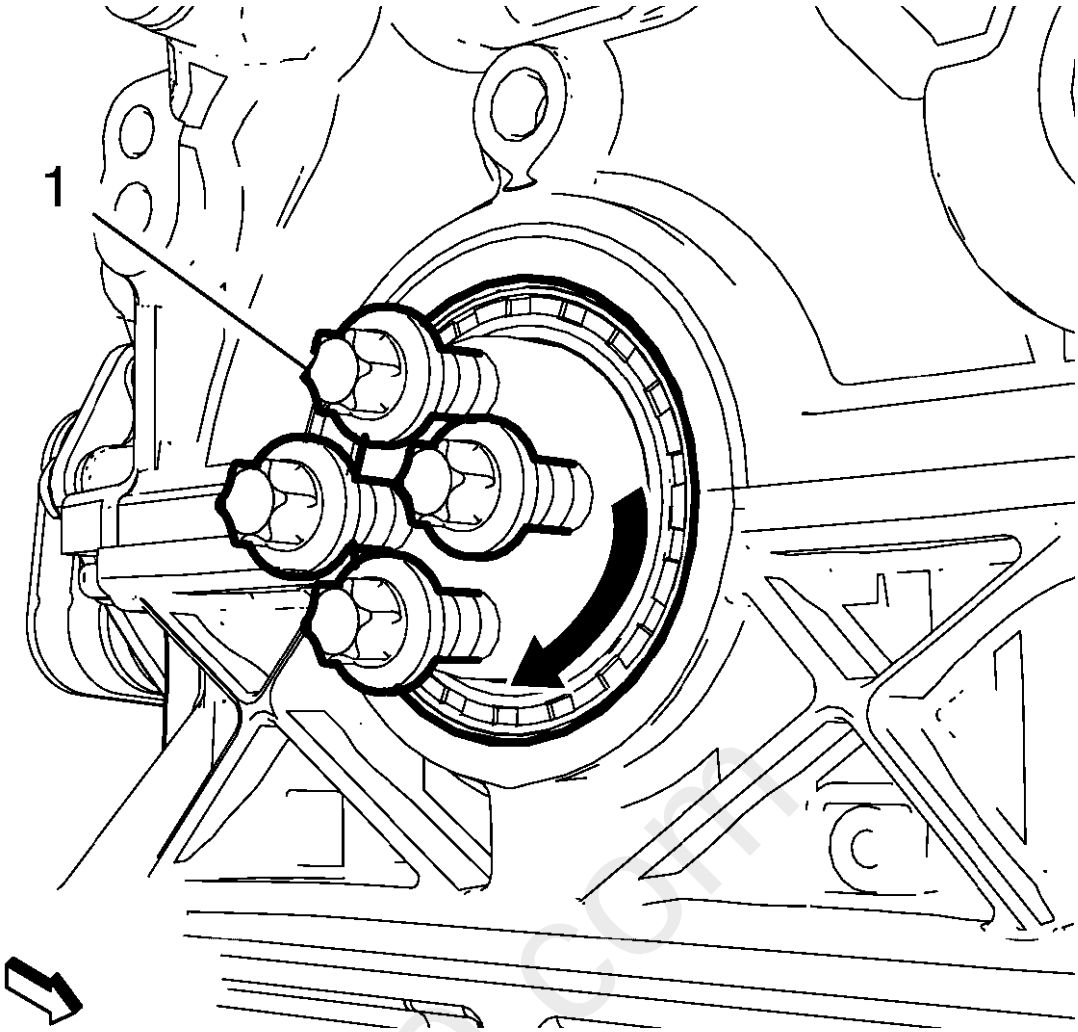


Fig. 257: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the 4 crankshaft pulley bolts (1).

mcx30.com

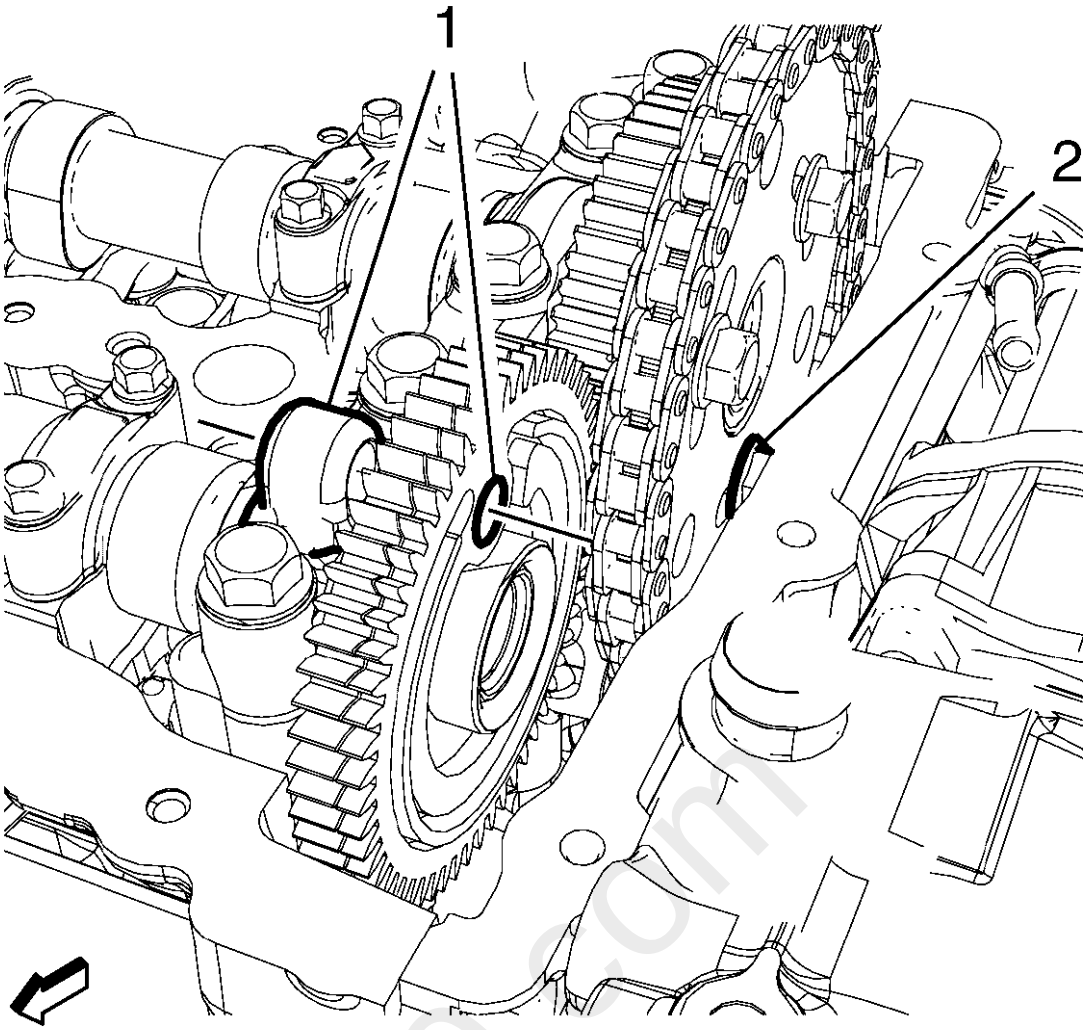


Fig. 258: Aligning Bores
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the bores not aligned turn the crankshaft at the crankshaft pulley bolts.**

mcx30.com

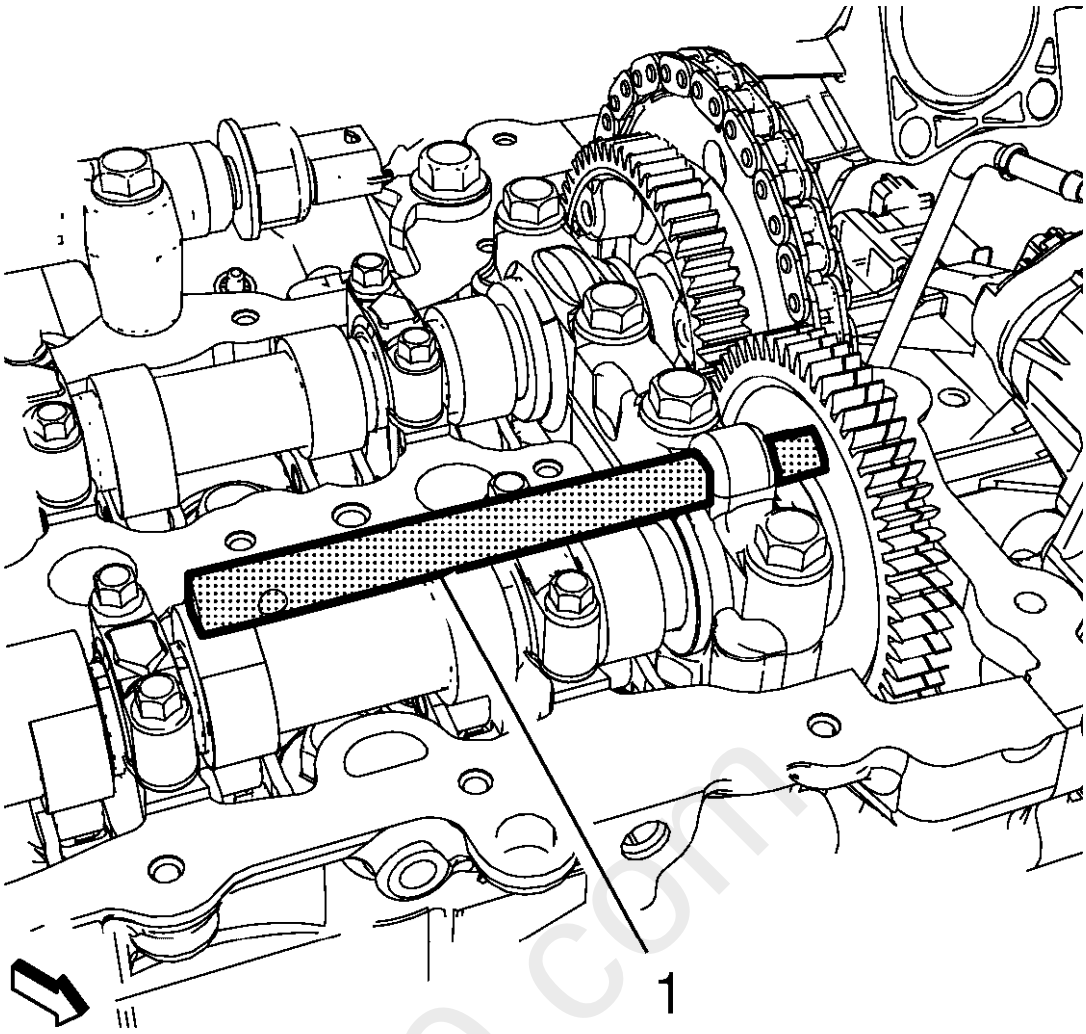


Fig. 259: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

4. Check if the bores (1) are aligned.

   Turn the exhaust camshaft at the hexagon so far if the **EN-51143** fixing tool (1) can be installed.

5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

mcx30.com

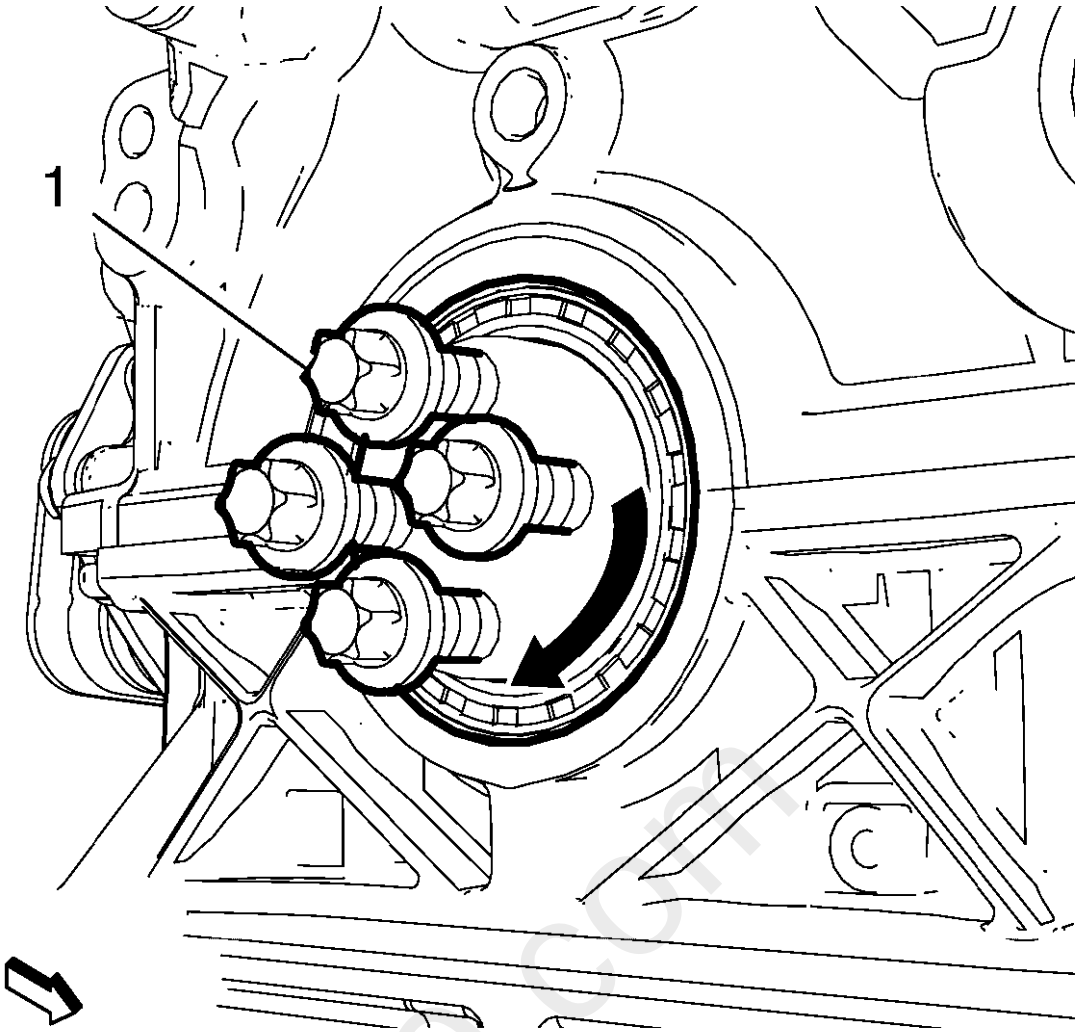


Fig. 260: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the 4 crankshaft pulley bolts (1).

mcx30.com

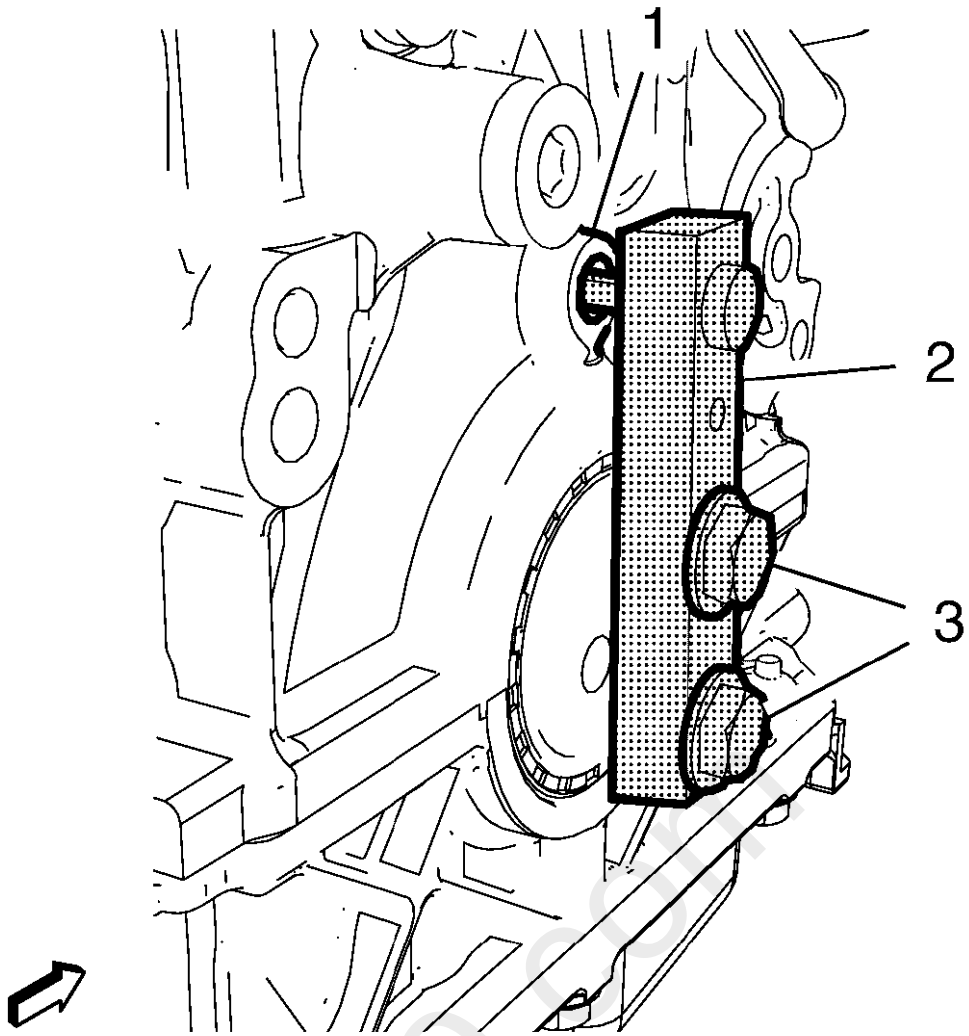


Fig. 261: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

7. Install **EN-51140** fixing tool (2).
8. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).
9. If the **EN-51140** fixing tool can not installed. Refer to **Camshaft Timing Chain Adjustment**.
10. Lower the vehicle.

mtx30.com

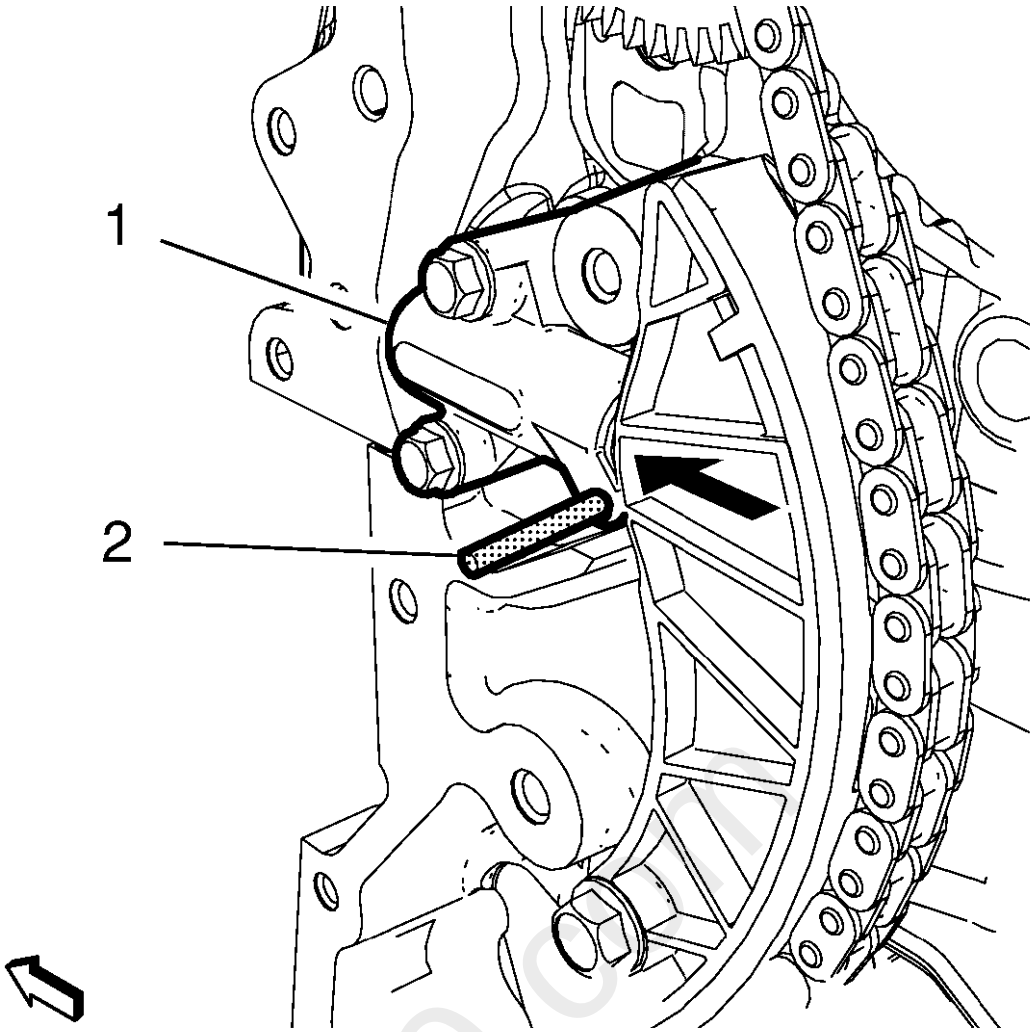


Fig. 262: Timing Chain Tensioner And Pin
Courtesy of GENERAL MOTORS COMPANY

11. Tension the timing chain tensioner (1) in arrow direction.
12. Install the **EN-50513** pin (2).

mcx30.com

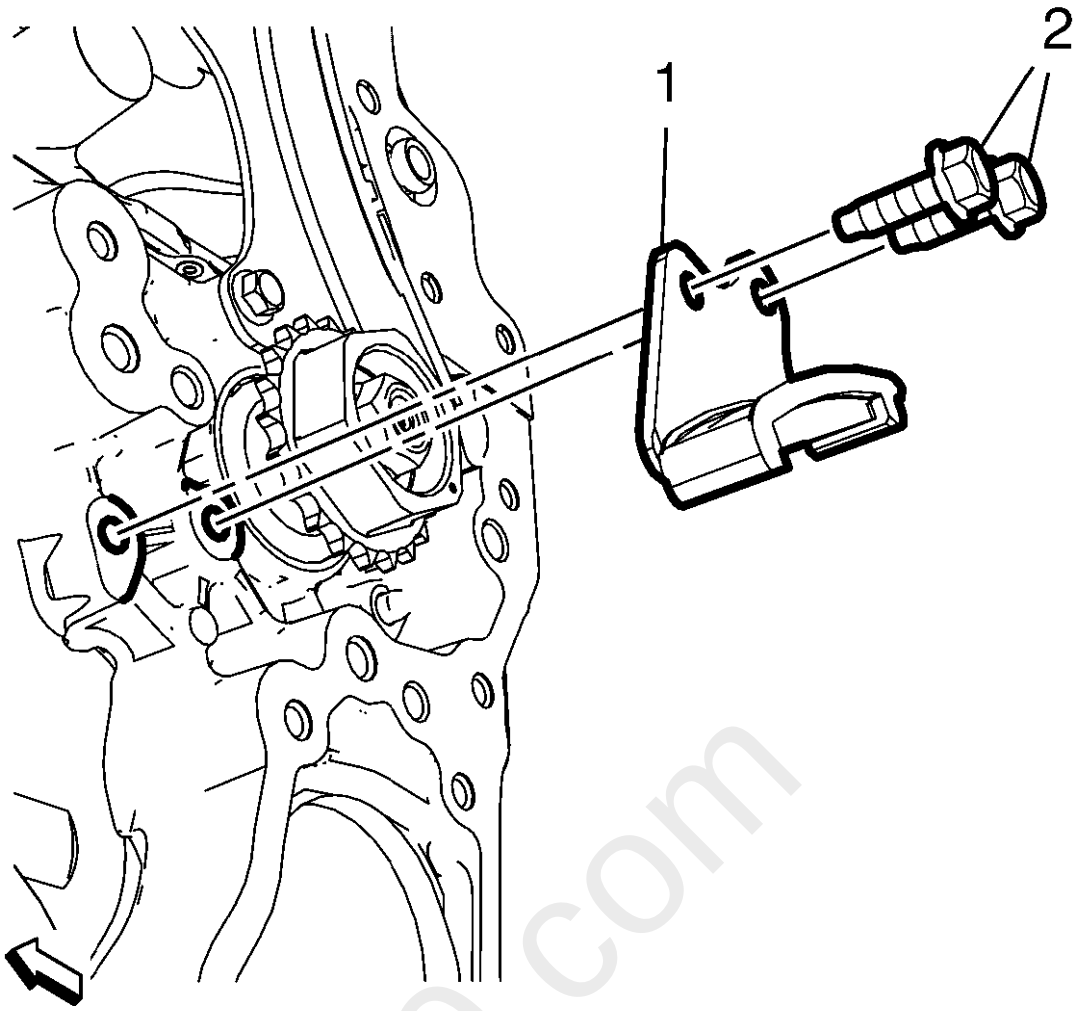


Fig. 263: Timing Chain Lower Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove the 2 timing chain lower guide bolts (2).
14. Remove the timing chain lower guide (1).

Installation Procedure

NOTE: **Before installing the timing chain lower guide, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
    - Timing chain guides with plastic attachment
    - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
    - Timing chain and all timing chain sprockets
    - Oil pump sprocket
    - Oil pump drive chain tensioner

mcx30.com

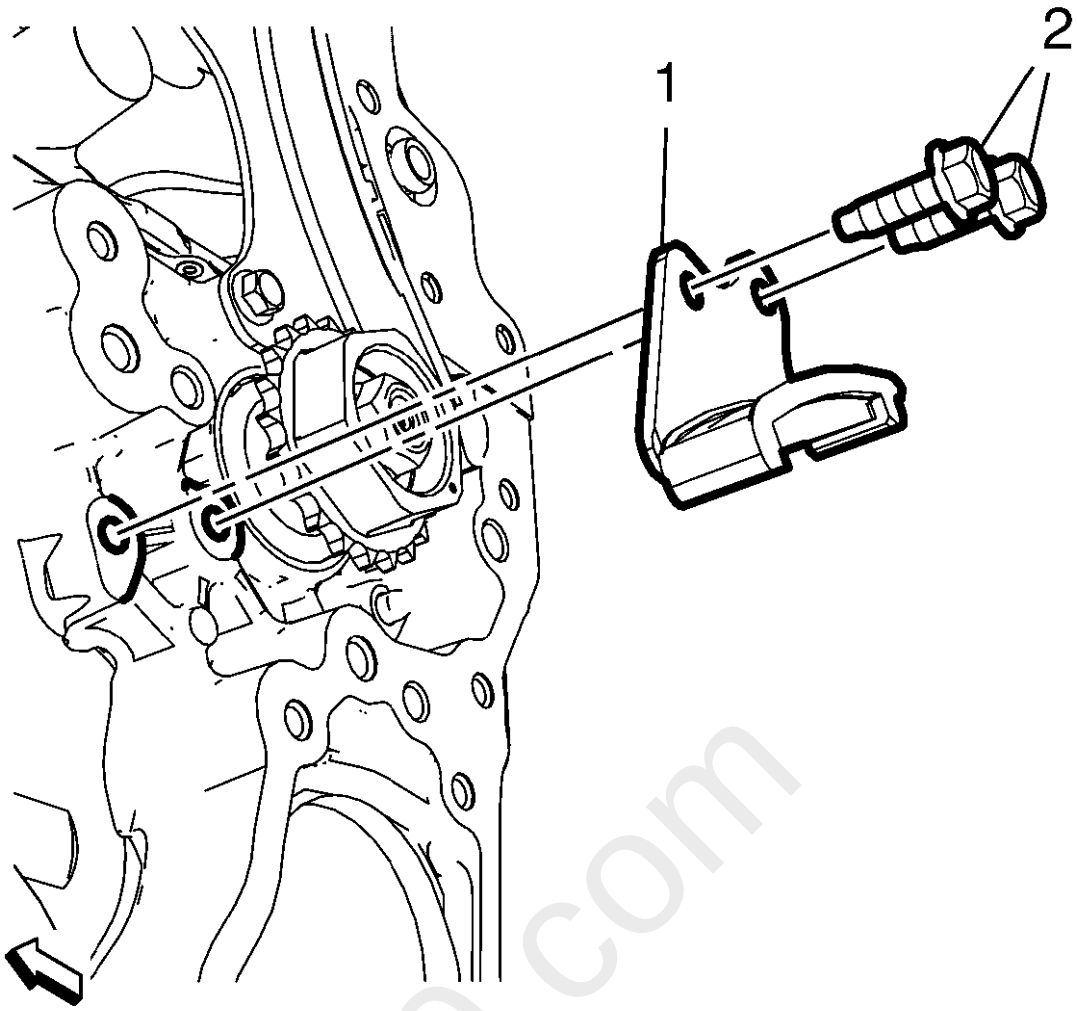


Fig. 264: Timing Chain Lower Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the timing chain lower guide (1).

CAUTION: **Refer to Fastener Caution .**

3. Install the 2 timing chain lower guide bolts (2) and tighten to 10 N.m (89 lb in).

mcx30.com

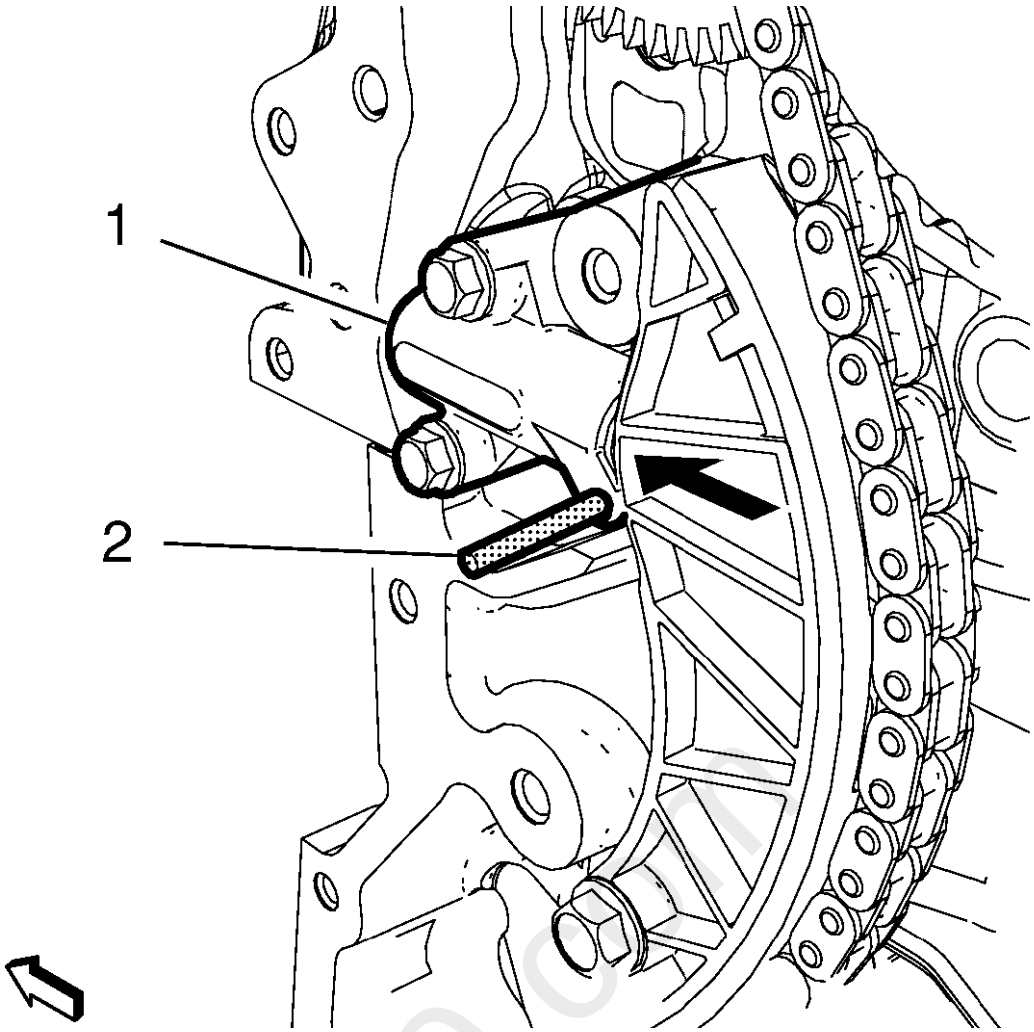


Fig. 265: Timing Chain Tensioner And Pin
Courtesy of GENERAL MOTORS COMPANY

4. Remove the **EN-50513** pin (2).

mcx30.com

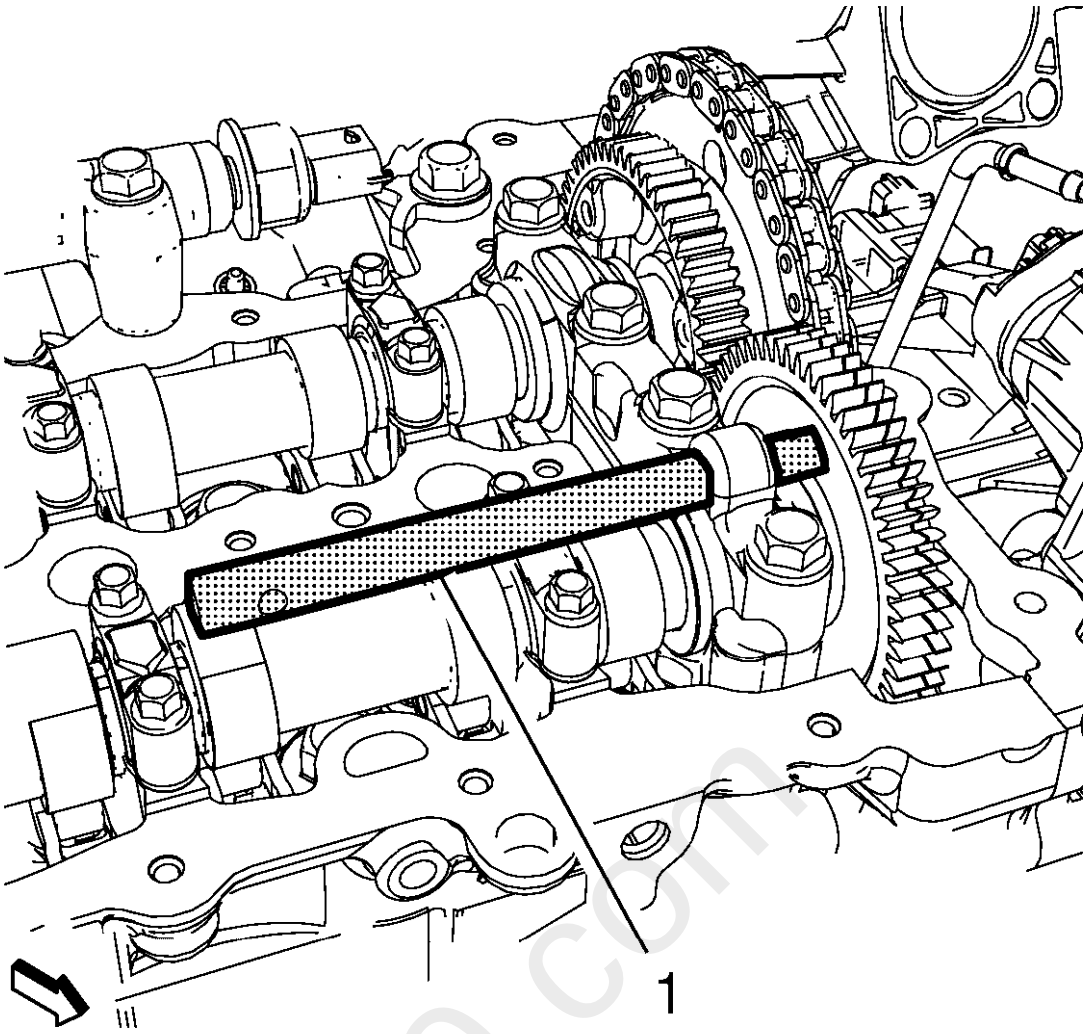


Fig. 266: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

5. Remove the **EN-51143** fixing tool (1).
6. Raise the vehicle.

mcx30.com

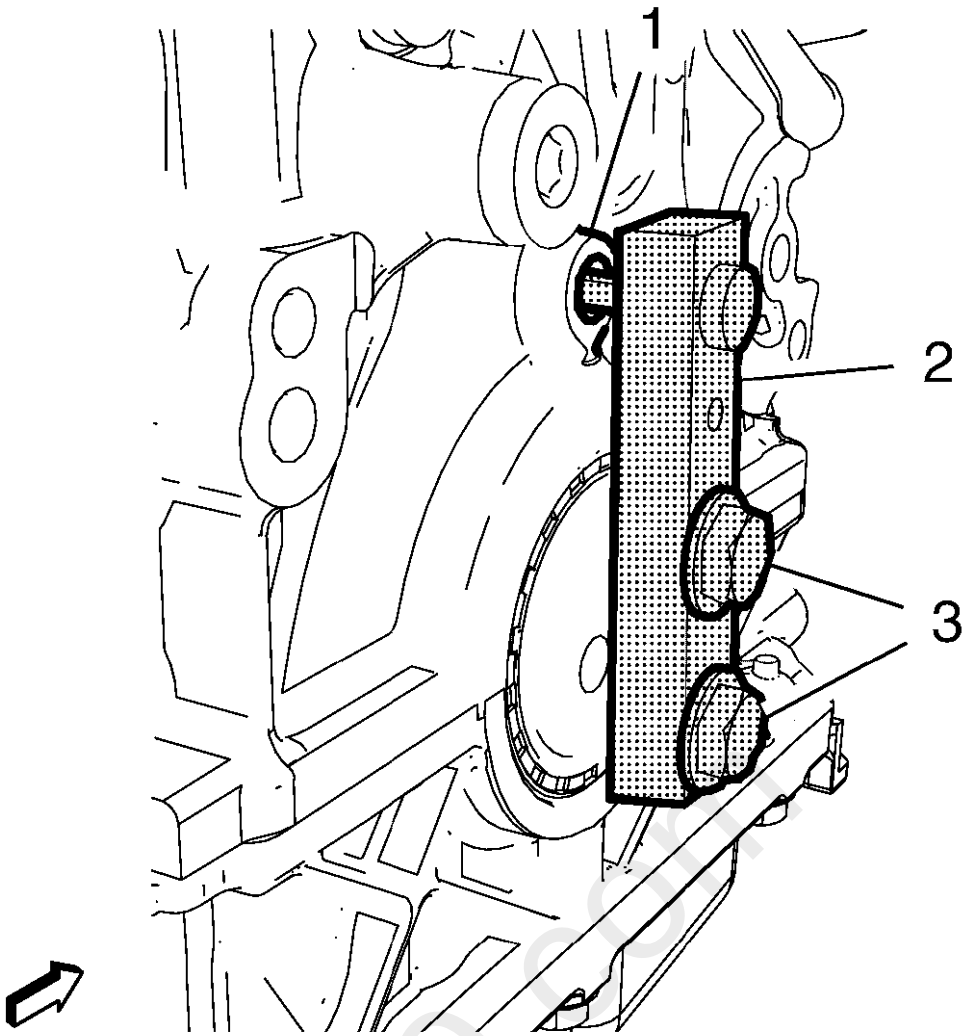


Fig. 267: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

7. Remove the 2 bolts (3).
8. Remove the **EN-51140** fixing tool (2).

mcx30.com

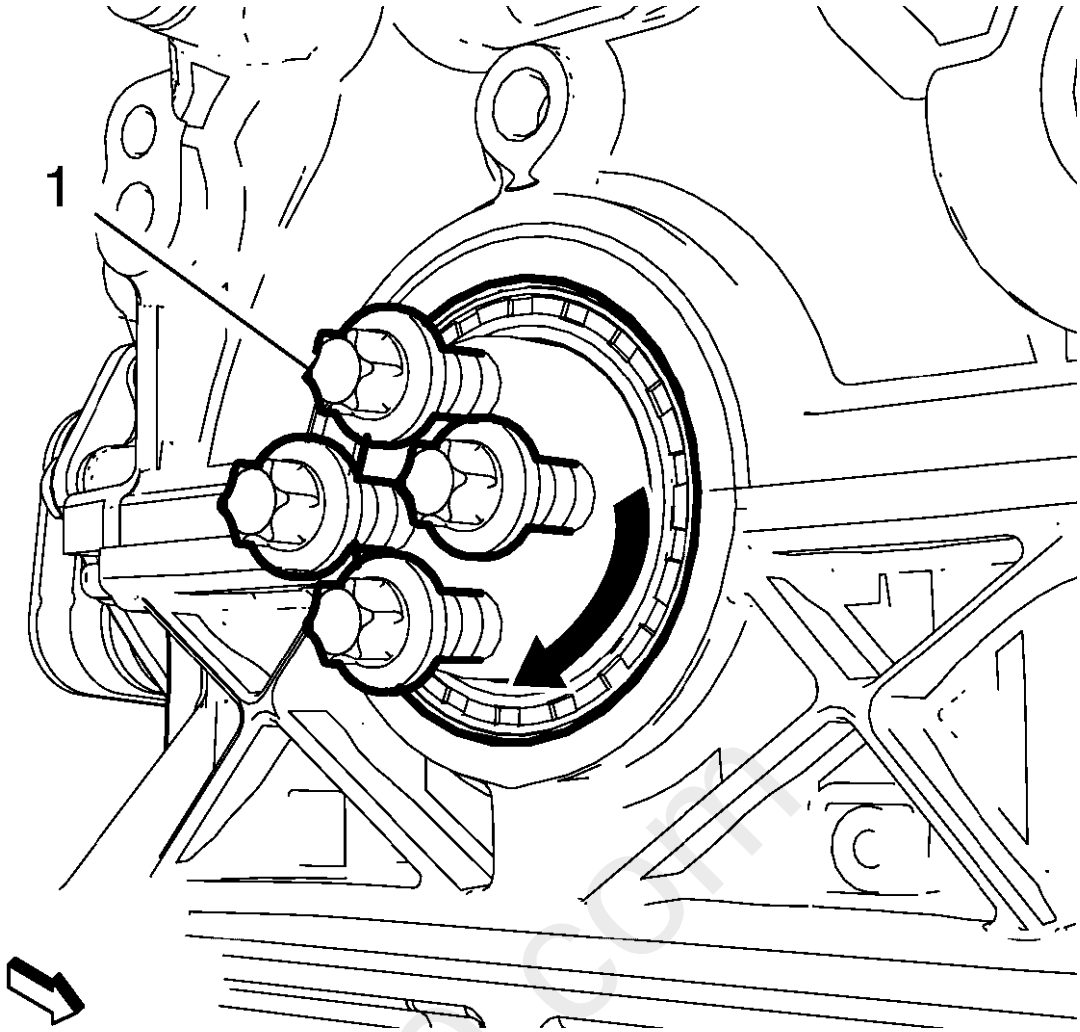


Fig. 268: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Install the 4 crankshaft pulley bolts (1).

   Rotate the crankshaft 720 degrees in direction of arrow. Use a pry bar at the 4 crankshaft pulley bolts (1).

10. Remove the 4 crankshaft pulley bolts (1).
11. Check the camshaft timing. Refer to **Camshaft Timing Chain Inspection**.
12. Install the crankshaft pulley. Refer to **Crankshaft Pulley Replacement**.
13. Install the timing chain lower cover. Refer to **Timing Chain Lower Cover Replacement**.

TIMING CHAIN TENSIONER REPLACEMENT

Special Tools

- **EN-50513** Fixing Pin
- **EN-51140** Crankshaft Fixing Tool
- **EN-51143** Camshaft Sprocket Fixing Tool

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

Removal Procedure

1. Remove the timing chain upper cover. Refer to **Timing Chain Upper Cover Replacement**
2. Remove the crankshaft pulley. Refer to **Crankshaft Pulley Replacement**.

mcx30.com

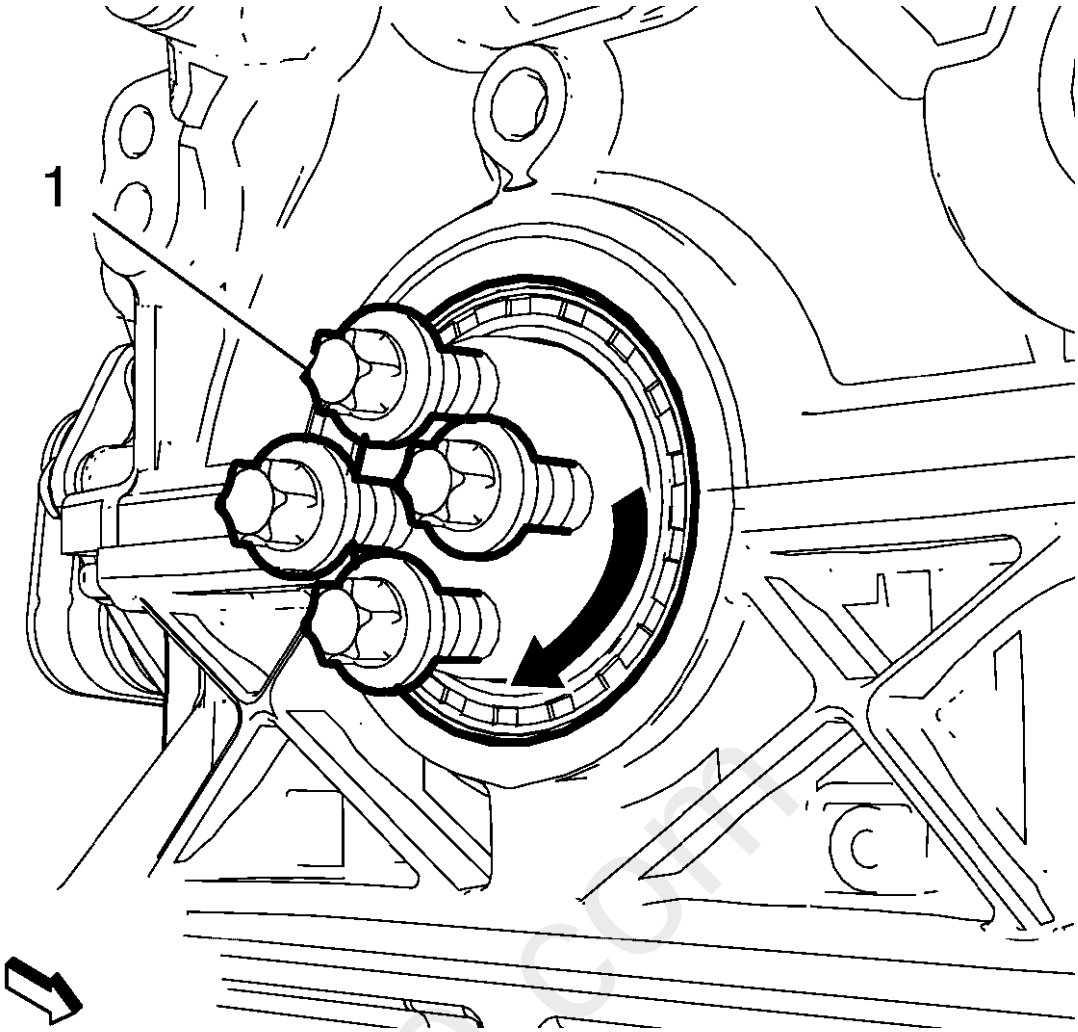


Fig. 269: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the 4 crankshaft pulley bolts (1).

mcx30.com

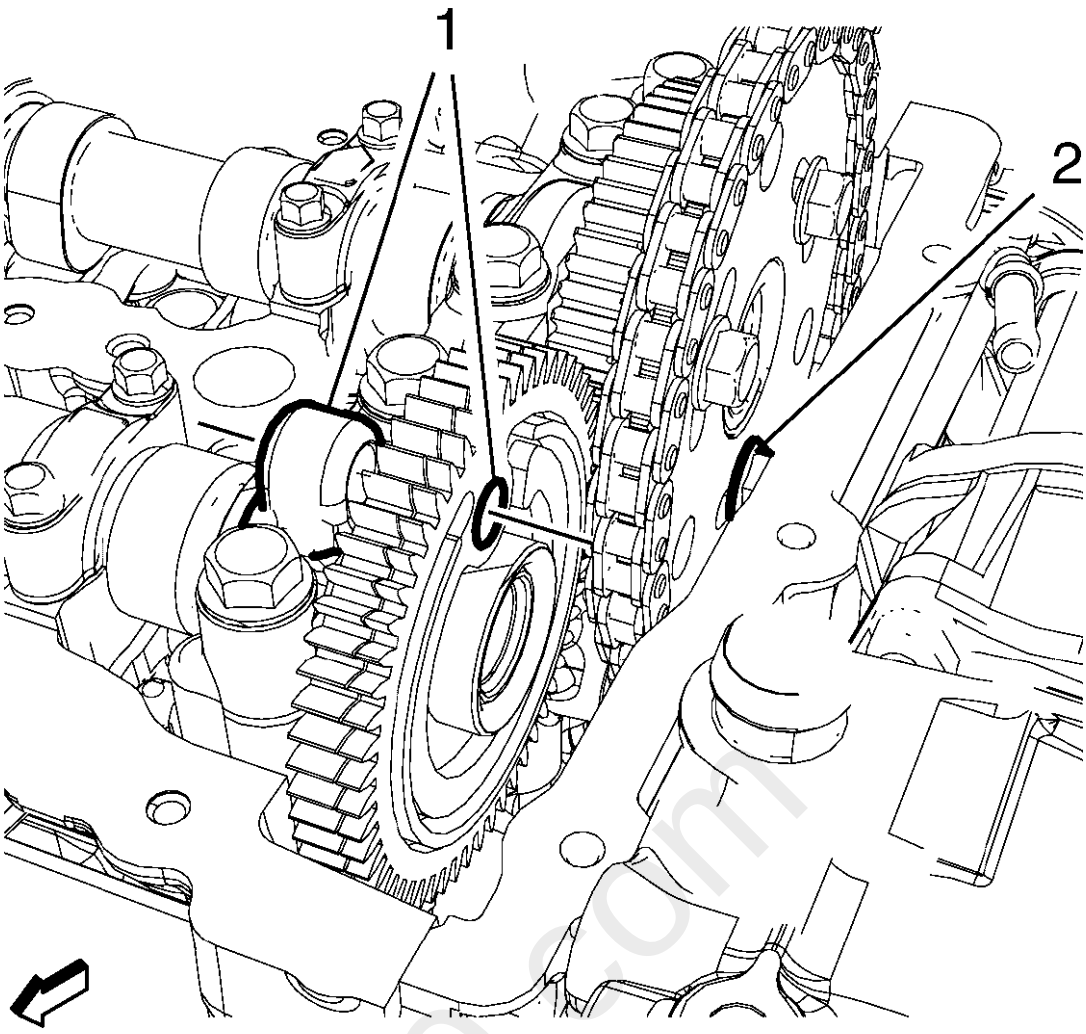


Fig. 270: Aligning Bores
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the bores not aligned turn the crankshaft at the crankshaft pulley bolts.**

mcx30.com

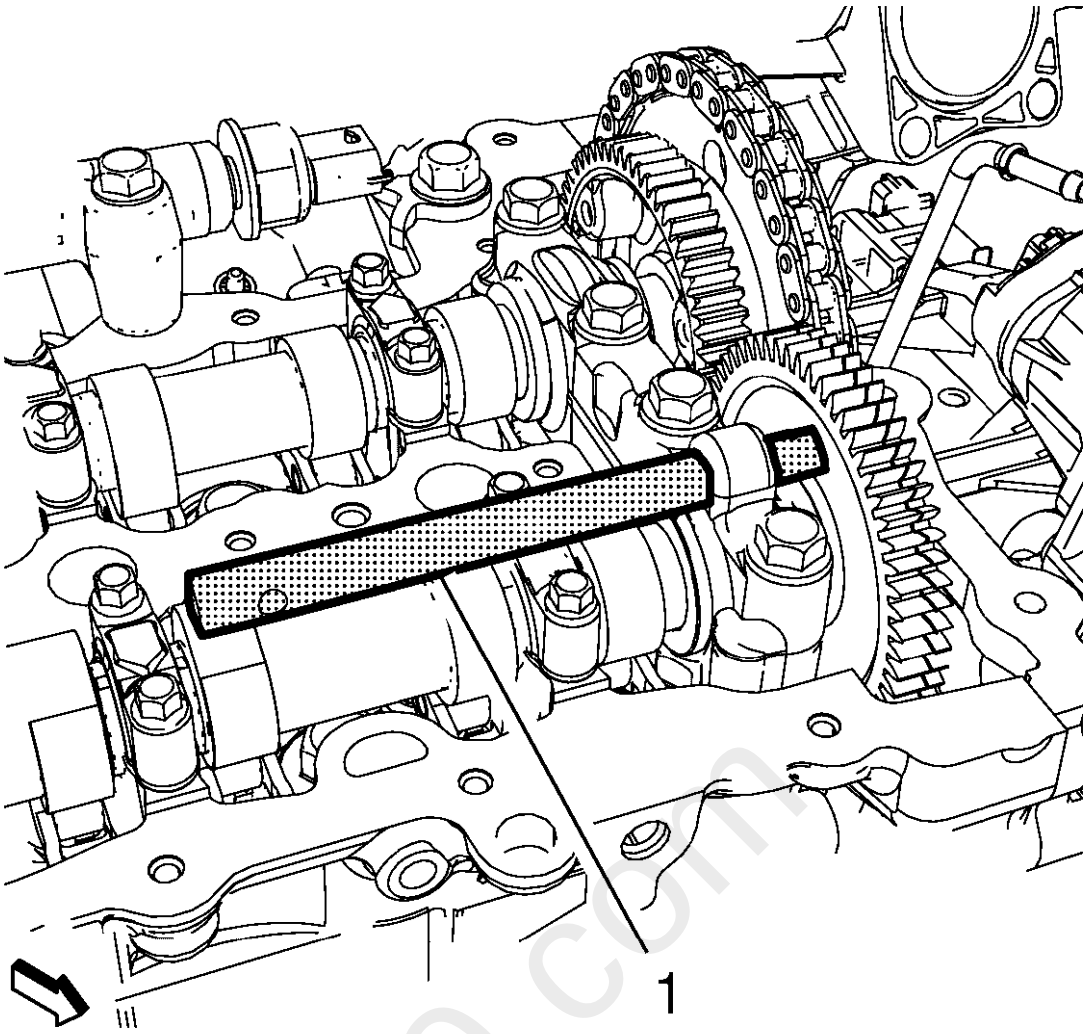


Fig. 271: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

4. Check if the bores (1) are aligned.

   Turn the exhaust camshaft at the hexagon so far if the **EN-51143** fixing tool (1) can be installed.

5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**

mcx30.com

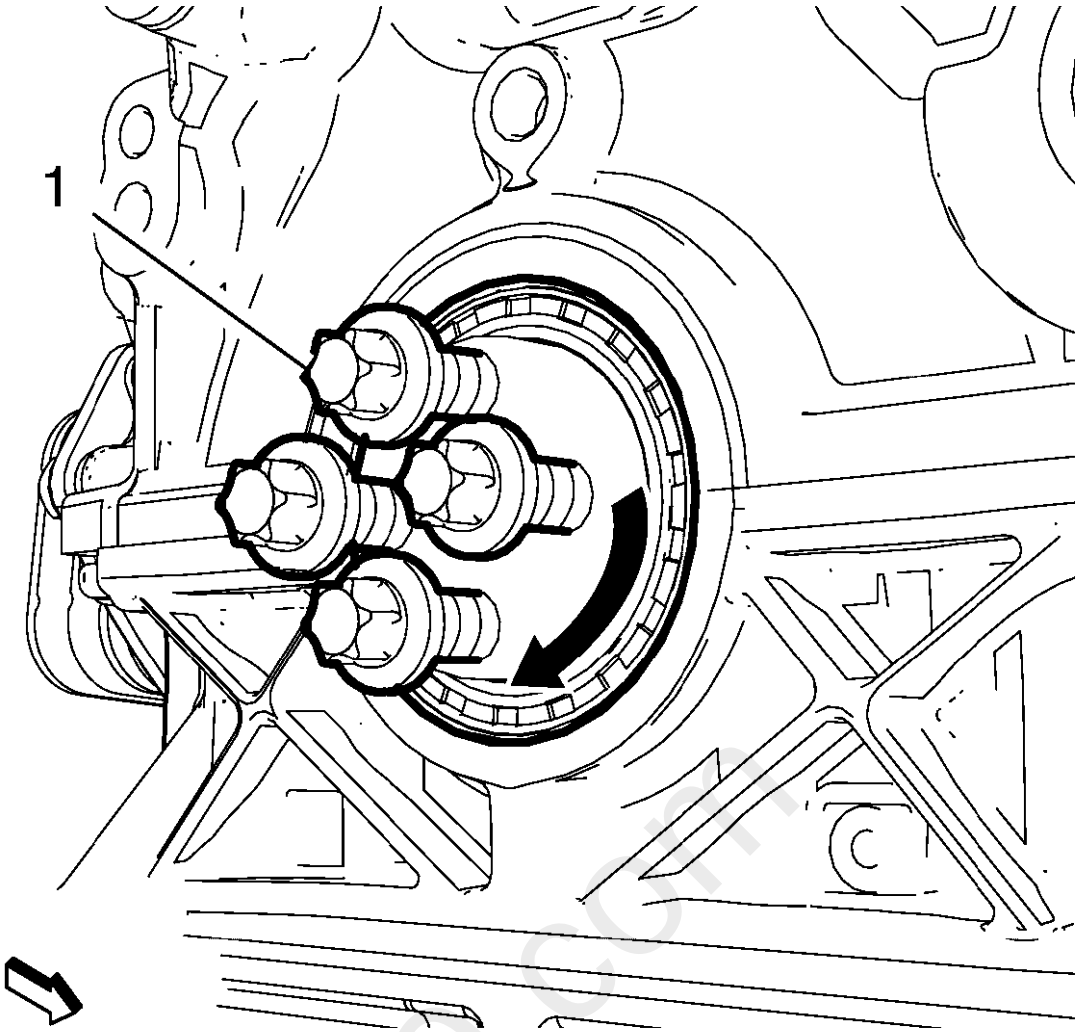


Fig. 272: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the 4 crankshaft pulley bolts (1).

mcx30.com

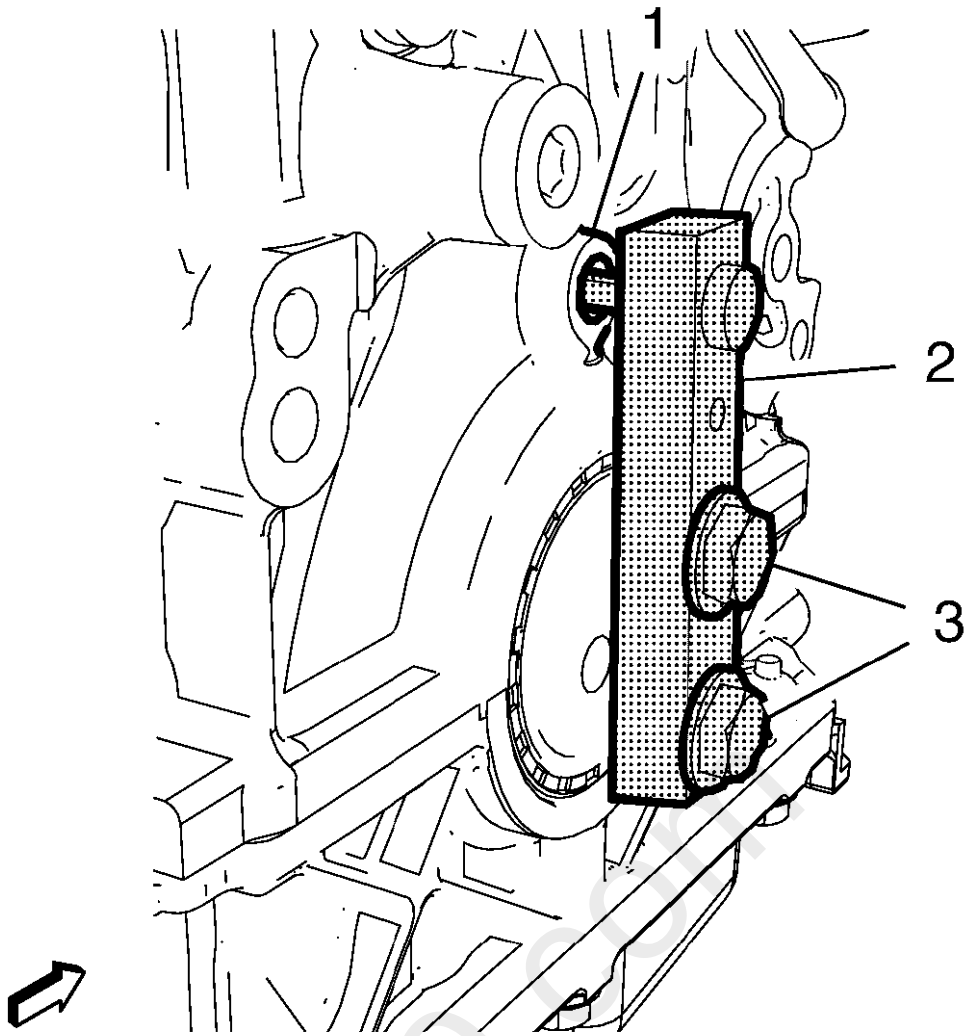


Fig. 273: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

7. Install **EN-51140** fixing tool (2).
8. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).
9. If the **EN-51140** fixing tool can not installed. Refer to **Camshaft Timing Chain Adjustment**.
10. Lower the vehicle.

mtx30.com

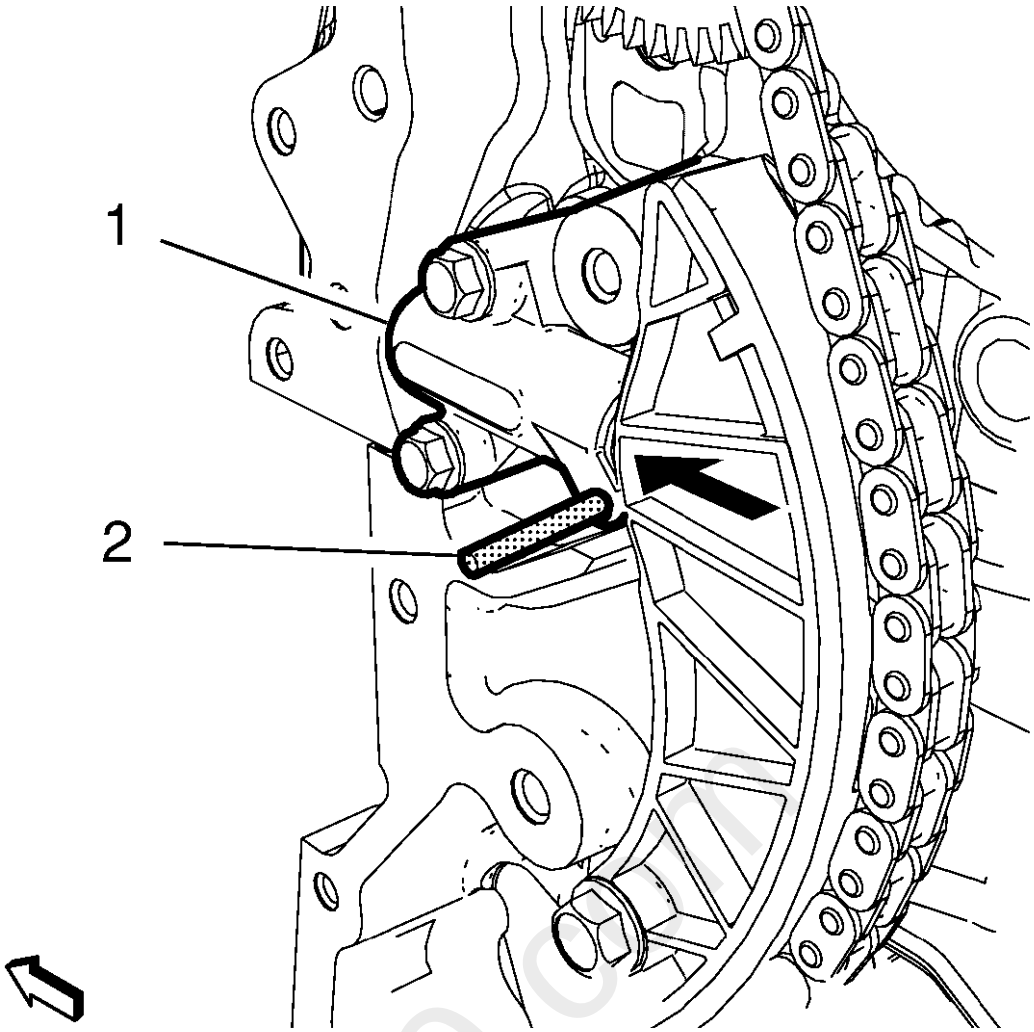


Fig. 274: Timing Chain Tensioner And Pin
Courtesy of GENERAL MOTORS COMPANY

11. Tension the timing chain tensioner (1) in arrow direction.
12. Install the **EN-50513** pin (2).

mcx30.com

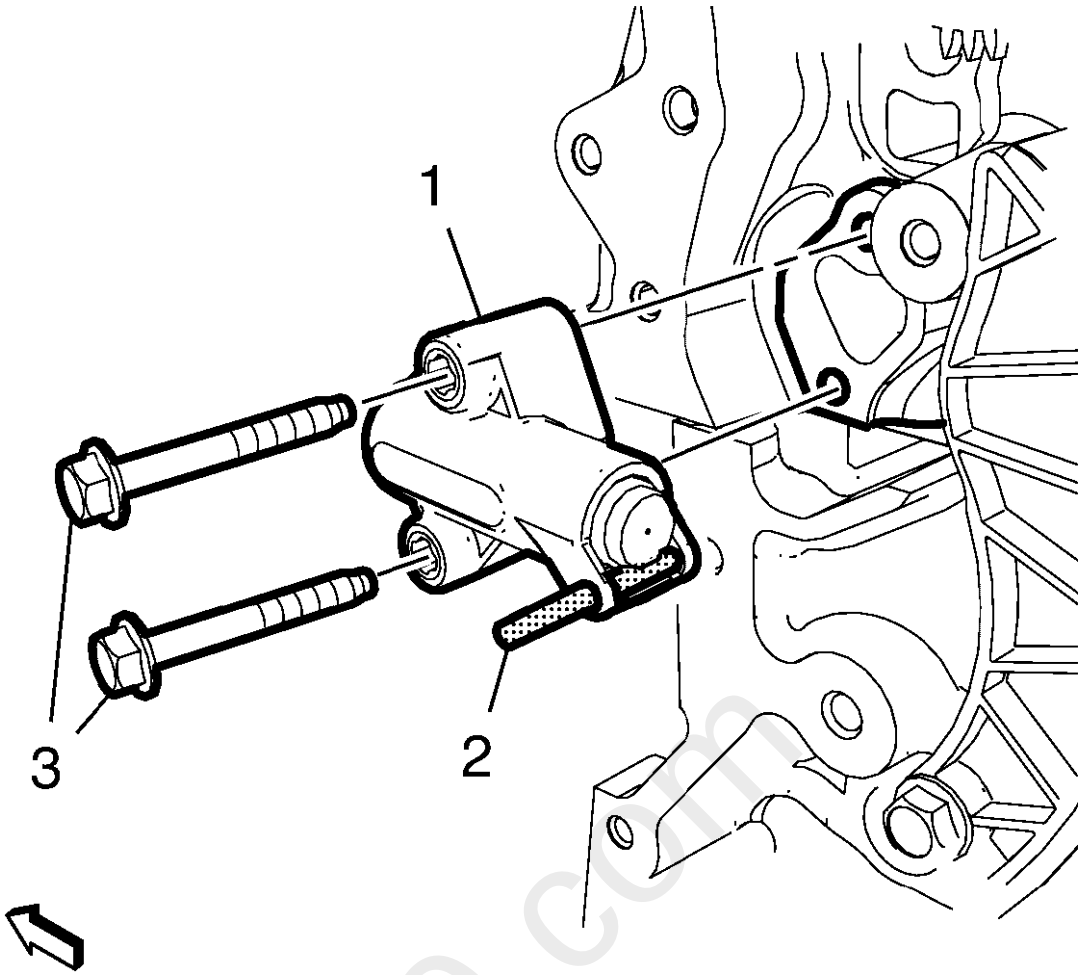


Fig. 275: Timing Chain Tensioner, Bolts And Pin
Courtesy of GENERAL MOTORS COMPANY

13. Remove the 2 timing chain tensioner bolts (3).

NOTE: **If the timing chain tensioner will be reused, do not remove the EN-50513 pin (2).**

14. Remove the timing chain tensioner (1).

Installation Procedure

NOTE: **Before installing the timing chain tensioner, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

mcx30.com

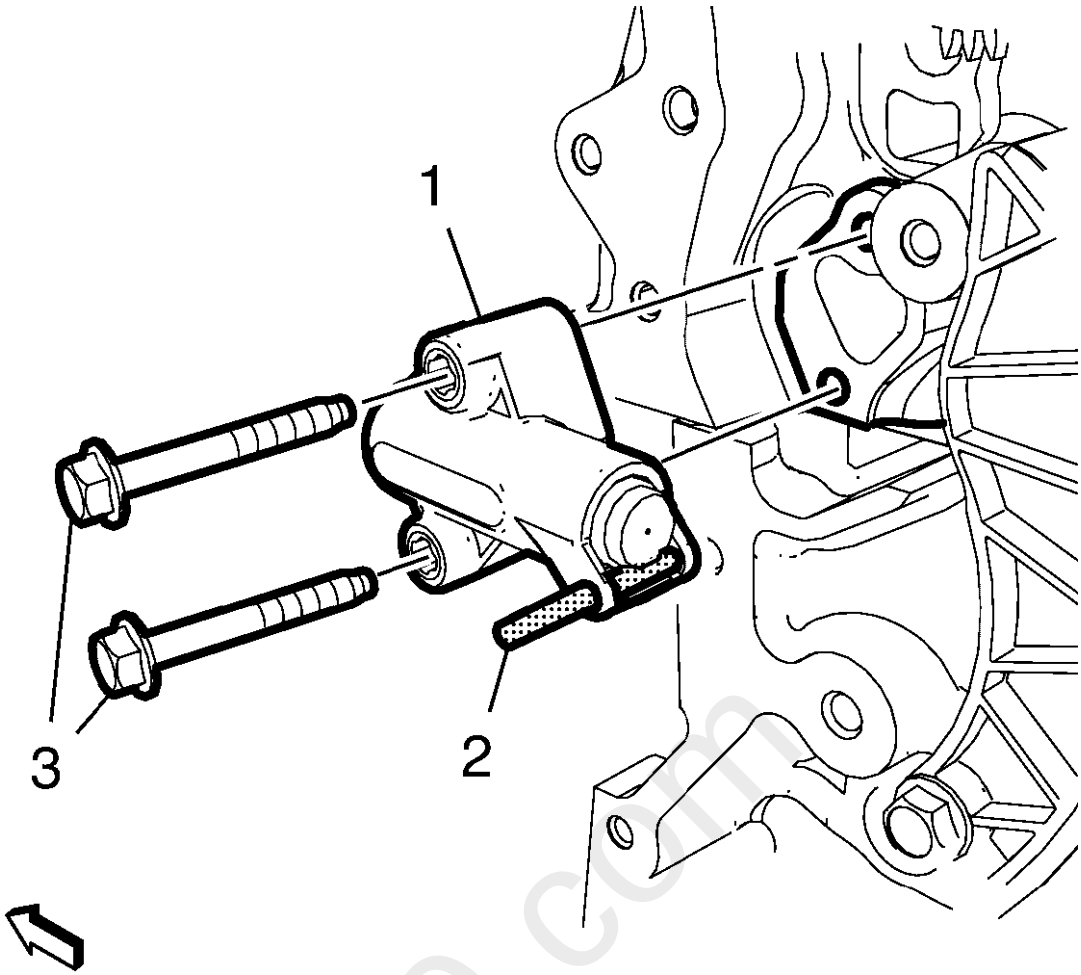


Fig. 276: Timing Chain Tensioner, Bolts And Pin
Courtesy of GENERAL MOTORS COMPANY

2. Install the timing chain tensioner (1).

CAUTION: **Refer to Fastener Caution .**

3. Install the 2 timing chain tensioner bolts (3) and tighten to 10 N.m (89 lb in).

mcx30.com

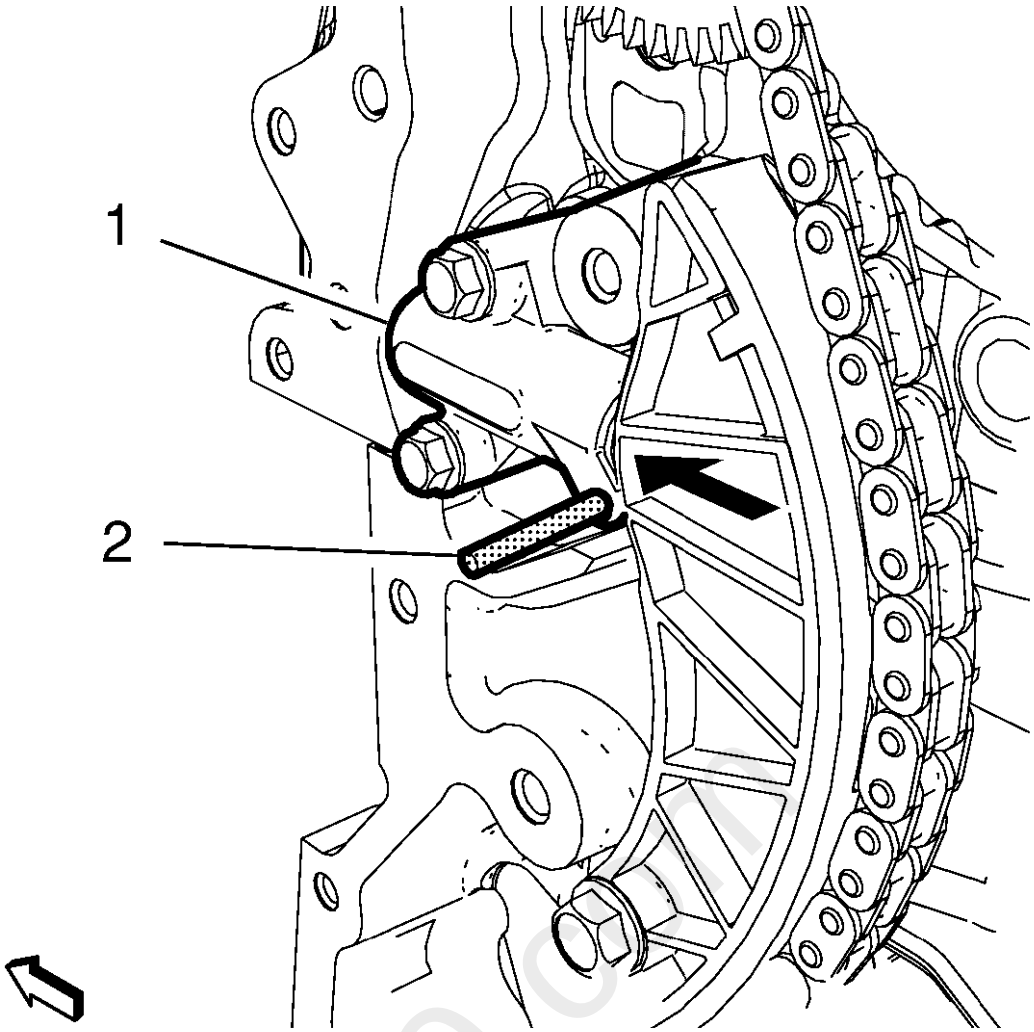


Fig. 277: Timing Chain Tensioner And Pin
Courtesy of GENERAL MOTORS COMPANY

4. Remove the **EN-50513** pin (2).

mcx30.com

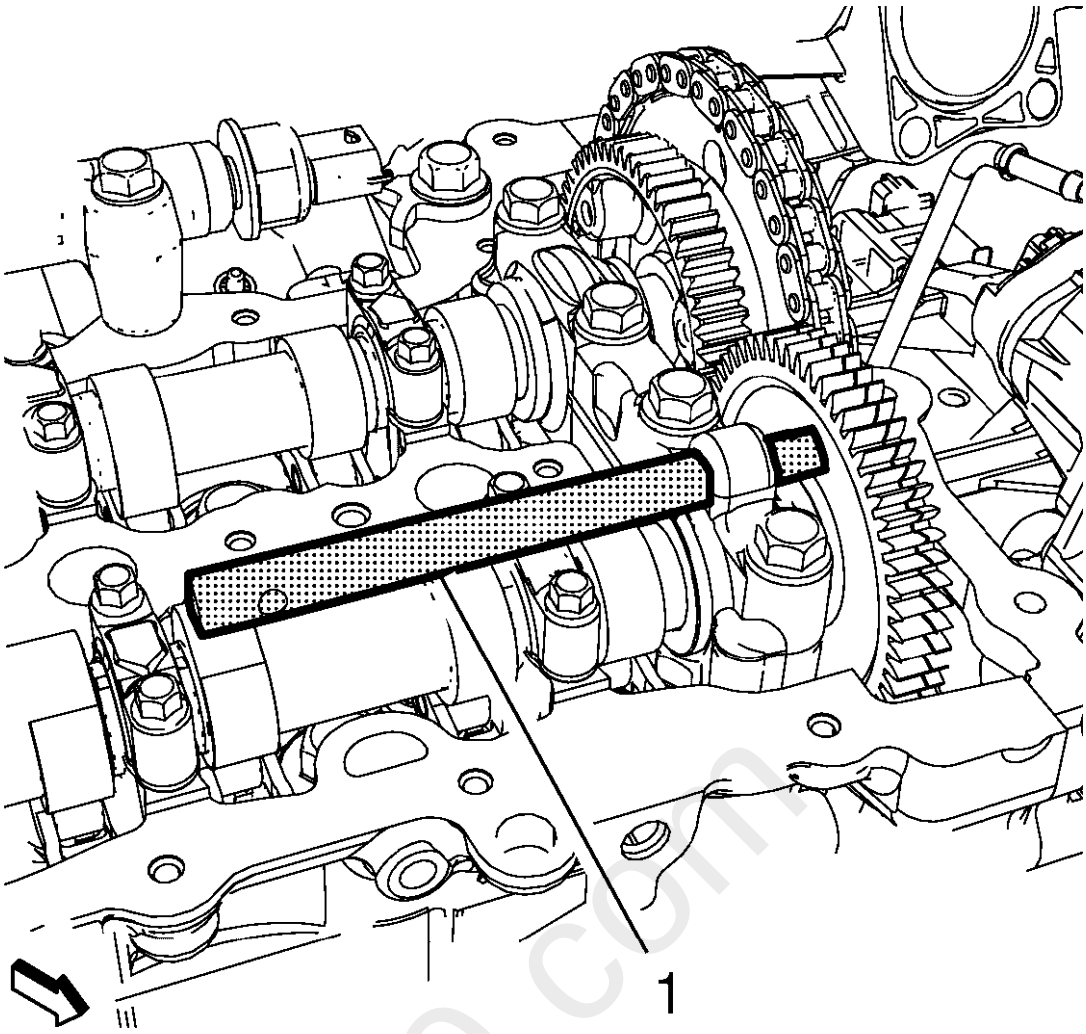


Fig. 278: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

5. Remove the **EN-51143** fixing tool (1).
6. Raise the vehicle.

mcx30.com

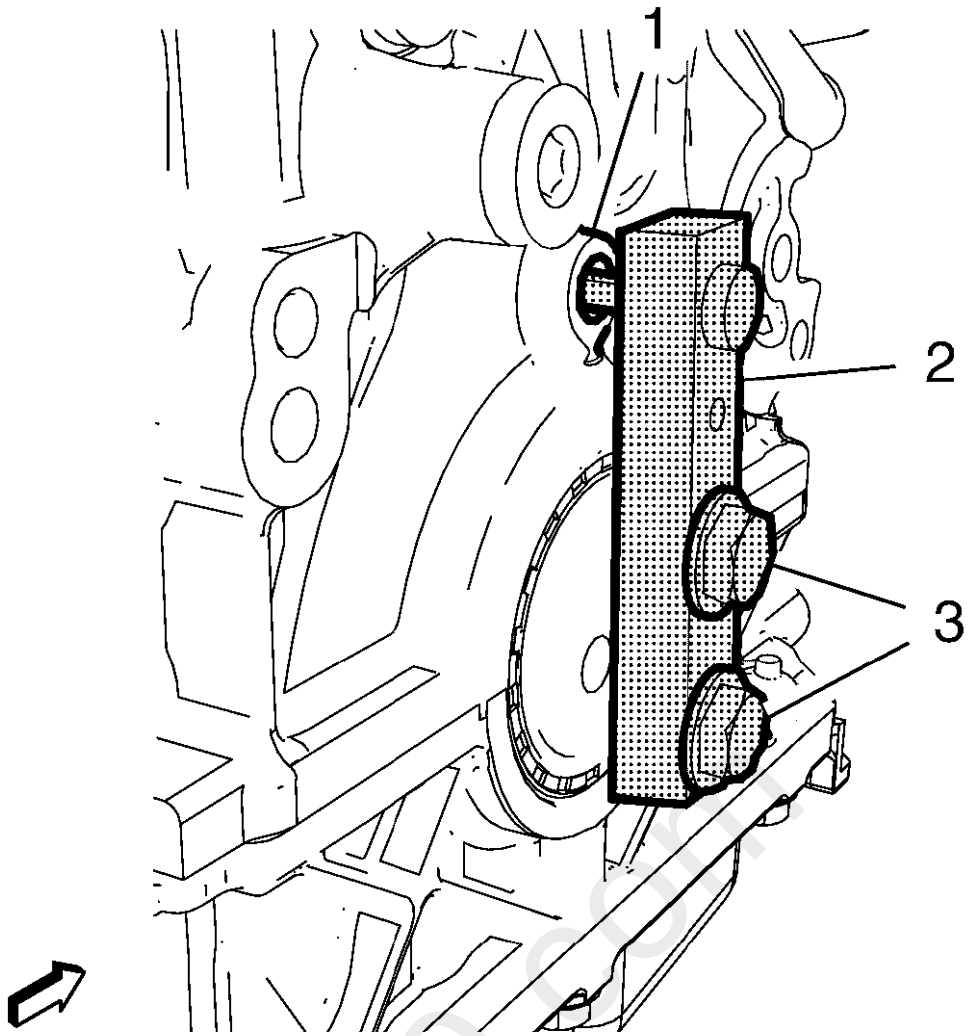


Fig. 279: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

7. Remove the 2 bolts (3).
8. Remove the **EN-51140** fixing tool (2).

mcx30.com

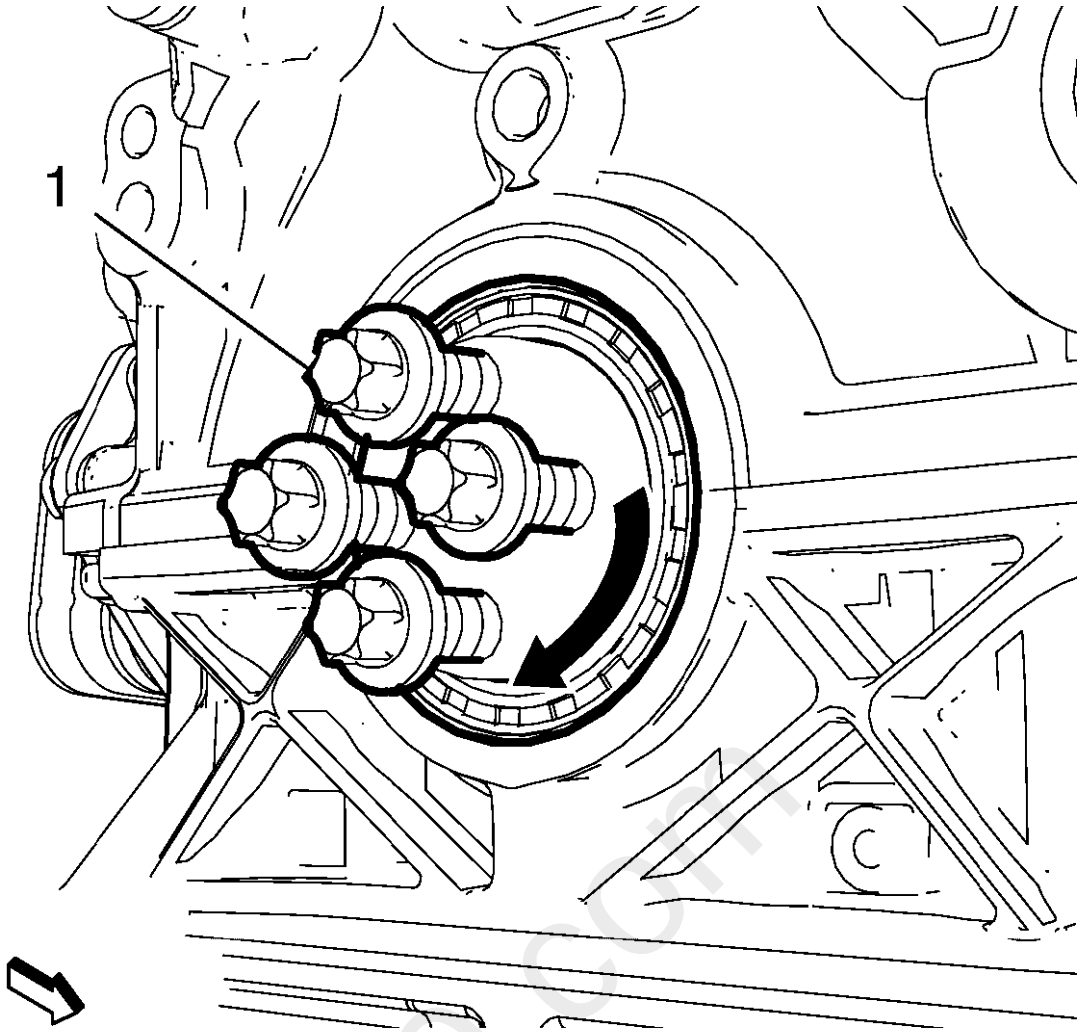


Fig. 280: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Install the 4 crankshaft pulley bolts (1).

   Rotate the crankshaft 720 degrees in direction of arrow. Use a pry bar at the 4 crankshaft pulley bolts (1).

10. Remove the 4 crankshaft pulley bolts (1).
11. Check the camshaft timing. Refer to **Camshaft Timing Chain Inspection**.
12. Install the crankshaft pulley. Refer to **Crankshaft Pulley Replacement**.
13. Install the timing chain upper cover. Refer to **Timing Chain Upper Cover Replacement**.

TIMING CHAIN TENSIONER SHOE REPLACEMENT

Special Tools

- **EN-50513** Fixing Pin
- **EN-51140** Crankshaft Fixing Tool
- **EN-51143** Camshaft Sprocket Fixing Tool

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

Removal Procedure

1. Remove the timing chain lower cover. Refer to **Timing Chain Lower Cover Replacement**.
2. Remove the crankshaft pulley. Refer to **Crankshaft Pulley Replacement**.

mcx30.com

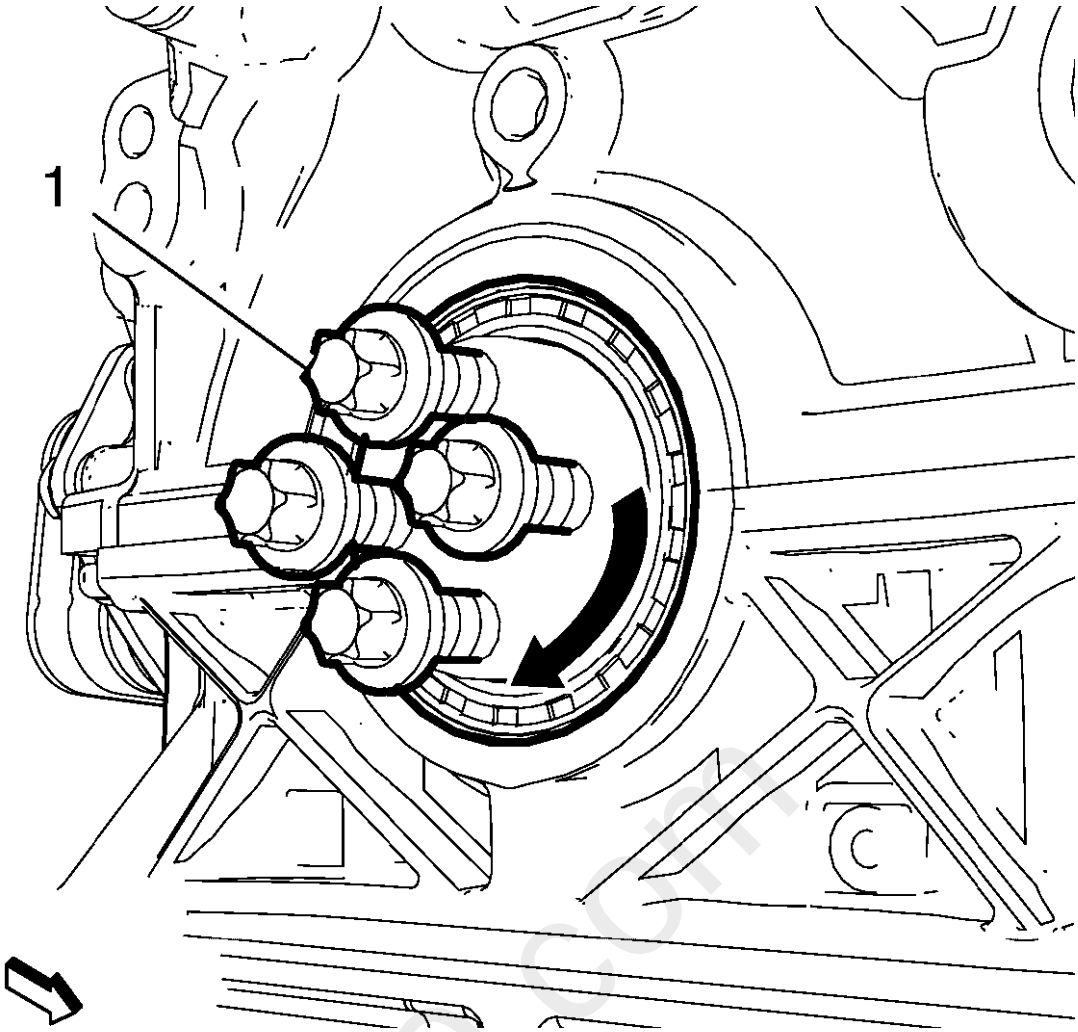


Fig. 281: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the 4 crankshaft pulley bolts (1).

mcx30.com

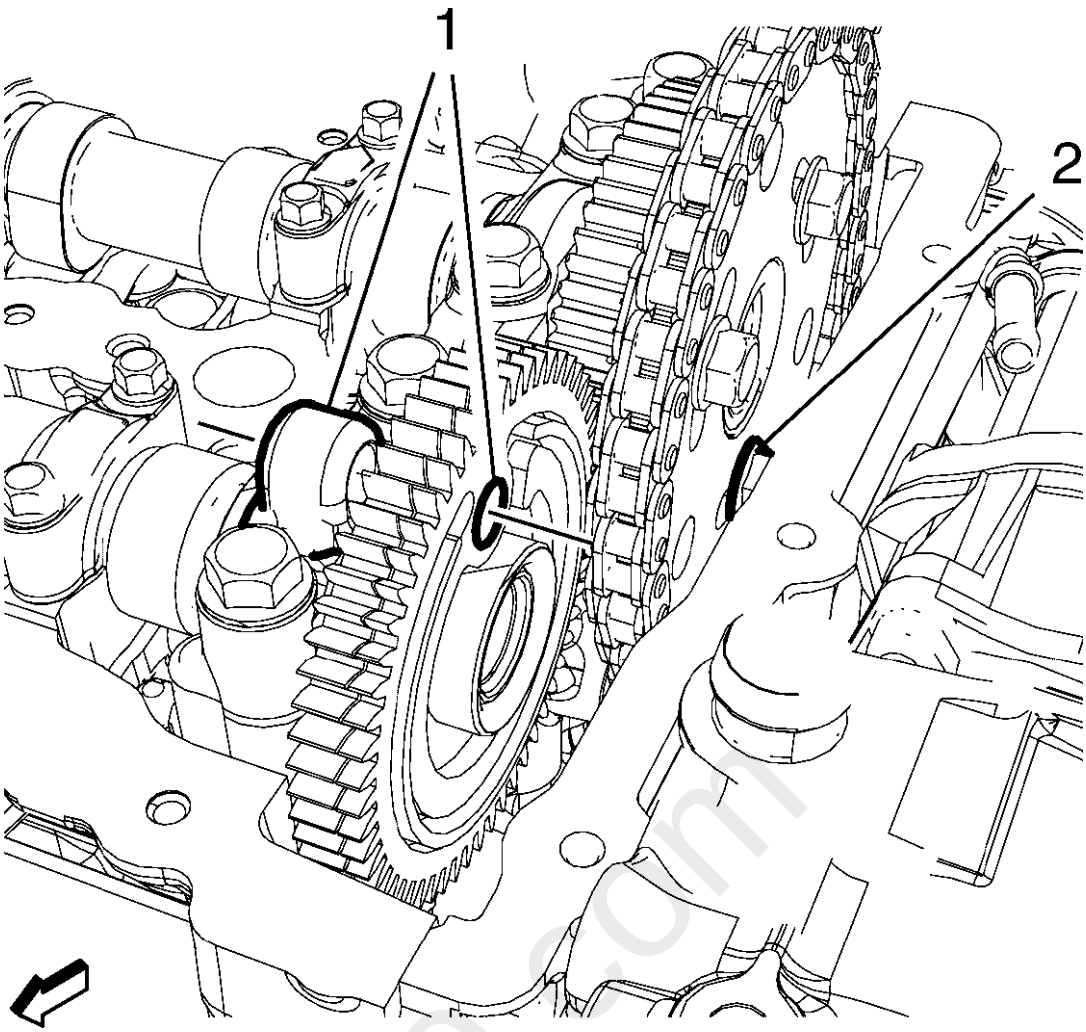


Fig. 282: Aligning Bores
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the bores not aligned turn the crankshaft at the crankshaft pulley bolts.**

mcx30.com

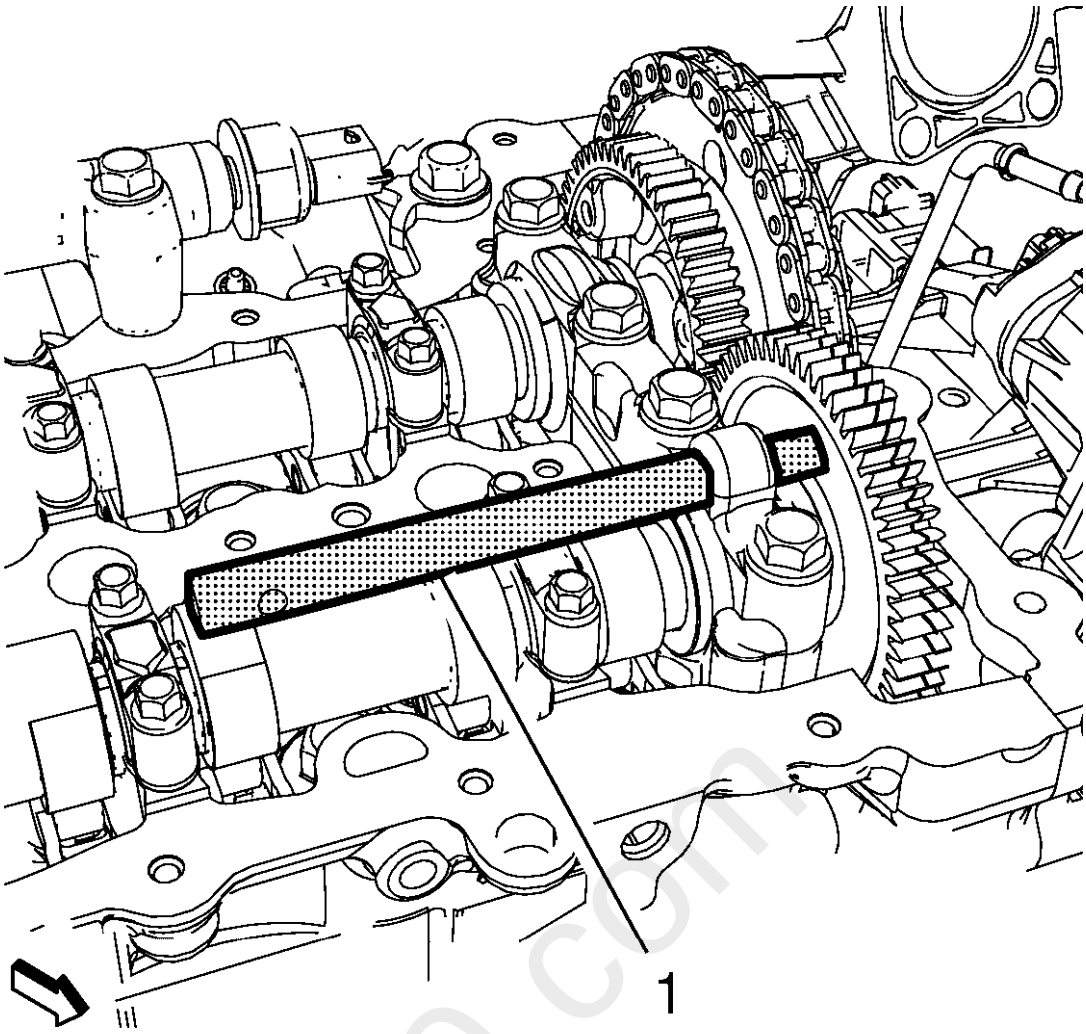


Fig. 283: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

4. Check if the bores (1) are aligned.

   Turn the exhaust camshaft at the hexagon so far if the **EN-51143** fixing tool (1) can be installed.

5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**

mcx30.com

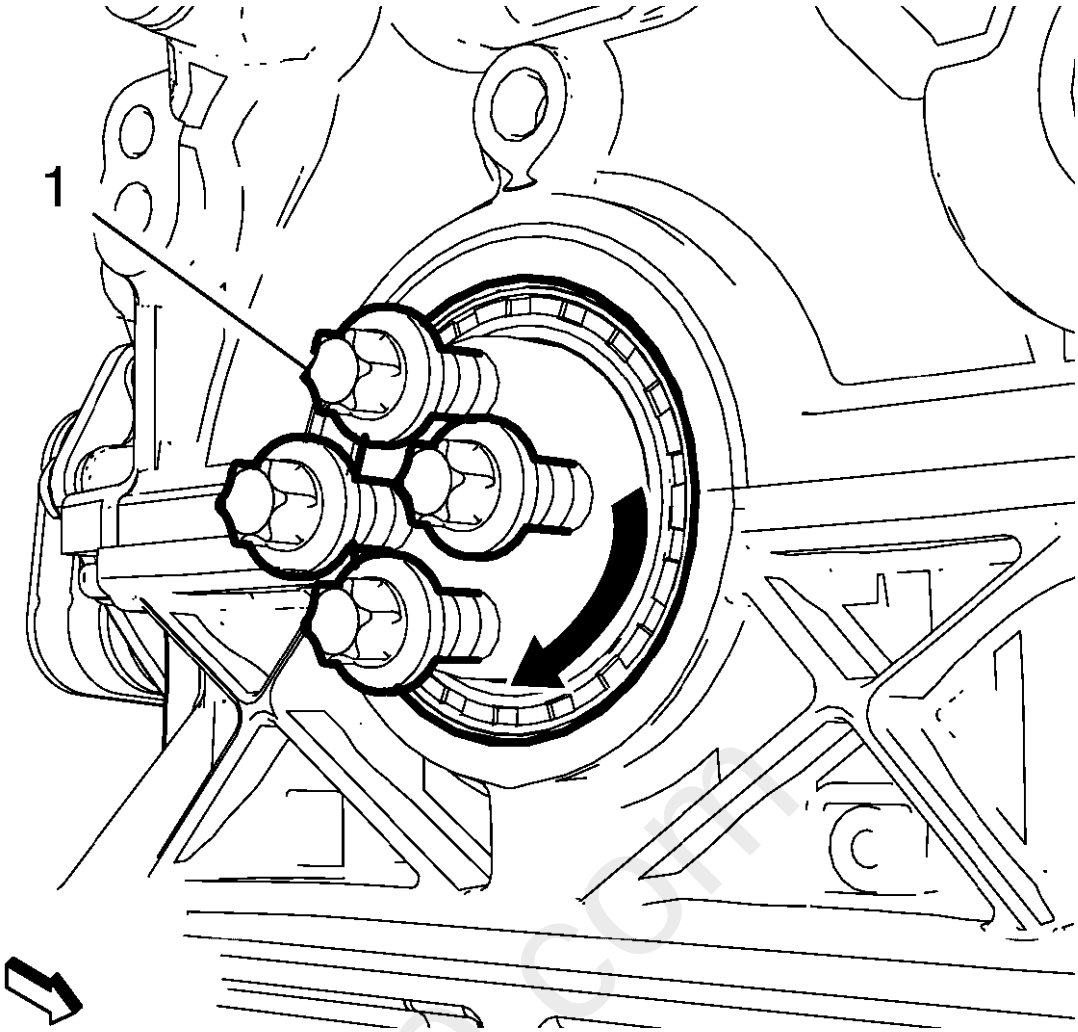


Fig. 284: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the 4 crankshaft pulley bolts (1).

mcx30.com

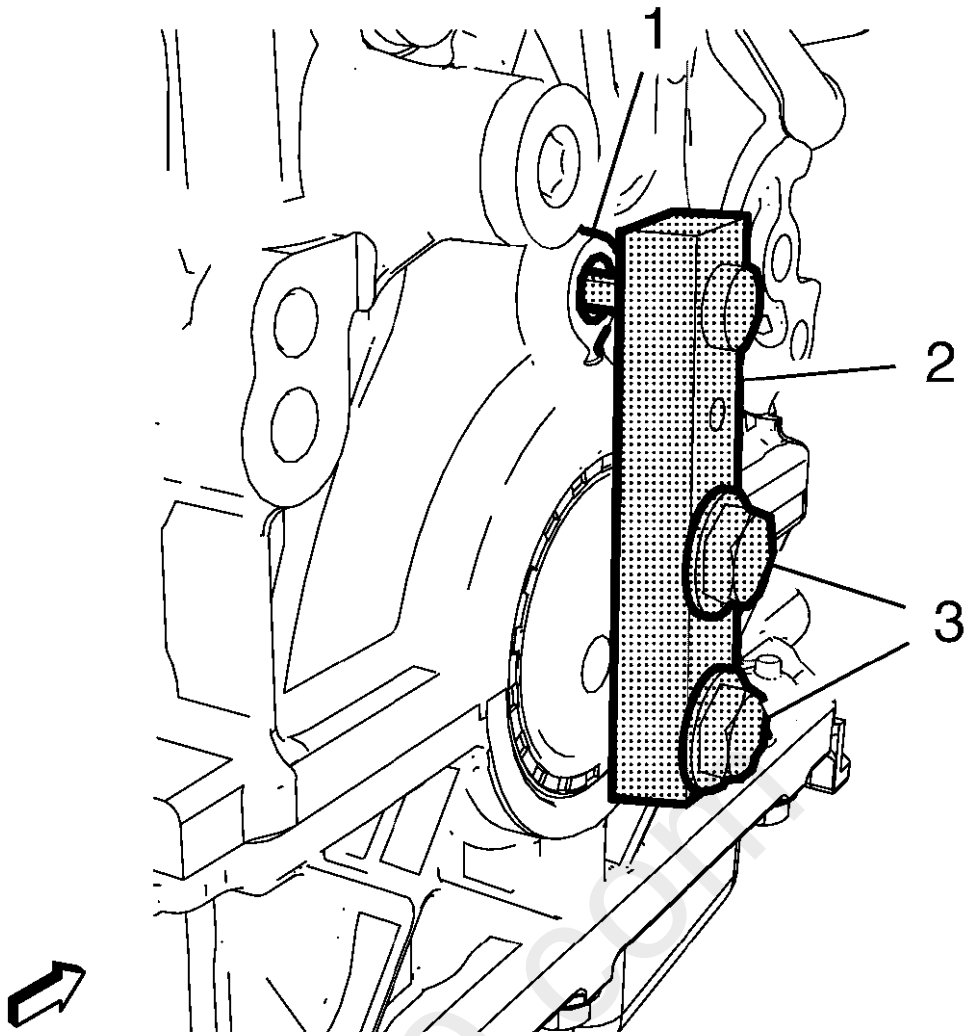


Fig. 285: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

7. Install **EN-51140** fixing tool (2).
8. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).
9. If the **EN-51140** fixing tool can not installed. Refer to **Camshaft Timing Chain Adjustment**.
10. Lower the vehicle.

mtx30.com

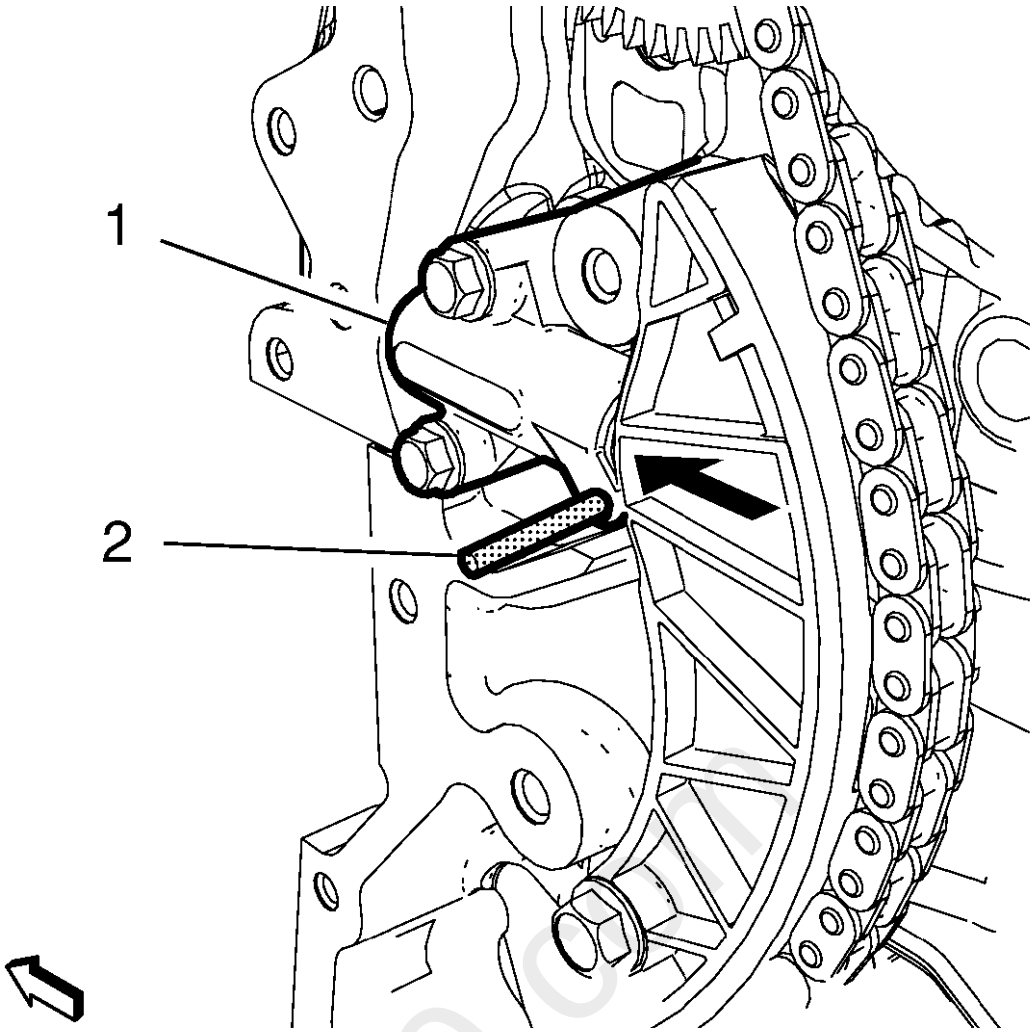


Fig. 286: Timing Chain Tensioner And Pin
Courtesy of GENERAL MOTORS COMPANY

11. Tension the timing chain tensioner (1) in arrow direction.
12. Install the **EN-50513** pin (2).

mcx30.com

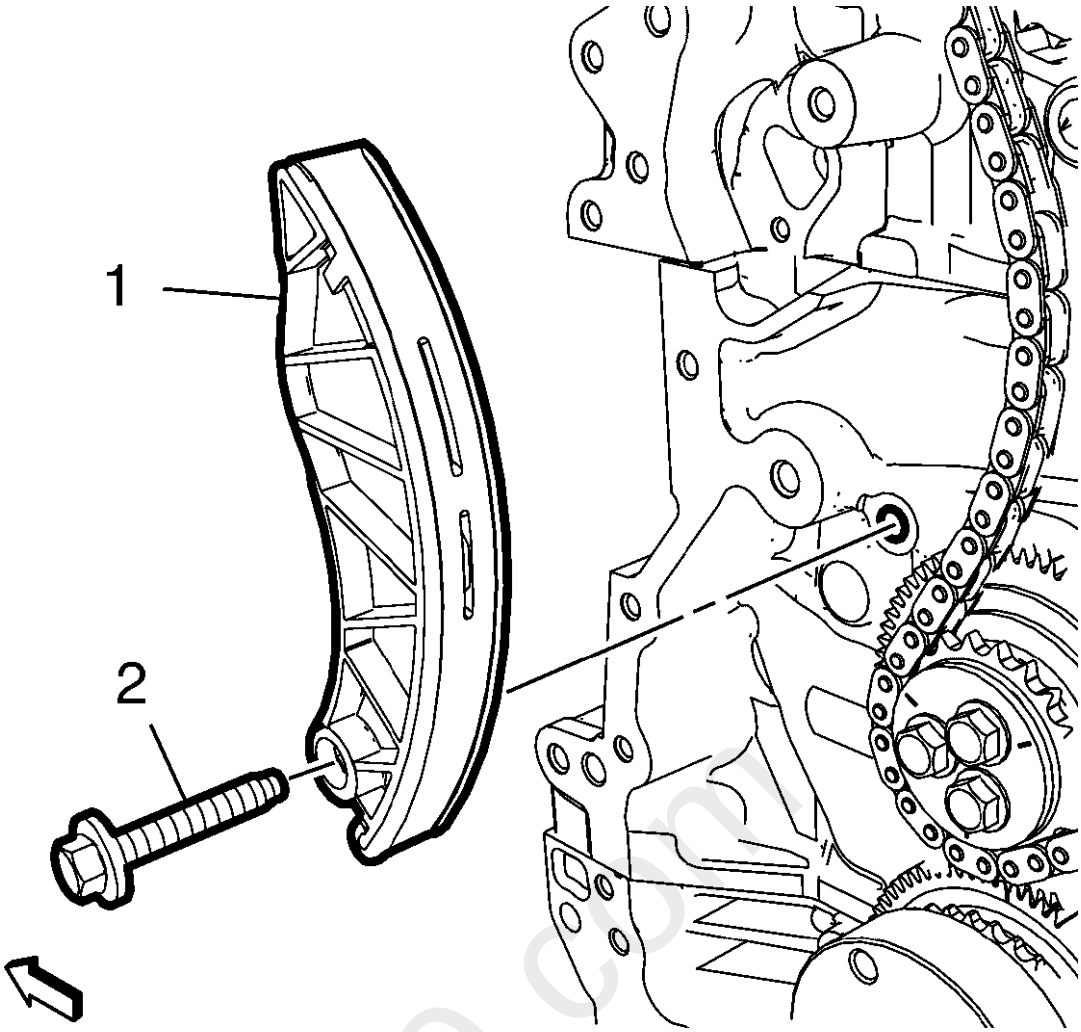


Fig. 287: Timing Chain Tensioner Shoe And Bolt
Courtesy of GENERAL MOTORS COMPANY

13. Remove the timing chain tensioner shoe bolt (2).
14. Remove the timing chain tensioner shoe (1).

Installation Procedure

NOTE: **Before installing the timing chain tensioner shoe, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

mcx30.com

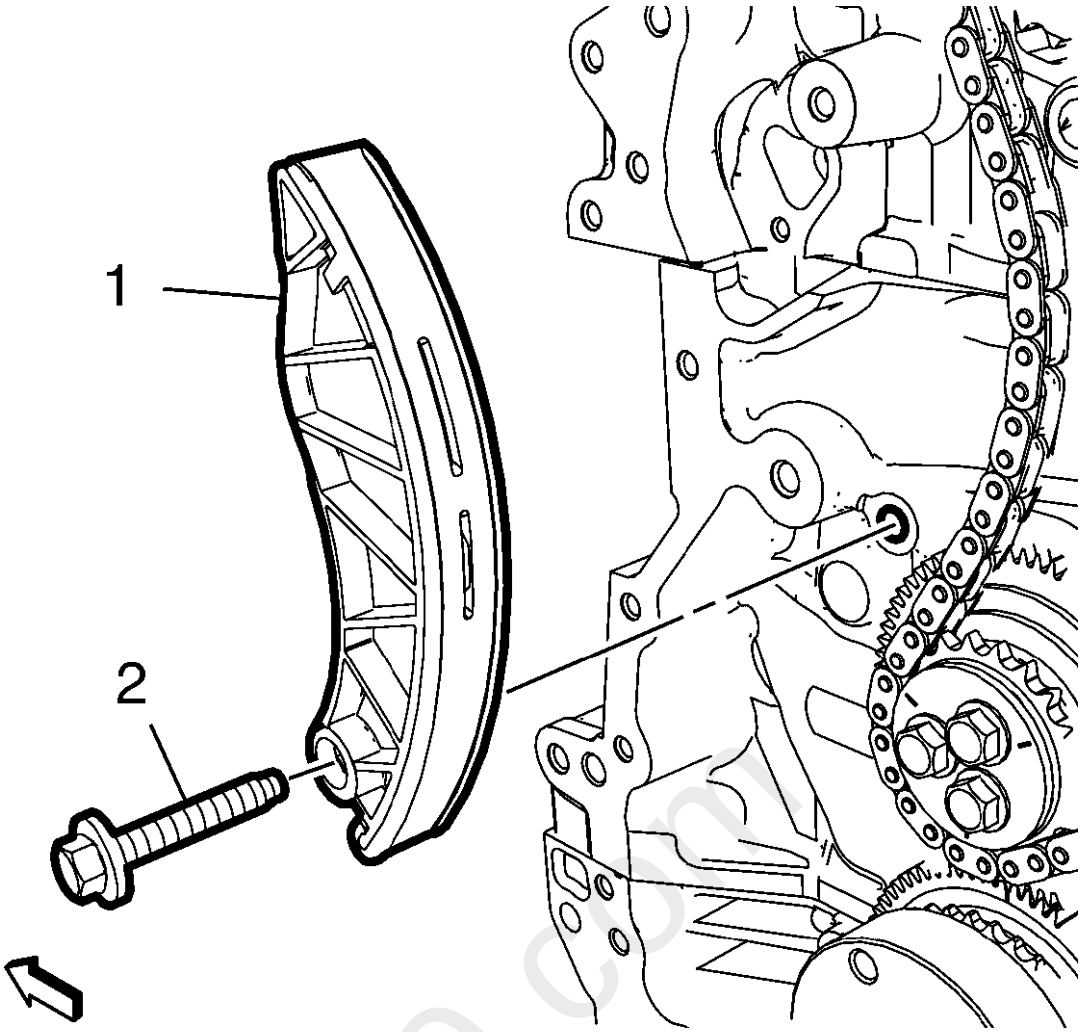


Fig. 288: Timing Chain Tensioner Shoe And Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Install the timing chain tensioner shoe (1).

CAUTION: **Refer to Fastener Caution .**

3. Install the timing chain tensioner shoe bolt (2) and tighten to 25 N.m (18 lb ft).

mcx30.com

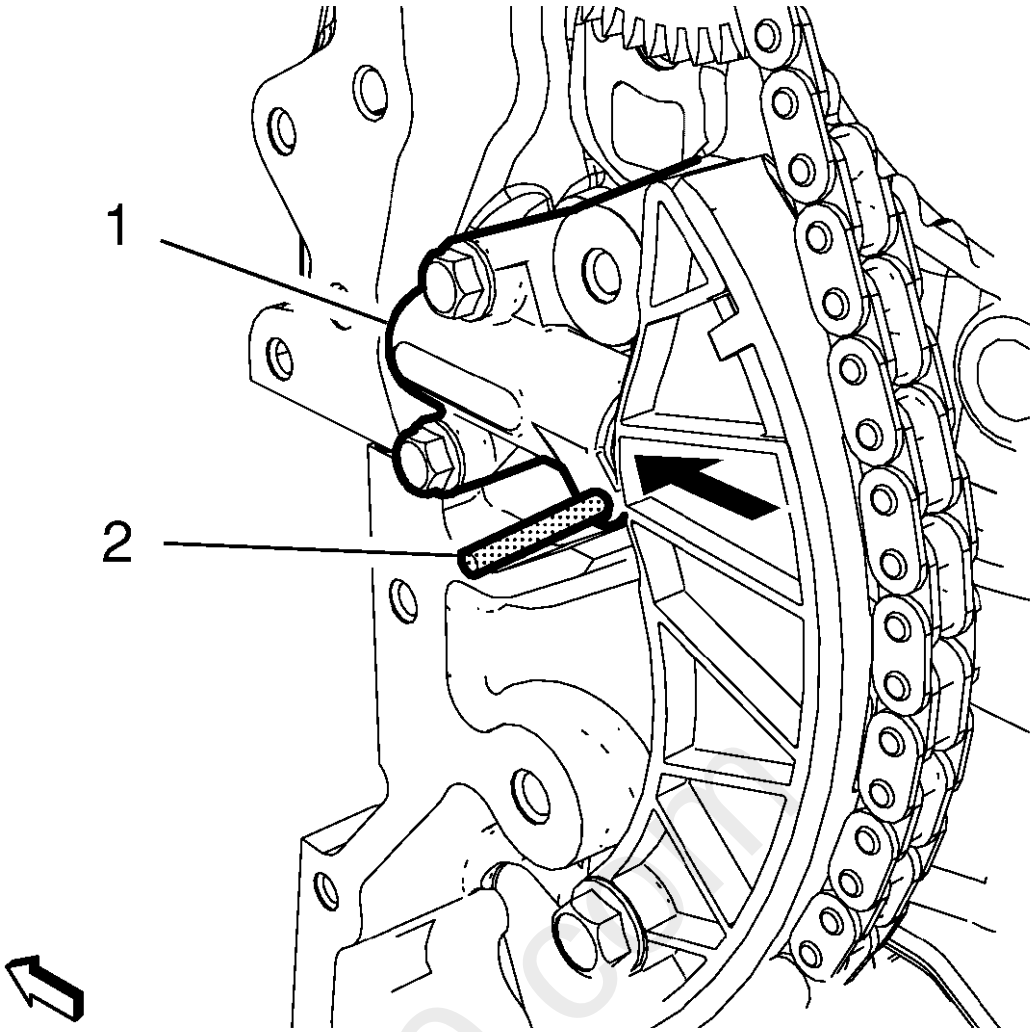


Fig. 289: Timing Chain Tensioner And Pin
Courtesy of GENERAL MOTORS COMPANY

4. Remove the **EN-50513** pin (2).

mcx30.com

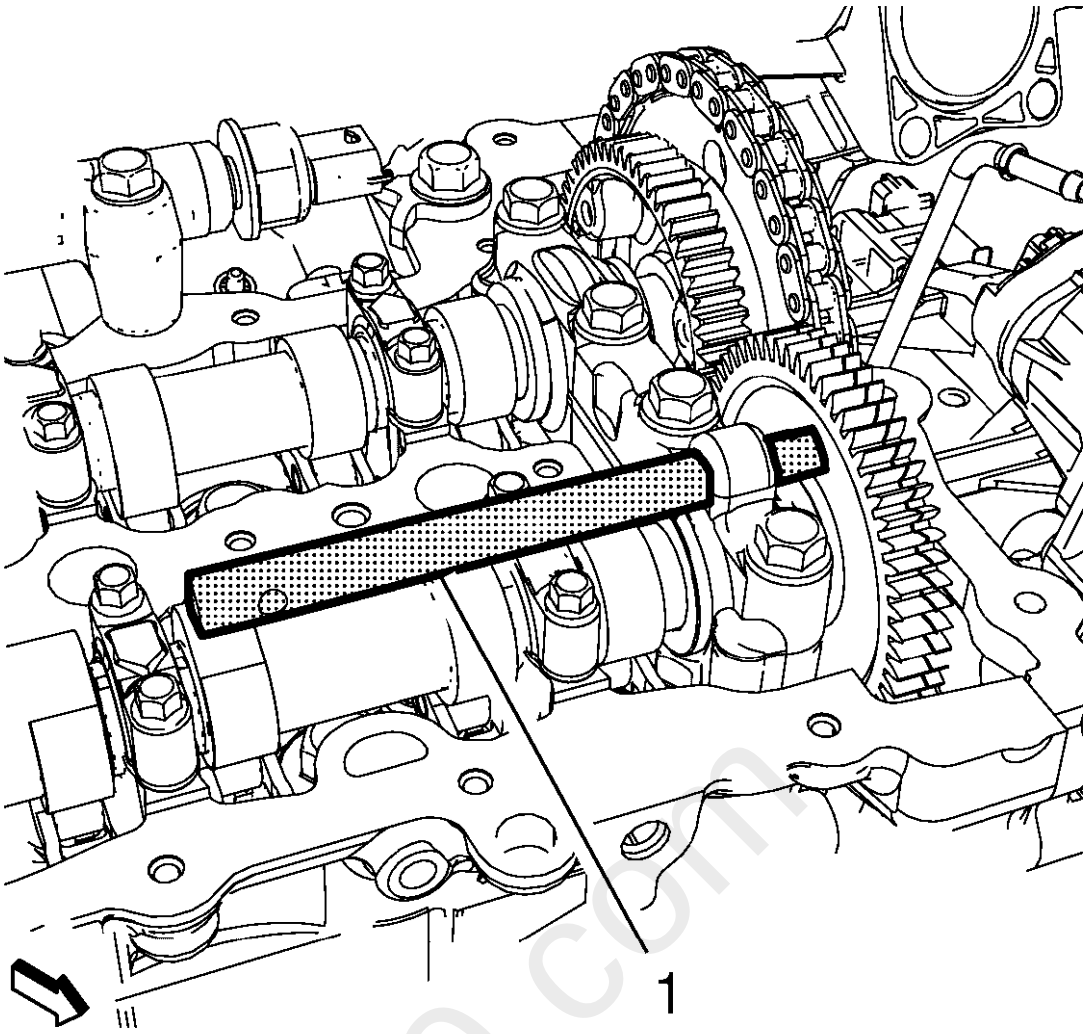


Fig. 290: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

5. Remove the **EN-51143** fixing tool (1).
6. Raise the vehicle.

mcx30.com

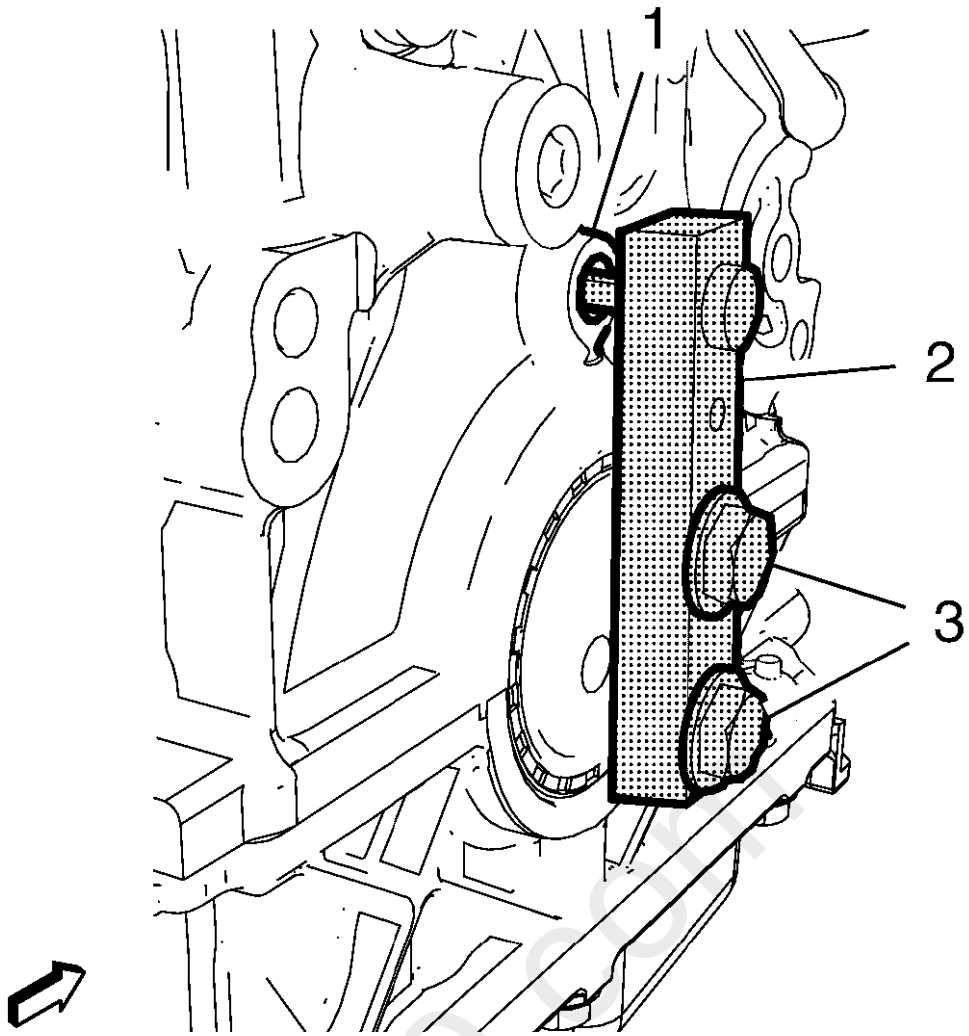


Fig. 291: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

7. Remove the 2 bolts (3).
8. Remove the **EN-51140** fixing tool (2).

mcx30.com

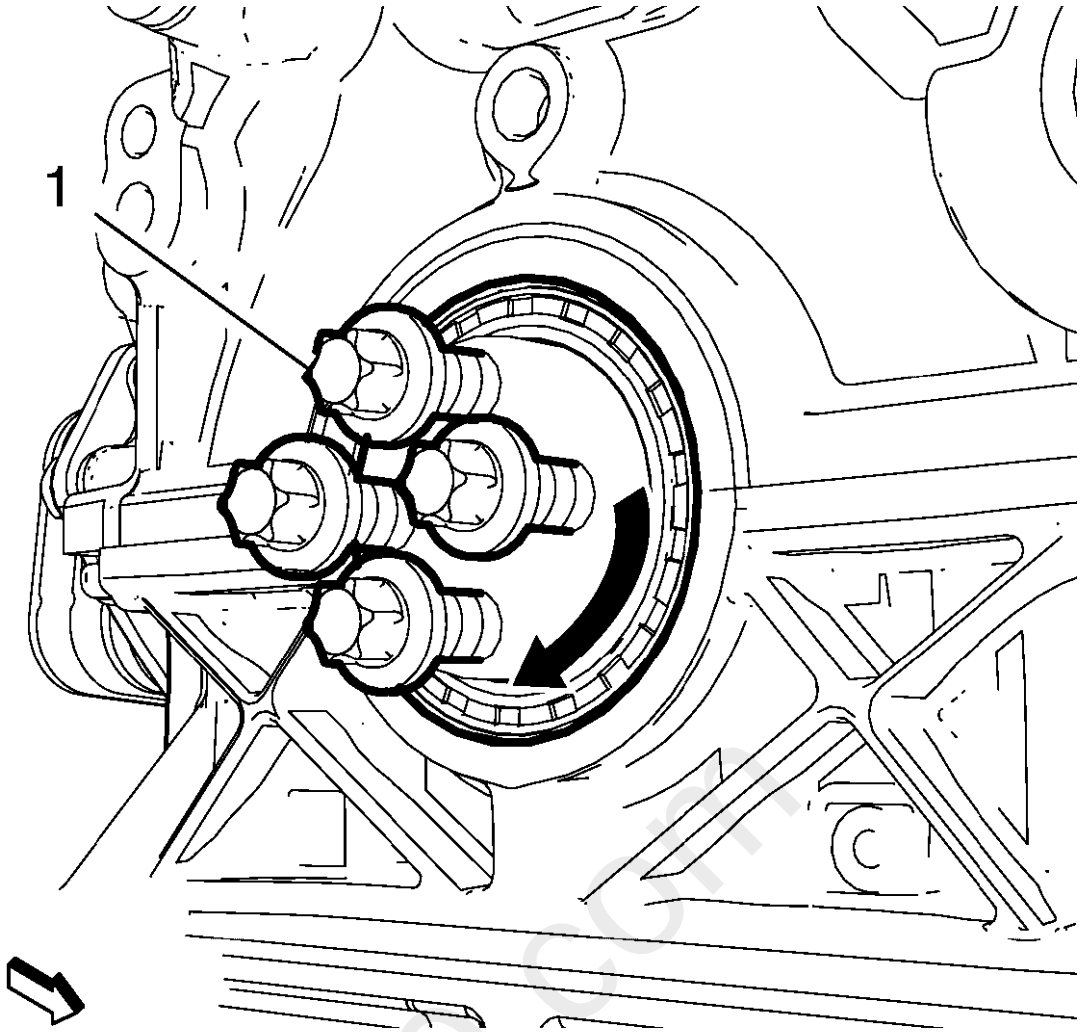


Fig. 292: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Install the 4 crankshaft pulley bolts (1).

   Rotate the crankshaft 720 degrees in direction of arrow. Use a pry bar at the 4 crankshaft pulley bolts (1).

10. Remove the 4 crankshaft pulley bolts (1).
11. Check the camshaft timing. Refer to **Camshaft Timing Chain Inspection**.
12. Install the crankshaft pulley. Refer to **Crankshaft Pulley Replacement**.
13. Install the timing chain lower cover. Refer to **Timing Chain Lower Cover Replacement**.

TIMING CHAIN UPPER COVER REPLACEMENT

Removal Procedure

1. Remove Power Brake Booster Inlet Hose Connector Fitting. Refer to **Power Brake Booster Inlet Hose Connector Fitting Replacement** .
2. Remove Camshaft Housing. Refer to **Camshaft Housing Replacement**.

mcx30.com

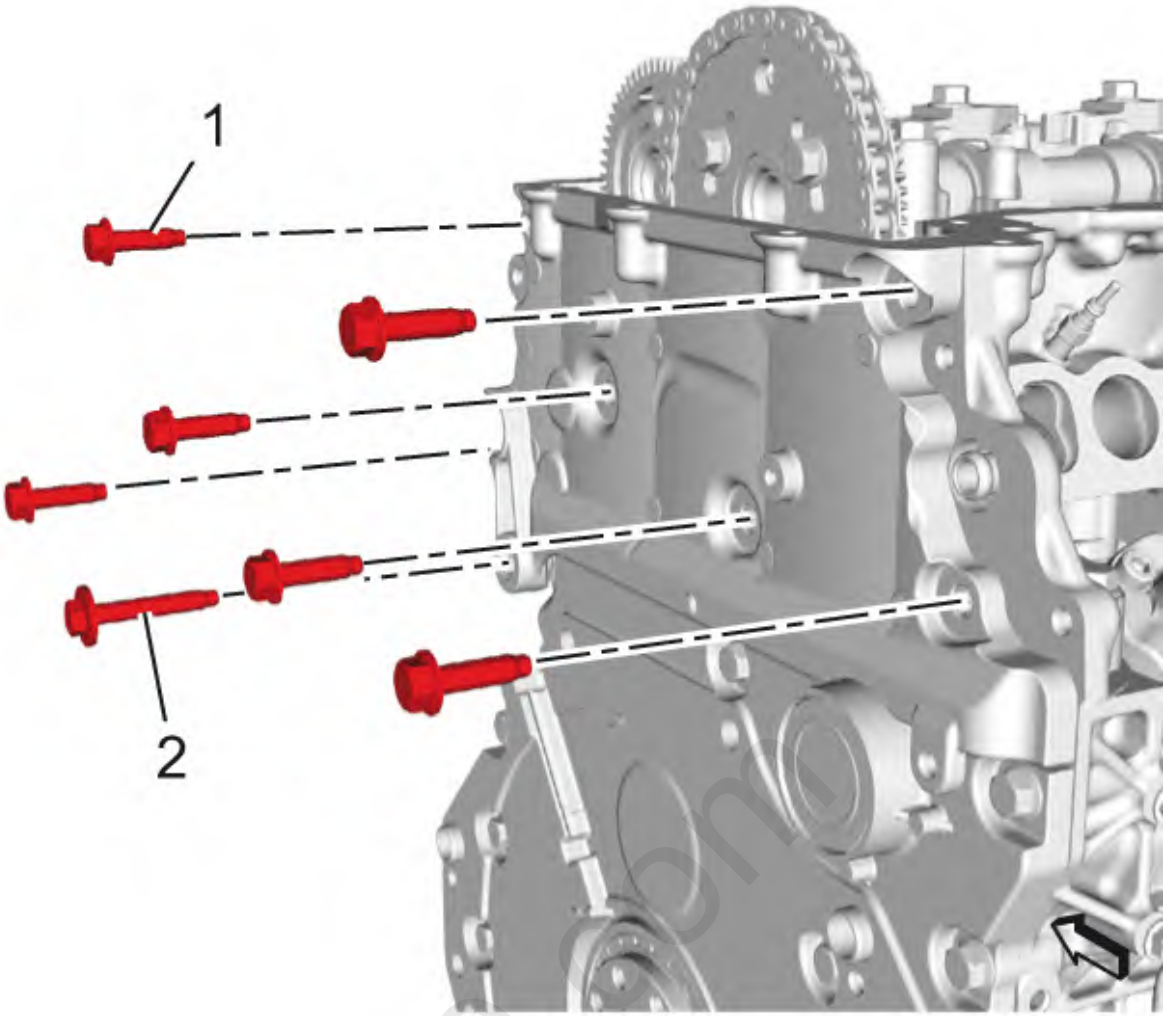


Fig. 293: Timing Chain Upper Cover Bolts And Sleeve Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove the 6 timing chain upper cover bolts (1).
4. Remove the sleeve bolt (2).

mcx30.com

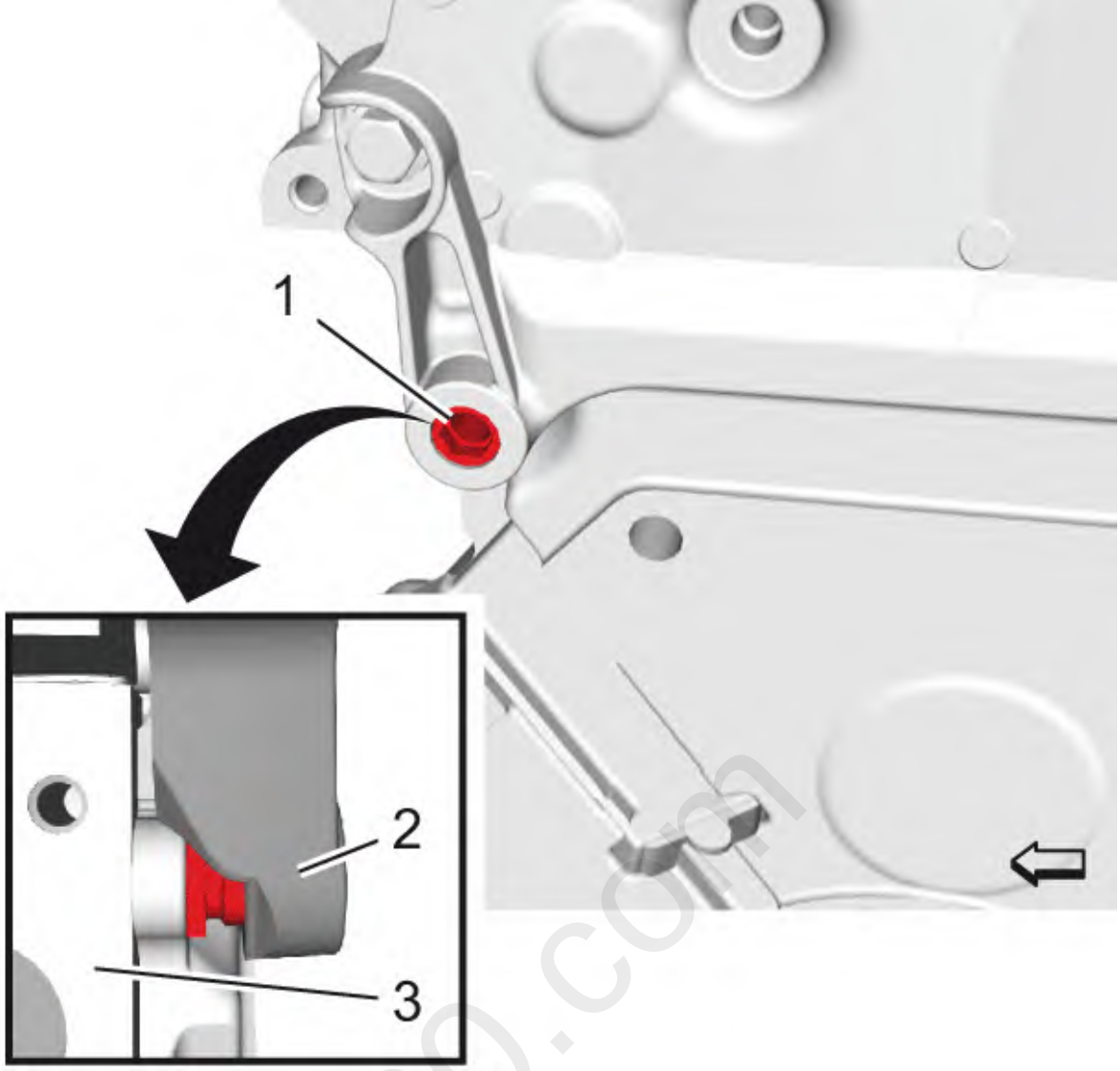


Fig. 294: Timing Chain Upper Cover, Sleeve And Engine Block
Courtesy of GENERAL MOTORS COMPANY

5. Release the timing chain upper cover (2) from the engine block (3) by turning the sleeve (1) for a few turns in direction of arrow.
6. If you there is a gap between the timing chain upper cover (2) and the engine block (3), stop turning the sleeve (1) and use a suitable tool to pry.

mcx30.com

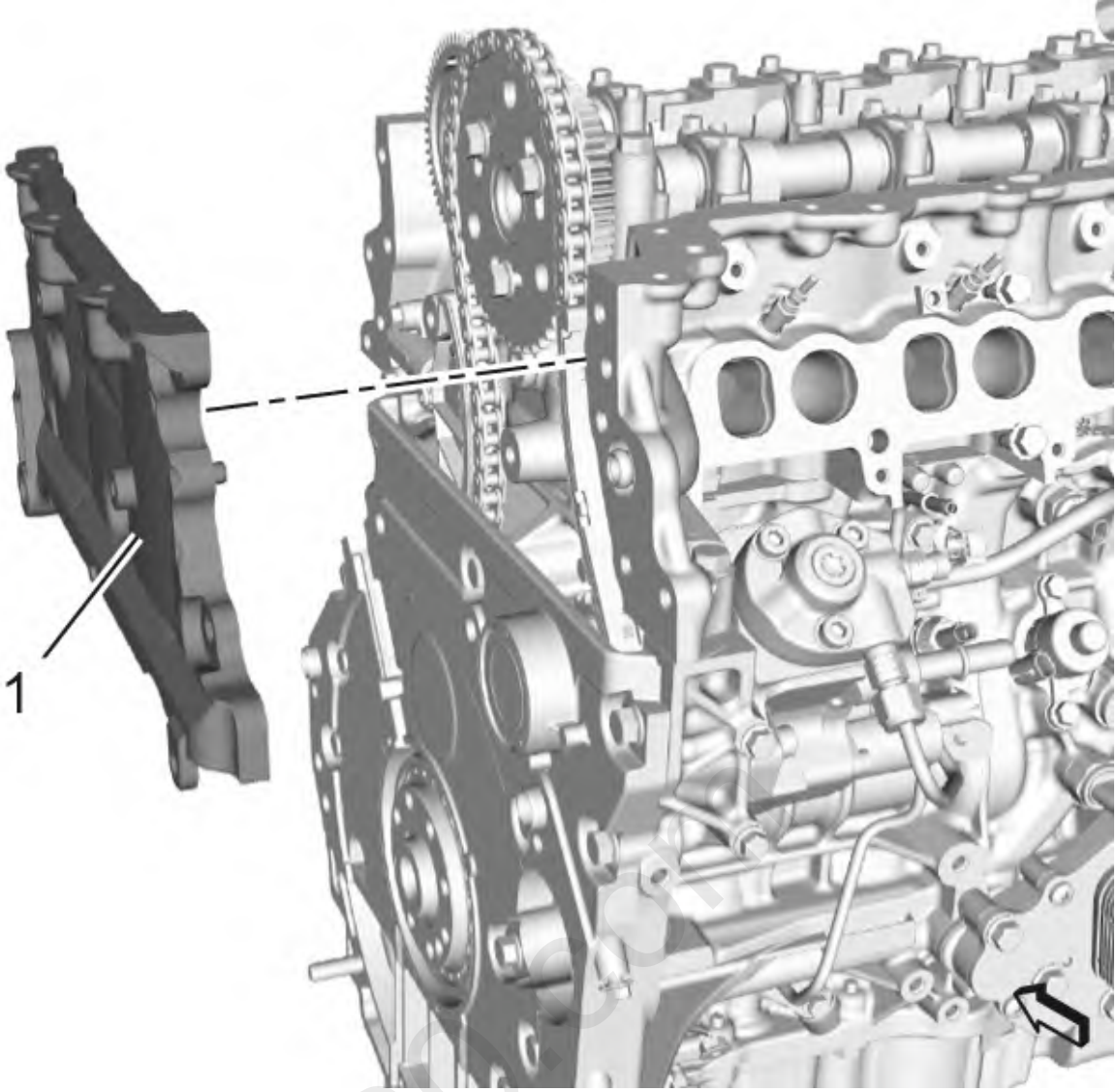


Fig. 295: Timing Chain Upper Cover
Courtesy of GENERAL MOTORS COMPANY

7. Remove Timing Chain Upper Cover (1)

Installation Procedure

NOTE: **Before installing the timing chain upper cover, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner
2. Clean all sealing surfaces.

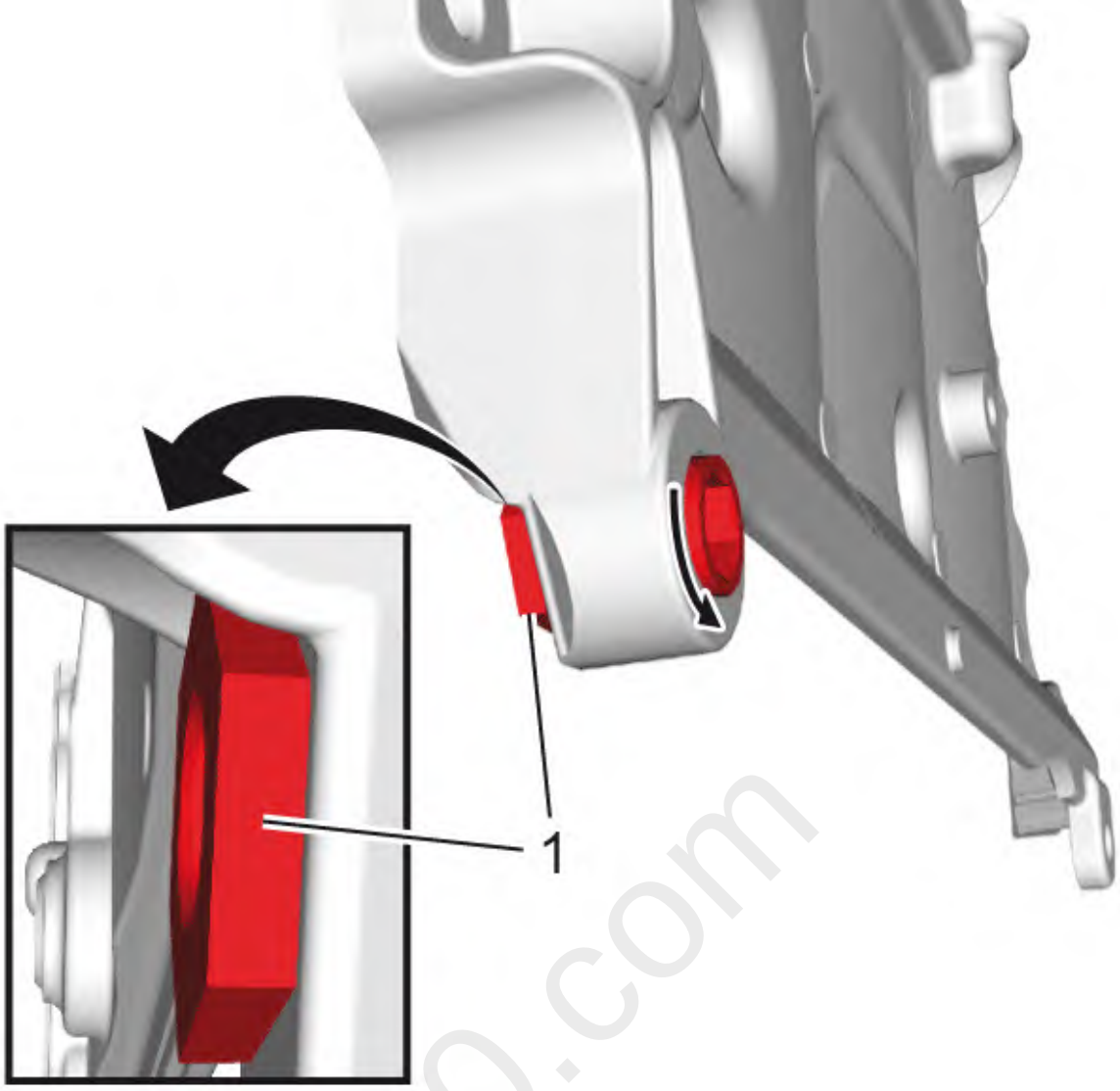


Fig. 296: Timing Chain Upper Cover Sleeve
Courtesy of GENERAL MOTORS COMPANY

3. Unscrew the timing chain upper cover sleeve (1) to the initial position in arrow direction.

mcx30.com

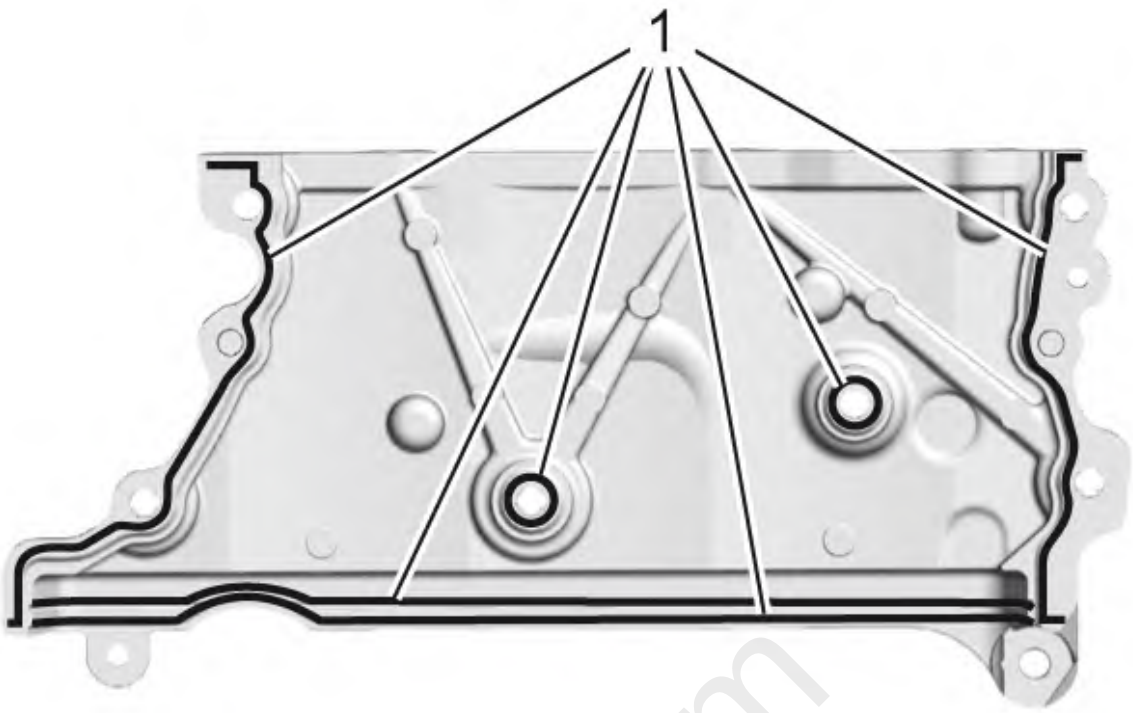


Fig. 297: Silicone Sealing Compound Application Area
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The complete installation procedure of the timing chain upper cover should be done in 20 minutes.**

4. Apply silicone sealing compound (1) to the timing chain upper cover sealing surface. The thickness of the sealing bead should be 2.0 - 3.0 mm (0.079 - 0.118 in).

mox30.com

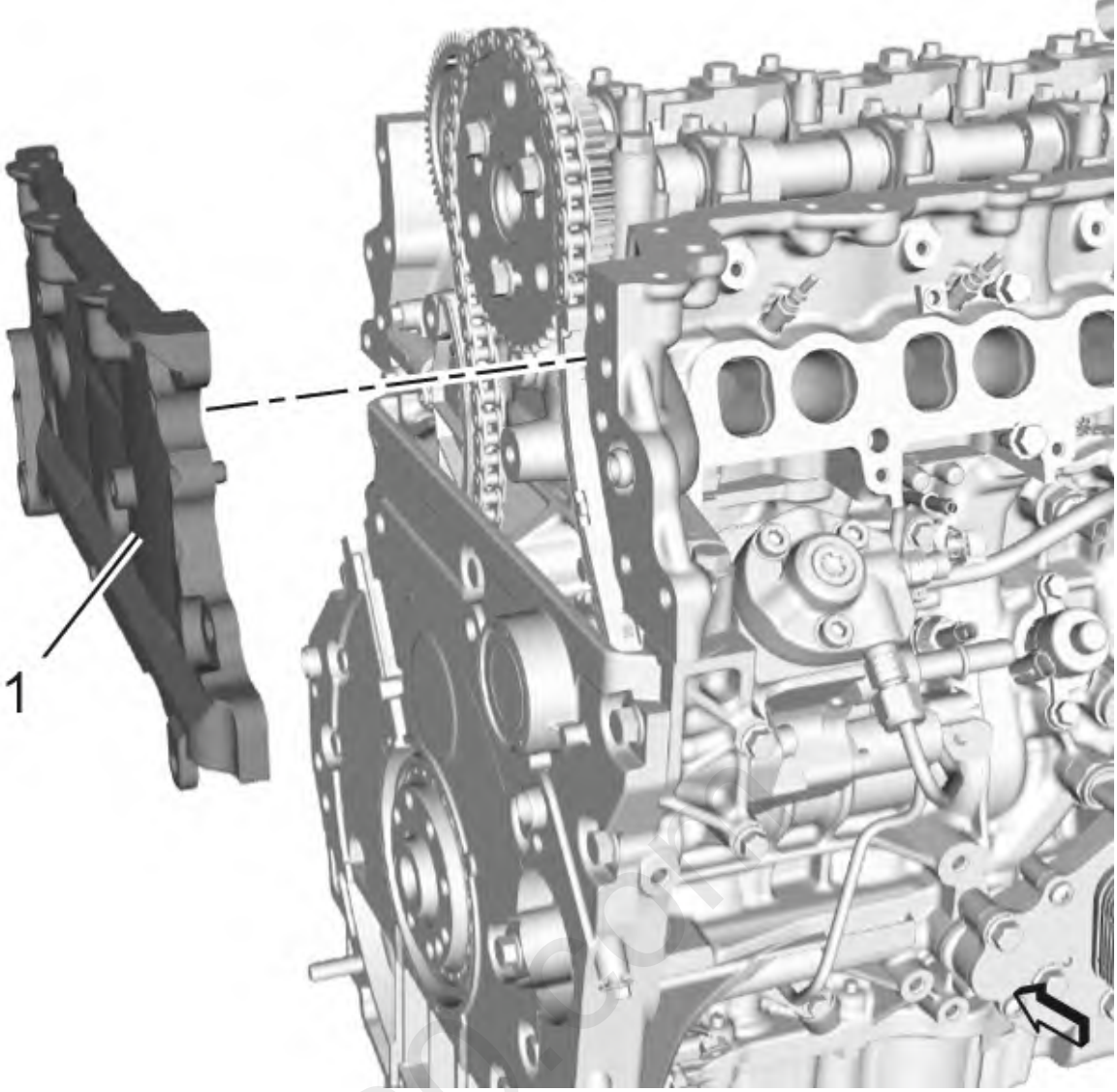


Fig. 298: Timing Chain Upper Cover
Courtesy of GENERAL MOTORS COMPANY

5. Install Timing Chain Upper Cover (1)

mcx30.com

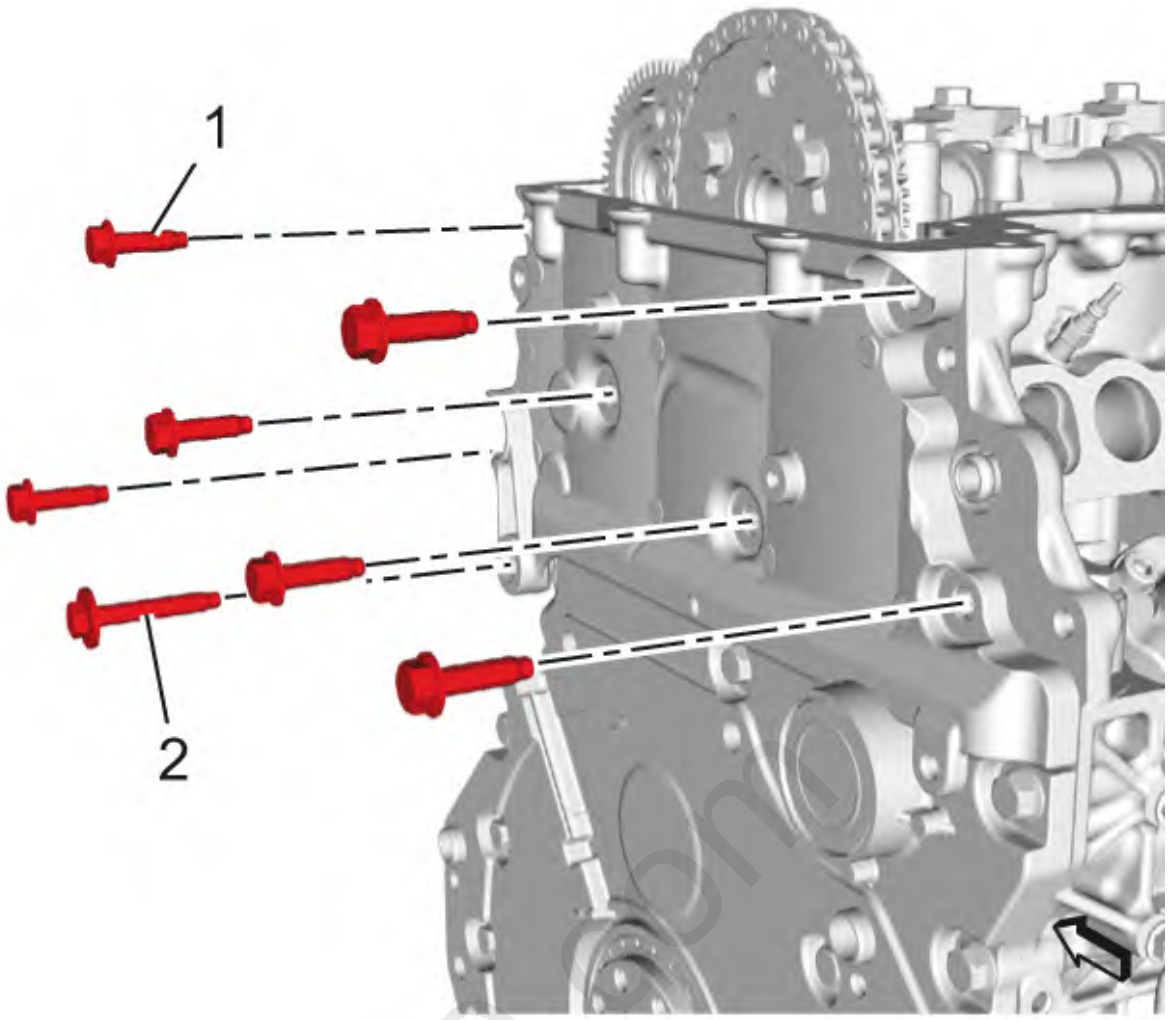


Fig. 299: Timing Chain Upper Cover Bolts And Sleeve Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not install the sleeve bolt (2).**

6. Install the 6 timing chain upper cover bolts (1).

mcx30.com

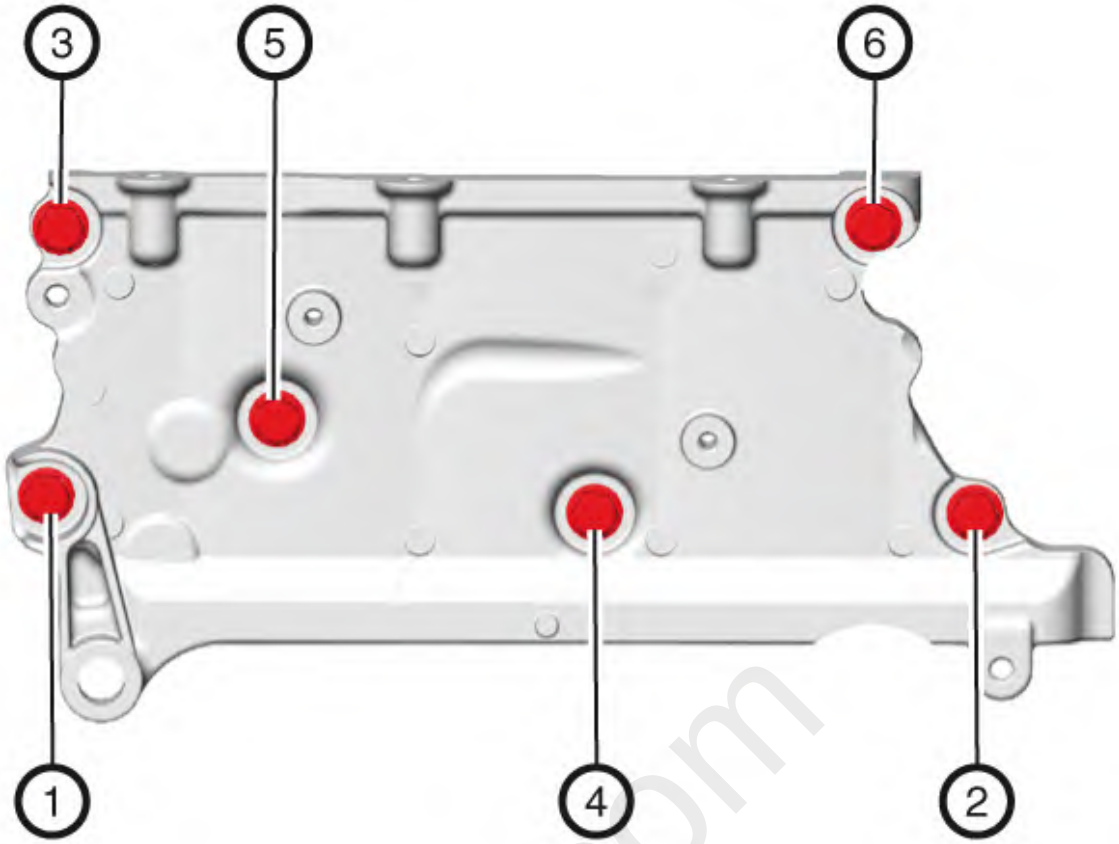


Fig. 300: Timing Chain Upper Cover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to: Fastener Caution .**

7. Tighten the 6 timing chain upper cover bolts in sequence as shown to 25 N.m (18 lb ft).

mcx30.com

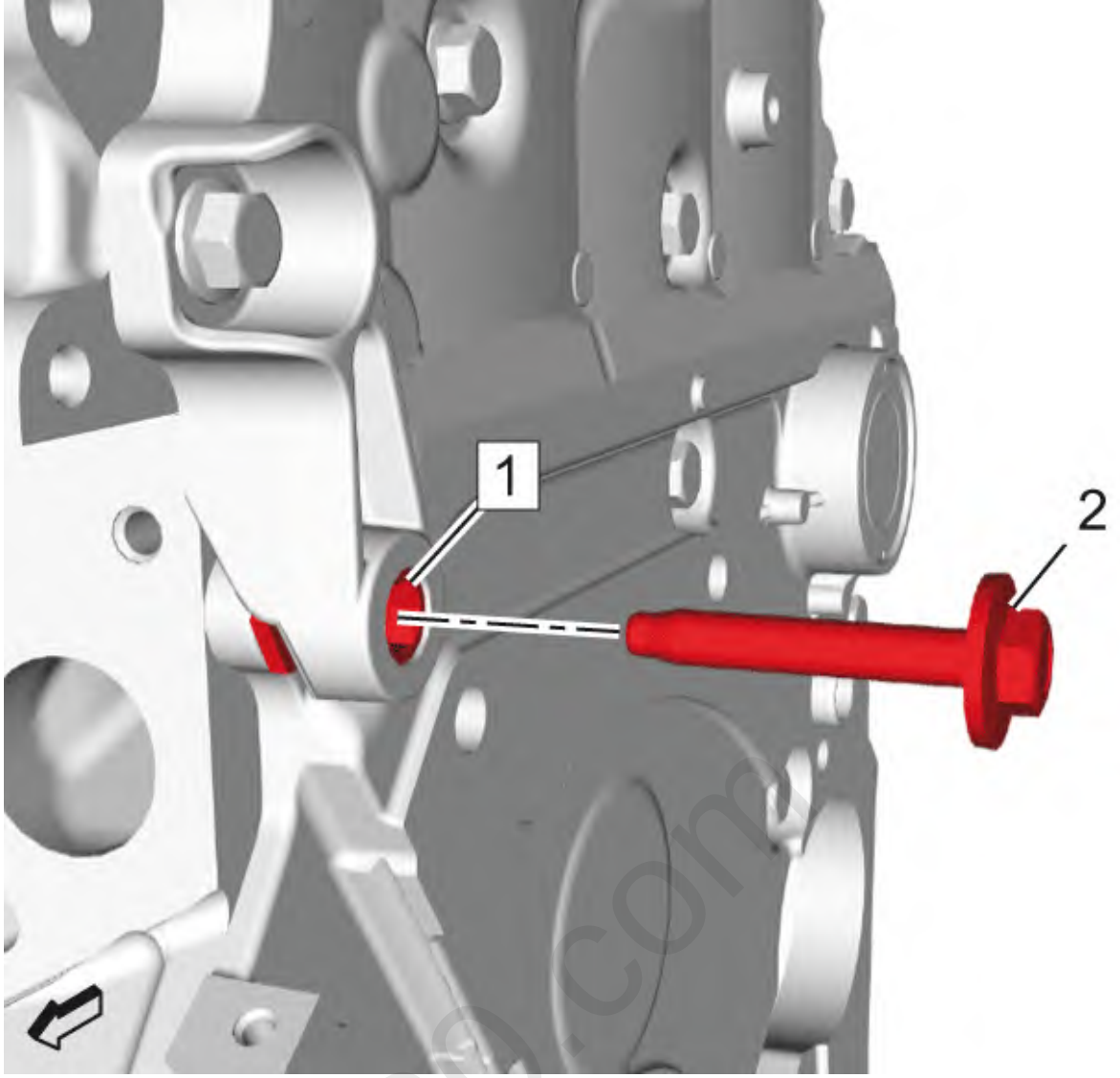


Fig. 301: Timing Chain Upper Cover Sleeve And Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Tighten the timing chain upper cover sleeve (1) to 3.5 N.m (31 lb in).
9. Install the timing chain upper cover sleeve bolt (2) and tighten to 25 N.m (18 lb ft).
10. Install Camshaft Housing. Refer to **Camshaft Housing Replacement**.
11. Install Power Brake Booster Inlet Hose Connector Fitting. Refer to **Power Brake Booster Inlet Hose Connector Fitting Replacement** .

TIMING CHAIN UPPER GUIDE REPLACEMENT

Removal Procedure

1. Remove the camshaft timing chain. Refer to **Camshaft Timing Chain Replacement**.

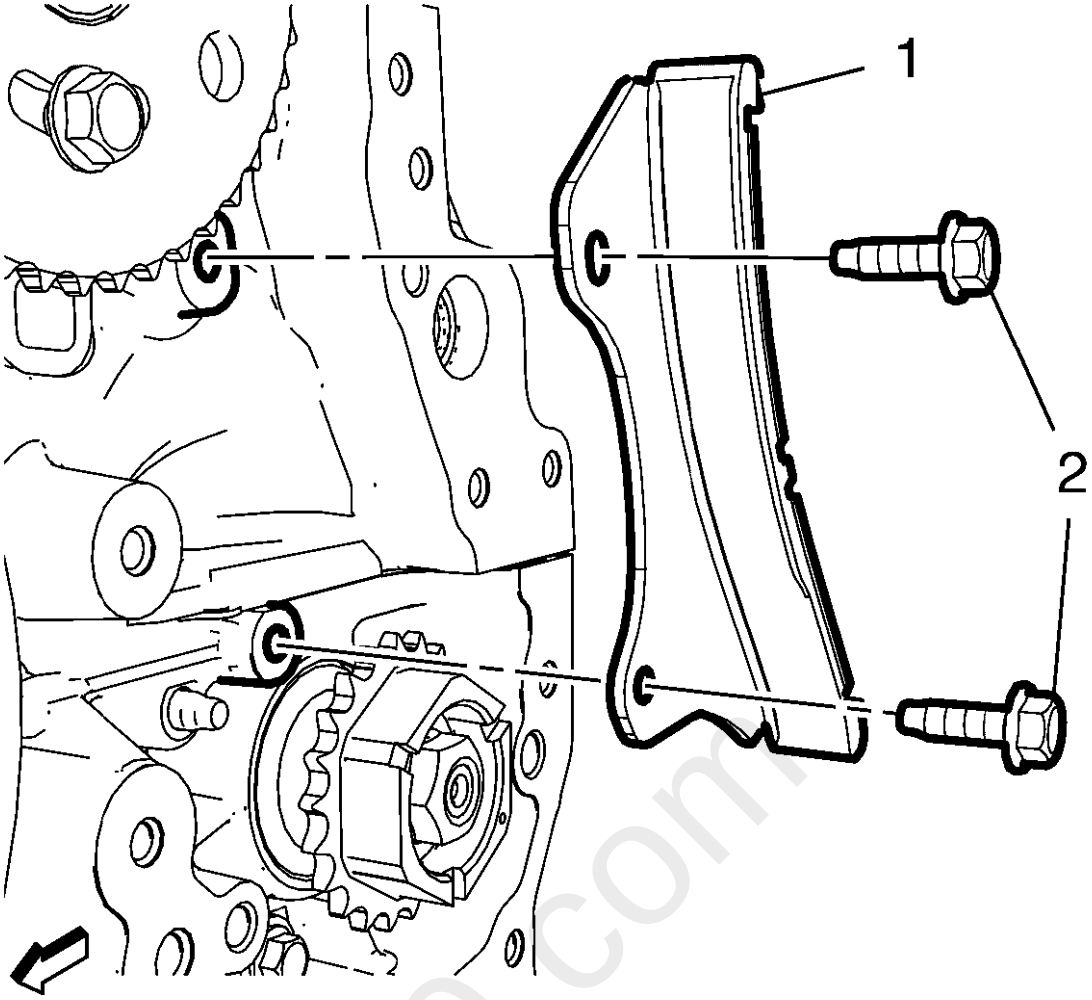


Fig. 302: Timing Chain Upper Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the upper timing chain upper guide bolt (2).
3. Remove the timing chain upper guide (1).

Installation Procedure

NOTE: **Before installing the timing chain upper guide, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

mcx30.com

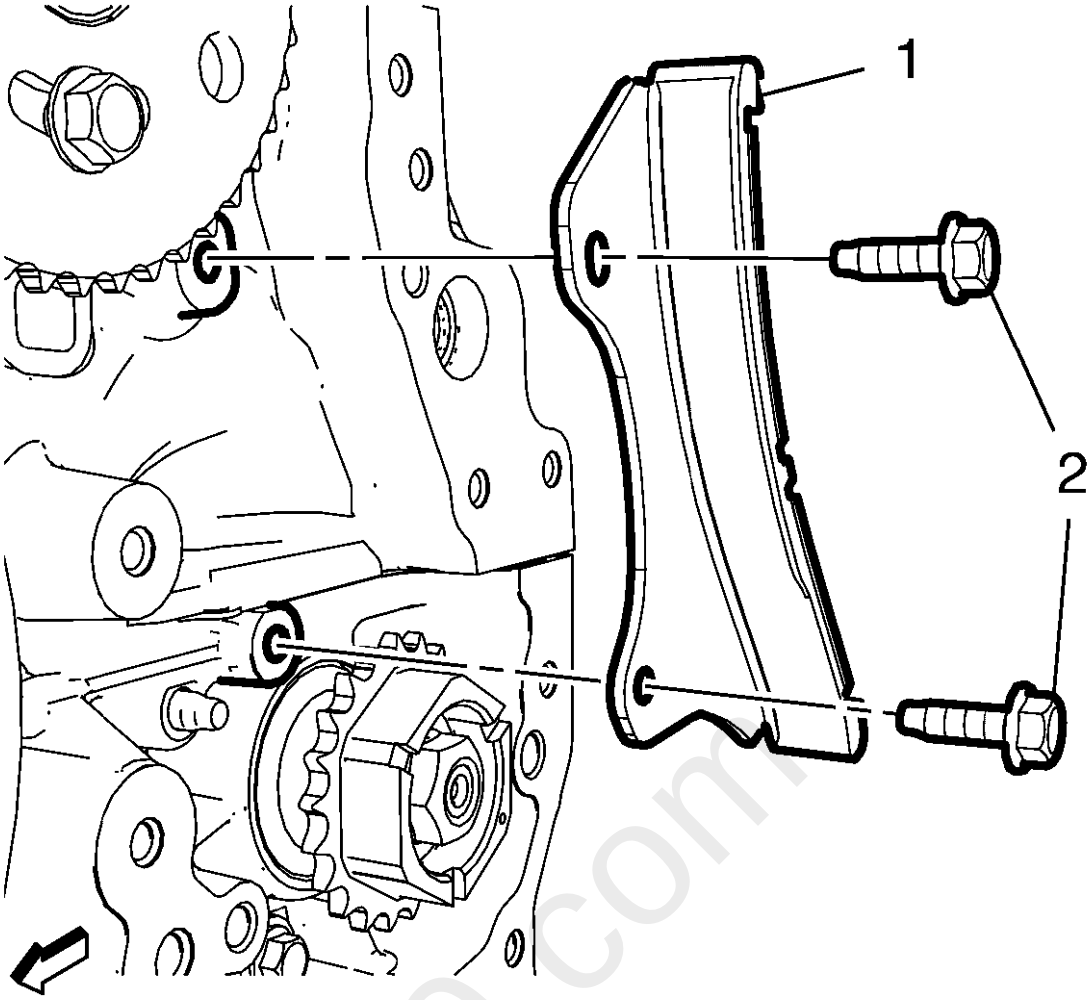


Fig. 303: Timing Chain Upper Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Re-cut thread at cylinder head and engine block for the 2 timing chain upper guide bolts (2).
3. Install the timing chain upper guide (1).

NOTE: **The tightening procedure of the upper timing chain upper guide bolts should be completed within 10 minutes**

4. Apply thread lock agent to the upper timing chain upper guide bolt (2).

NOTE: **Do not tighten the upper timing chain upper guide bolt before the camshaft timing chain is installed.**

5. Install the upper timing chain upper guide bolt (2).
6. Install the camshaft timing chain. Refer to **Camshaft Timing Chain Replacement**.

CRANKSHAFT PULLEY REPLACEMENT

Special Tools

- **EN-956-1** Extension
- **EN-45059** Angle Meter
- **EN-49979** Crankshaft Holder
- **EN-49979-100** Crankshaft Holder Pins

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

Removal Procedure

1. Remove the drive belt. Refer to **Generator and Air Conditioning Compressor Belt Replacement**.

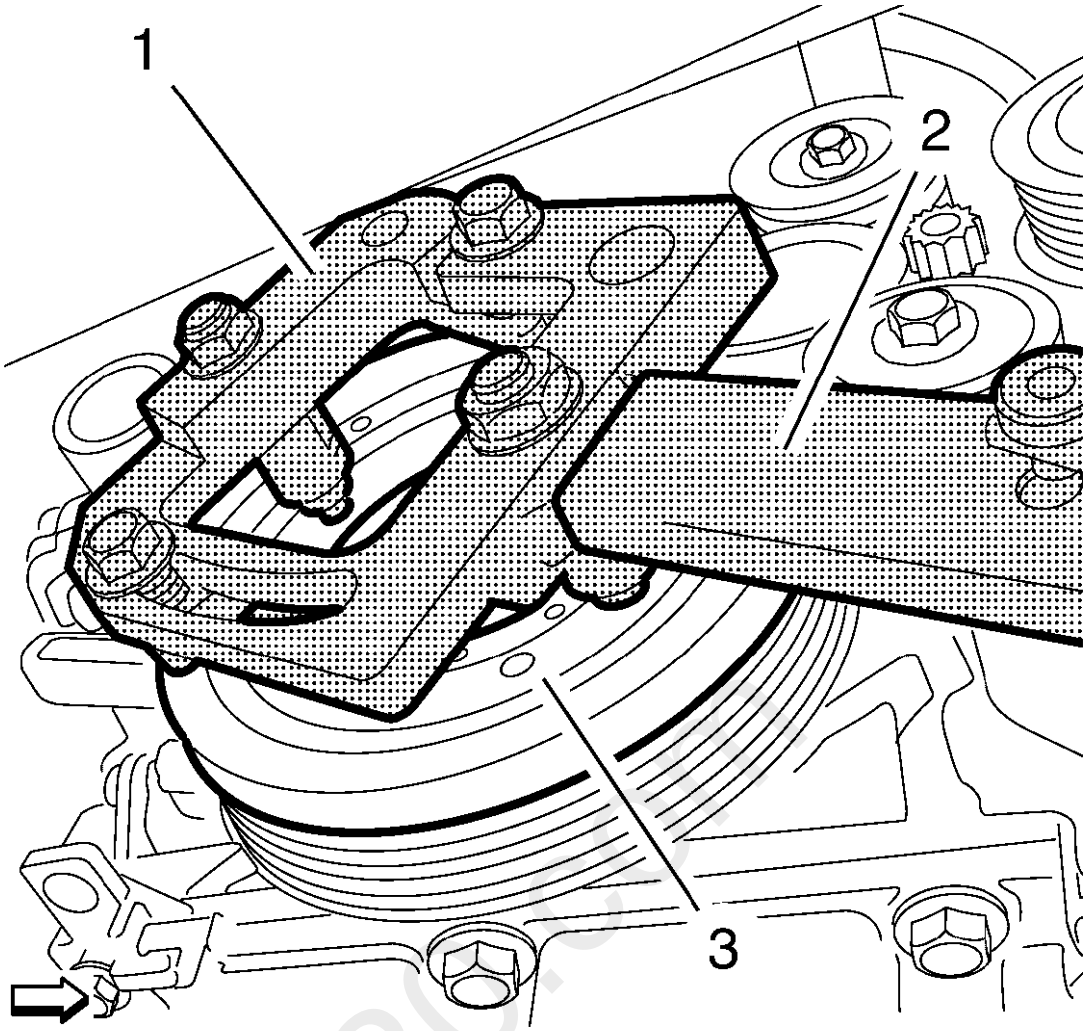


Fig. 304: Crankshaft Holder, Pins, Extension And Crankshaft Pulley
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install the EN-49979 holder along with the EN-49979-100 pins to the outer hole pattern.**

2. Install the **EN-49979** holder (1) in compound with the **EN-49979-100** pins and the **EN-956-1** extension (2) to counterhold the crankshaft pulley (3).

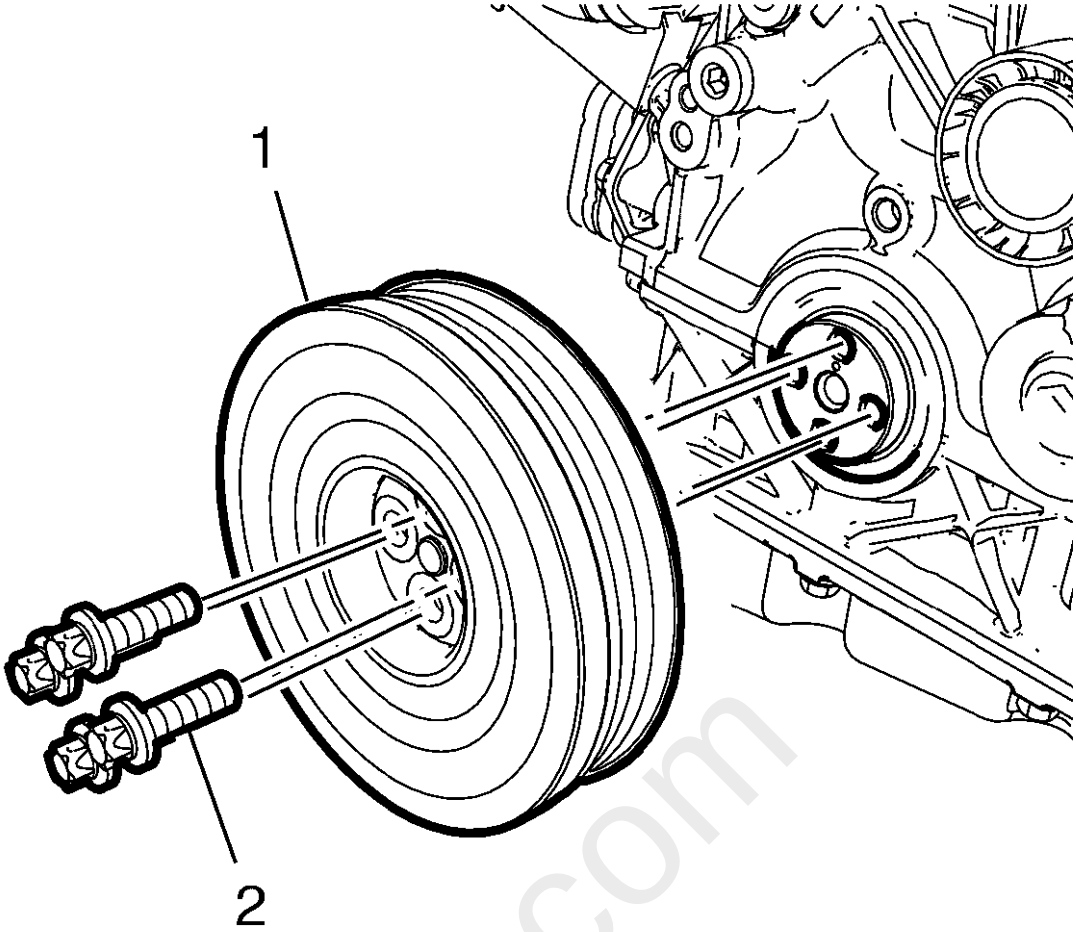


Fig. 305: Crankshaft Pulley And Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove and DISCARD the 4 crankshaft pulley bolts (2).
4. Remove the crankshaft pulley (1).

Installation Procedure

mcx30.com

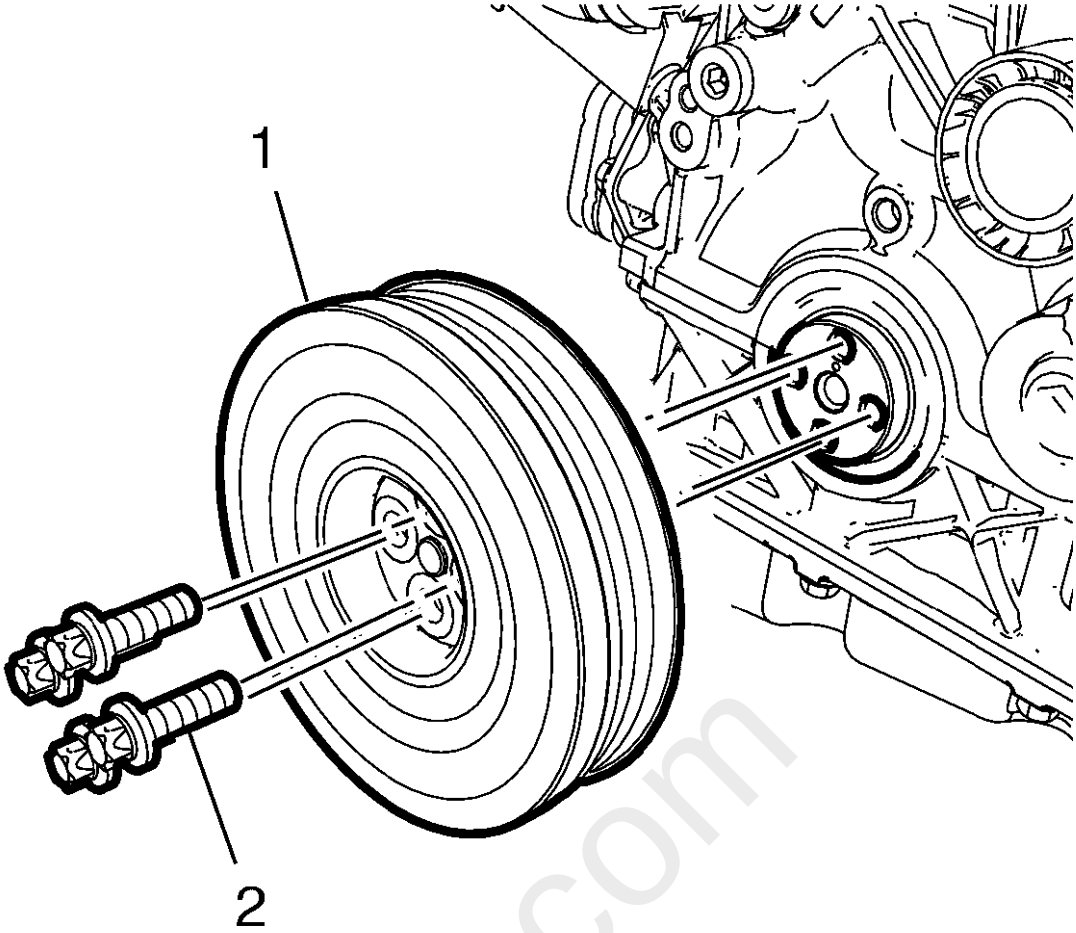


Fig. 306: Crankshaft Pulley And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the crankshaft pulley (1).
2. Pre-install the 4 NEW crankshaft pulley bolts (2).

mcx30.com

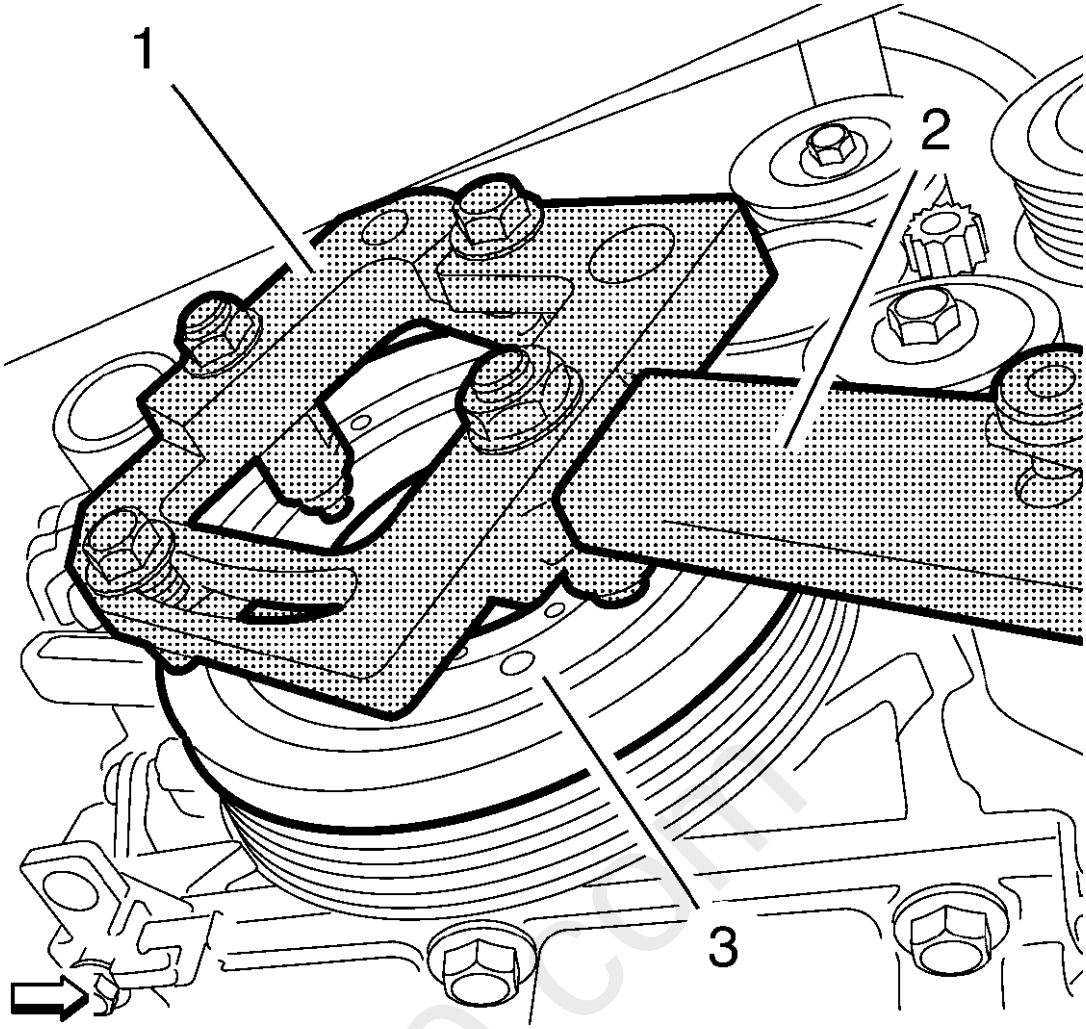


Fig. 307: Crankshaft Holder, Pins, Extension And Crankshaft Pulley
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install the EN-49979 holder with the EN-49979-100 pins to the outer hole pattern.**

3. Install the **EN-49979** holder (1) in compound with the **EN-49979-100** pins and the **EN-956-1** extension (2) to counterhold the crankshaft pulley (3).

mcx30.com

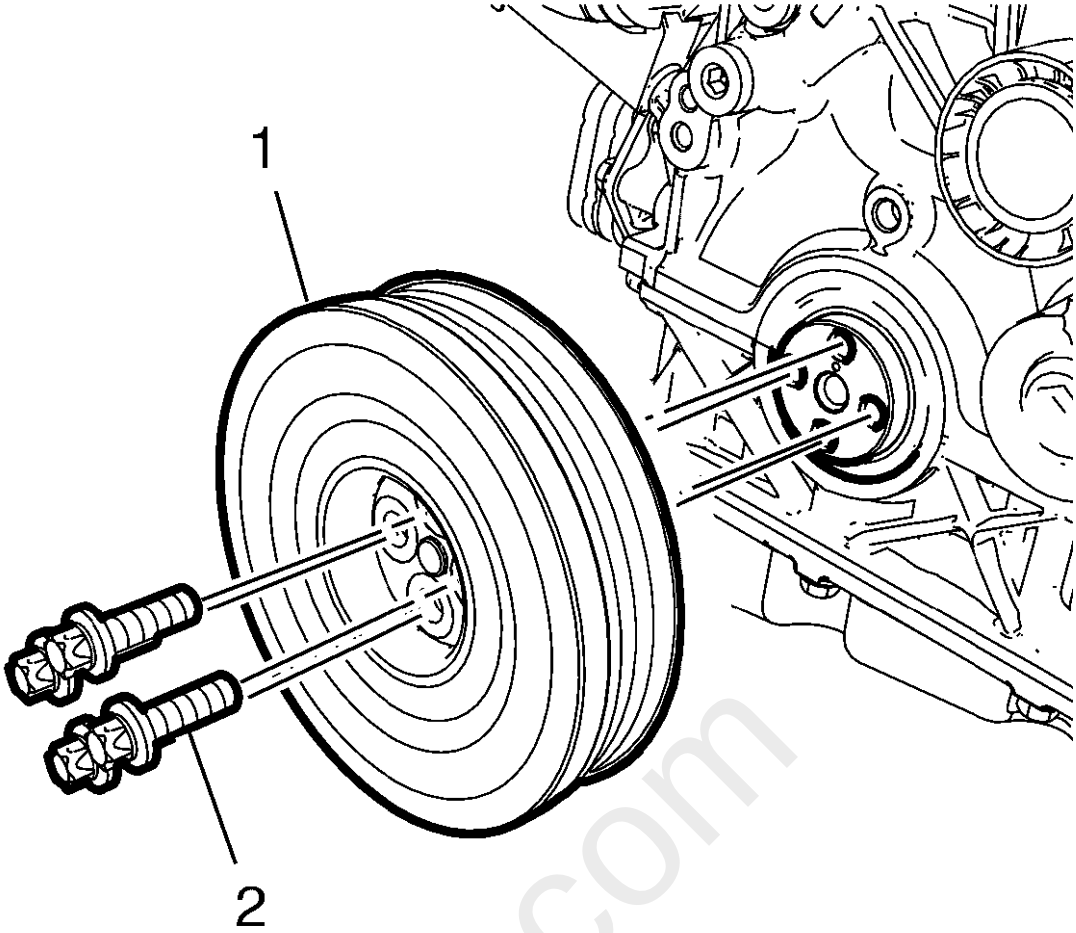


Fig. 308: Crankshaft Pulley And Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

4. Install the 4 crankshaft pulley bolts (2) and tighten in first pass to 50 N.m (37 lb ft).

CAUTION: **Refer to Torque-to-Yield Fastener Caution .**

5. Tighten the 4 crankshaft pulley bolts a final pass to an additional 45 degrees, use the **EN-45059** meter.
6. Install the drive belt. Refer to **Generator and Air Conditioning Compressor Belt Replacement**.

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Special Tools

- **GE-328-B** Pin Remover
- **EN-6624** Remover
- **EN-51144** Crankshaft Seal Installer
- **EN-51144-100** Crankshaft Seal Installer

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

Removal Procedure

1. Remove the crankshaft pulley. Refer to **Crankshaft Pulley Replacement**.

mcx30.com

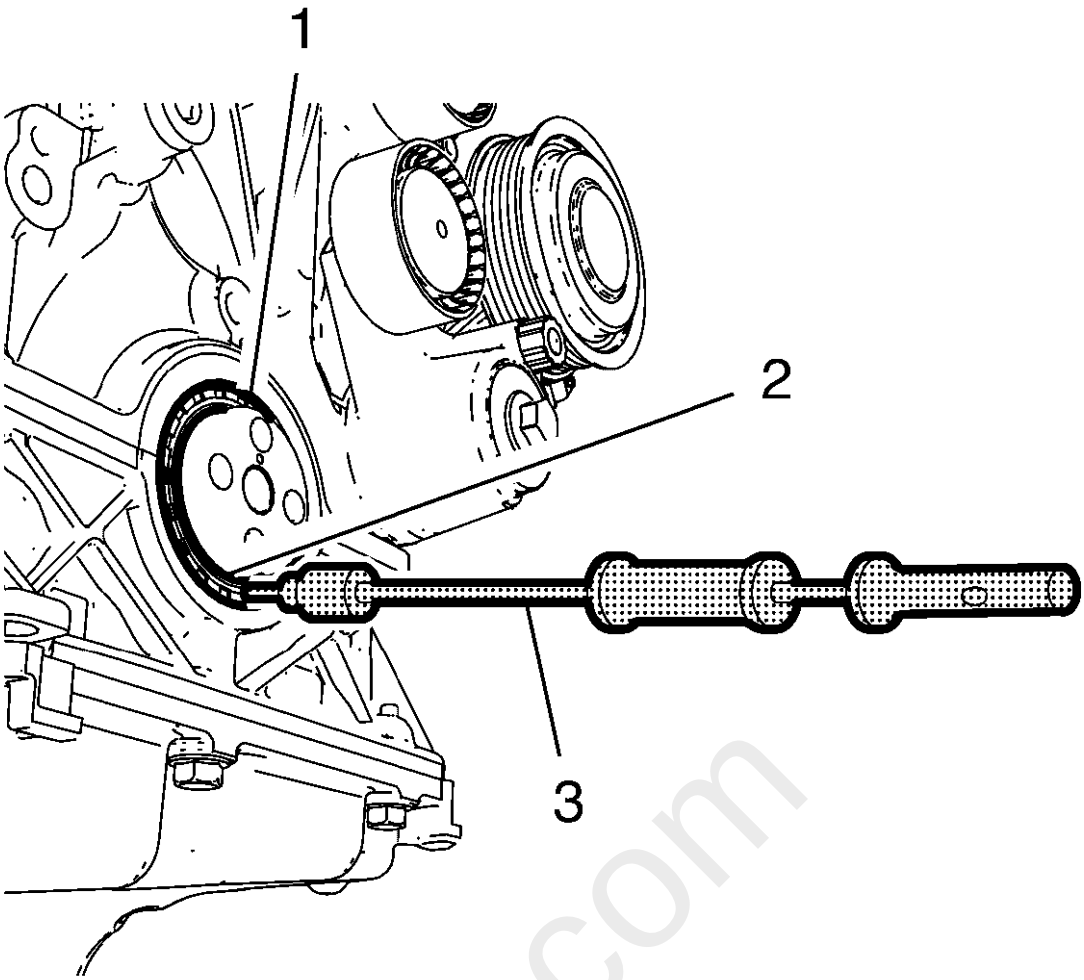


Fig. 309: Removers And Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

2. Punch a bore into the crankshaft seal, use a suitable tool.
3. Install the **EN-6624** remover (2) into the oil sealing ring (1).
4. Install the **GE-328-B** remover (3) to **EN-6624** remover (2).
5. Remove the crankshaft front oil seal, with the **GE-328-B** remover.

Installation Procedure

mox30.com

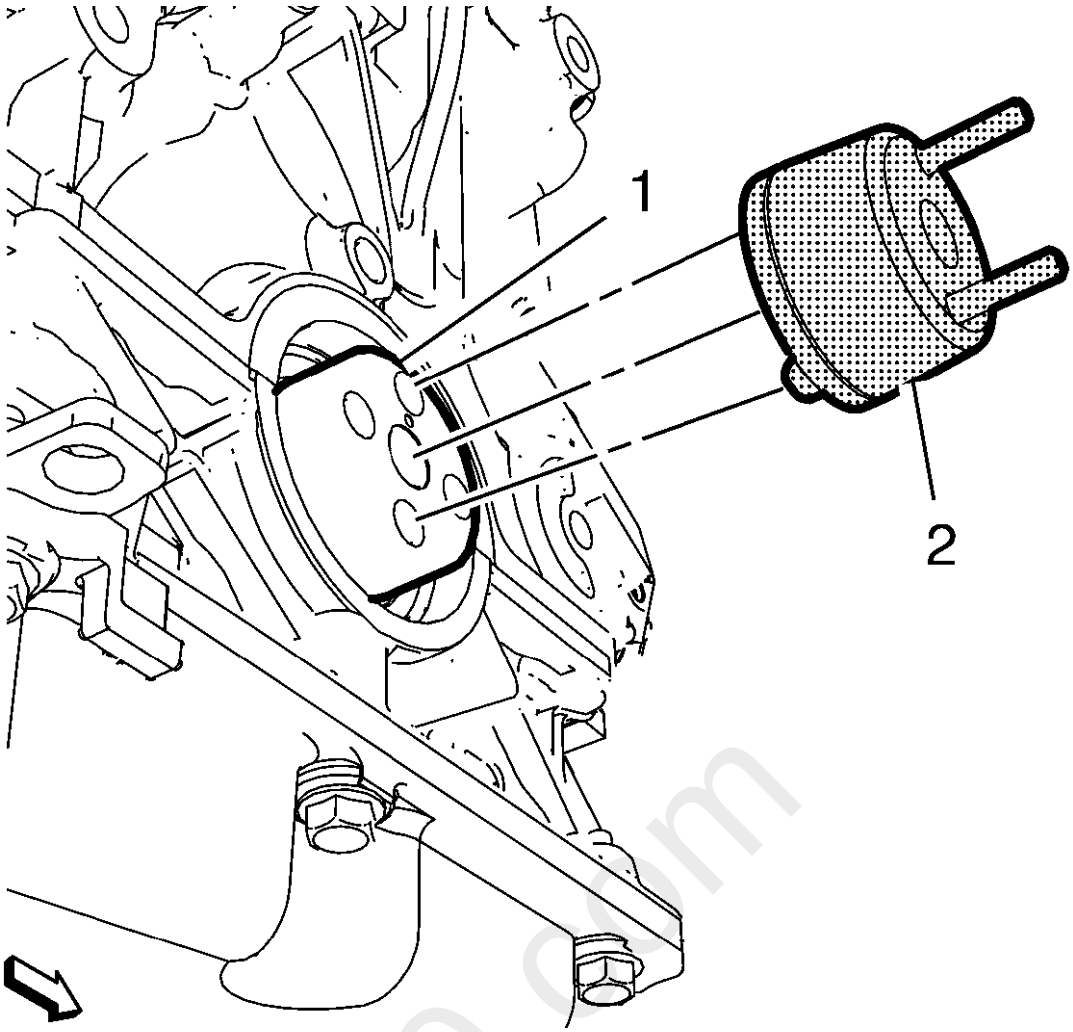


Fig. 310: Installer And Crankshaft
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-51144-1** installer (2) to the crankshaft (1).

mcx30.com

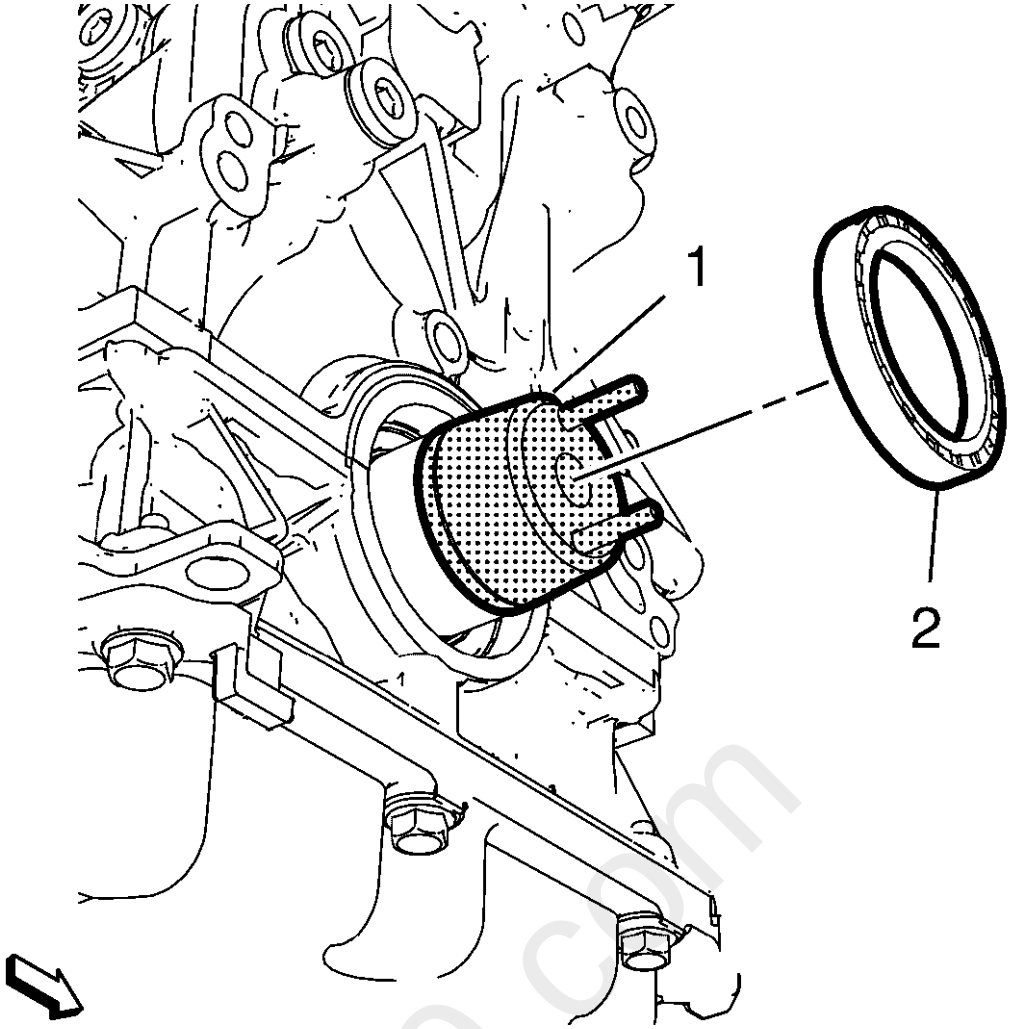


Fig. 311: Crankshaft Front Oil Seal And Installer
Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW crankshaft front oil seal (2) to the **EN-51144-1** installer (1).

mcx30.com

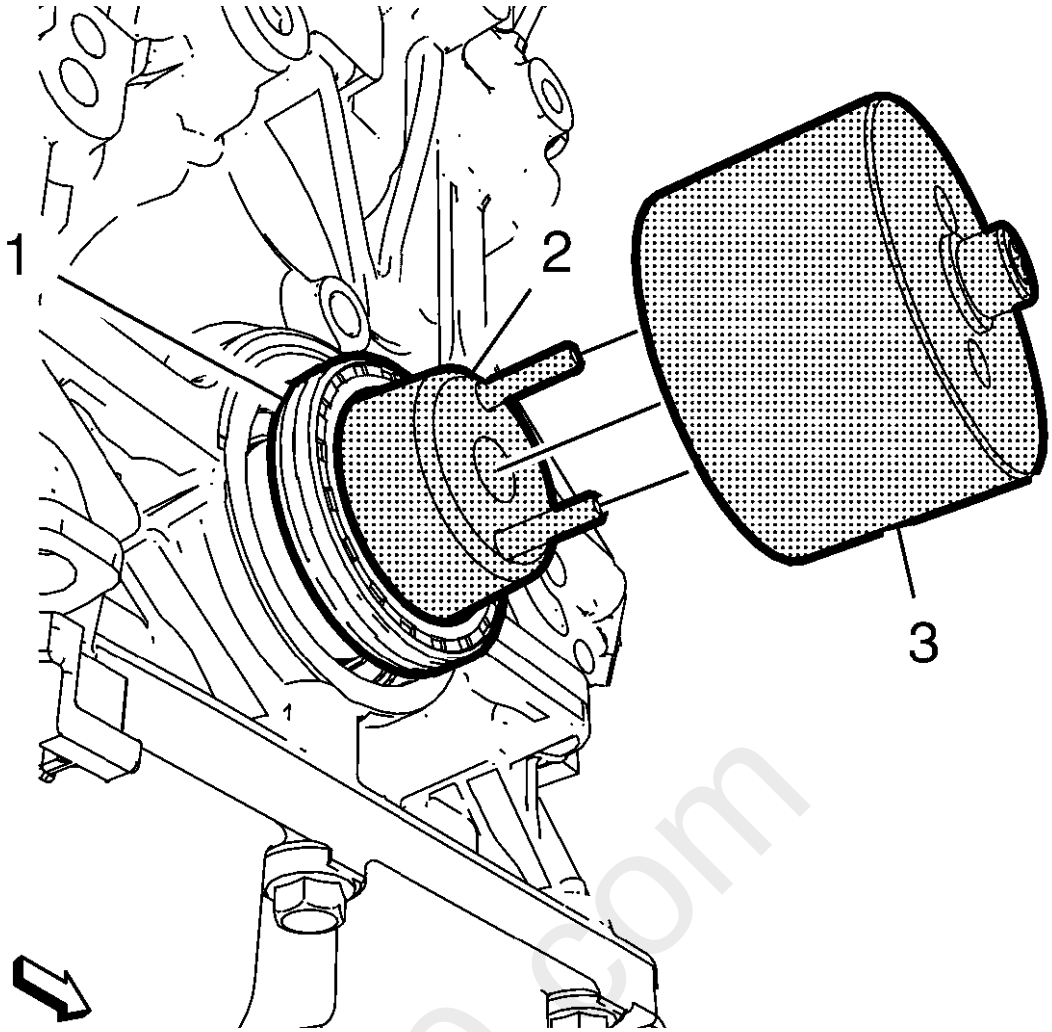


Fig. 312: Crankshaft Seal Installers
Courtesy of GENERAL MOTORS COMPANY

3. Install the **EN-51144-100** crankshaft seal installer (3) to the **EN-51144-1** installer (2).

mcx30.com

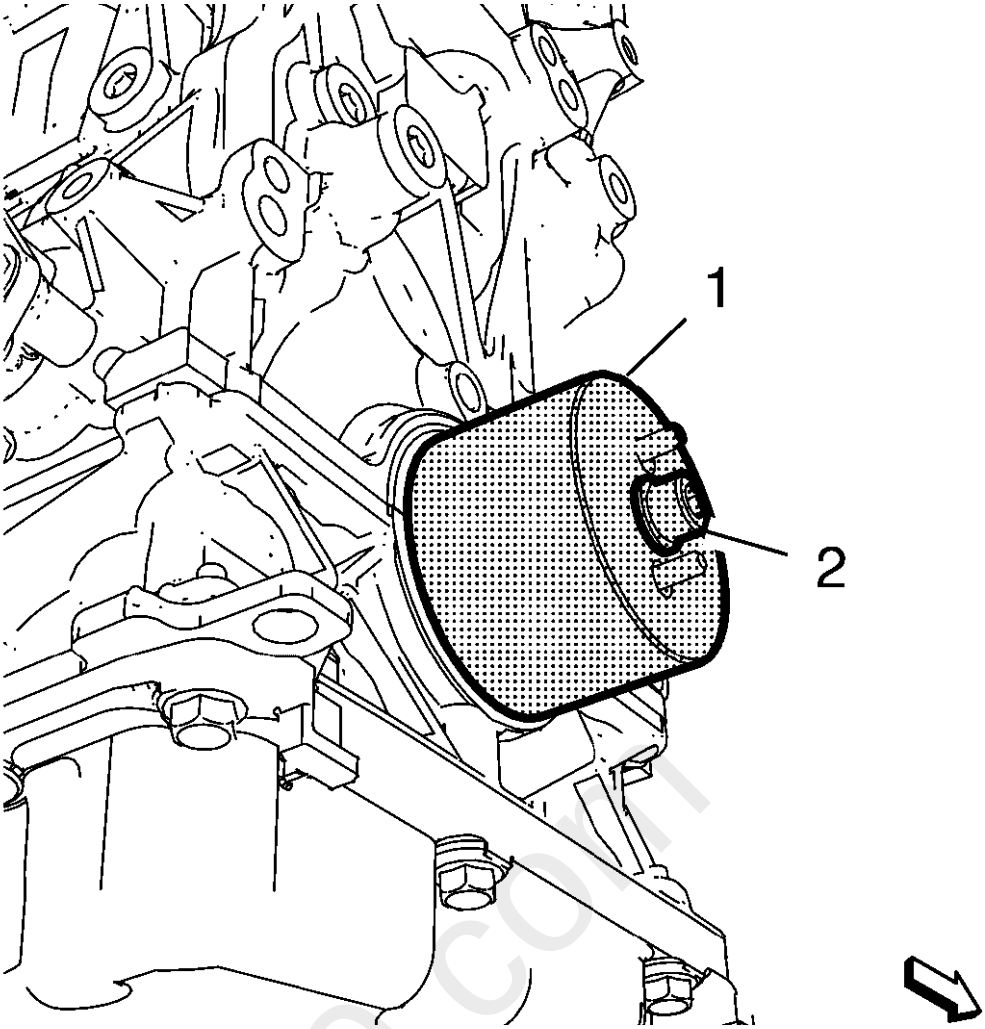


Fig. 313: Seating Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

4. Press the crankshaft front oil seal into the correct seat, by tighten the bolt (2) from **EN-51144** installer (1).
5. Thus they drive the crankshaft front oil seal as far purely until the **EN-51144** installer (1) on the stop is.
6. Remove the **EN-51144** installer.
7. Install the crankshaft pulley. Refer to **Crankshaft Pulley Replacement**.
8. Check and correct the engine oil level.

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Special Tools

- **DT-523-1** Handle
- **EN-6624** Remover
- **EN-51145** Crankshaft Seal Installer
- **GE-328-B** Pin Remover

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

Removal Procedure

1. Remove the crankshaft position sensor reluctor ring. Refer to **Crankshaft Position Sensor Reluctor Ring Replacement**.

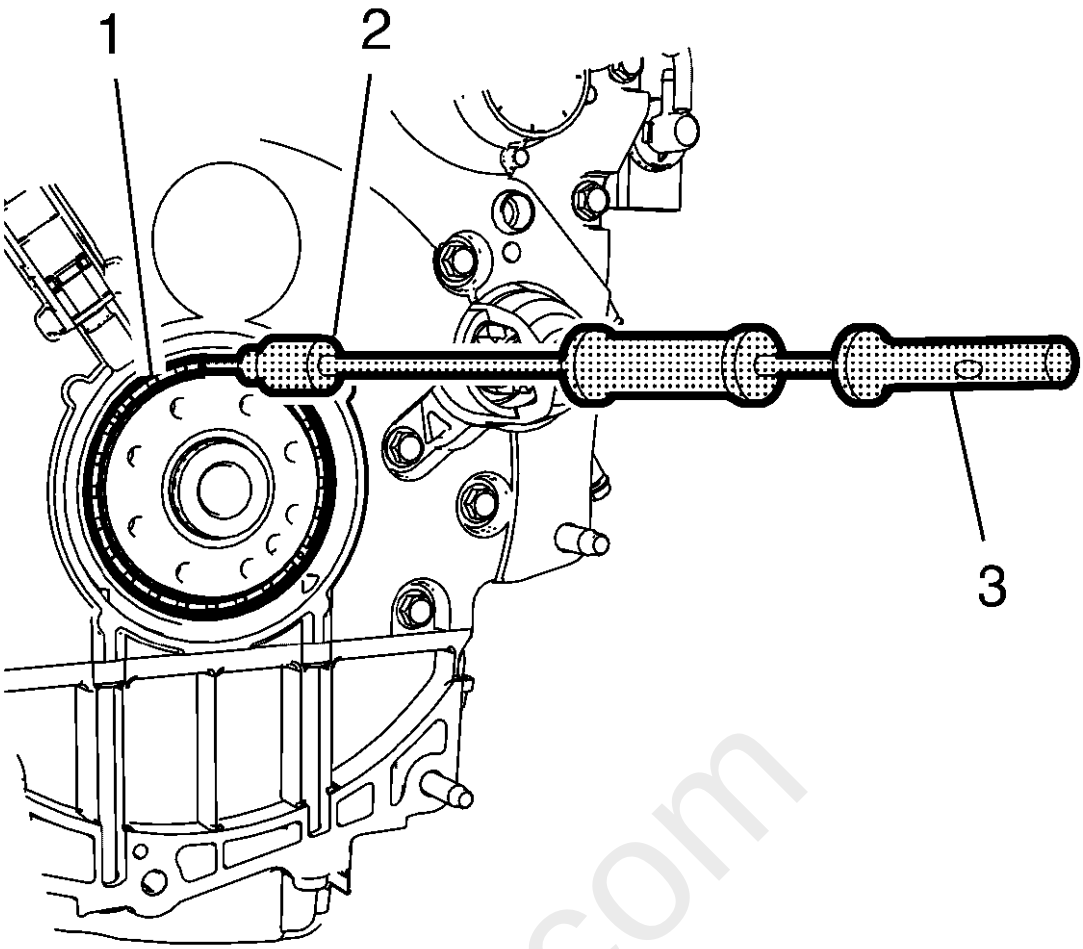


Fig. 314: Crankshaft Rear Oil Seal And Removers
Courtesy of GENERAL MOTORS COMPANY

2. Punch a bore into the crankshaft seal, use a suitable tool.
3. Install the **EN-6624** remover (2) into the oil sealing ring (1).
4. Install the **GE-328-B** remover (3) to the **EN-6624** remover (2).
5. Remove the crankshaft rear oil seal, with the **GE-328-B** remover.

Installation Procedure

mx30.com

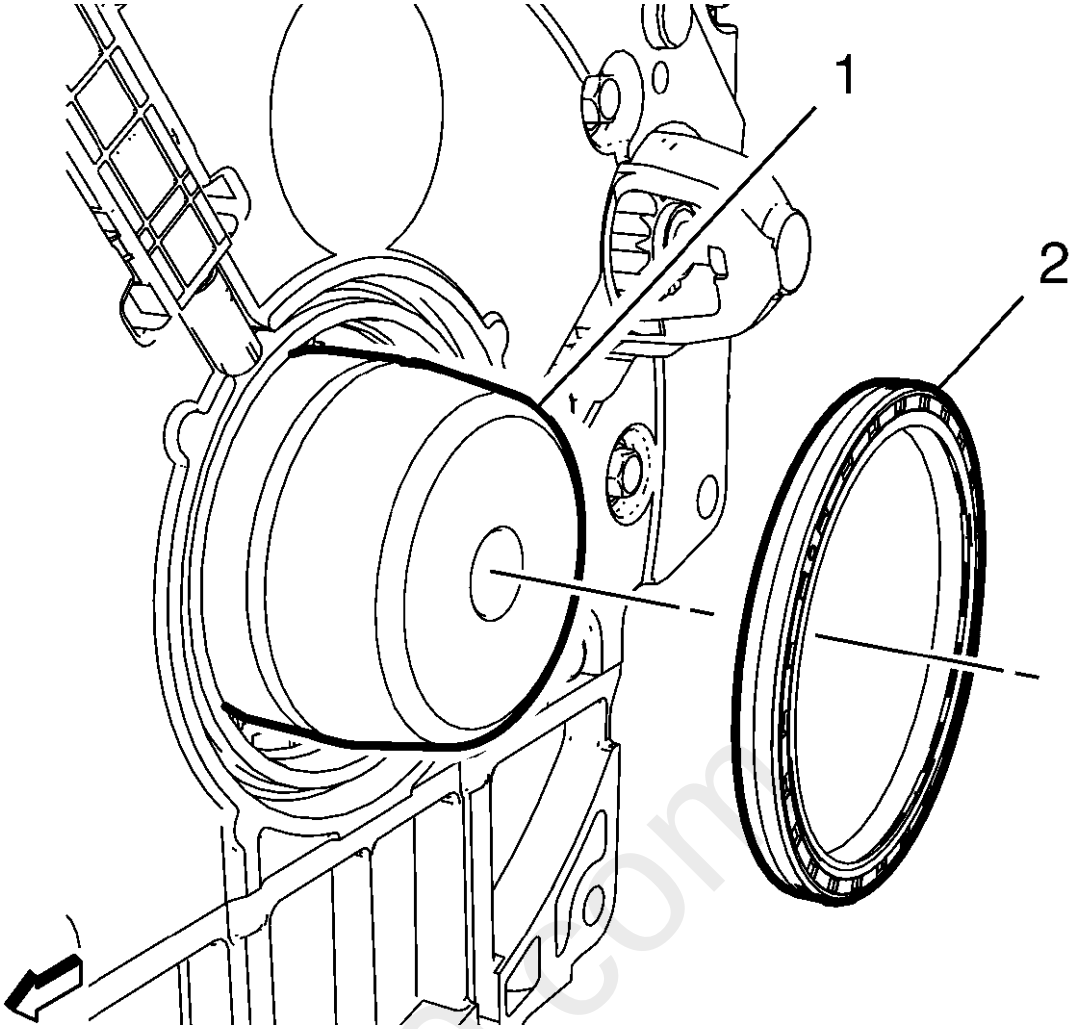


Fig. 315: Crankshaft Rear Oil Seal And Installer
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-51145-1** installer (1) to the crankshaft.
2. Install the crankshaft rear oil seal (2) to the **EN-51145-1** installer (1).

mcx30.com

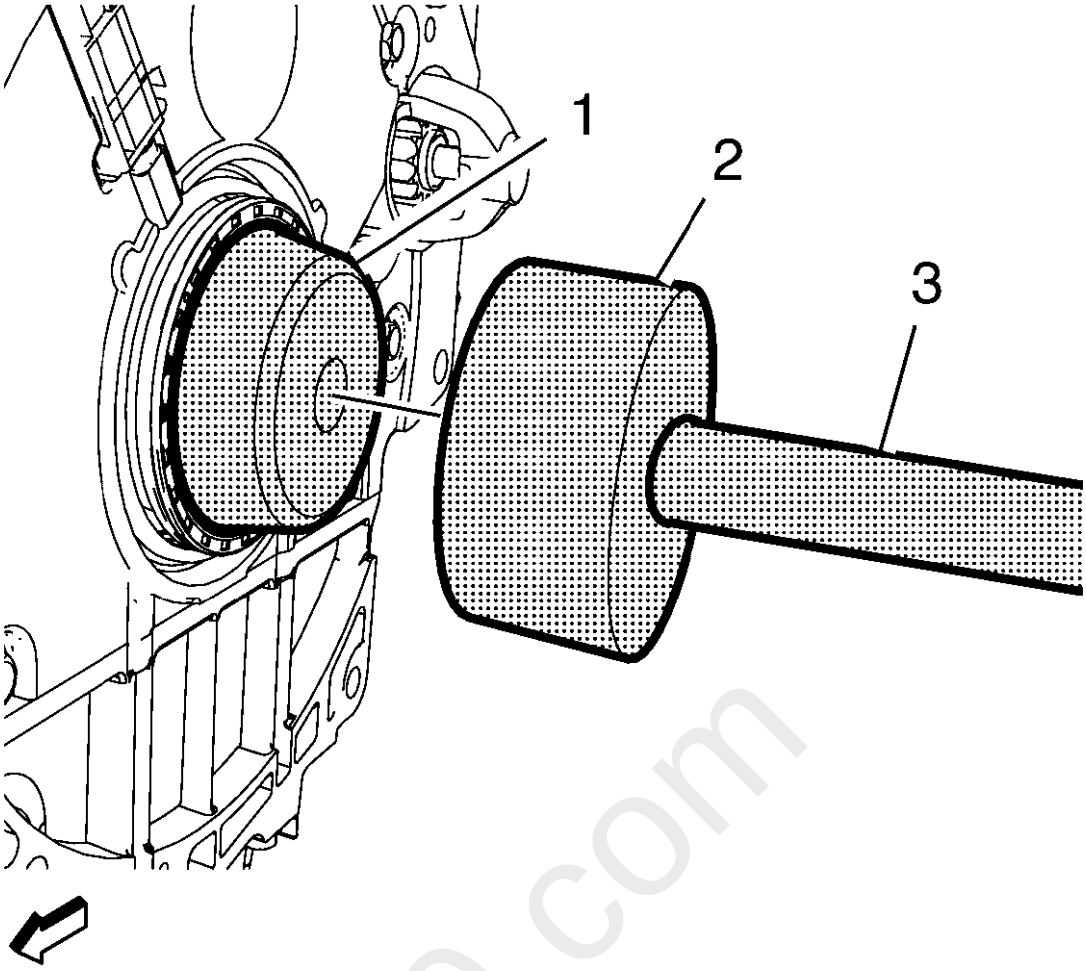


Fig. 316: Seating Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

3. Pull in the crankshaft rear oil seal with the **EN-51145-2** installer (2) and the **DT-523-1** handle (3).
4. Remove the **EN-51145** installer.

mcx30.com

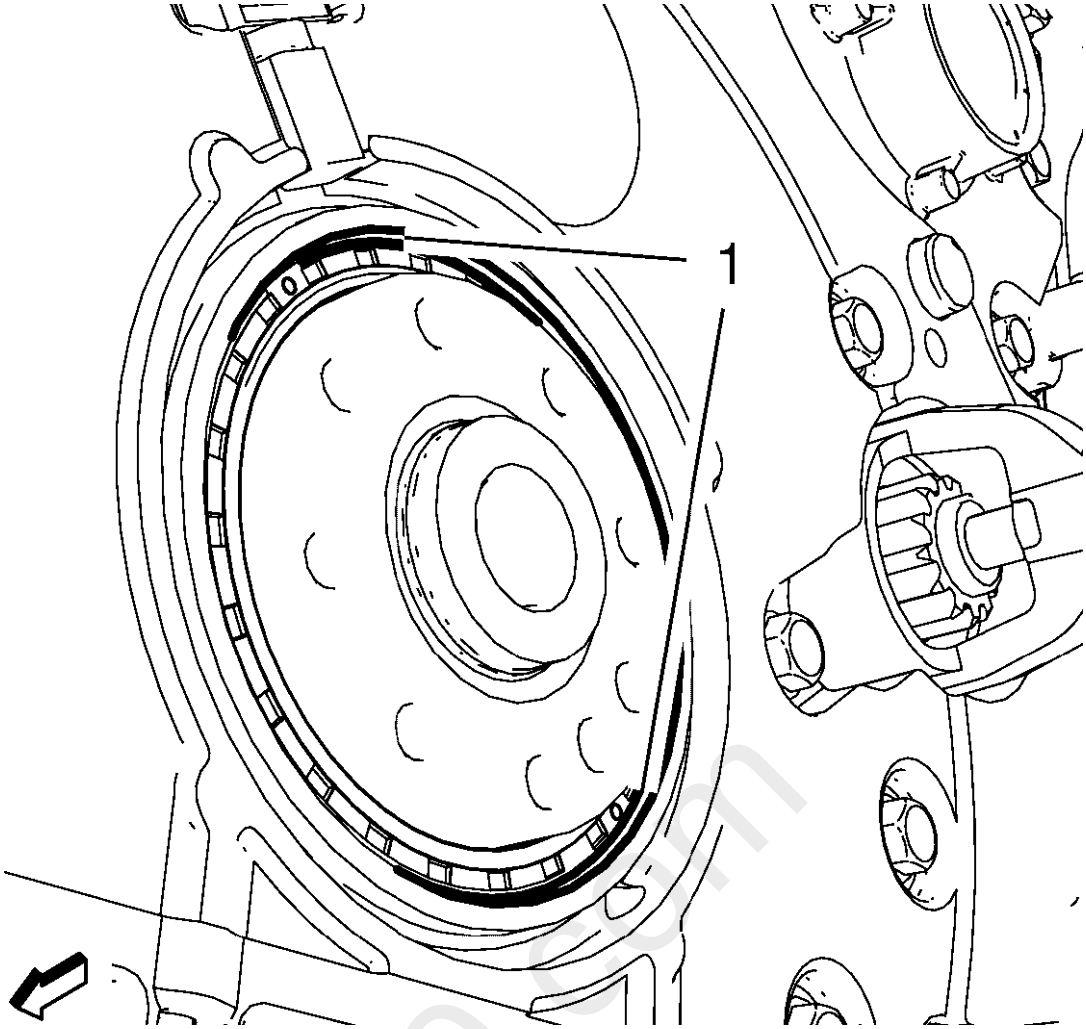


Fig. 317: Ensure Crankshaft Rear Oil Seal Is Properly Seated
Courtesy of GENERAL MOTORS COMPANY

5. Check the proper seat (1) of the crankshaft rear oil seal.
6. Install the crankshaft position sensor reluctor ring. Refer to **Crankshaft Position Sensor Reluctor Ring Replacement**.

CRANKSHAFT POSITION SENSOR RELUCTOR RING REPLACEMENT

Removal Procedure

1. Remove Automatic Transmission Flex Plate. Refer to **Automatic Transmission Flex Plate Replacement**

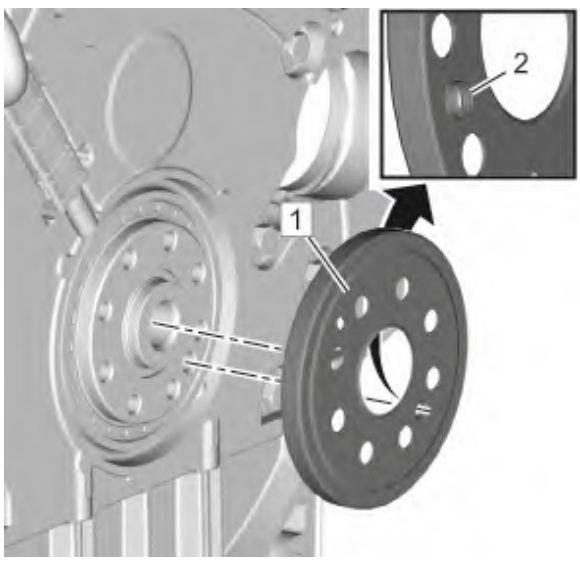


Fig. 318: Crankshaft Position Sensor Reluctor Ring And Pin
Courtesy of GENERAL MOTORS COMPANY

mcx30.com

2. Remove Crankshaft Position Sensor Reluctor Ring (1)

Installation Procedure

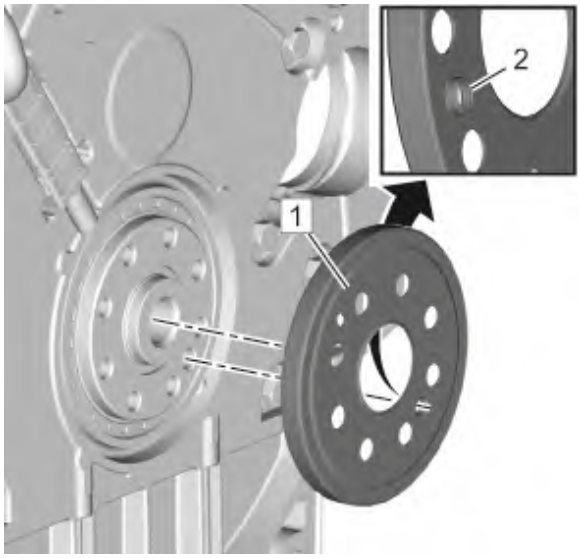


Fig. 319: Crankshaft Position Sensor Reluctor Ring And Pin
Courtesy of GENERAL MOTORS COMPANY

1. Install the crankshaft position sensor reluctor ring (1) by installing the pin (2) in the correct hole of the engine block.
2. Install Automatic Transmission Flex Plate. Refer to **Automatic Transmission Flex Plate Replacement**

CYLINDER HEAD REPLACEMENT

Special Tools

- **EN-45059** Angle Meter
- **EN-50509** Fixing Tool
- **EN-50513** Fixing Pin
- **EN-51140** Crankshaft Fixing Tool
- **EN-51143** Camshaft Sprocket Fixing Tool
- **GE-7872** Magnetic Base Dial Indicator

Equivalent regional tools: **Special Tools**

Removal Procedure

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**
2. Remove the exhaust manifold. Refer to **Exhaust Manifold Replacement (LH7)**
3. Remove Camshaft Sprocket. Refer to **Camshaft Sprocket Replacement**
4. Remove Glow Plugs (Qty: 4). Refer to **Glow Plug Replacement**

mex30.com

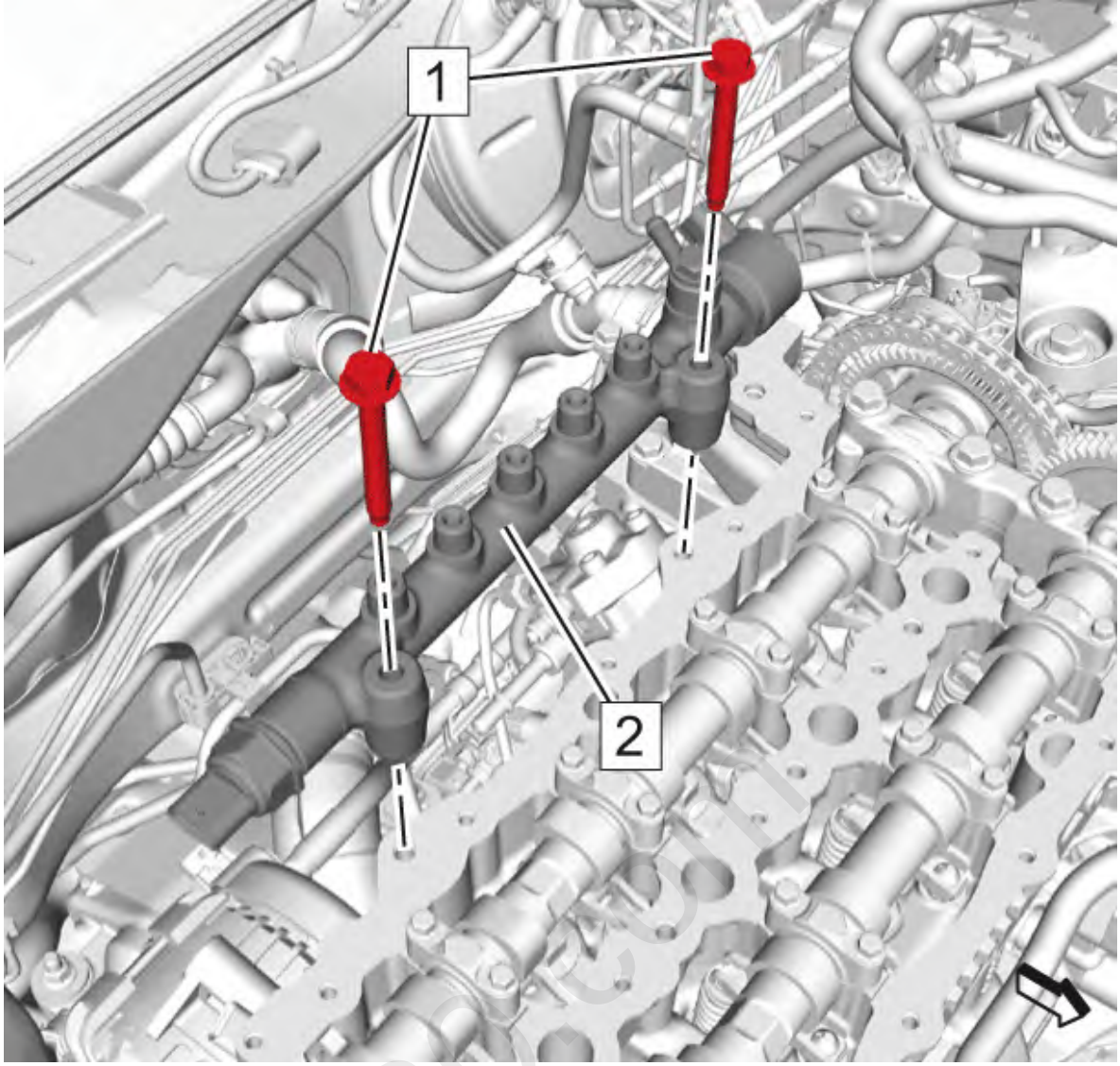


Fig. 320: Fuel Injection Fuel Rail And Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove Fuel Injection Fuel Rail Bolts (1) (Qty: 2)
6. Remove Fuel Injection Fuel Rail (2)

mexspec.com

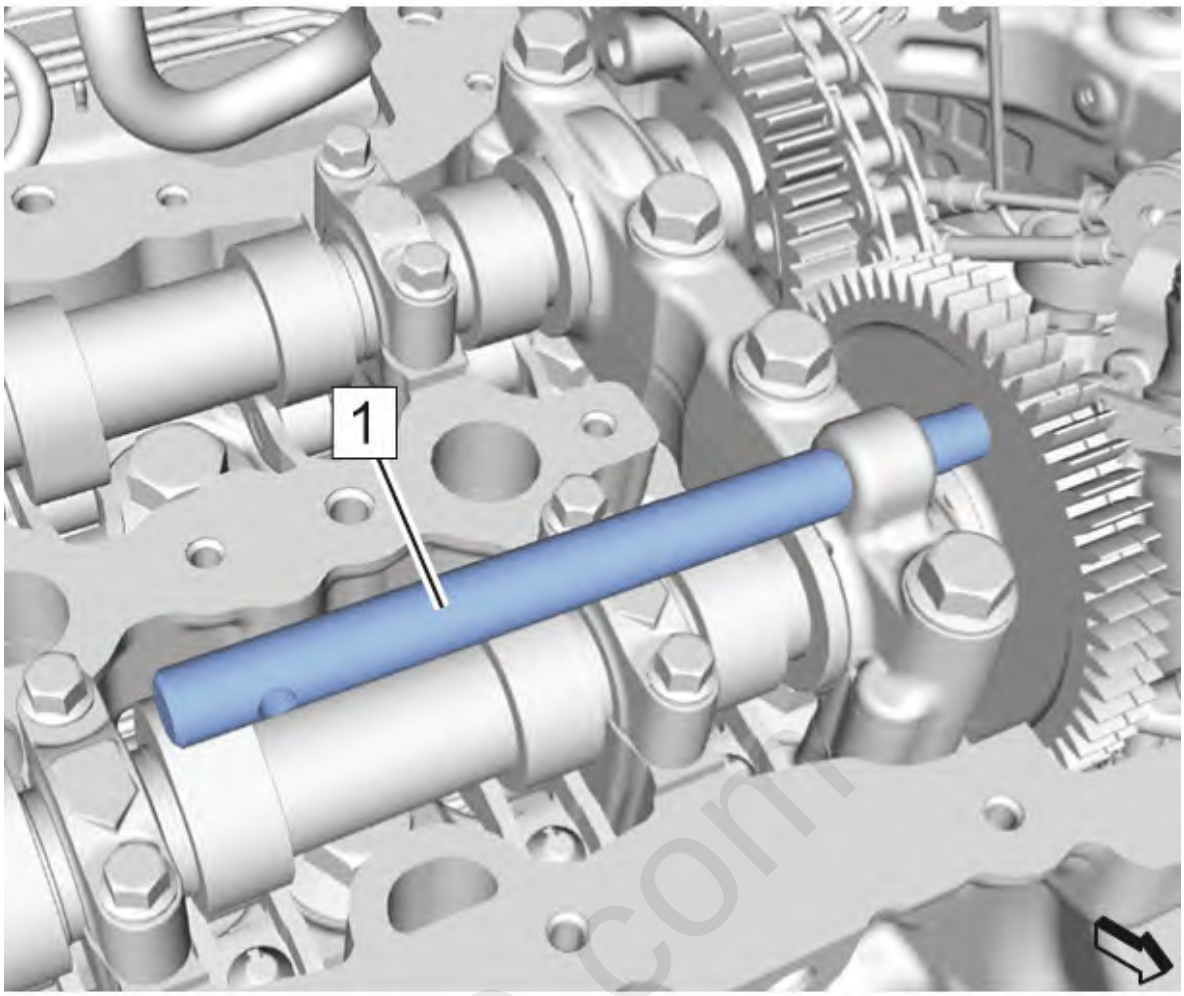


Fig. 321: Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

7. Remove the **EN-51143** fixing tool (1).

mcx30.com

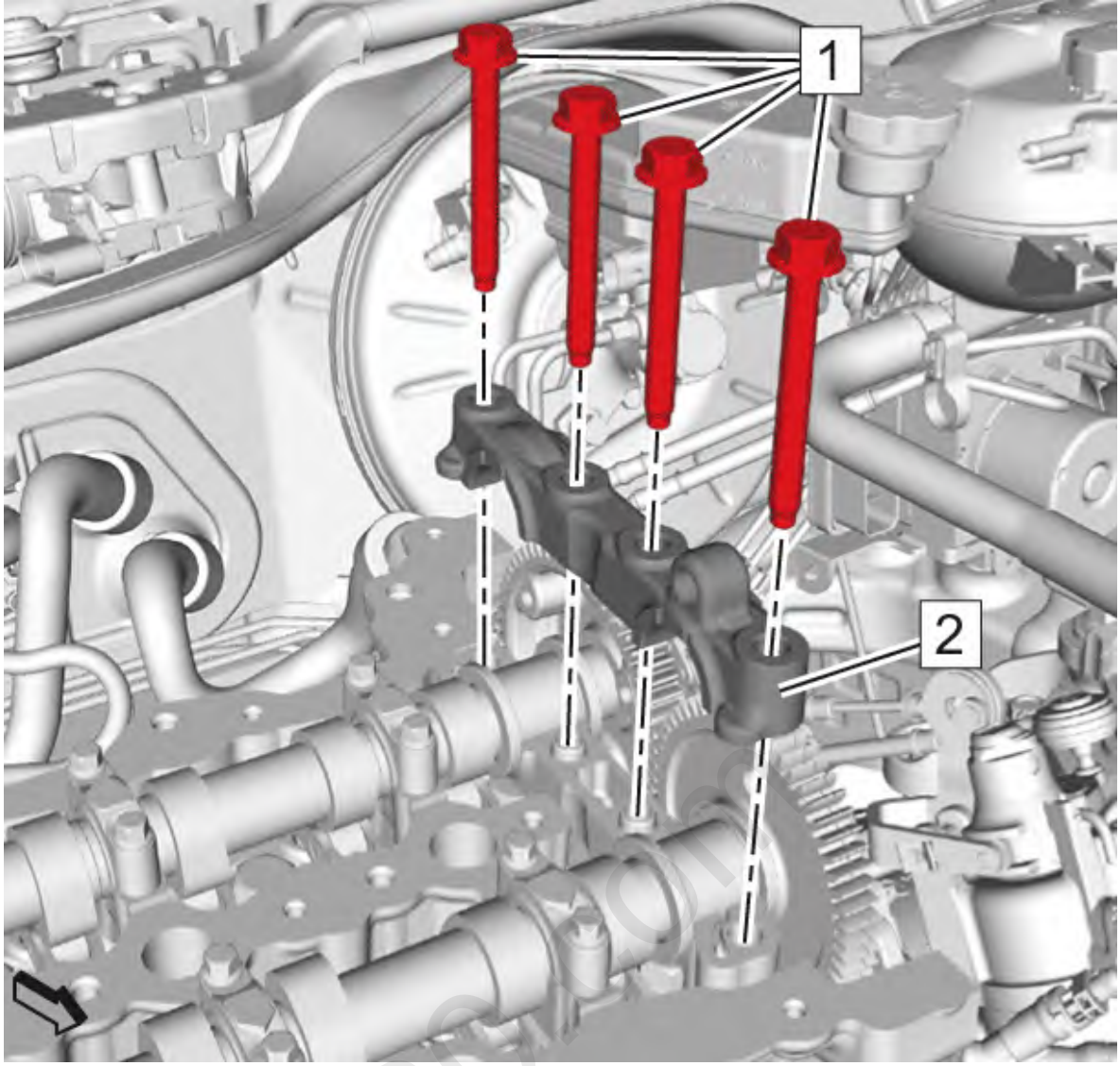


Fig. 322: Camshaft Bearing Rear Cap And Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the 4 camshaft bearing rear cap bolts (1).
9. Remove Camshaft Bearing Rear Cap (2)

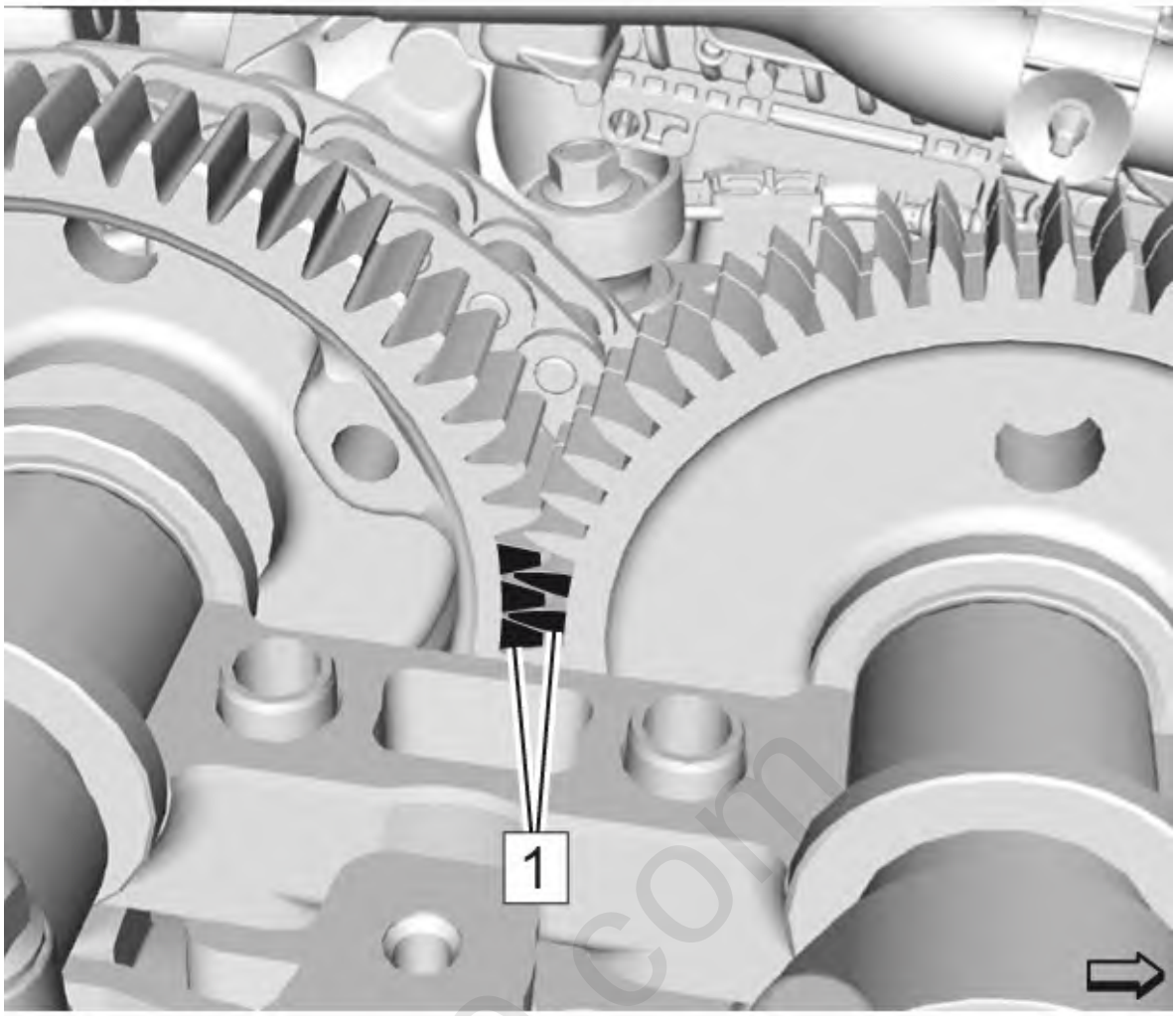


Fig. 323: Mark Exhaust Camshaft Sprocket And Intake Camshaft Sprocket With Paint Marks
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Marking the camshaft sprockets.**

10. Marking the exhaust camshaft sprocket and intake camshaft sprocket with paint marks (1).

mcx30.com

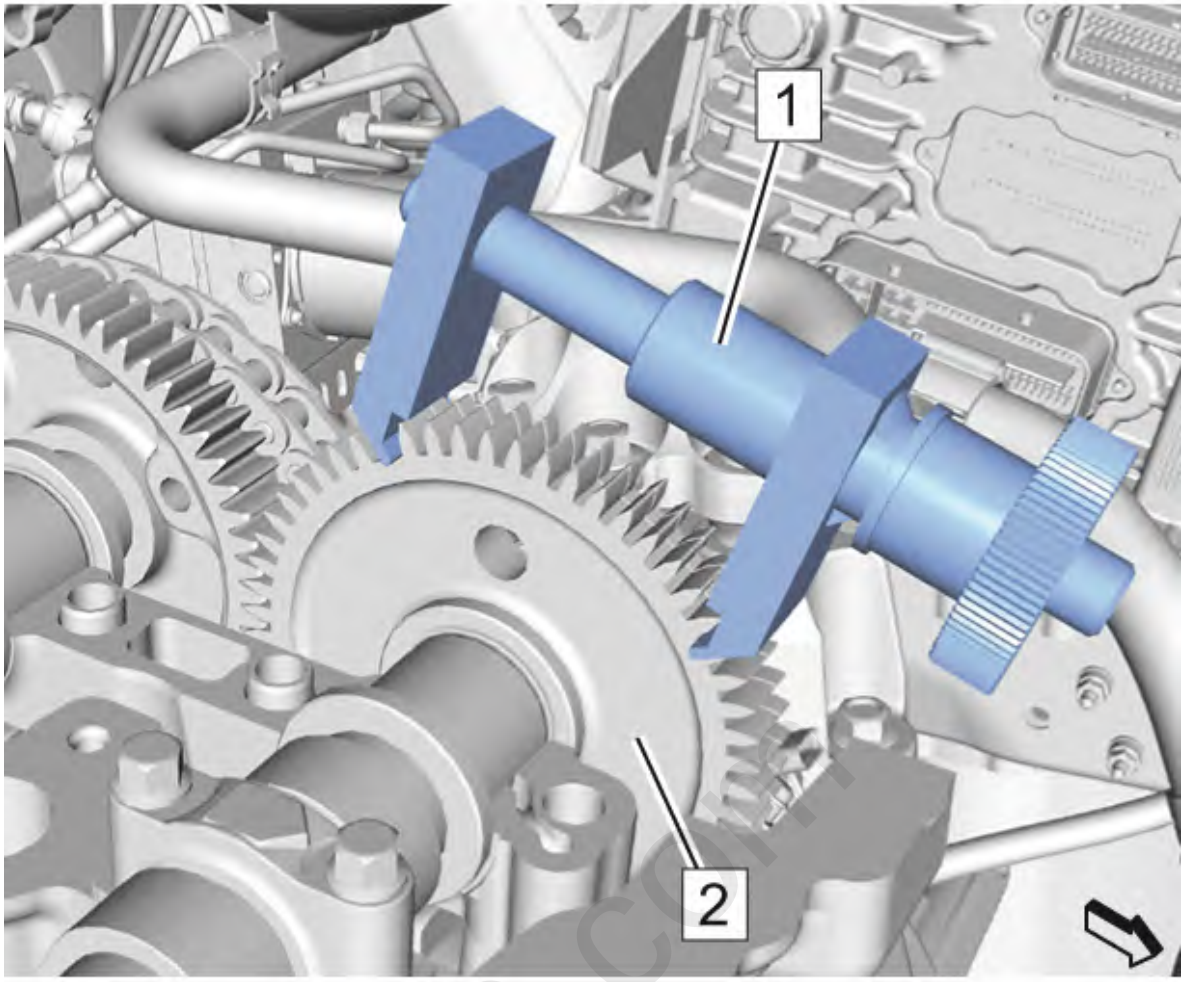


Fig. 324: Split Intake Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

11. Install the **EN-50509** fixing tool (1) to the exhaust camshaft sprocket (2).

mcx30.com

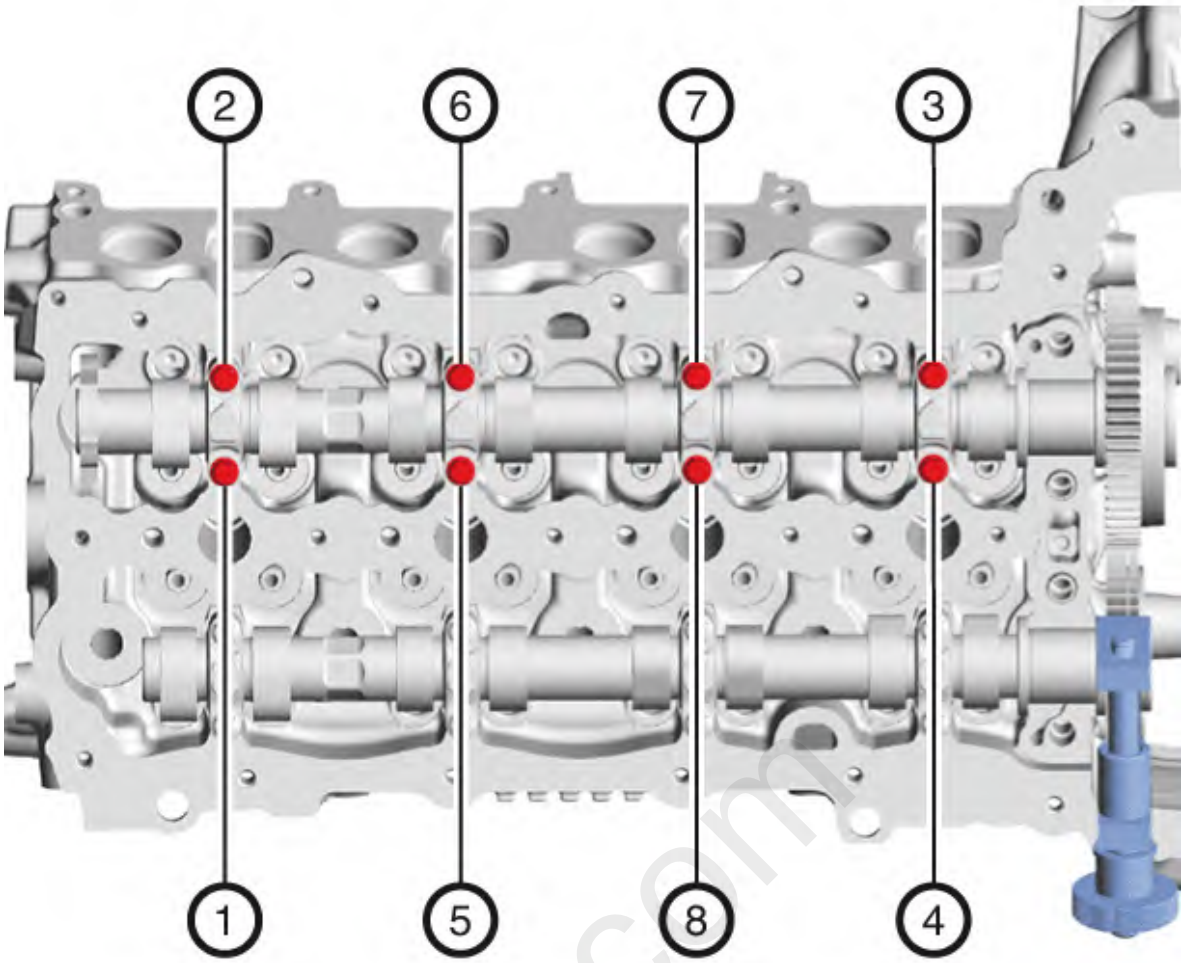


Fig. 325: Intake Camshaft Bearing Cap Bolt Loosening Sequence
Courtesy of GENERAL MOTORS COMPANY

12. Loosen the 8 intake camshaft bearing cap bolts in sequence as shown.

mcx30.com

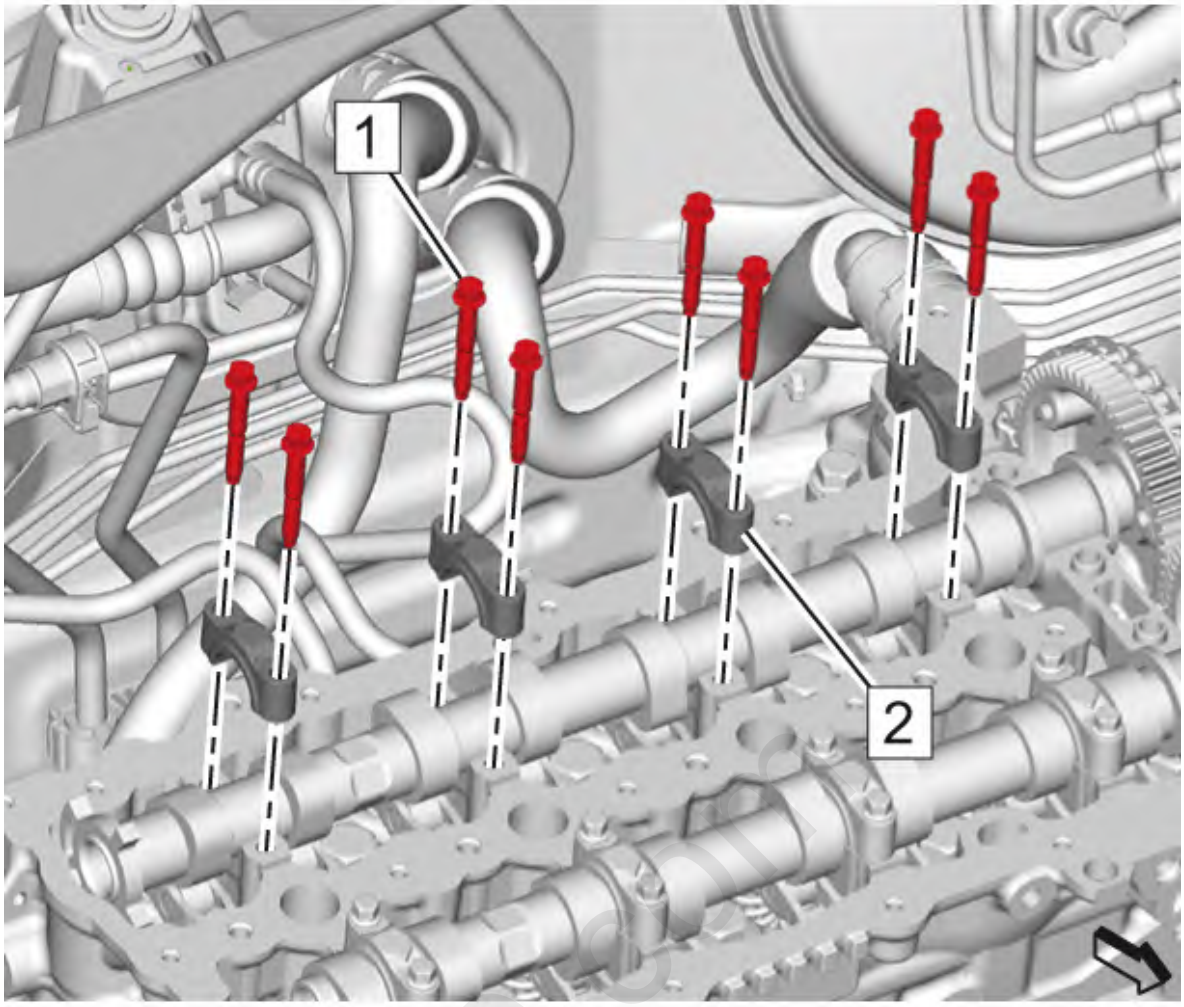


Fig. 326: Intake Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove the 8 intake camshaft bearing cap bolts (1).
14. Remove the 4 intake camshaft bearing caps (2) and lay aside in the order as they were removed.

mcx30.com

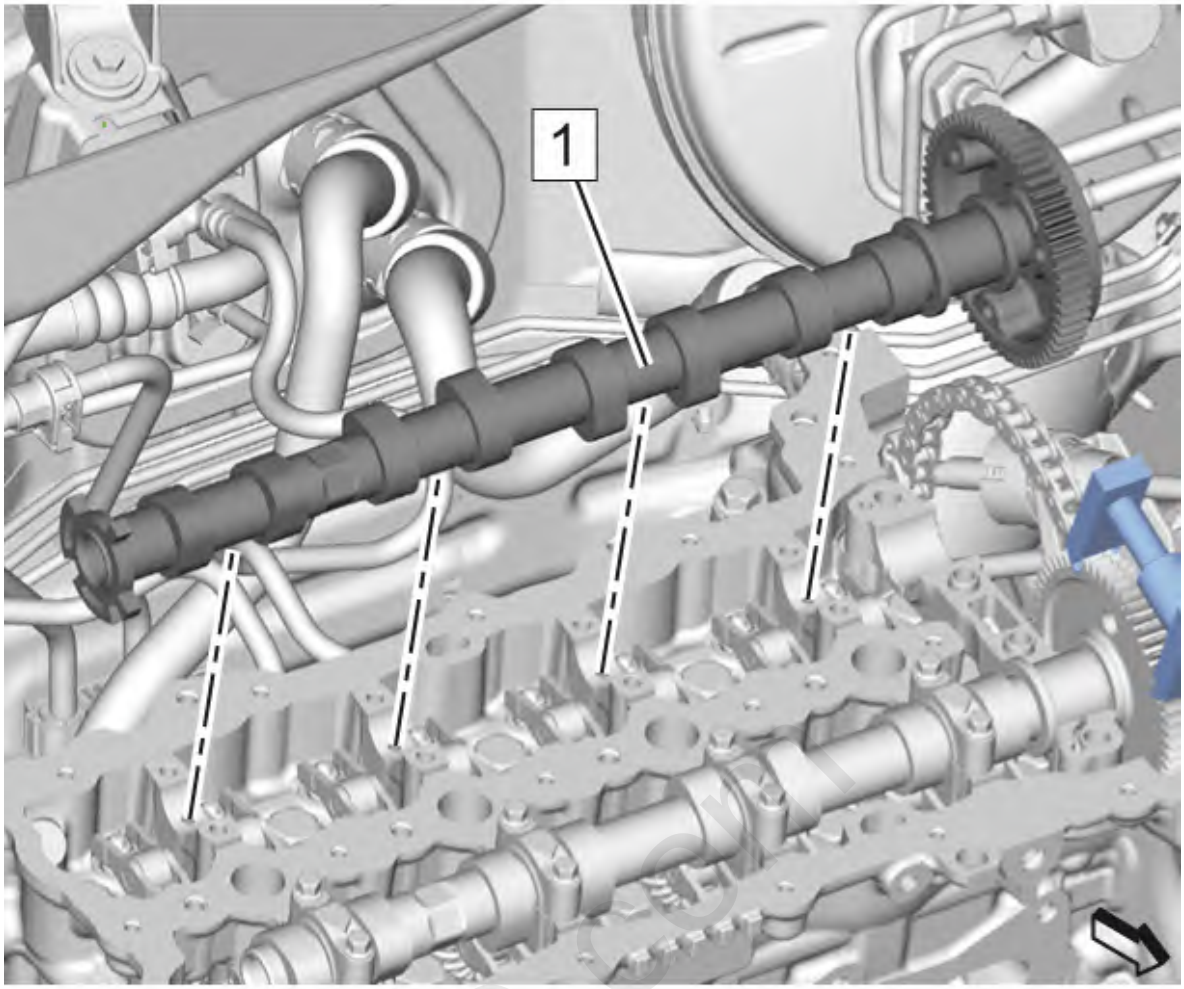


Fig. 327: Intake Camshaft
Courtesy of GENERAL MOTORS COMPANY

15. Remove Intake Camshaft (1)

mcx30.com

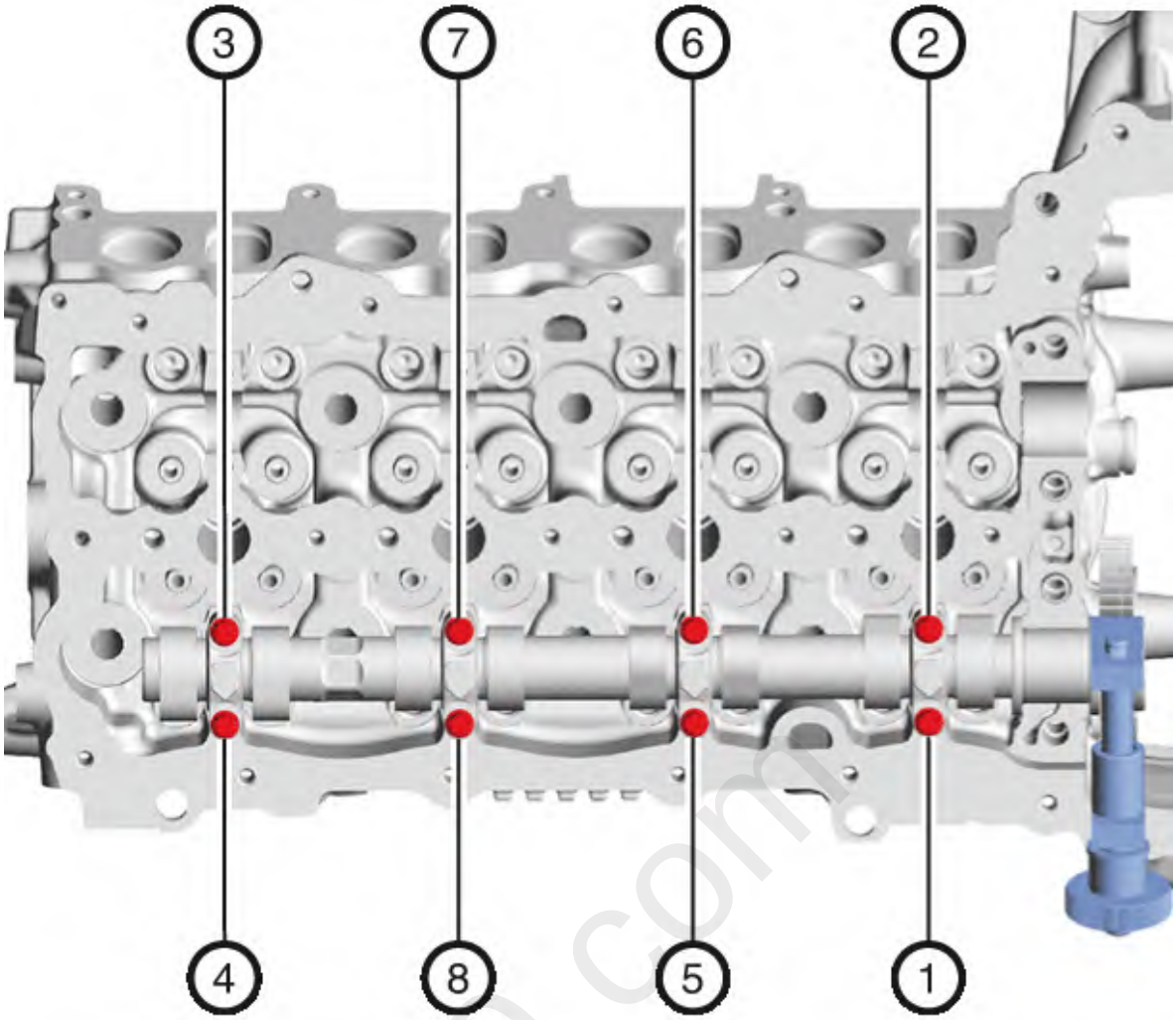


Fig. 328: Exhaust Camshaft Bearing Cap Bolt Loosening Sequence
Courtesy of GENERAL MOTORS COMPANY

16. Loosen the 8 exhaust camshaft bearing cap bolts in sequence as shown.

mcx30.com

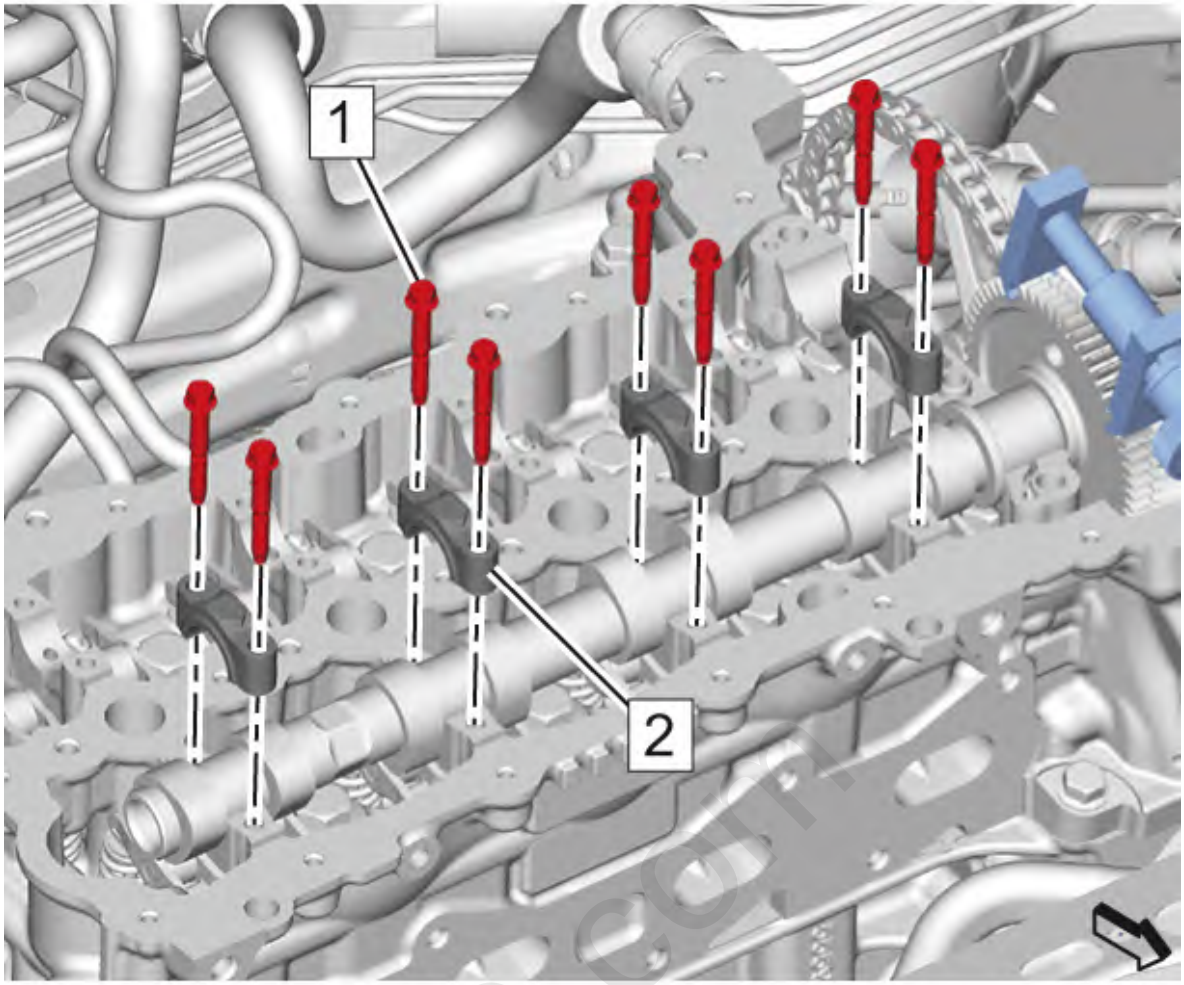


Fig. 329: Exhaust Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

17. Remove the 8 exhaust camshaft bearing cap bolts (1).
18. Remove the 4 exhaust camshaft bearing caps (2) and lay aside in the order as they were removed.

mcx30.com

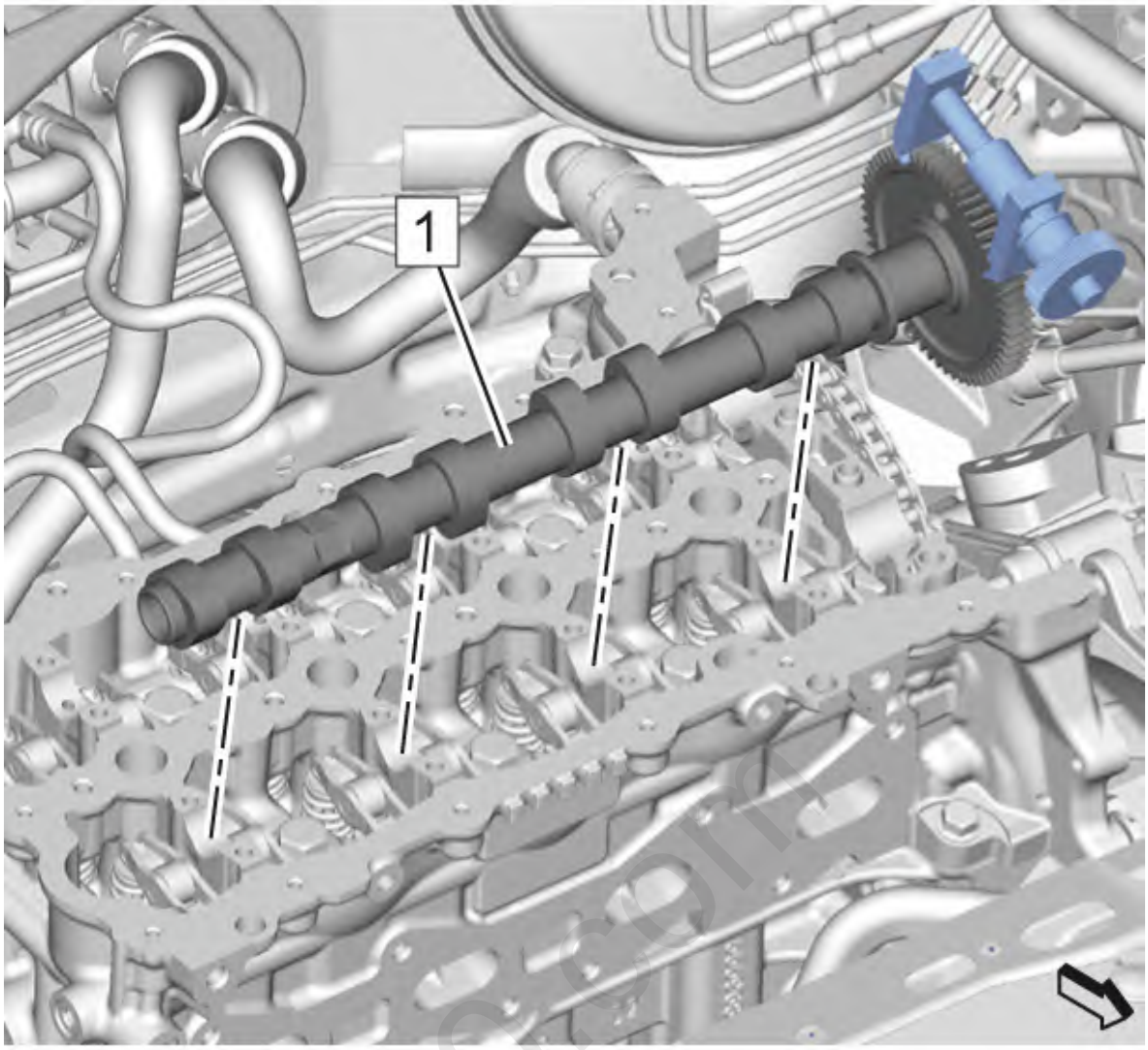


Fig. 330: Exhaust Camshaft With Bore Of Camshaft Sprocket Upwards
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not remove the EN-50509 fixing tool.**

19. Remove Exhaust Camshaft (1)

mcx8.com

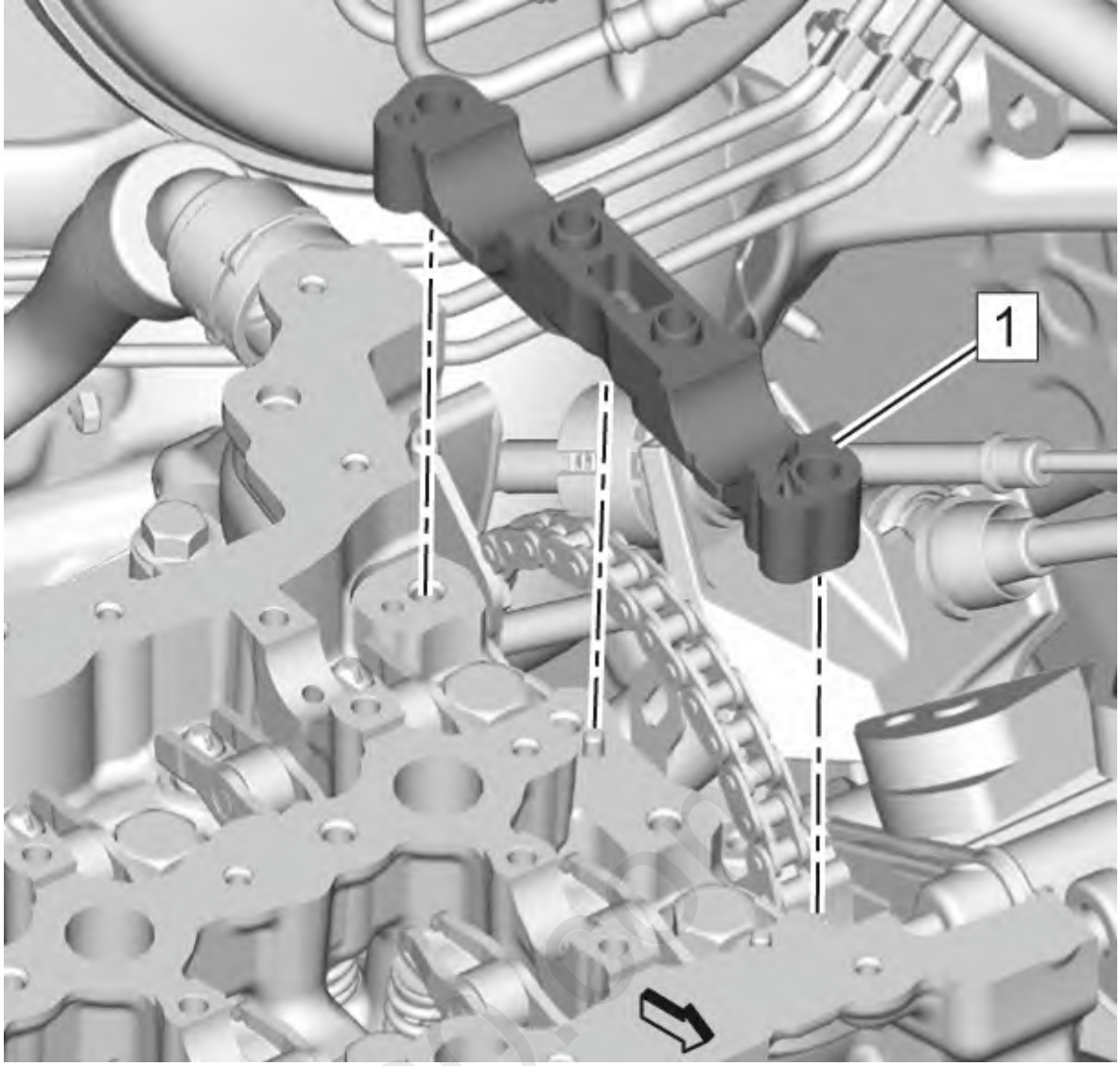


Fig. 331: Bearing Bracket
Courtesy of GENERAL MOTORS COMPANY

20. Remove the bearing bracket (1).

mcx30.com

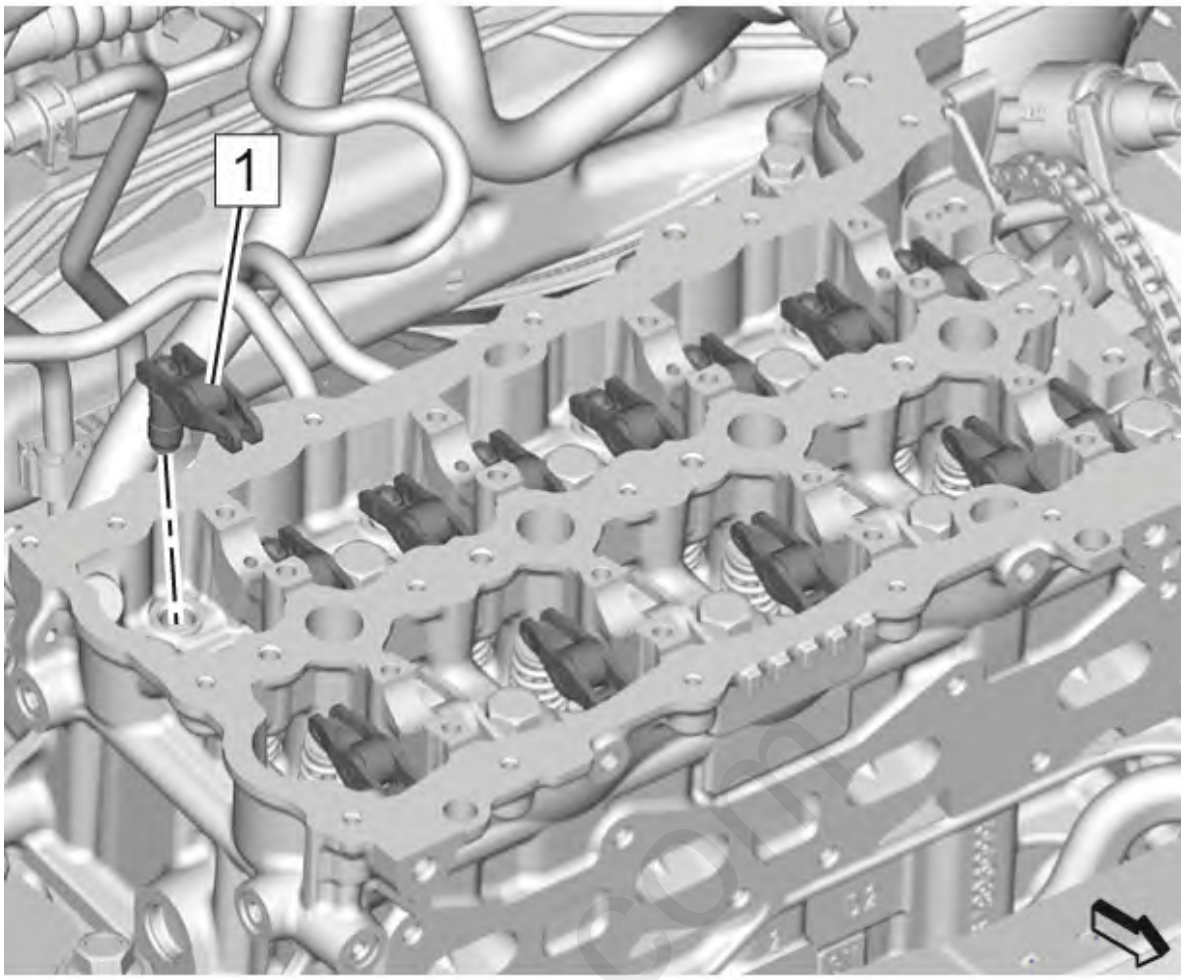


Fig. 332: Valve Lifter Roller Assemblies
Courtesy of GENERAL MOTORS COMPANY

21. Remove the 16 valve lifter with valve lifter roller (1) and lay aside in the order as they was removed.

mcx30.com

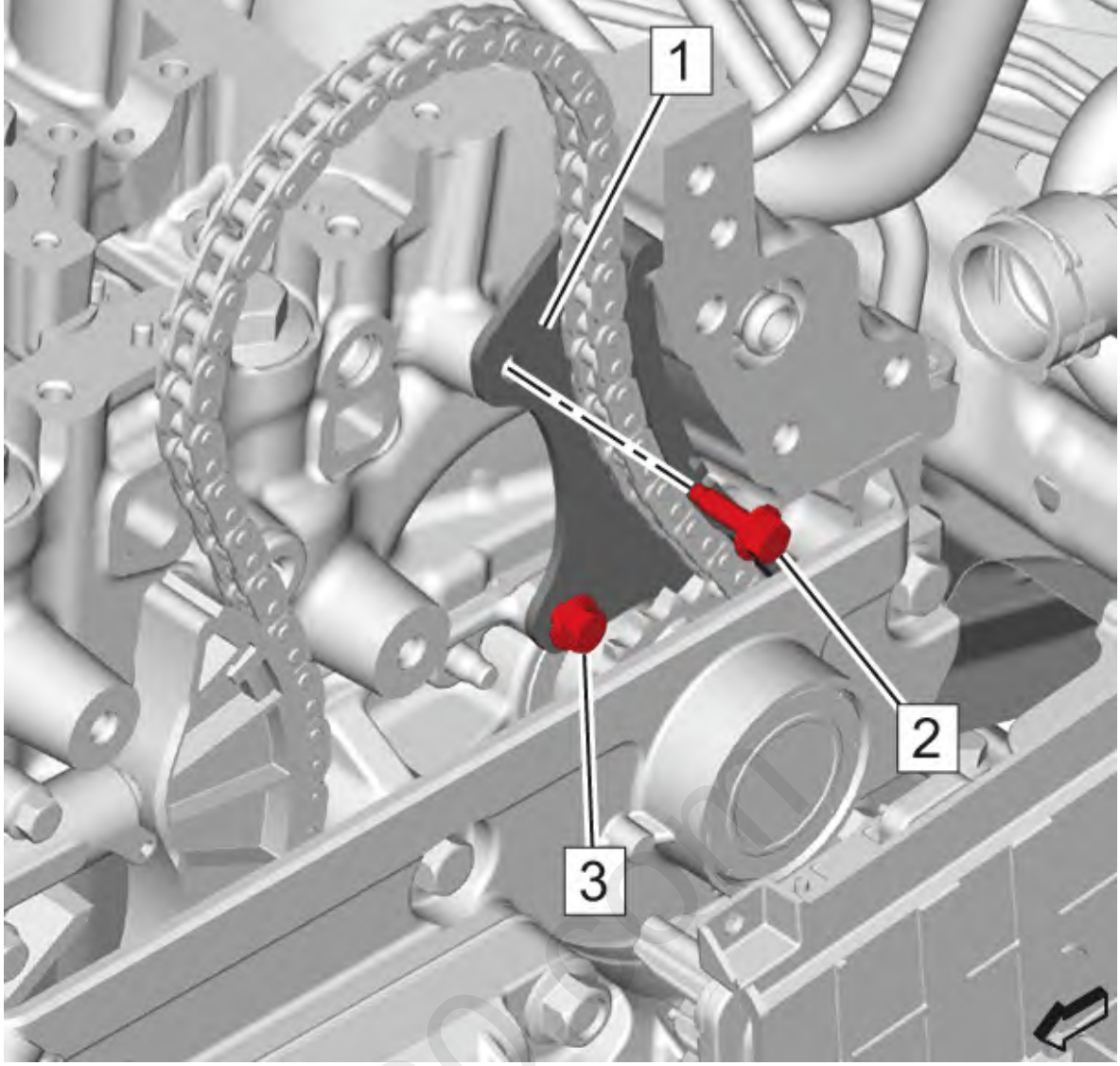


Fig. 333: Upper Timing Chain Upper Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

22. Remove the upper timing chain upper guide bolt (2).
23. Loosen the timing chain upper guide (1) by loosen the lower bolt (3).

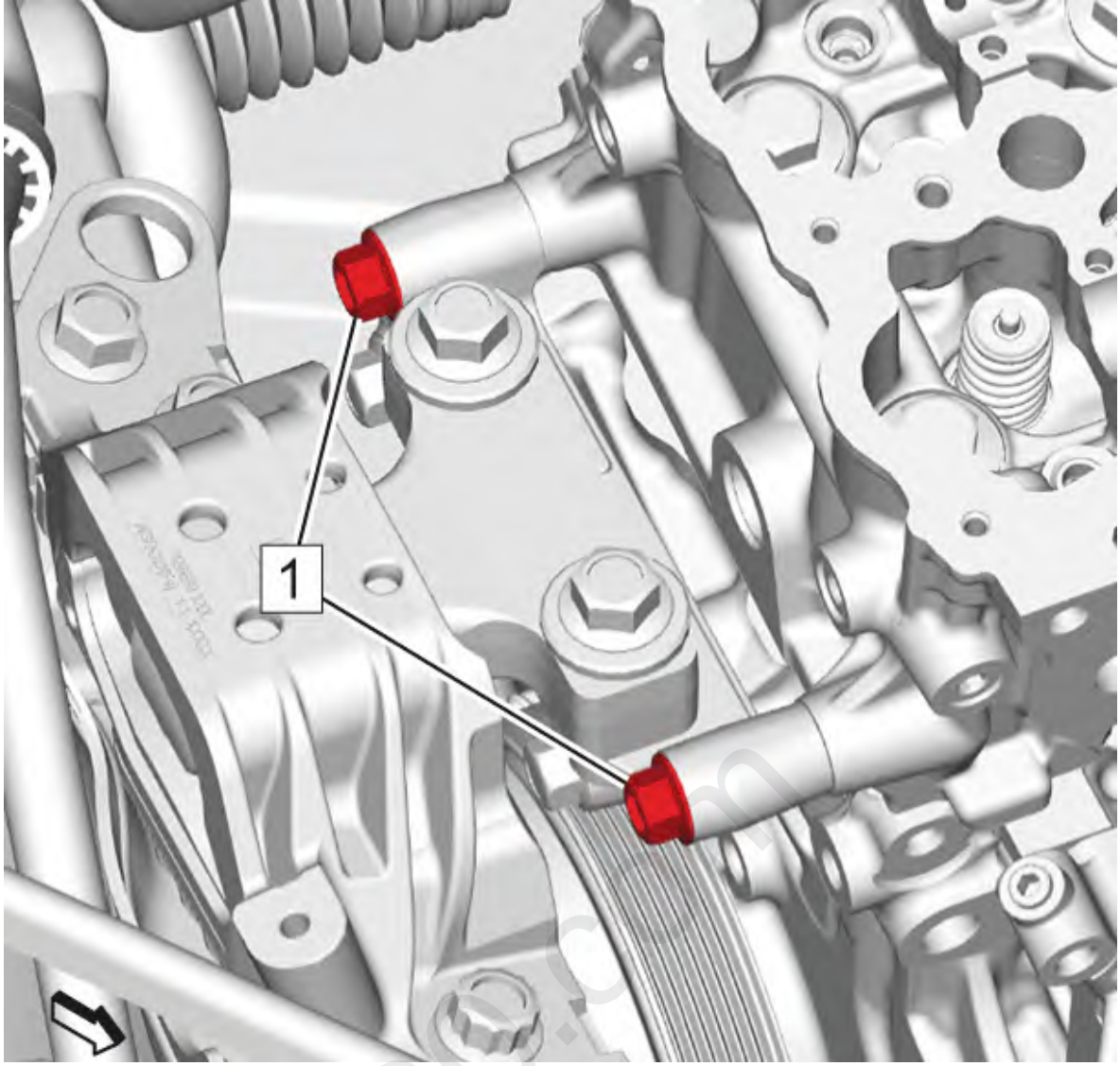


Fig. 334: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

24. Remove Engine Mount Bracket Bolts (1) (Qty: 2)

mcx30.com

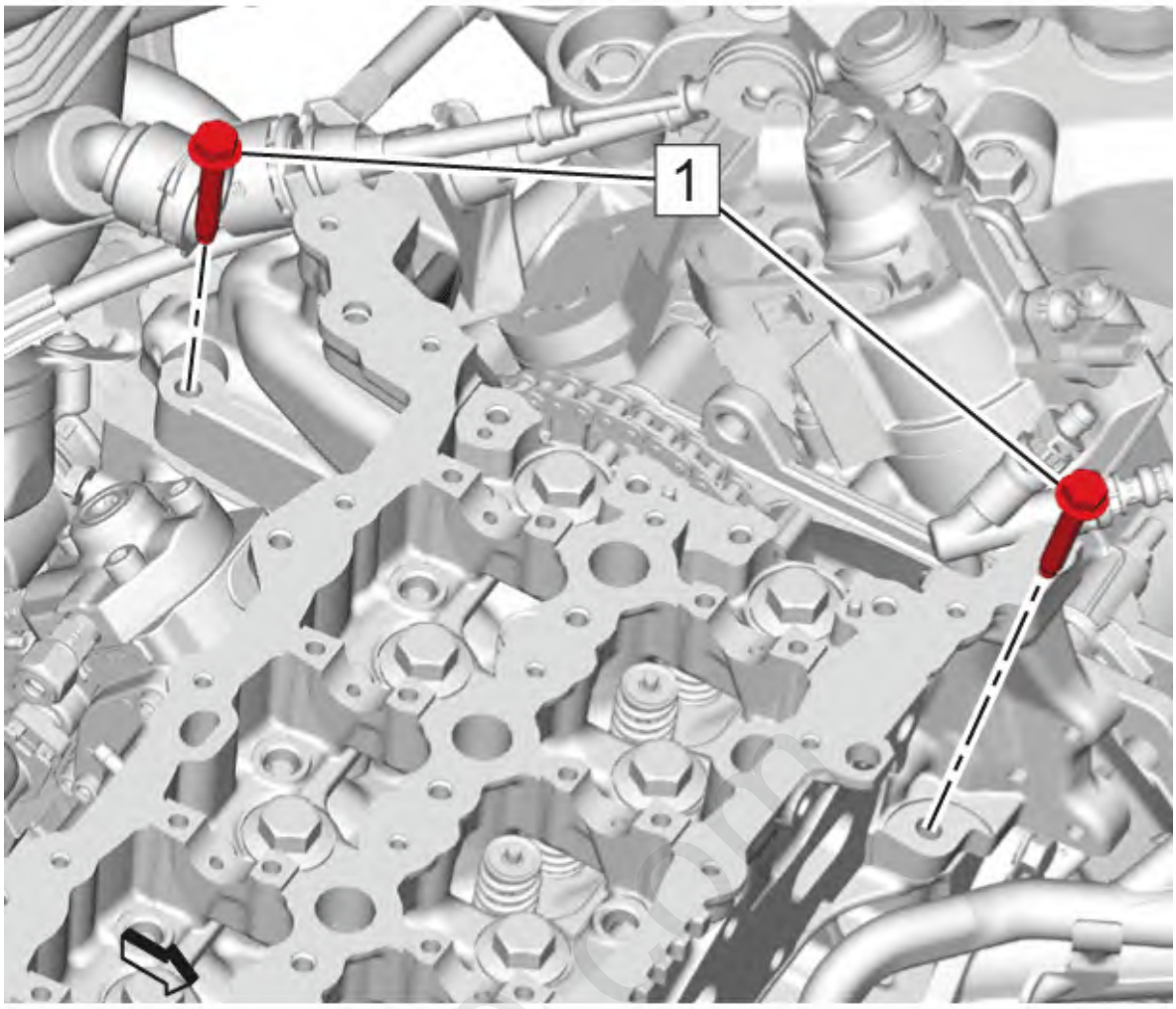


Fig. 335: Outer Cylinder Head Bolts
Courtesy of GENERAL MOTORS COMPANY

25. Remove and DISCARD the 2 outer cylinder head bolts (1).

mcx30.com

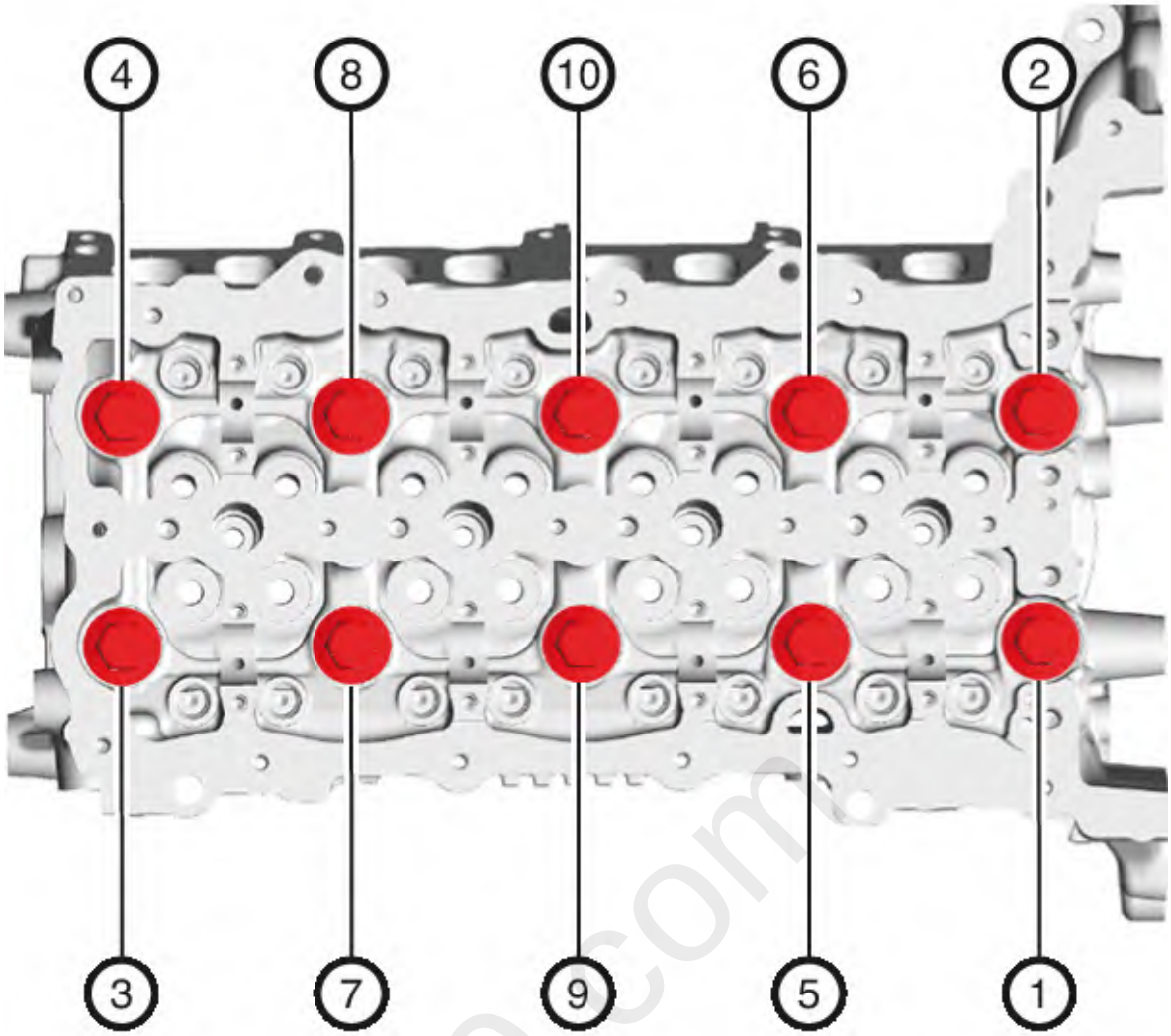


Fig. 336: Cylinder Head Bolt Loosening Sequence
Courtesy of GENERAL MOTORS COMPANY

26. Loosen the 10 cylinder head bolts in sequence as shown step by step.

mcx30.com

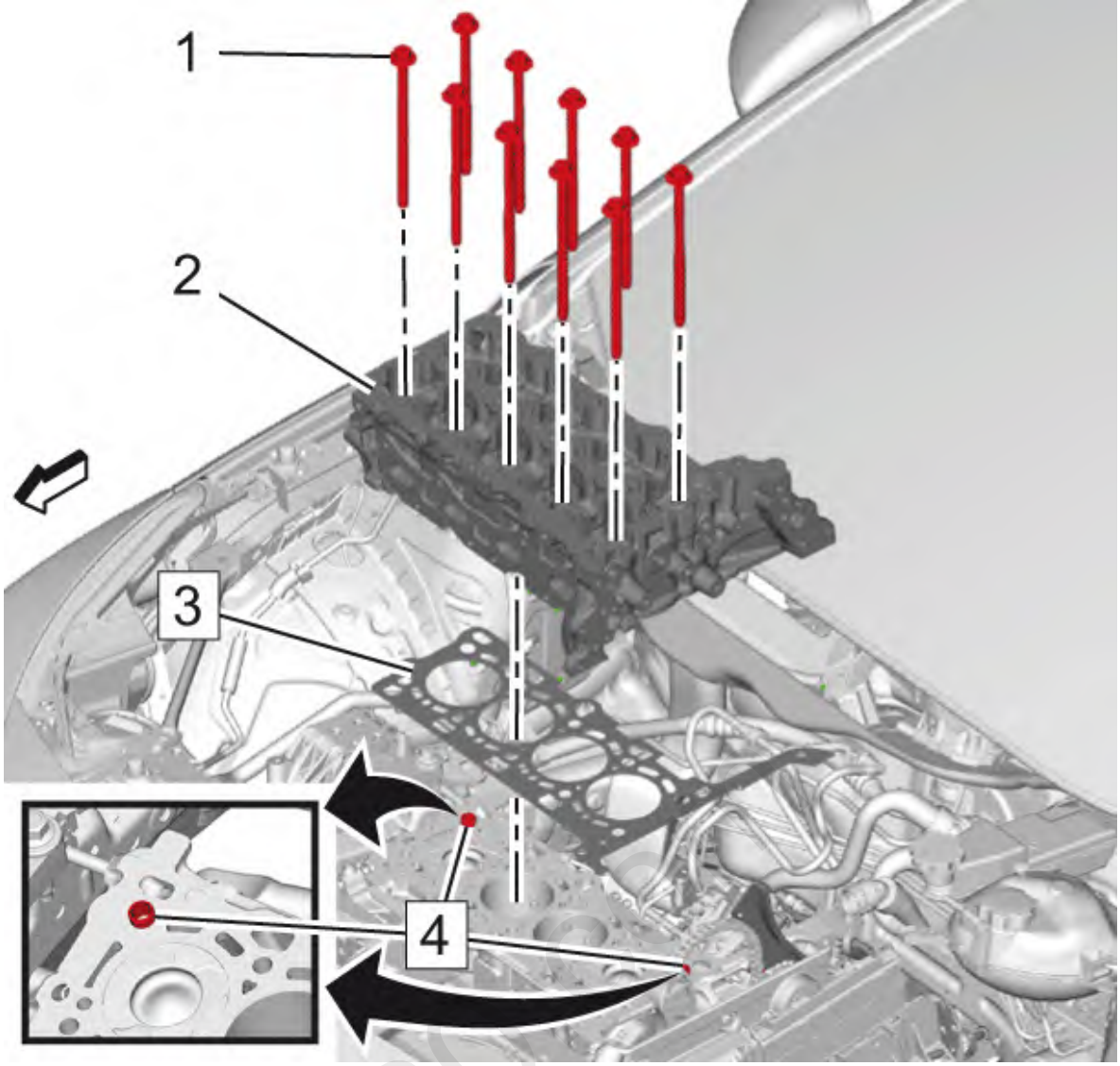


Fig. 337: Cylinder Head, Bolts, Gasket And Guide Sleeves
Courtesy of GENERAL MOTORS COMPANY

27. Remove and DISCARD Cylinder Head Bolts (1) (Qty: 10)

NOTE: **Ensure the guide sleeves (4) are properly seated in the engine block.**

28. Remove Cylinder Head (2)
29. Remove and DISCARD Cylinder Head Gasket (3)
30. Disassemble the cylinder head. Refer to Cylinder Head Disassemble

Installation Procedure

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.**
- **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.**

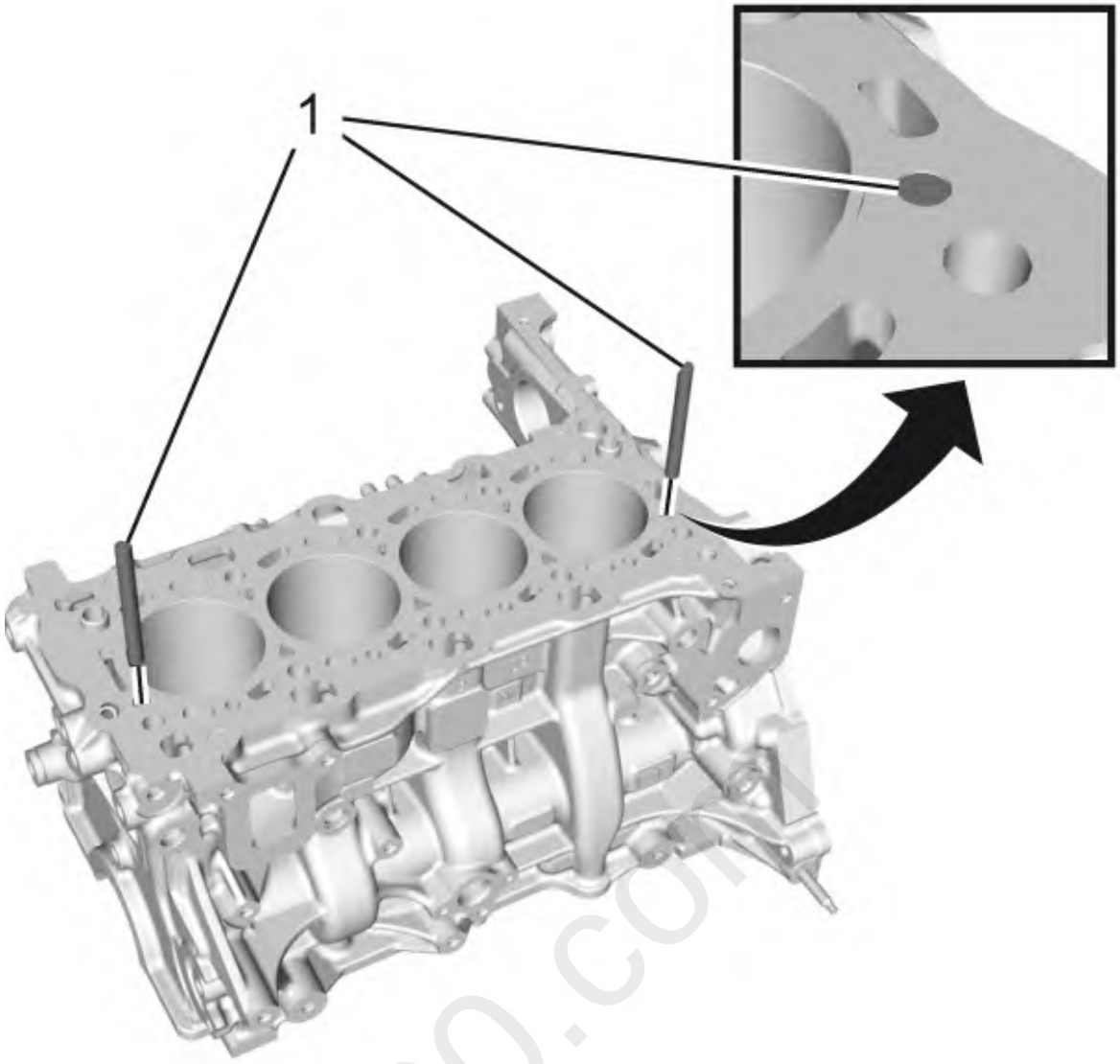


Fig. 338: Deflectors
Courtesy of GENERAL MOTORS COMPANY

1. Check that the 2 deflectors (1) are installed in the engine block and install 2 NEW deflectors if the deflectors are missing.

NOTE: **Ensure that the cylinder head and the cylinder block sealing surfaces are clear of oil, grease and old gasket material.**

2. Clean all sealing surfaces.
3. Inspect the flatness of the cylinder head and cylinder block sealing surfaces.
4. Assemble Cylinder Head. Refer to **Cylinder Head Assemble**.

mcx30.com

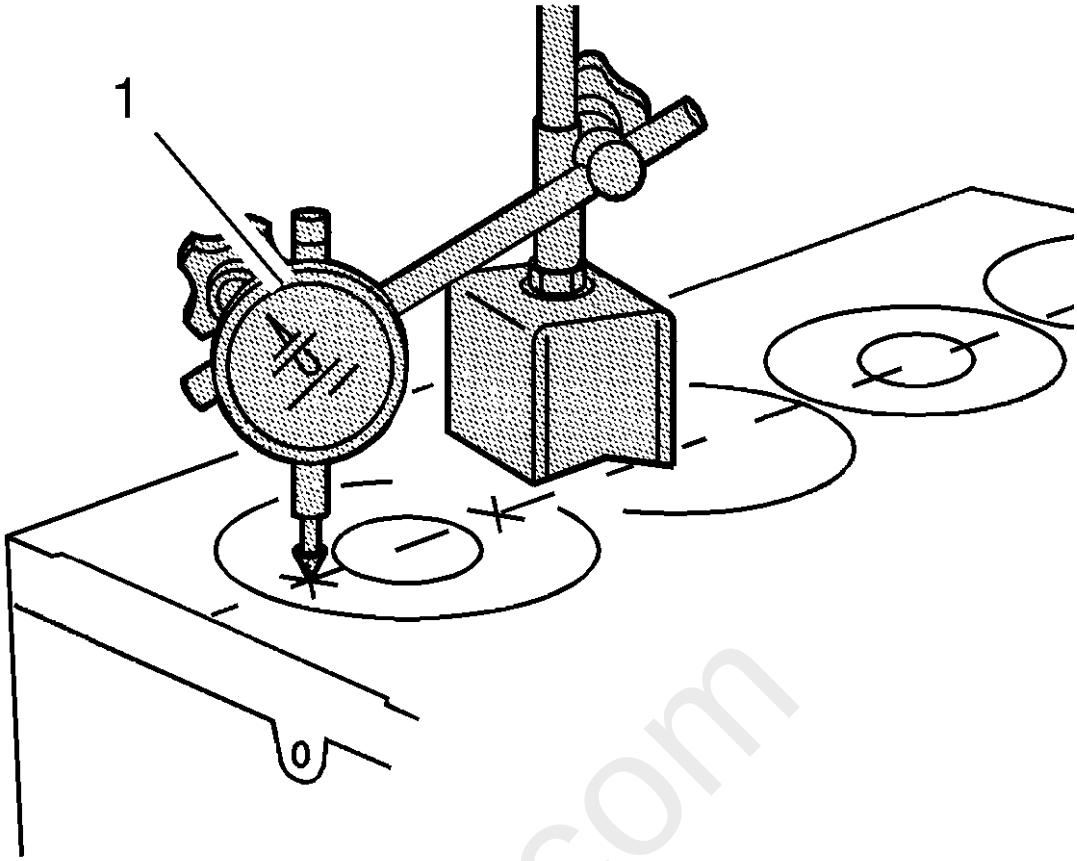


Fig. 339: Indicator
Courtesy of GENERAL MOTORS COMPANY

NOTE: **For the measurement, the piston has to stay on TDC. Measure the piston projection dimensions at all pistons.**

5. Install the **GE-7872** indicator (1).
6. Measure the piston projection of the cylinder 1 and the cylinder 4.

mox30.com

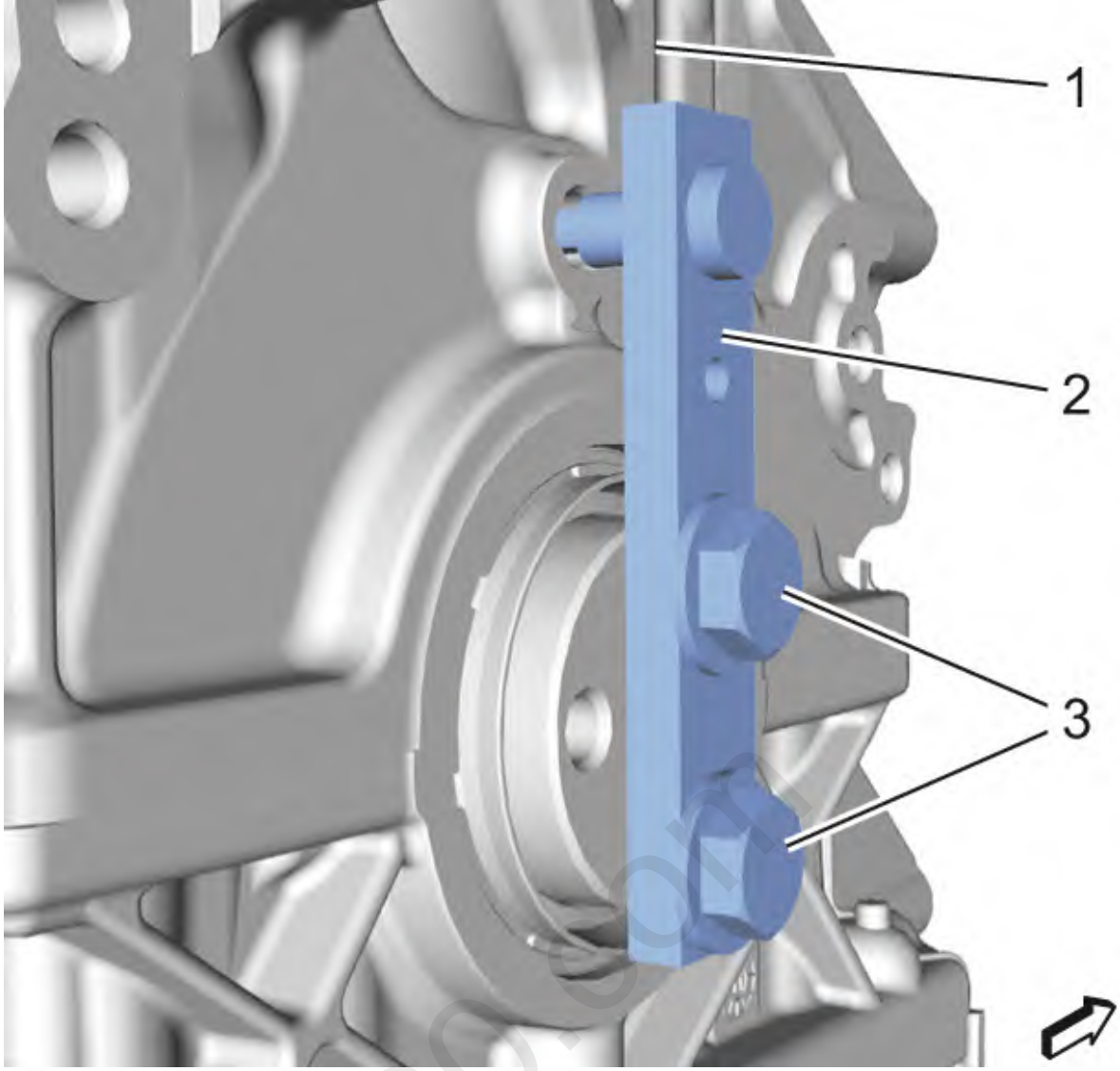


Fig. 340: Crankshaft Fixing Tool And Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove Bolts (3) (Qty: 2)
8. Remove the **EN-51140** fixing tool (2).

mcx30.com

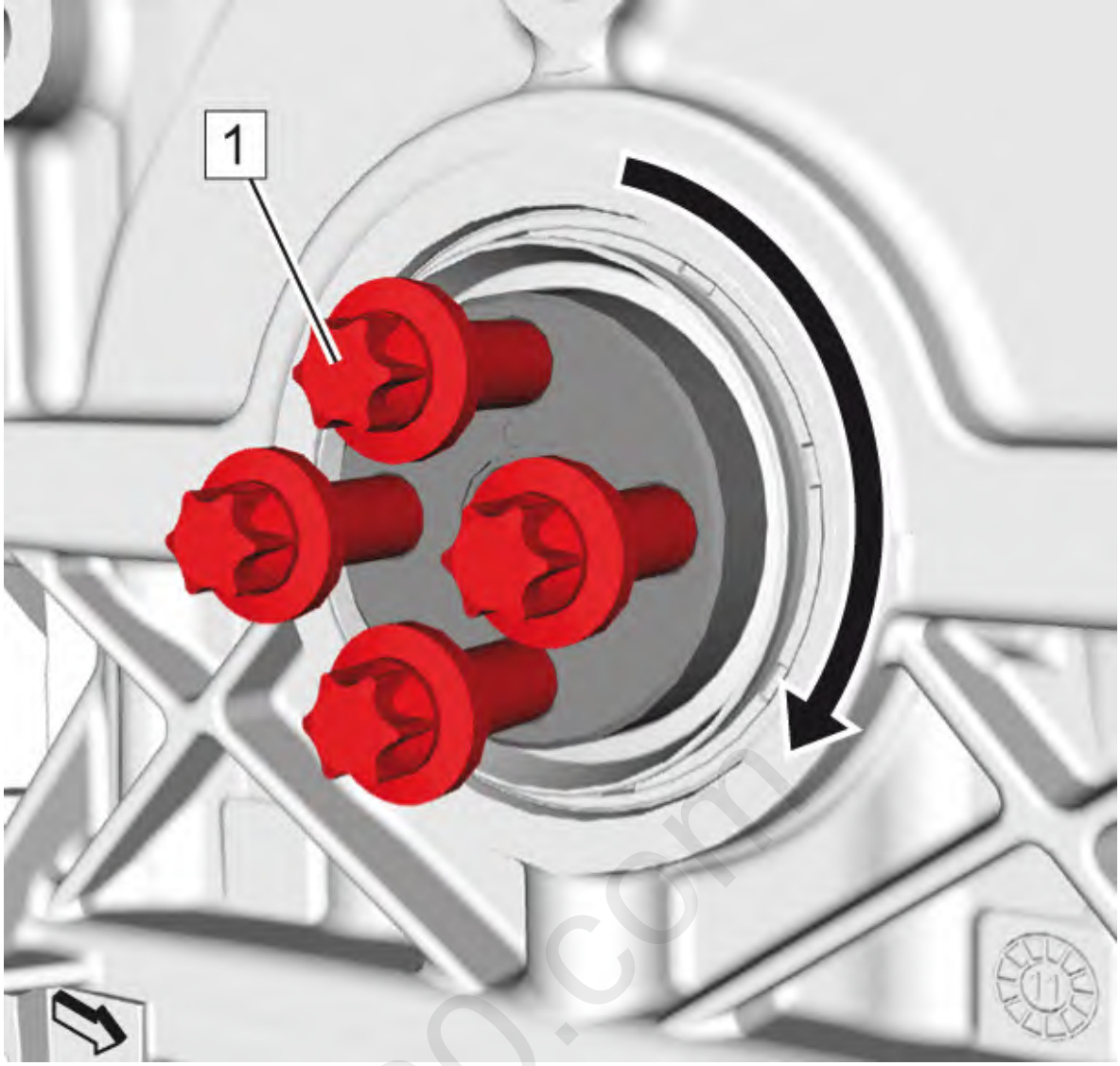


Fig. 341: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Install Crankshaft Pulley Bolts (1) (Qty: 4)

mcx30.com

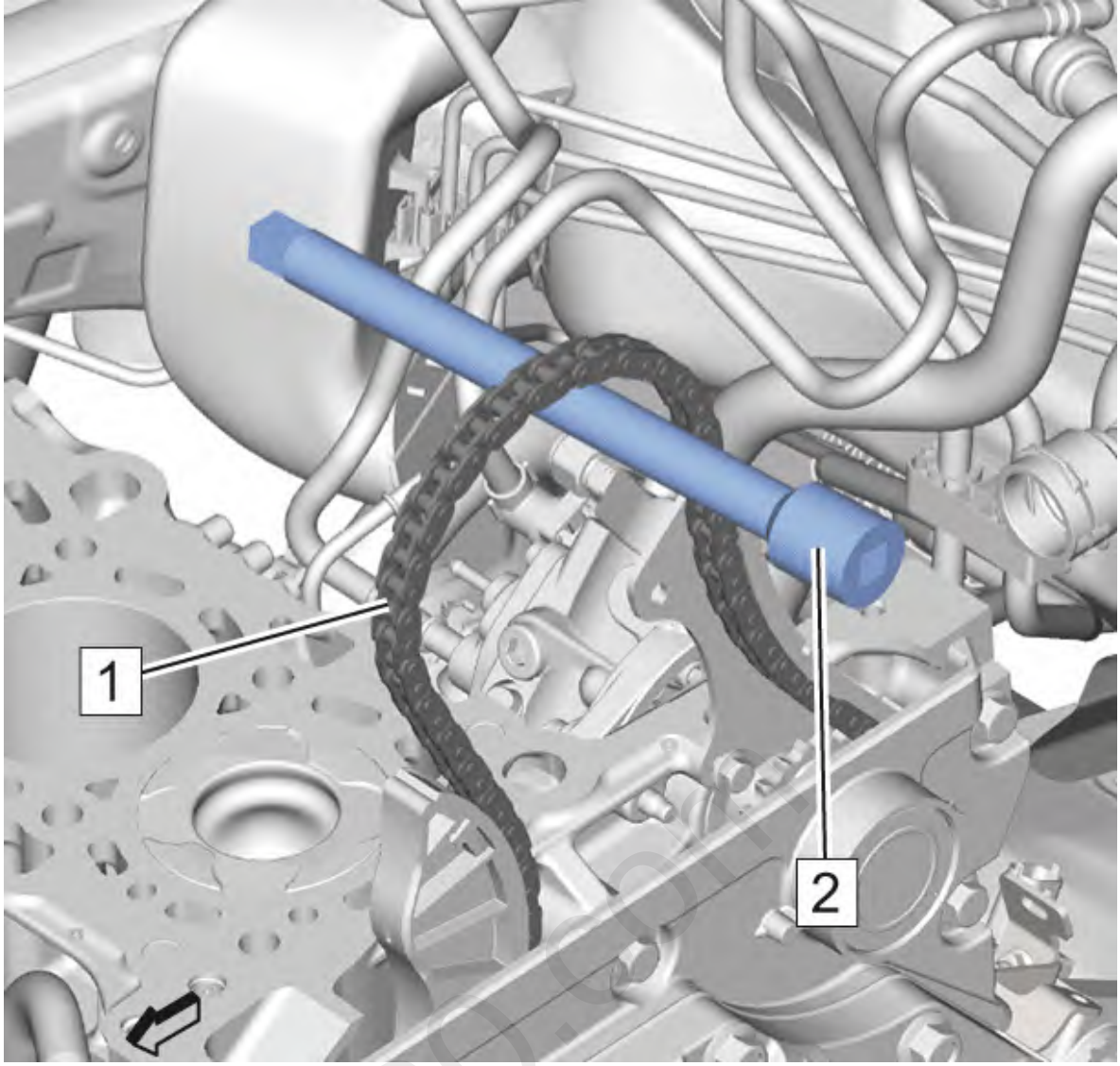


Fig. 342: Timing Chain And Suitable Tool
Courtesy of GENERAL MOTORS COMPANY

10. Hold the timing chain (1) up with a suitable tool like an extension (2).

NOTE: **A second technician is required.**

11. Rotate the crankshaft 180 degrees, use a pry bar at the 4 crankshaft pulley bolts.
12. Measure the piston projection of the cylinder 2 and the cylinder 3.
13. Rotate the crankshaft 180 degrees

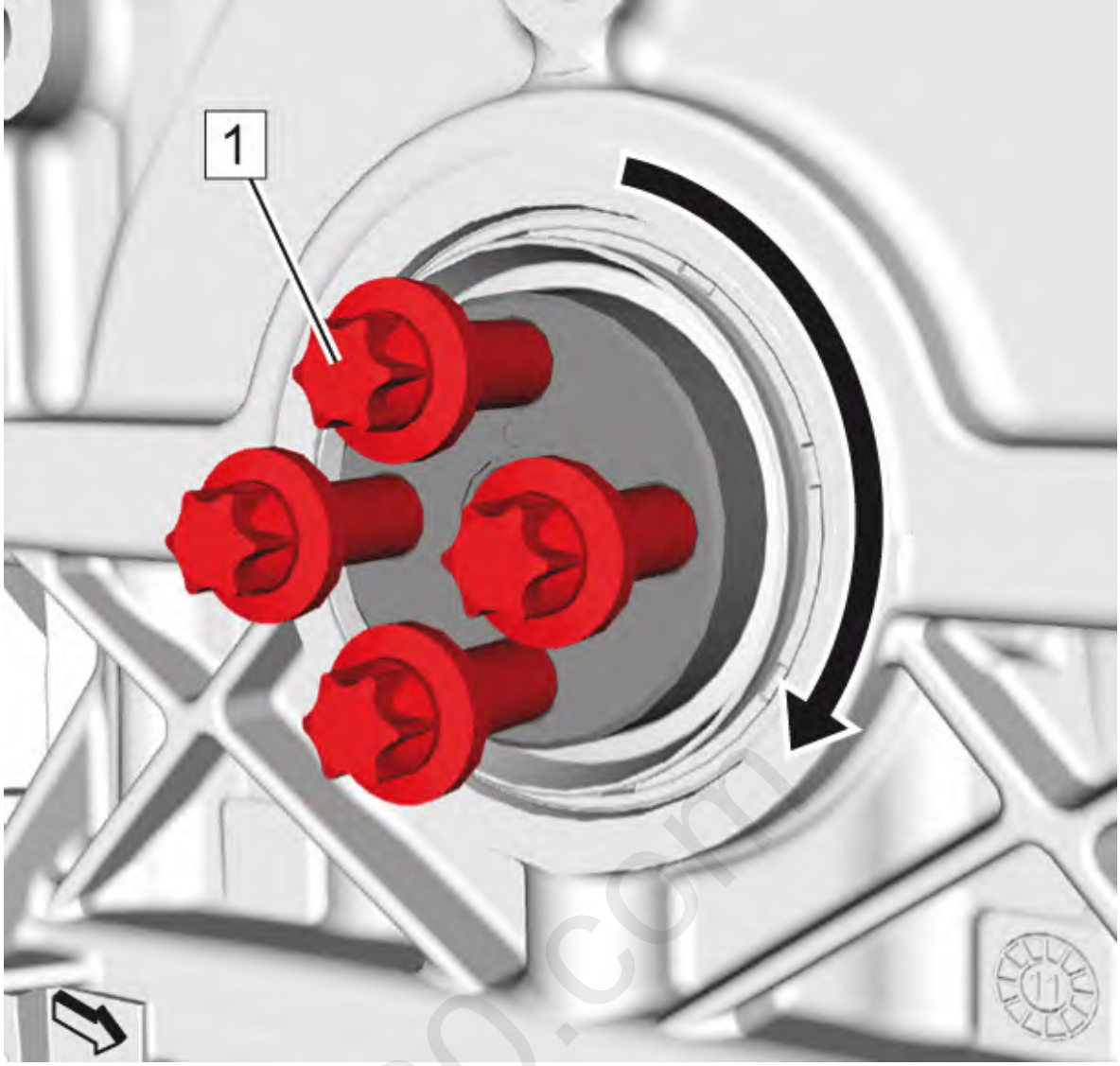


Fig. 343: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

14. Remove Crankshaft Pulley Bolts (1) (Qty: 4)

mcx30.com

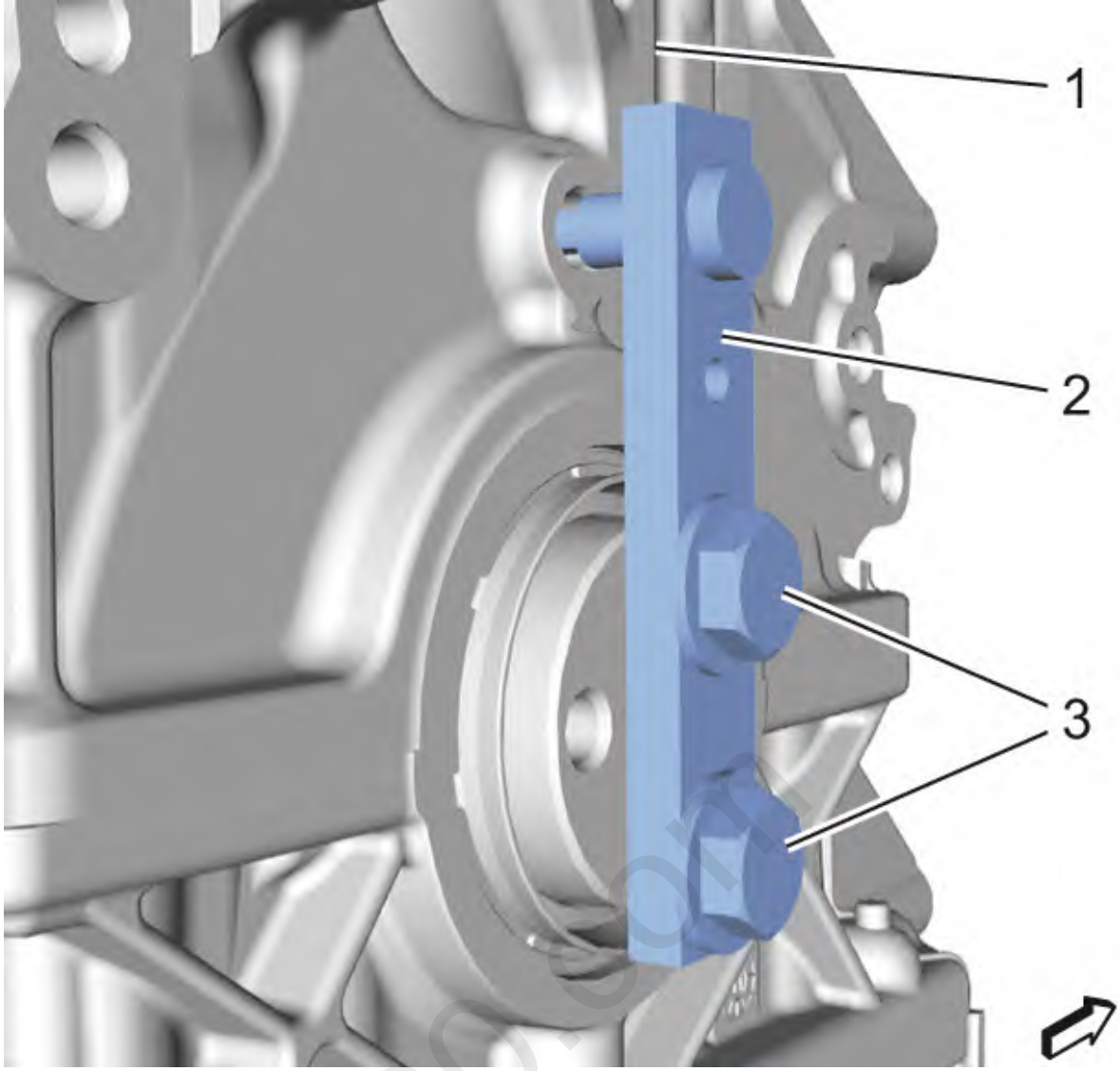


Fig. 344: Crankshaft Fixing Tool And Bolts
Courtesy of GENERAL MOTORS COMPANY

15. Install the **EN-51140** fixing tool (2).
16. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).

mcx30.com

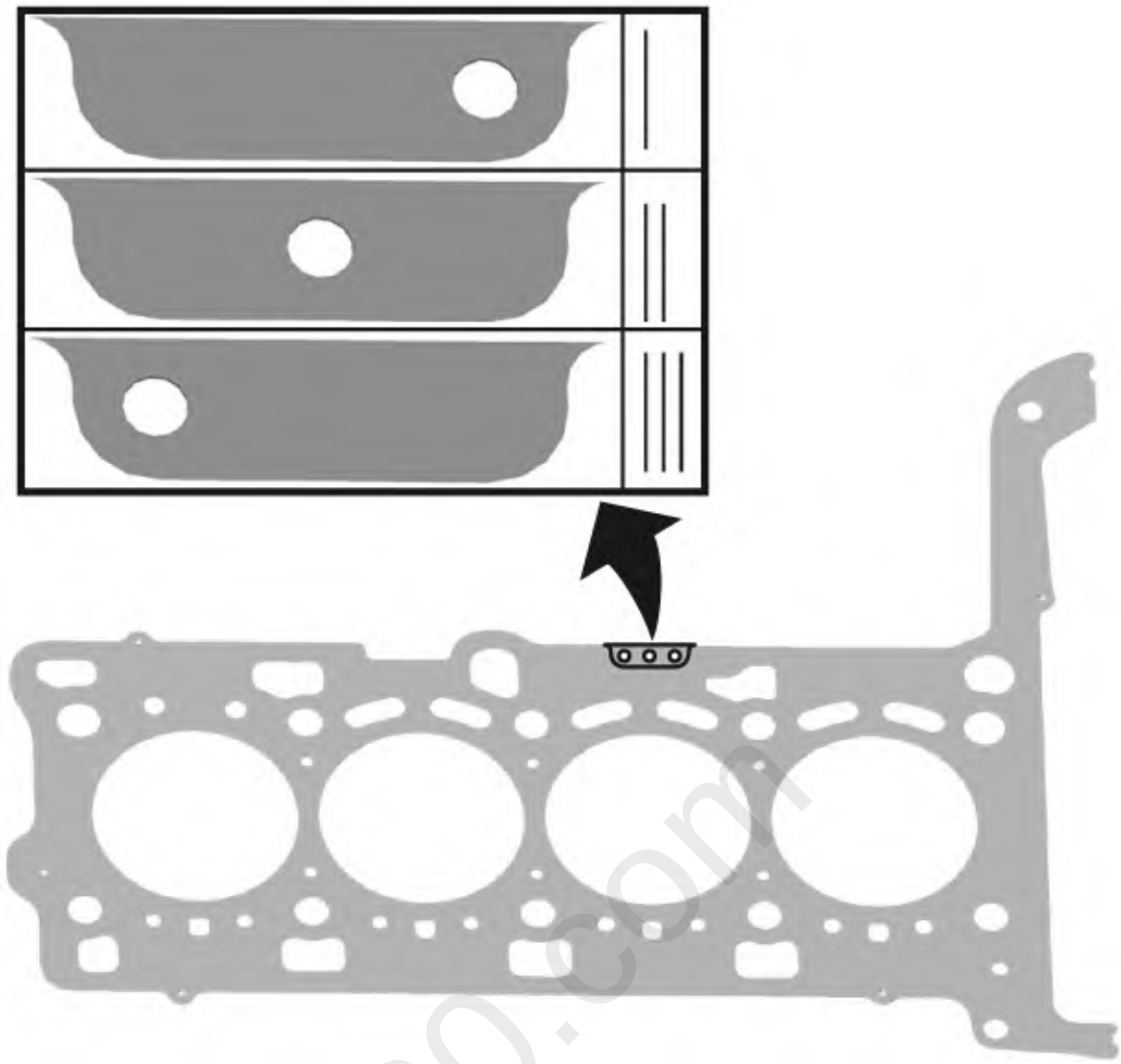


Fig. 345: Cylinder Head Gasket Identification Marks
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The largest piston projection is decisive for the selection of the cylinder head gasket with the corresponding marking. The different between the three max. projection measurements must be no greater than 0.1 mm (0.0039 in).**

17. Select the cylinder head gasket with the correct identification marks (1):
    1. Piston projection 0.440 - 0.535 mm (0.0173 - 0.0211 in), choose cylinder head gasket with identification mark on Position I, thickness 1.25 mm (0.049 in).
    2. Piston projection 0.535 - 0.630 mm (0.0211 - 0.0248 in), choose cylinder head gasket with identification mark on Position II, thickness 1.35 mm (0.053 in).
    3. Piston projection 0.630 - 0.725 mm (0.0248 - 0.0285 in), choose cylinder head gasket with identification mark on Position III, thickness 1.45 mm (0.057 in).

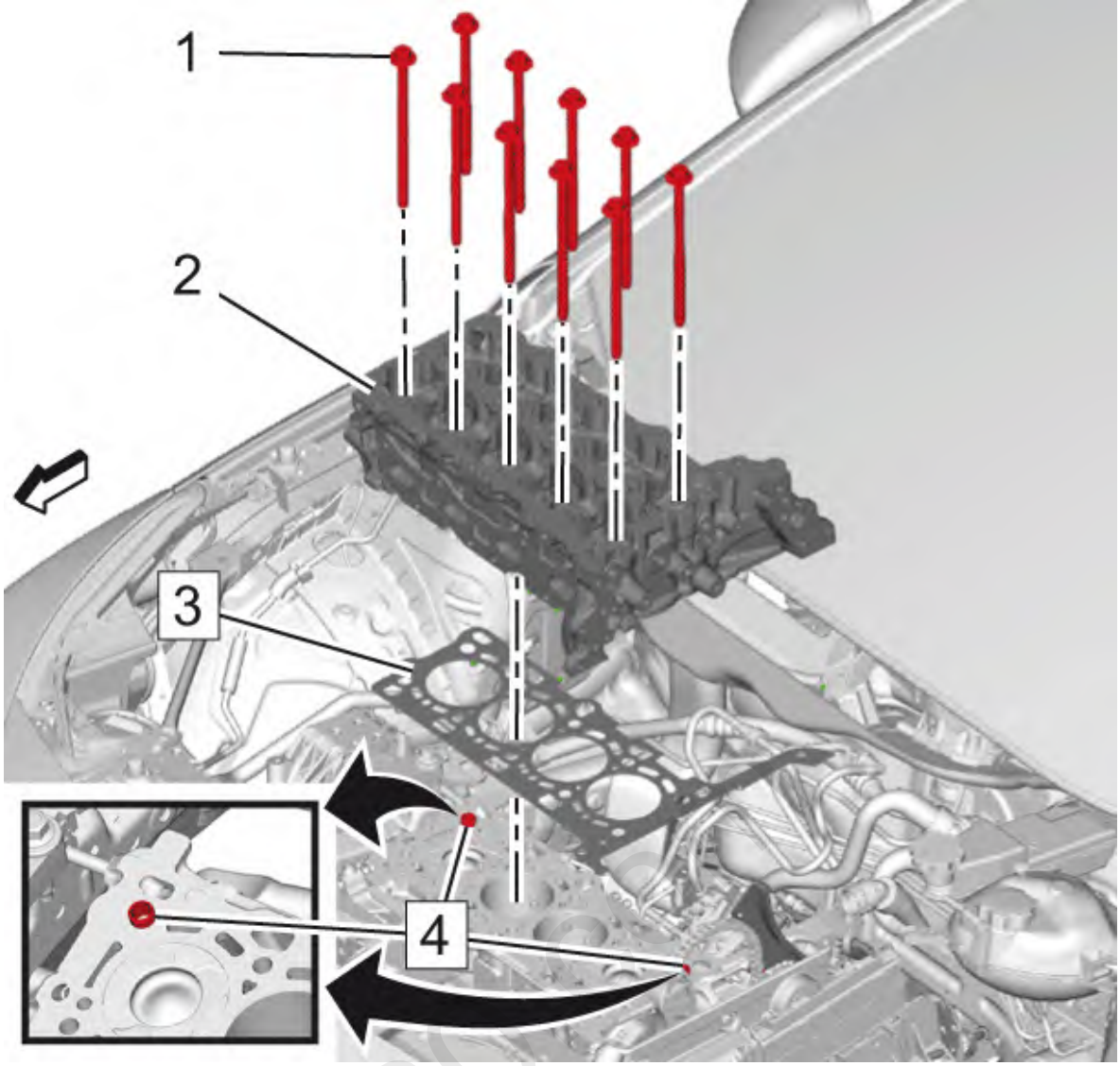


Fig. 346: Cylinder Head, Bolts, Gasket And Guide Sleeves
Courtesy of GENERAL MOTORS COMPANY

18. Install NEW Cylinder Head Gasket (3)
19. Install Cylinder Head (2)
20. Install NEW Cylinder Head Bolts (1) (Qty: 10) - Do NOT tighten.

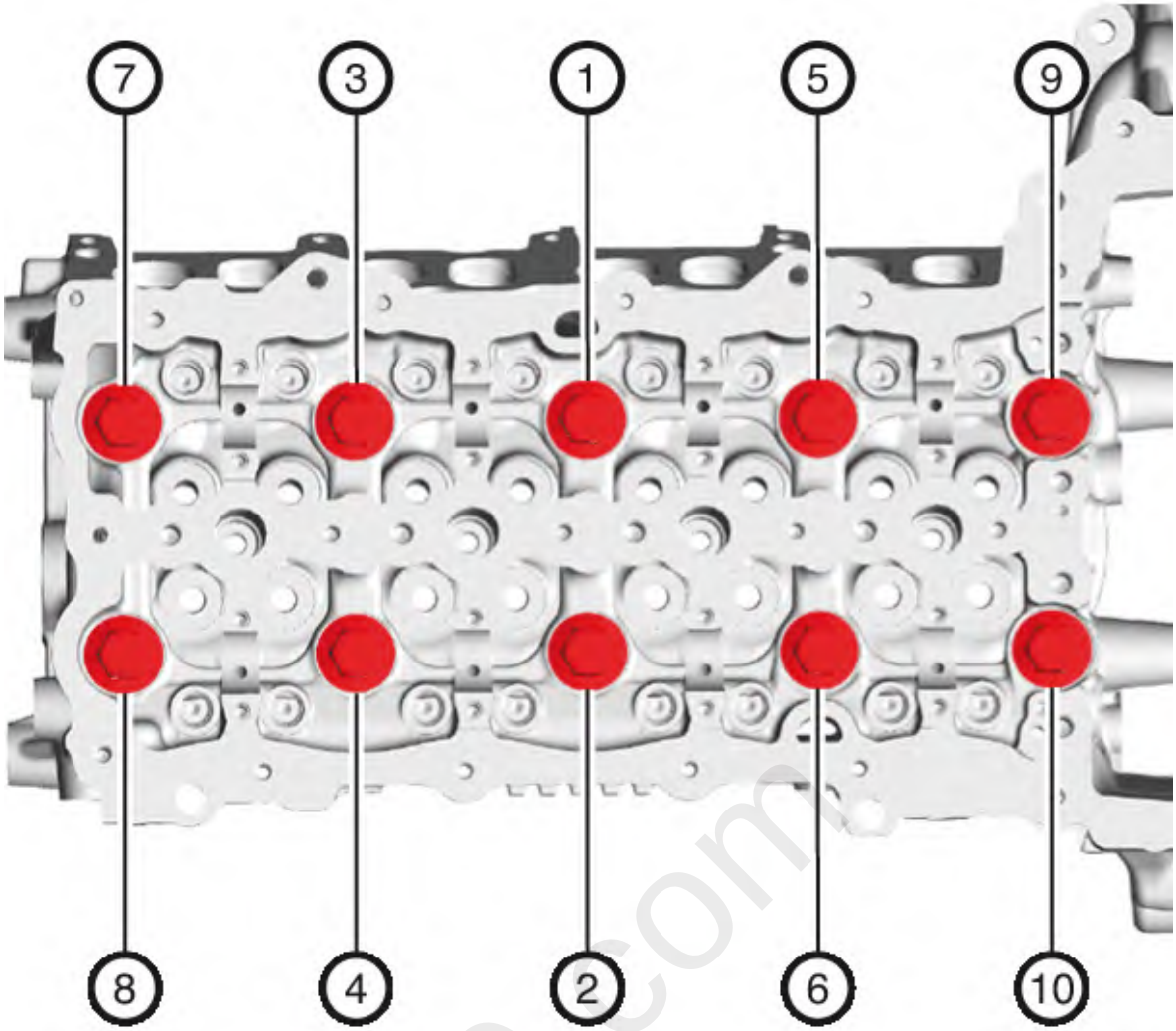


Fig. 347: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

21. Tighten Cylinder Head Bolts in sequence

CAUTION: **Refer to Fastener Caution**

CAUTION: **Refer to Torque-to-Yield Fastener Caution**

1. First Pass: 50 N.m (37 lb ft)
2. Second Pass: 90 degrees - Use the special tool: **EN-45059** angle meter
3. Third Pass: 90 degrees - Use the special tool: **EN-45059** angle meter
4. Final Pass: 90 degrees - Use the special tool: **EN-45059** angle meter

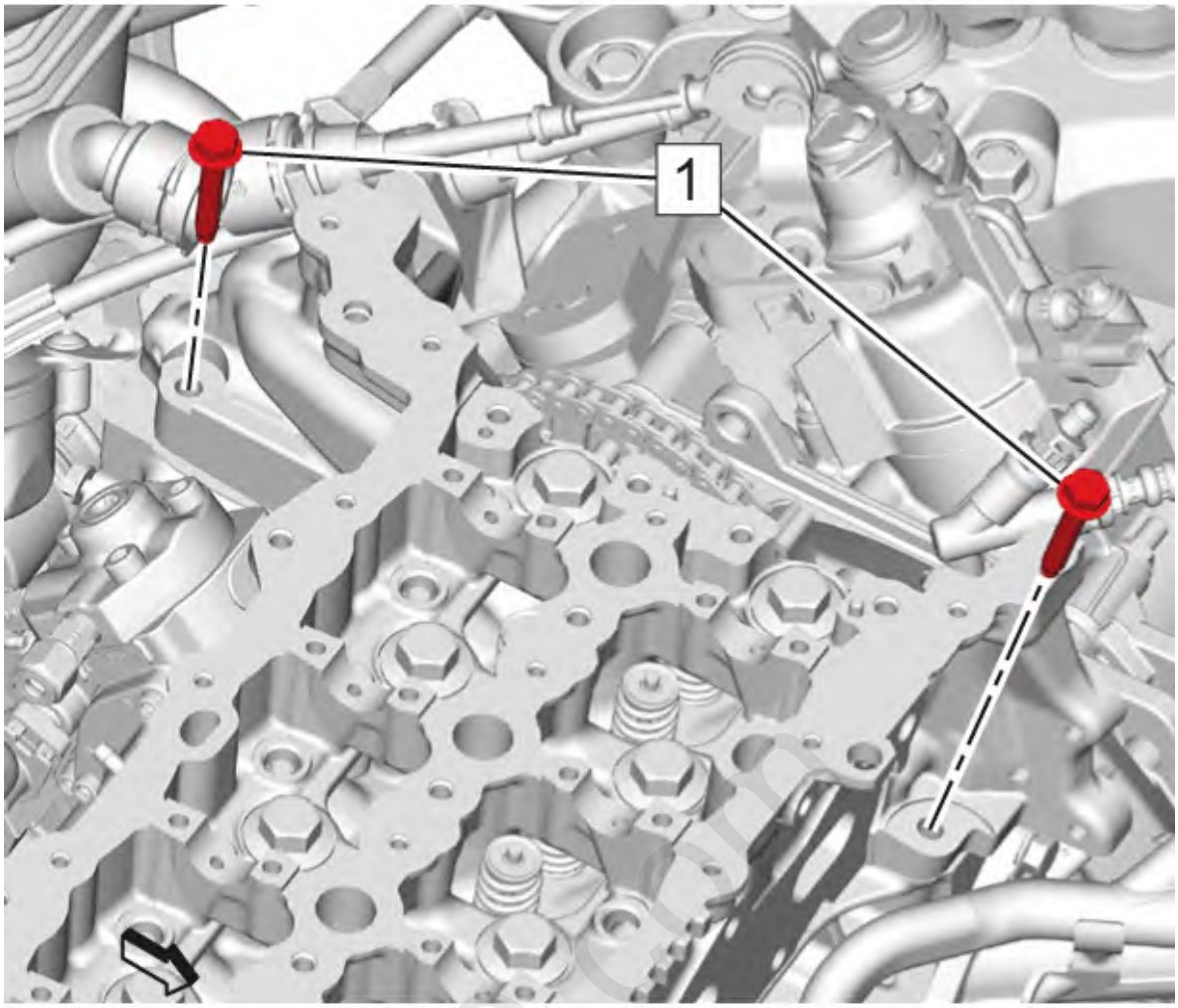


Fig. 348: Outer Cylinder Head Bolts
Courtesy of GENERAL MOTORS COMPANY

22. Install the NEW 2 cylinder head outer bolts (1) and tighten in 2 passes:

CAUTION: **Refer to Torque-to-Yield Fastener Caution**

1. First Pass: 20 N.m (15 lb ft)
2. Final Pass: 45 degrees - Use the special tool: **EN-45059** angle meter

mcx30.com

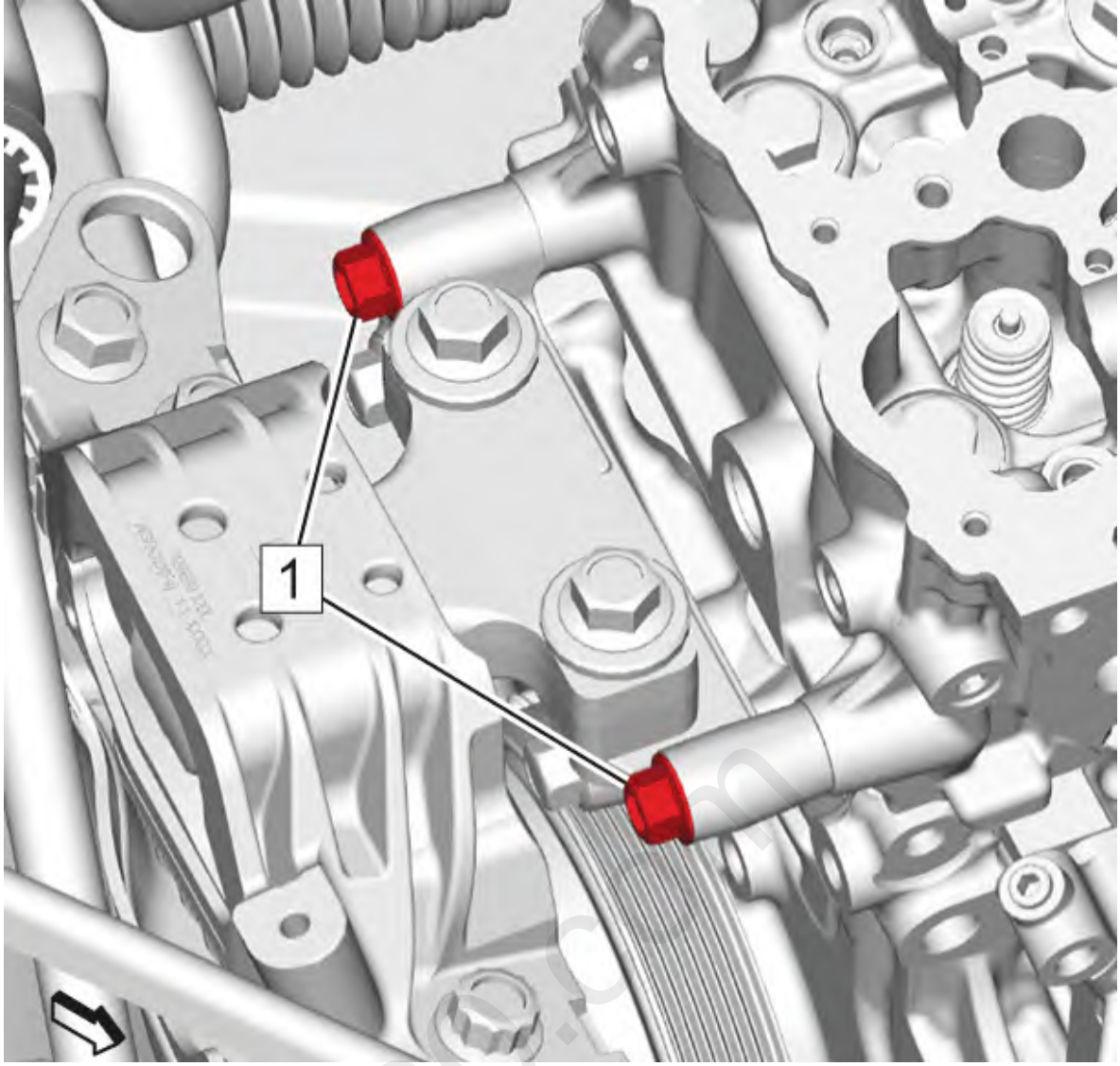


Fig. 349: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

23. Install and tighten Engine Mount Bracket Bolts (1) (Qty: 2) to 62 N.m (46 lb ft)

mcx30.com

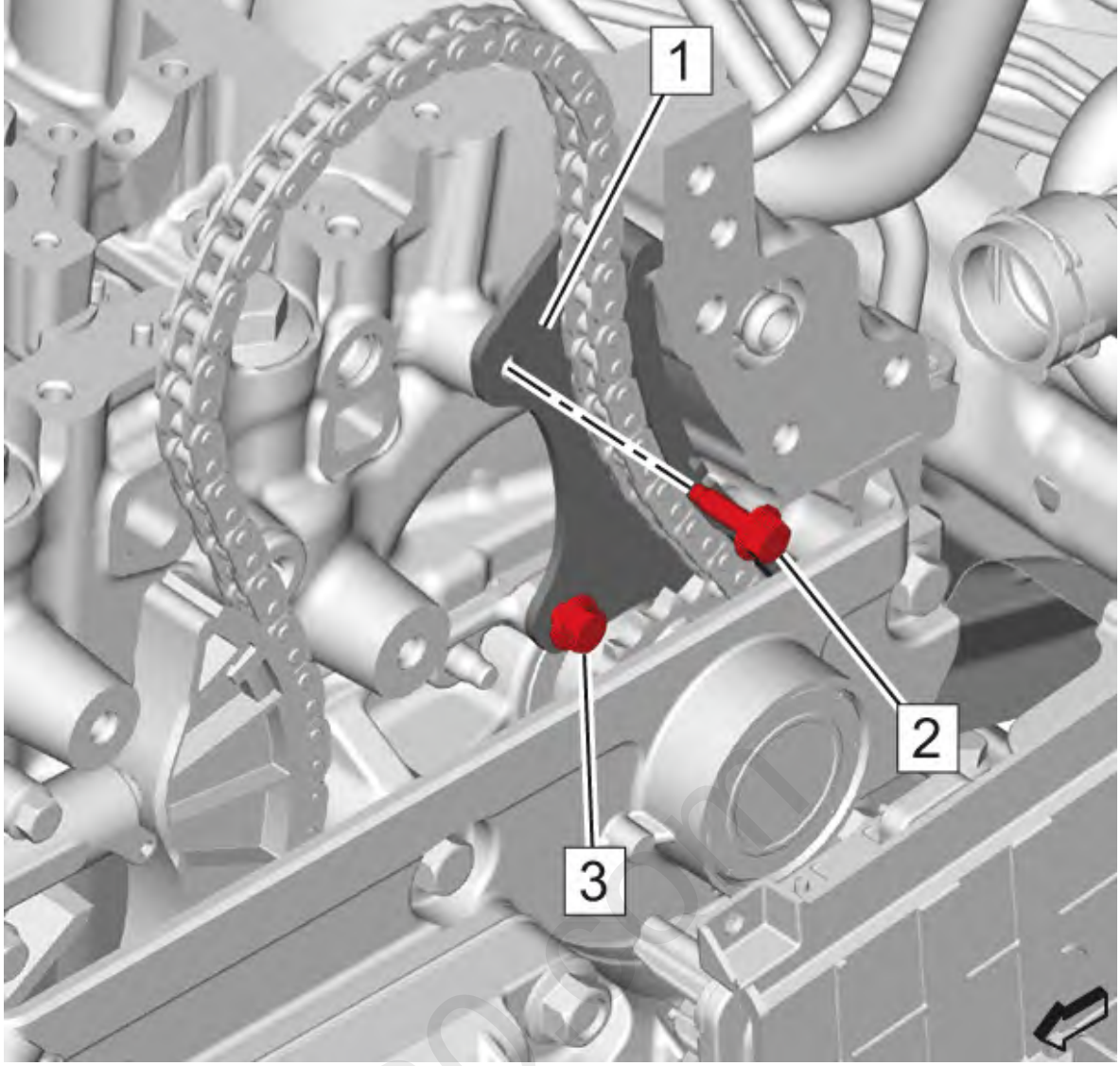


Fig. 350: Upper Timing Chain Upper Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

24. Re-cut thread at cylinder head for the upper timing chain upper guide bolt (2).

NOTE: **The tightening procedure of the timing chain upper guide bolts should be completed within 10 minutes.**

25. Apply thread lock agent to the upper timing chain upper guide bolt (2).
26. Install the upper timing chain upper guide bolt (2) and tighten to 11 N.m (97 lb in).
27. Remove the lower timing chain upper guide bolt (3).
28. Re-cut thread at engine block for the lower timing chain upper guide bolt (3).
29. Apply thread lock agent to the lower timing chain upper guide bolt.
30. Install and tighten the lower timing chain upper guide bolt (3) to 11 N.m (97 lb in).

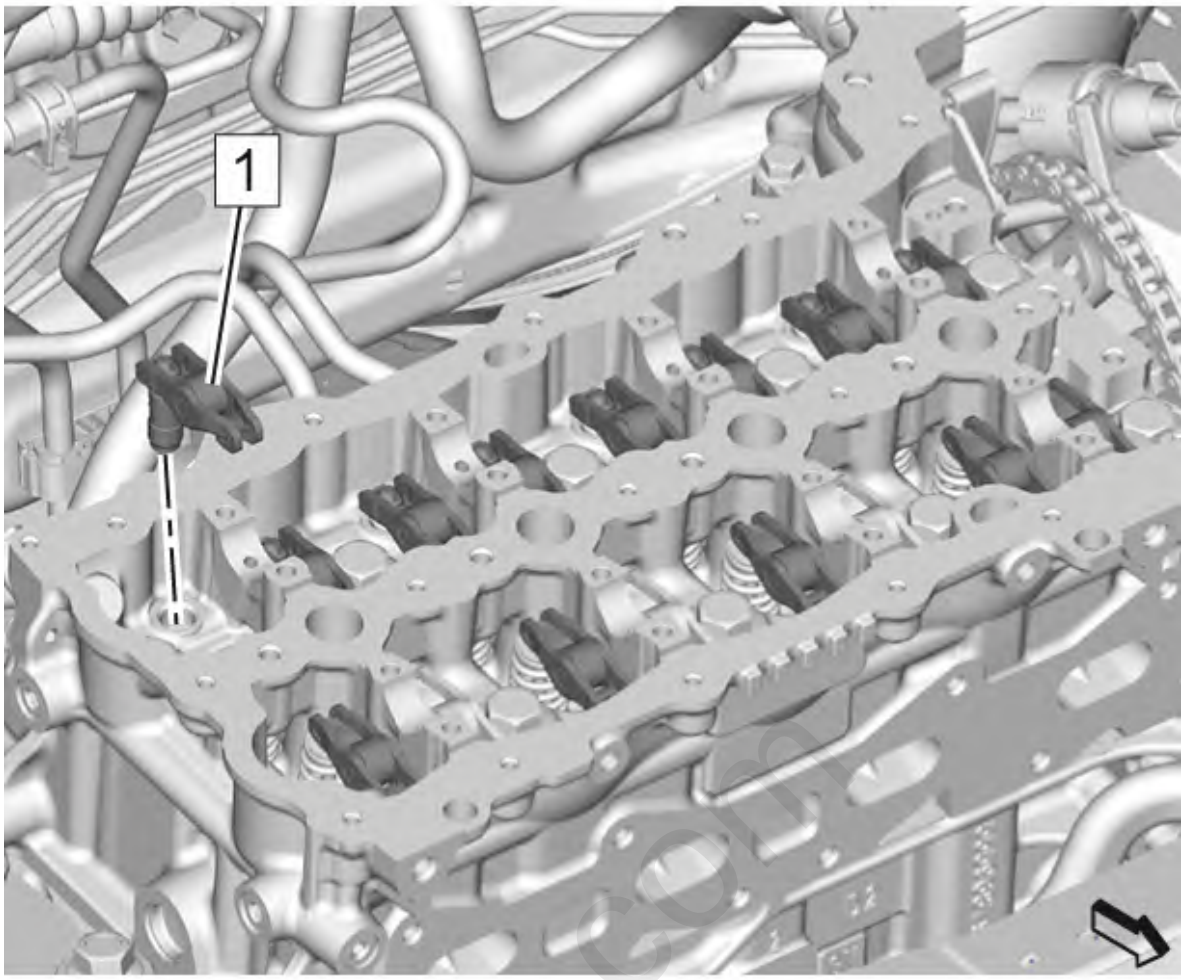


Fig. 351: Valve Lifter Roller Assemblies
Courtesy of GENERAL MOTORS COMPANY

31. Coat the 16 valve lifter with engine oil.
32. Install the 16 valve lifter with valve lifter roller (1) in the order as they was removed.

mcx30.com

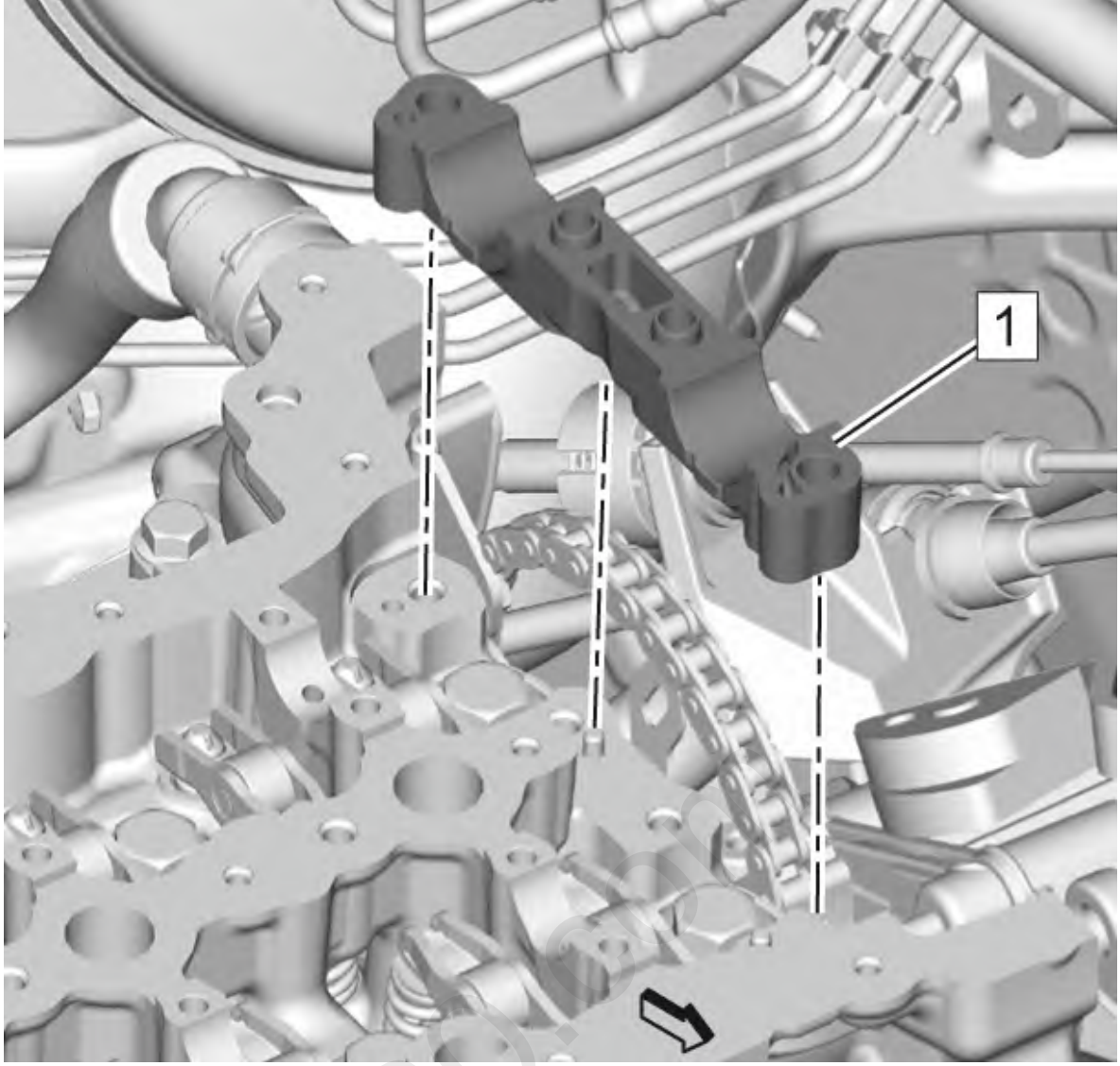


Fig. 352: Bearing Bracket
Courtesy of GENERAL MOTORS COMPANY

33. Install the bearing bracket (1).

mcx30.com

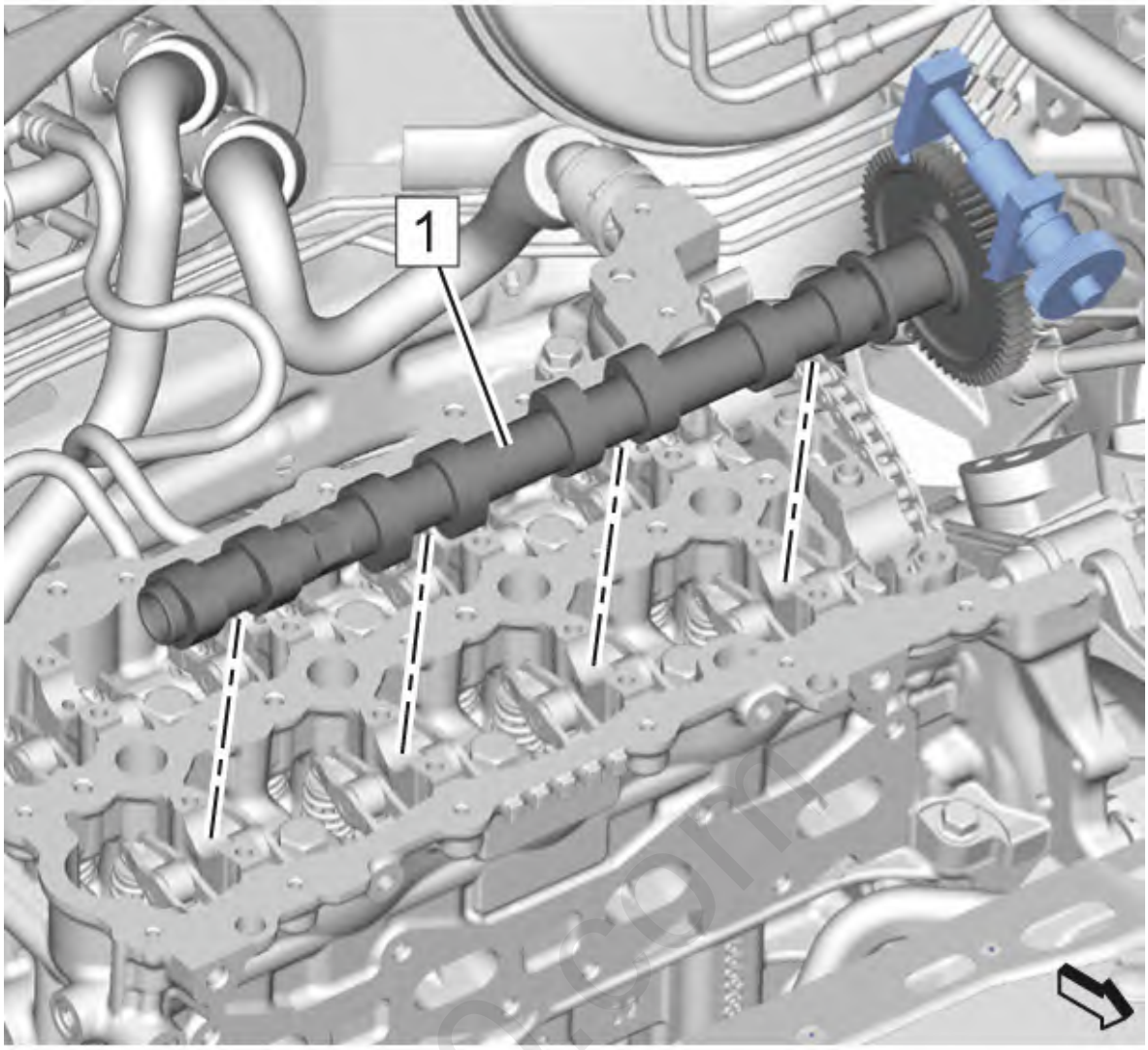


Fig. 353: Exhaust Camshaft With Bore Of Camshaft Sprocket Upwards
Courtesy of GENERAL MOTORS COMPANY

34. Coat all bearing surfaces with engine oil.
35. Install the exhaust camshaft (1), ensure the bore (2) of the camshaft sprocket shows upwards.

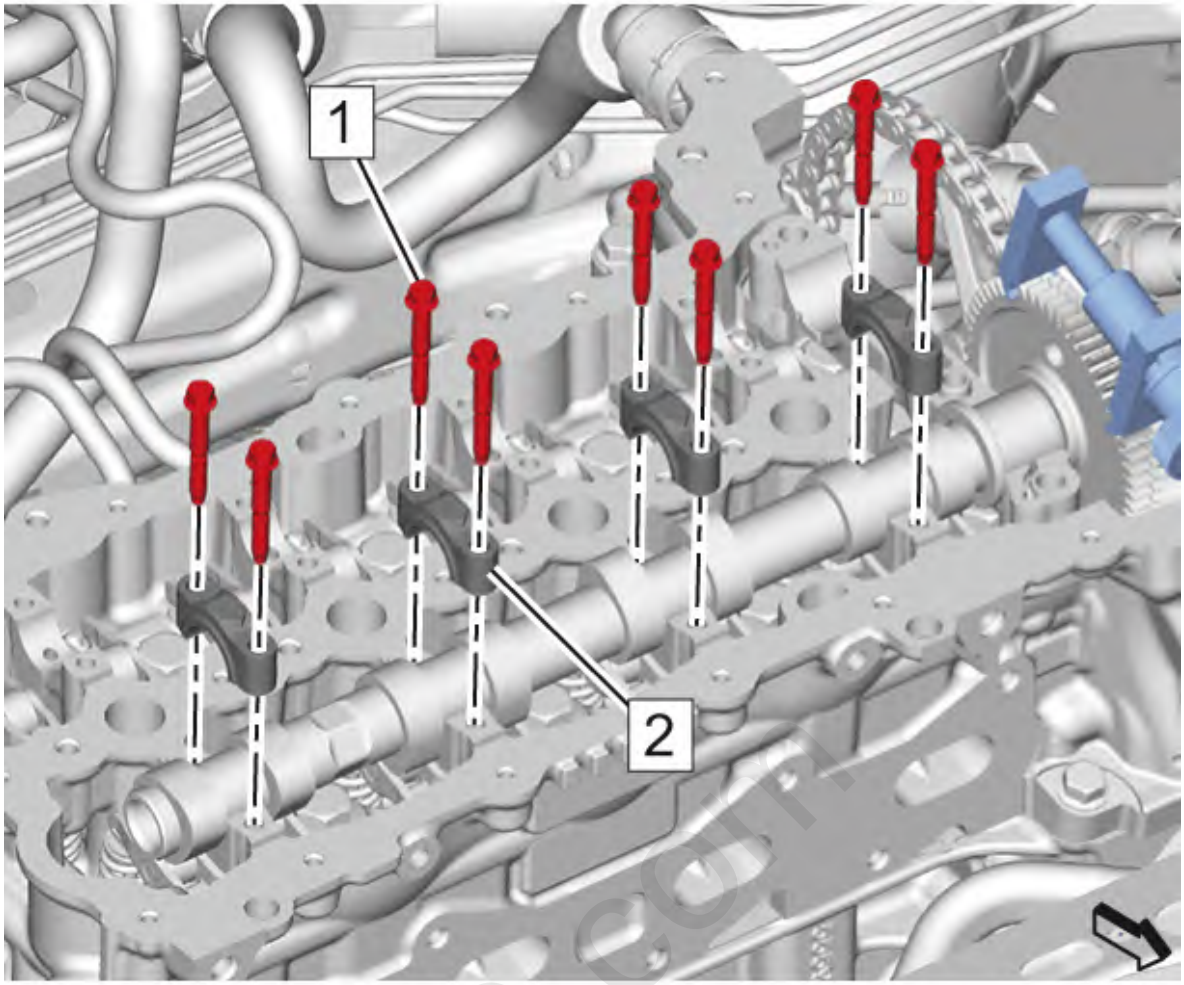


Fig. 354: Exhaust Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the arrows as marks on the camshaft bearing caps, which shows on the outside of the cylinder head.**

36. Install the exhaust camshaft bearing caps (2) in the order as they was removed.
37. Install the 8 exhaust camshaft bearing cap bolts (1).

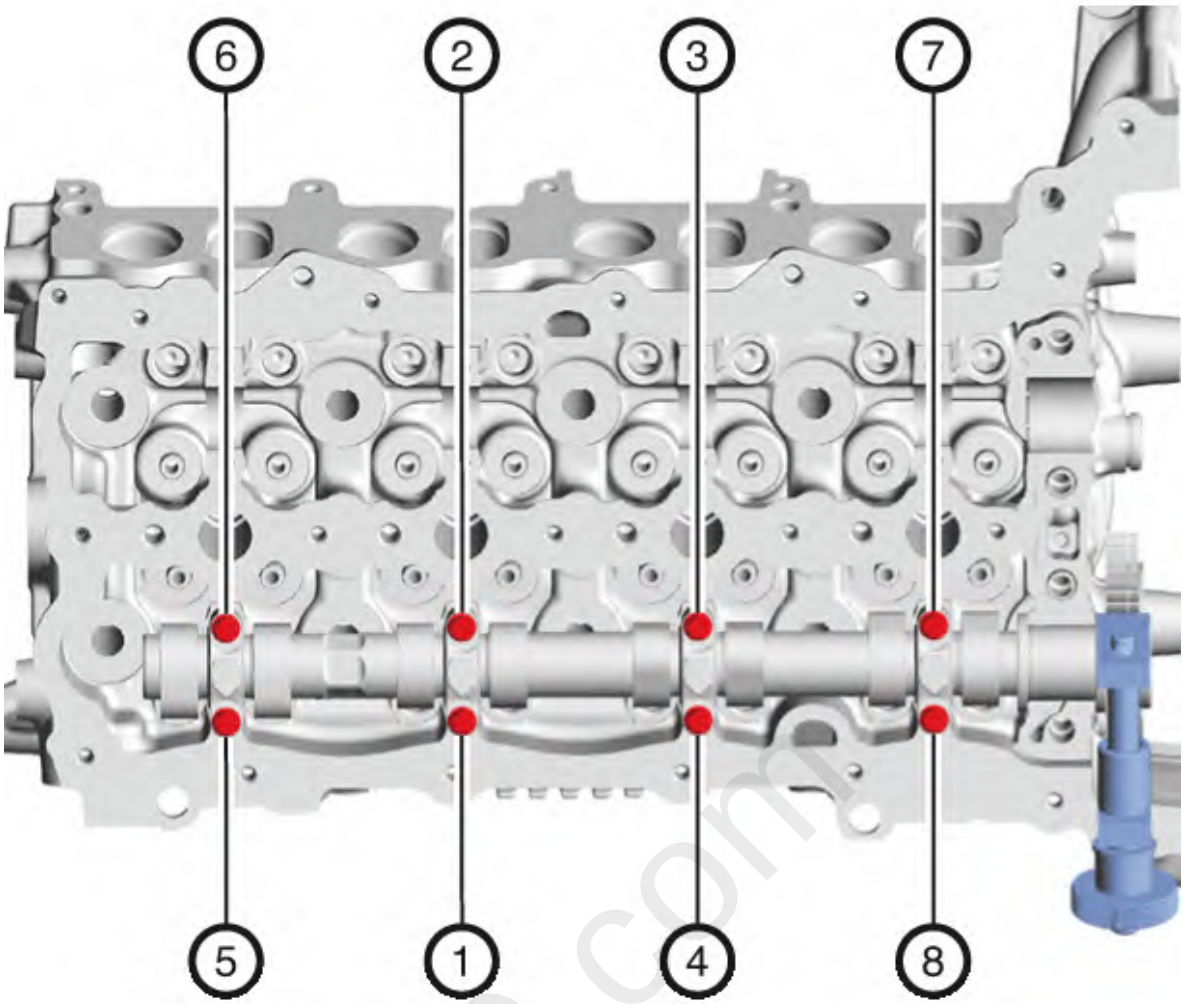


Fig. 355: Exhaust Camshaft Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

38. Tighten the 8 exhaust camshaft bearing cap bolts in sequence as shown to 10 N.m (89 lb in).

mcx30.com

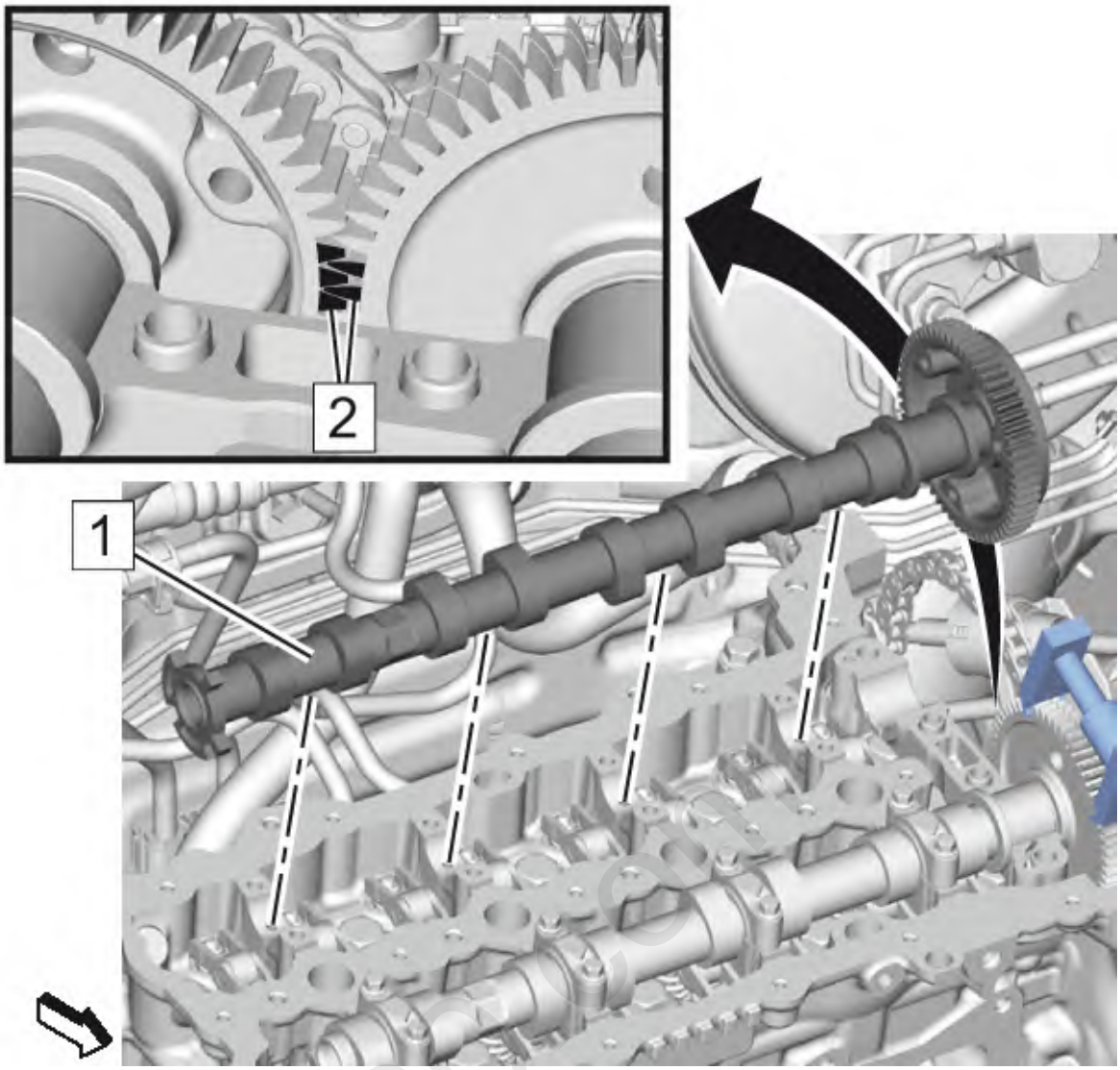


Fig. 356: Intake Camshaft With Camshaft Sprocket Marks Aligned
Courtesy of GENERAL MOTORS COMPANY

39. Coat all bearing surfaces with engine oil.

NOTE: **Ensure the marks (2) of the camshaft sprocket are aligned.**

40. Install Intake Camshaft (1)

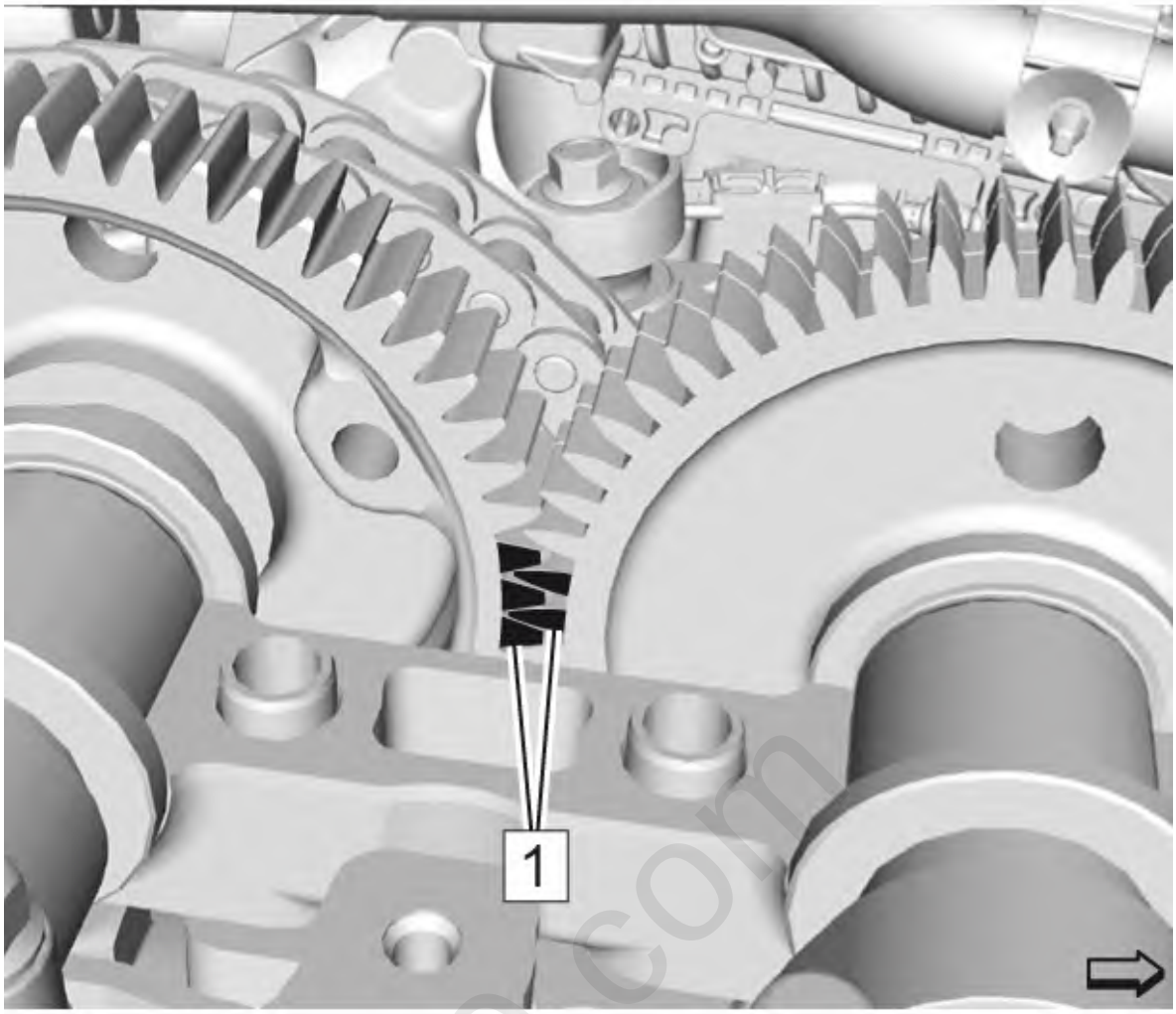


Fig. 357: Mark Exhaust Camshaft Sprocket And Intake Camshaft Sprocket With Paint Marks
Courtesy of GENERAL MOTORS COMPANY

41. Check the marks (1) of the camshaft sprockets whether they are aligned.

mcx30.com

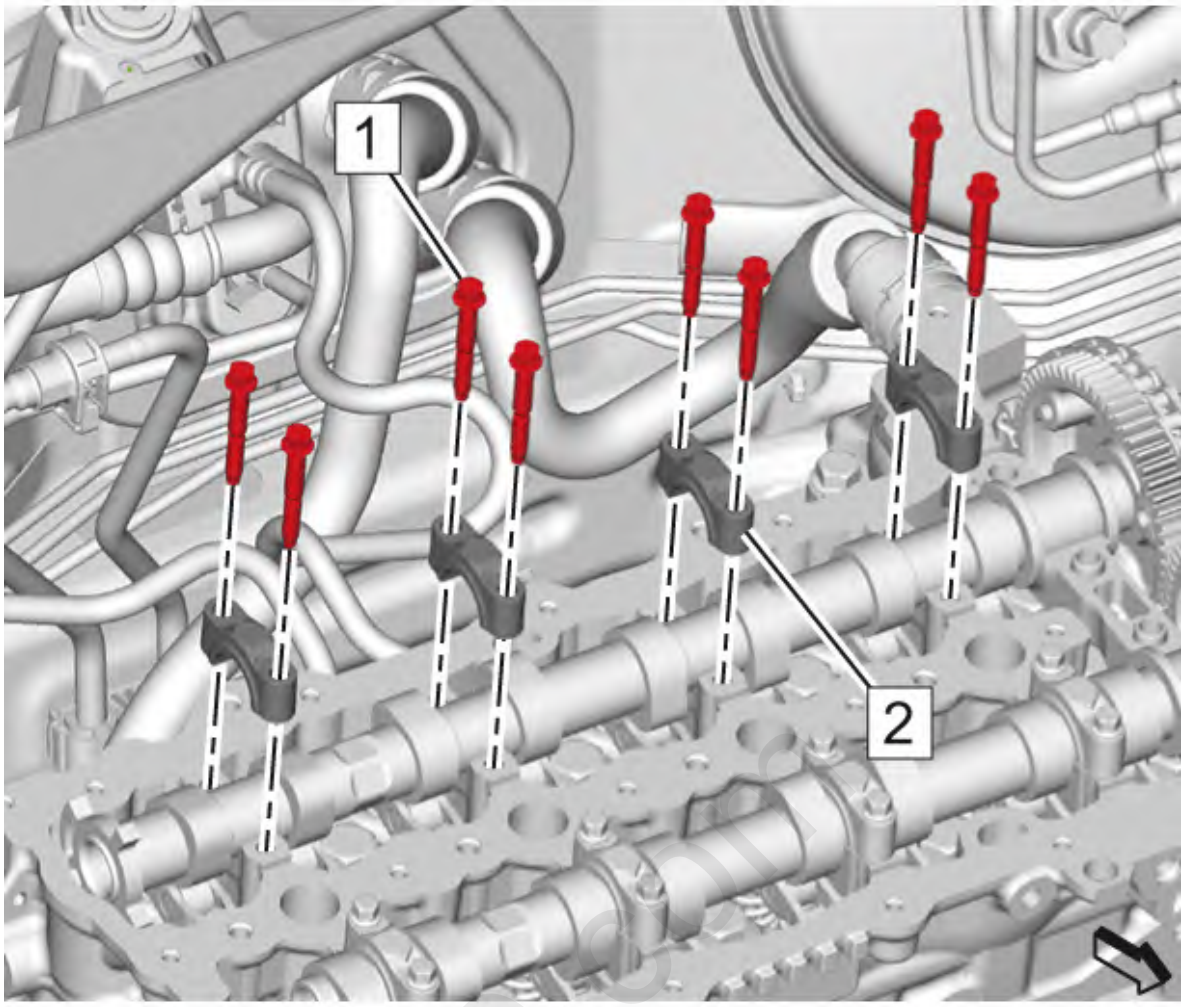


Fig. 358: Intake Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the arrows as marks on the camshaft bearing caps, which shows on the outside of the cylinder head.**

42. Install the 4 intake camshaft bearing caps (2) in the order as they was removed.
43. Install the 8 intake camshaft bearing cap bolts (1).

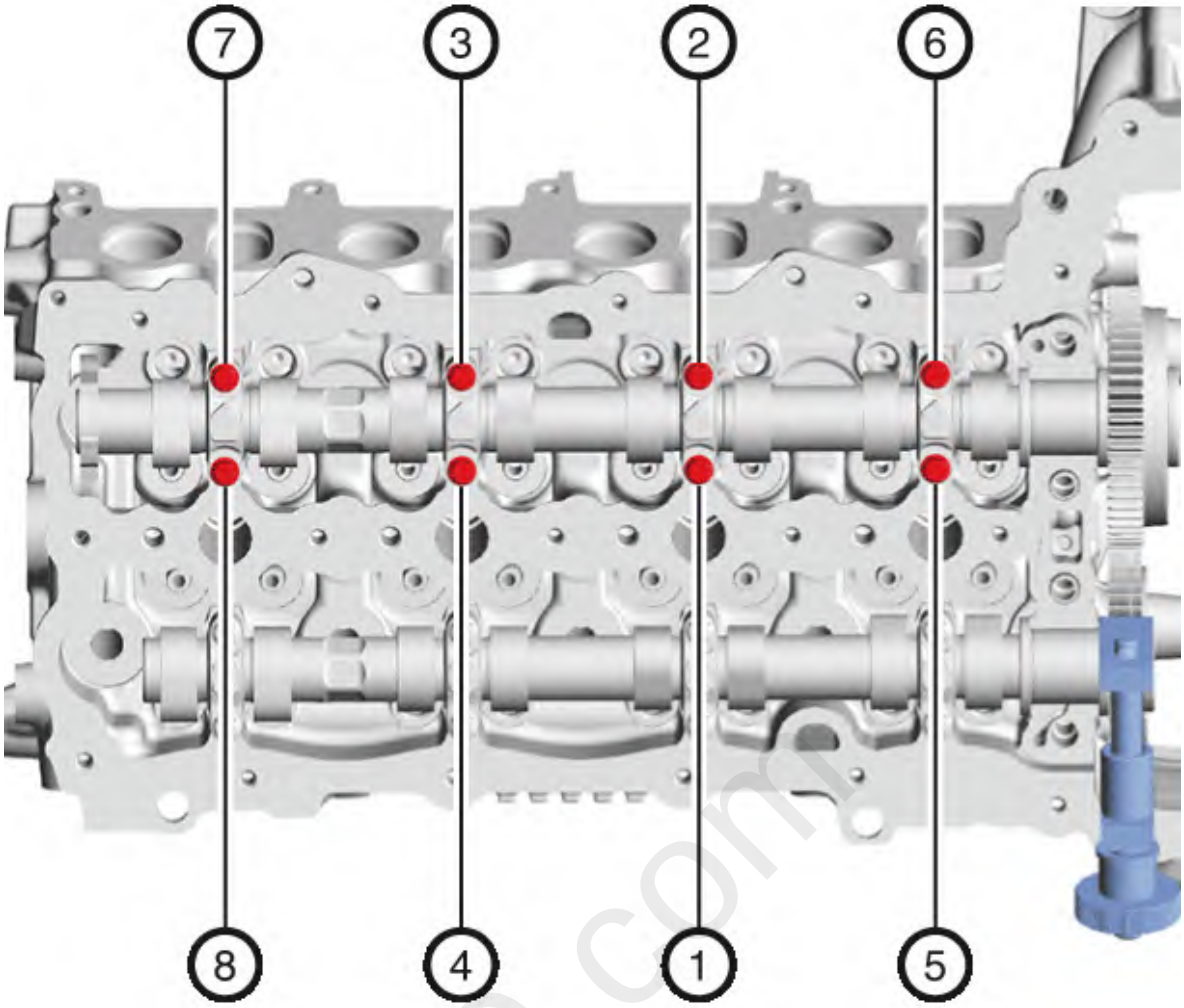


Fig. 359: Intake Camshaft Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

44. Tighten the 8 intake camshaft bearing cap bolts in sequence as shown to 10 N.m (89 lb in).

mcx30.com

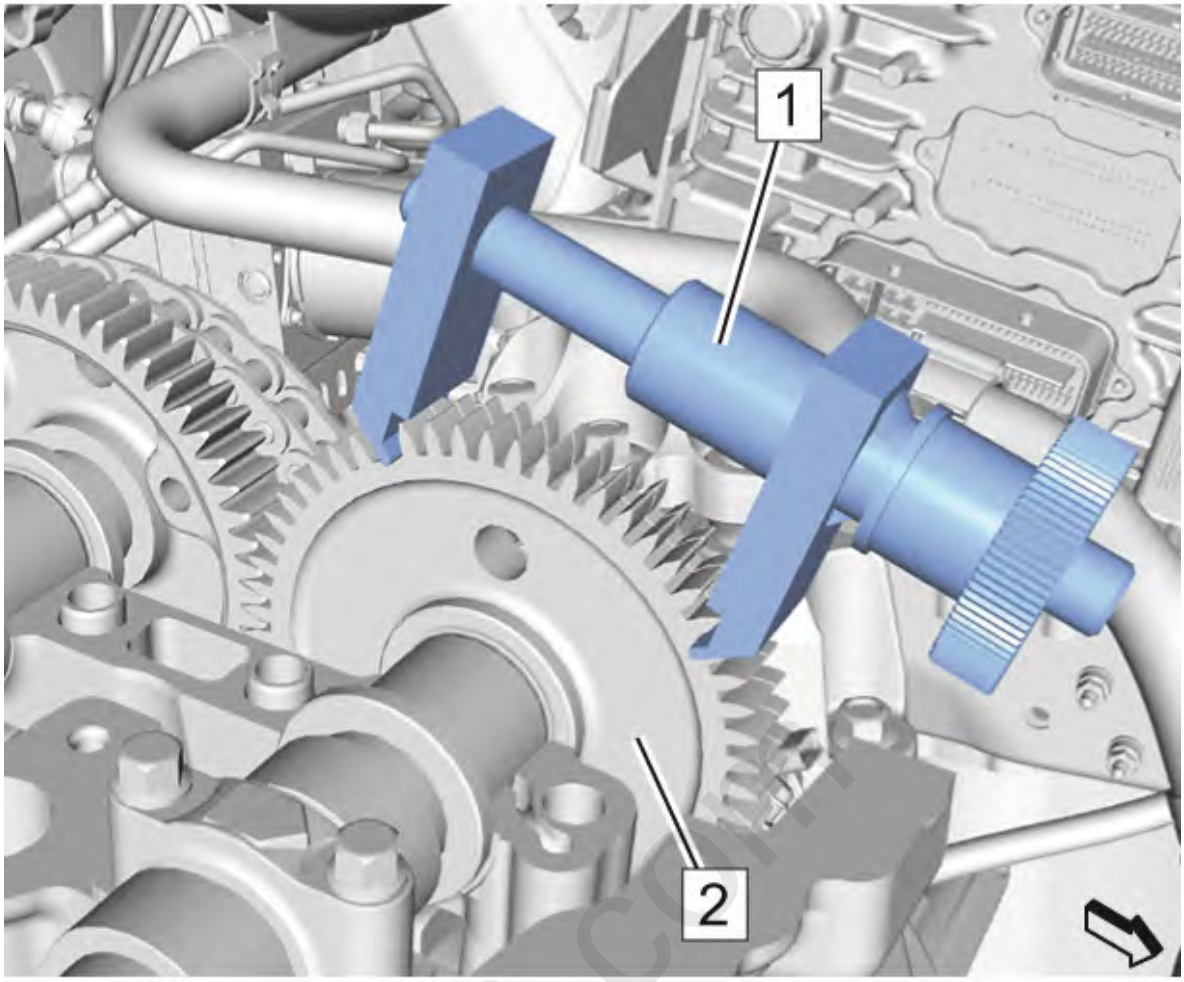


Fig. 360: Split Intake Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

45. Remove the **EN-50509** fixing tool (1).

mcx30.com

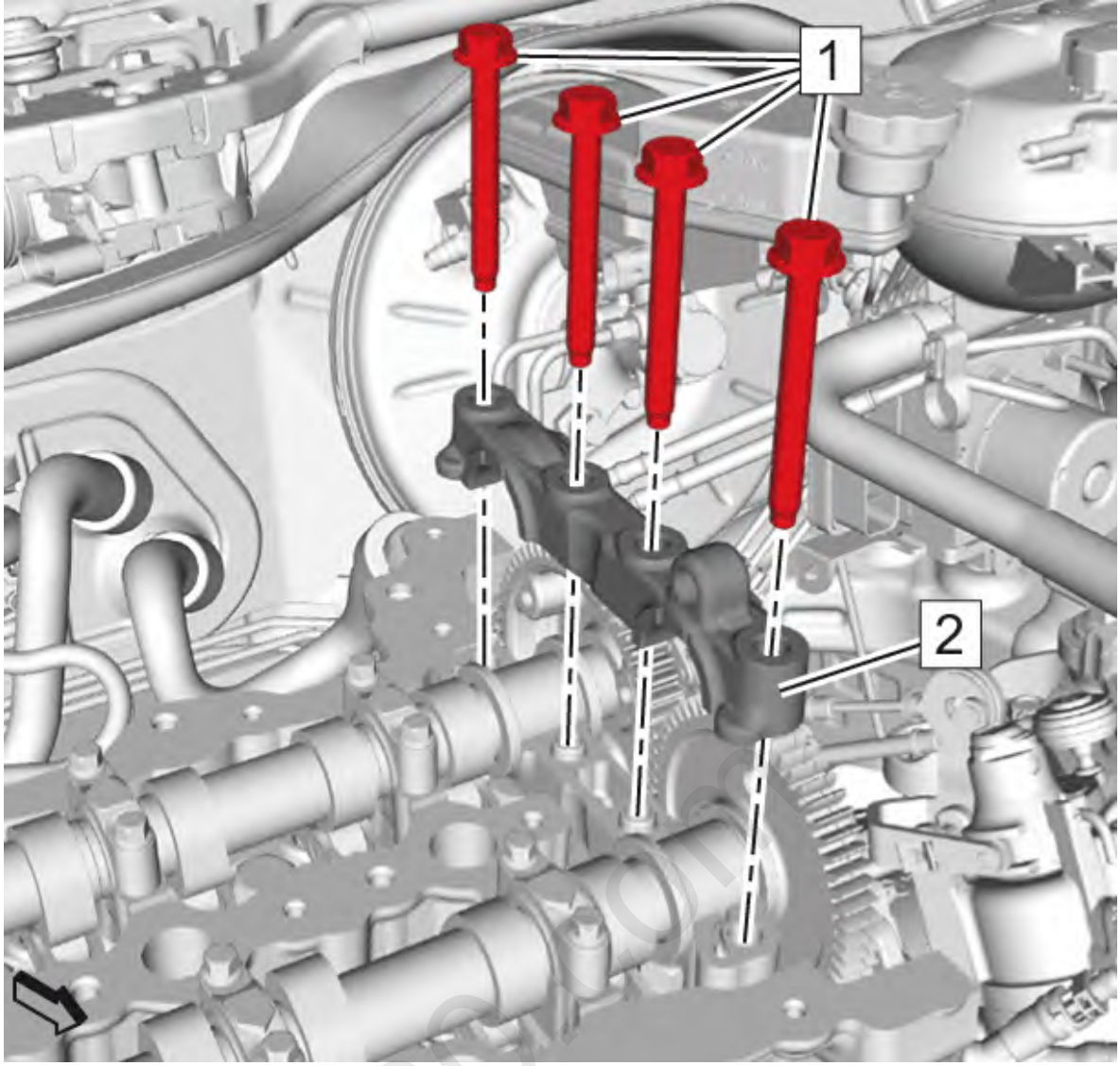


Fig. 361: Camshaft Bearing Rear Cap And Bolts
Courtesy of GENERAL MOTORS COMPANY

46. Coat all bearing surfaces with engine oil.
47. Install Camshaft Bearing Rear Cap (2)
48. Install the 4 camshaft bearing rear cap bolts (1).

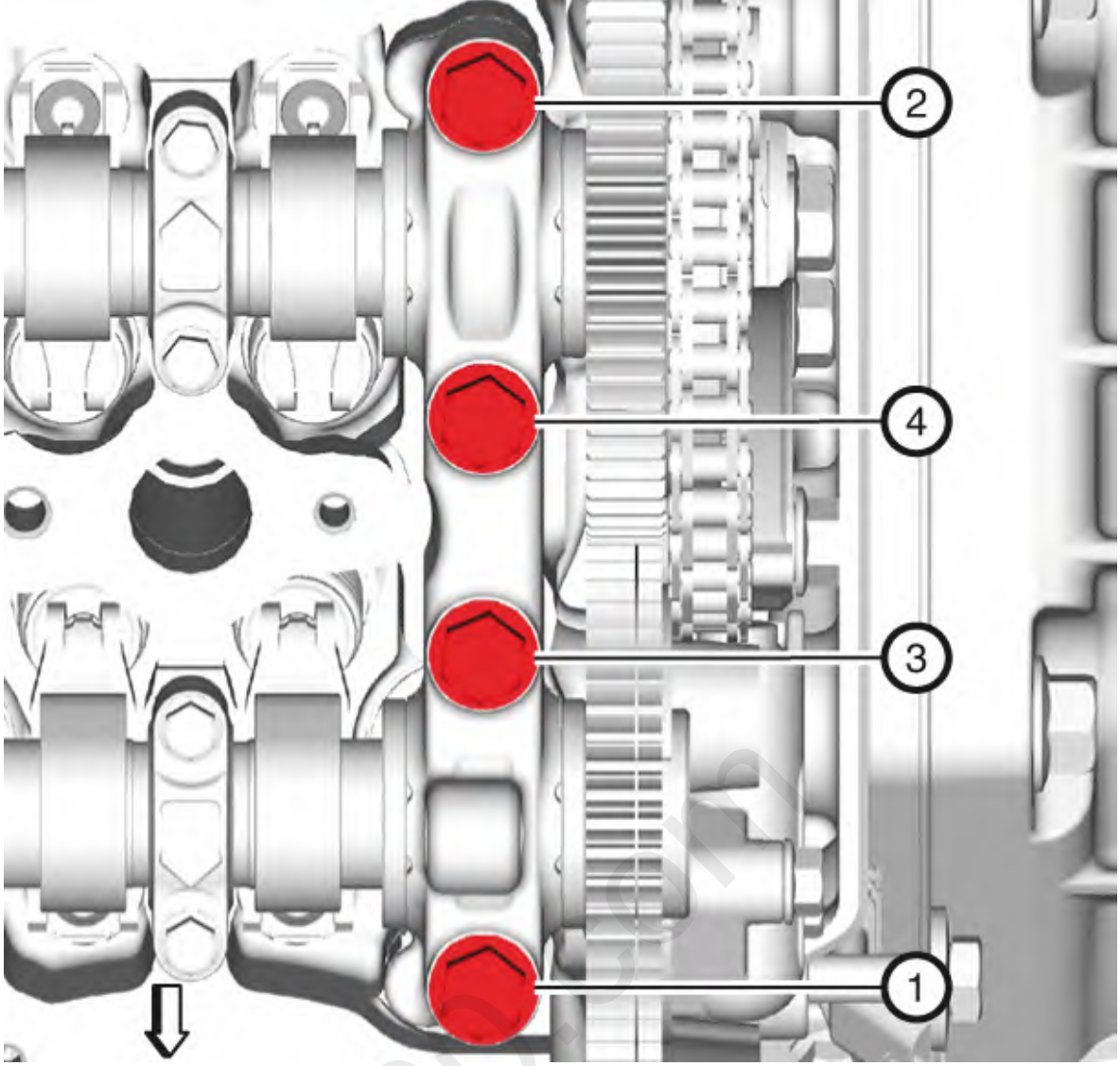


Fig. 362: Camshaft Rear Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

49. Tighten the 4 camshaft rear cap bolts in sequence as shown to 25 N.m (18 lb ft).

mcx30.com

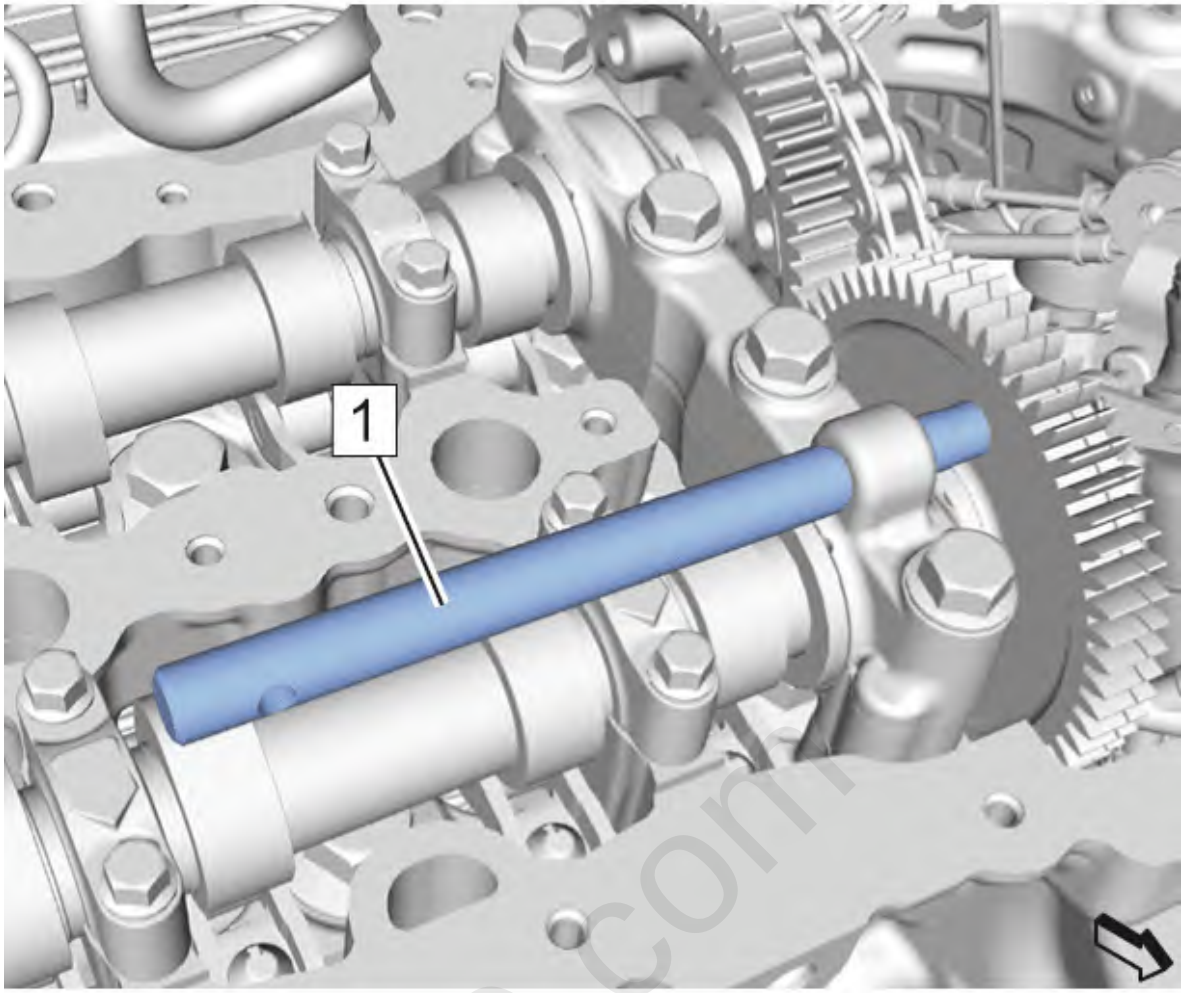


Fig. 363: Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

50. Install the **EN-51143** fixing tool (1), by carefully turning the hexagon of the camshaft.

mcx30.com

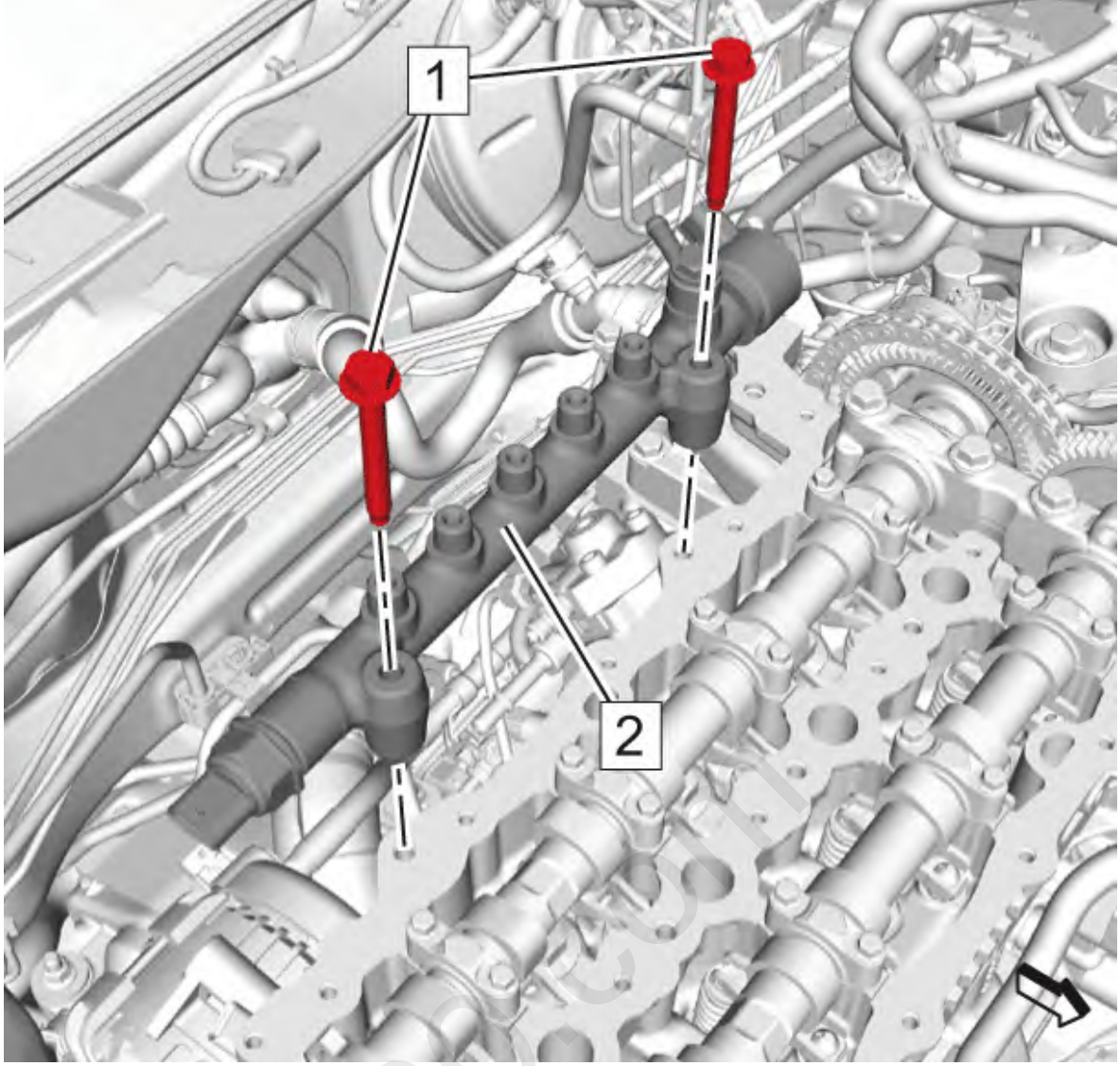


Fig. 364: Fuel Injection Fuel Rail And Bolts
Courtesy of GENERAL MOTORS COMPANY

51. Install Fuel Injection Fuel Rail (2)
52. Install and tighten Fuel Injection Fuel Rail Bolts (1) (Qty: 2) to 25 N.m (18 lb ft)
53. Install Glow Plugs (Qty: 4). Refer to **Glow Plug Replacement**
54. Install Camshaft Sprocket. Refer to **Camshaft Sprocket Replacement**
55. Install the exhaust manifold. Refer to **Exhaust Manifold Replacement (LH7)**
56. Install the intake manifold. Refer to **Intake Manifold Replacement**

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

Special Tools

- **EN-652** Holder Flex Plate
- **EN-45059** Angle Meter

Equivalent regional tools: **Special Tools**

Removal Procedure

1. Remove Transmission. Refer to **Transmission Replacement (Front Wheel Drive)** **Transmission Replacement (All Wheel Drive)**

Fig. 365: Flex Plate Holder
Courtesy of GENERAL MOTORS COMPANY

2. Install the **EN-652** holder (1) in order to fix the flex plate.

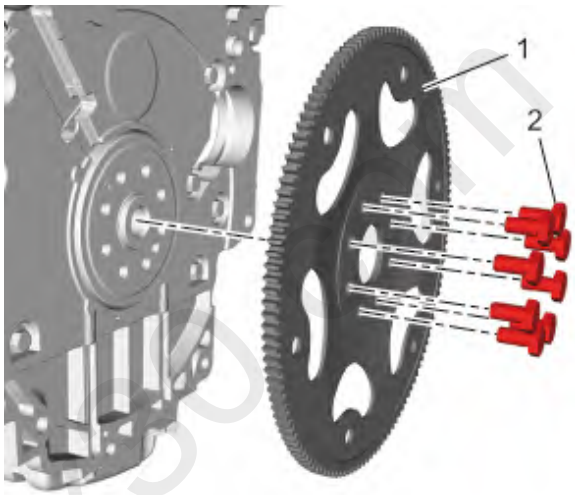


Fig. 366: Automatic Transmission Flex Plate And Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove and DISCARD Automatic Transmission Flex Plate Bolts (2) (Qty: 8)
4. Remove the **EN-652** holder.
5. Remove Automatic Transmission Flex Plate (1)

Installation Procedure

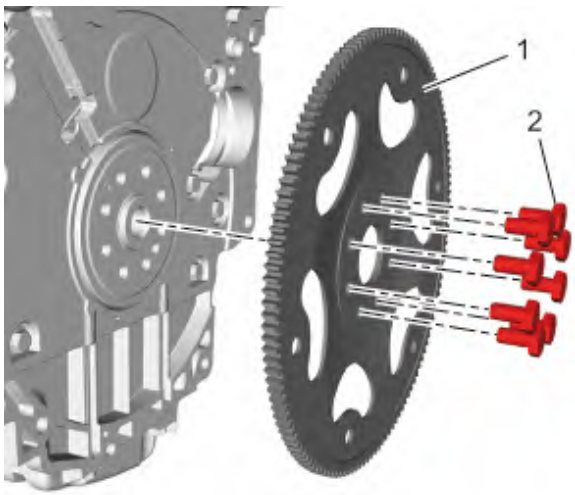


Fig. 367: Automatic Transmission Flex Plate And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install Automatic Transmission Flex Plate (1)

NOTE: **Install NEW bolts.**

2. Install Automatic Transmission Flex Plate Bolts (2) (Qty: 8)

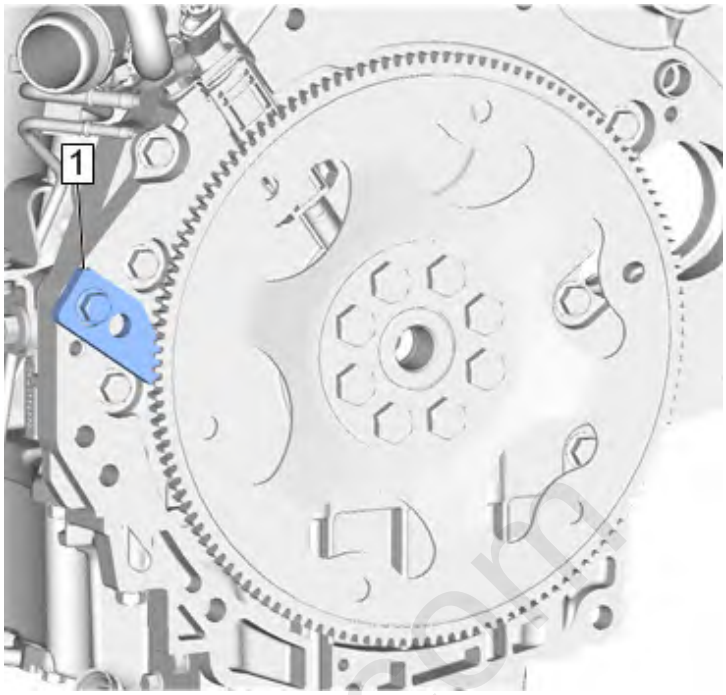


Fig. 368: Flex Plate Holder
Courtesy of GENERAL MOTORS COMPANY

3. Install the **EN-652** holder (1) in the position shown.

CAUTION: **Refer to Fastener Caution**

CAUTION: **Refer to Torque-to-Yield Fastener Caution**

4. Tighten the flex plate bolts crosswise in the following order:
   1. First Pass: 60 N.m (44 lb ft)
   2. Final Pass: 45 degrees - **EN-45059** meter
5. Remove the **EN-652** holder.
6. Install Transmission. Refer to **Transmission Replacement (Front Wheel Drive)** **Transmission Replacement (All Wheel Drive)**

ENGINE OIL LEVEL INDICATOR SWITCH REPLACEMENT

Removal Procedure

1. Drain the engine oil. Refer to **Engine Oil and Oil Filter Replacement**

mcx30.com

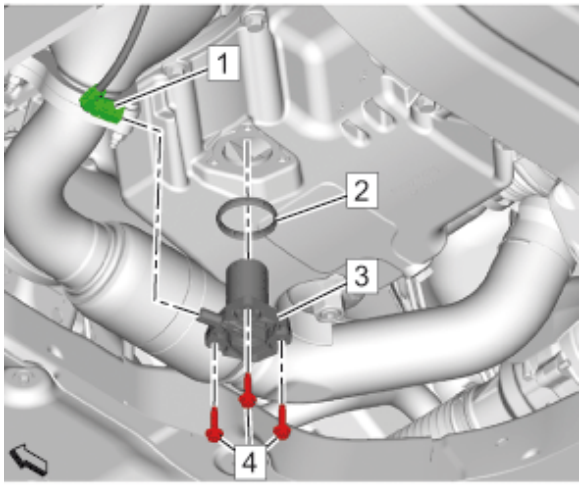


Fig. 369: Engine Oil Level Indicator Switch, Bolts, O-Ring Seal And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the electrical connector. (1)
3. Remove Engine Oil Level Indicator Switch Bolt (4) (Qty: 3)
4. Remove Engine Oil Level Indicator Switch (3)
5. Remove and DISCARD Engine Oil Level Indicator Switch O-Ring Seal (2)

Installation Procedure

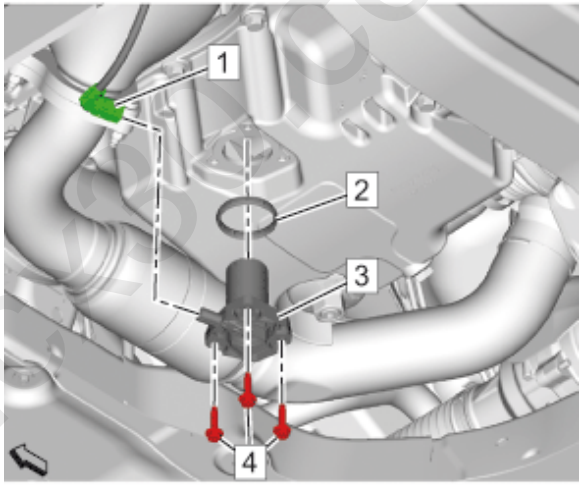


Fig. 370: Engine Oil Level Indicator Switch, Bolts, O-Ring Seal And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW O-ring seal. (2)
2. Install Engine Oil Level Indicator Switch (3)

CAUTION: **Refer to: Fastener Caution**

3. Install and tighten Engine Oil Level Indicator Switch Bolts (4) (Qty: 3) to 10 N.m (89 lb in)
4. Connect the electrical connector. (1)
5. Fill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**

ENGINE OIL PRESSURE SWITCH REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**

3. Remove Exhaust Front Pipe. Refer to **Exhaust Front Pipe Replacement (LH7)**

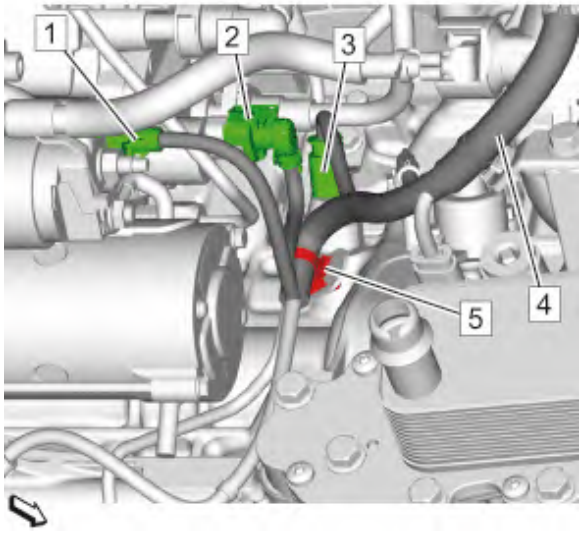


Fig. 371: Electrical Connectors, Wiring Harness And Clip
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the electrical connector:
    1. Starter (1)
    2. Fuel Injection Pump (2)
    3. Engine Oil Pressure Switch (3)
5. Unclip Wiring Harness Clip (5)
6. Hang the wiring harness (4) aside.

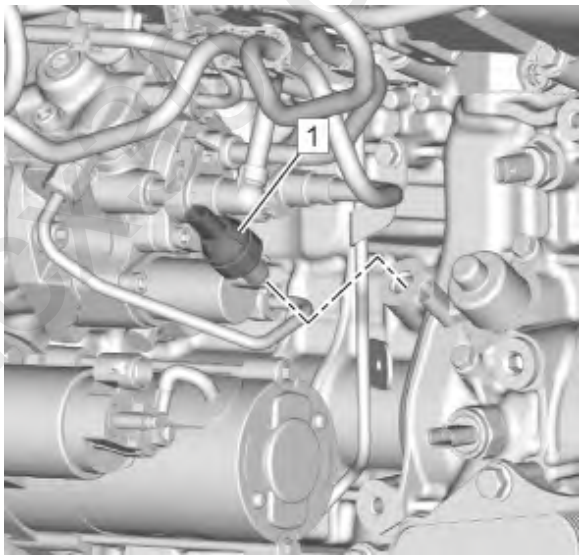


Fig. 372: Engine Oil Pressure Switch
Courtesy of GENERAL MOTORS COMPANY

7. Remove Engine Oil Pressure Switch (1)

Installation Procedure

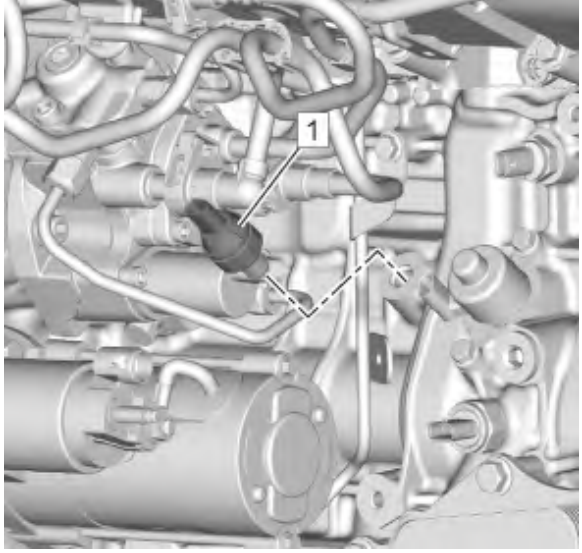


Fig. 373: Engine Oil Pressure Switch
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to: Fastener Caution**

1. Install and tighten Engine Oil Pressure Switch (1) to 35 N.m (26 lb ft)

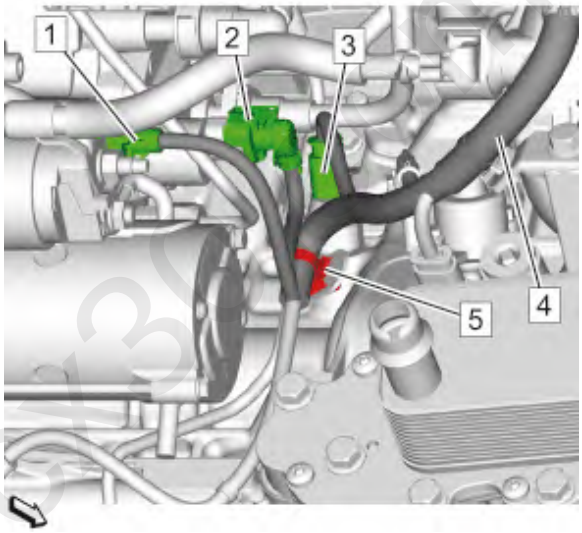


Fig. 374: Electrical Connectors, Wiring Harness And Clip
Courtesy of GENERAL MOTORS COMPANY

2. Install Wiring Harness Clip (5)
3. Connect the electrical connector:
    1. Starter (1)
    2. Fuel Injection Pump (2)
    3. Engine Oil Pressure Switch (3)
4. Install Exhaust Front Pipe. Refer to **Exhaust Front Pipe Replacement (LH7)**
5. Lower the vehicle.
6. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

ENGINE OIL AND OIL FILTER REPLACEMENT

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**
3. Place a drain pan under the vehicle.

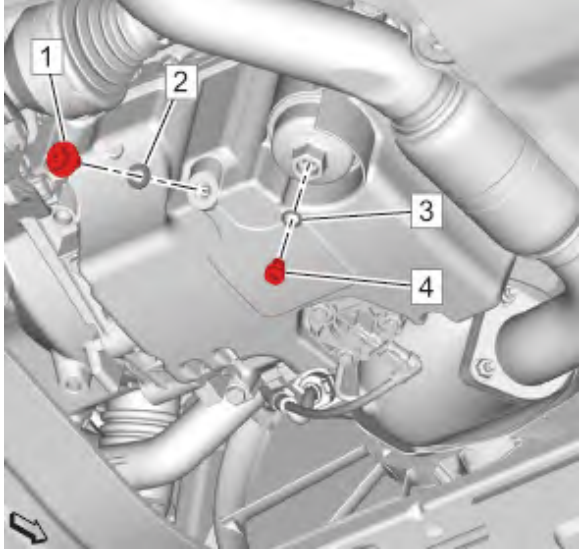


Fig. 375: Oil Pan Drain Plug, Bolt And Seals
Courtesy of GENERAL MOTORS COMPANY

4. Remove Oil Pan Drain Plug (1)
5. Remove and DISCARD Oil Pan Drain Plug Seal (2)
6. Remove Oil Filter Cap Plug (4)
7. Remove and DISCARD the O-ring seal. (3)
8. Drain the engine oil into a suitable container.

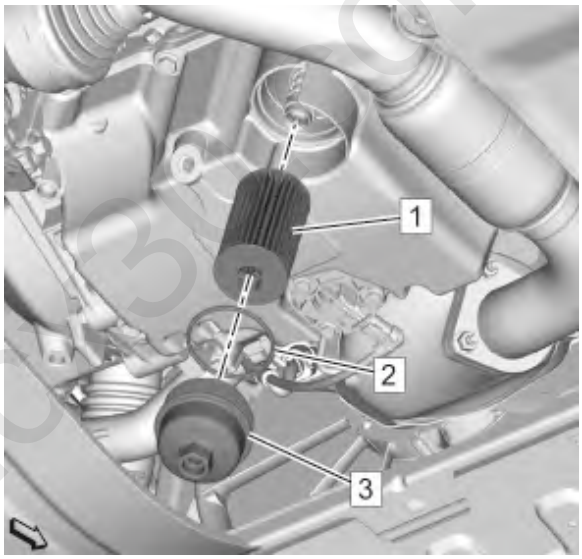


Fig. 376: Oil Filter Cap, O-Ring And Filter Insert
Courtesy of GENERAL MOTORS COMPANY

9. Remove the oil filter cap. (3)
10. Remove and DISCARD Oil Filter Cap O-Ring (2)

CAUTION: **This engine uses a special high performance oil filter. Use of any other filter may lead to filter failure and/or severe engine damage.**

11. Remove and properly dispose the oil filter insert (1).

Installation Procedure

1. Clean the oil filter housing of the oil pan and oil filter cap free from debris.

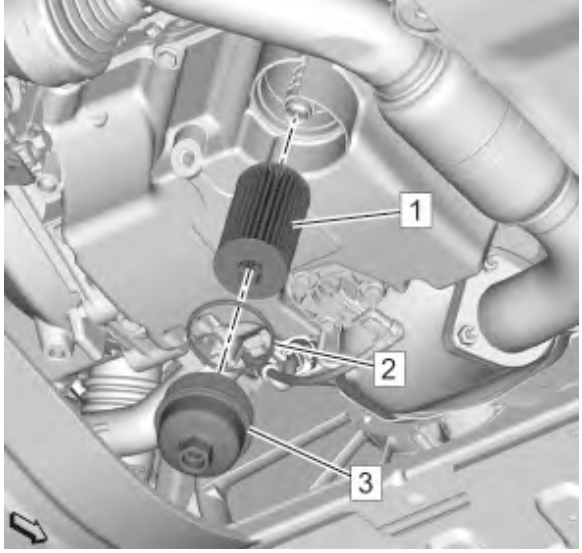


Fig. 377: Oil Filter Cap, O-Ring And Filter Insert
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW oil filter insert (1).

NOTE: **Coat the o-ring with NEW clean engine oil.**

3. Install NEW Oil Filter Cap O-Ring (2)

CAUTION: **Refer to Fastener Caution**

CAUTION: **Over torquing the oil filter cap may cause damage to the oil filter cap resulting in an oil leak.**

4. Install and tighten Oil Filter Cap (3) to 25 N.m (18 lb ft)

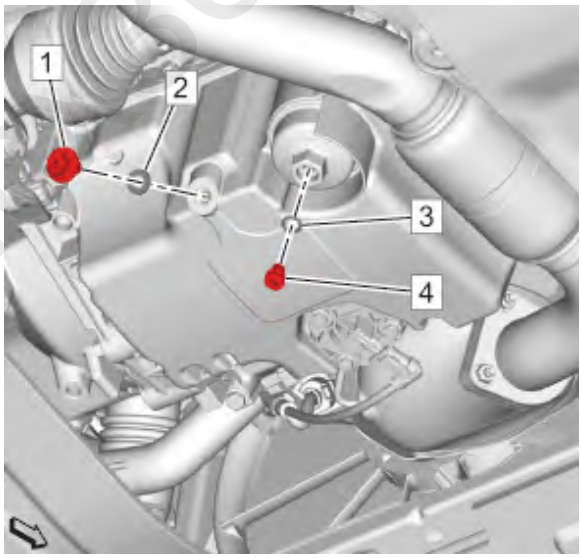


Fig. 378: Oil Pan Drain Plug, Bolt And Seals
Courtesy of GENERAL MOTORS COMPANY

5. Install a NEW O-ring seal. (3)
6. Install and tighten Oil Filter Cap Plug (4) to 10 N.m (89 lb in)
7. Install a NEW oil pan drain plug seal (2).
8. Install and tighten Oil Pan Drain Plug (1) to 25 N.m (18 lb ft)
9. Lower the vehicle.
10. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
11. Fill in NEW engine oil. Refer to **Approximate Fluid Capacities**, **Adhesives, Fluids, Lubricants, and Sealers**
12. Start the engine and allow it to run until the oil pressure control indicator goes off.

13. Inspect the engine oil level.
14. Perform the engine oil life reset. Refer to **GM Oil Life System Resetting (Without Scan Tool)** **GM Oil Life System Resetting (With Scan Tool)**

OIL LEVEL INDICATOR REPLACEMENT

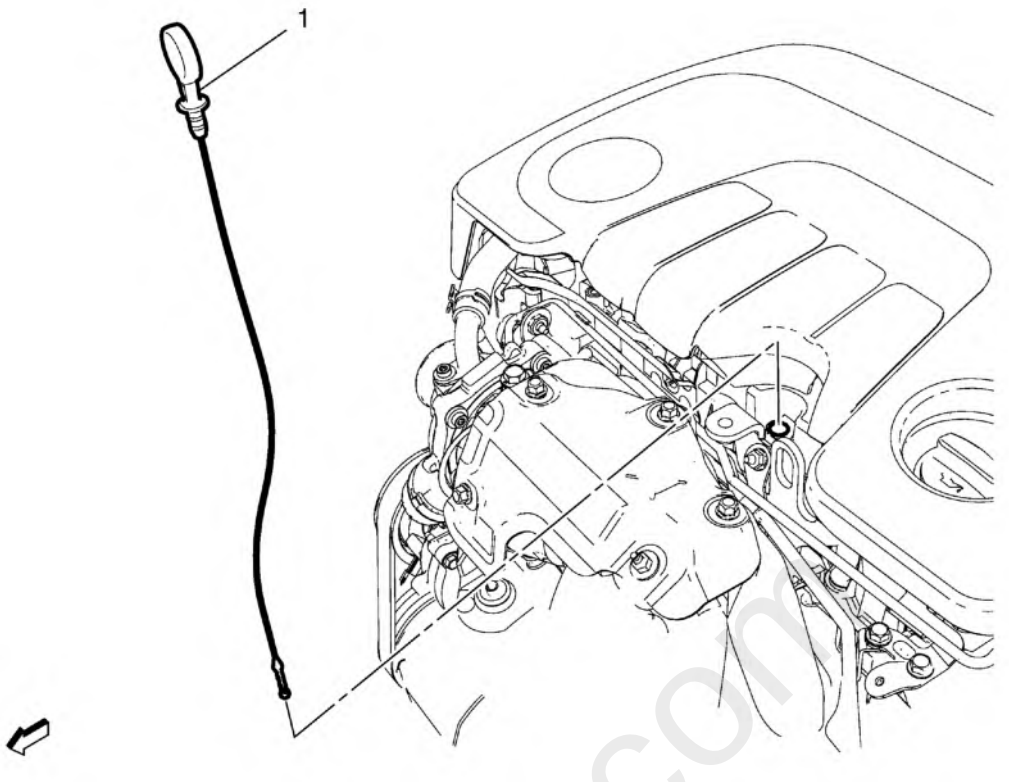


Fig. 379: Oil Level Indicator
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Level Indicator

ENGINE OIL HEATER REPLACEMENT

Removal Procedure

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle**

mcx30.com

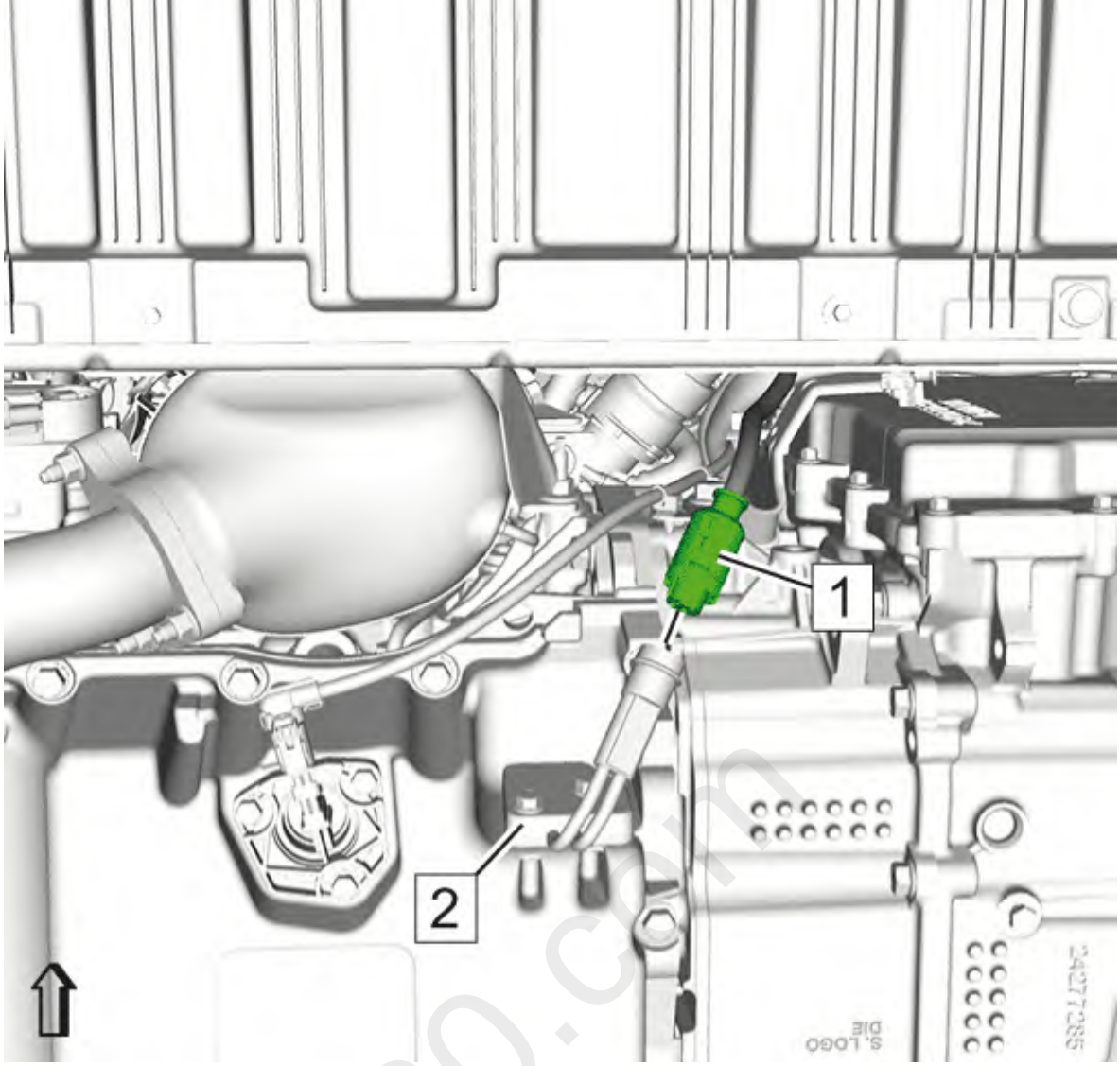


Fig. 380: Engine Oil Heater And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the electrical connector (1) at the engine oil heater (2).

mcx30.com

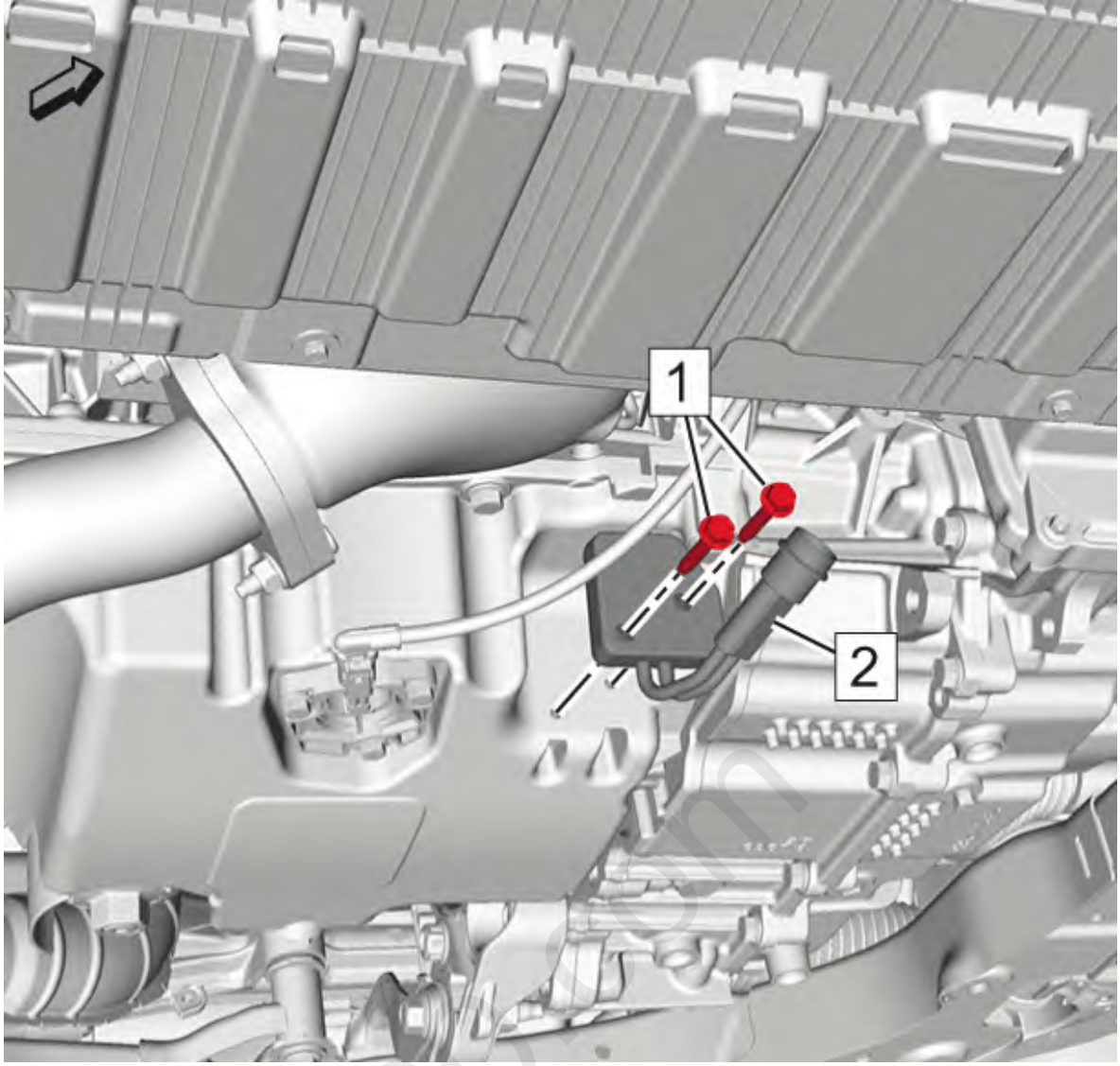


Fig. 381: Engine Oil Heater And Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the 2 engine oil heater bolts (1).
4. Remove the engine oil heater (2).

Installation Procedure

mcx30.com

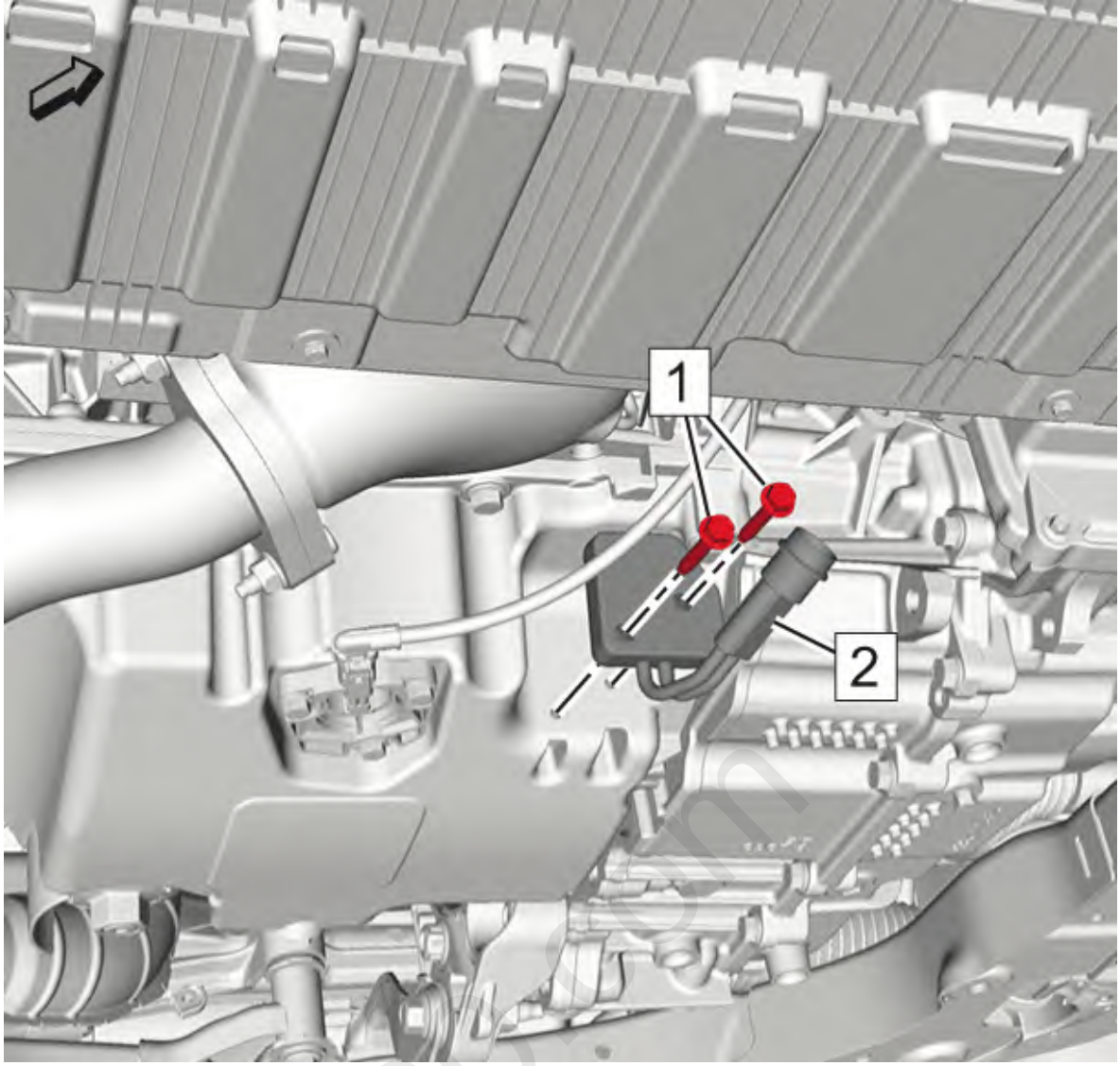


Fig. 382: Engine Oil Heater And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine oil heater (2).

CAUTION: **Refer to Fastener Caution**

2. Install the 2 engine oil heater bolts (1) and tighten to 9 N.m (80 lb in).

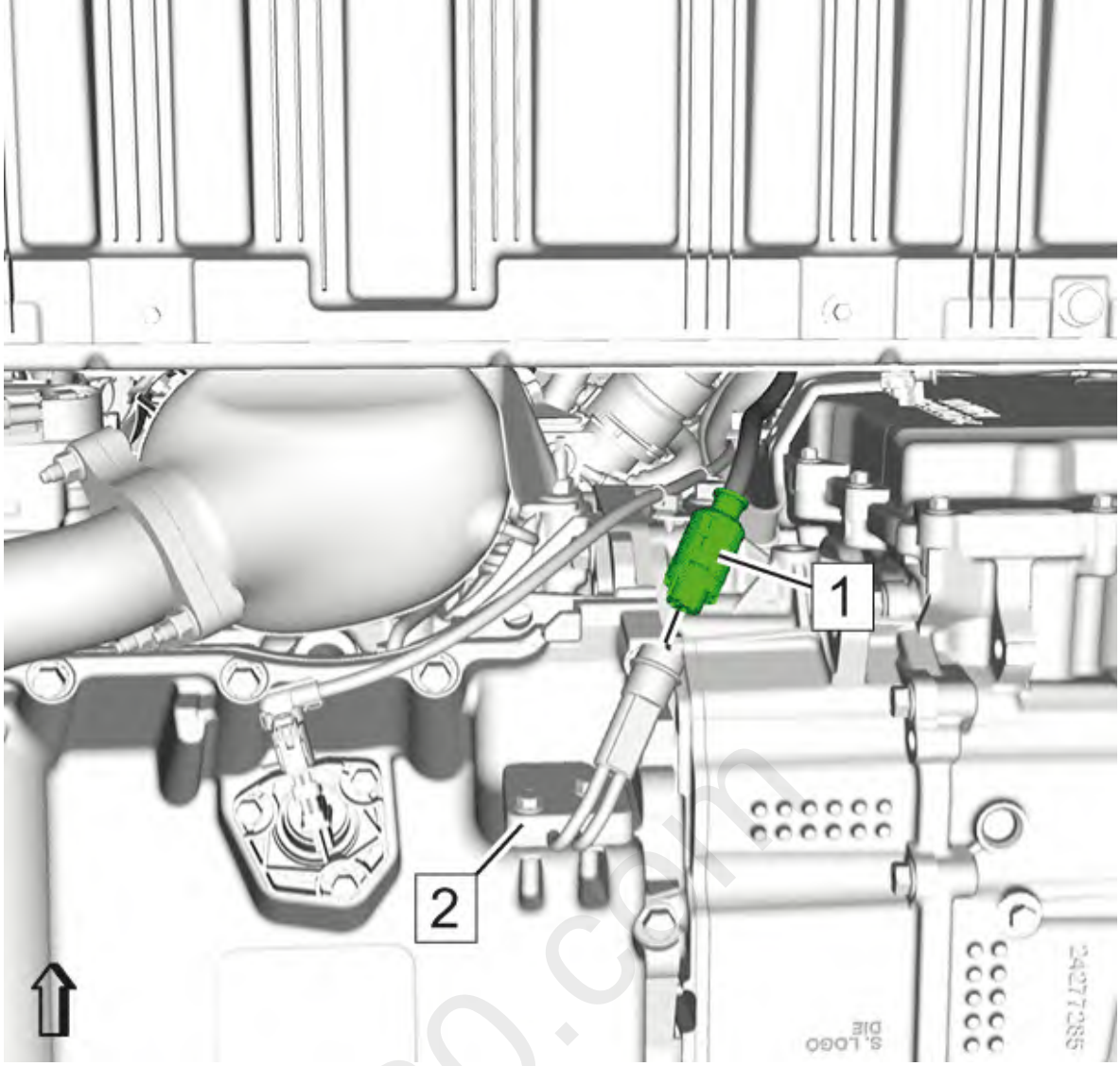


Fig. 383: Engine Oil Heater And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Connect the electrical connector (1) to the engine oil heater (2).
4. Lower the vehicle. Refer to **Lifting and Jacking the Vehicle**

OIL PAN REPLACEMENT

Removal Procedure

1. Remove the oil level indicator. Refer to **Oil Level Indicator Replacement**
2. Remove Exhaust Front Pipe. Refer to **Exhaust Front Pipe Replacement (LH7)**
3. Remove the engine oil heater. Refer to **Engine Oil Heater Replacement**
4. Place a drain pan under the vehicle.

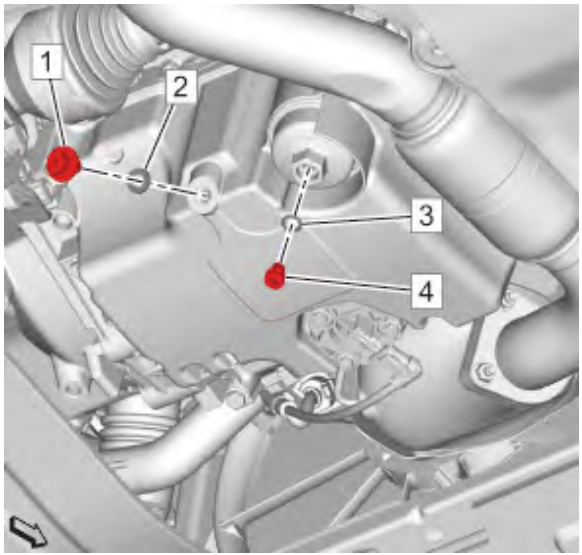


Fig. 384: Oil Pan Drain Plug, Bolt And Seals
Courtesy of GENERAL MOTORS COMPANY

5. Remove Oil Pan Drain Plug (1)
6. Remove and DISCARD Oil Pan Drain Plug Seal (2)
7. Remove the oil filter cap bolt (4).
8. Remove and DISCARD Oil Filter Cap O-Ring (3)
9. Drain the engine oil into a suitable container.
10. If the oil pan will be reused:
    1. Install NEW Oil Filter Cap O-Ring (3)

       CAUTION: **Refer to Fastener Caution**

    2. Install the oil filter cap bolt (4) and tighten to 10 N.m (89 lb in)
    3. Install NEW Oil Pan Drain Plug Seal (2)
    4. Install and tighten Oil Pan Drain Plug (1) to 25 N.m (18 lb ft)

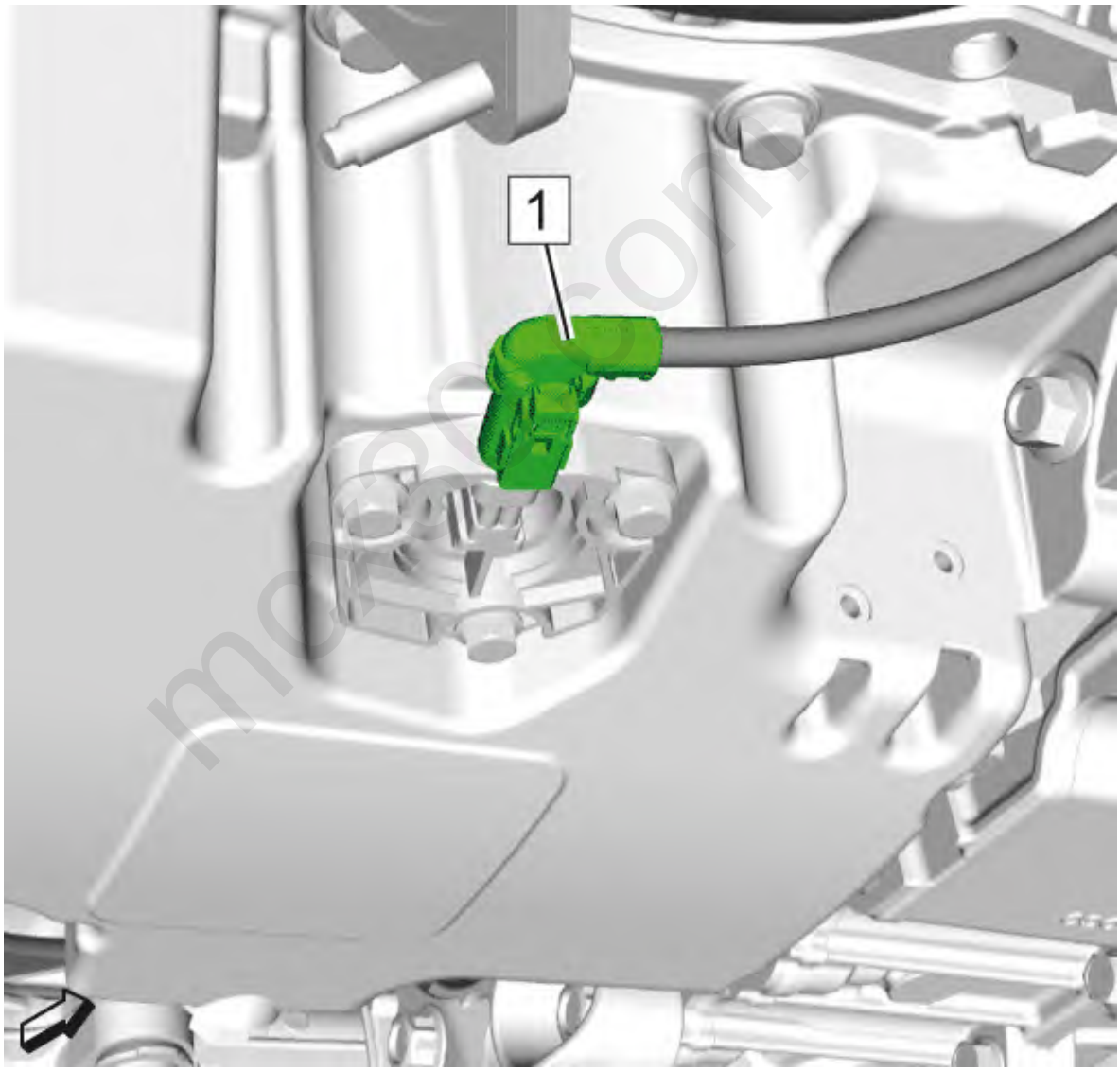


Fig. 385: Engine Oil Level Indicator Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

11. Disconnect Electrical Connector (1) @ Engine Oil Level Indicator

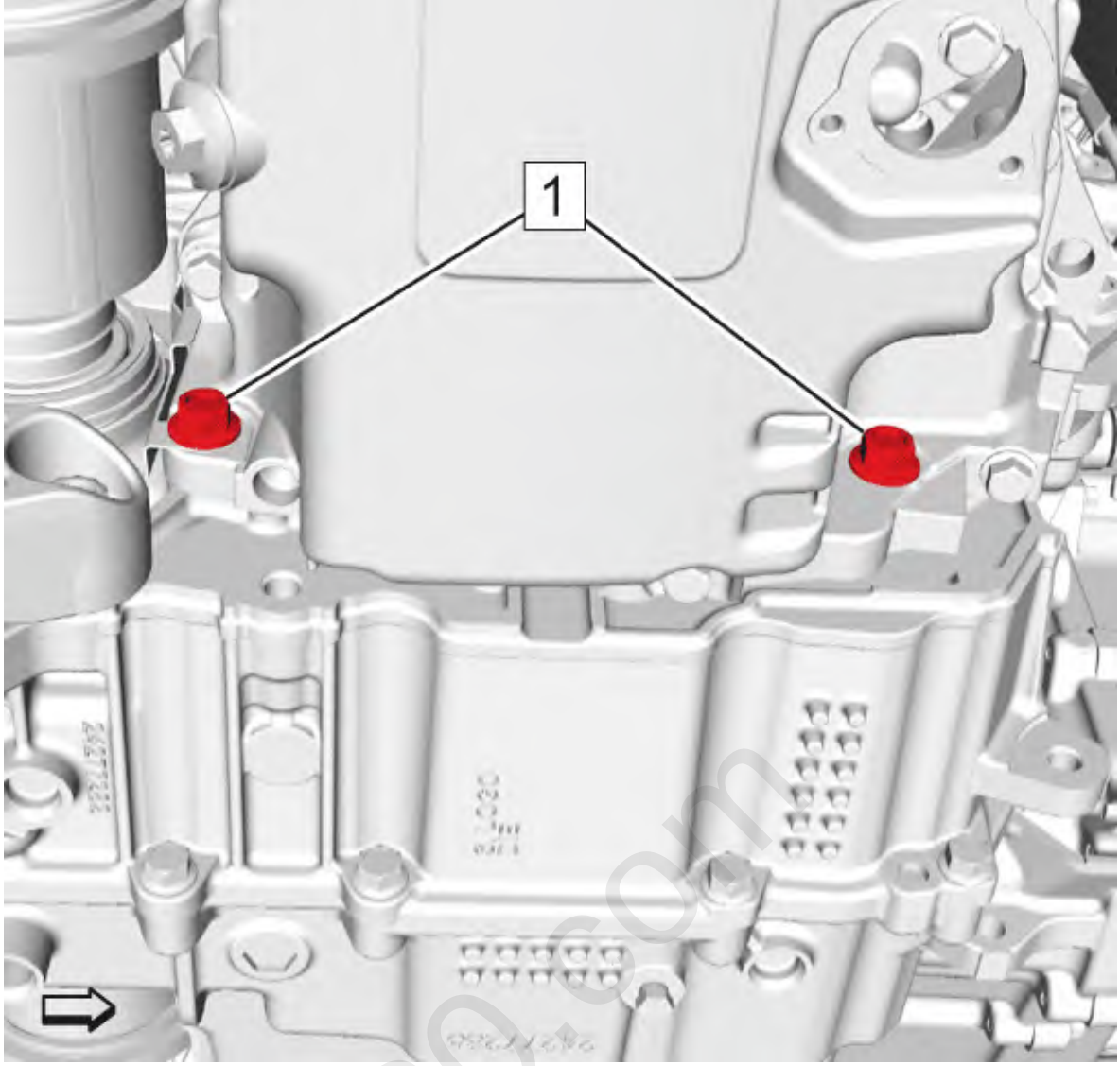


Fig. 386: Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Remove Transmission Bolts (1) (Qty: 2)

mcx30.com

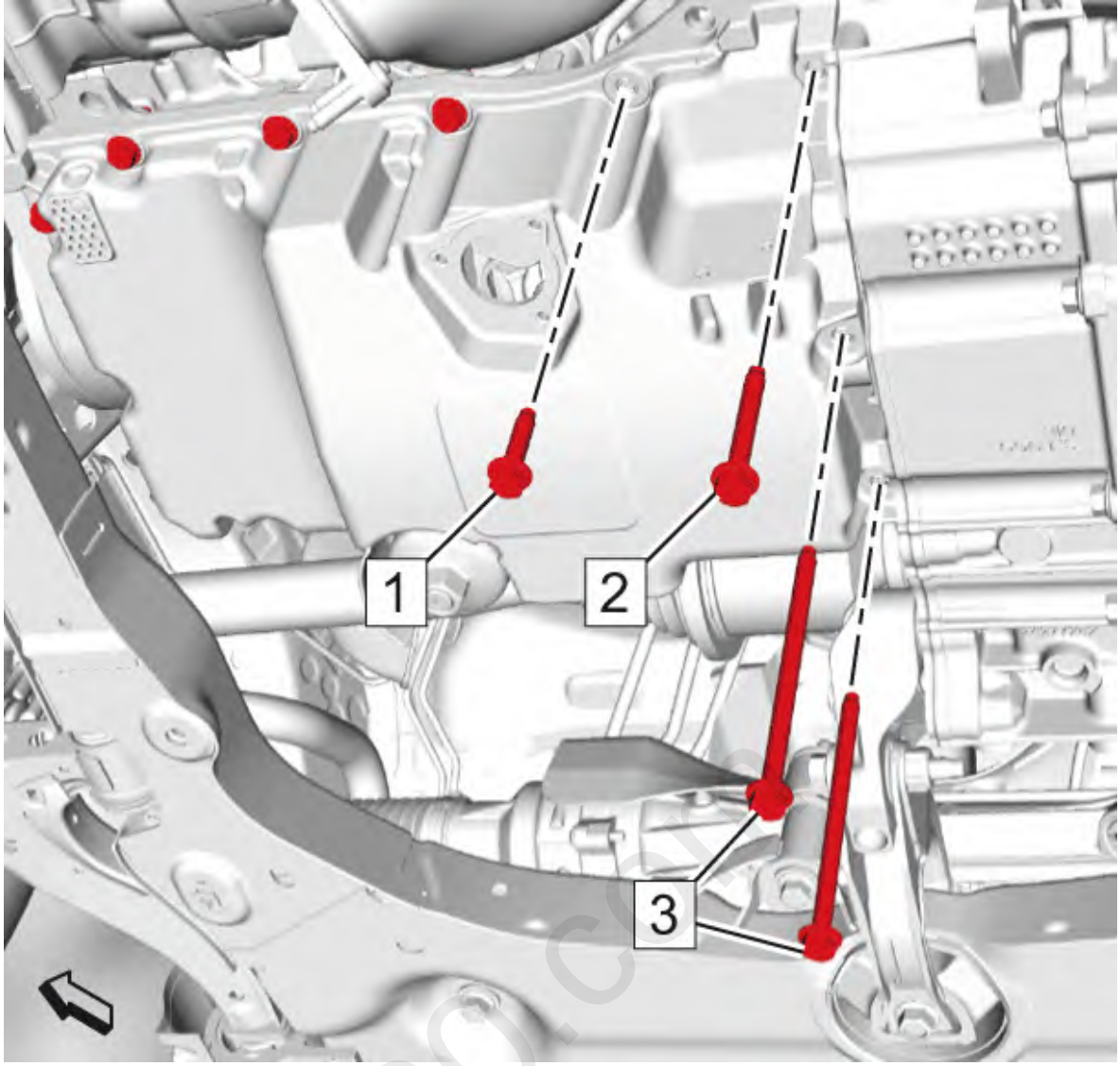


Fig. 387: Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Mark the position of the oil pan bolts because of different length.**

13. Remove Oil Pan Bolts (1, 2, 3) (Qty: 15)

mcx30.com

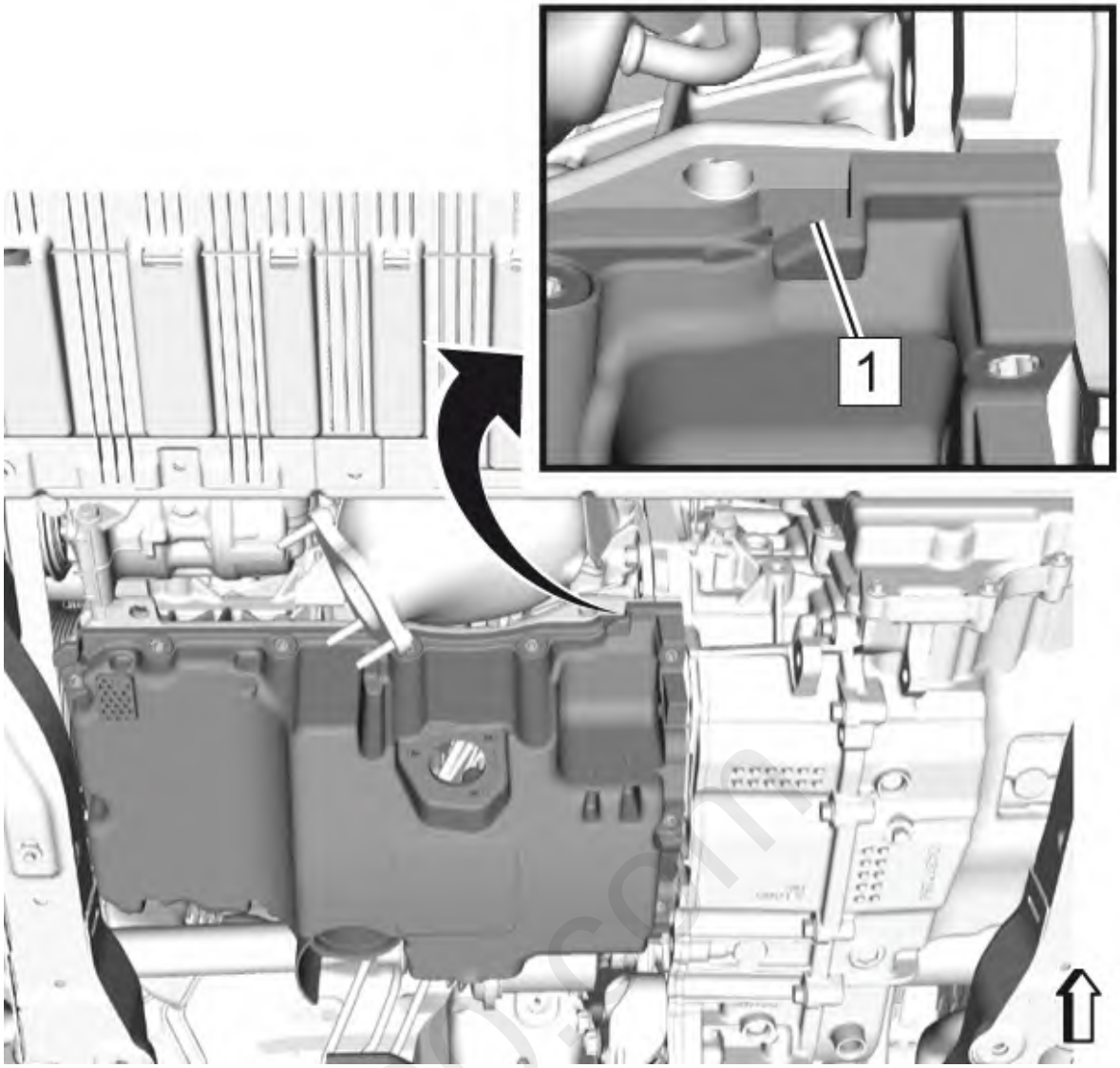


Fig. 388: Oil Pan Pry Point
Courtesy of GENERAL MOTORS COMPANY

14. Loosen the oil pan carefully from the lower cylinder block, use a suitable tool at the location as shown to pry (1).

mcx30.com

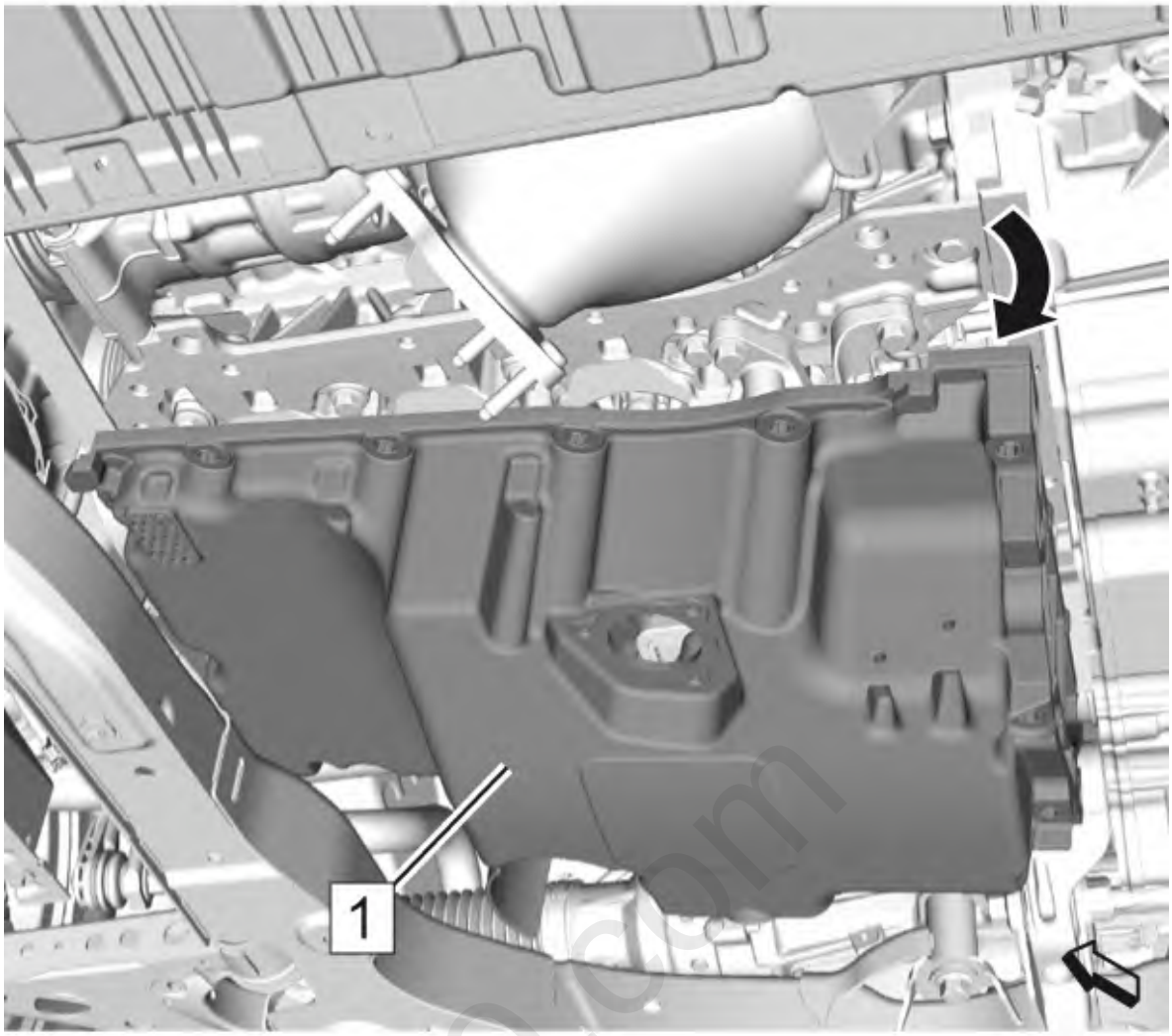


Fig. 389: Oil Pan
Courtesy of GENERAL MOTORS COMPANY

15. Remove Oil Pan (1)

mcx30.com

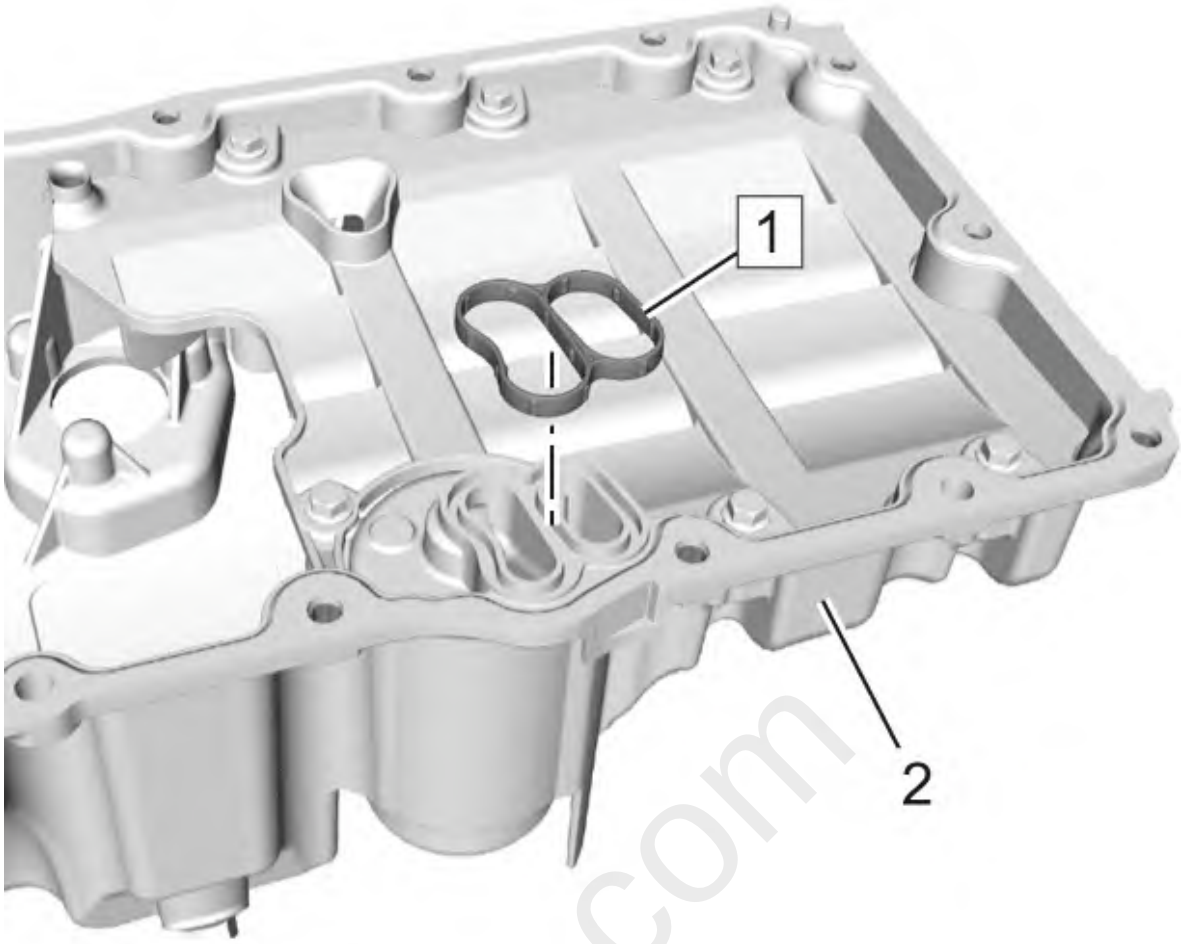


Fig. 390: Oil Filter Seal
Courtesy of GENERAL MOTORS COMPANY

16. Remove and DISCARD the oil filter seal (1)
17. Disassemble the oil pan. Refer to **Oil Pan Disassemble**

Installation Procedure

1. Clean all sealing surfaces.
2. Assemble the oil pan. Refer to **Oil Pan Assemble**

mcx30.com

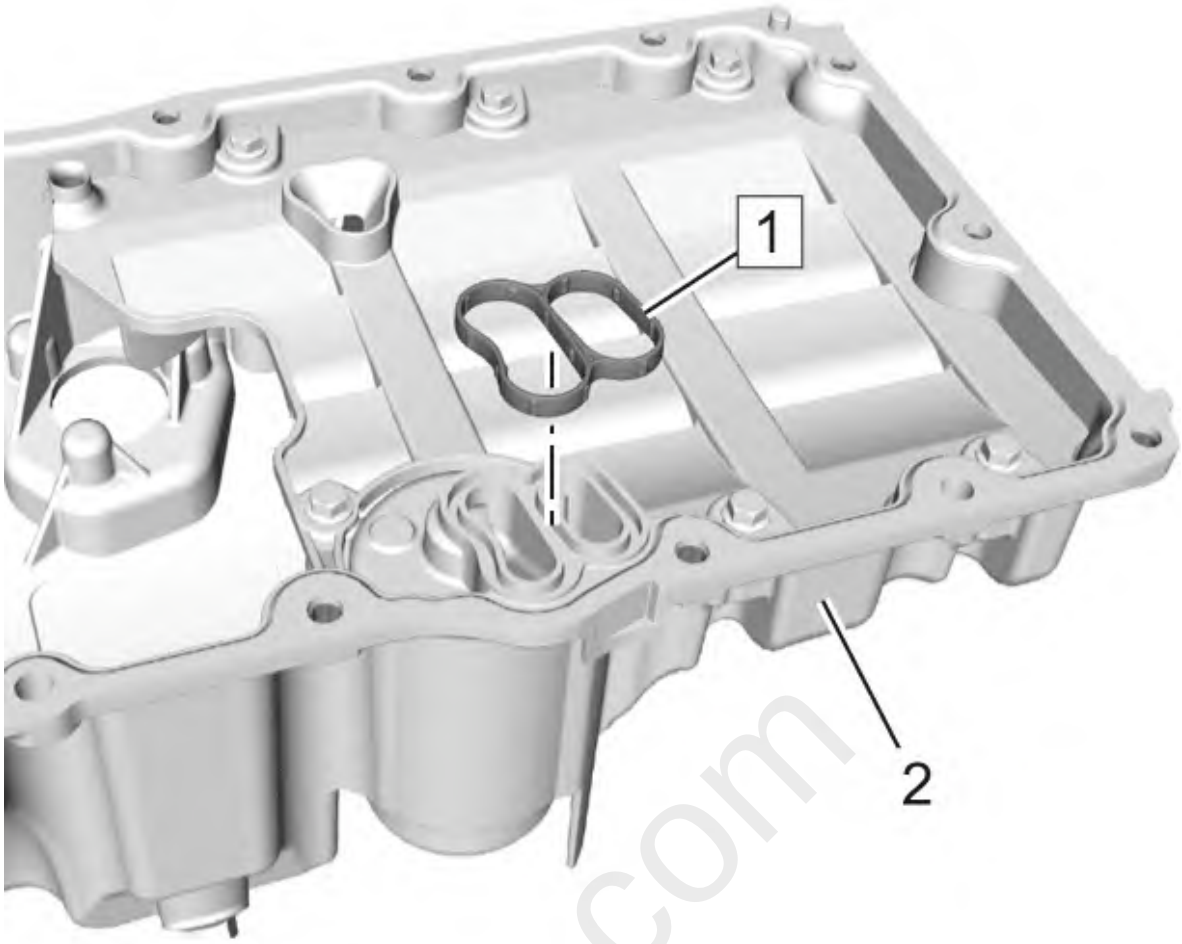


Fig. 391: Oil Filter Seal
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW oil filter seal (1)

mcx30.com

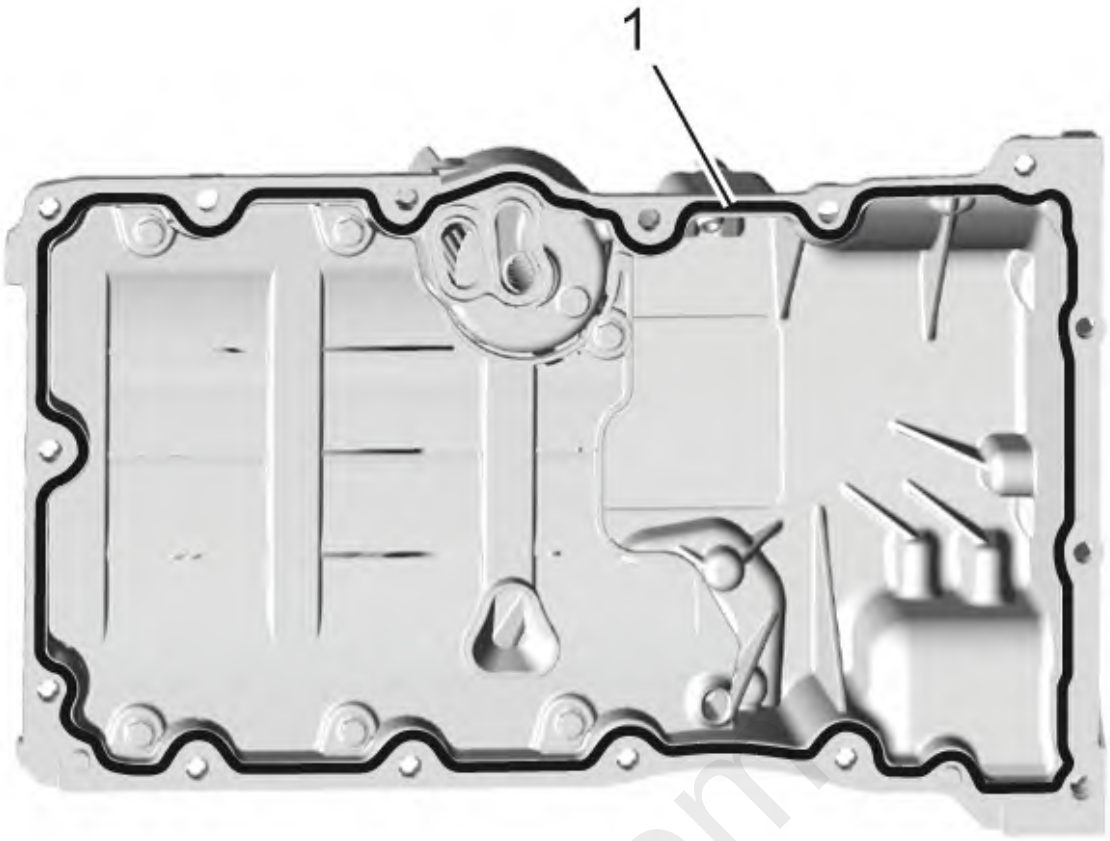


Fig. 392: Silicone Sealing Compound Application Area
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The complete installation procedure of the oil pan should be completed within 20 minutes.**

4. Apply silicone sealing compound (1) to the oil pan surface. The thickness of the sealing bead (1) should be 3.0 - 4.0 mm (0.118 - 0.157 in).

mcx30.com

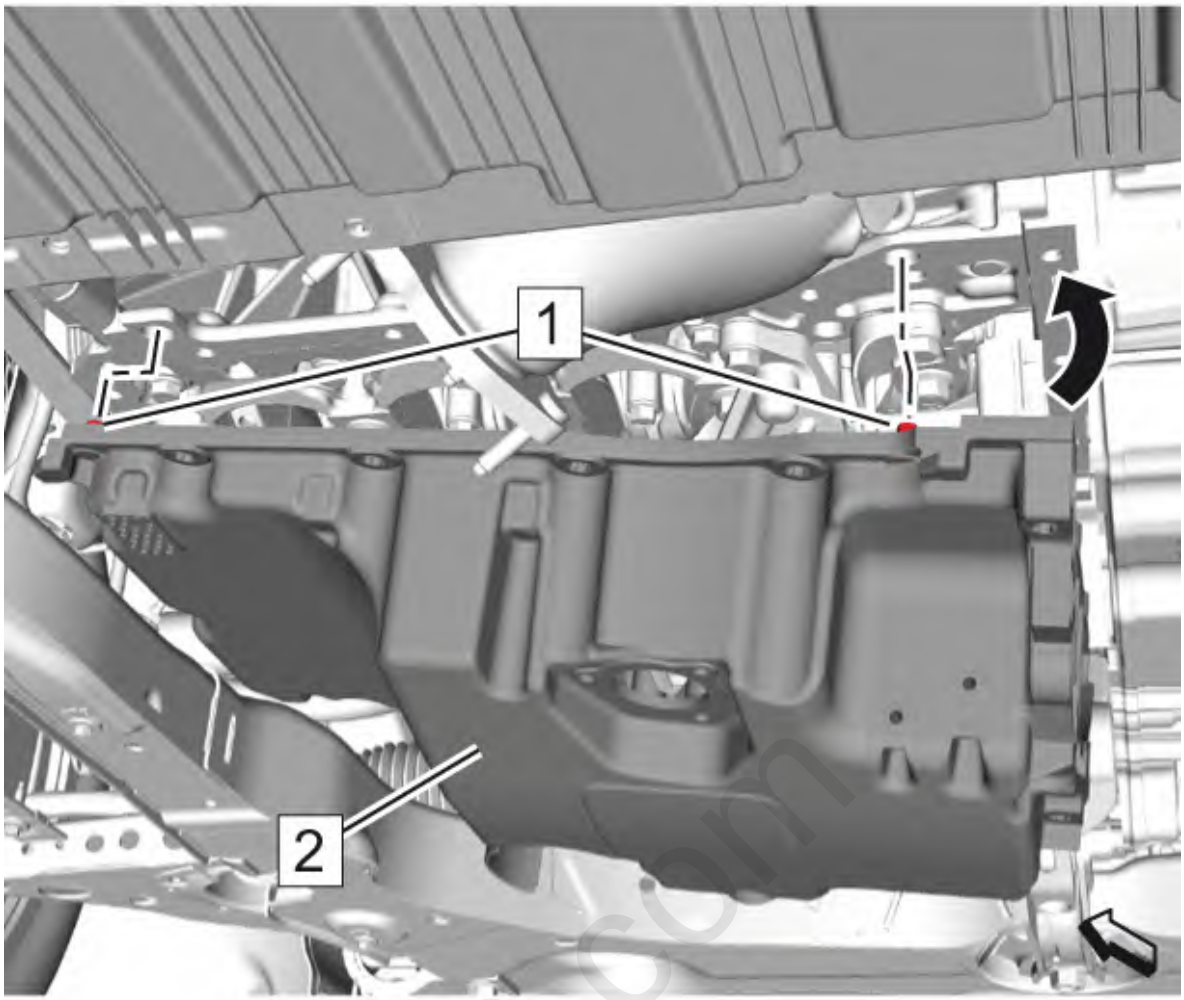


Fig. 393: Align Pins To Install Oil Pan
Courtesy of GENERAL MOTORS COMPANY

5. Install the oil pan (2) with the pins (1) in their holes.

mcx30.com

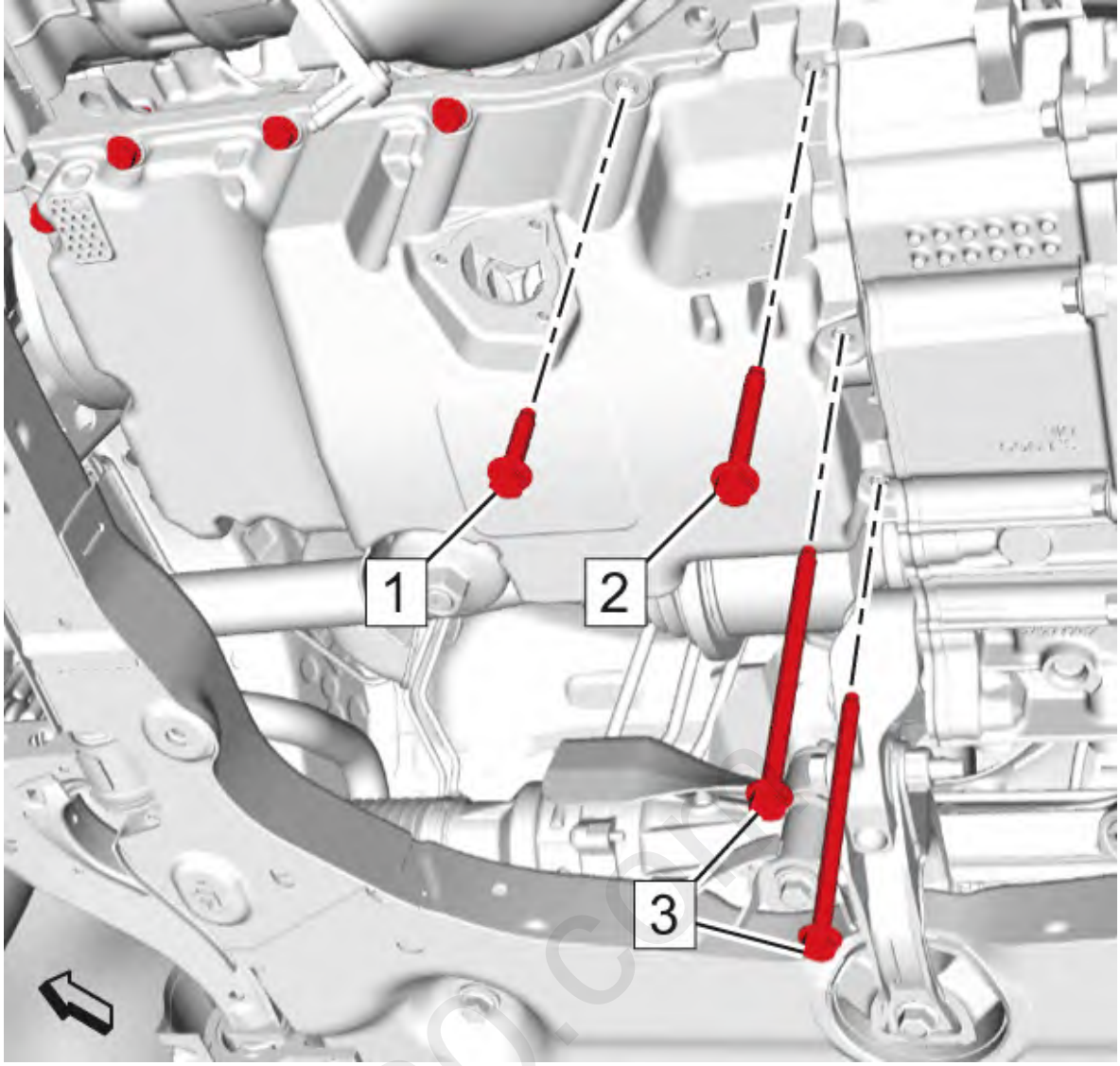


Fig. 394: Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Loosely install the oil pan bolts. (1, 2, 3) (Qty: 15)

mcx30.com

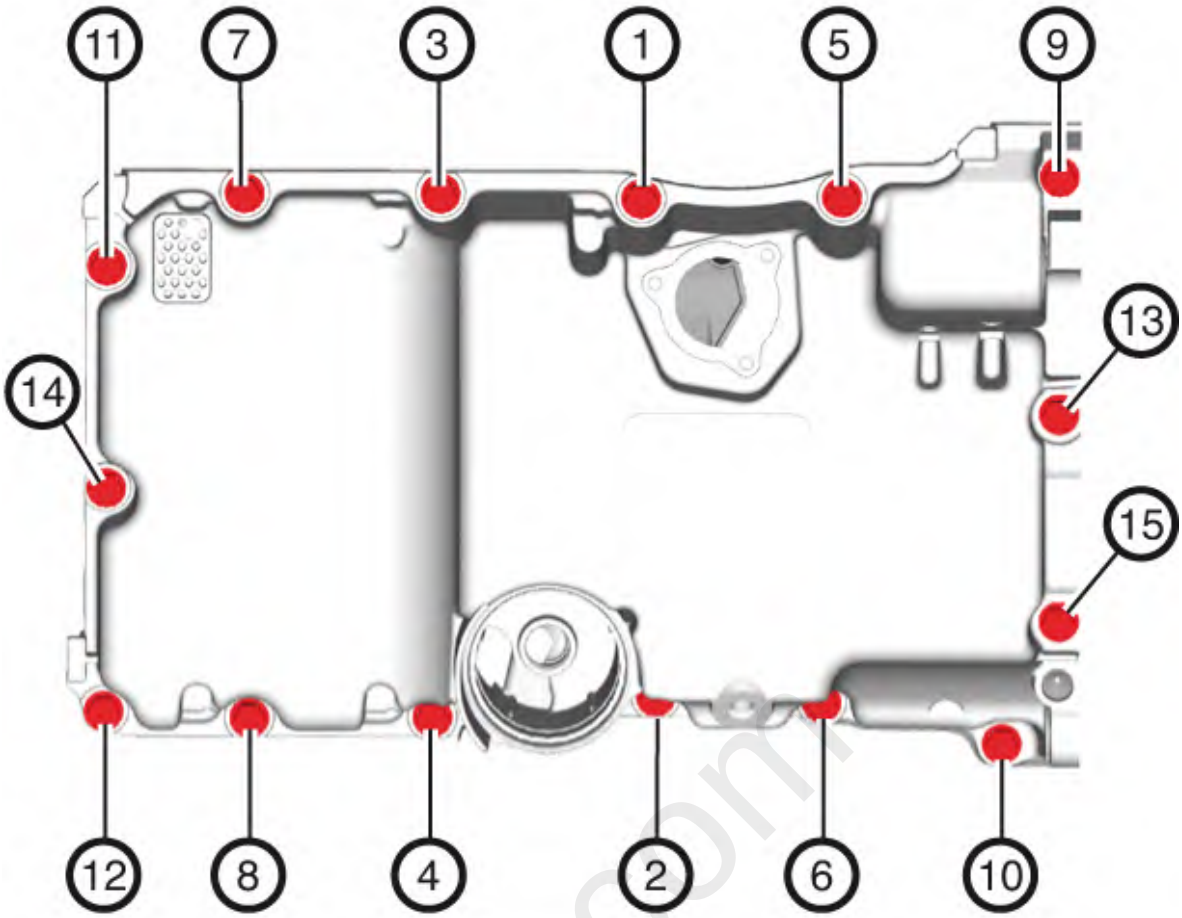


Fig. 395: Oil Pan Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution**

7. Tighten Oil Pan Bolts (Qty: 15) in sequence to 25 N.m (18 lb ft)

mcx30.com

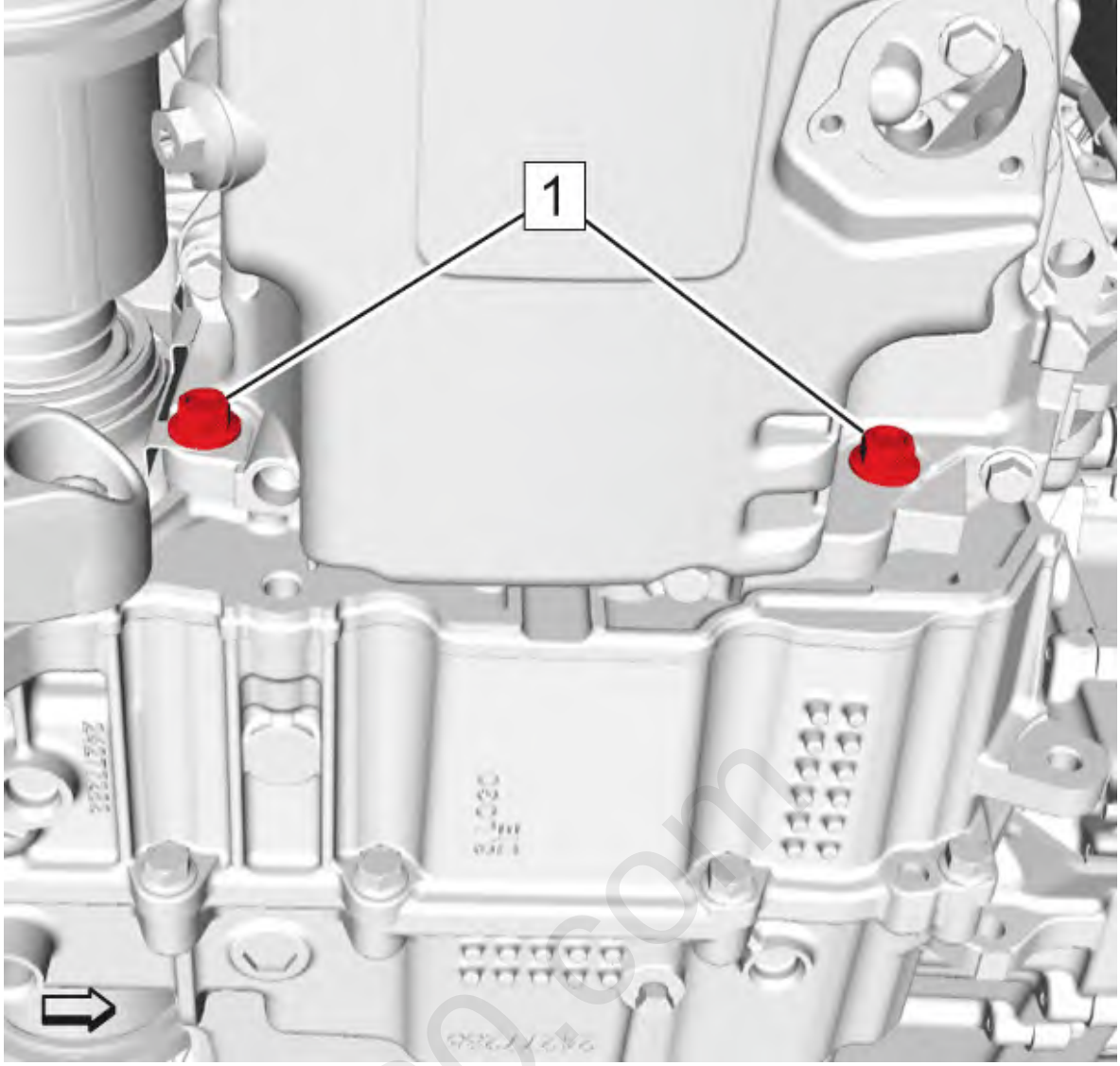


Fig. 396: Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install and tighten Transmission Bolts (1) (Qty: 2) to 58 N.m (43 lb ft).

mcx30.com

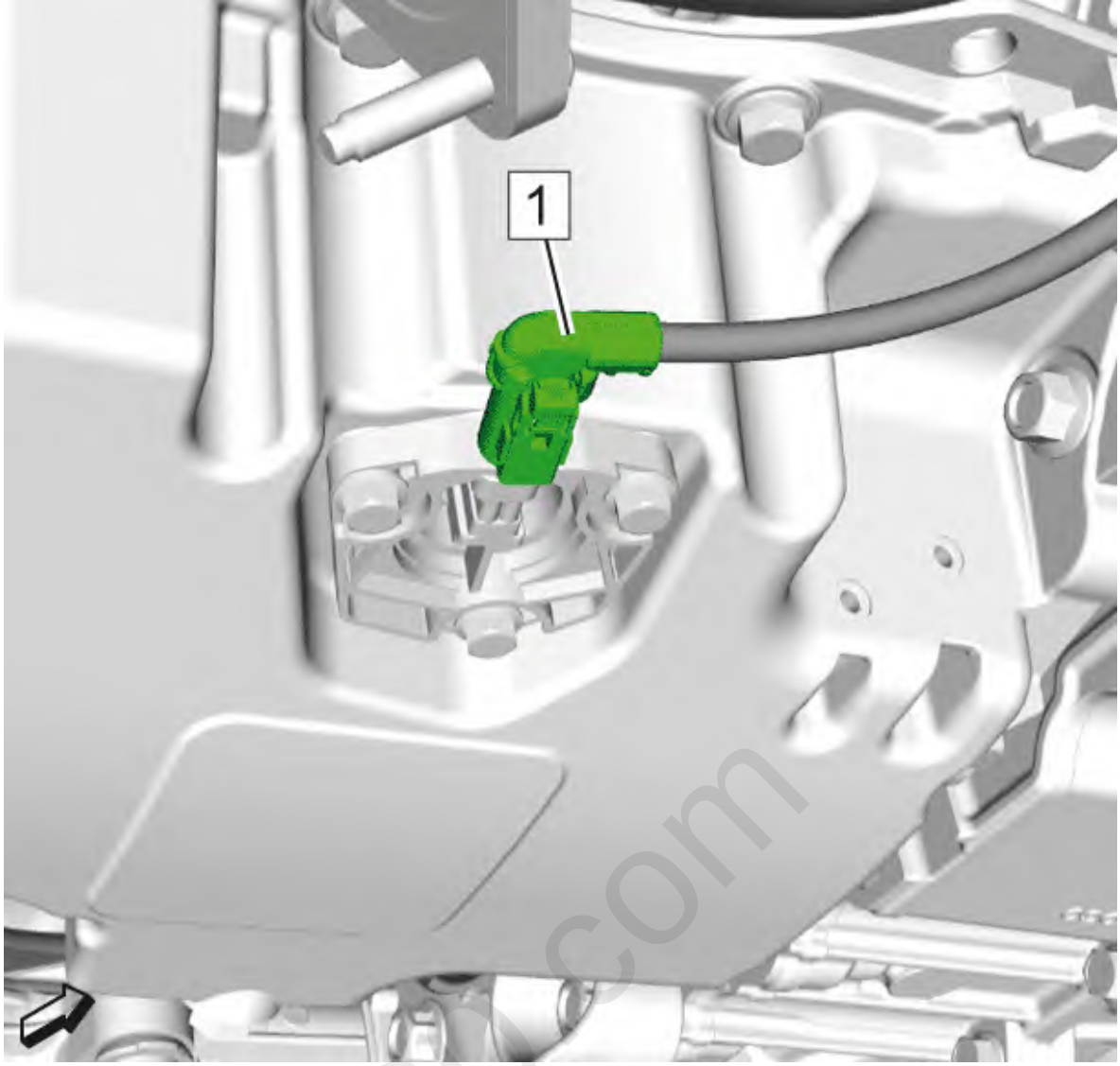


Fig. 397: Engine Oil Level Indicator Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

9. Connect Electrical Connector (1) @ Engine Oil Level Indicator
10. Install the engine oil heater. Refer to **Engine Oil Heater Replacement**
11. Install Exhaust Front Pipe. Refer to **Exhaust Front Pipe Replacement (LH7)** .
12. Install the oil level indicator. Refer to **Oil Level Indicator Replacement**
13. Fill and check the engine oil level. Refer to **Engine Oil and Oil Filter Replacement**

PISTON, CONNECTING ROD, AND BEARING REPLACEMENT

Special Tools

- **CH-904** Base Frame
- **CH-49290** Engine Support Tool
- **EN-45059** Angle Meter
- **EN-51140** Crankshaft Fixing Tool

Equivalent regional tools: **Special Tools**.

Removal Procedure

1. Remove Cylinder Head. Refer to **Cylinder Head Replacement**

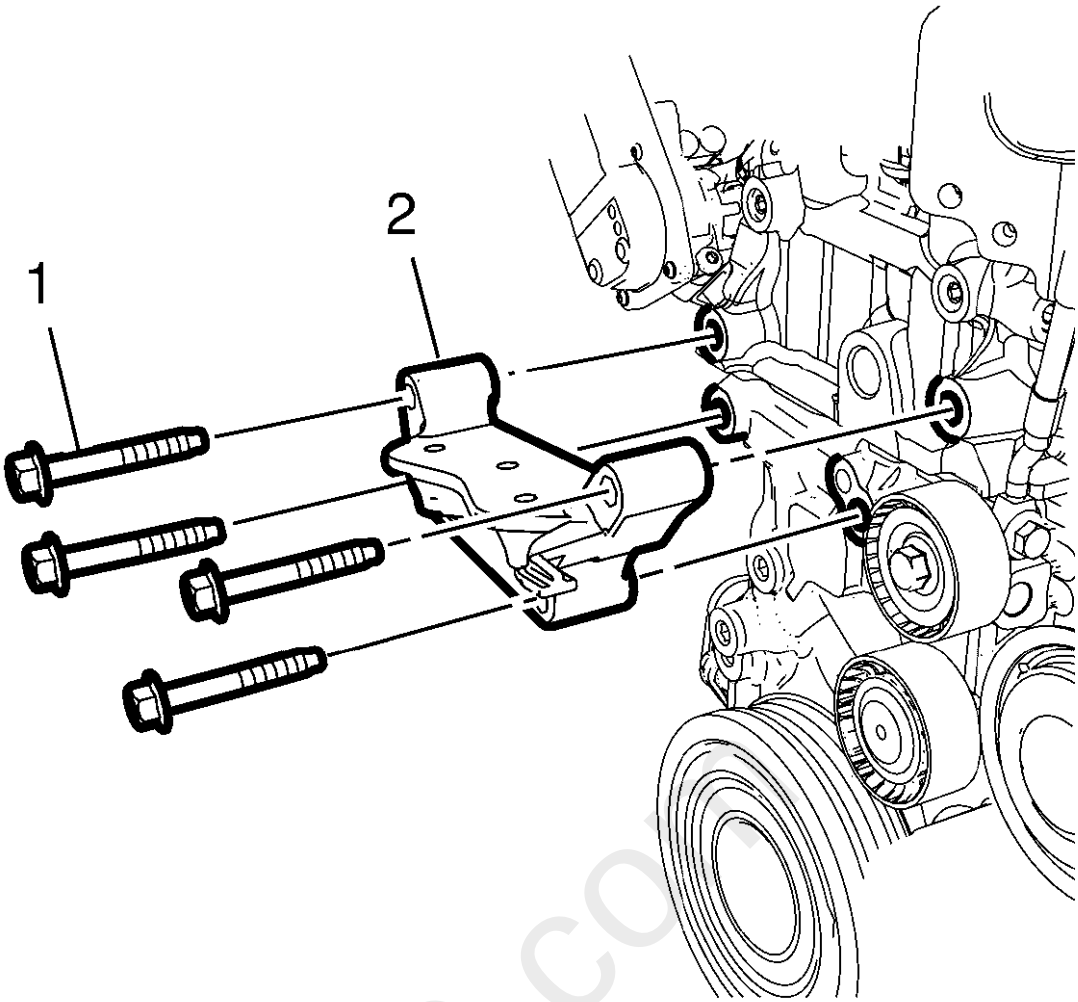


Fig. 398: Engine Mount Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install Engine Mount Bracket (2)
3. Install the 2 lower engine mount bracket bolts (1) to the engine block and tighten to 58 N.m (43 lb ft).
4. Install Engine Mount. Refer to **Engine Mount Replacement**
5. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle**

NOTE: **The service information is supplied with the special tool and is also available online. Go to https://gmtoolsandequipment.com.**

6. Lower the **CH-49290** support tool with the **CH-904** base frame and a jack.
7. Remove Oil and Power Brake Booster Pump. Refer to **Oil and Power Brake Booster Pump Replacement**

mcx30.com

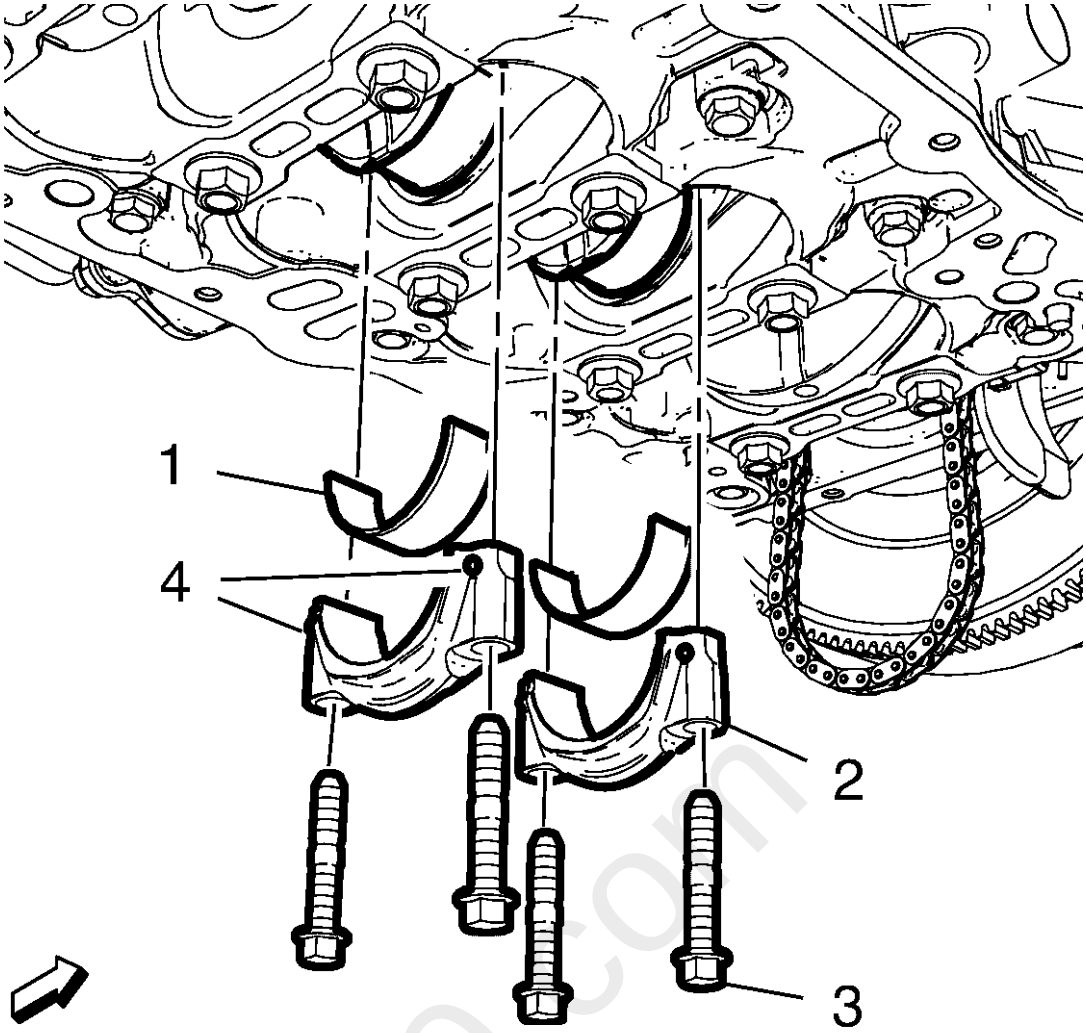


Fig. 399: Cylinder 2 And 3 Connecting Rod Caps, Bolts And Lower Bearings
Courtesy of GENERAL MOTORS COMPANY

8. Remove and DISCARD the 4 connecting rod bearing cap bolts (3) from the cylinder 2 and the cylinder 3.

NOTE: **Lay aside in the order as they was removed.**

NOTE: **The shear surfaces of the connecting rod and the connecting rod bearing cap form a unique fit and must not be swapped or damaged. Do not lay down on the shear surfaces.**

9. Remove the 2 connecting rod bearing caps (2) from the cylinder 2 and the cylinder 3.

NOTE: **Lay aside in the order as they was removed.**

10. Remove the 2 connecting rod lower bearings (1).
11. Lower the vehicle.

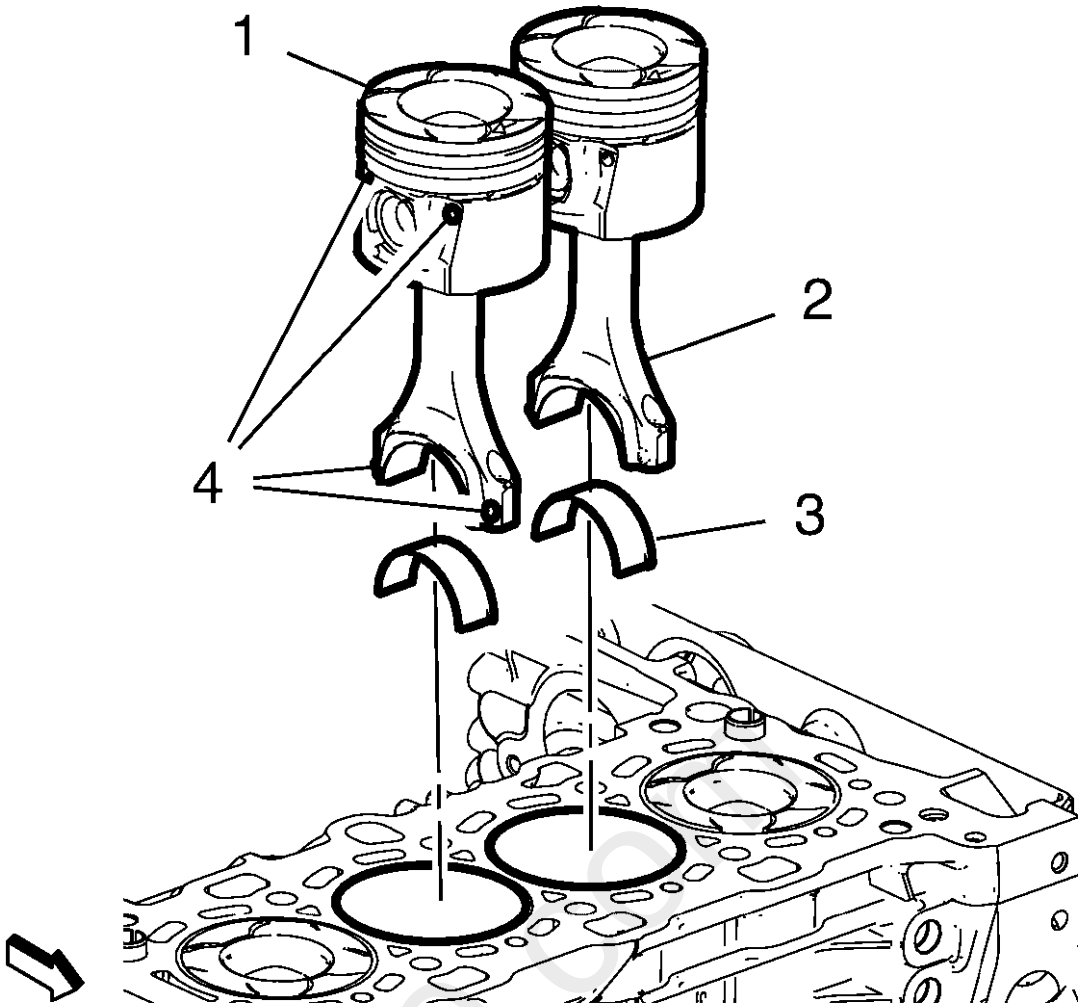


Fig. 400: Cylinder 2 And 3 Piston/Connecting Rod Assemblies And Upper Bearings
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Lay aside in the order as they was removed.**

12. Push the 2 pistons (1) with the 2 connecting rods (2) out of the cylinder 2 and the cylinder 3 upwards.

NOTE: **Lay aside in the order as they was removed.**

13. Remove the 2 connecting rod upper bearings (3) from the 2 connecting rods (2).
14. Raise the vehicle.

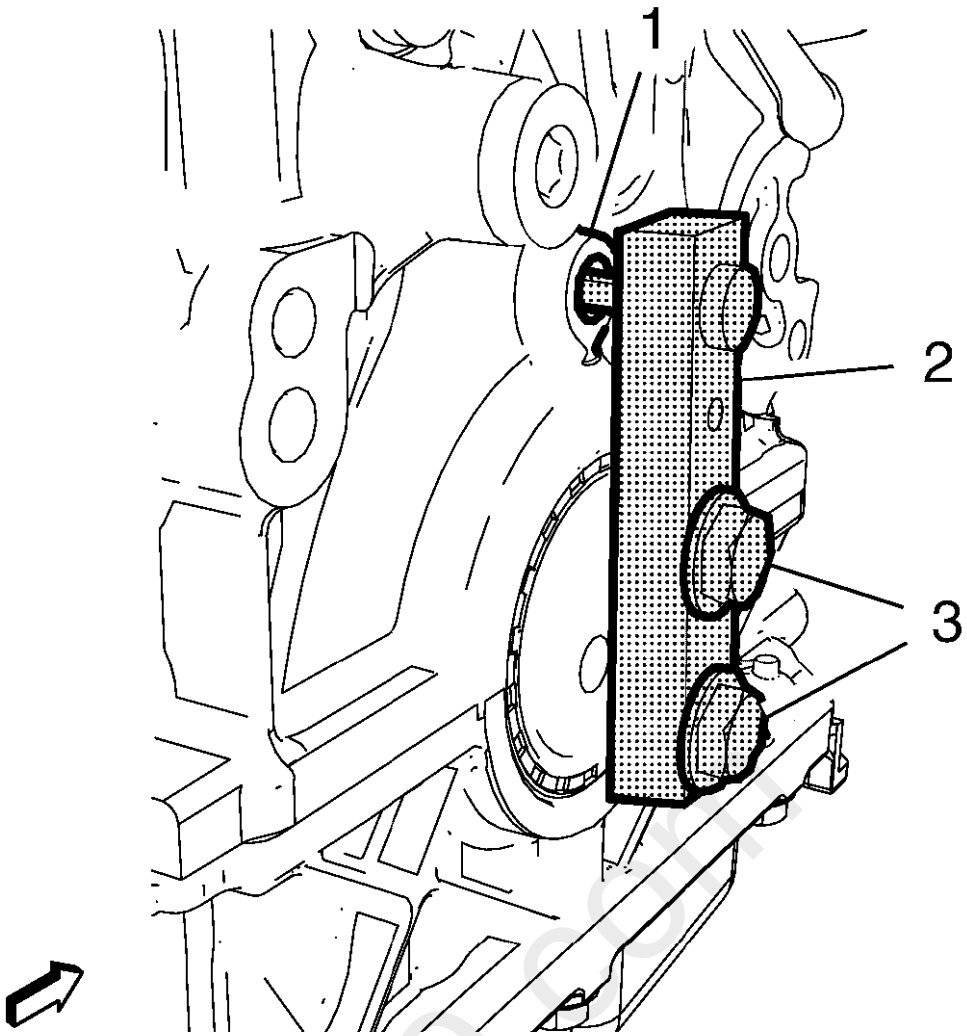


Fig. 401: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

15. Remove the 2 bolts (3).
16. Remove the **EN-51140** fixing tool (2).

mcx30.com

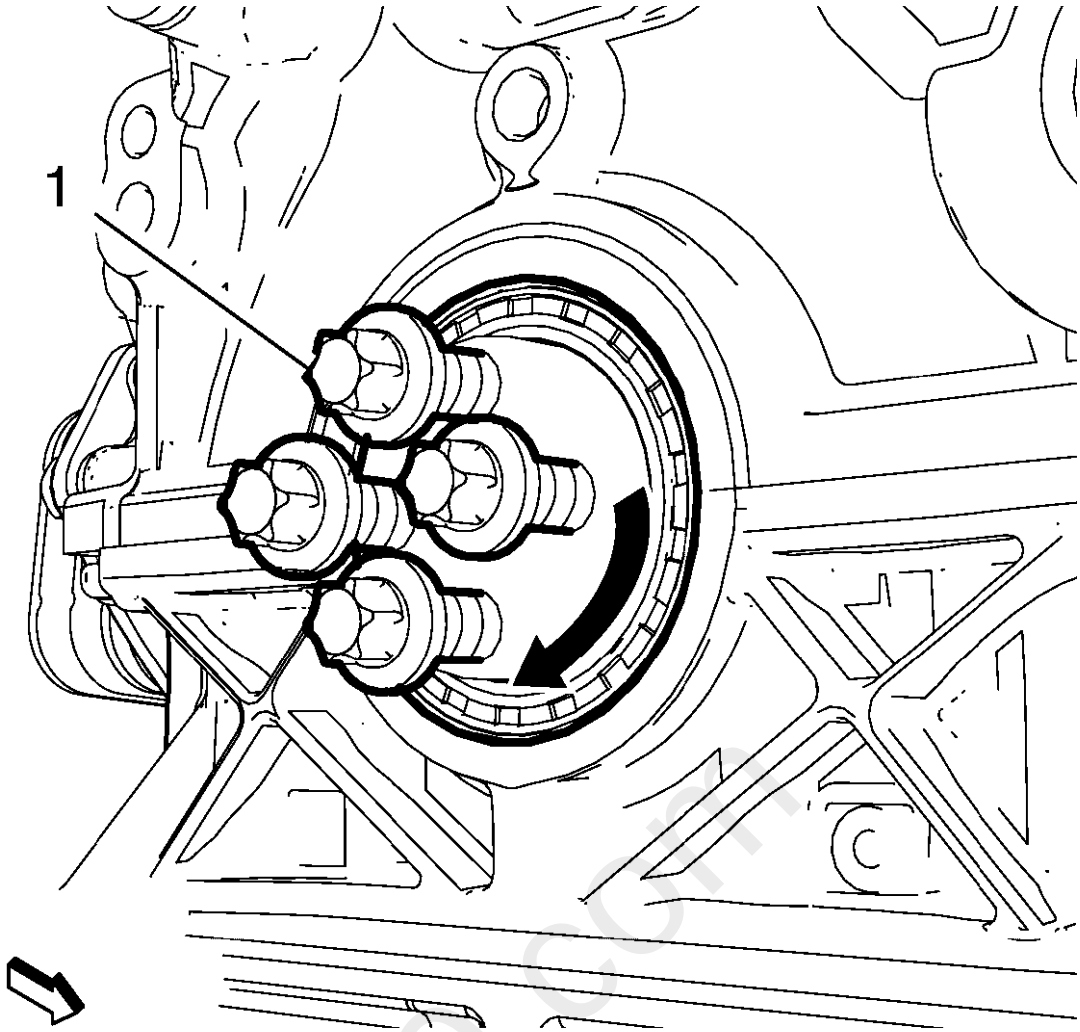


Fig. 402: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

17. Install the 4 crankshaft pulley bolts (1).

mcx30.com

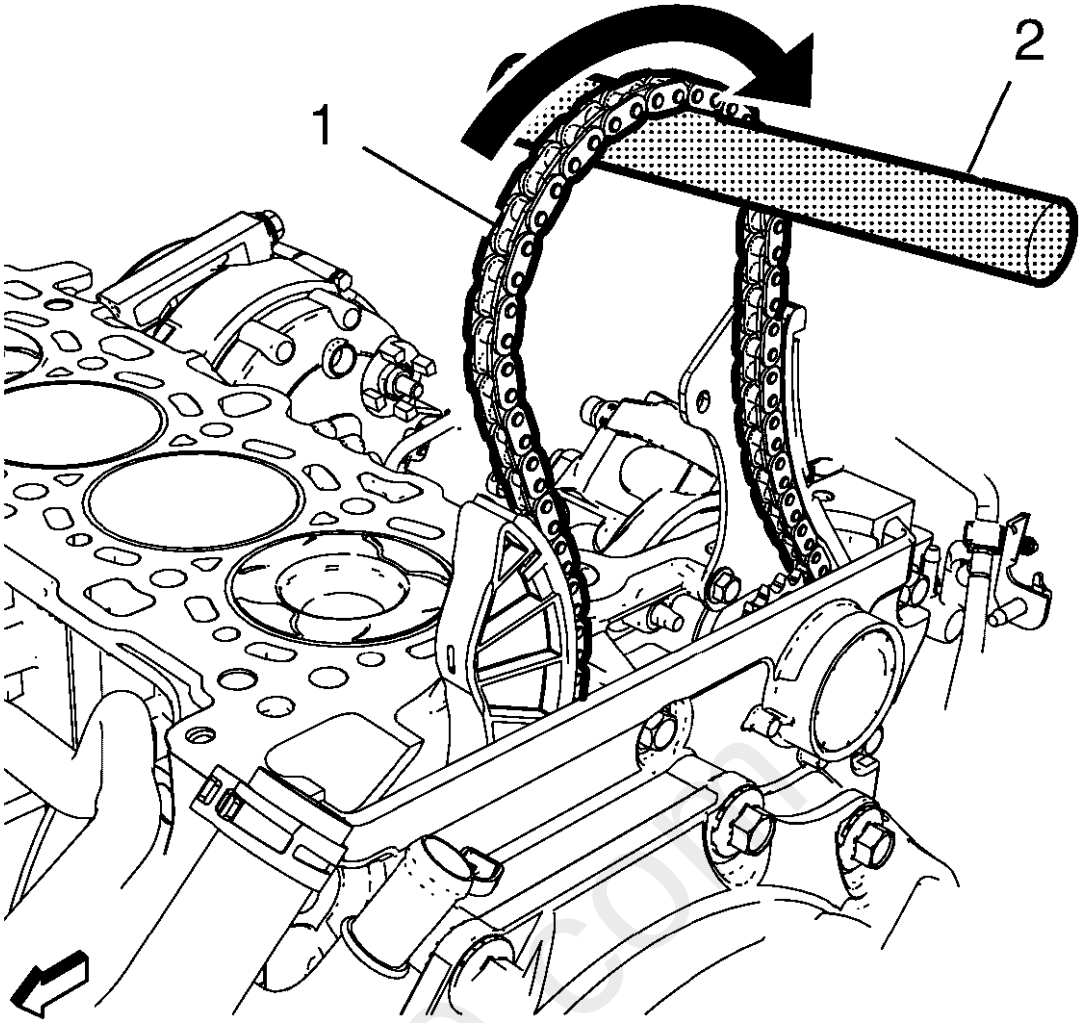


Fig. 403: Timing Chain And Suitable Tool
Courtesy of GENERAL MOTORS COMPANY

18. Hold the timing chain (1) up with a suitable tool like a extension (2).

NOTE: **A second technician is required.**

19. Set the cylinder 2 to TDC. Rotate the crankshaft 180 degrees, use a pry bar at the 4 crankshaft pulley bolts (1).

mcx30.com

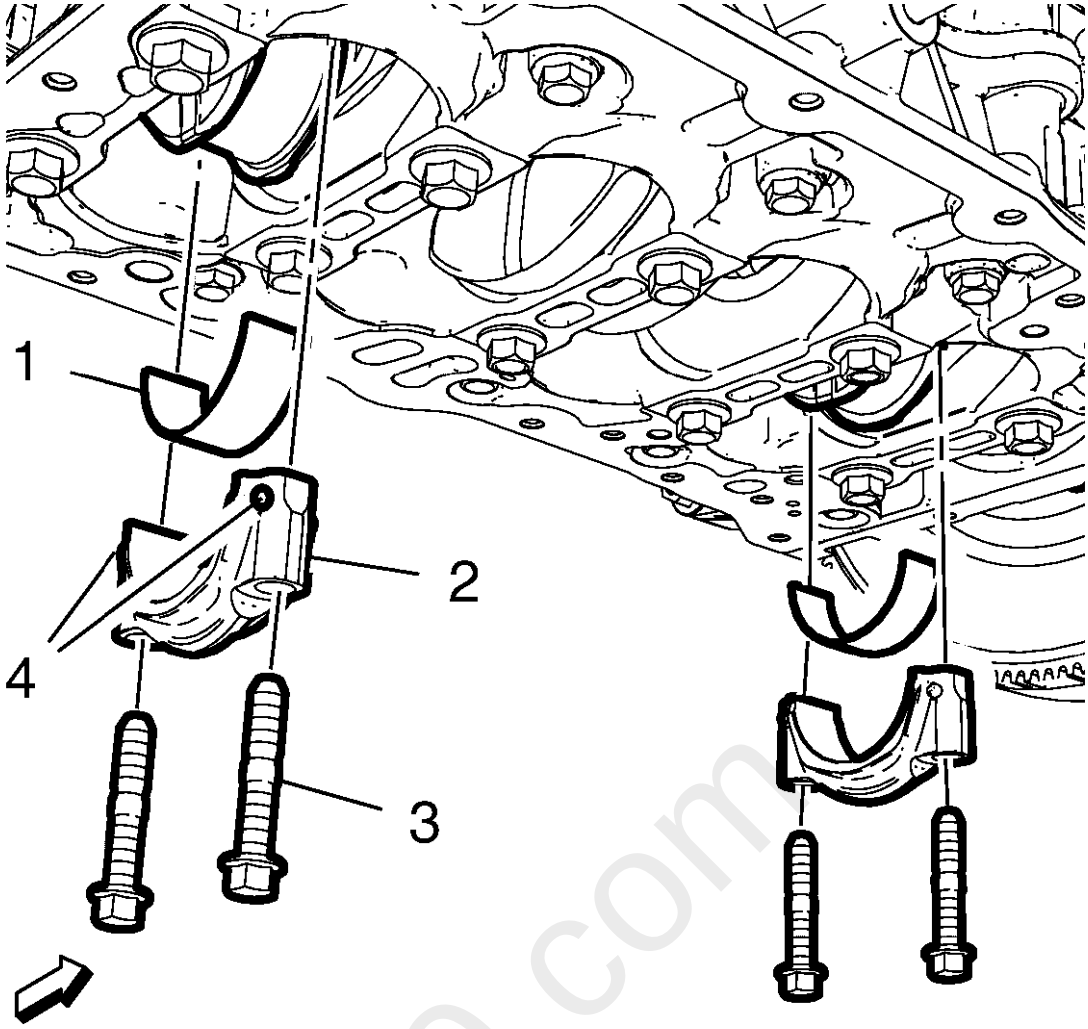


Fig. 404: Cylinder 1 And 4 Connecting Rod Caps, Bolts And Lower Bearings
Courtesy of GENERAL MOTORS COMPANY

20. Remove and DISCARD the 4 connecting rod bearing cap bolts (3) from the cylinder 1 and the cylinder 4.

NOTE: **Lay aside in the order as they was removed.**

NOTE: **The shear surfaces of the connecting rod and the connecting rod bearing cap form a unique fit and must not be swapped or damaged. Do not lay down on the shear surfaces.**

21. Remove the 2 connecting rod bearing caps (2) from the cylinder 1 and the cylinder 4.

NOTE: **Lay aside in the order as they was removed.**

22. Remove the 2 connecting rod lower bearings (1).
23. Lower the vehicle.

mcx30.com

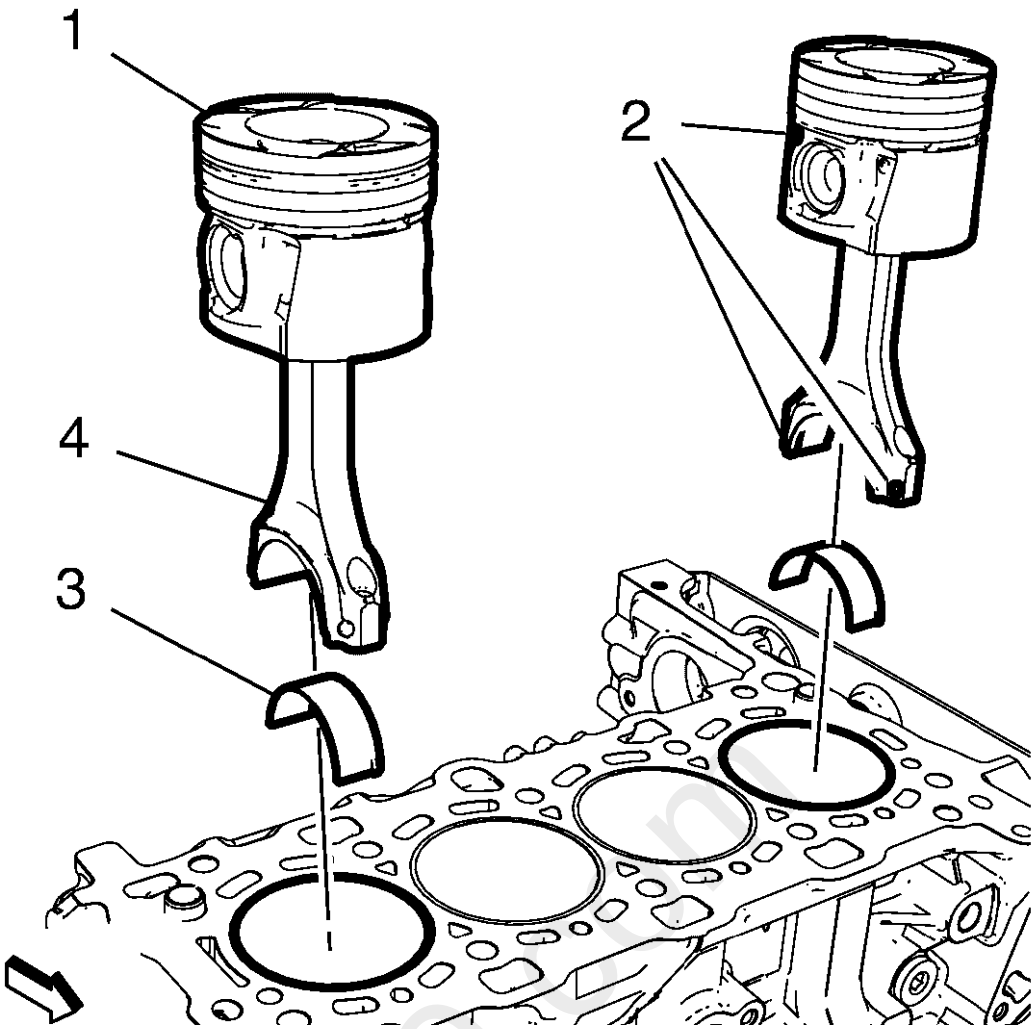


Fig. 405: Cylinder 1 And 4 Piston/Connecting Rod Assemblies And Upper Bearings
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Lay aside in the order as they was removed.**

24. Push the 2 pistons (1) with the 2 connecting rods (4) out of the cylinder 1 and the cylinder 4 upwards.

NOTE: **Lay aside in the order as they was removed.**

25. Remove the 2 connecting rod upper bearings (3) from the 2 connecting rods (4).
26. Disassemble the piston and connecting rod. Refer to **Piston and Connecting Rod Disassemble**.

Installation Procedure

1. Assemble the piston and connecting rod. Refer to **Piston and Connecting Rod Assemble**.

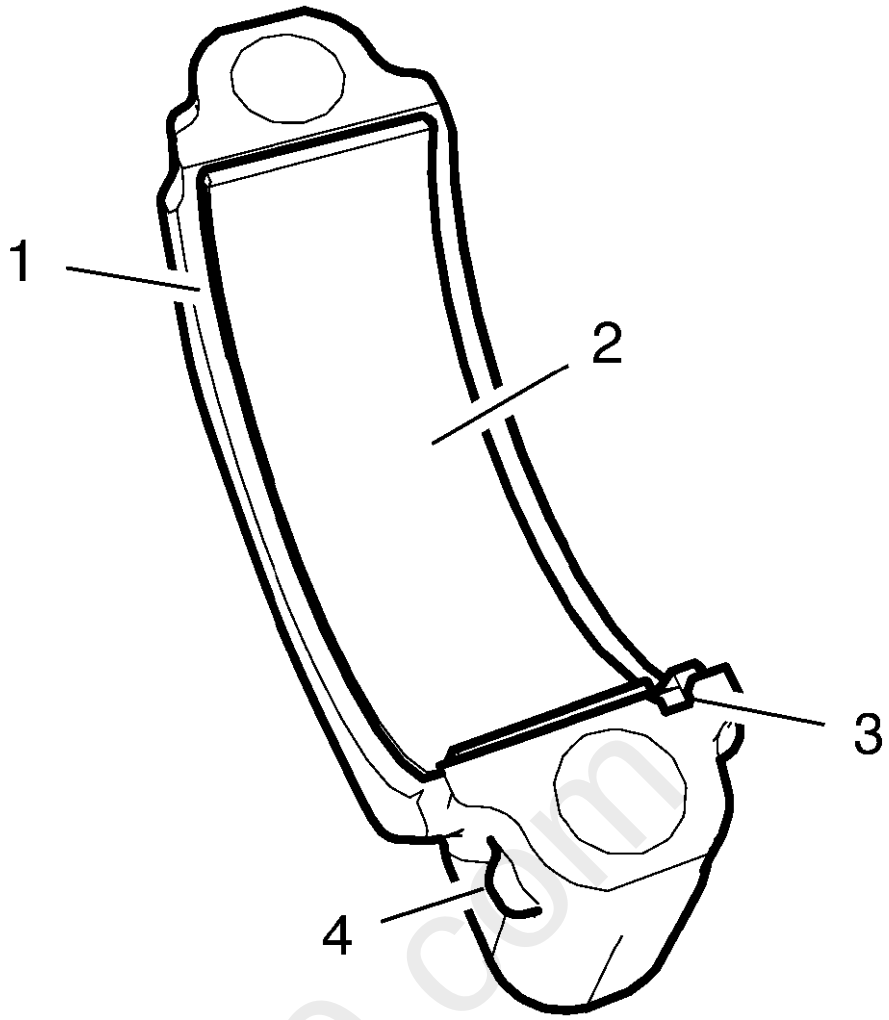


Fig. 406: Connecting Rod Bearings, Caps And Oil Notches
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the proper seat of the oil notches (3).**

NOTE: **If the old connecting rod bearings will be reused, install in their original position.**

2. Install the 8 connecting rod bearings (2) to the connecting rod bearing cap (1) and the connecting rod.
3. Coat the 8 connecting rod bearings and cylinder bores with engine oil.

mcx30.com

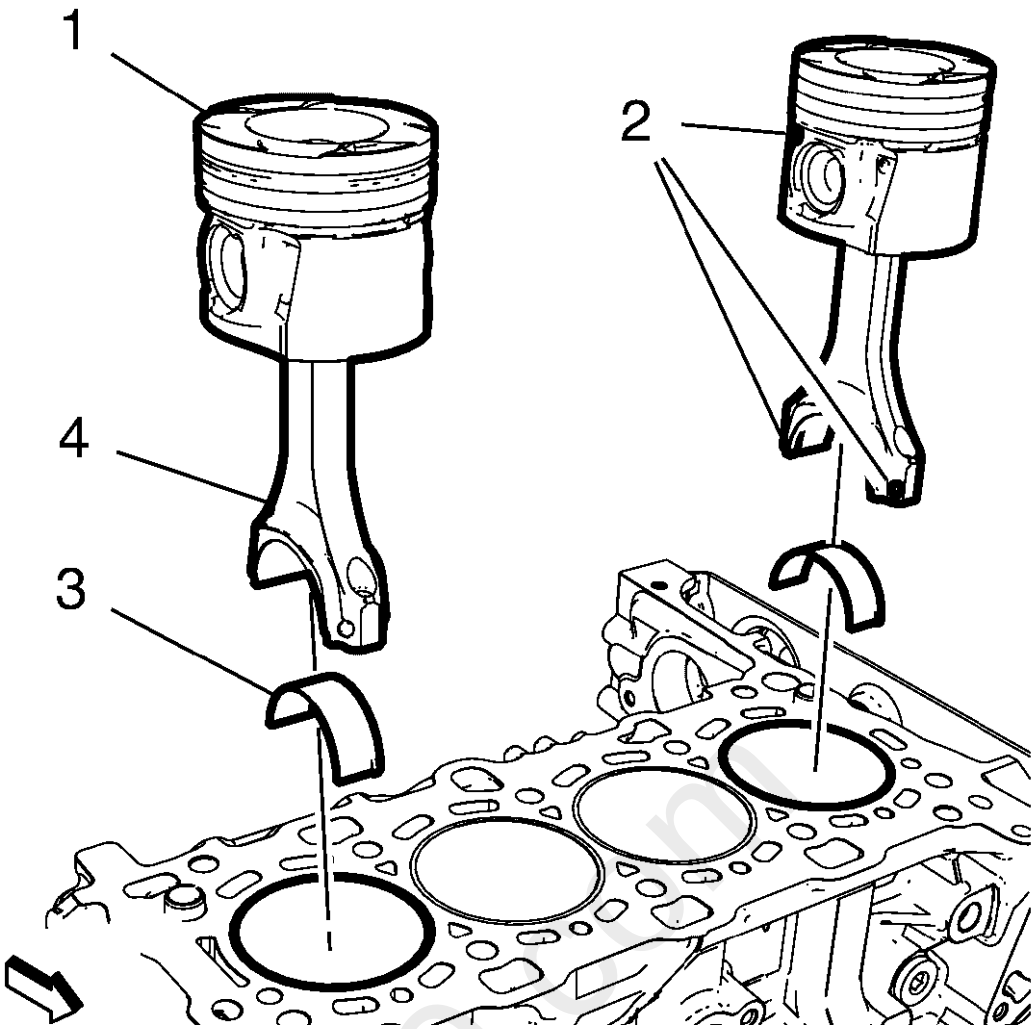


Fig. 407: Cylinder 1 And 4 Piston/Connecting Rod Assemblies And Upper Bearings
Courtesy of GENERAL MOTORS COMPANY

4. Install a piston ring compressor in order to compress the piston rings.

NOTE: **The arrow on the top of the piston and the marks (2) of the piston and connecting rod, must point to front of the engine.**

NOTE: **If the old piston and connecting rod will be reused, install in their original position.**

5. Install the 2 pistons (1) and the 2 connecting rods (4) with the connecting rod upper bearing (3) to the cylinder 1 and the cylinder 4.

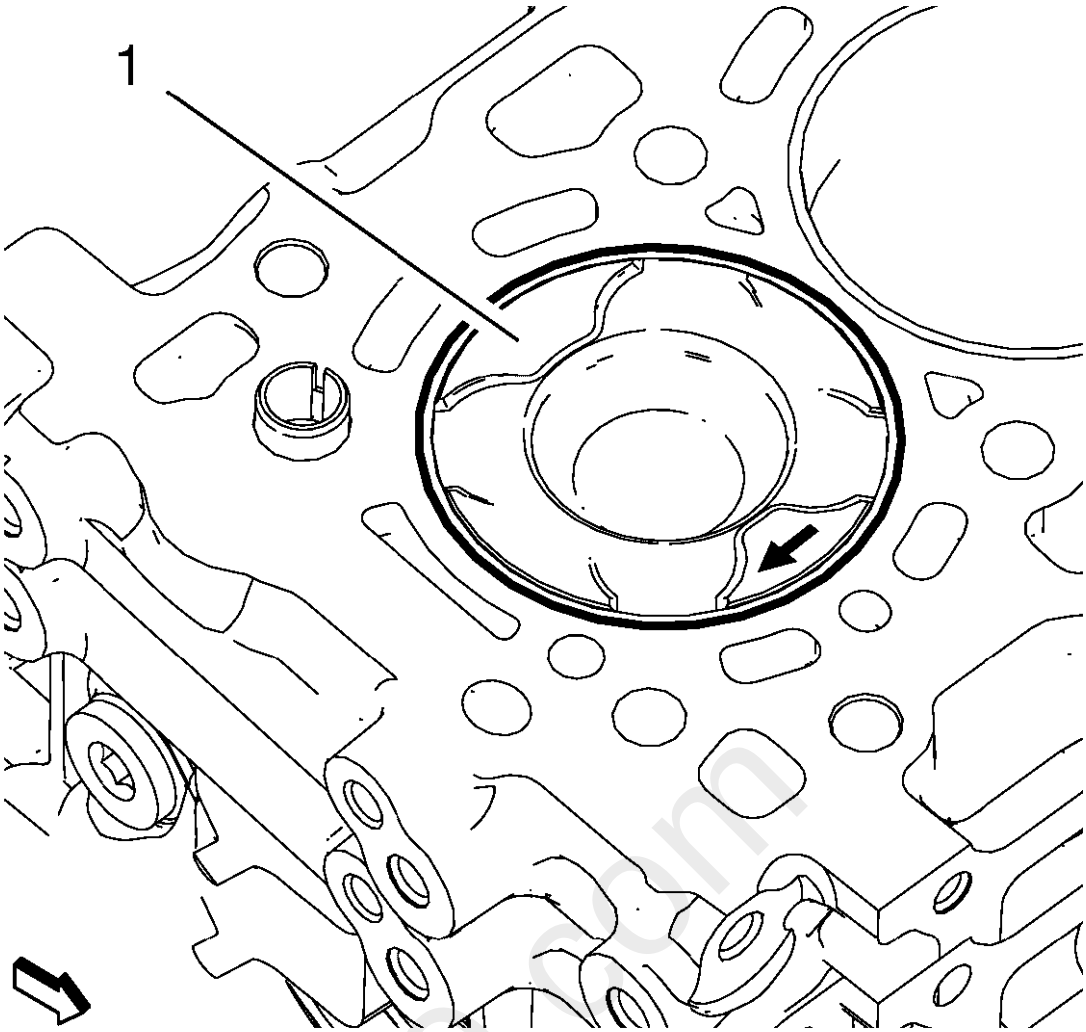


Fig. 408: Arrow On Top Of Pistons Must Point To Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

6. The arrow on the top of the pistons (1) must point to front of the engine.
7. Raise the vehicle.

mcx30.com

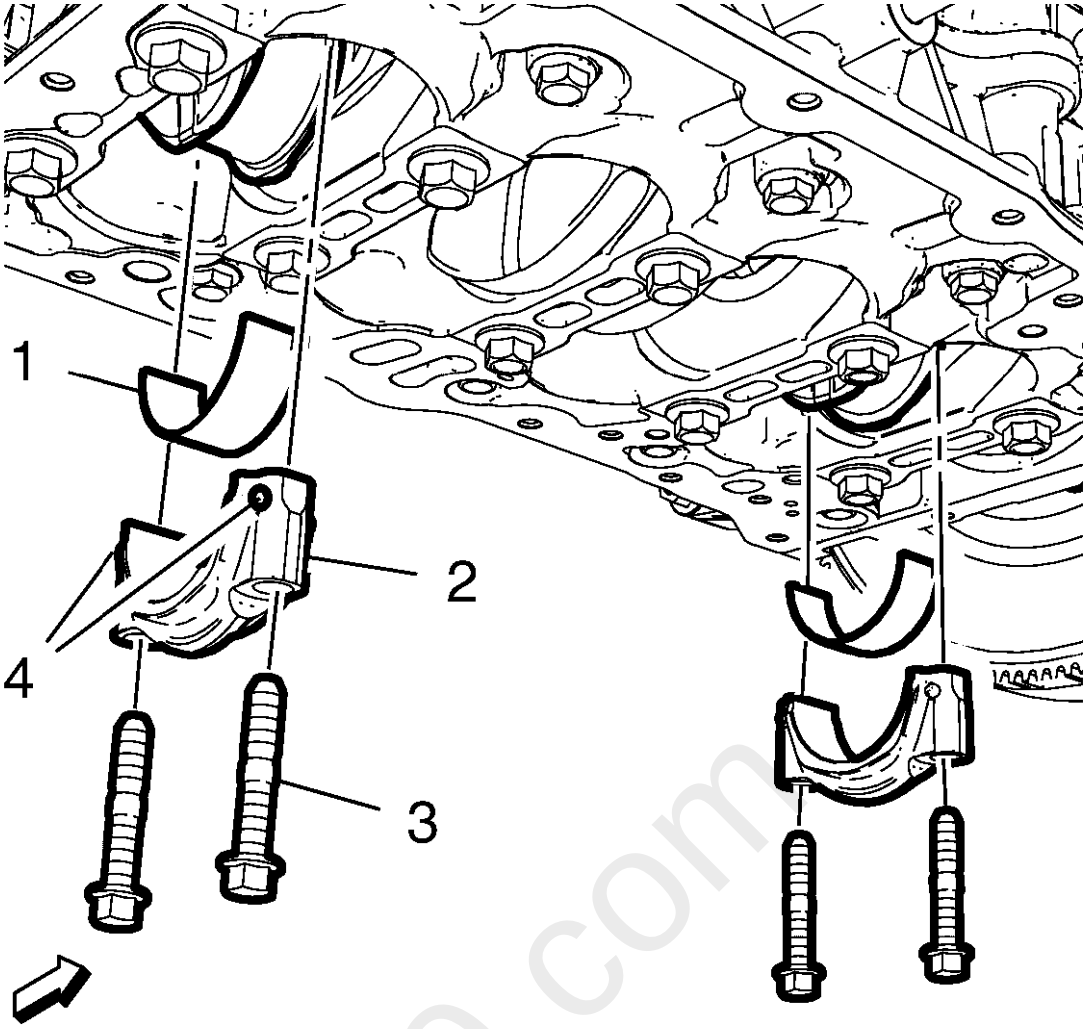


Fig. 409: Cylinder 1 And 4 Connecting Rod Caps, Bolts And Lower Bearings
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The marks (4) of the connecting rod bearing caps, must point to front of the engine.**

NOTE: **If the old connecting rod bearing caps will be reused, install in their original position.**

8. Install the 2 connecting rod bearing caps (2) with the 2 connecting rod lower bearings (1) to the cylinder 1 and the cylinder 4.

CAUTION: **Refer to Fastener Caution**

CAUTION: **Refer to Torque-to-Yield Fastener Caution**

9. Install 4 NEW connecting bearing cap bolts (3) and tighten in two passes:
    1. First Pass: 25 N.m (18 lb ft).
    2. Final Pass: 110 degrees, using the **EN-45059** angle meter.

mcx30.com

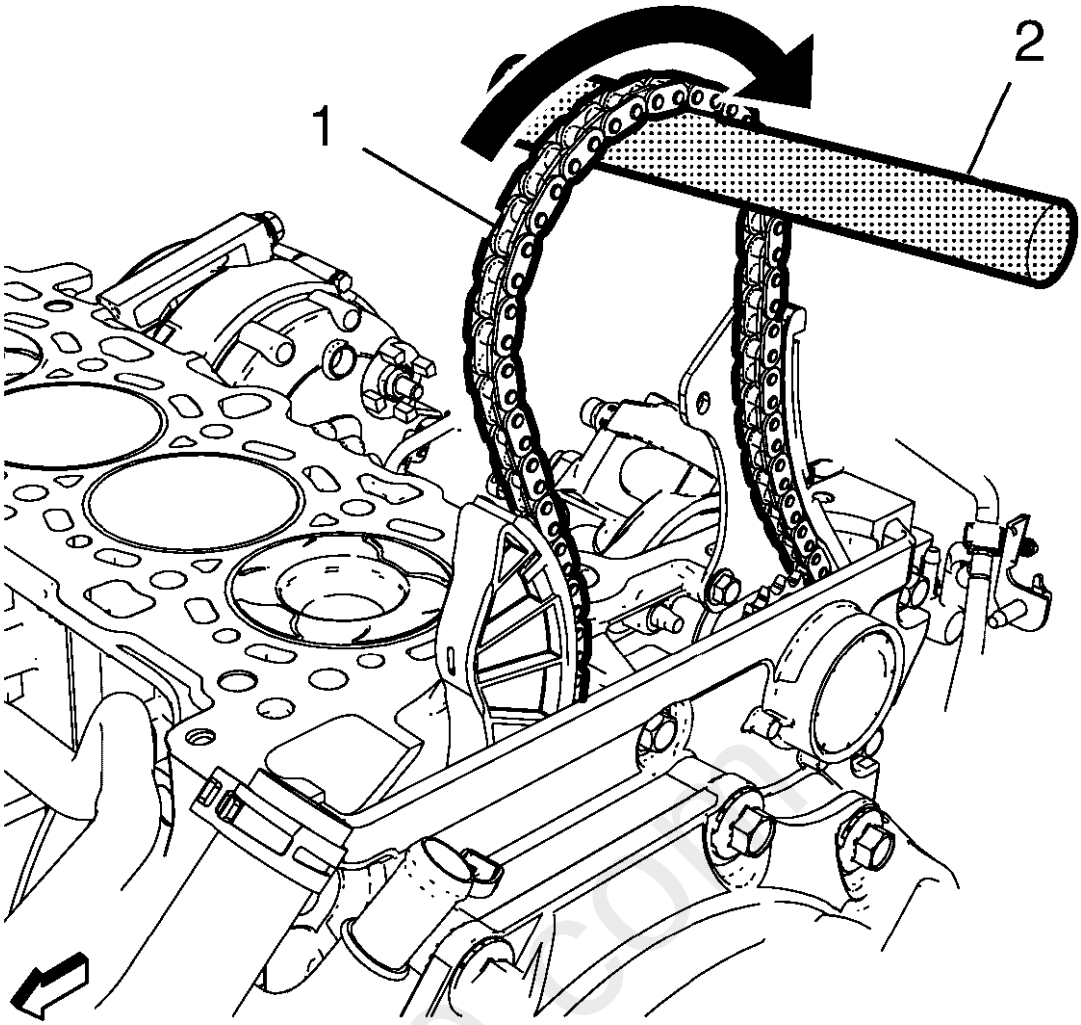


Fig. 410: Timing Chain And Suitable Tool
Courtesy of GENERAL MOTORS COMPANY

10. Hold the timing chain (1) up with a suitable tool like a extension (2).

NOTE: **A second technician is required.**

11. Set TDC of the cylinder 1. Rotate the crankshaft 180 degrees, use a pry bar at the 4 crankshaft pulley bolts (1).

mcx30.com

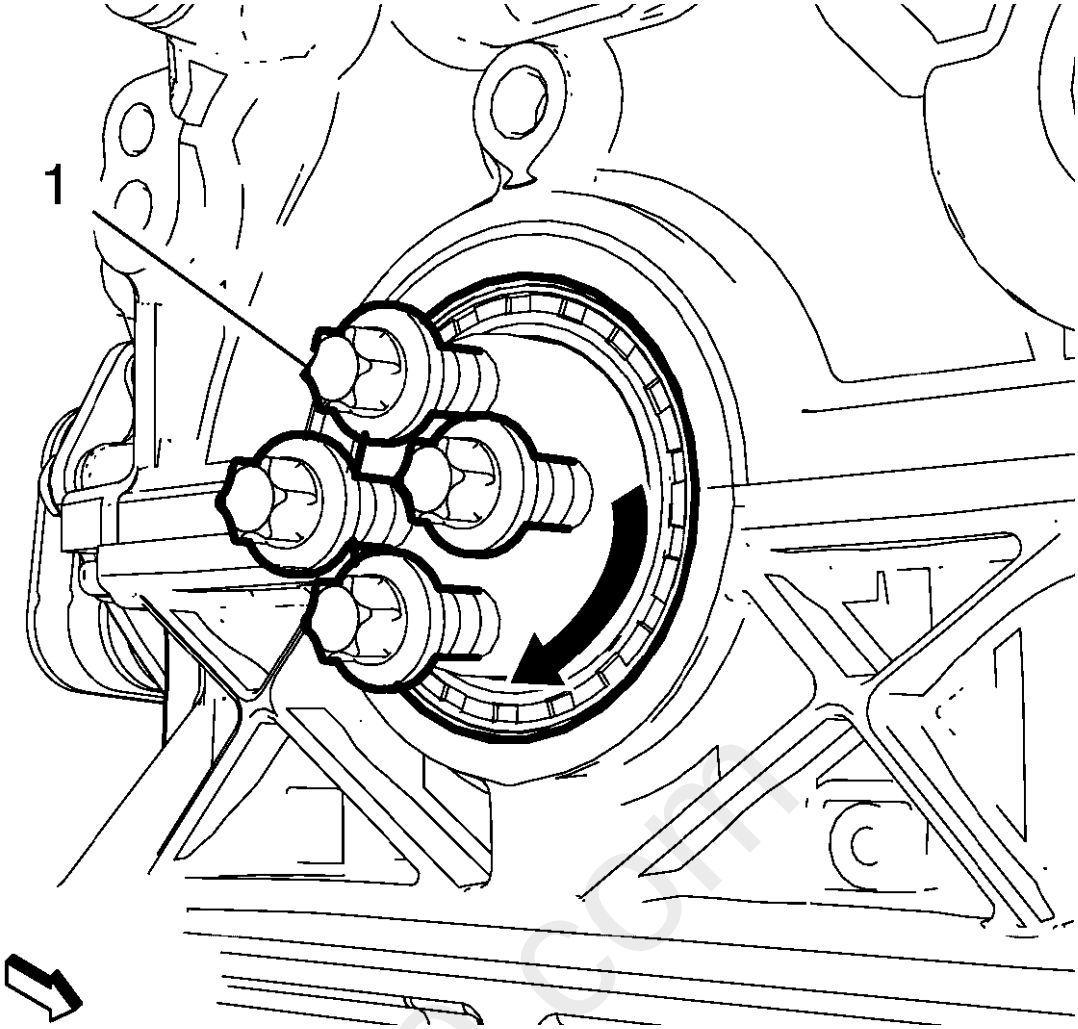


Fig. 411: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Remove the 4 crankshaft pulley bolts (1).

mcx30.com

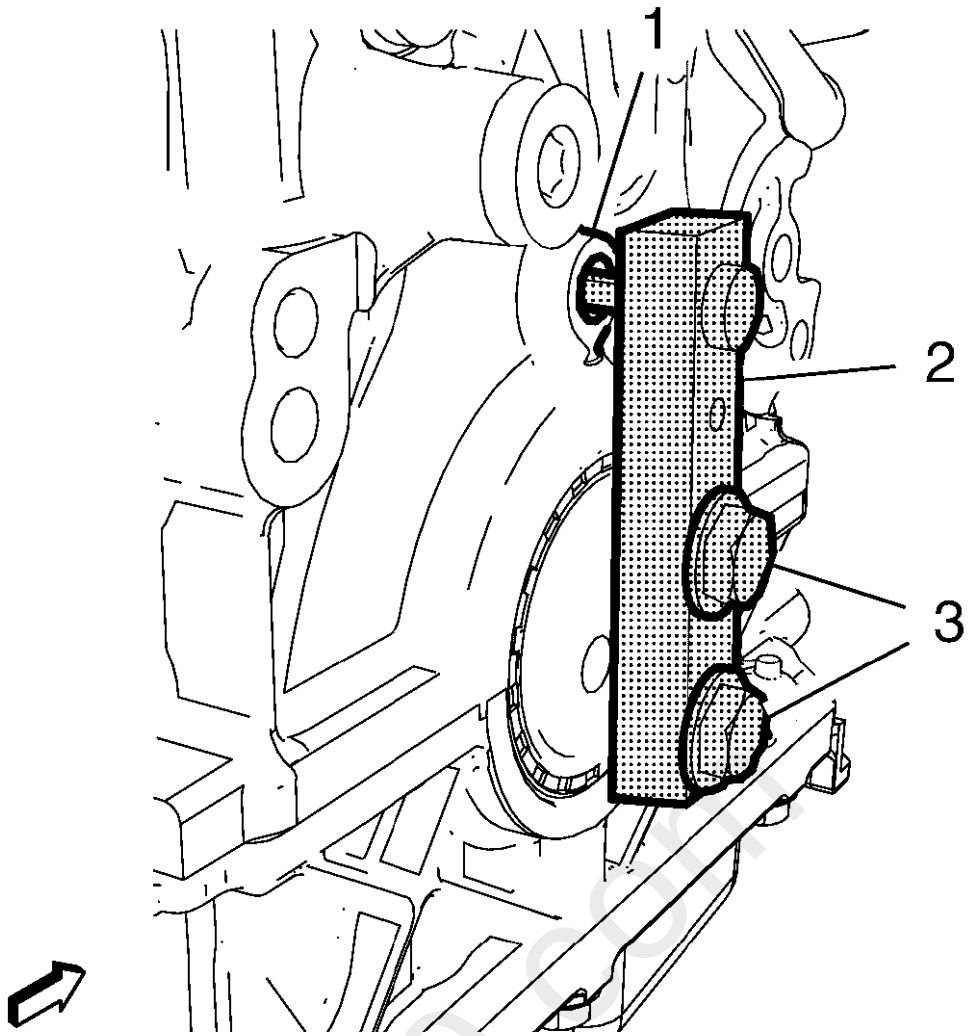


Fig. 412: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

13. Install **EN-51140** fixing tool (2).
14. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).
15. Lower the vehicle.

mcx30.com

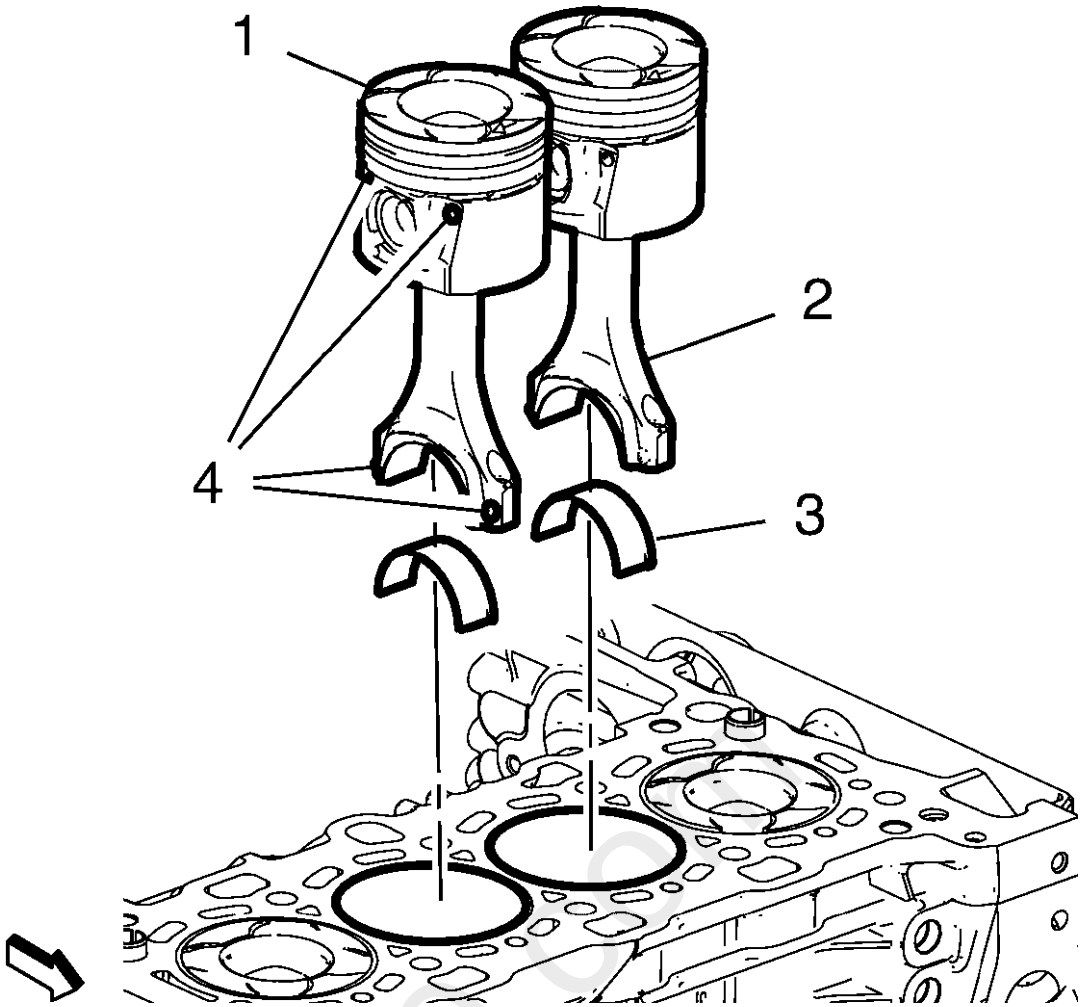


Fig. 413: Cylinder 2 And 3 Piston/Connecting Rod Assemblies And Upper Bearings
Courtesy of GENERAL MOTORS COMPANY

16. Install a piston ring compressor in order to compress the piston rings.

NOTE: **The arrow on the top of the piston and the marks (4) of the piston and connecting rod, must point to front of the engine.**

NOTE: **If the old piston and connecting rod will be reused, install in their original position.**

17. Install the 2 pistons (1) and the 2 connecting rods (2) with the connecting rod upper bearing (3) to the cylinder 2 and the cylinder 3.

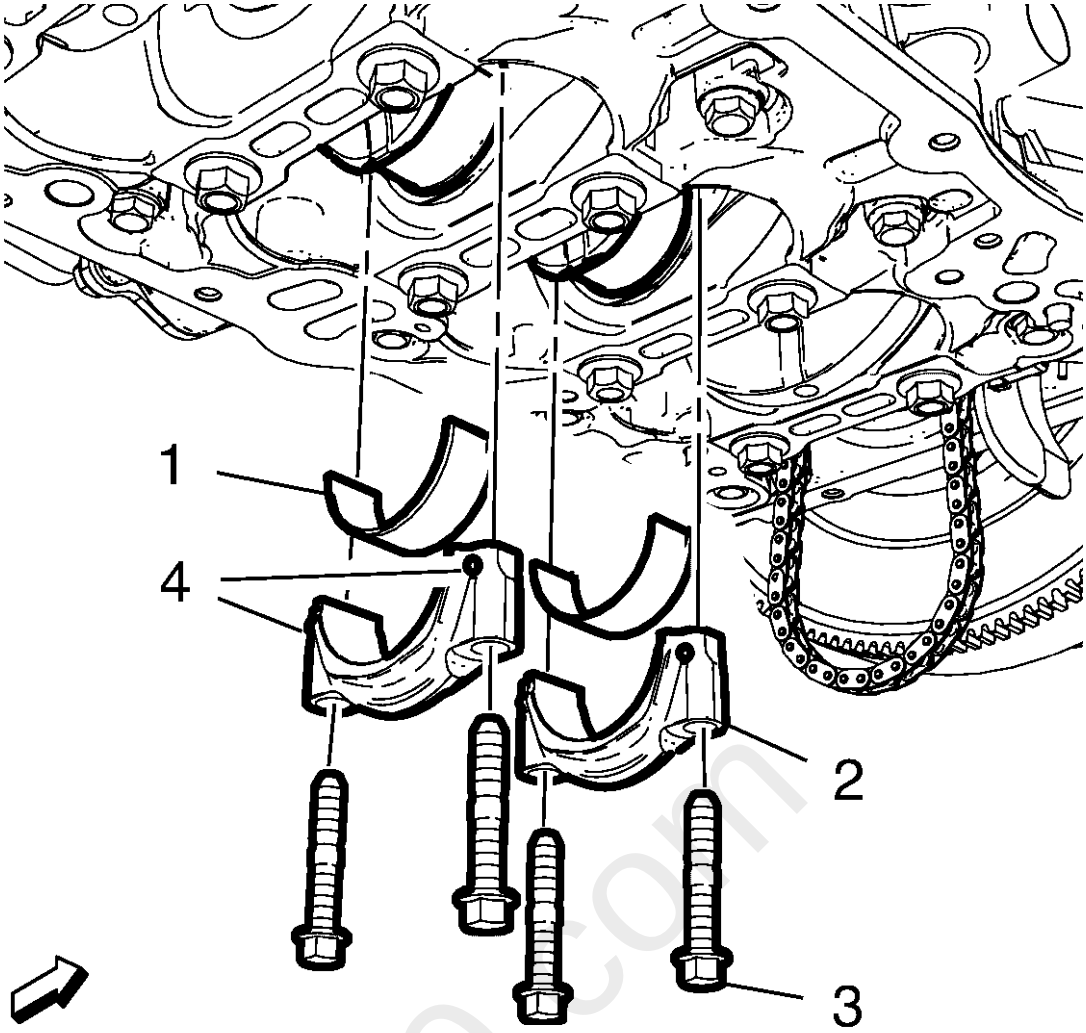


Fig. 414: Cylinder 2 And 3 Connecting Rod Caps, Bolts And Lower Bearings
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The marks (4) of the connecting rod bearing caps, must point to front of the engine.**

NOTE: **If the old connecting rod bearing caps will be reused, install in their original position.**

18. Install the 2 connecting rod bearing caps (2) with the 2 connecting rod lower bearings (1) to the cylinder 2 and the cylinder 3.
19. Install 4 NEW connecting bearing cap bolts (3) and tighten in two passes:

    CAUTION: **Refer to Fastener Caution**

    1. First pass tighten to 25 N.m (18 lb ft).
    2. Final pass to an additional 110 degrees, using the **EN-45059** angle meter.
20. Install Oil and Power Brake Booster Pump. Refer to **Oil and Power Brake Booster Pump Replacement**

    NOTE: **The service information is supplied with the special tool and is also available online. Go to https://gmtoolsandequipment.com.**

21. Install the **CH-49290** support tool with the **CH-904** base frame and a jack. According to the details provided in the installation manual.
22. Lower the vehicle.
23. Remove Engine Mount. Refer to **Engine Mount Replacement**

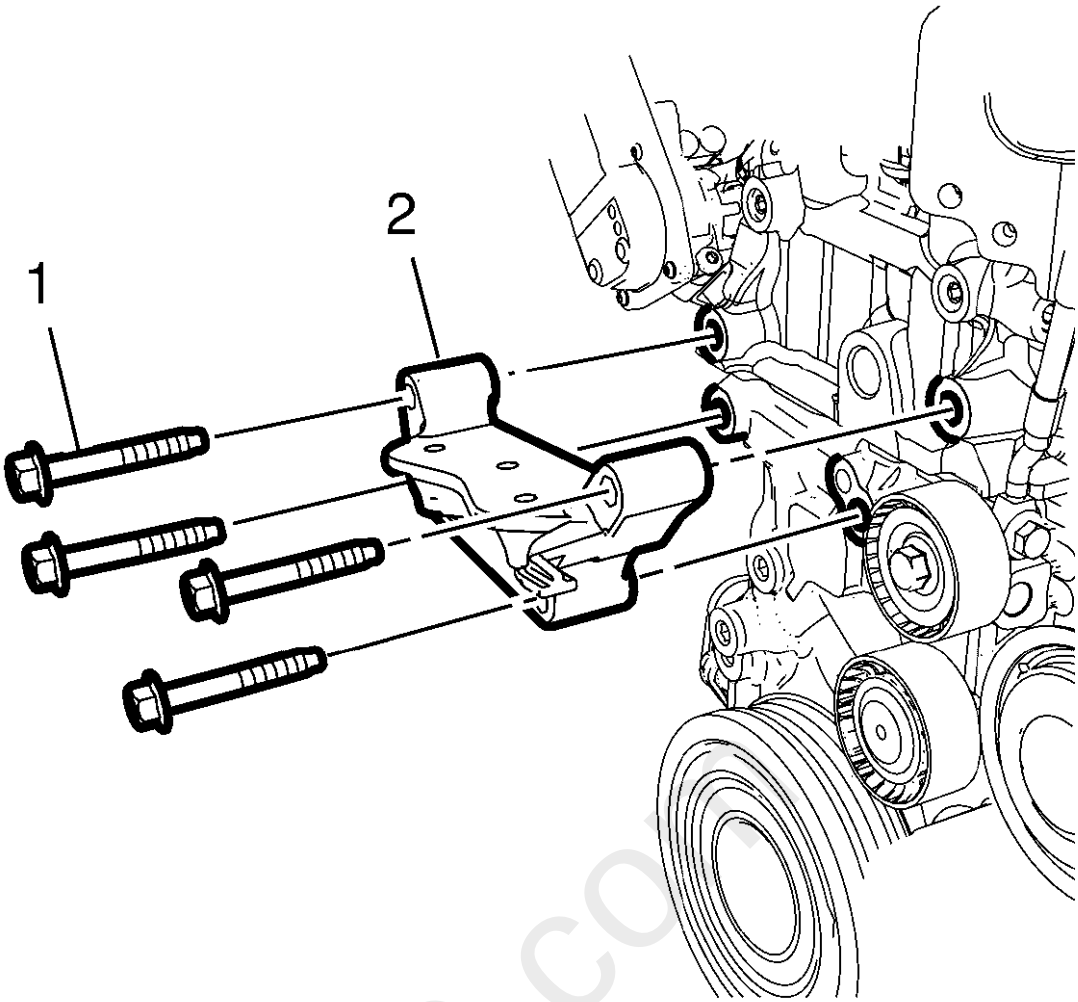


Fig. 415: Engine Mount Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

24. Remove the 2 lower engine mount bracket bolts (1) from the engine block.
25. Remove Engine Mount Bracket (2)
26. Install Cylinder Head. Refer to **Cylinder Head Replacement**

OIL PUMP DRIVE CHAIN AND SPROCKET REPLACEMENT

Special Tools

- **EN-45059** Angle Meter
- **EN-50513** Fixing Pin
- **EN-51142** Oil Pump Sprocket Unit Holding Tool

Equivalent regional tools: **Special Tools**.

Removal Procedure

1. Remove the timing chain lower cover. Refer to **Timing Chain Lower Cover Replacement**.

mcx30.com

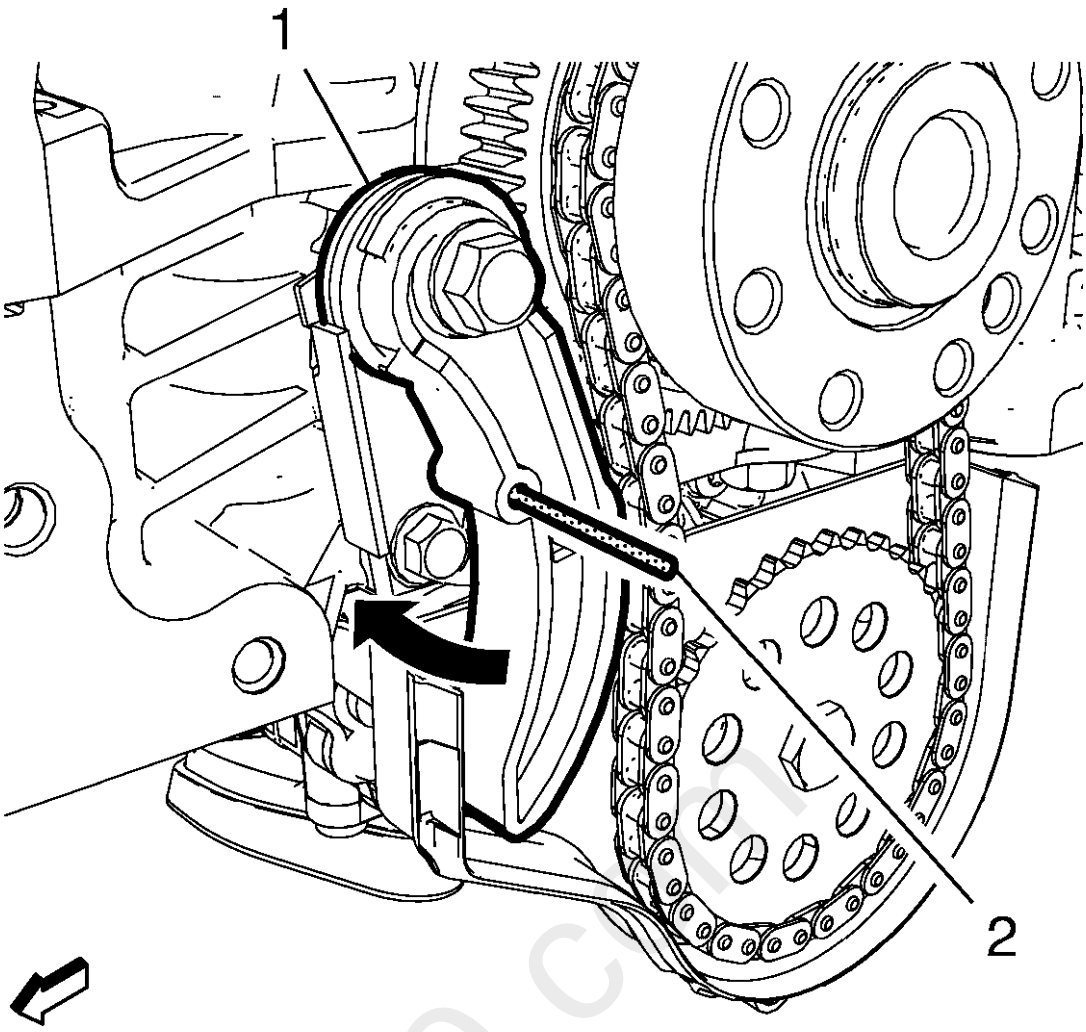


Fig. 416: Oil Pump Drive Chain Tensioner And Fixing Pin
Courtesy of GENERAL MOTORS COMPANY

2. Tension the oil pump drive chain tensioner (1) in arrow direction.
3. Install the **EN-50513** fixing pin (2).

mcx80.com

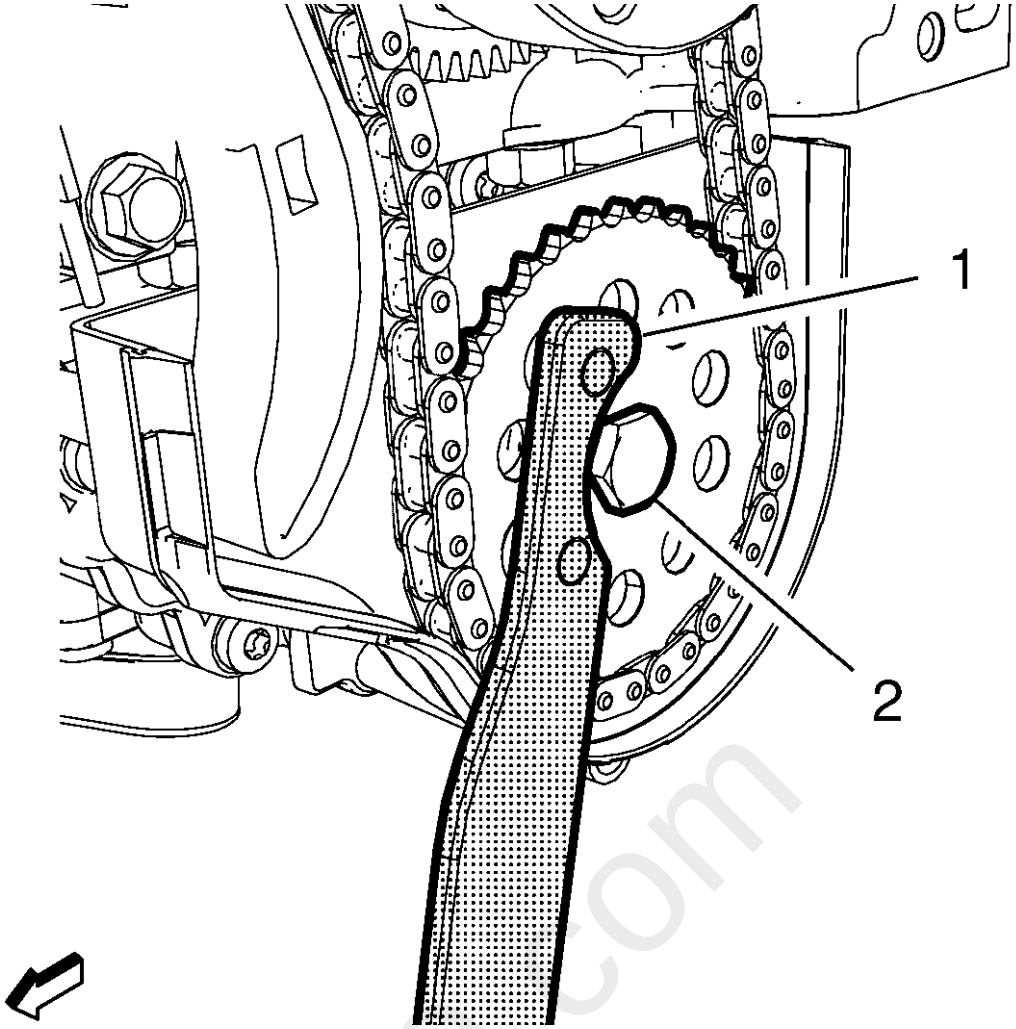


Fig. 417: Oil Pump Sprocket Bolt And Sprocket Holding Tool
Courtesy of GENERAL MOTORS COMPANY

4. Loosen the oil pump sprocket bolt (2), by counterhold with the **EN-51142** holding tool (1).

mcx30.com

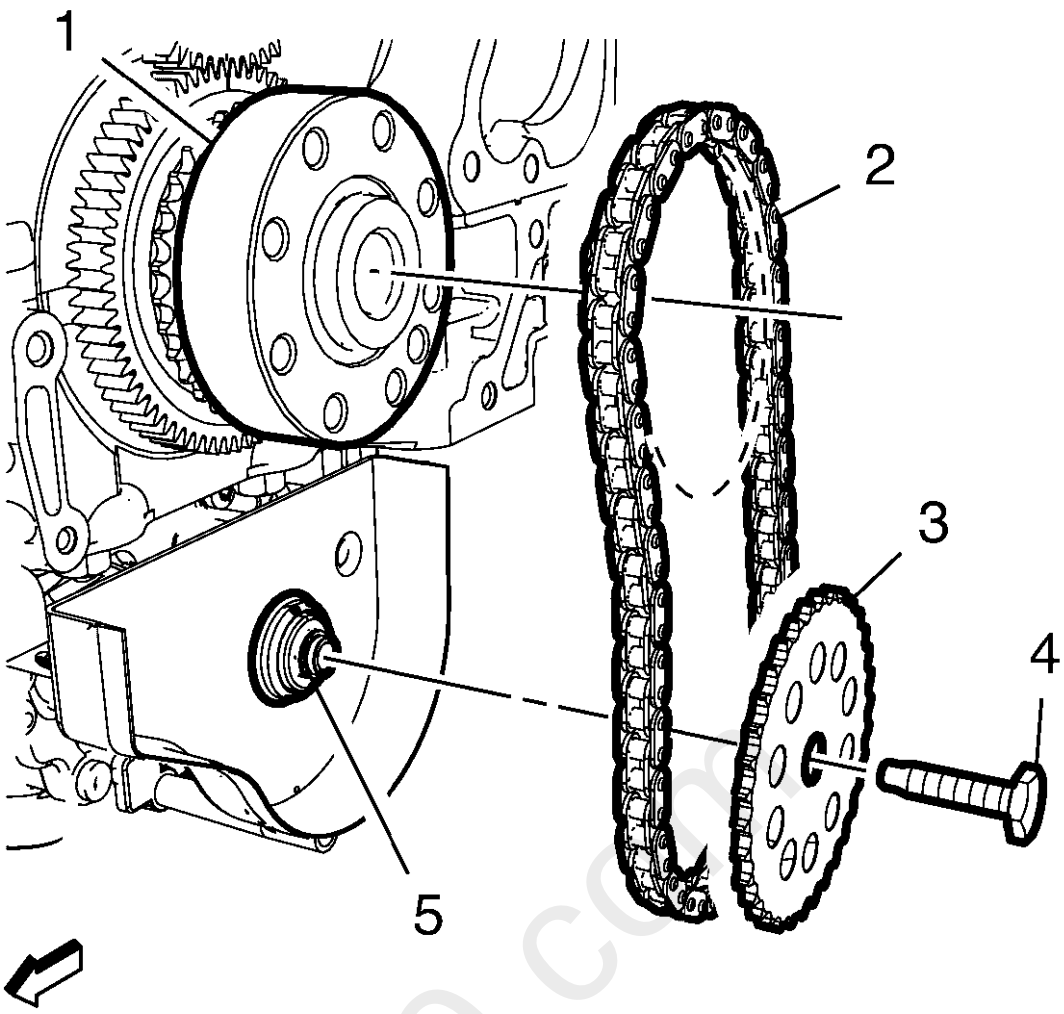


Fig. 418: Oil Pump Sprocket, Bolt, Shaft, Drive Chain And Drive Chain Sprocket
Courtesy of GENERAL MOTORS COMPANY

5. Remove and DISCARD the oil pump sprocket bolt (4).
6. Remove the oil pump sprocket (3) from the oil pump shaft (5).
7. Remove the oil pump drive chain (2) from the oil pump drive chain sprocket (1).

Installation Procedure

NOTE: **Before installing the oil pump drive chain, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

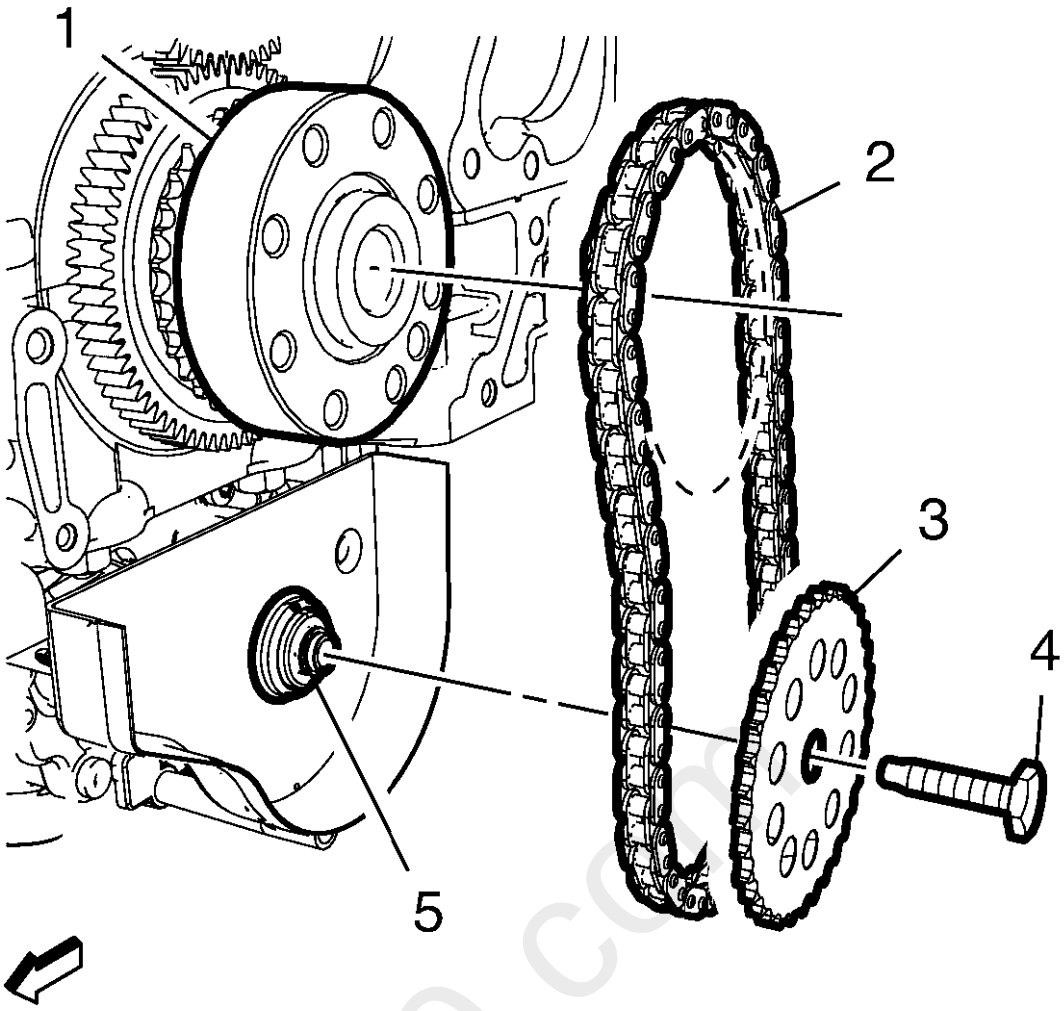


Fig. 419: Oil Pump Sprocket, Bolt, Shaft, Drive Chain And Drive Chain Sprocket
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil pump drive chain (2) to the oil pump drive chain sprocket (1).
3. Install the oil pump sprocket (3) to the oil pump shaft (5).
4. Install a NEW oil pump sprocket bolt (4).

mx30.com

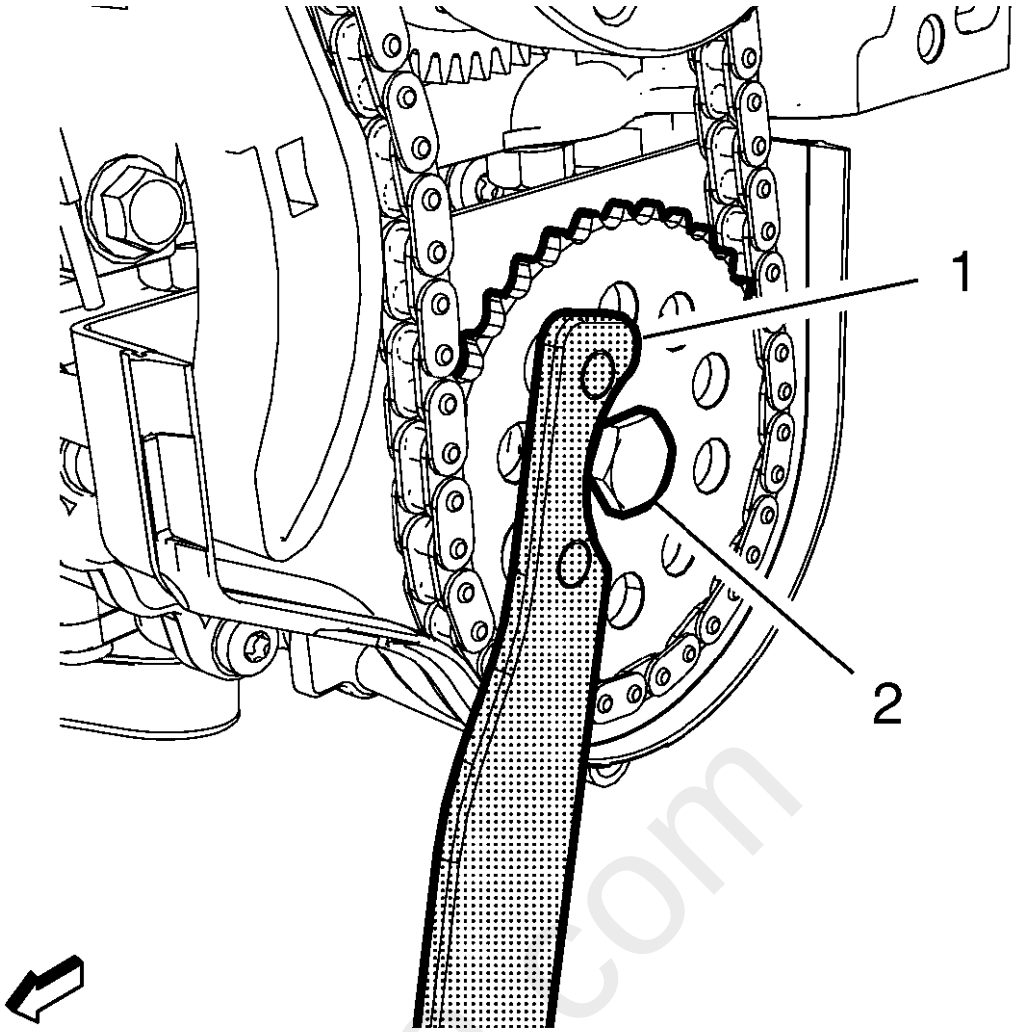


Fig. 420: Oil Pump Sprocket Bolt And Sprocket Holding Tool
Courtesy of GENERAL MOTORS COMPANY

5. Hold the sprocket with the **EN-51142** holding tool (1), and tighten the oil pump sprocket bolt (2) in 2 steps:

   CAUTION: **Refer to Fastener Caution .**

   CAUTION: **Refer to Torque-to-Yield Fastener Caution .**

   1. Tighten in the first step to 25 N.m (18 lb ft).
   2. Tighten in the final step to an additional 60 degrees, using the **EN-45059** angle meter.
6. Install the timing chain lower cover. Refer to **Timing Chain Lower Cover Replacement**.

OIL PUMP DRIVE CHAIN TENSIONER REPLACEMENT

Special Tools

- **EN-45059** Angle Meter
- **EN-50513** Fixing Pin

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

Removal Procedure

1. Remove the timing chain lower cover. Refer to **Timing Chain Lower Cover Replacement**.

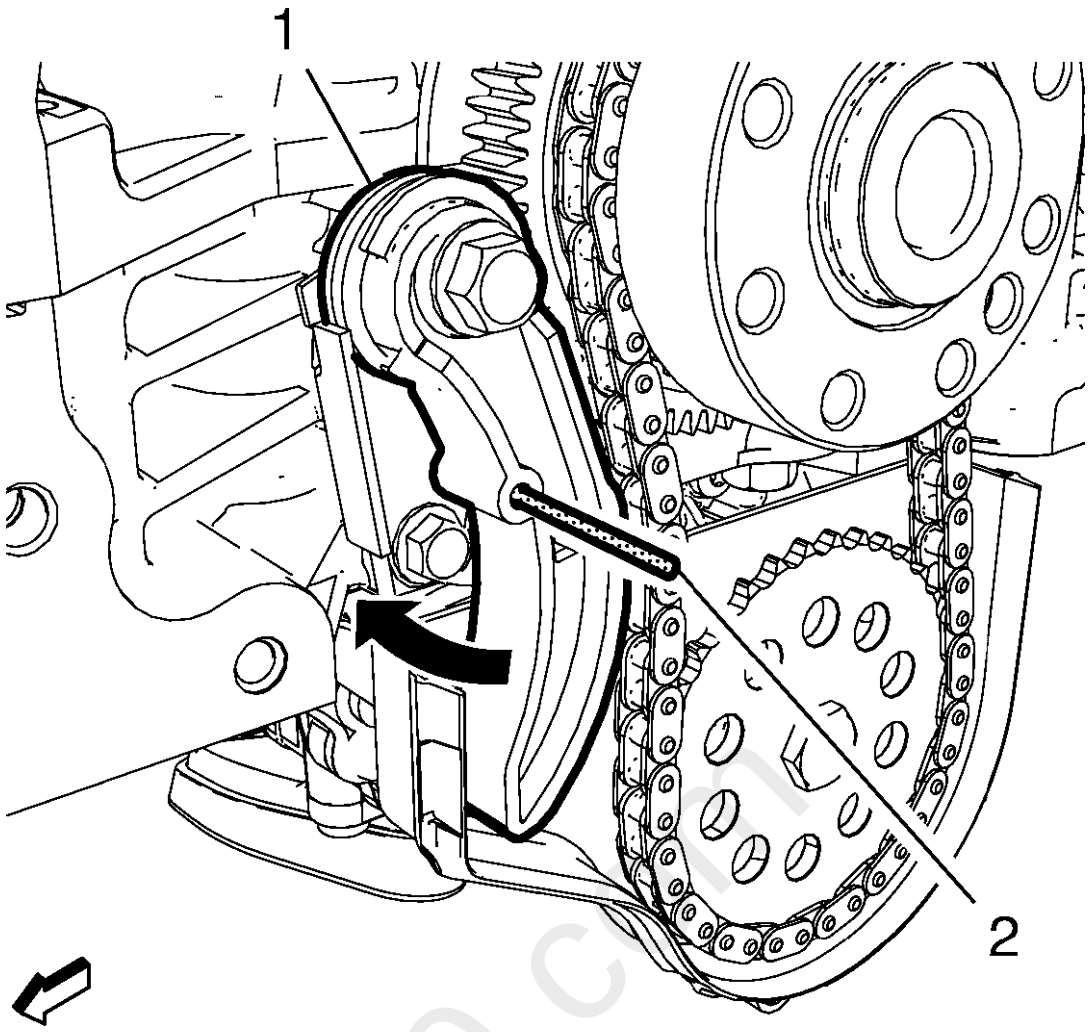


Fig. 421: Oil Pump Drive Chain Tensioner And Fixing Pin
Courtesy of GENERAL MOTORS COMPANY

2. Tension the oil pump drive chain tensioner (1) in arrow direction.
3. Install the **EN-50513** fixing pin (2).

mcx80.com

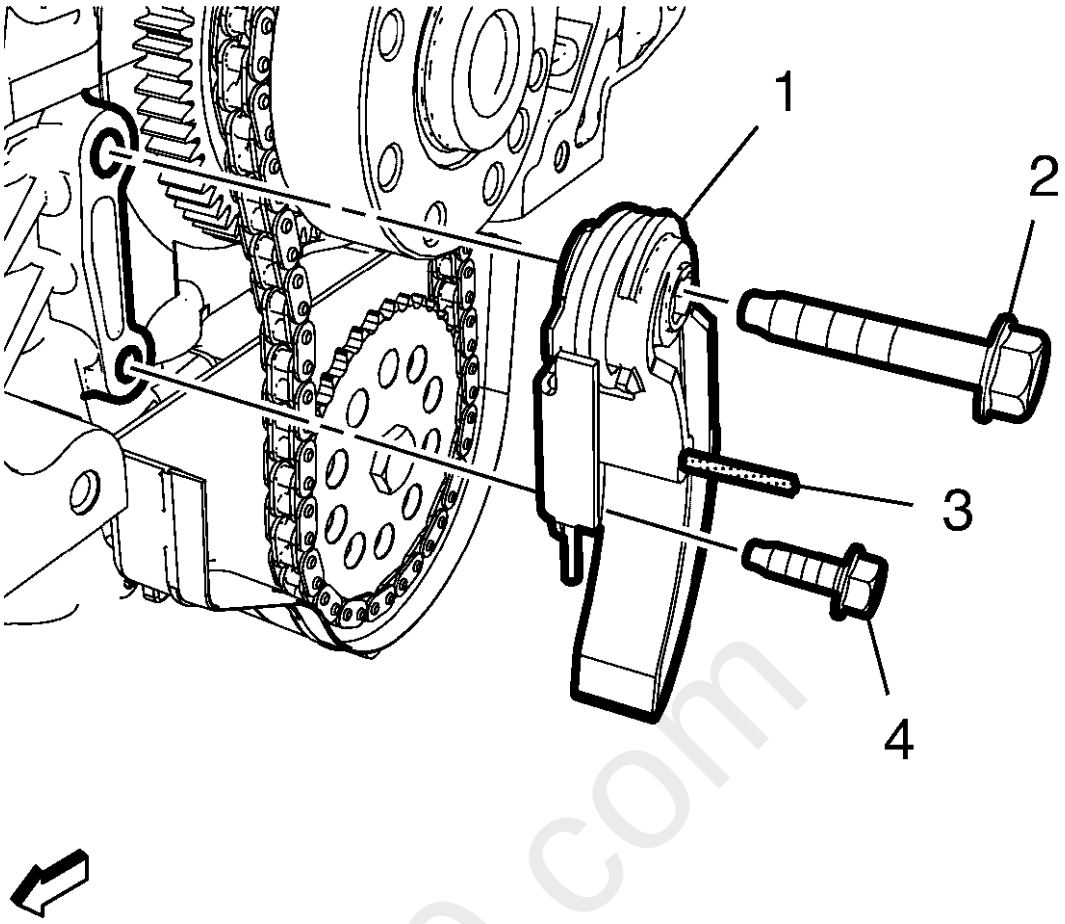


Fig. 422: Oil Pump Drive Chain Tensioner, Bolts And Fixing Pin
Courtesy of GENERAL MOTORS COMPANY

4. Remove the oil pump drive chain tensioner bolt (4).
5. Remove the oil pump drive chain tensioner bolt (2)

NOTE: **If the oil pump drive chain tensioner reused, do not remove the EN-50513 fixing pin (3).**

6. Remove the oil pump drive chain tensioner (1).

Installation Procedure

NOTE: **Before installing the oil pump drive chain tensioner, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

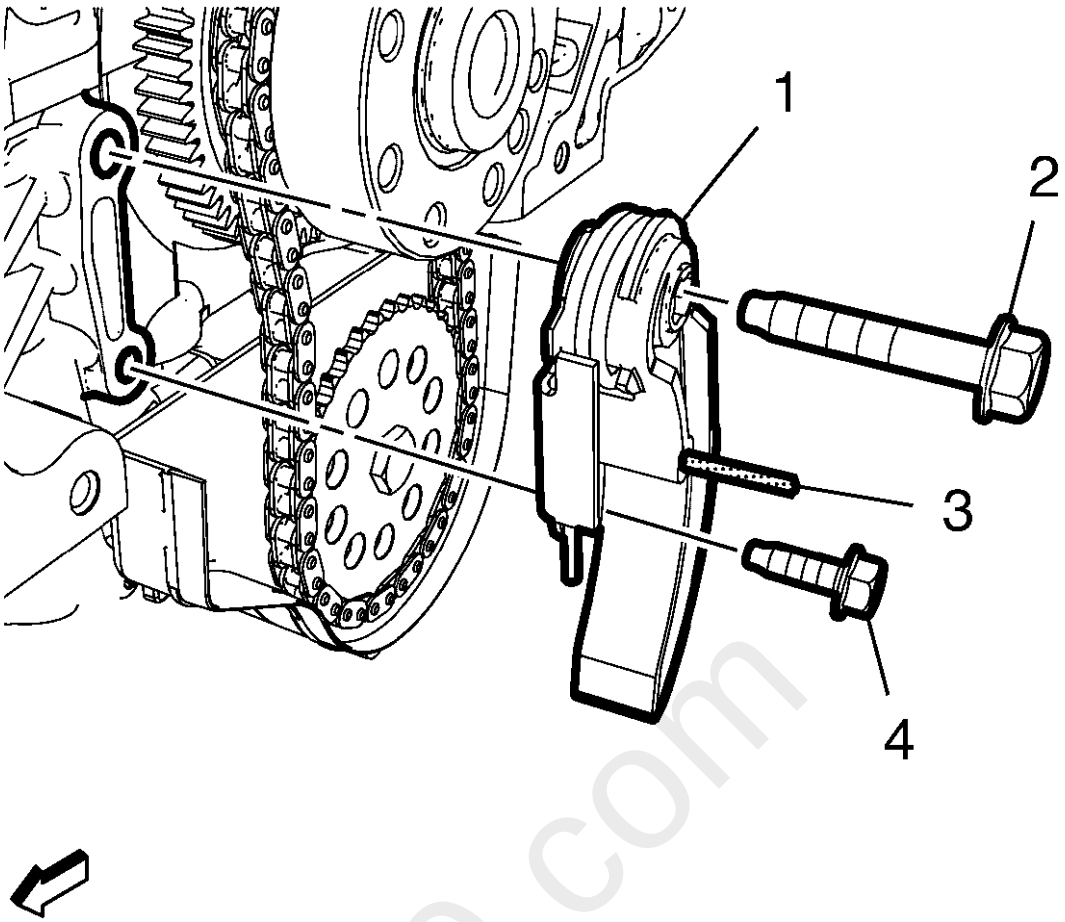


Fig. 423: Oil Pump Drive Chain Tensioner, Bolts And Fixing Pin
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil pump drive chain tensioner (1).
3. Install the oil pump drive chain tensioner bolts (2, 4).

CAUTION: **Refer to Fastener Caution .**

4. Tighten the oil pump drive chain tensioner bolt (2) to 25 N.m (18 lb ft).
5. Tighten the oil pump drive chain tensioner bolt (4) to 10 N.m (89 lb in).

mcx30.com

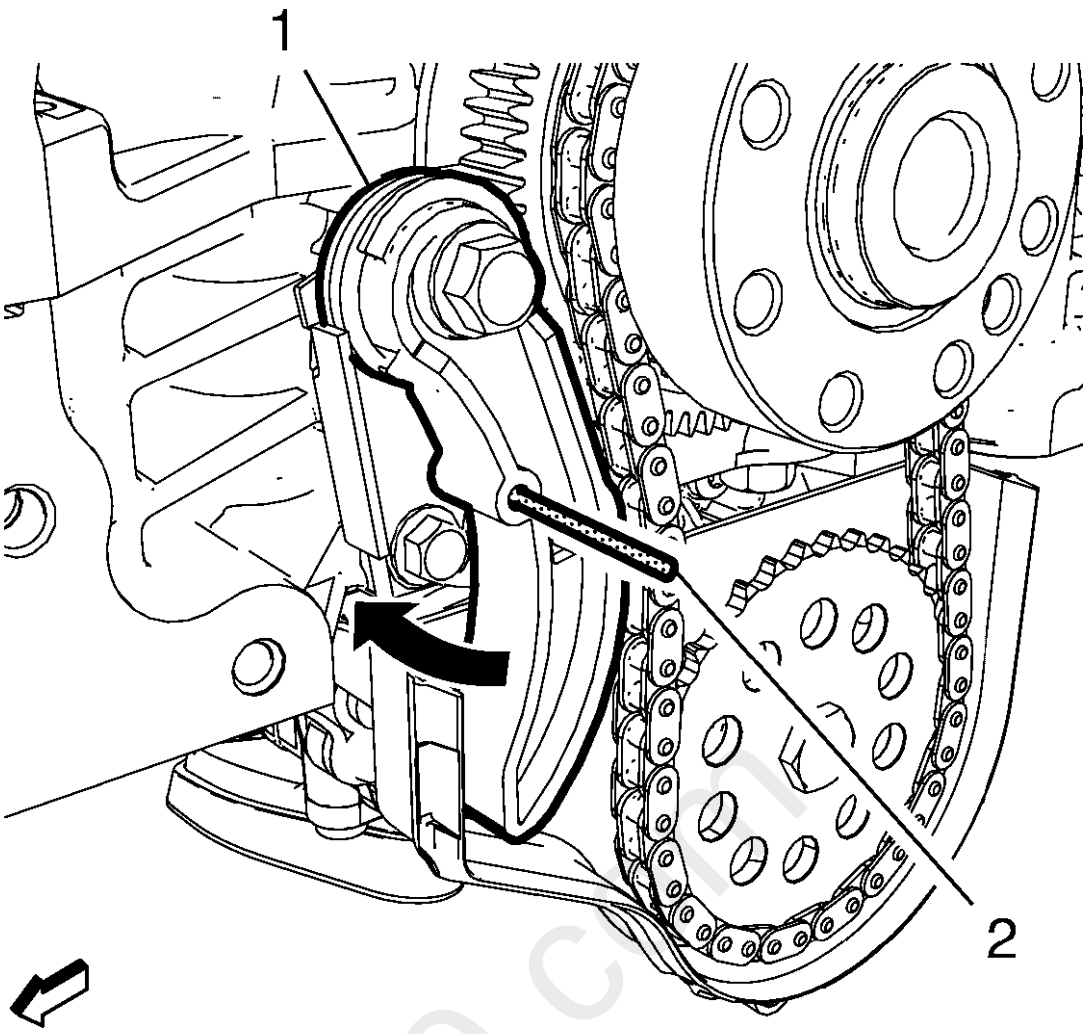


Fig. 424: Oil Pump Drive Chain Tensioner And Fixing Pin
Courtesy of GENERAL MOTORS COMPANY

6. Remove the **EN-50513** fixing pin (2).
7. Install the timing chain lower cover. Refer to **Timing Chain Lower Cover Replacement**.

OIL AND POWER BRAKE BOOSTER PUMP REPLACEMENT

Special Tools

EN-51142 Oil Pump Sprocket Unit Holding Tool

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

Removal Procedure

1. Remove the automatic transmission flex plate. Refer to **Automatic Transmission Flex Plate Replacement**.
2. Remove the oil pan. Refer to **Oil Pan Replacement**.

mcx30.com

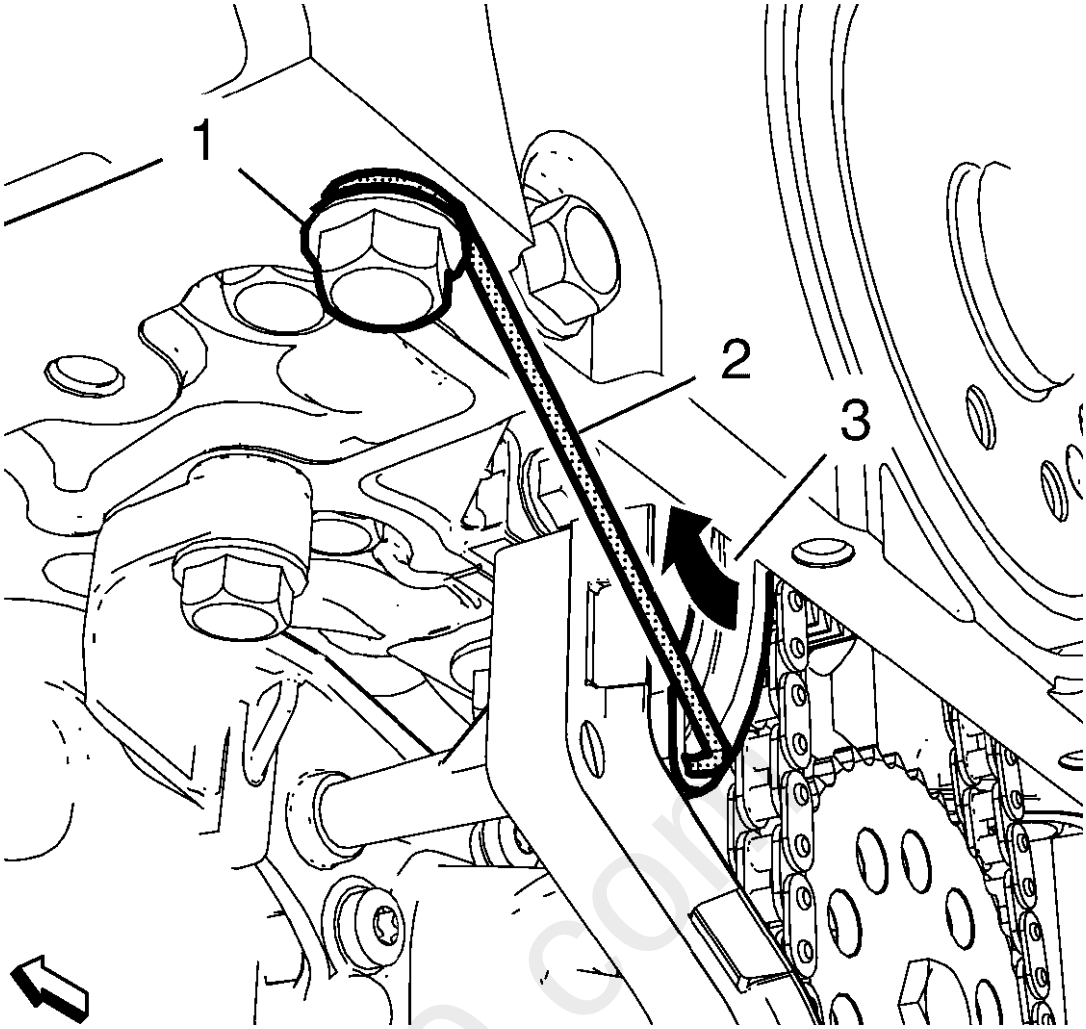


Fig. 425: Oil Pump Drive Chain Tensioner, Holding Tool And Oil Pan Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Tension the oil pump drive chain tensioner (3) with the **EN-51142-2** holding tool (2) in arrow direction.
4. Install the oil pan bolt (1) to fix the **EN-51142-2** holding tool.

mcx30.com

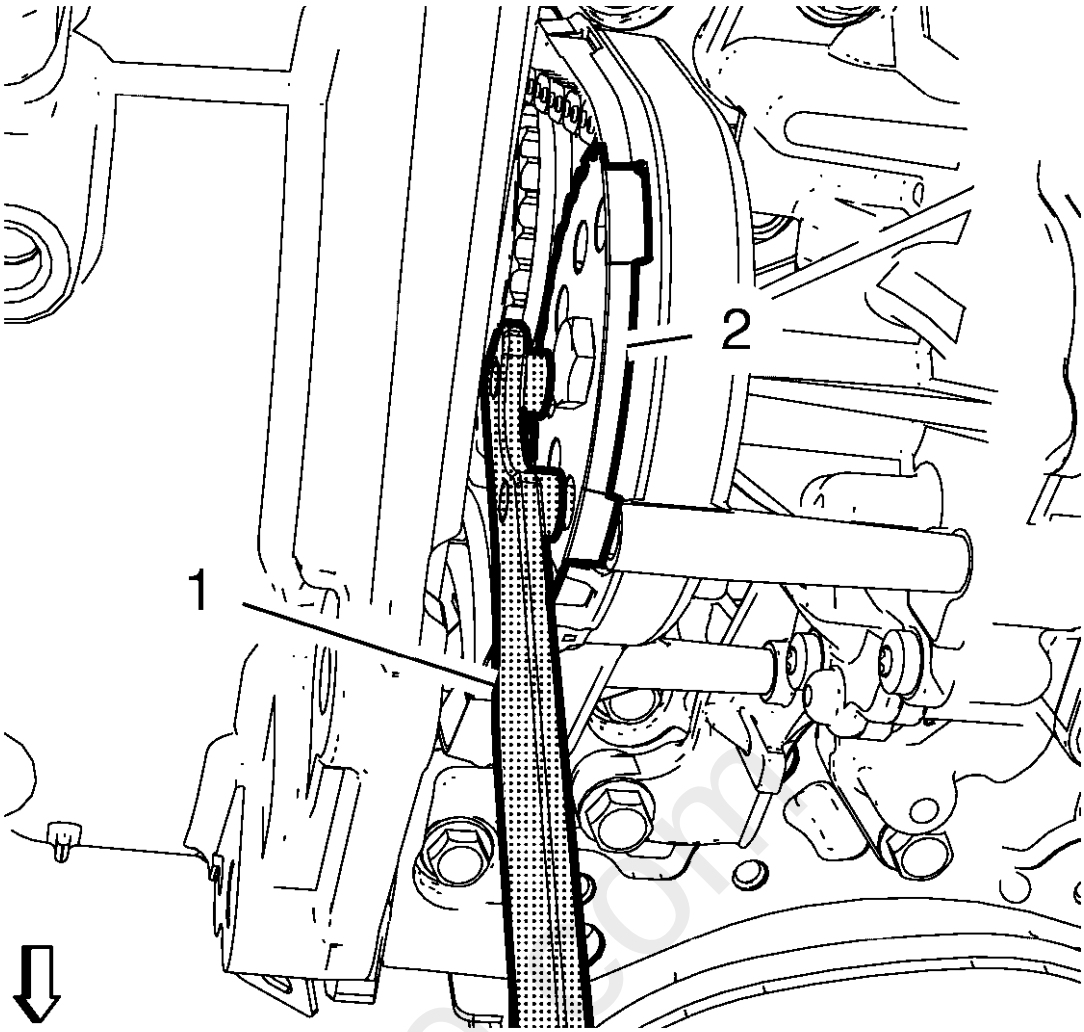


Fig. 426: Oil Pump Sprocket Bolt And Holding Tool
Courtesy of GENERAL MOTORS COMPANY

5. Install the **EN-51142-1** holding tool (1) to oil pump sprocket.
6. Loosen the oil pump sprocket bolt (2) by counterhold at the **EN-51142-1** holding tool.

mox30.com

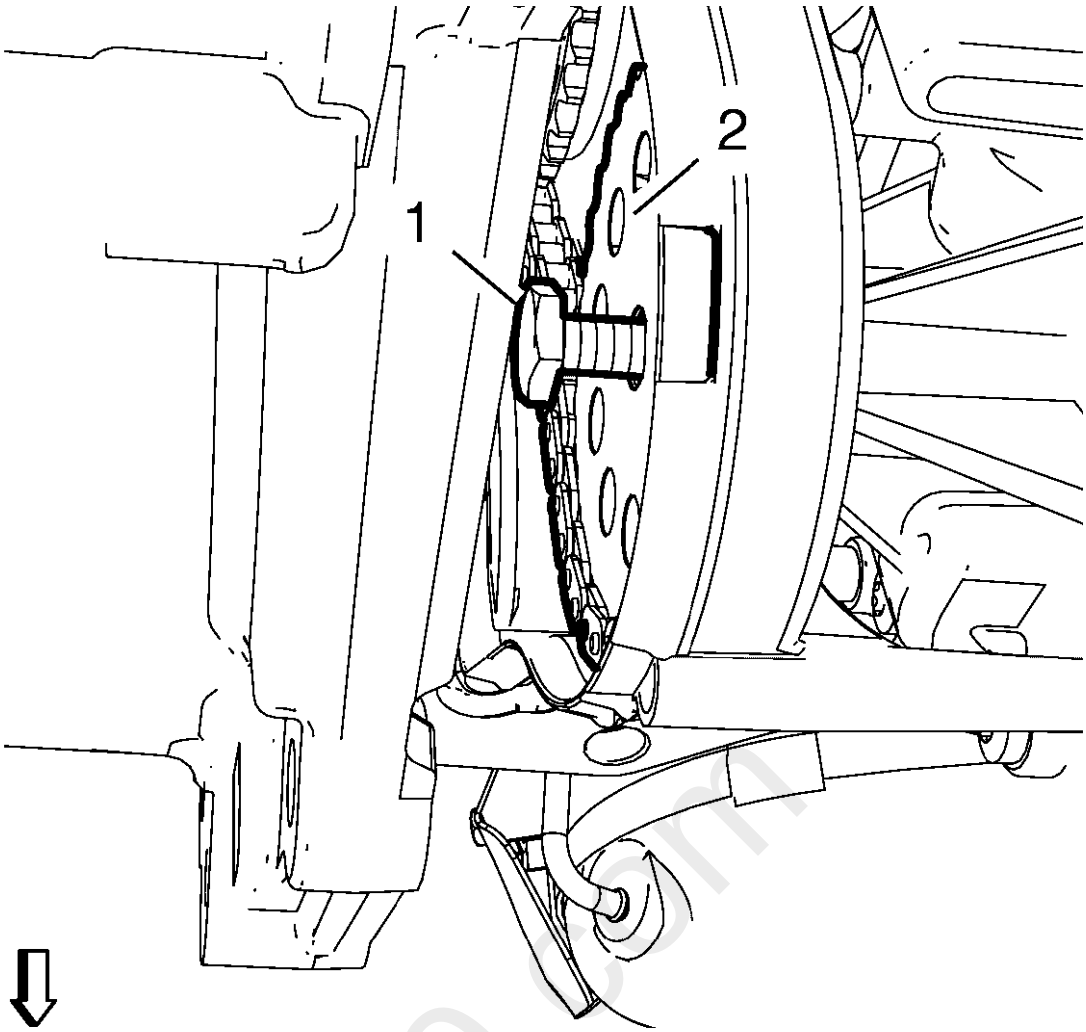


Fig. 427: Oil Pump Sprocket And Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Unscrew the oil pump sprocket bolt (1) as far as possible.
8. Detach the oil pump sprocket (2) from the oil and power brake booster pump shaft, use a suitable tool.

mcx30.com

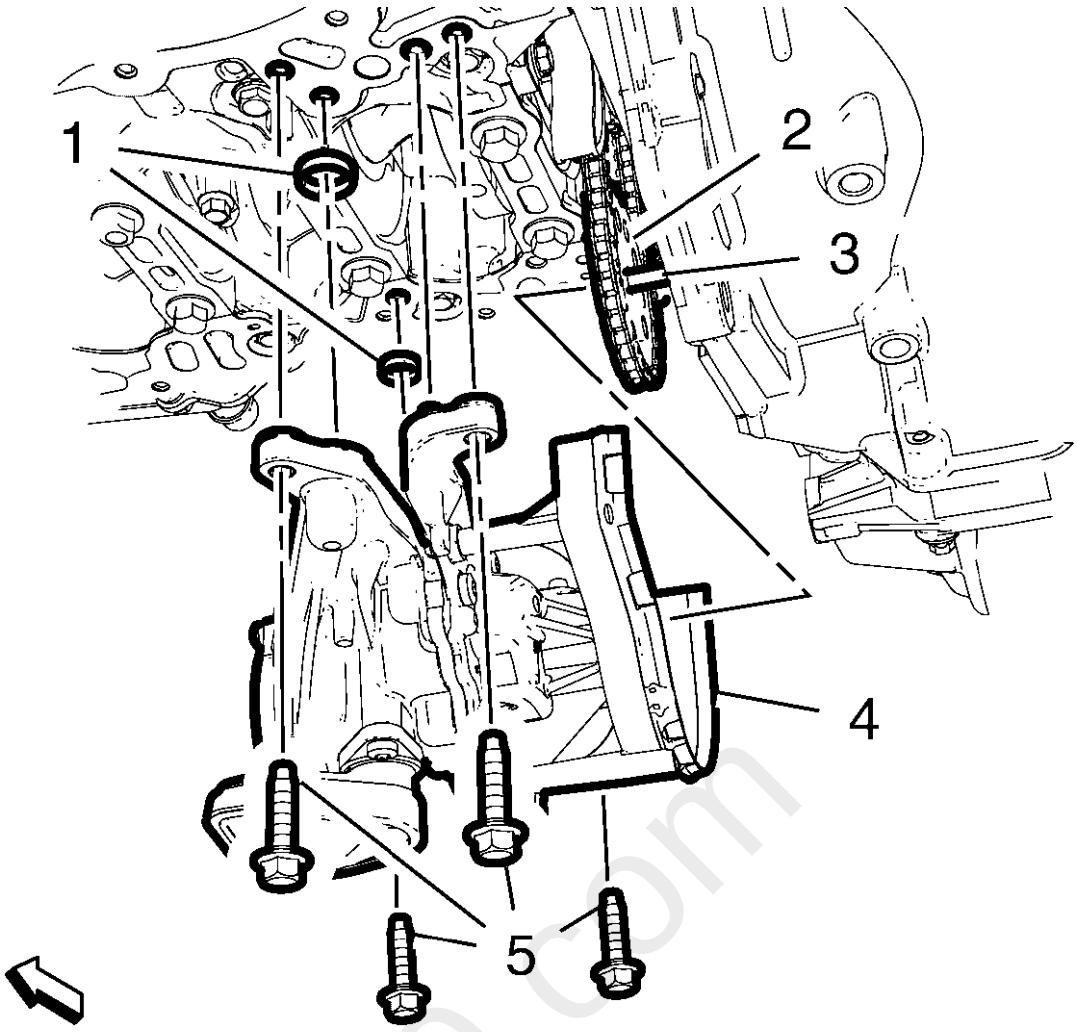


Fig. 428: Oil Pump Bolts, Sprocket, Sprocket Bolt, Oil/Power Brake Booster Pump And Gaskets
Courtesy of GENERAL MOTORS COMPANY

9. Remove the 4 oil pump bolts (5).
10. Remove the oil and power brake booster pump (4).
11. Remove and DISCARD the oil pump sprocket bolt (3) from the oil pump sprocket (2).
12. Remove the 2 oil and power brake booster pump gaskets (1).

Installation Procedure

mcx30.com

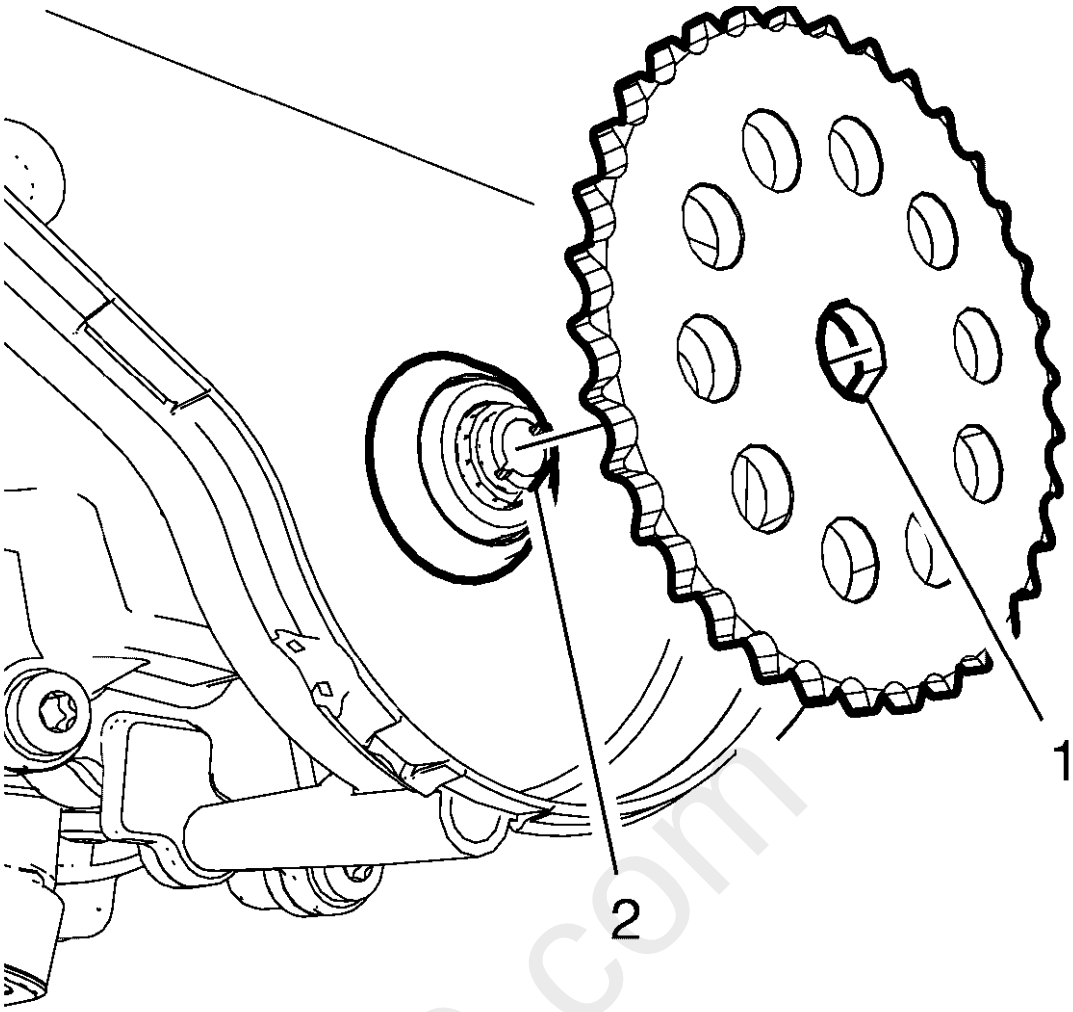


Fig. 429: Oil Pump Shaft Face And Oil Pump Sprocket Face Positioning
Courtesy of GENERAL MOTORS COMPANY

1. Check the position of the oil pump shaft face (2) to the oil pump sprocket face (1) before installing the oil and power brake booster pump.

mcx30.com

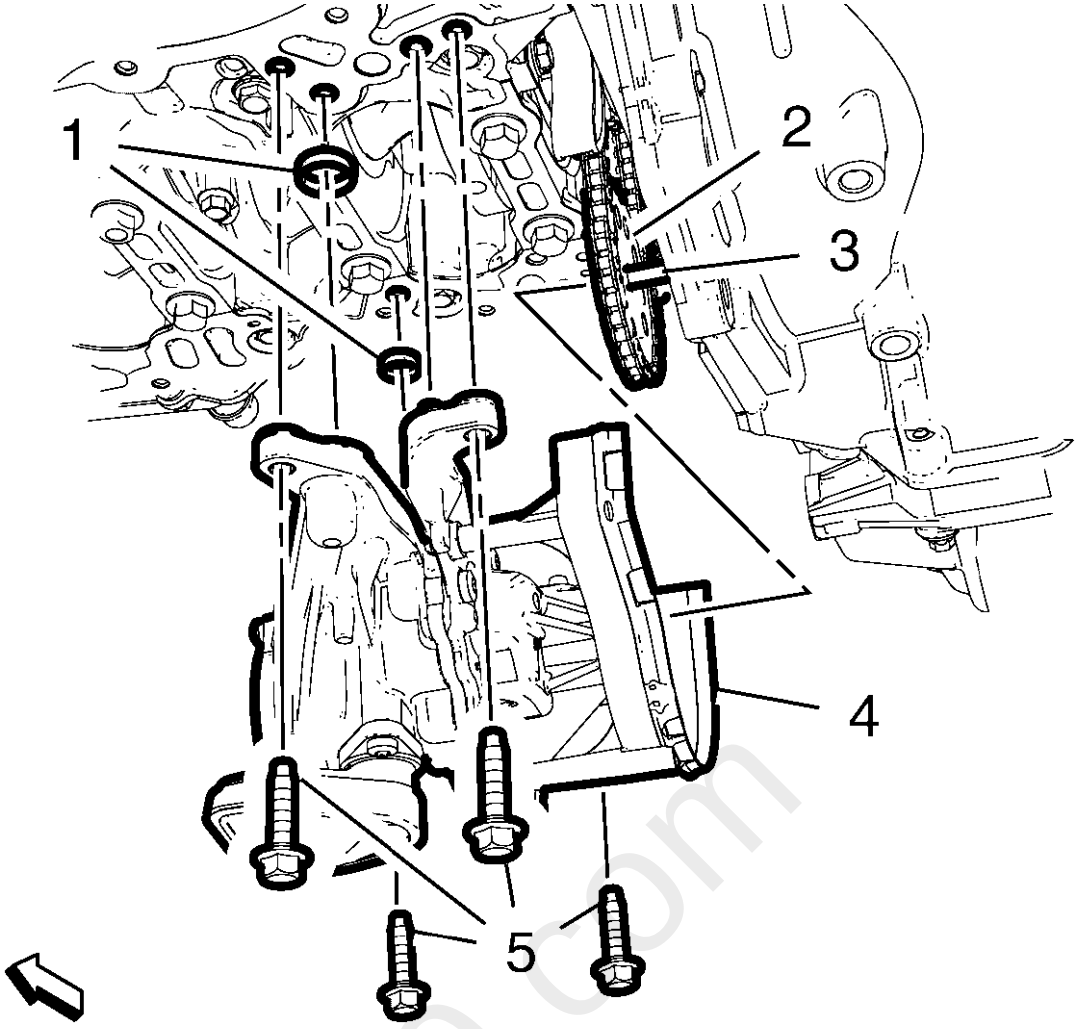


Fig. 430: Oil Pump Bolts, Sprocket, Sprocket Bolt, Oil/Power Brake Booster Pump And Gaskets
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The oil pump sprocket bolt can not be installed, if the oil and power brake booster pump is installed.**

2. Install the NEW oil pump sprocket bolt (3) to the oil pump sprocket (2).
3. Install 2 oil and power brake booster pump gaskets (1).
4. Install the oil and power brake booster pump (4).

CAUTION: **Refer to Fastener Caution .**

5. Install the 4 oil pump bolts (5) and tighten to 25 N.m (18 lb ft).

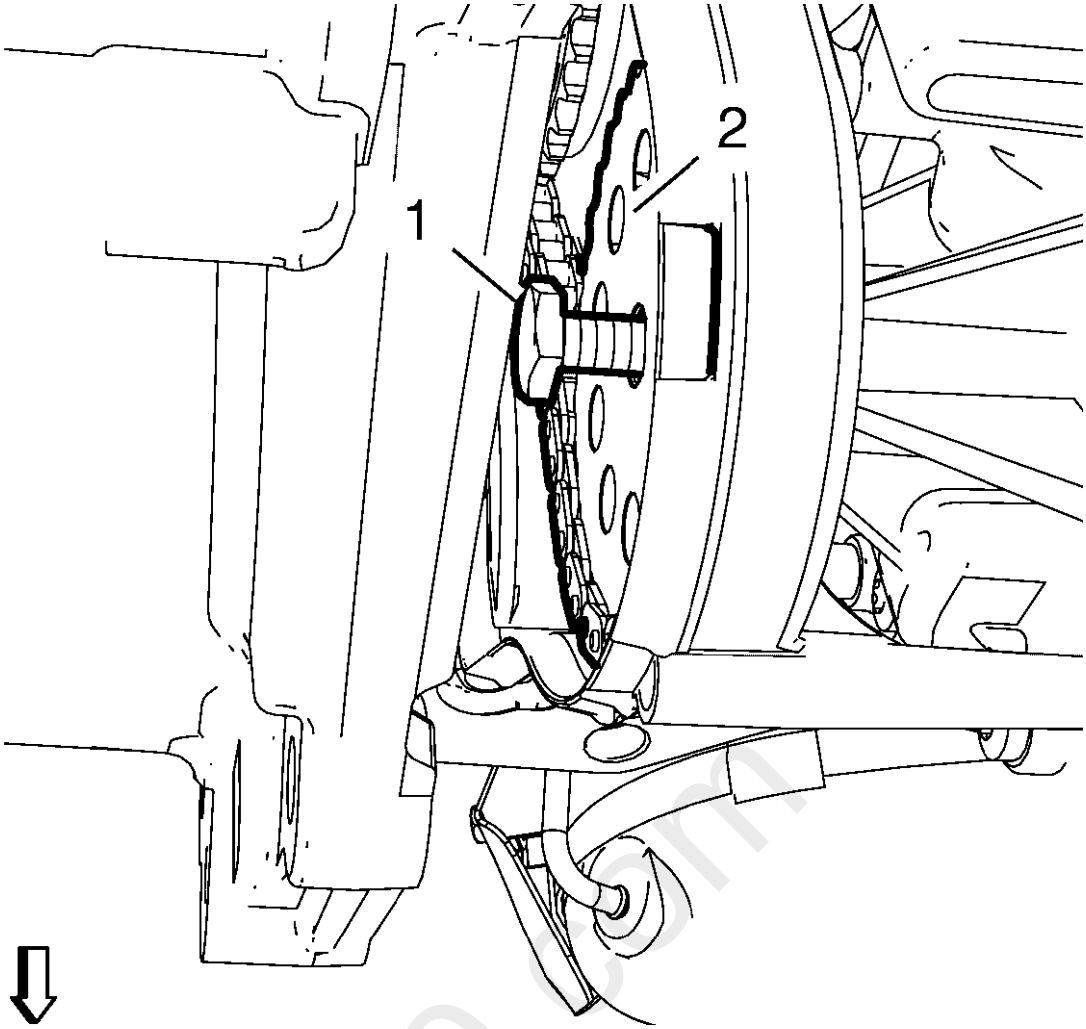


Fig. 431: Oil Pump Sprocket And Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Attach the oil pump sprocket (2) to the oil and power brake booster pump shaft.
7. Screw in the NEW oil pump sprocket bolt (1).

mx30.com

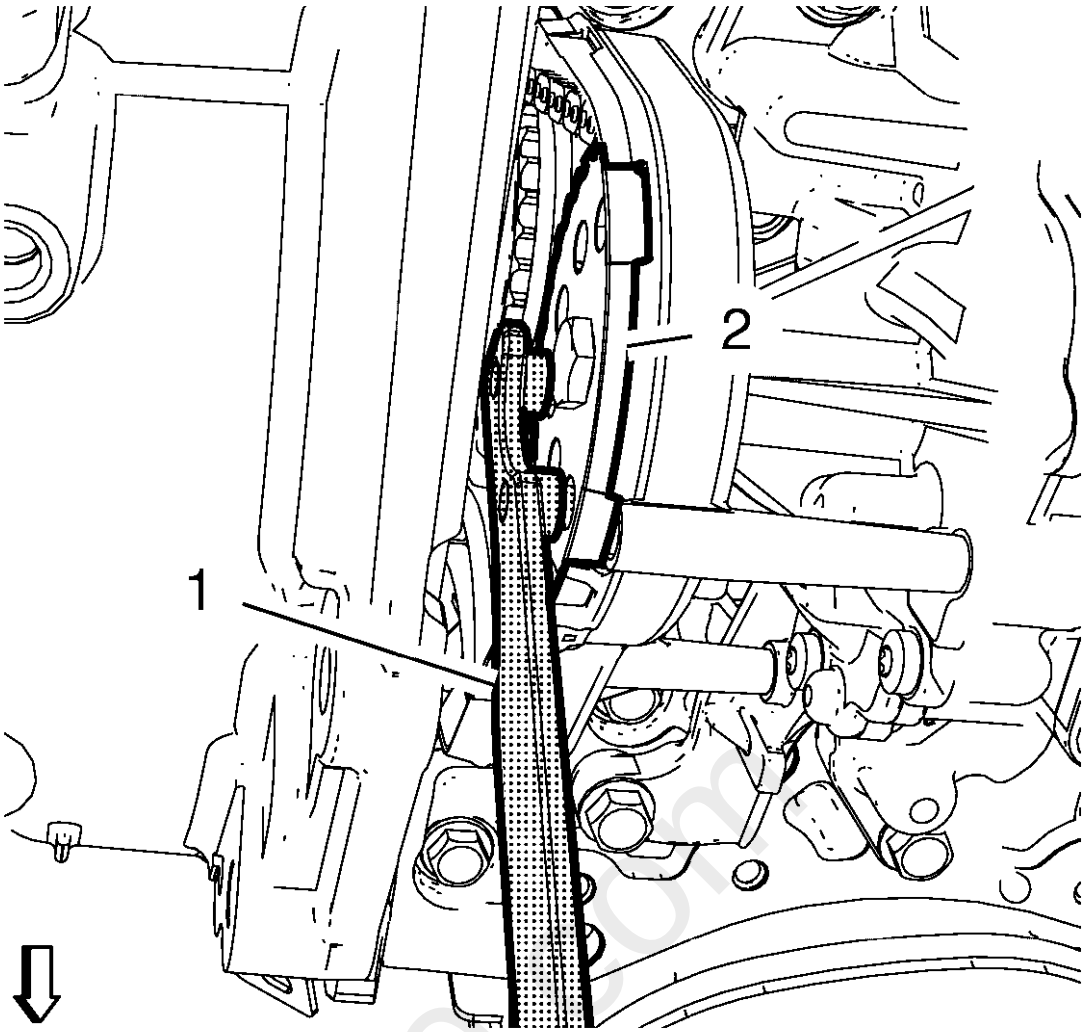


Fig. 432: Oil Pump Sprocket Bolt And Holding Tool
Courtesy of GENERAL MOTORS COMPANY

8. Install the **EN-51142-1** holding tool (1) to oil pump sprocket.
9. Tighten the NEW oil pump sprocket bolt (2) by counterhold at the **EN-51142-1** holding tool to:

CAUTION: **Refer to Torque-to-Yield Fastener Caution .**

1. Tighten in the bolts a first pass to 25 N.m (18 lb ft).
2. Tighten the bolts a final pass an additional to 60 degrees.

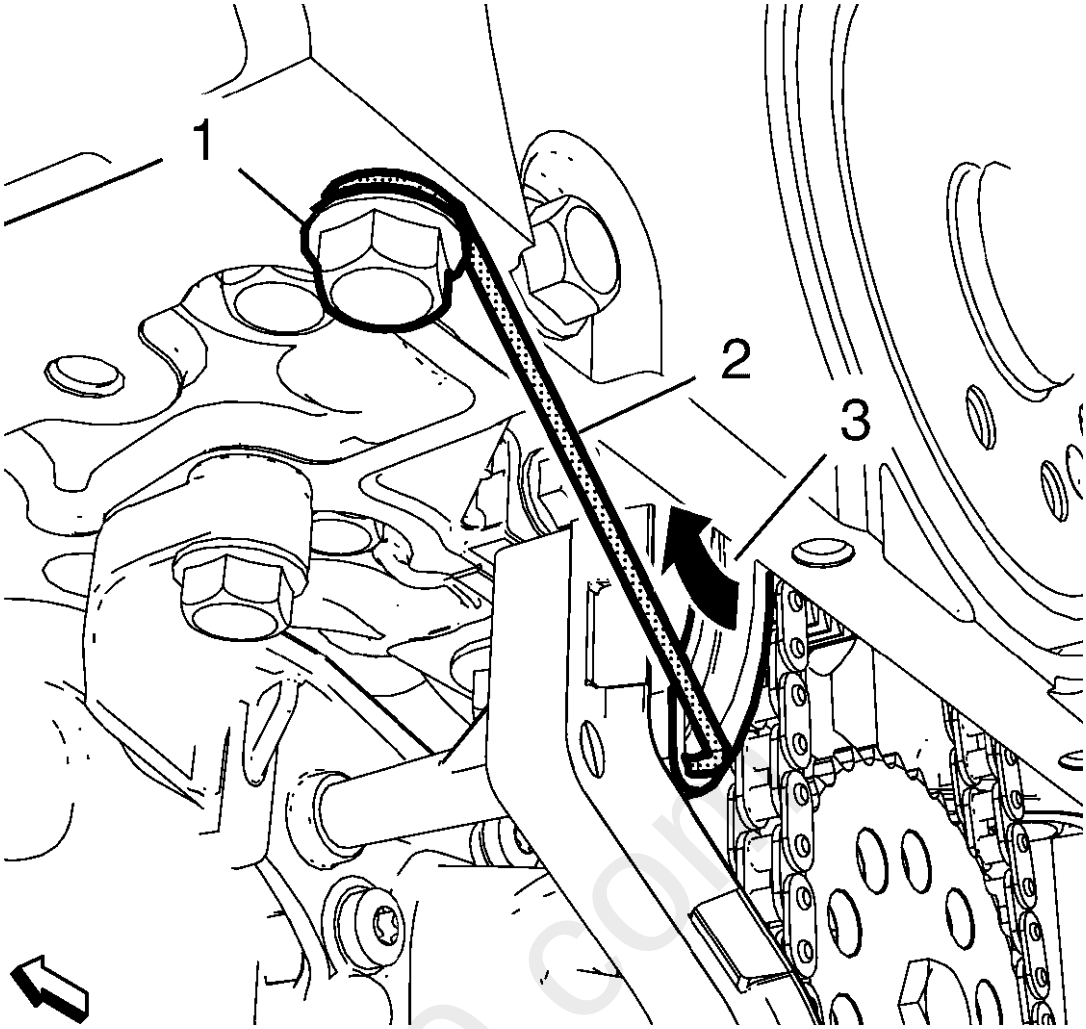


Fig. 433: Oil Pump Drive Chain Tensioner, Holding Tool And Oil Pan Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Remove the oil pan bolt (1).
11. Remove the **EN-51142-2** holding tool (2).
12. Install the oil pan. Refer to **Oil Pan Replacement**.
13. Install the automatic transmission flex plate. Refer to **Automatic Transmission Flex Plate Replacement**.

INTAKE MANIFOLD COVER REPLACEMENT

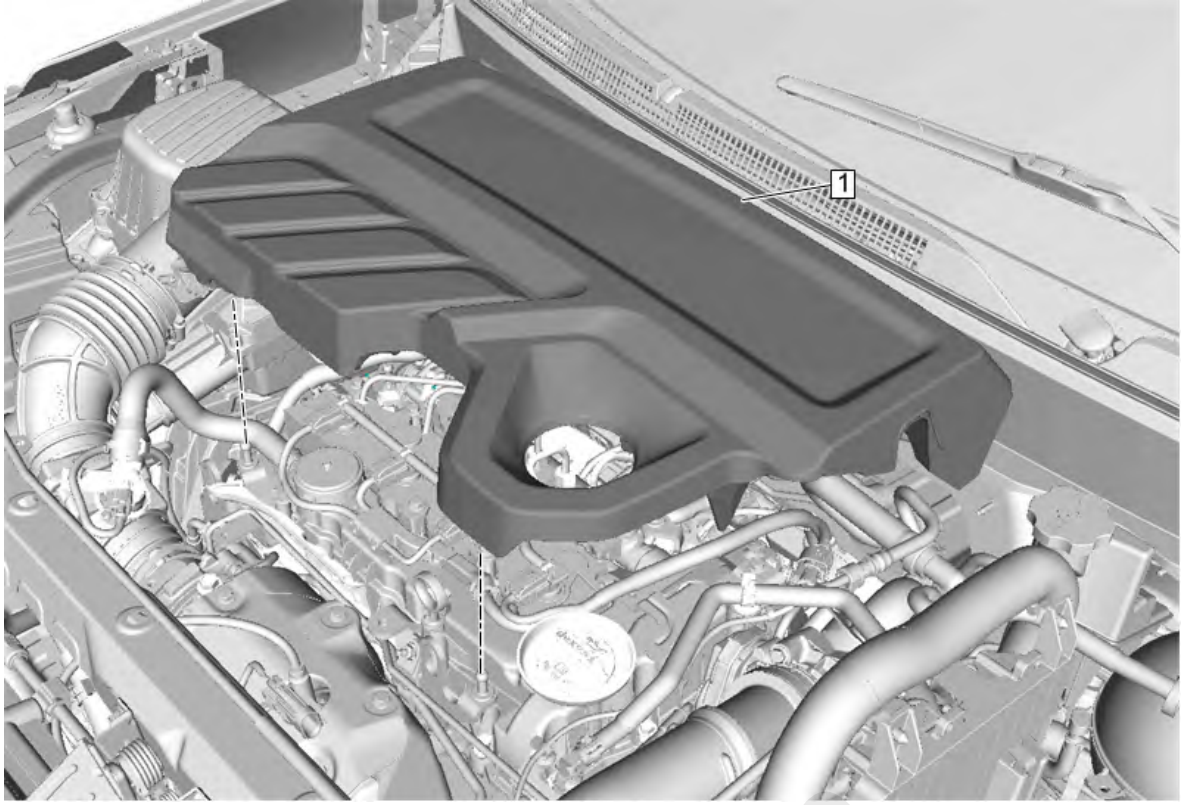


Fig. 434: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Intake Manifold Cover **Procedure** Release the intake manifold cover retainers by pulling the cover upwards.

INTAKE MANIFOLD REPLACEMENT

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Diesel Fuel Separator. Refer to **Diesel Fuel Separator Replacement**

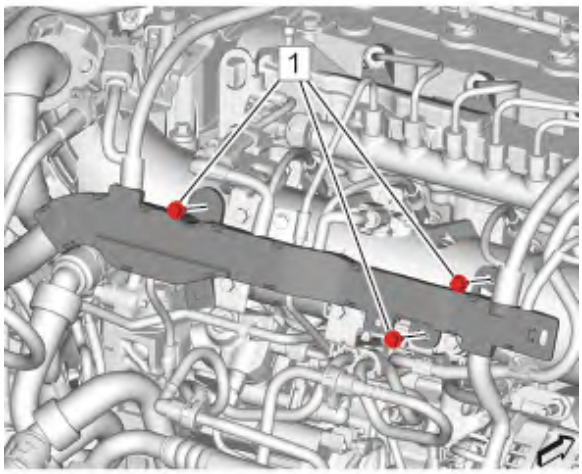


Fig. 435: Engine Wiring Harness Conduit Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove Engine Wiring Harness Conduit Bolts (1) (Qty: 3)

mcx30.com

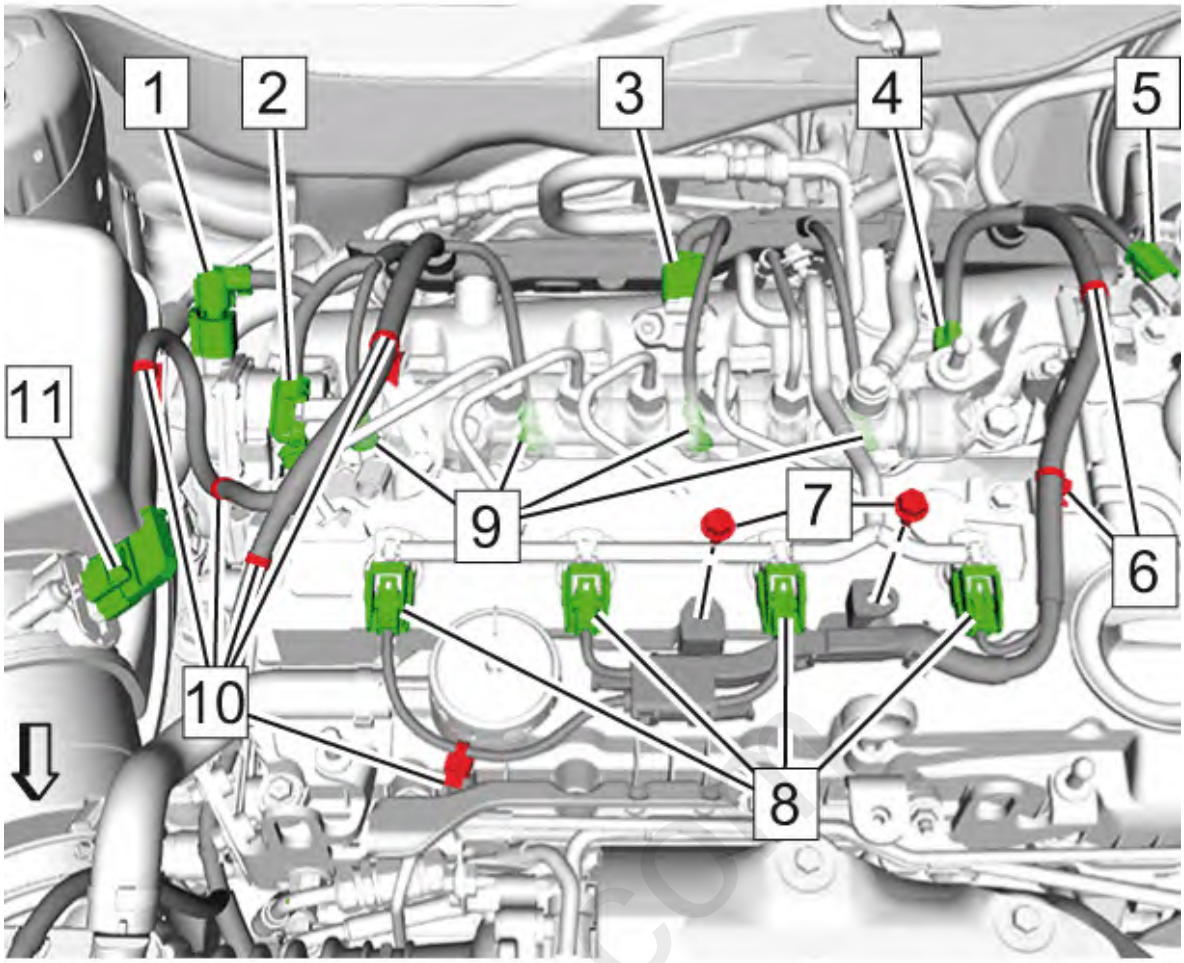


Fig. 436: Electrical Connectors, Bolts And Retainers
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the electrical connector:
    1. Intake Manifold Runner Control Valve Actuator (1)
    2. Fuel Rail Pressure Sensor (2)
    3. Intake Air Pressure and Temperature Sensor (3)
    4. Fuel Pressure Regulator (4)
    5. Exhaust Temperature Sensor - Position 1 (5)
    6. Fuel Injector (8) (Qty: 4)
    7. Mass Airflow Sensor (11)
    8. Camshaft Position Sensor (12)
5. Remove Engine Wiring Harness Conduit Bolts (7) (Qty: 2)
6. Unclip Engine Wiring Harness Retainers (6, 10) (Qty: 7)

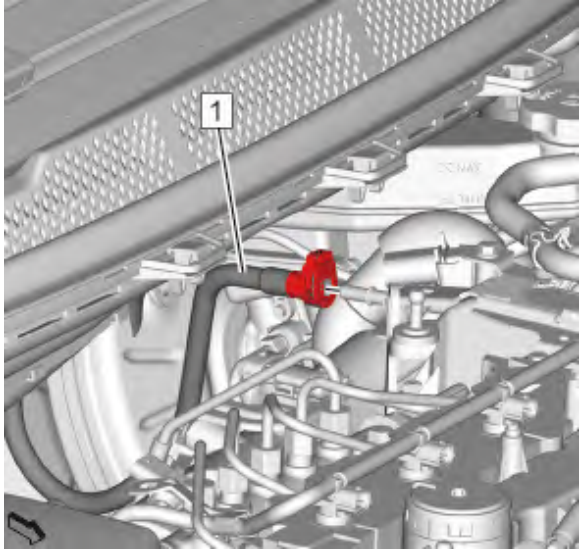


Fig. 437: Power Brake Booster Vacuum Pipe
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect Power Brake Booster Vacuum Pipe (1). Refer to **Plastic Collar Quick Connect Fitting Service**

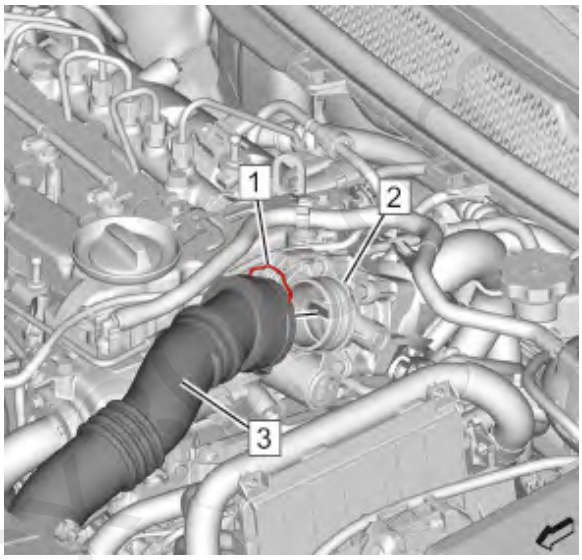


Fig. 438: Charge Air Cooler Outlet Air Hose, Retainer Spring And Throttle Body
Courtesy of GENERAL MOTORS COMPANY

8. Loosen Charge Air Cooler Outlet Air Hose Retainer Spring (1)
9. Disconnect Charge Air Cooler Outlet Air Hose (3) @ Throttle Body Assembly (2)

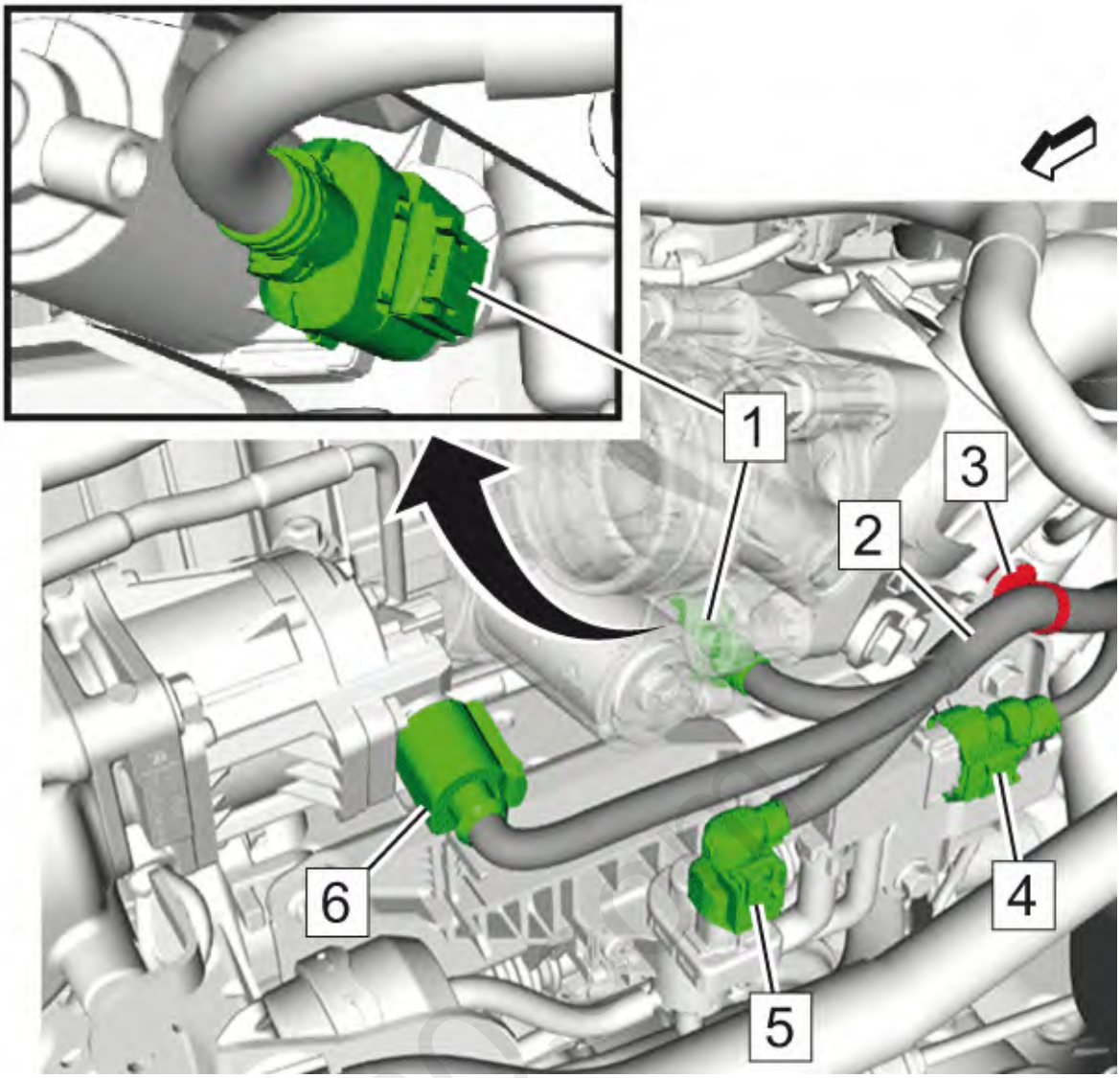


Fig. 439: Electrical Connectors, Engine Wiring Harness And Clip
Courtesy of GENERAL MOTORS COMPANY

10. Disconnect the electrical connector:
    1. Exhaust Gas Recirculation Valve (6)
    2. Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve (5)
    3. Exhaust Pressure Differential Sensor (4)
    4. Throttle Body (1)
11. Unclip Engine Wiring Harness Clip (3)
12. Position aside Engine Wiring Harness (2)

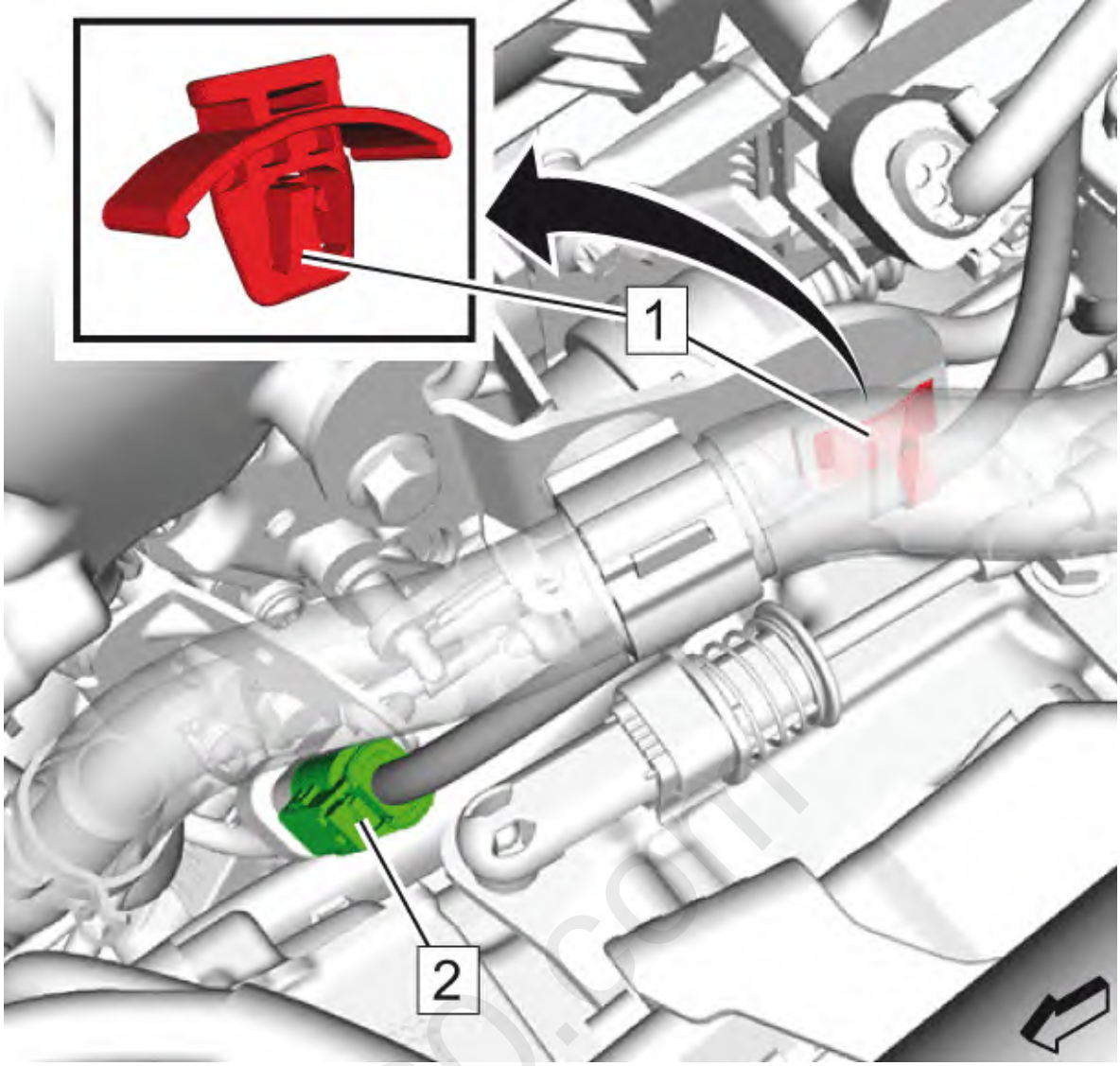


Fig. 440: Exhaust Temperature Sensor Electrical Connector And Retainer
Courtesy of GENERAL MOTORS COMPANY

13. Disconnect Exhaust Temperature Sensor Electrical Connector (2)
14. Unclip Engine Wiring Harness Retainer (1)

mcx30.com

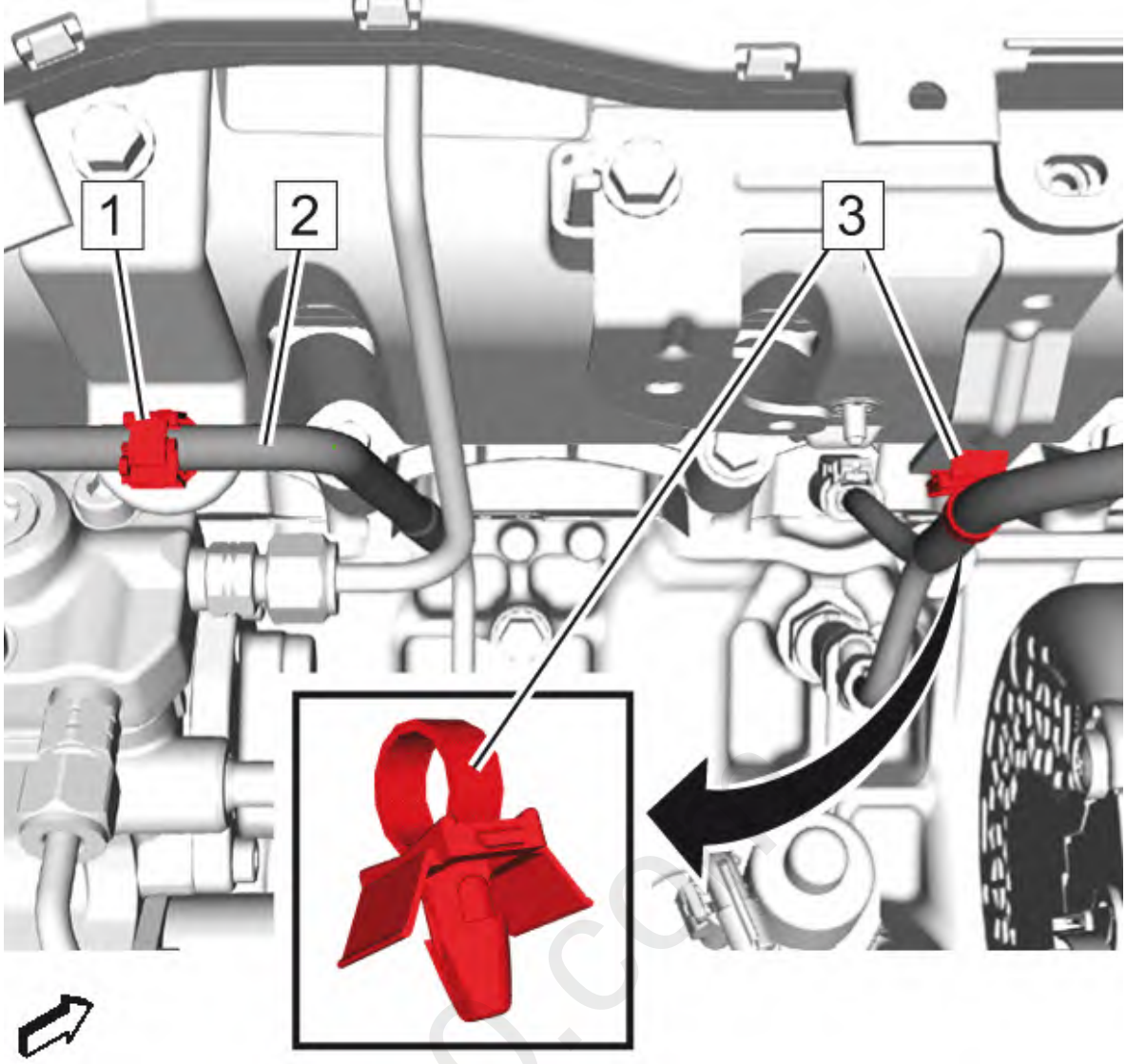


Fig. 441: Charge Air Bypass Valve Vacuum Hose, Retainer And Clip
Courtesy of GENERAL MOTORS COMPANY

15. Unclip the charge air bypass valve vacuum hose (2) from the retainer (1).
16. Unclip Engine Wiring Harness Clip (3)

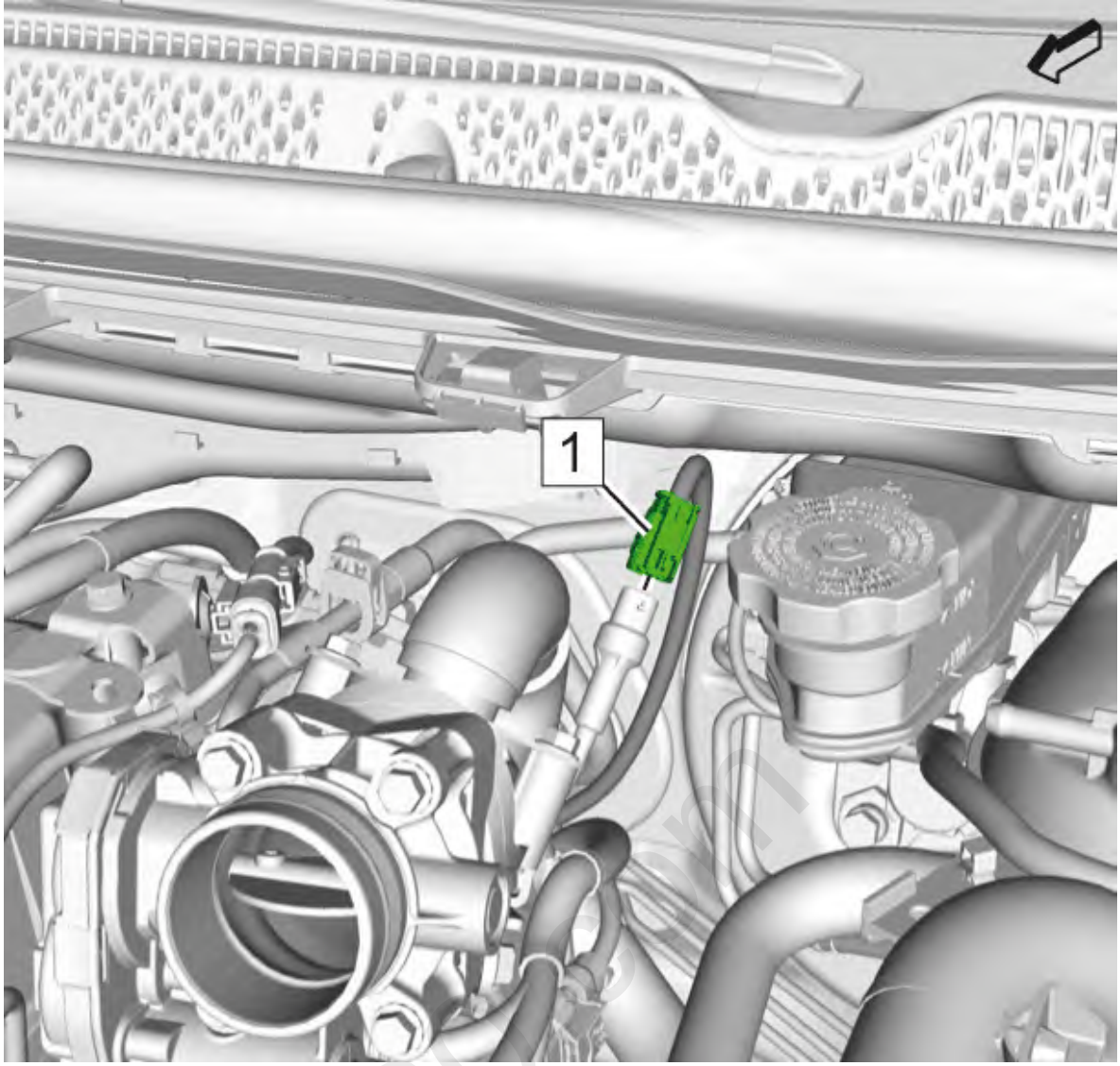


Fig. 442: Exhaust Gas Recirculation Cooler Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

17. Disconnect Exhaust Gas Recirculation Cooler Temperature Sensor Electrical Connector (1)

mcx30.com

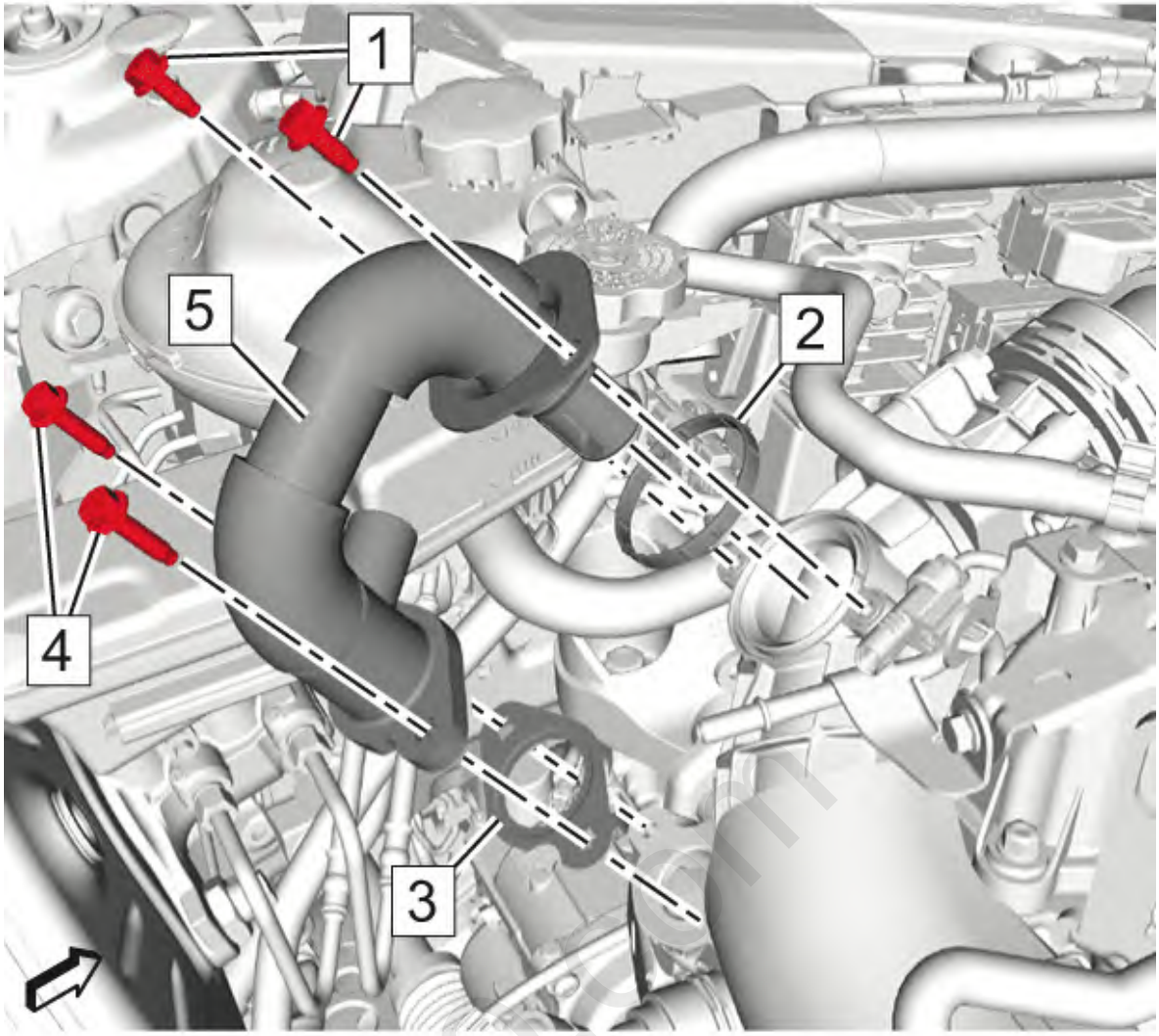


Fig. 443: Exhaust Gas Recirculation Cooler Outlet Pipe, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

18. Remove Exhaust Gas Recirculation Cooler Outlet Pipe Bolts (1, 4) (Qty: 4)
19. Remove Exhaust Gas Recirculation Cooler Outlet Pipe (5)
20. Remove and DISCARD the gaskets. (2, 3) (Qty: 2)

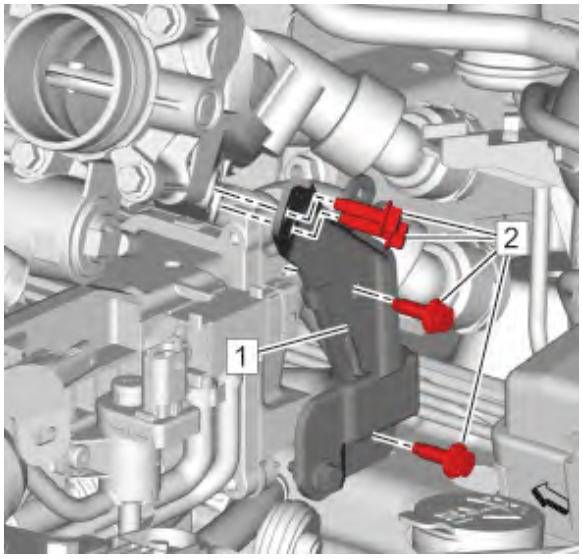


Fig. 444: Intake Manifold Brace And Bolts
Courtesy of GENERAL MOTORS COMPANY

21. Remove Intake Manifold Brace Bolts (2) (Qty: 4)
22. Remove Intake Manifold Brace (1)

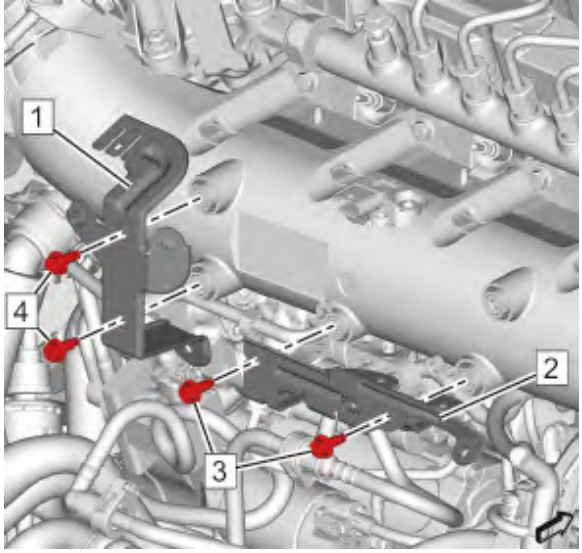


Fig. 445: Fuel Rail Fuel Pressure Sensor Wire Bracket, Fuel Return Pipe Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

23. Remove Fuel Injection Fuel Rail Fuel Pressure Sensor Wire Bracket Bolts (4) (Qty: 2)
24. Remove Fuel Injection Fuel Rail Fuel Pressure Sensor Wire Bracket (1)
25. Remove Fuel Injection Fuel Return Pipe Bracket Bolts (3) (Qty: 2)
26. Remove Fuel Injection Fuel Return Pipe Bracket (2)

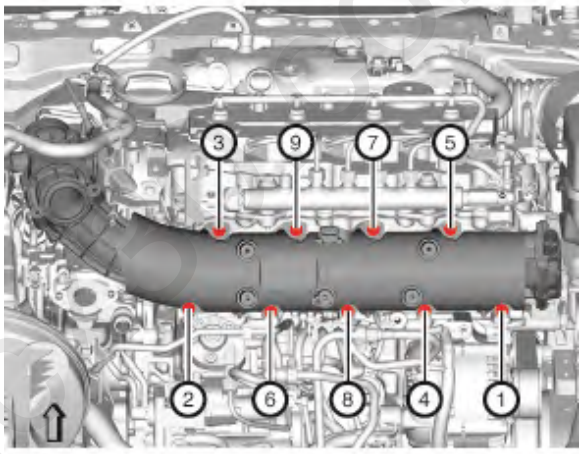


Fig. 446: Intake Manifold Bolt Loosening Sequence
Courtesy of GENERAL MOTORS COMPANY

27. Loosen the 9 intake manifold bolts in sequence as shown.

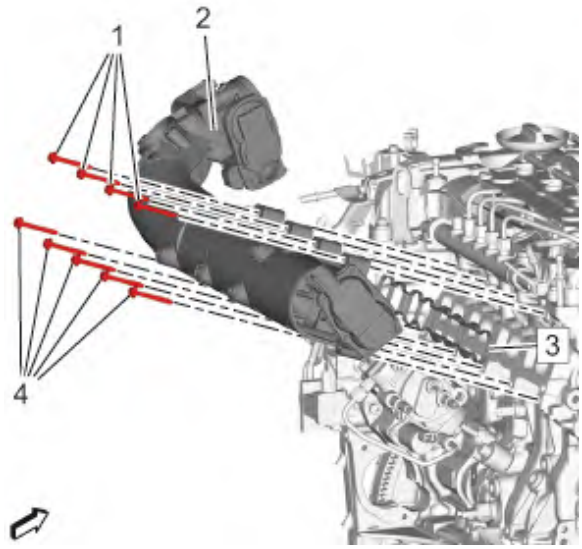


Fig. 447: Intake Manifold, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

28. Remove Intake Manifold Bolts (1, 4) (Qty: 9)
29. Remove Intake Manifold (2)
30. Remove and DISCARD Intake Manifold Gasket (3)
31. Disassemble the intake manifold. Refer to **Intake Manifold Disassemble**

Installation Procedure

1. Assemble the intake manifold. Refer to **Intake Manifold Assemble**

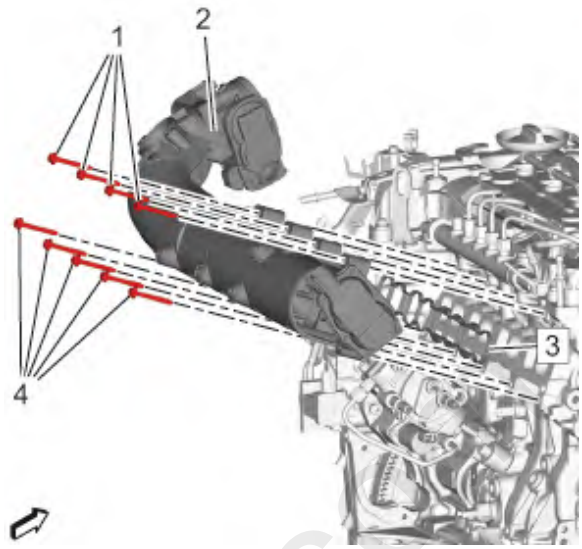


Fig. 448: Intake Manifold, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW intake manifold gasket. (3)
3. Install Intake Manifold (2)
4. Install Intake Manifold Bolts (1, 4) (Qty: 9)

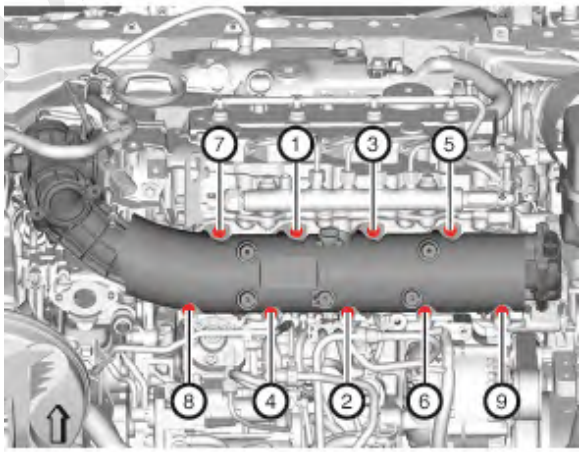


Fig. 449: Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution**

5. Tighten Intake Manifold Bolts in sequence (Qty: 9) to 12 N.m (106 lb in)

mcx30.com

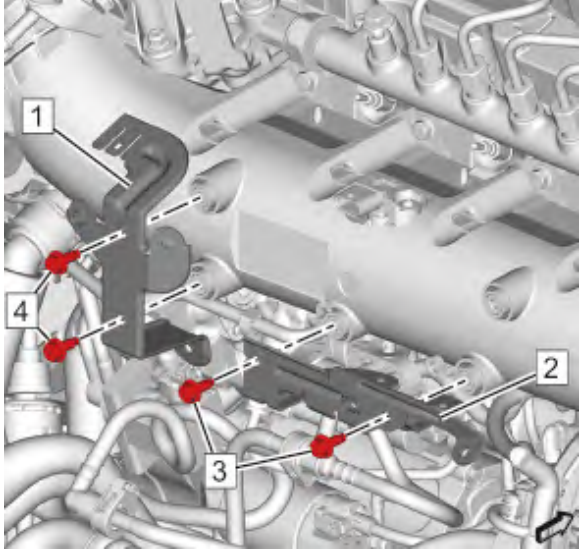


Fig. 450: Fuel Rail Fuel Pressure Sensor Wire Bracket, Fuel Return Pipe Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Install Fuel Injection Fuel Return Pipe Bracket (2)
7. Install and tighten Fuel Injection Fuel Return Pipe Bracket Bolts (3) (Qty: 2) to 9 N.m (80 lb in)
8. Install Fuel Injection Fuel Rail Fuel Pressure Sensor Wire Bracket (1)
9. Install and tighten Fuel Injection Fuel Rail Fuel Pressure Sensor Wire Bracket Bolts (4) (Qty: 2) to 9 N.m (80 lb in)

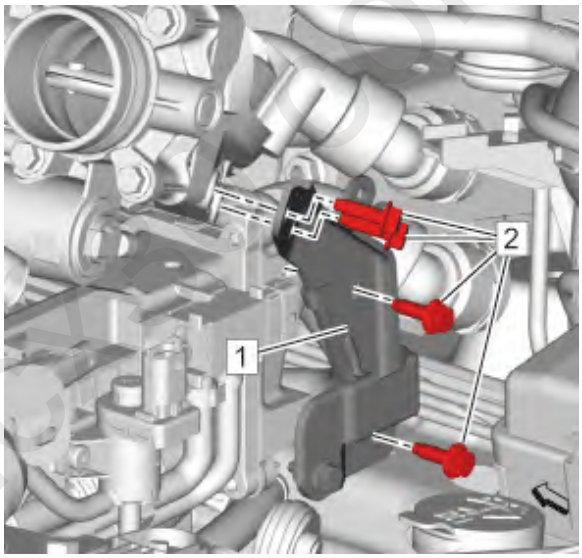


Fig. 451: Intake Manifold Brace And Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Install Intake Manifold Brace (1)
11. Install and tighten Intake Manifold Brace Bolts (2) (Qty: 4) to 10 N.m (89 lb in)

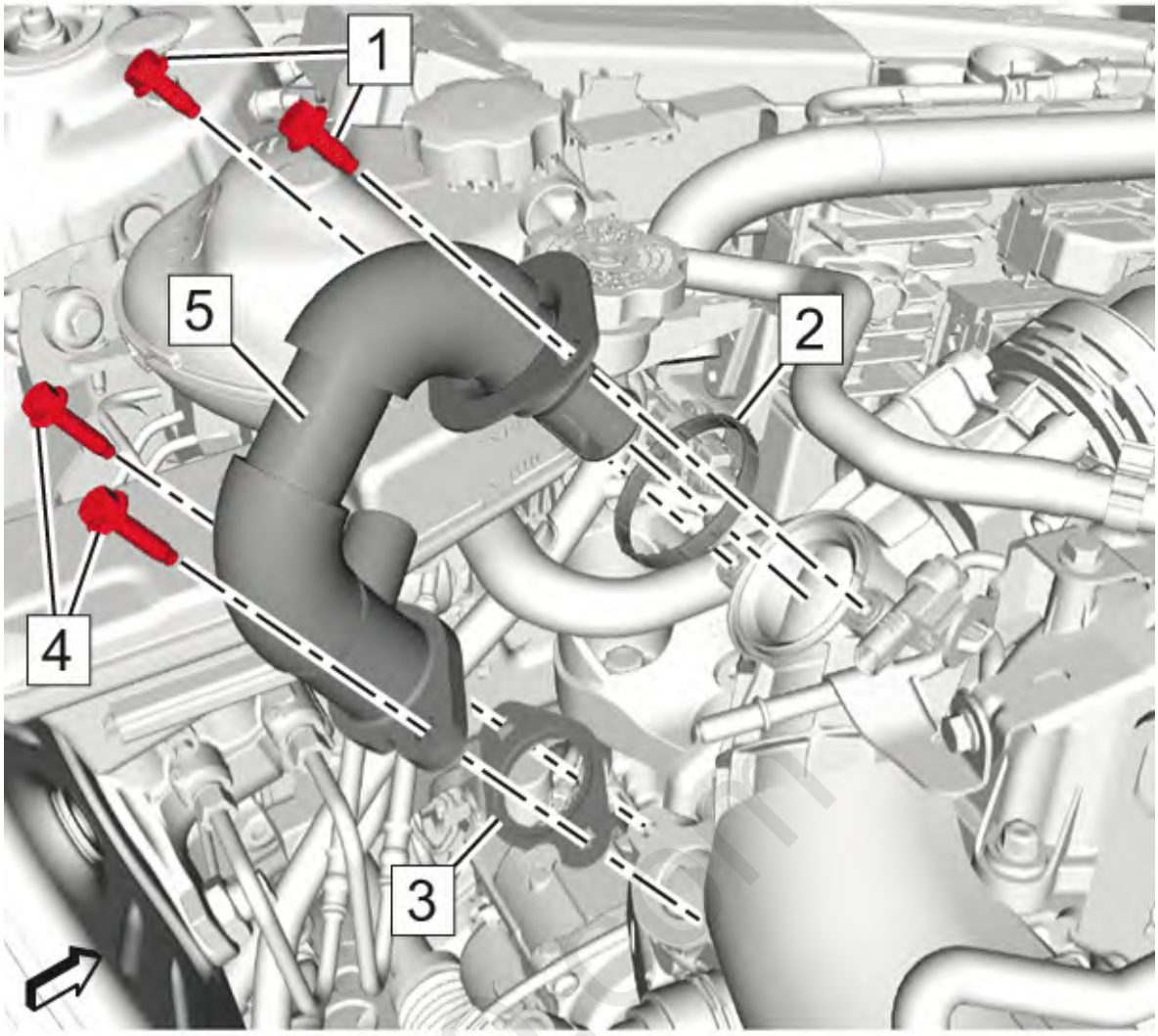


Fig. 452: Exhaust Gas Recirculation Cooler Outlet Pipe, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

12. Install NEW gaskets. (2, 3) (Qty: 2)
13. Install Exhaust Gas Recirculation Cooler Outlet Pipe (5)
14. Install and tighten Exhaust Gas Recirculation Cooler Outlet Pipe Bolts (1, 4) (Qty: 4) to 10 N.m (89 lb in)

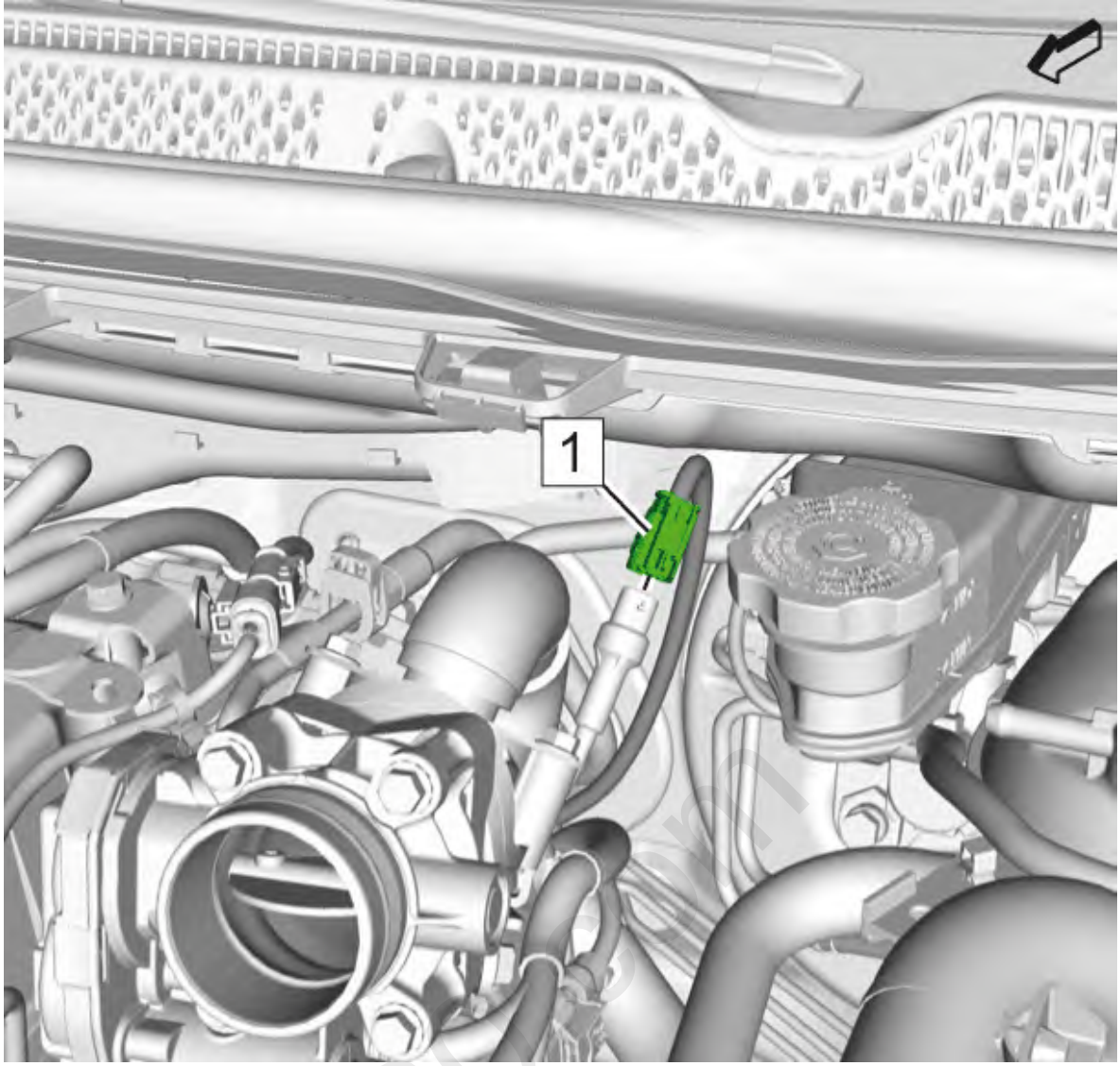


Fig. 453: Exhaust Gas Recirculation Cooler Temperature Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

15. Connect Exhaust Gas Recirculation Cooler Temperature Sensor Electrical Connector (1)

mcx3.com

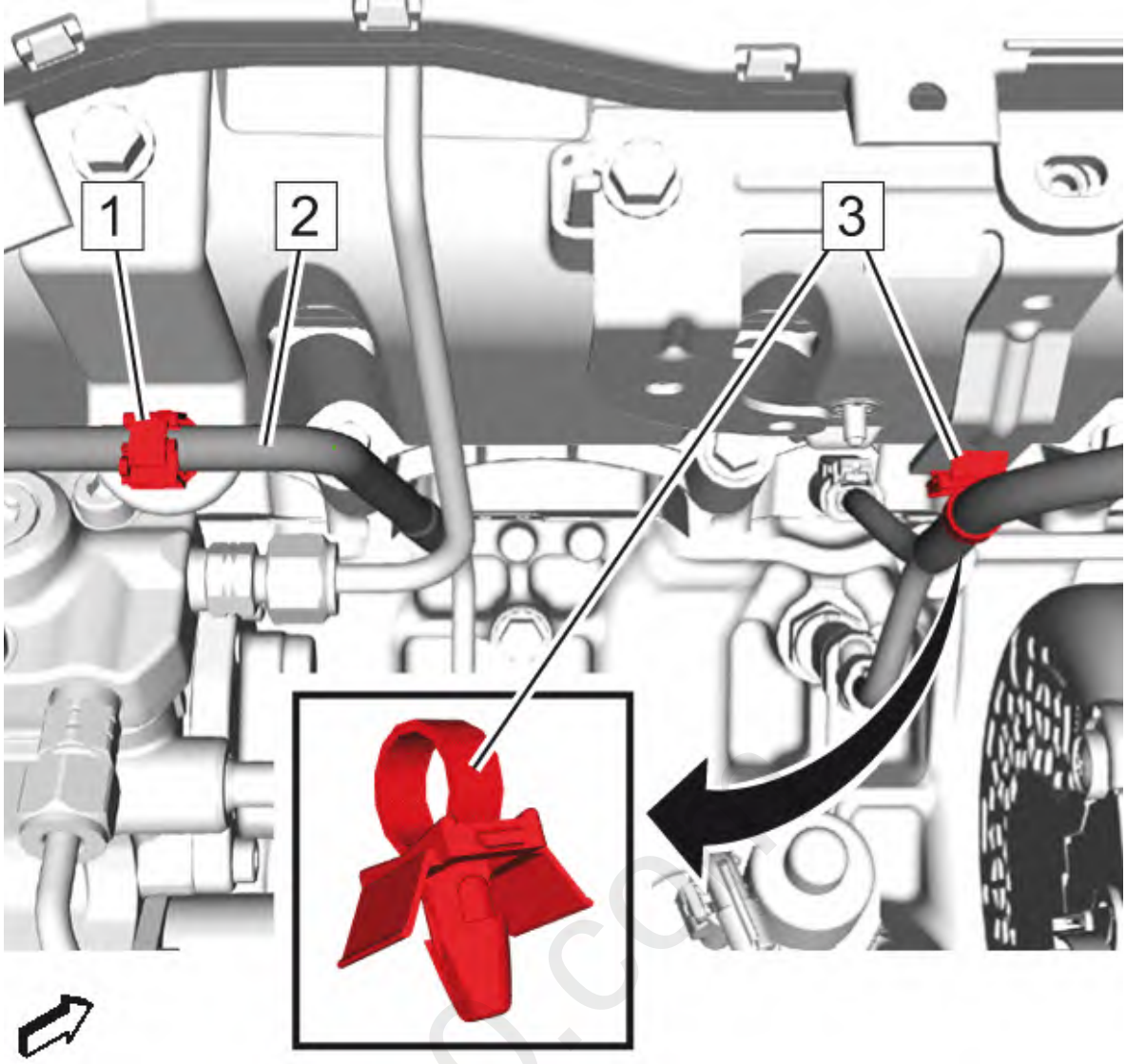


Fig. 454: Charge Air Bypass Valve Vacuum Hose, Retainer And Clip
Courtesy of GENERAL MOTORS COMPANY

16. Install Engine Wiring Harness Clip (3)
17. Install the charge air bypass valve vacuum hose (2) to the retainer (1).

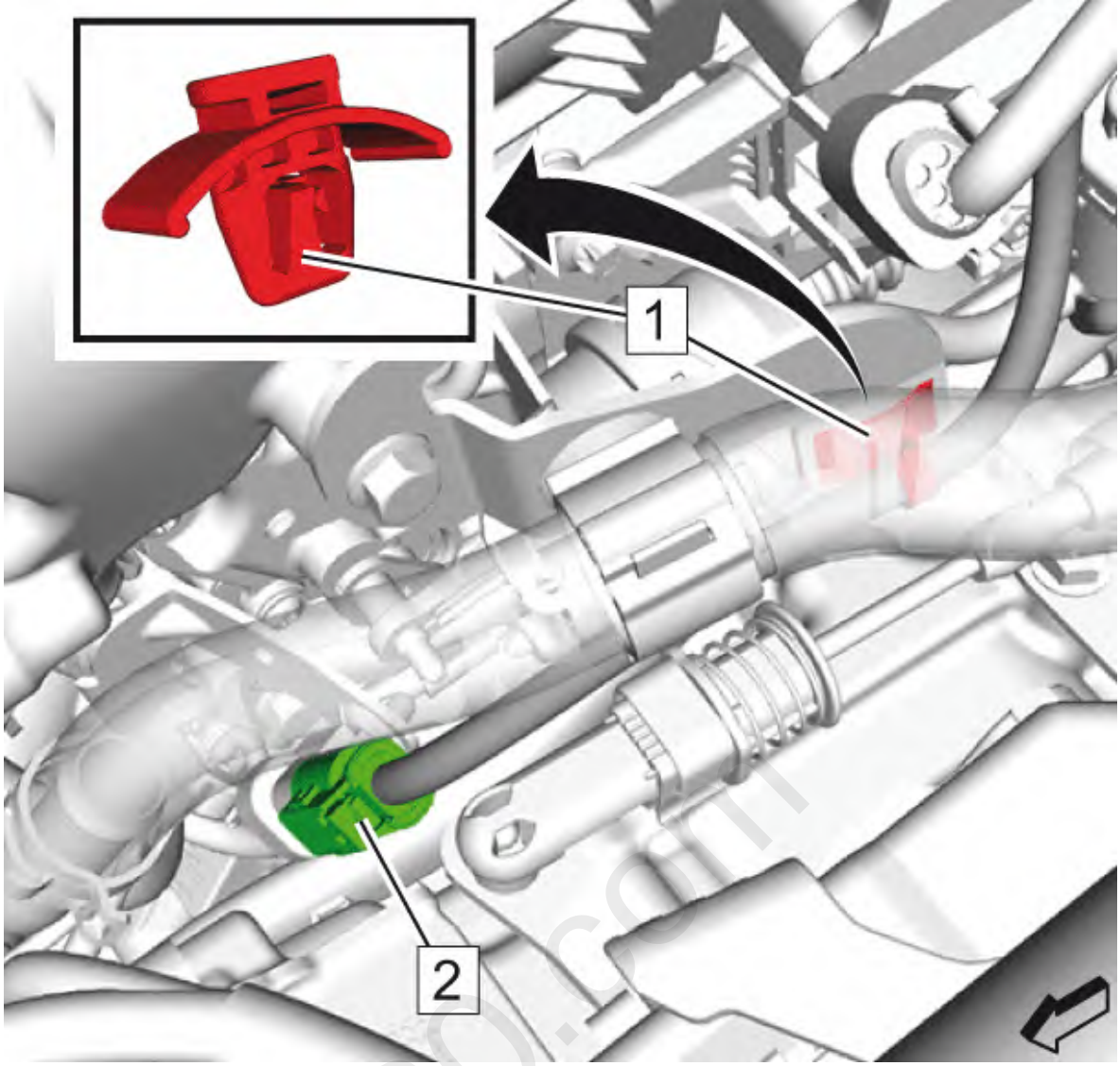


Fig. 455: Exhaust Temperature Sensor Electrical Connector And Retainer
Courtesy of GENERAL MOTORS COMPANY

18. Install Engine Wiring Harness Retainer (1)
19. Connect Exhaust Temperature Sensor Electrical Connector (2)

mcx30.com

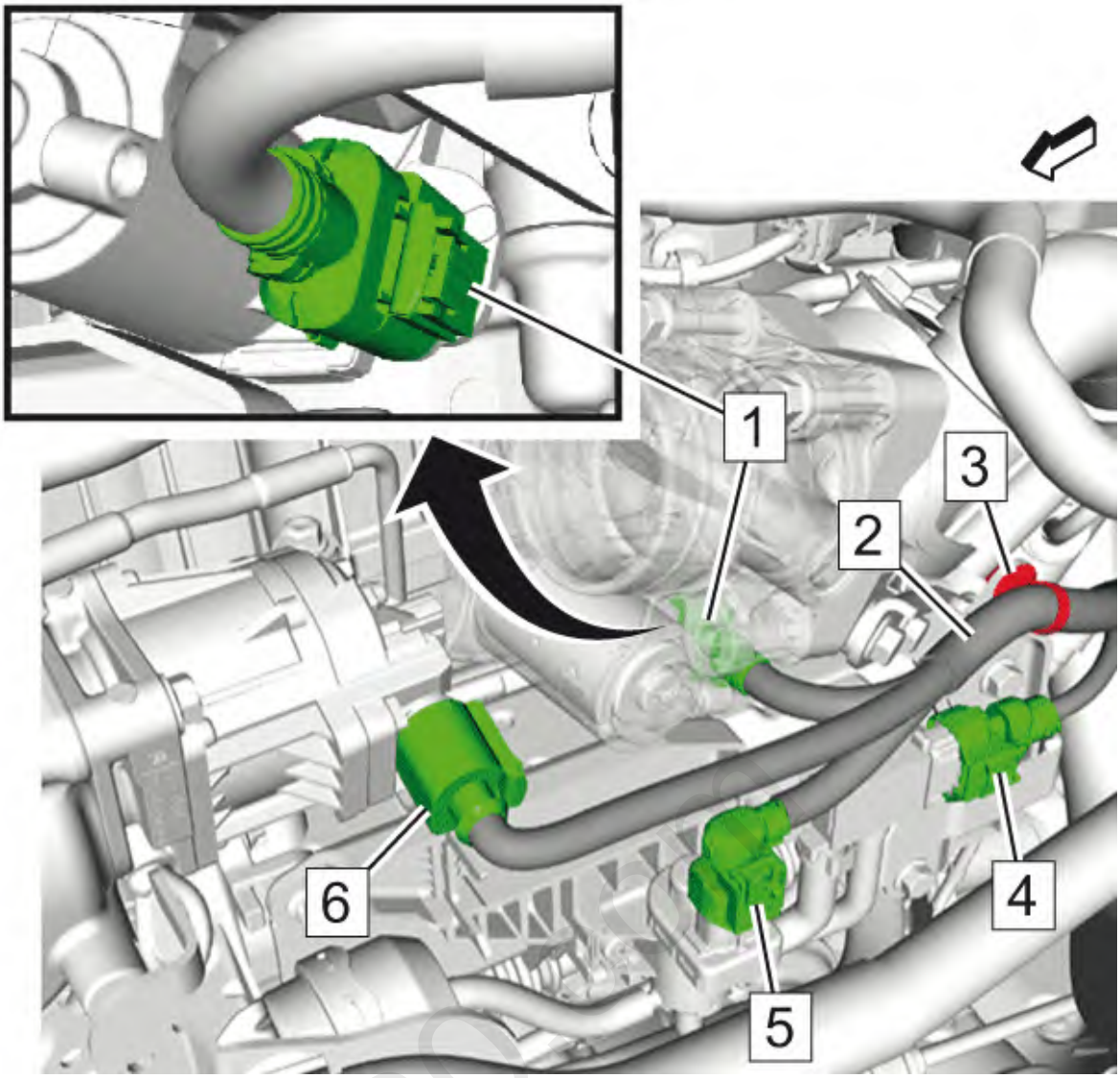


Fig. 456: Electrical Connectors, Engine Wiring Harness And Clip
Courtesy of GENERAL MOTORS COMPANY

20. Reposition Engine Wiring Harness (2)
21. Connect the electrical connector:
    1. Exhaust Gas Recirculation Valve (6)
    2. Exhaust Gas Recirculation Vacuum Regulator Solenoid Valve (5)
    3. Exhaust Pressure Differential Sensor (4)
    4. Throttle Body (1)
22. Install Engine Wiring Harness Clip (3)

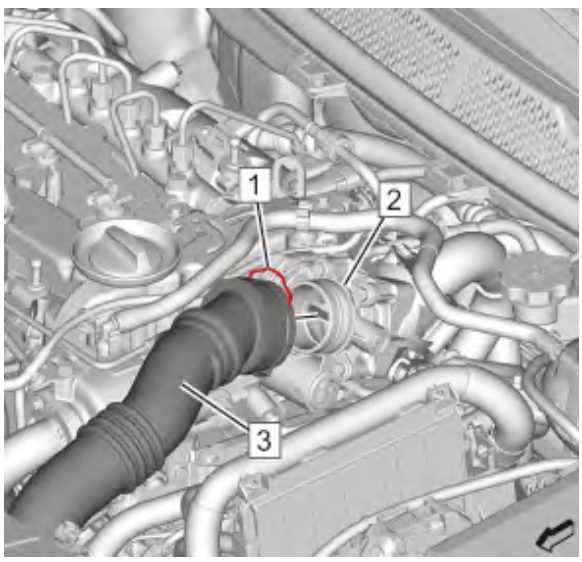


Fig. 457: Charge Air Cooler Outlet Air Hose, Retainer Spring And Throttle Body
Courtesy of GENERAL MOTORS COMPANY

23. Connect Charge Air Cooler Outlet Air Hose (3) @ Throttle Body Assembly (2)
24. Lock Charge Air Cooler Outlet Air Hose Retainer Spring (1)

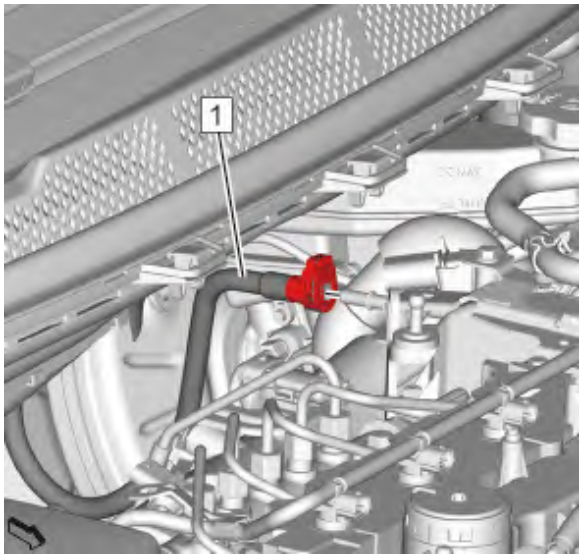


Fig. 458: Power Brake Booster Vacuum Pipe
Courtesy of GENERAL MOTORS COMPANY

25. Connect Power Brake Booster Vacuum Pipe (1). Refer to **Plastic Collar Quick Connect Fitting Service**

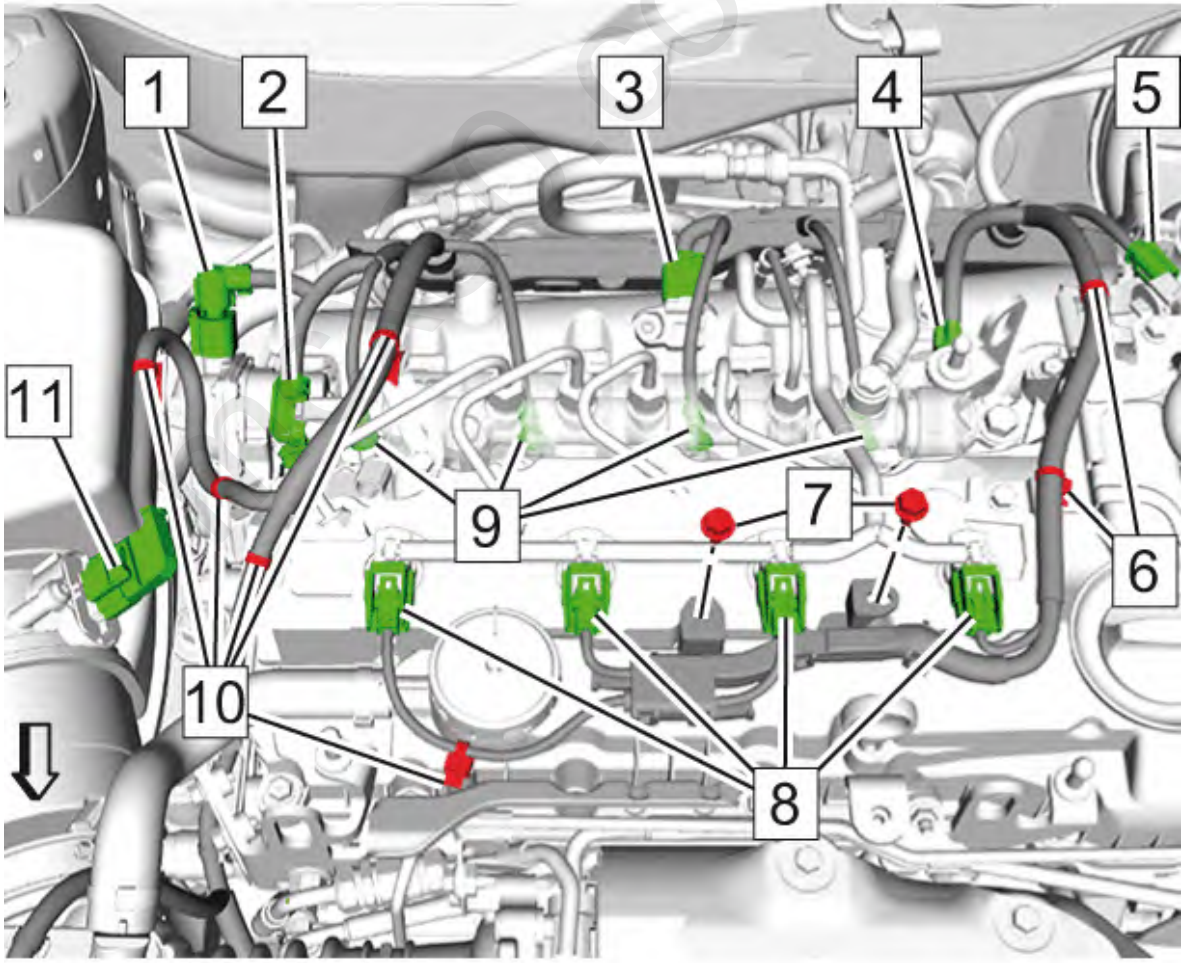


Fig. 459: Electrical Connectors, Bolts And Retainers
Courtesy of GENERAL MOTORS COMPANY

26. Connect the electrical connector:
    1. Intake Manifold Runner Control Valve Actuator (1)
    2. Fuel Rail Pressure Sensor (2)

3. Intake Air Pressure and Temperature Sensor (3)
4. Fuel Pressure Regulator (4)
5. Exhaust Temperature Sensor - Position 1 (5)
6. Fuel Injector (8) (Qty: 4)
7. Mass Airflow Sensor (11)
8. Camshaft Position Sensor (12)

27. Install and tighten Engine Wiring Harness Conduit Bolts (7) (Qty: 2) to 9 N.m (80 lb in)
28. Install Engine Wiring Harness Retainers (6, 10) (Qty: 7)

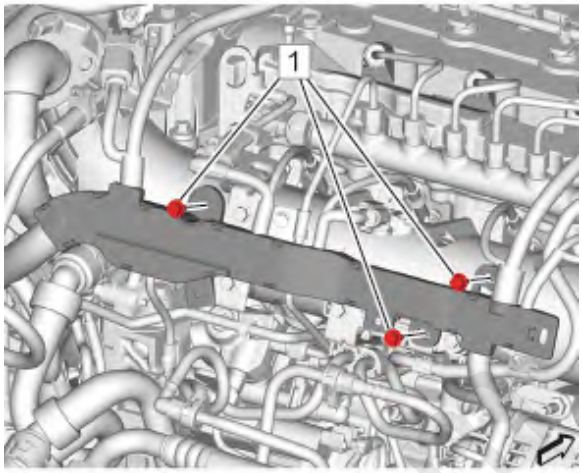


Fig. 460: Engine Wiring Harness Conduit Bolts
Courtesy of GENERAL MOTORS COMPANY

29. Install and tighten Engine Wiring Harness Conduit Bolts (1) (Qty: 3) to 9 N.m (80 lb in)
30. Install Diesel Fuel Separator. Refer to **Diesel Fuel Separator Replacement**
31. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
32. Check the fuel system for leaks. Refer to **Fuel Leak Diagnosis**

INTAKE MANIFOLD BRACE REPLACEMENT

Removal Procedure

mcx30.com

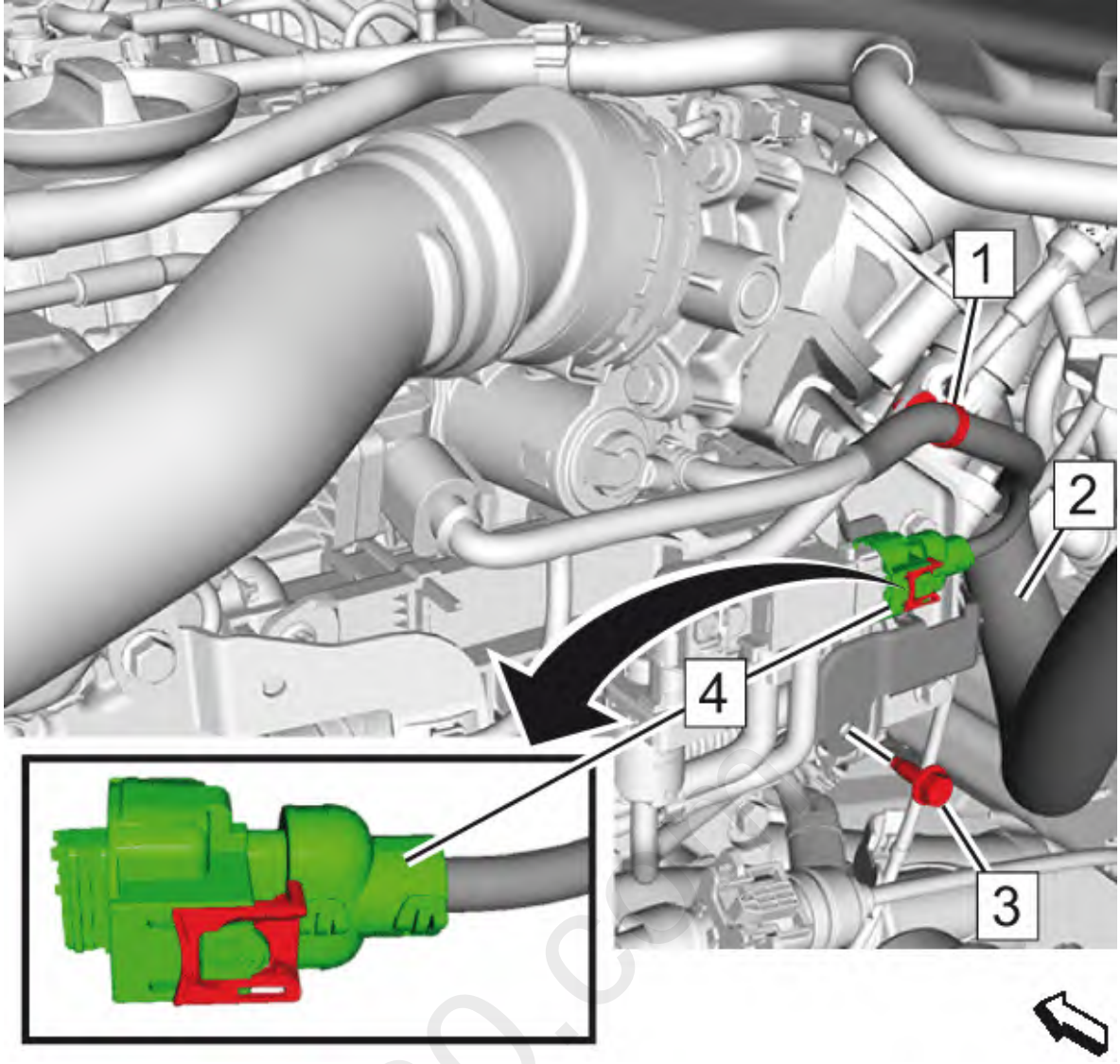


Fig. 461: Engine Wiring Harness, Bracket, Bolt, Retainer And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Unclip Wiring Harness Retainer (1)
2. Disconnect Electrical Connector (4)
3. Remove Engine Wiring Harness Bracket Bolt (3)
4. Position aside Engine Wiring Harness (2)

mex30.com

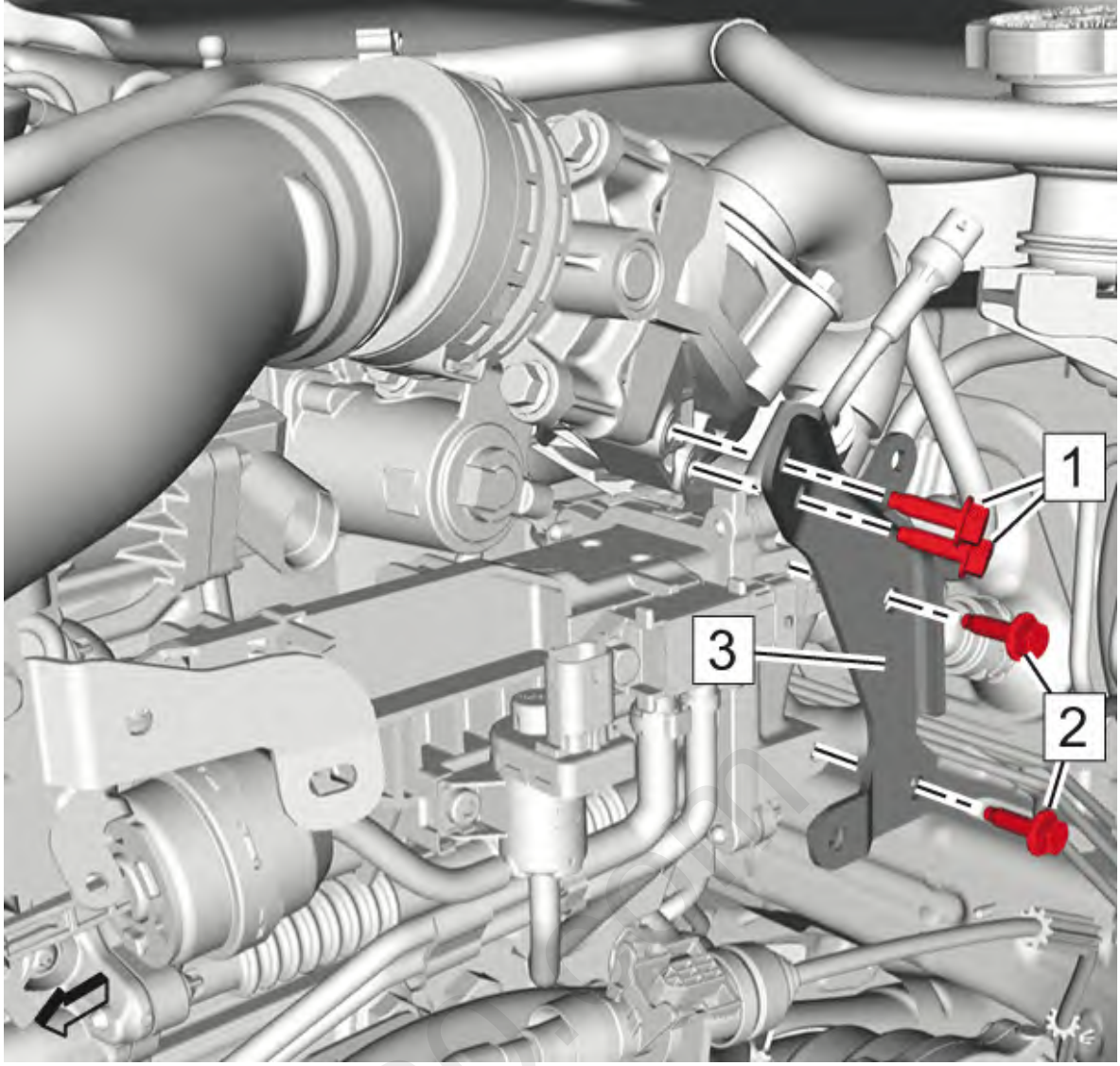


Fig. 462: Intake Manifold Brace And Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove Intake Manifold Brace Bolts (1, 2) (Qty: 4)
6. Remove Intake Manifold Brace (3)

Installation Procedure

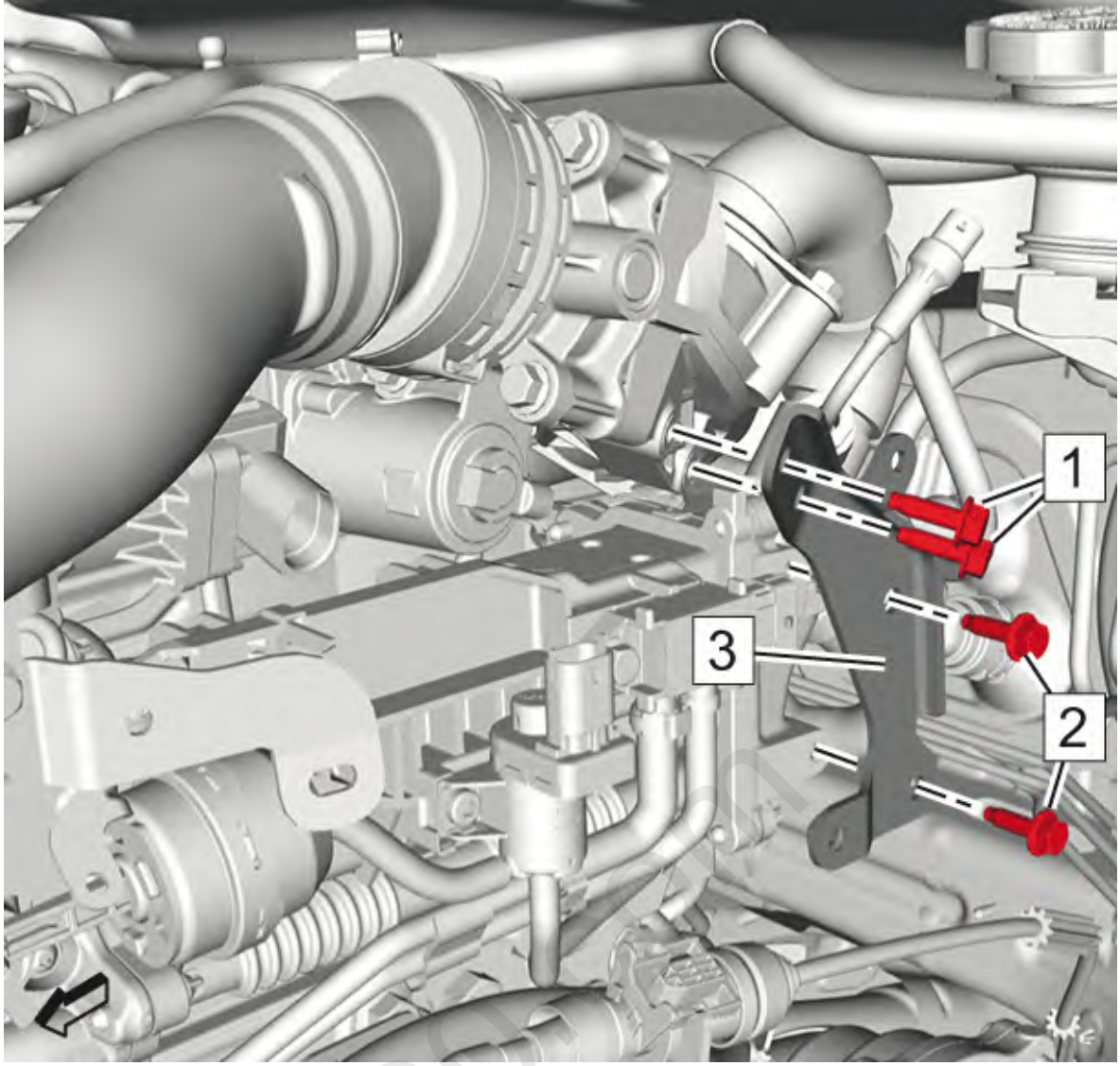


Fig. 463: Intake Manifold Brace And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install Intake Manifold Brace (3)

CAUTION: **Refer to Fastener Caution**

2. Install and tighten Intake Manifold Brace Bolts (1, 2) (Qty: 4) to 10 N.m (89 lb in)

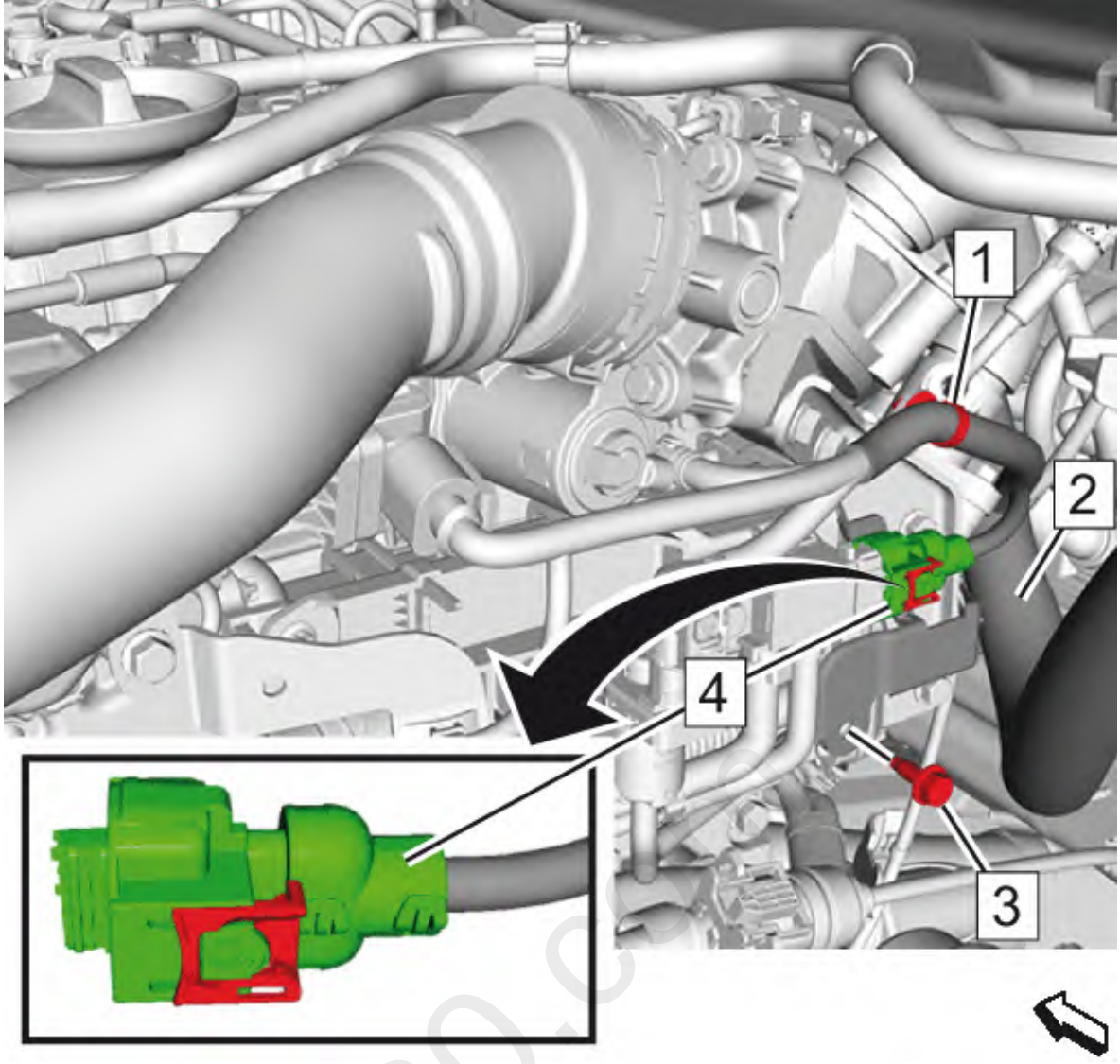


Fig. 464: Engine Wiring Harness, Bracket, Bolt, Retainer And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Reposition Engine Wiring Harness (2)
4. Install and tighten Engine Wiring Harness Bracket Bolt (3) to 10 N.m (89 lb in)
5. Install Wiring Harness Retainer (1)
6. Connect Electrical Connector (4)

TURBOCHARGER OIL FEED PIPE REPLACEMENT

Removal Procedure

1. Remove Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**
2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**

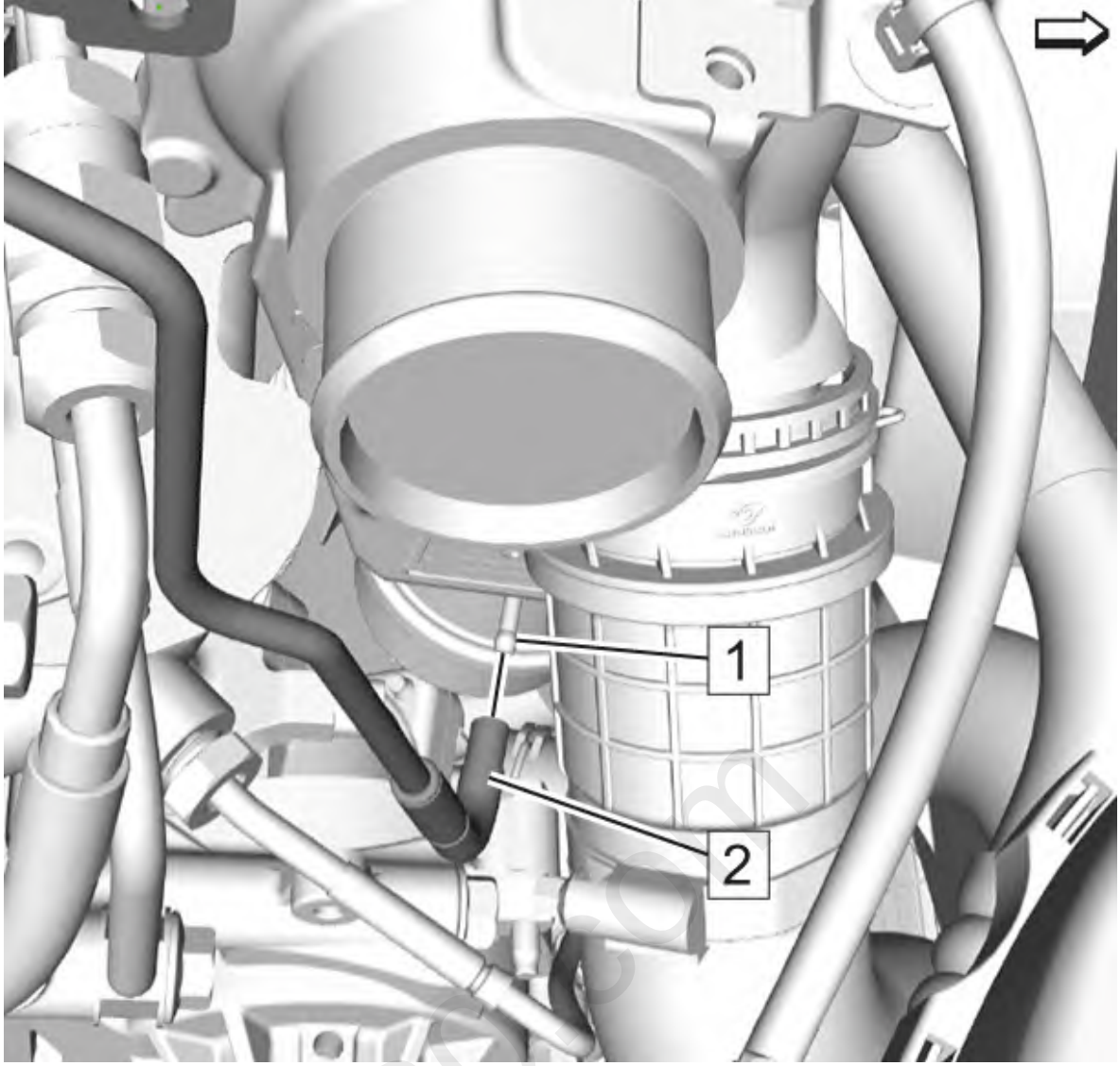


Fig. 465: Turbocharger Wastegate Actuator Pipe And Turbocharger
Courtesy of GENERAL MOTORS COMPANY

3. Remove Turbocharger Wastegate Actuator Pipe (2) @ Turbocharger (1)

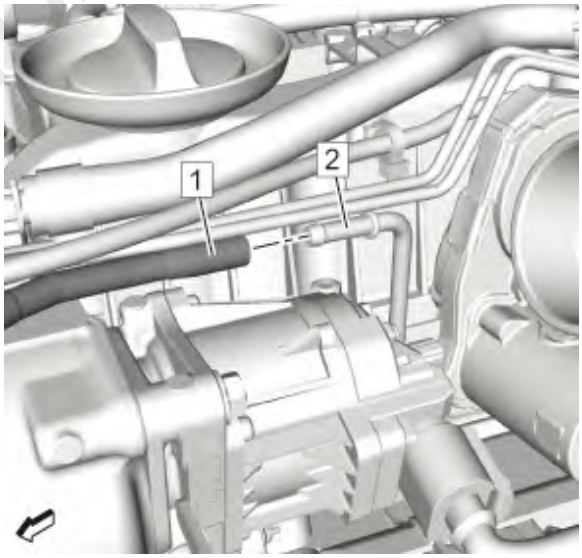


Fig. 466: Turbocharger Wastegate Actuator Pipe And Power Brake Booster Inlet Hose Connector Fitting
Courtesy of GENERAL MOTORS COMPANY

4. Remove Turbocharger Wastegate Actuator Pipe (1) @ Power Brake Booster Inlet Hose Connector Fitting (2)

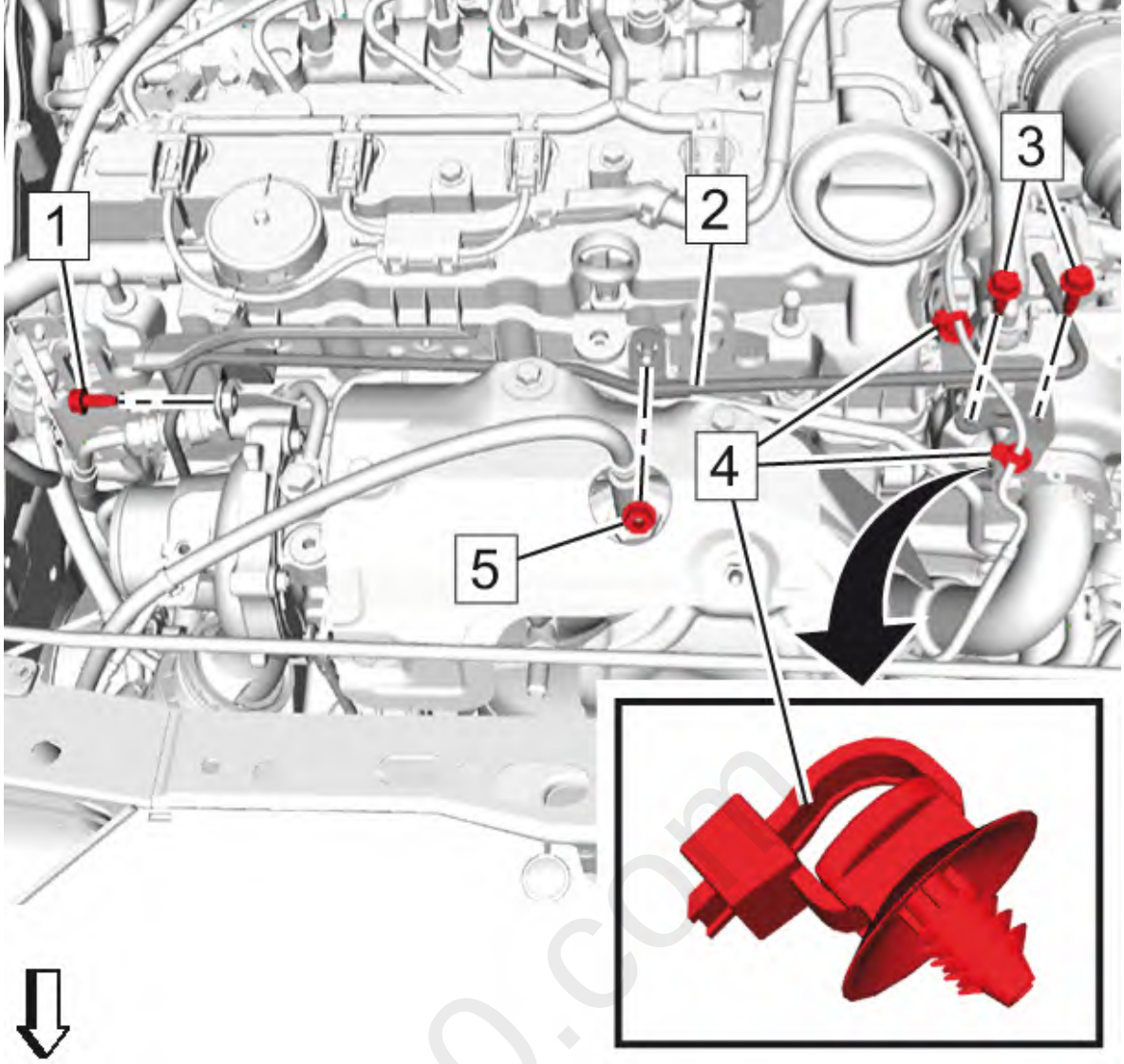


Fig. 467: Turbocharger Wastegate Actuator Pipe, Bolts, Nut And Clips
Courtesy of GENERAL MOTORS COMPANY

5. Remove Turbocharger Wastegate Actuator Pipe Bolts (1, 3) (Qty: 3)
6. Remove the turbocharger wastegate actuator pipe nut (5).
7. Unclip Wiring Harness Clips (4) (Qty: 2)
8. Remove Turbocharger Wastegate Actuator Pipe (2)

mx30.com

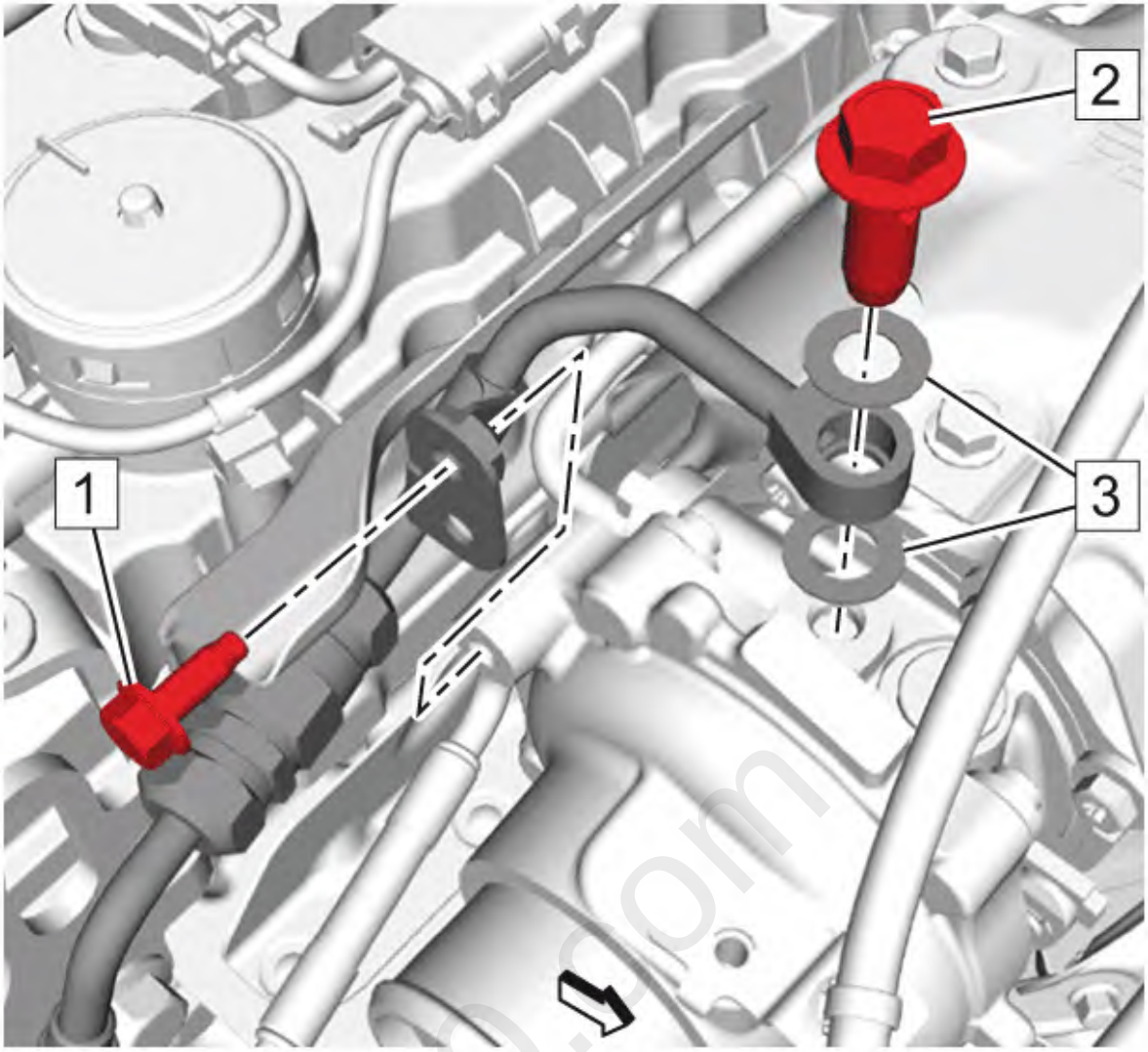


Fig. 468: Turbocharger Oil Feed Pipe Hollow Screw, Bracket Bolt And Gaskets
Courtesy of GENERAL MOTORS COMPANY

9. Remove Turbocharger Oil Feed Pipe Bracket Bolt (1)
10. Remove Turbocharger Oil Feed Pipe Hollow Screw (2)
11. Remove and DISCARD the gaskets. (3) (Qty: 2)

mox30.com

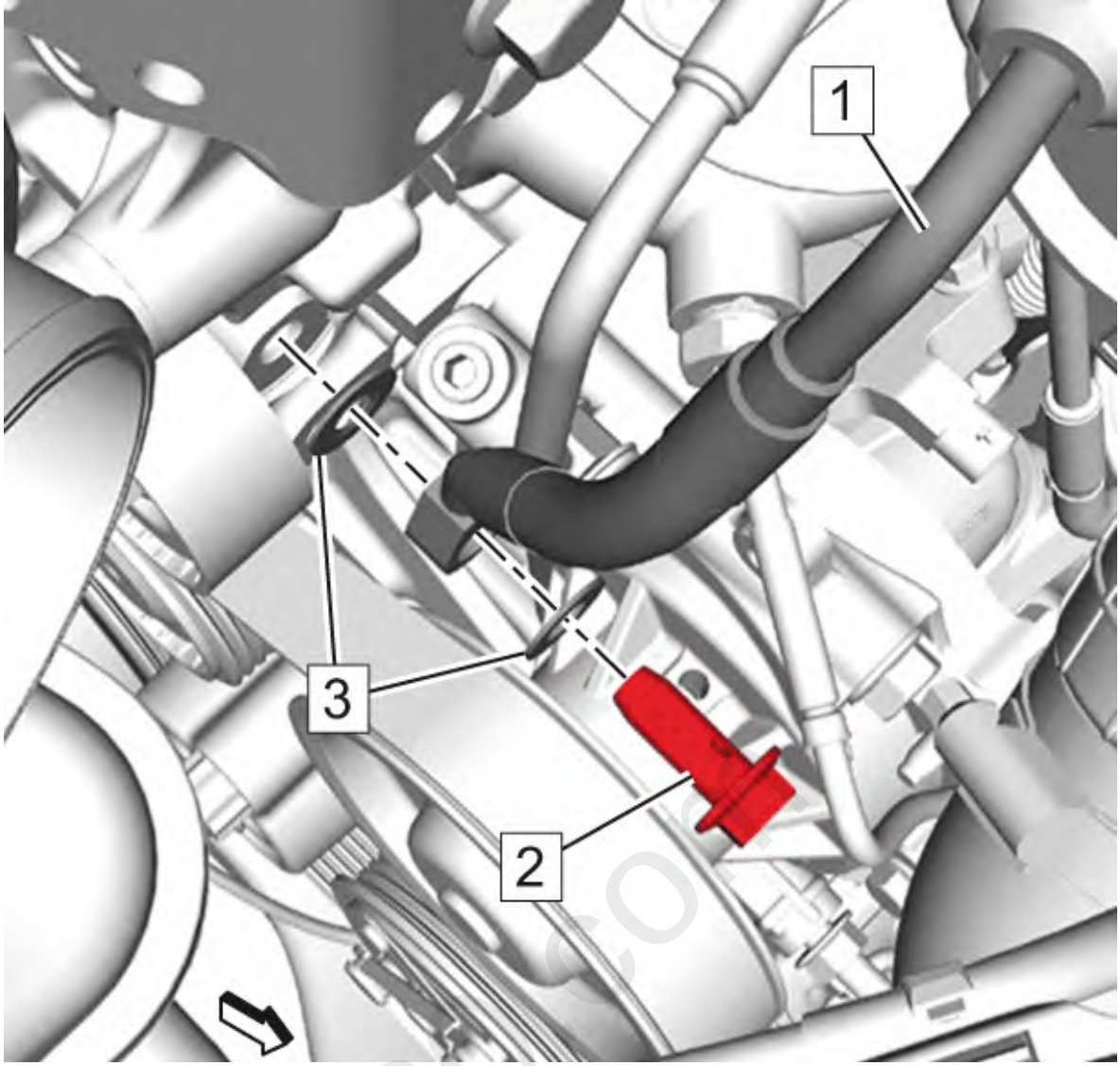


Fig. 469: Turbocharger Oil Feed Pipe, Hollow Screw And Gaskets
Courtesy of GENERAL MOTORS COMPANY

12. Remove Turbocharger Oil Feed Pipe Hollow Screw (2)
13. Remove and DISCARD the gaskets. (3) (Qty: 2)
14. Remove Turbocharger Oil Feed Pipe (1)

Installation Procedure

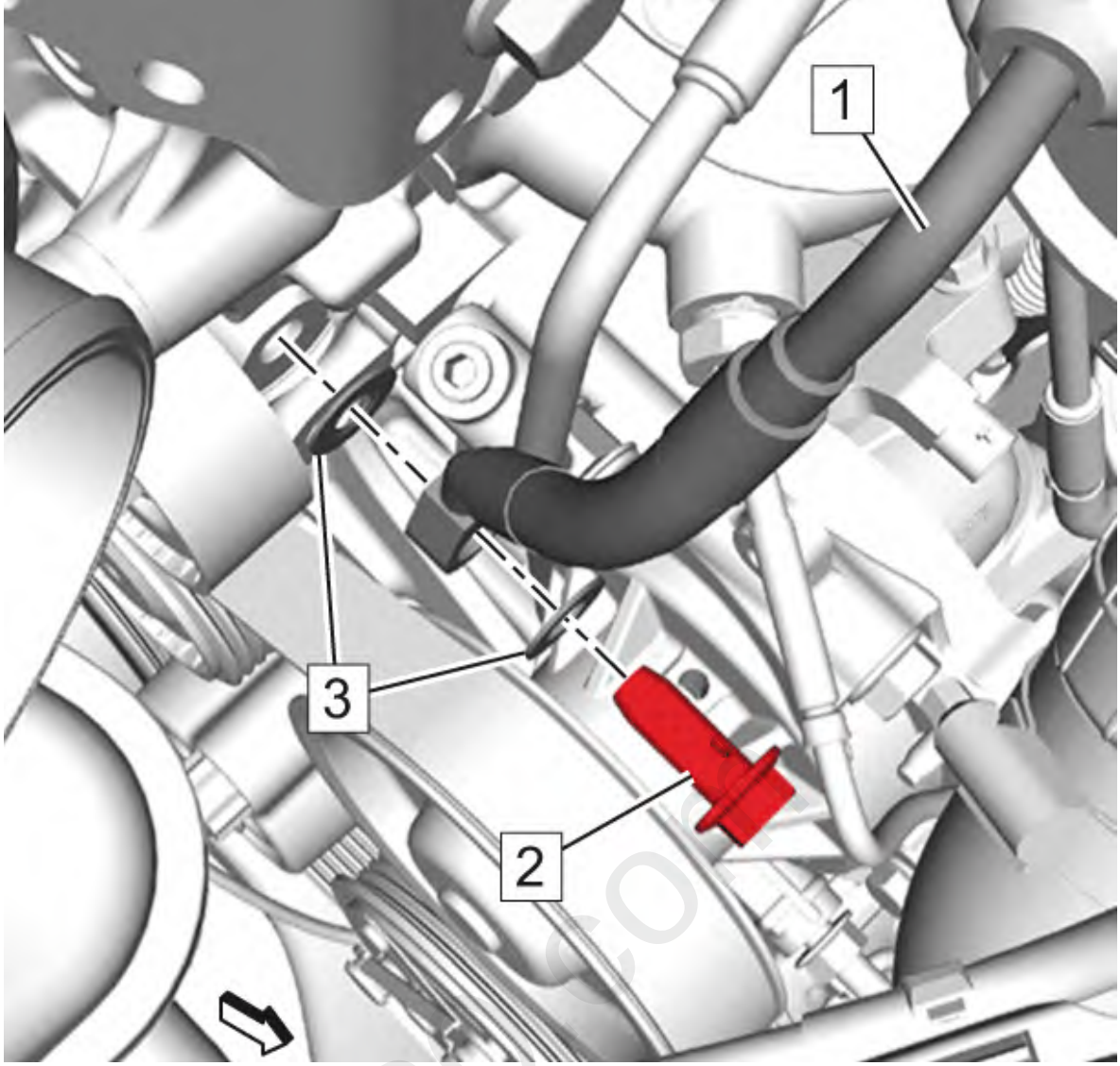


Fig. 470: Turbocharger Oil Feed Pipe, Hollow Screw And Gaskets
Courtesy of GENERAL MOTORS COMPANY

1. Install Turbocharger Oil Feed Pipe (1)
2. Install NEW gaskets. (3) (Qty: 2)
3. Install Turbocharger Oil Feed Pipe Hollow Screw (2) - Do NOT tighten.

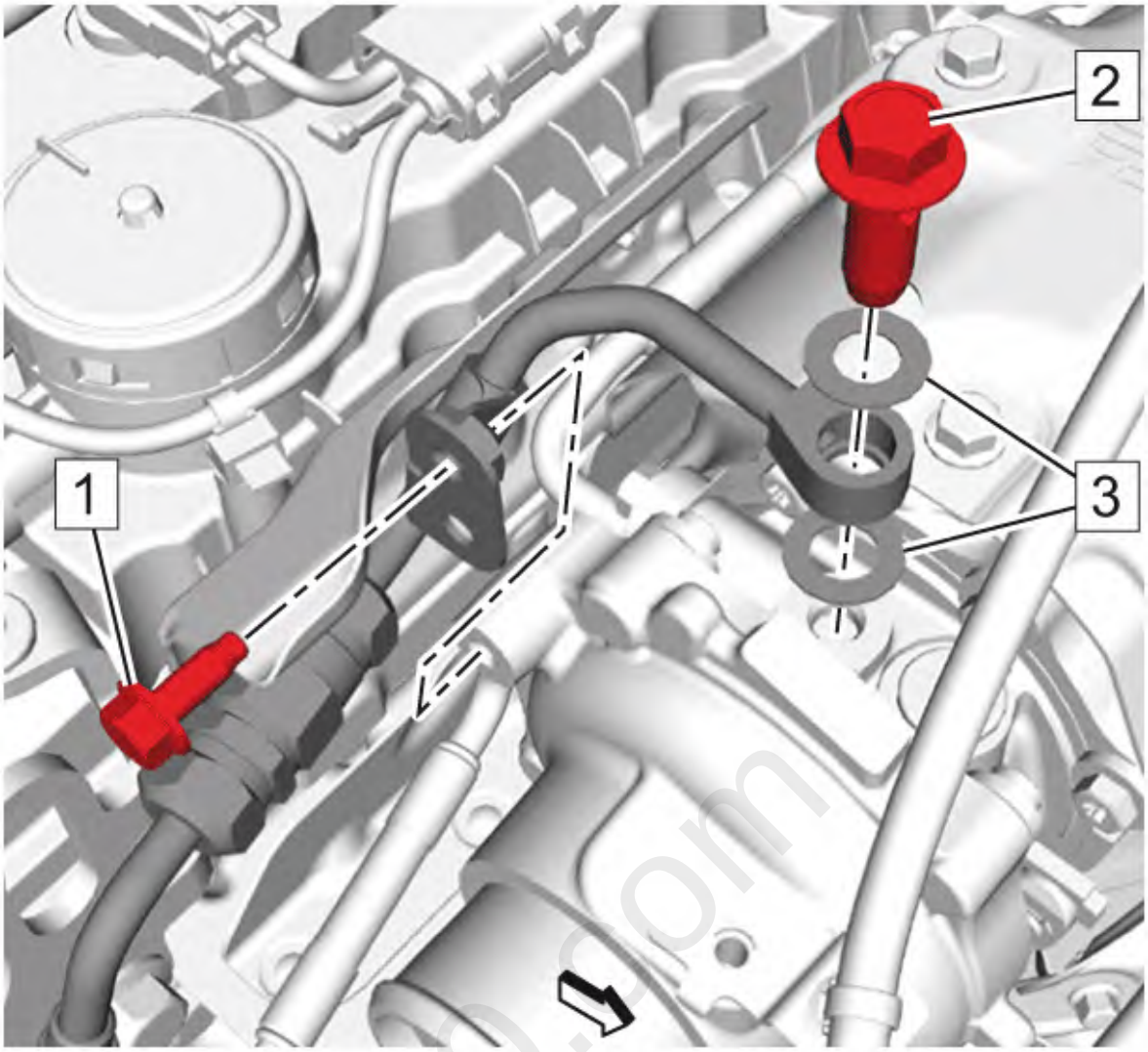


Fig. 471: Turbocharger Oil Feed Pipe Hollow Screw, Bracket Bolt And Gaskets
Courtesy of GENERAL MOTORS COMPANY

4. Install NEW gaskets. (3) (Qty: 2)

CAUTION: **Refer to Fastener Caution**

5. Install and tighten Turbocharger Oil Feed Pipe Hollow Screw (2) to 25 N.m (18 lb ft)

mcx30.com

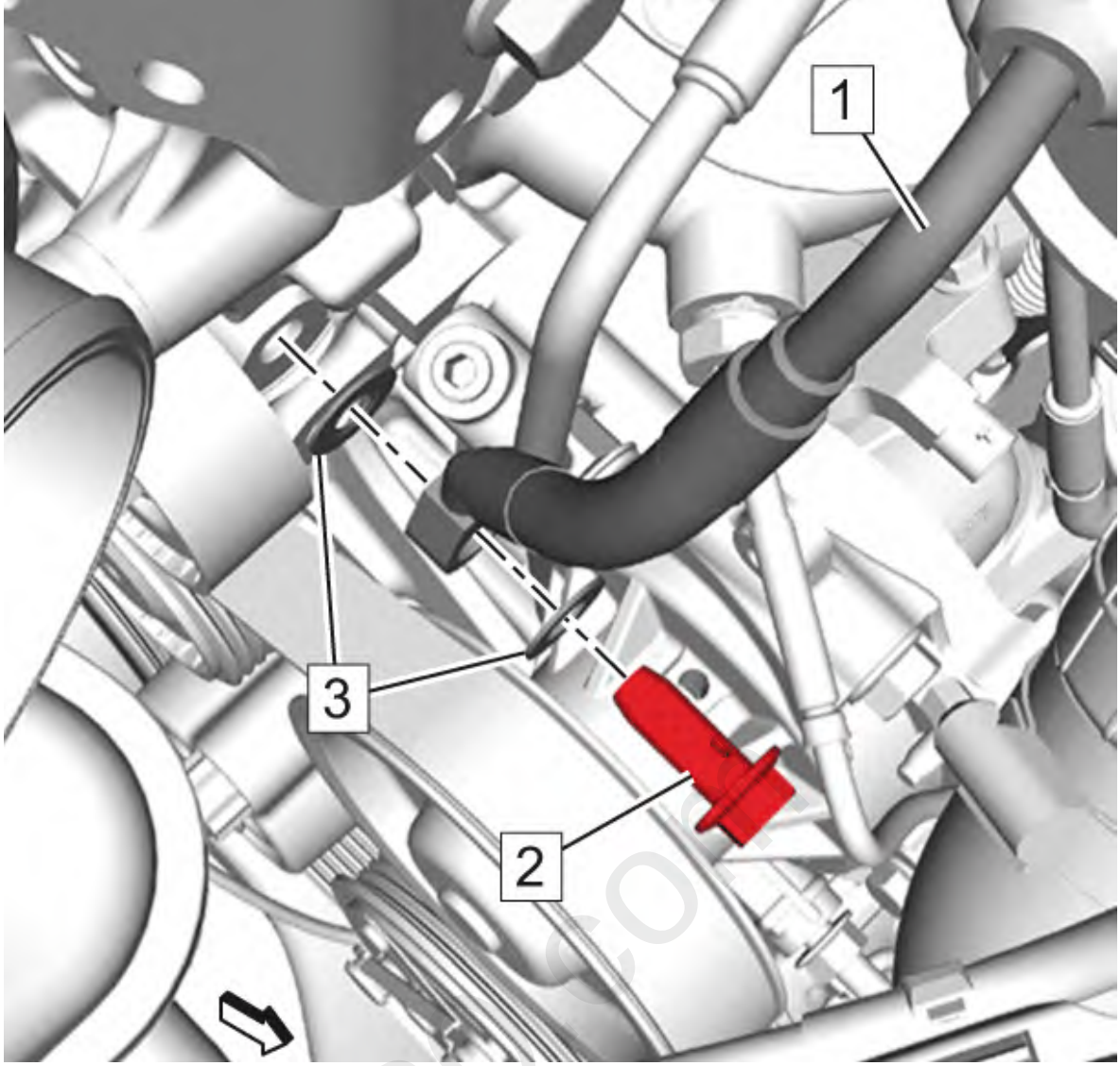


Fig. 472: Turbocharger Oil Feed Pipe, Hollow Screw And Gaskets
Courtesy of GENERAL MOTORS COMPANY

6. Tighten Turbocharger Oil Feed Pipe Hollow Screw (2) to 25 N.m (18 lb ft)

mcx2.com

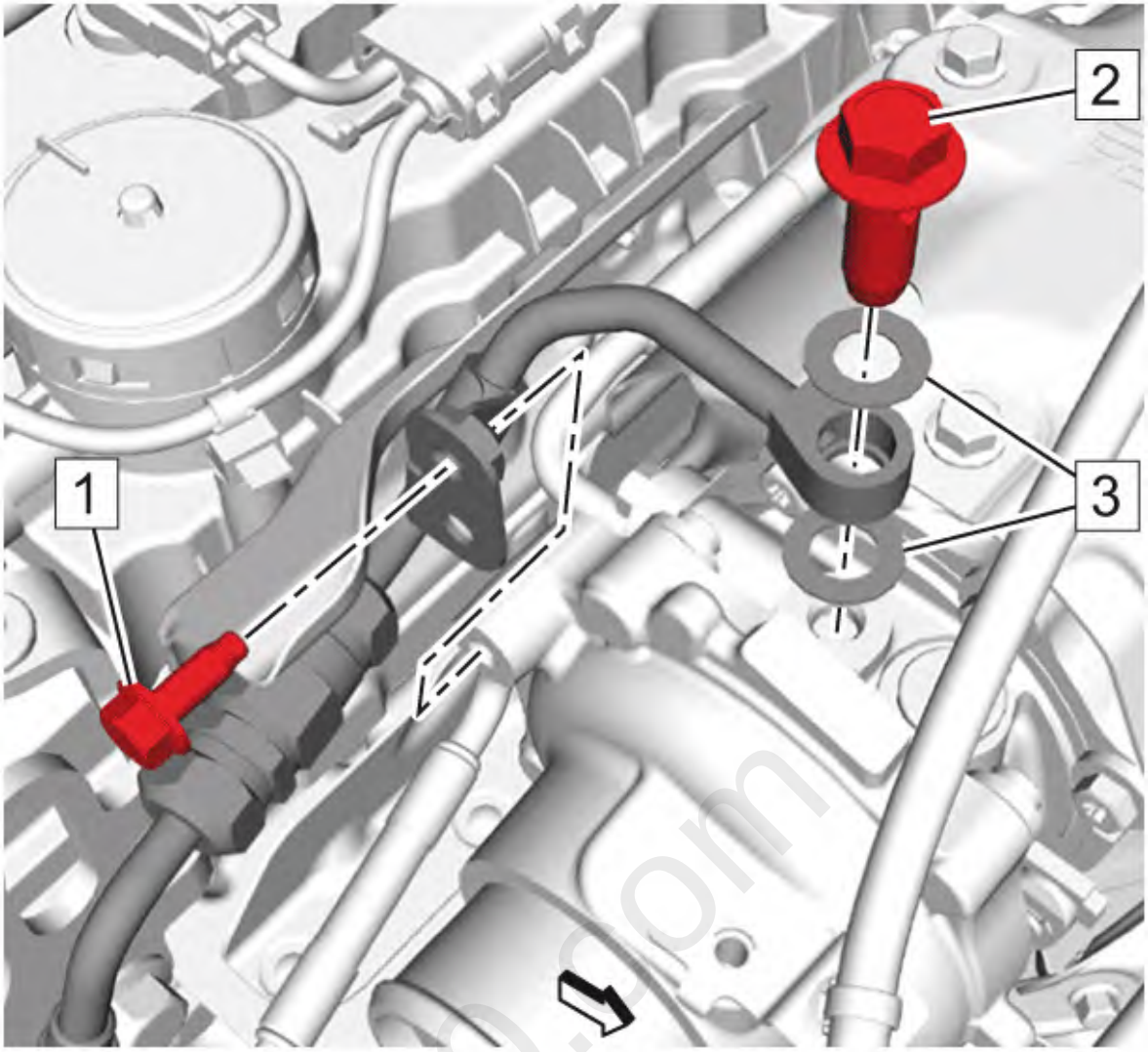


Fig. 473: Turbocharger Oil Feed Pipe Hollow Screw, Bracket Bolt And Gaskets
Courtesy of GENERAL MOTORS COMPANY

7. Install and tighten Turbocharger Oil Feed Pipe Bracket Bolt (1) to 10 N.m (89 lb in)

mcx30.com

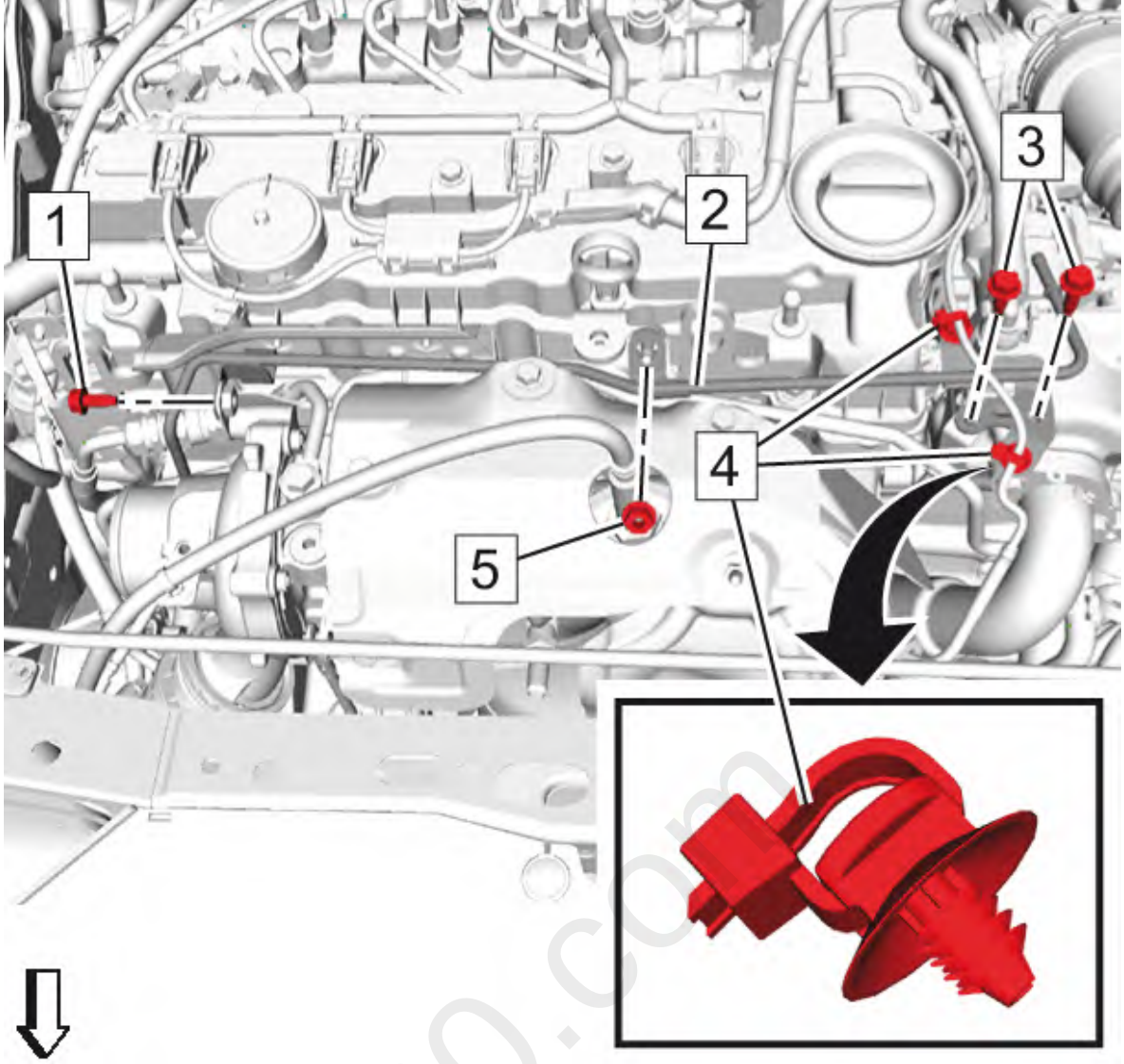


Fig. 474: Turbocharger Wastegate Actuator Pipe, Bolts, Nut And Clips
Courtesy of GENERAL MOTORS COMPANY

8. Install Turbocharger Wastegate Actuator Pipe (2)
9. Install Wiring Harness Clips (4) (Qty: 2)
10. Install the turbocharger wastegate actuator pipe nut (5) and tighten to 10 N.m (89 lb in)
11. Install and tighten Turbocharger Wastegate Actuator Pipe Bolts (1, 3) (Qty: 3) to 10 N.m (89 lb in)

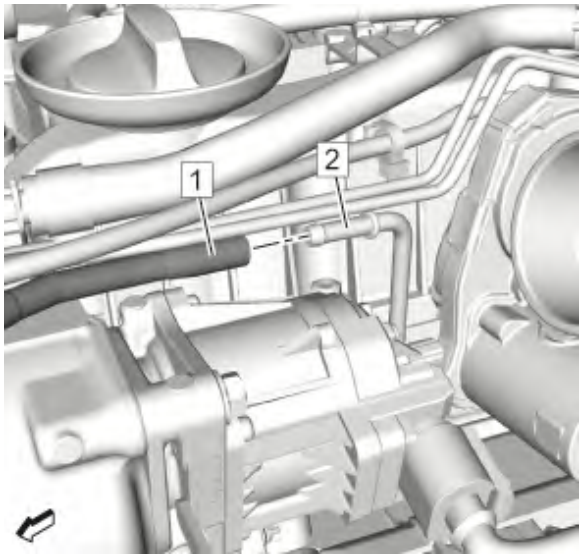


Fig. 475: Turbocharger Wastegate Actuator Pipe And Power Brake Booster Inlet Hose Connector Fitting
Courtesy of GENERAL MOTORS COMPANY

12. Install Turbocharger Wastegate Actuator Pipe (1) @ Power Brake Booster Inlet Hose Connector Fitting (2)

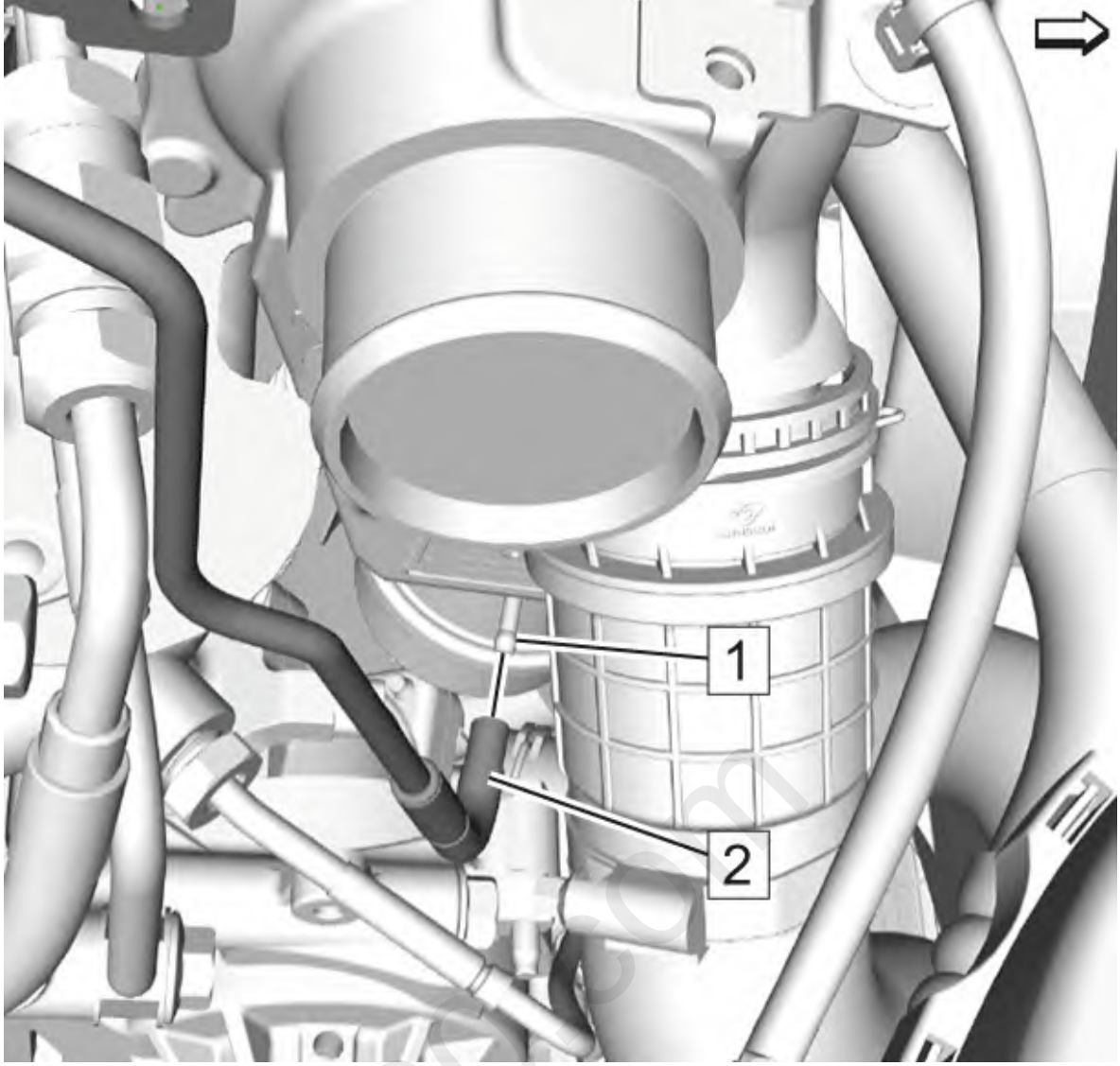


Fig. 476: Turbocharger Wastegate Actuator Pipe And Turbocharger
Courtesy of GENERAL MOTORS COMPANY

13. Install Turbocharger Wastegate Actuator Pipe (2) @ Turbocharger (1)
14. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**
15. Install Intake Manifold Cover. Refer to **Intake Manifold Cover Replacement**

TURBOCHARGER OIL RETURN PIPE REPLACEMENT

Removal Procedure

1. Remove Oxidation Catalytic Converter. Refer to **Oxidation Catalytic Converter Replacement (LH7)**

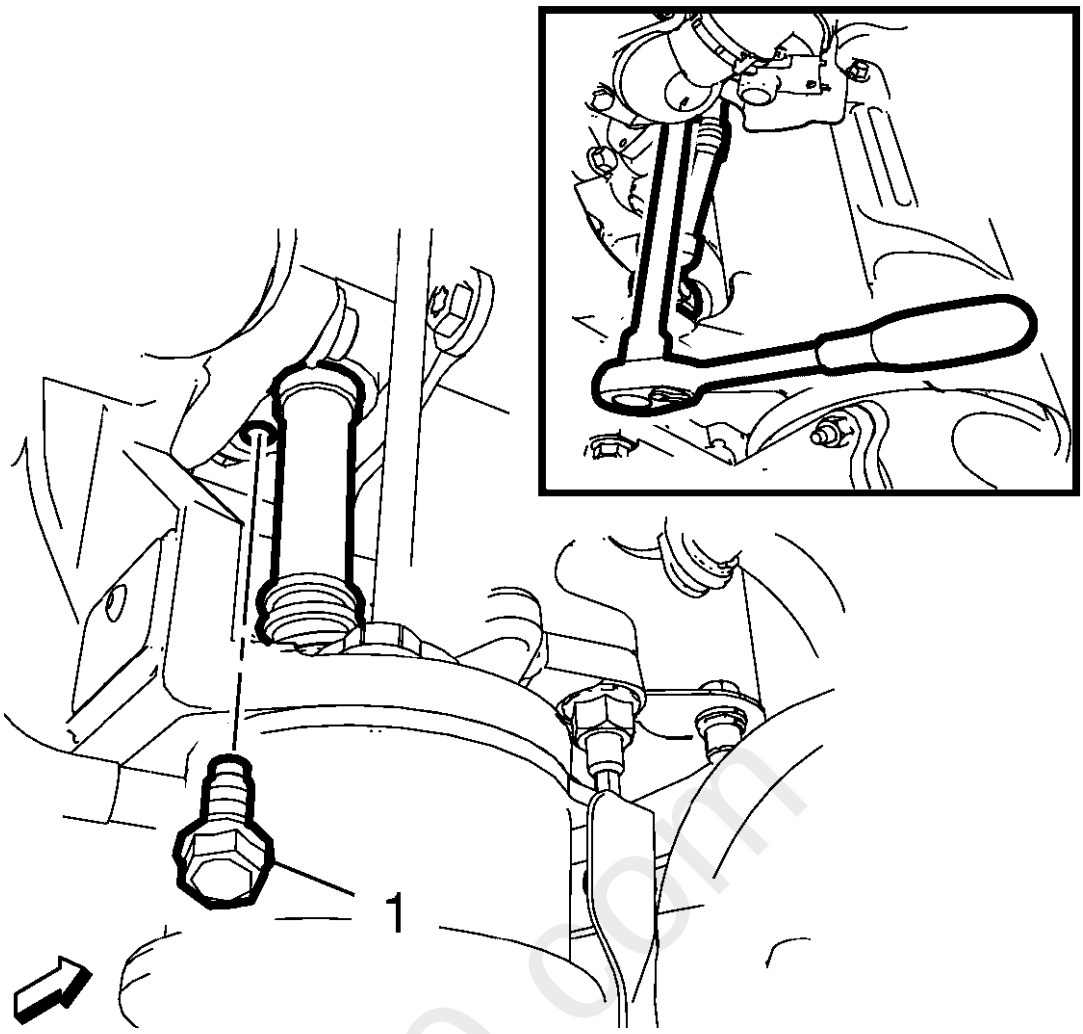


Fig. 477: Upper Turbocharger Oil Return Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove the upper turbocharger oil return pipe bolt (1).

mcx30.com

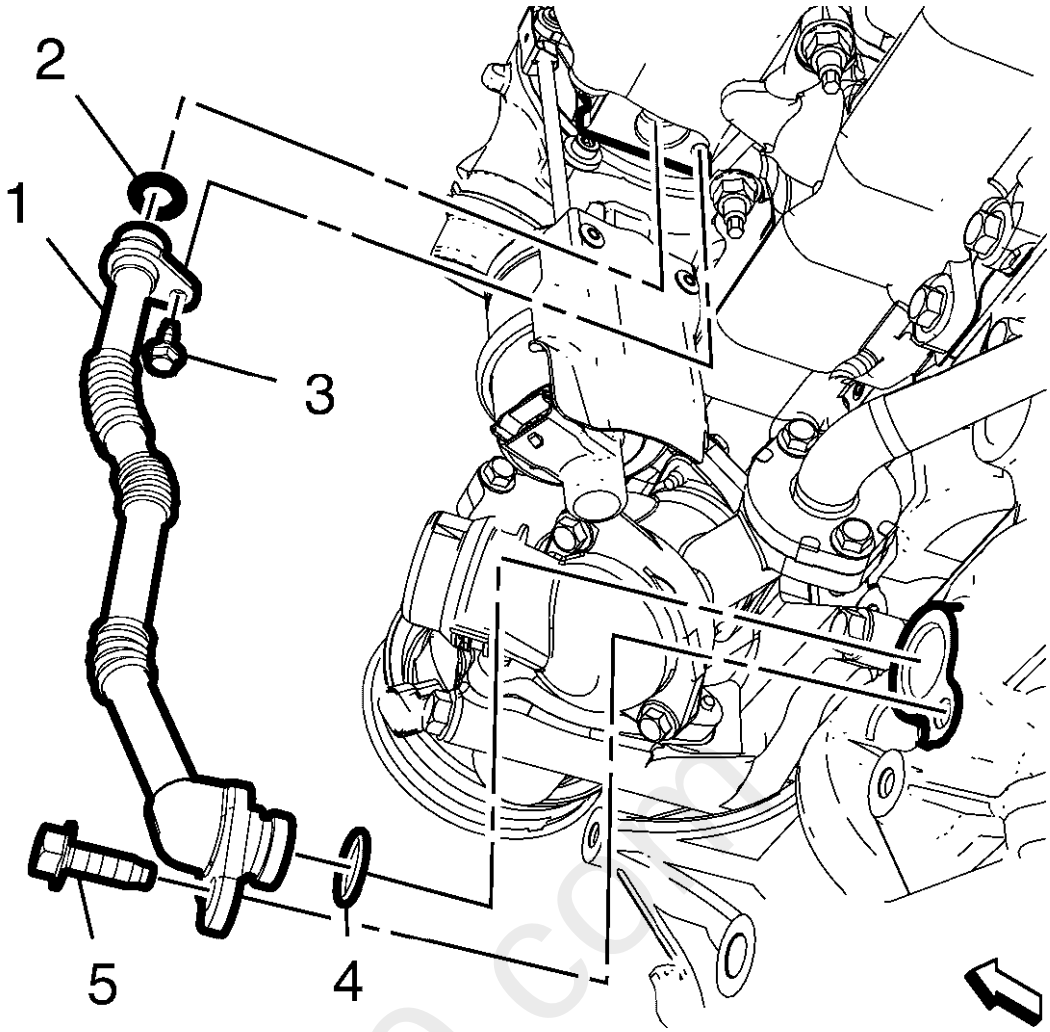


Fig. 478: Turbocharger Oil Return Pipe, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

3. Remove Turbocharger Oil Return Pipe Bolt (5)
4. Remove Turbocharger Oil Return Pipe (1)
5. Remove and DISCARD Turbocharger Oil Return Pipe Gaskets (2, 4)

Installation Procedure

mcx30.com

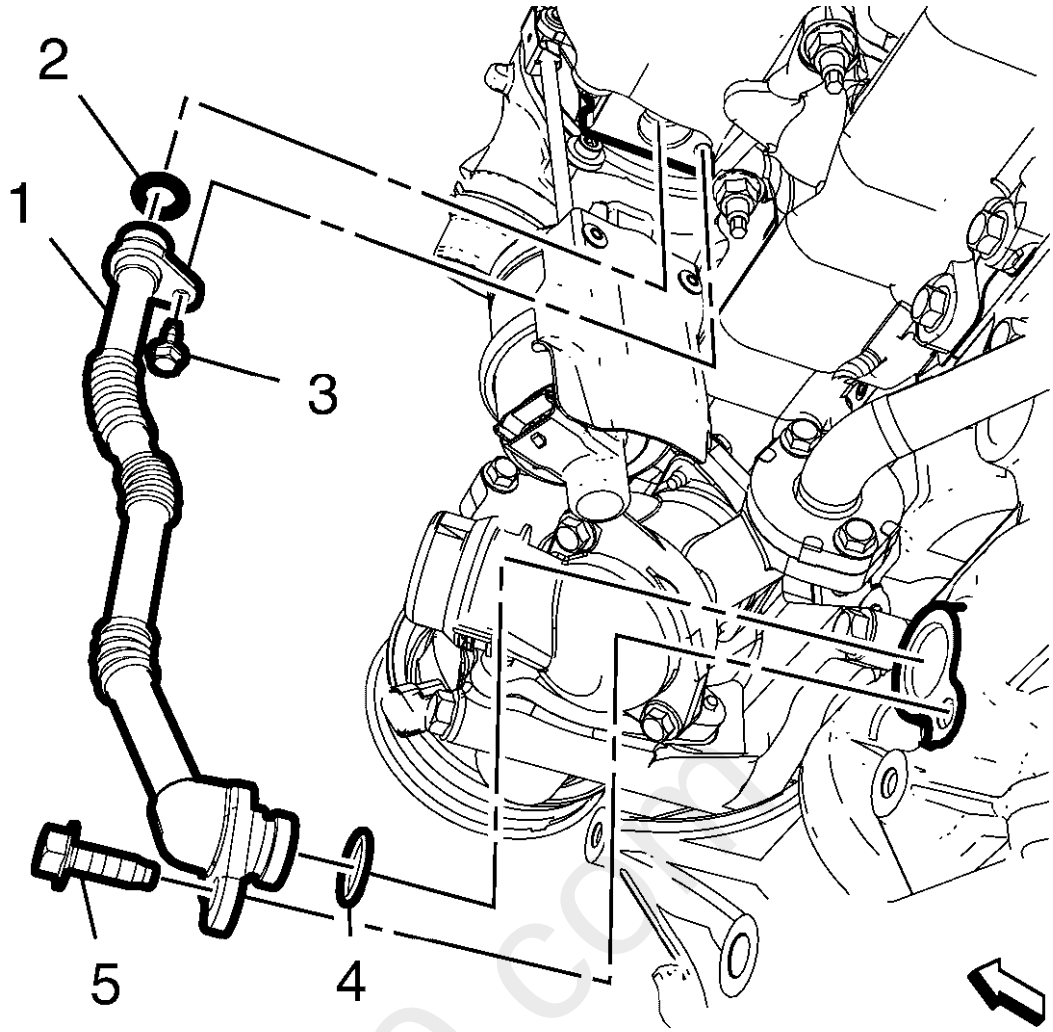


Fig. 479: Turbocharger Oil Return Pipe, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW Turbocharger Oil Return Pipe Gaskets (2, 4)

NOTE: **The new turbocharger oil return pipe has a flexible pipe.**

2. Install Turbocharger Oil Return Pipe (1)
3. Install, but do NOT tighten Turbocharger Oil Return Pipe Bolt (5)

mcx30.com

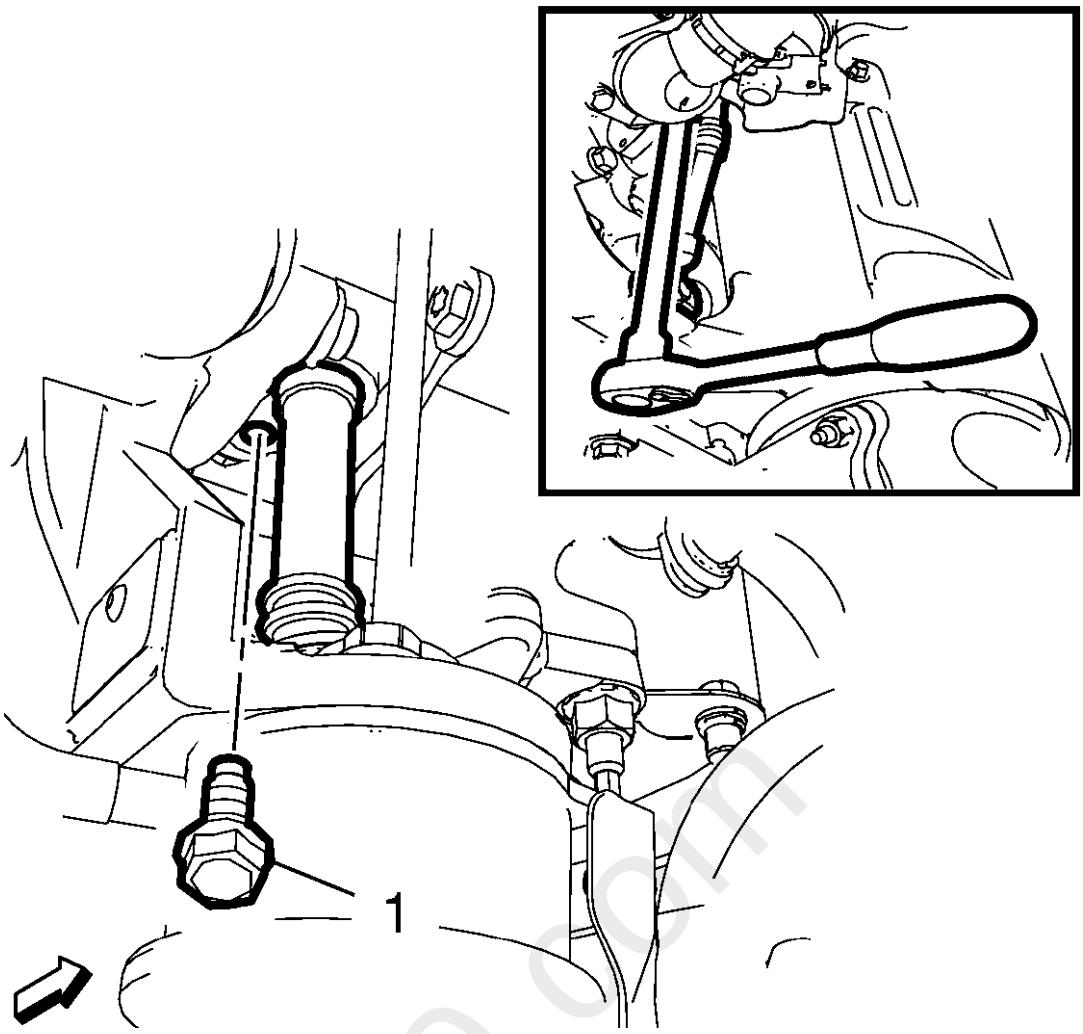


Fig. 480: Upper Turbocharger Oil Return Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Install and tighten the upper turbocharger oil return pipe bolt (1) to 10 N.m (89 lb in).

mcx30.com

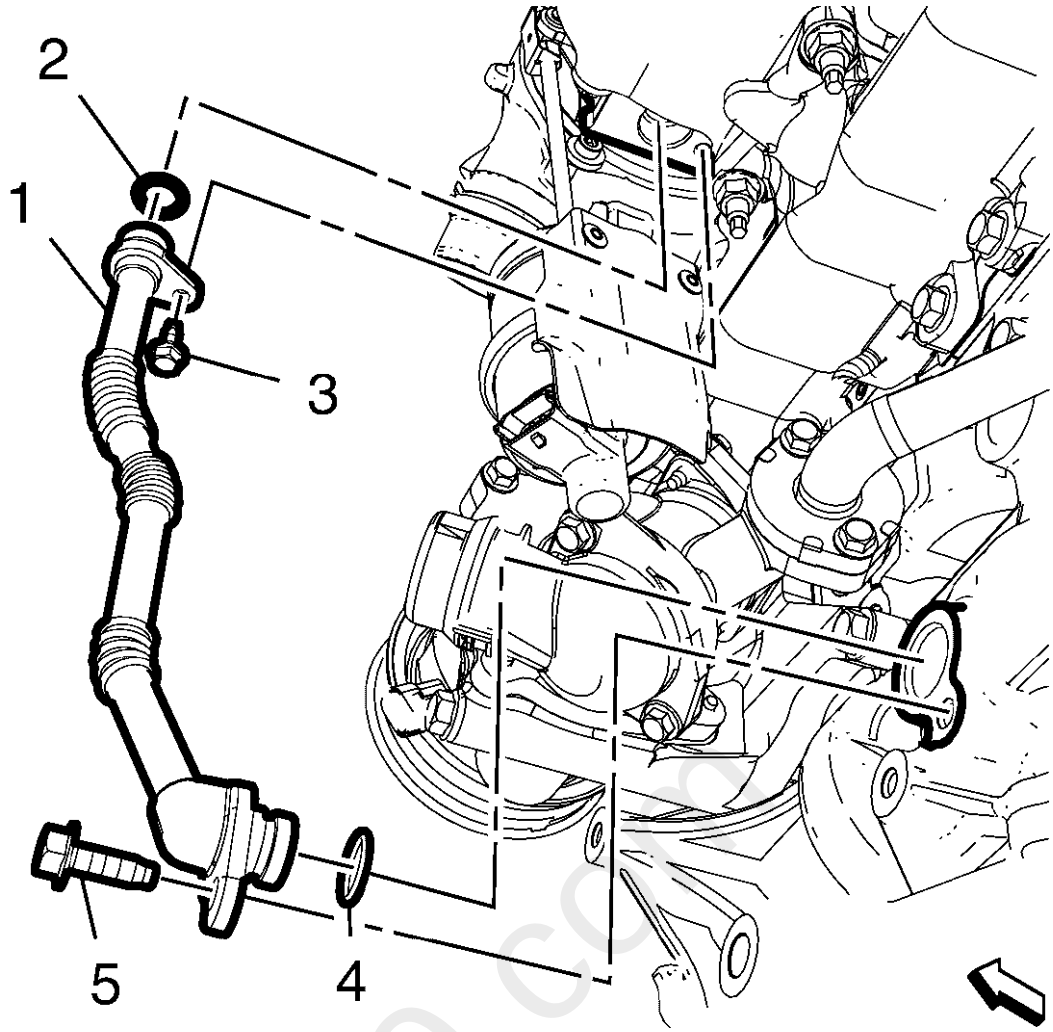


Fig. 481: Turbocharger Oil Return Pipe, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

5. Tighten Turbocharger Oil Return Pipe Bolt (5) to 25 N.m (18 lb ft)
6. Install Oxidation Catalytic Converter. Refer to **Oxidation Catalytic Converter Replacement (LH7)**

TURBOCHARGER REPLACEMENT

Removal Procedure

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**
2. Remove Oxidation Catalytic Converter. Refer to **Oxidation Catalytic Converter Replacement (LH7)**
3. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)**
4. Remove Turbocharger Wastegate Actuator Pipe. Refer to **Turbocharger Wastegate Actuator Pipe Replacement**

mcx30.com

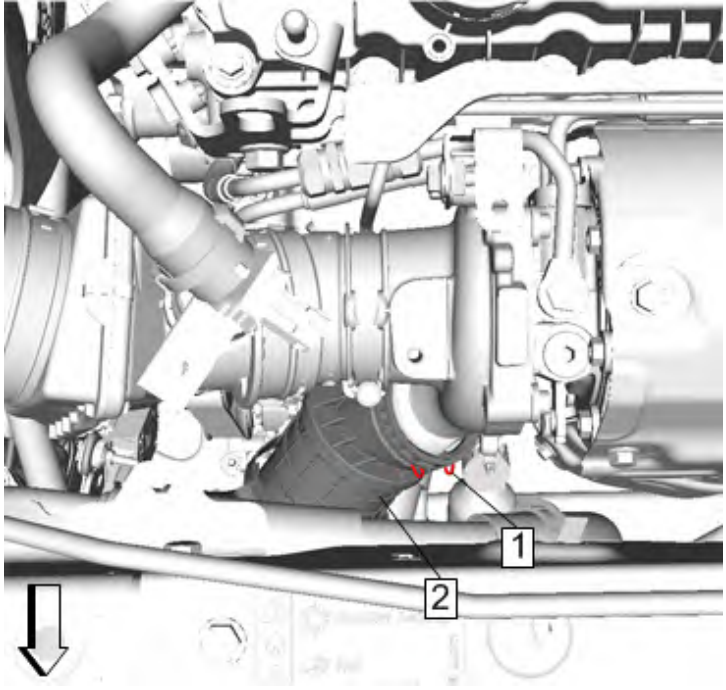


Fig. 482: Charge Air Cooler Inlet Air Tube And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect Charge Air Cooler Inlet Air Tube (2) @ Turbocharger. Refer to **Charge Air Cooler Inlet Air Tube Replacement**

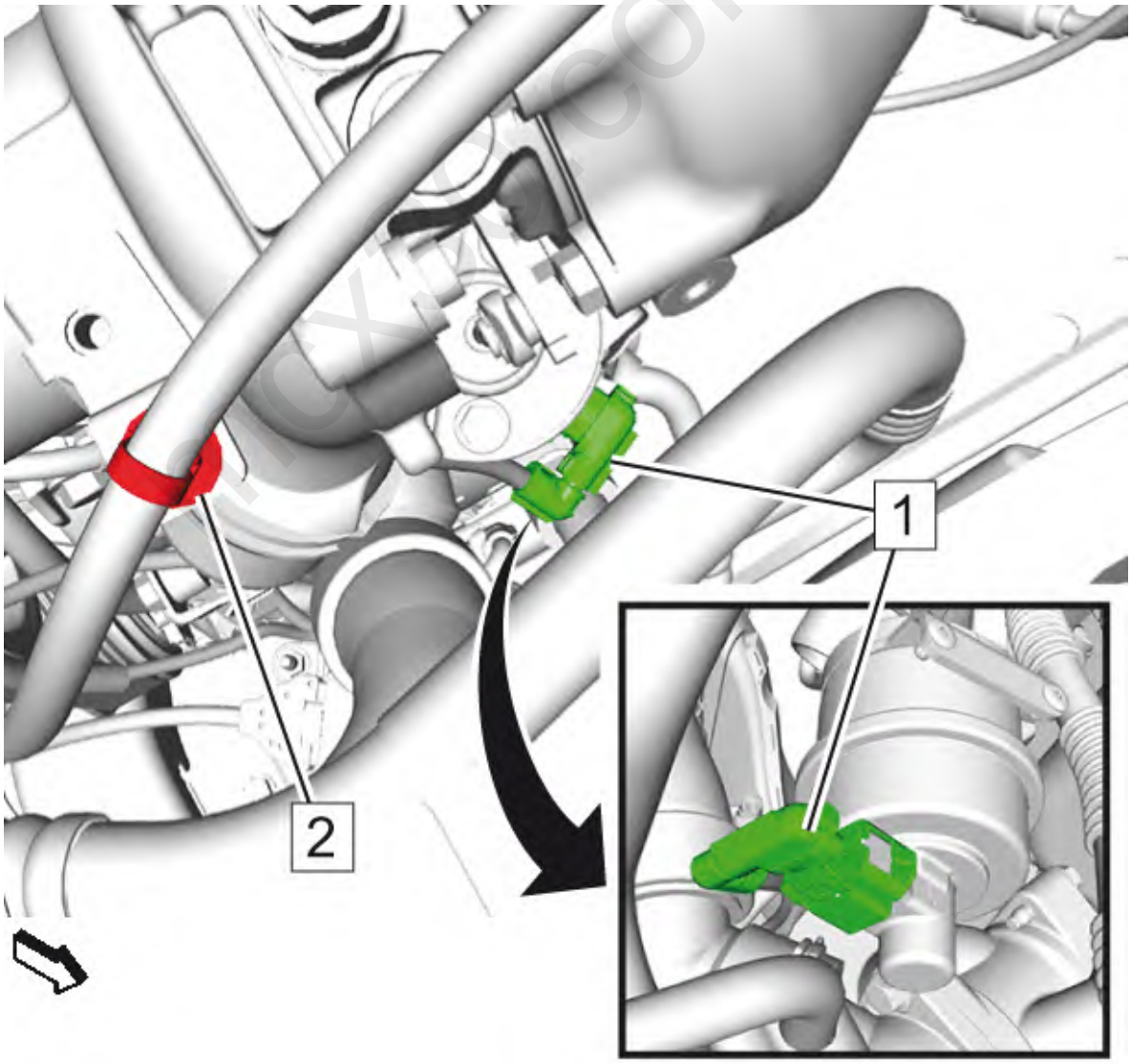


Fig. 483: Wiring Harness Retainer And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Remove Wiring Harness Retainer (2)

7. Disconnect the electrical connector. (1)

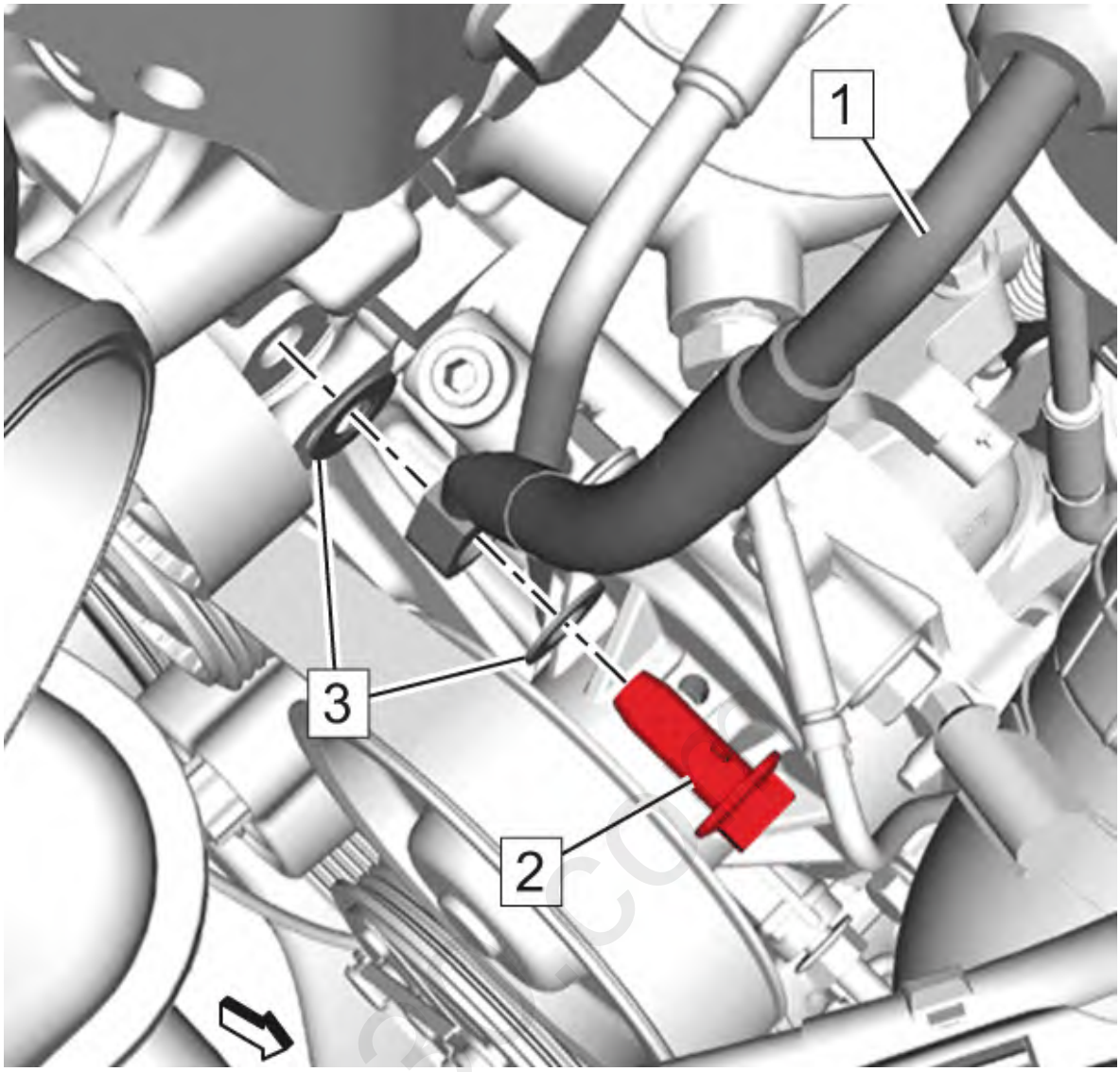


Fig. 484: Turbocharger Oil Feed Pipe, Hollow Screw And Gaskets
Courtesy of GENERAL MOTORS COMPANY

8. Remove Turbocharger Oil Feed Pipe Hollow Screw (2)
9. Remove and DISCARD the gaskets. (3) (Qty: 2)

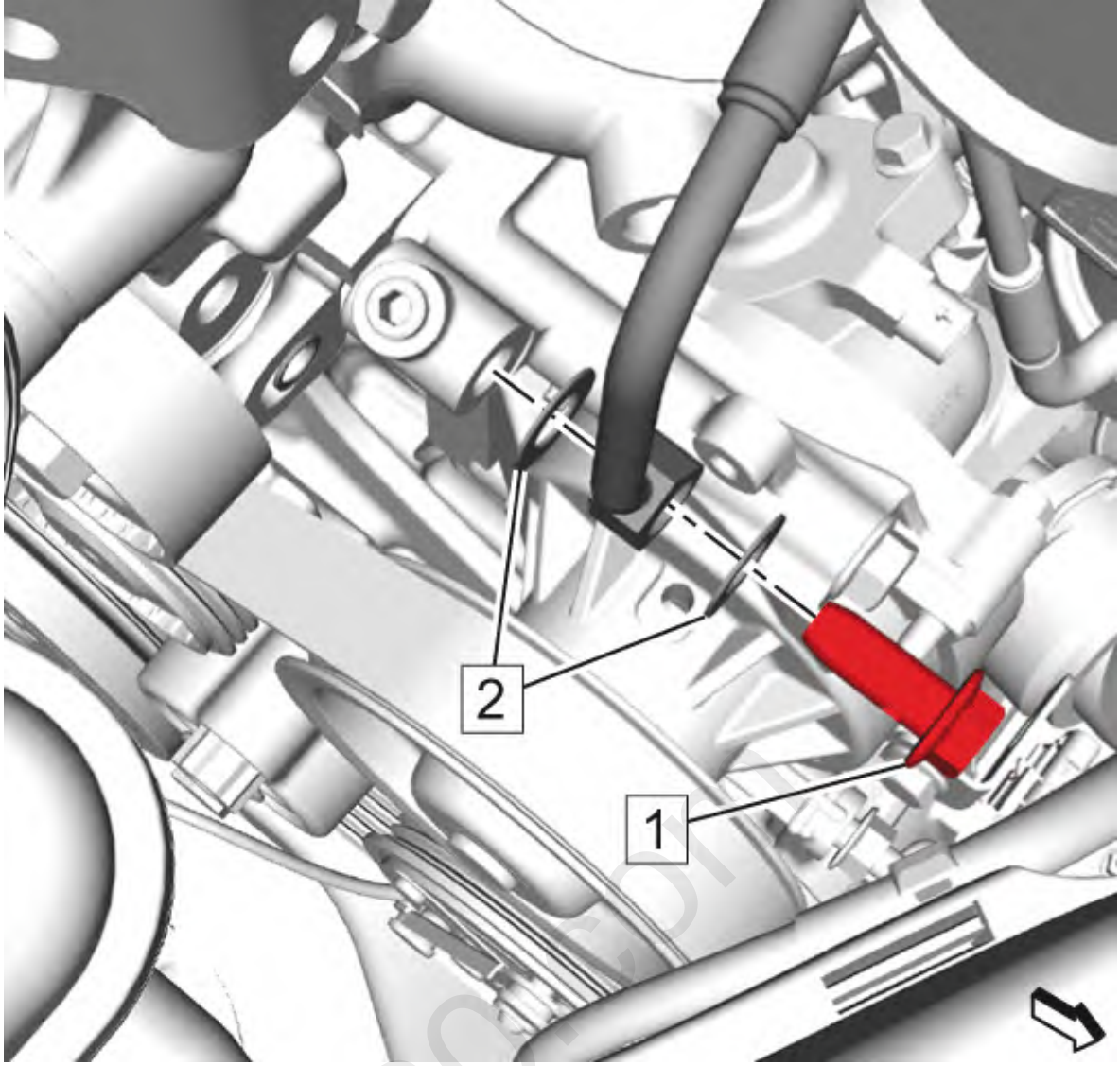


Fig. 485: Turbocharger Coolant Feed Pipe Hollow Screw And Gaskets
Courtesy of GENERAL MOTORS COMPANY

10. Remove Turbocharger Coolant Feed Pipe Hollow Screw (1)
11. Remove and DISCARD the gaskets. (2) (Qty: 2)

mcx2.com

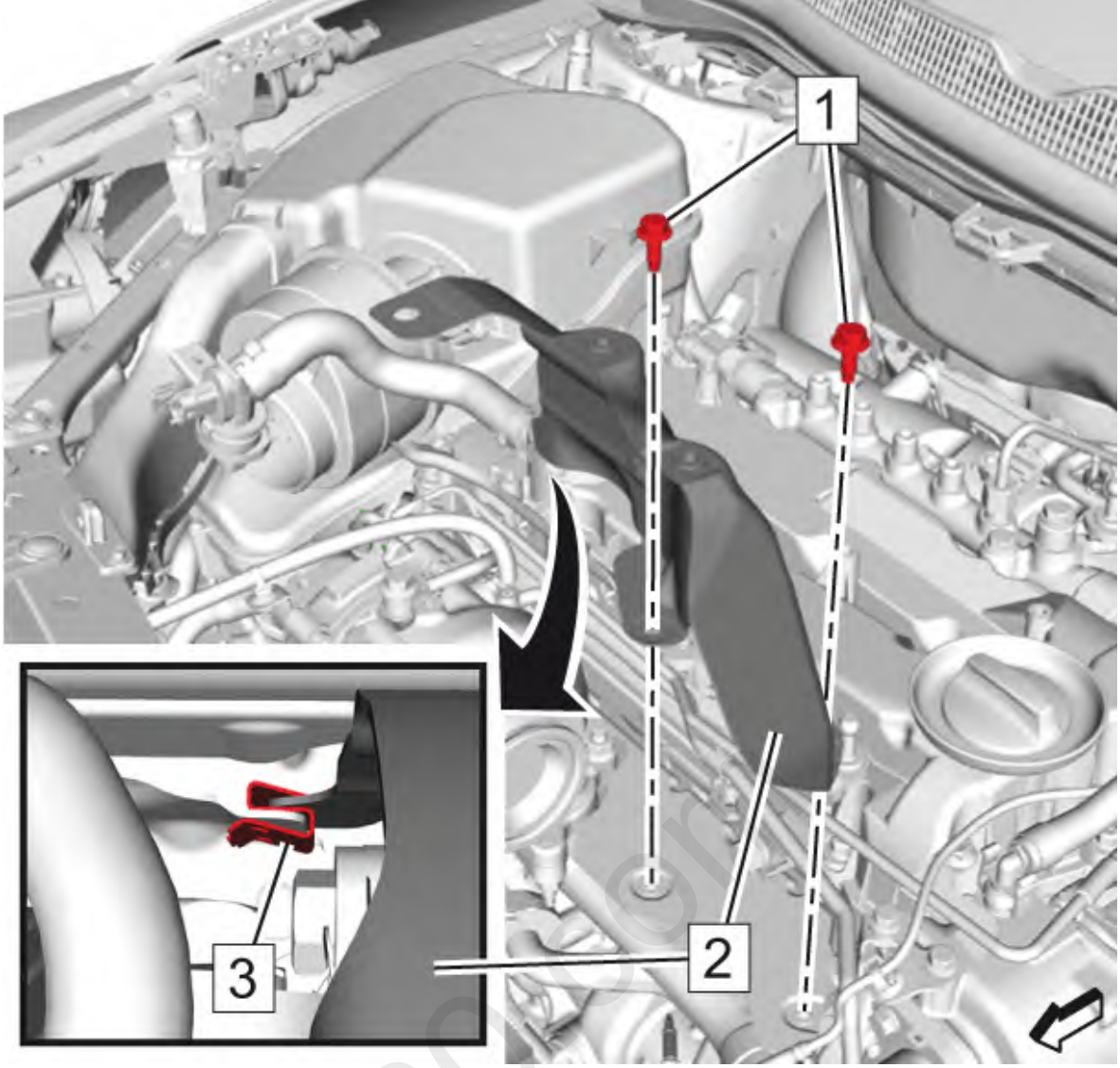


Fig. 486: Turbocharger Heat Shield, Bolts And Clamp
Courtesy of GENERAL MOTORS COMPANY

12. Remove Turbocharger Heat Shield Bolts (1) (Qty: 2)
13. Unclip Turbocharger Heat Shield (2) @ Clamp (3)
14. Remove Turbocharger Heat Shield (2)

mx5club.com

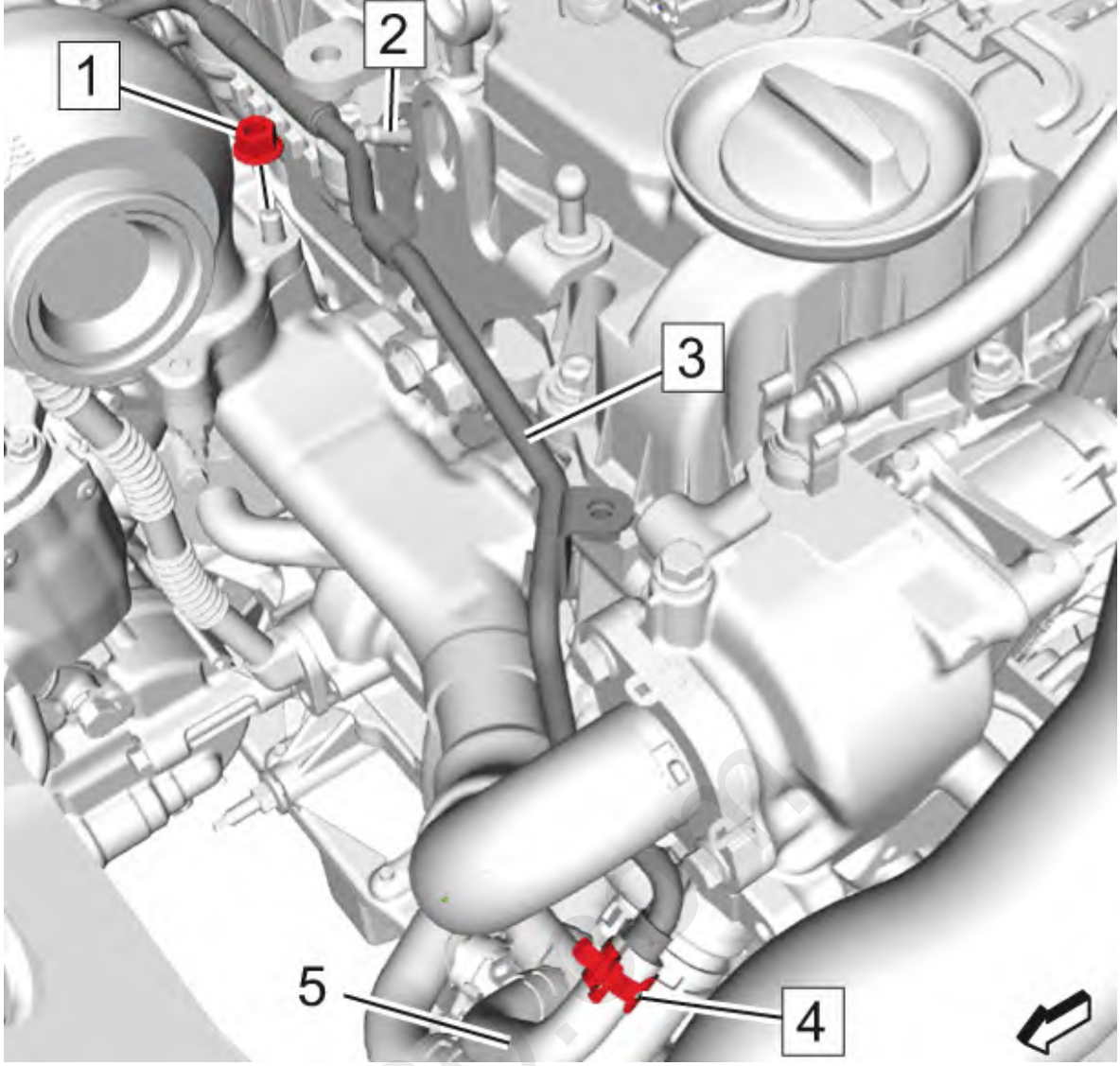


Fig. 487: Turbocharger Coolant Feed Hose, Feed Pipe, Clamp, Stud And Nut
Courtesy of GENERAL MOTORS COMPANY

15. Loosen Turbocharger Coolant Feed Hose Clamp (4)
16. Disconnect Turbocharger Coolant Feed Hose (5) @ Turbocharger Coolant Feed Pipe (3)
17. Remove Turbocharger Coolant Feed Pipe (3) @ Stud (2)
18. Remove Turbocharger Nut (1)
19. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**

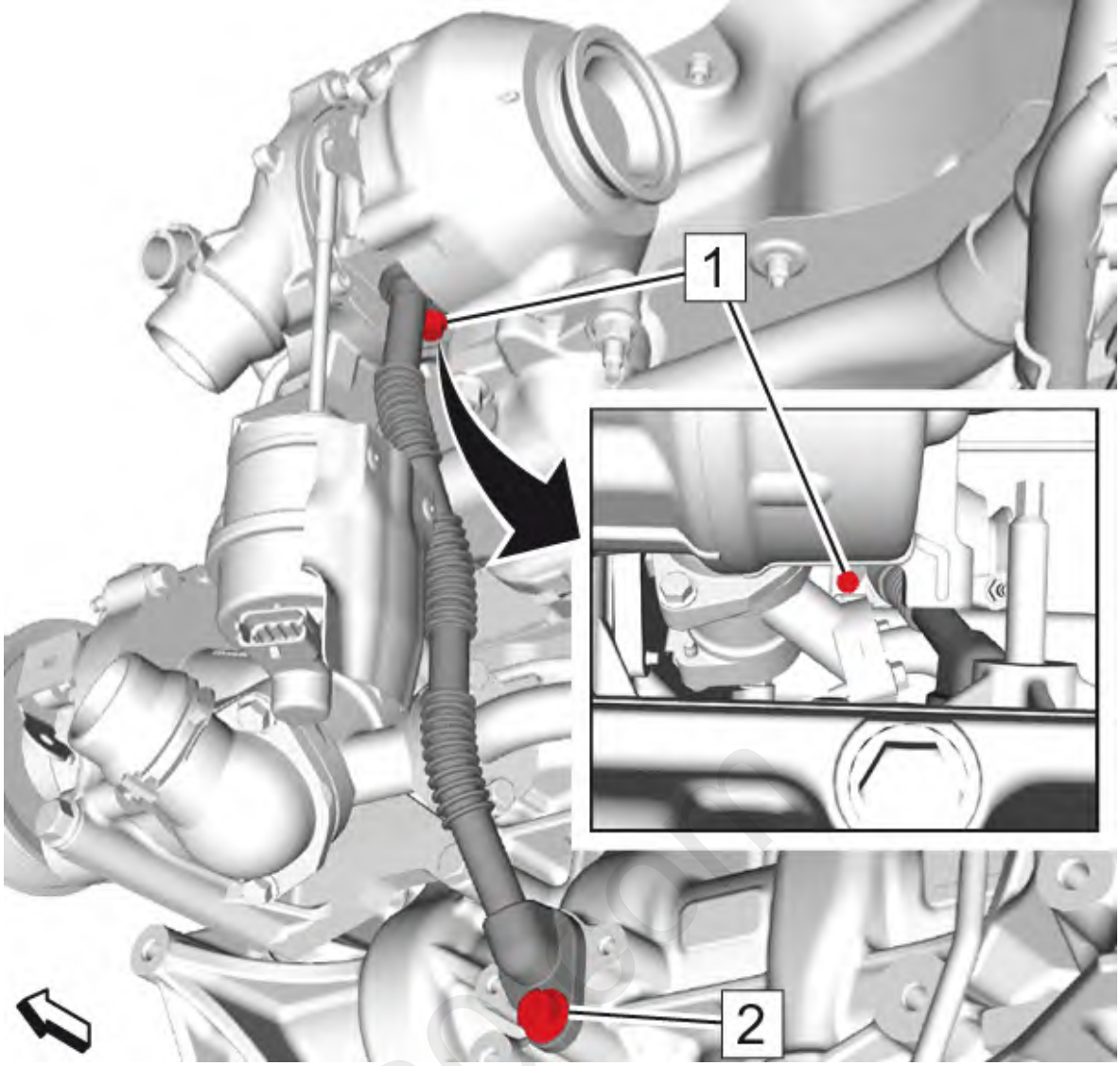


Fig. 488: Turbocharger Oil Return Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

20. Loosen Turbocharger Oil Return Pipe Bolt (2)
21. Remove Turbocharger Oil Return Pipe Bolt (1)

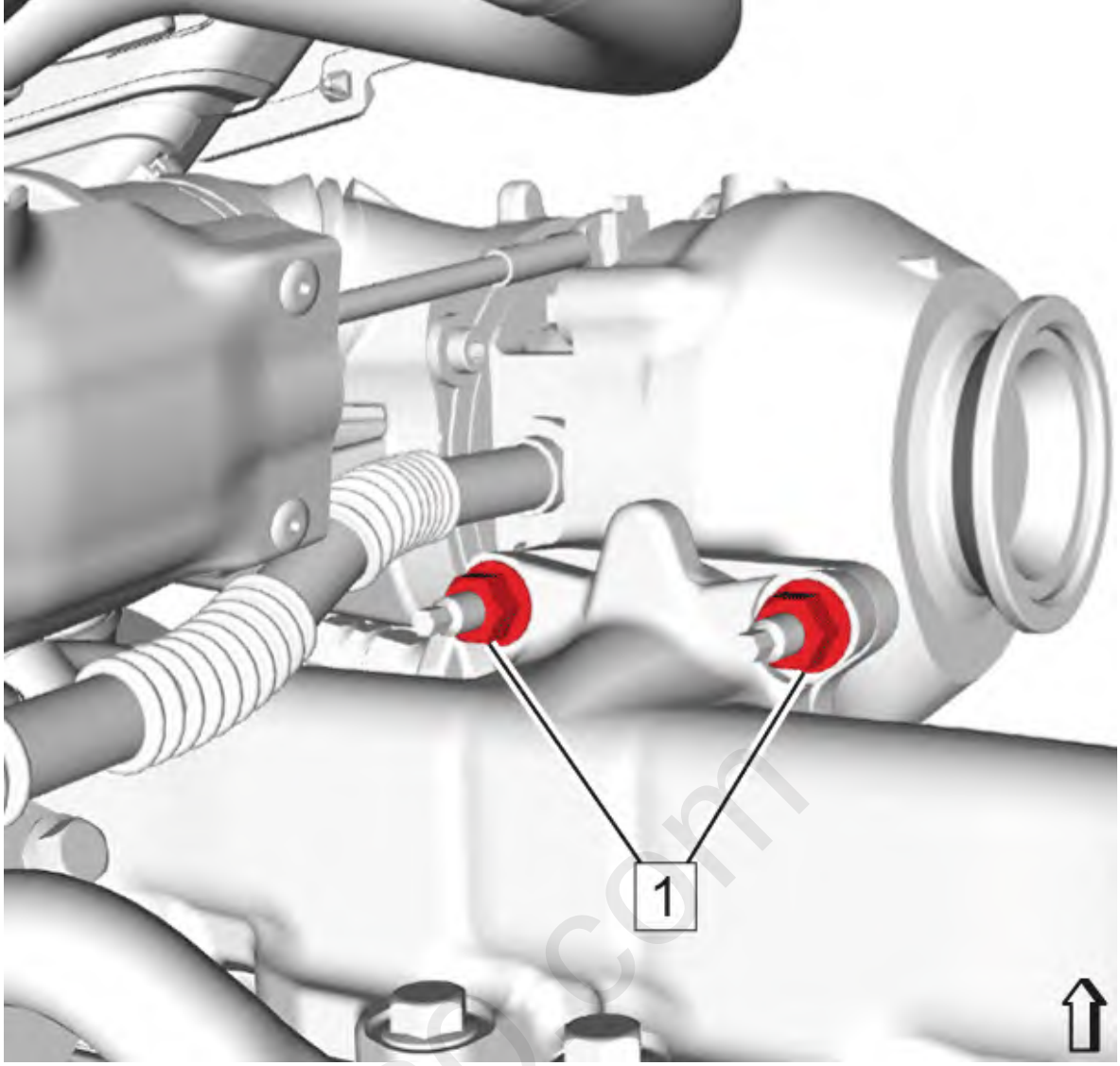


Fig. 489: Turbocharger Nuts
Courtesy of GENERAL MOTORS COMPANY

22. Remove Turbocharger Nuts (1) (Qty: 2)
23. Lower the vehicle.

mcx30.com

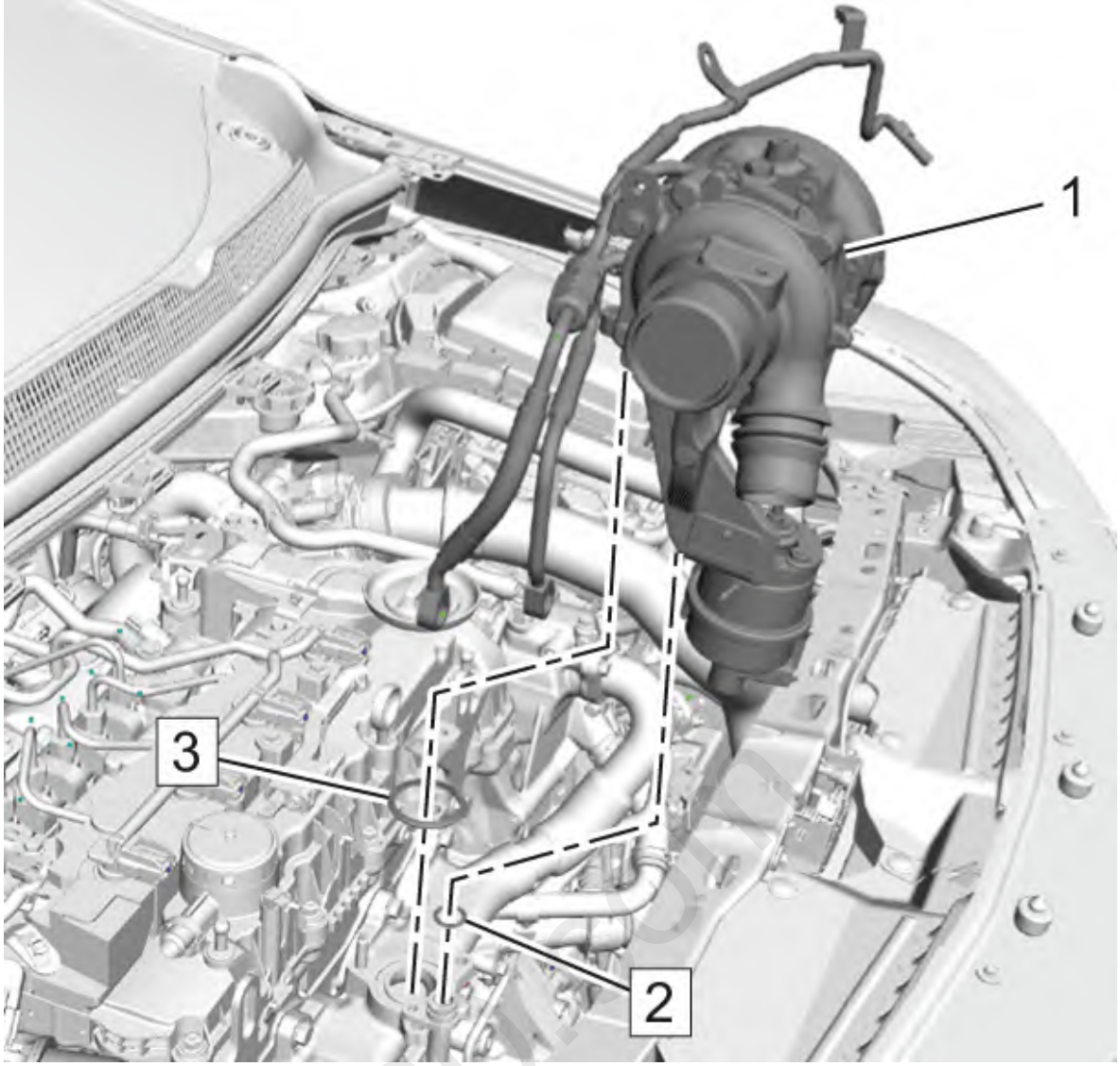


Fig. 490: Turbocharger Assembly And Gaskets
Courtesy of GENERAL MOTORS COMPANY

24. Remove Turbocharger Assembly (1)
25. Remove and DISCARD the gaskets. (2, 3) (Qty: 2)

mcx30.com

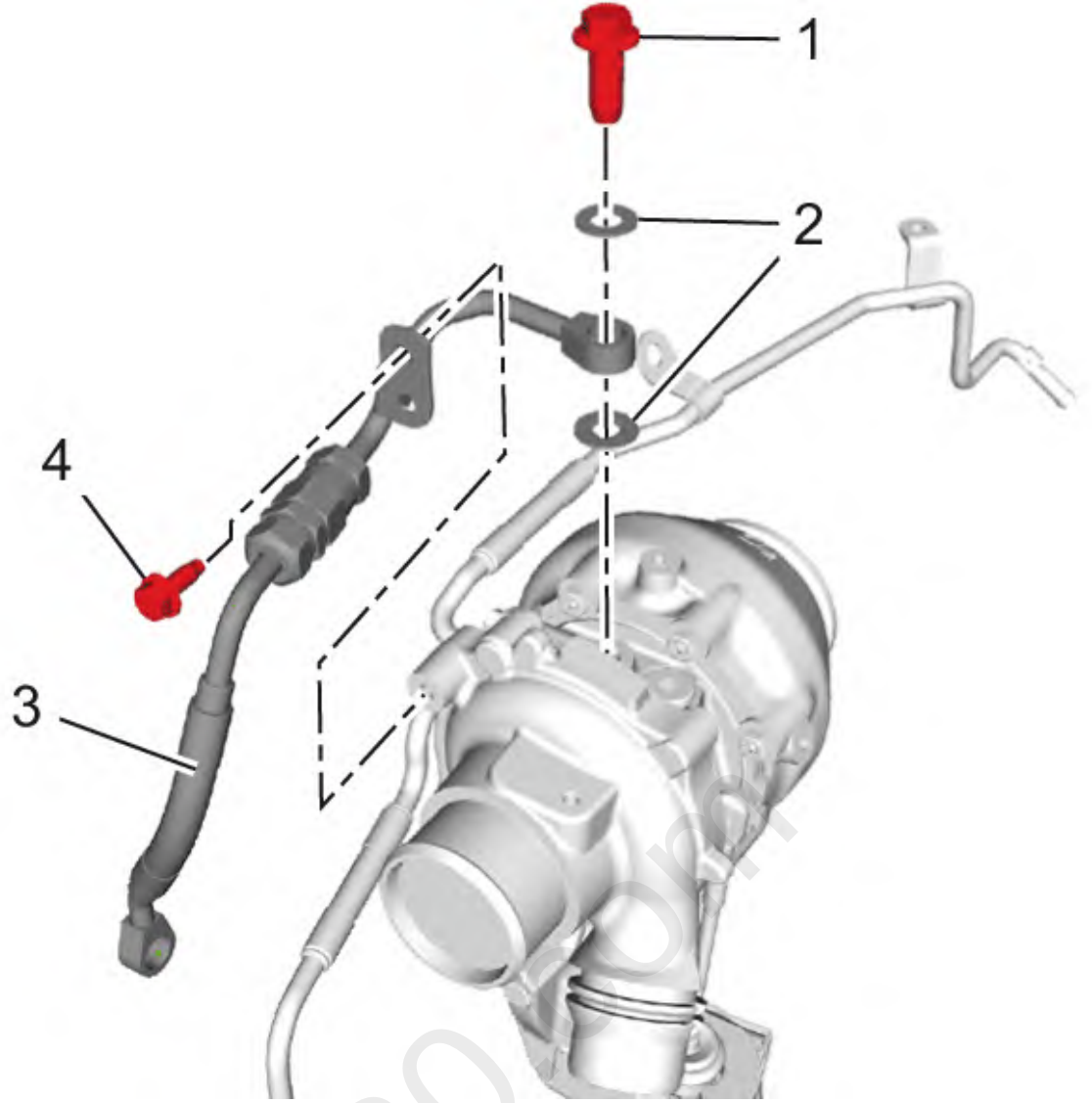


Fig. 491: Turbocharger Oil Feed Pipe, Hollow Screw, Bolt And Gaskets
Courtesy of GENERAL MOTORS COMPANY

26. Remove Turbocharger Oil Feed Pipe Hollow Screw (1)
27. Remove and DISCARD the gaskets. (2) (Qty: 2)
28. Remove Turbocharger Oil Feed Pipe Bolt (4)
29. Remove Turbocharger Oil Feed Pipe (3)

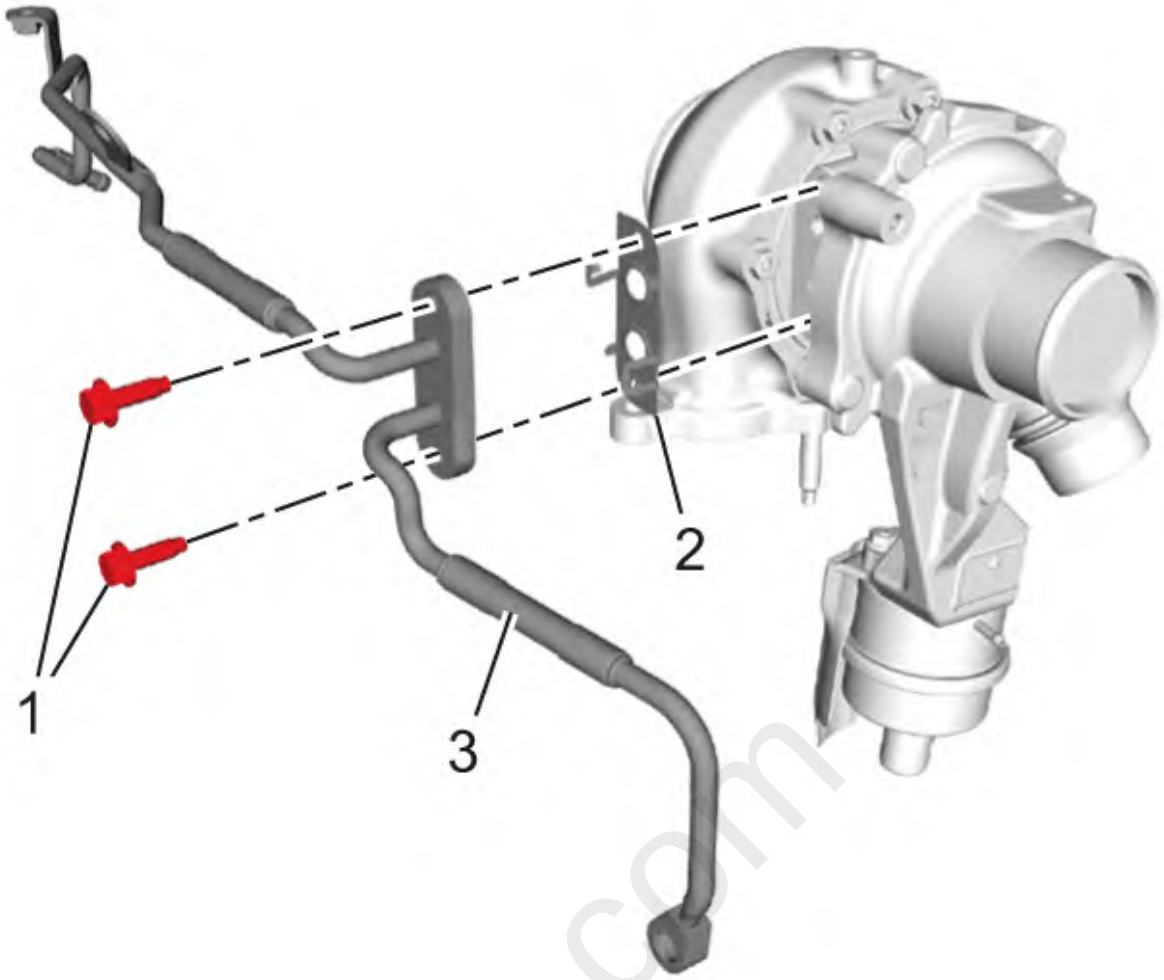


Fig. 492: Turbocharger Coolant Feed Pipe, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

30. Remove Turbocharger Coolant Feed Pipe Bolts (1) (Qty: 2)
31. Remove Turbocharger Coolant Feed Pipe (3)
32. Remove and DISCARD the gasket. (2)

Installation Procedure

mcx30.com

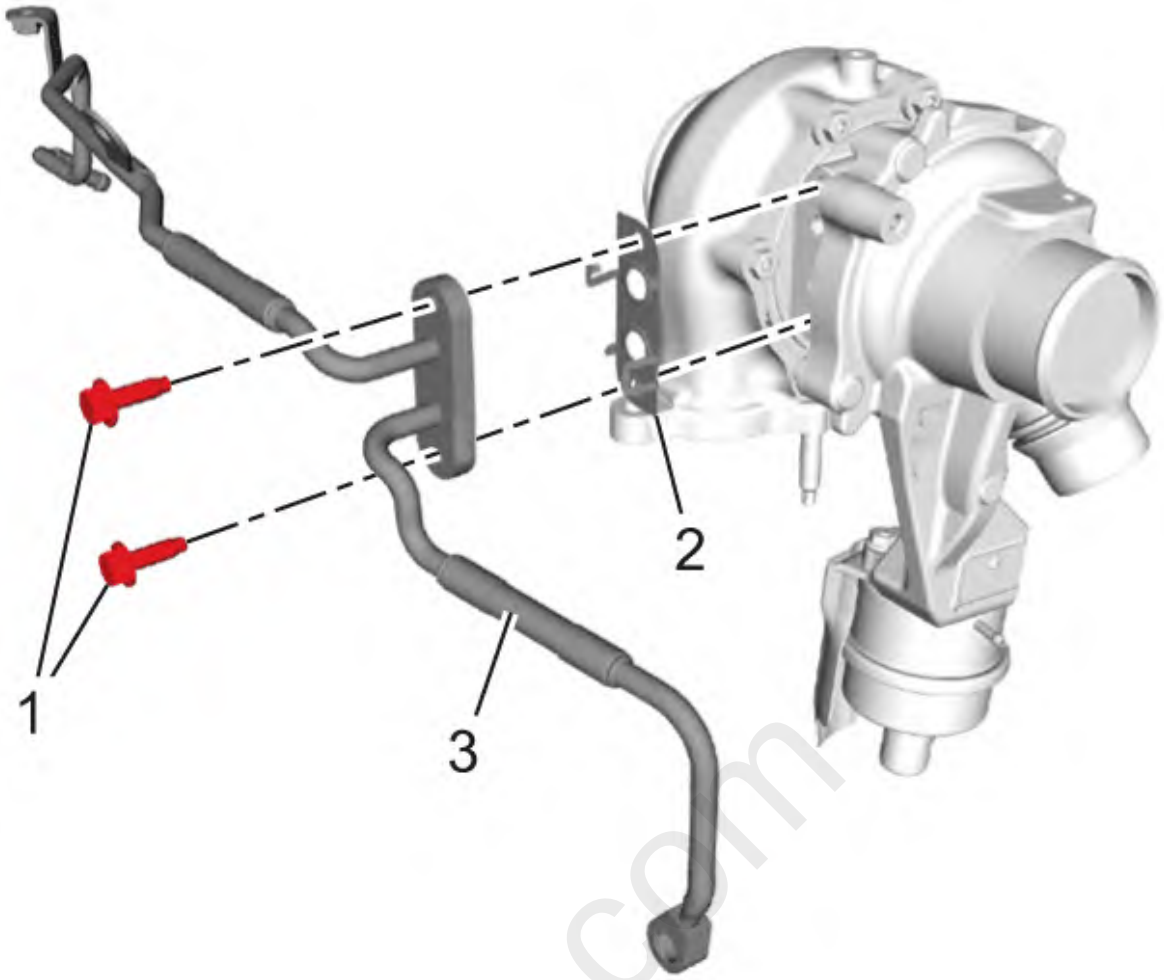


Fig. 493: Turbocharger Coolant Feed Pipe, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW gasket. (2)
2. Install Turbocharger Coolant Feed Pipe (3)

CAUTION: **Refer to Fastener Caution**

3. Install and tighten Turbocharger Coolant Feed Pipe Bolts (1) (Qty: 2) to 10 N.m (89 lb in)

mcx30.com

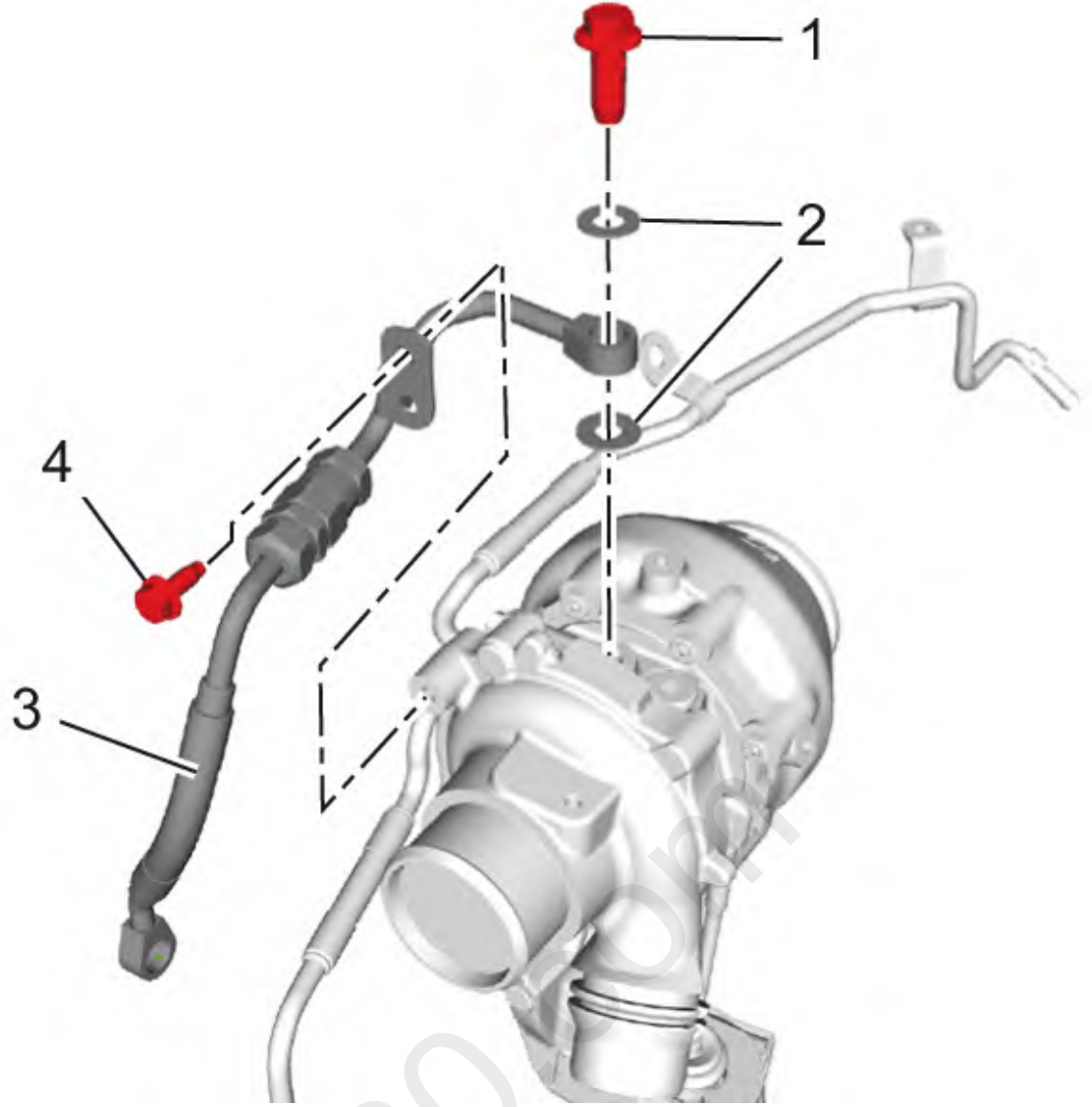


Fig. 494: Turbocharger Oil Feed Pipe, Hollow Screw, Bolt And Gaskets
Courtesy of GENERAL MOTORS COMPANY

4. Install Turbocharger Oil Feed Pipe (3)
5. Install NEW gaskets. (2) (Qty: 2)
6. Install and tighten Turbocharger Oil Feed Pipe Bolt (4) to 10 N.m (89 lb in)
7. Install and tighten Turbocharger Oil Feed Pipe Hollow Screw (1) to 25 N.m (18 lb ft)

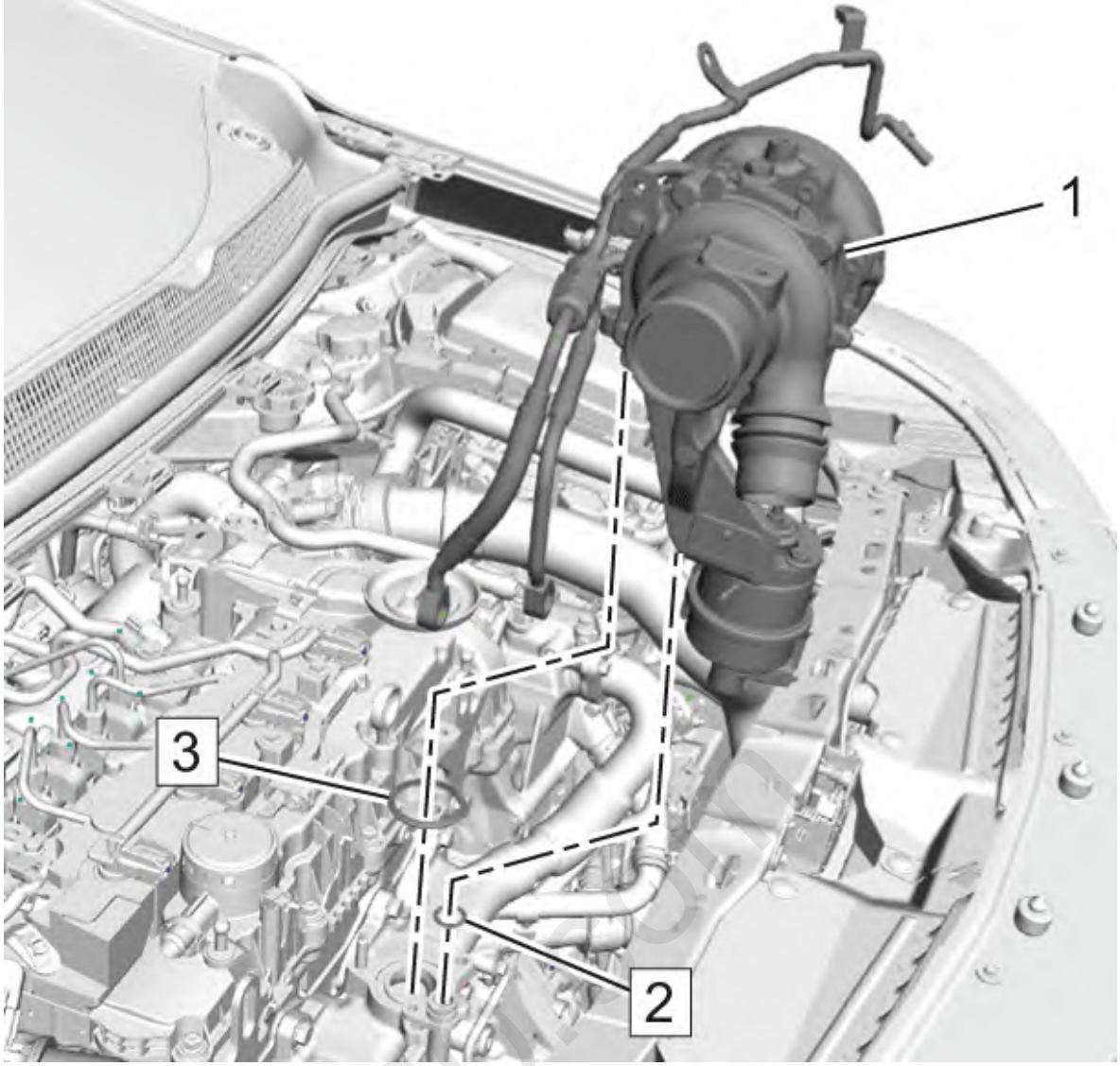


Fig. 495: Turbocharger Assembly And Gaskets
Courtesy of GENERAL MOTORS COMPANY

8. Install NEW gaskets. (2, 3) (Qty: 2)
9. Install Turbocharger Assembly (1)

mcx30.com

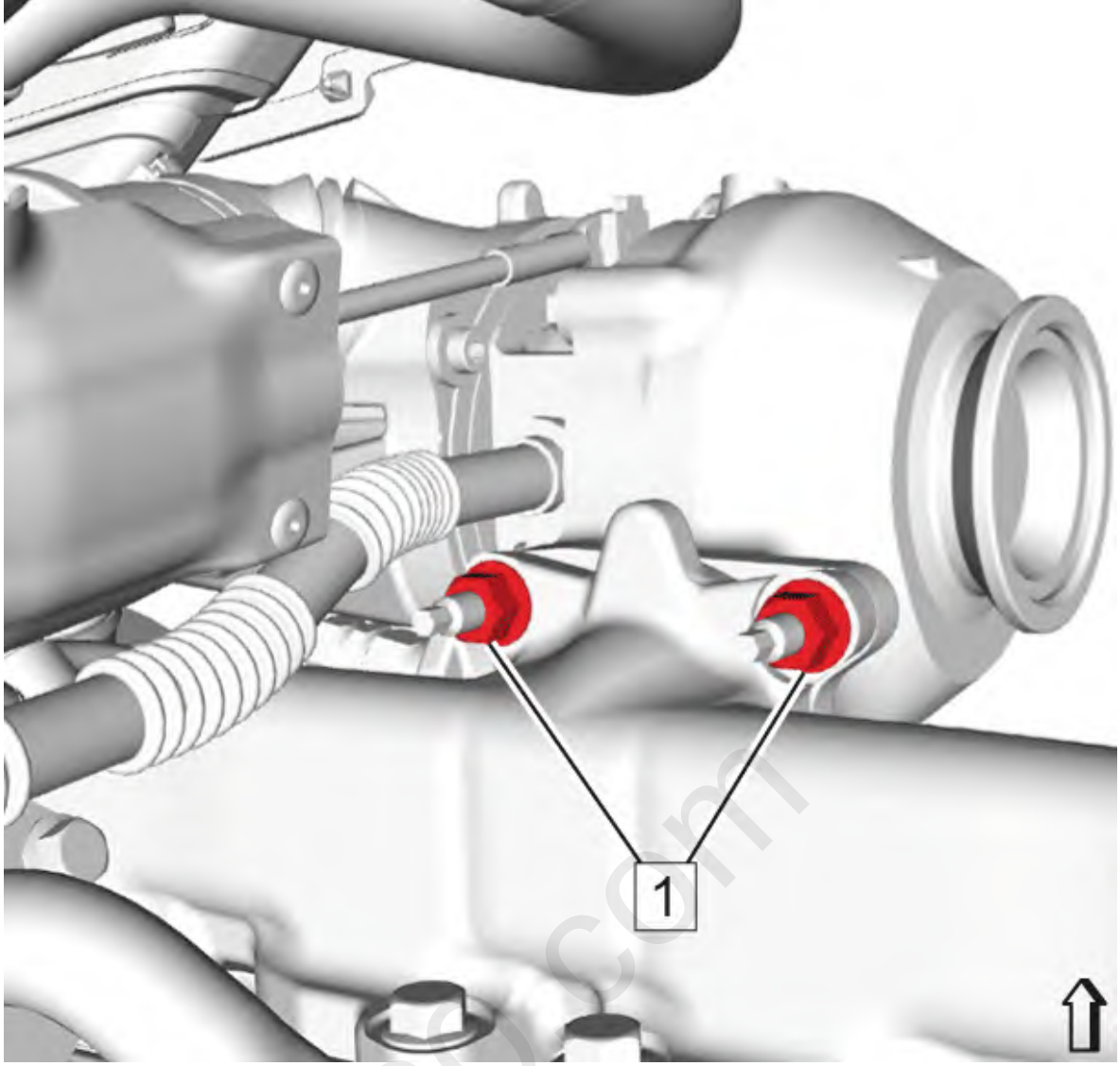


Fig. 496: Turbocharger Nuts
Courtesy of GENERAL MOTORS COMPANY

10. Install and tighten Turbocharger Nuts (1) (Qty: 2) to 30 N.m (22 lb ft)

mcx30.com

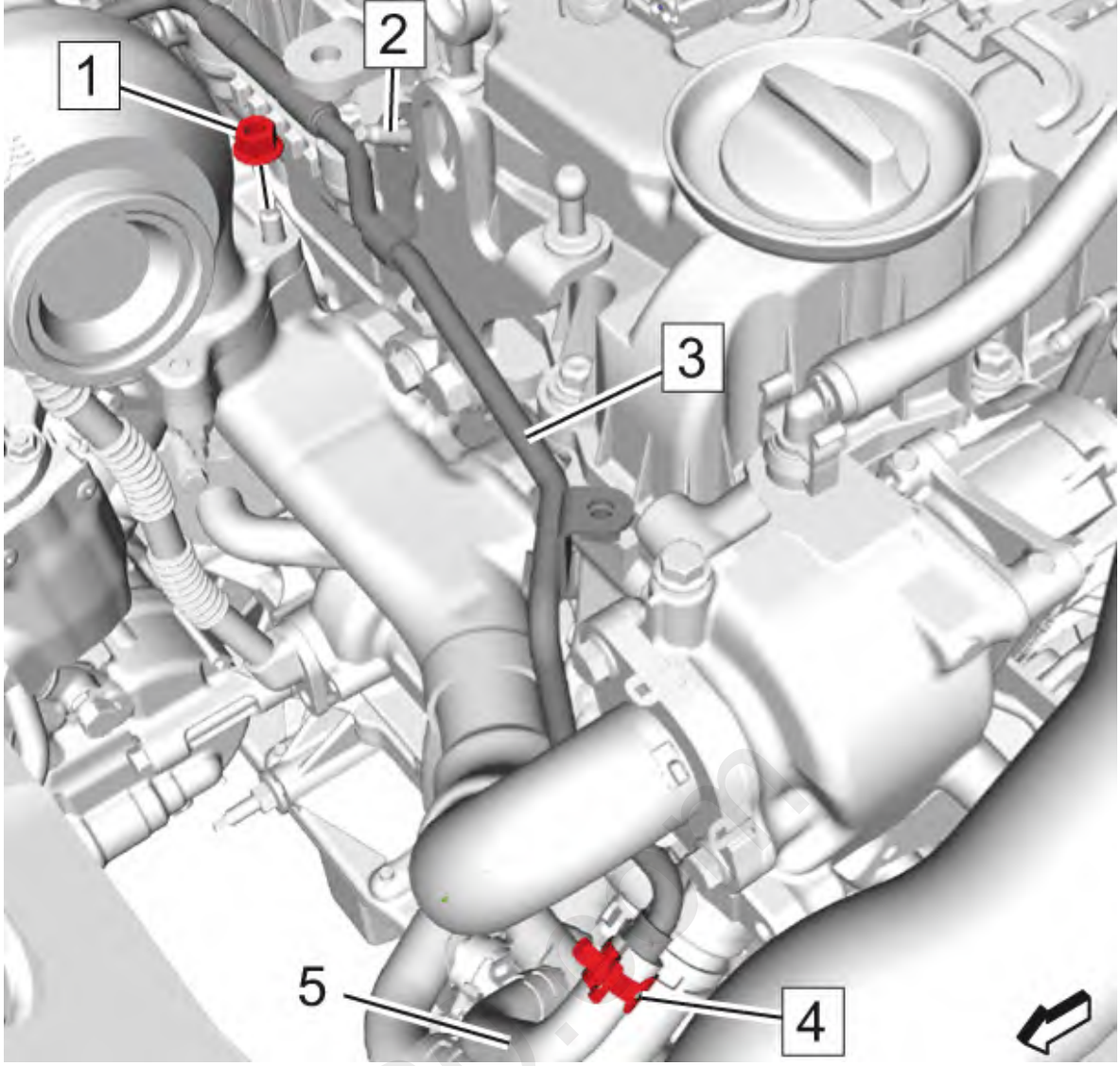


Fig. 497: Turbocharger Coolant Feed Hose, Feed Pipe, Clamp, Stud And Nut
Courtesy of GENERAL MOTORS COMPANY

11. Install and tighten Turbocharger Nut (1) to 30 N.m (22 lb ft)
12. Install Turbocharger Coolant Feed Pipe (3) @ Stud (2)
13. Connect Turbocharger Coolant Feed Hose (5) @ Turbocharger Coolant Feed Pipe (3)
14. Install Turbocharger Coolant Feed Hose Clamp (4)

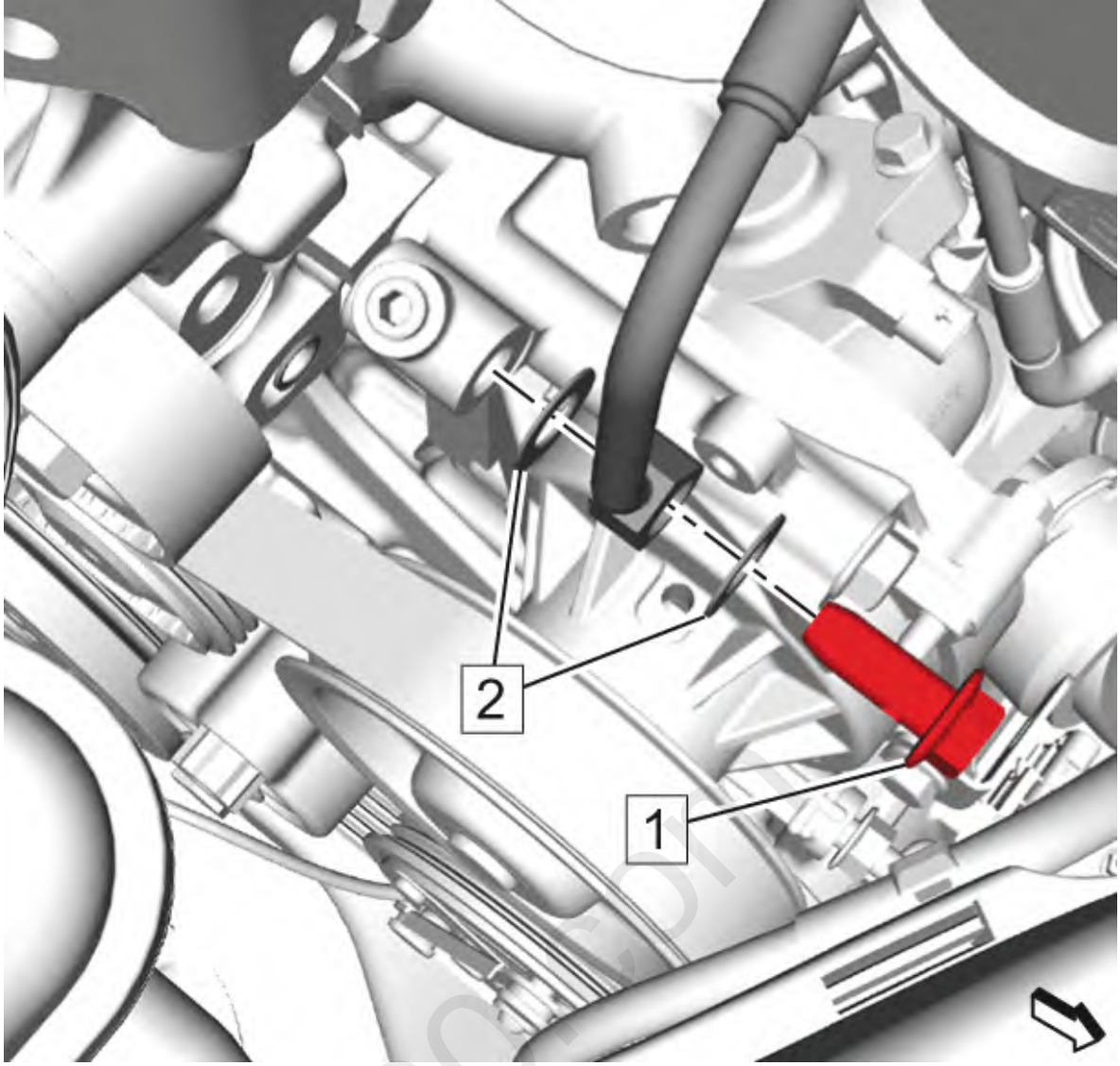


Fig. 498: Turbocharger Coolant Feed Pipe Hollow Screw And Gaskets
Courtesy of GENERAL MOTORS COMPANY

15. Install NEW gaskets. (2) (Qty: 2)
16. Install and tighten Turbocharger Coolant Feed Pipe Hollow Screw (1) to 25 N.m (18 lb ft)

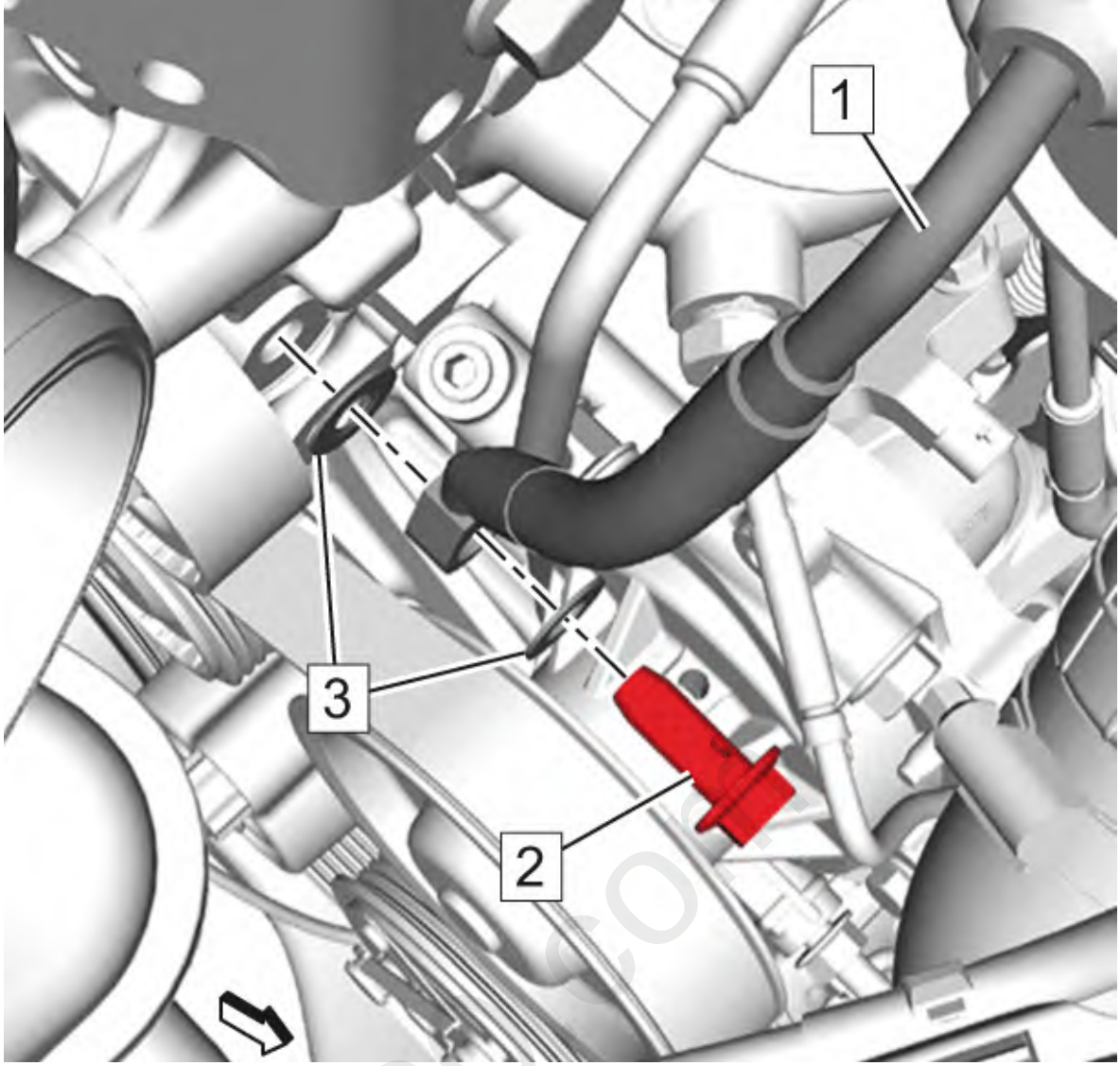


Fig. 499: Turbocharger Oil Feed Pipe, Hollow Screw And Gaskets
Courtesy of GENERAL MOTORS COMPANY

17. Install NEW gaskets. (3) (Qty: 2)
18. Install and tighten Turbocharger Oil Feed Pipe Hollow Screw (2) to 25 N.m (18 lb ft)

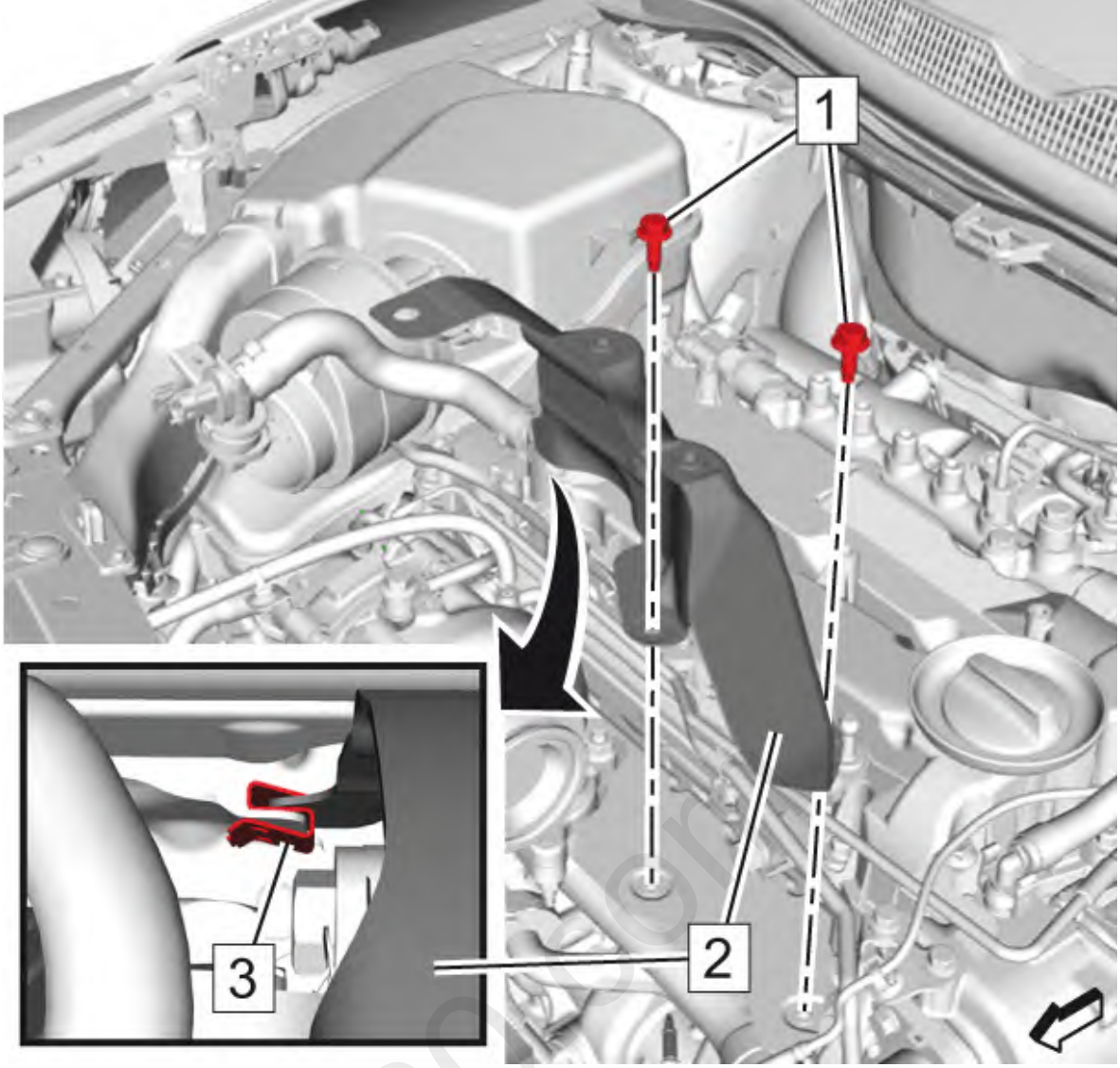


Fig. 500: Turbocharger Heat Shield, Bolts And Clamp
Courtesy of GENERAL MOTORS COMPANY

19. Install Turbocharger Heat Shield (2)
20. Install Turbocharger Heat Shield (2) @ Clamp (3)
21. Install and tighten Turbocharger Heat Shield Bolts (1) (Qty: 2) to 10 N.m (89 lb in)

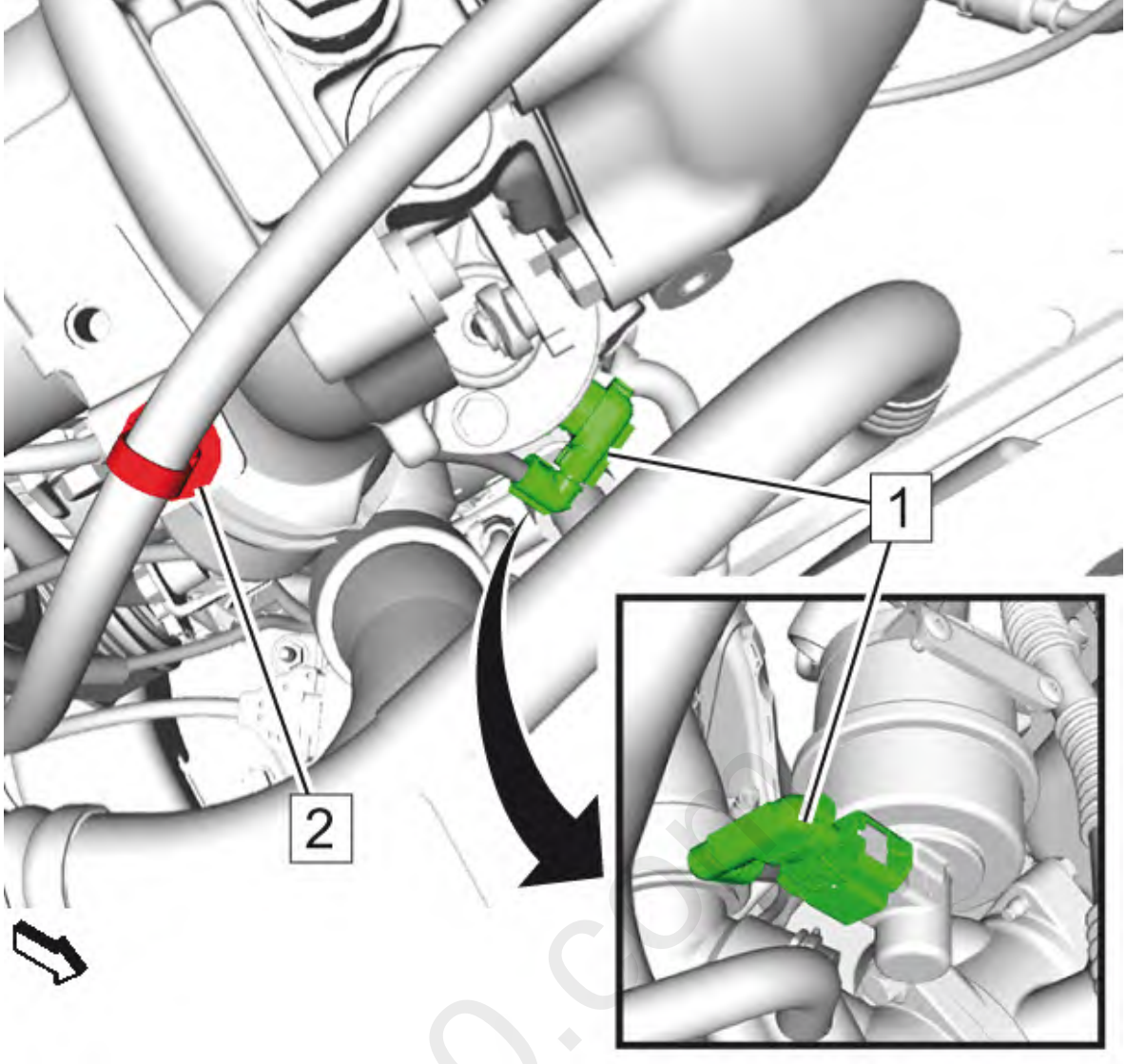


Fig. 501: Wiring Harness Retainer And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

22. Connect the electrical connector. (1)
23. Install Wiring Harness Retainer (2)

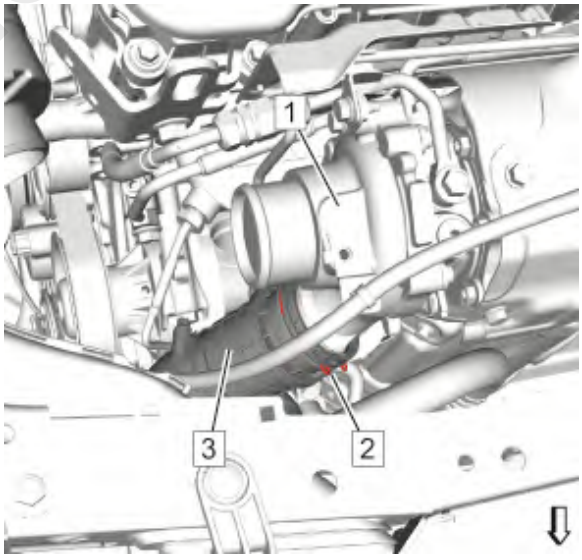


Fig. 502: Charge Air Cooler Inlet Air Hose, Retainer Spring And Turbocharger
Courtesy of GENERAL MOTORS COMPANY

24. Install Charge Air Cooler Inlet Air Hose (3) @ Turbocharger (1)
25. Install Charge Air Cooler Inlet Air Hose Retainer Spring (2)
26. Raise the vehicle.

mcx30.com

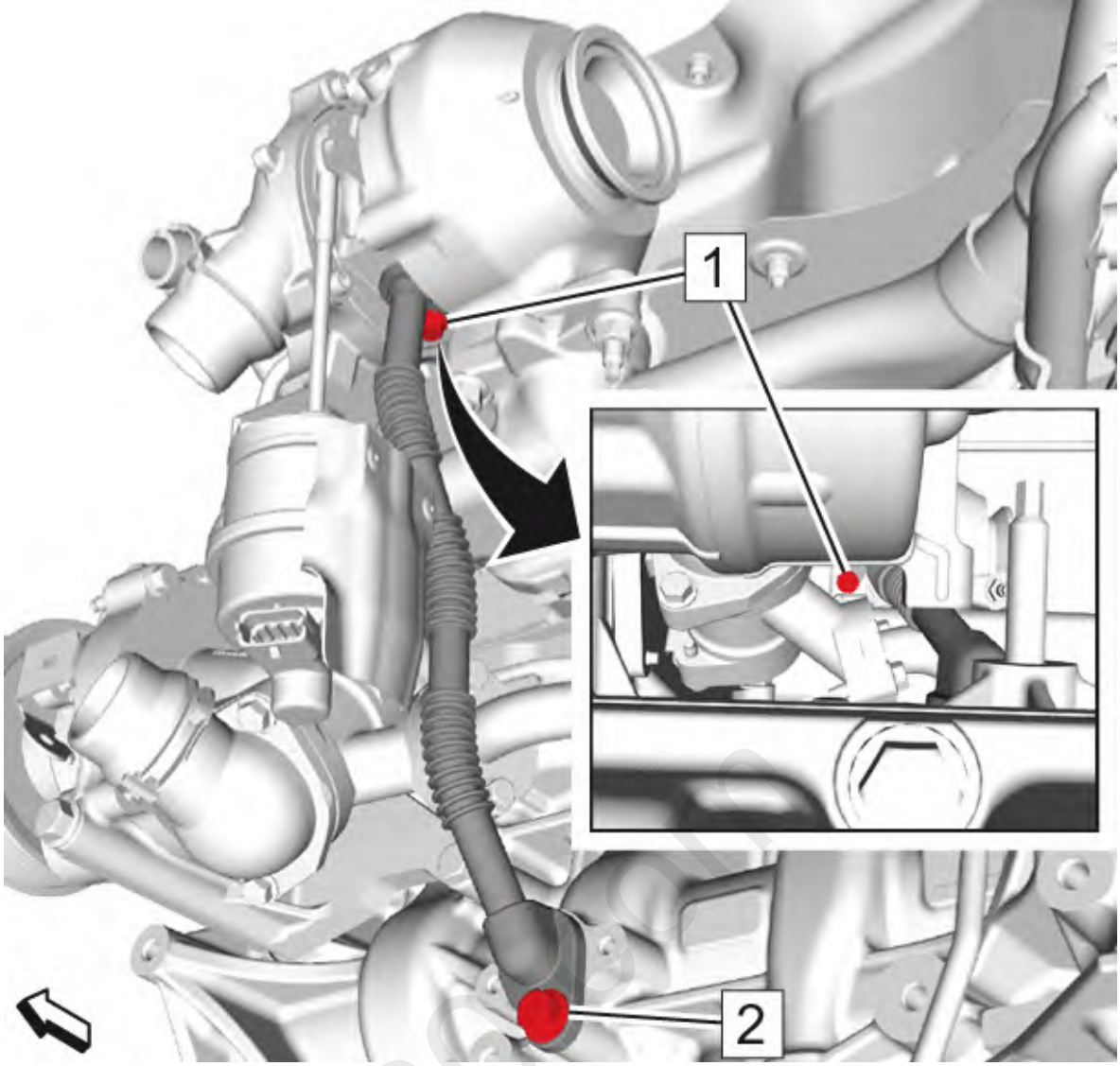


Fig. 503: Turbocharger Oil Return Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

27. Install and tighten Turbocharger Oil Return Pipe Bolt (1) to 10 N.m (89 lb in)
28. Tighten Turbocharger Oil Return Pipe Bolt (2) to 25 N.m (18 lb ft)
29. Install Turbocharger Wastegate Actuator Pipe. Refer to **Turbocharger Wastegate Actuator Pipe Replacement**
30. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)**
31. Install Oxidation Catalytic Converter. Refer to **Oxidation Catalytic Converter Replacement (LH7)**
32. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**

VALVE LIFTER REPLACEMENT

Removal Procedure

1. Remove the intake and exhaust camshaft. Refer to **Camshaft Replacement**.

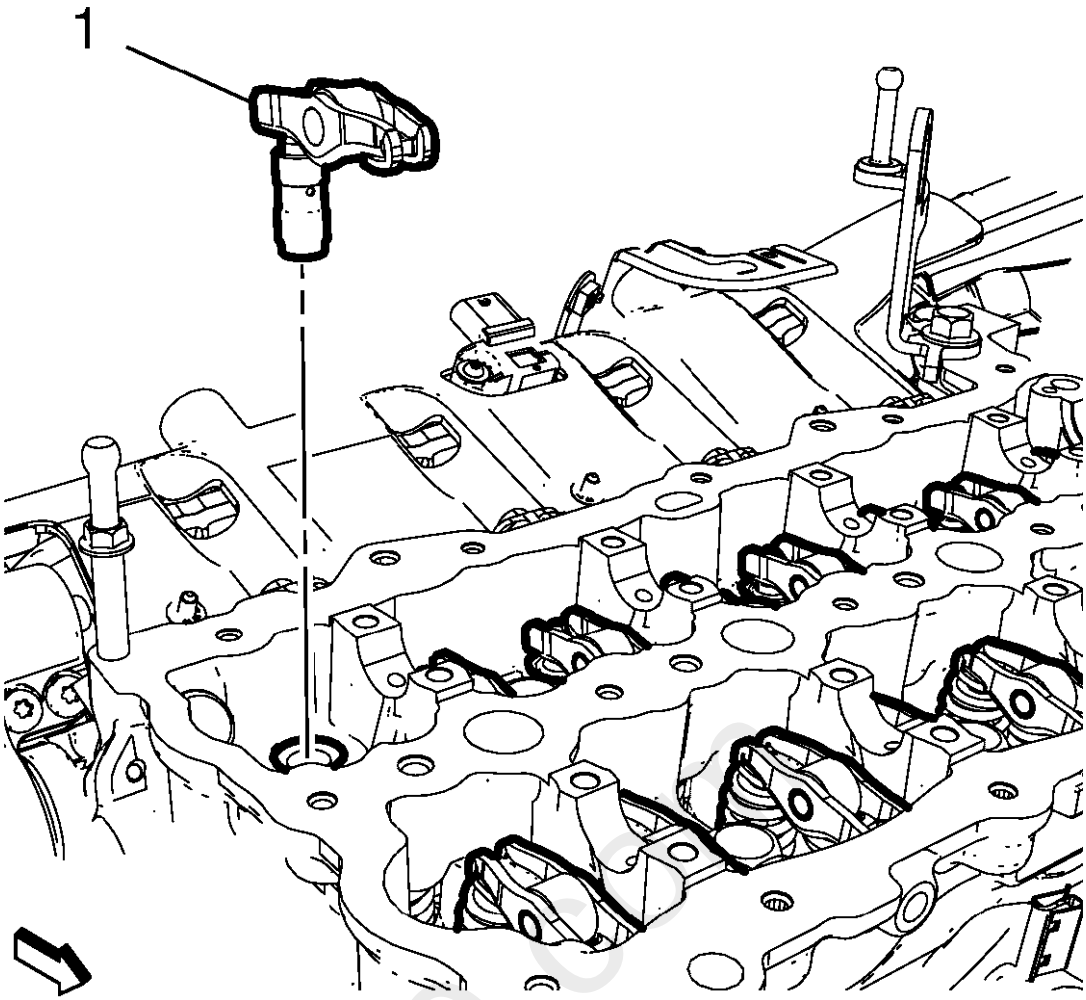


Fig. 504: Valve Lifter Roller Assemblies
Courtesy of GENERAL MOTORS COMPANY

2. Remove the 16 valve lifter with valve lifter roller (1) and lay aside in the order as they was removed.

mcx30.com

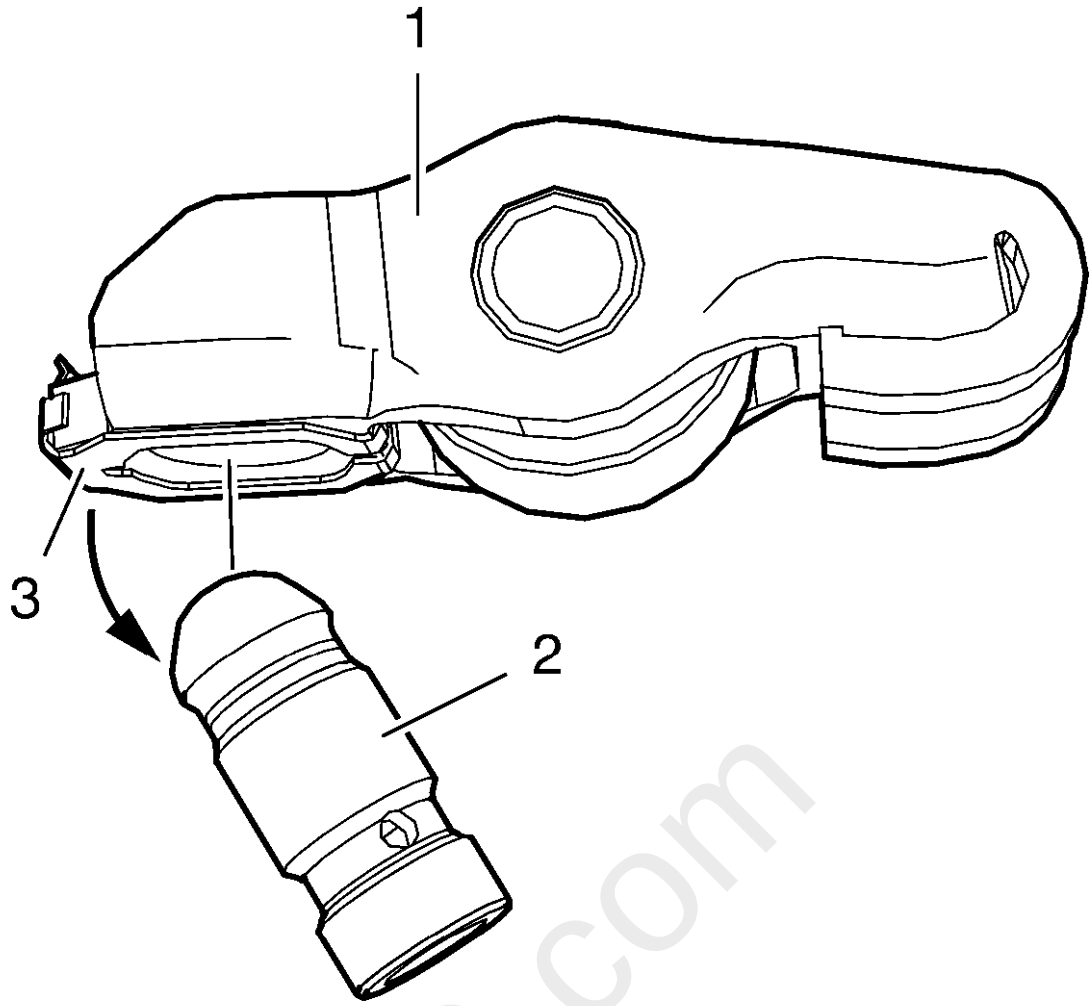


Fig. 505: Valve Rocker Arms And Valve Lifters
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Unclip the valve lifter from the valve lifter roller in direction as shown (arrow). Mind to the centering link on retainer spring (3).**

3. Remove the 16 valve lifters (2) from the valve lifter rollers (1).

Installation Procedure

mox20.com

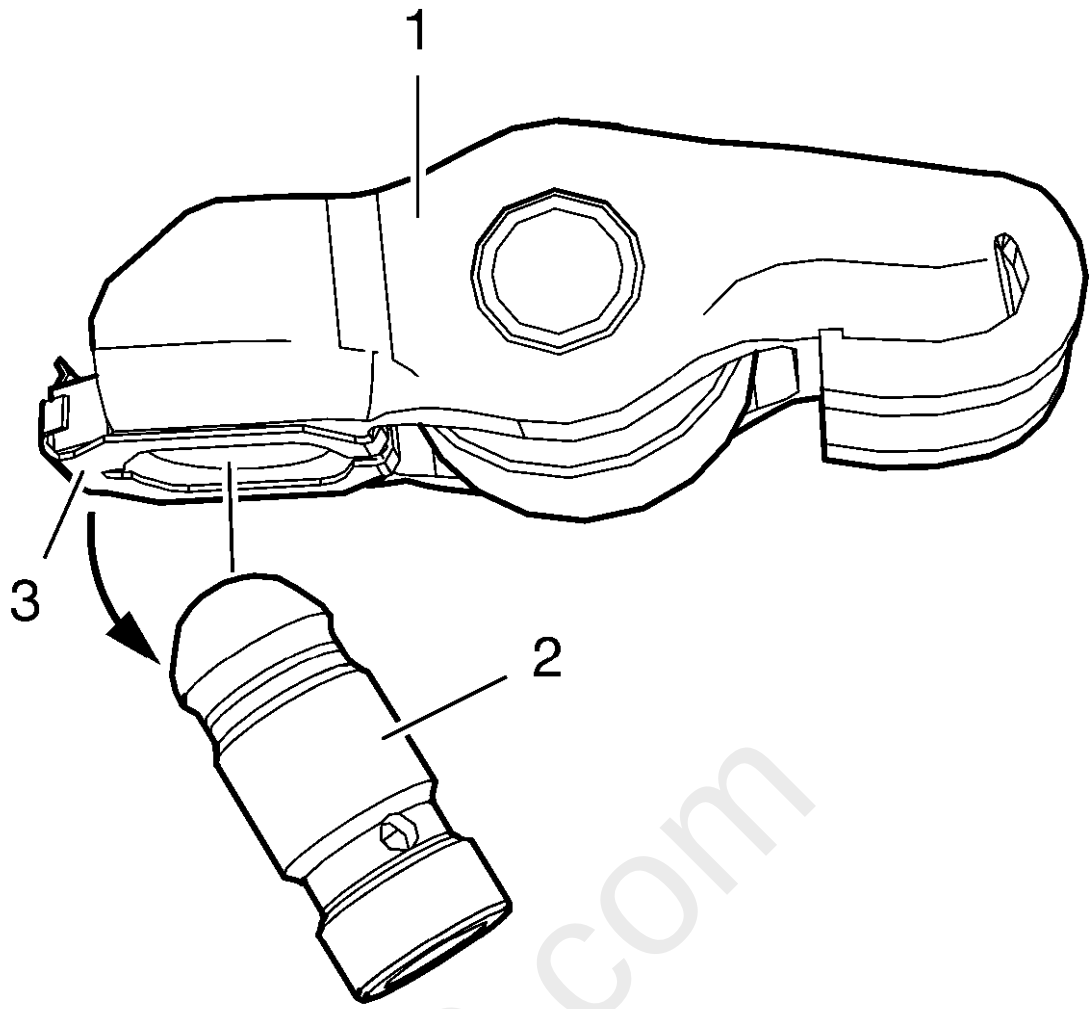


Fig. 506: Valve Rocker Arms And Valve Lifters
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Clip in the valve lifter to the valve lifter roller. Mind to the centering link on retainer spring (3).**

1. Install the 16 valve lifters (2) to the valve lifter rollers (1).
2. Coat the 16 valve lifter with engine oil.

mox30.com

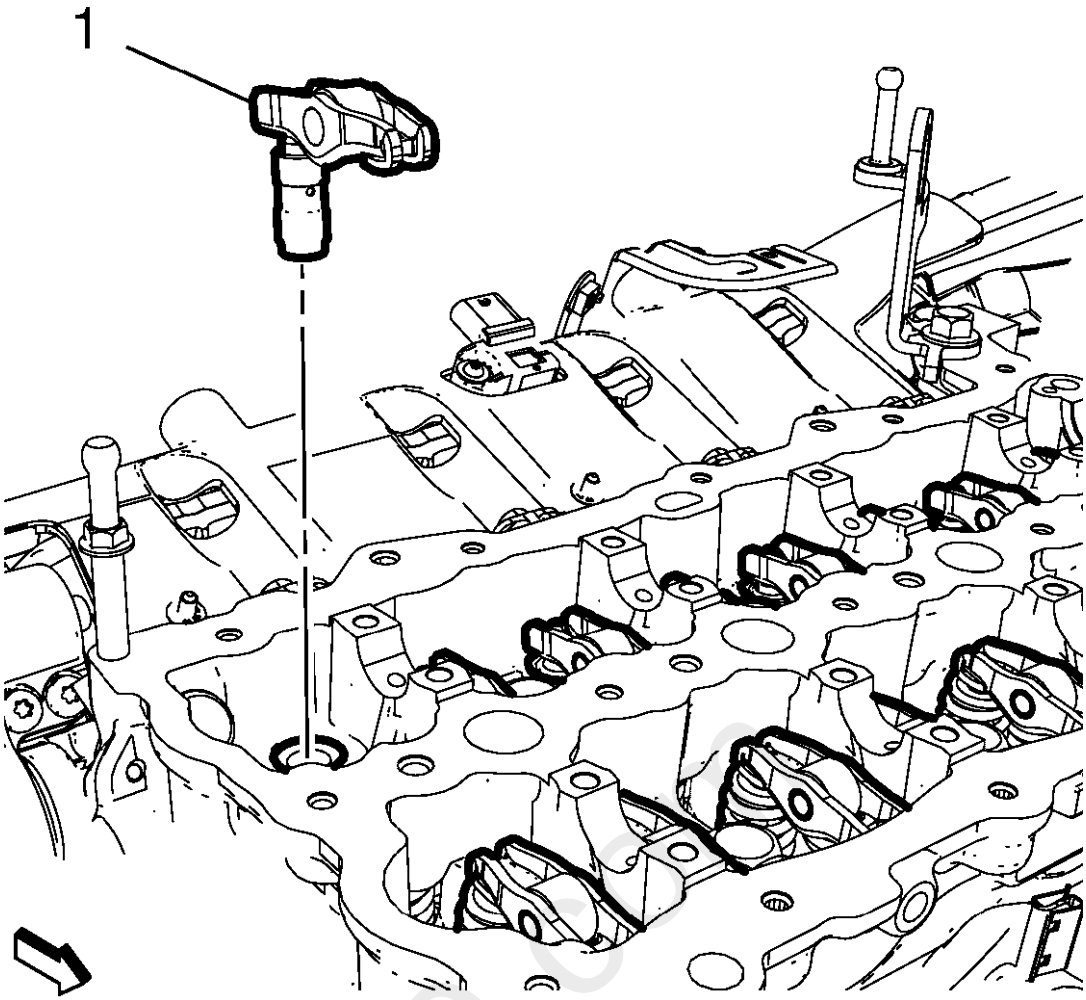


Fig. 507: Valve Lifter Roller Assemblies
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the valve lifters or valve lifter rollers are reused, the valve lifter or valve lifter roller must be installed in their original position.**

3. Install the 16 valve lifter with valve lifter roller (1) in the order as they was removed.
4. Install the intake and exhaust camshaft. Refer to **Camshaft Replacement**.

ENGINE SUPPORT FIXTURE

Special Tools

EN-51007 Engine Support Fixture

Equivalent regional tools: **Special Tools**

Assemble EN-51007 Engine Support Fixture

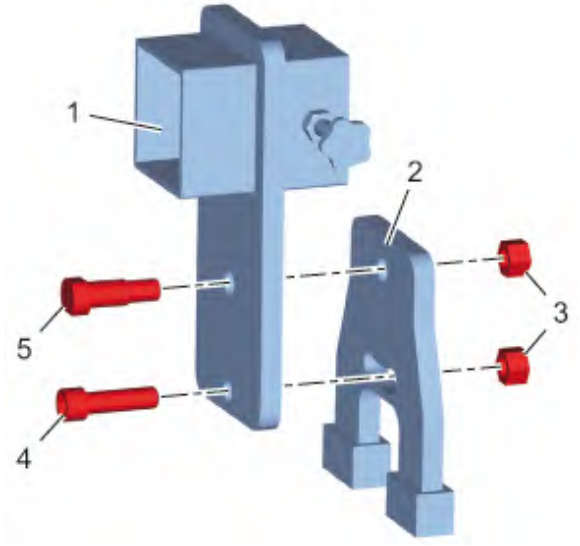
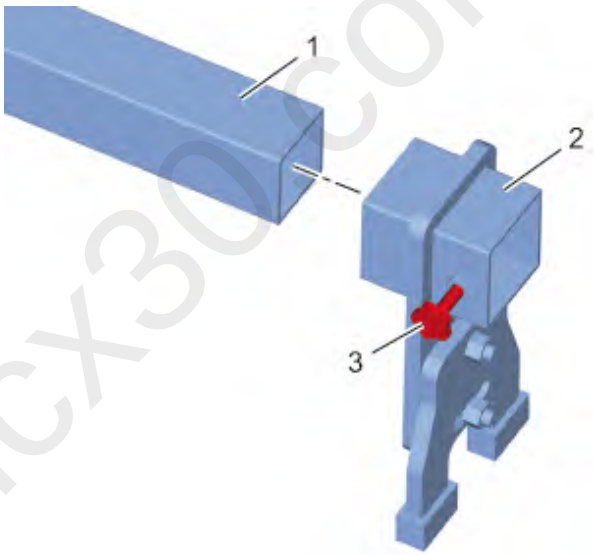


Fig. 508: Engine Support Fixture Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Pre-assemble special tool assembly outside the vehicle.**

1. Install the lower foot (2) to the upper foot (1).
2. Install the mounting bolt (5).
3. Install the adjustment screw (4) and tighten the 2 nuts (3).



mcx30.com

Fig. 509: Engine Support Fixture Components
Courtesy of GENERAL MOTORS COMPANY

4. Install the 2 **EN-51007-7** adapters (2) to the **EN-51007-1** adapter (1).
5. Tighten the adjustment screw (3).

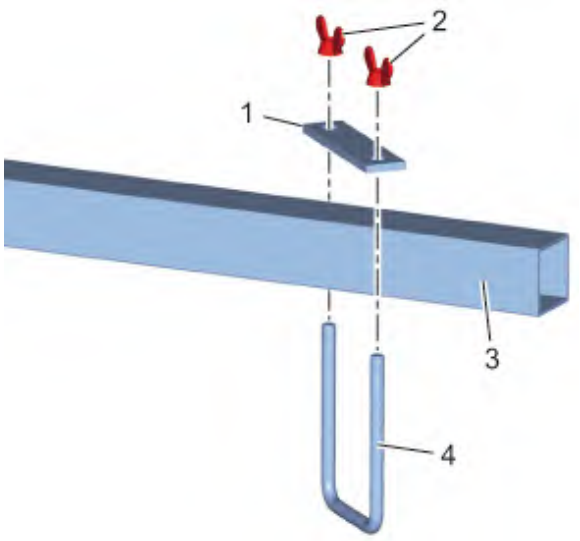


Fig. 510: Engine Support Fixture Components
Courtesy of GENERAL MOTORS COMPANY

6. Install the 2 **EN-51007-4** adapters to the **EN-51007-1** adapter by guiding the bail (4) into the board (1).
7. Install the 2 thumb nuts (2).

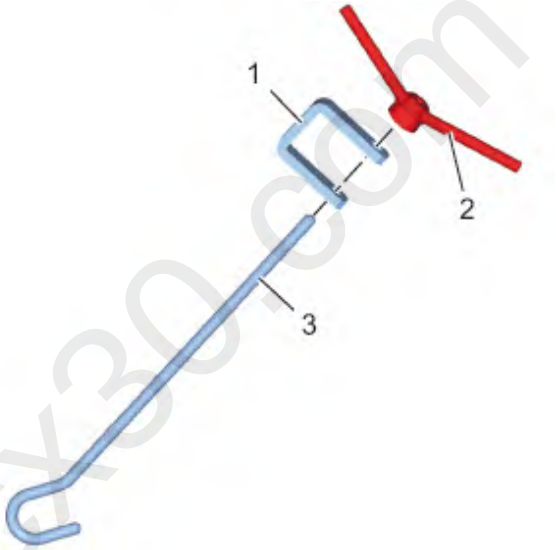


Fig. 511: Bushing, Lever And Hook
Courtesy of GENERAL MOTORS COMPANY

8. Install the bushing (1) to the hook (3).
9. Install the lever (2) to the hook (3).

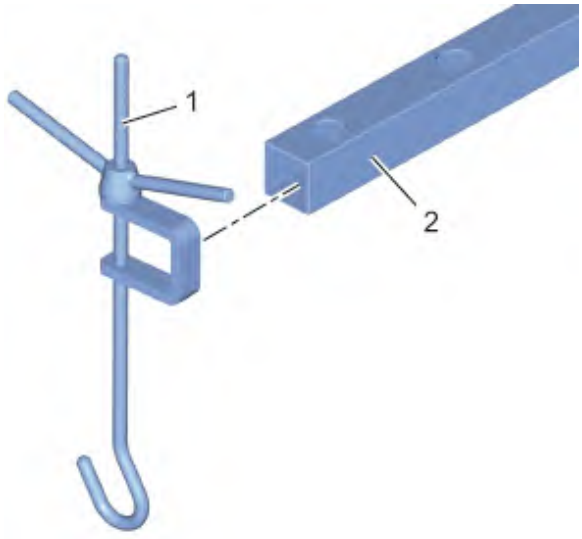


Fig. 512: Engine Support Fixture Adapters
Courtesy of GENERAL MOTORS COMPANY

10. Install the **EN-51007-6** adapters (1) to the **EN-51007-3** adapters (2).

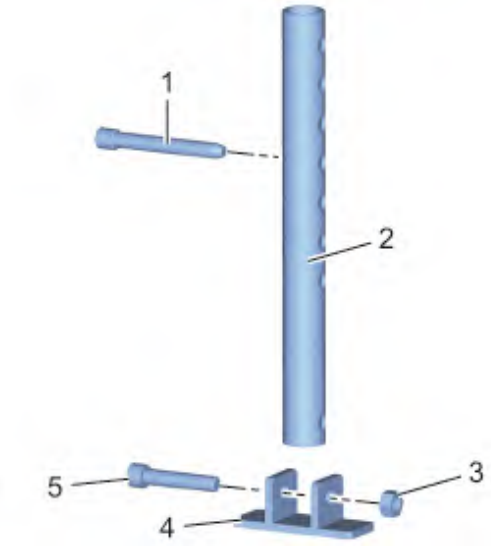


Fig. 513: Foot, Rod, Bolts And Nut
Courtesy of GENERAL MOTORS COMPANY

11. Install the foot (4) to the rod (2)
12. Install and tighten the bolt (5) and the nut (3).
13. Install the bolt (1).

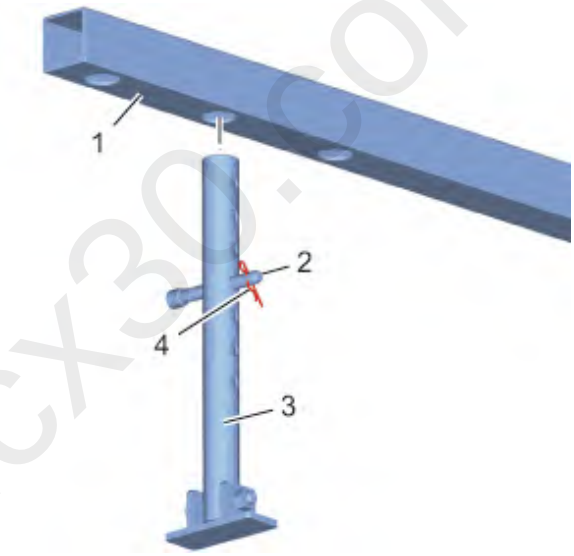


Fig. 514: Adapters, Bolt And Cotter Pin
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The feet should stay in the second hole of the rakes.**

14. Install **EN-51007-5** adapter (3) to the **EN-51007-3** adapter (1).
15. Install the cotter pin (4) into the bolt (2).

mcx30.com

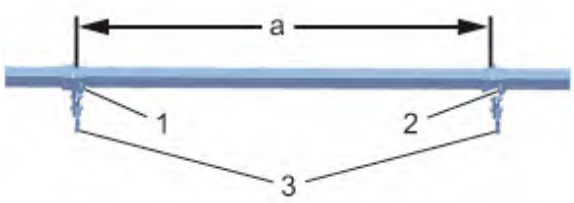


Fig. 515: Distance Between Feet And Adjustment Screws
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The distance (a) must be aligned to 1400 mm (55 in).**

16. Check the distance between the 2 feet (3).
17. Tighten the 2 adjustment screws (1, 2).

Installation Procedure

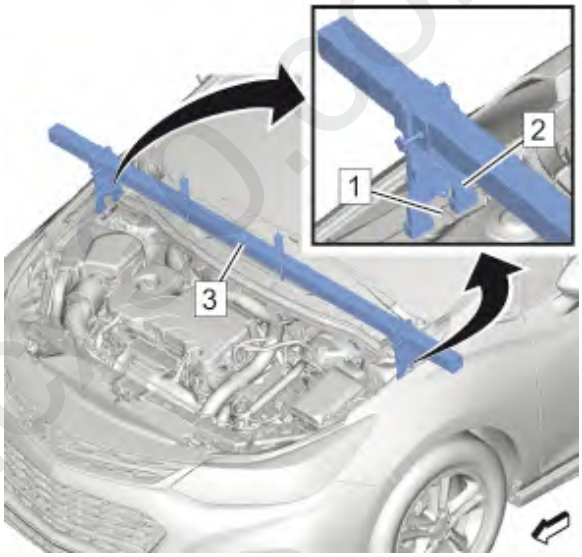


Fig. 516: Engine Support Fixture Adapters And Front Compartment Upper Side Rail
Courtesy of GENERAL MOTORS COMPANY

NOTE: **A second technician is required.**

1. Install the **EN-51007-1** adapter (3) with the **EN-51007-7** adapters (2) between the bulge (1) of the front compartment upper side rail.

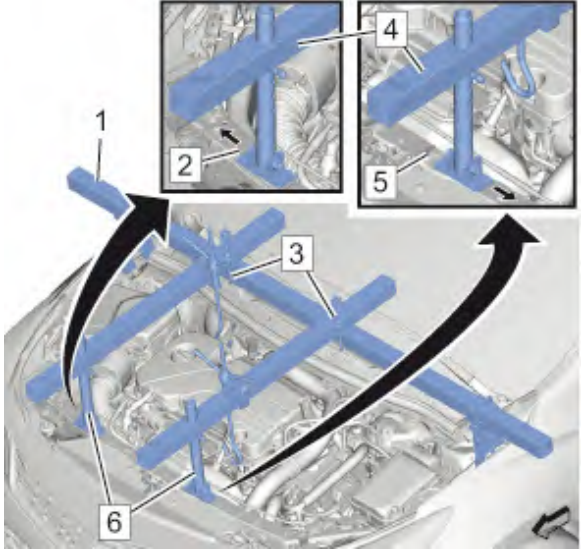


Fig. 517: Engine Support Fixture Adapters And Front End Upper Tie Bar
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The 2 feet of the rakes should be placed as far as possible in the direction as shown.**

2. Install the **EN-51007-3** adapters (4) to the **EN-51007-1** adapter (1) with the **EN-51007-5** adapters (6) on the front end upper tie bar (2, 5).

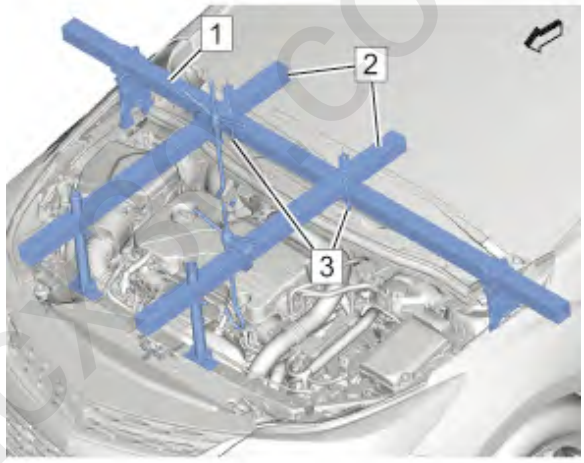


Fig. 518: Engine Support Fixture Adapters
Courtesy of GENERAL MOTORS COMPANY

3. Tighten the **EN-51007-3** adapters (2) to the **EN-51007-1** adapter (1) by tighten it with the **EN-51007-4** adapters (3).

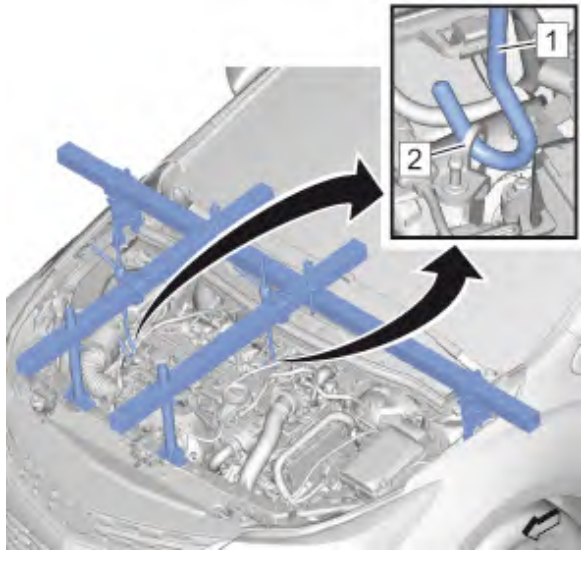


Fig. 519: Engine Support Fixture Adapters And Engine Lift Brackets
Courtesy of GENERAL MOTORS COMPANY

4. Install the 2 **EN-51007-6** adapters (1) into the 2 engine lift brackets (2).
5. When the tool assembly **EN-51007** support fixture is under load, adjust complete assemble and re-tighten ALL fasteners.

Removal Procedure

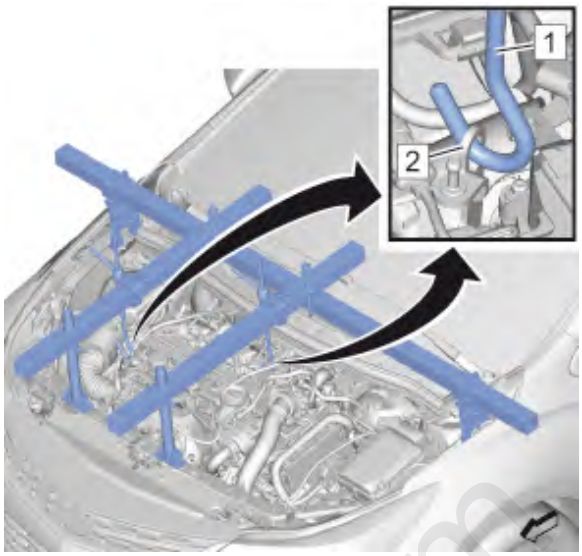


Fig. 520: Engine Support Fixture Adapters And Engine Lift Brackets
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 2 **EN-51007-6** adapters (1) from the 2 engine lift brackets (2).

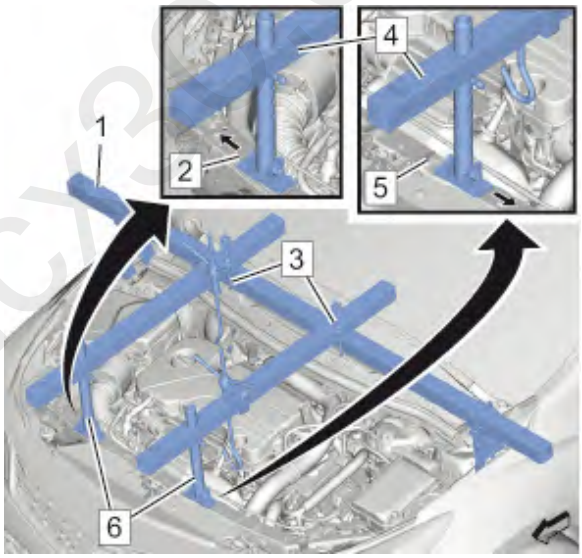


Fig. 521: Engine Support Fixture Adapters And Front End Upper Tie Bar
Courtesy of GENERAL MOTORS COMPANY

2. Loosen the 2 **EN-51007-4** adapters (3).

NOTE: **A second technician is required.**

3. Remove the 2 **EN-51007-3** adapters (4) with the **EN-51007-5** adapters (6) from the **EN-51007-1** adapter (1).

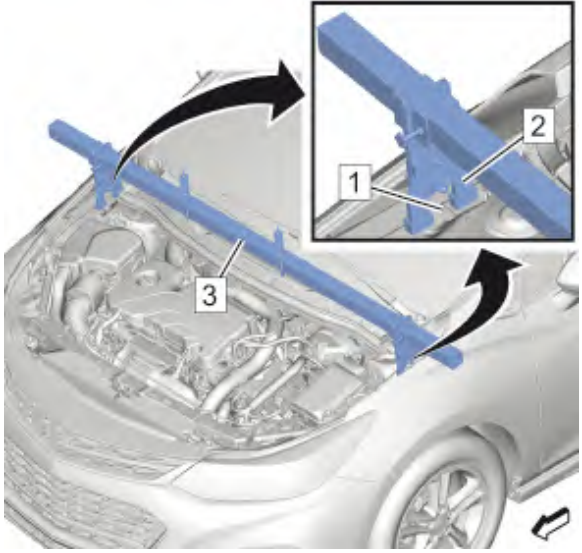


Fig. 522: Engine Support Fixture Adapters And Front Compartment Upper Side Rail
Courtesy of GENERAL MOTORS COMPANY

4. Remove the **EN-51007-1** adapter (3).
5. Clean the contact surfaces from the **EN-51007-5** adapters on the front end upper tie bar with solvent.

ENGINE REPLACEMENT

Special Tools

- **CH-51034** Guide Pins
- **EN-45059** Angle Meter

Equivalent regional tools: **Special Tools**

Removal Procedure

1. Recover the refrigerant. Refer to **Refrigerant Recovery and Recharging (R-134a)** **Refrigerant Recovery and Recharging (R-1234yf)**
2. Drain the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)**
3. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
4. Remove Battery Tray. Refer to **Battery Tray Replacement**

mc730.com

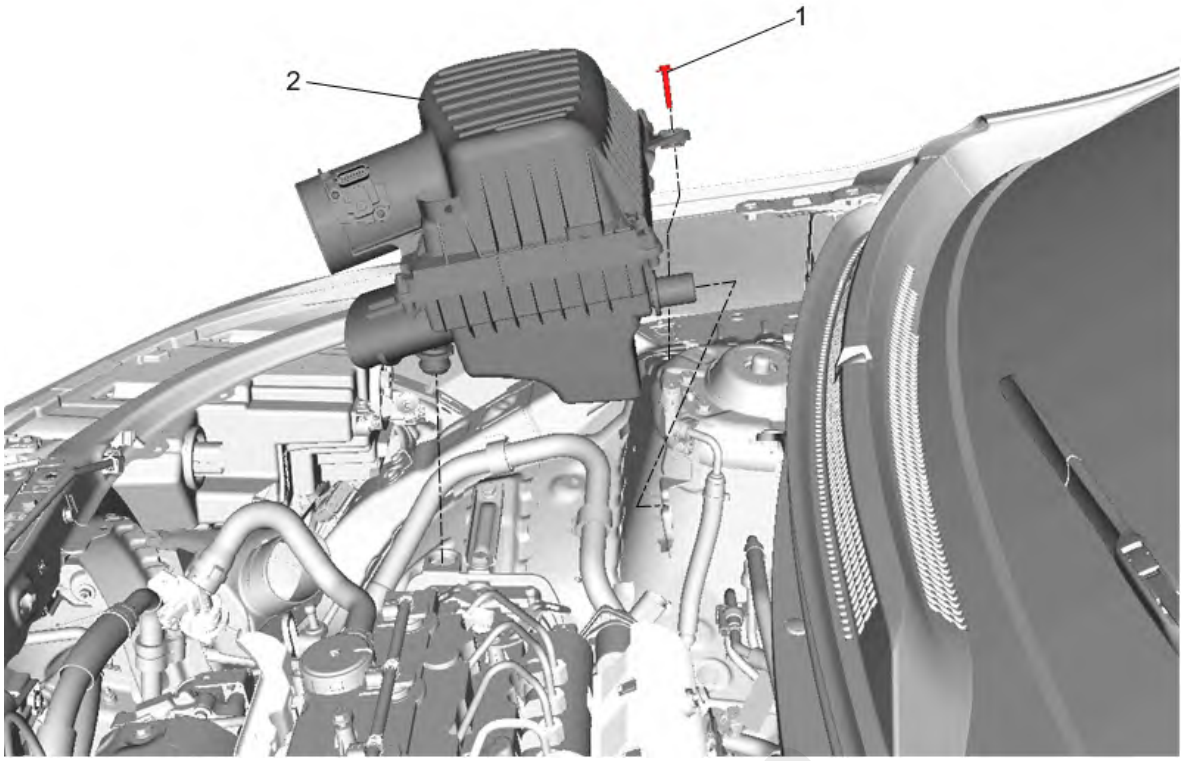


Fig. 523: Air Cleaner Assembly And Fastener
Courtesy of GENERAL MOTORS COMPANY

5. Remove the air cleaner assembly (2). Refer to **Air Cleaner Assembly Replacement**
6. Remove Engine Wiring Harness Junction Block. Refer to **Engine Wiring Harness Junction Block Replacement**
7. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**
8. Remove Exhaust Front Pipe. Refer to **Exhaust Front Pipe Replacement (LH7)**

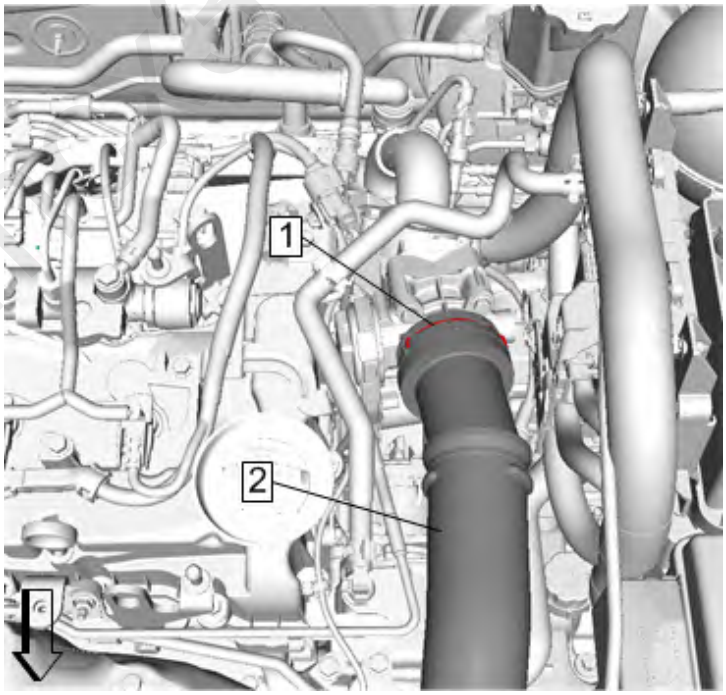


Fig. 524: Charge Air Cooler Outlet Air Tube And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

9. Remove Charge Air Cooler Outlet Air Tube (2). Refer to **Charge Air Cooler Outlet Air Tube Replacement**

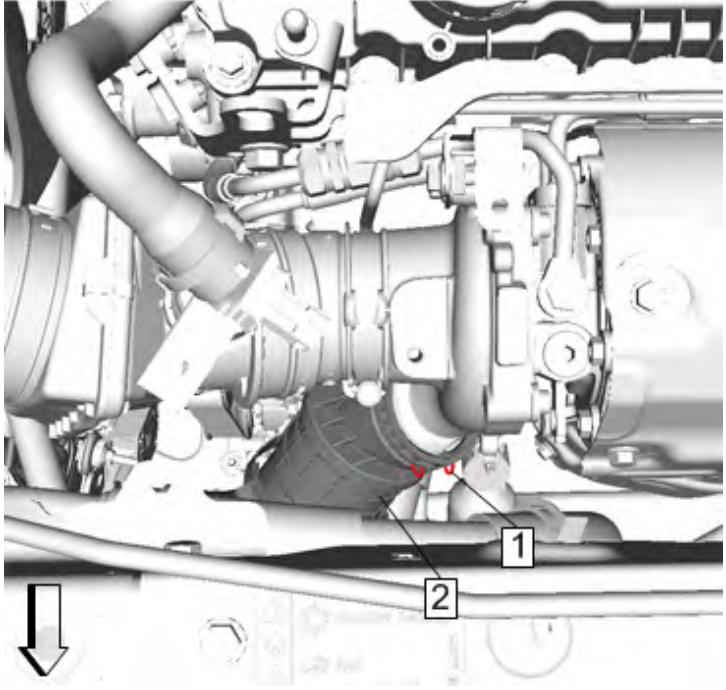


Fig. 525: Charge Air Cooler Inlet Air Tube And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

10. Remove Charge Air Cooler Inlet Air Tube (2). Refer to **Charge Air Cooler Inlet Air Tube Replacement**

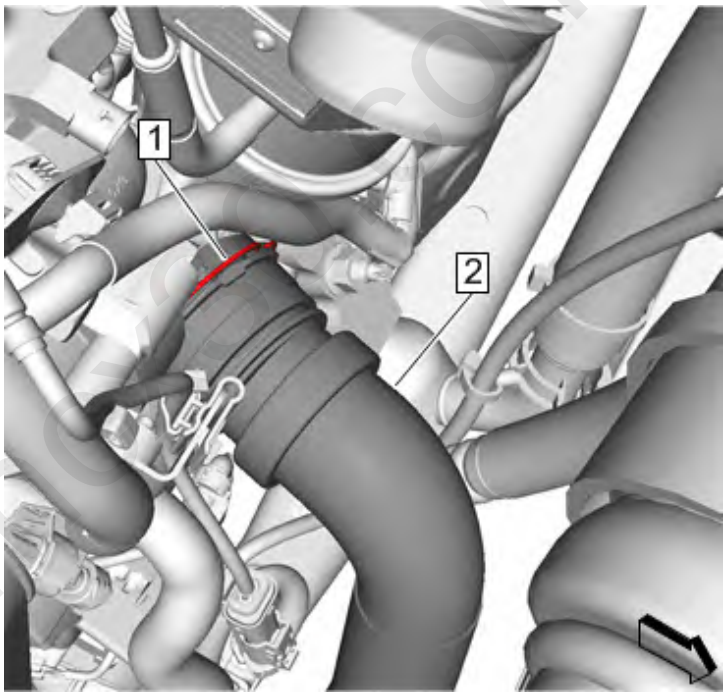


Fig. 526: Radiator Outlet Hose And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

11. Disconnect Radiator Outlet Hose (2)@ Engine. Refer to **Radiator Outlet Hose Replacement (LH7)**

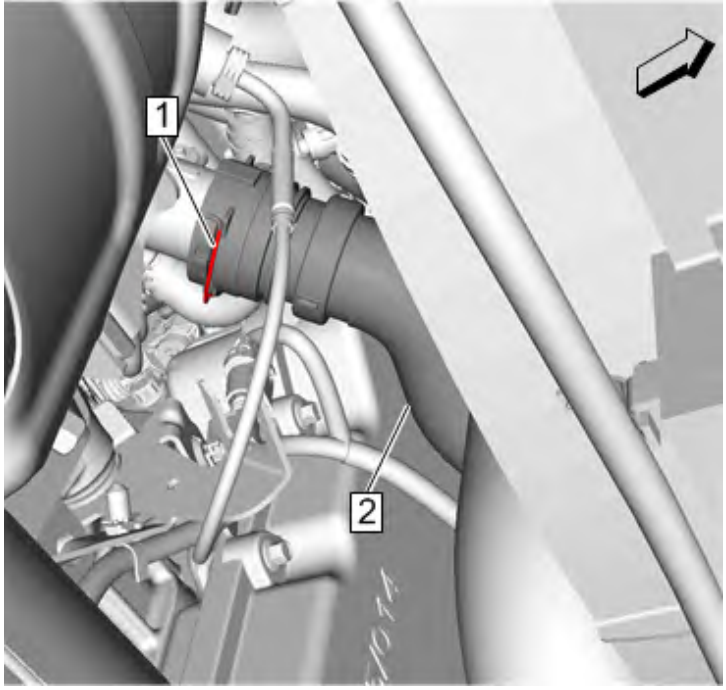


Fig. 527: Radiator Inlet Hose And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

12. Disconnect Radiator Inlet Hose (2) @ Engine. Refer to **Radiator Inlet Hose Replacement (LH7)**

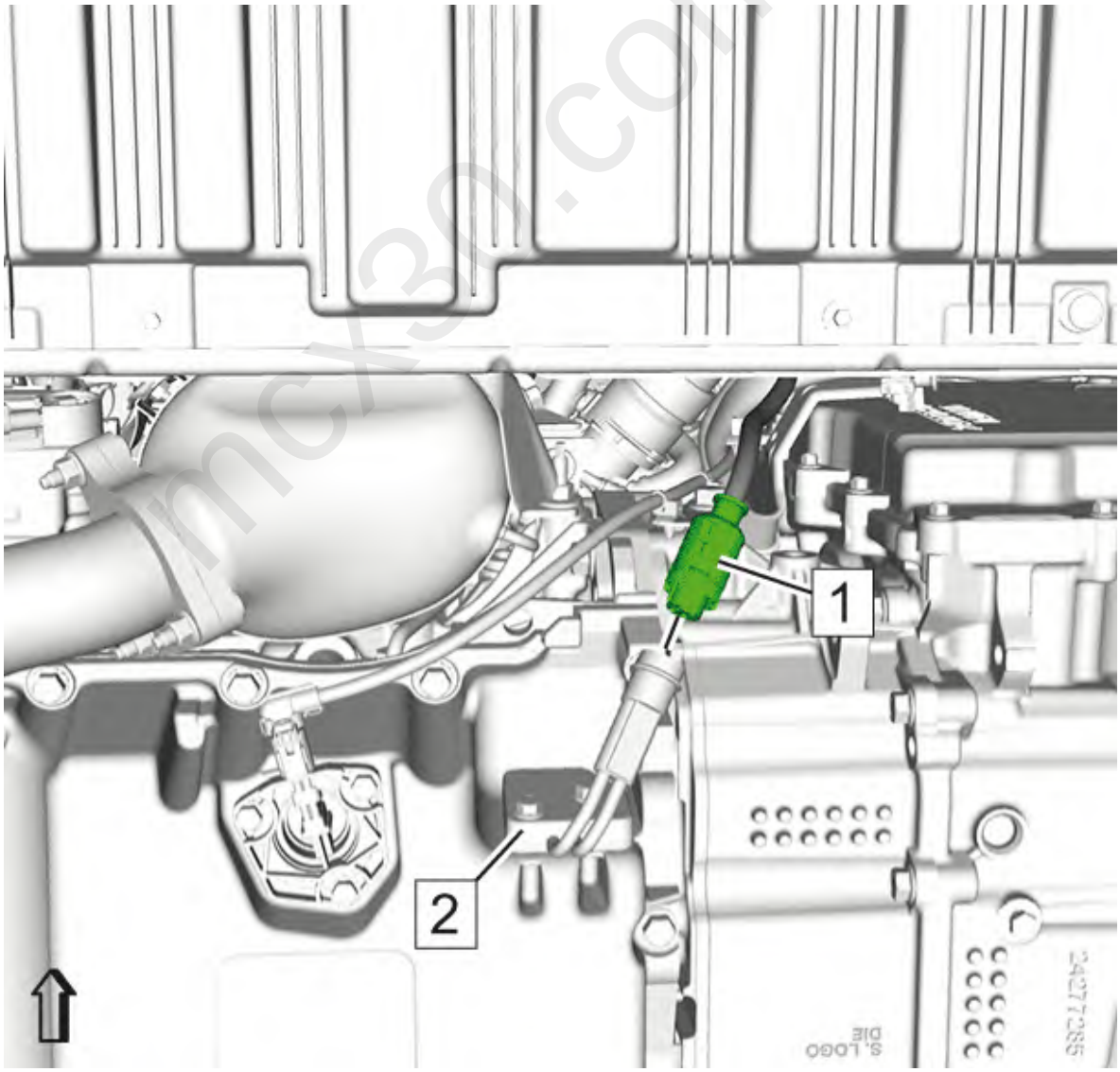


Fig. 528: Engine Oil Heater And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

13. Disconnect the electrical connector (1) at the engine oil heater (2).

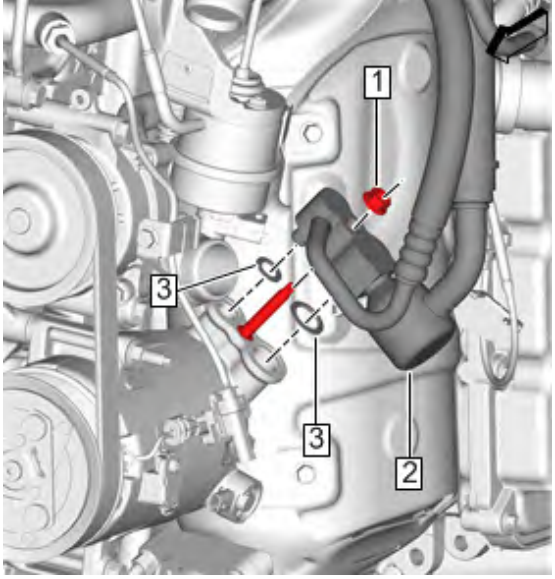


Fig. 529: A/C Evaporator Connector Hose/Tube And Compressor Hose, Seals And Retaining Nut
Courtesy of GENERAL MOTORS COMPANY

14. Disconnect Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose (2) @ Air Conditioning Compressor. Refer to **Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose Replacement (LH7)**

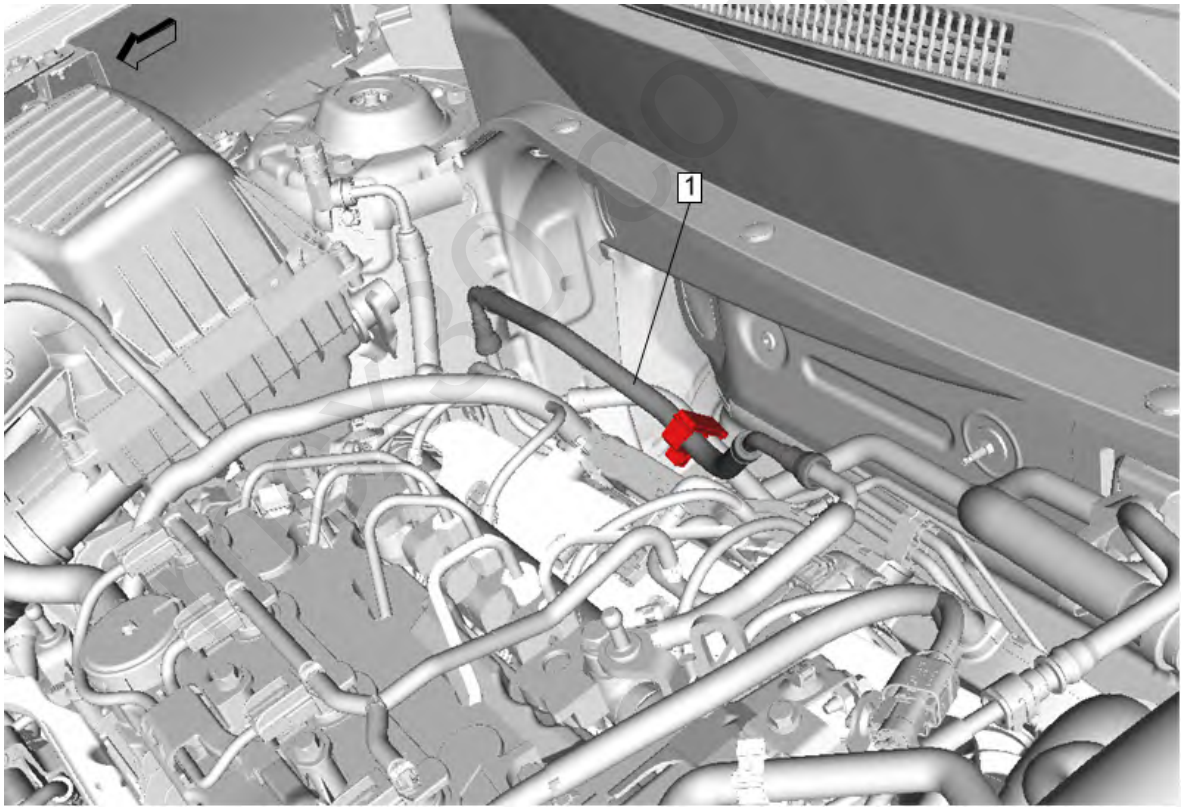


Fig. 530: Fuel Return Front Pipe
Courtesy of GENERAL MOTORS COMPANY

15. Remove Fuel Return Front Pipe (1). Refer to **Fuel Return Front Pipe Replacement**

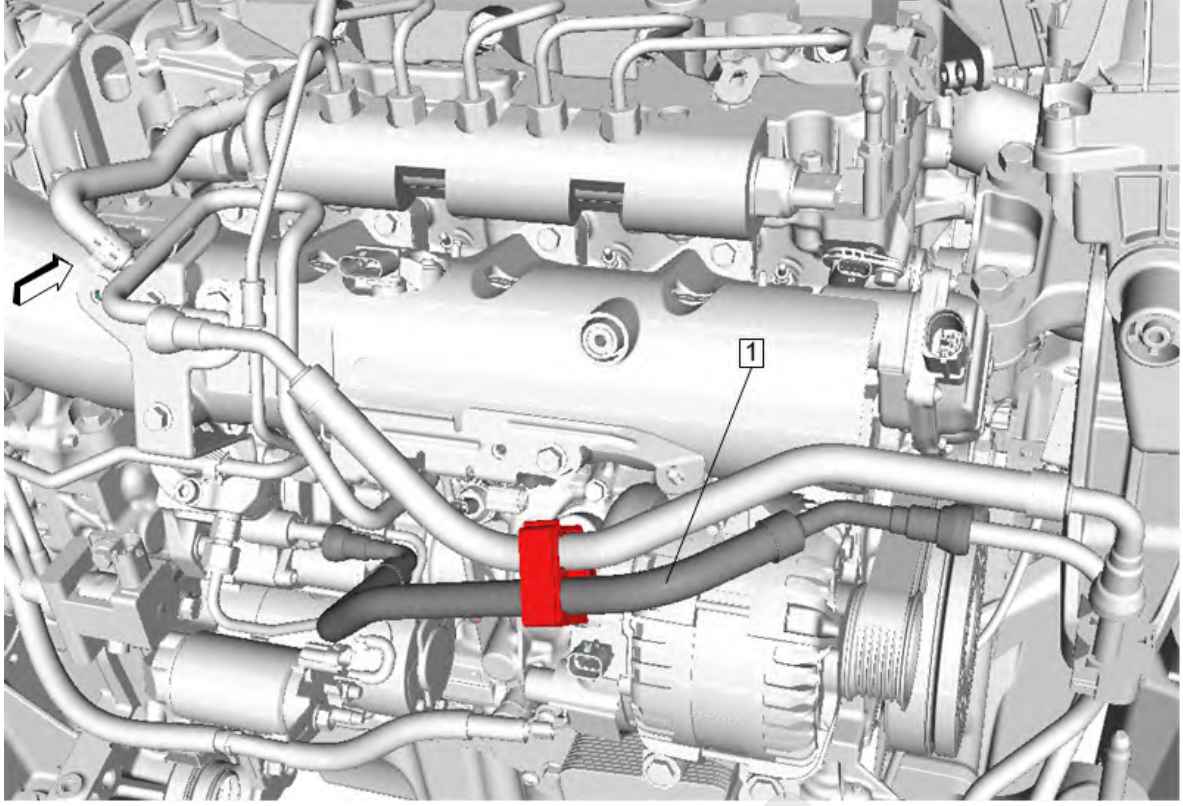


Fig. 531: Fuel Feed Front Pipe
Courtesy of GENERAL MOTORS COMPANY

16. Disconnect Fuel Feed Front Pipe (1) @ Fuel Feed Pipe. Refer to **Fuel Feed Front Pipe Replacement**

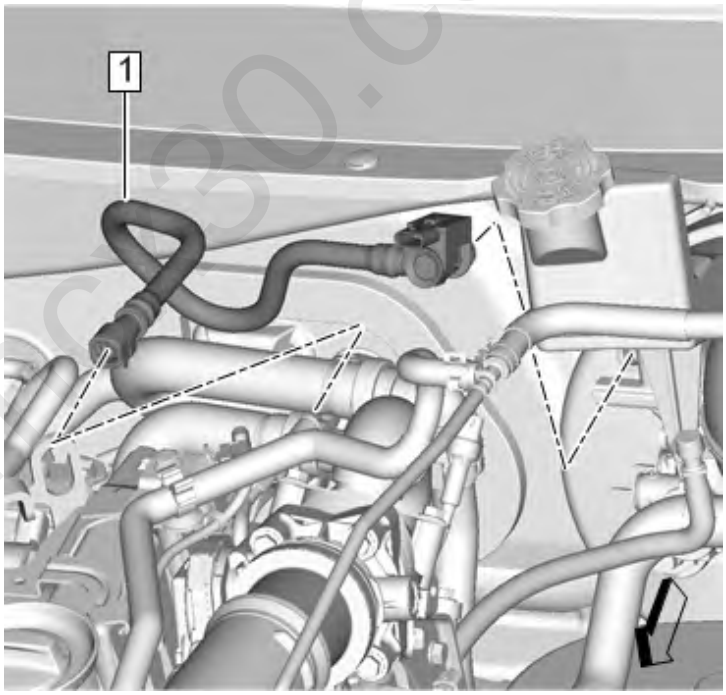


Fig. 532: Power Brake Booster Vacuum Pipe
Courtesy of GENERAL MOTORS COMPANY

17. Remove Power Brake Booster Vacuum Pipe (1). Refer to **Power Brake Booster Vacuum Pipe Replacement (LH7)**

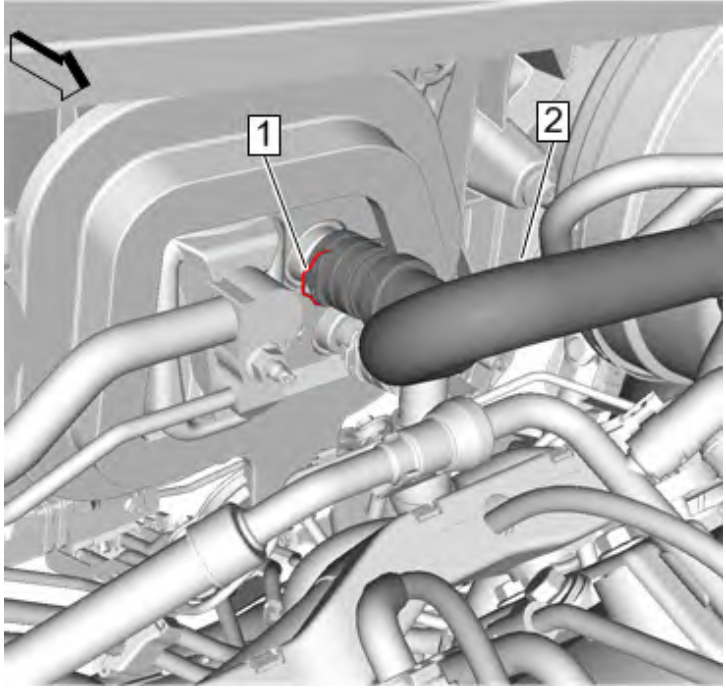


Fig. 533: Heater Inlet Hose And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

18. Disconnect Heater Inlet Hose (2) @ Heater Core. Refer to **Heater Inlet Hose Replacement (LH7 Terrain)** **Heater Inlet Hose Replacement (LH7 Equinox)**

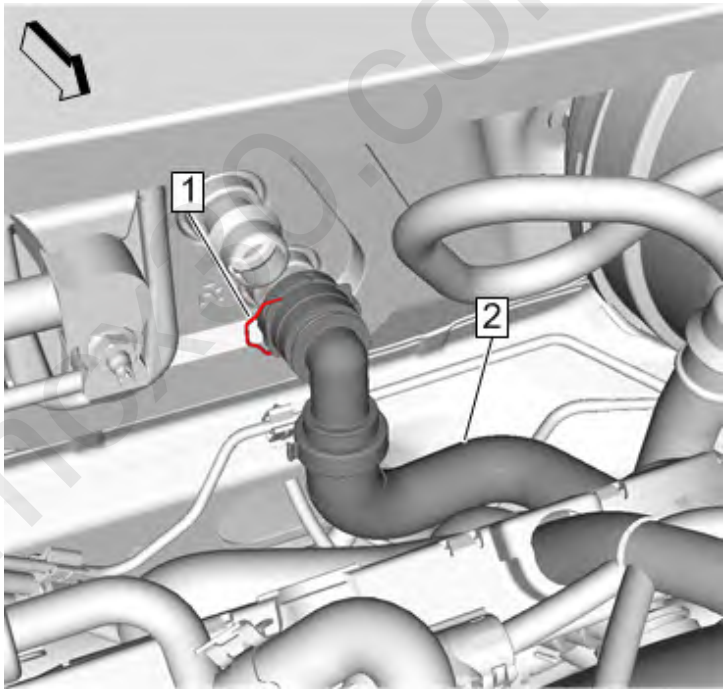


Fig. 534: Heater Outlet Hose And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

19. Disconnect Heater Outlet Hose (2) @ Heater Core. Refer to **Heater Outlet Hose Replacement (LH7)**

CAUTION: **Do not disconnect the nitrogen oxide sensor from the nitrogen oxide sensor control module. A separation of the two components may cause a defect on the nitrogen oxide sensor control module. Always replace the nitrogen oxide sensor along with the nitrogen oxide sensor control module as an assembly.**

20. Remove Nitrogen Oxides Sensor - Position 1. Refer to **Nitrogen Oxides Sensor Replacement - Position 1**
21. Remove Power Transfer Unit Case. Refer to **Power Transfer Unit Case Replacement (MHG Transmission with LH7 Engine)**
22. Disconnect the steering intermediate shaft from the steering gear. Refer to **Intermediate Steering Shaft Replacement (Equinox)** **Intermediate Steering Shaft Replacement (Terrain)**

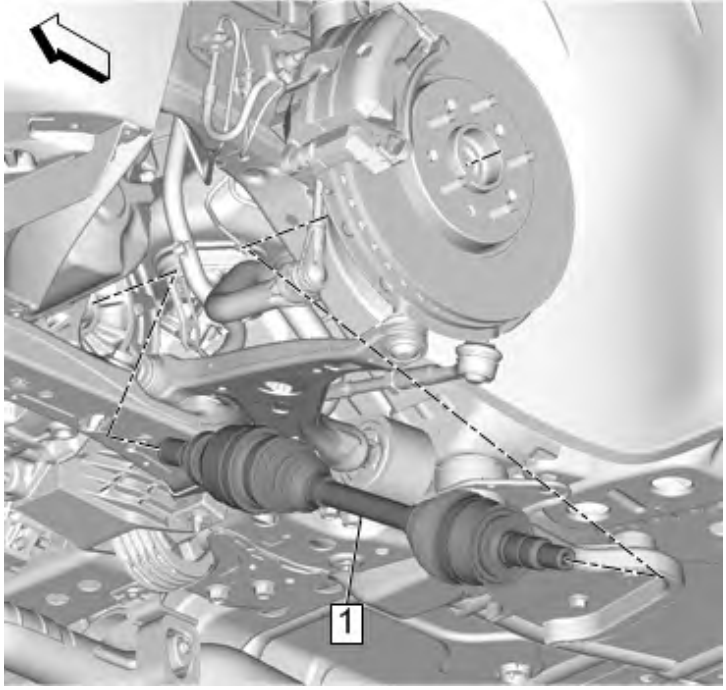


Fig. 535: Wheel Drive Shaft
Courtesy of GENERAL MOTORS COMPANY

23. Remove Front Wheel Drive Half Shaft-Left Side. Refer to **Front Wheel Drive Half Shaft Replacement - Left Side**
24. Remove Front Wheel Drive Half Shaft-Right Side. Refer to **Front Wheel Drive Half Shaft Replacement - Right Side (AWD)** **Front Wheel Drive Half Shaft Replacement - Right Side (M3U, MHG, MNH, MNK with FWD)**
25. Disconnect Stabilizer Shaft Link (Qty: 2) @ Stabilizer Shaft. Refer to **Stabilizer Shaft Link Replacement (Equinox)** **Stabilizer Shaft Link Replacement (Terrain)**

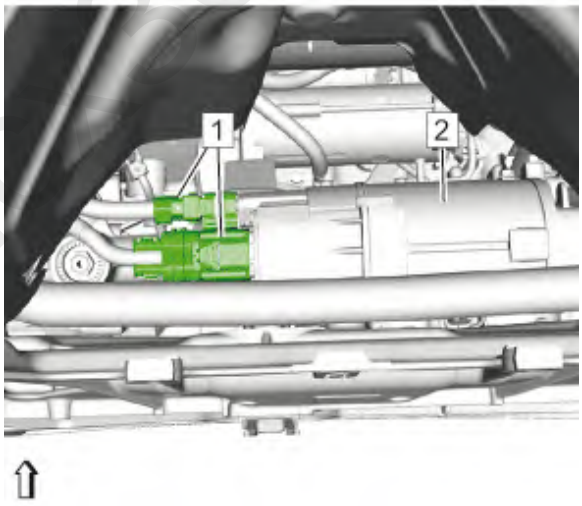


Fig. 536: Power Steering Assist Motor And Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

26. Disconnect Electrical Connectors (1) (Qty: 2) @ Power Steering Assist Motor (2)

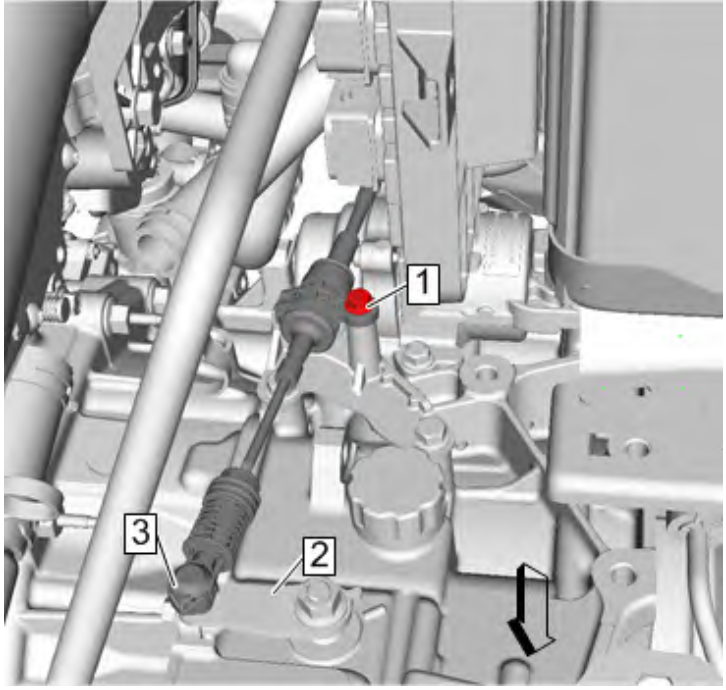


Fig. 537: Automatic Transmission Range Selector Lever Cable Terminal, Shift Lever And Clamp Bolt
Courtesy of GENERAL MOTORS COMPANY

27. Disconnect Automatic Transmission Range Selector Lever Cable Terminal (3) And Clamp Bolt (1) @ Transmission. Refer to **Automatic Transmission Range Selector Lever Cable Replacement**
28. Position aside Radiator Surge Tank. Refer to **Radiator Surge Tank Replacement (LH7 FWD)** **Radiator Surge Tank Replacement (LH7 AWD)**
29. Remove Transmission Fluid Cooler Inlet and Outlet Pipe @ Transmission. Refer to **Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (MNH, MHG)**

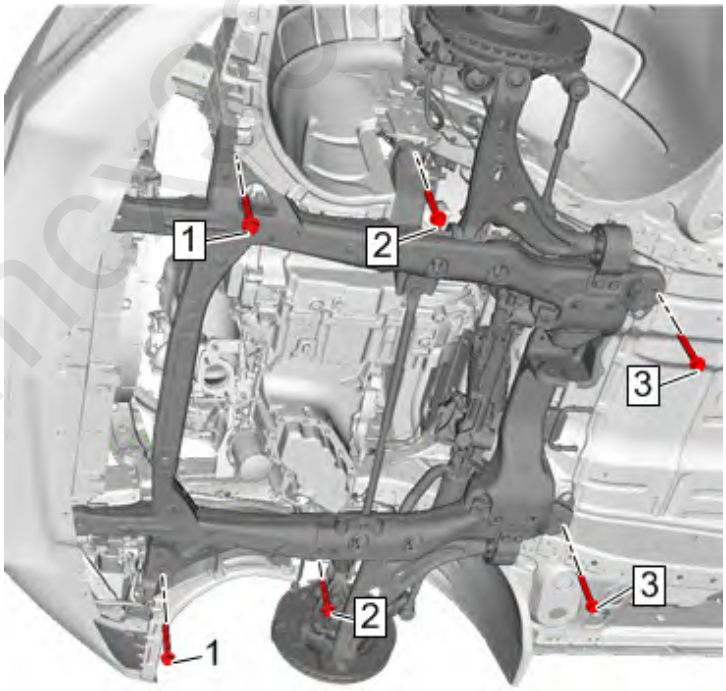


Fig. 538: Front Cradle Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Use a suitable device to hold the cradle while removing the fasteners.**

NOTE: **Remove ONLY the body to frame bolts as the powertrain will be removed while still bolted to the frame.**

30. Remove bolts necessary to remove the cradle (1) (2) and (3). Refer to **Drivetrain and Front Suspension Cradle Replacement (Front Wheel Drive)** **Drivetrain and Front Suspension Cradle Replacement (All Wheel Drive)**
31. Disconnect remaining electrical connections, hoses and reposition harnesses as needed.

32. Lower the vehicle.
33. Position an engine support table under the powertrain assembly.
34. Position blocks of wood below the oil pan and transmission to stabilize the powertrain on the support table.
35. With the table positioned, fully raise the table to contact with the powertrain assembly.

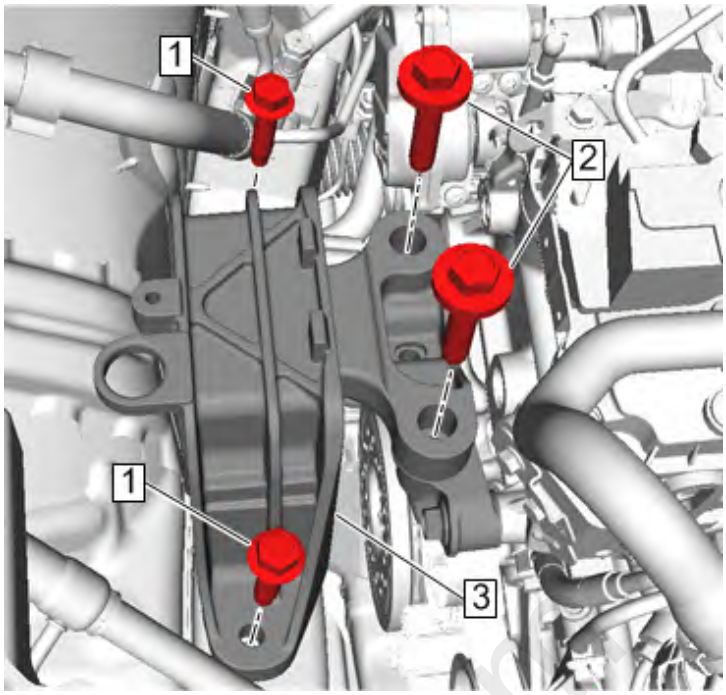


Fig. 539: Engine Mount And Bolts
Courtesy of GENERAL MOTORS COMPANY

36. Remove Engine Mount Bolts (2) (Qty: 2). Refer to **Engine Mount Replacement**

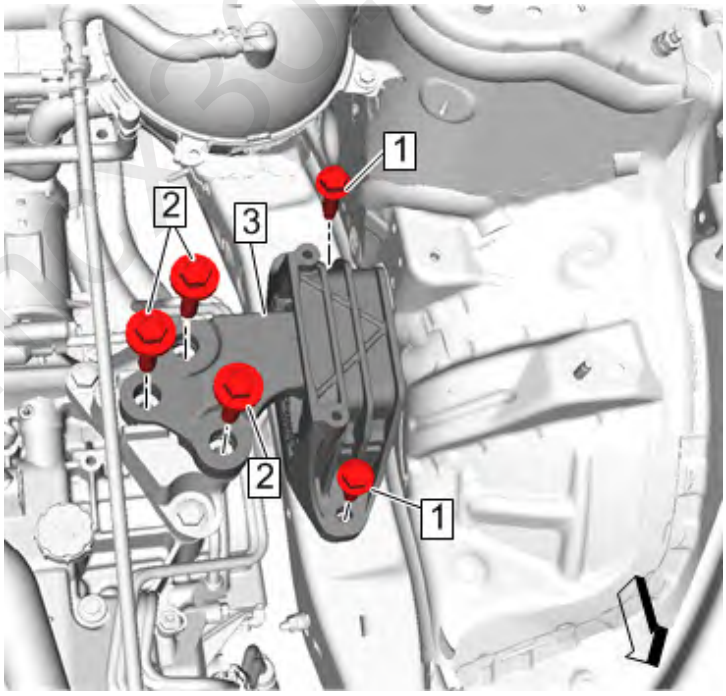


Fig. 540: Transmission Mount And Bolts
Courtesy of GENERAL MOTORS COMPANY

37. Remove Transmission Mount Bolts (2) (Qty: 3). Refer to **Transmission Mount Replacement - Left Side**

NOTE: **A second technician is required.**

NOTE: **Ensure the powertrain assembly is free from wiring, hoses and other engine compartment components.**

38. Carefully lower the engine table and raise the body on the hoist until the engine/transaxle and frame are separated from the vehicle.

39. Separate the engine from the transmission. Refer to **Transmission Replacement (All Wheel Drive with Diesel Engine, Equinox)** **Transmission Replacement (Front Wheel Drive with Diesel Engine)** **Transmission Replacement (All Wheel Drive with Diesel Engine, Terrain)**
40. Install the engine to a suitable engine stand.
41. If replacing the engine, transfer components as necessary.

Installation Procedure

1. Install the transmission to the engine. Refer to **Transmission Replacement (All Wheel Drive with Diesel Engine, Equinox)** **Transmission Replacement (Front Wheel Drive with Diesel Engine)** **Transmission Replacement (All Wheel Drive with Diesel Engine, Terrain)**
2. Position the powertrain and support table under the vehicle.

   NOTE: **A second technician is required.**

3. Slowly and carefully lower the vehicle, ensure the powertrain assembly is free from wiring, hoses and other engine compartment components.

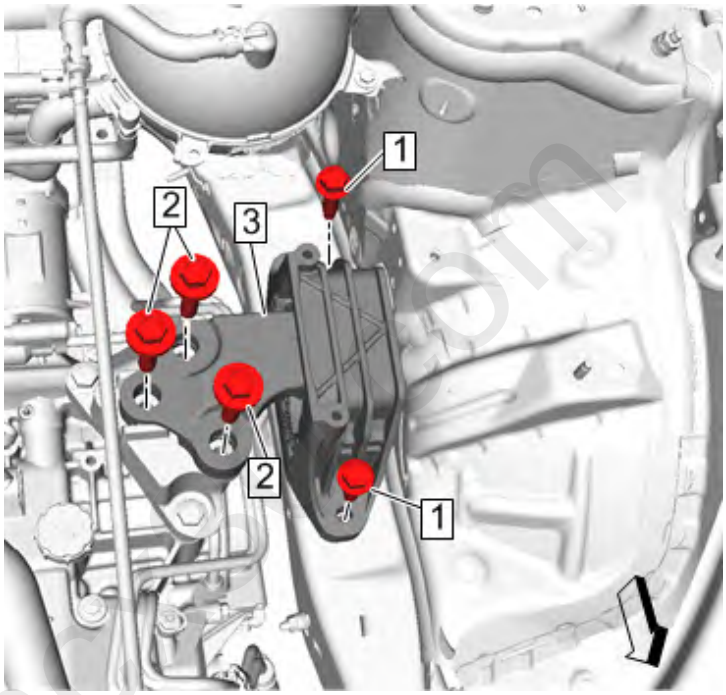


Fig. 541: Transmission Mount And Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install Transmission Mount Bolts (2) (Qty: 3). Refer to **Transmission Mount Replacement - Left Side**

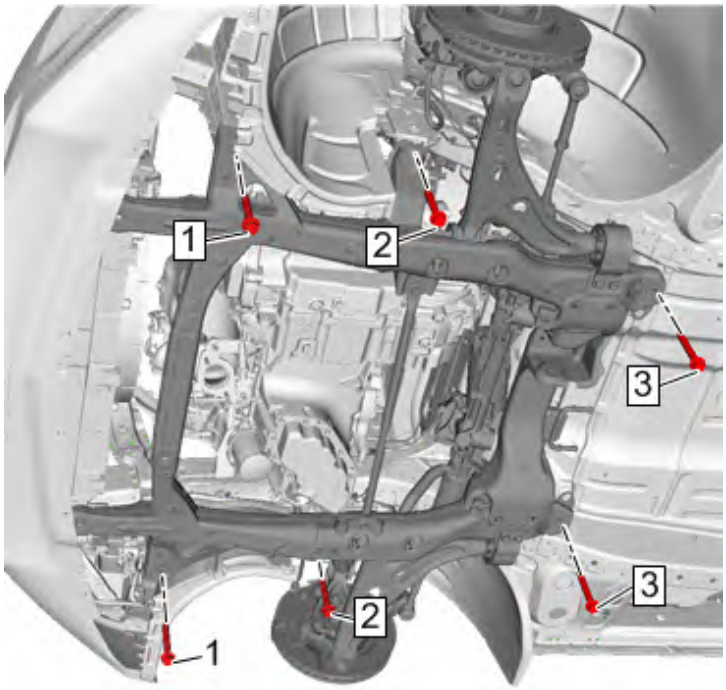


Fig. 542: Front Cradle Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Use a suitable device to hold the cradle while installing the fasteners.**

5. Install fasteners (1) (2) and (3). Refer to Drivetrain and Front Suspension Cradle Replacement (Front Wheel Drive) Drivetrain and Front Suspension Cradle Replacement (All Wheel Drive)
6. Connect electrical connections, hoses and reposition harnesses as needed.
7. Install Transmission Fluid Cooler Inlet and Outlet Pipe @ Transmission. Refer to Transmission Fluid Cooler Inlet and Outlet Pipe Replacement (MNH, MHG)
8. Install Radiator Surge Tank. Refer to Radiator Surge Tank Replacement (LH7 FWD) Radiator Surge Tank Replacement (LH7 AWD)

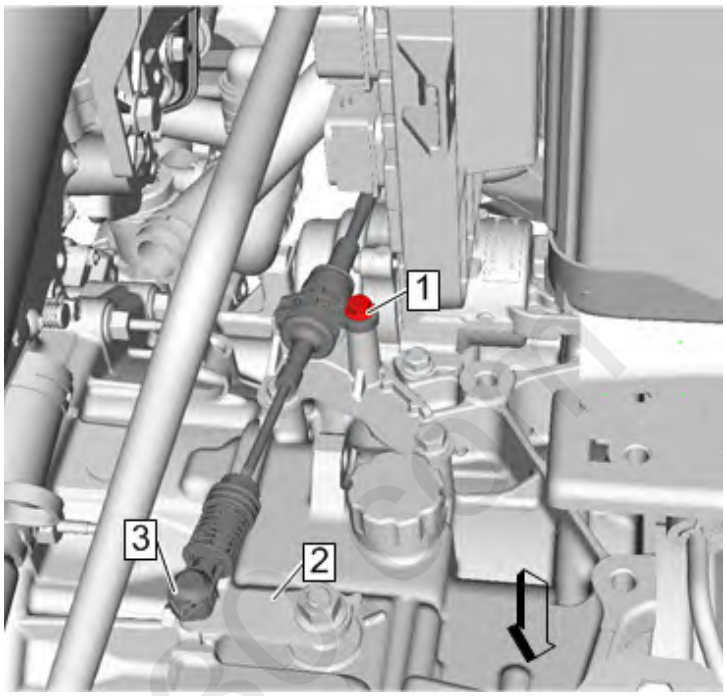


Fig. 543: Automatic Transmission Range Selector Lever Cable Terminal, Shift Lever And Clamp Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Install Automatic Transmission Range Selector Lever Cable Terminal (3) And Clamp Bolt (1) @ Transmission. Refer to Automatic Transmission Range Selector Lever Cable Replacement

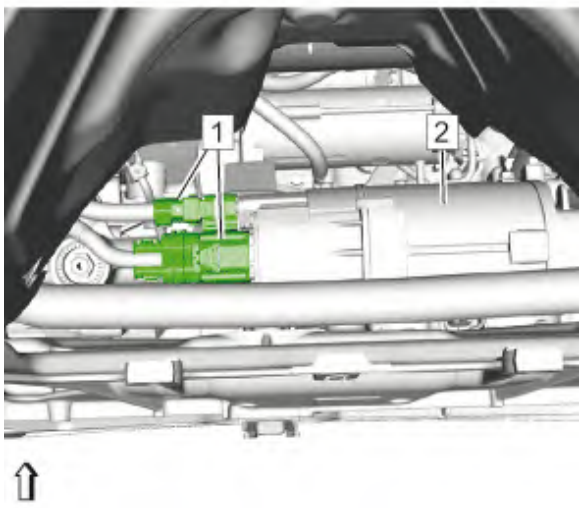


Fig. 544: Power Steering Assist Motor And Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

10. Connect Electrical Connectors (1) (Qty: 2) @ Power Steering Assist Motor (2)
11. Install Front Wheel Drive Half Shaft-Right Side. Refer to Front Wheel Drive Half Shaft Replacement - Right Side (AWD) Front Wheel Drive Half Shaft Replacement - Right Side (M3U, MHG, MNH, MNK with FWD)

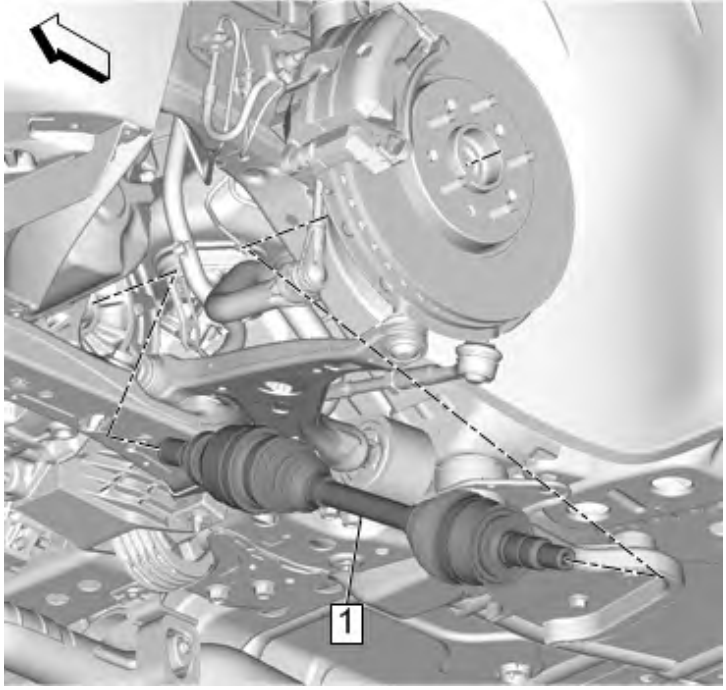


Fig. 545: Wheel Drive Shaft
Courtesy of GENERAL MOTORS COMPANY

12. Install Front Wheel Drive Half Shaft-Left Side (1). Refer to **Front Wheel Drive Half Shaft Replacement - Left Side**
13. Connect Stabilizer Shaft Link (Qty: 2) @ Stabilizer Shaft. Refer to **Stabilizer Shaft Link Replacement (Equinox)** **Stabilizer Shaft Link Replacement (Terrain)**
14. Connect the steering intermediate shaft to the steering gear. Refer to **Intermediate Steering Shaft Replacement (Equinox)** **Intermediate Steering Shaft Replacement (Terrain)**
15. Install Power Transfer Unit Case. Refer to **Power Transfer Unit Case Replacement (MHG Transmission with LH7 Engine)**

CAUTION: **Do not disconnect the nitrogen oxide sensor from the nitrogen oxide sensor control module. A separation of the two components may cause a defect on the nitrogen oxide sensor control module. Always replace the nitrogen oxide sensor along with the nitrogen oxide sensor control module as an assembly.**

16. Install Nitrogen Oxides Sensor - Position 1. Refer to **Nitrogen Oxides Sensor Replacement - Position 1**

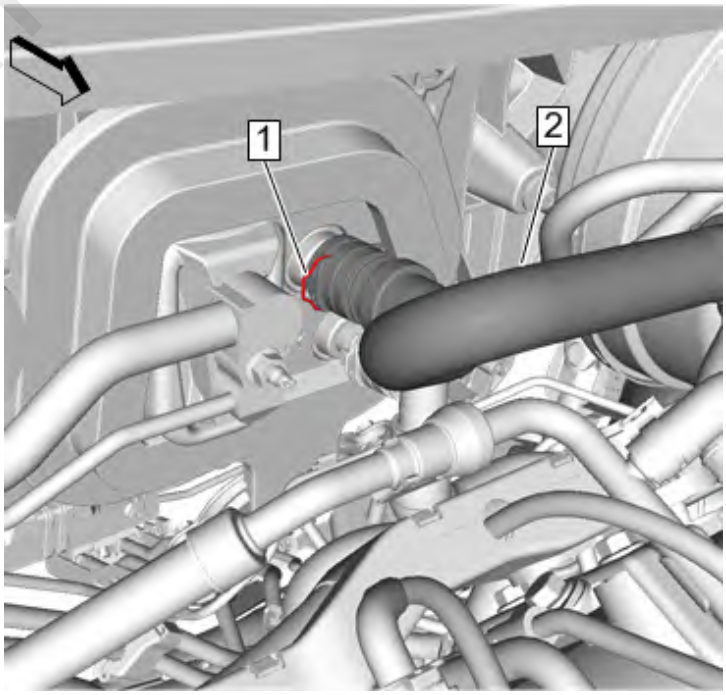


Fig. 546: Heater Inlet Hose And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

17. Connect Heater Inlet Hose (2) @ Heater Core. Refer to **Heater Inlet Hose Replacement (LH7 Terrain)** **Heater Inlet Hose Replacement (LH7 Equinox)**

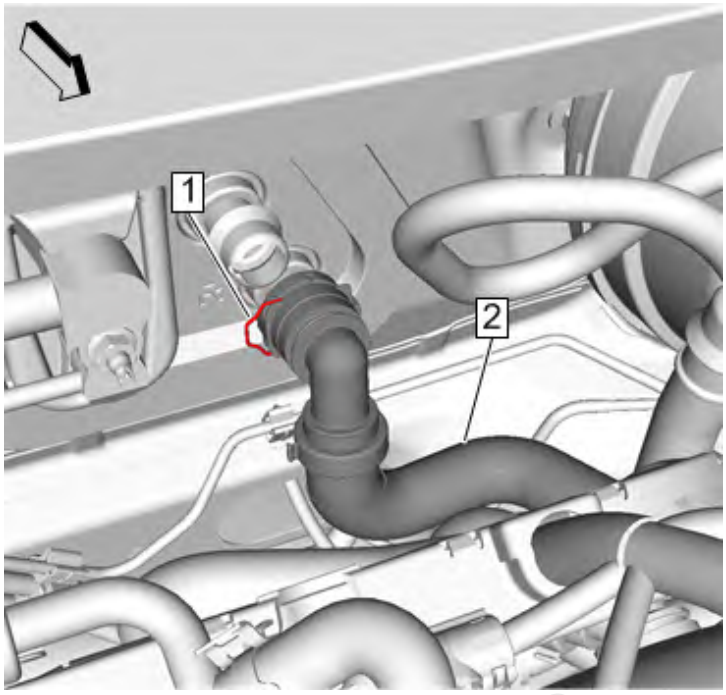


Fig. 547: Heater Outlet Hose And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

18. Connect Heater Outlet Hose (2) @ Heater Core. Refer to **Heater Outlet Hose Replacement (LH7)**

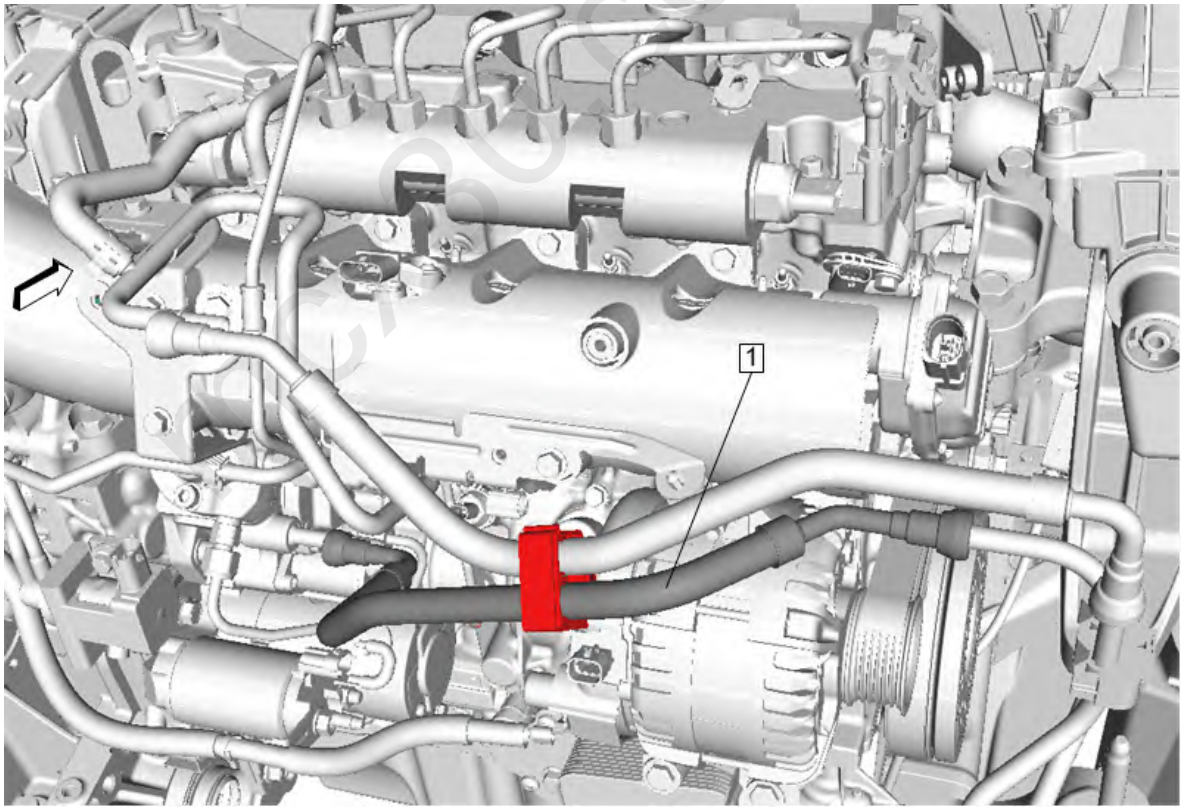


Fig. 548: Fuel Feed Front Pipe
Courtesy of GENERAL MOTORS COMPANY

19. Connect Fuel Feed Front Pipe (1) @ Fuel Feed Pipe. Refer to **Fuel Feed Front Pipe Replacement**

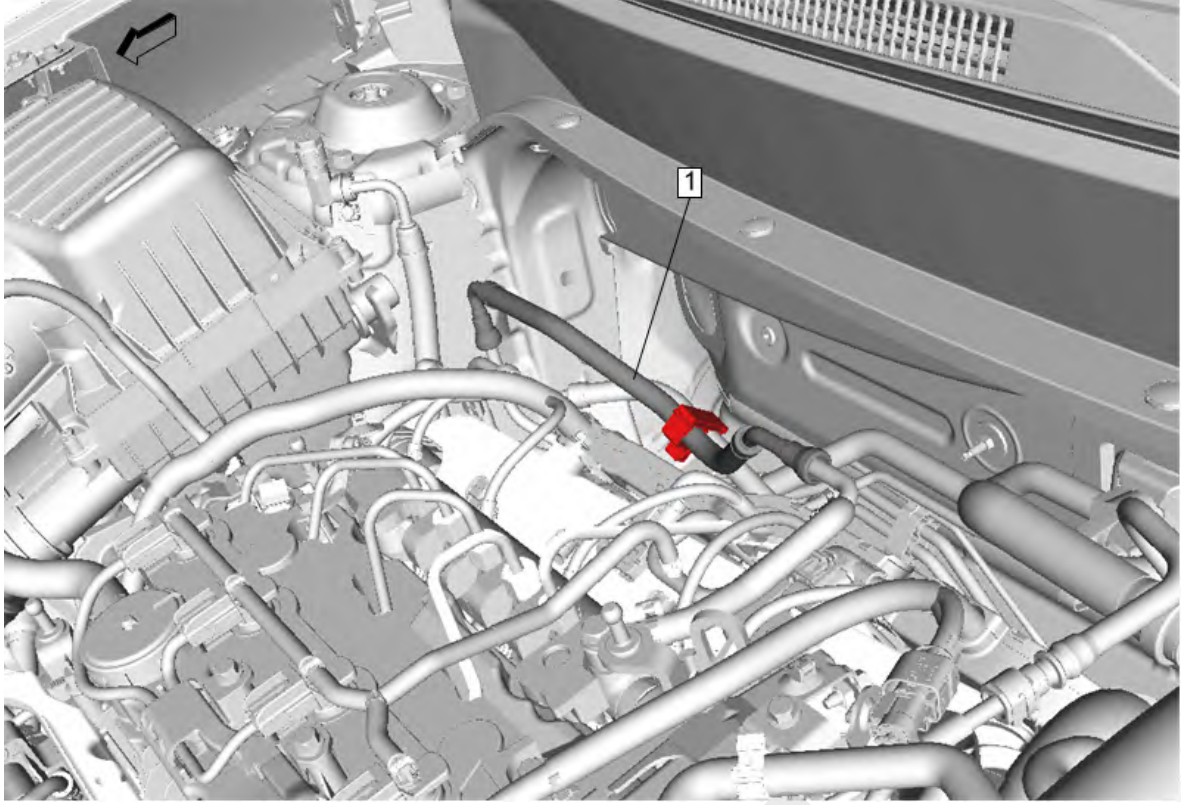


Fig. 549: Fuel Return Front Pipe
Courtesy of GENERAL MOTORS COMPANY

20. Install Fuel Return Front Pipe (1). Refer to **Fuel Return Front Pipe Replacement**

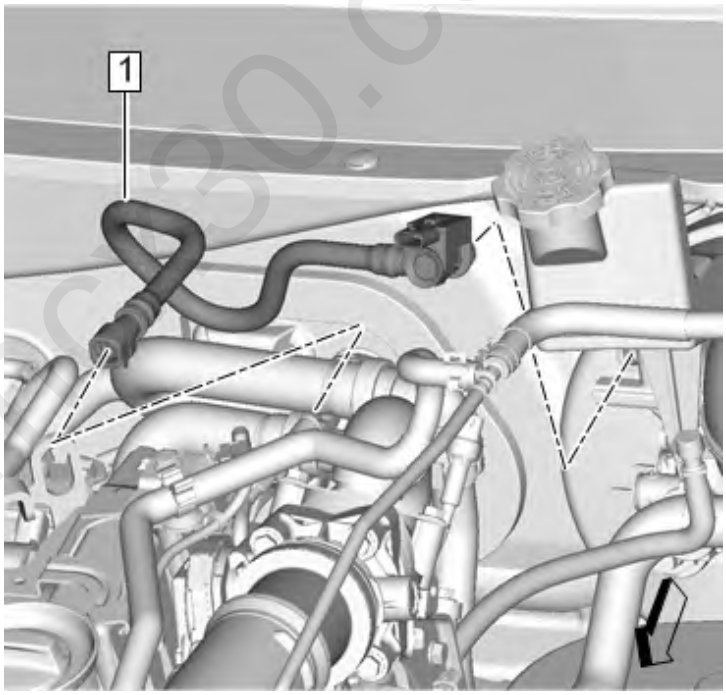


Fig. 550: Power Brake Booster Vacuum Pipe
Courtesy of GENERAL MOTORS COMPANY

21. Install Power Brake Booster Vacuum Pipe (1). Refer to **Power Brake Booster Vacuum Pipe Replacement (LH7)**

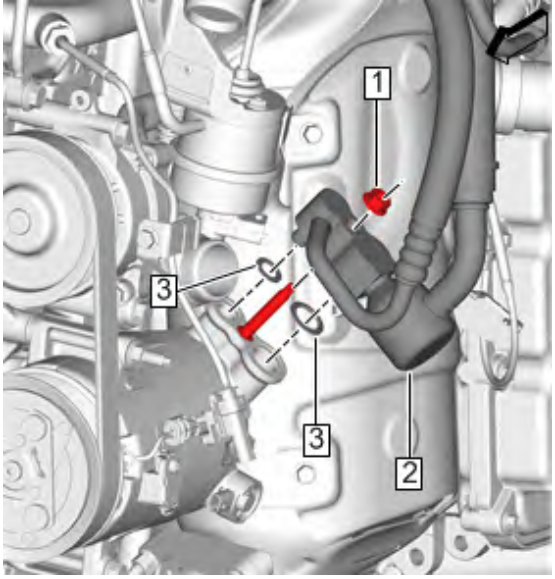


Fig. 551: A/C Evaporator Connector Hose/Tube And Compressor Hose, Seals And Retaining Nut
Courtesy of GENERAL MOTORS COMPANY

22. Connect Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose (2) @ Air Conditioning Compressor. Refer to **Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose Replacement (LH7)**

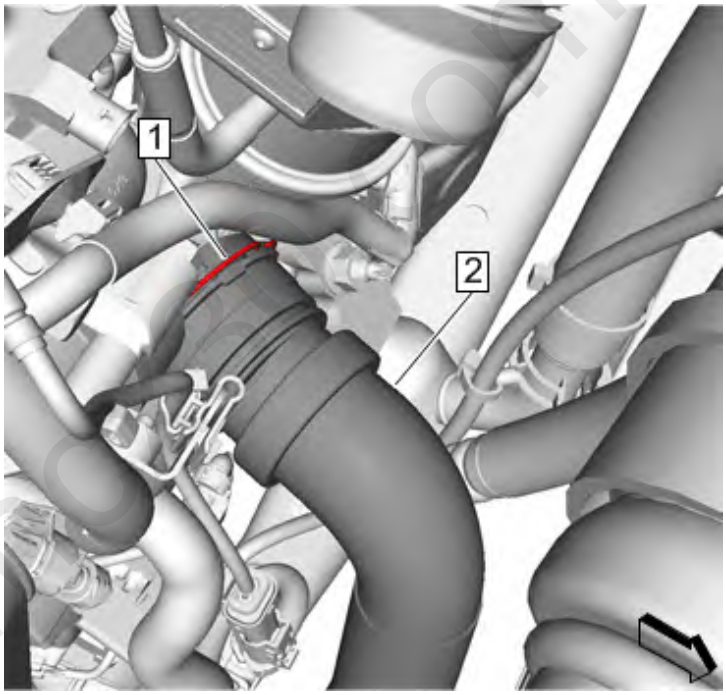


Fig. 552: Radiator Outlet Hose And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

23. Connect Radiator Outlet Hose (2) @ Engine. Refer to **Radiator Outlet Hose Replacement (LH7)**

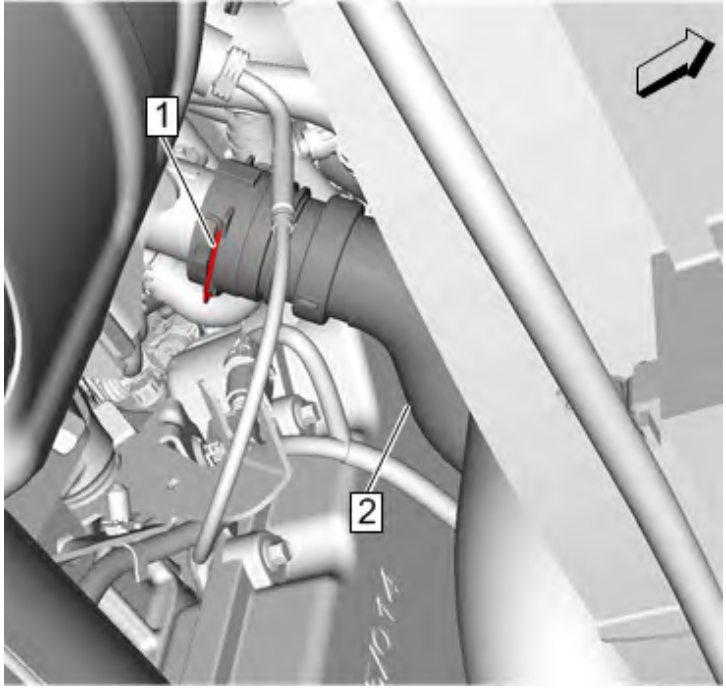


Fig. 553: Radiator Inlet Hose And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

24. Connect Radiator Inlet Hose (2) @ Engine. Refer to **Radiator Inlet Hose Replacement (LH7)**

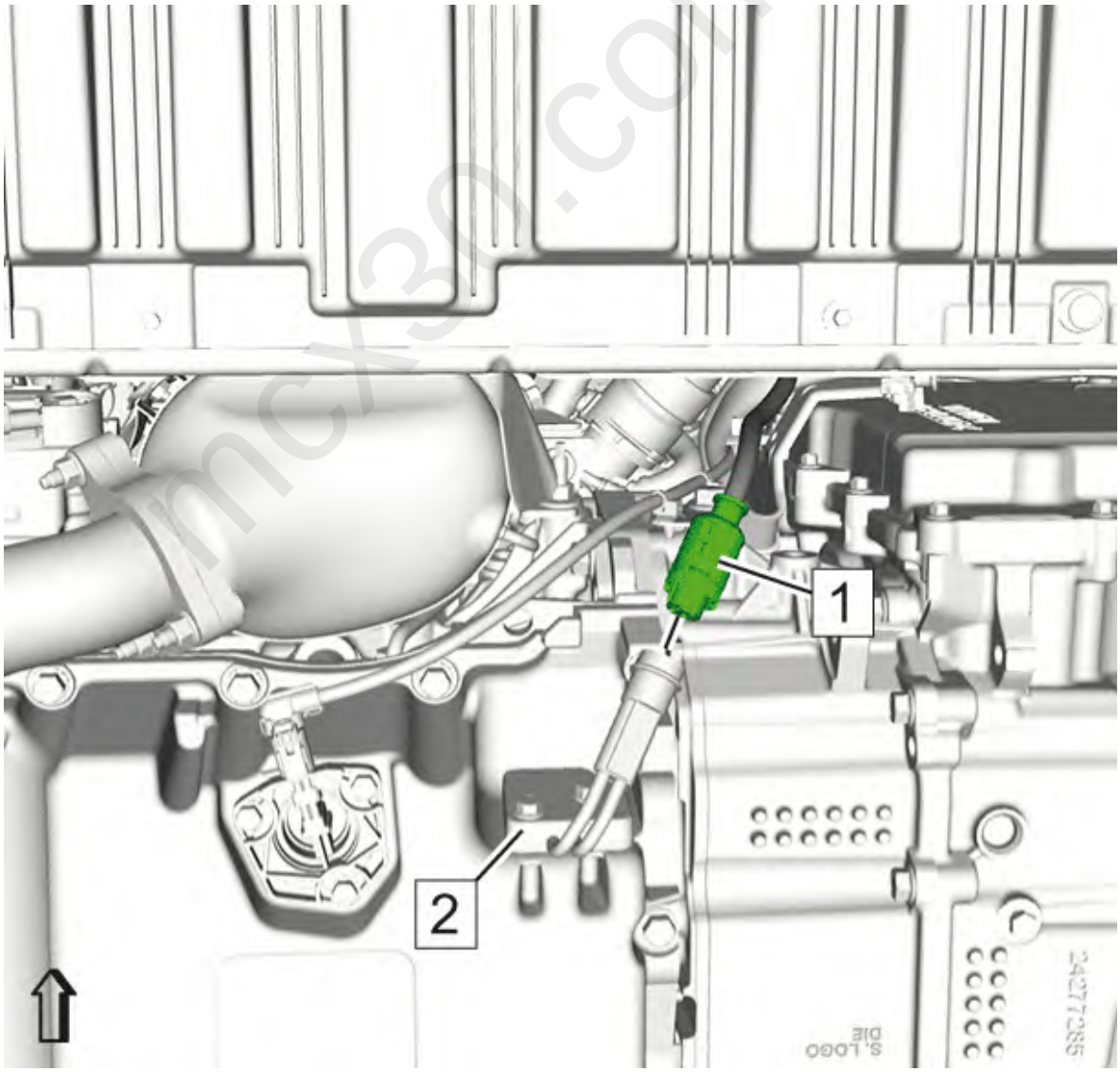


Fig. 554: Engine Oil Heater And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

25. Connect the electrical connector (1) at the engine oil heater (2).

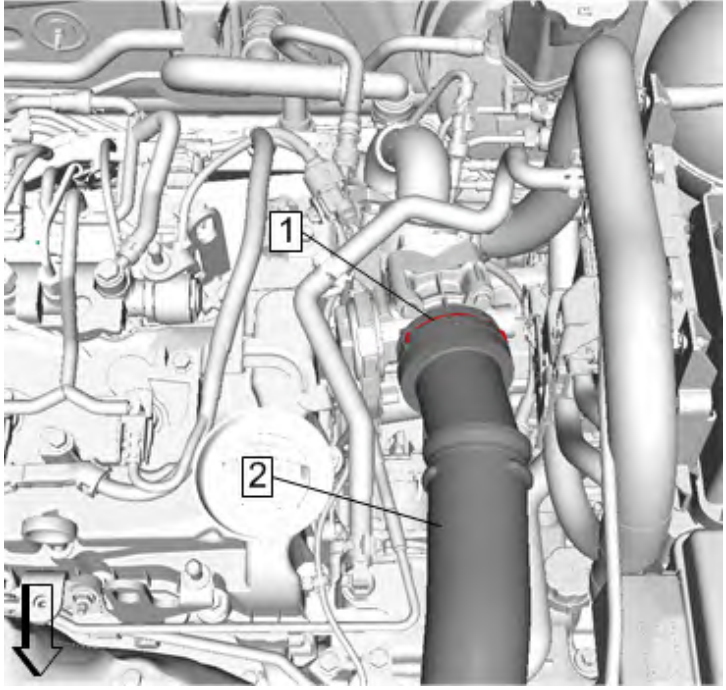


Fig. 555: Charge Air Cooler Outlet Air Tube And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

26. Install Charge Air Cooler Outlet Air Tube (2). Refer to **Charge Air Cooler Outlet Air Tube Replacement**

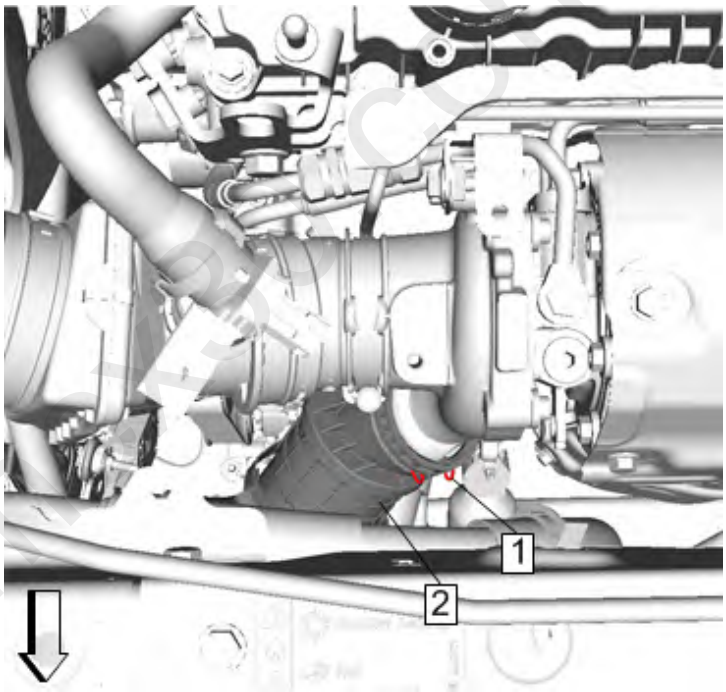


Fig. 556: Charge Air Cooler Inlet Air Tube And Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

27. Install Charge Air Cooler Inlet Air Tube (2). Refer to **Charge Air Cooler Inlet Air Tube Replacement**
28. Install Exhaust Front Pipe. Refer to **Exhaust Front Pipe Replacement (LH7)**
29. Install Battery Tray. Refer to **Battery Tray Replacement**
30. Install Engine Wiring Harness Junction Block. Refer to **Engine Wiring Harness Junction Block Replacement**

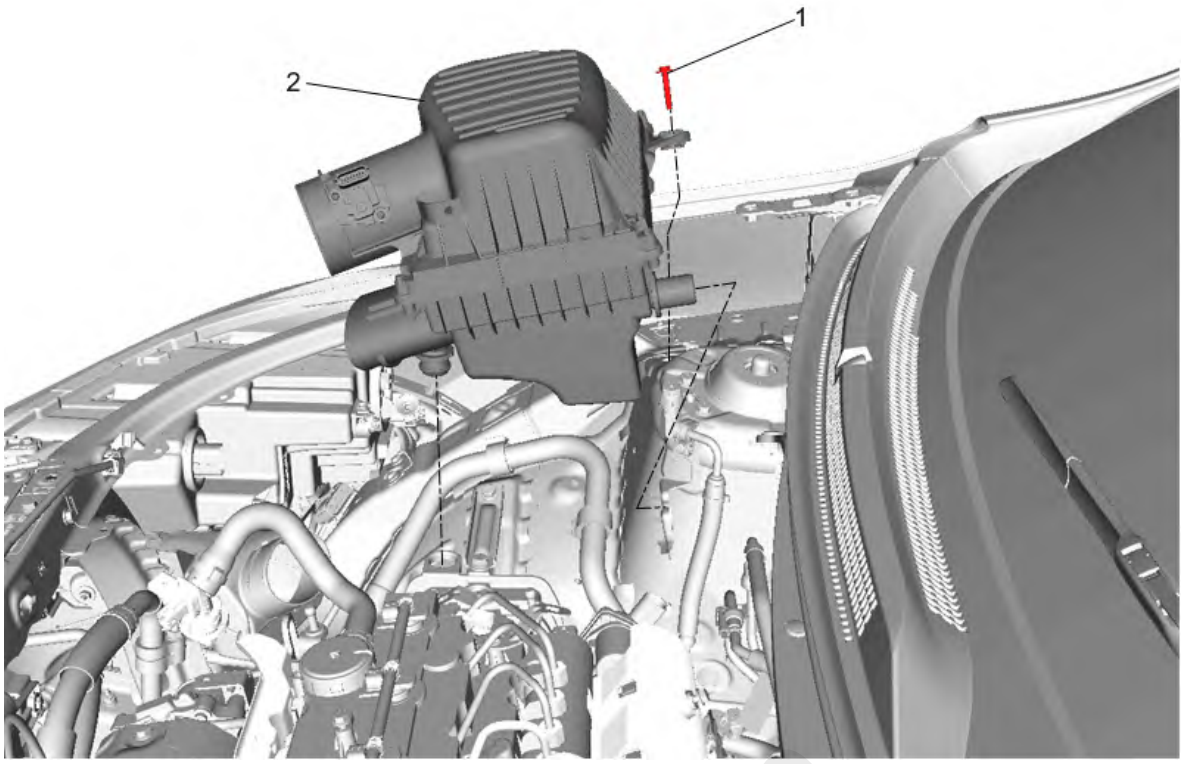


Fig. 557: Air Cleaner Assembly And Fastener
Courtesy of GENERAL MOTORS COMPANY

31. Install the air cleaner assembly (2). Refer to **Air Cleaner Assembly Replacement**
32. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**
33. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
34. Fill the cooling system. Refer to **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)**
35. Recharge the refrigerant. Refer to **Refrigerant Recovery and Recharging (R-134a)** **Refrigerant Recovery and Recharging (R-1234yf)**
36. Change the engine oil and filter. Refer to **Engine Oil and Oil Filter Replacement**
37. When the replacement is completed, use a scan tool to perform the appropriate reset functions. Refer to **Control Module References**

CAMSHAFT TIMING CHAIN ADJUSTMENT

Special Tools

- **EN-51140** Crankshaft Fixing Tool
- **EN-51143** Camshaft Sprocket Fixing Tool

Equivalent regional tools: **Special Tools**

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Throttle Body Assembly. Refer to **Throttle Body Assembly Replacement**
3. Remove Camshaft Housing. Refer to **Camshaft Housing Replacement**
4. Remove Crankshaft Pulley. Refer to **Crankshaft Pulley Replacement**
5. Lower the vehicle. Refer to **Lifting and Jacking the Vehicle**

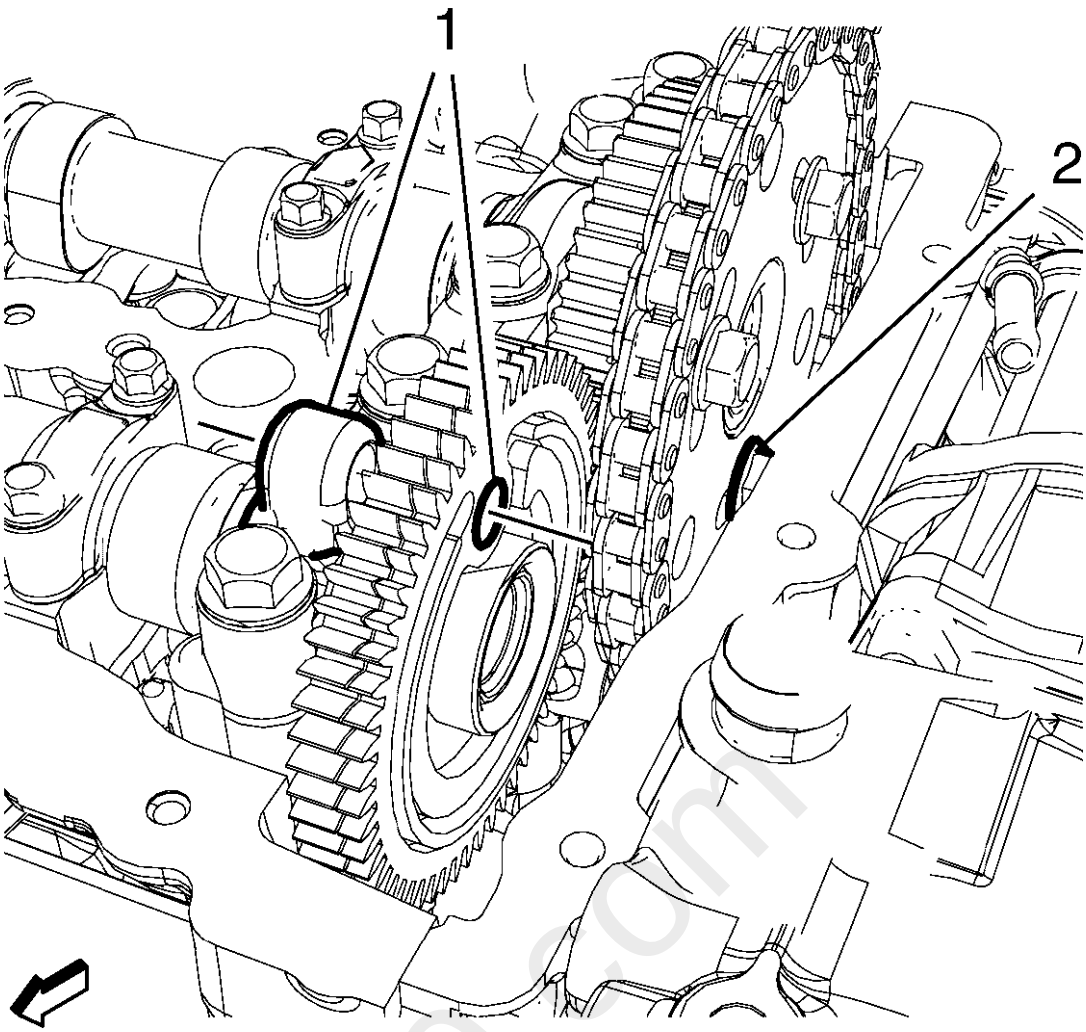


Fig. 558: Aligning Bores
Courtesy of GENERAL MOTORS COMPANY

NOTE: **To locate the correct camshaft sprocket bolt (2) check the TDC position.**

6. Check if the bores (1) are aligned.
7. Raise the vehicle.

mcx30.com

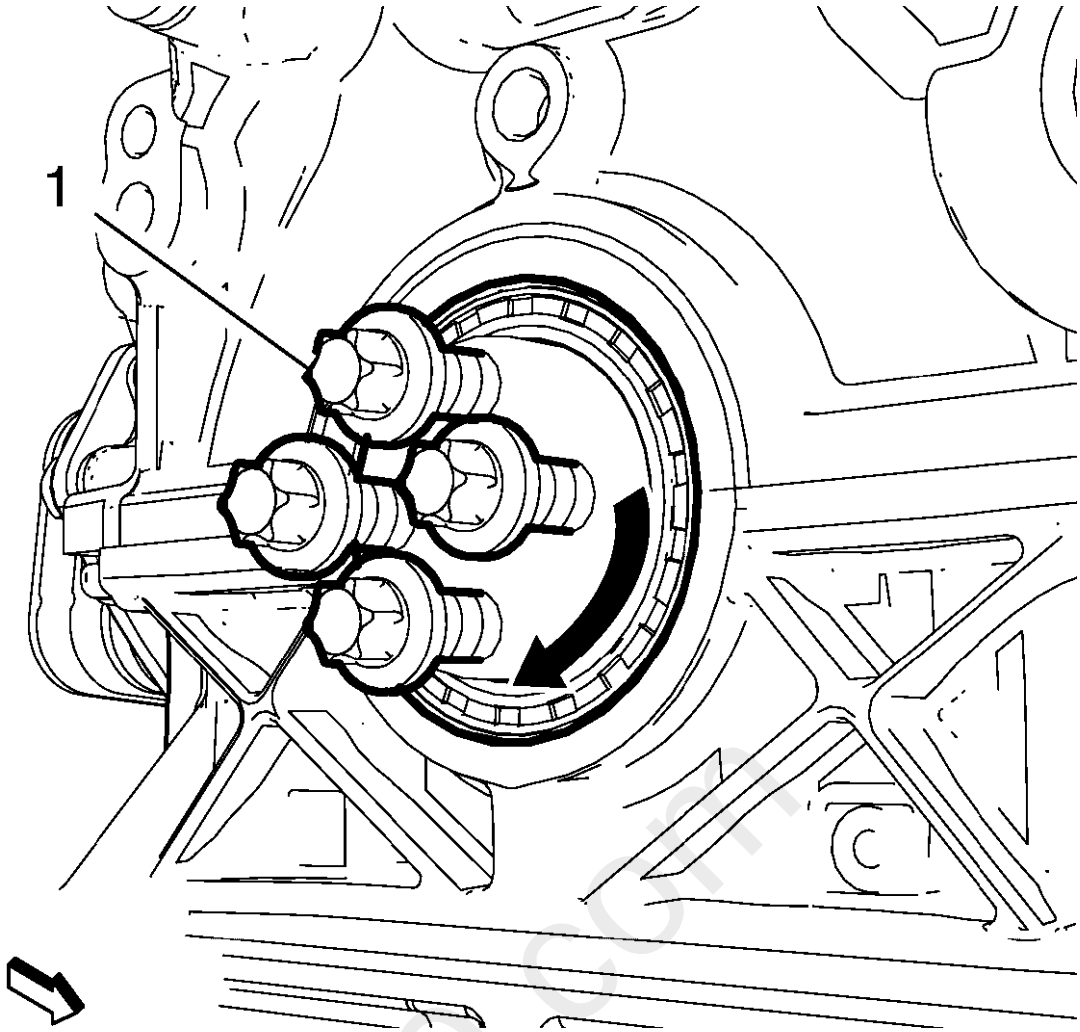


Fig. 559: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the 4 crankshaft pulley bolts (1).
9. Rotate the crankshaft 360 degrees in direction of arrow. Use a pry bar.
10. Lower the vehicle.

mcx30.com

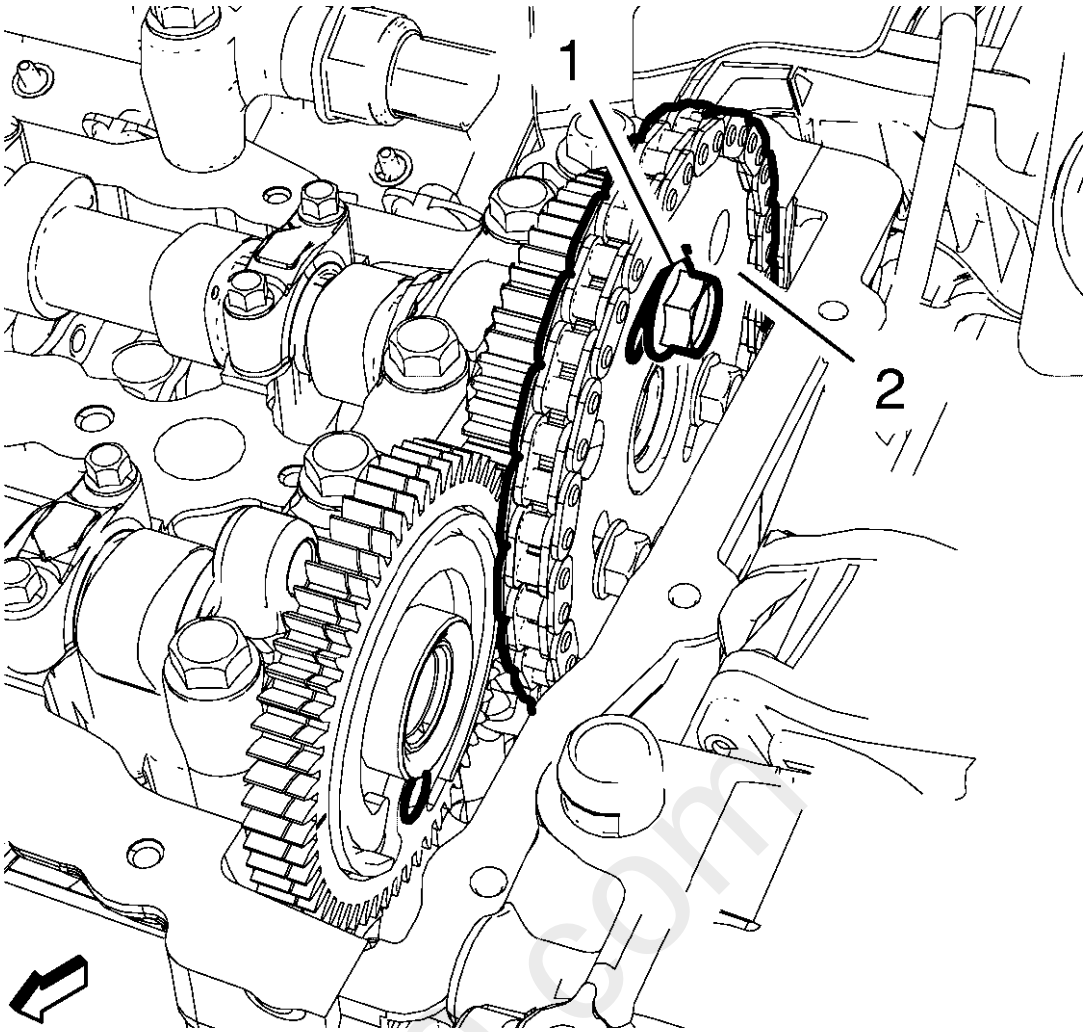


Fig. 560: Intake Camshaft Sprocket And Bolt
Courtesy of GENERAL MOTORS COMPANY

11. Loosen the camshaft sprocket bolt (1) from the intake camshaft sprocket (2). Counterhold with a wrench at the camshaft hexagon.
12. Raise the vehicle.

mcx30.com

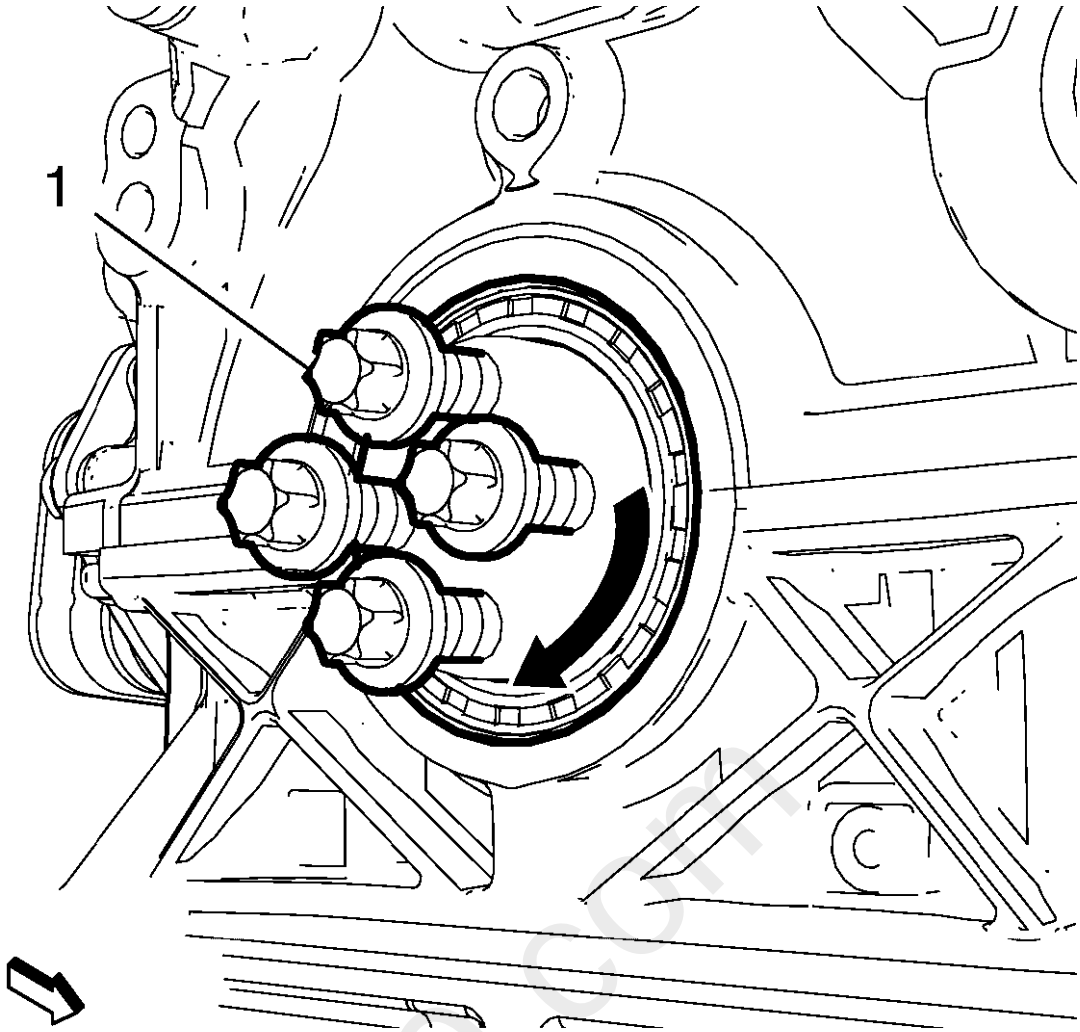


Fig. 561: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Rotate the crankshaft 360 degrees in direction of arrow. Use a pry bar at the 4 crankshaft pulley bolts (1).
14. Remove the 4 crankshaft pulley bolts (1).

mcx30.com

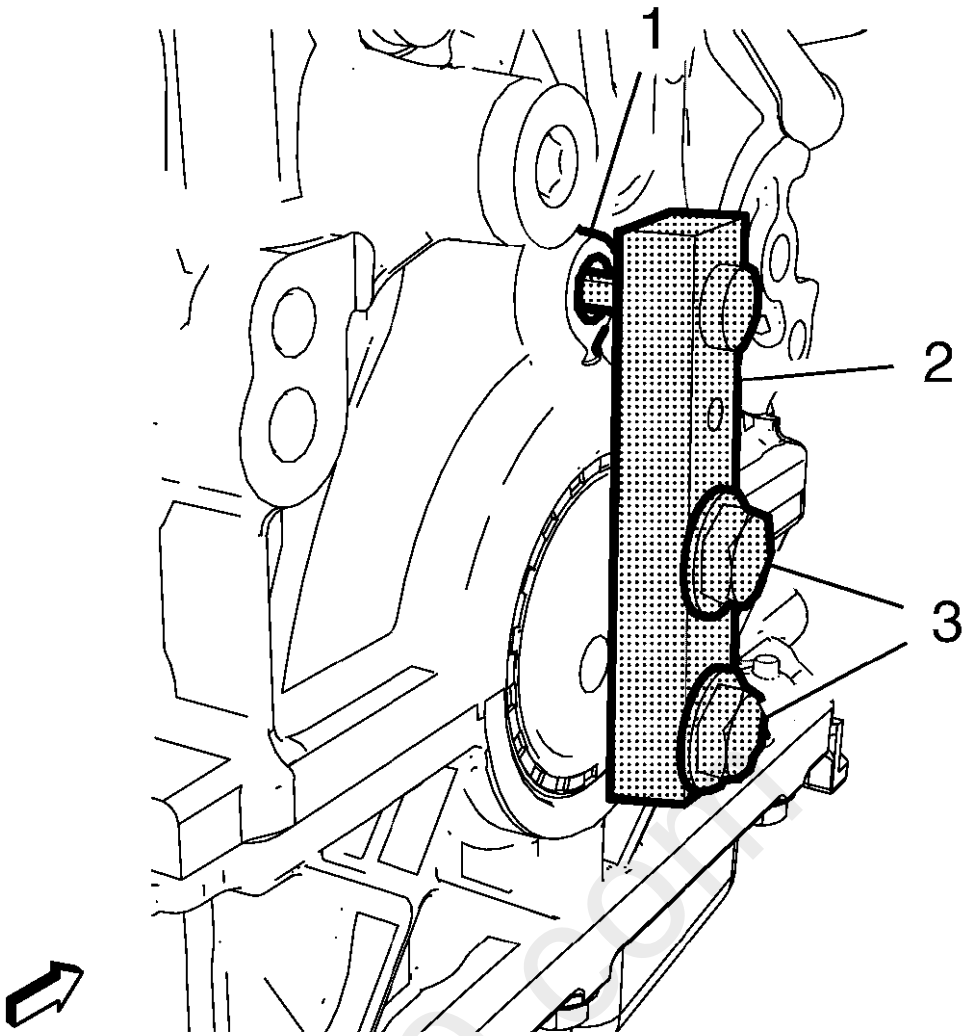


Fig. 562: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

15. Install **EN-51140** fixing tool (2).
16. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).
17. Lower the vehicle.

mcx30.com

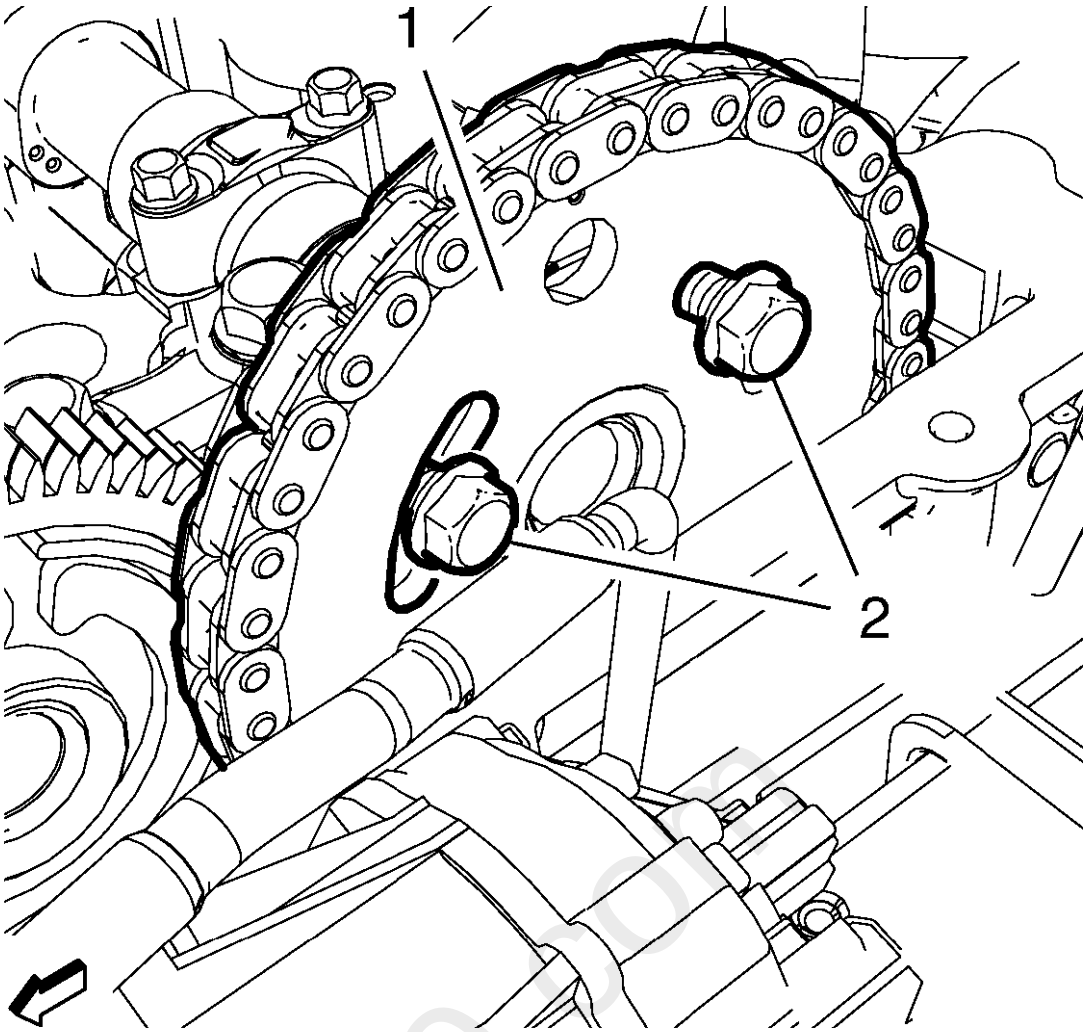


Fig. 563: Intake Camshaft Sprocket And Bolts
Courtesy of GENERAL MOTORS COMPANY

18. Loosen the 2 camshaft sprocket bolts (2) from the camshaft sprocket (1). Counterhold with a wrench at the camshaft hexagon.

mcx30.com

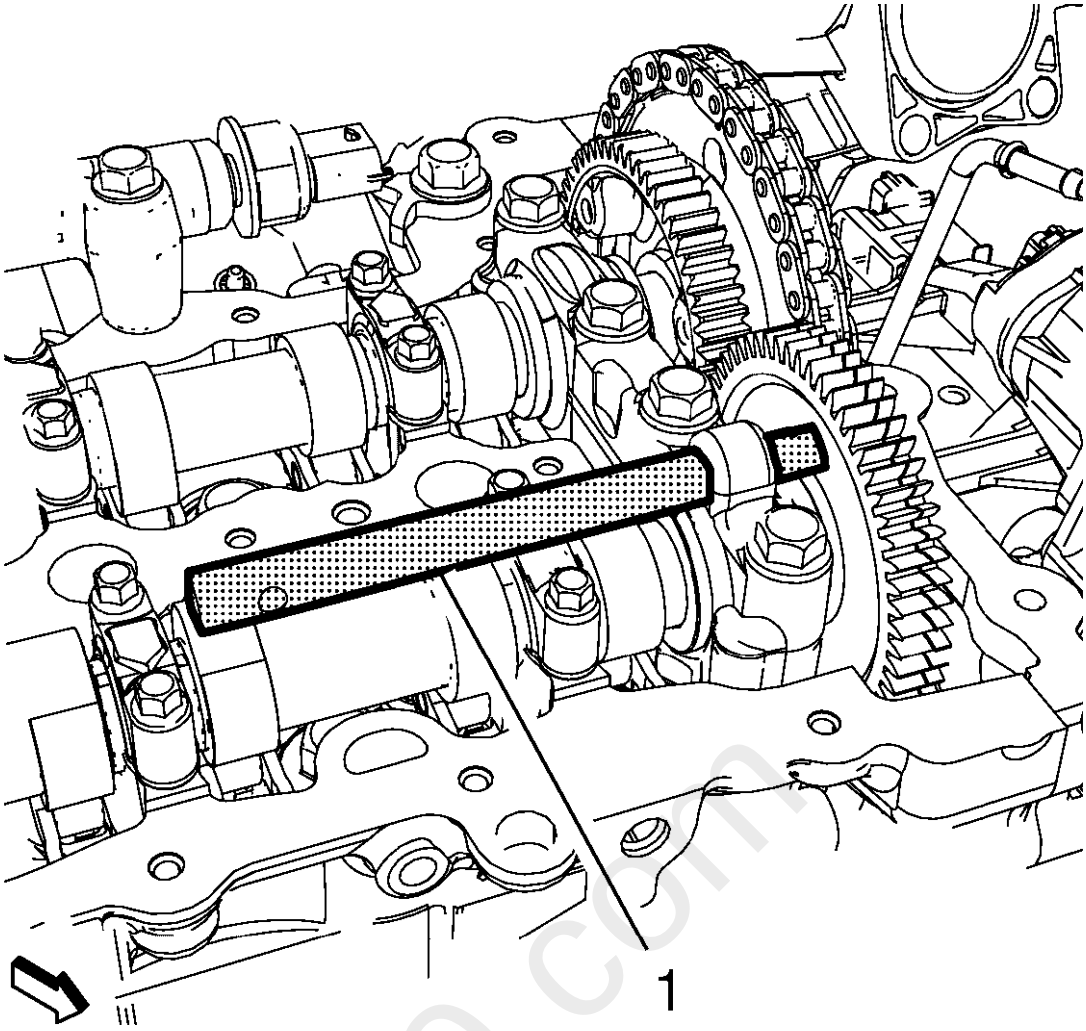


Fig. 564: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

19. Turn the exhaust camshaft at the hexagon until the **EN-51143** fixing tool (1) can be installed.

Installation Procedure

NOTE: Before installation, check the components of the timing chain system for damage and wear.

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

mcx30.com

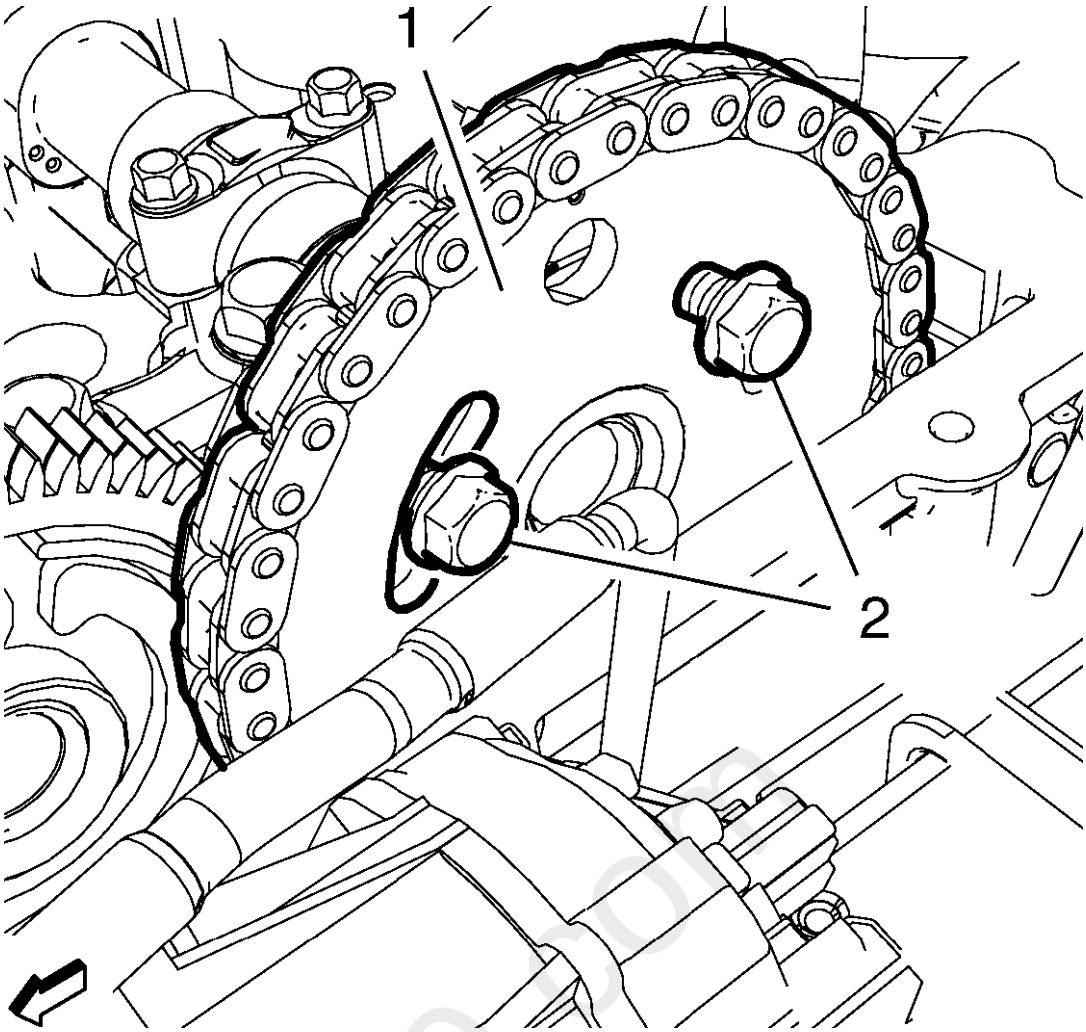


Fig. 565: Intake Camshaft Sprocket And Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. Counterhold with a wrench at the camshaft hexagon, and tighten the 2 camshaft sprocket bolts (2) to 25 N.m (18 lb ft).

mcx30.com

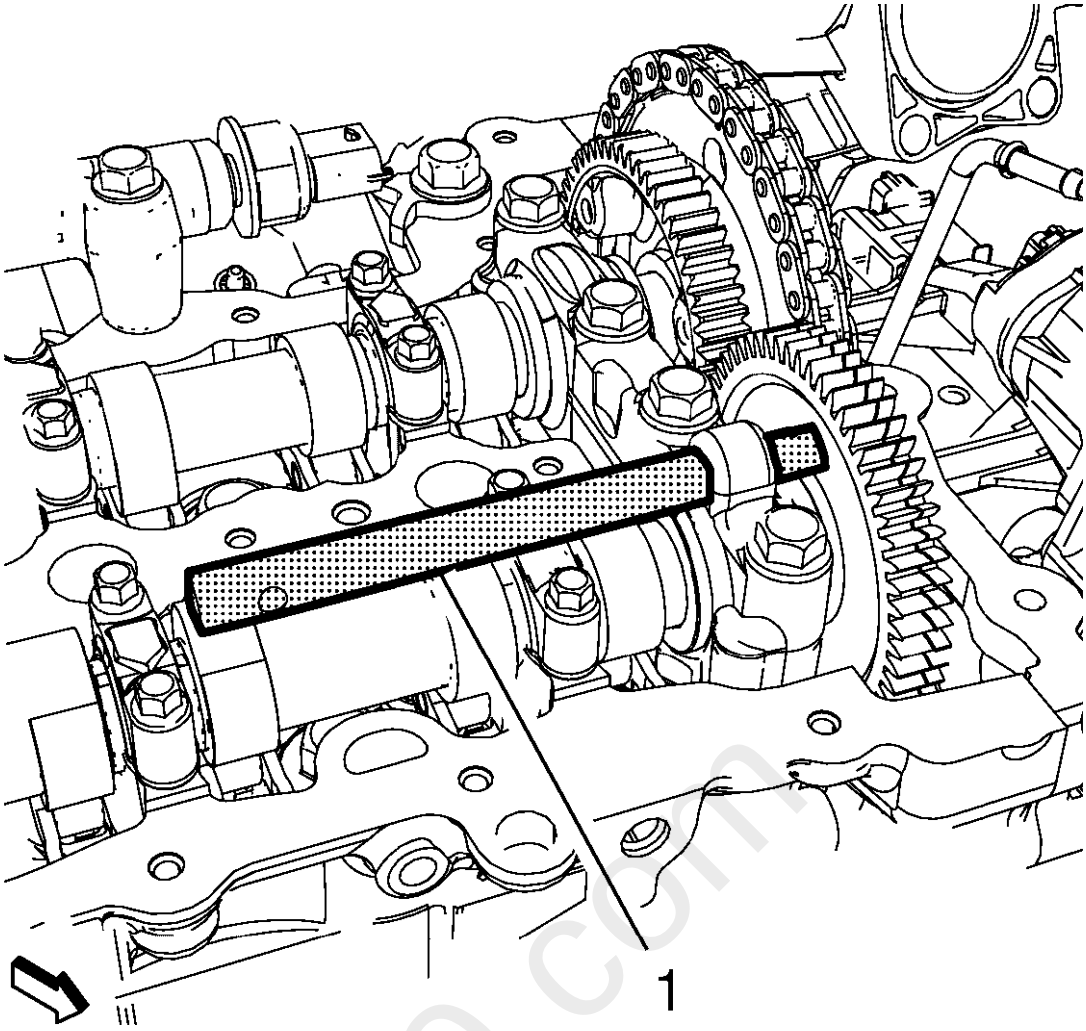


Fig. 566: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

3. Remove the **EN-51143** fixing tool (1).
4. Raise the vehicle.

mcx30.com

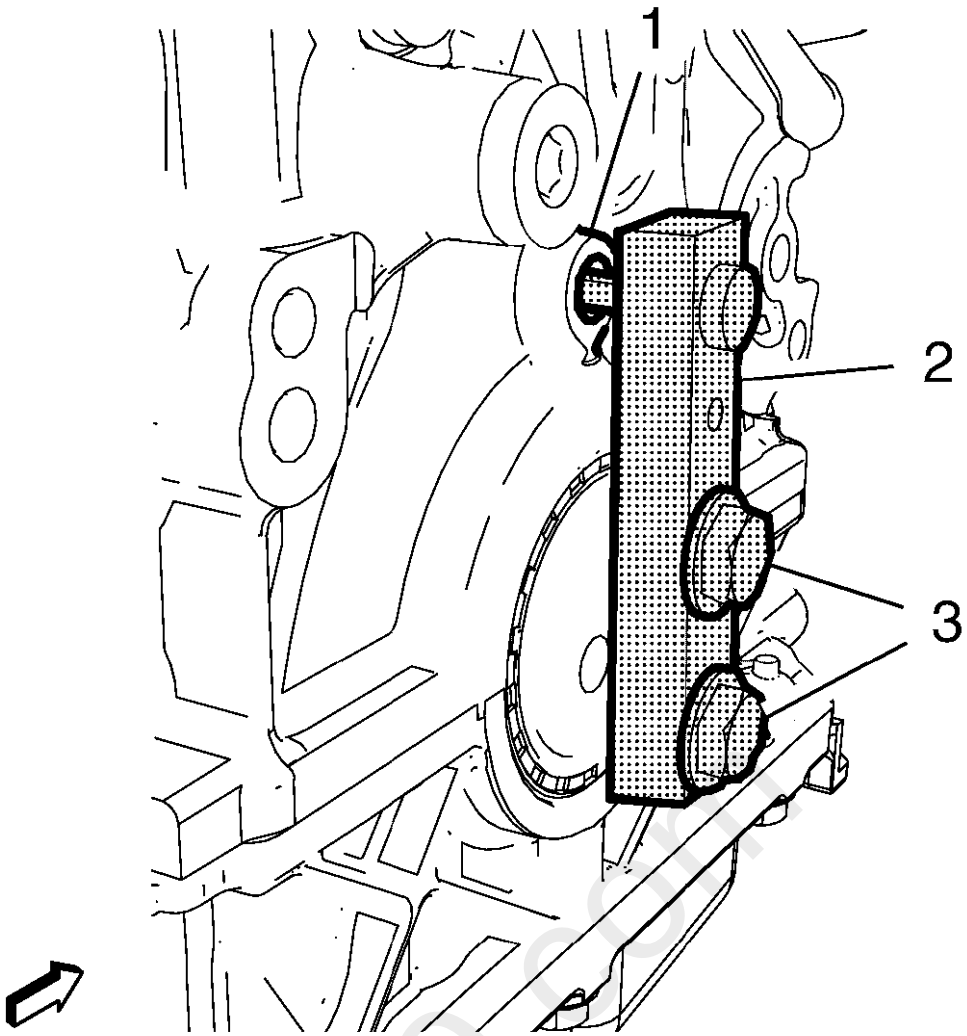


Fig. 567: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

5. Remove the 2 bolts (3).
6. Remove the **EN-51140** fixing tool (2).

mcx30.com

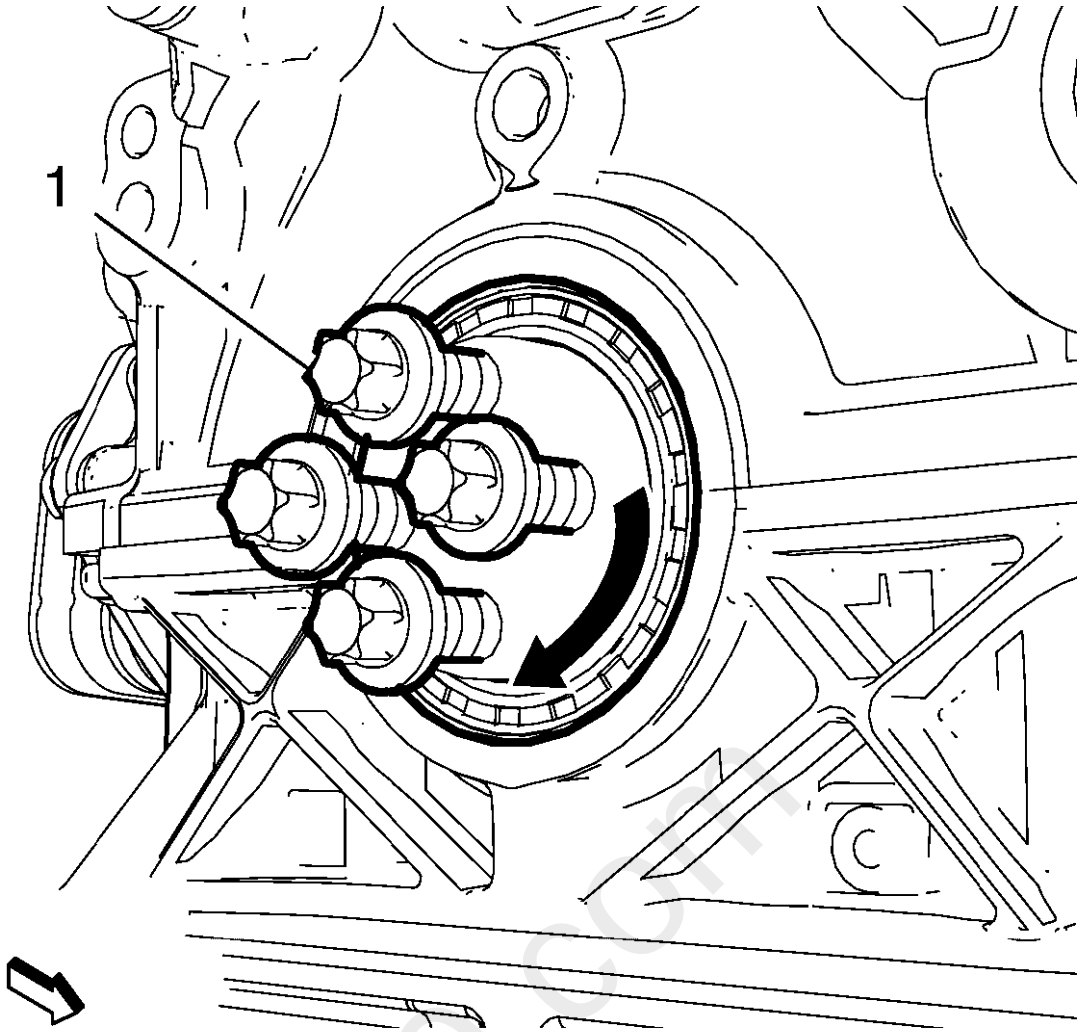


Fig. 568: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install the 4 crankshaft pulley bolts (1) and rotate the crankshaft 360 degrees in direction of arrow. Use a pry bar at the 4 crankshaft pulley bolts (1).
8. Lower the vehicle.

mcx30.com

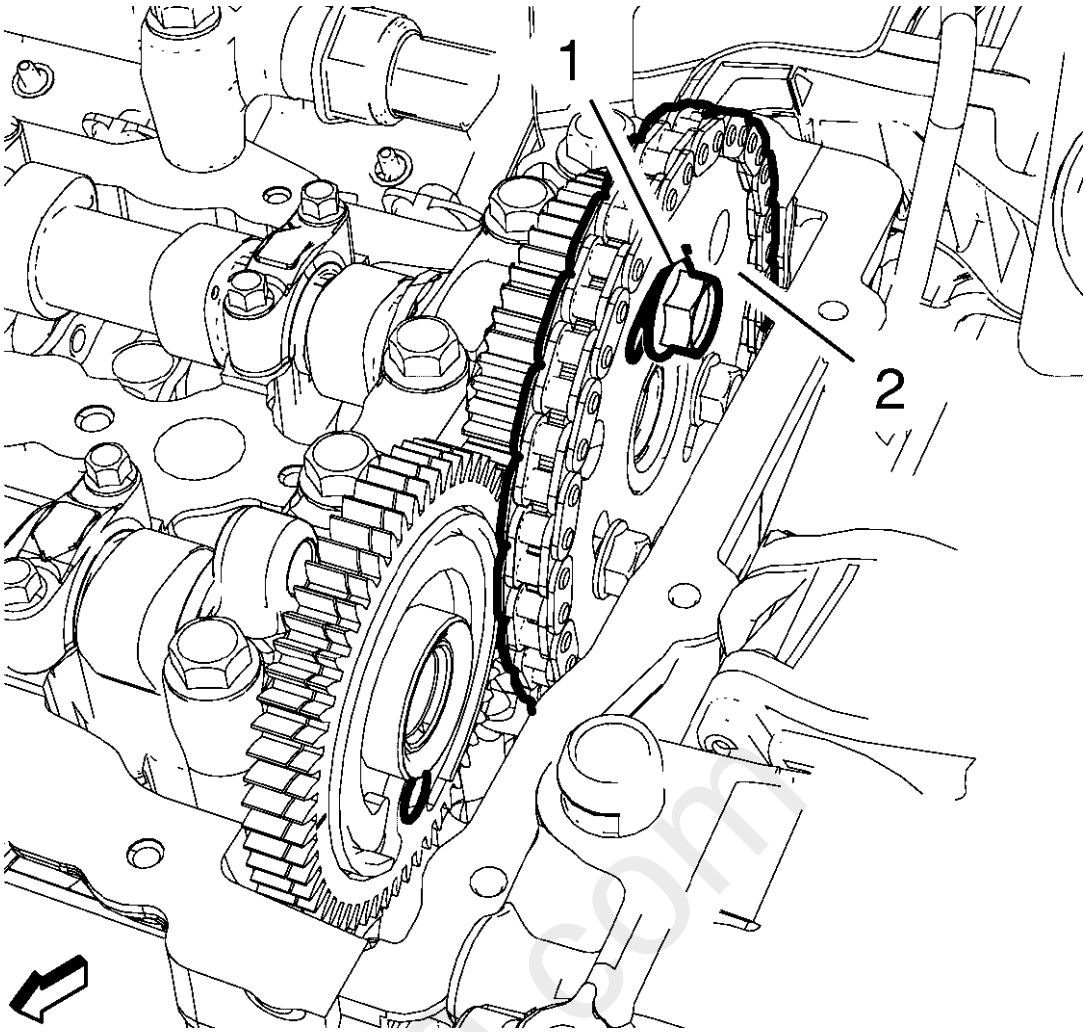


Fig. 569: Intake Camshaft Sprocket And Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Counterhold with a wrench at the camshaft hexagon, and tighten the camshaft sprocket bolt (1) to 25 N.m (18 lb ft).

mcx30.com

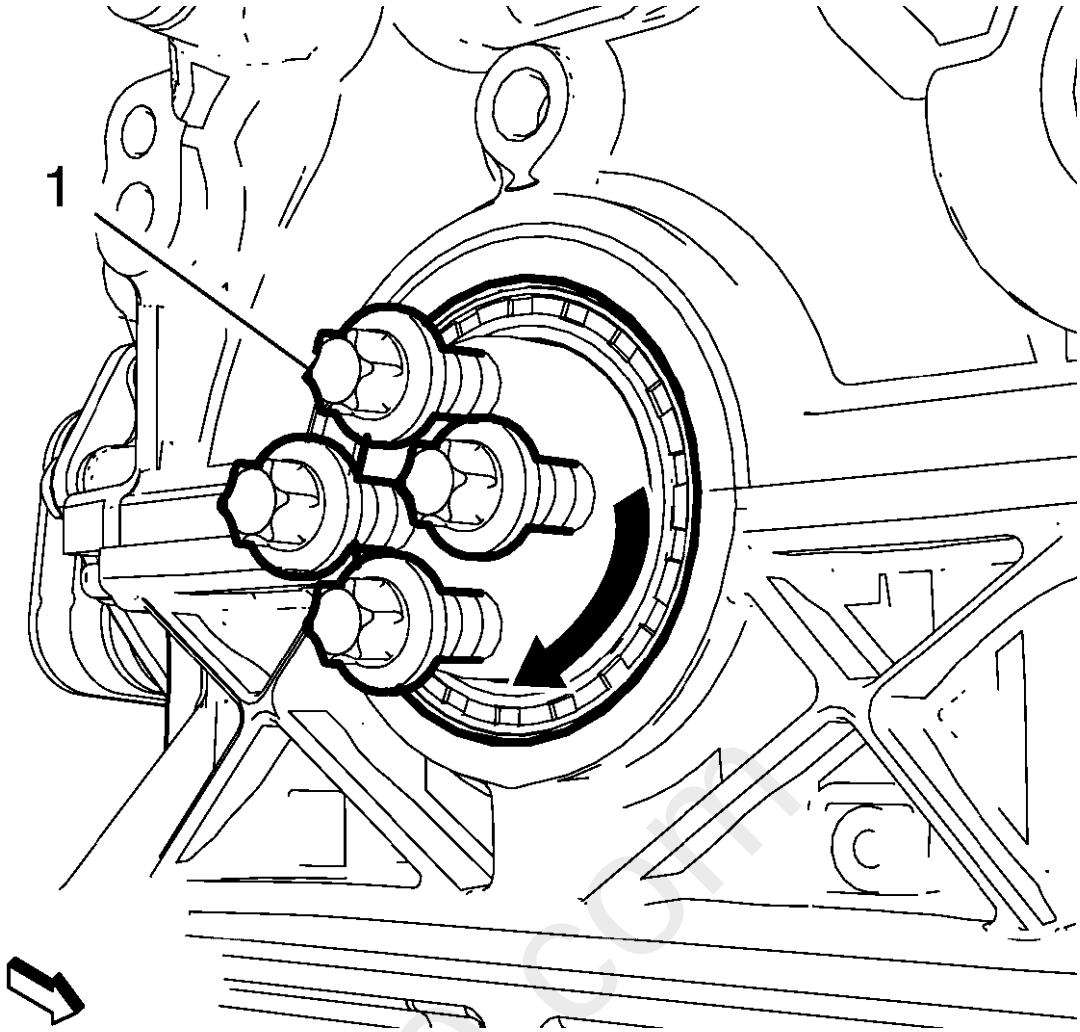


Fig. 570: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Rotate the crankshaft 360 degrees in direction of arrow. Use a pry bar at the 4 crankshaft pulley bolts (1).
11. Remove the 4 crankshaft pulley bolts (1).

mcx30.com

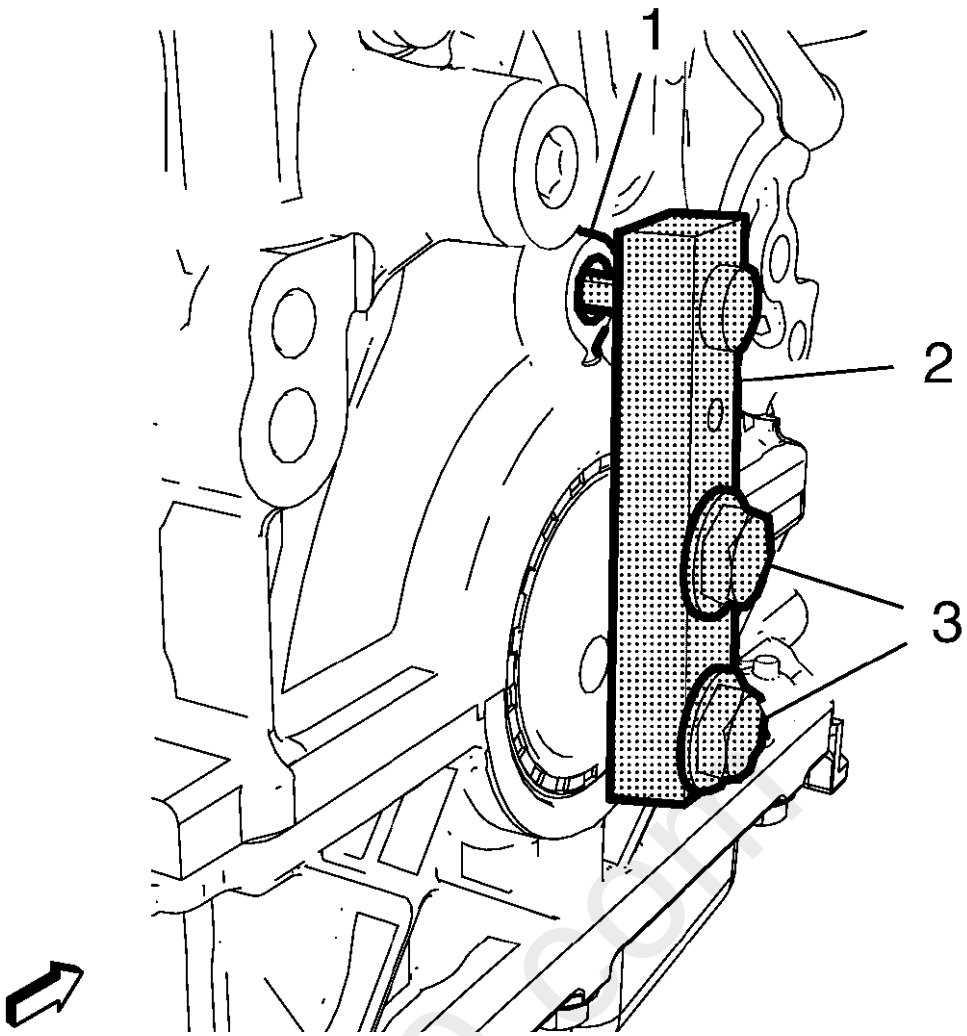


Fig. 571: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

12. Install **EN-51140** fixing tool (2).
13. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).
14. Lower the vehicle.

mcx30.com

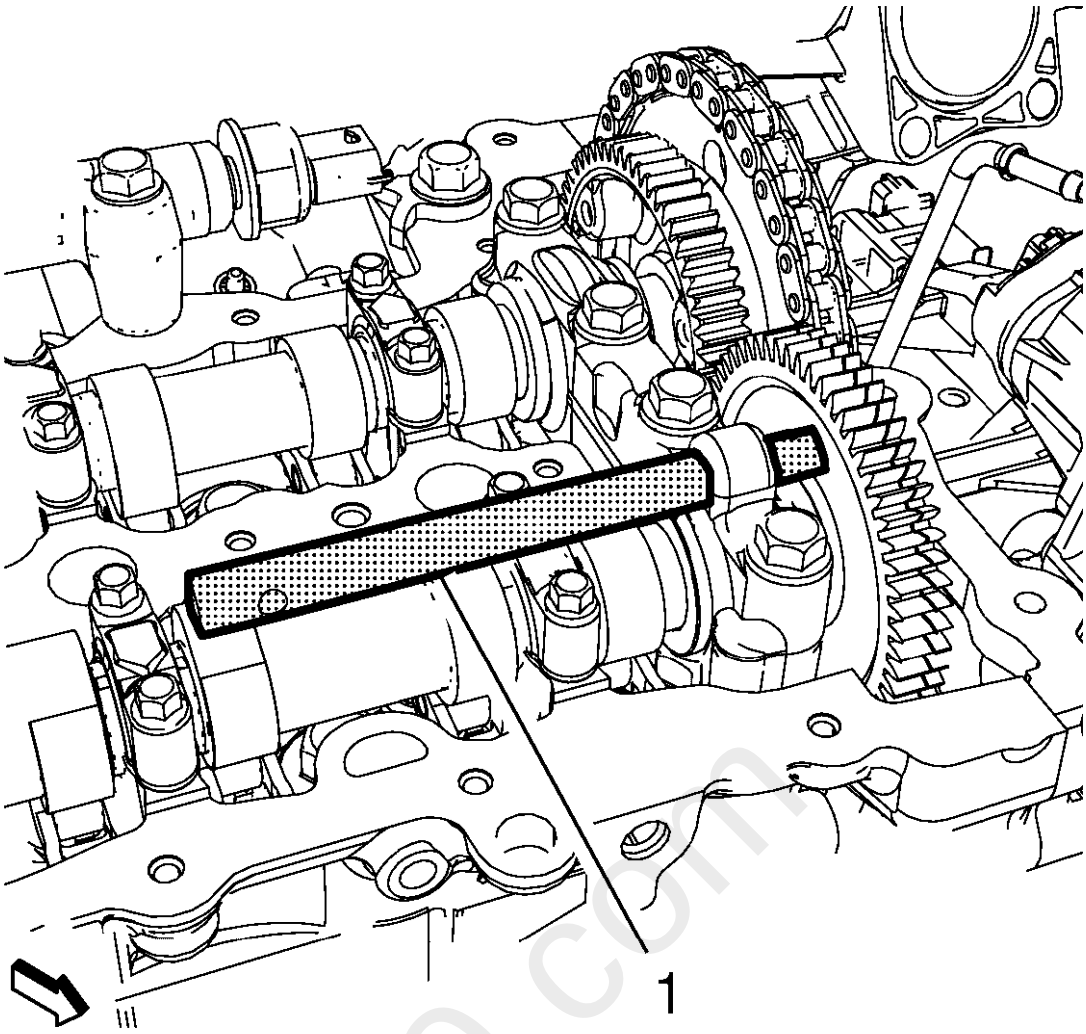


Fig. 572: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

15. Install the **EN-51143** fixing tool (1).
16. Remove the **EN-51143** fixing tool (1).
17. Raise the vehicle.

mcx30.com

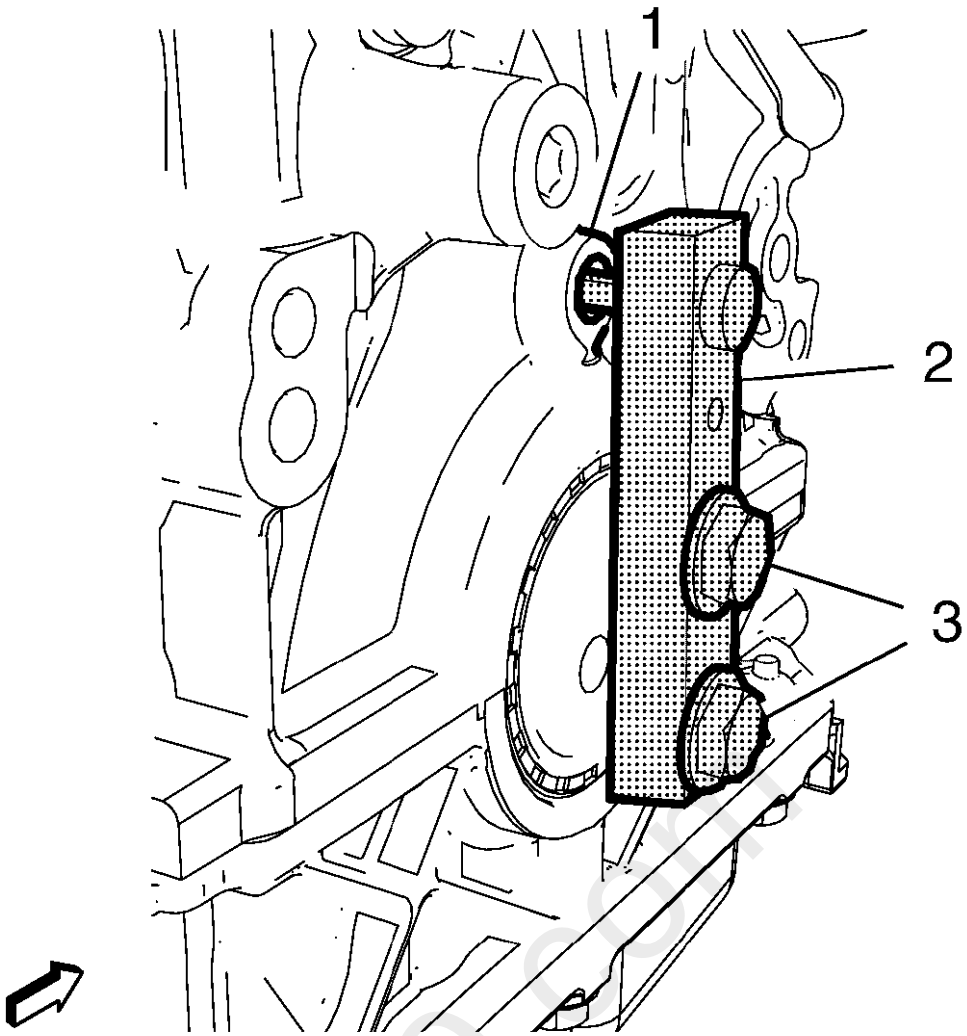


Fig. 573: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

18. Remove the 2 bolts (3).
19. Remove the **EN-51140** fixing tool (2).
20. Install Crankshaft Pulley. Refer to **Crankshaft Pulley Replacement**
21. Install Camshaft Housing. Refer to **Camshaft Housing Replacement**
22. Install Throttle Body Assembly. Refer to **Throttle Body Assembly Replacement**
23. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

CAMSHAFT TIMING CHAIN INSPECTION

Special Tools

- **EN-51140** Crankshaft Fixing Tool
- **EN-51143** Camshaft Sprocket Fixing Tool

Equivalent regional tools: **Special Tools**

Removal Procedure

1. Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**
2. Remove Camshaft Housing. Refer to **Camshaft Housing Replacement**
3. Remove Crankshaft Pulley. Refer to **Crankshaft Pulley Replacement**
4. Lower the vehicle. Refer to **Lifting and Jacking the Vehicle** .

mcx30.com

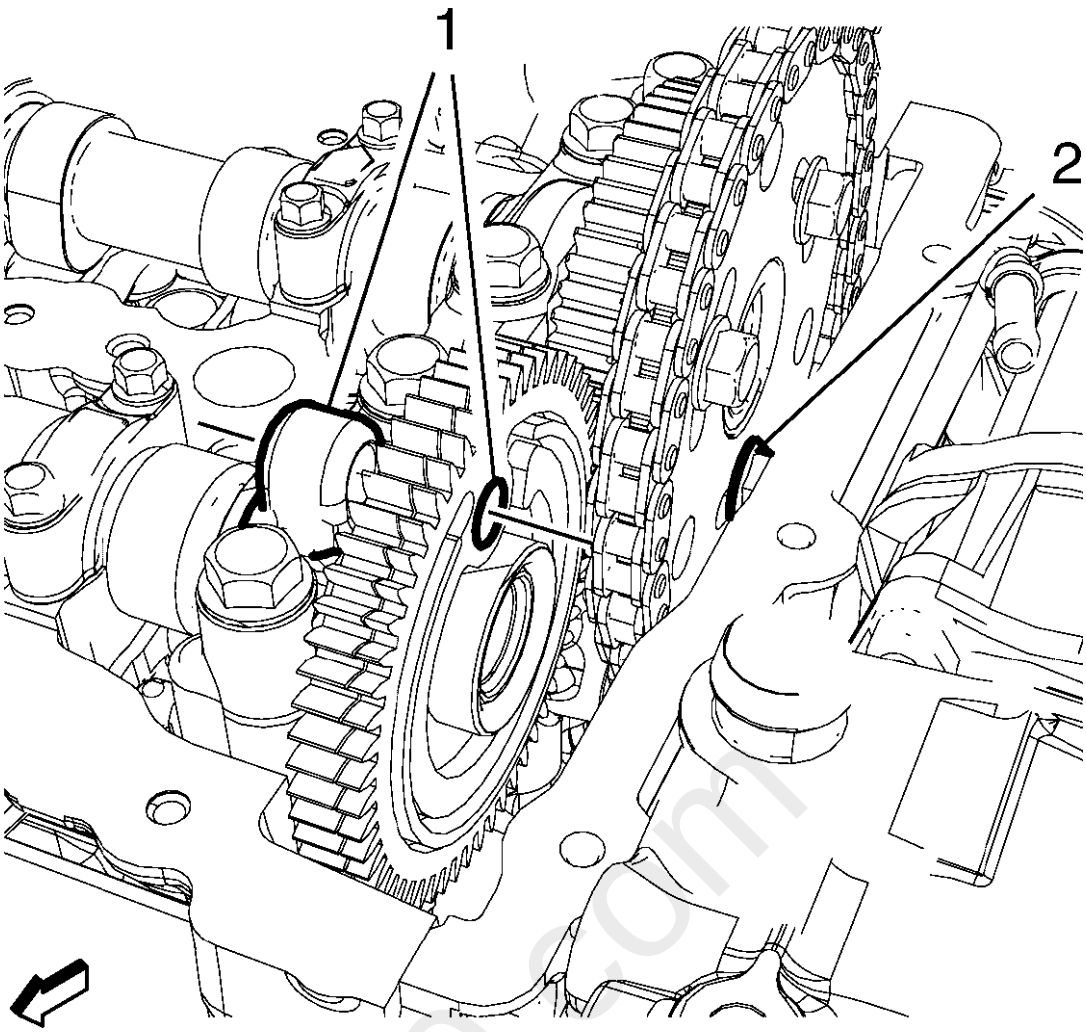


Fig. 574: Aligning Bores
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Check the TDC position of cylinder 1.**

5. Check if the bores (1) are aligned.
6. Rotate the crankshaft, if the bores (1) are not aligned.

mcx30.com

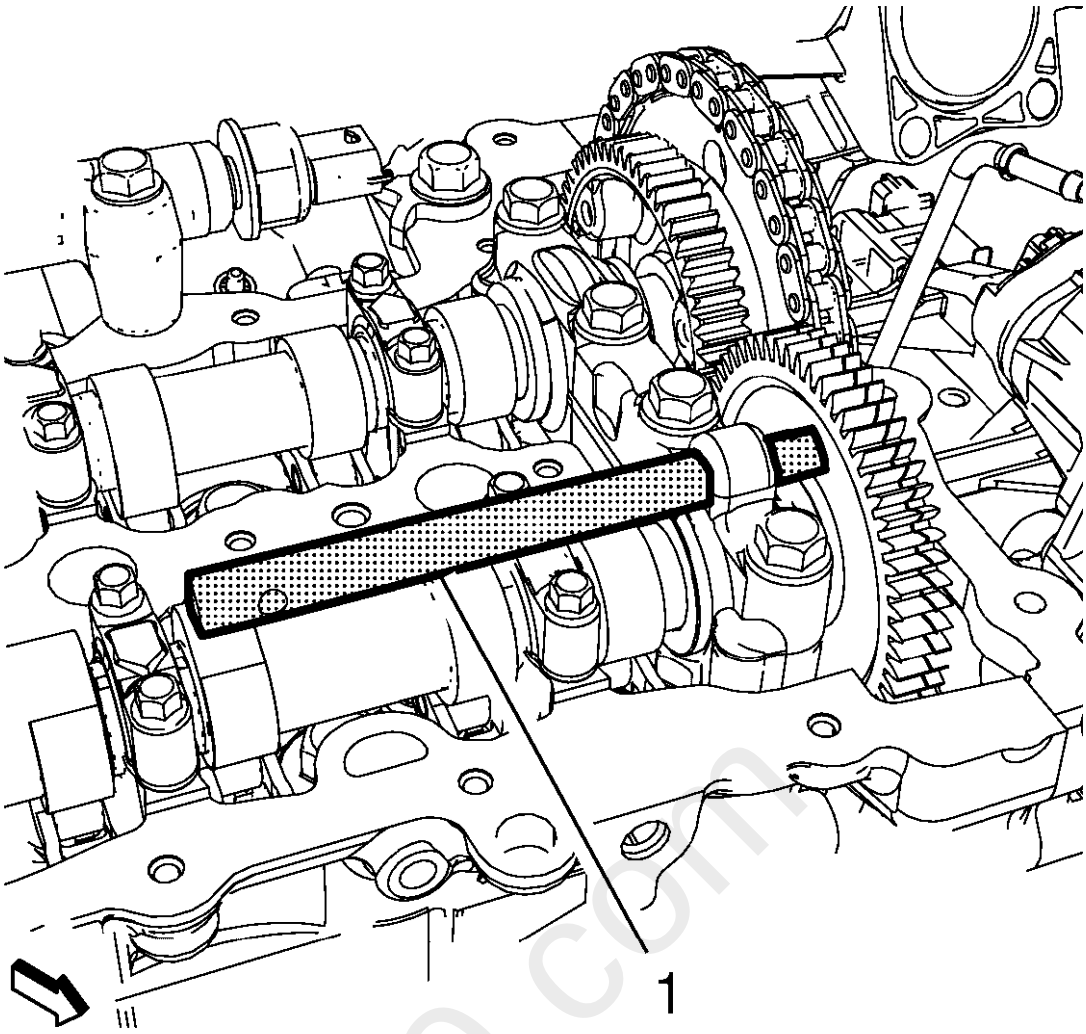


Fig. 575: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Turn the exhaust camshaft at the hexagon until the EN-51143 fixing tool can be installed.**

7. Install the **EN-51143** fixing tool (1).
8. Raise the vehicle.

mcx30.com

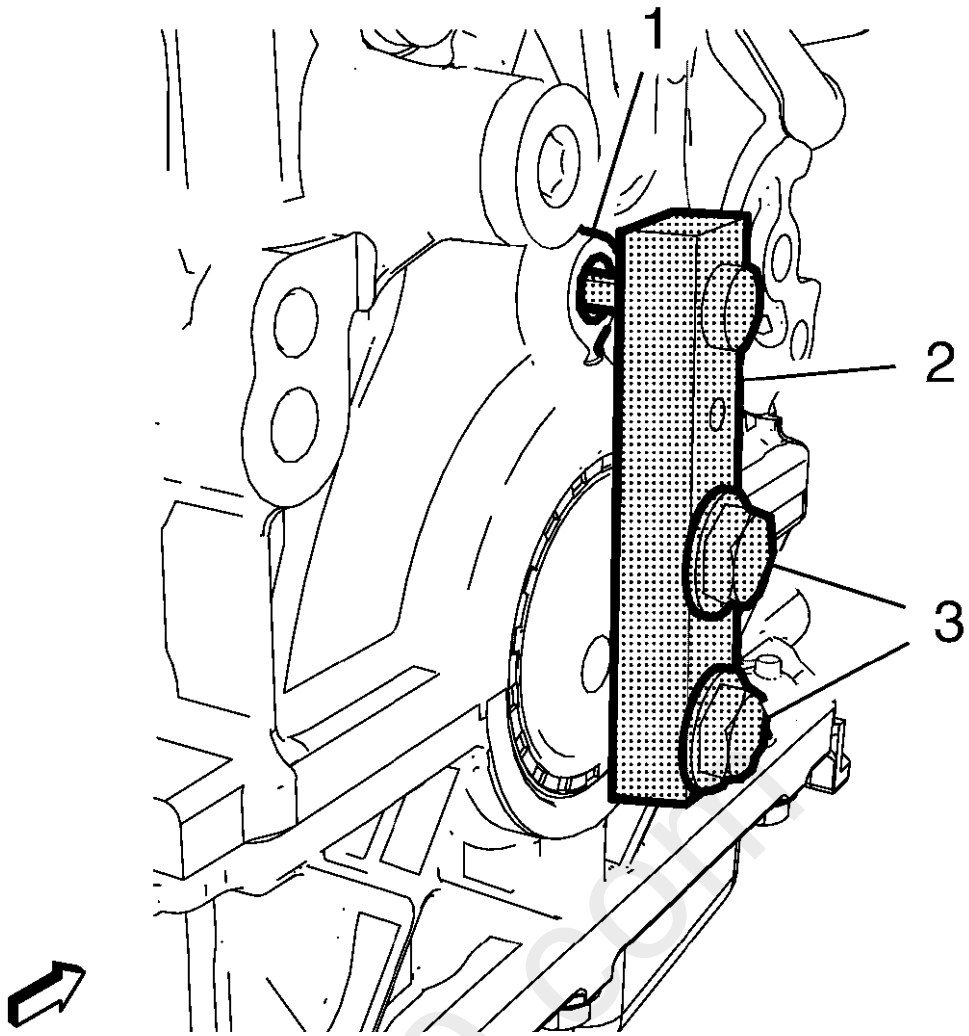


Fig. 576: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

9. Install **EN-51140** fixing tool (2).
10. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).
11. If the fixing pin does not fit into the engine block bore, the camshaft timing must be adjusted. Refer to **Camshaft Timing Chain Adjustment**.

Installation Procedure

NOTE: **Before installation, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

mcx30.com

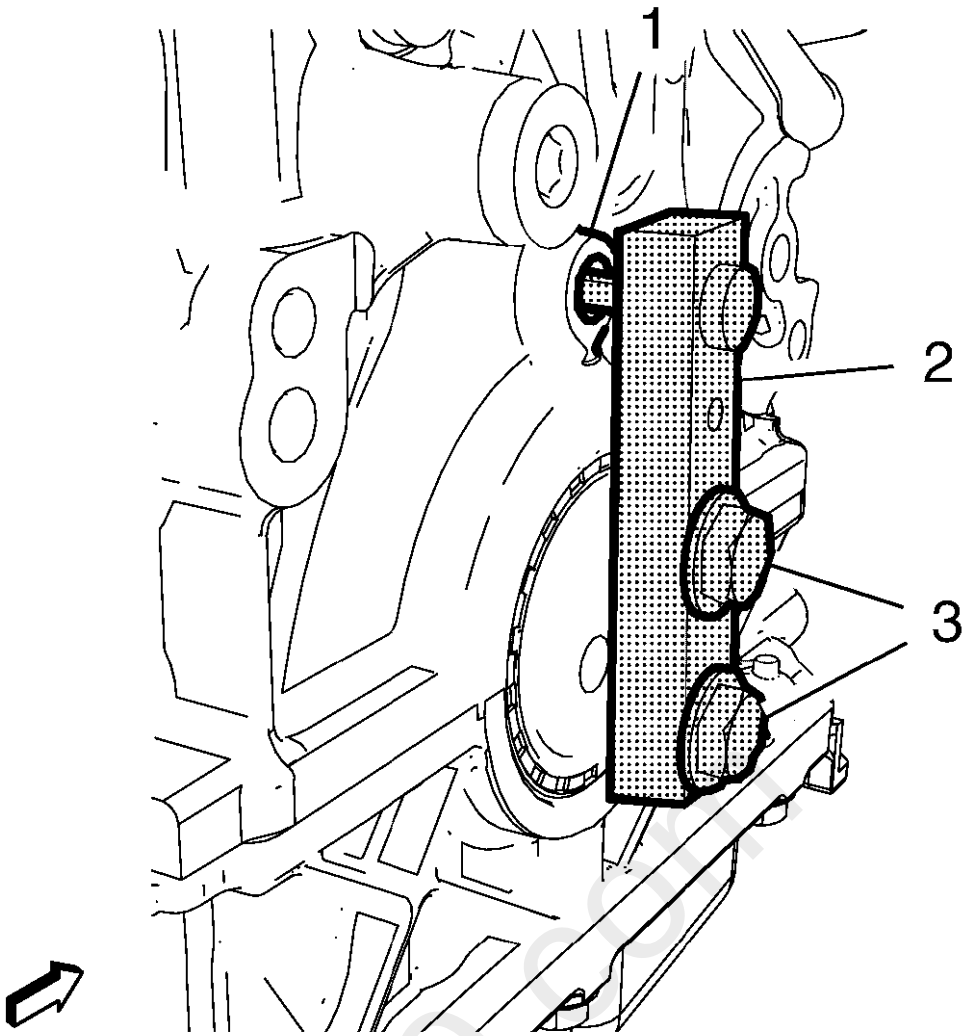


Fig. 577: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

2. Remove the 2 bolts (3).
3. Remove the **EN-51140** fixing tool (2).
4. Lower the vehicle.

mcx30.com

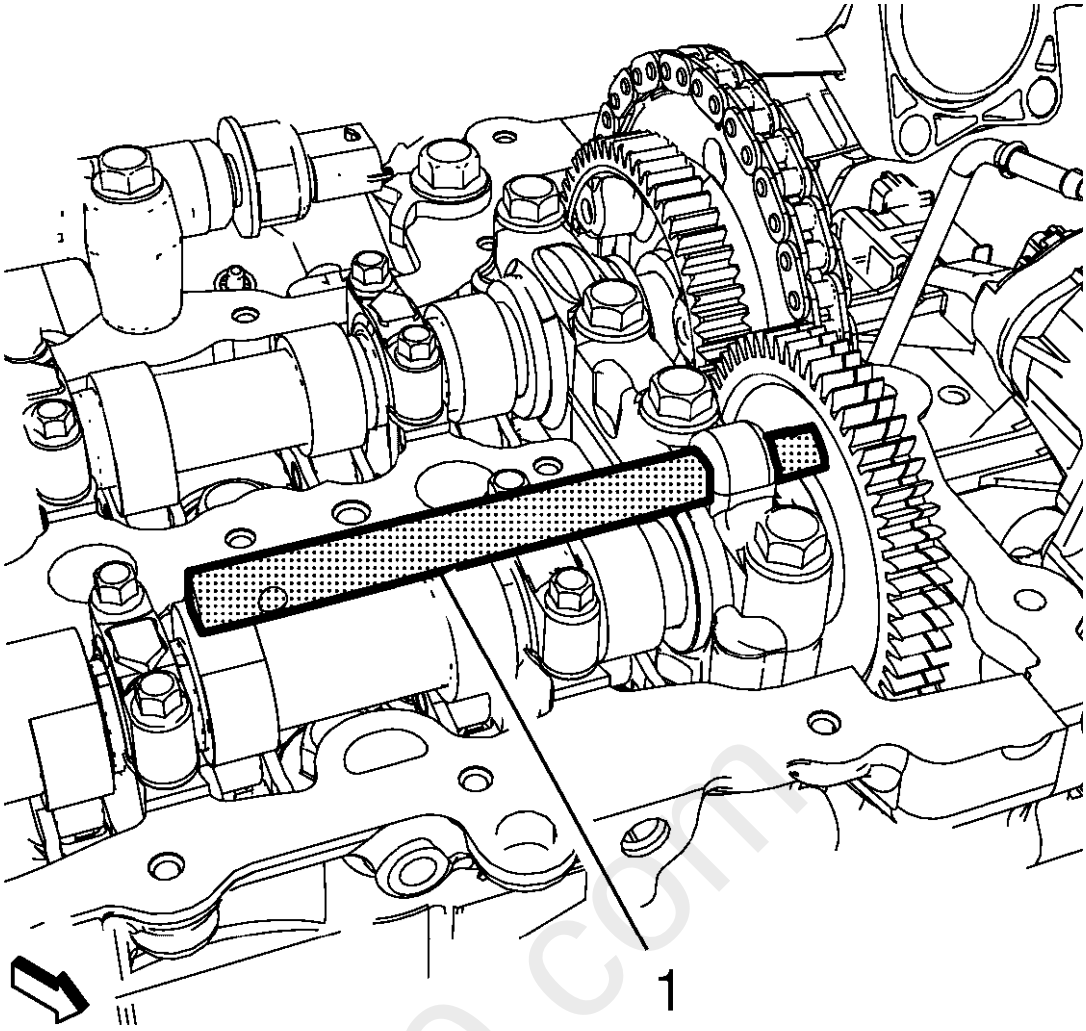


Fig. 578: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

5. Remove the **EN-51143** fixing tool (1).
6. Raise the vehicle.
7. Install Crankshaft Pulley. Refer to **Crankshaft Pulley Replacement**
8. Install Camshaft Housing. Refer to **Camshaft Housing Replacement**
9. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)**

REPAIR INSTRUCTIONS - OFF VEHICLE

ENGINE MOUNT BRACKET REMOVAL

mcx30.com

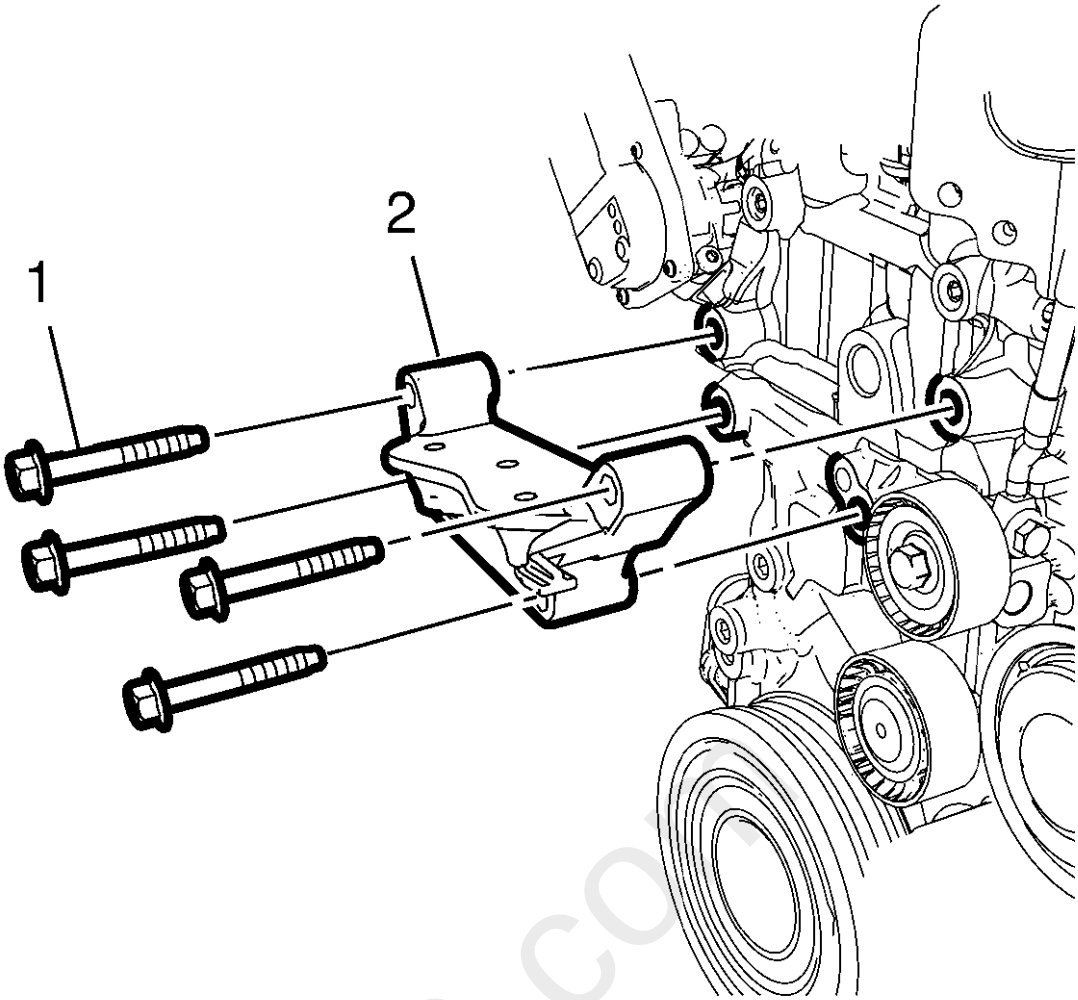


Fig. 579: Engine Mount Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 4 engine mount bracket bolts (1).
2. Remove the engine mount bracket (2).

BELT IDLER PULLEY REMOVAL

mcx30.com

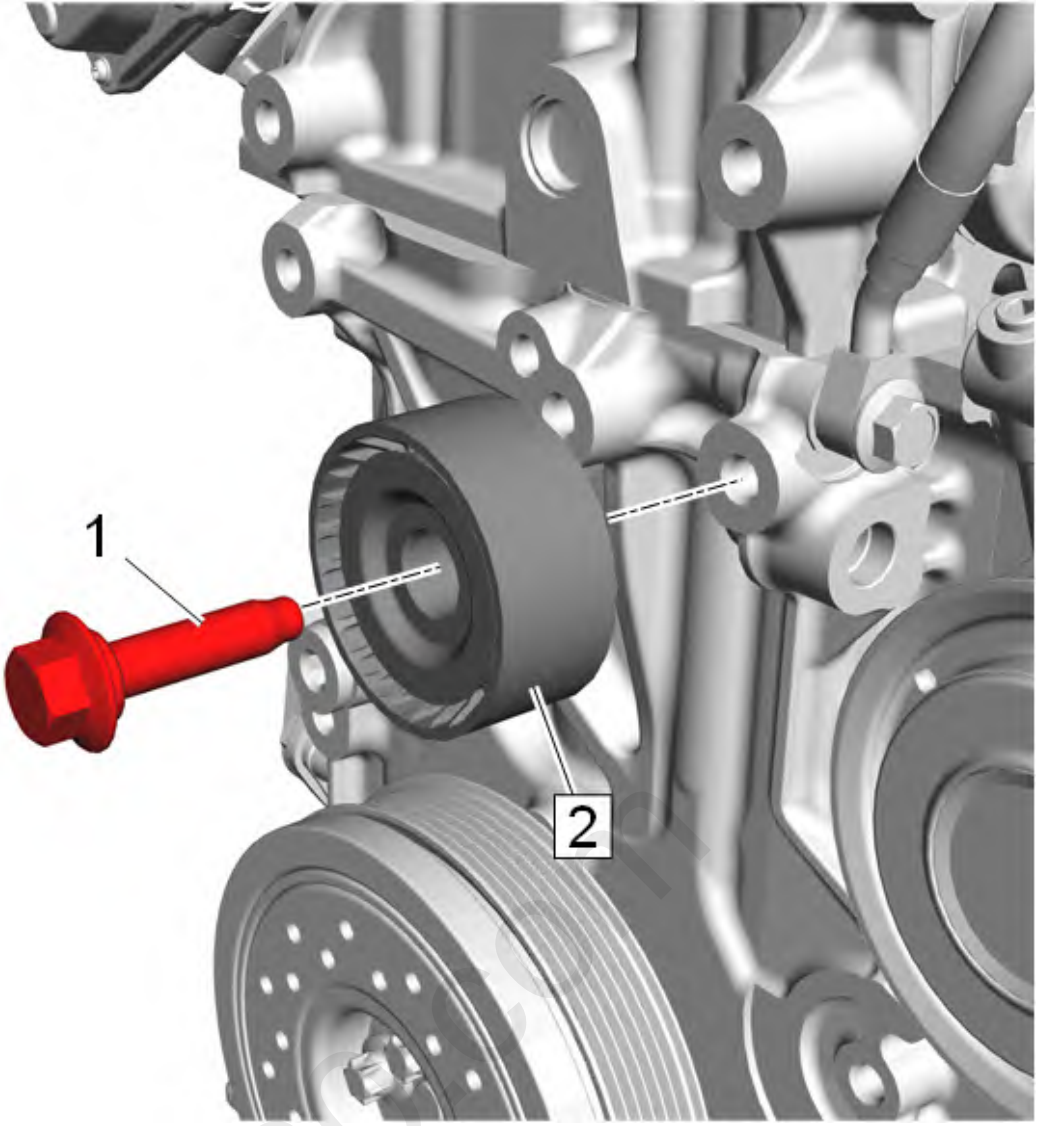


Fig. 580: Drive Belt Idler Pulley And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the drive belt idler pulley bolt (1).
2. Remove the drive belt idler pulley (2).

DRIVE BELT TENSIONER REMOVAL

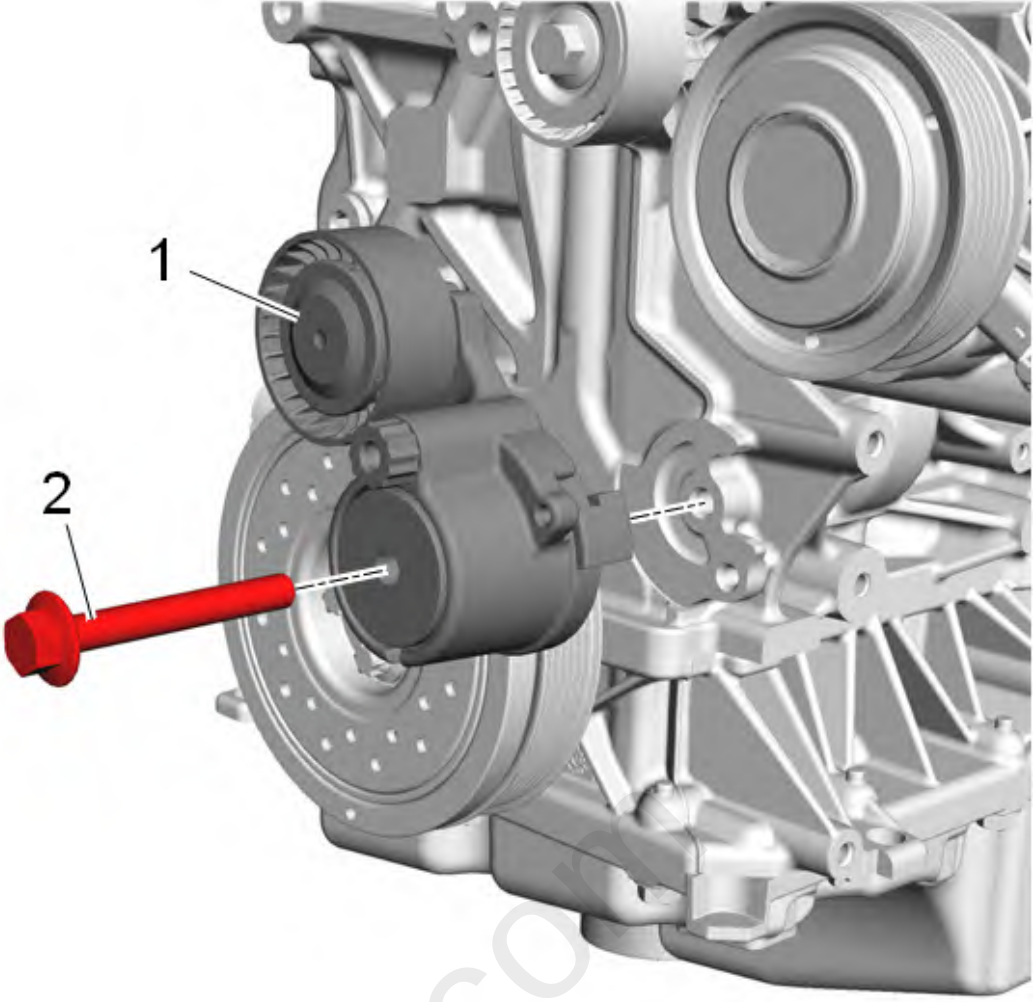


Fig. 581: Drive Belt Tensioner And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the drive belt tensioner bolt (2).
2. Remove the drive belt tensioner (1).

CRANKSHAFT PULLEY REMOVAL

Special Tools

- **EN-956-1** Extension
- **EN-49979** Crankshaft Holder
- **EN-49979-100** Crankshaft Holder Pins

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

mcx30.com

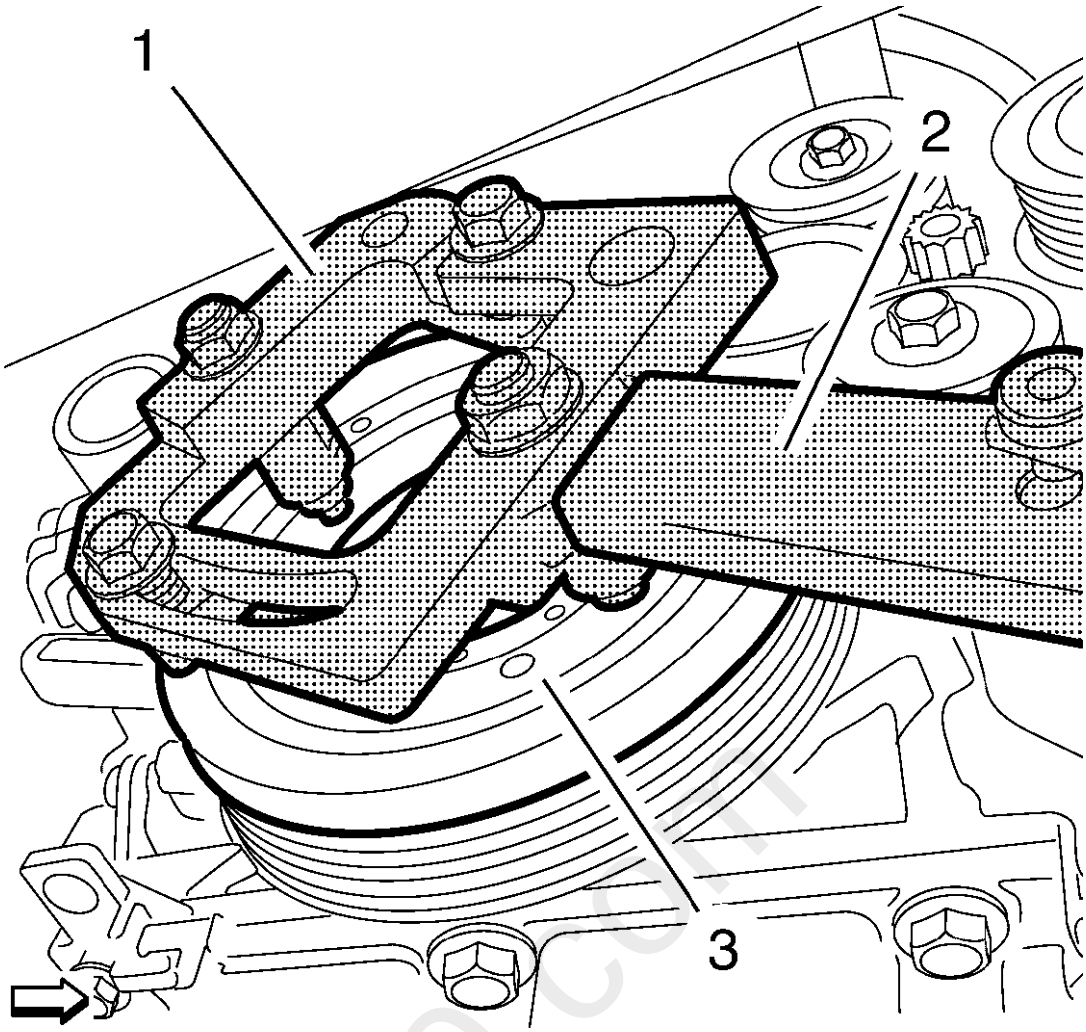


Fig. 582: Crankshaft Holder, Pins, Extension And Crankshaft Pulley
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-49979** holder (1) in compound with the **EN-49979-100** pins and the **EN-956-1** extension (2) to counterhold the crankshaft pulley (3).

mx30.com

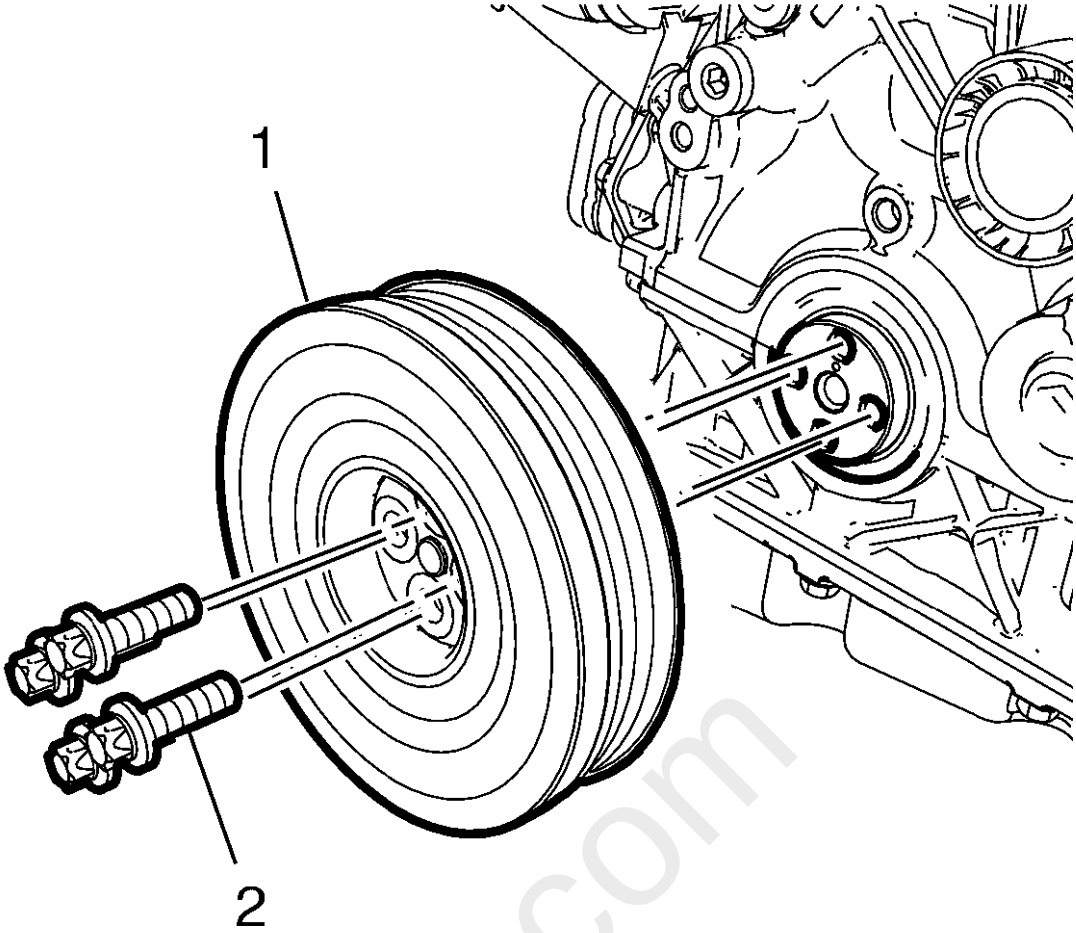


Fig. 583: Crankshaft Pulley And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove and DISCARD the 4 crankshaft pulley bolts (2).
3. Remove the crankshaft pulley (1).

TURBOCHARGER HEAT SHIELD REMOVAL

mcx30.com

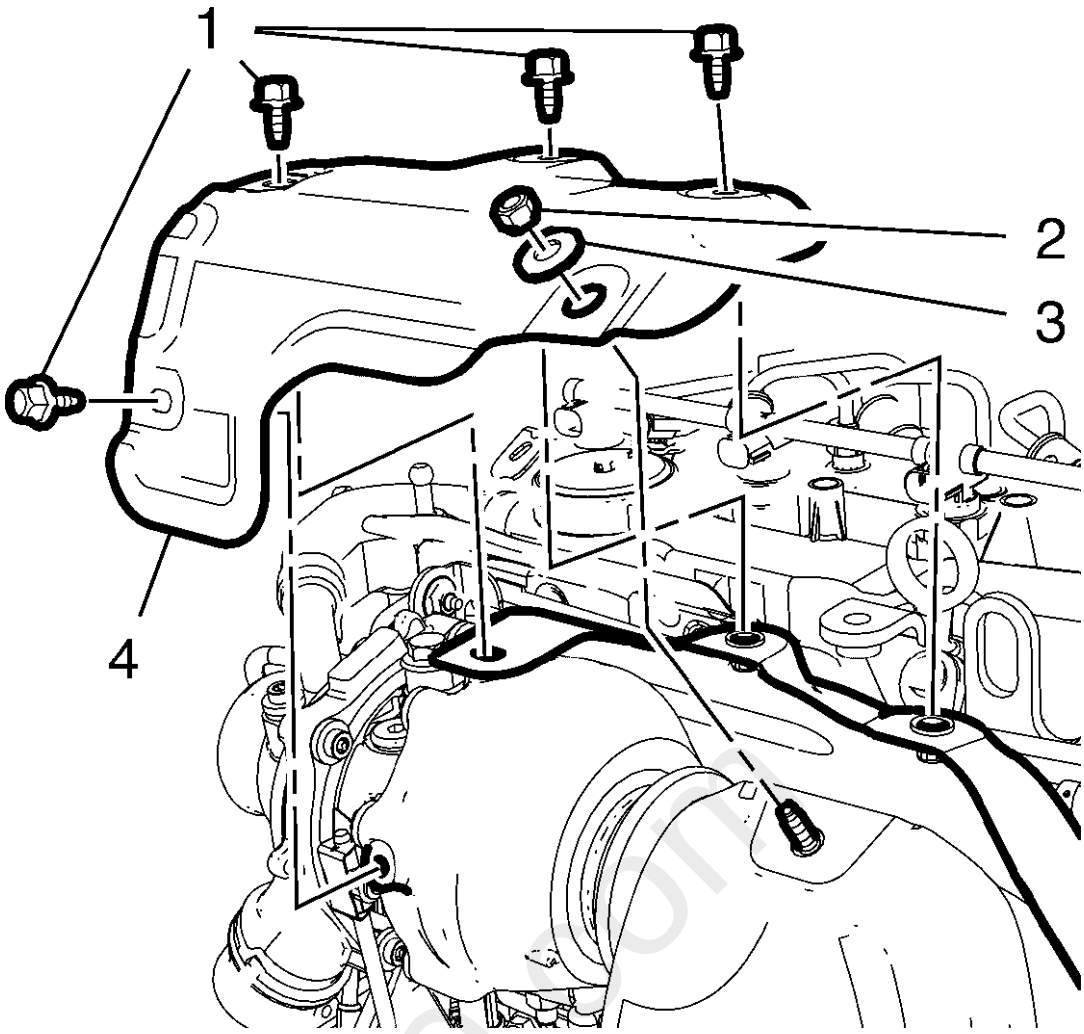


Fig. 584: Turbocharger Heat Shield, Bolts, Nut And Washer
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 4 turbocharger heat shield bolts (1).
2. Remove the turbocharger heat shield nut (2).
3. Remove the turbocharger heat shield washer (3).
4. Remove the turbocharger heat shield (4).

CATALYTIC CONVERTER HEAT SHIELD REMOVAL

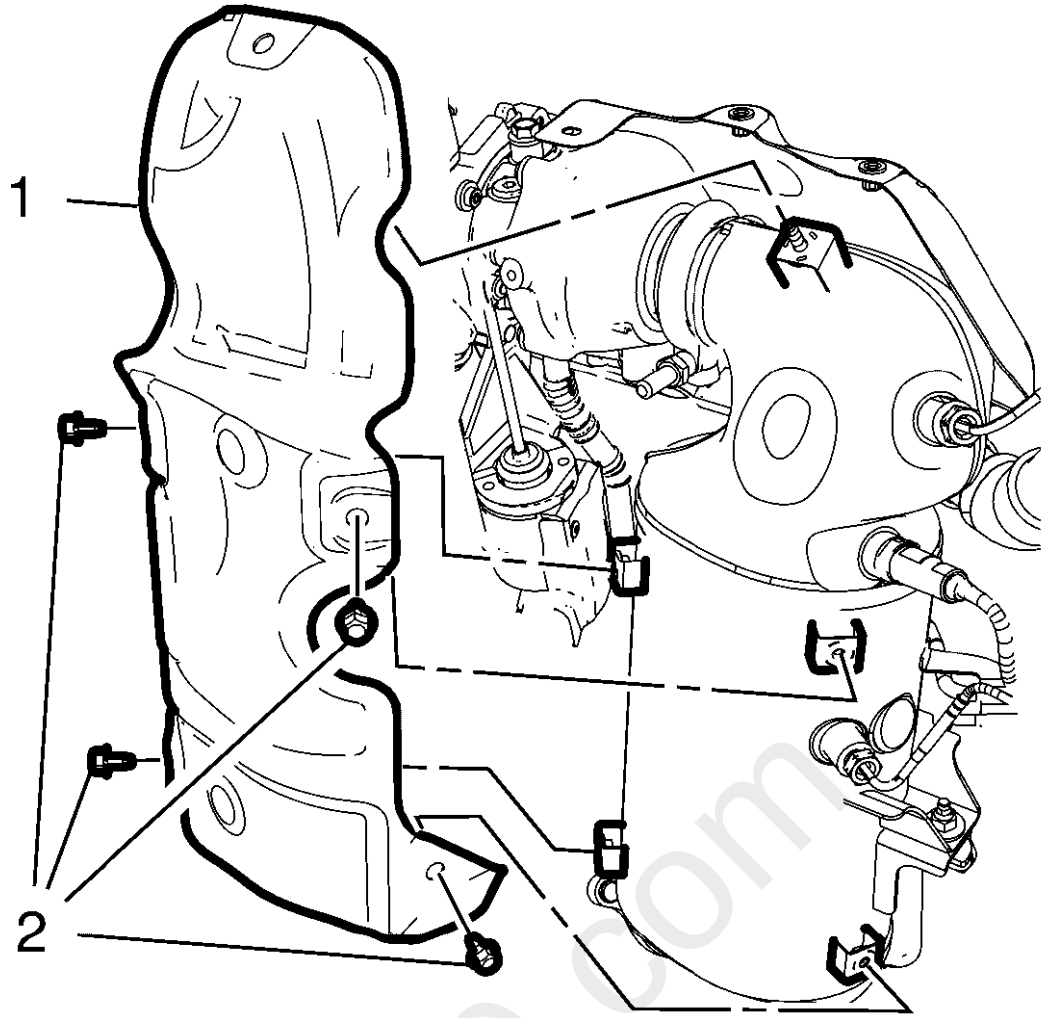


Fig. 585: Catalytic Converter Heat Shield And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 4 catalytic converter heat shield bolts (2).
2. Remove the catalytic converter heat shield (1).

EXHAUST TEMPERATURE SENSOR REMOVAL - POSITION 1

mcx30.com

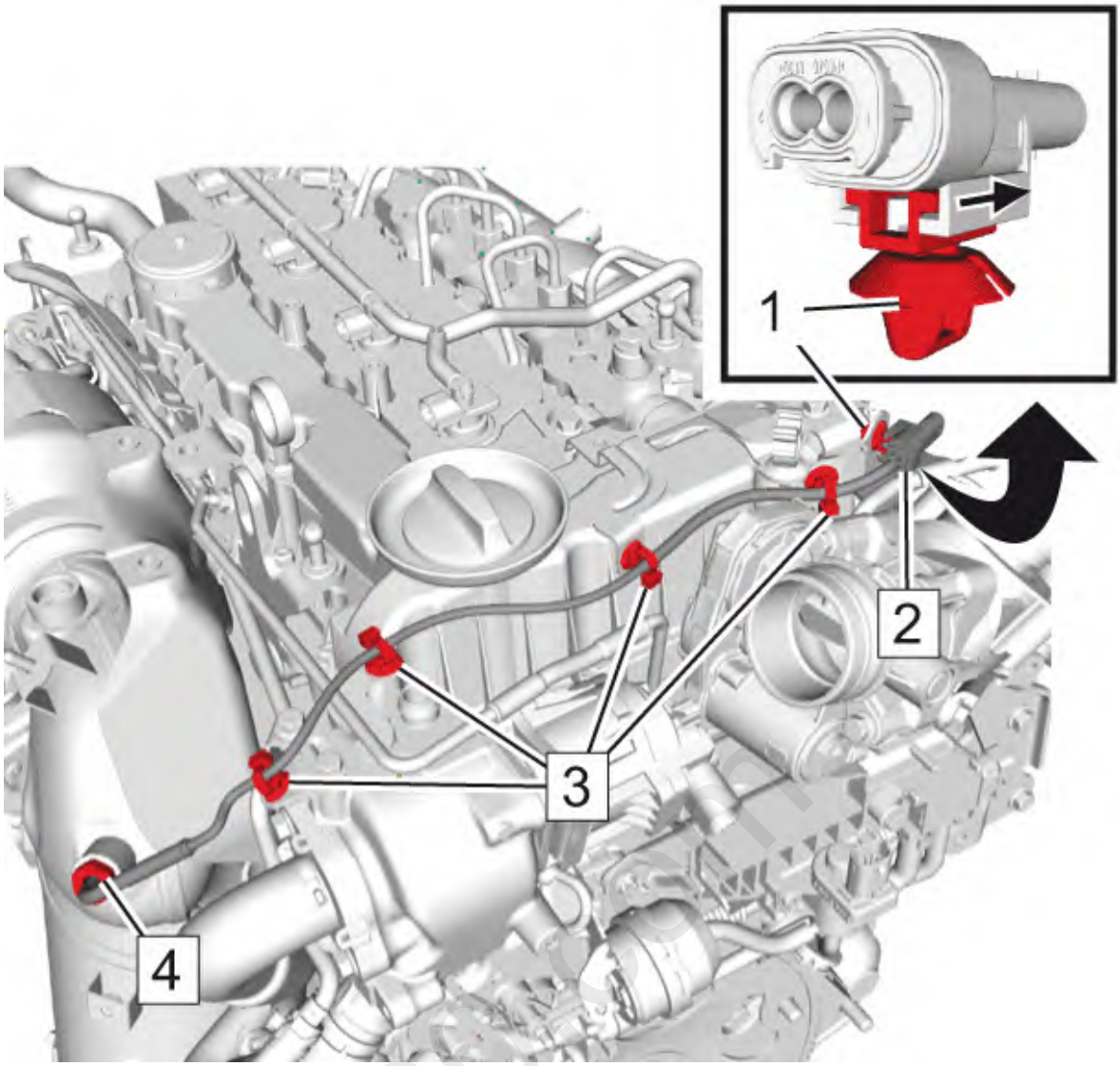


Fig. 586: Exhaust Temperature Sensor - Position 1, Electrical Connector And Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Unclip Electrical Connector (2) @ Retainer (1)
2. Remove Wiring Harness Retainers (3) (Qty: 4)
3. Remove Exhaust Temperature Sensor - Position 1 (4)

EXHAUST TEMPERATURE SENSOR REMOVAL - POSITION 2

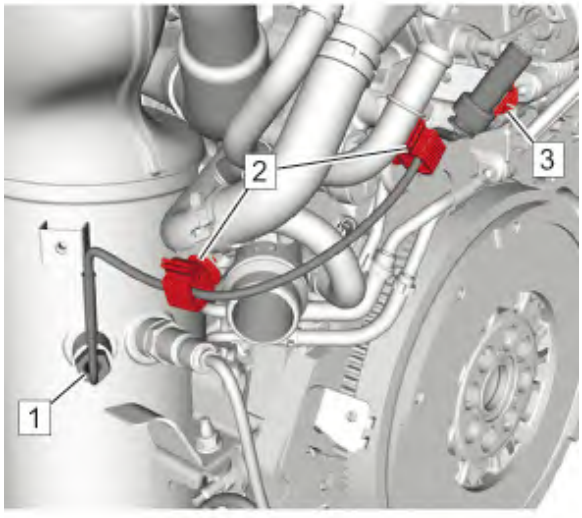


Fig. 587: Exhaust Temperature Sensor - Position 2 And Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Unclip Retainers (2, 3) (Qty: 3)
2. Remove the exhaust temperature sensor - position 2 (1) from the catalytic converter.

EXHAUST PRESSURE DIFFERENTIAL SENSOR PIPE REMOVAL

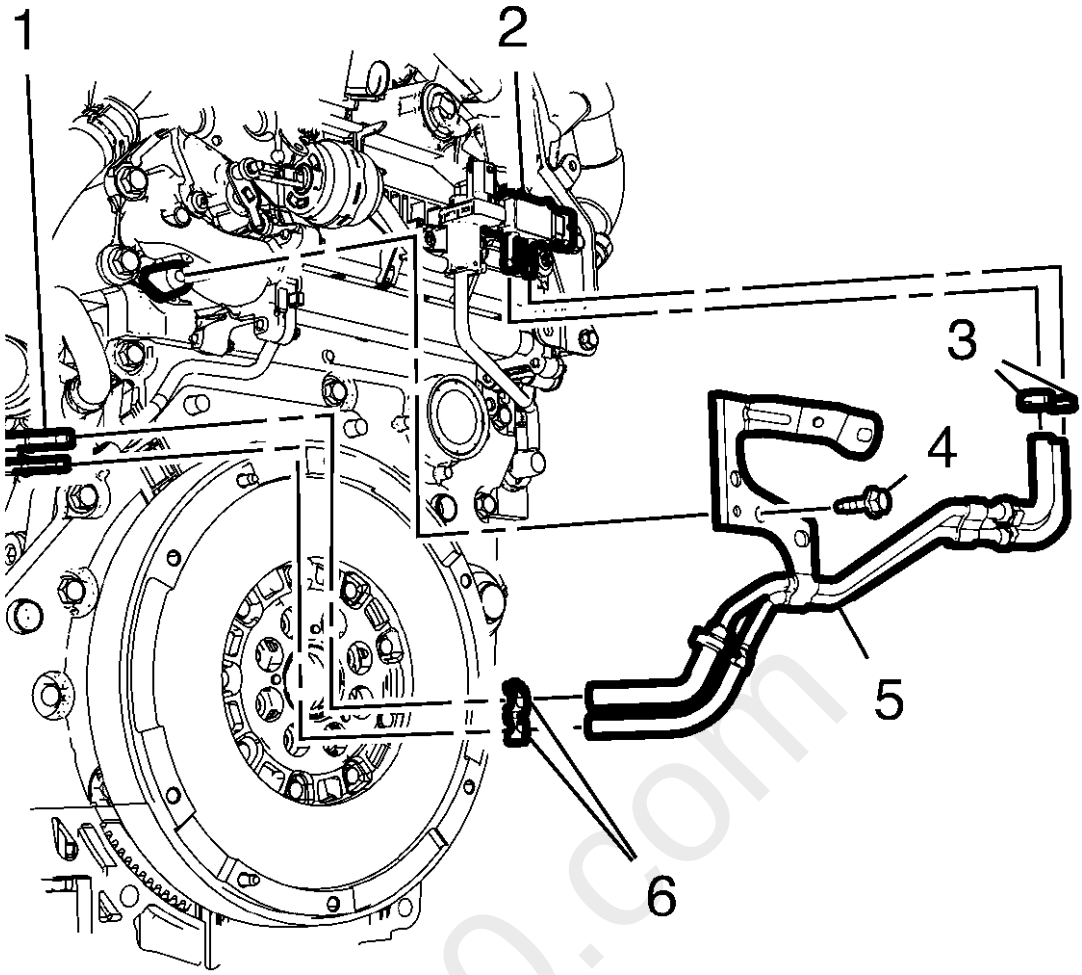


Fig. 588: Exhaust Pressure Differential Sensor Pipe And Components
Courtesy of GENERAL MOTORS COMPANY

1. Remove and DISCARD the 2 clamps (3).
2. Disconnect the 2 hoses from the exhaust pressure differential sensor (2).
3. Remove and DISCARD the 2 clamps (6).
4. Disconnect the 2 hoses from the catalytic converter connection pipes (1).
5. Remove the exhaust pressure differential sensor pipe bracket bolt (4).
6. Remove the exhaust pressure differential sensor pipe (5).

CATALYTIC CONVERTER REMOVAL

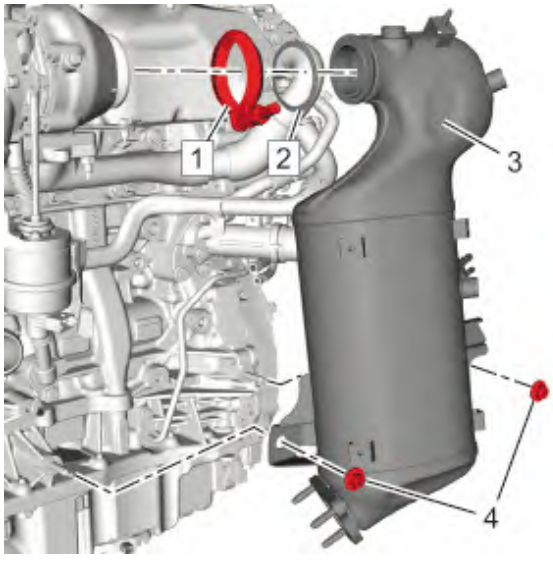


Fig. 589: Catalytic Converter, Clamp, Nuts And Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Remove Catalytic Converter Clamp (1)
2. Remove Catalytic Converter Bracket Nuts (4) (Qty: 2)
3. Remove Catalytic Converter (3)
4. Remove and DISCARD Gasket (2)

TURBOCHARGER WASTEGATE ACTUATOR PIPE REMOVAL

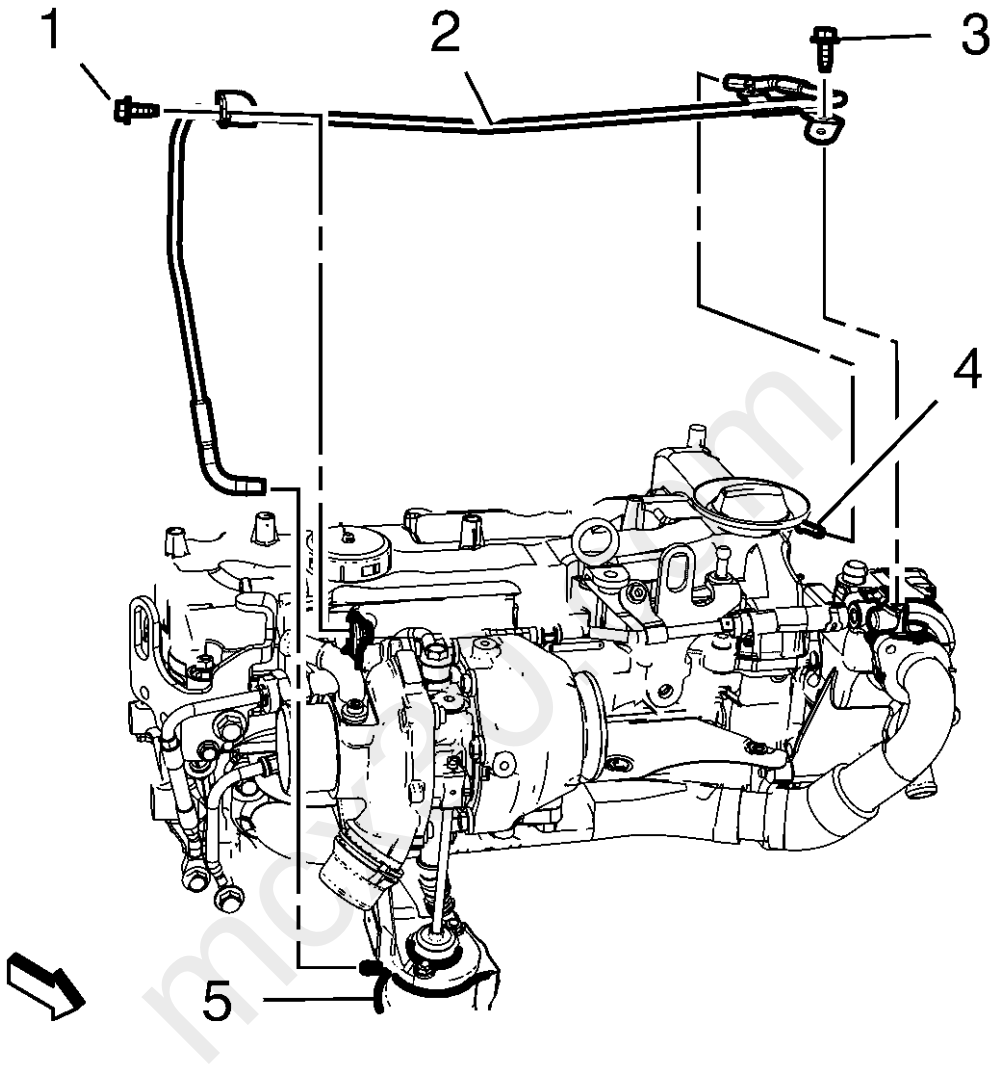


Fig. 590: Turbocharger Wastegate Actuator Pipe And Components
Courtesy of GENERAL MOTORS COMPANY

1. Remove the turbocharger wastegate actuator pipe bracket bolt (1).
2. Remove the turbocharger wastegate actuator pipe bracket bolt (3).
3. Disconnect the turbocharger wastegate actuator pipe (2) from the turbocharger wastegate actuator (5).
4. Disconnect the turbocharger wastegate actuator pipe (2) from the power brake booster vacuum pipe (4).
5. Remove the turbocharger wastegate actuator pipe (2).

TURBOCHARGER OIL FEED PIPE REMOVAL

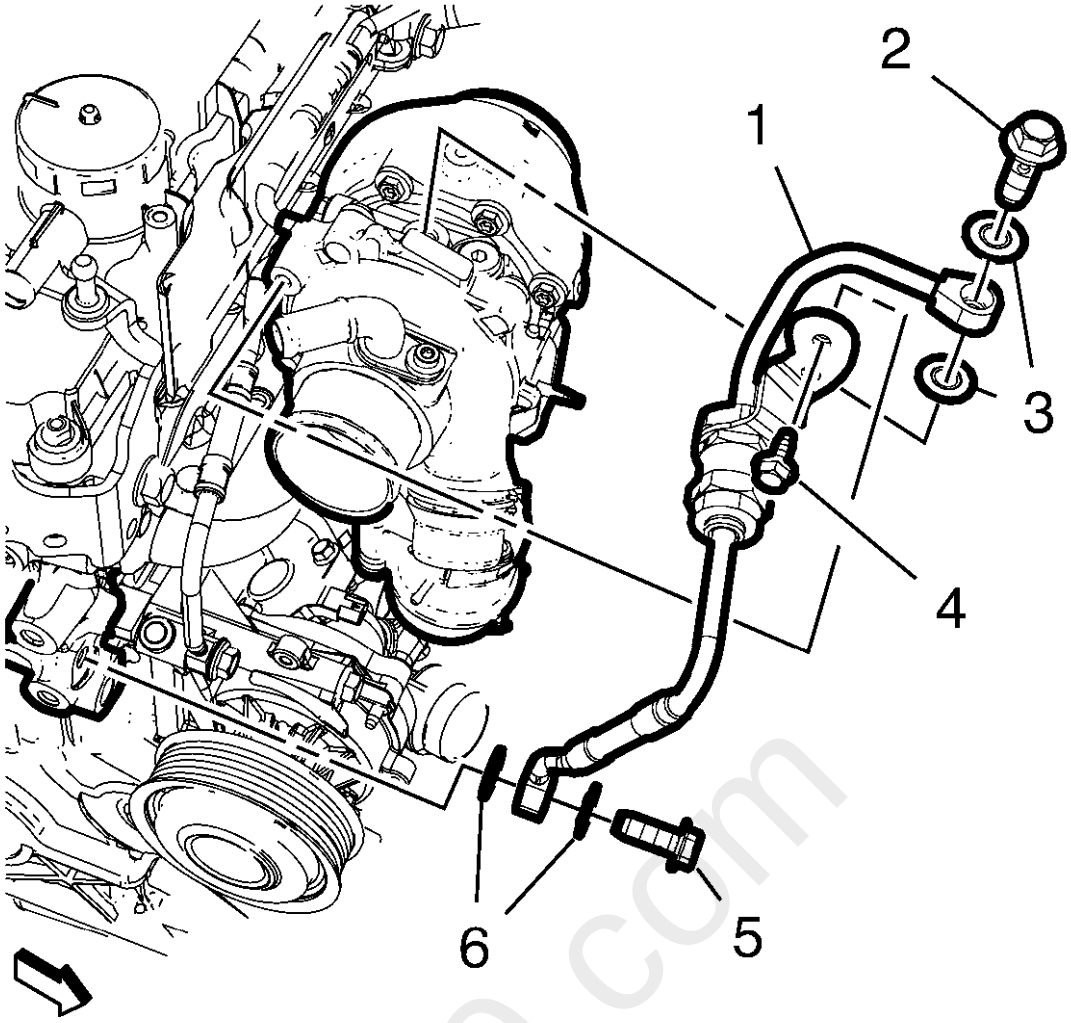


Fig. 591: Turbocharger Oil Feed Pipe And Components
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 2 turbocharger oil feed pipe hollow bolts (2, 5).
2. Remove the 4 turbocharger oil feed pipe gaskets (3, 6).
3. Remove the turbocharger oil feed pipe bracket bolt (4).
4. Remove the turbocharger oil feed pipe (1).

TURBOCHARGER OIL RETURN PIPE REMOVAL

mcx30.com

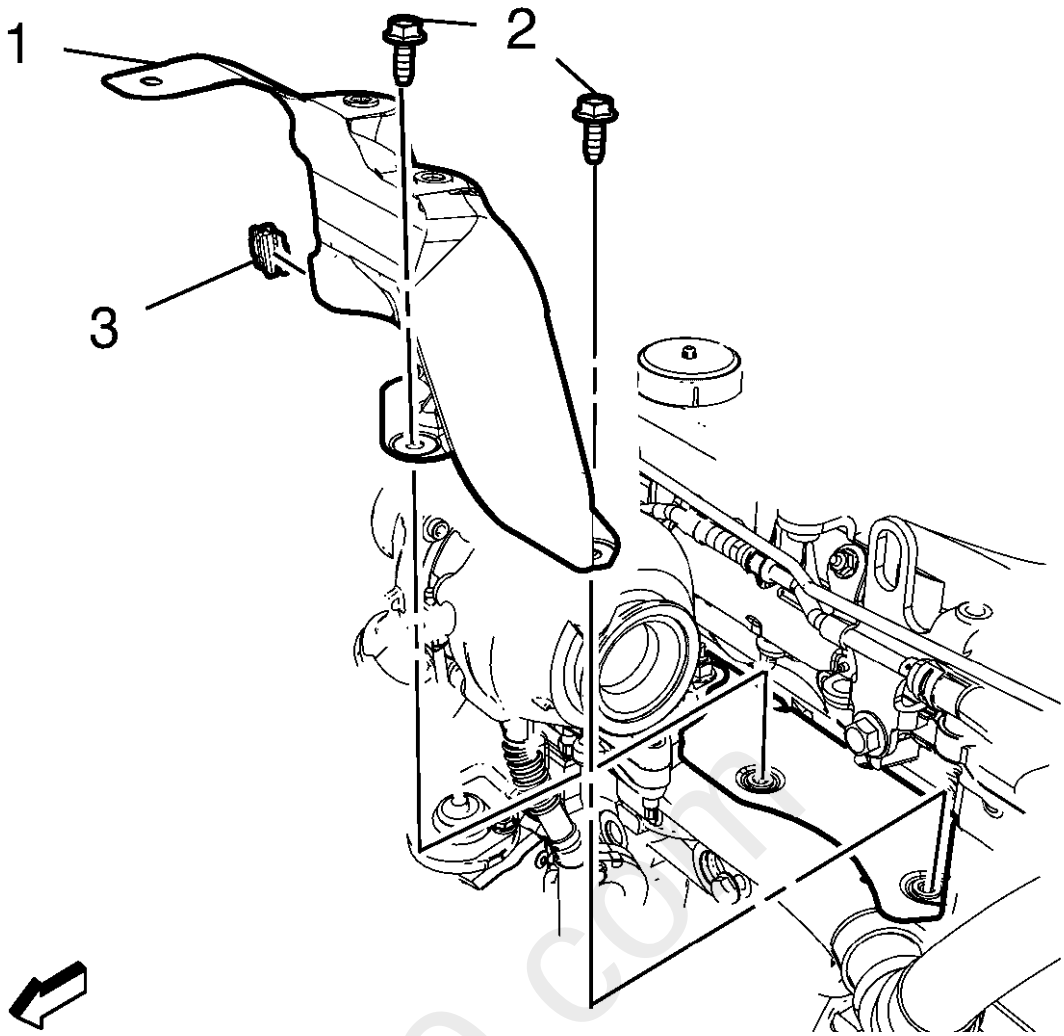


Fig. 592: Turbocharger Heat Shield, Bolts And Clip
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 2 turbocharger heat shield bolts (2).
2. Unclip the turbocharger heat shield connection clip (3).
3. Remove the turbocharger heat shield (1).

mx30.com

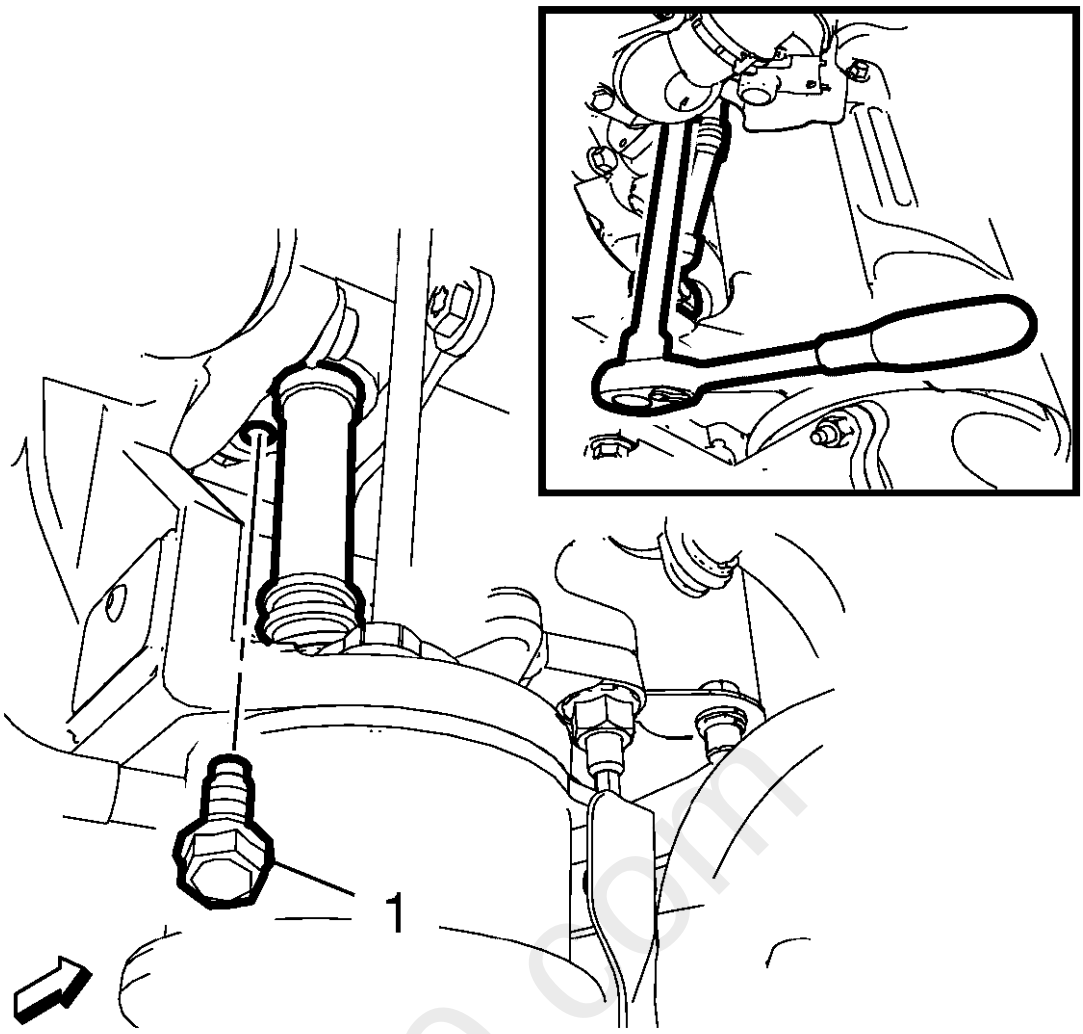


Fig. 593: Upper Turbocharger Oil Return Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the upper turbocharger oil return pipe bolt (1)

mcx30.com

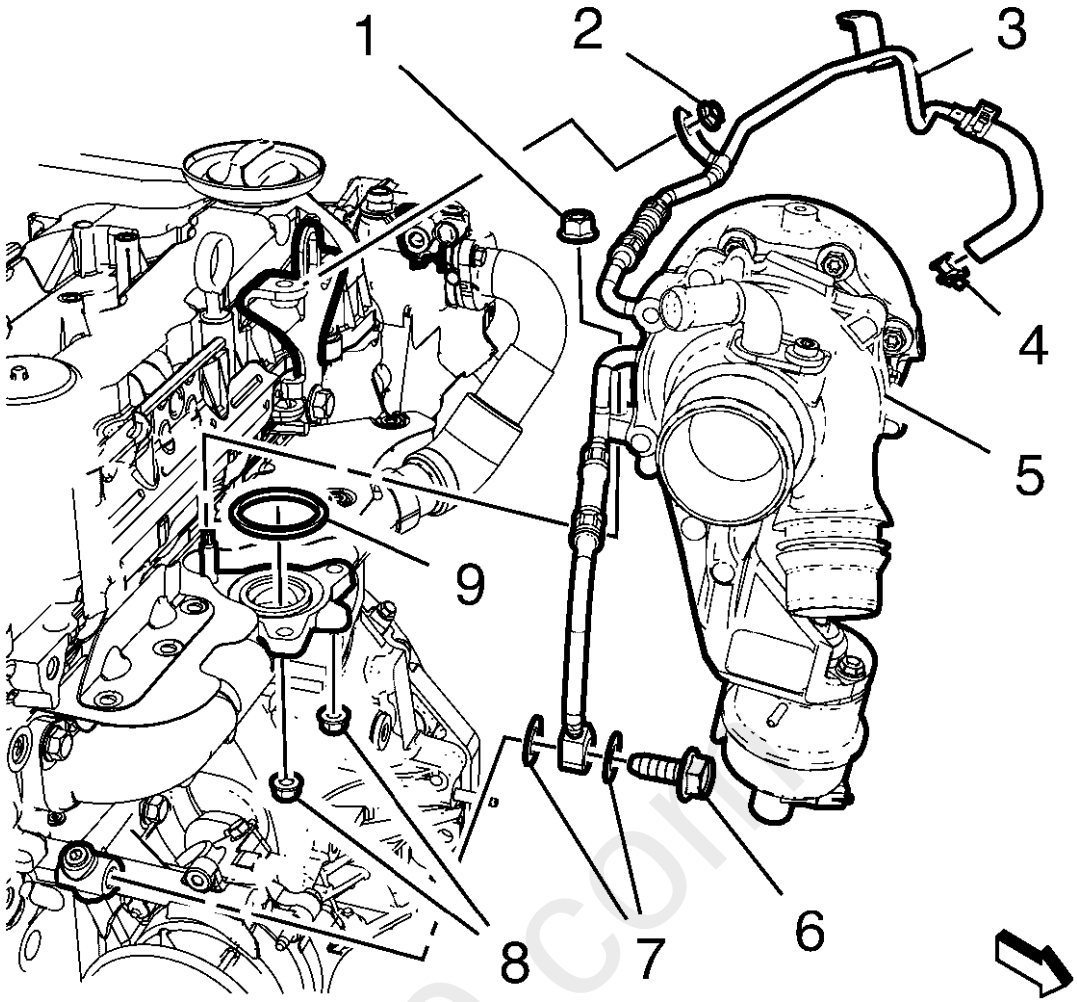


Fig. 594: Turbocharger And Components
Courtesy of GENERAL MOTORS COMPANY

5. Remove the clamp (4) from thermostat bypass pipe.
6. Remove the turbocharger coolant feed pipe bracket nut (2).
7. Remove the turbocharger coolant feed pipe hollow bolt (6).
8. Remove and DISCARD the 2 turbocharger coolant feed pipe gaskets (7).
9. Remove the 3 turbocharger nuts (1, 8).
10. Pull the turbocharger (5) slightly upwards and remove the turbocharger coolant feed pipe (3) from the thermostat bypass pipe.
11. Remove the turbocharger (5) from the exhaust manifold.
12. Remove and DISCARD the turbocharger gasket (9).

mcx30.com

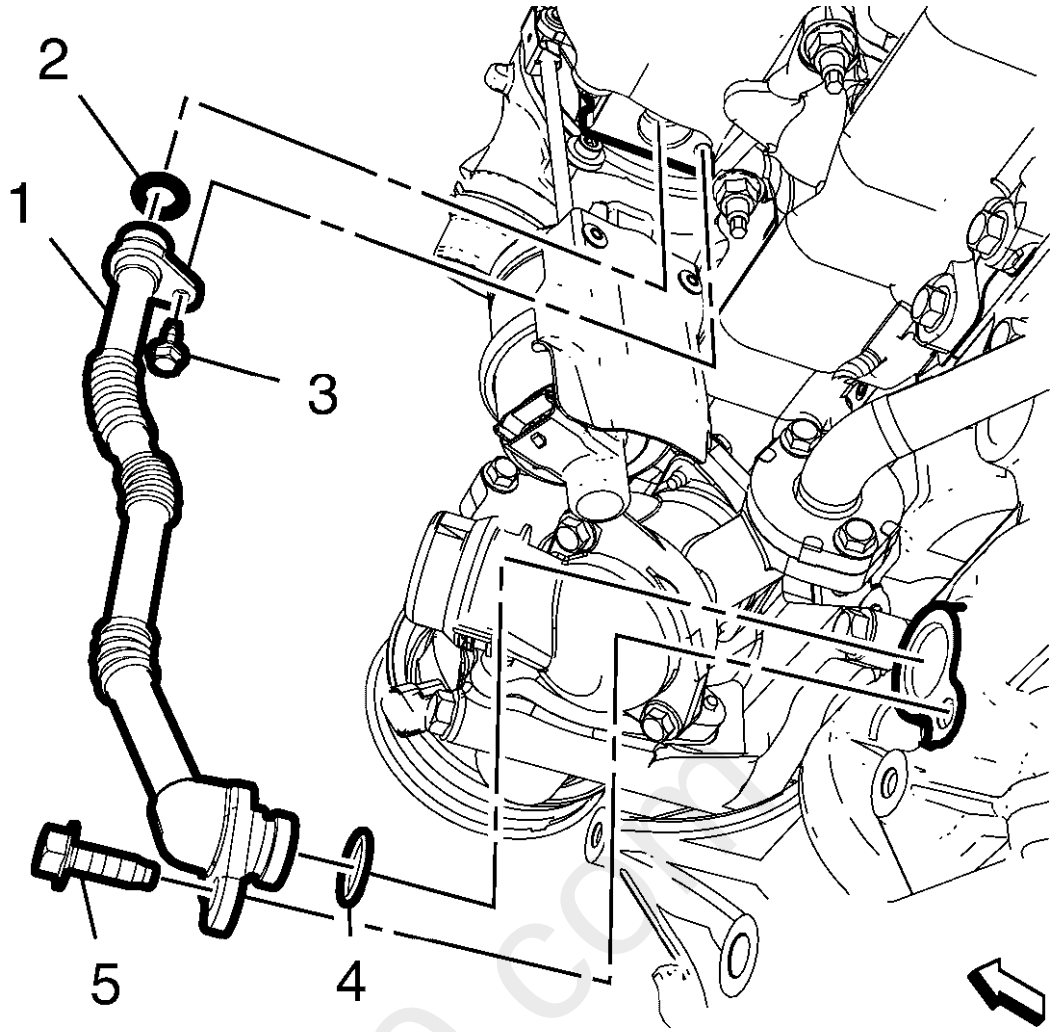


Fig. 595: Turbocharger Oil Return Pipe, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

13. Remove the turbocharger oil return pipe bolt (5).
14. Remove the lower turbocharger oil return pipe joint out of the engine block.
15. Remove the turbocharger oil return pipe (1).
16. Remove and DISCARD the turbocharger oil return pipe seals (2, 4).

TURBOCHARGER REMOVAL

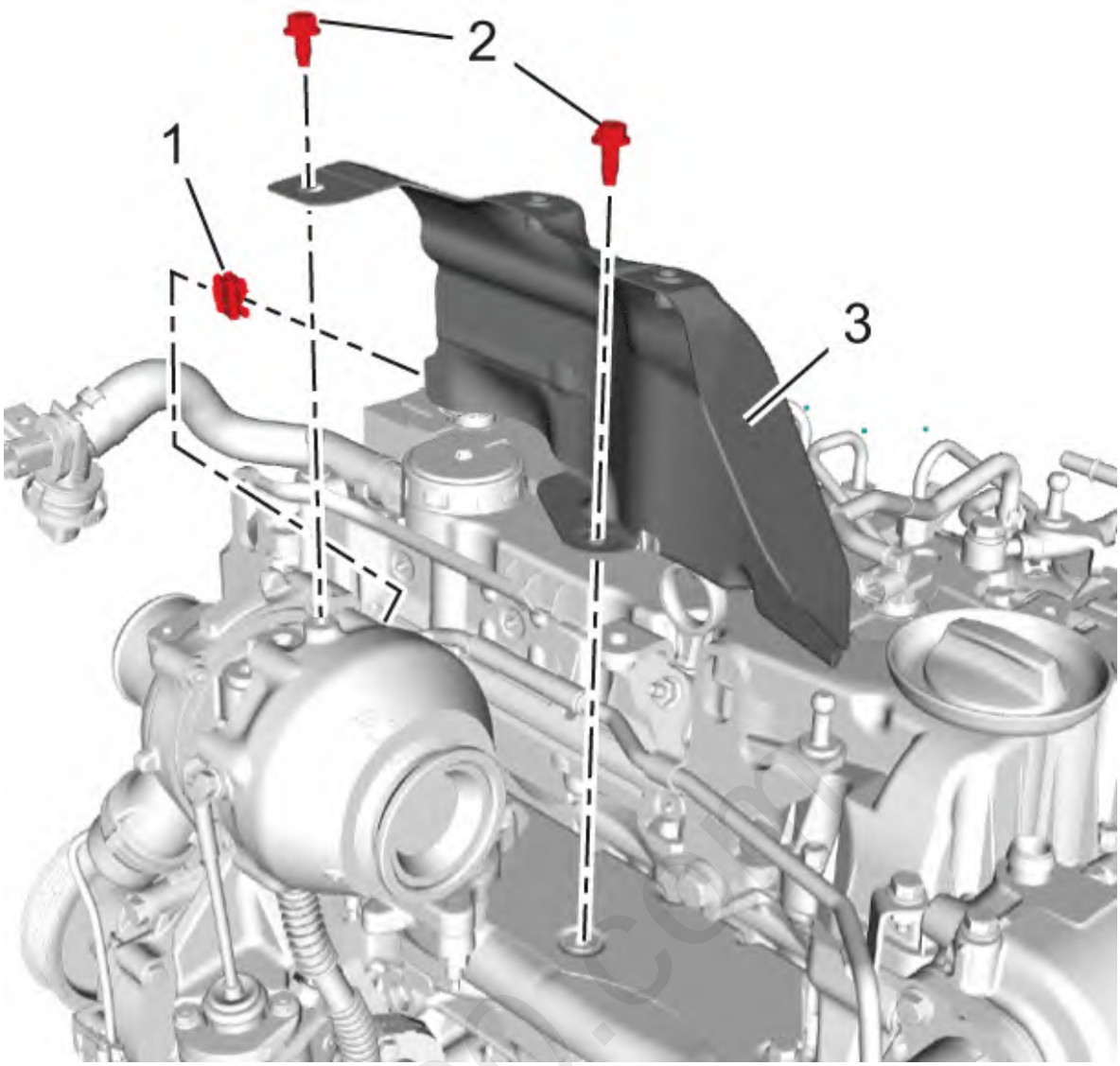


Fig. 596: Turbocharger Heat Shield, Bolts And Clamp
Courtesy of GENERAL MOTORS COMPANY

1. Remove Turbocharger Heat Shield Bolts (2) (Qty: 2)
2. Unclip Turbocharger Heat Shield (3) @ Clamp (1)
3. Remove Turbocharger Heat Shield (3)

mnx30.com

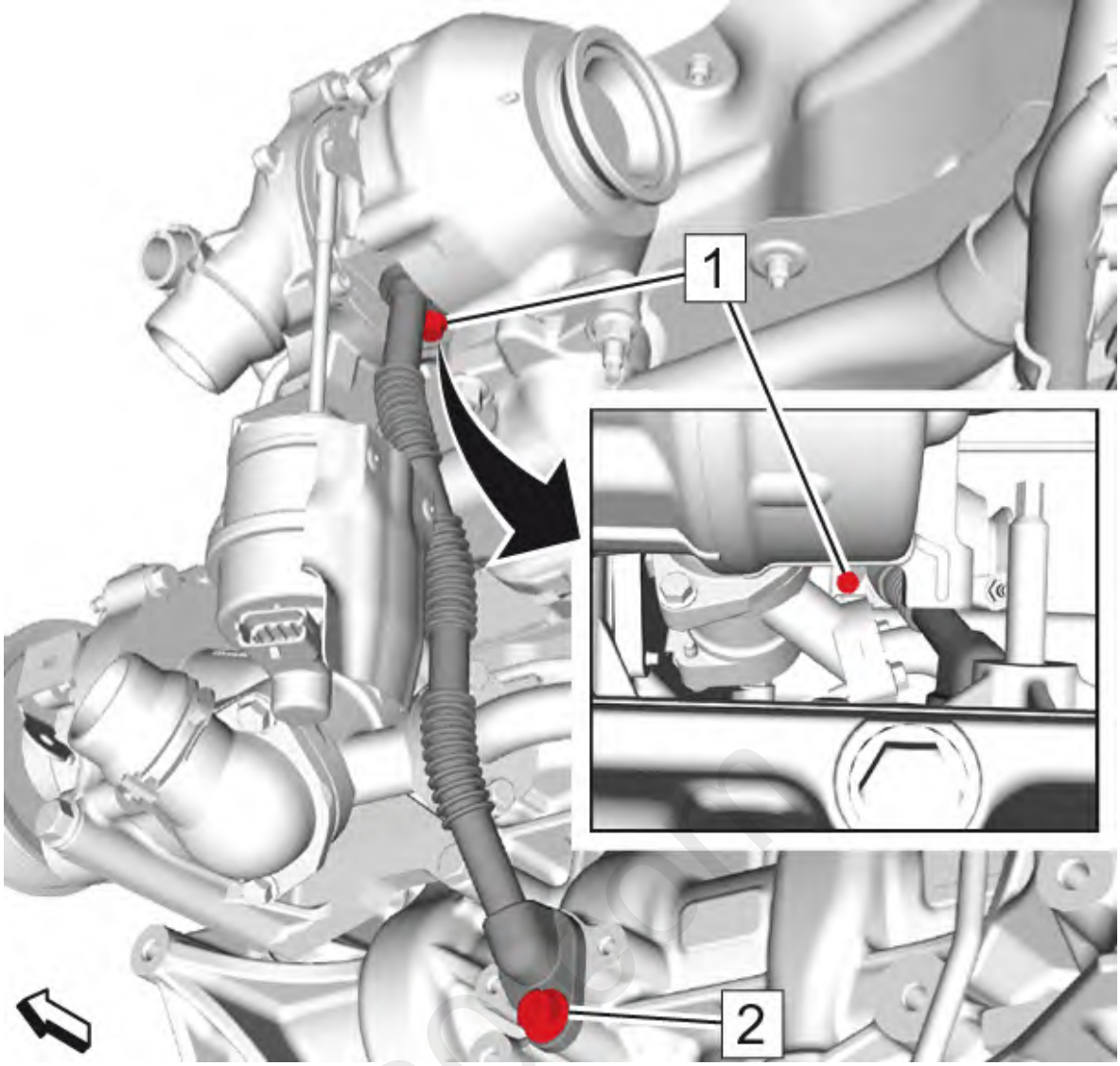


Fig. 597: Turbocharger Oil Return Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove Turbocharger Oil Return Pipe Bolt (1)
5. Loosen Turbocharger Oil Return Pipe Bolt (2)

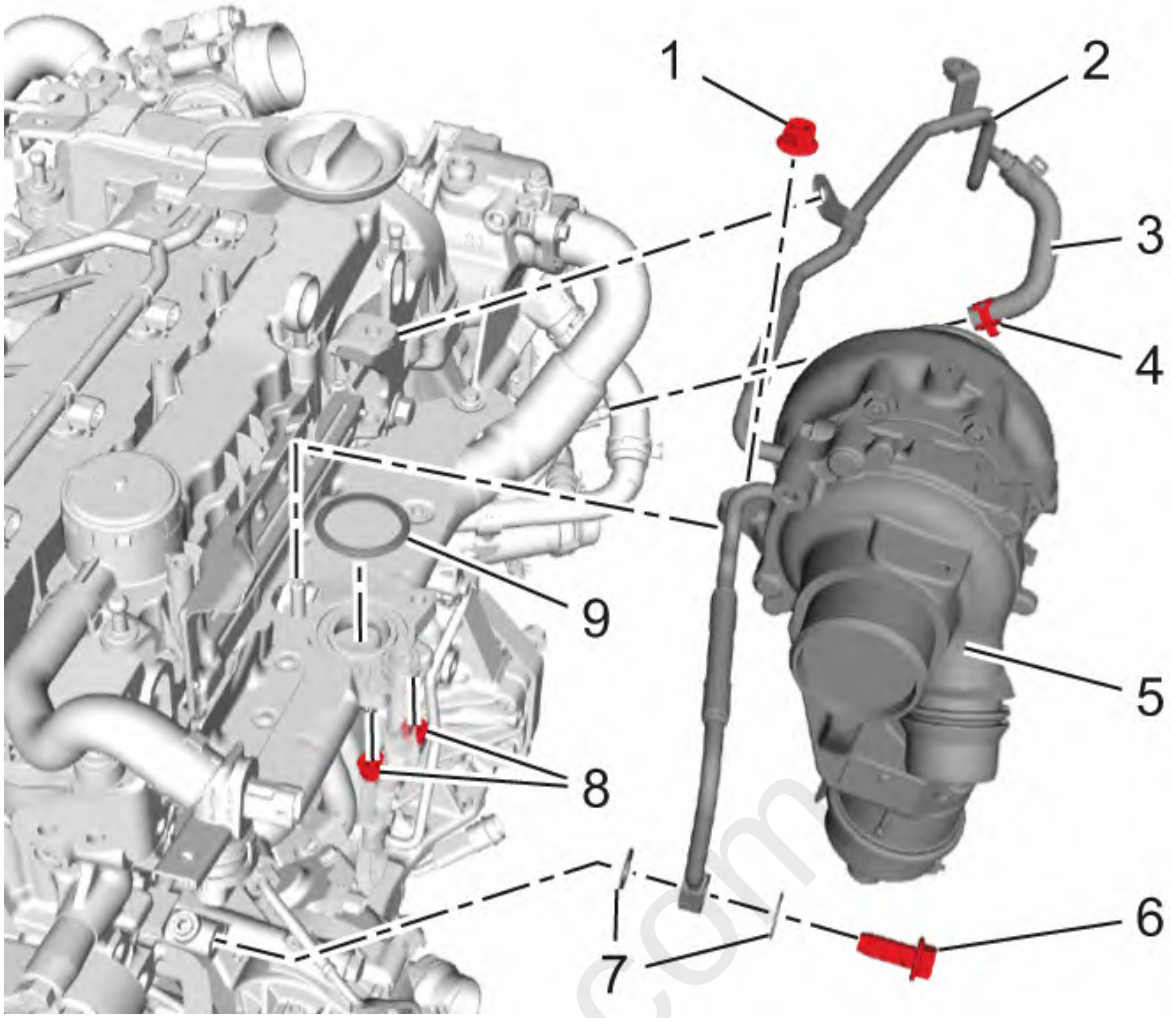


Fig. 598: Turbocharger And Components
Courtesy of GENERAL MOTORS COMPANY

6. Loosen Thermostat Bypass Hose Clamp (4)
7. Disconnect Thermostat Bypass Hose (3) @ Thermostat Bypass Pipe
8. Remove Turbocharger Coolant Feed Pipe Hollow Screw (6)
9. Remove and DISCARD Turbocharger Coolant Feed Pipe Gasket (7) (Qty: 2)
10. Remove Turbocharger Nuts (1, 8) (Qty: 3)
11. Pull the turbocharger (5) slightly upwards and remove the turbocharger oil return pipe from the turbocharger.
12. Remove Turbocharger (5) @ Exhaust Manifold
13. Remove and DISCARD Turbocharger Gasket (9)

EXHAUST GAS RECIRCULATION COOLER TEMPERATURE SENSOR REMOVAL - POSITION 1

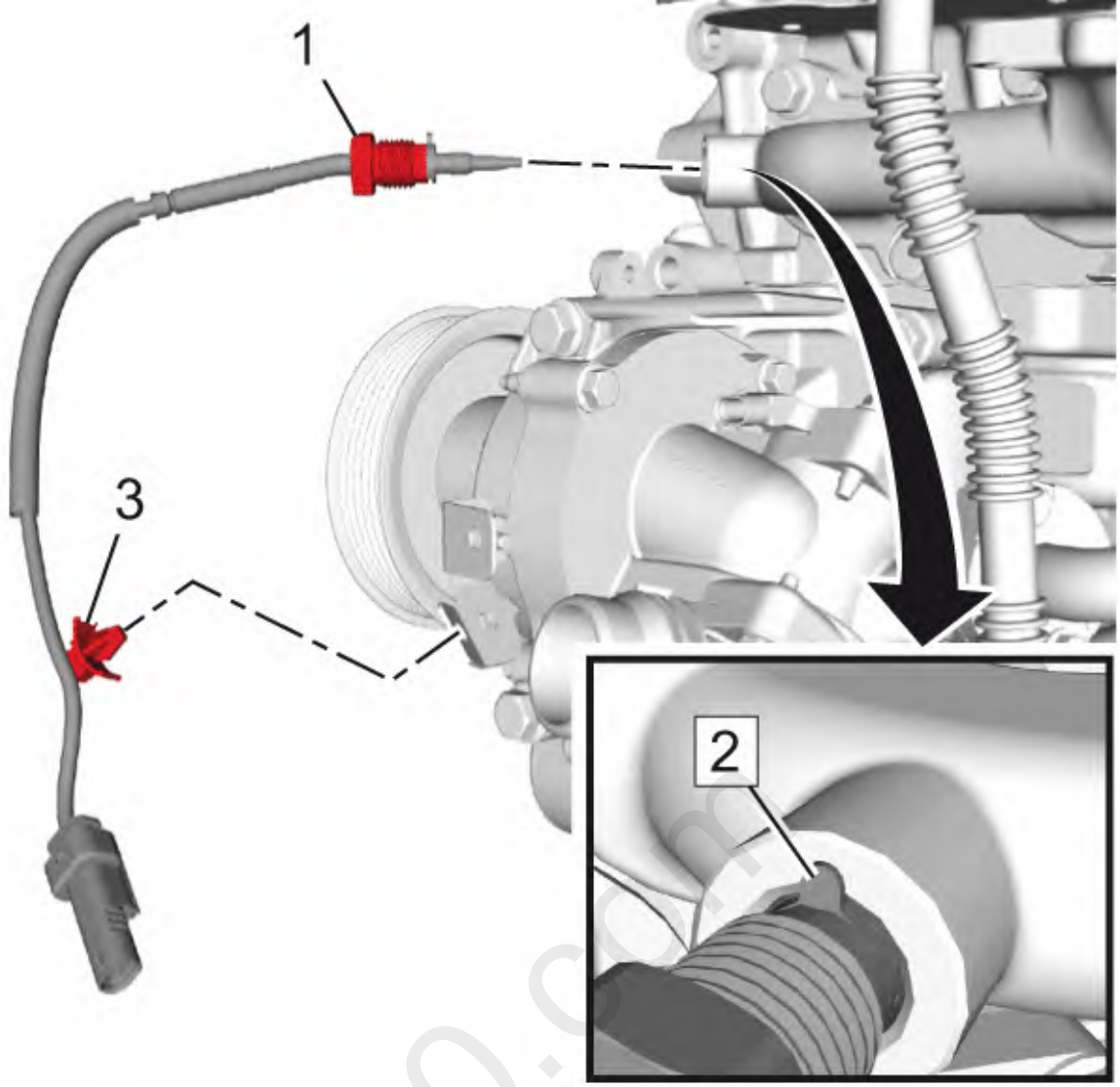


Fig. 599: Exhaust Gas Recirculation Cooler Temperature Sensor - Position 1 And Clip
Courtesy of GENERAL MOTORS COMPANY

1. Unclip Wiring Harness Clip (3)
2. Remove Exhaust Gas Recirculation Cooler Temperature Sensor-Position 1 (1)

EXHAUST MANIFOLD REMOVAL

mcx30.com

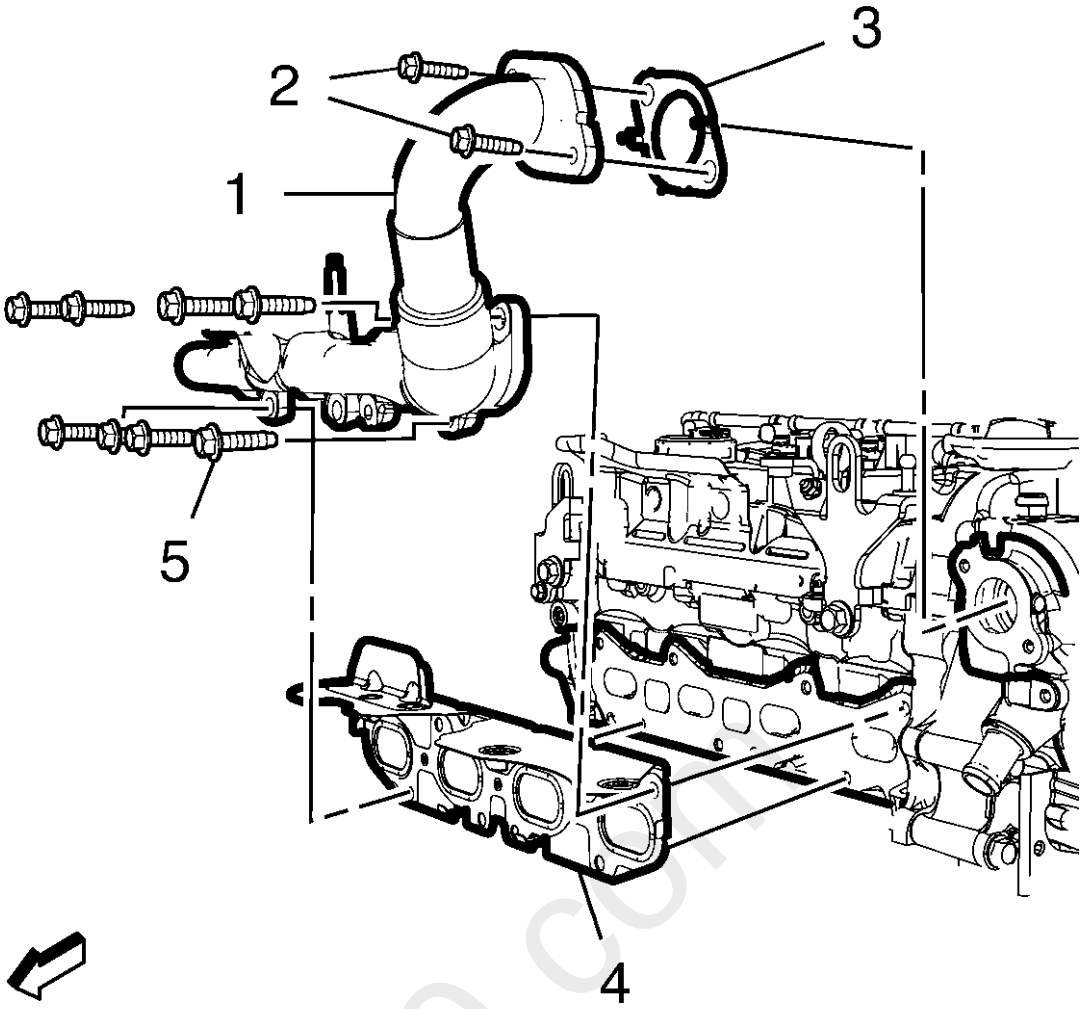


Fig. 600: Exhaust Manifold Components
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 2 exhaust gas recirculation pipe bolts (2).
2. Remove and DISCARD the 8 exhaust manifold bolts (5).

NOTE: **Do not bend the exhaust gas recirculation pipe.**

3. Remove the exhaust manifold (1).
4. Remove and DISCARD the exhaust manifold gasket (4).
5. Remove and DISCARD the exhaust gas recirculation pipe gasket (3).

THERMOSTAT BYPASS PIPE REMOVAL

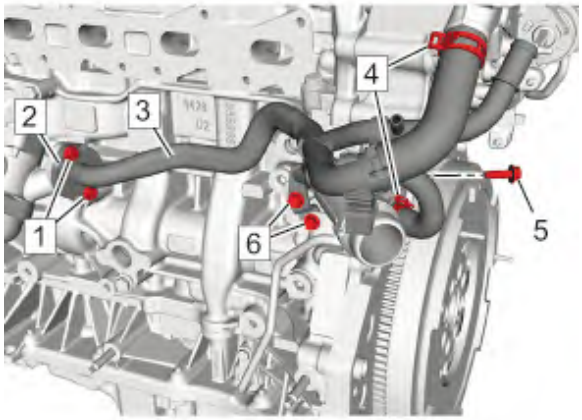


Fig. 601: Thermostat Bypass Pipe Components
Courtesy of GENERAL MOTORS COMPANY

1. Release Clamps (4) (Qty: 2)
2. Remove Thermostat Bypass Pipe Bolts (1) (Qty: 2)
3. Remove the 3 thermostat bypass pipe bracket bolts (5, 6).
4. Remove Thermostat Bypass Pipe (3)
5. Remove and DISCARD Gasket (2)

WATER PUMP REMOVAL

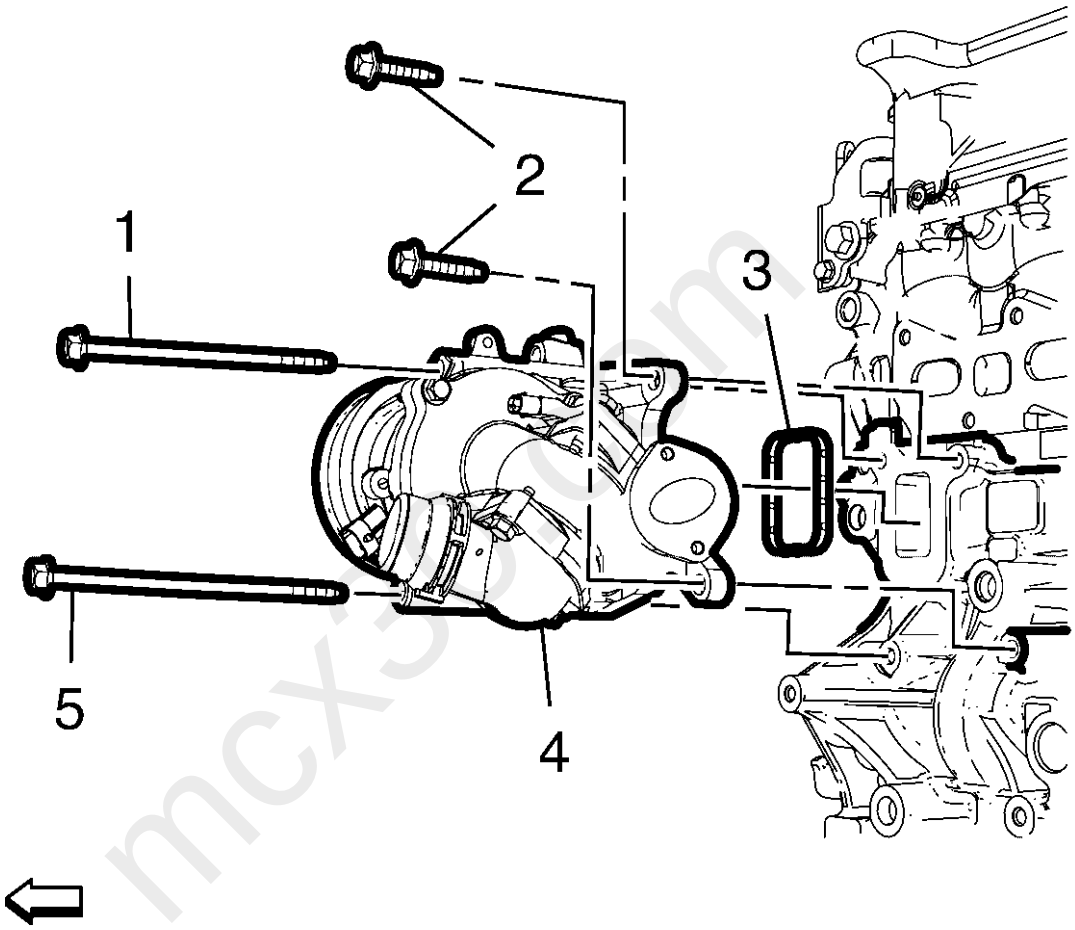


Fig. 602: Water Pump And Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Different bolt length.**

1. Remove the 4 water pump bolts (1, 2, 5).
2. Remove the water pump (4).
3. Remove and DISCARD the water pump seal (3).

ENGINE COOLANT OUTLET PIPE REMOVAL

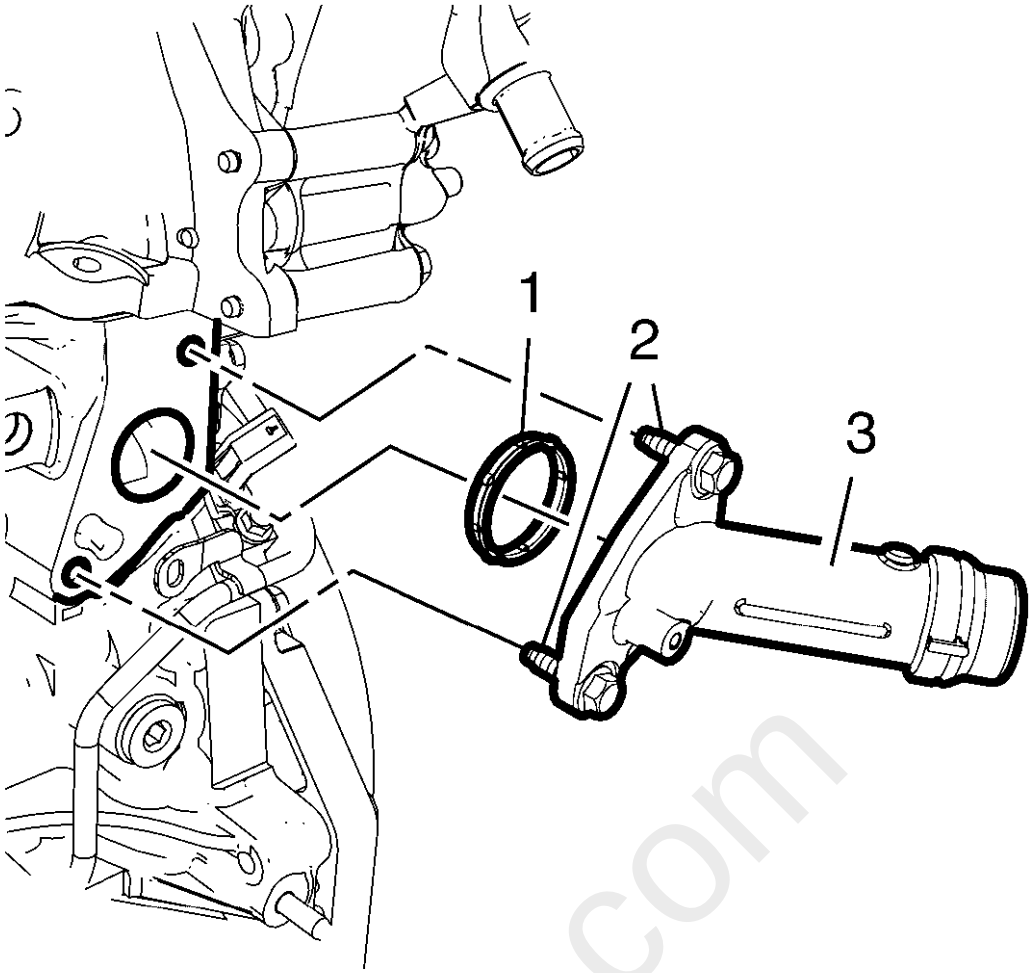


Fig. 603: Engine Coolant Outlet Pipe And Components
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 2 engine coolant outlet pipe bolts (2).
2. Remove the engine coolant outlet pipe (3).
3. Remove and DISCARD the engine coolant outlet pipe seal (1).

EXHAUST GAS RECIRCULATION COOLER TEMPERATURE SENSOR REMOVAL - POSITION 2

mcx30.com

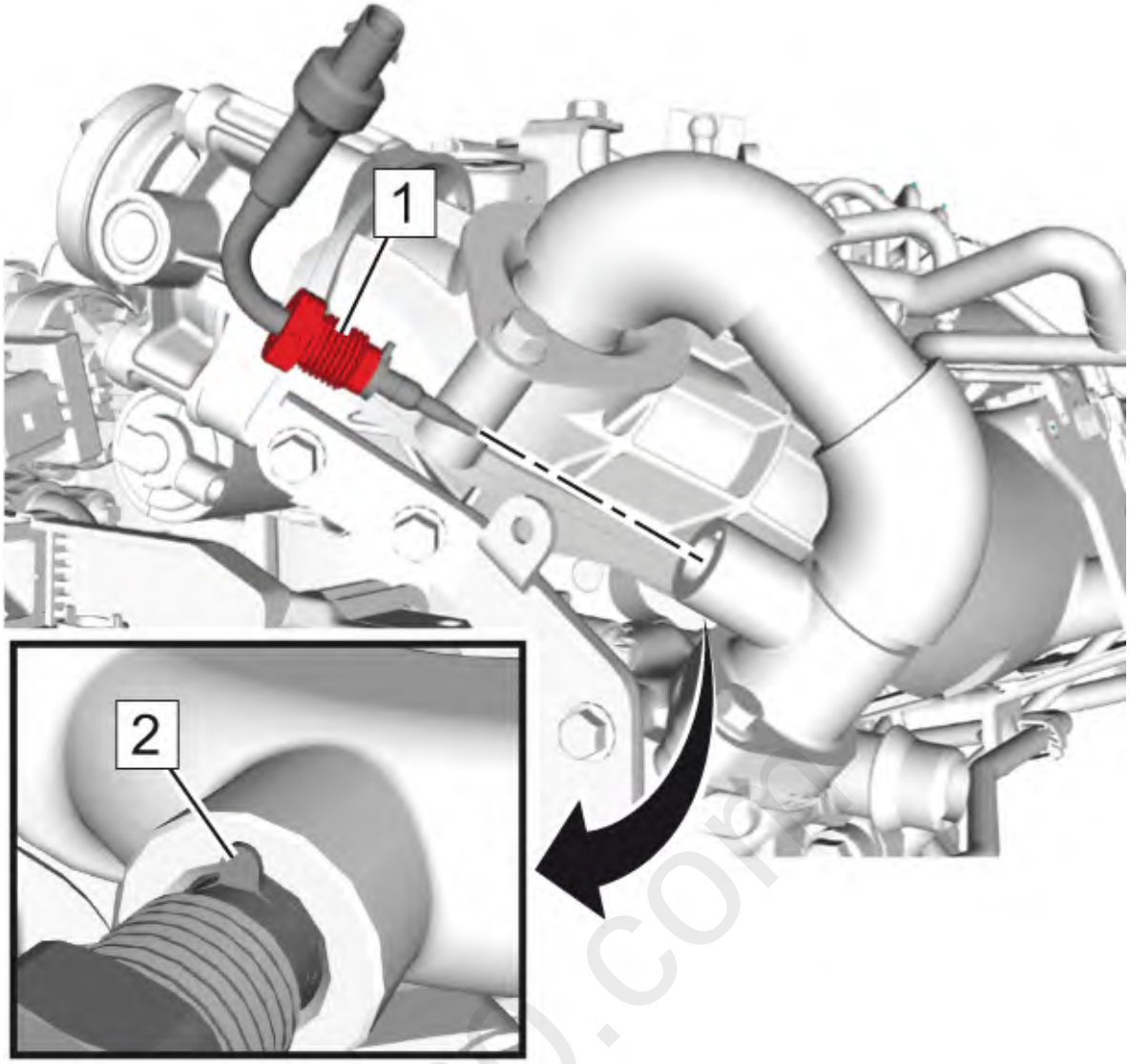


Fig. 604: Exhaust Gas Recirculation Cooler Temperature Sensor - Position 2
Courtesy of GENERAL MOTORS COMPANY

Remove Exhaust Gas Recirculation Cooler Temperature Sensor - Position 2 (1)

EXHAUST GAS RECIRCULATION COOLER OUTLET PIPE REMOVAL

mcx30.com

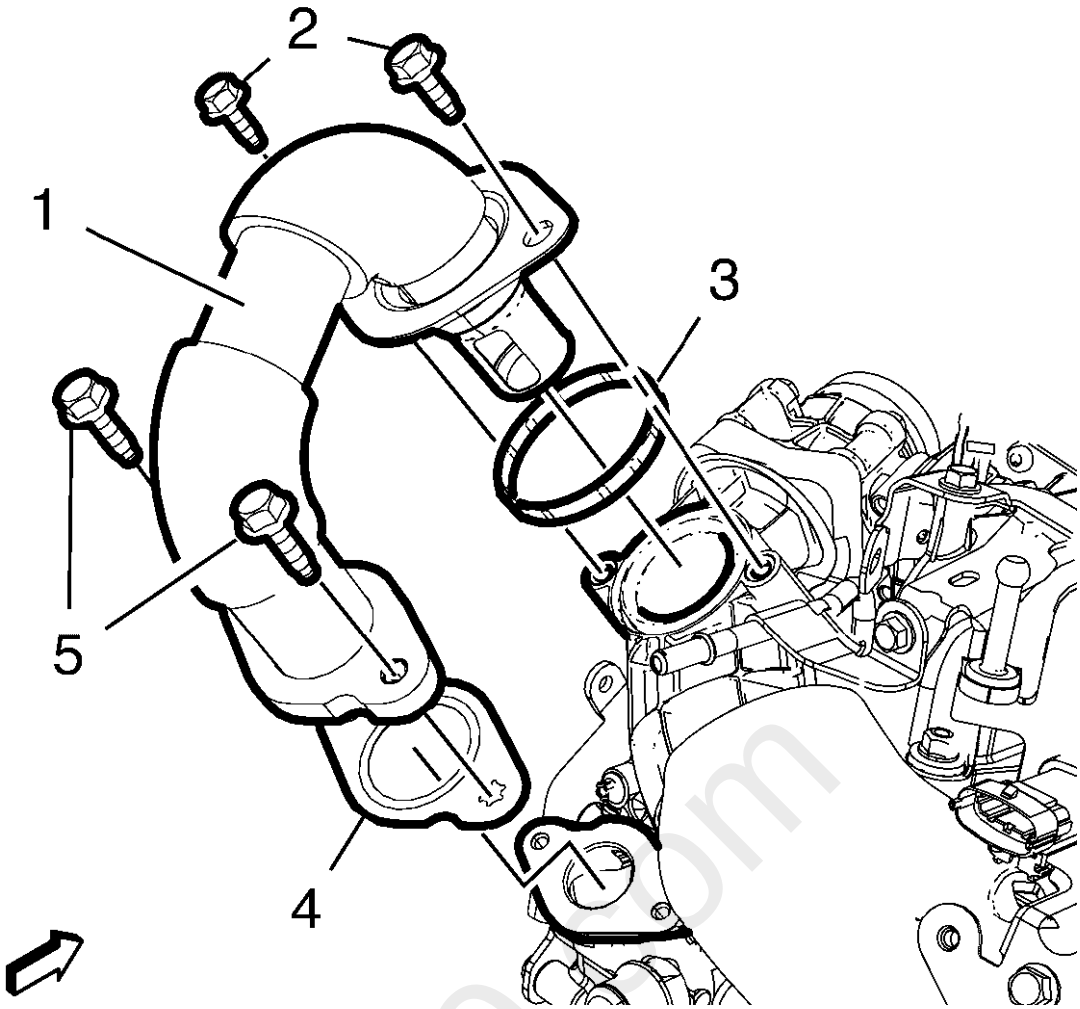


Fig. 605: Exhaust Gas Recirculation Cooler Outlet Pipe And Components
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 4 exhaust gas recirculation cooler outlet pipe bolts (2, 5).
2. Remove the exhaust gas recirculation cooler outlet pipe (1).
3. Remove the exhaust gas recirculation cooler outlet pipe seal (3).
4. Remove and DISCARD the exhaust gas recirculation cooler outlet pipe gasket (4).

INTAKE MANIFOLD BRACE REMOVAL

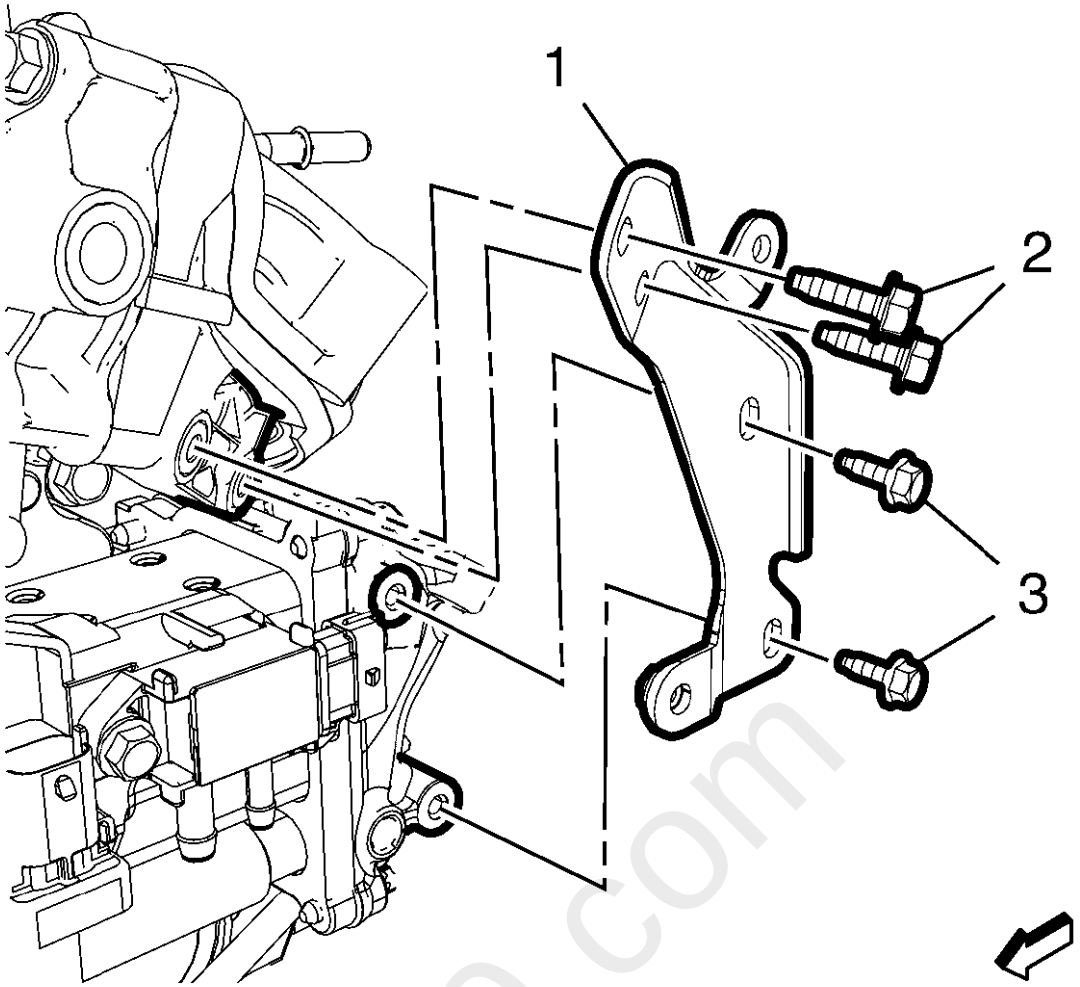


Fig. 606: Intake Manifold Brace And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 4 intake manifold brace bolts (2, 3).
2. Remove the intake manifold brace (1).

EXHAUST GAS RECIRCULATION COOLER HOUSING REMOVAL

mcx30.com

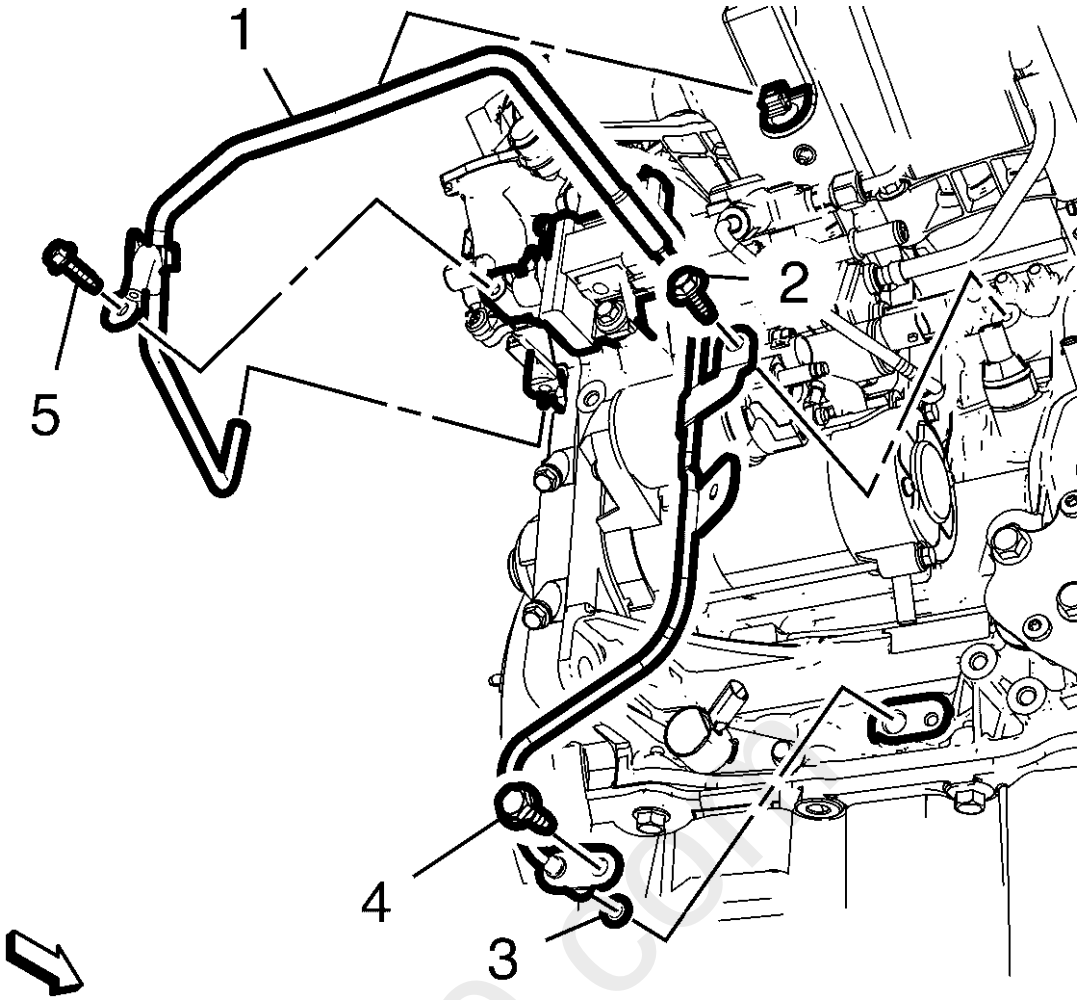


Fig. 607: Charge Air Bypass Regulator Solenoid Valve Vacuum Tube Components
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 3 charge air bypass valve vacuum hose bracket bolts (2, 4, 5).
2. Disconnect the charge air bypass valve vacuum hose (1) from the exhaust gas recirculation vacuum regulator solenoid valve.
3. Unclip the charge air bypass valve vacuum hose retainer clip.
4. Remove the charge air bypass valve vacuum hose (1).
5. Remove the charge air bypass valve vacuum hose seal (3).

mcx30.com

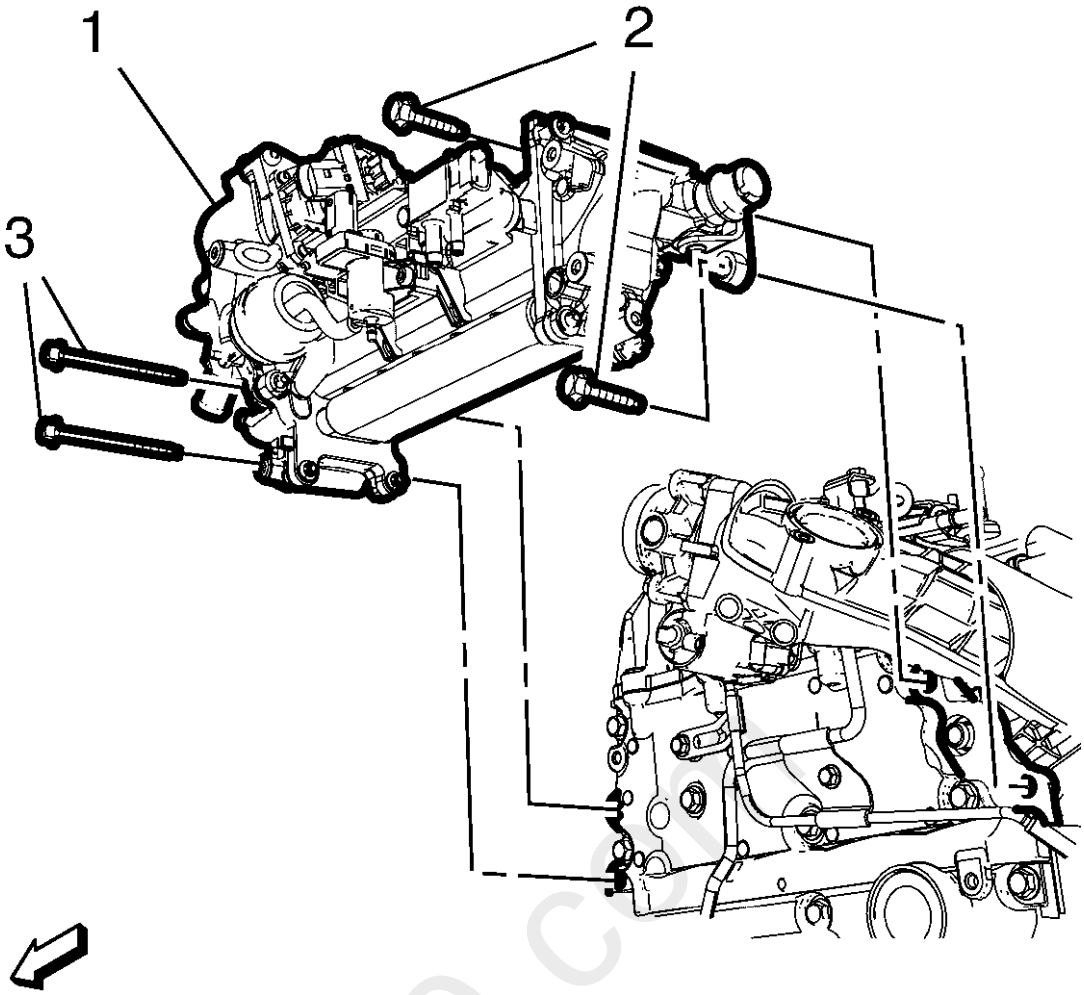


Fig. 608: Exhaust Gas Recirculation Cooler Housing And Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the 4 exhaust gas recirculation cooler housing bolts (2, 3).
7. Remove the exhaust gas recirculation cooler housing (1).
8. Remove the exhaust gas recirculation cooler housing gasket.

THROTTLE BODY ASSEMBLY REMOVAL

mcx30.com

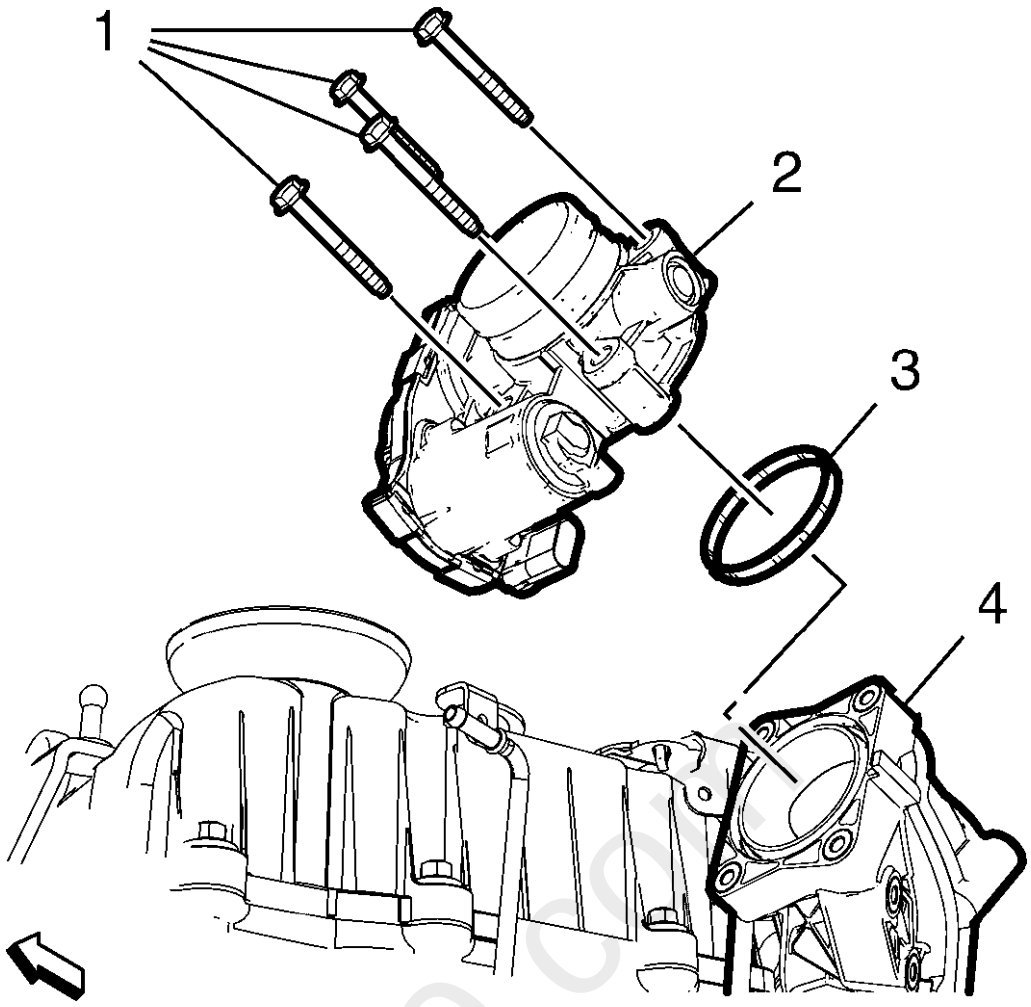


Fig. 609: Throttle Body Assembly, Bolts, Gasket And Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 4 throttle body assembly bolts (1).
2. Remove the throttle body assembly (2) from the intake manifold (4).
3. Remove the throttle body assembly gasket (3).

FUEL RETURN HOSE REMOVAL

mcx30.com

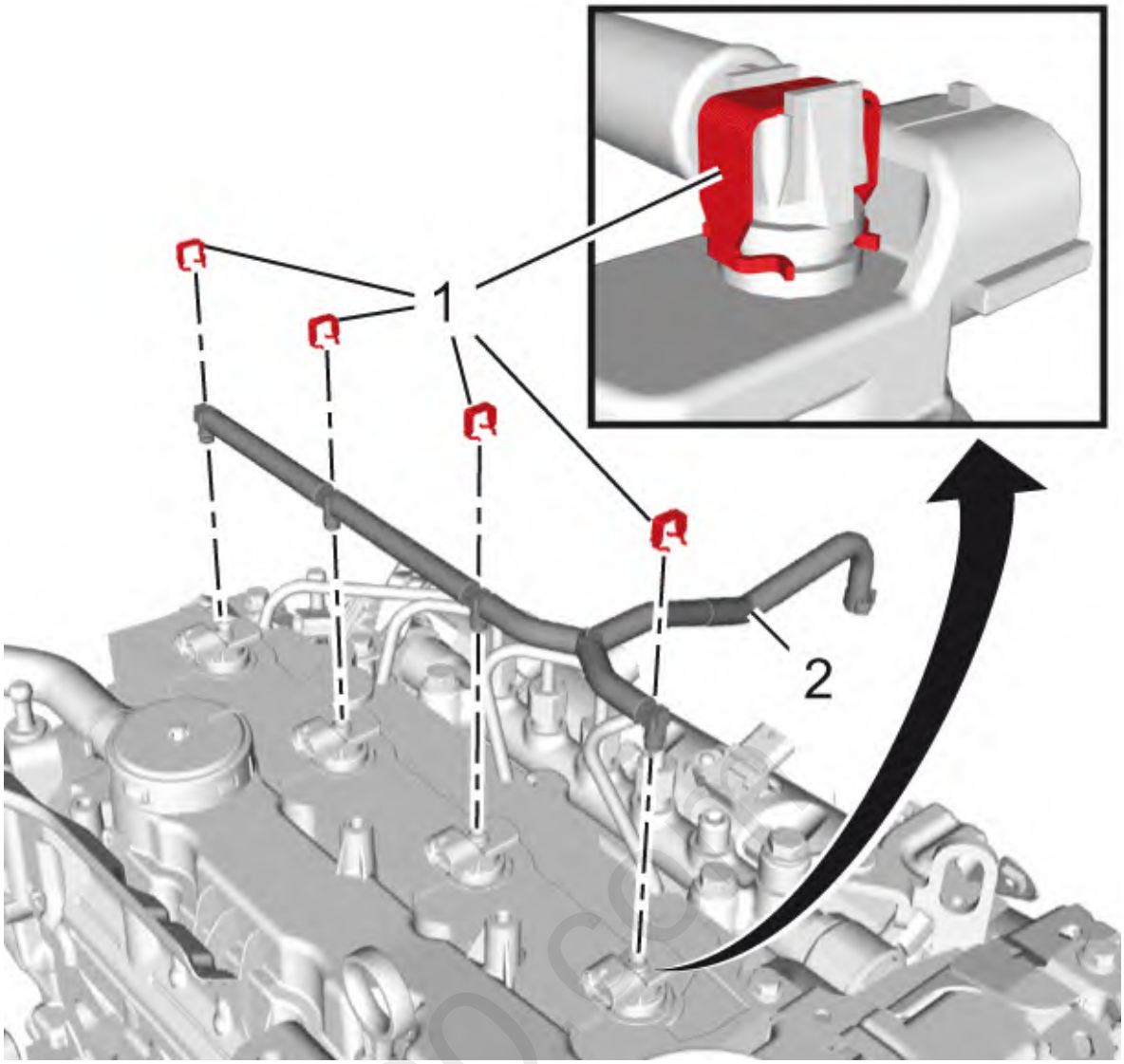


Fig. 610: Fuel Return Hose And Clamps
Courtesy of GENERAL MOTORS COMPANY

1. Remove and DISCARD Fuel Return Hose Clamps (1) (Qty: 4)
2. Unclip Fuel Return Hose (2) @ Fuel Injectors (Qty: 4)
3. Remove Fuel Return Hose (2)

FUEL INJECTION FUEL FEED PIPE REMOVAL - FUEL INJECTION PUMP TO FUEL RAIL

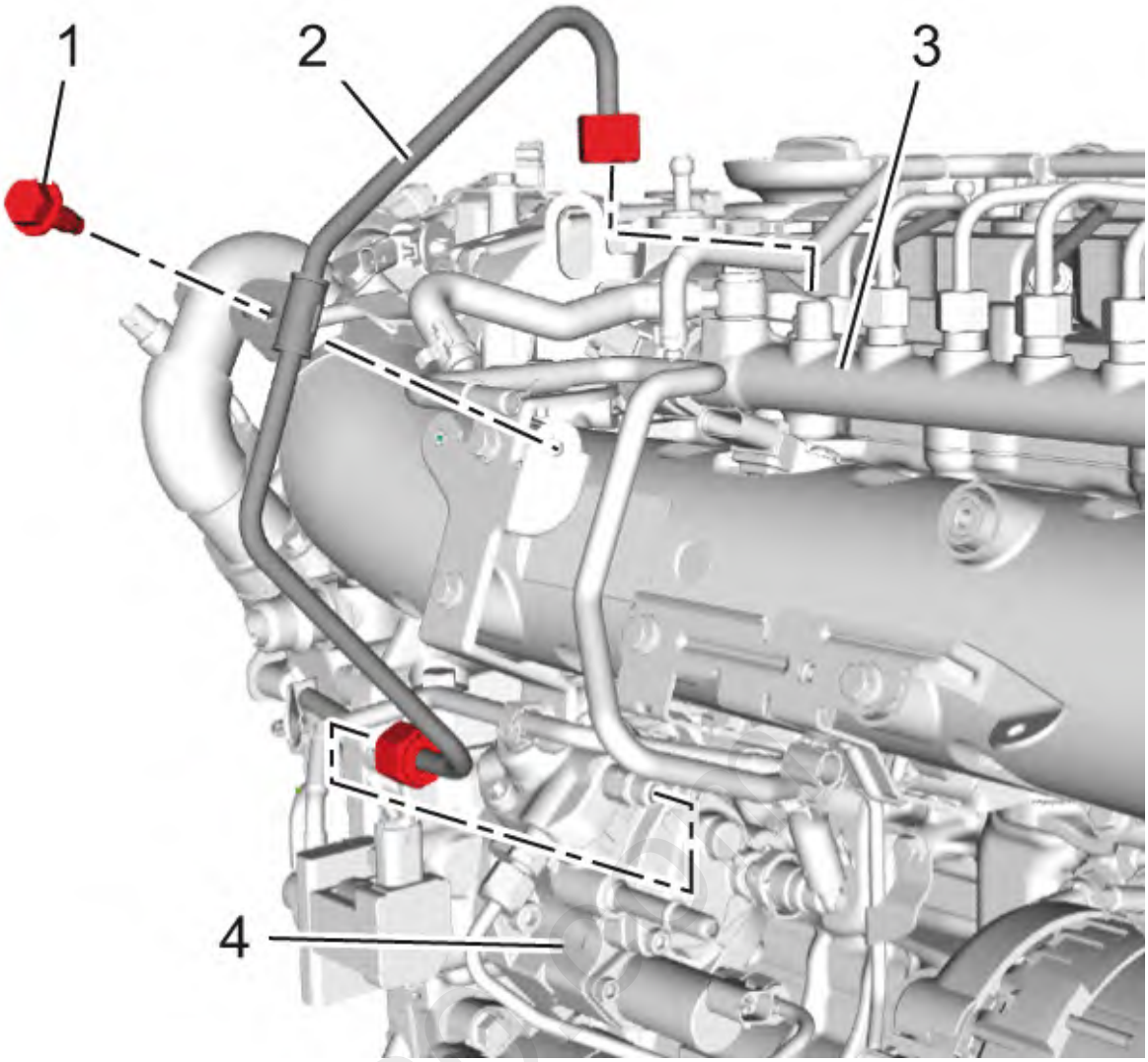


Fig. 611: Fuel Injection Fuel Feed Pipe And Components - Fuel Injection Pump to Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

1. Remove Fuel Injection Fuel Feed Pipe Bracket Bolt (1)
2. Loosen Fuel Injection Fuel Feed Pipe (2) @ Fuel Rail (3)

NOTE: **Counterhold at the fuel injection pump hexagon connector.**

3. Loosen Fuel Injection Fuel Feed Pipe (2) @ Fuel Injection Pump (4)
4. Remove and DISCARD Fuel Injection Fuel Feed Pipe (2)

DIESEL FUEL SEPARATOR REMOVAL

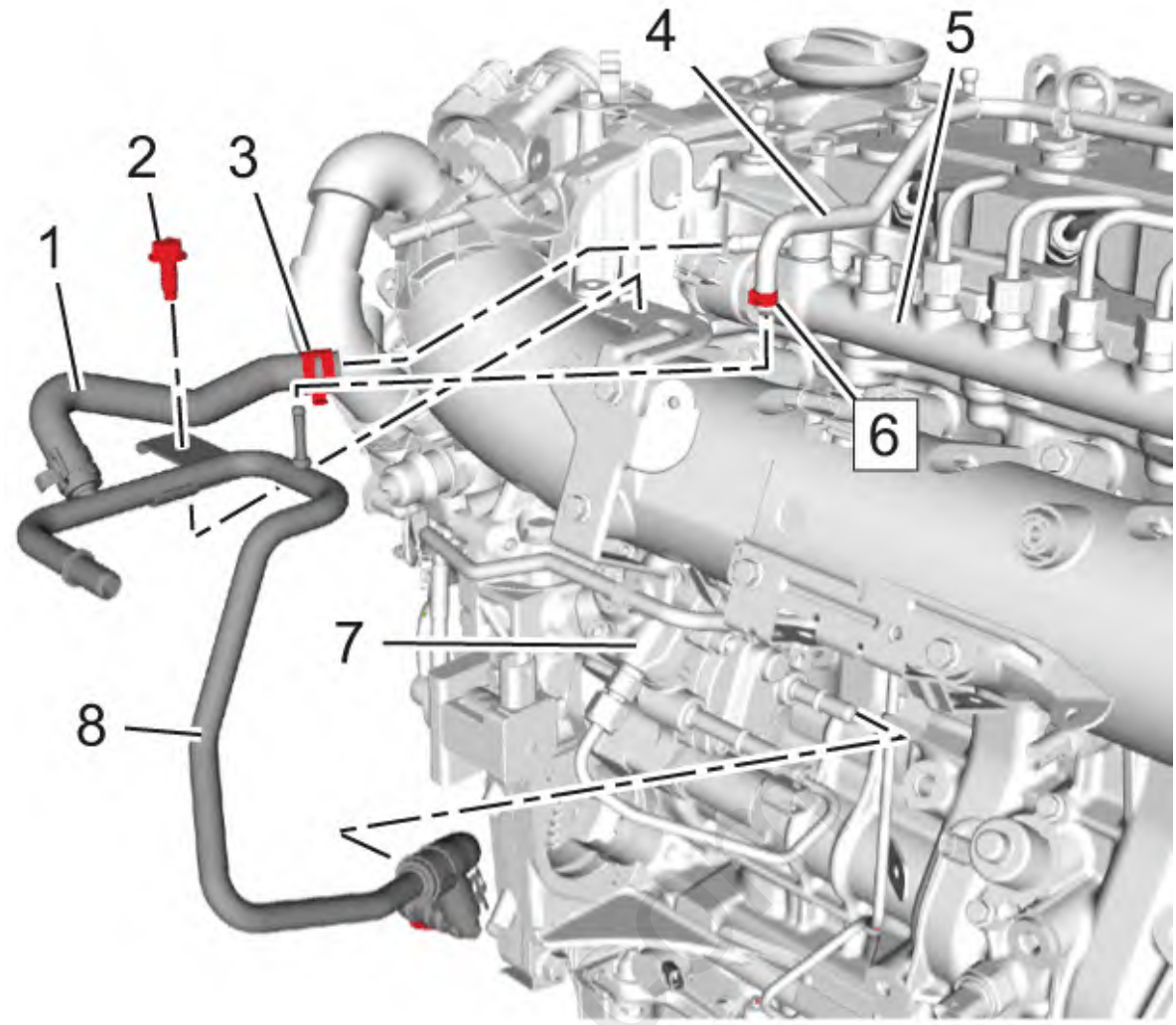


Fig. 612: Diesel Fuel Separator And Components
Courtesy of GENERAL MOTORS COMPANY

1. Loosen Diesel Fuel Separator Hose Clamp (3)
2. Disconnect Diesel Fuel Separator Hose (1) @ Fuel Rail (5)
3. Remove and DISCARD Clamp (6)
4. Disconnect Fuel Return Hose (4) @ Diesel Fuel Separator (8)
5. Remove Diesel Fuel Separator Bolt (2)
6. Disconnect Diesel Fuel Separator (8) @ Fuel Injection Pump (7). Refer to **Plastic Collar Quick Connect Fitting Service**

INTAKE MANIFOLD REMOVAL

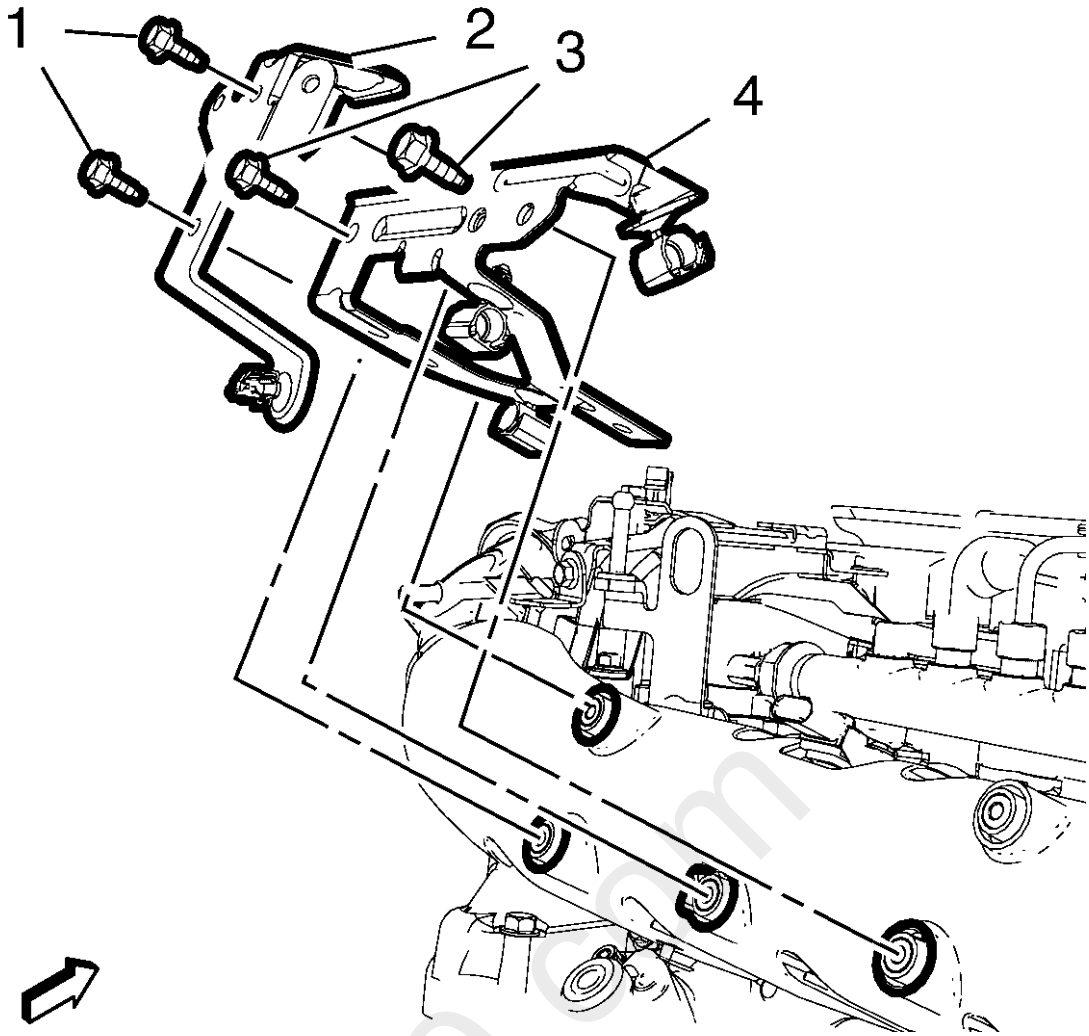


Fig. 613: Fuel Rail Fuel Pressure Sensor Wiring Harness Bracket, Fuel Rail Return Pipe Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 2 fuel rail fuel pressor sensor wiring harness bracket bolts (1).
2. Remove the fuel rail fuel pressor sensor wiring harness bracket (2).
3. Remove the 2 fuel rail return pipe bracket bolts (3).
4. Remove the fuel rail return pipe bracket (4).

mx30.com

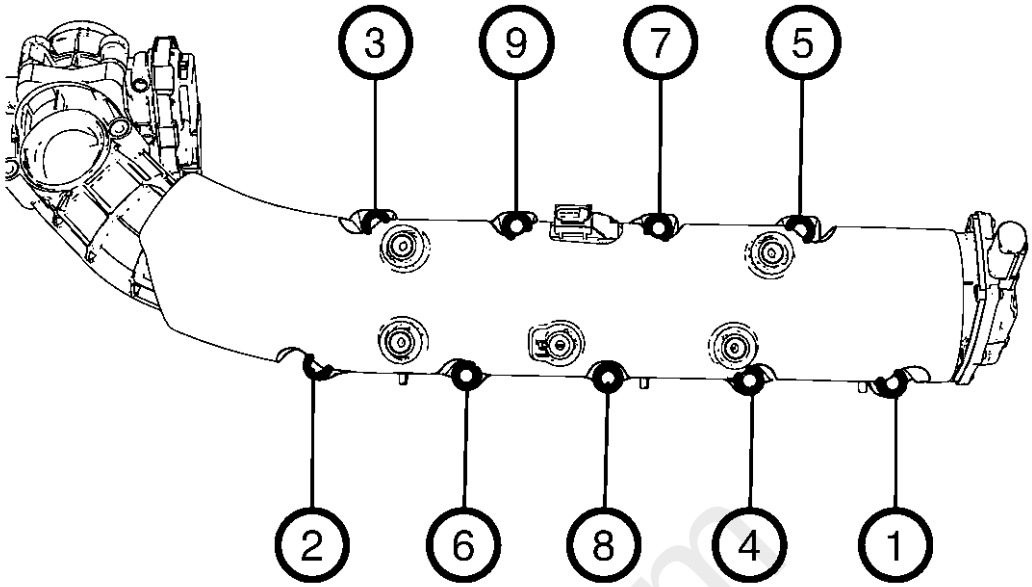


Fig. 614: Intake Manifold Bolt Loosening Sequence
Courtesy of GENERAL MOTORS COMPANY

5. Loosen 9 intake manifold bolts in the sequence as shown.

mcx30.com

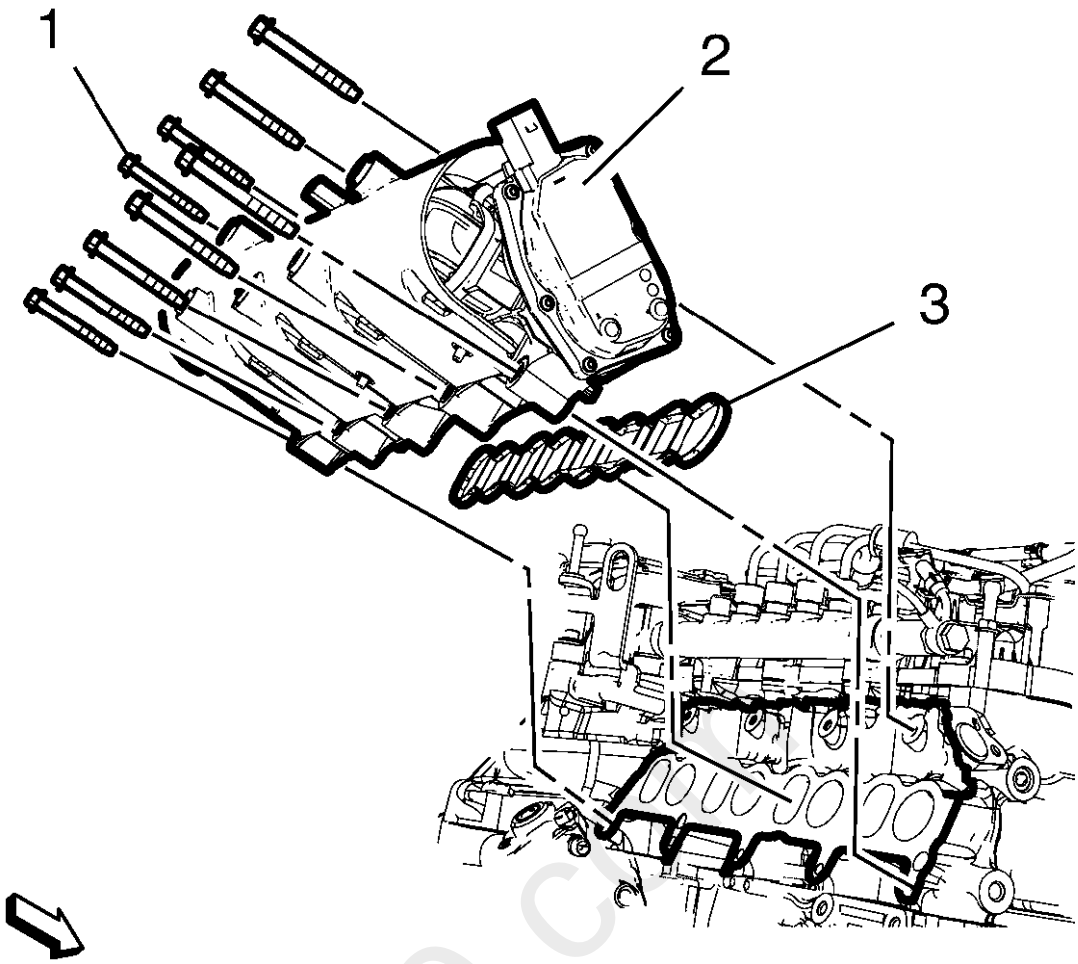


Fig. 615: Intake Manifold, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

6. Remove the 9 intake manifold bolts (1).
7. Remove the intake manifold (2).
8. Remove and DISCARD the intake manifold gasket (3).

CHARGE AIR BYPASS REGULATOR SOLENOID VALVE VACUUM TUBE REMOVAL

mcx20.com

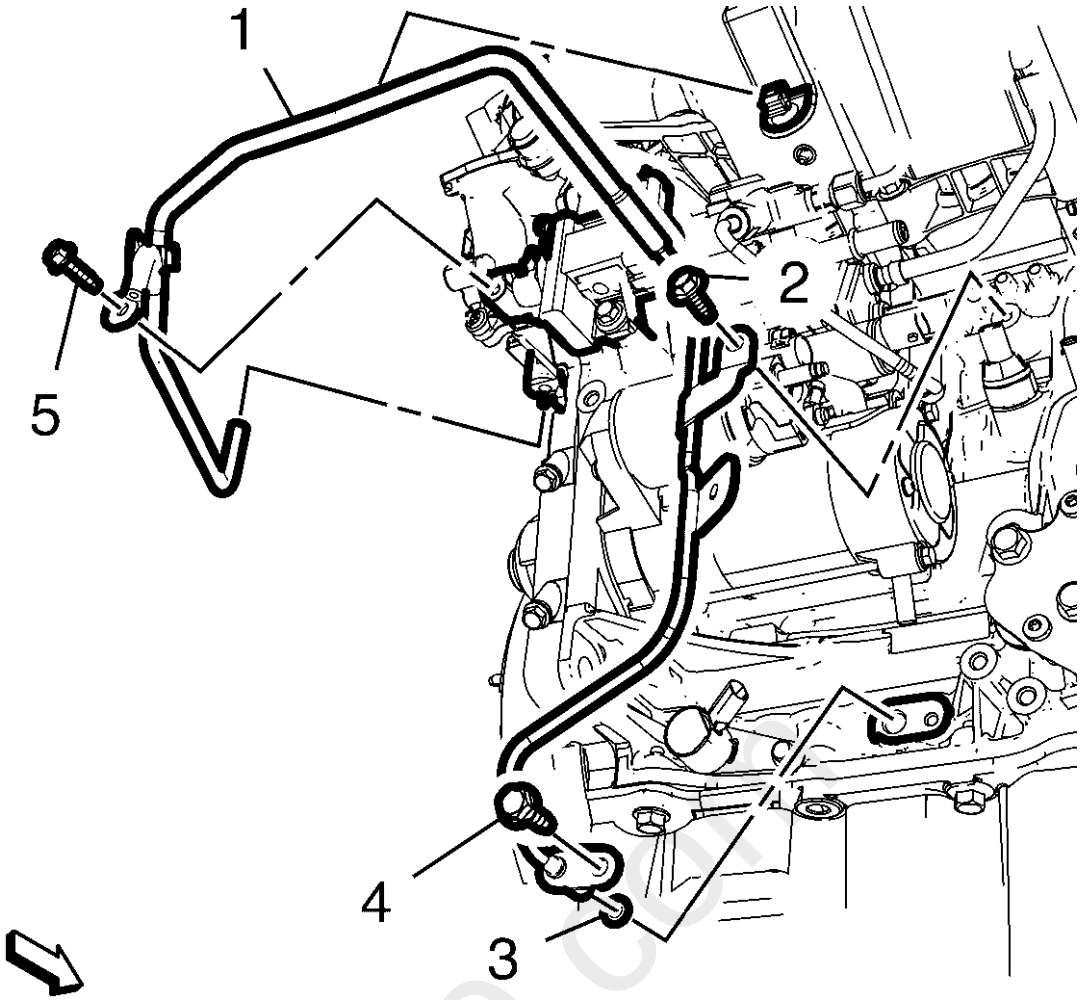


Fig. 616: Charge Air Bypass Regulator Solenoid Valve Vacuum Tube Components
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 3 charge air bypass valve vacuum hose bracket bolts (2, 4, 5).
2. Disconnect the charge air bypass valve vacuum hose (1) from the exhaust gas recirculation vacuum regulator solenoid valve.
3. Unclip the charge air bypass valve vacuum hose retainer clip.
4. Remove the charge air bypass valve vacuum hose (1).
5. Remove the charge air bypass valve vacuum hose seal (3).

POWER BRAKE BOOSTER INLET HOSE CONNECTOR FITTING REMOVAL

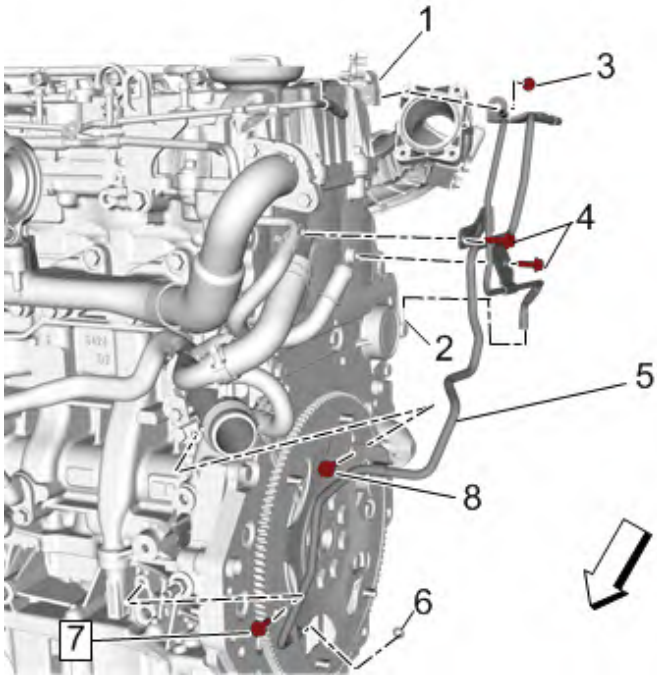


Fig. 617: Power Brake Booster Inlet Hose Connector Fitting And Components
Courtesy of GENERAL MOTORS COMPANY

1. Remove the power brake booster inlet hose connector fitting bracket bolt (3) from the exhaust temperature sensor wiring harness bracket (1).
2. Remove the 2 power brake booster inlet hose connector fitting bolts (4)
3. Remove the power brake booster inlet hose from the turbocharger wastegate actuator vacuum control solenoid valve (2).
4. Remove the power brake booster inlet hose connector fitting bolt (7) from the lower crankcase.
5. Remove the power brake booster inlet hose connector fitting (5).
6. Remove the power brake booster inlet hose connector fitting seal (6).

STARTER REMOVAL

mcx30.com

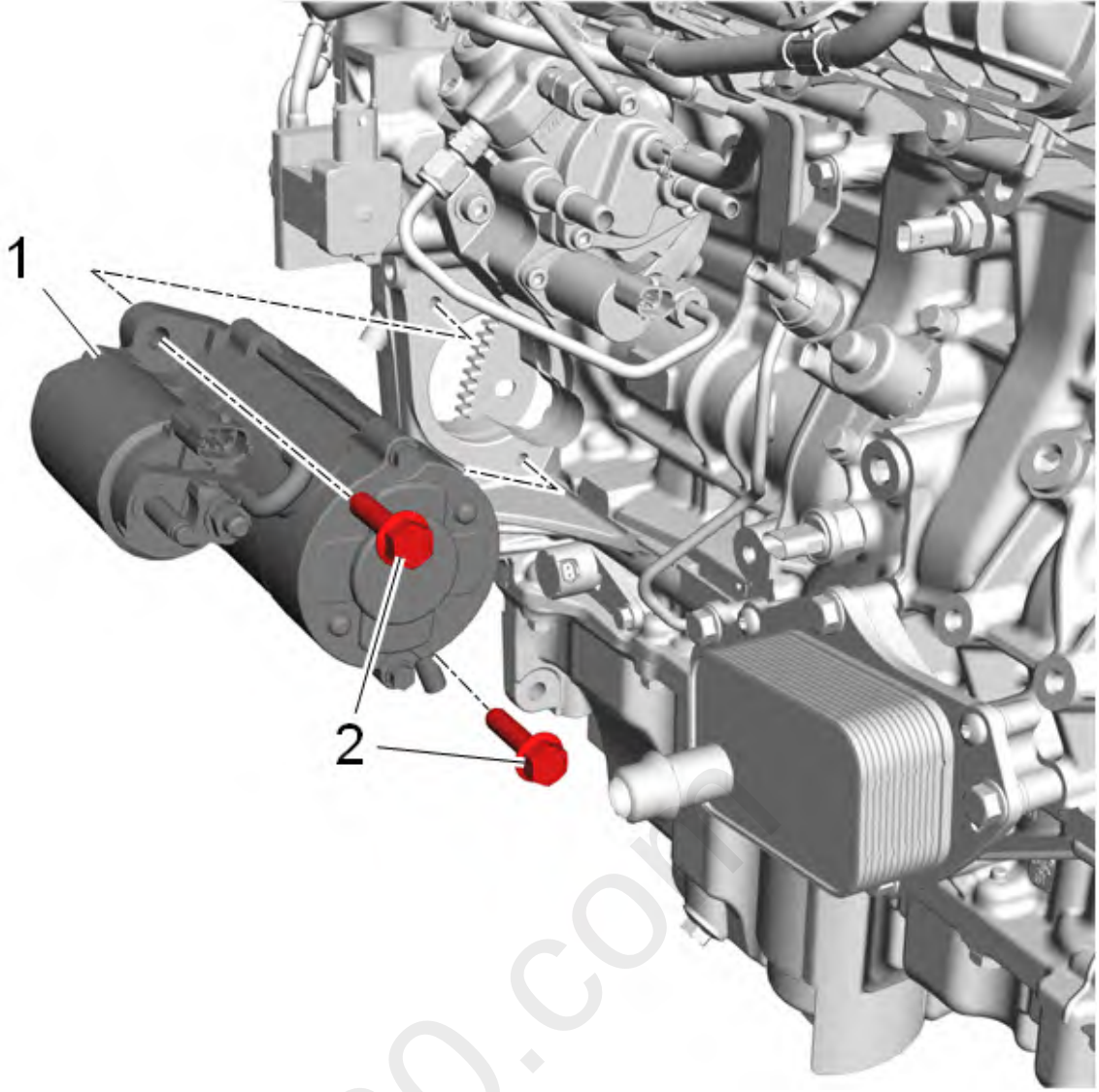


Fig. 618: Starter And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 2 starter bolts (2).
2. Remove the starter (1).

GENERATOR REMOVAL

mcx30.com

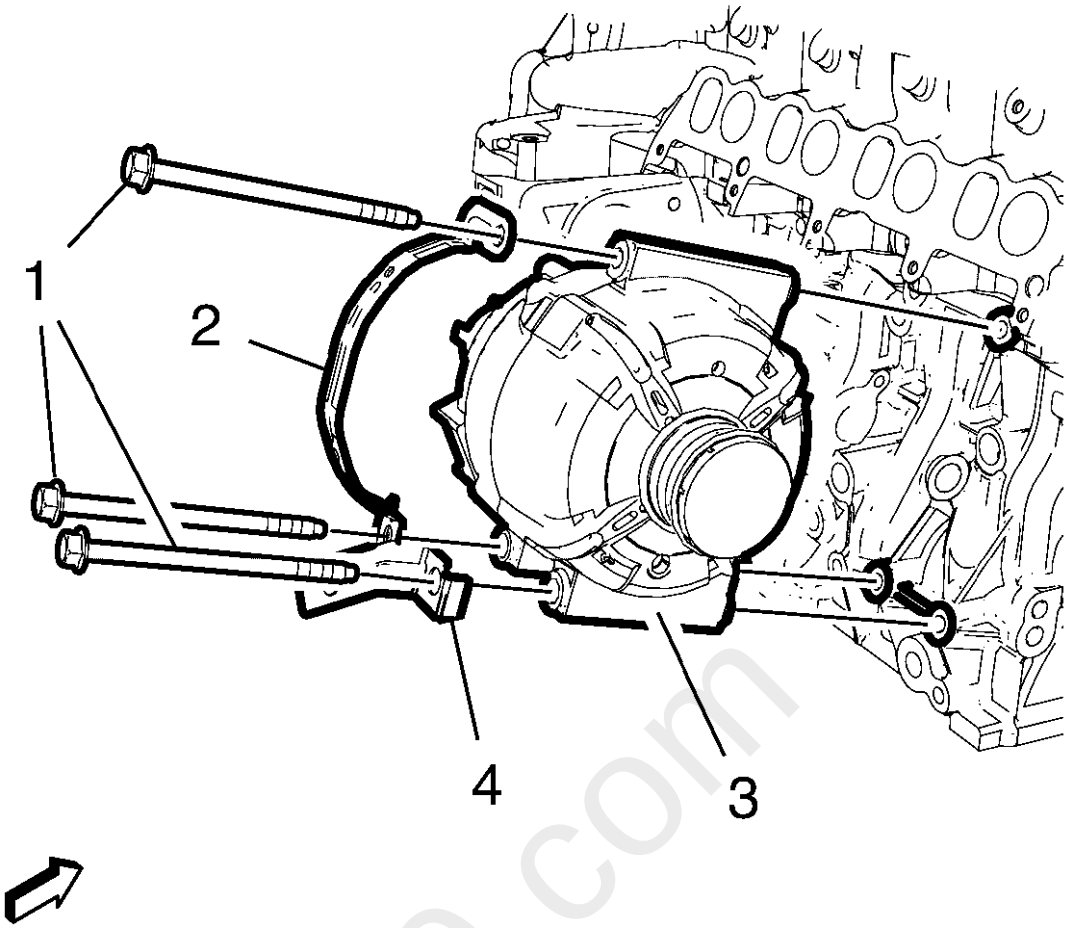


Fig. 619: Generator, Bolts And Wiring Brackets
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 3 generator bolts (1).
2. Remove the wiring harness bracket (2).
3. Remove the nitrogen oxide sensor wire bracket (4).
4. Remove the generator (3).

ENGINE OIL COOLER REMOVAL

mcx30.com

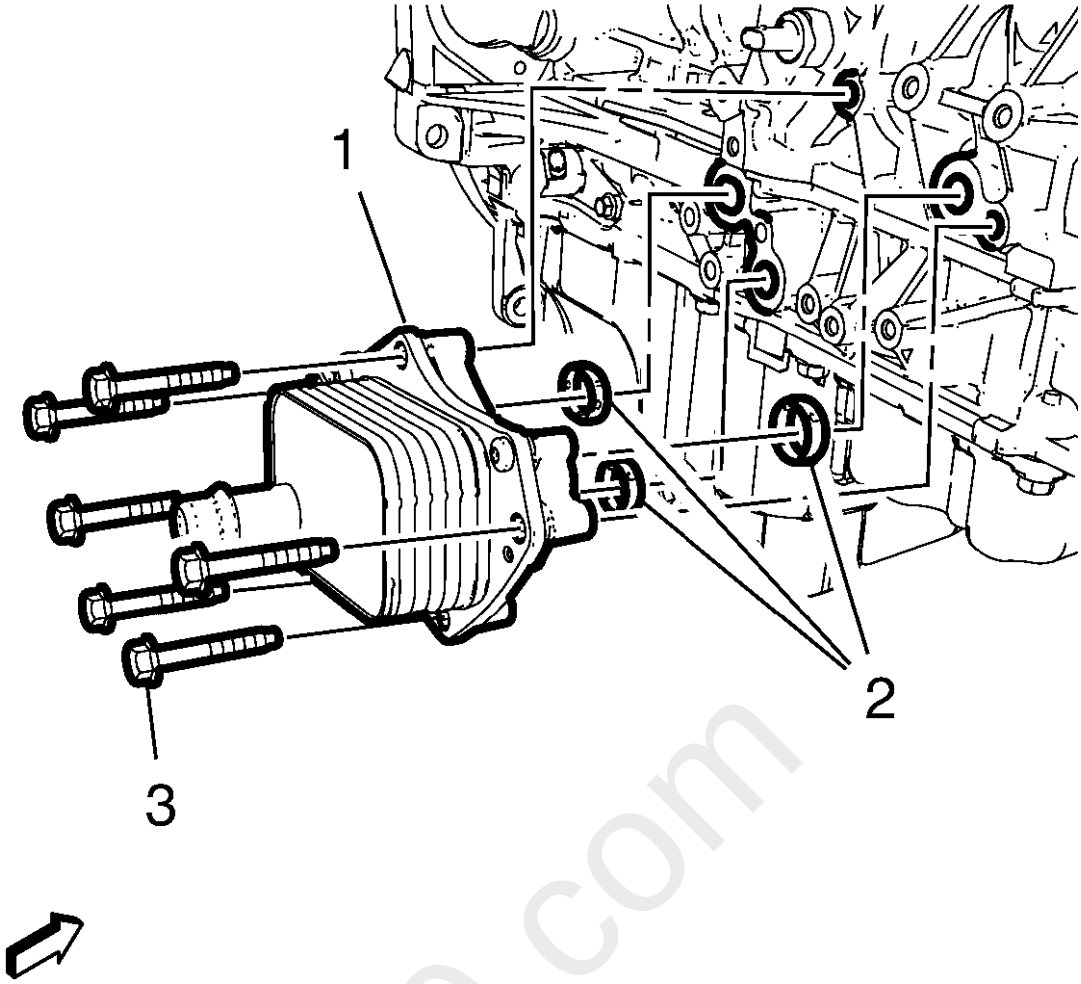


Fig. 620: Engine Oil Cooler, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 6 oil cooler bolts (3).
2. Remove and DISCARD the 3 oil cooler adapter gaskets (2).
3. Remove the oil cooler with oil cooler adapter (1).

FUEL INJECTION FUEL FEED PIPE REMOVAL - FUEL RAIL TO FUEL INJECTOR

mcx30.com

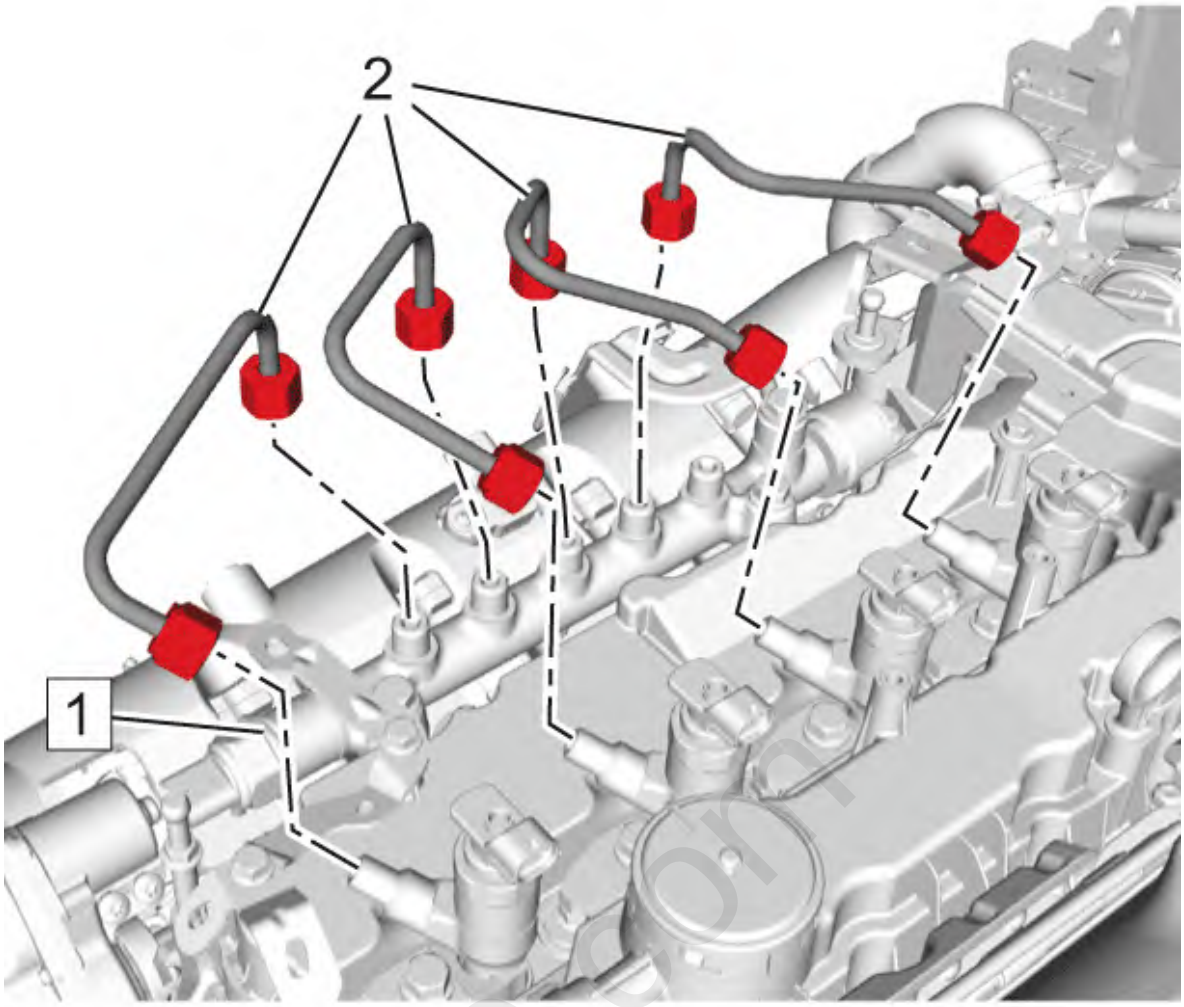


Fig. 621: Fuel Injection Fuel Feed Pipes And Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

1. Loosen Fuel Injection Fuel Feed Pipes (2) (Qty: 4) @ Fuel Rail (1)
2. Loosen Fuel Injection Fuel Feed Pipes (2) (Qty: 4) @ Fuel Injector (3)
3. Remove and DISCARD Fuel Injection Fuel Feed Pipes (2) (Qty: 4)

FUEL PRESSURE SENSOR REMOVAL

mcx30.com

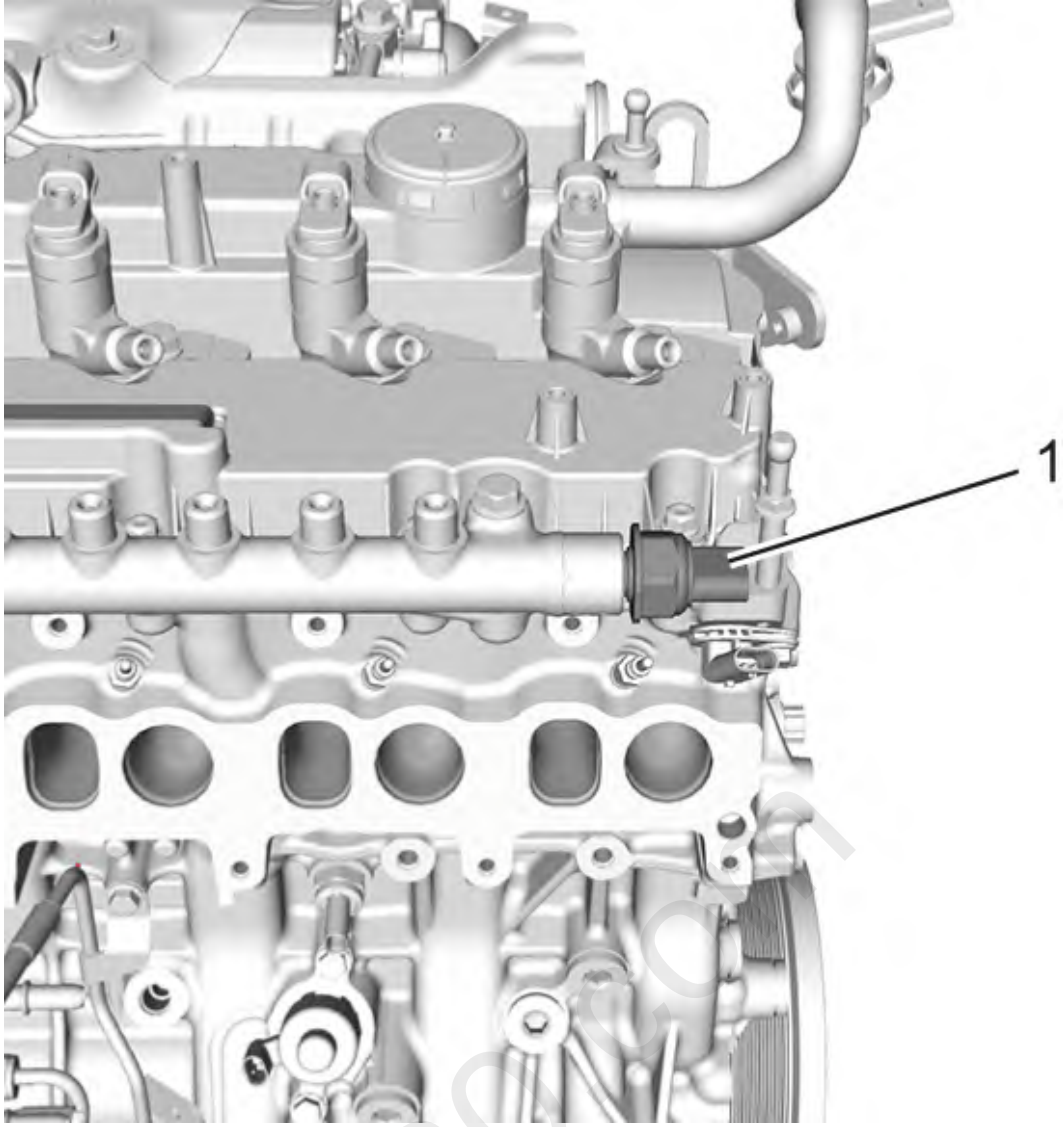


Fig. 622: Fuel Injection Fuel Rail Fuel Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Remove and DISCARD Fuel Injection Fuel Rail Fuel Pressure Sensor (1)

FUEL RAIL REMOVAL

mcx30.com

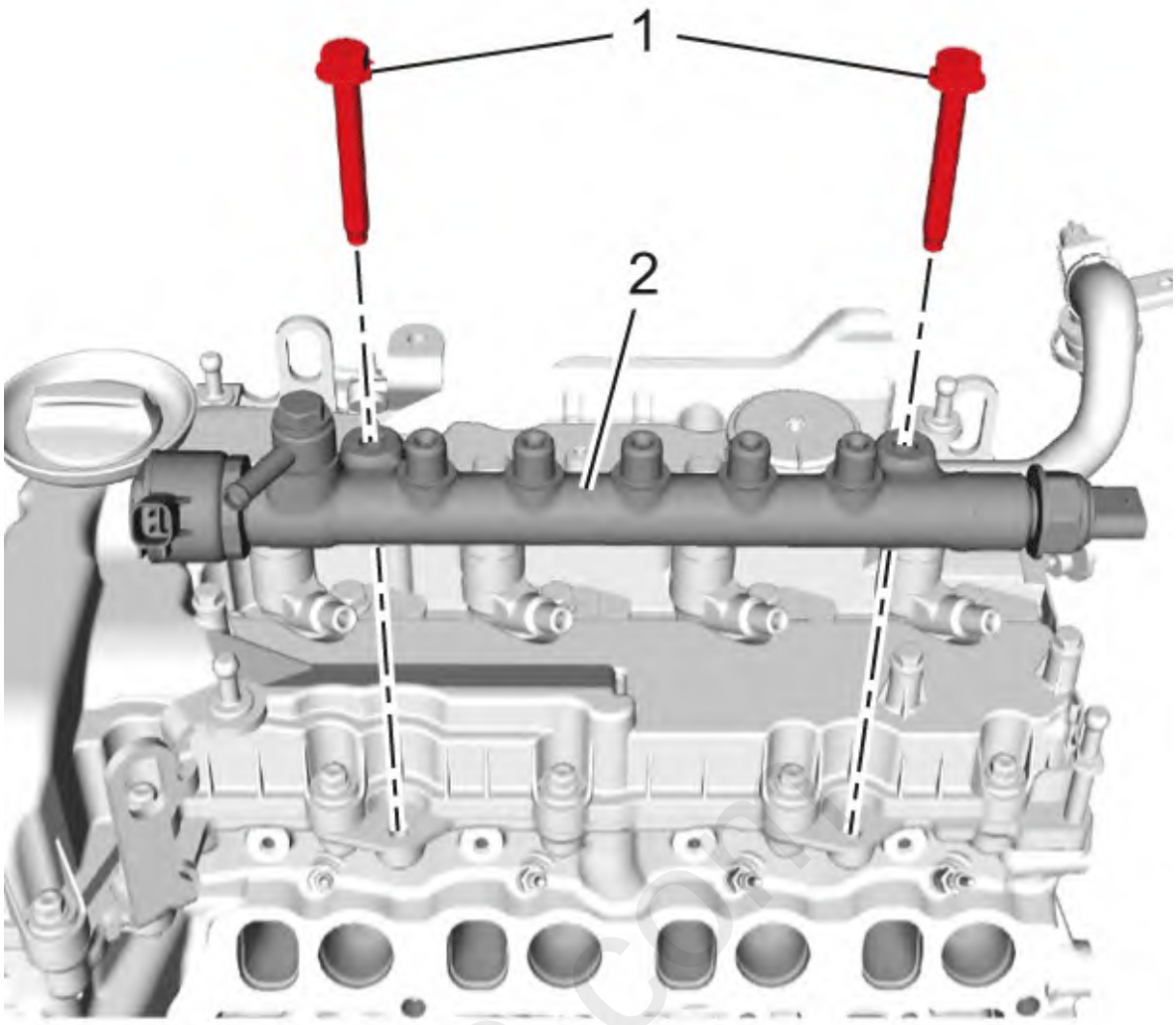


Fig. 623: Fuel Injection Fuel Rail And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove Fuel Injection Fuel Rail Bolts (1) (Qty: 2)
2. Remove Fuel Injection Fuel Rail (2)

FUEL INJECTOR REMOVAL

Special Tools

- **EN-51146-1-3** Sliding Hammer
- **EN-51187** Injector Remover

Equivalent regional tools: Special Tools

WARNING: **Refer to Diesel/Gasoline Vapors Warning**

WARNING: **Always wear safety goggles when working with fuel in order to protect the eyes from fuel splash.**

NOTE:

- **Be very thorough in terms of cleanliness when working in the fuel system. Malfunctions can also occur due to very small dirt particles. Prevent dirt from entering the fuel system by cleaning the hoses and plugging the pipes and lines upon removal. Store the components so that contaminants cannot enter.**
- **In order to reuse the injectors, mark the injectors so that they can be installed to the same cylinder.**

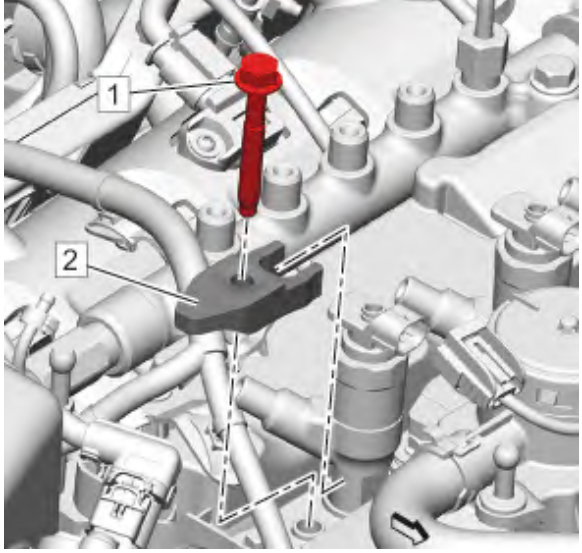


Fig. 624: Fuel Injector Brackets And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove and DISCARD Fuel Injector Bracket Bolts (1) (Qty: 4)
2. Remove Fuel Injector Brackets (2) (Qty: 4)

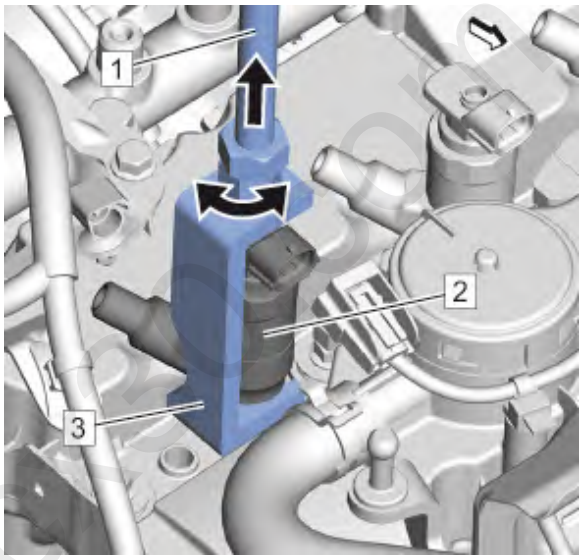


Fig. 625: Fuel Injector And Special Tools
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the injector can not be removed by hand, use the EN-51187 remover and solve the Injector by turning at the hexagon.**

3. Pull out the 4 fuel injectors (2) with the **EN-51187** remover (3) along with the **EN-51146-1-3** sliding hammer (1).

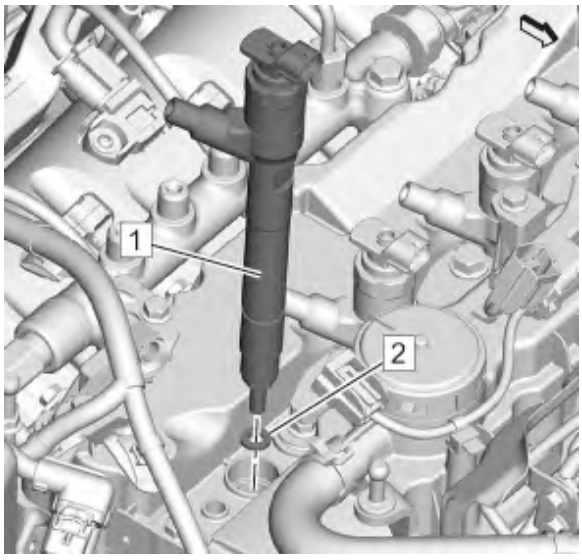


Fig. 626: Fuel Injectors And Washers
Courtesy of GENERAL MOTORS COMPANY

4. Remove Fuel Injectors (1) (Qty: 4)
5. Remove and DISCARD Fuel Injector Washers (2) (Qty: 4)
6. Protect the 4 fuel injector nozzles with suitable closure caps.

CAMSHAFT HOUSING REMOVAL

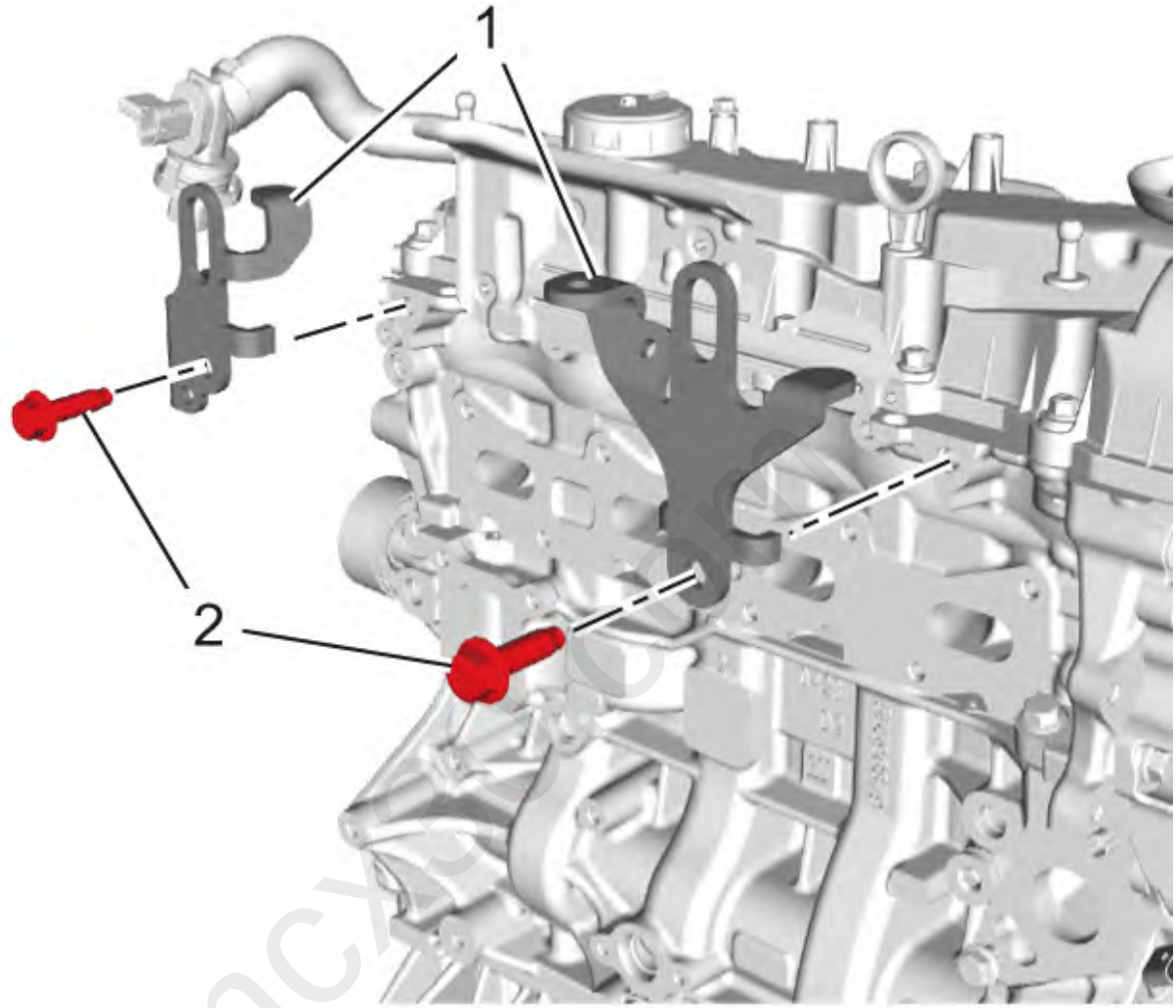


Fig. 627: Engine Lift Brackets And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove Engine Lift Bracket Bolts (2) (Qty: 2)
2. Remove Engine Lift Brackets (1) (Qty: 2)

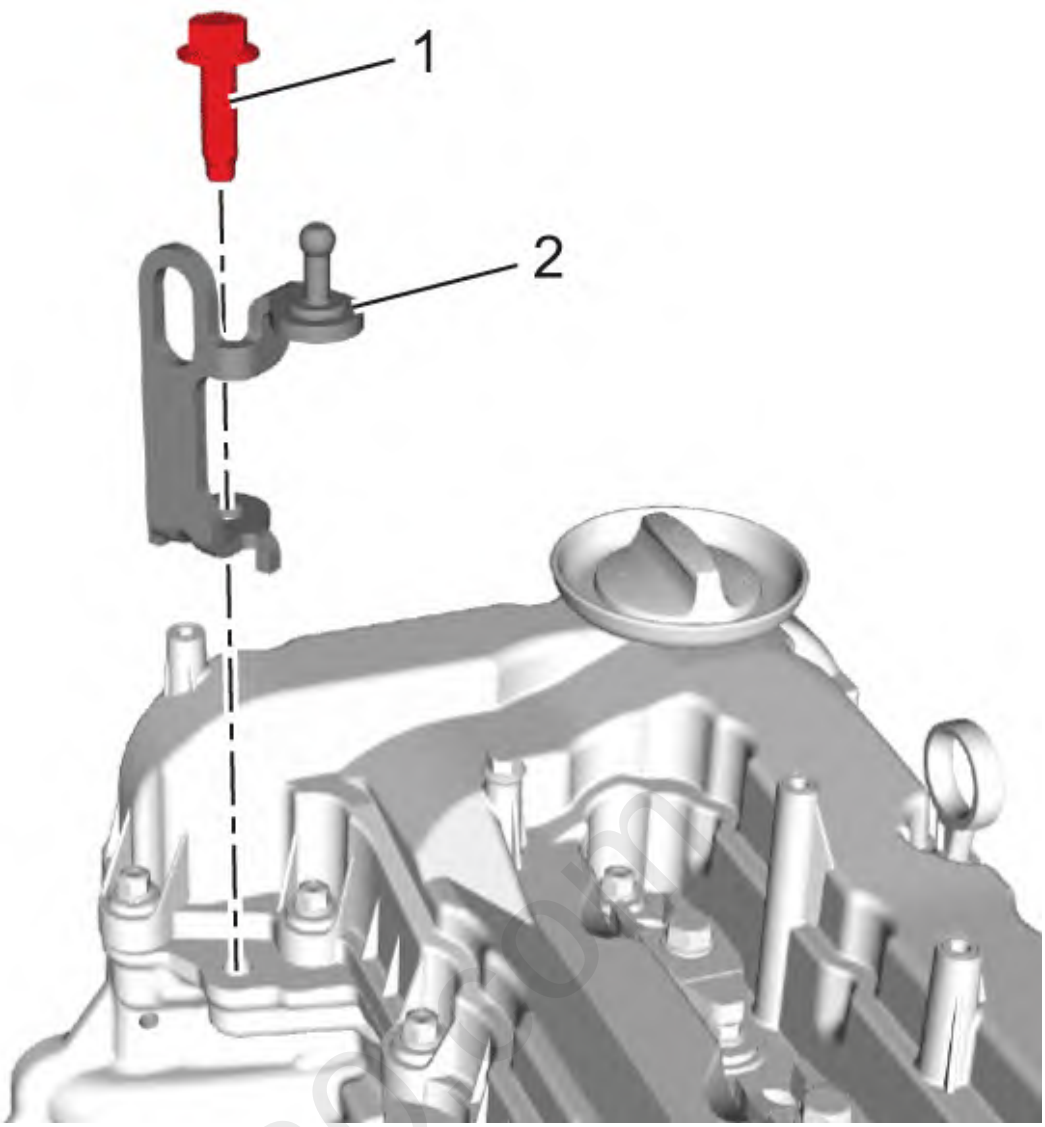


Fig. 628: Engine Lift Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove Engine Lift Bracket Bolt (1)
4. Remove Engine Lift Bracket (2)

mcx30.com

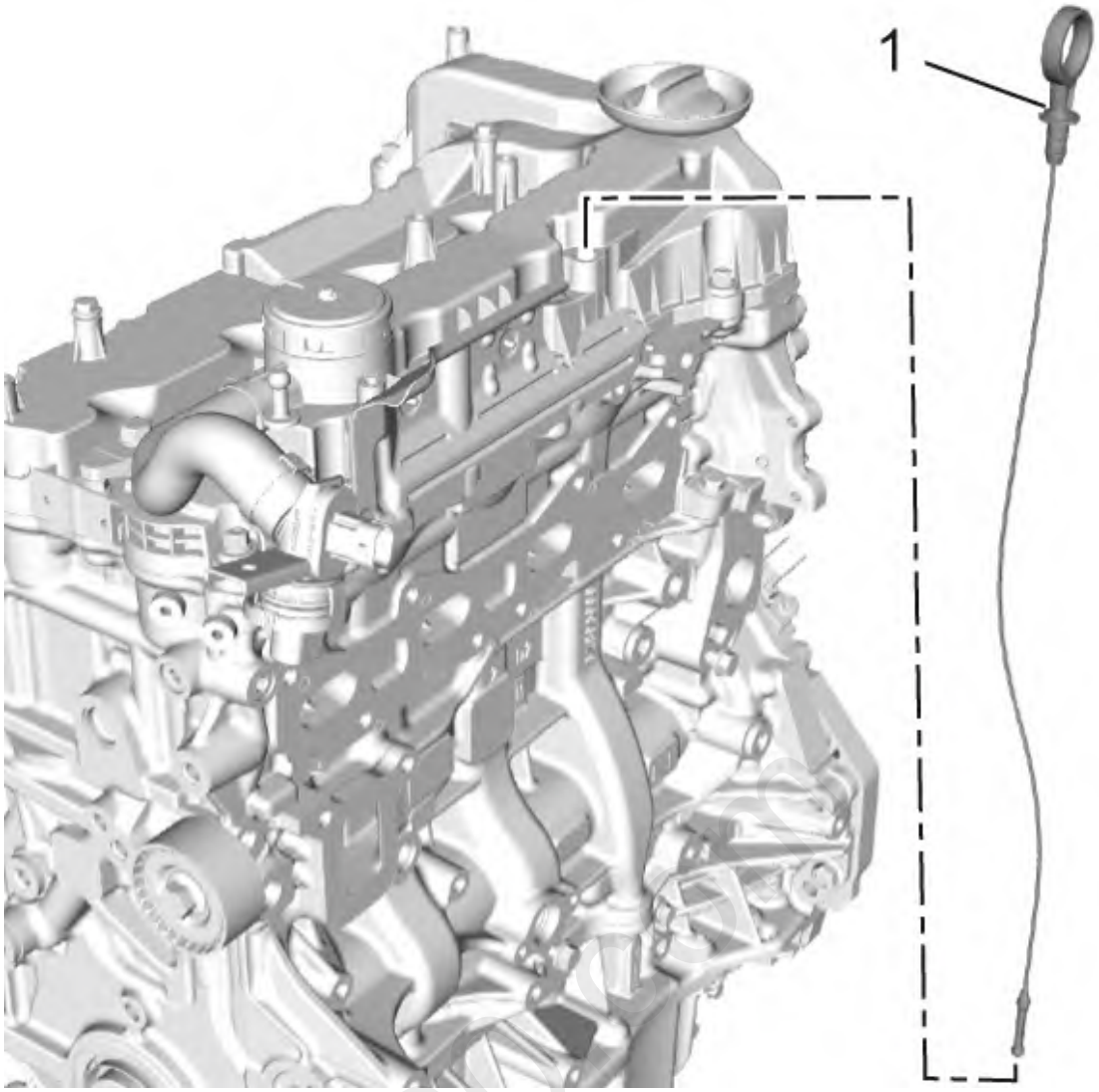


Fig. 629: Engine Oil Level Indicator
Courtesy of GENERAL MOTORS COMPANY

5. Remove Engine Oil Level Indicator (1)

mcx30.com

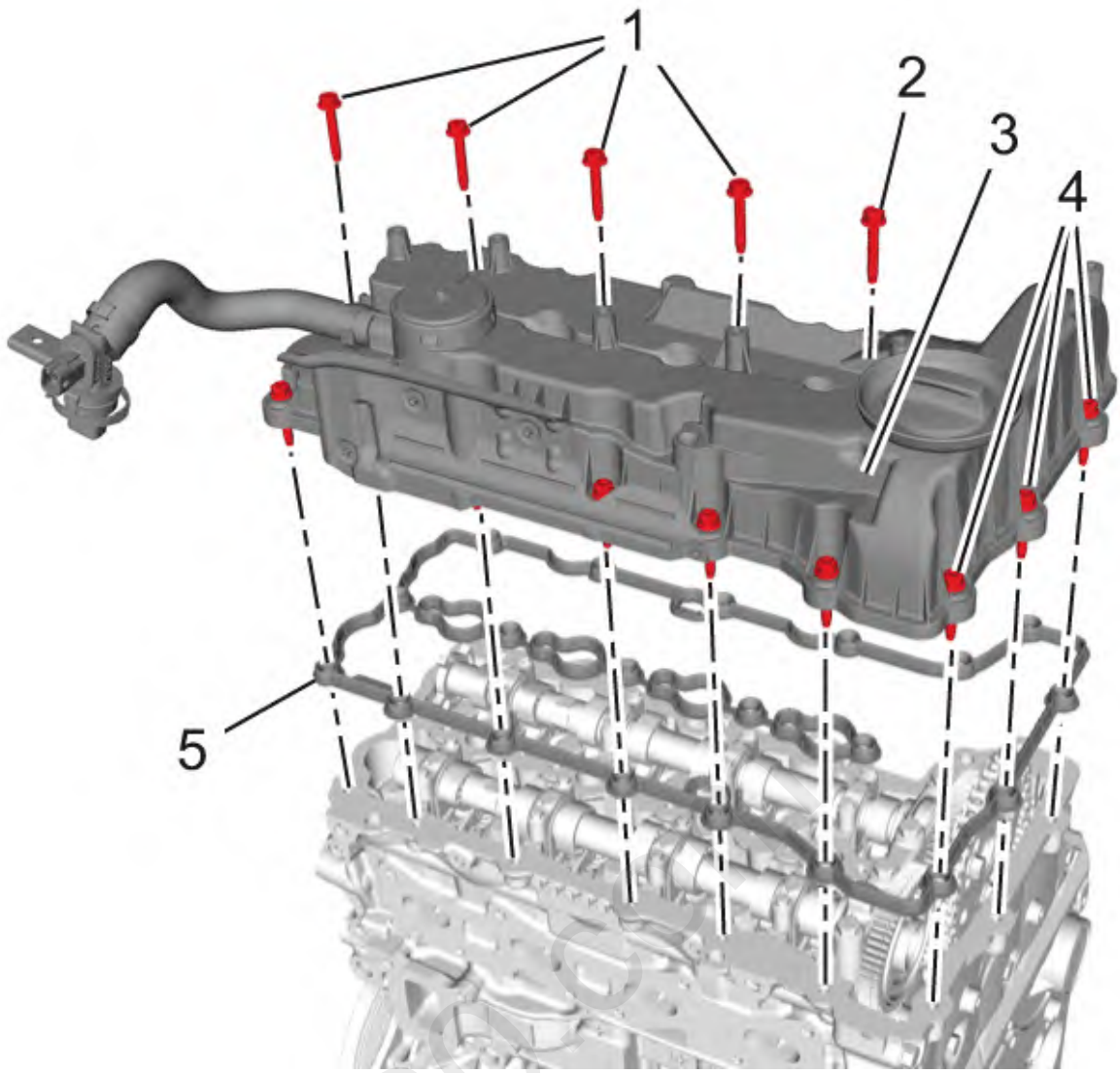


Fig. 630: Camshaft Housing, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Mind the different bolts.**

6. Remove Camshaft Housing Bolt - Outer (4) (Qty: 15)
7. Remove Camshaft Housing Bolt - Inner (1, 2) (Qty: 5)
8. Remove Camshaft Housing (3)
9. Remove and DISCARD Camshaft Housing Gasket (5)

TIMING CHAIN UPPER COVER REMOVAL

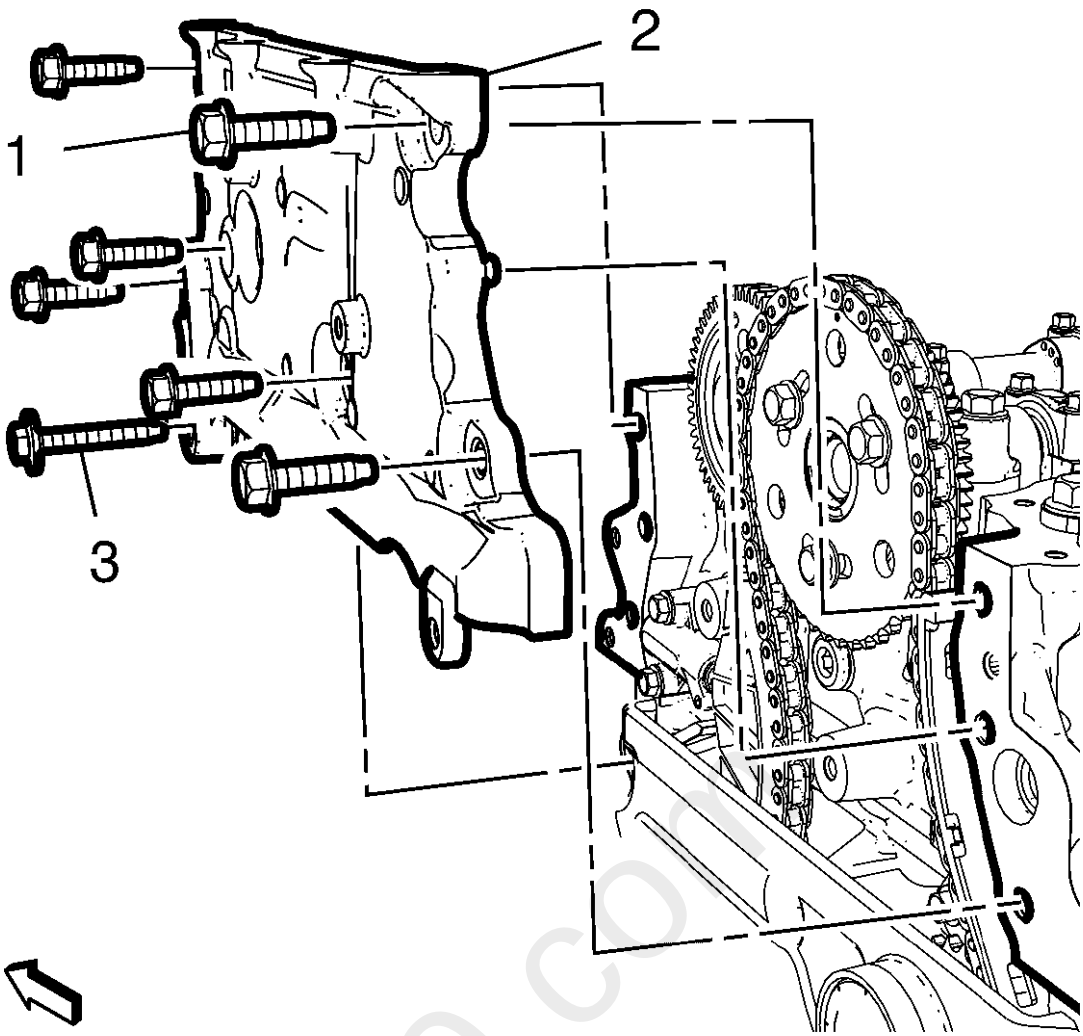


Fig. 631: Timing Chain Upper Cover And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 6 timing chain upper cover bolts (1).
2. Remove the sleeve bolt (3).
3. Remove the timing chain upper cover (2), by loosen the timing chain upper cover from the cylinder head with a suitable tool.

CRANKSHAFT POSITION SENSOR REMOVAL

mcx30.com

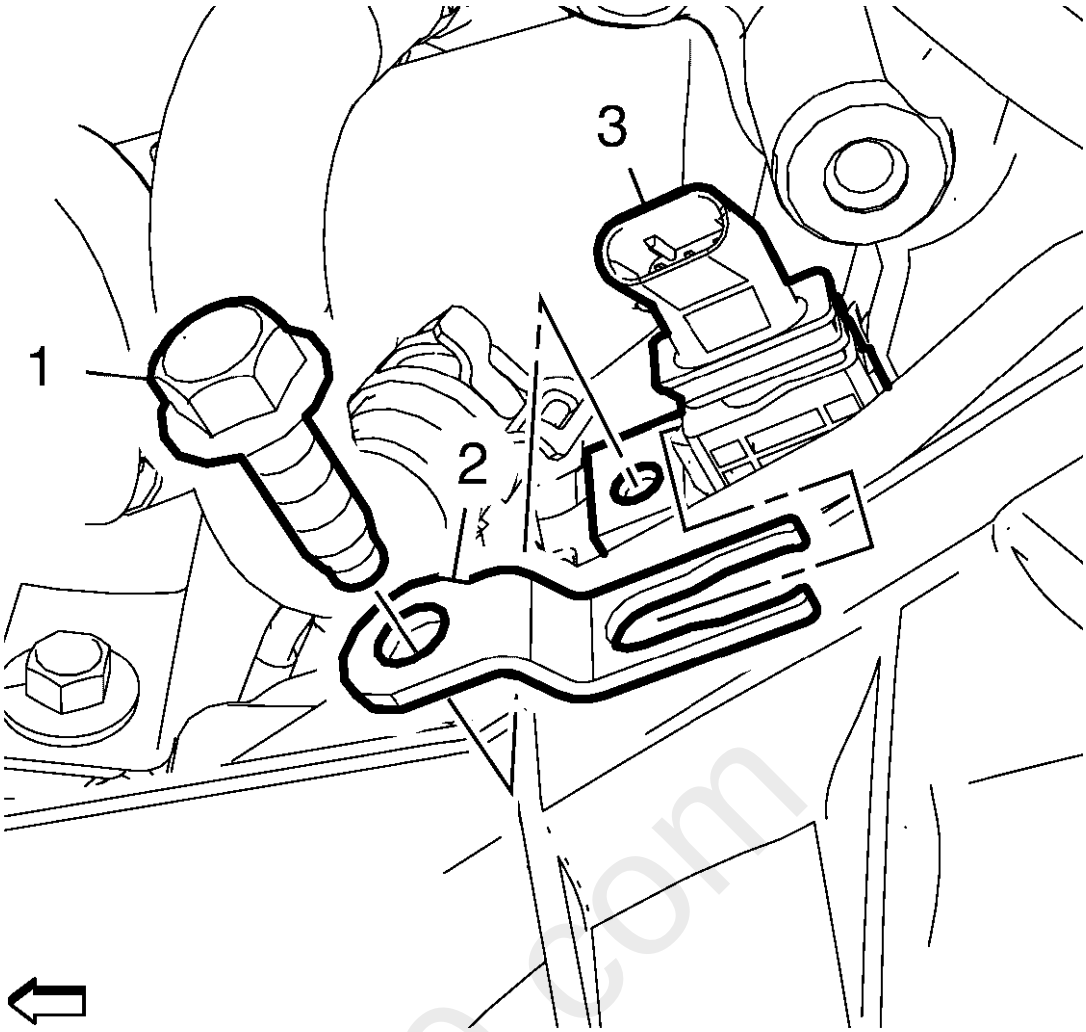


Fig. 632: Crankshaft Position Sensor, Bolt And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

1. Remove the crankshaft position sensor bolt (1).
2. Remove the crankshaft position sensor retainer spring (2) from the crankshaft position sensor (3)

mcx30.com

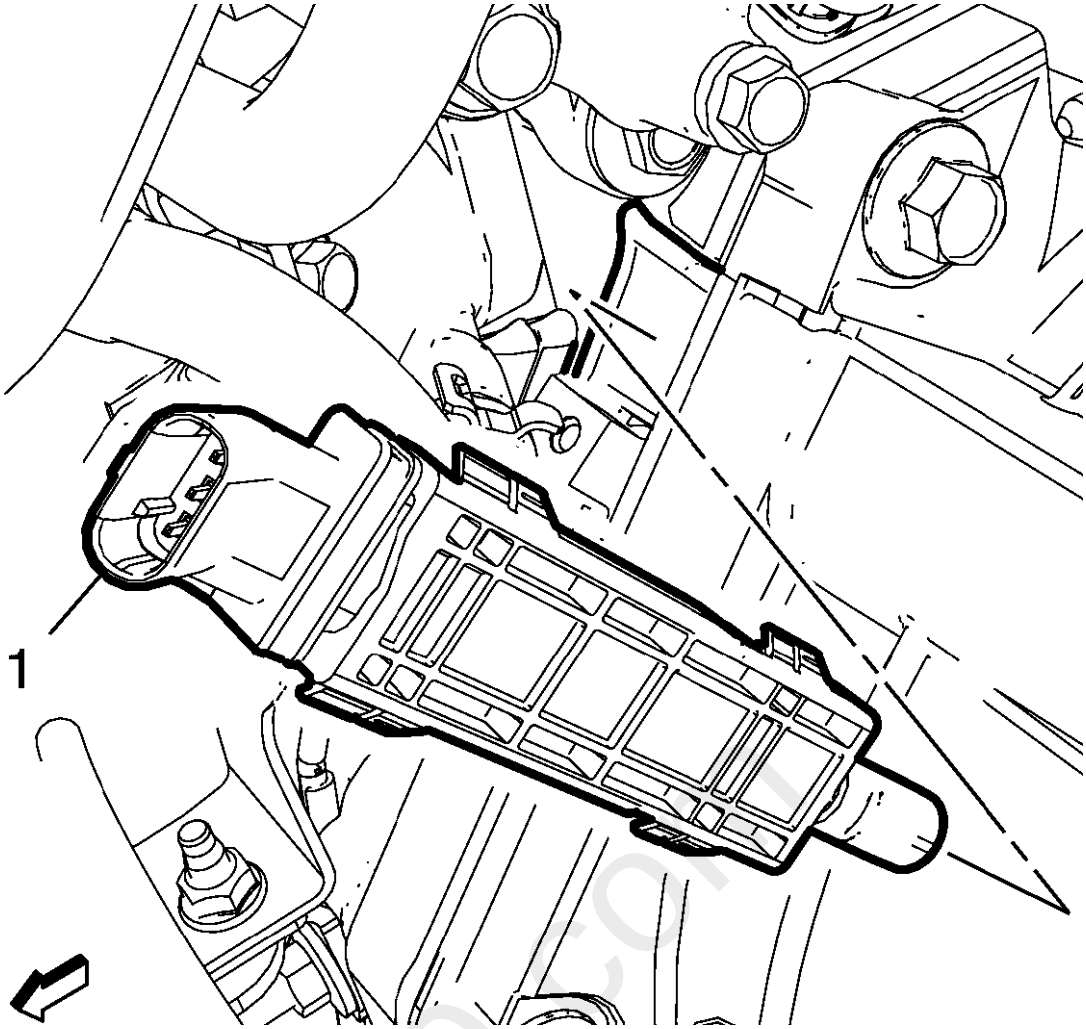


Fig. 633: Crankshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

3. Remove the crankshaft position sensor (1).

CRANKSHAFT POSITION SENSOR RELUCTOR RING REMOVAL

Special Tools

EN-652 Flywheel Holder

Equivalent regional tools: **Special Tools**

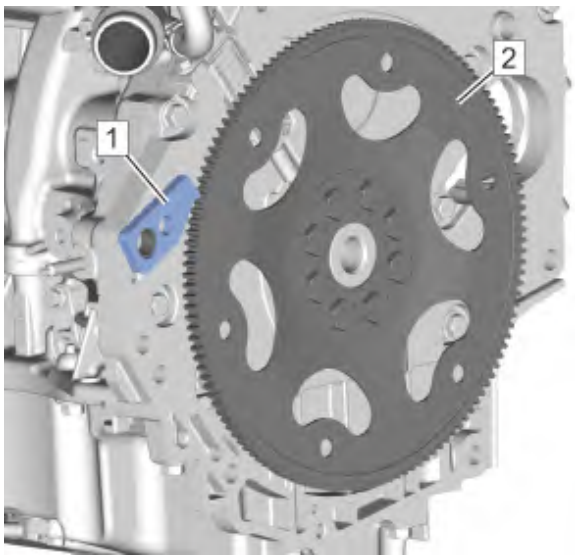


Fig. 634: Flex Plate Holder
Courtesy of GENERAL MOTORS COMPANY

mcx30.com

1. Install the **EN-652** flywheel holder (1) in order to fix the automatic transmission flex plate (2).

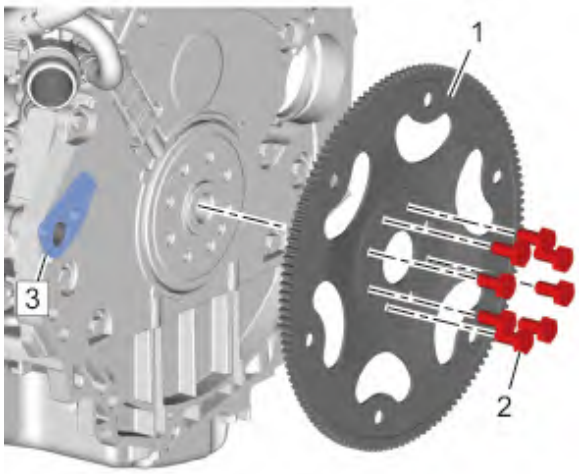


Fig. 635: Automatic Transmission Flex Plate And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove and DISCARD Automatic Transmission Flex Plate Bolts (2) (Qty: 8)
3. Remove the **EN-652** flywheel holder (3).
4. Remove Automatic Transmission Flex Plate (1)

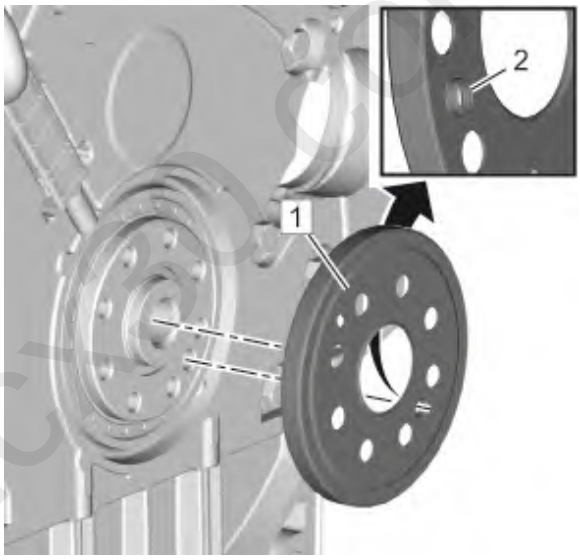


Fig. 636: Crankshaft Position Sensor Reluctor Ring And Pin
Courtesy of GENERAL MOTORS COMPANY

5. Remove Crankshaft Position Sensor Reluctor Ring (1)

CRANKSHAFT REAR OIL SEAL REMOVAL

Special Tools

- **GE-328-B** Pin Remover
- **EN-6624** Remover

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

Removal Procedure

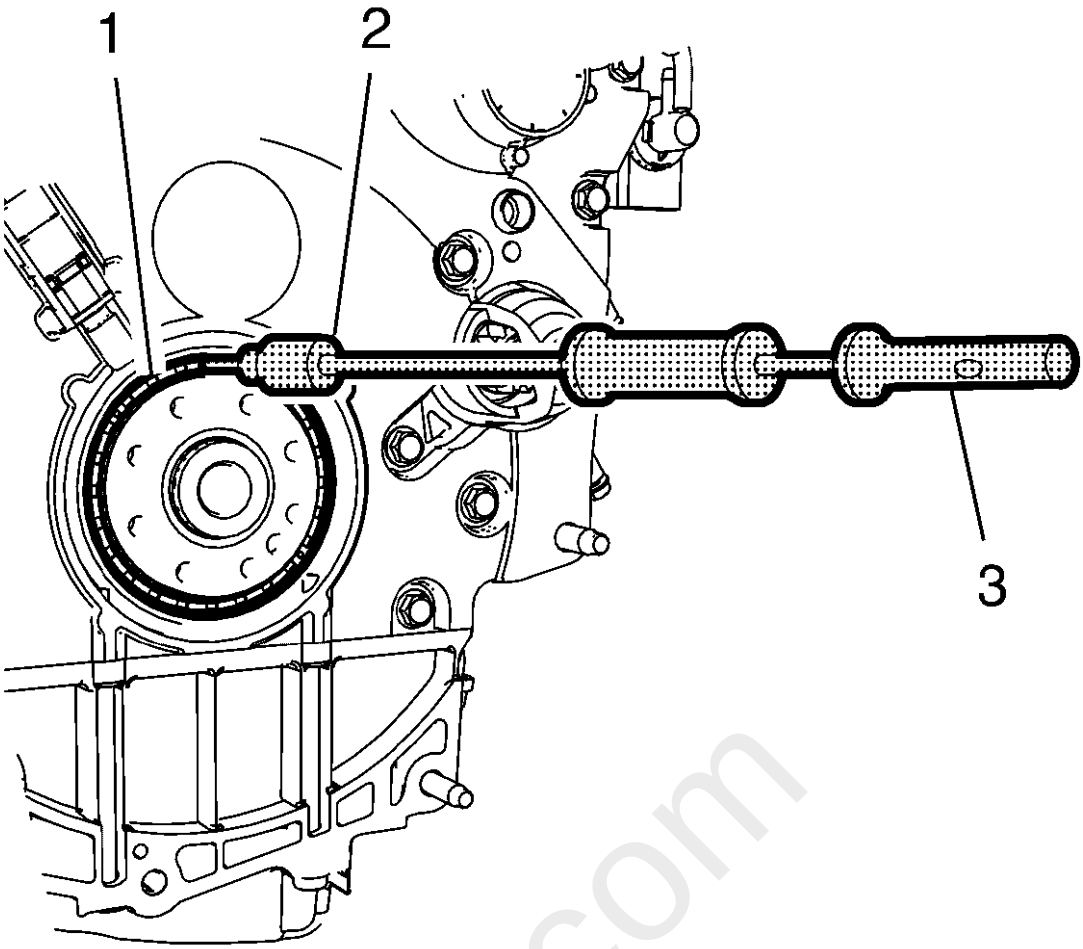


Fig. 637: Crankshaft Rear Oil Seal And Removers
Courtesy of GENERAL MOTORS COMPANY

1. Punch a bore into the crankshaft seal, use a suitable tool.
2. Install the **EN-6624** remover (2) into the oil sealing ring (1).
3. Install the **GE-328-B** remover (3) to the **EN-6624** remover (2).
4. Remove the crankshaft rear oil seal, with the **GE-328-B** remover.

AUTOMATIC TRANSMISSION FLEX PLATE REMOVAL

Special Tools

EN-652 Holder Flex Plate

Equivalent regional tools: **Special Tools**

Removal Procedure

Fig. 638: Flex Plate Holder
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-652** holder (1) in order to fix the flex plate.

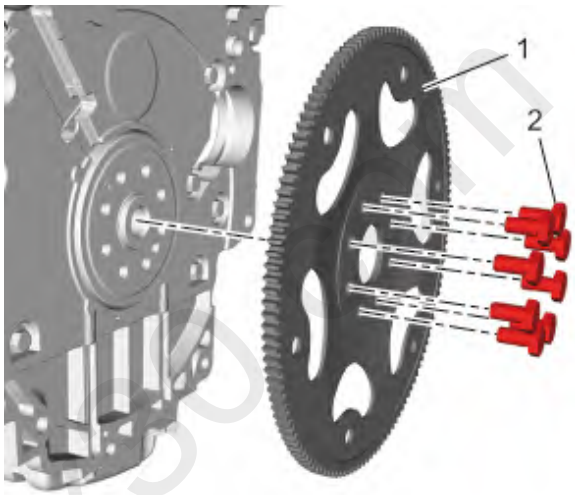


Fig. 639: Automatic Transmission Flex Plate And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove and DISCARD Automatic Transmission Flex Plate Bolts (2) (Qty: 8)
3. Remove the **EN-652** holder.
4. Remove Automatic Transmission Flex Plate (1)

ENGINE FLYWHEEL REMOVAL

Special Tools

EN-652 Flywheel Holder

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

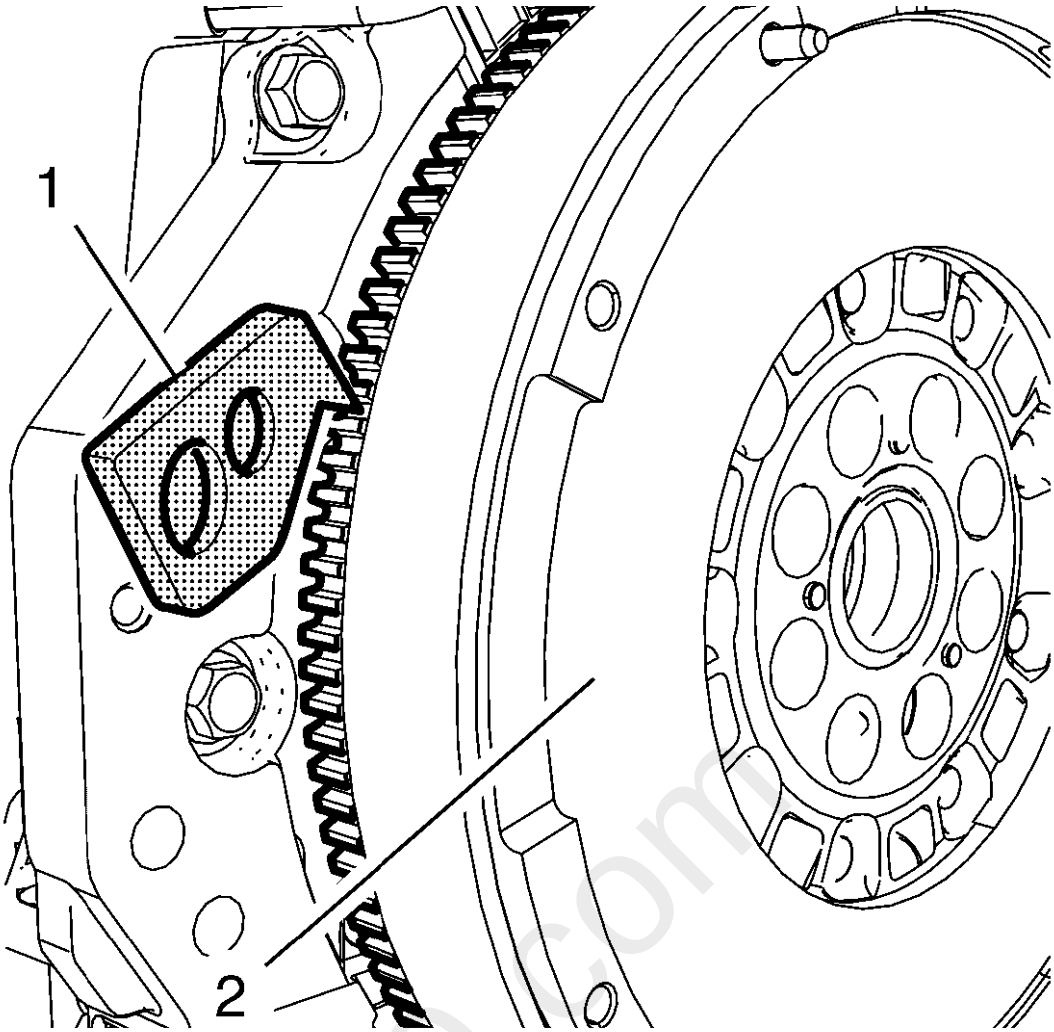


Fig. 640: Flywheel Holder
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-652** holder (1) in order to fix the flywheel (2).

mcx30.com

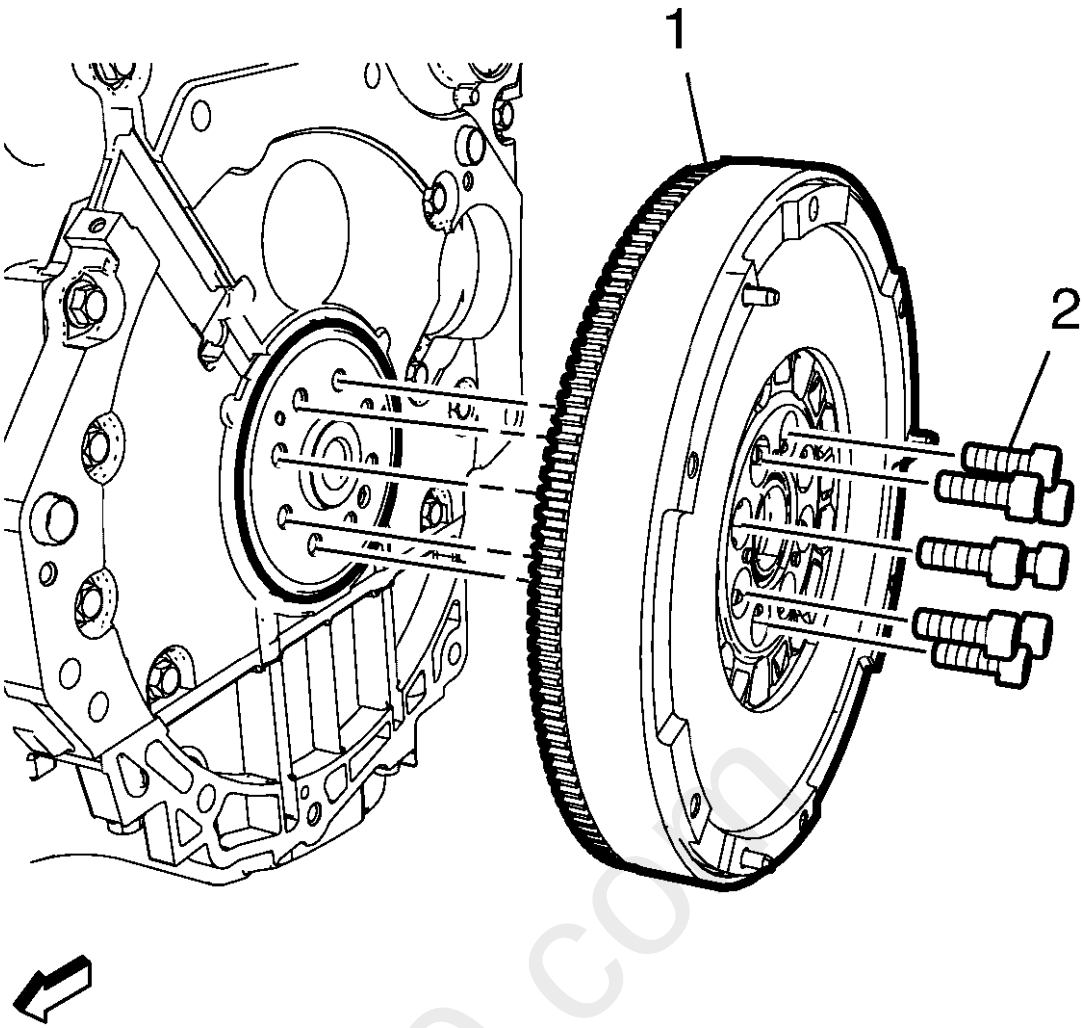


Fig. 641: Engine Flywheel And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove and DISCARD the 8 engine flywheel bolts (2).
3. Remove the **EN-652** flywheel holder.
4. Remove the engine flywheel (1).

OIL PAN REMOVAL

mcx30.com

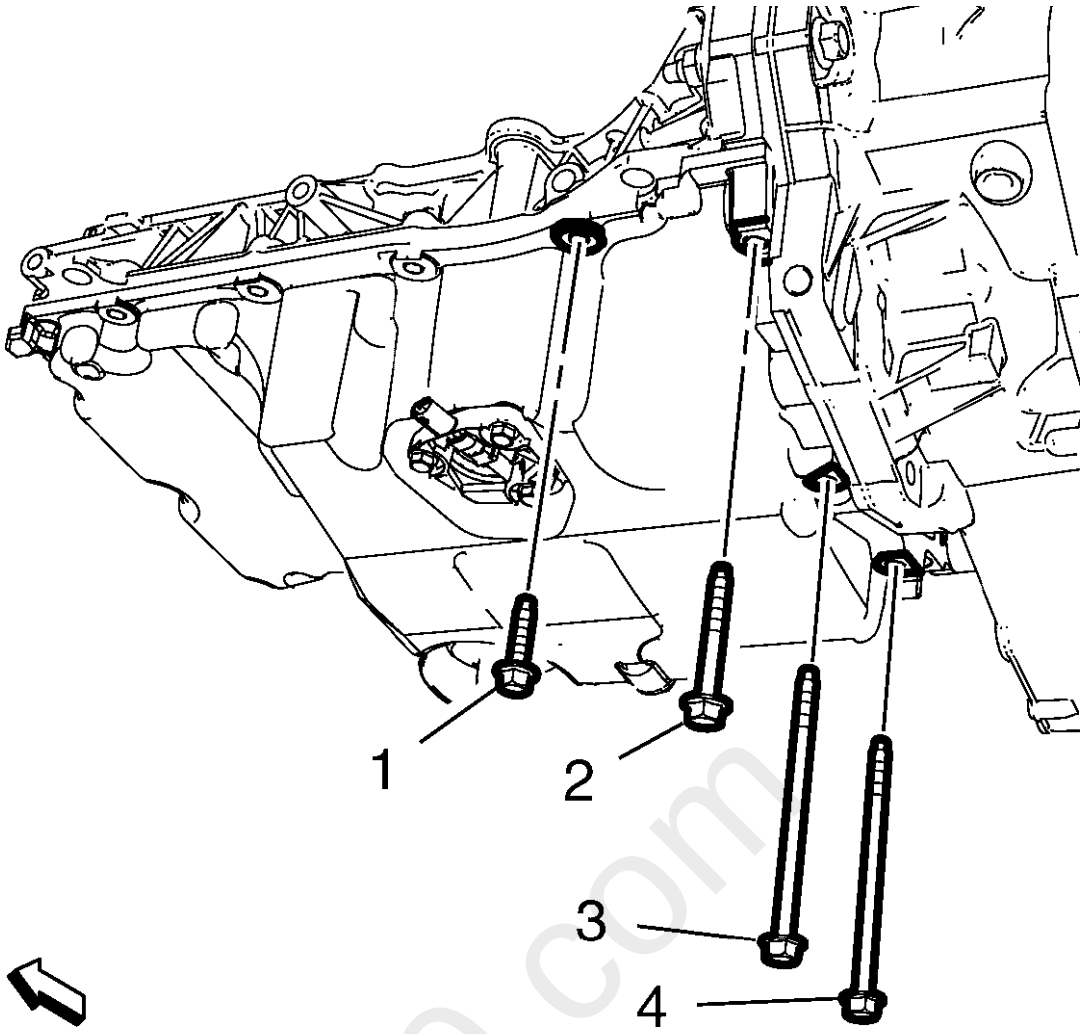


Fig. 642: Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the difference bolt lengths.**

1. Remove the 2 oil pan bolts (3, 4).
2. Remove the oil pan bolt (2).
3. Remove the 12 oil pan bolts (1).

mcx30.com

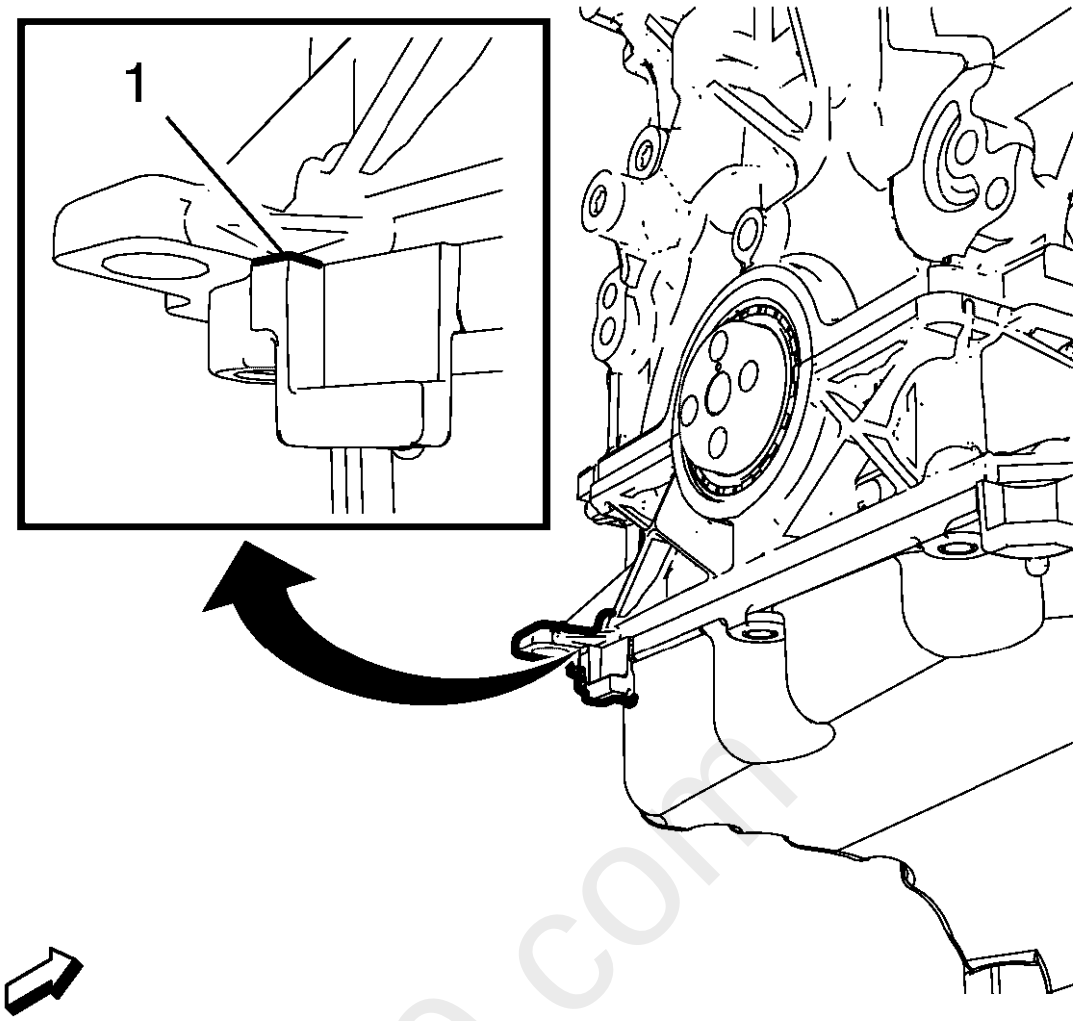


Fig. 643: Oil Pan And Pry Point
Courtesy of GENERAL MOTORS COMPANY

4. Loosen the oil pan carefully from the lower cylinder block, use a suitable tools at the location as shown to pry (1).
5. Remove the oil pan.

mcx30.com

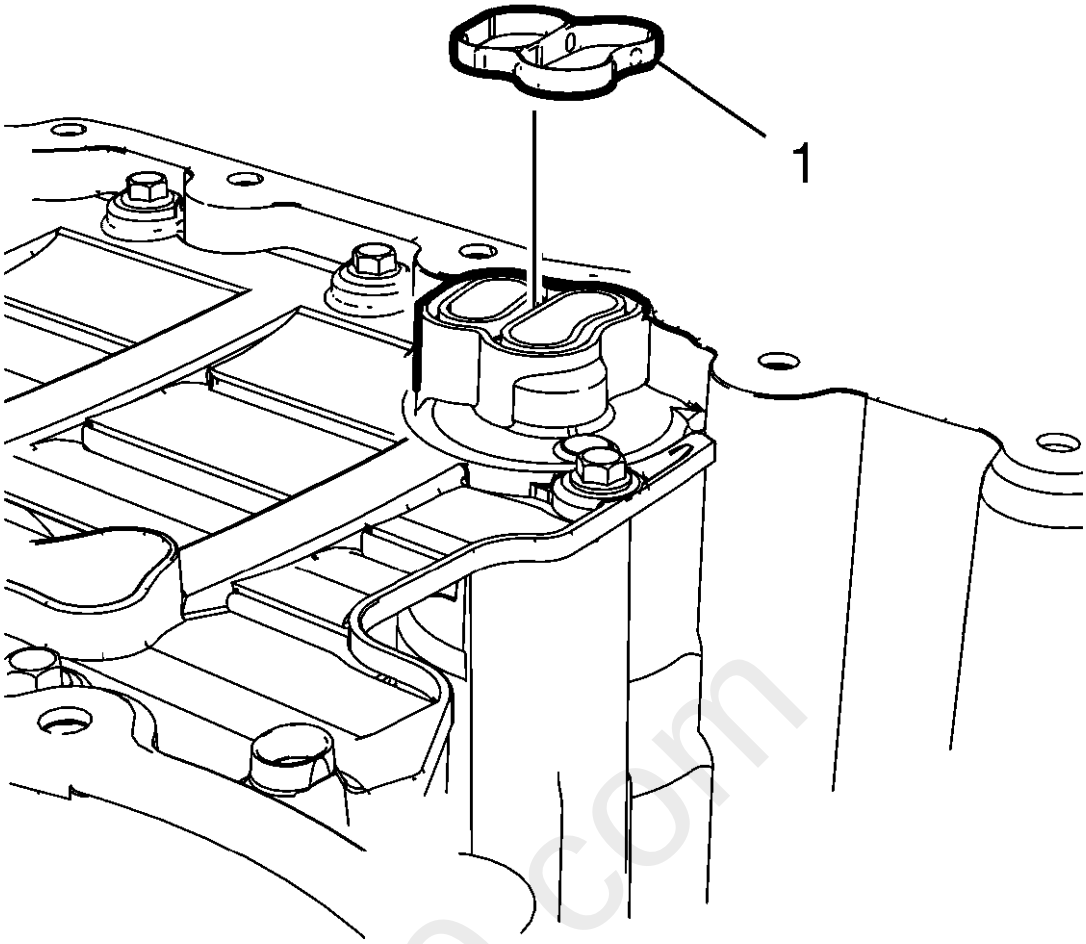


Fig. 644: Oil Filter Seal
Courtesy of GENERAL MOTORS COMPANY

6. Remove and DISCARD the oil filter seal (1).

TIMING CHAIN LOWER COVER REMOVAL

mcx30.com

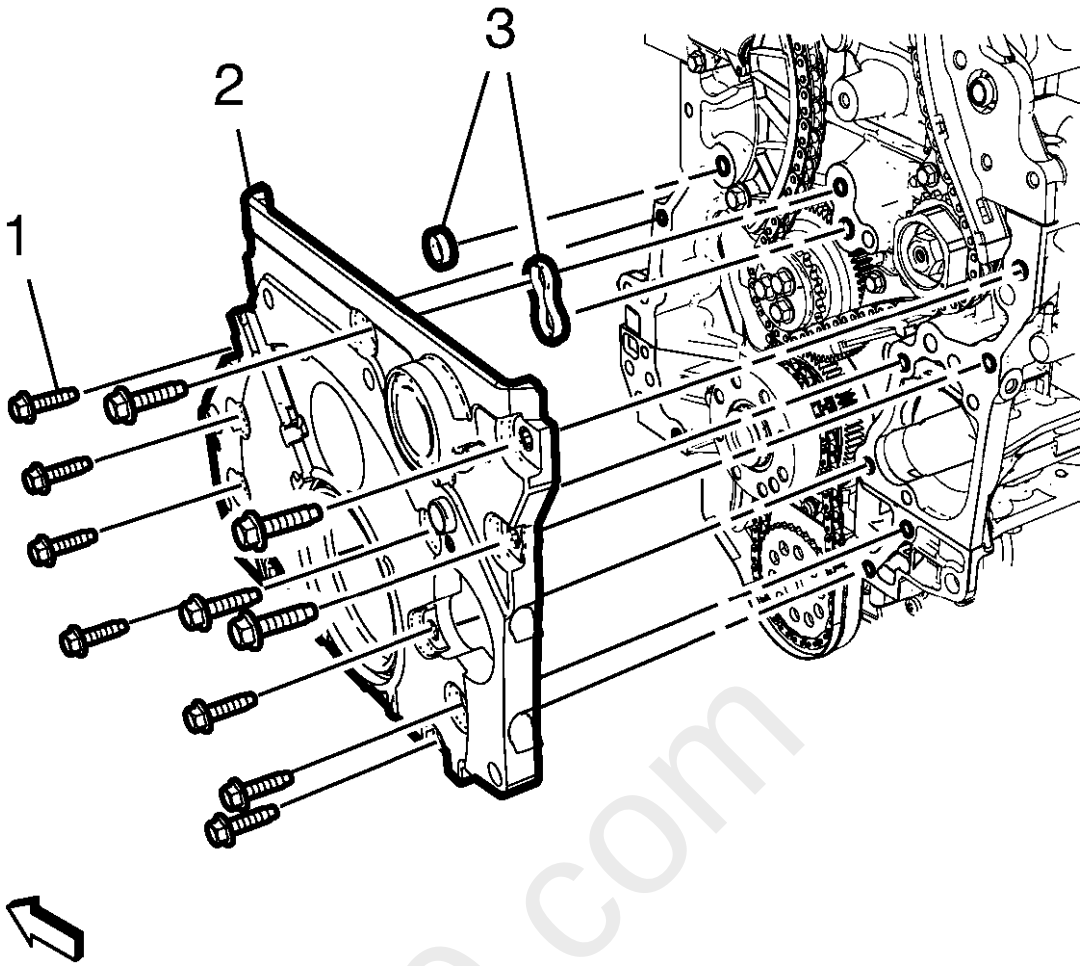


Fig. 645: Timing Chain Lower Cover, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 11 timing chain lower cover bolts (1).
2. Remove the timing chain lower cover (2), by loosen the timing chain upper cover from the cylinder block with a suitable tool.
3. Remove the 2 timing chain lower cover gaskets (3).
4. Remove the crankshaft rear oil seal, if the timing chain lower cover is reused.

OIL PUMP DRIVE CHAIN TENSIONER REMOVAL

Special Tools

EN-50513 Fixing Pin

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

mcx30.com

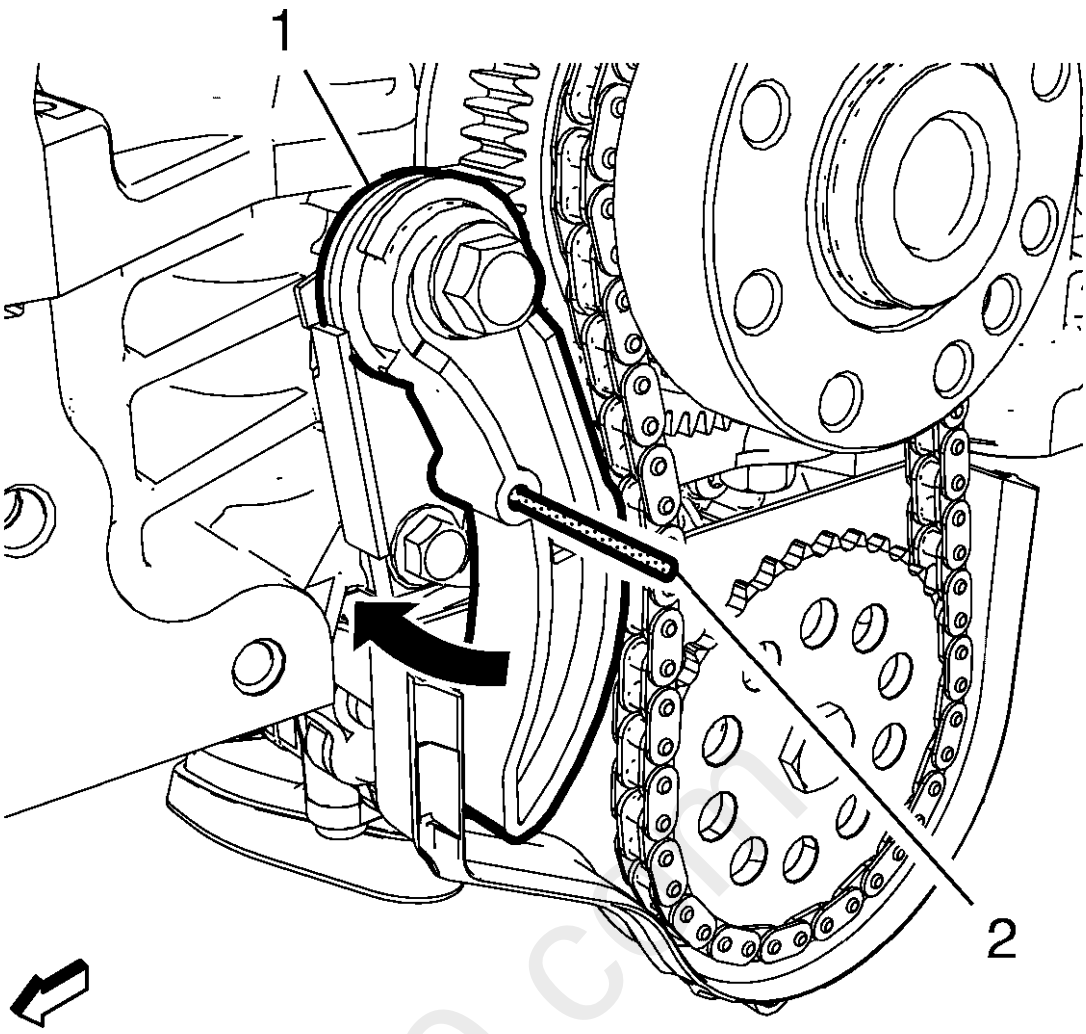


Fig. 646: Oil Pump Drive Chain Tensioner And Fixing Pin
Courtesy of GENERAL MOTORS COMPANY

1. Tension the oil pump drive chain tensioner (1) in arrow direction.
2. Install the **EN-50513** fixing pin (2).

mcx30.com

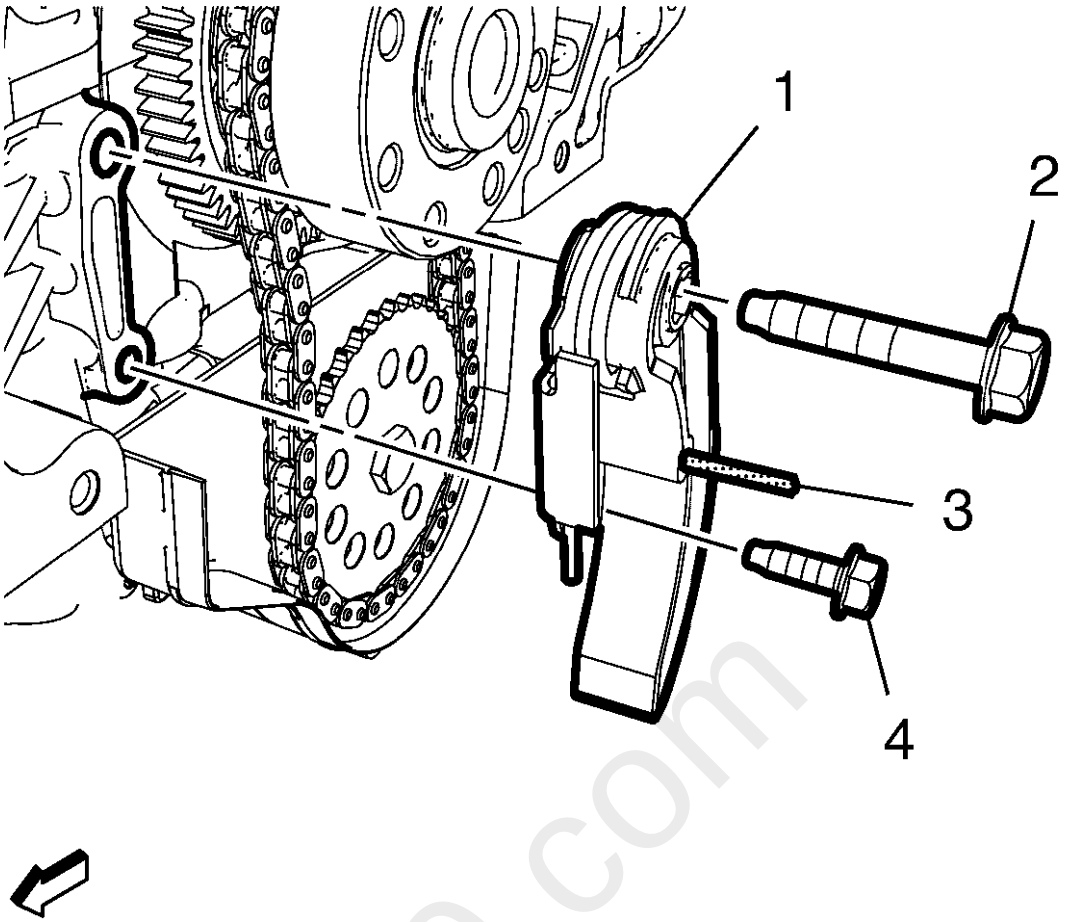


Fig. 647: Oil Pump Drive Chain Tensioner, Bolts And Fixing Pin
Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil pump drive chain tensioner bolt (4).
4. Remove the oil pump drive chain tensioner bolt (2)

NOTE: **If the oil pump drive chain tensioner is reused, do not remove the EN-50513 fixing pin (3).**

5. Remove the oil pump drive chain tensioner (1).

OIL PUMP DRIVE CHAIN AND SPROCKET REMOVAL

Special Tools

EN-51142 Oil Pump Sprocket Unit Holding Tool

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

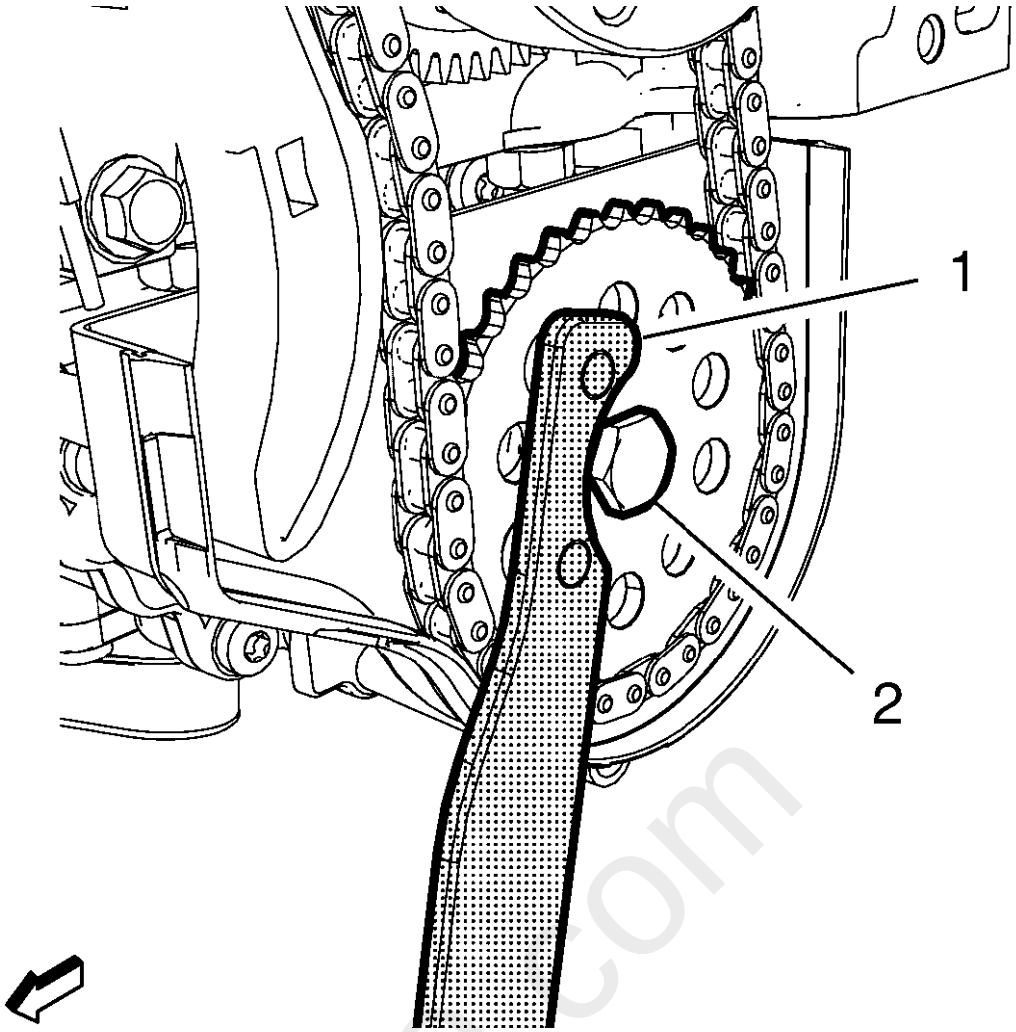


Fig. 648: Oil Pump Sprocket Bolt And Sprocket Holding Tool
Courtesy of GENERAL MOTORS COMPANY

1. Loosen the oil pump sprocket bolt (2), by counterhold with the **EN-51142** holding tool (1).

mcx30.com

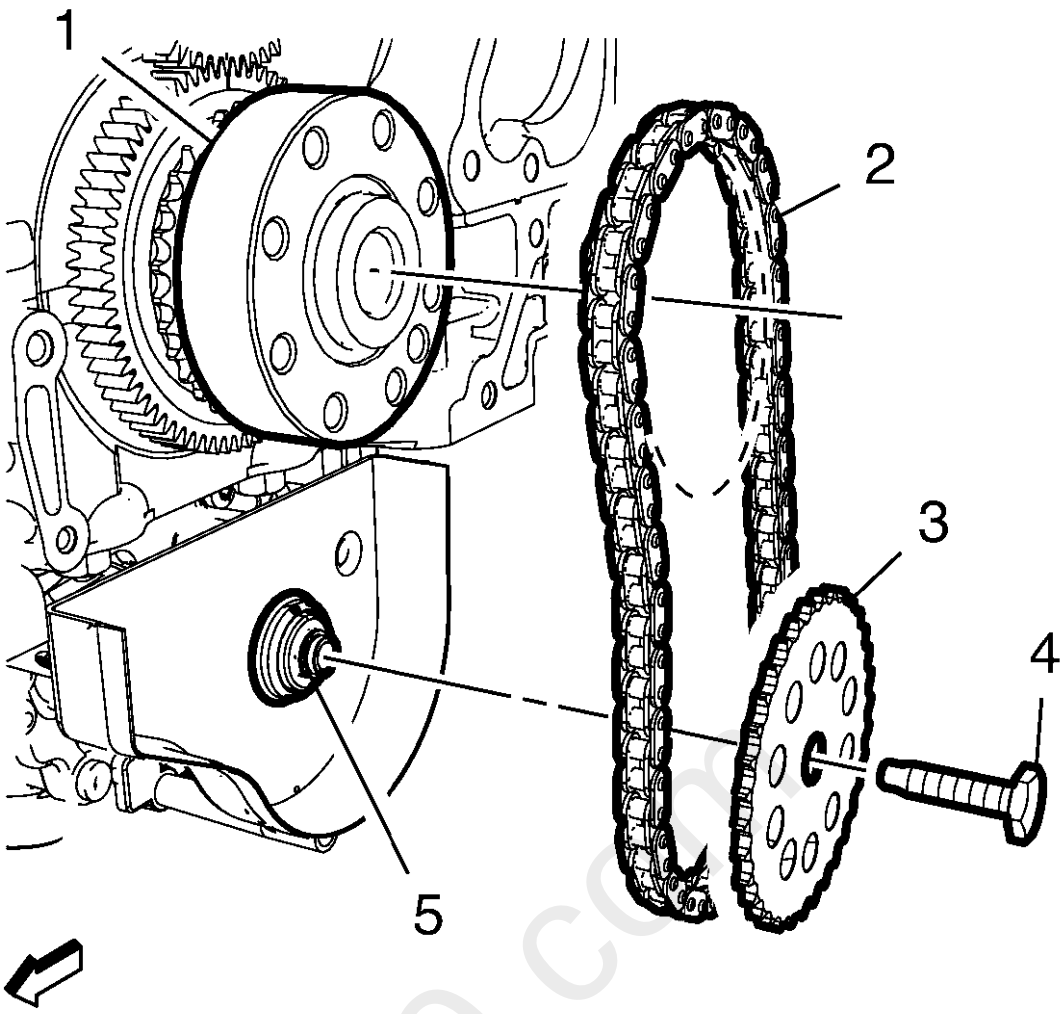


Fig. 649: Oil Pump Sprocket, Bolt, Shaft, Drive Chain And Drive Chain Sprocket
Courtesy of GENERAL MOTORS COMPANY

2. Remove and DISCARD the oil pump sprocket bolt (4).
3. Remove the oil pump sprocket (3) from the oil pump shaft (5).
4. Remove the oil pump drive chain (2) from the oil pump drive chain sprocket (1).

OIL AND POWER BRAKE BOOSTER PUMP REMOVAL

mx30.com

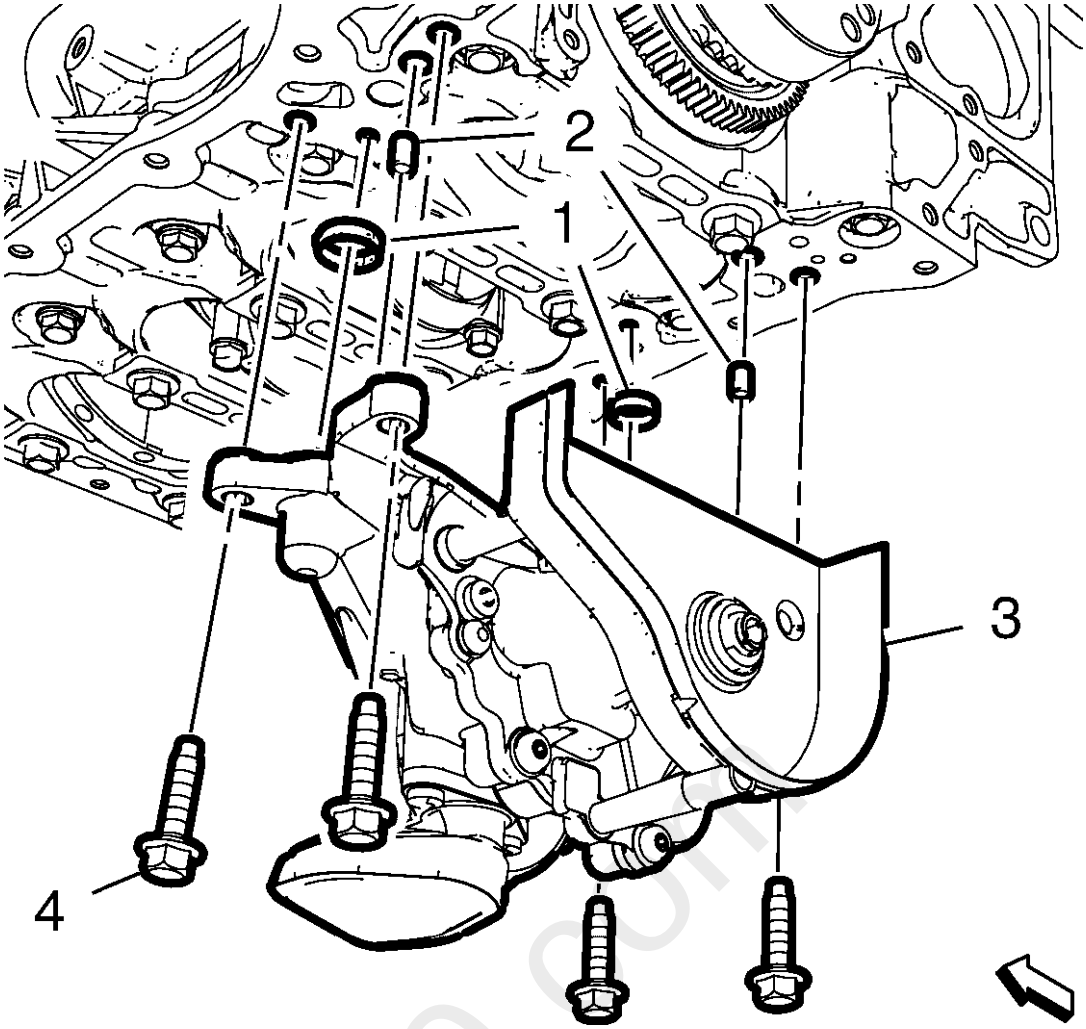


Fig. 650: Oil And Power Steering Pump, Bolts, Locating Pins And Gaskets
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 4 oil pump bolts (4).
2. Remove the oil and power steering pump (3).
3. Remove the 2 oil and power steering pump gaskets (1).
4. Remove the 2 location pins (2).

CAMSHAFT TIMING CHAIN REMOVAL

Special Tools

- **EN-50513** Fixing Pin
- **EN-51140** Crankshaft Fixing Tool
- **EN-51143** Camshaft Sprocket Fixing Tool

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

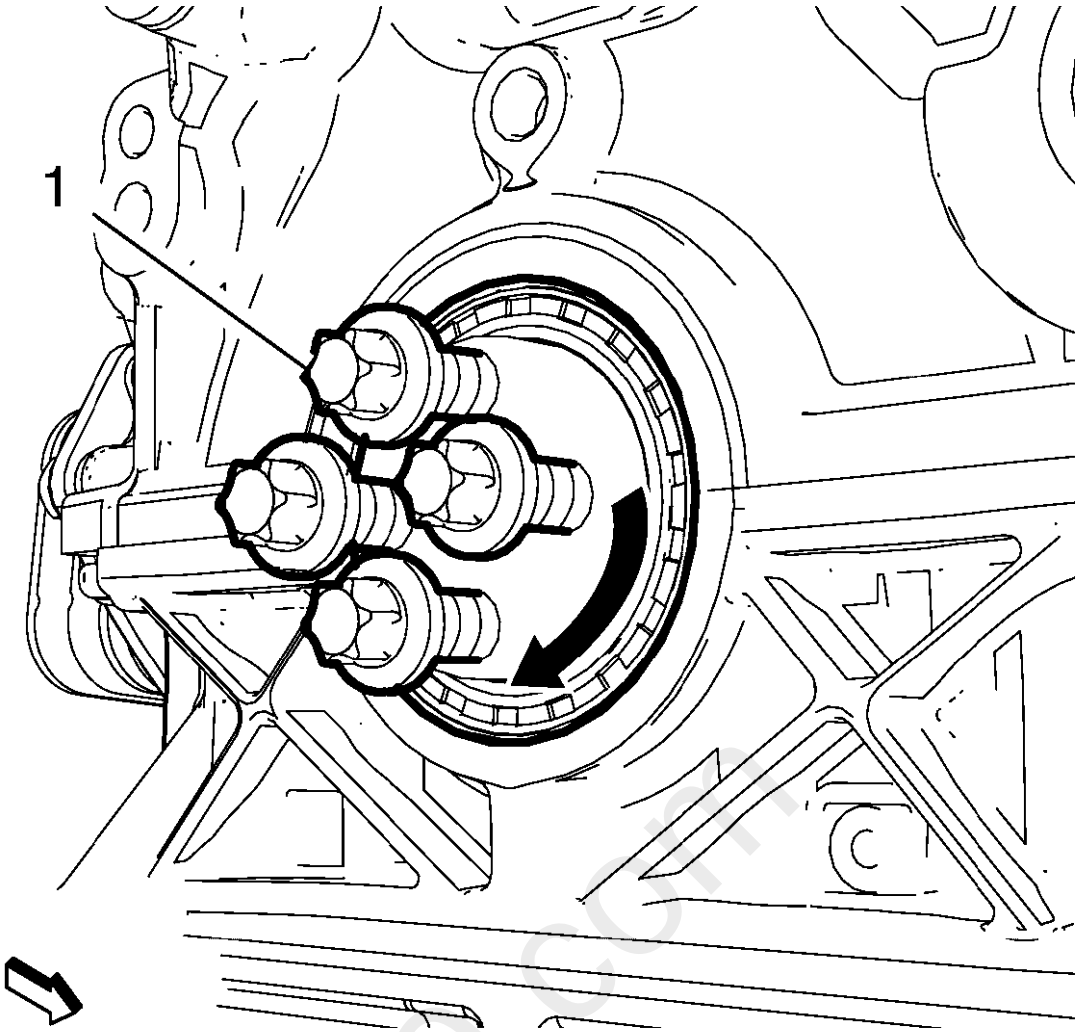


Fig. 651: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the 4 crankshaft pulley bolts (1).

mcx30.com

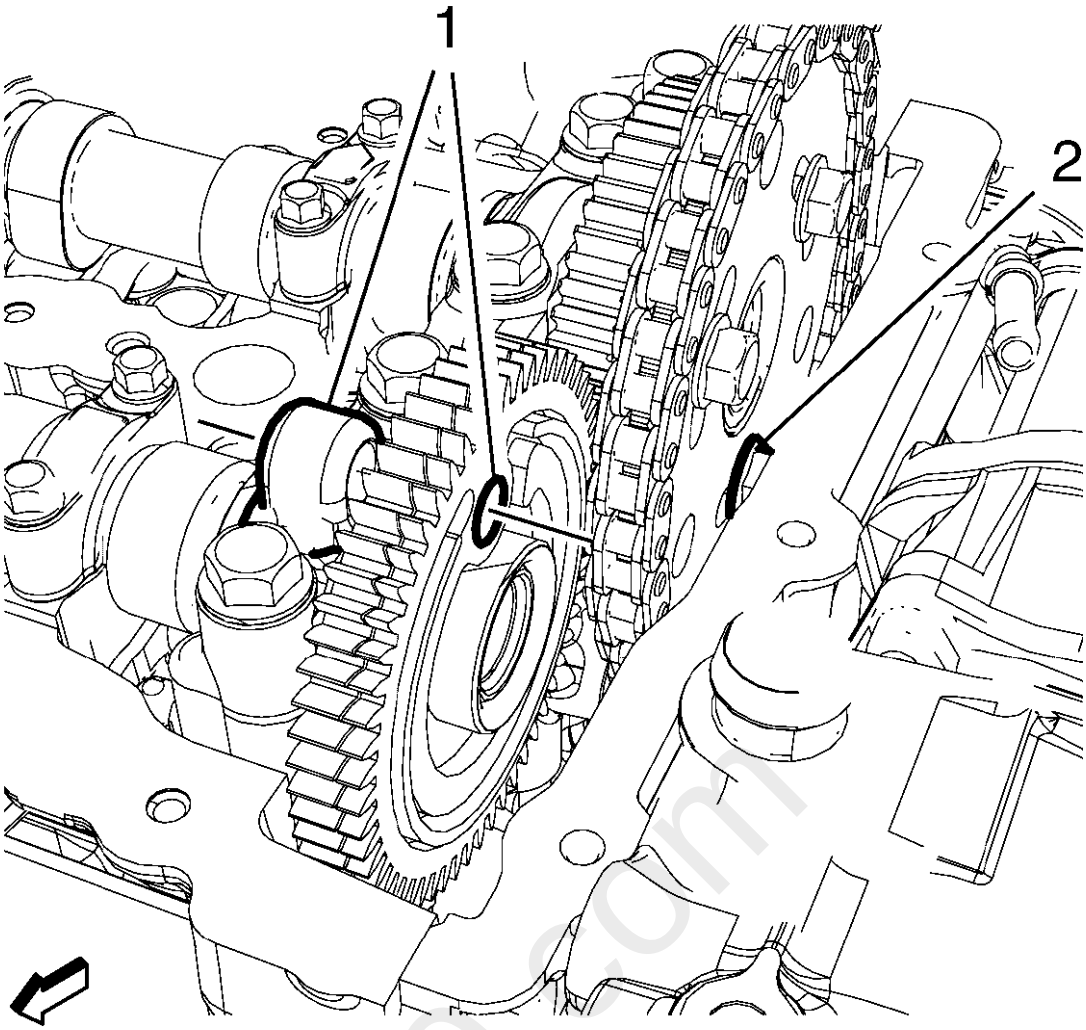


Fig. 652: Aligning Bores
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the bores not aligned turn the crankshaft at the crankshaft pulley bolts.**

mcx30.com

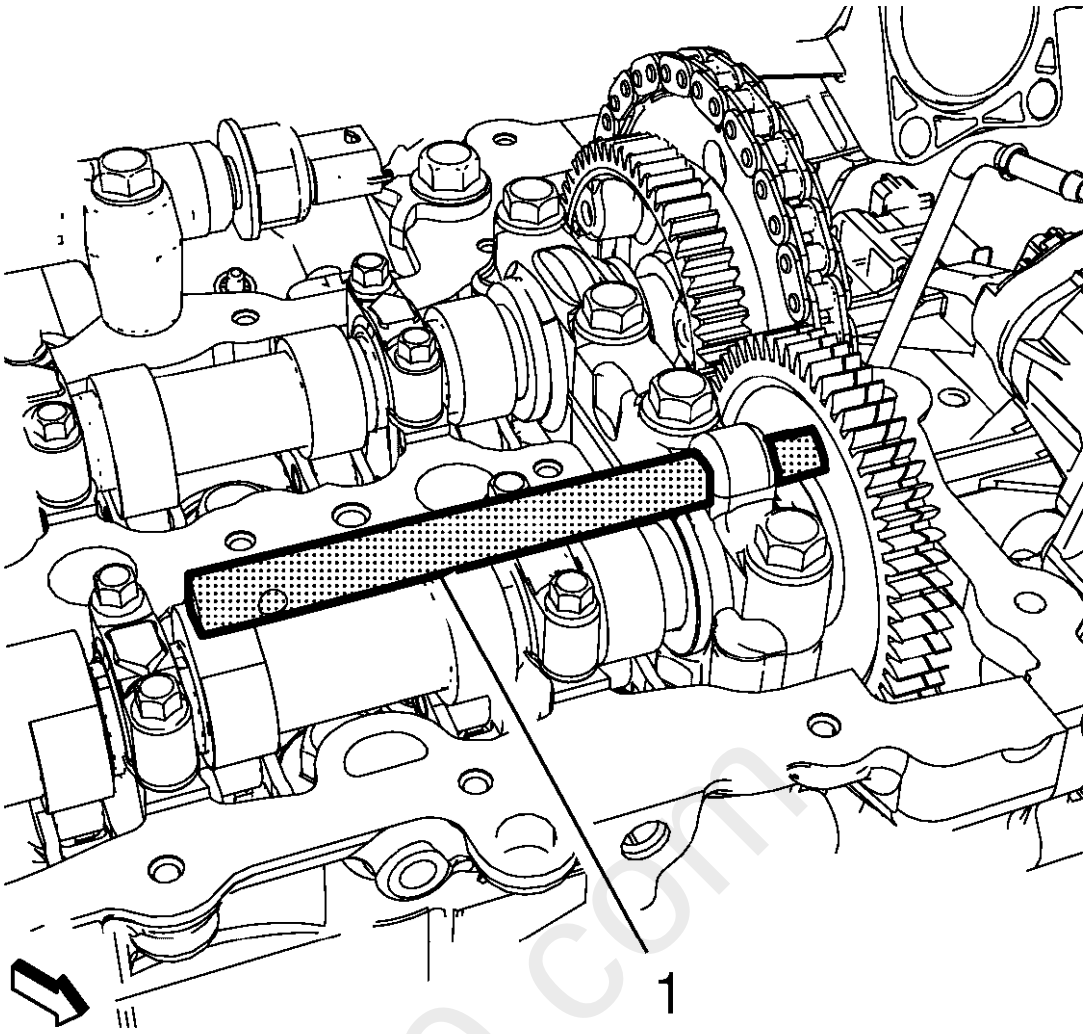


Fig. 653: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

2. Check if the bores (1) are aligned.

   Turn the exhaust camshaft at the hexagon so far if the **EN-51143** fixing tool (1) can be installed.

mcx30.com

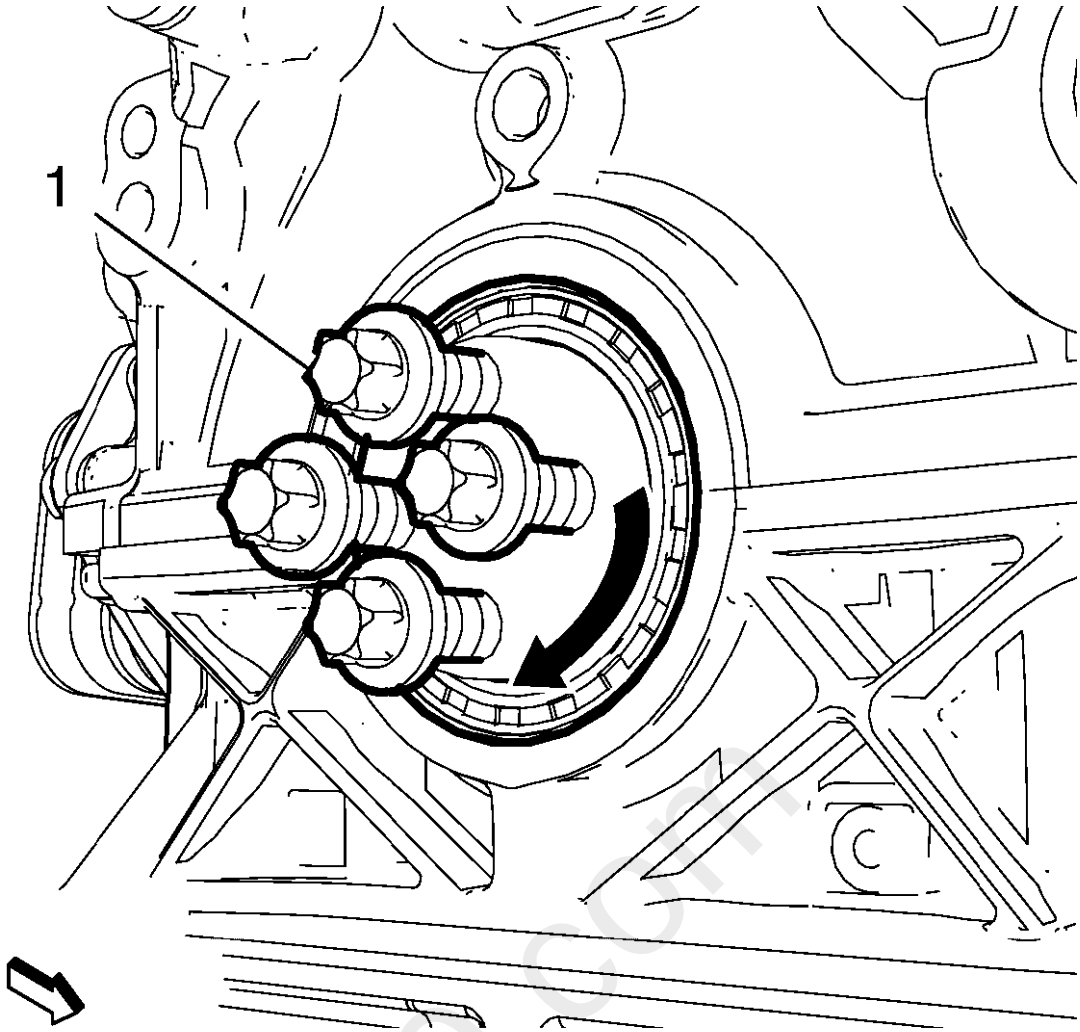


Fig. 654: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the 4 crankshaft pulley bolts (1).

mcx30.com

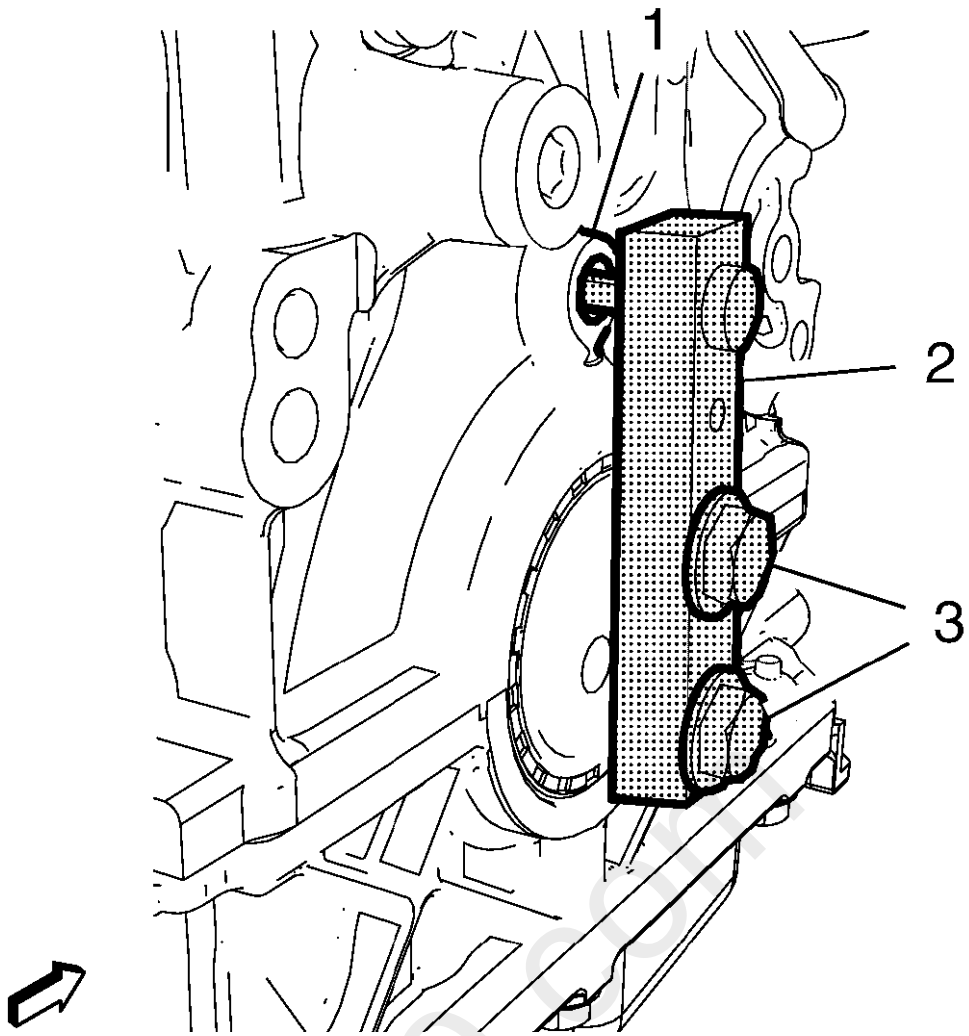


Fig. 655: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-51140** fixing tool (2).
5. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).

mcx30.com

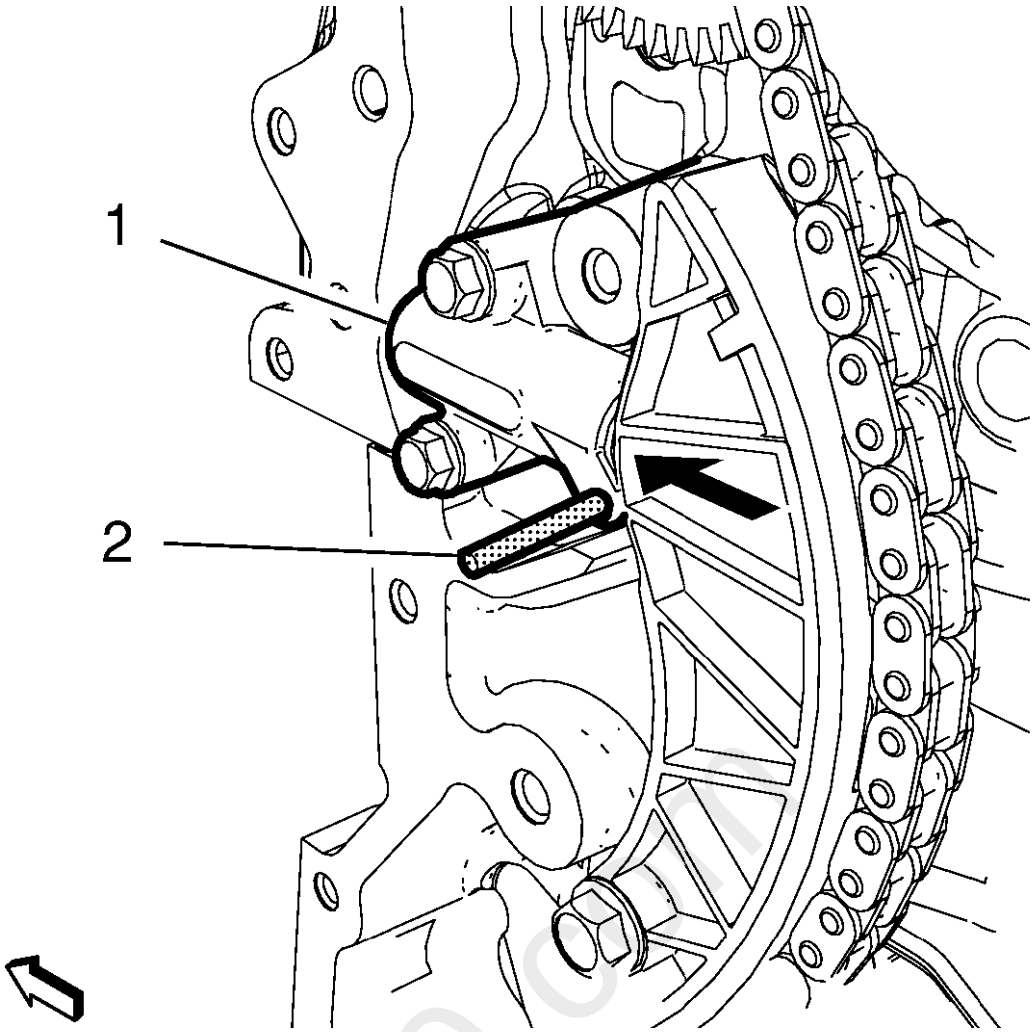


Fig. 656: Timing Chain Tensioner And Pin
Courtesy of GENERAL MOTORS COMPANY

6. Tension the timing chain tensioner (1) in arrow direction.
7. Install the **EN-50513** pin (2).

mcx30.com

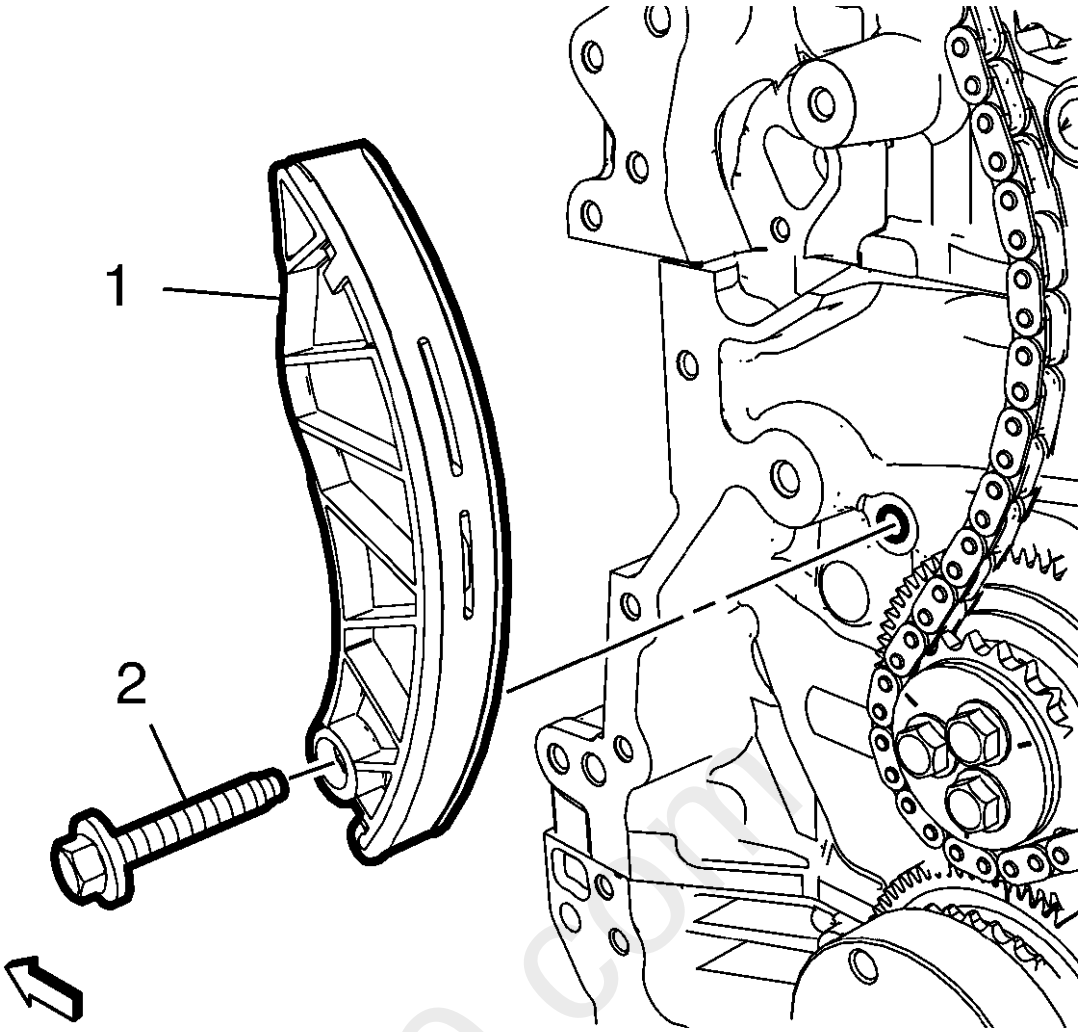


Fig. 657: Timing Chain Tensioner Shoe And Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove the timing chain tensioner shoe bolt (2).
9. Remove the timing chain tensioner shoe (1).

mcx30.com

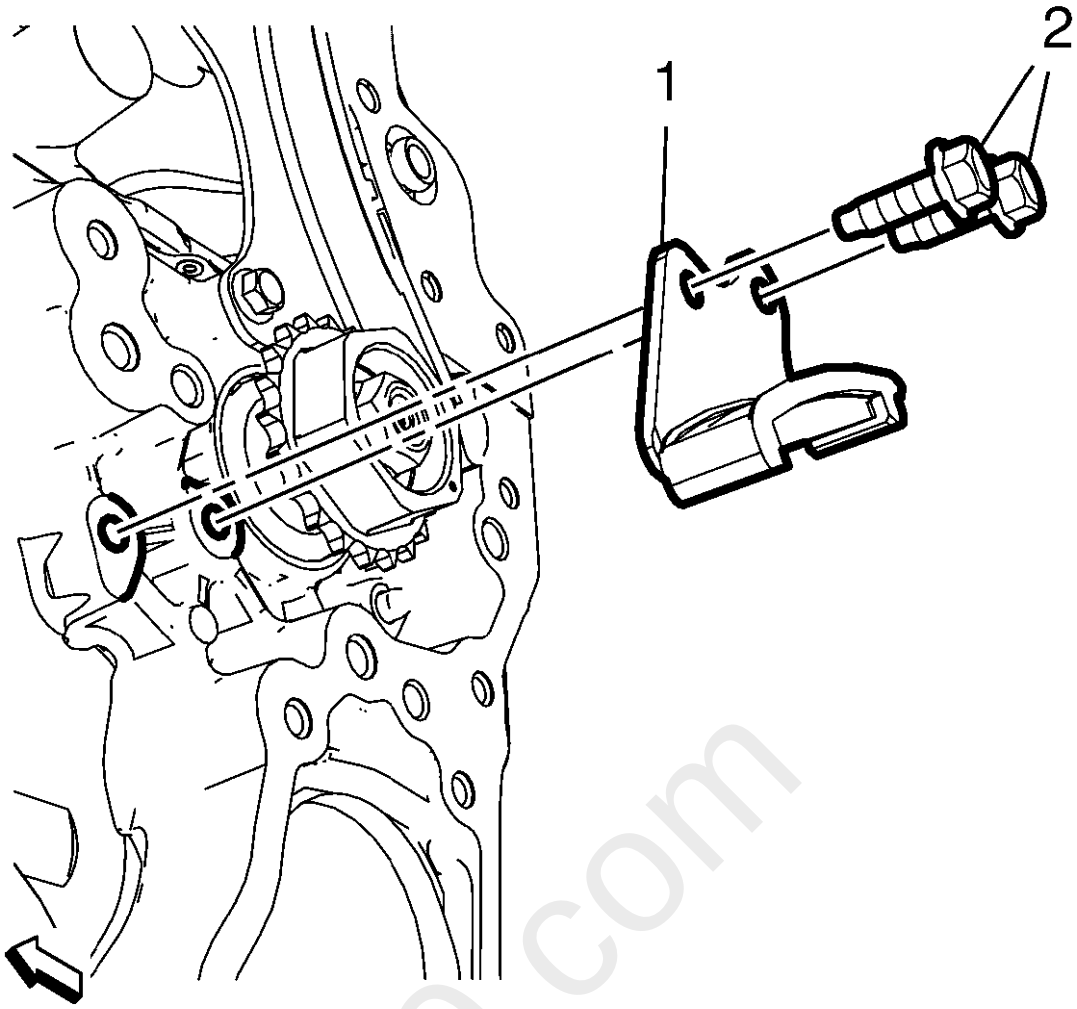


Fig. 658: Timing Chain Lower Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Remove the 2 timing chain lower guide bolts (2).
11. Remove the timing chain lower guide (1).

mcx30.com

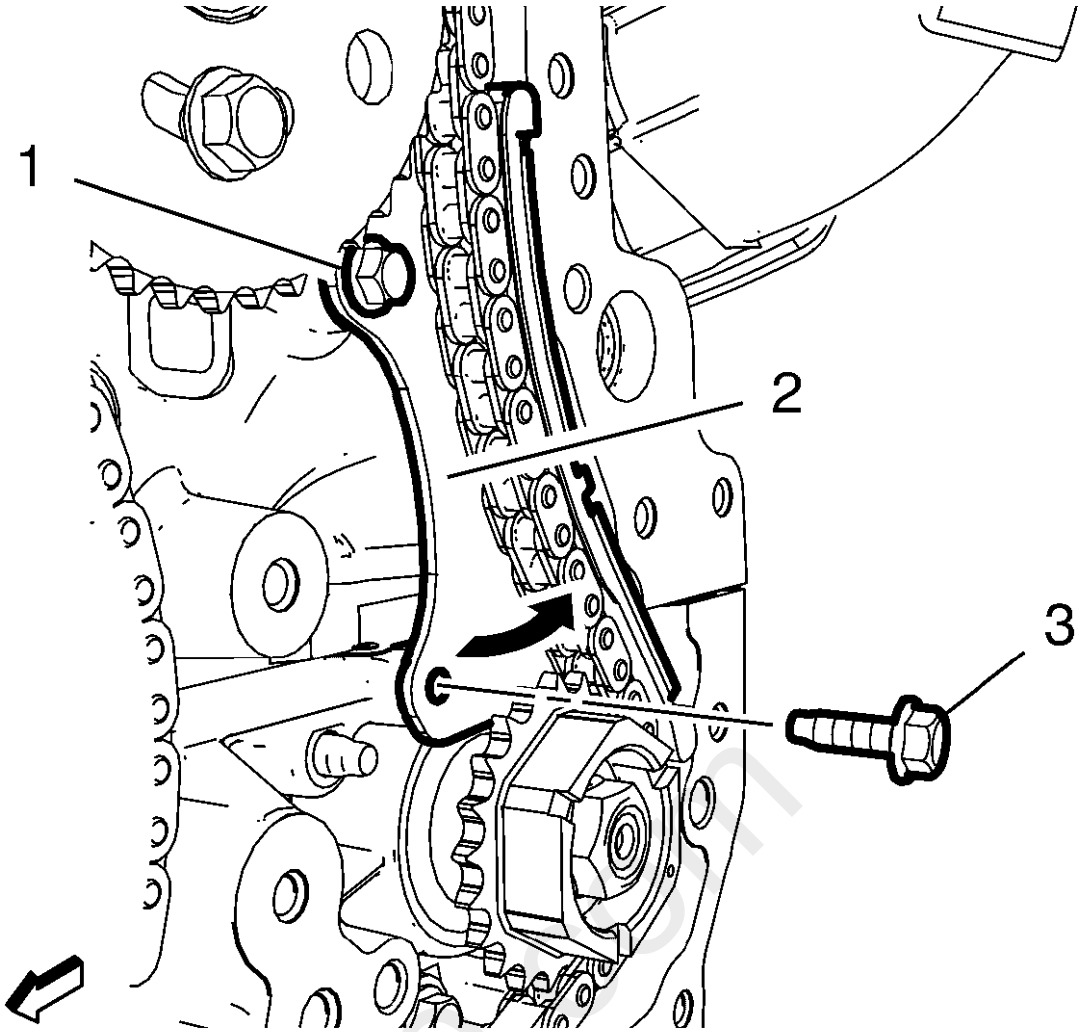


Fig. 659: Timing Chain Upper Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Loosen the timing chain upper guide bolt (1).
13. Remove the timing chain upper guide bolt (3).
14. Move the timing chain upper guide (2) in the direction of arrow.

mcx30.com

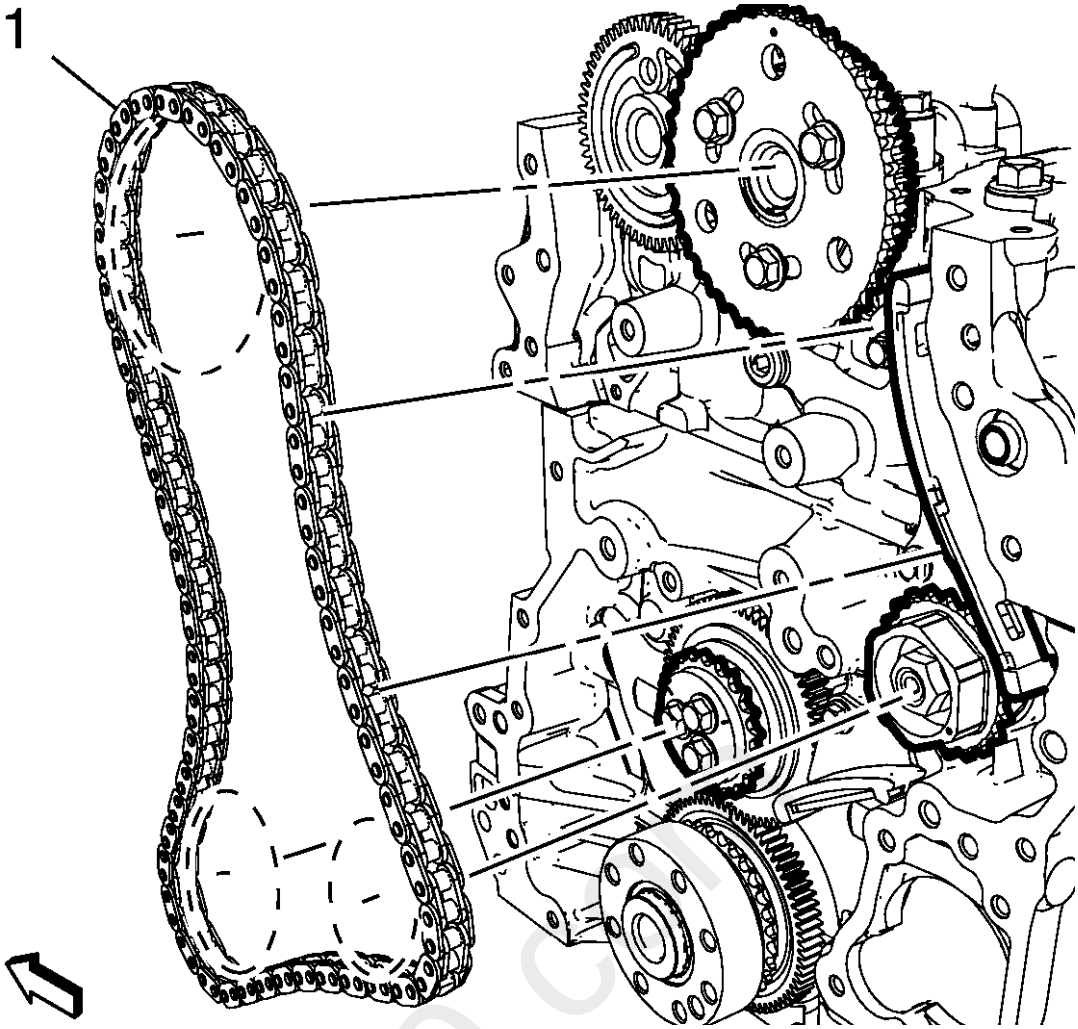


Fig. 660: Timing Chain
Courtesy of GENERAL MOTORS COMPANY

15. Remove the timing chain (1).

mcx30.com

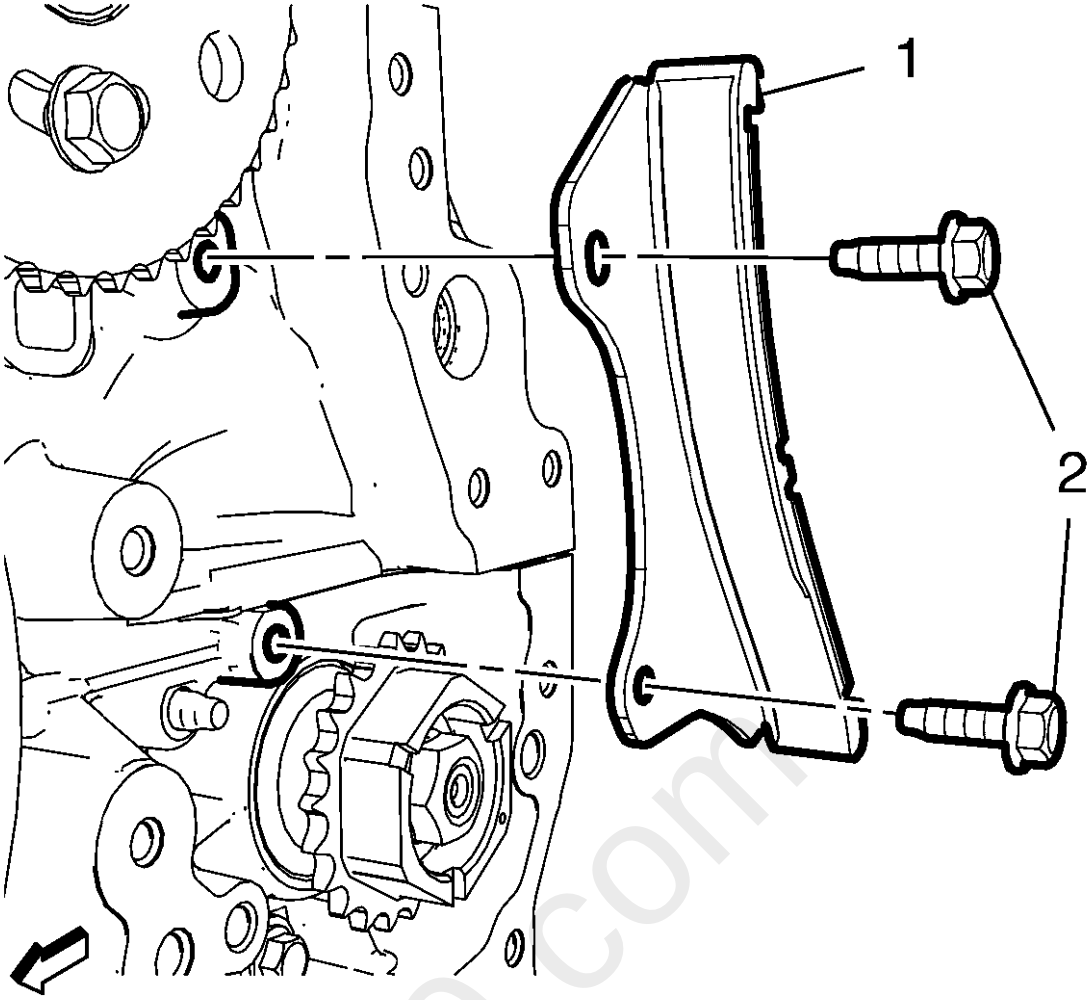


Fig. 661: Timing Chain Upper Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

16. Remove the upper timing chain upper guide bolt (2).
17. Remove the timing chain upper guide (1).

TIMING CHAIN TENSIONER REMOVAL

Special Tools

EN-50513 Fixing Pin

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

mcx30.com

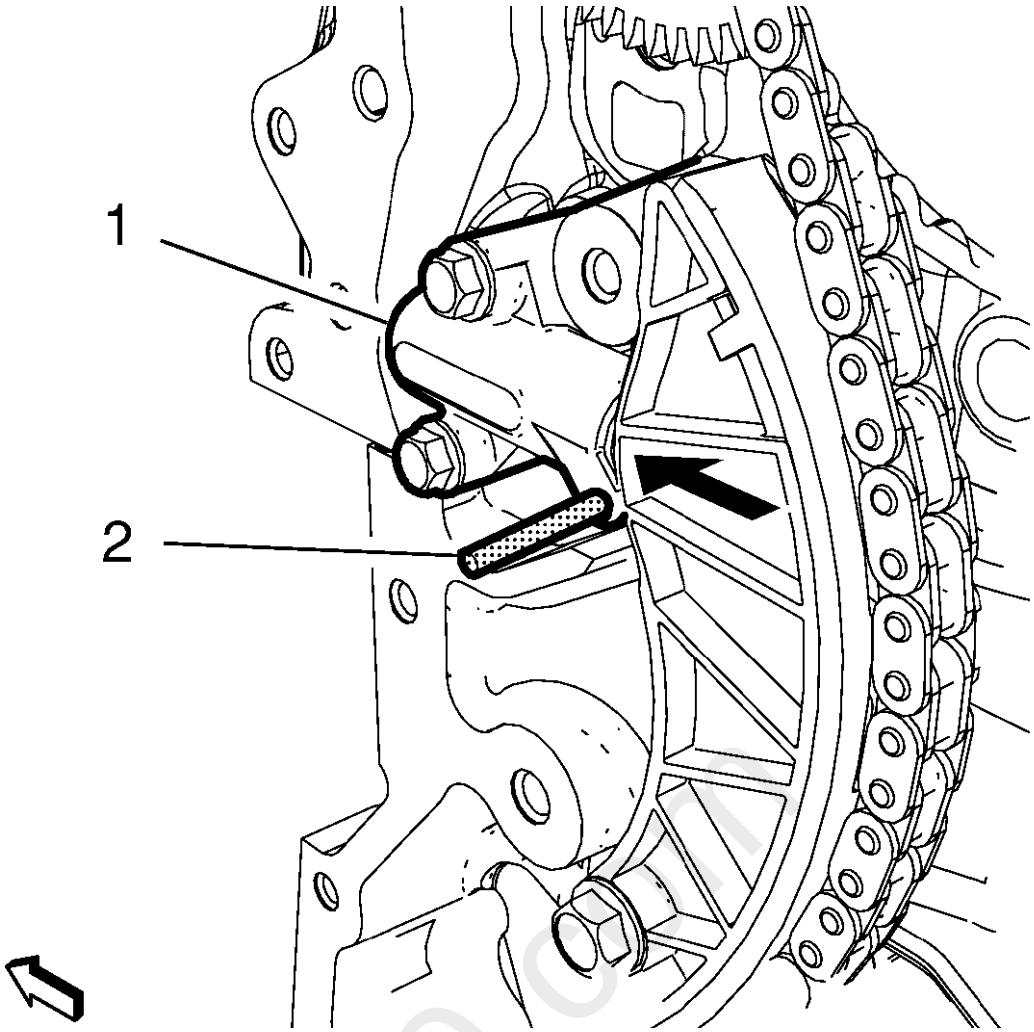


Fig. 662: Timing Chain Tensioner And Pin
Courtesy of GENERAL MOTORS COMPANY

1. Tension the timing chain tensioner (1) in arrow direction.
2. Install the **EN-50513** pin (2).

mcx30.com

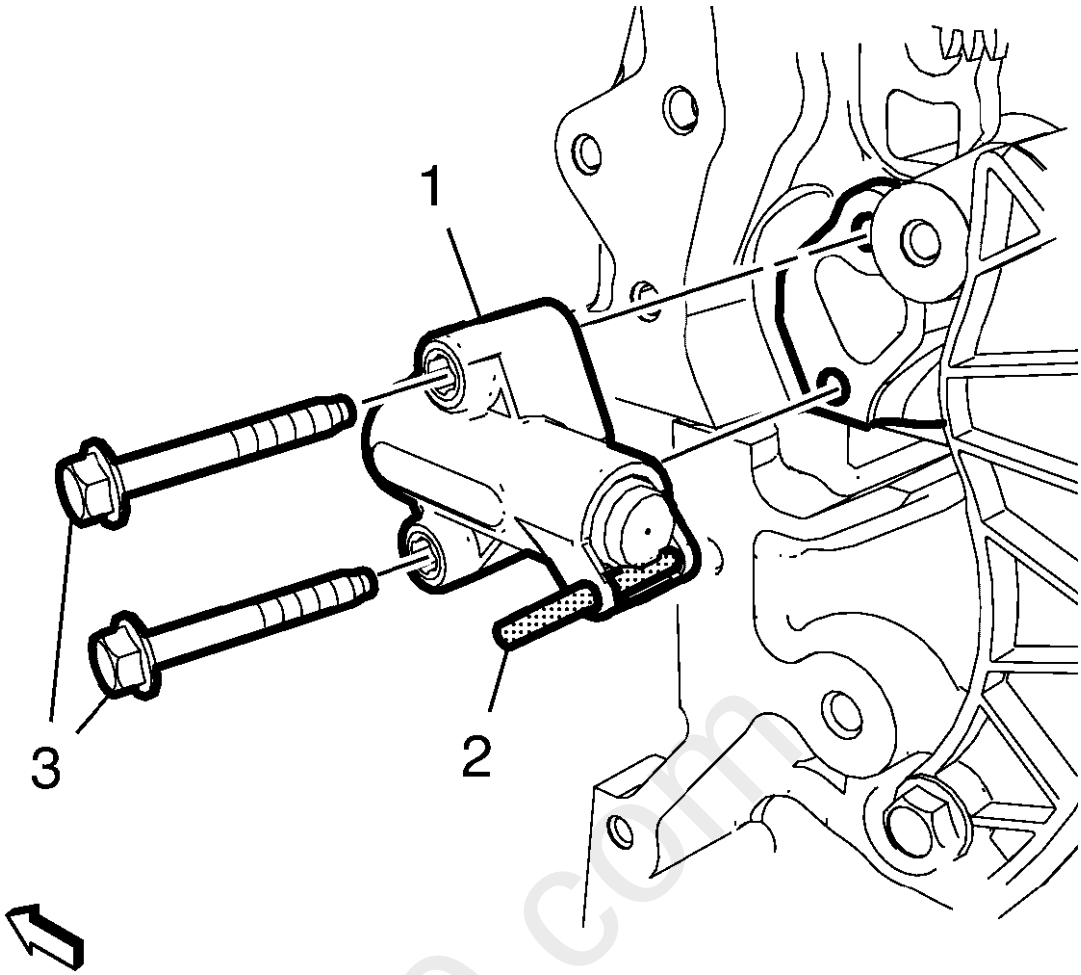


Fig. 663: Timing Chain Tensioner, Bolts And Pin
Courtesy of GENERAL MOTORS COMPANY

3. Remove the 2 timing chain tensioner bolts (3).

NOTE: **If the timing chain tensioner reused, do not remove the EN-50513 pin (2).**

4. Remove the timing chain tensioner (1).

TIMING CHAIN TENSIONER SHOE REMOVAL

mcx30.com

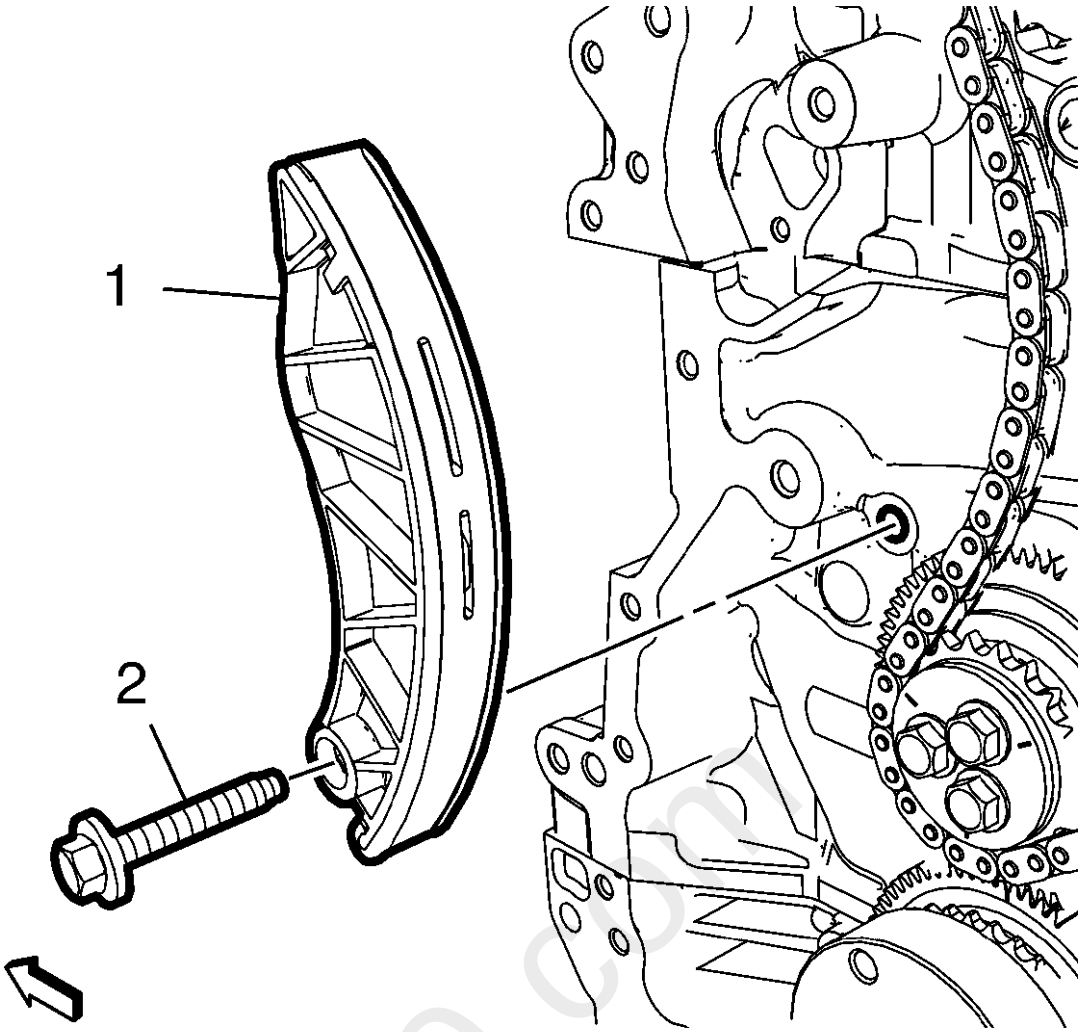


Fig. 664: Timing Chain Tensioner Shoe And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the timing chain tensioner shoe bolt (2).
2. Remove the timing chain tensioner shoe (1).

TIMING CHAIN LOWER GUIDE REMOVAL

mcx30.com

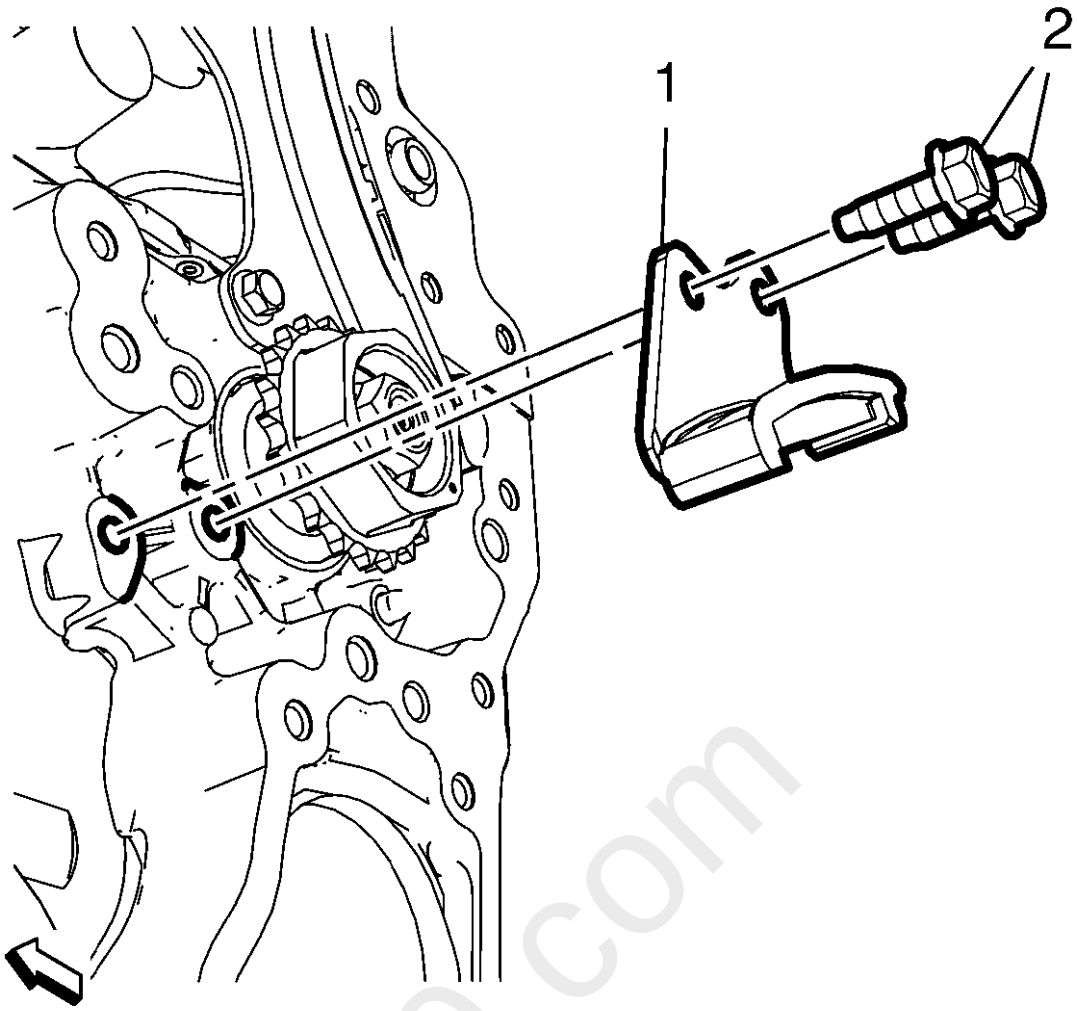


Fig. 665: Timing Chain Lower Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 2 timing chain lower guide bolts (2).
2. Remove the timing chain lower guide (1).

TIMING CHAIN UPPER GUIDE REMOVAL

mex30.com

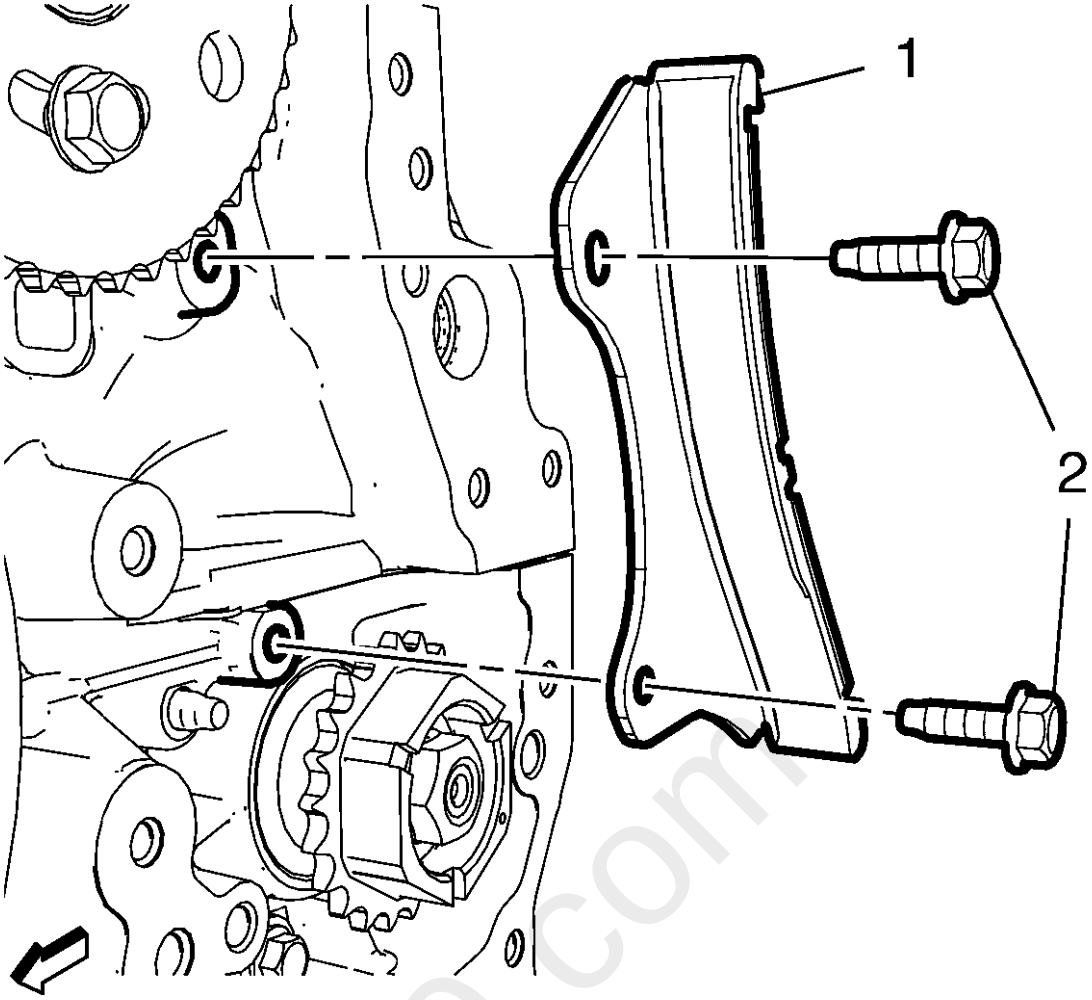


Fig. 666: Timing Chain Upper Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The camshaft timing chain must be removed. The lower timing chain bolt has already removed by the camshaft timing chain removal.**

1. Remove the upper timing chain upper guide bolt (2).
2. Remove the timing chain upper guide (1).

TIMING CHAIN IDLER SPROCKET REMOVAL

Special Tools

EN-51141 Intermediate Drive Gear Fixing Tool

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

mox30.com

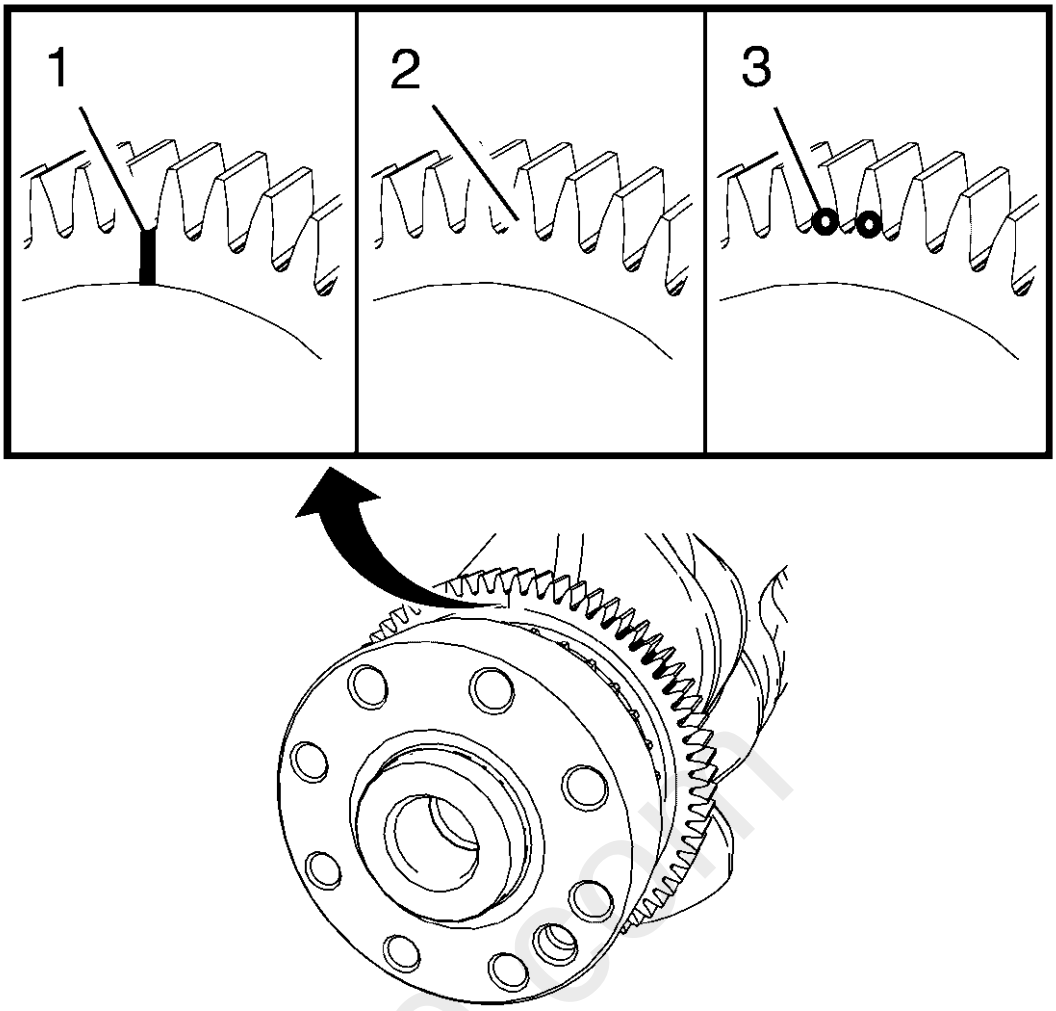


Fig. 667: Crankshaft Sprocket Marks
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Depending on the crankshaft, two different marks (1) and (3) or none (2) can be located on the crankshaft sprocket.**

1. Mark the crankshaft sprocket align with the timing chain idler sprocket if there is no mark.

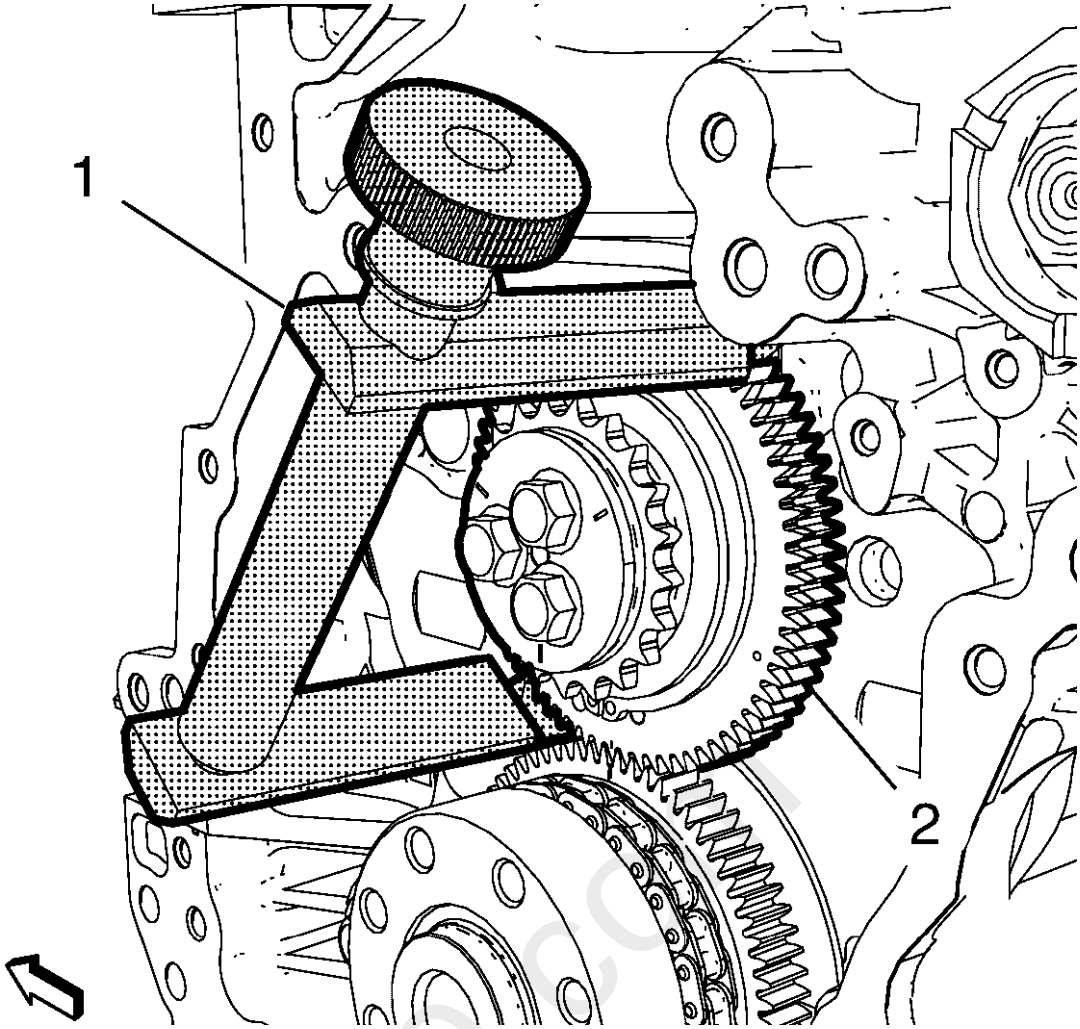


Fig. 668: Intermediate Drive Gear Fixing Tool And Timing Chain Idler Sprocket
Courtesy of GENERAL MOTORS COMPANY

2. Install the **EN-51141** fixing tool (1) to the timing chain idler sprocket (2).

mcx30.com

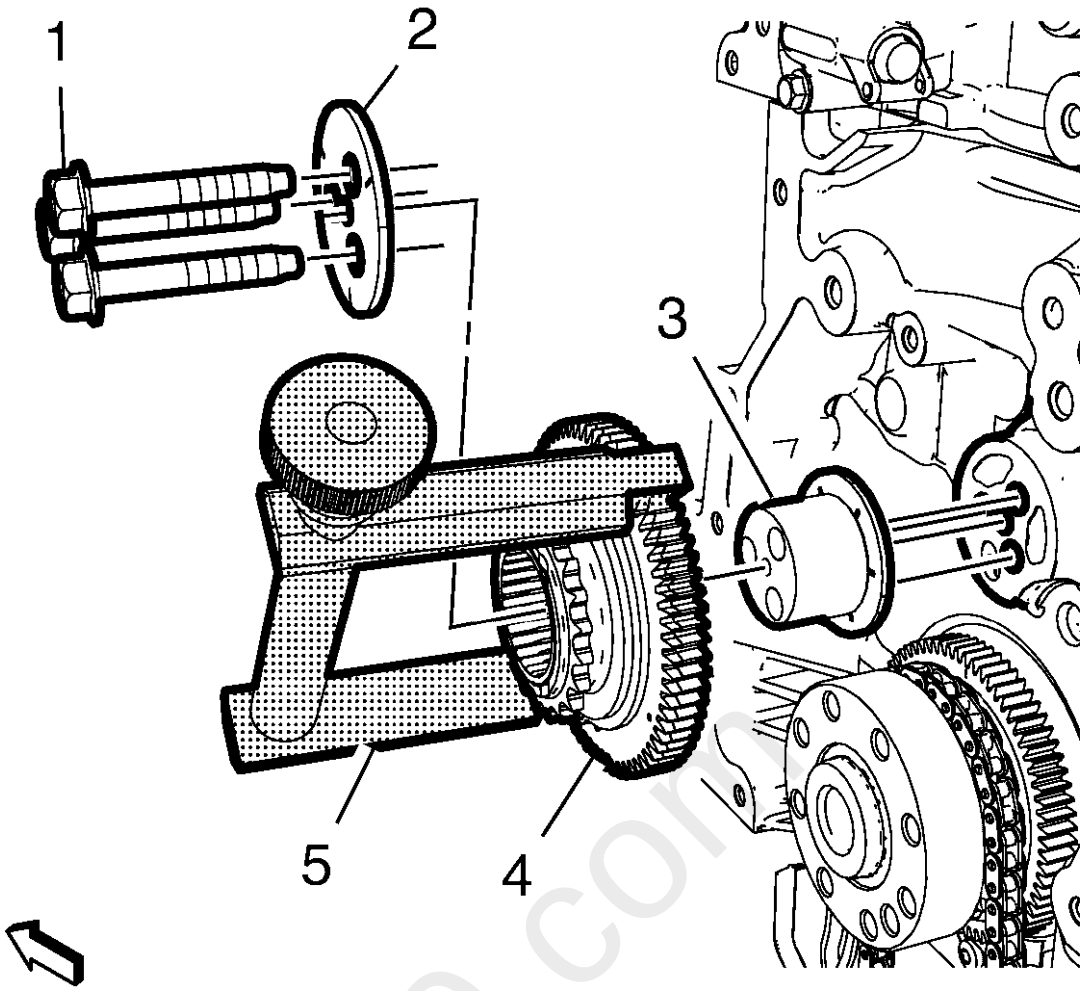


Fig. 669: Timing Chain Idler Sprocket, Bolts, Bearing Plate And Gear Shaft Distributor
Courtesy of GENERAL MOTORS COMPANY

3. Remove the 3 timing chain idler sprocket bolts (1).
4. Remove the timing chain idler sprocket bearing plate (2).

NOTE: **If the timing chain idler sprocket is reused, do not remove the EN-51141 fixing tool (5).**

5. Remove the timing chain idler sprocket (4).
6. Remove the gear shaft distributor (3).

FUEL INJECTION PUMP DRIVEN SPROCKET REMOVAL

Special Tools

EN-50885-2 Locking Tool

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

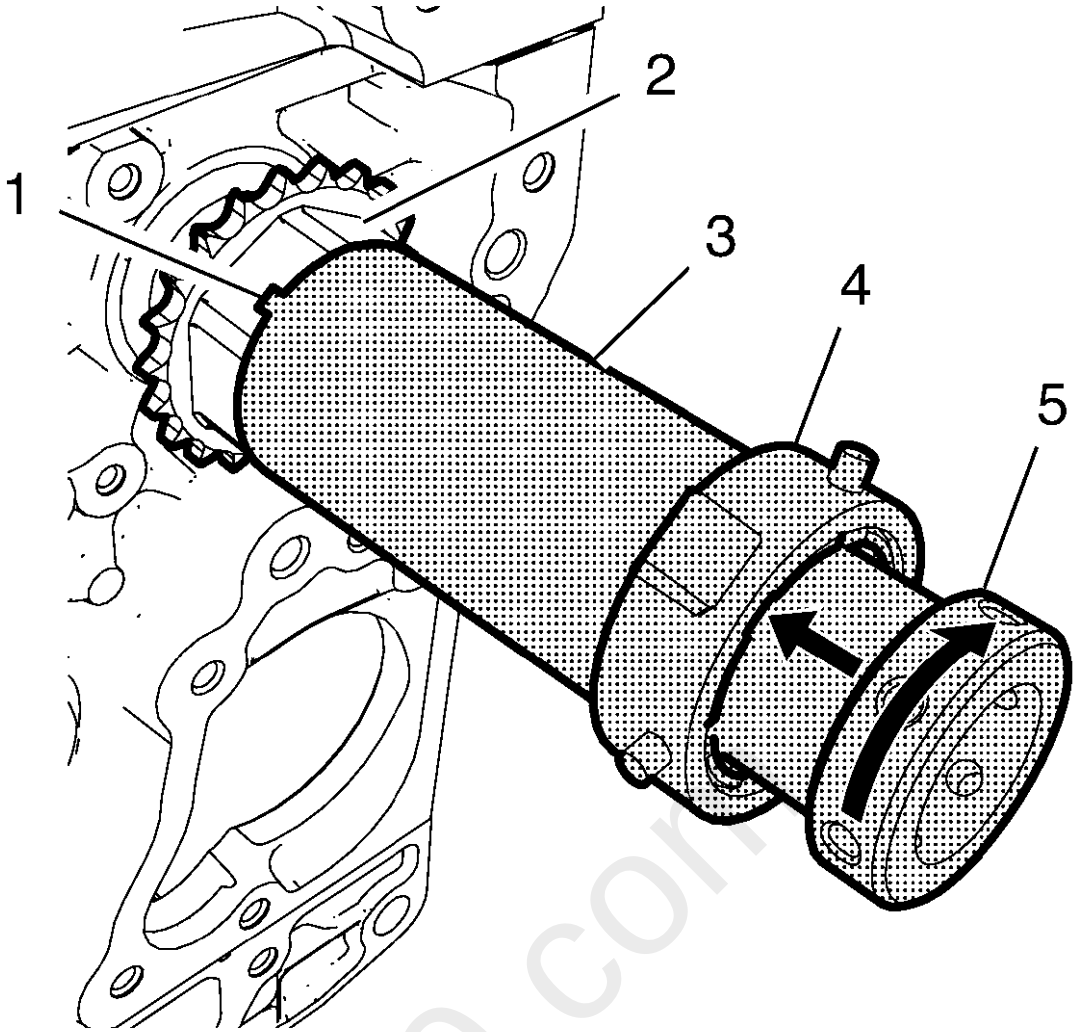


Fig. 670: Locking Tool Installed
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-50885-2** locking tool.
    1. Install the housing (3) to the fuel injection pump driven sprocket nut (2). Ensure that the 3 tappets (1) mesh with the 3 slots of the fuel injection pump driven sprocket nut.
    2. Position the ring (4) for a good handling.
    3. Screw in the fixing tool (5) into the fuel injection pump driven sprocket nut.

mx30.com

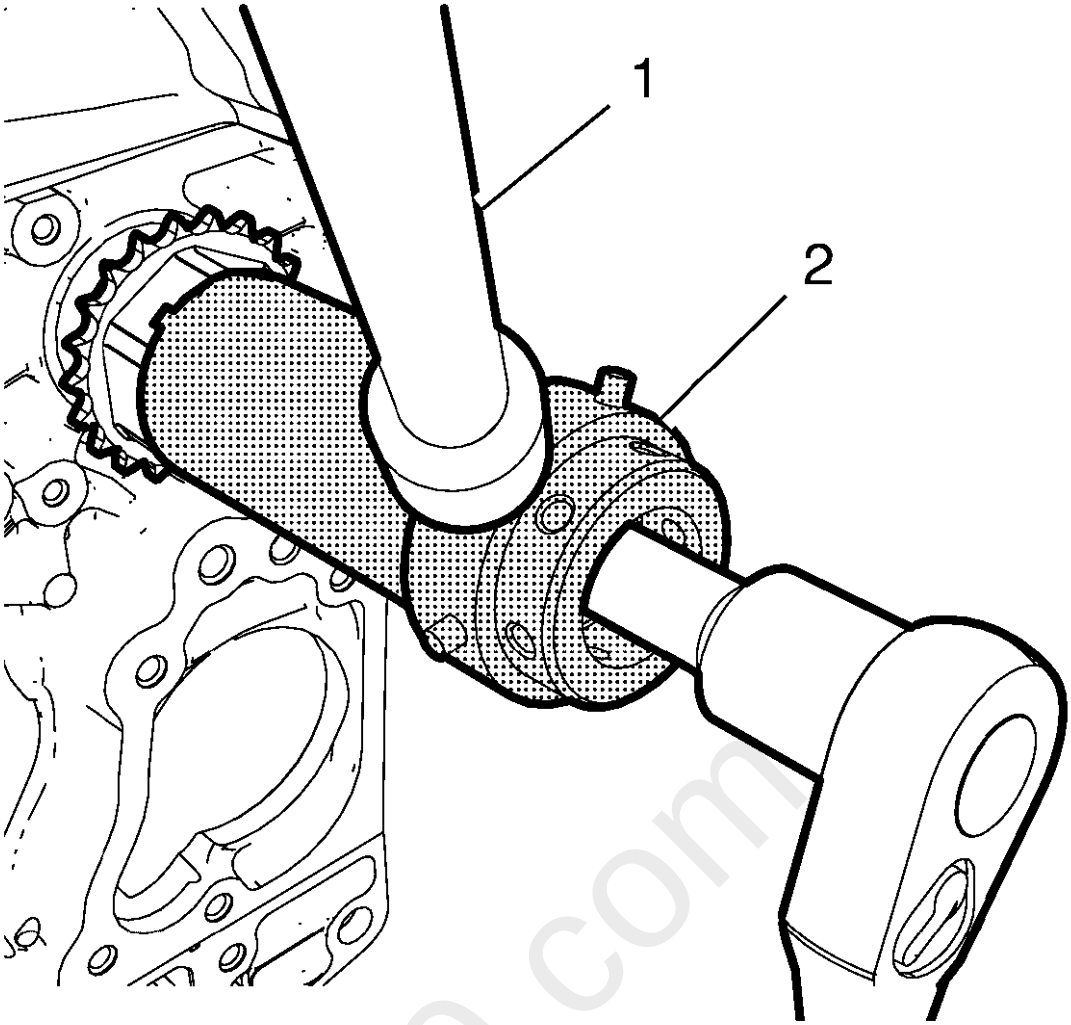


Fig. 671: Extension And Locking Tool
Courtesy of GENERAL MOTORS COMPANY

2. Install a 1/2" extension (1) to the **EN-50885-2** locking tool (2) to counterhold.
3. Loosen the fuel injection pump driven sprocket nut.

mcx30.com

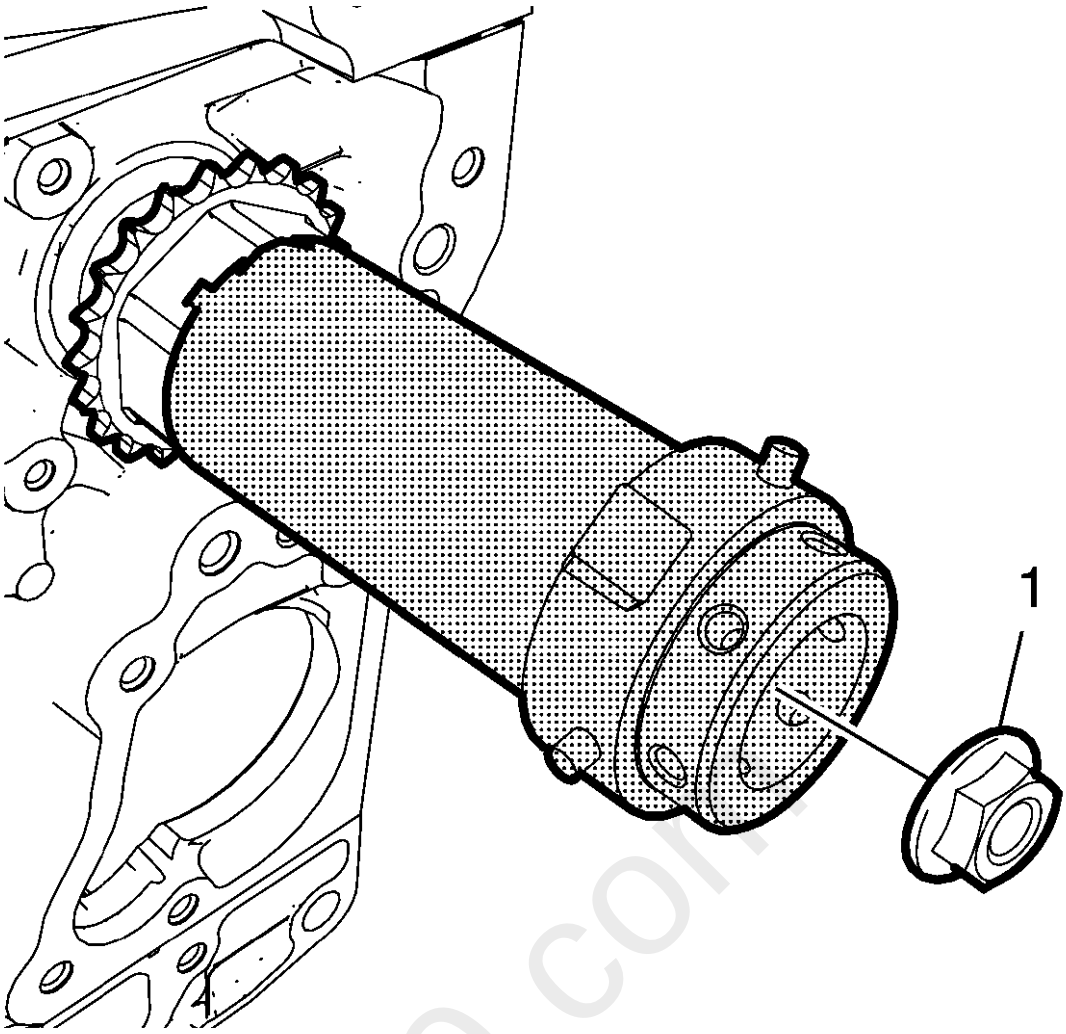


Fig. 672: Fuel Injection Pump Driven Sprocket Nut
Courtesy of GENERAL MOTORS COMPANY

4. Remove the fuel injection pump driven sprocket nut (1).

mcx30.com

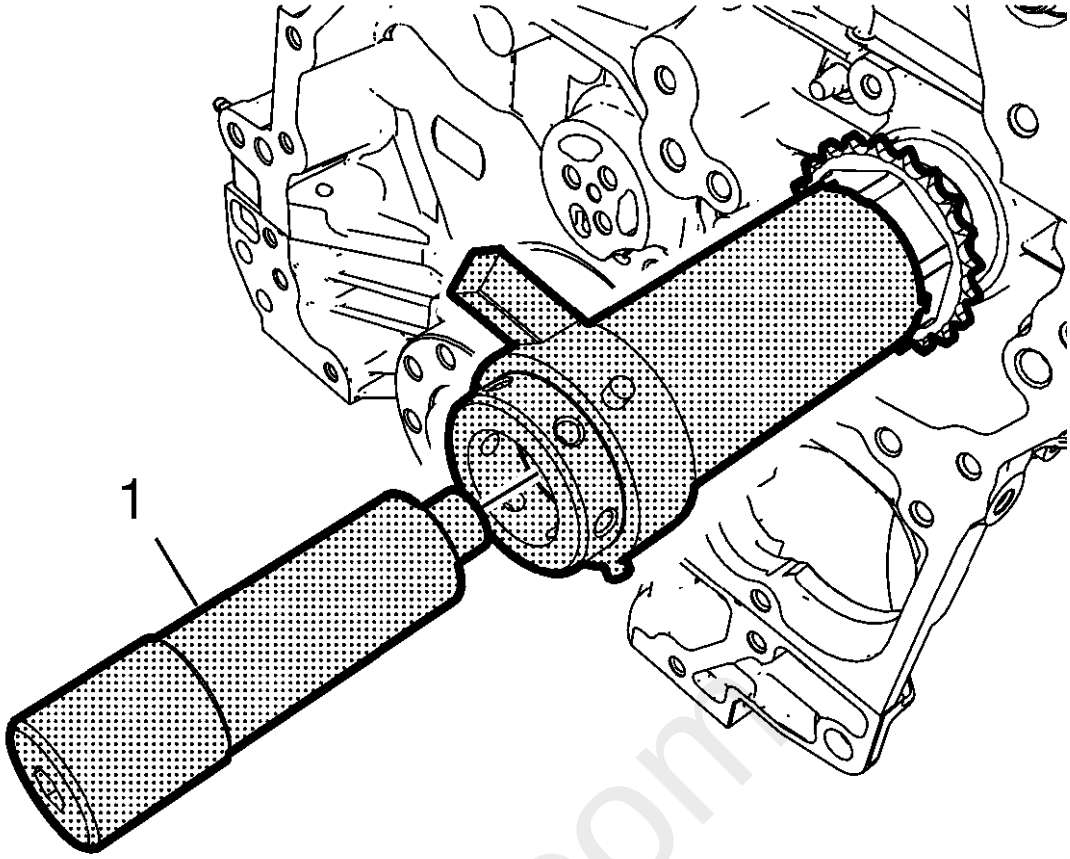


Fig. 673: Pressure Spindle And Locking Tool
Courtesy of GENERAL MOTORS COMPANY

5. Install the pressure spindle (1) to the **EN-50885-2** locking tool (2).

mcx30.com

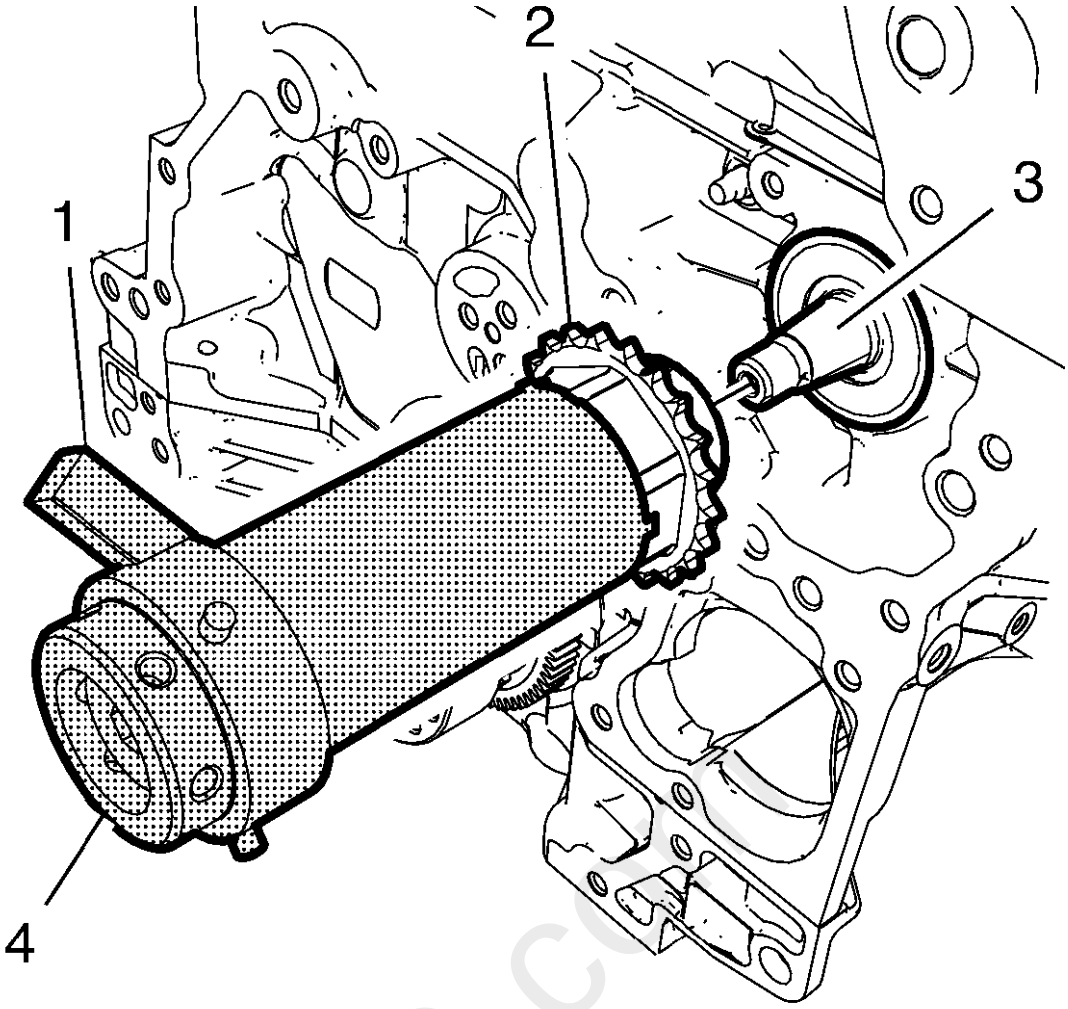


Fig. 674: Fuel Injection Pump Sprocket, Pressure Spindle And Locking Tool
Courtesy of GENERAL MOTORS COMPANY

6. Press out the fuel injection pump sprocket (2), by screw in the pressure spindle (4) into the **EN-50885-2** fixing tool (1).
7. Remove the fuel injection fuel pump driven sprocket.
8. Remove the **EN-50885-2** fixing tool from the fuel injection pump driven sprocket.

FUEL INJECTION PUMP REMOVAL

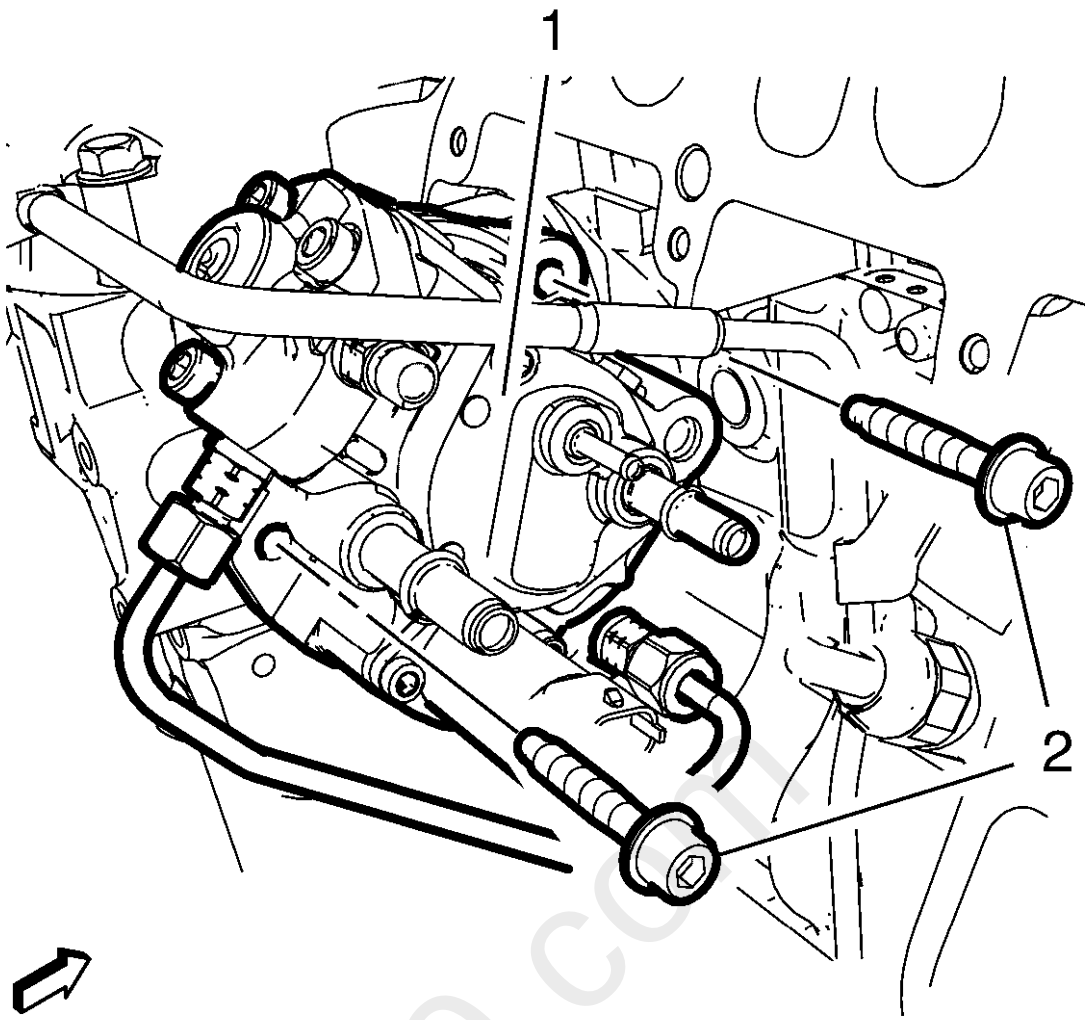


Fig. 675: Fuel Injection Fuel Pump And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 2 fuel injection fuel pump bolts (2) from the fuel injection fuel pump (1).

mcx30.com

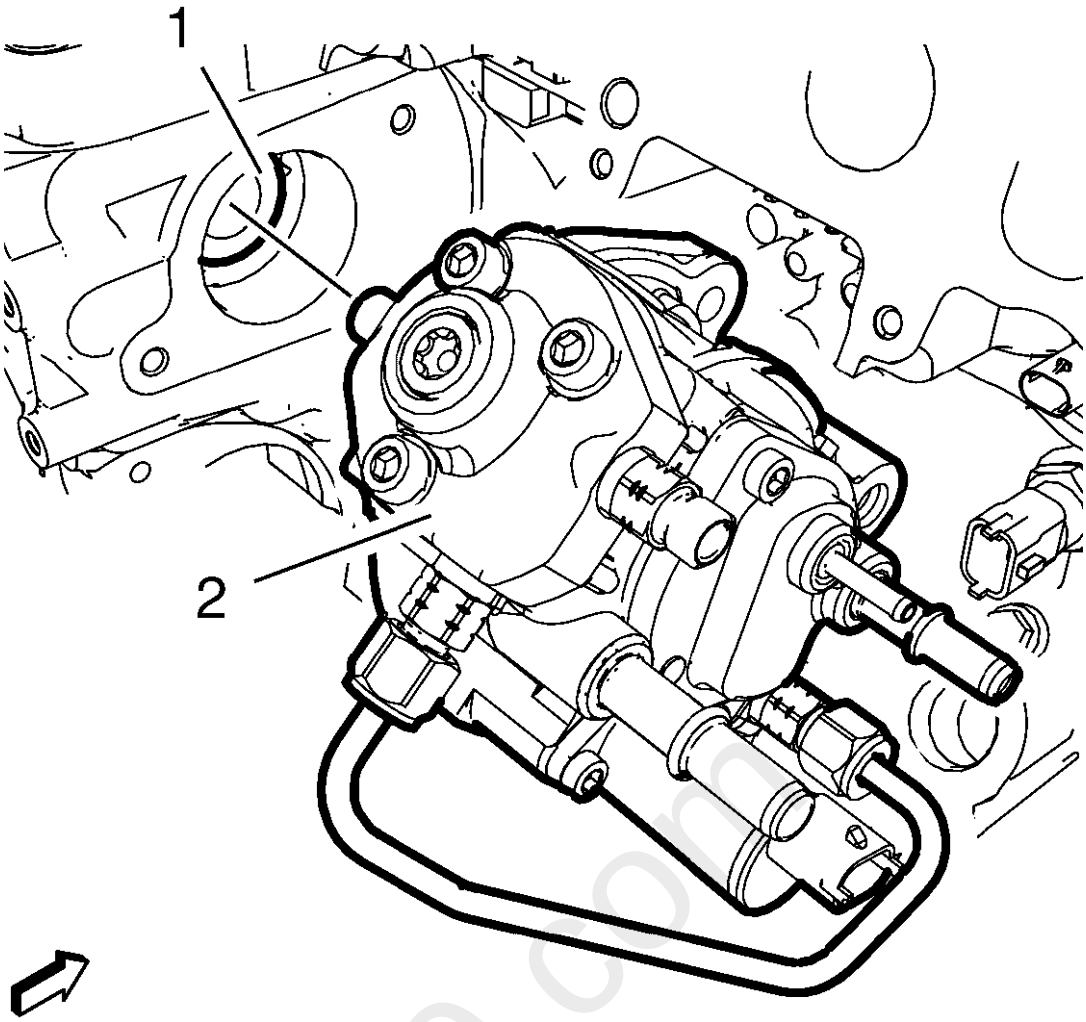


Fig. 676: Fuel Injection Fuel Pump
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fuel injection pump (2).

mcx30.com

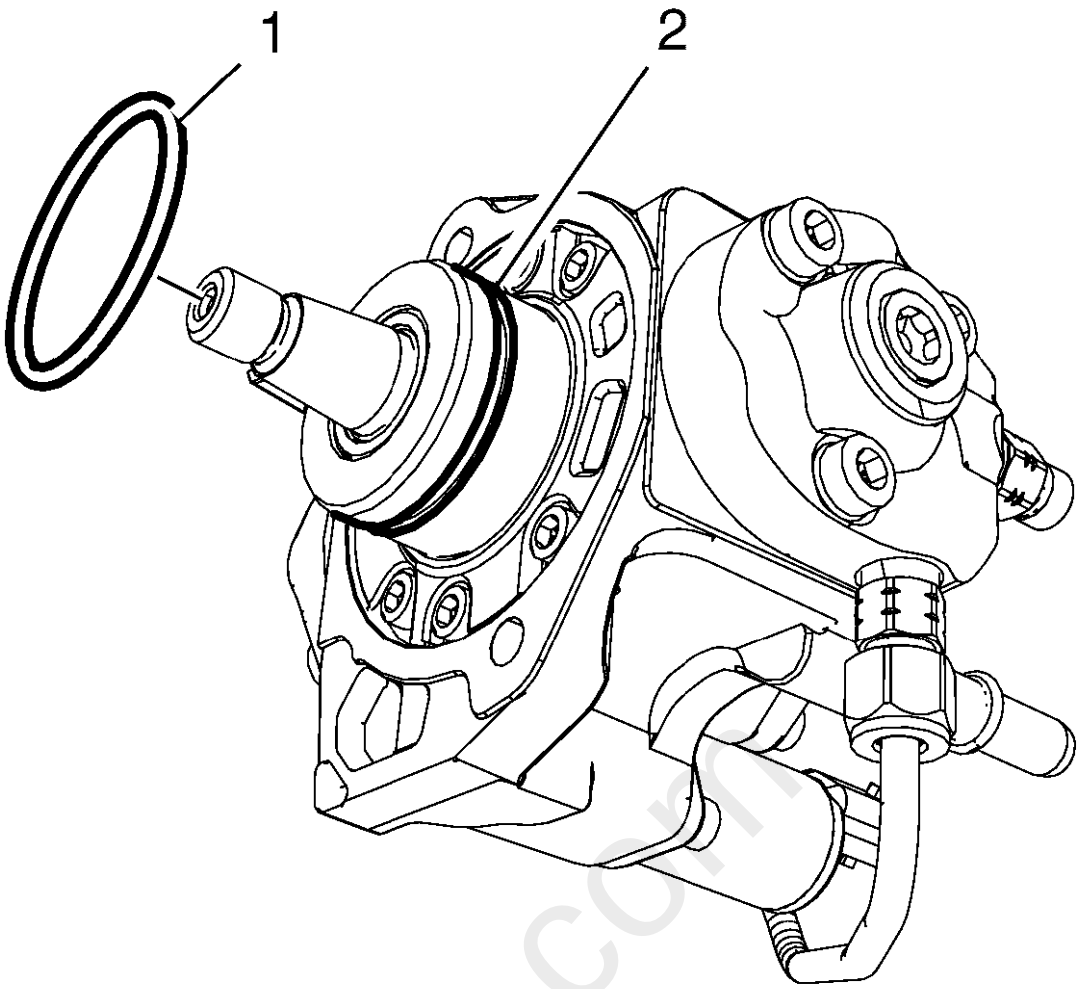


Fig. 677: Fuel Injection Pump Seal Ring And Fuel Injection Pump Sealing Groove
Courtesy of GENERAL MOTORS COMPANY

3. Remove and DISCARD the fuel injection pump seal ring (1) from the fuel injection pump sealing groove (2).

CAMSHAFT SPROCKET REMOVAL

mcx30.com

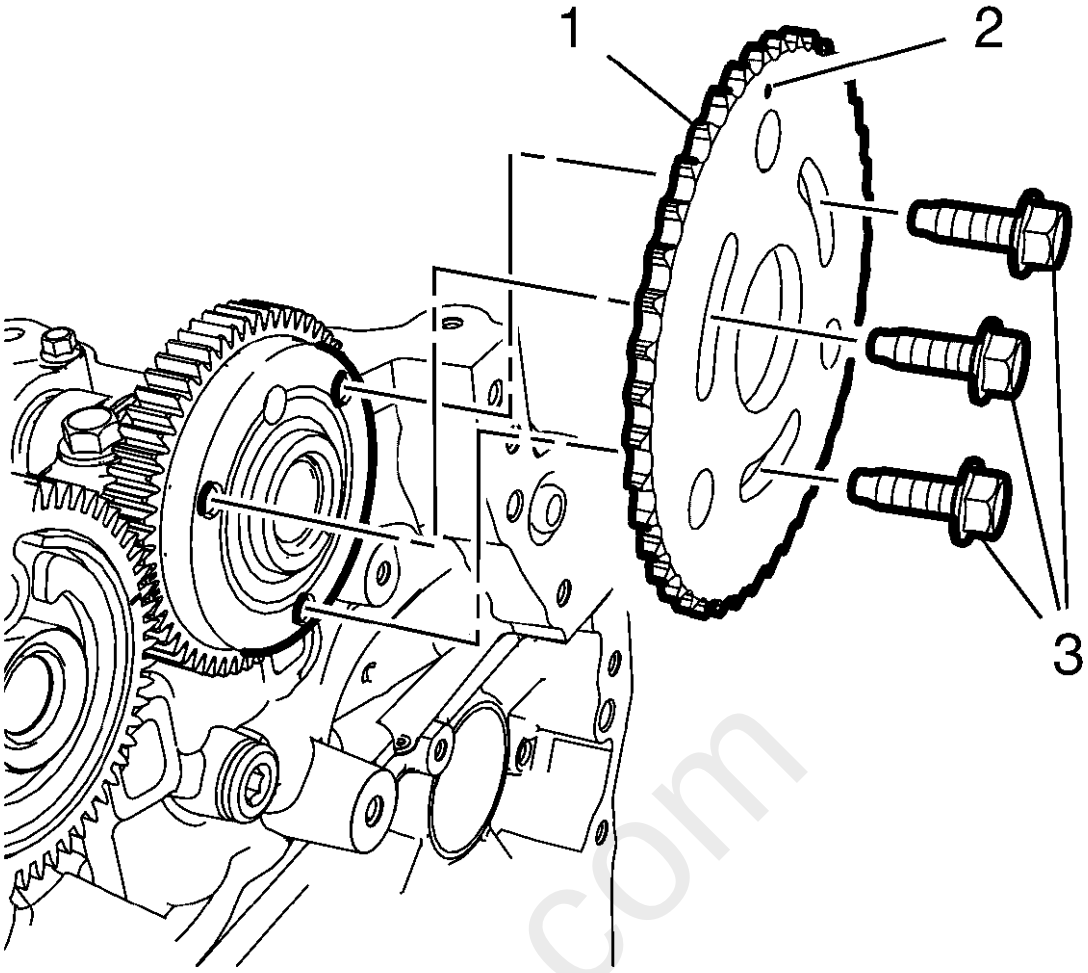


Fig. 678: Camshaft Sprocket And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 3 camshaft sprocket bolts (3), counterhold with a wrench at the camshaft hexagon.
2. Remove the camshaft sprocket (1) from the intake camshaft.

INTAKE CAMSHAFT REMOVAL

Special Tools

- **EN-50509** Split Intake Camshaft Sprocket Fixing Tool
- **EN-51143** Camshaft Sprocket Fixing Tool

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

mcx30.com

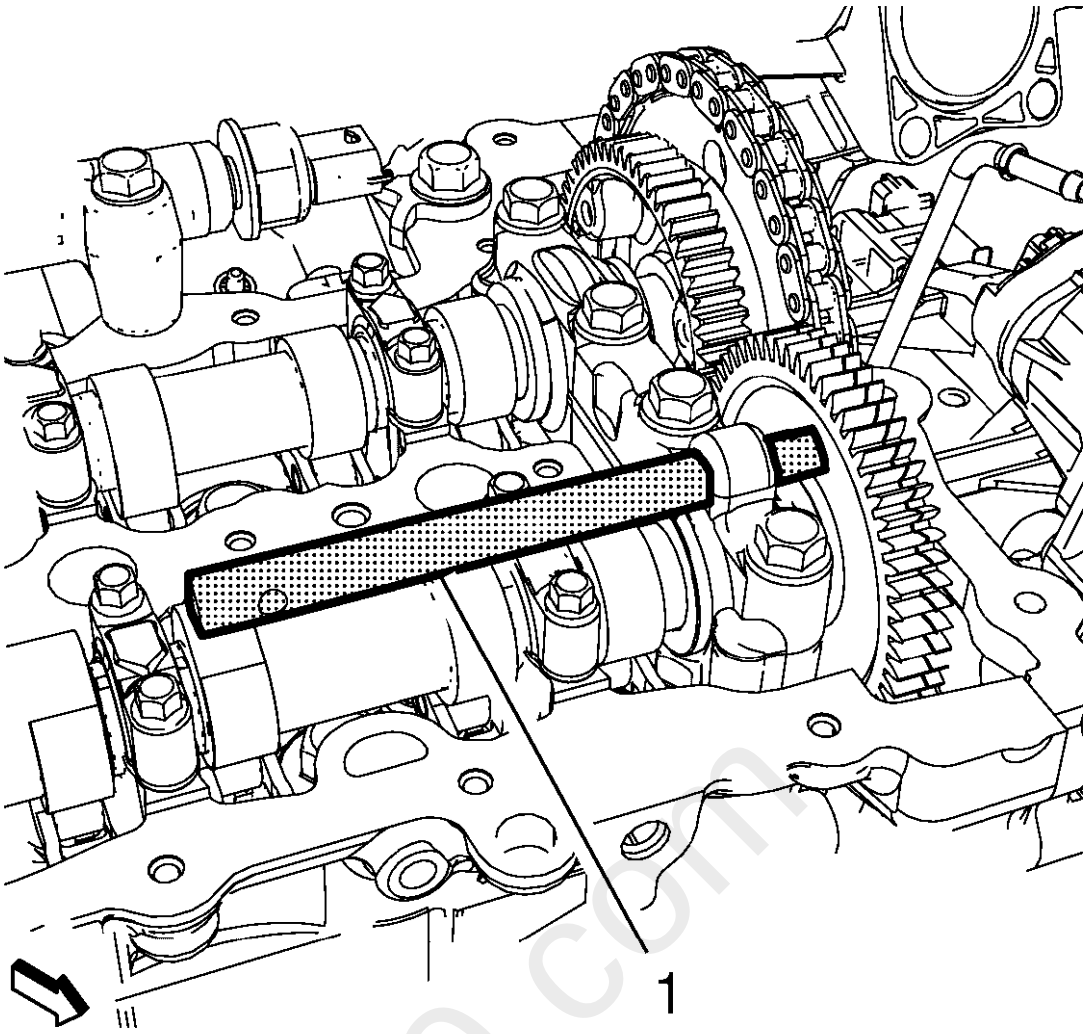


Fig. 679: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

1. Remove the **EN-51143** fixing tool (1), by carefully turning the hexagon of the camshaft.

mcx30.com

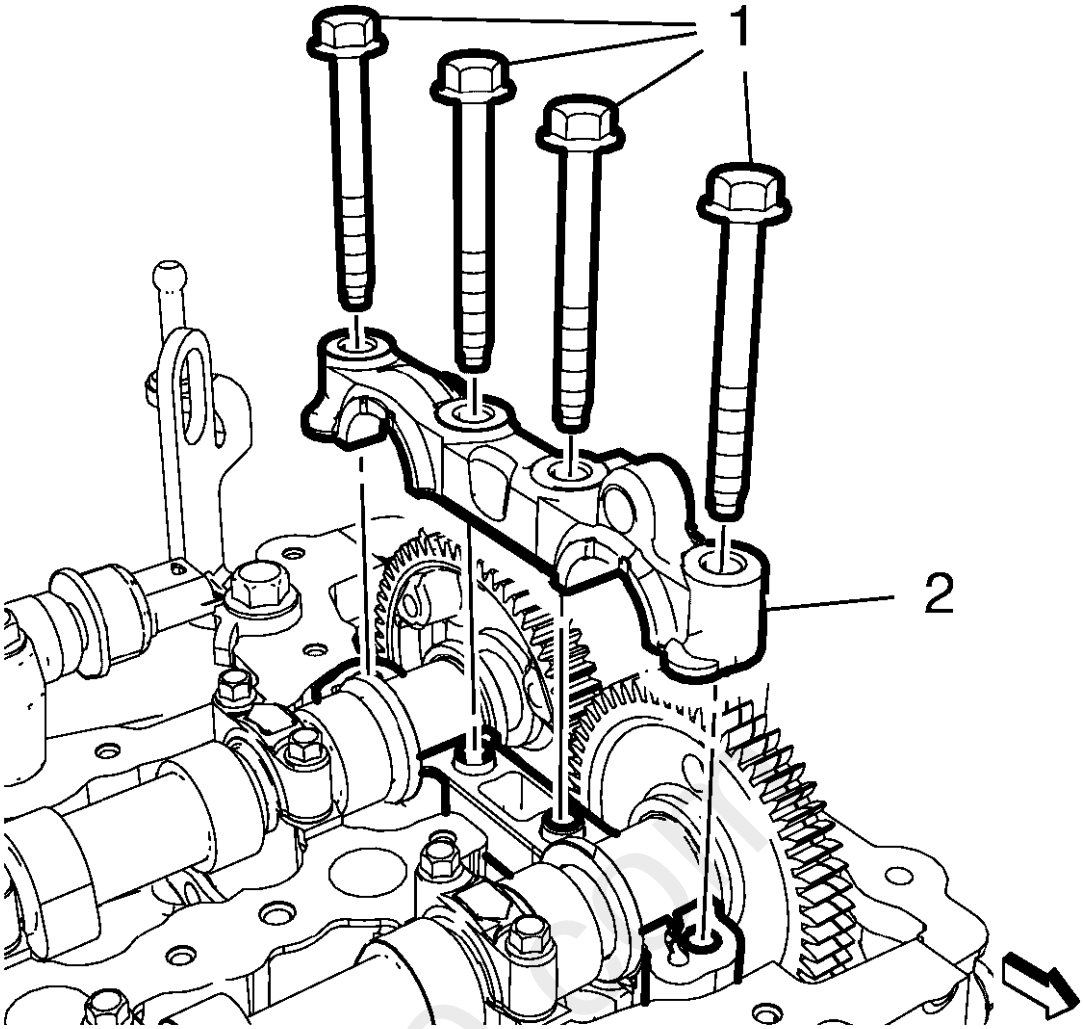


Fig. 680: Camshaft Bearing Rear Cap And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the camshaft bearing rear cap bolts (1).
3. Remove the camshaft bearing rear cap (2).

mcx80.com

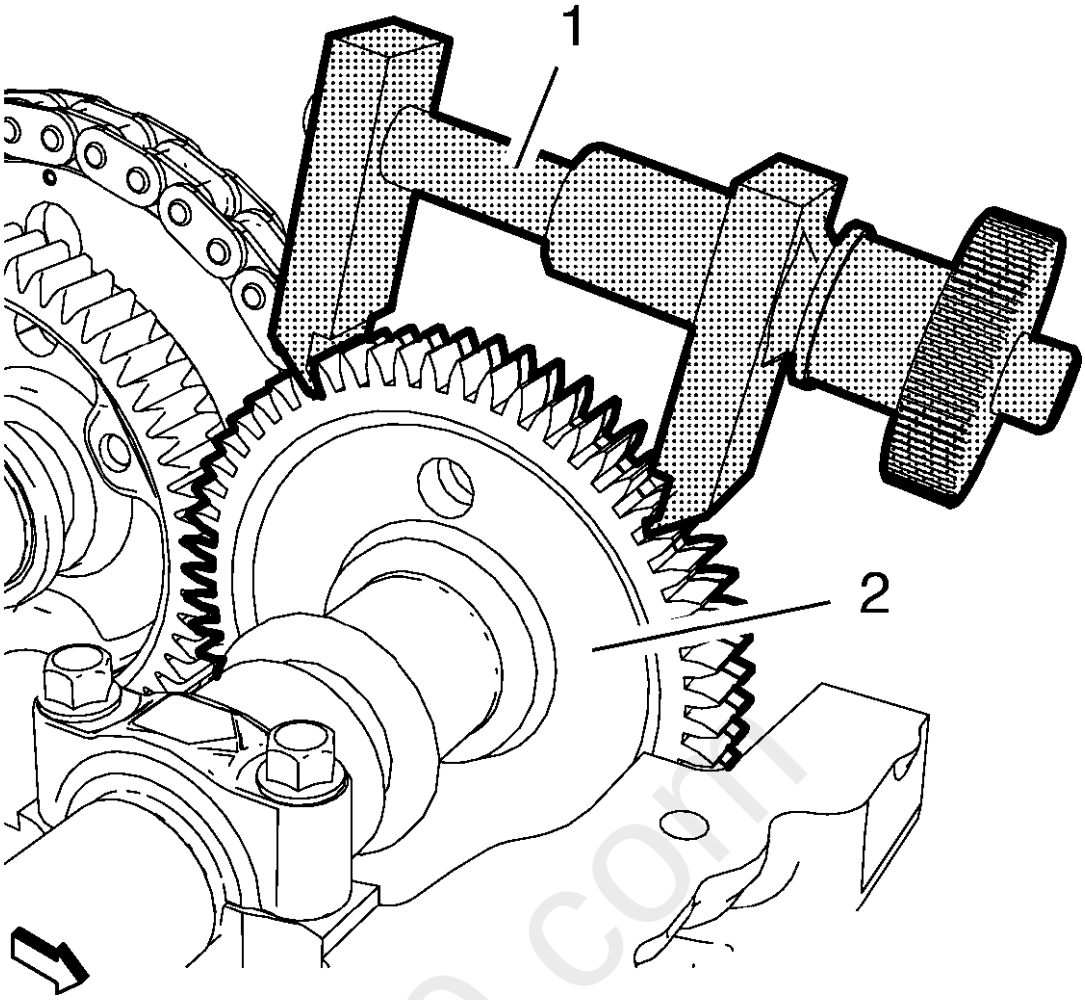


Fig. 681: Split Intake Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-50509** fixing tool (1) to the exhaust camshaft sprocket (2).

mcx30.com

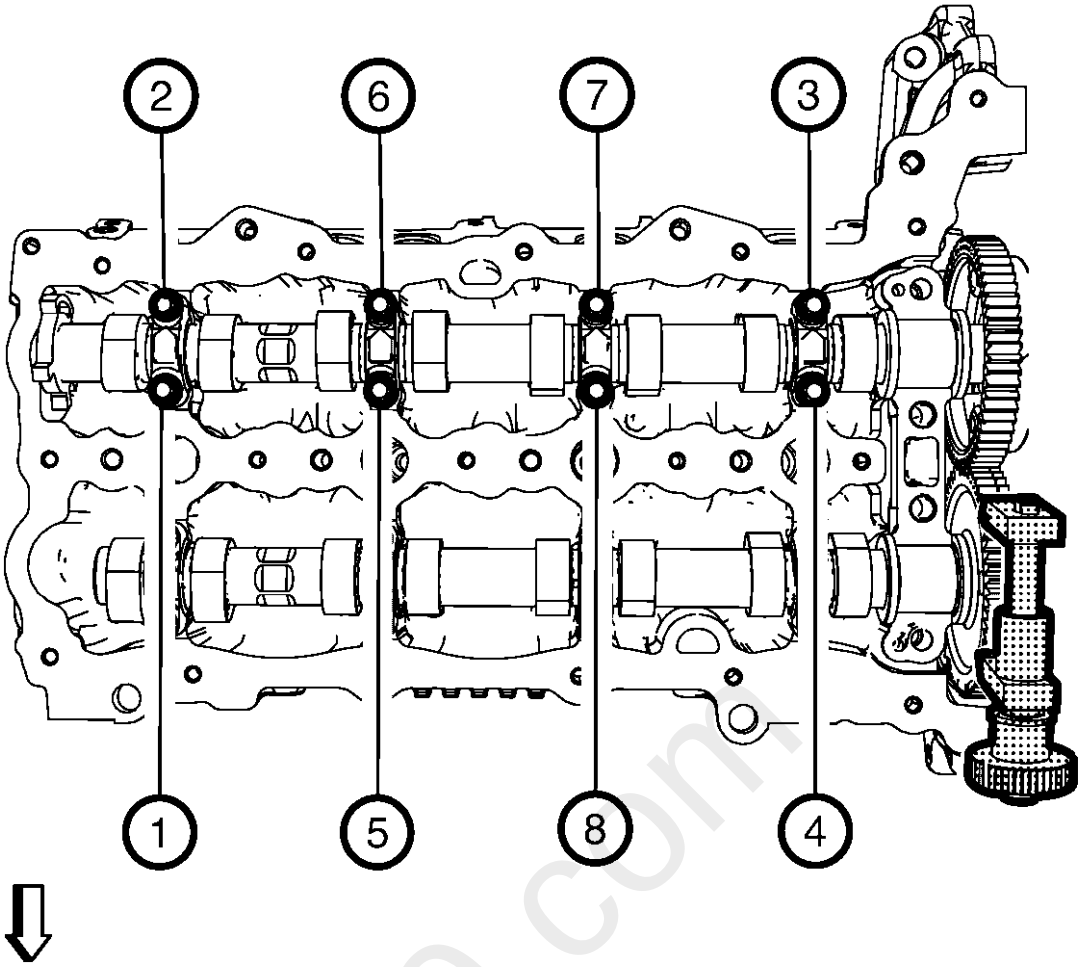


Fig. 682: Intake Camshaft Bearing Cap Bolt Loosening Sequence
Courtesy of GENERAL MOTORS COMPANY

5. Loosen the 8 intake camshaft bearing cap bolts in sequence as shown.

mcx30.com

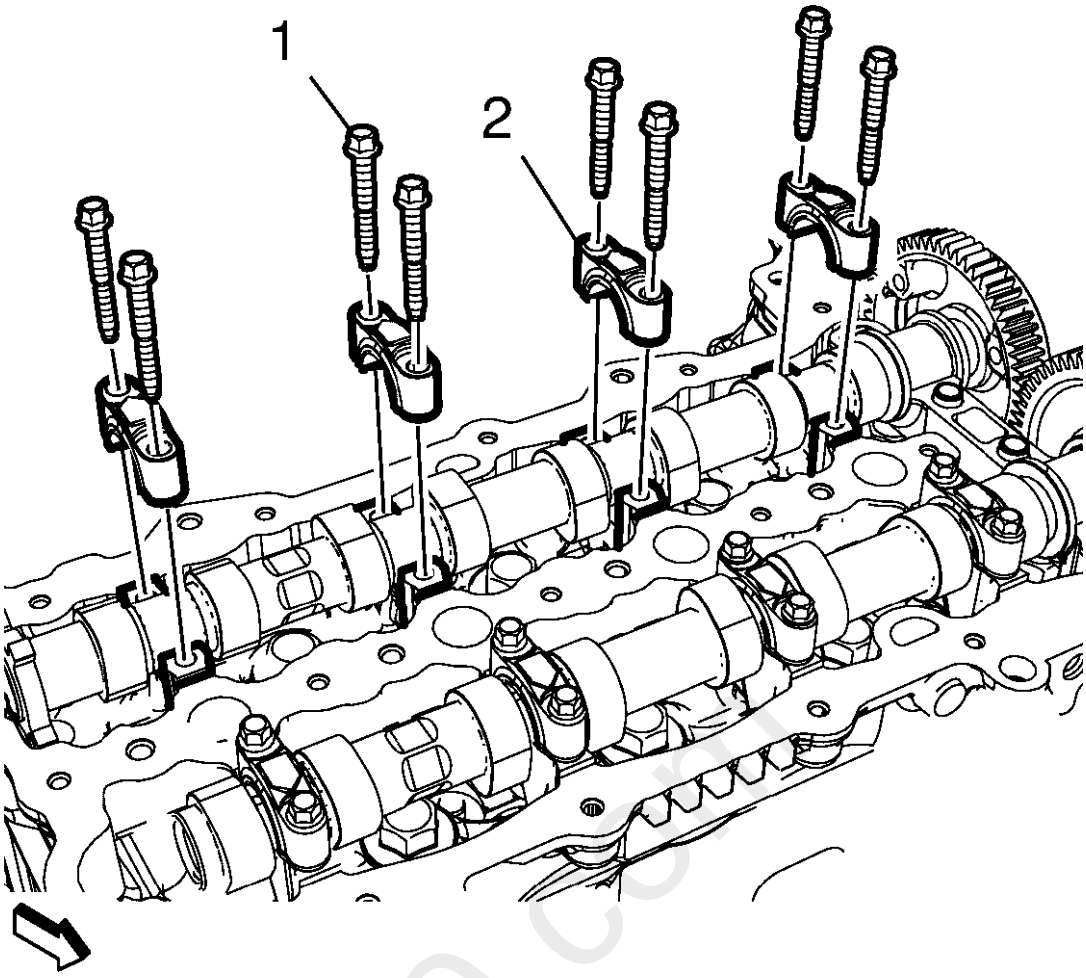


Fig. 683: Intake Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the 8 intake camshaft bearing cap bolts (1).
7. Remove the 4 intake camshaft bearing caps (2) and lay aside in the order as they was removed.

mcx30.com

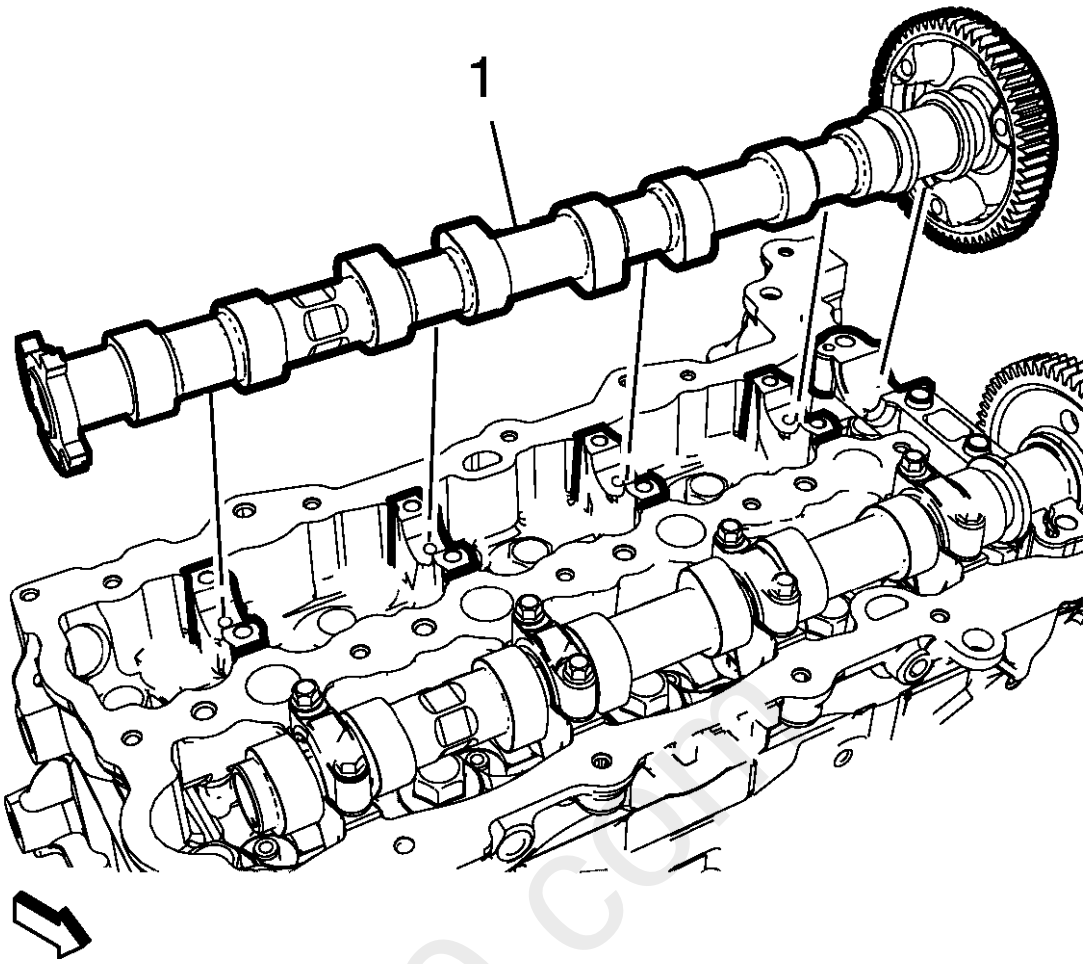


Fig. 684: Intake Camshaft
Courtesy of GENERAL MOTORS COMPANY

8. Remove the intake camshaft (1).

EXHAUST CAMSHAFT REMOVAL

Special Tools

- **EN-50509** Split Intake Camshaft Sprocket Fixing Tool
- **EN-51143** Camshaft Sprocket Fixing Tool

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

mcx30.com

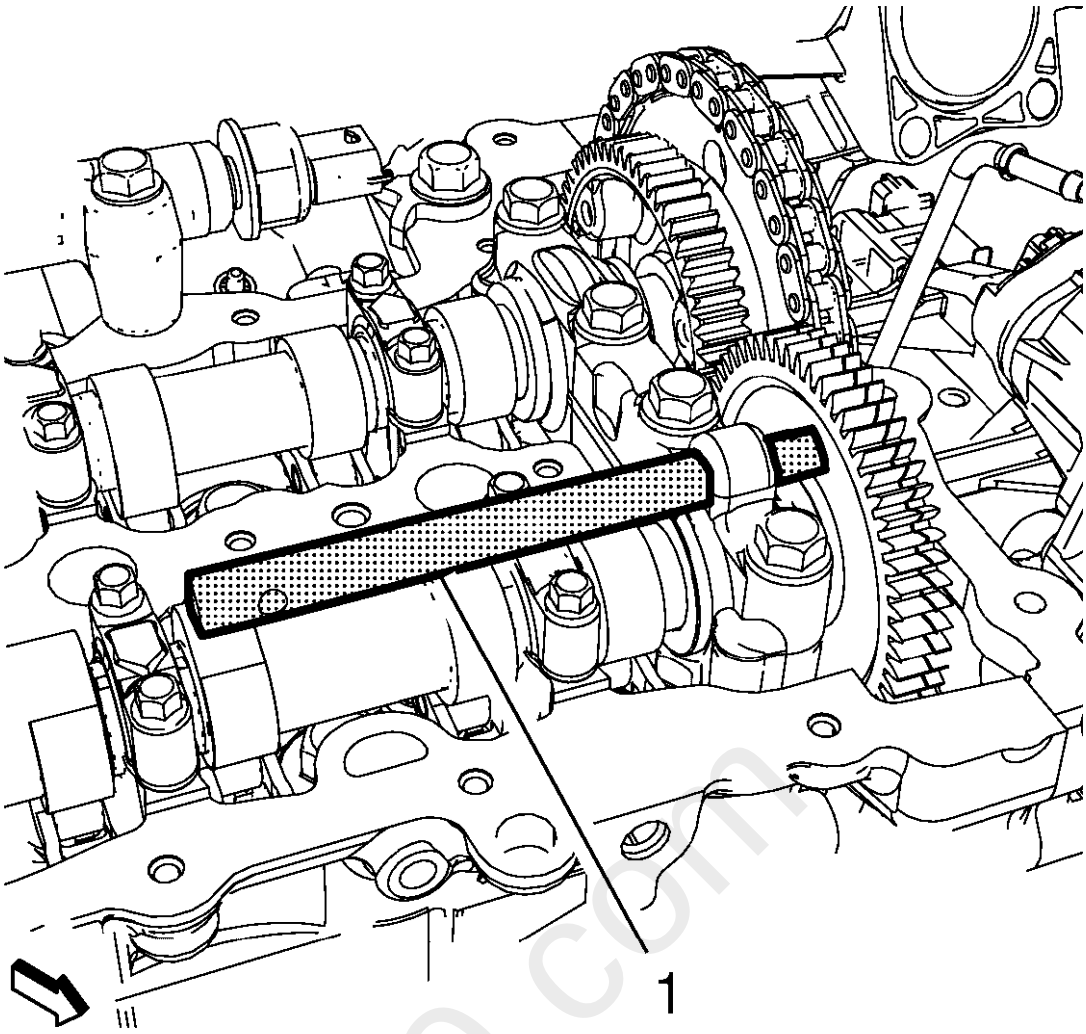


Fig. 685: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

1. Remove the **EN-51143** fixing tool (1).

mcx30.com

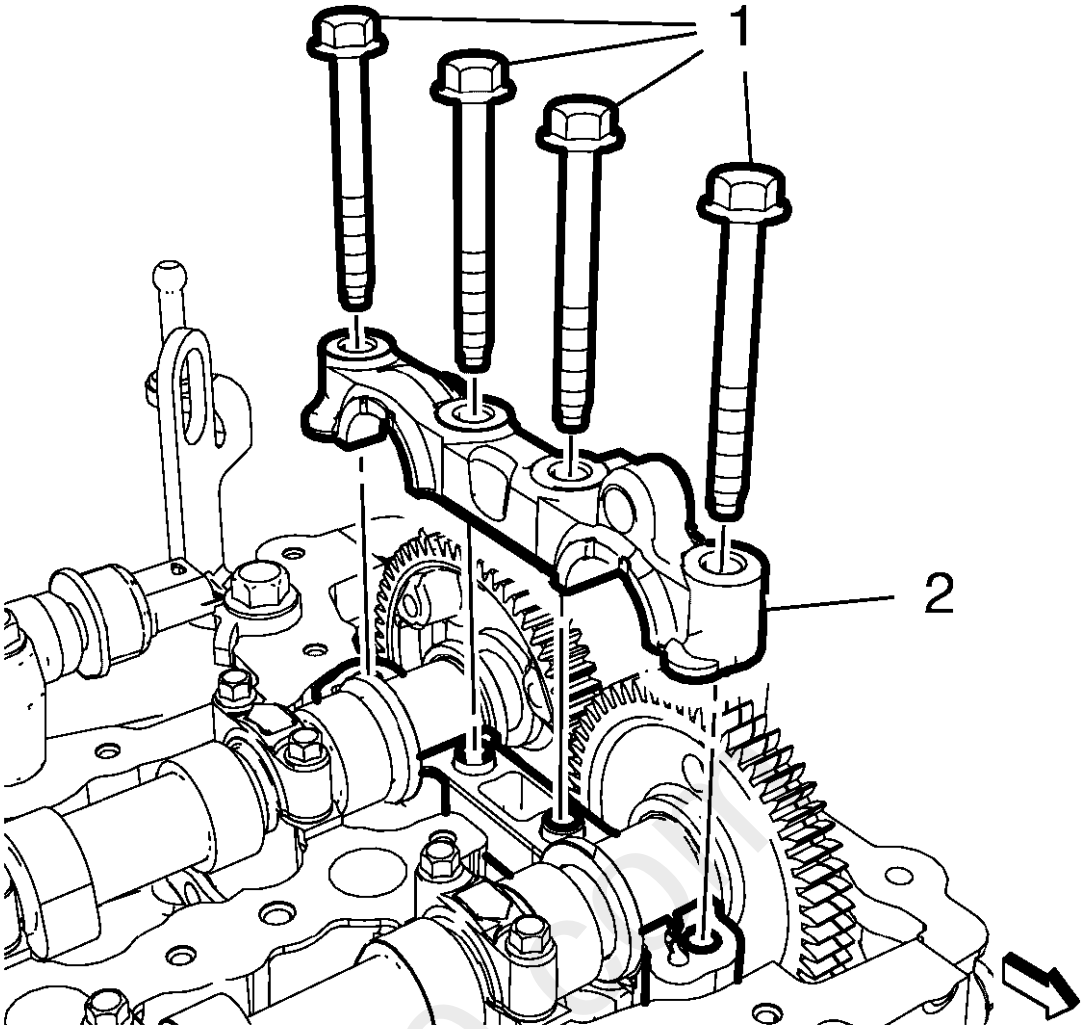


Fig. 686: Camshaft Bearing Rear Cap And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the camshaft bearing rear cap bolts (1).
3. Remove the camshaft bearing rear cap (2).

mcx30.com

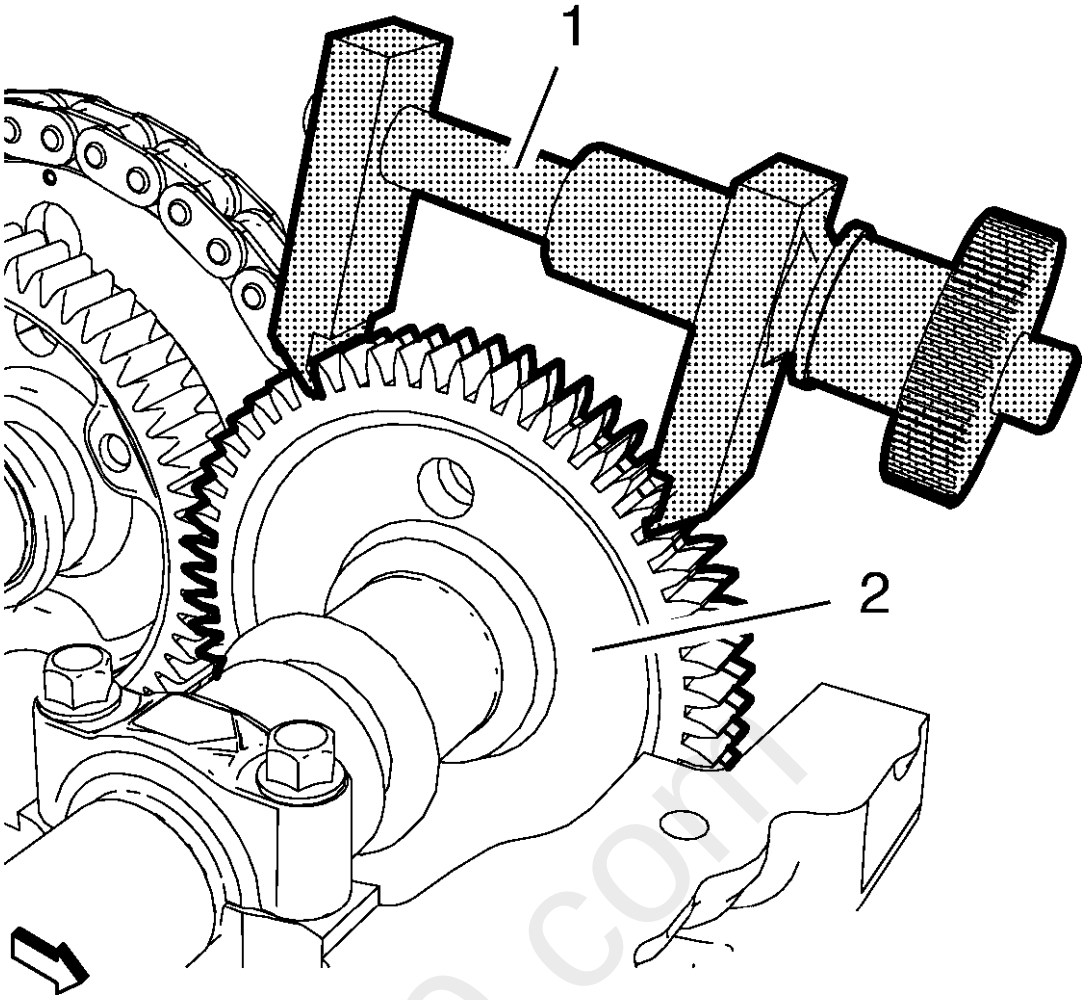


Fig. 687: Split Intake Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-50509** fixing tool (1) to the exhaust camshaft sprocket (2).

mcx30.com

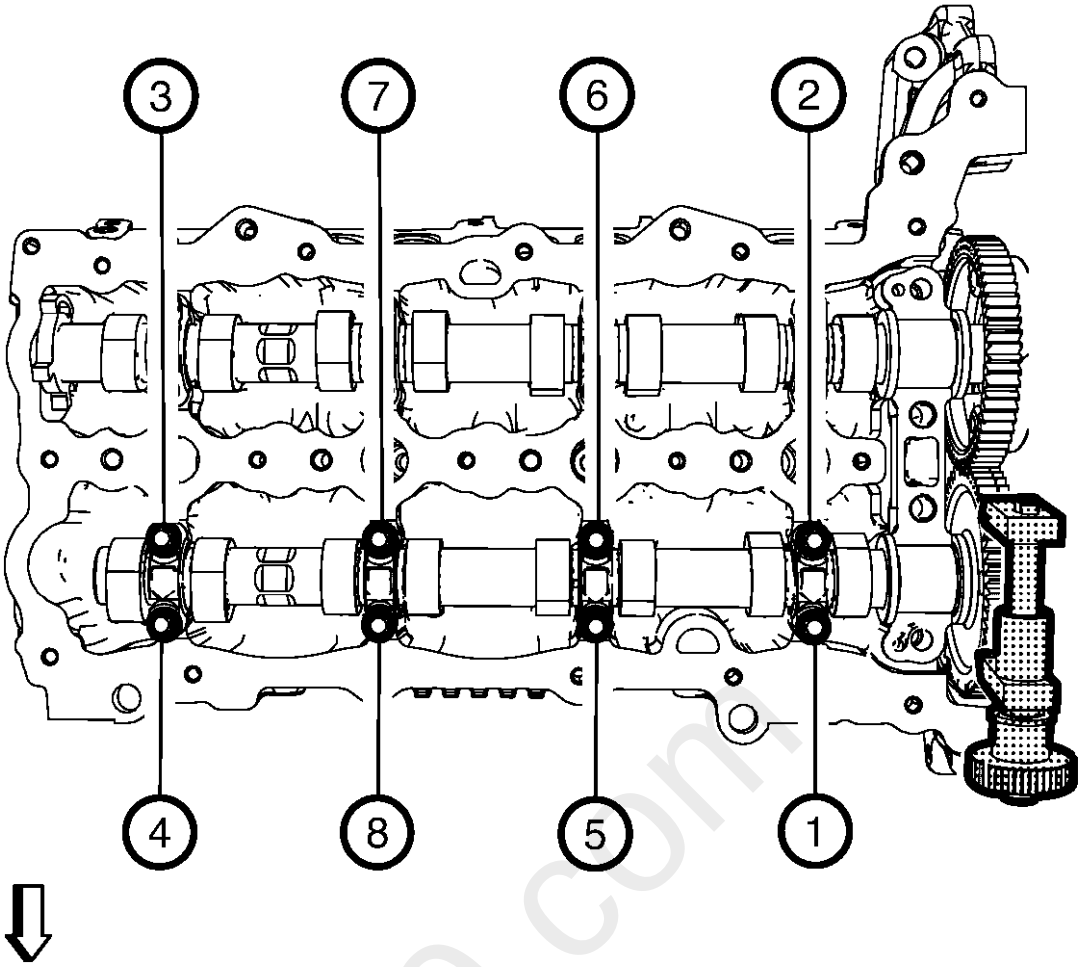


Fig. 688: Exhaust Camshaft Bearing Cap Bolt Loosening Sequence
Courtesy of GENERAL MOTORS COMPANY

5. Loosen the 8 exhaust camshaft bearing cap bolts in sequence as shown.

mcx30.com

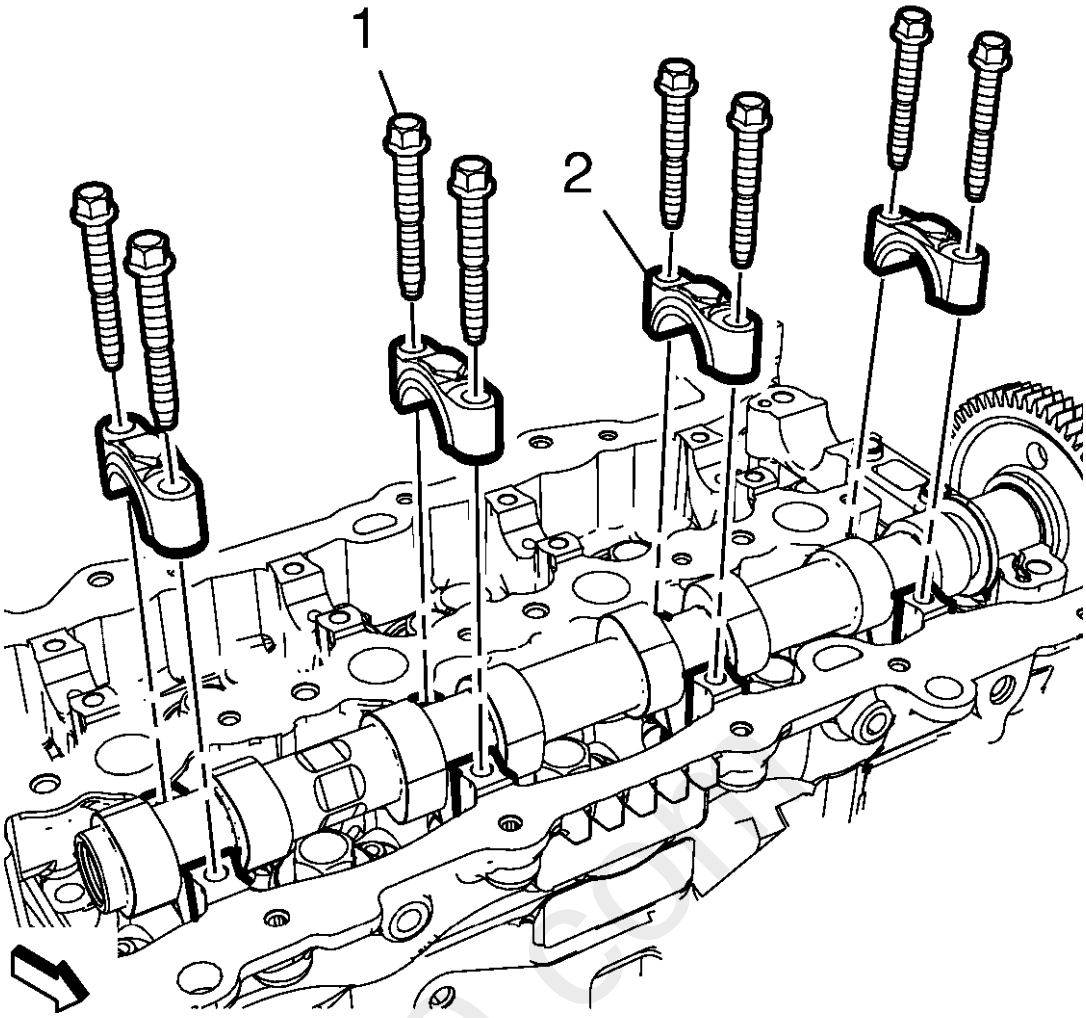


Fig. 689: Exhaust Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the 8 exhaust camshaft bearing cap bolts (1).
7. Remove the 4 exhaust camshaft bearing caps (2) and lay aside in the order as they was removed.

mcx30.com

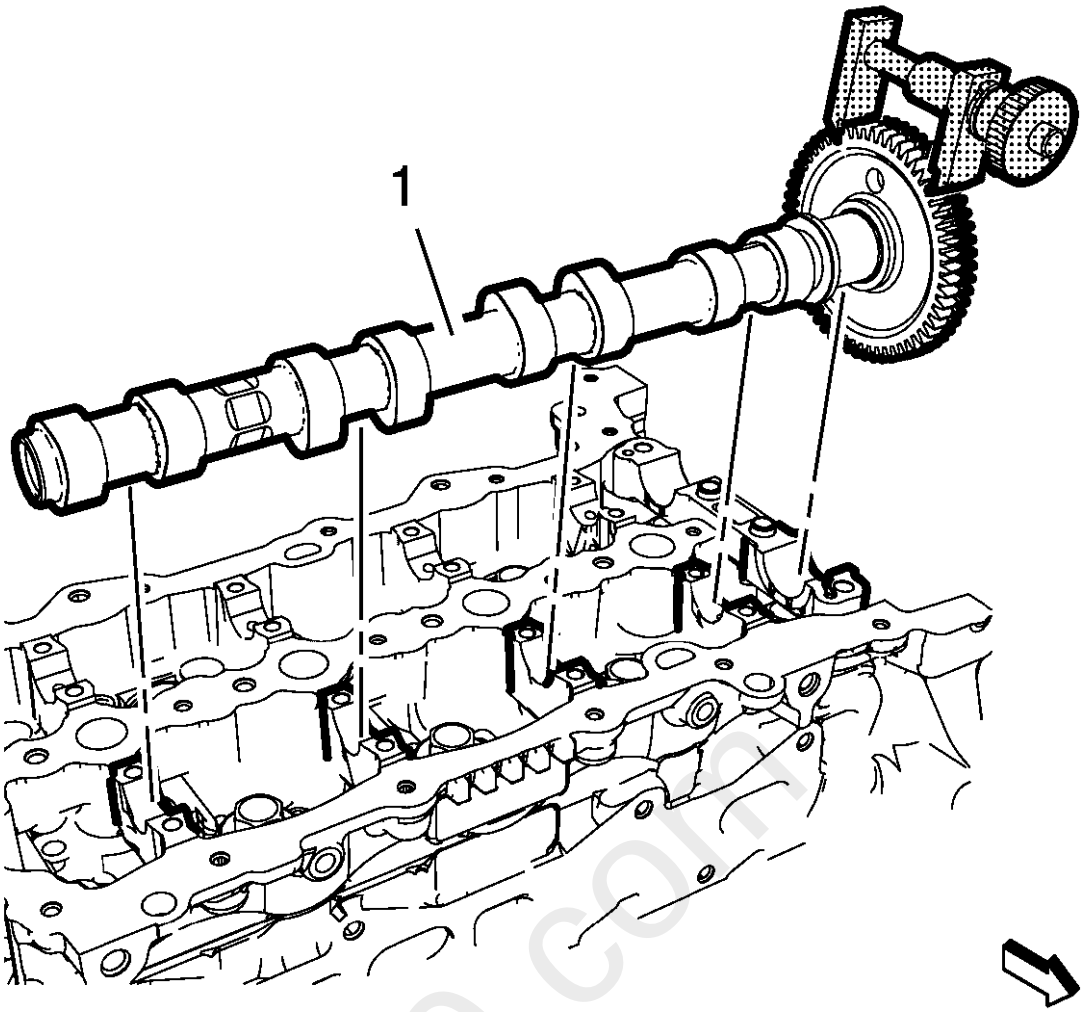


Fig. 690: Exhaust Camshaft
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the exhaust camshaft are reinstall, do not remove the EN-50509 fixing tool.**

8. Remove the exhaust camshaft (1).

VALVE LIFTER REMOVAL

mcx30.com

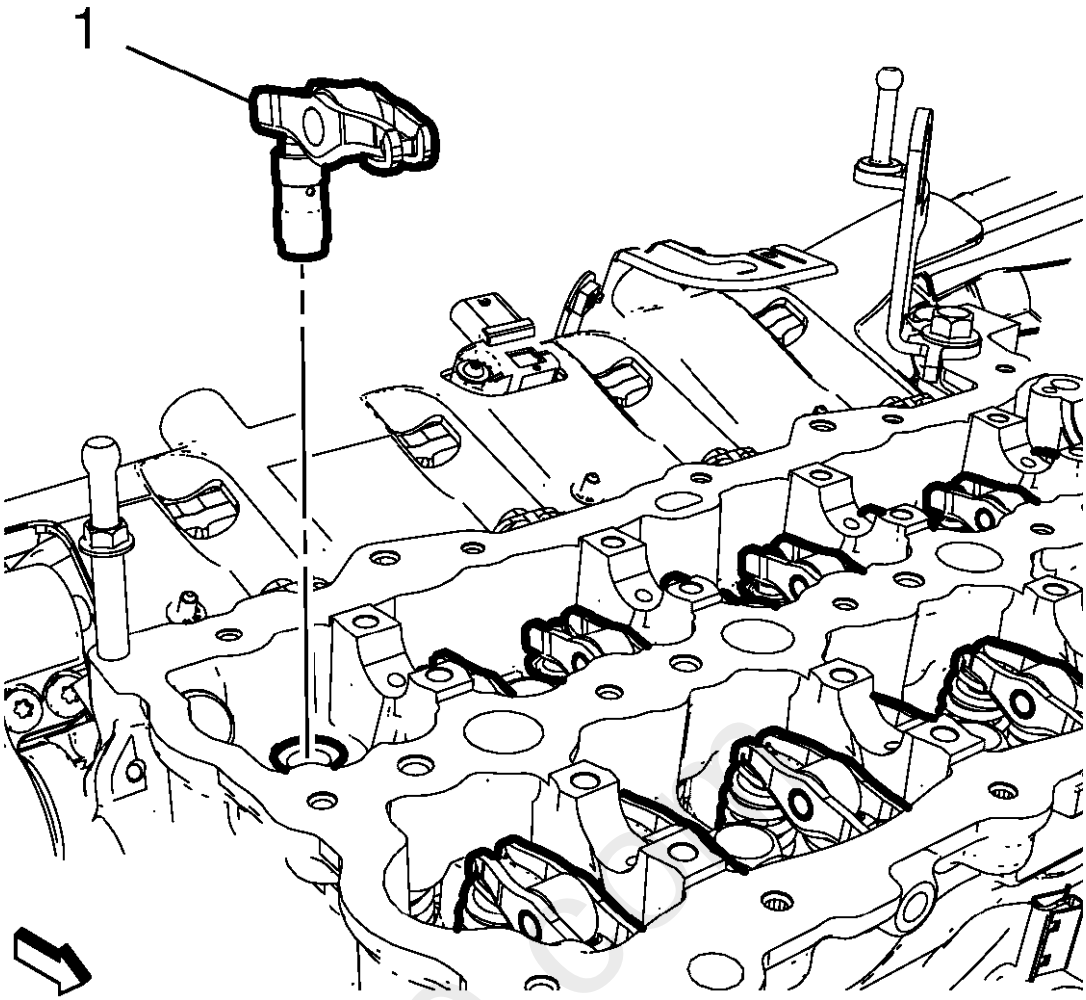


Fig. 691: Valve Lifter Roller Assemblies
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 16 valve lifters with valve lifter roller (1) and lay aside in the order as they was removed.

mcx30.com

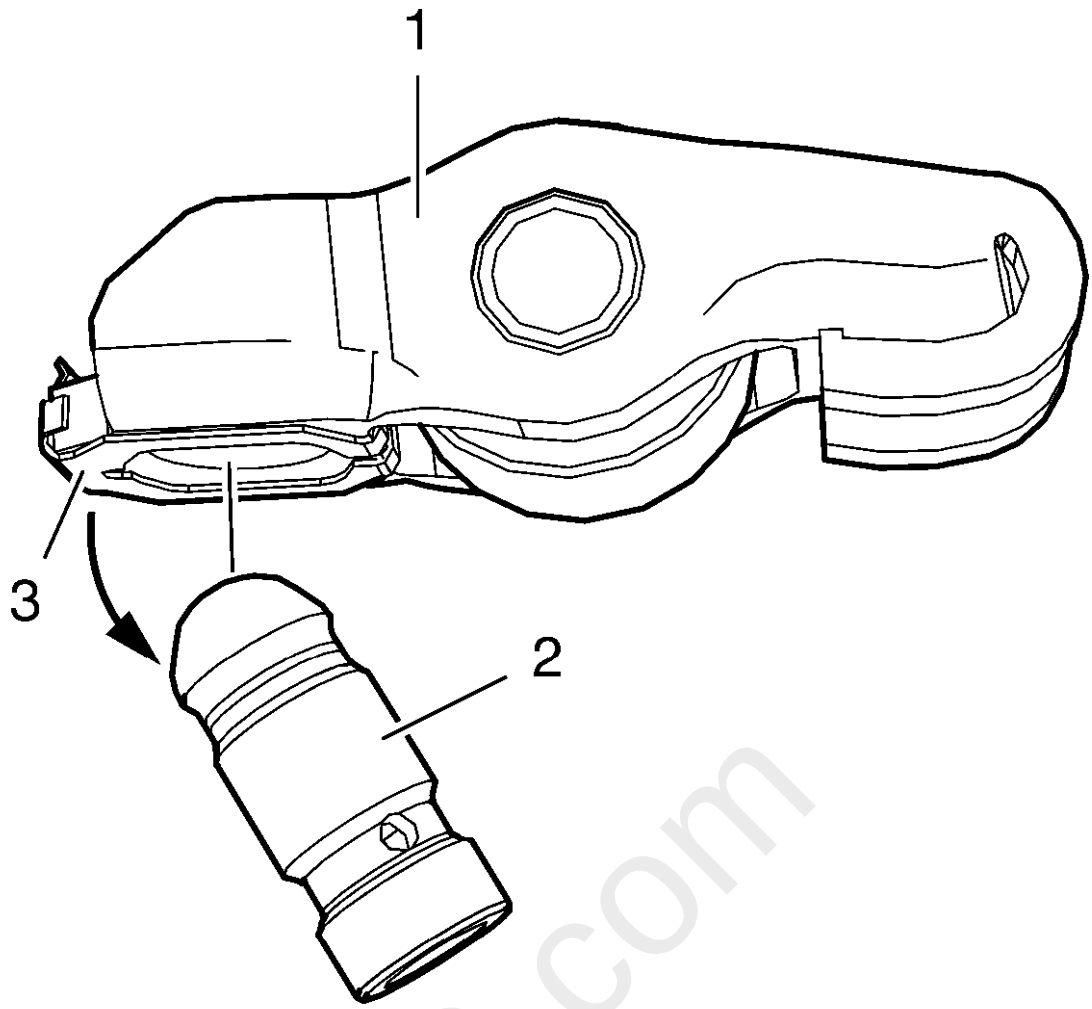


Fig. 692: Valve Rocker Arms And Valve Lifters
Courtesy of GENERAL MOTORS COMPANY

2. Unclip the valve lifter from the valve lifter roller in direction as shown (arrow). Mind to the centering link on retainer spring (3).
3. Remove the 16 valve lifters (2) from the valve lifter roller (1).

CAMSHAFT POSITION SENSOR REMOVAL

mcx30.com

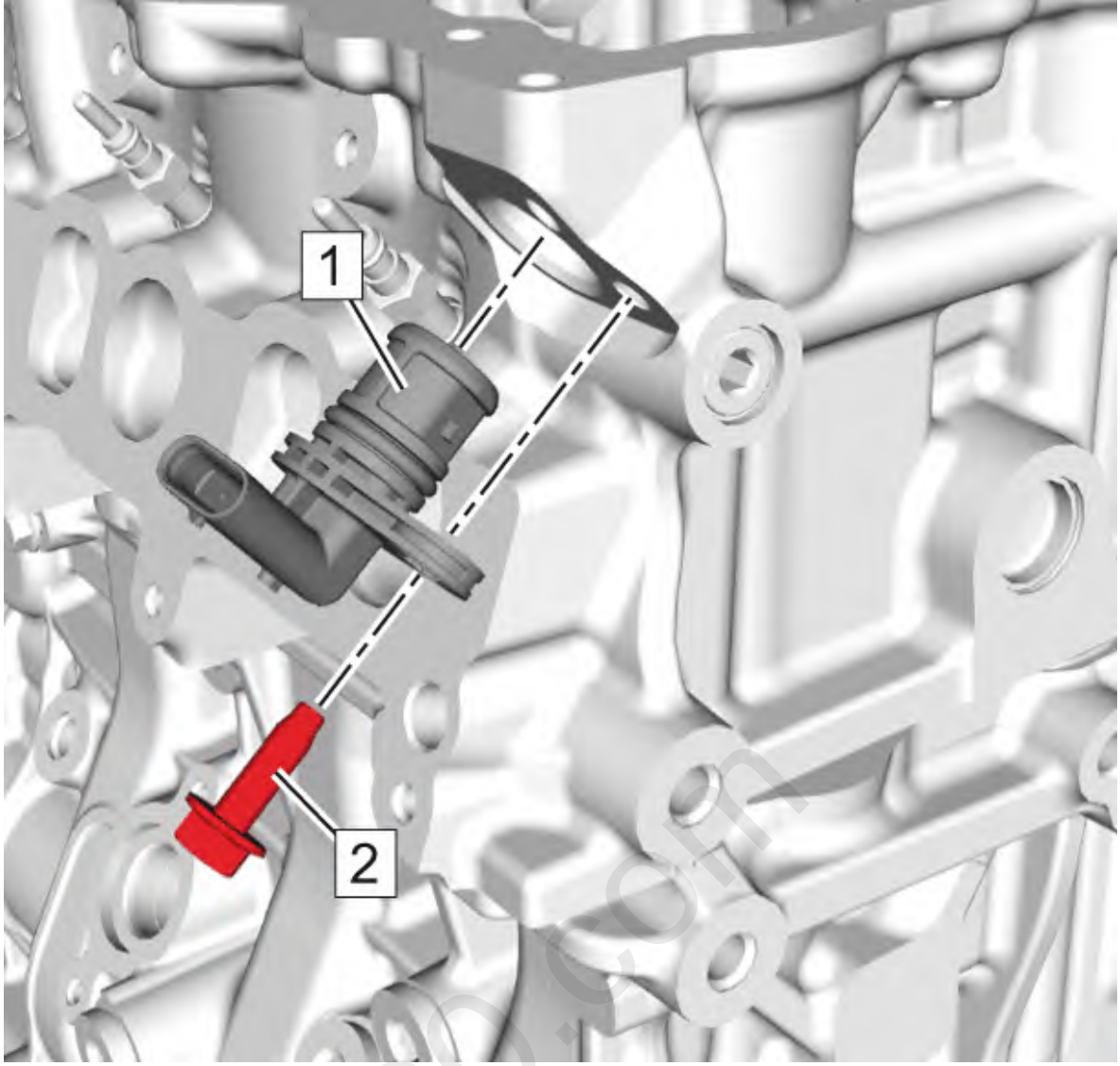


Fig. 693: Camshaft Position Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove Camshaft Position Sensor Bolt (2)
2. Remove Camshaft Position Sensor (1)

GLOW PLUG REMOVAL

Special Tools

EN-6104 Glow Plug Socket

Equivalent regional tools: **Special Tools**

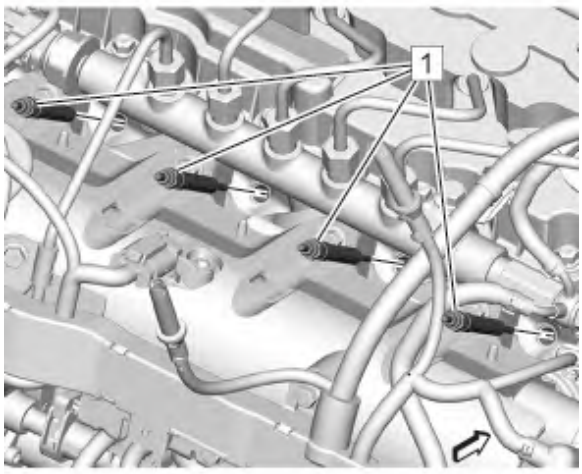


Fig. 694: Glow Plugs
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 4 glow plugs (1), using the **EN-6104** socket.

CYLINDER HEAD REMOVAL

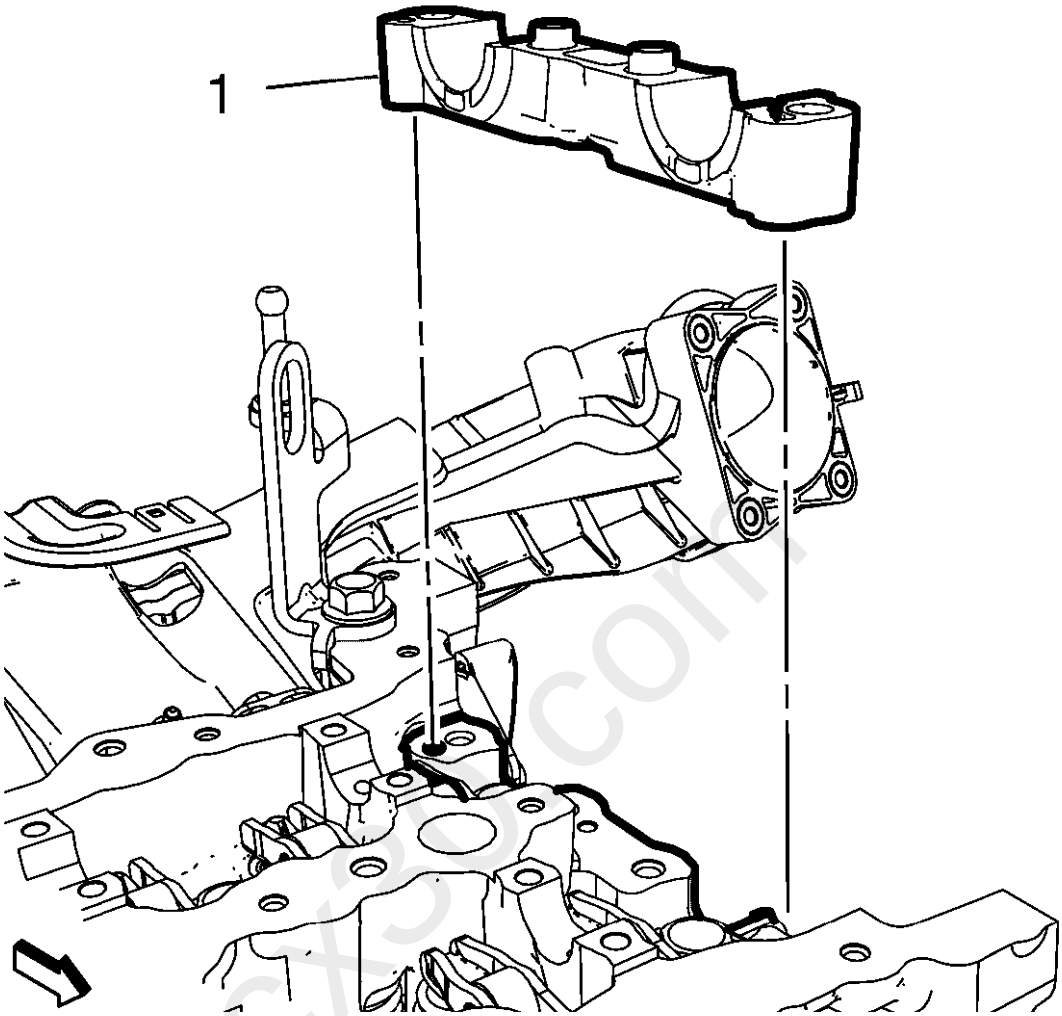


Fig. 695: Bearing Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Remove the bearing bracket (1).

mcx30.com

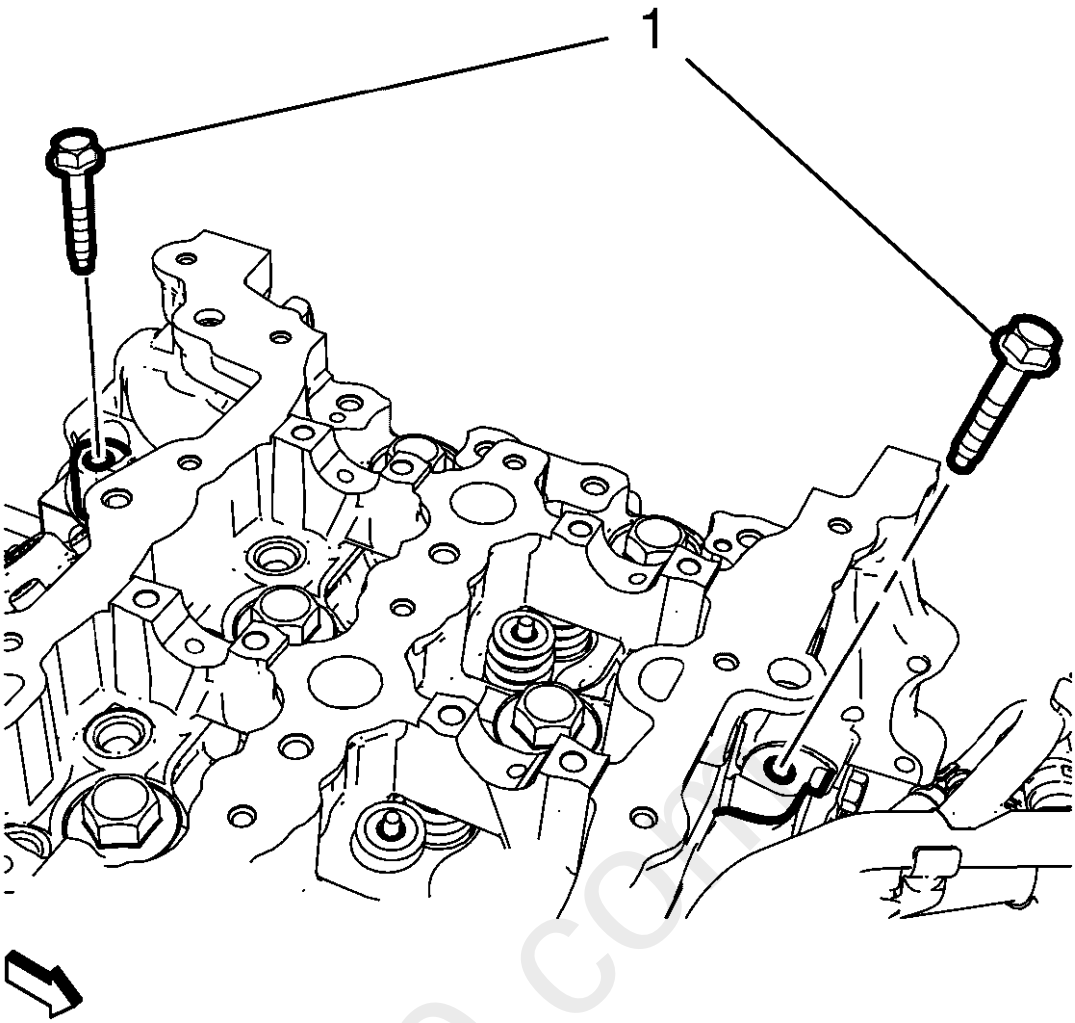


Fig. 696: Outer Cylinder Head Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove and DISCARD the 2 outer cylinder head bolts (1).

mcx30.com

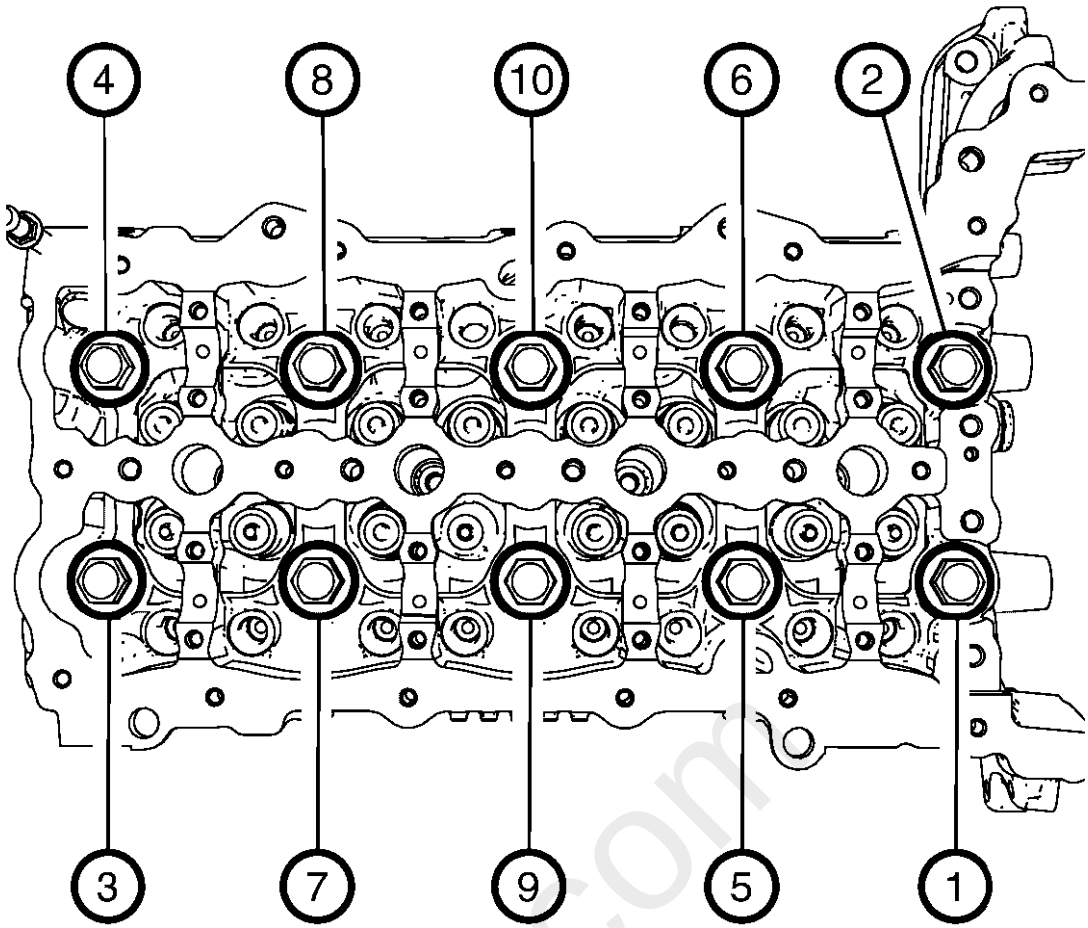


Fig. 697: Cylinder Head Bolt Loosening Sequence
Courtesy of GENERAL MOTORS COMPANY

3. Loosen the 10 cylinder head bolts in sequence as shown.

mcx30.com

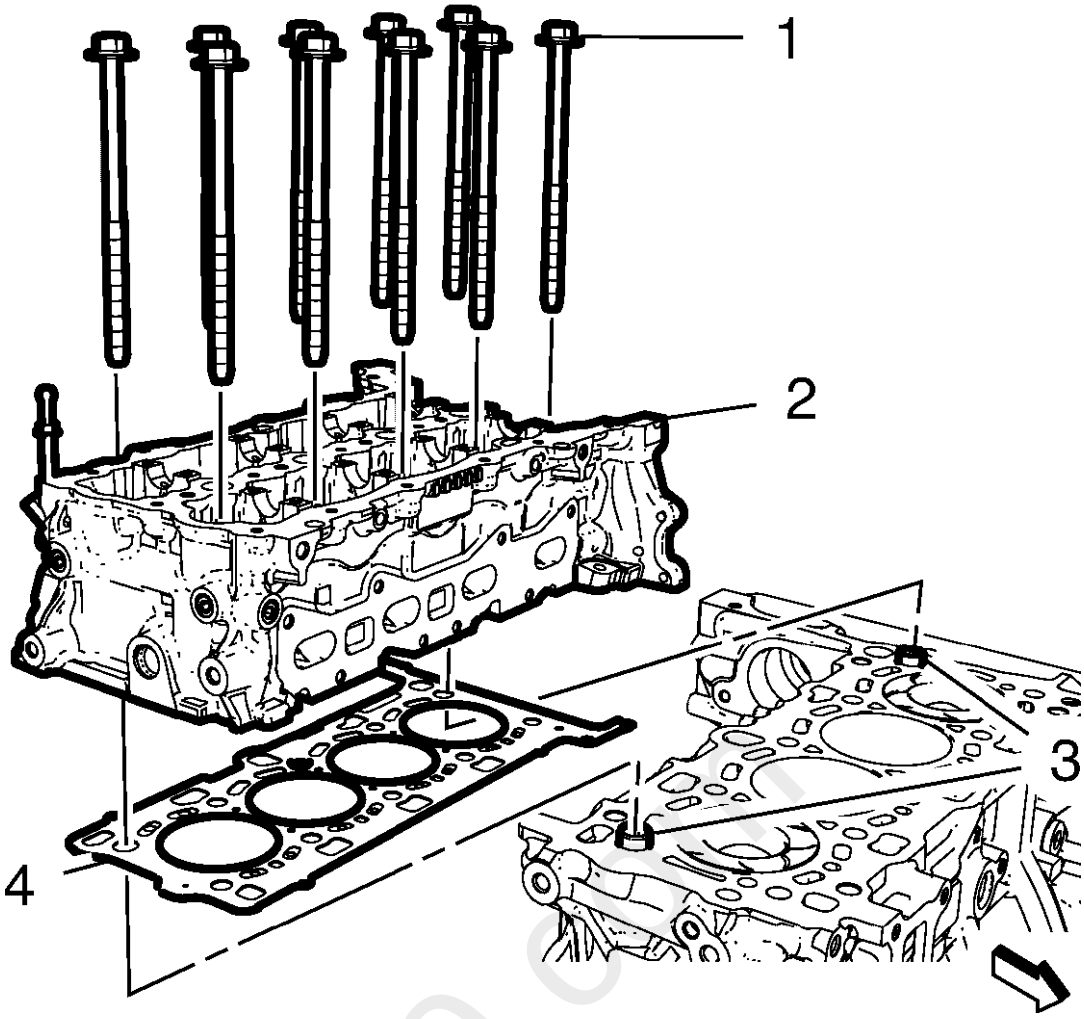


Fig. 698: Cylinder Head, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

4. Remove and DISCARD the 10 cylinder head bolts (1).

NOTE: **Ensure the guide sleeves (3) are properly seated in the engine block.**

5. Remove the cylinder head (2).
6. Remove and DISCARD the cylinder head gasket (4).

PISTON, CONNECTING ROD, AND BEARING REMOVAL

Special Tools

EN-51140 Crankshaft Fixing Tool

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

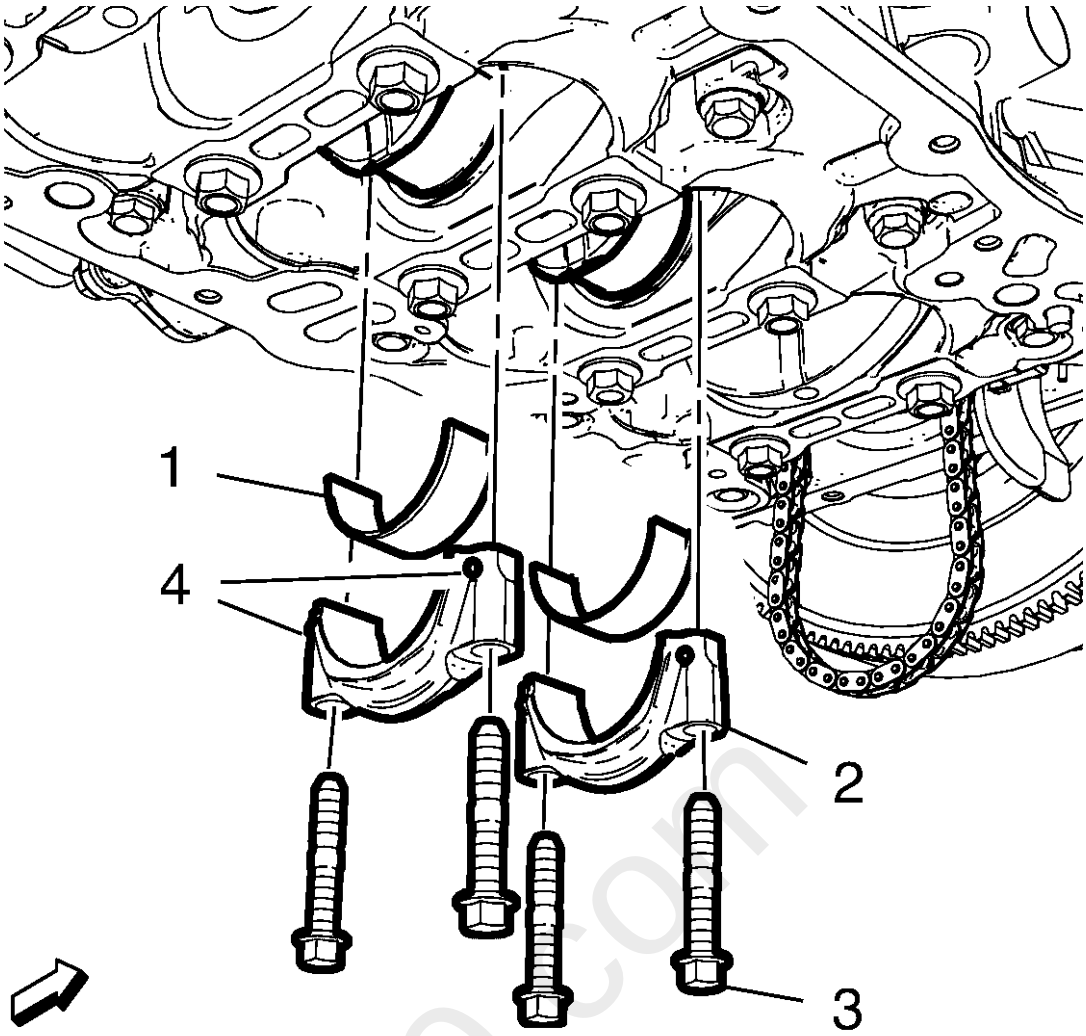


Fig. 699: Cylinder 2 And 3 Connecting Rod Caps, Bolts And Lower Bearings
Courtesy of GENERAL MOTORS COMPANY

1. Remove and DISCARD the 4 connecting rod bearing cap bolts (3) from the cylinder 2 and the cylinder 3.

NOTE: **Lay aside in the order as they was removed.**

NOTE: **The shear surfaces of the connecting rod and the connecting rod bearing cap form a unique fit and must not be swapped or damaged. Do not lay down on the shear surfaces.**

2. Remove the 2 connecting rod bearing caps (2) from the cylinder 2 and the cylinder 3.

NOTE: **Lay aside in the order as they was removed.**

3. Remove the 2 connecting rod lower bearings (1).

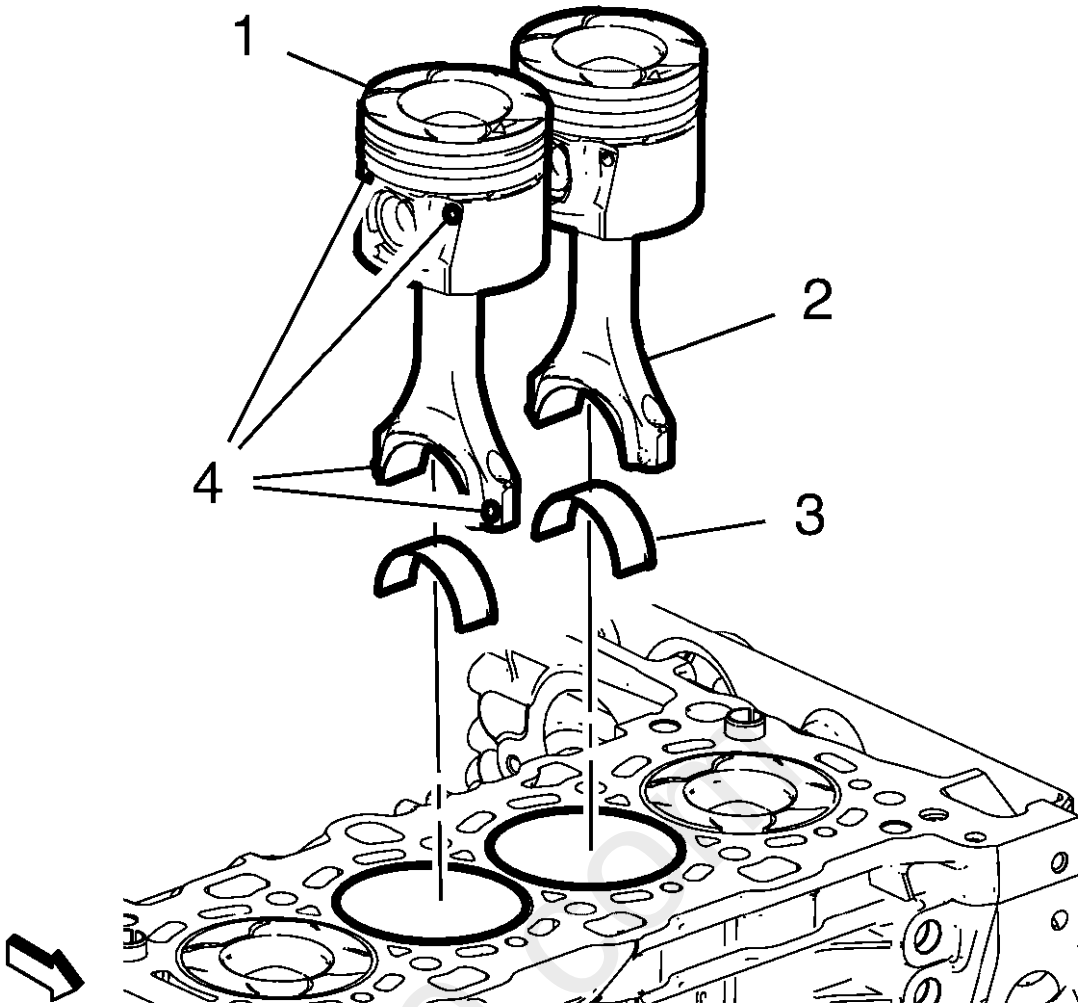


Fig. 700: Cylinder 2 And 3 Piston/Connecting Rod Assemblies And Upper Bearings
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Lay aside in the order as they was removed.**

4. Push the 2 pistons (1) with the 2 connecting rods (2) out of the cylinder 2 and the cylinder 3 upwards.

NOTE: **Lay aside in the order as they was removed.**

5. Remove the 2 connecting rod upper bearings (3) from the 2 connecting rods (2).

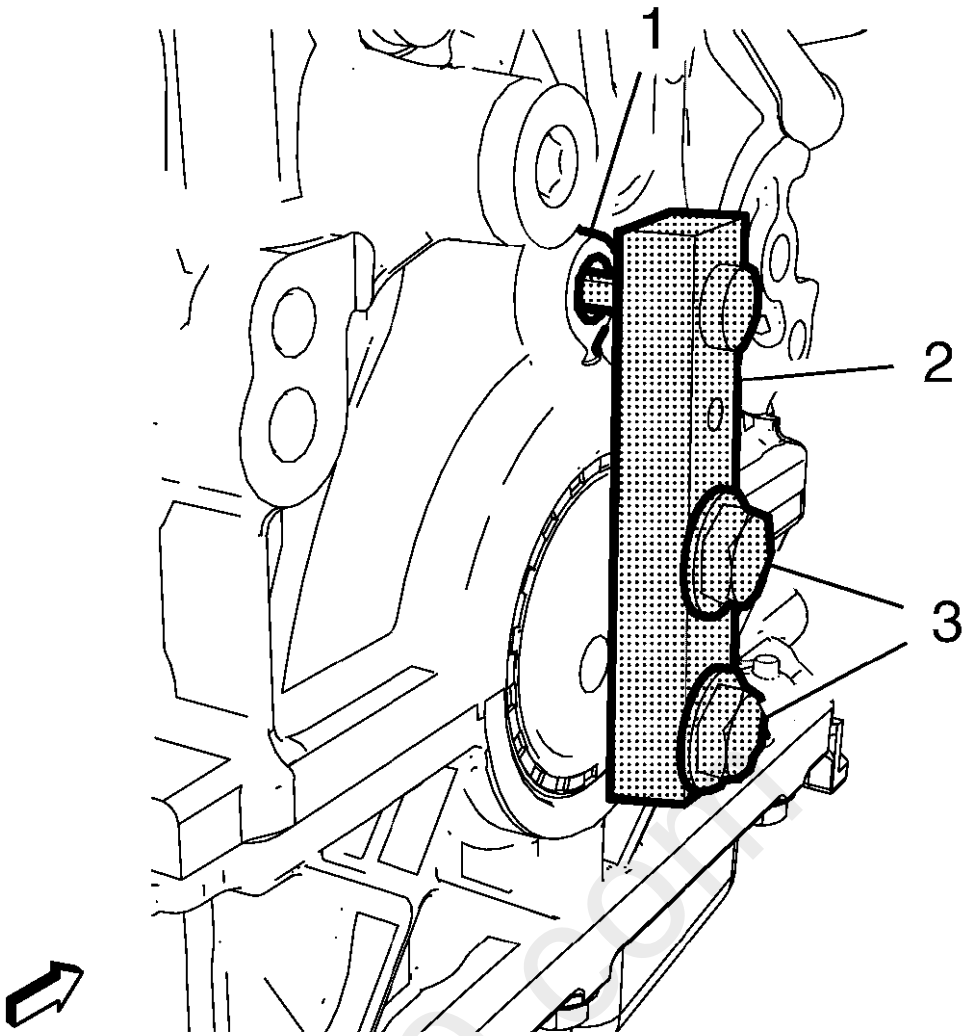


Fig. 701: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

6. Remove the 2 bolts (3).
7. Remove the **EN-51140** fixing tool (2).

mcx30.com

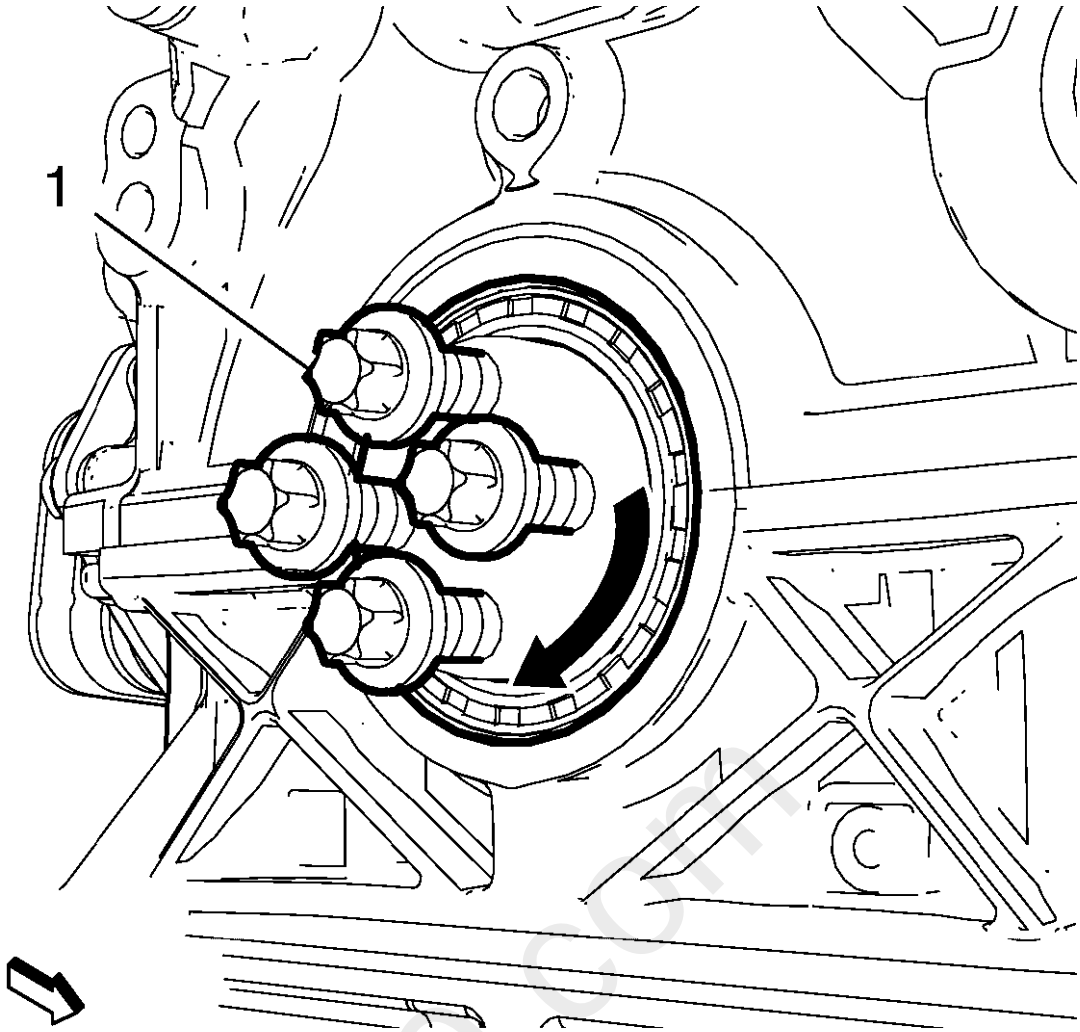


Fig. 702: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the 4 crankshaft pulley bolts (1).
9. Set the cylinder 2 to TDC. Rotate the crankshaft 180 degrees, use a pry bar at the 4 crankshaft pulley bolts (1).

mcx30.com

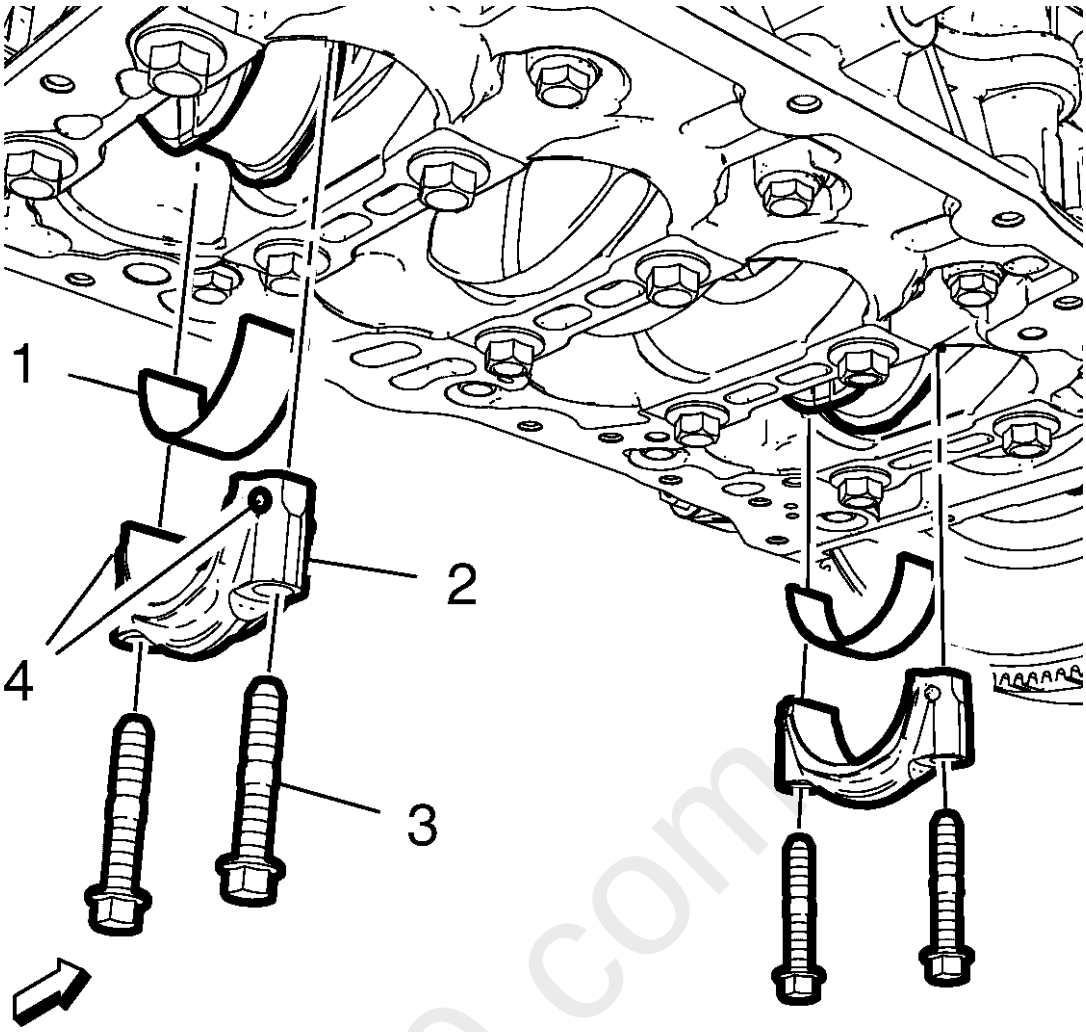


Fig. 703: Cylinder 1 And 4 Connecting Rod Caps, Bolts And Lower Bearings
Courtesy of GENERAL MOTORS COMPANY

10. Remove and DISCARD the 4 connecting rod bearing cap bolts (3) from the cylinder 1 and the cylinder 4.

NOTE: **Lay aside in the order as they was removed.**

NOTE: **The shear surfaces of the connecting rod and the connecting rod bearing cap form a unique fit and must not be swapped or damaged. Do not lay down on the shear surfaces.**

11. Remove the 2 connecting rod bearing caps (2) from the cylinder 1 and the cylinder 4.

NOTE: **Lay aside in the order as they was removed.**

12. Remove the 2 connecting rod lower bearings (1).

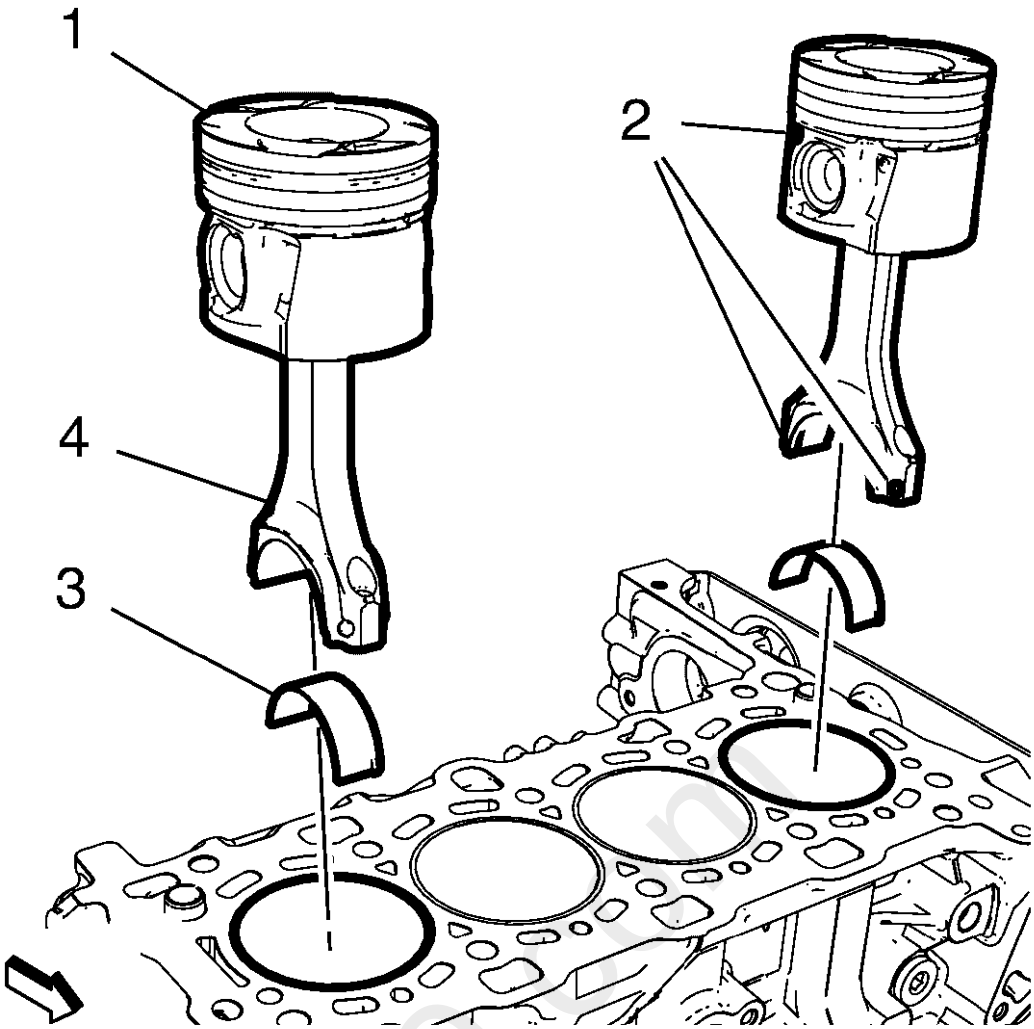


Fig. 704: Cylinder 1 And 4 Piston/Connecting Rod Assemblies And Upper Bearings
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Lay aside in the order as they was removed.**

13. Push the 2 pistons (1) with the 2 connecting rods (4) out of the cylinder 1 and the cylinder 4 upwards.

NOTE: **Lay aside in the order as they was removed.**

14. Remove the 2 connecting rod upper bearings (3) from the 2 connecting rods (4).

CRANKSHAFT FRONT OIL SEAL REMOVAL

Special Tools

- **EN-6624** Remover
- **GE-328-B** Pin Remover

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

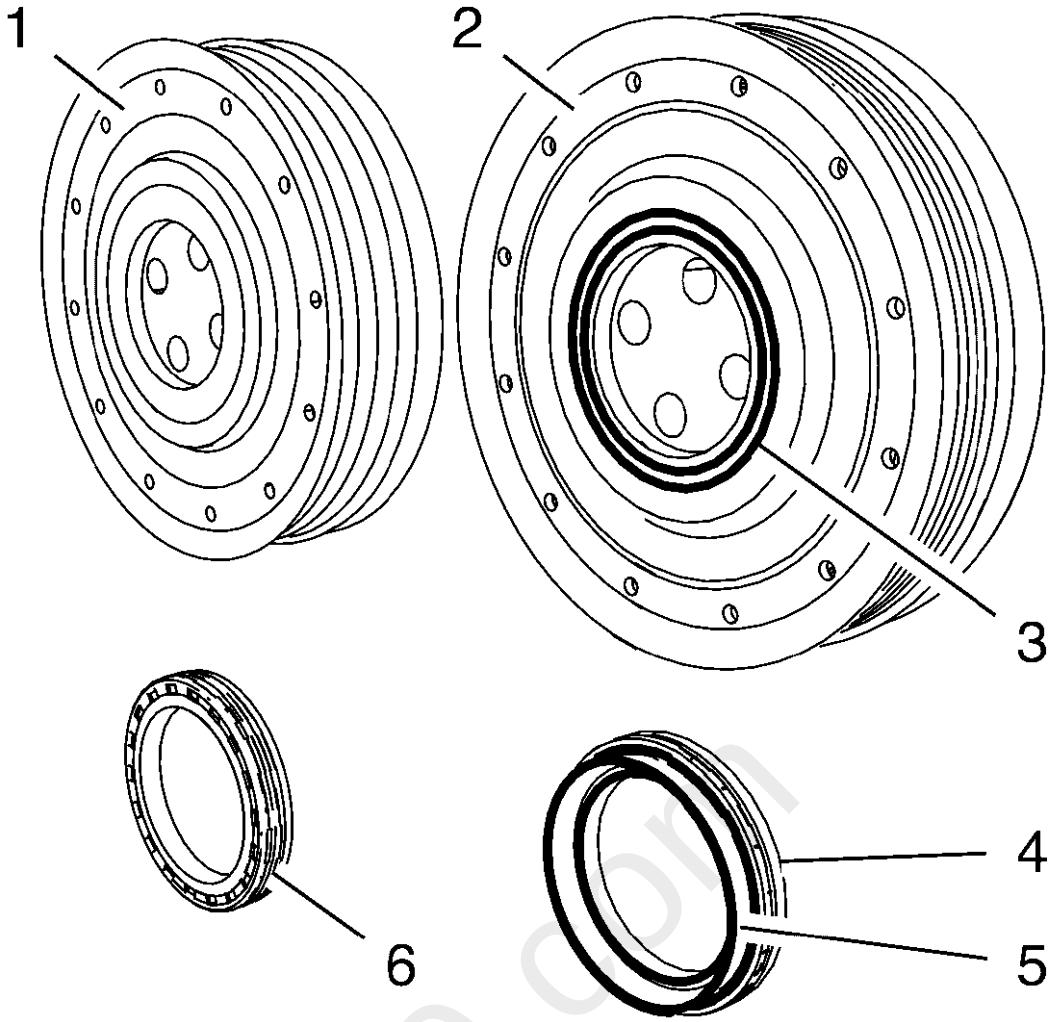


Fig. 705: Crankshaft Pulley And Crankshaft Front Oil Seal Variations
Courtesy of GENERAL MOTORS COMPANY

NOTE: **To ensure installation of the correct version of the crankshaft pulley and crankshaft front oil seal, use the following procedure.**

1. Check the installed version of the crankshaft pulley (1, 2) and the crankshaft front oil seal (4, 6).

   If the crankshaft pulley version (1) without groove (3) is installed, the crankshaft pulley must be replaced.

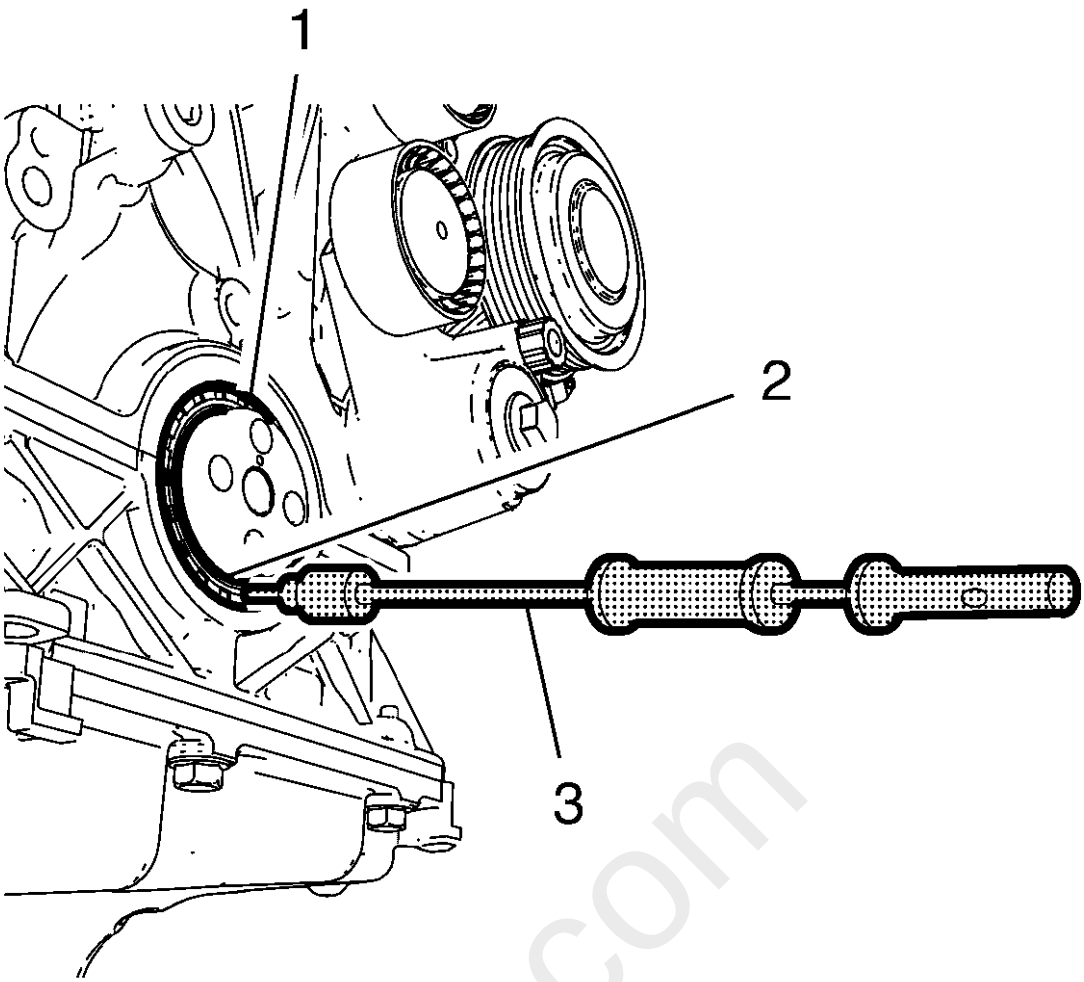


Fig. 706: Removers And Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

2. Punch a bore into the crankshaft seal, use a suitable tool.
3. Install the **EN-6624** remover (2) into the oil sealing ring (1).
4. Install the **GE-328-B** remover (3) to **EN-6624** remover (2).
5. Remove the crankshaft front oil seal with the **GE-328-B** remover.

CRANKSHAFT AND BEARING REMOVAL

Special Tools

EN-571-B Dial Gauge

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

mox30.com

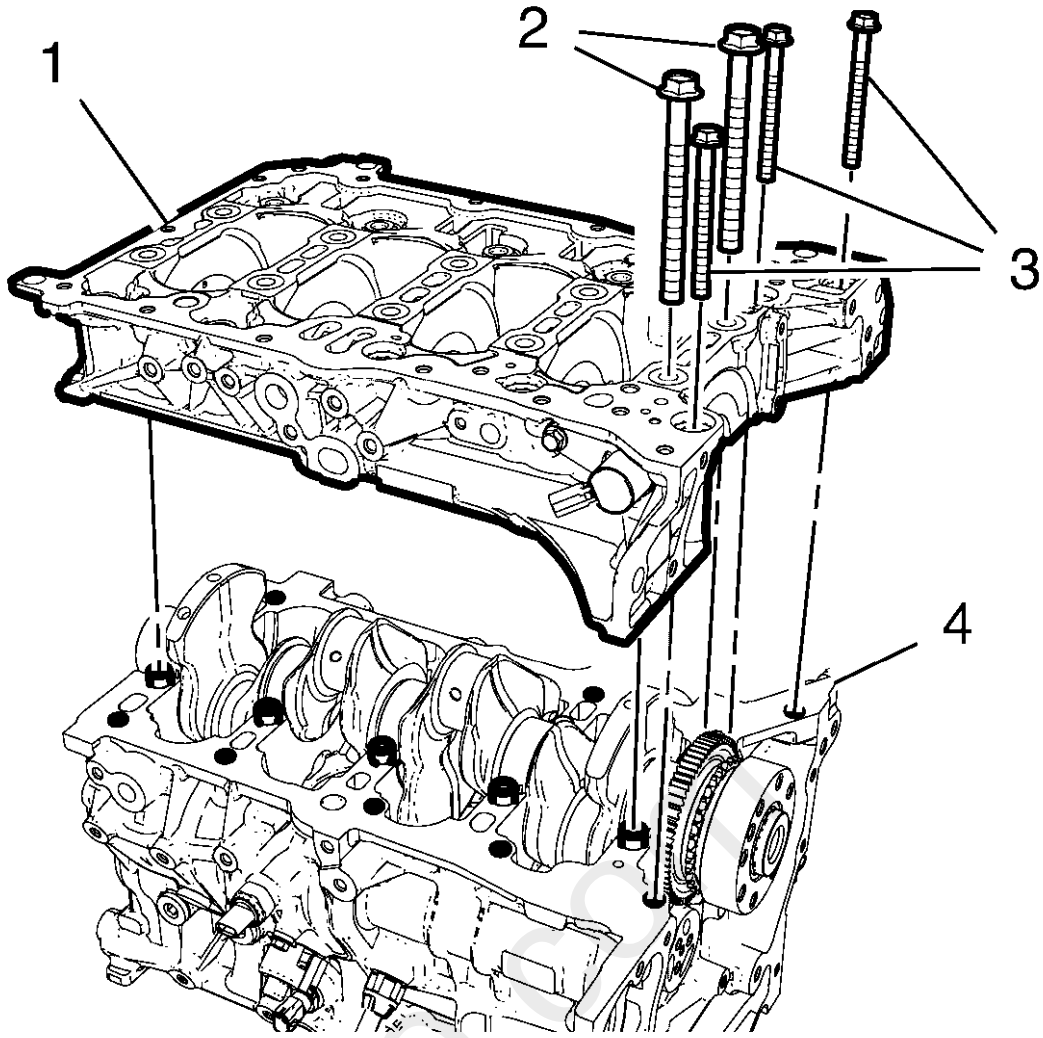


Fig. 707: Lower Crankcase And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 11 lower crankcase bolts M8 (3).
2. Remove and DISCARD the 10 main bearing bolts M10 (2).

NOTE: **Carefully detach the lower crankcase from the engine block, using a suitable tool.**

3. Remove the lower crankcase (1).

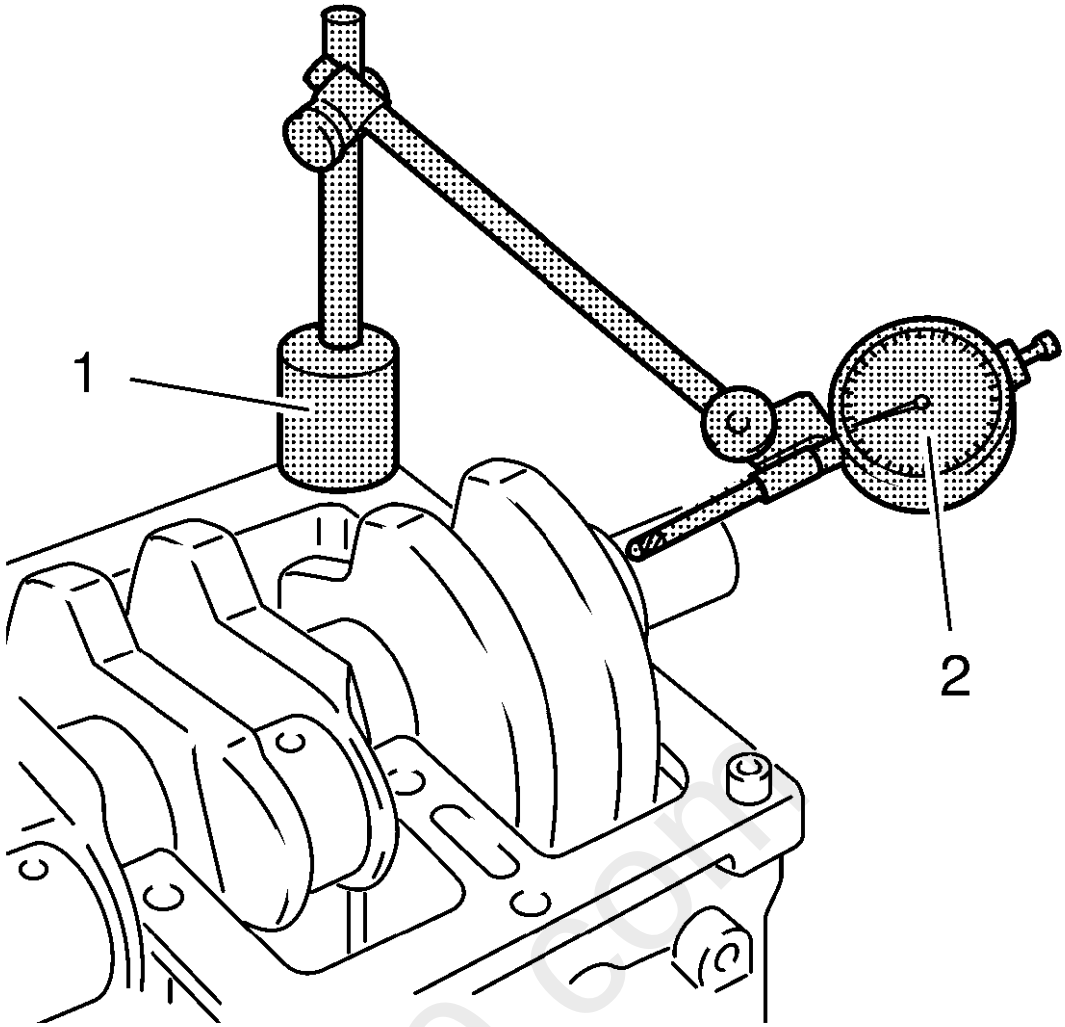


Fig. 708: Measuring Crankshaft Axial Play
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The check is conducted with the crankshaft bearings installed in the cylinder block and the flywheel/automatic transmission flex plate is removed. The crankshaft is only loosely fitted in the cylinder block.**

4. Install the **EN-571-B** dial gauge (2) with the bracket (1) to the timing side of the engine block.

NOTE: **If the value for the crankshaft axial play does not correspond with the permissible axial play, regrind the crankcase seat and use suitable oversize thrust bearings. For oversize thrust bearings, refer to Engine Mechanical Specifications.**

5. Measure the crankshaft axial play. For permissible axial play, refer to **Engine Mechanical Specifications**.

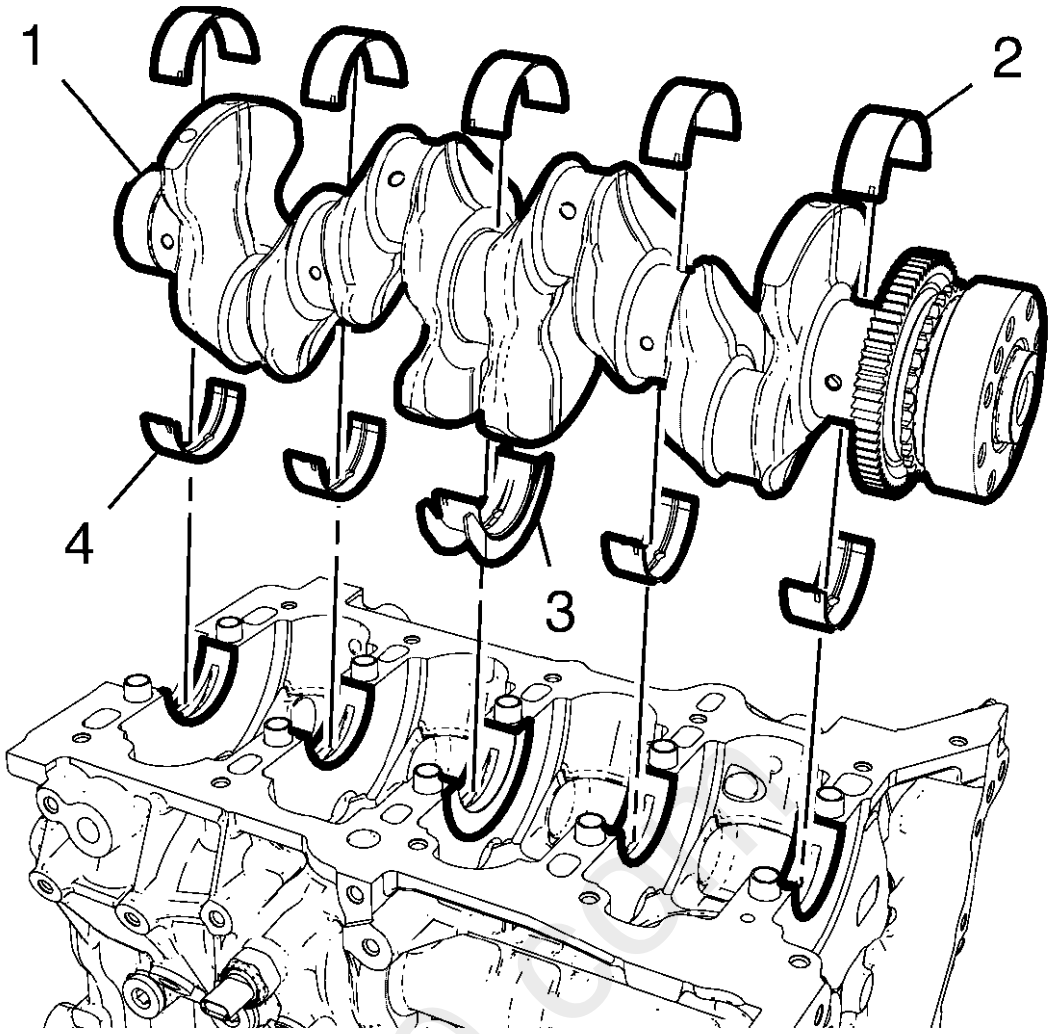


Fig. 709: Crankshaft And Bearings
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Mark the installation position of the crankshaft main bearing. Lay aside in order removed.**

6. Remove the 5 crankshaft lower main bearings (2) from the crankcase.
7. Remove the crankshaft (1).

NOTE: **Mark the installation position of the crankshaft main bearing. Set aside in order removed.**

NOTE: **The middle crankshaft main bearing contains the thrust bearing (3).**

8. Remove the 5 crankshaft upper main bearings (3, 4).
9. Check the crankshaft and bearings. Refer to Crankshaft and Bearing Cleaning and Inspection.

WATER PUMP DISASSEMBLE

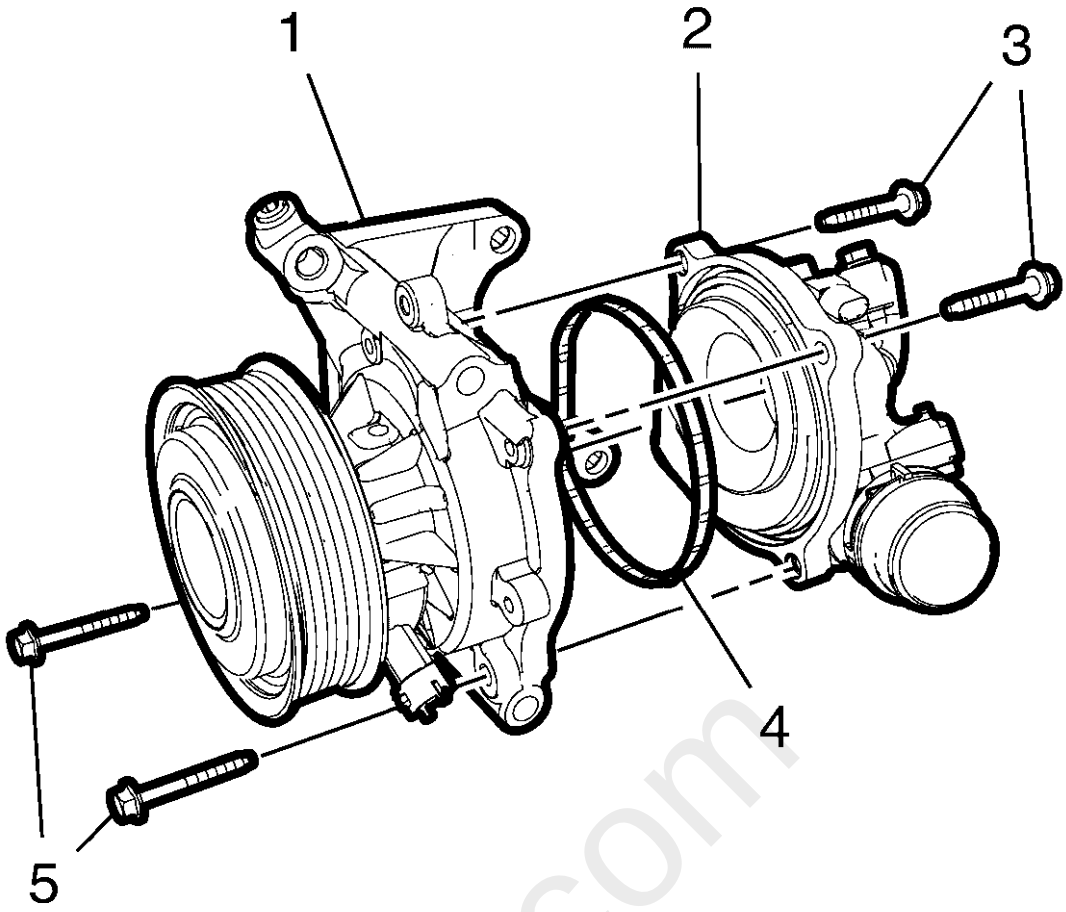


Fig. 710: Water Pump, Bolts And Seal
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 4 water pump bolts (3, 5).
2. Remove the thermostat housing (2) from the water pump (1).
3. Remove and DISCARD the water pump seal (4).

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

mcx30.com

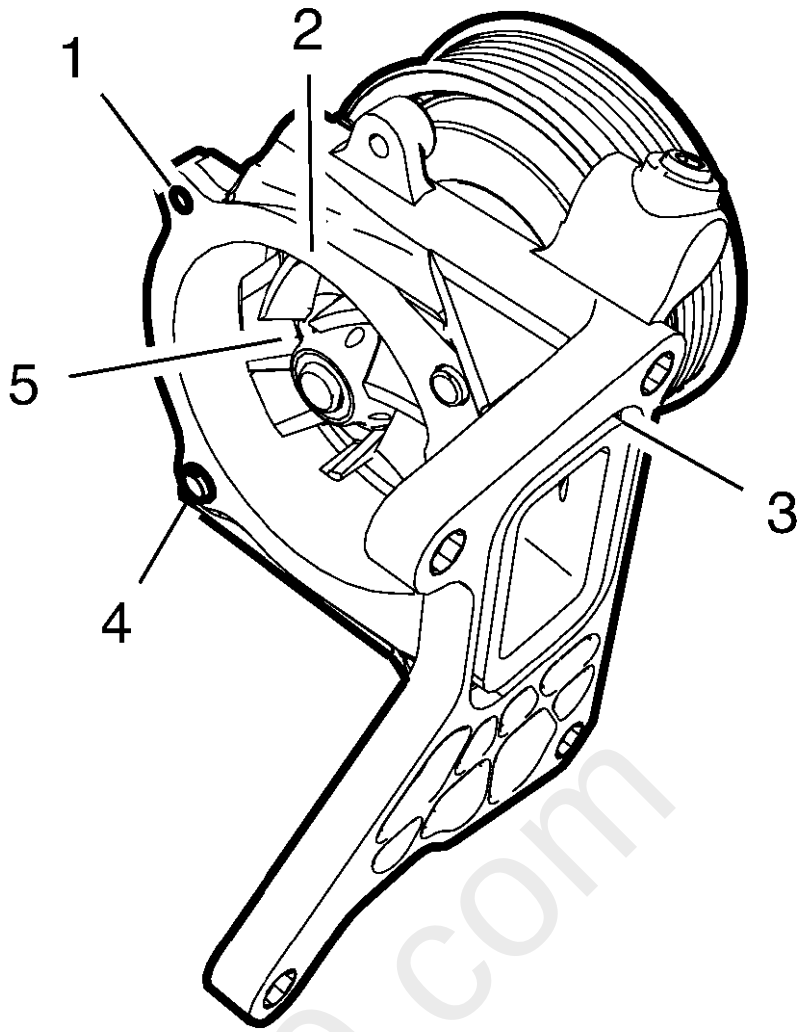


Fig. 711: Water Pump Inspection Points
Courtesy of GENERAL MOTORS COMPANY

NOTE: **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.**

1. Rotate the water pump hub (5).
2. Inspect the exterior of the water pump for the following:
    - Damage to the water pump bolt holes (1)
    - Damage to the water pump gasket sealing surface (2, 3)
    - Damage or deformations of the location pin (4)
    - Damage, corrosion or restrictions
3. Repair or replace the water pump as necessary.

WATER PUMP ASSEMBLE

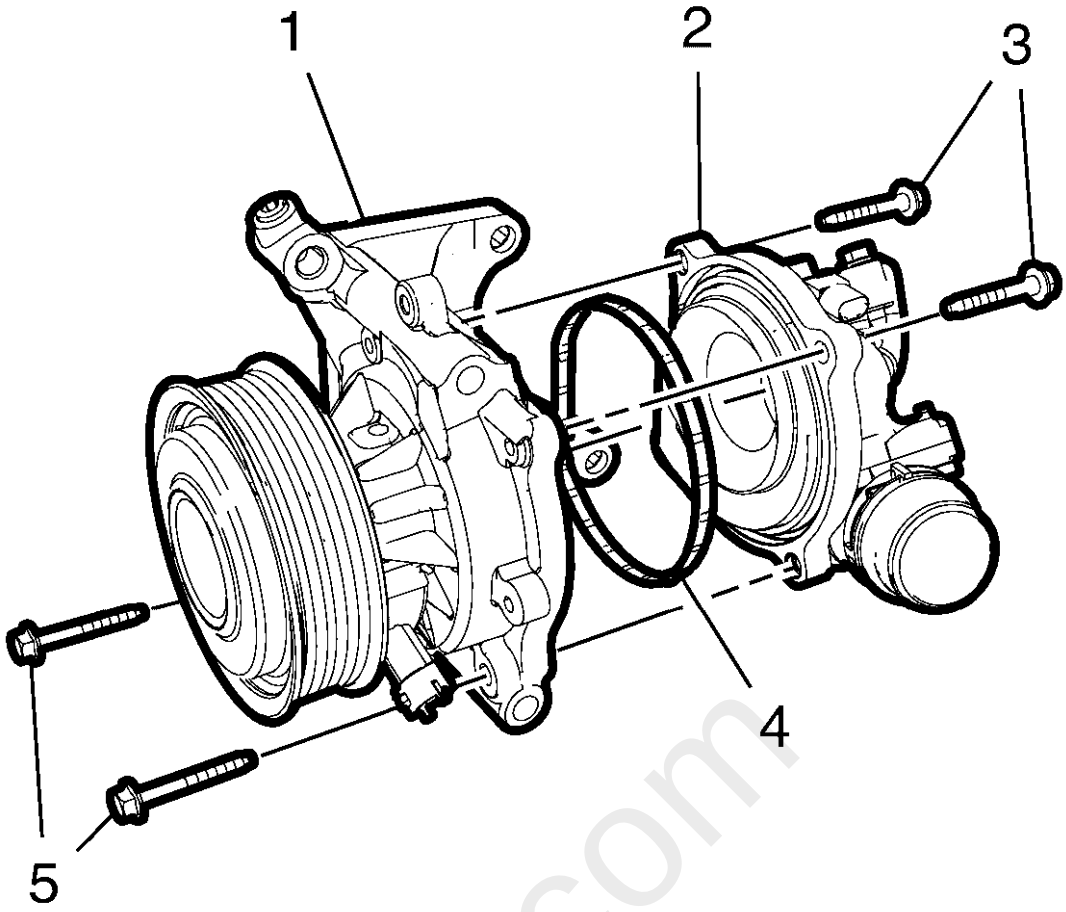


Fig. 712: Water Pump, Bolts And Seal
Courtesy of GENERAL MOTORS COMPANY

1. Clean the sealing surfaces of the water pump (1) and the thermostat housing (2).
2. Install a NEW water pump seal (4).
3. Install the thermostat housing (2) to the water pump (1).

CAUTION: **Refer to Fastener Caution .**

4. Install the 4 water pump bolts (3, 5) and tighten to 10 N.m (89 lb in).

EXHAUST GAS RECIRCULATION COOLER HOUSING DISASSEMBLE

mcx30.com

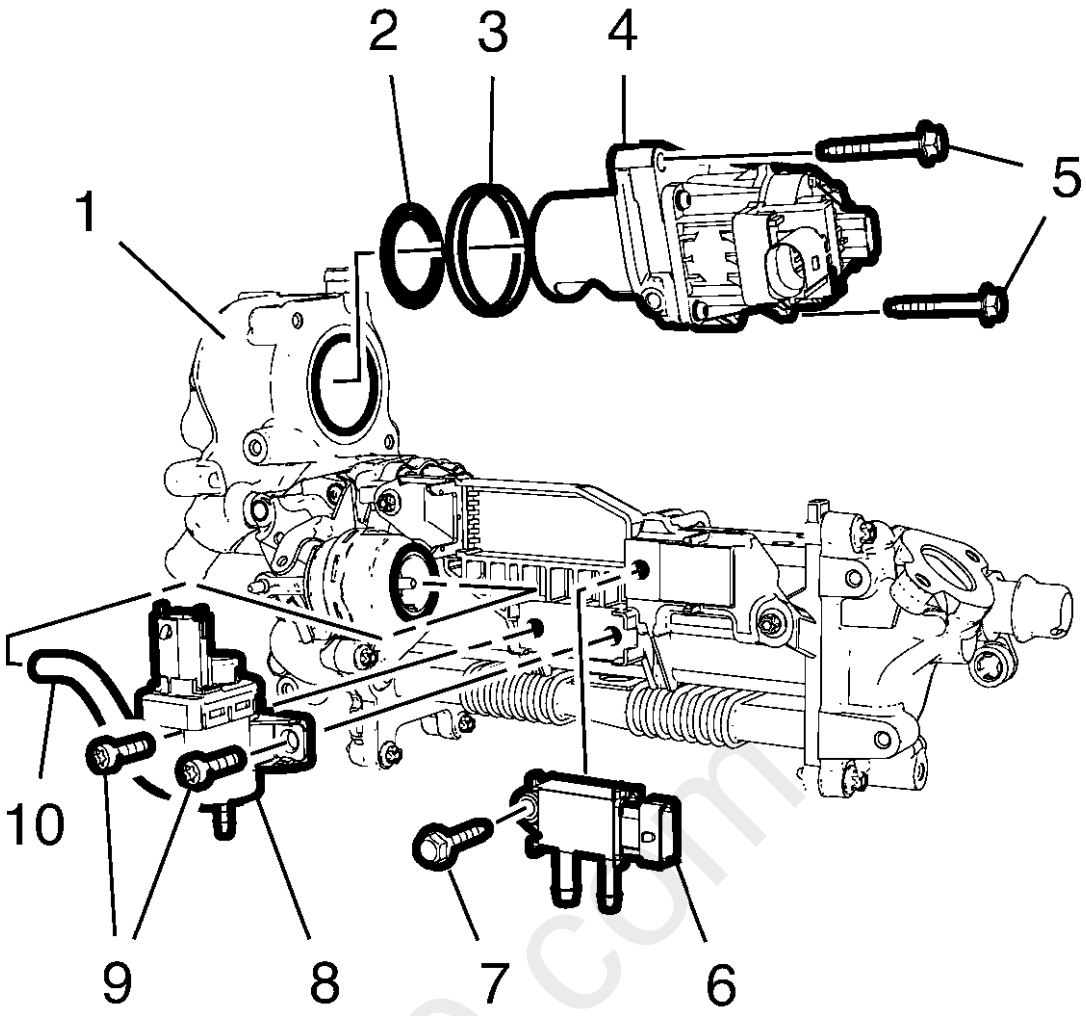


Fig. 713: Exhaust Gas Recirculation Cooler Housing And Components
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 2 exhaust gas recirculation valve bolts (5).
2. Remove the exhaust gas recirculation valve (4) from the exhaust gas recirculation valve cooler (1).
3. Remove and DISCARD the exhaust gas recirculation valve gasket (3).
4. Remove and DISCARD the exhaust gas recirculation valve seat gasket (2).
5. Remove the exhaust pressure differential sensor bolt (7).
6. Remove the exhaust pressure differential sensor (6).
7. Remove the exhaust gas recirculation vacuum regulator hose (10).
8. Remove the 2 exhaust gas recirculation vacuum regulator solenoid valve bolts (9).
9. Remove the exhaust gas recirculation vacuum regulator solenoid valve (8).

EXHAUST GAS RECIRCULATION COOLER HOUSING ASSEMBLE

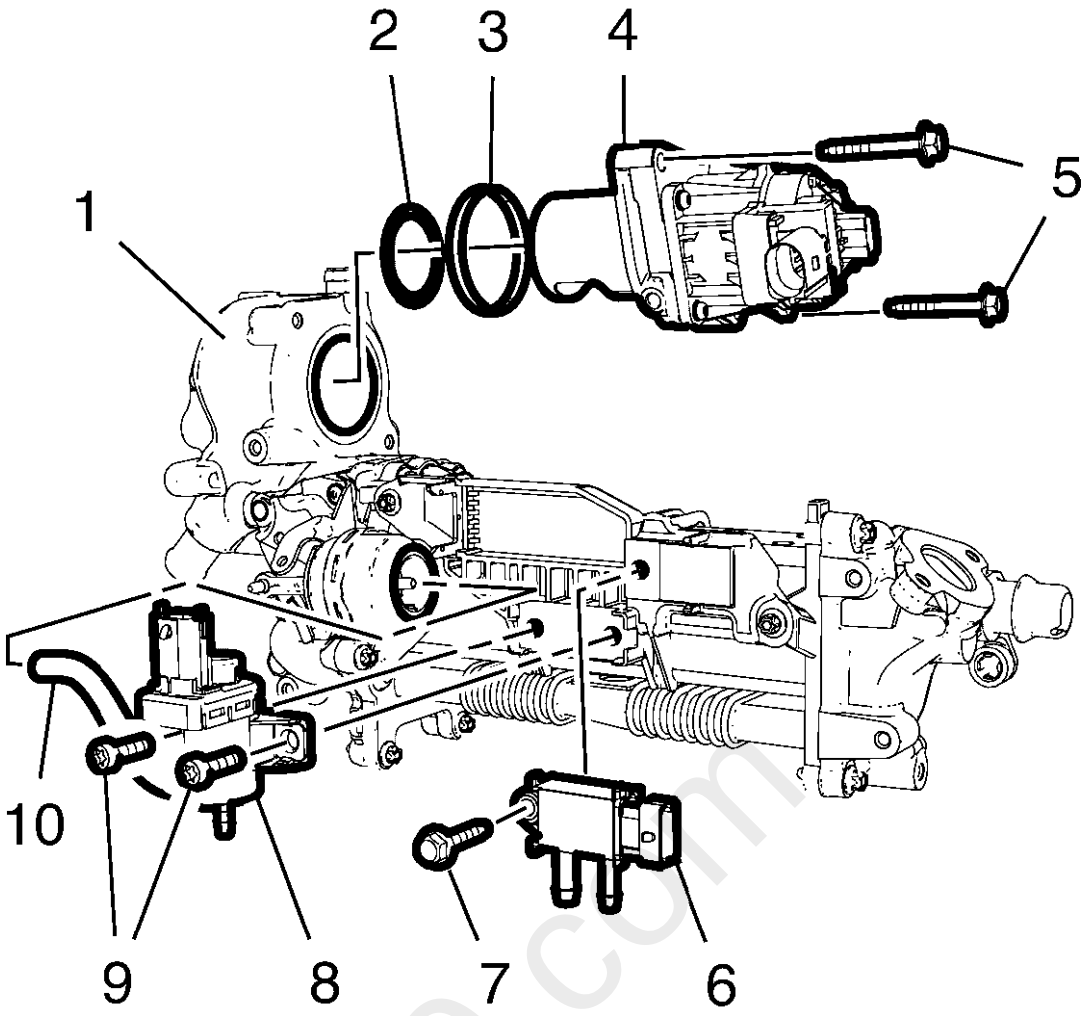


Fig. 714: Exhaust Gas Recirculation Cooler Housing And Components
Courtesy of GENERAL MOTORS COMPANY

1. Install the exhaust gas recirculation vacuum regulator solenoid valve (8).

CAUTION: **Refer to Fastener Caution .**

2. Install the 2 exhaust gas recirculation vacuum regulator solenoid valve bolts (9) and tighten to 7 N.m (62 lb in).
3. Install the exhaust gas recirculation vacuum regulator hose (10).
4. Install the exhaust pressure differential sensor (6).
5. Install the exhaust pressure differential sensor bolt (7) and tighten to 9 N.m (80 lb in).
6. Install a NEW exhaust gas recirculation valve seat gasket (2).
7. Install a NEW exhaust gas recirculation valve gasket (3).
8. Install the exhaust gas recirculation valve (4) to the exhaust gas recirculation valve cooler (1).
9. Install the 2 exhaust gas recirculation valve bolts (5) and tighten to 10 N.m (89 lb in).

INTAKE MANIFOLD DISASSEMBLE

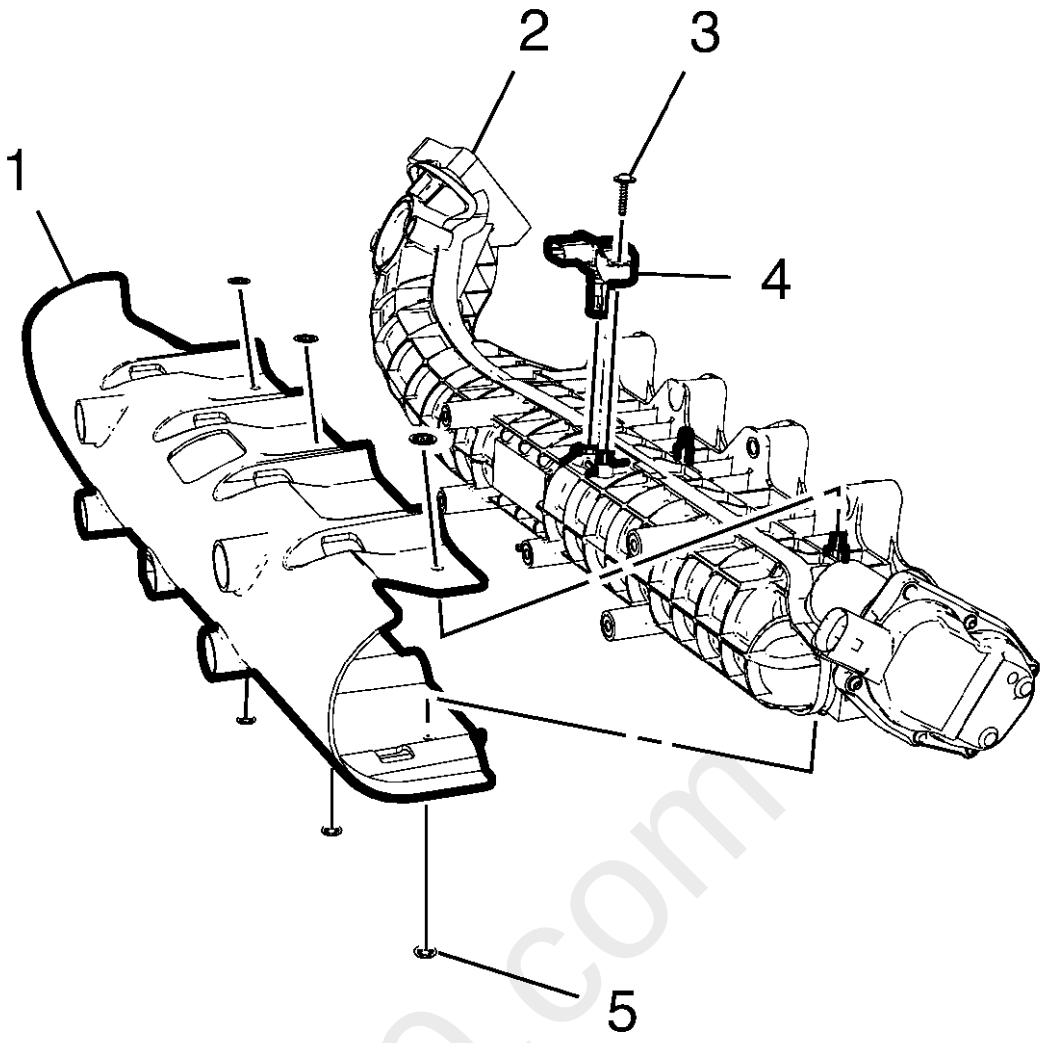


Fig. 715: Intake Manifold And Components
Courtesy of GENERAL MOTORS COMPANY

1. Remove Throttle Body Assembly @ Intake Manifold (2). Refer to **Throttle Body Assembly Replacement**
2. Remove the intake air pressure and temperature sensor bolt (3).
3. Remove the intake air pressure and temperature sensor (4).
4. Remove the 6 intake manifold cover washers (5).
5. Remove the intake manifold cover (1) from the intake manifold (2).

INTAKE MANIFOLD CLEANING AND INSPECTION

mcx30.com

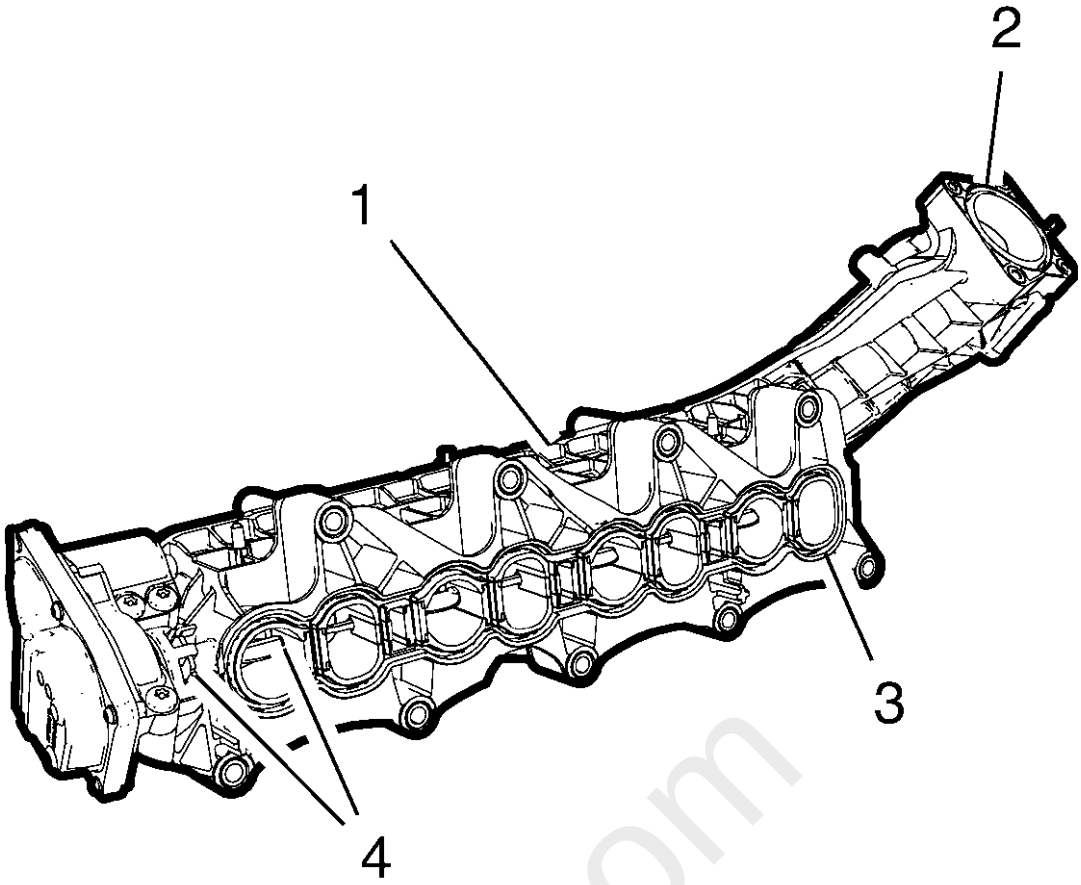


Fig. 716: Intake Manifold Inspection Points
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the intake manifold (1) for damage.
2. Inspect the intake manifold for cracks near metallic inserts.
3. Inspect the crankcase ventilation passages in the intake manifold face for blockage.
4. Inspect the intake manifold runner (4) for proper operation.

WARNING: Wear safety glasses in order to avoid eye damage.

5. Clean the crankcase ventilation passages with compressed air if necessary. Use a maximum of 172 kPa (25 psi) of air pressure.
6. Clean the intake manifold runner with compressed air if necessary. Use a maximum of 172 kPa (25 psi) of air pressure.
7. Clean the throttle body sealing surface (2).
8. Clean the intake manifold to cylinder head sealing surface (3).
9. Replace the intake manifold as necessary.

INTAKE MANIFOLD ASSEMBLE

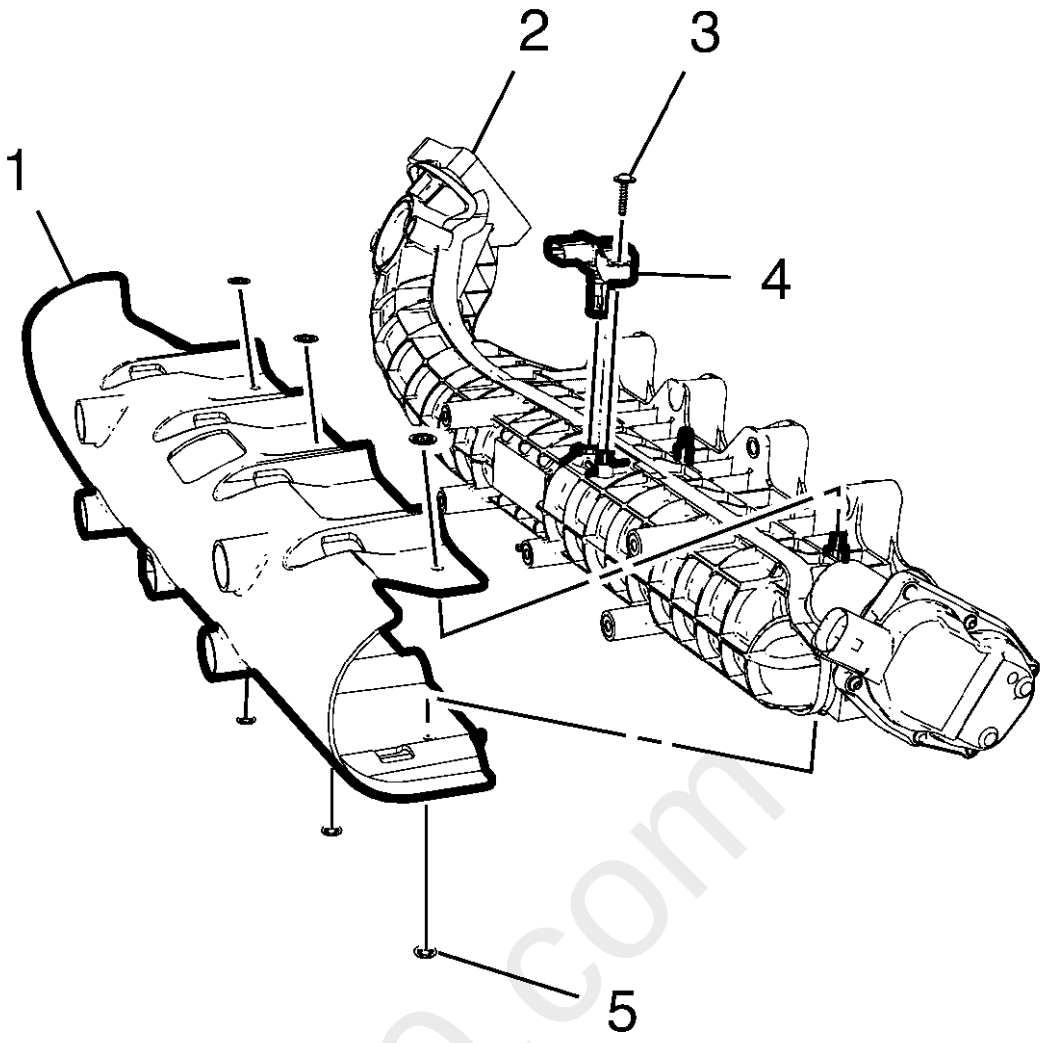


Fig. 717: Intake Manifold And Components
Courtesy of GENERAL MOTORS COMPANY

1. Install the intake manifold cover (1) to the intake manifold.
2. Install 6 intake manifold washers (5).
3. Install the intake air pressure and temperature sensor (4).

CAUTION: **Refer to Fastener Caution .**

4. Install the intake air pressure and temperature sensor bolt (3) and tighten to 1.6 N.m (14 lb in).
5. Install Throttle Body Assembly @ Intake Manifold (2). Refer to **Throttle Body Assembly Replacement**

OIL PAN DISASSEMBLE

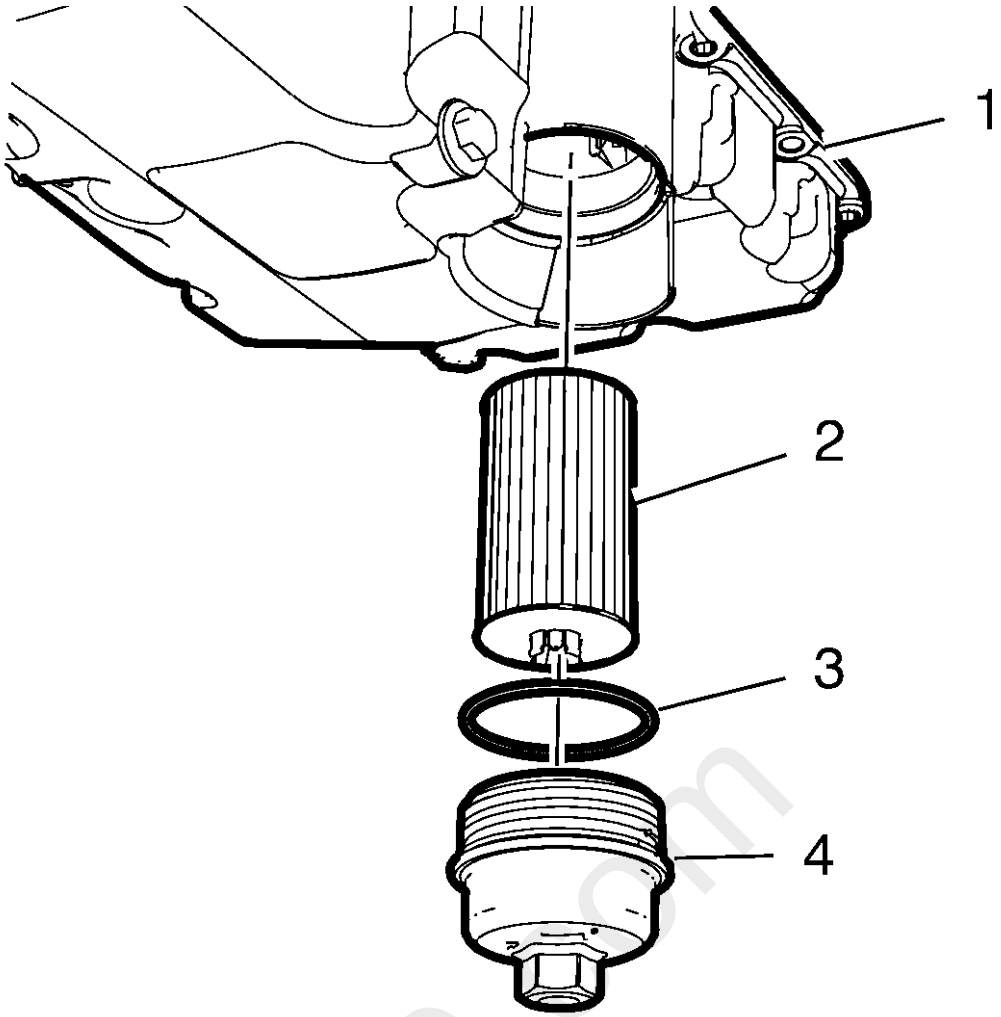


Fig. 718: Oil Filter And Components
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil filter cap (4) from the oil pan (1).
2. Remove and DISCARD the oil filter cap seal (3)

CAUTION: **This engine uses a special high performance oil filter. Use of any other filter may lead to filter failure and/or severe engine damage.**

3. Remove and properly dispose the oil filter insert (2).

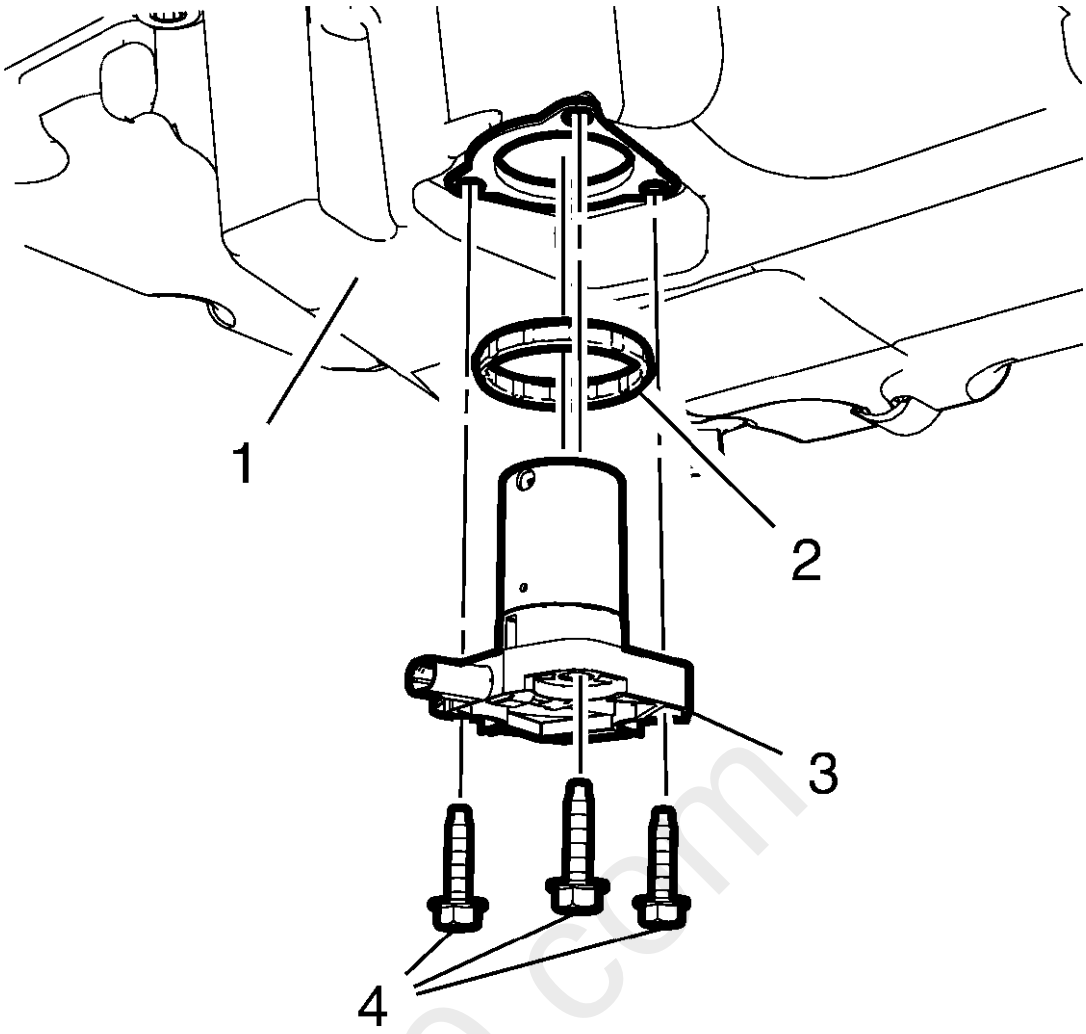


Fig. 719: Oil Level Indicator Switch Components
Courtesy of GENERAL MOTORS COMPANY

4. Remove the 3 oil level indicator switch bolts (4).
5. Remove the oil level indicator switch (3) from the oil pan (1).
6. Remove and DISCARD the oil level indicator switch gasket (2).

mcx30.com

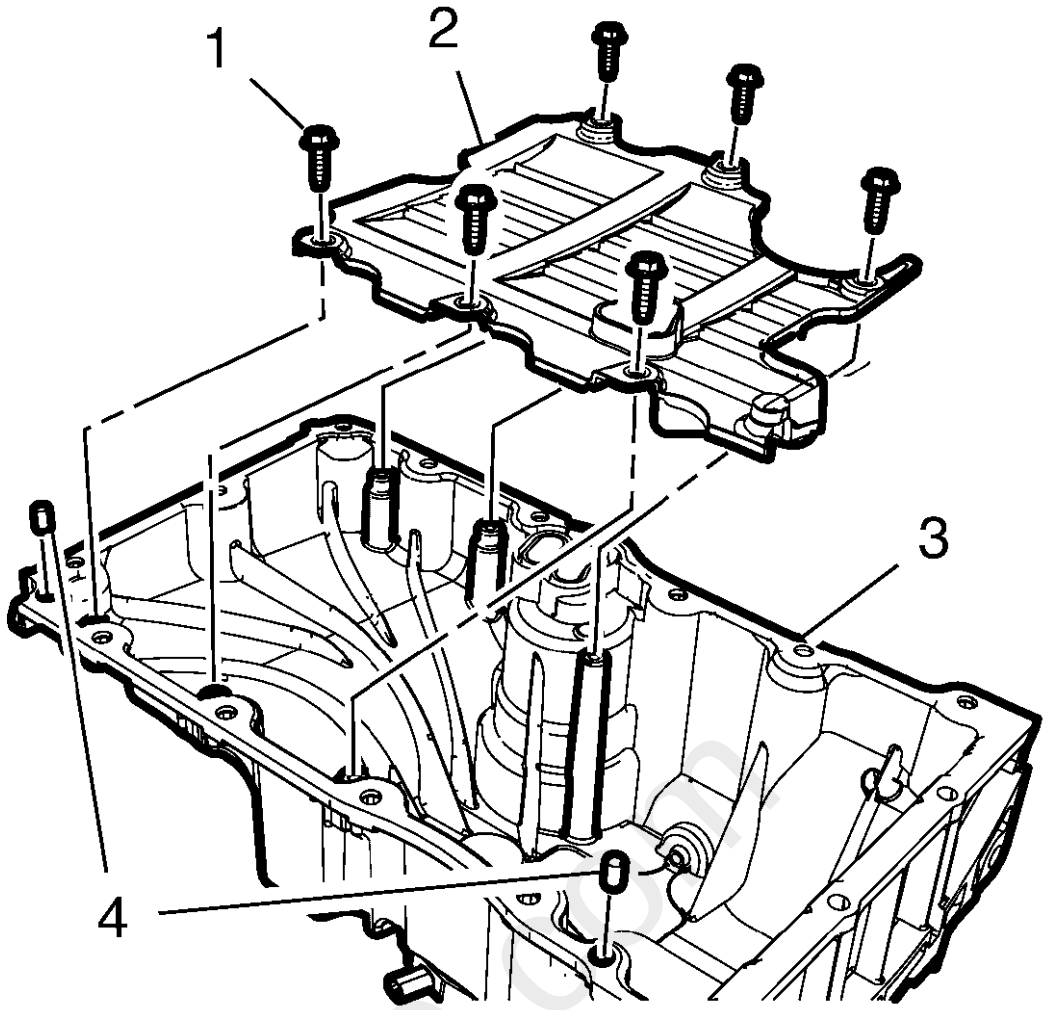


Fig. 720: Oil Pan, Baffle, Pins And Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the 2 location pins (4) from the oil pan (3).
8. Remove the 6 oil pan baffle bolts (1).
9. Remove the oil pan baffle (2).

OIL PAN CLEANING AND INSPECTION

mcx30.com

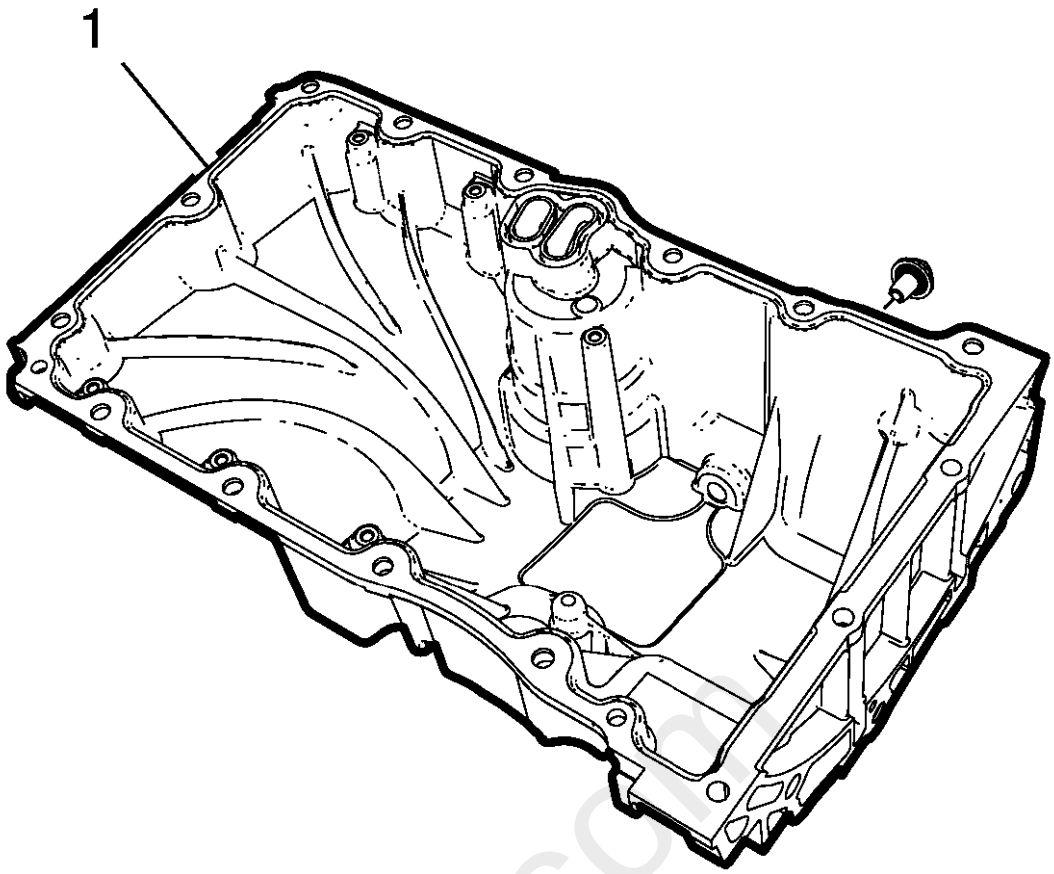


Fig. 721: Oil Pan
Courtesy of GENERAL MOTORS COMPANY

1. Clean the oil pan mating surface
2. Clean the oil pan (1). Remove all the sludge and the oil deposits.
3. Inspect the threads for the engine oil drain plug.
4. Inspect the oil pan for cracking near the pan rail and the transmission mounting points.
5. Inspect the oil pan for cracking resulting from impact or flying road debris.
6. Repair or replace the oil pan as necessary.

OIL PAN ASSEMBLE

mcx30.com

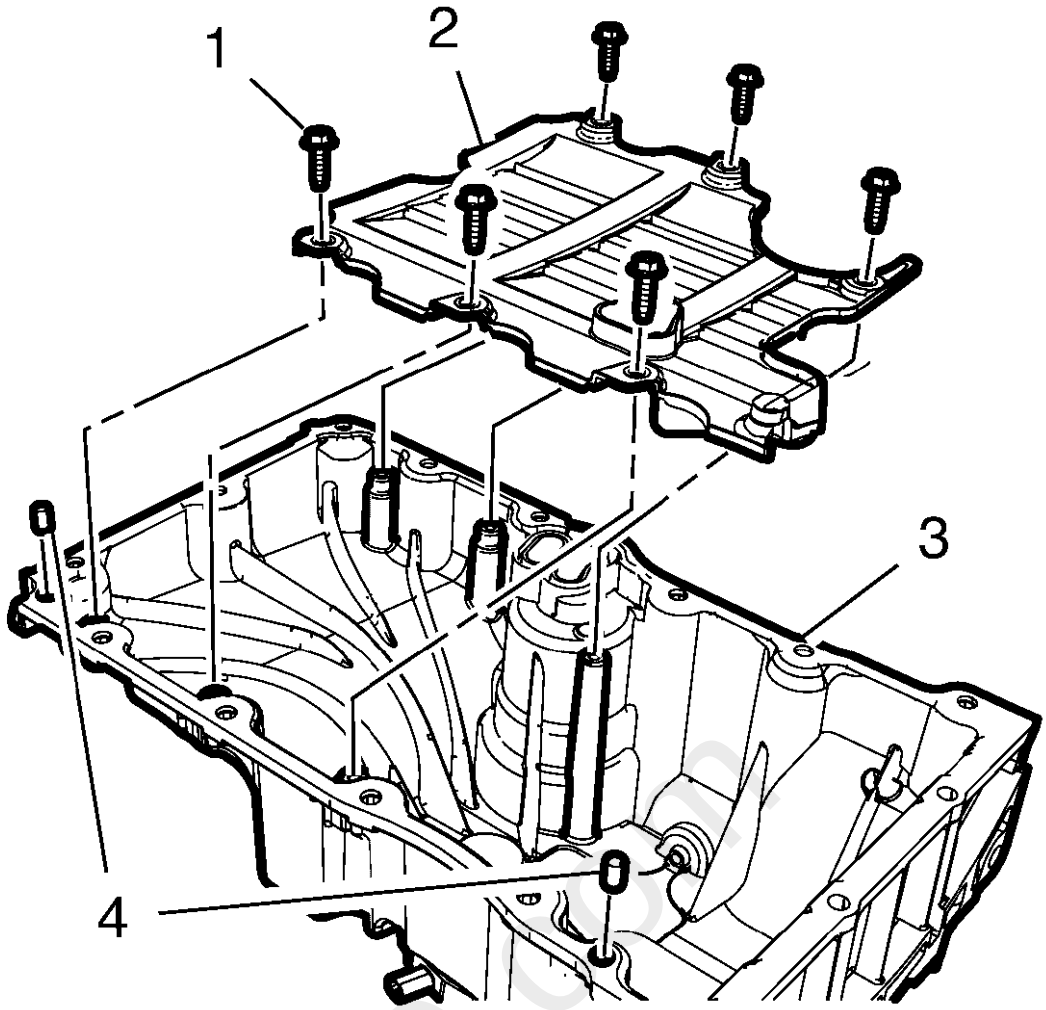


Fig. 722: Oil Pan, Baffle, Pins And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the oil pan baffle (2) to the oil pan (3).

CAUTION: **Refer to Fastener Caution .**

2. Install the 6 oil pan baffle bolts (1) and tighten to 10 N.m (89 lb in).
3. Install the 2 location pins (4).

mcx30.com

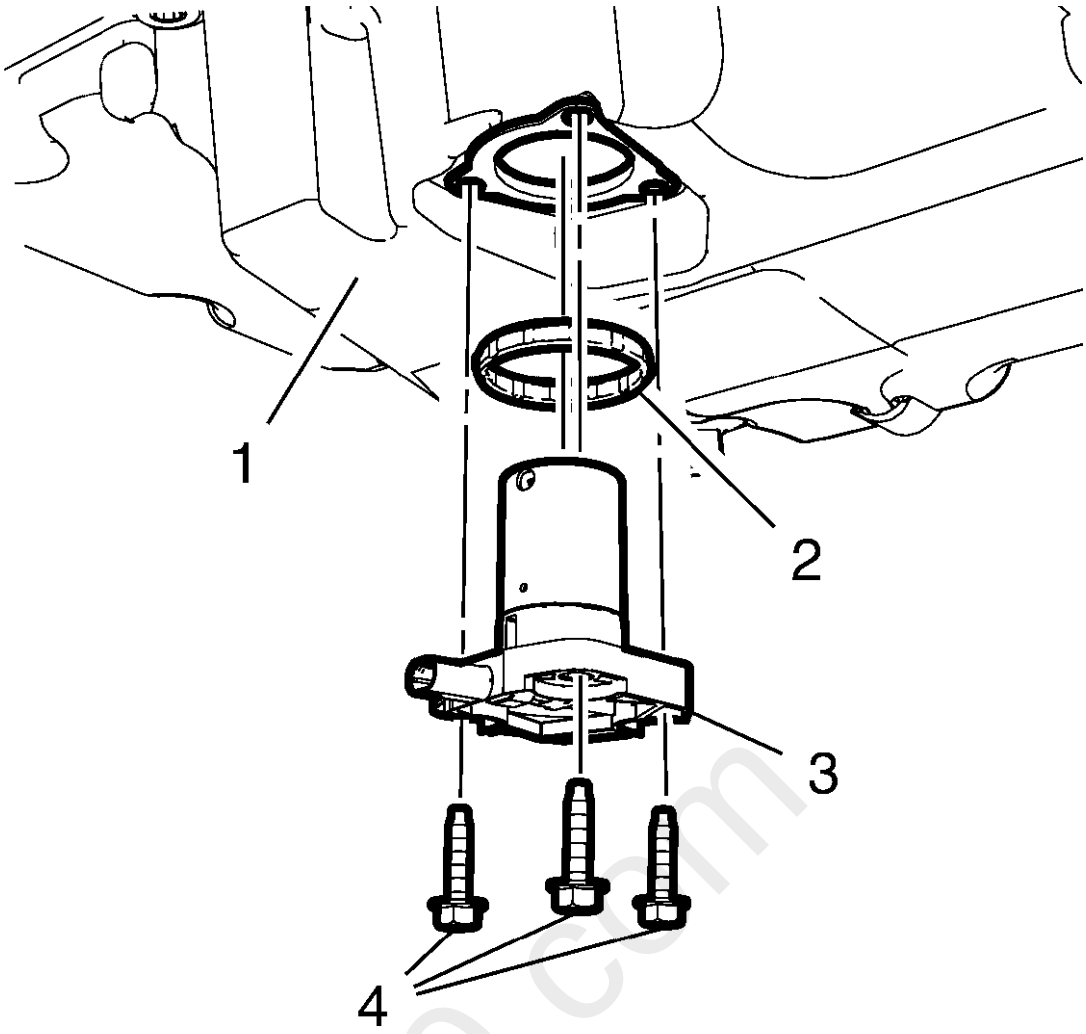


Fig. 723: Oil Level Indicator Switch Components
Courtesy of GENERAL MOTORS COMPANY

4. Install a NEW oil level indicator switch gasket (2).
5. Install the oil level indicator switch (3) to the oil pan (1).
6. Install the 3 oil level indicator switch bolts (4) and tighten to 10 N.m (89 lb in).
7. Clean the oil filter housing of the oil pan and oil filter cap until it is completely free of debris.

mcx30.com

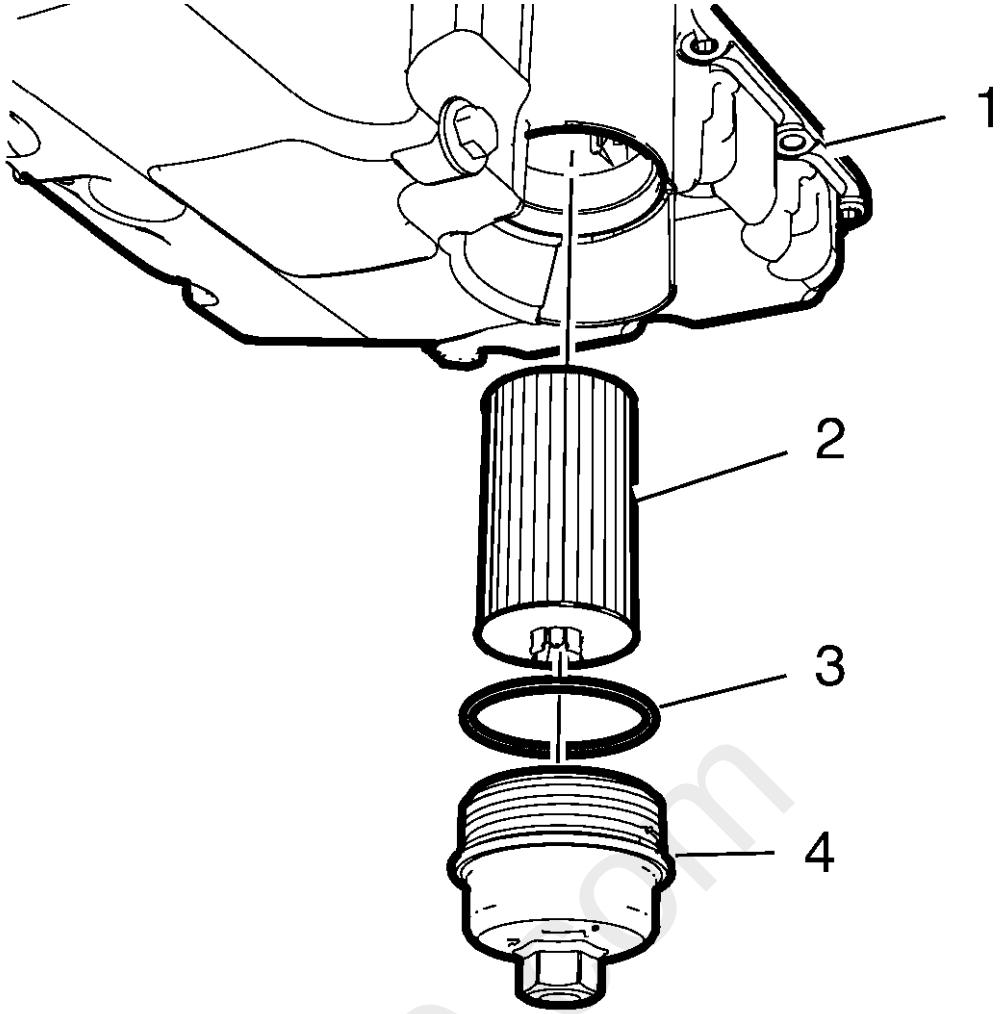


Fig. 724: Oil Filter And Components
Courtesy of GENERAL MOTORS COMPANY

8. Install a NEW oil filter insert (2).
9. Coat the seal ring with NEW clean engine oil.
10. Install a NEW oil filter cap seal (3).

CAUTION: **Over torquing the oil filter cap may cause damage to the oil filter cap resulting in an oil leak.**

11. Install the oil filter cap (4) to the oil pan (1) and tighten to 25 N.m (18 lb ft).

CAMSHAFT HOUSING DISASSEMBLE

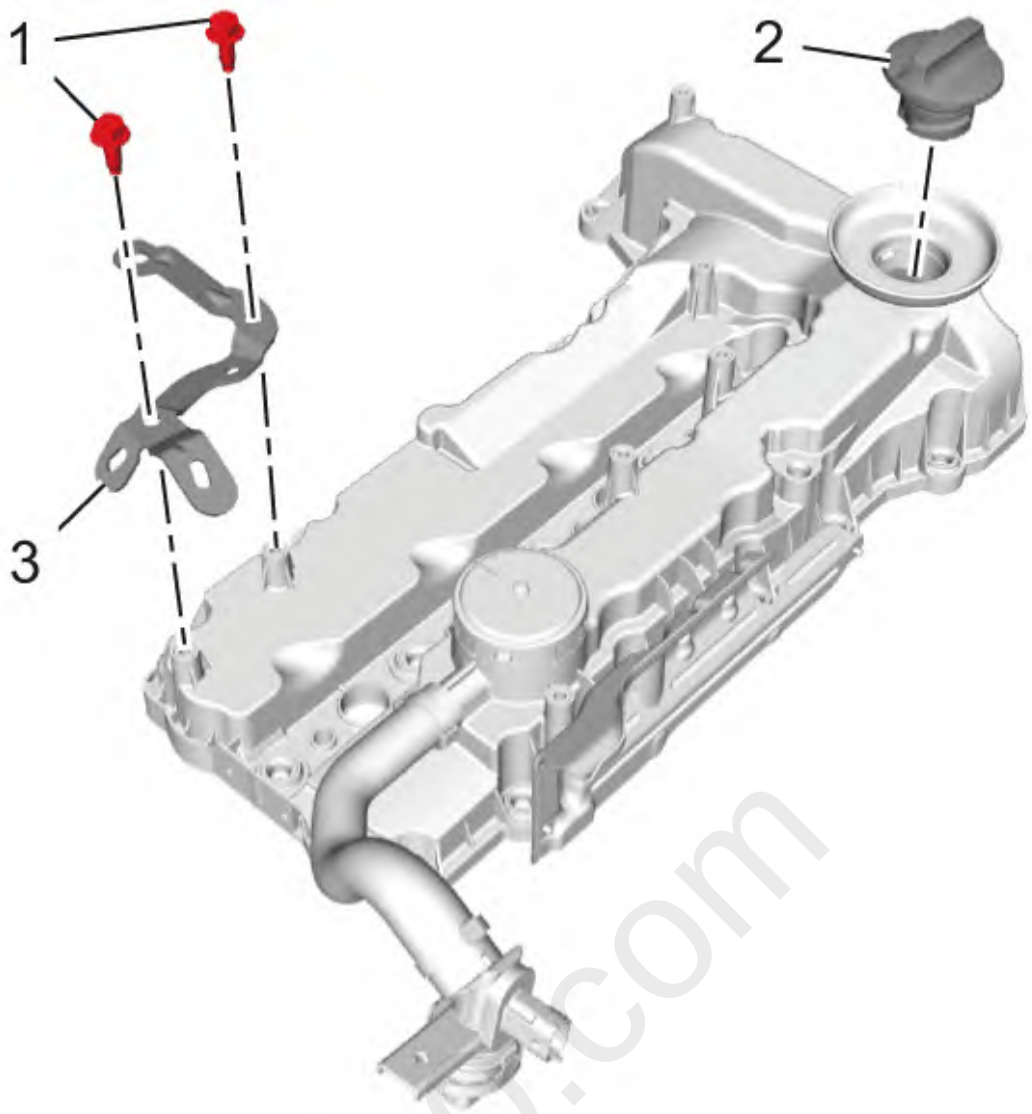


Fig. 725: Wiring Harness Bracket, Bolts And Oil Filler Cap
Courtesy of GENERAL MOTORS COMPANY

1. Remove Wiring Harness Bracket Bolts (1) (Qty: 2)
2. Remove Wiring Harness Bracket (3)
3. Remove Oil Filler Cap (2)

CAMSHAFT AND HOUSING CLEANING AND INSPECTION

Cleaning Procedure

1. Clean the camshaft covers in solvent.

   WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

2. Dry the camshaft covers with compressed air.

Inspection Procedure

1. Inspect each camshaft cover for the dents or damage to the exterior. A dented or damaged camshaft cover may:
   - Leak engine oil
   - Affect crankcase ventilation
   - Interfere with the camshafts
   - Interfere with the ignition coil sealing
   - Allow water or condensation to enter the engine

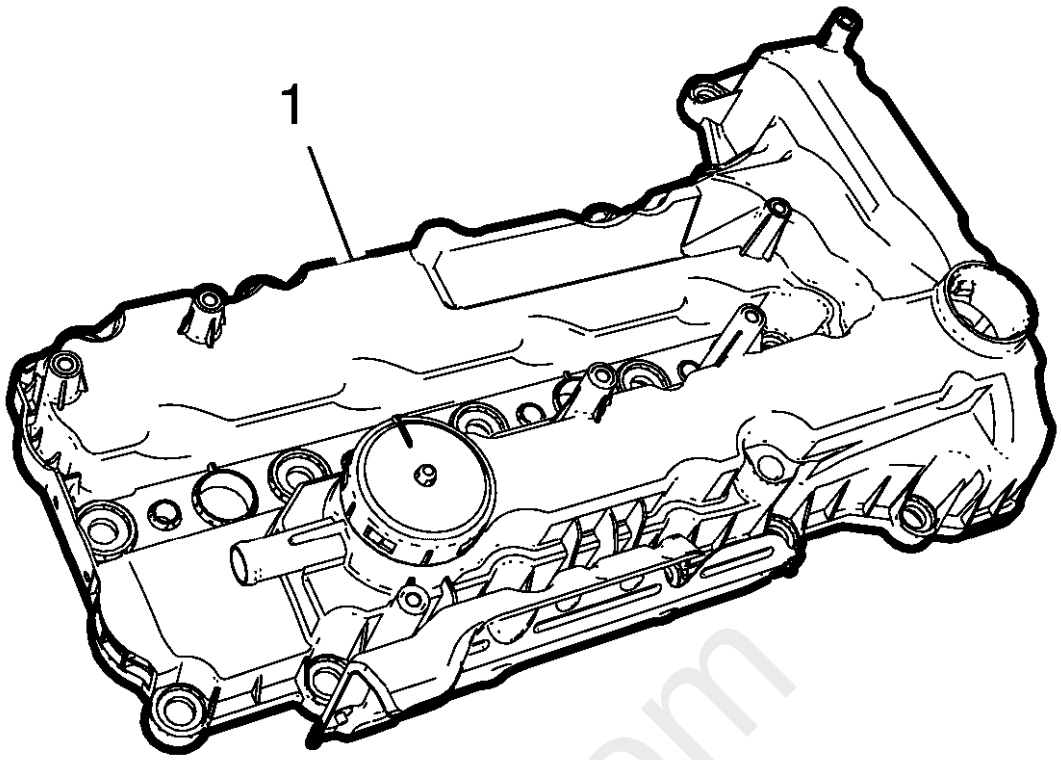


Fig. 726: Camshaft Cover Exterior
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the exterior of the camshaft cover (1) for the following conditions:
    - Damage to the camshaft cover bolt holes
    - Damage to the camshaft cover injector bracket bolt holes

mcx30.com

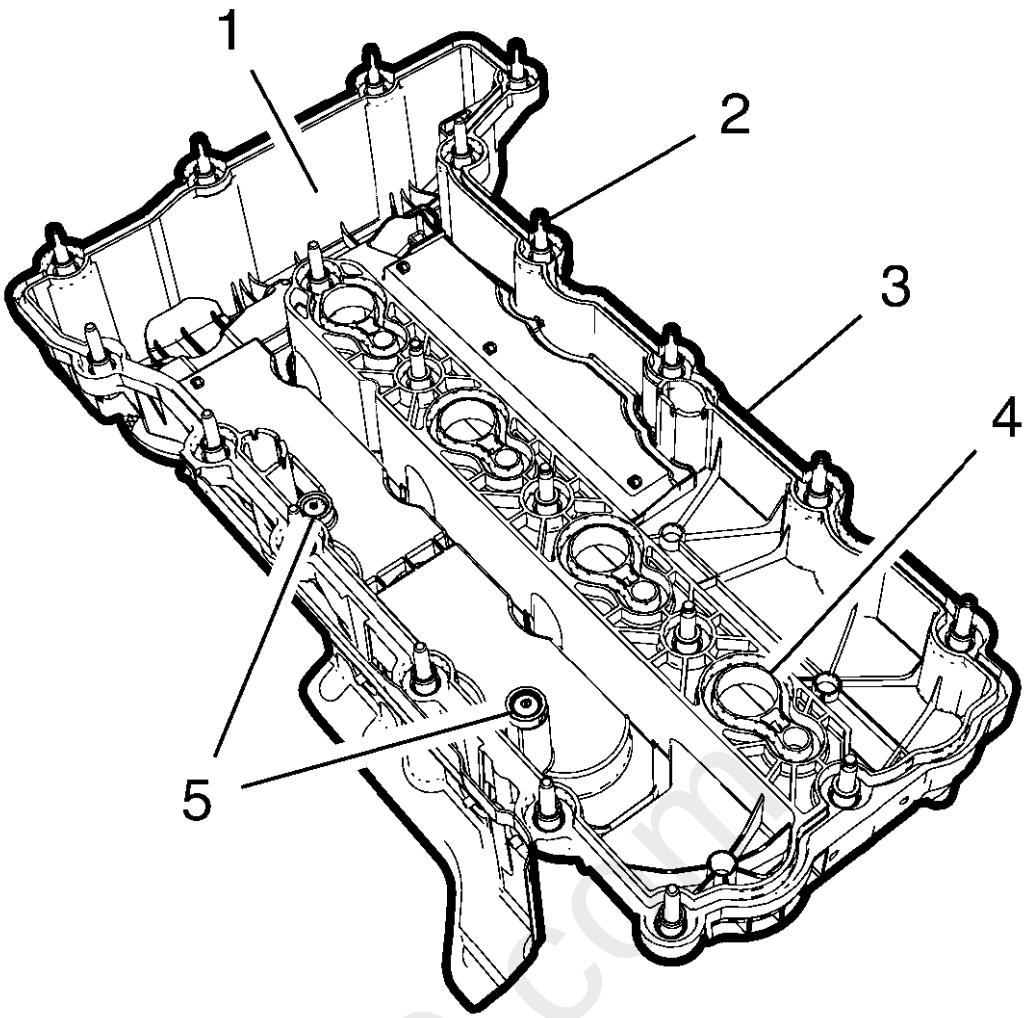


Fig. 727: Camshaft Cover Interior Inspection Points
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the interior of the camshaft cover (1) for the following conditions:
    - Inspect the camshaft cover for cracks, casting imperfections or damage
    - Inspect the camshaft cover sealing (3) and the fuel injector sealing (4) for cracks or damage
    - Inspect the camshaft cover bolts (2) for flawless thread
    - Inspect the positive crankcase oil separator valves (5) for cracks or damages

CAMSHAFT HOUSING ASSEMBLE

mcx30.com

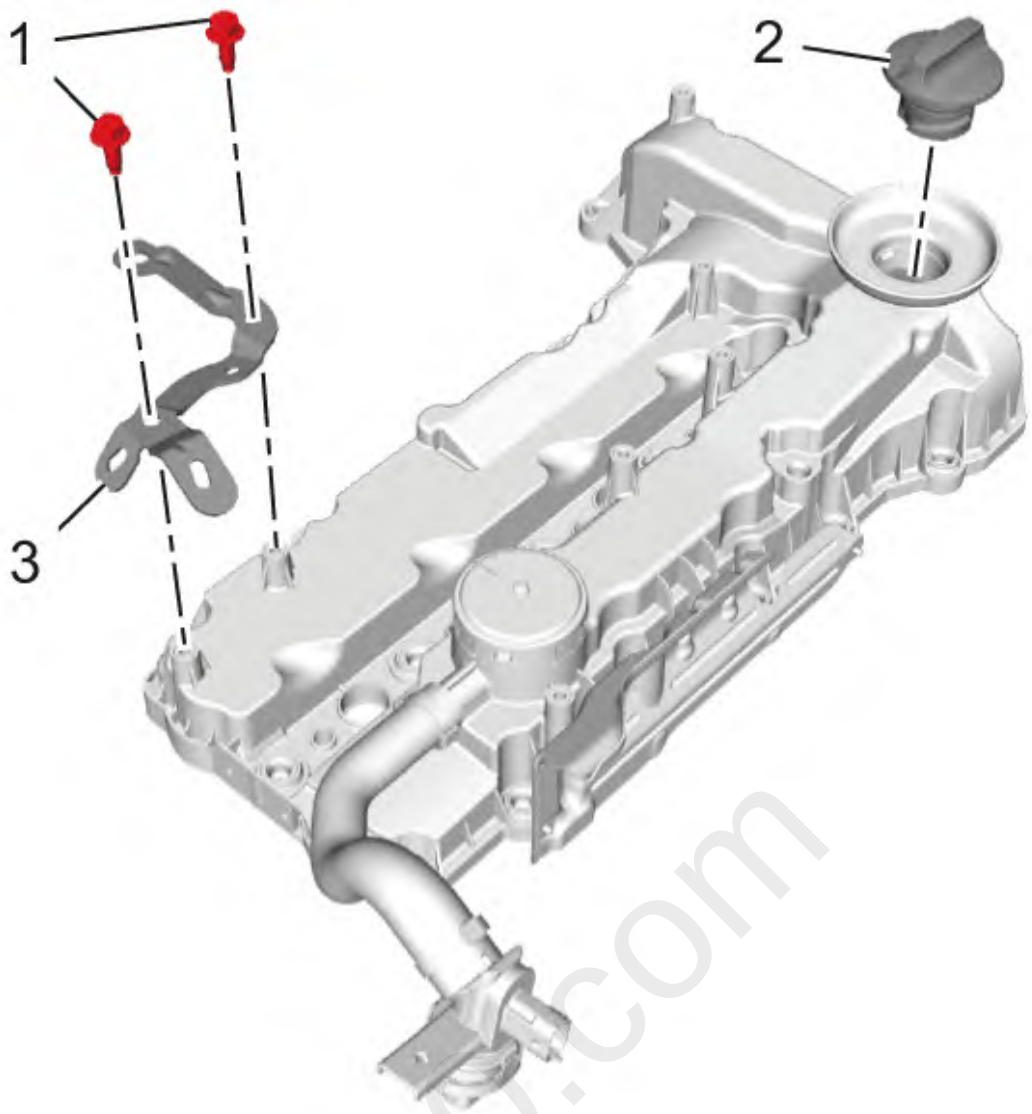


Fig. 728: Wiring Harness Bracket, Bolts And Oil Filler Cap
Courtesy of GENERAL MOTORS COMPANY

1. Install Oil Filler Cap (2)
2. Install Wiring Harness Bracket (3)

CAUTION: **Refer to Fastener Caution**

3. Install and tighten Wiring Harness Bracket Bolts (1) (Qty: 2) to 9 N.m (80 lb in)

PISTON AND CONNECTING ROD DISASSEMBLE

mcx30.com

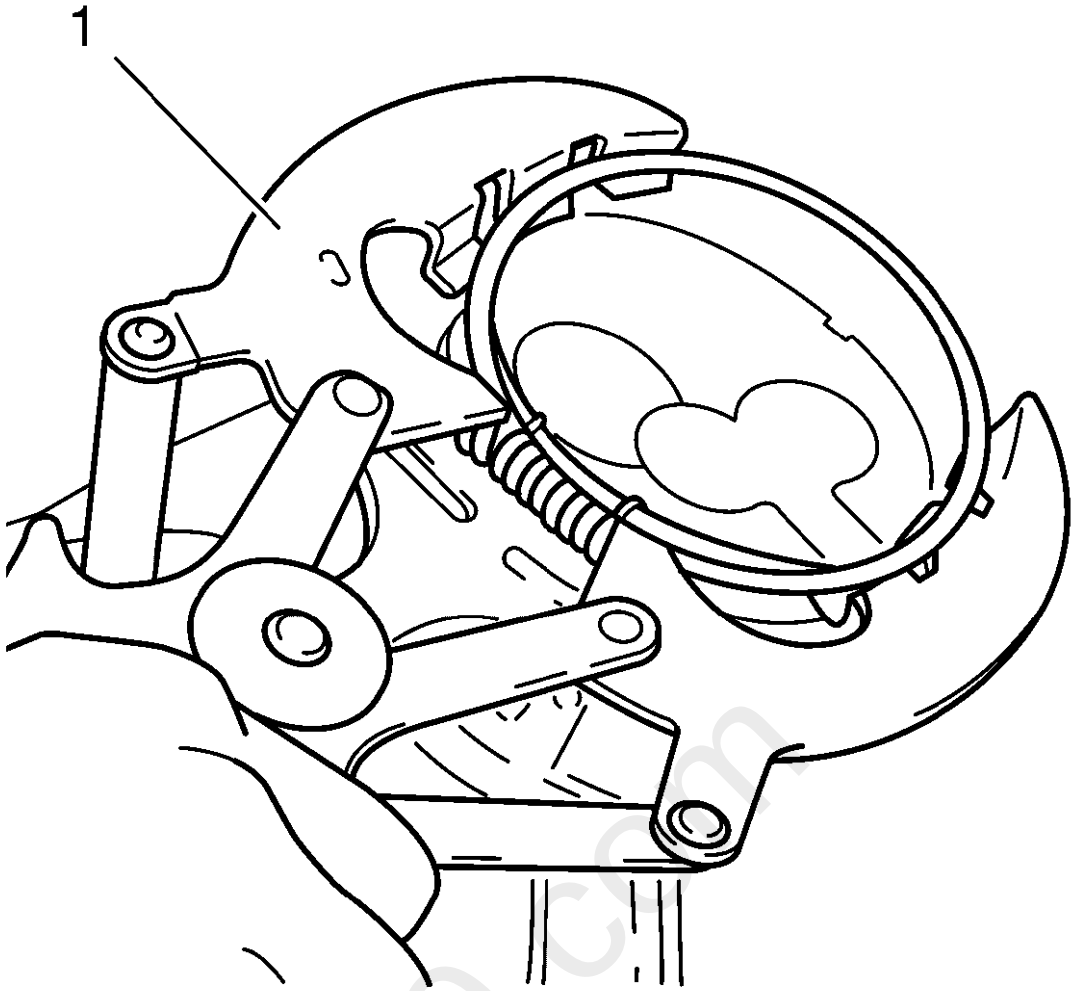


Fig. 729: Using Piston Ring Pliers
Courtesy of GENERAL MOTORS COMPANY

1. Remove the piston rings. Use a piston ring plier (1).

mcx30.com

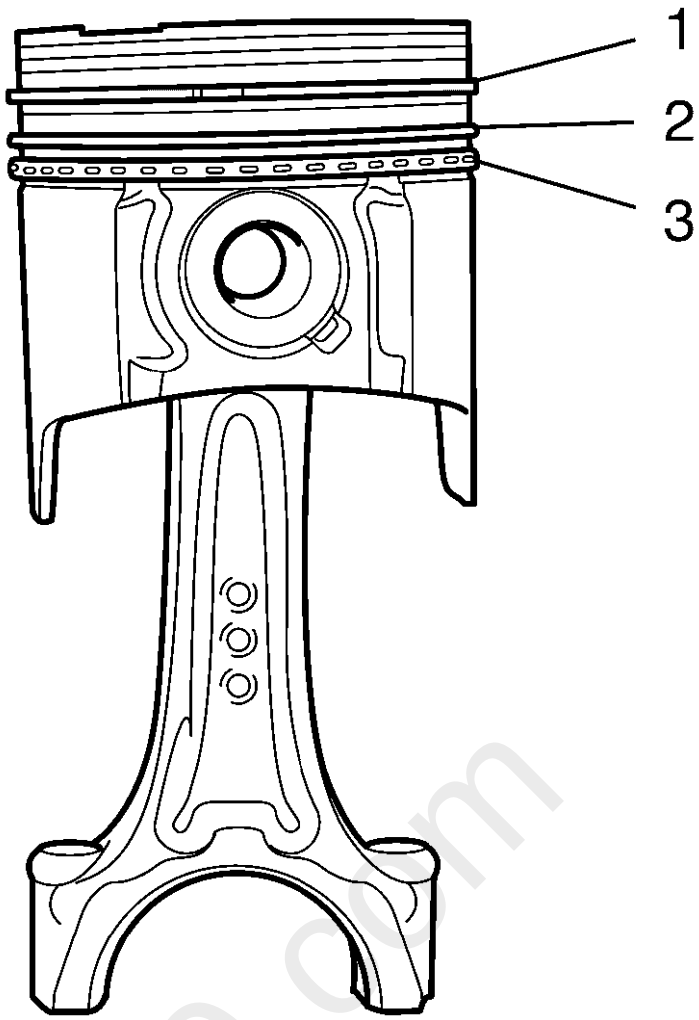


Fig. 730: Piston Rings
Courtesy of GENERAL MOTORS COMPANY

2. The piston rings are ordered as followed:
    - Upper compression ring (1)
    - Lower compression ring (2)
    - Oil ring (3)

mcx30.com

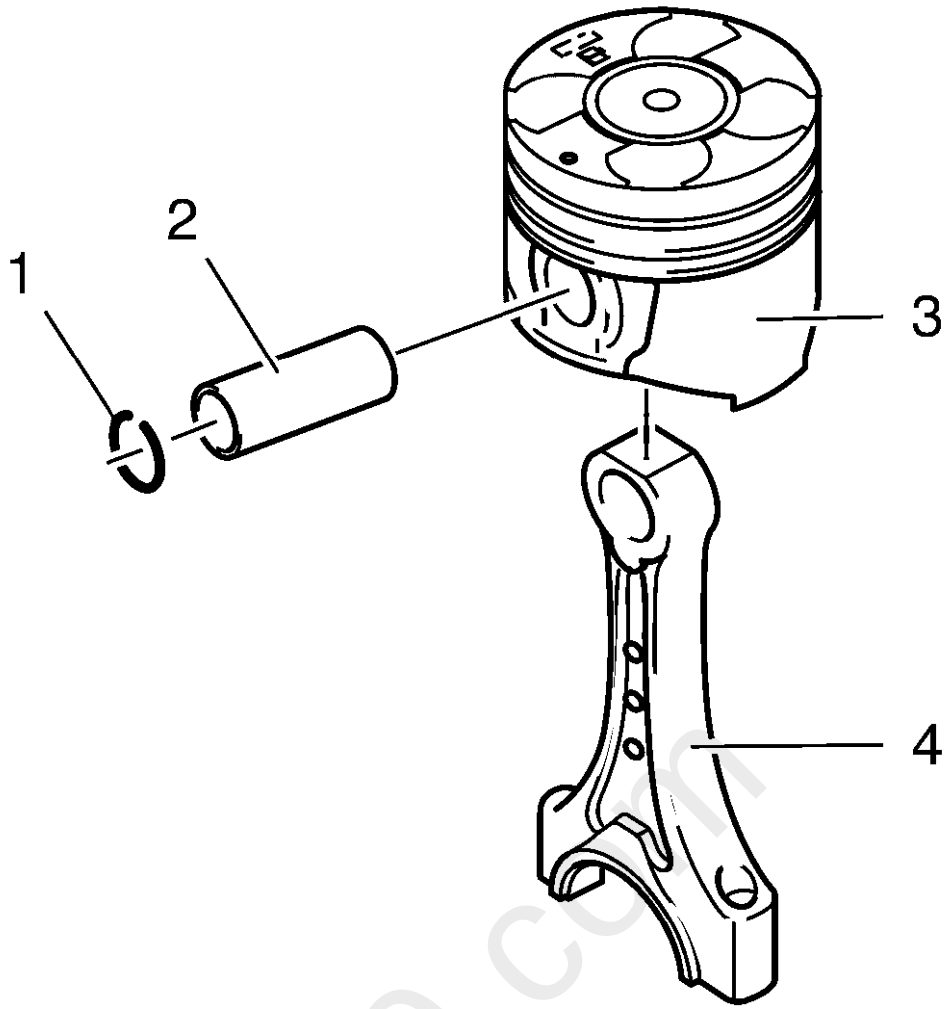


Fig. 731: Connecting Rod, Piston, Piston Pin And Retainer
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Clamp the connecting rod.**

3. Remove the 2 piston pin retainer (1).
4. Remove the piston pin (2).
5. Remove the piston (3) from the connecting rod (4).

PISTON, CONNECTING ROD, AND BEARING CLEANING AND INSPECTION

Special Tools

EN-45059 Angle Meter

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

Visual Inspection And Cleaning Procedure

Connecting Rod

mcx30.com

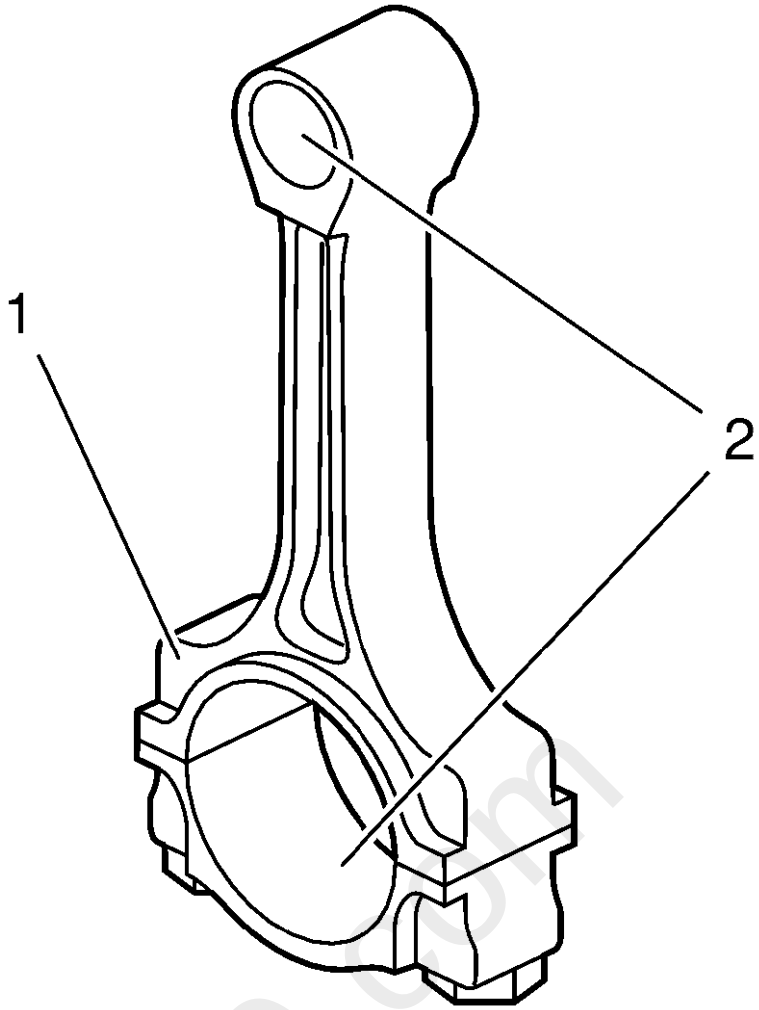


Fig. 732: Connecting Rods
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Safety Glasses Warning .**

1. Clean the connecting rods (1) in solvent and dry with compressed air.
2. Inspect the connecting rod for the following:
   - Signs of being twisted, bent, nicked or cracked
   - Scratches or abrasion on the connecting rod bearing seating surfaces
3. If the connecting rod bores (2) contain minor scratches or abrasions, clean the bores in a circular direction with a light emery paper. DO NOT scrape the rod or rod cap.
4. If the beam of the rod is scratched or has other damage replace the connecting rod.

Piston

mcx30.com

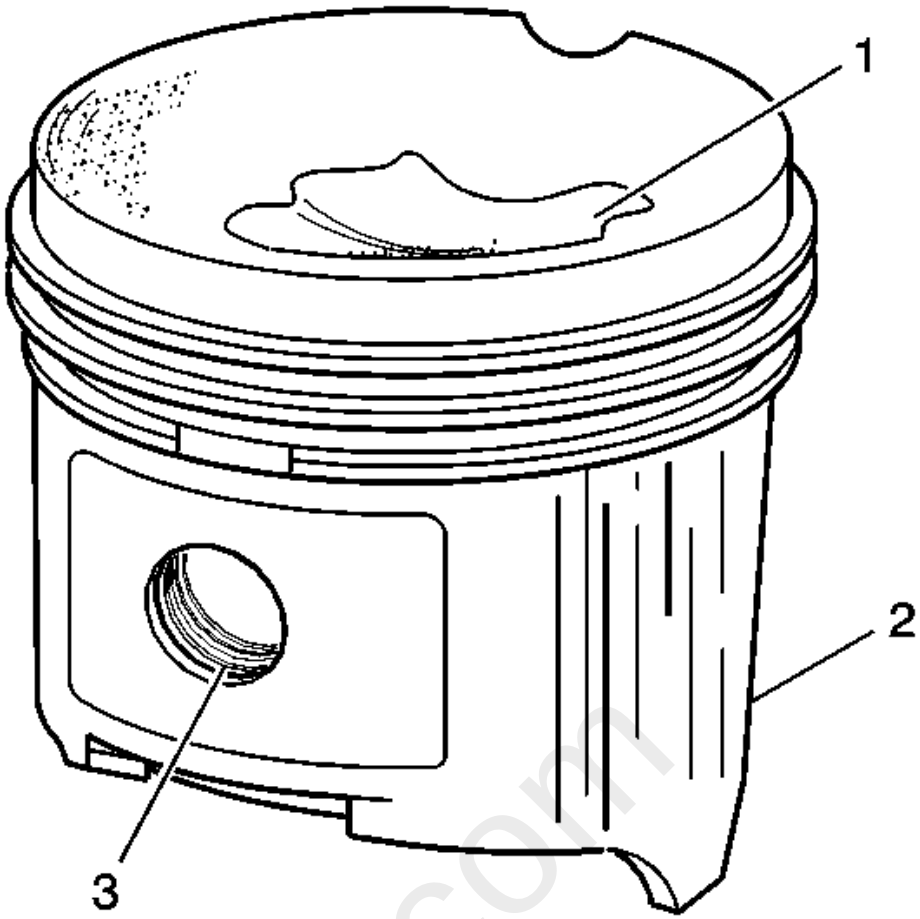


Fig. 733: Identifying Piston Damage Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

1. Clean the piston with a cleaning solvent. DO NOT wire brush any parts of the piston.
2. Clean the piston ring grooves.
3. Inspect the piston on the following:
   - Cracked ring lands, skirts or pin bosses
   - Ring grooves for nicks
   - Eroded areas on the top of the piston (1)
   - Scuffed or damaged skirts (2)
   - Worn piston pin bores (3)
4. If there is any excessive wear, replace the piston.
5. Measure the clearance between piston pin and piston bore. Use the following procedure:

Piston And Connecting Rod Measurement Procedure

Piston Pin To Connecting Rod Bore And Piston Bore Clearance

1. Measure clearance between piston pin and connecting rod bore. Use the following procedure:
   1. Measure the piston pin outside diameter.
   2. Measure the connecting rod bore diameter.
   3. Substract the piston pin outside diameter from the connecting rod diameter to calculate the clearance.
   4. Refer to the **Engine Mechanical Specifications** for the correct value of the clearance piston pin in connecting rod.
2. If there is excessive clearance, replace the piston pin.
3. If there is still excessive clearance, replace the connecting rod.
4. Measure clearance between piston pin and piston bore. Use the following procedure:

1. Measure the piston pin outside diameter.
2. Measure the piston bore diameter.
3. Substract the piston pin outside diameter from the piston bore diameter to calculate the clearance.
4. Refer to **Engine Mechanical Specifications** for the correct value of the clearance piston pin in piston.

5. If there is excessive clearance, replace the piston pin.
6. If there is still excessive clearance, replace the piston.

Piston Ring Clearance

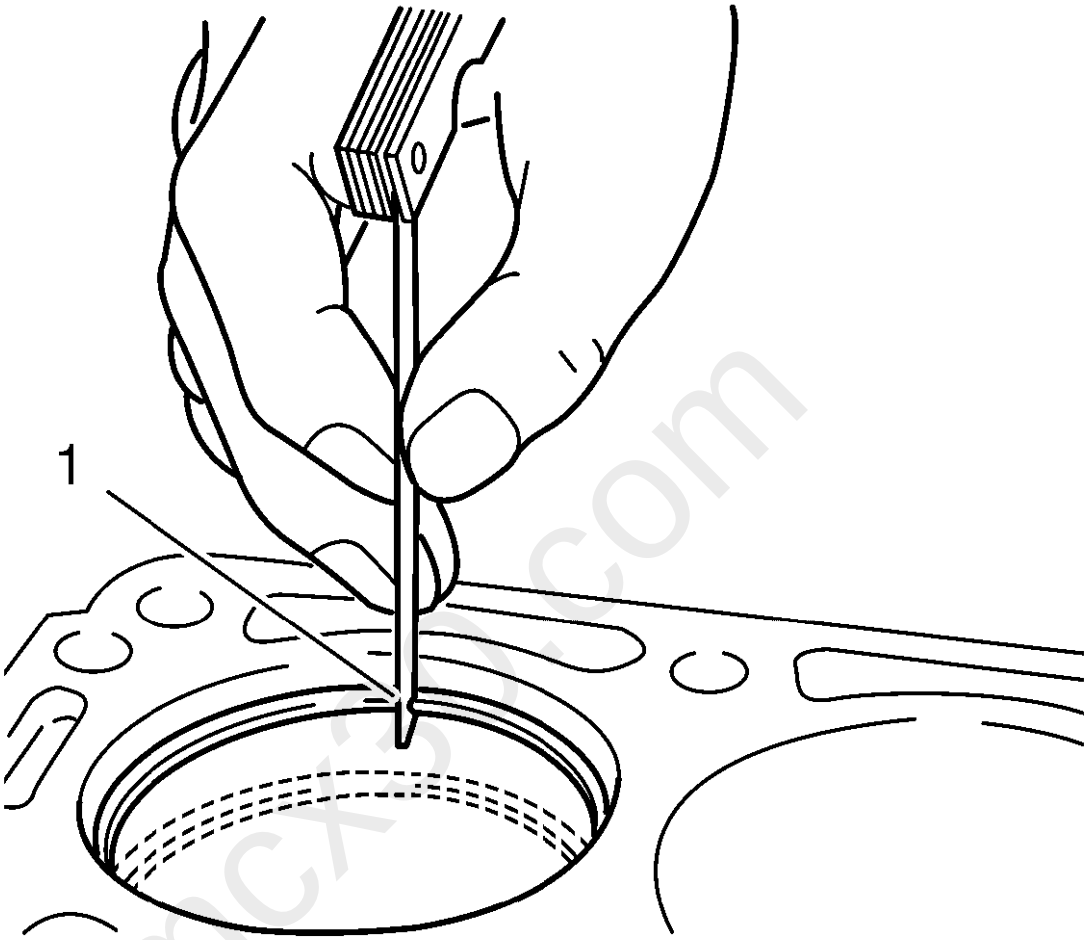


Fig. 734: Measuring Piston Ring End Clearance
Courtesy of GENERAL MOTORS COMPANY

1. Install the piston rings to the cylinder as shown (1) and measure the piston ring end gap. Compare the measurements with those provided below:
   - The upper compression ring end gap. Refer to **Engine Mechanical Specifications** for the correct value of the clearance.
   - The lower compression ring end gap. Refer to **Engine Mechanical Specifications** for the correct value of the clearance.
   - The oil scraper ring end gap. Refer to **Engine Mechanical Specifications** for the correct value of the clearance.
2. If the clearance is greater than the provided specifications, the piston rings must be replaced.

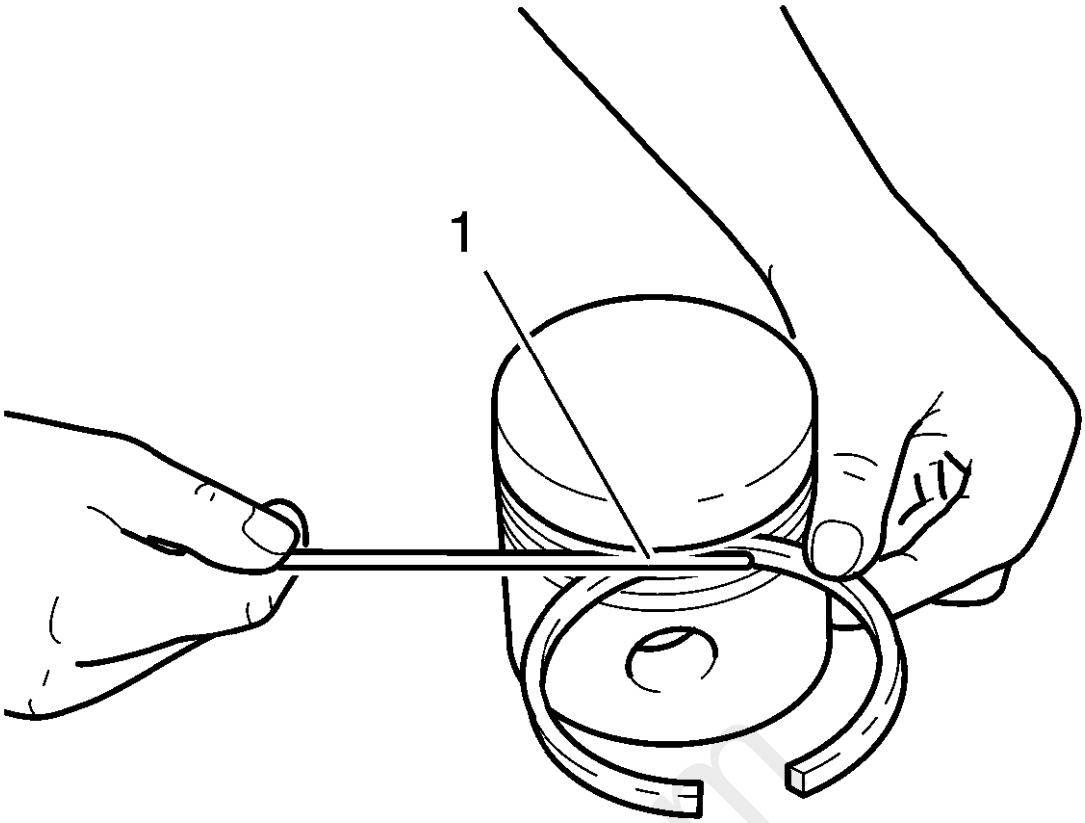


Fig. 735: Measuring Piston Ring Side Clearance
Courtesy of GENERAL MOTORS COMPANY

3. Measure the piston ring axial clearance as shown (1). Compare the measurements with those provided below:
   - The upper compression ring end gap. Refer to **Engine Mechanical Specifications** for the correct value of the clearance.
   - The lower compression ring end gap. Refer to **Engine Mechanical Specifications** for the correct value of the clearance.
   - The oil scraper ring end gap. Refer to **Engine Mechanical Specifications** for the correct value of the clearance.
4. If the clearance is greater than the provided specifications, replace the piston rings.
5. If the clearance is still to great, replace the pistons.

Piston to Engine Block Cylinder Bore Clearance

1. Measure the engine cylinder bore. Refer to **Engine Block Cleaning and Inspection**.

mcx30.com

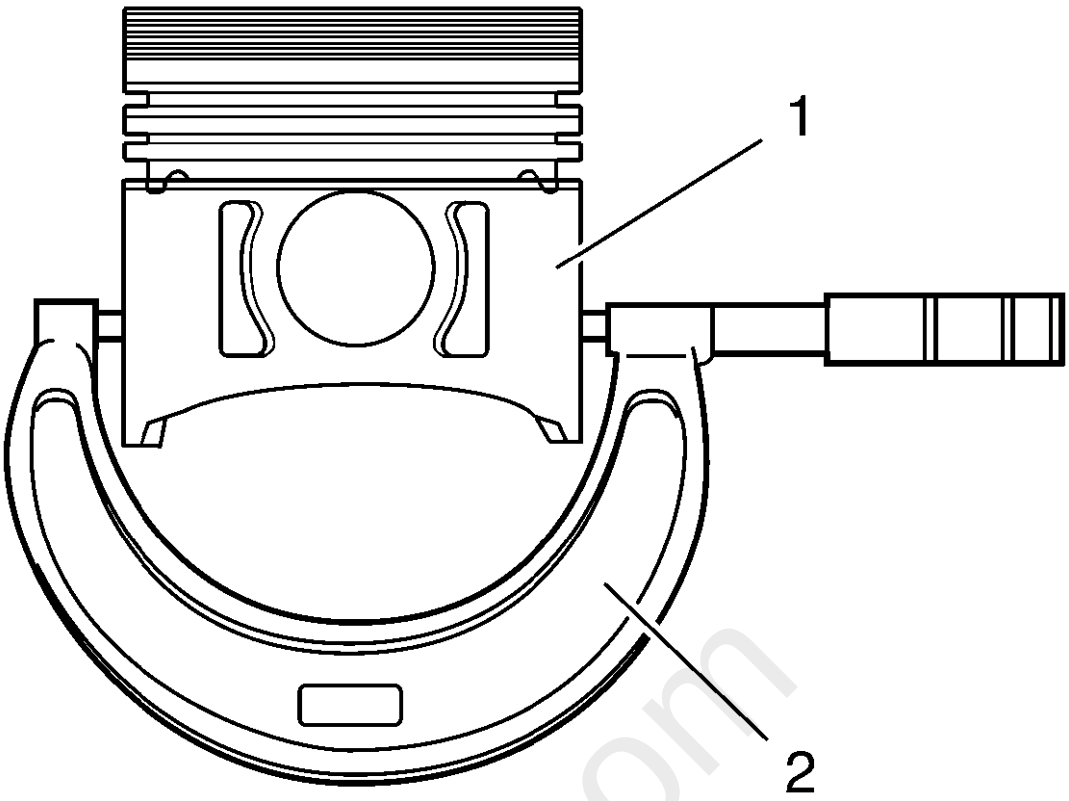


Fig. 736: Outside Micrometer And Piston
Courtesy of GENERAL MOTORS COMPANY

2. Measure the piston (1) 10 mm (0.3937 in) from the bottom of the skirt, with a micrometer (2) or caliper at a right angle to the piston.
3. Subtract the piston diameter from the cylinder bore diameter in order to calculate the piston-to-bore clearance.
4. Refer to **Engine Mechanical Specifications** for the correct value of the clearance piston-to-bore.
5. If the clearance obtained through measurement is greater than these specifications and the cylinder bores are within specification, replace the piston.

Connecting Rod Bearing Clearance (with Micrometer Gauge Internal Measuring Device)

1. Install the connecting bearings and the connecting rod bearing caps.
2. Tighten the connecting rod bearing cap bolts in the following sequence:

CAUTION: **Refer to Fastener Caution .**

NOTE: **The old bolts can be reused for the measuring procedure.**

1. Tighten the connecting rod bearing cap bolts a first pass to 25 N.m (18 lb ft).

CAUTION: **Refer to Torque-to-Yield Fastener Caution .**

2. Tighten the bolts a final pass an additional to 110 degrees using the **EN-45059** meter.

mcx30.com

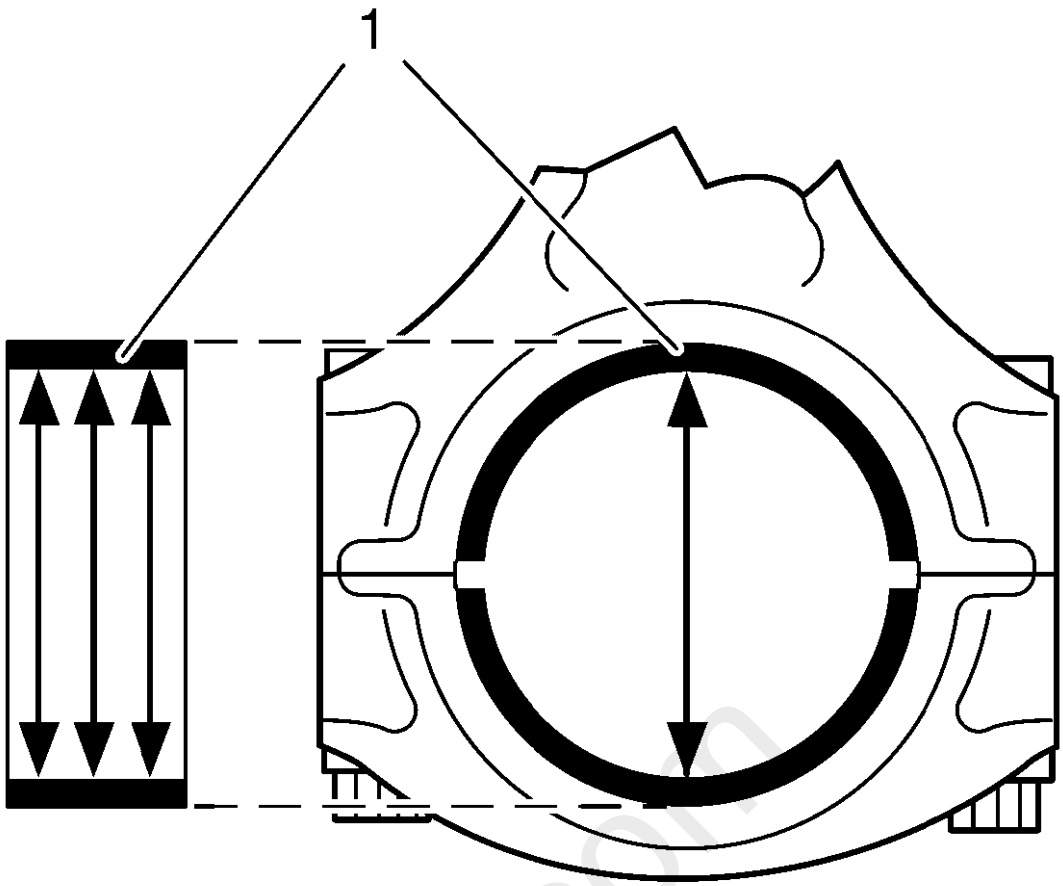


Fig. 737: Measuring Connecting Rod Bearing Diameters
Courtesy of GENERAL MOTORS COMPANY

3. Measure the connecting rod bearing diameters at 3 points as shown (1). Use a internal measuring device.
4. Calculate the average connecting rod inner diameter.

   Formula: 1. result + 2. result + 3. result / 3

mcx30.com

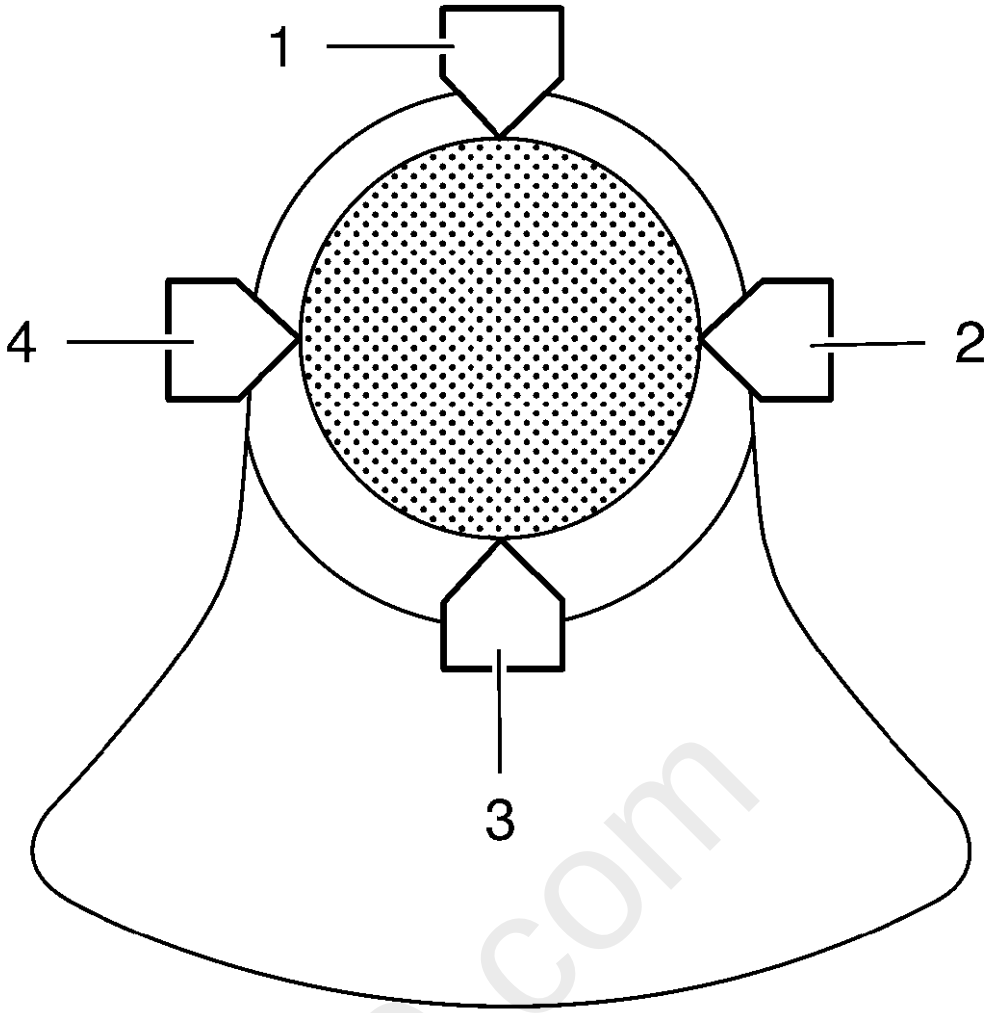


Fig. 738: Connecting Rod Journal Diameter Points
Courtesy of GENERAL MOTORS COMPANY

5. Measure the connecting rod journal diameter at 2 points between (1) and (3) and between (2) and (4). Use a micrometer gauge.
6. Calculate the average connecting rod journal diameter.

   Formula: 1. result + 2. result / 2.

7. Subtract the average connecting rod journal diameter from the average connecting rod bearing diameter in order to determine the connecting rod bearing clearance.
8. Refer to **Engine Mechanical Specifications** for the correct value of the connecting rod bearing clearance.

PISTON AND CONNECTING ROD ASSEMBLE

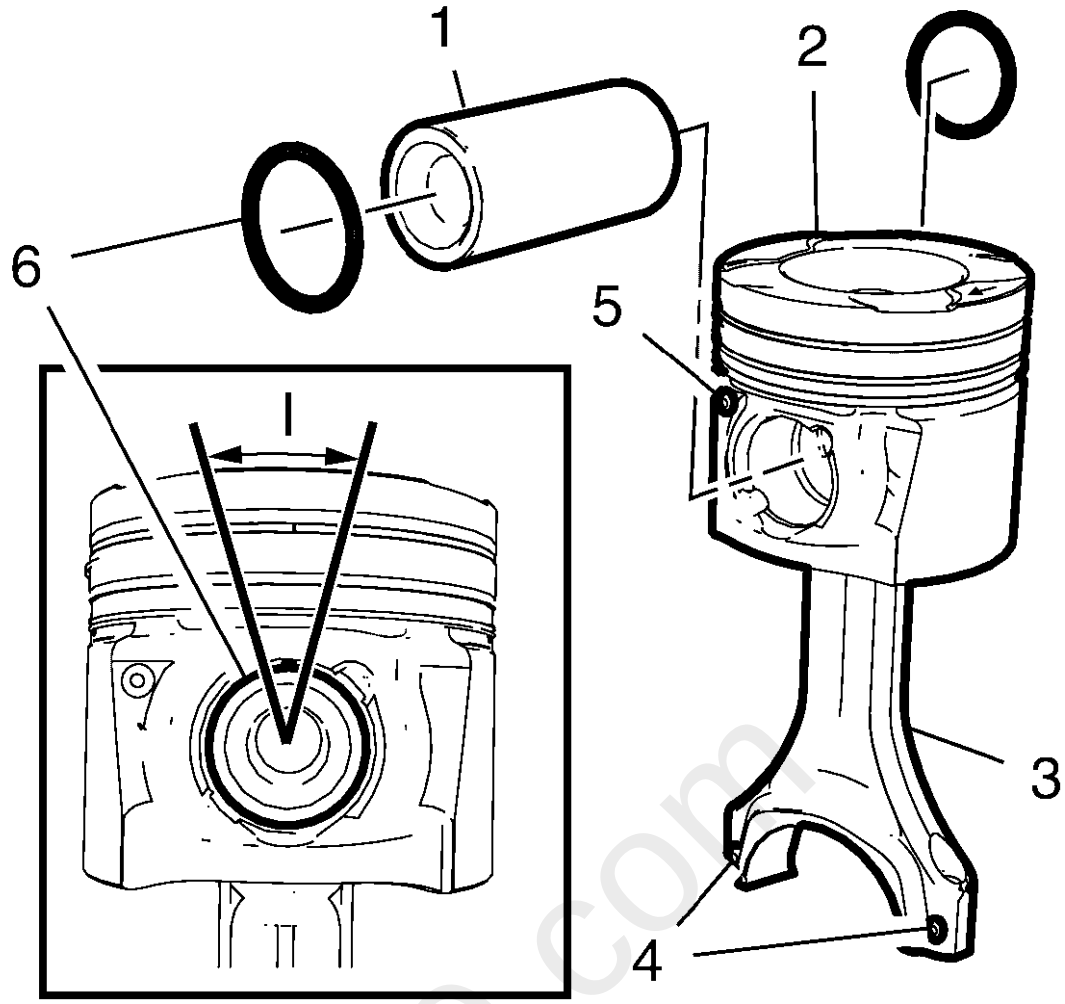


Fig. 739: Connecting Rod, Piston, Piston Pin, Retainer And Marks
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Lubricate the piston pin and the piston bore with engine oil.**

1. Install the connecting rod (3) to the piston (2).

NOTE: **The marks (4) on the connecting rod must show in direction to the mark (5) from the piston and the arrow on the top of the piston.**

2. Install the piston pin (1).

NOTE: **The 2 piston pin retainer (6) must be positioned in region of measurement maximum 30Â° as shown in the extensional graphic position (I).**

3. Install the 2 piston pin retainer (6).

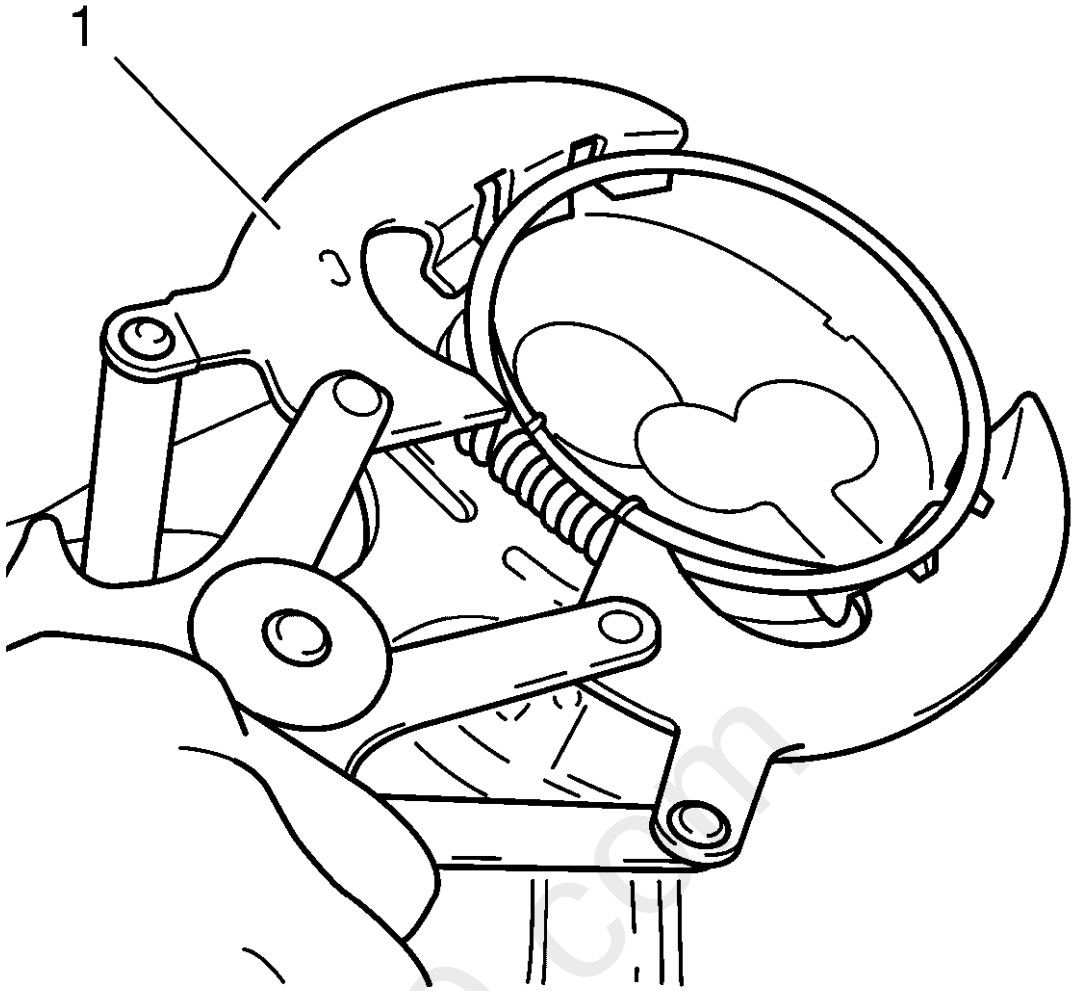


Fig. 740: Using Piston Ring Pliers
Courtesy of GENERAL MOTORS COMPANY

4. Install the piston rings. Use a piston ring plier (1).

mcx30.com

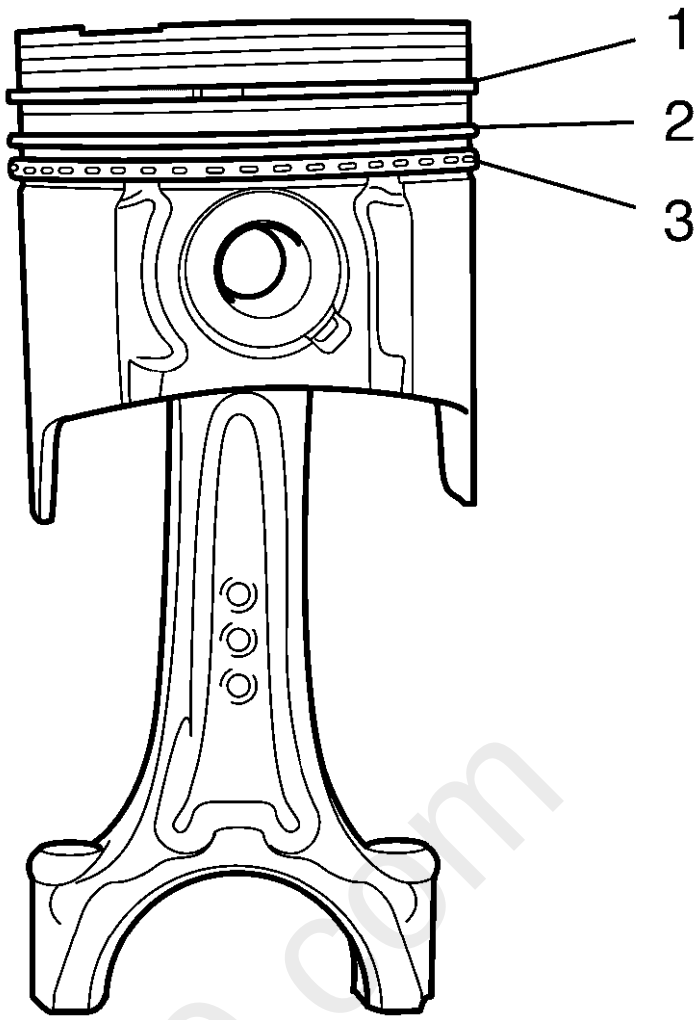


Fig. 741: Piston Rings
Courtesy of GENERAL MOTORS COMPANY

5. The piston rings must be ordered as followed:
    - Upper compression ring (1)
    - Lower compression ring (2)
    - Oil ring (3)
6. The piston ring joints must be displaced 120 degrees to each other.

CRANKSHAFT AND BEARING CLEANING AND INSPECTION

Special Tools

EN-45059 Angle Meter

Equivalent regional tools: **Special Tools**.

Cleaning Procedure

1. Clean the crankshaft with solvent.
2. Thoroughly clean all oil passages and inspect for restrictions or burrs.

    WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

3. Dry the crankshaft with compressed air.

Visual Inspection

mcx30.com

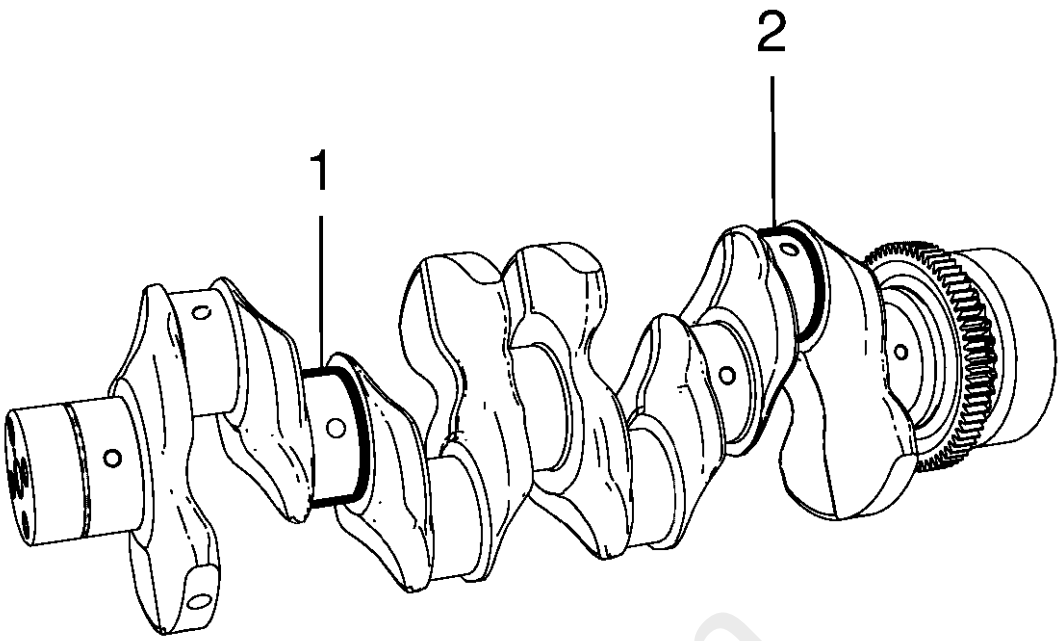


Fig. 742: Inspecting Crankshaft Bearing Journals And Connecting Rod Bearing Journals
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the 5 crankshaft bearing journals (1) and 4 connecting rod bearing journals (2) for wear:
    - grooves or scoring
    - scratches
    - pitting or imbedded bearing material

mcx30.com

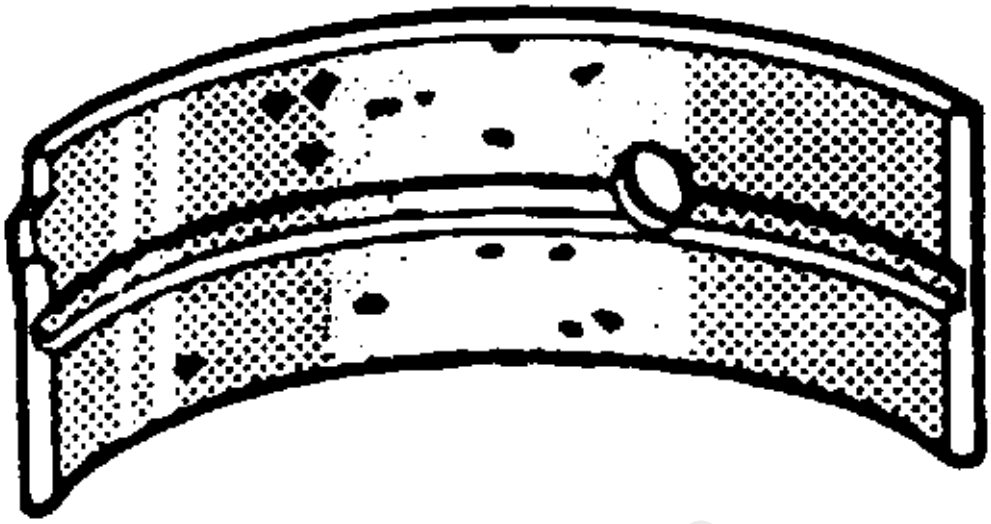


Fig. 743: Identifying Crankshaft Bearing Craters Or Pockets
Courtesy of GENERAL MOTORS COMPANY

2. Inspect crankshaft bearings for craters or pockets. Flattened sections on the bearing halves also indicate fatigue.

mcr30.com

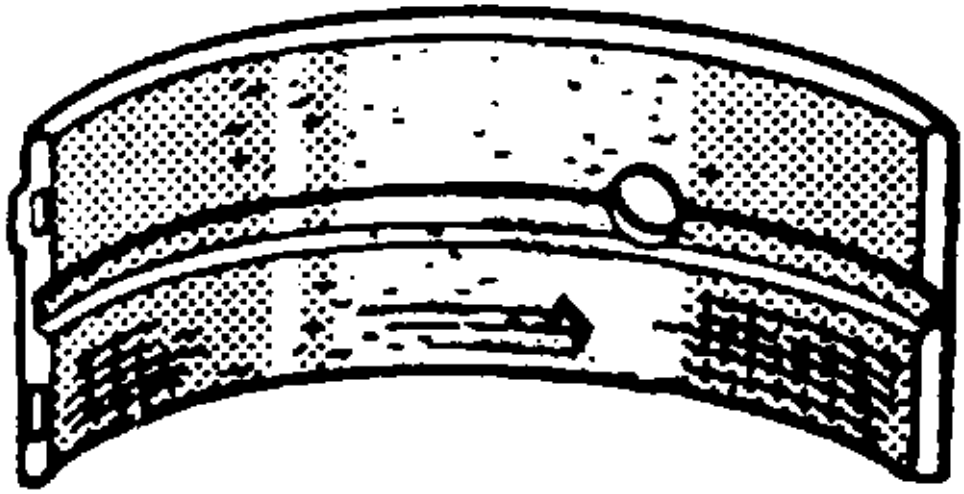


Fig. 744: Identifying Connecting Rod Bearing Scoring Or Discoloration
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the crankshaft bearings for excessive scoring or discoloration.
4. Inspect the crankshaft bearings for dirt or debris imbedded into the bearing material.

mc730.com

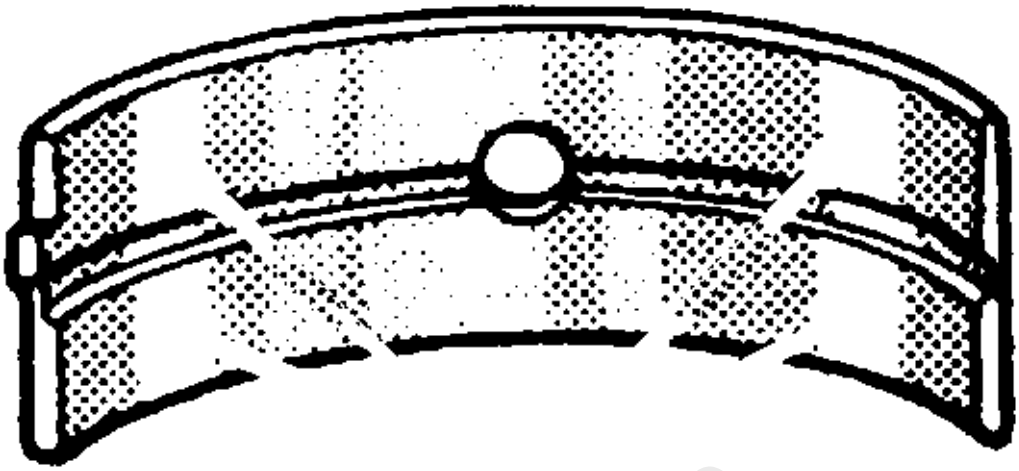


Fig. 745: View Of Crankshaft Bearing Improper Seating
Courtesy of GENERAL MOTORS COMPANY

NOTE: **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.

5. Inspect the crankshaft bearings for improper seating indicated by bright, polished sections of the bearing.

Check Crankshaft Bearing Clearance (with Micrometer Gage Internal Measuring Device)

mc730.com

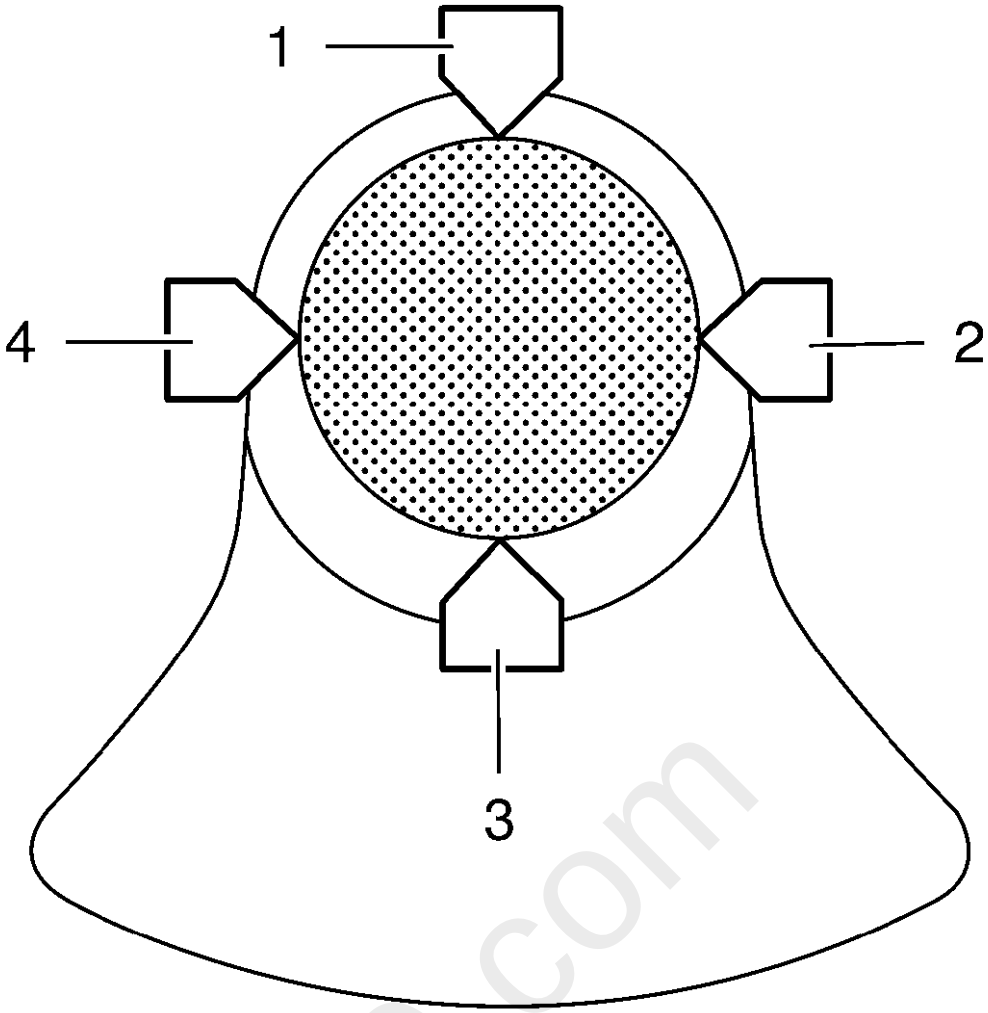


Fig. 746: Connecting Rod Journal Diameter Points
Courtesy of GENERAL MOTORS COMPANY

1. Measurement the crankshaft bearing journal diameter with a micrometer gauge at the measuring points (1, 3) and (2, 4).
2. Calculate the average crankshaft bearing journal diameter. Formula: 1. result + 2. result / 2.

   Refer to **Engine Mechanical Specifications** for the recommended limits.

   NOTE: **Different classes of bearing shells can be used for a crankshaft bearing to reduce bearing clearance. The stronger of the two bearing shells must be inserted in the crankcase.**

3. Crankshaft bearing clearance is calculated by using:
   - Crankshaft bearing bore diameter, refer to **Engine Block Cleaning and Inspection**.
   - Crankshaft bearing journal diameter
   - Crankshaft bearing shell thickness
4. Determine the crankshaft bearing clearance.

   Calculation formula: average crankshaft bearing bore diameter minus average crankshaft bearing journal diameter minus crankshaft bearing shell thickness from lower crankcase minus crankshaft bearing shell thickness from engine block.

   Refer to **Engine Mechanical Specifications** for the recommended limits.

Check Crankshaft Bearing Clearance (with Plastigage)

1. Clean all sealant surfaces from lower crankcase and engine block.

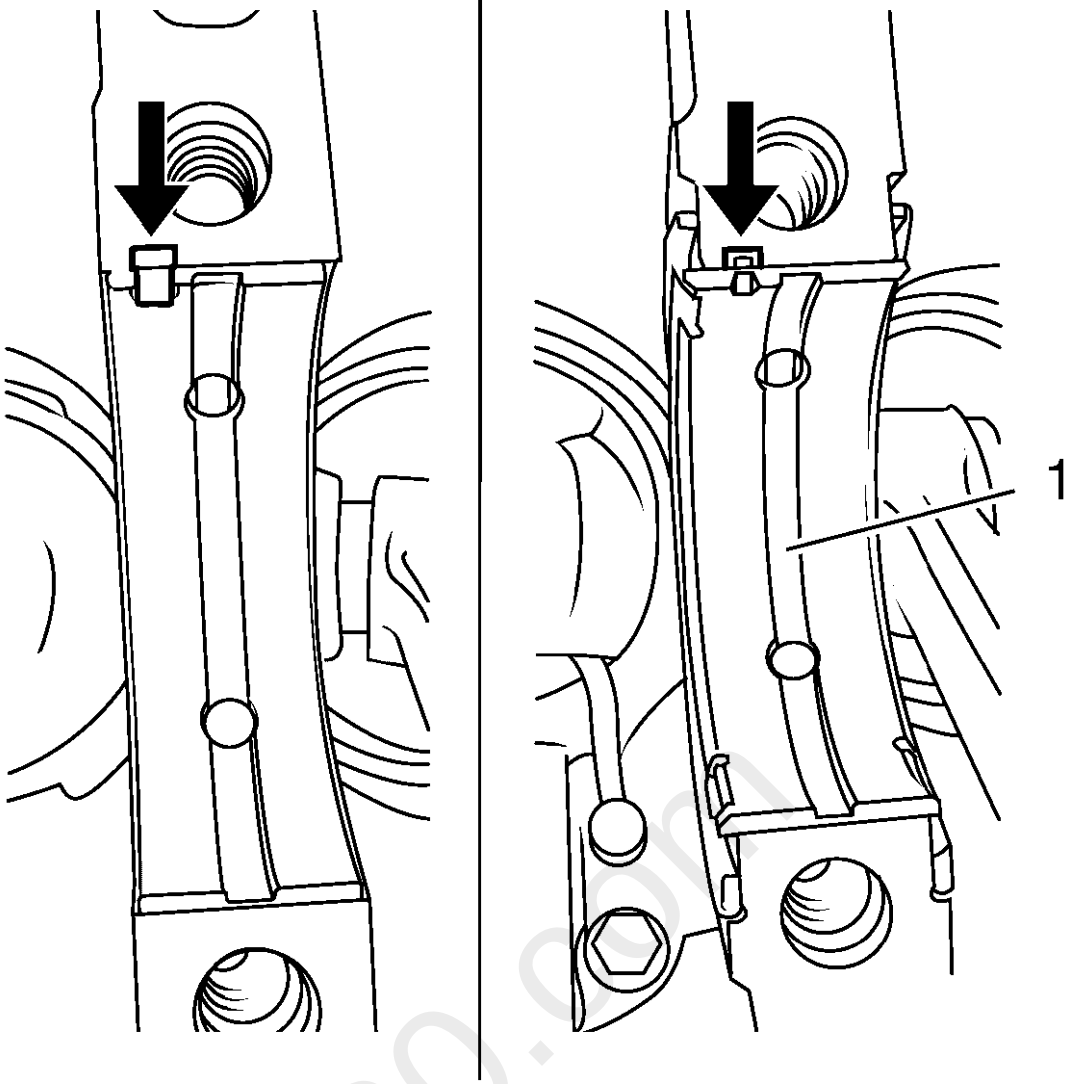


Fig. 747: Crankshaft Thrust Bearing
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that guide lugs (arrows) are properly seated. Note position of thrust bearing (1) at middle crankshaft bearing.**

If the old crankshaft bearing shells was reused, set it in as removed.

2. Install the 5 upper crankshaft bearings to the engine block.

mdx30.com

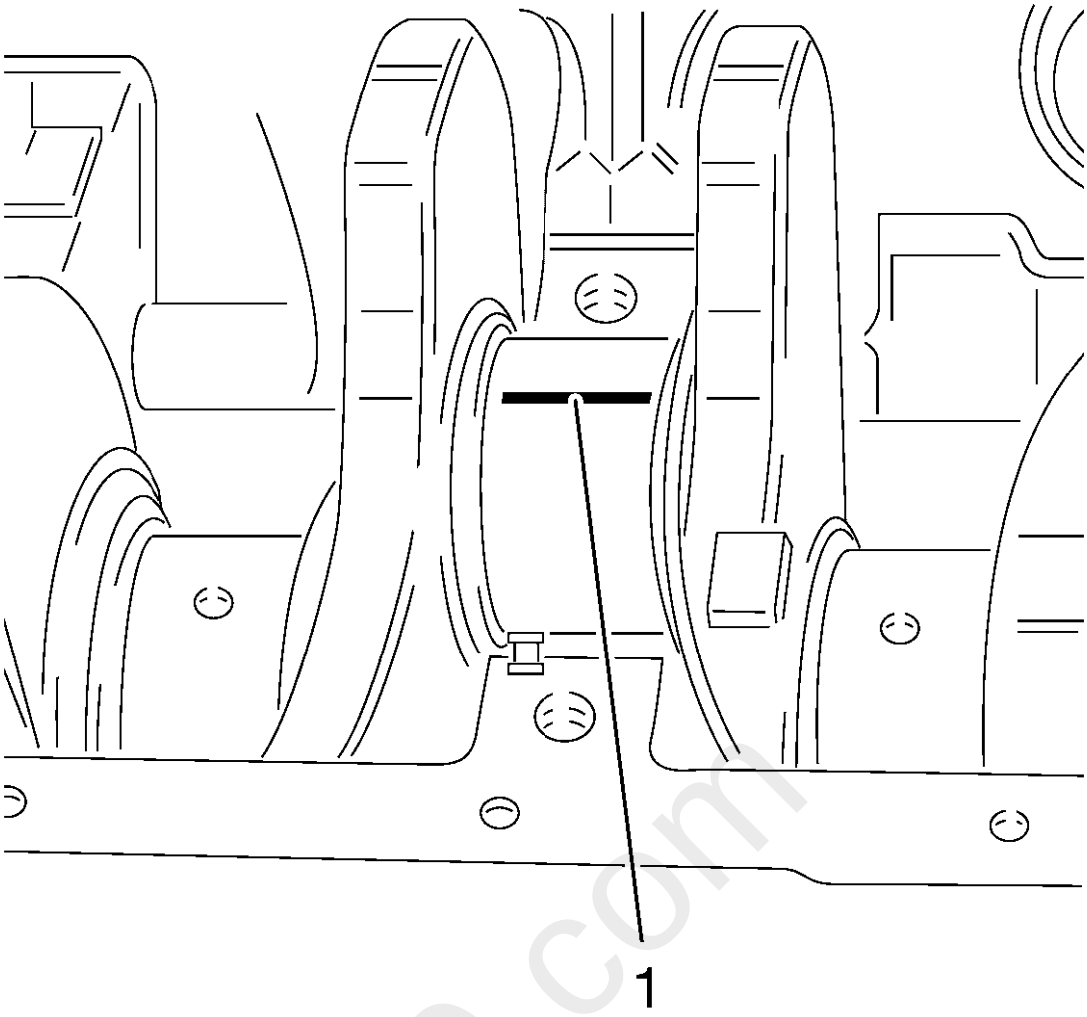


Fig. 748: Plastigage
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not rotate the crankshaft.**

3. Lay on 5 times plastigage (flexible plastic thread) axially over the entire width of the crankshaft bearing journal (1).

mcx30.com

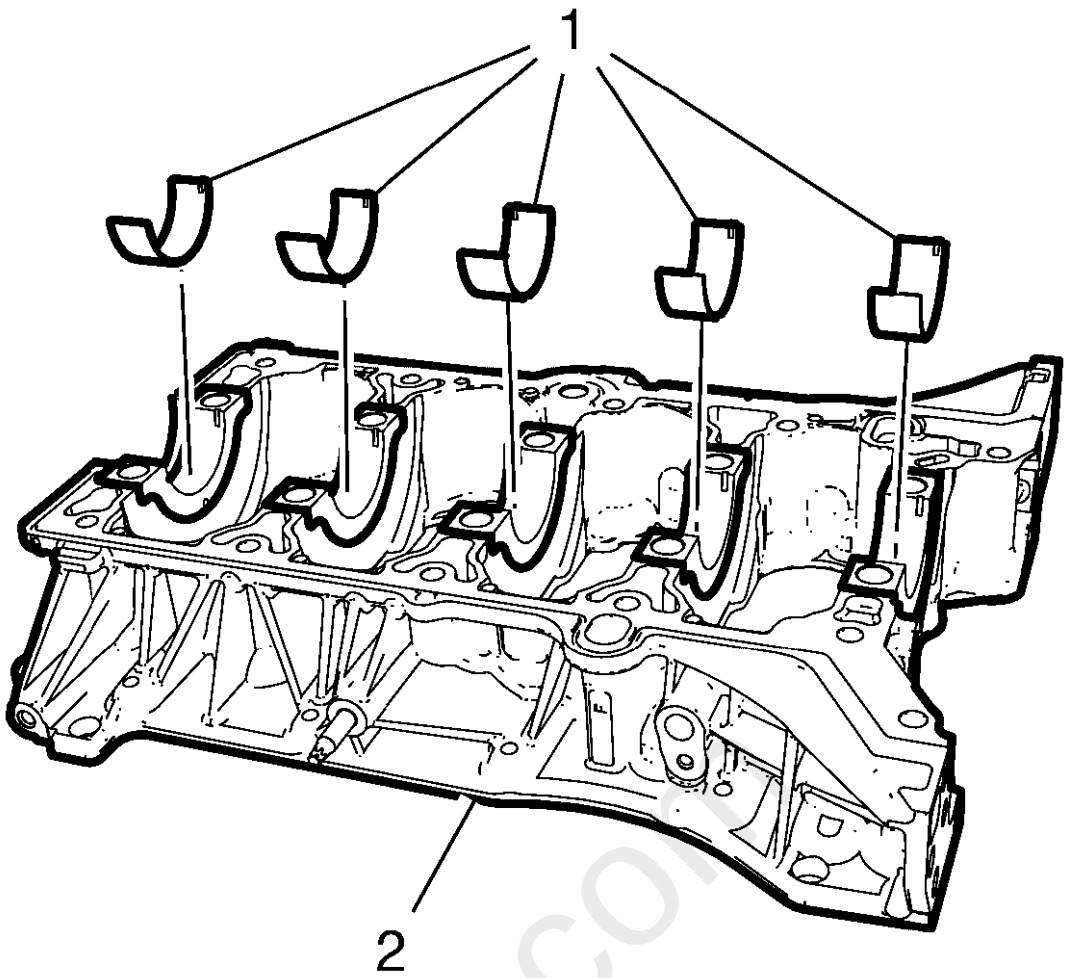


Fig. 749: Lower Crankshaft Bearings And Crankcase
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that guide lugs are properly seated. If the old crankshaft bearings are reused, set it in as removed.**

4. Install the 5 lower crankshaft bearings (1) into the crankcase (2).

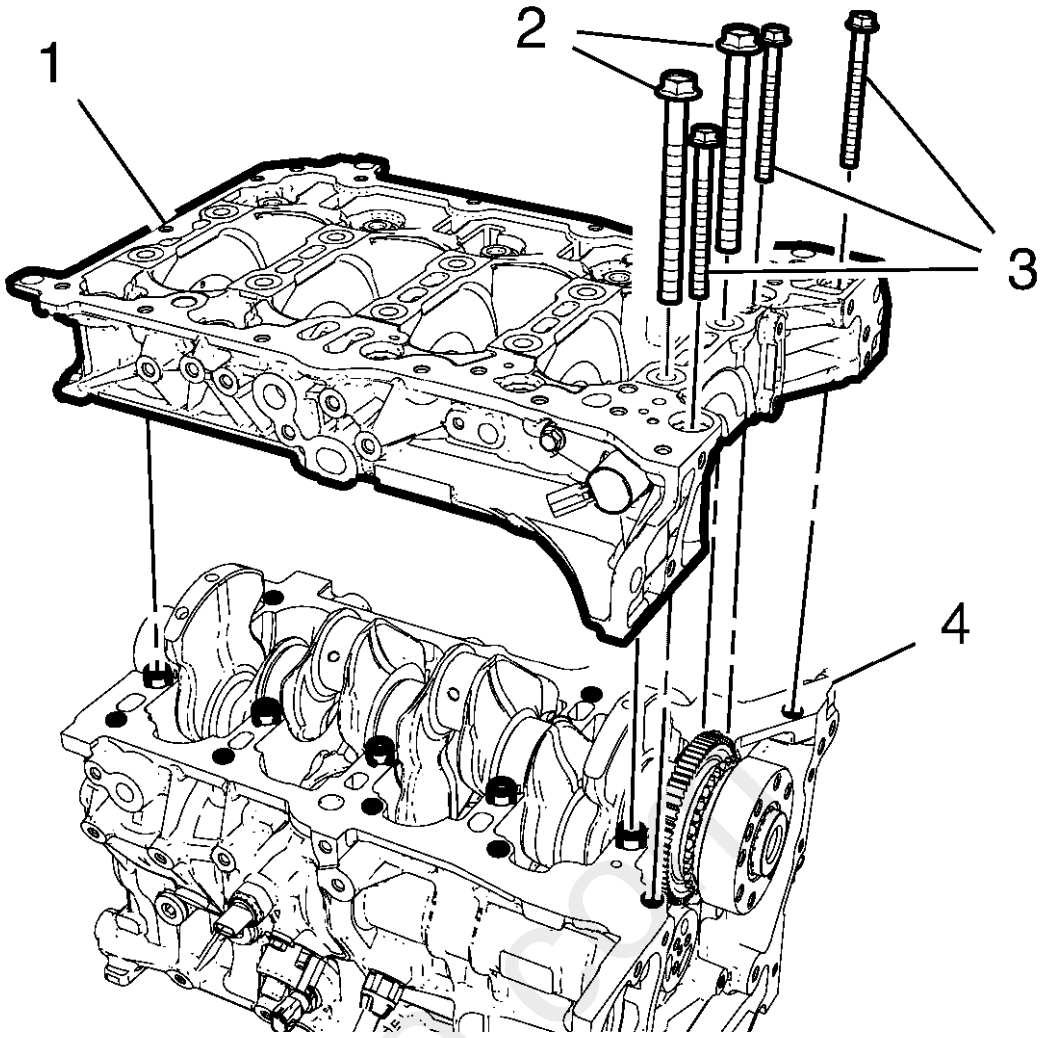


Fig. 750: Lower Crankcase And Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the crankshaft to the engine block (4).
6. Install the lower crankcase (1).
7. Loosely install 10 main bearing bolts M10 (2).
8. Loosely install the 11 lower crankcase bolts M8 (3).

mcx30.com

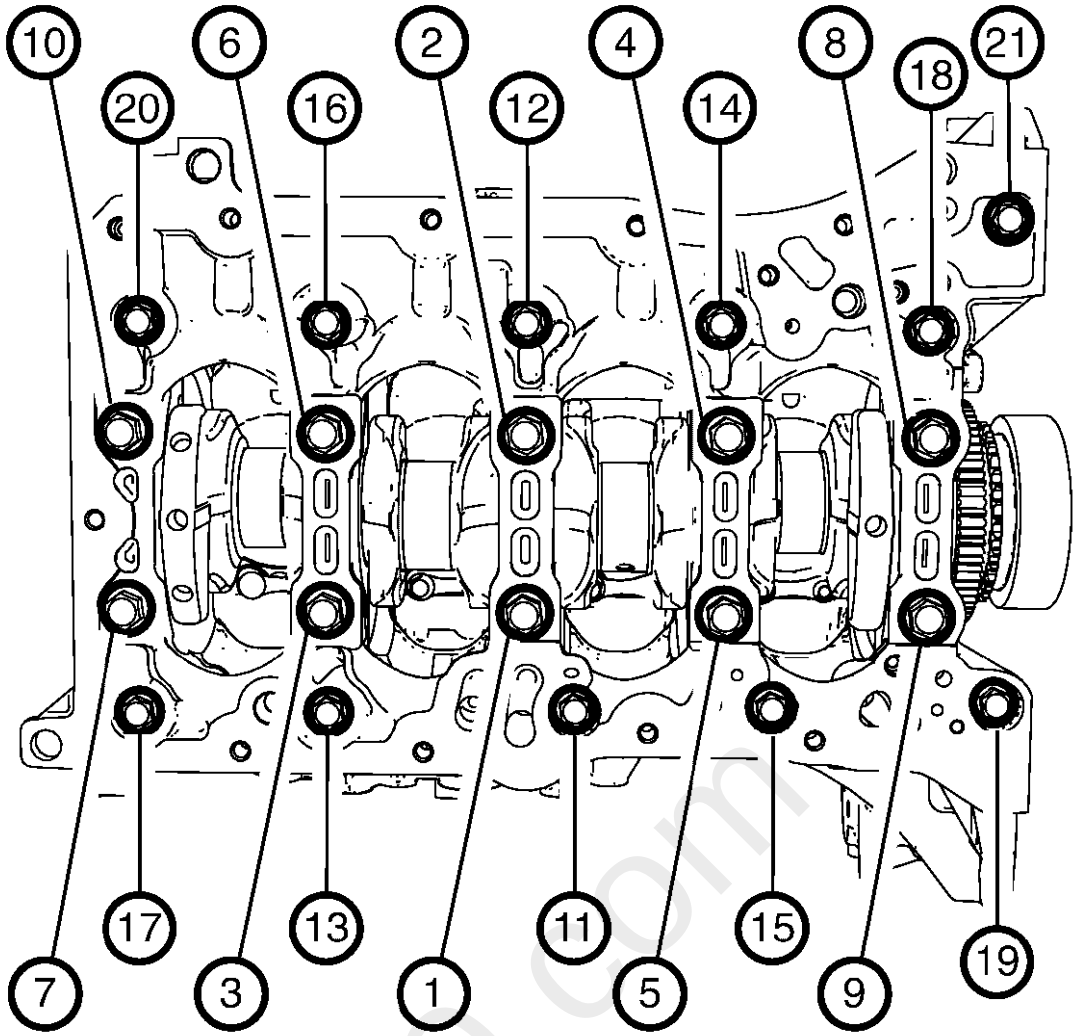


Fig. 751: Main Bearing And Lower Crankcase Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

CAUTION: **Refer to Torque-to-Yield Fastener Caution .**

9. Tighten the 10 main bearing bolts.
    1. Tighten the bolts (1-10) a first pass in sequence shown to 50 N.m (37 lb ft).
    2. Tighten the bolts (1-10) a second pass in sequence shown an additional to 90 degrees, using the **EN-45059** meter.
    3. Tighten the bolts (1-10) a final pass in sequence shown an additional to 90 degrees, using the **EN-45059** meter.
10. Tighten the 11 lower crankcase bolts (11-21) in sequence shown to 34 N.m (25 lb ft).

mcx30.com

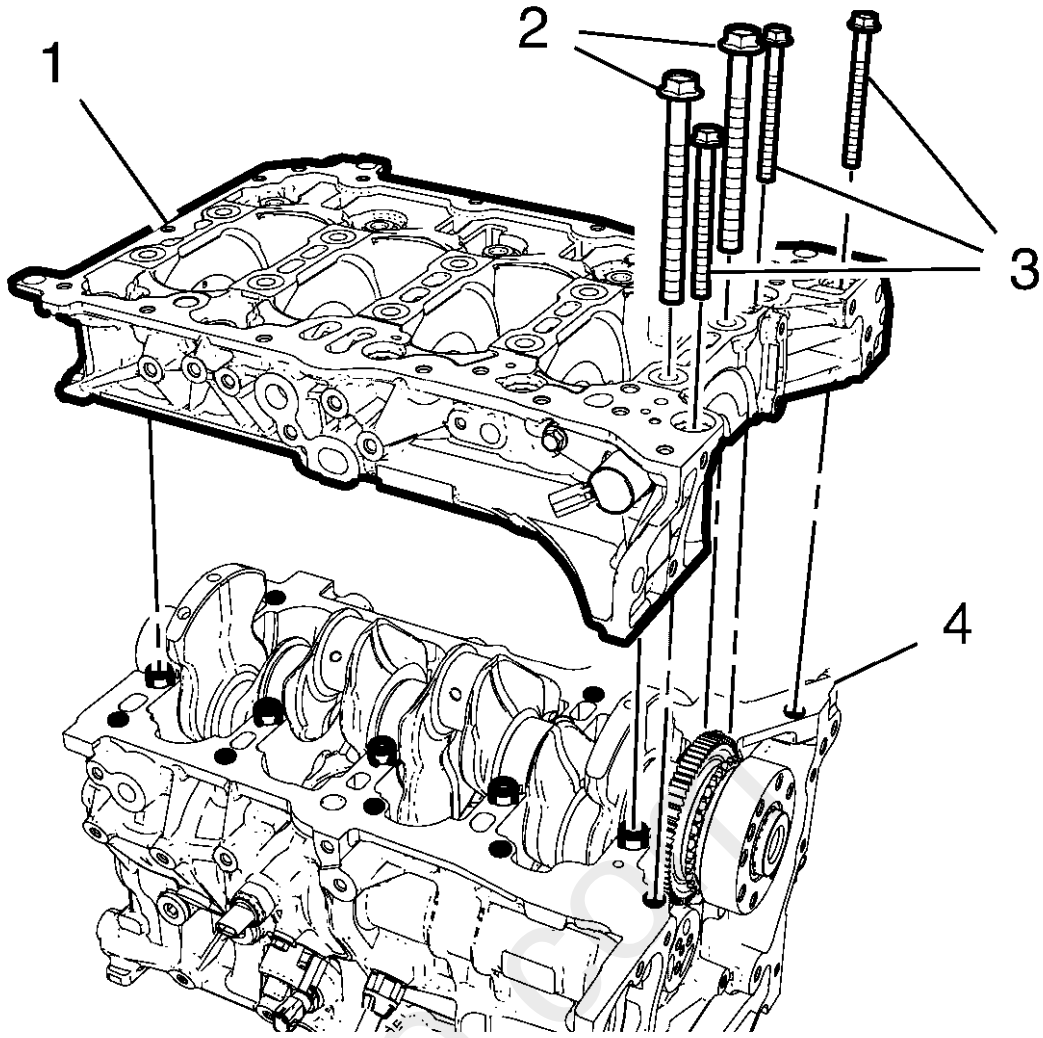


Fig. 752: Lower Crankcase And Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Remove the 11 lower crankcase bolts M8 (3).
12. Remove 10 main bearing bolts M10 (2).
13. Remove the lower crankcase (1) from the engine block (4).

mx30.com

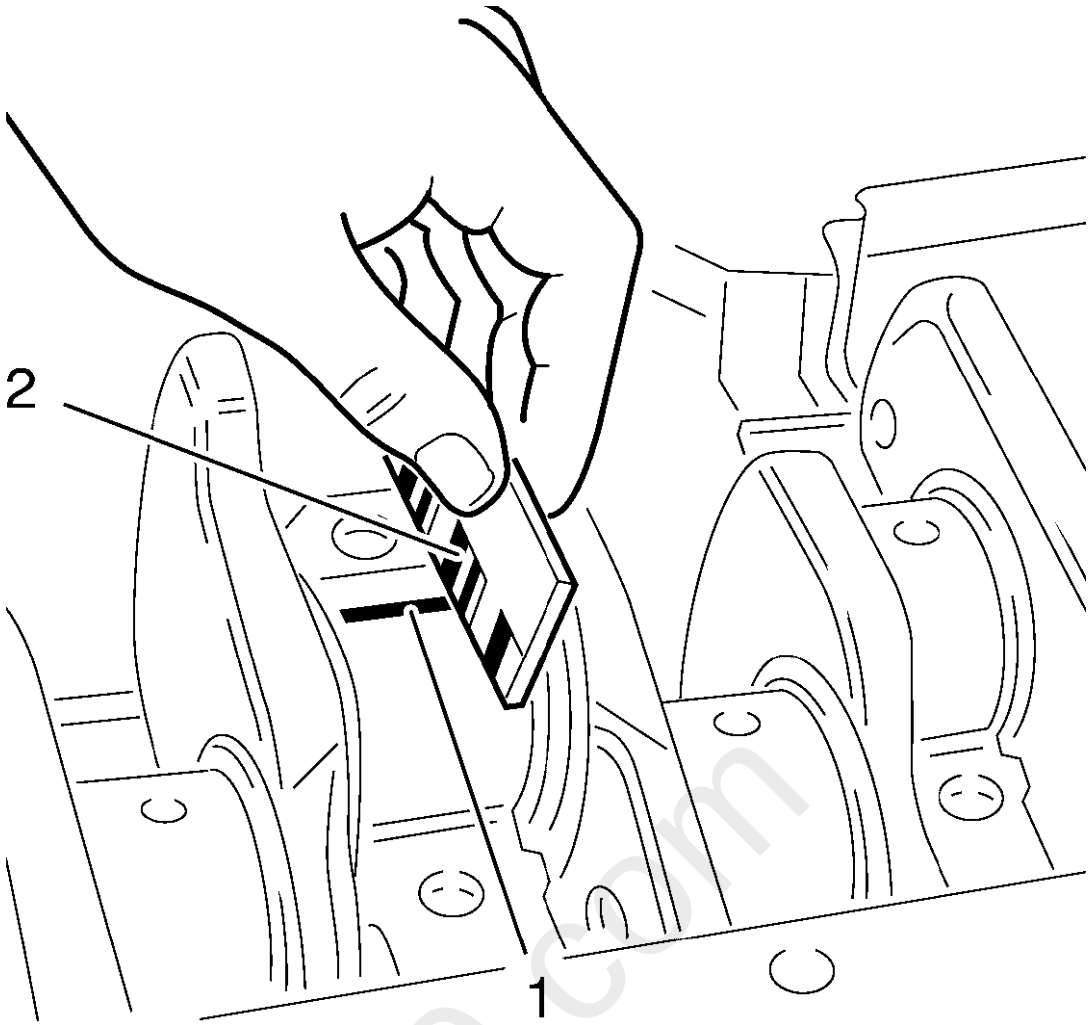


Fig. 753: Measuring Plastigage
Courtesy of GENERAL MOTORS COMPANY

NOTE: **When reading the value, do not confuse millimeters and inches on the measuring scale.**

14. Measure the crankshaft bearing play.
    - Compare the width of the flattened plastic thread (1) to the measuring scale (2).
    - For the permissible crankshaft bearing clearance, refer to **Engine Mechanical Specifications**.

CYLINDER HEAD DISASSEMBLE

Special Tools

- **EN-8062** Valve Spring Compressor
- **EN-8062-5** Adapter
- **EN-43963** Adapter
- **EN-46116** Pliers/Remover

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

mox30.com

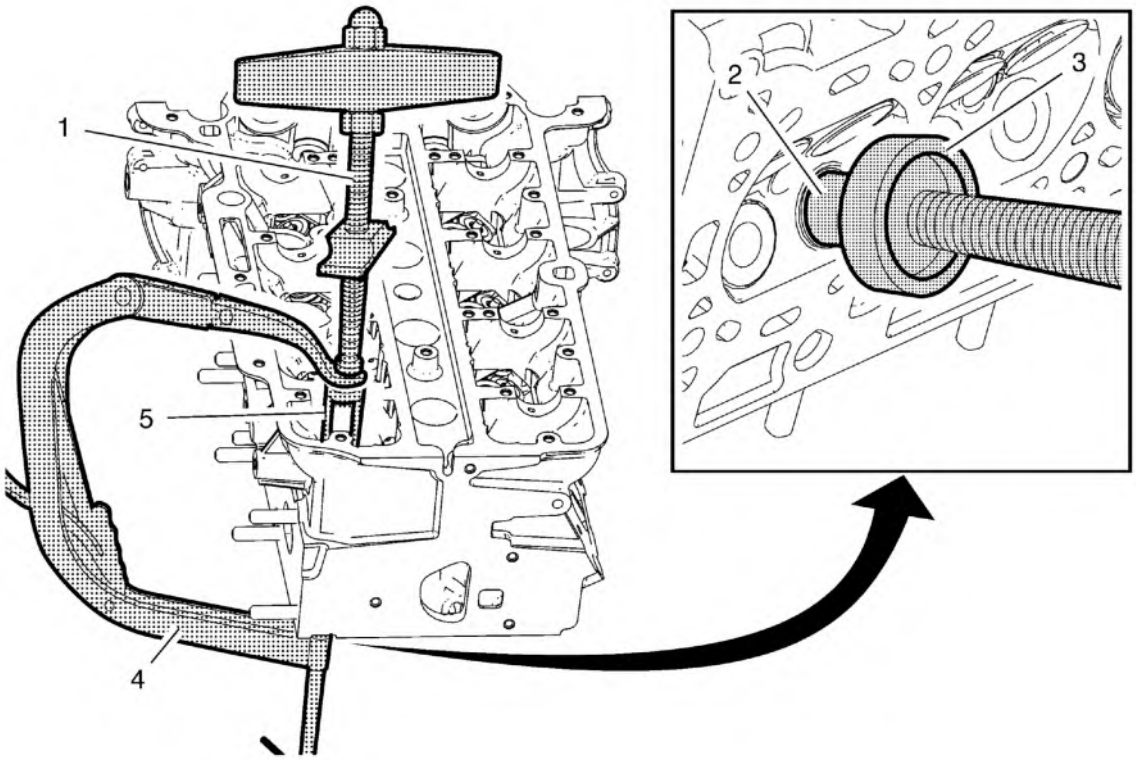
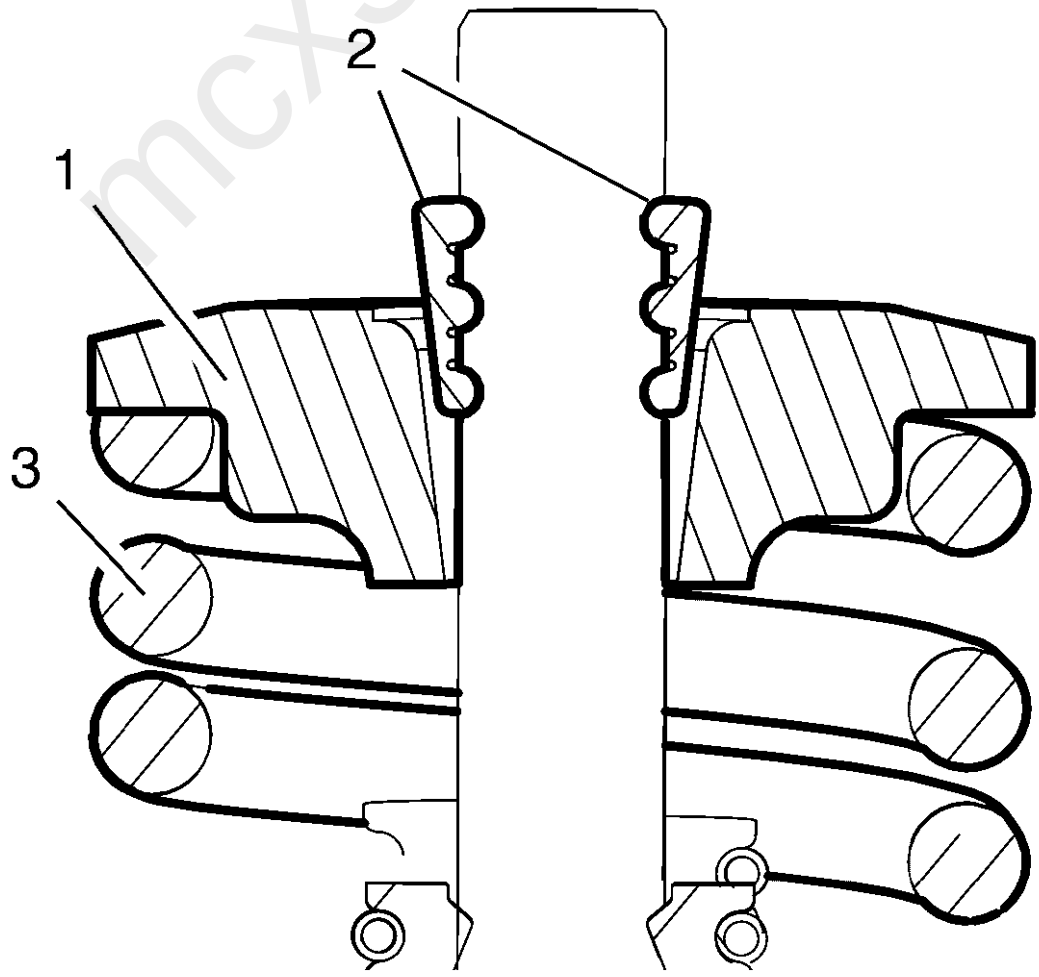


Fig. 754: Valve Spring Compressor And Adapter Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-8062-5** adapter (3) to the **EN-8062** compressor (4).
2. Install the compressor assembly to the cylinder head, so that the **EN-43963** adapter (5) of the **EN-8062** compressor (1) contacts the valve spring retainer properly and the **EN-8062-5** adapter (3) contacts the valve disc (2). Prefix the **EN-8062** compressor (4).



mcx30.com

Fig. 755: Valve Spring Retainer, Valve Spring And Valve Keys
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Valve springs can be tightly compressed. Use care when removing the retainers and plugs. Personal injury could result.**

3. Apply pressure to the **EN-8062** compressor to push down the valve spring retainer (1) and compress the valve spring (3) until the valve keys (2) are free from tension. Carefully remove the valve keys.

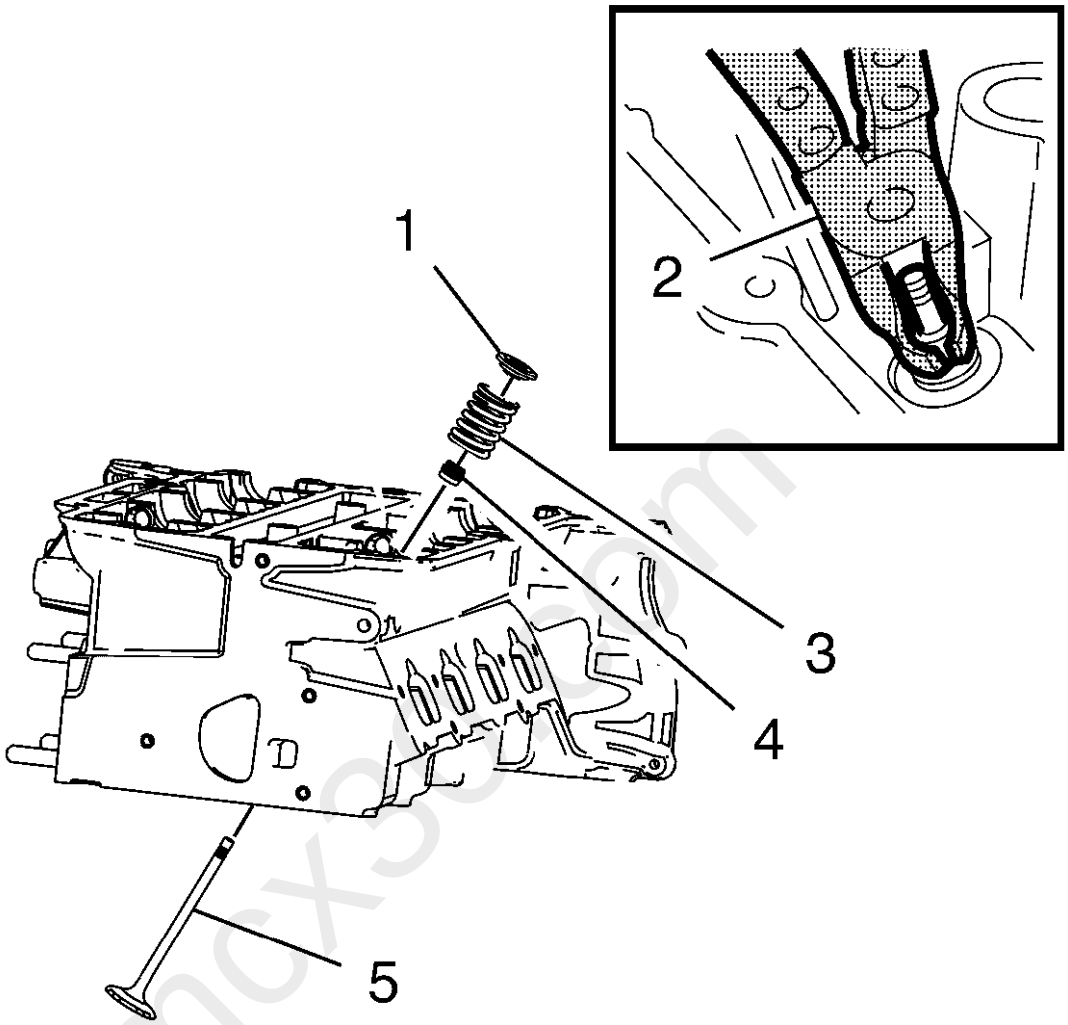


Fig. 756: Spring Compressor
Courtesy of GENERAL MOTORS COMPANY

4. Slowly and carefully loosen the **EN-8062** compressor until the valve spring is entirely expanded.
5. Remove the compressor assembly from the cylinder head.
6. Remove the valve spring retainer (1) and the valve spring (3).
7. Remove and DISCARD the valve stem oil seal (4), using the **EN-46116** pliers (2).
8. Remove the valve (5).

NOTE: **Ensure that the valve train components are kept together and identified in order for proper installation in their original position.**

9. Repeat the procedure with the remaining valves.
10. In case of re-using the cylinder head, refer to Cylinder Head Cleaning and Inspection.

CYLINDER HEAD CLEANING AND INSPECTION

Special Tools

GE-7872 Magnetic Base Dial Indicator

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

Cleaning Procedure

1. Remove any old thread sealant, gasket material or sealant.
2. Clean all cylinder head surfaces with non-corrosive cleaning 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 chamber.

Visual Inspection

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 war page as described under cylinder head measurement - deck flatness inspection.
   - Damage to any gasket surfaces.
   - 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 allowed.

Valve Inspection And Measurement

mbx30.com

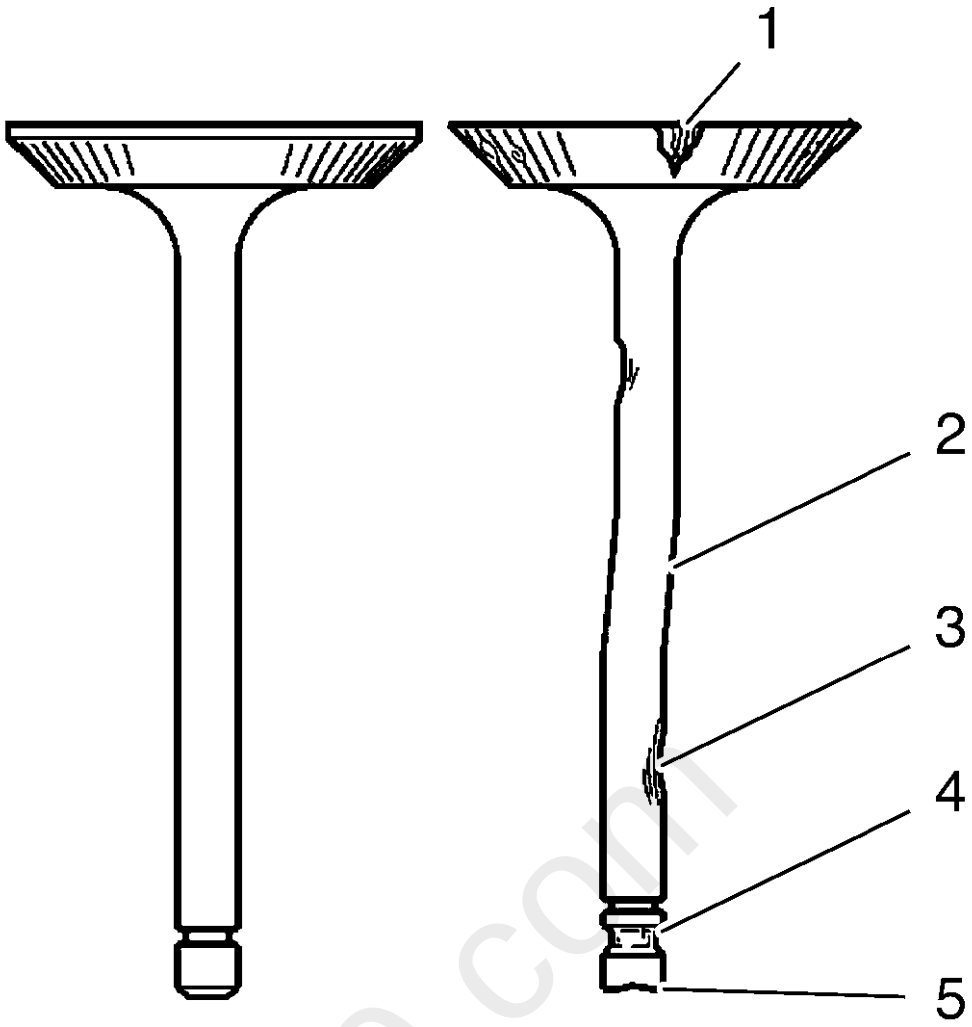


Fig. 757: Valve Inspection And Measurement
Courtesy of GENERAL MOTORS COMPANY

1. Clean the valves of carbon and oil. Carbon can be removed with a wire brush.
2. Inspect the valves for the following conditions:
    1. Inspect the valve faces for burning and cracking (1). If pieces are broken, replace the valve and inspect the corresponding piston and cylinder head area for damage.
    2. Inspect the valve for straightness and distortion (2). Distorted valve must be replaced.
    3. Inspect the valve stem for wear (3).
    4. Inspect the valve key grooves for chipping and wear (4) and (5). Replace the valve if chipped or worn.

mcx30.com

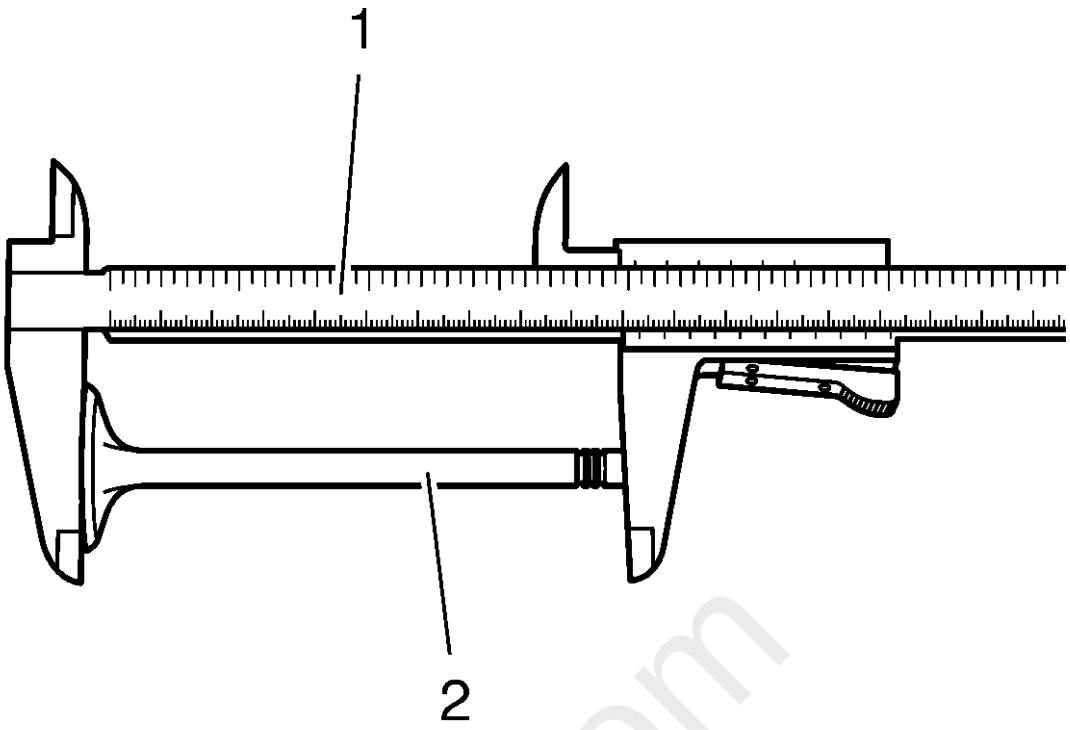


Fig. 758: Measuring Valve Length Using Slide Gauge
Courtesy of GENERAL MOTORS COMPANY

3. Measure the valve length (2). Use a slide gauge (1). Refer to **Engine Mechanical Specifications** to find the permitted values.

mcx30.com

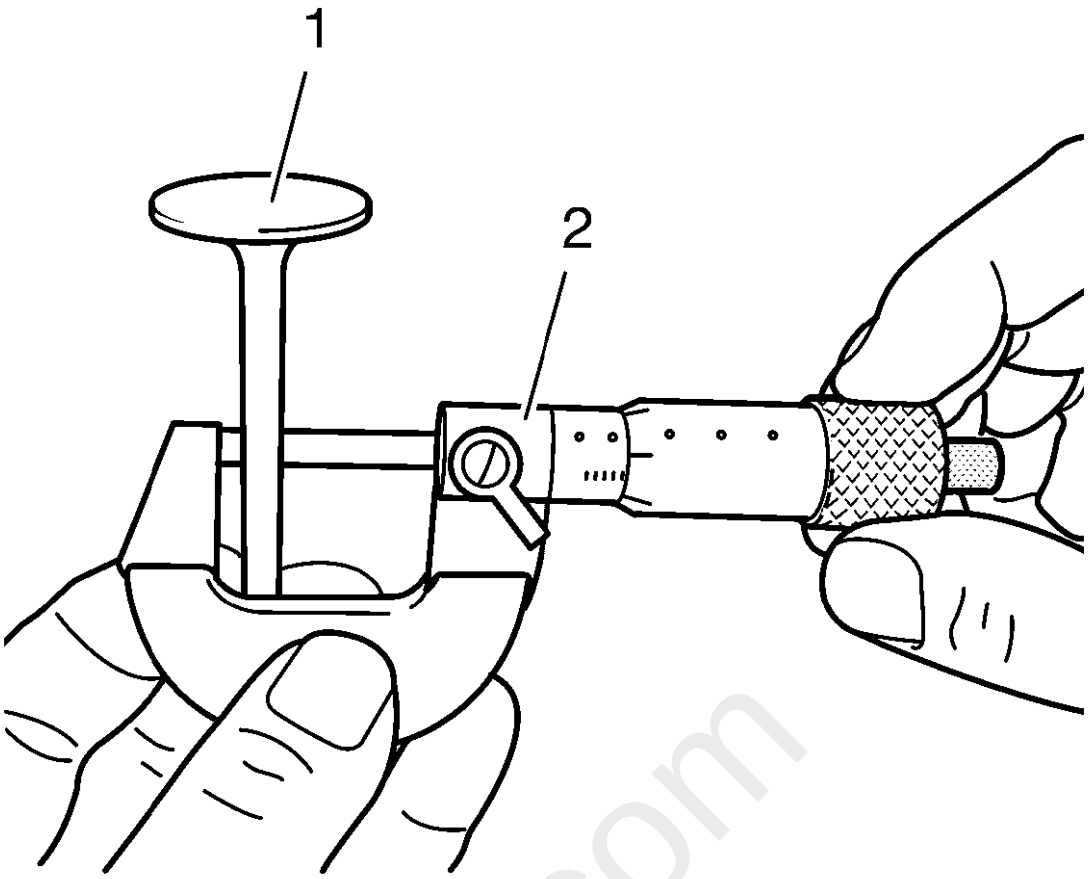


Fig. 759: Measuring Valve Stem Diameter Using Micrometer Gauge
Courtesy of GENERAL MOTORS COMPANY

4. Measure the valve stem diameter. Use a micrometer gauge (2). Refer to **Engine Mechanical Specifications** to find the permitted values. Note the measurement results.

Cylinder Head Measurement

mcx30.com

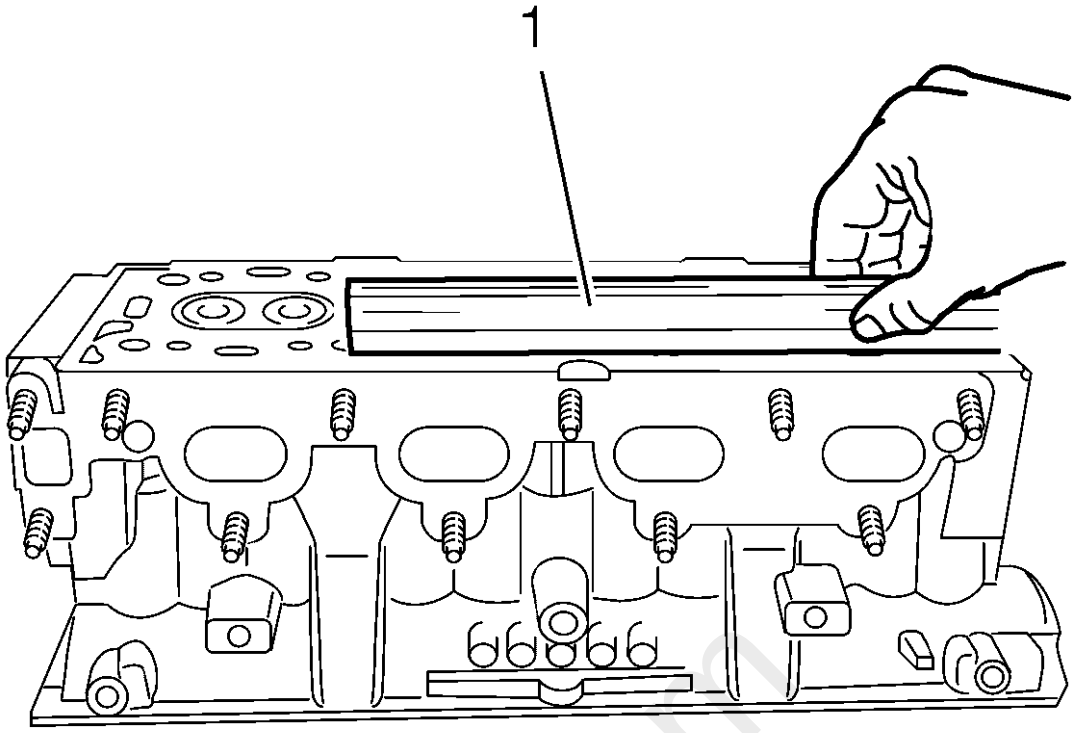


Fig. 760: Using Straightedge To Inspect Cylinder Head Sealing Surface For Flatness
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the cylinder head sealing surface for flatness. Use a straightedge (1).
2. Turn the cylinder head upside down.

mcx30.com

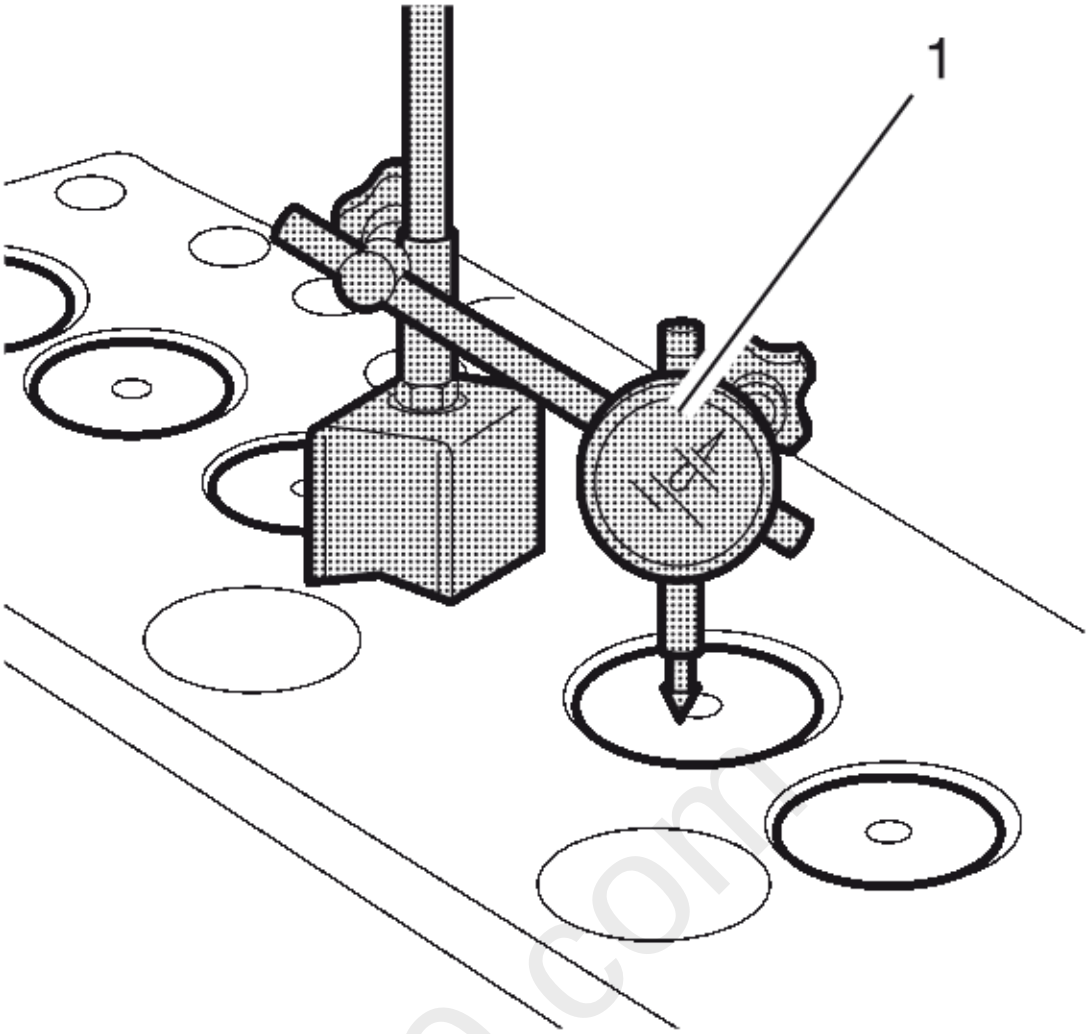


Fig. 761: Using Dial Indicator To Measure Valve Assembly Height
Courtesy of GENERAL MOTORS COMPANY

3. Loosely install one valve to the cylinder head.
4. Place the **GE-7872** indicator (1) to the cylinder head sealing surface and measure the valve assembly height. Refer to **Engine Mechanical Specifications** to find the permitted values.

CYLINDER HEAD ASSEMBLE

Special Tools

- **EN-958** Valve Stem Seal Installer
- **EN-8062** Valve Spring Compressor
- **EN-8062-5** Adapter
- **EN-43963** Adapter

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

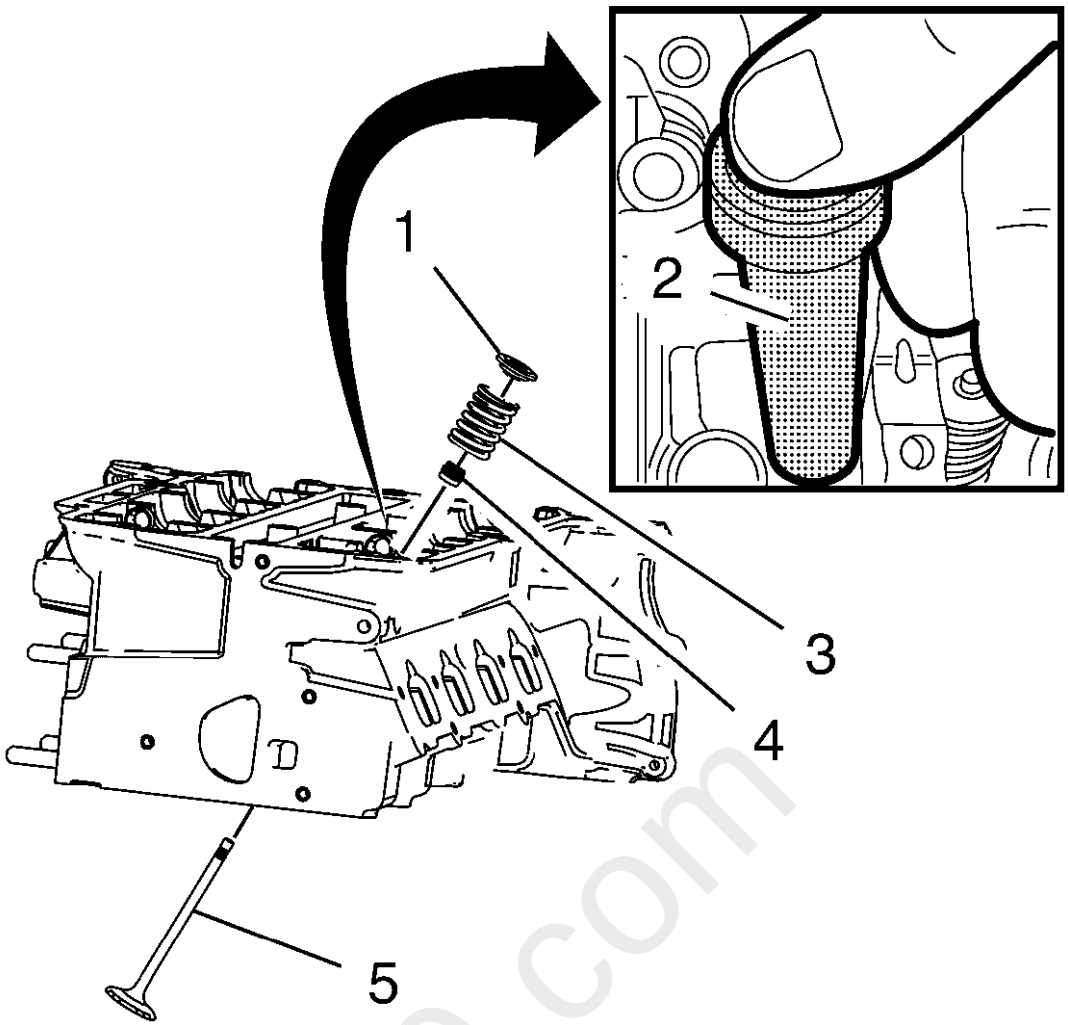


Fig. 762: Valve Stem Oil Seal And Installer
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the valve stem and the valve guide with clean engine oil.

NOTE: **Ensure all valve train components will be installed in their original position.**

2. Install the valve (5).
3. Install the NEW valve stem oil seal (4), using the **EN-958** installer (2).
4. Loosely install the valve spring (3) and the valve spring retainer (1).

mcx30.com

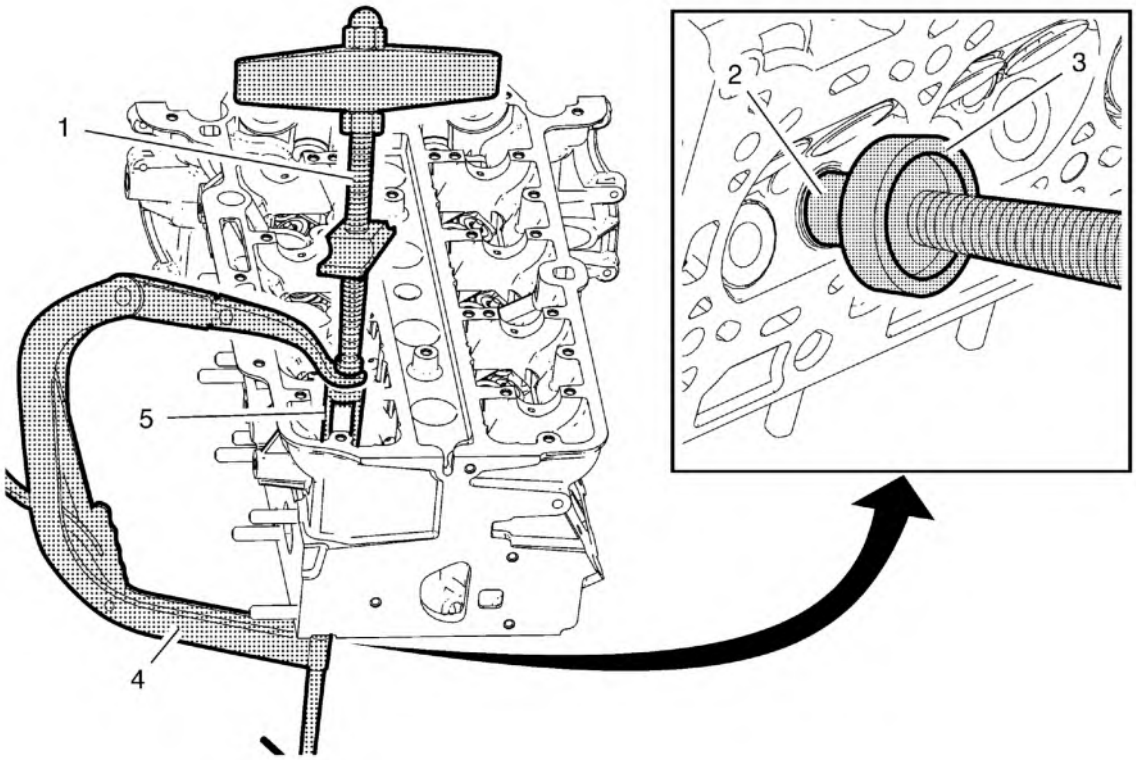
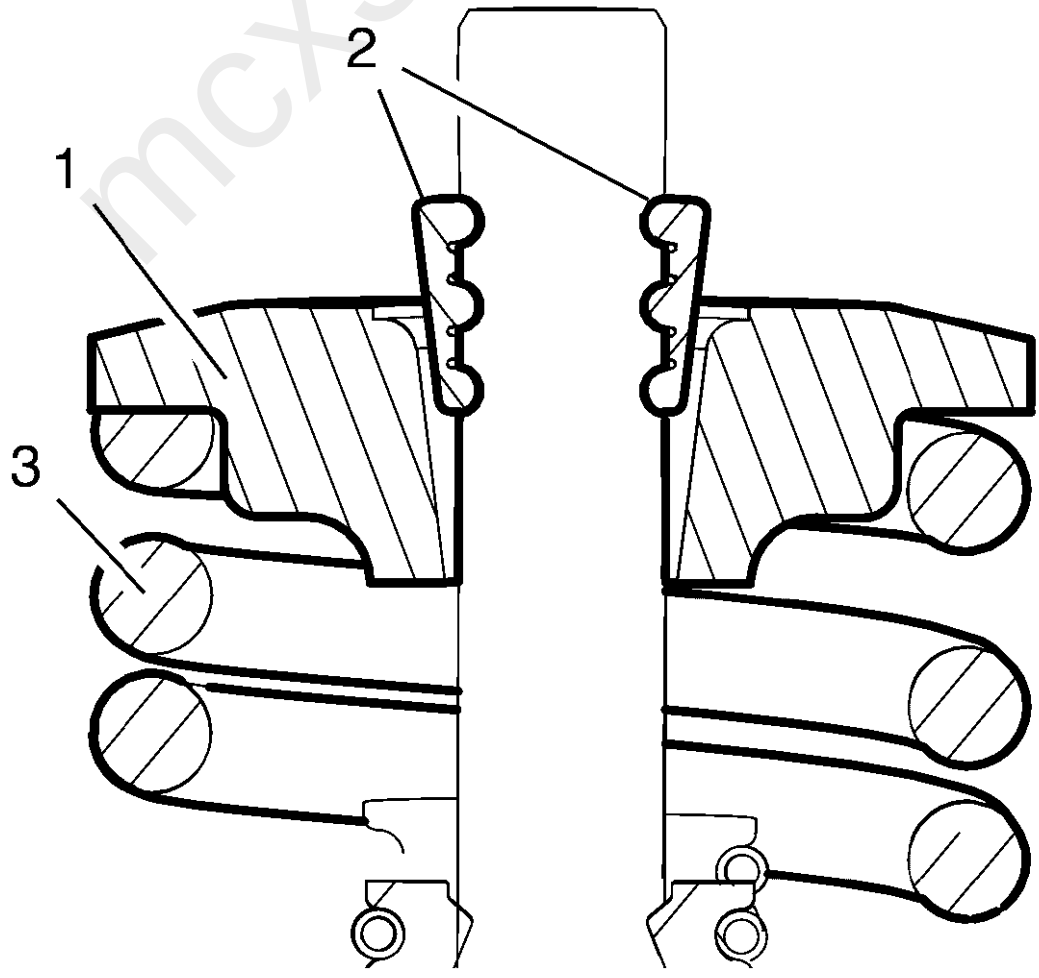


Fig. 763: Valve Spring Compressor And Adapter Assembly
Courtesy of GENERAL MOTORS COMPANY

5. Install the **EN-8062-5** adapter (3) to the **EN-8062** compressor (4).
6. Install the compressor assembly to the cylinder head, so that the **EN-43963** adapter (5) of the **EN-8062** compressor (1) contacts the valve spring retainer properly and the **EN-8062-5** adapter (3) contacts the valve disc (2). Prefix the **EN-8062** compressor (4).



mcx30.com

Fig. 764: Valve Spring Retainer, Valve Spring And Valve Keys
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **The valve stem keys must correctly seat in the valve spring cap. Engine damage may occur by not installing properly.**

7. Apply pressure to the **EN-8062** compressor to push down the vale spring retainer (1) and compress the valve spring (3) until the valve keys (2) can be inserted. Carefully insert the valve keys then, so that they are proper installed to the valve stem grooves.
8. Carefully release the tension from the **EN-8062** compressor.
9. Inspect the valve keys and valve spring retainers for proper seat.
10. Remove the compressor assembly from the cylinder head.
11. Repeat the procedure with the remaining valves.

ENGINE BLOCK DISASSEMBLE

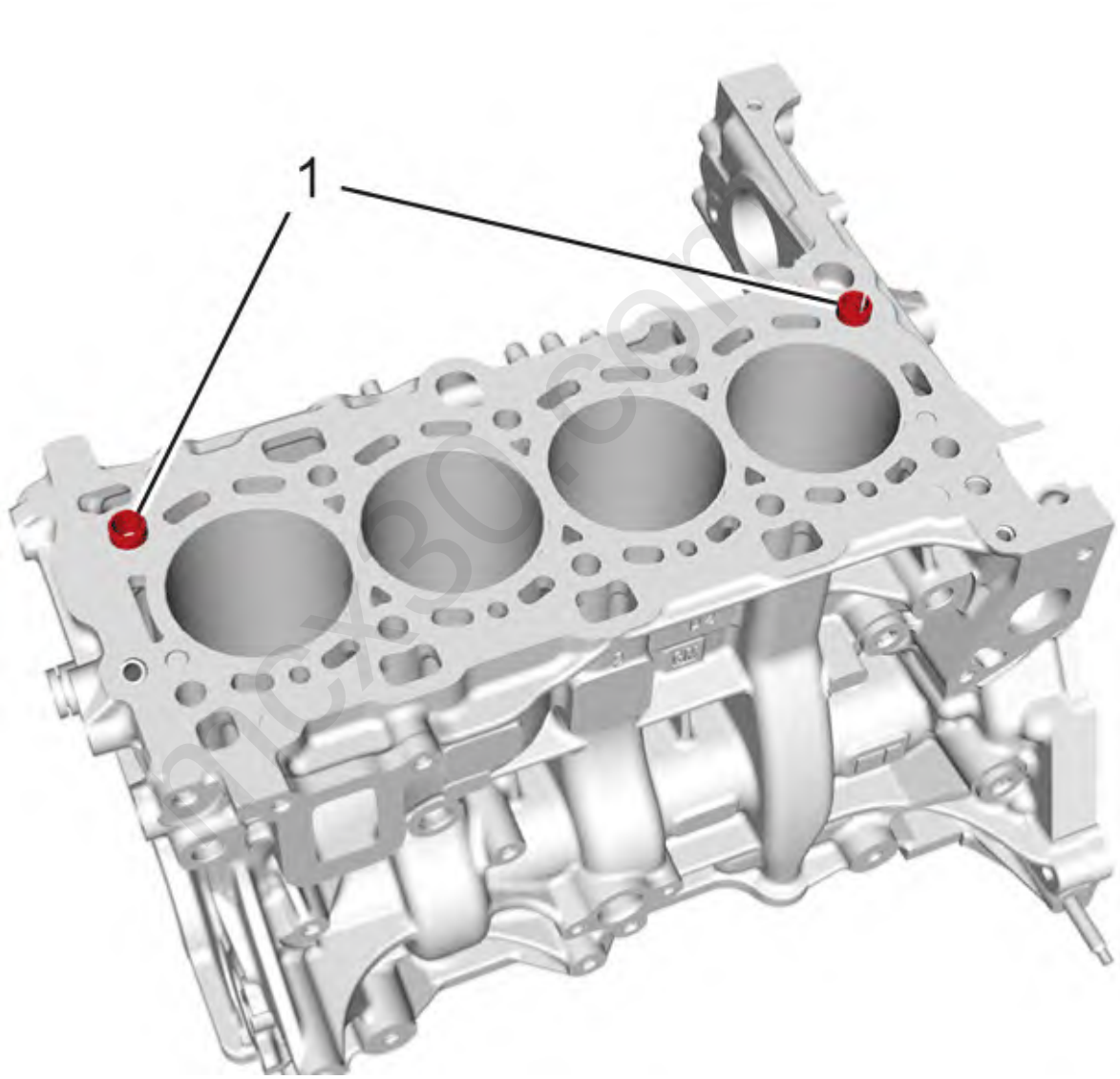


Fig. 765: Cylinder Head Guide Sleeves
Courtesy of GENERAL MOTORS COMPANY

1. Remove the 2 cylinder head guide sleeves (1).

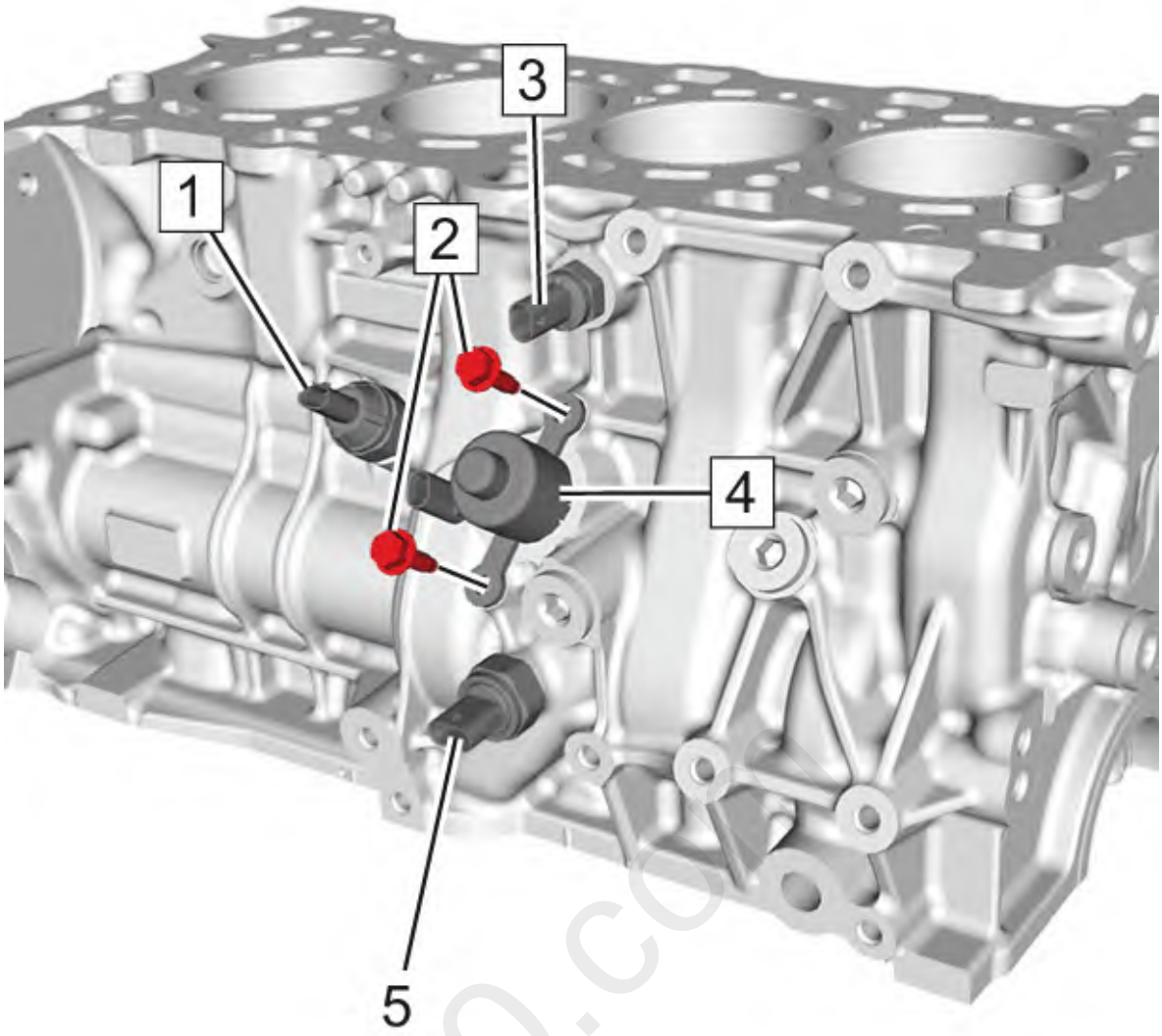


Fig. 766: Engine Oil Pressure Switch, Engine Oil Pressure Sensor, Engine Coolant Temperature Sensor, Piston Oil Nozzle Oil Control Solenoid Valve And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove Engine Oil Pressure Switch (1)
3. Remove Engine Coolant Temperature Sensor (3)
4. Remove the 2 piston oil nozzle oil control solenoid valve bolts (2).
5. Remove the piston oil nozzle oil control solenoid valve (4).
6. Remove Engine Oil Pressure Sensor (5)

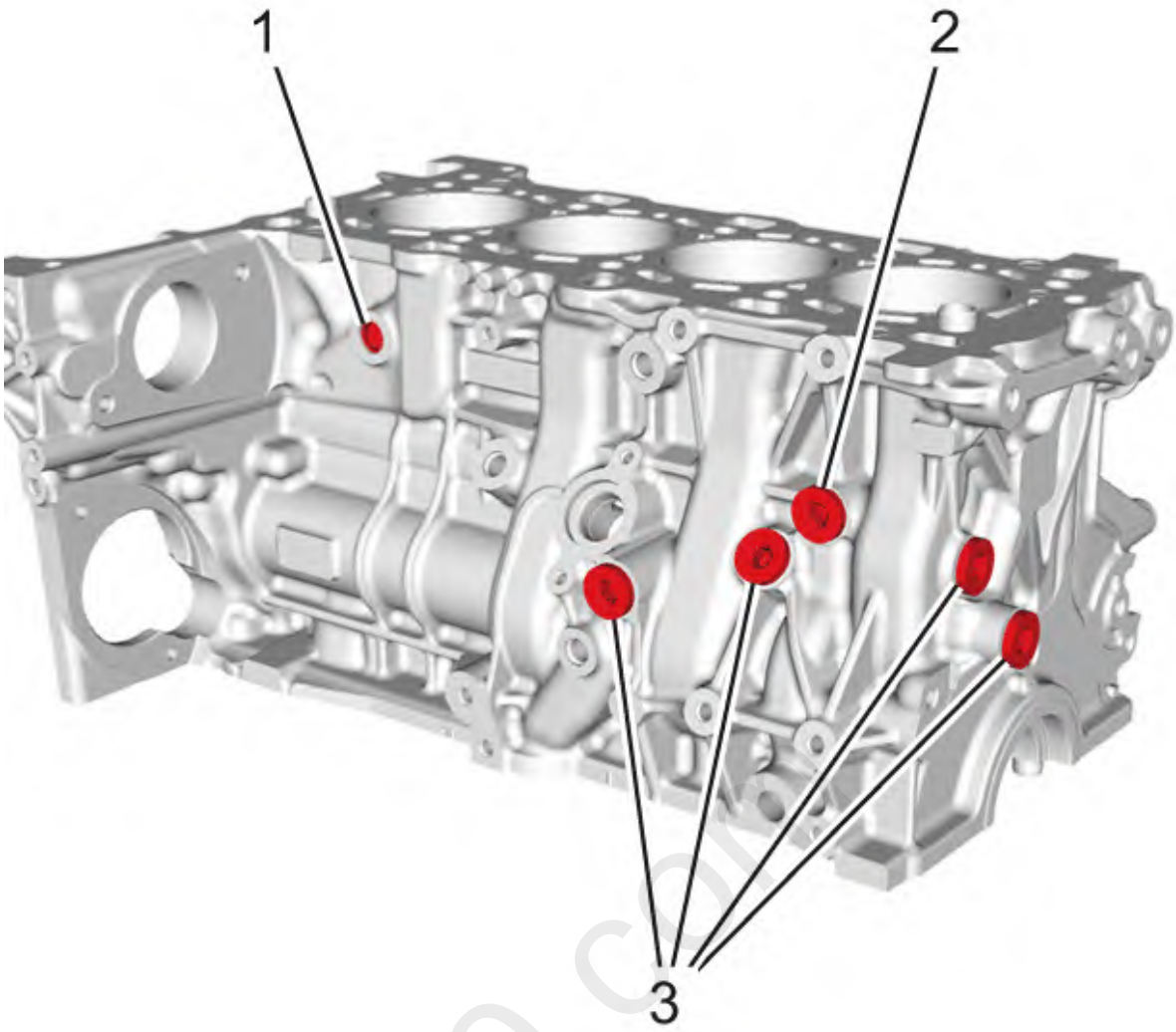


Fig. 767: Engine Block Plugs
Courtesy of GENERAL MOTORS COMPANY

7. Remove and DISCARD Engine Block Core Hole Plug (1)
8. Remove Engine Block Coolant Drain Hole Plug (2)
9. Remove Engine Block Oil Gallery Plugs (3) (Qty: 4)

mcx30.com

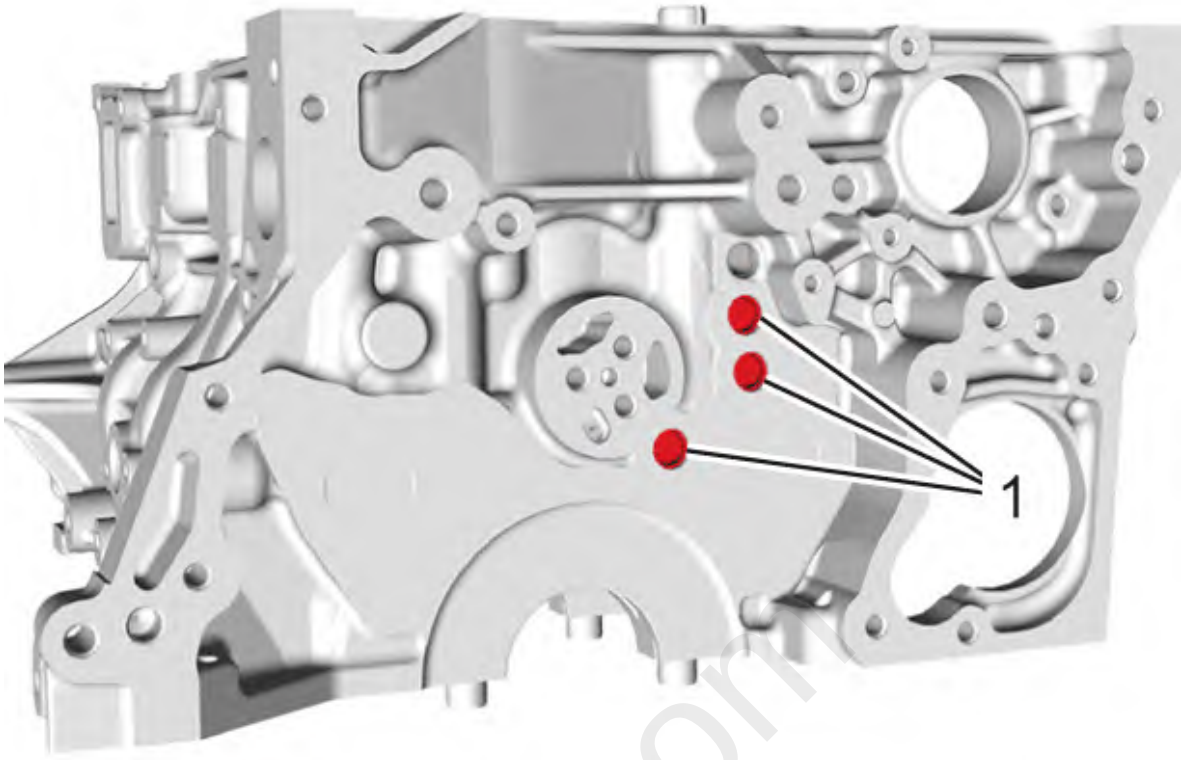


Fig. 768: Engine Block Core Hole Plugs
Courtesy of GENERAL MOTORS COMPANY

10. Remove and DISCARD Engine Block Core Hole Plugs (1) (Qty: 3)

mcx30.com

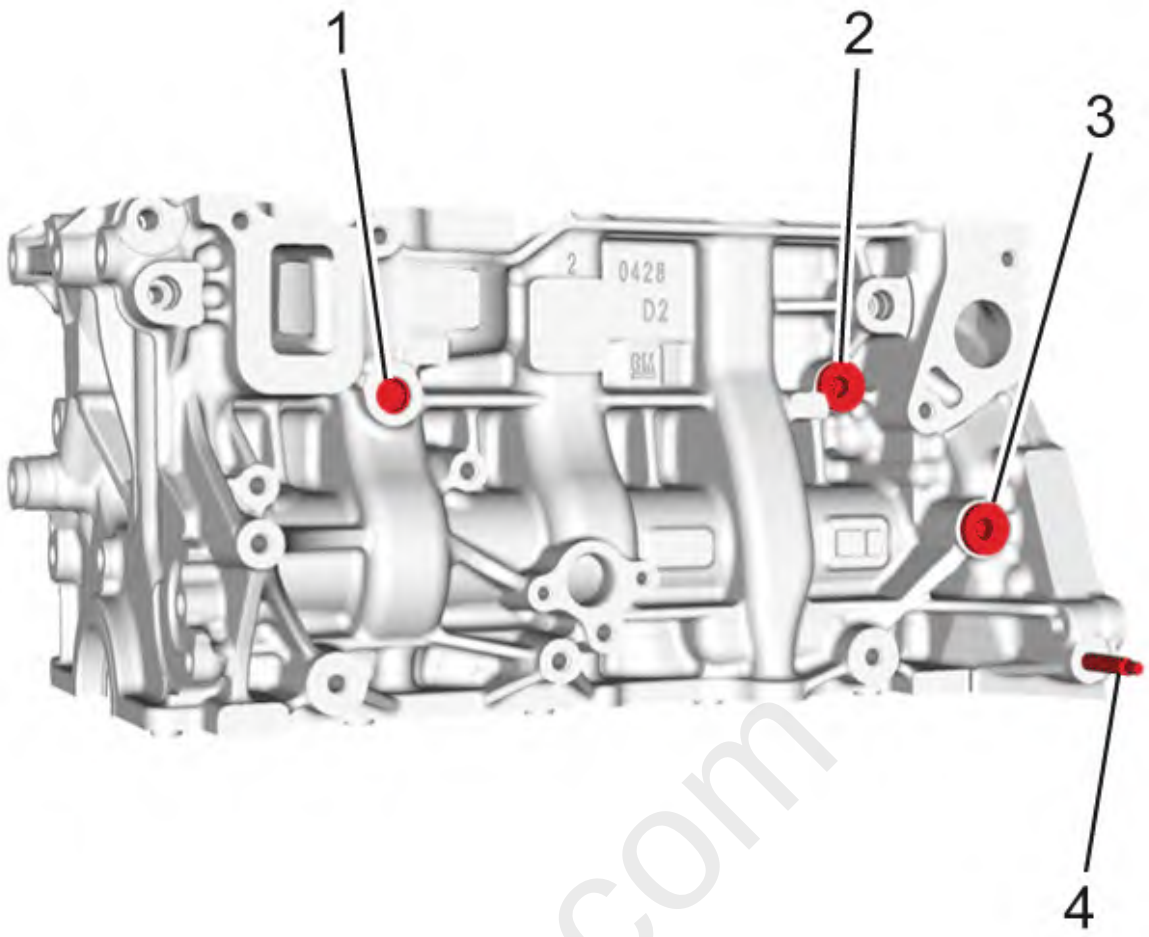


Fig. 769: Catalytic Converter Stud And Engine Block Plugs
Courtesy of GENERAL MOTORS COMPANY

11. Remove Catalytic Converter Stud (4)
12. Remove and DISCARD Engine Block Core Hole Plug (1)
13. Remove Engine Block Coolant Drain Hole Plug (2)
14. Remove Engine Block Oil Gallery Plug (3)

mcx30.com

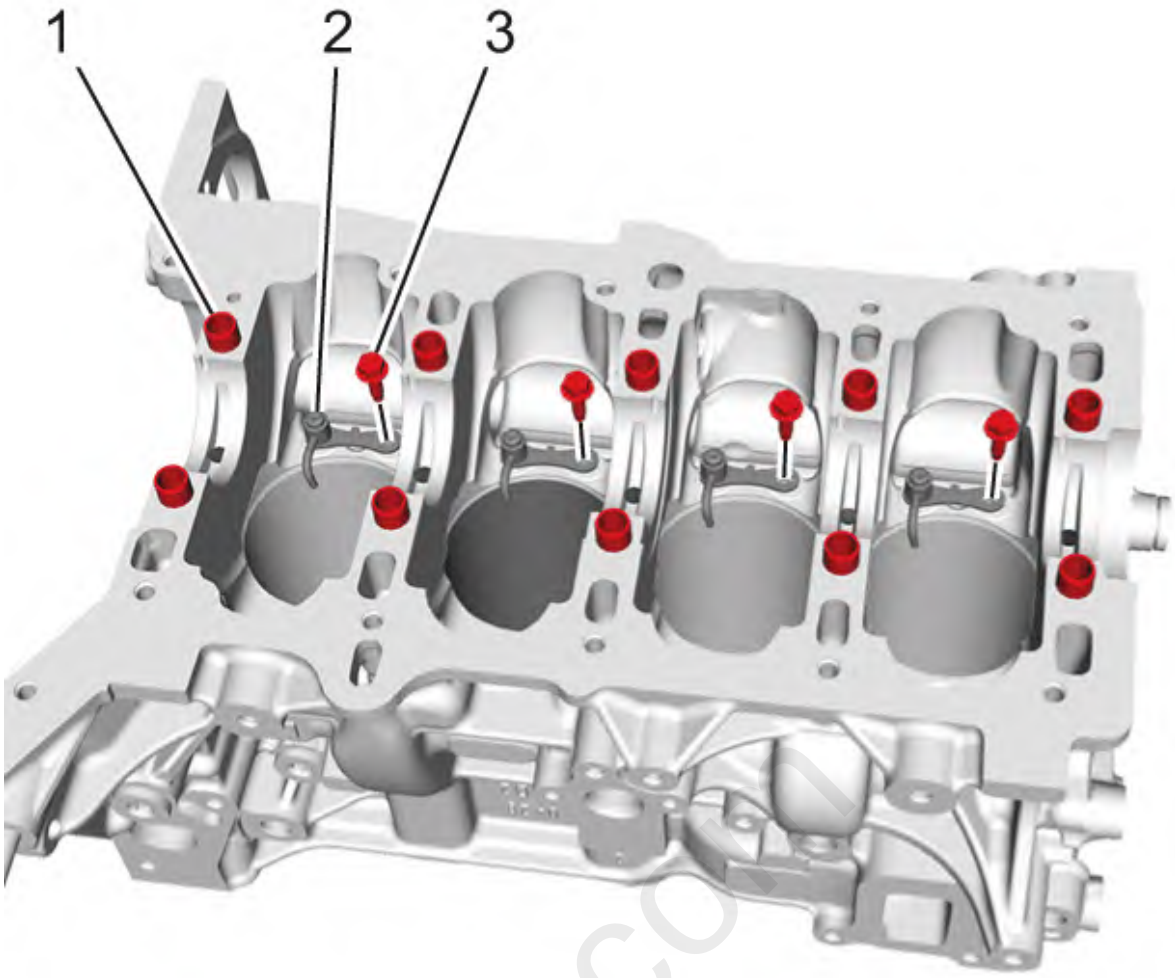


Fig. 770: Piston Oil Nozzles, Bolts And Lower Crankcase Guide Sleeves
Courtesy of GENERAL MOTORS COMPANY

15. Remove Piston Oil Nozzle Bolts (3) (Qty: 4)
16. Piston Oil Nozzles (2) (Qty: 4)
17. Remove the 10 lower crankcase guide sleeves (1).

ENGINE BLOCK CLEANING AND INSPECTION

Special Tools

- **EN-8087** Gauge
- **EN-45059** Angle Meter

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

Cleaning Procedure

1. Remove any old thread sealant, gasket material or sealant.
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 and Compressed Air Warning .**

4. Dry the engine block with compressed air.

mcx30.com

Visual Inspection

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 engine block assembly must be replaced.
2. Inspect all sealing and mating surfaces for damage, repair or replace the engine block assembly if necessary.
3. Inspect all threaded and through holes for damage or excessive debris.
4. Inspect all bolts for damage, if damaged replace with NEW bolts only.
5. 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.
6. Inspect the engine block for cracks. Do not repair any cracks. If cracks are found, the cylinder block assembly must be replaced.

Measuring Procedure

Engine Block Flatness Inspection

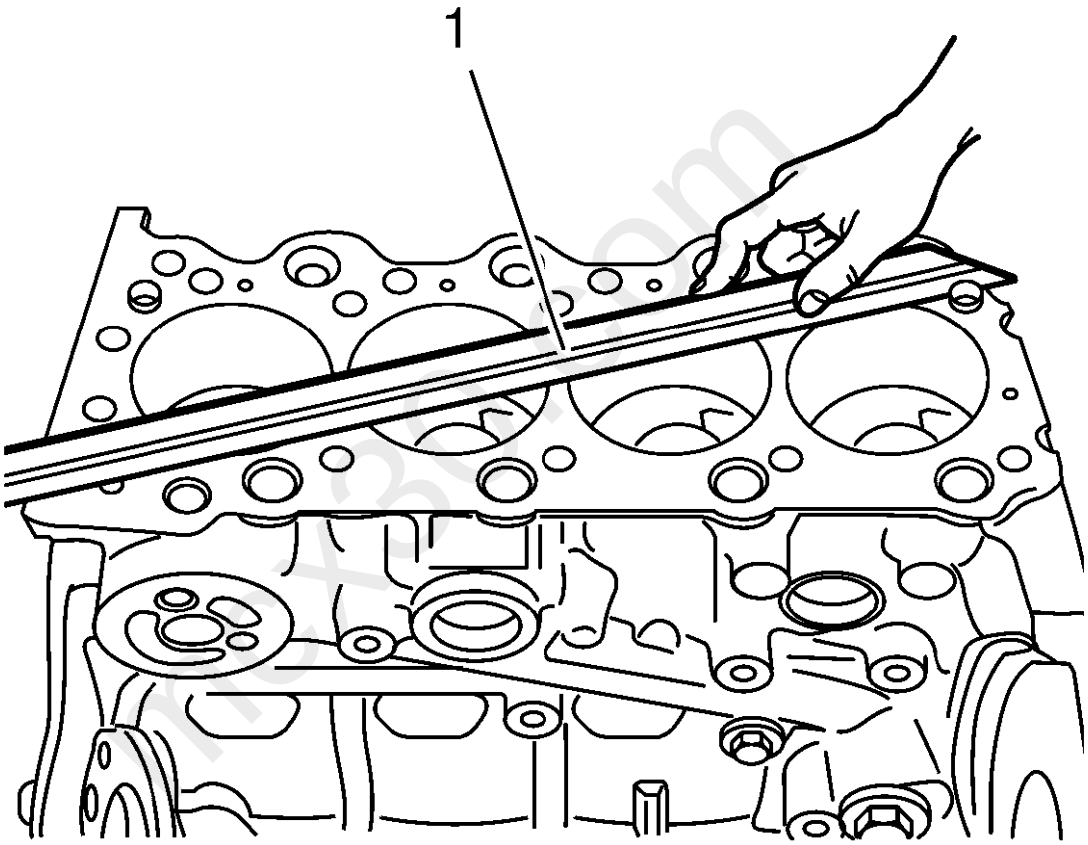


Fig. 771: Inspecting Engine Block For Distortion Using Straight Edge
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the engine block as shown for distortion. Use a straightedge (1).

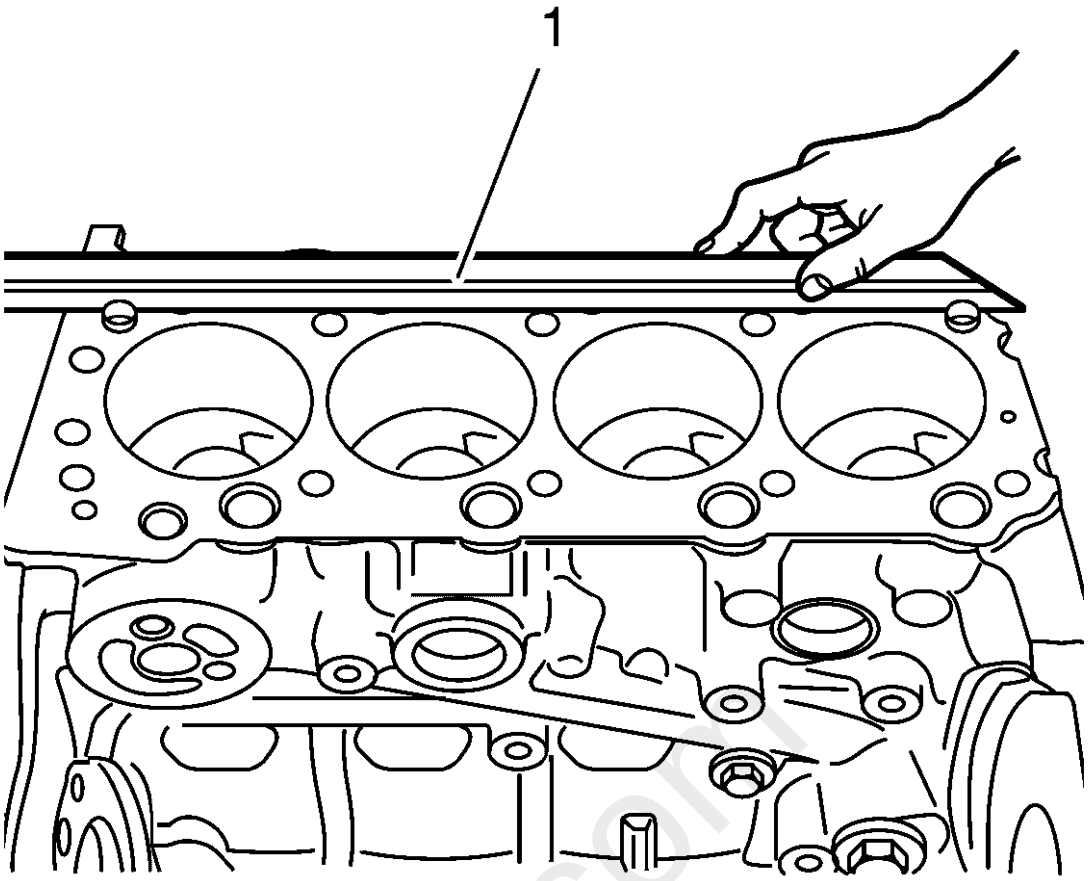


Fig. 772: Inspecting Engine Block For Deflection Using Straight Edge
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the engine block as shown for deflection. Use a straightedge (1).

Cylinder Sleeve Diameter Inspection

mcx30.com

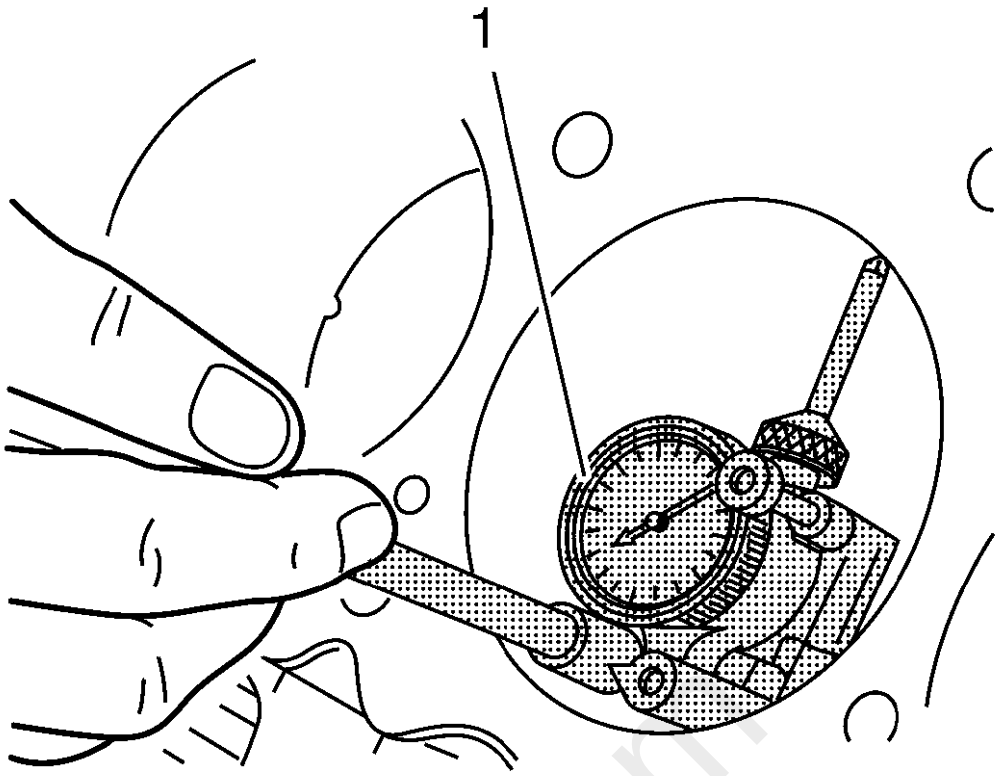


Fig. 773: Inspecting Cylinder Bore
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the cylinder sleeve measurements are not within the recommended limits, ream the cylinder bores with the recommended oversize. Refer to Engine Mechanical Specifications.**

1. Inspect the cylinder bores using the **EN-8087** gauge (1). Inspect for the following items:
   - Wear of cylinder sleeve
   - Cylinder sleeve diameter
   - Tapering of cylinder sleeve
   - Oval status of cylinder sleeve

   Refer to **Engine Mechanical Specifications** for the recommended limits.

Bearing Bore Diameter In Cylinder Block Inspection

mx30.com

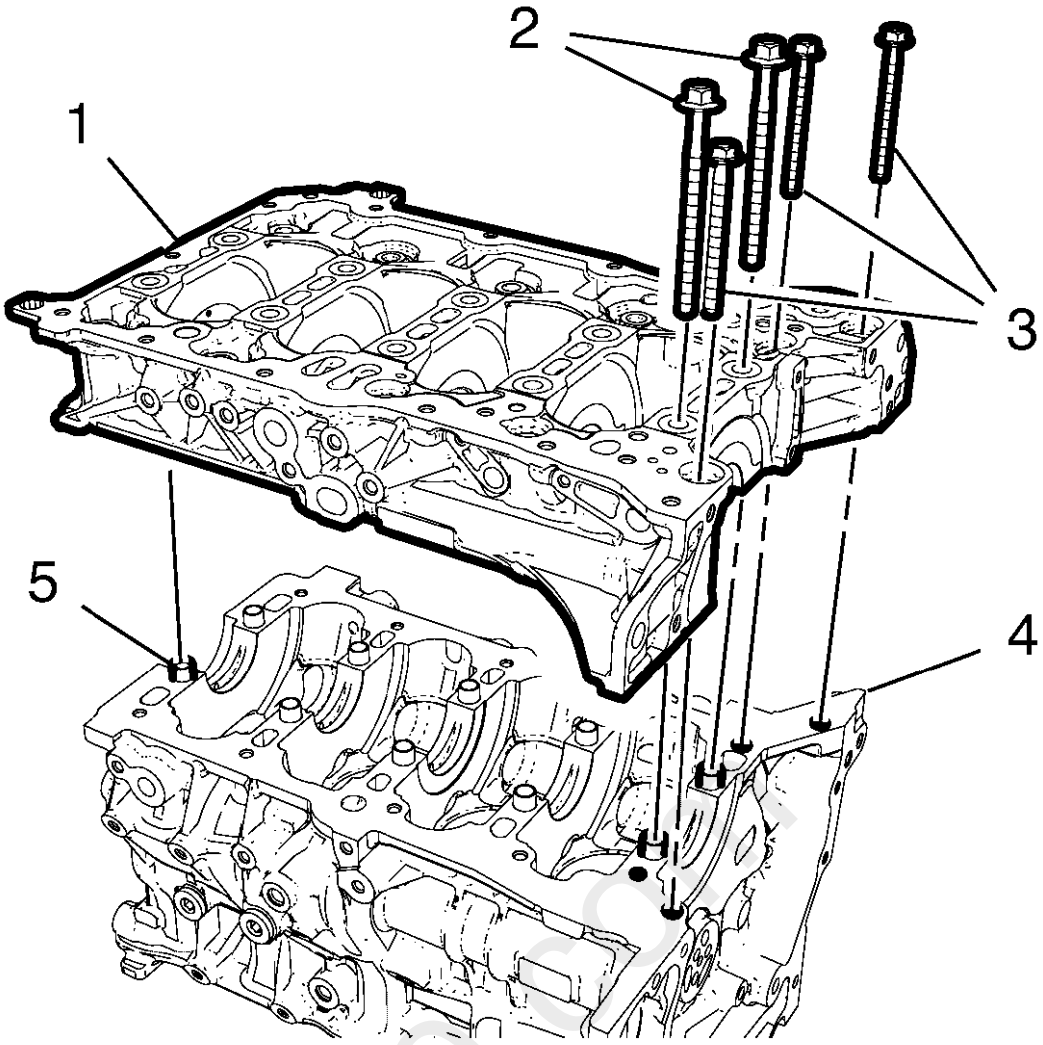


Fig. 774: Crankshaft, Lower Crankcase, Locating Pins And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the 10 lower crankcase locating pin, if they was removed.
2. Install the crankshaft to the engine block (4).
3. Install the lower crankcase (1).
4. Loosely install the 10 main bearing bolts M10 (2).
5. Loosely install the 11 lower crankcase bolts M8 (3).

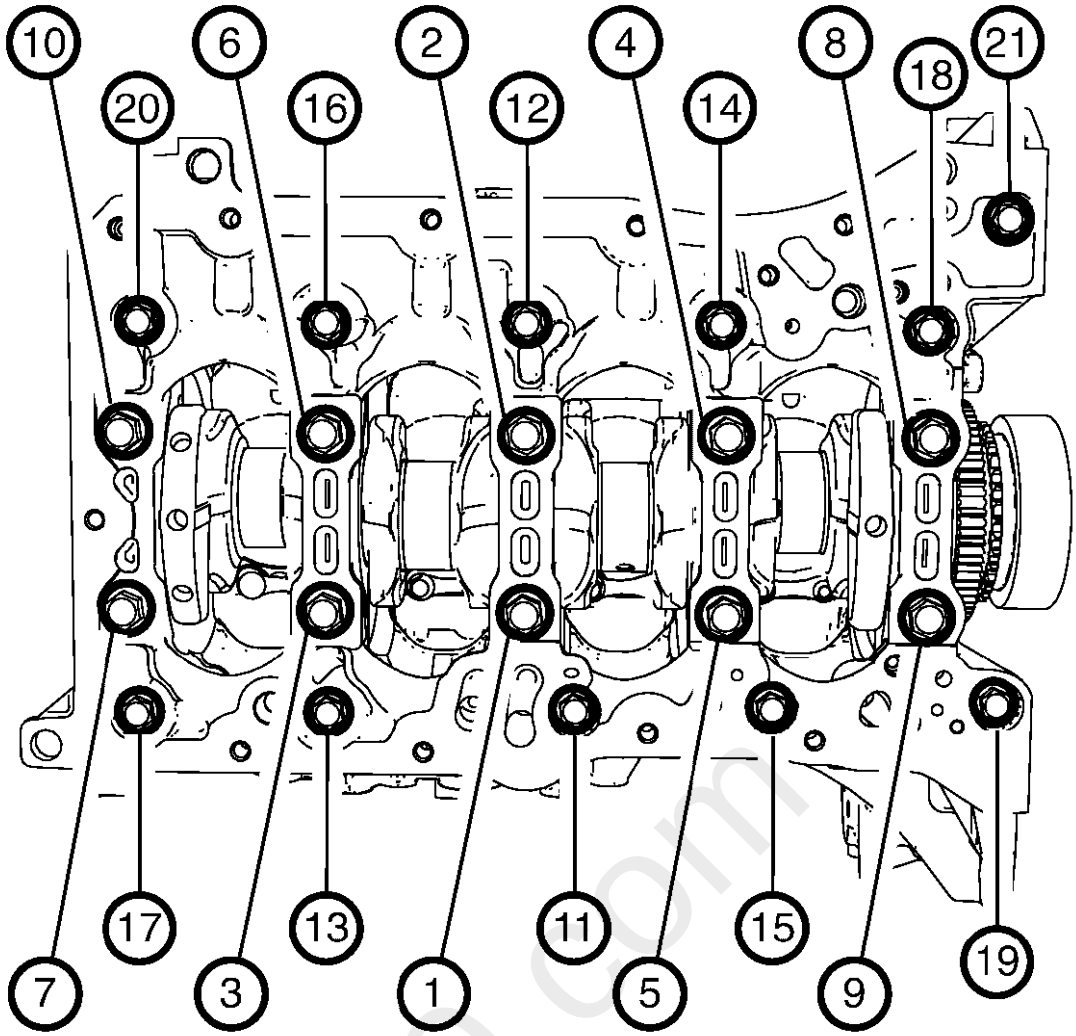


Fig. 775: Main Bearing And Lower Crankcase Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

CAUTION: **Refer to Torque-to-Yield Fastener Caution .**

6. Tighten the 10 main bearing bolts.
    1. Tighten the bolts (1-10) a first pass in sequence shown to 50 N.m (37 lb ft).
    2. Tighten the bolts (1-10) a second pass in sequence shown an additional to 90 degrees, using the **EN-45059** meter.
    3. Tighten the bolts (1-10) a final pass in sequence shown an additional to 90 degrees, using the **EN-45059** meter.
7. Tighten the 11 lower crankcase bolts (11-21) in sequence shown to 34 N.m (25 lb ft).

mcx30.com

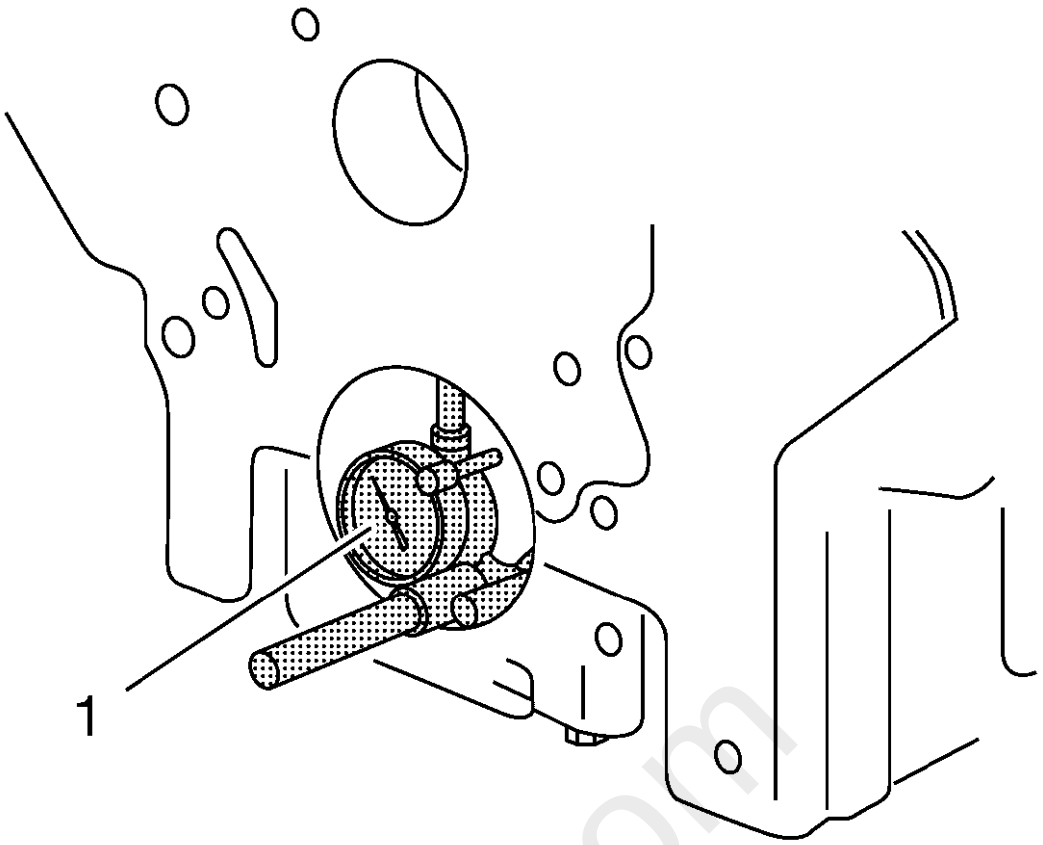


Fig. 776: Measuring Bearing Bore Concentricity And Alignment Using Gauge Tool
Courtesy of GENERAL MOTORS COMPANY

8. Inspect the bearing bore diameter in cylinder block using the **EN-8087** gauge (1). Refer to **Engine Mechanical Specifications** for the recommended limits.

mcx30.com

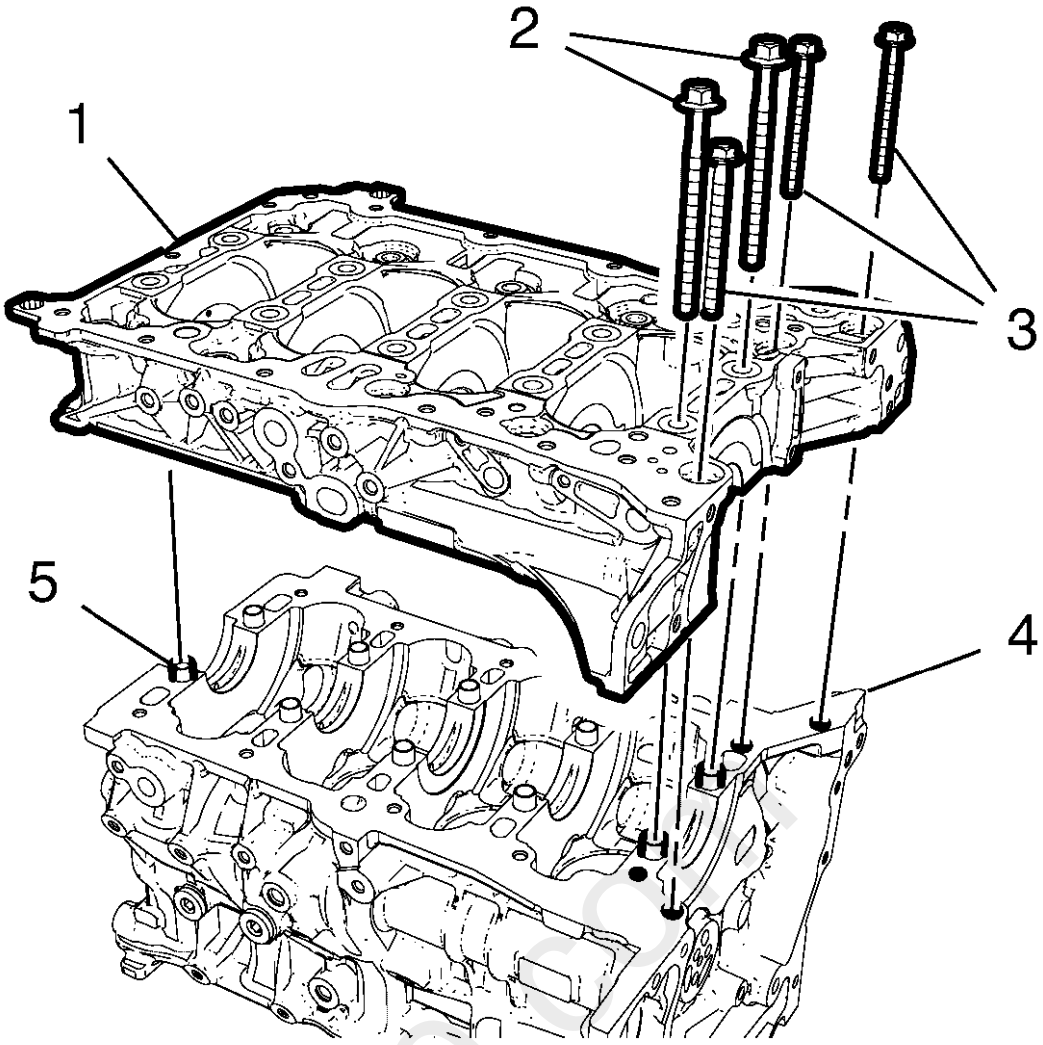


Fig. 777: Crankshaft, Lower Crankcase, Locating Pins And Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the 11 lower crankcase bolts (3).
10. Remove the 10 main bearing bolts (2).
11. Remove the lower crankcase (1) from the engine block (4).
12. Remove the 10 lower crankcase locating pin (5), if they was removed.

ENGINE BLOCK ASSEMBLE

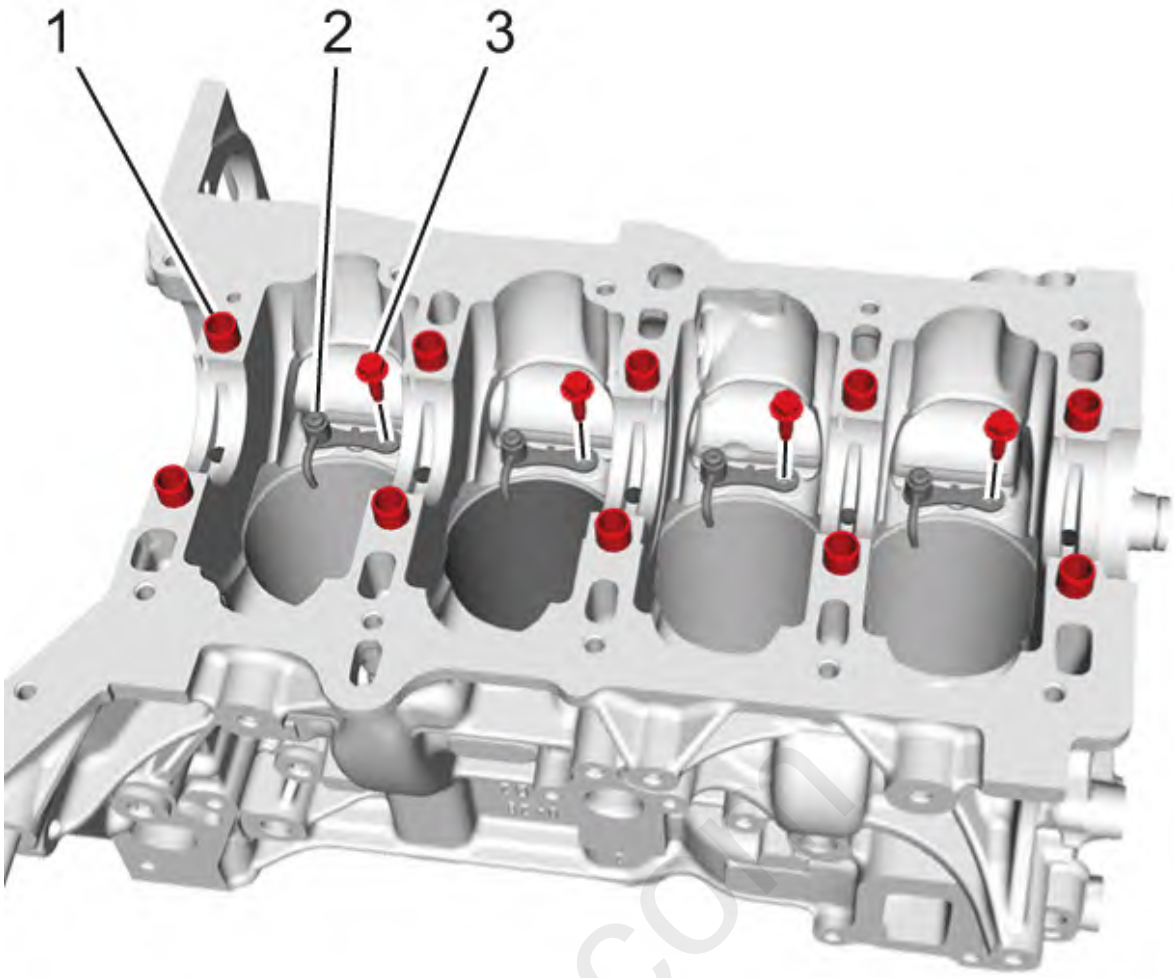


Fig. 778: Piston Oil Nozzles, Bolts And Lower Crankcase Guide Sleeves
Courtesy of GENERAL MOTORS COMPANY

1. Install the 10 lower crankcase guide sleeves (1).

CAUTION: **Refer to Fastener Caution**

2. Install Piston Oil Nozzles (2) (Qty: 4)
3. Install and tighten Piston Oil Nozzle Bolts (3) (Qty: 4) to 10 N.m (89 lb in)

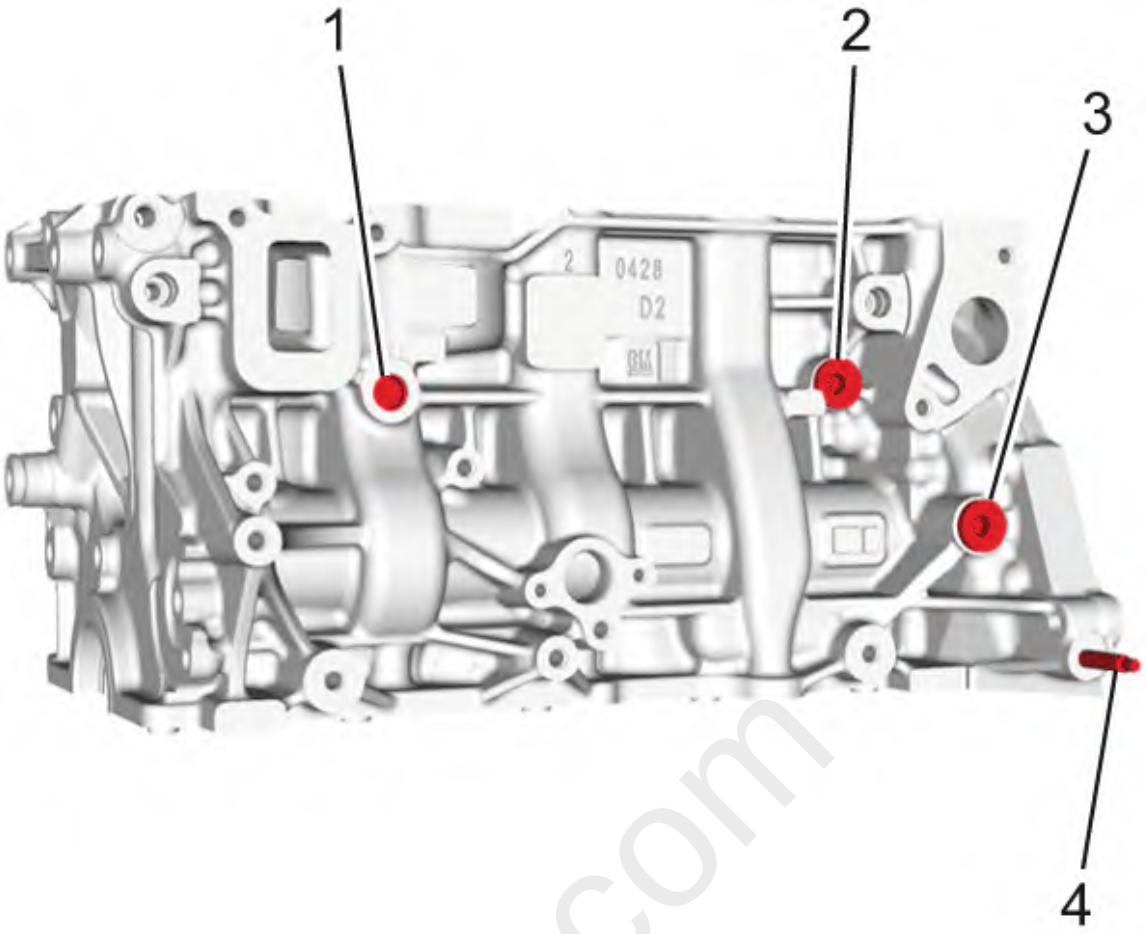


Fig. 779: Catalytic Converter Stud And Engine Block Plugs
Courtesy of GENERAL MOTORS COMPANY

4. Install and tighten Engine Block Coolant Drain Hole Plug (2) to 65 N.m (48 lb ft)
5. Install and tighten Engine Block Oil Gallery Plug (3) to 65 N.m (48 lb ft)
6. Install NEW Engine Block Core Hole Plug (1)
7. Install and tighten Catalytic Converter Stud (4) to 9 N.m (80 lb in)

mcx30.com

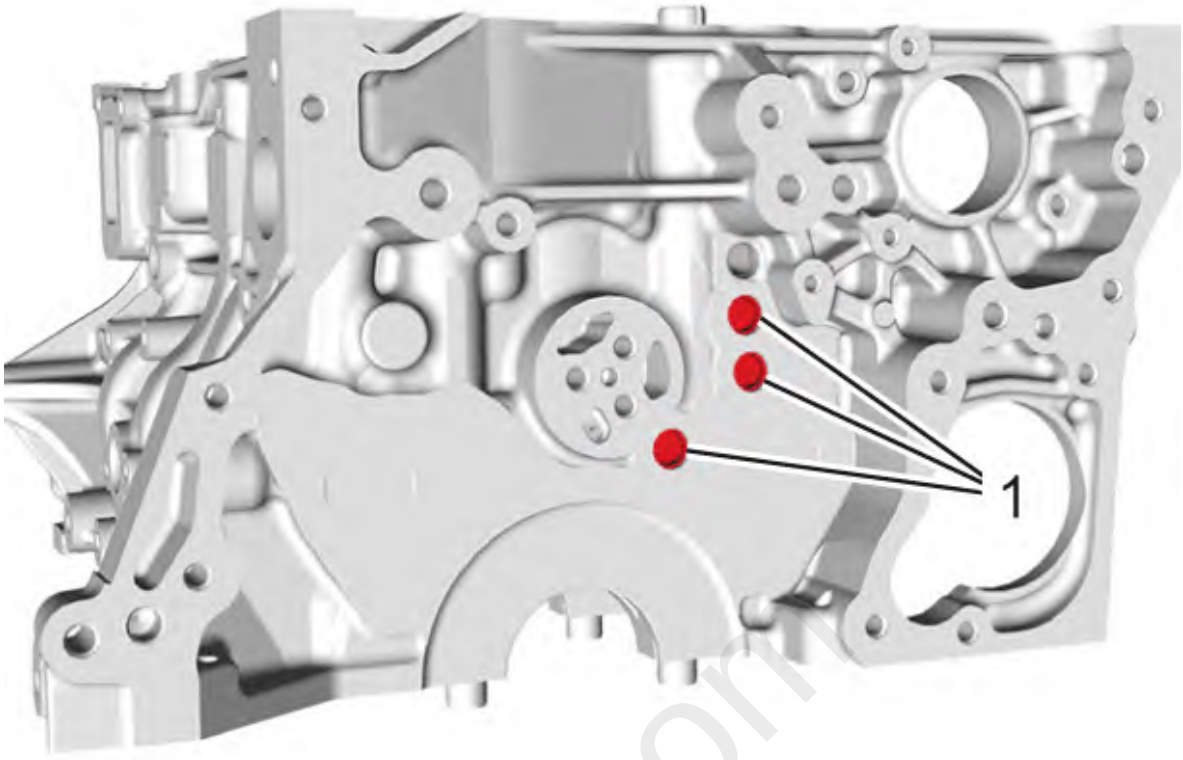


Fig. 780: Engine Block Core Hole Plugs
Courtesy of GENERAL MOTORS COMPANY

8. Install NEW Engine Block Core Hole Plugs (1) (Qty: 3)

mcx30.com

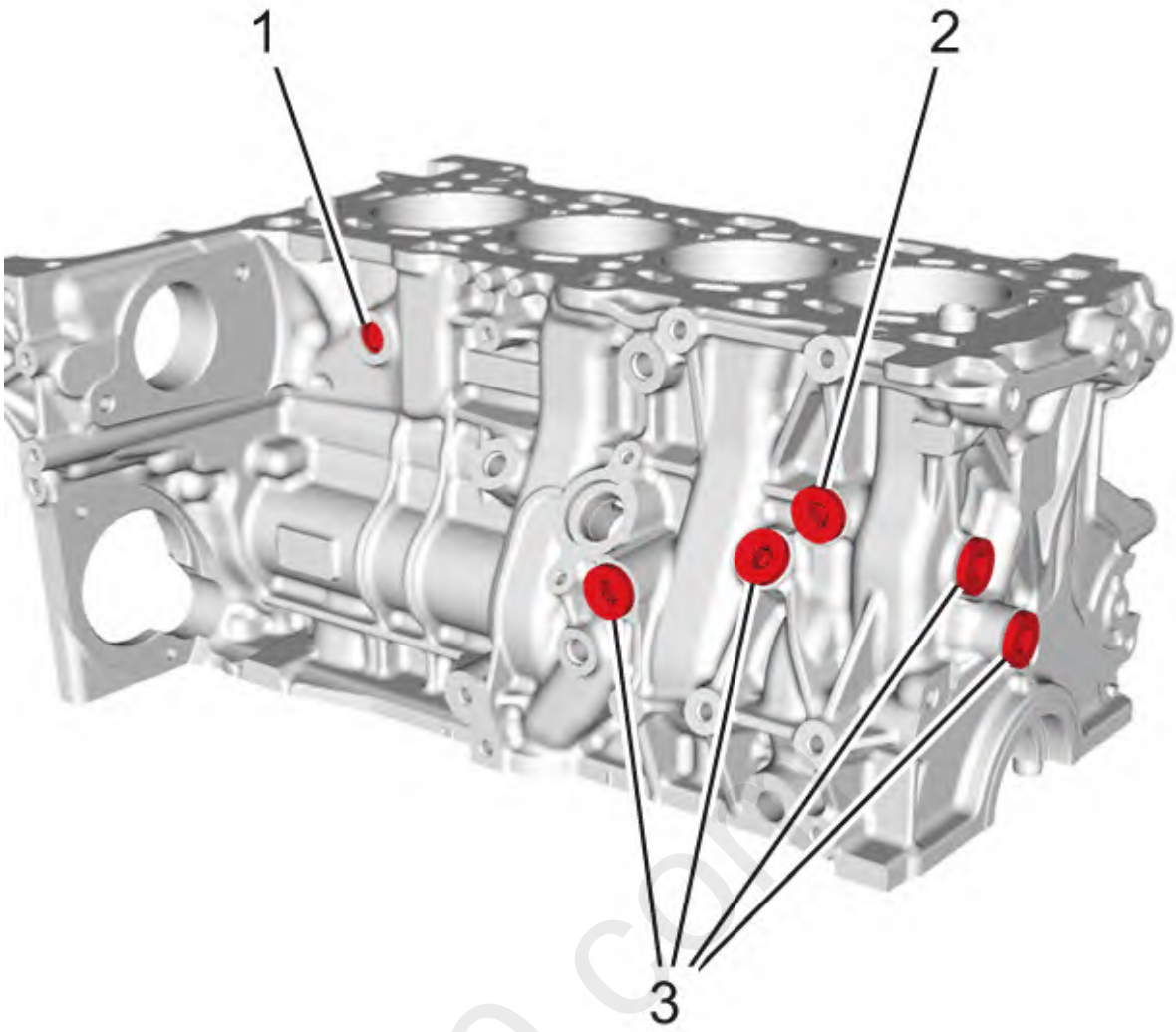


Fig. 781: Engine Block Plugs
Courtesy of GENERAL MOTORS COMPANY

9. Install and tighten Engine Block Coolant Drain Hole Plug (2) to 65 N.m (48 lb ft)
10. Install and tighten Engine Block Oil Gallery Plugs (3) (Qty: 4) to 65 N.m (48 lb ft)
11. Install NEW Engine Block Core Hole Plug (1)

mdx30.com

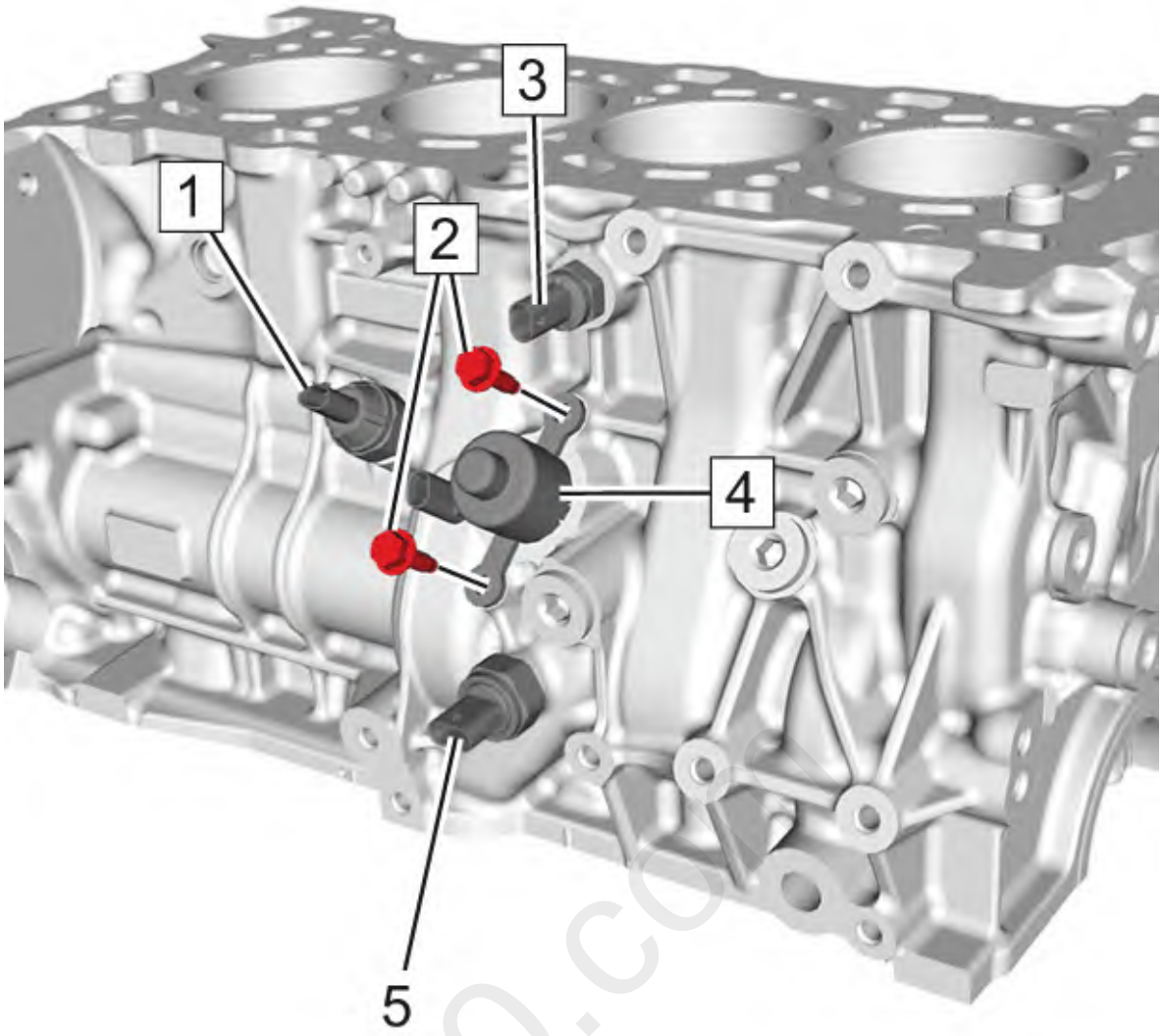


Fig. 782: Engine Oil Pressure Switch, Engine Oil Pressure Sensor, Engine Coolant Temperature Sensor, Piston Oil Nozzle Oil Control Solenoid Valve And Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Component Fastener Tightening Caution**

12. Install and tighten Engine Oil Pressure Sensor (5) to 35 N.m (26 lb ft)
13. Install the piston oil nozzle oil control solenoid valve (4).
14. Install the 2 piston oil nozzle oil control solenoid valve bolts (2) and tighten to 10 N.m (89 lb in).
15. Install and tighten Engine Coolant Temperature Sensor (3) to 33 N.m (24 lb ft)
16. Install and tighten Engine Oil Pressure Switch (1) to 35 N.m (26 lb ft)

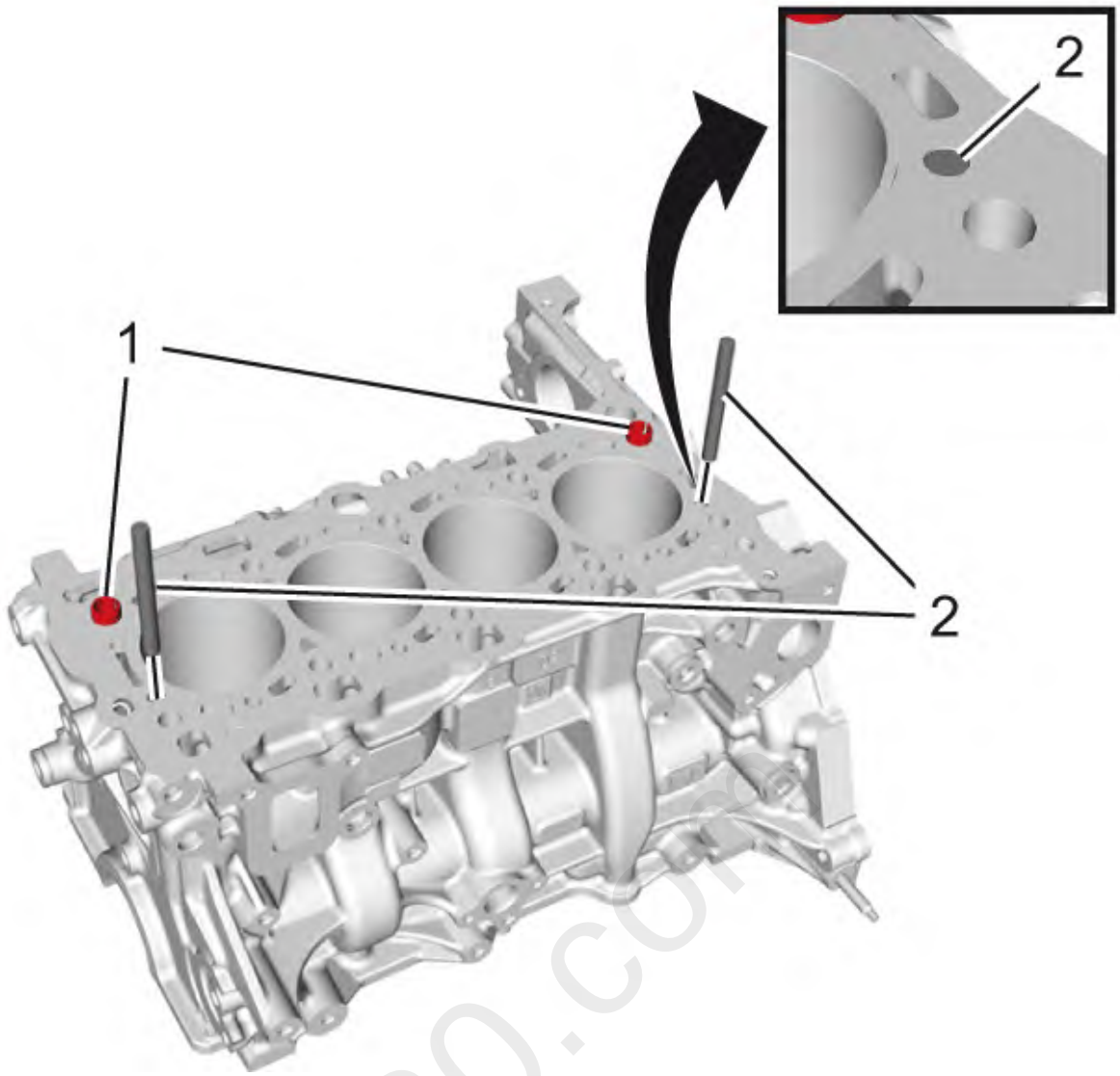


Fig. 783: Cylinder Head Guide Sleeves And Deflectors
Courtesy of GENERAL MOTORS COMPANY

17. Install the 2 cylinder head guide sleeves (1).
18. Check that the 2 deflectors (2) are installed in the engine block and install 2 NEW deflectors if the deflectors are missing.

CRANKSHAFT AND BEARING INSTALLATION

Special Tools

EN-45059 Angle Meter

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

1. Clean all sealant surfaces from lower crankcase and engine block.

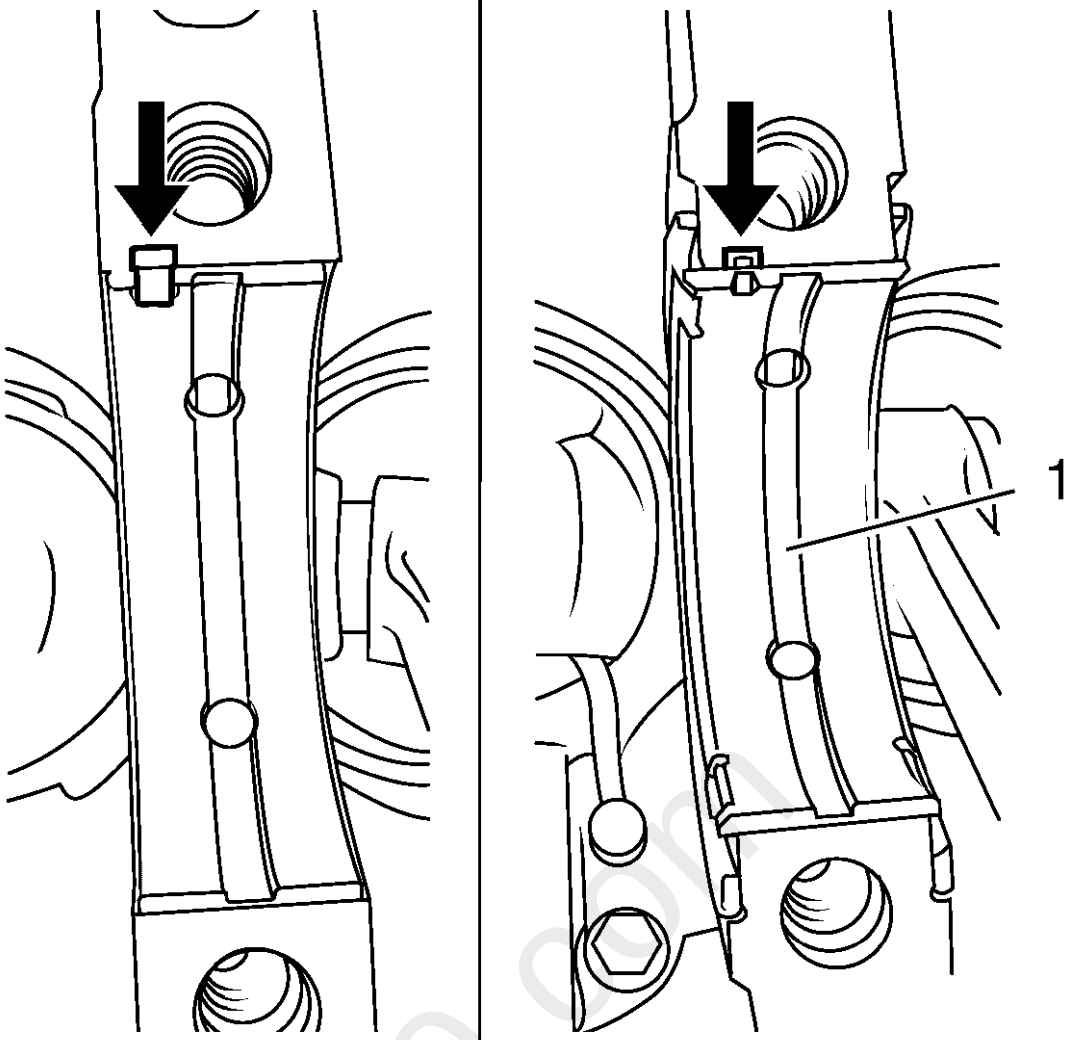


Fig. 784: Crankshaft Thrust Bearing
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that guide lugs (arrows) are properly seated. Note position of thrust bearing (1) at middle crankshaft bearing.**

If the old crankshaft bearing shells was reused, set it in as removed.

2. Install the 5 upper crankshaft bearings to the engine block.
3. Coat the crankshaft bearings with engine oil.

mdx30.com

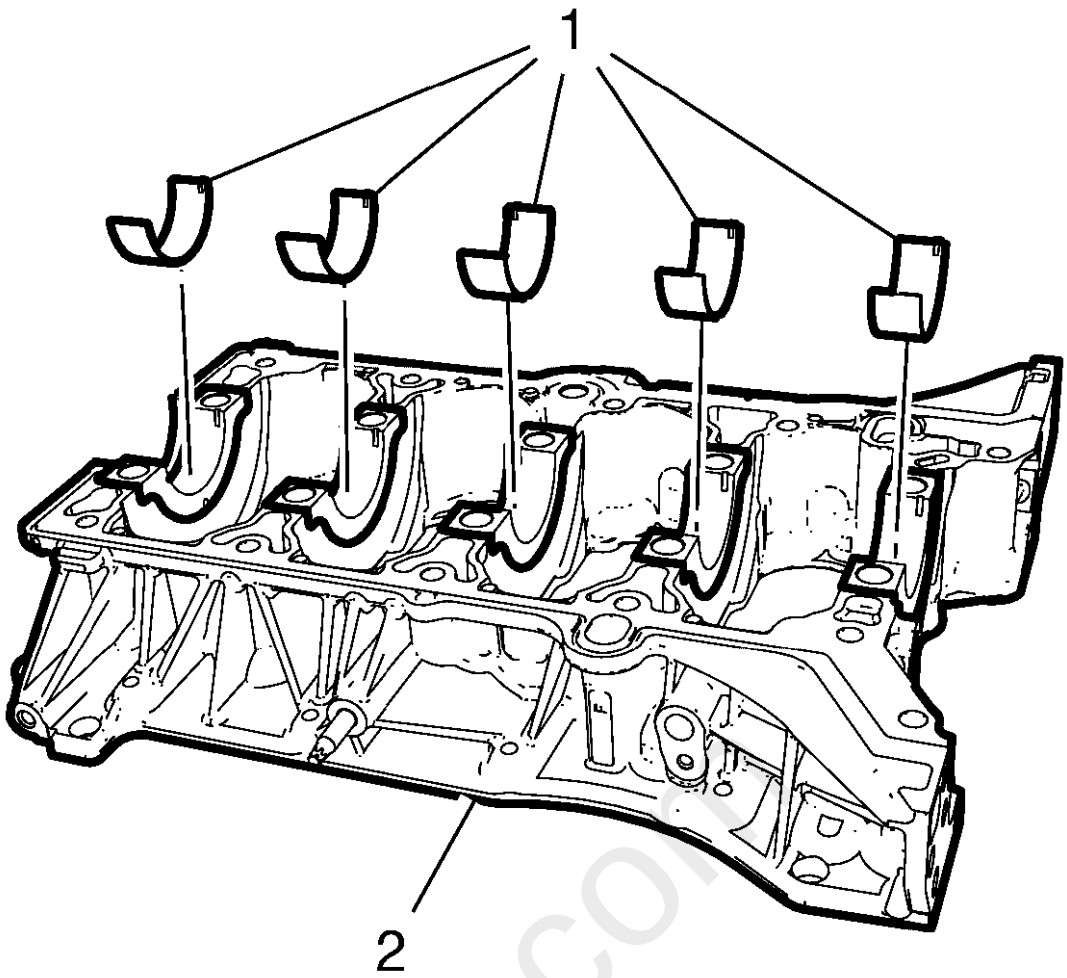


Fig. 785: Lower Crankshaft Bearings And Crankcase
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that guide lugs are properly seated. If the old crankshaft bearings are reused, set it in as removed.**

4. Install the 5 lower crankshaft bearings (1) into the crankcase (2).
5. Coat the crankshaft bearings with engine oil.

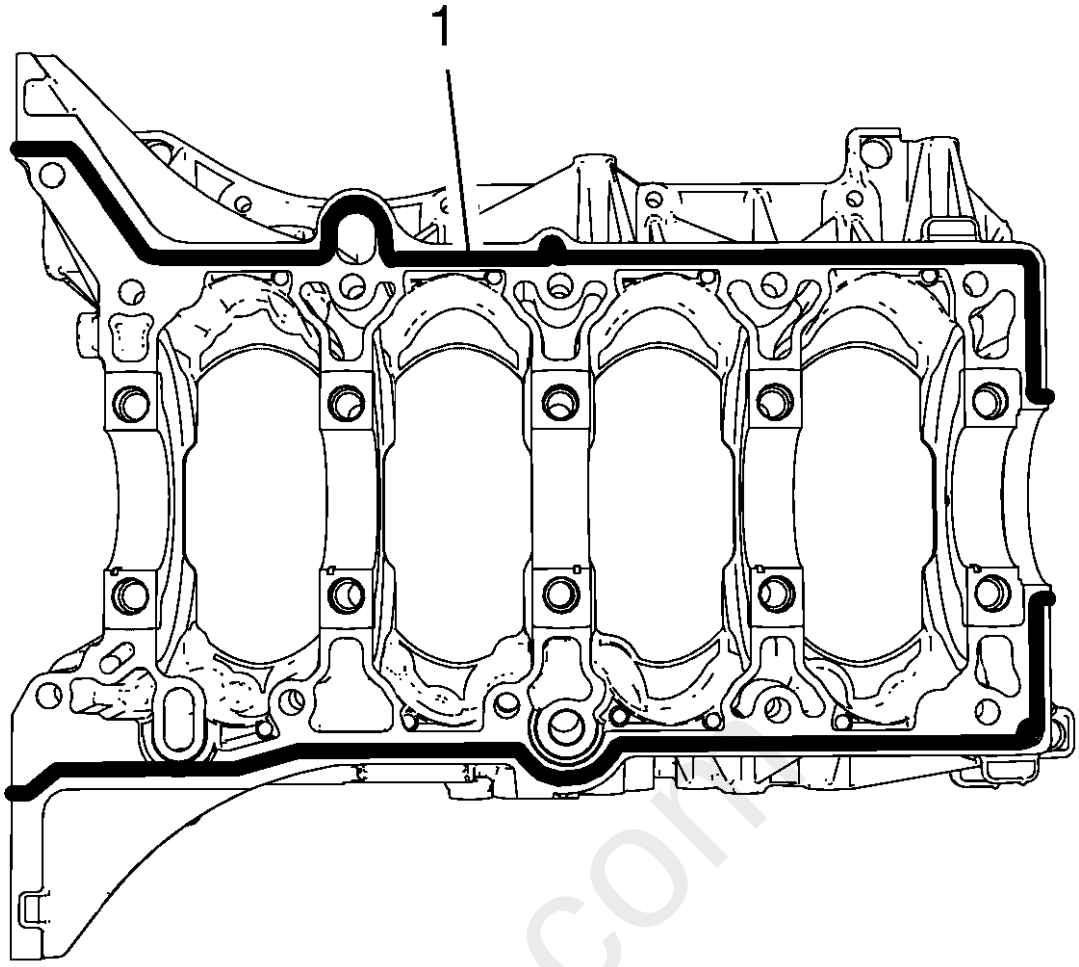


Fig. 786: Silicone Sealing Compound Lower Crankcase Application Area
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The complete installation procedure of the lower crankcase should be done in 20 minutes.**

6. Apply silicone sealing compound to the lower crankcase. The thickness of the sealing bead (1) should be 2.0 - 3.0 mm (0.0787 - 0.1181 in).

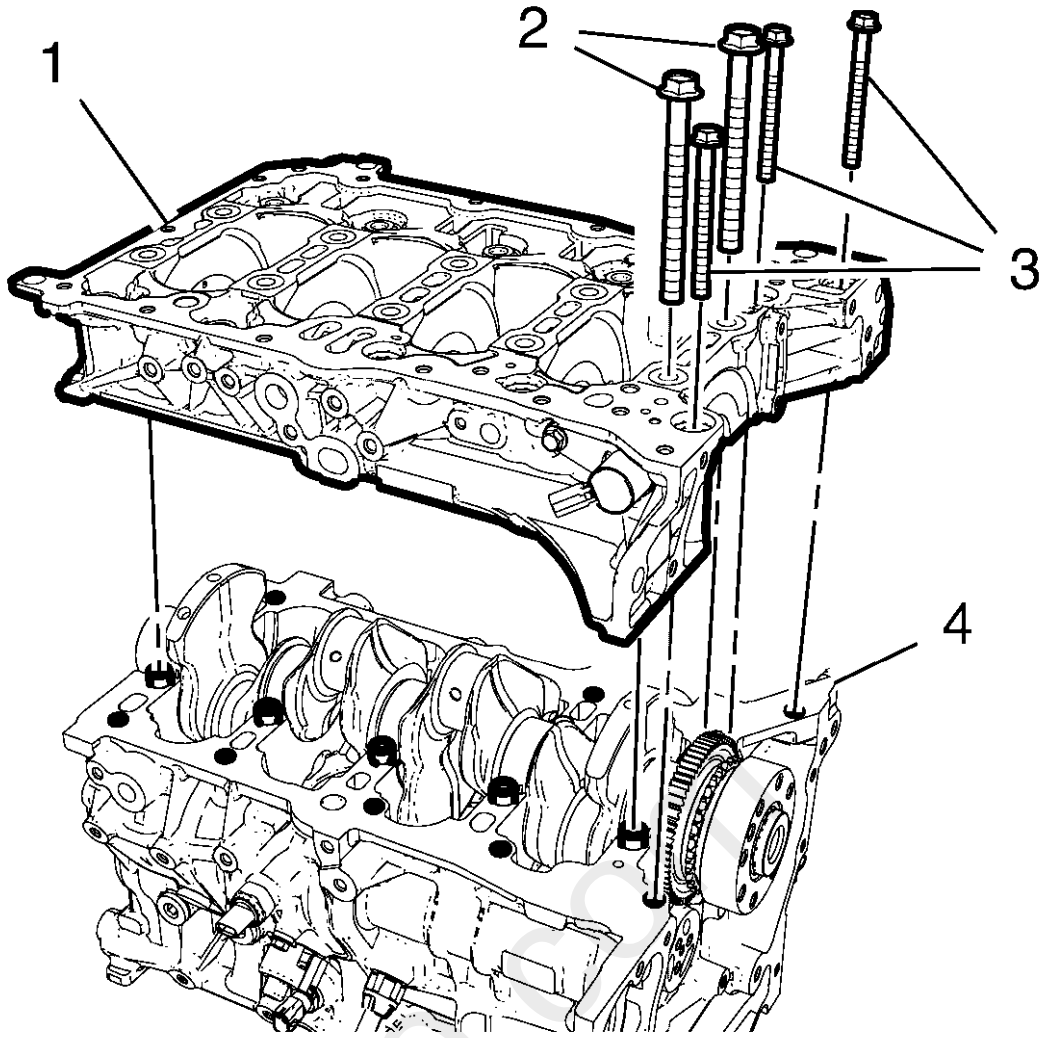


Fig. 787: Lower Crankcase And Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install the crankshaft to the engine block (4).
8. Install the lower crankcase (1).
9. Loosely install 10 NEW main bearing bolts M10 (2).
10. Loosely install the 11 lower crankcase bolts M8 (3).

mcx30.com

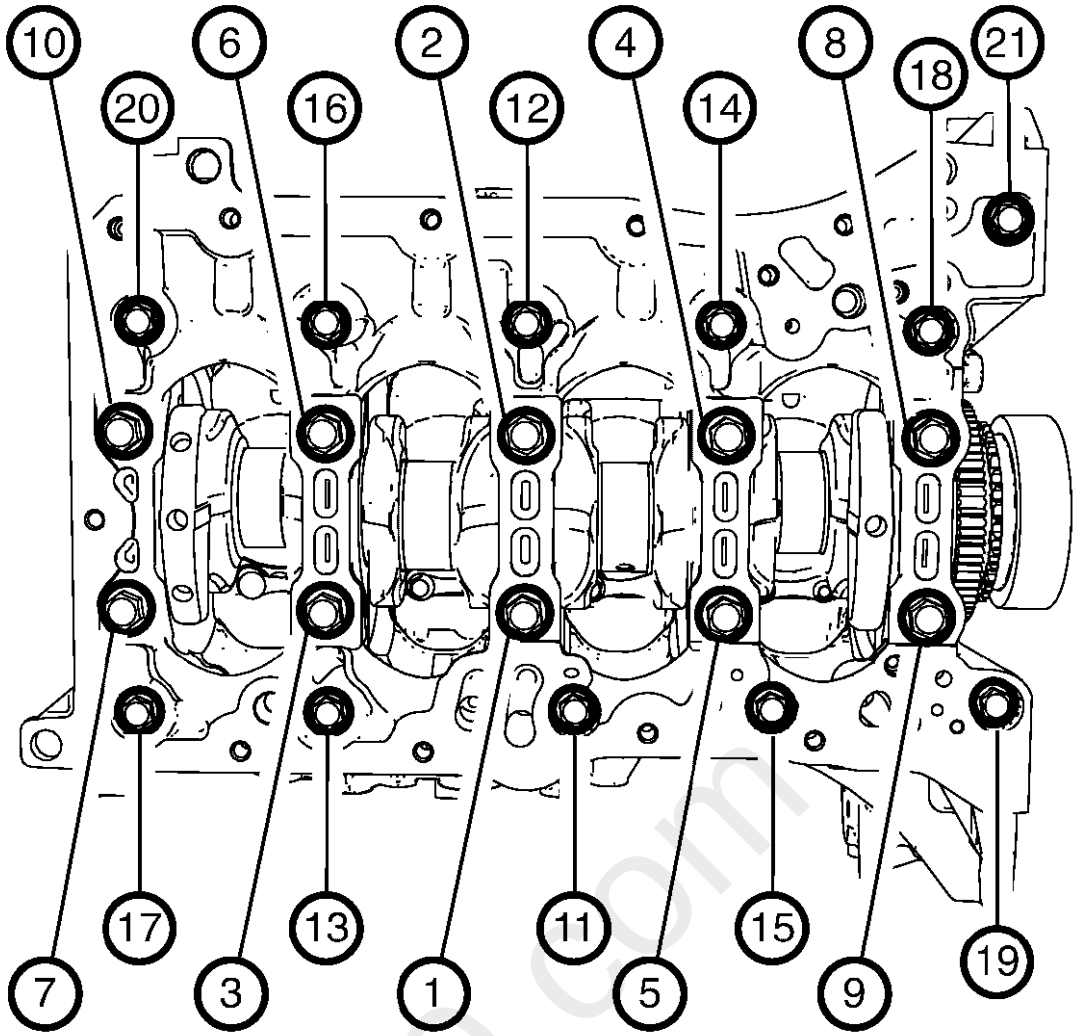


Fig. 788: Main Bearing And Lower Crankcase Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

CAUTION: **Refer to Torque-to-Yield Fastener Caution .**

11. Tighten the 10 main bearing bolts.
    1. Tighten the bolts (1-10) a first pass in sequence shown to 50 N.m (37 lb ft).
    2. Tighten the bolts (1-10) a second pass in sequence shown an additional 90 degrees, using the **EN-45059** meter.
    3. Tighten the bolts (1-10) a final pass in sequence shown an additional 90 degrees, using the **EN-45059** meter.
12. Tighten the 11 lower crankcase bolts (11-21) in sequence shown to 34 N.m (25 lb ft).

CRANKSHAFT FRONT OIL SEAL INSTALLATION

Special Tools

- **EN-51144** Crankshaft Seal Installer
- **EN-51144 - 100** Crankshaft Seal Installer

For equivalent regional tools, refer to Special Tools.

mcx30.com

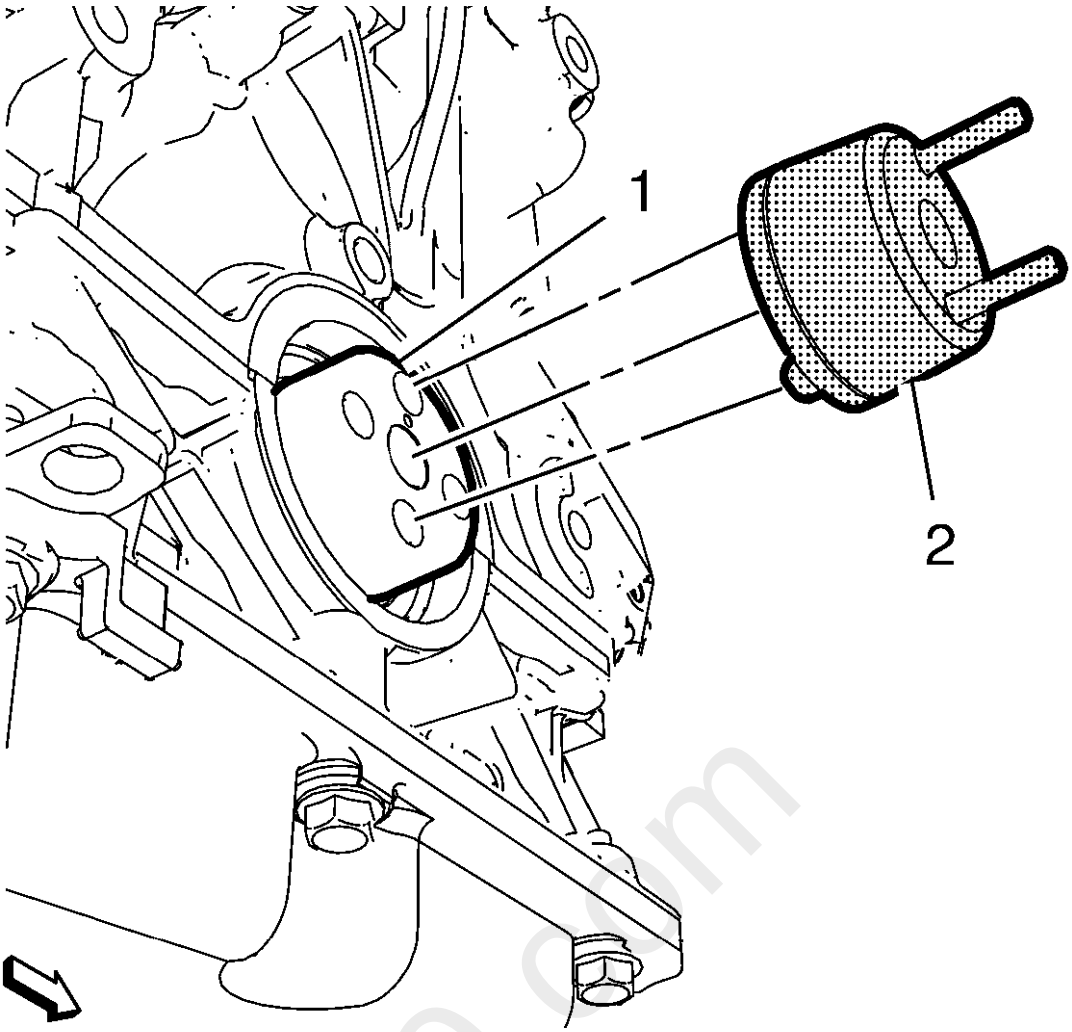


Fig. 789: Installer And Crankshaft
Courtesy of GENERAL MOTORS COMPANY

1. Install **EN-51144-1** installer (2) to crankshaft (1).

mcx30.com

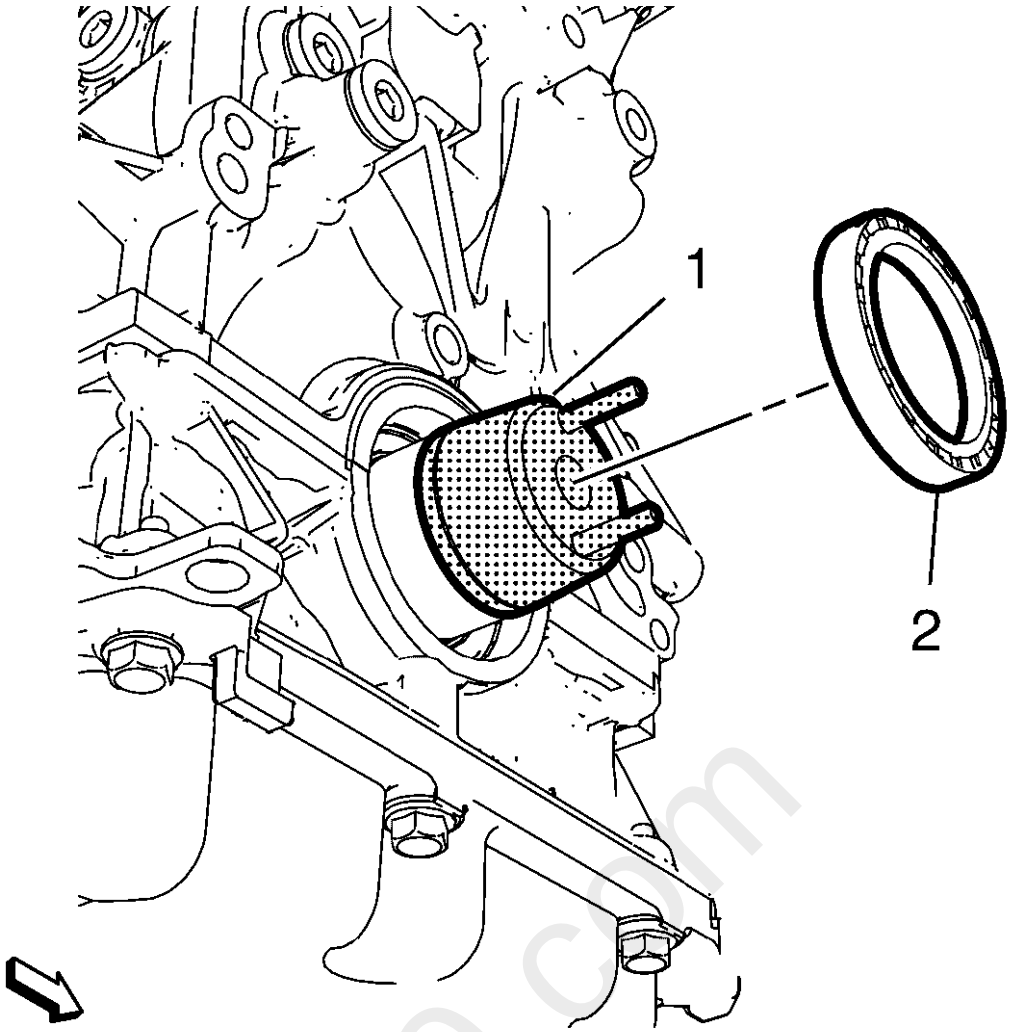


Fig. 790: Crankshaft Front Oil Seal And Installer
Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW crankshaft front oil seal (2) to **EN-51144-1** installer (1).

mcx30.com

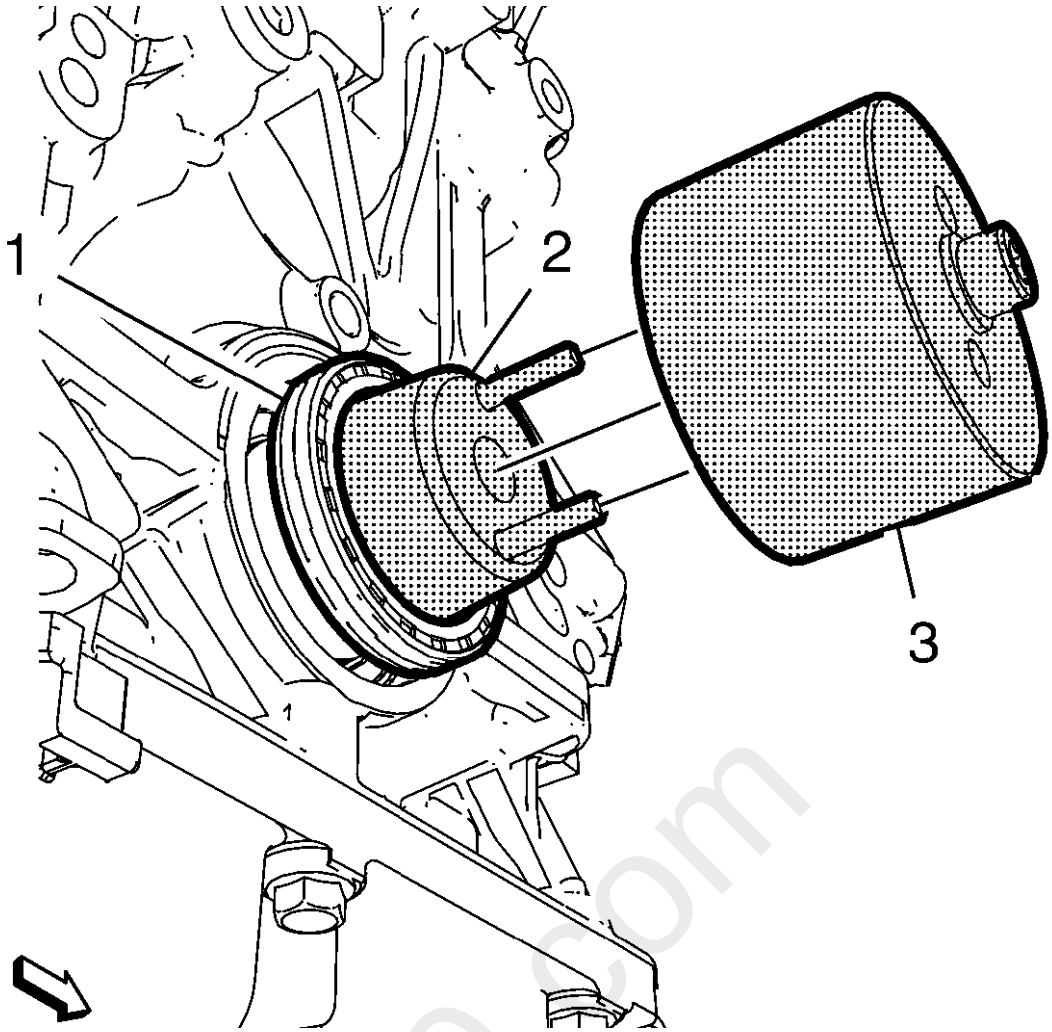


Fig. 791: Crankshaft Seal Installers
Courtesy of GENERAL MOTORS COMPANY

3. Install **EN-51144-100** crankshaft seal installer (3) to the **EN-51144-1** installer (2).

mcx30.com

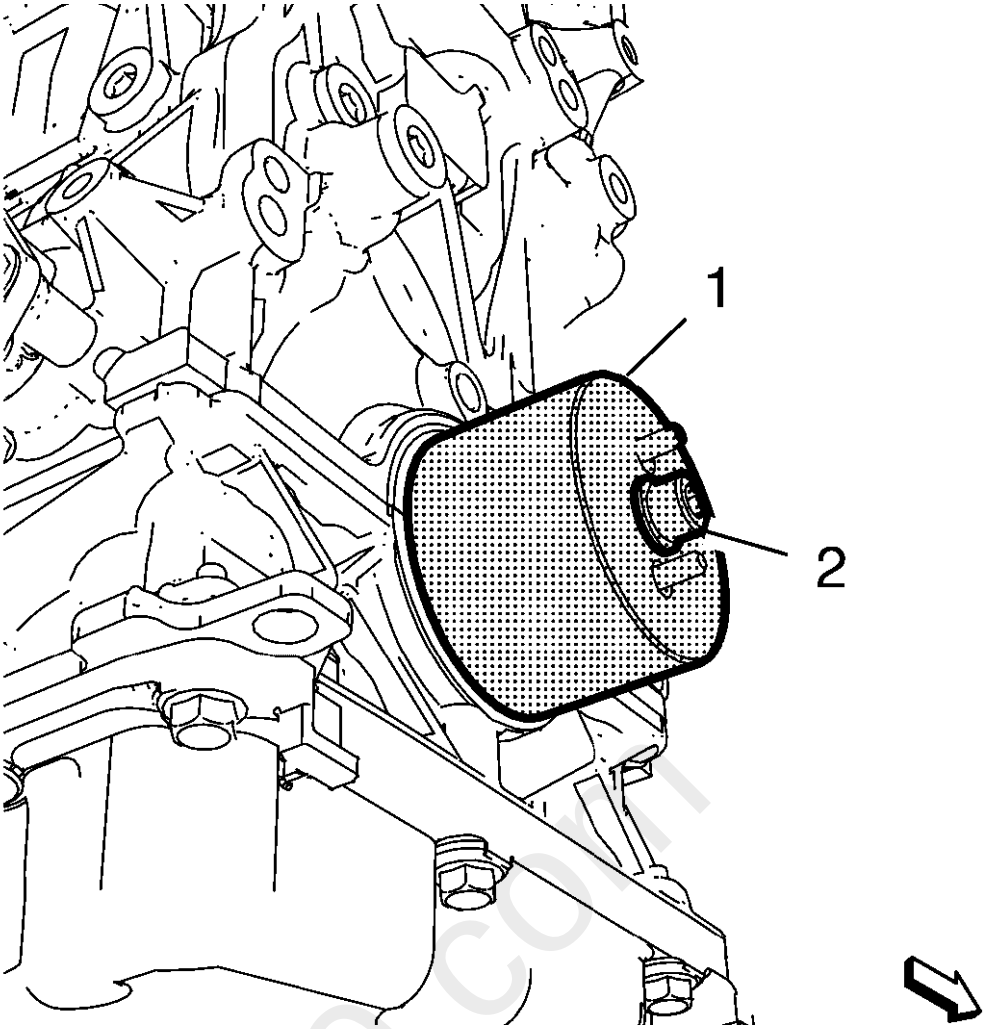


Fig. 792: Seating Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

4. Press the crankshaft front oil seal into the correct seat, by tighten the bolt (2) of the **EN-51144** installer (1).
5. Press the crankshaft front oil seal as far purely until the **EN-51144** installer is on the stop.
6. Remove the **EN-51144** installer.

PISTON, CONNECTING ROD, AND BEARING INSTALLATION

Special Tools

- **EN-45059** Angle Meter
- **EN-51140** Crankshaft Fixing Tool

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

1. Coat the 8 connecting rod bearings and cylinder bores with engine oil.

mcx30.com

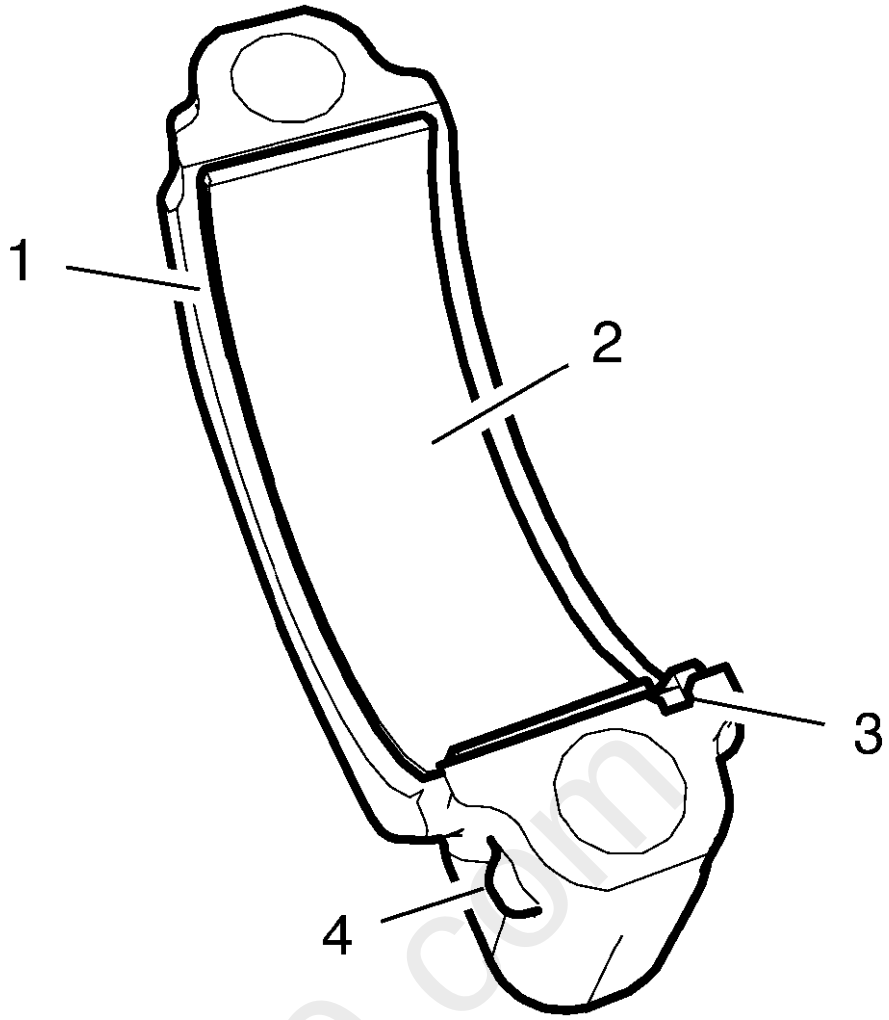


Fig. 793: Connecting Rod Bearings, Caps And Oil Notches
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the proper seat of the oil notches (3).**

NOTE: **If the old connecting rod bearings will be reused, install in their original position.**

2. Install the 8 connecting rod bearings (2) to the connecting rod bearing cap (1) and the connecting rod.

mcx30.com

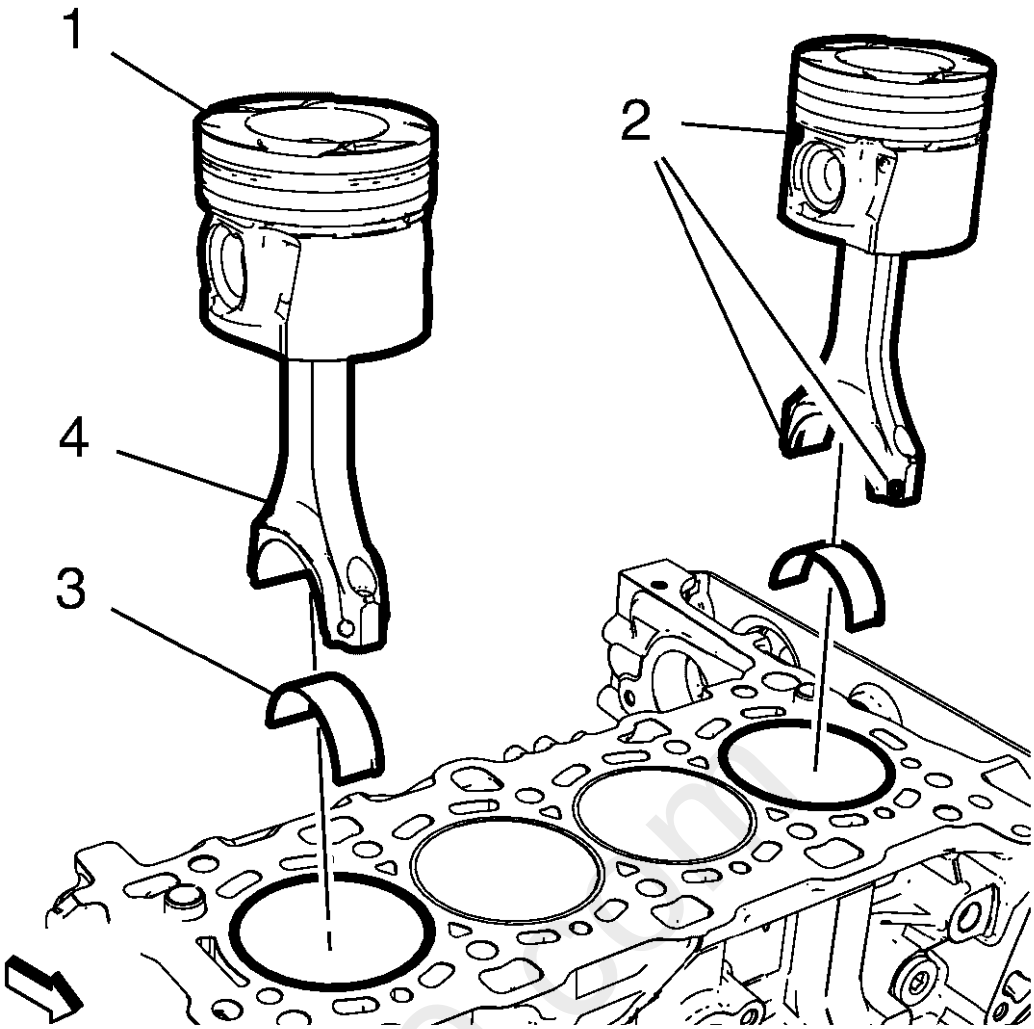


Fig. 794: Cylinder 1 And 4 Piston/Connecting Rod Assemblies And Upper Bearings
Courtesy of GENERAL MOTORS COMPANY

3. Install a piston ring compressor in order to compress the piston rings.

NOTE: **The arrow on the top of the piston and the marks (2) of the piston and connecting rod, must point to front of the engine.**

NOTE: **If the old piston and connecting rod will be reused, install in their original position.**

4. Install the 2 pistons (1) and the 2 connecting rods (4) with the connecting rod upper bearing (3) to the cylinder 1 and the cylinder 4.

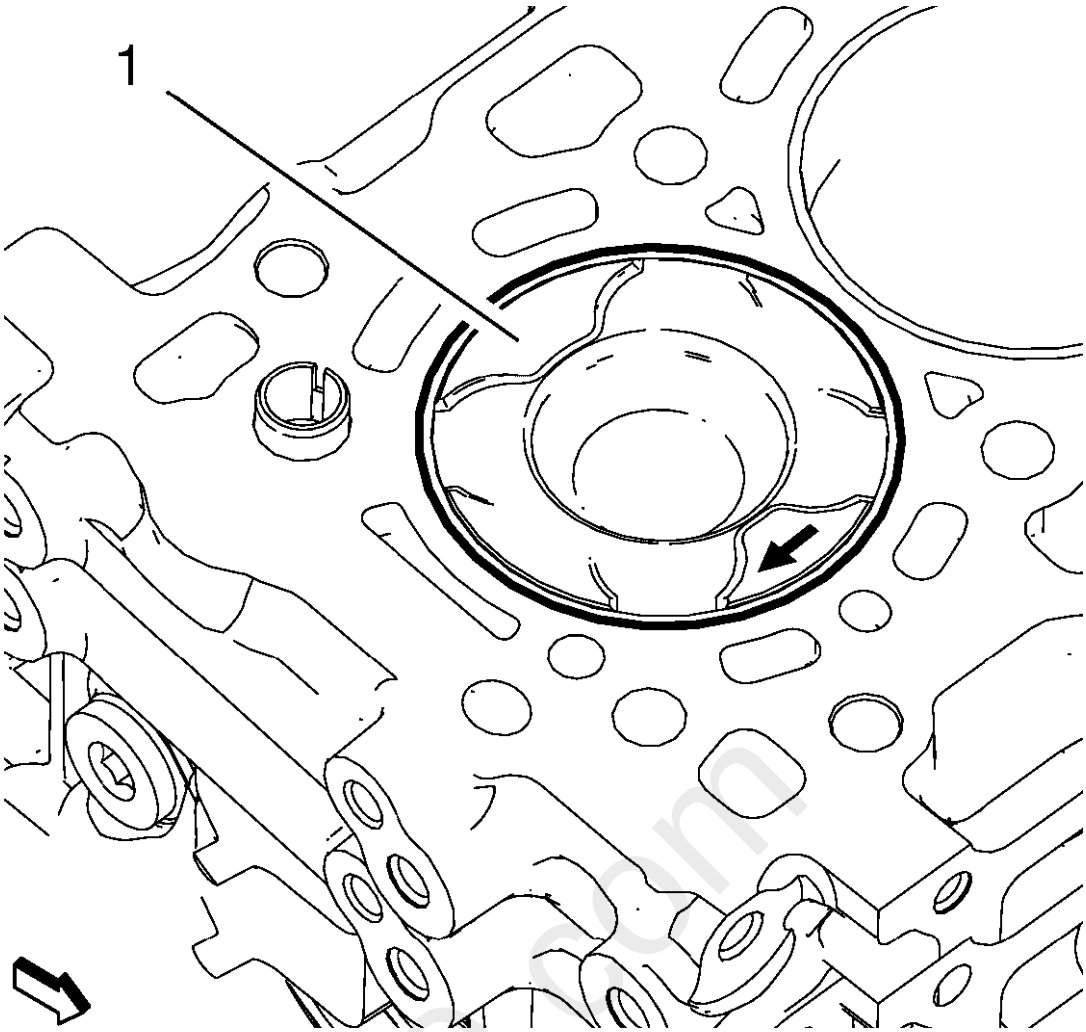


Fig. 795: Arrow On Top Of Pistons Must Point To Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

5. The arrow on the top of the pistons (1) must point to front of the engine.

mcx30.com

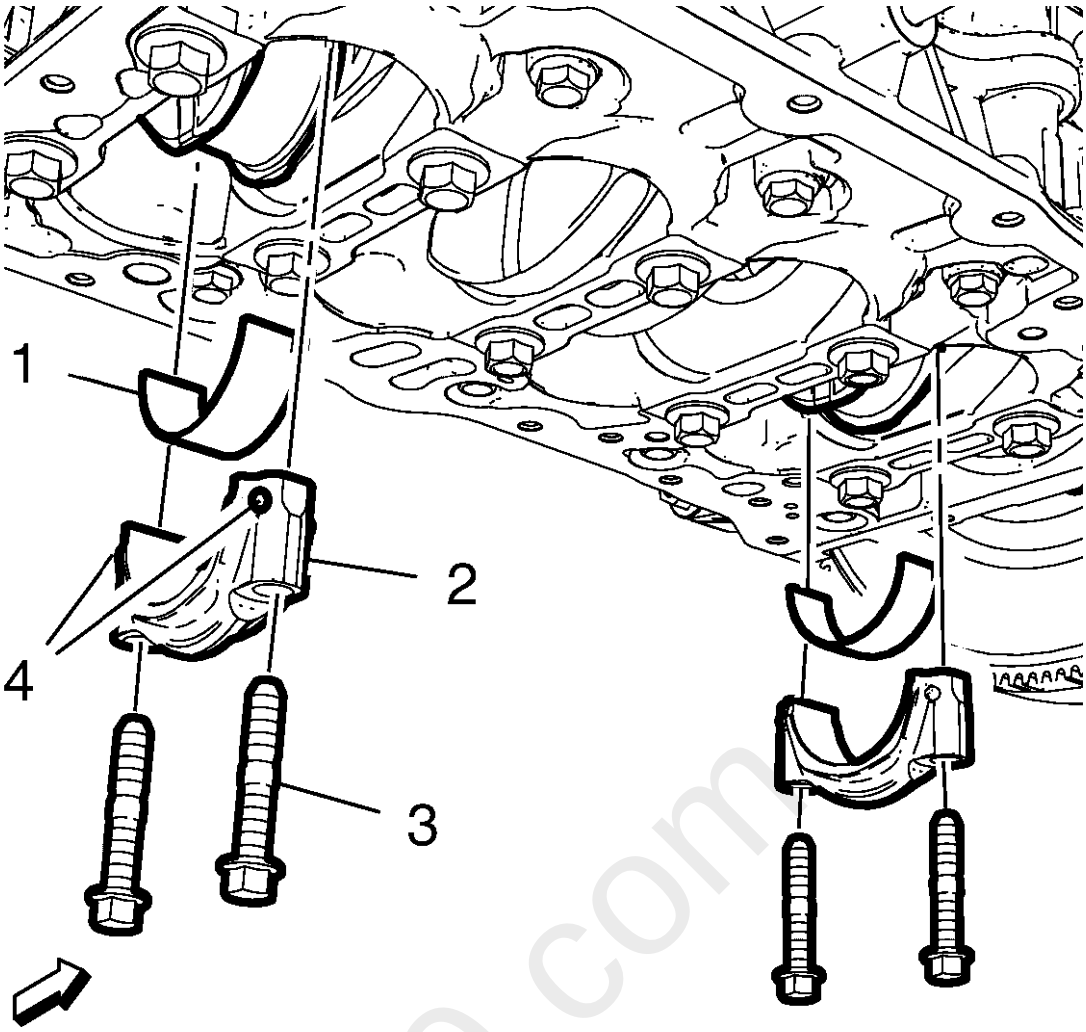


Fig. 796: Cylinder 1 And 4 Connecting Rod Caps, Bolts And Lower Bearings
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The marks (4) of the connecting rod bearing caps, must point to front of the engine.**

NOTE: **If the old connecting rod bearing caps will be reused, install in their original position.**

6. Install the 2 connecting rod bearing caps (2) with the 2 connecting rod lower bearings (1) to the cylinder 1 and the cylinder 4.

CAUTION: **Refer to Fastener Caution .**

CAUTION: **Refer to Torque-to-Yield Fastener Caution .**

7. Install 4 NEW connecting bearing cap bolts (3) and tighten in two passes:
    1. First pass tighten to 25 N.m (18 lb ft).
    2. Final pass an additional to 110 degrees, using the **EN-45059** angle meter.
8. Set TDC of the cylinder 1. Rotate the crankshaft 180 degrees, use a pry bar at the 4 crankshaft pulley bolts (1).

mcx30.com

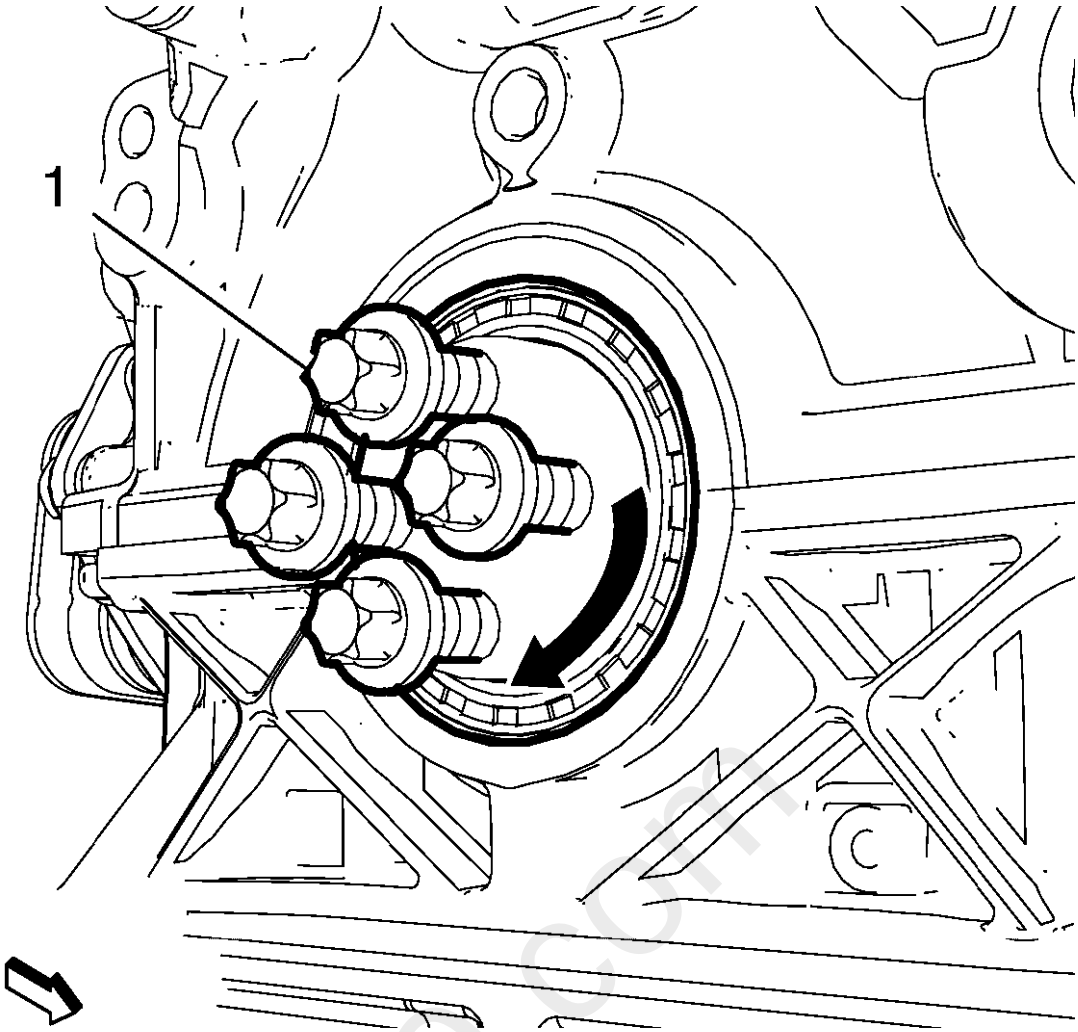


Fig. 797: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the 4 crankshaft pulley bolts (1).

mcx30.com

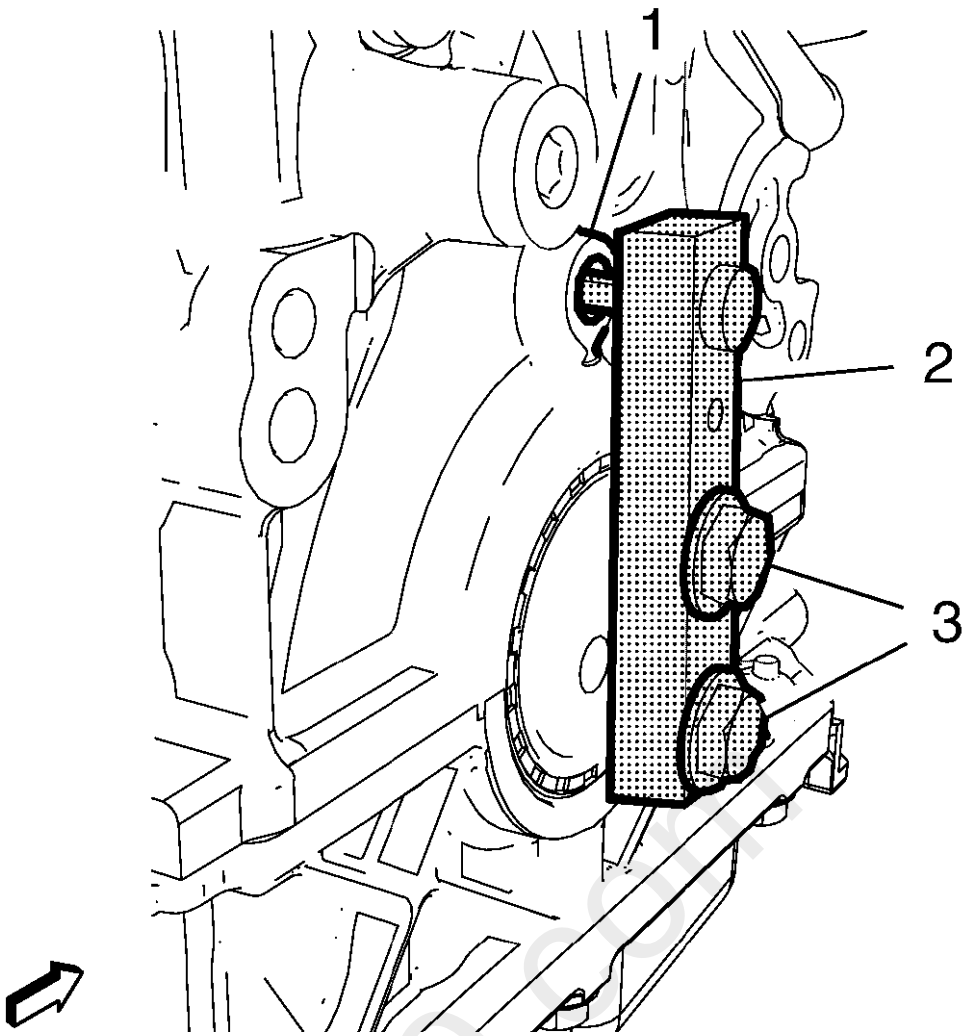


Fig. 798: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

10. Install **EN-51140** fixing tool (2).
11. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).

mcx30.com

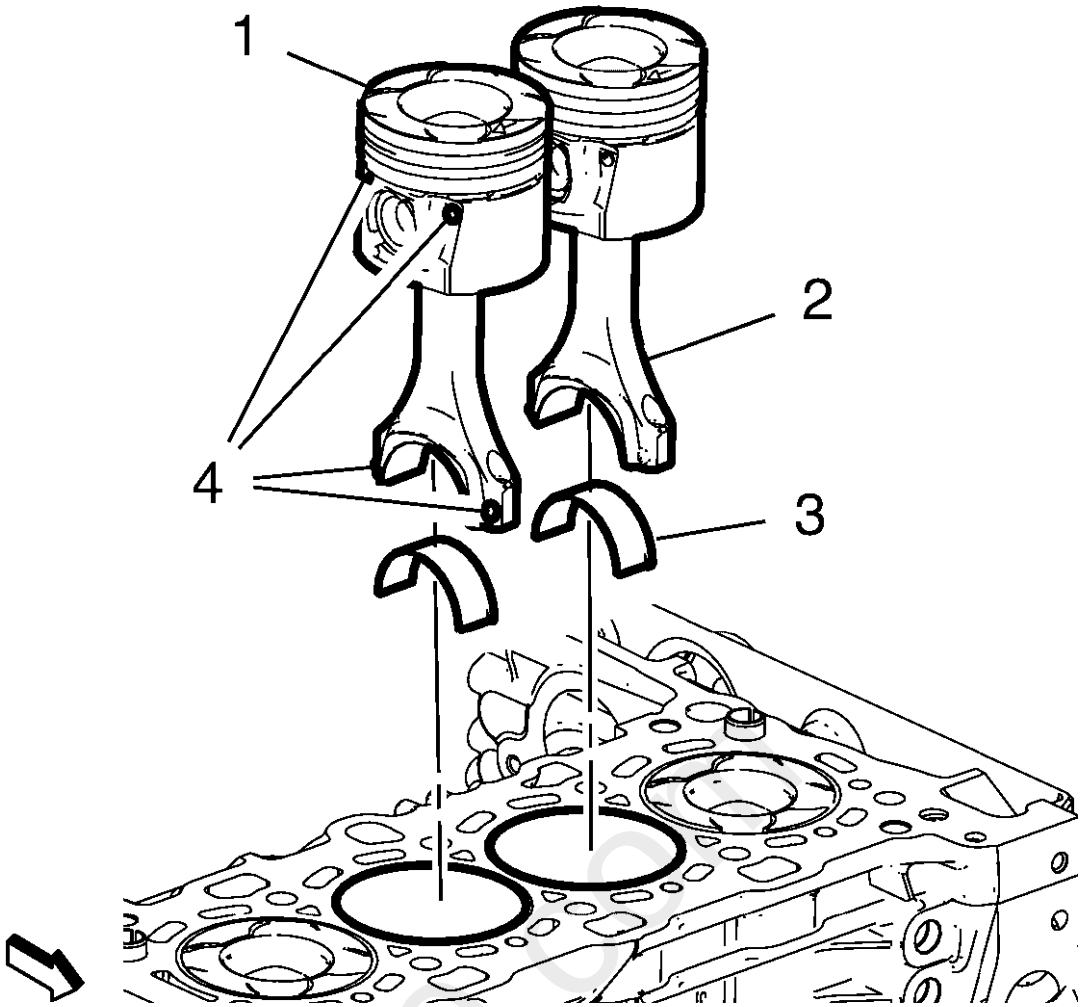


Fig. 799: Cylinder 2 And 3 Piston/Connecting Rod Assemblies And Upper Bearings
Courtesy of GENERAL MOTORS COMPANY

12. Install a piston ring compressor in order to compress the piston rings.

NOTE: **The arrow on the top of the piston and the marks (4) of the piston and connecting rod, must point to front of the engine.**

NOTE: **If the old piston and connecting rod will be reused, install in their original position.**

13. Install the 2 pistons (1) and the 2 connecting rods (2) with the connecting rod upper bearing (3) to the cylinder 2 and the cylinder 3.

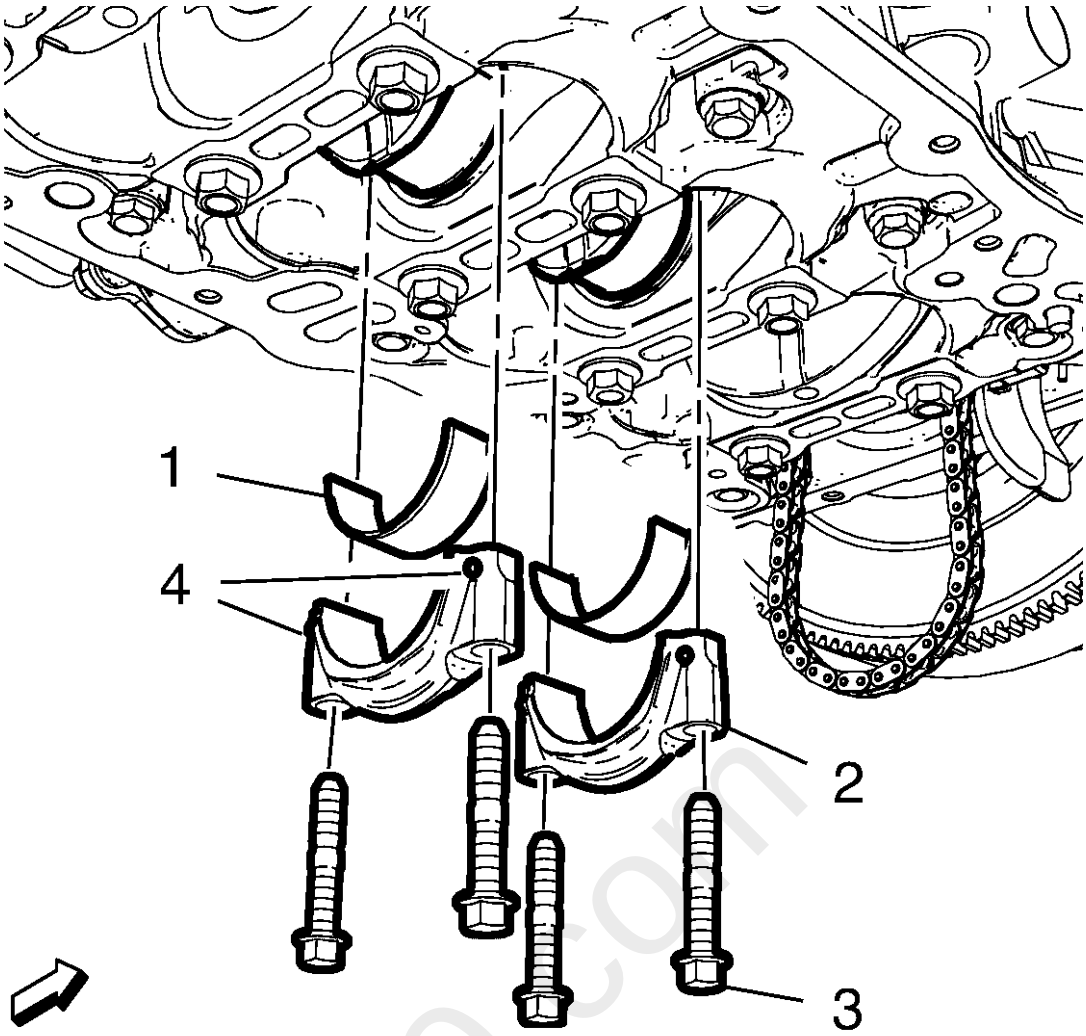


Fig. 800: Cylinder 2 And 3 Connecting Rod Caps, Bolts And Lower Bearings
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The marks (4) of the connecting rod bearing caps, must point to front of the engine.**

NOTE: **If the old connecting rod bearing caps will be reused, install in their original position.**

14. Install the 2 connecting rod bearing caps (2) with the 2 connecting rod lower bearings (1) to the cylinder 2 and the cylinder 3.

CAUTION: **Refer to Torque-to-Yield Fastener Caution .**

15. Install 4 NEW connecting bearing cap bolts (3) and tighten in two passes:
    1. First pass tighten to 25 N.m (18 lb ft).
    2. Final pass an additional to 110 degrees, using the **EN-45059** angle meter.

CYLINDER HEAD INSTALLATION

Special Tools

- **EN-45059** Angle Meter
- **EN-51140** Crankshaft Fixing Tool
- **GE-7872** Magnetic Base Dial Indicator

Equivalent regional tools: Special Tools

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.**
- **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.**

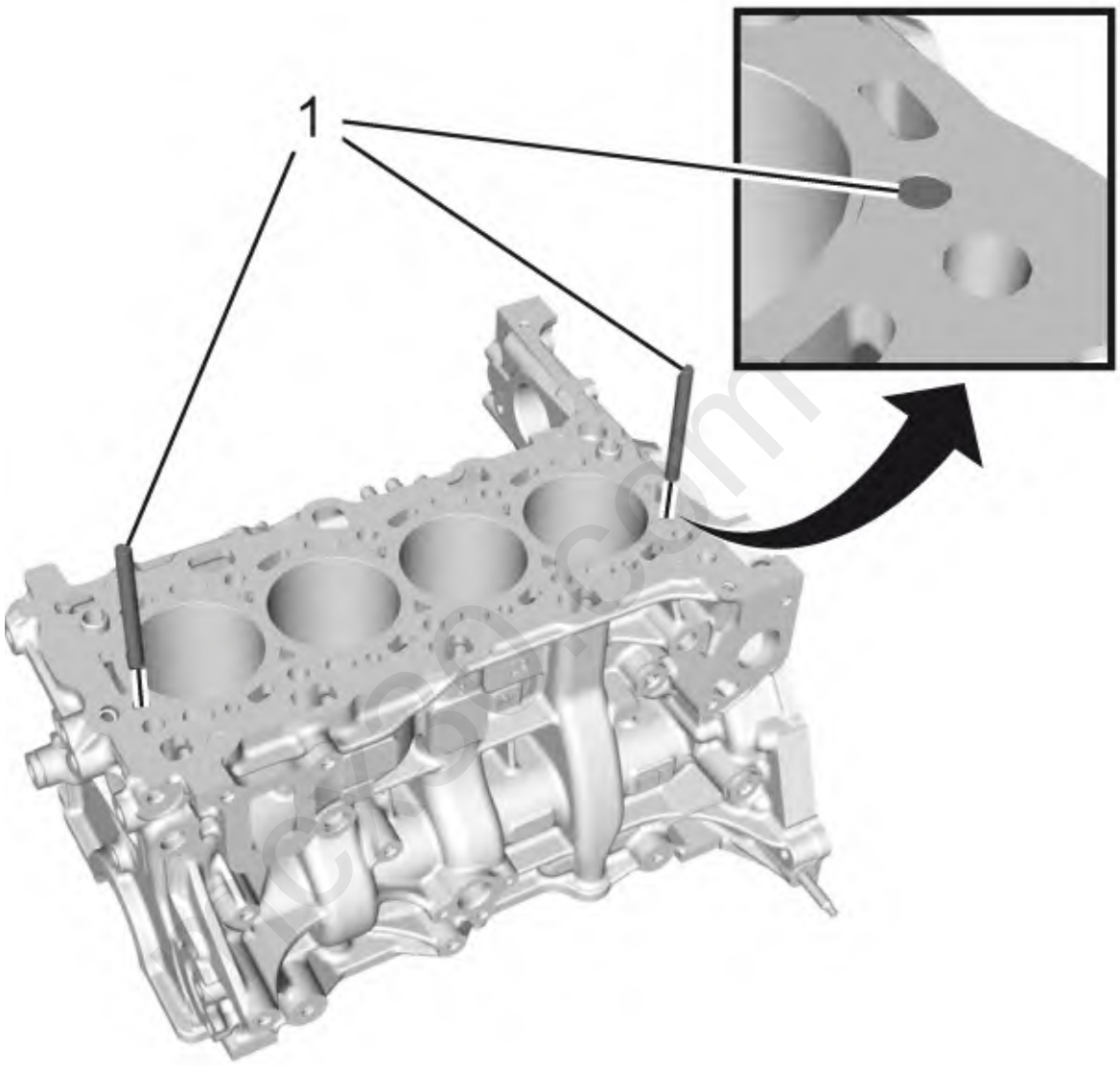


Fig. 801: Deflectors
Courtesy of GENERAL MOTORS COMPANY

1. Check that the 2 deflectors (1) are installed in the engine block and install 2 NEW deflectors if the deflectors are missing.

NOTE: **Ensure that the cylinder head and the cylinder block sealing surfaces are clear of oil, grease and old gasket material.**

2. Clean all sealing surfaces.
3. Inspect the flatness of the cylinder head and cylinder block sealing surfaces.
4. Set the TDC of cylinder 1.

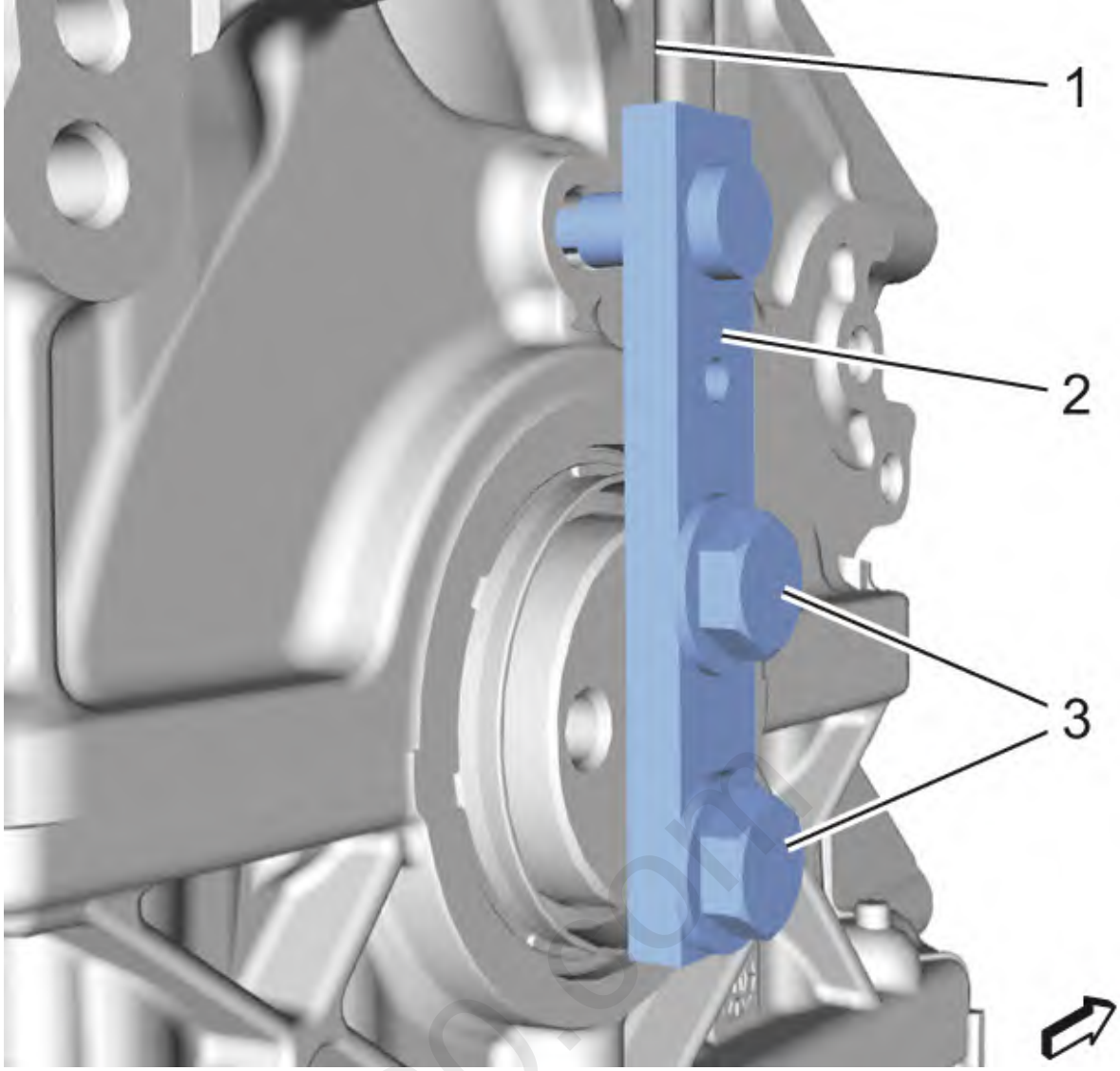


Fig. 802: Crankshaft Fixing Tool And Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the **EN-51140** fixing tool (2).
6. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).

mcx30.com

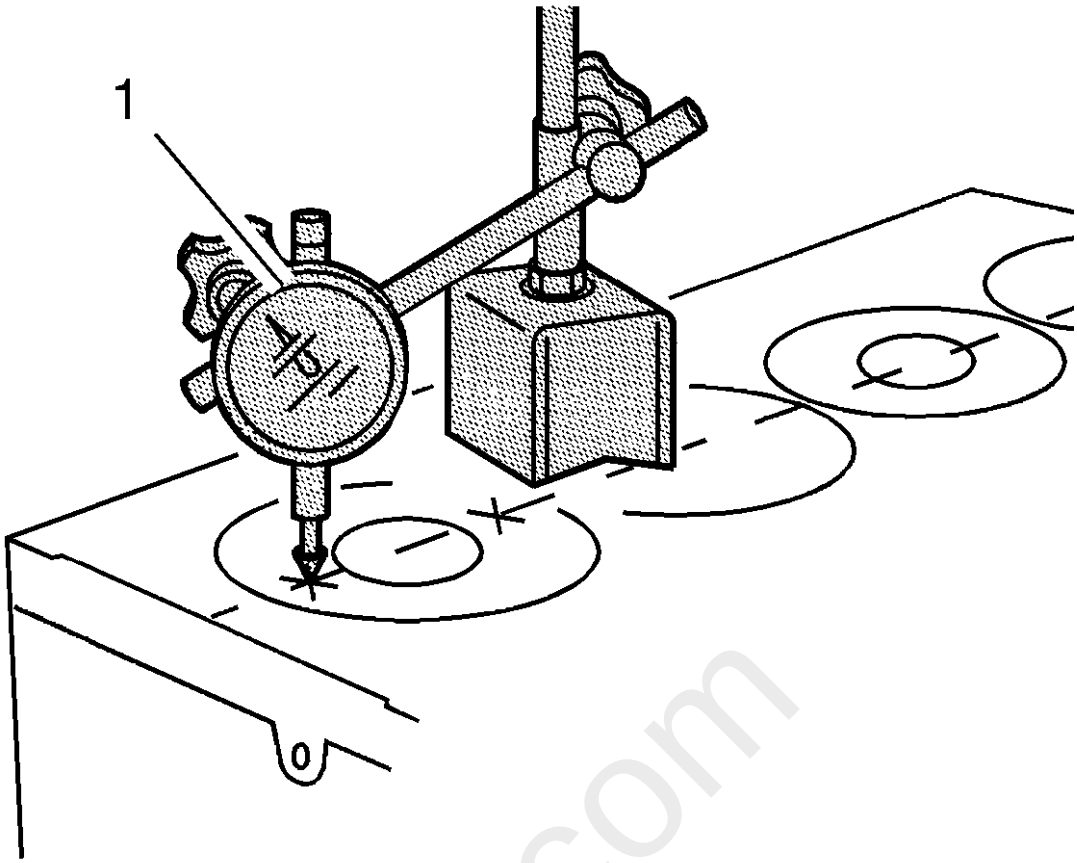


Fig. 803: Indicator
Courtesy of GENERAL MOTORS COMPANY

NOTE: **For the measurement, the piston has to stay on TDC. Measure the piston projection dimensions at all pistons.**

7. Install the **GE-7872** indicator (1).
8. Measure the piston projection of the cylinder 1 and the cylinder 4.

mox30.com

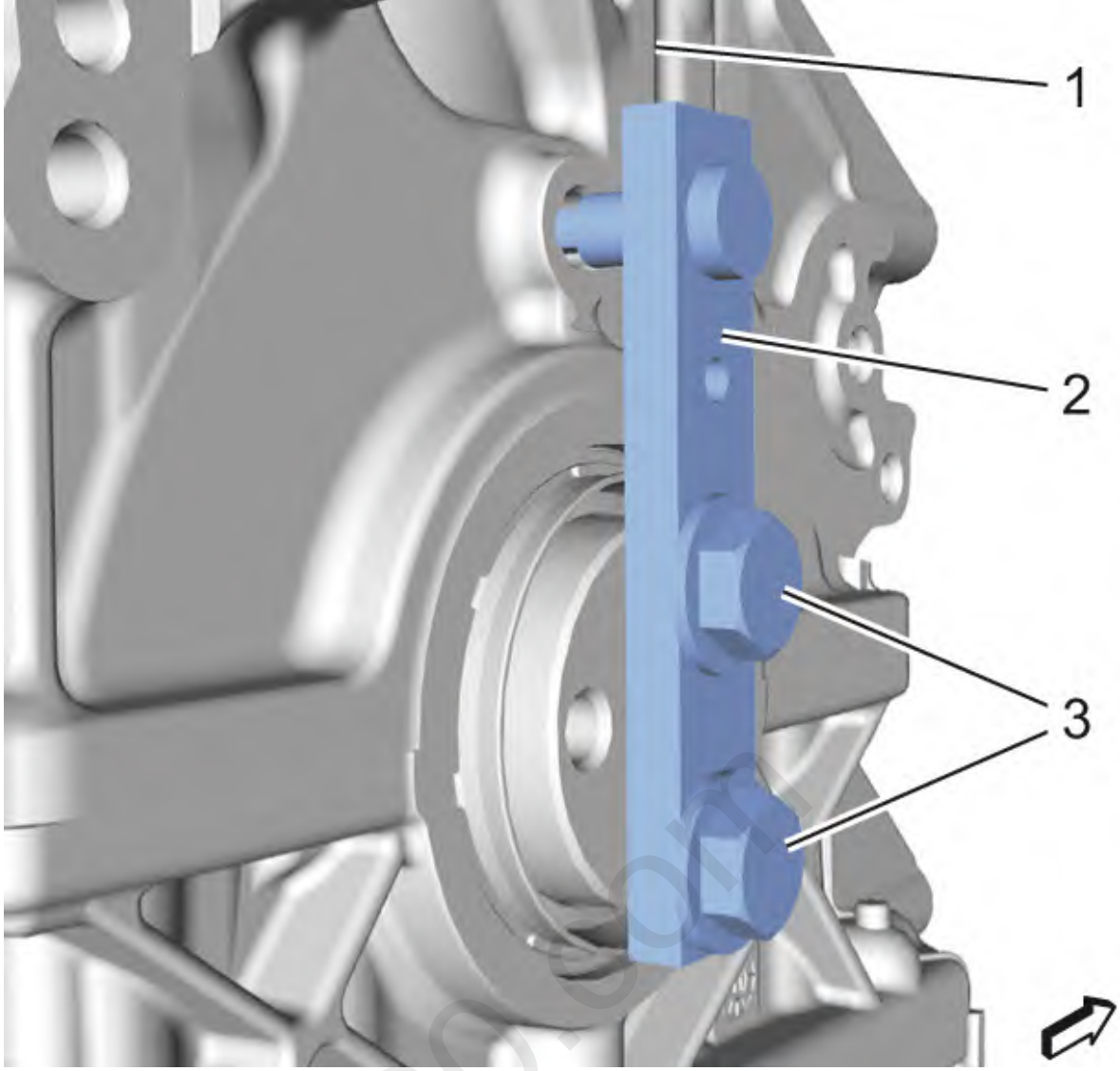


Fig. 804: Crankshaft Fixing Tool And Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove Bolts (3) (Qty: 2)
10. Remove the **EN-51140** fixing tool (2).

mcx30.com

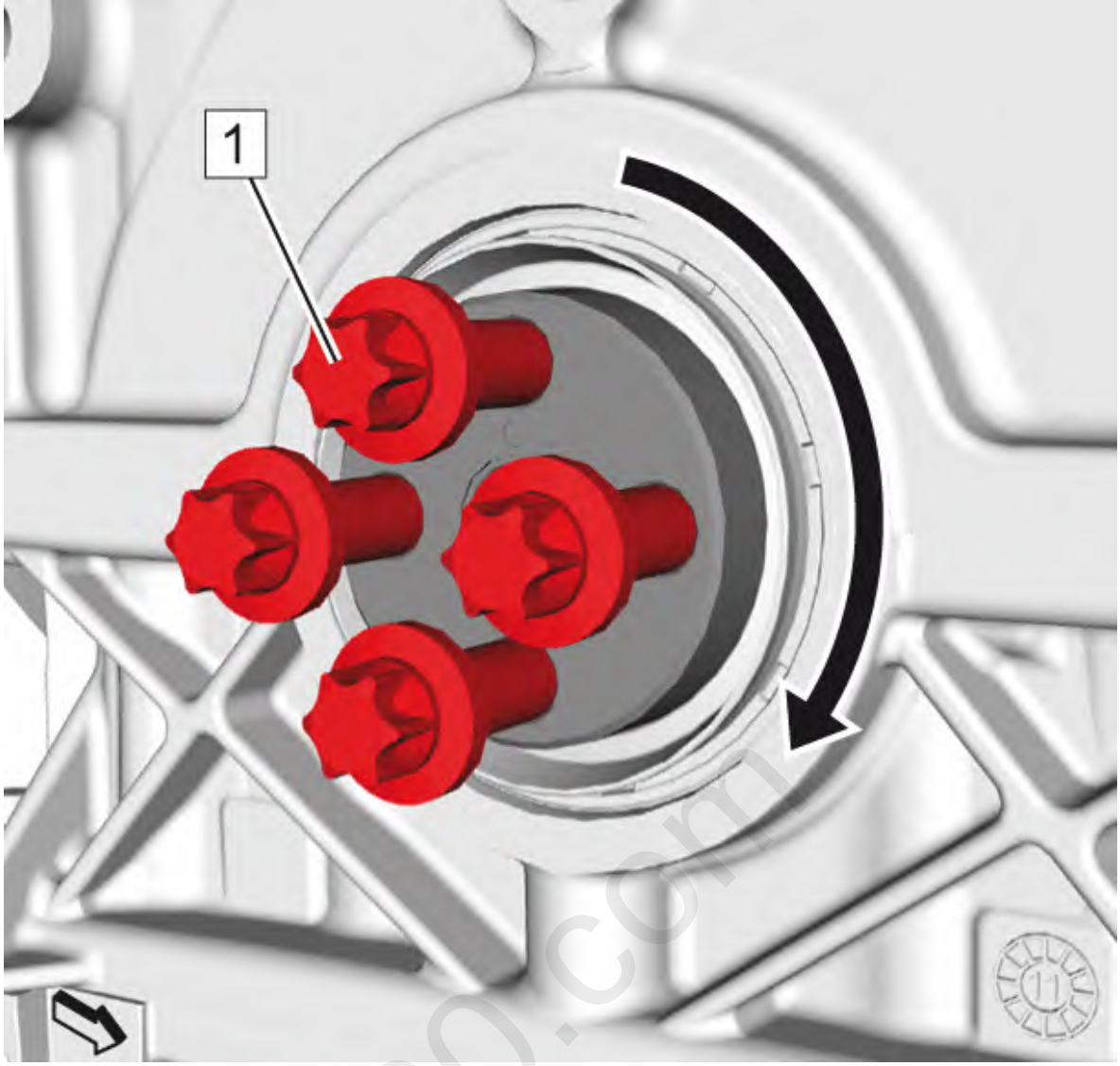


Fig. 805: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Install Crankshaft Pulley Bolts (1) (Qty: 4)
12. Rotate the crankshaft 360 degrees, use a pry bar at the 4 crankshaft pulley bolts (1).
13. Remove Crankshaft Pulley Bolts (1) (Qty: 4)

mx30.com

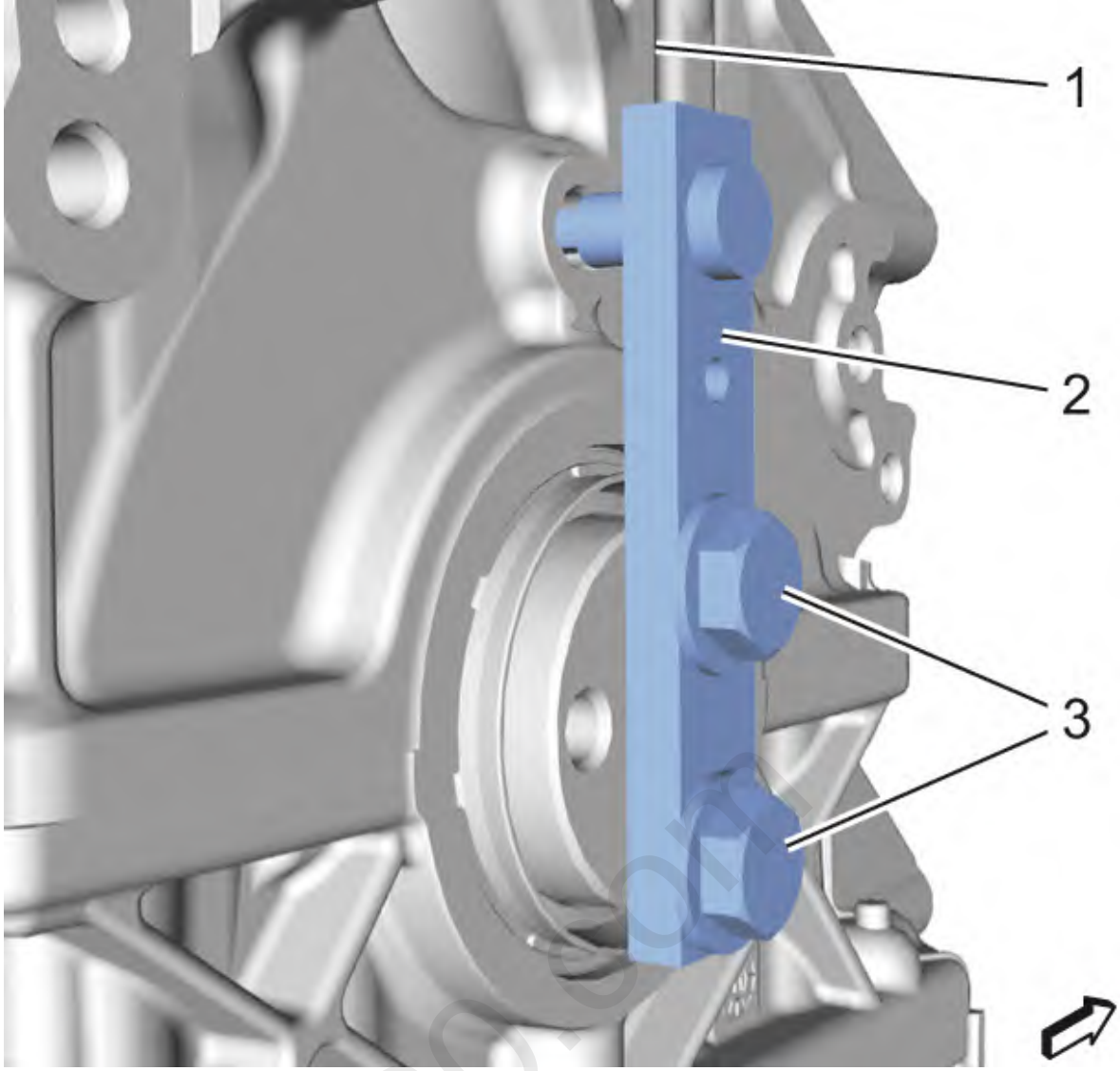


Fig. 806: Crankshaft Fixing Tool And Bolts
Courtesy of GENERAL MOTORS COMPANY

14. Install the **EN-51140** fixing tool (2).
15. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).
16. Measure the piston projection of the cylinder 2 and the cylinder 3.

mx5.com

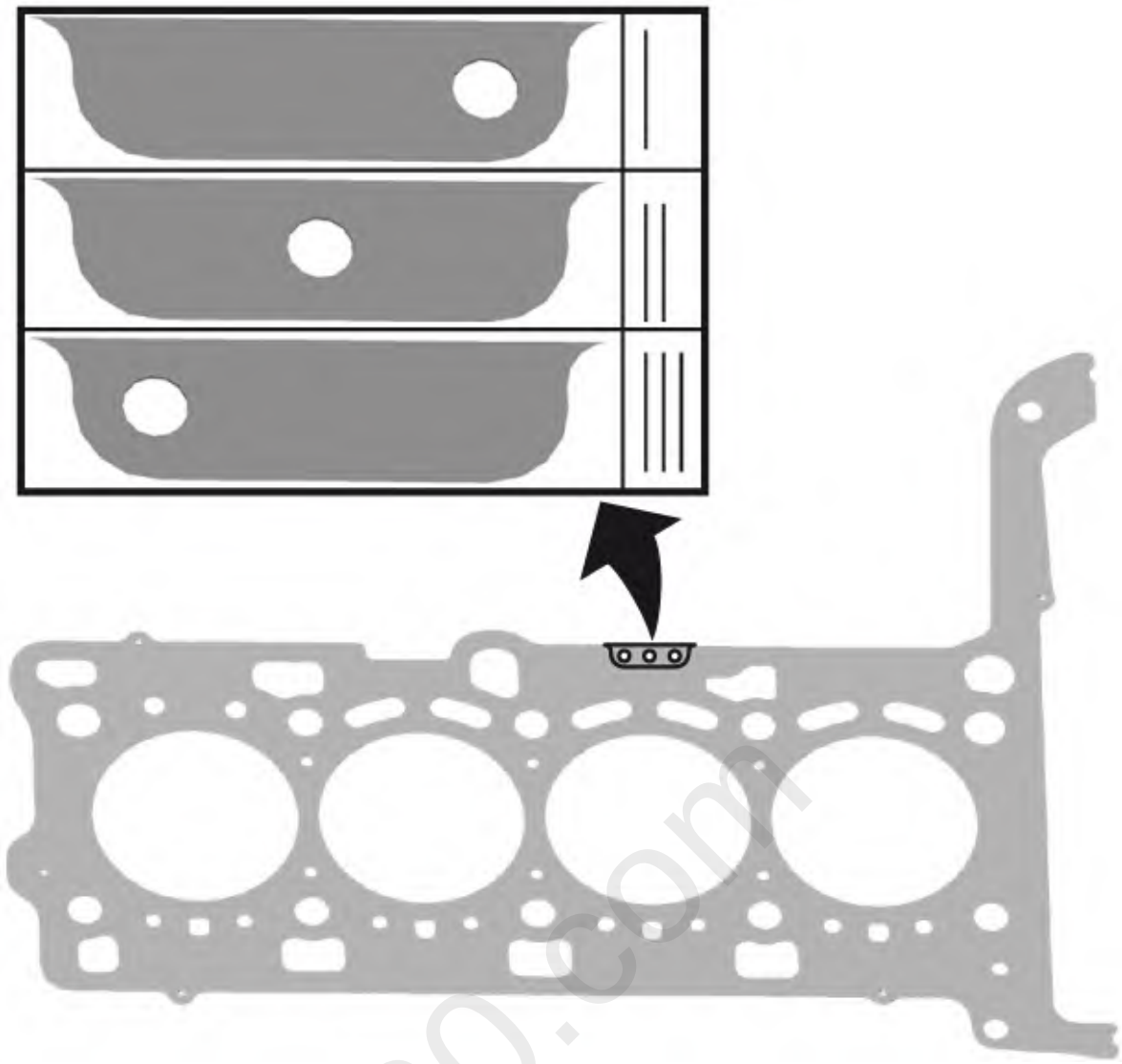


Fig. 807: Cylinder Head Gasket Identification Marks
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The largest piston projection is decisive for the selection of the cylinder head gasket with the corresponding marking. The different between the three max. projection measurements must be no greater than 0.1 mm (0.0039 in).**

17. Select the cylinder head gasket with the correct identification marks (1):
    1. Piston projection 0.440 - 0.535 mm (0.0173 - 0.0211 in), choose cylinder head gasket with identification mark on Position I, thickness 1.25 mm (0.049 in).
    2. Piston projection 0.535 - 0.630 mm (0.0211 - 0.0248 in), choose cylinder head gasket with identification mark on Position II, thickness 1.35 mm (0.053 in).
    3. Piston projection 0.630 - 0.725 mm (0.0248 - 0.0285 in), choose cylinder head gasket with identification mark on Position III, thickness 1.45 mm (0.057 in).

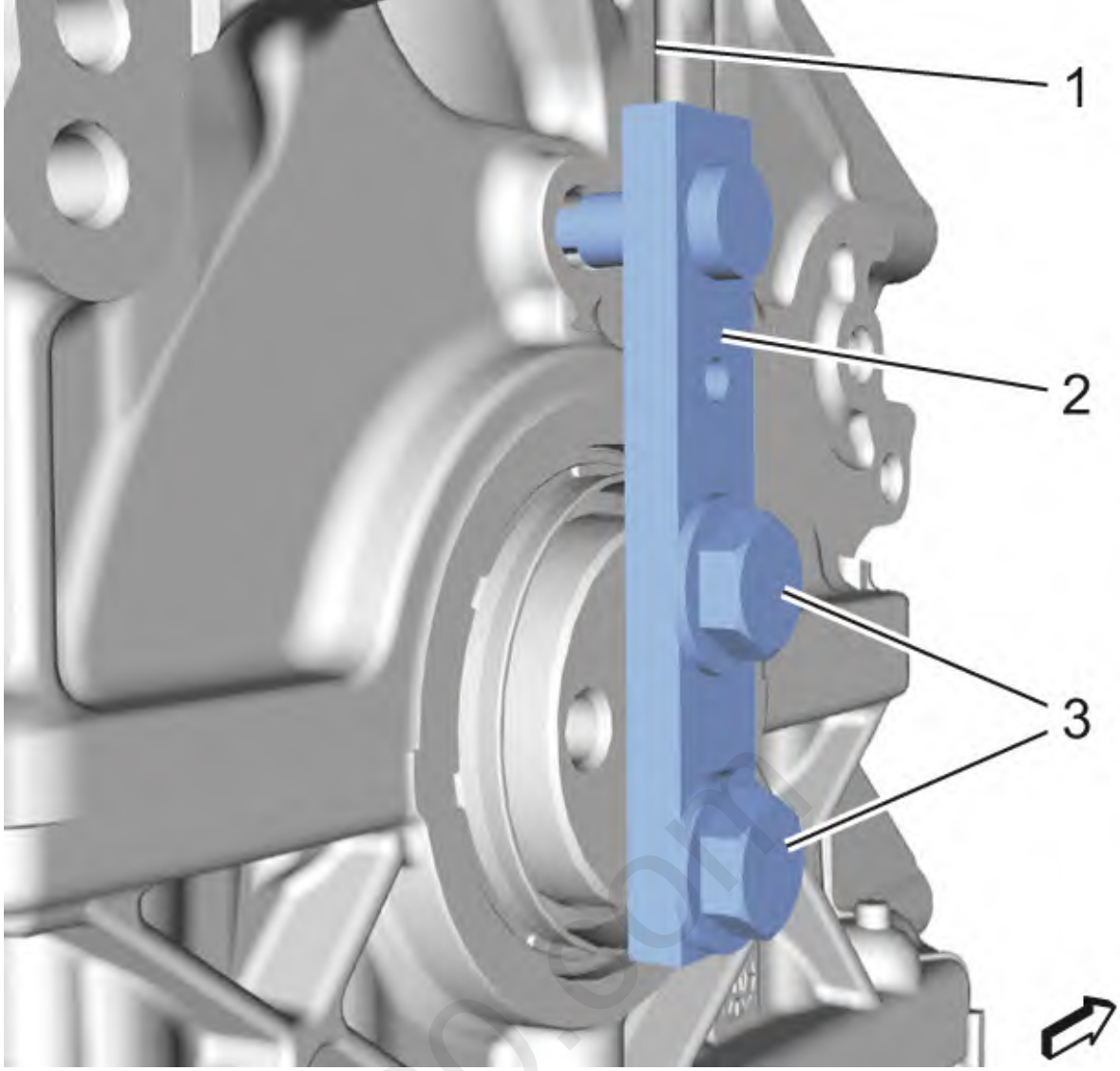


Fig. 808: Crankshaft Fixing Tool And Bolts
Courtesy of GENERAL MOTORS COMPANY

18. Remove Bolts (3) (Qty: 2)
19. Remove the **EN-51140** fixing tool (2).

mcx30.com

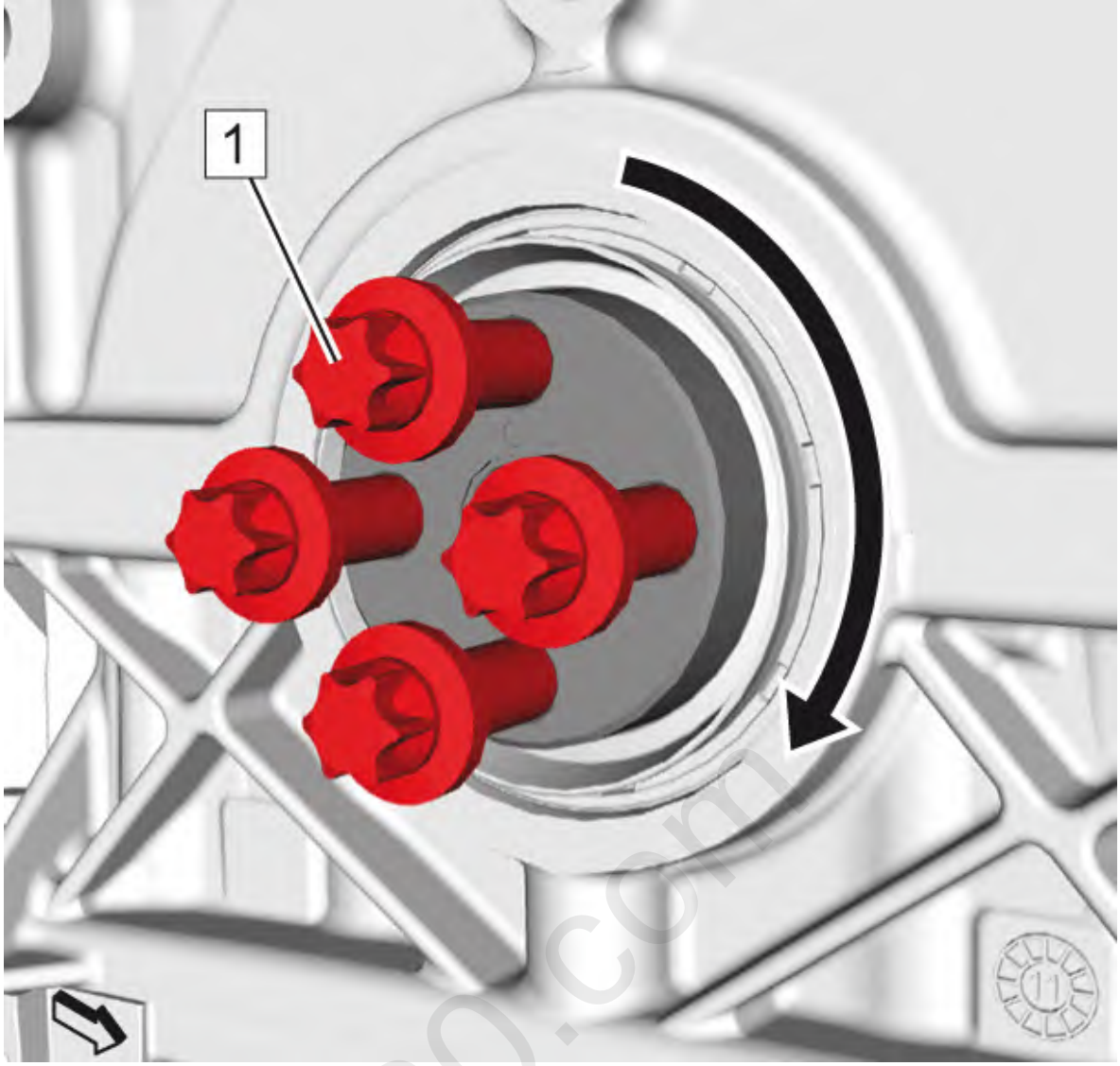


Fig. 809: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

20. Install Crankshaft Pulley Bolts (1) (Qty: 4)
21. Rotate the crankshaft 360 degrees, use a pry bar at the 4 crankshaft pulley bolts (1).
22. Remove Crankshaft Pulley Bolts (1) (Qty: 4)

mx30.com

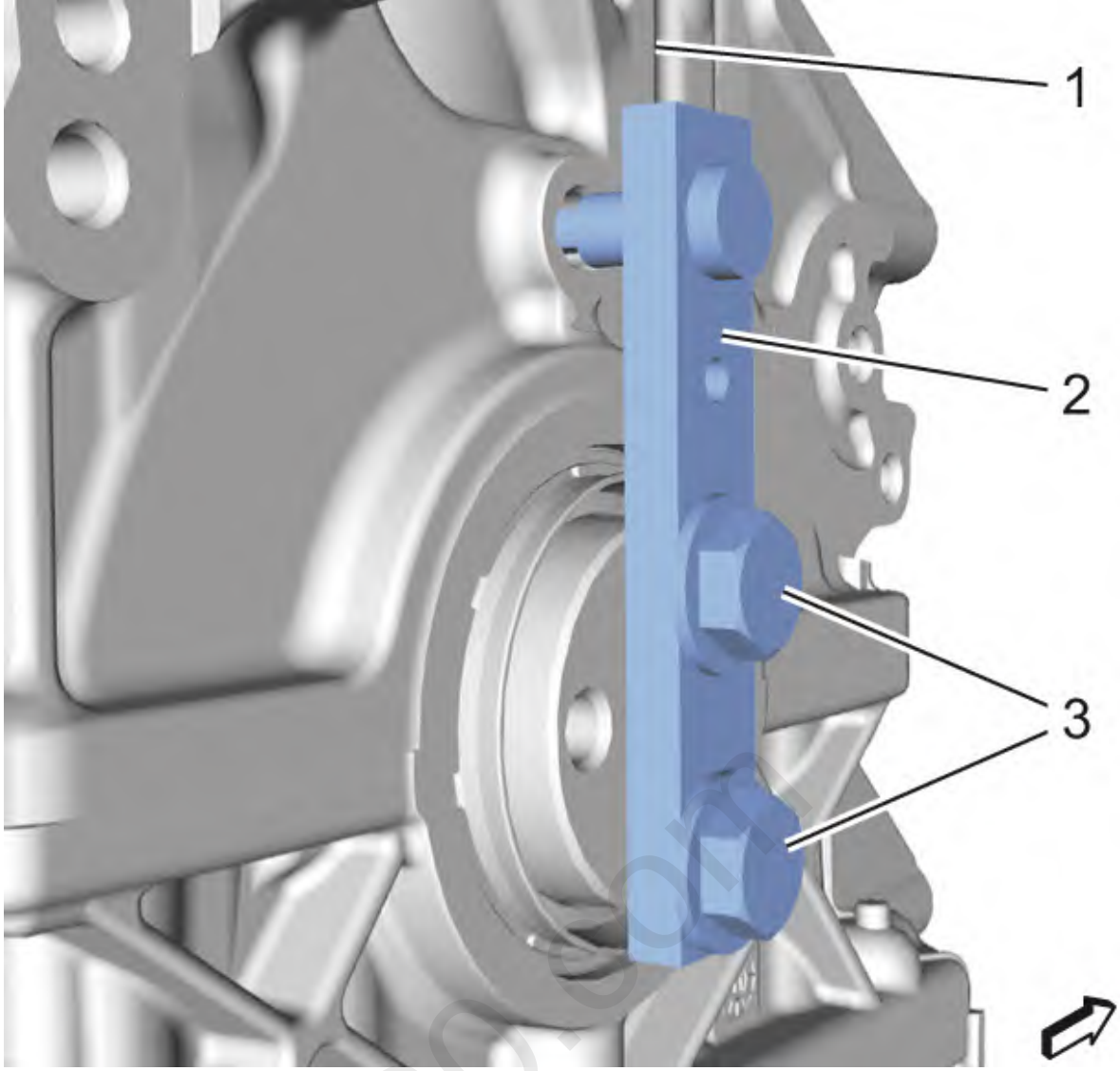


Fig. 810: Crankshaft Fixing Tool And Bolts
Courtesy of GENERAL MOTORS COMPANY

23. Install the **EN-51140** fixing tool (2) to fix the TDC of cylinder 1.
24. Install the fixing pin into the engine block bore (1) and tighten the 2 bolts (3).

mox2.com

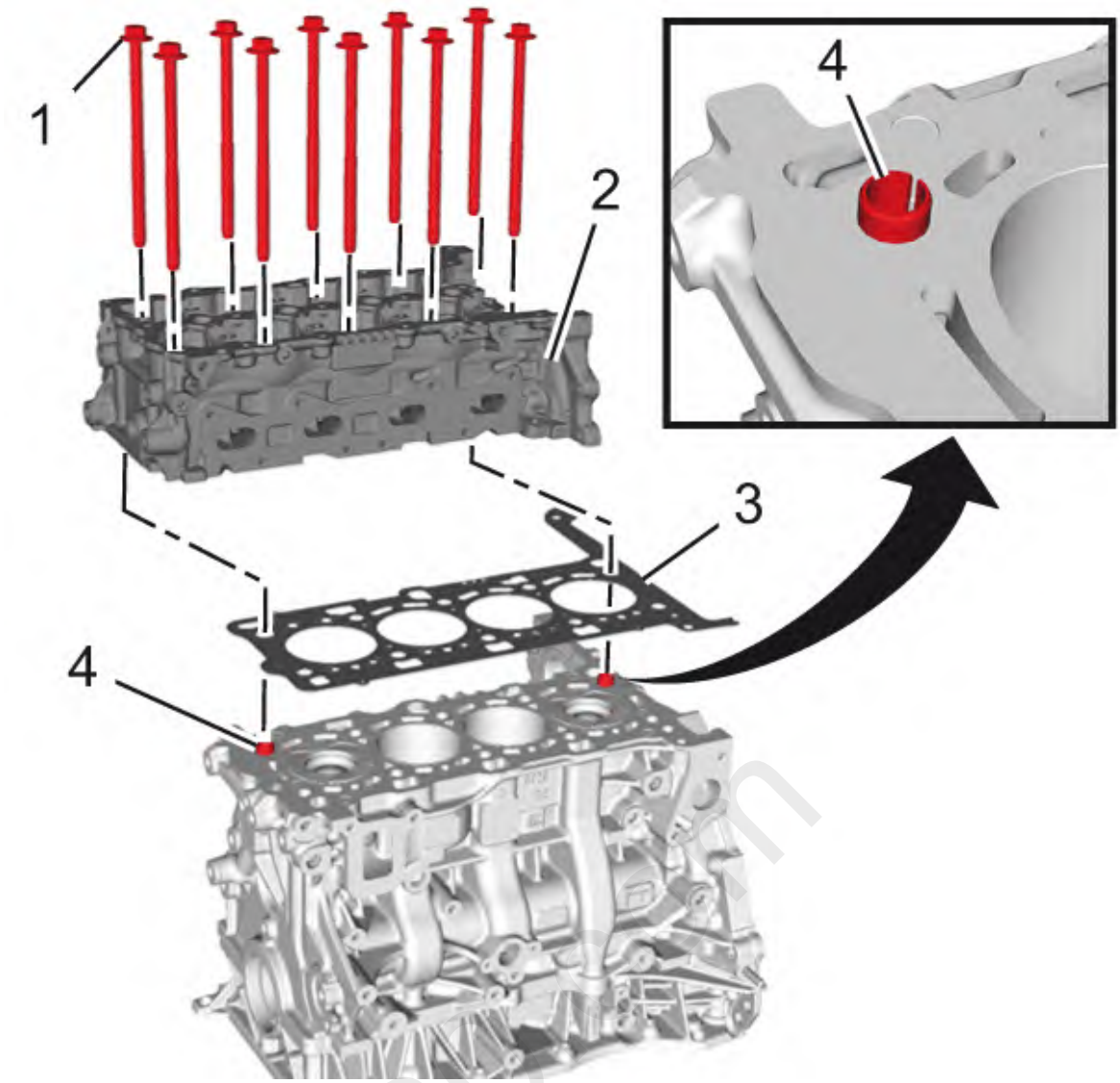


Fig. 811: Cylinder Head, Guide Sleeves, Gasket And Bolts
Courtesy of GENERAL MOTORS COMPANY

25. Install NEW Cylinder Head Gasket (3)

NOTE: **Ensure the guide sleeves (4) are properly seated in the engine block.**

26. Install Cylinder Head (2)
27. Install NEW Cylinder Head Bolts (1) (Qty: 10) - Do NOT tighten.

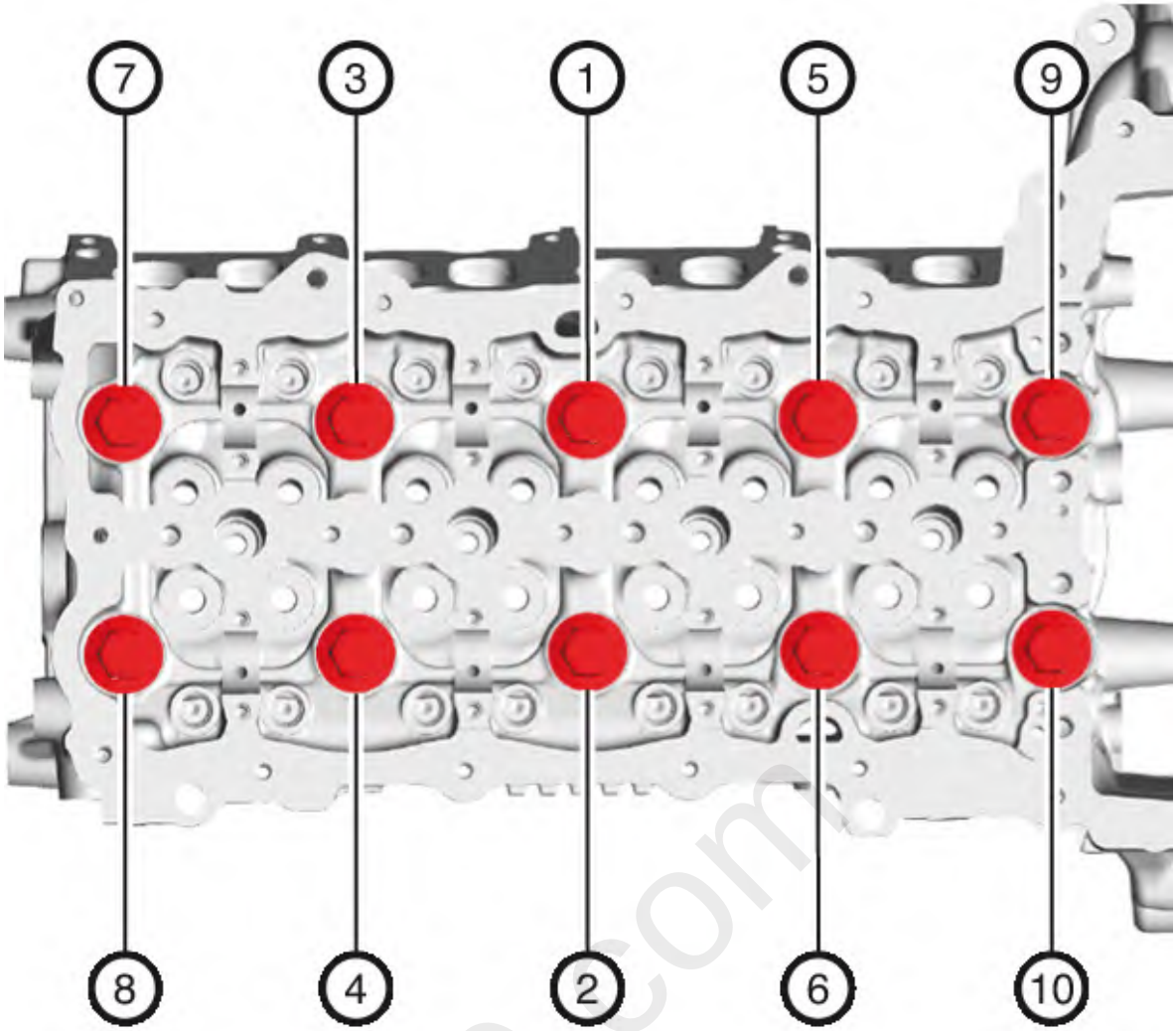


Fig. 812: Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

28. Tighten Cylinder Head Bolts in sequence

CAUTION: **Refer to Fastener Caution**

CAUTION: **Refer to Torque-to-Yield Fastener Caution**

1. First Pass: 50 N.m (37 lb ft)
2. Second Pass: 90 degrees - Use the special tool: **EN-45059** angle meter
3. Third Pass: 90 degrees - Use the special tool: **EN-45059** angle meter
4. Final Pass: 90 degrees - Use the special tool: **EN-45059** angle meter

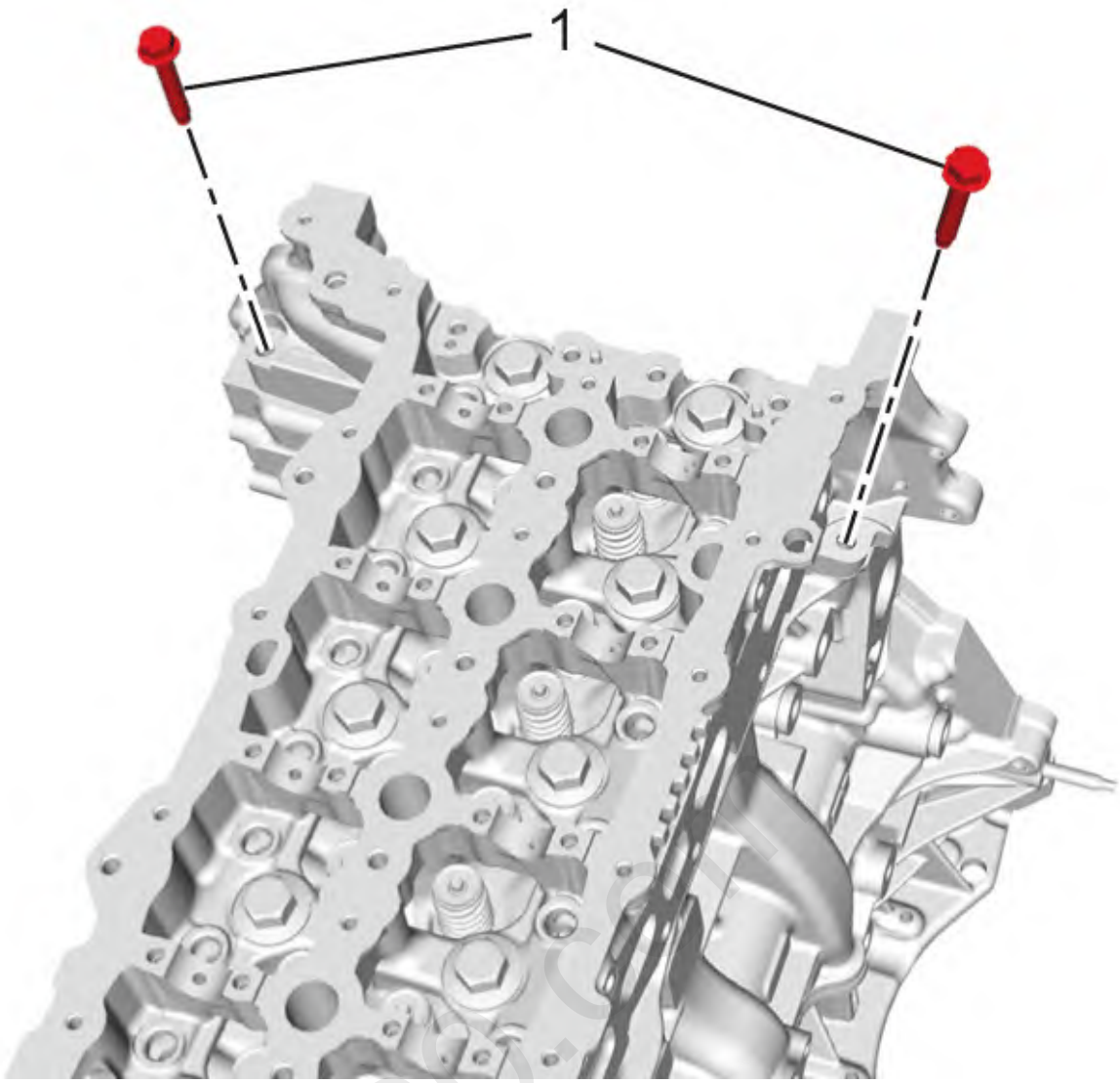


Fig. 813: Cylinder Head Outer Bolts
Courtesy of GENERAL MOTORS COMPANY

29. Install the NEW 2 cylinder head outer bolts (1) and tighten in 2 passes:

CAUTION: **Refer to Torque-to-Yield Fastener Caution**

1. First Pass: 20 N.m (15 lb ft)
2. Final Pass: 45 degrees - Use the special tool: **EN-45059** angle meter

mcx30.com

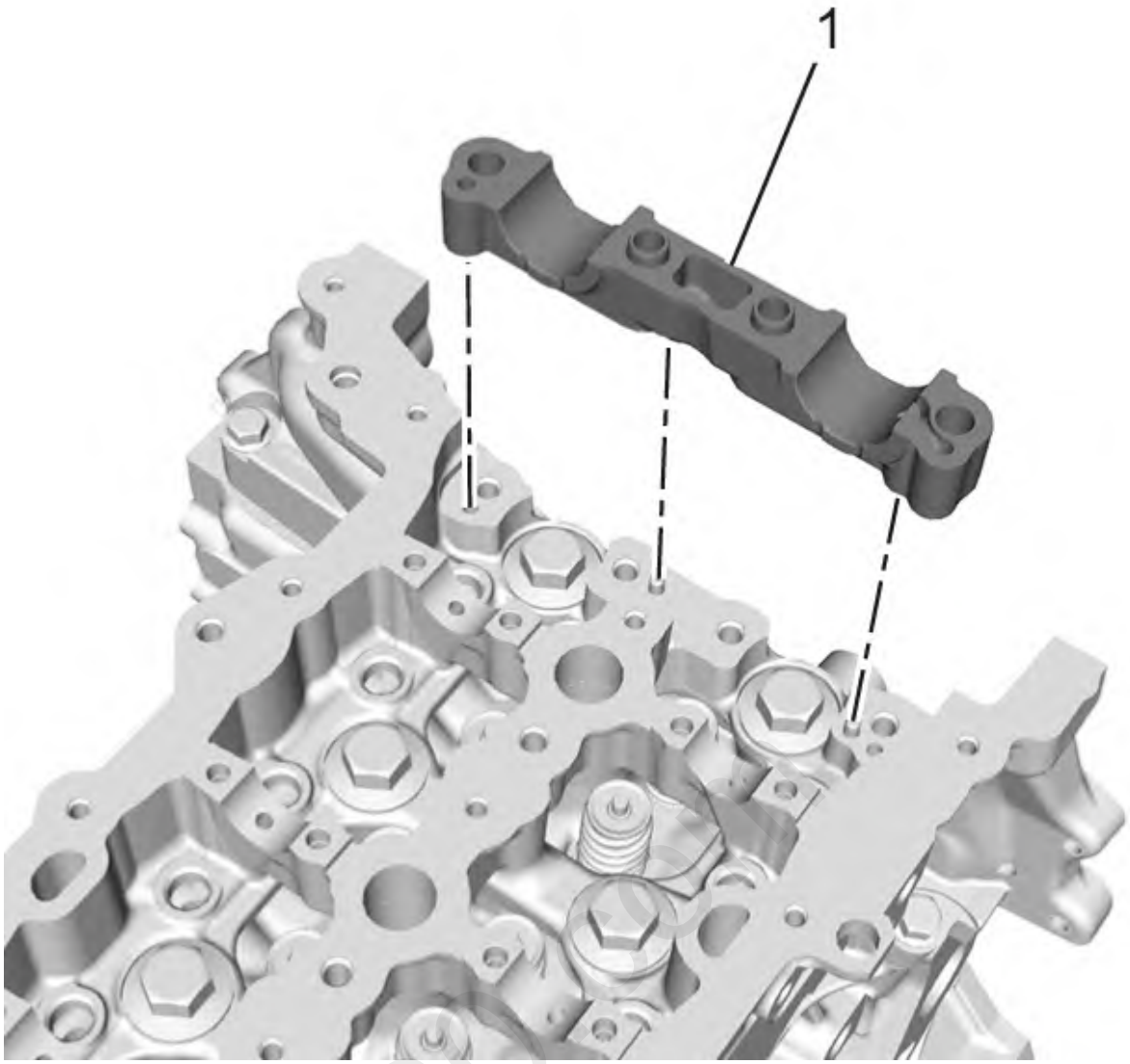


Fig. 814: Bearing Bracket
Courtesy of GENERAL MOTORS COMPANY

30. Install the bearing bracket (1).

CAMSHAFT POSITION SENSOR INSTALLATION

mcx30.com

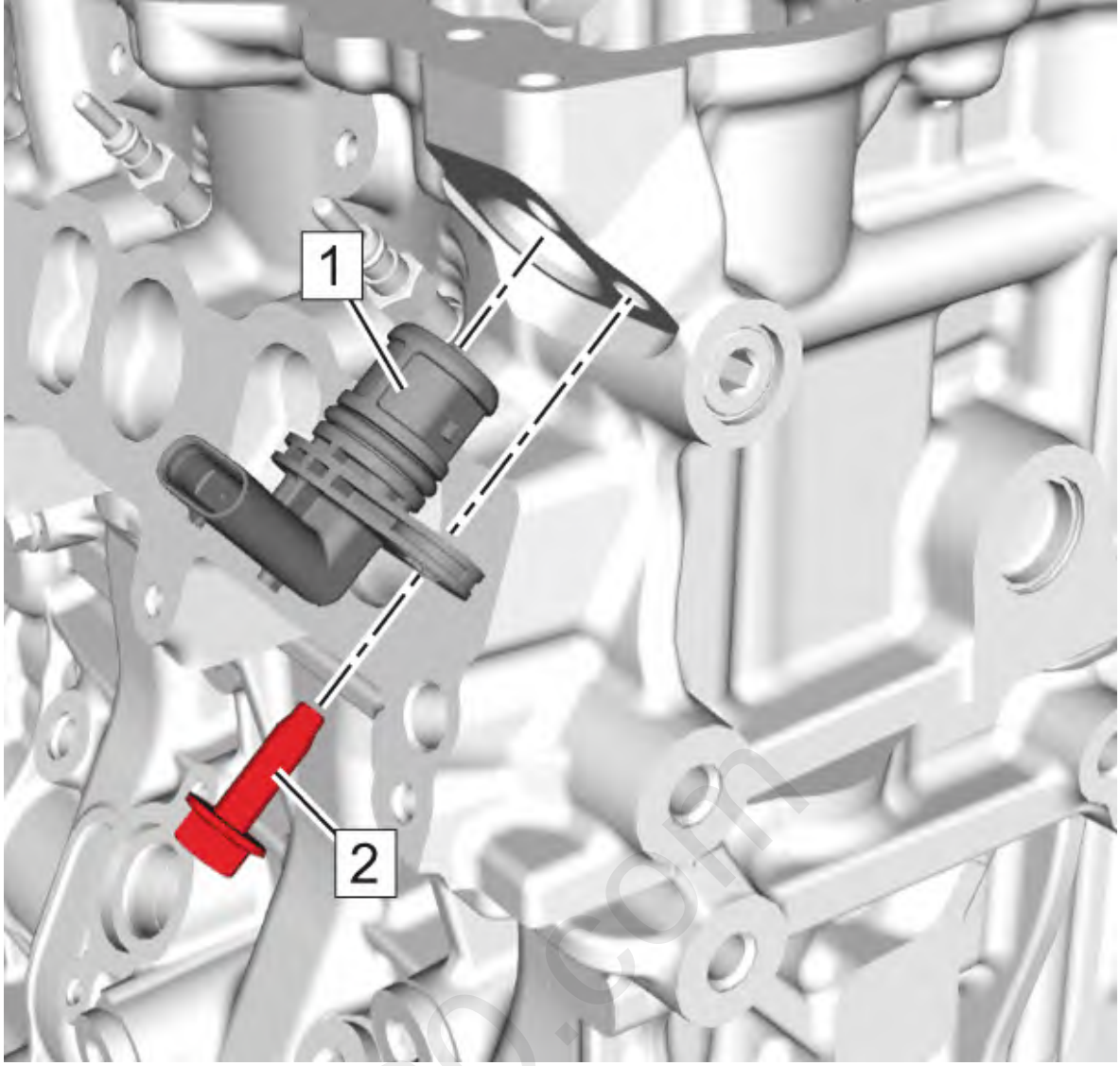


Fig. 815: Camshaft Position Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install Camshaft Position Sensor (1)

CAUTION: **Refer to Fastener Caution**

2. Install and tighten Camshaft Position Sensor Bolt (2) to 10 N.m (89 lb in)

GLOW PLUG INSTALLATION

Special Tools

EN-6104 Glow Plug Socket

Equivalent regional tools :**Special Tools**

mcx30.com

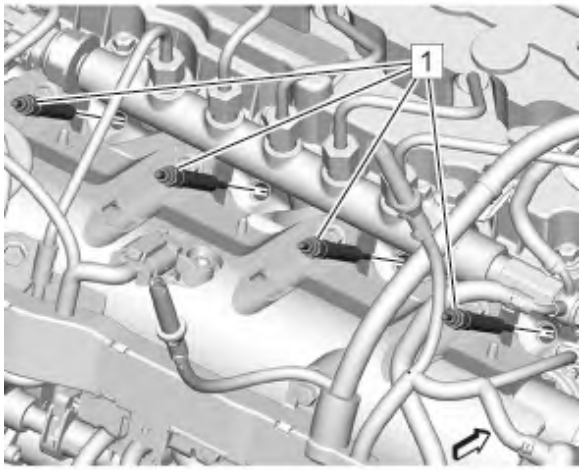


Fig. 816: Glow Plugs
Courtesy of GENERAL MOTORS COMPANY

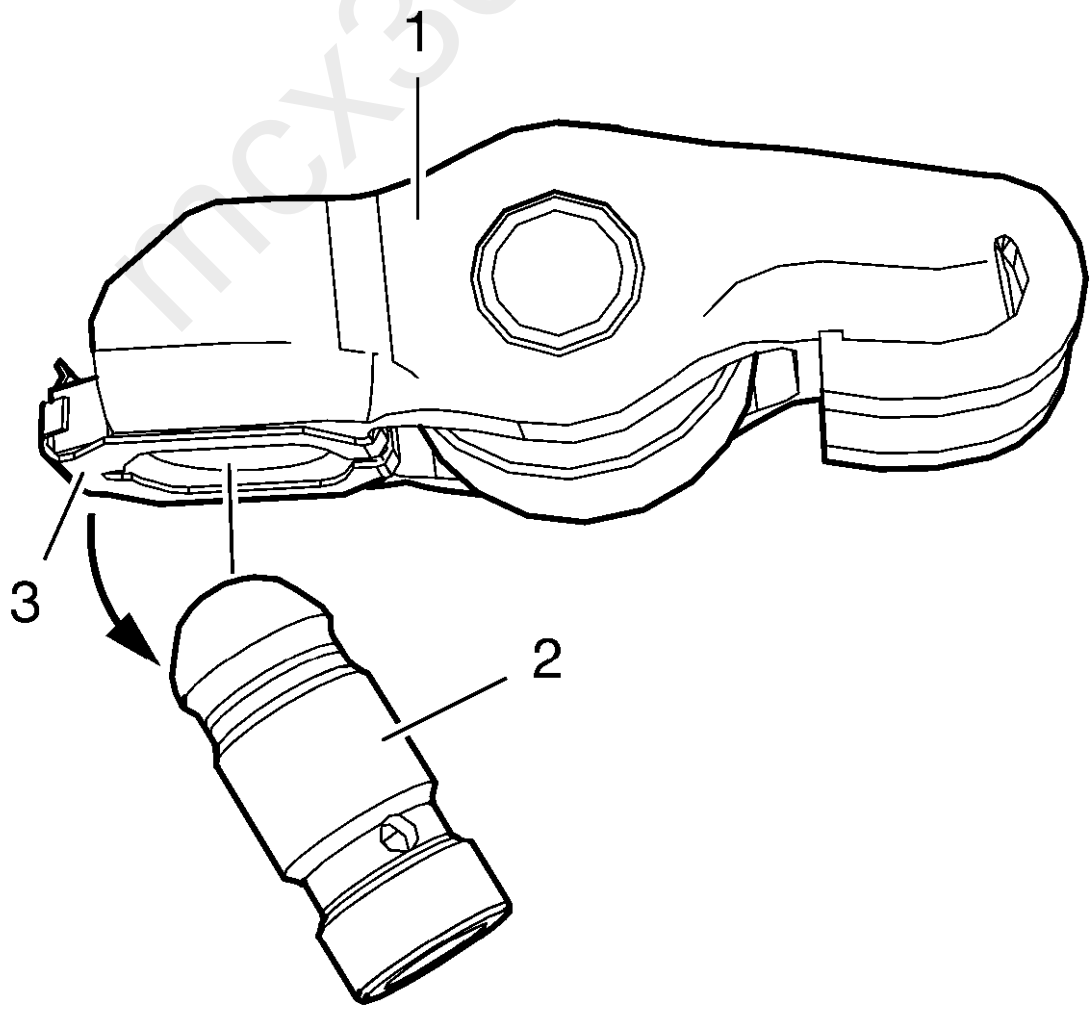
CAUTION: **Refer to Fastener Caution**

NOTE: **To aid in hand starting glow plugs into their bores, a hose or tube with an inner diameter of 4 mm (0.2 in) can be used as an extension when installed on the end of the glow plug.**

1. Install the 4 glow plugs (1) and tighten to 16.5 N.m (12 lb ft), using the **EN-6104** socket.

VALVE LIFTER INSTALLATION

1. Coat the 16 valve lifters with engine oil.



mcx30.com

Fig. 817: Valve Rocker Arms And Valve Lifters
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Clip in the valve lifter to the valve lifter roller. Mind to the centering link on retainer spring (3).**

2. Install the 16 valve lifters (2) to the valve lifter roller (1).

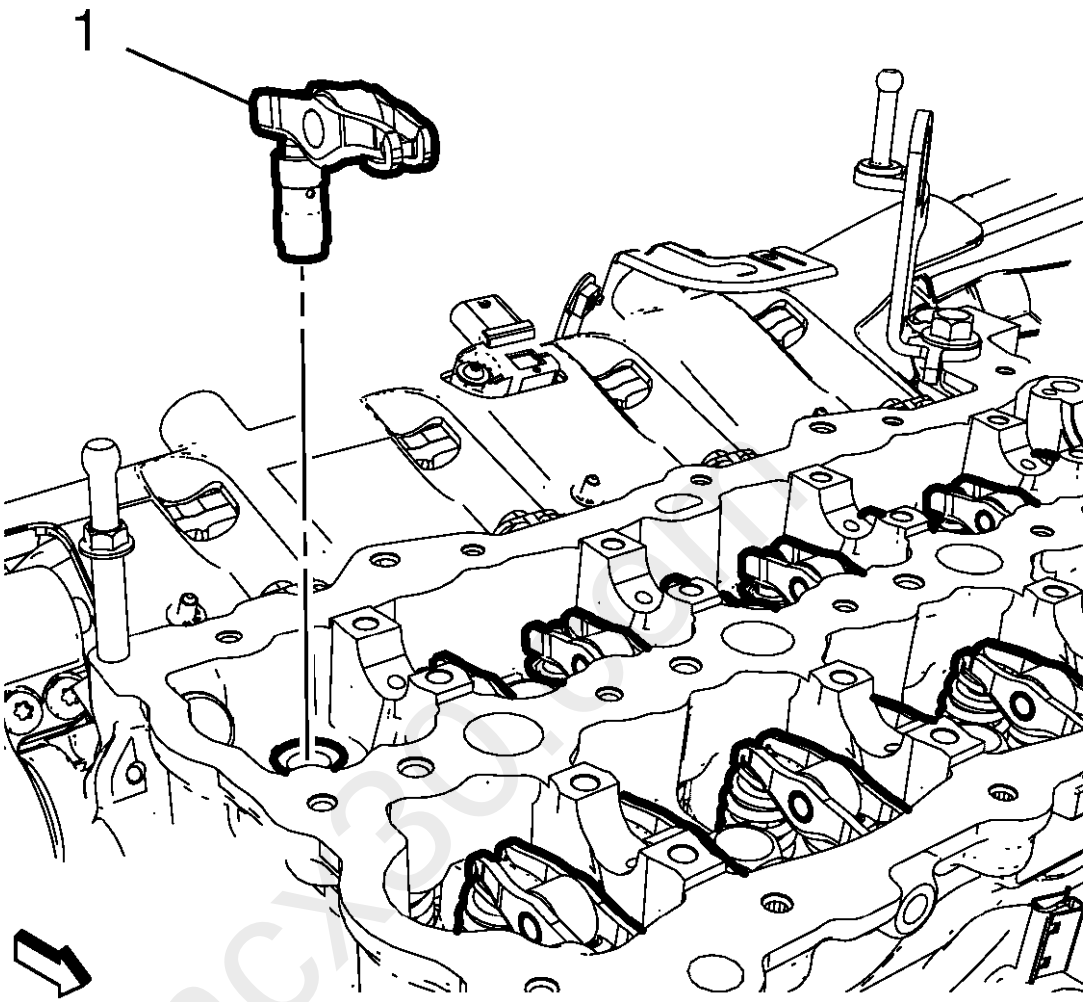


Fig. 818: Valve Lifter Roller Assemblies
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the valve lifters or valve lifter rollers are reused, the valve lifter or valve lifter roller must be installed in their original position.**

3. Install the 16 valve lifter with valve lifter roller (1) in the order as they was removed.

EXHAUST CAMSHAFT INSTALLATION

Special Tools

- **EN-50509** Split Intake Camshaft Sprocket Fixing Tool
- **EN-51143** Camshaft Sprocket Fixing Tool

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

NOTE: **Before installing the exhaust camshaft, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment

- Timing chain tensioner and timing chain tensioner shoe with plastic attachment
- Timing chain and all timing chain sprockets
- Oil pump sprocket
- Oil pump drive chain tensioner

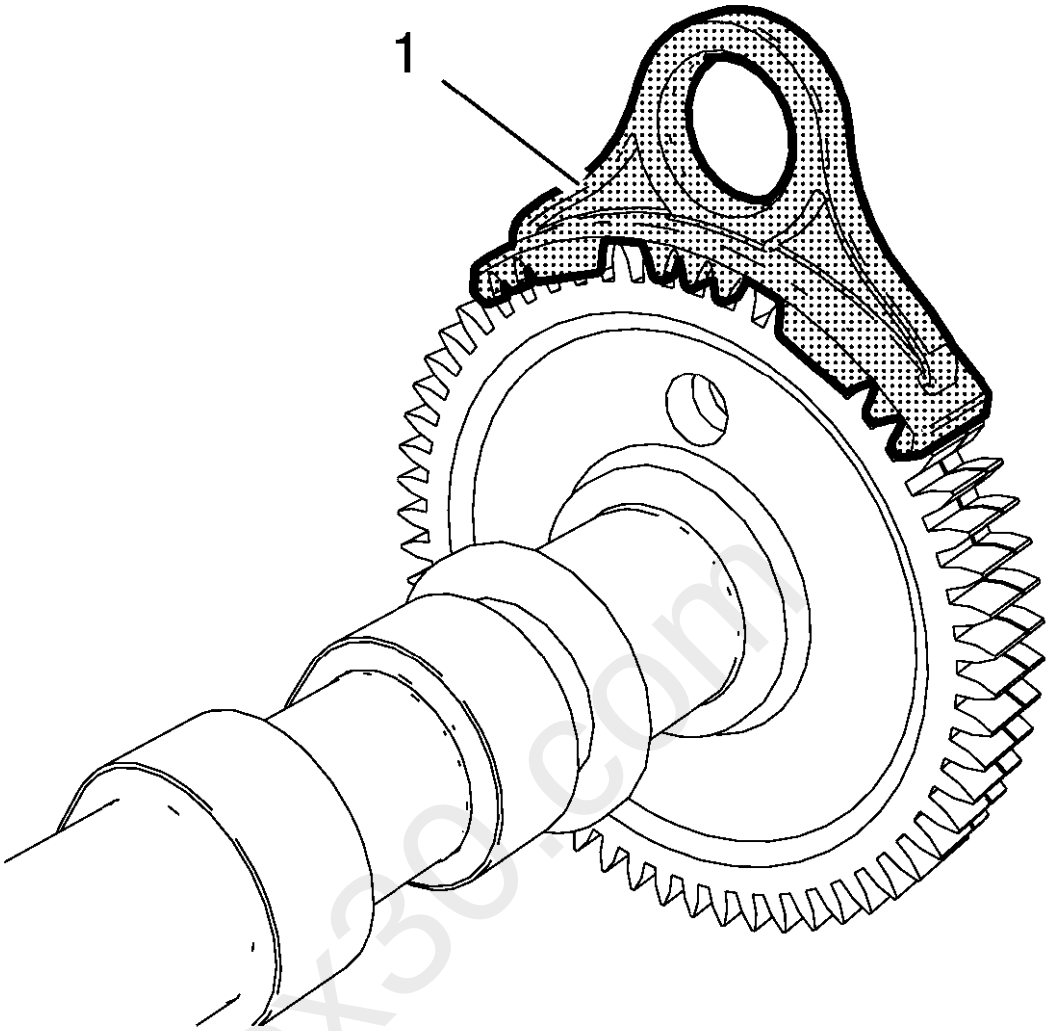


Fig. 819: Transport Lock
Courtesy of GENERAL MOTORS COMPANY

2. For Install a NEW exhaust camshaft do not remove the transport lock (1), before the exhaust camshaft and intake camshaft are installed.

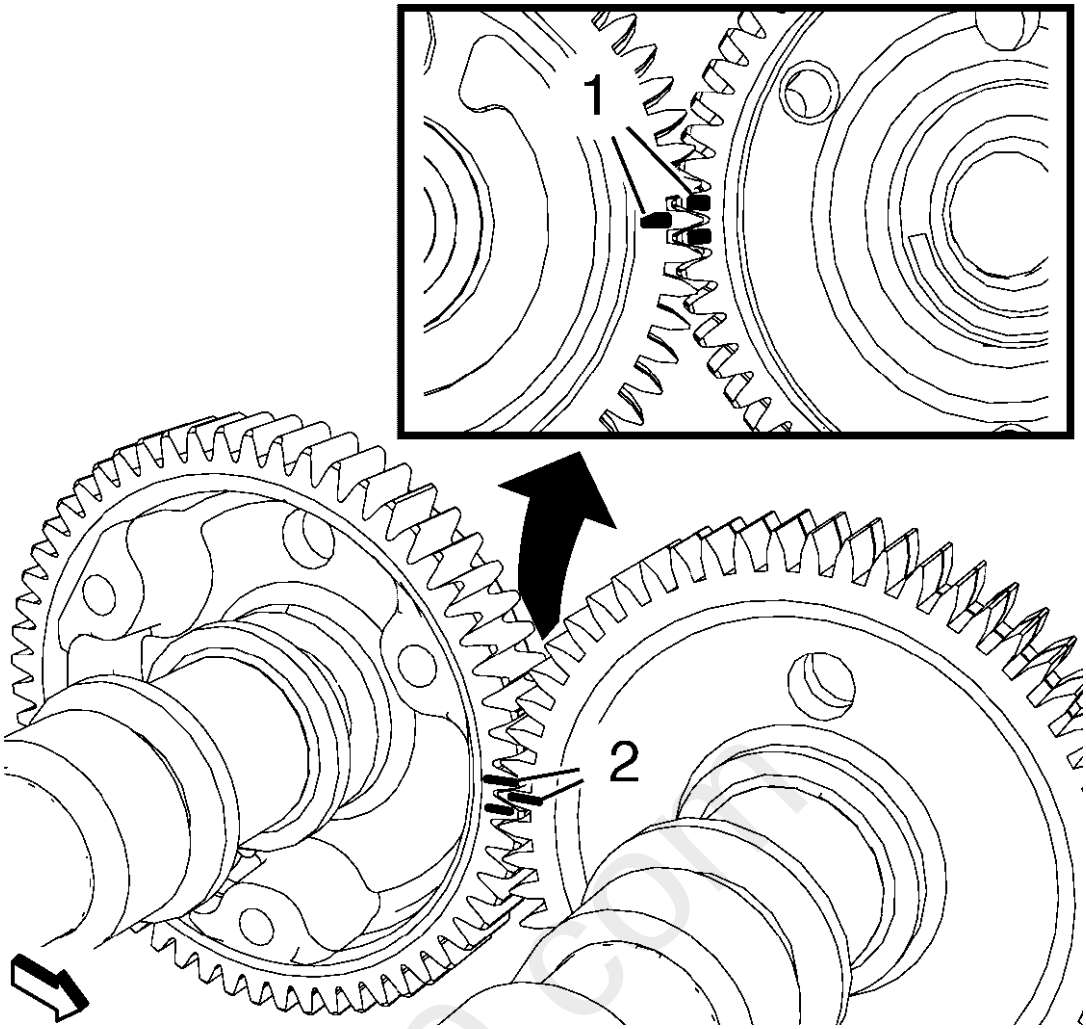


Fig. 820: Marking Camshaft Sprockets With Paint Marks By Transmitting Front Marks
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Transmit the front marks (1) on the back of the camshaft sprockets.**

3. Marking the exhaust camshaft sprocket and intake camshaft sprocket with paint marks (2), by transmit the front marks (1).

mcx30.com

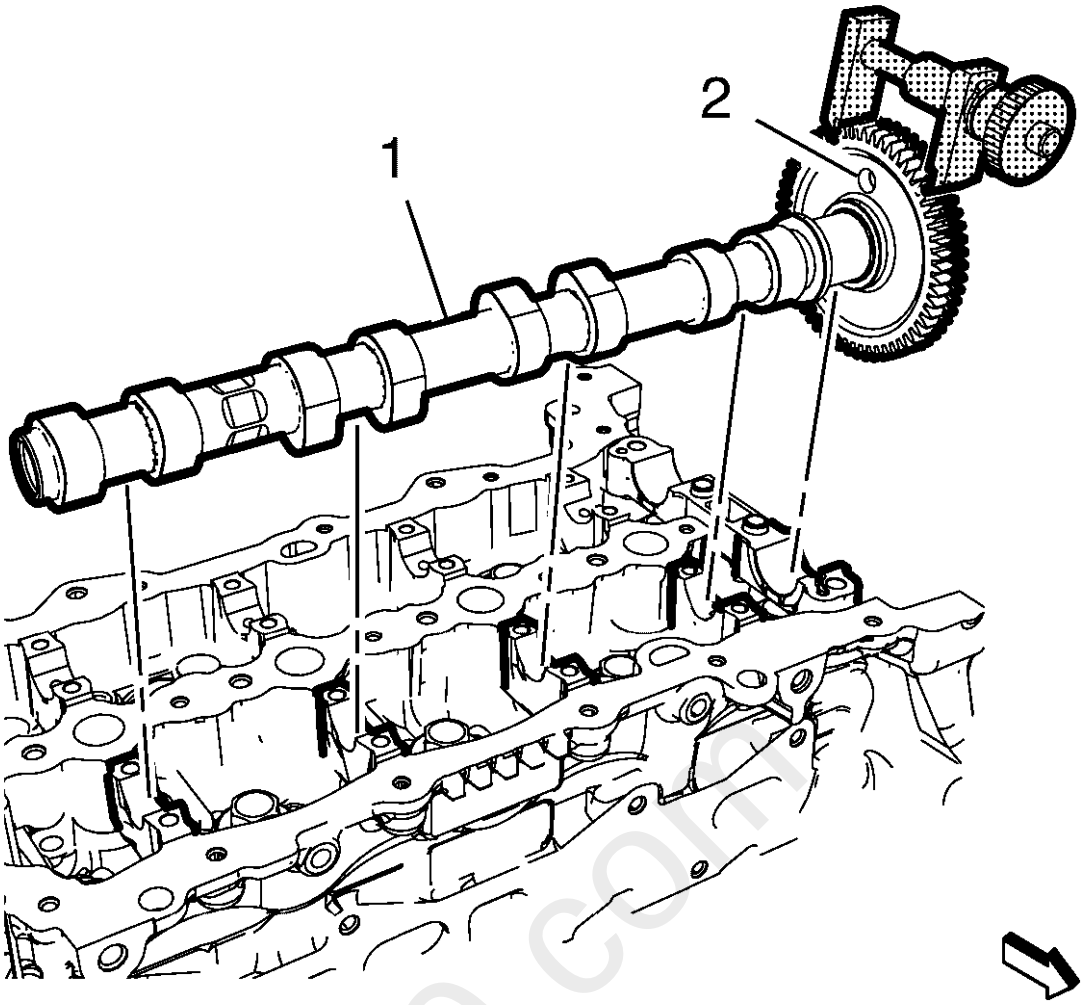


Fig. 821: Exhaust Camshaft With Bore Of Camshaft Sprocket Upwards
Courtesy of GENERAL MOTORS COMPANY

4. Coat all bearing surfaces with engine oil.
5. Install the exhaust camshaft (1), ensure the bore (2) of the camshaft sprocket shows upwards.

mx30.com

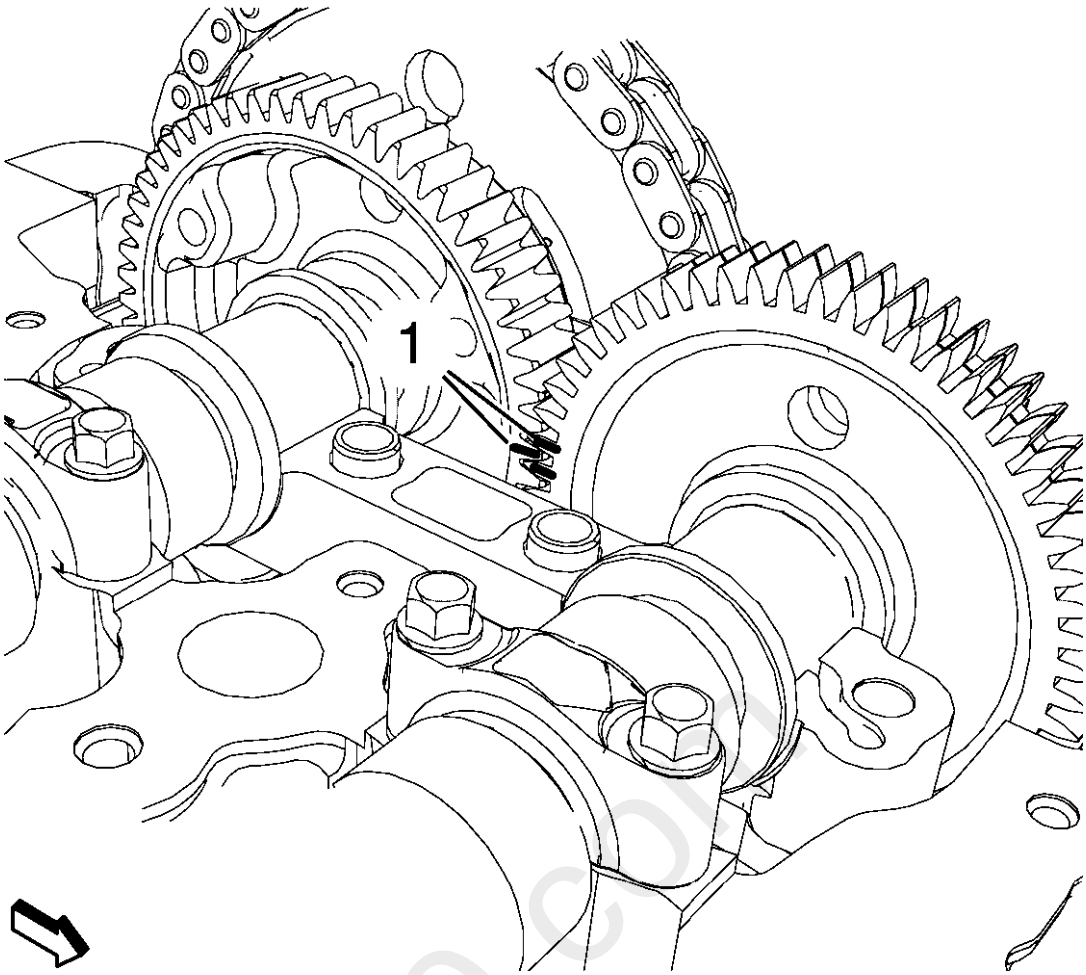


Fig. 822: Marking Exhaust Camshaft Sprocket And Intake Camshaft Sprocket With Paint Marks
Courtesy of GENERAL MOTORS COMPANY

6. Check the marks (1) of the camshaft sprockets whether they are aligned.

mcx30.com

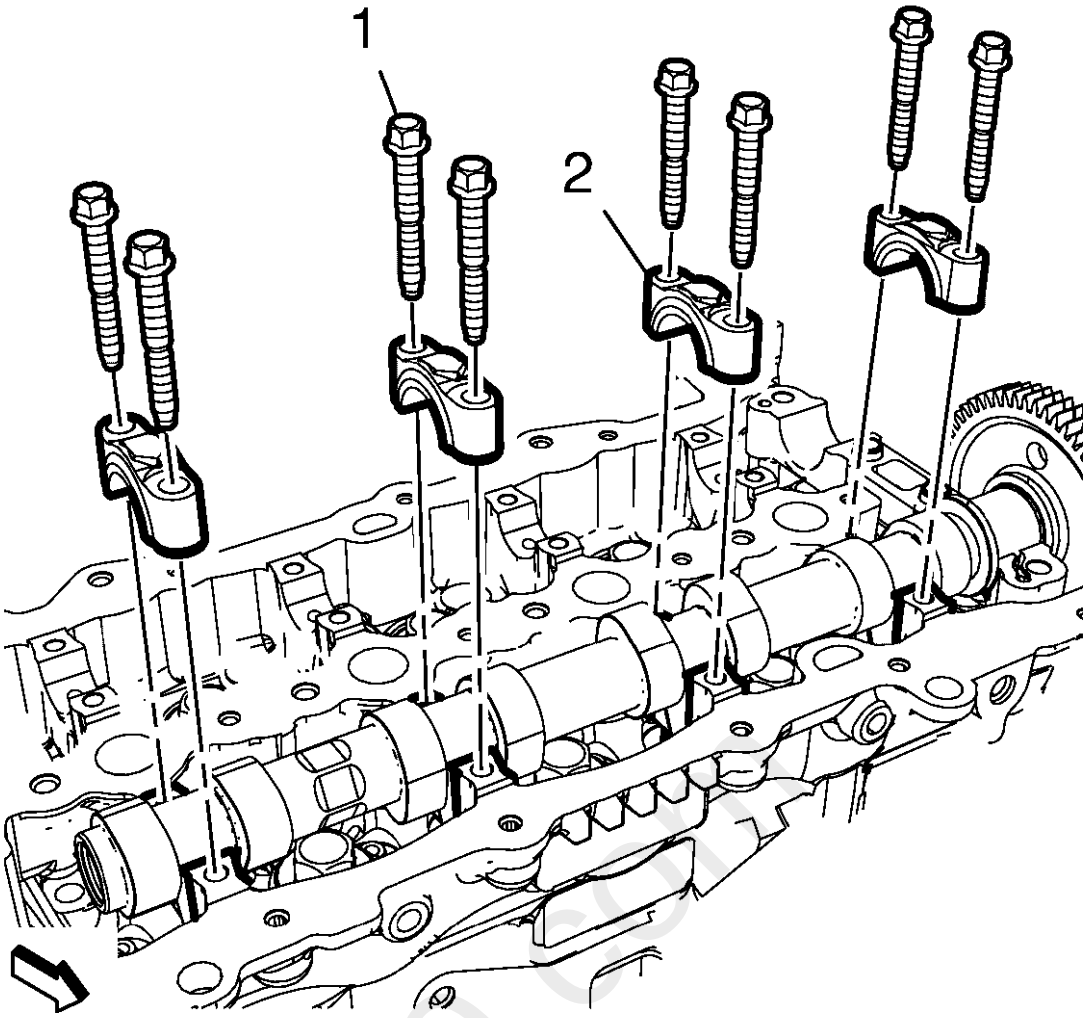


Fig. 823: Exhaust Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the arrows as marks on the camshaft bearing caps, which shows on the outside of the cylinder head.**

7. Install the exhaust camshaft bearing caps (2) in the order as they was removed.
8. Install the exhaust camshaft bearing cap bolts (1).

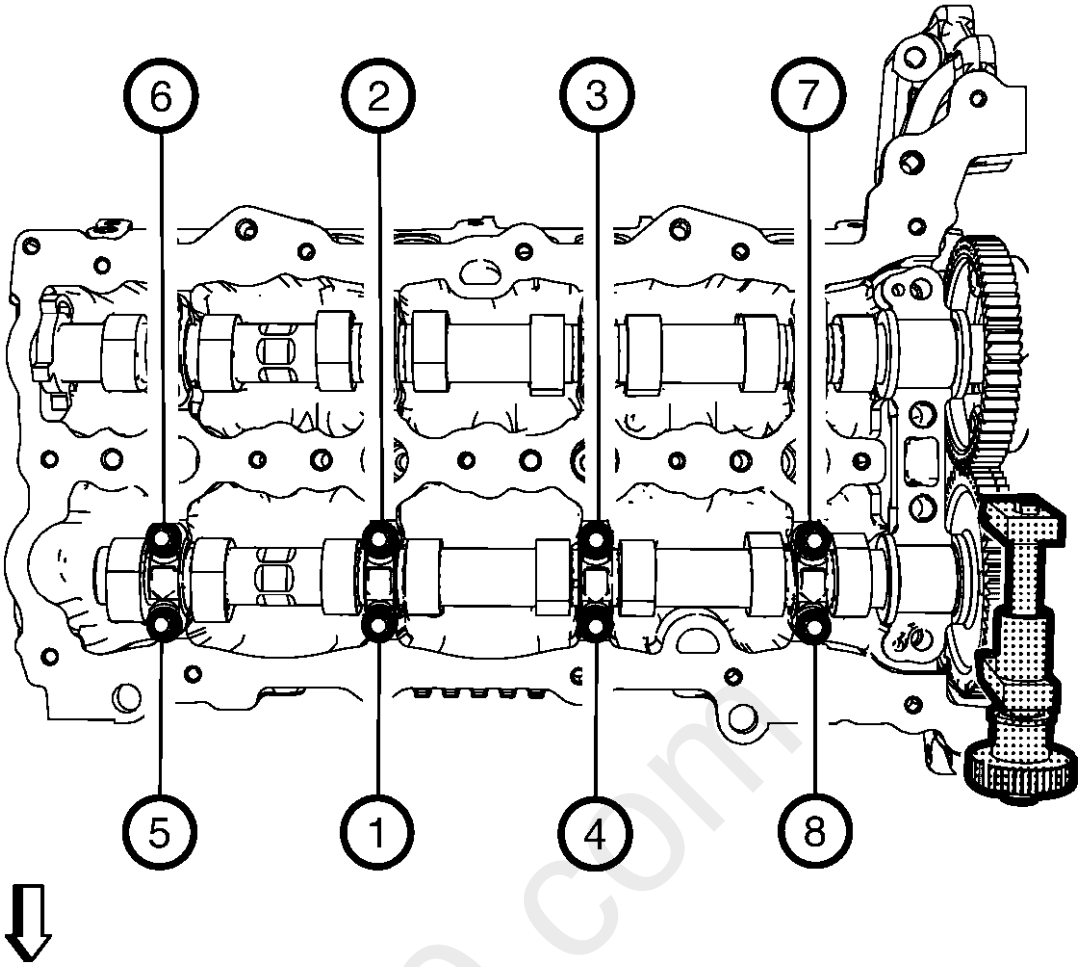


Fig. 824: Exhaust Camshaft Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

9. Tighten the 8 exhaust camshaft bearing cap bolts in sequence as shown to 10 N.m (89 lb in).

mcx30.com

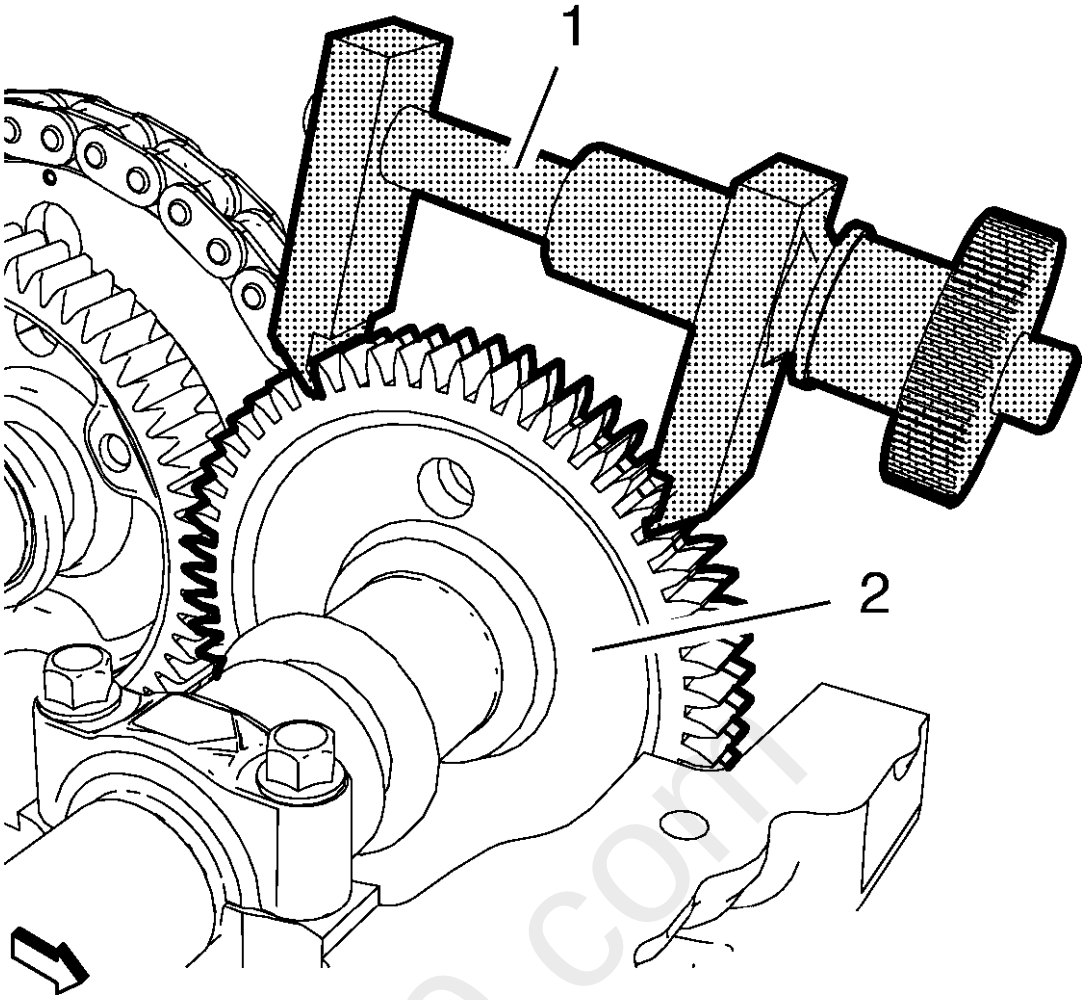


Fig. 825: Split Intake Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

10. Remove the **EN-50509** fixing tool (1) or the transport lock from the exhaust camshaft sprocket (2).

mcx30.com

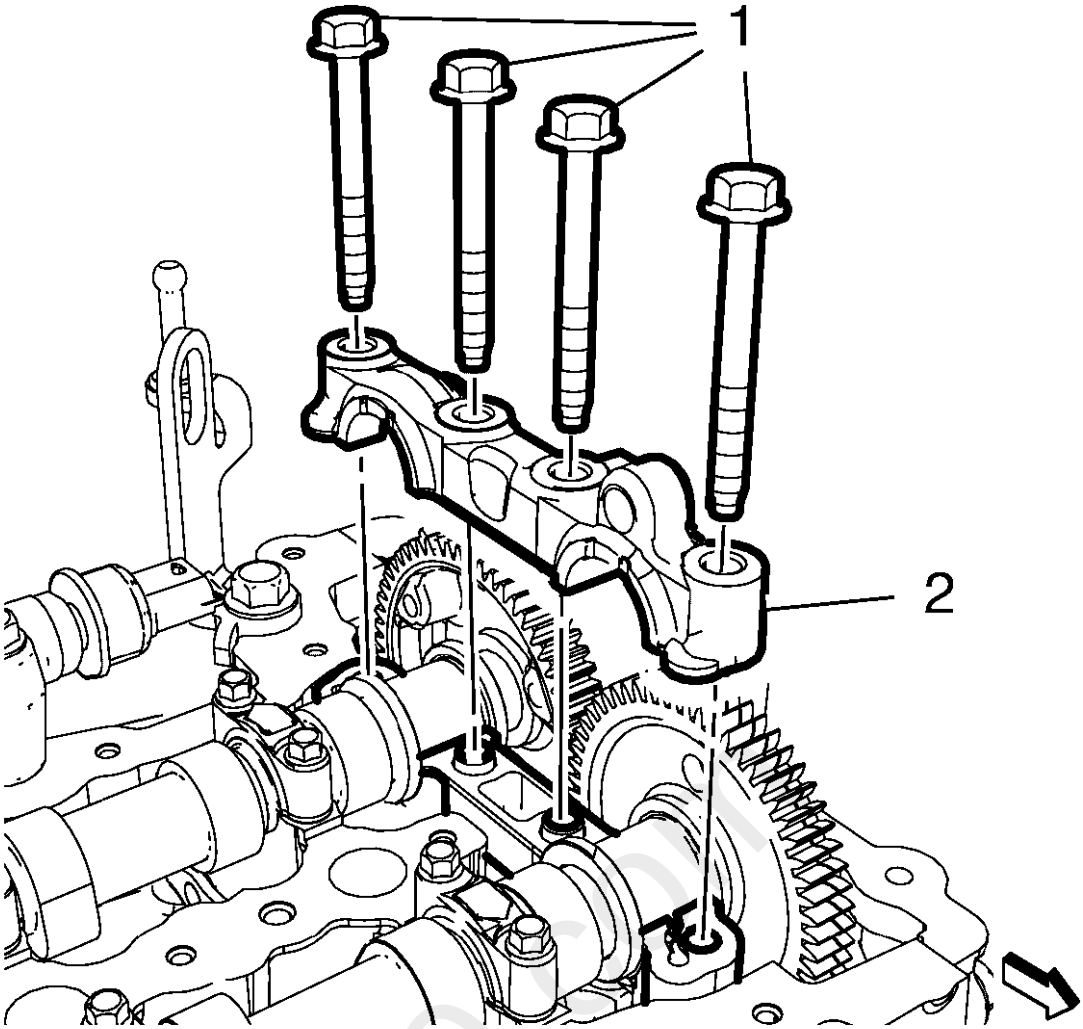


Fig. 826: Camshaft Bearing Rear Cap And Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Coat all bearing surfaces with engine oil.
12. Install the camshaft bearing rear cap (2).
13. Install the 4 camshaft bearing rear cap bolts (1).

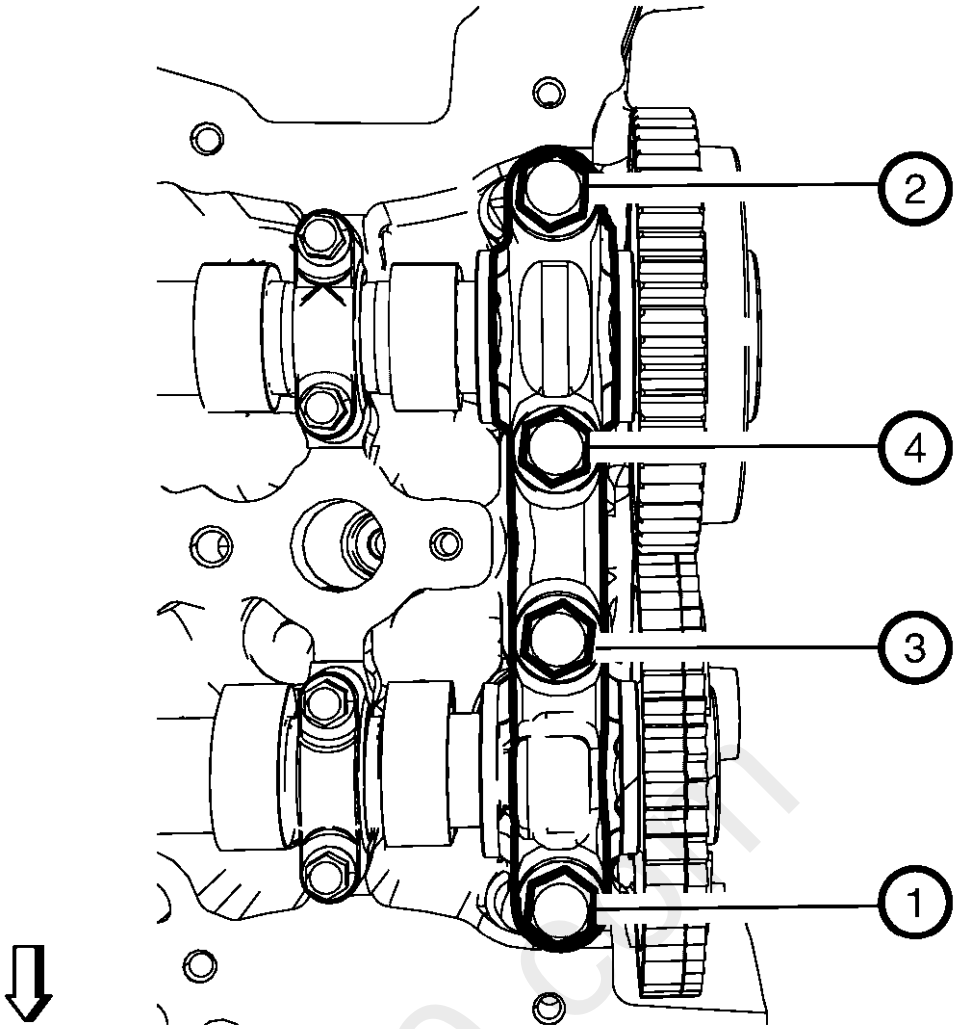


Fig. 827: Camshaft Rear Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

14. Tighten the 4 camshaft rear cap bolts in sequence as shown to 25 N.m (18 lb ft).

mcx30.com

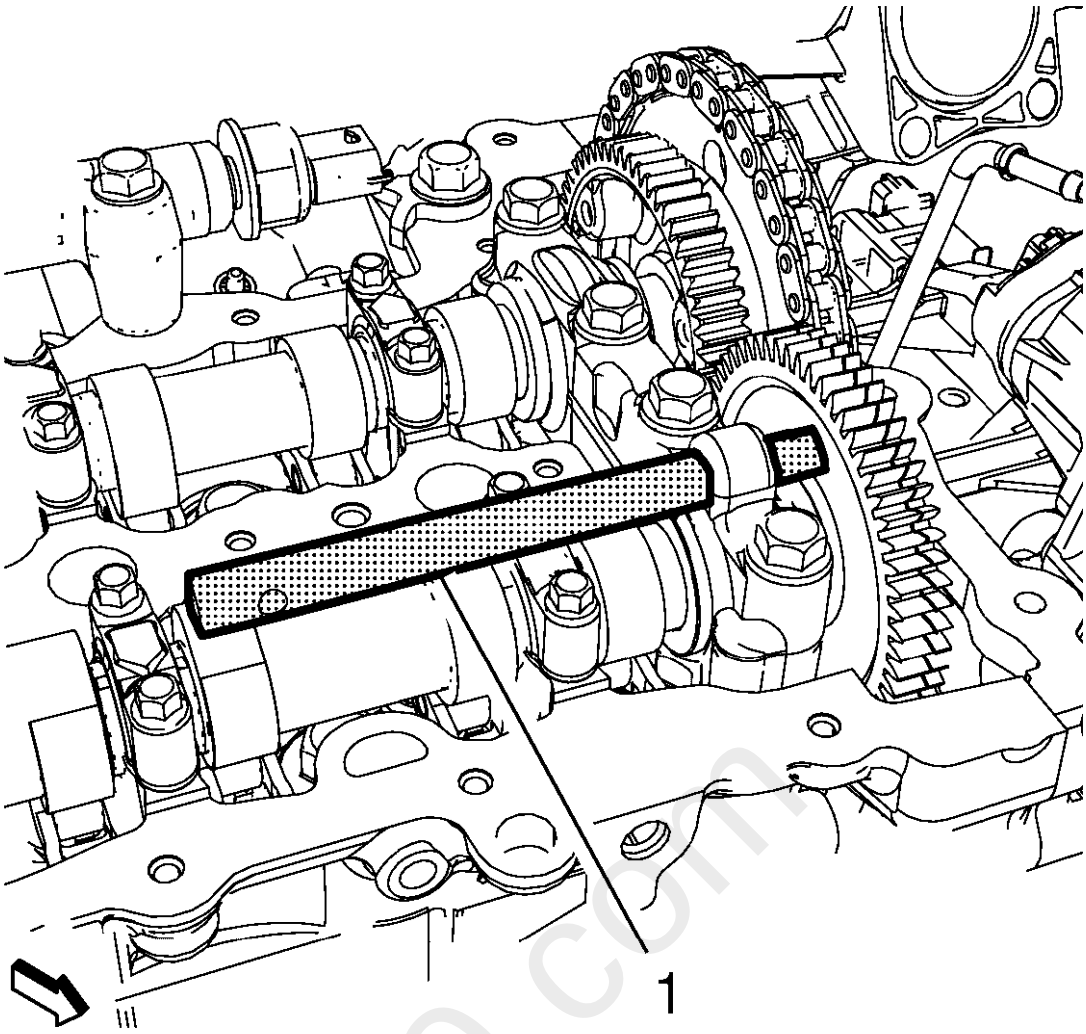


Fig. 828: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

15. Install the **EN-51143** fixing tool (1), by carefully turning the hexagon of the camshaft.

INTAKE CAMSHAFT INSTALLATION

Special Tools

- **EN-50509** Split Intake Camshaft Sprocket Fixing Tool
- **EN-51143** Camshaft Sprocket Fixing Tool

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

NOTE: **Before installing the intake camshaft, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

mgx30.com

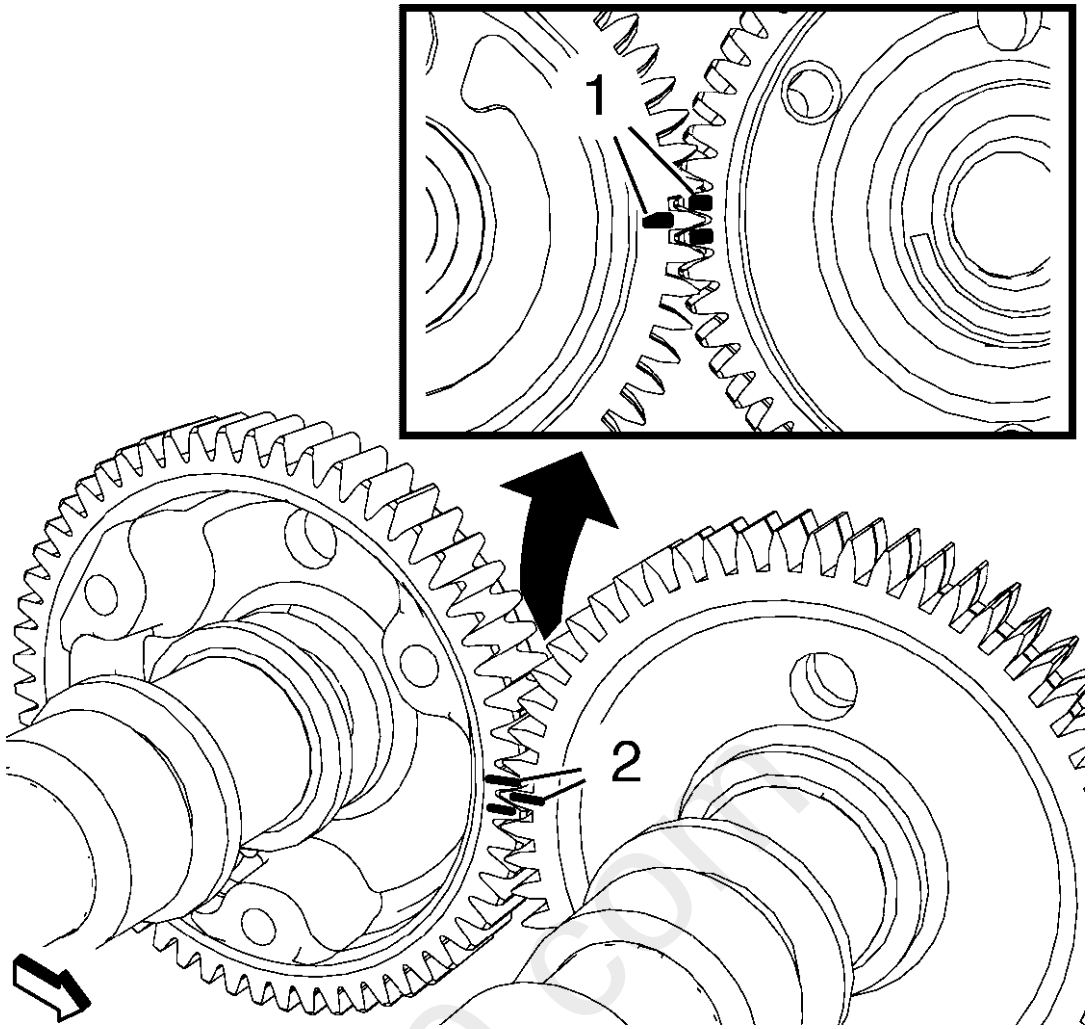


Fig. 829: Marking Camshaft Sprockets With Paint Marks By Transmitting Front Marks
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Transmit the front marks (1) on the back of the camshaft sprockets.**

2. Marking the exhaust camshaft sprocket and intake camshaft sprocket with paint marks (2), by transmit the front marks (1).

mcx30.com

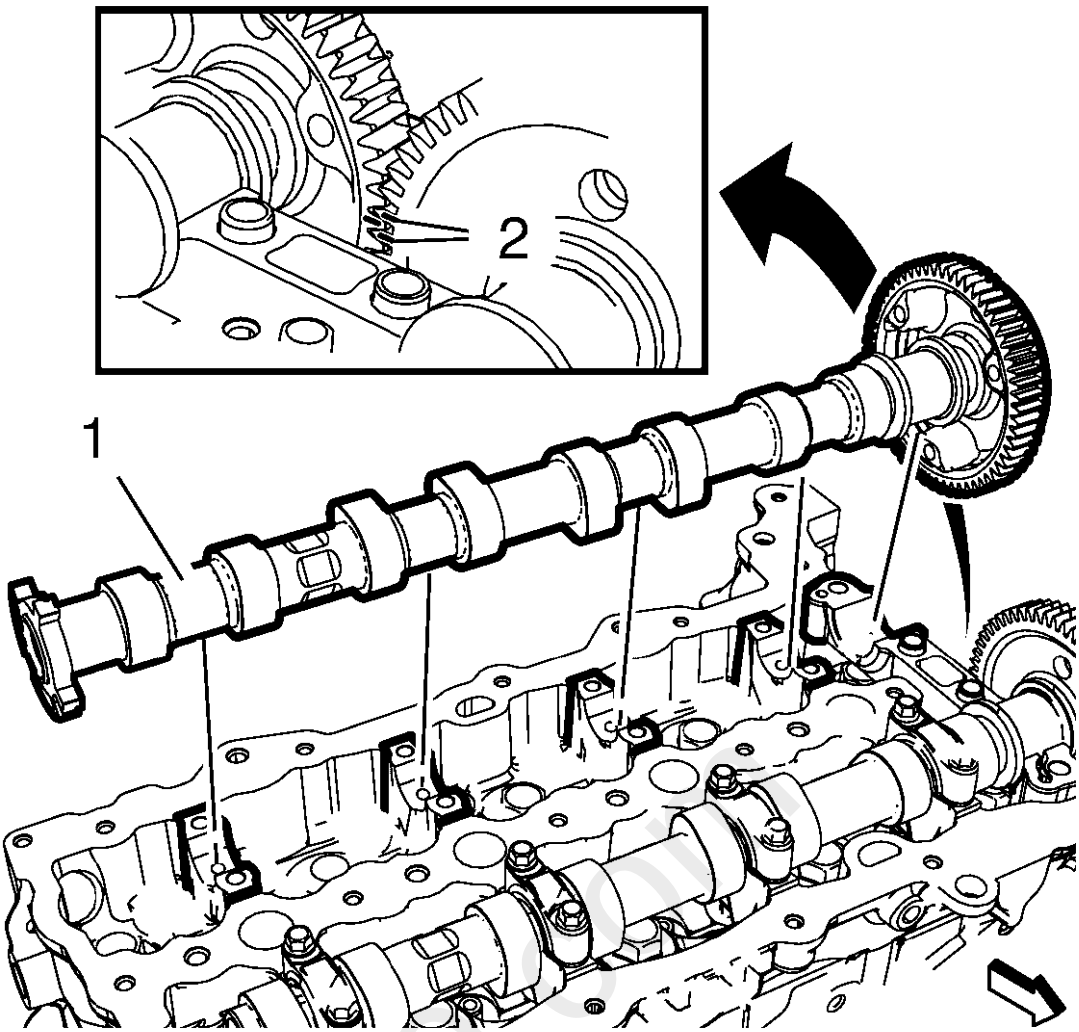


Fig. 830: Intake Camshaft With Camshaft Sprocket Marks Aligned
Courtesy of GENERAL MOTORS COMPANY

3. Coat all bearing surfaces with engine oil.

NOTE: **Ensure the marks (2) of the camshaft sprocket are aligned.**

4. Install the intake camshaft (1).

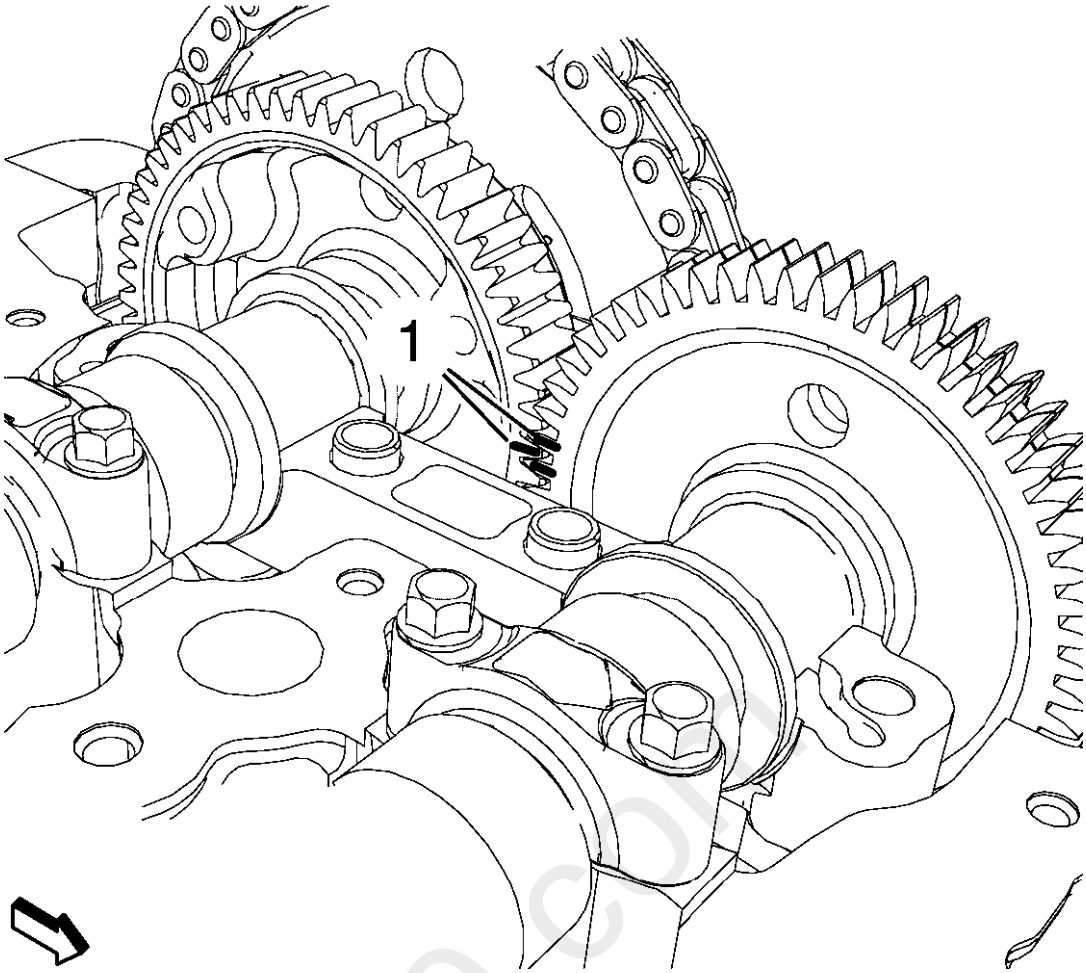


Fig. 831: Marking Exhaust Camshaft Sprocket And Intake Camshaft Sprocket With Paint Marks
Courtesy of GENERAL MOTORS COMPANY

5. Check the marks (1) of the camshaft sprockets whether they are aligned.

mcx30.com

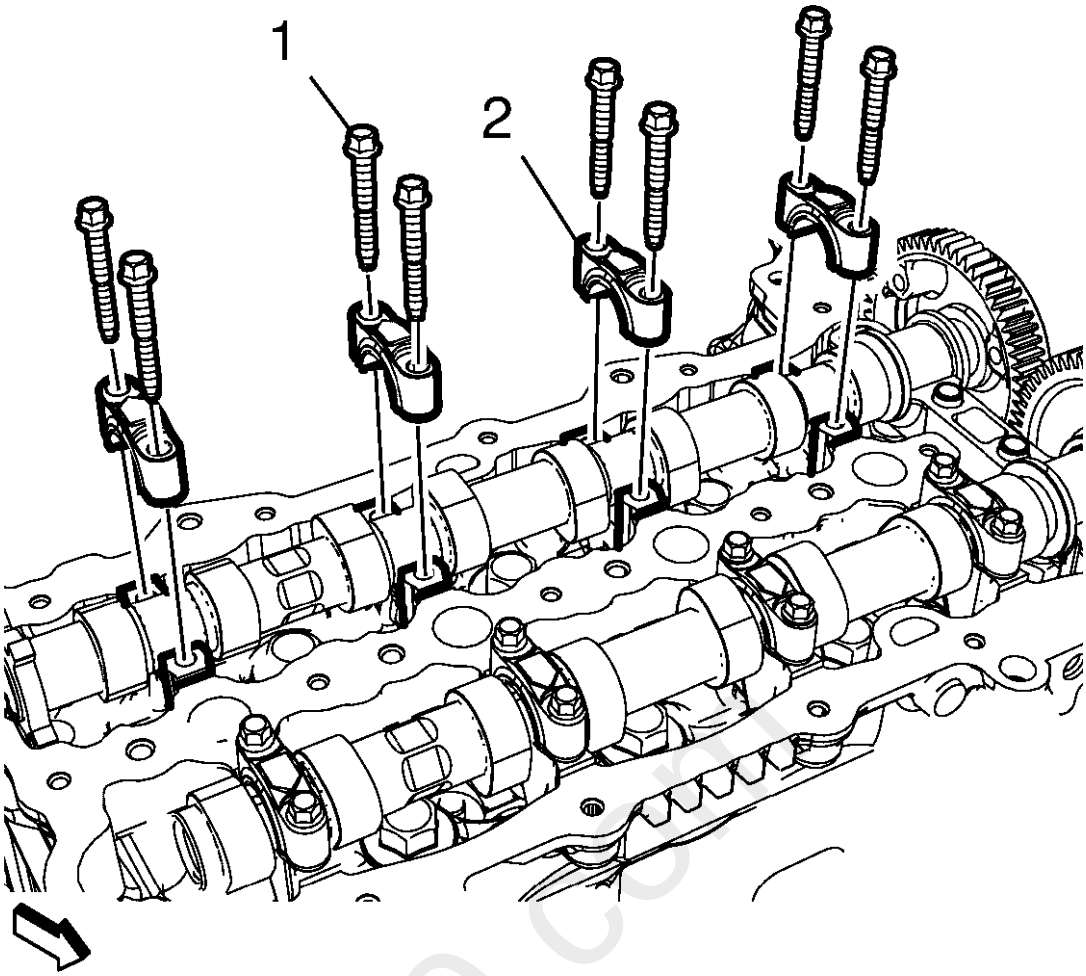


Fig. 832: Intake Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the arrows as marks on the camshaft bearing caps, which shows on the outside of the cylinder head.**

6. Install the intake camshaft bearing caps (2) in the order as they was removed.
7. Install the intake camshaft bearing cap bolts (1).

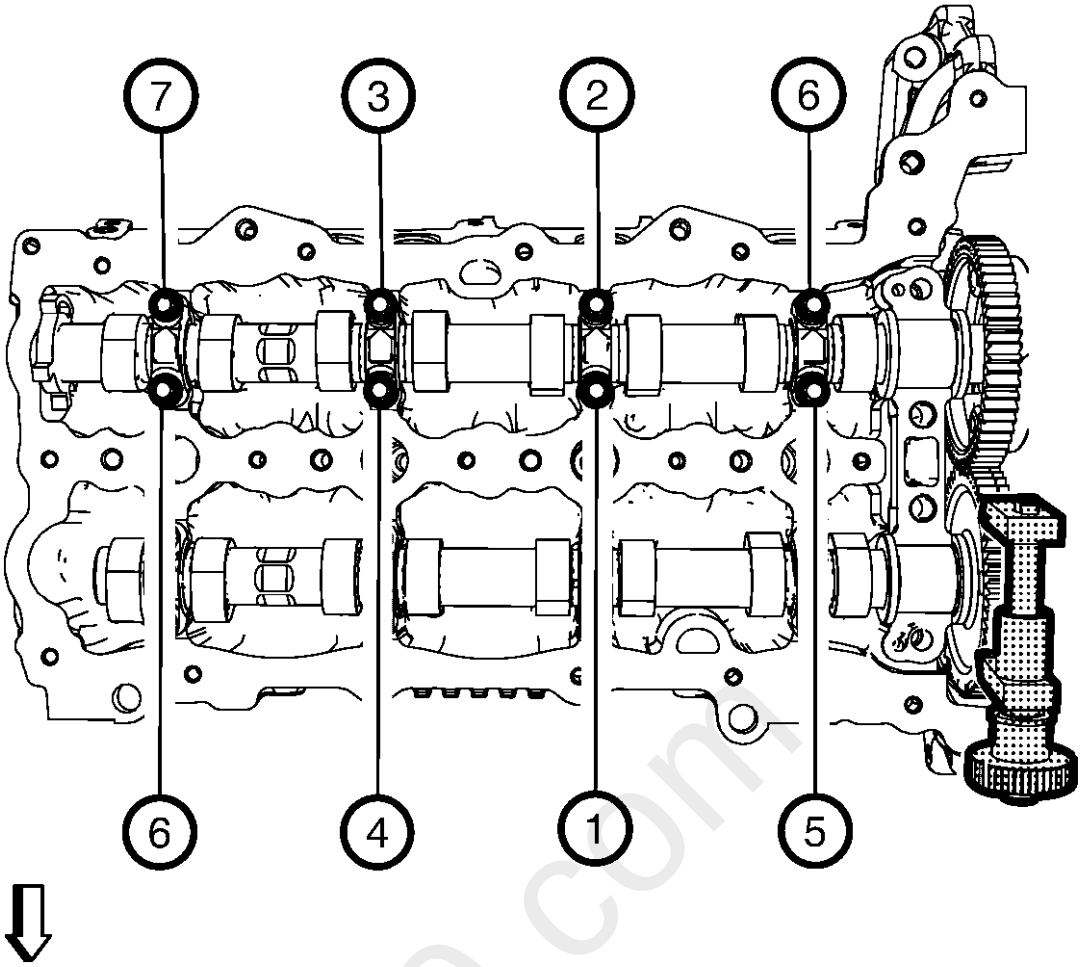


Fig. 833: Intake Camshaft Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

8. Tighten the 8 intake camshaft bearing cap bolts in sequence as shown to 10 N.m (89 lb in).

mcx30.com

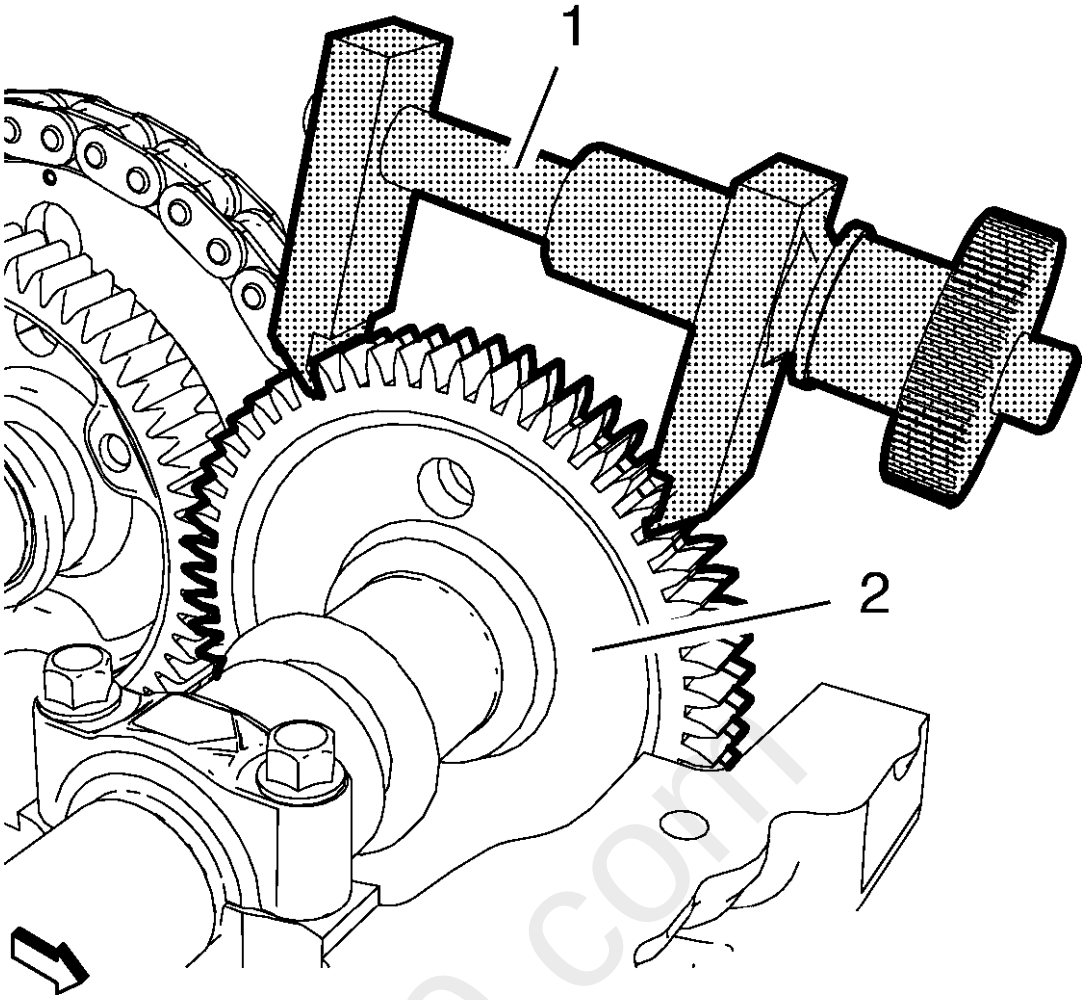


Fig. 834: Split Intake Camshaft Sprocket Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

9. Remove the **EN-50509** fixing tool (1) or the transport lock from the exhaust camshaft sprocket (2).

mcx30.com

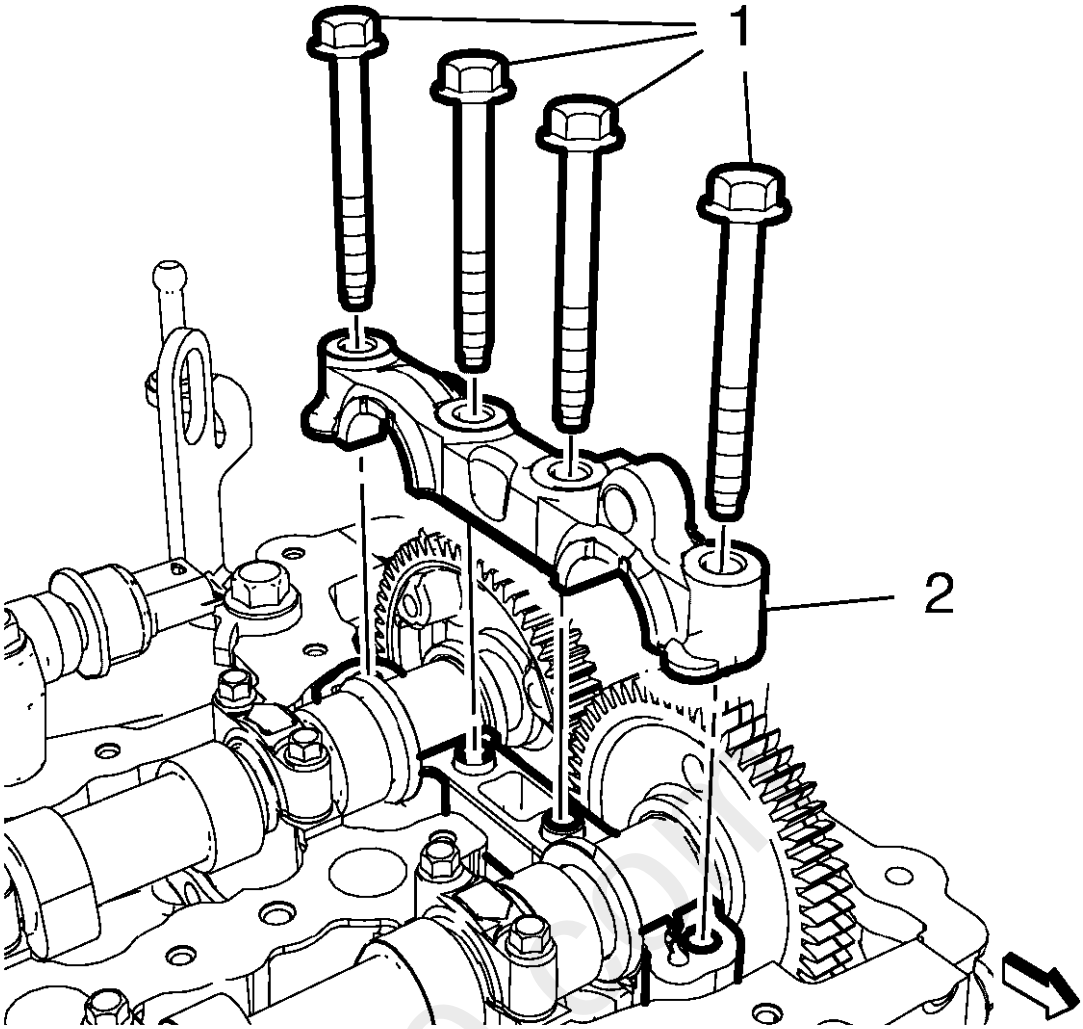


Fig. 835: Camshaft Bearing Rear Cap And Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Coat all bearing surfaces with engine oil.
11. Install the camshaft bearing rear cap (2).
12. Install the 4 camshaft bearing rear cap bolts (1).

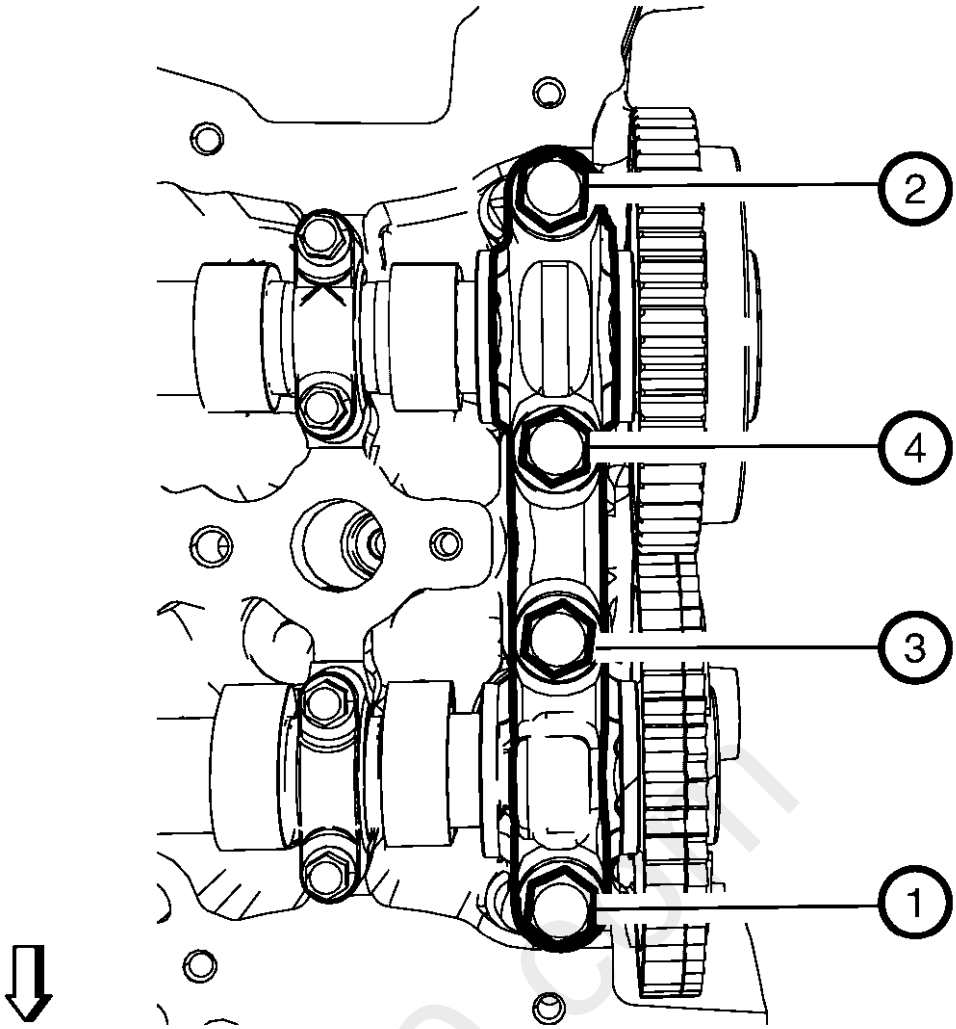


Fig. 836: Camshaft Rear Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

13. Tighten the 4 camshaft rear cap bolts in sequence as shown to 25 N.m (18 lb ft).

mcx30.com

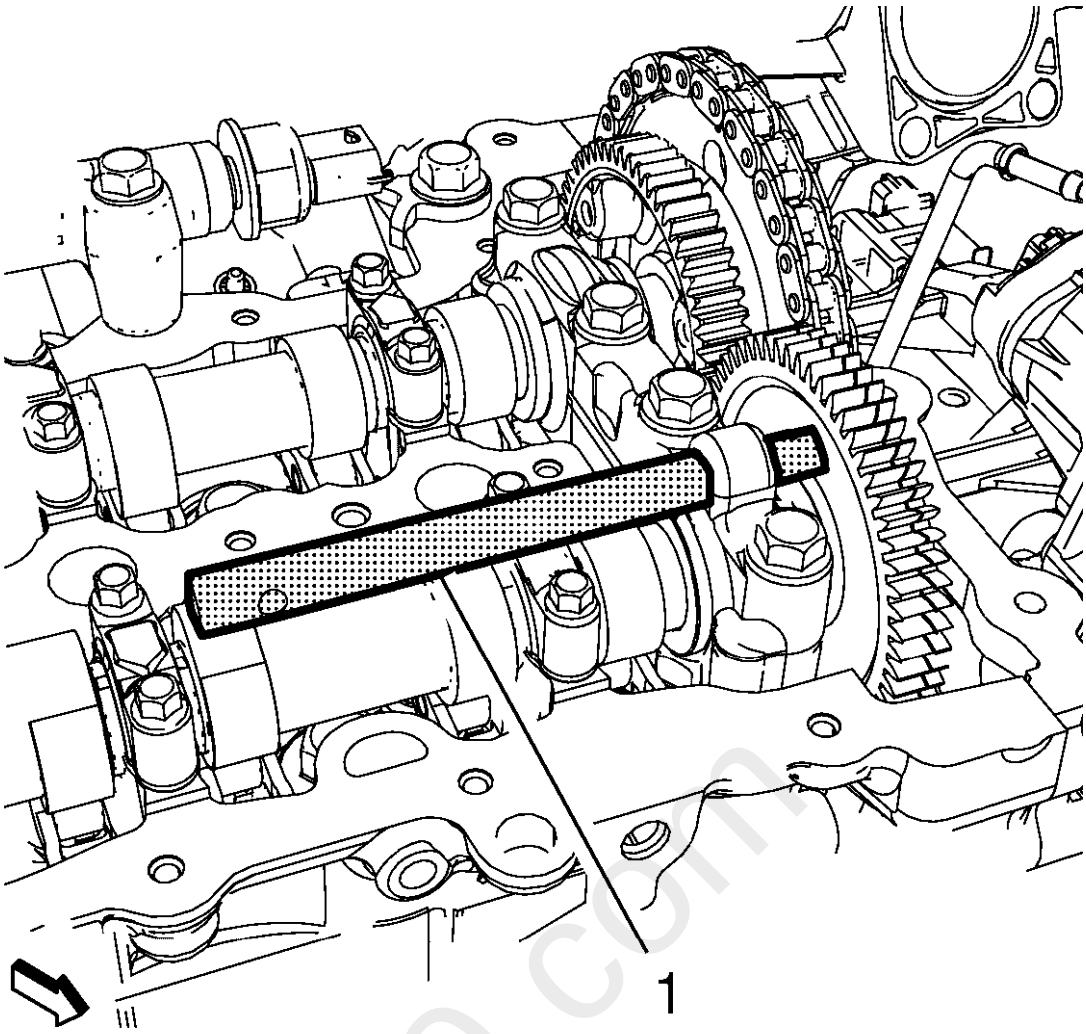


Fig. 837: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

14. Install the **EN-51143** fixing tool (1), by carefully turning the hexagon of the camshaft.

CAMSHAFT SPROCKET INSTALLATION

NOTE: **Before installing the camshaft sprocket, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

mcx30.com

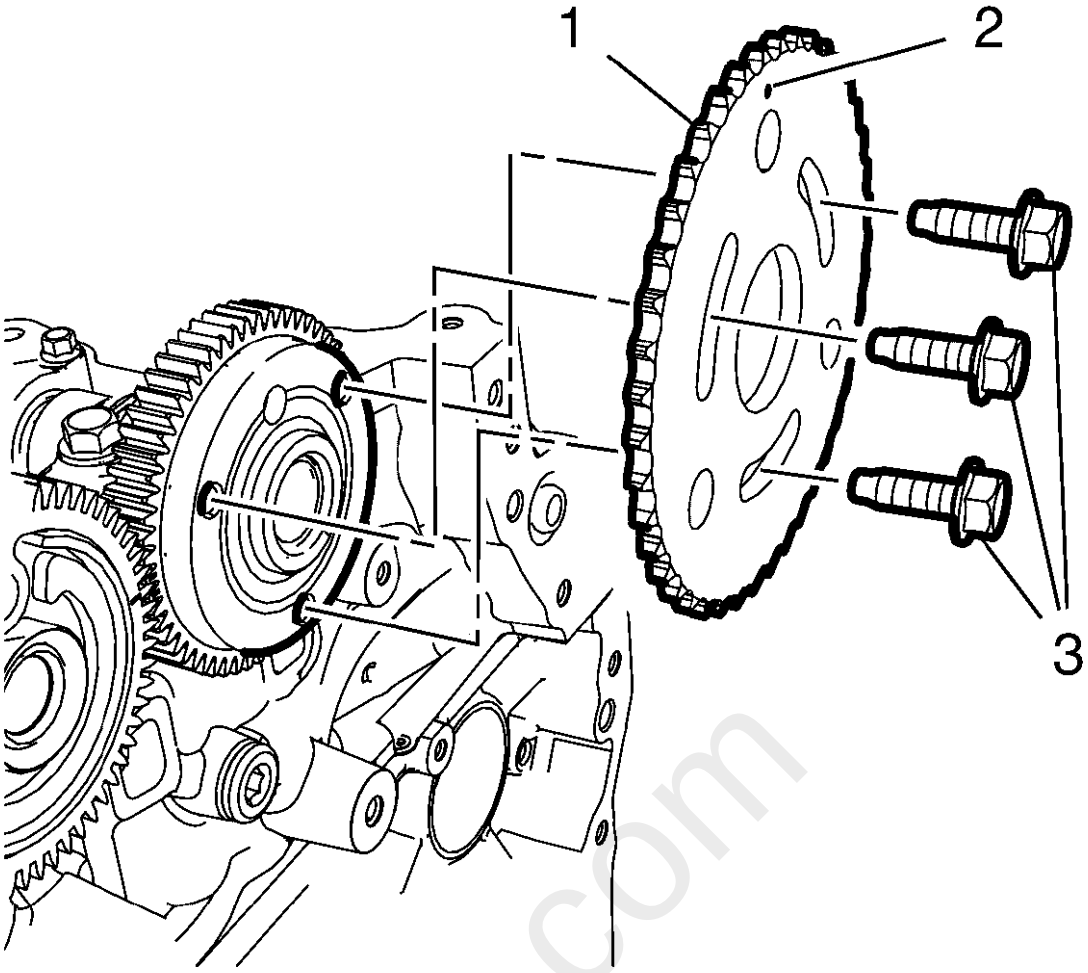


Fig. 838: Camshaft Sprocket And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Position the camshaft sprocket mark (2) at a 12 o'clock position and install the camshaft sprocket (1) to the intake camshaft.

CAUTION: **Refer to Fastener Caution .**

3. Install the 3 camshaft sprocket bolts (3) and tighten to 25 N.m (18 lb ft), counterhold with a wrench at the camshaft hexagon.

FUEL INJECTION PUMP INSTALLATION

mcx30.com

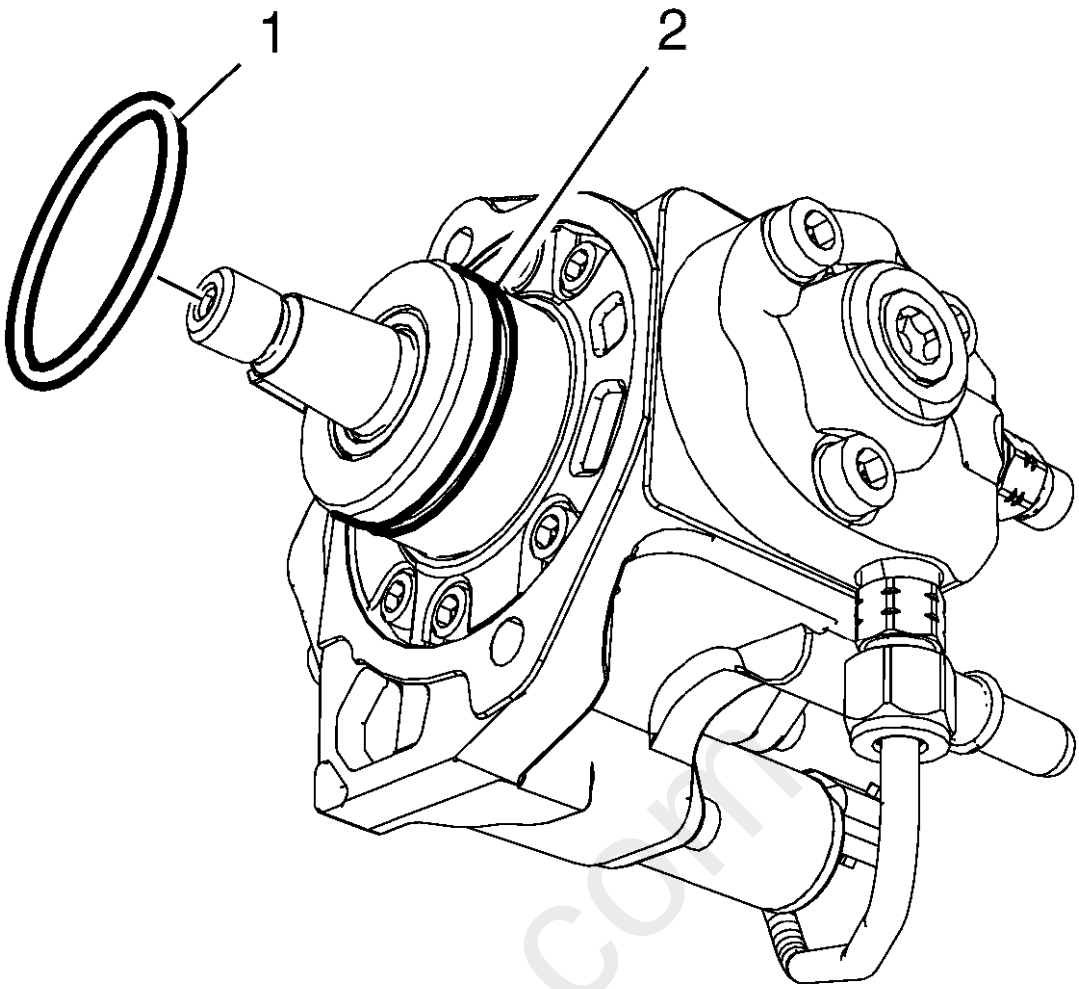


Fig. 839: Fuel Injection Pump Seal Ring And Fuel Injection Pump Sealing Groove
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW fuel injection pump seal ring (1) to the fuel injection pump sealing groove (2).

mcx30.com

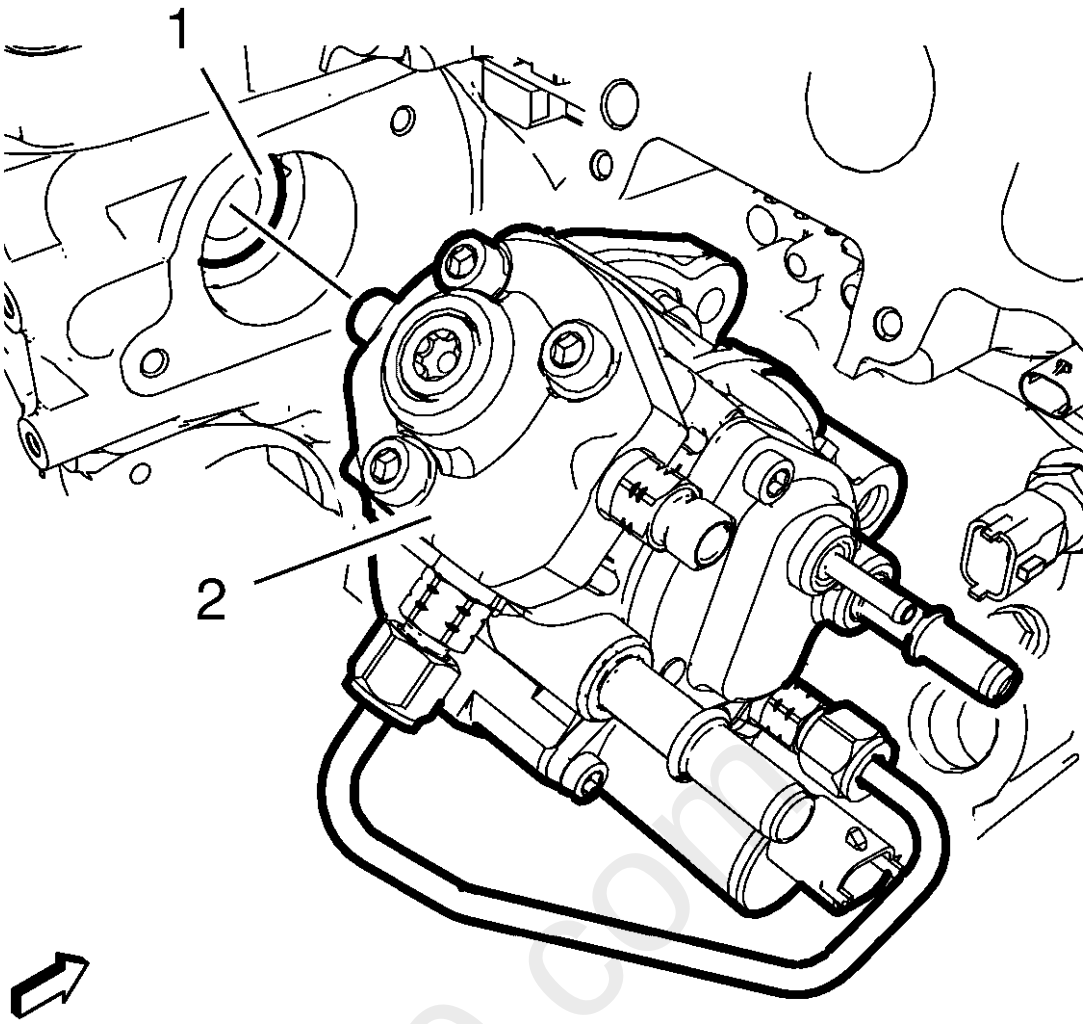


Fig. 840: Fuel Injection Fuel Pump
Courtesy of GENERAL MOTORS COMPANY

2. Install the fuel injection pump (2).

mcx30.com

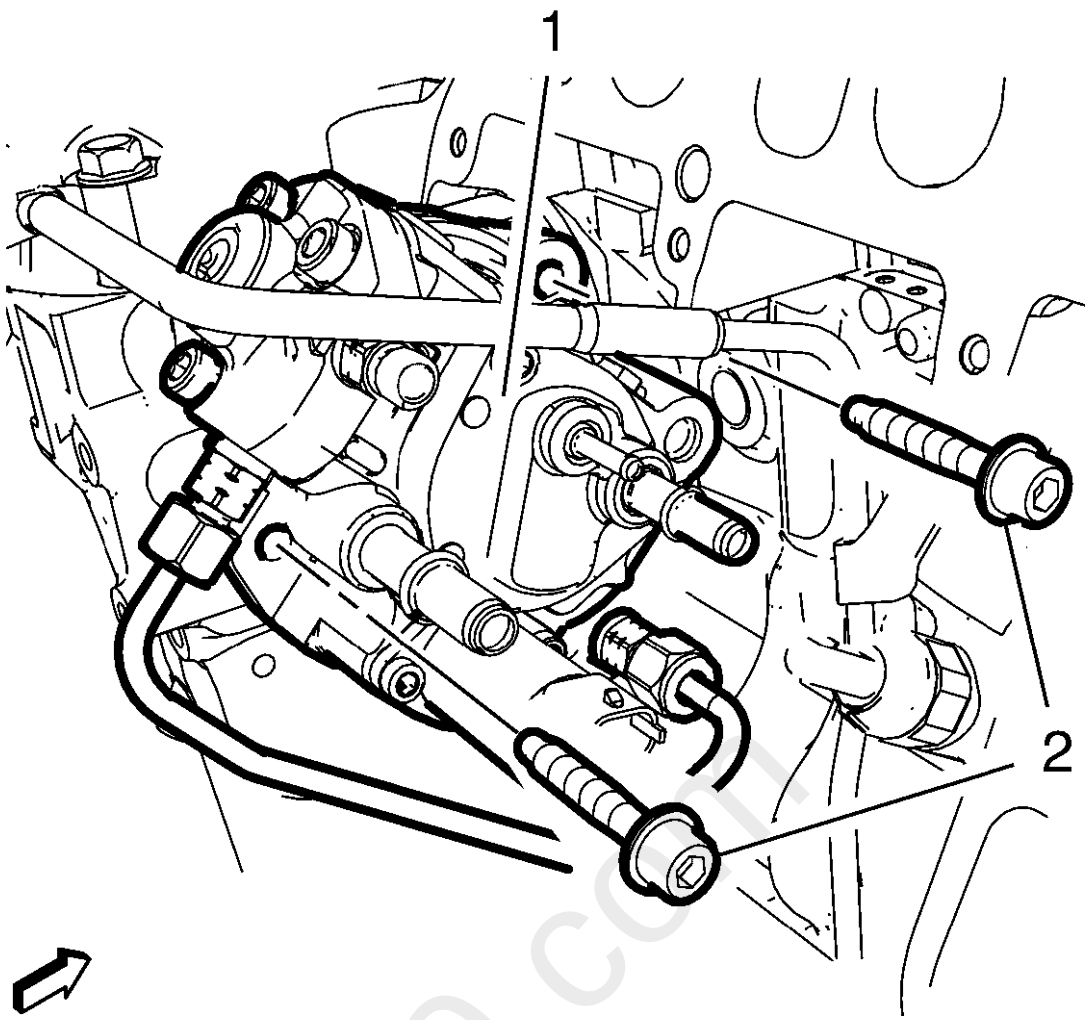


Fig. 841: Fuel Injection Fuel Pump And Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

3. Install the 2 fuel injection fuel pump bolts (2) to the fuel injection fuel pump (1) and tighten to 25 N.m (18 lb ft).

FUEL INJECTION PUMP DRIVEN SPROCKET INSTALLATION

Special Tools

EN-50885-2 Locking Tool

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

mcx30.com

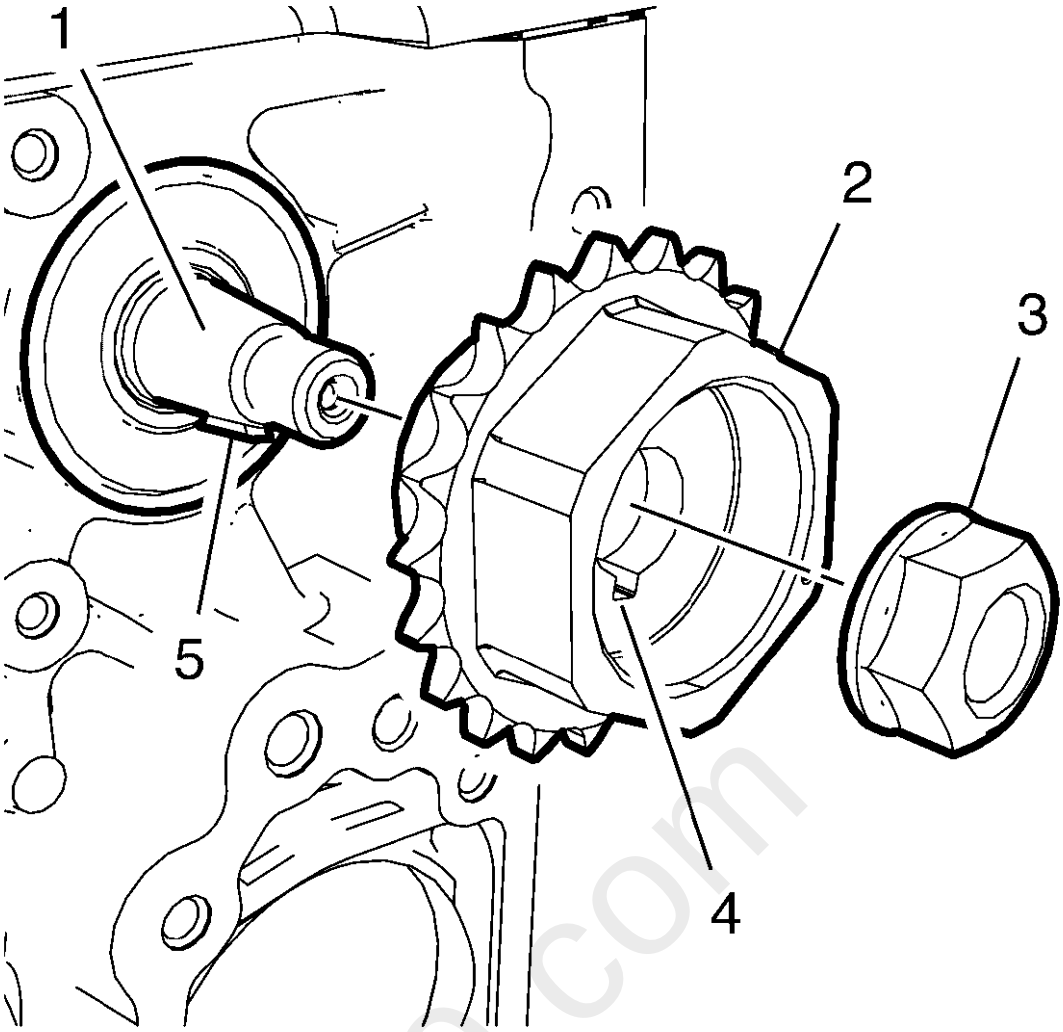


Fig. 842: Fuel Injection Pump, Driven Sprocket, Pump Shaft Wedge, Sprocket Groove And Nut
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel injection pump driven sprocket (2) to the fuel injection pump (1). Ensure the fuel injection pump shaft wedge (5) and the fuel injection pump driven sprocket groove (4) are aligned.
2. Pre-install the fuel injection pump driven sprocket nut (3).

mixs0.com

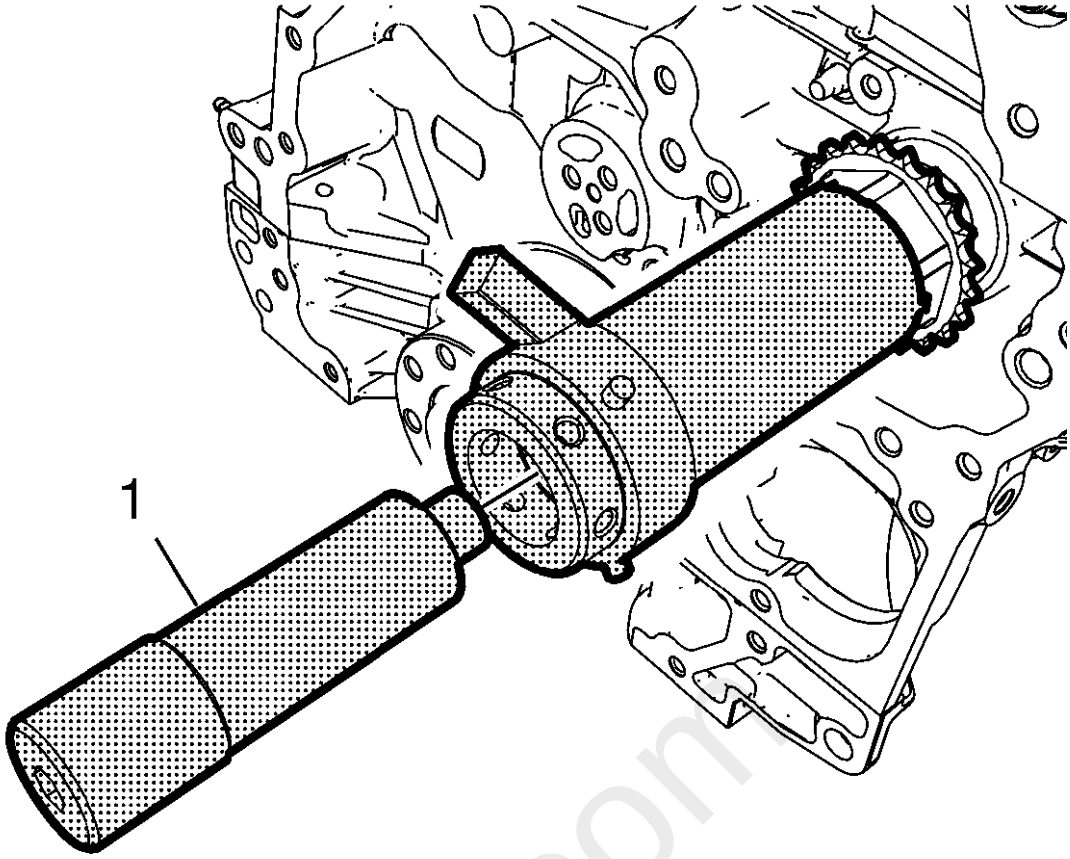


Fig. 843: Pressure Spindle And Locking Tool
Courtesy of GENERAL MOTORS COMPANY

3. Remove the pressure spindle (1) from the **EN-50885-2** locking tool (2).

mcx30.com

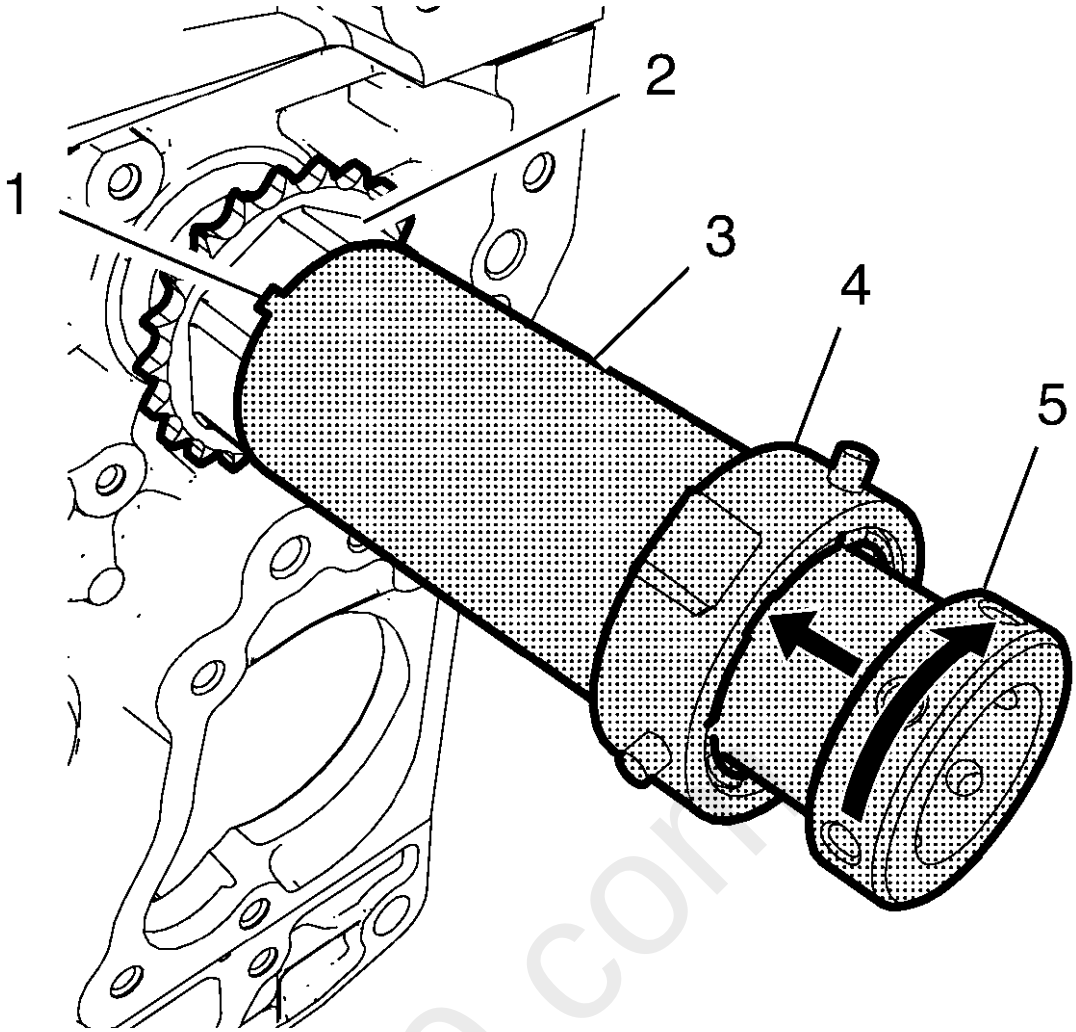


Fig. 844: Locking Tool Installed
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-50885-2** locking tool.
    1. Install the housing (3) to the fuel injection pump driven sprocket nut (2). Ensure that the 3 tappets (1) mesh with the 3 slots of the fuel injection pump driven sprocket nut.
    2. Position the ring (4) for a good handling.
    3. Screw in the fixing tool (5) into the fuel injection pump driven sprocket nut.

mx30.com

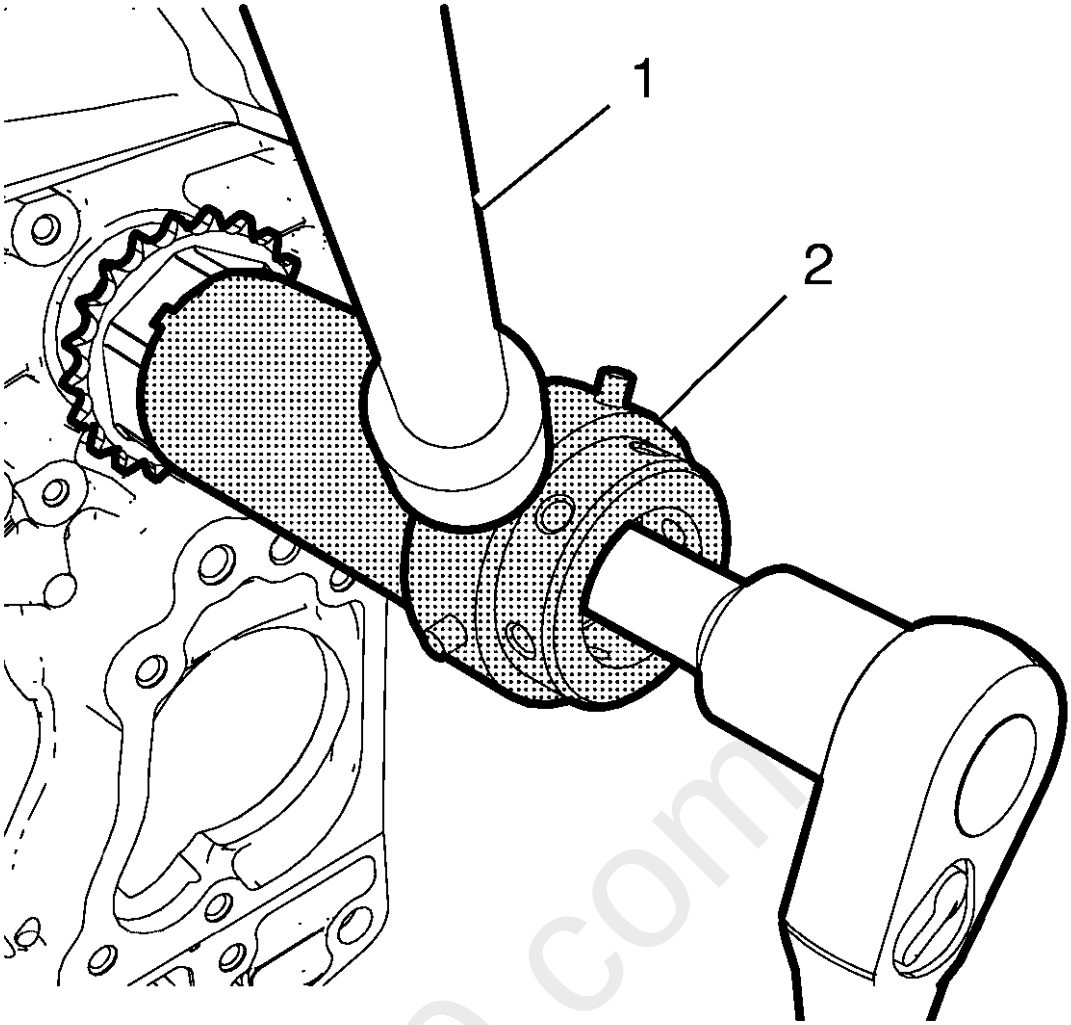


Fig. 845: Extension And Locking Tool
Courtesy of GENERAL MOTORS COMPANY

5. Install a 1/2" extension (1) to the **EN-50885-2** locking tool (2) to counterhold.

CAUTION: **Refer to Fastener Caution .**

6. Tighten the fuel injection pump driven sprocket nut to 64 N.m (47 lb ft).
7. Remove the **EN-50885-2** locking tool.

TIMING CHAIN IDLER SPROCKET INSTALLATION

Special Tools

EN-51141 Intermediate Drive Gear Fixing Tool

For equivalent regional tools, refer to Special Tools

NOTE: **Before installing the timing chain idler sprocket, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

mcx30.com

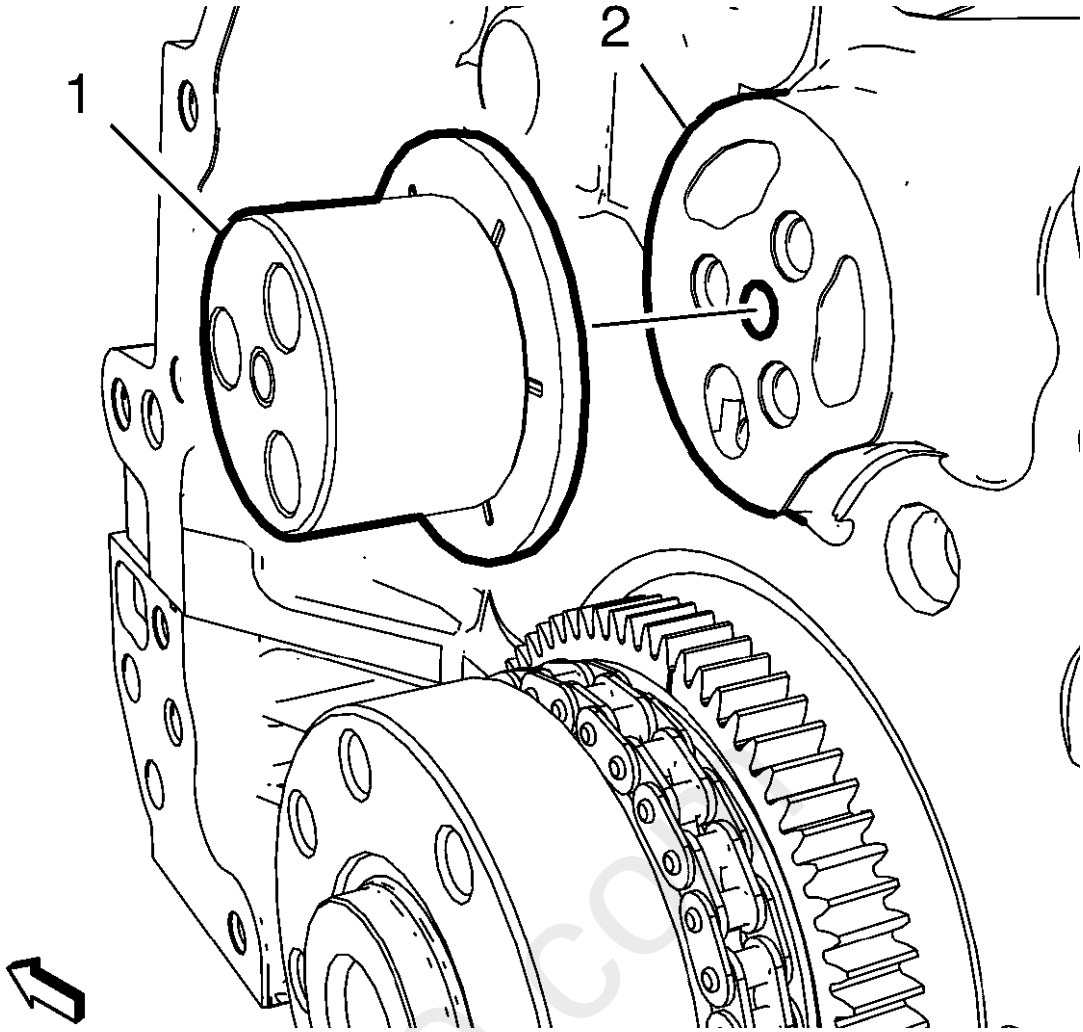


Fig. 846: Gear Shaft Distributor And Engine Block
Courtesy of GENERAL MOTORS COMPANY

2. Install the gear shaft distributor (1) to the engine block (2).

mcx30.com

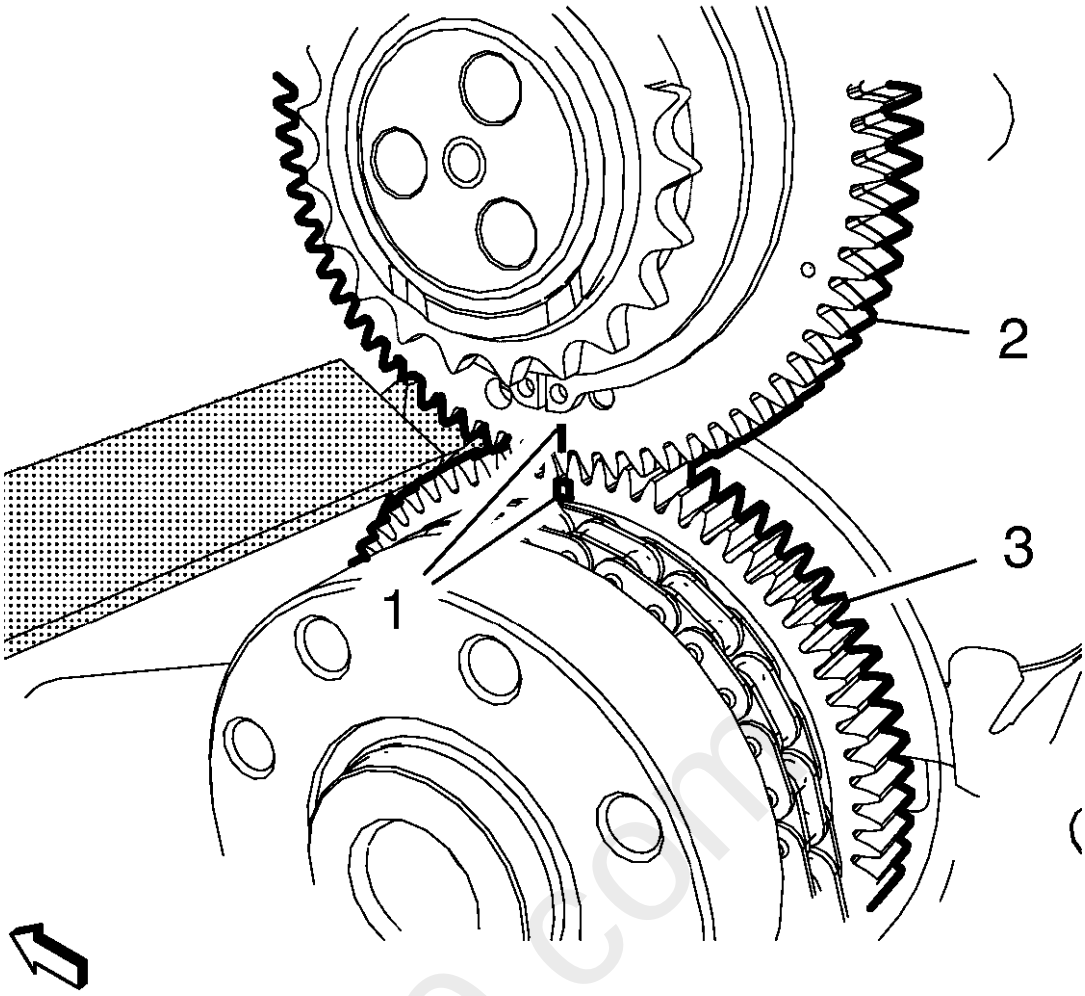


Fig. 847: Timing Chain Idler Sprocket, Alignment Marks And Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

3. Install the timing chain idler sprocket (2), by align the marks (1) with the timing chain idler sprocket and the crankshaft sprocket (3).

mcx30.com

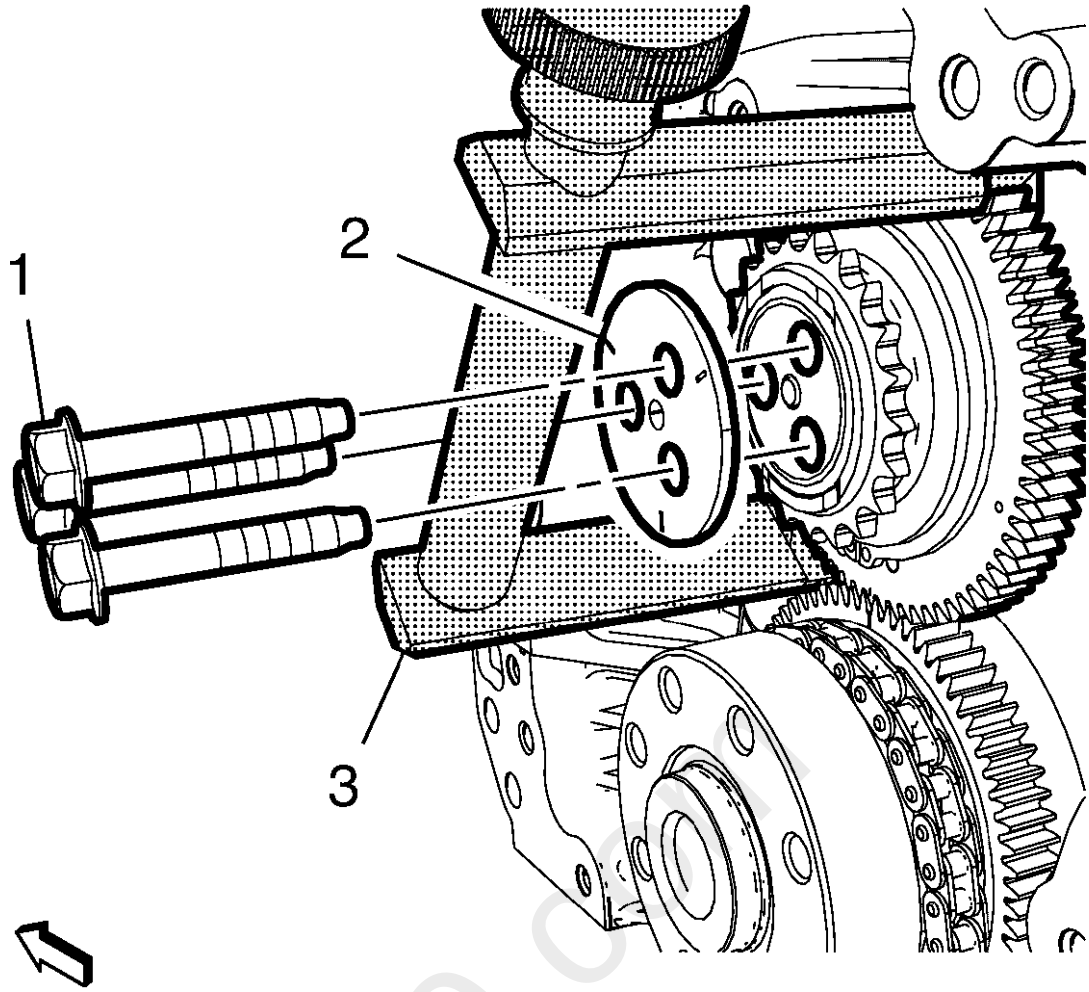


Fig. 848: Timing Chain Idler Sprocket Bearing Plate, Sprocket Bolts And Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

4. Install the timing chain idler sprocket bearing plate (2).

CAUTION: **Refer to Fastener Caution .**

5. Install the 3 timing chain idler sprocket bolts (1) and tighten to 25 N.m (18 lb ft).
6. Remove the **EN-51141** fixing tool (3).

TIMING CHAIN UPPER GUIDE INSTALLATION

NOTE: **Before installing the timing chain upper guide, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

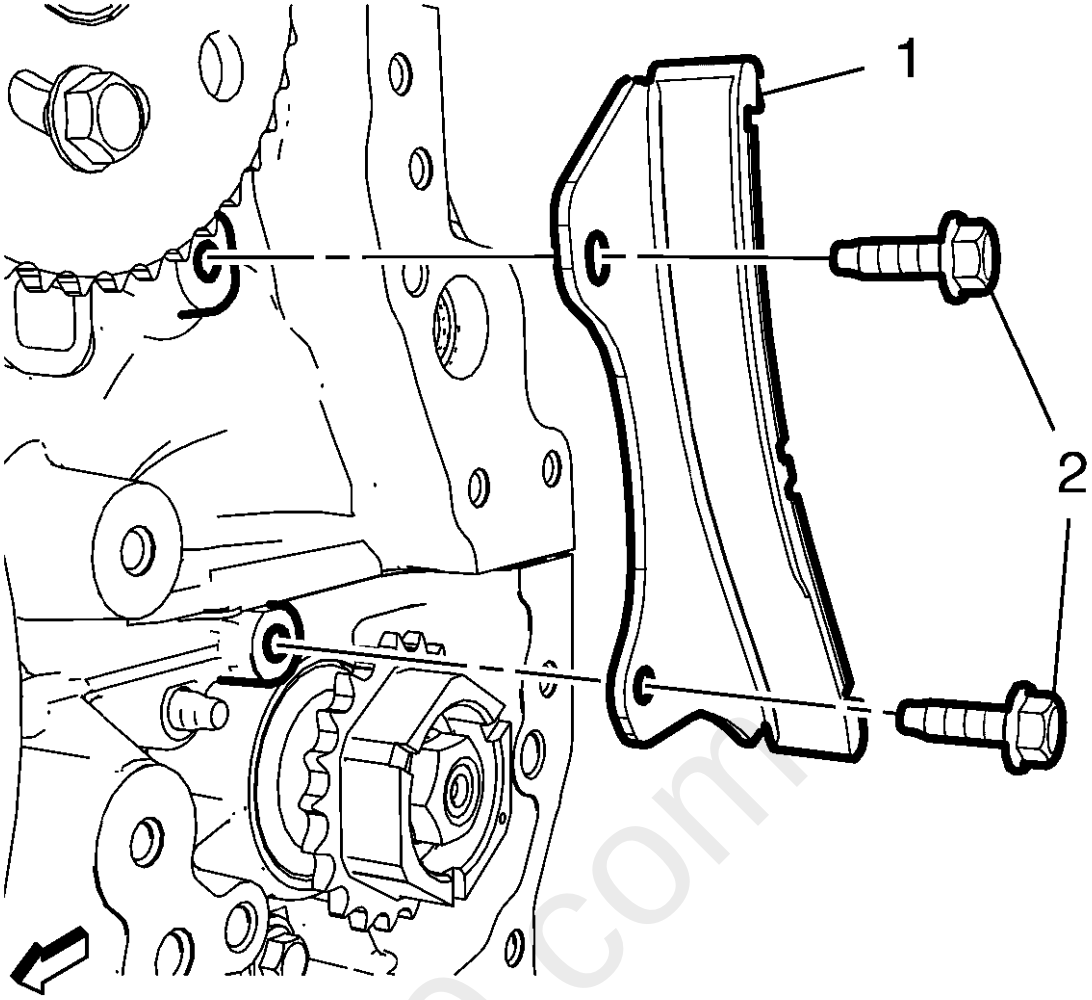


Fig. 849: Timing Chain Upper Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Re-cut thread at cylinder head and engine block for the 2 timing chain upper guide bolts (2).
3. Install the timing chain upper guide (1).

NOTE: **The tightening procedure of the upper timing chain upper guide bolts should be completed within 10 minutes**

4. Apply thread lock agent to the upper timing chain upper guide bolt (2).

NOTE: **Do not tighten the upper timing chain upper guide bolt before the camshaft timing chain is installed.**

5. Install the upper timing chain upper guide bolt (2).

TIMING CHAIN LOWER GUIDE INSTALLATION

NOTE: **Before installing the timing chain lower guide, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

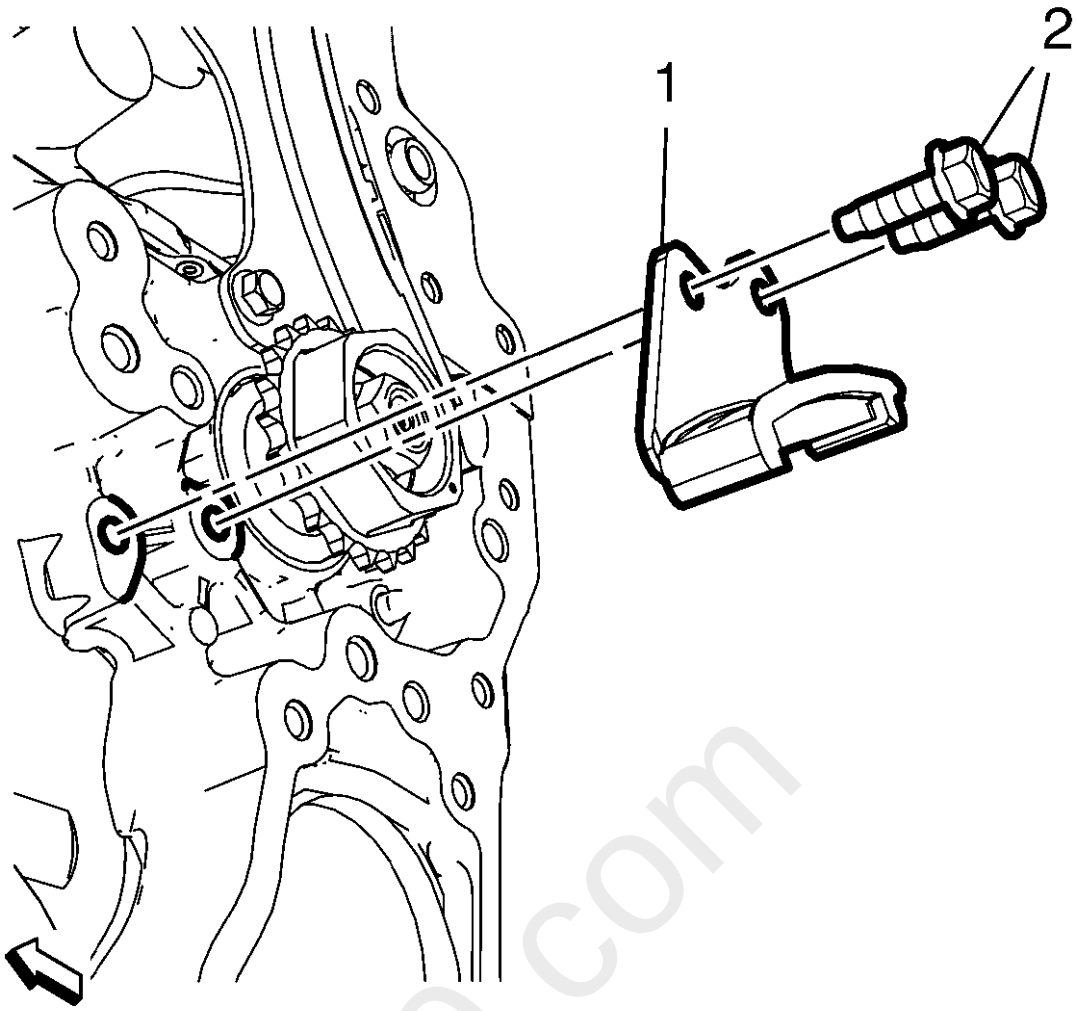


Fig. 850: Timing Chain Lower Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the timing chain lower guide (1).

CAUTION: **Refer to Fastener Caution .**

3. Install the 2 timing chain lower guide bolts (2) and tighten to 10 N.m (89 lb in).

TIMING CHAIN TENSIONER SHOE INSTALLATION

NOTE: **Before installing the timing chain tensioner shoe, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

mcx30.com

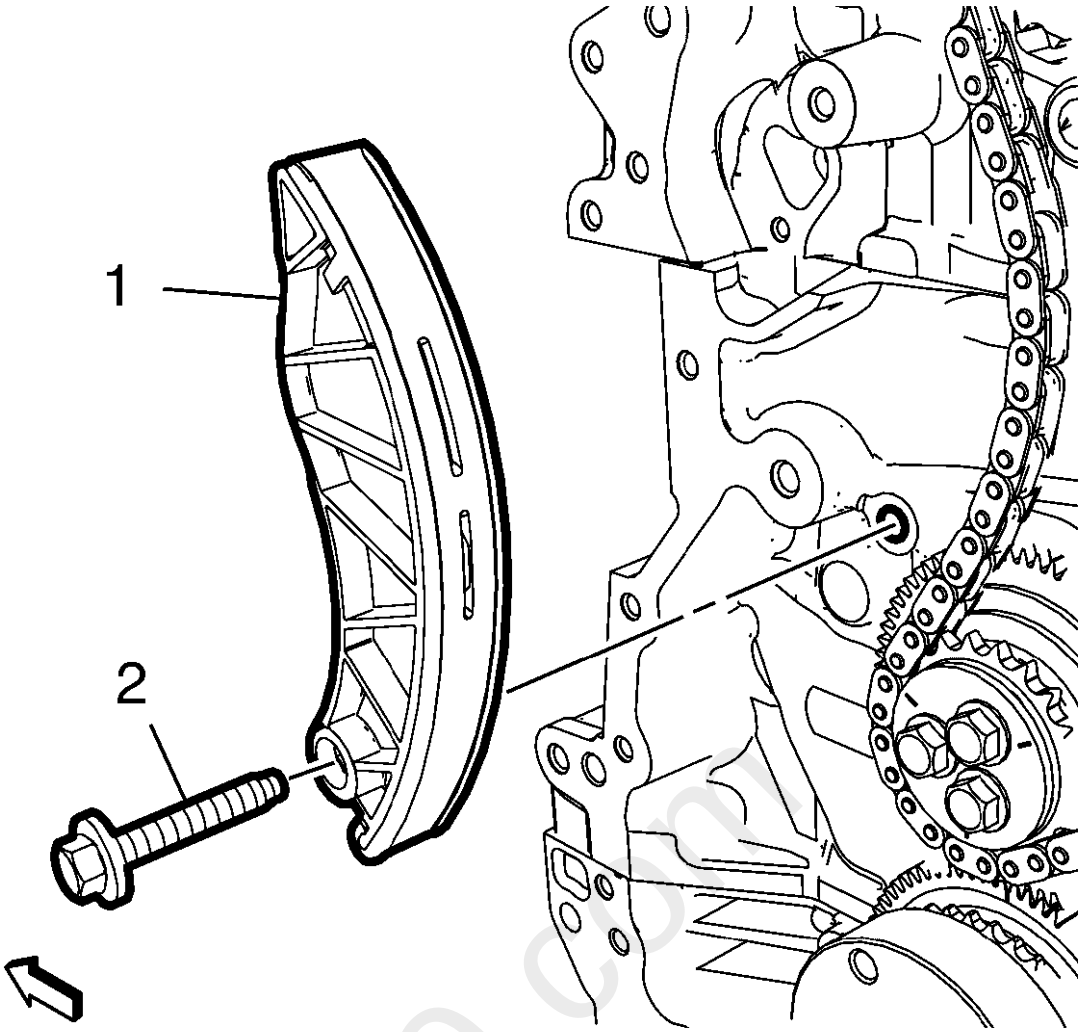


Fig. 851: Timing Chain Tensioner Shoe And Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Install the timing chain tensioner shoe (1).

CAUTION: **Refer to Fastener Caution .**

3. Install the timing chain tensioner shoe bolt (2) and tighten to 25 N.m (18 lb ft).

TIMING CHAIN TENSIONER INSTALLATION

Special Tools

EN-50513 Fixing Pin

For equivalent regional tools, refer to Special Tools.

NOTE: **Before installing the timing chain tensioner, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

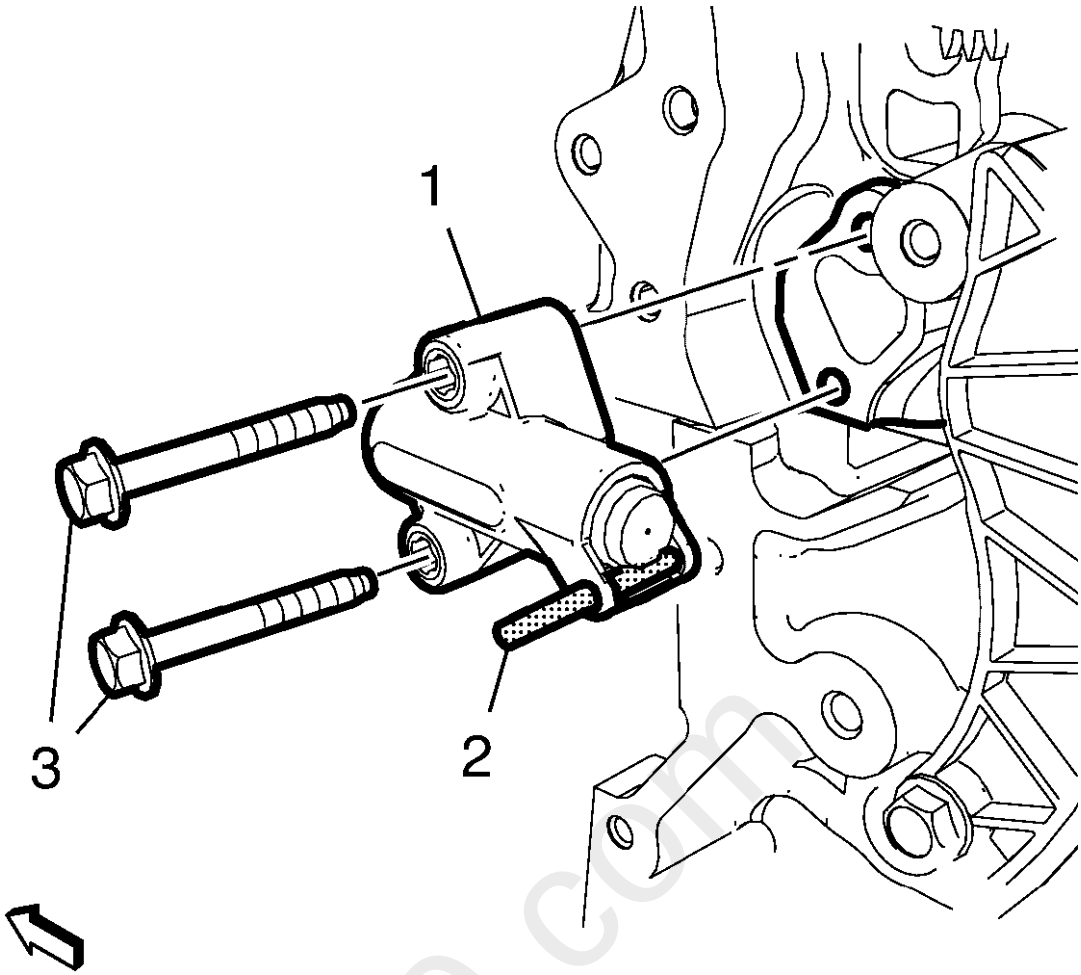


Fig. 852: Timing Chain Tensioner, Bolts And Pin
Courtesy of GENERAL MOTORS COMPANY

2. Install the timing chain tensioner (1).

CAUTION: **Refer to Fastener Caution .**

3. Install the 2 timing chain tensioner bolts (3) and tighten to 10 N.m (89 lb in).

mcx30.com

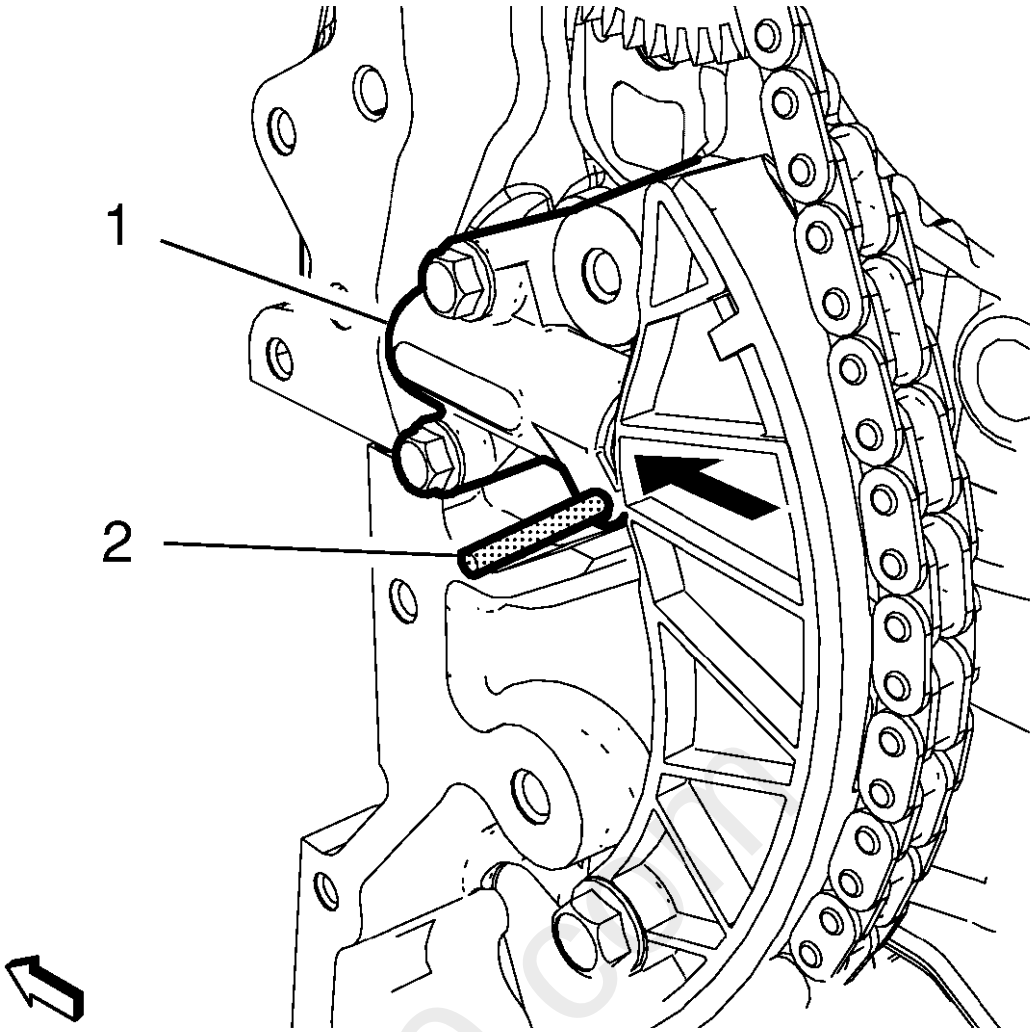


Fig. 853: Timing Chain Tensioner And Pin
Courtesy of GENERAL MOTORS COMPANY

4. Remove the **EN-50513** pin (2).

CAMSHAFT TIMING CHAIN INSTALLATION

Special Tools

- **EN-50513** Fixing Pin
- **EN-51140** Crankshaft Fixing Tool
- **EN-51143** Camshaft Sprocket Fixing Tool

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

NOTE: **Before installing the camshaft timing chain, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

mcx30.com

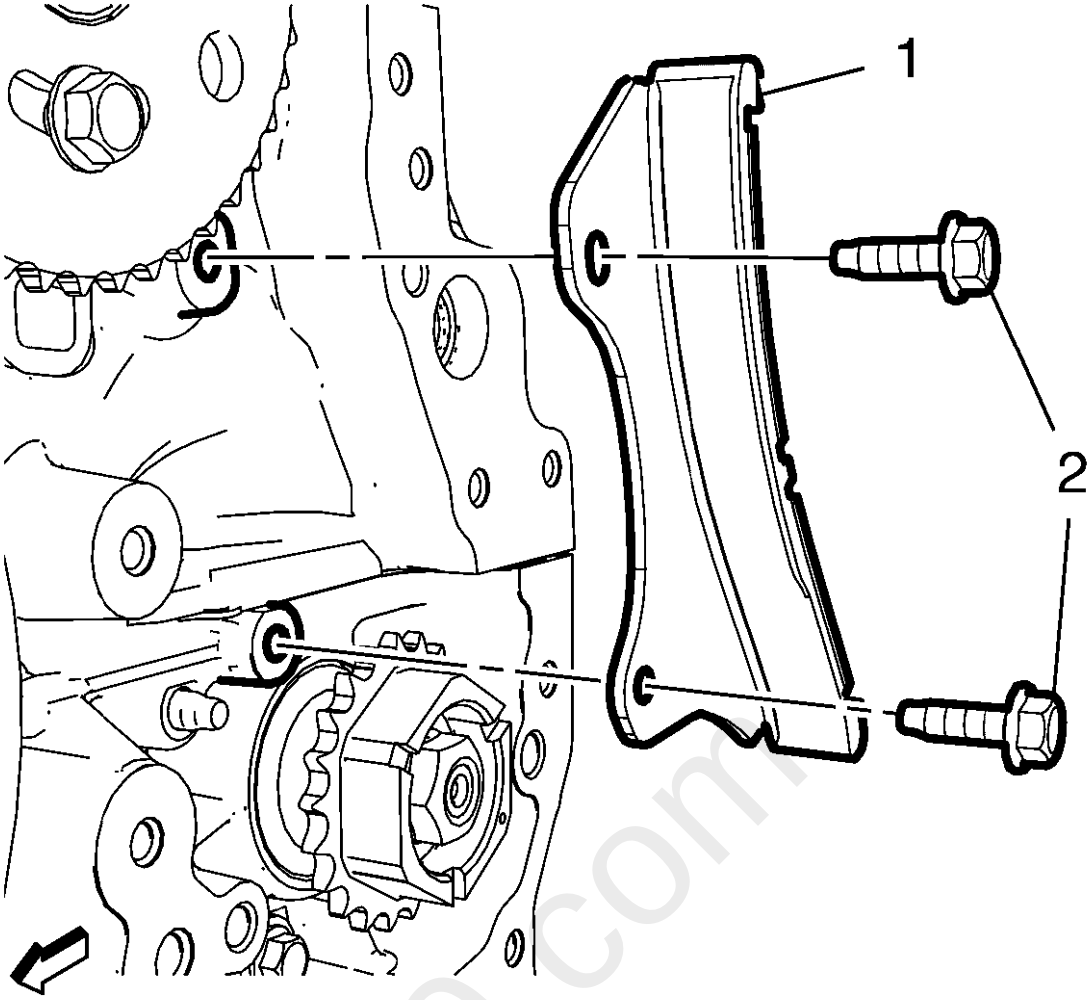


Fig. 854: Timing Chain Upper Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Re-cut thread at cylinder head and engine block for the 2 timing chain upper guide bolts (2).
3. Install the timing chain upper guide (1).

NOTE: **The tightening procedure of the upper timing chain upper guide bolts should be completed within 10 minutes**

4. Apply thread lock agent to the upper timing chain upper guide bolt (2).

NOTE: **Do not tighten the upper timing chain upper guide bolt before the camshaft timing chain is installed.**

5. Install the upper timing chain upper guide bolt (2).

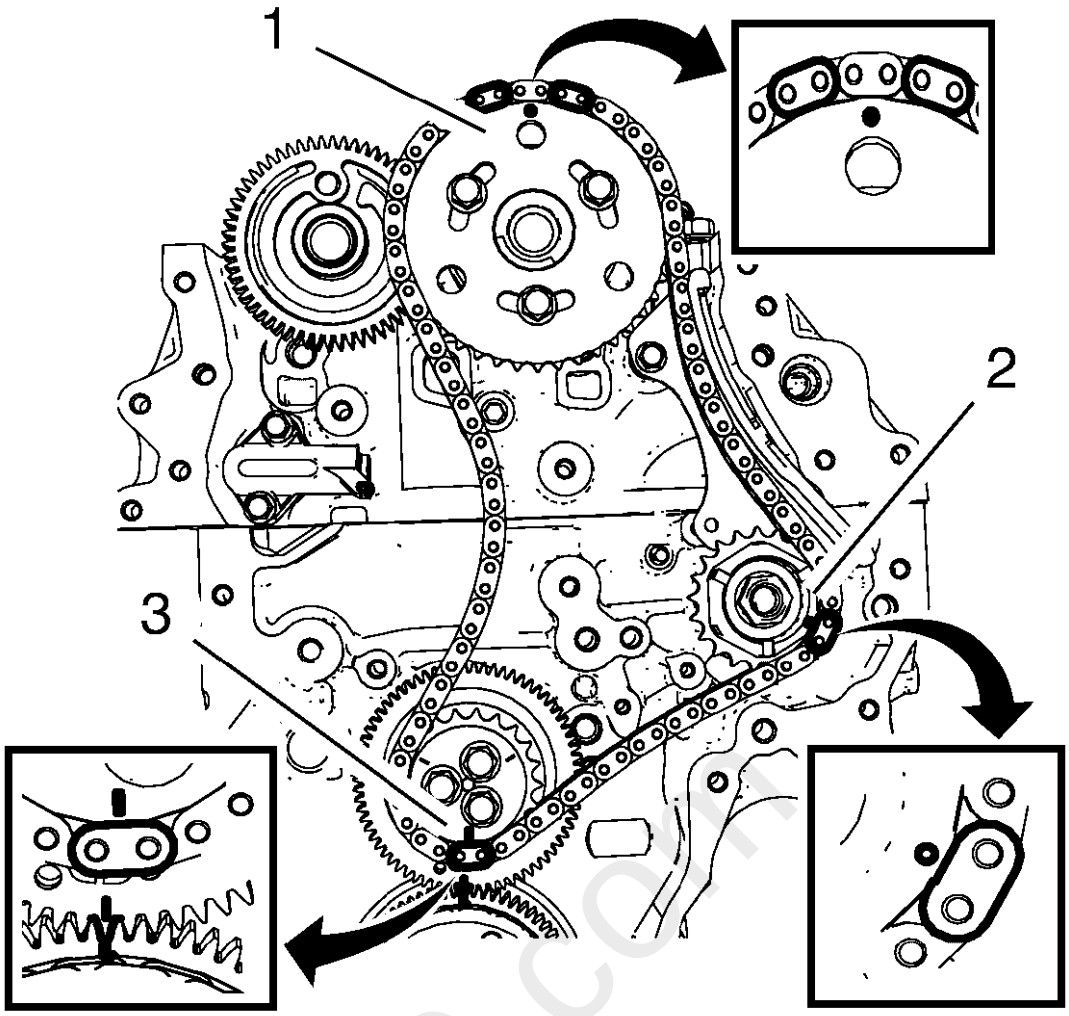


Fig. 855: Aligning Timing Chain Marked Chain Links
Courtesy of GENERAL MOTORS COMPANY

6. Install the timing chain with the marked chain links as shown and follow the installation sequence:
    1. Install the timing chain in the first step to the fuel injection pump sprocket (2).
    2. Install the timing chain in the second step to the camshaft sprocket (1).
    3. Install the timing chain in the final step to the timing chain idler sprocket (3).

mcx30.com

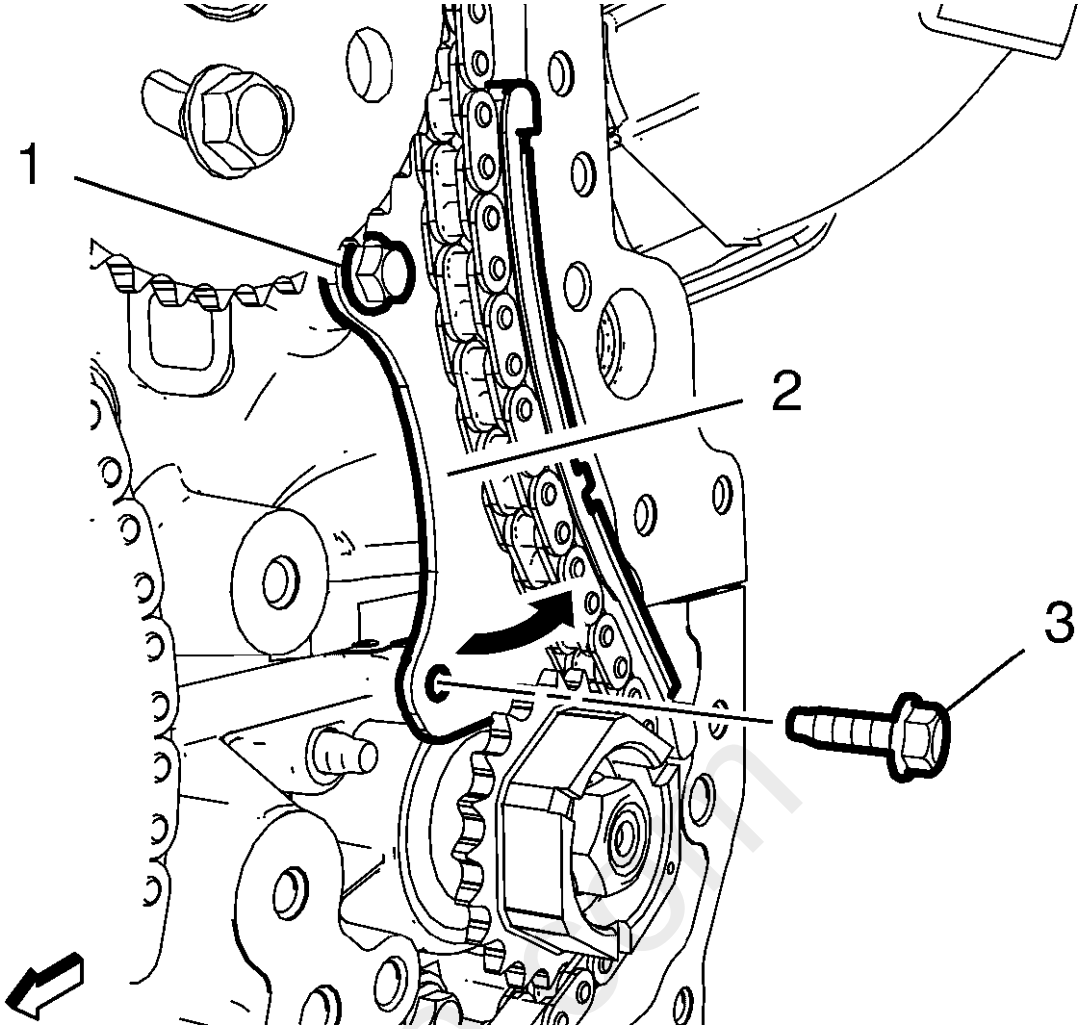


Fig. 856: Timing Chain Upper Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

7. Apply thread lock agent to the lower timing chain upper guide bolt (3).
8. Install the timing chain upper guide bolt (3) and tighten to 11 N.m (97 lb in).
9. Tighten the timing chain upper guide bolt (1) to 11 N.m (97 lb in).

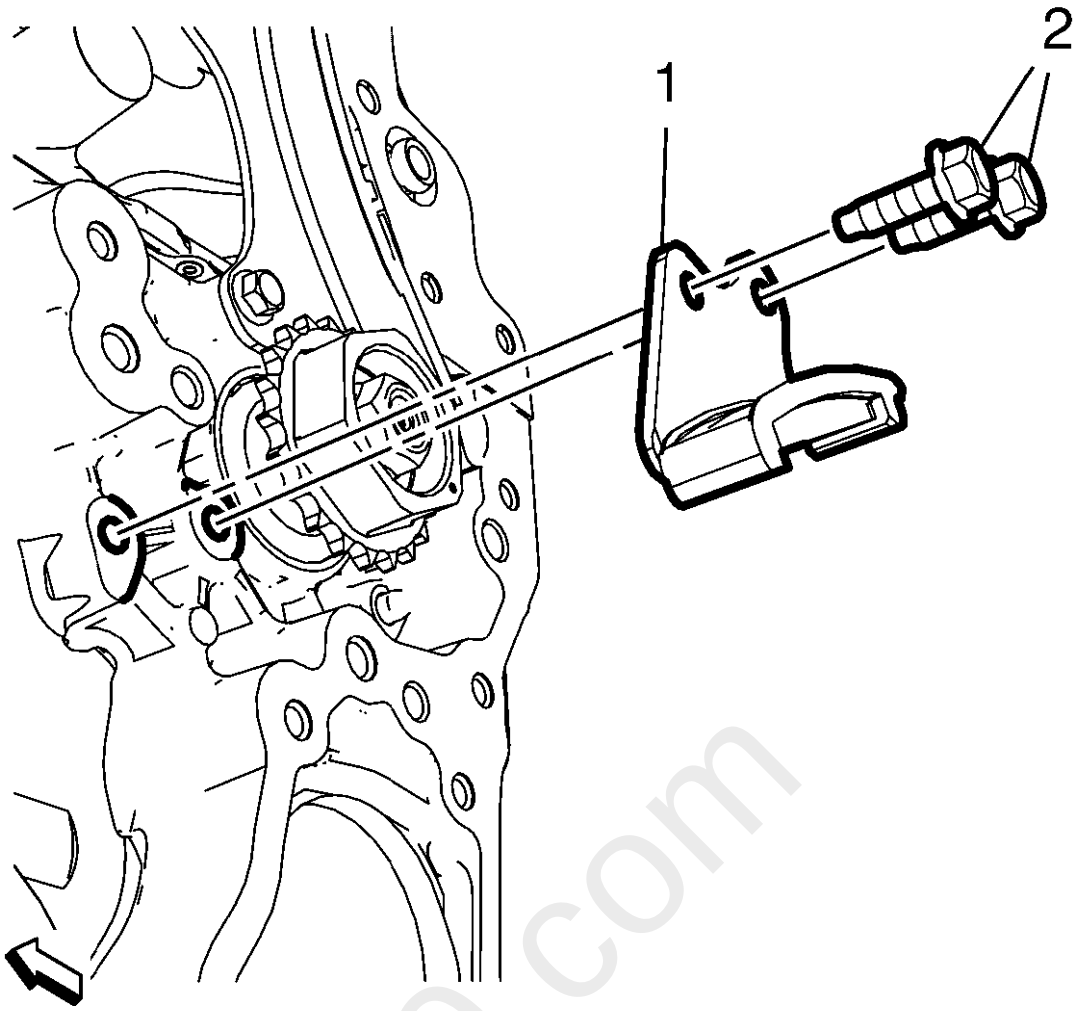


Fig. 857: Timing Chain Lower Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Install the timing chain lower guide (1).
11. Install the 2 timing chain lower guide bolts (2) and tighten to 10 N.m (89 lb in).

mcx30.com

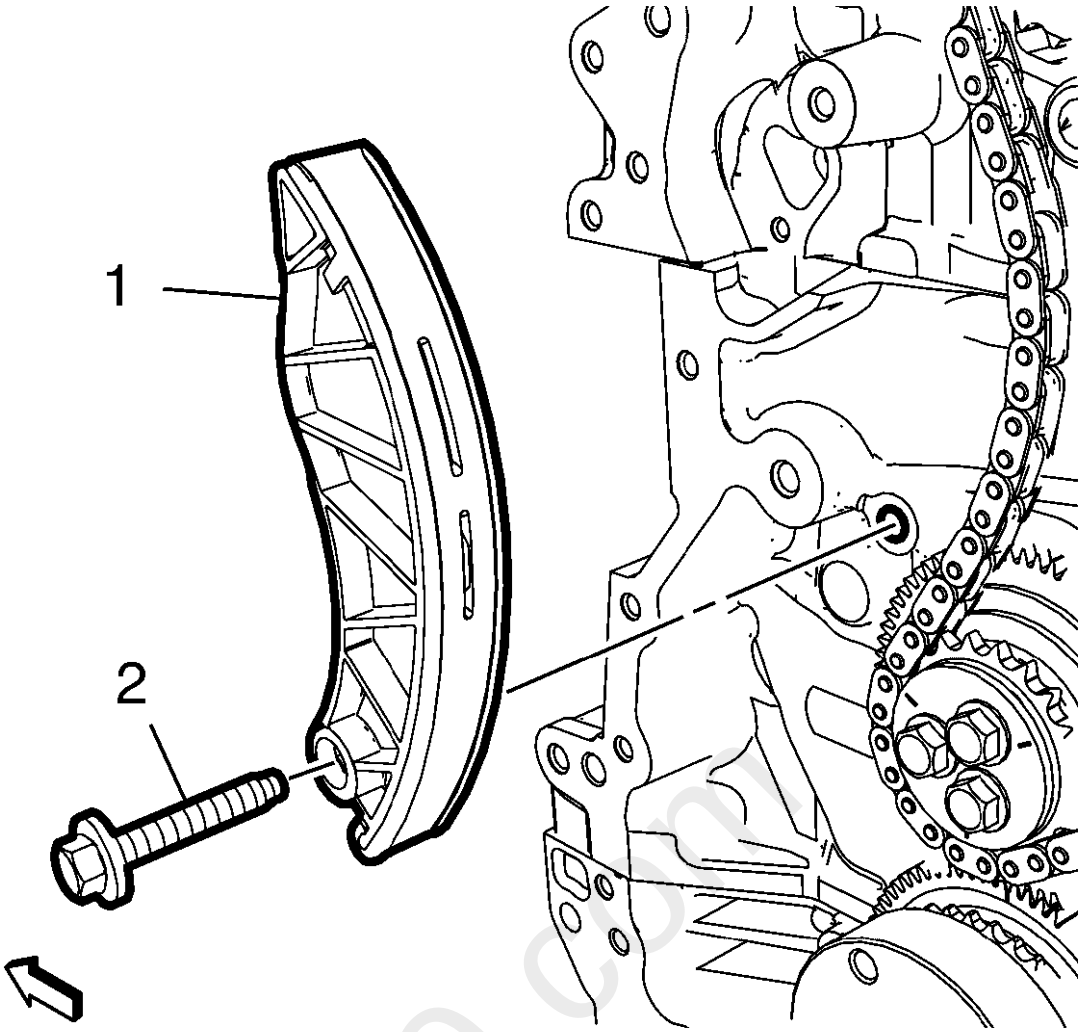


Fig. 858: Timing Chain Tensioner Shoe And Bolt
Courtesy of GENERAL MOTORS COMPANY

12. Install the timing chain tensioner shoe (1).
13. Install the timing chain tensioner shoe bolt (2) and tighten to 25 N.m (18 lb ft).

mcx30.com

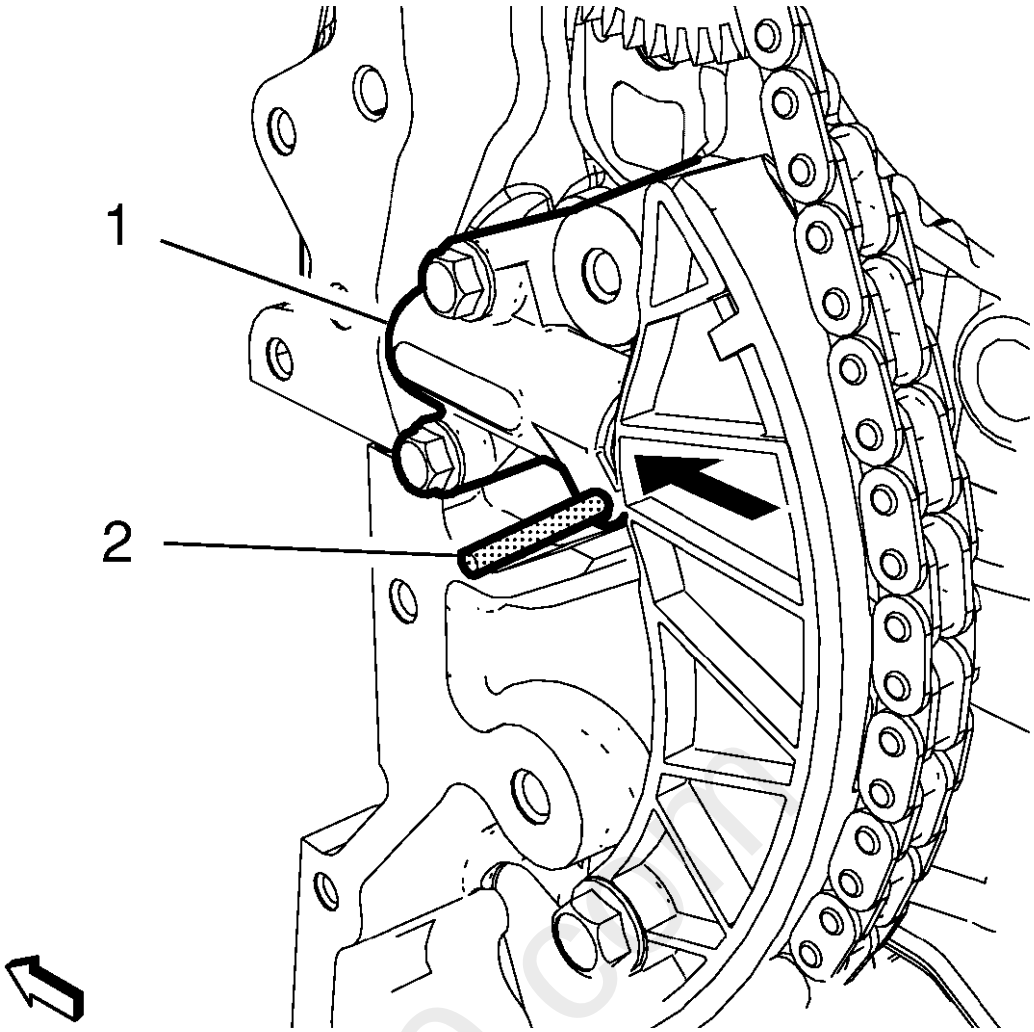


Fig. 859: Timing Chain Tensioner And Pin
Courtesy of GENERAL MOTORS COMPANY

14. Remove the **EN-50513** pin (2).

mcx30.com

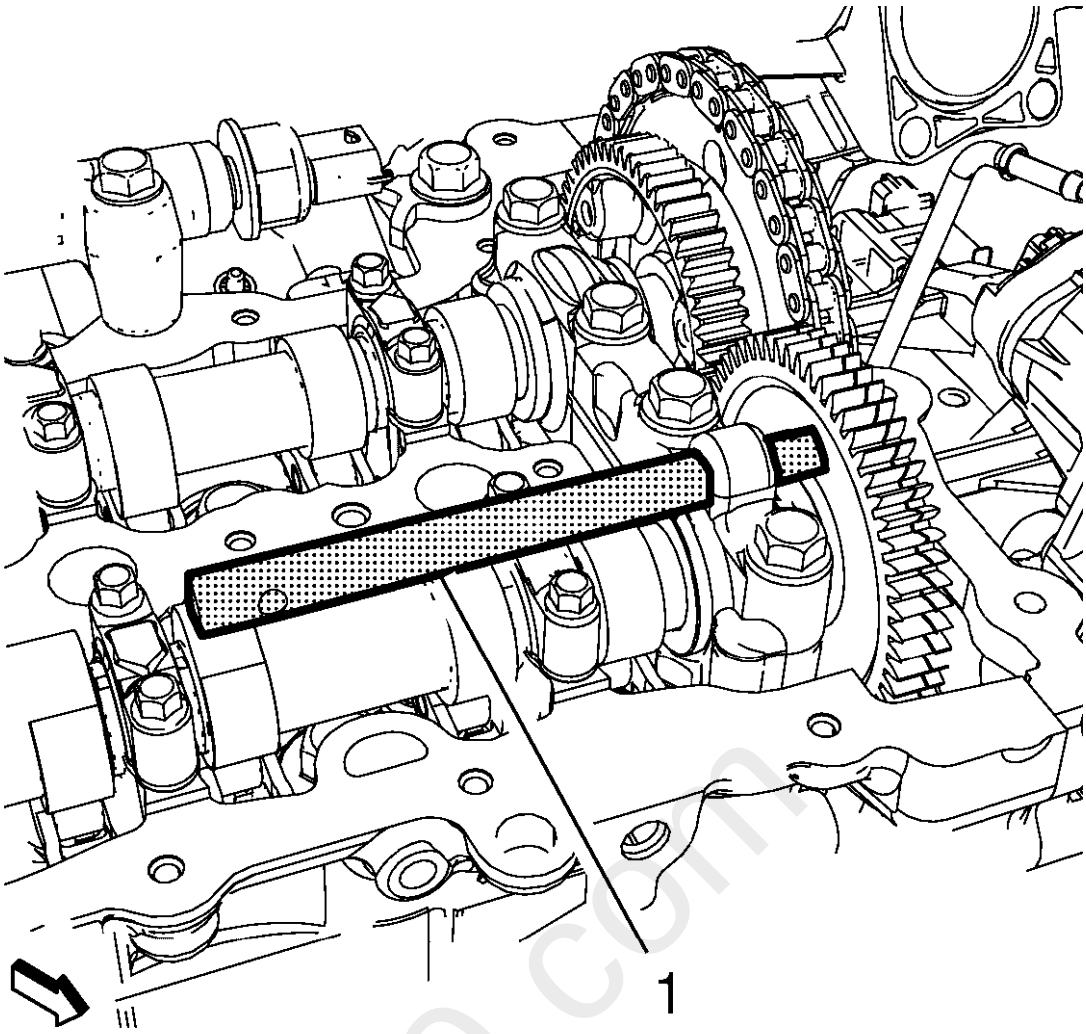


Fig. 860: Camshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

15. Remove the **EN-51143** fixing tool (1).

mcx30.com

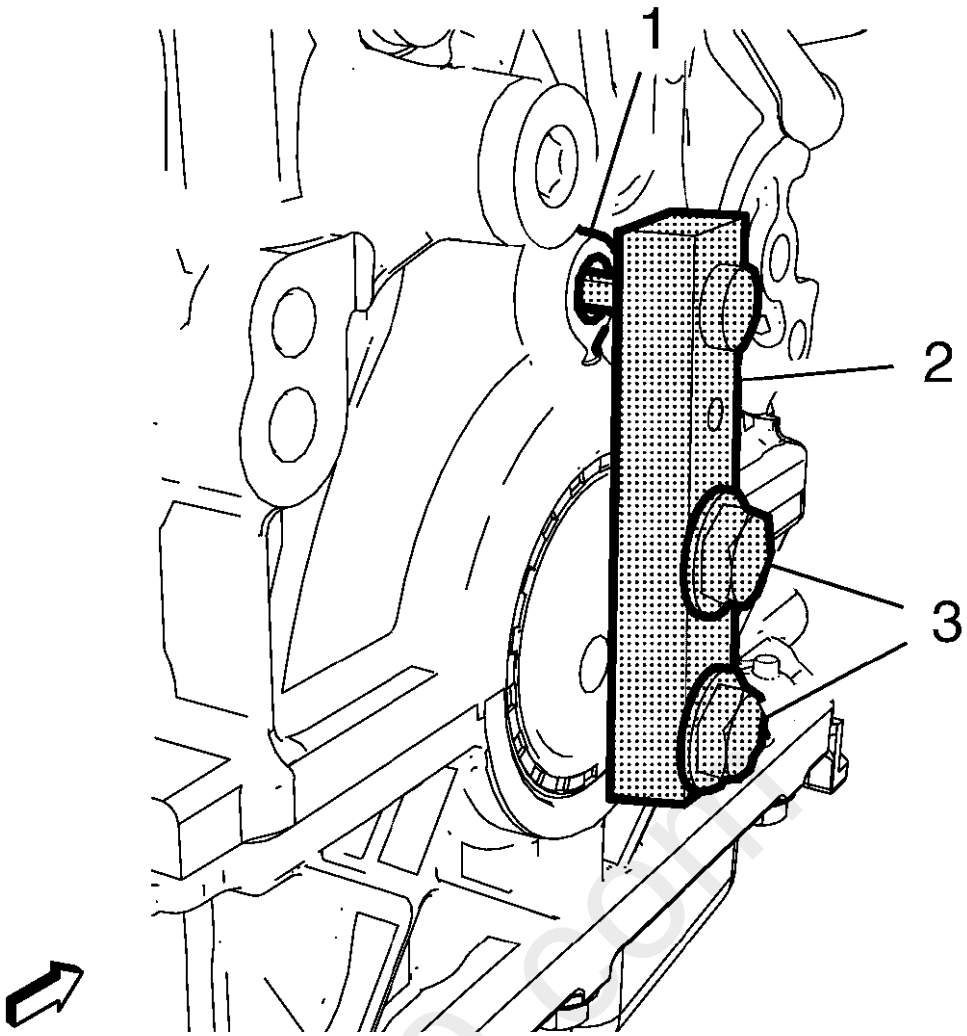


Fig. 861: Crankshaft Fixing Tool
Courtesy of GENERAL MOTORS COMPANY

16. Remove the 2 bolts (3).
17. Remove the **EN-51140** fixing tool (2).

mcx30.com

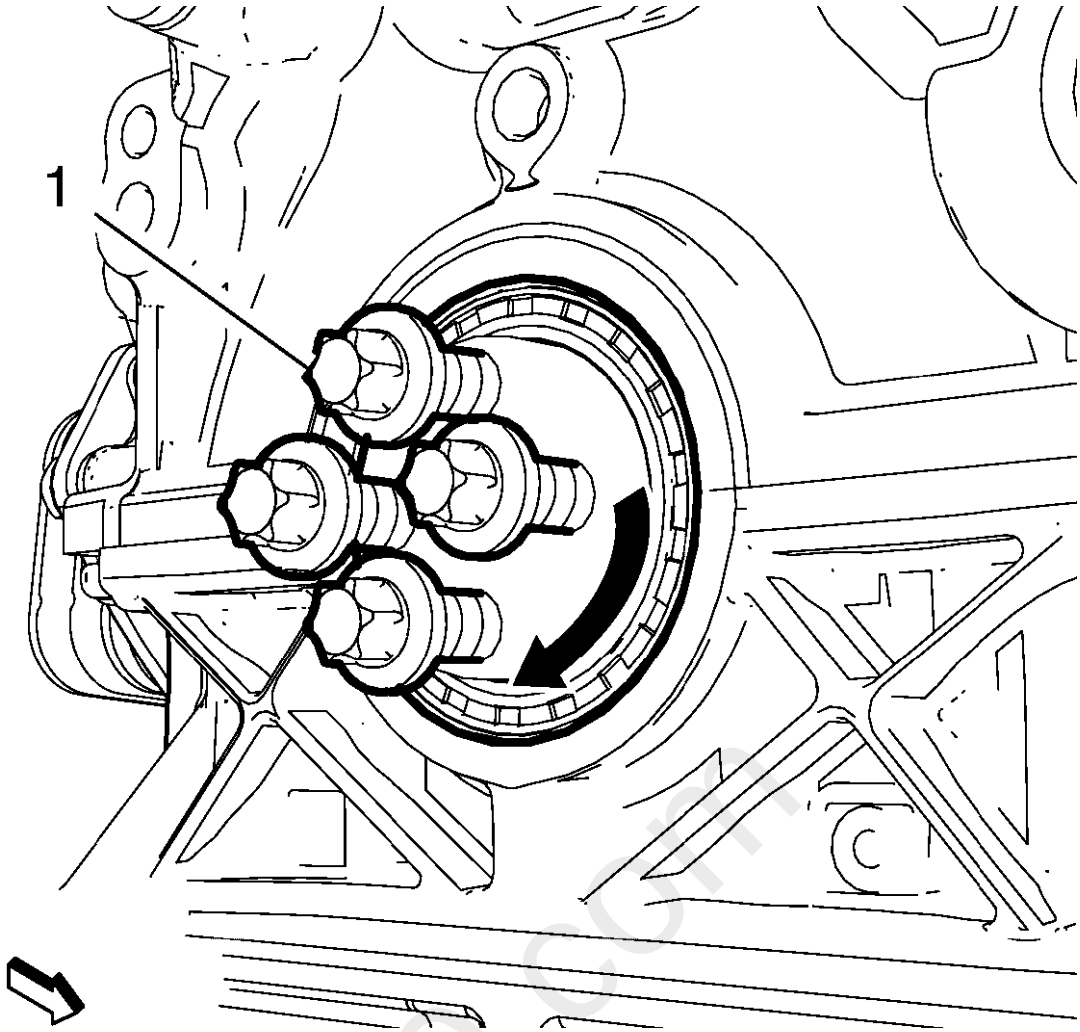


Fig. 862: Crankshaft Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

18. Install the 4 crankshaft pulley bolts (1).

    Rotate the crankshaft 720 degrees in direction of arrow. Use a pry bar at the 4 crankshaft pulley bolts (1).

19. Remove the 4 crankshaft pulley bolts (1).
20. Check the camshaft timing. Refer to **Camshaft Timing Chain Inspection**.

OIL AND POWER BRAKE BOOSTER PUMP INSTALLATION

mcx30.com

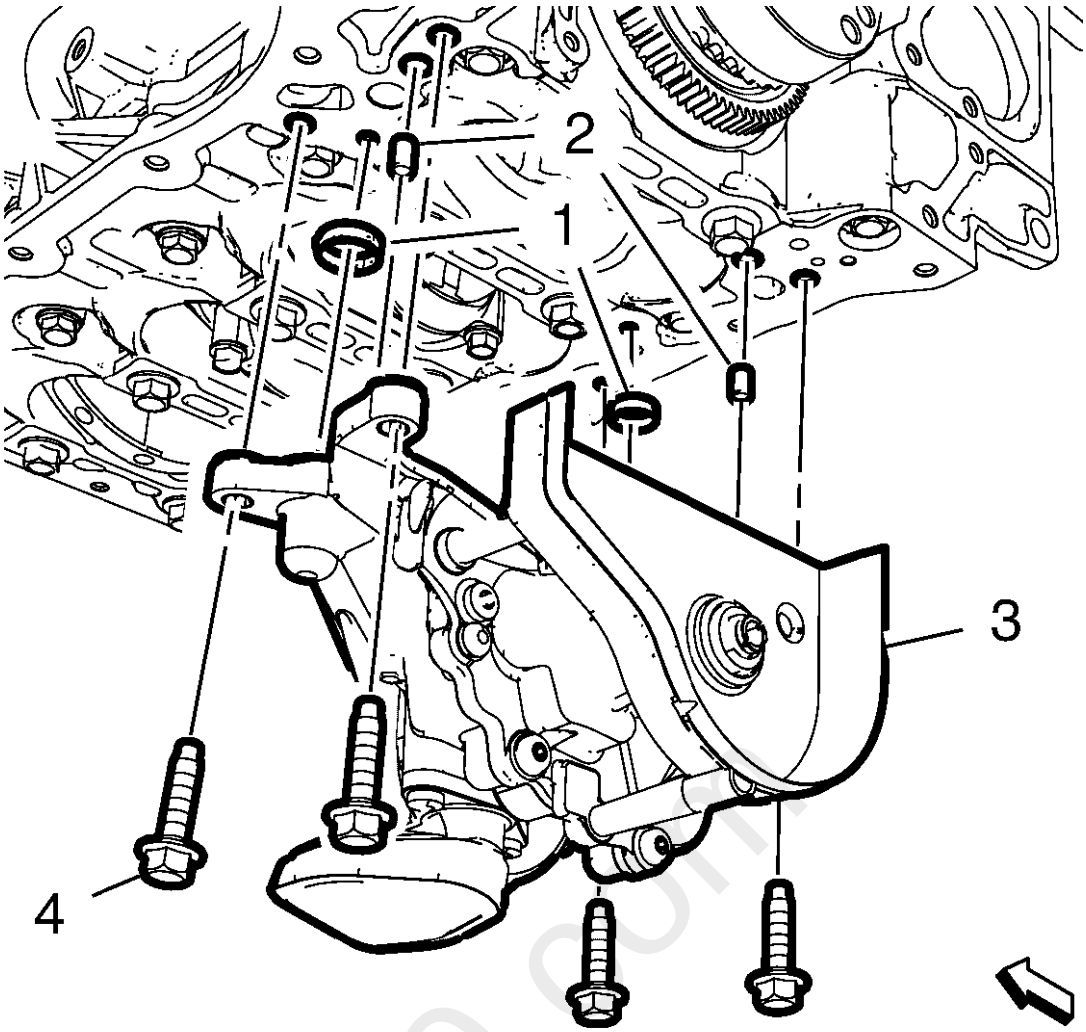


Fig. 863: Oil And Power Steering Pump, Bolts, Locating Pins And Gaskets
Courtesy of GENERAL MOTORS COMPANY

1. Install the 2 location pins (2).
2. Install 2 NEW oil and power steering pump gaskets (1).
3. Install the oil and power steering pump (3).

CAUTION: **Refer to Fastener Caution .**

4. Install the 4 oil pump bolts (4) and tighten to 25 N.m (18 lb ft).

OIL PUMP DRIVE CHAIN AND SPROCKET INSTALLATION

Special Tools

- **EN-45059** Angle Meter
- **EN-51142** Oil Pump Sprocket Unit Holding Tool

For equivalent regional tools, refer to Special Tools.

NOTE: **Before installing the oil pump drive chain, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner

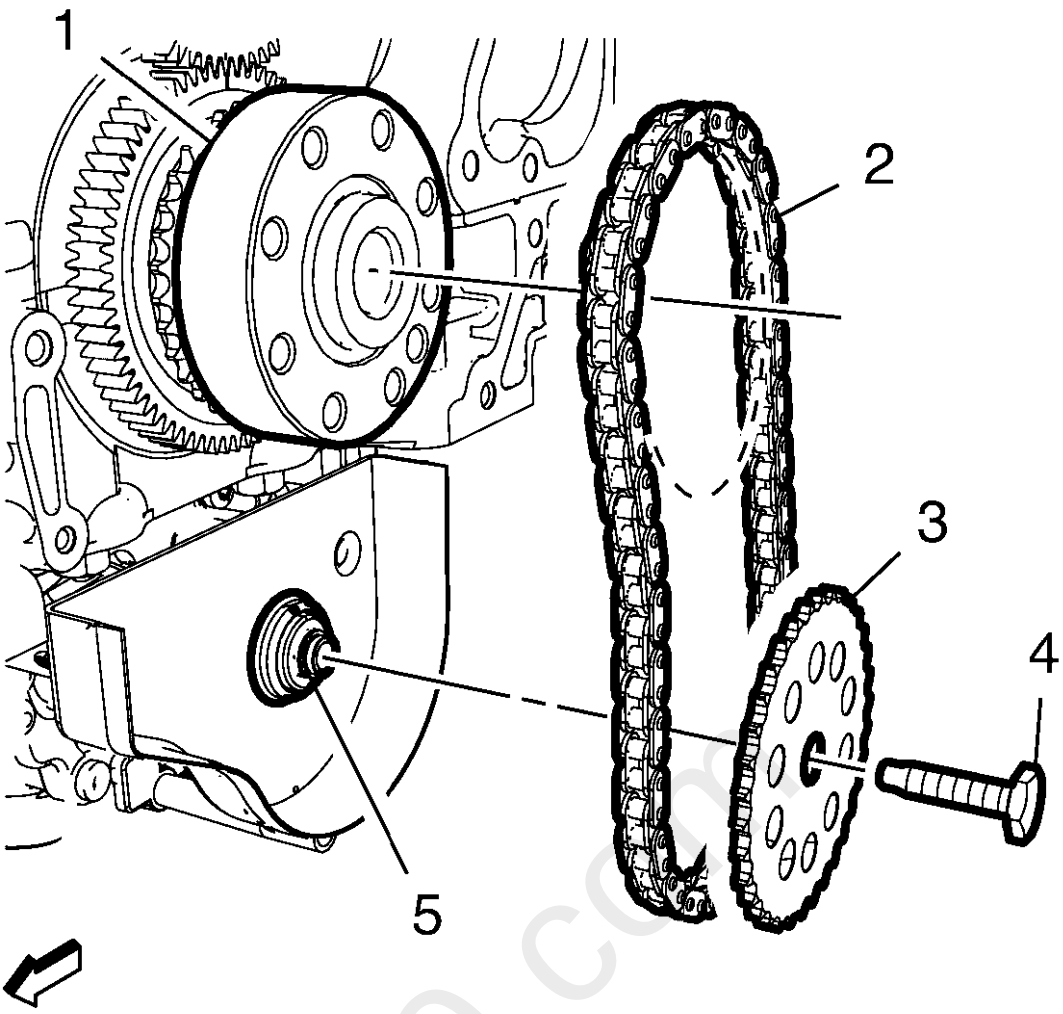


Fig. 864: Oil Pump Sprocket, Bolt, Shaft, Drive Chain And Drive Chain Sprocket
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil pump drive chain (2) to the oil pump drive chain sprocket (1).
3. Install the oil pump sprocket (3) to the oil pump shaft (5).
4. Install a NEW oil pump sprocket bolt (4).

mx30.com

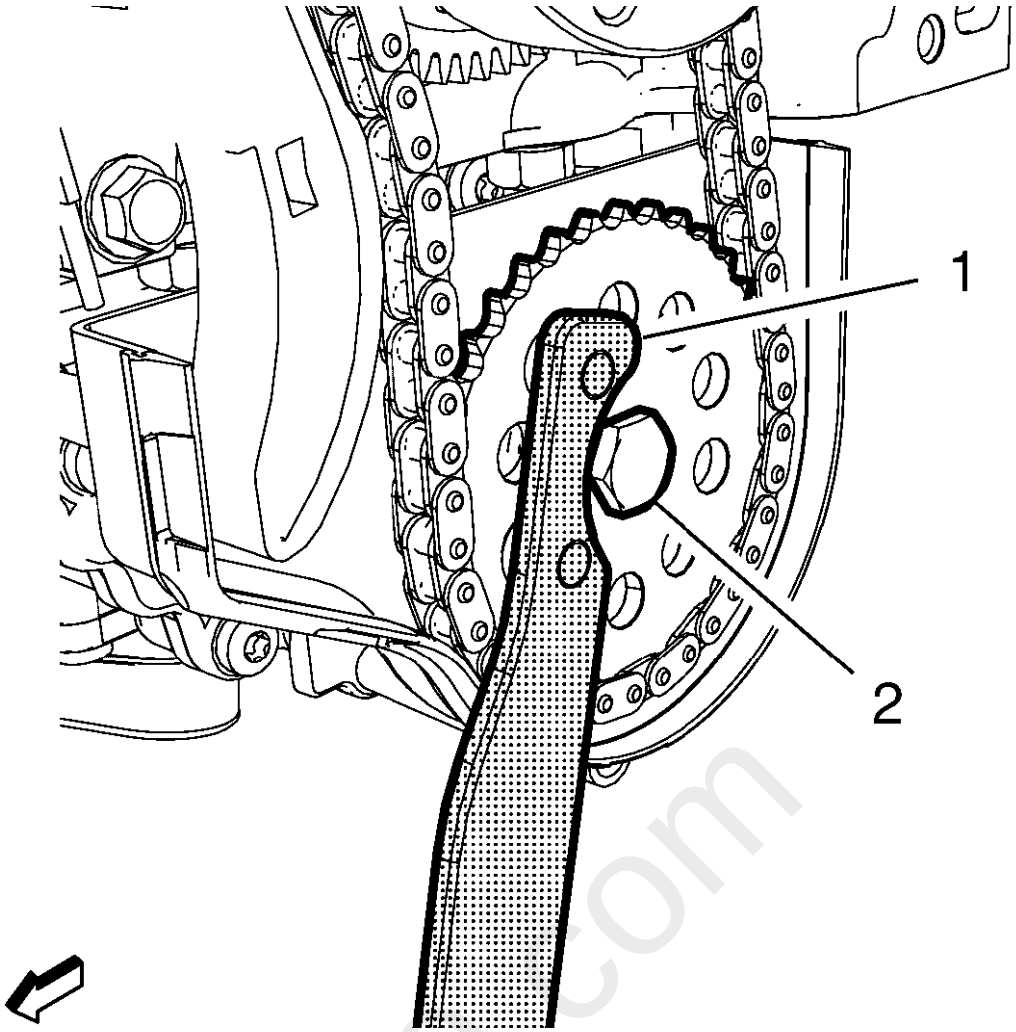


Fig. 865: Oil Pump Sprocket Bolt And Sprocket Holding Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

CAUTION: **Refer to Torque-to-Yield Fastener Caution .**

5. Tighten the NEW oil pump sprocket bolt (2), by counterhold with the **EN-51142** holding tool (1) in 2 passes:
    1. Tighten a first pass to 25 N.m (18 lb ft)
    2. Tighten a final pass an additional to 60 degrees, use the **EN-45059** angle meter.

OIL PUMP DRIVE CHAIN TENSIONER INSTALLATION

Special Tools

EN-50513 Fixing Pin

For equivalent regional tools, refer to Special Tools.

NOTE: **Before installing the oil pump drive chain tensioner, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
    - Timing chain guides with plastic attachment
    - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
    - Timing chain and all timing chain sprockets
    - Oil pump sprocket
    - Oil pump drive chain tensioner

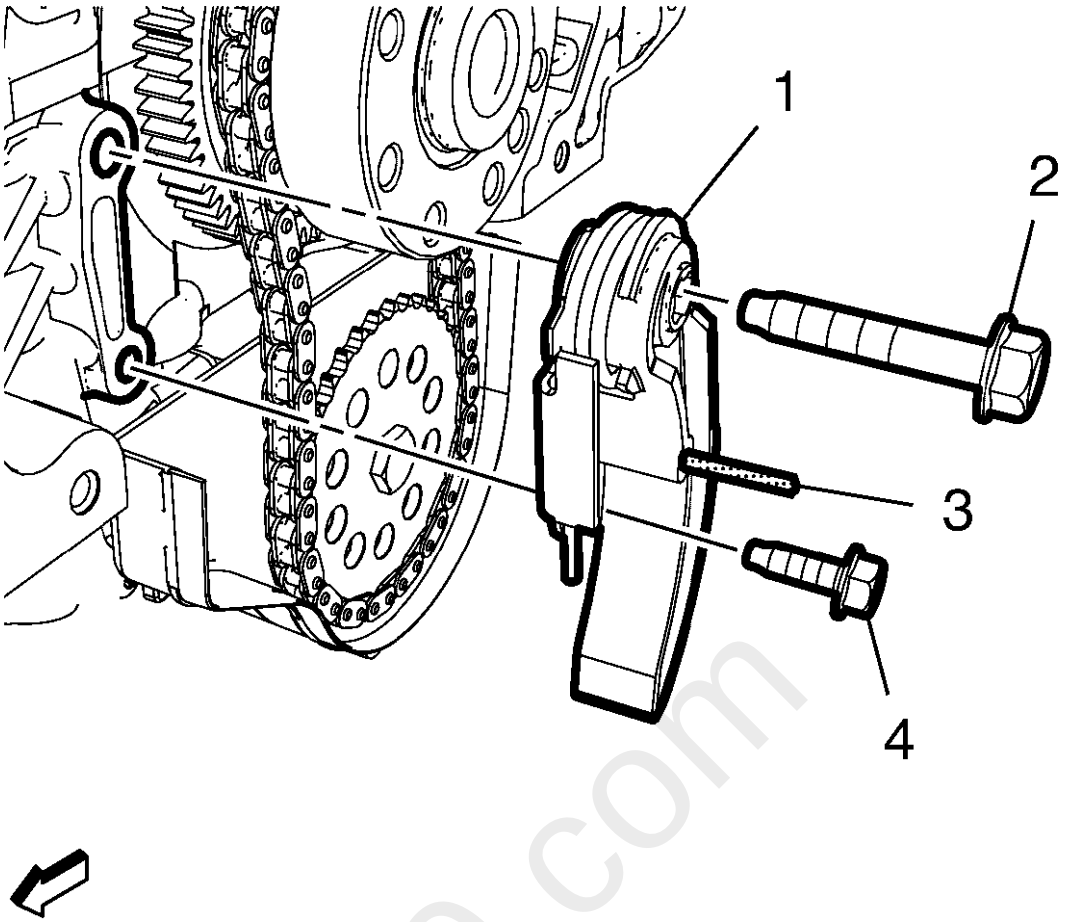


Fig. 866: Oil Pump Drive Chain Tensioner, Bolts And Fixing Pin
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil pump drive chain tensioner (1).
3. Install the oil pump drive chain tensioner bolts (2, 4).

CAUTION: **Refer to Fastener Caution .**

4. Tighten the oil pump drive chain tensioner bolt (2) to 25 N.m (18 lb ft).
5. Tighten the oil pump drive chain tensioner bolt (4) to 10 N.m (89 lb in).

mcx30.com

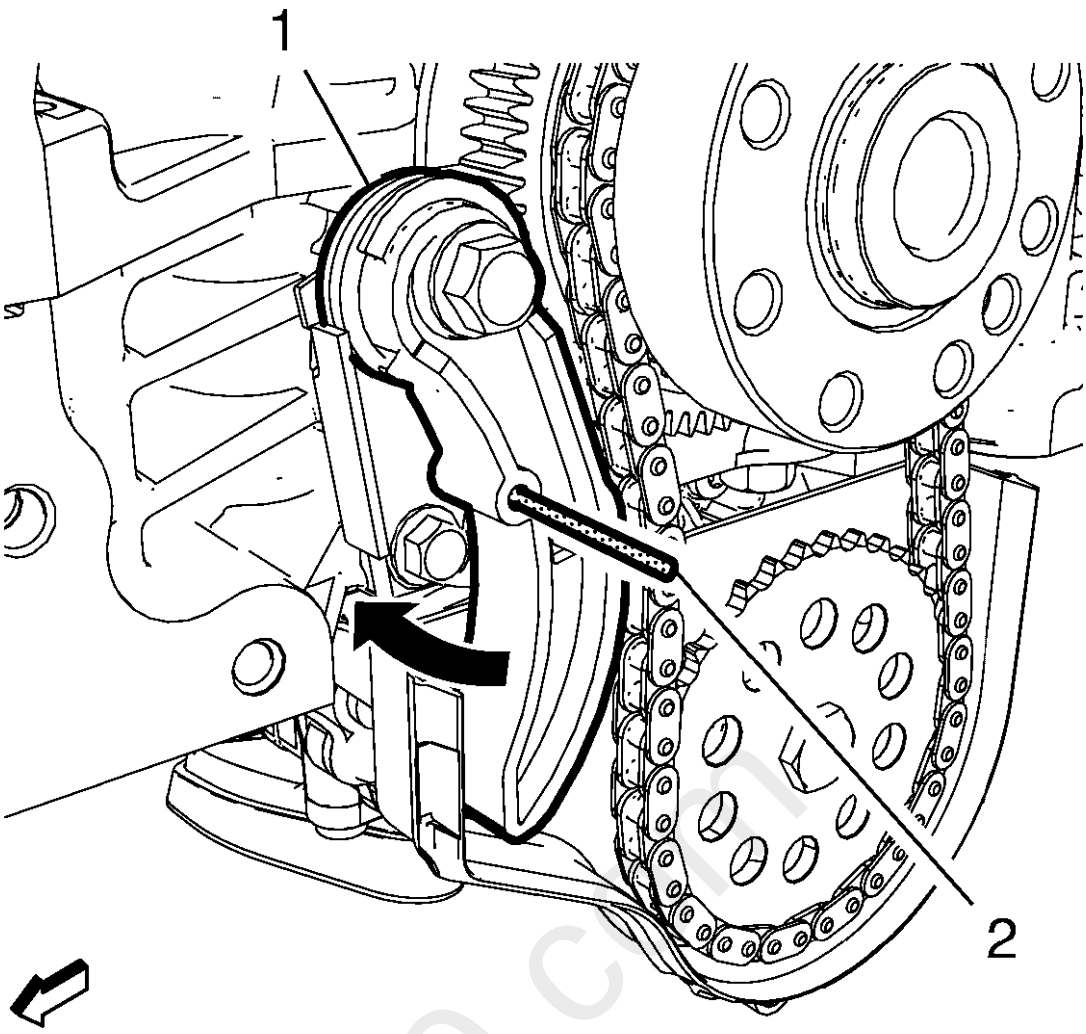


Fig. 867: Oil Pump Drive Chain Tensioner And Fixing Pin
Courtesy of GENERAL MOTORS COMPANY

6. Remove the **EN-50513** fixing pin (2).

TIMING CHAIN LOWER COVER INSTALLATION

Special Tools

- **DT-523-1** Handle
- **EN-51145** Crankshaft Rear Oil Seal Installer

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

NOTE: **Before installing the timing chain lower cover, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner
2. Clean the sealant surfaces.

mcx30.com

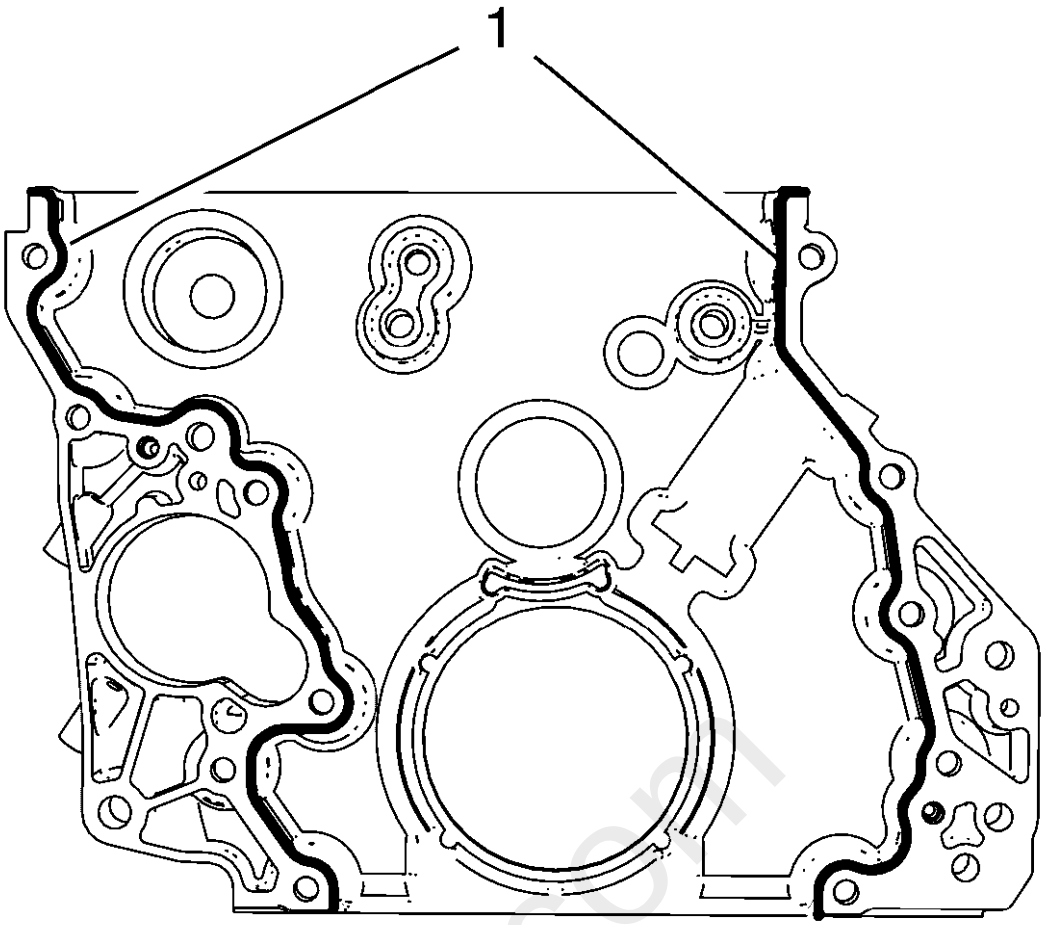


Fig. 868: Silicone Sealing Compound Application Area
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The complete installation procedure of the timing chain lower cover should be done in 20 minutes.**

3. Apply silicone sealing compound (1) to the timing chain lower cover sealing surface. The thickness of the sealing bead should be 2.0 - 3.0 mm (0.079 - 0.118 in).

nexso.com

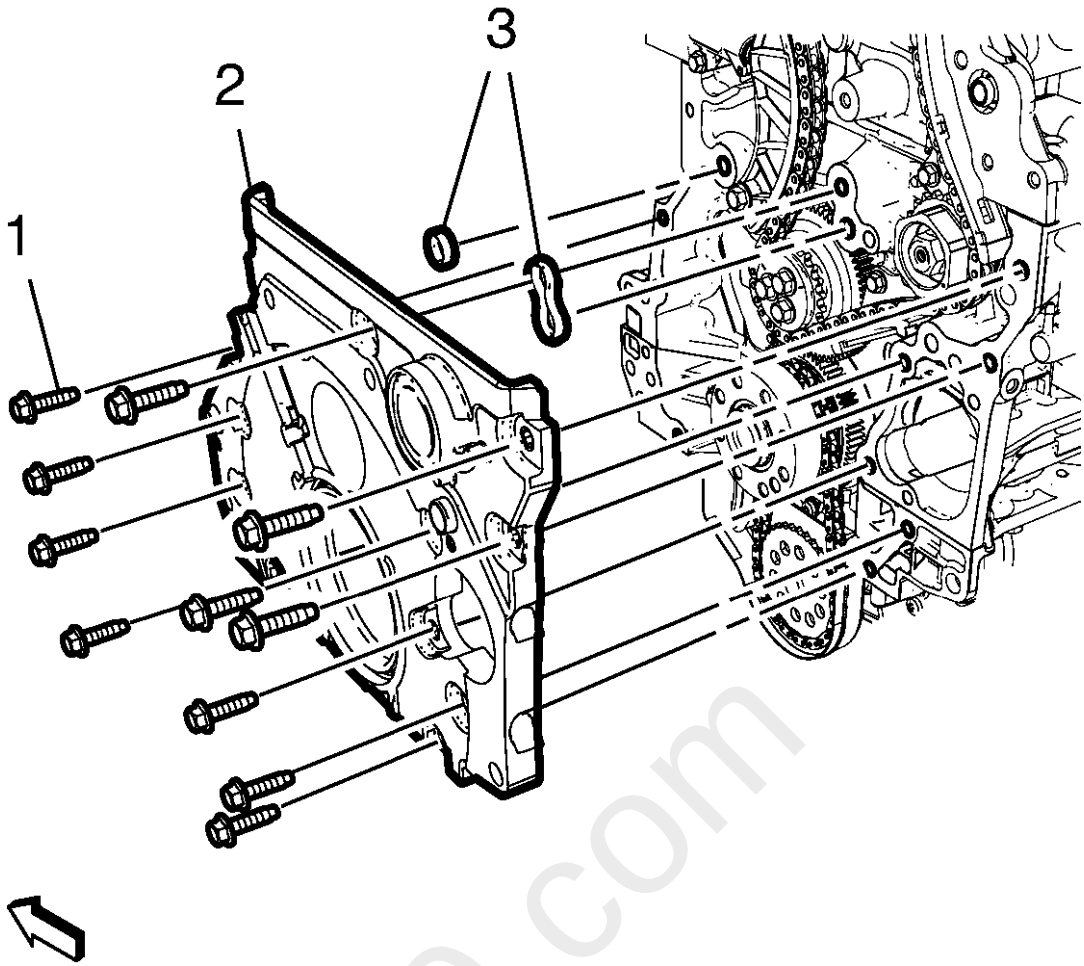


Fig. 869: Timing Chain Lower Cover, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

4. Install the 2 NEW timing chain lower cover gaskets (3).
5. Install the timing chain lower cover (2)
6. Install the 11 timing chain lower cover bolts (1).

mcx30.com

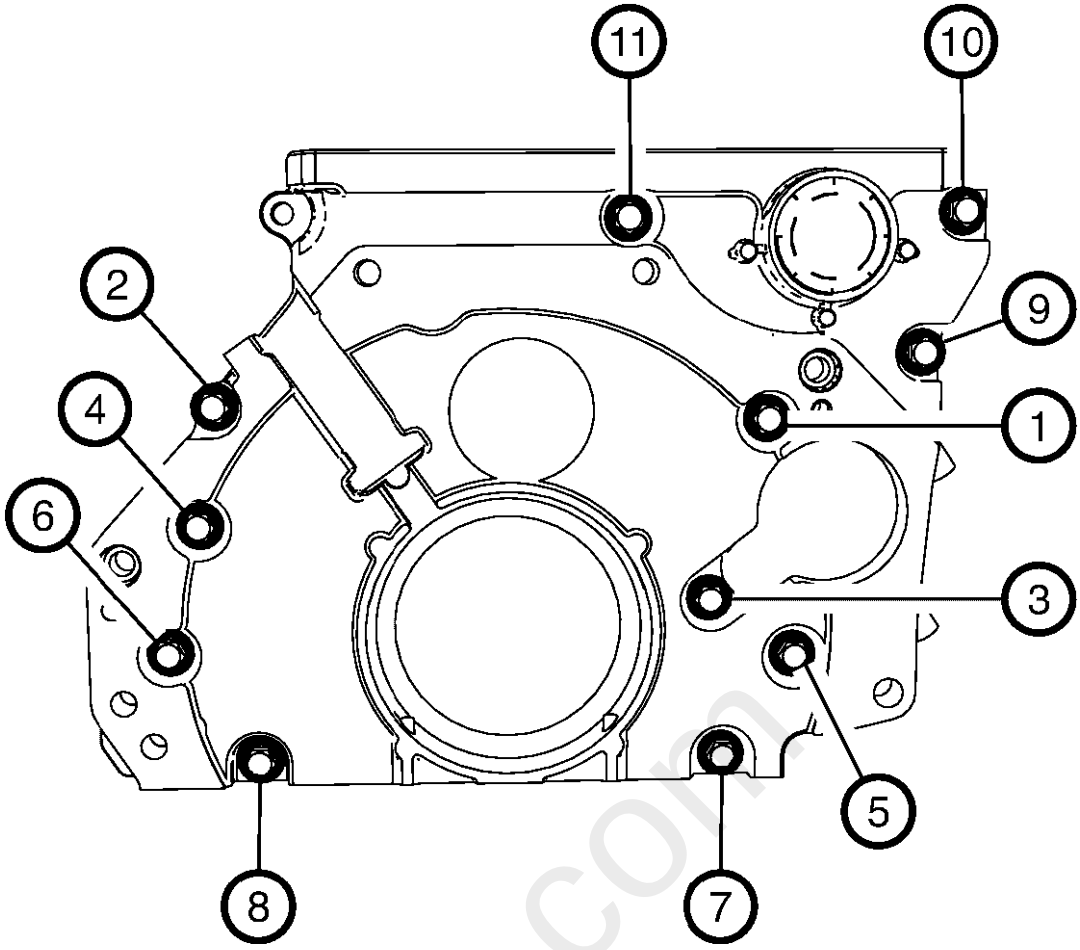


Fig. 870: Timing Chain Lower Cover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

7. Tighten the 11 timing chain lower cover bolts in sequence as shown to 25 N.m (18 lb ft).

mcx30.com

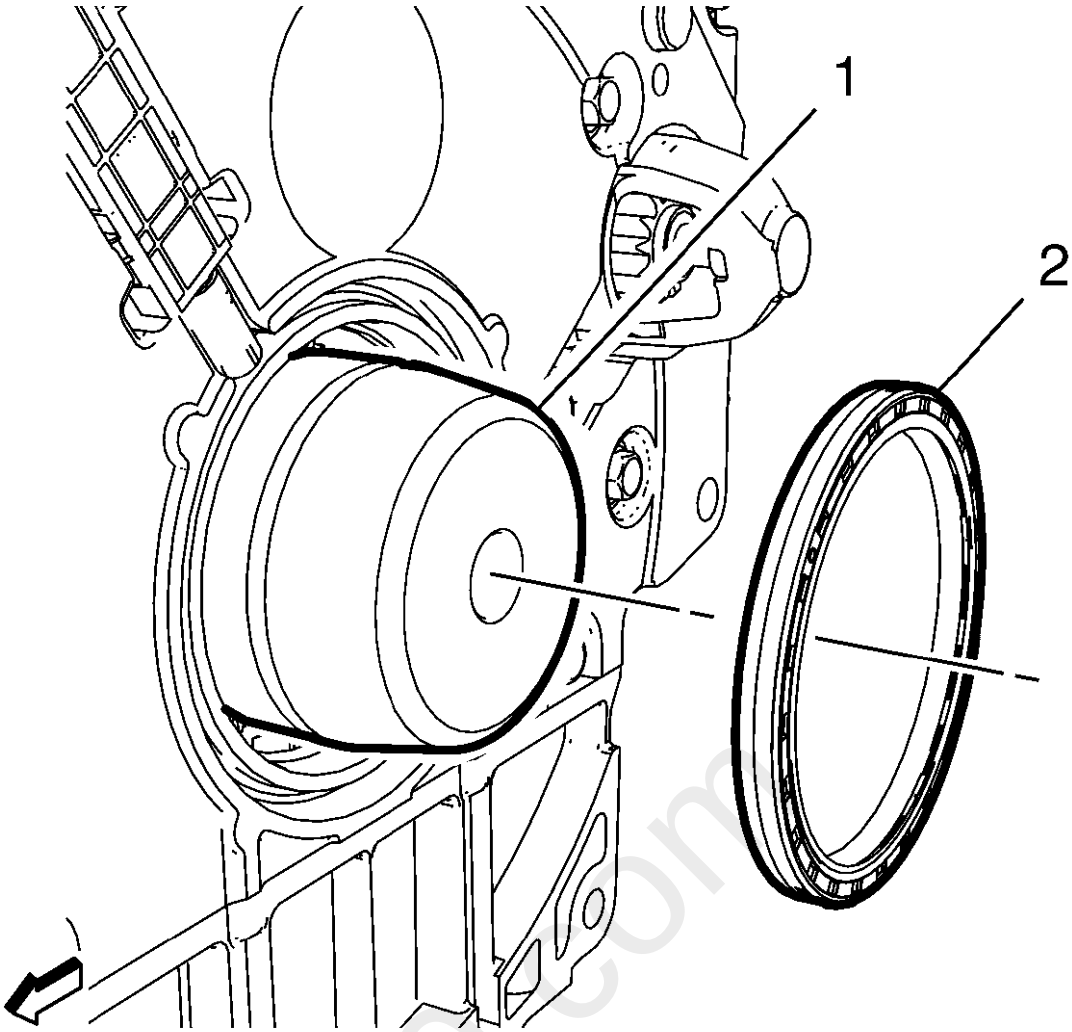


Fig. 871: Crankshaft Rear Oil Seal And Installer
Courtesy of GENERAL MOTORS COMPANY

8. Install the **EN-51145-1** installer (1) to the crankshaft.
9. Install a NEW crankshaft rear oil seal (2) to the **EN-51145-1** installer (1).

mcx30.com

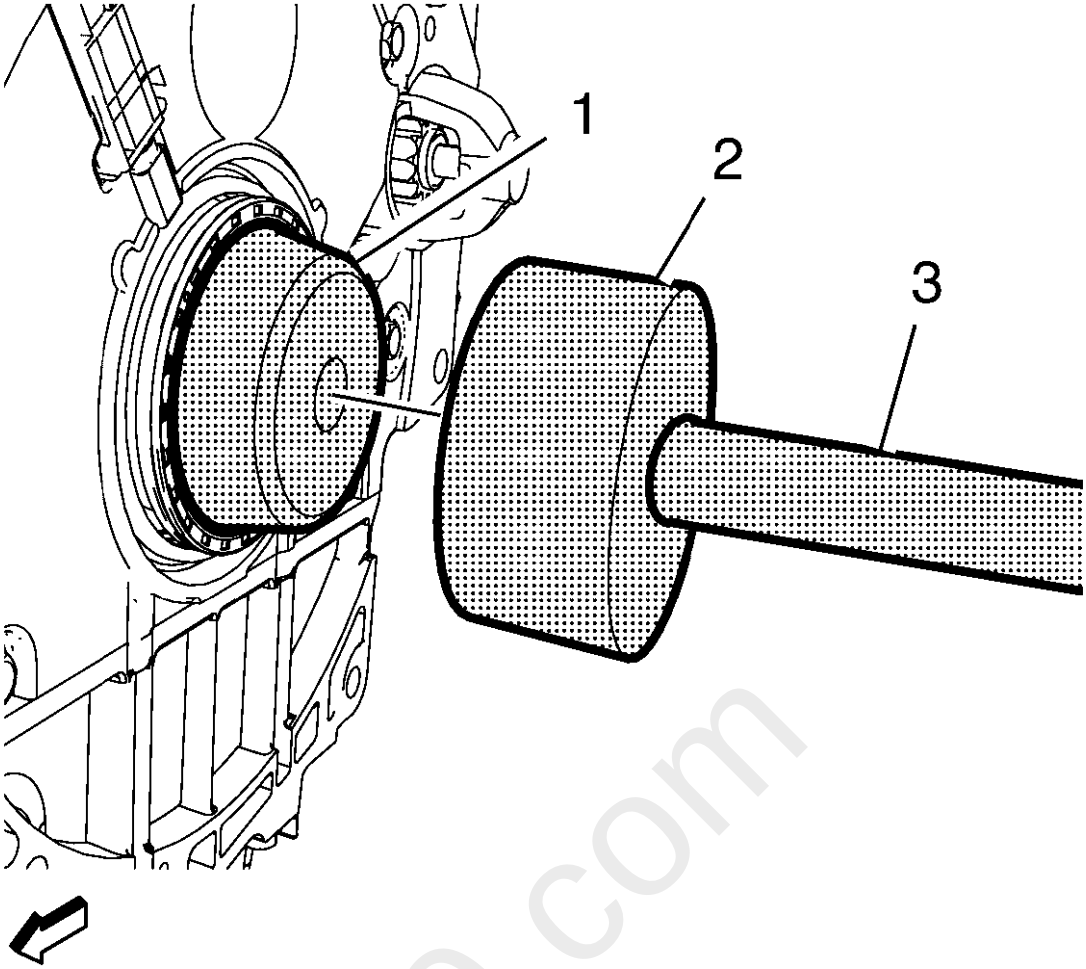


Fig. 872: Seating Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

10. Pull in the crankshaft rear oil seal (1) with the **EN-51145-2** installer (2) and the **DT-523-1** handle (3).
11. Remove the **EN-51145** installer.

mcx30.com

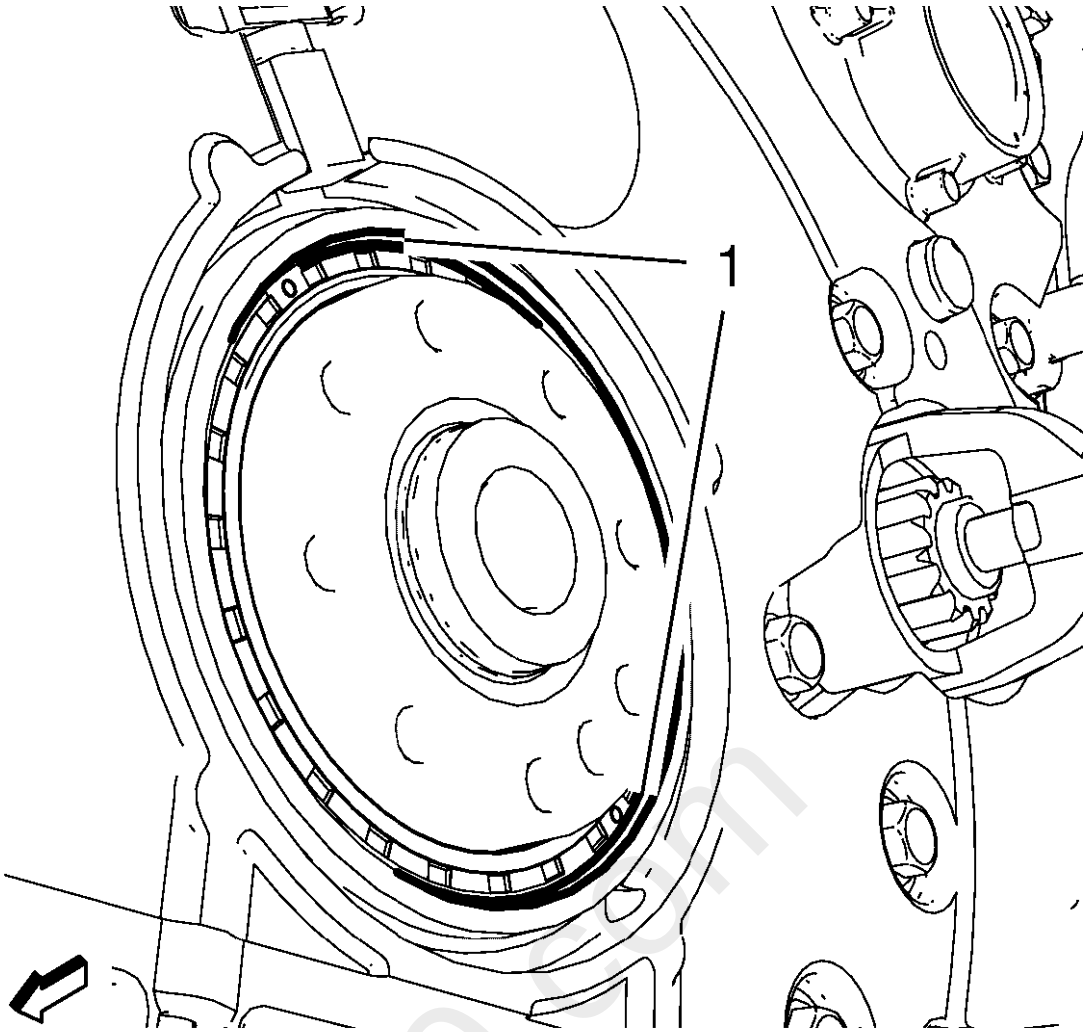


Fig. 873: Ensure Crankshaft Rear Oil Seal Is Properly Seated
Courtesy of GENERAL MOTORS COMPANY

12. Check the proper seat (1) of the crankshaft rear oil seal.

OIL PAN INSTALLATION

1. Clean the sealing surfaces.

mcx30.com

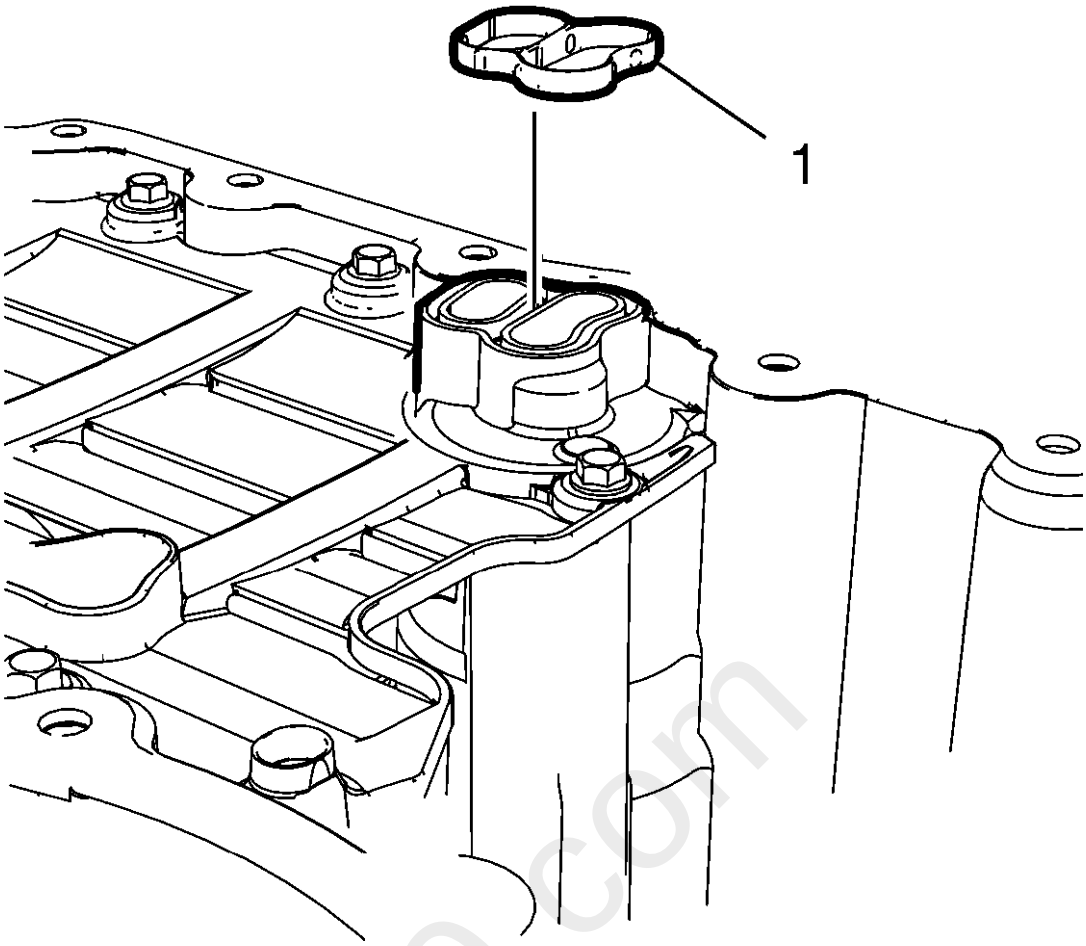


Fig. 874: Oil Filter Seal
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW oil filter seal (1)

mcx30.com

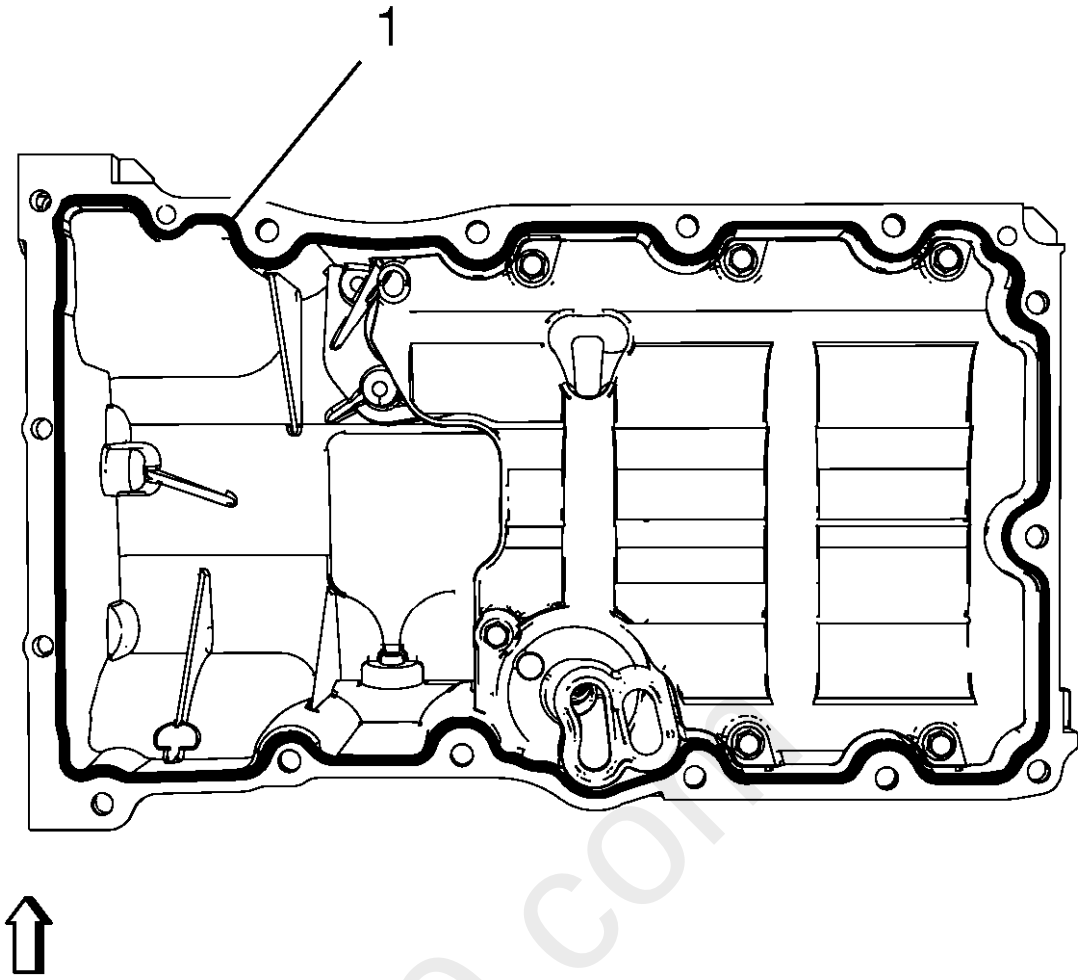


Fig. 875: Silicone Sealing Compound Application Area
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The complete installation procedure of the oil pan should be done in 20 minutes.**

3. Apply silicone sealing compound (1) to the oil pan surface. The thickness of the sealing bead (1) should be 3.0 - 4.0 mm (0.118 - 0.157 in).

mcx30.com

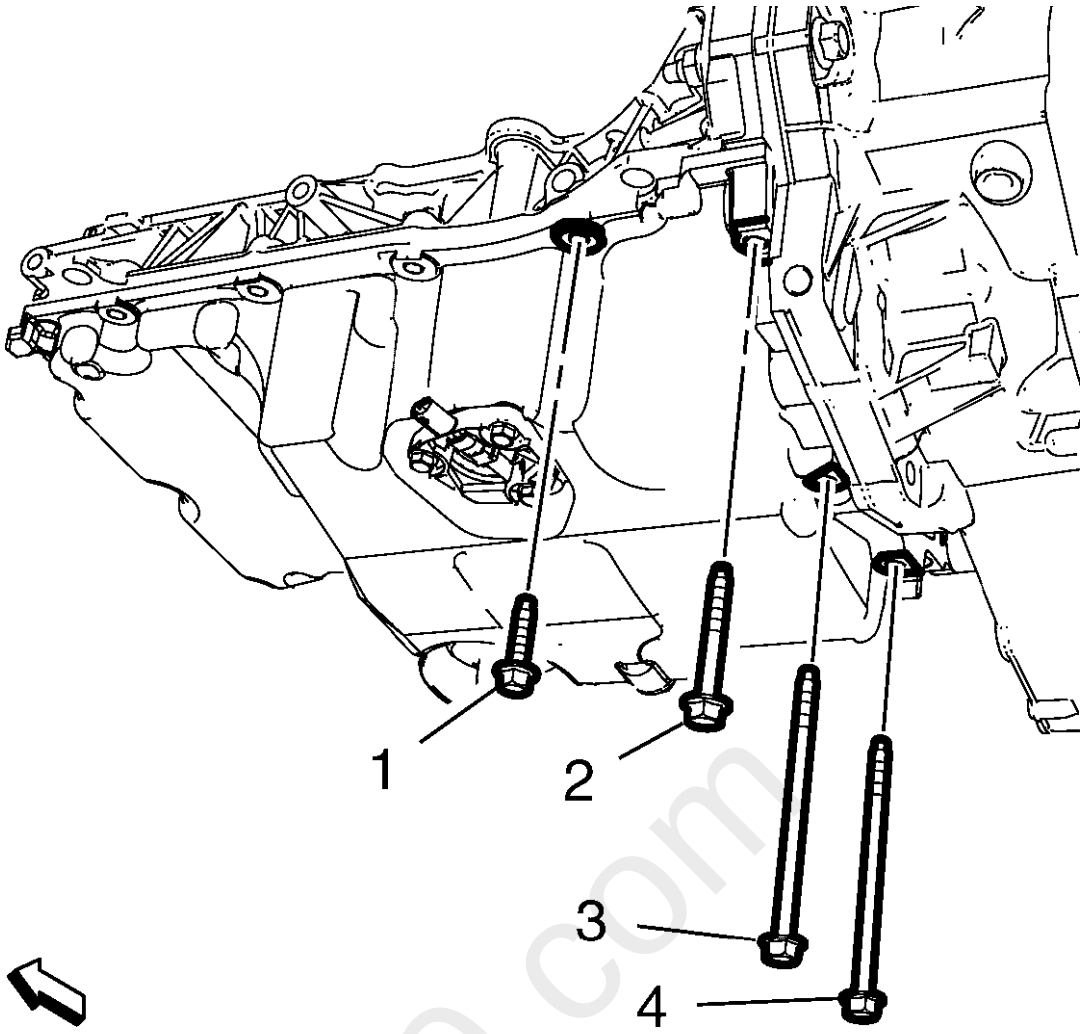


Fig. 876: Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install the oil pan.
5. Hand tighten the 12 oil pan bolts (1).
6. Hand tighten the oil pan bolt (2).
7. Hand tighten the 2 oil pan bolts (3, 4).

mcx30.com

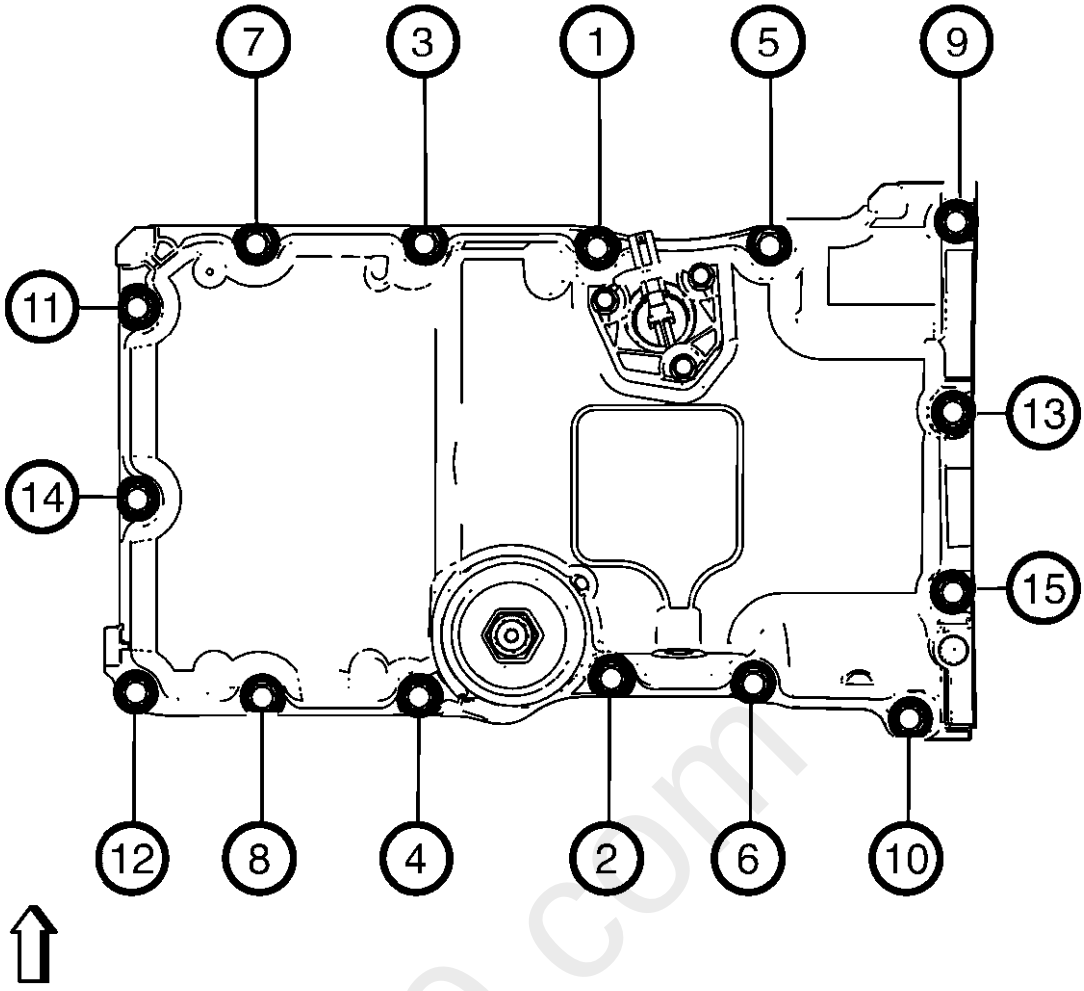


Fig. 877: Oil Pan Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

8. Tighten the 15 oil pan bolts in sequence as shown to 25 N.m (18 lb ft).

CRANKSHAFT POSITION SENSOR RELUCTOR RING INSTALLATION

Special Tools

- **EN-652** Flywheel Holder
- **EN-45059** Angle Meter

Equivalent regional tools: **Special Tools**

mcx30.com

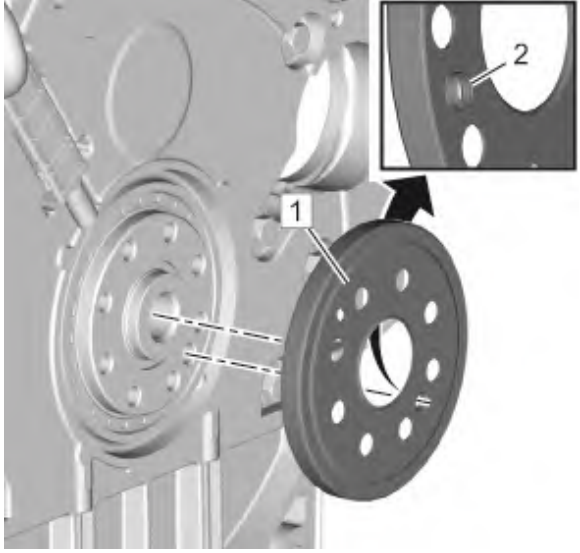


Fig. 878: Crankshaft Position Sensor Reluctor Ring And Pin
Courtesy of GENERAL MOTORS COMPANY

1. Install the crankshaft position sensor reluctor ring (1) by install the pin (2) in the correct hole of the engine block.

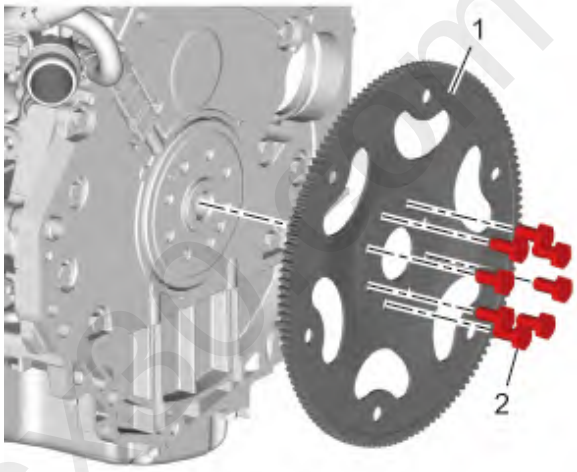


Fig. 879: Automatic Transmission Flex Plate And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install Automatic Transmission Flex Plate (1)
3. Install the 8 NEW automatic transmission flex plate bolts.

   Install NEW Automatic Transmission Flex Plate Bolts (2).

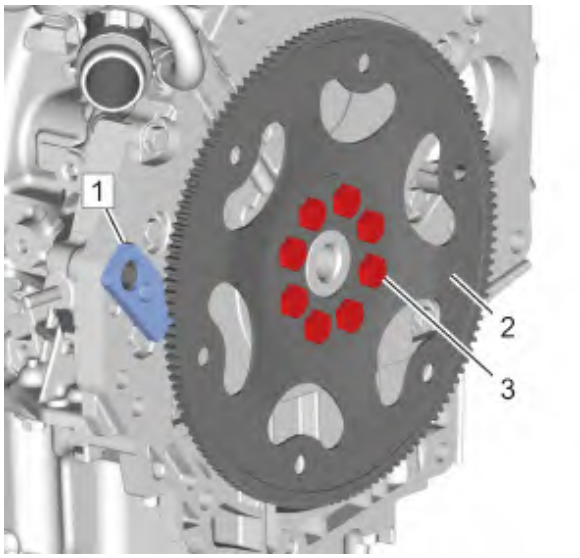


Fig. 880: Flywheel Holder
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-652** flywheel holder (1) in order to fix the automatic transmission flex plate (2).

   CAUTION: Refer to Fastener Caution

   CAUTION: Refer to Torque-to-Yield Fastener Caution

5. Tighten the 8 automatic transmission flex plate bolts (3) crosswise to the following order:

   First Pass: 60 N.m (44 lb ft).

   Final Pass: 45 degrees, use the **EN-45059** meter.

6. Remove the **EN-652** flywheel holder.

CRANKSHAFT REAR OIL SEAL INSTALLATION

Special Tools

- **EN-51145** Crankshaft Seal Installer
- **DT-523-1** Handle

For equivalent regional tools, refer to Special Tools.

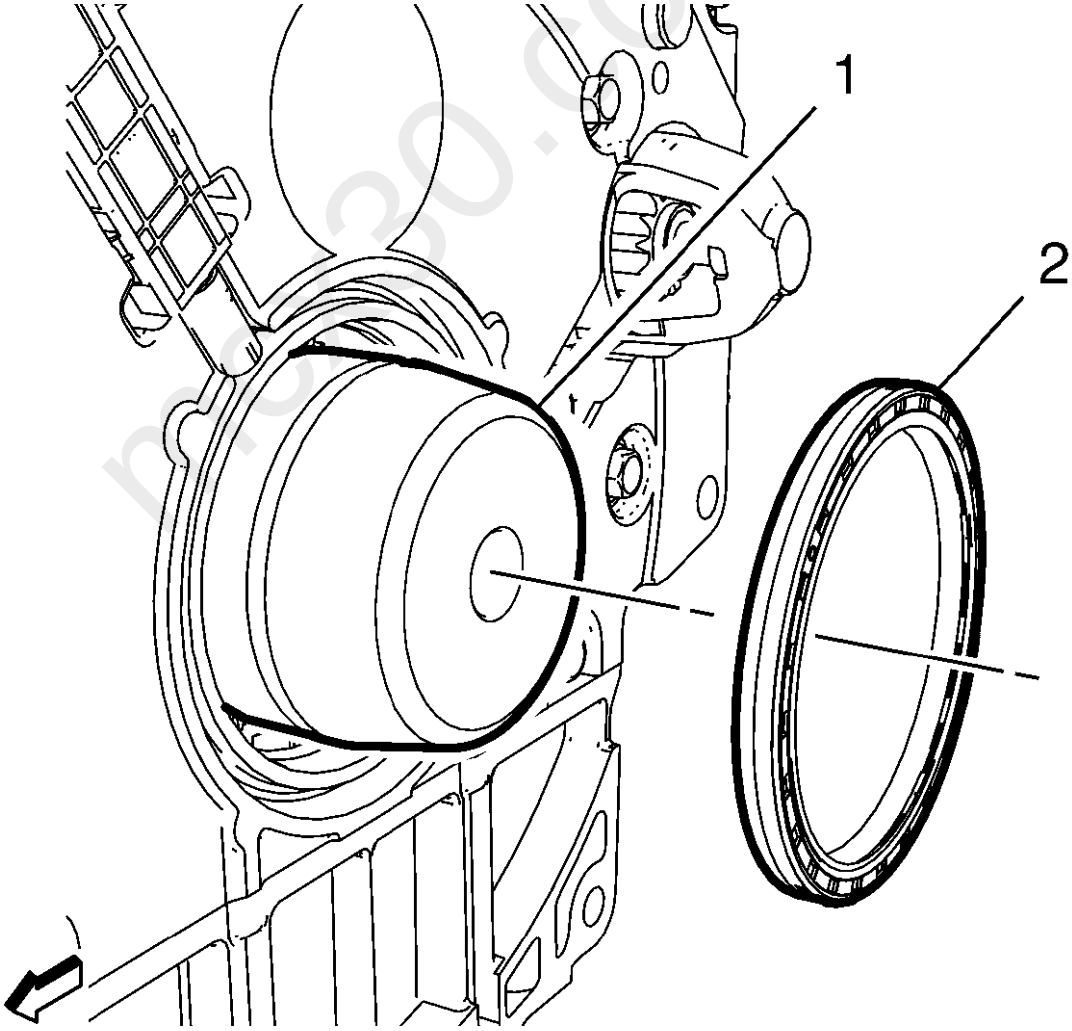


Fig. 881: Crankshaft Rear Oil Seal And Installer
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-51145-1** installer (1) to the crankshaft.
2. Install the crankshaft rear oil seal (2) to the **EN-51145-1** installer (1).

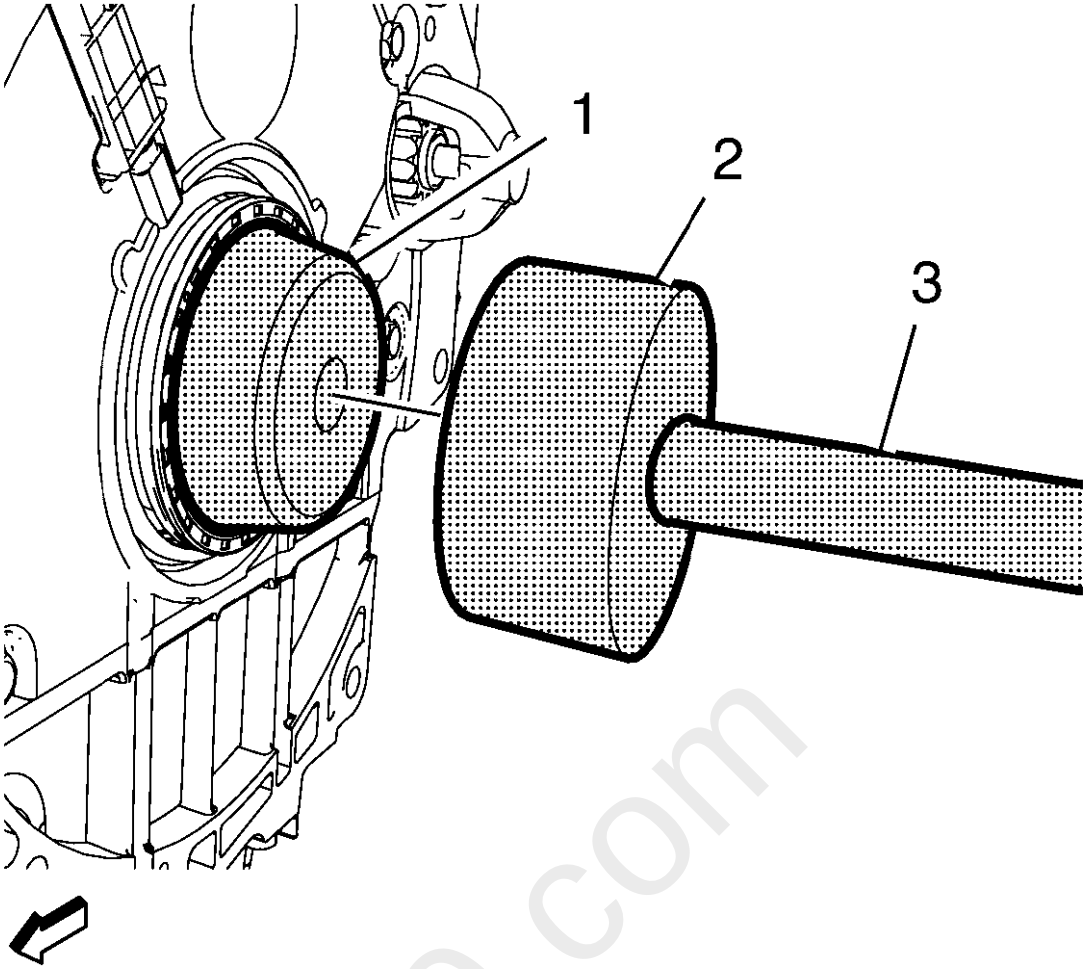


Fig. 882: Seating Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

3. Pull in the crankshaft rear oil seal (1) with the **EN-51145-2** installer (2) and the **DT-523-1** handle (3).
4. Remove **EN-51145** installer.

mcx30.com

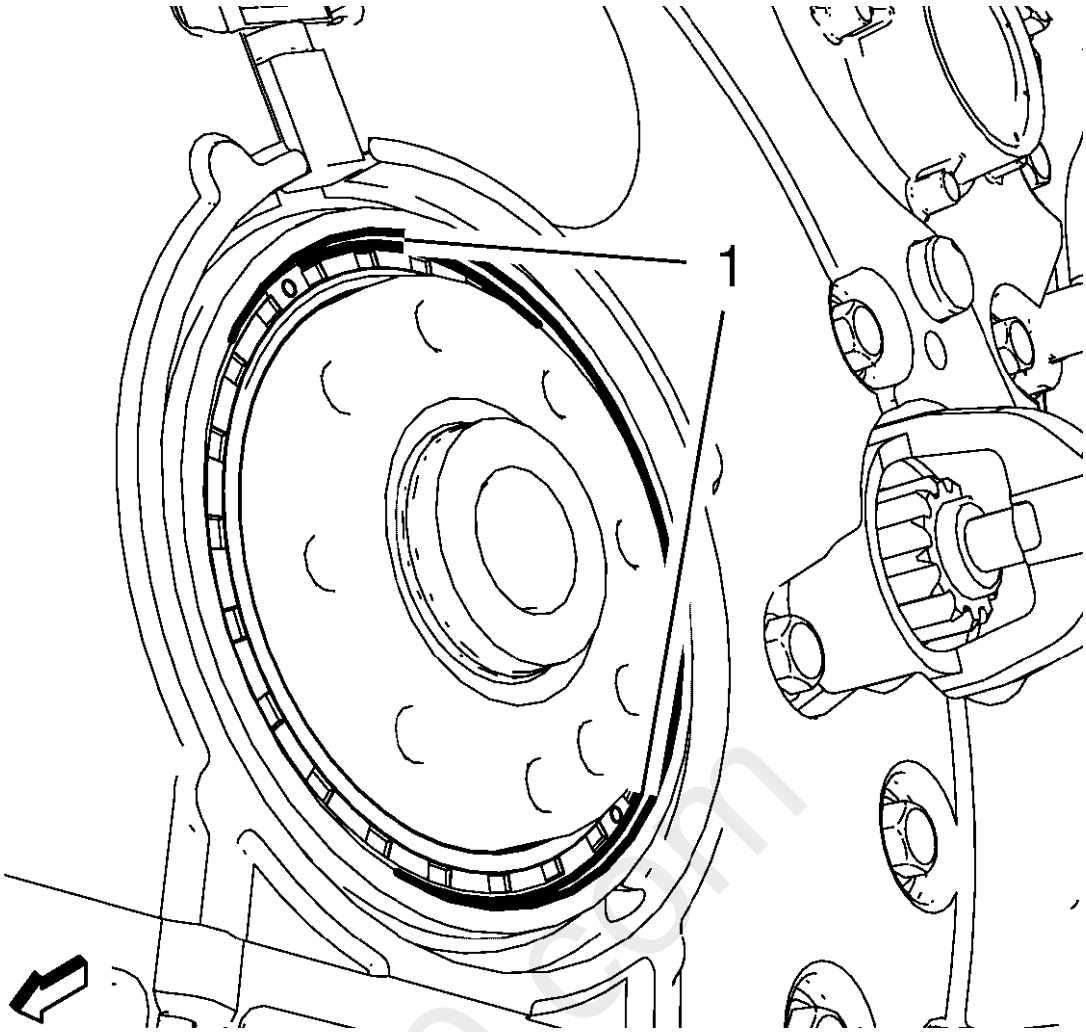


Fig. 883: Ensure Crankshaft Rear Oil Seal Is Properly Seated
Courtesy of GENERAL MOTORS COMPANY

5. Check the proper seat (1) of the crankshaft rear oil seal.

ENGINE FLYWHEEL INSTALLATION

Special Tools

- **EN-652** Flywheel Holder
- **EN-45059** Angle Meter

Equivalent regional tools: **Special Tools**.

mcx30.com

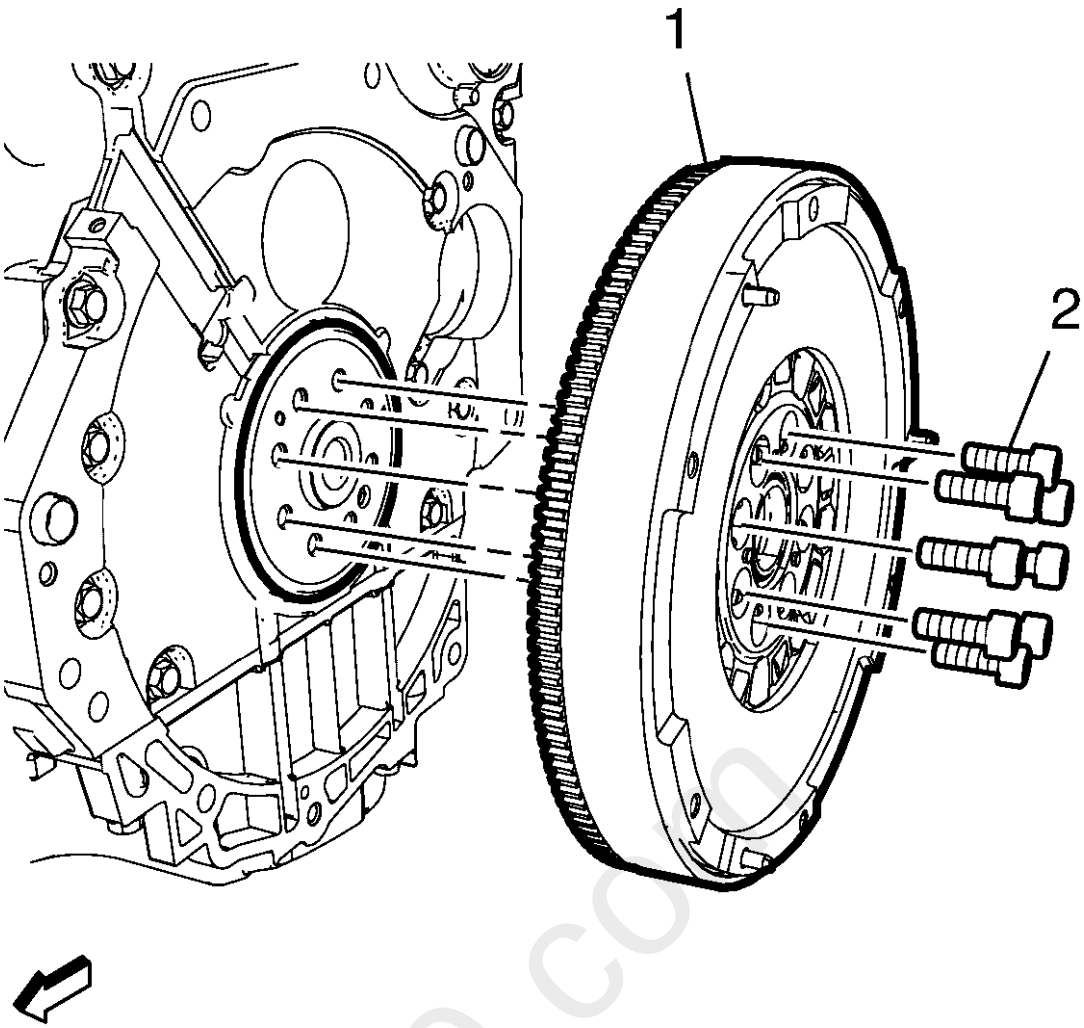


Fig. 884: Engine Flywheel And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine flywheel (1).
2. Install the **EN-652** flywheel holder in order to fix the flywheel (1).

   CAUTION: **Refer to Fastener Caution .**

   CAUTION: **Refer to Torque-to-Yield Fastener Caution .**

3. Install the 8 NEW engine flywheel bolts (2) and tighten in the following order:

   Tighten the bolts a first pass to 60 N.m (44 lb ft).

   Tighten the bolts a final pass an additional to 45 degrees, use the **EN-45059** meter.

4. Remove the **EN-652** holder.

AUTOMATIC TRANSMISSION FLEX PLATE INSTALLATION

Special Tools

- **EN-652** Holder Flex Plate
- **EN-45059** Angle Meter

Equivalent regional tools: **Special Tools**

Installation Procedure

mcx30.com

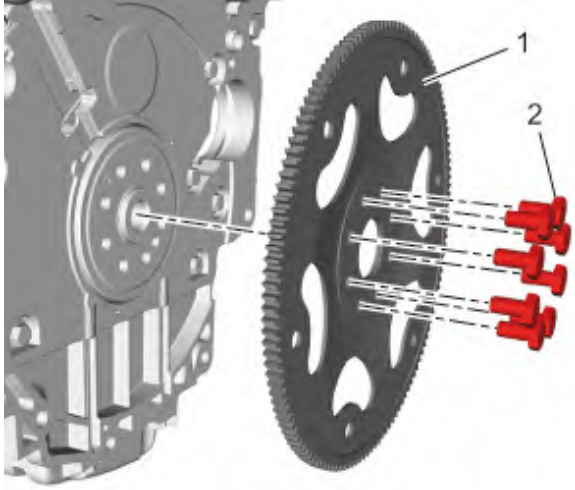


Fig. 885: Automatic Transmission Flex Plate And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install Automatic Transmission Flex Plate (1)

NOTE: **Install NEW bolts.**

2. Install Automatic Transmission Flex Plate Bolts (2) (Qty: 8)

Fig. 886: Flex Plate Holder
Courtesy of GENERAL MOTORS COMPANY

3. Install the **EN-652** holder (1) in order to fix the flex plate.
4. Tighten the flex plate bolts crosswise in the following order:

CAUTION: **Refer to Fastener Caution**

CAUTION: **Refer to Torque-to-Yield Fastener Caution**

   1. First Pass: 60 N.m (44 lb ft)
   2. Final Pass: 45 degrees - **EN-45059** meter
5. Remove the **EN-652** holder.

CRANKSHAFT POSITION SENSOR INSTALLATION

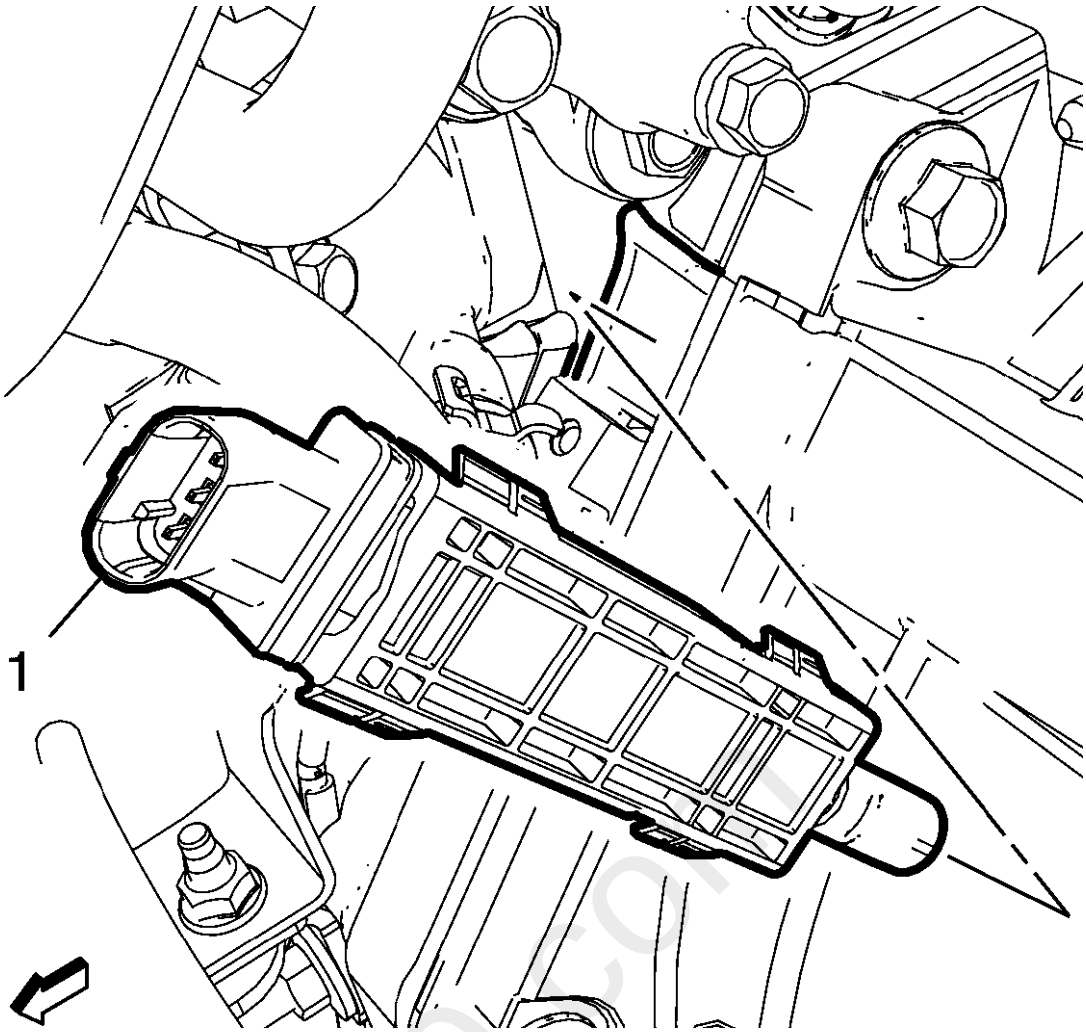


Fig. 887: Crankshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Install the crankshaft position sensor (1).

mcx30.com

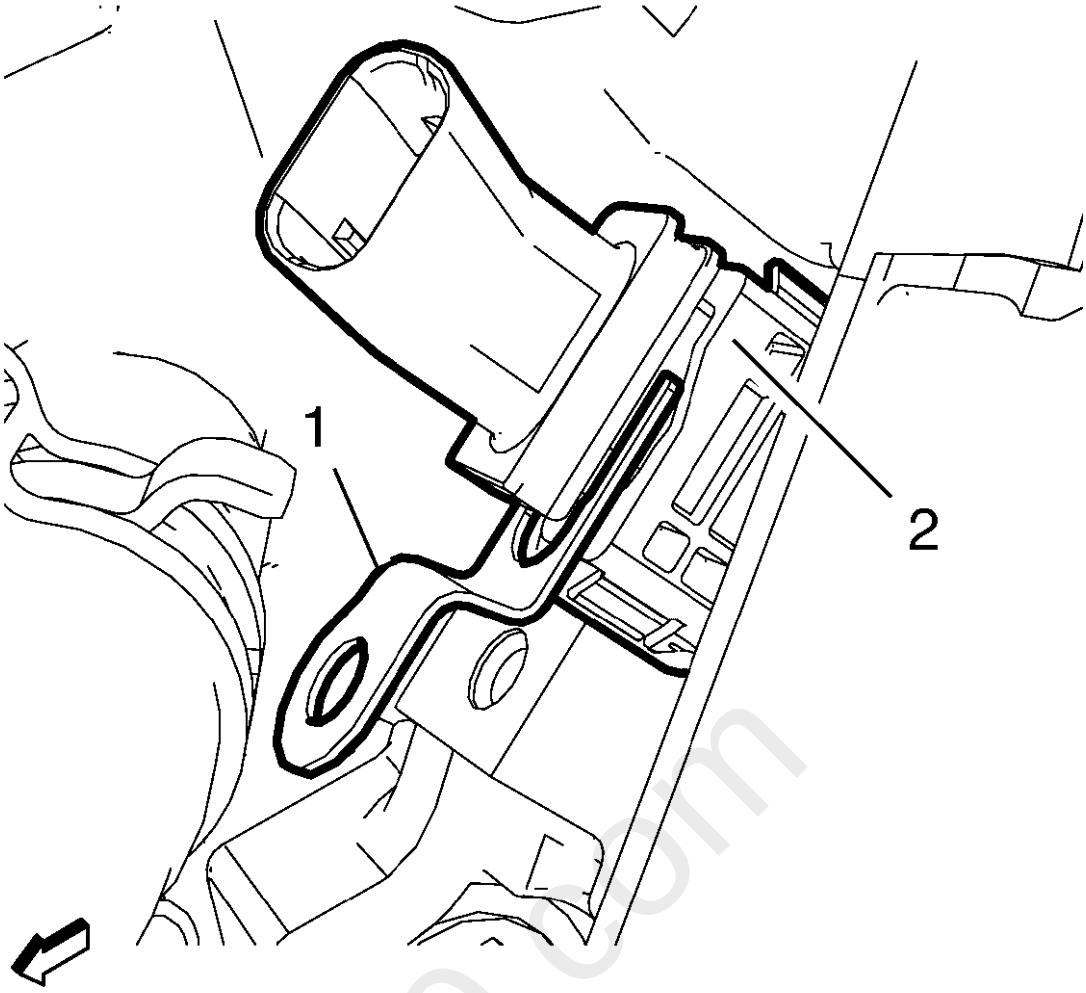


Fig. 888: Crankshaft Position Sensor Retainer Spring Into Correct Channel
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Slightly lift the crankshaft position sensor to install the retainer spring.**

2. Install the crankshaft position sensor retainer spring (1) into the correct channel (2) of the crankshaft position sensor.

mcx30.com

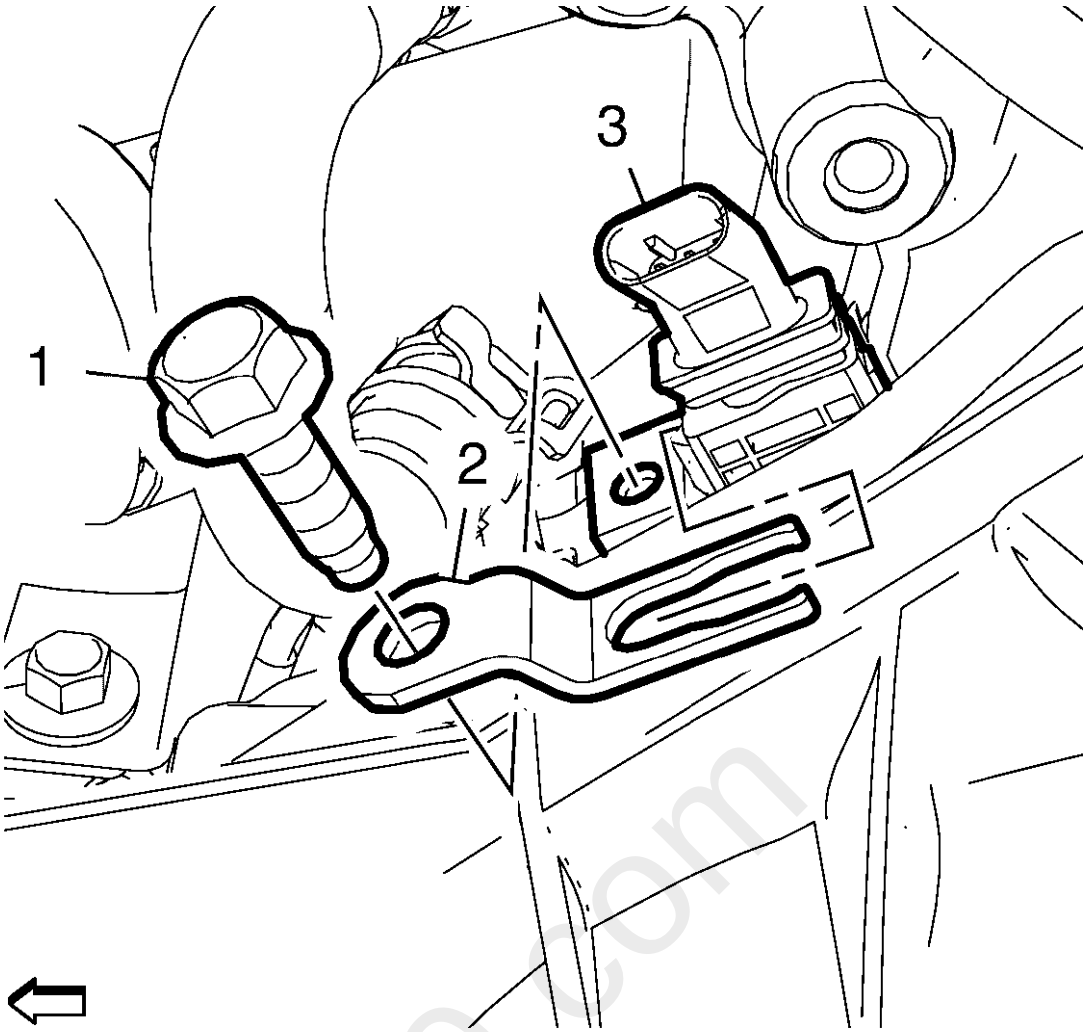


Fig. 889: Crankshaft Position Sensor, Bolt And Retainer Spring
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

3. Install the crankshaft position sensor bolt (1) and tighten to 10 N.m (89 lb in).

TIMING CHAIN UPPER COVER INSTALLATION

NOTE: **Before installing the timing chain upper cover, check the components of the timing chain system for damage and wear.**

1. Check the components of the timing chain system for damage and wear:
   - Timing chain guides with plastic attachment
   - Timing chain tensioner and timing chain tensioner shoe with plastic attachment
   - Timing chain and all timing chain sprockets
   - Oil pump sprocket
   - Oil pump drive chain tensioner
2. Clean the sealant surfaces.

mcx30.com

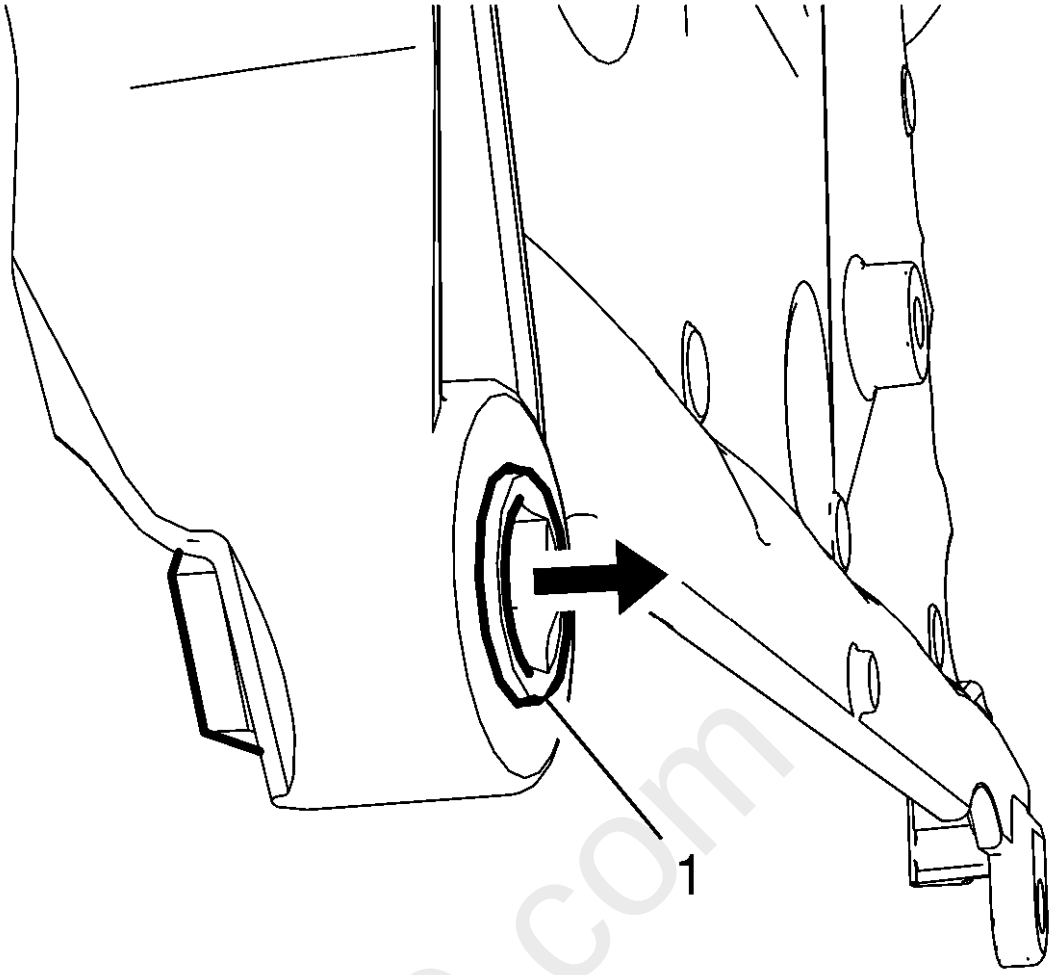


Fig. 890: Timing Chain Upper Cover Sleeve
Courtesy of GENERAL MOTORS COMPANY

3. Unscrew the timing chain upper cover sleeve (1) to the initial position in arrow direction.

mcx30.com

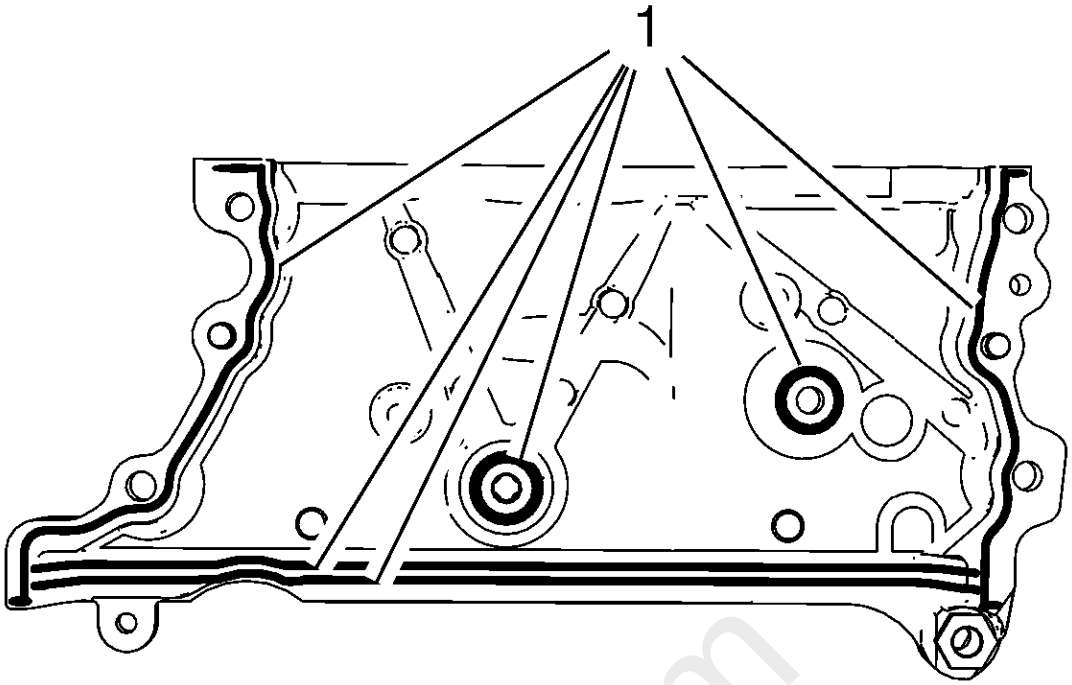


Fig. 891: Silicone Sealing Compound Application Area
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The complete installation procedure of the timing chain upper cover should be done in 20 minutes.**

4. Apply silicone sealing compound (1) to the timing chain upper cover sealing surface. The thickness of the sealing bead should be 2.0 - 3.0 mm (0.079 - 0.118 in).

nox80.com

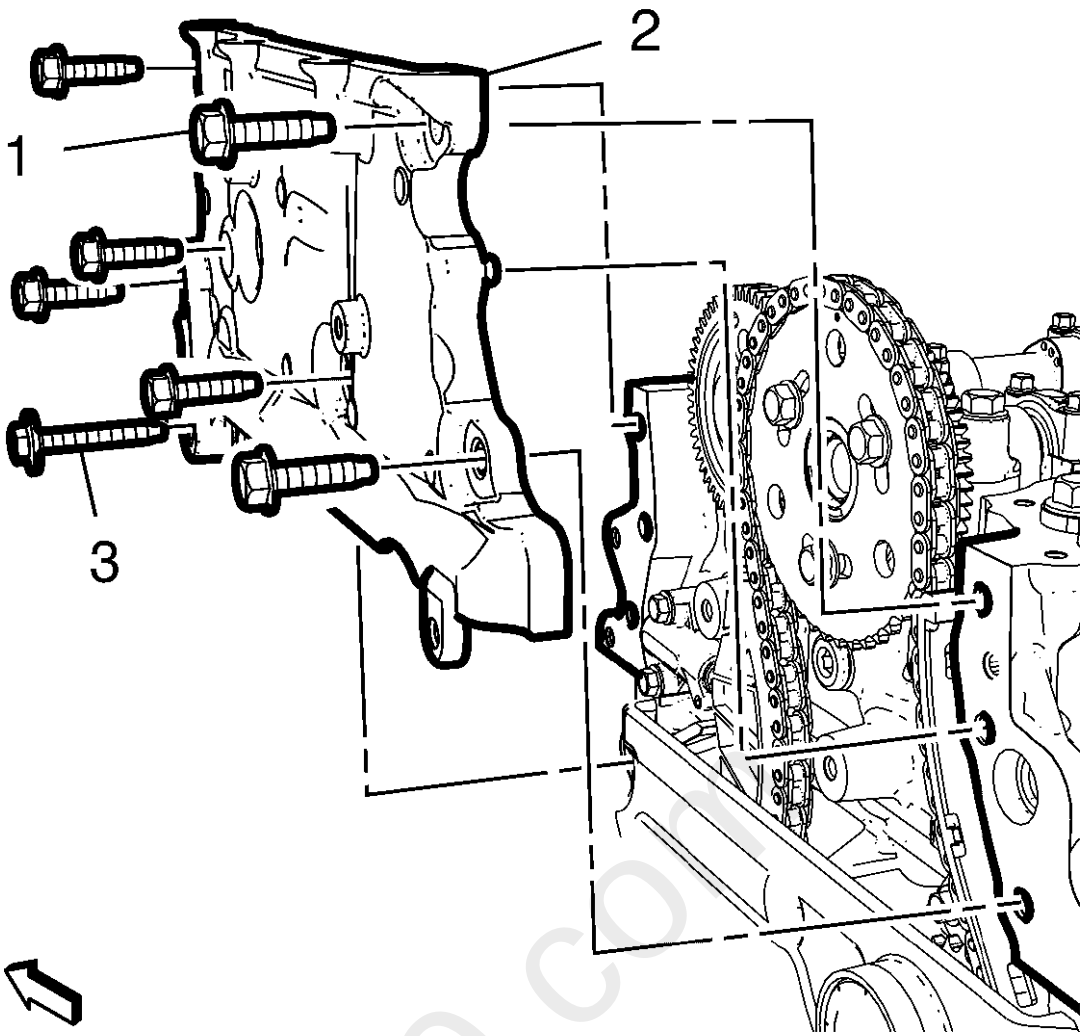


Fig. 892: Timing Chain Upper Cover And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not install the sleeve bolt (3).**

5. Install the 6 timing chain upper cover bolts (1).

mcx30.com

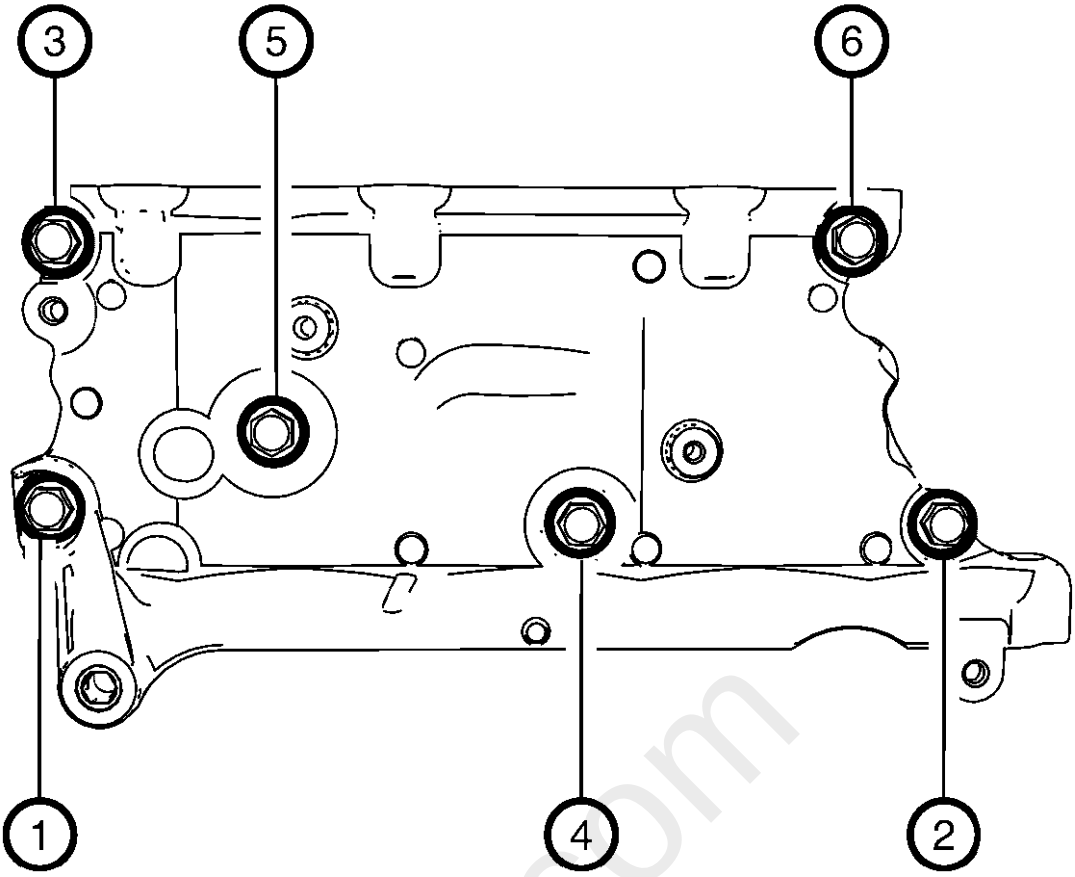


Fig. 893: Timing Chain Upper Cover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

6. Tighten the 6 chain upper cover bolts in sequence as shown to 25 N.m (18 lb ft).

mcx30.com

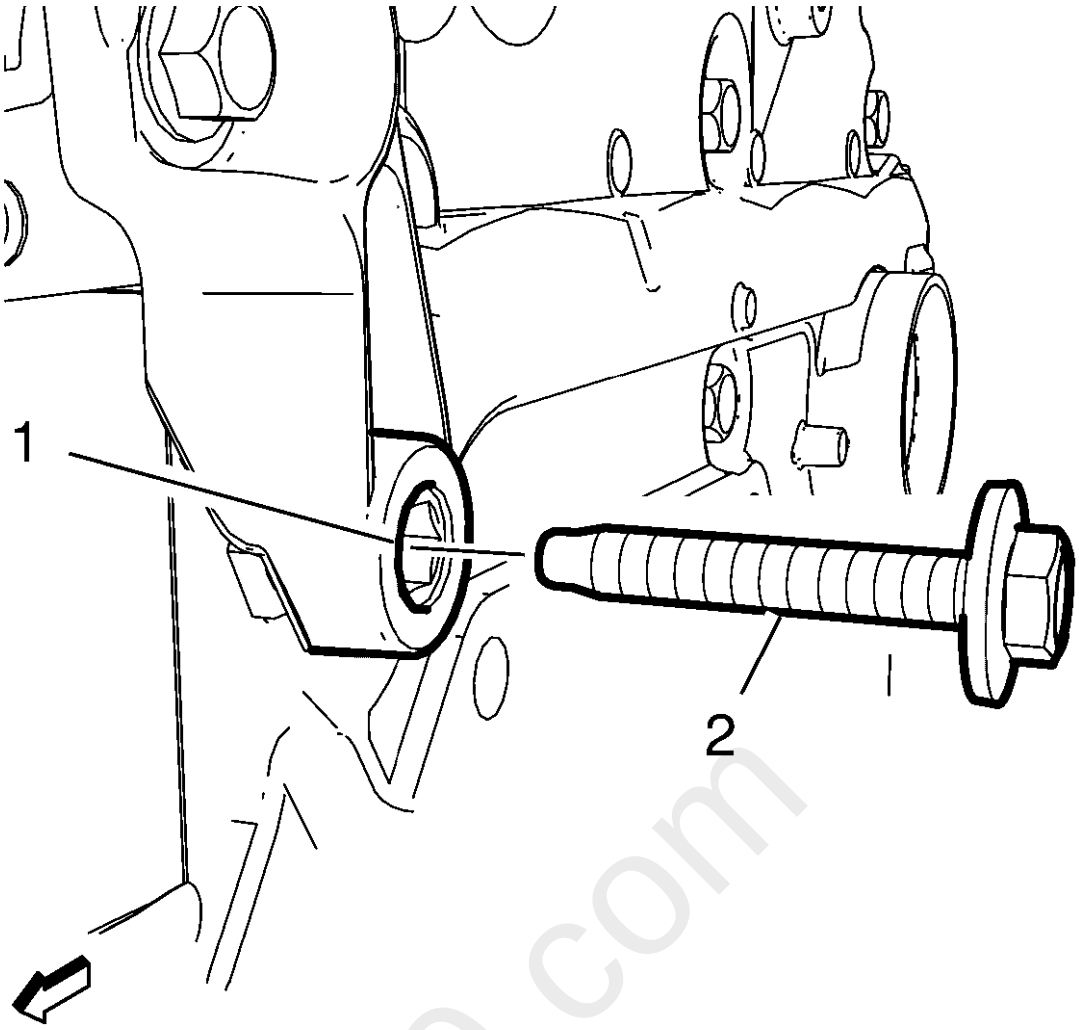


Fig. 894: Timing Chain Upper Cover Sleeve And Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Tighten the timing chain upper cover sleeve (1) to 3.5 N.m (31 lb in).
8. Install the timing chain upper cover sleeve bolt (2) and tighten to 25 N.m (18 lb ft).

CAMSHAFT HOUSING INSTALLATION

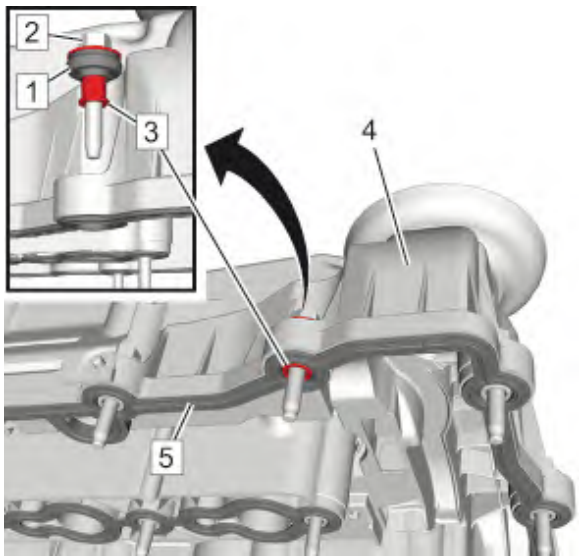


Fig. 895: Camshaft Housing, Gasket, Bolts, Bushings And Insulators
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW Camshaft Housing Gasket (5) @ Camshaft Housing (4)
2. Install Camshaft Housing Bolts (2) (Qty: 20) @ Camshaft Housing (4)

3. Inspect the correct seat of the camshaft housing bolt bushings (3) and the camshaft housing cover insulators (1).

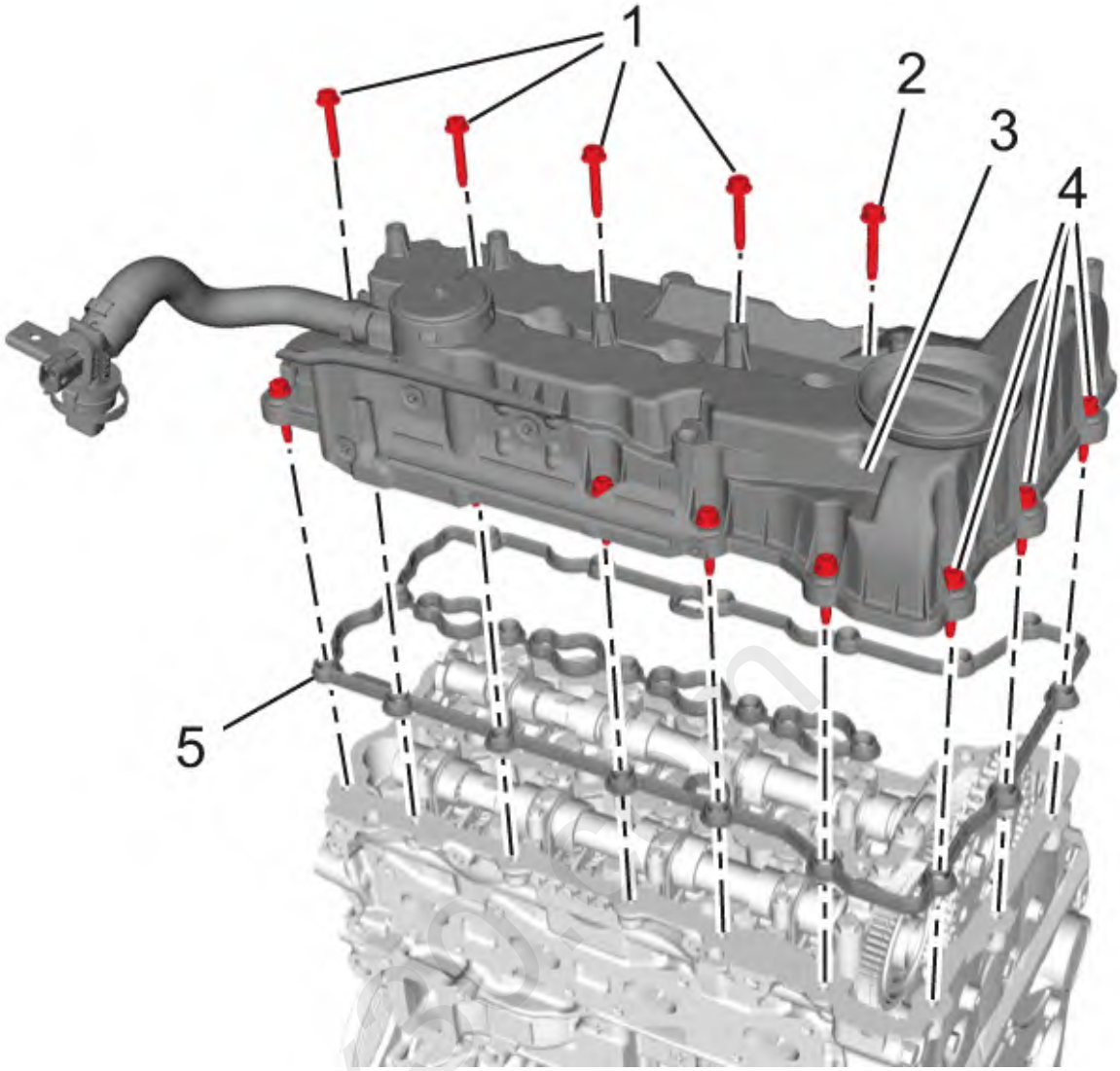


Fig. 896: Camshaft Housing, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Mind the different bolts.**

4. Install the camshaft housing cover (3) along with the camshaft housing gasket (5) and the 20 camshaft housing bolts (1, 2, 4).
5. Hand tighten Camshaft Housing Bolts (1, 2, 4) (Qty: 20)

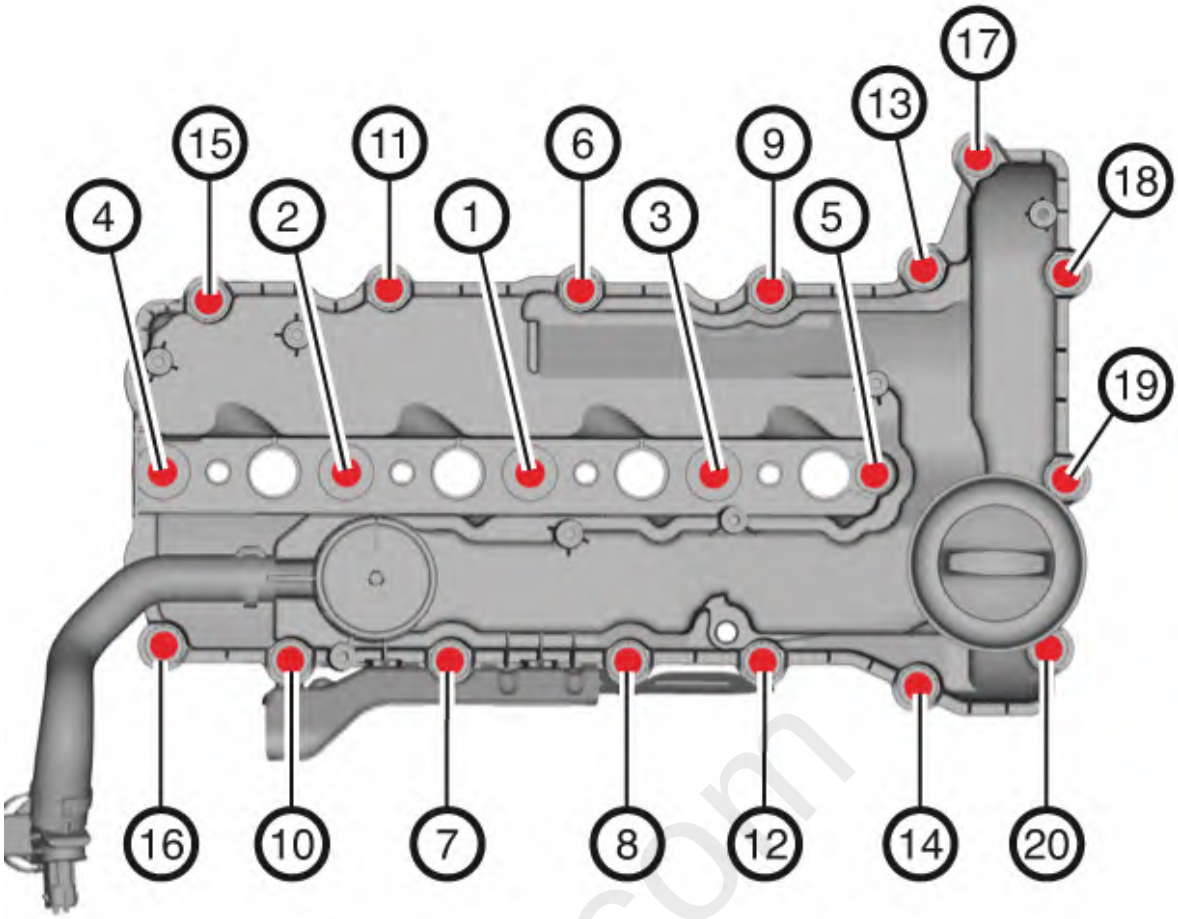


Fig. 897: Camshaft Housing Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution**

6. Tighten Camshaft Housing Bolts (Qty: 20) in sequence to 10 N.m (89 lb in)

mcx30.com

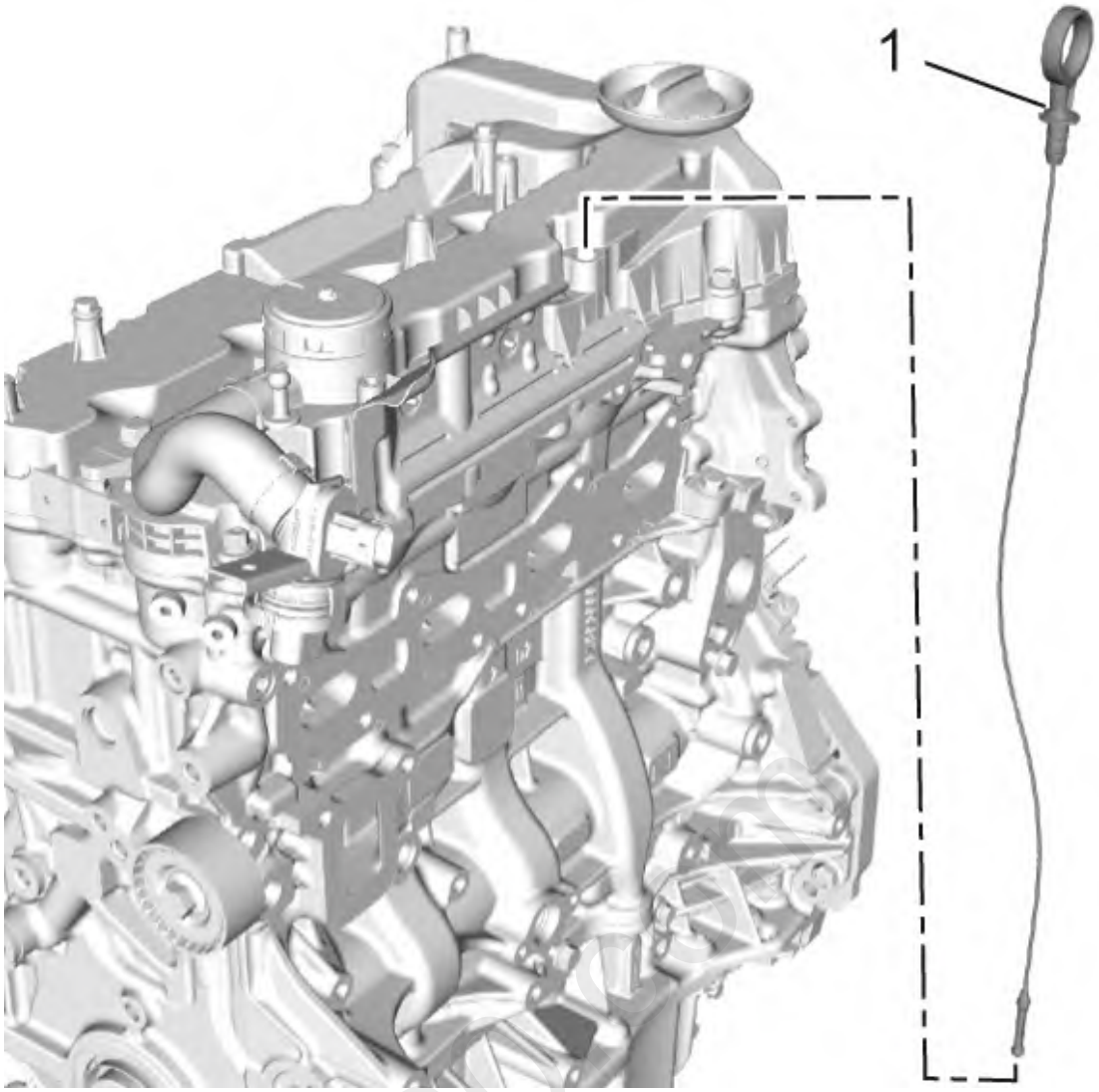


Fig. 898: Engine Oil Level Indicator
Courtesy of GENERAL MOTORS COMPANY

7. Install Engine Oil Level Indicator (1)

mcx30.com

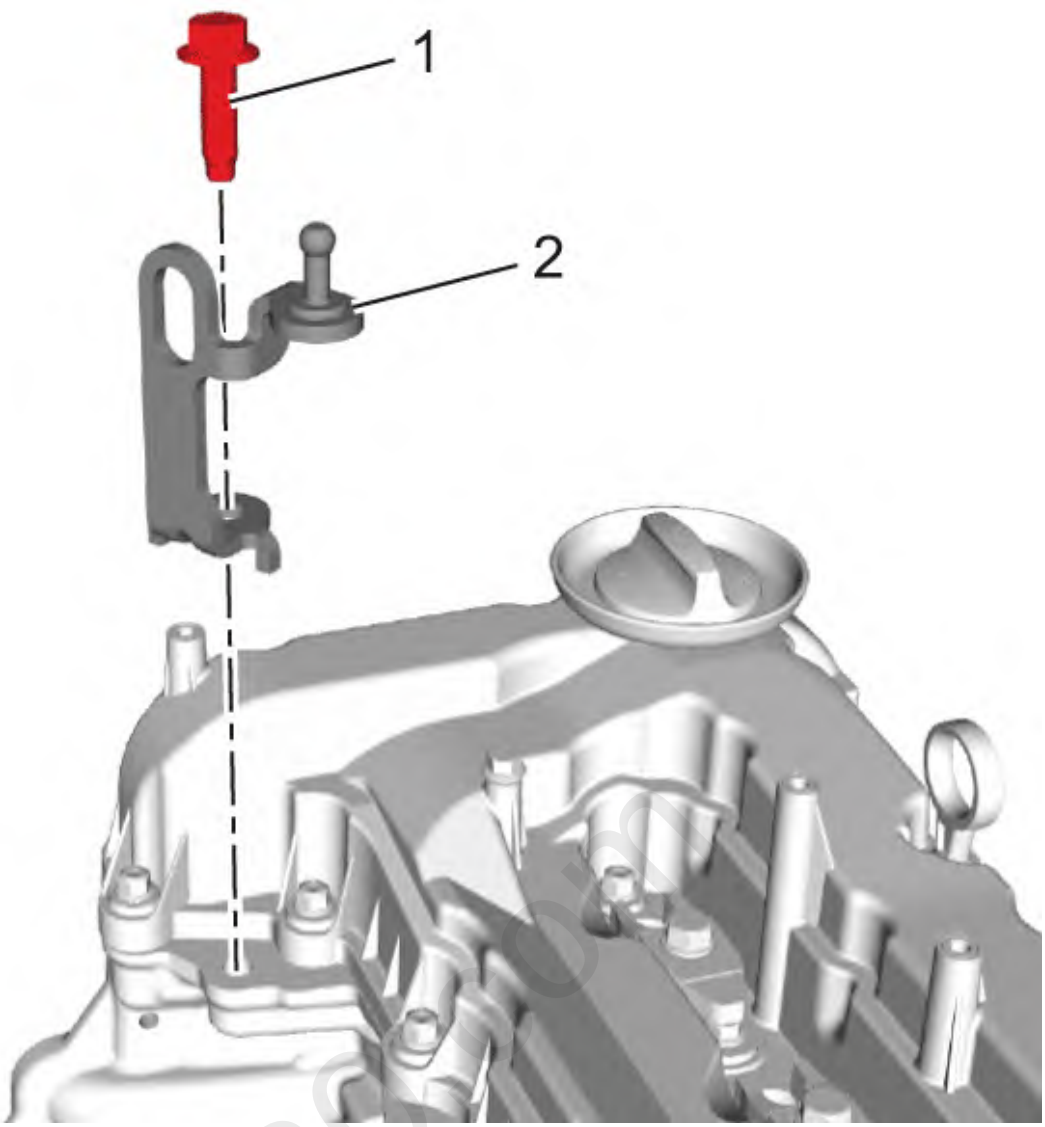


Fig. 899: Engine Lift Bracket And Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Install Engine Lift Bracket (2)
9. Install and tighten Engine Lift Bracket Bolt (1) to 58 N.m (43 lb ft)

mcx30.com

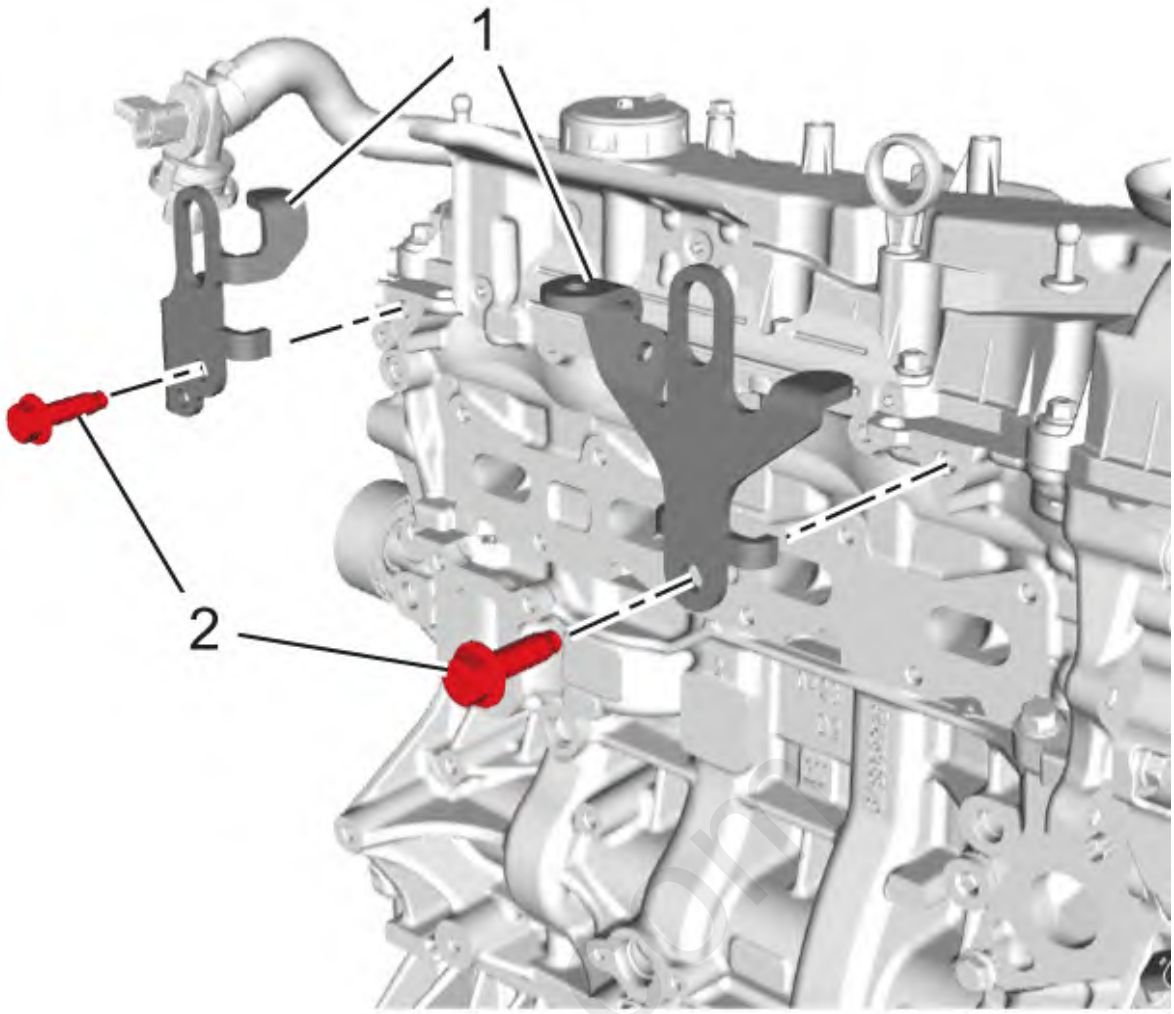


Fig. 900: Engine Lift Brackets And Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Install Engine Lift Brackets (1) (Qty: 2)
11. Install and tighten Engine Lift Bracket Bolts (2) (Qty: 2) to 58 N.m (43 lb ft)

FUEL INJECTOR INSTALLATION

Special Tools

EN-45059-A Angle Meter

Equivalent regional tools: **Special Tools**

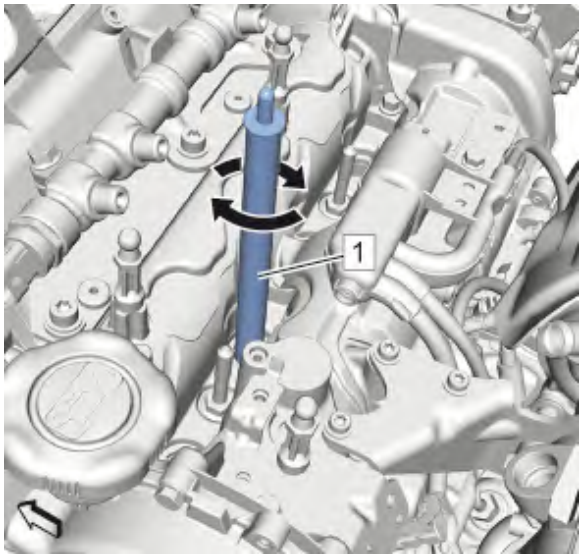


Fig. 901: Cleaning Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to EN-47632 Cleaning Tool Rotation Caution**

1. Clean the 4 injector sealing surfaces in the cylinder head with a suitable cleaning tool (1) in the following procedure:
    1. First take the brush side to loosen the dirt.
    2. Accordingly take the sponge side to remove the dirt.

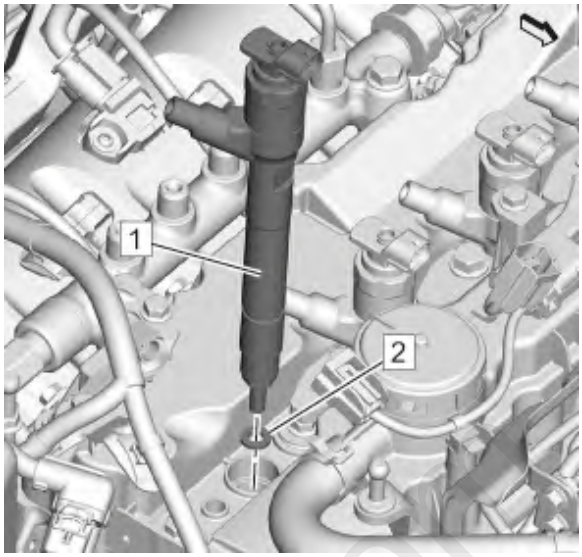


Fig. 902: Fuel Injectors And Washers
Courtesy of GENERAL MOTORS COMPANY

2. Remove the closure caps from the 4 fuel injector nozzles.
3. Install NEW Fuel Injector Washers (2) (Qty: 4)
4. Install Fuel Injectors (1) (Qty: 4)

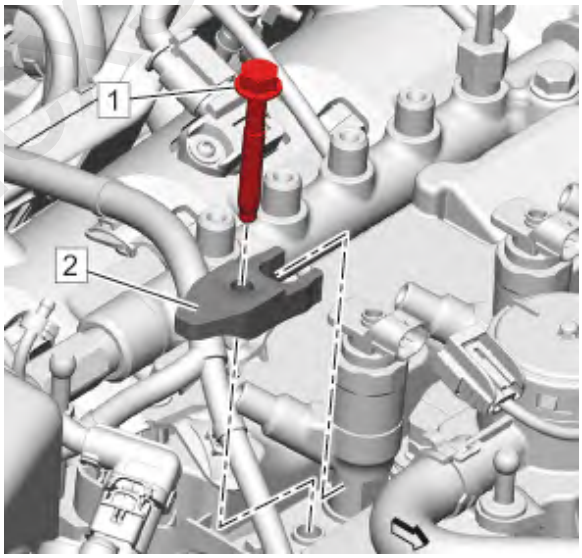


Fig. 903: Fuel Injector Brackets And Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install Fuel Injector Brackets (2) (Qty: 4)
6. Install NEW Fuel Injector Bracket Bolts (1) (Qty: 4)

CAUTION: **Refer to Fastener Caution**

7. Tighten Fuel Injector Bracket Bolts (1) (Qty: 4) in sequence
    1. First Pass: 10 N.m (89 lb in)
    2. Final Pass: 60 degrees, use the **EN-45059-A** meter

mc30.com

FUEL RAIL INSTALLATION

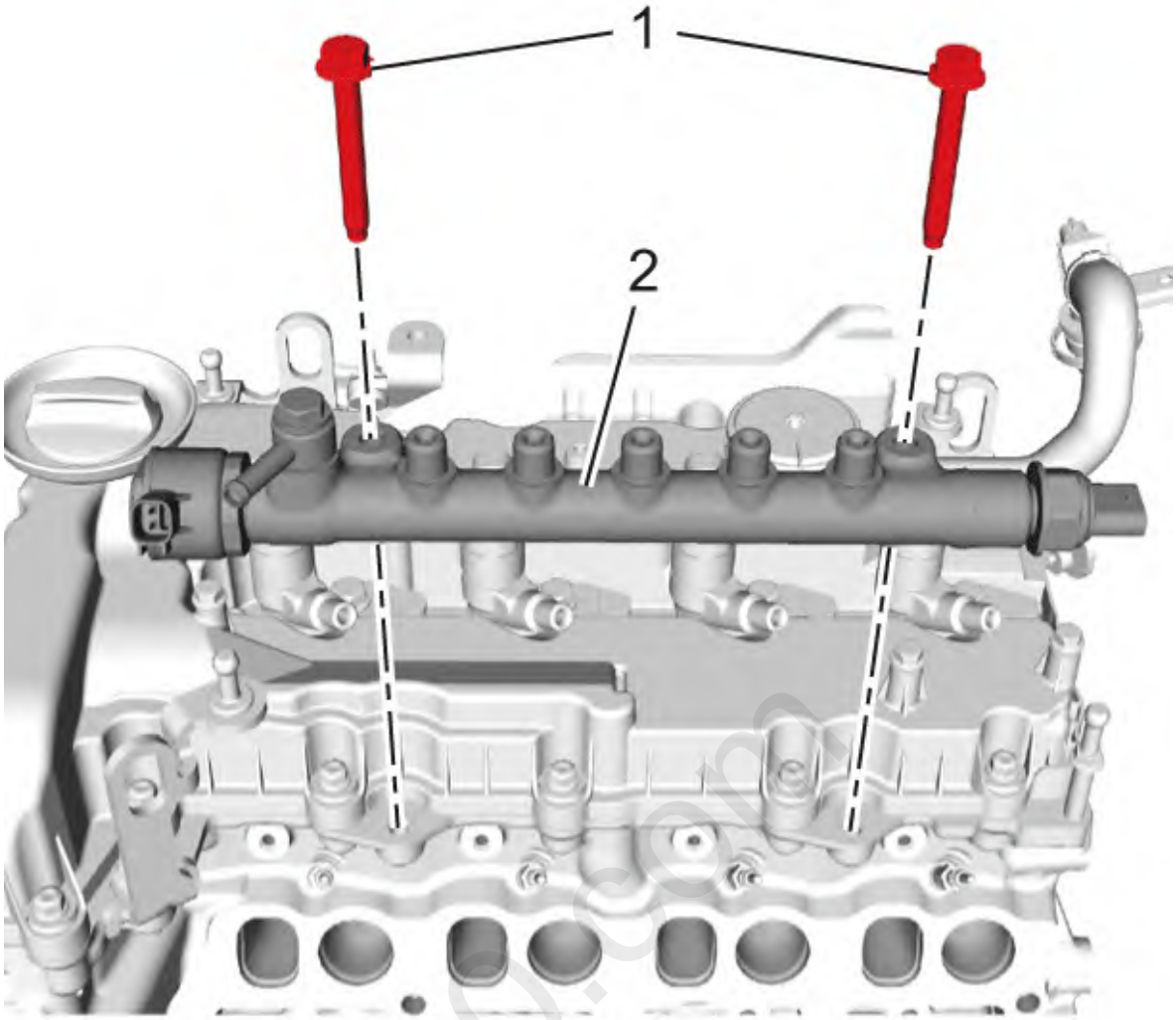


Fig. 904: Fuel Injection Fuel Rail And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install Fuel Injection Fuel Rail (2)

CAUTION: **Refer to Fastener Caution**

2. Install and tighten Fuel Injection Fuel Rail Bolts (1) (Qty: 2) to 25 N.m (18 lb ft)

FUEL PRESSURE SENSOR INSTALLATION

mc730.com

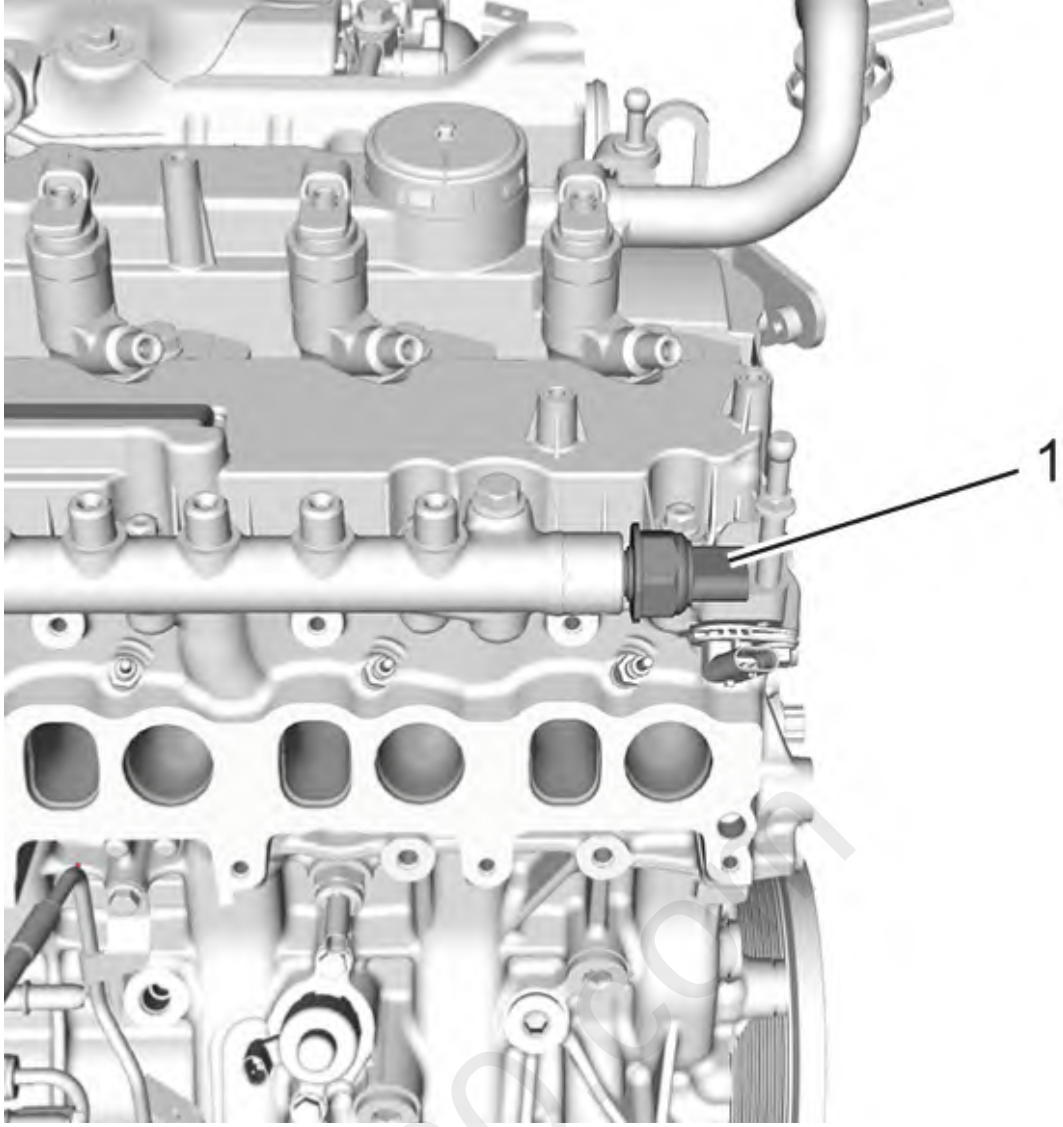


Fig. 905: Fuel Injection Fuel Rail Fuel Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW Fuel Injection Fuel Rail Fuel Pressure Sensor (1) - Hand tighten

CAUTION: **Refer to Component Fastener Tightening Caution**

2. Tighten Fuel Injection Fuel Rail Fuel Pressure Sensor (1) to 35 N.m (26 lb ft)

FUEL INJECTION FUEL FEED PIPE INSTALLATION - FUEL RAIL TO FUEL INJECTOR

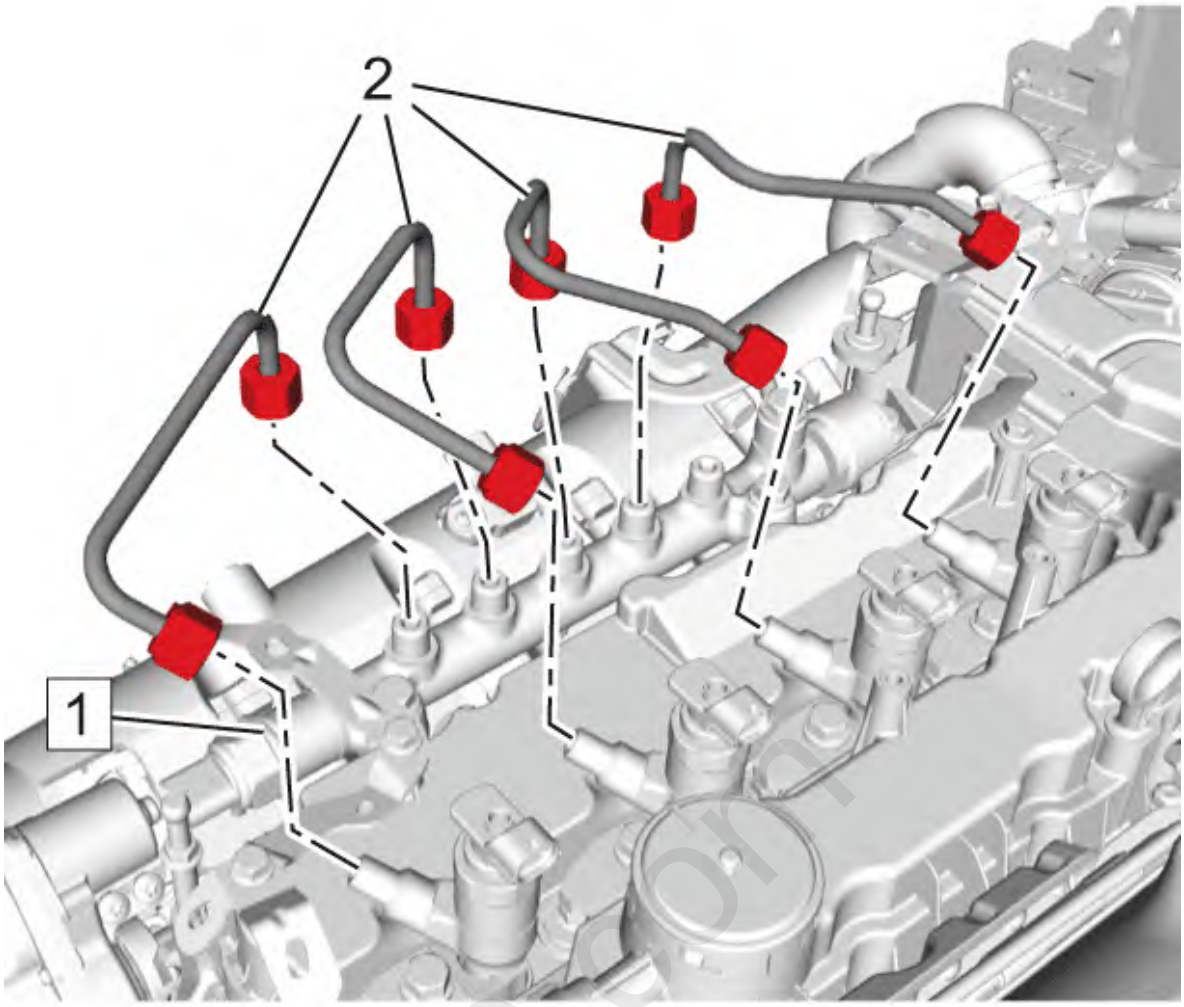


Fig. 906: Fuel Injection Fuel Feed Pipes And Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW Fuel Injection Fuel Feed Pipes (2) (Qty: 4)
2. Install Fuel Injection Fuel Feed Pipes (2) (Qty: 4) @ Fuel Injector (3)
3. Install Fuel Injection Fuel Feed Pipes (2) (Qty: 4) @ Fuel Rail (1)

CAUTION: **Refer to Fastener Caution**

4. Tighten Fuel Injection Fuel Feed Pipes (2) (Qty: 4) @ Fuel Injector (3) to 28 N.m (21 lb ft)
5. Tighten Fuel Injection Fuel Feed Pipes (2) (Qty: 4) @ Fuel Rail (1) to 28 N.m (21 lb ft)

ENGINE OIL COOLER INSTALLATION

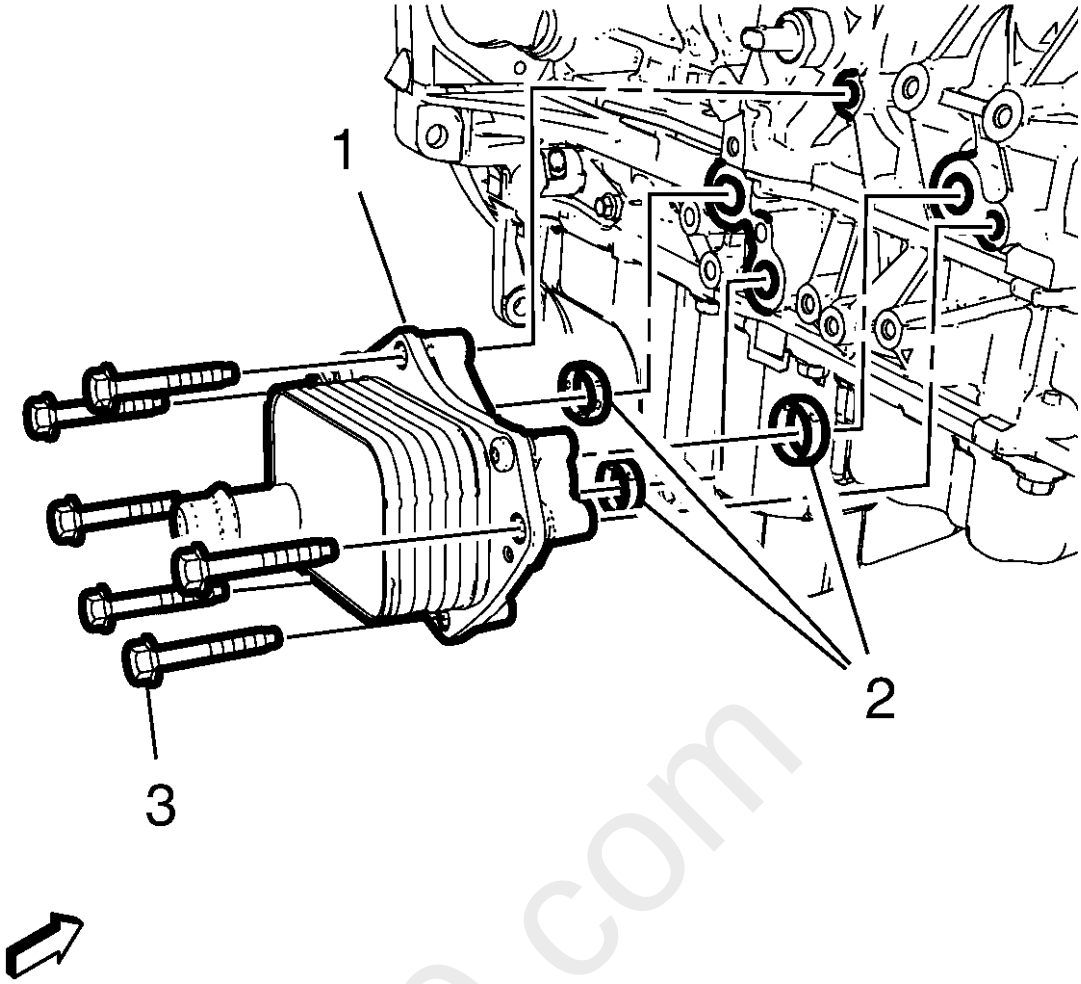


Fig. 907: Engine Oil Cooler, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW 3 oil cooler adapter gaskets (2).
2. Install the oil cooler with oil cooler adapter (1).

CAUTION: **Refer to Fastener Caution .**

3. Install the 6 oil cooler bolts (3) and tighten to 25 N.m (18 lb ft).

GENERATOR INSTALLATION

mcx30.com

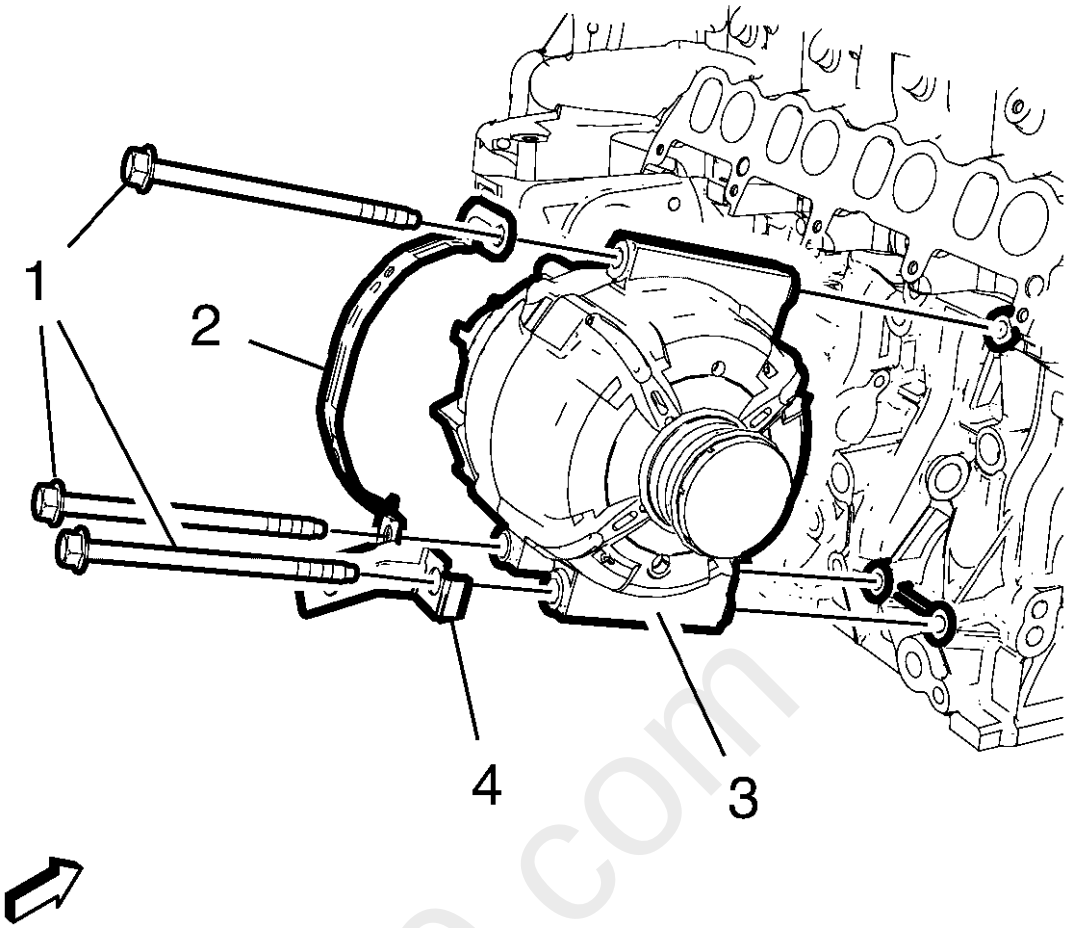


Fig. 908: Generator, Bolts And Wiring Brackets
Courtesy of GENERAL MOTORS COMPANY

1. Install the generator (3).
2. Install the wiring harness bracket (2).
3. Install the nitrogen oxide sensor wire bracket (4).

CAUTION: **Refer to Fastener Caution .**

4. Install the 3 generator bolts (1) and tighten to 22 N.m (16 lb ft).

STARTER INSTALLATION

mcx30.com

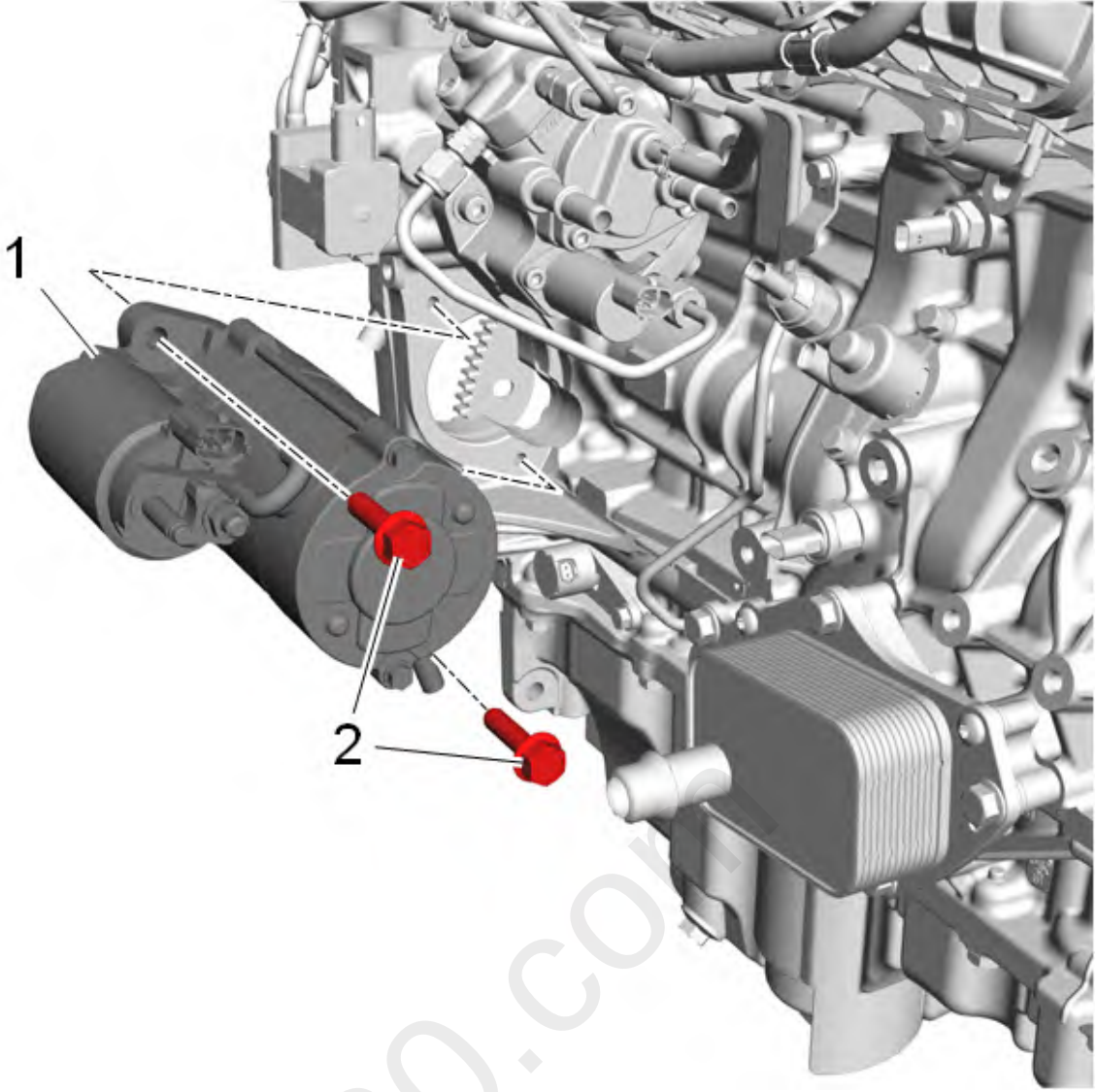


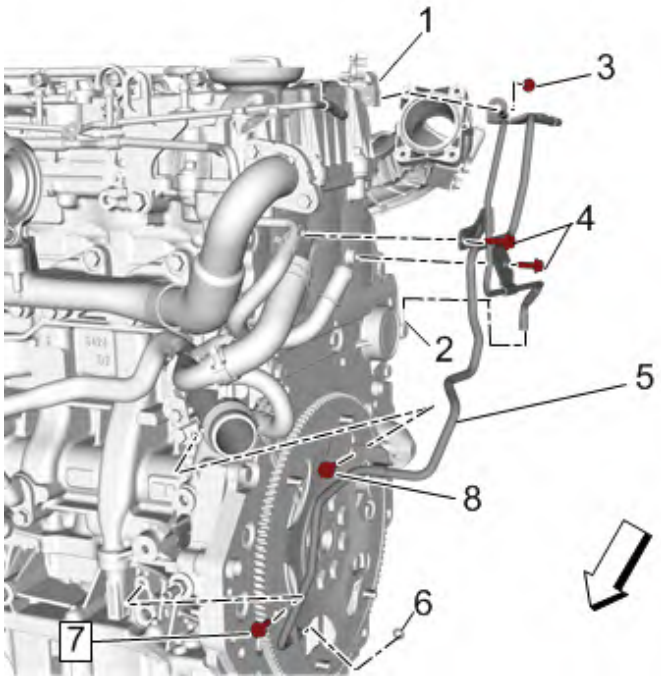
Fig. 909: Starter And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the starter (1).

CAUTION: **Refer to Fastener Caution .**

2. Install the 2 starter bolts (2) and tighten to 22 N.m (16 lb ft).

POWER BRAKE BOOSTER INLET HOSE CONNECTOR FITTING INSTALLATION



mcx30.com

Fig. 910: Power Brake Booster Inlet Hose Connector Fitting And Components
Courtesy of GENERAL MOTORS COMPANY

1. Install the power brake booster inlet hose connector fitting seal (6).
2. Install the power brake booster inlet hose connector fitting (5).

CAUTION: Refer to Fastener Caution .

3. Install the power brake booster inlet hose connector fitting bolt (7) to lower crankcase and tighten to 10 N.m (89 lb in).
4. Install the 2 power brake booster inlet hose connector fitting bolts (4) and tighten to 10 N.m (89 lb in).
5. Install the power brake booster inlet hose to turbocharger wastegate actuator vacuum control solenoid valve (2).
6. Install the power brake booster inlet hose connector fitting bracket bolt (3) to the exhaust temperature sensor wiring harness bracket (1) and tighten to 10 N.m (89 lb in).

CHARGE AIR BYPASS REGULATOR SOLENOID VALVE VACUUM TUBE INSTALLATION

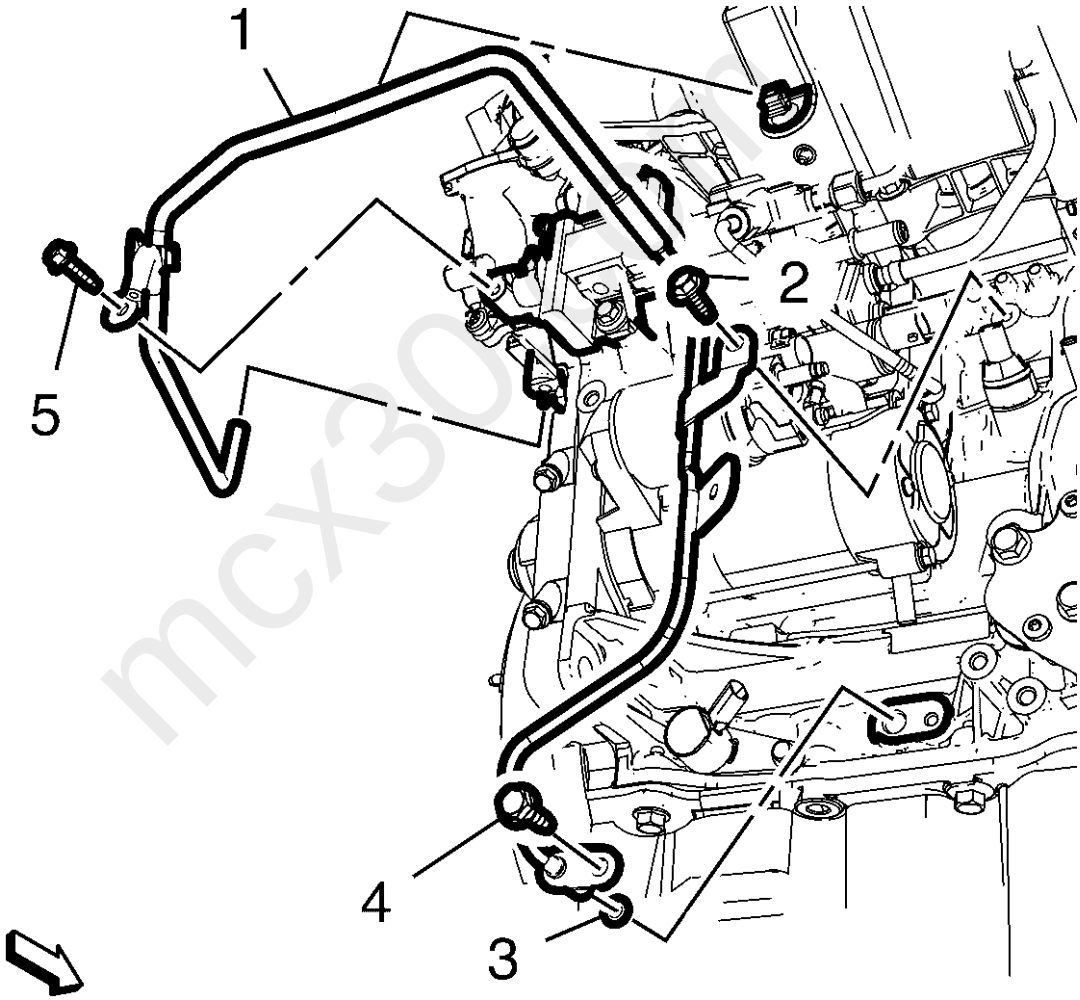


Fig. 911: Charge Air Bypass Regulator Solenoid Valve Vacuum Tube Components
Courtesy of GENERAL MOTORS COMPANY

1. Install a new charge bypass valve vacuum hose seal (3).
2. Install the charge bypass valve vacuum hose (1).
3. Clip the charge bypass valve vacuum hose (1) into the retainer clip.
4. Connect the charge bypass valve vacuum hose (1) to the exhaust gas recirculation vacuum regulator solenoid valve.

CAUTION: Refer to Fastener Caution .

5. Install the 2 charger bypass valve vacuum hose bracket bolts (2, 5) and tighten to 10 N.m (89 lb in).
6. Install the charger bypass valve vacuum hose bracket bolt (4) and tighten to 10 N.m (89 lb in).

INTAKE MANIFOLD INSTALLATION

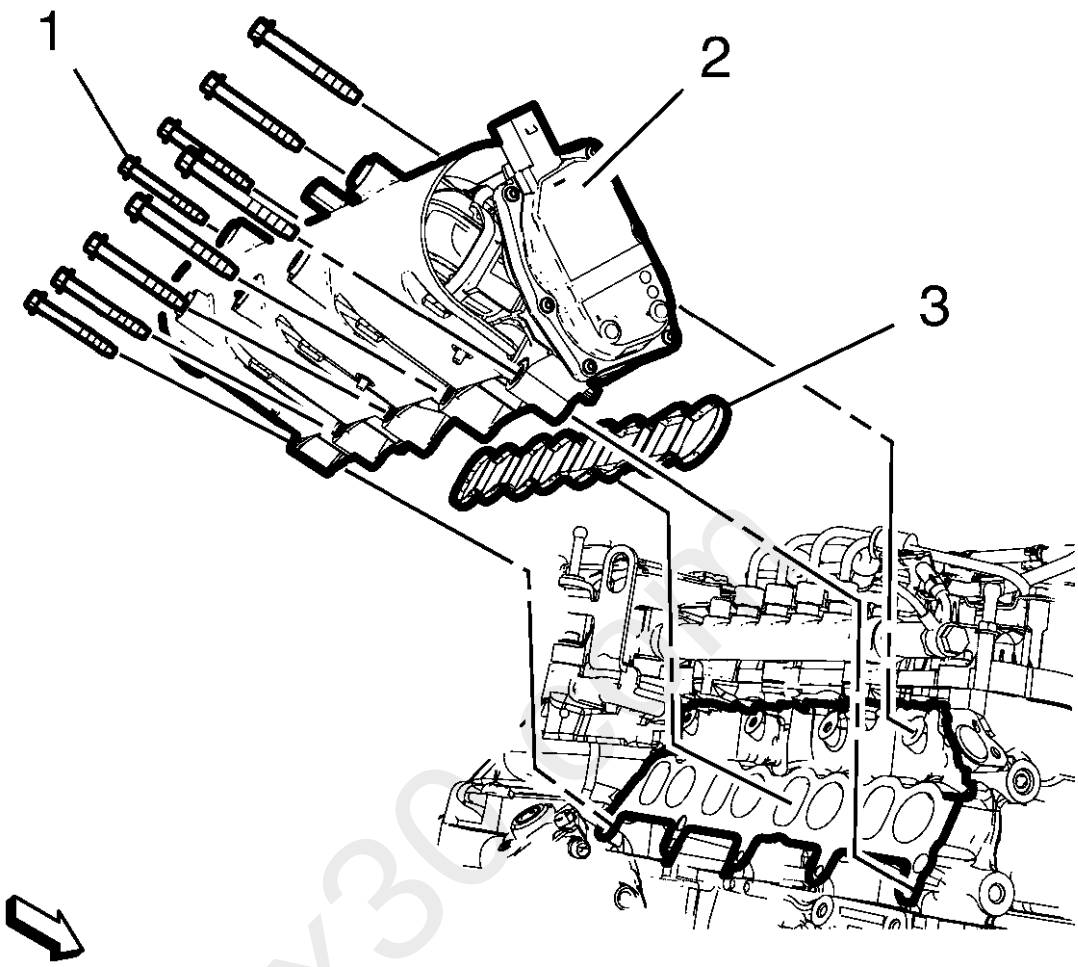


Fig. 912: Intake Manifold, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW intake manifold gasket (3).
2. Install the intake manifold (2).
3. Loosely install the 9 intake manifold bolts (1).

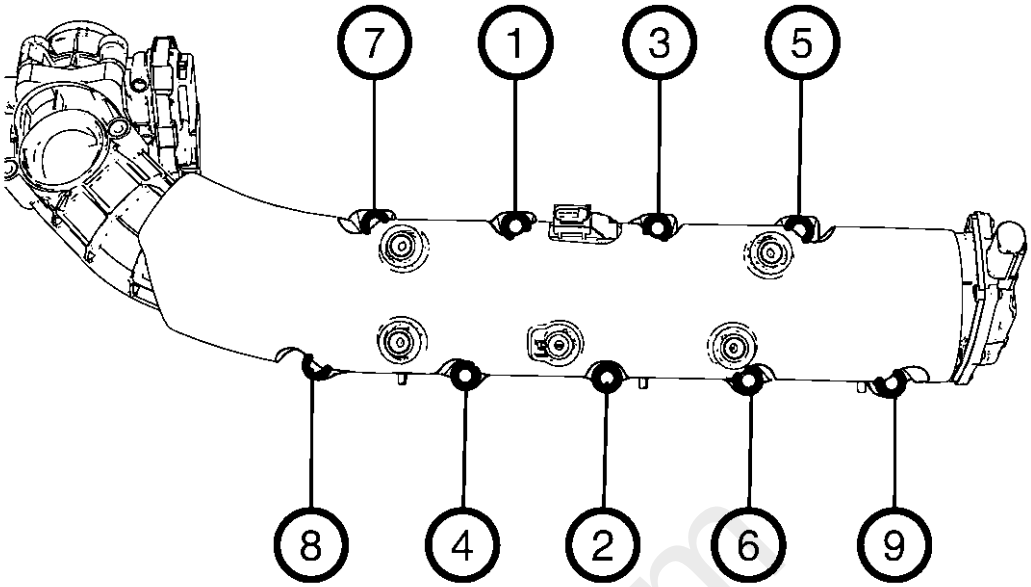


Fig. 913: Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

4. Tighten the 9 Intake manifold bolts in sequence as shown to 12 N.m (106 lb in).

mcx30.com

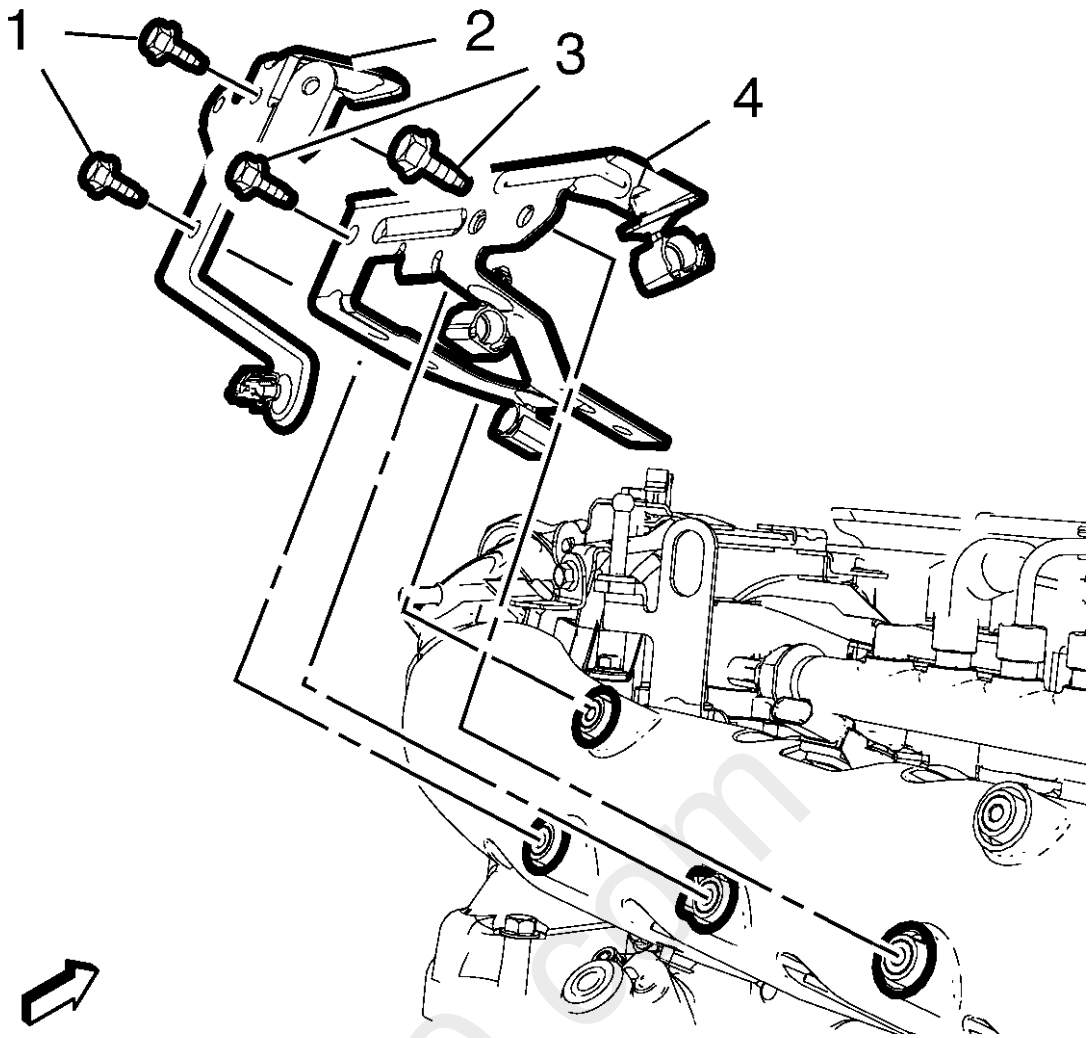


Fig. 914: Fuel Rail Fuel Pressure Sensor Wiring Harness Bracket, Fuel Rail Return Pipe Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the fuel rail return pipe bracket (4).
6. Install the 2 fuel rail return pipe bracket bolts (3) and tighten to 9 N.m (80 lb in).
7. Install the fuel rail fuel pressor sensor wiring harness bracket (2).
8. Install the 2 fuel rail fuel pressor sensor wiring harness bracket bolts (1) and tighten to 9 N.m (80 lb in).

DIESEL FUEL SEPARATOR INSTALLATION

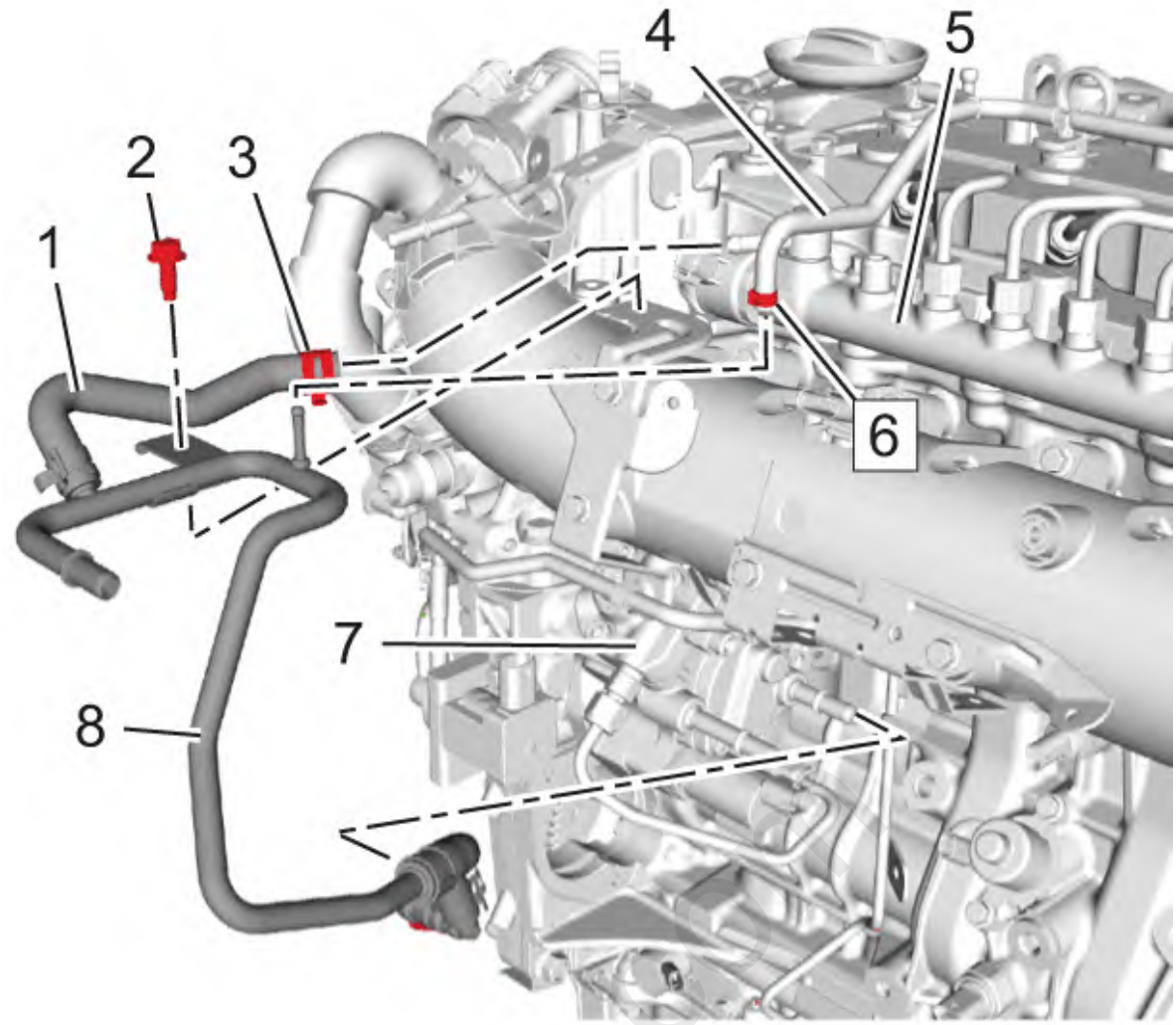


Fig. 915: Diesel Fuel Separator And Components
Courtesy of GENERAL MOTORS COMPANY

1. Connect Diesel Fuel Separator (8) @ Fuel Injection Pump (7). Refer to **Plastic Collar Quick Connect Fitting Service**
2. Connect Diesel Fuel Separator Hose (1) @ Fuel Rail (5)
3. Install Diesel Fuel Separator Hose Clamp (3)

CAUTION: **Refer to Fastener Caution**

4. Install and tighten Diesel Fuel Separator Bolt (2) to 10 N.m (89 lb in)
5. Connect Fuel Return Hose (4) @ Diesel Fuel Separator (8)
6. Install NEW Clamp (6)

FUEL INJECTION FUEL FEED PIPE INSTALLATION - FUEL INJECTION PUMP TO FUEL RAIL

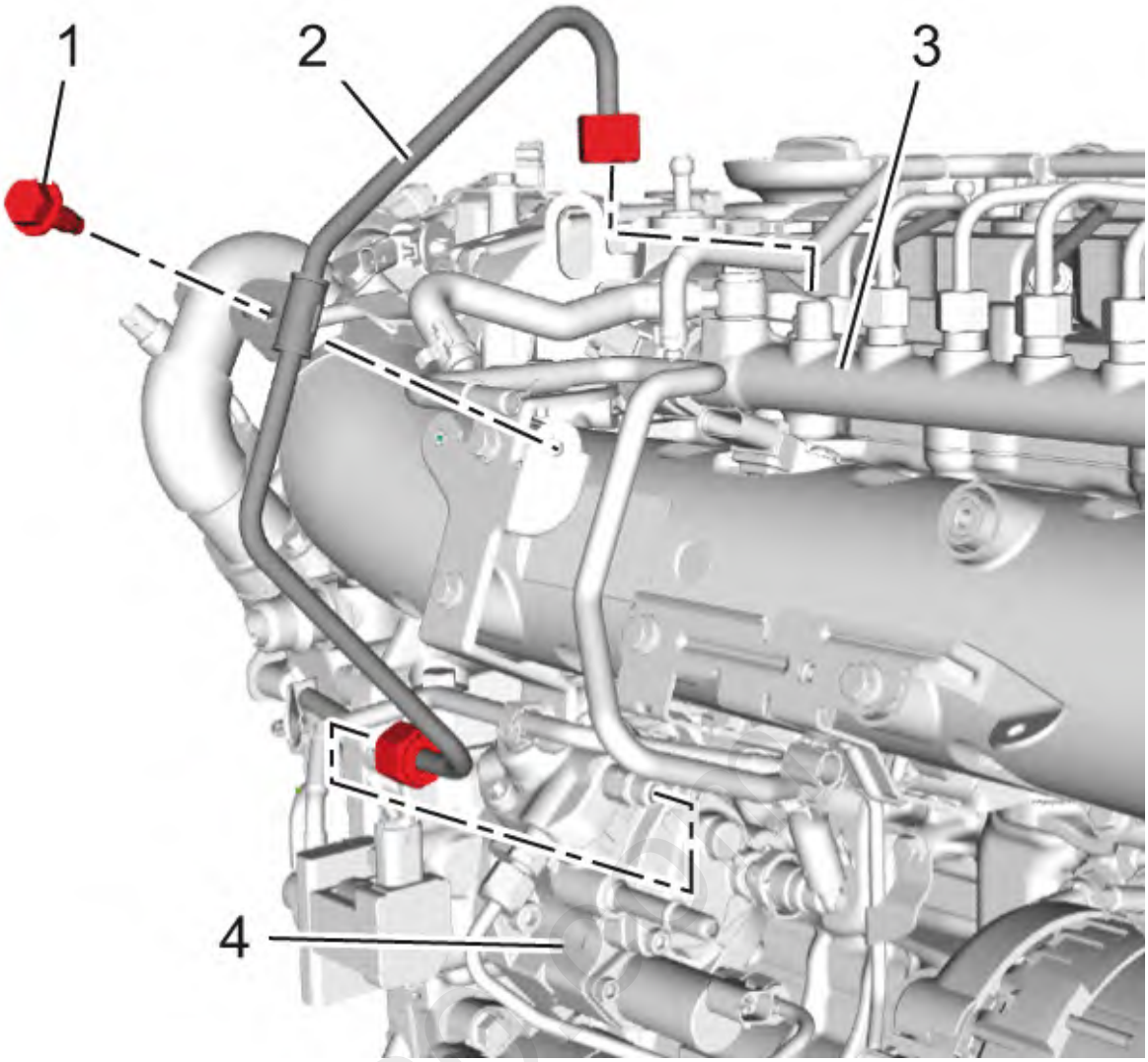


Fig. 916: Fuel Injection Fuel Feed Pipe And Components - Fuel Injection Pump to Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW Fuel Injection Fuel Feed Pipe (2)

NOTE: **Counterhold at the fuel injection pump hexagon connector.**

2. Install Fuel Injection Fuel Feed Pipe (2) @ Fuel Injection Pump (4)
3. Install Fuel Injection Fuel Feed Pipe (2) @ Fuel Rail (3)

NOTE: **Counterhold at the fuel injection pump hexagon connector.**

CAUTION: **Refer to Fastener Caution**

4. Tighten Fuel Injection Fuel Feed Pipe (2) @ Fuel Injection Pump (4) to 28 N.m (21 lb ft)
5. Tighten Fuel Injection Fuel Feed Pipe (2) @ Fuel Rail (3) to 28 N.m (21 lb ft)
6. Install and tighten Fuel Injection Fuel Feed Pipe Bracket Bolt (1) to 9 N.m (80 lb in)

FUEL RETURN HOSE INSTALLATION

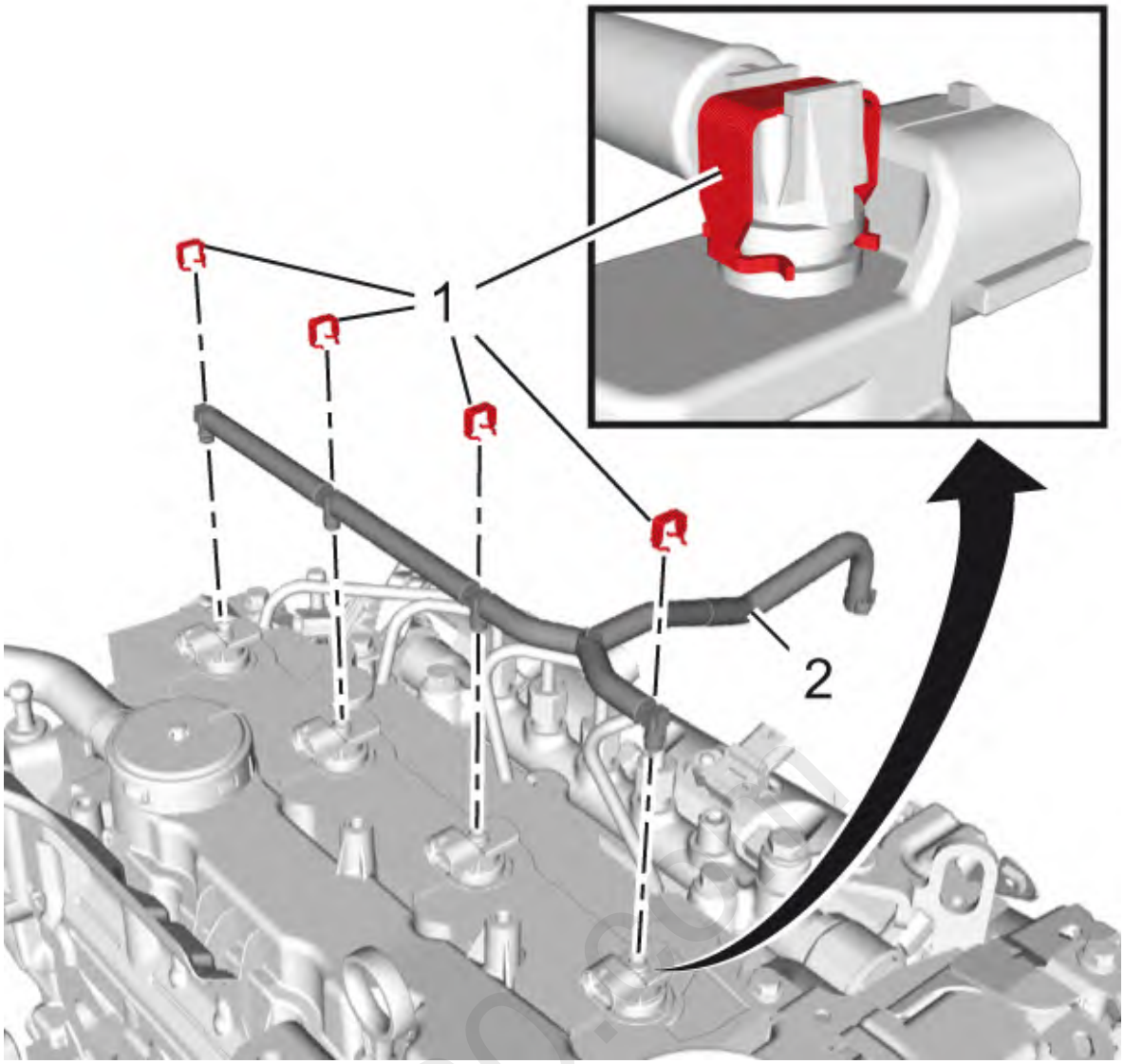


Fig. 917: Fuel Return Hose And Clamps
Courtesy of GENERAL MOTORS COMPANY

1. Install Fuel Return Hose (2) @ Fuel Injector
2. Install NEW Fuel Return Hose Clamps (1) (Qty: 4)

THROTTLE BODY ASSEMBLY INSTALLATION

1. Clean the sealing surfaces of the throttle body assembly and the intake manifold.

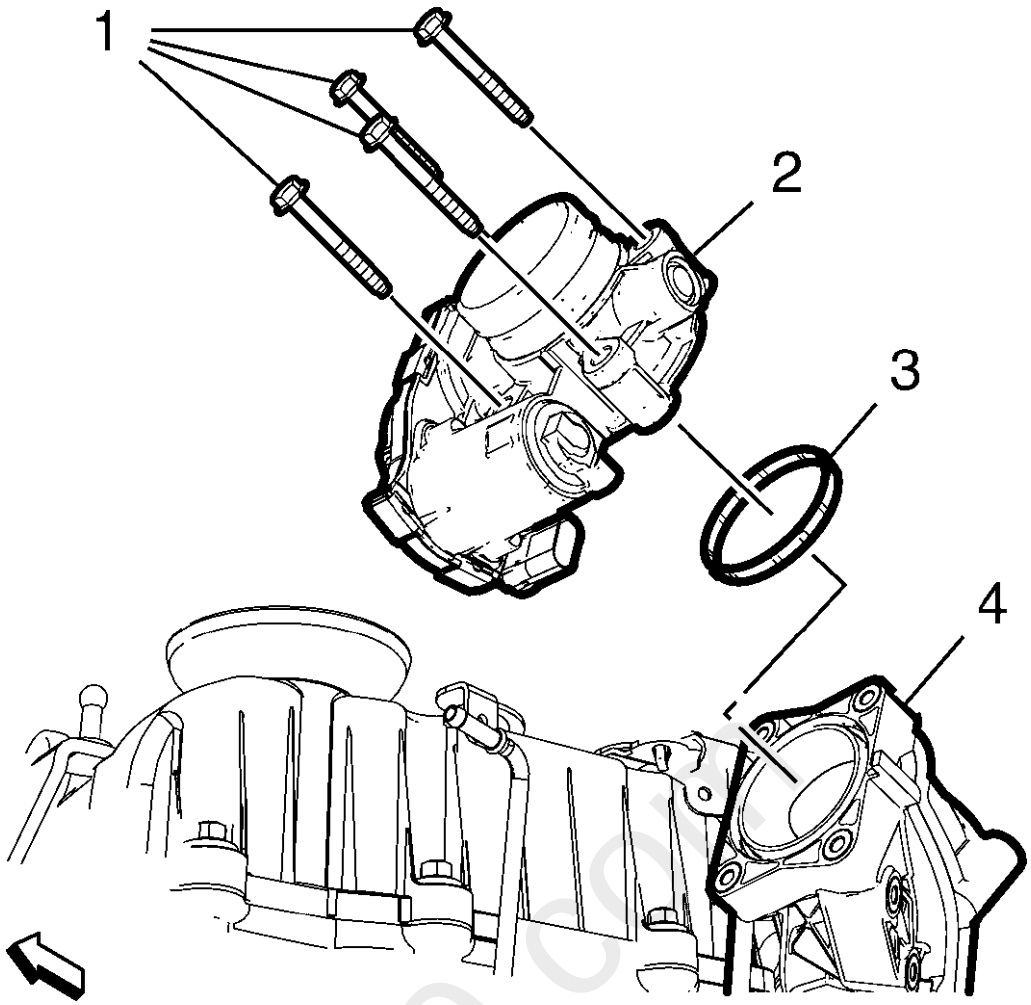


Fig. 918: Throttle Body Assembly, Bolts, Gasket And Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

2. Install a new throttle body assembly gasket (3) into the intake manifold (4).
3. Install the throttle body assembly (2).

CAUTION: **Refer to Fastener Caution .**

4. Install the 4 throttle body assembly bolts (1) and tighten to 10 N.m (89 lb in).

EXHAUST GAS RECIRCULATION COOLER HOUSING INSTALLATION

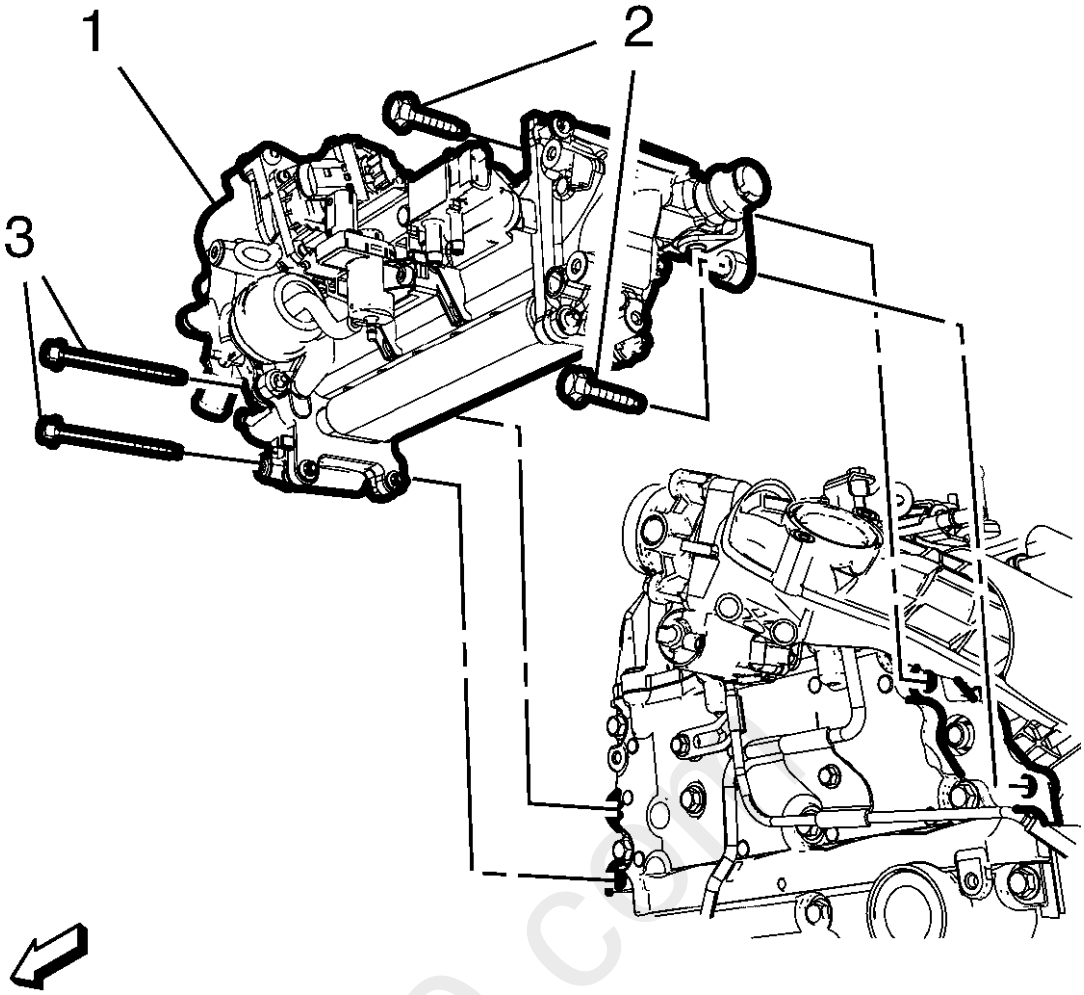


Fig. 919: Exhaust Gas Recirculation Cooler Housing And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW exhaust gas recirculation cooler housing gasket.
2. Install the exhaust gas recirculation cooler housing (1).

CAUTION: **Refer to Fastener Caution .**

NOTE: **Different bolt length.**

3. Install the 2 exhaust gas recirculation cooler bolts (2) and tighten to 25 N.m (18 lb ft).
4. Install the 2 exhaust gas recirculation cooler bolts (3) and tighten to 25 N.m (18 lb ft).

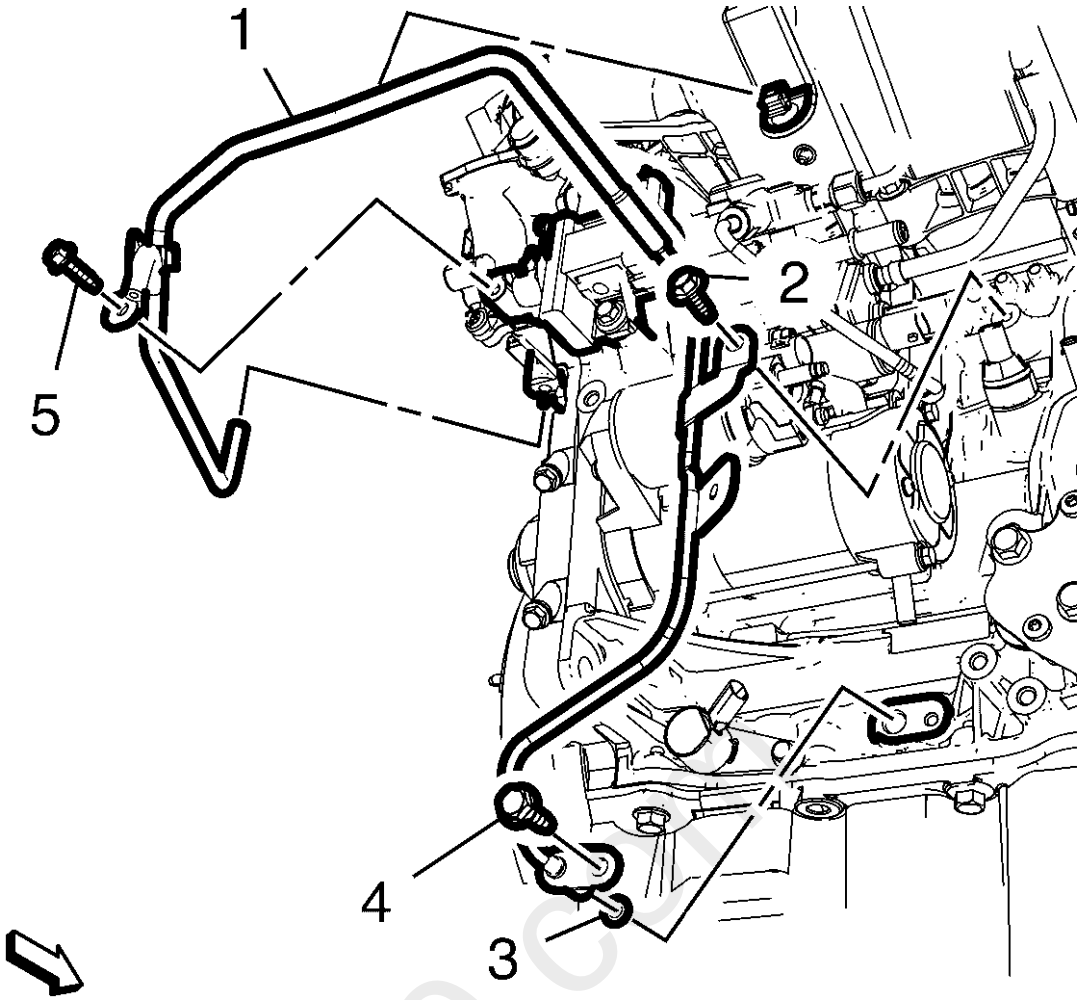


Fig. 920: Charge Air Bypass Regulator Solenoid Valve Vacuum Tube Components
Courtesy of GENERAL MOTORS COMPANY

5. Install a NEW charge bypass valve vacuum hose seal (3).
6. Install the charge bypass valve vacuum hose (1).
7. Clip the charge bypass valve vacuum hose (1) into the retainer clip.
8. Connect the charge bypass valve vacuum hose (1) to the exhaust gas recirculation vacuum regulator solenoid valve.

NOTE: **Different bolt length.**

9. Install the 2 charger bypass valve vacuum hose bracket bolts (2, 5) and tighten to 10 N.m (89 lb in).
10. Install the charger bypass valve vacuum hose bracket bolt (4) and tighten to 10 N.m (89 lb in).

INTAKE MANIFOLD BRACE INSTALLATION

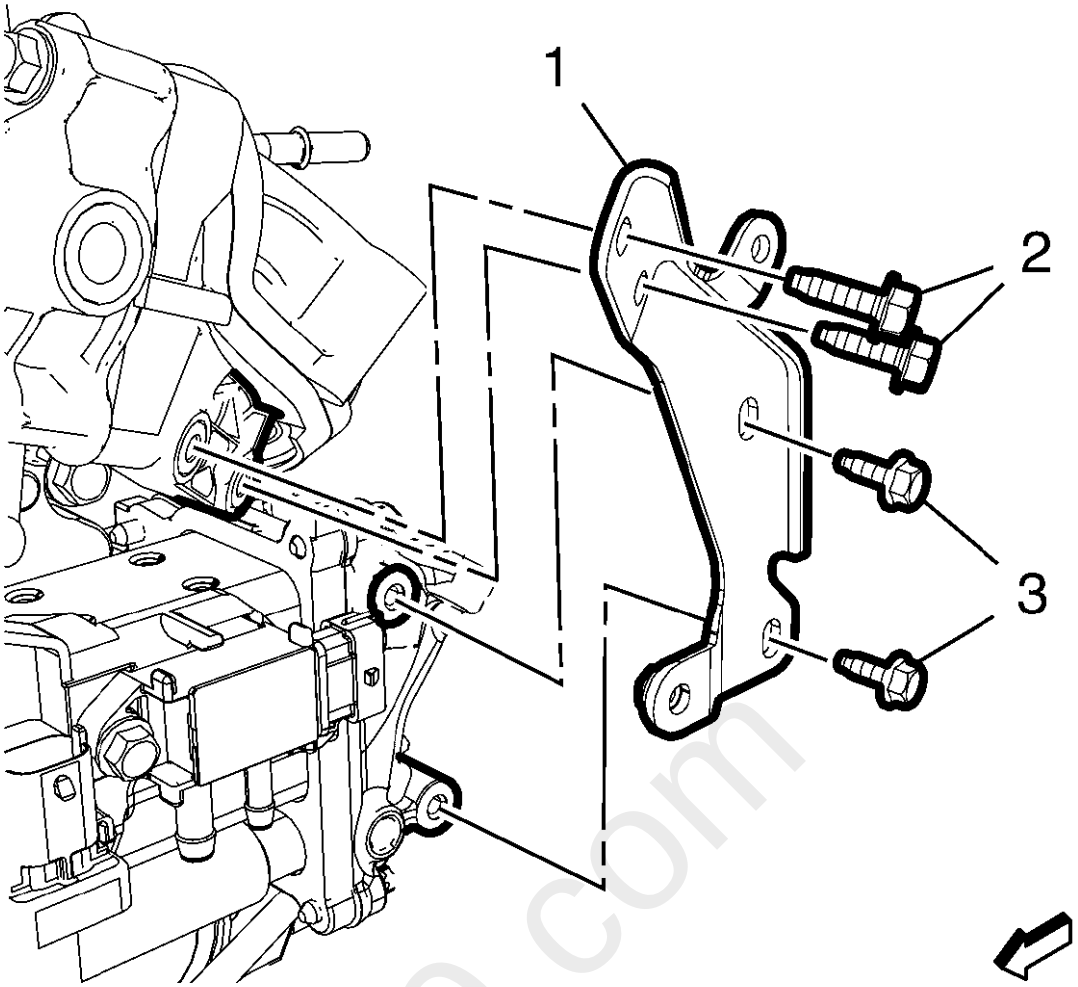


Fig. 921: Intake Manifold Brace And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the intake manifold brace (1).

CAUTION: **Refer to Fastener Caution .**

2. Install the 4 intake manifold brace bolts (2, 3) and tighten to 10 N.m (89 lb in).

EXHAUST GAS RECIRCULATION COOLER OUTLET PIPE INSTALLATION

1. Clean the sealing surfaces of the intake manifold, the exhaust gas recirculation cooler housing and the exhaust gas recirculation cooler outlet pipe.

mcx30.com

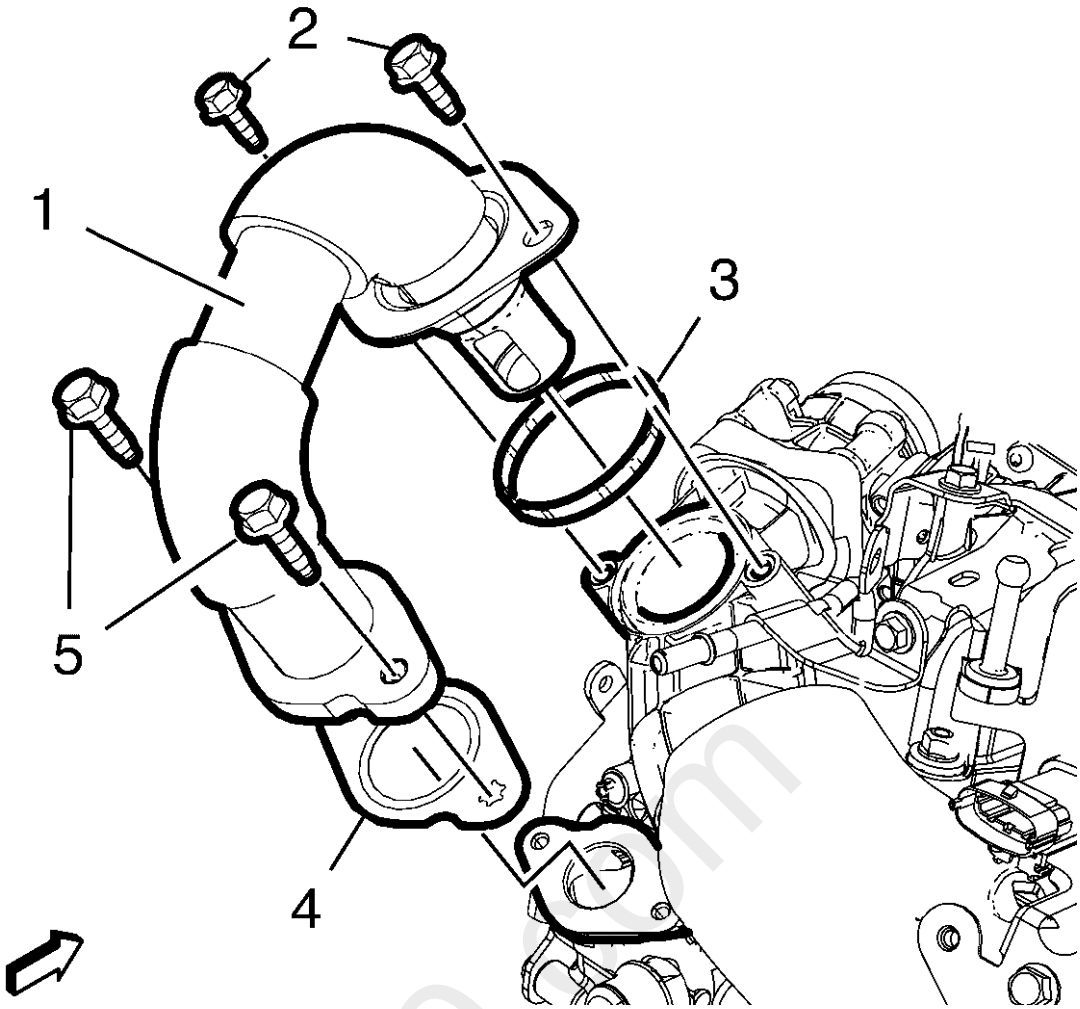


Fig. 922: Exhaust Gas Recirculation Cooler Outlet Pipe And Components
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW exhaust gas recirculation cooler outlet pipe seal (3) into the intake manifold.
3. Install a NEW exhaust gas recirculation cooler pipe gasket (4).
4. Install the exhaust gas recirculation cooler pipe (1).

CAUTION: **Refer to Fastener Caution .**

NOTE: **Different bolt lengths.**

5. Install the 2 exhaust gas recirculation cooler outlet pipe bolts (2) and tighten to 10 N.m (89 lb in).
6. Install the 2 exhaust gas recirculation cooler outlet pipe bolts (5) and tighten to 10 N.m (89 lb in).

EXHAUST GAS RECIRCULATION COOLER TEMPERATURE SENSOR INSTALLATION - POSITION 2

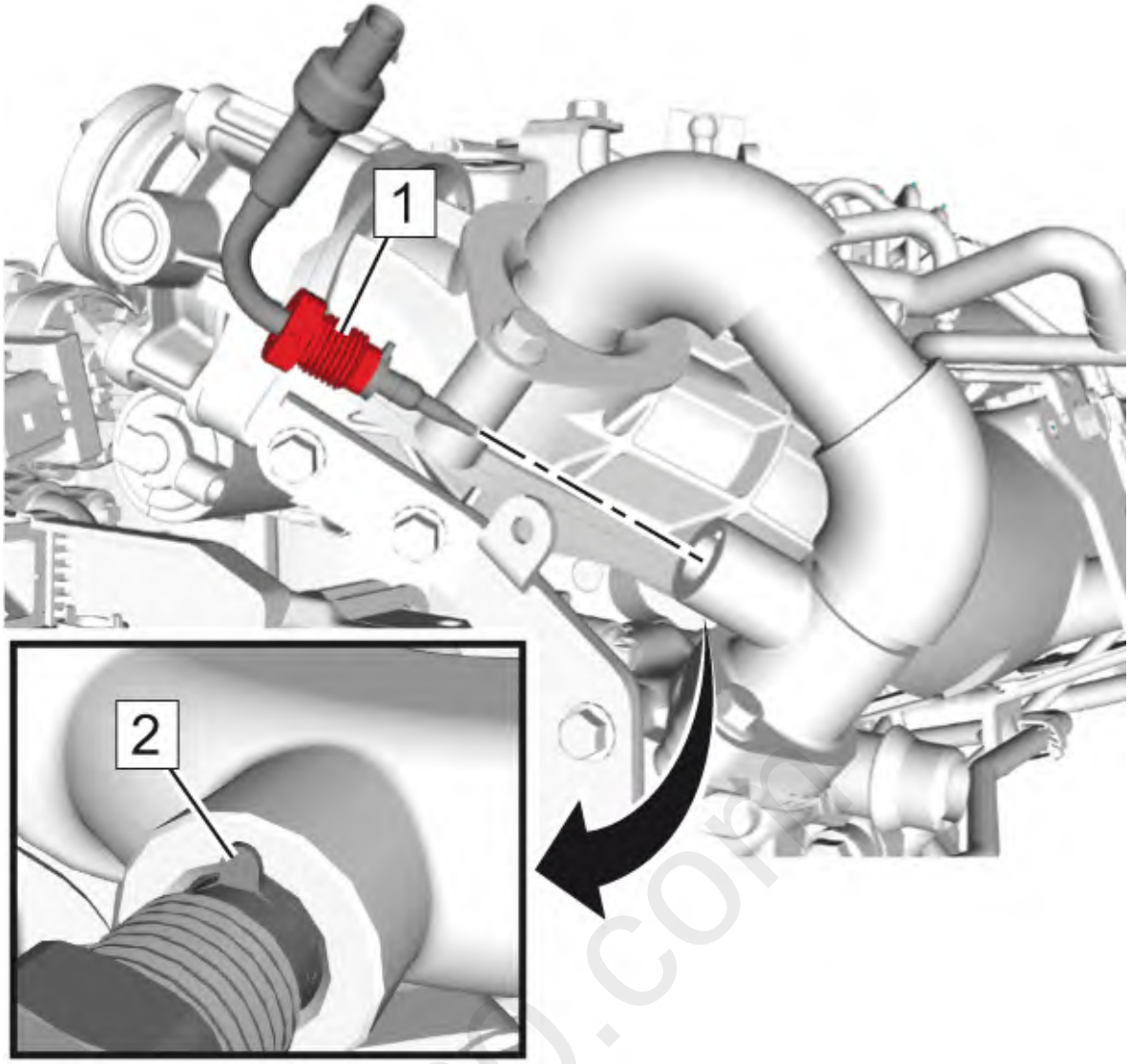


Fig. 923: Exhaust Gas Recirculation Cooler Temperature Sensor - Position 2
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The guide lug (2) must fit the groove.**

CAUTION: **Refer to Fastener Caution**

Install and tighten Exhaust Gas Recirculation Cooler Temperature Sensor - Position 2 (1) to 45 N.m (33 lb ft)

ENGINE COOLANT OUTLET PIPE INSTALLATION

1. Clean the sealing surfaces of the engine block and the engine cooler outlet pipe.

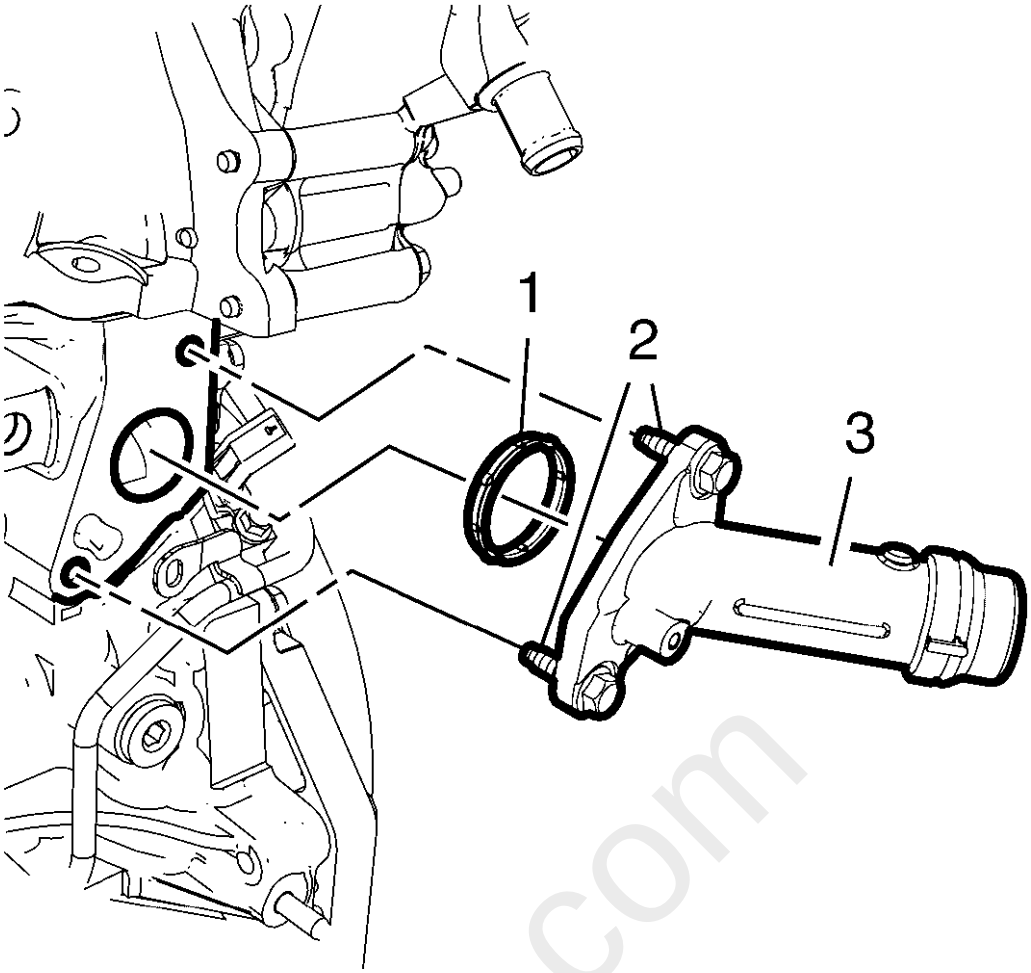


Fig. 924: Engine Coolant Outlet Pipe And Components
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW engine cooler outlet pipe seal (1).
3. Install the engine cooler outlet pipe (3).

CAUTION: **Refer to Fastener Caution .**

4. Install the 2 engine cooler outlet pipe bolts (2) and tighten to 25 N.m (18 lb ft).

WATER PUMP INSTALLATION

1. Clean the sealing surfaces of the water pump and the engine block.

mcx30.com

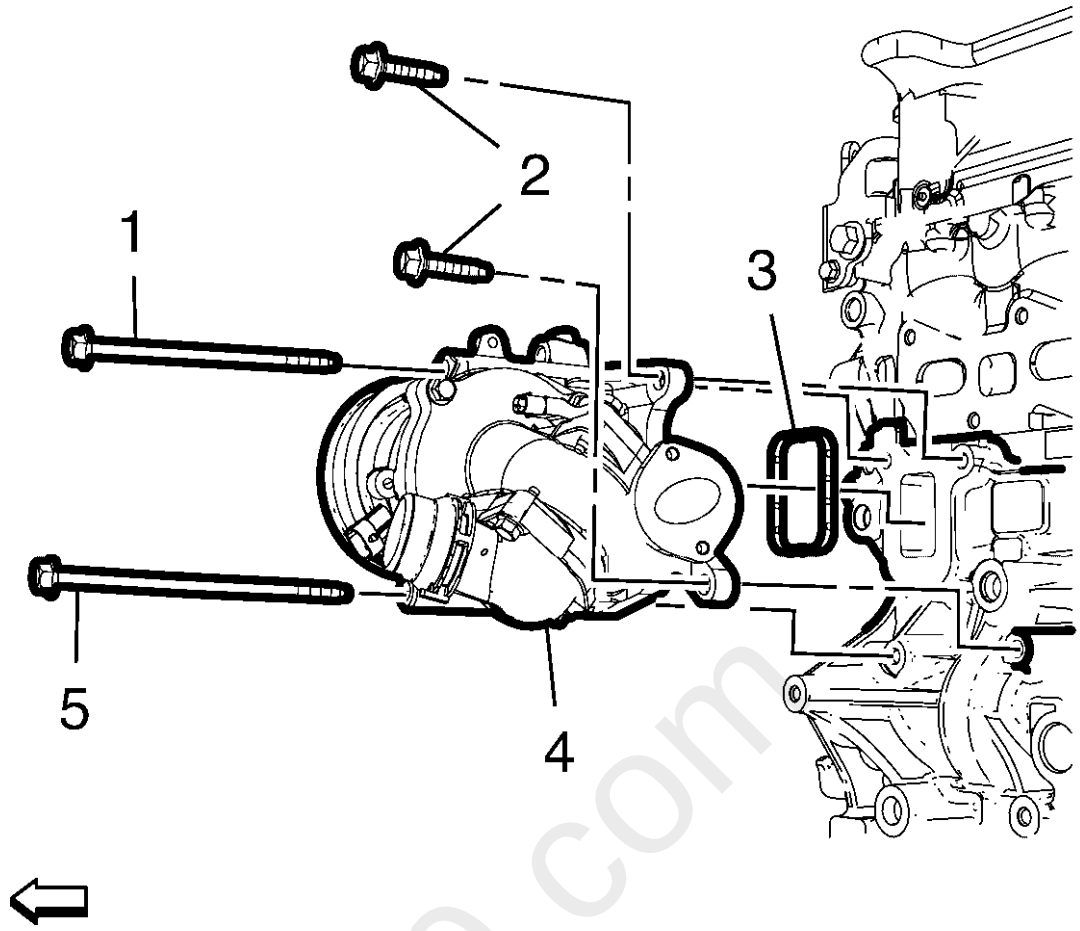


Fig. 925: Water Pump And Components
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW water pump seal (3) into the water pump housing (4).
3. Install the water pump (4).

CAUTION: **Refer to Fastener Caution .**

NOTE: **Mind the different bolt lengths.**

4. Install the 4 water pump bolts (1, 2, 5) and tighten to 25 N.m (18 lb ft).

THERMOSTAT BYPASS PIPE INSTALLATION

1. Clean all sealing surfaces.

mcx30.com

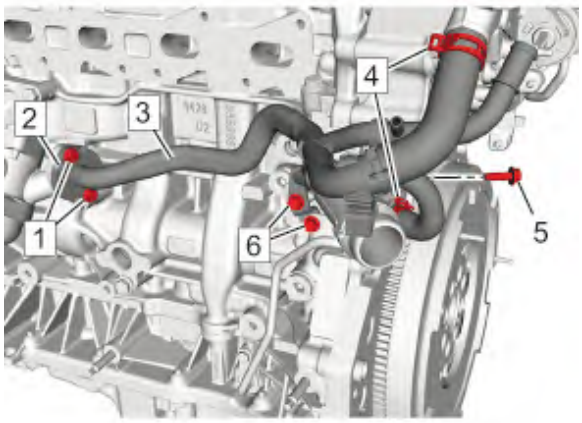


Fig. 926: Thermostat Bypass Pipe Components
Courtesy of GENERAL MOTORS COMPANY

2. Insert a NEW gasket. (2)
3. Install Thermostat Bypass Pipe (3)

CAUTION: **Refer to Fastener Caution**

4. Install the 3 thermostat bypass pipe bracket bolts (5, 6) and tighten to 10 N.m (89 lb in).
5. Install and tighten Thermostat Bypass Pipe Bolts (1) (Qty: 2) to 10 N.m (89 lb in)
6. Install Clamps (4) (Qty: 2)

EXHAUST MANIFOLD INSTALLATION

1. Re-cut the thread at cylinder head for the 8 exhaust manifold bolts.

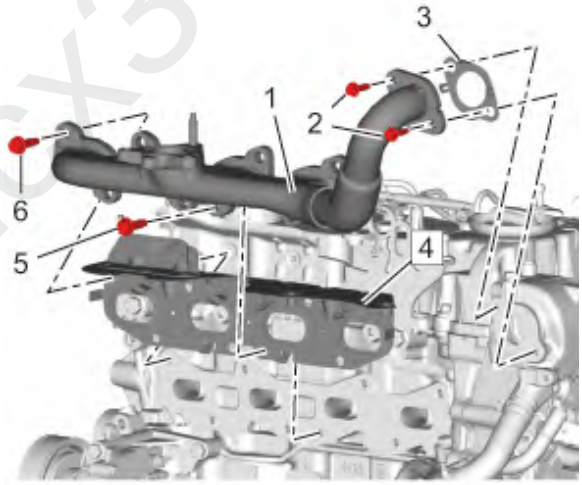


Fig. 927: Exhaust Manifold And Components
Courtesy of GENERAL MOTORS COMPANY

2. Install NEW Exhaust Gas Recirculation Pipe Gasket (3)
3. Install a NEW exhaust manifold gasket. (4)

NOTE: **Do not grab the exhaust manifold during assembly procedure at the EGR pipe as this is a sensitive part.**

4. Install Exhaust Manifold (1)

NOTE: **Service may offer bolts without micro-encapsulated thread locking adhesive. If this is the case, apply thread locking adhesive to the bolt. Do NOT reuse old**

mcx30.com

bolts.

5. Loosely install NEW Exhaust Manifold Bolts (5, 6) (Qty: 2) - Use NEW bolts.
6. Loosely install NEW Exhaust Gas Recirculation Pipe Bolts (2) (Qty: 2) - Use NEW bolts.

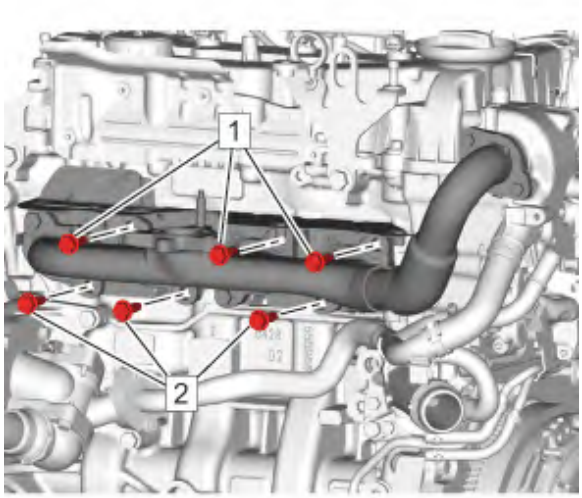


Fig. 928: Exhaust Manifold Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Loosely install NEW Exhaust Manifold Bolts (1, 2) (Qty: 6) - Use NEW bolts.

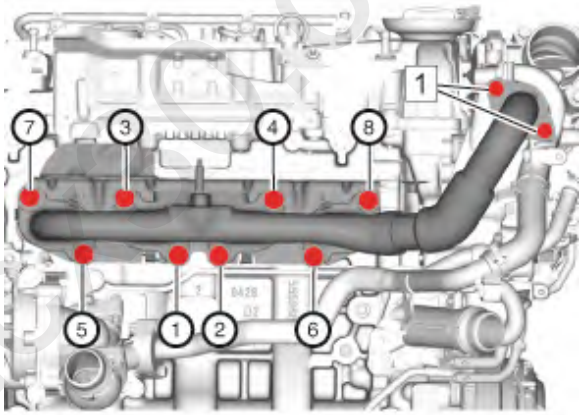


Fig. 929: Exhaust Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution**

NOTE: **The complete tightening procedure should be completed within 10 minutes.**

8. Tighten Exhaust Manifold Bolts (Qty: 6) in sequence
    1. First Pass: 27 N.m (20 lb ft)
    2. Second Pass: 27 N.m (20 lb ft)
    3. Final Pass: 27 N.m (20 lb ft)
9. Tighten Exhaust Gas Recirculation Pipe Bolts (1) (Qty: 2) to 10 N.m (89 lb in)

EXHAUST GAS RECIRCULATION COOLER TEMPERATURE SENSOR INSTALLATION - POSITION 1

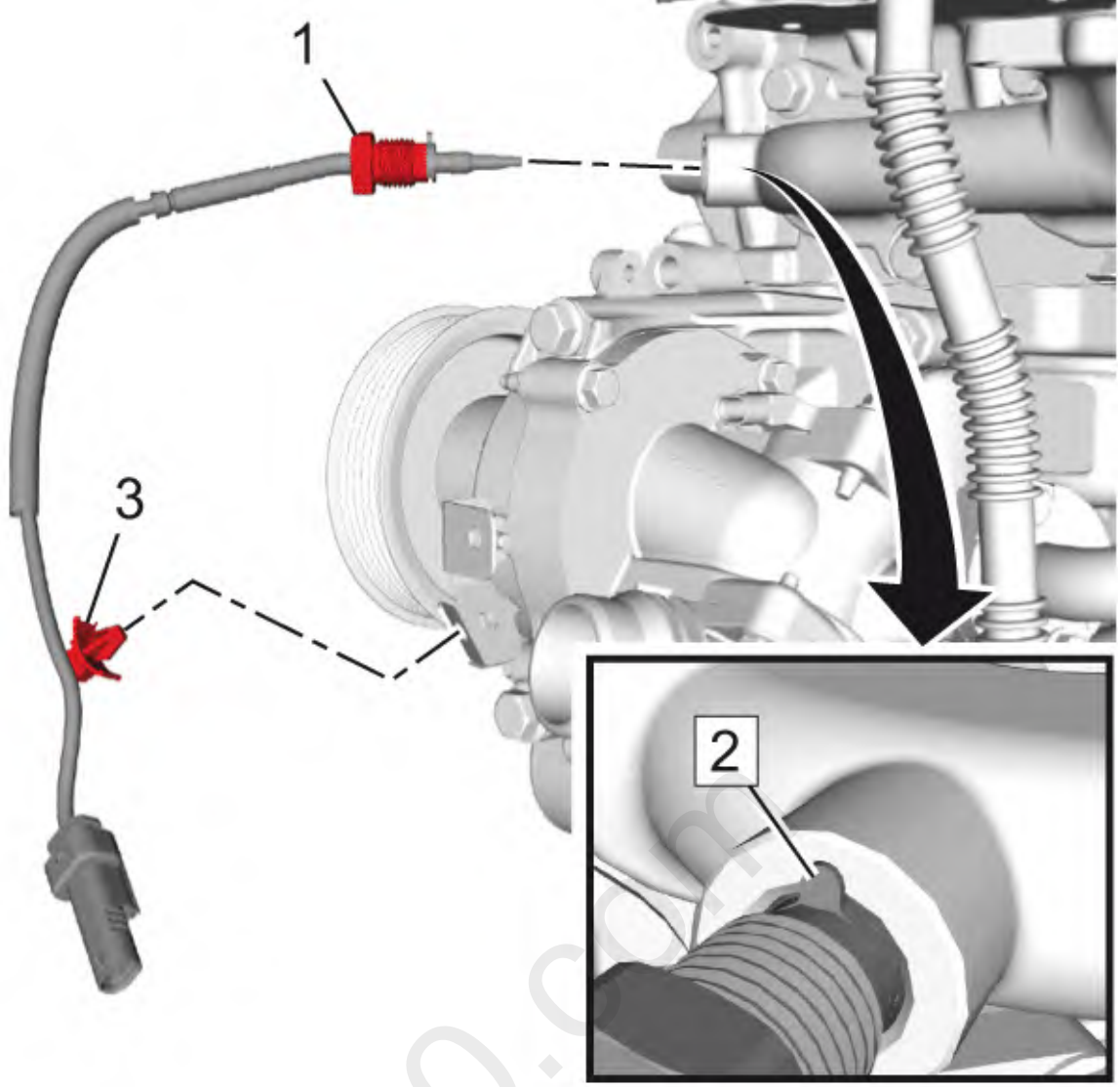


Fig. 930: Exhaust Gas Recirculation Cooler Temperature Sensor - Position 1 And Clip
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The guide lug (2) must fit the groove.**

CAUTION: **Refer to Fastener Caution**

1. Install and tighten Exhaust Gas Recirculation Cooler Temperature Sensor-Position 1 (1) to 45 N.m (33 lb ft)
2. Install Wiring Harness Clip (3)

TURBOCHARGER INSTALLATION

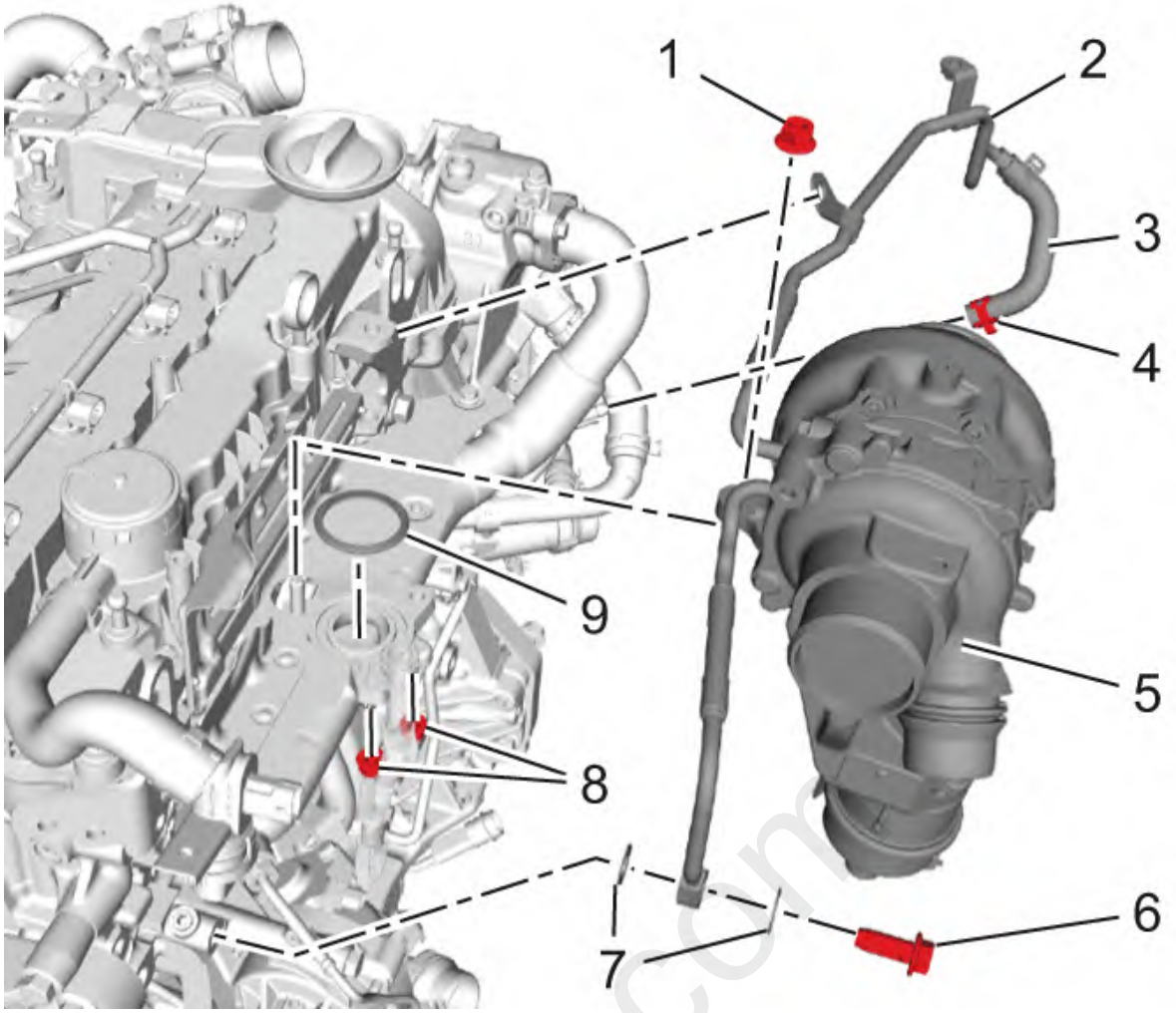


Fig. 931: Turbocharger And Components
Courtesy of GENERAL MOTORS COMPANY

1. Install NEW Turbocharger Gasket (9)
2. Position the turbocharger to the turbocharger oil return pipe.
3. Install Turbocharger (5) @ Exhaust Manifold

CAUTION: **Refer to Fastener Caution**

4. Install and tighten Turbocharger Nuts (1, 8) (Qty: 3) to 30 N.m (22 lb ft)
5. Install NEW Turbocharger Coolant Feed Pipe Gaskets (7) (Qty: 2)
6. Install and tighten Turbocharger Coolant Feed Pipe Hollow Screw (6) to 25 N.m (18 lb ft)
7. Connect Thermostat Bypass Hose (3) @ Thermostat Bypass Pipe
8. Install Thermostat Bypass Hose Clamp (4)

mcx30.com

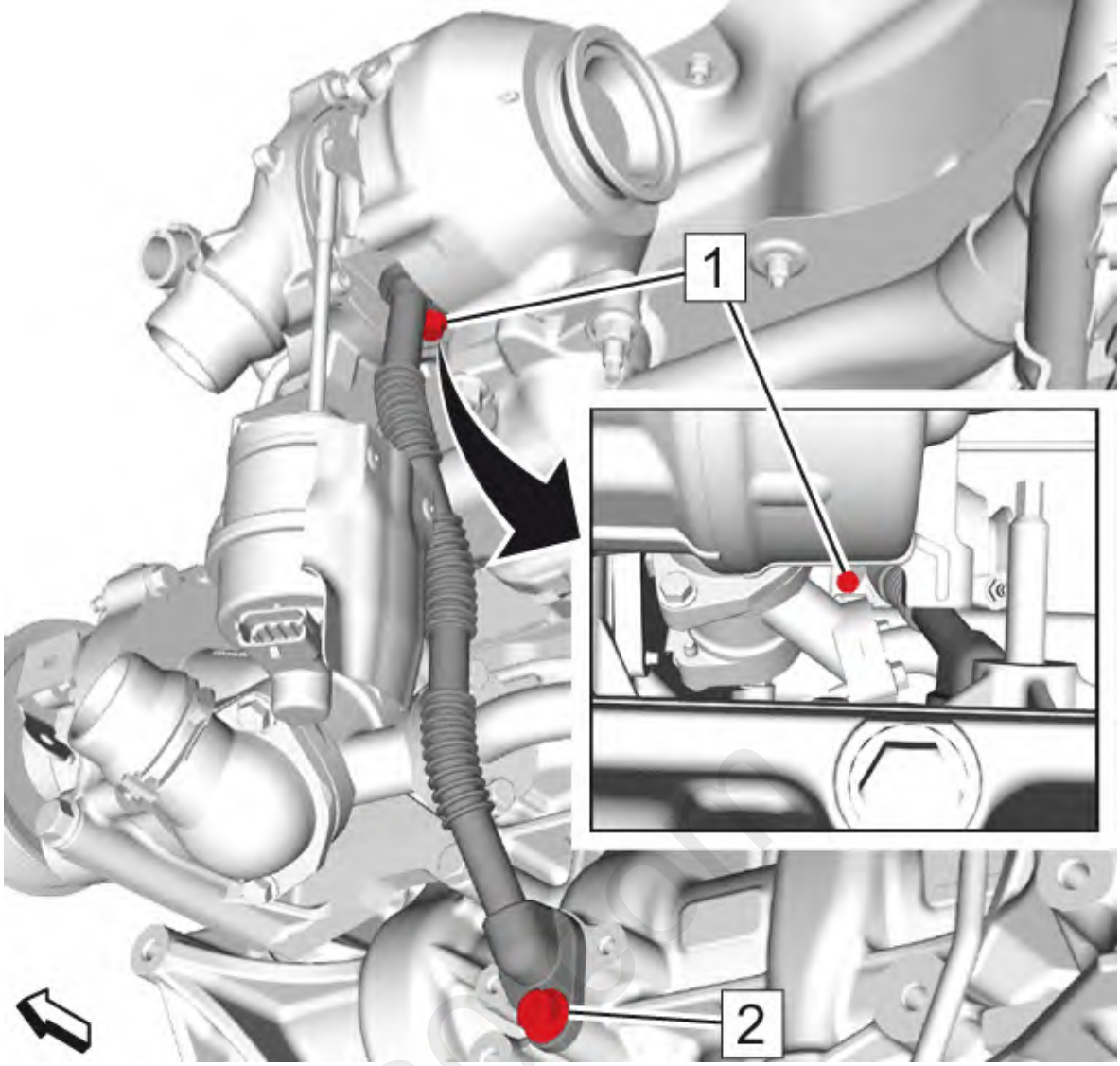


Fig. 932: Turbocharger Oil Return Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Install and tighten Turbocharger Oil Return Pipe Bolt (1) to 10 N.m (89 lb in)
10. Tighten Turbocharger Oil Return Pipe Bolt (2) to 25 N.m (18 lb ft)

mcx3.com

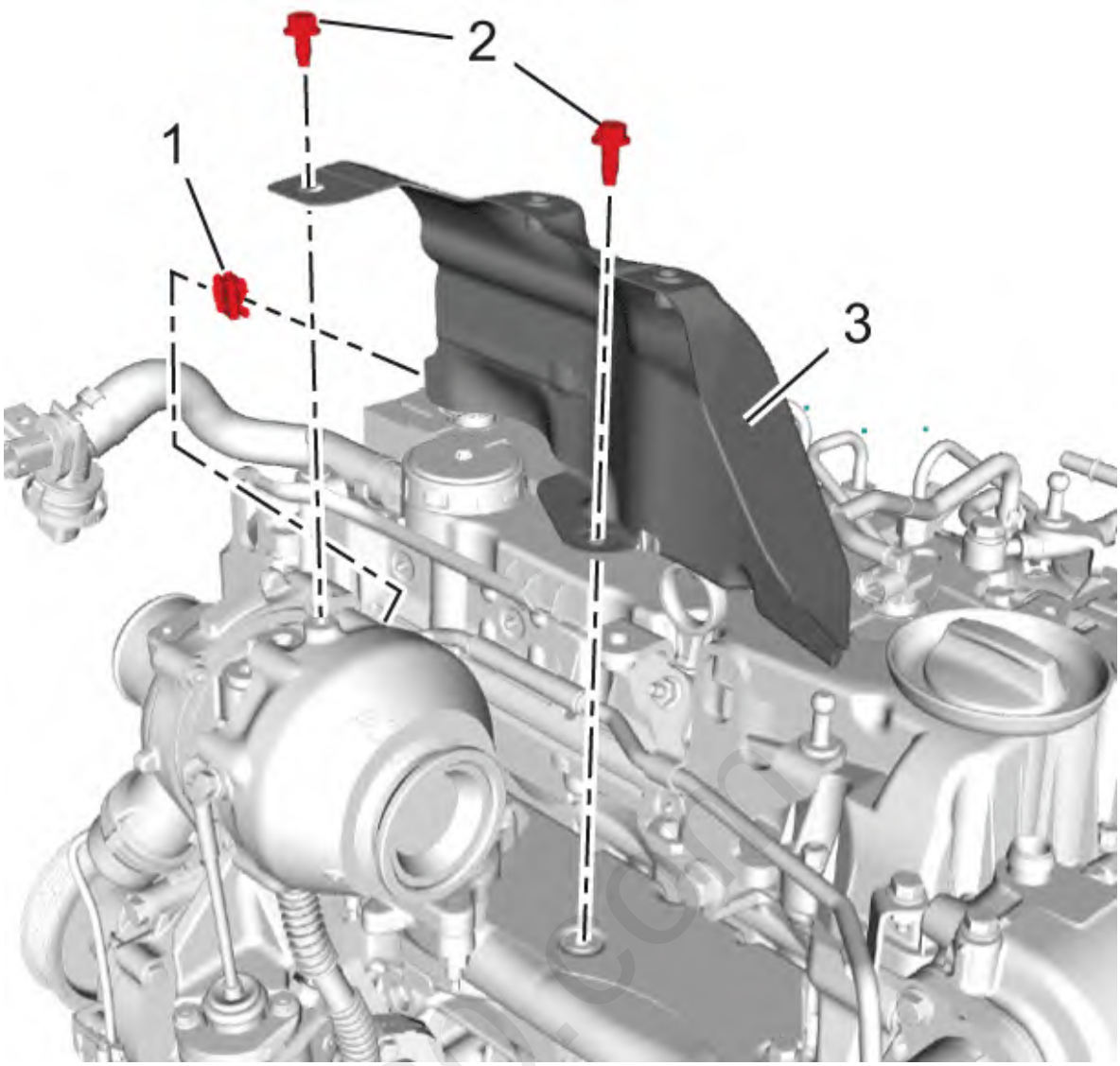


Fig. 933: Turbocharger Heat Shield, Bolts And Clamp
Courtesy of GENERAL MOTORS COMPANY

11. Install Turbocharger Heat Shield (3)
12. Install Turbocharger Heat Shield (3) @ Clamp (1)
13. Install and tighten Turbocharger Heat Shield Bolts (2) (Qty: 2) to 10 N.m (89 lb in)

TURBOCHARGER OIL RETURN PIPE INSTALLATION

mex20.com

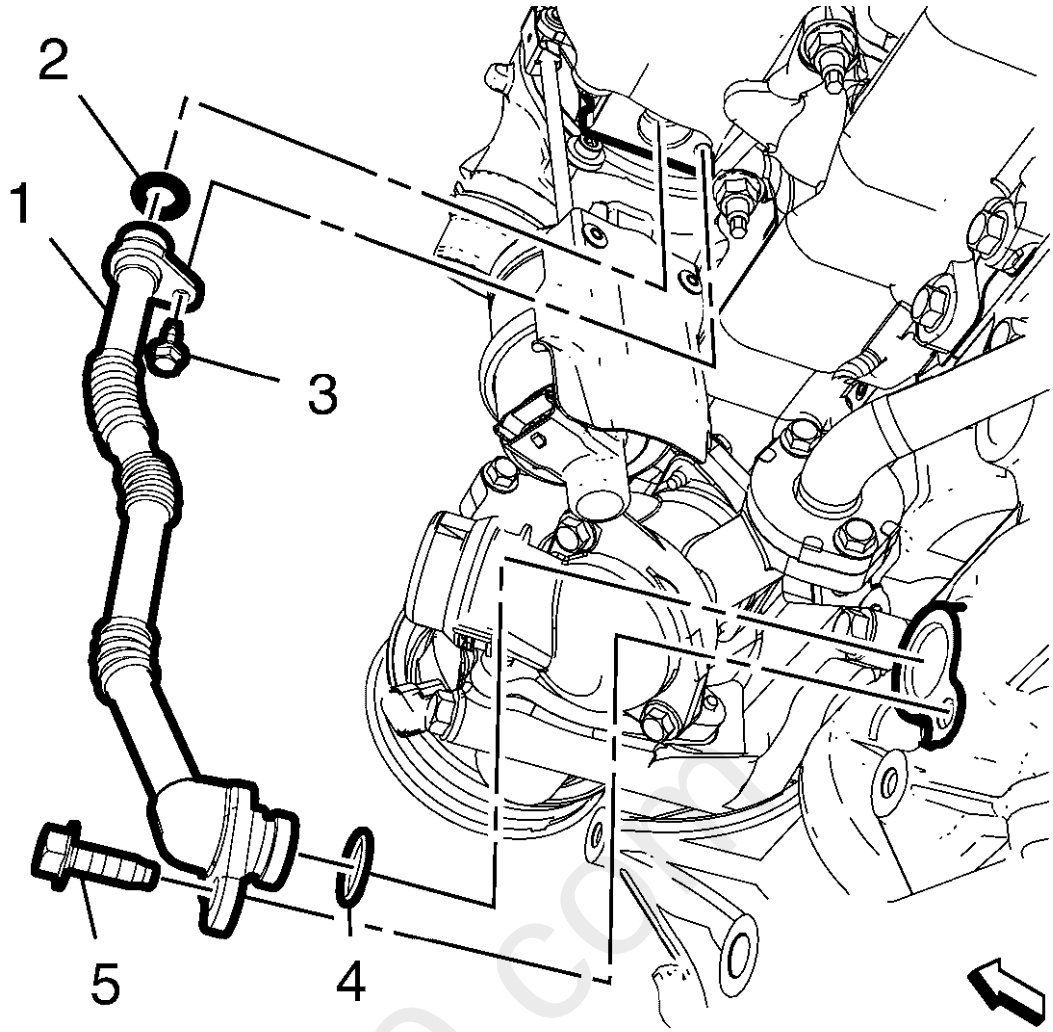


Fig. 934: Turbocharger Oil Return Pipe, Bolts And Gaskets
Courtesy of GENERAL MOTORS COMPANY

1. Install 2 NEW turbocharger oil return pipe seals (2, 4).
2. Install the turbocharger oil return pipe (1) to the lower crankcase.
3. Install the turbocharger oil return bolt (5) and handtighten.

mcx30.com

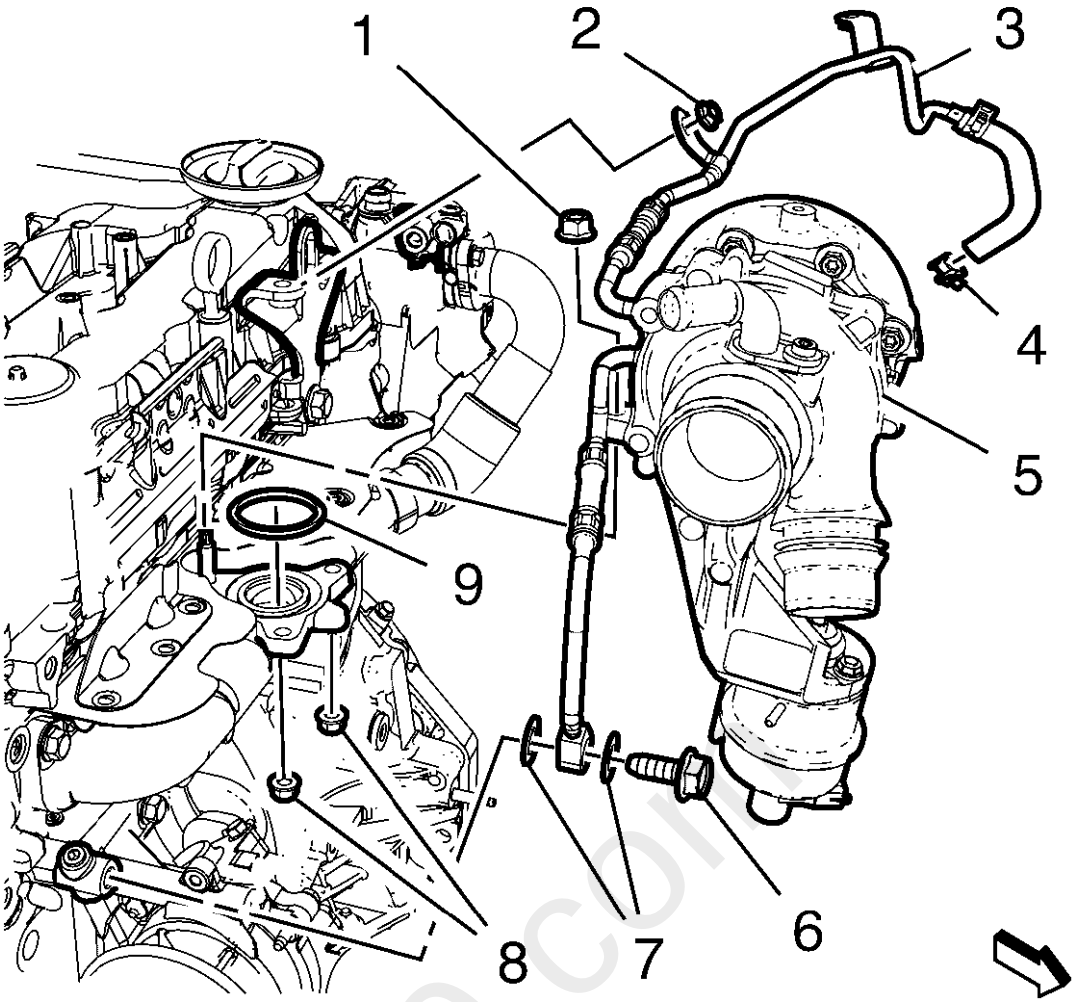


Fig. 935: Turbocharger And Components
Courtesy of GENERAL MOTORS COMPANY

4. Install the NEW turbocharger gasket (9).
5. Position the turbocharger to the turbocharger oil return pipe.
6. Install the turbocharger (5) to the exhaust manifold.

CAUTION: **Refer to Fastener Caution .**

7. Install the 3 turbocharger nuts (1, 8) and tighten to 30 N.m (22 lb ft).
8. Connect the turbocharger coolant feed pipe (3) to the thermostat bypass pipe.
9. Install the clamp (4).
10. Install the 2 turbocharger coolant feed pipe gaskets (7).
11. Install the turbocharger coolant feed pipe hollow bolt (6) and tighten to 25 N.m (18 lb ft).
12. Install the turbocharger coolant feed pipe bracket nut (2) and tighten to 10 N.m (89 lb in).

mcx30.com

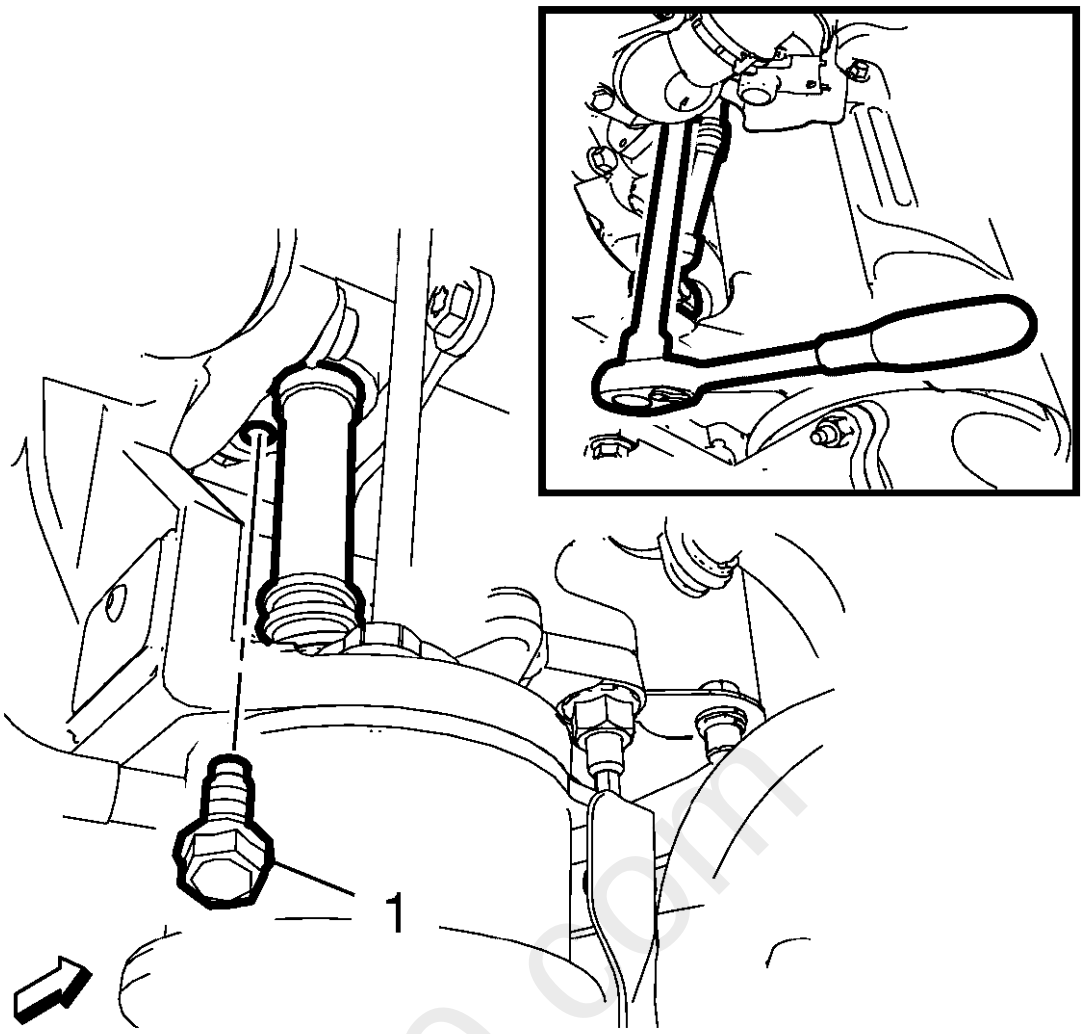


Fig. 936: Upper Turbocharger Oil Return Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

13. Tighten the upper turbocharger oil return pipe bolt (1) to 10 N.m (89 lb in).

mcx30.com

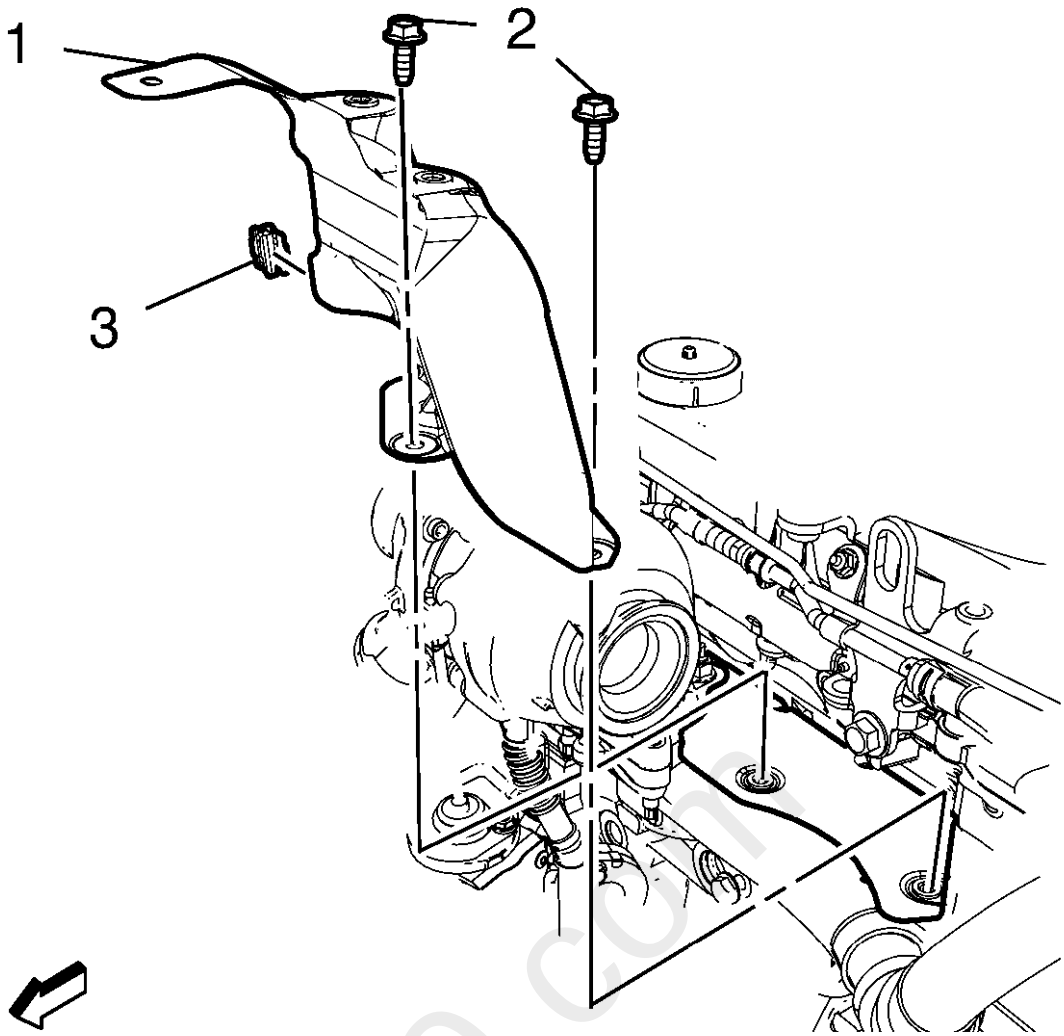


Fig. 937: Turbocharger Heat Shield, Bolts And Clip
Courtesy of GENERAL MOTORS COMPANY

14. Install the turbocharger heat shield (1).
15. Install the turbocharger heat shield connection clamp (3).
16. Install the turbocharger heat shield bolts (2) and tighten to 9 N.m (80 lb in).

TURBOCHARGER OIL FEED PIPE INSTALLATION

mx30.com

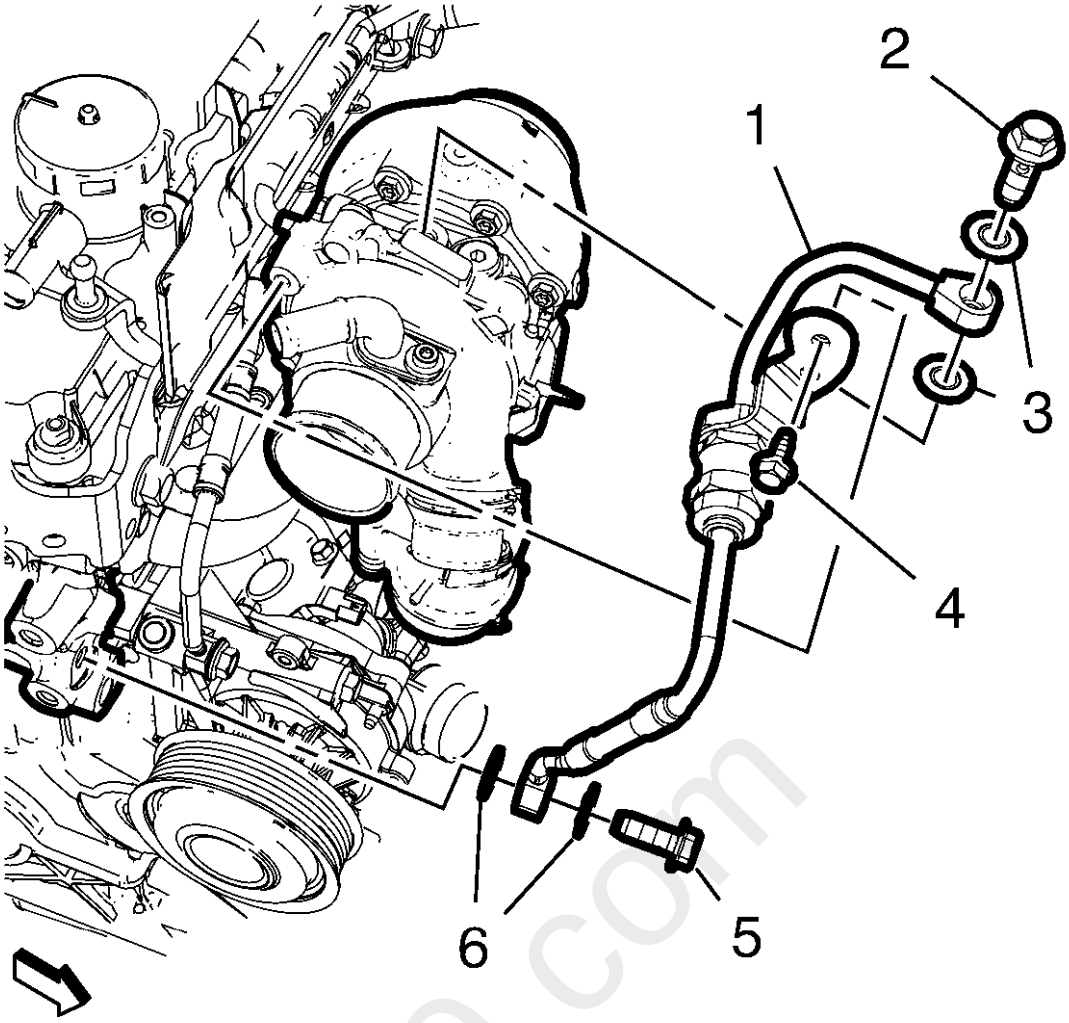


Fig. 938: Turbocharger Oil Feed Pipe And Components
Courtesy of GENERAL MOTORS COMPANY

1. Install the turbocharger oil feed pipe (1).
2. Install the turbocharger oil feed pipe bracket bolt (4) but do not tighten yet.
3. Install the 2 NEW turbocharger oil feed pipe gaskets (6).

CAUTION: **Refer to Fastener Caution .**

4. Install the turbocharger oil feed hollow bolt (5) and tighten to 25 N.m (18 lb ft).
5. Install the 2 NEW turbocharger oil feed pipe gaskets (3).
6. Install the turbocharger oil feed pipe hollow bolt (2) and tighten to 25 N.m (18 lb ft).
7. Tighten the turbocharger oil feed pipe bracket bolt (4) to 10 N.m (89 lb in).

TURBOCHARGER WASTEGATE ACTUATOR PIPE INSTALLATION

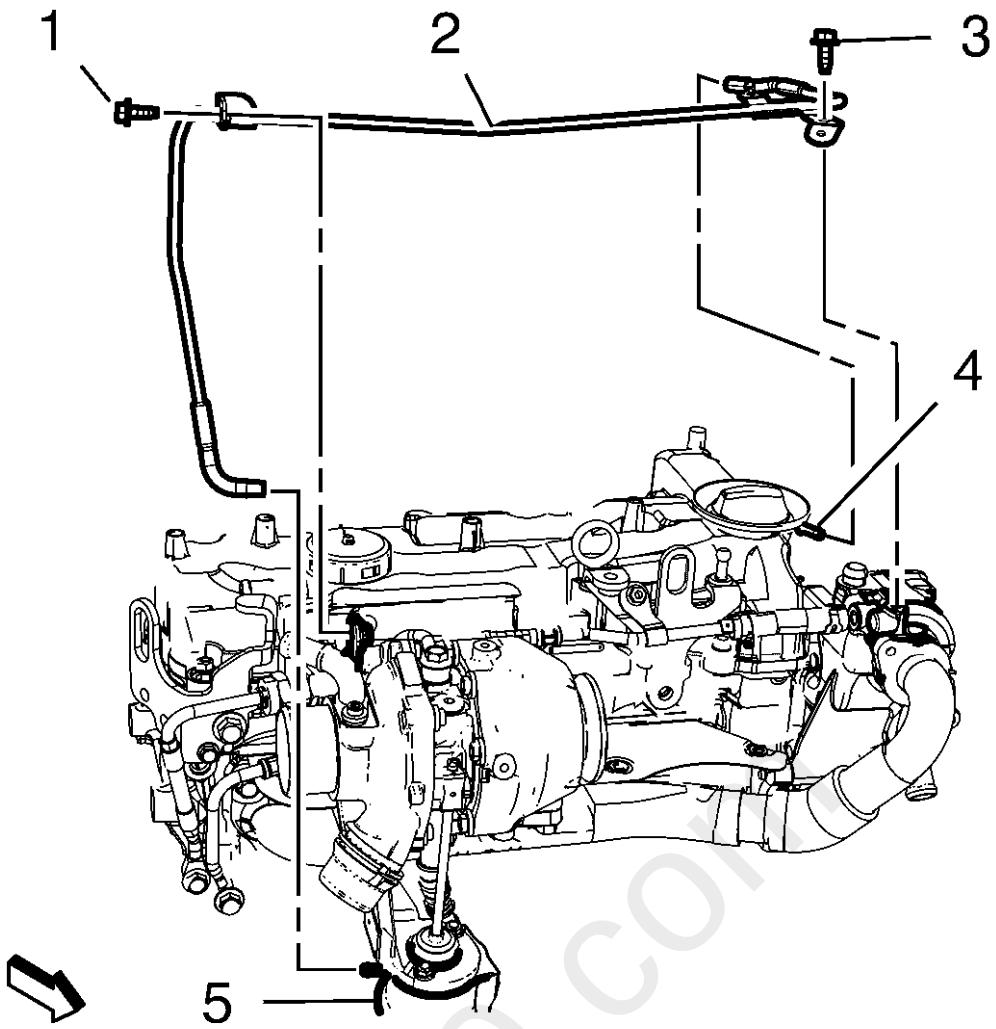


Fig. 939: Turbocharger Wastegate Actuator Pipe And Components
Courtesy of GENERAL MOTORS COMPANY

1. Install the turbocharger wastegate actuator pipe (2).
2. Connect the turbocharger wastegate actuator pipe (2) to the power brake booster vacuum pipe (4).
3. Connect the turbocharger wastegate actuator pipe (2) to the turbocharger wastegate actuator (5).

CAUTION: **Refer to Fastener Caution .**

4. Install the turbocharger wastegate actuator pipe bracket bolt (3) and tighten to 10 N.m (89 lb in).
5. Install the turbocharger wastegate actuator pipe bracket bolt (1) and tighten to 10 N.m (89 lb in).

CATALYTIC CONVERTER INSTALLATION

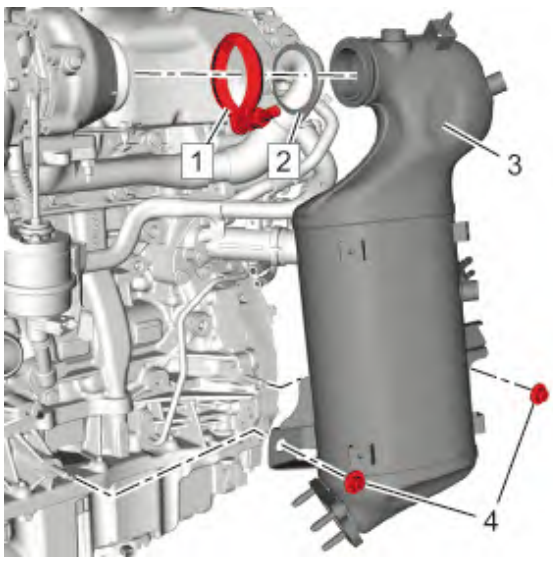


Fig. 940: Catalytic Converter, Clamp, Nuts And Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW gasket. (2)
2. Install Catalytic Converter Clamp (1)
3. Install Catalytic Converter (3)

CAUTION: **Refer to Fastener Caution**

NOTE: **Only tighten the catalytic converter clamp bolt that a rotation of the catalytic converter is possible.**

4. Tighten Catalytic Converter Clamp (1) to 6 N.m (53 lb in)
5. Install and tighten Catalytic Converter Bracket Nuts (4) (Qty: 2) to 22 N.m (17 lb ft)
6. Tighten Catalytic Converter Clamp (1) to 25 N.m (18 lb ft)

EXHAUST PRESSURE DIFFERENTIAL SENSOR PIPE INSTALLATION

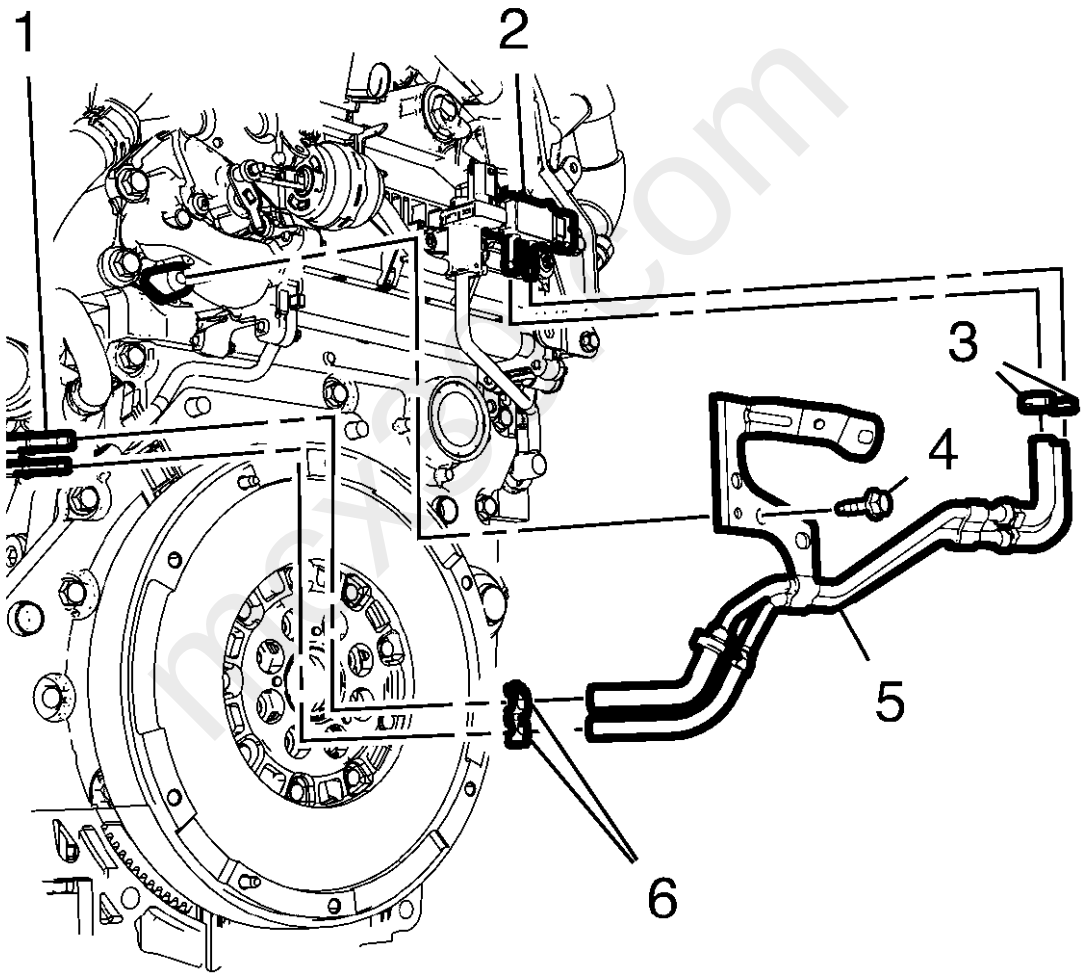


Fig. 941: Exhaust Pressure Differential Sensor Pipe And Components
Courtesy of GENERAL MOTORS COMPANY

1. Install the exhaust pressure differential sensor pipe (5).

CAUTION: **Refer to Fastener Caution .**

2. Install the exhaust pressure differential sensor pipe bracket bolt (4) and tighten to 9 N.m (80 lb in).
3. Install 2 NEW clamps (6) to the hoses.
4. Connect the hoses to the catalytic converter connection pipes (1) and fasten the clamps (6).
5. Install 2 NEW clamps (3) to the hoses.

6. Connect the hoses to the exhaust pressure differential sensor (2) and fasten the clamps (3).

EXHAUST TEMPERATURE SENSOR INSTALLATION - POSITION 2

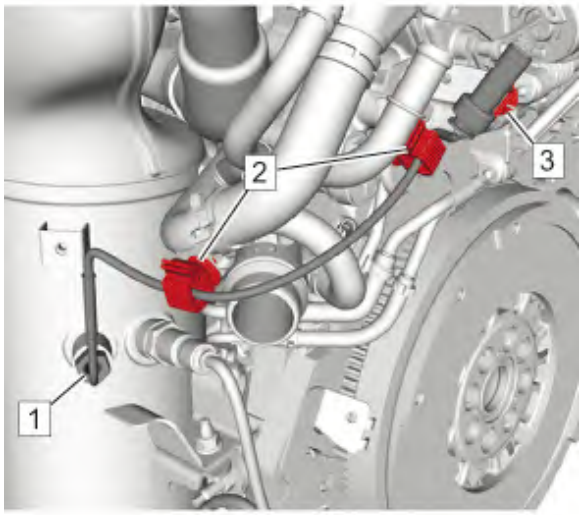


Fig. 942: Exhaust Temperature Sensor - Position 2 And Retainers
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

1. Install the exhaust temperature sensor - position 2 (1) to the catalytic converter and tighten to 45 N.m (33 lb ft).
2. Install Retainers (2, 3) (Qty: 3)

EXHAUST TEMPERATURE SENSOR INSTALLATION - POSITION 1

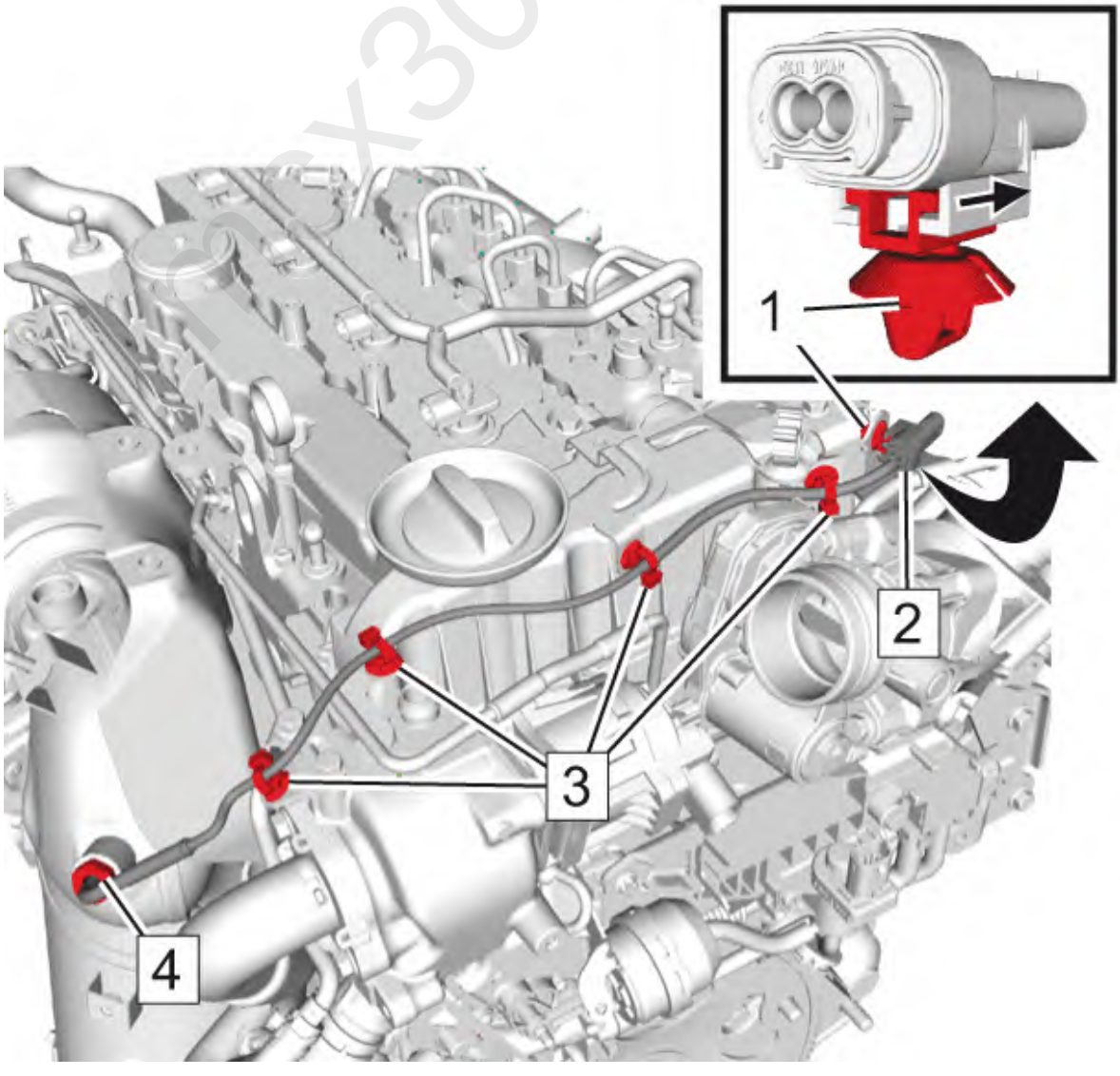


Fig. 943: Exhaust Temperature Sensor - Position 1, Electrical Connector And Retainers
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install and tighten Exhaust Temperature Sensor - Position 1 (4) to 45 N.m (33 lb ft)
2. Install Wiring Harness Retainers (3) (Qty: 4)
3. Install Electrical Connector (2) @ Retainer (1)

CATALYTIC CONVERTER HEAT SHIELD INSTALLATION

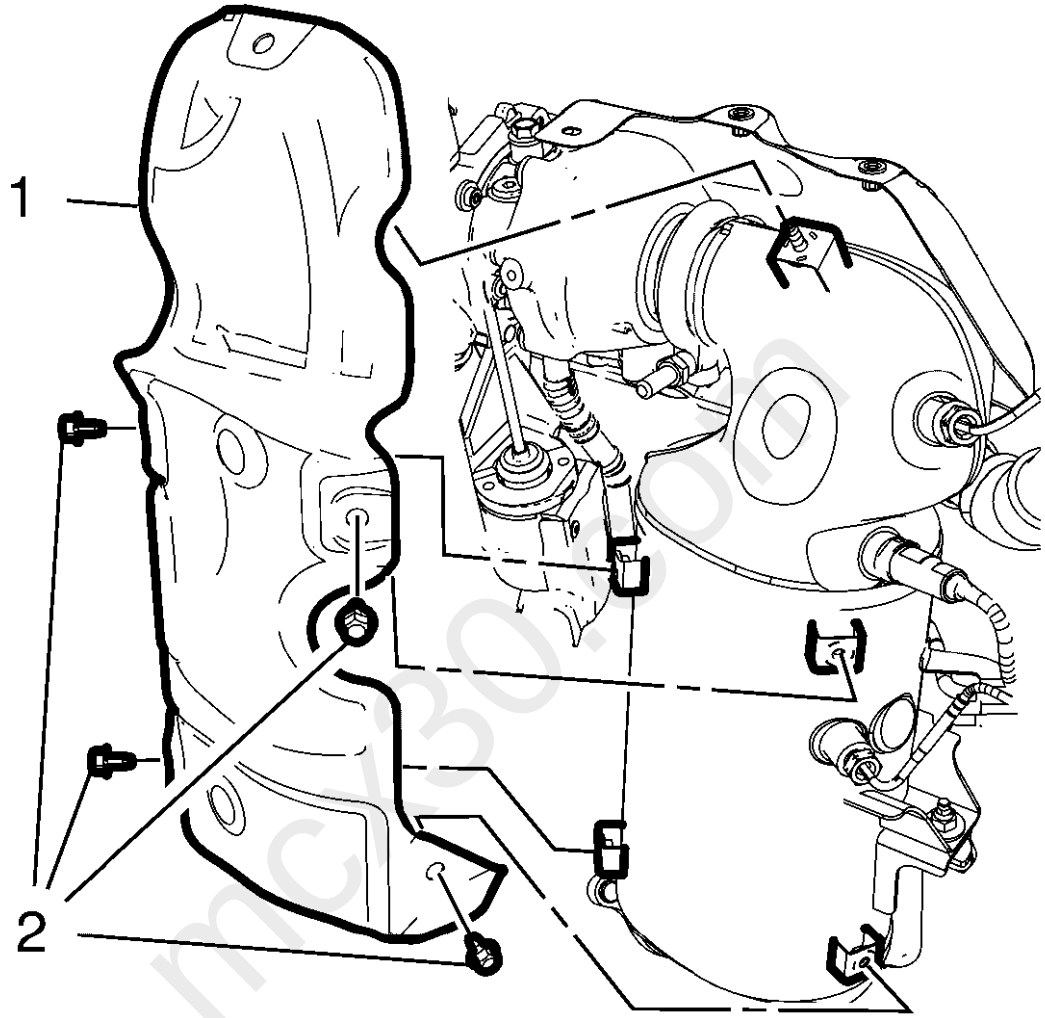


Fig. 944: Catalytic Converter Heat Shield And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the catalytic converter heat shield (1).

CAUTION: Refer to Fastener Caution .

2. Install the 4 catalytic converter heat shield bolts (2) and tighten to 9 N.m (80 lb in).

TURBOCHARGER HEAT SHIELD INSTALLATION

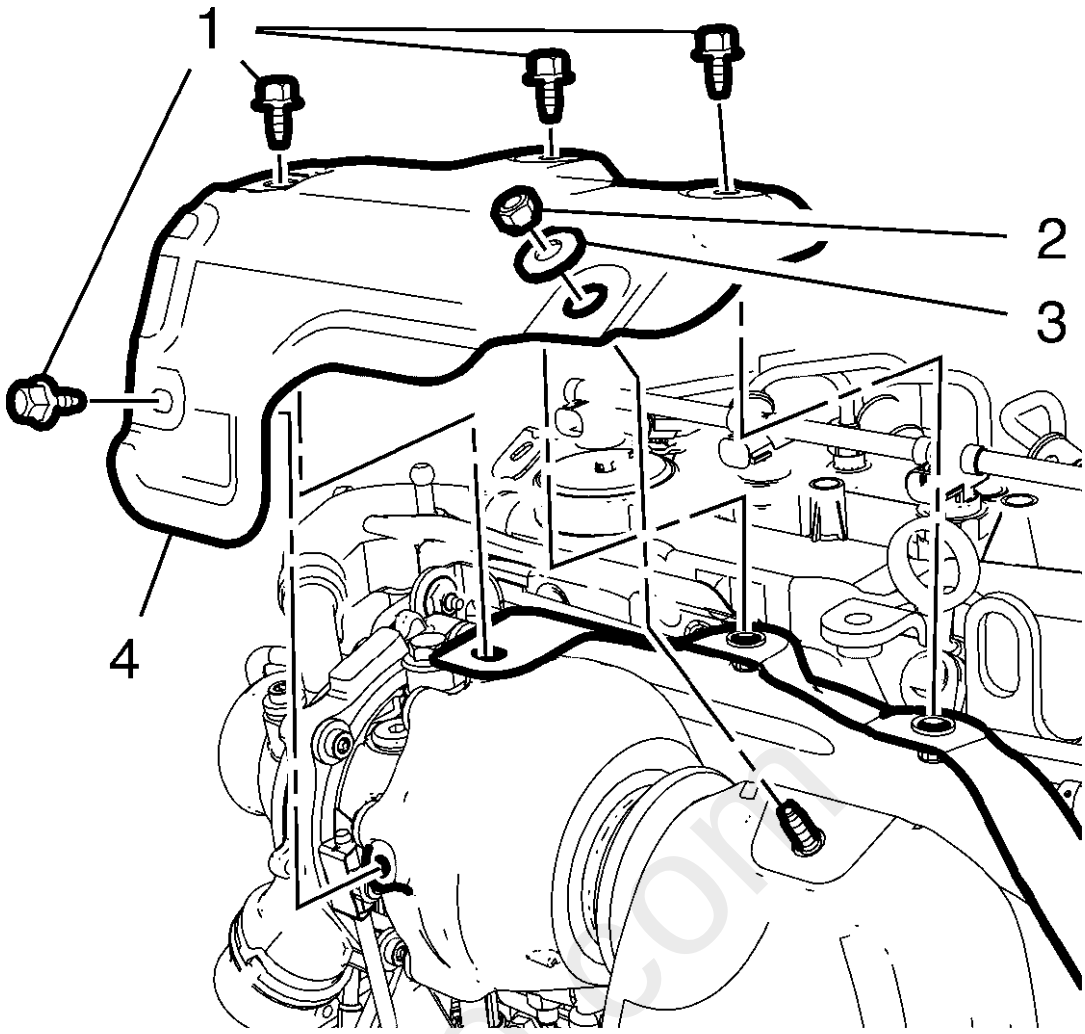


Fig. 945: Turbocharger Heat Shield, Bolts, Nut And Washer
Courtesy of GENERAL MOTORS COMPANY

1. Install the turbocharger heat shield (4).
2. Install the turbocharger heat shield washer (3).

CAUTION: **Refer to Fastener Caution .**

3. Install the 4 turbocharger heat shield bolts (1) and tighten to 9 N.m (80 lb in).
4. Install the turbocharger heat shield nut (2) and tighten to 9 N.m (80 lb in).

CRANKSHAFT PULLEY INSTALLATION

Special Tools

- **EN-956-1** Extension
- **EN-45059** Angle Meter
- **EN-49979** Crankshaft Holder
- **EN-49979-100** Crankshaft Holder Pins

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

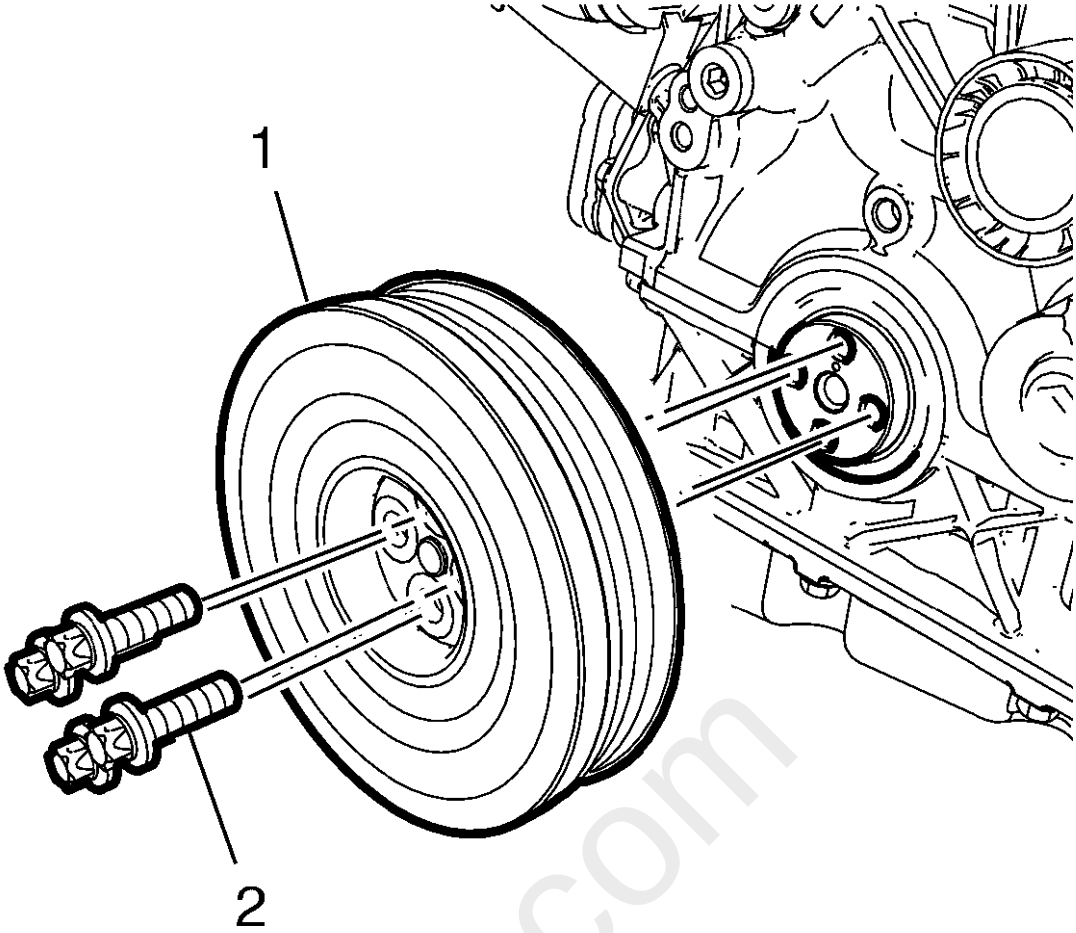


Fig. 946: Crankshaft Pulley And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the crankshaft pulley (1).
2. Pre-install the 4 NEW crankshaft pulley bolts (2).

mcx30.com

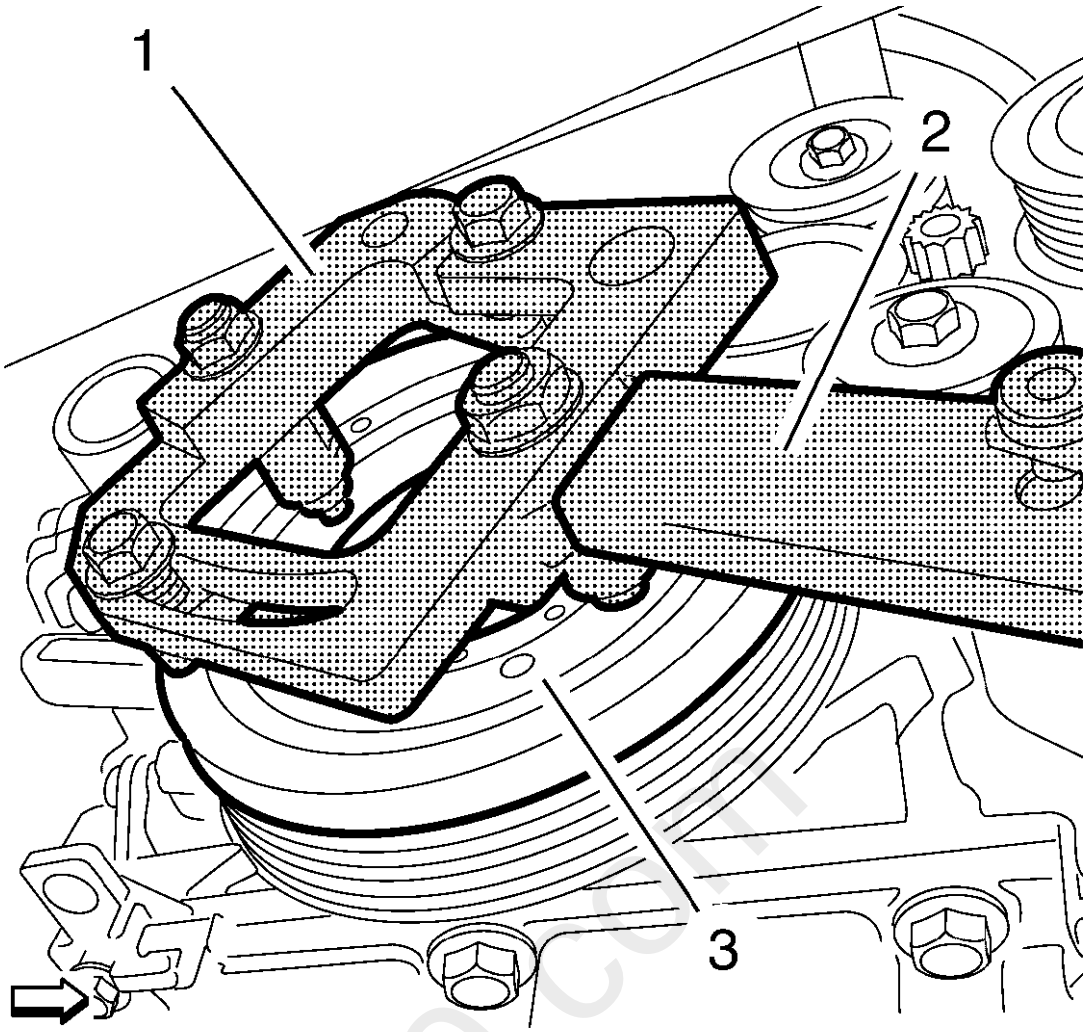


Fig. 947: Crankshaft Holder, Pins, Extension And Crankshaft Pulley
Courtesy of GENERAL MOTORS COMPANY

3. Install the **EN-49979** holder (1) in compound with the **EN-49979-100** pins and the **EN-956-1** extension (2) to counterhold the crankshaft pulley (3).

mox30.com

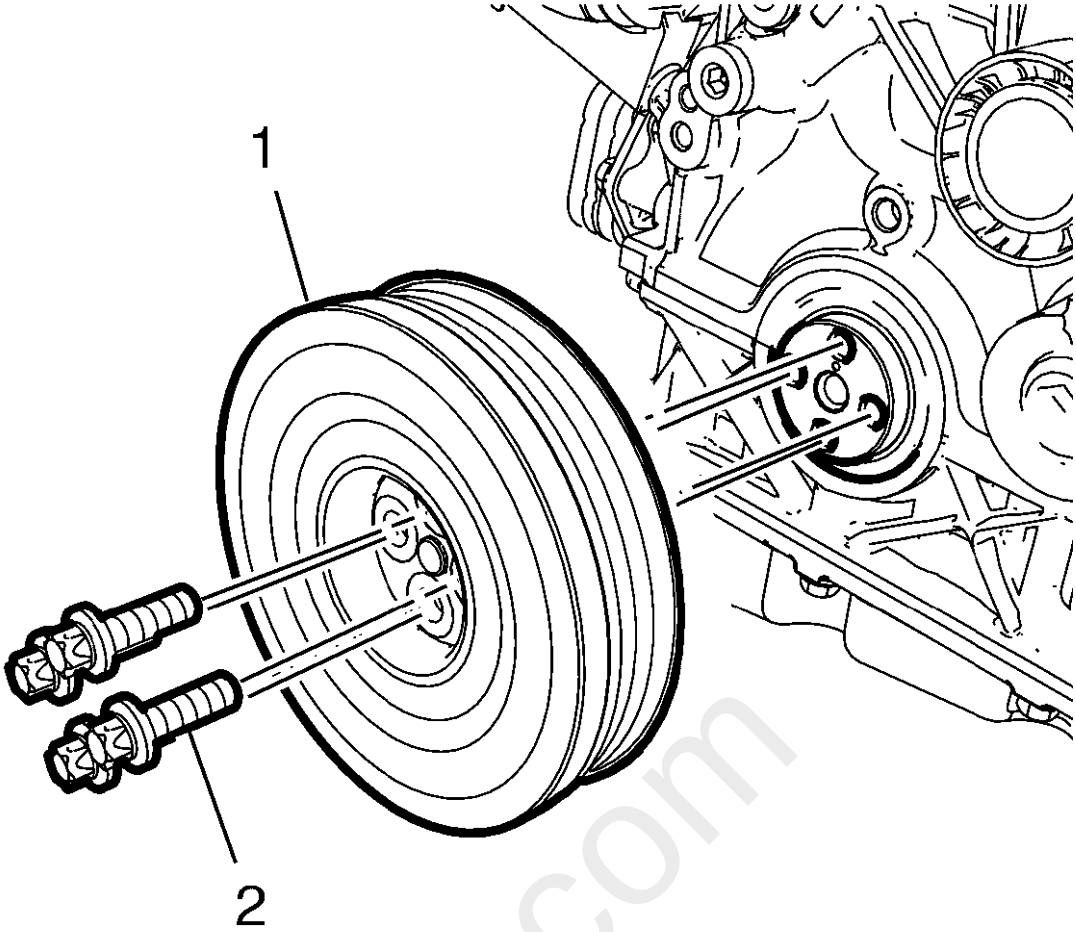


Fig. 948: Crankshaft Pulley And Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

CAUTION: **Refer to Torque-to-Yield Fastener Caution .**

4. Install the 4 crankshaft pulley bolts (2) and tighten in first pass to 50 N.m (37 lb ft).
5. Tighten in final pass to 45 degrees, use the **EN-45059** meter.

DRIVE BELT TENSIONER INSTALLATION

mcx30.com

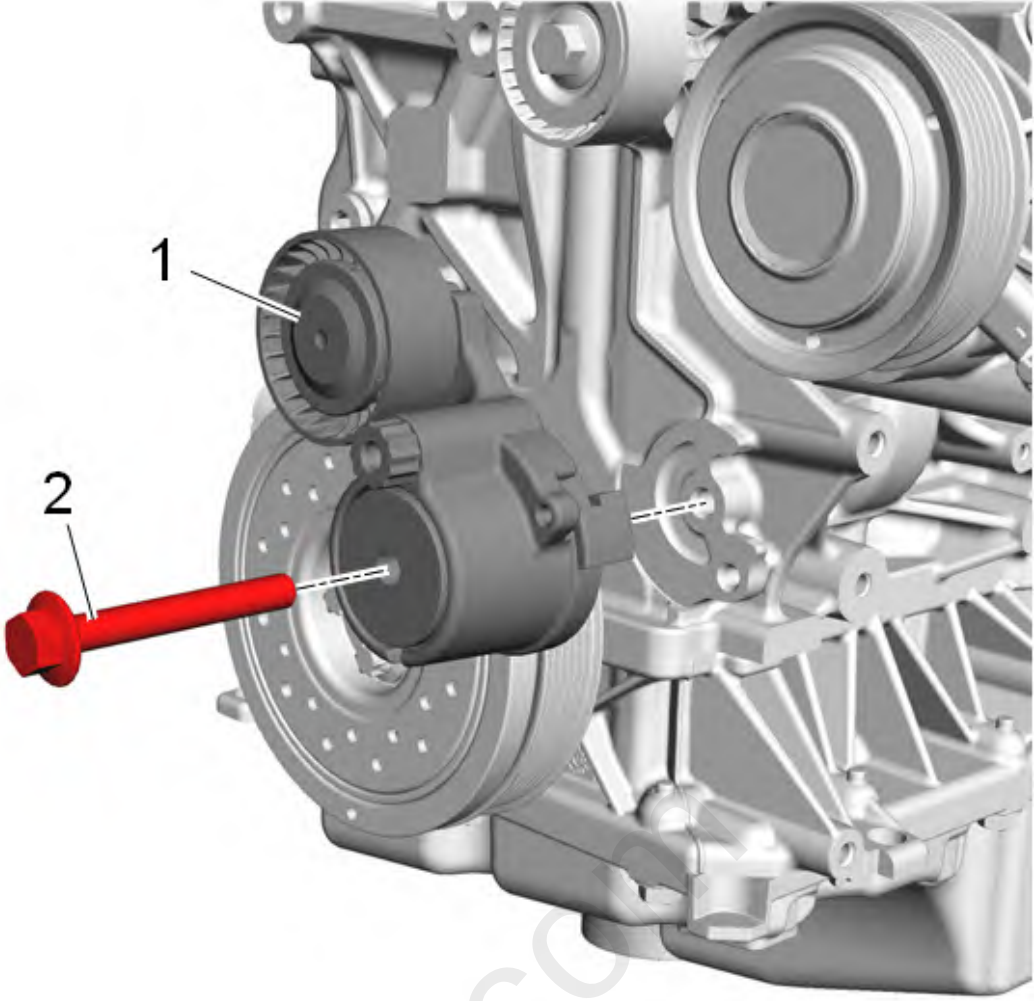


Fig. 949: Drive Belt Tensioner And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install Drive Belt Tensioner (1)

CAUTION: **Refer to Fastener Caution**

2. Install and tighten Drive Belt Tensioner Bolt (2) to 58 N.m (43 lb ft)

BELT IDLER PULLEY INSTALLATION

mcx30.com

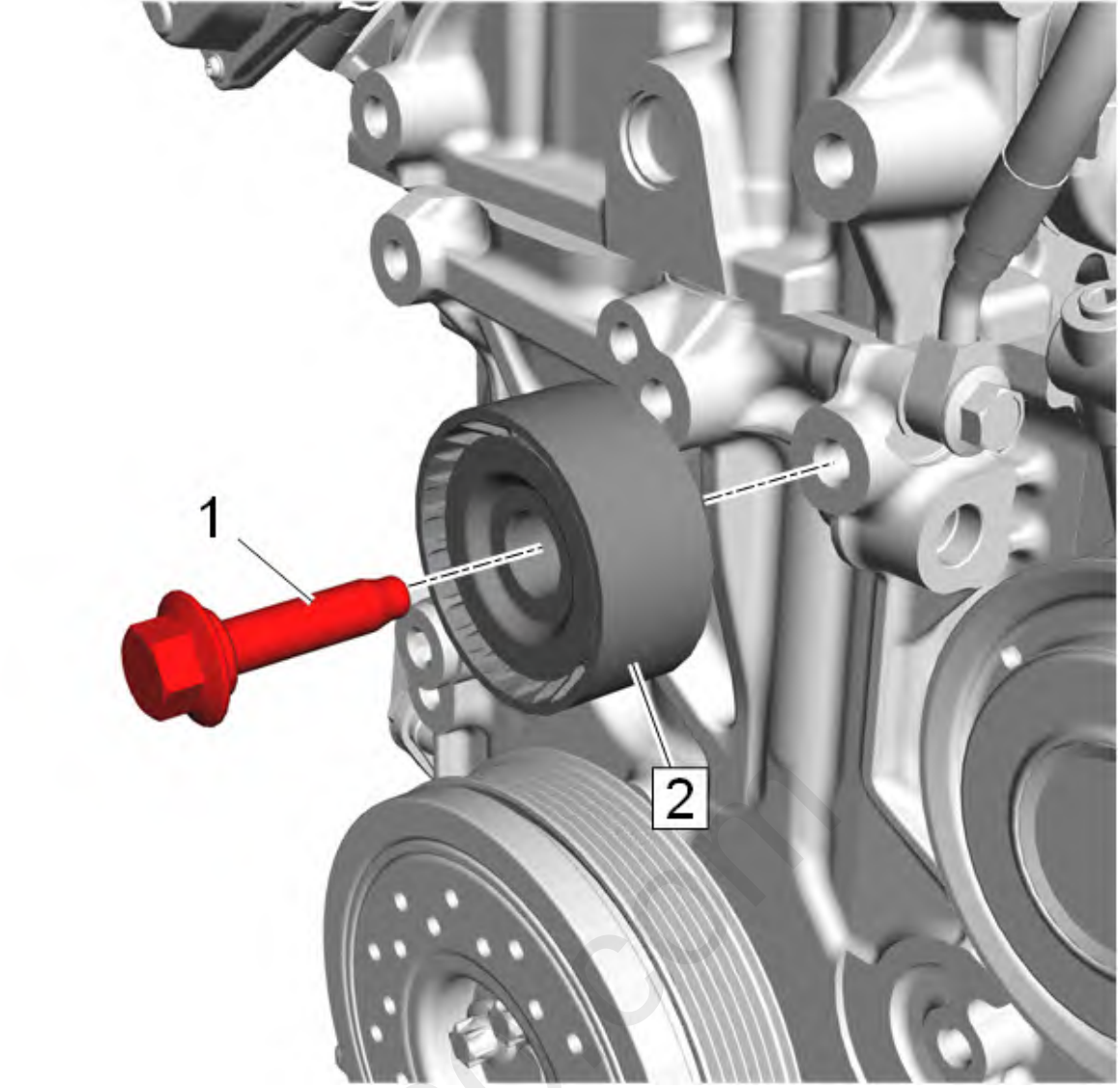


Fig. 950: Drive Belt Idler Pulley And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the drive belt idler pulley (2).

CAUTION: **Refer to Fastener Caution .**

2. Install the drive belt idler pulley bolt (1) and tighten to 58 N.m (43 lb ft).

ENGINE MOUNT BRACKET INSTALLATION

Special Tools

EN-45059 Angle Meter

Equivalent regional tools: **Special Tools**

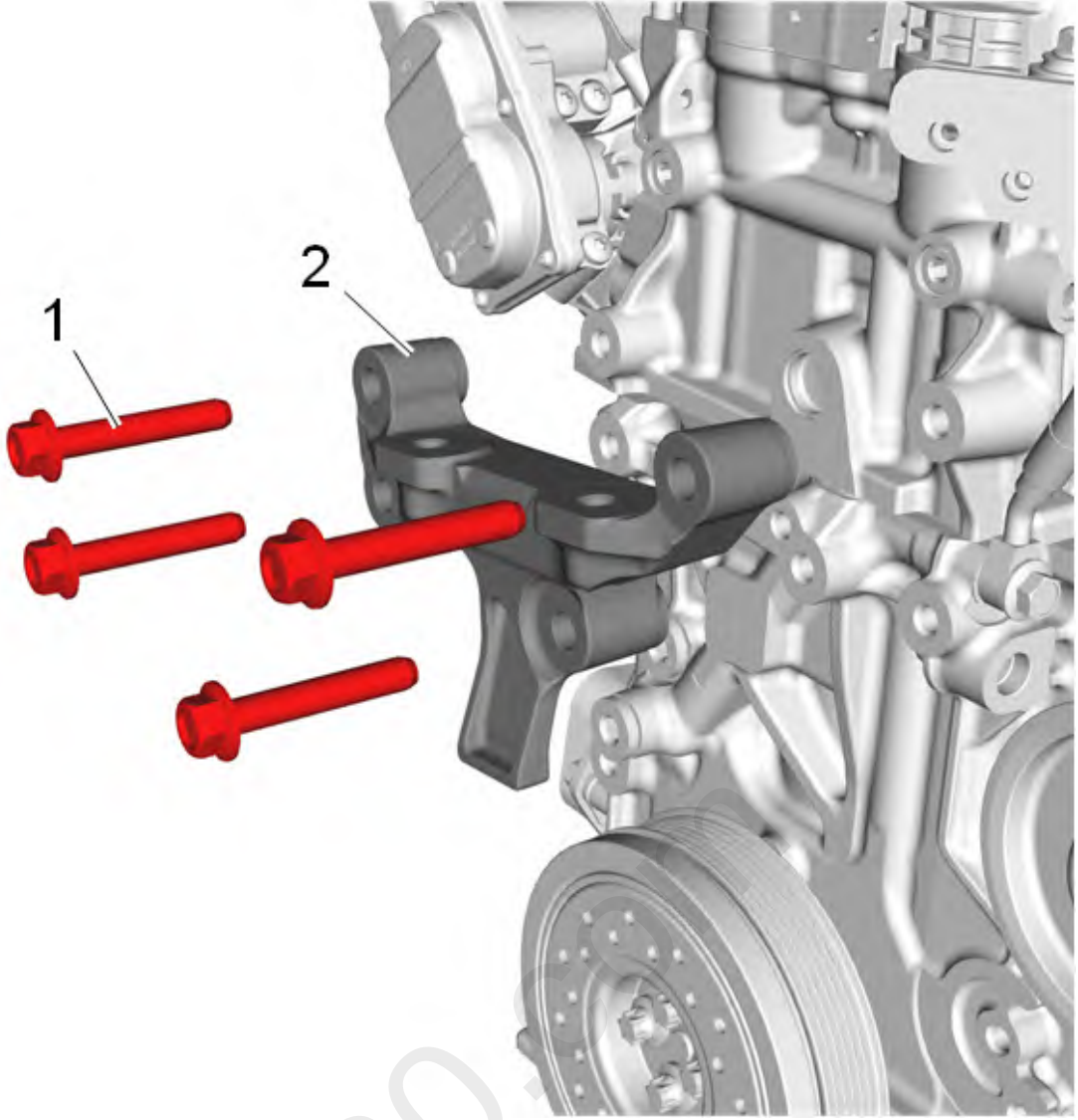


Fig. 951: Engine Mount Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install Engine Mount Bracket (2)

   CAUTION: **Refer to Fastener Caution**

2. Install NEW Engine Mount Bracket Bolts (1) (Qty: 4) - Hand tighten

   CAUTION: **Refer to Torque-to-Yield Fastener Caution**

3. Tighten Engine Mount Bracket Bolts (1) (Qty: 4) in sequence
   1. First Pass: 58 N.m (43 lb ft)
   2. Final Pass: 60-75 degrees - Use the special tool: **EN-45059** Angle Meter

DESCRIPTION AND OPERATION

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 pulley
- The accessory drive components
  - The generator
  - The A/C compressor, if equipped

- The water pump

The drive belt is thin so that it can bend backward and has several ribs to match the grooves in the pulleys. The drive belts are made of different types of rubber (chloroprene or EPDM) and have different layers or plays 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.

LUBRICATION DESCRIPTION

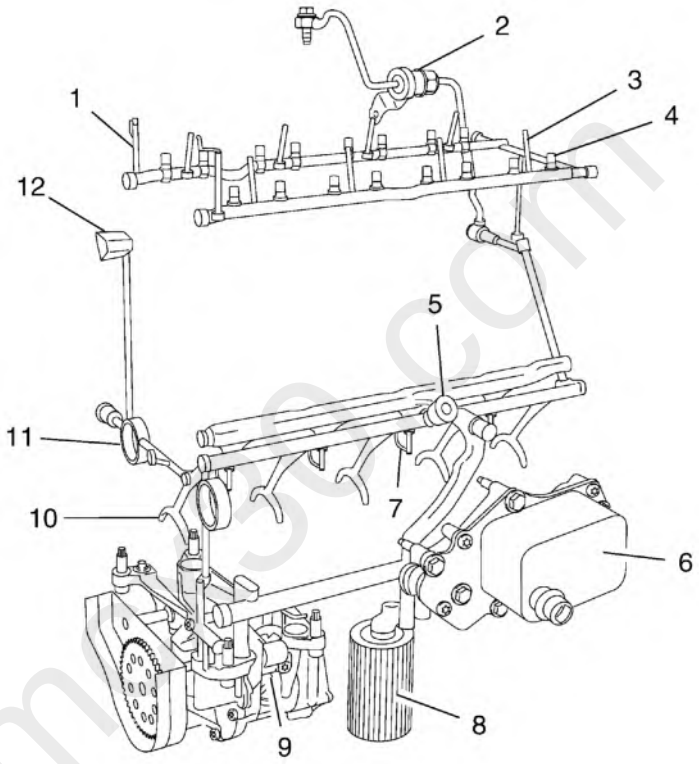


Fig. 952: Engine Lubrication System
Courtesy of GENERAL MOTORS COMPANY

Oil is applied under pressure to the crankshaft bearings (10), connecting rod bearings, balancer bearings (11) (if equipped), piston cooling nozzles (7), camshaft bearings (3), camshaft rear bearings (1) and hydraulic lash adjusters (4). In addition the variable oil pump (9) and hydraulic chain tensioner (12) are supplied with pressurized oil. Oil is sucked from the oil pan through the fixed screen into the variable vane type oil pump. The pump is driven by the oil pump chain and the crankshaft. The piston oil nozzle oil control solenoid valve (5) is fixed at the engine block. The piston oil nozzle oil control solenoid valve close or open the oil passes into the engine oil gallery to the piston oil nozzles (7). The oil cooler (6) is before the oil filter (8), to improve the cleanliness. The pressurized oil from the pump passes through the oil filter. The oil filter is located in the oil pan.

The turbocharger is supplied with oil over the turbocharger oil feed pipe (2), which is installed at the engine block. The turbocharger oil feed pipe including a dedicated filter to reduce the risk of turbo damage. The oil is cleaned by passing the filter from the outer to the inner side of the filter. Then the oil flows into the main oil gallery. The connecting rod bearings are supplied by oil flow passages through the crankshaft connecting the main journals to the rod journals. A groove around each upper main bearing furnishes oil to the drilled crankshaft passages. In the cylinder head the oil is distributed to the chain tensioner, oil pump flow control valve (5) and into the camshaft feed oil gallery. From there the hydraulic valve lifters and camshaft bearings are supplied with oil.

CLEANLINESS AND CARE

An automobile engine is a combination of many machined, honed, polished, and lapped surfaces with tolerances that are measured in ten thousandths of an inch. When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of engine oil should be applied to friction areas during assembly to protect and lubricate the surfaces during initial operation. Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas are part of the repair procedure. This is considered standard shop practice even if not specifically stated.

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

When valve train components are removed for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed.

WARNING: **Unless directed otherwise, the ignition must be OFF with the key removed, 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 OnStarÂ® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStarÂ® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStarÂ® module). Do not disconnect the main vehicle battery or remove the OnStarÂ® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStarÂ® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStarÂ® Back-Up Battery 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 back-up battery is not rechargeable and once activated the back-up battery must be replaced.

Disconnect the negative battery cables before you perform any major work on the engine. For more information on the disconnection of the battery, refer to **Battery Negative Cable Disconnection and Connection (KL9)** .

SEPARATING PARTS

NOTE:

- **Disassembly of the piston, press fit design piston pin, and connecting rod may create scoring or damage to the piston pin and piston pin bore. If the piston, pin, and connecting rod have been disassembled, replace the components as an assembly.**
- **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 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 tappets
- Valve to the valve guide
- Valve spring and shim to the cylinder head location
- Engine block main bearing cap location and direction
- Oil pump drive and driven gears

REPLACING ENGINE GASKETS

Gasket Reuse and Applying Sealants

- 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 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 a suitable tool.
- 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

- 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.
- Do not allow the sealant to enter into any blind threaded holes, as it may prevent the bolt from clamping properly or cause component damage when tightened.
- 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 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.**

- Pipe joint compound is a pliable sealer that does not completely harden. This type 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**.

mcx30.com

- 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. Do not allow the sealer to enter any blind threaded holes, as it may prevent the bolt from clamping properly or cause component damage when the bolt is tightened.
- 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 the bolts.

ENGINE COMPONENT DESCRIPTION

Camshaft

Two camshafts are used, one for all intake valves, the other for all exhaust valves. The camshafts are cast iron. The camshafts are driven by a cam to cam gear. The exhaust camshaft have a split gear.

Crankshaft

The crankshaft is a steel crankshaft with 4 counterweights. It is supported in 5 main journals with main bearings which have oil clearance for lubricating. The 3rd bearing of the 5 main bearing is the thrust bearing where the crankshaft has properly axial end play. A crankshaft balancer is used to control torsional vibration.

Cylinder Block

The cylinder block is a light weight aluminum block and the cap inserts are a nodular cast iron. The block has 5 crankshaft bearings with the thrust bearing located on the third bearing from the front of the engine.

Cylinder Head

This cylinder head is double over head camshaft (DOHC) type and has 2 camshafts that open 4 valves per cylinder with the finger followers with roller type and the valve bridges. Because of the cam follower of the hydraulic type, it does not need to adjust of valve clearance. The cylinder head is made of cast aluminum alloy for better strength in hardness with light weight. The combustion chamber of plate type of the cylinder head is designed for increasing of squish and swirl efficiency and then this is maximized to diesel combustion efficiency.

Exhaust Manifold

The exhaust manifold is located to the cylinder head and send the turbocharger the exhaust gas out of the combustion chamber. It is designed to endure on high pressure and high temperature.

Intake Manifold

The intake manifold is air flow passage to the cylinder combustion chamber through the throttle body and has an effect on engine torque, power, noise, driveability, emission, fuel economy and performance. It is made of plastic for better strength in hardness with light.

Oil Pan

The oil pan includes the oil suction pipe, this pipe is connected with the oil pump. The oil pan is attached at the lower crankcase.

Oil Pump

The oil pump is a variable displacement oil pump with a integrated power brake booster vacuum pump. The oil pump draws engine oil from the oil pan and feeds it under pressure to the various parts of the engine. An oil strainer is mounted before the inlet of the oil pump to remove impurities which could clog or damage the oil pump or other engine components. When the crankshaft rotates, the oil pump driven gear rotates. This causes the space between the gears to constantly open and narrow, pulling oil in from the oil pan when the space opens and pumping the oil out to the engine as it narrows. At high engine speeds, the oil pump supplies a much higher amount of oil than required for lubrication of the engine. The oil pressure regulator prevents too much oil from entering the engine lubrication passages.

Positive Crankcase Ventilation System

The positive crankcase ventilation (PCV) valve carries the blow-by gas to the turbocharger inlet of the intake system. According to the engine conditions, driving conditions and the pressure of turbocharger, it is different from the amount of blow-by gas. So, the PCV valve controls the amount of blow-by gas.

mcx30.com

Solenoid Injector Fuel Injection System

The fuel injection occurs by a common rail system of the third generation. The fuel pressure goes up to 2000 bar (29008 psi). The solenoid injector fuel injection system is piloted by a closed loop combustion control.

Timing Chain

The Timing chain are installed at the transmission side. A timing chain is used for camshaft drive and a oil pump chain is used for the oil pump drive. There are tensioner to control the tension of camshaft timing chain and a tensioner to control the oil pump chain.

Valve Lash Adjusters

The valve train uses a roller finger follower acted on by a hydraulic lash adjuster. The roller finger follower reduces friction and noise.

Valves

There are 2 intake and 2 exhaust valves per cylinder with "minilash" hydraulic adjusters with roller fingers.

Variable Turbine Geometry Turbocharger

The turbocharger is the device that supplies hot, compressed air, that is from the turbine/impeller created from the passing exhaust gas or ram air, to the engine to increase the power. Quick compressed air from this turbocharger expands with high temperature and causes decreasing of charging efficiency into the cylinder because density of oxygen gets lower. However charging efficiency into the cylinder increases as compressed hot air is cooled and density of air gets higher through the charge air cooler. It brings also higher fuel efficiency as well as lower CO2 emissions. Charge air cooler which is installed on top of radiator in front of car makes compressed hot air cool by airflow through the radiator grill. With the variable turbine geometry turbocharger the boost pressure is optimized in all engine conditions.

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 will 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.

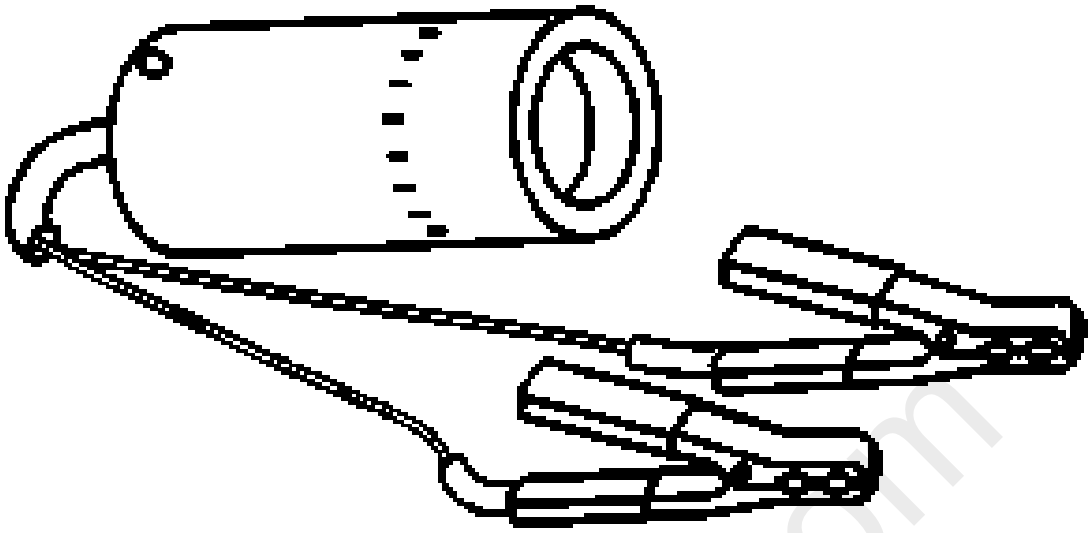
To properly service the engine assembly, the following items should be readily available:

- 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

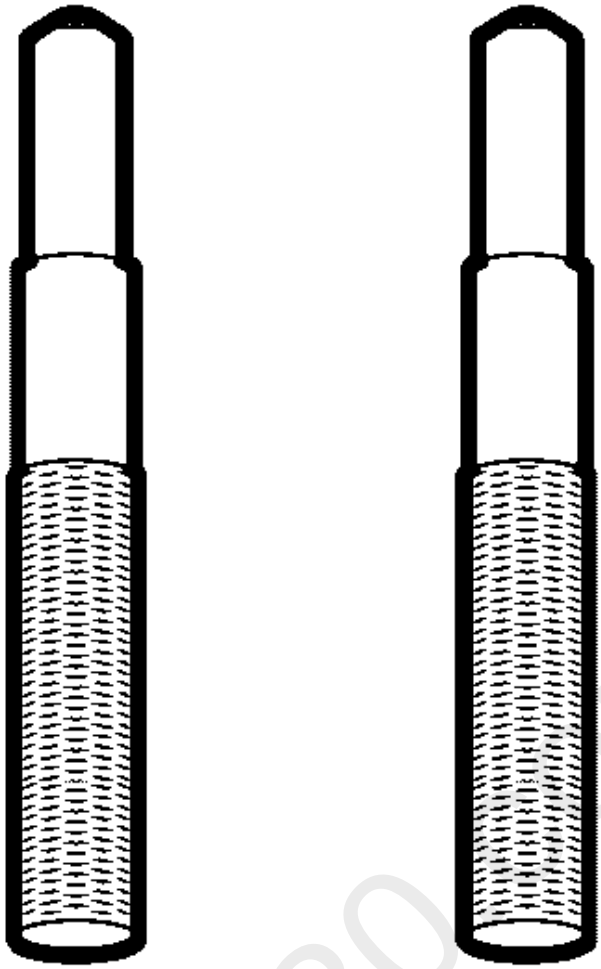
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

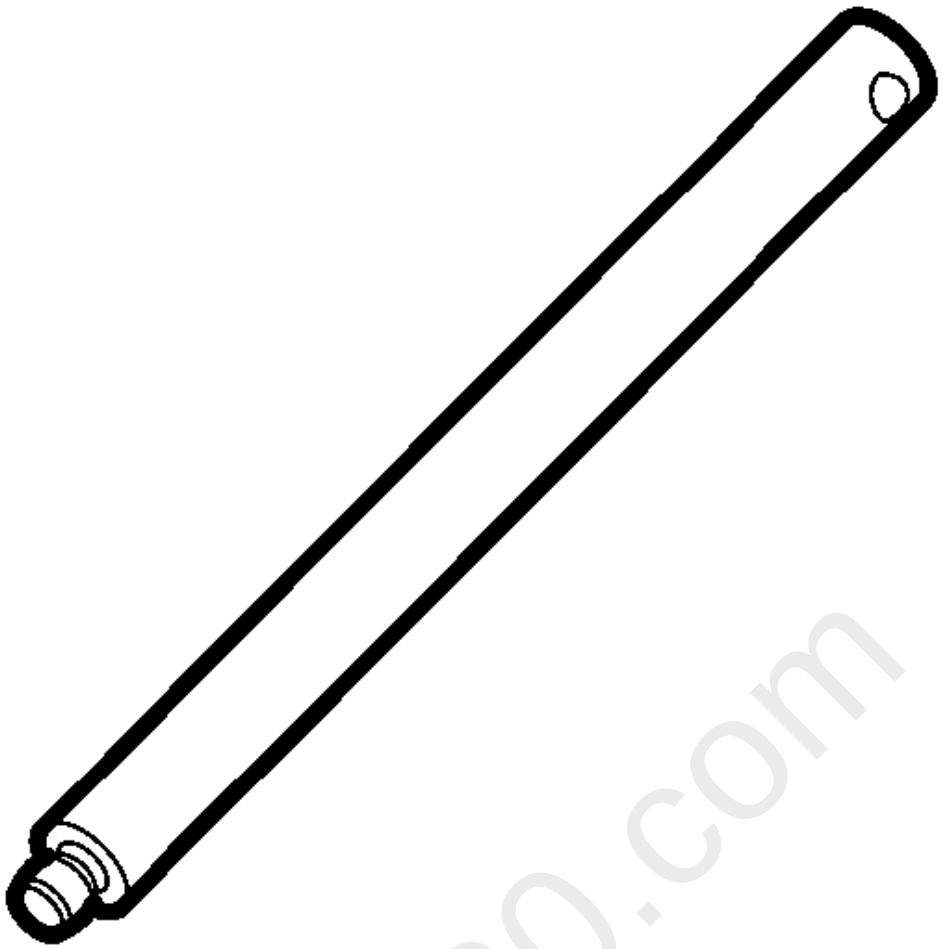
Illustration	Tool Number/Description

Illustration	Tool Number/Description
	BO-42220 J-42220 Universal Leak Detection Lamp

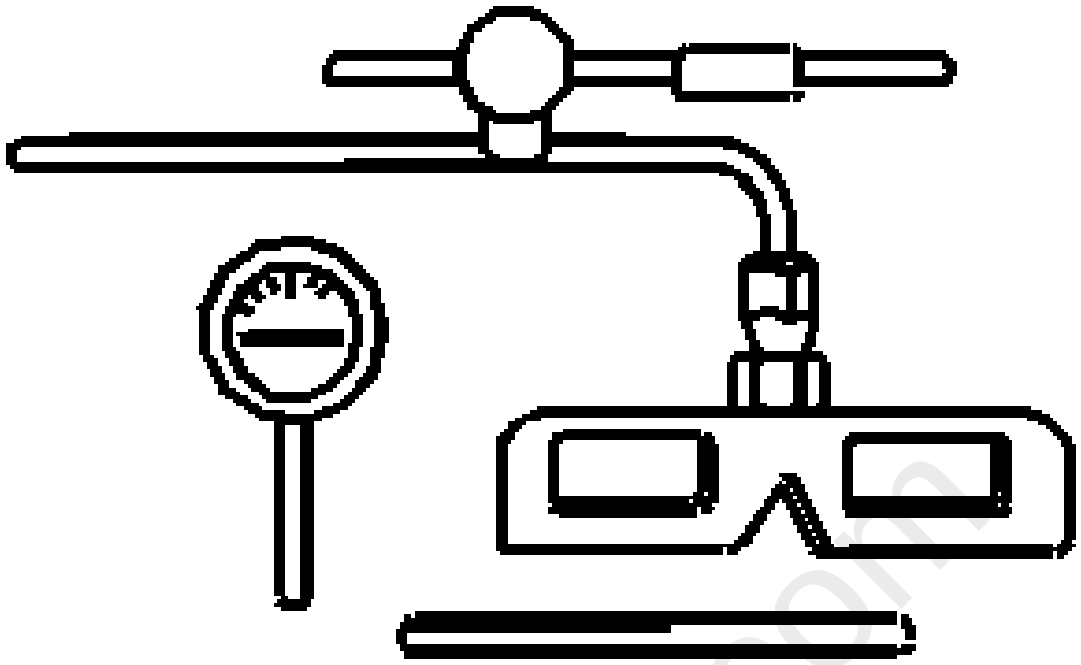
mcx30.com

Illustration	Tool Number/Description
	CH-51034 Guide Pins

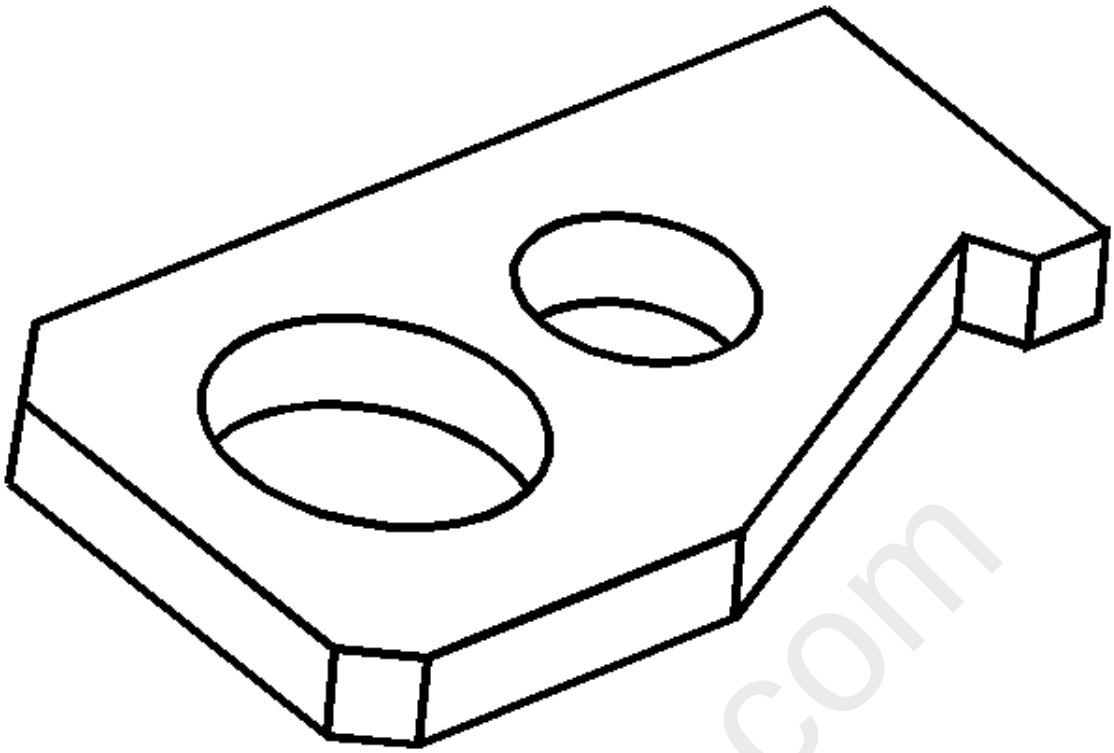
mcx30.com

Illustration	Tool Number/Description
	DT-523-1 KM-523-1 Handle
	GE-7872 J-7872 Magnetic Base Dial Indicator

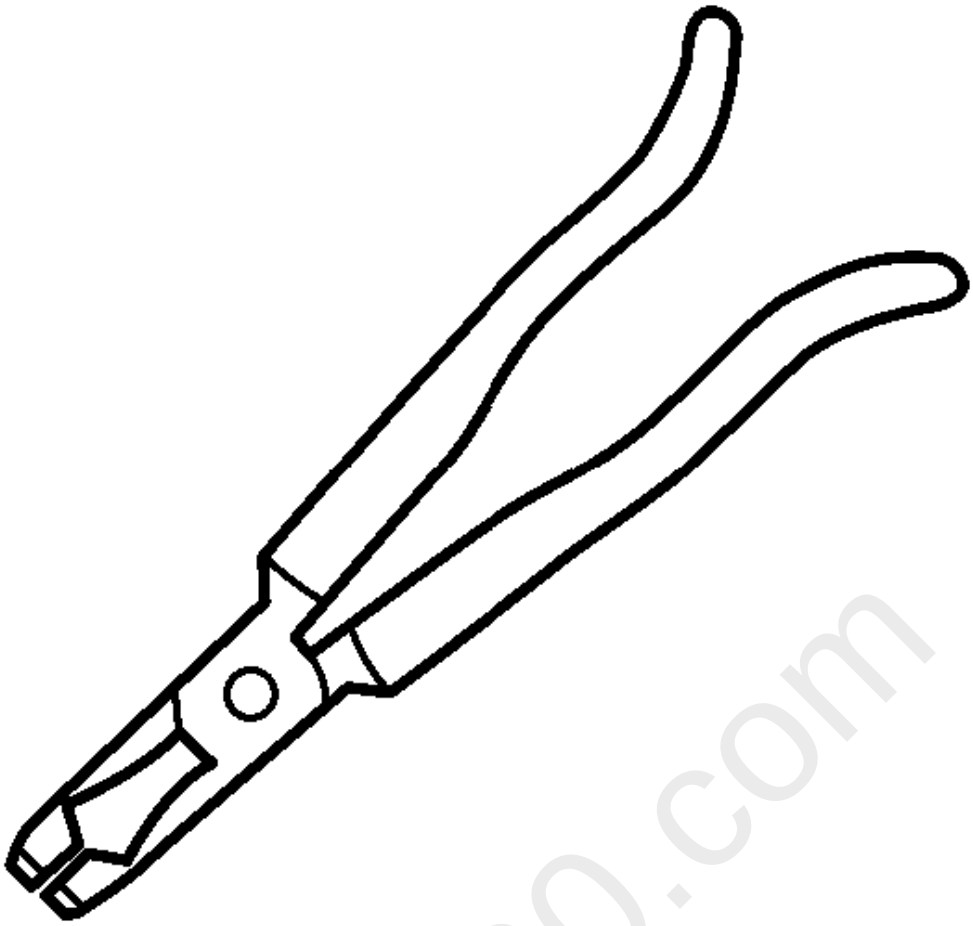
mcx30.com

Illustration	Tool Number/Description
	

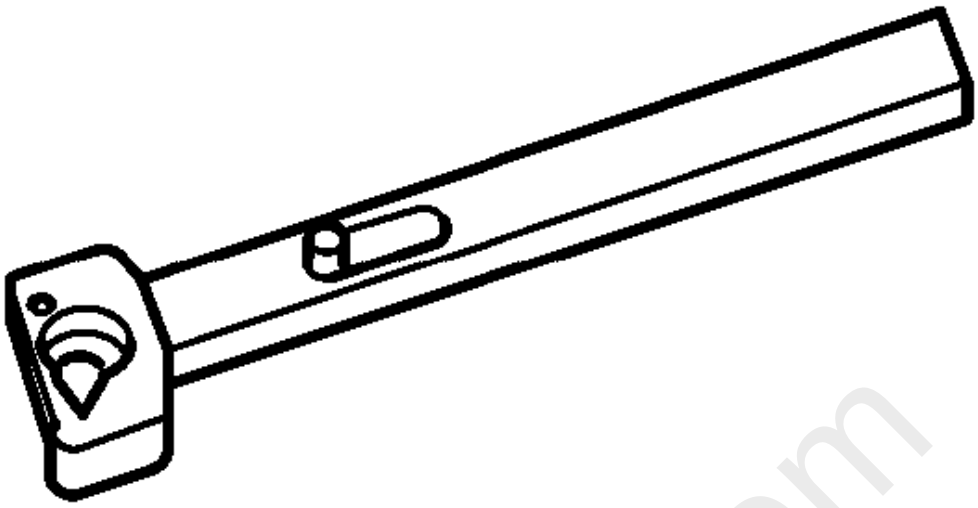
mcx30.com

Illustration	Tool Number/Description
	EN-652 KM-652 Flywheel Holder

mcx30.com

Illustration	Tool Number/Description
	EN-840 KM-840 EN-46116 83 94 157 Pliers Remover

mcx30.com

Illustration	Tool Number/Description
	EN-956-1 KM-956-1 Extension

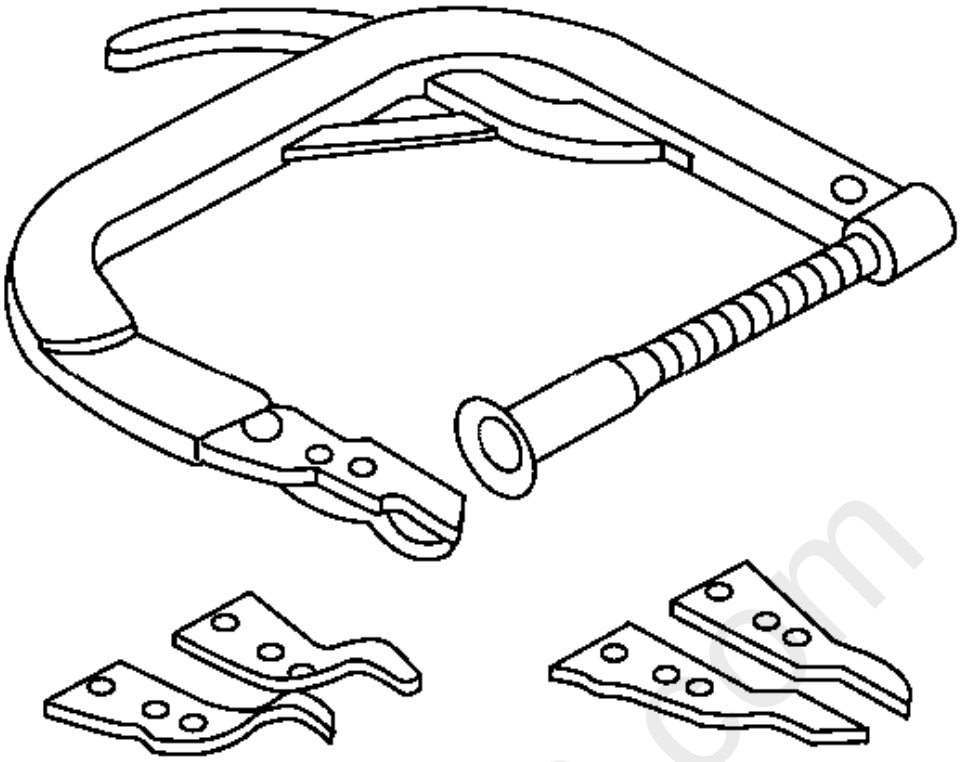
mcx30.com

Illustration	Tool Number/Description
	EN-958 KM-958 Valve Stem Seal Installer

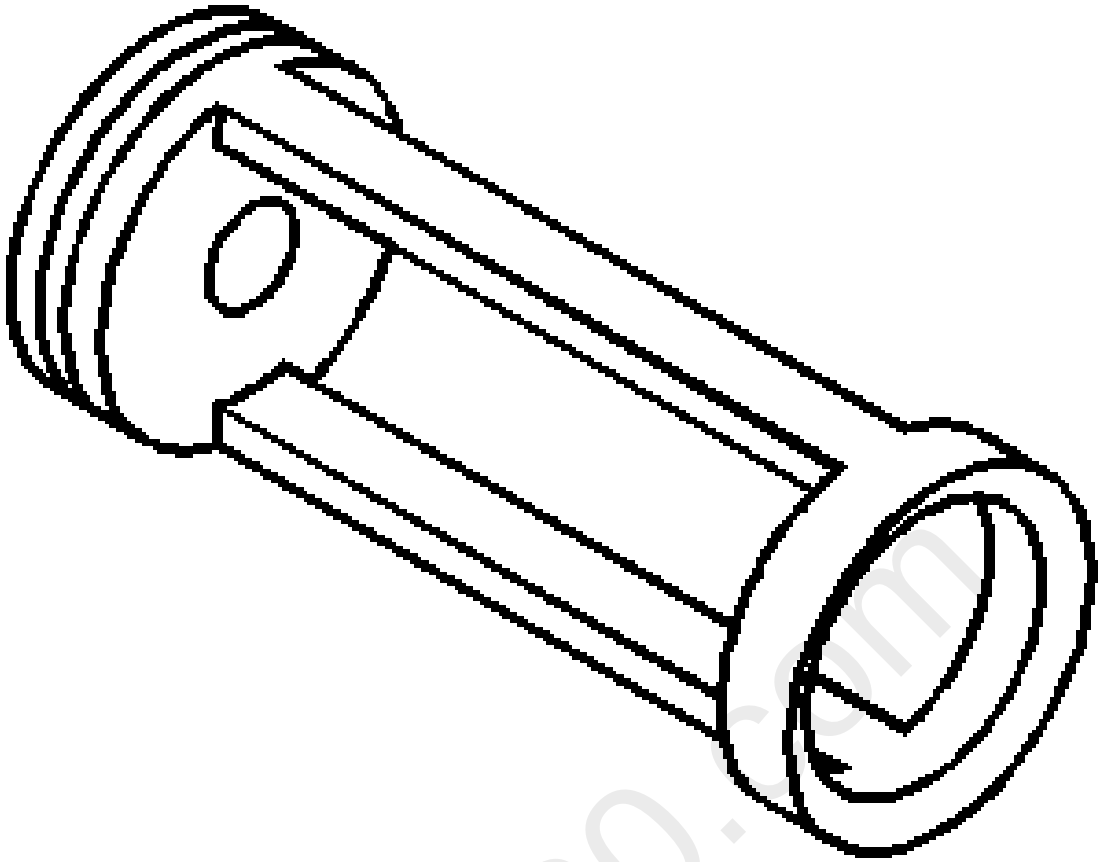
mcx30.com

Illustration	Tool Number/Description
	EN-6104 Glow Plug Remover/Installer

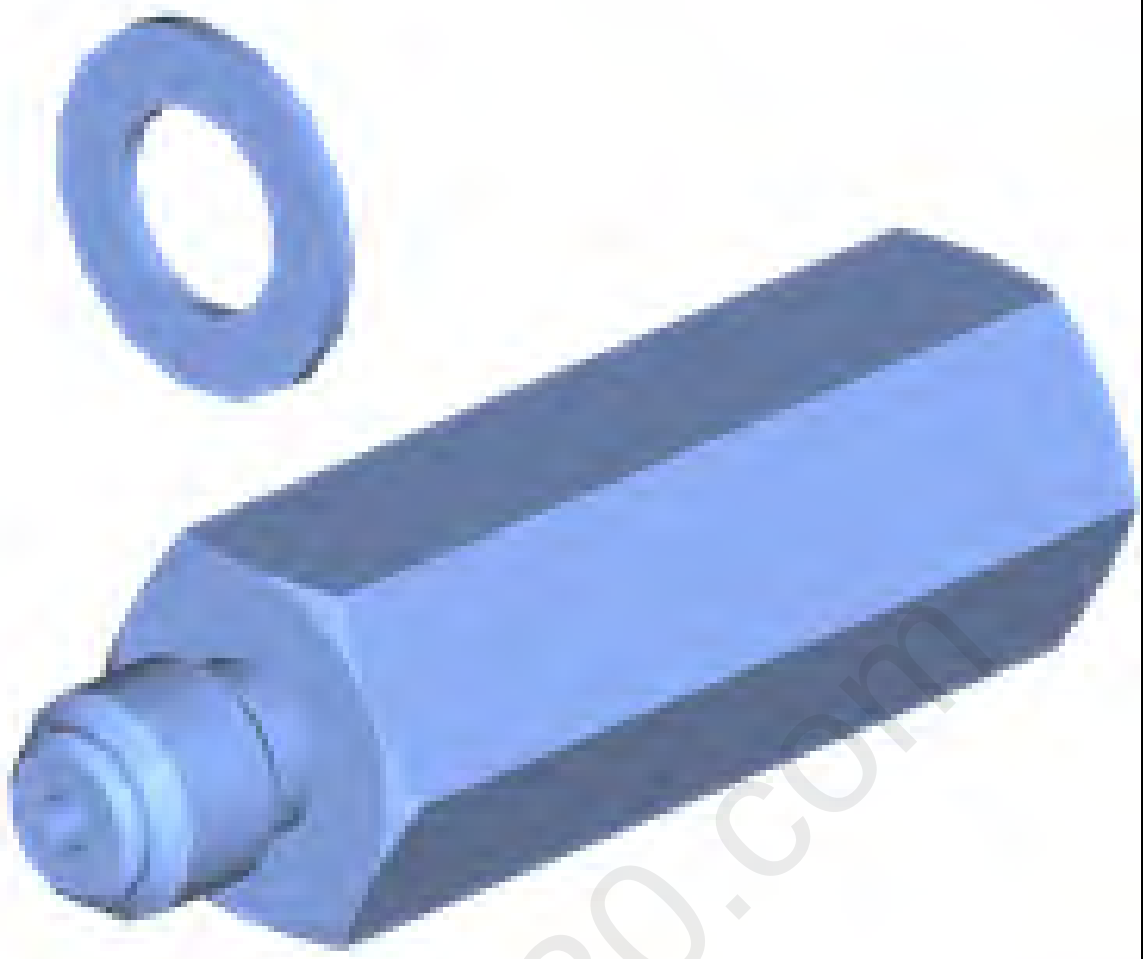
mcx30.com

Illustration	Tool Number/Description
	EN-8062 J8062 Valve Spring Compressor
	EN-43963 J-43963 Valve Spring Compressor Adapter

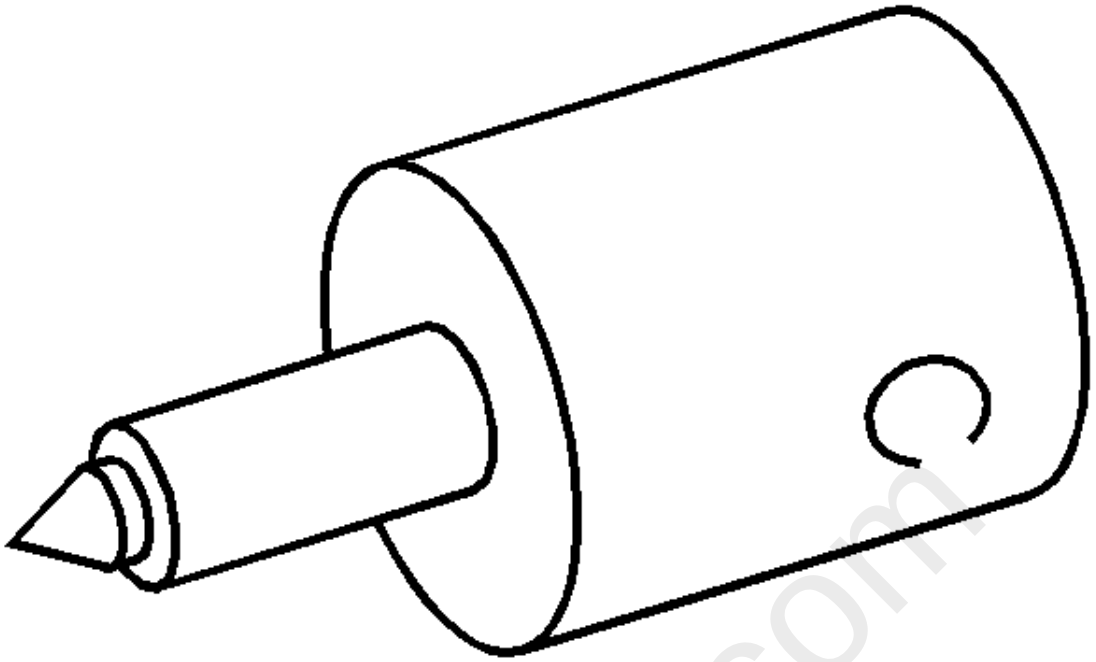
mcx30.com

Illustration	Tool Number/Description
	

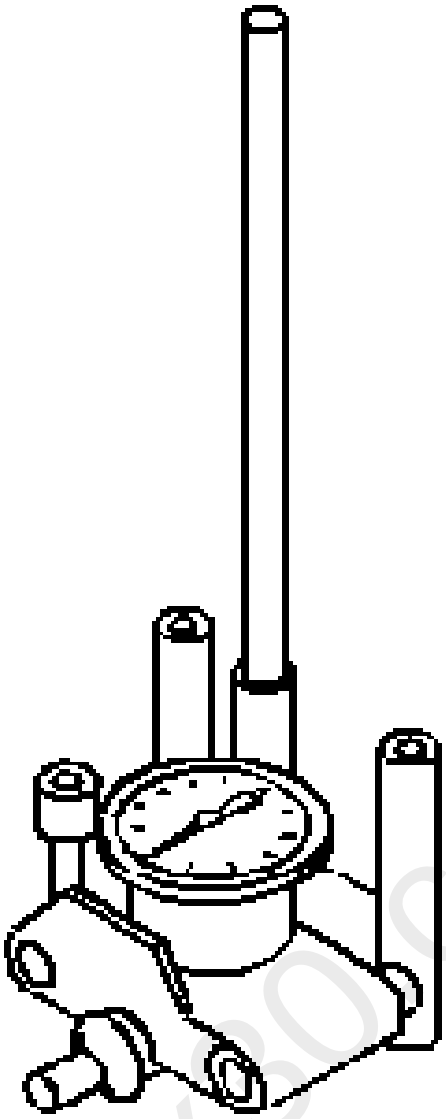
mcx30.com

Illustration	Tool Number/Description
	EN-21867-850 J-21867-850 EN-6106 Oil Pressure Gage Adapter

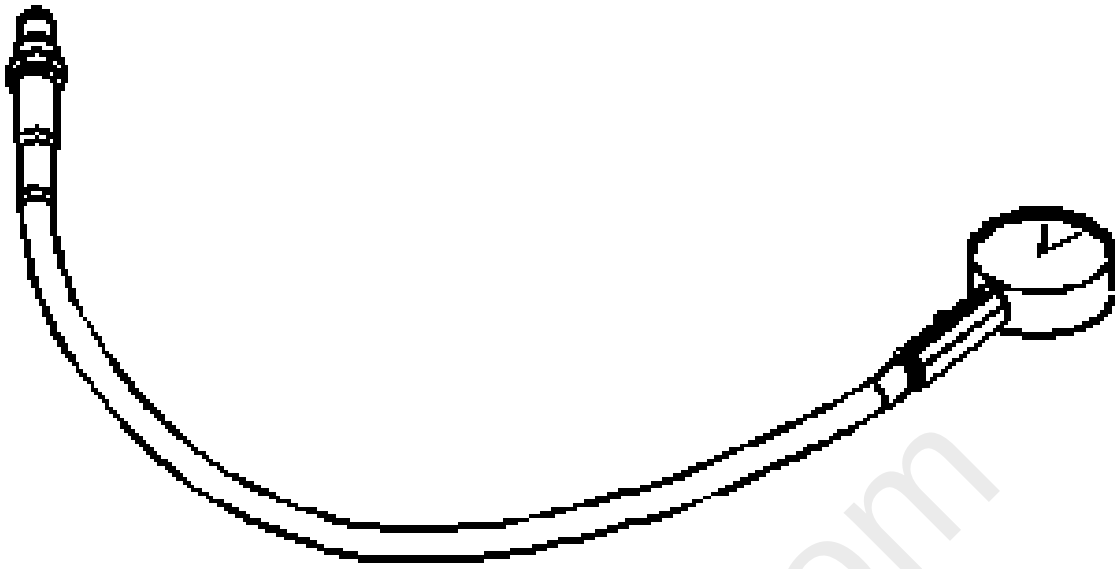
mcx30.com

Illustration	Tool Number/Description
	EN-6624 KM-6624 J-36825-A Seal Remover
	EN-8087 J-8087 Cylinder Bore Gauge

mcx30.com

Illustration	Tool Number/Description
	

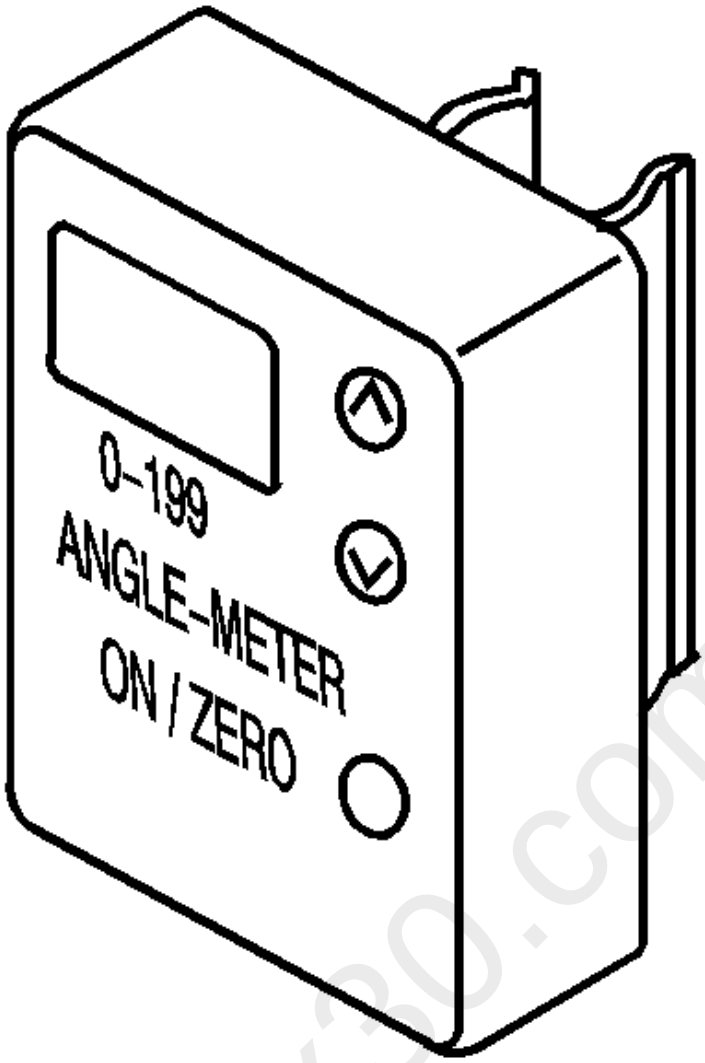
mcx30.com

Illustration	Tool Number/Description
	EN-26999 J-26999 Compression Gauge

mcx30.com

Illustration	Tool Number/Description
	EN-35667-A J-35667-A Cylinder Leakdown Tester

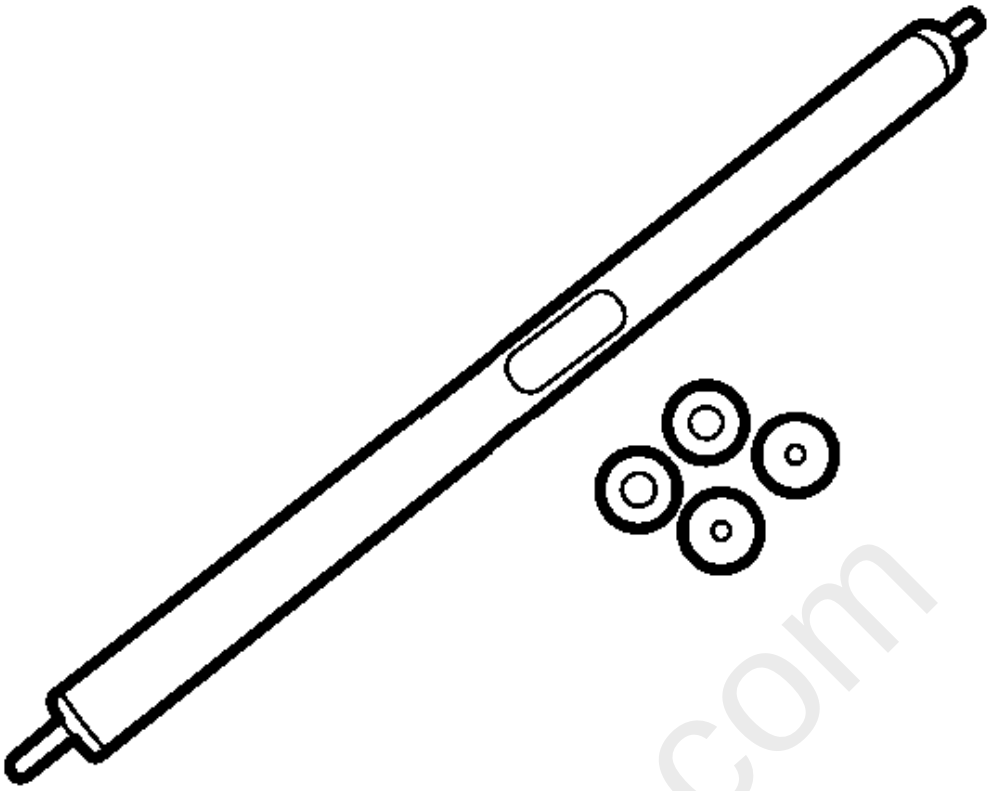
mcx30.com

Illustration	Tool Number/Description
	EN-45059-A J-45059-A Angle Meter

mcx30.com

Illustration	Tool Number/Description
	EN-46116 Valve Stem Seal Remover

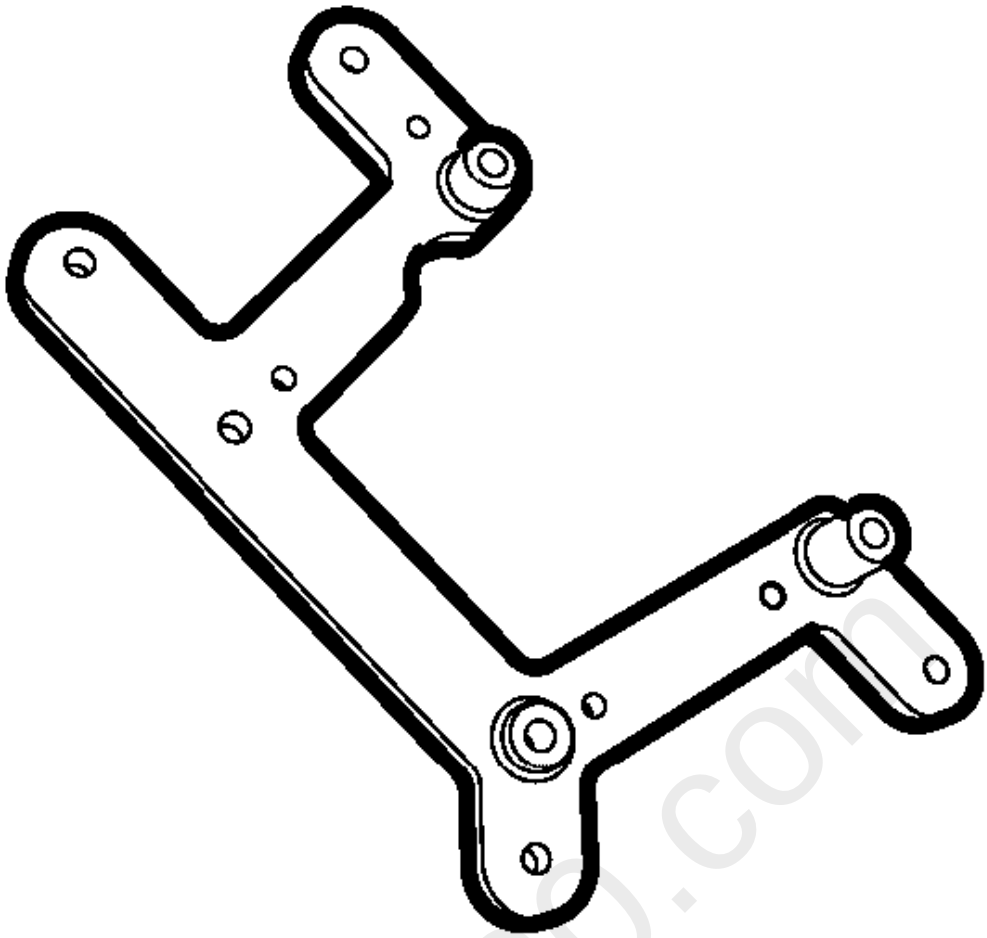
mcx30.com

Illustration	Tool Number/Description
	EN-47632 Injector Cleaning Tool

mcx30.com

Illustration	Tool Number/Description
	EN-49075 Valve Spring Compressor Adapter

mcx30.com

Illustration	Tool Number/Description
	EN-49271-200 Adapter Engine Stand

mcx30.com

Illustration	Tool Number/Description
	EN-49979 Retainer Shock Mount Crankshaft along with EN-49979-100

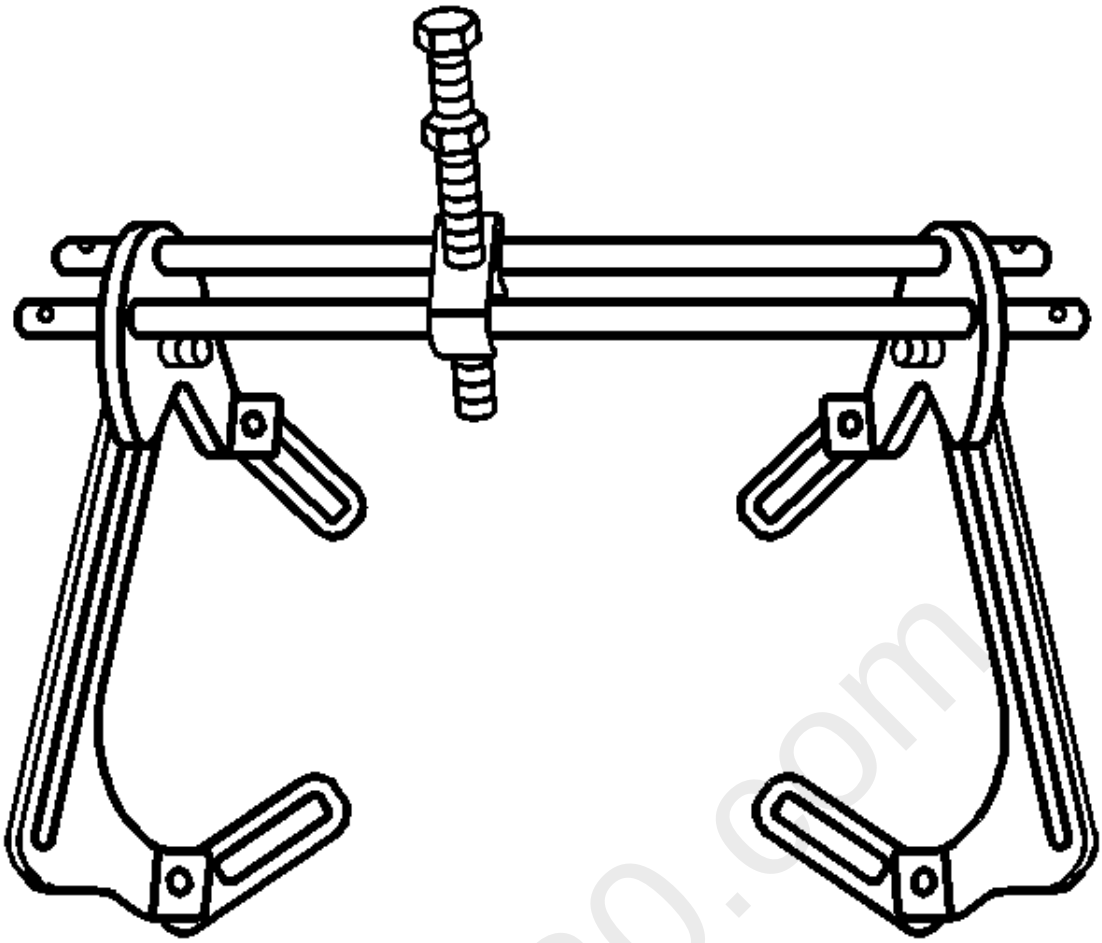
mcx30.com

Illustration	Tool Number/Description
	EN-49979-100 Decoupler Holder Pins along with EN-49979

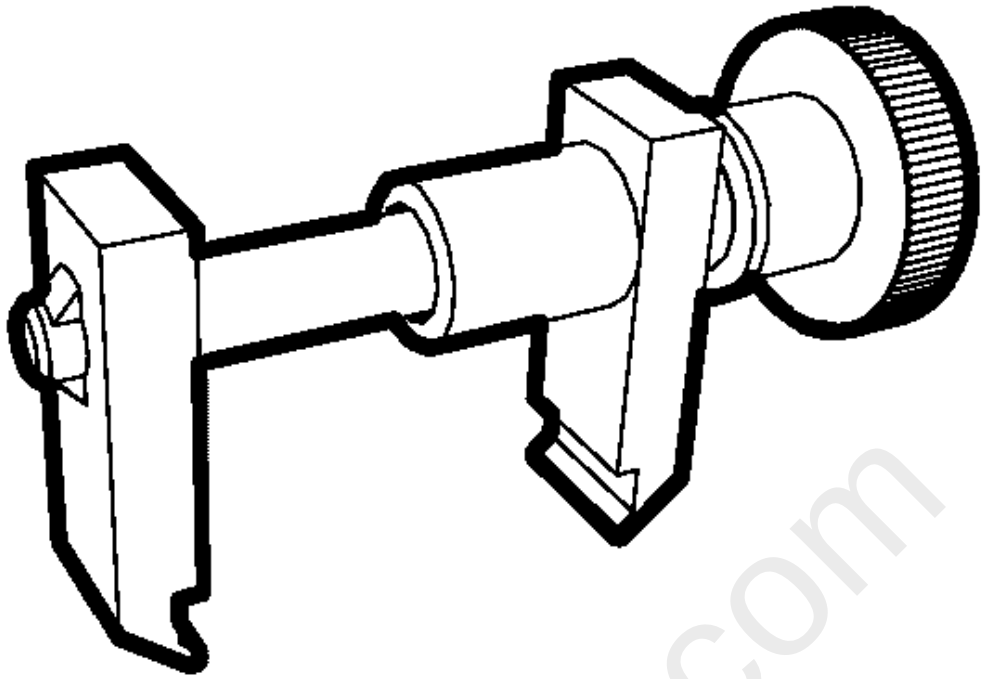
mcx30.com

Illustration	Tool Number/Description
	EN-50513 EN-52234 Locking pin

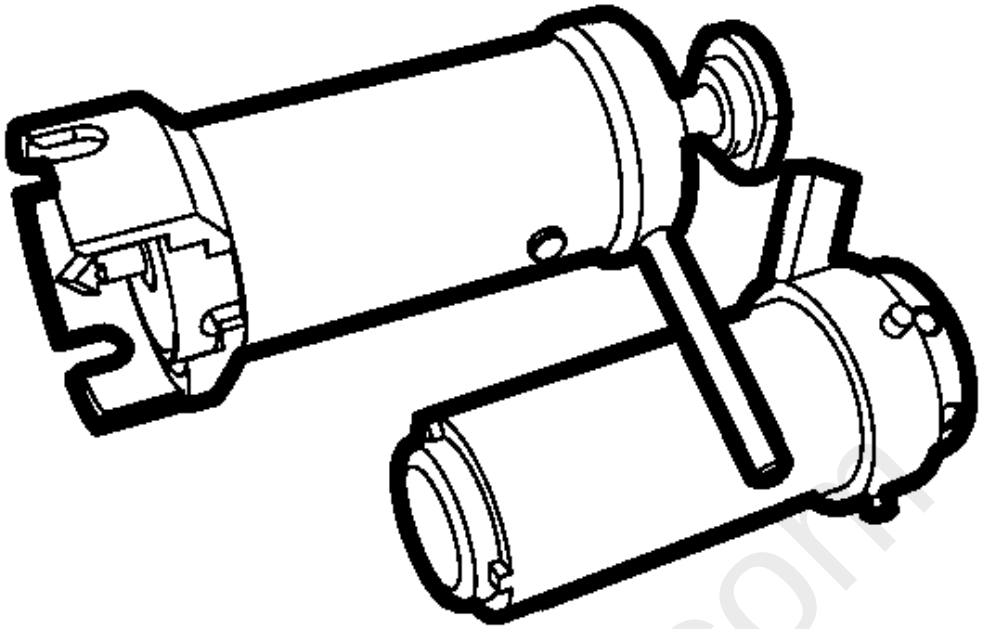
mcx30.com

Illustration	Tool Number/Description
	EN-50173 Universal Valve Spring Compressor

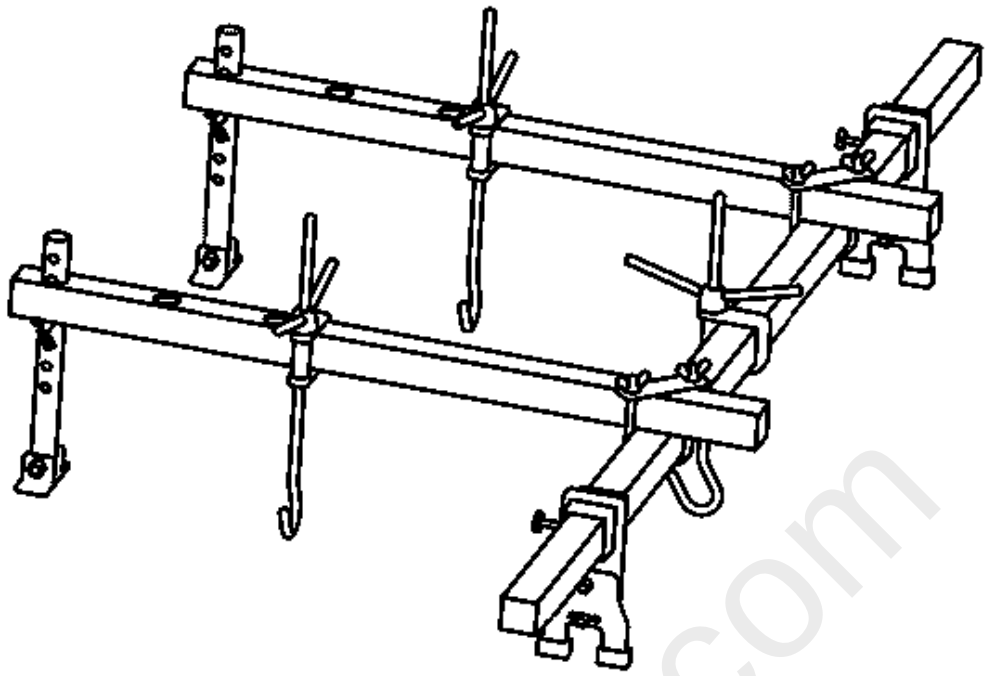
mcx30.com

Illustration	Tool Number/Description
	EN-50509 Fixing Tool

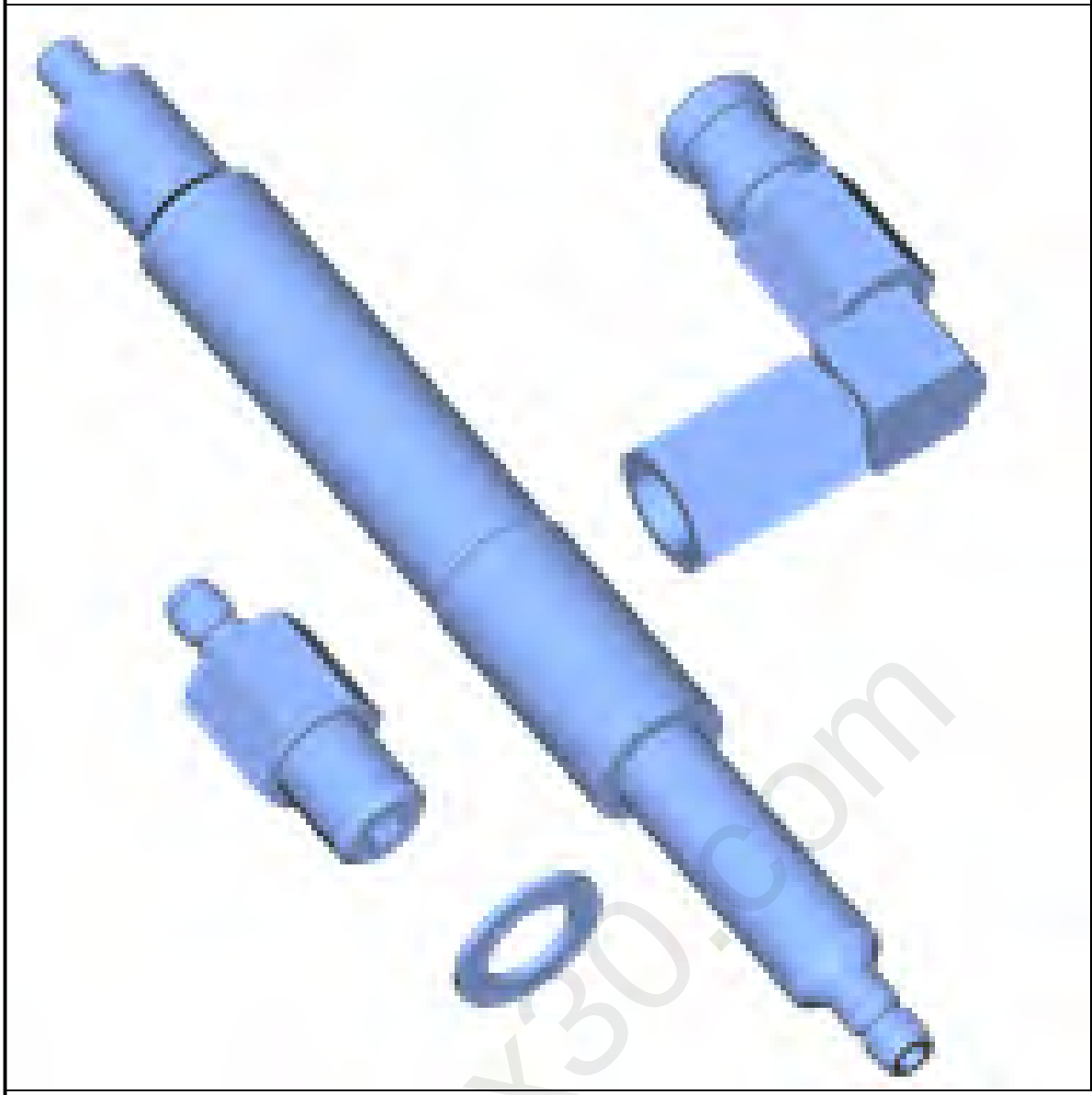
mcx30.com

Illustration	Tool Number/Description
	EN-50885 High Pressure Pump Locking Tool

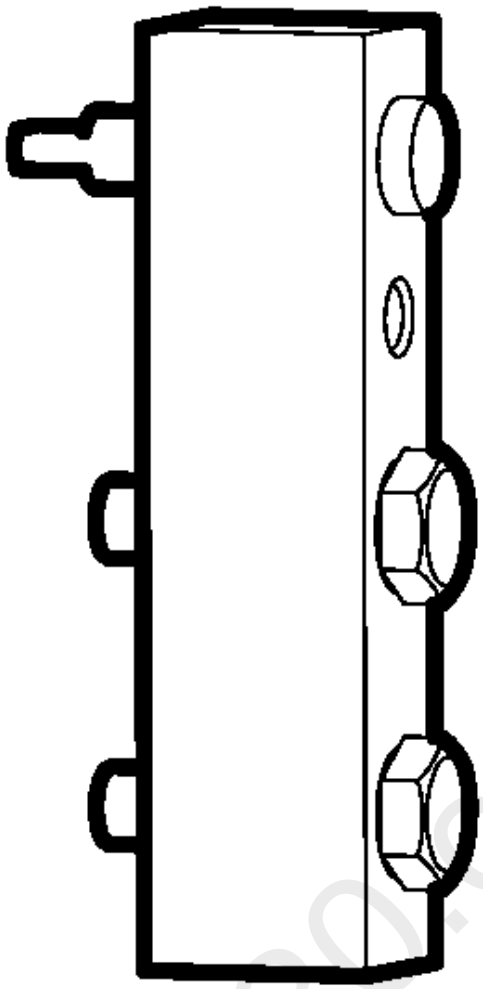
mcx30.com

Illustration	Tool Number/Description
	EN-51007 J-28467-B Engine Support Fixture

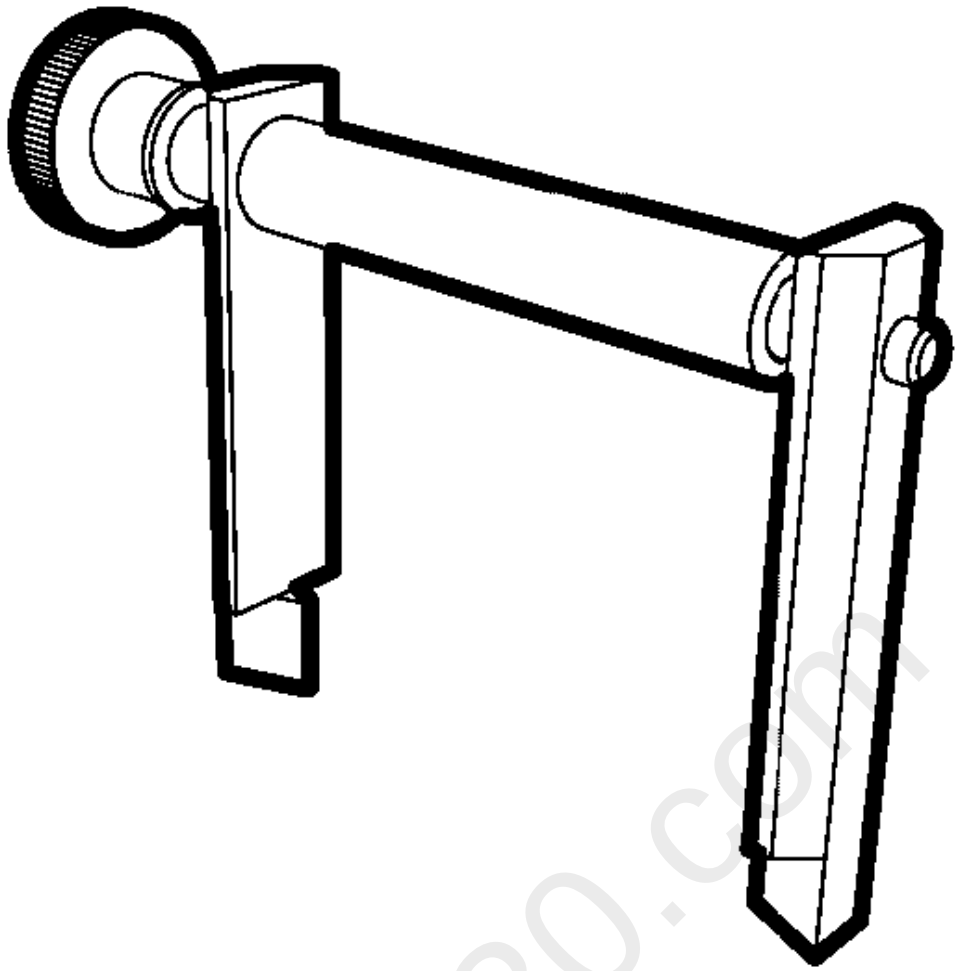
mcx30.com

Illustration	Tool Number/Description
	EN-51110 Compression Tester Adapter

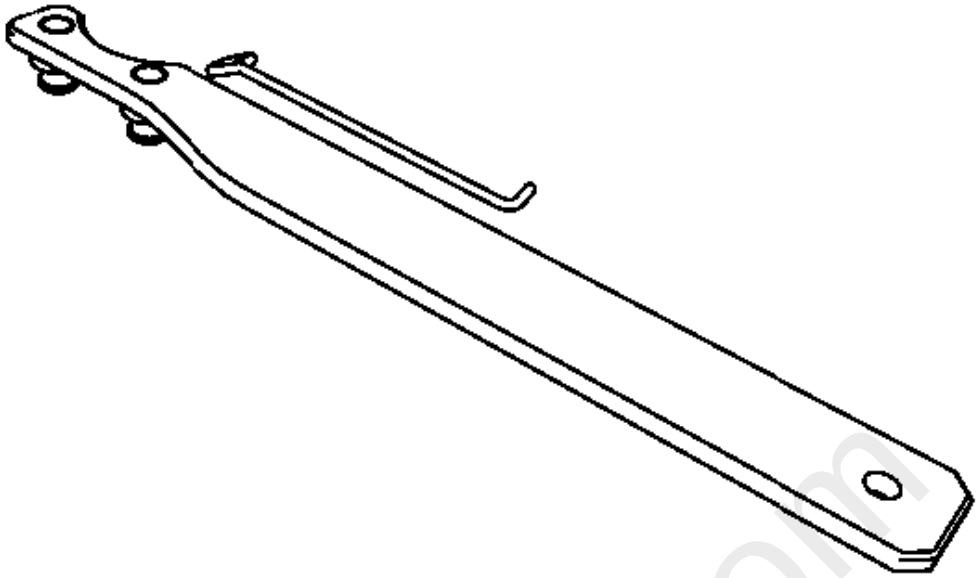
mcx30.com

Illustration	Tool Number/Description
	EN-51140 Crankshaft Fixing Tool

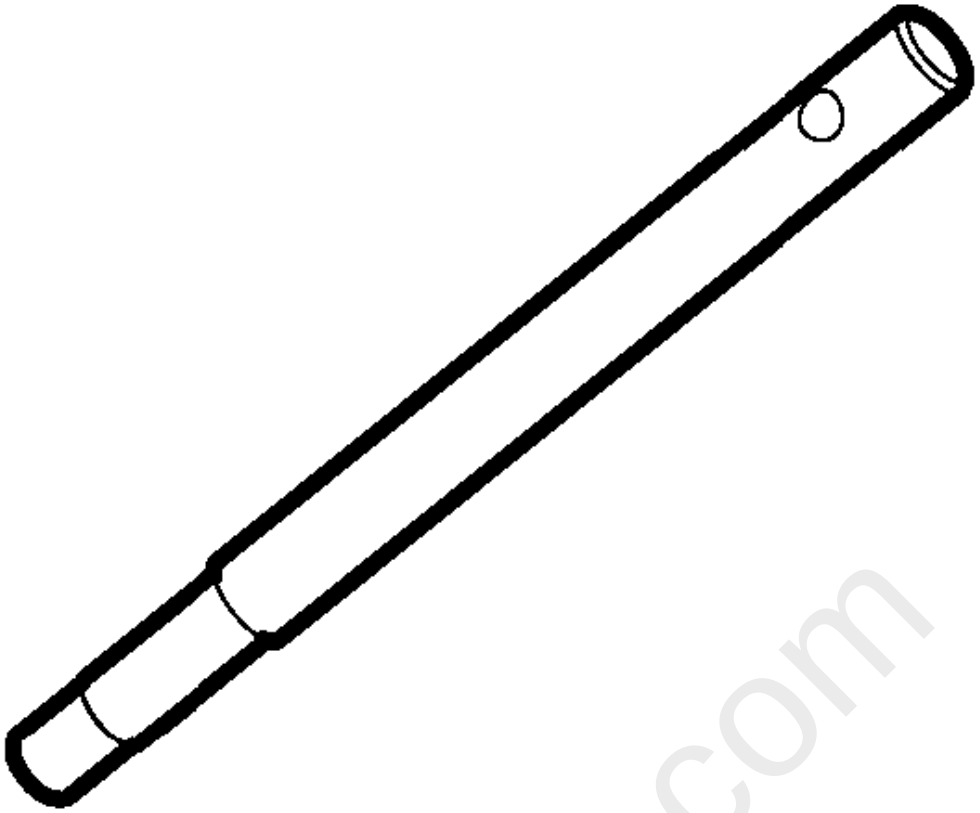
mcx30.com

Illustration	Tool Number/Description
	EN-51141 Intermediate Drive Gear Fixing Tool

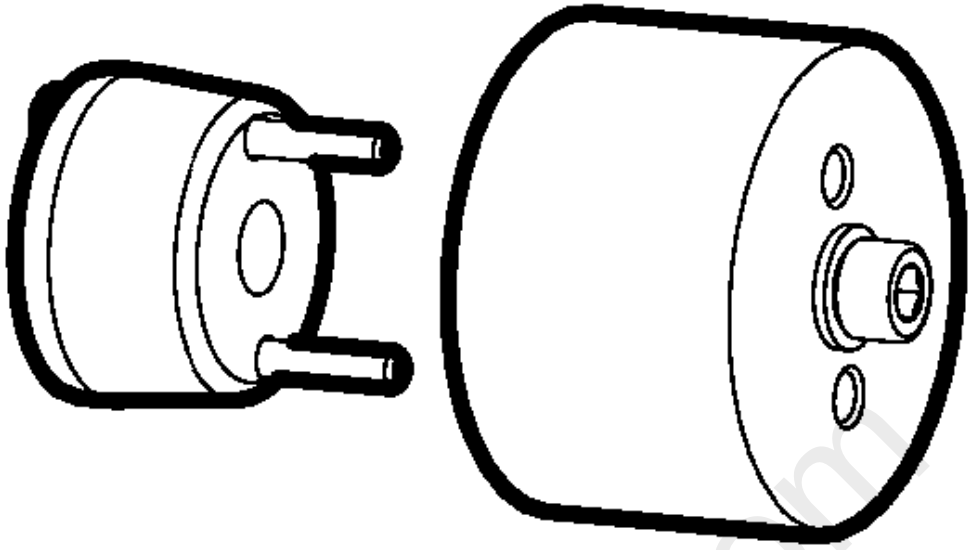
mcx30.com

Illustration	Tool Number/Description
	EN-51142 Oil Pump Sprocket Unit Holding Tool

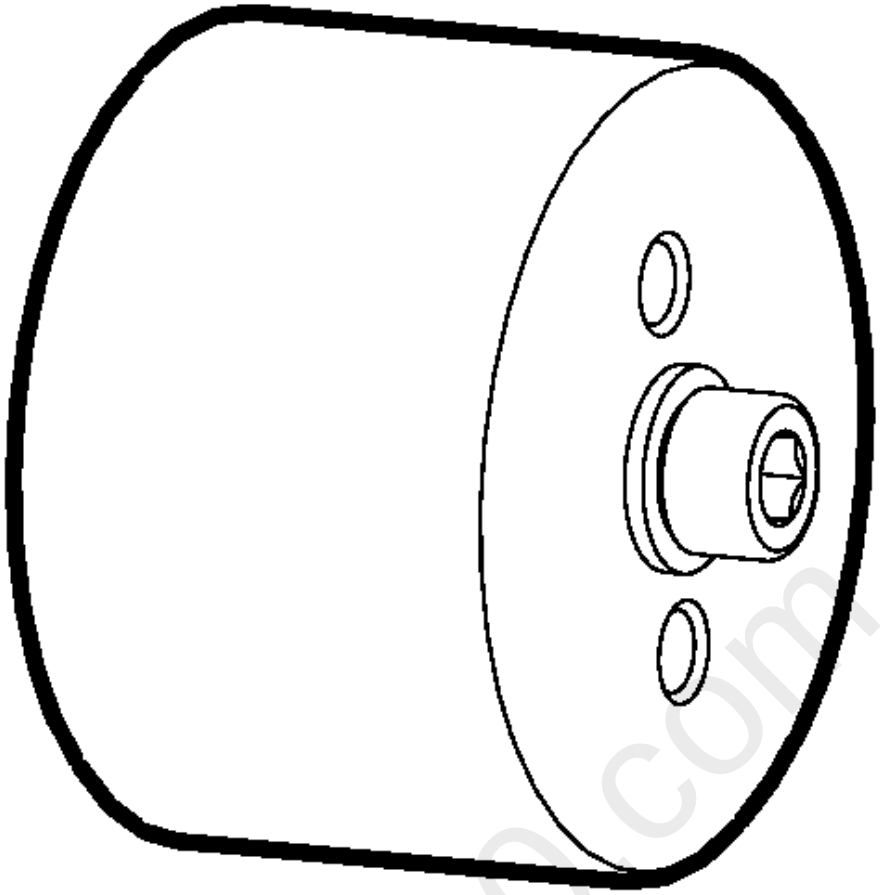
mcx30.com

Illustration	Tool Number/Description
	EN-51143 Camshaft Fixing Tool

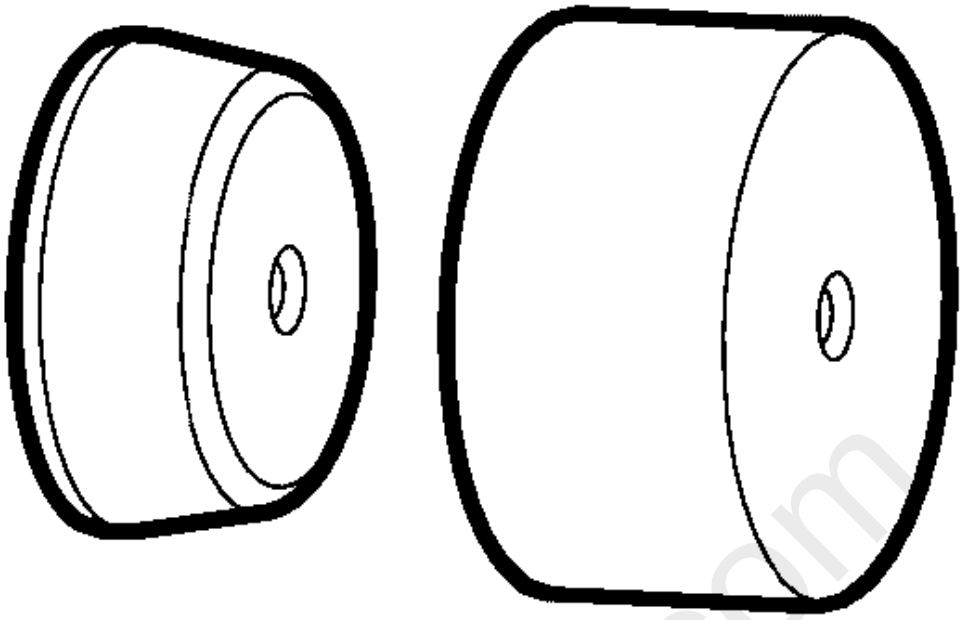
mcx30.com

Illustration	Tool Number/Description
	EN-51144 Crankshaft Seal Installer

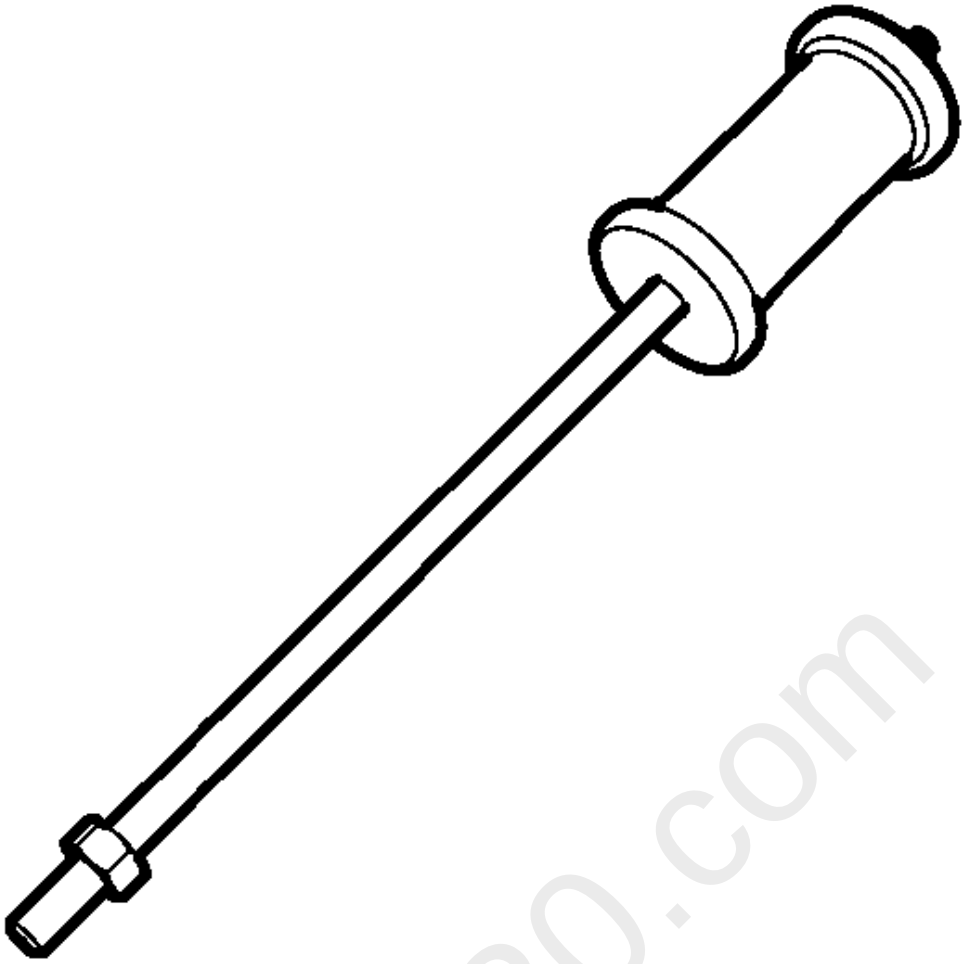
mcx30.com

Illustration	Tool Number/Description
	EN-51144-100 Crankshaft Seal Installer

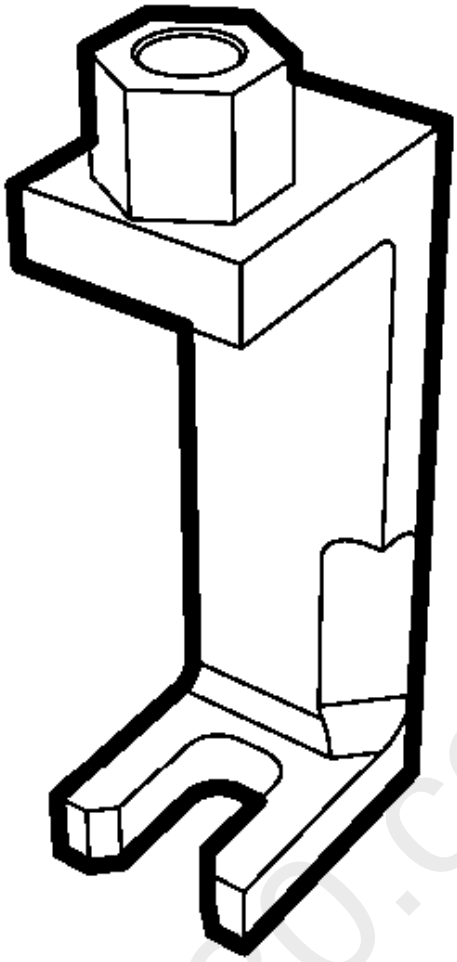
mcx30.com

Illustration	Tool Number/Description
	EN-51145 Crankshaft Seal Installer

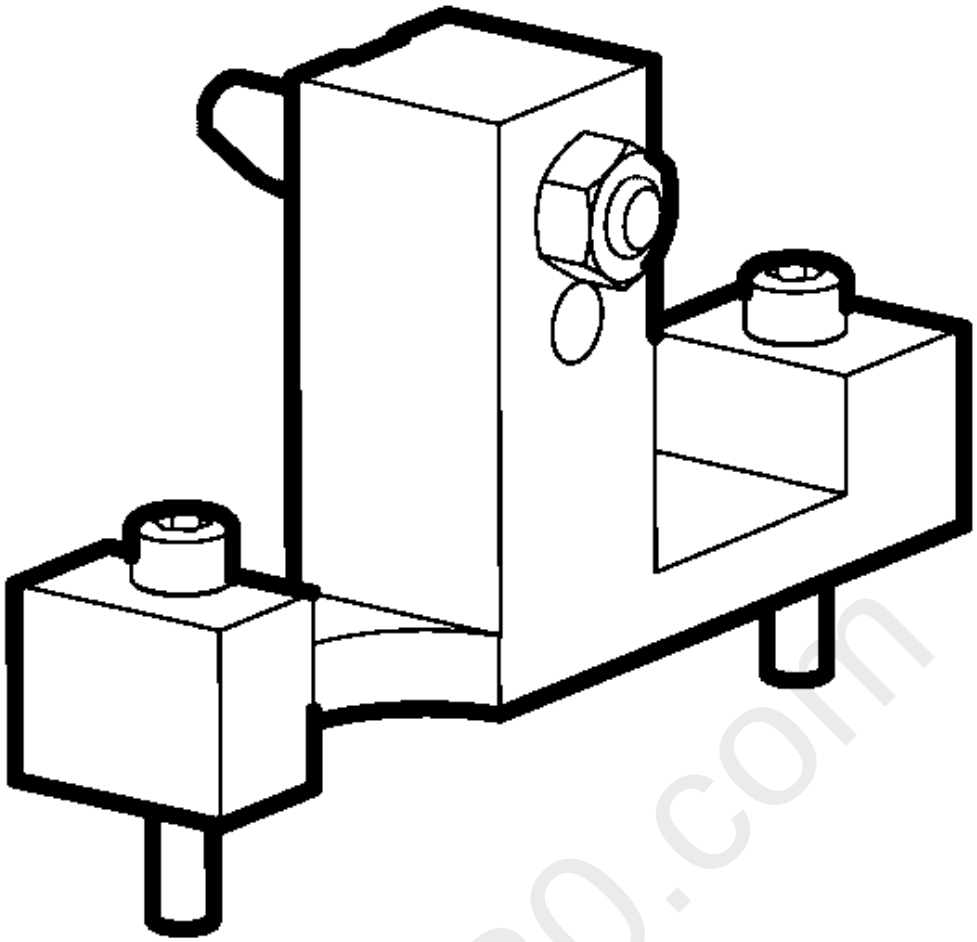
mcx30.com

Illustration	Tool Number/Description
	EN-51146-1-3 Sliding Hammer

mcx30.com

Illustration	Tool Number/Description
	EN-51187 Injector Remover

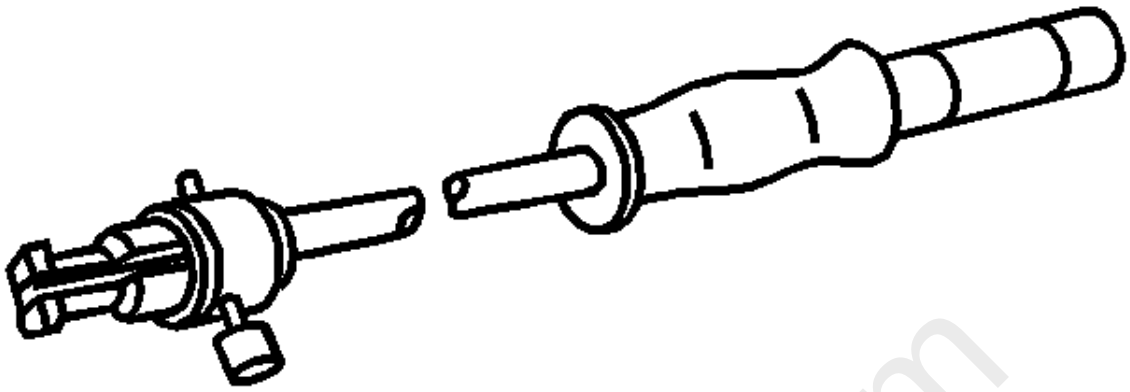
mcx30.com

Illustration	Tool Number/Description
	EN-51188 Camshaft Sprocket Support

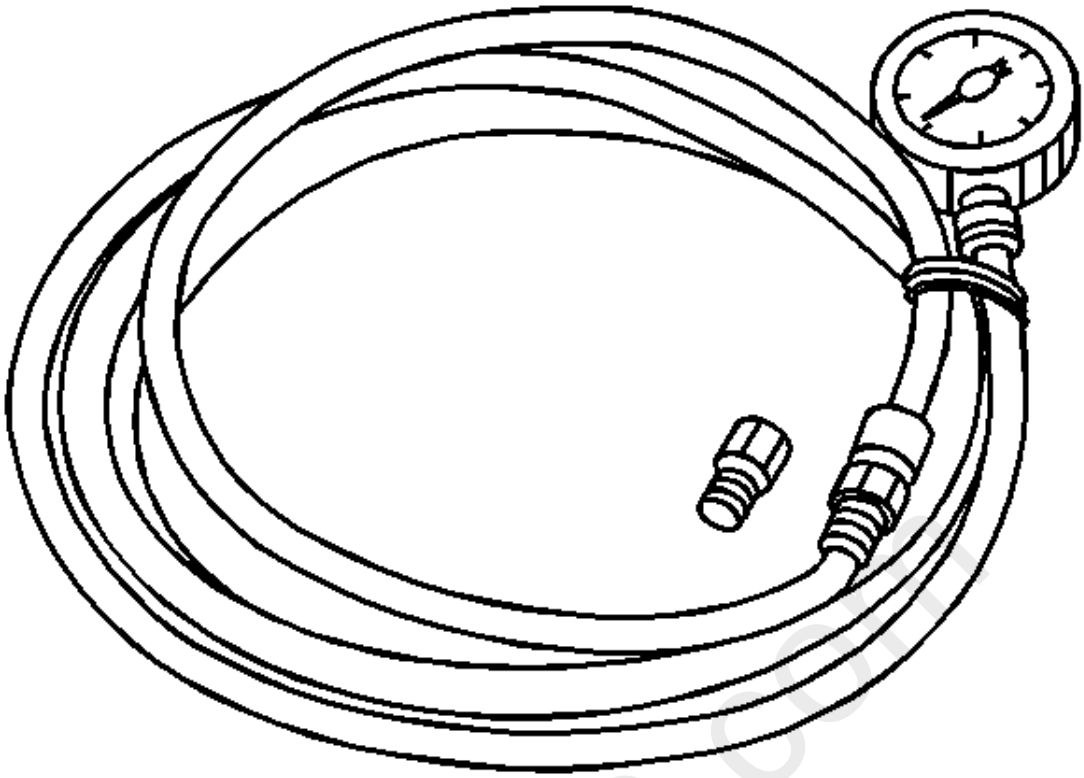
mcx30.com

Illustration	Tool Number/Description
	EN-51878 Compression and Cylinder Leakdown Adapter Kit

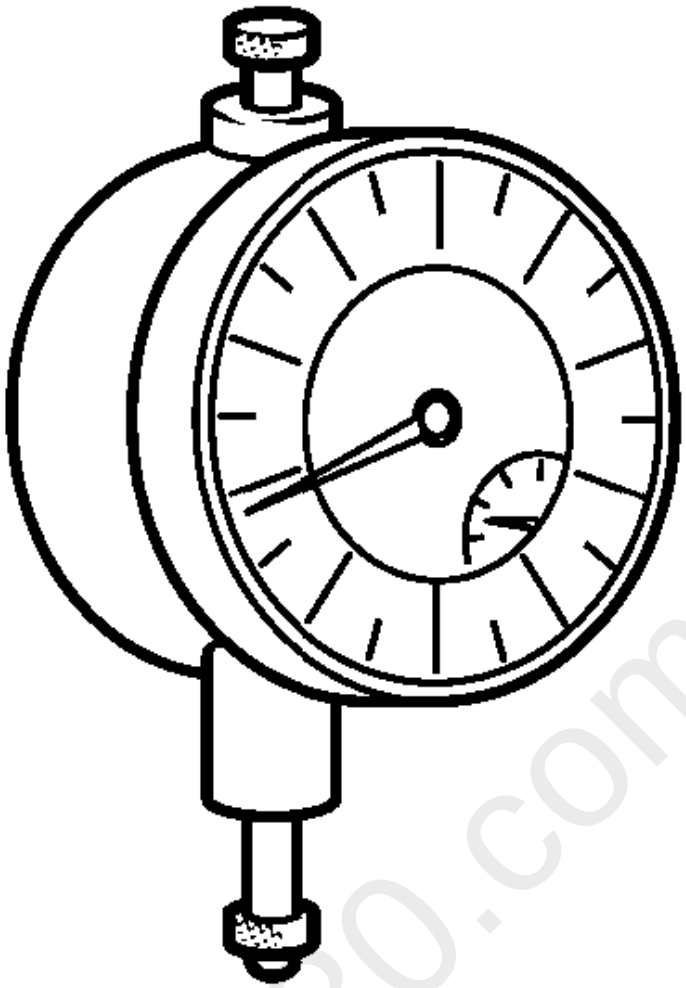
mcx30.com

Illustration	Tool Number/Description
	GE-328-B KM-328-B J-6215-1B Sliding Hammer

mcx30.com

Illustration	Tool Number/Description
	GE-498-B KM-498-B CH-48027 J-21867-A 83 92 516 or 87 91 600 Oil Pressure Gauge

mcx30.com

Illustration	Tool Number/Description
	GE-571-B MKM-571-B J-8001 Dial Gauge

mcx30.com

Back To Article

SPECIFICATIONS

FASTENER SPECIFICATIONS

Single Use Non-Threaded Fasteners/Components

Application
NOTE: ***All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.***
Camshaft Cover Gasket
Combustion Fuel Injector Seal
Connecting Rod Bearing
Crankshaft Front Oil Seal
Crankshaft Rear Oil Seal
Cylinder Head Core Hole Plug
Cylinder Head Gasket
Engine Coolant Thermostat Gasket
Engine Oil Cooler Gasket
Exhaust Manifold Gasket
Fuel Injector Seal Ring
Fuel Injector Spacer
Fuel Pump Gasket
Fuel Pump Housing Seal
Intake Manifold Gasket
Oil Pump Screen Gasket
Oil Pump Seal
Piston Pin Retainer
Positive Crankcase Ventilation Hose Fitting
Positive Crankcase Ventilation Tube
Positive Crankcase Ventilation Valve
Thermostat Bypass Pipe Gasket
Throttle Body Gasket
Timing Chain Tensioner Gasket
Turbocharger Coolant Feed and Return Pipe Gasket
Turbocharger Coolant Feed and Return Pipe Washer
Turbocharger Gasket
Turbocharger Oil Feed Pipe Gasket
Turbocharger Oil Feed Pipe Washer
Turbocharger Oil Return Pipe Gasket
Vacuum Pump Gasket
Vacuum Pump Seal
Valve Stem Oil Seal
Water Outlet Gasket
Water Pump Gasket

Single Use Threaded Fastener/Component tightening Specifications

mcx30.com

NOTE:

All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application	Specification Metric (English)
Automatic Transmission Flex Plate Bolt [8x]	
• First Pass:	20 N.m (15 lb ft)
• Second Pass:	30 N.m (22 lb ft)
• Final Pass:	40 degrees
Balance Shaft Sprocket Bolt	
• First Pass:	40 N.m (30 lb ft)
• Final Pass:	50 degrees
Camshaft Position Actuator Bolt	
• First Pass:	30 N.m (22 lb ft)
• Final Pass:	100 degrees
Connecting Rod Bolt	
• First Pass:	25 N.m (18 lb ft)
• Final Pass:	110 degrees
Crankshaft Balancer Bolt	
• First Pass:	150 N.m (111 lb ft)
• Final Pass:	140 degrees
Cylinder Head Bolt [10x]	
• First Pass:	30 N.m (22 lb ft)
• Final Pass:	190 degrees
Cylinder Head Core Hole Plug	50 N.m (37 lb ft)
Cylinder Head Oil Gallery Plug	40 N.m (30 lb ft)
Engine Front Cover Bolt - M10 [3x]	
• First Pass:	15 N.m (11 lb ft)
• Final Pass:	130 degrees
Engine Mount Engine Side Bolt [2x]	

mcx30.com

NOTE:
All fasteners/components listed in this table MUST BE DISCARDED and replaced with NEW after removal.

Application	Specification Metric (English)
• First Pass:	100 N.m (74 lb ft)
• Final Pass:	75 degrees
Exhaust Manifold Bolt [5x]	20 N.m (15 lb ft)
Exhaust Manifold Brace Nut [2x]	25 N.m (18 lb ft)
Fuel Feed Intermediate Pipe	
• First Pass:	15 N.m (11 lb ft)
• Final Pass:	30 N.m (22 lb ft)
Fuel Pump Bolt [2x]	
• First Pass:	8 N.m (71 lb in)
• Final Pass:	50 degrees
Lower Crankcase Bolt [10x]	
• First Pass:	20 N.m (15 lb ft)
• Final Pass:	140 degrees
Oil Filter	3/4 to 1 full turn after gasket makes contact with the sealing surface on the filter mounting flange
Positive Crankcase Ventilation Valve Bolt	10 N.m (89 lb in)
Turbocharger Nut [4x]	
• First Pass:	30 N.m (22 lb ft)
• Second Pass:	90 degrees

Reusable Threaded Fastener tightening Specifications

NOTE:
All fasteners listed in this table can be reused after removal.

Application	Specification Metric (English)
Air Conditioning Compressor Bolt	22 N.m (16 lb ft)
Balance Chain Guide Bolt [2x]	10 N.m (89 lb in)
Balancer Chain Tensioner Bolt	10 N.m (89 lb in)
Balancer Shaft with Oil Pump Bolt [8x]	
• First Pass:	58 N.m (43 lb ft)

mcx30.com

NOTE:

All fasteners listed in this table can be reused after removal.

Application	Specification Metric (English)
• Final Pass:	58 N.m (43 lb ft)
Camshaft Bearing Cap Bolt [18x]	10 N.m (89 lb in)
Camshaft Bearing Cap Bolt- Front [4x]	10 N.m (89 lb in)
Camshaft Cover Bolt [23x]	10 N.m (89 lb in)
Camshaft Cover Heat Shield Bolt [4x]	10 N.m (89 lb in)
Camshaft Cover Plug	35 N.m (26 lb ft)
Camshaft Position Actuator Solenoid Valve Bolt	10 N.m (89 lb in)
Camshaft Position Sensor Bolt	10 N.m (89 lb in)
Catalytic Converter Brace Bolt [4x]	25 N.m (18 lb ft)
Crankshaft Position Sensor Bolt	10 N.m (89 lb in)
Drive Belt Tensioner Bolt	58 N.m (43 lb ft)
Engine Block Oil Gallery Plug	65 N.m (48 lb ft)
Engine Block Oil Gallery Plug	40 N.m (30 lb ft)
Engine Coolant Air Bleed Pipe Bolt	10 N.m (89 lb in)
Engine Coolant Heater	50 N.m (37 lb ft)
Engine Coolant Heater Hole Plug	60 N.m (44 lb ft)
Engine Coolant Thermostat Housing Bolt [2x]	10 N.m (89 lb in)
Engine Front Cover Bolt - [4x]	10 N.m (89 lb in)
Engine Front Cover Bolt - [13x]	25 N.m (18 lb ft)
Engine Lift Front Bracket Bolt [2x]	25 N.m (18 lb ft)
Engine Lift Rear Bracket Bolt [2x]	25 N.m (18 lb ft)
Engine Mount Bolt [2x]	100 N.m (74 lb ft)
Engine Mount Brace Bolt [2x]	22 N.m (16 lb ft)
Engine Oil Cooler Bolt	10 N.m (89 lb in)
Engine Oil Cooler Connector	50 N.m (37 lb ft)
Engine Oil Level Indicator Switch Bolt	10 N.m (89 lb in)
Engine Oil Pressure Sensor	35 N.m (26 lb ft)
Exhaust Manifold Brace Bolt [2x]	25 N.m (18 lb ft)
Exhaust Manifold Heat Shield Bolt [2x]	14 N.m (124 lb in)
Fuel Feed Pipe Fitting	30 N.m (22 lb ft)
Fuel Feed Pipe Clip Stud	10 N.m (89 lb in)
Fuel Injection Fuel Rail Bolt [4x]	25 N.m (18 lb ft)
Fuel Injection Fuel Rail Fuel Pressure Sensor	33 N.m (24 lb ft)
Fuel Pump Shield Bolt [2x]	10 N.m (89 lb in)
Ignition Coil Bolt [4x]	10 N.m (89 lb in)
Intake Manifold Bolt [5x]	12 N.m (106 lb in)
Intake Manifold Cover Bolt [3x]	9 N.m (80 lb in)
Knock Sensor Bolt [2x]	25 N.m (18 lb ft)
Lower Crankcase Bolt [11x]	25 N.m (18 lb ft)
Lower Oil Pan Bolt [8x]	10 N.m (89 lb in)
Manifold Absolute Pressure Sensor Bolt	5 N.m (44 lb in)
Oil Pan Baffle Bolt [5x]	10 N.m (89 lb in)
Oil Pan Bolt [2x]	10 N.m (89 lb in)
Oil Pan Bolt [11x]	25 N.m (18 lb ft)
Oil Pan Bolt @ Transmission [2x]	25 N.m (18 lb ft)
Oil Pan Cover Bolt	10 N.m (89 lb in)
Oil Pan Drain Plug	25 N.m (18 lb ft)

mcx30.com

NOTE:

All fasteners listed in this table can be reused after removal.

Application	Specification
	Metric (English)
Oil Pump Suction Pipe Bolt [2x]	10 N.m (89 lb in)
Oil Pump Flow Control Valve Bolt	10 N.m (89 lb in)
Oil Pump Flow Control Valve Heat Shield Bolt	58 N.m (43 lb in)
Piston Oil Nozzle Bolt [4x]	10 N.m (89 lb in)
Positive Crankcase Ventilation Hose Fastener	12 N.m (106 lb in)
Positive Crankcase Ventilation Hose Fitting Bolt	8 N.m (71 lb in)
Pump and Component Oil Heat Shield Bolt [2x]	9 N.m (80 lb in)
Thermostat Bypass Pipe Bolt [2x]	10 N.m (89 lb in)
Throttle Body Bolt [4x]	10 N.m (89 lb in)
Timing Chain Guide Bolt [2x]	25 N.m (18 lb ft)
Timing Chain Tensioner Bolt [2x]	25 N.m (18 lb ft)
Timing Chain Tensioner Shoe Bolt	25 N.m (18 lb ft)
Turbocharger Bypass Valve Solenoid Bolt [3x]	8 N.m (71 lb in)
Turbocharger Coolant Feed Pipe Bolt	35 N.m (26 lb ft)
Turbocharger Coolant Feed Pipe Bolt [2x]	10 N.m (89 lb in)
Turbocharger Coolant Return Pipe Bolt	35 N.m (26 lb ft)
Turbocharger Heat Shield Bolt [3x]	14 N.m (124 lb in)
Turbocharger Exhaust Pipe Stud [4x]	25 N.m (18 lb ft)
Turbocharger Oil Feed Pipe Bolt	35 N.m (26 lb ft)
Turbocharger Oil Feed Pipe Bolt [2x]	10 N.m (89 lb in)
Turbocharger Oil Return Pipe Bolt [4x]	10 N.m (89 lb in)
Turbocharger Wastegate Actuator Bolt [2x]	8 N.m (71 lb in)
Turbocharger Wastegate Regulator Solenoid Valve Bolt	8 N.m (71 lb in)
Vacuum Pump Bolt [3x]	10 N.m (89 lb in)
Water Outlet Bolt [2x]	10 N.m (89 lb in)
Water Pump Bolt [3x]	25 N.m (18 lb ft)

APPROXIMATE FLUID CAPACITIES

Application	Specification	
	Metric	English
LCV, LHP, LTG		
Oil Capacity - 2WD	4.7L	5.0 quarts
Oil Capacity - AWD	5.7L	6.0 quarts

ENGINE MECHANICAL SPECIFICATIONS

Application	Specification	
	Metric	English
General Data		
• Engine Type	Inline 4 Cylinder	
• Displacement	2.0 L	122 CID
• RPO	LTG	
• VIN	-	

mcx30.com

Application	Specification	
	Metric	English
• Bore	85.992 - 86.008 mm	3.3855 - 3.3861 in
• Stroke	86 mm	3.386 in
• Compression Ratio	9.50	
• Spark Plug Gap	0.95 - 1.10 mm	0.037 - 0.043 in
Block		
• Crankshaft Main Bearing Bore Diameter	60.862 - 60.876 mm	2.3961 - 2.3967 in
• Cylinder Bore Diameter	85.992 - 86.008 mm	3.3855 - 3.3861 in
• Cylinder Bore Out-of-Round - Maximum	0.013 mm	0.0005 in
• Cylinder Head Deck Surface Flatness - over 25 mm length	0.025 mm	0.001 in
• Cylinder Head Deck Surface Flatness - over 150 mm length	0.050 mm	0.002 in
Engine Block to Bedplate Flatness - overall	0.1 mm	0.0039 in
Engine Block to Bedplate Flatness - straightness	0.050 mm within every 100 mm	0.002 in within every 3.937 in
Piston Deck Height - Below Deck	1.155 - 1.725 mm	0.0455 - 0.0679 in
Camshaft		
• Camshaft End Play	0.040 - 0.307 mm	0.0016 - 0.0121 in
• Camshaft Journal Diameter - Journal 1	34.935 - 34.960 mm	1.3754 - 1.3764 in
• Camshaft Journal Diameter - Journal 2 thru 5	26.935 - 26.960 mm	1.0604 - 1.0614 in
• Camshaft Thrust Width - Camshaft with Phaser installed	30.025 - 30.175 mm	1.1821 - 1.1880 in
• Camshaft Thrust Width - Cylinder Head	29.868 - 29.890 mm	1.1759 - 1.1768 in
Connecting Rod		
• Connecting Rod Bearing to Crankpin Clearance	0.030 - 0.073 mm	0.0012 - 0.0029 in
• Connecting Rod Bore Diameter - Bearing End	52.118 - 52.134 mm	2.0519 - 2.05252 in
• Connecting Rod Bore Diameter - Pin End	24.007 - 24.017 mm	0.9452 - 0.9455 in

mcx30.com

Application	Specification	
	Metric	English
• Connecting Rod Side Clearance	0.070 - 0.370 mm	0.0028 - 0.0146 in
• Connecting Rod Straightness - Bend - Maximum	0.017 mm	0.0007 in
• Connecting Rod Straightness - Twist - Maximum	0.040 mm	0.0016 in
Crankshaft		
• Connecting Rod Pin Diameter	48.999 - 49.015 mm	1.9291 - 1.9297 in
• Crankshaft End Play	0.040 - 0.270 mm	0.0016 - 0.0106 in
• Crankshaft Main Bearing Clearance	0.020 - 0.048 mm	0.0008 - 0.0019 in
• Crankshaft Main Journal Diameter	55.993 - 56.009 mm	2.2044 - 2.2051 in
• Crankshaft Thrust Bearing Width	20.30 - 20.45 mm	0.799 - 0.805
Cylinder Head		
• Surface Flatness - Block Deck - in 25 mm	0.025 mm	0.0001 in
• Surface Flatness - Block Deck - in 150 mm	0.050 mm	0.0019 in
• Surface Flatness - Block Deck - between bolts	0.030 mm	0.0012 in
• Surface Flatness - Block Deck - Overall	0.100 mm	0.0039 in
• 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 Lifter Bore Diameter - Stationary Lash Adjusters	12.008 - 12.030 mm	0.4728 - 0.4736 in
• Valve Seat Angle - Relief Surface	30 Degrees	
• Valve Seat Angle - Seating Surface	45 Degrees	
• Valve Seat Angle - Undercut Surface	60 Degrees	
• Valve Seat Runout - Maximum	0.080 mm	0.0031 in
Lubrication System		

mcx30.com

Application	Specification	
	Metric	English
• Oil Pressure - @ 700 RPM 100Â°C	140 - 200 kPa	20 - 29 psi
Piston Rings		
• Piston Ring End Gap - Top	0.20 - 0.35 mm	0.008 - 0.014 in
• Piston Ring End Gap - Second	0.35 - 0.55 mm	0.014 - 0.022 in
• Piston Ring End Gap - Oil Control	0.25 - 0.75 mm	0.010 - 0.030 in
• Piston Ring to Groove Clearance - Top	0.04 - 0.08 mm	0.0015 - 0.0031 in
• Piston Ring to Groove Clearance - Second	0.030 - 0.070 mm	0.0012 - 0.0030 in
• Piston Ring to Groove Clearance - Oil Control	0.024 - 0.176 mm	0.0009 - 0.0069 in
• Piston Ring Thickness - Top	1.170 - 1.190 mm	0.0461 - 0.0469 in
• Piston Ring Thickness - Second	1.470 - 1.490 mm	0.0579 - 0.0587 in
• Piston Ring Thickness - Oil Control - Rail	0.447 - 0.473 mm	0.0176 - 0.0186 in
• Piston Ring Thickness - Oil Control - Spacer	0.960 - 1.040 mm	0.0378 - 0.0409 in
Pistons and Pins		
• Pin - Piston Pin Clearance to Connecting Rod Bore	0.007 - 0.020 mm	0.0003 - 0.0008 in
• Pin - Piston Pin Clearance to Piston Pin Bore	0.005 - 0.013 mm	0.0002 - 0.0005 in
• Pin - Piston Pin Diameter	23.997 - 24.000 mm	0.9448 - 0.9449 in
• Pin - Piston Pin End Play	0.263 - 1.164 mm	0.0104 - 0.0458 in
• Piston - Piston Diameter - @ 14.8 mm up	85.968 - 85.982 mm	3.3846 - 3.3851 in
• Piston - Piston Pin Bore Diameter	24.005 - 24.010 mm	0.9451 - 0.9453 in
• Piston - Piston Ring Groove Width - Top	1.23 - 1.25 mm	0.0484 - 0.0492 in
• Piston - Piston Ring Groove Width - Second	1.52 - 1.54 mm	0.0598 - 0.0606 in
• Piston - Piston Ring Groove Width - Oil Control	2.01 - 2.03 mm	0.0791 - 0.0799 in

mcx30.com

Application	Specification	
	Metric	English
• Piston - Piston to Bore Clearance - w/o polymer	0.010 - 0.041 mm	0.0004 - 0.0016 in
Valve System		
• Valves - Valve Face Angle	45 Degrees	
• Valves - Valve Face Runout - Maximum	0.040 mm	0.0016 in
• Valves - Valve Seat Runout - Maximum	0.080 mm	0.0031 in
• Valves - Valve Seat Gauge Ball Height - Exhaust	12.746 - 12.976 mm	0.4912 - 0.5038 in
• Valves - Valve Seat Gauge Ball Height - Intake	12.425 - 12.653 mm	0.4892 - 0.4981 in
• Valves - Valve Stem Diameter - Exhaust	5.945-5.965 mm	0.2341 - 0.2348 in
• Valves - Valve Stem Diameter - Intake	5.955 - 5.975 mm	0.2344 - 0.2352 in
• Valves - Valve Stem Installed Height	Check and Record	
• Valves - Valve Stem to Guide Clearance - Exhaust	0.038 - 0.082 mm	0.0015 - 0.0032 in
• Valves - Valve Stem to Guide Clearance - Intake	0.030 - 0.057 mm	0.0012 - 0.0022 in
• Valve Lash Adjusters - Valve Lash Adjuster Diameter - Stationary Lash Adjuster	11.986 - 12.000 mm	0.0005 - 0.0020 in
• Valve Lash Adjusters - Valve Lash-Adjuster-to-Bore Clearance - Stationary Lash Adjuster	0.013 - 0.051 mm	3.2210 - 3.2299 in
• Valve Springs - Valve Spring Installed Height	35.0 mm	1.3779 in
• Valve Springs - Valve Spring Load - Closed - @ 35 mm	247 - 273 N	56 - 61 lb
• Valve Springs - Valve Spring Load - Open - @ 24 mm	598 - 662 N	134 - 149 lb

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	
		United States	Canada
Balance Shaft Bearings	5W-30, Dexos1 Gen 2	88865635	88865988
Cam Lobes	5W-30, Dexos1 Gen 2	88865635	88865988
Camshaft Cover[1]	Sealant	12378521	88901148
Crank Sensor O-ring	5W-30, Dexos1 Gen 2	88865635	88865988

mcx30.com

Application	Type of Material	GM Part Number	
		United States	Canada
Cylinder Bores	5W-30, Dexos1 Gen 2	88865635	88865988
Cylinder Head Plugs	Threadlocker	12345382	10953489
Engine Block Threaded Plugs	Sealant	12346004	10953480
Engine Block to Bedplate[1]	Sealant	12378521	88901148
Engine Front Cover[1]	Sealant	12378521	88901148
Engine Oil	5W-30, Dexos1 Gen 2	88865635	88865988
Fuel Injection Pump Bolt	Threadlocker	12345382	10953489
Fuel Injector O-rings	5W-30, Dexos1 Gen 2	88865635	88865988
Fuel Injector Tip Insulators, for Multiple Port Injection Only	5W-30, Dexos1 Gen 2	88865635	88865988
Hydraulic Lash Adjusters	5W-30, Dexos1 Gen 2	88865635	88865988
Ignition Coils	Lubricant	19260901	19260902
Intake and Exhaust Valve Stems	5W-30, Dexos1 Gen 2	88865635	88865988
Lower Oil Pan[1]	Sealant	12378521	88901148
Main Bearings	5W-30, Dexos1 Gen 2	88865635	88865988
Oil Filter - Threads and O-ring Lead-in Chamfers	5W-30, Dexos1 Gen 2	88865635	88865988
Oil Level Indicator Tube O-ring	Lubricant	88862586	88862827
Oil Pan to Bedplate Joint[1]	Sealant	12378521	88901148
Oil Pump - Pump Elements	5W-30, Dexos1 Gen 2	88865635	88865988
Oxygen Sensor Threads	Anti-seize	88862477	88862478
Piston Pin to Piston/Rod - Pin Bores of Piston and Rod	5W-30, Dexos1 Gen 2	88865635	88865988
Rod Bearings - Rod Pins of Crankshaft	5W-30, Dexos1 Gen 2	88865635	88865988
Thread Repair Cutting Oil	Lubricant	1052864	992881
Thread Repair	Cleaner	88862650	88901247
Timing Chain Tensioner Cover	Sealant	12378521	88901148
Valves	Parts Immersion Solvent	12345368	10953514
Valve Rocker Arm/Valve Tip	5W-30, Dexos1 Gen 2	88865635	88865988
Water Feed Tube O-rings	Lubricant	19260901	19260902

[1] Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**

THREAD REPAIR SPECIFICATIONS

Engine Block - Front View

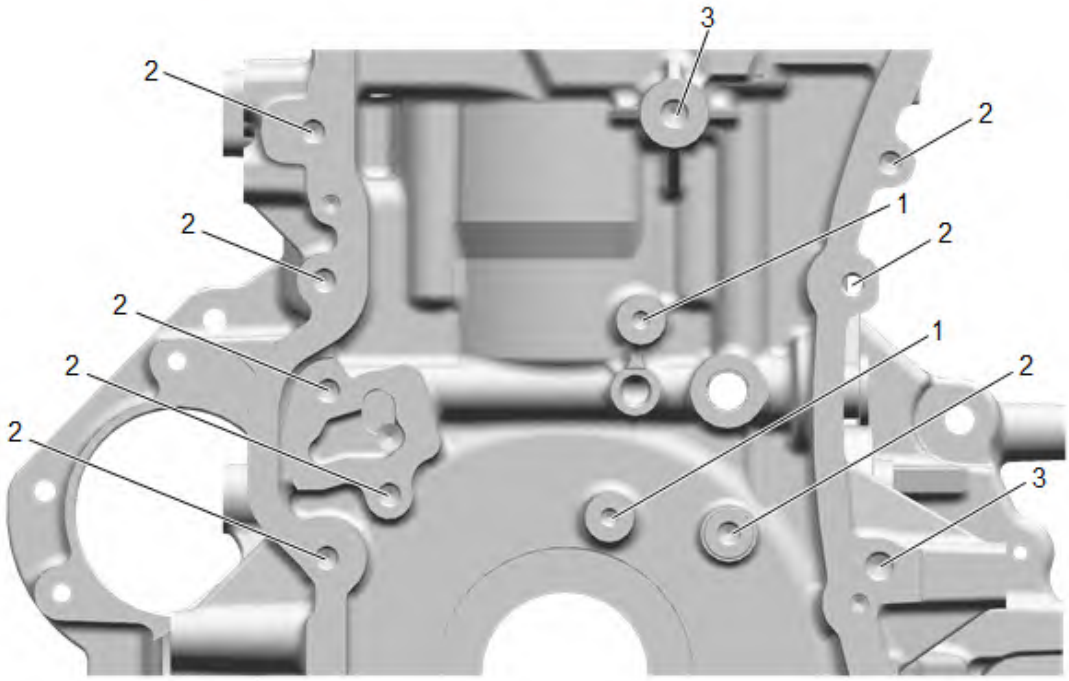


Fig. 1: Engine Block -- Front View
Courtesy of GENERAL MOTORS COMPANY

Engine Block - Front View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907
2	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14
3	M10x1.5	420	211	212	213	214	34.0	1.35	34.0	1.35

Engine Block - Back View

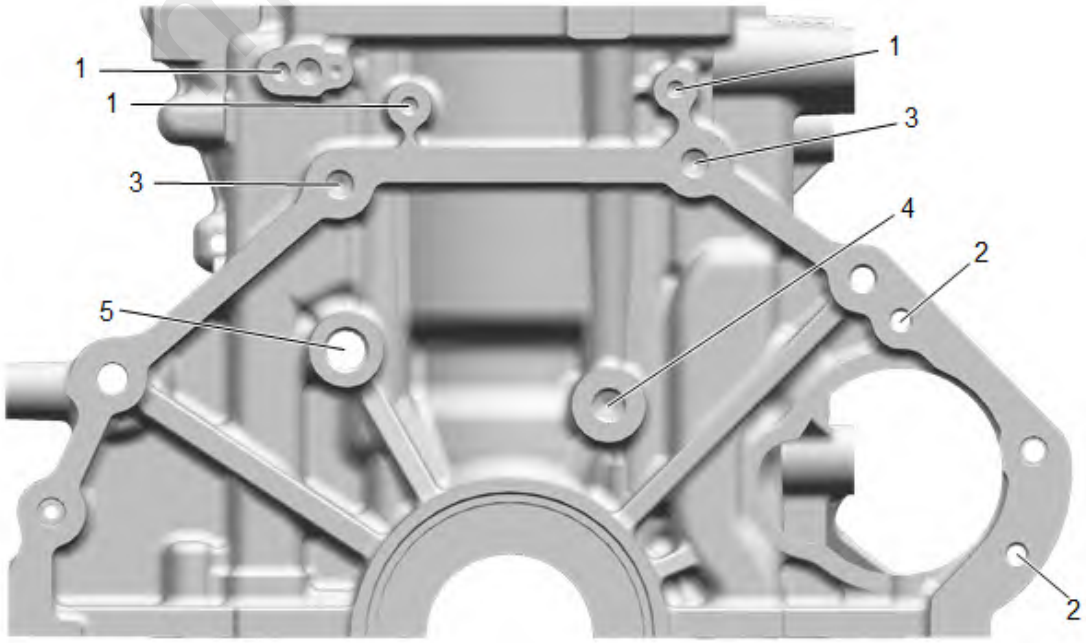


Fig. 2: Engine Block -- Back View
Courtesy of GENERAL MOTORS COMPANY

mcx30.com

Engine Block - Back View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907
2	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14
3	M10x1.5	420	211	212	213	214	34.0	1.35	24.0	1.35
4	M12x1.75	865	856	857	858	859	27.5	1.08	27.5	1.08
5	M16x1.5	420	211	212	213	214	34.0	1.35	34.0	1.35

Engine Block - Right Side View

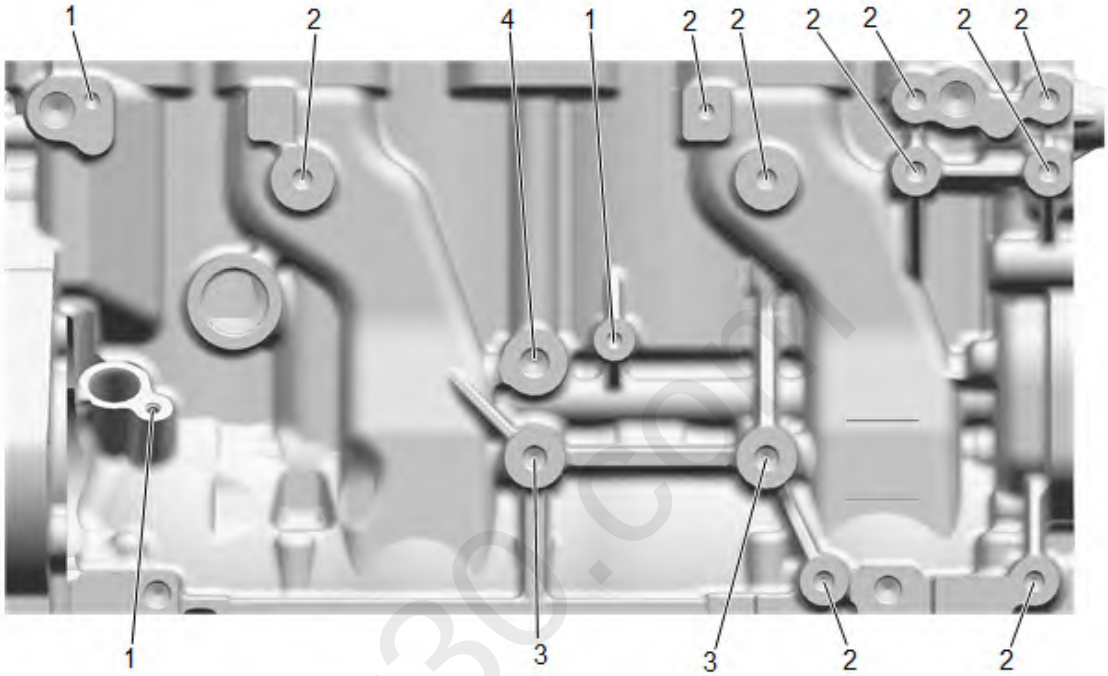


Fig. 3: Engine Block -- Right Side View
Courtesy of GENERAL MOTORS COMPANY

Engine Block - Right Side View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907
2	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14
3	m10x1.5	420	211	212	213	214	34.0	1.35	34.0	1.35
4	M12x1.75	865	856	857	858	859	27.5	1.08	27.5	1.08

Engine Block - Bottom View

mcx30.com

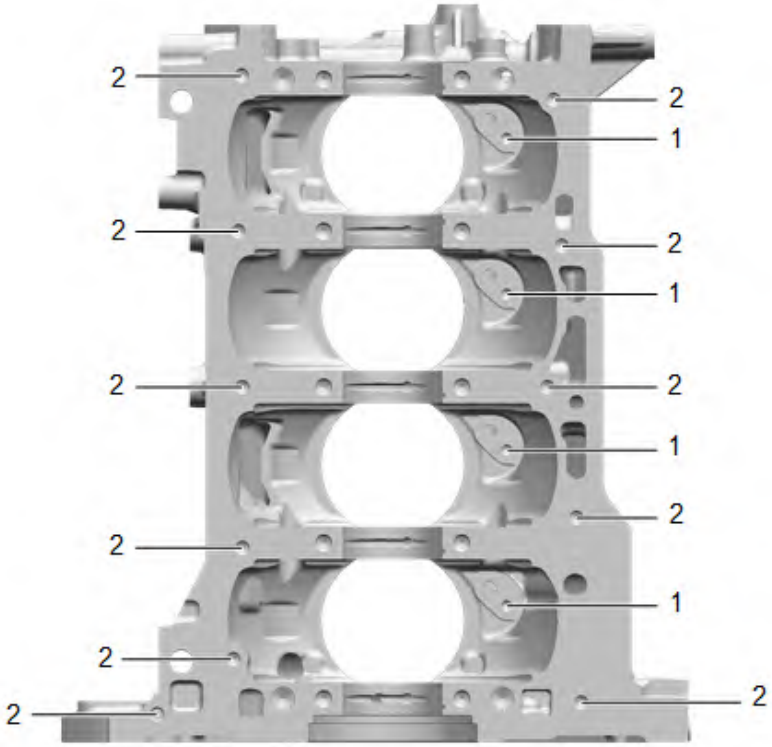


Fig. 4: Engine Block -- Bottom View
Courtesy of GENERAL MOTORS COMPANY

Engine Block - Bottom View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907
2	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14

Engine Block - Left Side View

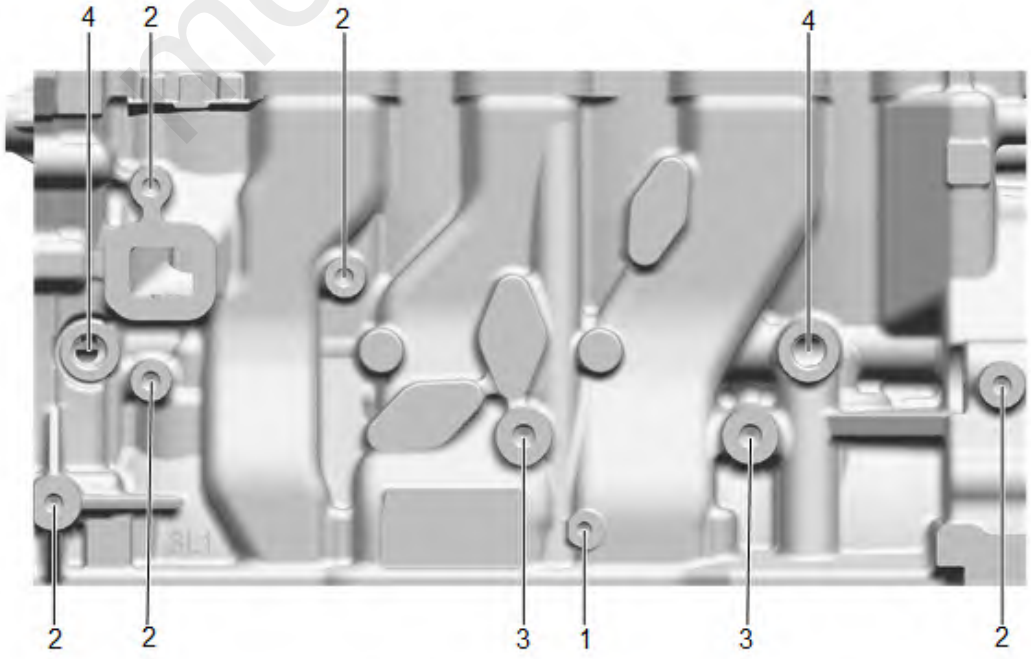


Fig. 5: Engine Block -- Left Side View
Courtesy of GENERAL MOTORS COMPANY

Engine Block - Left Side View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907
2	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14
3	M10x1.5	420	211	212	213	214	34.0	1.35	34.0	1.35
4	M16x1.5	420	211	212	213	214	22.0	0.866	22.0	0.866

Engine Block - Top View

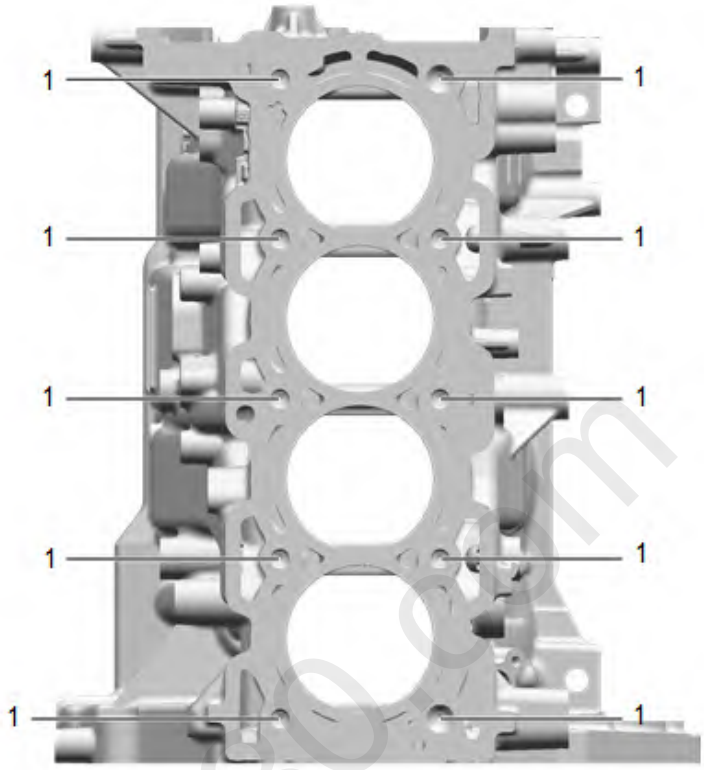


Fig. 6: Engine Block -- Top View
Courtesy of GENERAL MOTORS COMPANY

Engine Block - Top View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M11x2.0	108	723	none	724	725	88.0	3.46	80.0	3.15

Lower Crankcase - Bottom View

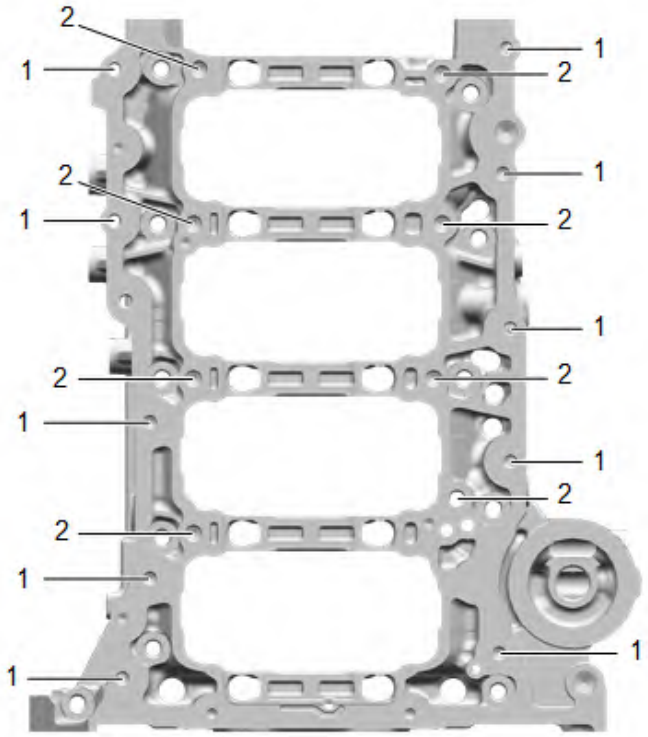


Fig. 7: Lower Crankcase -- Bottom View
Courtesy of GENERAL MOTORS COMPANY

Lower Crankcase - Bottom View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14
2	M10x1.5	420	211	212	213	214	34.0	1.35	34.0	1.35

Lower Crankcase - Right Side View

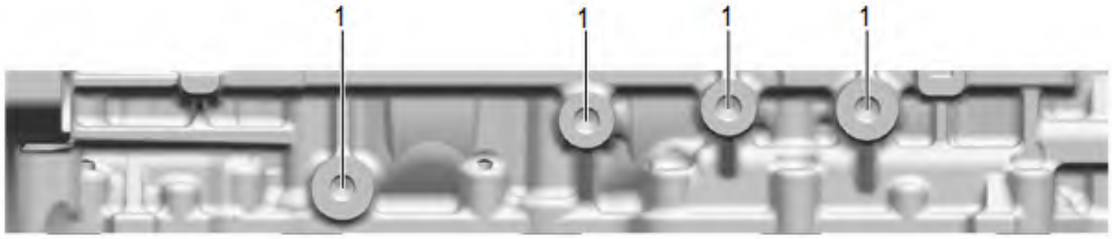


Fig. 8: Lower Crankcase -- Right Side View
Courtesy of GENERAL MOTORS COMPANY

Lower Crankcase - Right Side View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M10x1.5	420	211	212	213	214	34.0	1.35	34.0	1.35

Lower Crankcase - Left Side View

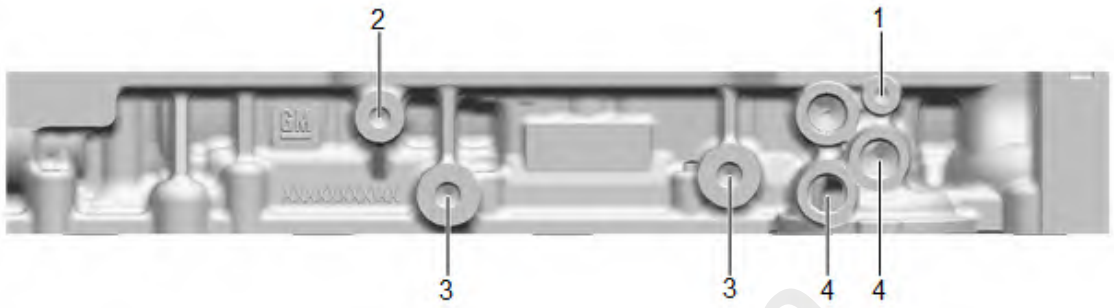


Fig. 9: Lower Crankcase -- Left Side View
Courtesy of GENERAL MOTORS COMPANY

Lower Crankcase - Left Side View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907
2	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14
3	M10x1.5	420	211	212	213	214	34.0	1.35	34.0	1.35
4	M16x1.5	420	211	212	213	214	22.0	0.866	22.0	0.866

Cylinder Head - Top View

mx30.com

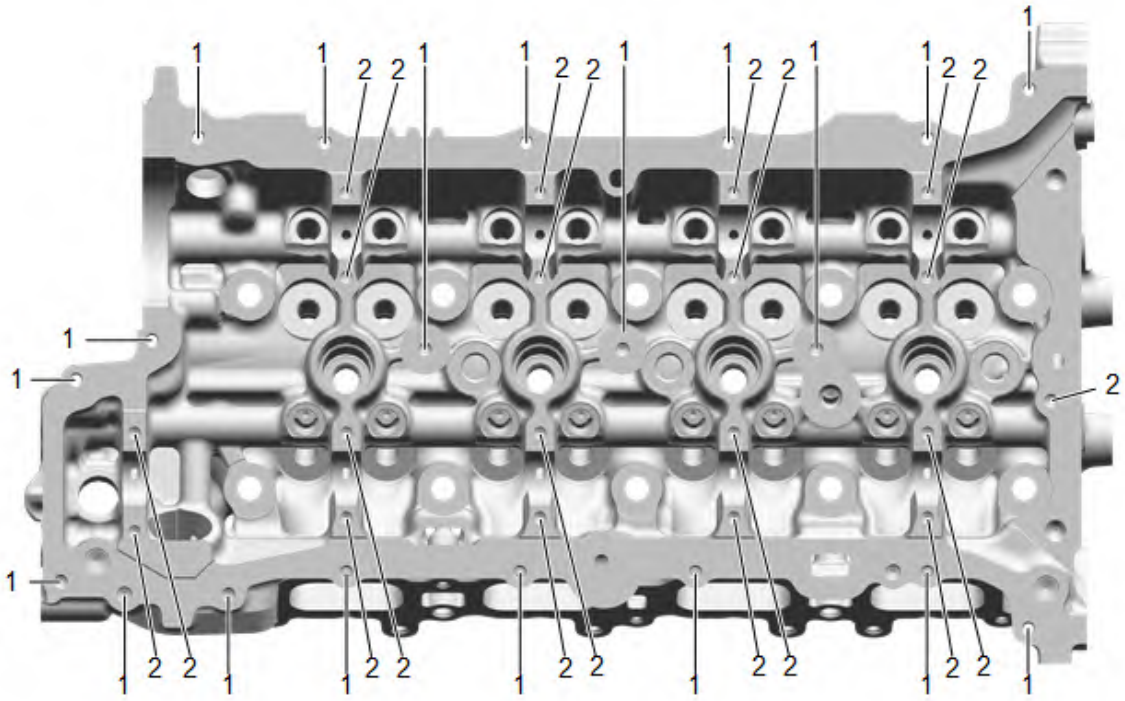


Fig. 10: Cylinder Head -- Top View
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head - Top View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	205	201	202	203	204	23.0	0.907	23.0	0.907
2	M6x1.0	205	701	none	203	204	23.0	0.907	23.0	0.907

Cylinder Head Right Side View - Intake Manifold Deck Face

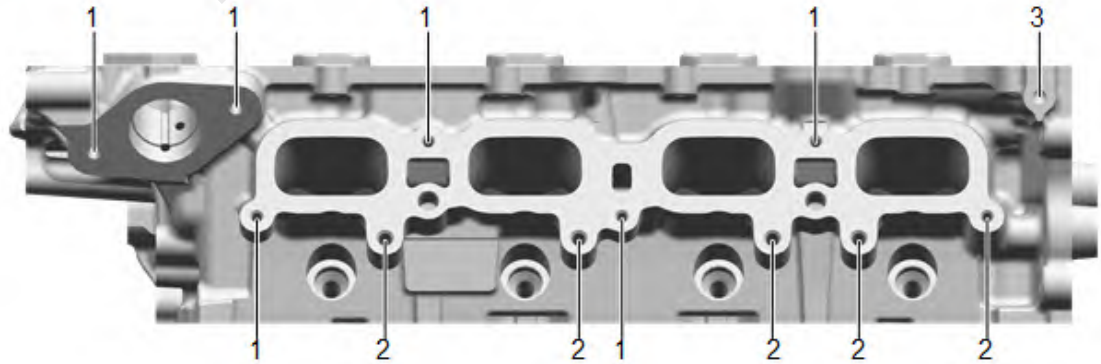


Fig. 11: Cylinder Head Right Side View -- Intake Manifold Deck Face
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head Right Side View - Intake Manifold Deck Face

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth Maximum		Tap Depth Maximum	
EN 42385							MM	IN	MM	IN
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907
2	M6x1.0	205	201	202	203	204	23.0	0.907	23.0	0.907
3	M6x1.0	205	701	none	203	204	23.0	0.907	23.0	0.907

Cylinder Head Left Side View - Exhaust Manifold Deck Face

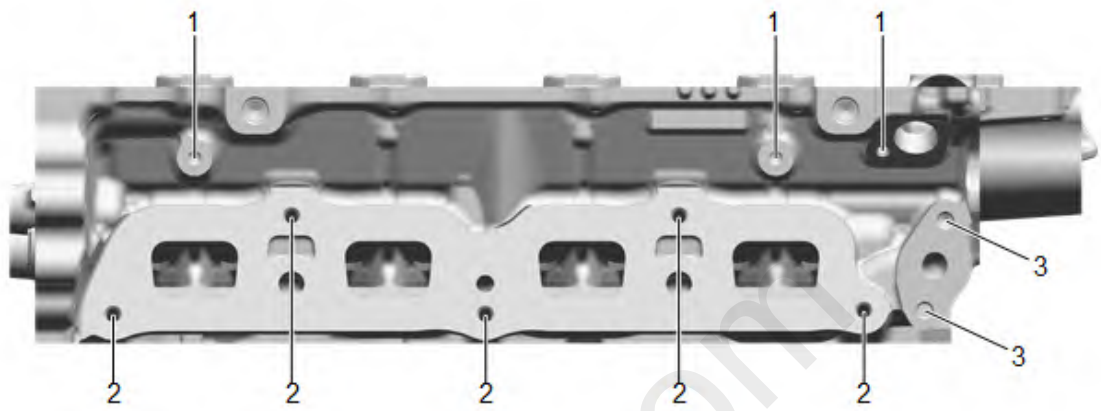


Fig. 12: Cylinder Head Left Side View -- Exhaust Manifold Deck Face
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head Left Side View - Exhaust Manifold Deck Face

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385 - 850							MM	(IN)	MM	(IN)
1	M6x1.0	205	201	202	203	204	23.0	0.907	23.0	0.907
2	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14
3	M8x1.25	210	206	207	208	209	29.0	1.14	29.0	1.14

Cylinder Head - Front View

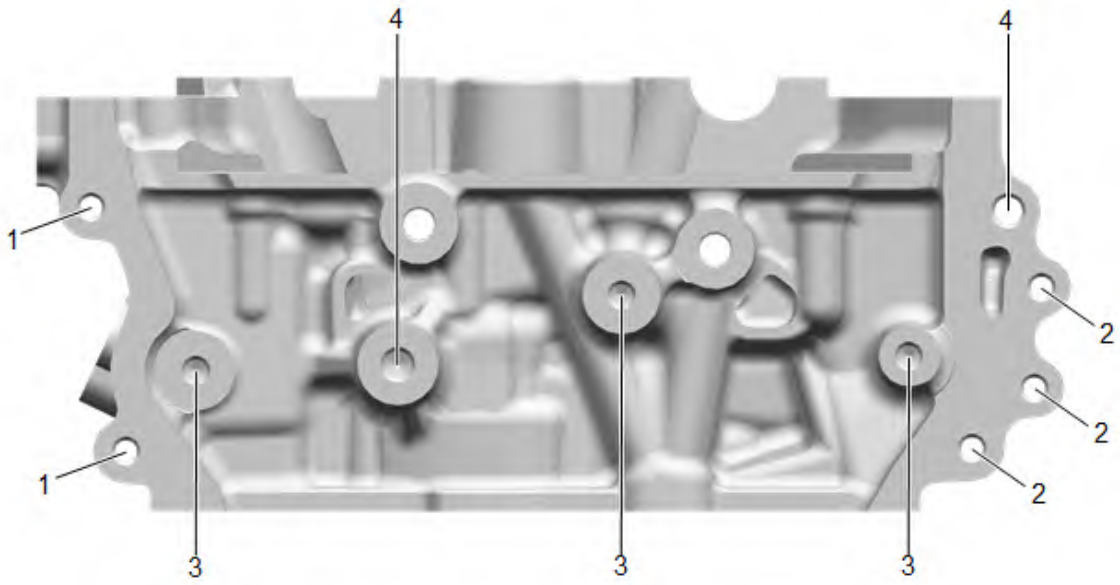
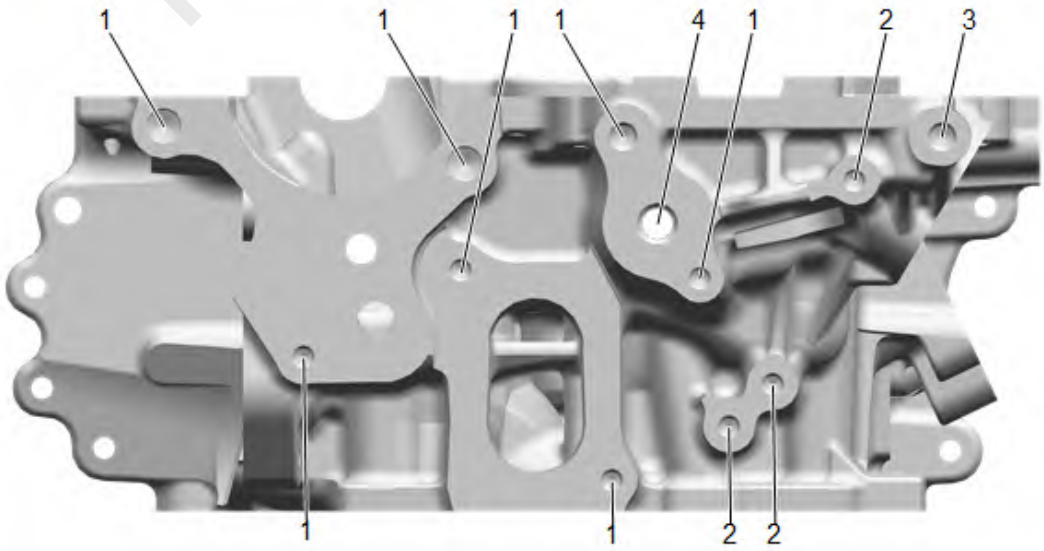


Fig. 13: Cylinder Head -- Front View
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head - Front View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M8x1.25	18129	206	207	208	209	29.0	1.14	29.0	1.14
2	M8x1.25	18127	206	207	208	209	29.0	1.14	29.0	1.14
3	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14
4	M10x1.5	420	211	212	213	214	34.0	1.35	34.0	1.35

Cylinder Head - Back View



mcx30.com

Fig. 14: Cylinder Head -- Back View
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head - Back View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth Maximum		Tap Depth Maximum	
EN 42385							MM	IN	MM	IN
1	M6X1	205	201	202	203	204	20	0.787	16	0.63
2	M6X1	205	701	none	203	204	20	0.787	16	0.63
3	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14
4	M12x1.75	865	856	857	858	859	18	0.709	14	0.551

Upper Oil Pan - Top View

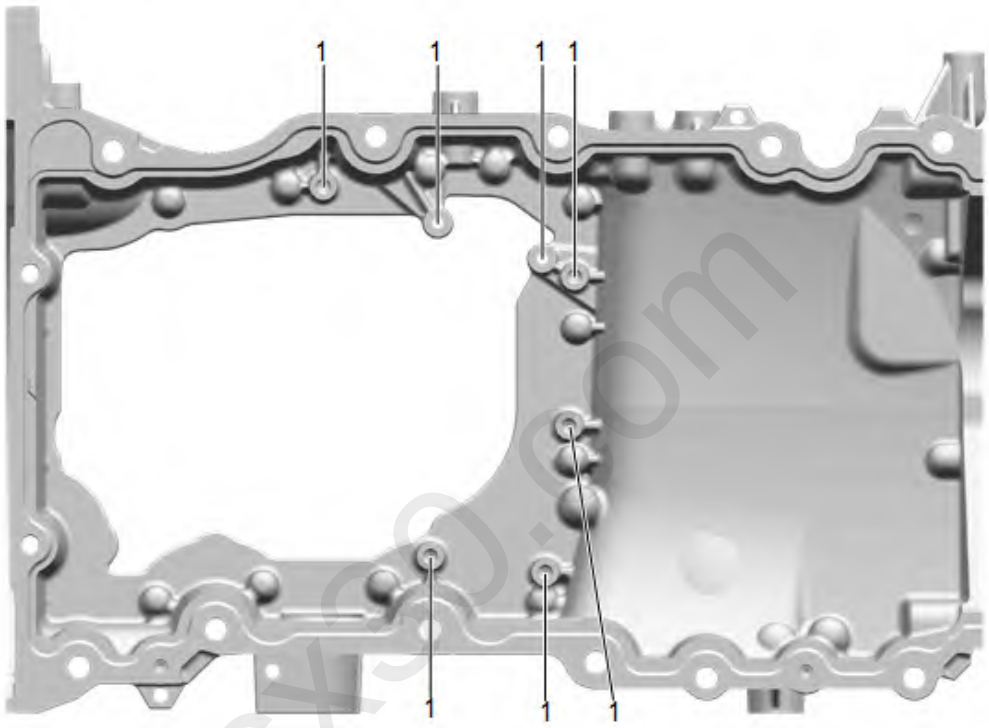


Fig. 15: Upper Oil Pan -- Top View
Courtesy of GENERAL MOTORS COMPANY

Upper Oil Pan - Top View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907

Upper Oil Pan - Bottom View

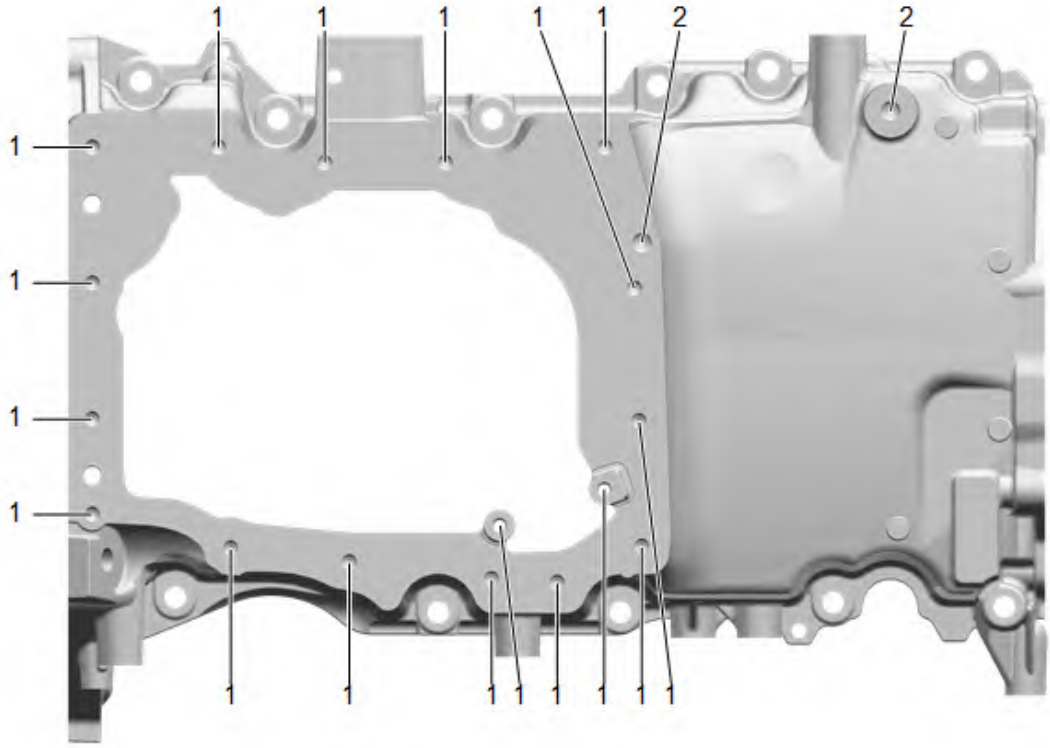


Fig. 16: Upper Oil Pan -- Bottom View
Courtesy of GENERAL MOTORS COMPANY

Upper Oil Pan - Bottom View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907
2	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14

Upper Oil Pan - Front View

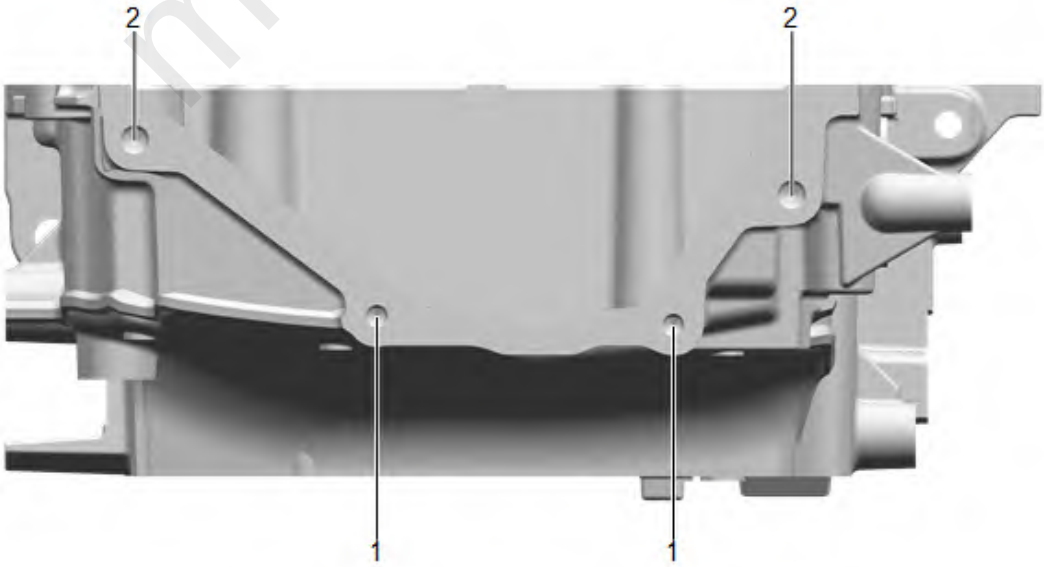


Fig. 17: Upper Oil Pan -- Front View
Courtesy of GENERAL MOTORS COMPANY

Upper Oil Pan - Front View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M10x1.5	216	211	212	213	214	34.0	1.35	34.0	1.35
2	M8x1.25	181213	206	207	208	209	29.0	1.14	29.0	1.14

Upper Oil Pan - Back View

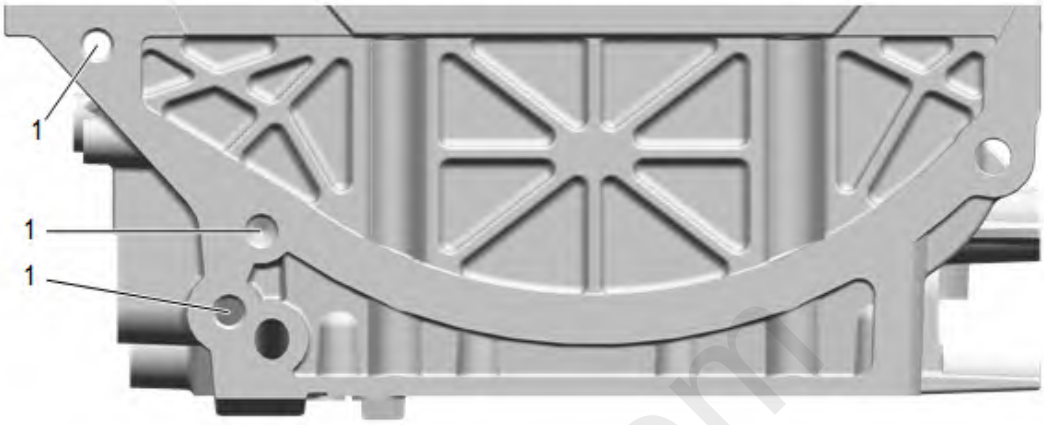


Fig. 18: Upper Oil Pan -- Back View
Courtesy of GENERAL MOTORS COMPANY

Upper Oil Pan - Back View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M6x1.0	161031	201	202	203	204	23.0	0.907	23.0	0.907

Engine Front Cover - Top View

mcx30.com

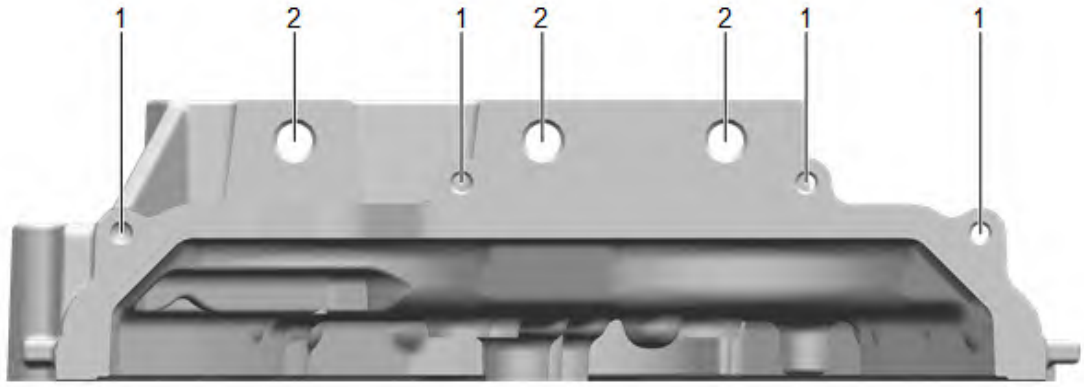


Fig. 19: Engine Front Cover -- Top View
Courtesy of GENERAL MOTORS COMPANY

Engine Front Cover - Top View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385							MM	(IN)	MM	(IN)
1	M5x0.8	3005	3001	3002	3003	3004	23.0	0.907	23.0	0.907
2	M6x1.0	205	201	202	203	204	23.0	0.907	23.0	0.907

Engine Front Cover - Front View

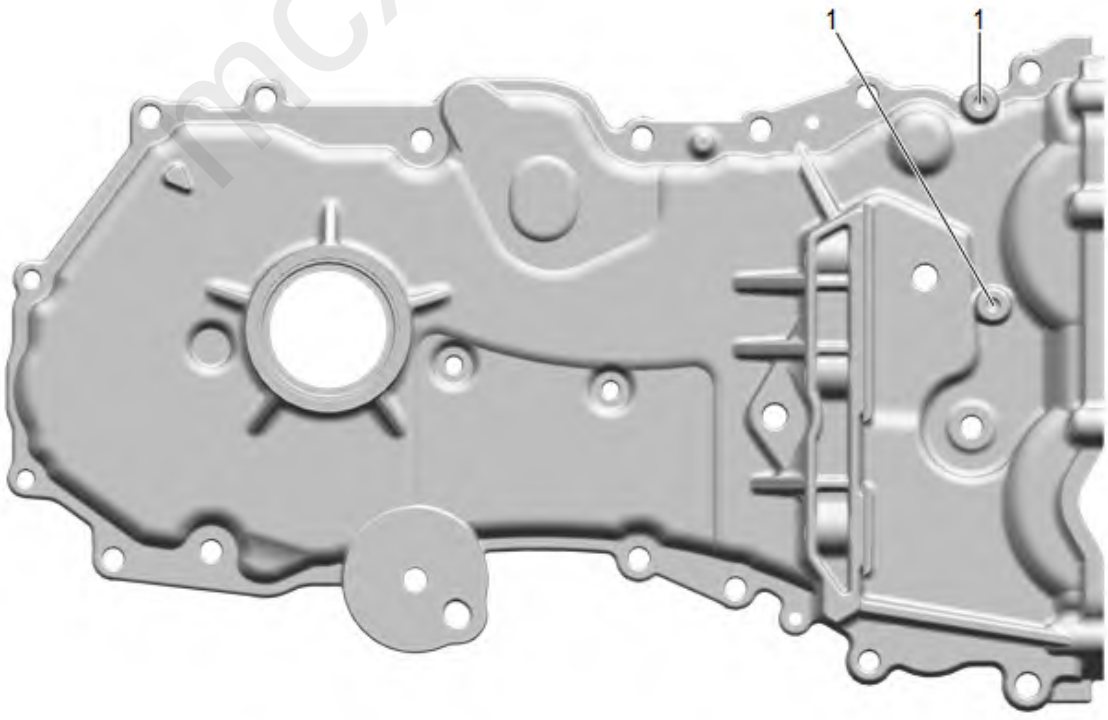


Fig. 20: Engine Front Cover -- Front View
Courtesy of GENERAL MOTORS COMPANY

Engine Front Cover - Front View

Service Call Out	Thread Size	Insert	Drill	Counterbore Tool	Tap	Driver	Drill Depth (Maximum)		Tap Depth (Maximum)	
EN 42385 - 850							MM	(IN)	MM	(IN)
1	M6x1.0	16105	201	202	203	204	23.0	0.907	23.0	0.907
2	M6x1.0	420	201	202	203	204	23.0	0.907	23.0	0.907

SCHEMATIC WIRING DIAGRAMS

ENGINE MECHANICAL WIRING SCHEMATICS (2.0L (LTG))

Oil Pressure Control (LTG)

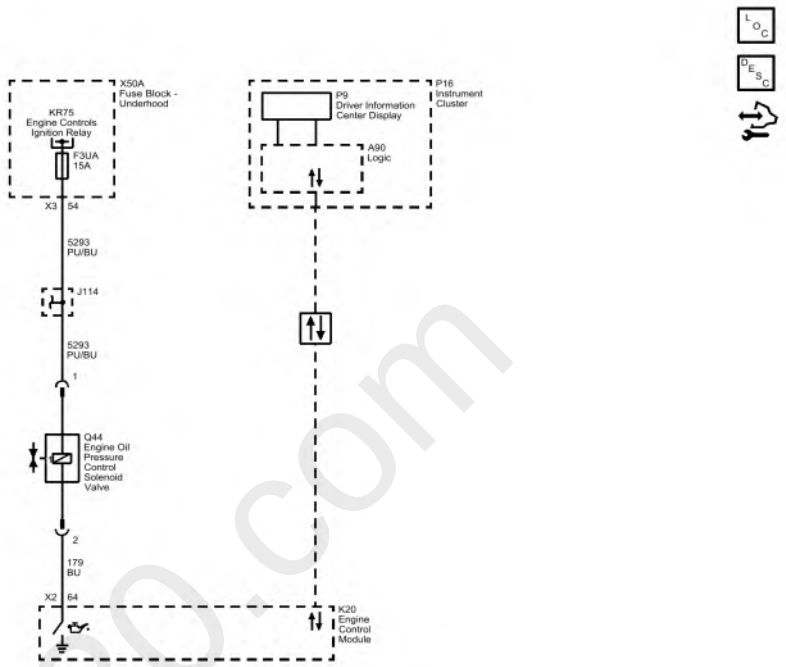


Fig. 21: Oil Pressure Control (LTG)
Courtesy of GENERAL MOTORS COMPANY

COMPONENT LOCATOR

DISASSEMBLED VIEWS

Camshaft Cover and Components

mcx30.com

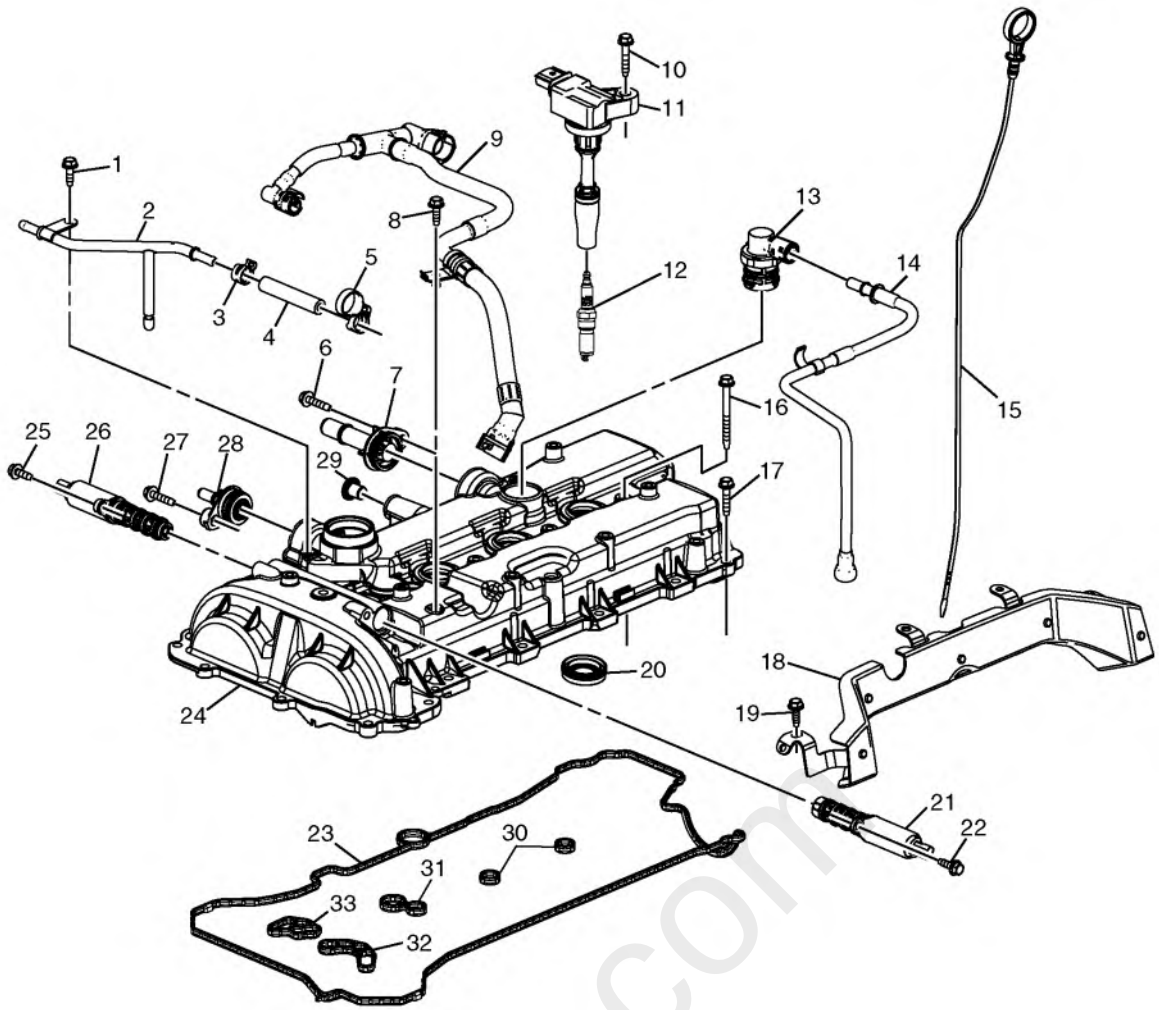


Fig. 22: Camshaft Cover and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Coolant Air Bleed Pipe Bolt
2	Engine Coolant Air Bleed Pipe
3	Engine Coolant Air Bleed Hose Clamp
4	Engine Coolant Air Bleed Hose
5	Engine Coolant Air Bleed Hose Clamp
6	PCV Valve Bolt
7	PCV Valve
8	PCV Tube Assembly Bolt
9	PCV Tube Assembly
10	Ignition Coil Bolt
11	Ignition Coil
12	Spark Plug
13	PCV Valve Assembly
14	PCV Tube Assembly
15	Oil Level Indicator
16	Camshaft Cover Bolt
17	Camshaft Cover Bolt
18	Camshaft Housing Cover Heat Shield
19	Camshaft Housing Cover Heat Shield Bolt
20	Spark Plug Shield Seal
21	Camshaft Position Actuator Control Solenoid Valve - Exhaust
22	Camshaft Position Actuator Control Solenoid Valve Bolt - Exhaust
23	Camshaft Cover Gasket
24	Camshaft Cover

Callout	Component Name
25	Camshaft Position Actuator Control Solenoid Valve Bolt - Intake
26	Camshaft Position Actuator Control Solenoid Valve - Intake
27	PCV Valve Bolt
28	PCV Valve
29	Camshaft Cover Plug
30	Camshaft Cover Inner Gasket
31	Camshaft Cover Inner Gasket
32	Exhaust Camshaft Cover Gasket
33	Intake Camshaft Cover Gasket

Cylinder Head and Components

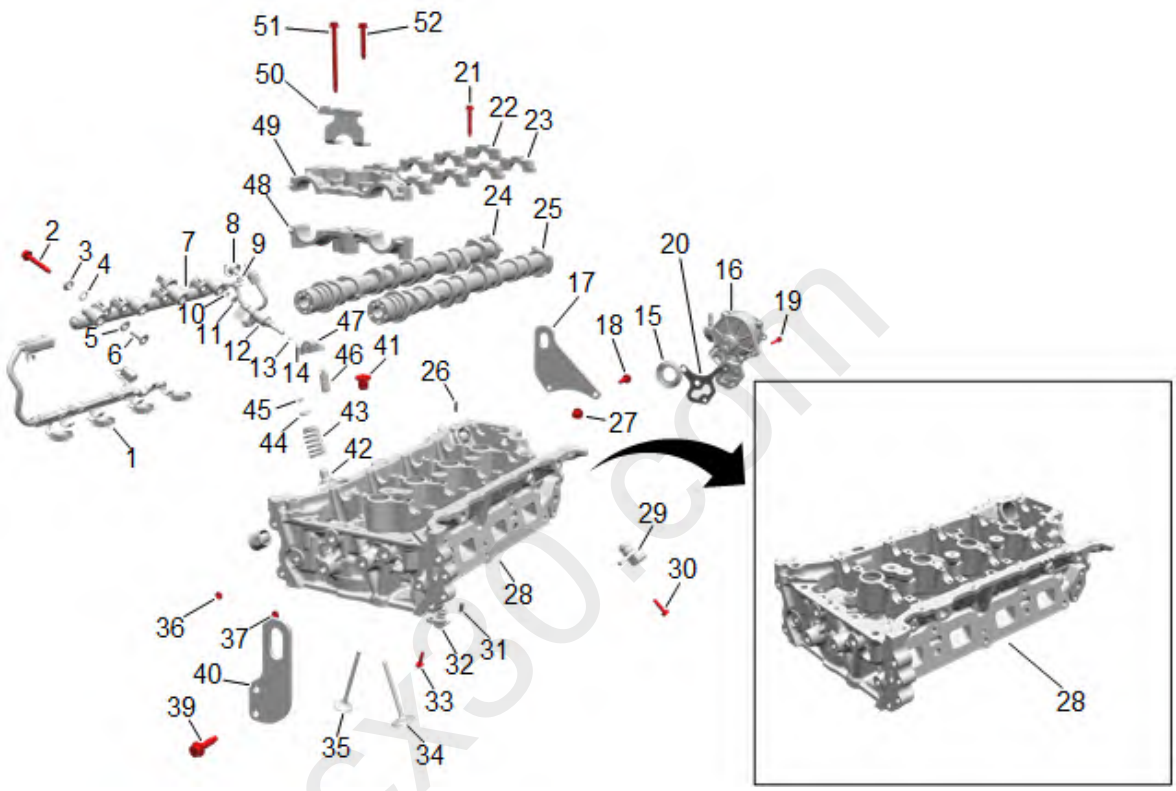


Fig. 23: Cylinder Head and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Fuel Injector Wiring Harness
2	Fuel Injection Fuel Rail Bolt
3	Fuel Rail Insulator Bushing
4	Fuel Rail Insulator Washer
5	Fuel Rail Insulator Washer
6	Fuel Rail Insulator Sleeve
7	Fuel Injection Fuel Rail
8	Fuel Injector Holding Clamp
9	Fuel Injector Retainer
10	Fuel Injection Fuel Rail O-Ring Seal
11	Fuel Injector Seal Spacer
12	Direct Fuel Injector Assembly
13	Fuel Injector Nozzle Housing Seal
14	Fuel Injector Nozzle Housing Seal
15	Vacuum Pump Seal
16	Vacuum Pump Assembly
17	Engine Rear Lift Bracket
18	Engine Rear Lift Bracket Bolt

Callout	Component Name
19	Vacuum Pump Bolt
20	Vacuum Pump Gasket
21	Camshaft Bearing Cap Bolt
22	Camshaft Bearing Cap
23	Camshaft Bearing Cap
24	Intake Camshaft
25	Exhaust Camshaft
26	Cylinder Head Locating Pin
27	Cylinder Head Oil Gallery Plug
28	Cylinder Head
29	Camshaft Position Sensor
30	Camshaft Position Sensor Bolt
31	Cylinder Head Oil Gallery Restrictor
32	Camshaft Position Sensor
33	Camshaft Position Sensor Bolt
34	Intake Valve
35	Exhaust Valve
36	Cylinder Head Oil Gallery Plug
37	Cylinder Head Oil Gallery Plug
38	Engine Front Lift Bracket Bolt
39	Engine Front Lift Bracket
40	Valve Lifter Follower
41	Cylinder Head Core Hole Plug
42	Valve Stem Oil Seal
43	Valve Spring
44	Valve Spring Retainer
45	Valve Stem Key
46	Hydraulic Valve Lash Adjuster
47	Valve Rocker Arm
48	Camshaft Bearing Front Lower Cap
49	Camshaft Bearing Front Cap
50	Timing Chain Cam to Cam Guide
51	Camshaft Bearing Cap Bolt
52	Timing Chain Guide Bolt

mcx30.com

Intake Manifold and Components

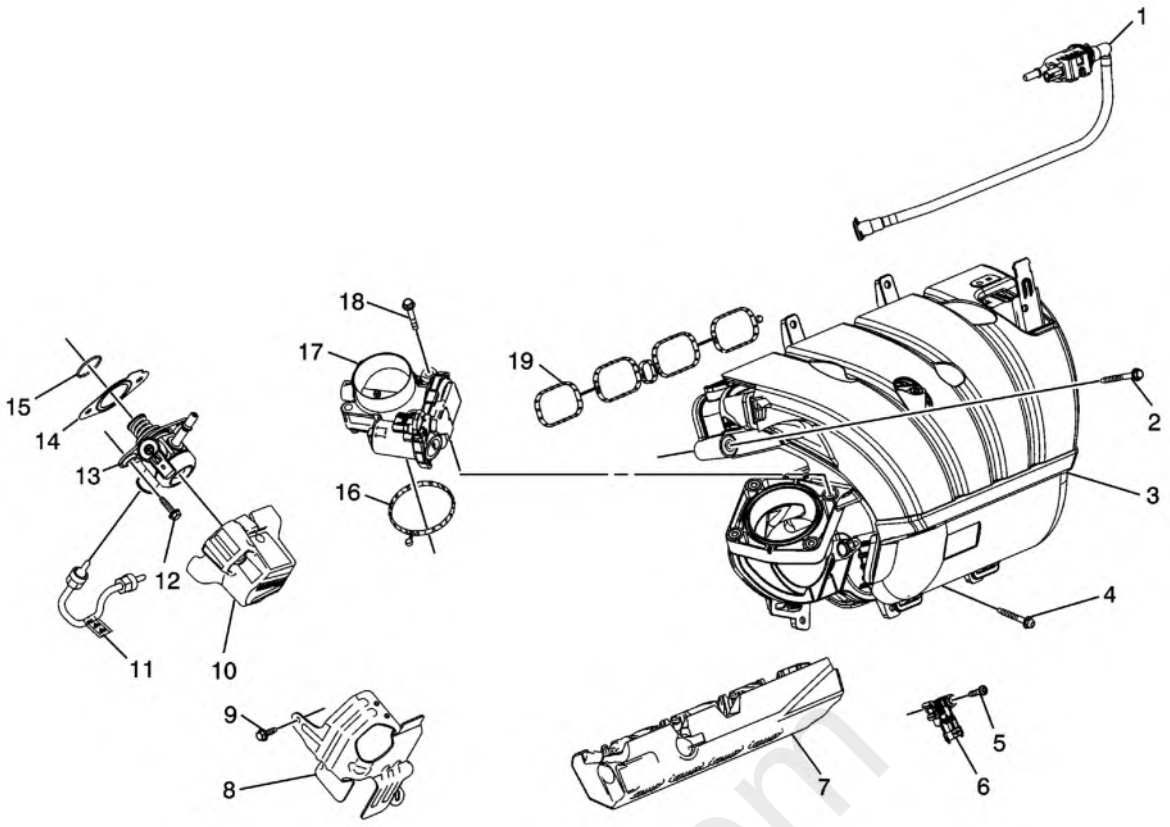


Fig. 24: Intake Manifold and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Evaporative Emission Canister Purge Valve Assembly
2	Intake Manifold Bolt
3	Intake Manifold
4	Intake Manifold Bolt
5	Manifold Absolute Pressure (MAP) Sensor Bolt
6	Manifold Absolute Pressure (MAP) Sensor
7	Fuel Rail Noise Shield
8	Fuel Pump Cover
9	Fuel Pump Cover Bolt
10	Fuel Pump Insulator
11	Fuel Feed Intermediate Pipe Assembly
12	Fuel Pump Bolt
13	Fuel Pump
14	Fuel Pump Housing Gasket
15	Fuel Pump Housing O-Ring Seal
16	Throttle Body Assembly Gasket
17	Throttle Body Assembly
18	Throttle Body Assembly Bolt
19	Intake Manifold Gasket

Turbocharger and Components

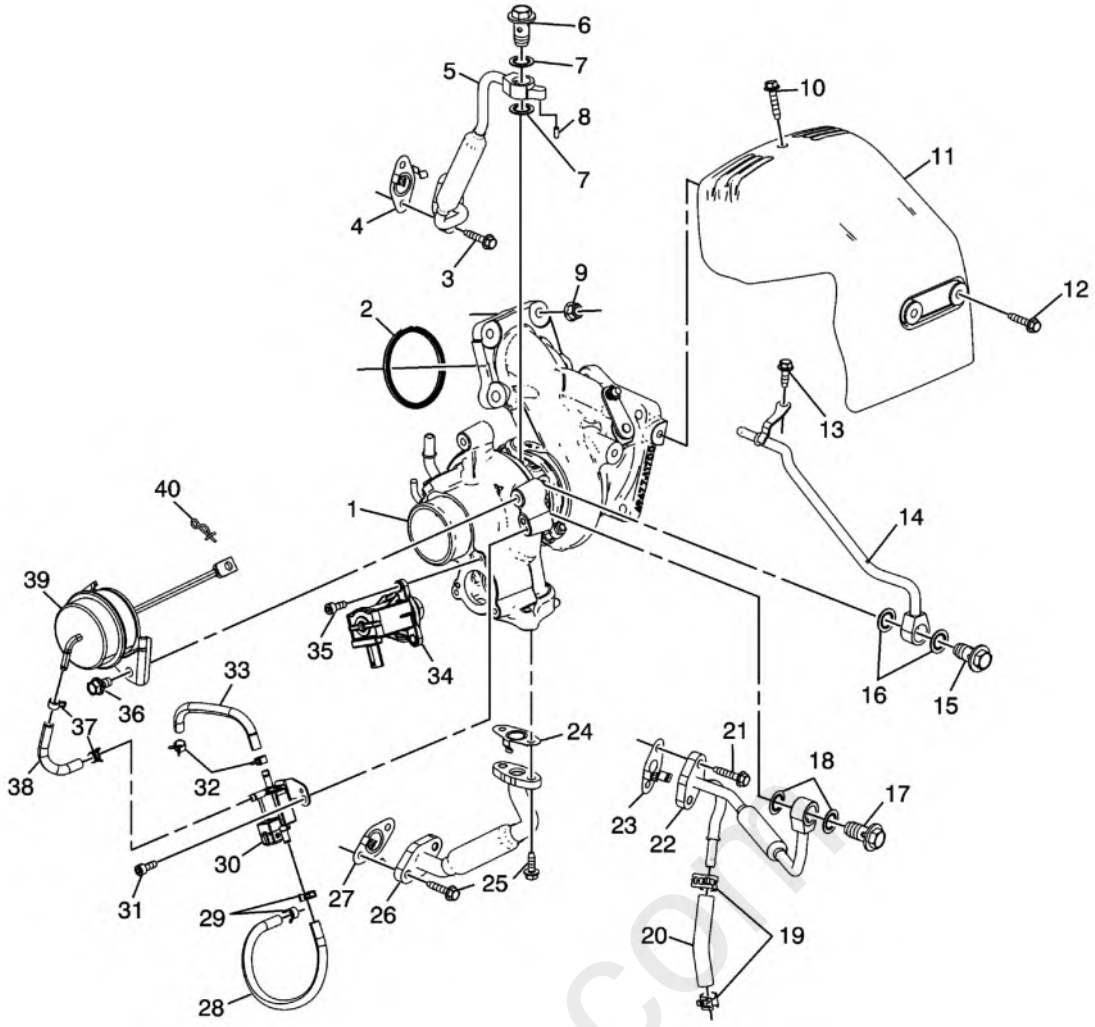


Fig. 25: Turbocharger and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Turbocharger
2	Turbocharger Gasket
3	Turbocharger Oil Feed Pipe Bolt
4	Turbocharger Oil Feed Pipe Gasket
5	Turbocharger Oil Feed Pipe Assembly
6	Turbocharger Oil Feed Pipe Bolt
7	Turbocharger Oil Feed Pipe Washer
8	Turbocharger Oil Feed Pipe Anti-Rotate Roll Pin
9	Turbocharger Nut
10	Turbocharger Heat Shield Bolt
11	Turbocharger Heat Shield
12	Turbocharger Heat Shield Bolt
13	Turbocharger Coolant Return Pipe Bolt
14	Turbocharger Coolant Return Pipe Assembly
15	Turbocharger Coolant Return Pipe Bolt
16	Turbocharger Coolant Return Pipe Washer
17	Turbocharger Coolant Feed Pipe Bolt
18	Turbocharger Coolant Feed Pipe Washer
19	Turbocharger Coolant Feed Hose Clamp
20	Turbocharger Coolant Feed Hose
21	Turbocharger Coolant Feed Pipe Bolt
22	Turbocharger Coolant Feed Pipe Assembly
23	Turbocharger Coolant Feed Pipe Gasket
24	Turbocharger Oil Return Pipe Gasket

Callout	Component Name
25	Turbocharger Oil Return Pipe Bolt
26	Turbocharger Oil Return Pipe Assembly
27	Turbocharger Oil Return Pipe Gasket
28	Turbocharger Wastegate Regulator Solenoid Valve Hose
29	Turbocharger Wastegate Regulator Solenoid Valve Hose Clamp
30	Turbocharger Wastegate Regulator Solenoid Valve
31	Turbocharger Wastegate Regulator Solenoid Valve Bolt
32	Turbocharger Wastegate Regulator Solenoid Valve Hose Clamp
33	Turbocharger Wastegate Regulator Solenoid Valve Hose
34	Turbocharger Air Bypass Valve Solenoid
35	Turbocharger Air Bypass Valve Solenoid Bolt
36	Turbocharger Wastegate Actuator Bolt
37	Turbocharger Wastegate Actuator Hose Clamp
38	Turbocharger Wastegate Actuator Hose
39	Turbocharger Wastegate Actuator
40	Turbocharger Wastegate Actuator Arm Retaining Clip

Exhaust Manifold and Components

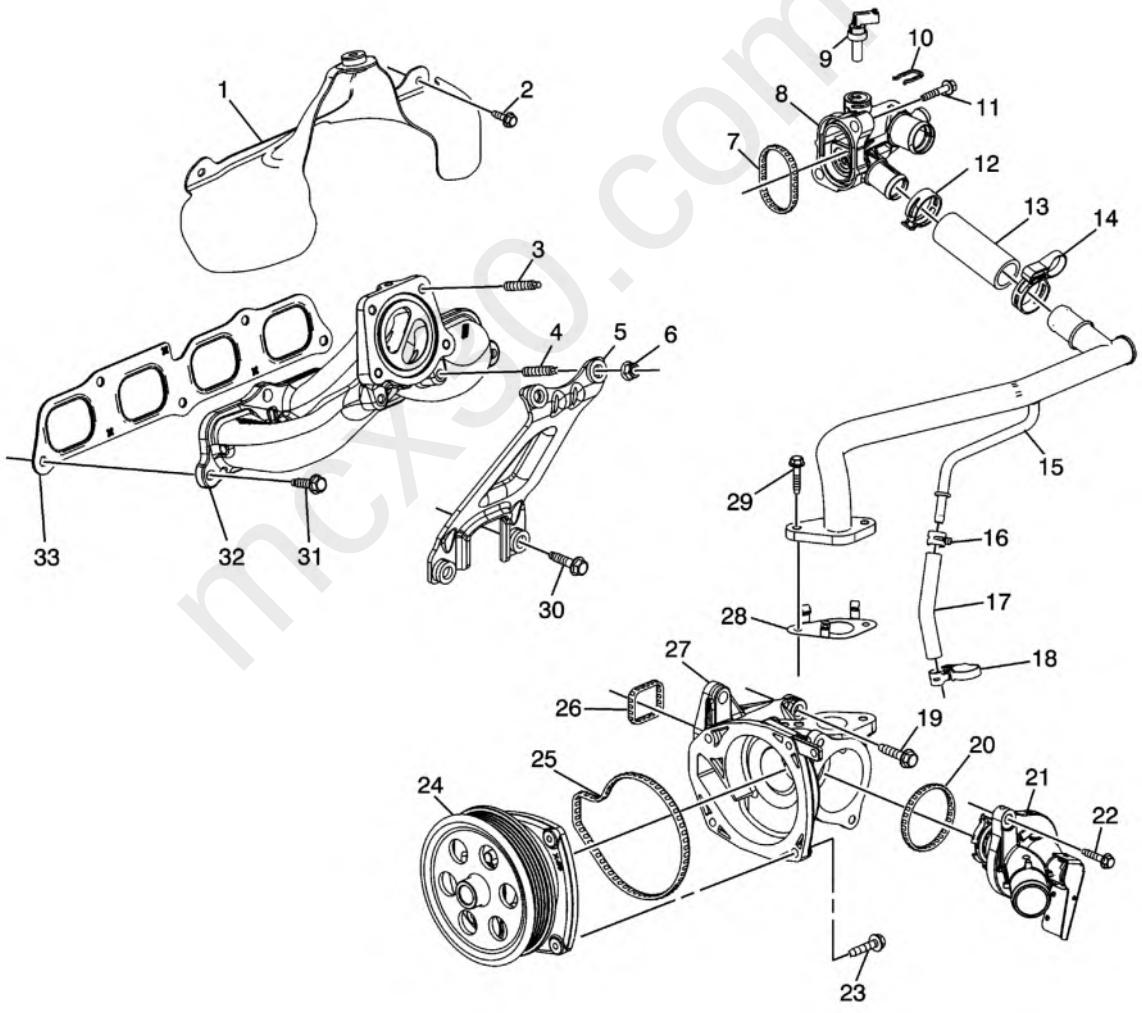


Fig. 26: Exhaust Manifold and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Exhaust Manifold Heat Shield
2	Exhaust Manifold Heat Shield Bolt
3	Exhaust Manifold Stud
4	Exhaust Manifold Stud
5	Exhaust Manifold Brace

Callout	Component Name
6	Exhaust Manifold Brace Nut
7	Water Outlet Gasket
8	Water Outlet
9	Engine Coolant Temperature Sensor
10	Engine Coolant Temperature Sensor Retainer
11	Water Outlet Bolt
12	Thermal Bypass Hose Clamp
13	Thermal Bypass Hose
14	Thermal Bypass Hose Clamp
15	Thermal Bypass Pipe
16	Engine Oil Cooler Coolant Outlet Hose Clamp
17	Engine Oil Cooler Coolant Outlet Hose
18	Engine Oil Cooler Coolant Outlet Hose Clamp
19	Water Pump Bolt
20	Engine Coolant Thermostat Housing Gasket
21	Engine Coolant Thermostat Housing
22	Engine Coolant Thermostat Housing Bolt
23	Water Pump Housing Bolt
24	Water Pump Front Housing
25	Water Pump Inlet Gasket
26	Water Pump Gasket
27	Water Pump Rear Housing
28	Thermal Bypass Pipe Gasket
29	Thermal Bypass Pipe Bolt
30	Exhaust Manifold Brace Bolt
31	Exhaust Manifold Bolt
32	Exhaust Manifold
33	Exhaust Manifold Gasket

mcx30.com

Engine Block and Components

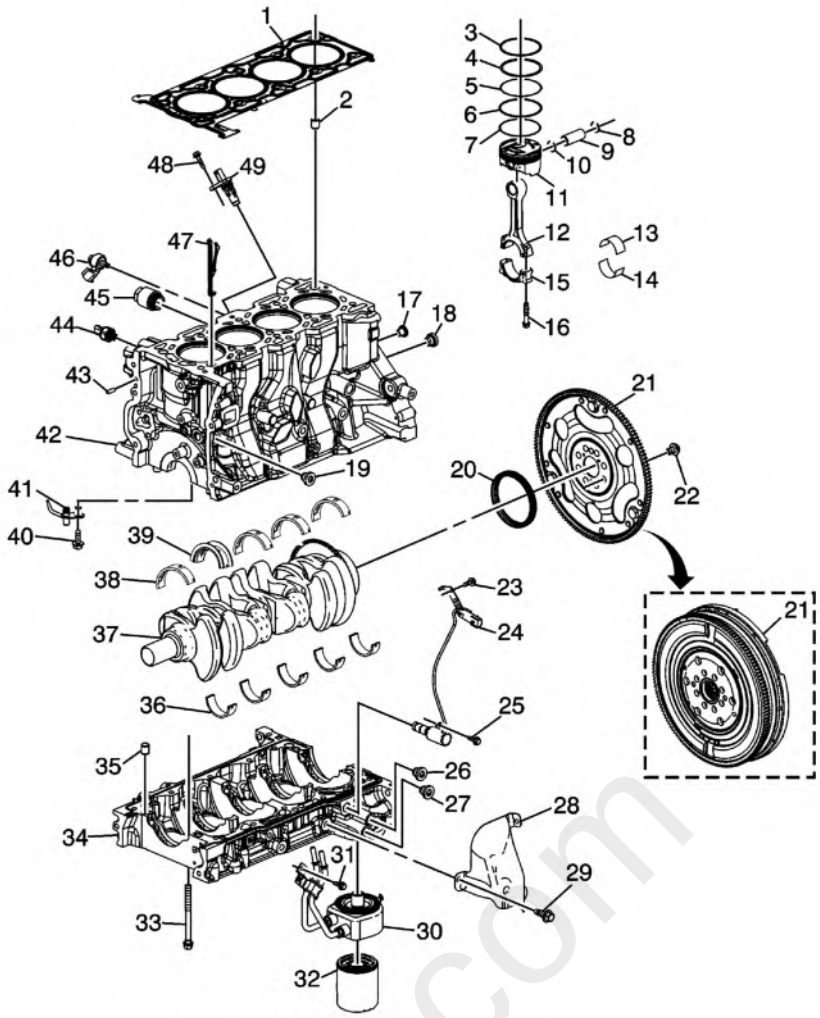


Fig. 27: Engine Block and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Cylinder Head Gasket
2	Cylinder Head Locating Pin
3	Piston Upper Compression Ring
4	Piston Lower Compression Ring
5	Piston Oil Ring Rail
6	Piston Oil Ring Rail Spacer
7	Piston Oil Ring Rail
8	Piston Pin Retainer
9	Piston Pin
10	Piston Pin Retainer
11	Piston
12	Connecting Rod
13	Connecting Rod Bearing
14	Connecting Rod Bearing
15	Connecting Rod Cap
16	Connecting Rod Bolt
17	Engine Block Oil Gallery Plug
18	Engine Block Oil Gallery Plug
19	Engine Block Oil Gallery Plug
20	Crankshaft Rear Oil Seal
21	Automatic Transmission Flex Plate
22	Automatic Transmission Flex Plate Bolt
23	Oil Pump Flow Control Valve Assembly Bolt
24	Oil Pump Flow Control Valve Assembly

Callout	Component Name
25	Oil Pump Flow Control Valve Assembly Bolt
26	Engine Block Oil Gallery Plug
27	Engine Block Oil Gallery Plug
28	Oil Pump and Compressor Heat Shield
29	Oil Pump and Compressor Heat Shield Bolt
30	Engine Oil Cooler Assembly
31	Engine Oil Cooler Assembly Bolt
32	Oil Filter
33	Lower Crankcase Bolt
34	Lower Crankcase
35	Lower Crankcase Locating Pin
36	Crankshaft Lower Bearing
37	Crankshaft
38	Crankshaft Upper Bearing
39	Crankshaft Upper Thrust Bearing
40	Piston Oil Nozzle Bolt
41	Piston Oil Nozzle
42	Engine Block
43	Engine Front Cover Locating Pin
44	Engine Oil Pressure Sensor
45	Engine Coolant Heater
46	Knock Sensor
47	Engine Block Coolant Baffle
48	Crankshaft Position Sensor Bolt
49	Crankshaft Position Sensor

Upper and Lower Oil Pan and Components - FWD

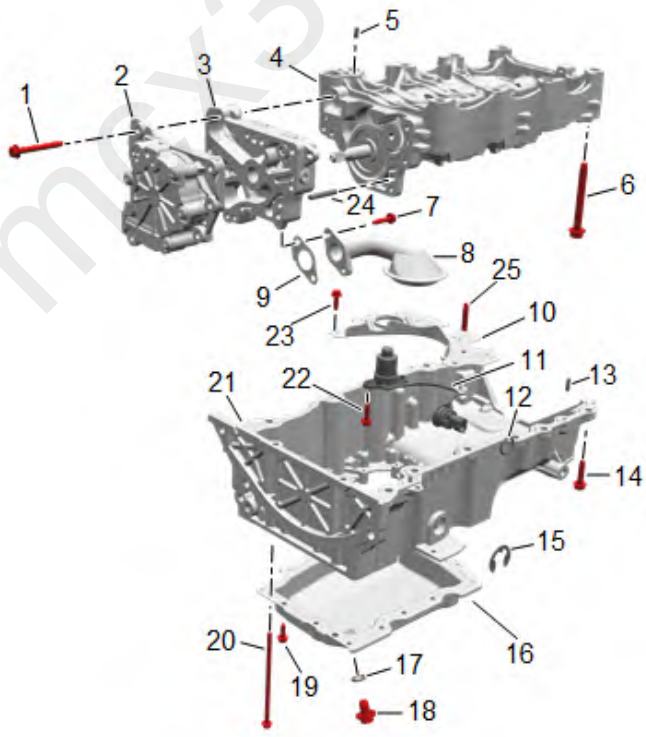


Fig. 28: Upper and Lower Oil Pan & Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Pump Assembly Bolt
2	Oil Pump Assembly

Callout	Component Name
3	Oil Pump Cover
4	Balancer Shaft Module
5	Balancer Shaft Housing Locating Pin
6	Balancer Shaft Housing Bolt
7	Oil Pump Suction Pipe Bolt
8	Oil Pump Screen Assembly with Suction Pipe
9	Oil Pump Screen Gasket
10	Oil Pan Baffle
11	Engine Oil Level Indicator Switch
12	Engine Oil Level Indicator Seal
13	Oil Pan Locating Pin
14	Oil Pan Bolt
15	Engine Oil Level Sensor Lead Clip
16	Lower Oil Pan
17	Oil Pan Drain Plug Seal
18	Oil Pan Drain Plug
19	Oil Pan Bolt
20	Oil Pan Bolt
21	Upper Oil Pan
22	Engine Oil Level Indicator Switch Bolt
23	Oil Pan Baffle Bolt
24	Oil Pump Locating Pin

Upper and Lower Oil Pan and Components - AWD

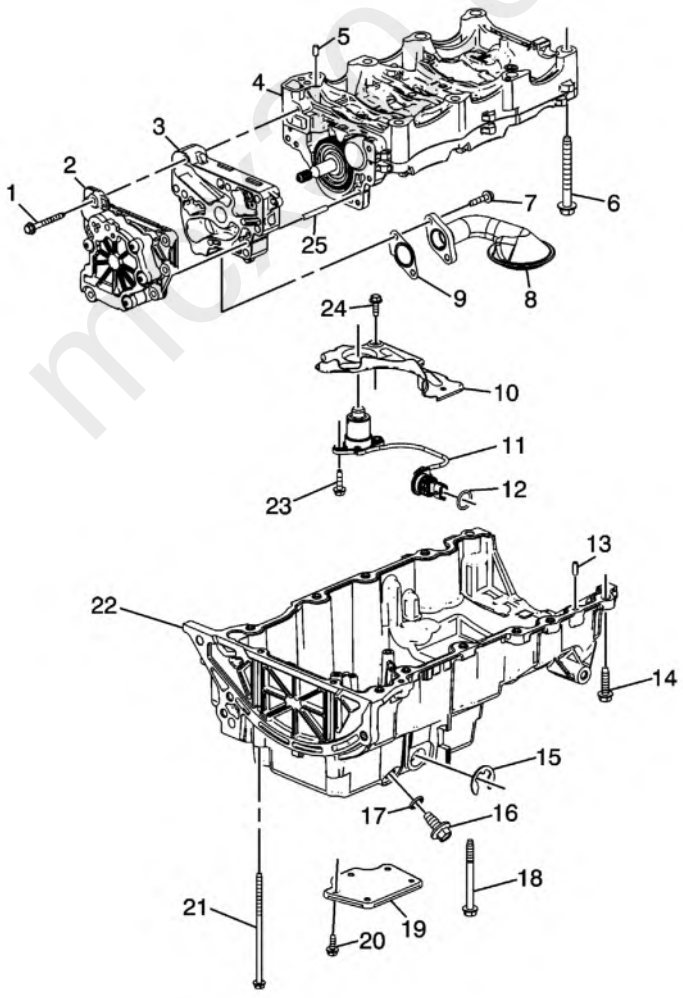


Fig. 29: Upper and Lower Oil Pan and Components - AWD
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Pump Assembly Bolt
2	Oil Pump Assembly
3	Oil Pump Cover
4	Balancer Shaft Module
5	Balancer Shaft Housing Locating Pin
6	Balancer Shaft Housing Bolt
7	Oil Pump Suction Pipe Bolt
8	Oil Pump Screen Assembly with Suction Pipe
9	Oil Pump Screen Gasket
10	Oil Pan Baffle
11	Engine Oil Level Indicator Switch
12	Engine Oil Level Indicator Seal
13	Oil Pan Locating Pin
14	Oil Pan Bolt
15	Engine Oil Level Sensor Lead Clip
16	Oil Pan Drain Plug
17	Oil Pan Drain Plug Seal
18	Oil Pan Bolt
19	Oil Pan Cover
20	Oil Pan Cover Bolt
21	Oil Pan Bolt
22	Upper Oil Pan
23	Engine Oil Level Indicator Switch Bolt
24	Oil Pan Baffle Bolt
25	Oil Pump Locating Pin

Timing Chain and Components

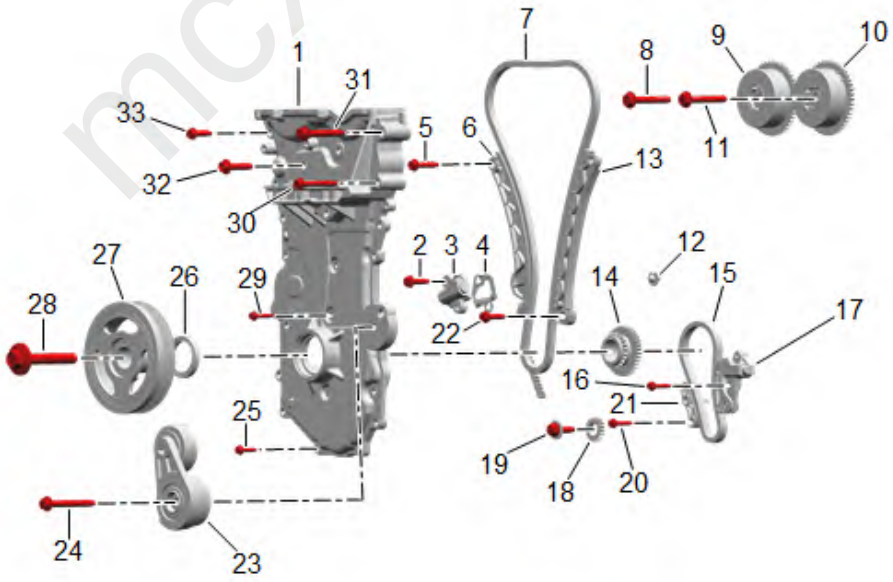


Fig. 30: Timing Chain and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Front Cover
2	Timing Chain Tensioner Bolt

Callout	Component Name
3	Timing Chain Tensioner
4	Timing Chain Tensioner Gasket
5	Timing Chain Tensioner Pivot Arm Bolt
6	Timing Chain Tensioner Pivot Arm
7	Timing Chain
8	Camshaft Position Actuator Bolt
9	Intake Camshaft Position Actuator
10	Exhaust Camshaft Position Actuator
11	Camshaft Position Actuator Bolt
12	Timing Chain Oil Nozzle
13	Timing Chain Guide
14	Crankshaft Sprocket
15	Balancer Chain
16	Balancer Chain Tensioner Bolt
17	Balancer Chain Tensioner
18	Balancer Shaft Driven Sprocket
19	Balancer Shaft Sprocket Bolt
20	Balancer Chain Guide Bolt
21	Balancer Chain Guide
22	Timing Chain Guide Bolt
23	Drive Belt Tensioner
24	Drive Belt Tensioner Bolt
25	Engine Front Cover Bolt
26	Crankshaft Front Oil Seal
27	Crankshaft Balancer
28	Crankshaft Balancer Bolt
29	Engine Front Cover Bolt
30	Engine Front Cover Bolt
31	Timing Chain Tensioner Cover
32	Timing Chain Tensioner Cover Bolt
33	Engine Front Cover Bolt
34	Engine Front Cover Bolt
35	Engine Front Cover Bolt

ENGINE IDENTIFICATION

mo130.com

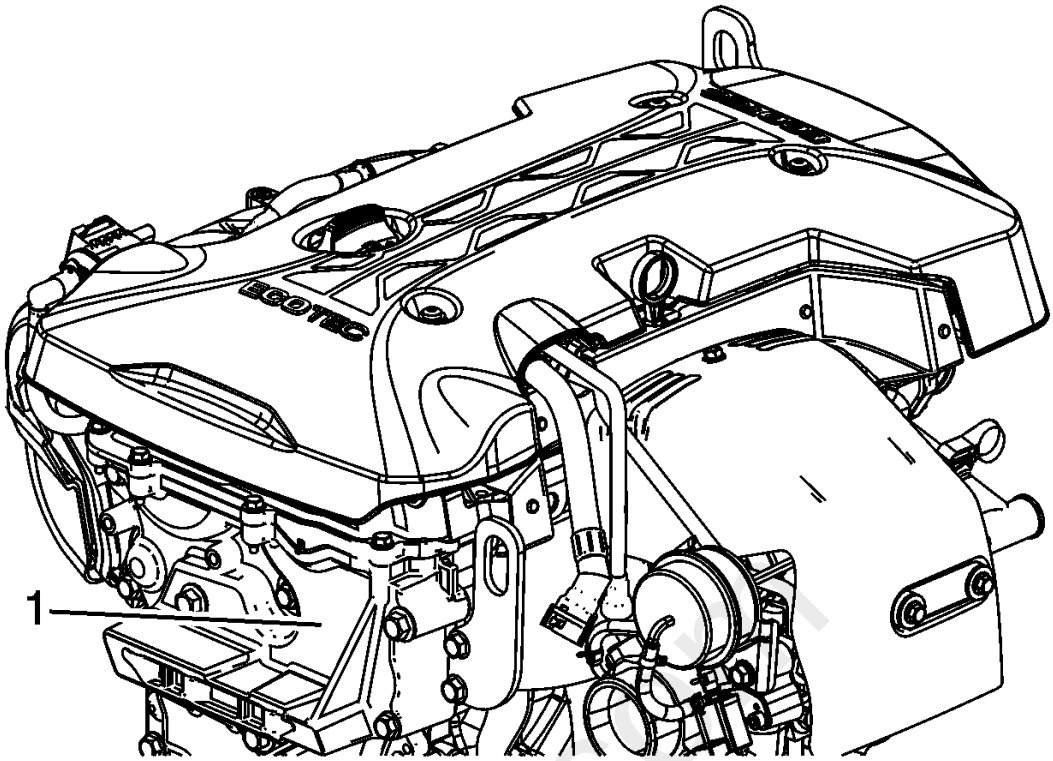


Fig. 31: Engine Identification (LTG)
Courtesy of GENERAL MOTORS COMPANY

Identification can be made through the use of the Engine Traceability label (1) on the engine.

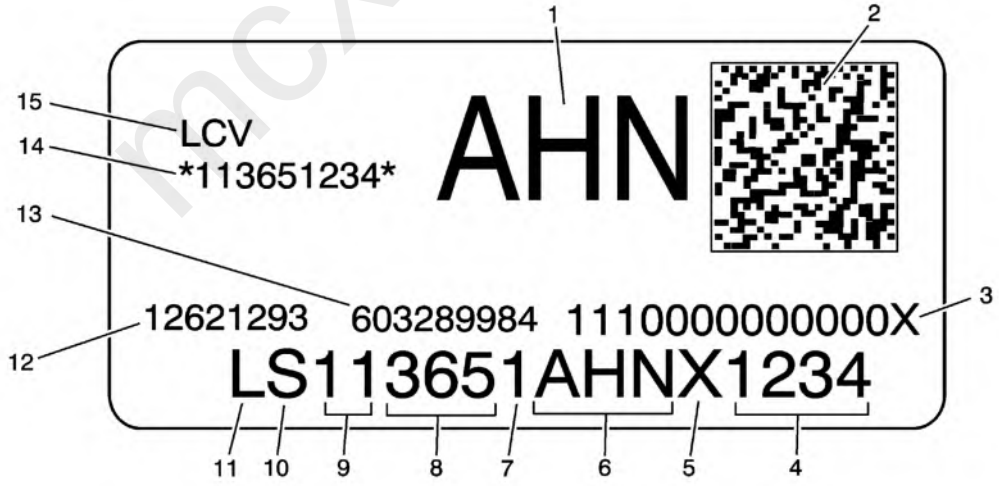


Fig. 32: Engine Traceability Label
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Broadcast Code
2	Machine Readable 2D Matrix
3	VPPS Code
4	Part Sequence Number
5	Reserved Use
6	Broadcast Code
7	Model Year

Callout	Component Name
8	Julian Date
9	Build Year
10	Shift ID
11	Plant ID
12	GM Part Number
13	Plant DUNS Number
14	Sequence Number
15	RPO/Engine Family Code

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P06DA-P06DC: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE CONTROL

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 P06DA

Engine Oil Pressure Control Solenoid Valve Control Circuit

DTC P06DB

Engine Oil Pressure Control Solenoid Valve Control Circuit Low Voltage

DTC P06DC

Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open / High Resistance	Short to Voltage	Signal Performance
Ignition	P0130, P0135, P0443, P0458, P06DA, P06DB, P16CF, P16D2, P2645, P2648	P06DA, P06DB	-	-
Control	P06DB	P06DA	P06DC	P06DD, P06DE

Circuit/System Description

The engine oil pressure control solenoid is a two port solenoid valve used to control engine oil pressure inside the mechanical engine oil pump. The ECM controls the commanded states of the engine oil pressure control solenoid with the following ECM inputs.

- Engine Speed
- Engine Oil Temperature (calculated from the Engine Coolant Temperature Sensor)
- Engine Oil Pressure
- Engine Run Time

With the engine oil pressure control solenoid commanded Off, engine oil pressure is higher. When commanded On engine oil pressure is lower. The purpose of this diagnostic is to isolate an electrical problem with the engine oil pressure control solenoid or wiring.

Conditions for Running the DTC

mcx30.com

- The system voltage is greater than 11 V.
- Engine is running

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for a minimum of 0.25 s.

Action Taken When the DTC Sets

- DTC P06DB is a Type A DTC.
- DTC P06DA and P06DC are Type B DTCs.
- ECM commands the engine oil pressure control solenoid valve Off.
- ECM commands Reduced Engine Power.

Conditions for Clearing the MIL/DTC

- DTC P06DB is a Type A DTC.
- DTC P06DA and P06DC are Type B DTCs.

Reference Information

Schematic Reference

Engine Mechanical Wiring Schematics (2.0L (LTG))

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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. Ignition ON.
2. Verify the parameters listed below do not display Malfunction when commanding the Engine Oil Pressure Control Solenoid Valve On/Decrease and Off/Increase with a scan tool.
    - Engine Oil Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status
    - Engine Oil Pressure Control Solenoid Valve Control Circuit Open Test Status
    - Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

      Refer to Circuit/System Testing.

    - **Go to next step: If Malfunction is not displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

mcx30.com

4. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **Go to next step: If the DTC is not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q44 Engine Oil Pressure Control Solenoid Valve, ignition ON.
2. Verify that a test lamp illuminates between the ignition circuit terminal 1 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF, remove the test lamp.
    2. Test for less than 2 Ω in the ignition circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF, remove the test lamp.

       NOTE: **An short to ground in any circuit or shorted component supplied voltage by the fuse may cause the fuse to open and set a DTC.**

    2. Test for infinite resistance between the ignition circuit and ground
        - If less than infinite resistance, repair the short to ground in the circuit.
        - If infinite resistance, test all the components connected to fuse and replace as necessary.
    - **Go to next step: If the test lamp illuminates**
3. Verify that a test lamp does not illuminate between the ignition circuit terminal 1 and the control circuit terminal 2.
    - **If the test lamp illuminates**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **Go to next step: If the test lamp does not illuminate**
4. Remove the test lamp, command the Q44 Engine Oil Pressure Control Solenoid Valve On with a scan tool.
5. Verify the scan tool Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status parameter displays OK.
    - **If OK is not displayed**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **Go to next step: If OK is displayed**
6. Install a 3 A fused jumper wire between the control circuit terminal 2 and the ignition circuit terminal 1.
7. Verify the scan tool Engine Oil Pressure Control Solenoid Valve Circuit High Voltage Test Status parameter displays Malfunction when commanding the Engine Oil Pressure Control Solenoid Valve On.
    - **If Malfunction is not displayed**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω replace the K20 Engine Control Module.
    - **Go to next step: If Malfunction is displayed**

mr30.com

8. Test or replace the Q44 Engine Oil Pressure Control Solenoid Valve.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the Q44 Engine Oil Pressure Control Solenoid Valve.
2. Test for 10 - 30 Ω between the control terminal 2 and the ignition voltage terminal 1.
    - **If not between 10.0-30.0 Ω**

      Replace the Q44 Engine Oil Pressure Control Solenoid Valve.

    - **Go to next step: If between 10.0-30.0 Ω**
3. Test for infinite resistance between each terminal and the Q44 Engine Oil Pressure Control Solenoid Valve housing.
    - **If not infinite**

      Replace the Q44 Engine Oil Pressure Control Solenoid Valve.

    - **Go to next step: If infinite**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Oil Pump Flow Control Valve Replacement** for engine oil pressure control solenoid valve replacement.
- **Control Module References** for engine control module replacement, programming, and setup.

DTC P06DD OR P06DE: ENGINE OIL PRESSURE CONTROL SOLENOID VALVE STUCK OFF/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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P06DD

Engine Oil Pressure Control Solenoid Valve Stuck Off

DTC P06DE

Engine Oil Pressure Control Solenoid Valve Stuck On

Circuit/System Description

The engine oil pressure control solenoid is a two port solenoid valve used to control engine oil pressure inside the mechanical engine oil pump. The ECM controls the commanded states of the engine oil pressure control solenoid with the following ECM input's.

- Engine Speed
- Engine Oil Temperature (calculated from the Engine Coolant Temperature Sensor)
- Engine Oil Pressure
- Engine Run Time

With the engine oil pressure control solenoid commanded Off, engine oil pressure is higher. When commanded On engine oil pressure is lower. The purpose of this diagnostic is to isolate either a stuck on or stuck off engine oil pressure control solenoid.

Conditions for Running the DTC

mcx30.com

P06DD

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0335, P0336, P0521, P0522, P0523, P06DA, P06DB, P06DC, P06DD, P06DE, P111E, P2227, P2228, P2229 or P2230 is not set.
- Engine speed within range of 1, 500 RPM to 2, 500 RPM.

P06DE

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0335, P0336, P0521, P0522, P0523, P06DA, P06DB, P06DC, P06DD, P06DE, P111E, P2227, P2228, P2229 or P2230 is not set.
- Engine running for greater than 20 s.
- Engine speed is within range of 1500 RPM to 2500 RPM.
- Engine oil pressure control solenoid in low pressure for greater than 1.5 s.

Conditions for Setting the DTC

P06DD or P06DE

Engine oil pressure is above or below a calibrated amount during the time the solenoid is changing from ON to OFF states.

Action Taken When the DTC Sets

P06DD

DTC P06DD is a Type B DTC.

P06DE

DTC P06DE is a Type A DTC.

- Reduced Engine Power = Active
- P16 Instrument Cluster = Reduced Engine Power
- Q44 Engine Oil Pressure Control Solenoid Valve = Inactive
- Engine Oil Pressure = High

Conditions for Clearing the DTC

P06DD

DTC P06DD is a Type B DTC.

P06DE

DTC P06DE is a Type A DTC.

Reference Information

Schematic Reference

Engine Mechanical Schematics (2.0L (LTG))

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

mc730.com

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **The engine oil level and condition has a major impact on the engine oil pressure control system. Debris in the oil can interfere with the engine oil pressure control solenoid valve operation. Inspect for dirty or degraded crankcase oil. The engine may require an oil change. Inquire with the customer when the last oil change was performed. You may also monitor the scan tool Engine Oil Life Remaining parameter. Advise the customer an oil change may be required.**

1. Verify correct engine oil level and condition.
2. Engine Running, increase and maintain the engine speed at 1, 800 RPM.

   NOTE: **Selecting the scan tool line graph function may make it easier to identify Engine Oil Pressure changes.**

3. Verify the scan tool Engine Oil Pressure parameter changes greater than 30 kPa (4 PSI) when commanding the Engine Oil Pressure Control Solenoid On and Off.
   - **If the parameter does not change**

     Replace the Q44 Engine Oil Pressure Control Solenoid.

   - **Go to next step: If the parameter changes**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to **Oil Pressure Diagnosis and Testing**.

   - **Go to next step: If the DTC is not set**
6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Oil Pump Flow Control Valve Replacement for engine oil pressure control solenoid replacement.

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**, **Engine Component 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 condition. The diagnostic flow is the place to start when repairs are necessary.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the engine.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

mcx30.com

- Check for the correct oil level, proper oil viscosity, and correct filter application.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, ambient temperature, engine temperature, amount of engine warm-up time, and other specifics.
- Compare the engine sounds, if applicable, to a known good engine and make sure you are not trying to correct a normal condition.

Intermittent

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

Symptom List

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

- **Base Engine Misfire without Internal Engine Noises**
- **Base Engine Misfire with Abnormal Internal Lower Engine Noises**
- **Base Engine Misfire with Abnormal Valve Train Noise**
- **Base Engine Misfire with Coolant Consumption**
- **Base Engine Misfire with Excessive Oil Consumption**
- **Engine Noise on Start-Up, but Only Lasting a Few Seconds**
- **Upper Engine Noise, Regardless of Engine Speed**
- **Lower Engine Noise, Regardless of Engine Speed**
- **Engine Noise Under Load**
- **Engine Will Not Crank - Crankshaft Will Not Rotate**
- **Coolant in Combustion Chamber**
- **Coolant in Engine Oil**
- **Engine Compression Test**
- **Turbocharger Leaking Fluids Externally**
- **Turbocharger Hissing Noise**
- **Turbocharger Noise**
- **Turbocharger Smoke or Smell**
- **Turbocharger Loss of Boost Pressure**
- **Oil Consumption Diagnosis**
- **Oil Pressure Diagnosis and Testing**
- **Oil Leak Diagnosis**
- **Drive Belt Chirping, Squeal, and Whine Diagnosis**
- **Drive Belt Rumbling and Vibration Diagnosis**
- **Drive Belt Falls Off and Excessive Wear Diagnosis**
- **Drive Belt Tensioner Diagnosis**

BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

Cause	Correction
Abnormalities, severe cracking, bumps, or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations and lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Replace the drive belt.
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout may lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Inspect the components, and repair or replace as required.

mcx30.com

Cause	Correction
A loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required.
Restricted exhaust system A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.	Repair or replace as required.
Improperly installed or damaged vacuum hoses	Repair or replace as required.
Improper sealing between the intake manifold and cylinder heads or throttle body.	Replace the intake manifold, gaskets, cylinder heads, and/or throttle body as required.
Improperly installed or damaged MAP sensor The sealing grommet of the MAP sensor should not be torn or damaged.	Repair or replace the MAP sensor as required.
Damage to the MAP sensor housing	Replace the intake manifold.
Worn or loose rocker arms The rocker arm bearing end caps and/or needle bearings should be intact and in the proper position.	Replace the valve rocker arms as required.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chain	Replace the timing chain and sprockets as required.
Worn camshaft lobes	Replace the camshaft and valve lash adjusters.
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. • Replace the oil control valve solenoid as required.
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages Coolant consumption may or may not cause the engine to overheat.	• Inspect for spark plugs saturated by coolant. • Inspect the cylinder heads, engine block, and/or head gaskets. • Repair or replace as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. • Inspect the cylinders for a loss of compression. Refer to **Engine Compression Test**. • Perform cylinder leak down and compression testing to identify the cause. • Repair or replace as required.

mx30.com

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

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

Cause	Correction
Abnormalities, severe cracking, bumps or missing areas in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine, and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.	Replace the drive belt.
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout A misfire code may be present without an actual misfire condition.	Inspect the components, repair or replace as required.
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. • Inspect the cylinders for a loss of compression. 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

mcx30.com

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.
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, valve lash adjusters, and roller finger followers.
Sticking valve lash adjusters	Replace as required.
Malfunctioning camshaft position actuators - improper oil viscosity or contamination.	1. Verify correct oil pressure. If low, inspect the bottom of the oil filter for oil filter drain back feature. Refer to **Oil Pressure Diagnosis and Testing**. 2. Isolate the noise to a specific camshaft position actuator. Disconnect the electrical connector on the camshaft position actuator solenoid valves and start the vehicle. If noise is gone, repeat procedure to limit to an individual actuator. Refer to **Camshaft Position Actuator and Camshaft Replacement - Intake**, or **Camshaft Position Actuator and Camshaft Replacement - Exhaust**.

BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

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

BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION

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

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

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

mcx30.com

Cause	Correction
Incorrect oil viscosity	1. Drain the oil. 2. Install the correct viscosity oil.
High valve lash adjuster leak down rate	Replace the lash adjusters as required.
Worn crankshaft thrust bearing	1. Inspect the thrust bearing and crankshaft. 2. Repair or replace as required.
Damaged or faulty oil filter by-pass valve	1. Inspect the oil filter by-pass valve for proper operation. 2. Repair or replace as required.
Malfunctioning camshaft position actuators - improper oil viscosity or contamination.	1. Verify correct oil pressure. If low, inspect the bottom of the oil filter for oil filter drain back feature. Refer to **Oil Pressure Diagnosis and Testing**. 2. Isolate the noise to a specific camshaft position actuator. Disconnect the electrical connector on the camshaft position actuator solenoid valves and start the vehicle. If noise is gone, repeat procedure to limit to an individual actuator. Refer to **Camshaft Position Actuator and Camshaft Replacement - Intake**, or **Camshaft Position Actuator and Camshaft Replacement - Exhaust**.

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Low oil pressure	• Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. • Repair or replace as required.
Worn valve rocker arm	Replace the valve rocker arm.
Improper lubrication to the valve rocker arms	Inspect the following components, and repair or replace as required: • The valve rocker arm • The valve lifter • The oil filter bypass valve • The oil pump and pump screen • The engine block oil galleries
Broken valve spring	Replace the valve spring.
Worn or dirty valve lash adjusters	Replace the valve lash adjusters.
Stretched or broken timing chain and/or damaged sprocket teeth	Replace the timing chain and sprockets.
Worn, damaged, or faulty timing chain tensioners	Replace tensioners
Worn engine camshaft lobes	• Inspect the engine camshaft lobes. • Replace the camshaft and valve lash adjusters as required.

mcx30.com

Cause	Correction
Worn valve guides or valve stems	Inspect the following components, and repair as required: • The valves • The valve guides
Stuck valves Carbon on the valve stem or valve seat may cause the valve to stay open.	Inspect the following components, and repair as required: • The valves • The valve guides

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Low oil pressure	• Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. • Repair or replace damaged components as required.
Worn accessory drive components - abnormalities, such as severe cracking, bumps, or missing areas in the accessory drive belt and/or misalignment of system components	1. Inspect the accessory drive system. 2. Repair or replace as required.
Loose or damaged crankshaft balancer	1. Inspect the crankshaft balancer. 2. Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the ignition system. Refer to **Symptoms - Engine Controls** .
Loose torque converter bolts	1. Inspect the torque converter bolts and flywheel. 2. Repair or replace as required.
Loose or damaged flywheel	Repair or replace the flywheel.
Damaged oil pan, contacting the oil pump screen - an oil pan that has been damaged, may improperly position the oil pump screen, preventing proper oil flow to the oil pump.	1. Inspect the oil pan. 2. Inspect the oil pump screen. 3. Repair or replace as required.
Oil pump screen loose, damaged or restricted	1. Inspect the oil pump screen. 2. Repair or replace as required.
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.

mcx30.com

Cause	Correction
Excessive connecting rod bearing clearance	Inspect the following components, and repair as required: • The connecting rod bearings • The connecting rods • The crankshaft • The crankshaft journals
Excessive crankshaft bearing clearance	Inspect the following components, and repair as required: • The crankshaft bearings • The crankshaft journals
Incorrect piston, piston pin, and connecting rod installation - pistons must be installed with the mark or dimple on the top of the piston, facing the front of the engine. Piston pins must be centered in the connecting rod pin bore.	1. Verify the pistons, piston pins and connecting rods are installed correctly. 2. Repair as required.

ENGINE 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. Refer to **Symptoms - Engine Controls** .
Loose torque converter bolts	1. Inspect the torque converter bolts and flywheel. 2. Repair as required.
Cracked flywheel, automatic transmission	1. Inspect the flywheel bolts and flywheel. 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

mcx30.com

Cause	Correction
Malfunctioning camshaft position actuators - improper oil viscosity or contamination.	1. Verify correct oil pressure. If low, inspect the bottom of the oil filter for oil filter drain back feature. Refer to **Oil Pressure Diagnosis and Testing**. 2. Isolate the noise to a specific camshaft position actuator. Disconnect the electrical connector on the camshaft position actuator solenoid valves and start the vehicle. If noise is gone, repeat procedure to limit to an individual actuator. Refer to **Camshaft Position Actuator Intake Solenoid Valve Replacement** , or **Camshaft Position Actuator Exhaust Solenoid Valve Replacement** .

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Cause	Correction
Seized accessory drive system component	1. Remove accessory drive belts. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Hydraulically locked cylinder • Coolant/antifreeze in cylinder • Oil in cylinder • Fuel in cylinder	1. Remove spark plugs and check for fluid. 2. Inspect for broken head gasket. 3. Inspect for cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector. 5. Inspect for cracked cylinder wall.
Seized automatic transmission torque converter	1. Remove the torque converter bolts. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Seized manual transmission	1. Disengage the clutch. 2. Rotate crankshaft by hand at the balancer or flywheel location.
Broken timing chain and/or gears	1. Inspect timing chain and gears. 2. Repair as required.
Seized balance shaft	1. Inspect balance shaft. 2. Repair as required.
Material in cylinder • Broken valve • Piston material • Foreign material • Cracked cylinder wall	1. Inspect cylinder for damaged components and/or foreign materials. 2. Inspect for fallen cylinder wall. 3. Repair or replace as required.

mcx30.com

Cause	Correction
Seized crankshaft or connecting rod bearings	1. Inspect crankshaft and connecting rod bearings. 2. Inspect for fallen cylinder wall. 3. Repair as required.
Bent or broken connecting rod	1. Inspect connecting rods. 2. Repair as required.
Broken crankshaft	1. Inspect crankshaft. 2. 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. **NOTE:** **While not always conclusive, use of hydrocarbon block test kits may reveal hydrocarbons indicating combustion chamber gases in cooling system. It is important to follow the kit instructions. This is not a substitute for service information. Combustion leak tests are available from a wide variety of aftermarket suppliers.** 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 Replacement**.
Warped cylinder head	Replace the cylinder head and gasket. Refer to **Cylinder Head Cleaning and Inspection**.
Cracked cylinder head	Replace the cylinder head and gasket.
Cylinder head or block porosity	Replace the components as required.

COOLANT IN ENGINE OIL

Cause	Correction

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 cylinder head gasket	Replace the head gasket and components as required. Refer to **Cylinder Head Cleaning and Inspection**, and **Cylinder Head Replacement**.
Warped cylinder head	Replace the cylinder head and gasket. Refer to **Cylinder Head Cleaning and Inspection**.
Cracked cylinder head	Replace the cylinder head and gasket.
Cylinder head or block porosity	Replace the components as required.

ENGINE COMPRESSION TEST

Special Tools

EN-51749 Compression Gauge Tester Kit

Equivalent regional tools:**Special Tools**

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

NOTE: **The battery must be at or near full charge.**

1. Connect a battery charger to the battery for the duration of the test to maintain an adequate battery level.
2. Engine OFF.
3. Remove the ignition coils and spark plugs from all cylinders. Refer to **Spark Plug Replacement** .
4. Connect the GDS2 to the vehicle and select "Compression Test". Enabling the Compression Test will disable the fuel pump, fuel injectors, and spark. The throttle body is opened to a Wide Open Throttle (WOT) position. The GDS2 will also automatically control the cranking procedure for many applications. If cranking control is not available use a remote start switch in place of the Starter Relay to control cranking.
5. Measure the engine compression, using the following procedure:
    1. Install the **EN-51749** adapter into the spark plug hole.
    2. Install the **EN-51749** gauge into the **EN-51749** adapter.

        NOTE: **When the compression measurement is normal, the compression builds up quickly and evenly to the specified compression on each cylinder.**

    3. Enable cranking via the GDS2 or remote start switch. When using a remote start switch, crank the engine for four compression strokes. Record the reading after the cranking cycle completes.
    4. Repeat the compression test for each cylinder.
6. Compare the compression readings from all of the cylinders.
    - The lowest reading should not be less than 70 percent of the highest reading.
    - No cylinder should read less than 690 kPa (100 psi).
    - For example, if the highest pressure in any 1 cylinder is 1035 kPa (150 psi), the lowest allowable pressure for any other cylinder would be 725 kPa (105 psi). (1035 x 70% = 725) (150 x 70% = 105).
7. The following are indicators of potential problems:

mcx30.com

- 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 to the cylinder. Use approximately 3 squirts of oil from a plunger-type oiler into the cylinder and replace the gauge and measure again.
- 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.

8. Disconnect GDS2 diagnostic tool or remote start switch.
9. Install the spark plugs for all cylinders. Refer to **Spark Plug Replacement** .
10. Install the ignition coils for all cylinders. Refer to **Ignition Coil Replacement** .

TURBOCHARGER LEAKING FLUIDS EXTERNALLY

Condition	Action
Leaking Coolant from Coolant interfaces; Feed and/or Return Pipe	• Inspect Seal Surfaces on Bearing Housing, Pipes, and Banjo Bolt • If Turbo Seal Surface is damaged replace turbo • If Pipe Seal Surface is damaged replace Pipe • If Banjo Bolt Seal Surface is damaged replace Banjo Bolt • Reassemble with new seals in all cases
Leaking Coolant from area other than Coolant interfaces; NOT Feed and/or Return Pipe	Replace component that is leaking
Leaking Oil from Oil interfaces; Feed and/or Return Pipe	• Inspect Seal Surfaces on Bearing Housing, Pipes, and Bolts • If Turbo Seal Surface is damaged replace turbo • If Pipe Seal Surface is damaged replace Pipe • If Bolt Seal Surface is damaged replace Bolt • Reassemble with new seals in all cases
Oil on Compressor Cover	• Check for correct PCV System functionality, refer to **Crankcase Ventilation System Inspection/Diagnosis** • Check Turbocharger Oil Drain Pipe for restriction • Check PCV connection in Compressor Housing, inspect O-ring • Check Fresh Air Duct connection at Compressor inlet, look for damage and replace if necessary • Check Compressor Outlet connection, look for damage and replace if necessary
All Other External Turbocharger Leaks	Replace Turbocharger

TURBOCHARGER HISSING NOISE

Condition	Action
Air inlet leaks or obstructions	Inspect for leaks or obstructions in the turbocharger inlet.
Leaking or restricted exhaust system	1. Inspect for a leak in the exhaust system. 2. Inspect for a restricted exhaust system.

mcx30.com

Condition	Action
Leaking or restricted intake system	1. Using less than 34 kPa (5 PSI) to pressurize the intake system, inspect for leaks in the following components: • Charge Air Cooler • Charge Air Cooler Outlet and Inlet Ducts • Intake Manifold • Purge Lines 2. Inspect for obstructions in the intake system.

TURBOCHARGER NOISE

Some noise is normal. Compare to a known good vehicle.

Condition	Action
Compressor Inlet leaks or Obstructions	Inspect for leaks or obstructions in the Turbocharger inlet.
Compressor Outlet Leaks or Obstruction	Inspect for leaks or obstructions in the Turbocharger outlet.
Charge Air Cooler and Engine Intake system Leaks or Obstructions	• Inspect for leaks • Inspect for obstructions
Damaged Electric Recirculation Valve	• Check Seal to Compressor Cover • Check DTCs for Bypass/Recirculation codes, replace if necessary
Compressor/Turbine Wheel Damage - Bent or Broken Blades	Replace the Turbocharger.
Compressor/Turbine Wheel to Housing contact	Replace the Turbocharger.

TURBOCHARGER SMOKE OR SMELL

Condition	Action
Oil or Coolant Leak	Correct the leak.
Exhaust Leak	• Inspect Gaskets and Sealing Surfaces • Correct Leak • Look for external cracks in Turbocharger components **NOTE:** **Cracks in the Turbine Inlet Partition Wall are acceptable.** • Replace turbocharger assembly if external cracks found
Nearby Component Out of Position/Touching Turbocharger	Check for Turbine housing for contact with nearby components.

TURBOCHARGER LOSS OF BOOST PRESSURE

Condition	Action

mex30.com

Condition	Action
Perceived Loss of Boost	• Check DTC codes • No Codes Present - Do not replace Turbocharger

CYLINDER LEAKAGE TEST

Special Tools

EN 35667-A Cylinder Head Leakdown Tester

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

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

- Worn or burnt valves
- Broken valve springs
- Stuck valve lash adjusters
- 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: **Unless directed otherwise, the ignition must be OFF with the key removed, 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 OnStarÂ® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStarÂ® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStarÂ®module). Do not disconnect the main vehicle battery or remove the OnStarÂ® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStarÂ® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStarÂ® Back-Up Battery 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 back-up battery is not rechargeable and once activated the back-up battery must be replaced.

1. Disconnect the battery ground negative cable.
2. Remove the spark plugs. Refer to **Spark Plug Replacement** in Engine Controls.
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 **EN 35667-A** tester or equivalent.

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

5. Apply shop air pressure to the **EN 35667-A** tester and adjust according to the manufacturers instructions.
6. Record the cylinder leakage value. Cylinder leakage that exceeds 25 percent is considered excessive and may require component service. In excessive leakage situations, inspect for the following conditions:
    - Air leakage sounds at the throttle body or air inlet hose that may indicate a worn or burnt intake valve or a broken valve spring.
    - Air leakage sounds at the exhaust system tailpipe that may indicate a worn or burnt exhaust valve or a broken valve spring.
    - Air leakage sounds from the crankcase, oil level indicator tube, or oil fill tube that may indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged engine block or a damaged cylinder head.
    - Air bubbles in the cooling system may indicate a damaged cylinder head or a damaged cylinder head gasket.
7. Perform the leakage test on the remaining cylinders and record the values.

OIL CONSUMPTION DIAGNOSIS

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

- External oil leaks

  tighten bolts and/or replace gaskets and oil seals as necessary.

- Incorrect oil level or improper reading of oil level indicator

  With the vehicle on a level surface, allow adequate drain down time and inspect for the correct oil level.

- Improper oil viscosity

  Use recommended SAE viscosity for the prevailing temperatures.

- Continuous high speed driving and/or severe usage
- Crankcase ventilation system restrictions or malfunctioning components
- Valve guides and/or valve stem oil seals worn, or the seal omitted

  Ream guides and install oversize service valves and/or new valve stem oil seals.

- Piston rings broken, improperly installed, worn, or not seated properly

  Allow adequate time for rings to seat. Replace broken or worn rings, as necessary.

- Piston improperly installed or mis-fitted

OIL PRESSURE DIAGNOSIS AND TESTING

Special Tools

- **EN-21867-850** Oil Pressure Gauge Adapter
- **GE-21867-A** Oil Pressure Gauge Kit

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

1. With the vehicle on a level surface, allow adequate drain down time of 2 - 3 minutes and measure for a low oil level.

   Add the recommended grade engine oil and fill the crankcase until the oil level measures full on the oil level indicator.

2. Run the engine, and verify low, or no oil pressure on the vehicle gauge or light.

   Listen for a noisy valve train or a knocking noise.

3. Inspect for the following:

mcx30.com

- Correct oil filter with anti-drain back feature and O-ring on the cylinder block side of the filter
- Oil diluted by moisture or unburned fuel mixtures
- Improper oil viscosity for the expected temperature
- Incorrect or malfunctioning oil pressure sender
- Incorrect or malfunctioning oil pressure gauge
- Plugged oil filter
- Malfunctioning oil bypass valve

4. Remove the oil pressure sender or another engine block oil gallery plug.
5. Install **EN-21867-850** adapter and **GE-21867** gauge and measure the engine oil pressure.
6. Compare the readings to specifications. Refer to **Engine Mechanical Specifications**.
7. If the engine oil pressure is below specifications, inspect the engine for one or more of the following:
    - Correct oil filter with anti-drain back feature and O-ring on the cylinder block side of the filter
    - Oil pump worn or dirty

      Refer to **Balancer Shaft with Oil Pump Cleaning and Inspection**.

    - Oil pump screen loose, plugged, or damaged
    - Oil pump screen O-ring seal missing or damaged
    - Malfunctioning oil control valve solenoid
    - Excessive bearing clearance

      Refer to **Crankshaft and Bearing Cleaning and Inspection**.

    - Cracked, porous or restricted oil galleries
    - Oil gallery plugs missing or incorrectly installed

      Refer to **Engine Block Assemble**.

    - Broken lash adjusters

OIL LEAK DIAGNOSIS

Step	Action	Yes	No
DEFINITION: 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. Refer to **Engine Mechanical Specifications**. 2. Park the vehicle on a level surface, over a large sheet of paper or other clean surface. 3. Wait 15 minutes. 4. Check for drippings. Are drippings present?	Go to 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

mrx30.com

Step	Action	Yes	No
3	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 4
4	1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several 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. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 6
6	1. Completely clean the entire engine and surrounding components. 2. Apply an aerosol-type powder, for example, baby powder or foot powder, to the suspected area. 3. Operate the vehicle for several miles at normal operating temperature and at varying speeds. 4. Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface. Can you identify the type of fluid and the approximate location of the leak?	Go to 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. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 8

mc30.com

Step	Action	Yes	No
8	Use **EN 28428-E** Dye and Light Kit, in order to identify the type of fluid, and the approximate location of the leak. Refer to the manufacturer's instructions when using the tool. Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	Go to Step 9
9	1. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 2. Check for leaks at the following locations: • Sealing surfaces • Fittings • Cracked or damaged components Can you identify the type of fluid and the approximate location of the leak?	Go to Step 10	System OK
10	1. Inspect the engine for mechanical damage. Special interest 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 tighten ed or damaged fasteners • Cracked or porous components • Improper sealants or gaskets where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals • Damaged or worn sealing surfaces 2. Inspect the engine for customer modifications. Is there mechanical damage, or customer modifications to the engine?	Go to Step 11	System OK
11	Repair or replace all damaged or modified components. Did you complete the repair?	Go to Step 1	-

CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS

Special Tools

EN 23951 Valve Manometer

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

1. Verify clean air cleaner.
2. Verify oil fill cap is in place.
3. Verify oil level indicator is installed.
4. Remove the oil level indicator. Install a **EN 23951** valve manometer or equivalent, into the oil level indicator hole.
5. Start the engine.
6. Check for slight vacuum. The vacuum level should be less than 3.377 kPa (13.571 in H^2 O).
7. If vacuum is higher, inspect and verify that the clean air hose from cam cover to air intake is not blocked or kinked.
8. If vacuum is in the normal range, remove the PCV line from the fresh air valve near oil fill cap. Block fresh air valve and also plug the fresh air hose. Vacuum should increase on the manometer. If held too long, vacuum

will be drawn through the crankshaft seals creating a sucking sound.

9. If vacuum does not increase, the orifice in the camshaft cover assembly could be plugged. The valve is between the camshaft cover assembly and the cylinder head assembly.
10. If there is zero vacuum or pressure, verify compression of the engine.
11. If compression is normal, check for a blocked orifice at the camshaft cover assembly. Clean the orifice.
12. The hose from valve cover to the turbo is also for the positive crankcase ventilation (PCV) and is used for PCV flow under normal operation and only PCV flow during turbo boost conditions. If the hose is plugged, replace the PCV hose assembly and PCV fitting assembly at the turbocharger.

Concern	Action
External Oil Leak	Inspect for any of the following conditions: • Plugged air intake system • Plugged positive crankcase ventilation (PCV) orifice/check valve in the camshaft cover assembly • Plugged or kinked PCV hoses • Damaged or incorrectly installed PCV hoses • Excessive crankcase pressure • Plugged PCV hose from camshaft cover to turbocharger
Rough Idle	Inspect for any of the following conditions: • Plugged or incorrectly installed air intake system • Plugged PCV orifice/check valve in the camshaft cover assembly • Plugged or kinked PCV hoses • Leaking or damaged PCV hoses • Leaking PCV hose from camshaft cover to turbocharger
Stalling or Slow Idle Speed	Inspect for any of the following conditions: • Plugged air intake system • Plugged PCV orifice in the camshaft cover assembly • Plugged or kinked PCV hoses • Leaking or damaged PCV hoses • Leaking PCV hose from camshaft cover to turbocharger
High Idle Speed	Inspect for any of the following conditions: • Air intake system incorrectly installed • Leaking or damaged PCV hoses
Sludge in the Engine	Inspect for any of the following conditions: • Plugged or incorrectly installed air intake system • Plugged PCV orifice in the camshaft cover assembly • Plugged or kinked PCV hoses • Plugged PCV hose from camshaft cover to turbocharger

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.

mcx30.com

- 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, worn, misaligned drive belt pulleys or a generator failing are suggested items to inspect.
- A chirping, squeal or whine noise may be caused by a loose or improper installation of a body or suspension component. Other items of the vehicle may also cause the noise.
- The drive belts will not cause a whine noise.

Test Description

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

2

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

3

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

4

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

6

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

10

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

12

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

14

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

15

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

16

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

mcx30.com

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 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**

mcx30.com

Step	Action	Yes	No
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 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. If diagnosing a whine noise and the condition still exist, 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 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
18	Replace the bent pulley. Did you complete the repair?	Go to **Step 20**	Go to **Step 19**
19	Replace the drive belt. Refer to **Drive Belt Replacement**. Did you complete the repair?	Go to **Step 20**	Go to Diagnostic Aids
20	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

mcx30.com

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.

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 accessory component causing it to vibrate.

mcx30.com

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

Step	Action	Yes	No
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 **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**
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	**CAUTION:** **Refer to Fastener Caution .** 1. tighten any loose fasteners. Refer to **Fastener 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 (LTG)** . 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.

mcx30.com

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

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

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

Test Description

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

2

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

4

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

5

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

6

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

7

Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed. Missing. loose, or the wrong fasteners may cause pulley misalignment from the bracket moving under load. Over tightening of the fasteners may cause misalignment of the accessory component bracket.

13

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

14

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

15

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

Step	Action	Yes	No
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.			

mex30.com

Step	Action	Yes	No
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
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 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 Replacement**. 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

Step	Action	Yes	No
1	1. Remove the drive belt. Refer to **Drive Belt Replacement**. 2. Inspect the drive belt tensioner pulley. Is the drive belt tensioner pulley loose or misaligned?	Go to **Step 6**	Go to **Step 2**
2	Rotate the drive belt tensioner pulleys. Do the pulleys rotate without any unusual resistance or binding?	Go to **Step 3**	Go to **Step 6**
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?	Go to **Step 4**	Go to **Step 6**
4	Inspect tensioner for indication of oil leaks. Does it show signs of oil leaking?	Go to **Step 6**	Go to **Step 5**
5	Remove top tensioner bolt, above hydraulic tensioner and verify tensioner assembly moves about center pivot by applying light force. Does the tensioner Asm move without binding?	System OK	Go to **Step 6**
6	Replace the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**. Is the repair complete?	System OK	-

REPAIR INSTRUCTIONS - ON VEHICLE

INTAKE MANIFOLD COVER REPLACEMENT

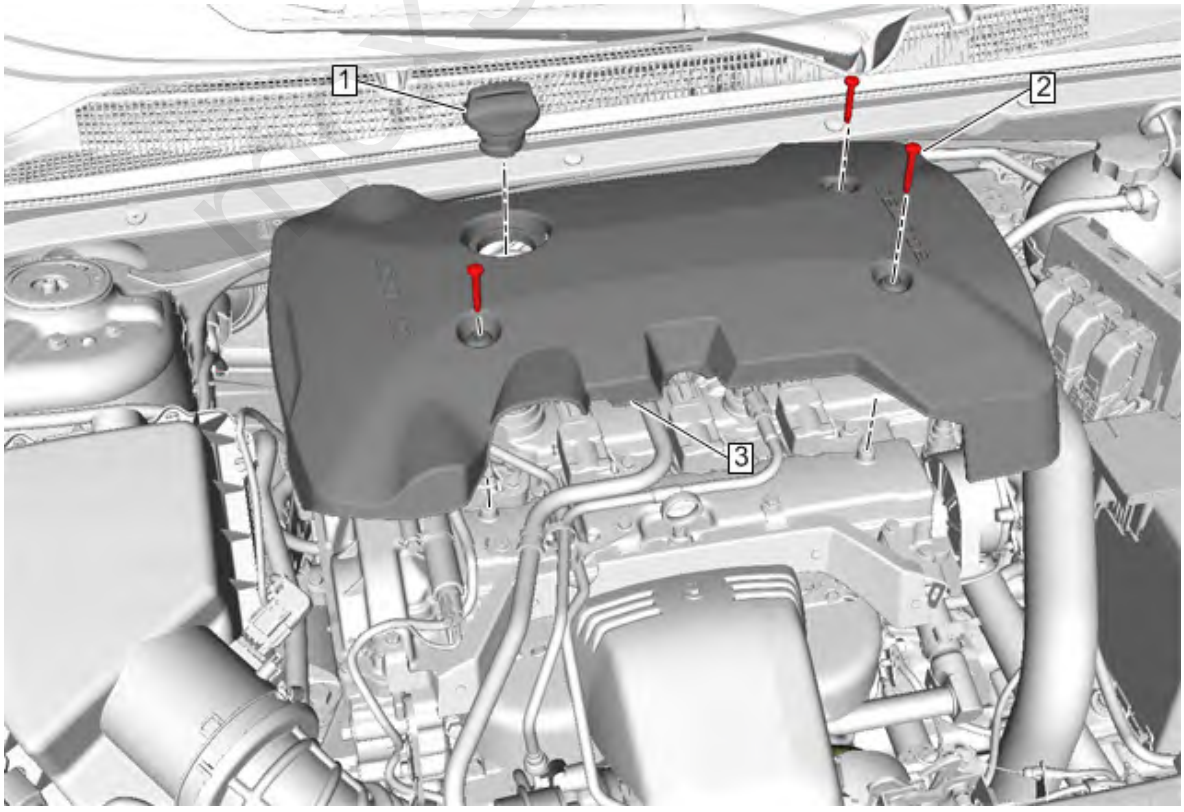


Fig. 33: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Oil Filler Cap

Callout	Component Name
2	Intake Manifold Cover Bolt [3x] **CAUTION:** **Refer to Fastener Caution .** **tighten** 9 N.m (80 lb in)
3	Intake Manifold Cover

DRIVE BELT REPLACEMENT

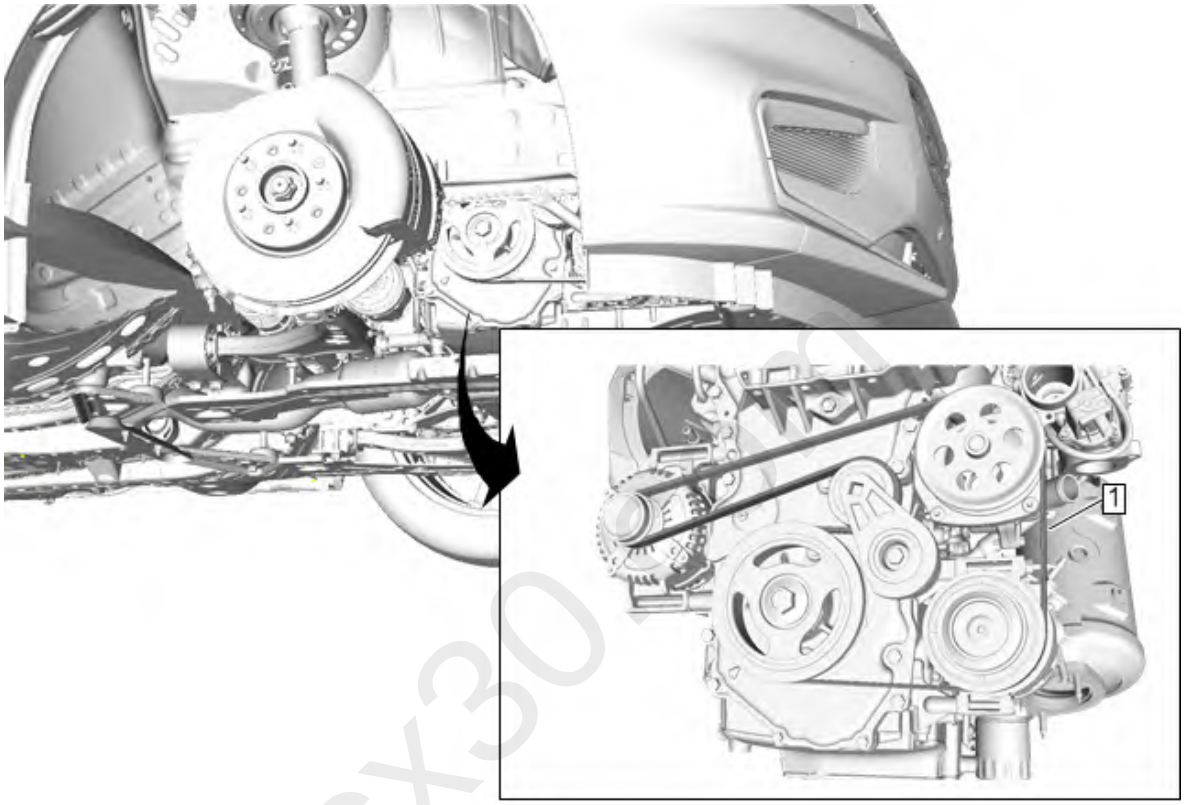


Fig. 34: Drive Belt Routing
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Front Wheelhouse Liner Replacement - Right Side (Equinox) Front Wheelhouse Liner Replacement - Right Side (Terrain)	
1	Drive Belt **Procedure** 1. Slowly release the tension on the drive belt tensioner. 2. Remove the drive belt.

DRIVE BELT TENSIONER REPLACEMENT

mcx30.com

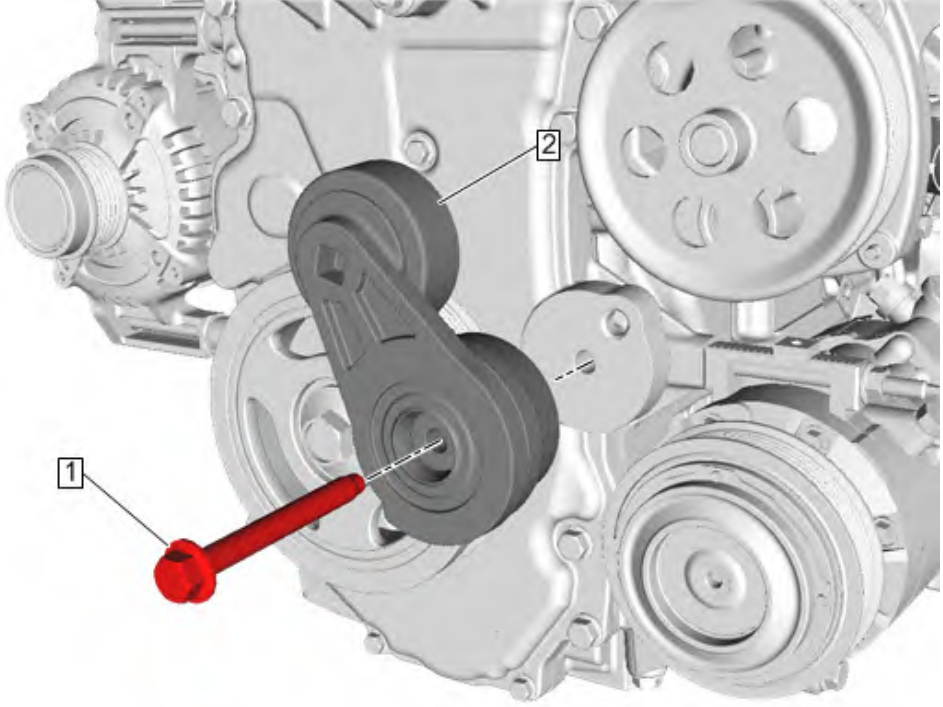


Fig. 35: Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures Drive Belt Replacement	
1	Drive Belt Tensioner Fastener **CAUTION:** **Refer to Fastener Caution .** **tighten** 58 N.m (43 lb ft)
2	Drive Belt Tensioner

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. Refer to **Engine Support Fixture**. Raising the engine removes the weight from the engine mount and creates slight tension in the rubber.
2. Observe the engine mount while raising the engine. Replace the engine mount if the engine mount exhibits any of the following conditions:
   - The hard rubber surface is covered with heat check cracks.
   - The rubber is split through the center of the engine mount.
   - The GLYCOL™ fluid is leaking from the engine mount.
3. Inspect the system for loose vacuum hose connections or vacuum leaks. Refer to Vacuum Operated Engine Mounts Description and Operation.
4. Inspect the engine mount valve assemblies for loose electrical connections. Inspect the electrical system connected to the engine mount valve assemblies. Refer to **Diagnostic System Check - Vehicle** .
5. Inspect for the presence of glycol fluid in the vacuum system. Remove the hose assembly connections at the engine mounts. If fluid is present in the engine mount vacuum system, the entire vacuum system should be replaced.

POWERTRAIN MOUNT BALANCING

mcx30.com

Removal Procedure

1. Raise the vehicle. **Lifting and Jacking the Vehicle**
2. Loosen the transmission front strut bolt at the transmission mount strut bracket. **Transmission Mount Strut Replacement (All Wheel Drive)** **Transmission Mount Strut Replacement (Front Wheel Drive)**
3. Position two floor jacks with wood blocks under the engine and transaxle in order to support the powertrain assembly.
4. Lower the vehicle. **Lifting and Jacking the Vehicle**

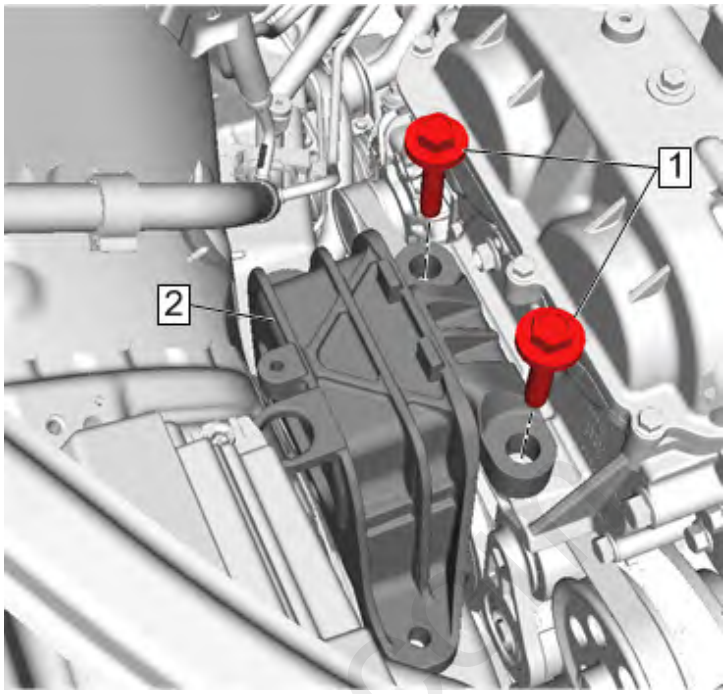


Fig. 36: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Loosen ONLY the engine mount to engine mount bracket bolts (1). **Engine Mount Replacement**

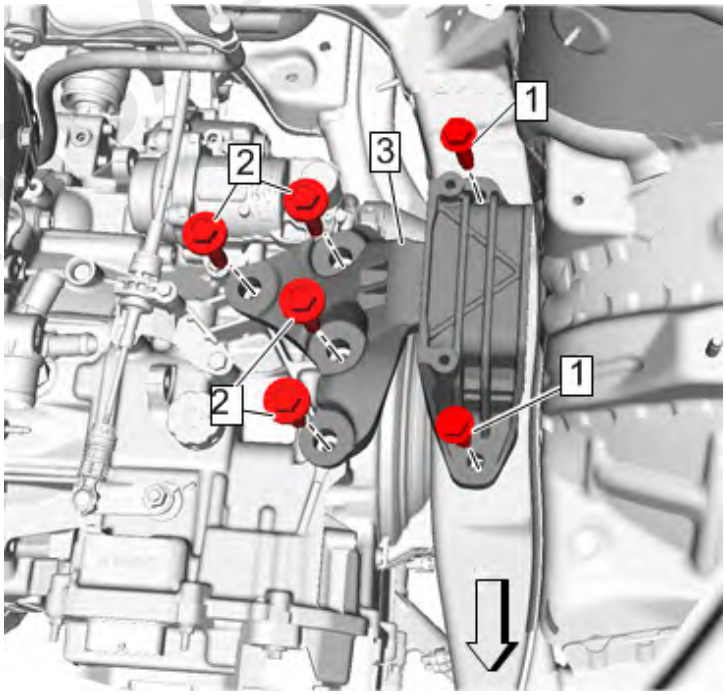


Fig. 37: Bolts At Left Transmission Mount
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Only the transmission mount to transmission bolts should be loosened. Bolts (1) should remain tighten during the balancing procedure.**

6. Loosen bolts (2) at the left transmission mount (3). **Transmission Mount Replacement (Left Side M3U)** **Transmission Mount Replacement (Left Side M3D/M3H)**

Installation Procedure

1. Reposition both floor jacks and blocks of wood in order to allow a 1/8 inch gap between the mount and bracket.
2. Shake the powertrain vigorously by hand from front to rear and allow the powertrain to settle.

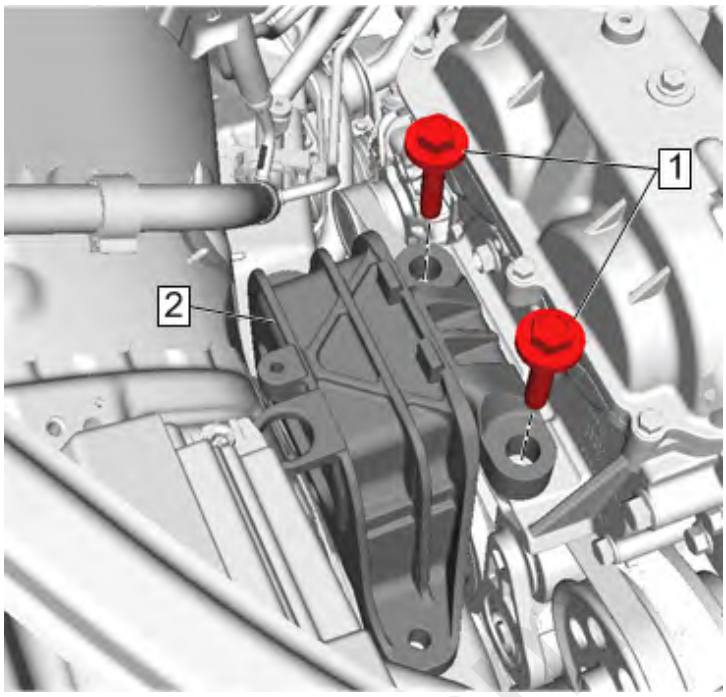


Fig. 38: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

3. tighten the engine mount to engine mount bracket bolts (1). **Engine Mount Replacement**

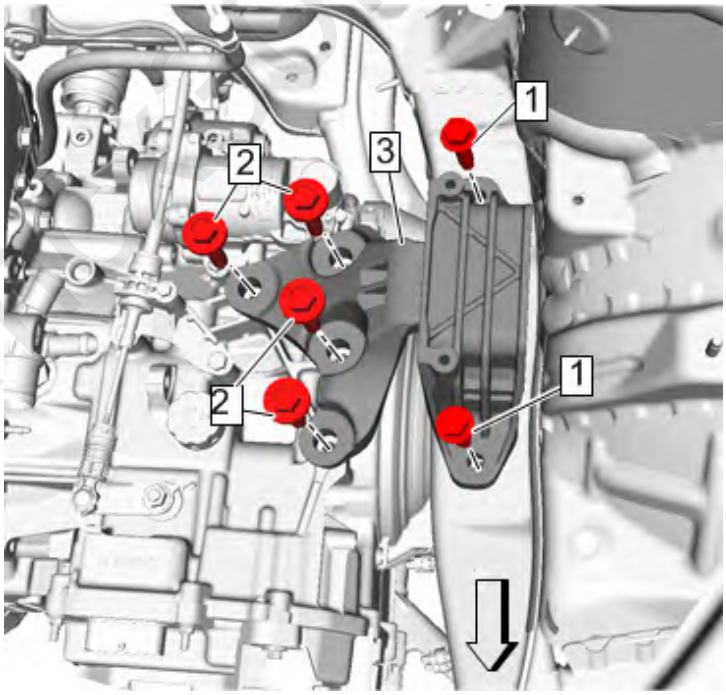


Fig. 39: Bolts At Left Transmission Mount
Courtesy of GENERAL MOTORS COMPANY

4. tighten bolts (2) at the left transmission mount (3). **Transmission Mount Replacement (Left Side M3U)** **Transmission Mount Replacement (Left Side M3D/M3H)**
5. Raise the vehicle. **Lifting and Jacking the Vehicle**
6. tighten the transmission front strut bolt at the transmission mount strut bracket. **Transmission Mount Strut Replacement (All Wheel Drive)** **Transmission Mount Strut Replacement (Front Wheel Drive)**
7. Remove the jack stands and wood blocks supporting the engine and transaxle from underneath the powertrain.
8. Lower the vehicle. **Lifting and Jacking the Vehicle**

ENGINE MOUNT REPLACEMENT

Special Tools

EN-45059 Angle Meter

Equivalent regional tools:**Special Tools**

Removal Procedure

1. Remove Intake Manifold Cover - **Intake Manifold Cover Replacement**
2. Remove Air Cleaner Assembly -**Air Cleaner Assembly Replacement**
3. Install Engine Support Fixture - **Engine Support Fixture**

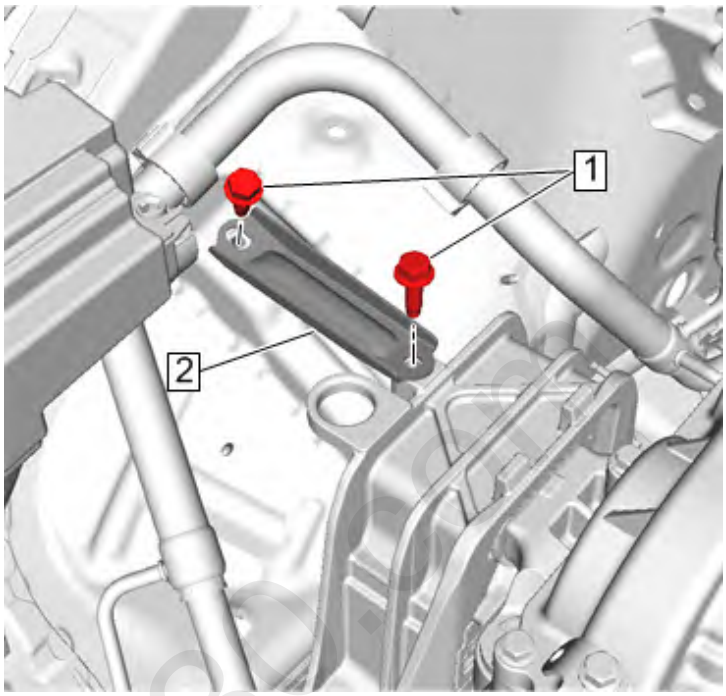


Fig. 40: Engine Mount Brace And Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove Engine Mount Brace Bolt (1) - [2x]
5. Remove Engine Mount Brace (2) -

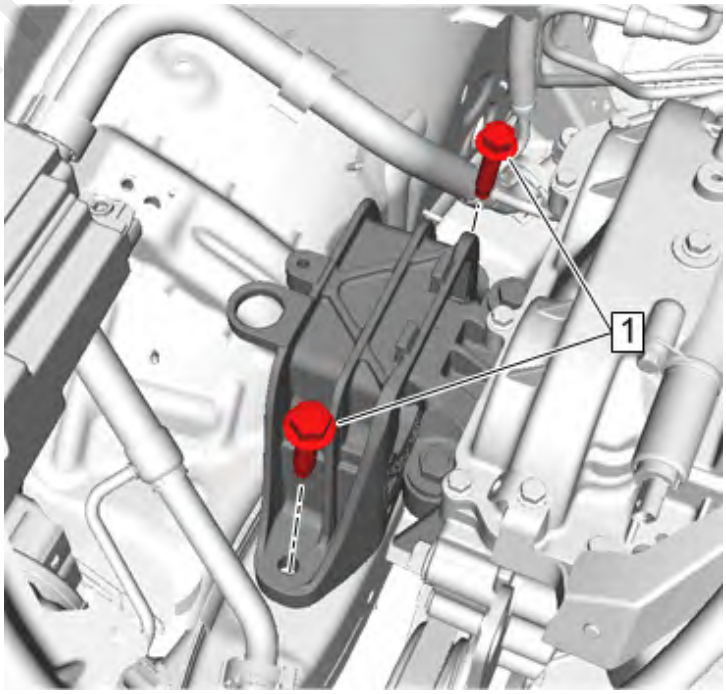


Fig. 41: Engine Mount Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove Engine Mount Bolt (1) - [2x]

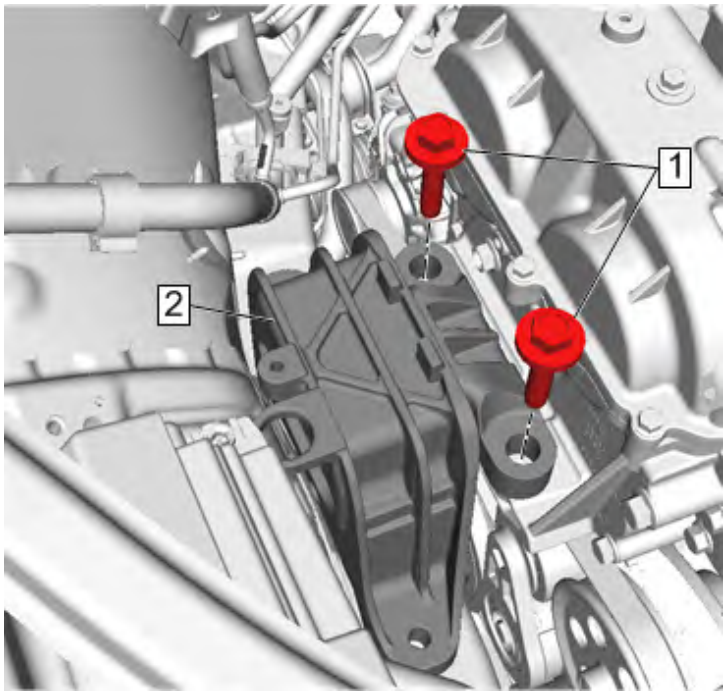


Fig. 42: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove Engine Mount Engine Side Bolt (1) and DISCARD [2x]
8. Remove Engine Mount (2)

Installation Procedure

NOTE: **For ease of installation, all engine mount bolts should be hand started prior to performing final tightening steps.**

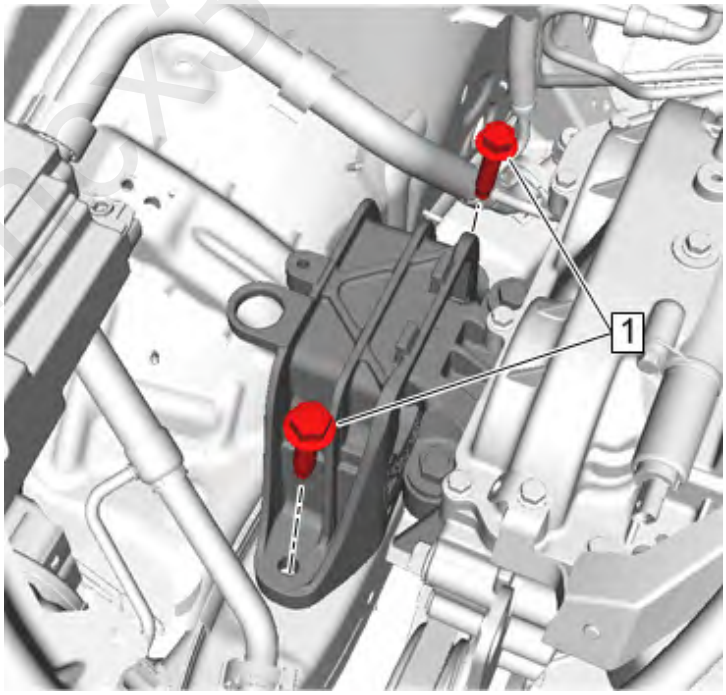


Fig. 43: Engine Mount Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

1. Install Engine Mount Bolt (1) and tighten [2x] 100 N.m (74 lb ft)

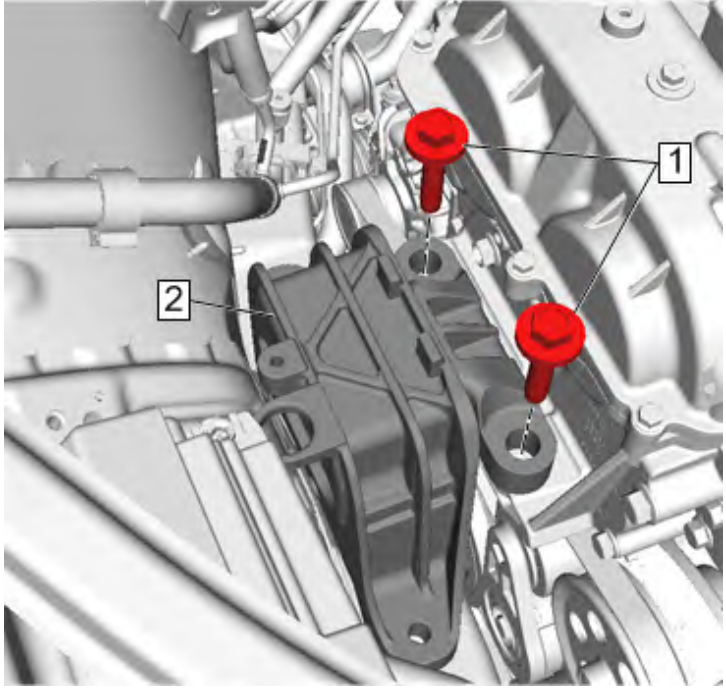


Fig. 44: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install NEW bolts.**

2. Hand start NEW engine mount engine side bolts (1).
3. With the mount fasteners hand tighten ed, release the tension from the engine support fixture.
    1. Shake the powertrain vigorously by hand to allow the powertrain to settle.

CAUTION: **Refer to Torque-to-Yield Fastener Caution .**

4. tighten the NEW engine mount engine side bolts (1).

tighten

1. First Pass:100 N.m (74 lb ft)
2. Final Pass:60 - 75 degrees - **EN-45059** meter

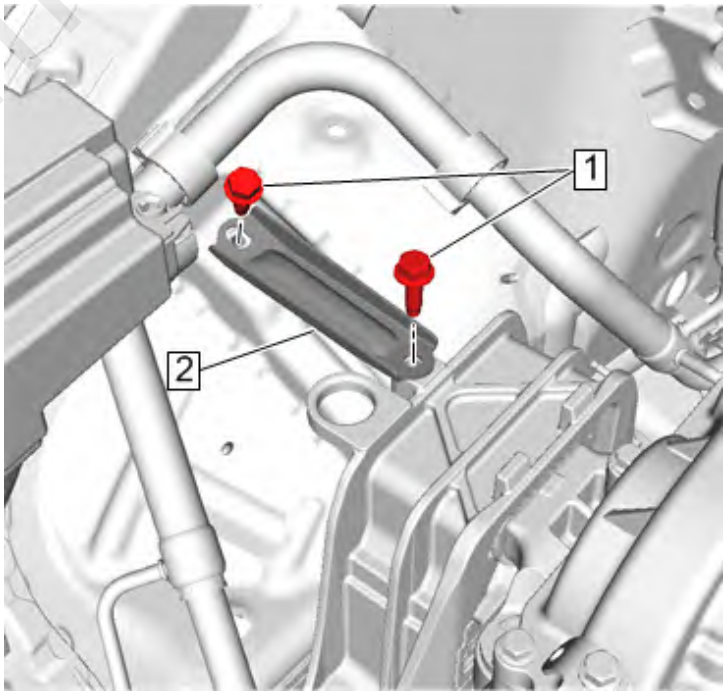


Fig. 45: Engine Mount Brace And Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Install Engine Mount Brace (2)

mcx30.com

6. Engine Mount Brace Bolt (2) and tighten [2x] 22 N.m (16 lb ft)
7. Remove Engine Support Fixture -**Engine Support Fixture**
8. Install Air Cleaner Assembly - **Air Cleaner Assembly Replacement**
9. Install Intake Manifold Cover - **Intake Manifold Cover Replacement**

ENGINE SUPPORT FIXTURE

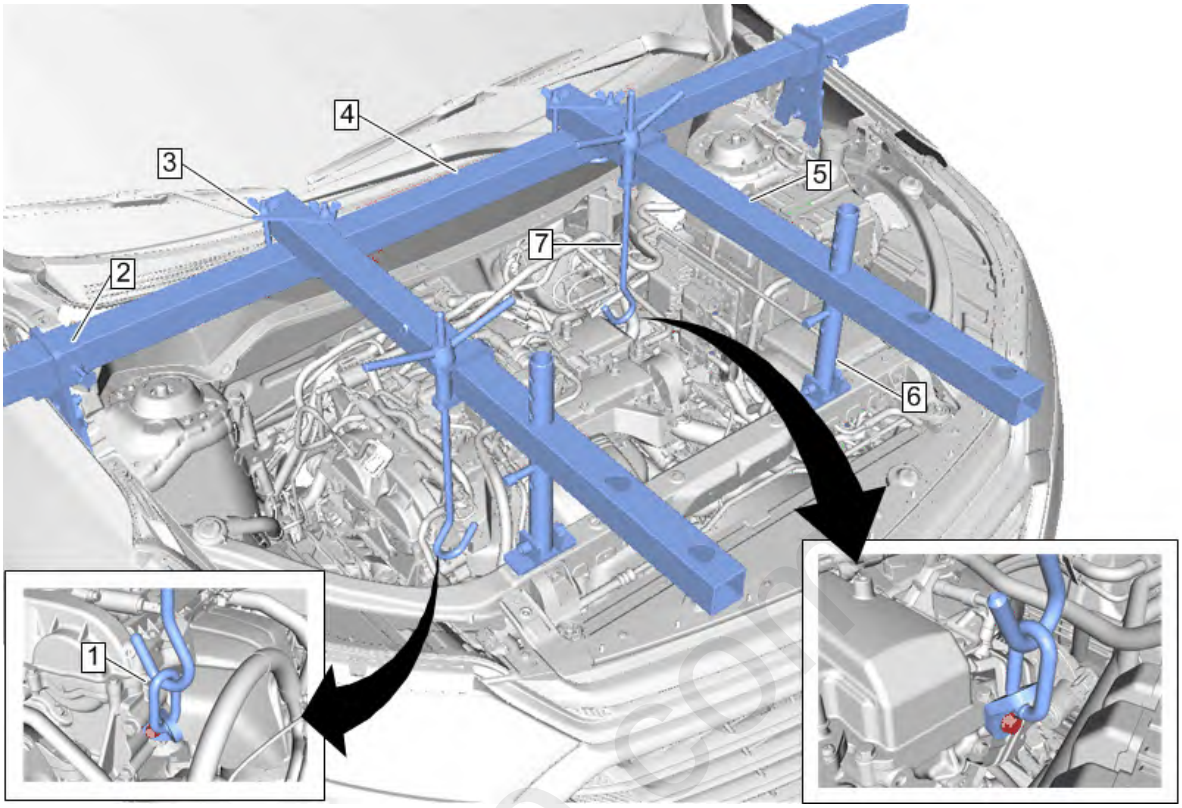


Fig. 46: Engine Support Fixture
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. **Intake Manifold Cover Replacement** 2. **Charge Air Cooler Outlet Air Tube Replacement** **Special Tools** • **EN-36857** Engine Lift Bracket • **EN-51007-1** Main Support Beam • **EN-51007-3** Radiator Support Beam • **EN-51007-4** Clamp • **EN-51007-5** Support Leg, Front • **EN-51007-6** Hook • **EN-51007-7** Support Leg, Side Equivalent regional tools:**Special Tools**.	
1	**EN-36857** Engine Lift Bracket **Procedure** **NOTE:** **The engine support fixture and lift brackets can be repositioned to either lift bracket to lift in desired lift points.** If engine lift brackets are not present, install **EN-36857** engine lift brackets as needed.

Callout	Component Name
2	**EN-51007-7** Support Leg, Side **Procedure** **NOTE:** **Do not install on top of fender lip.** Install the **EN-51007-7** Support Leg, Side to frame as shown.
3	**EN-51007-4** Clamp
4	**EN-51007-1** Main Support Beam
5	Z **EN-51007-3** Radiator Support Beam
6	**EN-51007-5** Support Leg, Front
7	**EN-51007-6** Hook

TURBOCHARGER HEAT SHIELD REPLACEMENT

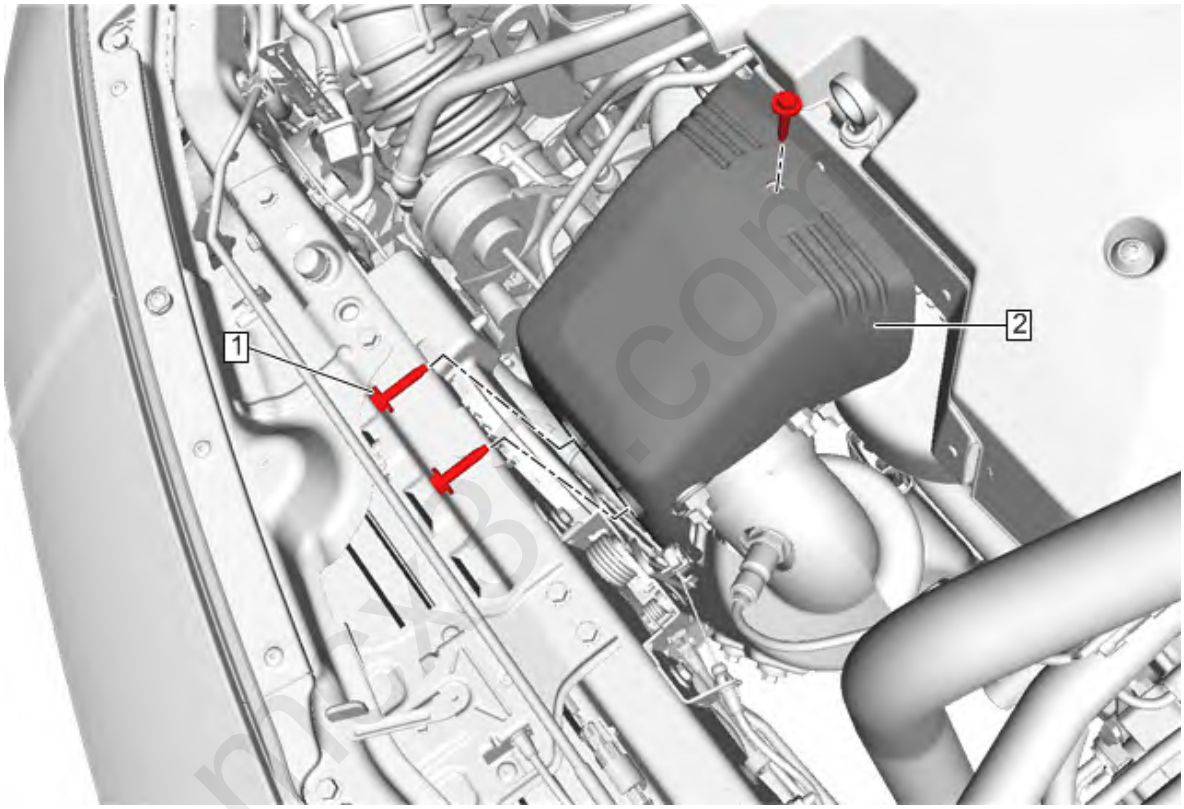


Fig. 47: Turbocharger Heat Shield
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Turbocharger Heat Shield Bolt [3x] **CAUTION:** **Refer to Fastener Caution .** **NOTE:** **In the event that a bolt breaks upon removal of components, perform an extraction of the broken bolt.** **tighten** 14 N.m (10 lb ft)
2	Turbocharger Heat Shield

TURBOCHARGER REPLACEMENT (1ST DESIGN TAMPER-PROOF PCV SYSTEM)

Removal Procedure

CAUTION: **If a turbocharger has failed, clean any turbocharger debris or excessive oil from the charge air cooler system before installing the new turbocharger. Failure to clean debris from the charge air cooler system will cause severe turbocharger and engine damage upon startup.**

1. Remove **Intake Manifold Cover Replacement**.
2. Remove **Air Cleaner Outlet Duct Replacement (Non-Tamperproof)** **Air Cleaner Outlet Duct Replacement (Tamperproof)** .

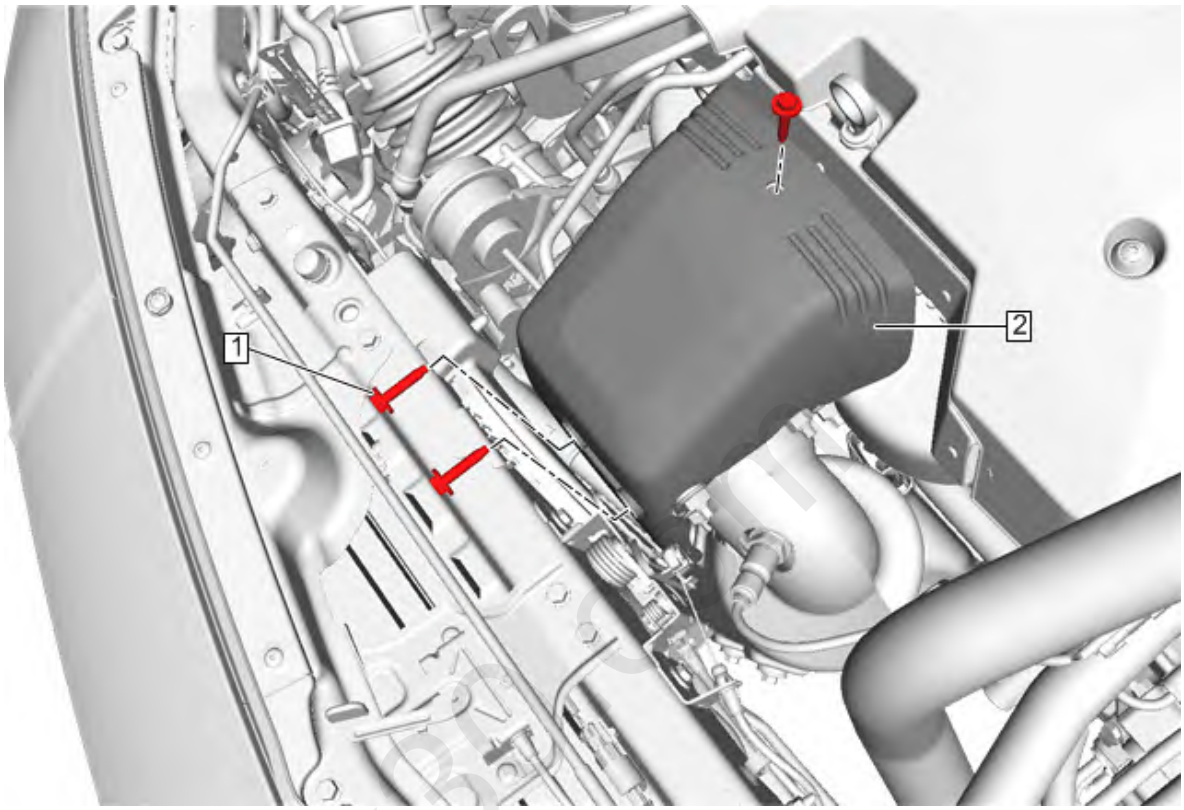


Fig. 48: Turbocharger Heat Shield
Courtesy of GENERAL MOTORS COMPANY

3. Remove Turbocharger Heat Shield (2) -**Turbocharger Heat Shield Replacement**
4. Remove **Turbocharger Coolant Return Pipe Replacement (LTG)** .
5. Remove **Warm Up Three-Way Catalytic Converter Replacement (LTG)** .
6. Remove **Turbocharger Oil Return Pipe Replacement**.
7. Raise and support the vehicle. **Lifting and Jacking the Vehicle**

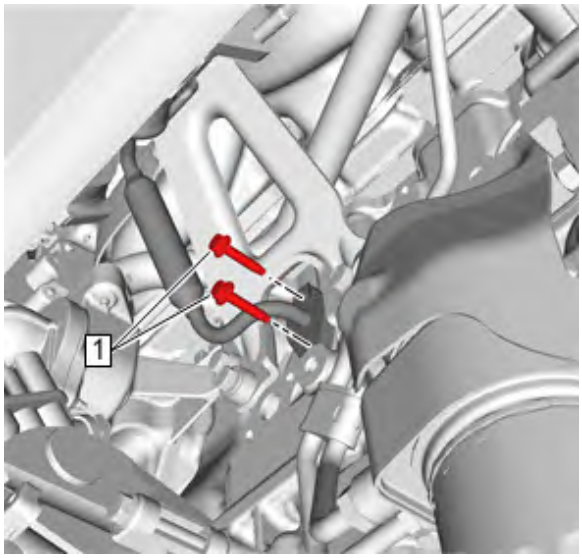


Fig. 49: Turbocharger Oil Feed Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove Turbocharger Oil Feed Pipe Bolt (1) [2x]
9. Remove **Turbocharger Coolant Feed Pipe Replacement (LTG)** .
10. Remove **Charge Air Cooler Inlet Air Tube Replacement**
11. Lower the vehicle. **Lifting and Jacking the Vehicle**

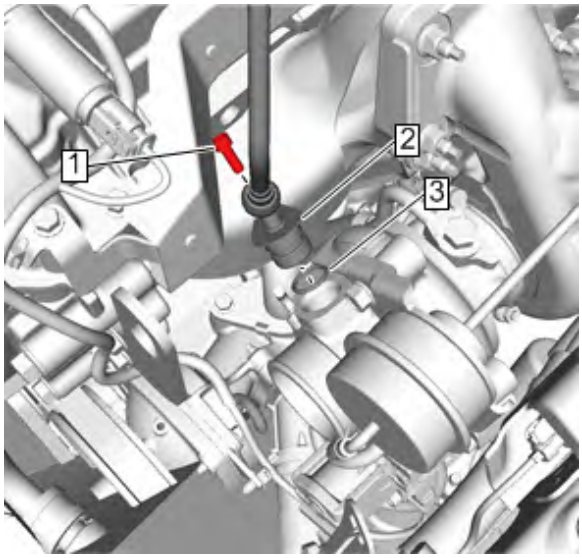


Fig. 50: PCV Valve
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The PCV hose and fitting assembly connection is permanent. Reinstall these components as an assembly unless new components are being used.**

NOTE: **Always ensure the PCV hose fitting O-Ring (3) seal is free of cuts or abrasions each time the fitting is attached to the turbocharger.**

12. Remove Positive Crankcase Ventilation Hose Fitting Bolt (1).
13. Disconnect Positive Crankcase Ventilation Hose Fitting (2).
14. Disconnect the electrical connectors from the turbocharger.

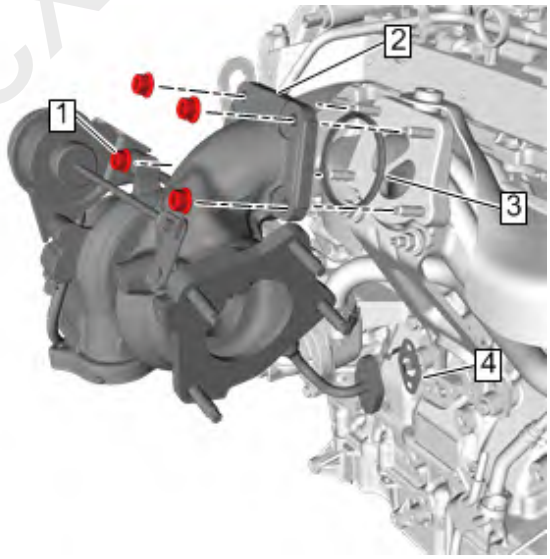


Fig. 51: Turbocharger Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The exhaust pipe studs do not come installed on new turbochargers. If the turbocharger is being replaced, new studs will need to be installed.**

15. Remove Turbocharger Nut (1) and DISCARD [4x]
16. Remove Turbocharger (2)
17. Remove Turbocharger Gasket (3) and DISCARD
18. Remove Turbocharger Oil Feed Pipe Gasket (4) and DISCARD

mcx30.com

19. Clean and inspect Turbocharger (2) - **Camshaft Cover and Compressor Air Intake Turbocharger Cleaning and Inspection**
20. Transfer components as necessary.

Installation Procedure

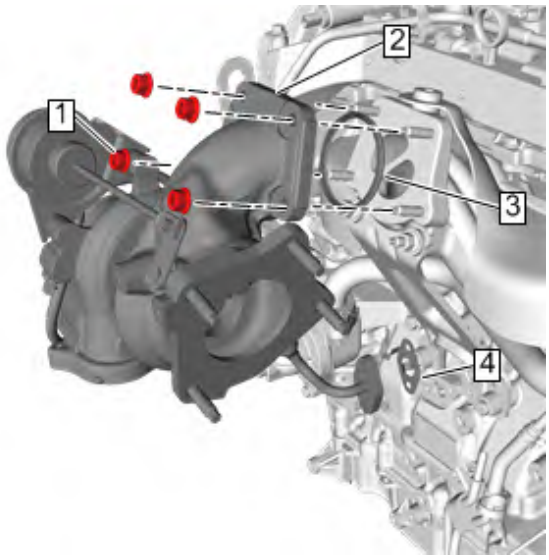


Fig. 52: Turbocharger Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install a NEW gasket.**

1. Install Turbocharger Oil Feed Pipe Gasket (4)

NOTE: **Install a NEW gasket.**

2. Install Turbocharger Gasket (3)
3. Install Turbocharger (2)

NOTE: **Install NEW nuts.**

NOTE: **The exhaust pipe studs do not come installed on new turbochargers. If the turbocharger is being replaced, new studs will need to be installed.**

4. Loosely Install Turbocharger Nut (1) - [4x]

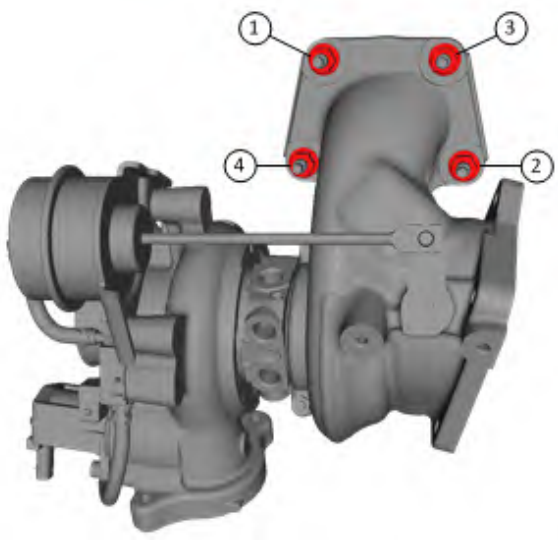


Fig. 53: Turbocharger Nut tighten in sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

mcx30.com

CAUTION: **This component uses torque-to-yield bolts. When servicing this component do not reuse the bolts, New torque-to-yield bolts must be installed. Reusing used torque-to-yield bolts will not provide proper bolt torque and clamp load. Failure to install NEW torque-to-yield bolts may lead to engine damage.**

5. Turbocharger Nut - tighten in sequence

   tighten

   1. First Pass:30 N.m (22 lb ft)
   2. Final Pass:an additional 90 degrees

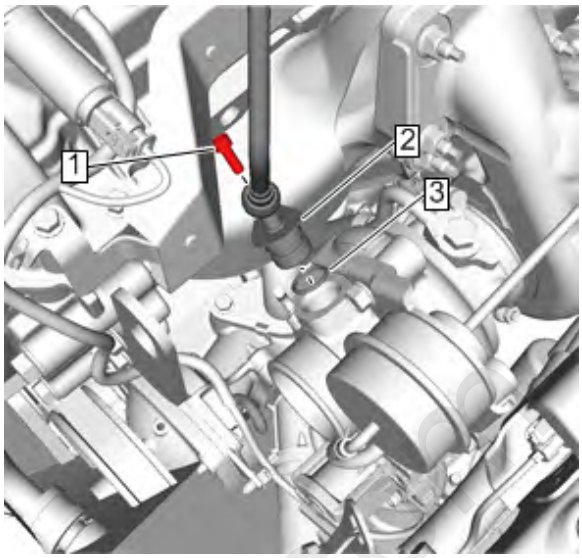


Fig. 54: PCV Valve
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Always ensure the PCV hose fitting O-Ring (3) seal is free of cuts or abrasions each time the fitting is attached to the turbocharger.**

6. Inspect the O-ring and replace if necessary. (3)
7. Connect Positive Crankcase Ventilation Hose Fitting (2)
8. Install Positive Crankcase Ventilation Hose Fitting Bolt (1) and tighten 8 N.m (71 lb in)
9. Raise and support the vehicle. **Lifting and Jacking the Vehicle**

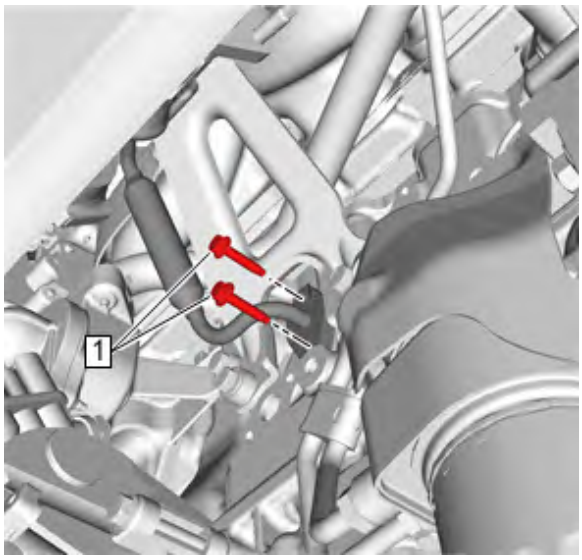


Fig. 55: Turbocharger Oil Feed Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

10. Install Turbocharger Oil Feed Pipe Bolt (1) and tighten [2x] 10 N.m (89 lb in)

11. Lower the vehicle. **Lifting and Jacking the Vehicle**
12. Install **Turbocharger Coolant Feed Pipe Replacement (LTG)** .
13. Install **Turbocharger Coolant Return Pipe Replacement (LTG)** .
14. Install **Warm Up Three-Way Catalytic Converter Replacement (LTG)** .
15. Install **Turbocharger Oil Return Pipe Replacement**.
16. Install **Charge Air Cooler Inlet Air Tube Replacement** .
17. Connect the turbocharger electrical connectors.

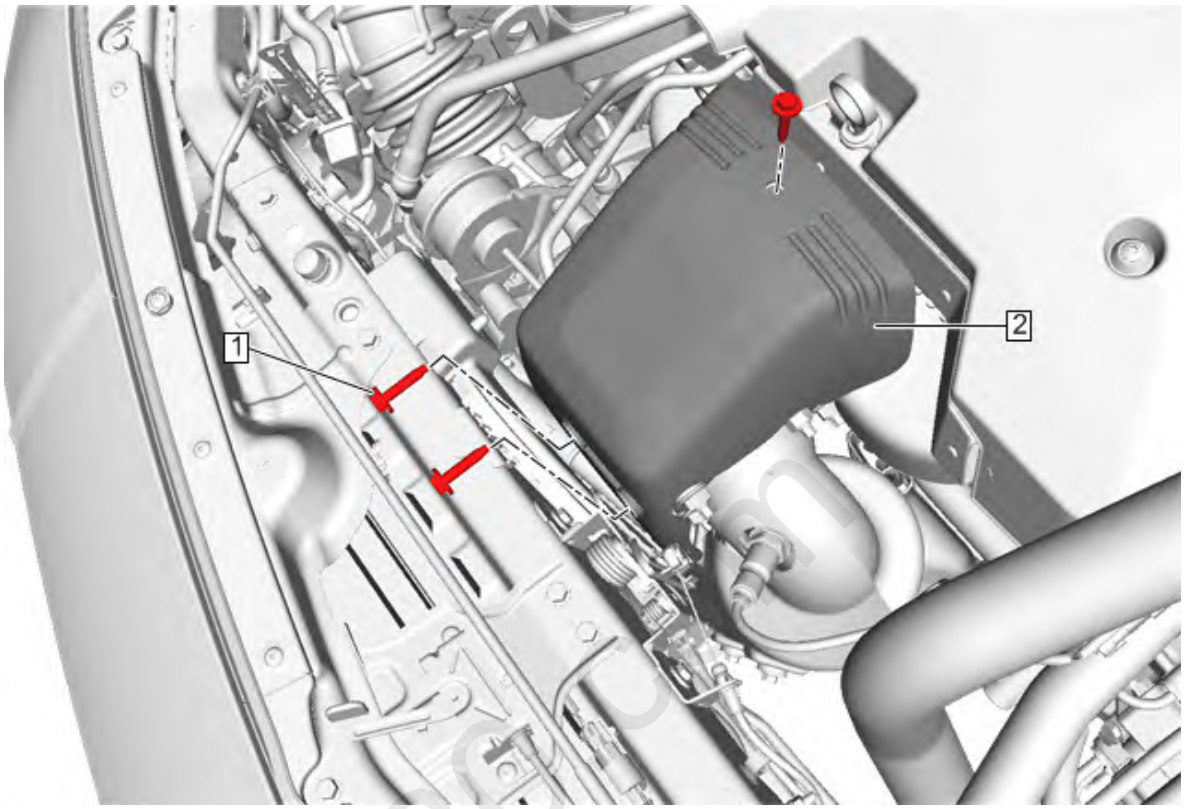


Fig. 56: Turbocharger Heat Shield
Courtesy of GENERAL MOTORS COMPANY

18. Install Turbocharger Heat Shield (2) - **Turbocharger Heat Shield Replacement**
19. Install **Air Cleaner Outlet Duct Replacement (Non-Tamperproof)** **Air Cleaner Outlet Duct Replacement (Tamperproof)** .
20. Install **Intake Manifold Cover Replacement**.

TURBOCHARGER OIL RETURN PIPE REPLACEMENT

Removal Procedure

1. Remove **Warm Up Three-Way Catalytic Converter Replacement (LTG)**
2. Raise and support the vehicle. **Lifting and Jacking the Vehicle**

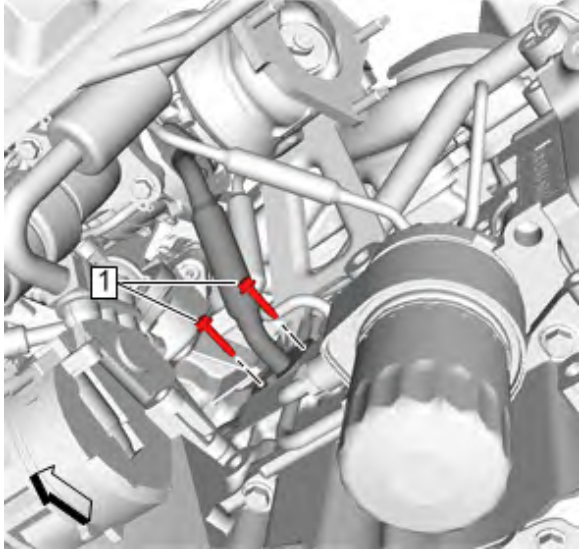


Fig. 57: Turbocharger Oil Return Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove Turbocharger Oil Return Pipe Bolt (1) - [2x]

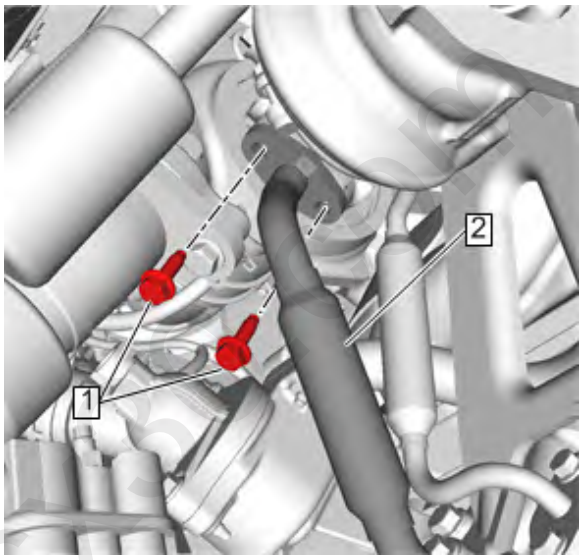


Fig. 58: Turbocharger Oil Return Pipe
Courtesy of GENERAL MOTORS COMPANY

4. Remove Turbocharger Oil Return Pipe Bolt (1) - [2x]
5. Remove Turbocharger Oil Return Pipe (2)

Fig. 59: Turbocharger Oil Return Pipe Gaskets
Courtesy of GENERAL MOTORS COMPANY

6. Remove Turbocharger Oil Return Pipe Gasket (1) and DISCARD [2x]

Installation Procedure

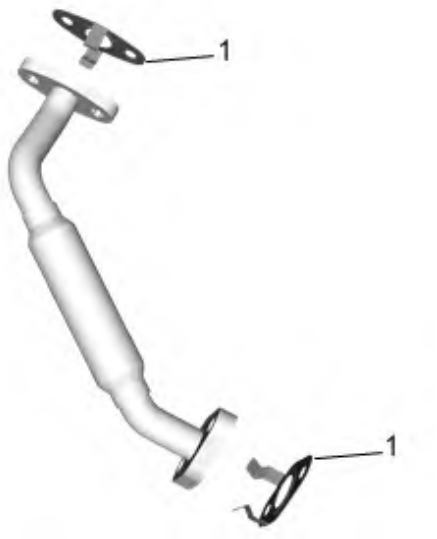


Fig. 60: Turbocharger Oil Return Pipe Gaskets
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install a NEW gasket.**

1. Install Turbocharger Oil Return Pipe Gasket (1) [2x]

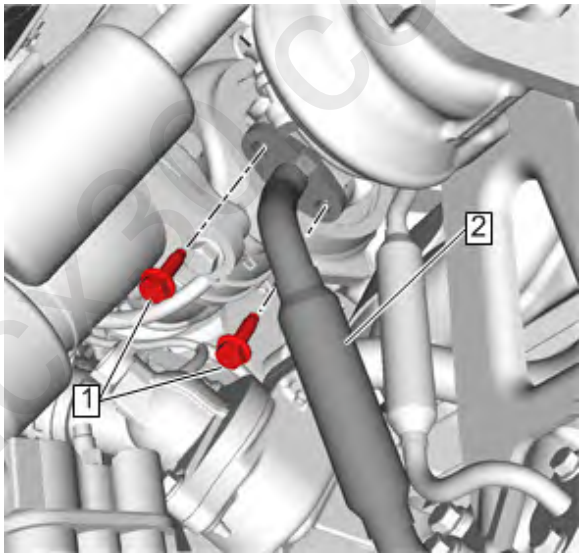


Fig. 61: Turbocharger Oil Return Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Install Turbocharger Oil Return Pipe (2)

CAUTION: **Refer to Fastener Caution .**

3. Install Turbocharger Oil Return Pipe Bolt (1) and tighten [2x] 10 N.m (89 lb in)

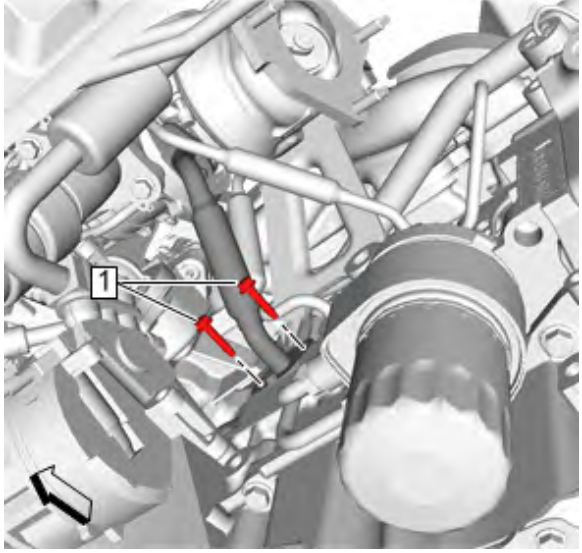


Fig. 62: Turbocharger Oil Return Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Install Turbocharger Oil Return Pipe Bolt (1) and tighten [2x] 10 N.m (89 lb in)
5. Install **Warm Up Three-Way Catalytic Converter Replacement (LTG)**
6. Lower the vehicle. **Lifting and Jacking the Vehicle**

TURBOCHARGER OIL FEED PIPE REPLACEMENT

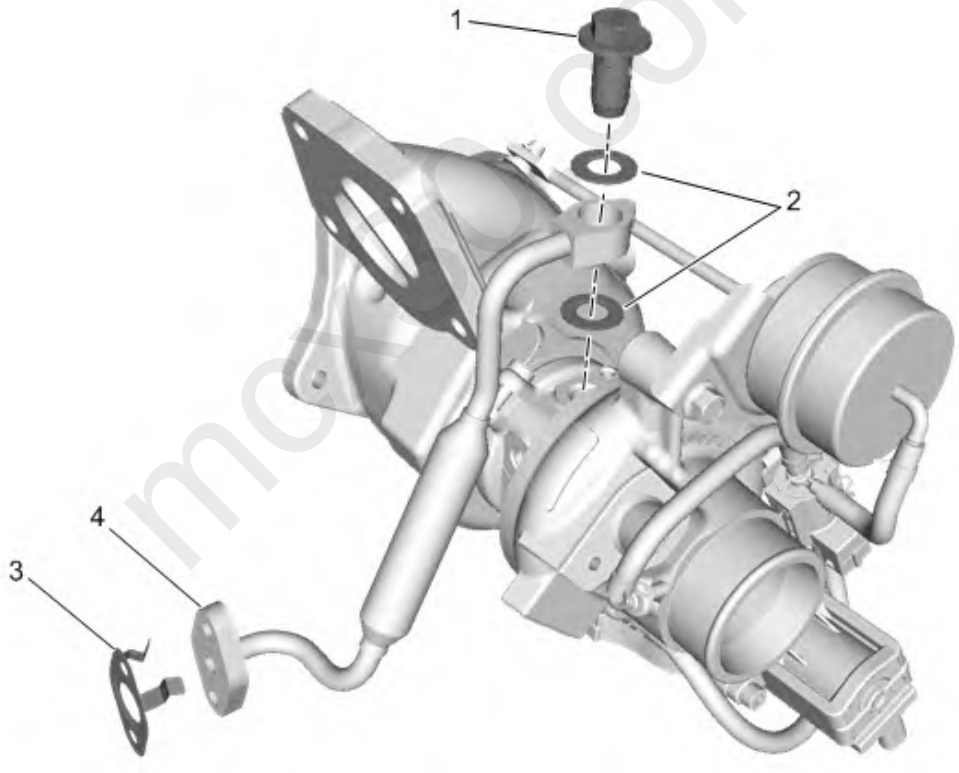


Fig. 63: Turbocharger Oil Feed Pipe Bolt And Sealing Washers
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Turbocharger Replacement (1st Design Tamper-Proof PCV System)	

Callout	Component Name
1	Turbocharger Oil Feed Pipe Bolt **CAUTION:** **Refer to Fastener Caution .** **tighten** 35 N.m (26 lb ft)
2	Turbocharger Oil Feed Pipe Washer [2x] **Procedure** Install NEW sealing washers.
3	Turbocharger Oil Feed Pipe Gasket **Procedure** Install a NEW gasket.
4	Turbocharger Oil Feed Pipe

POSITIVE CRANKCASE VENTILATION VALVE REPLACEMENT

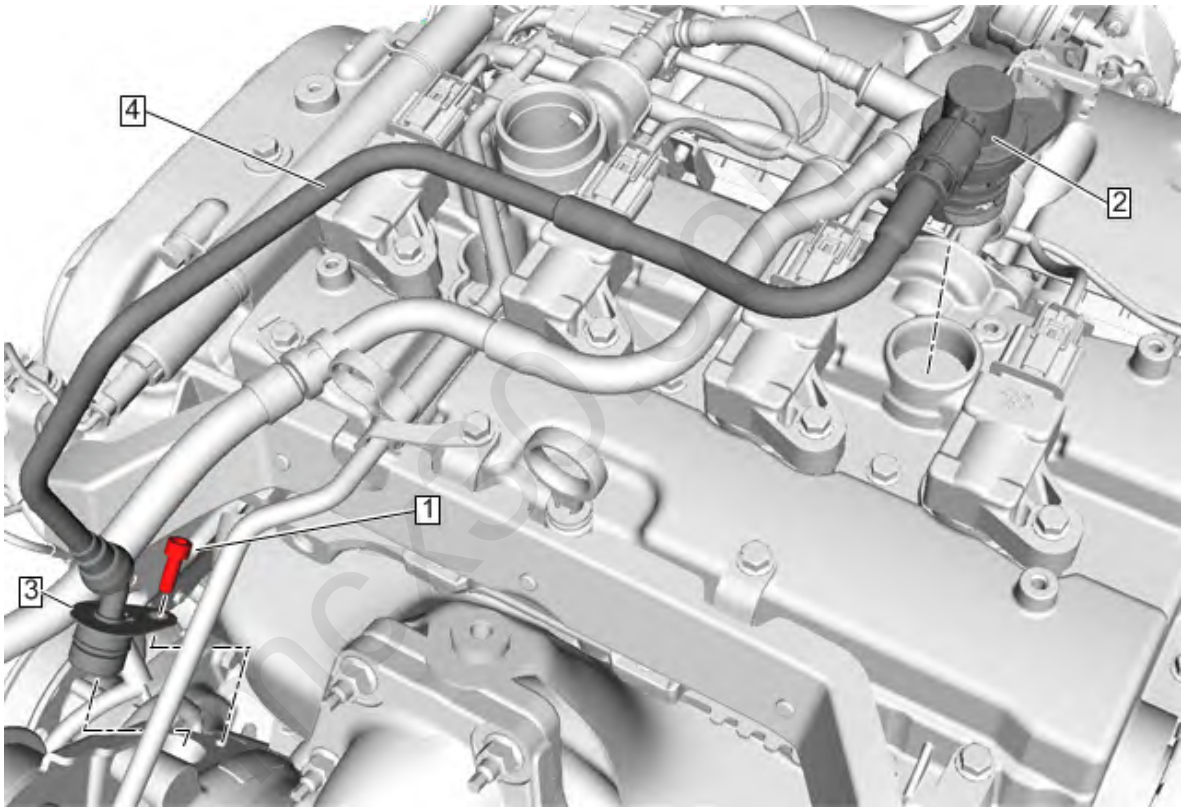


Fig. 64: Positive Crankcase Ventilation Valve (LTG)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures Intake Manifold Cover Replacement **NOTE:** **Inspect each component while attached to the camshaft cover. Do not remove the PCV components unless inspection indicates a suspect component. Replace the PCV valve, PCV tube assembly, and PCV hose fitting as an assembly. The connections between these components are permanent.**	

Callout	Component Name
1	Positive Crankcase Ventilation Hose Fitting Fastener **CAUTION:** **Refer to Fastener Caution .** **tighten** 8 N.m (71 lb in)
2	Positive Crankcase Ventilation Valve **Procedure** Inspect the PCV valve. If the PCV valve is suspect, use a suitable tool to pry the valve off of the cover. Retrieve any particles that fall onto the baffle in the cover. Discard the valve and particles. **NOTE:** **When the PCV valve is removed, small particles of the valve will break and fall into the cover.**
3	Positive Crankcase Ventilation Hose Fitting
4	Positive Crankcase Ventilation Hose/Tube **Procedure** If necessary, un-clip the hose from the retainer.

POSITIVE CRANKCASE VENTILATION HOSE/PIPE/TUBE REPLACEMENT (CAMSHAFT COVER TO AIR INLET)

Special Tools

- **EN-50956** Tamper Proof Drive Bit

Equivalent regional tools:**Special Tools**.

Removal Procedure

1. Remove **Intake Manifold Cover Replacement**.
2. Disconnect Positive Crankcase Ventilation Tube @ Air Cleaner Outlet Duct - **Air Cleaner Outlet Duct Replacement (Non-Tamperproof)** **Air Cleaner Outlet Duct Replacement (Tamperproof)**

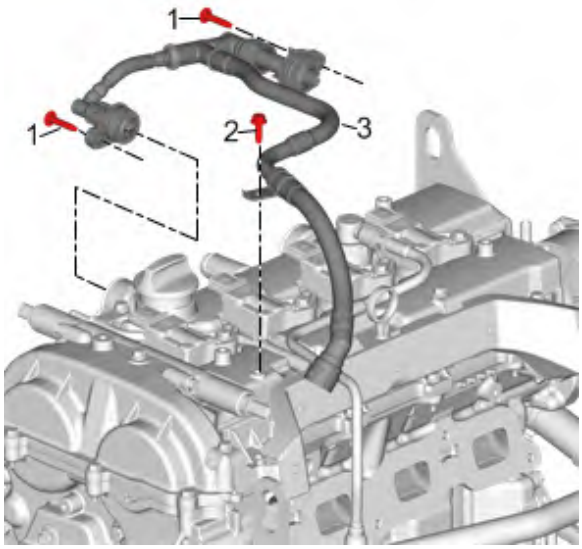


Fig. 65: PCV Valve/Tube Assembly And Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: **PCV Valve fasteners are tamper proof and must have a slot cut in the fastener to be removed.**

mrx30.com

3. Using a suitable cutting tool, cut a slot in the fasteners. Remove the PCV valve fasteners with a flat blade screw driver and DISCARD (1).
4. Remove the PCV hose fastener (2) from the camshaft cover.

NOTE: **PCV valves and PCV tube assembly have tamper-proof connections and cannot be disassembled.**

5. Remove the PCV valves and PCV tube assembly.

Installation Procedure

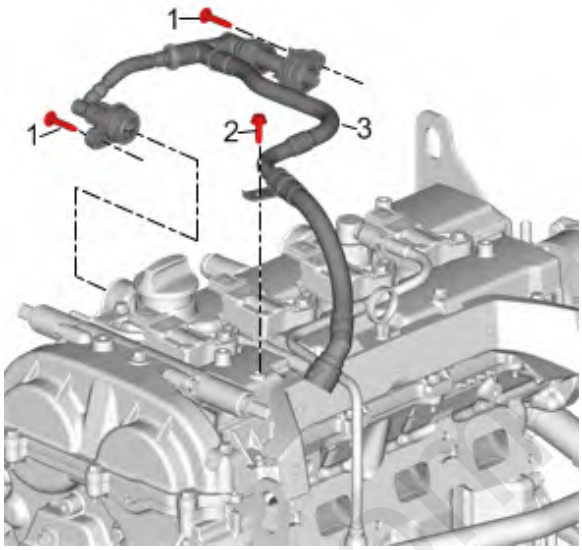


Fig. 66: PCV Valve/Tube Assembly And Fasteners
Courtesy of GENERAL MOTORS COMPANY

1. Install the PCV hose assembly and PCV valves (3).

CAUTION: **Refer to Fastener Caution .**

2. Install the NEW PCV valve fasteners (1) using **EN-50956** tamper proof drive bit and tighten to 10 N.m (89 lb in).
3. Install the PCV hose fastener (2) and tighten to 12 N.m (106 lb in).
4. Connect Positive Crankcase Ventilation Tube @ Air Cleaner Outlet Duct - **Air Cleaner Outlet Duct Replacement (Non-Tamperproof)** **Air Cleaner Outlet Duct Replacement (Tamperproof)**
5. Install **Intake Manifold Cover Replacement**

INTAKE MANIFOLD REPLACEMENT

Removal Procedure

1. Remove Intake Manifold Cover - **Intake Manifold Cover Replacement**

mcx30.com

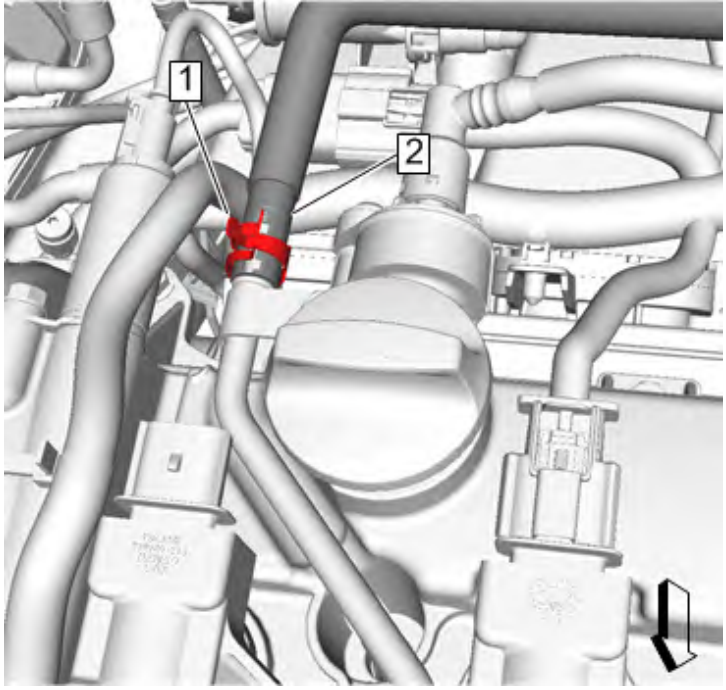


Fig. 67: Engine Coolant Air Bleed Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect and reposition the engine coolant air bleed hose (2) as necessary. **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Radiator to Engine Coolant Air Bleed Pipe LTG)**
3. Remove Fuel Feed Front Pipe - **Fuel Feed Front Pipe Replacement**
4. Remove Air Cleaner Outlet Duct -**Air Cleaner Outlet Duct Replacement (Non-Tamperproof)** **Air Cleaner Outlet Duct Replacement (Tamperproof)**
5. Remove Evaporative Emission Canister Purge Solenoid Valve -**Evaporative Emission Canister Purge Solenoid Valve Replacement**
6. Remove Throttle Body Assembly - **Throttle Body Assembly Replacement**
7. Disconnect Engine Coolant Air Bleed Hose @ Engine Coolant Air Bleed Pipe - **Engine Coolant Air Bleed Pipe Replacement (LTG)**

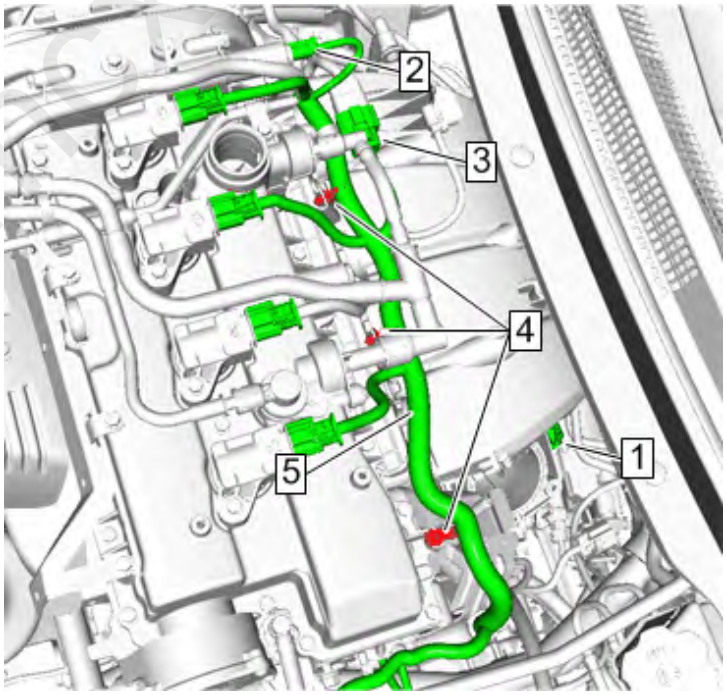


Fig. 68: Electrical Connector And Engine Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect Electrical Connector (1)
9. Disconnect Electrical Connector (2)
10. Disconnect Electrical Connector (3)
11. Disconnect Wiring Harness Retainer (4) [3x]

12. Reposition away Engine Wiring Harness (5)
13. Raise the vehicle. **Lifting and Jacking the Vehicle**

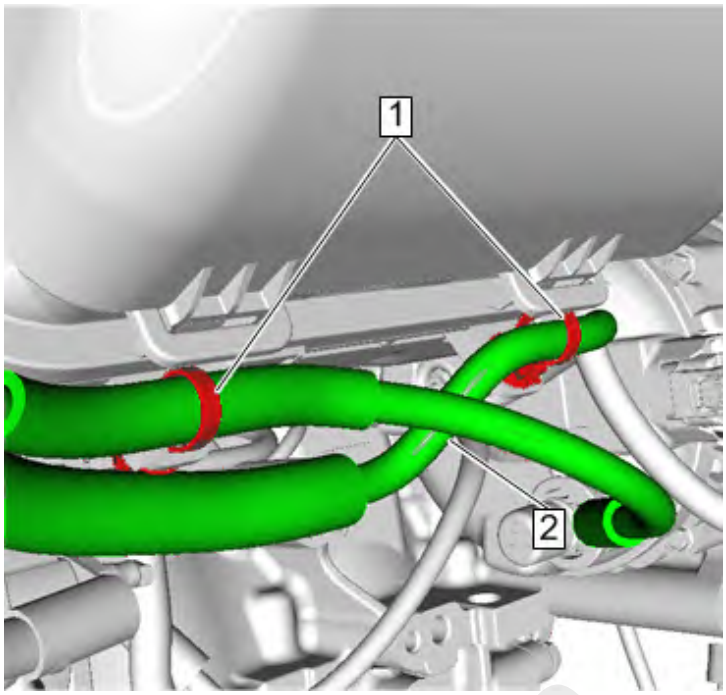


Fig. 69: Wiring Harness And Retainers
Courtesy of GENERAL MOTORS COMPANY

14. Remove the wiring harness retainers (1), then reposition the harness (2) as needed.

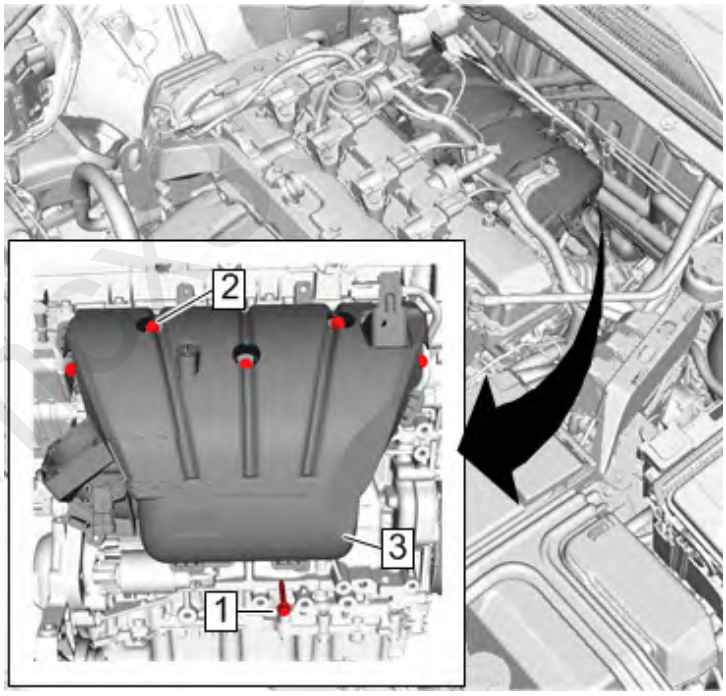


Fig. 70: Intake Manifold And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The intake manifold bolts are retained in the intake manifold. Fully loosen the bolts until the threads are disengaged from the cylinder head.**

15. Loosen Intake Manifold Bolt (1).
16. Lower the vehicle. **Lifting and Jacking the Vehicle**
17. Loosen Intake Manifold Bolt (2) - [5x]

NOTE: **The fuel injection fuel rail fuel pressure sensor must be removed to obtain enough clearance to remove the intake manifold from the vehicle.**

18. Separate the intake manifold from the engine to gain access to the fuel pressure sensor.

19. Remove the fuel injection fuel rail fuel pressure sensor. **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**

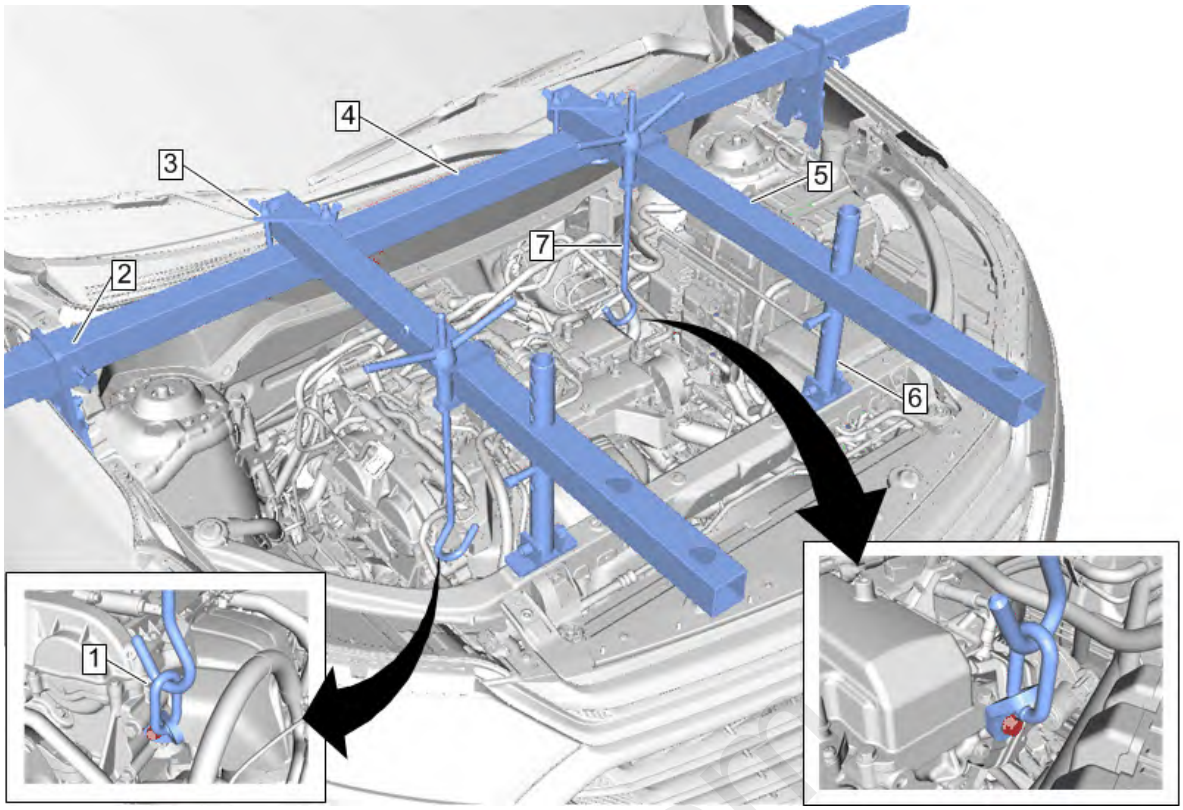


Fig. 71: Engine Support Fixture
Courtesy of GENERAL MOTORS COMPANY

20. Install Engine Support Fixture (1, 2, 3, 4. 6, and 7) - **Engine Support Fixture**

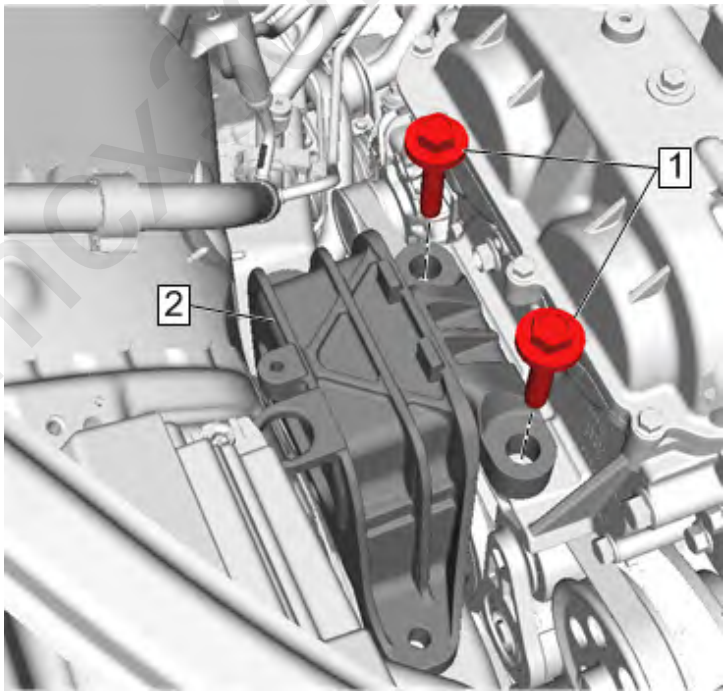


Fig. 72: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

21. Remove Engine Mount Bolt (1) - [2x] - **Engine Mount Replacement**
22. Lower the front of the engine enough to gain clearance to remove the intake manifold.
23. Remove Intake Manifold.

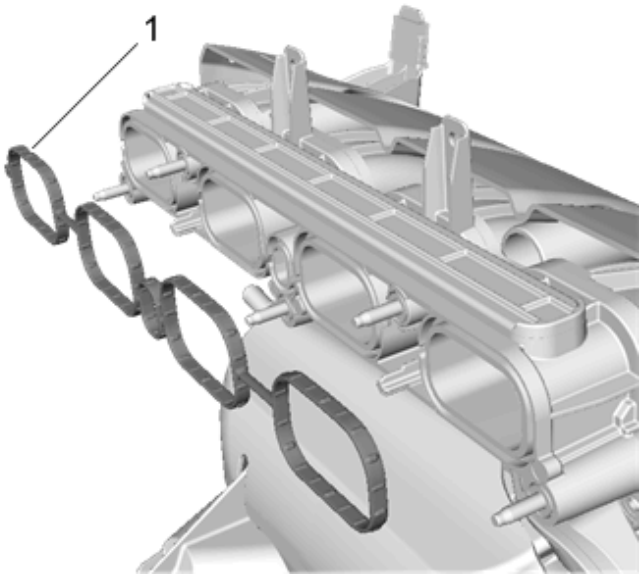


Fig. 73: Intake Manifold Gasket
Courtesy of GENERAL MOTORS COMPANY

24. Remove Intake Manifold Gasket (1) and DISCARD
25. Clean and inspect the intake manifold. **Intake Manifold Cleaning and Inspection**

Installation Procedure

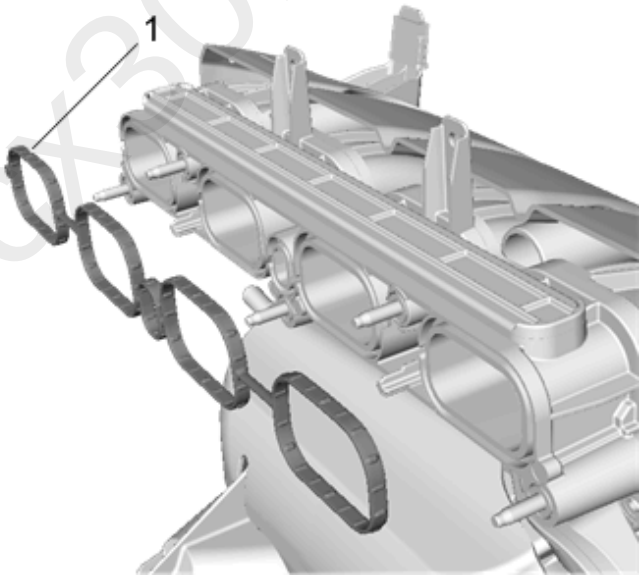


Fig. 74: Intake Manifold Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW Intake Manifold Gasket (1)
2. Install Intake Manifold.
3. Raise the front of the engine back into position.

mx30.com

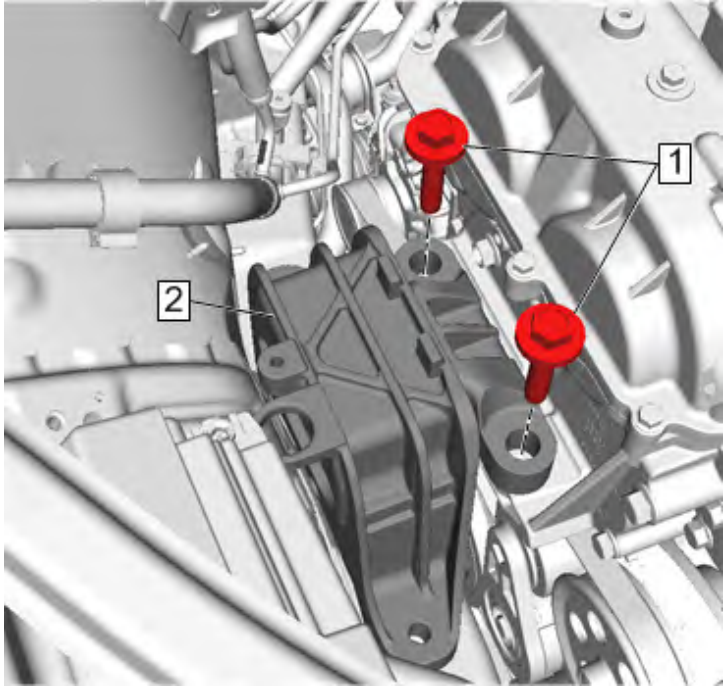


Fig. 75: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install Engine Mount Bolt (1) - [2x] - **Engine Mount Replacement**

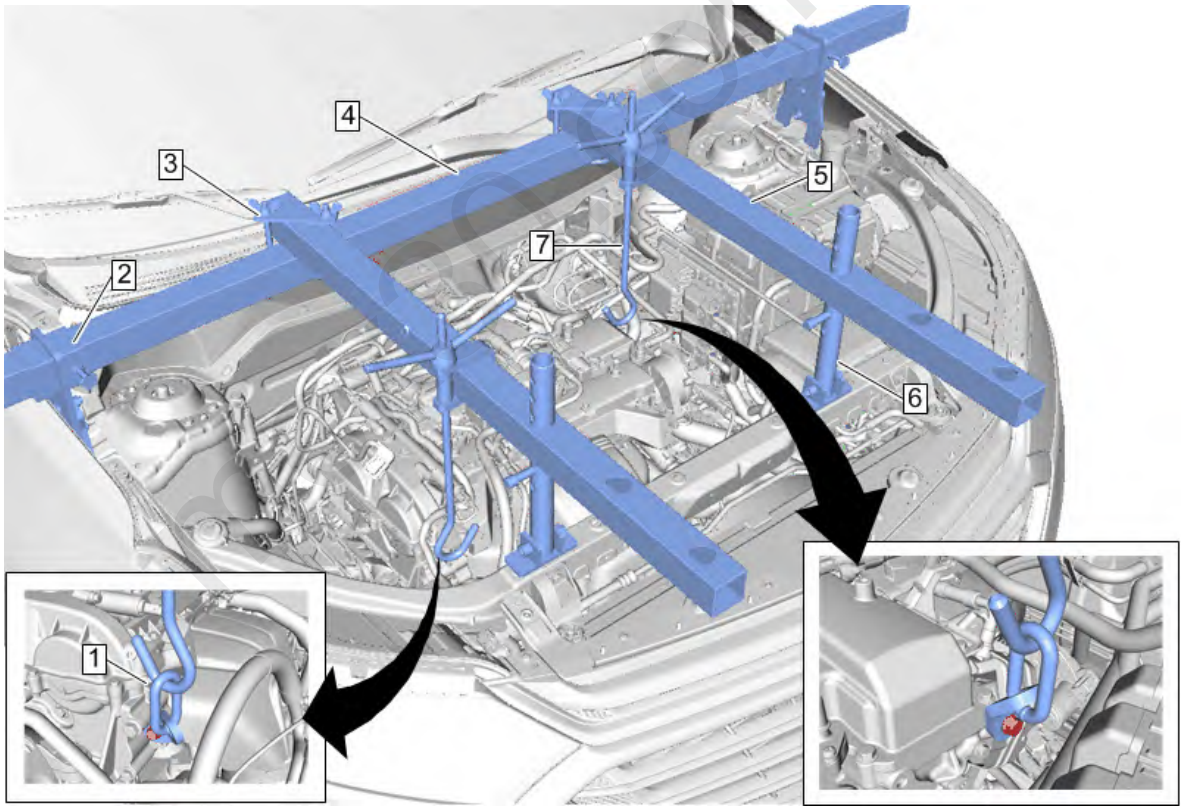


Fig. 76: Engine Support Fixture
Courtesy of GENERAL MOTORS COMPANY

5. Remove Engine Support Fixture (1, 2, 3, 4. 6, and 7) - **Engine Support Fixture**
6. Install the fuel injection fuel rail fuel pressure sensor. **Fuel Injection Fuel Rail Fuel Pressure Sensor Replacement**

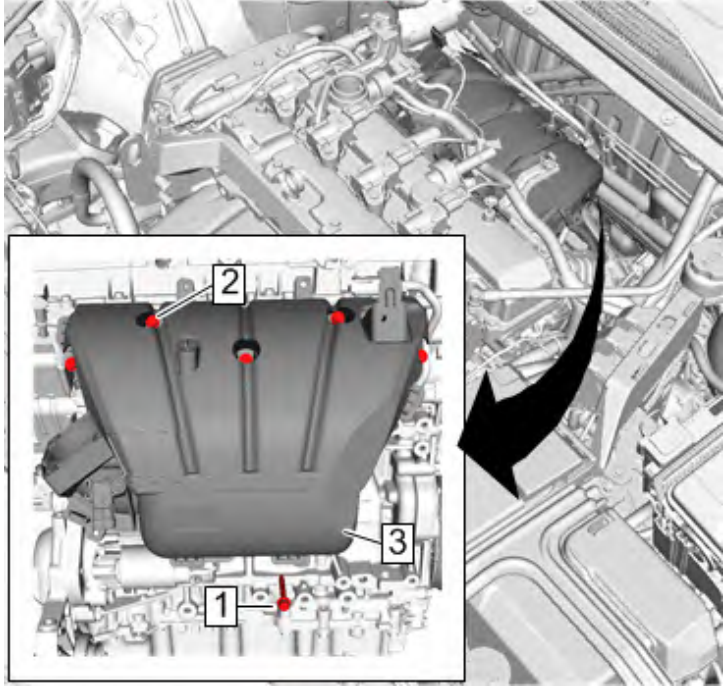


Fig. 77: Intake Manifold And Bolts
Courtesy of GENERAL MOTORS COMPANY

7.
8. Loosely install Upper Intake Manifold Bolt (3)
9. Raise the vehicle. **Lifting and Jacking the Vehicle**
10. Loosely install Lower Intake Manifold Bolt.

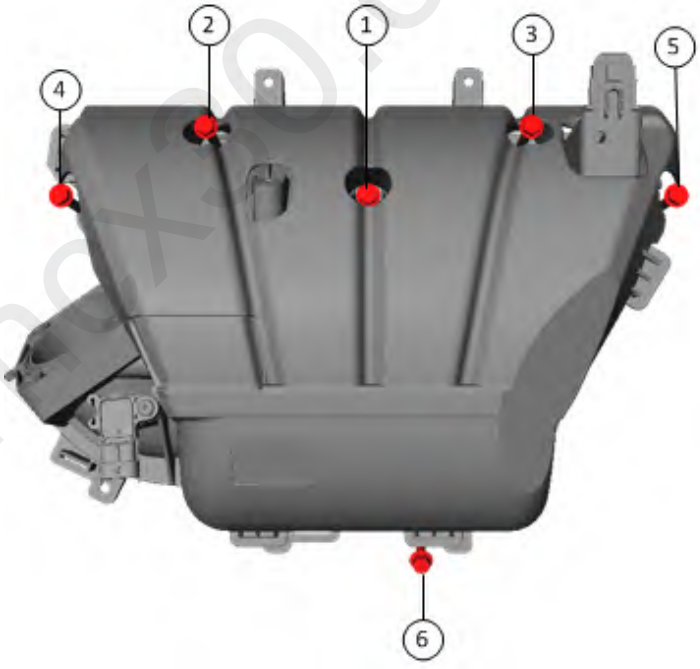


Fig. 78: Intake Manifold Bolts tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

11. tighten in sequence

tighten

1. First Pass:12 N.m (106 lb in)
2. Final Pass:12 N.m (106 lb in)

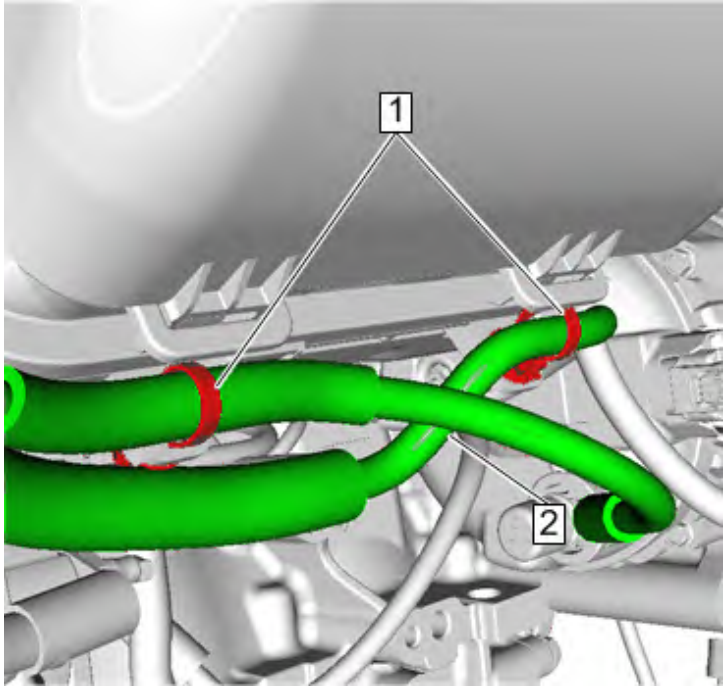


Fig. 79: Wiring Harness And Retainers
Courtesy of GENERAL MOTORS COMPANY

12. Reposition the harness (2) as needed, then install the wiring harness retainers (1).

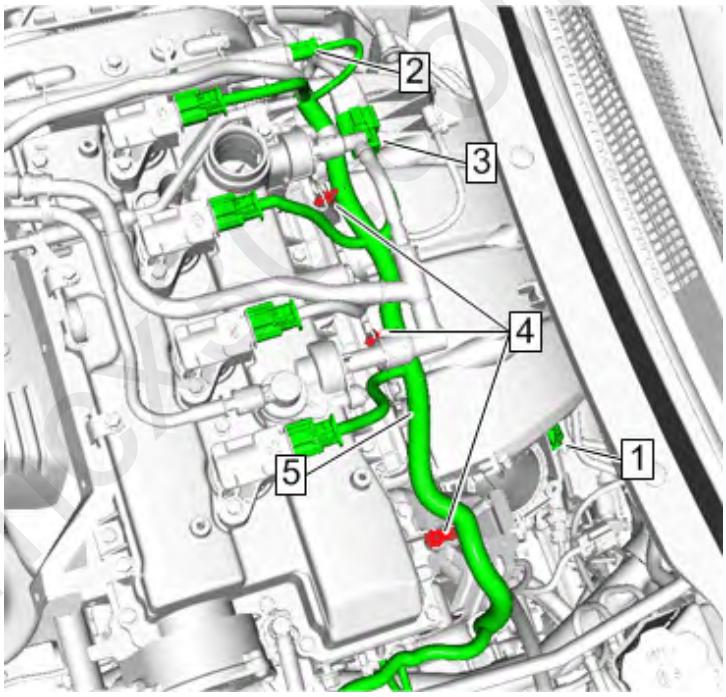


Fig. 80: Electrical Connector And Engine Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

13. Reposition Engine Wiring Harness (5)
14. Connect Electrical Connector (2)
15. Connect Electrical Connector (3)
16. Connect Wiring Harness Retainer (4) [3x]
17. Connect Electrical Connector (1)

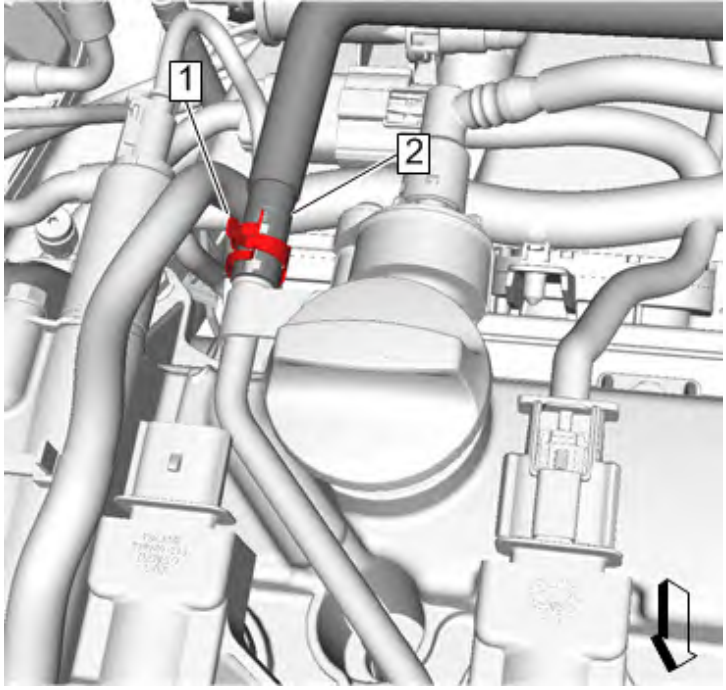


Fig. 81: Engine Coolant Air Bleed Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

18. Reposition and connect the engine cooant air bleed hose (2) as necessary. **Engine Coolant Air Bleed Hose Replacement (Radiator Surge Tank to Radiator to Engine Coolant Air Bleed Pipe LTG)**
19. Install Throttle Body Assembly -**Throttle Body Assembly Replacement**
20. Install Fuel Feed Front Pipe - **Fuel Feed Front Pipe Replacement**
21. Install Evaporative Emission Canister Purge Solenoid Valve - **Evaporative Emission Canister Purge Solenoid Valve Replacement**
22. Install Air Cleaner Outlet Duct - **Air Cleaner Outlet Duct Replacement (Non-Tamperproof)** **Air Cleaner Outlet Duct Replacement (Tamperproof)**
23. Remove Intake Manifold Cover - **Intake Manifold Cover Replacement**

CRANKSHAFT BALANCER REPLACEMENT

Special Tools

- **EN-45059** Angle Meter
- **EN-51577** Crankshaft Balancer Holder/Remover
- **J-41816-2 or EN-38416-2** Crankshaft End Protector

Equivalent regional tools:**Special Tools**

Removal Procedure

1. Remove the drive belt. **Drive Belt Replacement**

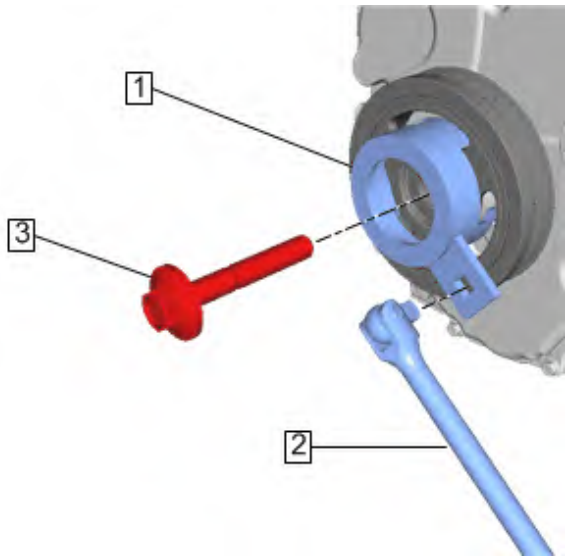


Fig. 82: Crankshaft Balancer Remover, Breaker Bar And Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Use **EN-51577-1** Crankshaft Balancer Remover (1) and breaker bar (2) prevent the crankshaft from rotating while loosening the crankshaft balancer fastener (3).
3. Remove and DISCARD the crankshaft balancer fastener (3).

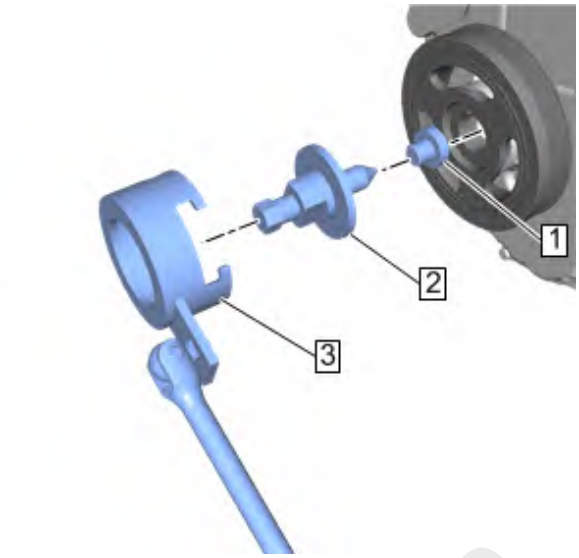


Fig. 83: Crankshaft End Protector And Balancer Remover
Courtesy of GENERAL MOTORS COMPANY

4. Remove the crankshaft balancer holder then install the **J-41816-2 or EN-38416-2** Crankshaft End Protector (1) and all components of **EN-51577** Crankshaft Balancer Remover (2, 3) as shown.

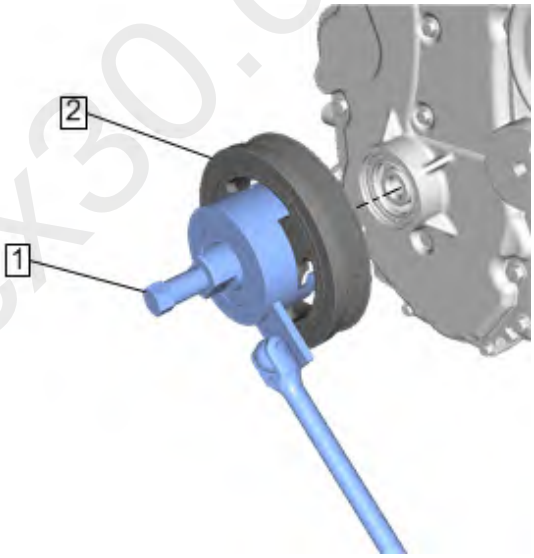


Fig. 84: Crankshaft Balancer Remover And Balancer
Courtesy of GENERAL MOTORS COMPANY

5. tighten the crankshaft balancer remover (1) in order to remove the crankshaft balancer (2).

Installation Procedure

mcx30.com

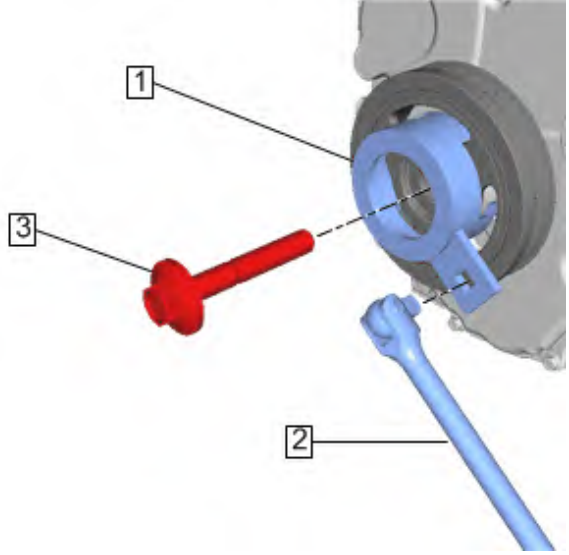


Fig. 85: Crankshaft Balancer Remover, Breaker Bar And Fastener
Courtesy of GENERAL MOTORS COMPANY

1. Install the crankshaft balancer with NEW fastener. Use **EN-51577-1** Crankshaft Balancer Remover (1) and breaker bar (2) prevent the crankshaft from rotating while tightening the NEW crankshaft balancer fastener (3).

CAUTION: **Refer to Fastener Caution .**

2. tighten the crankshaft balancer bolt to 150 N.m (111 lb ft) plus an additional 140 degrees using the **EN-45059** meter.
3. Install the drive belt. **Drive Belt Replacement**
4. Perform the crankshaft position variation learn procedure. **Crankshaft Position Variation Learn**

TIMING CHAIN CRANKSHAFT SPROCKET REPLACEMENT

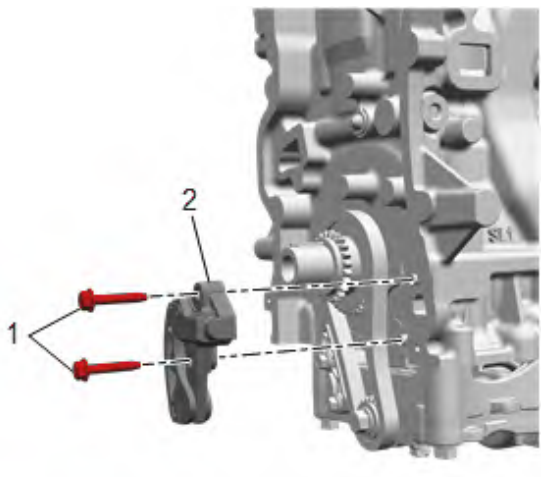
Special Tools

- **EN-51577-1** Crankshaft Balancer Remover
- **EN-50837** Timing Chain Tensioner Retraction Tool

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

Removal Procedure

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement (1st Design Tamper-Proof PCV System)**.
2. Remove the timing chain. Refer to **Camshaft Timing Chain and Tensioner Replacement**.



mcx30.com

Fig. 86: Balancer Chain Tensioner Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove the balancer chain tensioner bolt (1).
4. Remove the balancer chain tensioner (2).
5. Compress and lock the tensioner using **EN-50837** retention tool.
    1. Insert **EN-50837** retention tool into the lever arm and push in a counterclockwise direction.
    2. Compress the tensioner while holding lever arm.
    3. Relax the force on the lever and tensioner slightly, allowing the tensioner to extend 3 ratchet clicks, and then hold in place.
    4. Pull lever clockwise using **EN-50837** retention tool until the hole in the lever aligns with the hole in the tensioner assembly. Push the point of **EN-50837** retention tool through the lever and into the tensioner assembly.

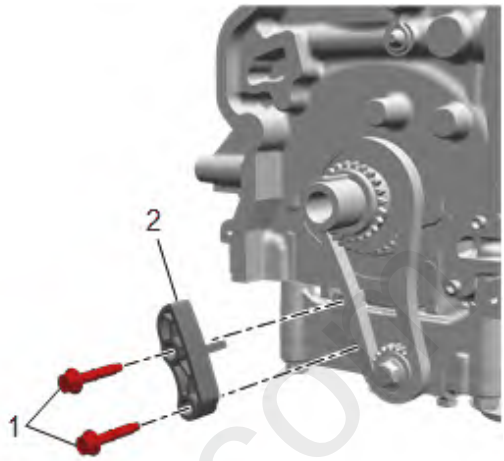


Fig. 87: Balancer Chain Guide Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the balancer chain guide bolt (1).
7. Remove the balancer chain guide (2).

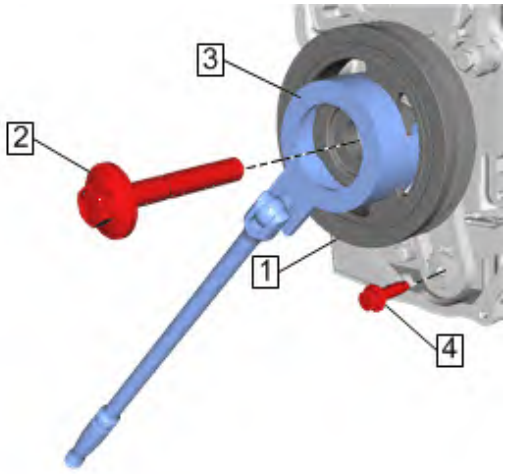


Fig. 88: Holding Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The crankshaft balancer and the ORIGINAL balancer bolt will be temporarily installed in order to counter hold the crankshaft while removing the balancer shaft driven sprocket bolt.**

8. TEMPORARILY install the crankshaft balancer (1).

mcx30.com

1. TEMPORARILY install the ORIGINAL crankshaft balancer bolt (2).
2. Counter hold the crankshaft balancer pulley (1) using the **EN-51577-1** Crankshaft Balancer Remover (3).
3. While counter holding, remove and DISCARD the balancer shaft driven sprocket bolt (4).
4. Remove the crankshaft balancer bolt (2), balancer (1) and tool (3).

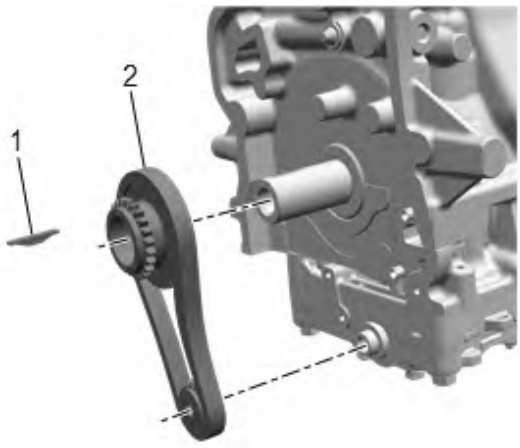


Fig. 89: Balancer Shaft Driven Sprocket And Balancer Chain
Courtesy of GENERAL MOTORS COMPANY

9. Remove the crankshaft sprocket, balancer shaft driven sprocket, and balancer chain (1) simultaneously.

Installation Procedure

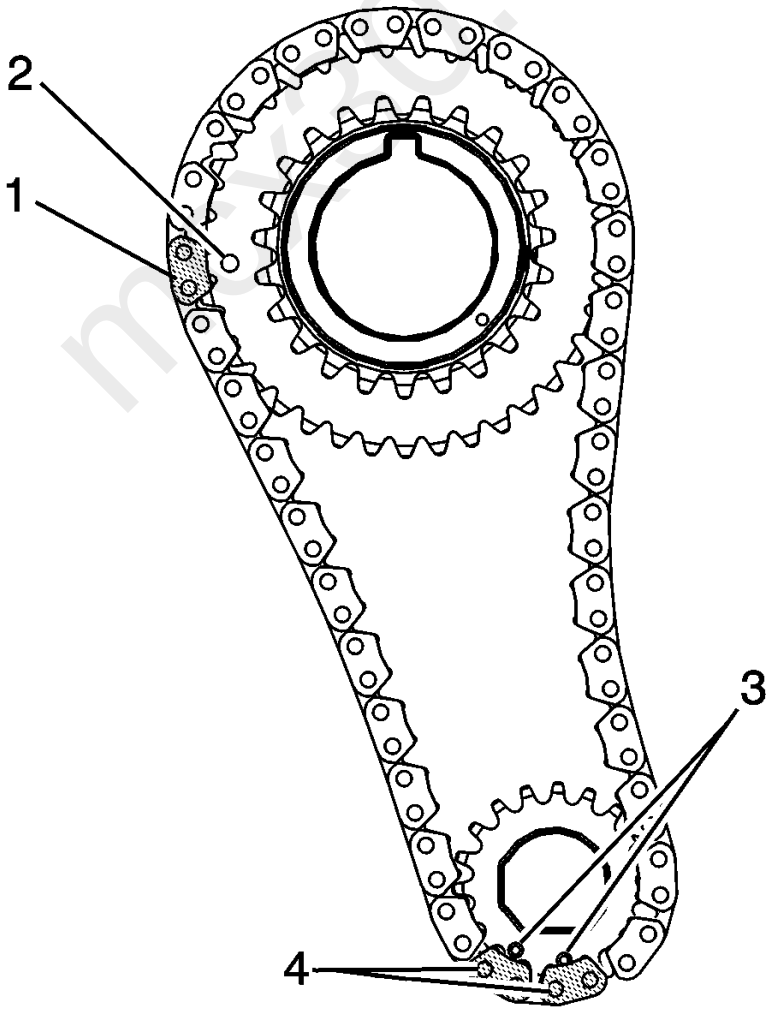


Fig. 90: Timing Link Lines & Timing Mark
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Proper setup is critical to ensure correct timing when installing the sprockets and chain simultaneously onto the shafts. The timing links are heat treated blued steel.**

1. Assemble the crankshaft sprocket, balancer shaft driven sprocket, and balancer chain. Ensure the timing link (1) lines up with the timing mark (2) on the crankshaft sprocket. Ensure that both timing teeth (3) on the balancer shaft driven sprocket line up with the timing links (4).

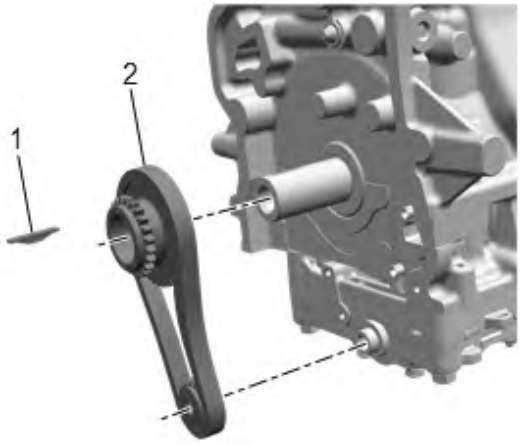


Fig. 91: Balancer Shaft Driven Sprocket And Balancer Chain
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The crankshaft keyway should be in the 12 O'clock position.**

2. Install the sprockets and chain (1) as an assembly to the crankshaft and balancer shaft assembly.

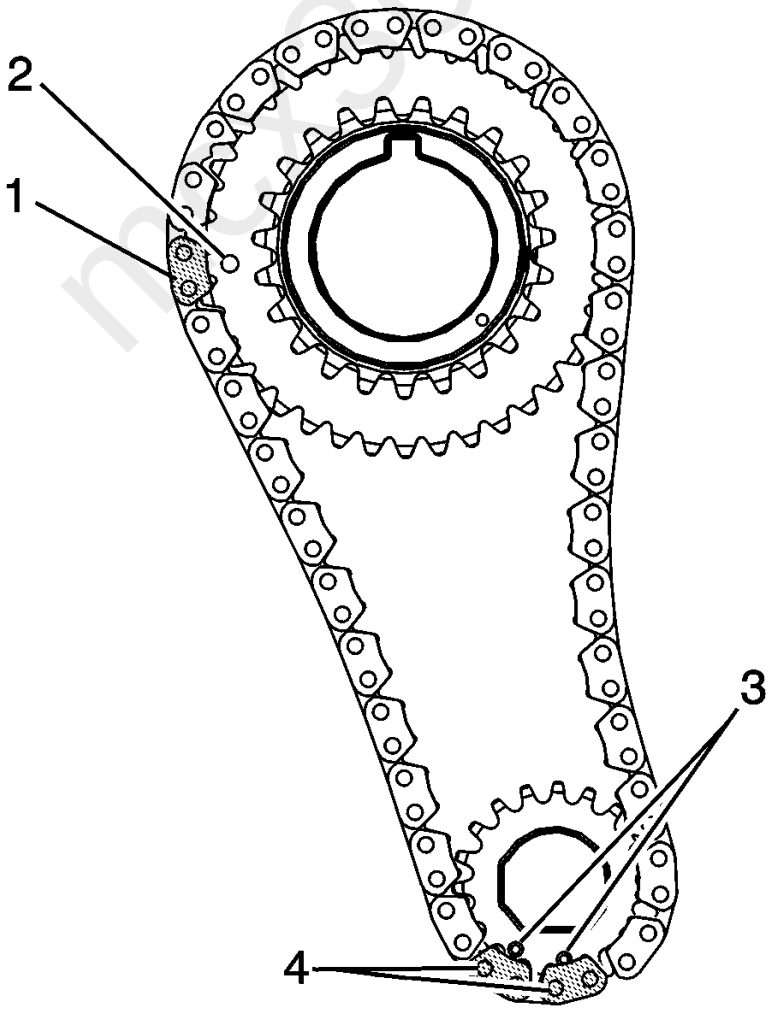


Fig. 92: Timing Link Lines & Timing Mark
Courtesy of GENERAL MOTORS COMPANY

3. Ensure the timing link (1) is aligned with the crankshaft sprocket timing mark (2).
4. Ensure the adjacent timing links (4) are aligned with both of the timing marks (3) on the balancer shaft driven sprocket.

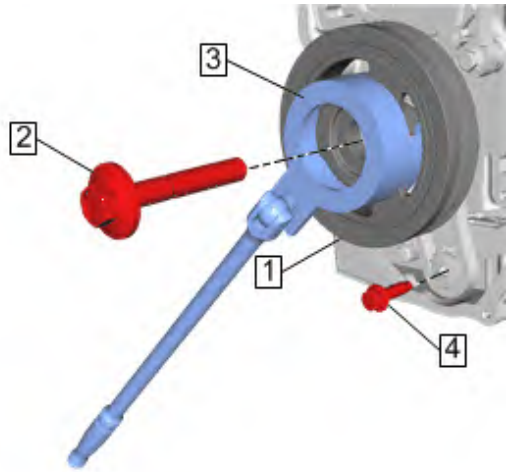


Fig. 93: Holding Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The crankshaft balancer and the ORIGINAL balancer bolt will be temporarily installed again in order to counter hold the crankshaft while tightening the balancer shaft driven sprocket bolt.**

5. Hand start the NEW balancer shaft driven sprocket bolt (4).
    1. TEMPORARILY install the crankshaft balancer (1).
    2. TEMPORARILY install the ORIGINAL crankshaft balancer bolt (2).
    3. Counter hold the crankshaft balancer pulley (1) using the **EN-51577-1** Crankshaft Balancer Remover (3).

    CAUTION: **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.**

    CAUTION: **Refer to Fastener Caution .**

    4. Counter hold the crankshaft balancer using the **EN-51577-1** Crankshaft Balancer Remover (3).
    5. While counter holding, tighten the balancer shaft driven sprocket bolt (4) to 40 N.m (30 lb ft) plus 50 degrees

    NOTE: **A NEW crankshaft balancer bolt will be installed during final installation of the crankshaft balancer.**

    6. Remove and DISCARD the crankshaft balancer bolt (2).
    7. Remove the crankshaft balancer (1) and **EN-51577-1** Crankshaft Balancer Remover (3).

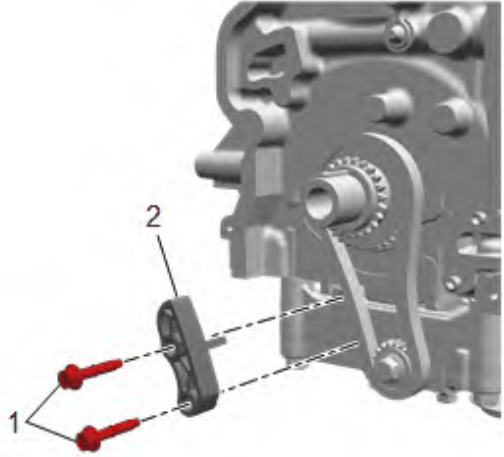


Fig. 94: Balancer Chain Guide Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the guide is installed in the correct orientation. The long end must point toward the crankshaft and the flat edge must be adjacent to the balance chain.**

6. Install the balancer chain guide (2).
7. Install the balancer chain guide bolts (1). tighten the bolts to 10 N.m (89 lb in).

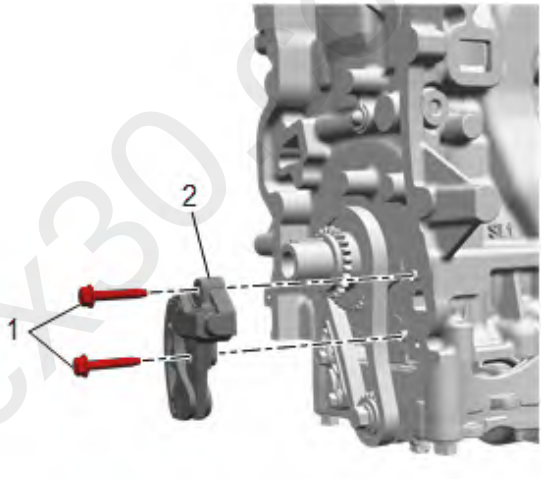


Fig. 95: Balancer Chain Tensioner Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Install the balancer chain tensioner (2).
9. Install the balancer chain tensioner bolts (1). tighten the bolts to 10 N.m (89 lb in).
10. Remove **EN-50837** retention tool to restore the tension to the balancer chain.
11. Install the timing chain. Refer to **Camshaft Timing Chain and Tensioner Replacement**.
12. Install the camshaft cover. Refer to **Camshaft Cover Replacement (1st Design Tamper-Proof PCV System)**.

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

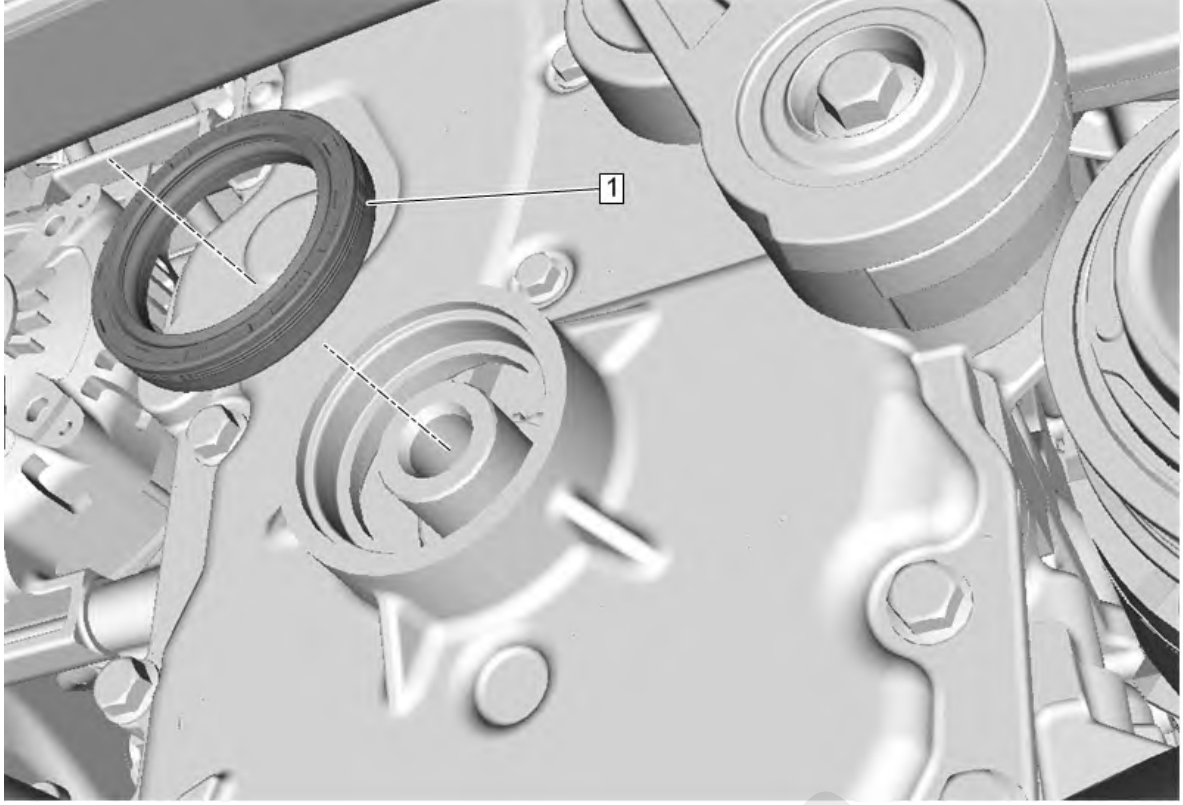


Fig. 96: Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure **Crankshaft Balancer Replacement**	
1	Crankshaft Front Oil Seal **Procedure** 1. Use a suitable tool to remove the seal. 2. Use the **EN 50820** Front Crankshaft Seal Installer to install the seal. **Special Tools** **EN 50820** Front Crankshaft Seal Installer Equivalent regional tools:**Special Tools**

ENGINE FRONT COVER REPLACEMENT

Special Tools

- **EN-45059** Angular Meter
- **EN-50820** Front Crankshaft Seal Installer
- **KM-470 - B** Angular Torque Gauge

Equivalent regional tools:**Special Tools**

Removal Procedure

1. Remove Air Cleaner Assembly - **Air Cleaner Assembly Replacement**
2. Remove Camshaft Cover - **Camshaft Cover Replacement (1st Design Tamper-Proof PCV System)**
3. Remove Engine Mount - **Engine Mount Replacement**
4. Remove Crankshaft Balancer - **Crankshaft Balancer Replacement**
5. Remove Drive Belt Tensioner - **Drive Belt Tensioner Replacement**

mc730.com

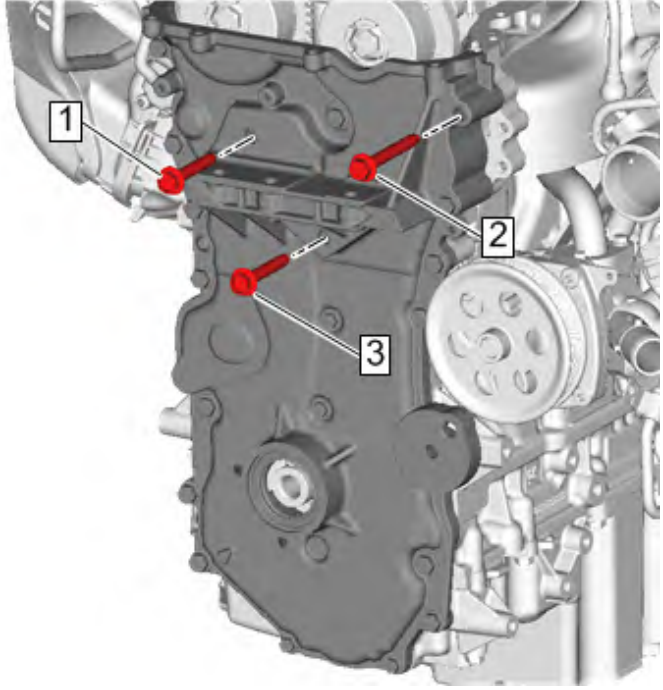


Fig. 97: Identifying Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove Engine Front Cover Bolt (1, 2, 3) and DISCARD

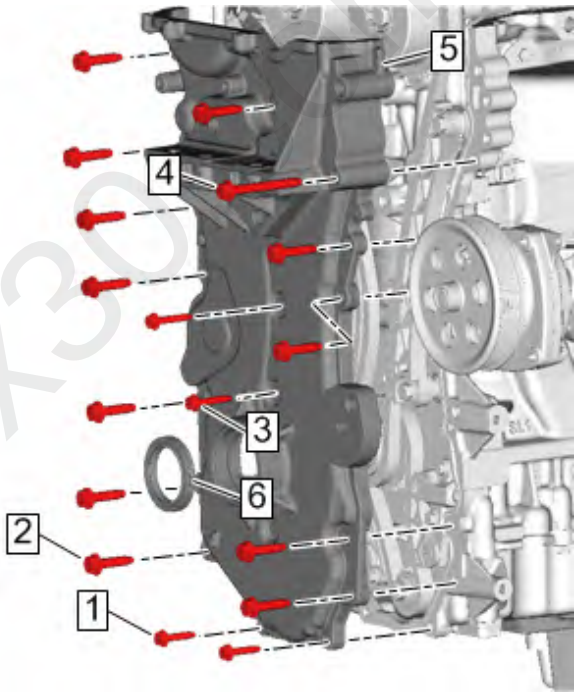


Fig. 98: Identifying Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The engine front cover bolts vary in lengths. Mark the bolts to ensure they are installed in the correct locations.**

7. Remove Engine Front Cover Bolt (1) [2x]
8. Remove Engine Front Cover Bolt (2) [12x]
9. Remove Engine Front Cover Bolt (3) [2x]
10. Remove Engine Front Cover Bolt (4)
11. Remove Engine Front Cover (5).
12. If replacing the engine front cover, remove and DISCARD the crankshaft front oil seal (6) using an appropriate tool.

Installation Procedure

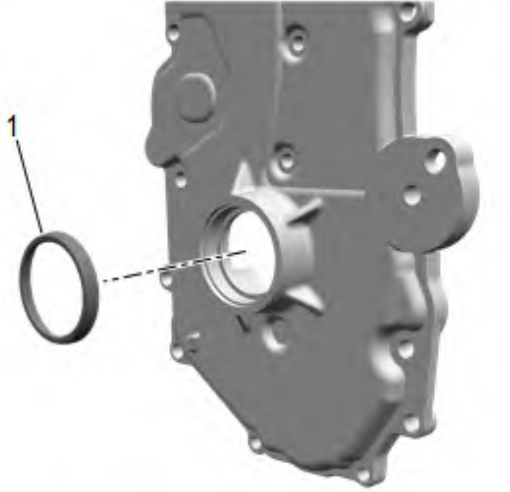


Fig. 99: Front Crankshaft Seal
Courtesy of GENERAL MOTORS COMPANY

1. If removed, Use **EN-50820** installer, to install the front crankshaft seal (1) into the engine front cover.

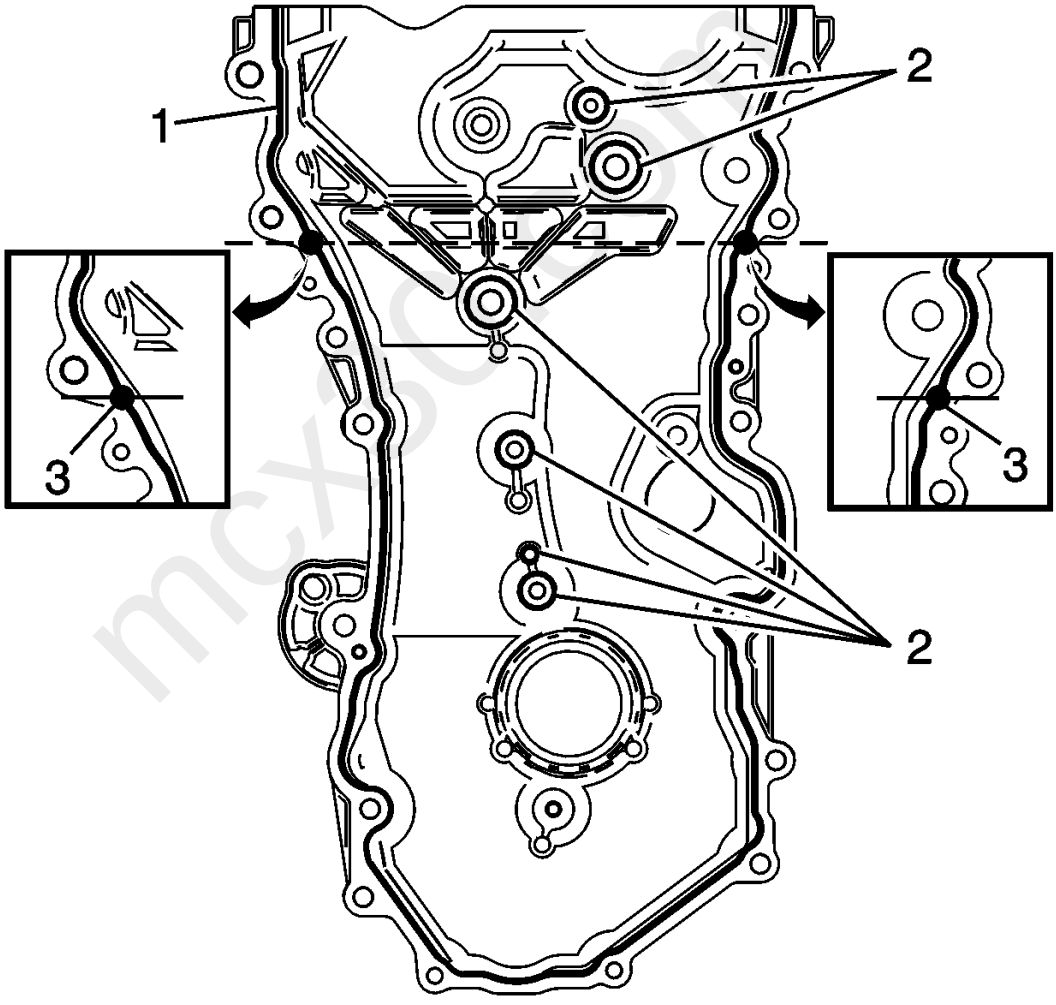


Fig. 100: Appling Bead Of Sealer Directly In Flange
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The engine front cover surface must be free of contamination prior to applying the sealer.**
- **Install and align the cover within 20 minutes of applying the sealer.**
- **The cover must be fastened to final torque specification within 60 minutes of applying the sealer.**
- **Additional sealant is necessary to reduce the possibility of leakage where the cylinder head to engine block interface along the bead path**

flange on the front cover.

2. Apply a 5 mm bead of sealer directly in the flange (1) of the engine front cover perimeter mating surface. Also apply a 5 mm bead of sealer directly to the locations indicated (2). Finally, apply a 14 mm dab of sealant at the locations indicated (3). **Adhesives, Fluids, Lubricants, and Sealers**.

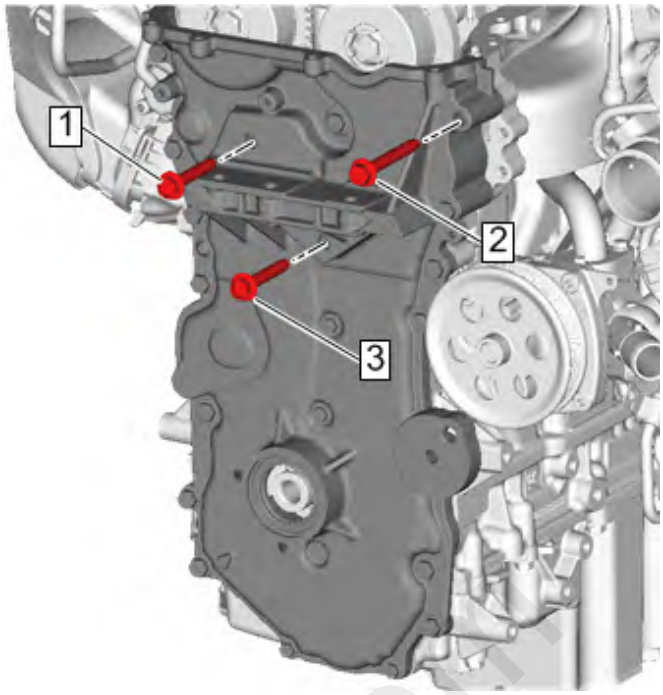


Fig. 101: Identifying Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

CAUTION: **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.**

3. Install by hand 3 NEW bolts (1, 2 and 3).

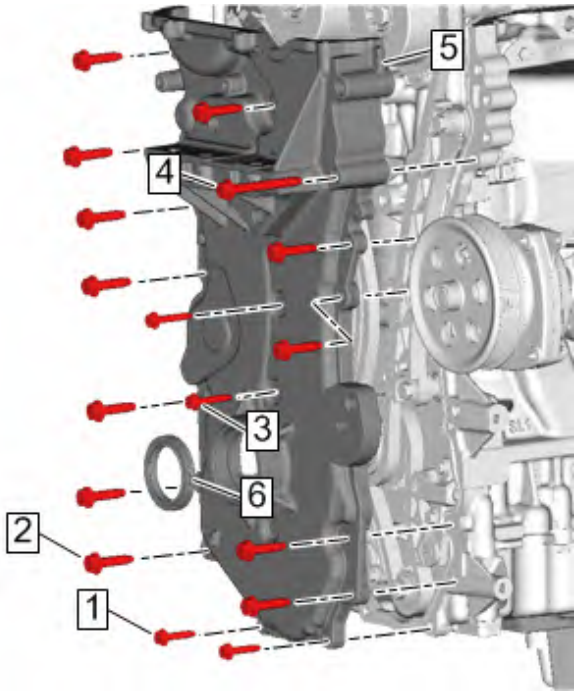


Fig. 102: Identifying Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that the bolts are installed in the previously marked positions.**

4. Install Engine Front Cover (5)
5. Loosely Install Engine Front Cover Bolt (1) [2x]
6. Loosely Install Engine Front Cover Bolt (2) [12x]
7. Loosely Install Engine Front Cover Bolt (3) [2x]
8. Loosely Install Engine Front Cover Bolt (4).

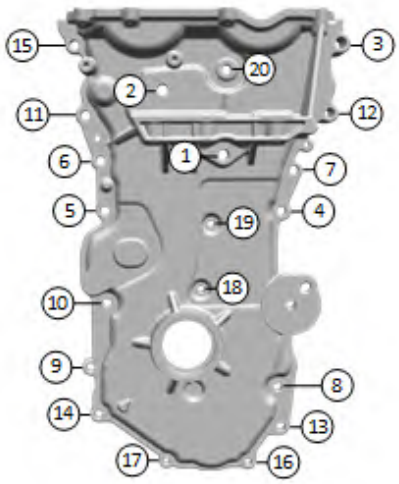


Fig. 103: Engine Front Cover Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

9. tighten the engine front cover bolts in sequence to final torque twice:

   tighten

   1. tighten sequence 1 - 3 bolts a first pass to 15 N.m (11 lb ft).
   2. tighten sequence 1 - 3 bolts a final pass 130 degrees using **EN-45059** meter.
   3. tighten sequence 4 - 15 bolts to 25 N.m (18 lb ft).
   4. tighten sequence 16 - 17 bolts to 10 N.m (7 lb ft)
   5. tighten sequence 18 - 19 bolts to 10 N.m (7 lb ft).
   6. tighten sequence 20 bolt to 25 N.m (18 lb ft).
10. Install Drive Belt Tensioner -**Drive Belt Tensioner Replacement**
11. Install Crankshaft Balancer - **Crankshaft Balancer Replacement**
12. Install Engine Mount - **Engine Mount Replacement**
13. Install Camshaft Cover -**Camshaft Cover Replacement (1st Design Tamper-Proof PCV System)**
14. Install Air Cleaner Assembly - **Air Cleaner Assembly Replacement**

INTAKE VALVE ROCKER ARM REPLACEMENT

Removal Procedure

1. Remove the camshaft position actuator and camshaft - intake. Refer to **Camshaft Position Actuator and Camshaft Replacement - Intake**.

mc930.com

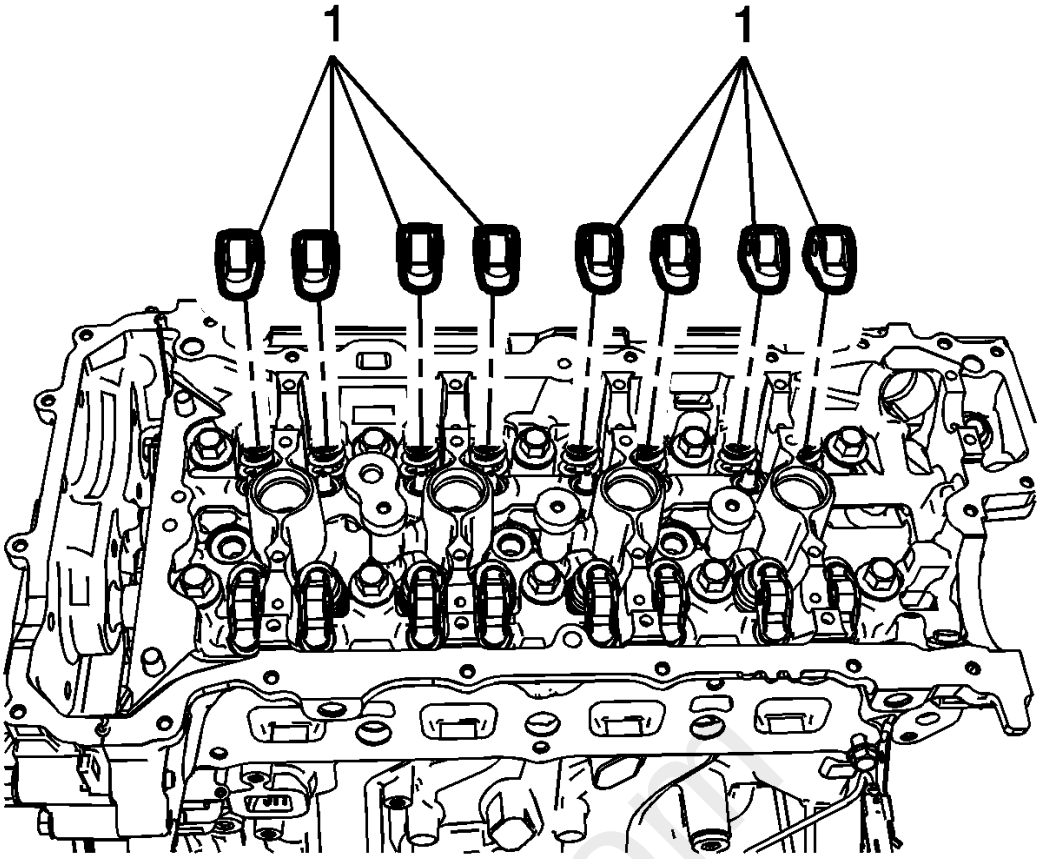


Fig. 104: Intake Rocker Arm
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Keep all of the valve rocker arms and hydraulic lash adjusters in order so that they can be reinstalled in their respective locations.**

2. Remove the intake rocker arm (1).

Installation Procedure

mc330.com

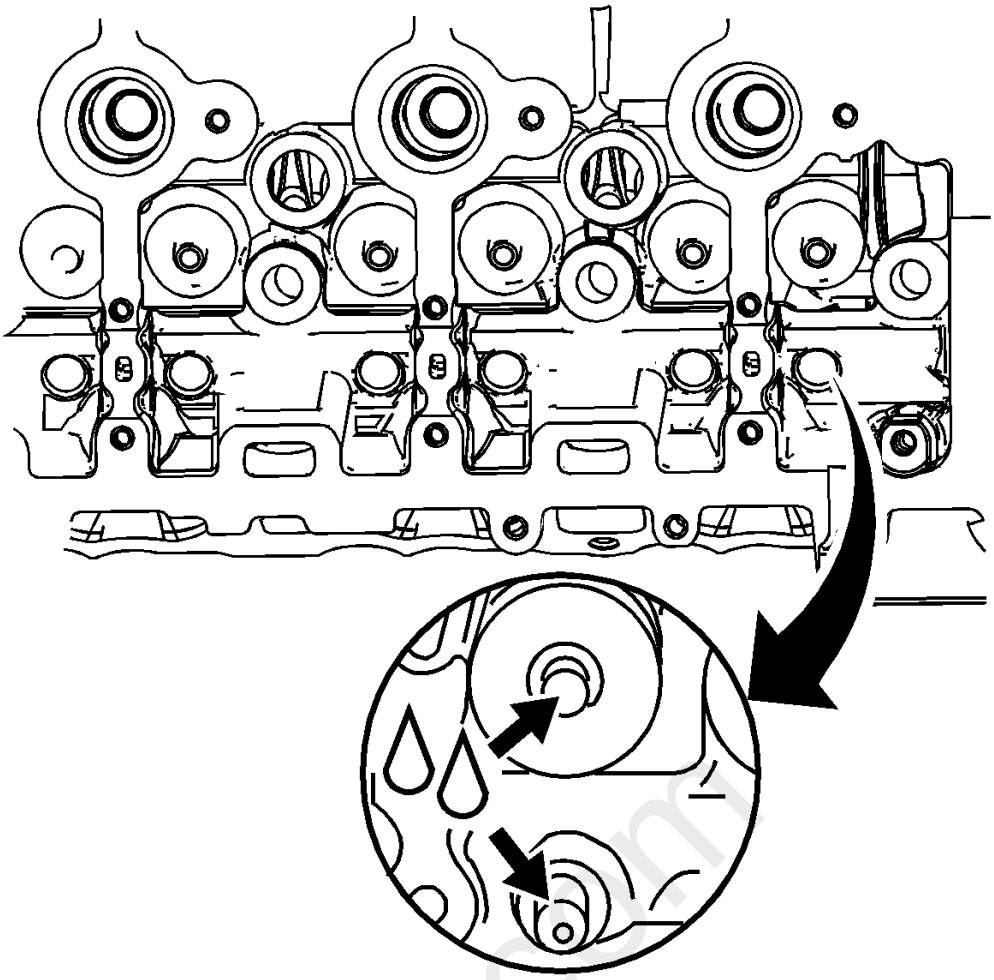


Fig. 105: Valve Tips
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the valve tips. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

mcx30.com

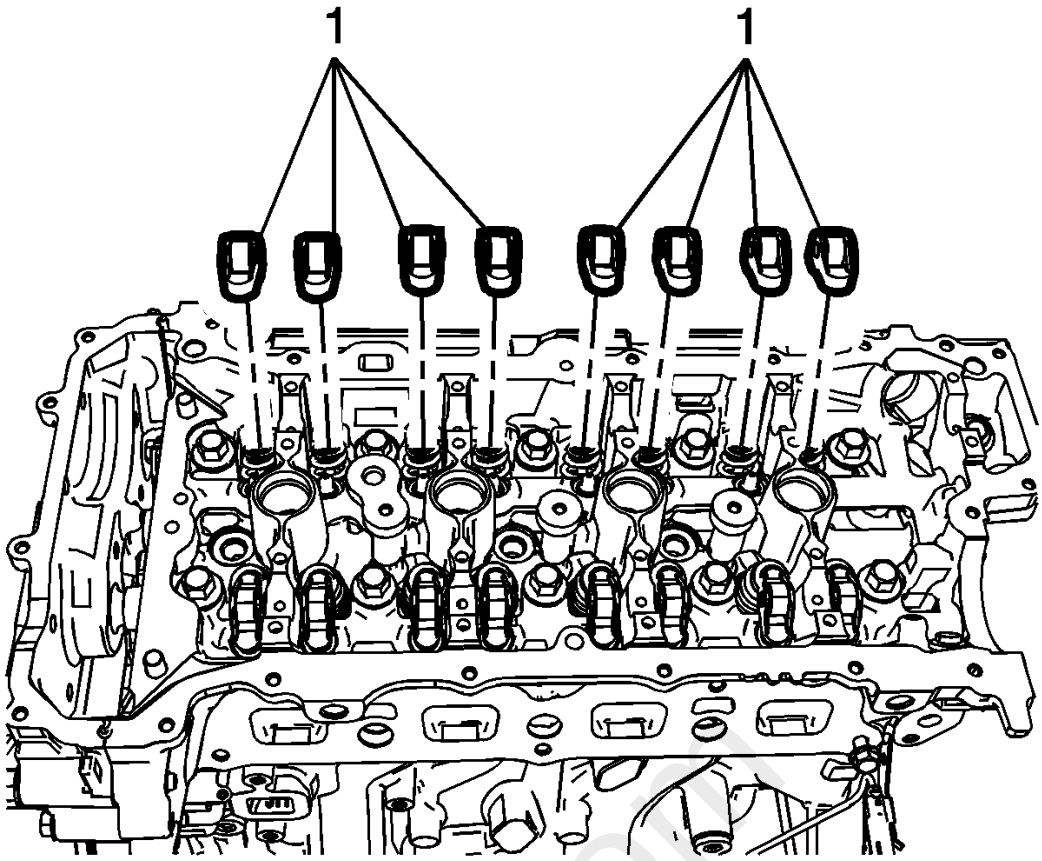


Fig. 106: Intake Rocker Arm
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Used rocker arms must be returned to the original position on the camshaft. If the camshaft is being replaced, the rocker arms actuated by the camshaft must also be replaced.**
- **Pre-oil roller bearings before installation.**

2. Lubricate the roller bearings with valve rocker arm lubricant. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
3. Position the valve rocker arm (1) on the tip of the valve stem and on the lash adjuster and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
4. Install the camshaft position actuator and camshaft - intake. Refer to **Camshaft Position Actuator and Camshaft Replacement - Intake**.

EXHAUST VALVE ROCKER ARM REPLACEMENT

Removal Procedure

1. Remove the camshaft position actuator and camshaft - exhaust. Refer to **Camshaft Position Actuator and Camshaft Replacement - Exhaust**.

mr30.com

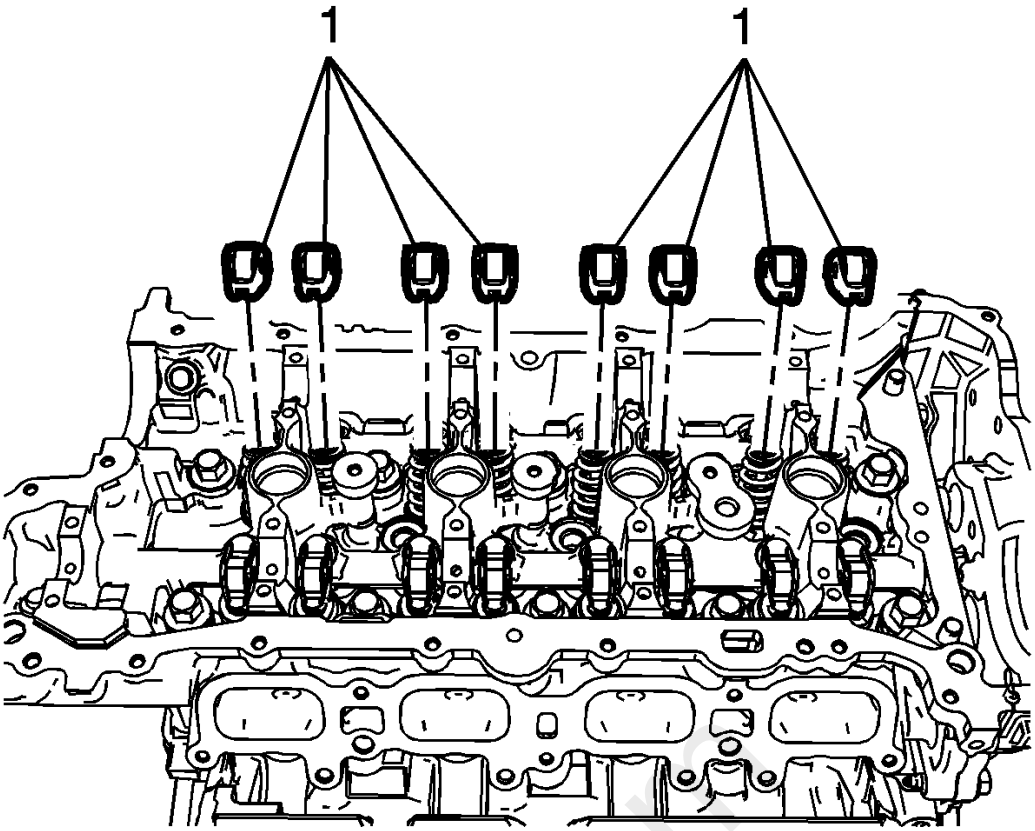


Fig. 107: Exhaust Rocker Arm
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Keep all of the Valve Rocker Arms and hydraulic lash adjusters in order so that they can be reinstalled in their respective locations.**

2. Remove the exhaust rocker arm (1).

Installation Procedure

mc330.com

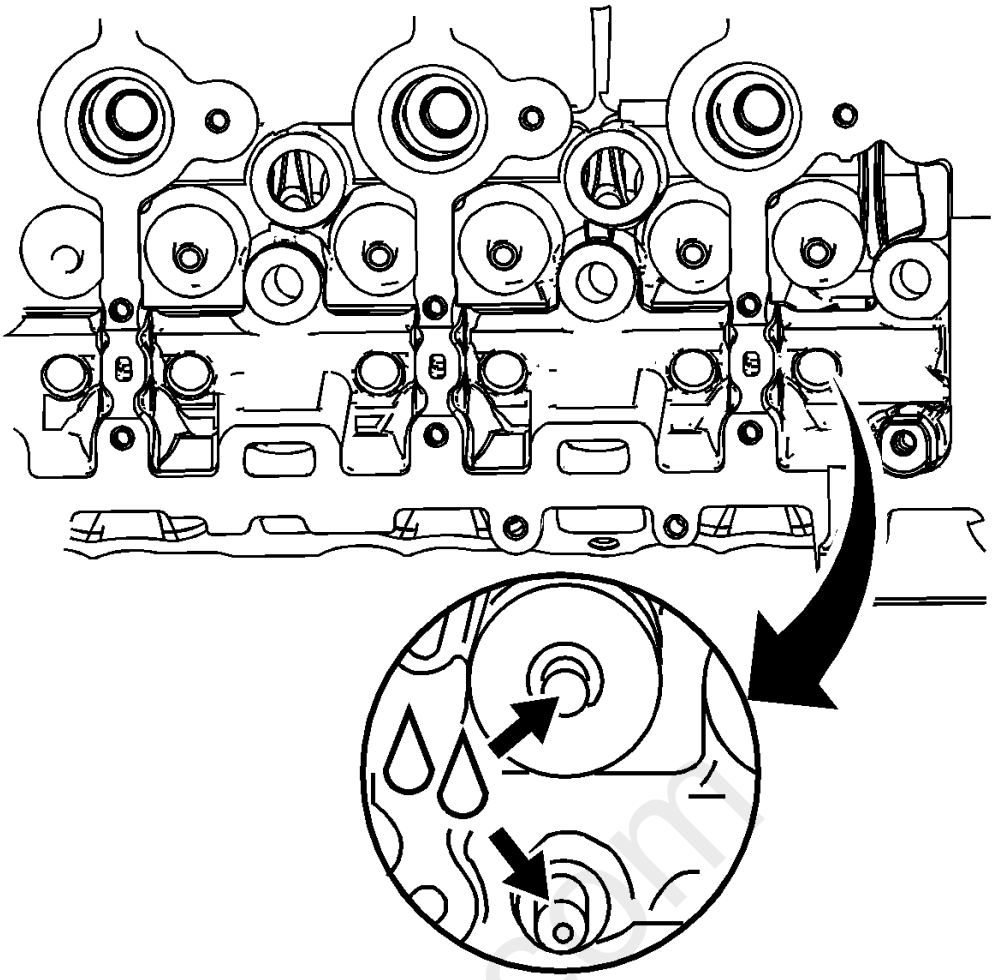


Fig. 108: Valve Tips
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the valve tips. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

mcx30.com

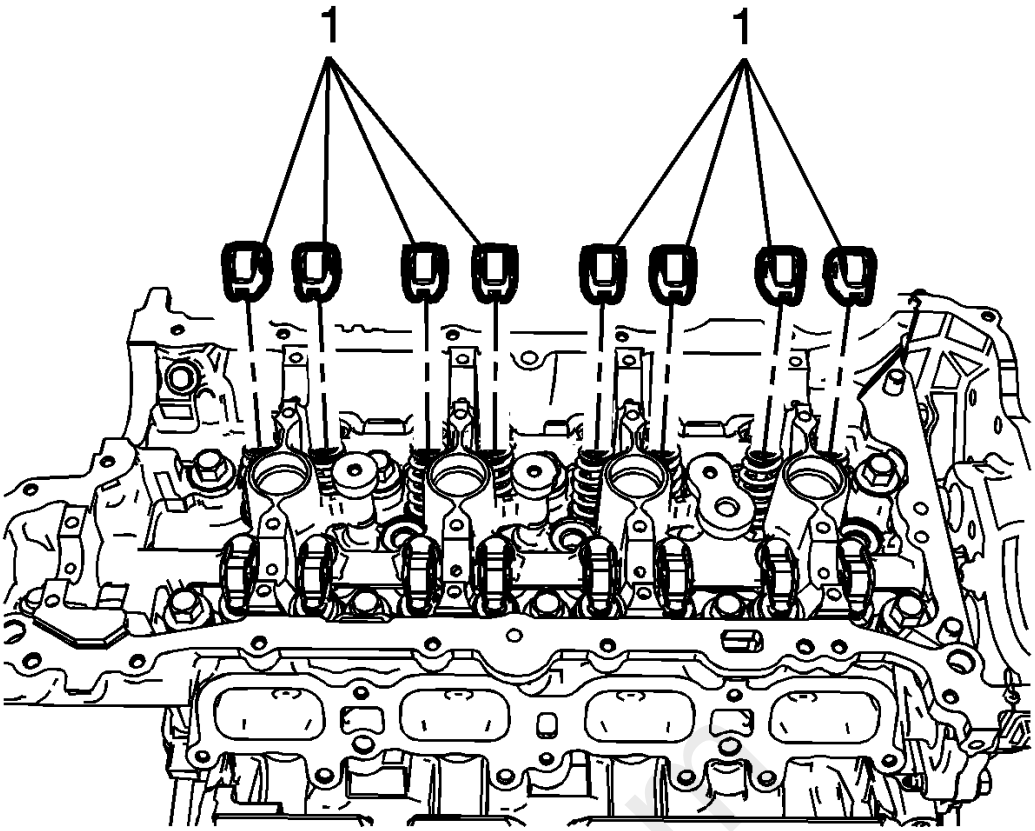


Fig. 109: Exhaust Rocker Arm
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Used rocker arms must be returned to the original position on the camshaft. If the camshaft is being replaced, the rocker arms actuated by the camshaft must also be replaced.**
- **Pre-oil roller bearings before installation.**

2. Lubricate the roller bearings with valve rocker arm lubricant. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
3. Position the valve rocker arm (1) on the tip of the valve stem and on the lash adjuster and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
4. Install the camshaft position actuator and camshaft - exhaust. Refer to **Camshaft Position Actuator and Camshaft Replacement - Exhaust**.

CAMSHAFT TIMING CHAIN AND TENSIONER REPLACEMENT

Removal Procedure

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

mr30.com

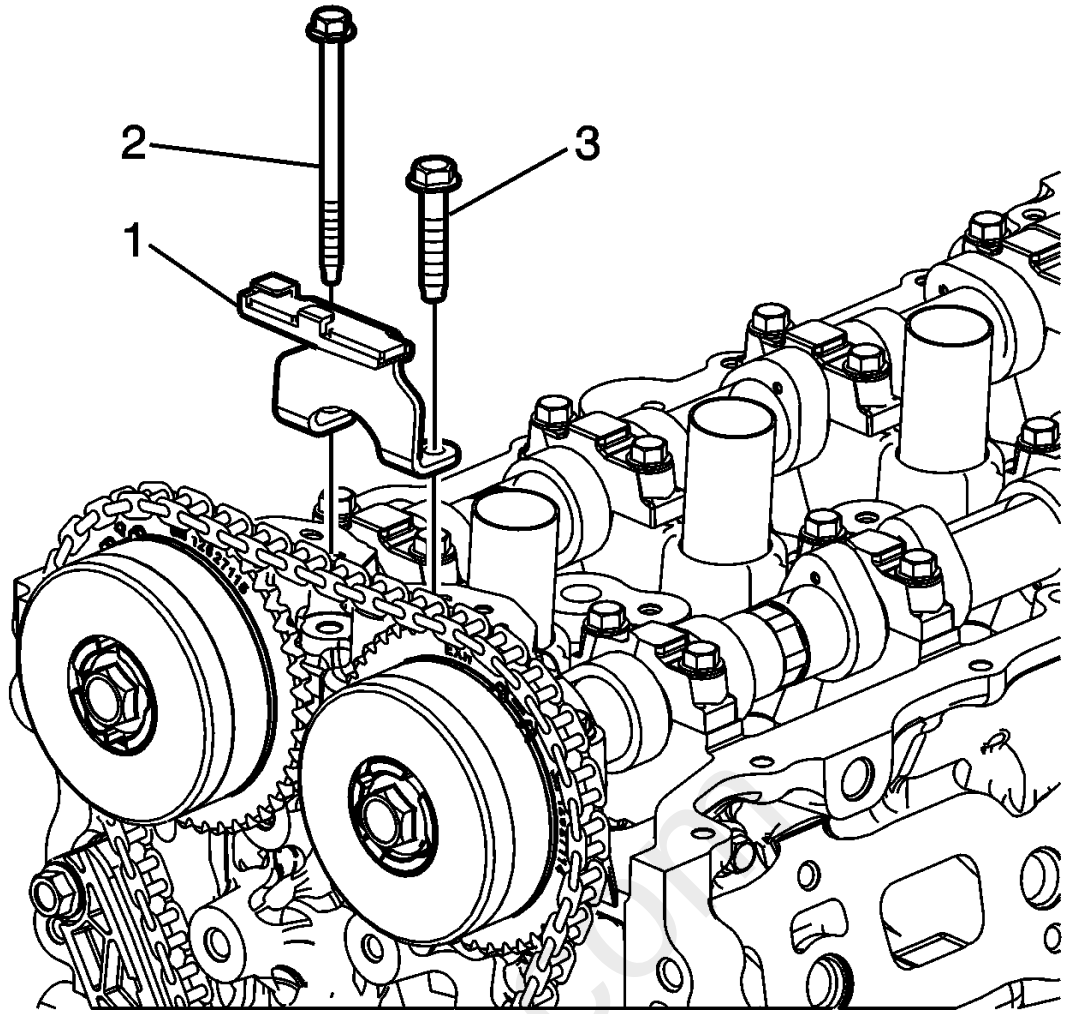


Fig. 110: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the upper timing chain guide bolts (2, 3).
3. Remove the upper timing chain guide (1).

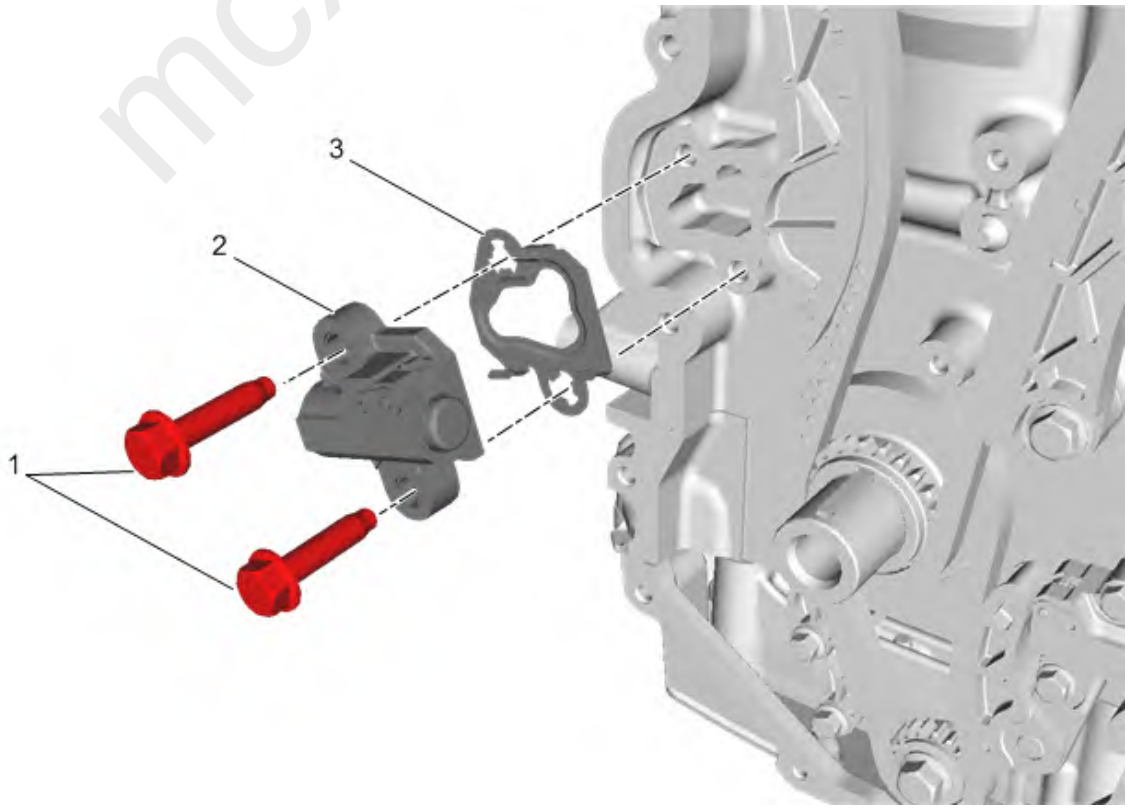


Fig. 111: Timing Chain Tensioner Bolts And Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

mc30.com

4. Remove Timing Chain Tensioner Bolt (1) [2x]
5. Remove Timing Chain Tensioner (2).
6. Remove Timing Chain Tensioner Gasket (3) and DISCARD

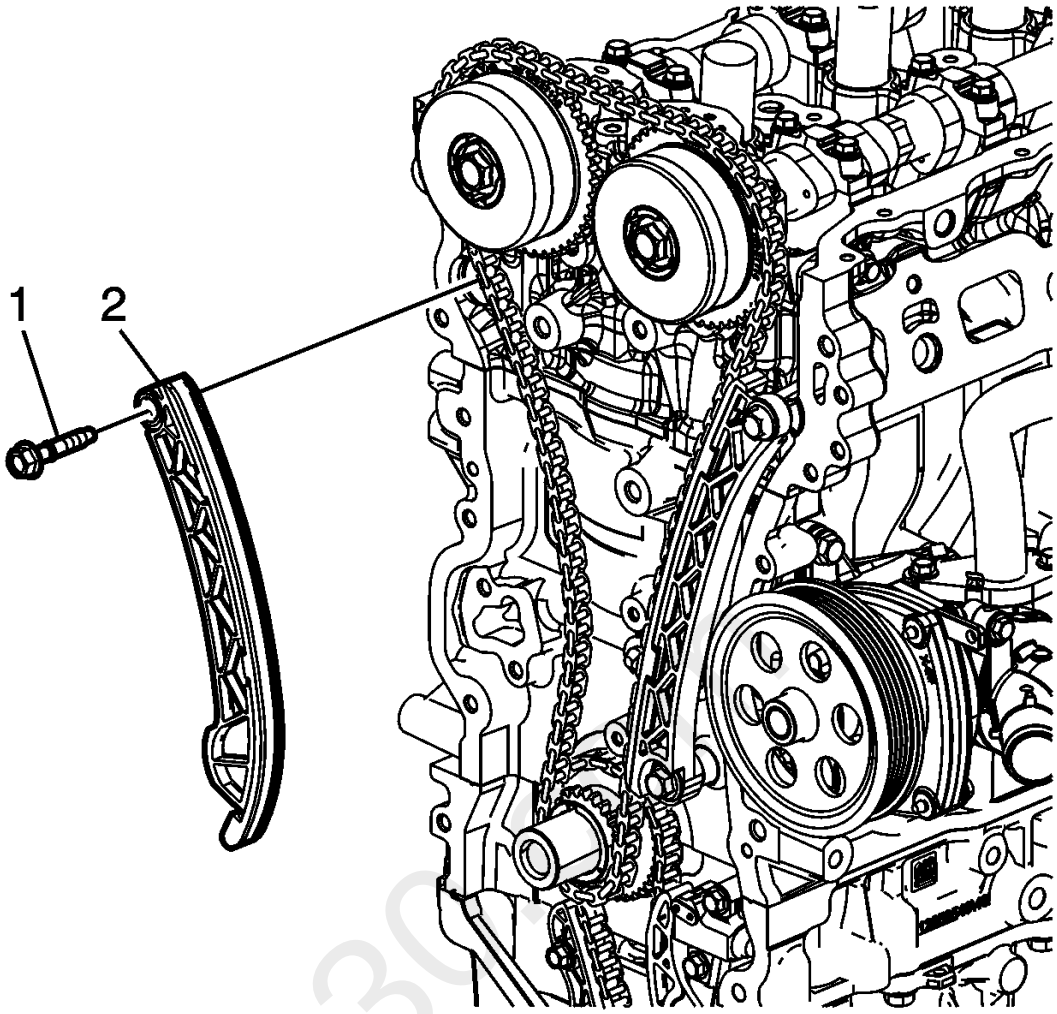


Fig. 112: Timing Chain Tensioner Pivot Arm Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Remove the timing chain tensioner pivot arm bolt (1).
8. Remove the timing chain tensioner pivot arm (2).

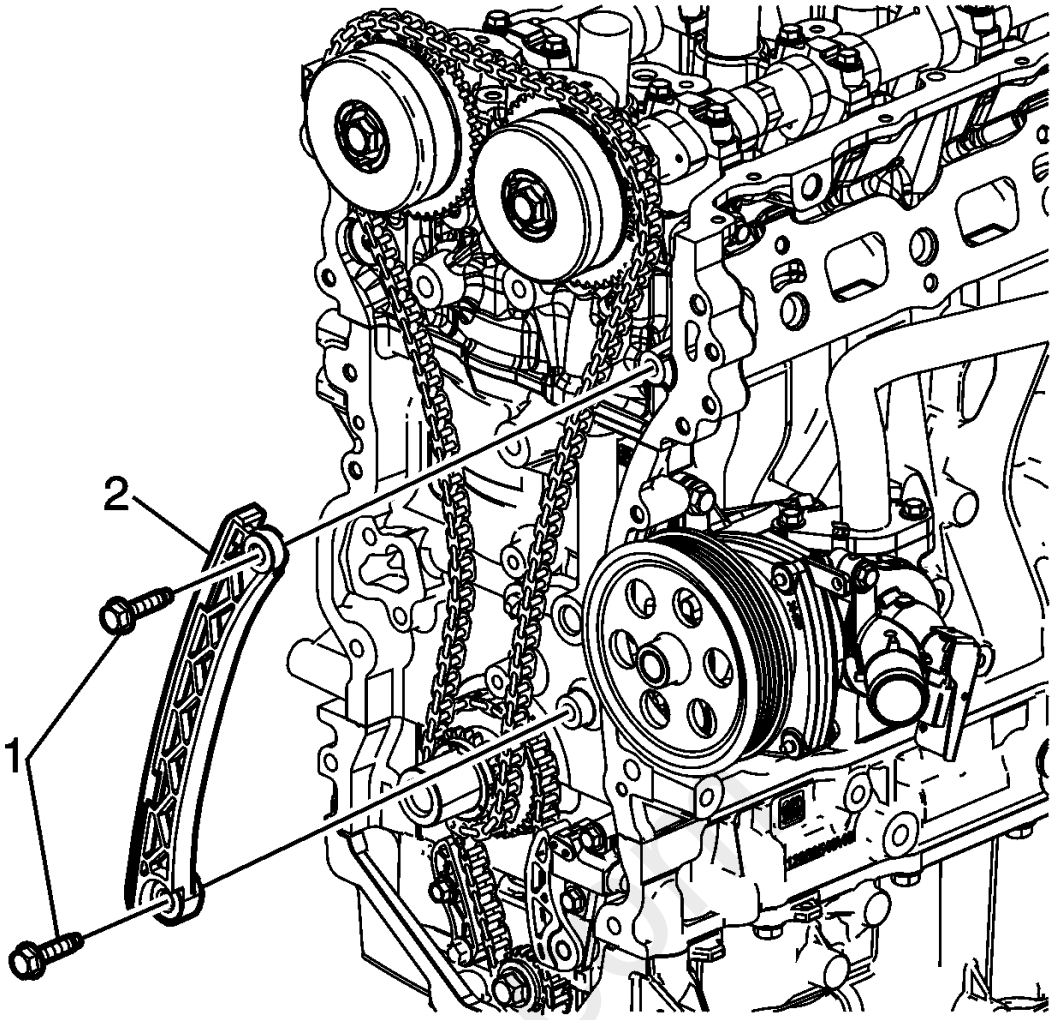


Fig. 113: Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the timing chain guide bolts (1).
10. Remove the timing chain guide (2).

mcx30.com

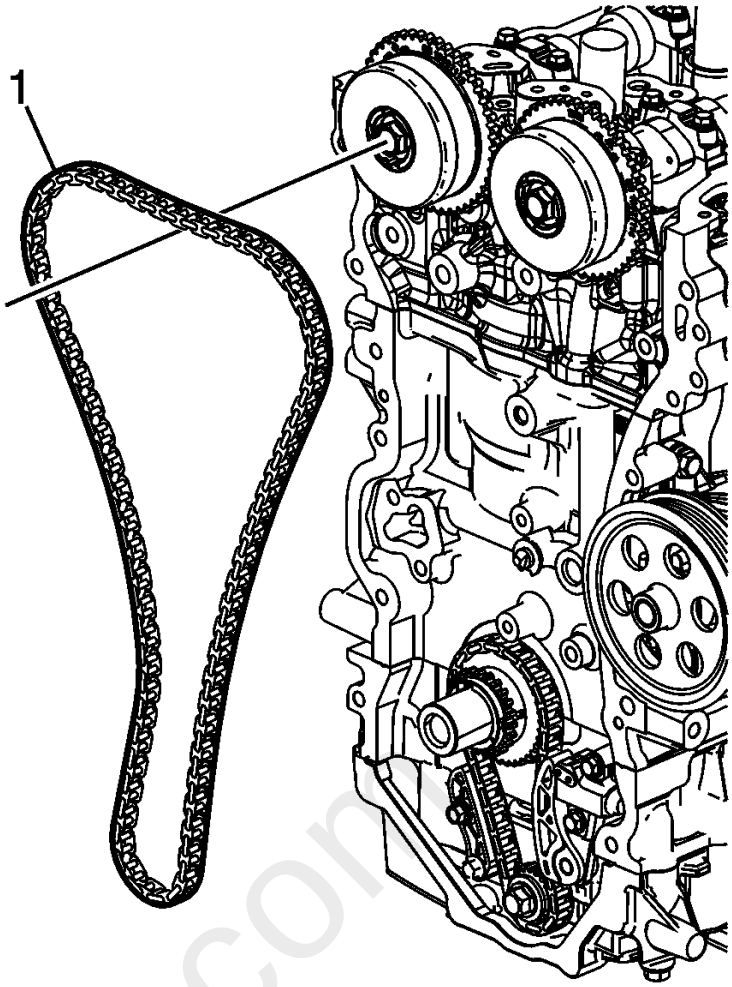


Fig. 114: Timing Chain
Courtesy of GENERAL MOTORS COMPANY

11. Remove the timing chain (1).

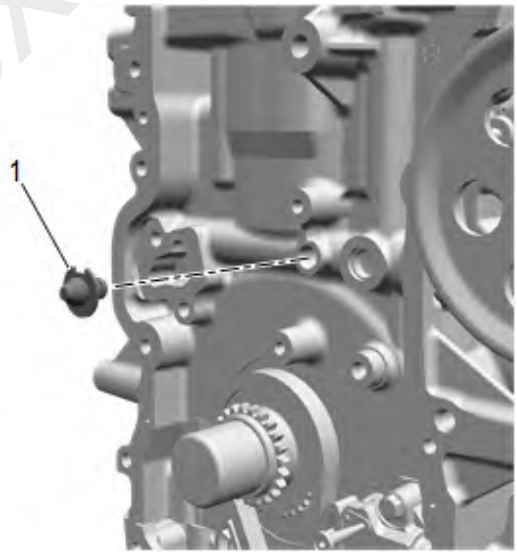


Fig. 115: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

12. Remove the timing chain oil nozzle (1).
13. For camshaft timing chain, sprocket, and tensioner cleaning and inspection. Refer to **Camshaft Timing Chain, Sprocket, and Tensioner Cleaning and Inspection**.

Installation Procedure

mcx30.com

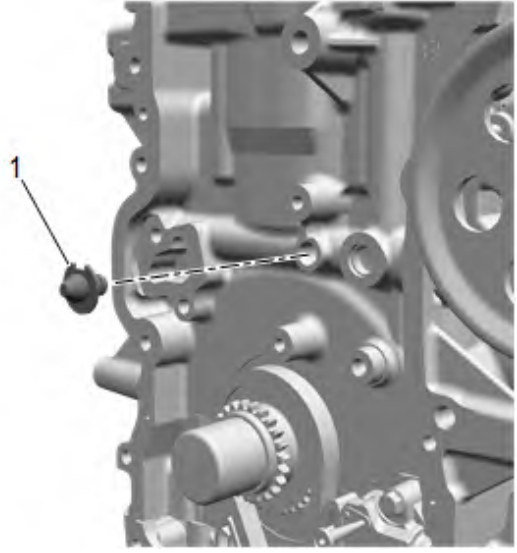


Fig. 116: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the timing chain oil nozzle is rotated with the notch facing upward, and aligned with the tab on the engine block.**

1. Install the timing chain oil nozzle (1).

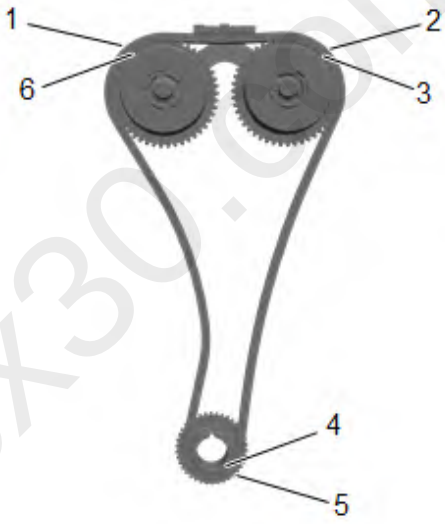


Fig. 117: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

NOTE: **There are three colored links on the timing chain. The two links that align to the timing marks on the actuators are the same color. The timing link that aligns with the timing mark on the crankshaft sprocket is a unique color. Use the following procedure to line up the links with the actuators. Orient the chain so that the colored links are visible.**

2. Loop the timing chain over the intake and exhaust camshaft actuators, aligning one of the same colored links (2) with the timing mark on the exhaust camshaft actuator (3).

NOTE: **The same colored link corresponding to the intake actuator will not initially align with the intake actuator timing mark, nor the unique colored timing chain link align with the crankshaft sprocket timing mark.**

3. Ensure the crankshaft key in the 12 O'clock position. Loop the timing chain onto the crankshaft sprocket.

mcx30.com

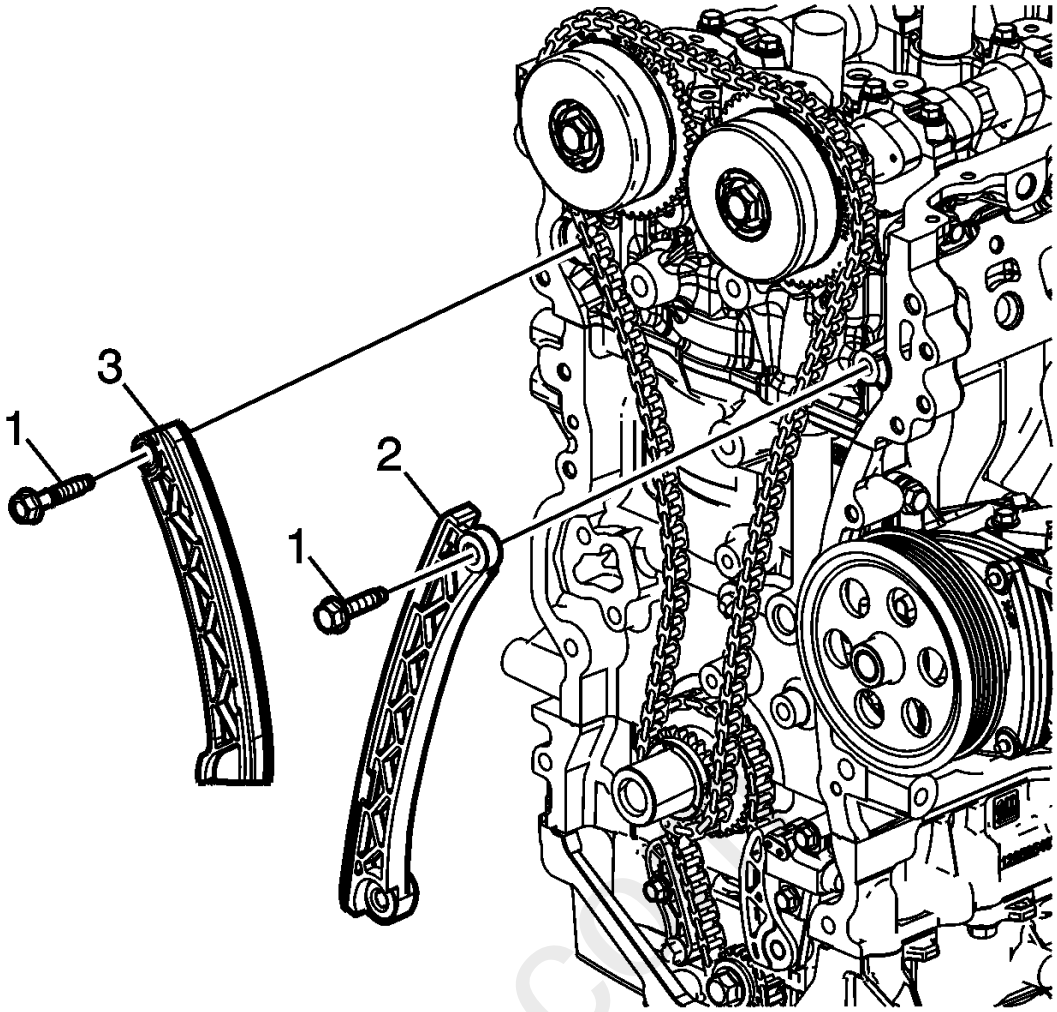


Fig. 118: Timing Chain Guides And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Timing will be established before the final install and torque of the guide bolts.**

4. Install the timing chain guide (2) and upper bolt (1) only, finger tight.
5. Install the timing chain tensioner pivot arm (3).
6. Install the pivot arm bolt (1) finger tight.

mex30.com

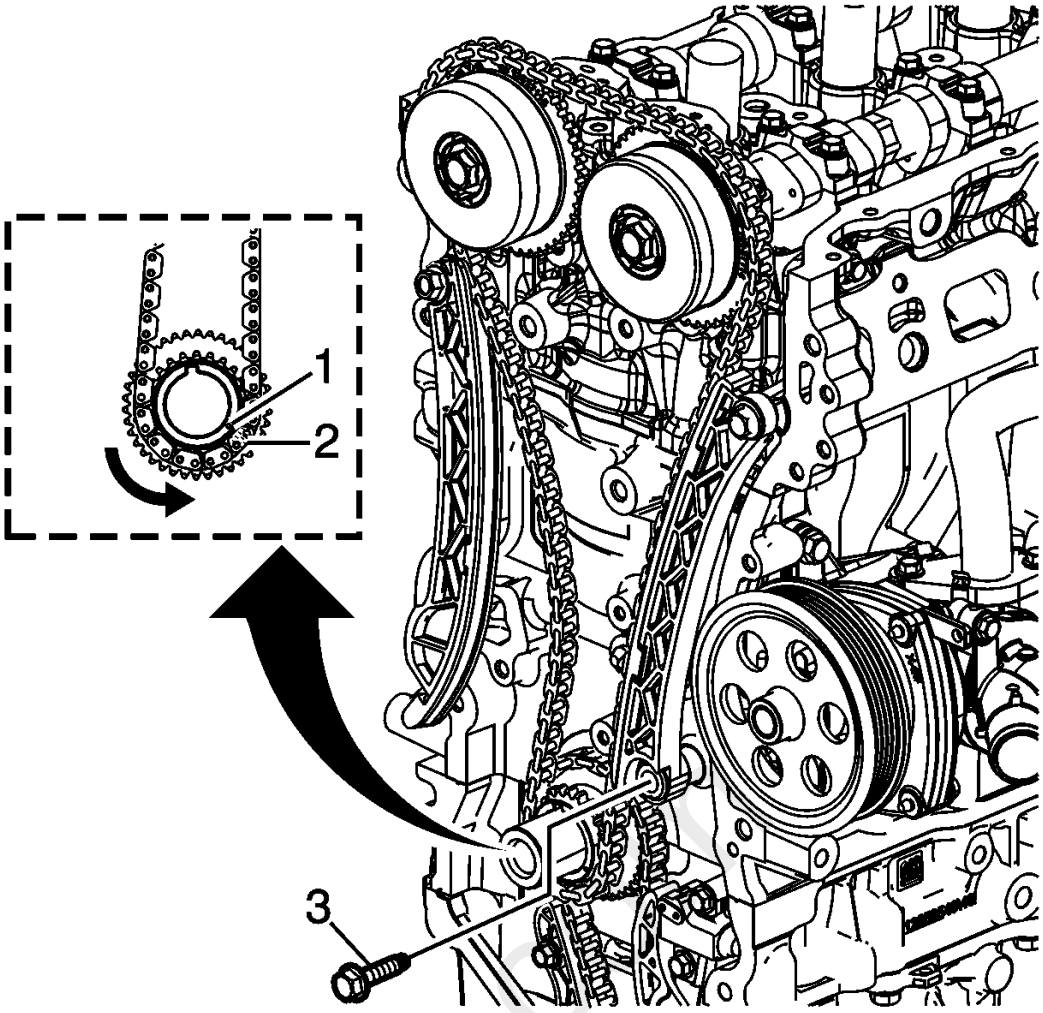


Fig. 119: Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

7. With a suitable tool, rotate the crankshaft counterclockwise to align the timing mark on the crankshaft sprocket (1) with the timing link (2).

NOTE:

- **Continue to rotate the crankshaft counterclockwise as necessary to maintain timing alignment.**
- **Ensure that the alignment mark on the exhaust camshaft actuator remains aligned with the timing link.**

8. Rotate the lower end of the fixed timing chain guide into installation position and install the lower bolt (3).

CAUTION: **Refer to Fastener Caution .**

9. tighten the timing chain guide upper and lower bolts to 25 N.m (18 lb ft).

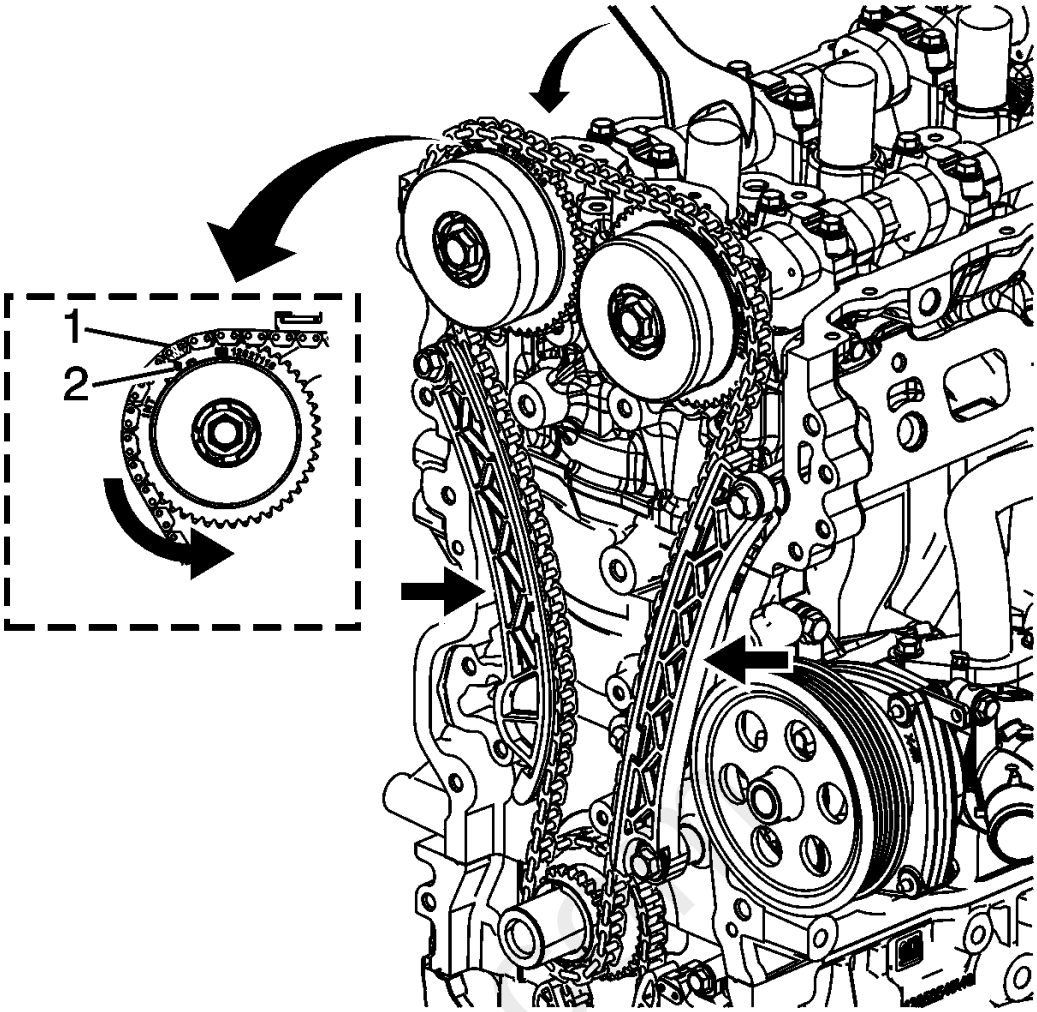


Fig. 120: Timing Mark On Intake Actuator
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The timing for the exhaust camshaft actuator and the crankshaft sprocket has been established.**
- **Applying or loosening pressure by hand between the timing chain guides will allow the chain to slip or bind during counterclockwise rotation of the camshaft.**

10. Using a suitable tool, rotate the intake camshaft counterclockwise until the timing mark on the intake actuator (2) is aligned with the timing link (1). Maintain tension on intake camshaft until the timing chain tensioner can be installed and activated.

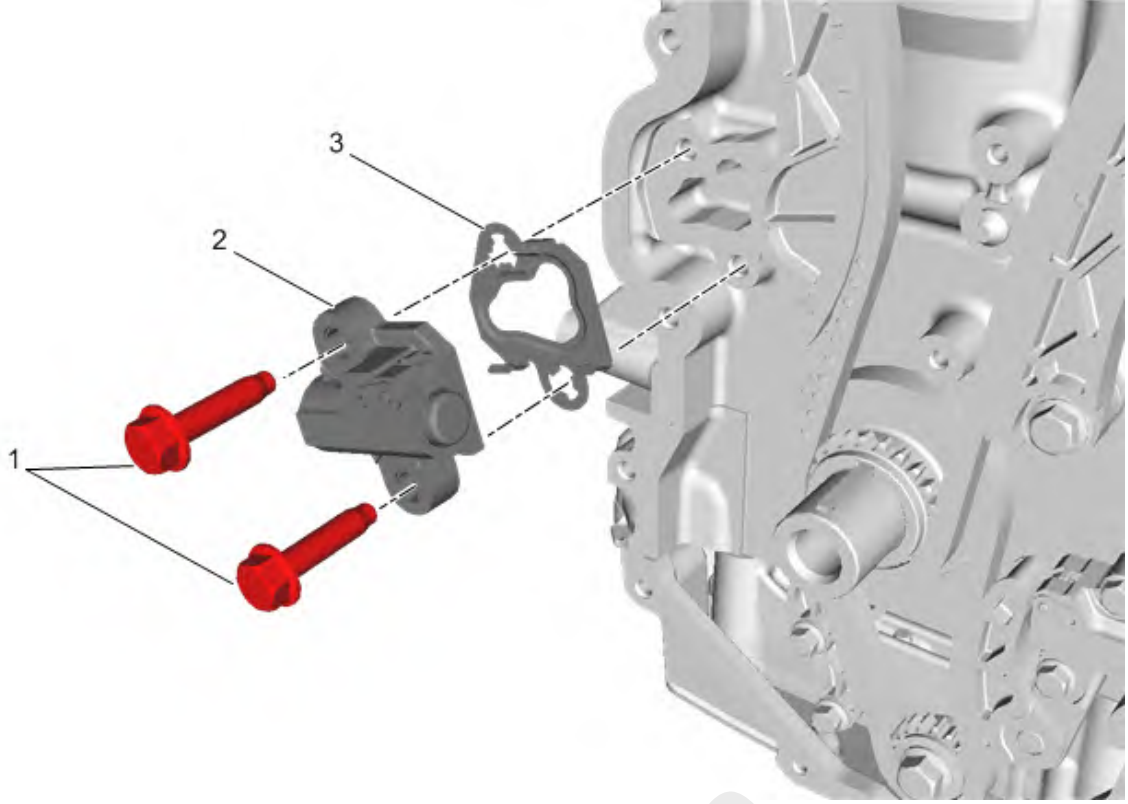


Fig. 121: Timing Chain Tensioner Bolts And Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Use a NEW gasket.**

11. Install Timing Chain Tensioner Gasket (3).
12. Install Timing Chain Tensioner (2).
13. Install Timing Chain Tensioner Bolt (1) and tighten [2x] 25 N.m (18 lb ft)

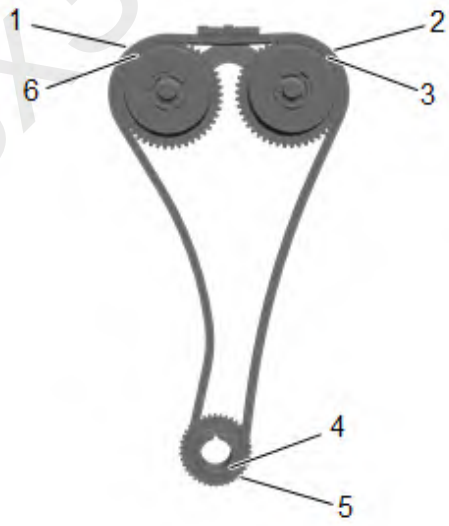


Fig. 122: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

14. Verify the timing links on the timing chain are properly aligned to the timing marks:
    1. The timing links (1, 2) are aligned to the appropriate timing marks on the camshaft actuators (6, 3).
    2. The unique colored link (5) is aligned to the timing mark on the crankshaft sprocket (4).
15. If they are not, repeat the portion of the procedure necessary to align the timing marks.

mcx30.com

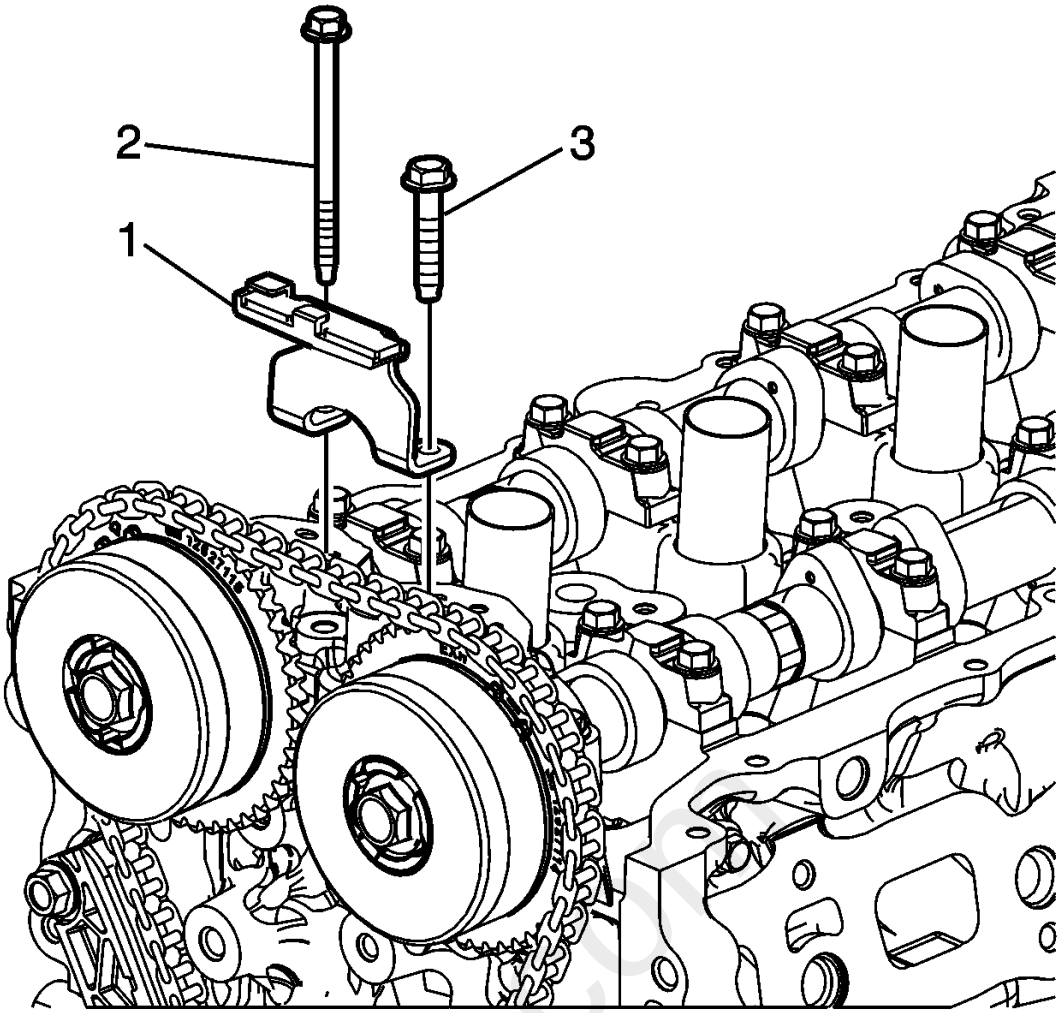


Fig. 123: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

16. Install the timing chain guide (1) and bolts (2, 3) finger tight.

mcx30.com

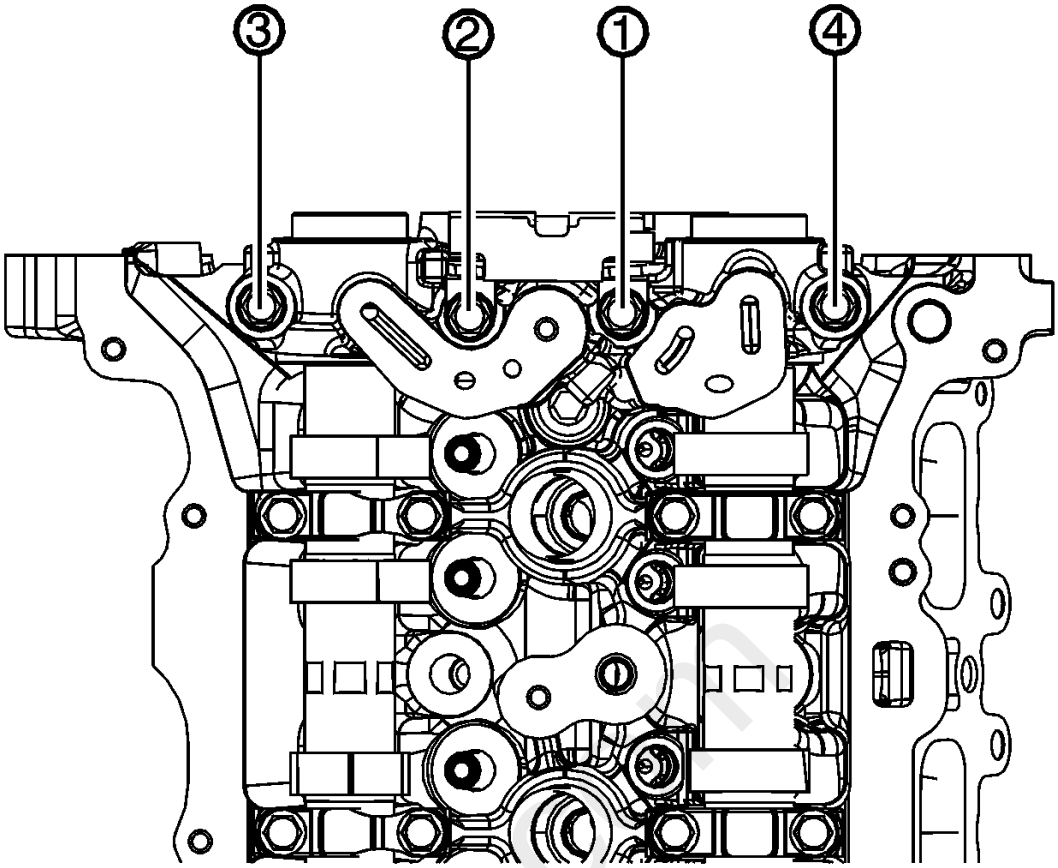


Fig. 124: Front Camshaft Cap Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

17. tighten the front camshaft cap bolts in sequence to 10 N.m (7 lb ft) twice.
18. Rotate the crankshaft clockwise to see if either of the actuators or the crankshaft sprocket jump timing chain teeth. If this occurs, repeat procedure to align the timing marks.

mcx30.com

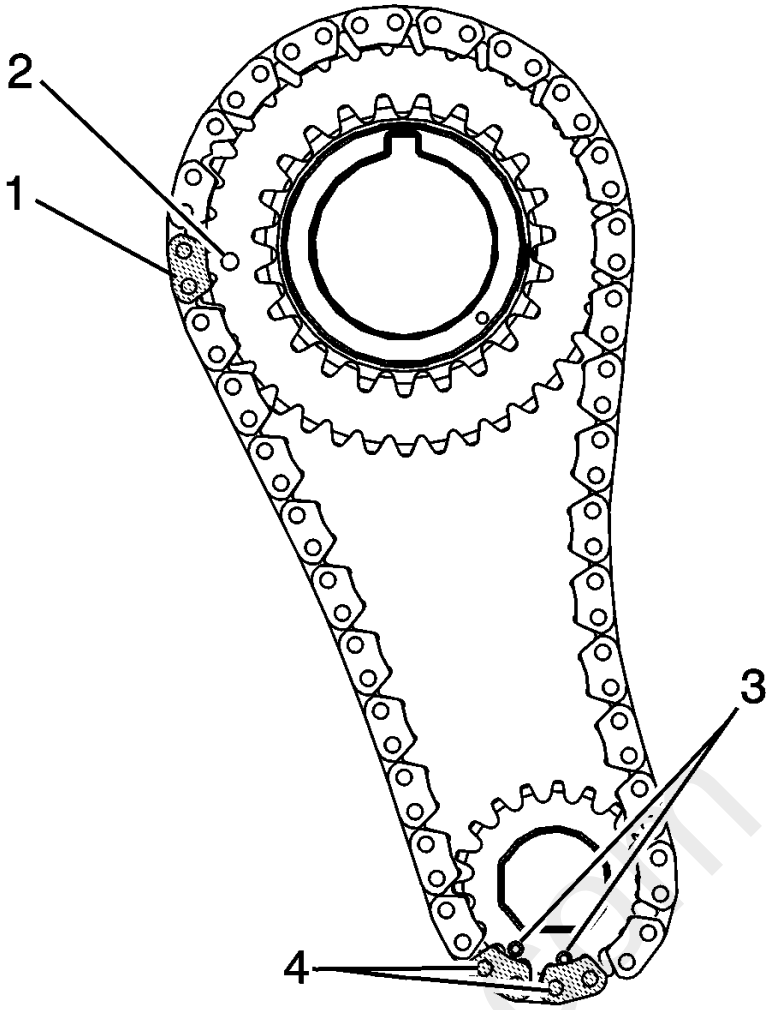


Fig. 125: Timing Link Lines & Timing Mark
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Due to the difference of crankshaft sprocket and balance shaft sprocket, timing marks on the chain will not match during every crankshaft revolution. Ensure that the marks on the sprockets are aligned appropriately before installing the timing chain.**

19. Rotate the crankshaft slightly in clockwise direction to allow chain to settle on actuator and sprocket teeth. If the timing chain jumps actuator teeth, repeat procedure to align the timing marks.
20. Verify the timing links on both the timing chain & balance chain are properly aligned to the timing marks:
    1. The timing link (1) is aligned to the timing mark on the crankshaft sprocket (2).
    2. The adjacent timing links (4) are aligned with both timing marks (3) on the balancer shaft driven sprocket.

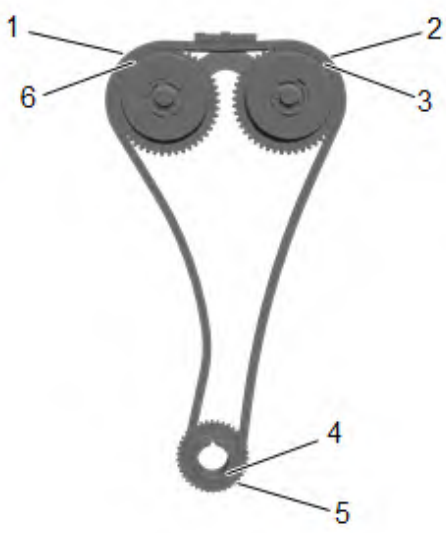


Fig. 126: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Because of slight clockwise rotation all chain marks may be advanced slightly in relation to the actuator and sprocket marks, yet still align.**

21. The timing chain links (1, 2) are aligned to the appropriate timing marks on the camshaft actuators (6, 3).
22. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

BALANCER SHAFT WITH OIL PUMP REPLACEMENT

Removal Procedure

1. Remove **Oil Pan Replacement (AWD)Oil Pan Replacement (FWD)**
2. Remove **Timing Chain Crankshaft Sprocket Replacement**

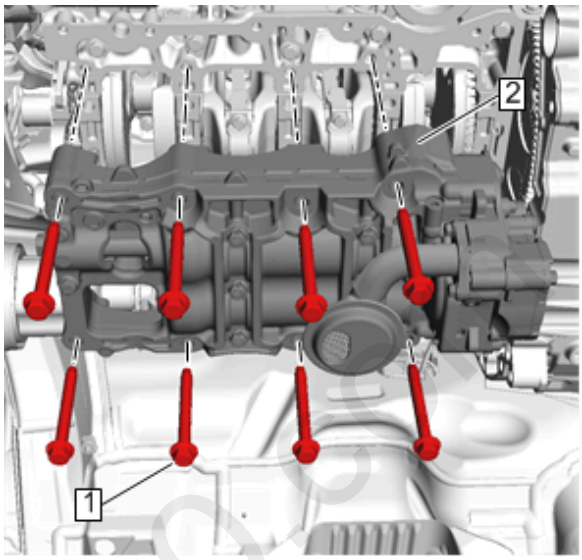


Fig. 127: Balancer Shaft with Oil Pump And Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove Balancer Shaft with Oil Pump Bolt (1) [8x]
4. Remove Balancer Shaft with Oil Pump (2)

NOTE: **If replacing the oil pump, remove it from the balancer shaft.**

5. Remove the oil pump. **Balancer Shaft with Oil Pump Disassemble**

Installation Procedure

1. Install the oil pump. **Balancer Shaft with Oil Pump Assemble**

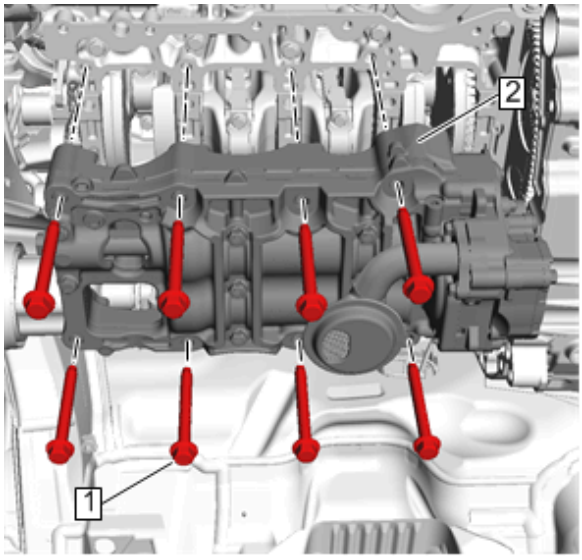


Fig. 128: Balancer Shaft with Oil Pump And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install Balancer Shaft with Oil Pump (2)
3. Loosely Install Balancer Shaft with Oil Pump Bolt (1) - [8x]

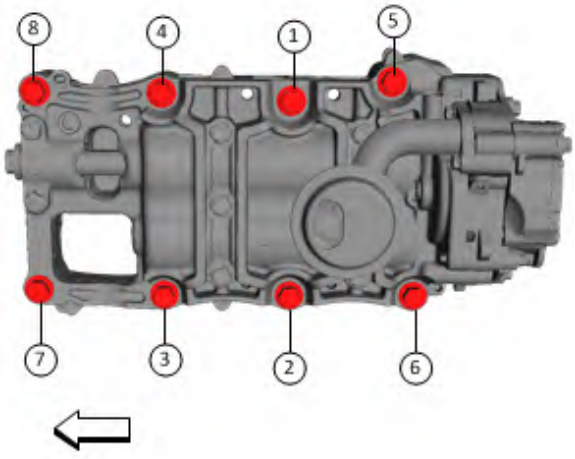


Fig. 129: Balancer Shaft With Oil Pump Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

4. Balancer Shaft with Oil Pump Bolt - tighten in sequence [8x]

   tighten

   1. **First pass** 58 N.m (43 lb ft)
   2. **Final pass** 58 N.m (43 lb ft)
5. Install Timing Chain Crankshaft Sprocket Replacement
6. Install Oil Pan Replacement (AWD)Oil Pan Replacement (FWD)

CAMSHAFT COVER REPLACEMENT (1ST DESIGN TAMPER-PROOF PCV SYSTEM)

Removal Procedure

1. Remove Ignition Coil - Ignition Coil Replacement
2. Remove Vacuum Pump -Vacuum Pump Replacement
3. Remove Turbocharger Heat Shield -Turbocharger Heat Shield Replacement

NOTE: **The air cleaner outlet duct is equipped with a tamper proof connection that should NOT be removed unless the PCV tube or air cleaner outlet duct is being replaced. Loosening the air cleaner outlet duct clamps will allow the duct to be disconnected from the air cleaner assembly and turbocharger for repositioning without removing the tamper proof connection.**

4. Loosen Air Cleaner Outlet Duct Clamp - Air Cleaner Outlet Duct Replacement (Non-Tamperproof) Air Cleaner Outlet Duct Replacement (Tamperproof)

mc730.com

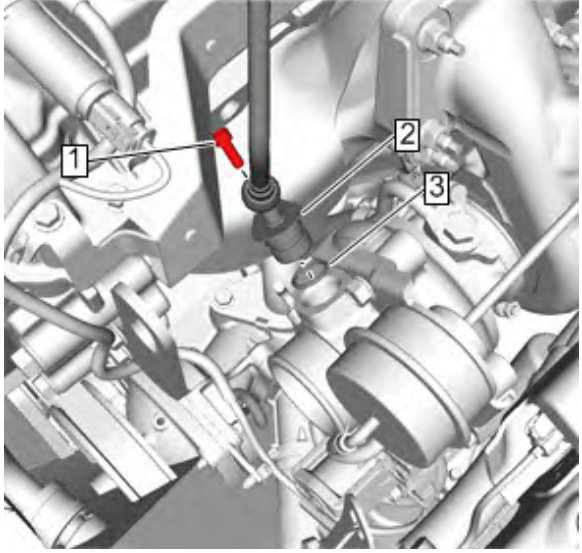


Fig. 130: PCV Valve
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The PCV hose and fitting assembly (2) is a permanent connection. Reinstall these components as an assembly unless new components are being used.**

NOTE: **Always ensure the PCV hose fitting O-Ring (3) seal is free of cuts or abrasions each time the fitting is attached to the turbocharger.**

5. Remove Positive Crankcase Ventilation Hose Fitting Bolt (1).
6. Disconnect Positive Crankcase Ventilation Hose Fitting (2).
7. Remove Turbocharger Coolant Return Pipe.Turbocharger Coolant Return Pipe Replacement (LTG)
8. Remove Oil Level Indicator.
9. Remove Engine Coolant Air Bleed Pipe. Engine Coolant Air Bleed Pipe Replacement (LTG)
10. Remove Camshaft Position Actuator Solenoid Valve - Intake -Camshaft Position Actuator Intake Solenoid Valve Replacement
11. Remove Camshaft Position Actuator Solenoid Valve - Exhaust -Camshaft Position Actuator Exhaust Solenoid Valve Replacement
12. Remove Camshaft Cover Heat Shield - Camshaft Cover Heat Shield Replacement
13. Disconnect and reposition engine electrical harness.

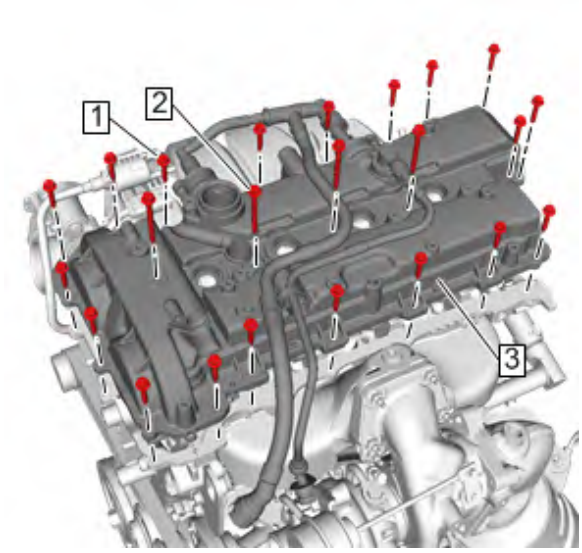


Fig. 131: Identifying Four Long Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the location of the four long camshaft cover bolts (2) for proper installation.**

14. Remove Camshaft Cover Bolt (1, 2).

mx30.com

NOTE: **If reinstalling the camshaft cover, remove the camshaft cover with the PCV tubes and the air cleaner outlet duct.**

15. Remove Camshaft Cover (3).

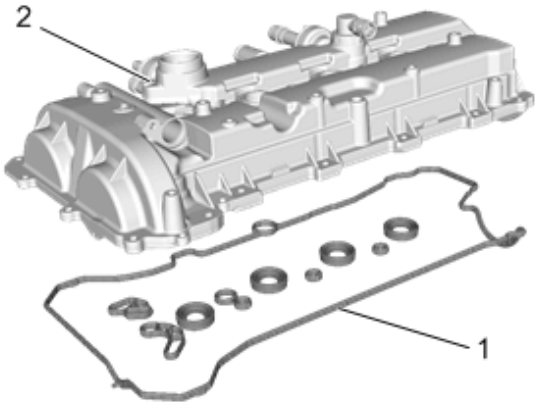


Fig. 132: Camshaft Cover Gasket
Courtesy of GENERAL MOTORS COMPANY

16. Remove Camshaft Cover Gasket (1) and DISCARD
17. If reinstalling the camshaft cover (2), clean and inspect as needed. **Camshaft Cover and Compressor Air Intake Turbocharger Cleaning and Inspection**

Installation Procedure

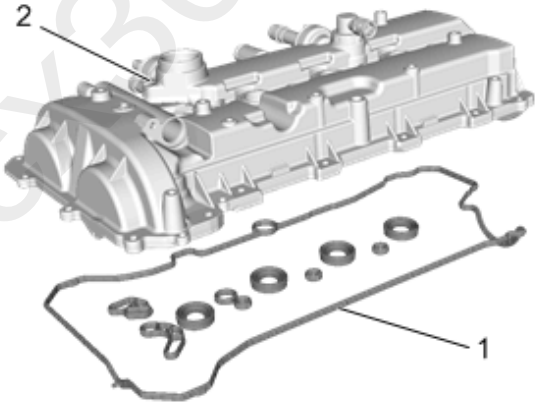


Fig. 133: Camshaft Cover Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install a NEW gasket.**

NOTE: **Add 14mm bead of sealant at right and left T-Joint where front cover meets head and at rear of camshaft cover right and left T-Joint where vacuum pump bolts on.**

1. Install Camshaft Cover Gasket (1)

mcy30.com

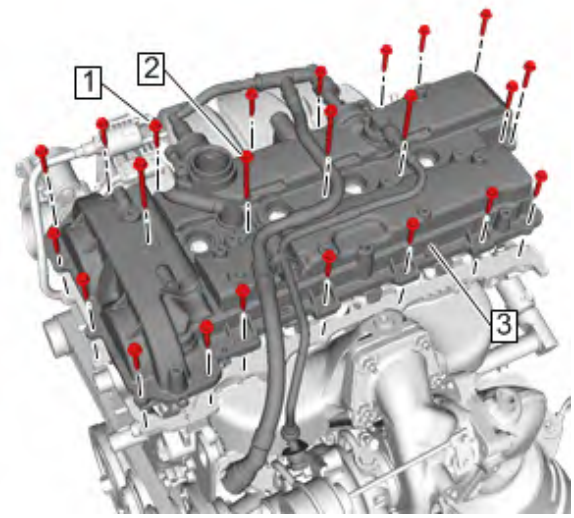


Fig. 134: Identifying Four Long Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install Camshaft Cover (3).

NOTE: **Ensure the long camshaft cover bolts (2) are installed in the correct positions.**

3. Loosely install Camshaft Cover Bolt (1, 2).

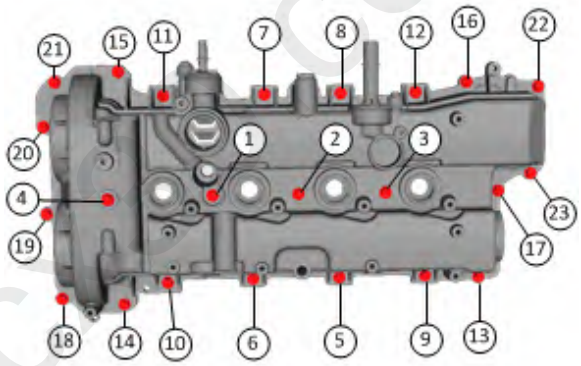


Fig. 135: Camshaft Cover Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

4. tighten the camshaft cover bolts in sequence to 10 N.m (89 lb in).
5. Reposition and reconnect engine wiring harness.
6. Install Camshaft Cover Heat Shield - **Camshaft Cover Heat Shield Replacement**

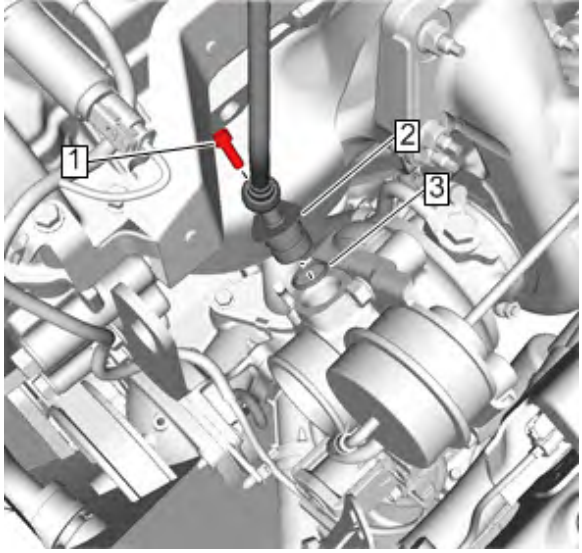


Fig. 136: PCV Valve
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Always ensure the PCV hose fitting O-Ring (3) seal is free of cuts or abrasions each time the fitting is attached to the turbocharger.**

7. Inspect the O-ring and replace if necessary. (3)
8. Connect Positive Crankcase Ventilation Hose Fitting (2).
9. Install Positive Crankcase Ventilation Hose Fitting Bolt (1) and tighten 8 N.m (71 lb in)
10. Install Camshaft Position Actuator Solenoid Valve - Exhaust - **Camshaft Position Actuator Exhaust Solenoid Valve Replacement**
11. Install Camshaft Position Actuator Solenoid Valve - Intake - **Camshaft Position Actuator Intake Solenoid Valve Replacement**
12. Install the engine oil level indicator.
13. Install Turbocharger Heat Shield - **Turbocharger Heat Shield Replacement**
14. Air Cleaner Outlet Duct Clamp - tighten - **Air Cleaner Outlet Duct Replacement (Non-Tamperproof)** **Air Cleaner Outlet Duct Replacement (Tamperproof)**
15. Install Turbocharger Coolant Return Pipe - **Turbocharger Coolant Return Pipe Replacement (LTG)**
16. Install Engine Coolant Air Bleed Pipe - **Engine Coolant Air Bleed Pipe Replacement (LTG)**
17. Install Vacuum Pump - **Vacuum Pump Replacement**
18. Install Ignition Coil - **Ignition Coil Replacement**

TIMING CHAIN TENSIONER REPLACEMENT

mc130.com

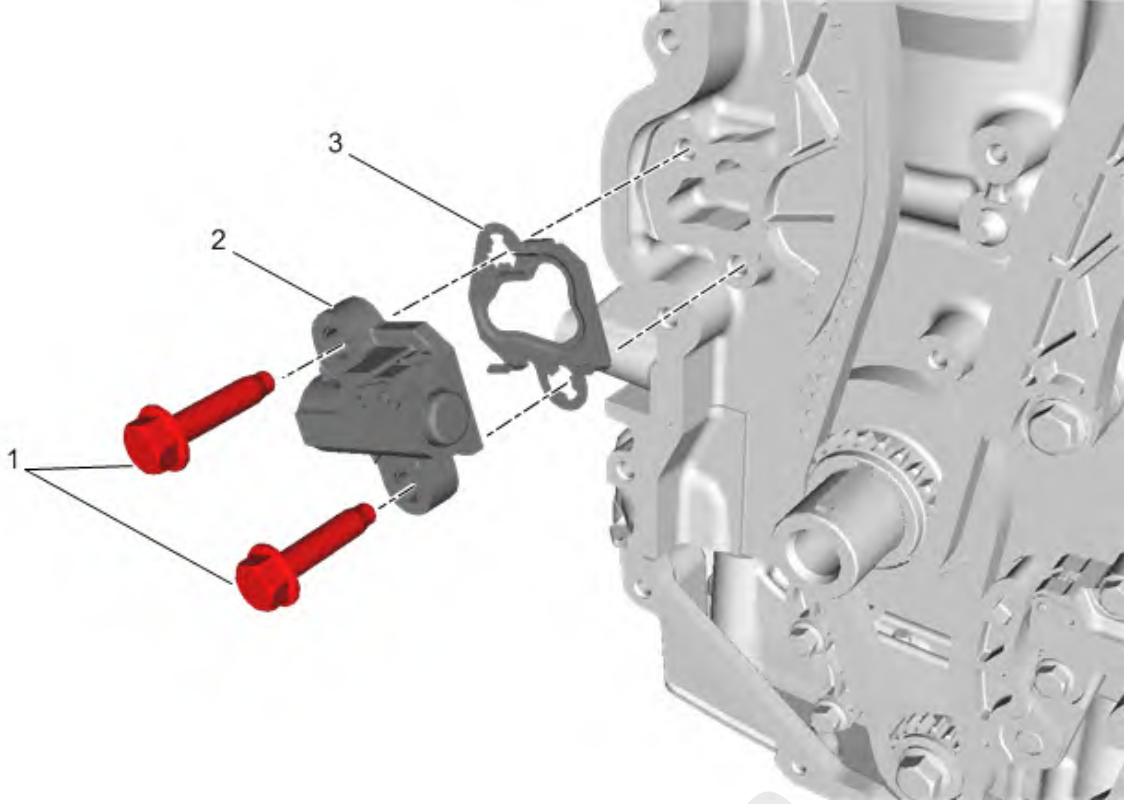


Fig. 137: Timing Chain Tensioner Bolts And Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure **Engine Front Cover Replacement**	
1	Timing Chain Tensioner Bolt (2) **CAUTION:** **Refer to Fastener Caution .** **tighten** 25 N.m (18 lb ft)
2	Timing Chain Tensioner
3	Timing Chain Tensioner Gasket **Procedure** Install a NEW gasket.

HYDRAULIC VALVE LASH ADJUSTER REPLACEMENT - EXHAUST

Removal Procedure

1. Remove the exhaust valve rocker arm. Refer to **Exhaust Valve Rocker Arm Replacement**.

mcx30.com

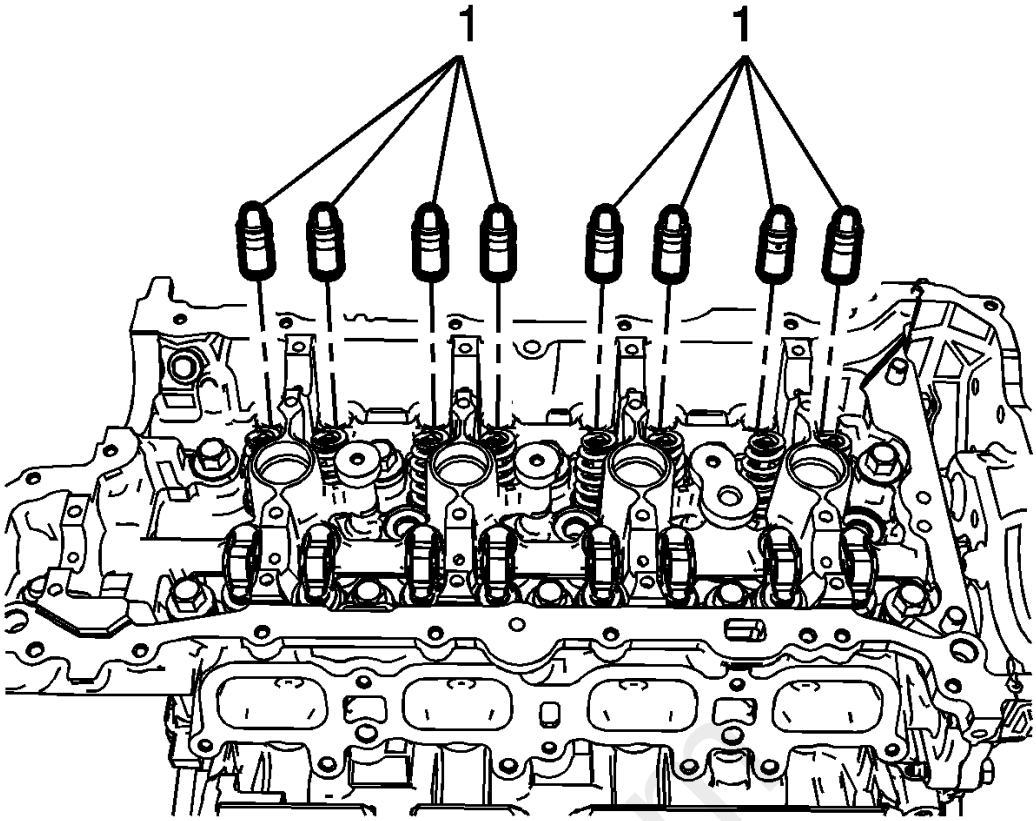


Fig. 138: Hydraulic Lash Adjusters - Exhaust
Courtesy of GENERAL MOTORS COMPANY

2. Remove the hydraulic lash adjusters (1).

Installation Procedure

mcx30.com

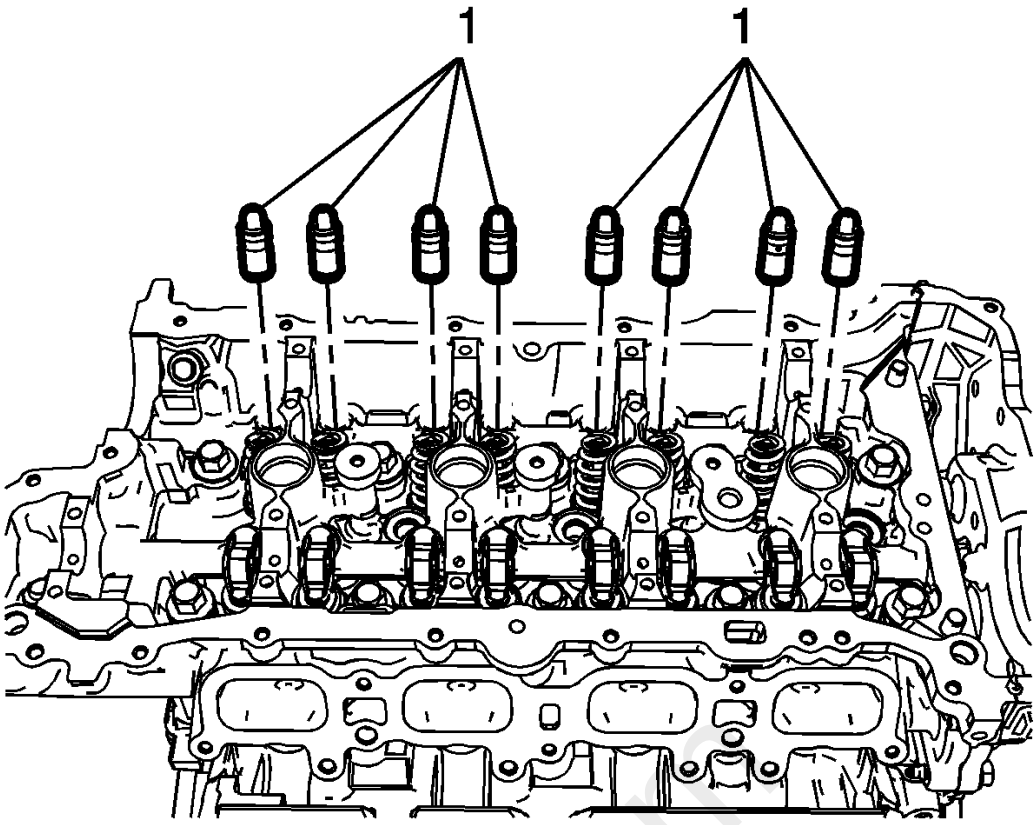


Fig. 139: Hydraulic Lash Adjusters - Exhaust
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Pre-fill the low pressure chamber with engine oil. Maintain a vertical orientation of the assembly to retain the oil in the reservoir and high pressure chamber. Do not install the lash adjusters without pre-filling the low pressure chamber. Apply engine oil to the outer diameter surface of all adjusters.**

1. Lubricate and install the hydraulic valve lash adjusters (1) into their bores in the cylinder head. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
2. Install the exhaust valve rocker arm. Refer to **Exhaust Valve Rocker Arm Replacement**.

HYDRAULIC VALVE LASH ADJUSTER REPLACEMENT - INTAKE

Removal Procedure

1. Remove the intake valve rocker arm. Refer to **Intake Valve Rocker Arm Replacement**.

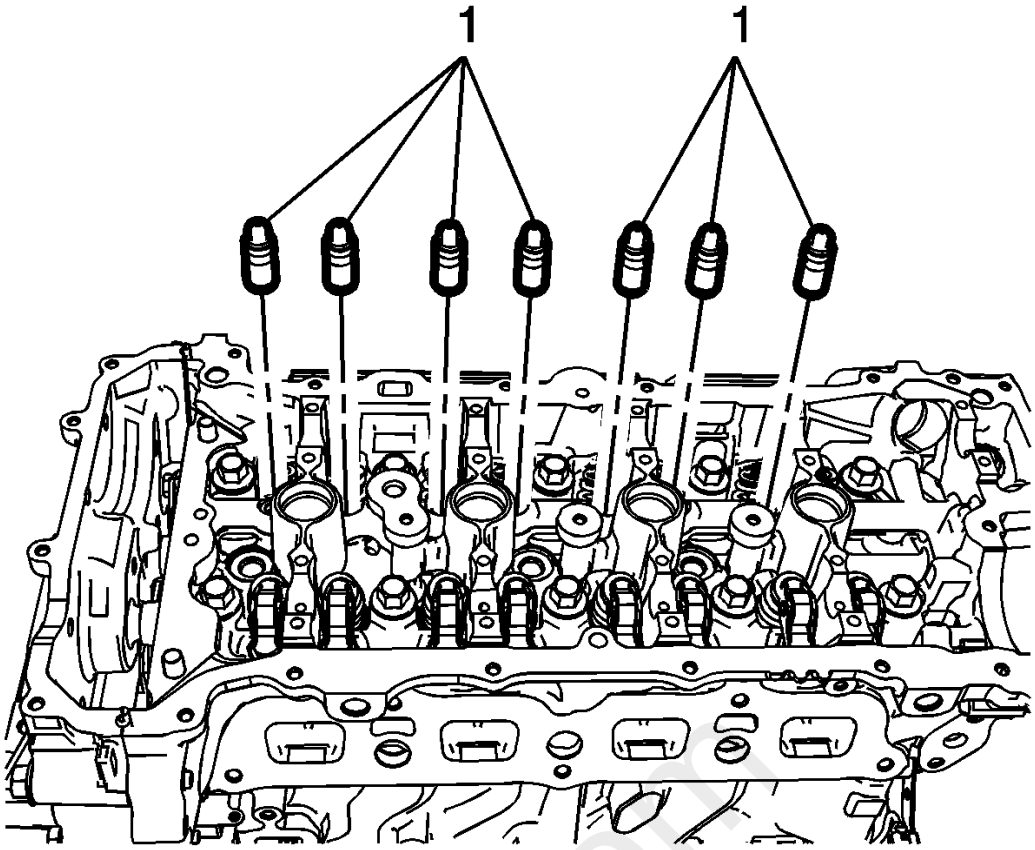


Fig. 140: Hydraulic Lash Adjusters - Intake
Courtesy of GENERAL MOTORS COMPANY

2. Remove the hydraulic lash adjusters (1).

Installation Procedure

mcx30.com

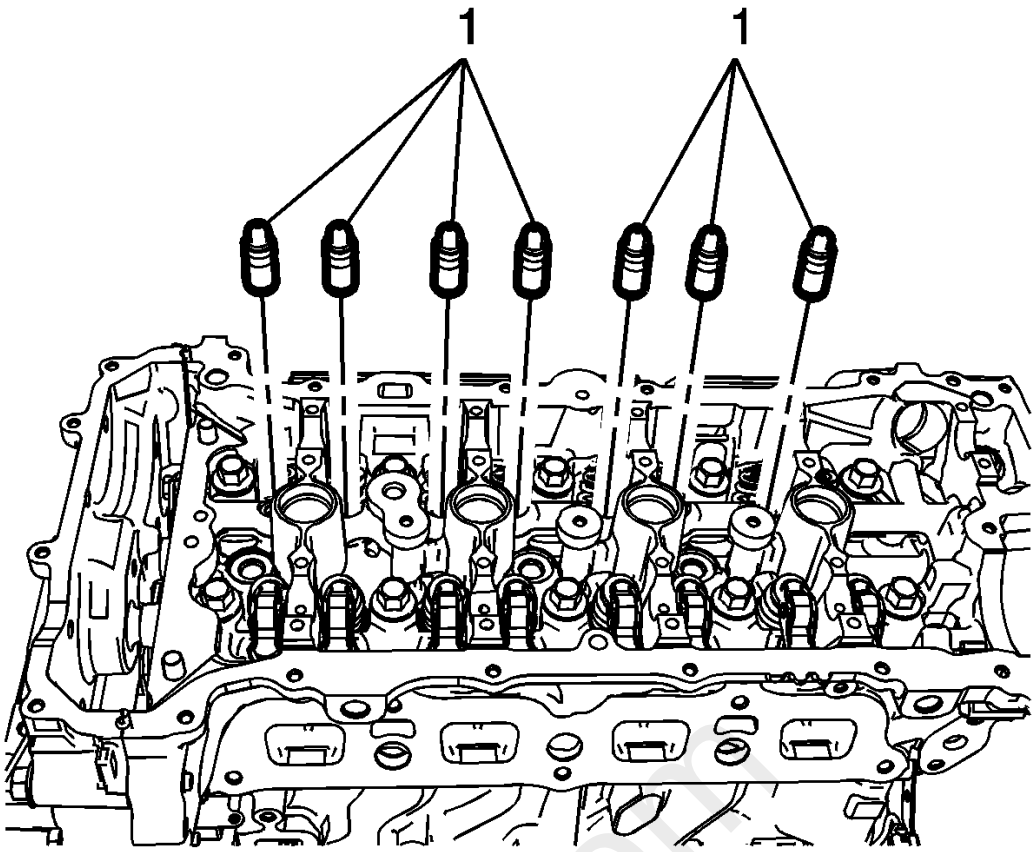


Fig. 141: Hydraulic Lash Adjusters - Intake
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Pre-fill the low pressure chamber with engine oil. Maintain a vertical orientation of the assembly to retain the oil in the reservoir and high pressure chamber. Do not install the lash adjusters without pre-filling the low pressure chamber. Apply engine oil to the outer diameter surface of all adjusters.**

1. Lubricate and install the hydraulic valve lash adjusters (1) into their bores in the cylinder head. Refer to Adhesives, Fluids, Lubricants, and Sealers.
2. Install the intake valve rocker arm. Refer to Intake Valve Rocker Arm Replacement.

CAMSHAFT POSITION ACTUATOR AND CAMSHAFT REPLACEMENT - INTAKE

Special Tools

- **EN-50656** Holding Tool
- **EN 50793** Locking Tool

For equivalent regional tools, refer to Special Tools.

Removal Procedure

NOTE: **Ensure the engine is properly timed to Top Dead Center (TDC), prior to performing repairs.**

1. Remove the camshaft cover. Refer to Camshaft Cover Replacement (1st Design Tamper-Proof PCV System).
2. Remove the high pressure fuel pump. Refer to Fuel Pump Replacement .

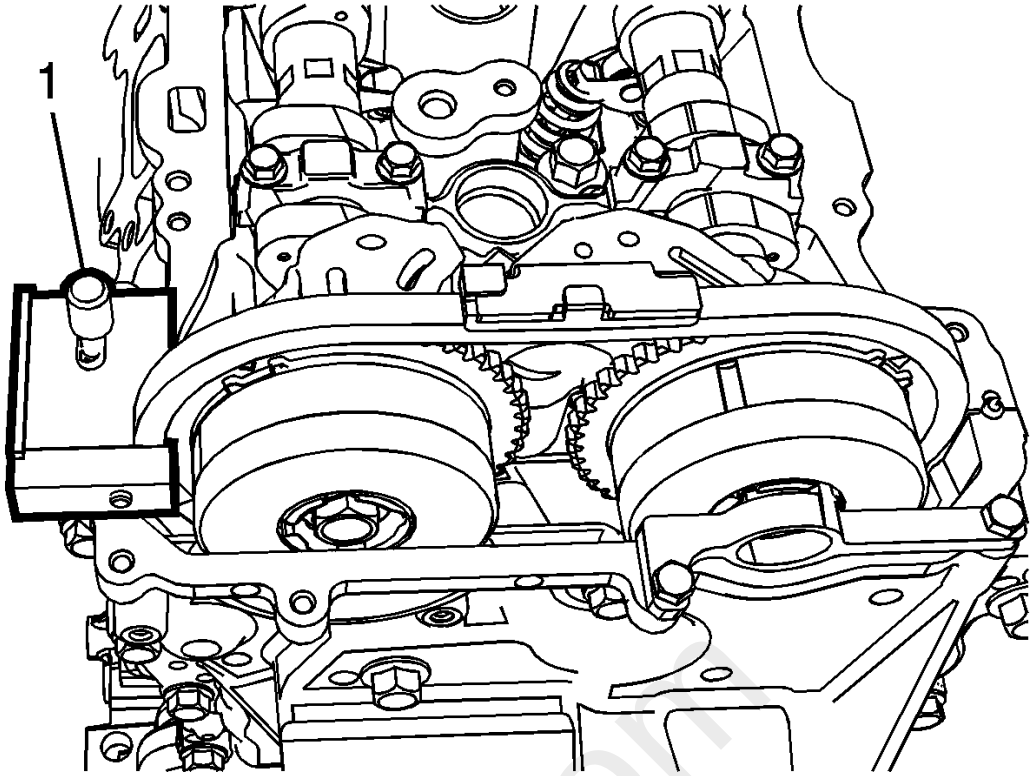


Fig. 142: Identifying Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the EN-50656 holding tool is installed and securely tighten ed to prevent the camshaft chain from dropping into the front engine cover during camshaft actuator replacement.**

3. Install **EN-50656** timing chain holding tool (1) and tighten to 8 N.m (71 lb in).

mc20.com

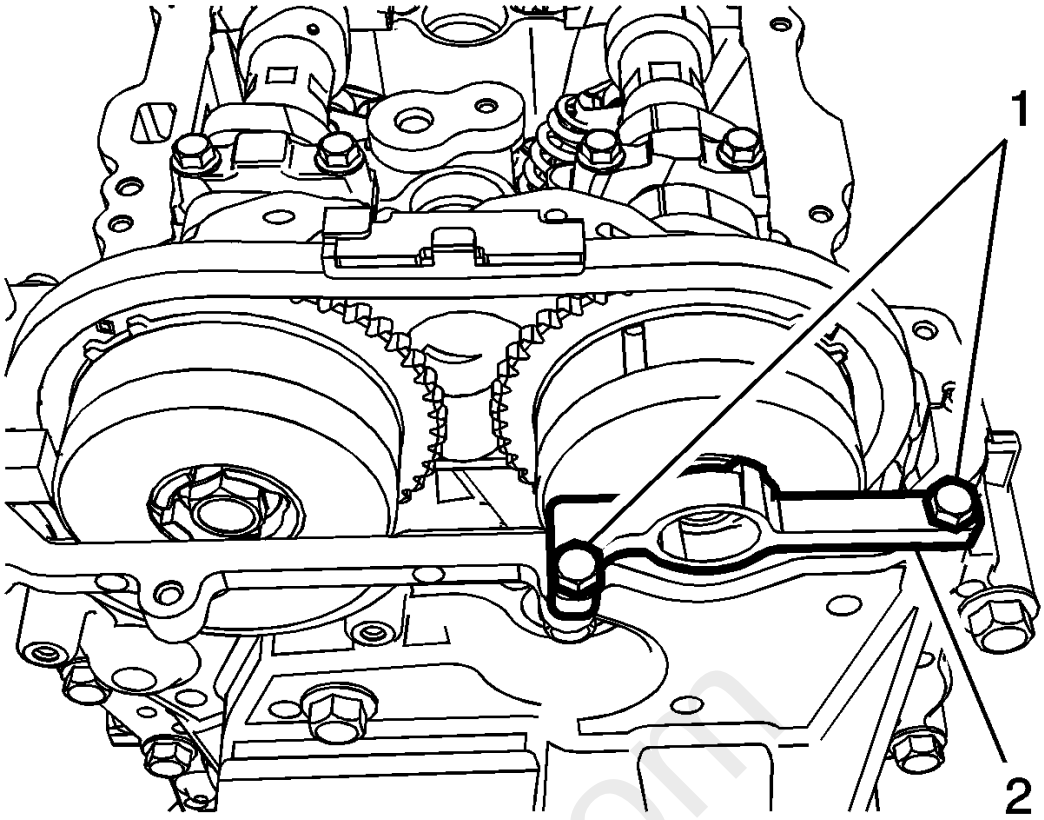


Fig. 143: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

NOTE: **Ensure to mark actuator sprocket and chain before removal.**

4. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the exhaust camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 N.m (89 lb in).

mcx30.com

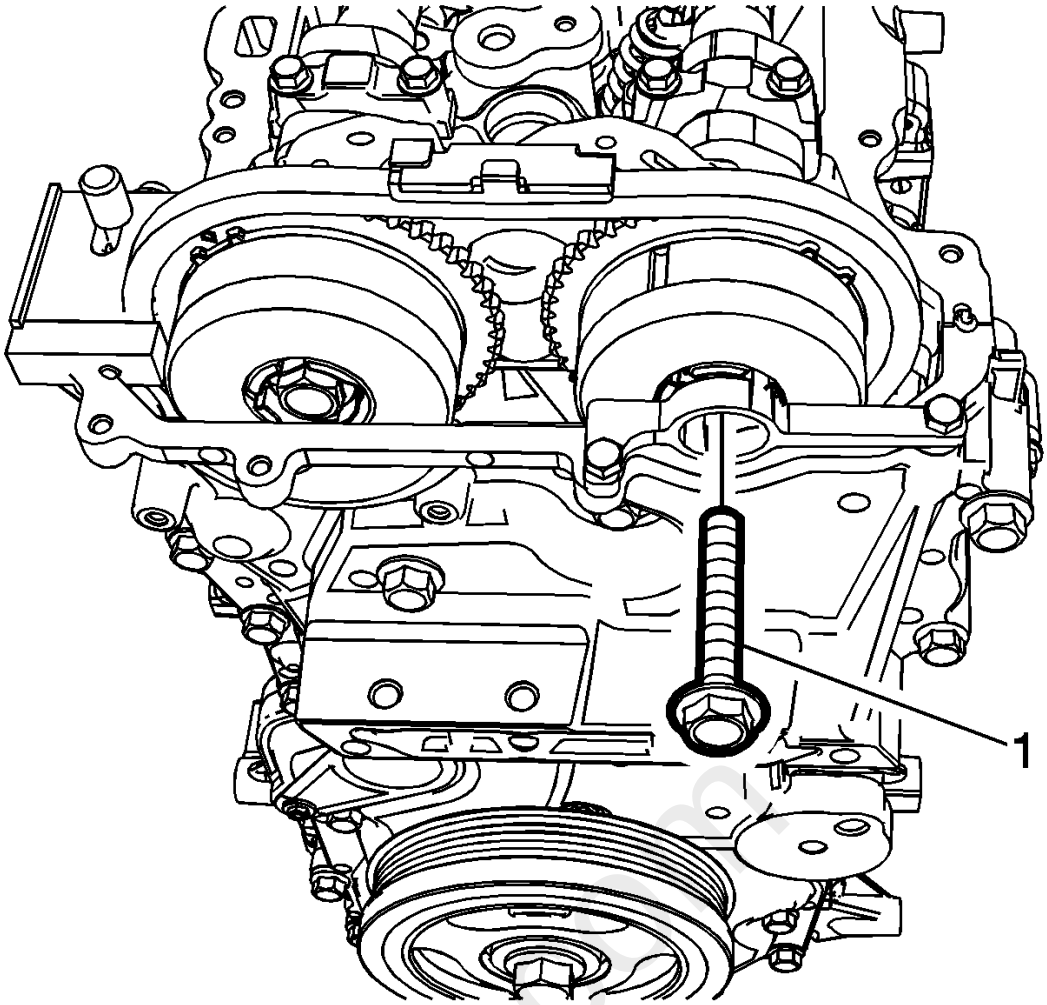


Fig. 144: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove and DISCARD the camshaft actuator bolt (1).

mcx30.com

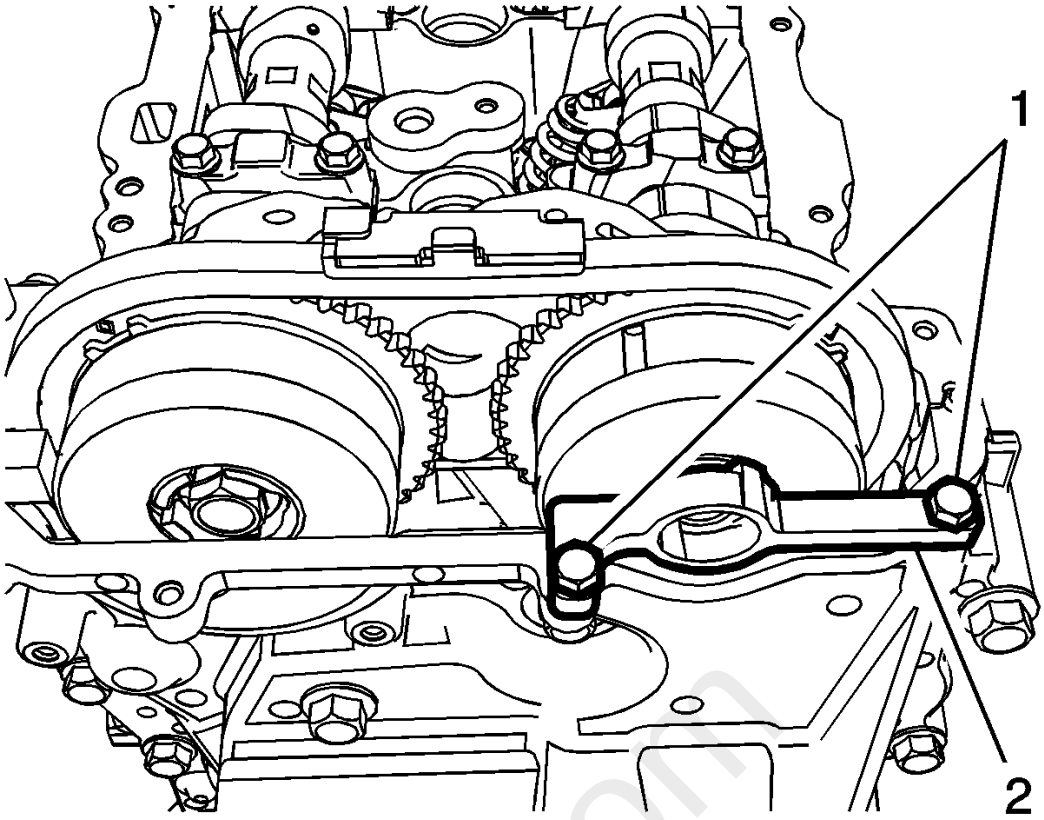


Fig. 145: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

6. Remove the **EN-50793** holding tool (2).

mcx30.com

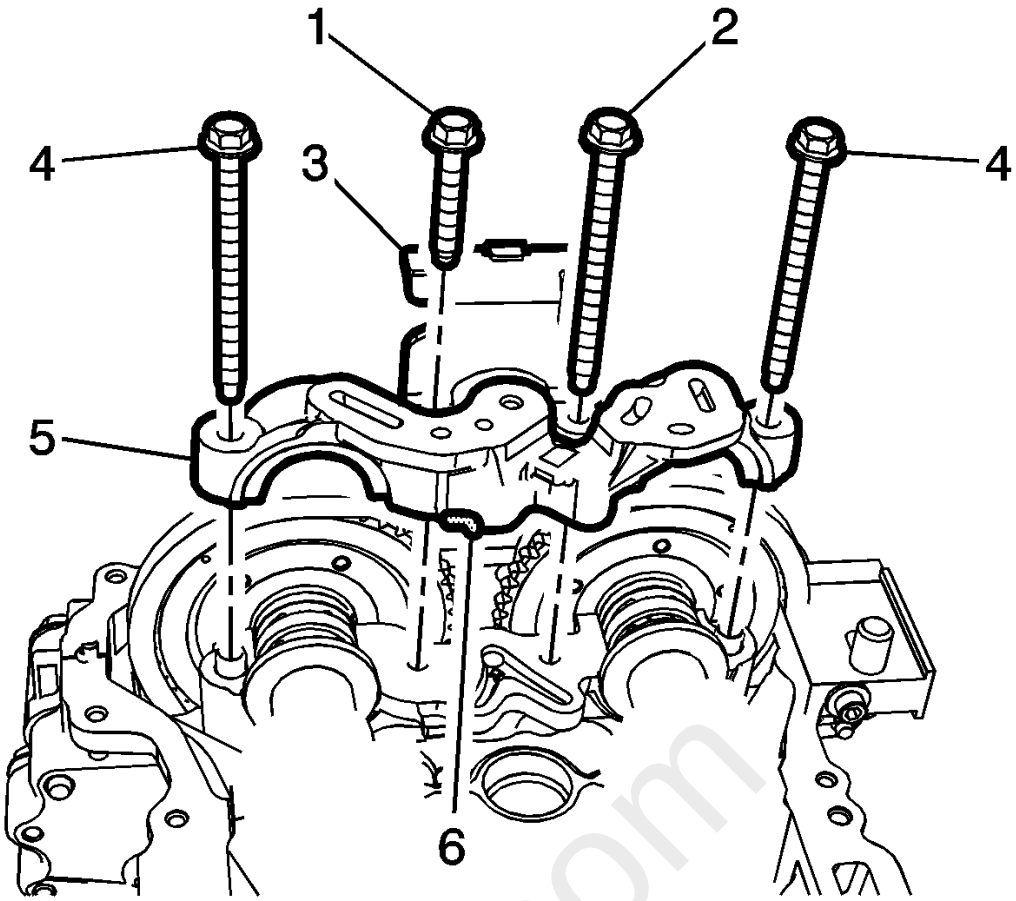


Fig. 146: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the upper timing chain guide bolts (1, 2).
8. Remove the upper timing chain guide (3).
9. Remove the camshaft front bearing cap bolts (4).

NOTE: **Locate the pry points (6) in the camshaft front bearing cap. When using the 3 pry points to remove the front bearing cap evenly, use a protective material between the camshaft lobes, the cylinder head flange, and pry tool.**

10. Remove the camshaft front bearing cap (5).

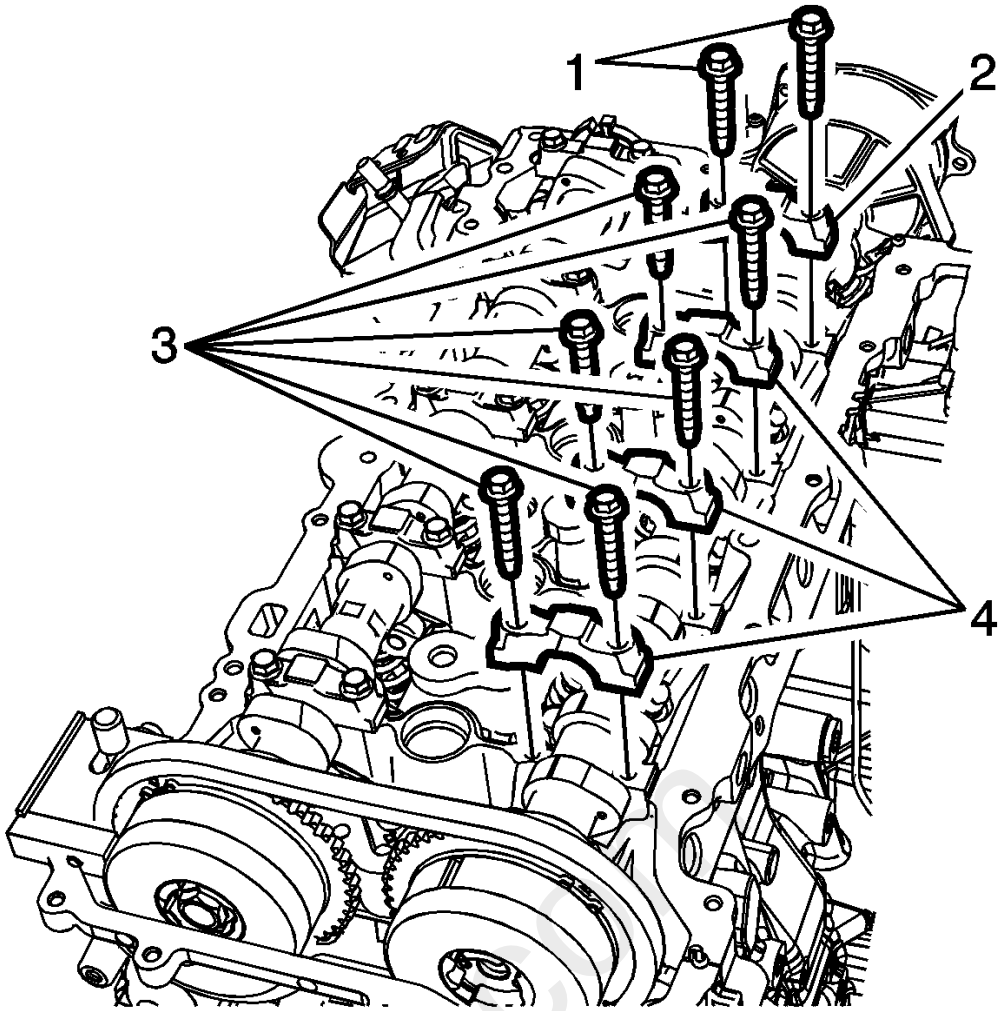


Fig. 147: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

11. Mark the exhaust camshaft rear cap to ensure it is installed in the same position. Remove the exhaust camshaft bearing rear cap bolts (1) and cap (2).

NOTE: **Loosen each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.**

12. Mark the camshaft caps (4) to ensure they are installed in the same position.
13. Remove the exhaust camshaft cap bolts (3).
14. Remove the camshaft caps (4).

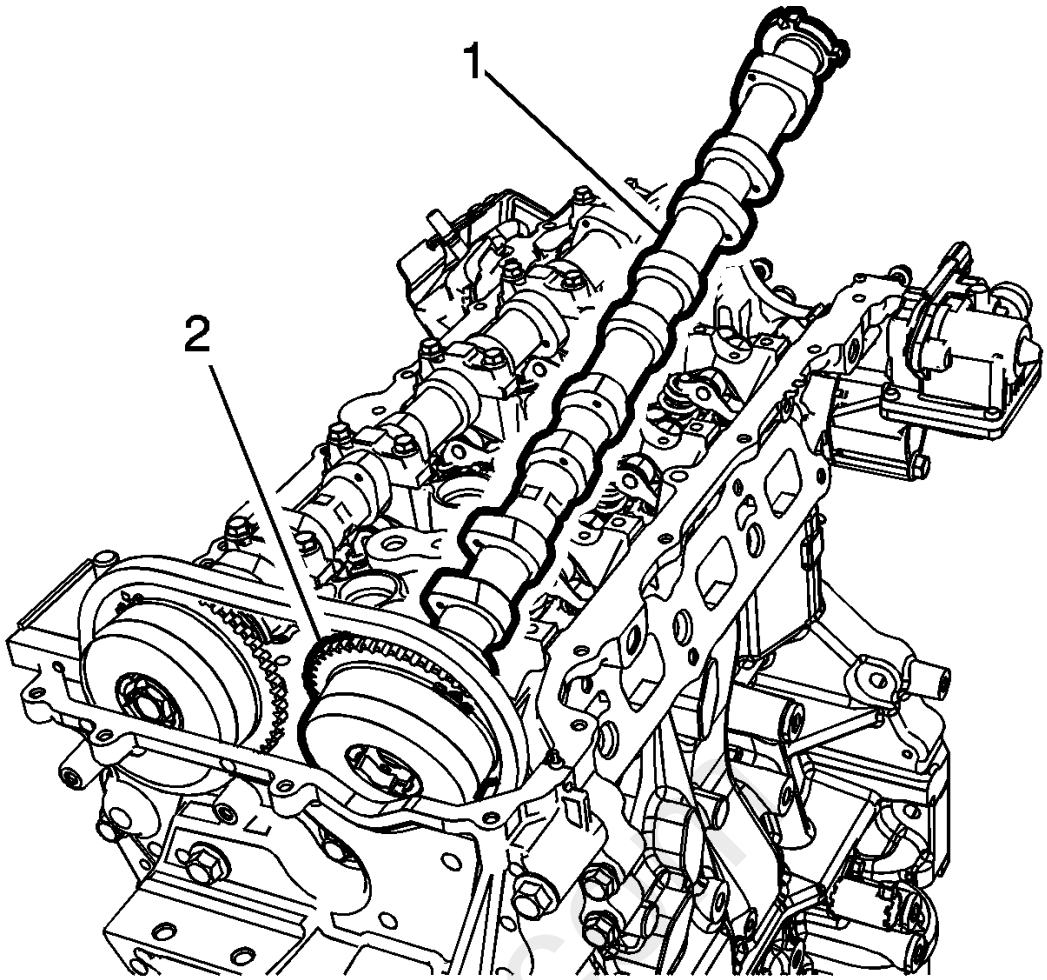


Fig. 148: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

15. Pull exhaust camshaft actuator assembly forward away from camshaft assembly (1), then lift rear of exhaust camshaft assembly to a tilt and pull free from exhaust camshaft actuator assembly (2).

mcx30.com

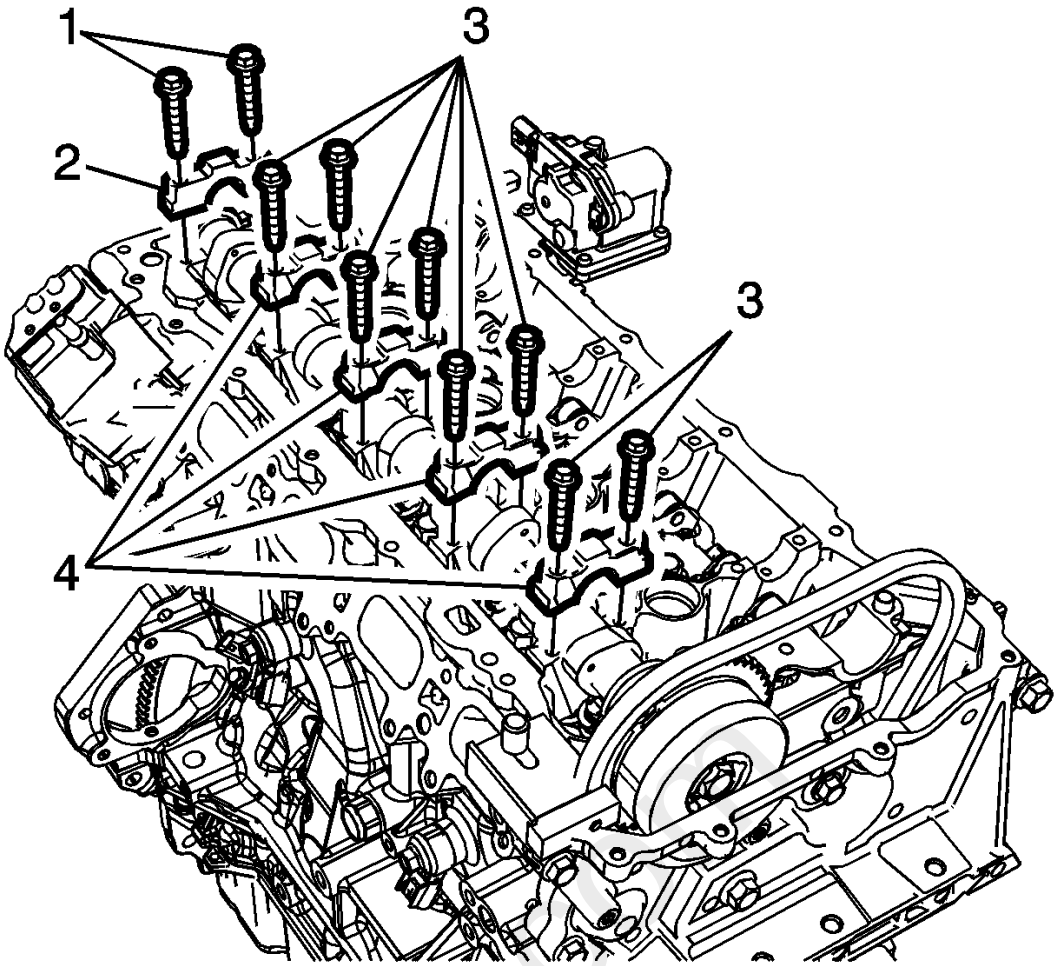


Fig. 149: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

16. Mark the intake camshaft rear cap to ensure it is installed in the same position. Remove the intake camshaft bearing rear cap bolts (1) and cap (2).

NOTE: **Loosen each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.**

17. Mark the camshaft caps (4) to ensure they are installed in the same position.
18. Remove the intake camshaft cap bolts (3).
19. Remove the camshaft caps (4).
20. Lift and roll intake camshaft assembly from original position over into exhaust camshaft position within engine head assembly.

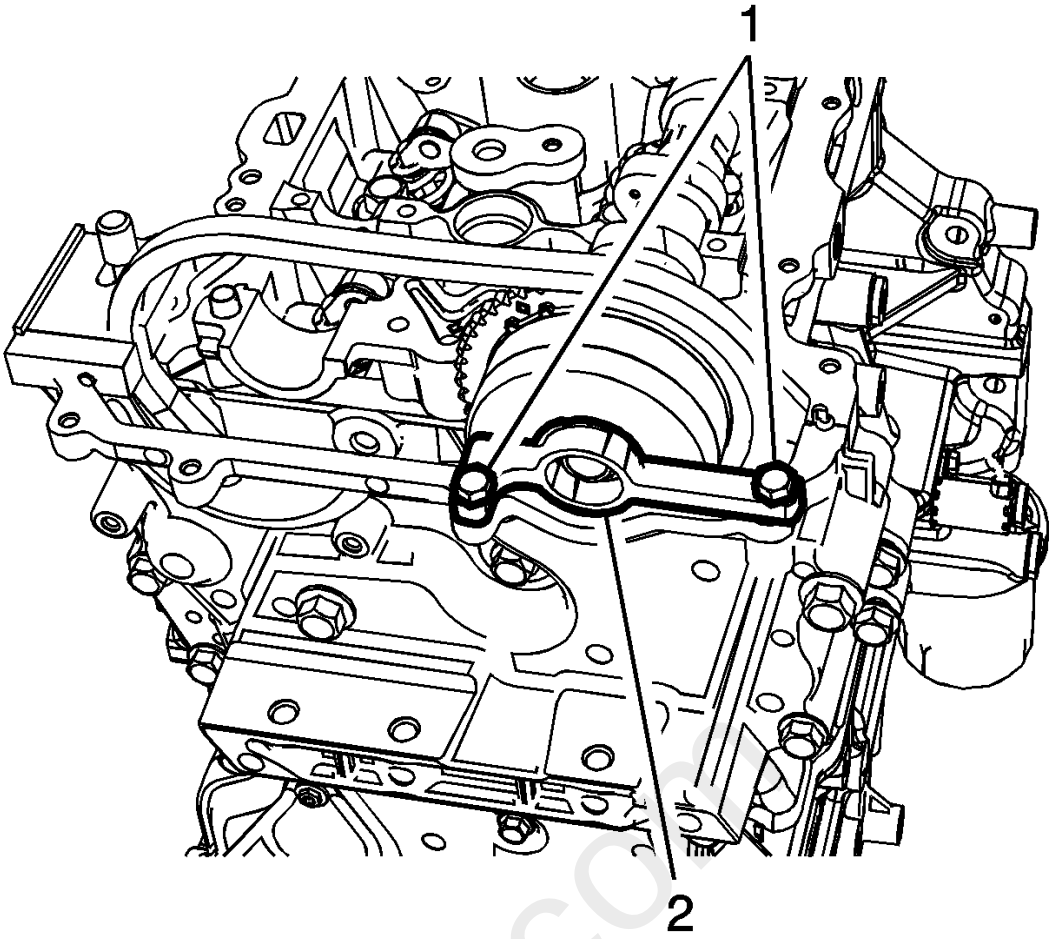


Fig. 150: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

21. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 N.m (89 lb in).

mcx30.com

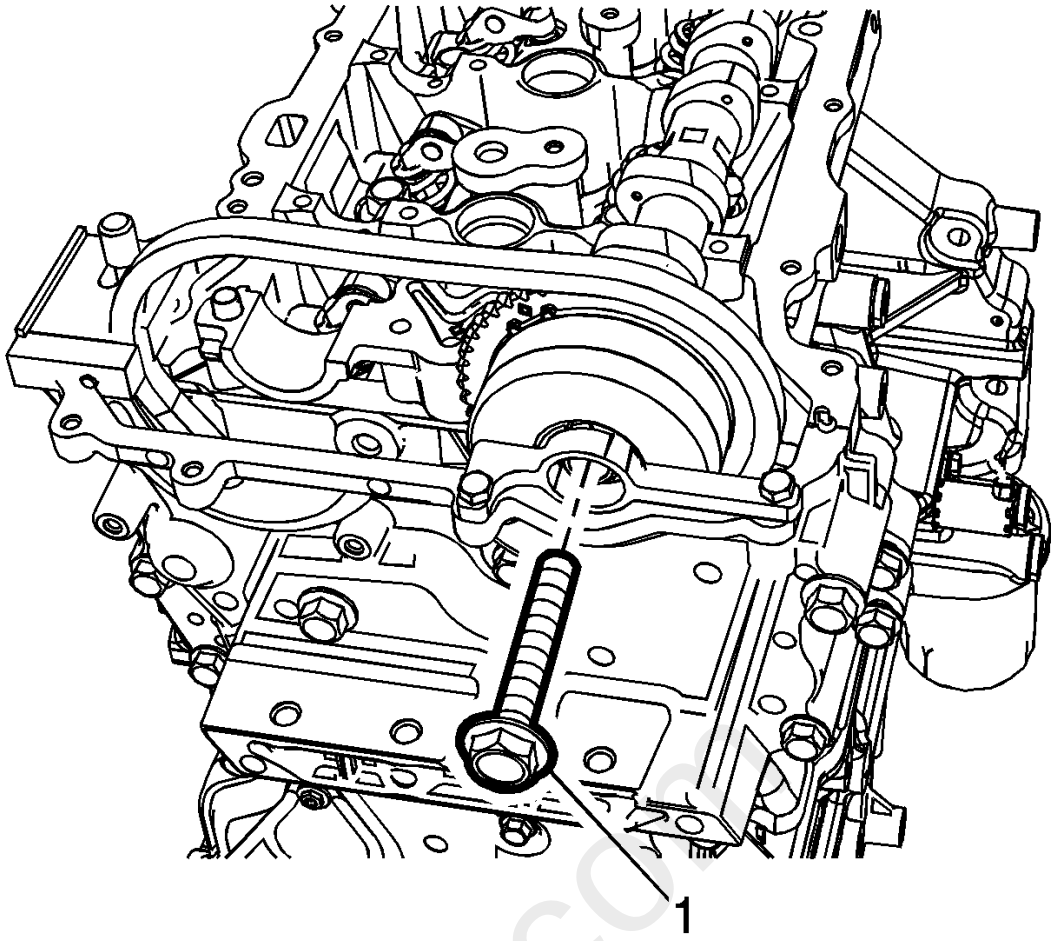


Fig. 151: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

22. Remove the camshaft actuator bolt (1).

mcx30.com

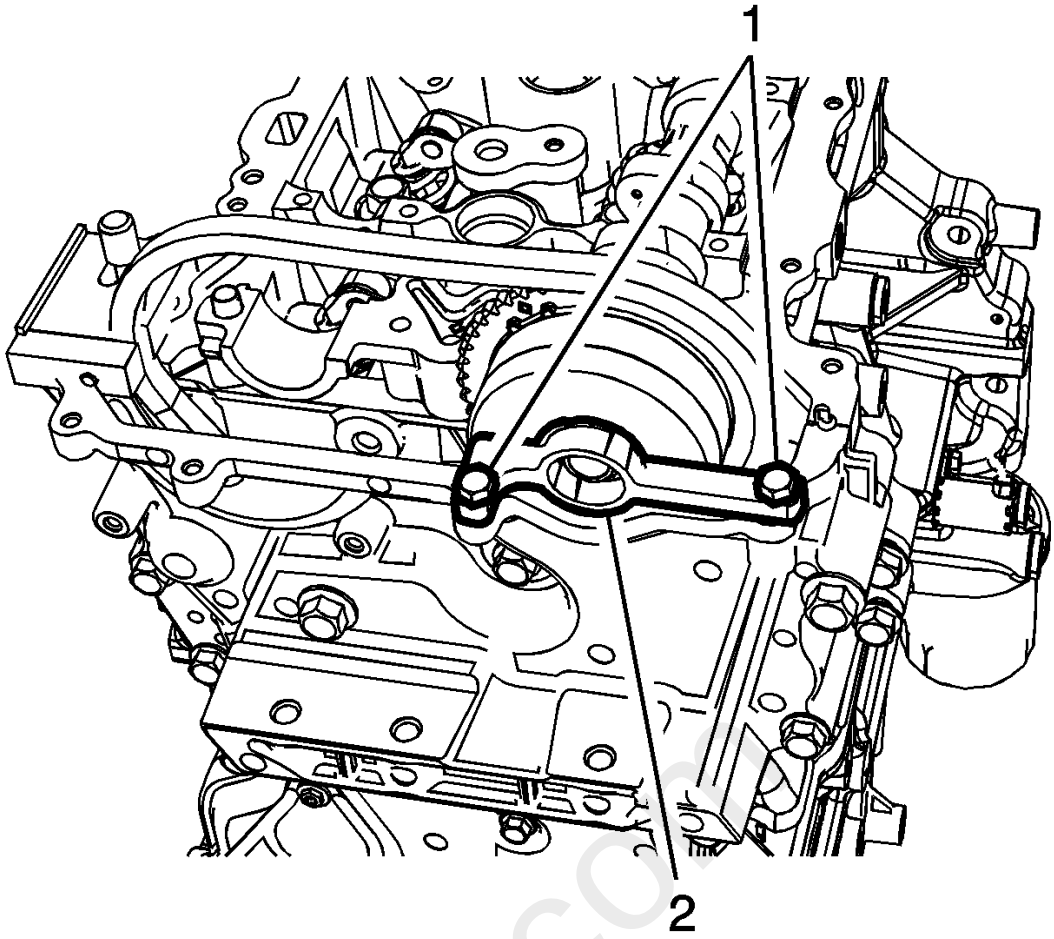


Fig. 152: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

23. Remove the **EN-50793** holding tool (2).

mcx30.com

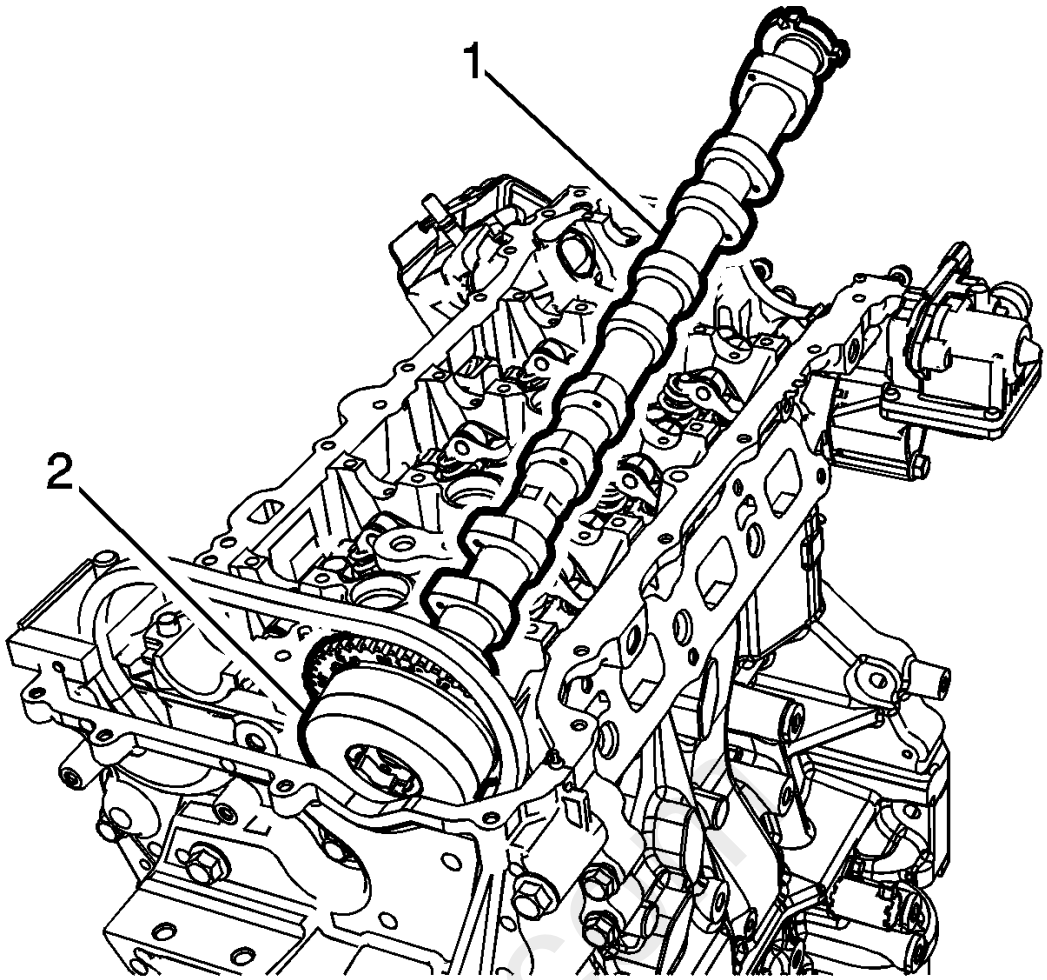


Fig. 153: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

24. Pull intake camshaft actuator assembly forward away from camshaft assembly (1), then lift rear of intake camshaft assembly to a tilt and pull free from intake camshaft actuator assembly (2).

NOTE: **If replacing the camshaft, ensure to transfer any marking from the old camshaft to the new one.**

25. Replace the camshaft if necessary.

Installation Procedure

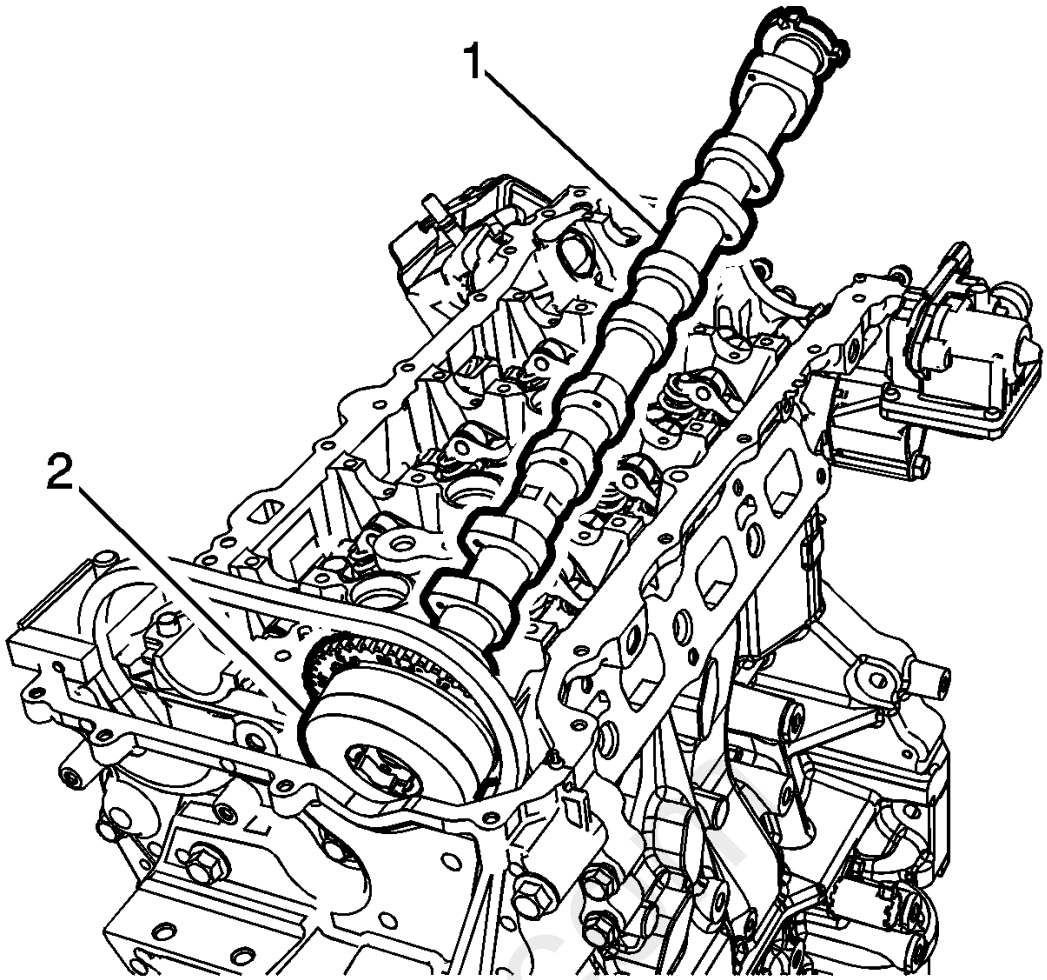


Fig. 154: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the intake camshaft (1) and camshaft actuator (2).

mcx30.com

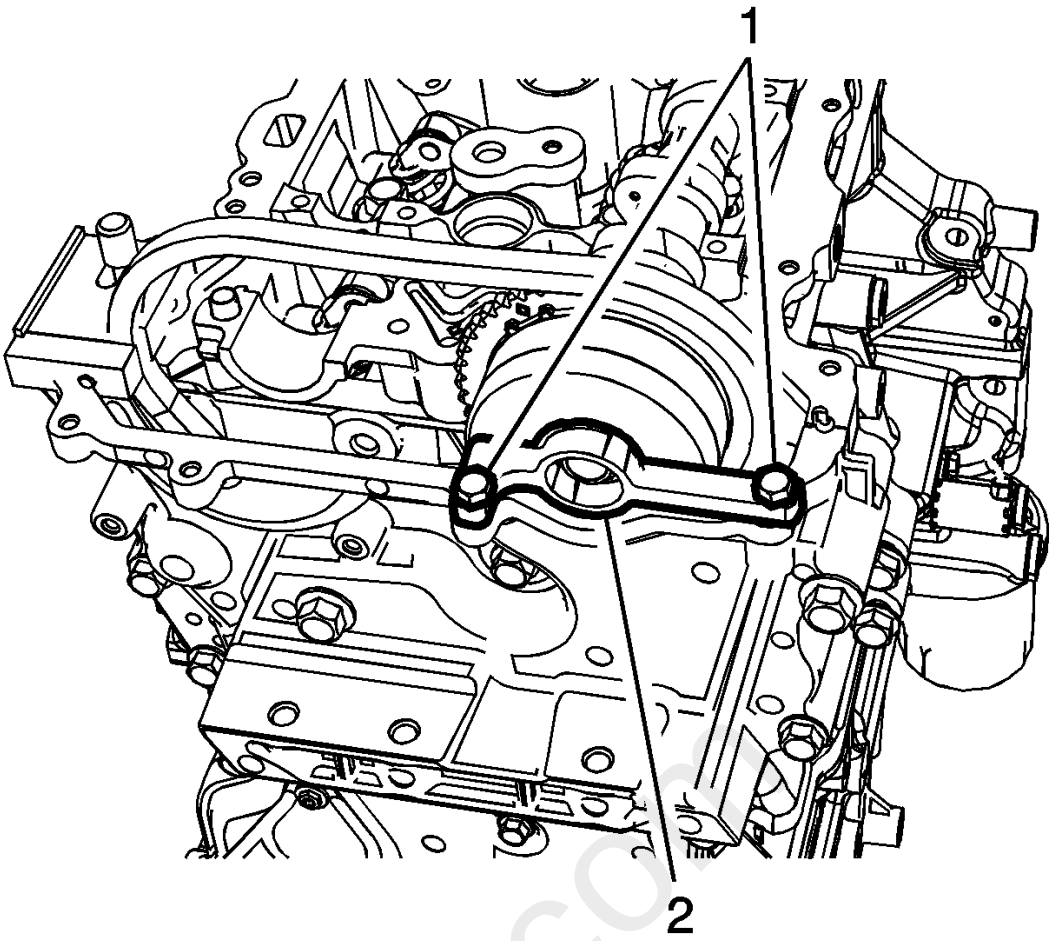


Fig. 155: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 N.m (89 lb in).

mex30.com

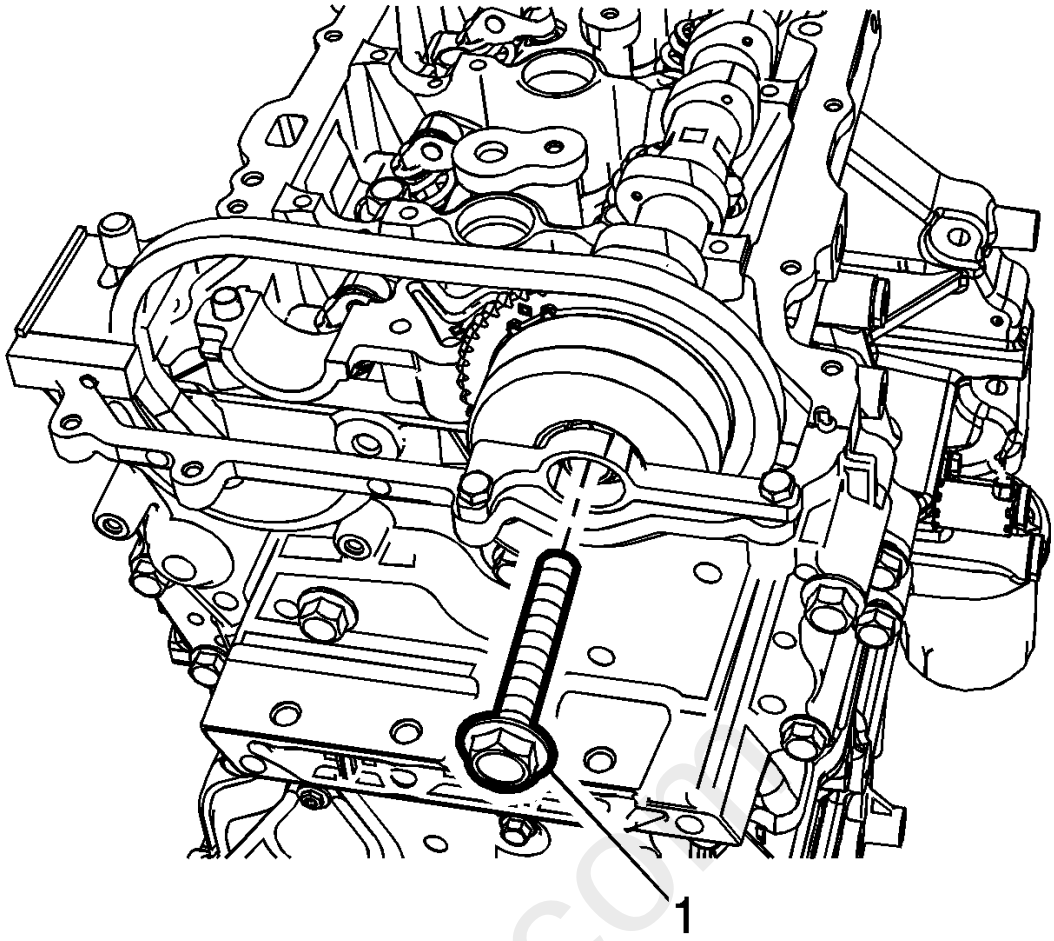


Fig. 156: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW camshaft actuator bolt (1) and tighten to 30 N.m (22 lb ft) plus 100 degrees.
4. Lift and roll intake camshaft assembly from exhaust camshaft position over into original position.

mc730.com

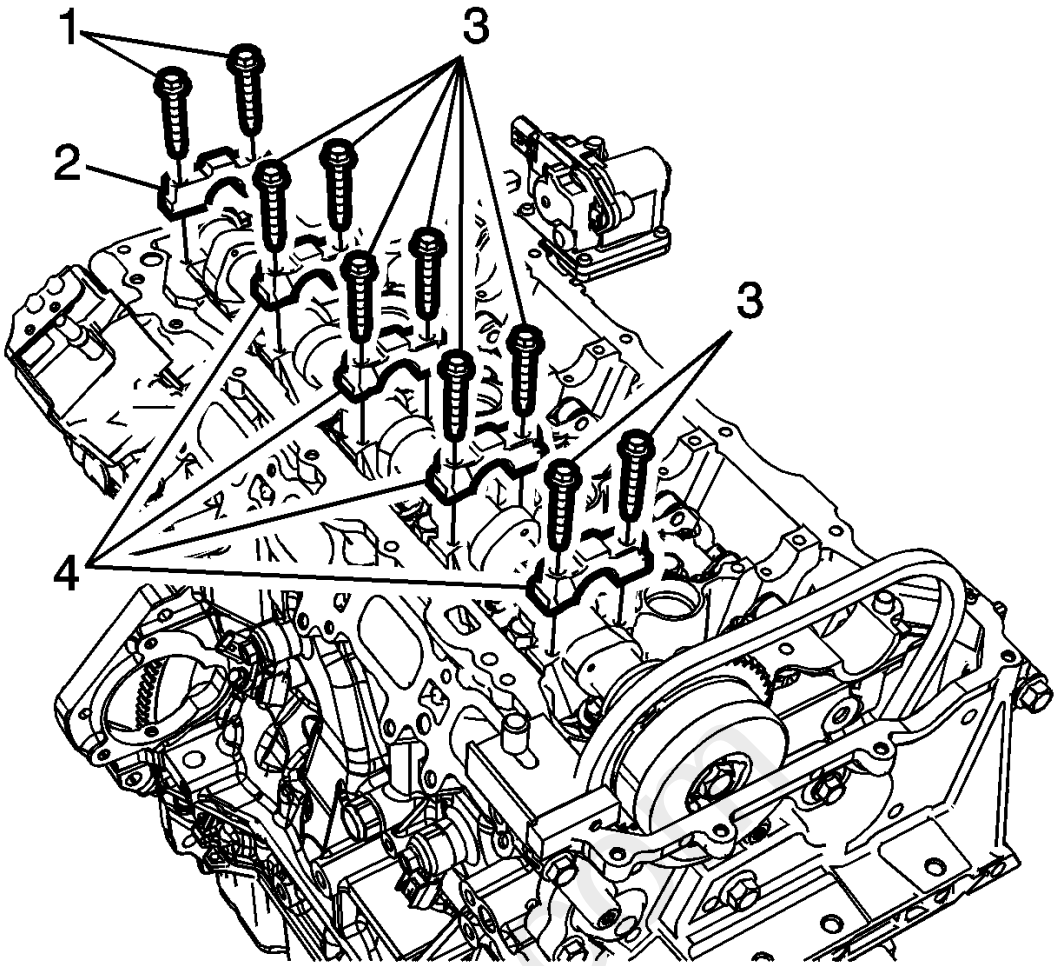


Fig. 157: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: Apply lubricant to all lobes and journals prior to installing the camshafts.

5. Set the intake camshaft on top of the roller followers in the camshaft bearing journals with the intake actuator timing mark at approximately the 11 O'clock position.

NOTE: To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the camshafts.

6. Install the camshaft cap bolts (1, 3) into the camshaft caps (2, 4).
7. Install the camshaft caps (2, 4) and hand start the camshaft cap bolts (1, 3).

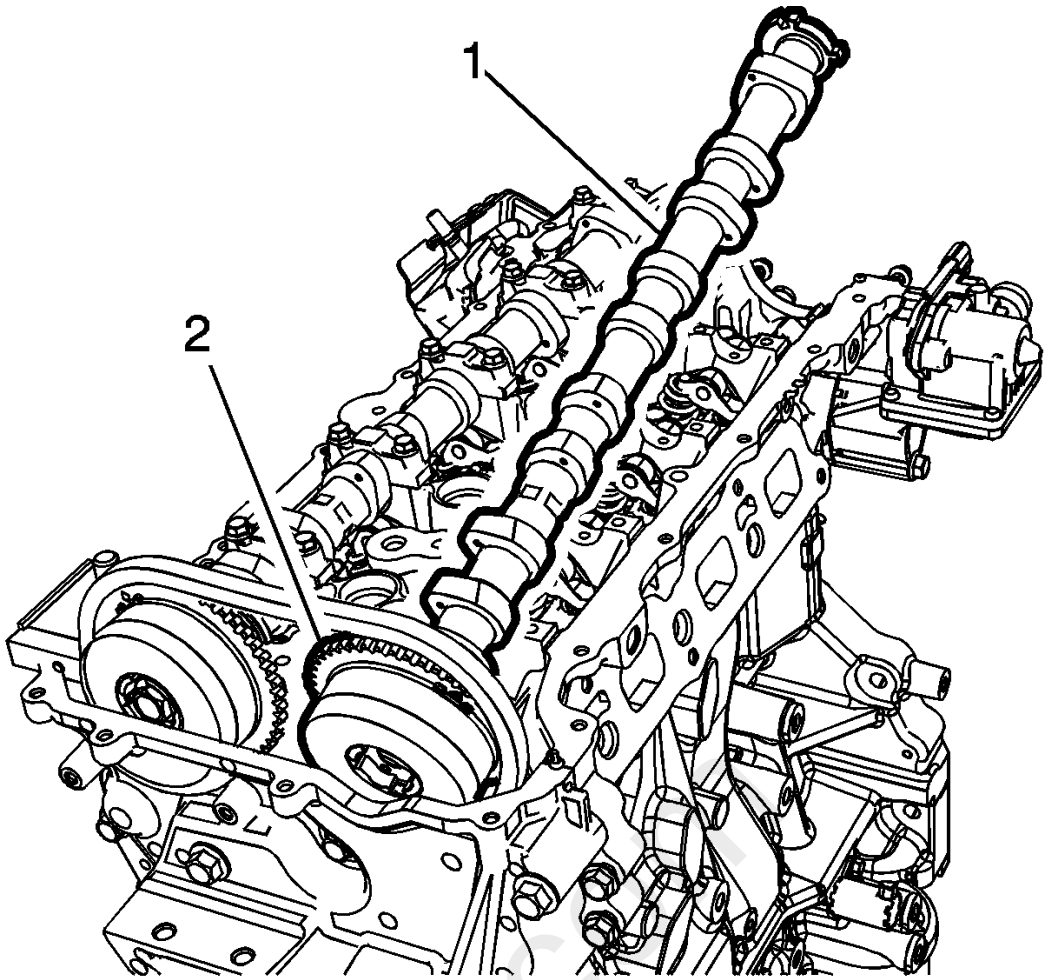


Fig. 158: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

8. Install the exhaust camshaft (1) and camshaft actuator (2).

mcx30.com

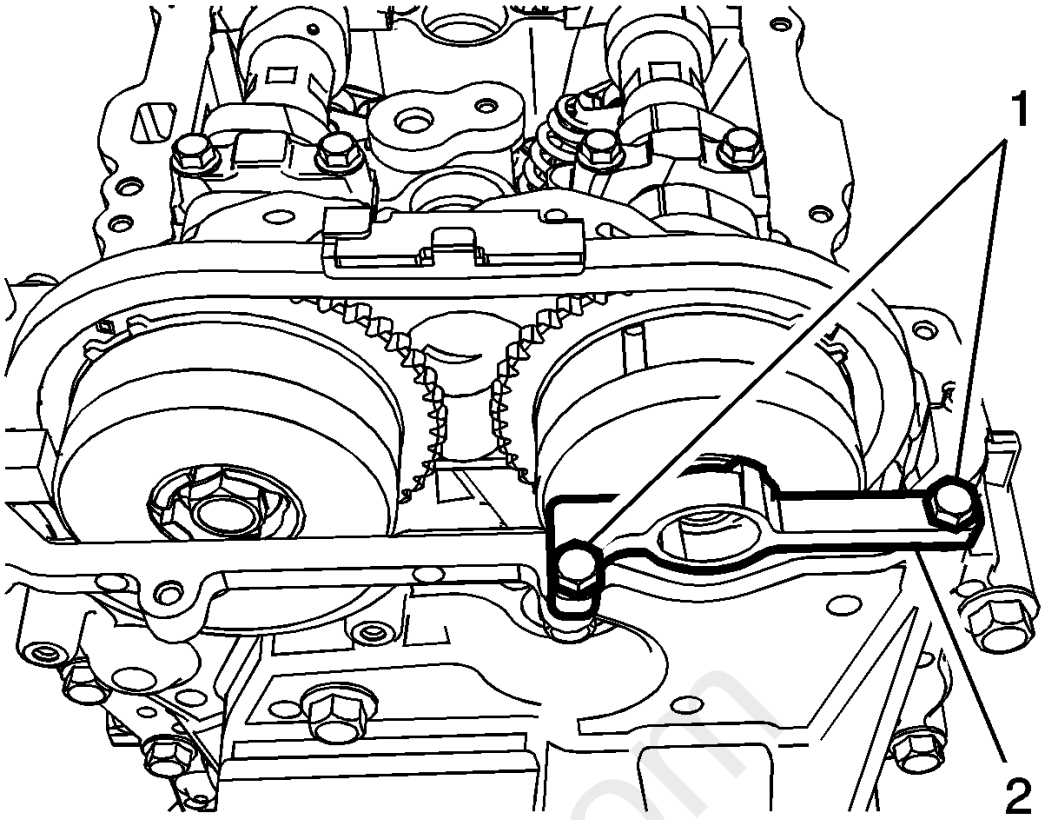


Fig. 159: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

9. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 N.m (89 lb in).

mcx30.com

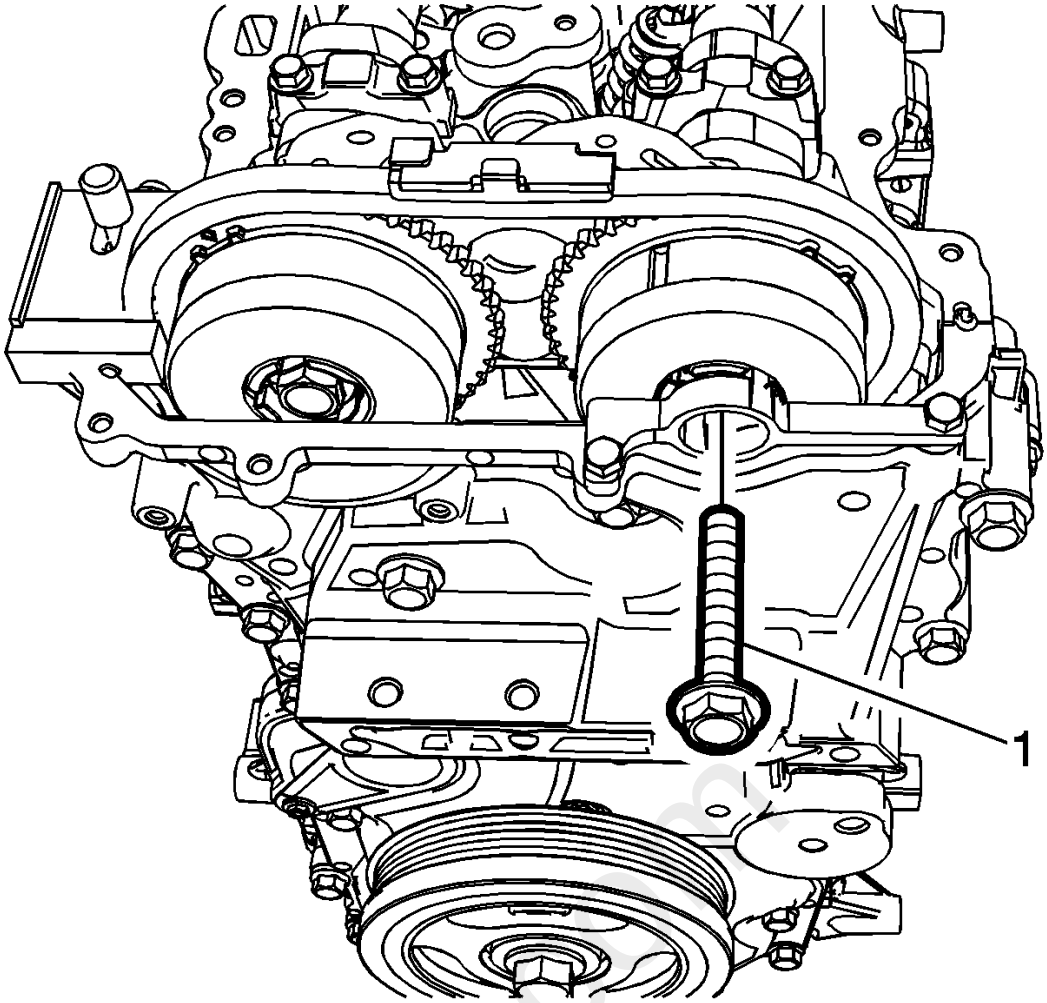


Fig. 160: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Install a NEW camshaft actuator bolt (1) and tighten to 30 N.m (22 lb ft) plus 100 degrees.

mcx30.com

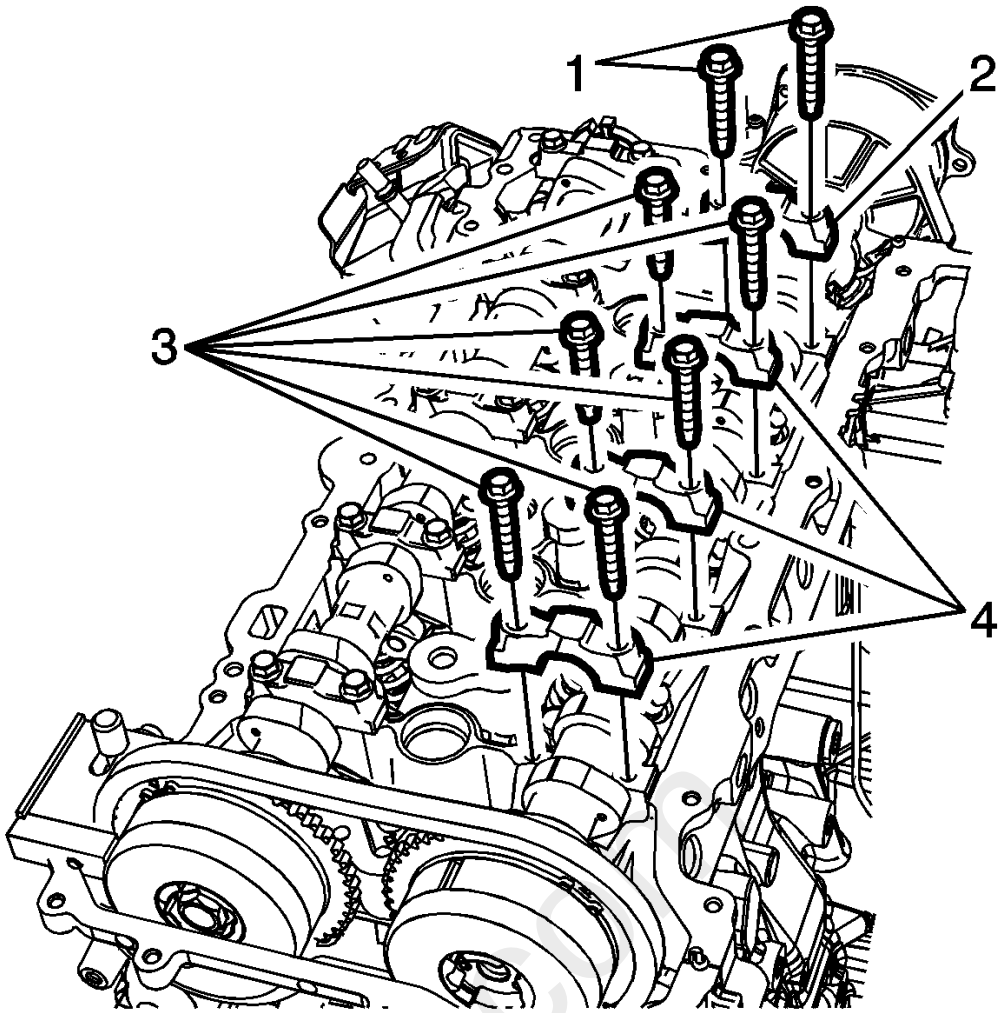


Fig. 161: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Apply lubricant to all lobes and journals prior to installing the camshafts.**

11. Set the exhaust camshaft on top of the roller followers in the camshaft bearing journals with the exhaust actuator timing mark at approximately the one O'clock position.

NOTE: **To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the camshafts.**

12. Install the camshaft cap bolts (1, 3) into the camshaft caps (2, 4).
13. Install the camshaft caps (2, 4) and hand start the camshaft cap bolts (1, 3).

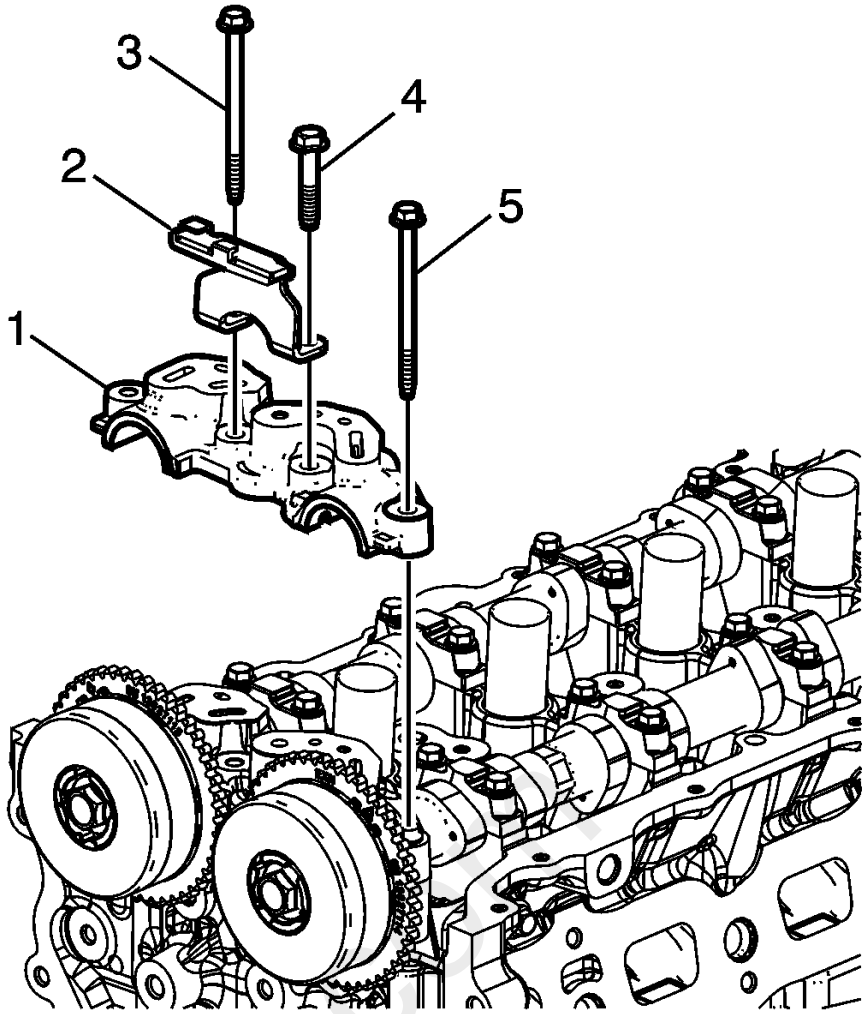


Fig. 162: Front Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

14. Install the front camshaft bearing cap (1). Install the timing chain guide (2) onto the front camshaft bearing cap, then hand start the camshaft cap bolts (3 - 5).

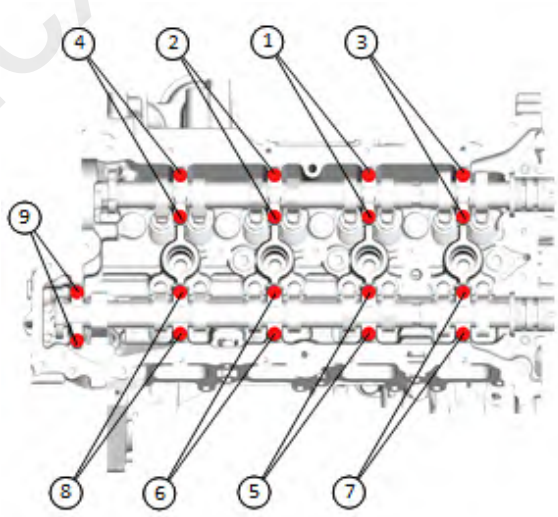


Fig. 163: Camshaft Cap Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

NOTE: **During the tightening sequence, locate and tighten each camshaft cap bolt installed into the circular hole first. Then, tighten the bolt installed into the slotted hole.**

15. tighten the camshaft cap bolts in sequence using the following procedure:
    1. tighten the camshaft cap bolts in sequence to 8 N.m (71 lb in).

2. Loosen both bolts in each cap in sequence to 180 degrees.
3. tighten the camshaft cap bolts in sequence to 10 N.m (89 lb in) twice.

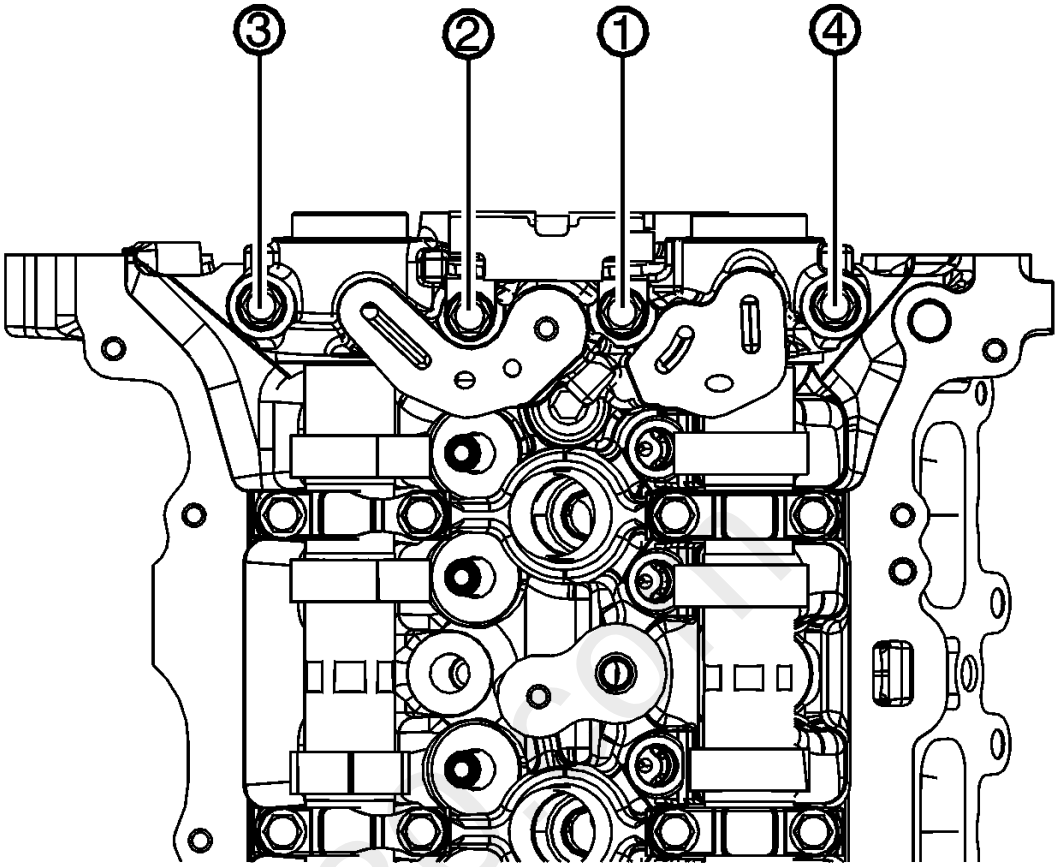


Fig. 164: Front Camshaft Cap Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

16. tighten the front camshaft cap bolts in sequence to 10 N.m (89 lb in) twice.

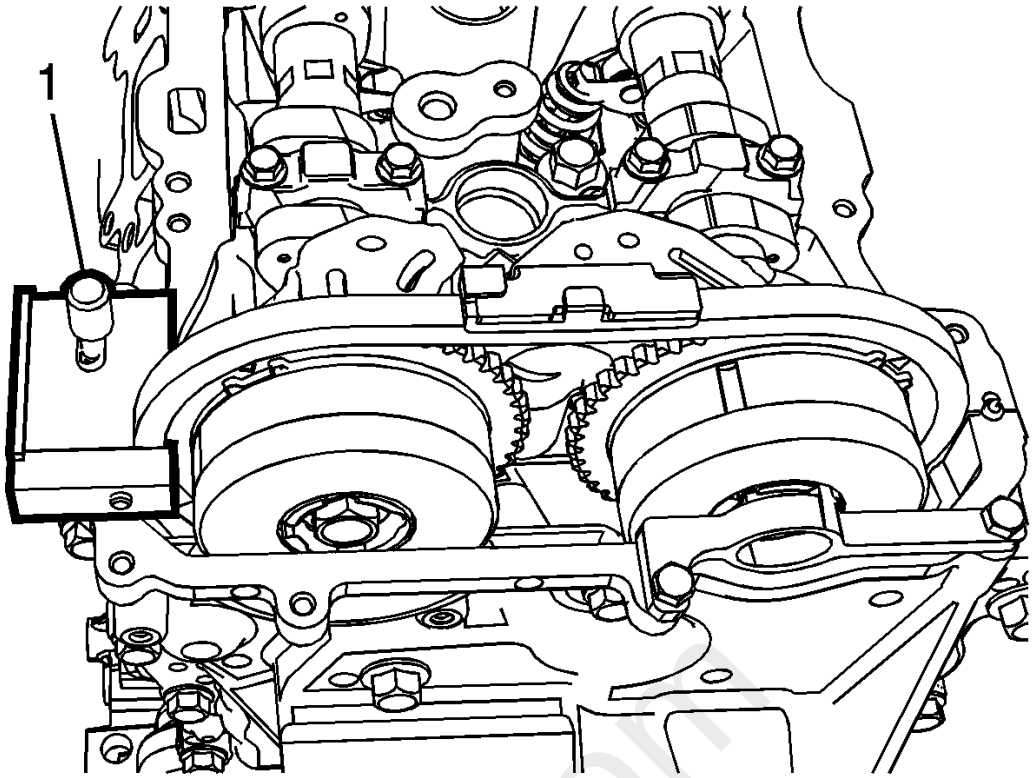


Fig. 165: Identifying Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

17. Remove **EN-50656** timing chain holding tool (1).
18. Install the high pressure fuel pump. Refer to **Fuel Pump Replacement** .
19. Install the camshaft cover. Refer to **Camshaft Cover Replacement (1st Design Tamper-Proof PCV System)**.

CAMSHAFT POSITION ACTUATOR AND CAMSHAFT REPLACEMENT - EXHAUST

Special Tools

- **EN-50656** Holding Tool
- **EN 50793** Locking Tool

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

Removal Procedure

NOTE: **Ensure the engine is properly timed to Top Dead Center (TDC), prior to performing repairs.**

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement (1st Design Tamper-Proof PCV System)**.

mc30.com

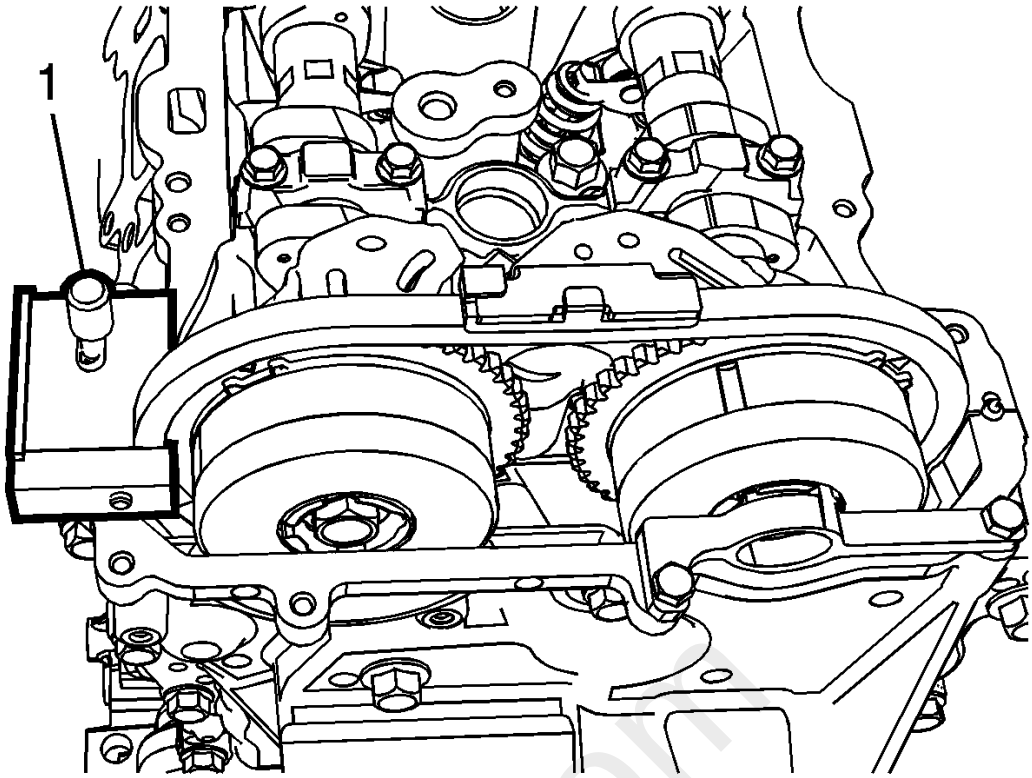


Fig. 166: Identifying Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the EN-50656 Holding tool is installed and securely tighten ed to prevent the camshaft chain from dropping into the front engine cover during camshaft actuator replacement.**

2. Install **EN-50656** timing chain holding tool (1) and tighten to 8 N.m (71 lb in).

mc30.com

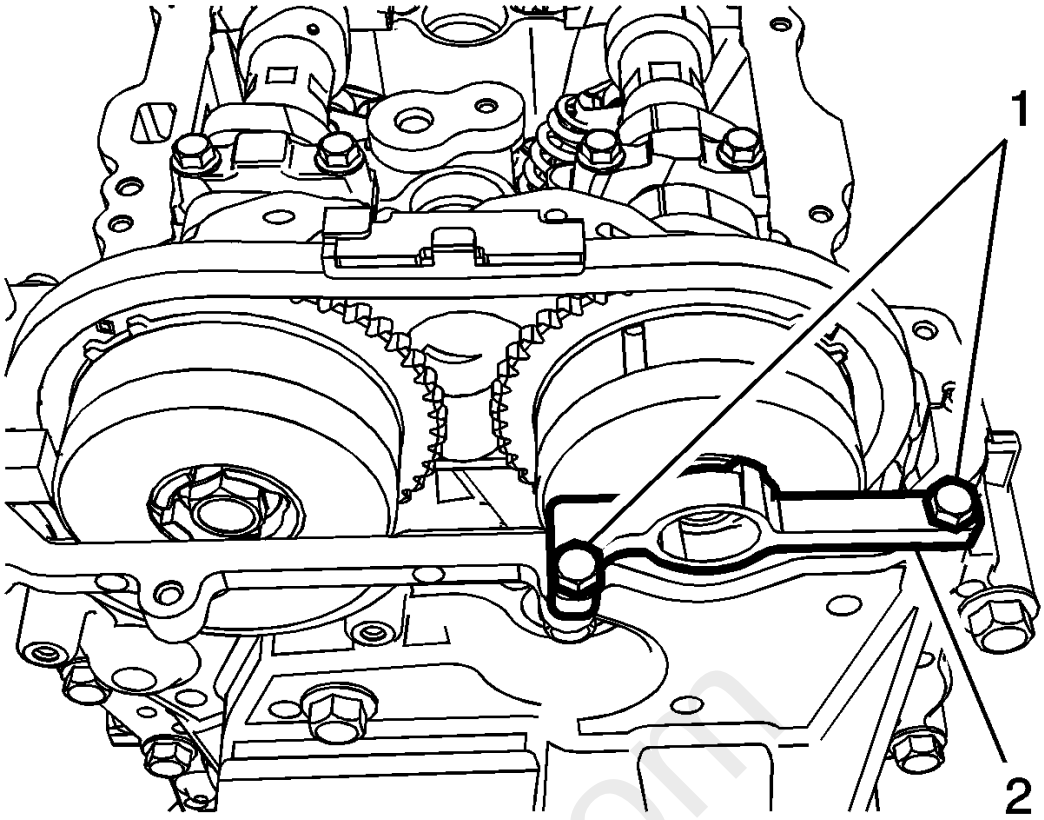


Fig. 167: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

NOTE: **Ensure to mark actuator sprocket and chain before removal.**

3. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the exhaust camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 N.m (89 lb in).

mcx30.com

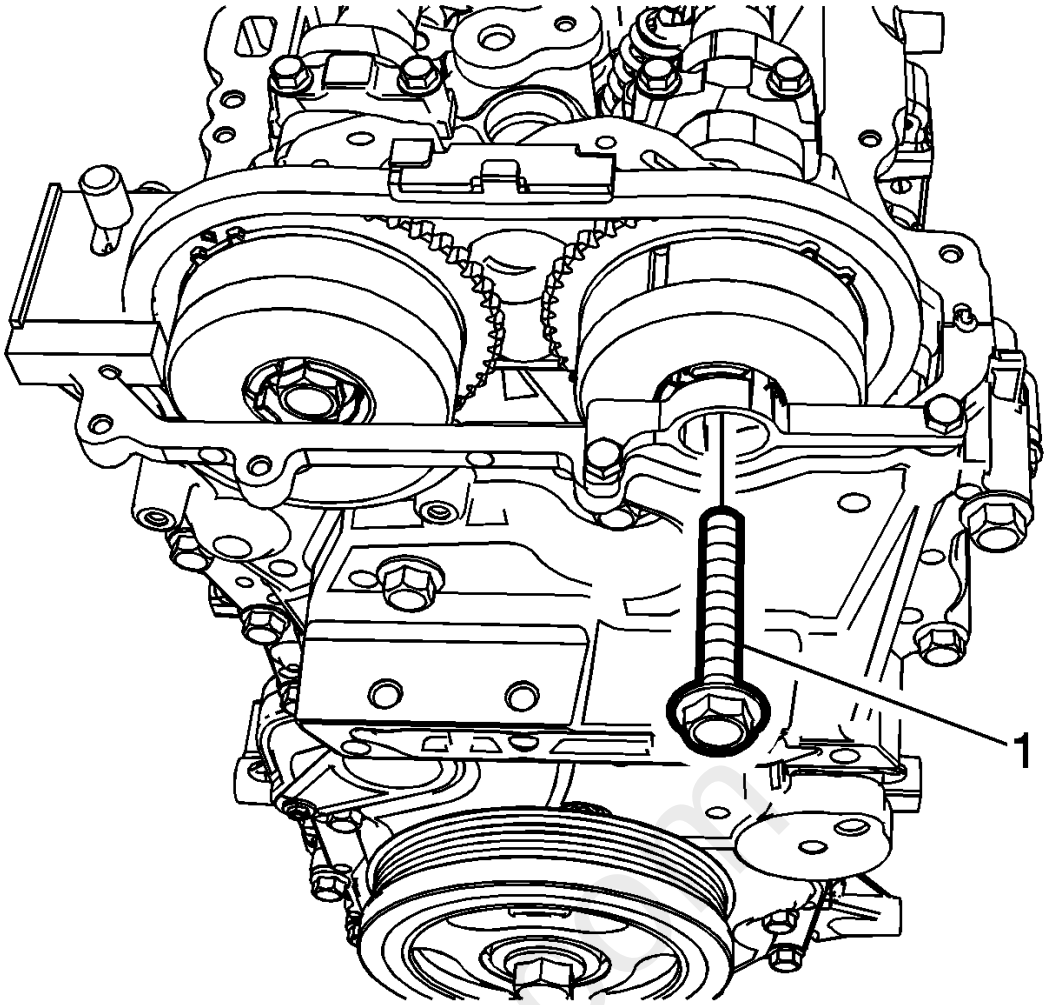


Fig. 168: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove and DISCARD the camshaft actuator bolt (1).

mcx30.com

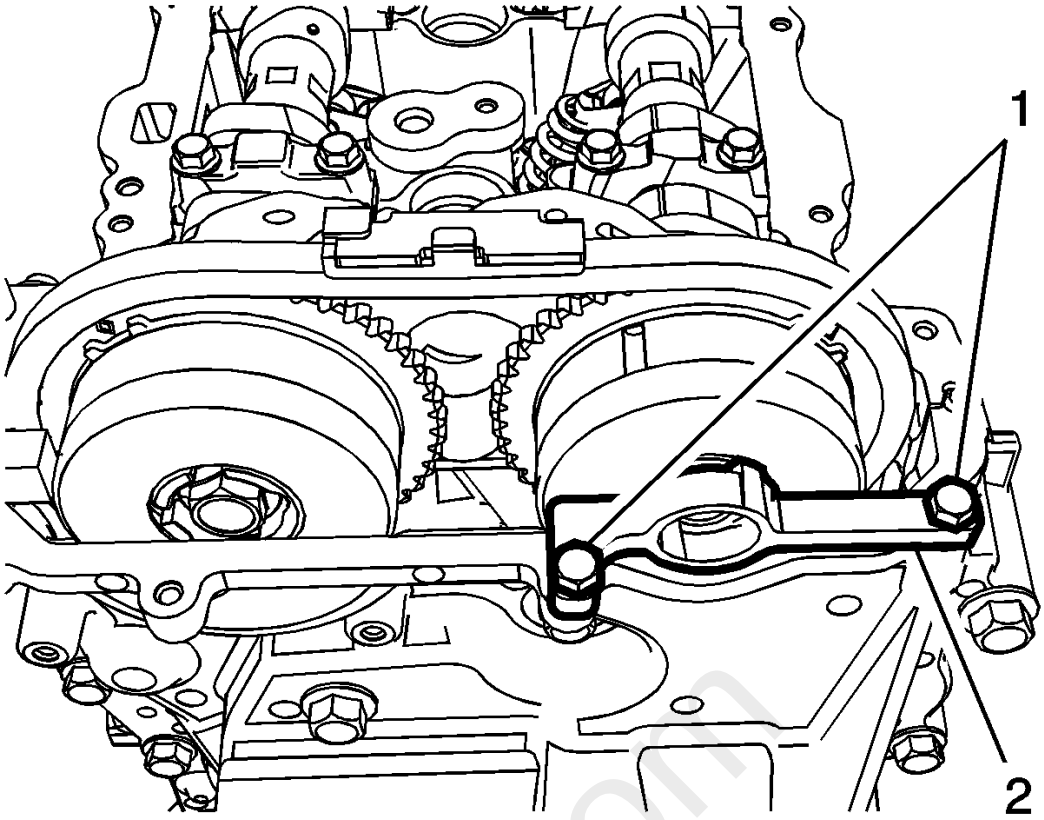


Fig. 169: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

5. Remove the **EN-50793** holding tool (2).

mcx30.com

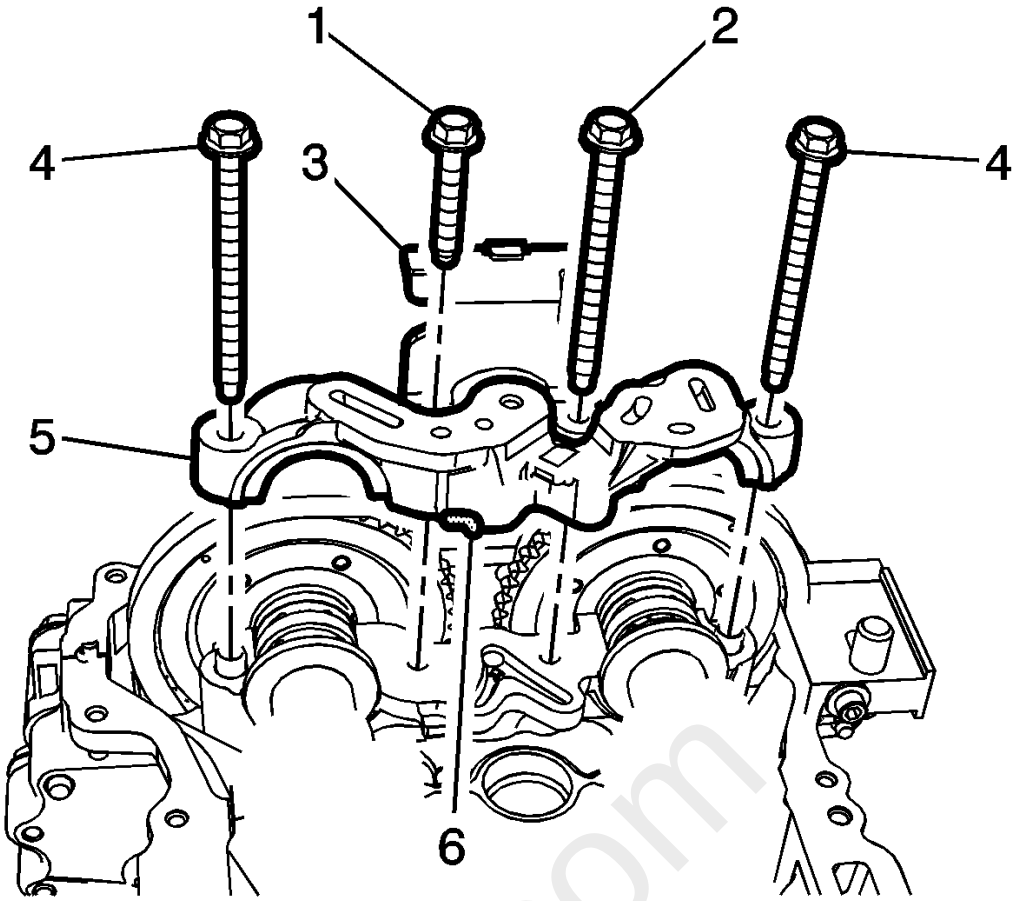


Fig. 170: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the upper timing chain guide bolts (1, 2).
7. Remove the upper timing chain guide (3).
8. Remove the camshaft front bearing cap bolts (4).

NOTE: **Locate the pry points (6) in the camshaft front bearing cap. When using the 3 pry points to remove the front bearing cap evenly, use a protective material between the camshaft lobes, the cylinder head flange, and pry tool.**

9. Remove the camshaft front bearing cap (5).

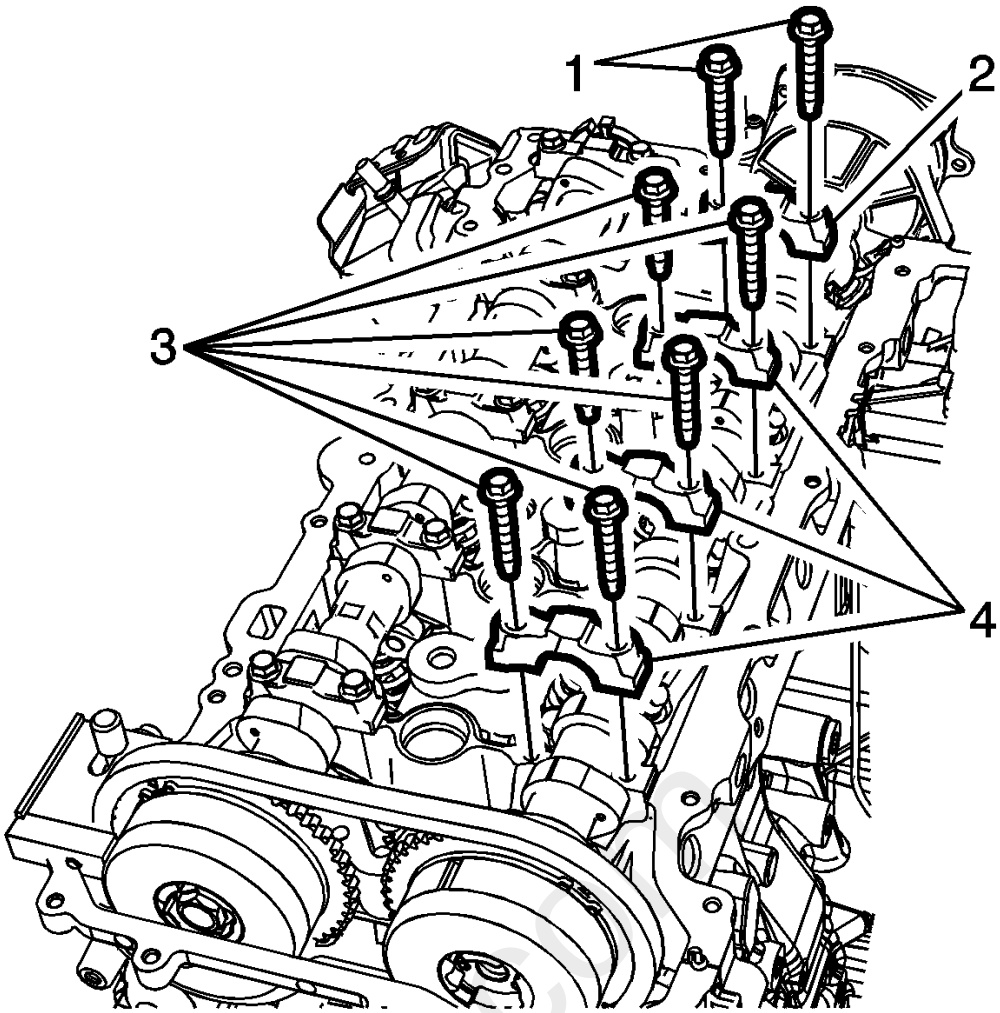


Fig. 171: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

10. Mark the exhaust camshaft rear cap to ensure it is installed in the same position. Remove the exhaust camshaft bearing rear cap bolts (1) and cap (2).

NOTE: **Loosen each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.**

11. Mark the camshaft caps (4) to ensure they are installed in the same position.
12. Remove the exhaust camshaft cap bolts (3).
13. Remove the camshaft caps (4).

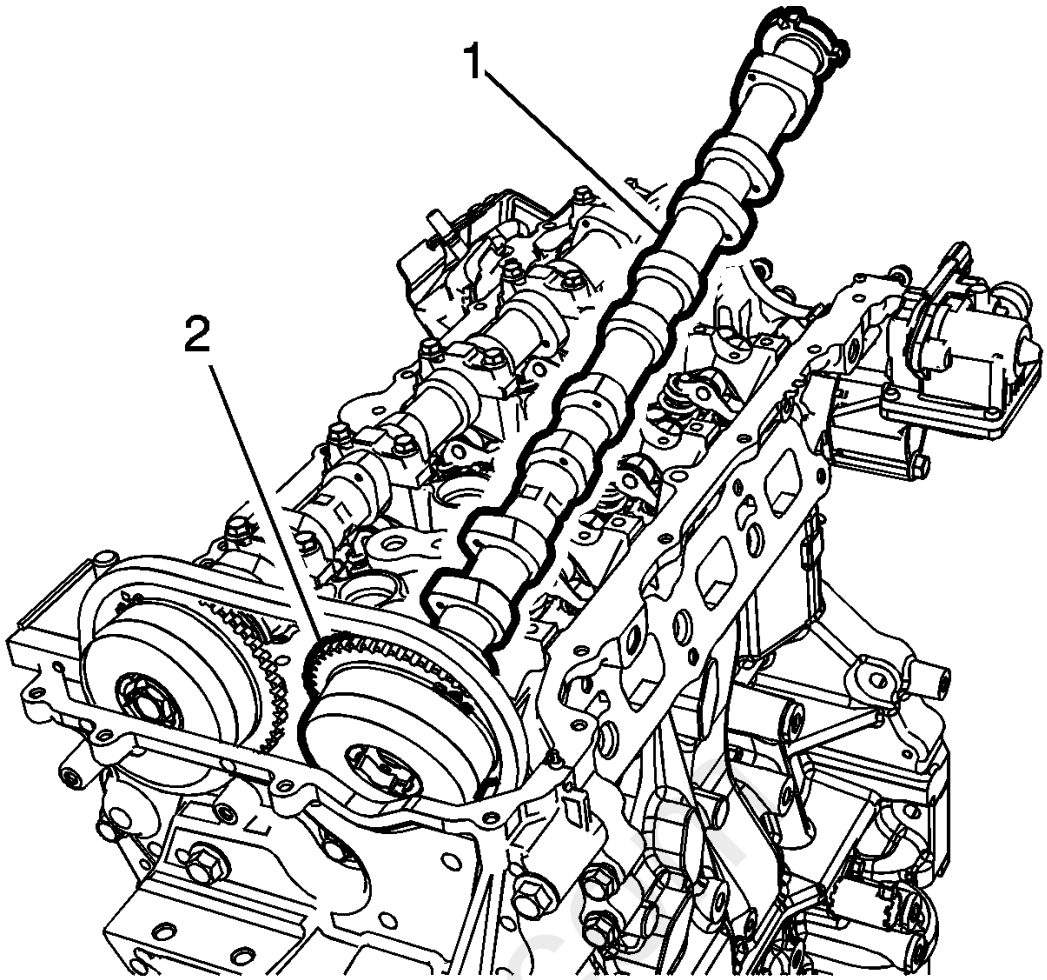


Fig. 172: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

14. Pull exhaust camshaft actuator assembly forward away from camshaft assembly (1), then lift rear of exhaust camshaft assembly to a tilt and pull free from exhaust camshaft actuator assembly (2).

NOTE: **If replacing the camshaft, ensure to transfer any marking from the old camshaft to the new one.**

15. Replace the camshaft if necessary.

Installation Procedure

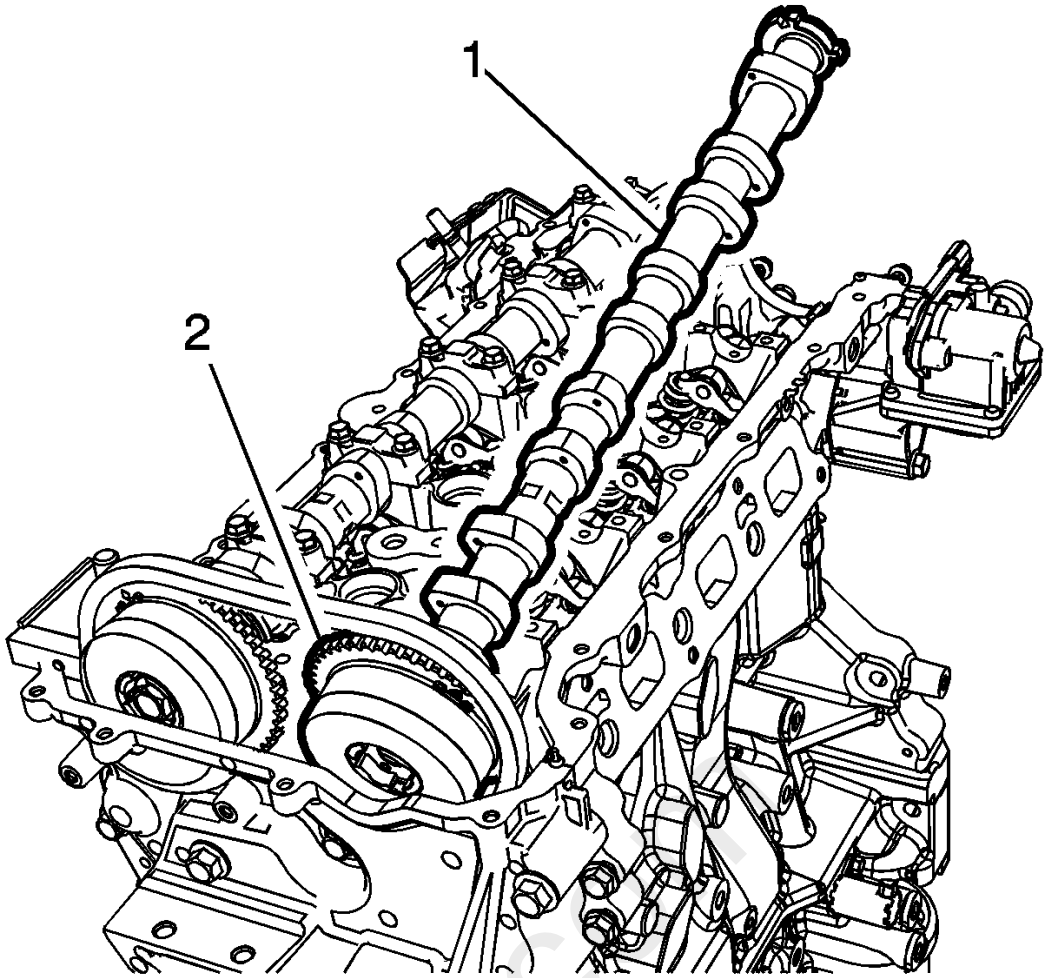


Fig. 173: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the exhaust camshaft (1) and camshaft actuator (2).

mcx30.com

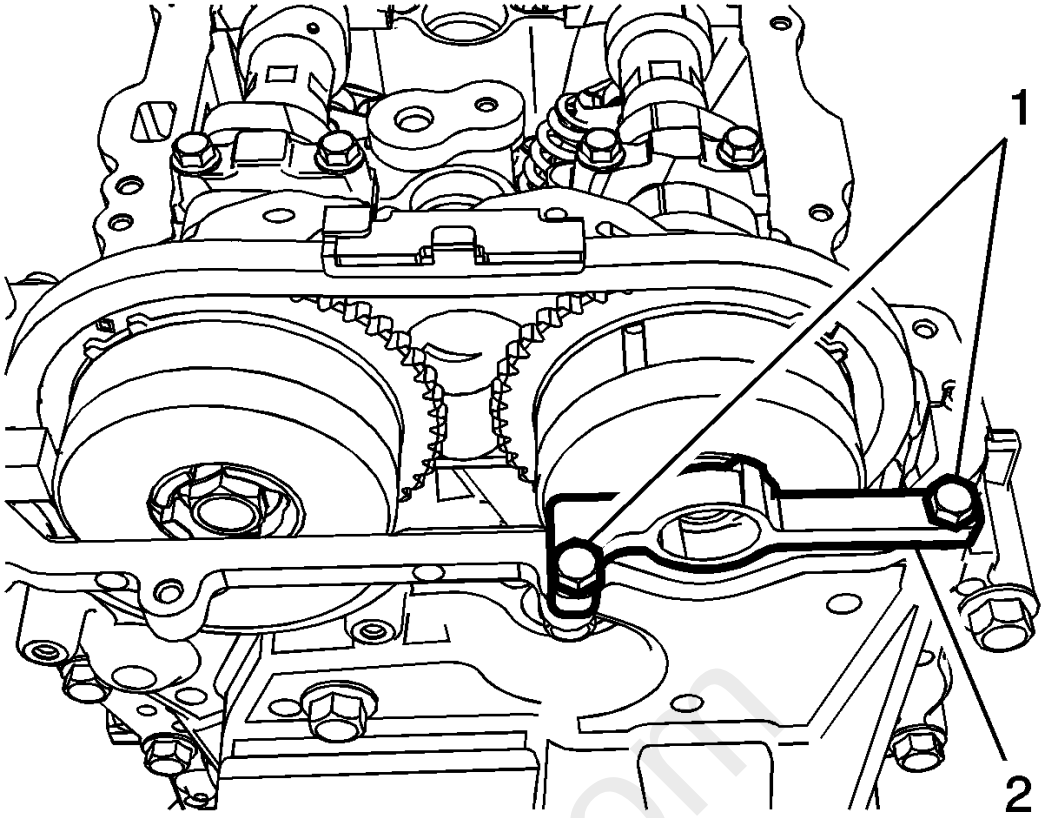


Fig. 174: Camshaft Actuator Locking Tool
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. Align and install camshaft actuator locking tool (2) **EN 50793** into the slots of the intake camshaft actuator and mount tool to engine front cover assembly and tighten the bolts (1) to 10 N.m (89 lb in).

mex30.com

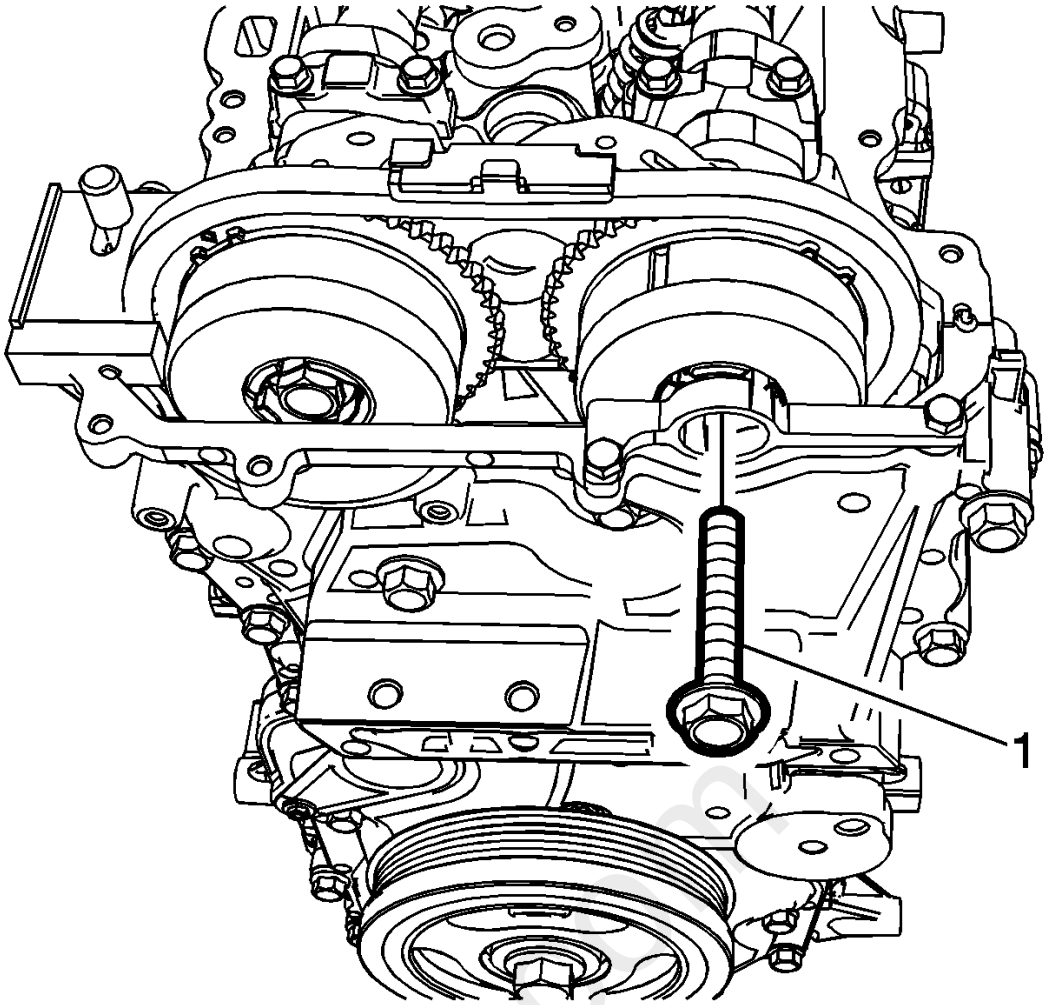


Fig. 175: Camshaft Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install a NEW camshaft actuator bolt (1) and tighten to 30 N.m (22 lb ft) plus 100 degrees.

mcx30.com

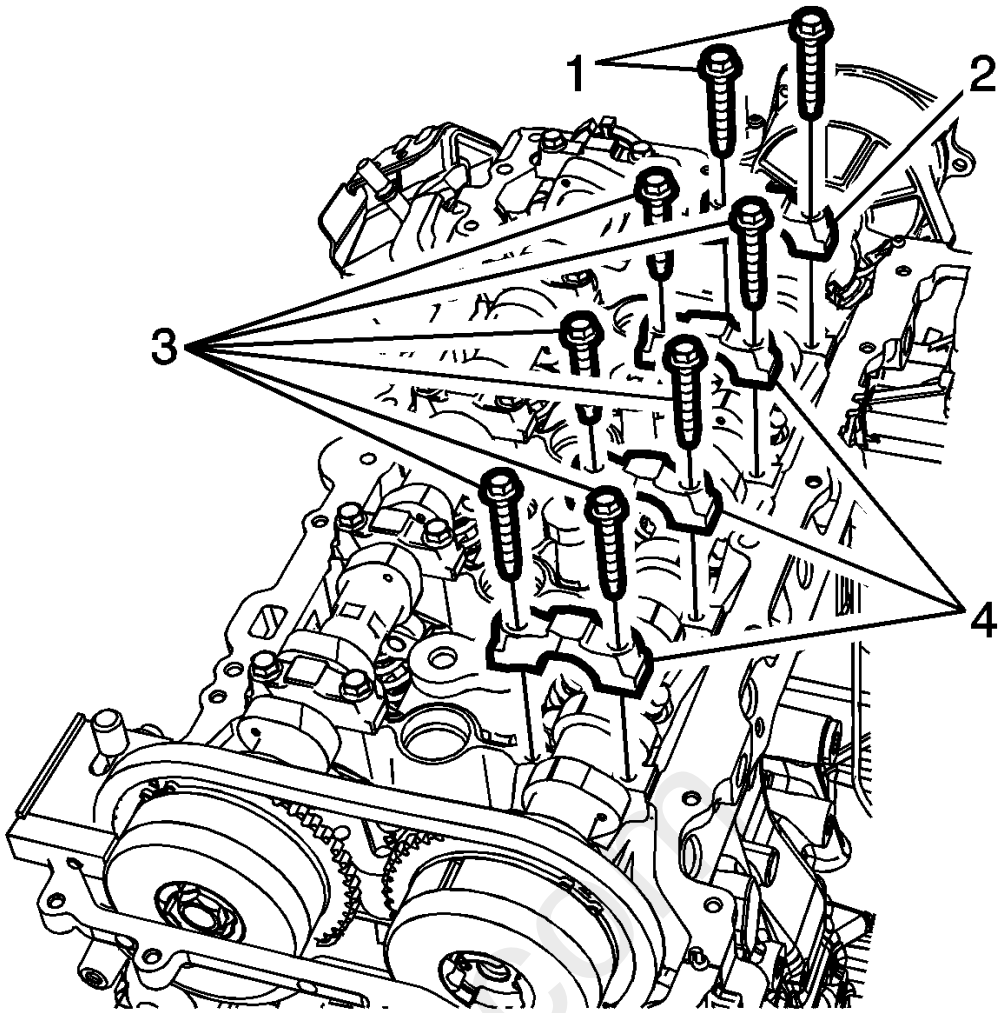


Fig. 176: Exhaust Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: Apply lubricant to all lobes and journals prior to installing the camshafts.

4. Set the exhaust camshaft on top of the roller followers in the camshaft bearing journals with the exhaust actuator timing mark at approximately the one O'clock position.

NOTE: To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the camshafts.

5. Install the camshaft cap bolts (1, 3) into the camshaft caps (2, 4).
6. Install the camshaft caps (2, 4) and hand start the camshaft cap bolts (1, 3).

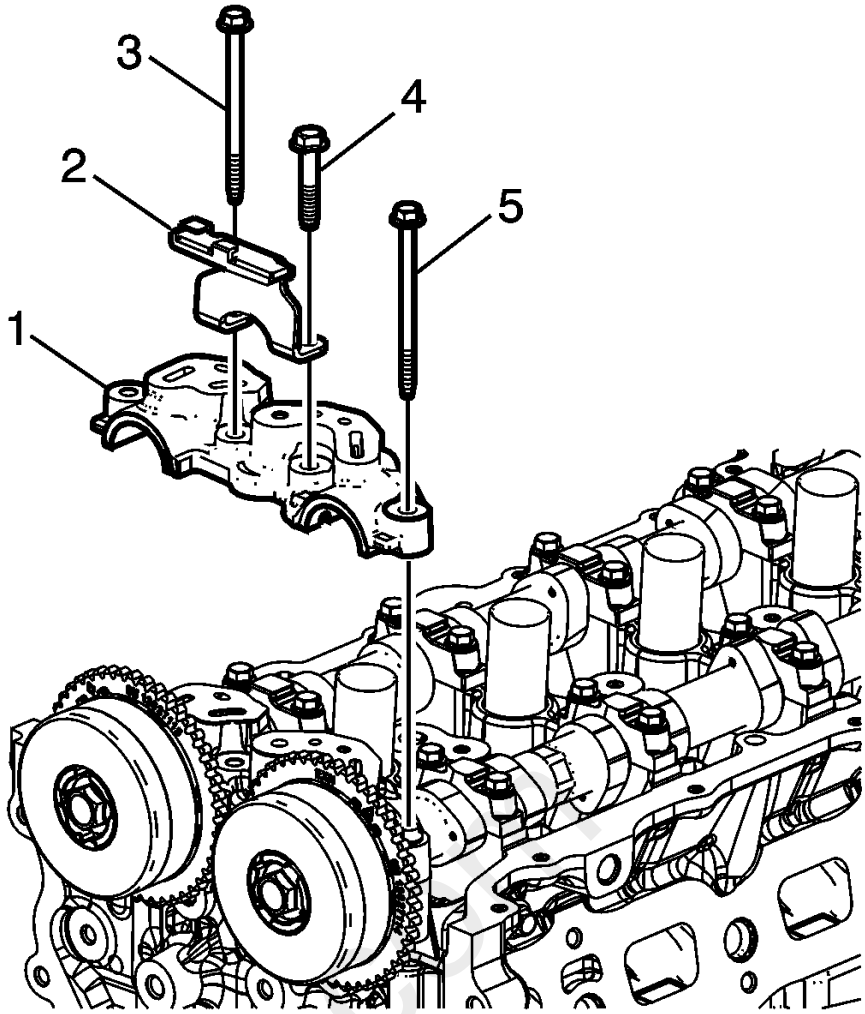


Fig. 177: Front Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

7. Install the front camshaft bearing cap (1). Install the timing chain guide (2) onto the front camshaft bearing cap, then hand start the camshaft cap bolts (3 - 5).

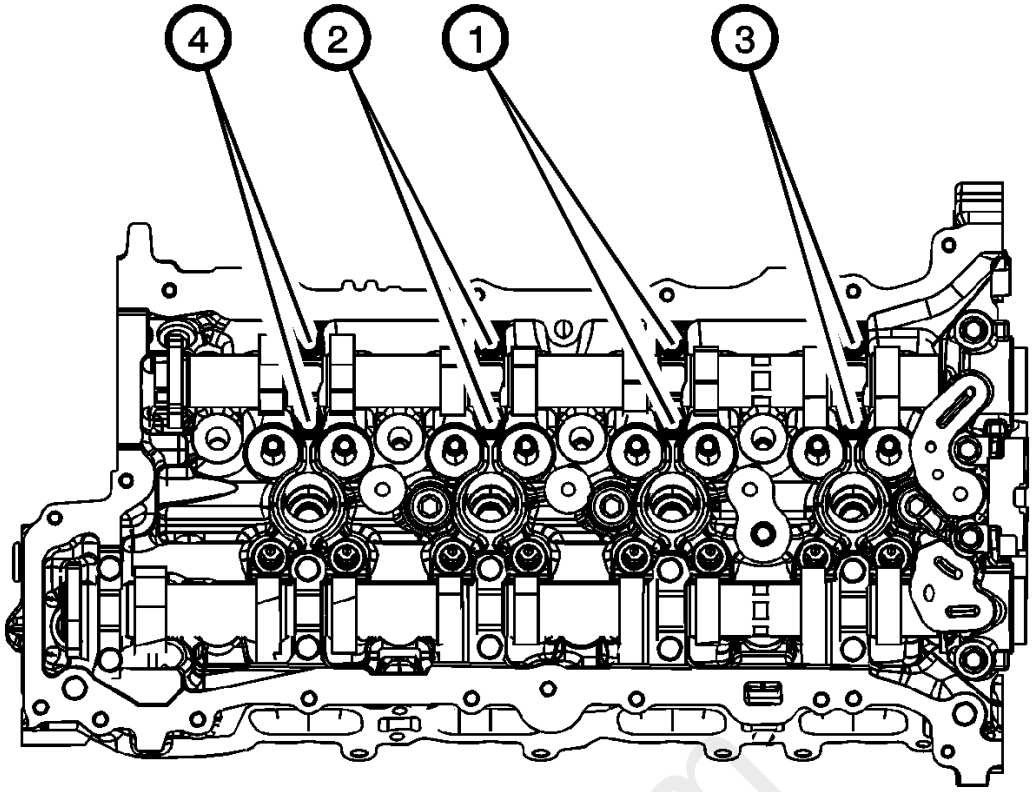


Fig. 178: Camshaft Cap Bolts tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

NOTE: **During the tightening sequence, locate and tighten each camshaft cap bolt installed into the circular hole first. Then, tighten the bolt installed into the slotted hole.**

8. Install the camshaft cap bolts in sequence using the following procedure:
    1. tighten the camshaft cap bolts in sequence to 8 N.m (71 lb in).
    2. Loosen both bolts in each cap in sequence to 180 degrees.
    3. tighten the camshaft cap bolts in sequence to 10 N.m (89 lb in) twice.

mc30.com

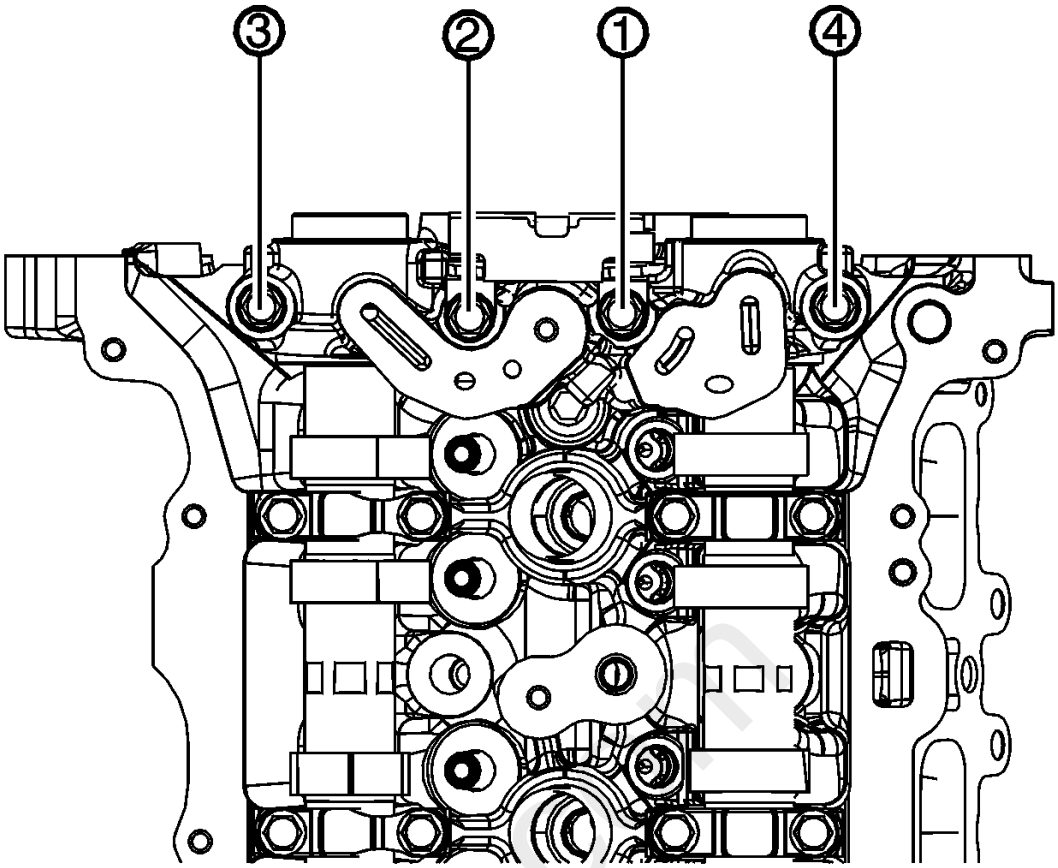


Fig. 179: Front Camshaft Cap Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

9. tighten the front camshaft cap bolts in sequence to 10 N.m (89 lb in) twice.

mcx30.com

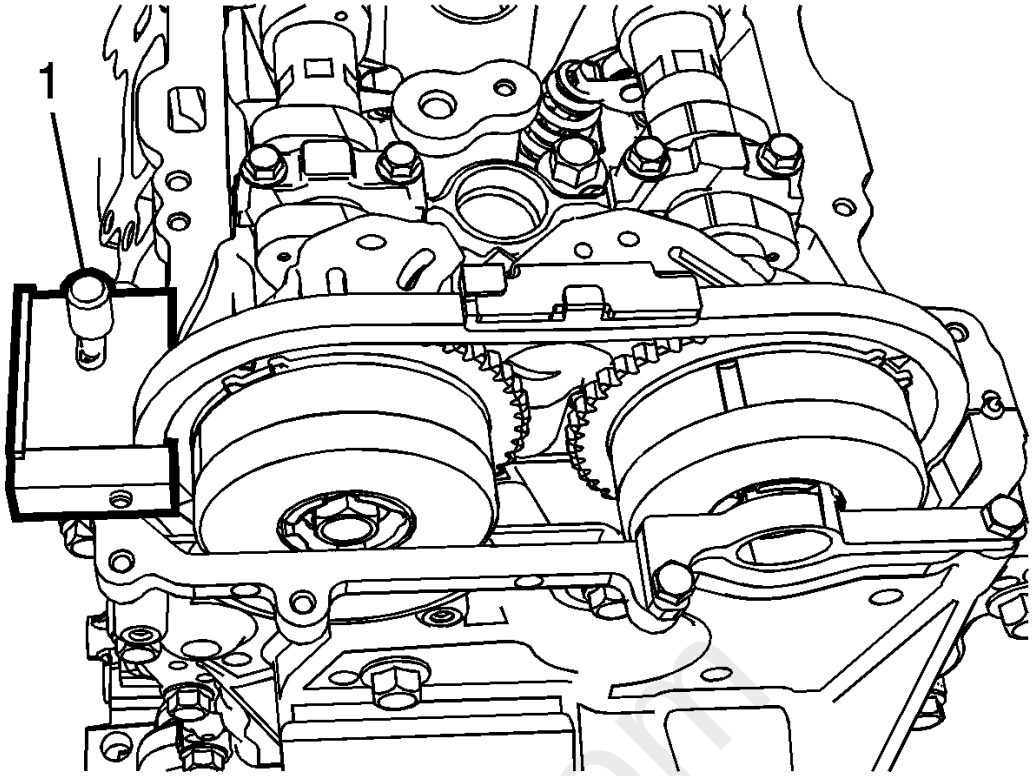


Fig. 180: Identifying Timing Chain Holding Tool
Courtesy of GENERAL MOTORS COMPANY

10. Remove **EN-50656** timing chain holding tool (1).
11. Install the camshaft cover. Refer to **Camshaft Cover Replacement (1st Design Tamper-Proof PCV System)**.

CAMSHAFT COVER HEAT SHIELD REPLACEMENT

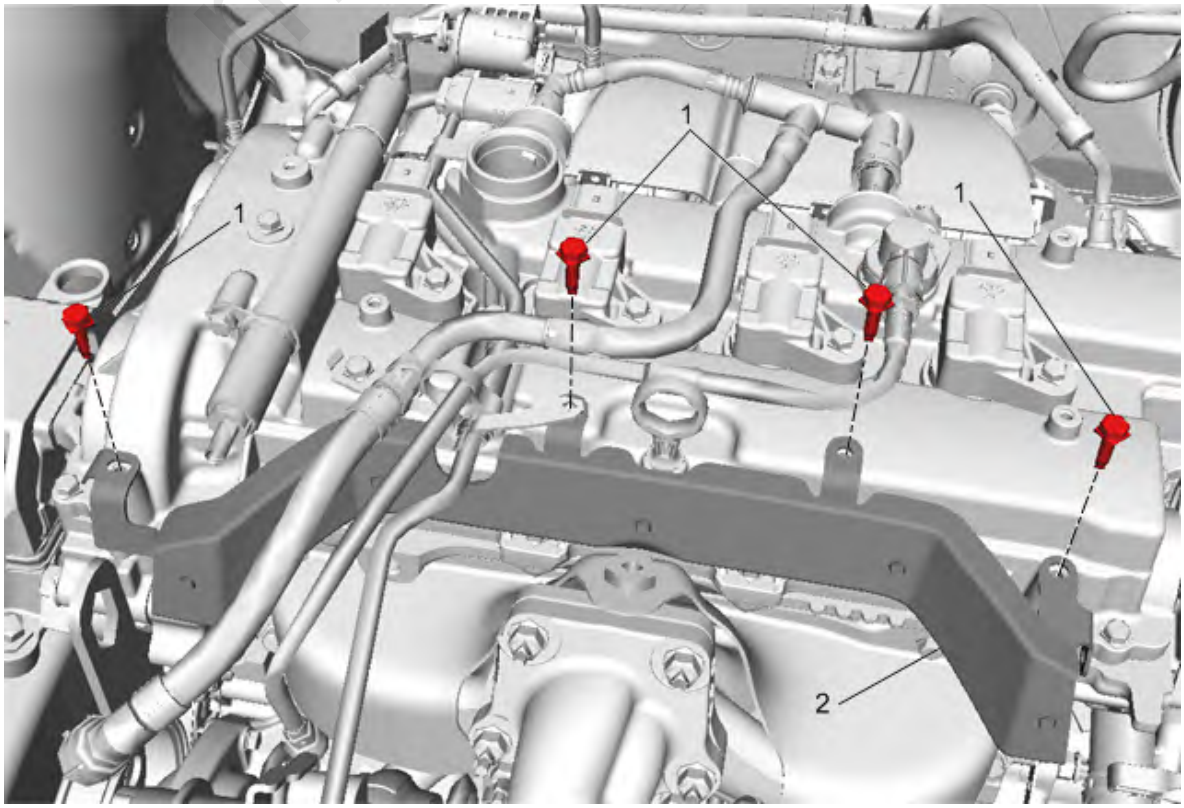


Fig. 181: Camshaft Cover Heat Shield
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Intake Manifold Cover Replacement 2. Turbocharger Heat Shield Replacement 3. Disconnect and reposition the engine wiring harness.	
1	Camshaft Cover Heat Shield Bolt [4x] **CAUTION:** **Refer to Fastener Caution .** **tighten** 10 N.m (89 lb in)
2	Camshaft Cover Heat Shield **Procedure** Disconnect the camshaft position actuator solenoid valve. **NOTE:** **When removing the camshaft cover heat shield, carefully guide the shield past the turbocharger coolant return and PCV pipes.**

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT

Special Tools

- **EN-37281-A** Valve Guide Seal Remover
- **EN-50717** Valve Spring Compressor
- **EN-50792** Flywheel Holding Tool

Equivalent regional tools:Special Tools

Removal Procedure

NOTE: **Prevent the crankshaft from rotating clockwise or counterclockwise before using compressed air in the cylinder. Rotation of the crankshaft may cause damage to EN-50792 Flywheel Holding Tool.**

1. If equipped with a manual transmission, leave the transmission in first gear with the vehicle on the ground and the parking brake set.
2. If equipped with an automatic transmission, remove the starter. Starter Replacement (LTG - All Wheel Drive) Starter Replacement (LTG - Front Wheel Drive)
3. Install **EN-50792** Flywheel Holding Tool.
4. Remove Valve Rocker Arm - Intake Valve Rocker Arm Replacement, Exhaust Valve Rocker Arm Replacement

mcx30.com

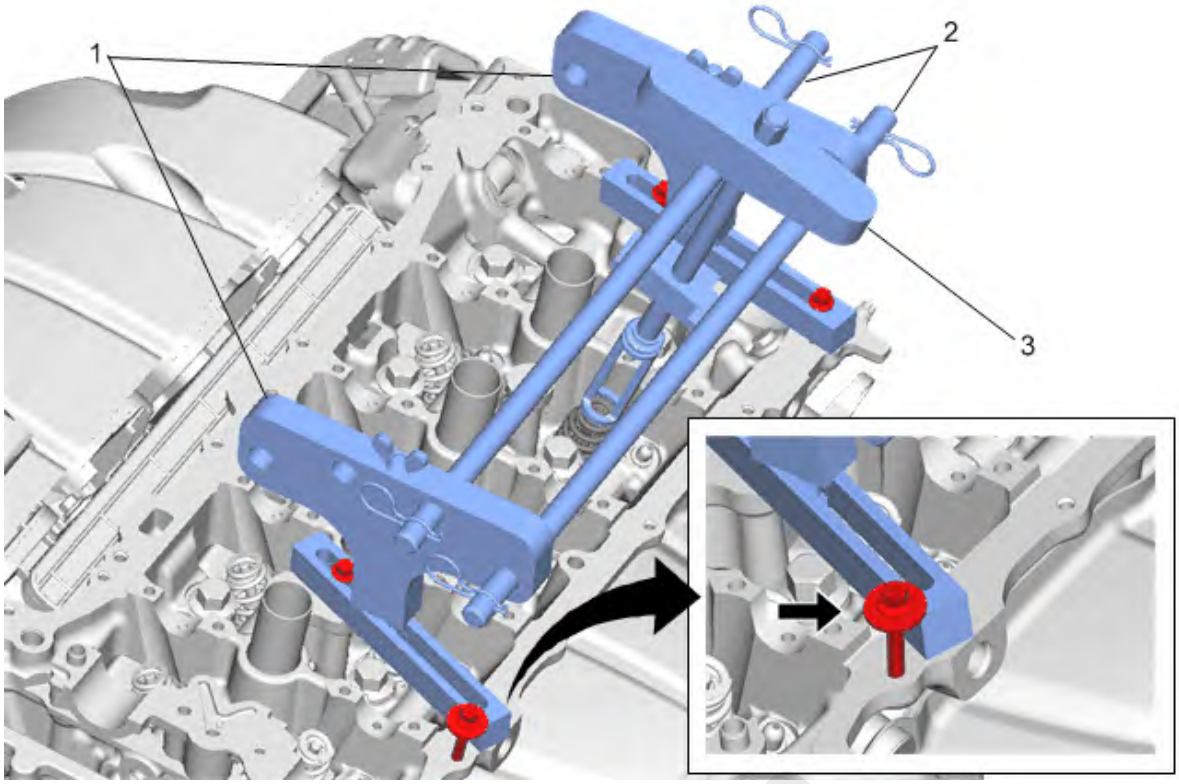


Fig. 182: Valve Spring Compressor
Courtesy of GENERAL MOTORS COMPANY

NOTE: **When mounting the valve spring compressor to the cylinder head, a suitable large washer should be used as indicated by the arrow.**

5. Install the **EN-50717** Valve Spring Compressor (1) to the front and rear of the cylinder head as shown.
6. Install the cross bars and locks (2) of the **EN-50717** Valve Spring Compressor to the valve spring compressor adaptors.
7. Remove the spark plugs. **Spark Plug Replacement**
8. Install an air hose adapter into the spark plug hole.
9. Attach an air hose to the adapter and pressurize the cylinder to 690 kPa (100 psi).
10. Compress the valve spring using the valve spring compressor (3).

mcx30.com

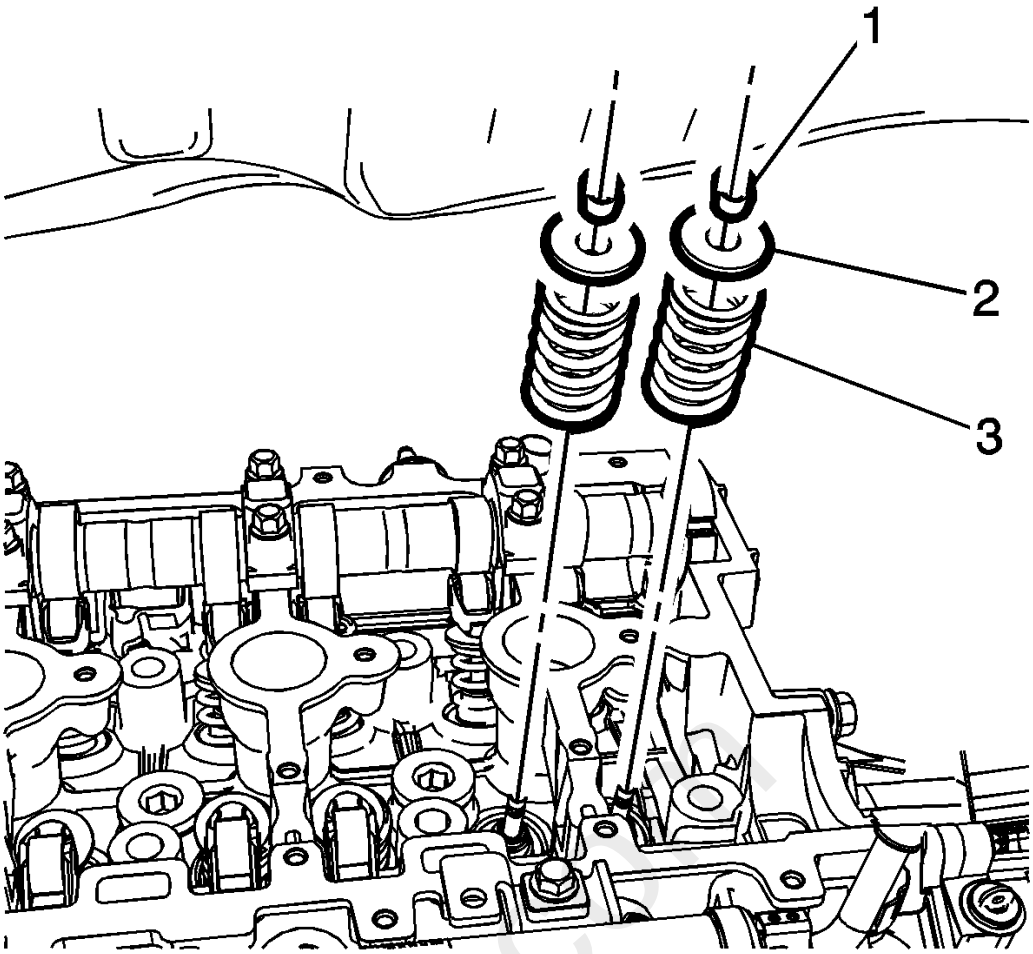


Fig. 183: Valve Spring, Keepers And Retainer
Courtesy of GENERAL MOTORS COMPANY

11. Remove the valve spring keepers (1).
12. Remove the valve spring (3) and retainer (2).
13. Use the **EN-37281-A** Valve Guide Seal Remover to remove the valve seal.

Installation Procedure

1. Using the **EN-37281-A** Valve Guide Seal Remover, install the NEW valve seal. Fully seat the seal onto the valve guide.

mcy30.com

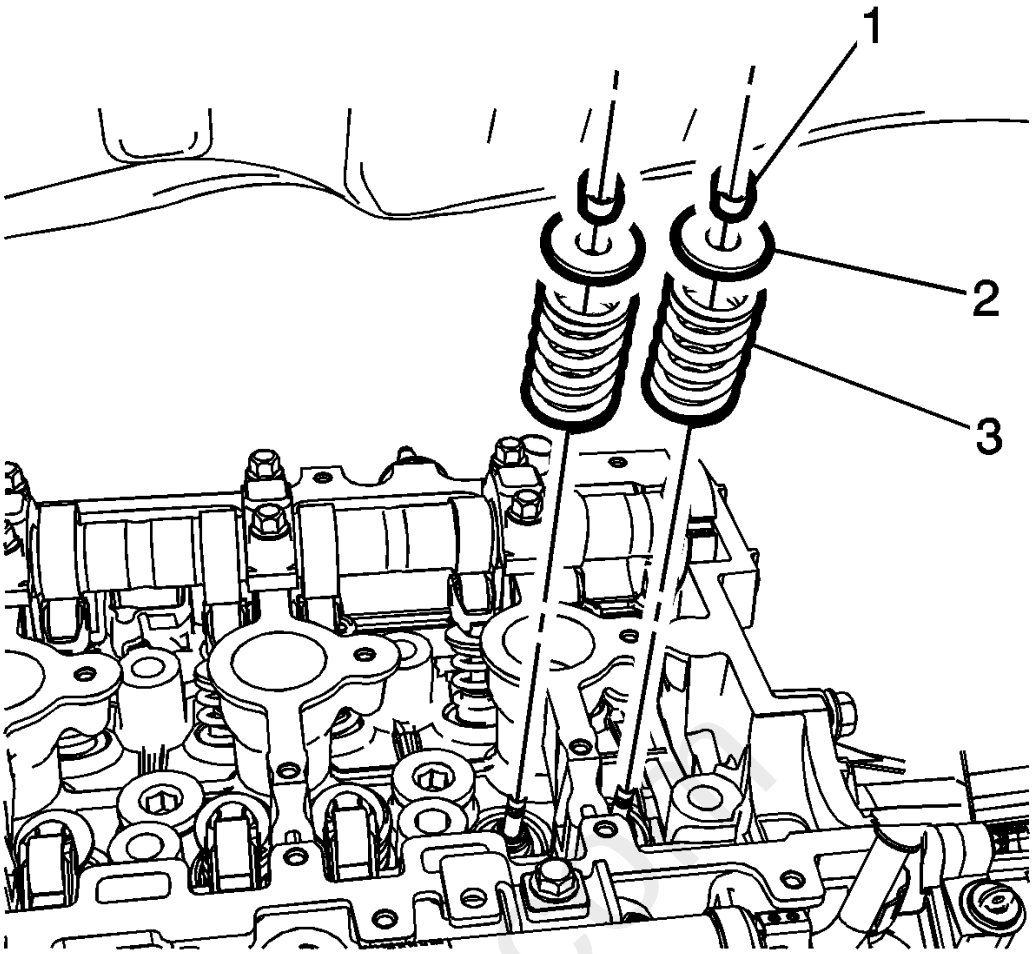


Fig. 184: Valve Spring, Keepers And Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Install the valve spring (3) and retainer (2).
3. Compress the valve spring using the valve spring compressor.
4. Install the valve spring keepers (1).
5. Disconnect the air hose and air hose adapter.

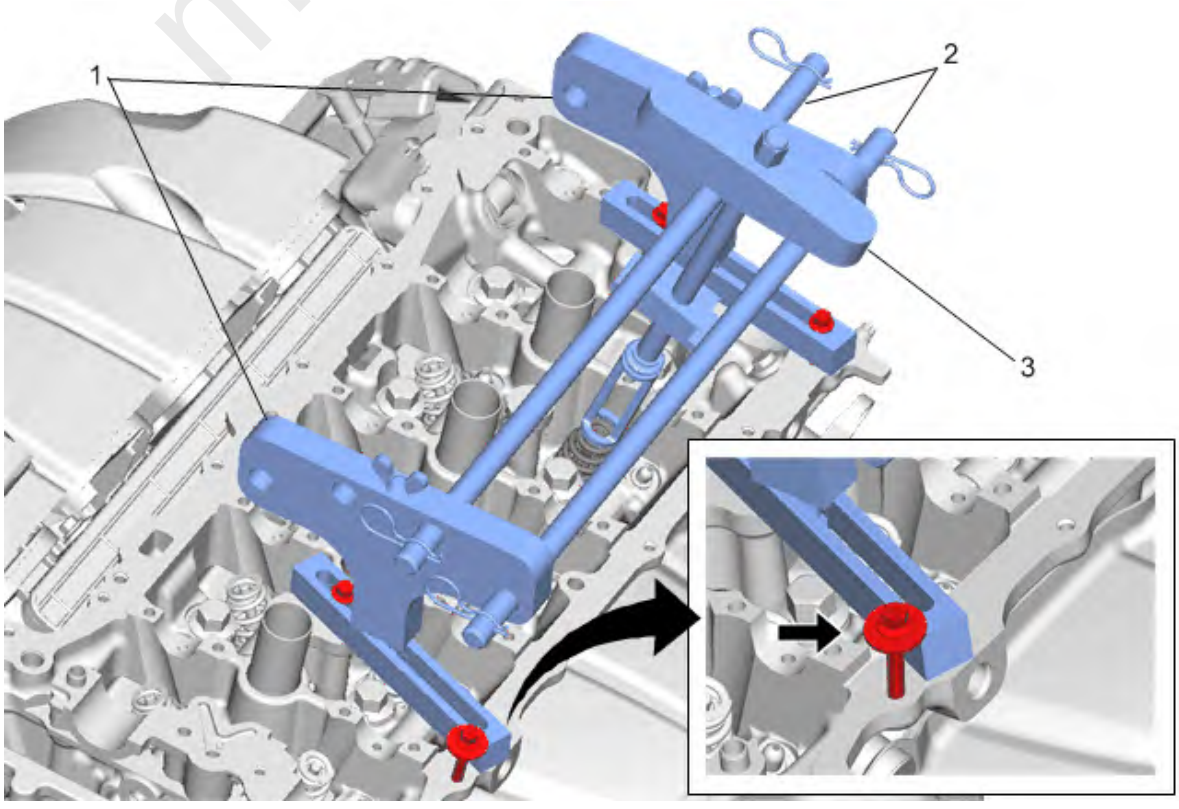


Fig. 185: Valve Spring Compressor
Courtesy of GENERAL MOTORS COMPANY

6. Remove the **EN-50717** Valve Spring Compressor and **EN-50717** Valve Spring Compressor adapter set from the cylinder head.
7. Install the spark plugs. **Spark Plug Replacement**
8. Install Valve Rocker Arm - **Intake Valve Rocker Arm Replacement**, **Exhaust Valve Rocker Arm Replacement**
9. Remove the **EN-50792** Flywheel Holding Tool.
10. If equipped with an automatic transmission, install the starter. **Starter Replacement (LTG - All Wheel Drive)** **Starter Replacement (LTG - Front Wheel Drive)**

CYLINDER HEAD REPLACEMENT

Special Tools

- **EN-38188** Cylinder Head Broken Bolt Extractor Kit - or equivalent aftermarket tool
- **EN-45059** Angle Meter
- **J-36857** Engine Lift Bracket

Removal Procedure

Equivalent regional tools:**Special Tools**

1. Drain the coolant system. **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)**
2. Drain the engine oil. **Engine Oil and Oil Filter Replacement**
3. Remove the camshaft cover. **Camshaft Cover Replacement (1st Design Tamper-Proof PCV System)**

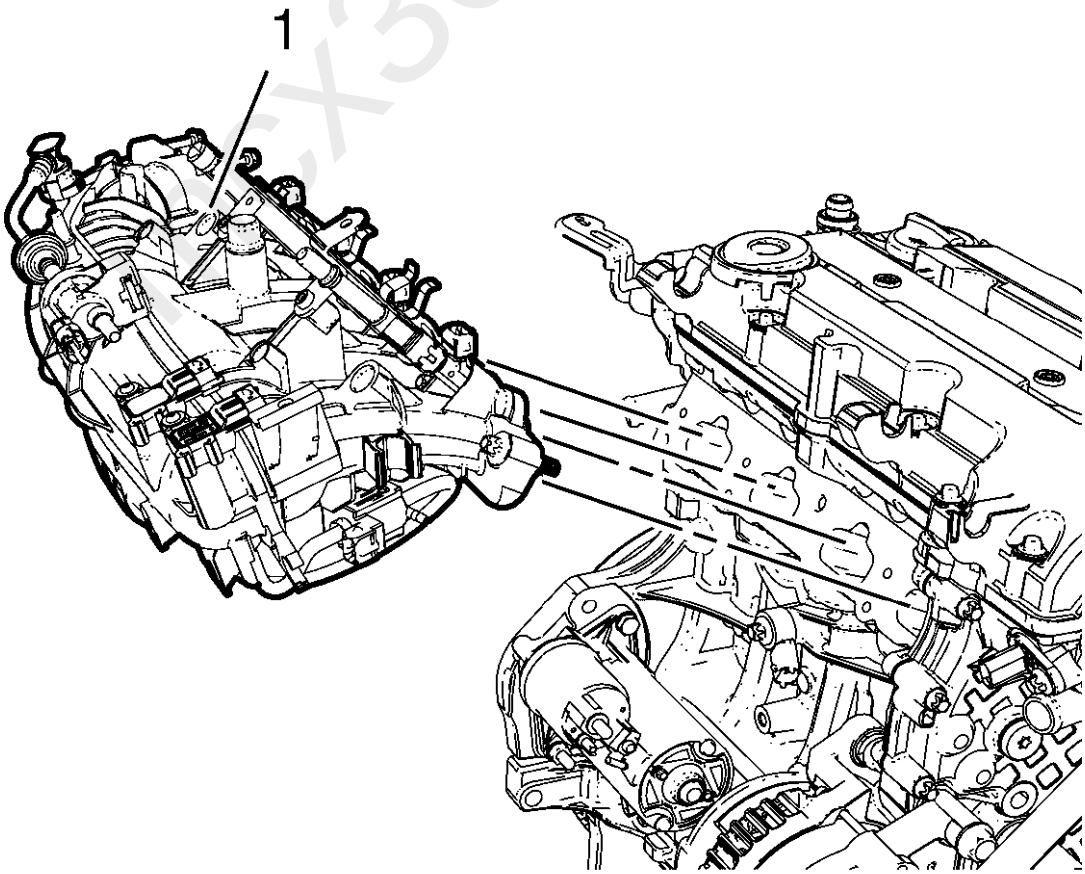


Fig. 186: Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

4. Remove the intake manifold (1). **Intake Manifold Replacement**
5. Remove the exhaust manifold. **Exhaust Manifold Replacement (LTG)**
6. Remove the engine front cover. **Engine Front Cover Replacement**

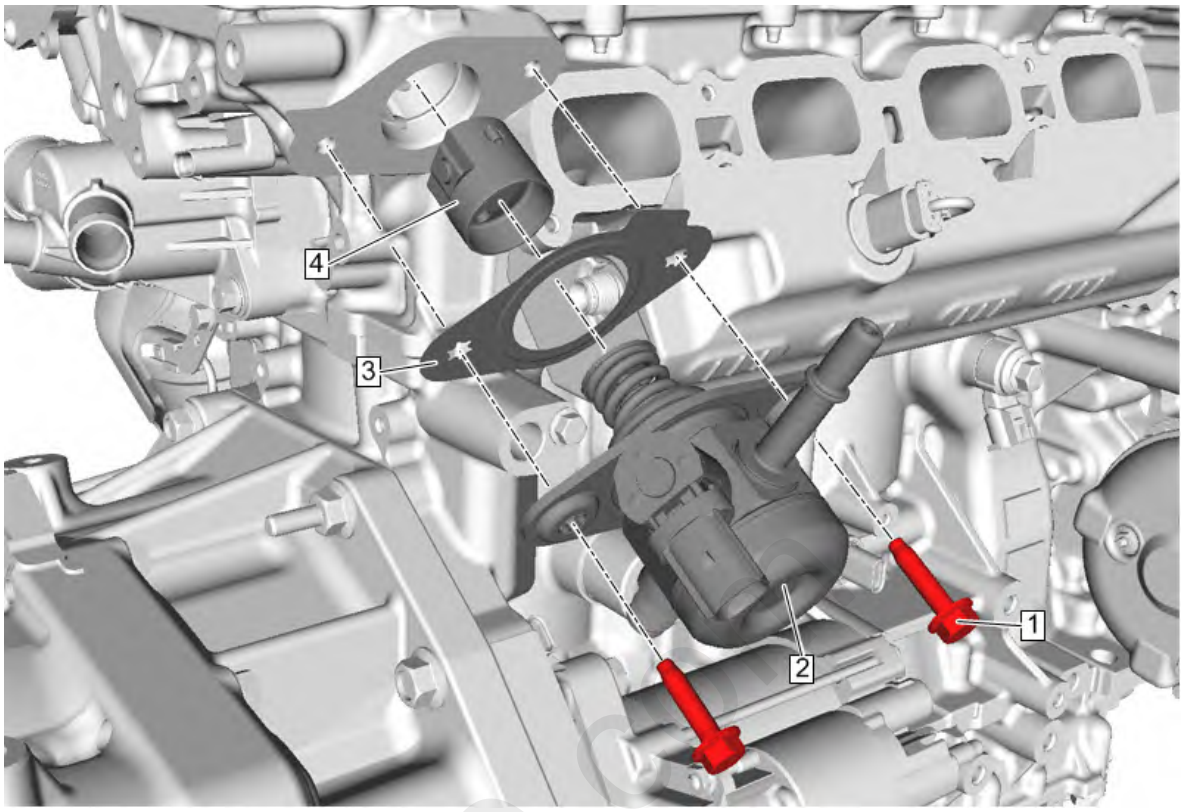


Fig. 187: Fuel Pump
Courtesy of GENERAL MOTORS COMPANY

7. Remove the fuel pump (2). **Fuel Pump Replacement**
8. Remove the timing chain and tensioner. **Camshaft Timing Chain and Tensioner Replacement**
9. Remove the intake and exhaust camshaft, bearing cap and lash adjuster. **Intake and Exhaust Camshaft, Bearing Cap, and Lash Adjuster Removal**
10. Disconnect the intake camshaft position sensor. **Camshaft Position Sensor Replacement - Intake**
11. Disconnect the exhaust camshaft position sensor. **Camshaft Position Sensor Replacement - Exhaust**

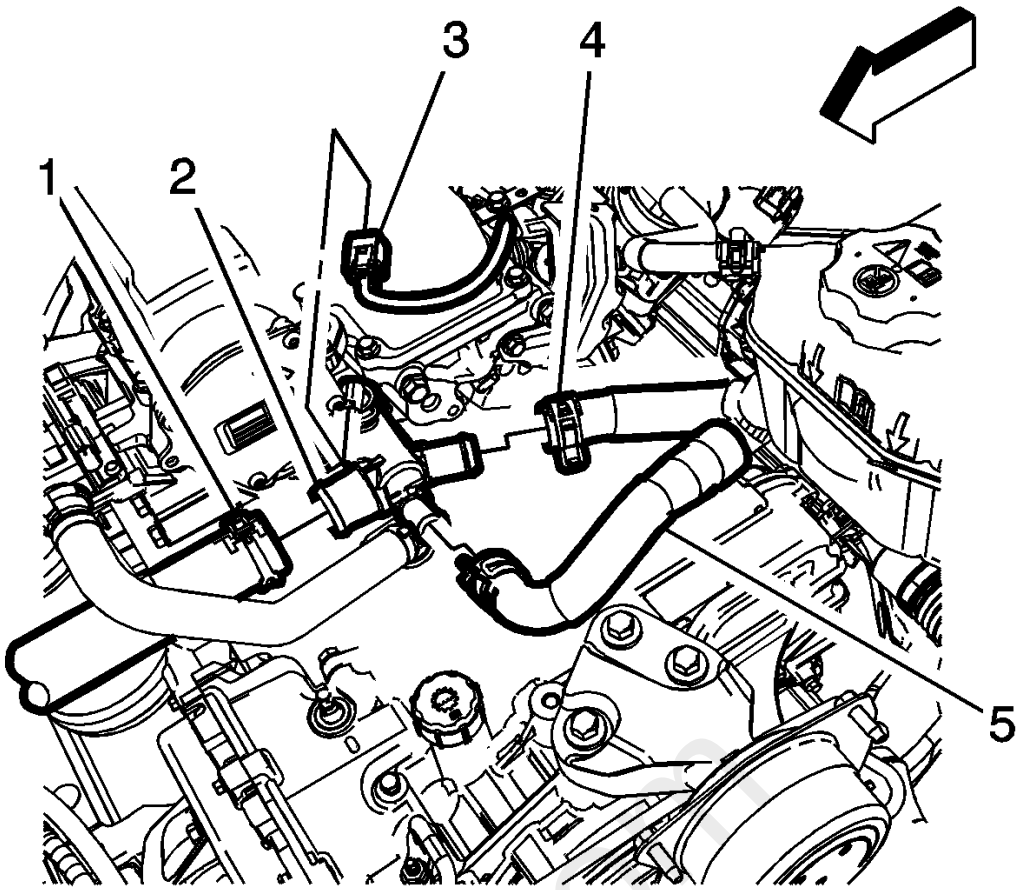


Fig. 188: Engine Coolant Temperature (ECT) Sensor Connector
Courtesy of GENERAL MOTORS COMPANY

12. Disconnect the hoses from the water outlet (2). **Water Outlet Replacement (LTG)**
13. Remove Thermostat Bypass Pipe - **Thermostat Bypass Pipe Replacement (LTG)**

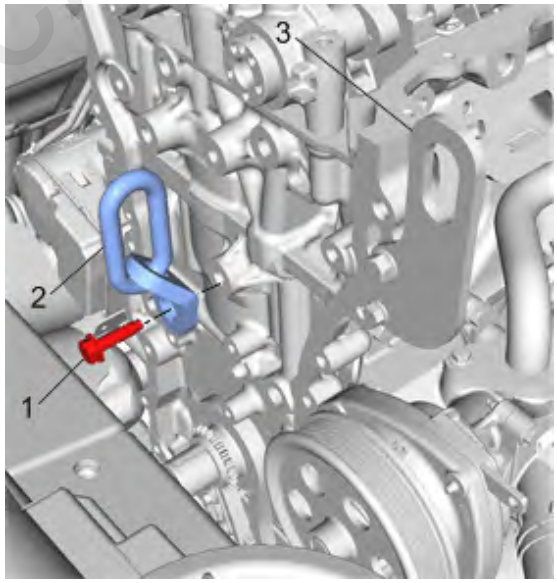


Fig. 189: Engine Lift Brackets And Fastener
Courtesy of GENERAL MOTORS COMPANY

14. Install the **J-36857** Engine Lift Bracket (2) and fastener (1) into the engine block.

NOTE: **Support the engine as necessary from underneath while repositioning the engine support fixture.**

15. Reposition the engine support fixture lift hook from the engine lift bracket (3) to the **J-36857** Engine Lift Bracket (2)

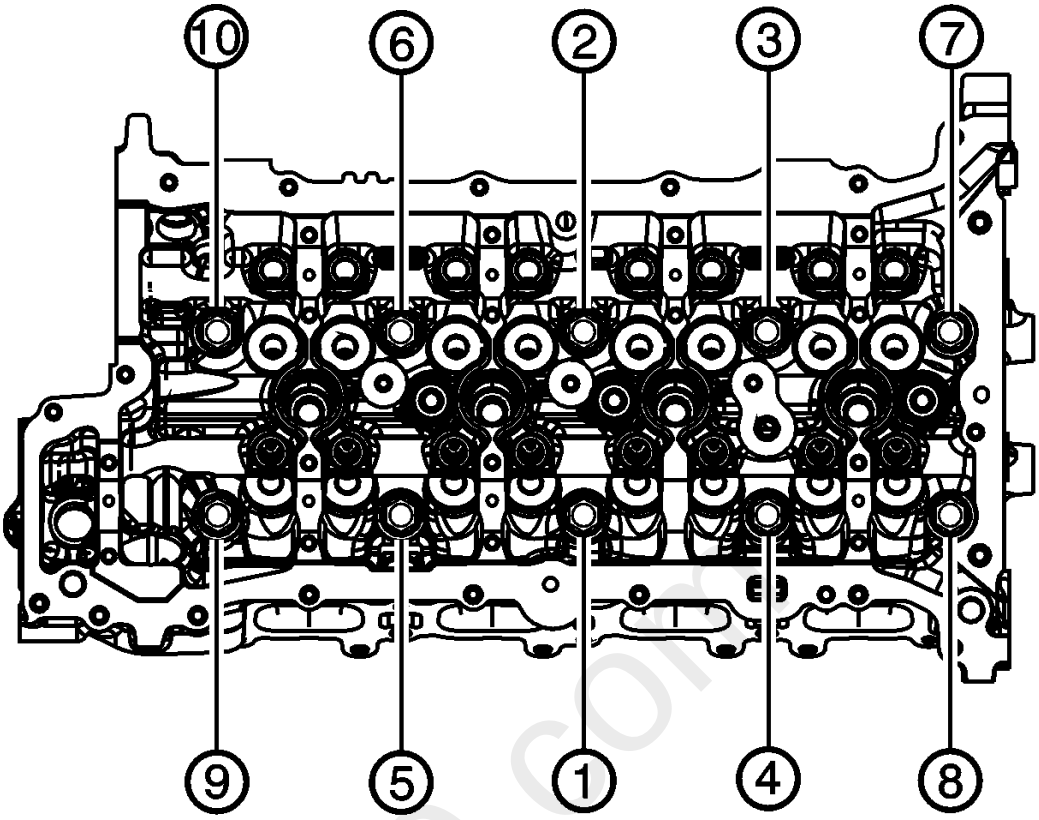


Fig. 190: Cylinder Head Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

16. Remove the cylinder head to the block bolts in sequence.

    Discard the bolts.

mcx30.com

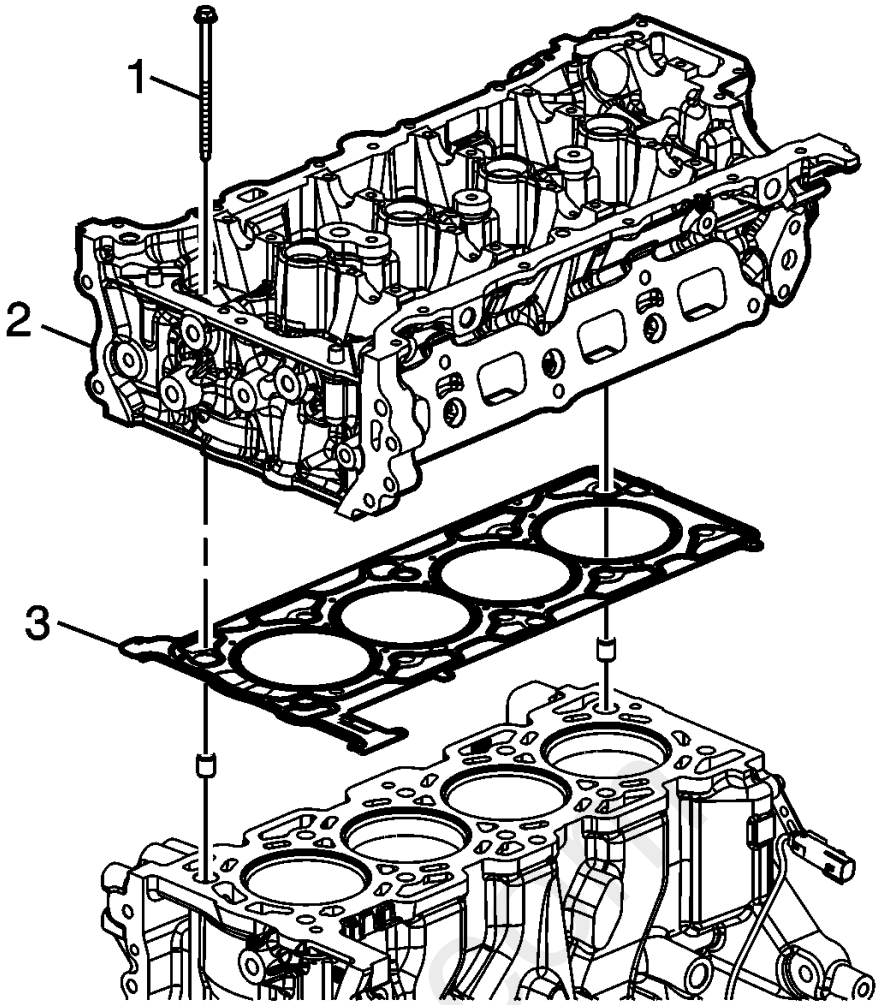


Fig. 191: Cylinder Head Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **In order to prevent damage to the valves and injectors during cylinder head removal, set the cylinder head on blocks.**

17. Disconnect ground wire.
18. Remove the cylinder head (2).
19. Remove the cylinder head gasket (3).
20. Clean all of the gasket surfaces.
21. Use the following procedures when cleaning the cylinder head and cylinder block surfaces:
    - Be careful not to gouge or scratch the gasket surfaces. Do not gouge or scrape the combustion chamber surfaces. The feel of the gasket surface is important, not the appearance. There will be indentations from the gasket left in the cylinder head after all of the gasket material is removed. These small indentations will be filled in by the new gasket.
    - Use a gasket scraper to clean the cylinder head and cylinder block gasket surfaces. Do not scratch or gouge any surface.
    - Do not use any other method or technique to clean these gasket surfaces.

NOTE: **Do not use a tap to clean the cylinder head bolt holes.**

22. Clean the old sealer/lube and dirt from the bolt holes.
23. Clean the bolt holes with a nylon bristle brush.

WARNING: **Wear safety glasses to avoid injury when using compressed air or any cleaning solvent. Bodily injury may occur if fumes are inhaled or if skin is exposed to chemicals.**

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

25. Remove any broken long cylinder head bolts using the **EN 38188** kit.
26. If replacing the cylinder head, remove the fuel injection fuel rail and transfer as necessary. **Fuel Injection Fuel Rail Assembly Replacement**
27. For cylinder head disassemble. **Cylinder Head Disassemble**
28. For cylinder head cleaning and inspection. **Cylinder Head Cleaning and Inspection**

Installation Procedure

1. For cylinder head assemble. **Cylinder Head Assemble**

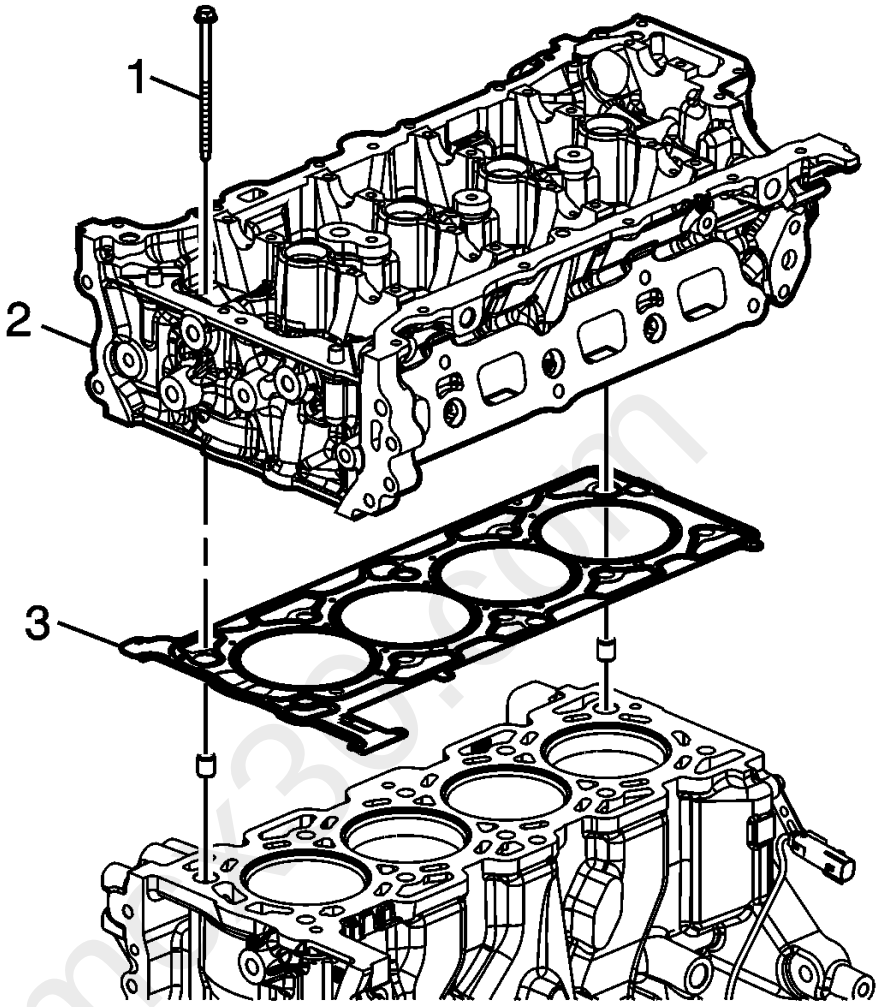


Fig. 192: Cylinder Head Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not use any sealing material.**

2. Install the cylinder head gasket (3) to the block.
3. Install the cylinder head (2). Ensure the number 1 cylinder is at top dead center (TDC). The key on the crankshaft should be on top in the 12 o'clock position.

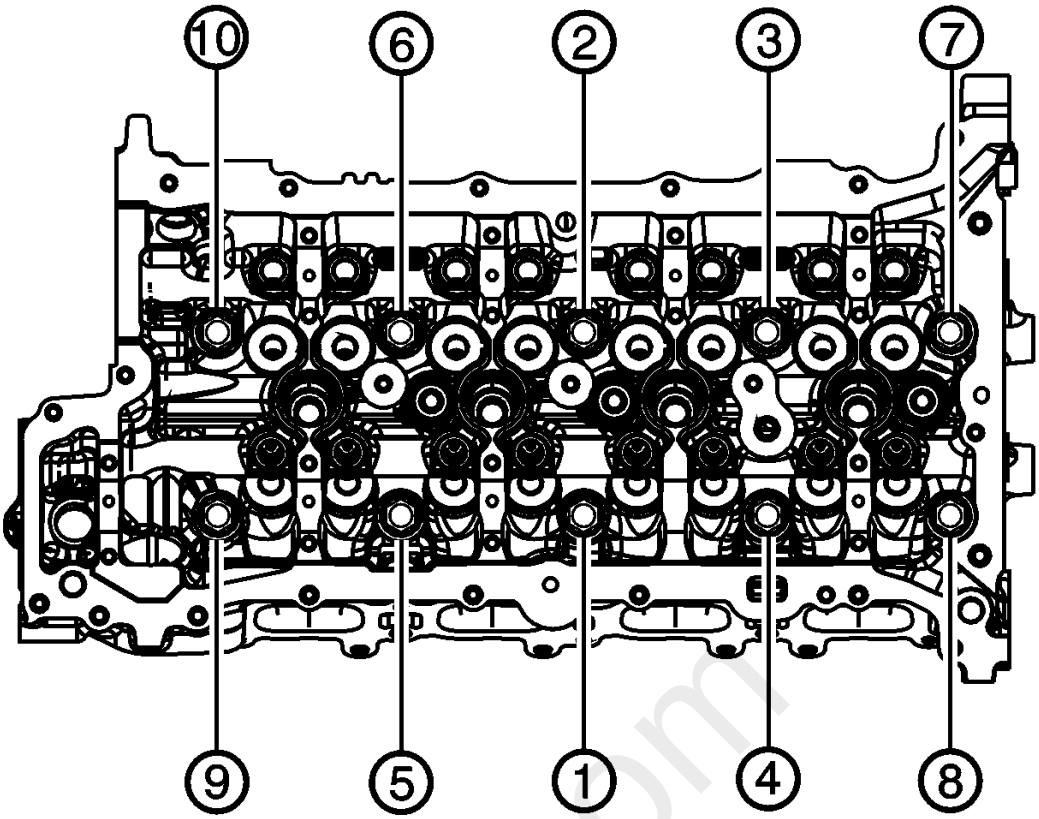


Fig. 193: Cylinder Head Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

NOTE: **Always use NEW cylinder head bolts.**

4. Install the cylinder head bolts.
    1. **First Pass:** tighten the bolts in sequence to 30 N.m (22 lb ft).
    2. **Final Pass:** tighten the bolts an additional 190 degrees in sequence using the **EN 45059** meter.

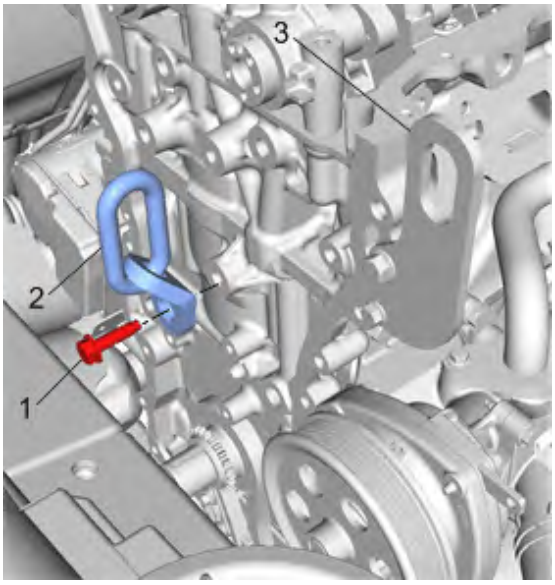


Fig. 194: Engine Lift Brackets And Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Support engine as necessary from underneath while repositioning the engine support fixture. Engine Support Fixture**

5. Reposition the engine support fixture lift hook from the **J-36857** Engine Lift Bracket (2) to the engine lift bracket (3).
6. Remove the **J-36857** Engine Lift Bracket (2) and fastener (1) from the engine block.
7. Install Thermostat Bypass Pipe - **Thermostat Bypass Pipe Replacement (LTG)**

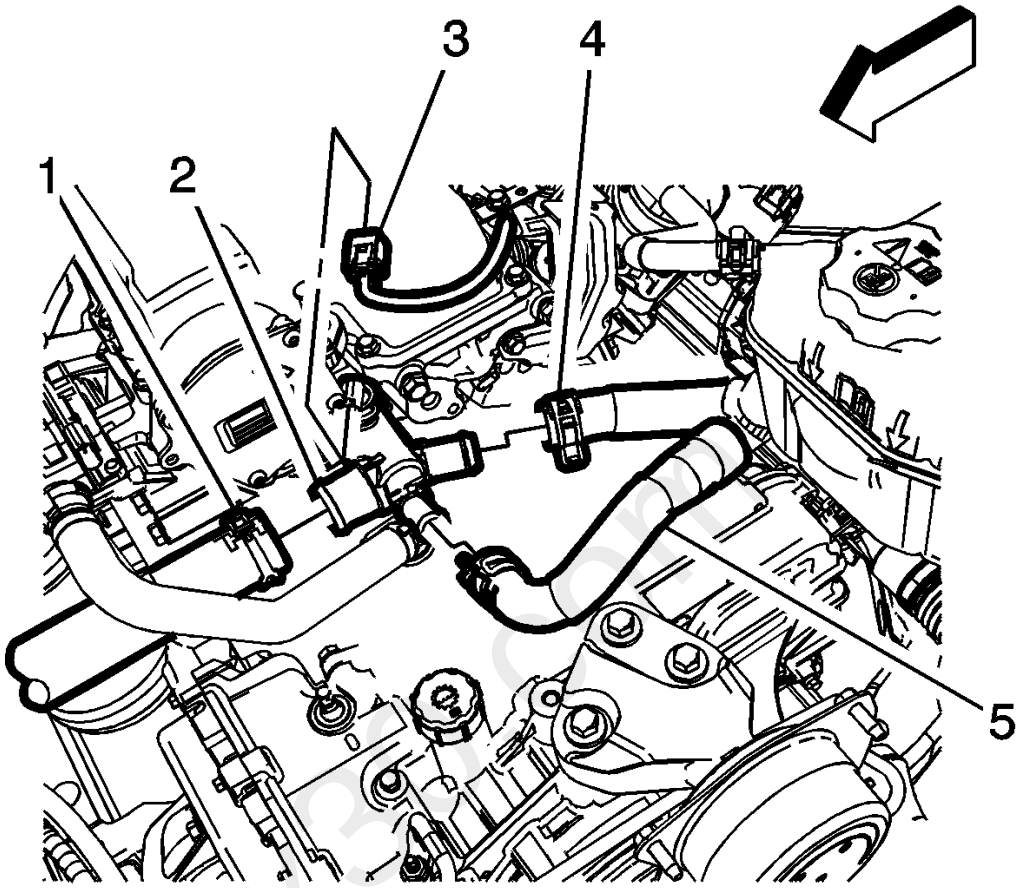


Fig. 195: Engine Coolant Temperature (ECT) Sensor Connector
Courtesy of GENERAL MOTORS COMPANY

8. Reconnect ground wire.
9. Connect the hoses at the water outlet. **Water Outlet Replacement (LTG)**
10. Install ground wire.
11. Connect the exhaust camshaft position sensor. **Camshaft Position Sensor Replacement - Exhaust**
12. Connect the intake camshaft position sensor. **Camshaft Position Sensor Replacement - Intake**
13. Install the intake and exhaust camshaft, bearing cap and lash adjuster. **Intake and Exhaust Camshaft, Bearing Cap, and Lash Adjuster Removal**
14. Install the timing chain and tensioner. **Camshaft Timing Chain and Tensioner Replacement**

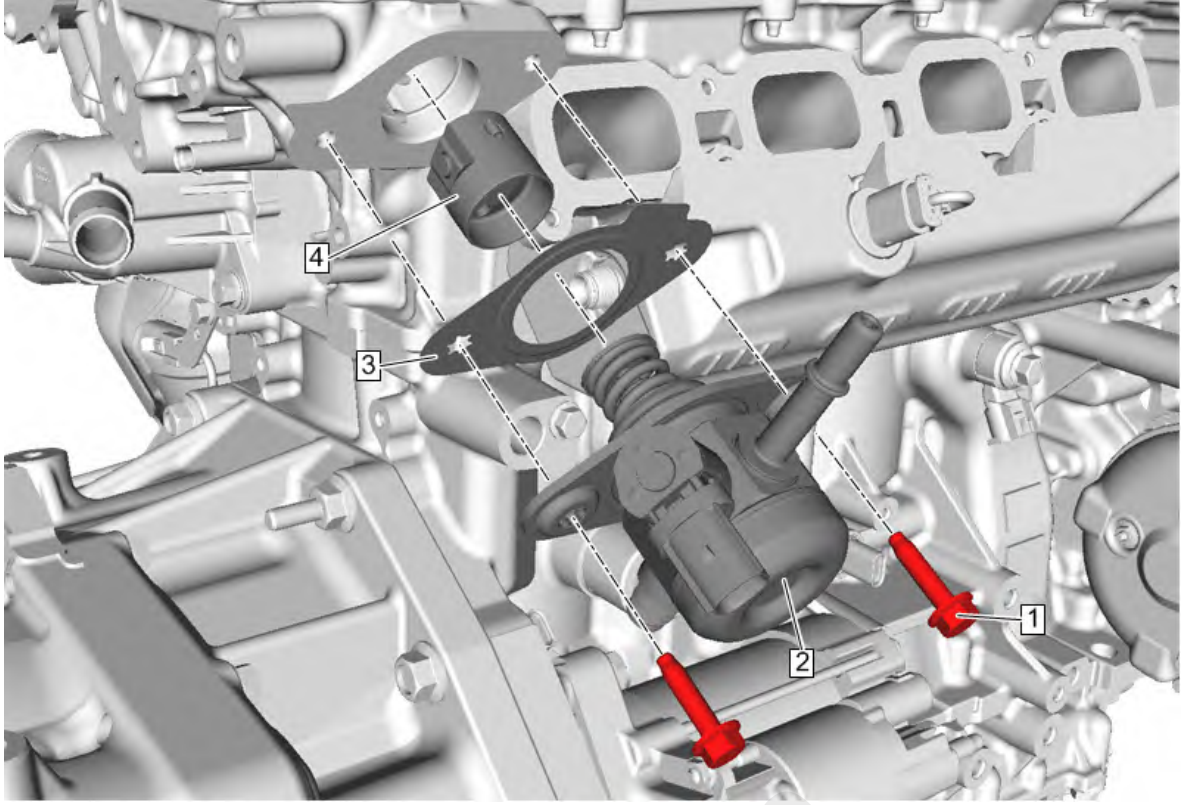
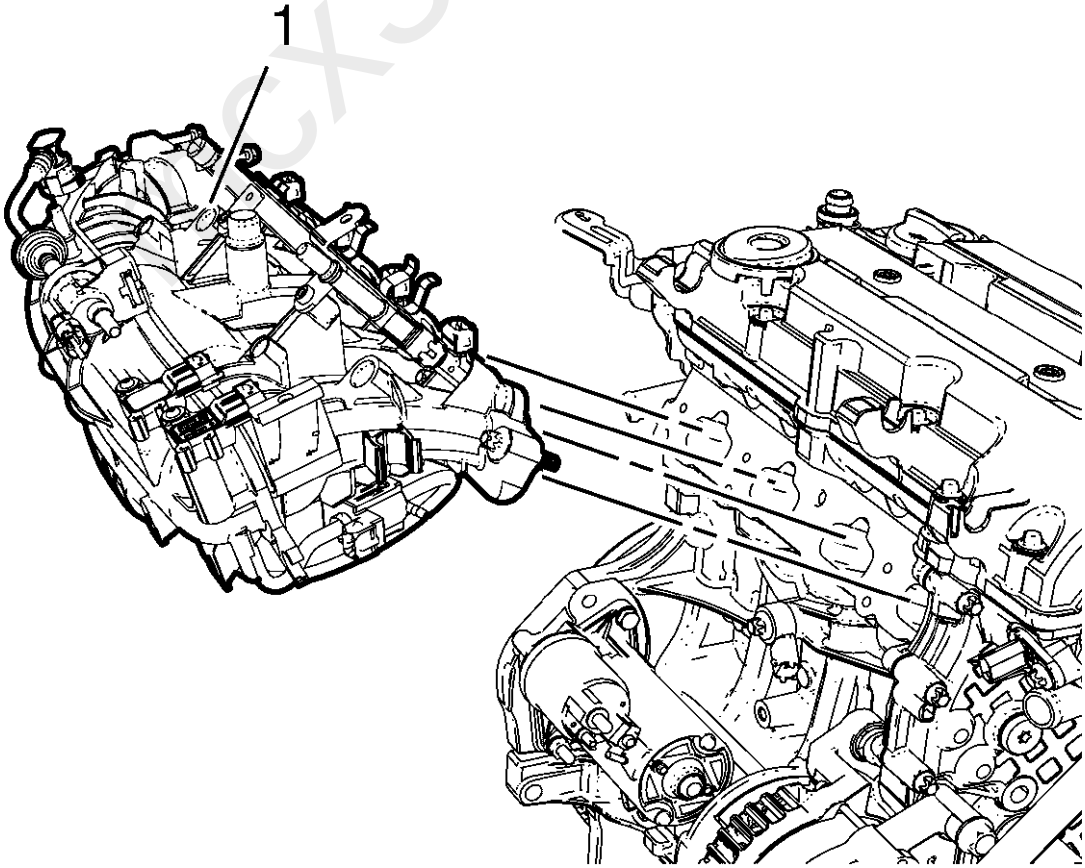


Fig. 196: Fuel Pump
Courtesy of GENERAL MOTORS COMPANY

15. Install the fuel pump. (2) **Fuel Pump Replacement**
16. Install the engine front cover. **Engine Front Cover Replacement**
17. Install the exhaust manifold. **Exhaust Manifold Replacement (LTG)**



ecx30.com

Fig. 197: Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

18. Install the intake manifold. Intake Manifold Replacement
19. Install the camshaft cover. Camshaft Cover Replacement (1st Design Tamper-Proof PCV System)
20. Refill the engine with NEW oil. Engine Oil and Oil Filter Replacement
21. Refill the coolant system. Cooling System Draining and Filling (GE 47716) Cooling System Draining and Filling (Static)

OIL PAN COVER REPLACEMENT

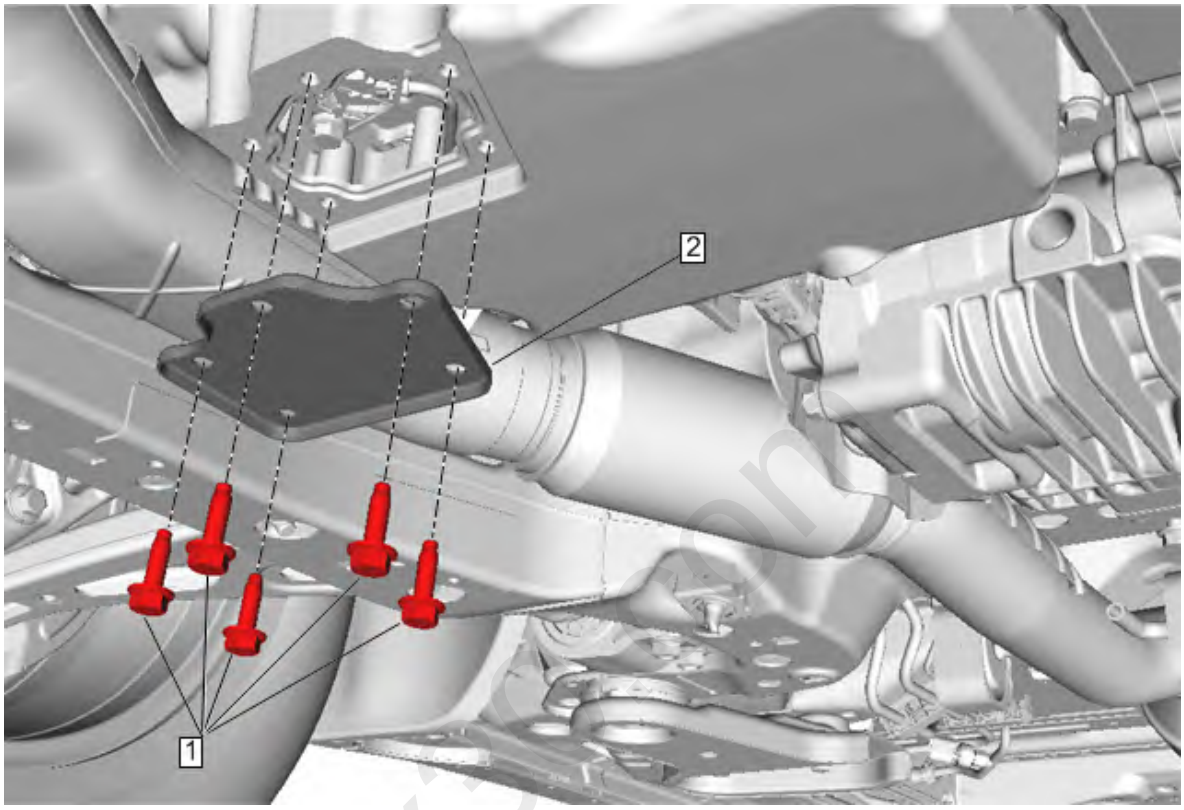


Fig. 198: Lower Oil Pan
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Procedure Engine Oil and Oil Filter Replacement	
1	Oil Pan Fastener [5x] **CAUTION:** **Refer to Fastener Caution .** **tighten** 10 N.m (89 lb in)
2	Lower Oil Pan **Procedure** Apply a 2.25 mm bead of sealer on the level part of the flange around the perimeter of the lower oil pan. Refer to Adhesives, Fluids, Lubricants, and Sealers. **NOTE:** • **The lower crankcase surface must be free of contamination prior to applying the sealer.** • **The oil pan must be fastened to final torque specification within 60 minutes of applying the sealer.**

OIL PAN REPLACEMENT (AWD)

Removal Procedure

1. Drain the engine oil and remove the oil filter. Refer to **Engine Oil and Oil Filter Replacement**.
2. Support the engine. Refer to **Engine Support Fixture**.
3. Remove **Drivetrain and Front Suspension Cradle Replacement (All Wheel Drive)**
4. Remove **Oil Pump Flow Control Valve Heat Shield Replacement**
5. Remove the front engine cover (1). Refer to **Engine Front Cover Replacement**.
6. Remove the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LTG)** .

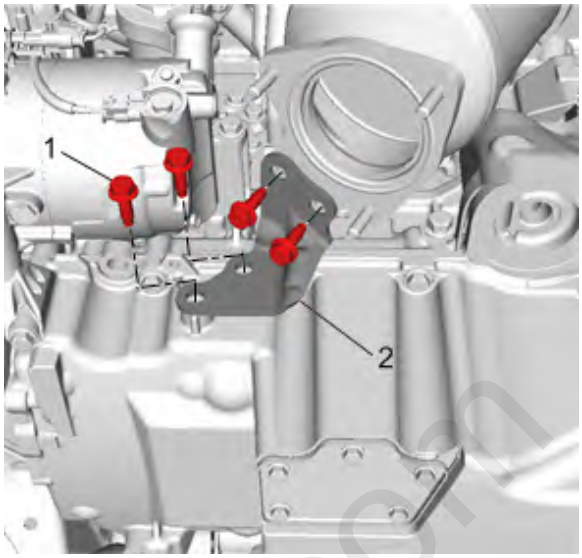


Fig. 199: Catalytic Lower Brace And Fasteners
Courtesy of GENERAL MOTORS COMPANY

7. Remove the catalytic converter to oil pan brace fasteners (1).
8. Remove the catalytic lower brace (2).

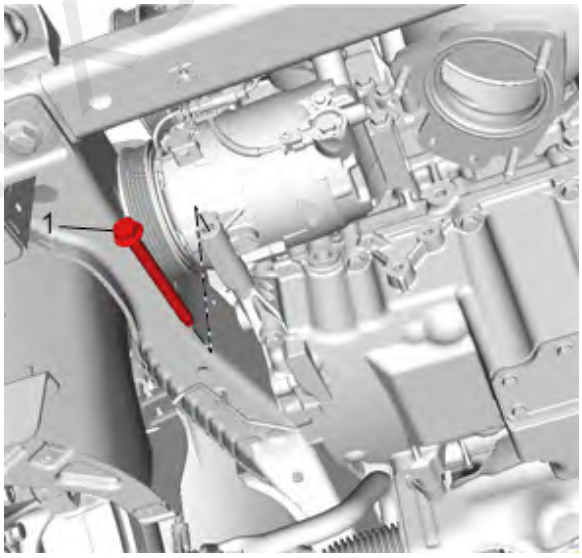


Fig. 200: Compressor Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Remove the bolt (1)

mx30.com

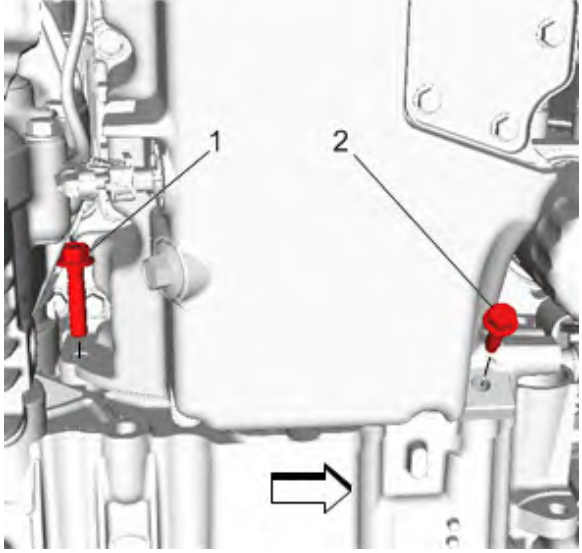


Fig. 201: Oil Pan To Transmission Fasteners
Courtesy of GENERAL MOTORS COMPANY

10. Remove the oil pan to transmission bolts (1, 2)

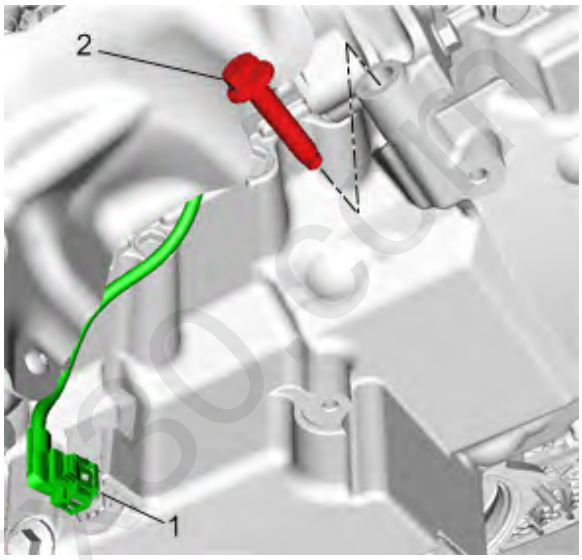


Fig. 202: Electrical Connector And Bolt
Courtesy of GENERAL MOTORS COMPANY

11. Disconnect the electrical connector (1)
12. Remove the bolt (2)

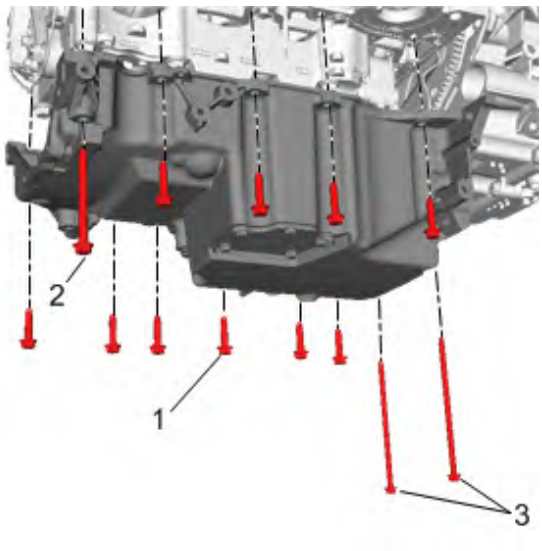


Fig. 203: Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove the long oil pan bolts (3), medium bolt (2) and short bolts (1), then remove the oil pan.
14. For part transfer, cleaning and inspection, refer to **Oil Pan Cleaning and Inspection**.

Installation Procedure

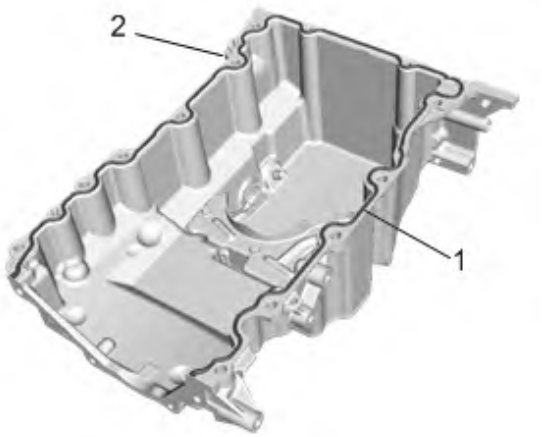


Fig. 204: ApplyingSealer
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The lower crankcase surface must be free of contamination prior to applying the sealer.**
- **Install and align the oil pan to block within 10 minutes of applying the sealer.**
- **The oil pan must be fastened to final torque specification within 60 minutes of applying the sealer.**

1. Apply a 4.25 mm bead of sealer (1) on the level part of the flange around the perimeter of the oil pan (2) as shown. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

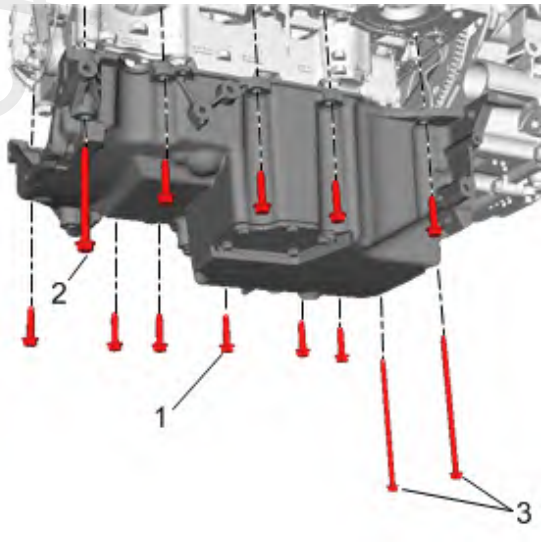


Fig. 205: Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **When installing the oil pan, carefully align the oil pan to the locating pins and install the pan onto the lower crankcase.**

2. Install the oil pan and hand start the oil pan bolts (1), (2) and (3).

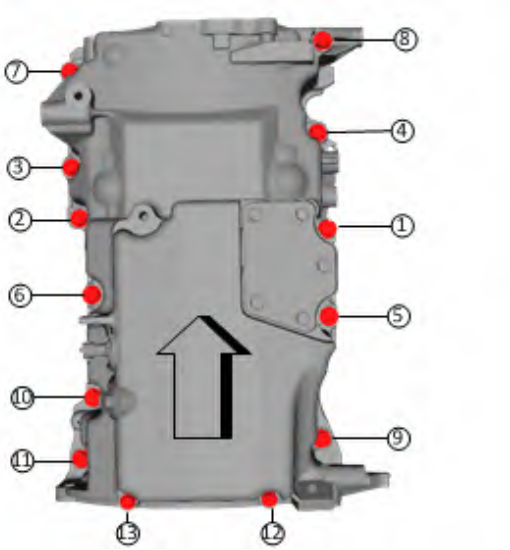


Fig. 206: Oil Pan Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

3. tighten the oil pan bolts in sequence to final torque twice using the following procedure:
    1. tighten bolts in sequence 1 - 11 to 25 N.m (18 lb ft).
    2. tighten bolts in sequence 12 - 13 to 10 N.m (89 lb in).

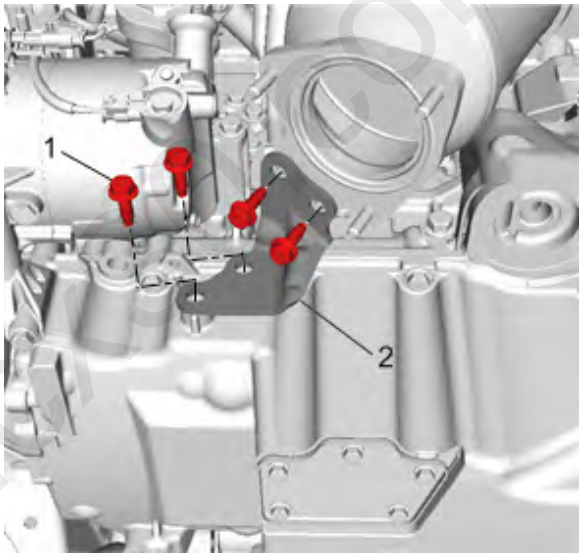


Fig. 207: Catalytic Lower Brace And Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Install the catalytic converter lower brace (2).
5. Install the catalytic converter to oil pan brace fasteners (1). tighten 25 N.m (18 lb ft)

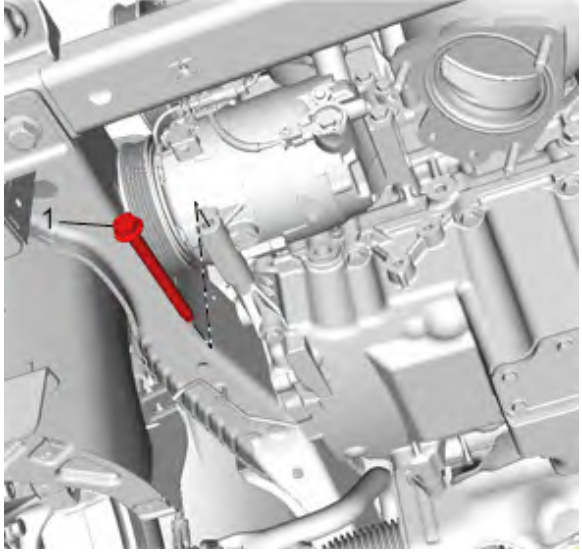


Fig. 208: Compressor Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Install the compressor bolt (1). tighten 22 N.m (16 lb ft)

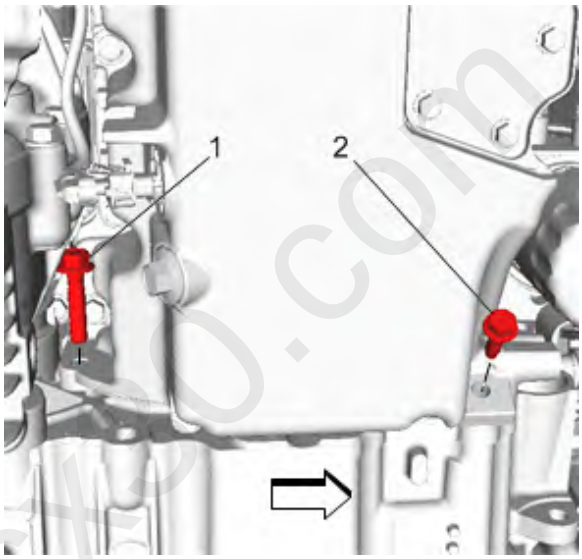


Fig. 209: Oil Pan To Transmission Fasteners
Courtesy of GENERAL MOTORS COMPANY

7. Install the oil pan to transmission fasteners.tighten 25 N.m (18 lb ft)

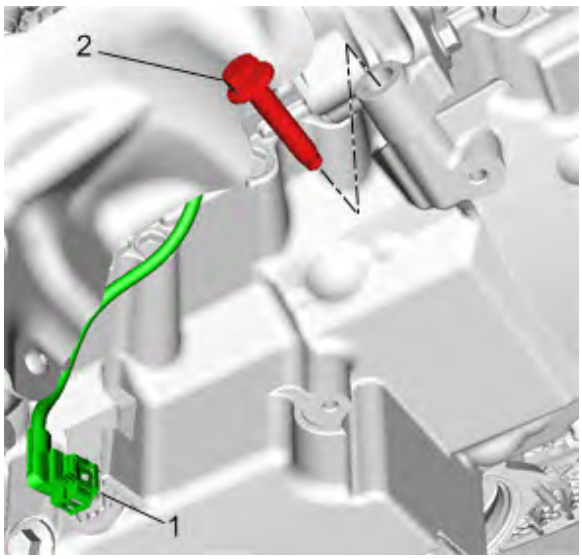


Fig. 210: Electrical Connector And Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Connect the electrical connector (1)

9. Install the bolt (2) tighten 58 N.m (43 lb ft)
10. Install **Oil Pump Flow Control Valve Heat Shield Replacement**
11. Install the exhaust front pipe. Refer to **Exhaust Front Pipe Replacement (LTG)** .
12. Install the front engine cover (1). Refer to **Engine Front Cover Replacement**.
13. Install **Drivetrain and Front Suspension Cradle Replacement (All Wheel Drive)**
14. Remove the engine support fixture. Refer to **Engine Support Fixture**.
15. Refill the engine oil and install a NEW oil filter. Refer to **Engine Oil and Oil Filter Replacement**.

OIL PAN REPLACEMENT (FWD)

Removal Procedure

1. Drain the engine oil and remove the oil filter. **Engine Oil and Oil Filter Replacement**
2. Remove Drivetrain and Front Suspension Cradle - **Drivetrain and Front Suspension Cradle Replacement (Front Wheel Drive)**
3. Remove Oil Pump Flow Control Valve Heat Shield - **Oil Pump Flow Control Valve Heat Shield Replacement**
4. Remove Engine Front Cover - **Engine Front Cover Replacement**

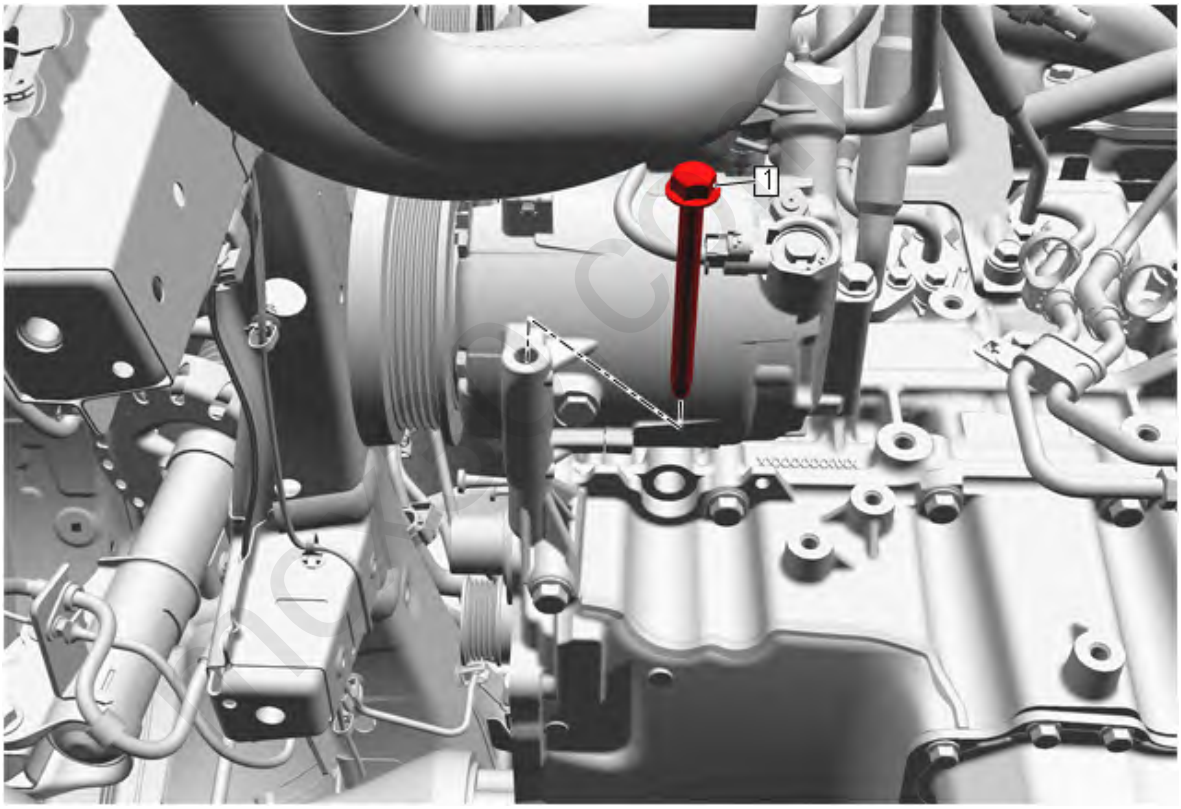


Fig. 211: Air Conditioning Compressor Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove Air Conditioning Compressor Bolt (1)

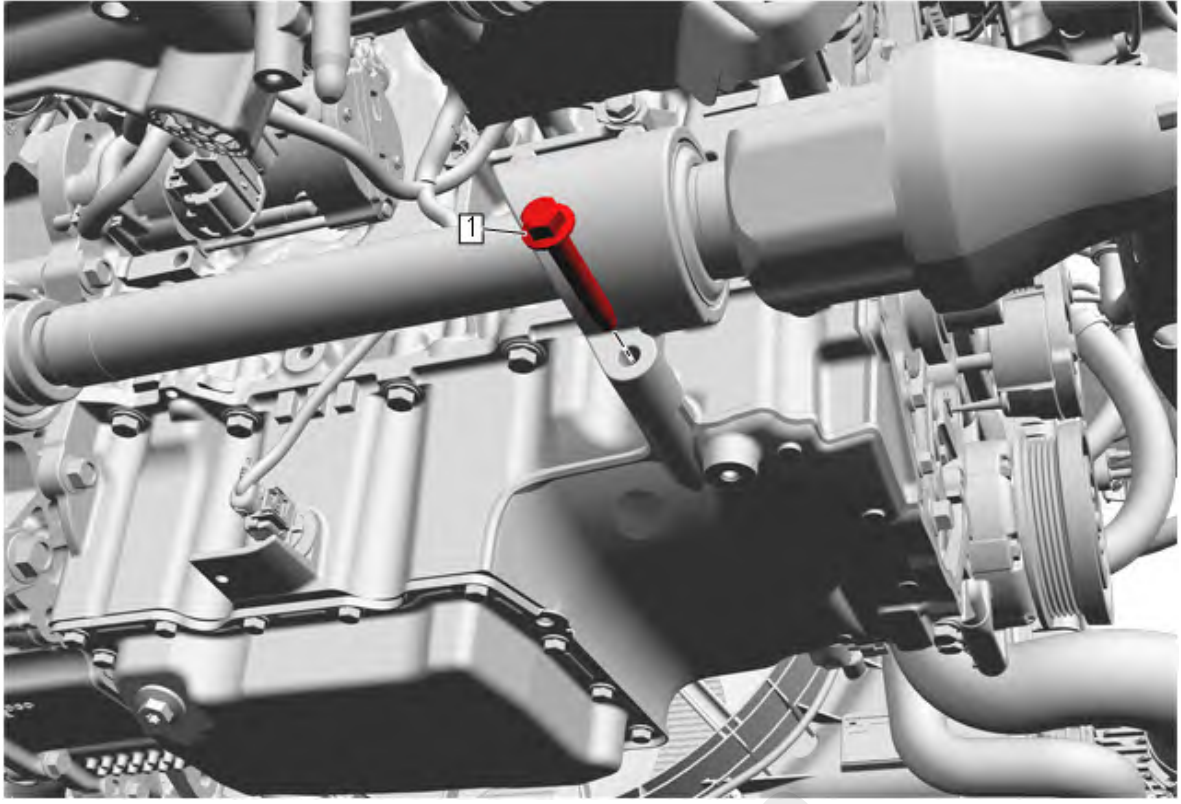


Fig. 212: Front Wheel Drive Intermediate Shaft Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove Front Wheel Drive Intermediate Shaft Bracket Bolt (1)

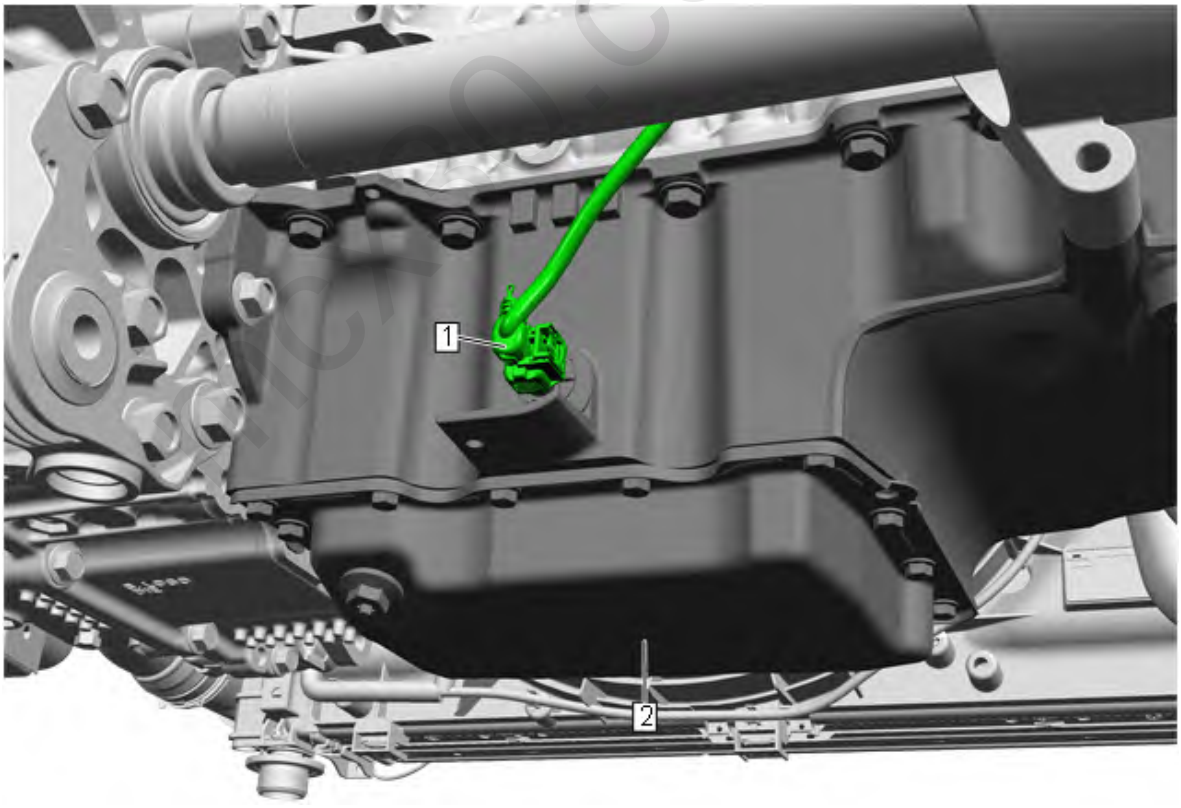


Fig. 213: Electrical Connector And Oil Pan
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect Electrical Connector (1) @ Oil Pan (2)

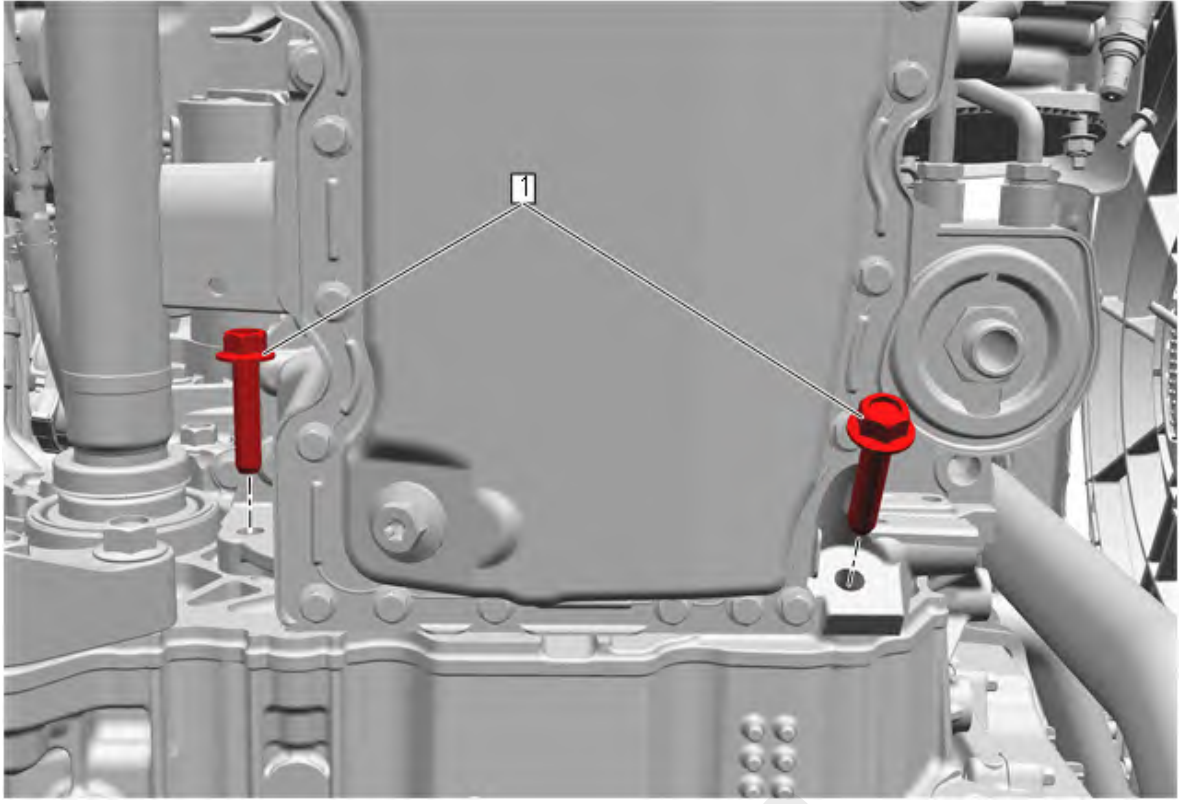


Fig. 214: Transmission Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove Transmission Bolt (1)

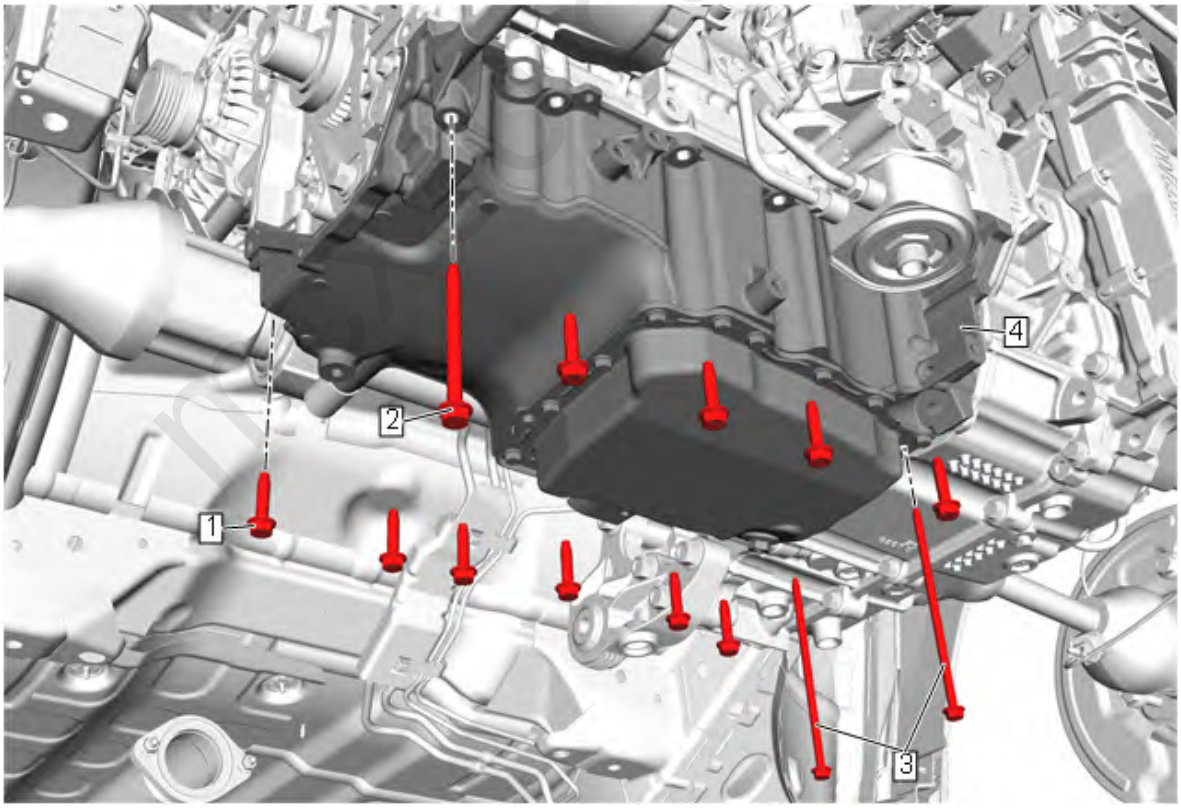


Fig. 215: Oil Pan Bolt And Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Remove Oil Pan Bolt.
10. Remove Oil Pan Bolt.
11. Remove Oil Pan Bolt.
12. Remove Oil Pan.
13. For part transfer, and cleaning and inspection, refer to **Oil Pan Cleaning and Inspection**.

Installation Procedure

1. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**

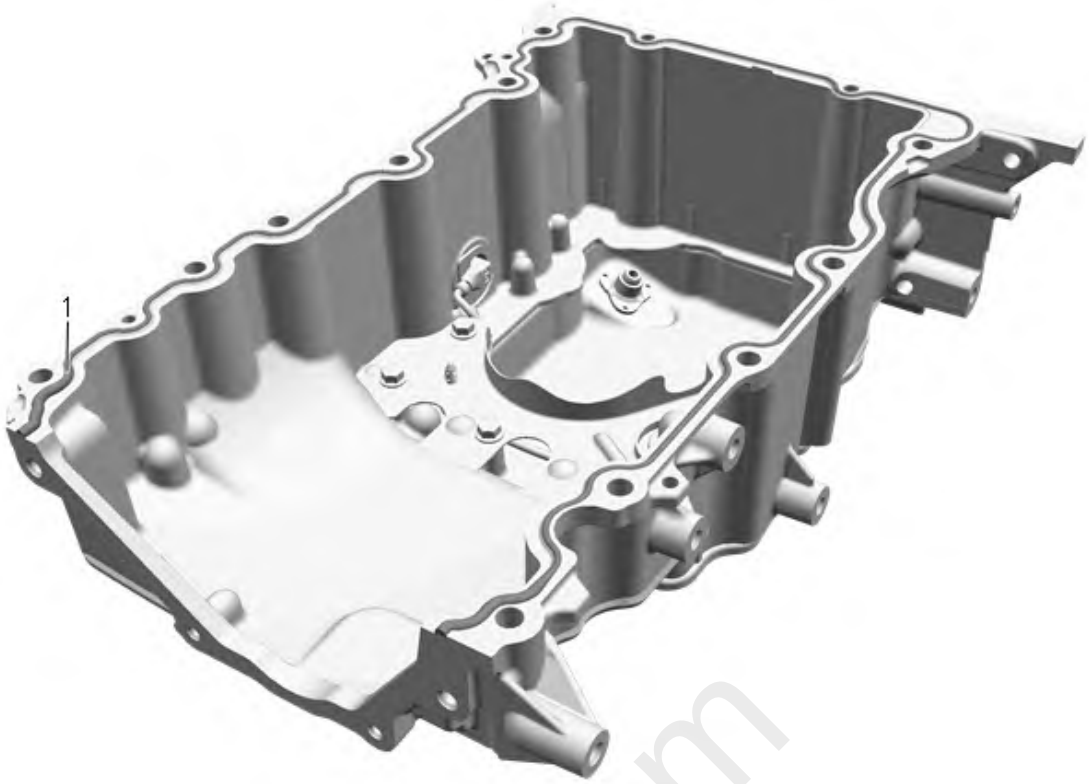


Fig. 216: Apply 4.25 mm Bead Of Sealer Around Perimeter Of Oil Pan
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The lower crankcase surface must be free of contamination prior to applying the sealer.**
- **Install and align the oil pan to block within 20 minutes of applying the sealer.**

2. Apply a 4.25 mm bead of sealer (1) on the level part of the flange around the perimeter of the oil pan as shown. **Adhesives, Fluids, Lubricants, and Sealers**

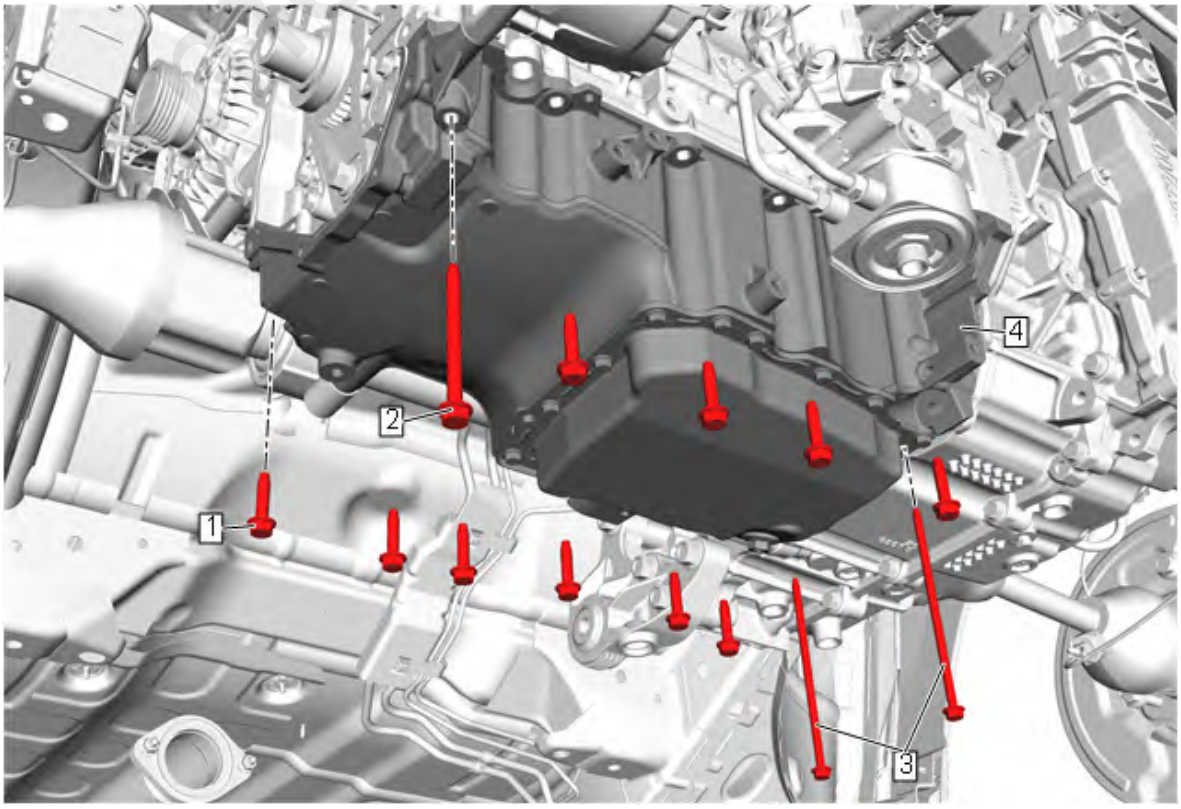


Fig. 217: Oil Pan Bolt And Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **When installing the oil pan, carefully align the oil pan to the locating pins and install the pan onto the lower crankcase.**

3. Install Oil Pan (4)
4. Install Oil Pan Bolt (3) and hand tighten
5. Install Oil Pan Bolt a (2) nd hand tighten
6. Install Oil Pan Bolt (1) and hand tighten
7. tighten the oil pan bolts in sequence. **Oil Pan Installation (FWD)**

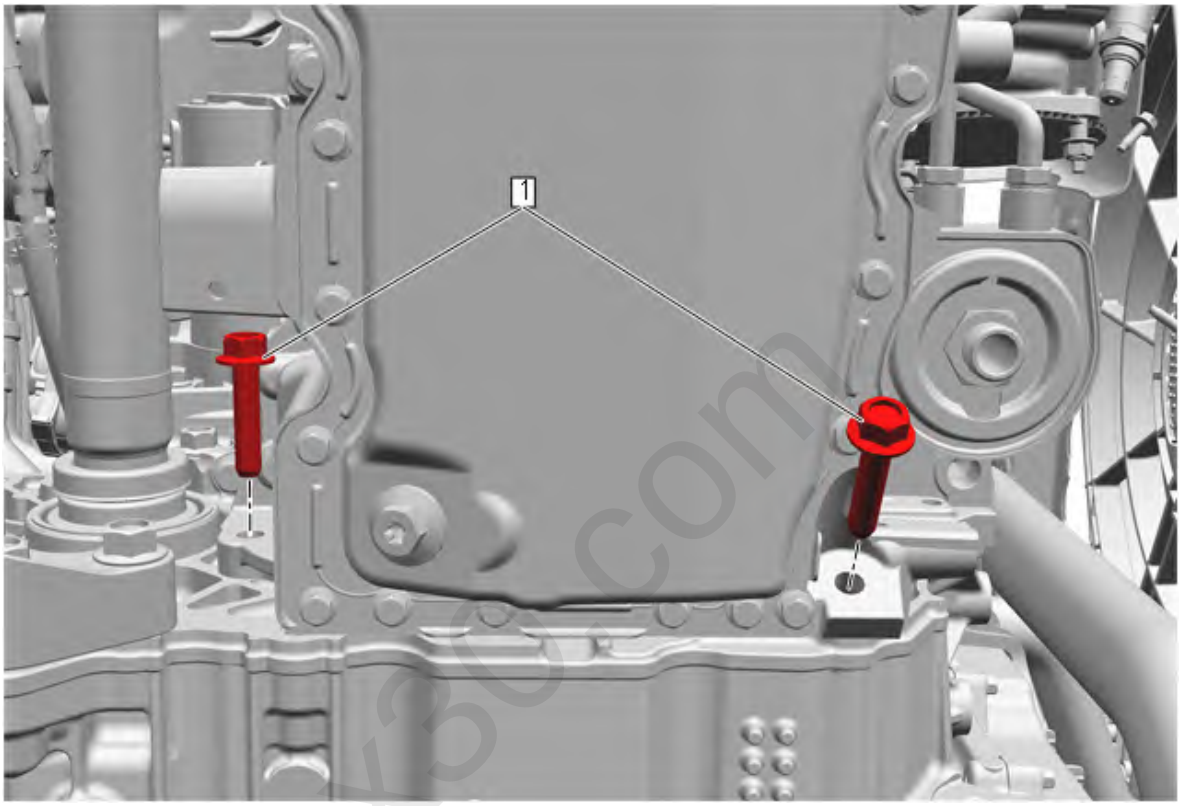


Fig. 218: Transmission Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Install Transmission Bolt (1) - **Transmission Replacement (Front Wheel Drive)**

mcx30.com

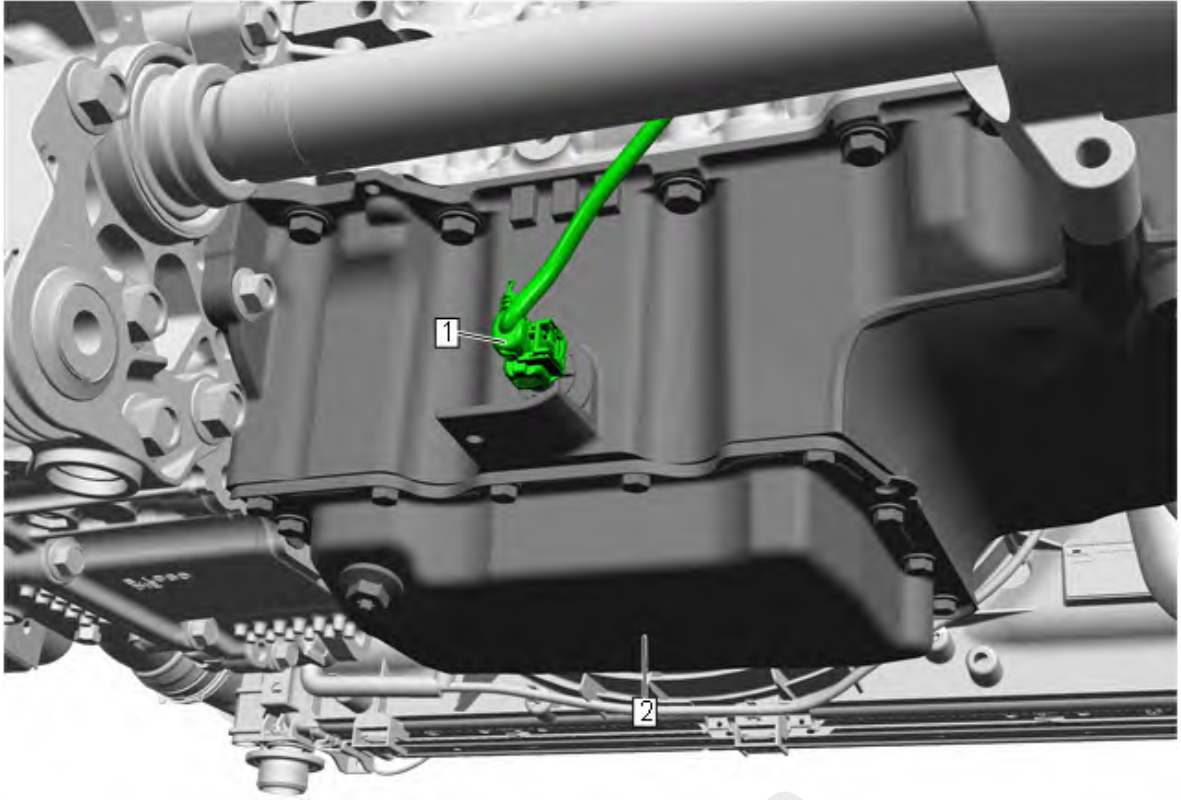


Fig. 219: Electrical Connector And Oil Pan
Courtesy of GENERAL MOTORS COMPANY

9. Connect Electrical Connector (1) @ Oil Pan (2)

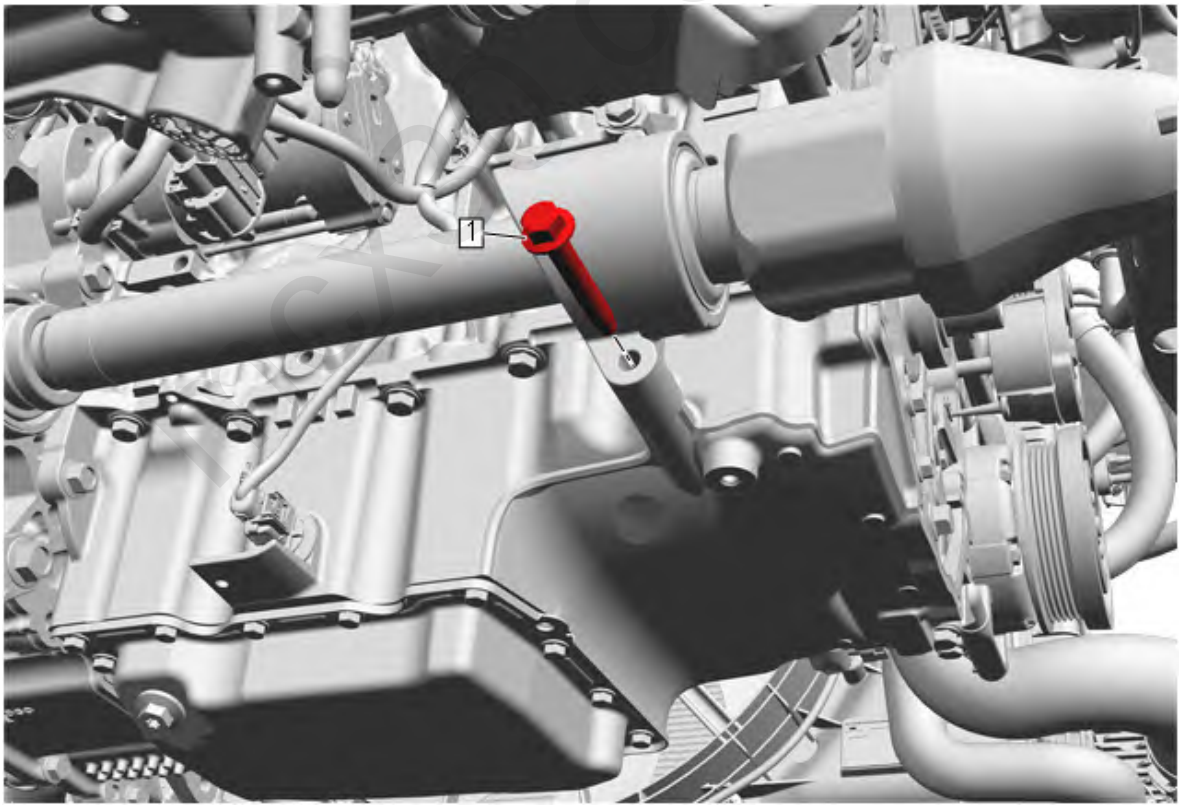


Fig. 220: Front Wheel Drive Intermediate Shaft Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Install Front Wheel Drive Intermediate Shaft Bracket Bolt (1) - **Front Wheel Drive Half Shaft Replacement - Right Side (M3U, MHG, MNH, MNK with FWD)** **Front Wheel Drive Half Shaft Replacement - Right Side (M3D, M3H with FWD)**

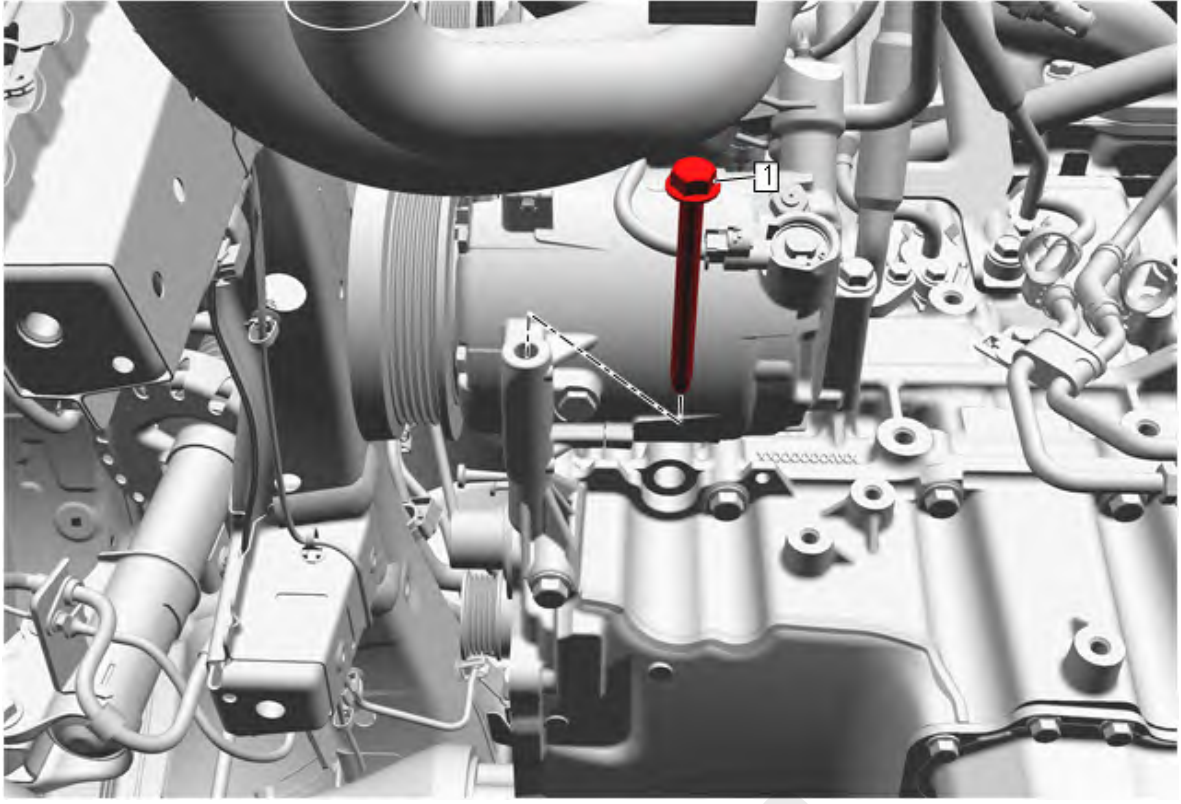


Fig. 221: Air Conditioning Compressor Bolt
Courtesy of GENERAL MOTORS COMPANY

11. Install Air Conditioning Compressor Bolt (1) - **Air Conditioning Compressor Replacement (LTG)**
12. Install Engine Front Cover - **Engine Front Cover Replacement**
13. Install Oil Pump Flow Control Valve Heat Shield -**Oil Pump Flow Control Valve Heat Shield Replacement**
14. Install Drivetrain and Front Suspension Cradle - **Drivetrain and Front Suspension Cradle Replacement (Front Wheel Drive)**
15. Fill the engine oil to the proper level with NEW engine oil. **Engine Oil and Oil Filter Replacement**

LOWER OIL PAN REPLACEMENT

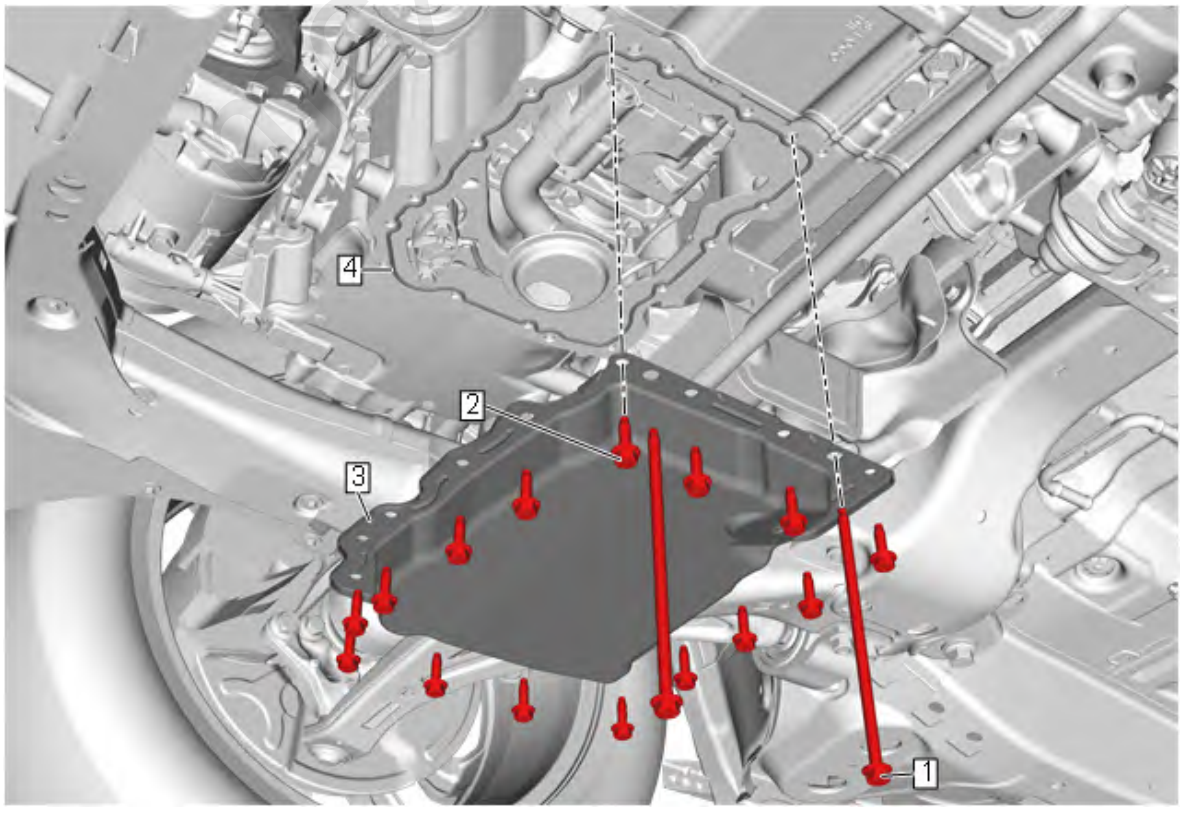


Fig. 222: Lower Oil Pan
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove Exhaust Front Pipe -**Exhaust Front Pipe Replacement (LTG)** 2. Drain the engine oil. **Engine Oil and Oil Filter Replacement**	
1	Oil Pan Bolt **CAUTION:** **Refer to Fastener Caution .** **tighten** 10 N.m (89 lb in)
2	Oil Pan Bolt **tighten** 10 N.m (89 lb in)
3	Lower Oil Pan
4	Lower Oil Pan Sealant **NOTE:** • **The lower crankcase surface must be free of contamination prior to applying the sealer.** • **Install and align the oil pans within 20 minutes of applying the sealer.** • **Ensure proper use of room temperature vulcanizing (RTV) sealant. Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant** Apply a bead of RTV sealant to the perimeter of the lower oil pan. **Adhesives, Fluids, Lubricants, and Sealers**

ENGINE OIL LEVEL INDICATOR SWITCH REPLACEMENT (AWD)

Removal Procedure

1. Remove the oil pan cover. **Oil Pan Cover Replacement**

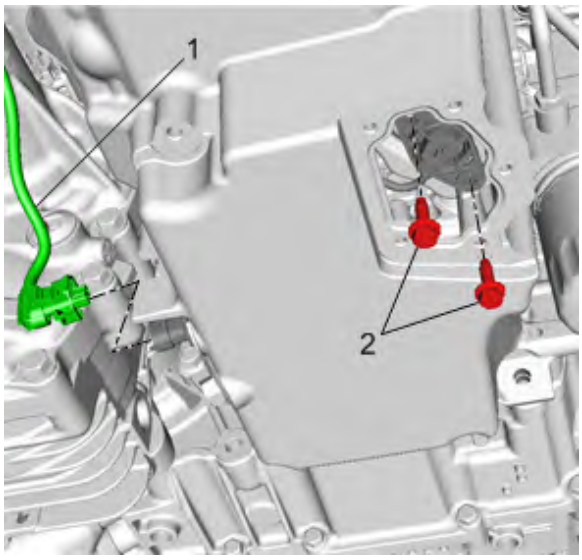


Fig. 223: Oil Level Sensor Connector And Fasteners
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the engine oil level indicator switch electrical connector (1).
3. Remove the 2 engine oil level indicator switch fasteners (2).

mc30.com

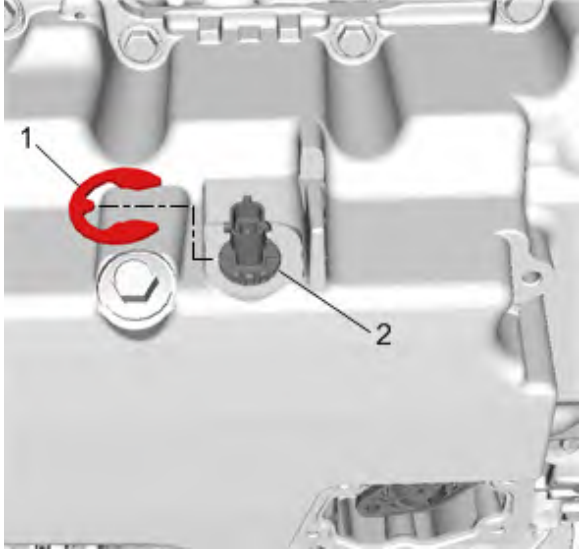


Fig. 224: Engine Oil Level Sensor Connector And C-Clip
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine oil level indicator switch C-clip (1).

NOTE: **Use wire or suitable device to route the indicator switch connector through the oil pan opening.**

5. Push the engine oil level indicator switch connector (2) through the oil pan to remove.

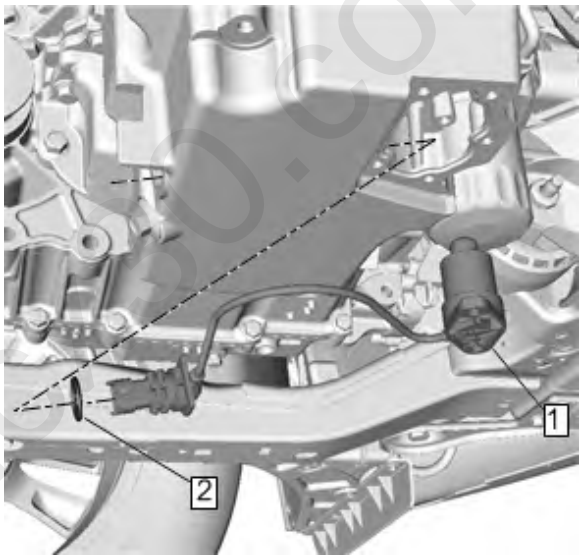


Fig. 225: Engine Oil Level Sensor And O-Ring
Courtesy of GENERAL MOTORS COMPANY

6. Remove the engine oil level indicator switch (1) from the oil pan.

NOTE: **This step is necessary only if reusing the old engine oil level indicator switch.**

7. Remove Engine Oil Level Indicator Switch O-Ring Seal and DISCARD

Installation Procedure

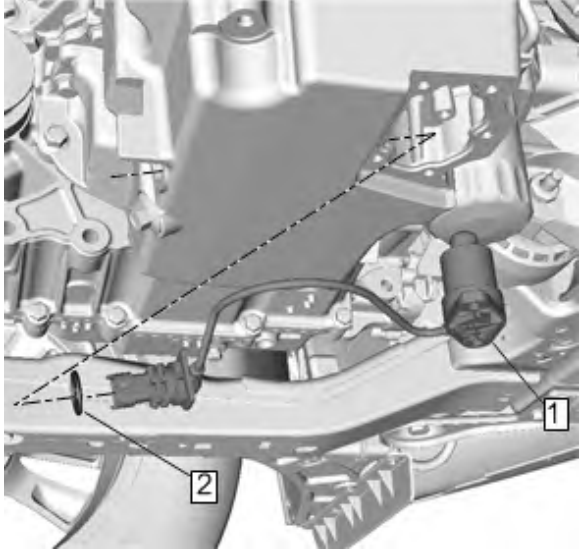


Fig. 226: Engine Oil Level Sensor And O-Ring
Courtesy of GENERAL MOTORS COMPANY

NOTE: **This step is necessary only if reusing the old engine oil level indicator switch.**

1. Install NEW Engine Oil Level Indicator Switch O-Ring Seal.

NOTE:

- **Lubricate the O-ring seal with clean engine oil prior to installing the indicator switch. Adhesives, Fluids, Lubricants, and Sealers**
- **Use wire or suitable device to route the indicator switch connector through the oil pan opening.**
- **If reinstalling the indicator switch, replace the O-ring (2).**

2. Install the engine oil level indicator switch (1).

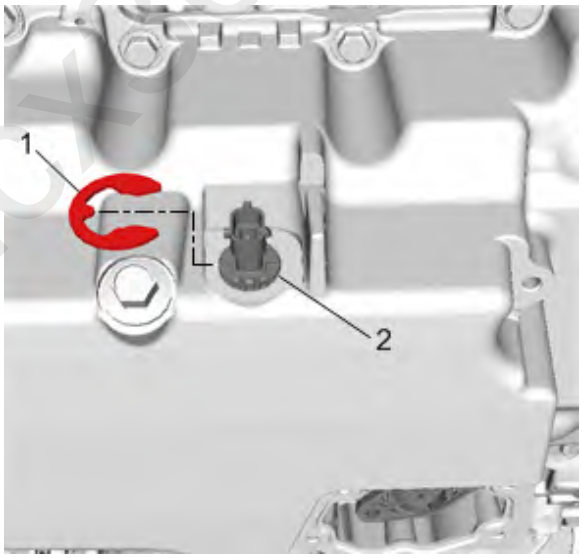


Fig. 227: Engine Oil Level Sensor Connector And C-Clip
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Pull the indicator switch connector (2) through the connector opening and ensure that it is properly seated.**

3. Install the engine oil level indicator switch C-clip (1).

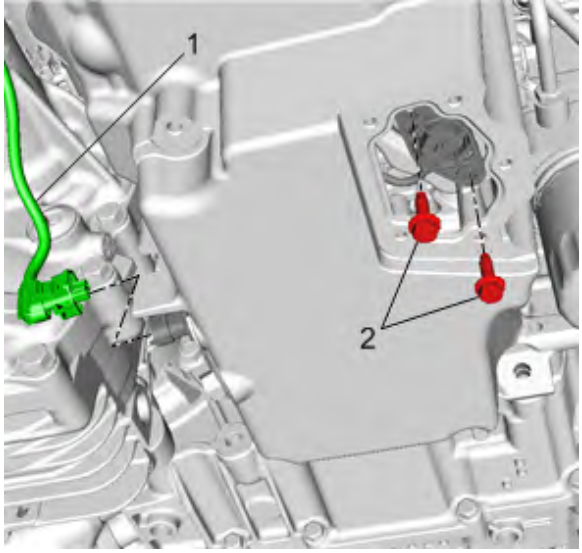


Fig. 228: Oil Level Sensor Connector And Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

4. Install the 2 engine oil level indicator switch fasteners (2) and tighten to 10 N.m (89 lb in).
5. Connect the oil level indicator switch electrical connector (1).
6. Install the oil pan cover. **Oil Pan Cover Replacement**

ENGINE OIL LEVEL INDICATOR SWITCH REPLACEMENT (FWD)

Removal Procedure

1. Remove Lower Oil Pan -**Lower Oil Pan Replacement**

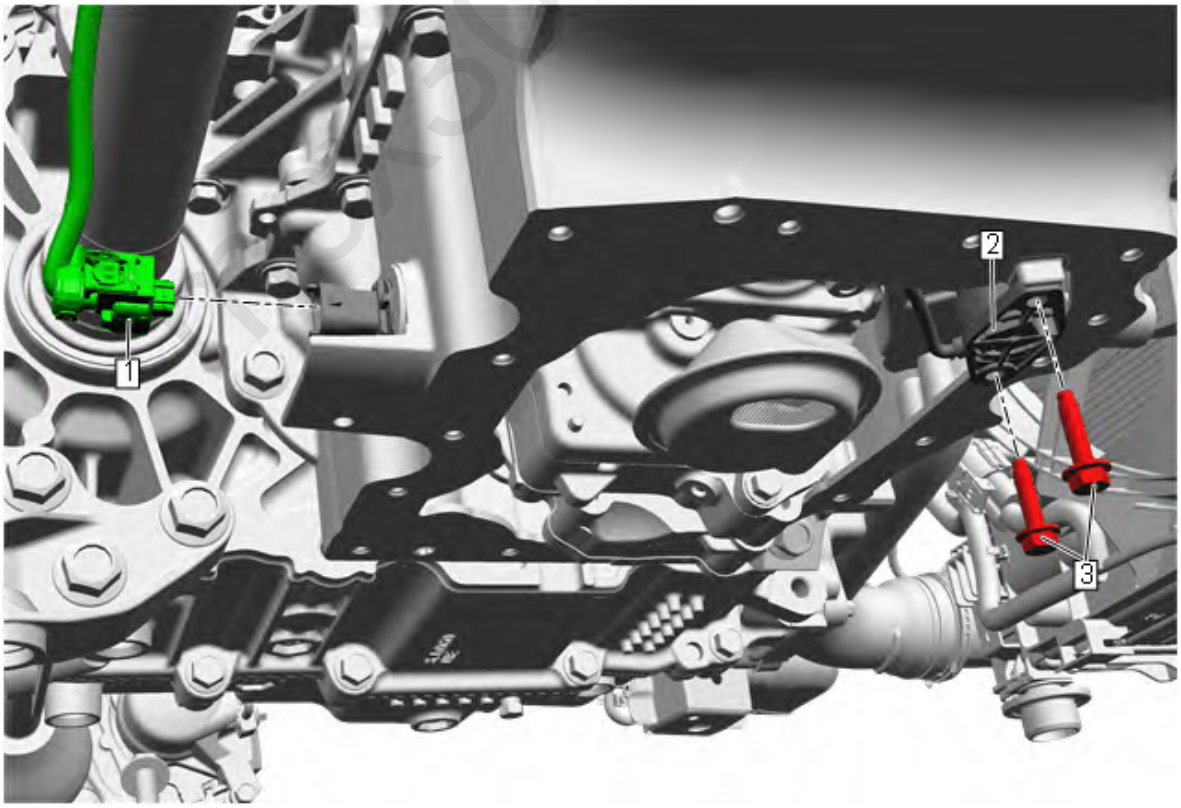


Fig. 229: Electrical Connector And Engine Oil Level Indicator Switch
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect Electrical Connector (1) @ Engine Oil Level Indicator Switch (2)
3. Remove Engine Oil Level Indicator Switch Bolt (3)

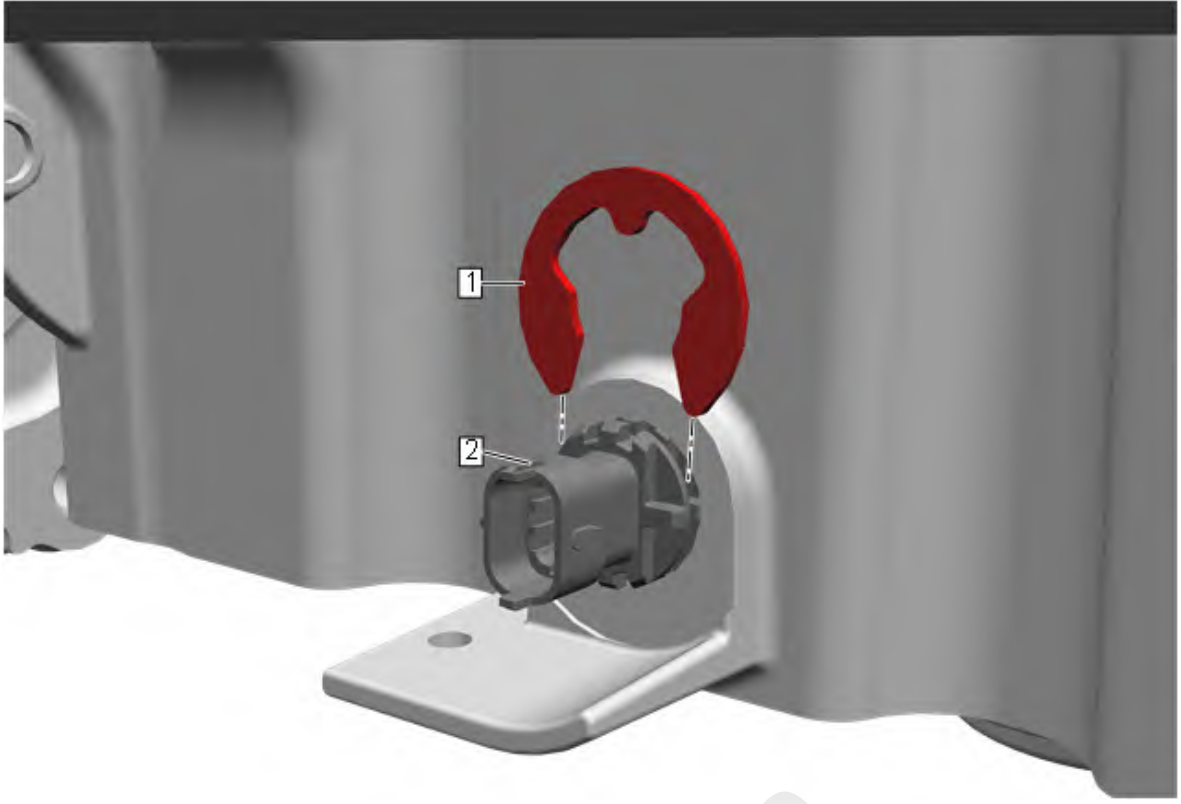


Fig. 230: Engine Oil Level Sensor Lead Clip And Sensor Connector
Courtesy of GENERAL MOTORS COMPANY

4. Remove Engine Oil Level Sensor Lead Clip (1)
5. Push the sensor connector (2) through the oil pan.

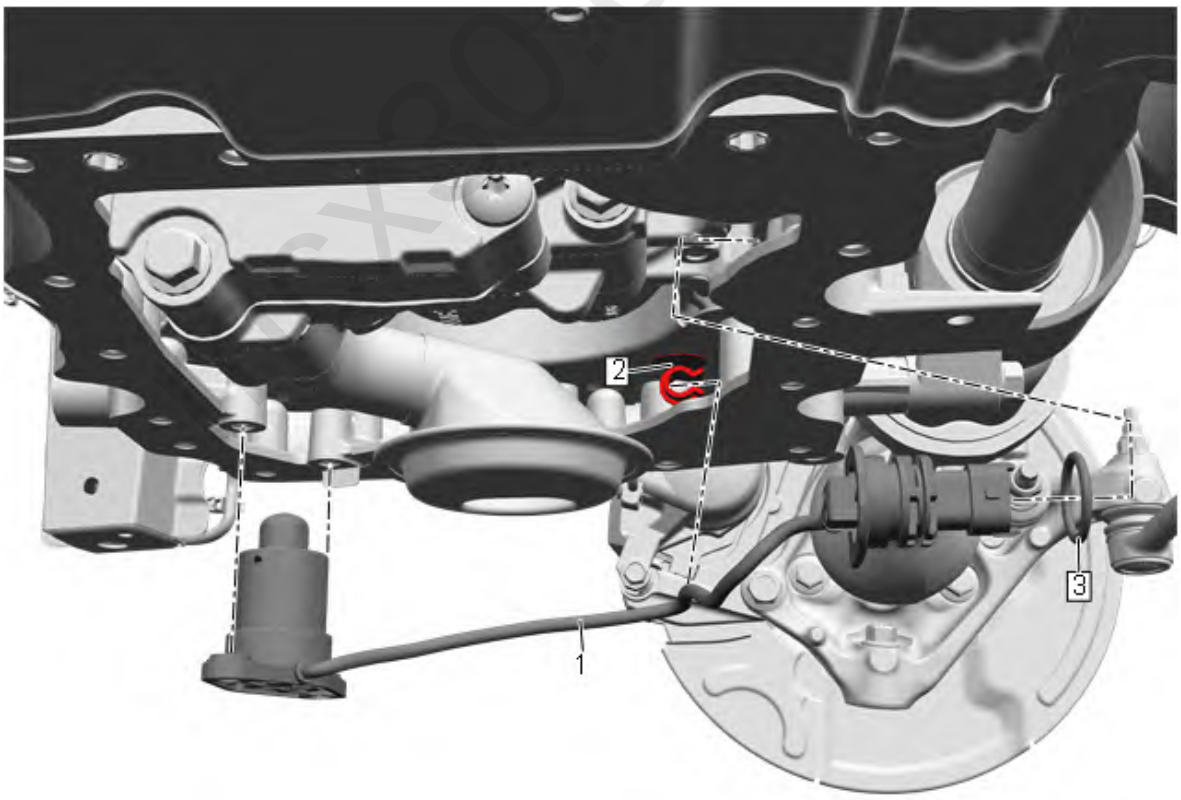


Fig. 231: O-Ring Seal And Engine Oil Level Indicator Switch
Courtesy of GENERAL MOTORS COMPANY

6. Disconnect Engine Oil Level Indicator Switch (1) @ Oil Pump Flow Control Solenoid Valve Wire Clip (2)
7. Remove Engine Oil Level Indicator Switch (1)

NOTE: **This step is necessary only if reusing the old engine oil level indicator switch.**

8. Engine Oil Level Indicator Switch O-Ring Seal (3) and DISCARD

Installation Procedure

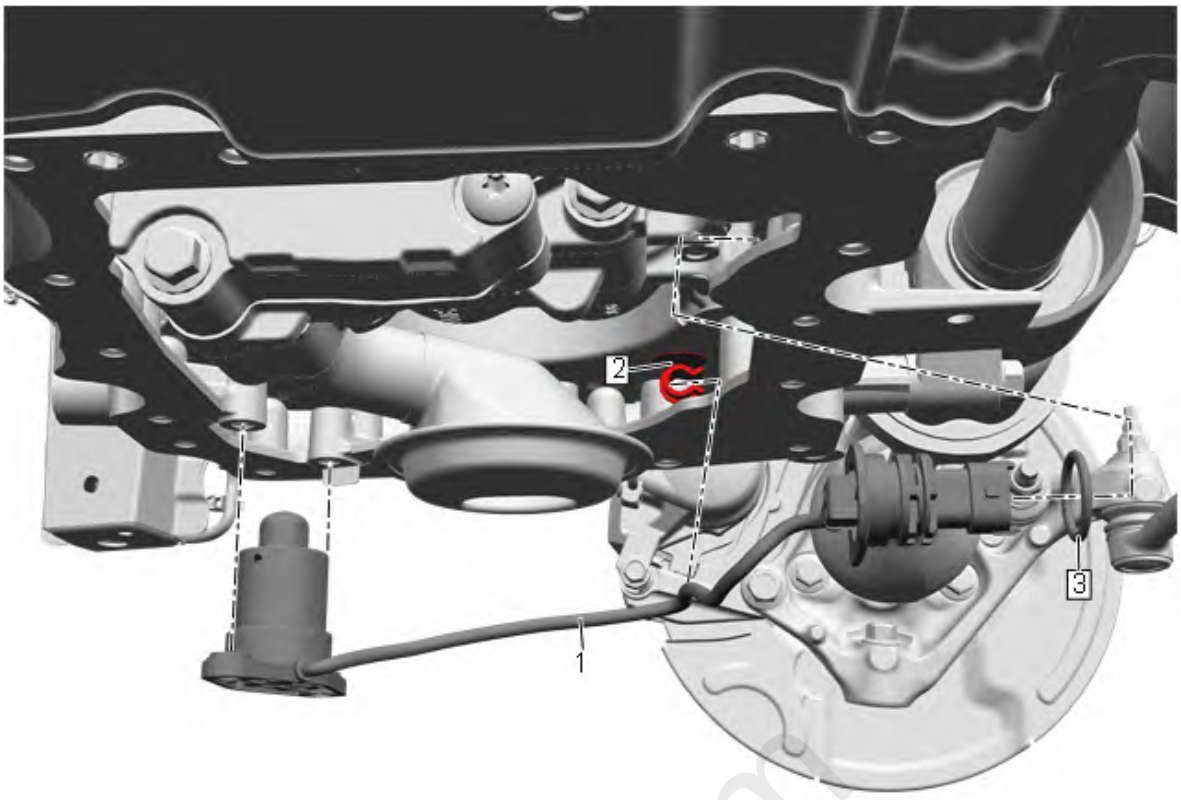


Fig. 232: O-Ring Seal And Engine Oil Level Indicator Switch
Courtesy of GENERAL MOTORS COMPANY

NOTE: **This step is necessary only if reusing the old engine oil level indicator switch.**

1. Install NEW Engine Oil Level Indicator Switch O-Ring Seal.

NOTE:

- **Lubricate the O-ring seal (3) with clean engine oil prior to installing the sensor. Adhesives, Fluids, Lubricants, and Sealers**
- **Use wire or suitable device to route the sensor connector through the oil pan opening.**

2. Install Engine Oil Level Indicator Switch (1)
3. Connect Engine Oil Level Indicator Switch (1) @ Oil Pump Flow Control Solenoid Valve Wire Clip (2)

mc20.com

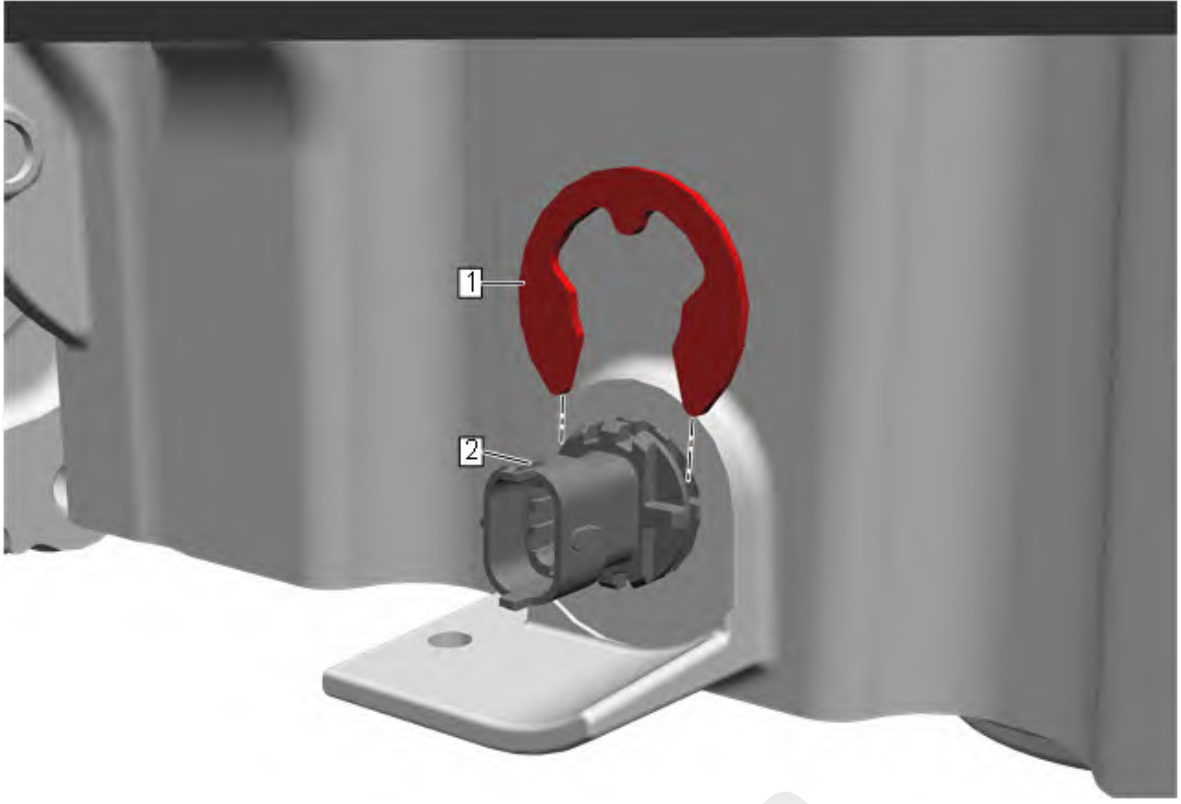


Fig. 233: Engine Oil Level Sensor Lead Clip And Sensor Connector
Courtesy of GENERAL MOTORS COMPANY

4. Pull the sensor connector (2) through the oil pan and ensure that it is fully seated.
5. Install Engine Oil Level Sensor Lead Clip (1)

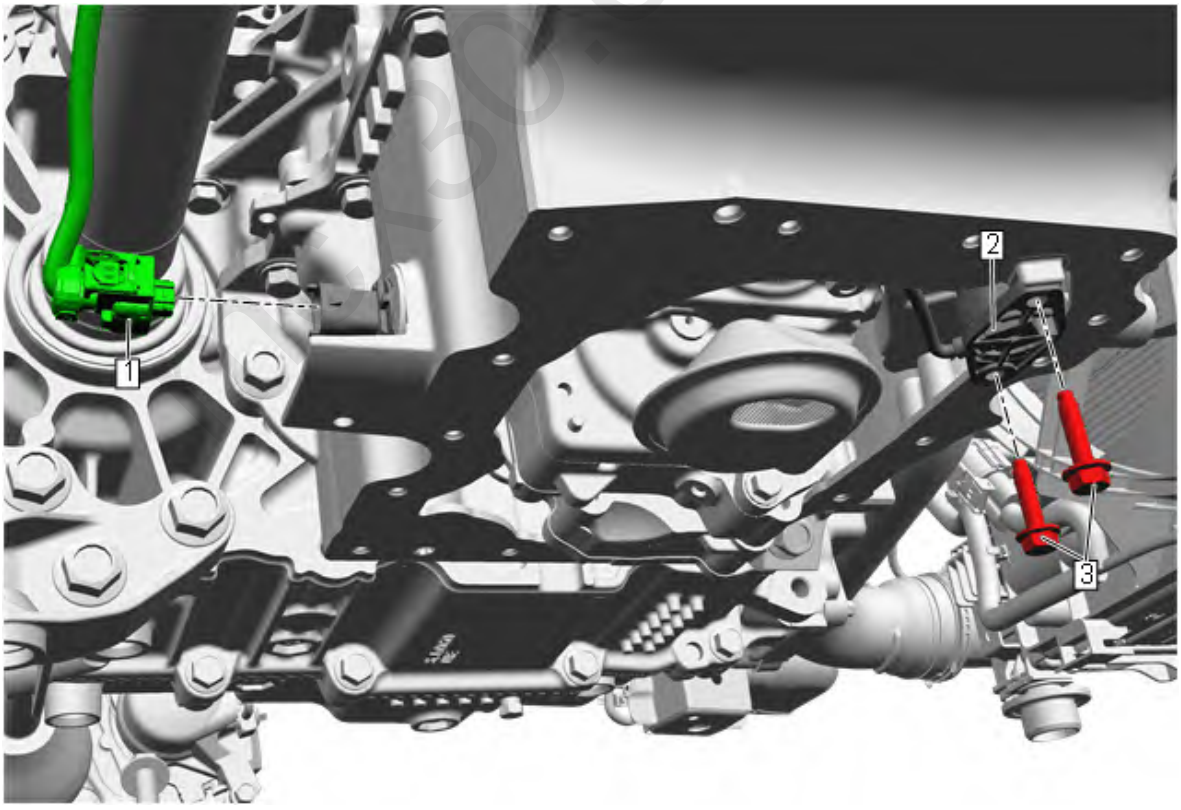


Fig. 234: Electrical Connector And Engine Oil Level Indicator Switch
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

6. Install Engine Oil Level Indicator Switch Bolt (3) and tighten [2x] 10 N.m (89 lb in)
7. Connect Electrical Connector (1) @ Engine Oil Level Indicator Switch (2)
8. Install Lower Oil Pan - **Lower Oil Pan Replacement**

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

Removal Procedure

Special Tools

- **EN-45059** Angle Meter
- **EN-50792** Holding Tool

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

1. Remove the transmission. Refer to **Transmission Replacement (Front Wheel Drive except Diesel Engine)** **Transmission Replacement (All Wheel Drive except Diesel Engine)** .

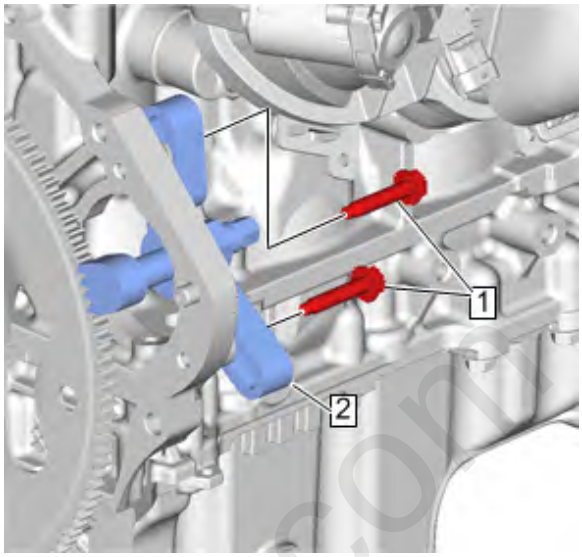


Fig. 235: Starter Motor Bolts
Courtesy of GENERAL MOTORS COMPANY

2. To prevent crankshaft rotation, install the **EN-50792** holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the automatic flex plate.

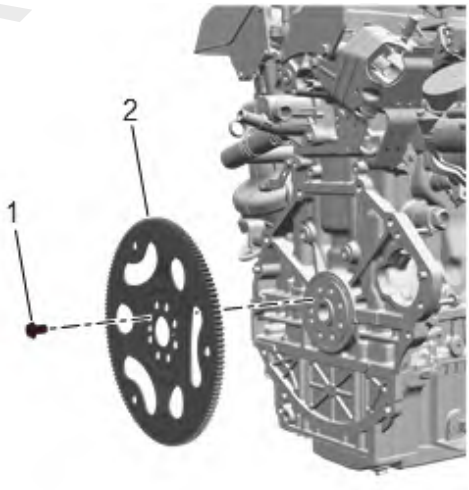


Fig. 236: Automatic Flex Plate Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the automatic transmission flex plate attaching bolts (1).
4. Remove the automatic transmission flex plate (2).
5. Remove the **EN-50792** holding tool.
6. For automatic transmission flex plate cleaning and inspection, Refer to **Automatic Transmission Flex Plate Cleaning and Inspection**.

Installation Procedure

mcx30.com

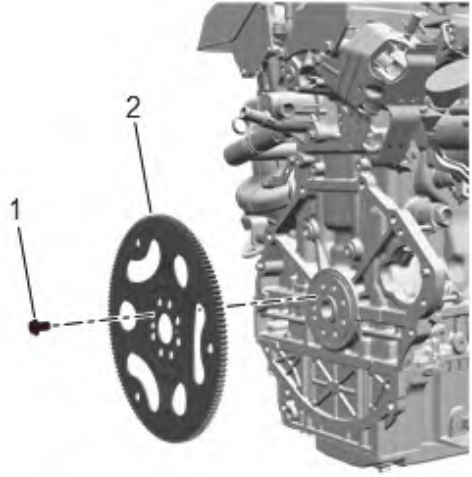


Fig. 237: Automatic Flex Plate Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Fasteners have adhesive patch and must be tighten ed to final torque within 5 minutes.**

1. Install the automatic transmission flex plate (2) and hand start NEW bolts (1).

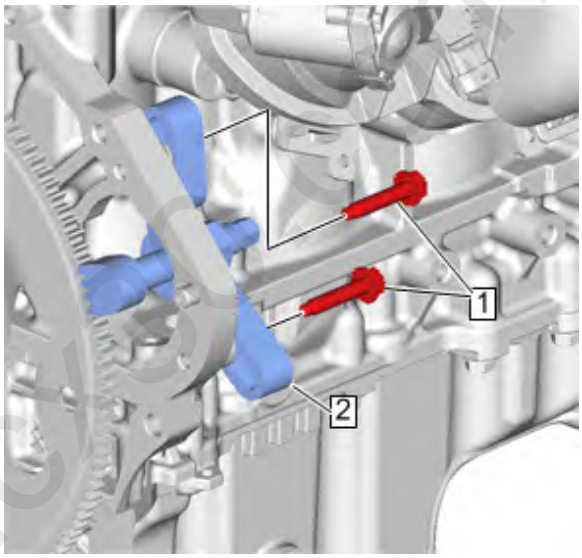


Fig. 238: Starter Motor Bolts
Courtesy of GENERAL MOTORS COMPANY

2. To prevent crankshaft rotation, install **EN-50792** holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the flex plate.

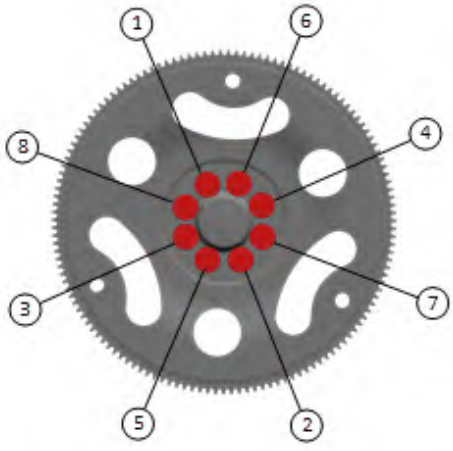


Fig. 239: Flex Plate Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

3. tighten the bolts evenly using the following procedure:
    1. tighten the bolts a first pass in sequence to 20 N.m (15 lb ft).
    2. tighten the bolts a second pass in sequence to 30 N.m (22 lb ft).
    3. tighten the bolts a final pass in sequence 40 degrees using the **EN 45059** meter.
4. Remove the **EN-50792** holding tool.
5. Install the transmission. Refer to Transmission Replacement (Front Wheel Drive except Diesel Engine) Transmission Replacement (All Wheel Drive except Diesel Engine) .

CRANKSHAFT REAR OIL SEAL REPLACEMENT

Special Tools

EN-51380 Seal Installer

For equivalent regional tools, refer to Special Tools.

Removal Procedure

1. Remove the automatic transmission flex plate. Refer to Automatic Transmission Flex Plate Replacement.

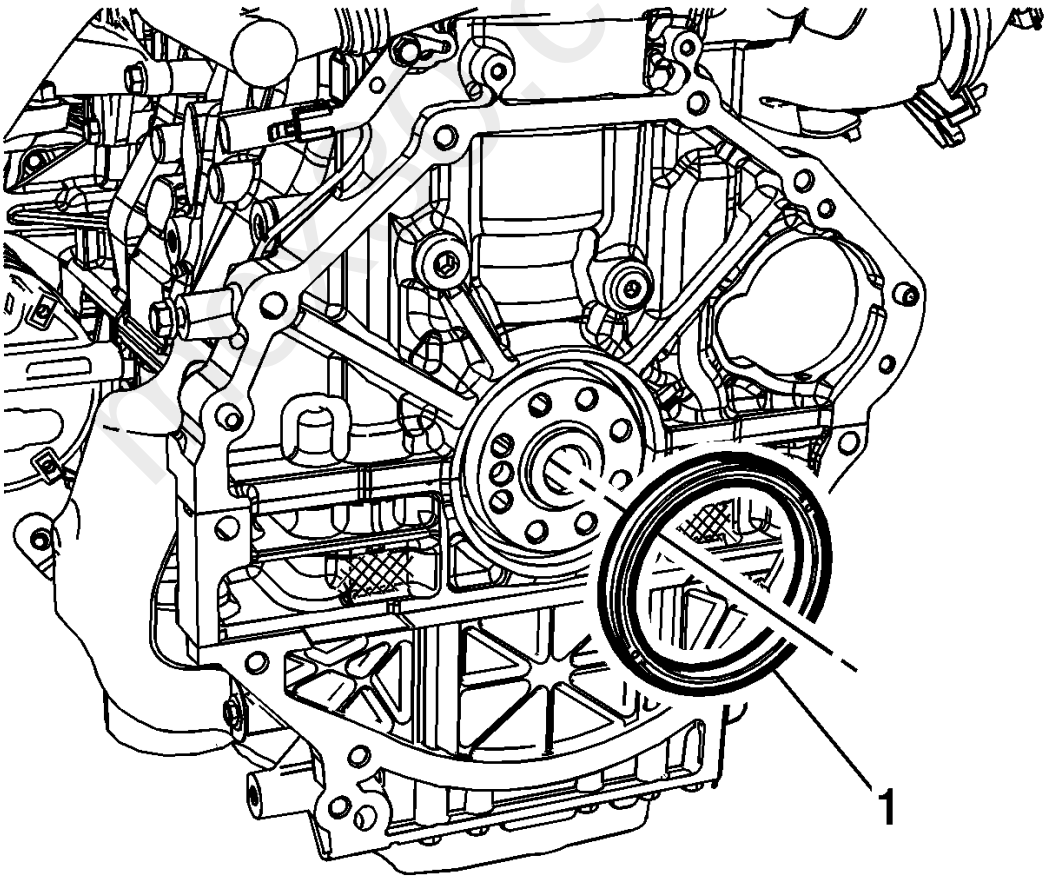


Fig. 240: Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not damage the outside diameter of the crankshaft or chamber with any tool.**

2. Use a suitable tool to remove the crankshaft rear oil seal (1).

Installation Procedure

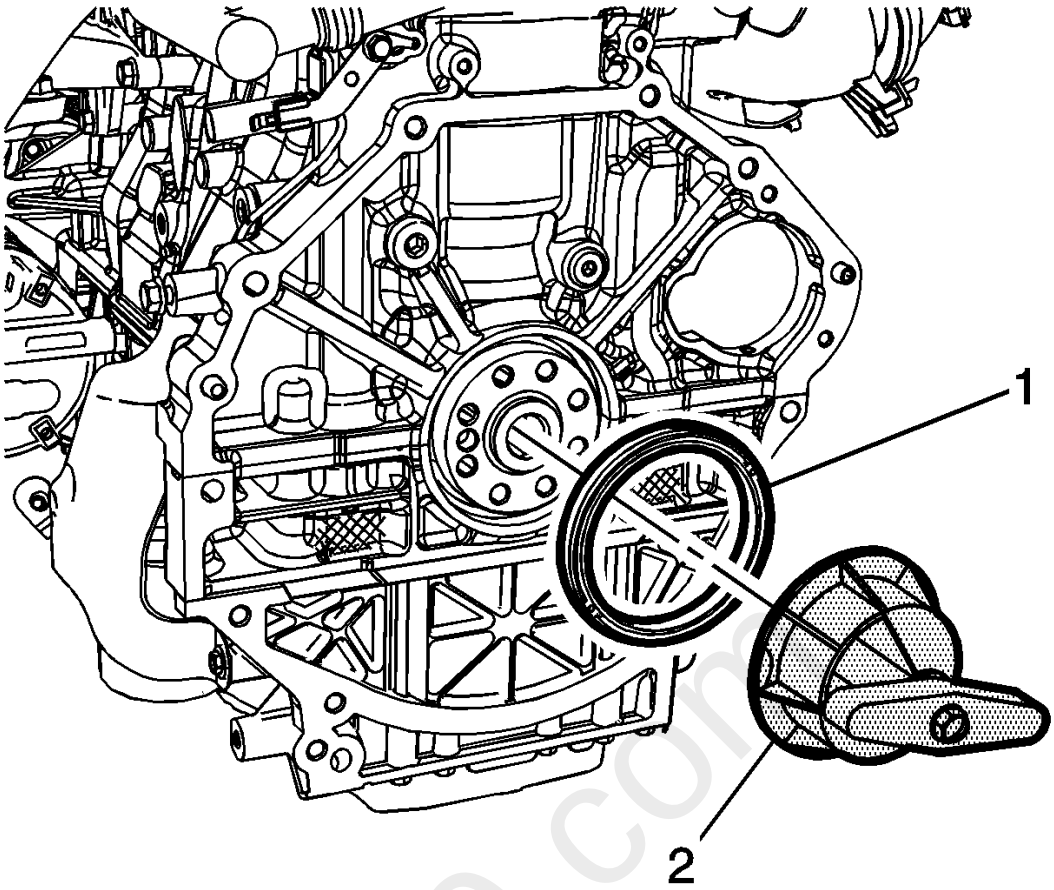


Fig. 241: Crankshaft Rear Oil Seal And Seal Installer
Courtesy of GENERAL MOTORS COMPANY

1. Using the (2) **EN-51380** seal installer, install a NEW crankshaft real oil seal (1).
2. Install the automatic transmission flex plate. Refer to **Automatic Transmission Flex Plate Replacement**.

ENGINE REPLACEMENT (2 WHEEL DRIVE)

Removal Procedure

1. Relieve the fuel system pressure. **Fuel Pressure Relief**
2. Recover the refrigerant. **Refrigerant Recovery and Recharging (R-134a)** **Refrigerant Recovery and Recharging (R-1234yf)**
3. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)**
4. Drain the engine oil. **Engine Oil and Oil Filter Replacement**
5. Remove Battery Tray **Battery Tray Replacement**

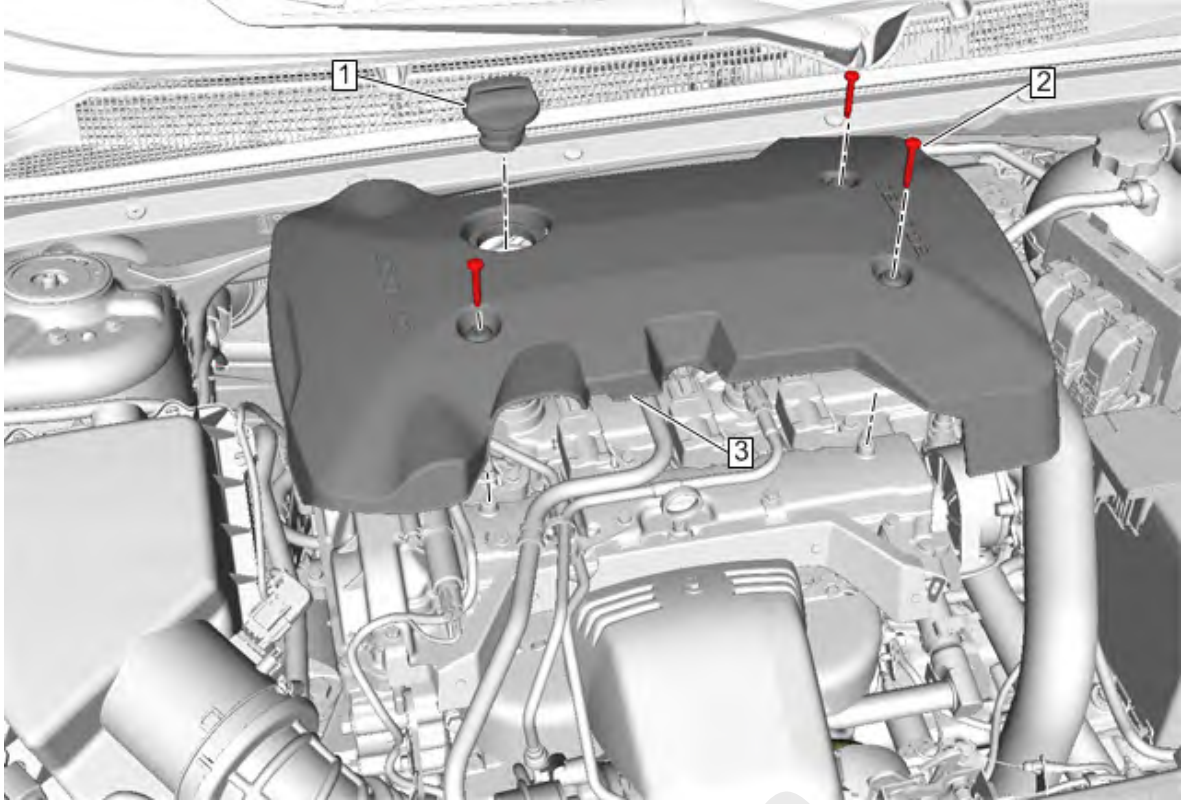


Fig. 242: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

6. Remove Intake Manifold Cover (3) **Intake Manifold Cover Replacement**

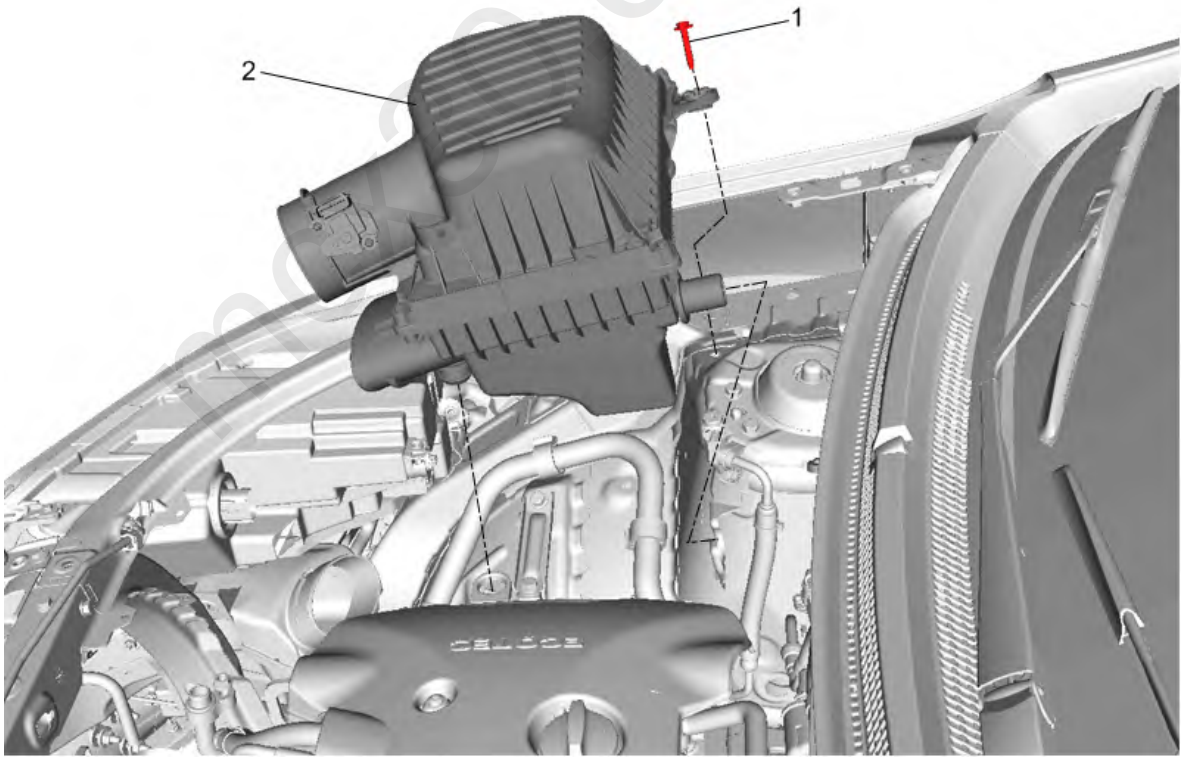


Fig. 243: Air Cleaner Assembly
Courtesy of GENERAL MOTORS COMPANY

7. Remove Air Cleaner Assembly (2)**Air Cleaner Assembly Replacement** .

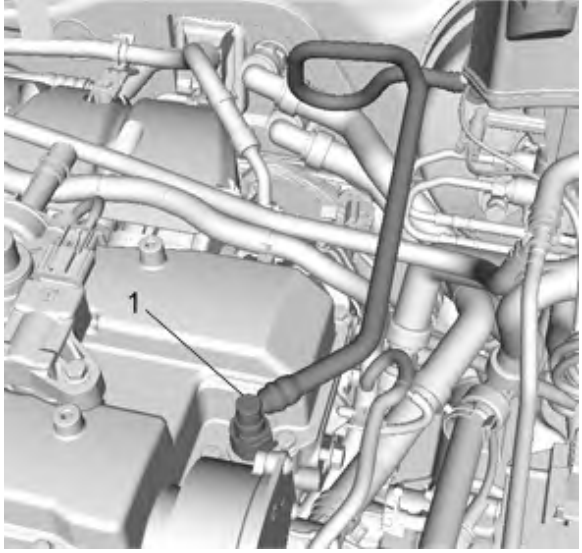


Fig. 244: Vacuum Hose
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect Power Brake Booster Vacuum Pipe (1)**Plastic Collar Quick Connect Fitting Service**

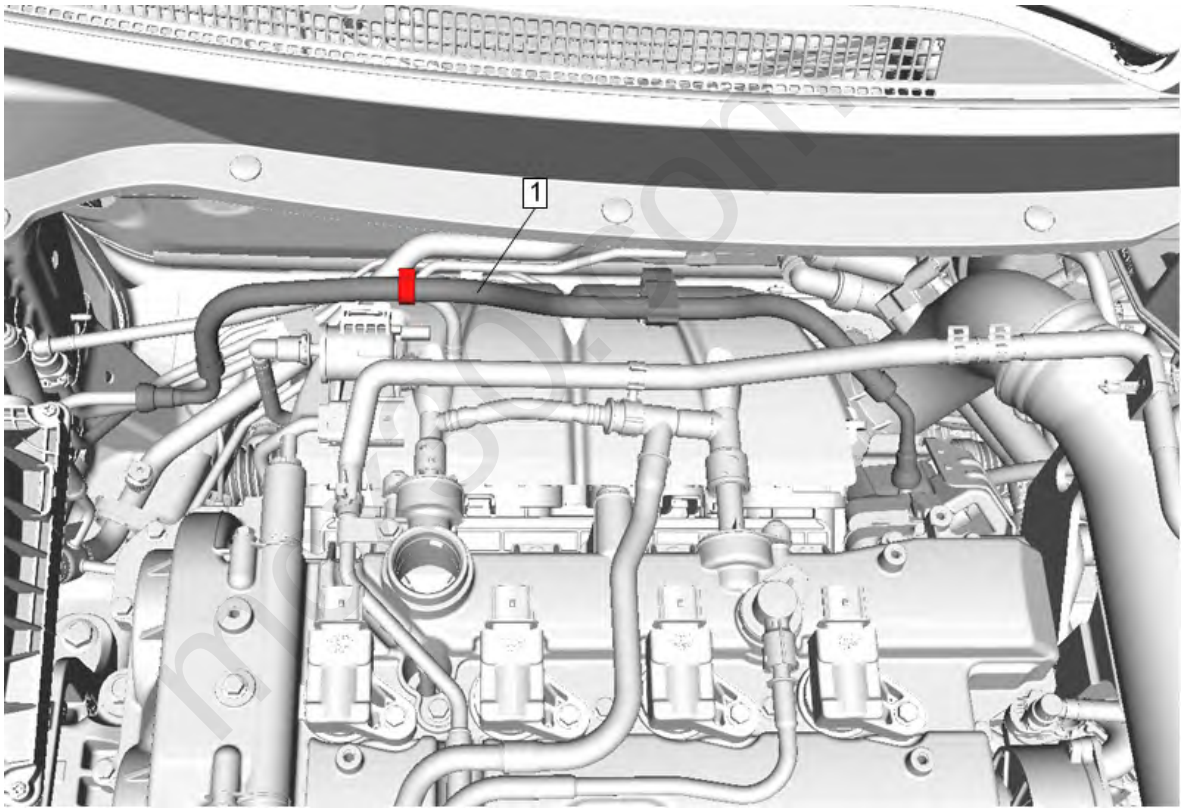


Fig. 245: Fuel Feed Front Pipe
Courtesy of GENERAL MOTORS COMPANY

9. Remove Fuel Feed Front Pipe (1)**Fuel Feed Front Pipe Replacement**

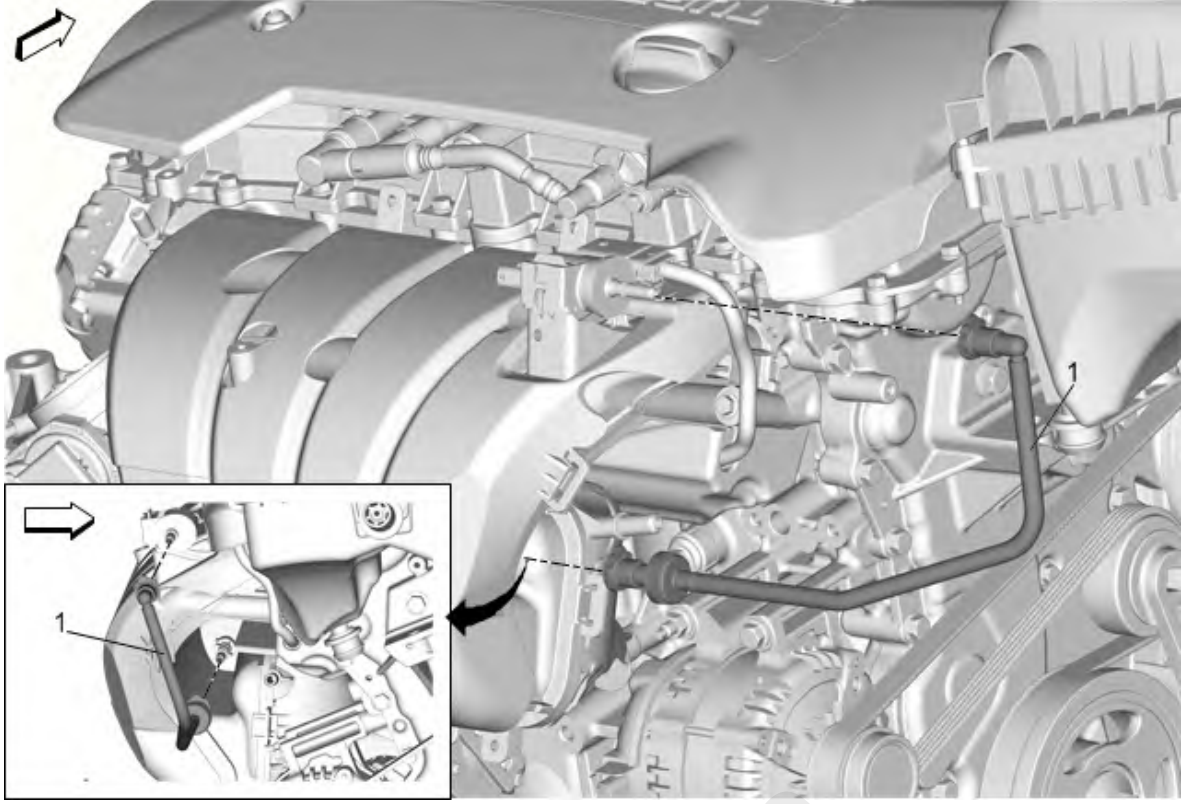


Fig. 246: Evaporative Emission Canister Purge Tube
Courtesy of GENERAL MOTORS COMPANY

10. Remove Evaporative Emission Canister Purge Tube (1) **Evaporative Emission Canister Purge Tube Replacement**

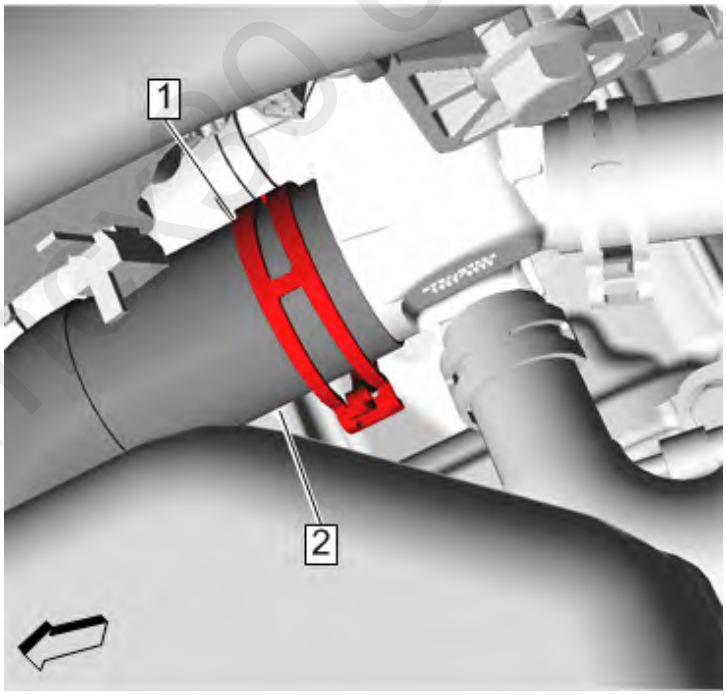


Fig. 247: Heater Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

11. Disconnect Heater Inlet Hose (2) @ Water Outlet - **Heater Inlet Hose Replacement (LTG with KL9)**

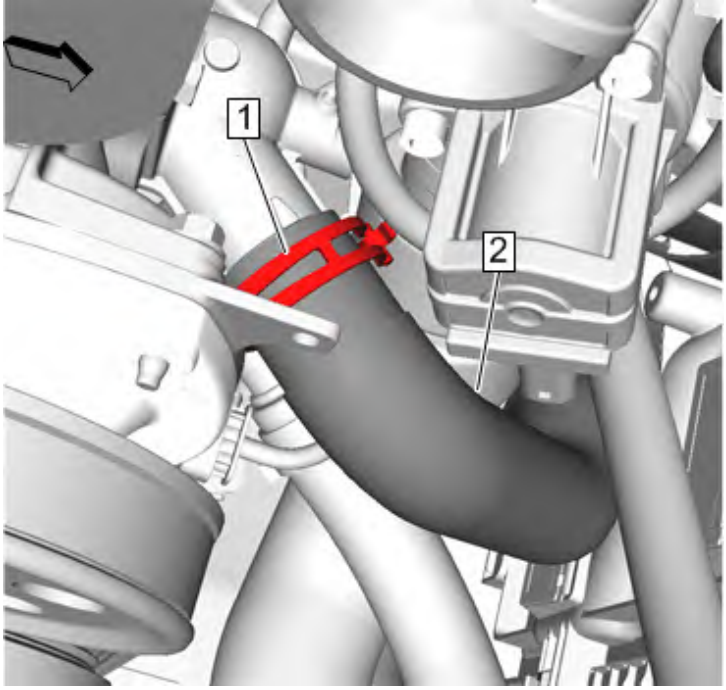


Fig. 248: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

12. Disconnect Radiator Outlet Hose (2) @ Engine Coolant Thermostat Housing - **Radiator Outlet Hose Replacement (LTG with KL9)**

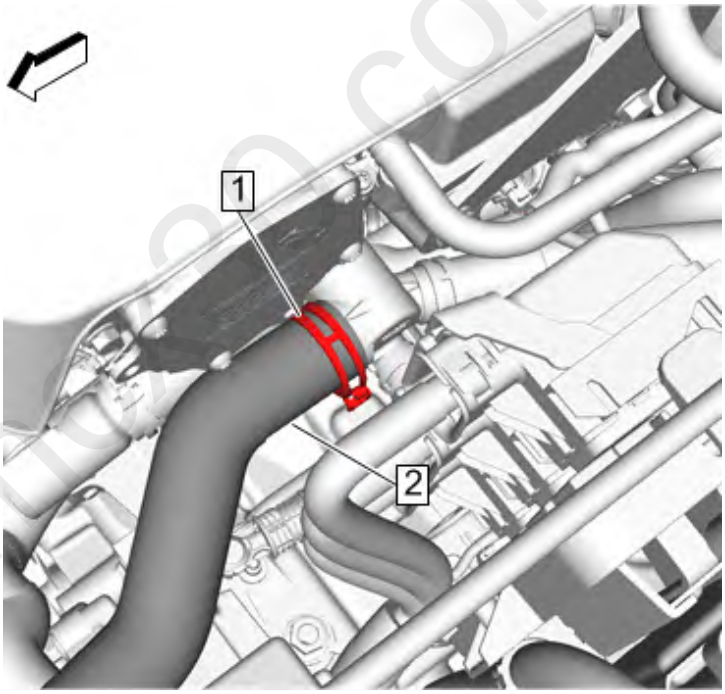


Fig. 249: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

13. Disconnect Radiator Inlet Hose (2) @ Water Outlet - **Radiator Inlet Hose Replacement (LTG with KL9)**

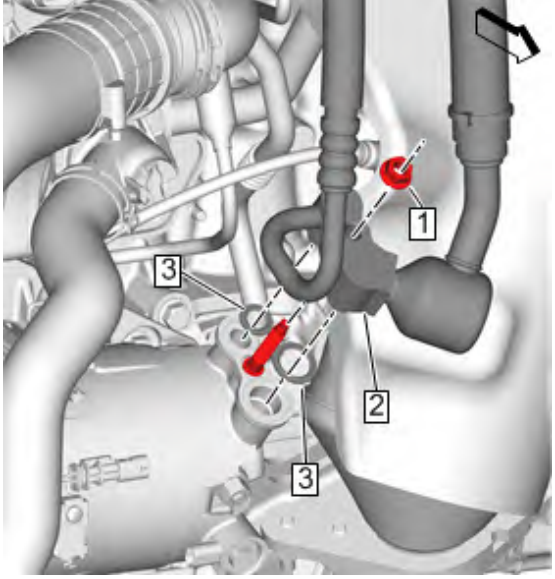


Fig. 250: Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose
Courtesy of GENERAL MOTORS COMPANY

14. Disconnect Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose (2) @ Air Conditioning Compressor - **Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose Replacement (LTG)**

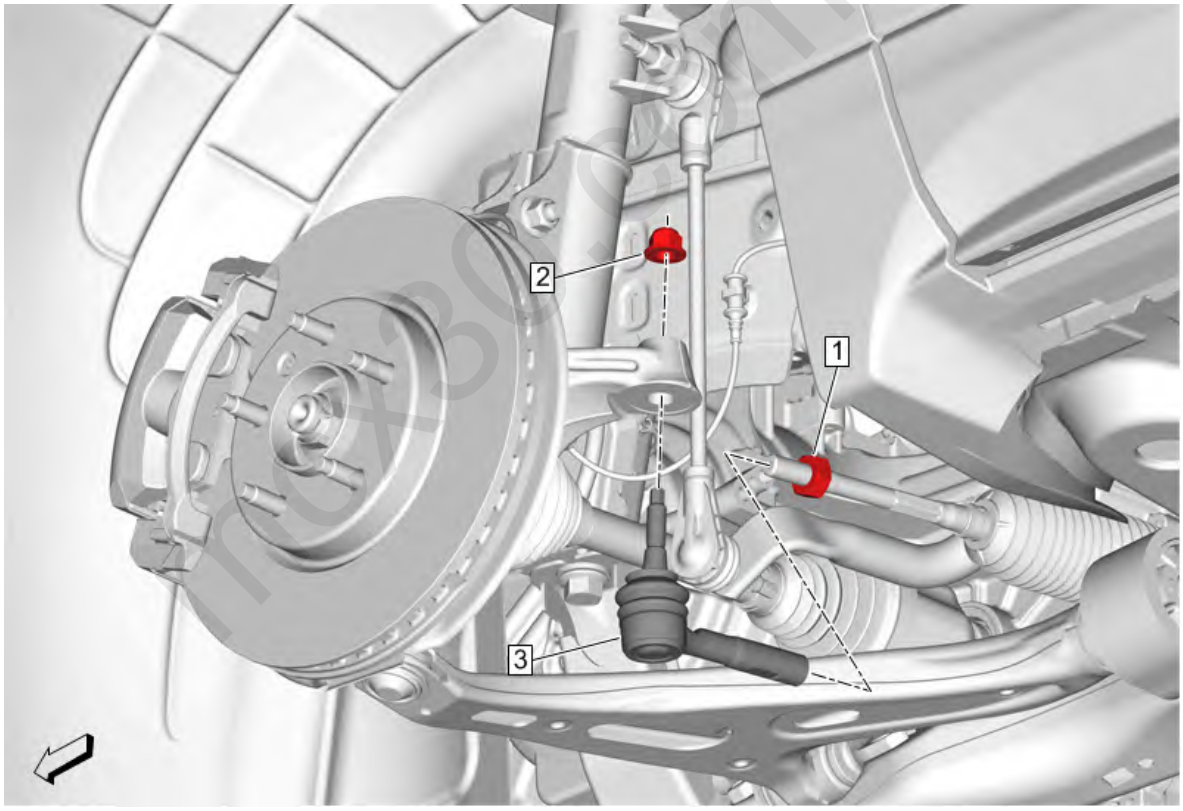


Fig. 251: Steering Linkage Outer Tie Rod
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Left side shown, right side similar.**

15. Disconnect Steering Linkage Outer Tie Rod (3) @ Steering Knuckle - **Steering Linkage Outer Tie Rod Replacement**

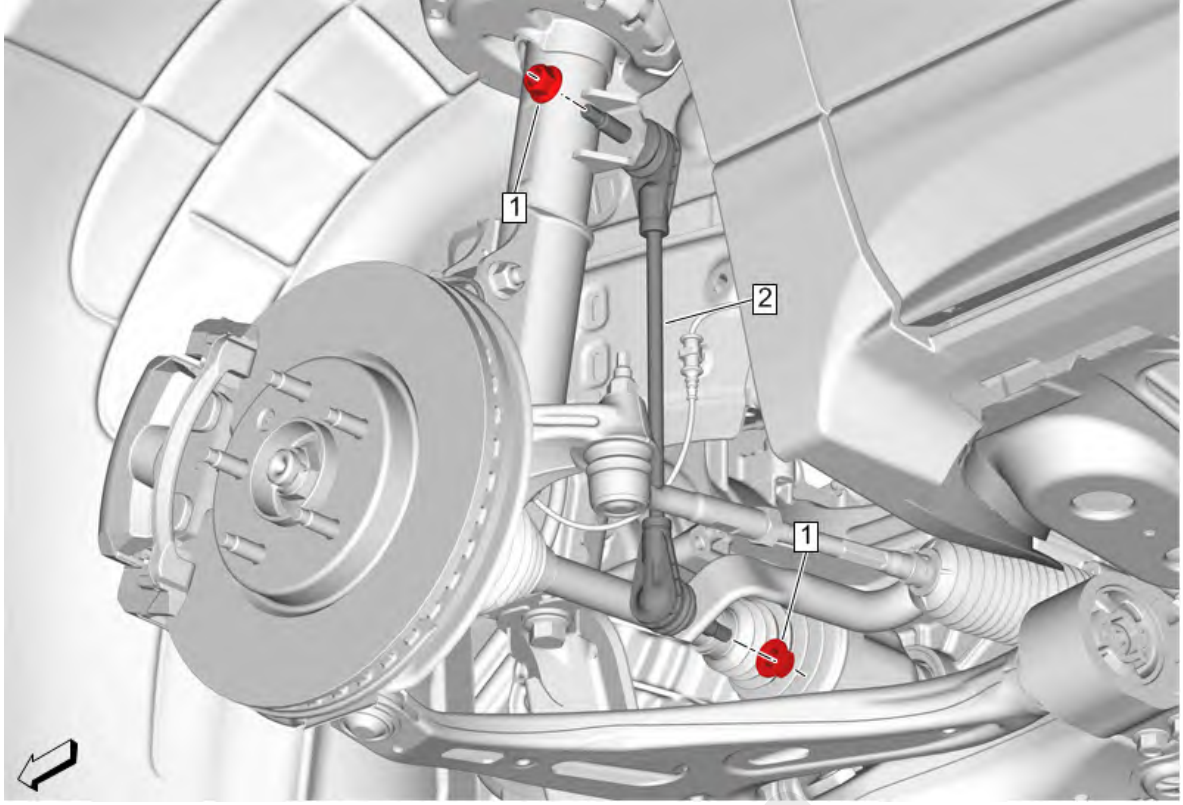


Fig. 252: Upper Stabilizer Shaft Link Nut
Courtesy of GENERAL MOTORS COMPANY

16. Disconnect Stabilizer Shaft Link(2) @ Stabilizer Shaft - **Stabilizer Shaft Link Replacement (Equinox)** **Stabilizer Shaft Link Replacement (Terrain)**

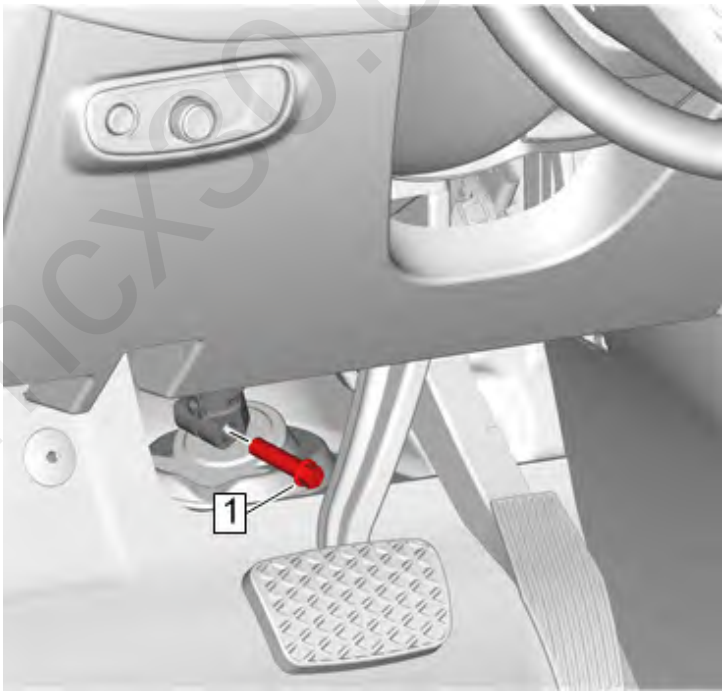


Fig. 253: Intermediate Shaft Pinch Bolt
Courtesy of GENERAL MOTORS COMPANY

17. Remove the intermediate shaft pinch bolt (1), then disconnect the intermediate shaft from the steering gear. **Intermediate Steering Shaft Replacement (Equinox)** **Intermediate Steering Shaft Replacement (Terrain)** .
18. Remove Exhaust Front Pipe - **Exhaust Front Pipe Replacement (LTG)**

mcx30.com

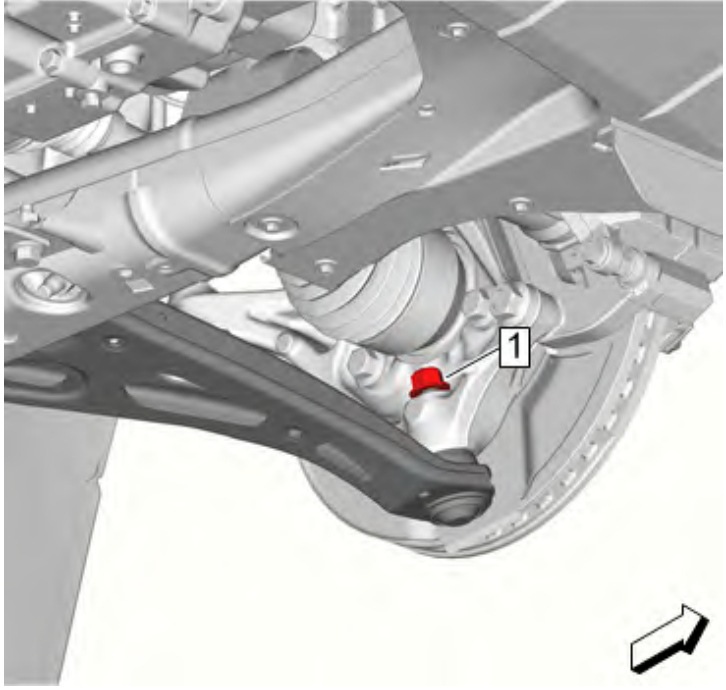


Fig. 254: Lower Control Arm To Steering Knuckle Nut
Courtesy of GENERAL MOTORS COMPANY

19. Remove the front lower control arm ball stud nuts (1) then disconnect the lower control arms from the steering knuckles. **Lower Control Arm Replacement (Equinox)** **Lower Control Arm Replacement (Terrain)** .
20. Remove Front Wheel Drive Half Shaft-Left Side -**Front Wheel Drive Half Shaft Replacement - Left Side**
21. Remove Front Wheel Drive Half Shaft- Right Side - **Front Wheel Drive Half Shaft Replacement - Right Side (AWD)** **Front Wheel Drive Half Shaft Replacement - Right Side (M3U, MHG, MNH, MNK with FWD)** **Front Wheel Drive Half Shaft Replacement - Right Side (M3D, M3H with FWD)**

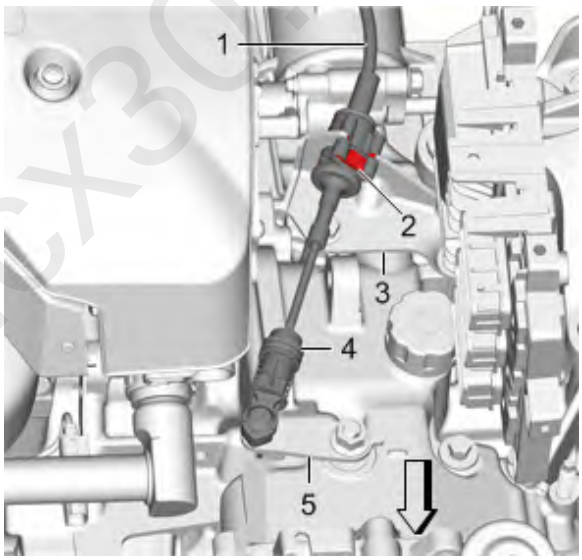


Fig. 255: Transmission Range Selector Lever Cable Components
Courtesy of GENERAL MOTORS COMPANY

22. Disconnect the range selector lever cable terminal from the transmission manual shift lever.

NOTE: **During the powertrain removal support the vehicle body by placing a jack at the rear of the vehicle.**

23. Position an engine support table under the powertrain assembly.
24. Blocks of wood can be used between the front of the frame and the oil pan to table in order to level the powertrain during the removal.
25. With the table positioned, fully raise the table to contact with the powertrain assembly.

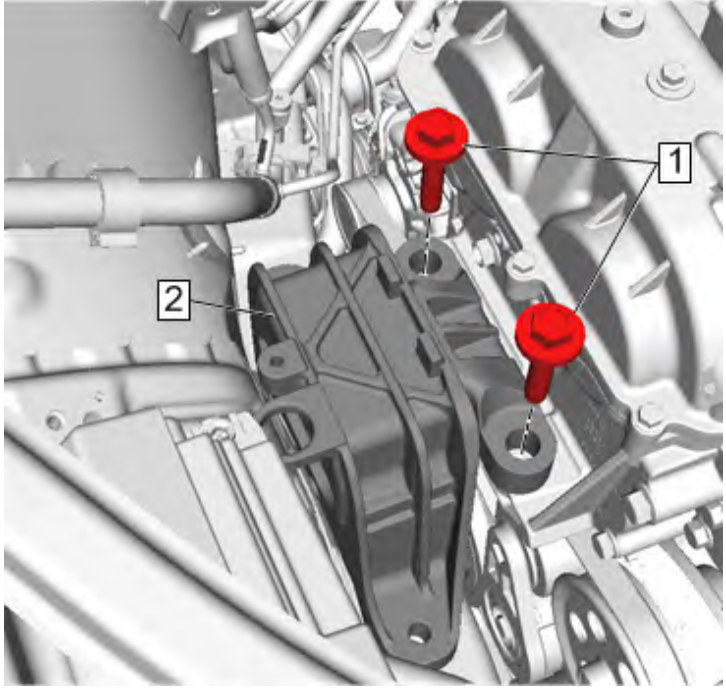


Fig. 256: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

26. Remove Engine Mount Bolt (1) - **Engine Mount Replacement**
27. Remove Transmission Mount - **Transmission Mount Replacement (Left Side M3U)** **Transmission Mount Replacement (Left Side M3D/M3H)**

NOTE: **Remove ONLY the body to frame bolts as the powertrain will be removed while still bolted to the frame.**

28. Remove the frame to body bolts. **Drivetrain and Front Suspension Cradle Replacement (Front Wheel Drive)** **Drivetrain and Front Suspension Cradle Replacement (All Wheel Drive)** .
29. Disconnect electrical connectors as necessary.
30. Carefully lower the engine table and raise the body on the hoist until the engine/transaxle and frame are separated from the vehicle.
31. Separate the engine from the transaxle. **Transmission Replacement (Front Wheel Drive)** **Transmission Replacement (All Wheel Drive)**
32. Install the engine to a suitable engine stand.

Installation Procedure

1. Install the engine to the transaxle. **Transmission Replacement (Front Wheel Drive)** **Transmission Replacement (All Wheel Drive)**
2. Position the powertrain support table under the vehicle.
3. Raise the powertrain into position under the vehicle.
4. With the table positioned, if required, lower the vehicle over the powertrain.
5. Install the frame to body bolts. **Drivetrain and Front Suspension Cradle Replacement (Front Wheel Drive)** **Drivetrain and Front Suspension Cradle Replacement (All Wheel Drive)**
6. Lower the vehicle.
7. Install Transmission Mount - **Transmission Mount Replacement (Left Side M3U)** **Transmission Mount Replacement (Left Side M3D/M3H)**

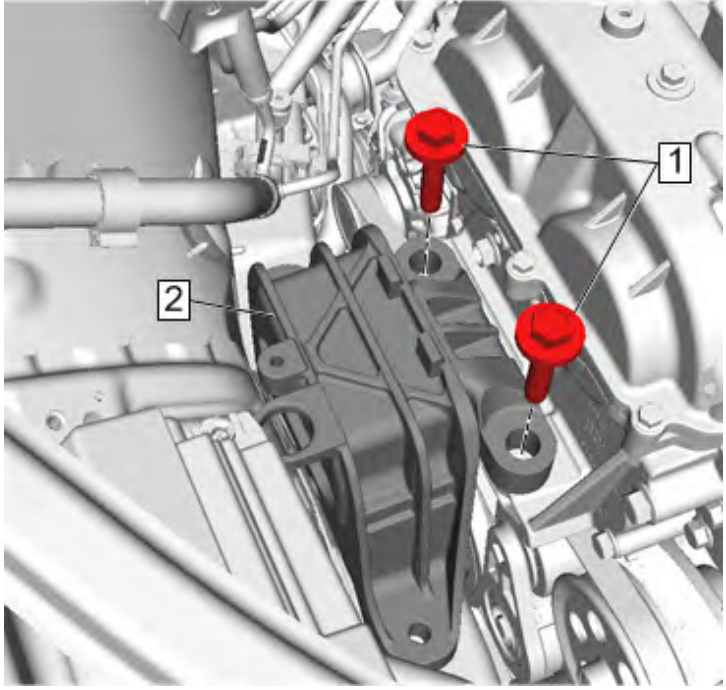


Fig. 257: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install Engine Mount Bolt (1) - **Engine Mount Replacement**

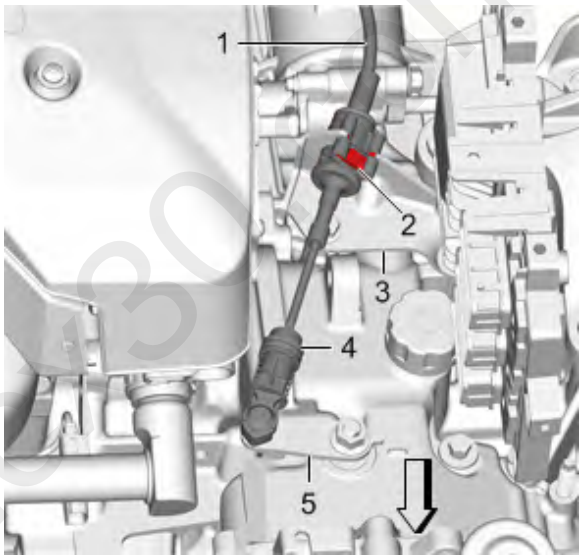


Fig. 258: Transmission Range Selector Lever Cable Components
Courtesy of GENERAL MOTORS COMPANY

9. Connect the range selector lever cable terminal(4) to the transmission manual shift lever (5)
10. Install Front Wheel Drive Half Shaft-Left Side -**Front Wheel Drive Half Shaft Replacement - Left Side**
11. Install Front Wheel Drive Half Shaft- Right Side - **Front Wheel Drive Half Shaft Replacement - Right Side (AWD) Front Wheel Drive Half Shaft Replacement - Right Side (M3U, MHG, MNH, MNK with FWD) Front Wheel Drive Half Shaft Replacement - Right Side (M3D, M3H with FWD)**

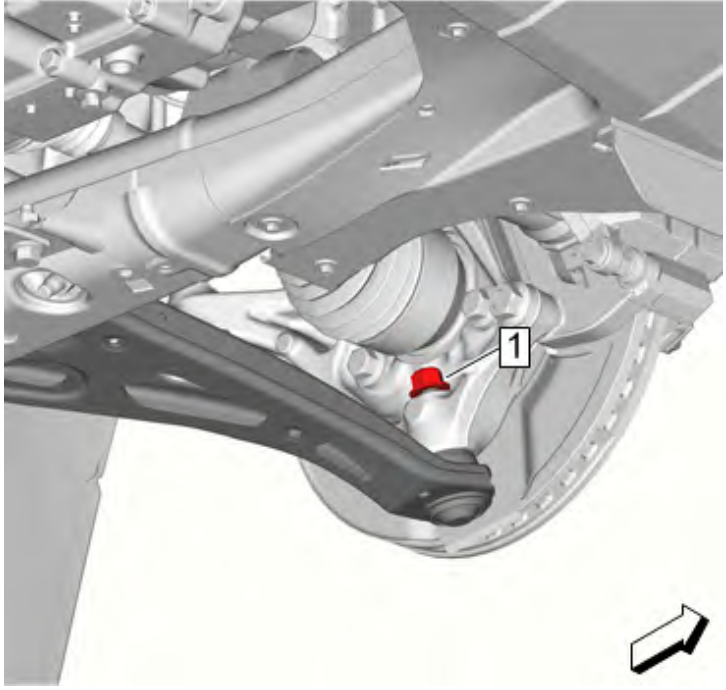


Fig. 259: Lower Control Arm To Steering Knuckle Nut
Courtesy of GENERAL MOTORS COMPANY

12. Connect the lower control arms to the steering knuckles then install the lower control arm ball stud nuts (1). **Lower Control Arm Replacement (Equinox)** **Lower Control Arm Replacement (Terrain)**
13. Install Exhaust Front Pipe - **Exhaust Front Pipe Replacement (LTG)**

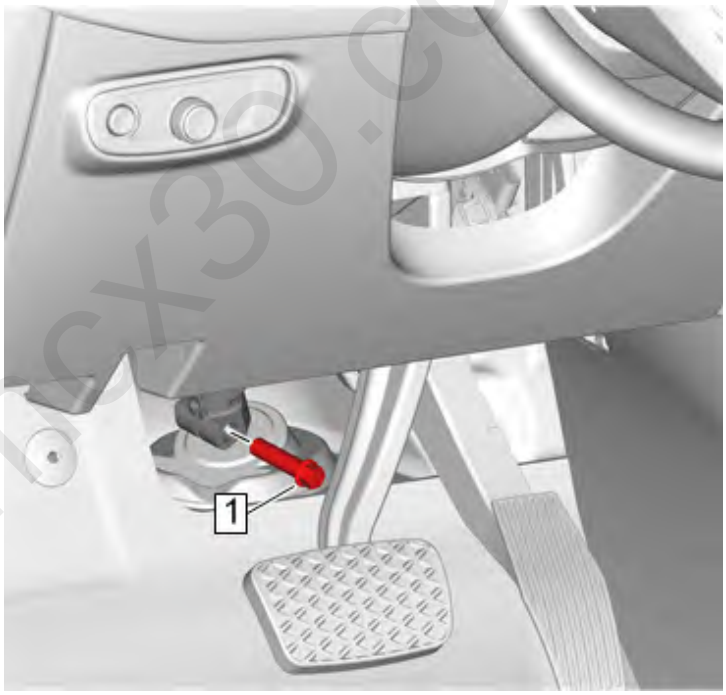


Fig. 260: Intermediate Shaft Pinch Bolt
Courtesy of GENERAL MOTORS COMPANY

14. Connect the intermediate shaft to the steering gear then install the pinch bolt (1). **Intermediate Steering Shaft Replacement (Equinox)** **Intermediate Steering Shaft Replacement (Terrain)**

mcx30.com

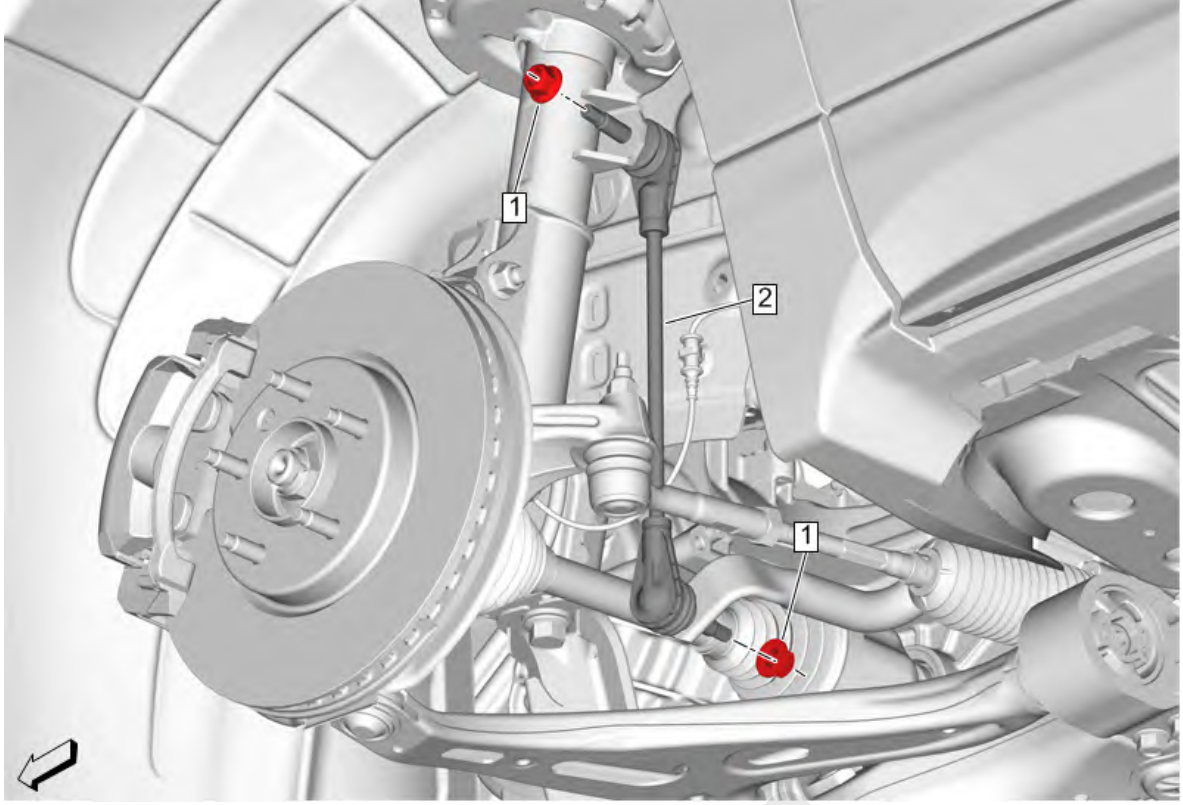


Fig. 261: Upper Stabilizer Shaft Link Nut
Courtesy of GENERAL MOTORS COMPANY

15. Connect Stabilizer Shaft Link @ Stabilizer Shaft (2)**Stabilizer Shaft Link Replacement (Equinox)** **Stabilizer Shaft Link Replacement (Terrain)**

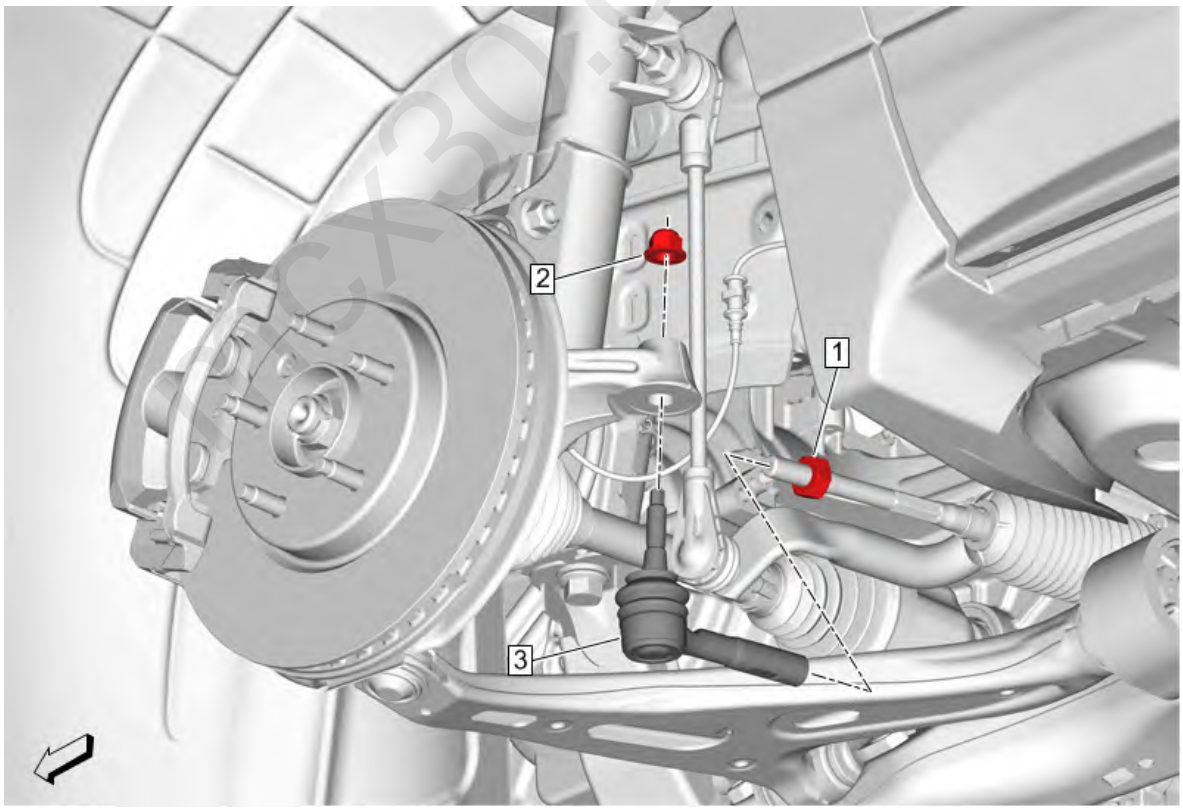


Fig. 262: Steering Linkage Outer Tie Rod
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Left side shown, right side similar.**

16. Connect Steering Linkage Outer Tie Rod (3) @ Steering Knuckle -**Steering Linkage Outer Tie Rod Replacement**

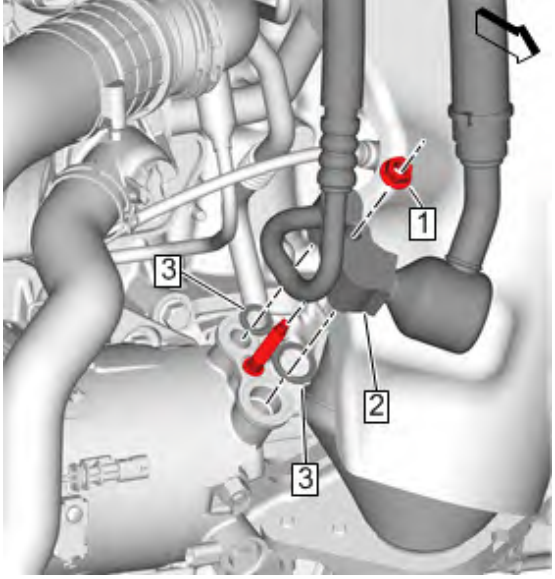


Fig. 263: Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose
Courtesy of GENERAL MOTORS COMPANY

17. Disconnect Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose (2) @ Air Conditioning Compressor - **Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose Replacement (LTG)**

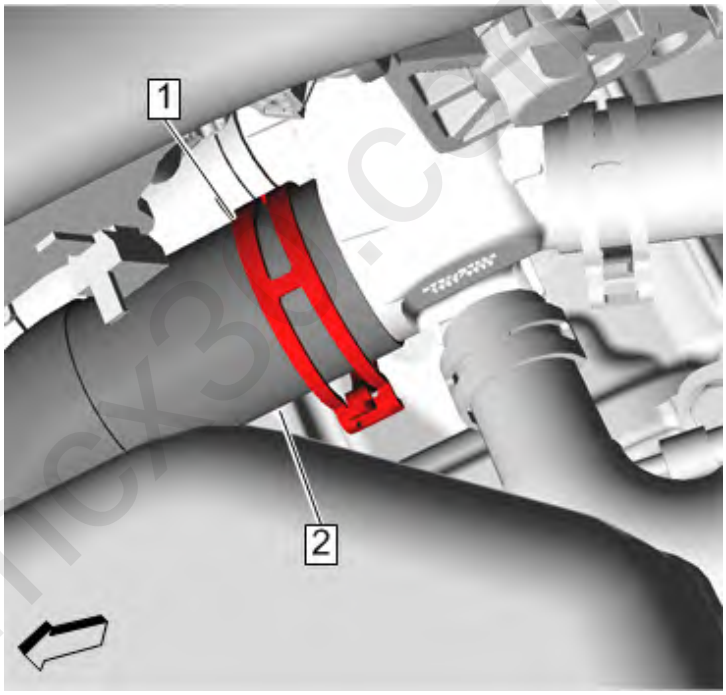


Fig. 264: Heater Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

18. Connect Heater Inlet Hose (2) @ Water Outlet - **Heater Inlet Hose Replacement (LTG with KL9)**

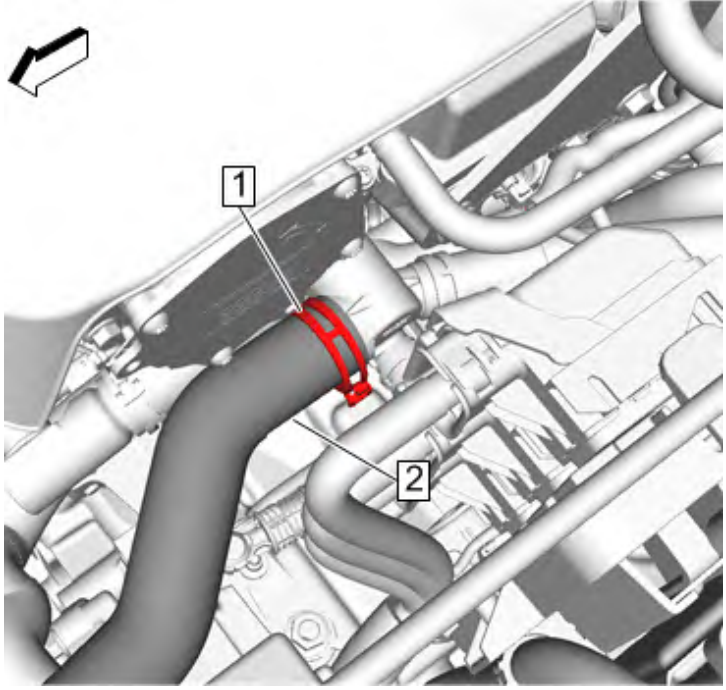


Fig. 265: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

19. Connect Radiator Inlet Hose (2) @ Water Outlet -**Radiator Inlet Hose Replacement (LTG with KL9)**

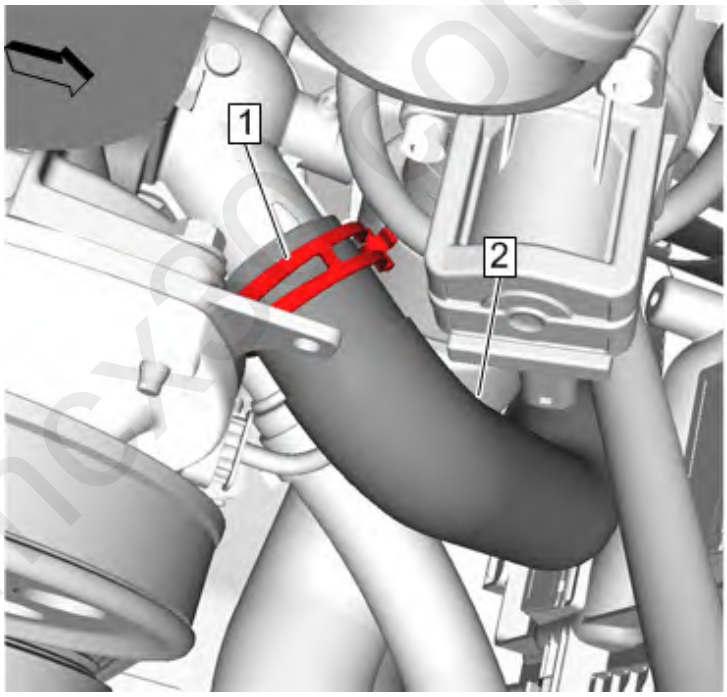


Fig. 266: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

20. Connect Radiator Outlet Hose (2) @ Engine Coolant Thermostat Housing - **Radiator Outlet Hose Replacement (LTG with KL9)**
21. Install Heater Core Outlet Hose - **Heater Outlet Hose Replacement (LYX without KL9)** .

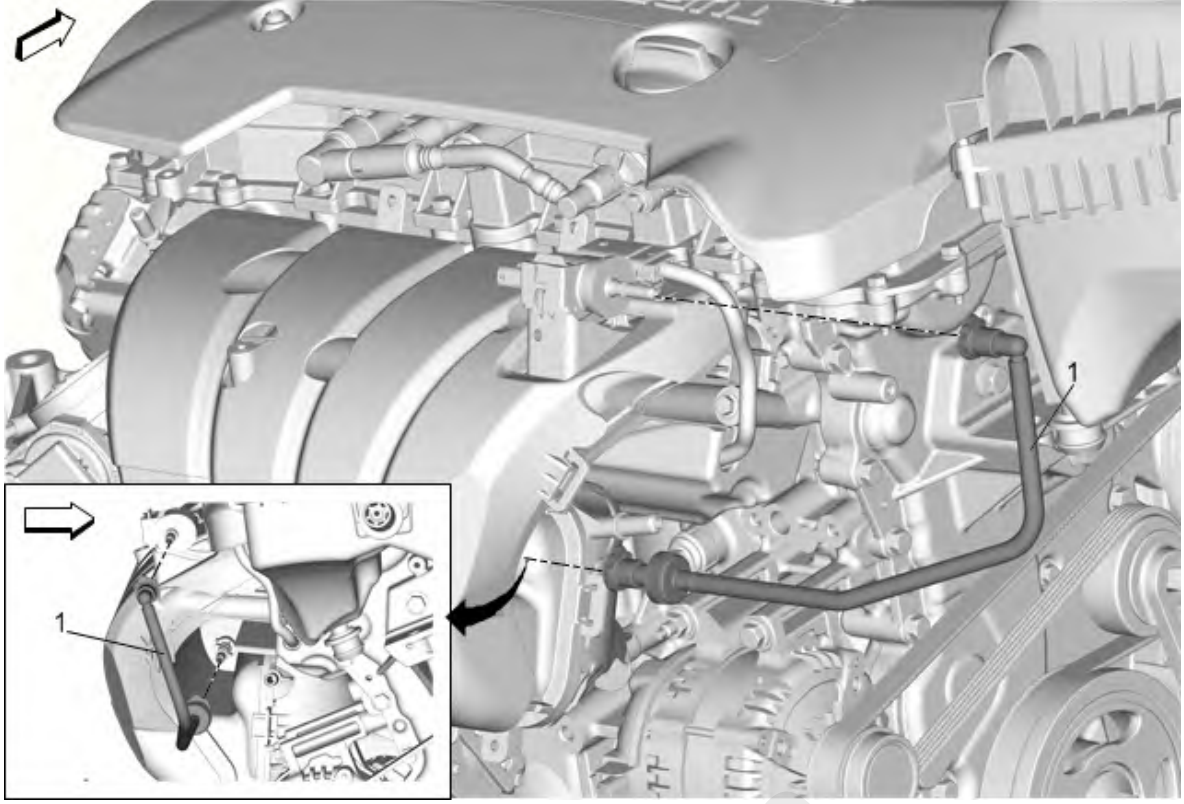


Fig. 267: Evaporative Emission Canister Purge Tube
Courtesy of GENERAL MOTORS COMPANY

22. Install Evaporative Emission Canister Purge Tube (1) - **Evaporative Emission Canister Purge Tube Replacement**

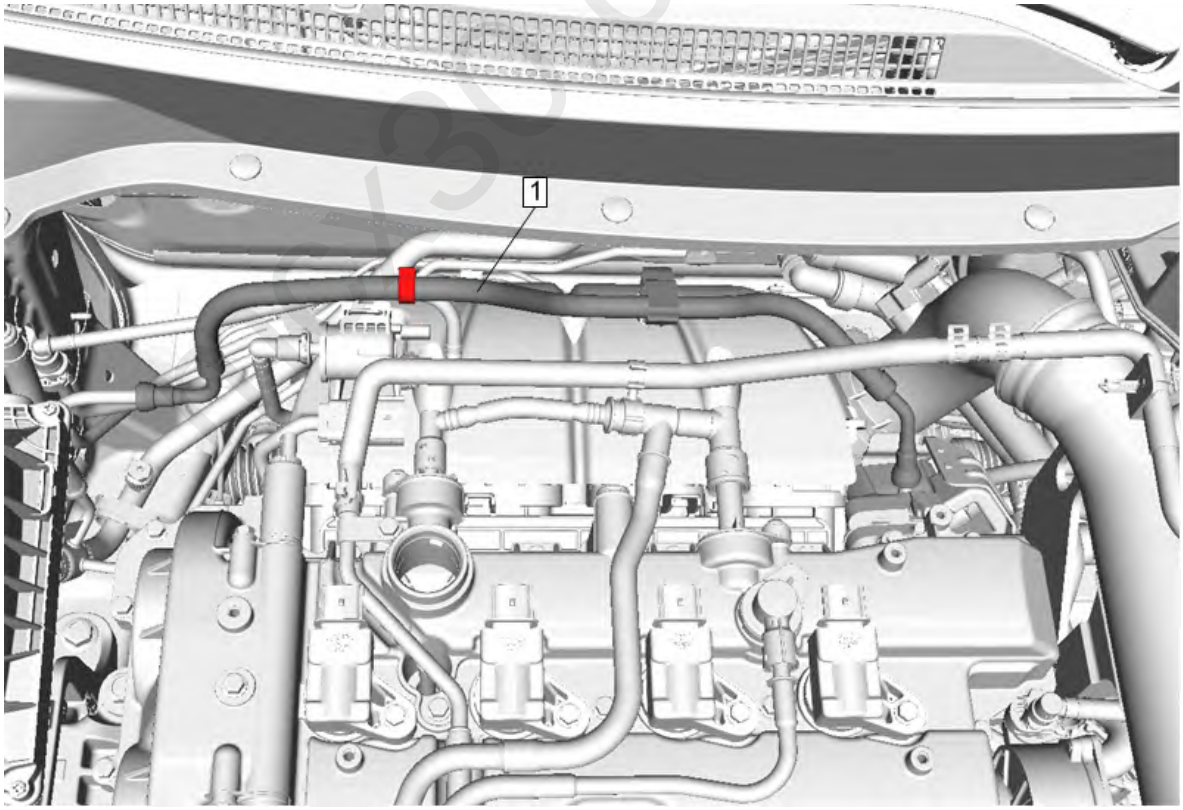


Fig. 268: Fuel Feed Front Pipe
Courtesy of GENERAL MOTORS COMPANY

23. Install Fuel Feed Front Pipe (1)- **Fuel Feed Front Pipe Replacement**

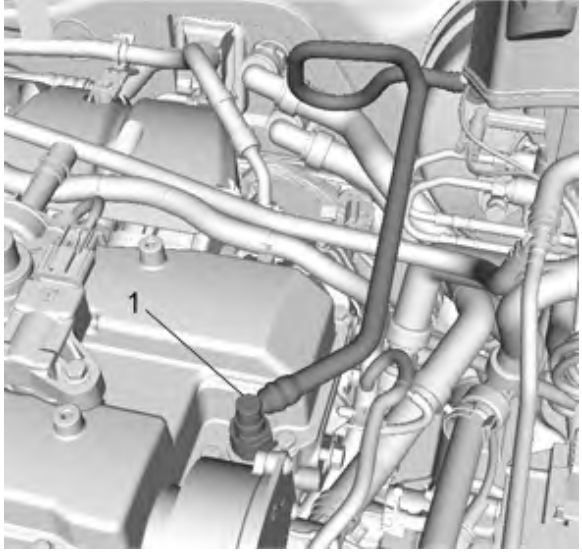


Fig. 269: Vacuum Hose
Courtesy of GENERAL MOTORS COMPANY

24. Connect Power Brake Booster Vacuum Pipe (1) - **Plastic Collar Quick Connect Fitting Service**
25. Connect electrical connectors as needed.

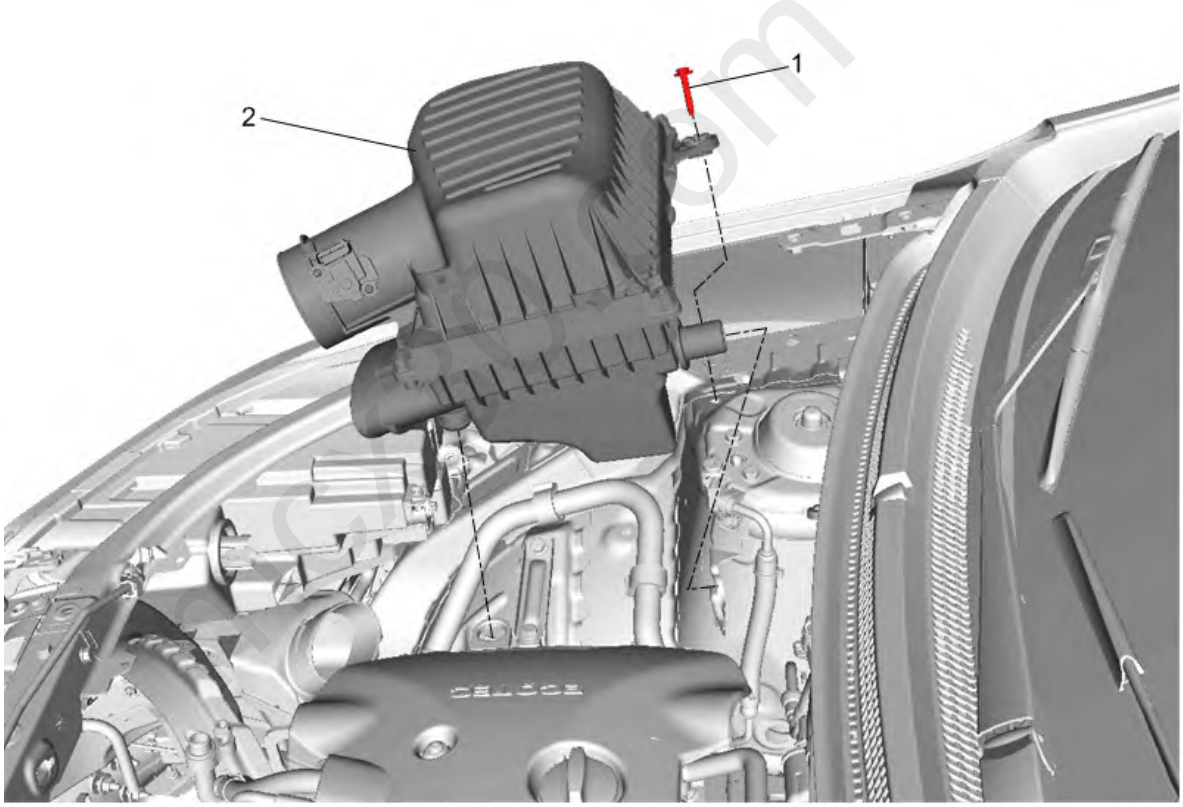


Fig. 270: Air Cleaner Assembly
Courtesy of GENERAL MOTORS COMPANY

26. Install Air Cleaner Assembly (2) - **Air Cleaner Assembly Replacement** .

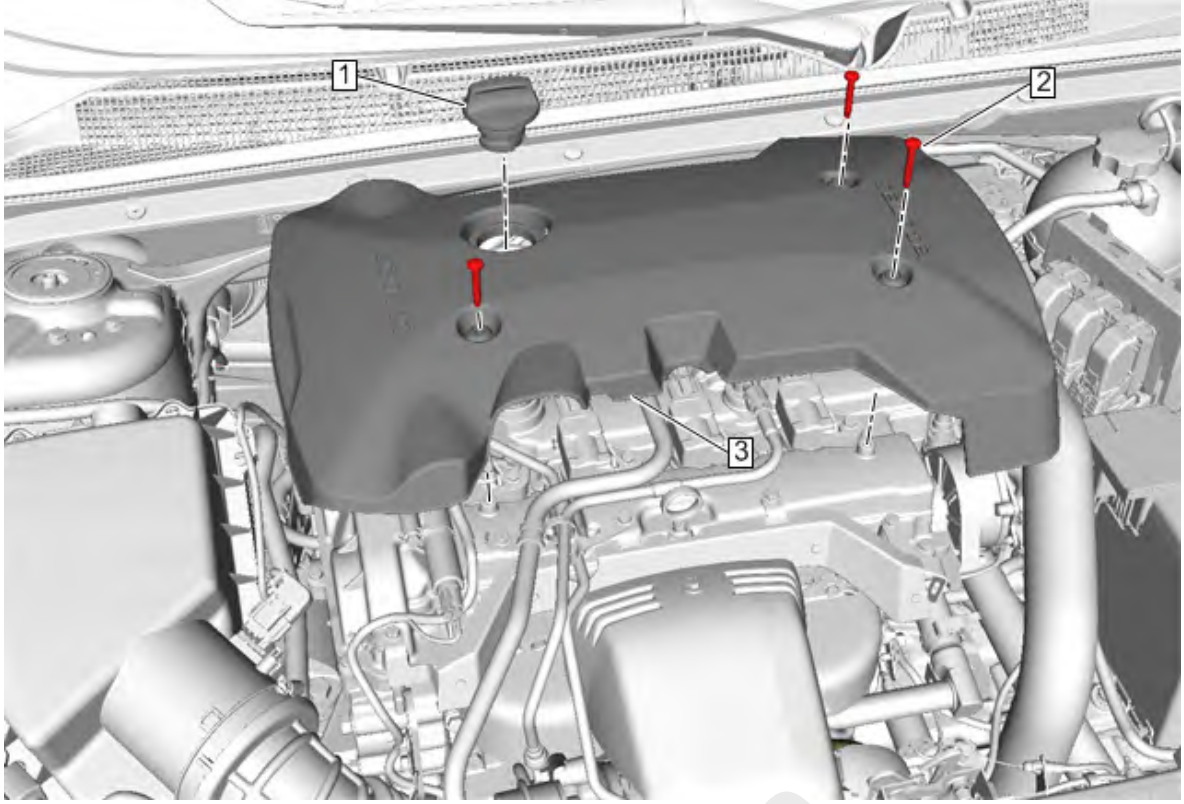


Fig. 271: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

27. Install Intake Manifold Cover (3) - **Intake Manifold Cover Replacement**
28. Install the battery tray. **Battery Tray Replacement**
29. Recharge the A/C system. **Refrigerant Recovery and Recharging (R-134a)** **Refrigerant Recovery and Recharging (R-1234yf)** .
30. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)** .

NOTE: **Prelube is necessary if the engine is replaced or overhauled.**

31. If the engine is replaced with a new engine or has been overhauled, perform the Engine Prelubing procedure. **Engine Prelubing**.
32. If prelubing has not been performed, fill the engine oil. **Engine Oil and Oil Filter Replacement**.
33. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (KL9)** .
34. Perform the Crankshaft Position Variation Learn procedure. **Crankshaft Position Variation Learn**

ENGINE REPLACEMENT (ALL WHEEL DRIVE)

Removal Procedure

1. Relieve the fuel system pressure. **Fuel Pressure Relief**
2. Recover the refrigerant. **Refrigerant Recovery and Recharging (R-134a)** **Refrigerant Recovery and Recharging (R-1234yf)**
3. Drain the cooling system. **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)**
4. Drain the engine oil. **Engine Oil and Oil Filter Replacement**
5. Remove Battery Tray -**Battery Tray Replacement**

mcx30.com

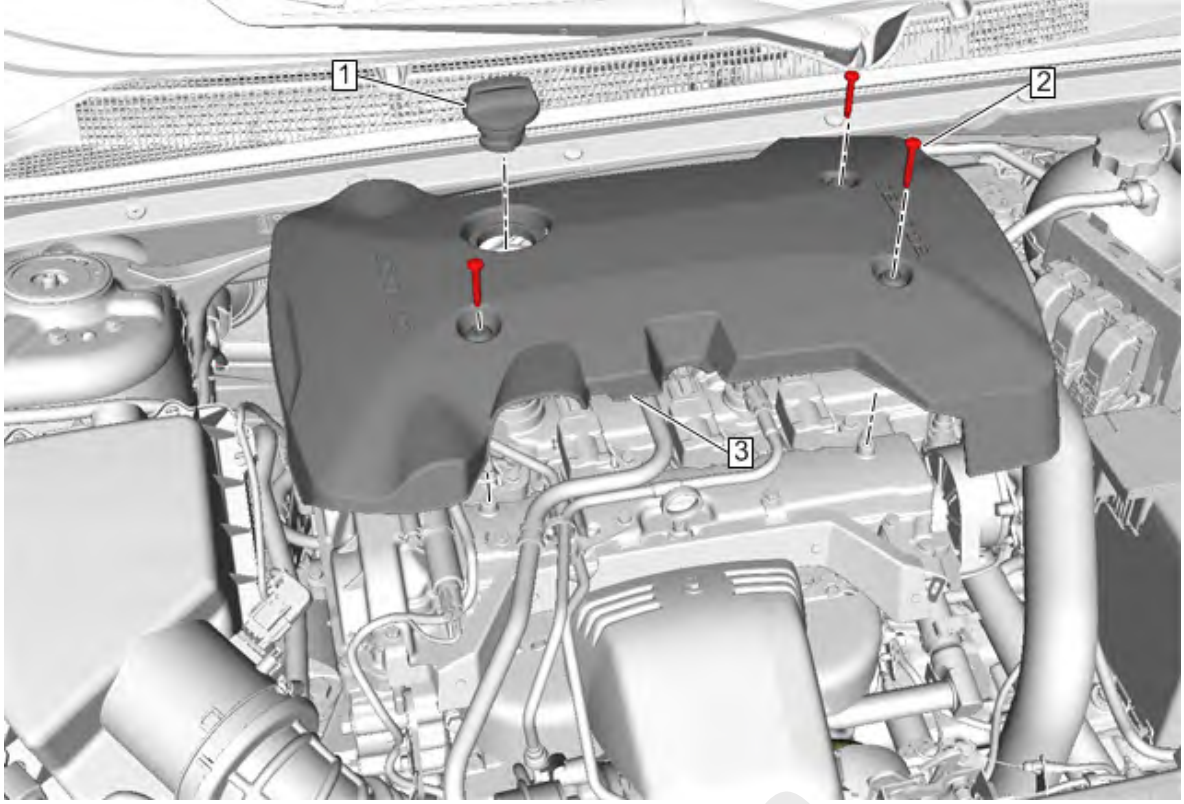


Fig. 272: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

6. Remove Intake Manifold Cover (3) - **Intake Manifold Cover Replacement**

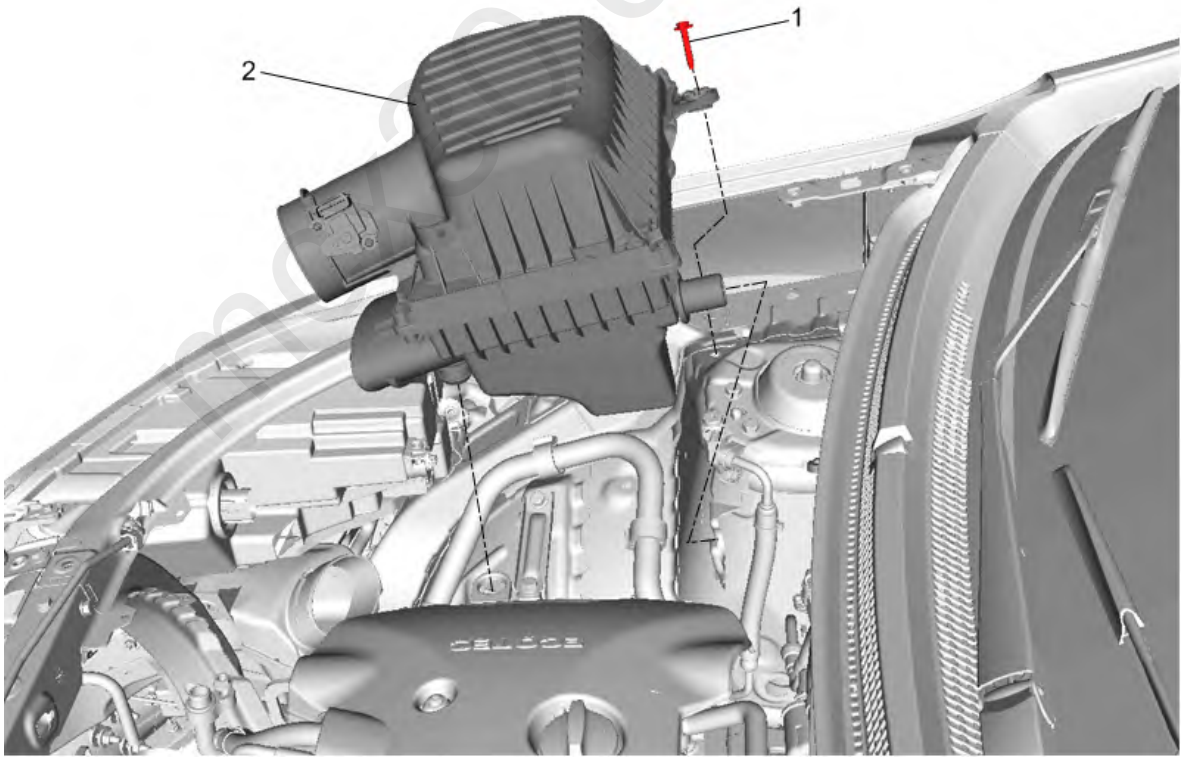


Fig. 273: Air Cleaner Assembly
Courtesy of GENERAL MOTORS COMPANY

7. Remove Air Cleaner Assembly (2) -**Air Cleaner Assembly Replacement** .

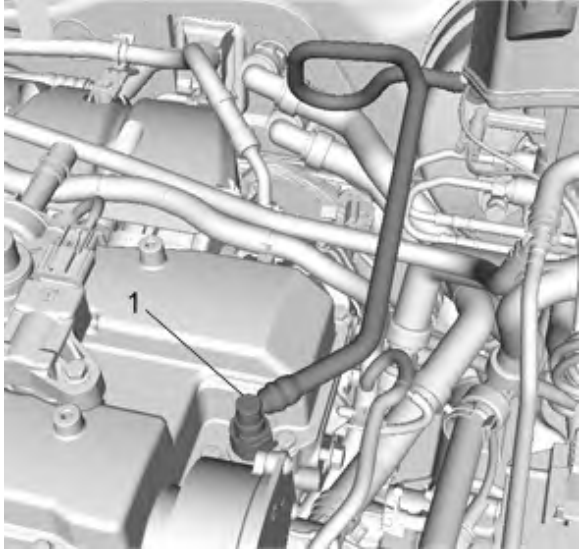


Fig. 274: Vacuum Hose
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect Power Brake Booster Vacuum Pipe (1) - **Plastic Collar Quick Connect Fitting Service**

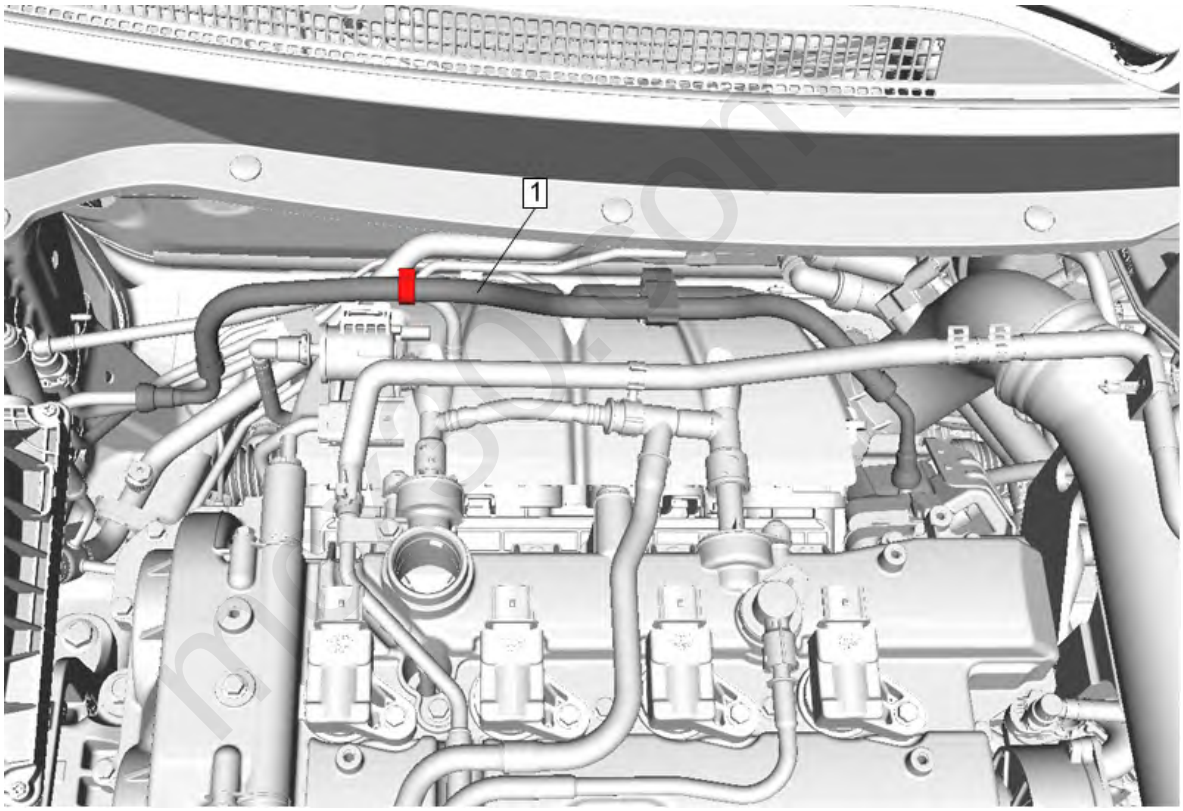


Fig. 275: Fuel Feed Front Pipe
Courtesy of GENERAL MOTORS COMPANY

9. Remove Fuel Feed Front Pipe (1) -**Fuel Feed Front Pipe Replacement**

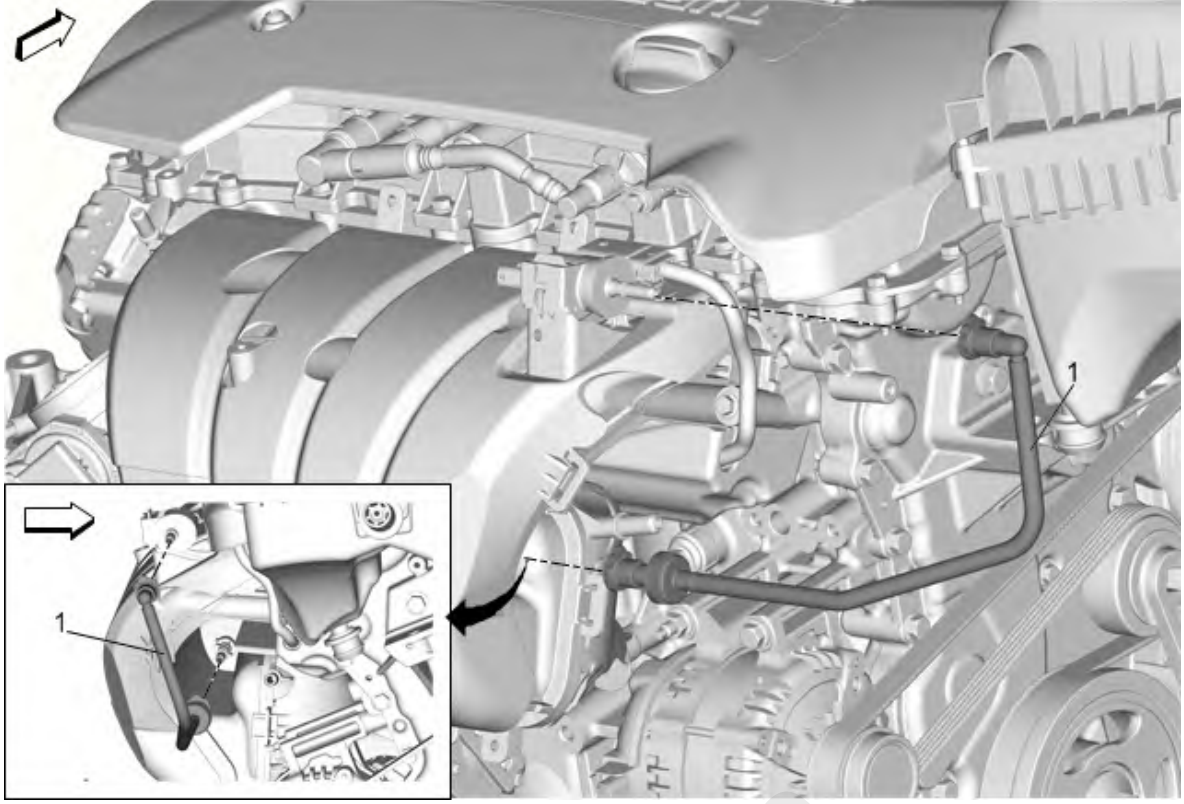


Fig. 276: Evaporative Emission Canister Purge Tube
Courtesy of GENERAL MOTORS COMPANY

10. Remove Evaporative Emission Canister Purge Tube (1) -**Evaporative Emission Canister Purge Tube Replacement**

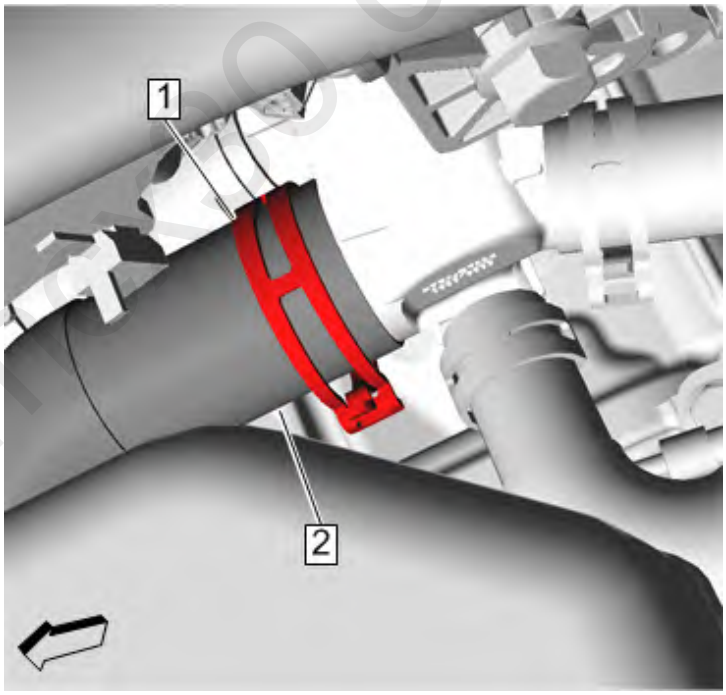


Fig. 277: Heater Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

11. Disconnect Heater Inlet Hose (2) @ Water Outlet - **Heater Inlet Hose Replacement (LTG with KL9)**

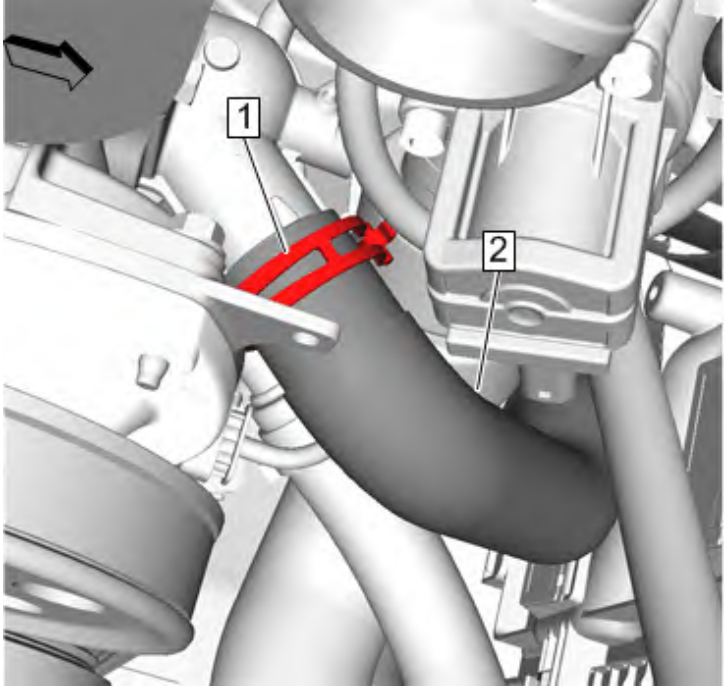


Fig. 278: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

12. Disconnect Radiator Outlet Hose (2) @ Engine Coolant Thermostat Housing - **Radiator Outlet Hose Replacement (LTG with KL9)**

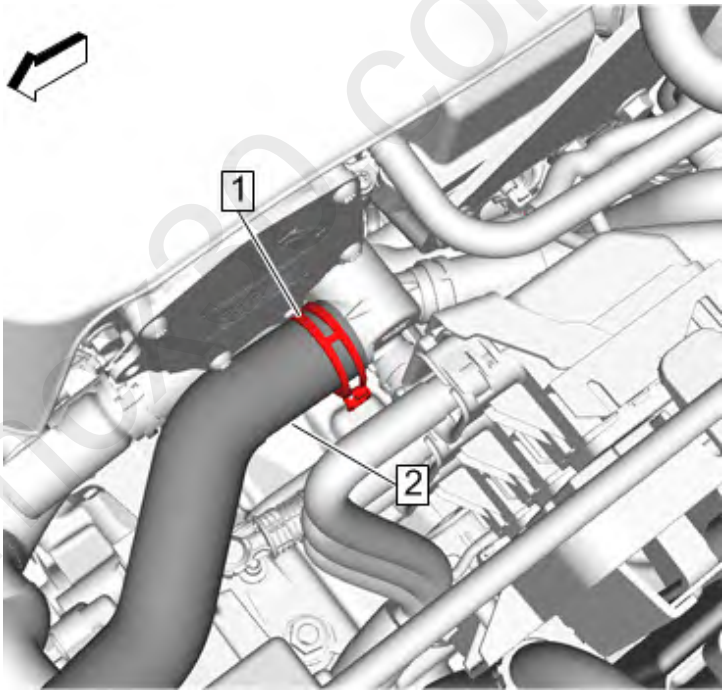


Fig. 279: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

13. Disconnect Radiator Inlet Hose (2) @ Water Outlet - **Radiator Inlet Hose Replacement (LTG with KL9)**

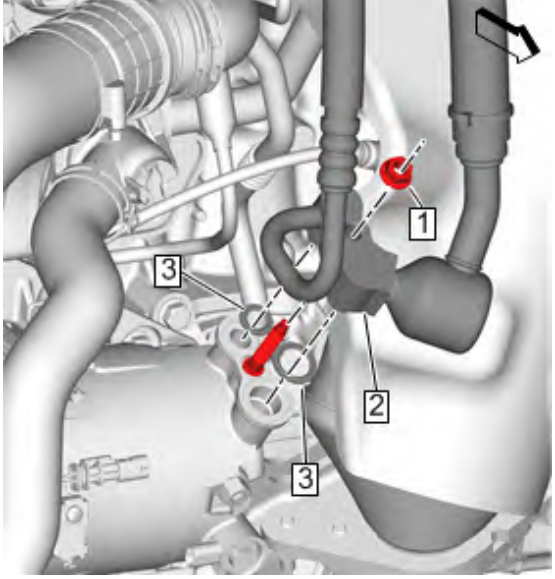


Fig. 280: Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose
Courtesy of GENERAL MOTORS COMPANY

14. Disconnect Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose (2) @ Air Conditioning Compressor - **Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose Replacement (LTG)**

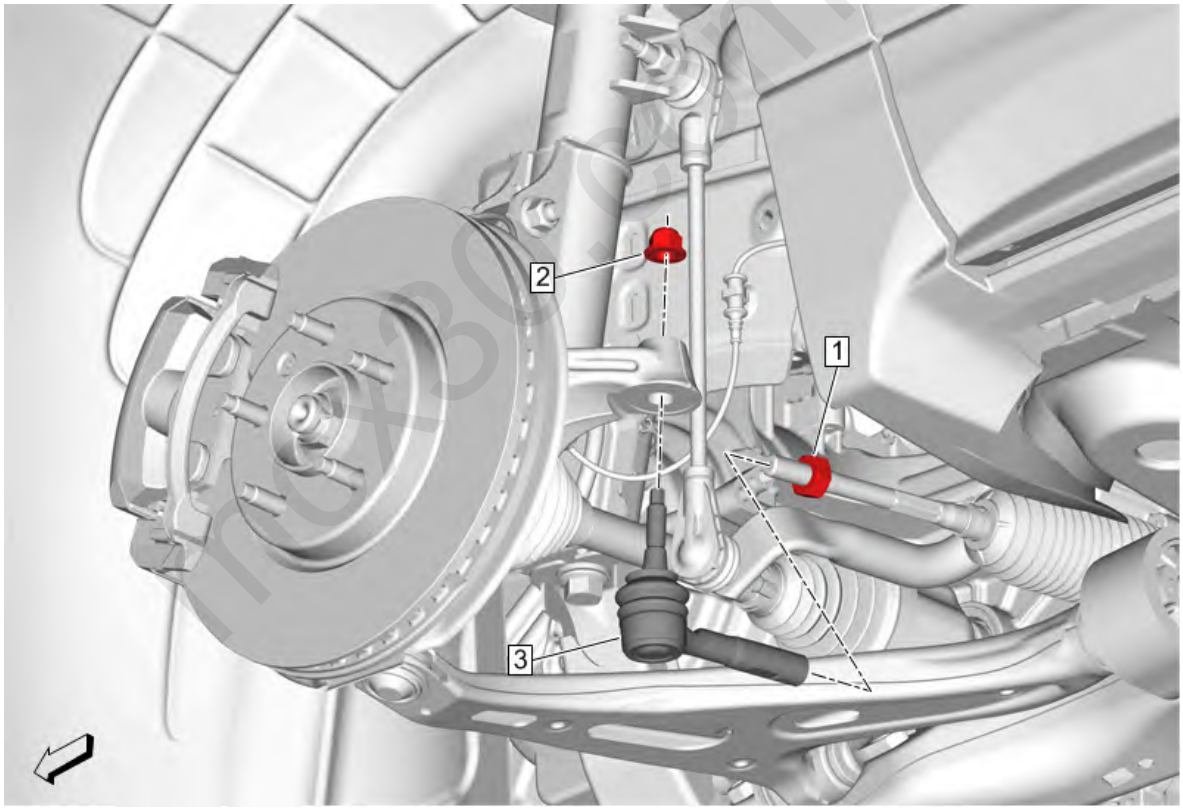


Fig. 281: Steering Linkage Outer Tie Rod
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Left side shown, right side similar.**

15. Disconnect Steering Linkage Outer Tie Rod (3) @ Steering Knuckle - **Steering Linkage Outer Tie Rod Replacement**

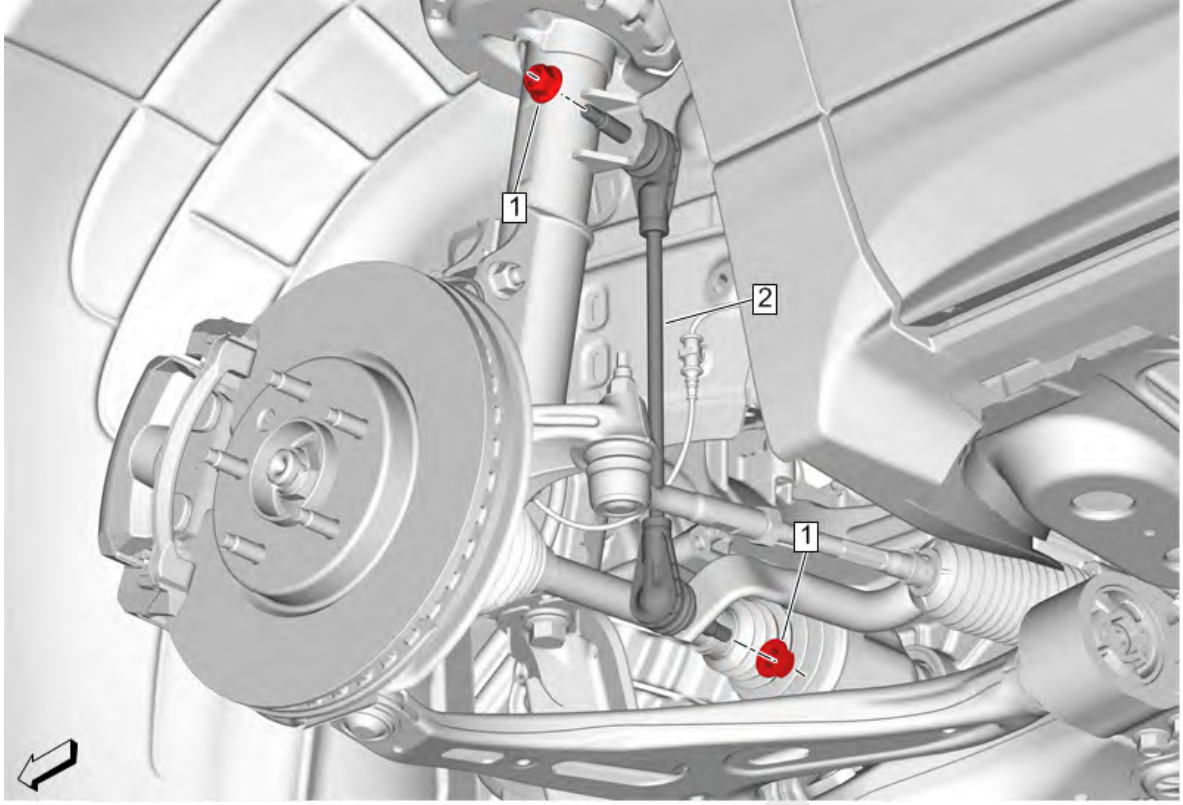


Fig. 282: Upper Stabilizer Shaft Link Nut
Courtesy of GENERAL MOTORS COMPANY

16. Disconnect Stabilizer Shaft Link (2) @ Stabilizer Shaft - **Stabilizer Shaft Link Replacement (Equinox)** **Stabilizer Shaft Link Replacement (Terrain)**

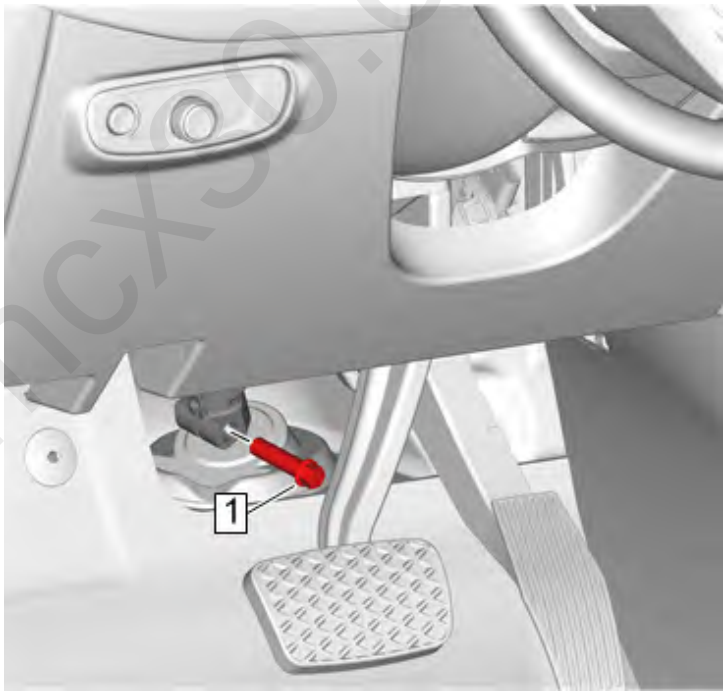


Fig. 283: Intermediate Shaft Pinch Bolt
Courtesy of GENERAL MOTORS COMPANY

17. Remove the intermediate shaft pinch bolt (1), then disconnect the intermediate shaft from the steering gear. **Intermediate Steering Shaft Replacement (Equinox)** **Intermediate Steering Shaft Replacement (Terrain)** .
18. Remove Exhaust Front Pipe - **Exhaust Front Pipe Replacement (LTG)**

mcx30.com

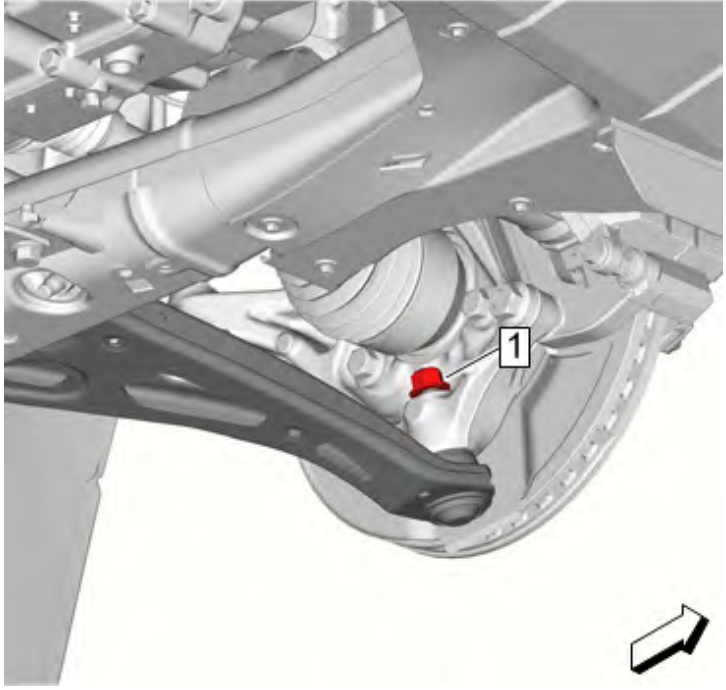


Fig. 284: Lower Control Arm To Steering Knuckle Nut
Courtesy of GENERAL MOTORS COMPANY

19. Remove the front lower control arm ball stud nuts (1) then disconnect the lower control arms from the steering knuckles. **Lower Control Arm Replacement (Equinox)** **Lower Control Arm Replacement (Terrain)** .
20. Remove Front Wheel Drive Half Shaft-Left Side - **Front Wheel Drive Half Shaft Replacement - Left Side**
21. Remove Front Wheel Drive Half Shaft- Right Side - **Front Wheel Drive Half Shaft Replacement - Right Side (AWD)**
22. Remove Propeller Shaft - **Two-Piece Propeller Shaft Replacement**

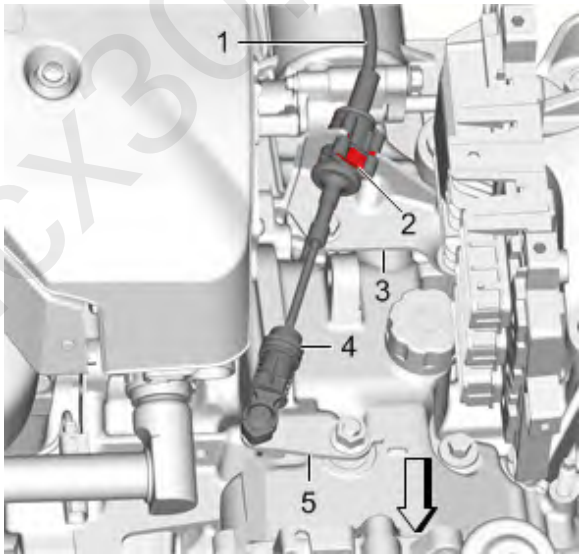


Fig. 285: Transmission Range Selector Lever Cable Components
Courtesy of GENERAL MOTORS COMPANY

23. Disconnect the range selector lever cable terminal from the transmission manual shift lever.

NOTE: **During the powertrain removal support the vehicle body by placing a jack at the rear of the vehicle.**

24. Position an engine support table under the powertrain assembly.
25. Blocks of wood can be used between the front of the frame and the oil pan to table in order to level the powertrain during the removal.
26. With the table positioned, fully raise the table to contact with the powertrain assembly.

mcx30.com

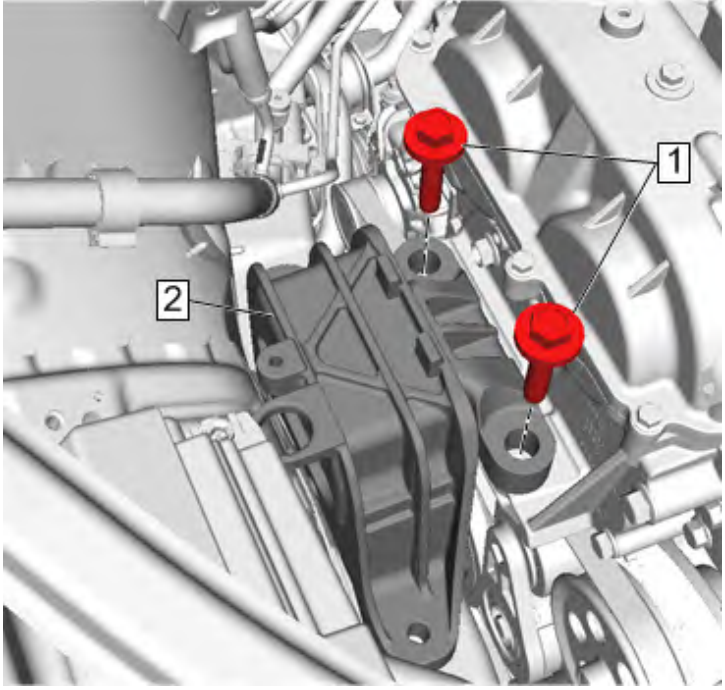


Fig. 286: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

27. Remove Engine Mount Bolt (1) - **Engine Mount Replacement**
28. Remove Transmission Mount - **Transmission Mount Replacement (Left Side M3U)** **Transmission Mount Replacement (Left Side M3D/M3H)**

NOTE: **Remove ONLY the body to frame bolts as the powertrain will be removed while still bolted to the frame.**

29. Remove the frame to body bolts. **Drivetrain and Front Suspension Cradle Replacement (All Wheel Drive)** .
30. Disconnect electrical connectors as necessary.
31. Carefully lower the engine table and raise the body on the hoist until the engine/transaxle and frame are separated from the vehicle.
32. Separate the engine from the transaxle. **Transmission Replacement (All Wheel Drive)**
33. Install the engine to a suitable engine stand.

Installation Procedure

1. Install the engine to the transaxle. **Transmission Replacement (All Wheel Drive)**
2. Position the powertrain support table under the vehicle.
3. Raise the powertrain into position under the vehicle.
4. With the table positioned, if required, lower the vehicle over the powertrain.
5. Install the frame to body bolts. **Drivetrain and Front Suspension Cradle Replacement (All Wheel Drive)**
6. Lower the vehicle.
7. Install Transmission Mount - **Transmission Mount Replacement (Left Side M3U)** **Transmission Mount Replacement (Left Side M3D/M3H)**

mx30.com

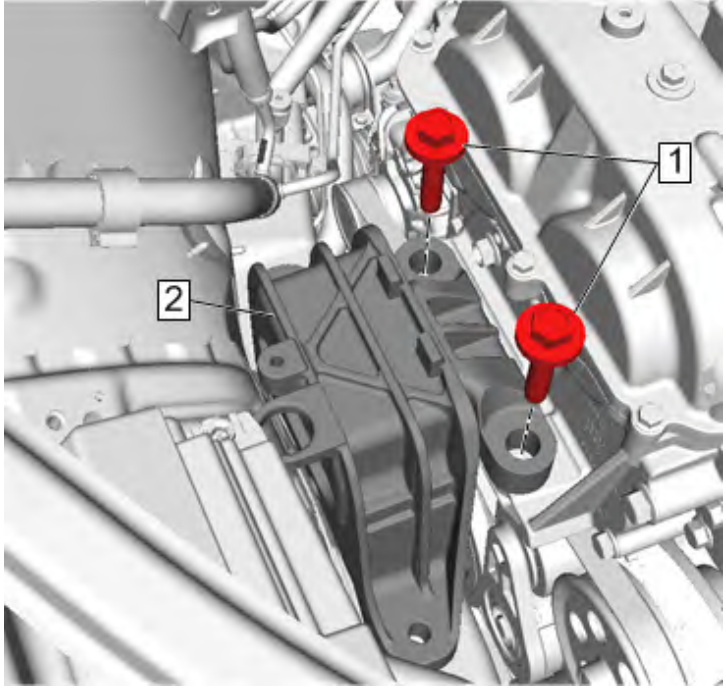


Fig. 287: Engine Mount Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install Engine Mount Bolt (1) - **Engine Mount Replacement**

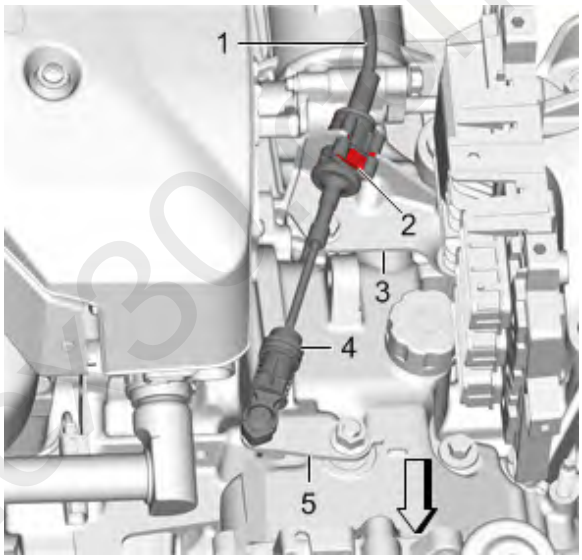


Fig. 288: Transmission Range Selector Lever Cable Components
Courtesy of GENERAL MOTORS COMPANY

9. Connect the range selector lever cable terminal (4) to the transmission manual shift lever (5)
10. Install Front Wheel Drive Half Shaft-Left Side - **Front Wheel Drive Half Shaft Replacement - Left Side**
11. Install Front Wheel Drive Half Shaft- Right Side - **Front Wheel Drive Half Shaft Replacement - Right Side (AWD)**
12. Install Propeller Shaft -**Two-Piece Propeller Shaft Replacement**

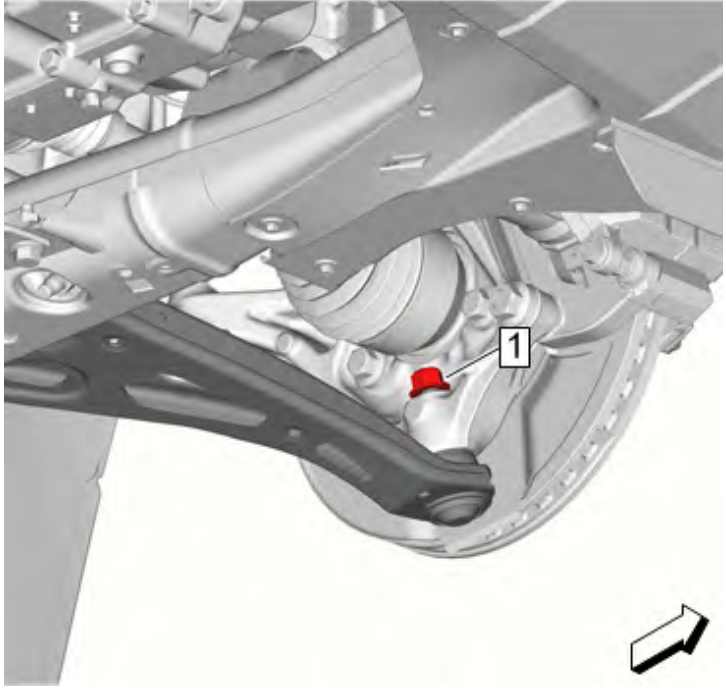


Fig. 289: Lower Control Arm To Steering Knuckle Nut
Courtesy of GENERAL MOTORS COMPANY

13. Connect the lower control arms to the steering knuckles then install the lower control arm ball stud nuts (1). **Lower Control Arm Replacement (Equinox)** **Lower Control Arm Replacement (Terrain)**
14. Install Exhaust Front Pipe - **Exhaust Front Pipe Replacement (LTG)**

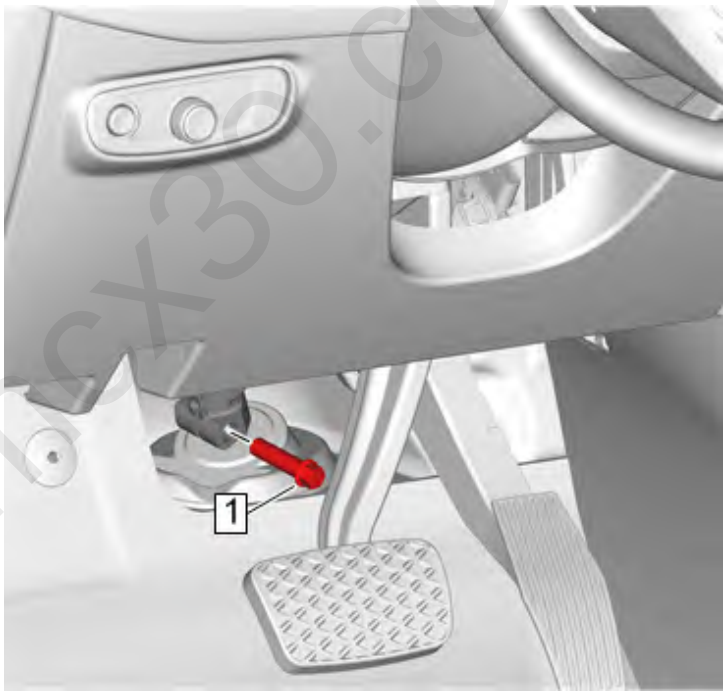


Fig. 290: Intermediate Shaft Pinch Bolt
Courtesy of GENERAL MOTORS COMPANY

15. Connect the intermediate shaft to the steering gear then install the pinch bolt (1). **Intermediate Steering Shaft Replacement (Equinox)** **Intermediate Steering Shaft Replacement (Terrain)**

mcx30.com

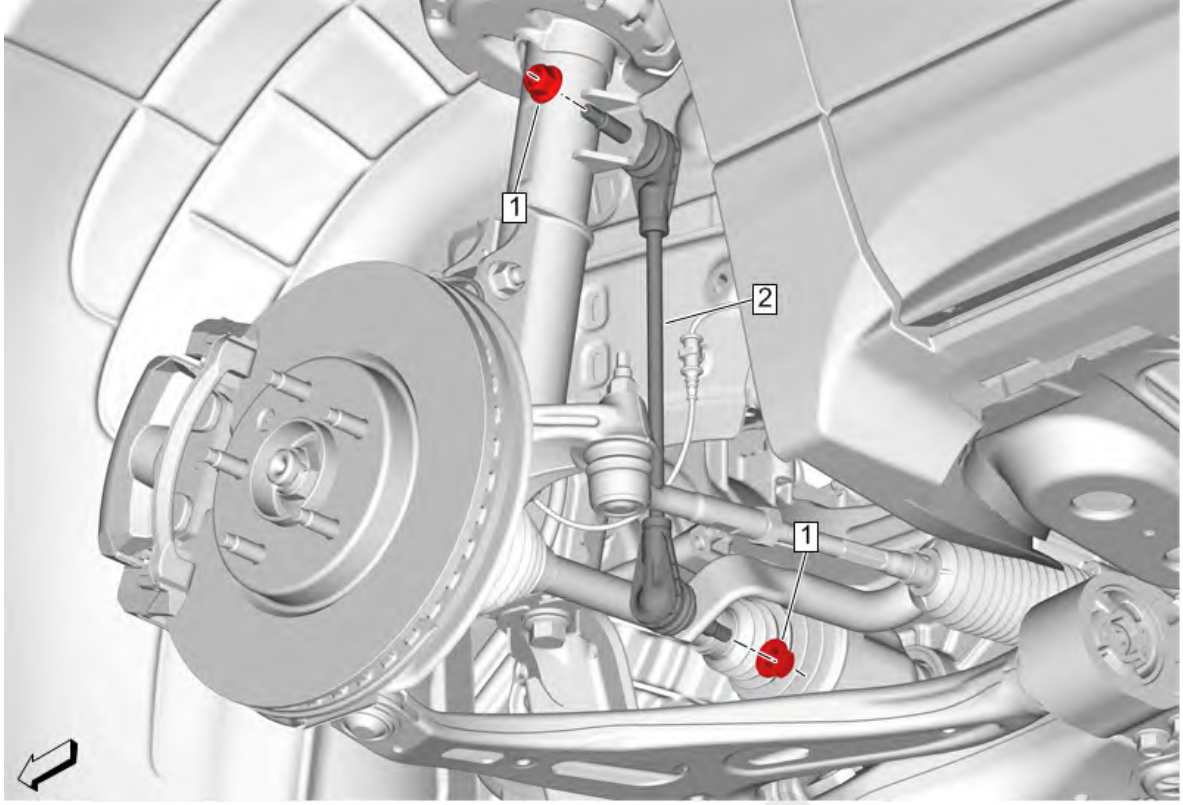


Fig. 291: Upper Stabilizer Shaft Link Nut
Courtesy of GENERAL MOTORS COMPANY

16. Connect Stabilizer Shaft Link (2) @ Stabilizer Shaft -**Stabilizer Shaft Link Replacement (Equinox)** **Stabilizer Shaft Link Replacement (Terrain)**

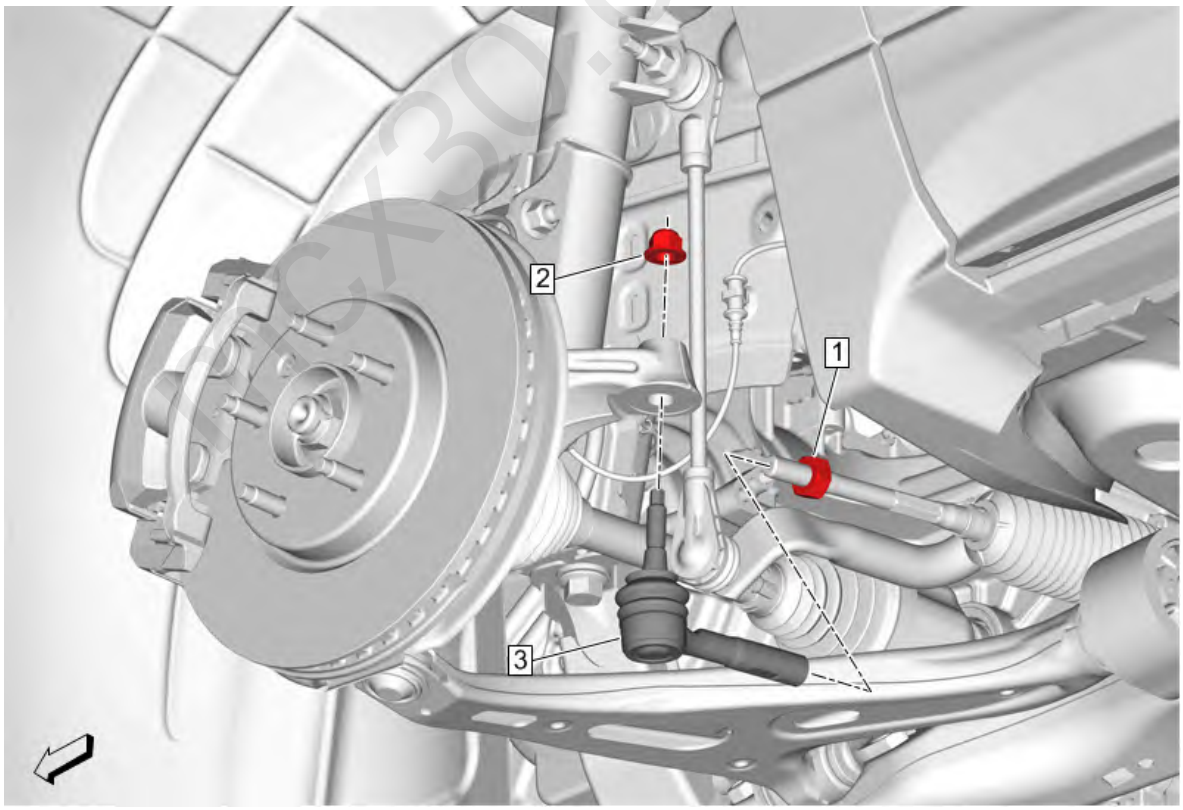


Fig. 292: Steering Linkage Outer Tie Rod
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Left side shown, right side similar.**

17. Connect Steering Linkage Outer Tie Rod (3) @ Steering Knuckle -**Steering Linkage Outer Tie Rod Replacement**

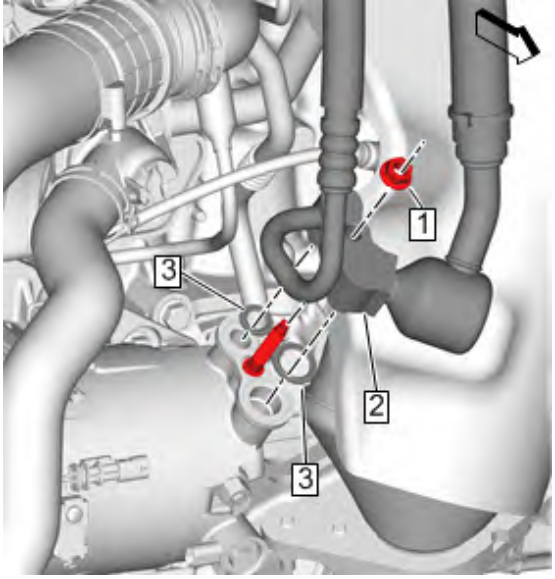


Fig. 293: Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose
Courtesy of GENERAL MOTORS COMPANY

18. Disconnect Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose (2) @ Air Conditioning Compressor - **Air Conditioning Evaporator Connector Hose/Tube and Compressor Hose Replacement (LTG)**

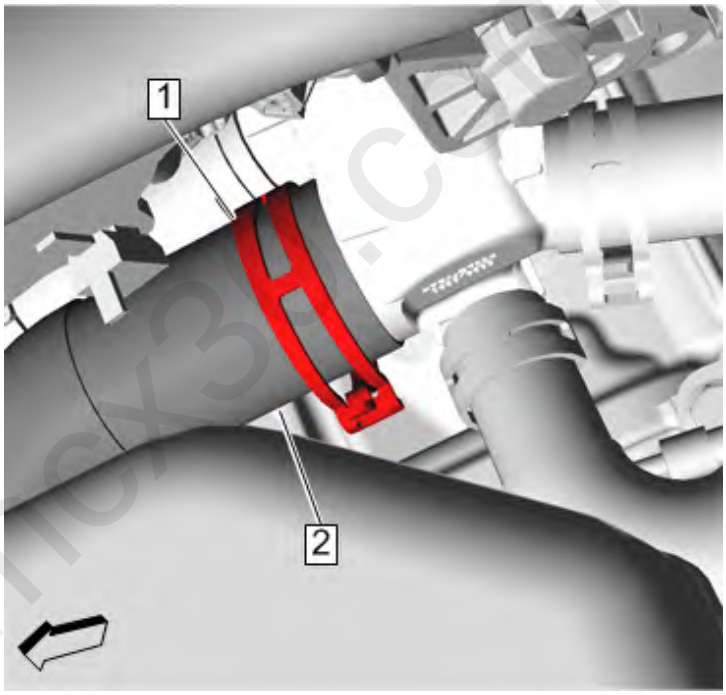


Fig. 294: Heater Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

19. Connect Heater Inlet Hose (2) @ Water Outlet -**Heater Inlet Hose Replacement (LTG with KL9)**

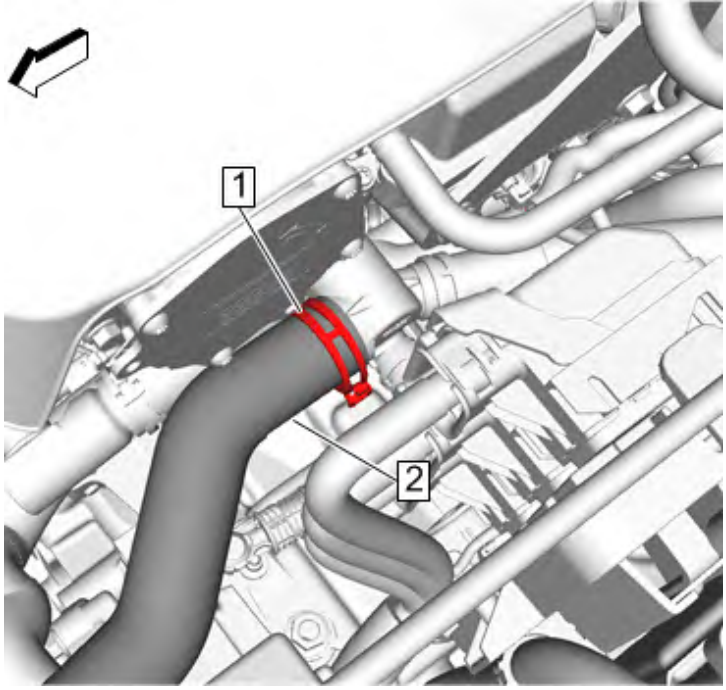


Fig. 295: Radiator Inlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

20. Connect Radiator Inlet Hose (2) @ Water Outlet -**Radiator Inlet Hose Replacement (LTG with KL9)**

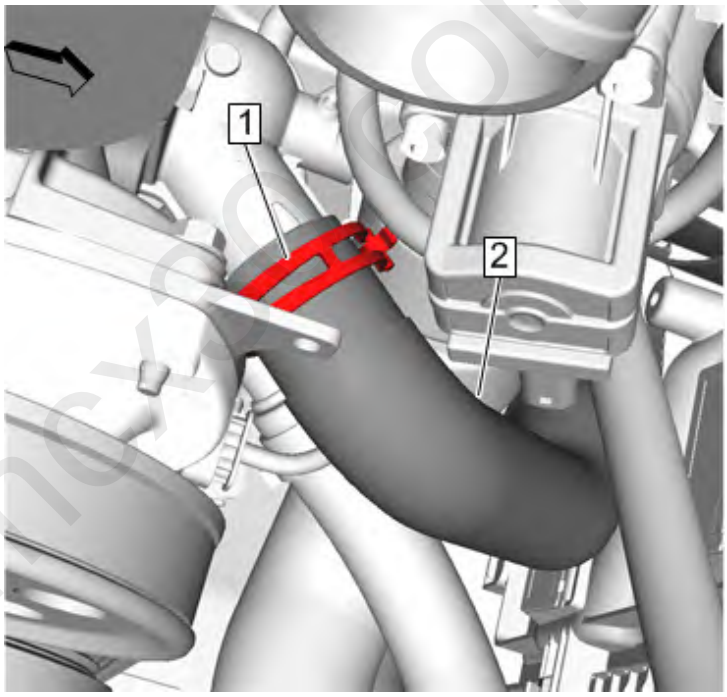


Fig. 296: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

21. Connect Radiator Outlet Hose (2) @ Engine Coolant Thermostat Housing - **Radiator Outlet Hose Replacement (LTG with KL9)**
22. Install Heater Core Outlet Hose -**Heater Outlet Hose Replacement (LYX without KL9)** **Heater Outlet Hose Replacement (LH7)** .

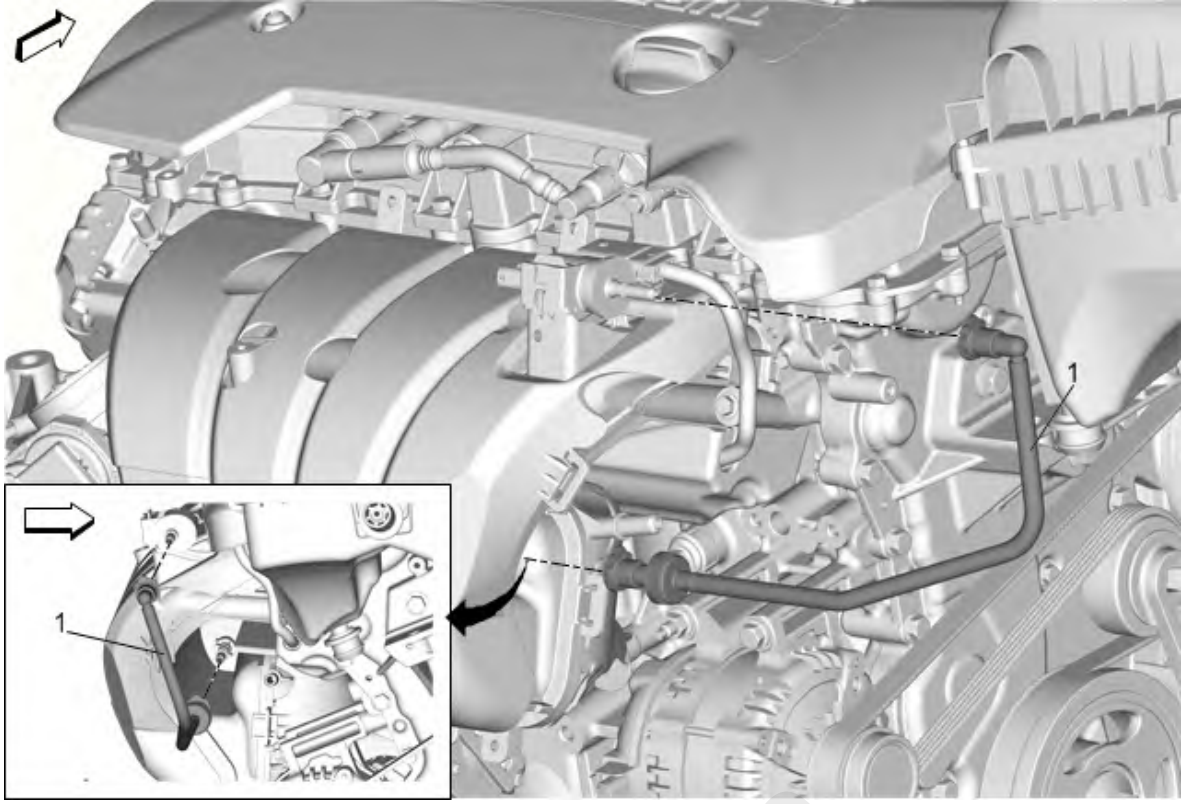


Fig. 297: Evaporative Emission Canister Purge Tube
Courtesy of GENERAL MOTORS COMPANY

23. Install Evaporative Emission Canister Purge Tube (1) - **Evaporative Emission Canister Purge Tube Replacement**

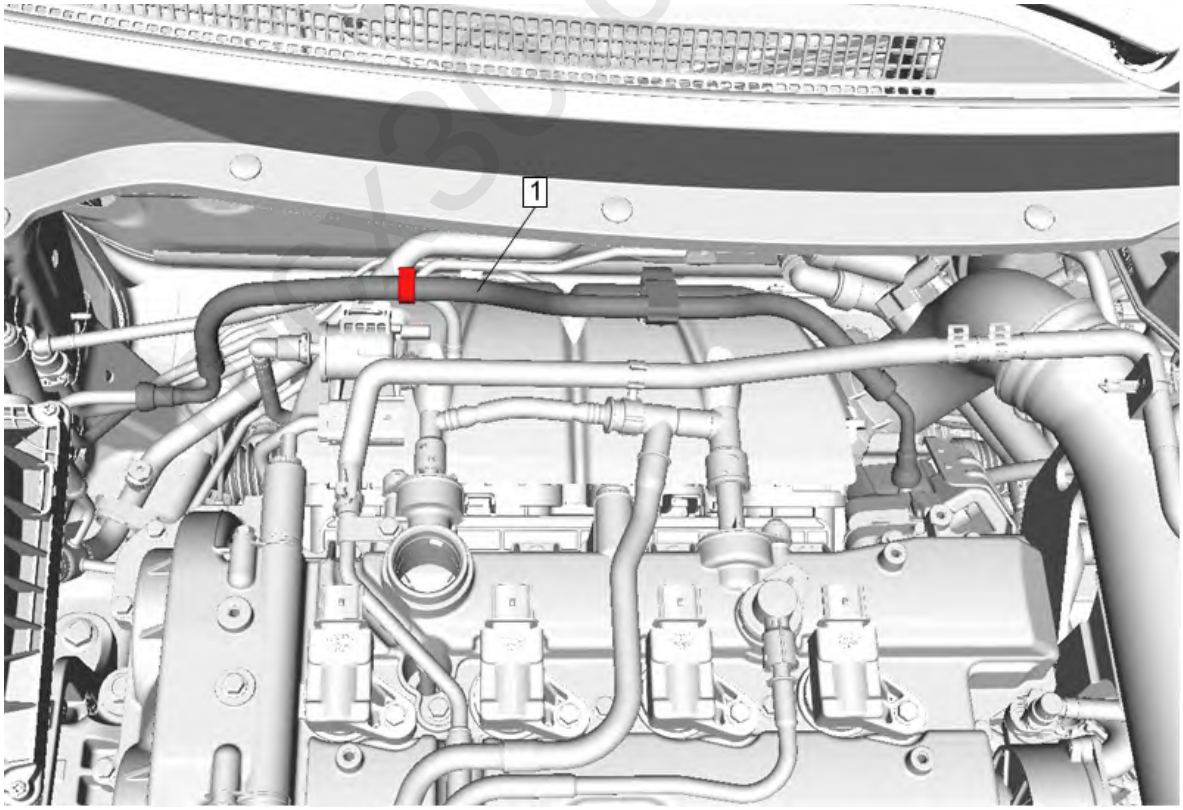


Fig. 298: Fuel Feed Front Pipe
Courtesy of GENERAL MOTORS COMPANY

24. Install Fuel Feed Front Pipe (1) -**Fuel Feed Front Pipe Replacement**

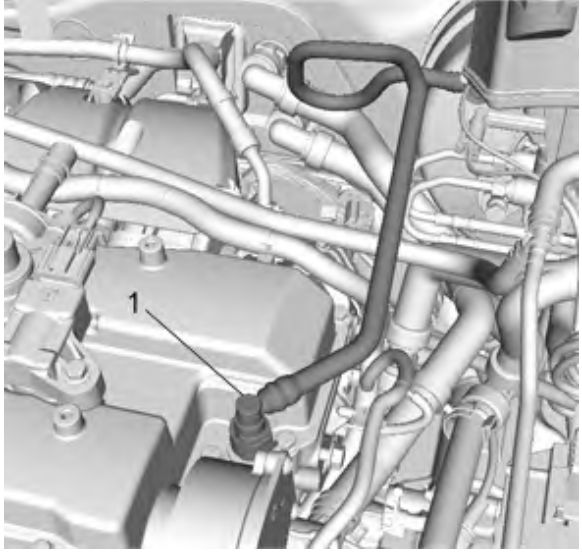


Fig. 299: Vacuum Hose
Courtesy of GENERAL MOTORS COMPANY

25. Connect Power Brake Booster Vacuum Pipe (1) - **Plastic Collar Quick Connect Fitting Service**
26. Connect electrical connectors as needed.

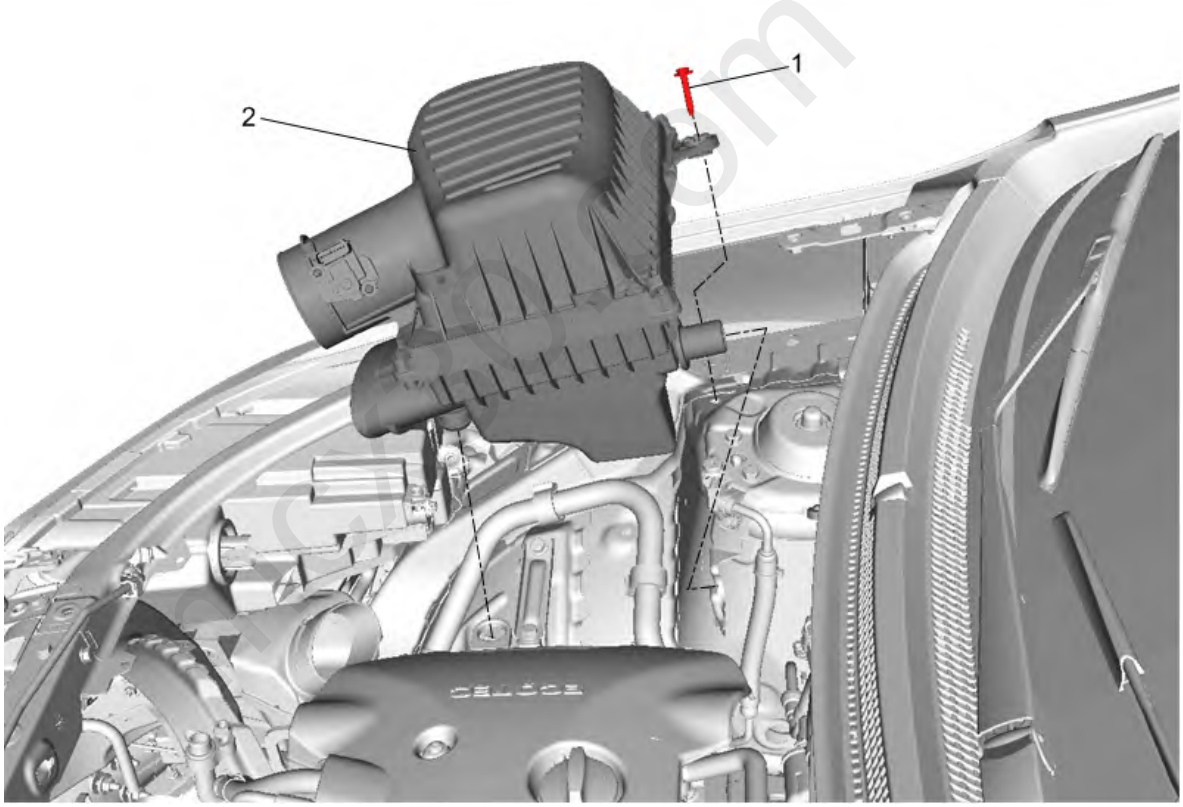


Fig. 300: Air Cleaner Assembly
Courtesy of GENERAL MOTORS COMPANY

27. Install Air Cleaner Assembly (2) - **Air Cleaner Assembly Replacement** .

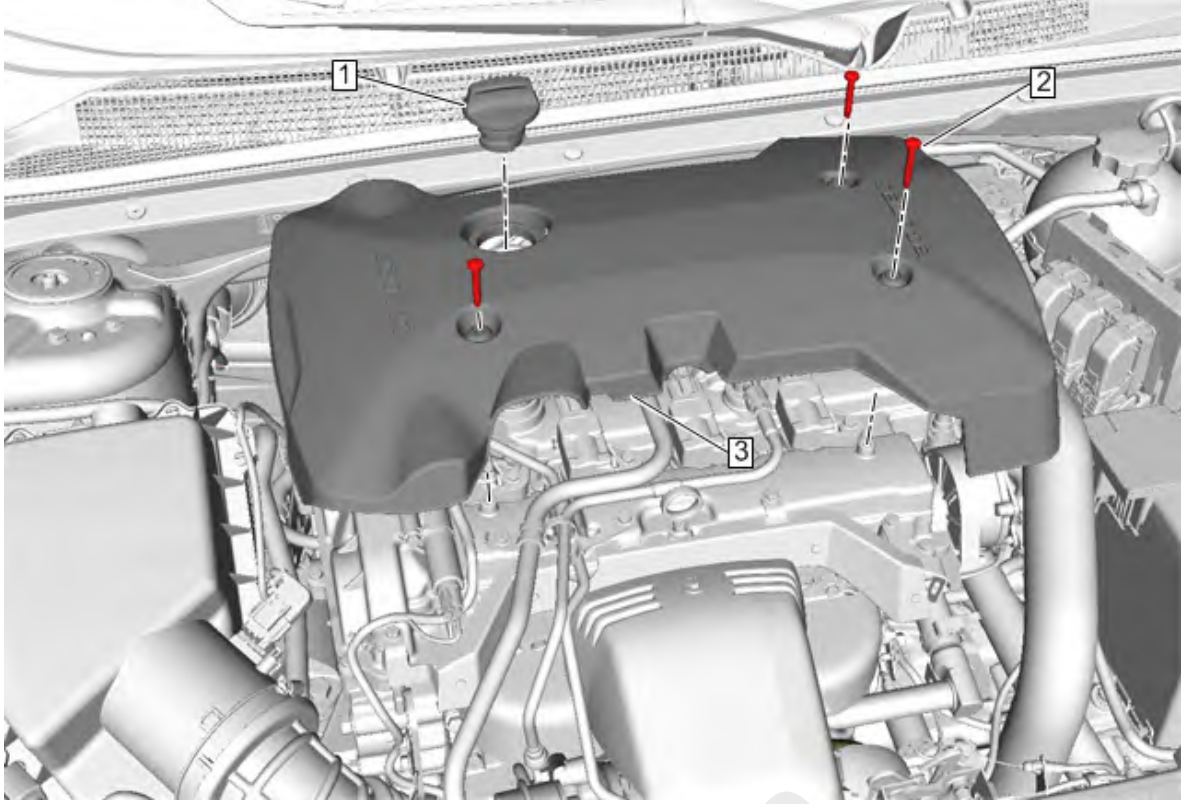


Fig. 301: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

28. Install Intake Manifold Cover (3) - **Intake Manifold Cover Replacement**
29. Install the battery tray. **Battery Tray Replacement**
30. Recharge the A/C system. **Refrigerant Recovery and Recharging (R-134a)** **Refrigerant Recovery and Recharging (R-1234yf)** .
31. Fill the cooling system. **Cooling System Draining and Filling (GE 47716)** **Cooling System Draining and Filling (Static)** .

NOTE: **Prelube is necessary if the engine is replaced or overhauled.**

32. If the engine is replaced with a new engine or has been overhauled, perform the Engine Prelubing procedure. **Engine Prelubing**.
33. If prelubing has not been performed, fill the engine oil. **Engine Oil and Oil Filter Replacement**.
34. Connect the negative battery cable. **Battery Negative Cable Disconnection and Connection (KL9)** .
35. Perform the Crankshaft Position Variation Learn procedure. **Crankshaft Position Variation Learn**

ENGINE OIL AND OIL FILTER REPLACEMENT

Removal Procedure

1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle**
2. Place a drain pan under the oil drain plug.

mcx30.com

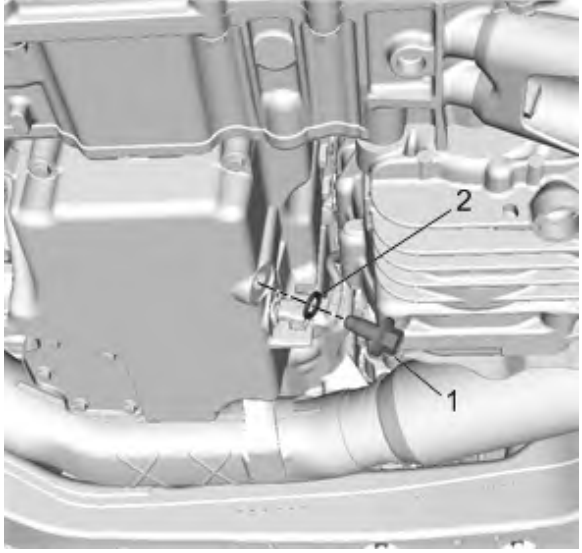


Fig. 302: Oil Pan Drain Plug And Seal
Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil pan drain plug (1)
4. Allow the oil to drain completely.

CAUTION: **Refer to Component Fastener tightening Caution .**

NOTE: **Inspect the oil drain plug (1) and ring seal (2), replace only if damaged.**

5. Install the oil pan drain plug (1).tighten 25 N.m (18 lb ft).

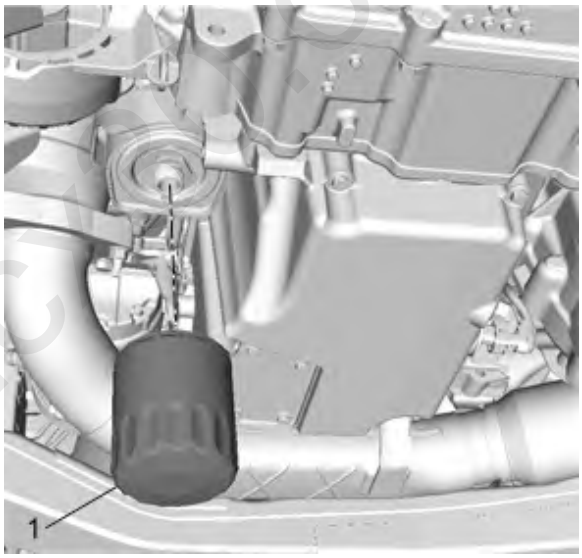


Fig. 303: Oil Filter
Courtesy of GENERAL MOTORS COMPANY

6. Place a drain pan under the vehicle.
7. Remove and DISCARD the oil filter (1)
8. Ensure that the old oil filter seal has been removed.

Installation Procedure

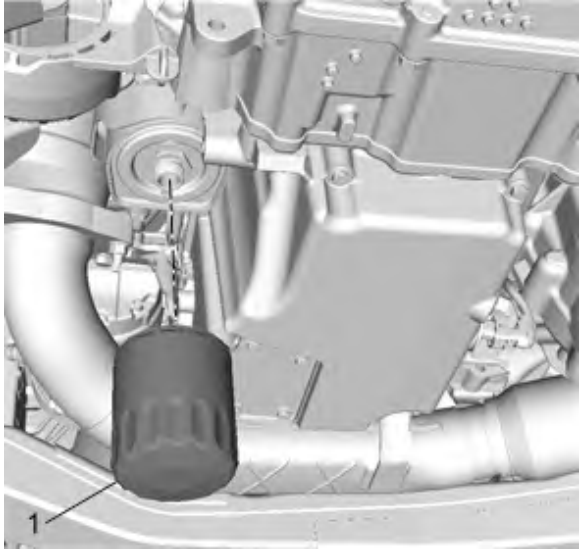


Fig. 304: Oil Filter
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the NEW oil filter gasket with clean engine oil.
2. Install a NEW oil filter and tighten 3/4 to 1 full turn after the gasket makes contact with the sealing surface on the filter mounting flange.
3. Remove the drain pan.
4. Lower the vehicle.
5. Fill the engine oil to the proper level with NEW engine oil.
6. Start the engine and inspect for leaks.

REPAIR INSTRUCTIONS - OFF VEHICLE

DRAINING FLUIDS AND OIL FILTER REMOVAL

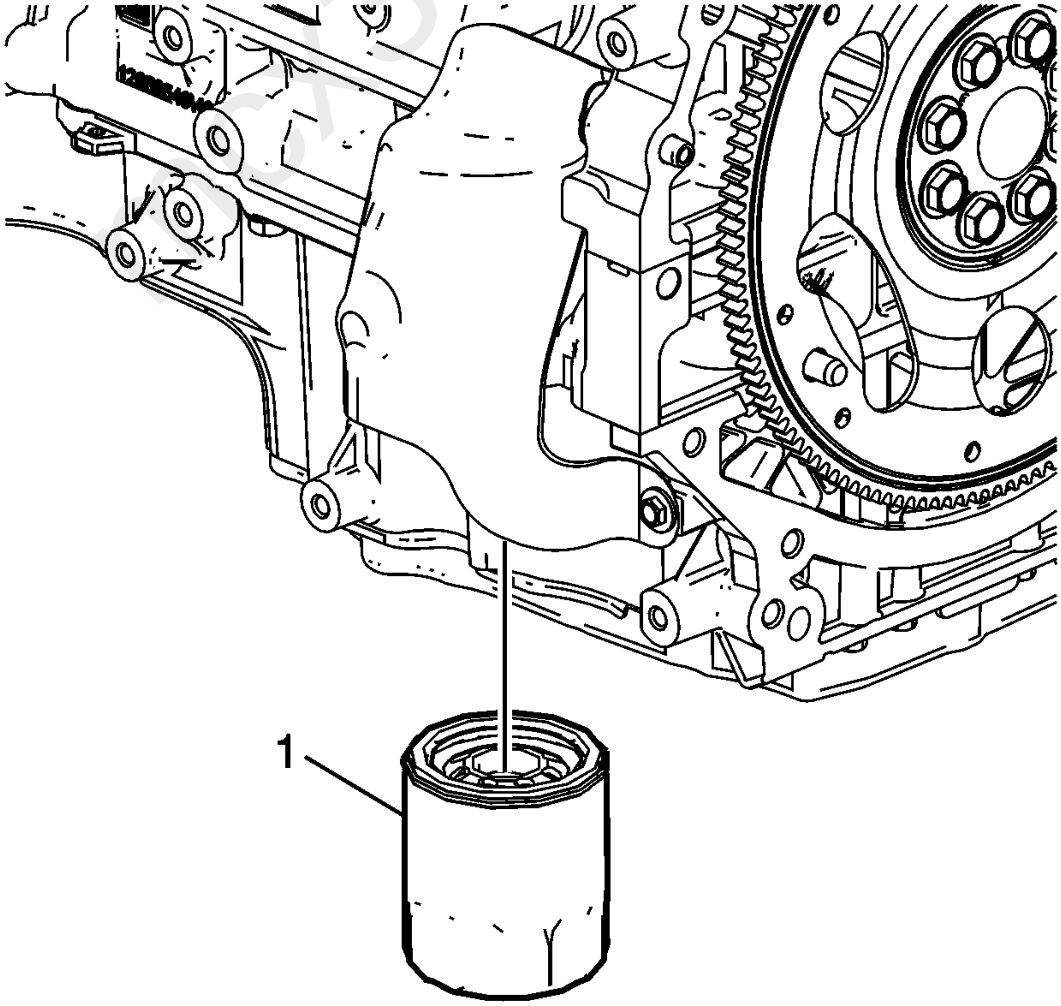


Fig. 305: Engine Oil Filter
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil filter (1). Remove the oil pan drain plug and allow the oil to drain out.
2. Clean the oil filter housing in the engine block.

CAUTION: **Refer to Fastener Caution .**

3. Install the oil pan drain plug and tighten to 25 N.m (18 lb ft).
4. If cleaning or repairing the engine block, it is not necessary to reinstall the plug.

CRANKSHAFT BALANCER REMOVAL

Special Tools

- **EN-38416-2** Crankshaft Button
- **EN-41816** Crankshaft Balancer Remover
- **EN-41816-2** Crankshaft End Protector
- **EN - 51760** Flywheel Holding Tool

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

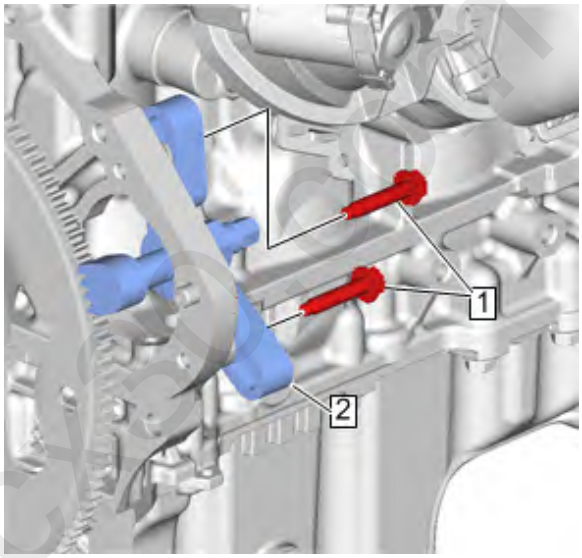


Fig. 306: Starter Motor Bolts
Courtesy of GENERAL MOTORS COMPANY

1. To prevent crankshaft rotation, install **EN-51760** holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the flywheel.

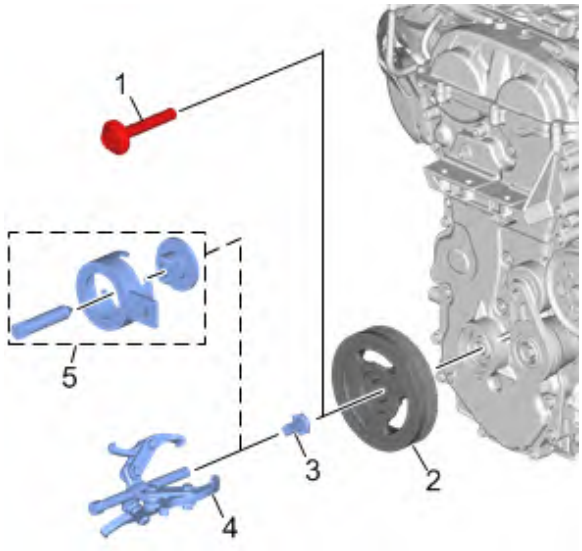


Fig. 307: Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

2. Remove and discard the crankshaft balancer bolt (1) and washer.

NOTE: **When necessary, EN-38416-2 button can be used instead of EN-41816-2 protector.**

3. Install **EN-41816-2** protector (3) to protect the crankshaft end during balancer removal.

NOTE: **EN-51577-1 remover (5) can be used alternatively for EN-41816 remover (4).**

4. Using **EN-41816** remover (4), remove the balancer (2).
5. Remove the special tools.

AUTOMATIC TRANSMISSION FLEX PLATE REMOVAL

Special Tools

EN-51760 Flywheel Holding Tool

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

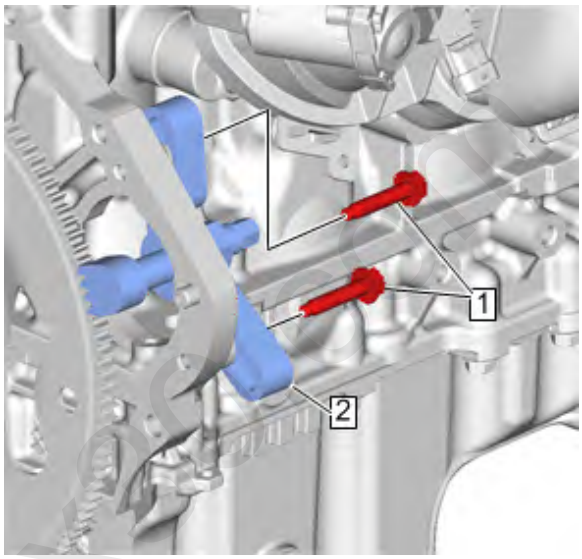


Fig. 308: Starter Motor Bolts
Courtesy of GENERAL MOTORS COMPANY

1. To prevent crankshaft rotation, install **EN-51760** holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the flywheel.

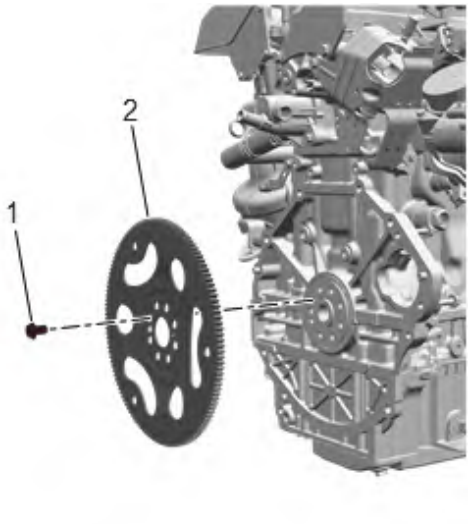


Fig. 309: Automatic Flex Plate Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove and discard the flywheel attaching bolts (1).

3. Remove the flywheel (2).
4. Remove **EN 51760** holding tool.

INTAKE MANIFOLD REMOVAL

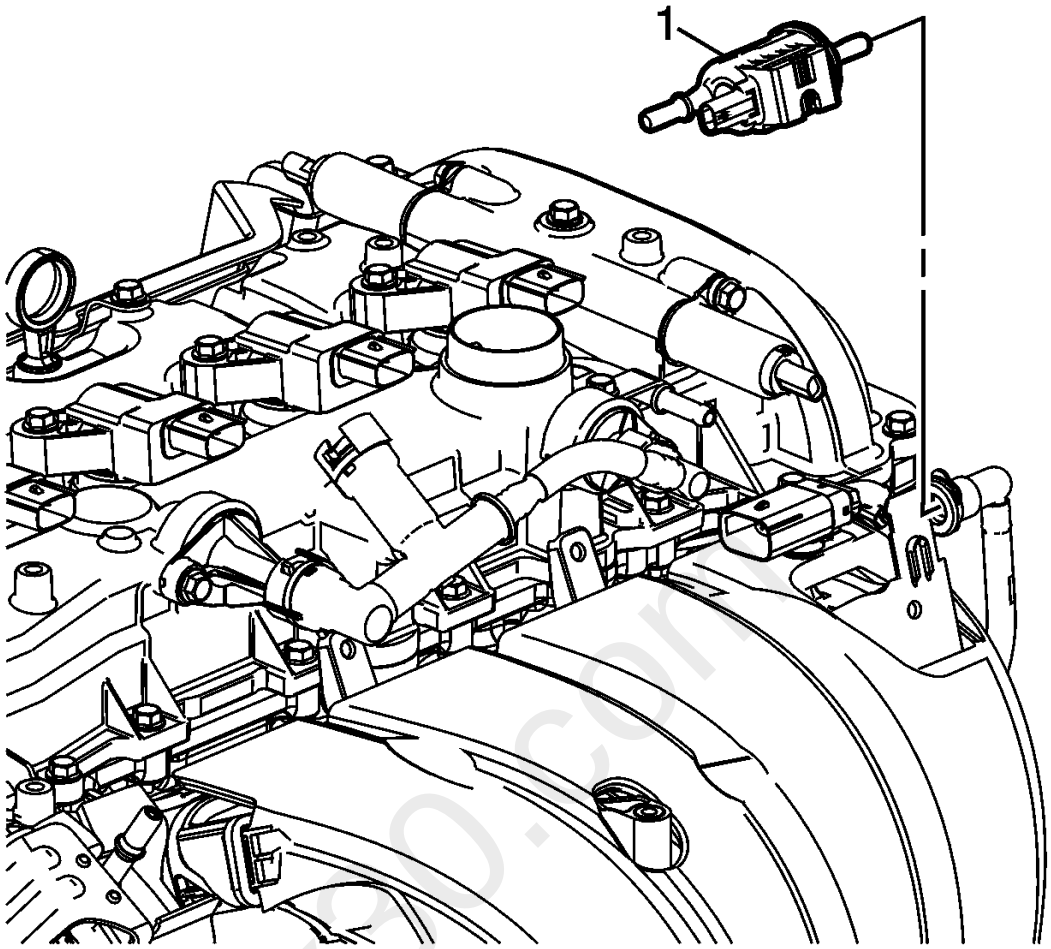


Fig. 310: EVAP Canister Valve
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Never attempt to remove the intake manifold from a hot engine, allow the engine to cool to ambient temperature. The intake manifold can be damaged if it is removed when the engine is hot.**

1. Remove the EVAP canister valve (1).

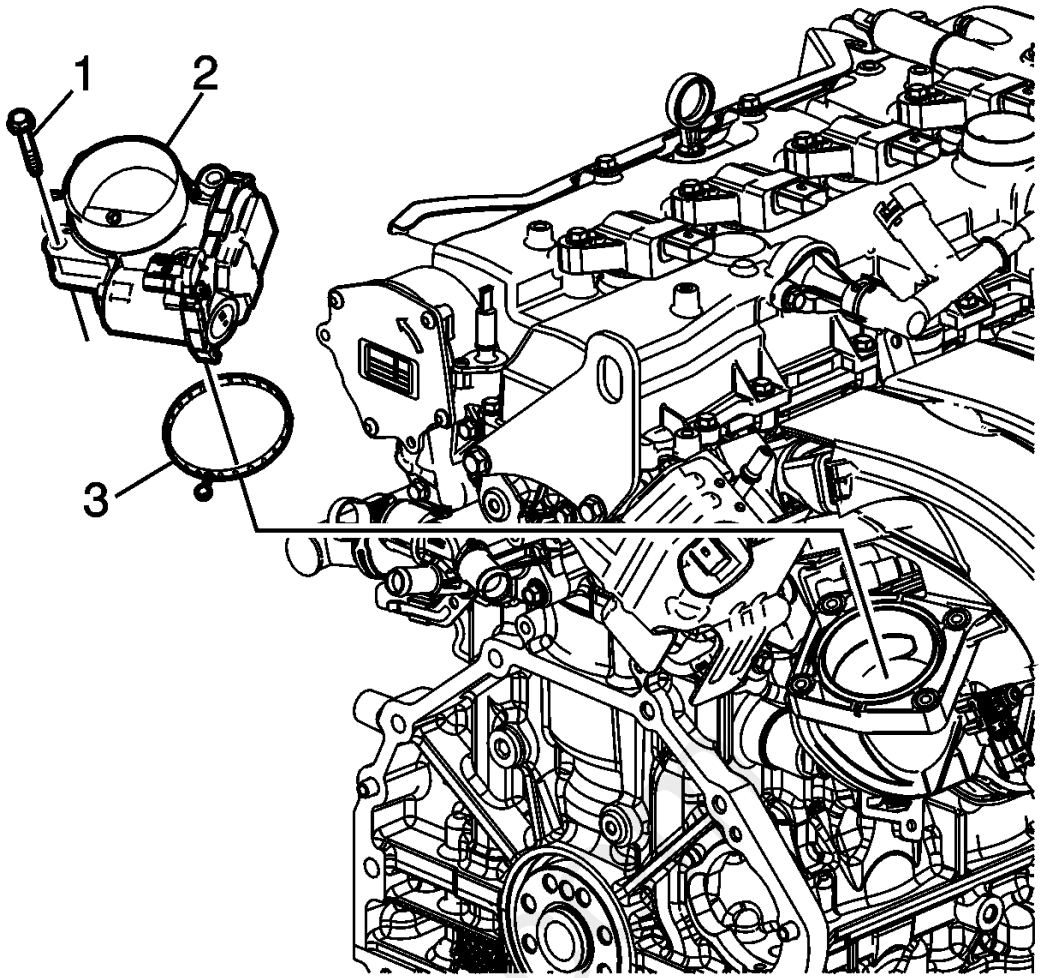


Fig. 311: Throttle Body Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the throttle body bolts (1).
3. Remove the throttle body (2) and seal (3).

mcx30.com

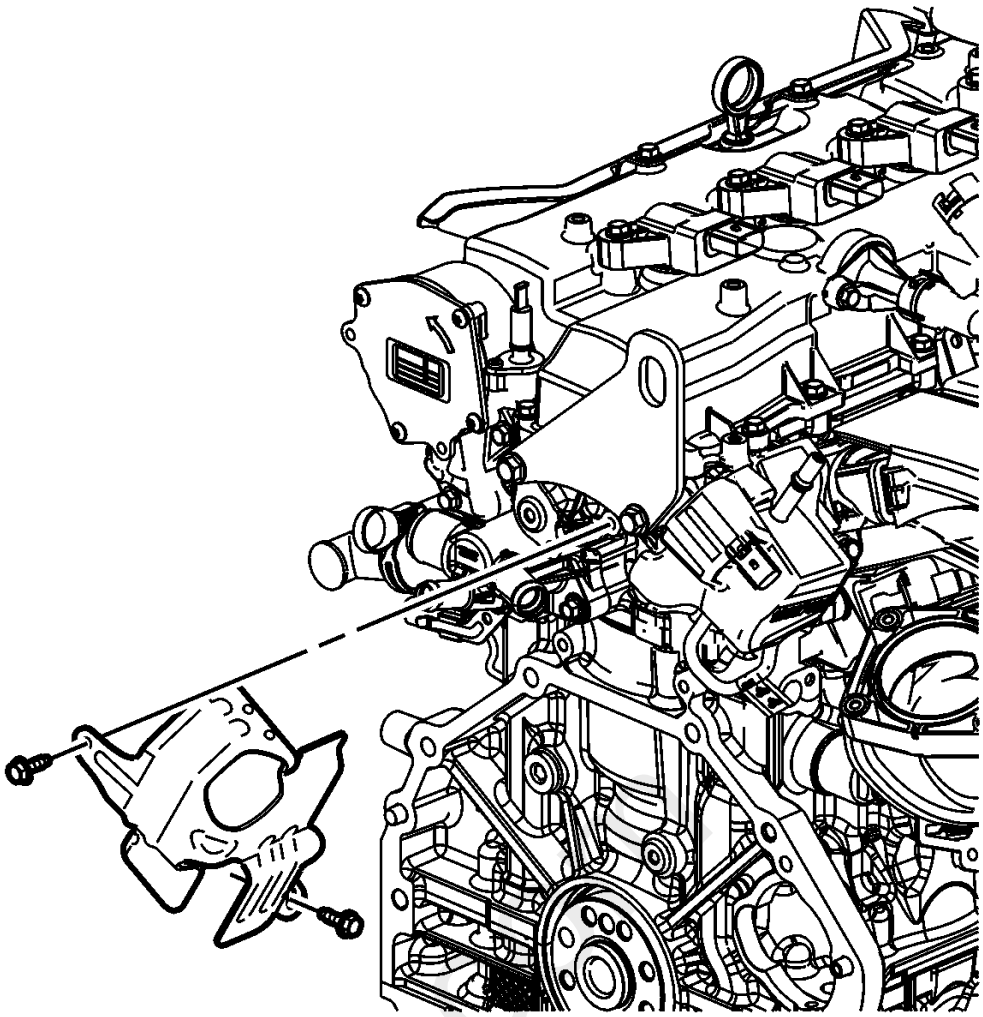


Fig. 312: Fuel Pump Cover Bolts And Cover
Courtesy of GENERAL MOTORS COMPANY

4. Remove the fuel pump cover bolts and cover.

mcx30.com

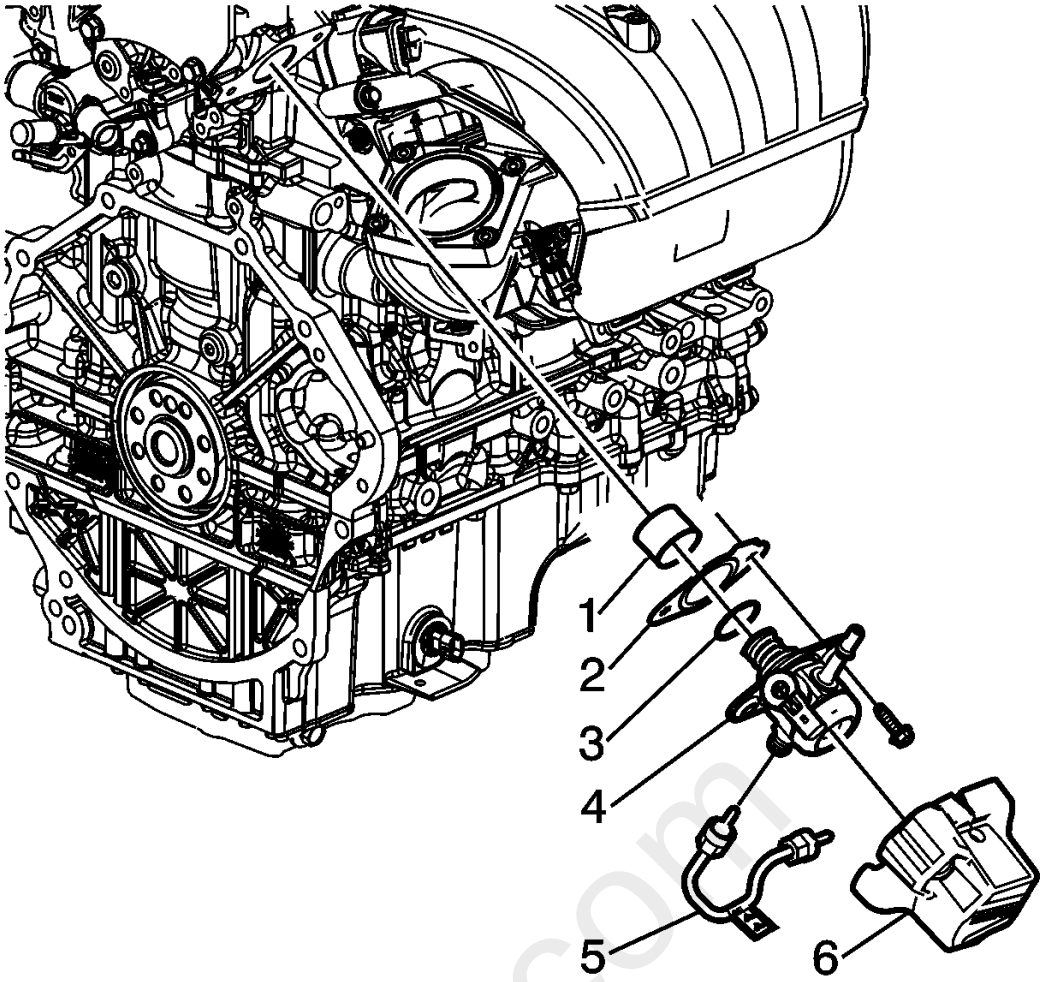


Fig. 313: High Pressure Fuel Pump Assembly
Courtesy of GENERAL MOTORS COMPANY

WARNING: **The noise cancelling foam component MUST be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.**

5. Remove the fuel pump insulator (6).

WARNING: **Fuel that flows out at high pressure can cause serious injury to the skin and eyes. ALWAYS depressurize the fuel system before removing components that are under high fuel pressure.**

6. Remove and discard the fuel feed intermediate pipe (5).

CAUTION: **Alternately loosen the fuel pump bolts one turn at a time until the pump is fully disengaged from fuel pump lifter follower. Trying to remove the pump bolts without even side-to-side loosening may result in pump plunger damage**

7. Remove and discard the fuel pump bolts.
8. Remove the fuel pump (4), O-ring (3), and gasket (2). Discard the O-ring and gasket.
9. Remove the valve lifter follower (1).

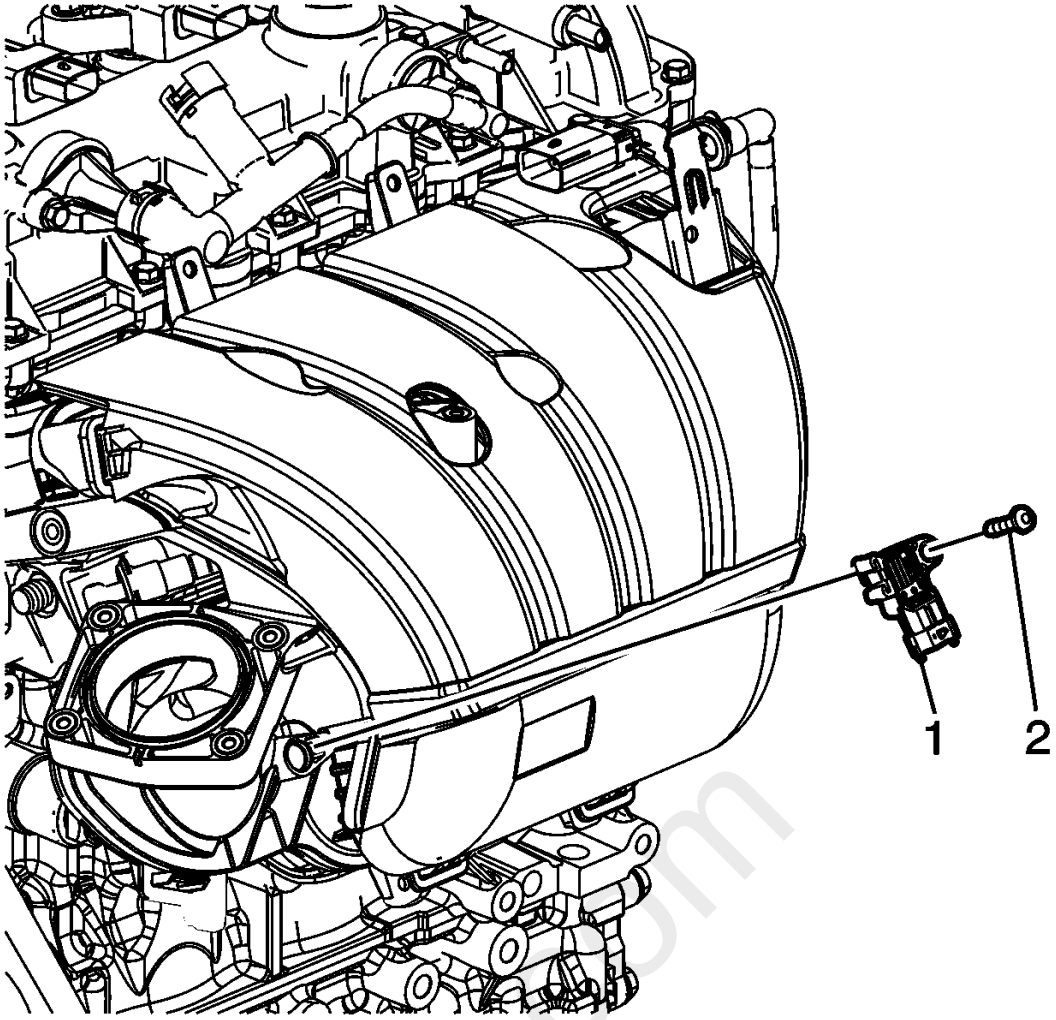


Fig. 314: MAP Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Remove the MAP sensor (1) and bolt (2).

mcx30.com

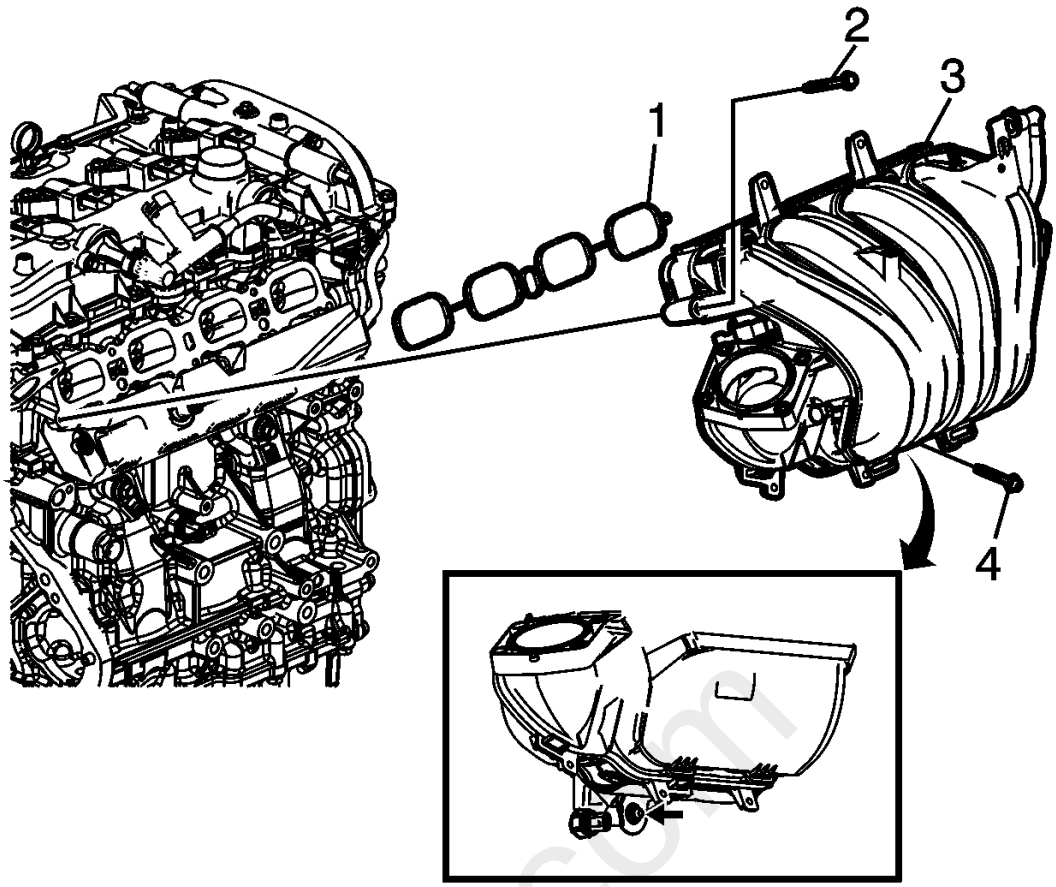


Fig. 315: Intake Manifold And Gasket
Courtesy of GENERAL MOTORS COMPANY

11. Remove the intake manifold retaining bolts (2, 4).
12. Remove the intake manifold (3) and gasket (1).
13. If the intake manifold needs to be replaced, transfer the throttle body to the new intake manifold.

CAMSHAFT COVER AND COMPRESSOR AIR INTAKE TURBOCHARGER REMOVAL (2ND DESIGN TAMPER-PROOF PCV SYSTEM)

Turbocharger Component Removal

mc30.com

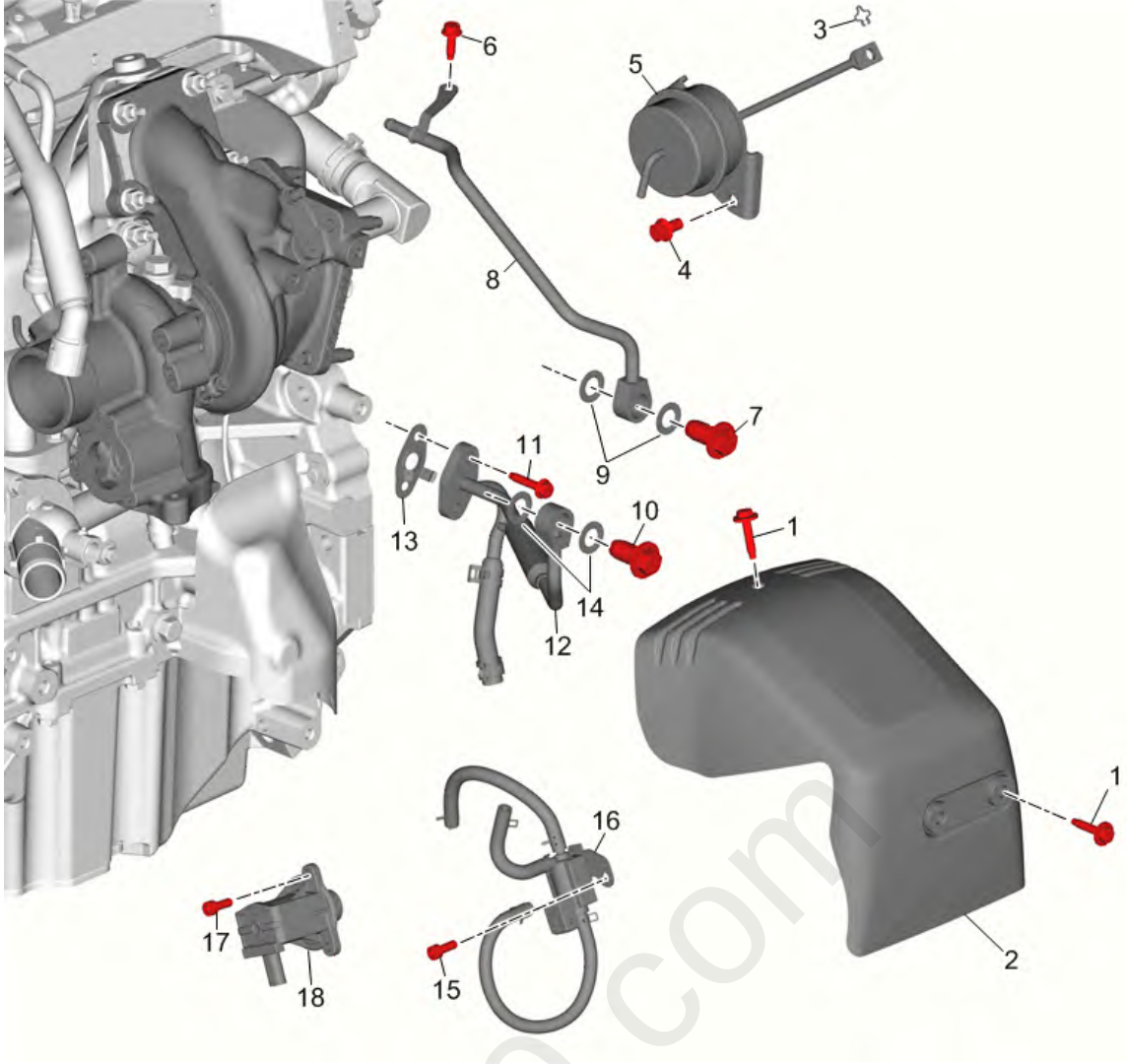


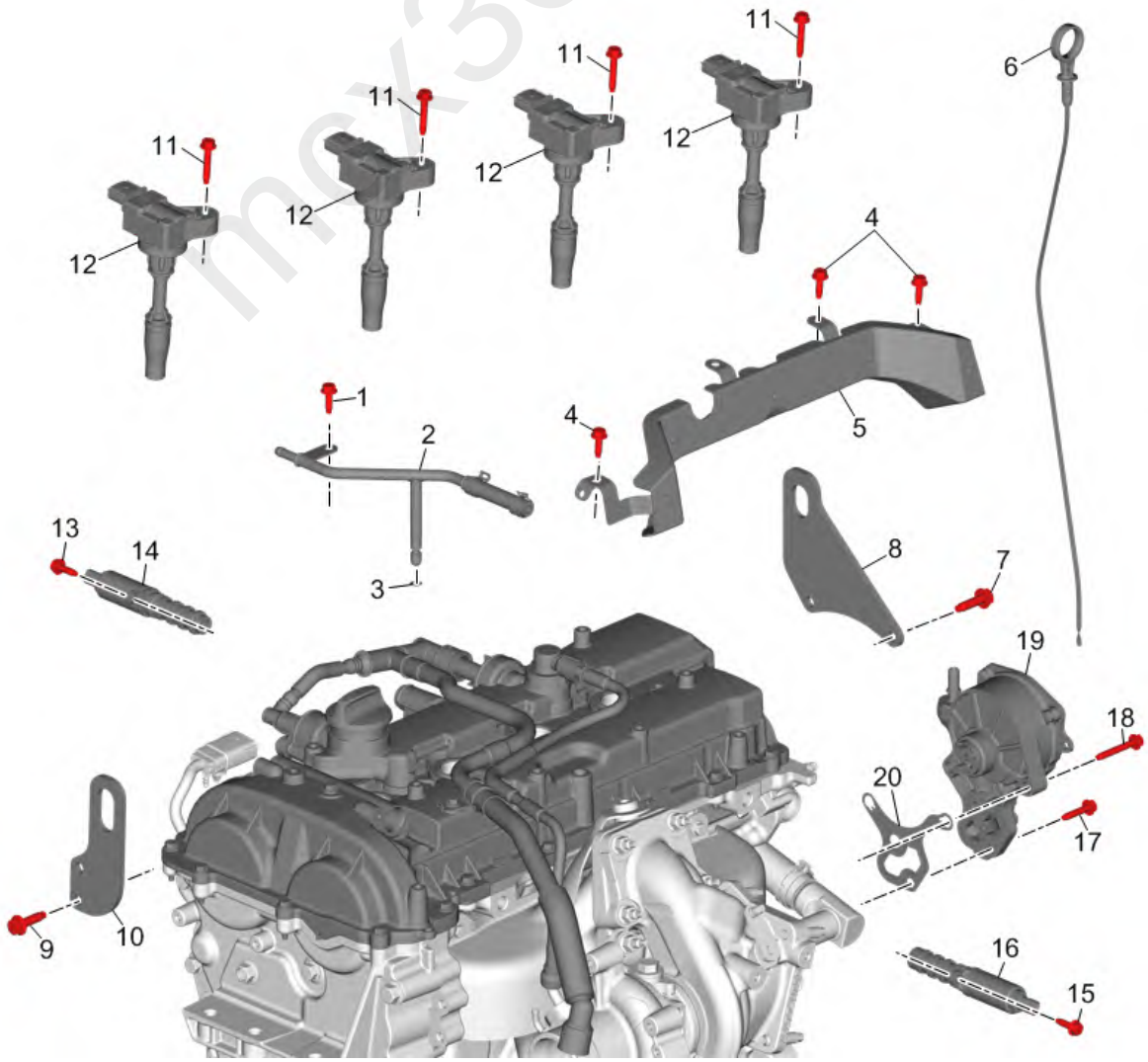
Fig. 316: Turbocharger Component
Courtesy of GENERAL MOTORS COMPANY

Turbocharger Component Removal

Callout	Component Name
1	Turbocharger Heat Shield Bolt **NOTE:** **In the event that a bolt breaks upon removal of components, perform an extraction of the broken bolt.**
2	Turbocharger Heat Shield
3	Turbocharger Wastegate Actuator Arm Retainer
4	Turbocharger Wastegate Actuator Bolt
5	Turbocharger Wastegate Actuator
6	Turbocharger Coolant Return Pipe Bolt **NOTE:** **One bolt retains the turbocharger coolant return pipe and the camshaft cover heat shield at the same location.**
7	Turbocharger Coolant Return Pipe Bolt
8	Turbocharger Coolant Return Pipe **Procedure** Disconnect the turbocharger coolant return pipe from the air bleed hose.

Callout	Component Name
9	Turbocharger Coolant Return Pipe Washer **NOTE:** **Discard the washers.**
10	Turbocharger Coolant Feed Pipe Bolt
11	Turbocharger Coolant Feed Pipe Bolt
12	Turbocharger Coolant Feed Pipe **Procedure** Disconnect the turbocharger coolant feed pipe hose from the engine oil cooler.
13	Turbocharger Coolant Feed Pipe Gasket **NOTE:** **Discard the gasket.**
14	Turbocharger Coolant Feed Pipe Washer **NOTE:** **Discard the washers.**
15	Turbocharger Wastegate Regulator Solenoid Valve Bolt
16	Turbocharger Wastegate Regulator Solenoid Valve **Procedure** Disconnect the turbocharger wastegate regulator solenoid valve hoses from the turbocharger.
17	Turbocharger Air Bypass Valve Solenoid Bolt
18	Turbocharger Air Bypass Valve Solenoid

Camshaft Cover Component Removal



mx30.com

Fig. 317: Camshaft Cover Component
Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover Component Removal

Callout	Component Name
1	Engine Coolant Air Bleed Pipe Bolt
2	Engine Coolant Air Bleed Pipe
3	Engine Coolant Air Bleed Pipe O-Ring **NOTE:** **Inspect O-ring and discard if necessary.**
4	Camshaft Cover Heat Shield Bolt **NOTE:** **An additional bolt retains the camshaft cover heat shield and the turbocharger coolant return pipe.**
5	Camshaft Cover Heat Shield
6	Oil Level Indicator **NOTE:** **Inspect and replace the oil indicator O-ring seals, if necessary.**
7	Engine Lift Rear Bracket Bolt
8	Engine Lift Rear Bracket
9	Engine Lift Front Bracket Bolt
10	Engine Lift Front Bracket
11	Ignition Coil Bolt
12	Ignition Coil
13	Camshaft Position Actuator Solenoid Valve Bolt
14	Camshaft Position Actuator Solenoid Valve - Intake
15	Camshaft Position Actuator Solenoid Valve Bolt
16	Camshaft Position Actuator Solenoid Valve - Exhaust
17	Vacuum Pump Bolt
18	Vacuum Pump Bolt
19	Vacuum Pump
20	Vacuum Pump Gasket **NOTE:** **Discard the gasket.**

Camshaft Cover and Turbocharger Removal

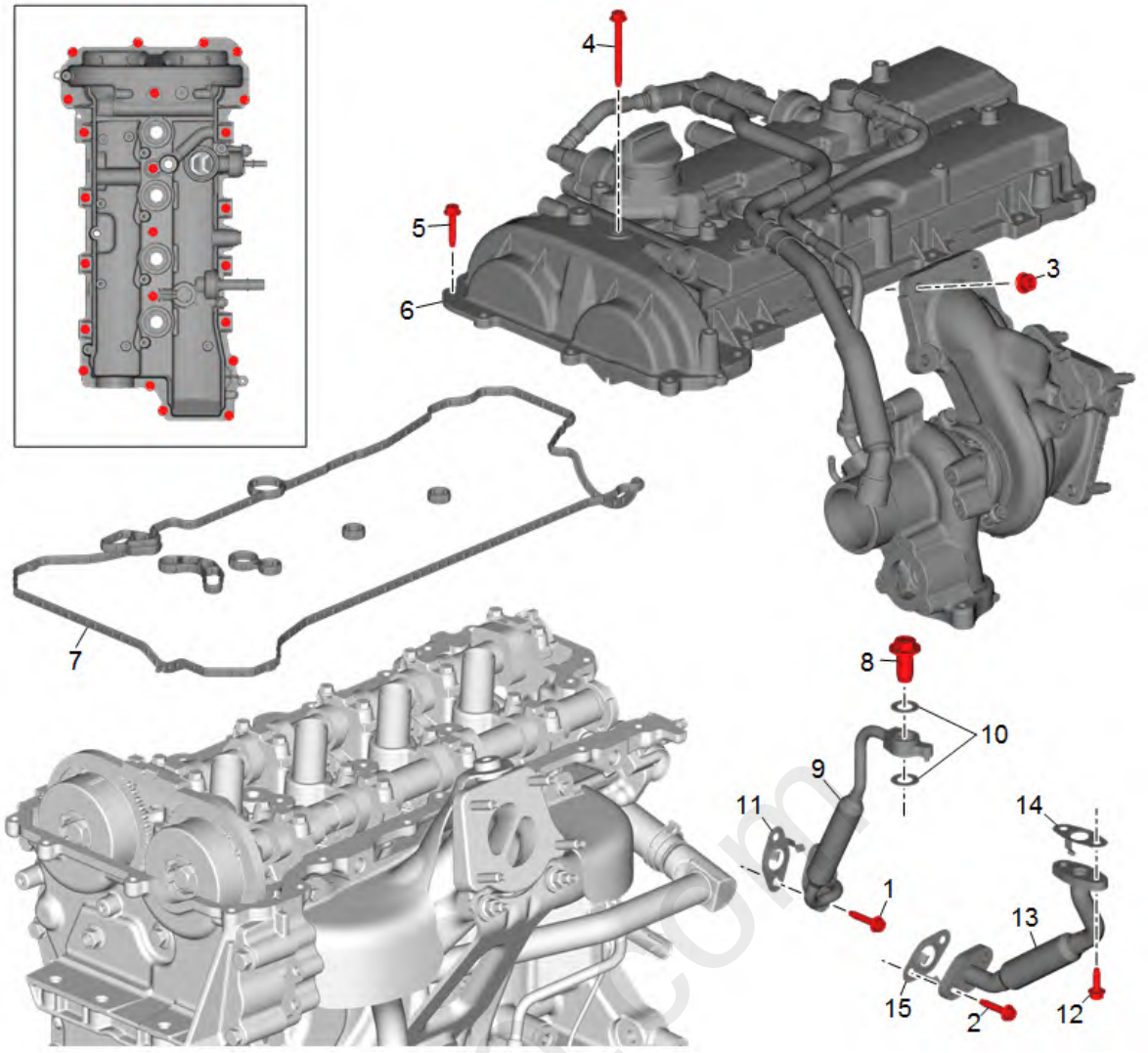


Fig. 318: Camshaft Cover and Turbocharger
Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover and Turbocharger Removal

Callout	Component Name
1	Turbocharger Oil Feed Pipe Bolt
2	Turbocharger Oil Return Pipe Bolt
3	Turbocharger Nut **NOTE:** **Discard the nuts.**
4	Camshaft Cover Bolt
5	Camshaft Cover Bolt

Callout	Component Name
6	Camshaft Cover Positive Crankcase Ventilation Tube Turbocharger **NOTE:** **The tamper-proof positive crankcase ventilation system includes components that may be replaced if necessary. The system may include an outlet duct connected to the end of the Positive Crankcase Ventilation Tube. If any component is suspect, refer to the inspection procedures and individual replacement procedures before attempting to disassemble the PCV system. Be careful when moving the assembled components with tamper-proof fittings to avoid stress on the connections.** **NOTE:** **The assembly is removed with the oil return pipe and oil feed pipe attached at the turbocharger.** **Procedure** 1. The assistance of a second technician may be necessary to support and move the assembly during removal. 2. Ensure a large enough clean area is prepared before removing the assembly. 3. Refer to **Camshaft Cover and Compressor Air Intake Turbocharger Cleaning and Inspection**.
7	Camshaft Cover Gasket **NOTE:** **Ensure all camshaft cover gaskets, including the inner gaskets, are removed and discarded.**
8	Turbocharger Oil Feed Pipe Bolt
9	Turbocharger Oil Feed Pipe
10	Turbocharger Oil Feed Pipe Washer **NOTE:** **Discard the washers.**
11	Turbocharger Oil Feed Pipe Gasket **NOTE:** **Discard the gasket.**
12	Turbocharger Oil Return Pipe Bolt
13	Turbocharger Oil Return Pipe
14	Turbocharger Oil Return Pipe Gasket **NOTE:** **Discard the gasket.**
15	Turbocharger Oil Return Pipe Gasket **NOTE:** **Discard the gasket.**

TURBOCHARGER REMOVAL (1ST DESIGN TAMPER-PROOF PCV SYSTEM)

mx30.com

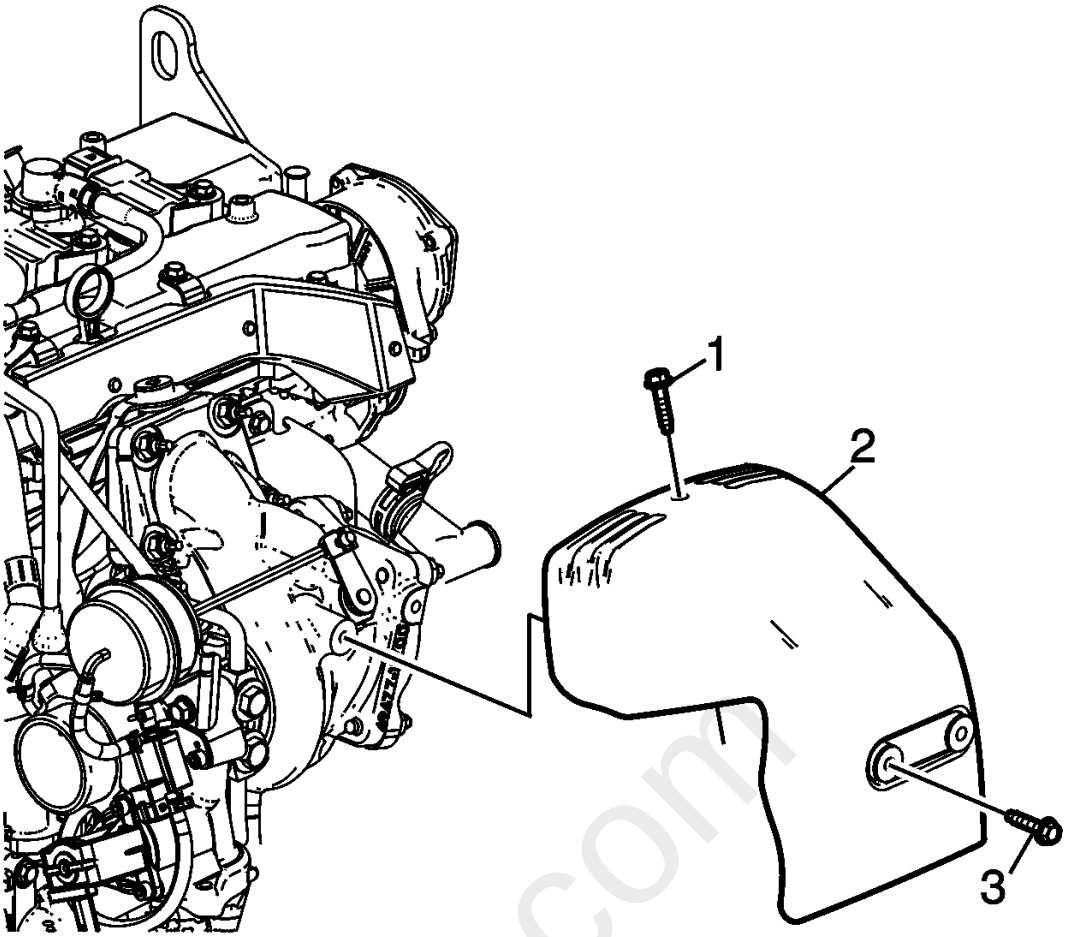


Fig. 319: Turbocharger Heat Shield Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **In the event that a bolt breaks upon removal of components, perform an extraction of the broken bolt.**

1. Remove the turbocharger heat shield bolts (1, 3).
2. Remove the turbocharger heat shield (2).

mc30.com

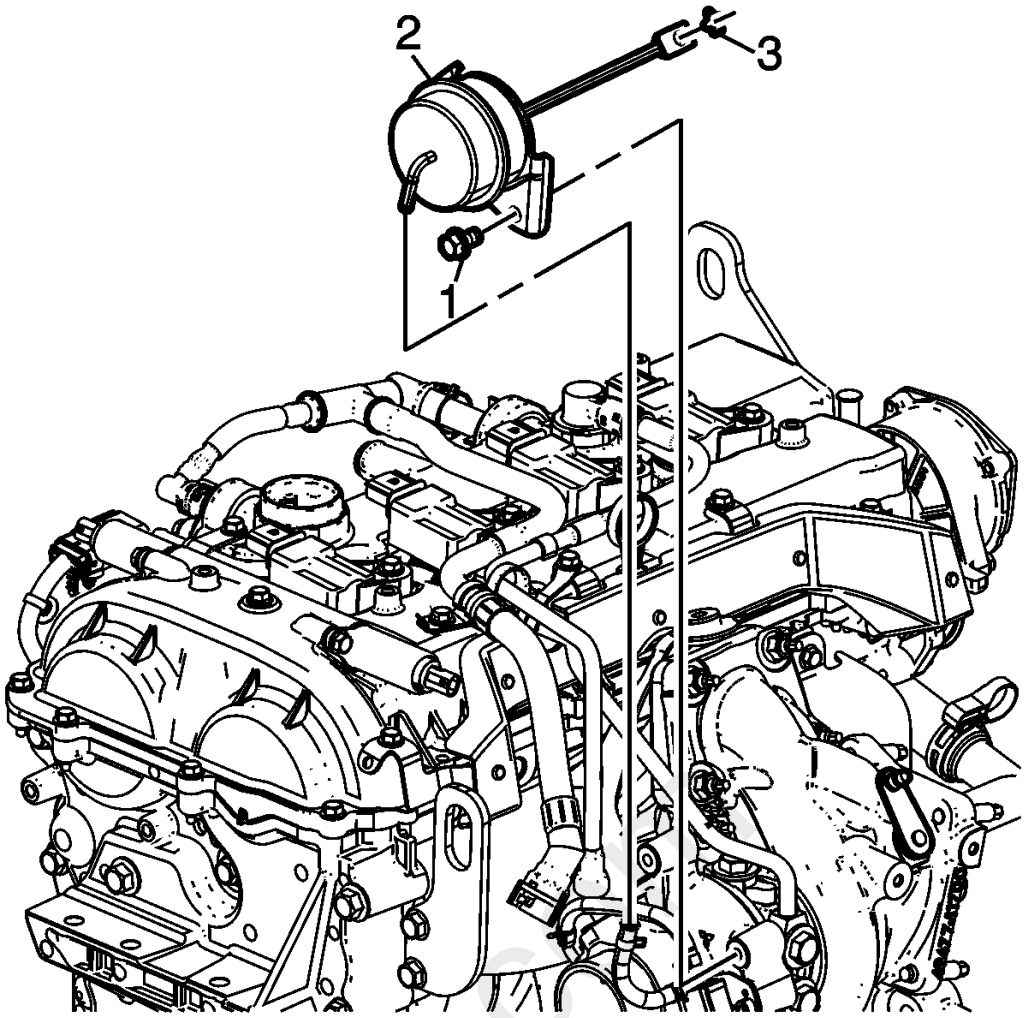


Fig. 320: Turbocharger Wastegate Actuator Arm Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Remove the turbocharger wastegate actuator arm retainer (3).
4. Remove the turbocharger wastegate actuator bolts (1) and actuator (2).

mc730.com

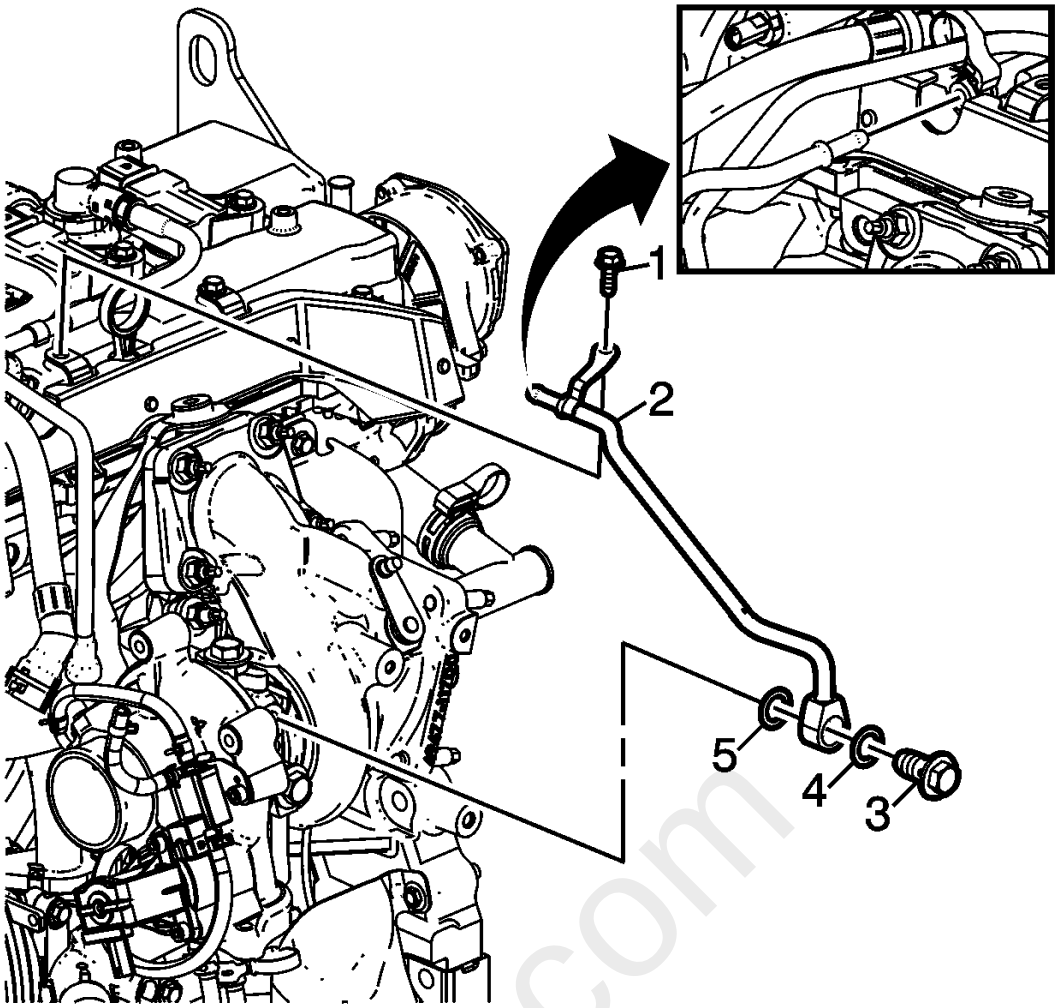


Fig. 321: Camshaft Cover Heat Shield Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the camshaft cover heat shield bolt (1) that retains the turbocharger coolant return pipe (2) at the camshaft cover.
6. Disconnect the turbocharger coolant return pipe from the air bleed hose.
7. Remove the turbocharger coolant return pipe bolt (3).
8. Remove the turbocharger coolant return pipe (2) and washers (4, 5). Discard the washers.

mex30.com

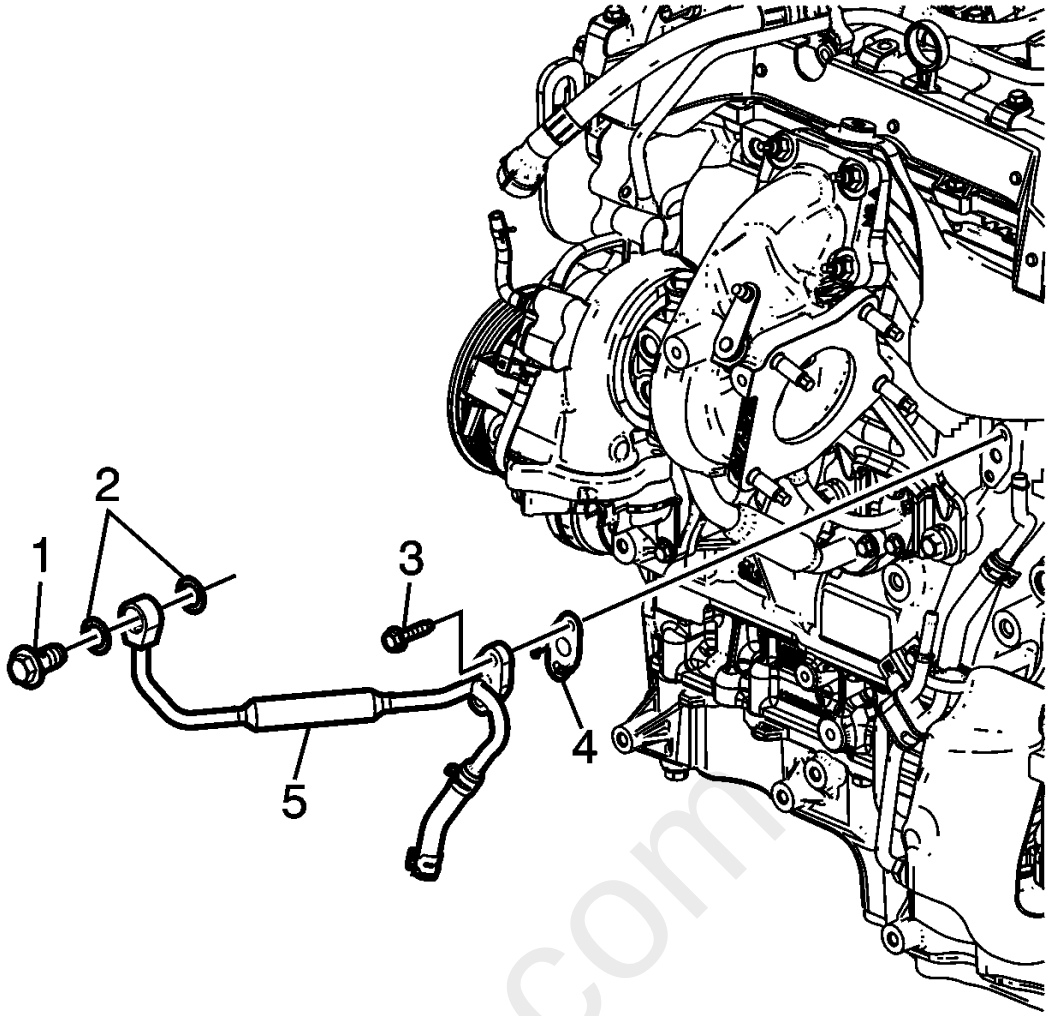


Fig. 322: Turbocharger Coolant Feed Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the turbocharger coolant feed pipe bolts (1, 3).
10. Disconnect the turbocharger coolant feed pipe hose from the engine oil cooler.
11. Remove the turbocharger coolant feed pipe gasket (4) and discard.
12. Remove the turbocharger coolant feed pipe (5) and washers (2). Discard the washers.

mo30.com

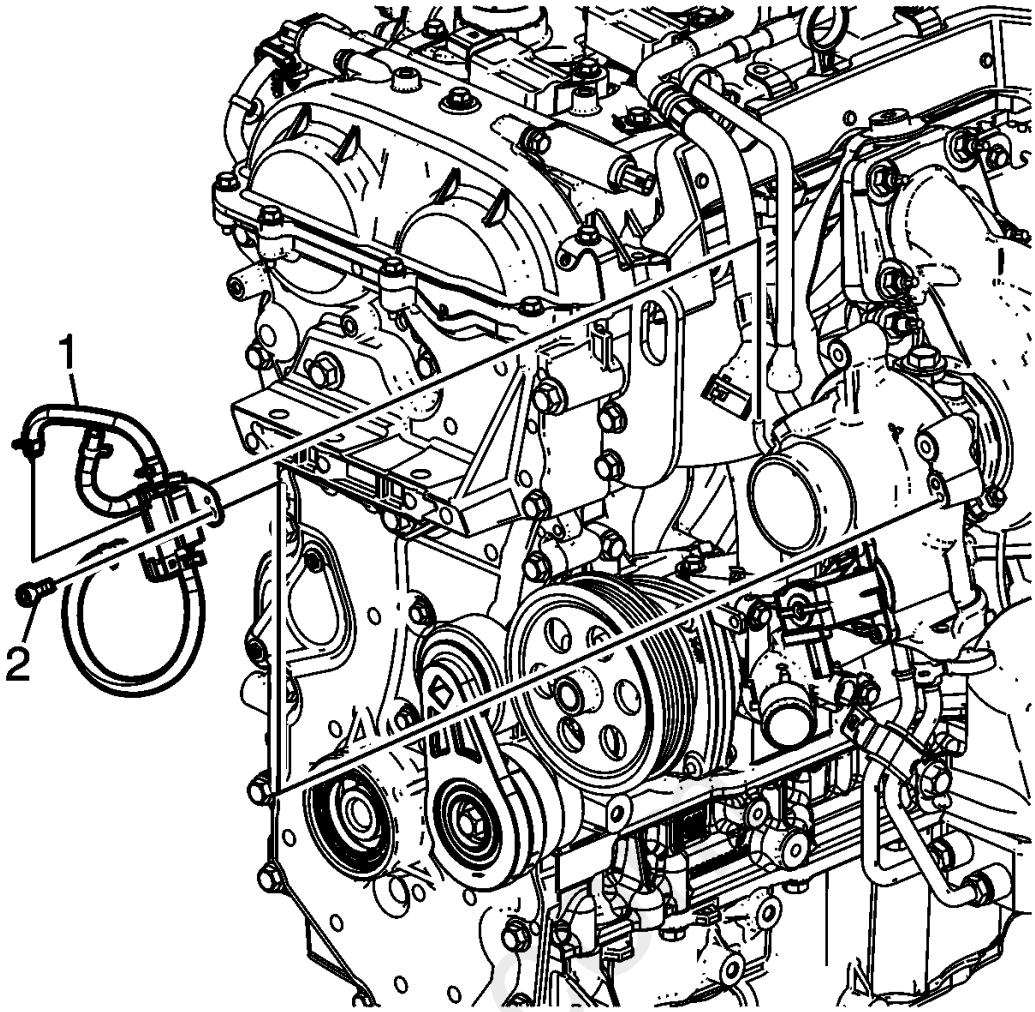


Fig. 323: Turbocharger Wastegate Regulator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

13. Disconnect the turbocharger wastegate regulator solenoid valve hoses from the turbocharger.
14. Remove the turbocharger wastegate regulator solenoid valve bracket bolt (2).
15. Remove the turbocharger wastegate regulator solenoid valve (1).

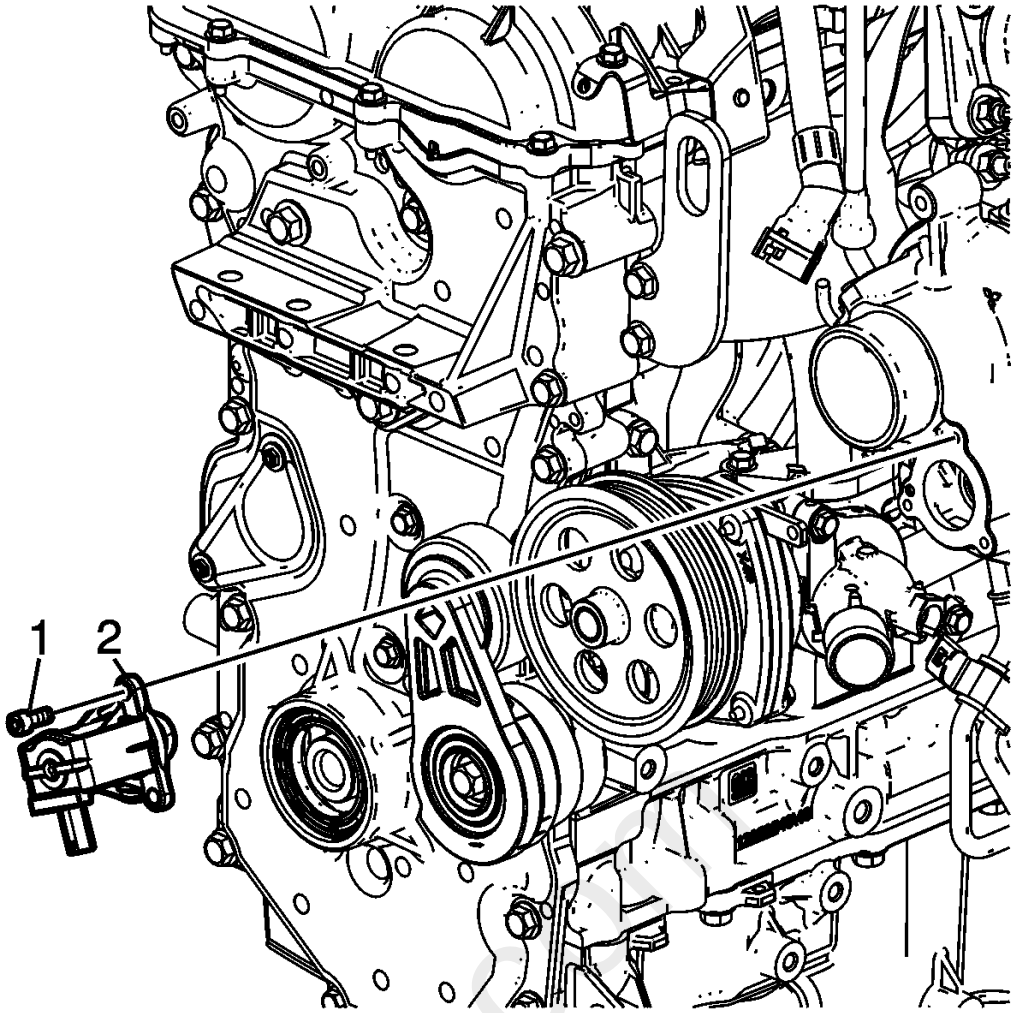


Fig. 324: Turbocharger Bypass Valve Solenoid Bolts
Courtesy of GENERAL MOTORS COMPANY

16. Remove the turbocharger bypass valve solenoid bolts (1).
17. Remove the turbocharger bypass valve solenoid (2).

mc30.com

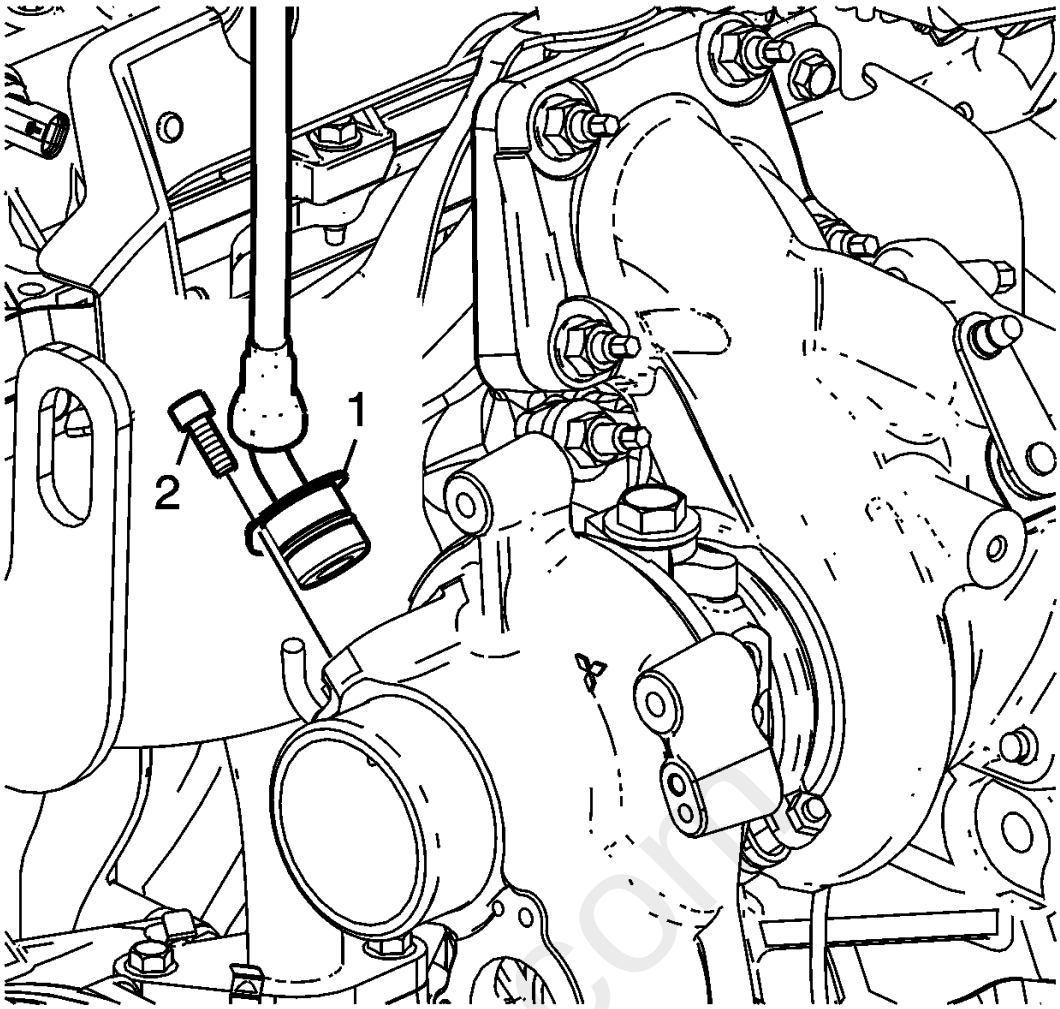


Fig. 325: PCV Hose Fitting Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not disturb the joint between the PCV hose and PCV hose fitting at the turbocharger. This is a permanent connection.**

18. Remove the PCV hose fitting bolt (2). Disconnect the PCV hose fitting (1) with the PCV hose attached from the turbocharger.

mc130.com

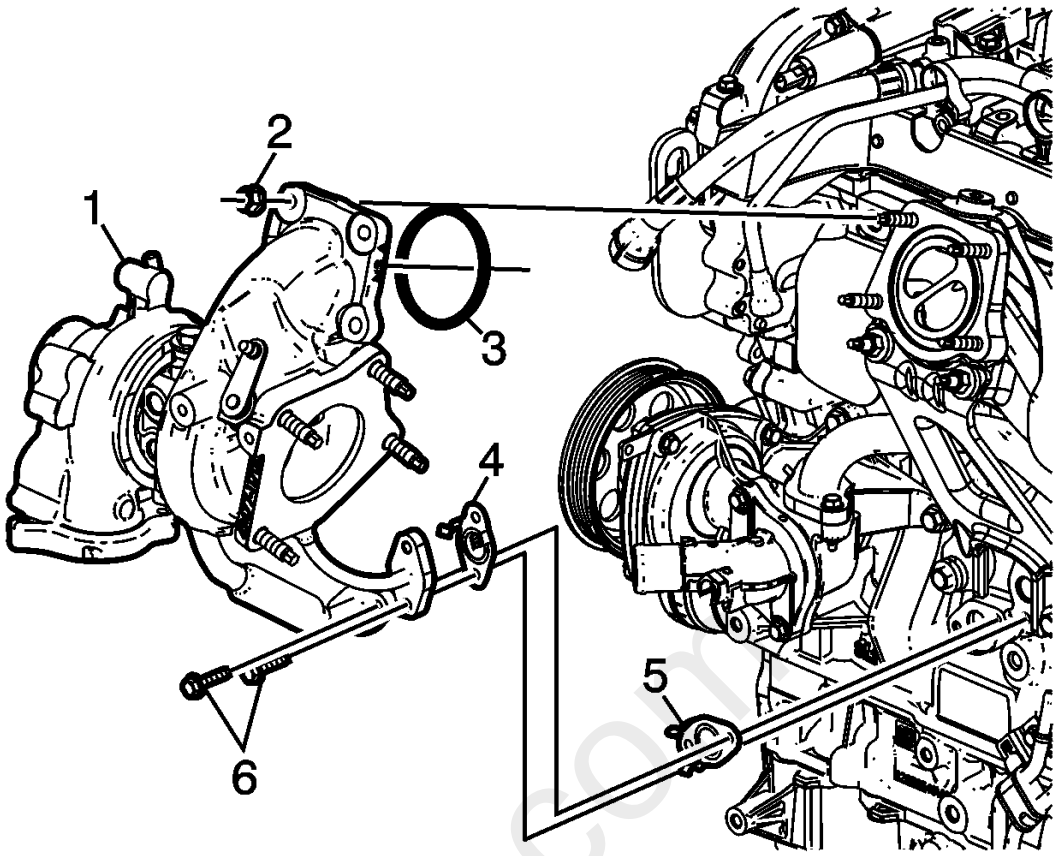


Fig. 326: Exploded View Of Turbocharger
Courtesy of GENERAL MOTORS COMPANY

19. Remove the turbocharger nuts (2) and discard.
20. Remove the turbocharger oil feed and return pipe bolts (6) at the engine block.
21. Remove the turbocharger (1) with the oil return pipe and oil feed pipe attached.
22. Remove the turbocharger oil feed and oil return pipe gaskets (4, 5) and discard.
23. Remove the turbocharger gasket (3) and discard.

mcx30.com

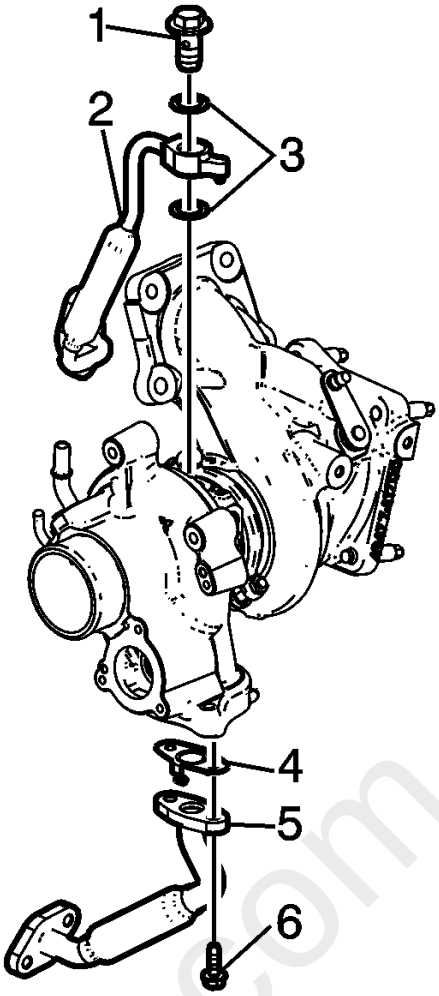


Fig. 327: Turbocharger Oil Feed Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

24. Remove the turbocharger oil feed pipe bolt (1) from the turbocharger.
25. Remove the turbocharger oil feed pipe (2) and washers (3). Discard the washers.
26. Remove the turbocharger oil return pipe bolts (6).
27. Remove the turbocharger oil return pipe (5).
28. Remove and discard the turbocharger oil return pipe gasket (4).
29. Clean and inspect the turbocharger and components. Refer to **Camshaft Cover and Compressor Air Intake Turbocharger Cleaning and Inspection**.

EXHAUST MANIFOLD REMOVAL

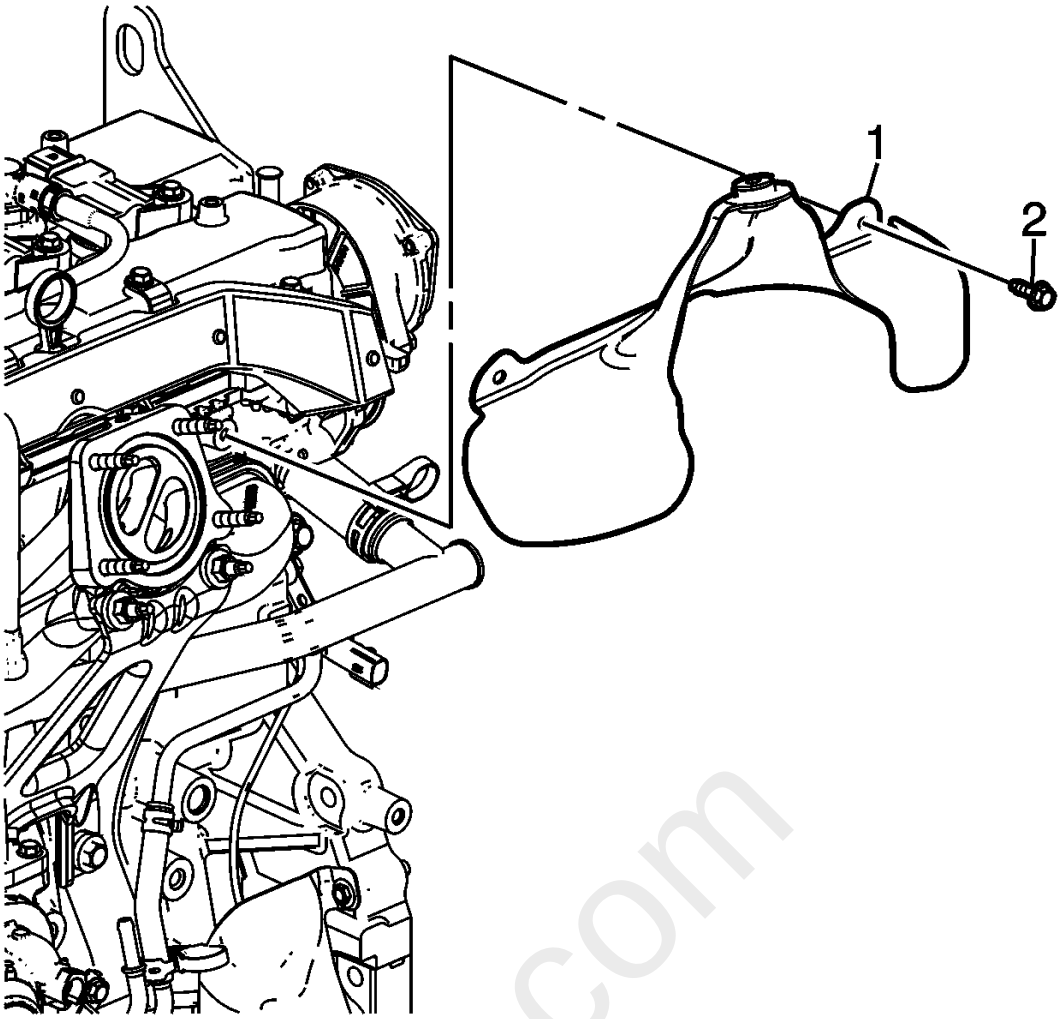


Fig. 328: Exhaust Manifold Heat Shield Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **In the event that a bolt breaks upon removal of components, perform an extraction of the broken bolt.**

1. Remove the exhaust manifold heat shield bolts (2).
2. Remove the exhaust manifold heat shield (1).

mc30.com

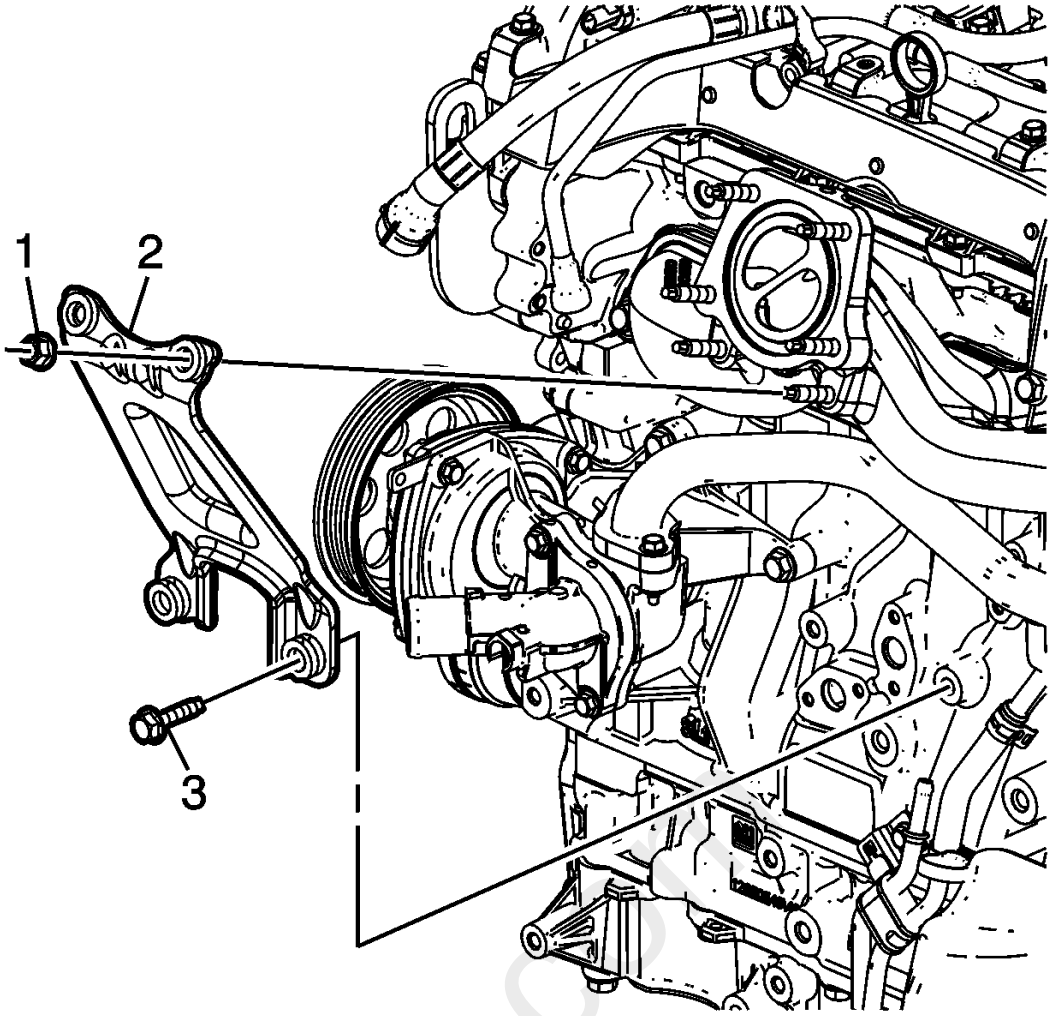


Fig. 329: Exhaust Manifold Brace Nuts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the exhaust manifold brace nuts (1) and discard.
4. Remove the exhaust manifold brace bolts (3).
5. Remove the exhaust manifold brace (2).

mc30.com

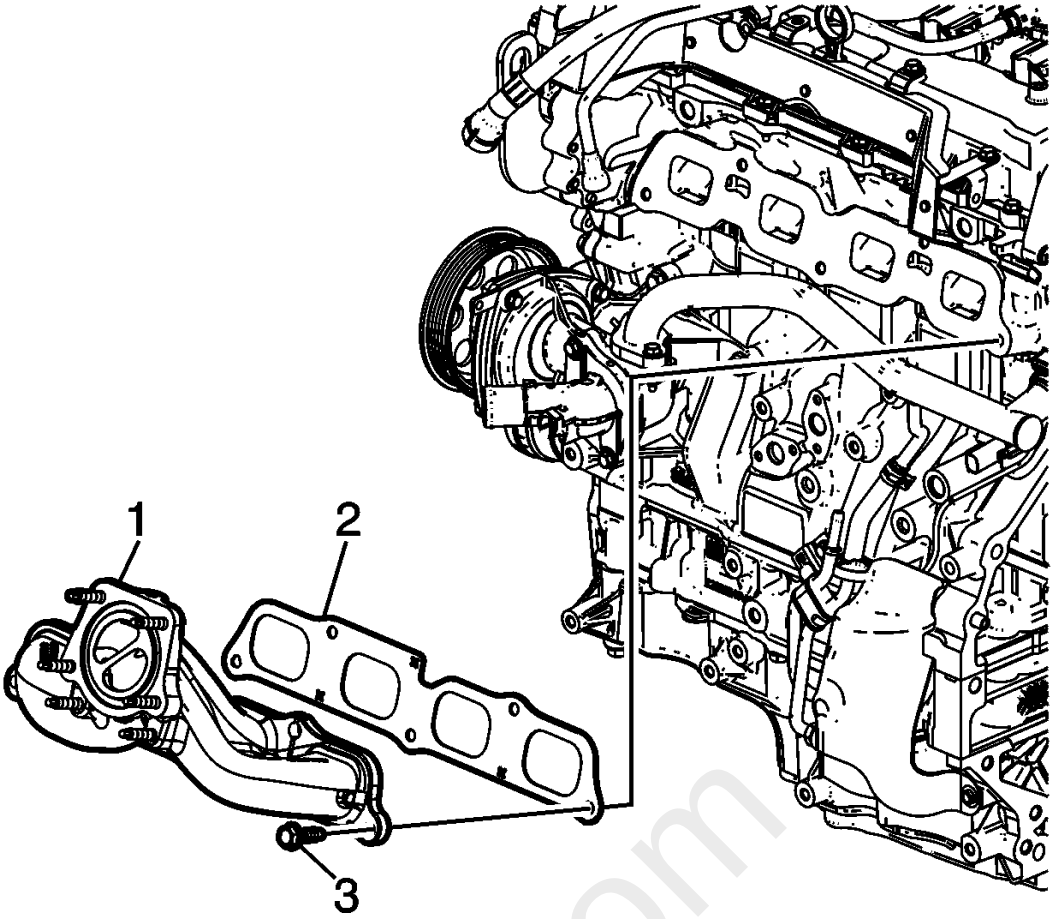


Fig. 330: Exhaust Manifold And Cylinder Head Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove and discard the exhaust manifold to cylinder head bolts (3).
7. Remove the exhaust manifold (1).
8. Remove and discard the exhaust manifold gasket (2).
9. Clean all of the sealing surfaces.

FUEL RAIL AND INJECTORS REMOVAL

Special Tools

EN-49248 Fuel Rail Assembly Remover

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

mcx30.com

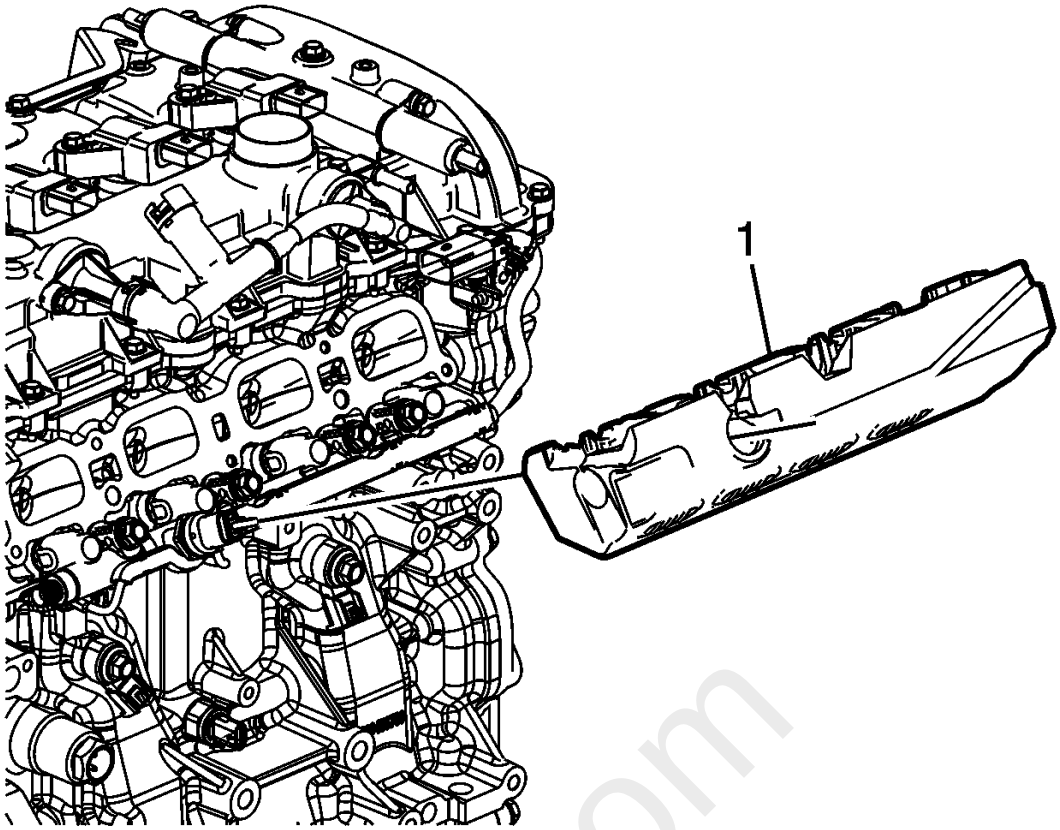


Fig. 331: Fuel Injection Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

WARNING: The noise cancelling foam component MUST be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.

1. Remove the fuel injection fuel rail noise shield (1).

mc30.com

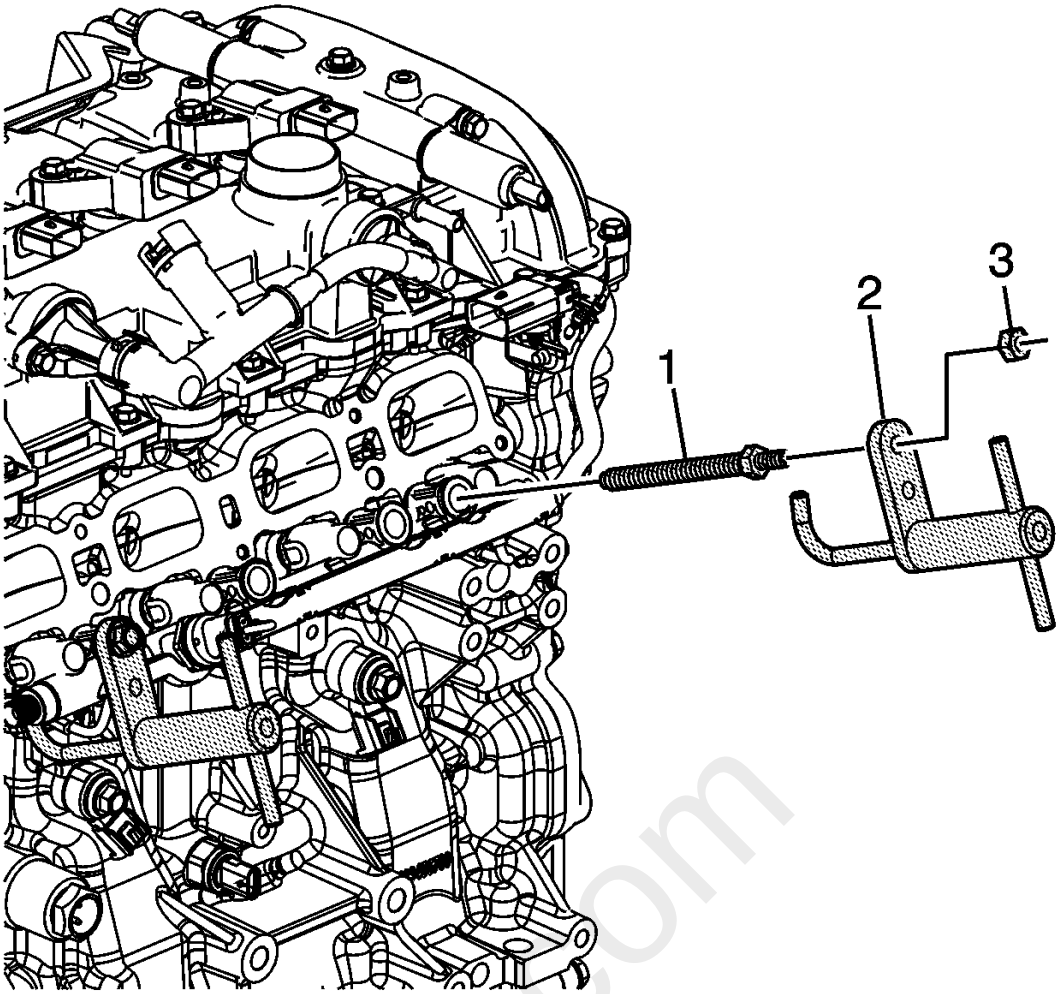


Fig. 332: Identifying Fuel Rail Assembly Remover Studs
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the electrical harness from the fuel rail harness connection.

NOTE: **Fuel rail bolts are captured in the fuel rail assembly**

- **Ensure the bolt is completely loosened, and the threads are no longer engaged.**
- **Use a suitable tool to apply enough force to pull the bolt straight out of the fuel rail.**

3. Remove the fuel rail assembly retaining bolts.

NOTE: **Use care to avoid contact with the fuel rail harness during special tool installation and fuel rail removal.**

4. Install **EN-49248** studs (1) into the 2 outermost fuel rail assembly retaining bolt locations. tighten the studs to 22 N.m (16 lb ft).
5. Install **EN-49248** remover (2) onto each stud, and engage the hooks to the fuel rail. Install the nuts (3) retaining the remover onto the studs and tighten until snug.

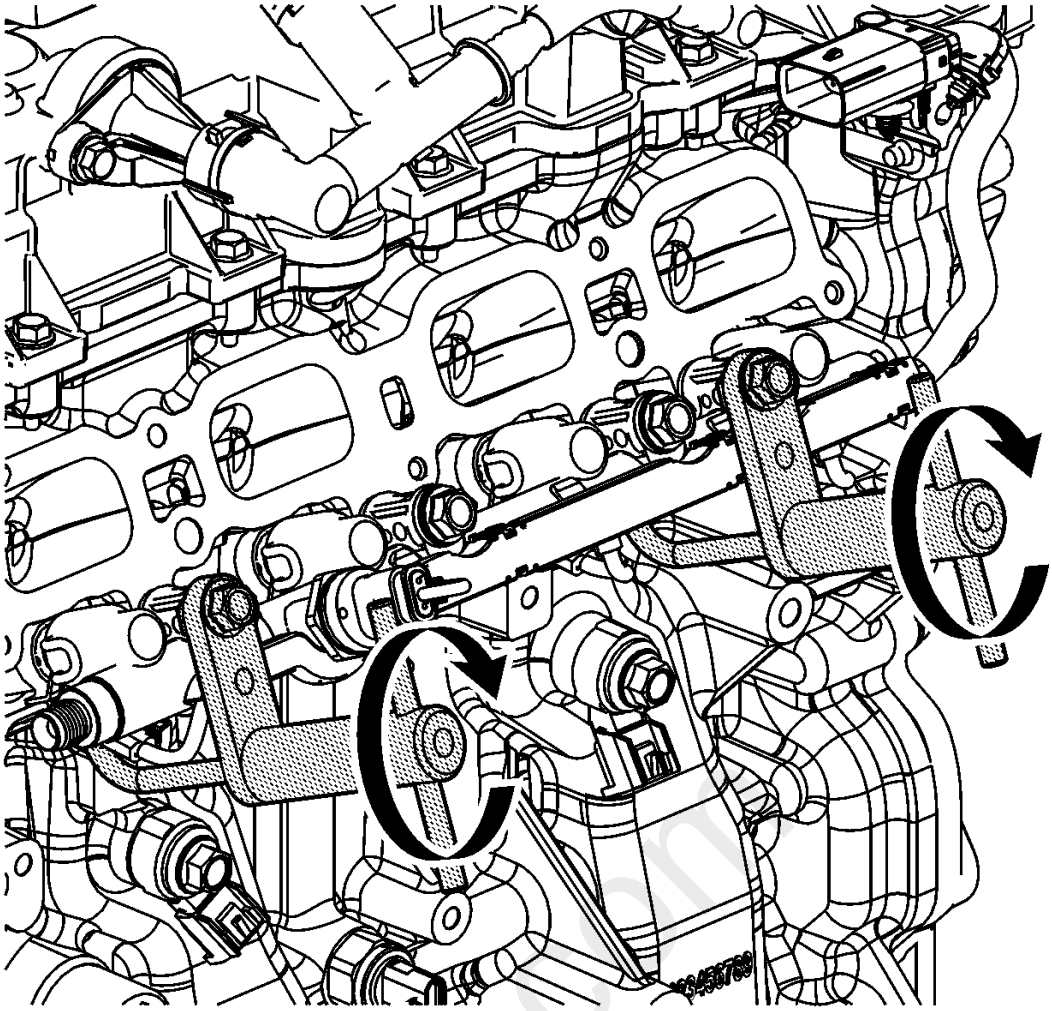


Fig. 333: Fuel Rail Assembly Remover
Courtesy of GENERAL MOTORS COMPANY

CAUTION:

- **Remove the fuel rail assembly carefully in order to prevent damage to the injector electrical connector terminals and the injector spray tips. Support the fuel rail after the fuel rail is removed in order to avoid damaging the fuel rail components.**
- **Cap the fittings and plug the holes when servicing the fuel system in order to prevent dirt and other contaminants from entering open pipes and passages.**

NOTE: **EN-49248 will assist in the proper removal of the fuel rail assembly. Ensure that the following conditions are met:**

- **Turn the handles simultaneously in order to pull the fuel rail straight out along the fuel injector axis.**
- **DO NOT twist when pulling out on the fuel rail and injector assembly.**

6. Using **EN-49248** remover, remove the fuel rail assembly.

CAMSHAFT COVER REMOVAL (1ST DESIGN TAMPER-PROOF PCV SYSTEM)

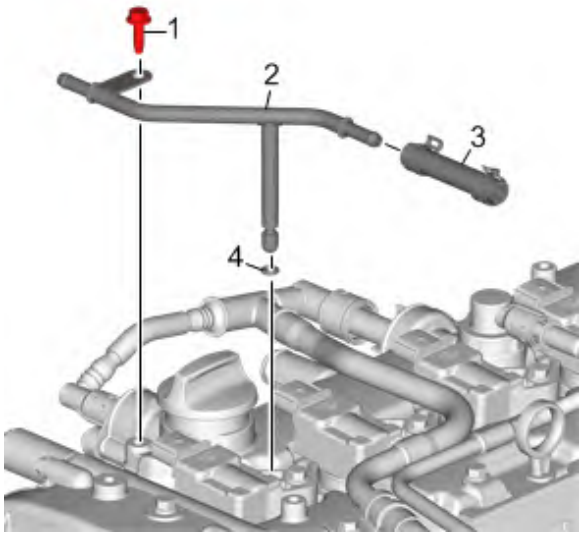


Fig. 334: Engine Coolant Air Bleed Pipe/Hose, Bolt And O-Ring
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine coolant air bleed pipe bolt (1).
2. Remove the engine coolant air bleed pipe (2), hose (3), and O-ring (4). Inspect O-ring and discard if necessary.

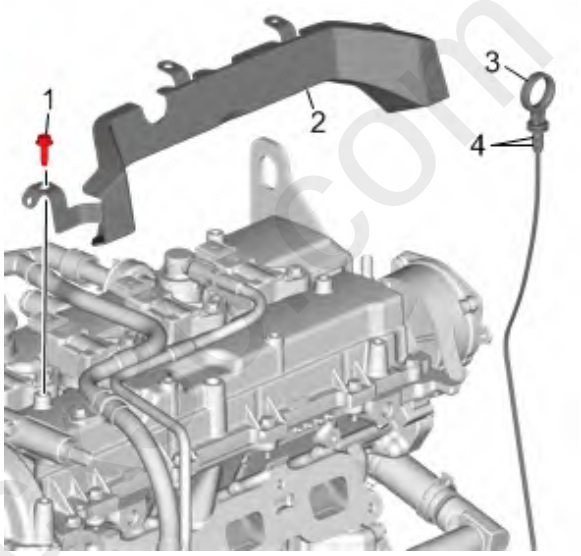


Fig. 335: Oil Level Indicator, O-Rings, Camshaft Cover Heat Shield And Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil level indicator (3). Inspect and replace the oil indicator O-ring seals (4), if necessary.
4. Remove the camshaft cover heat shield (2) and bolts (1).

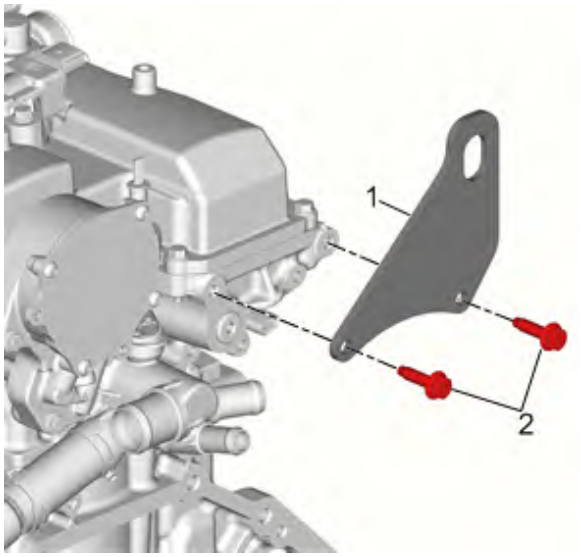


Fig. 336: Rear Lift Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the rear lift bracket (1) and bolts (2).

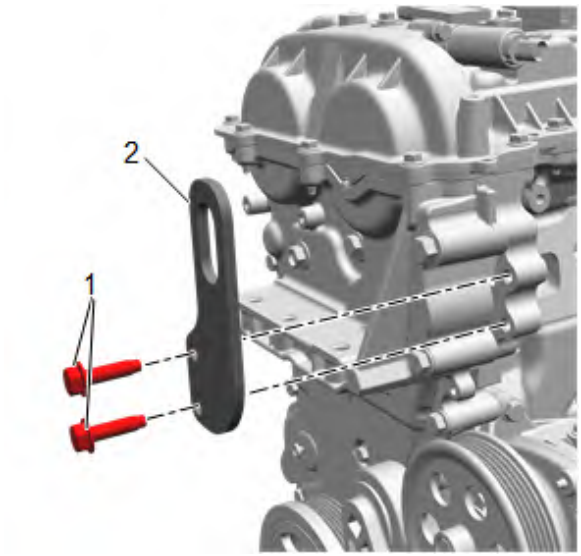


Fig. 337: Front Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Remove the front lift bracket (2) and bolts (1).

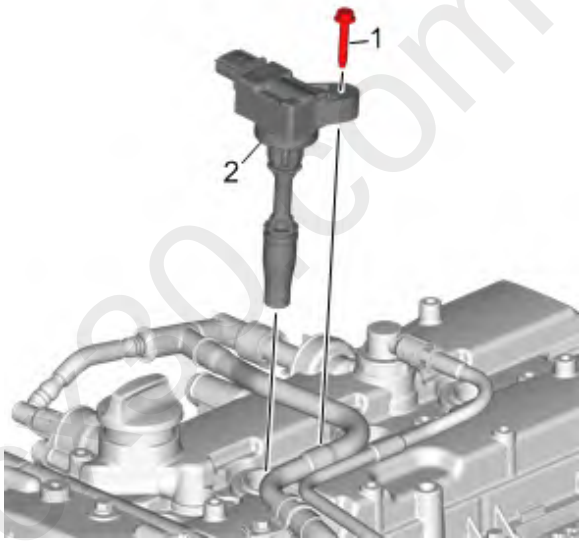


Fig. 338: Ignition Coils And Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the ignition coils (2) and bolts (1).

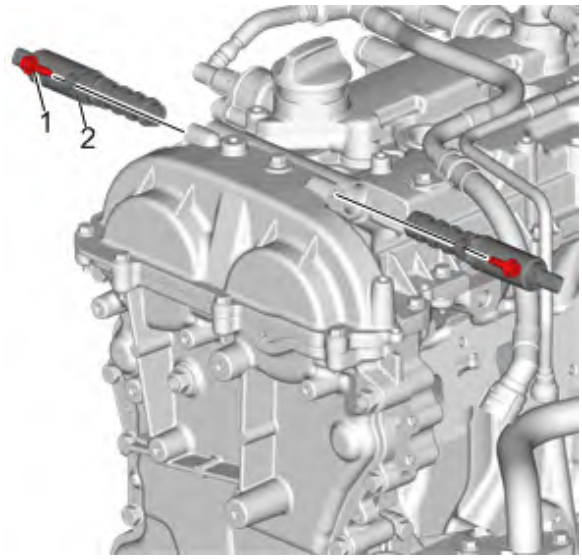


Fig. 339: Camshaft Position Actuator Solenoid Valves And Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the camshaft position actuator solenoid valves (2) and bolts (1).

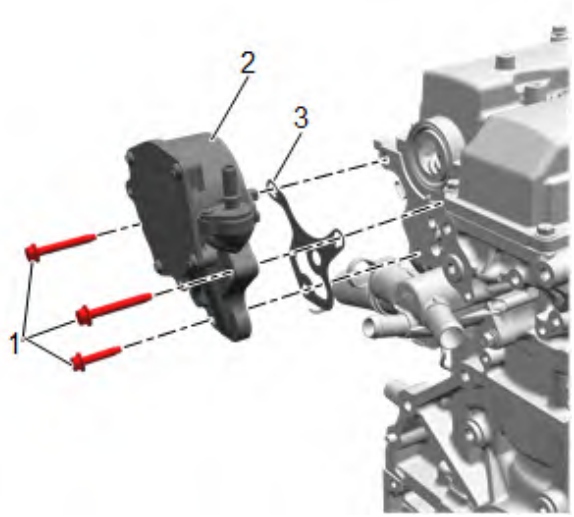


Fig. 340: Vacuum Assembly And Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the vacuum assembly (2) and bolts (1).
10. Remove the vacuum assembly gasket (3) and discard.

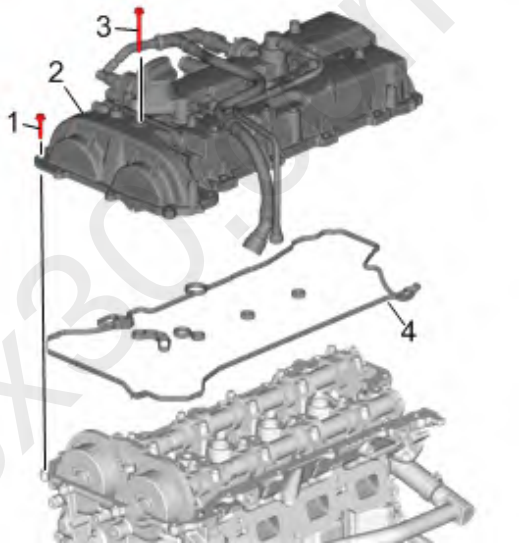


Fig. 341: Camshaft Cover, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

11. Remove the camshaft cover bolts (1, 3) and camshaft cover (2).

NOTE: **Ensure all camshaft cover gaskets, including the inner gaskets, are removed and discarded.**

12. Remove and discard the camshaft cover gaskets and camshaft cover inner gaskets (4).

ENGINE FRONT COVER REMOVAL

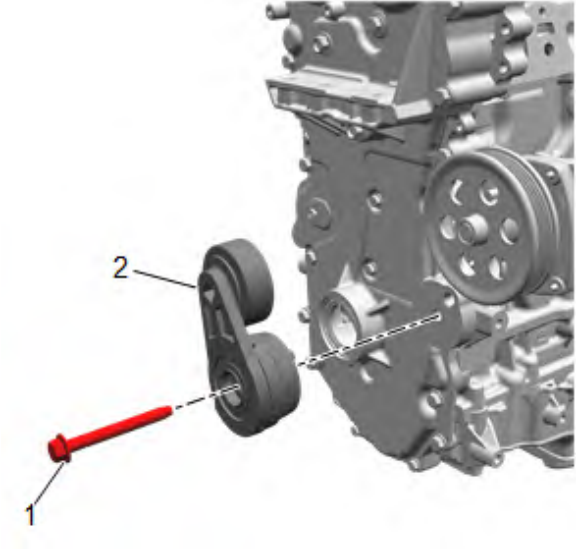


Fig. 342: Accessory Drive Belt Tensioner And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the accessory drive belt tensioner bolt (1).
2. Remove the accessory drive belt tensioner (2).

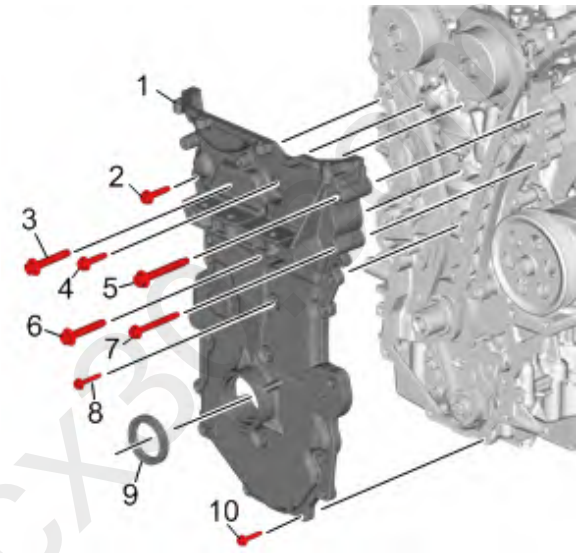


Fig. 343: Engine Front Cover, Bolts And Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine front cover bolts (2 - 8, 10).
4. Discard bolts 3, 5, and 6.

NOTE: **Inspect around the edges of the cover for pry locations. Use a suitable tool at the pry locations to assist with removal of the cover.**

5. Remove the engine front cover (1).
6. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**
7. Clean and Inspect the engine front cover mating surface.
8. Remove the front oil seal (9) with an appropriate tool, and discard.

CAMSHAFT TIMING CHAIN AND TENSIONER REMOVAL

Special Tools

EN 50837 Timing Chain Tensioner Retraction Tool

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

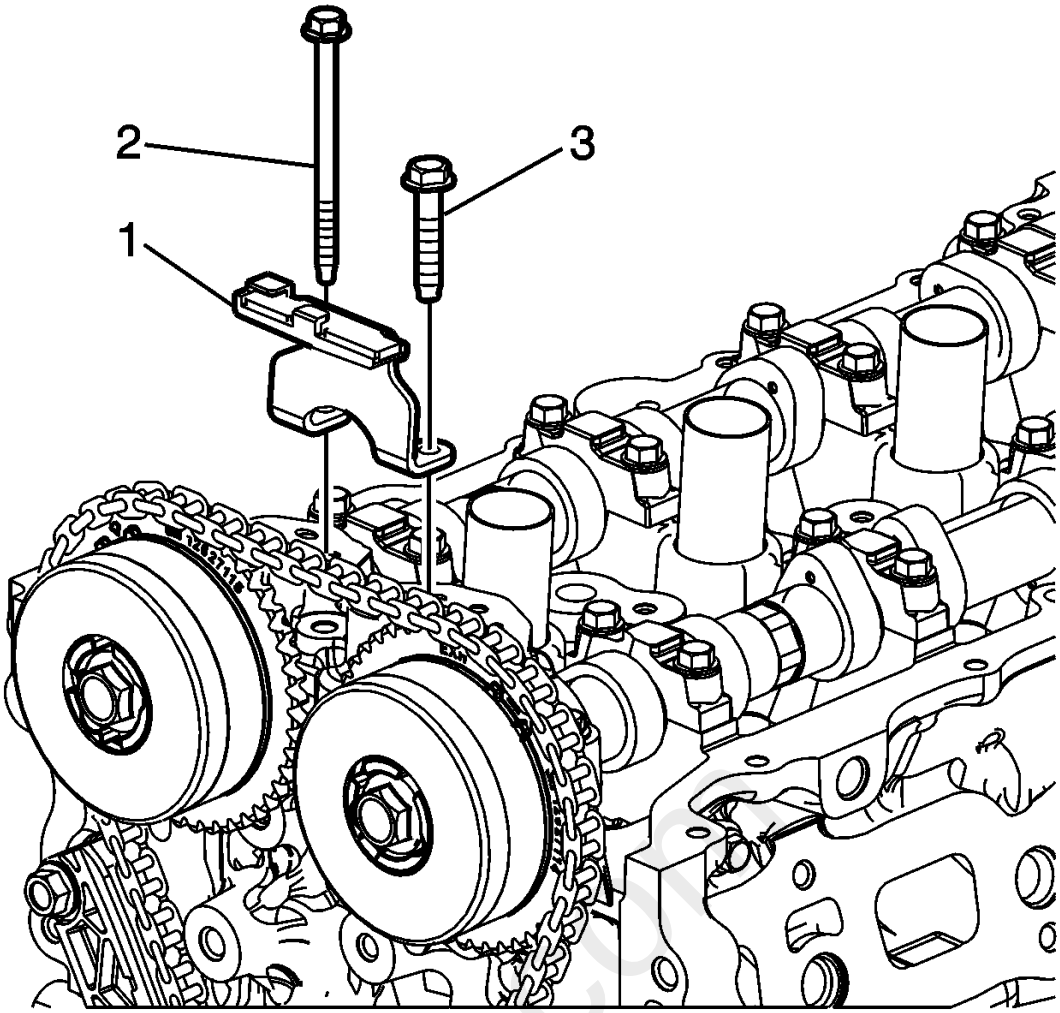


Fig. 344: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the upper timing chain guide bolts (2, 3).
2. Remove the upper timing chain guide (1).

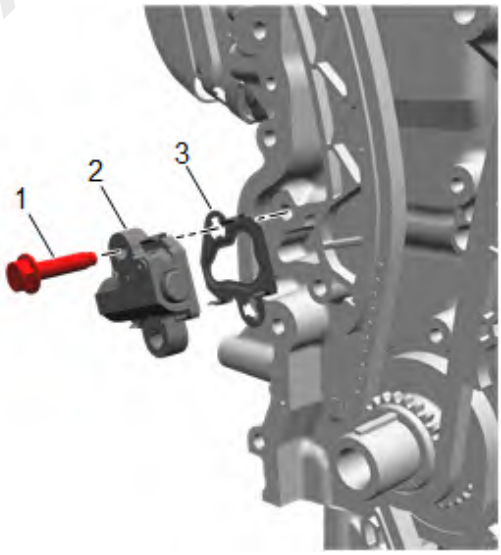


Fig. 345: Timing Chain Tensioner Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the timing chain tensioner bolts (1) and timing chain tensioner (2).
4. Remove the timing chain tensioner gasket (3) and discard.
5. Compress and lock the tensioner using **EN-50837** retention tool.
    1. Insert **EN-50837** retention tool into the lever arm and push in a counterclockwise direction.
    2. Compress the tensioner while holding lever arm.

mc30.com

3. Relax the force on the lever and tensioner slightly, allowing the tensioner to extend 3 ratchet clicks, and then hold in place.
4. Pull lever clockwise using **EN-50837** retention tool until the hole in the lever aligns with the hole in the tensioner assembly. Push the point of **EN-50837** retention tool through the lever and into the tensioner assembly.

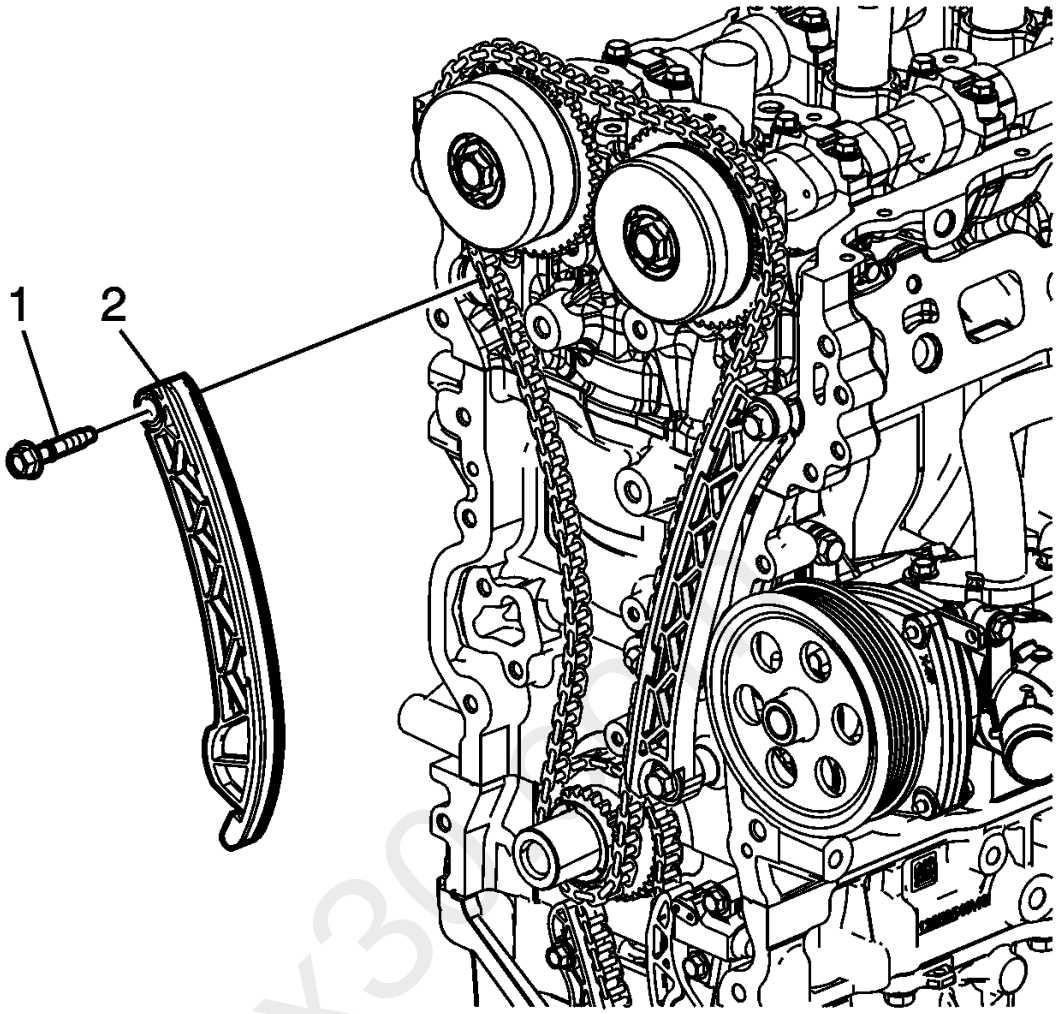


Fig. 346: Timing Chain Tensioner Pivot Arm Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the timing chain tensioner pivot arm bolt (1).
7. Remove the timing chain tensioner pivot arm (2).

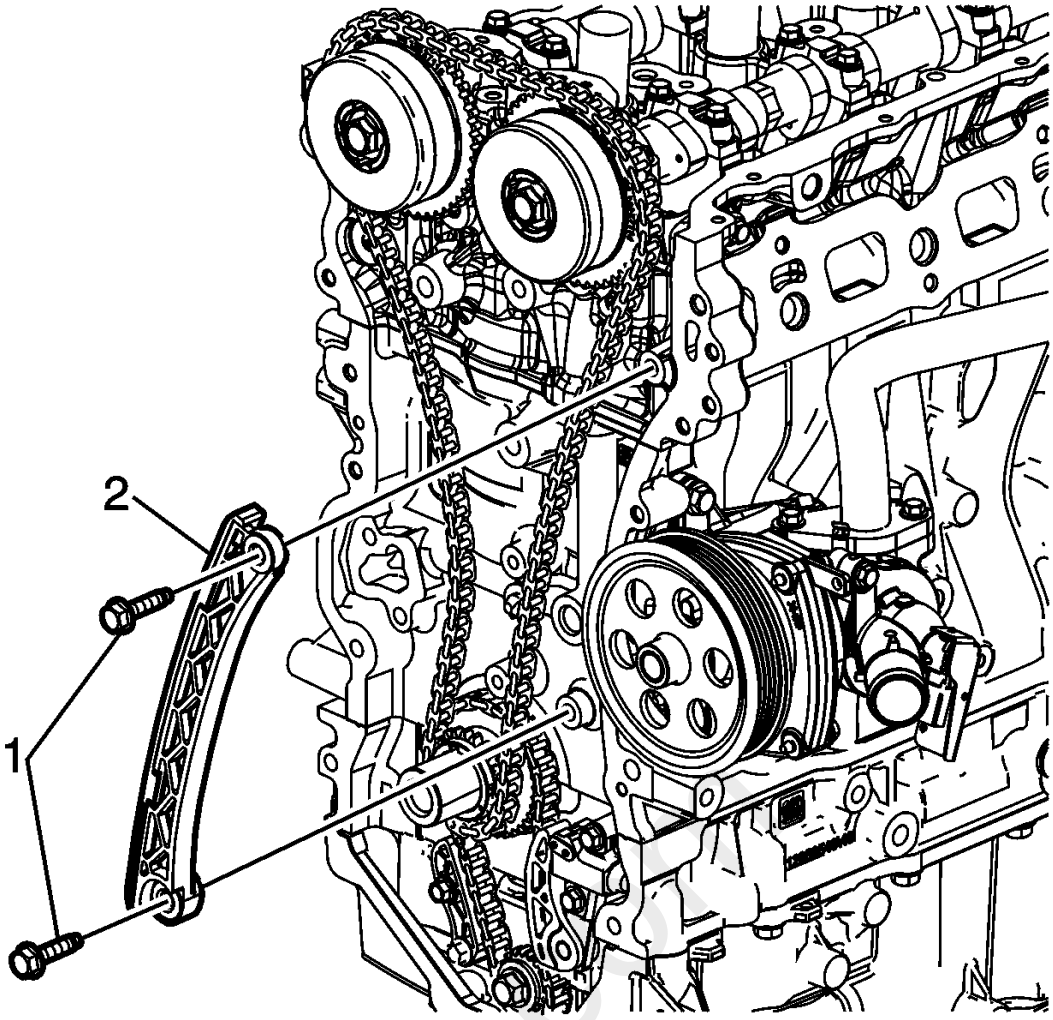


Fig. 347: Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the timing chain guide bolts (1).
9. Remove the timing chain guide (2).

mcx30.com

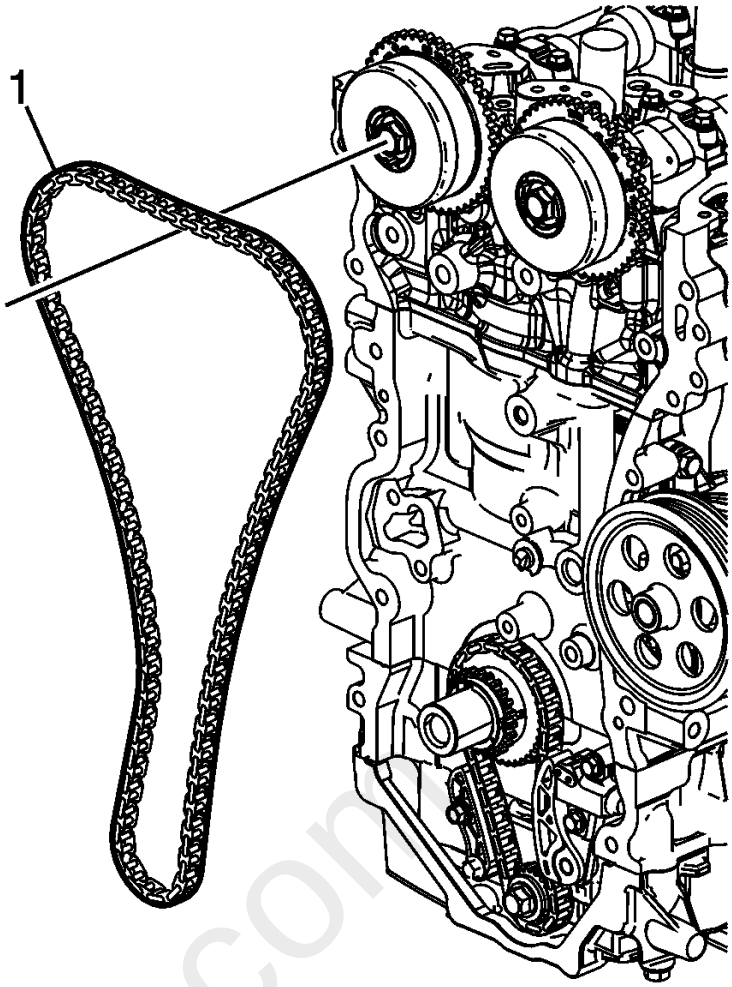


Fig. 348: Timing Chain
Courtesy of GENERAL MOTORS COMPANY

10. Remove the timing chain (1).

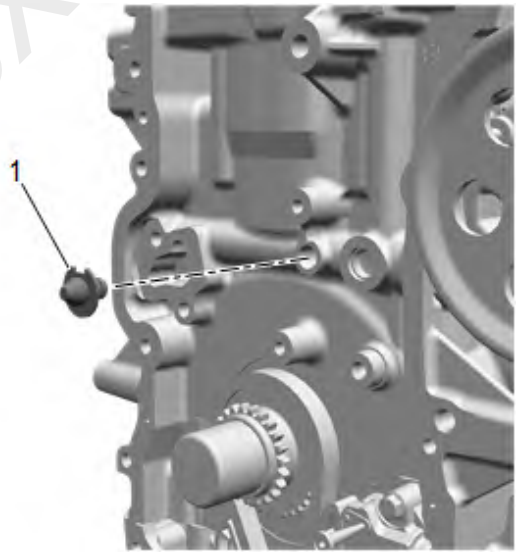


Fig. 349: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

11. Remove the timing chain oil nozzle (1).

OIL PAN REMOVAL (AWD)

mcx30.com

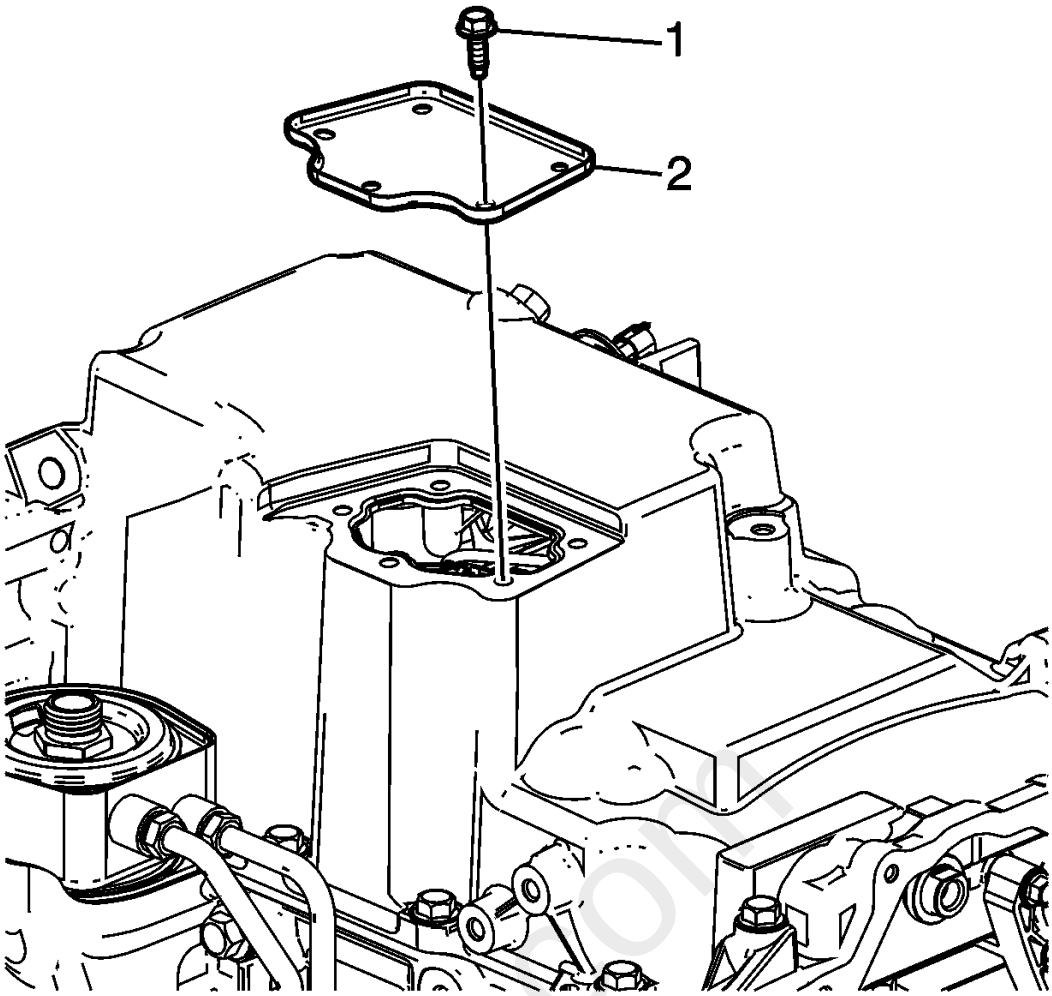


Fig. 350: Oil Pan Cover And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pan cover bolts (1).
2. Remove the oil pan cover (2).

mcx30.com

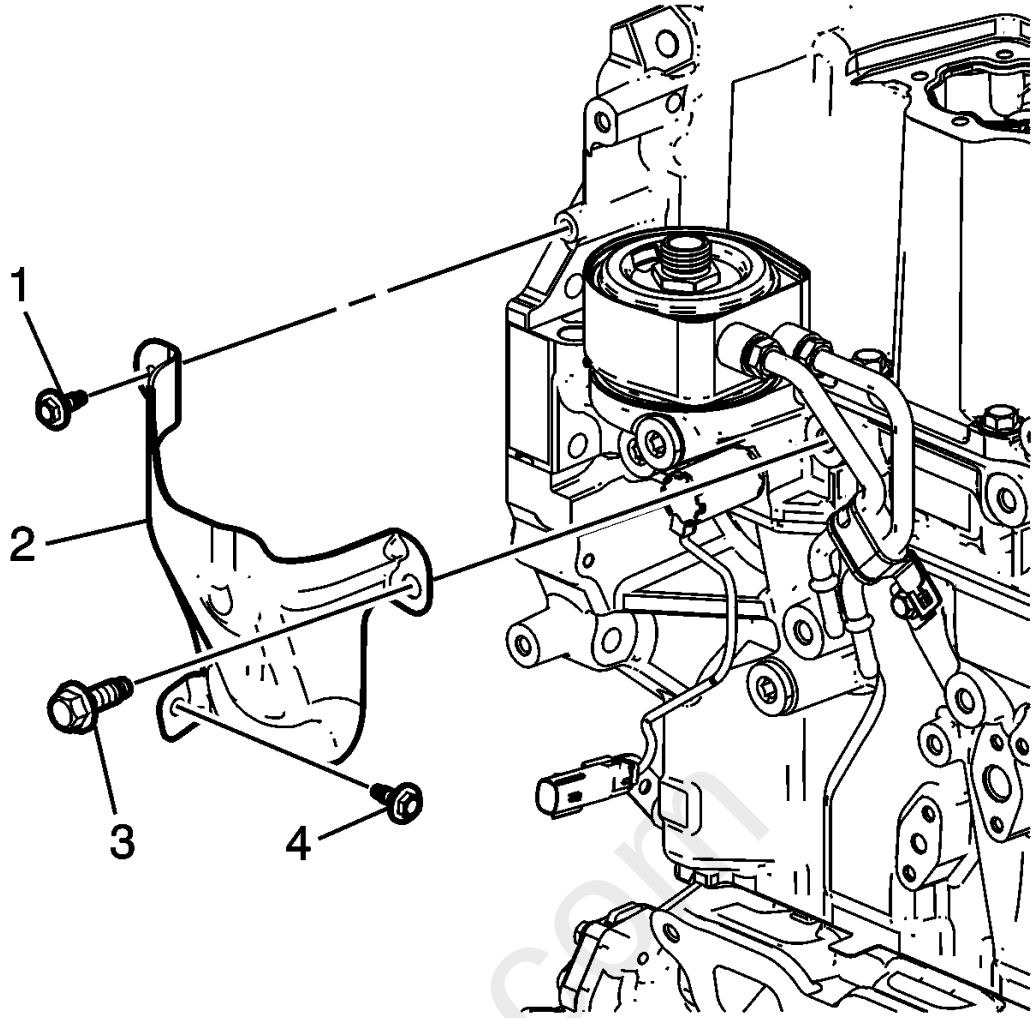


Fig. 351: Oil Pump Flow Control Valve Cover
Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil pump flow control valve cover (2) and bolts (1, 3, 4).

mcx30.com

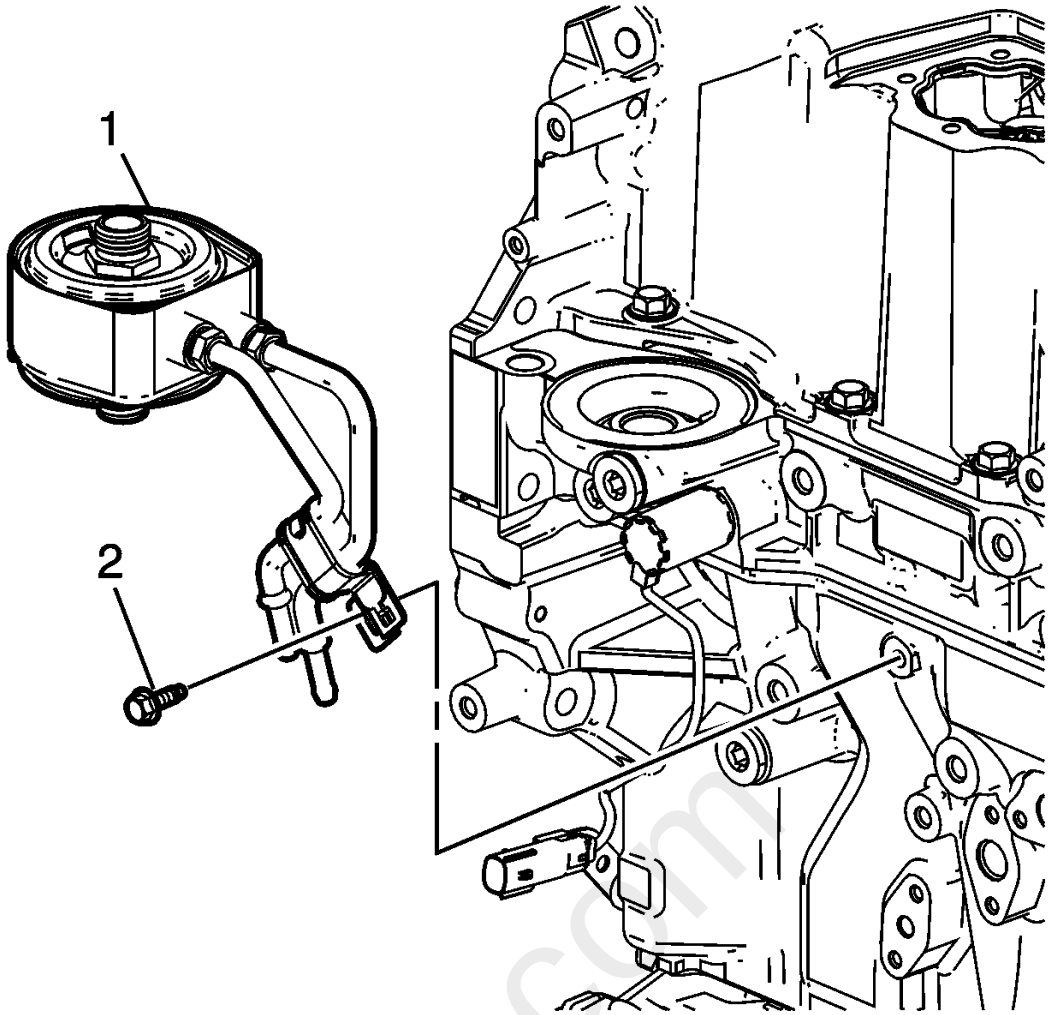


Fig. 352: Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine oil cooler (1) and bolts (2).

mcx30.com

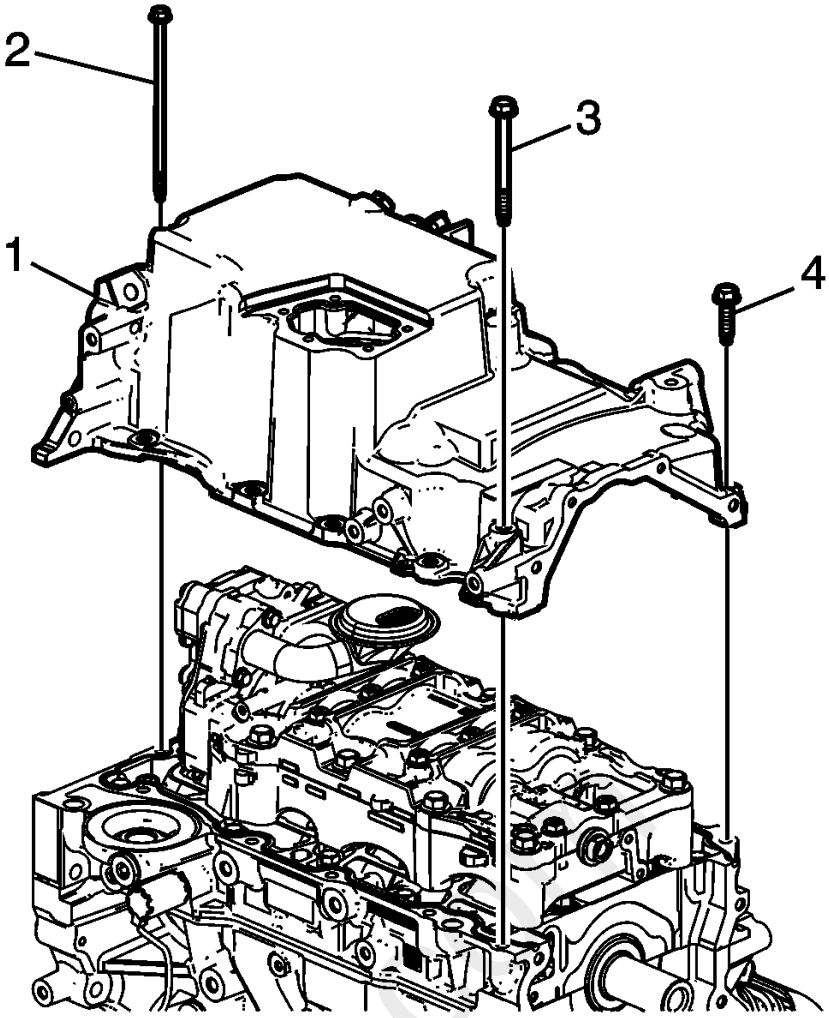


Fig. 353: Upper Oil Pan And Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the upper oil pan bolts (2, 3, 4).
6. Remove the upper oil pan (1).

OIL PAN REMOVAL (FWD)

Oil Pump Flow Control Valve Heat Shield Removal

mcx30.com

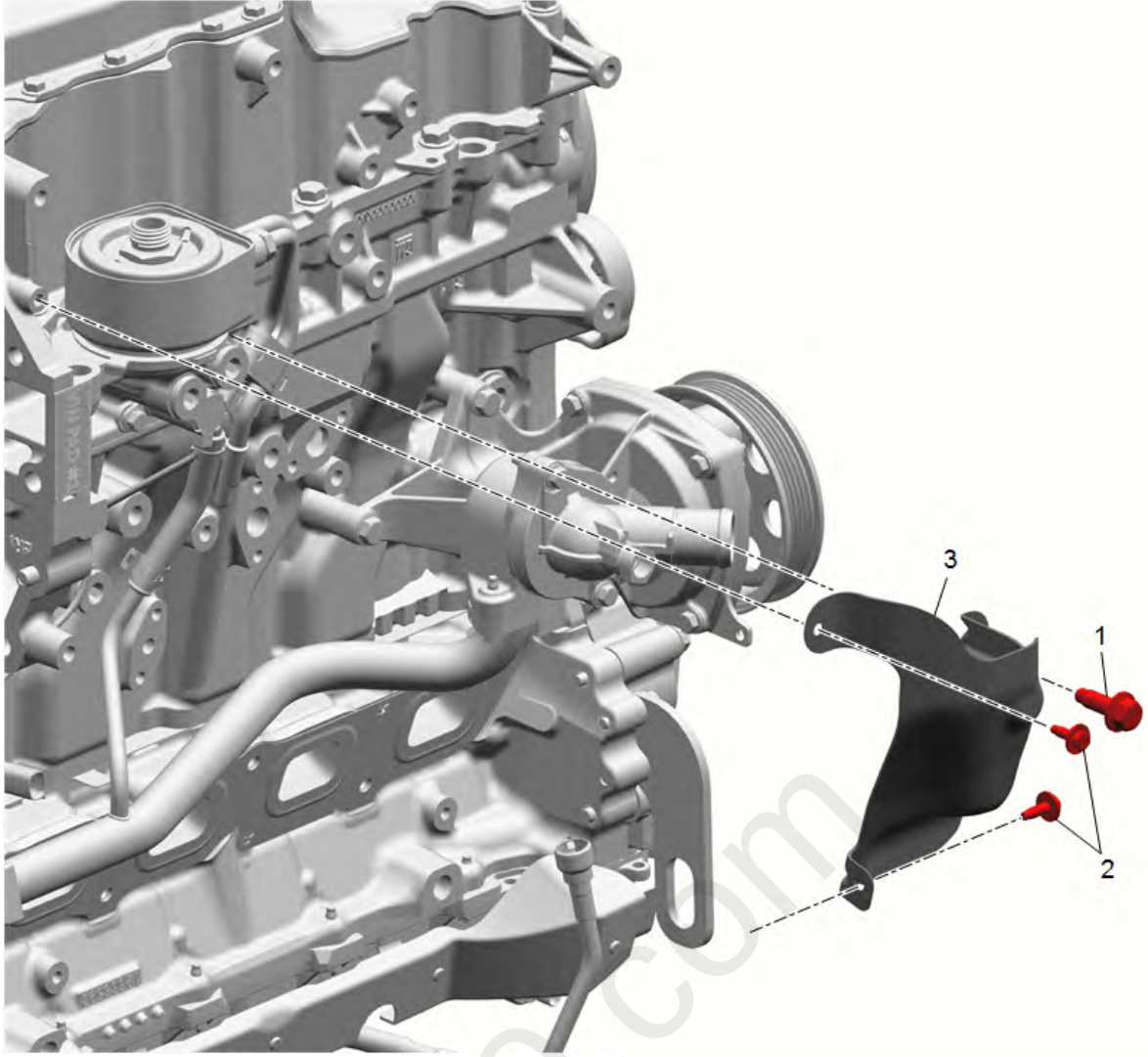


Fig. 354: Oil Pump Flow Control Valve Heat Shield
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Pump Flow Control Valve Heat Shield Bolt
2	Pump and Component Oil Heat Shield Bolt
3	Oil Pump Flow Control Valve Heat Shield

Lower Oil Pan and Engine Oil Cooler Removal

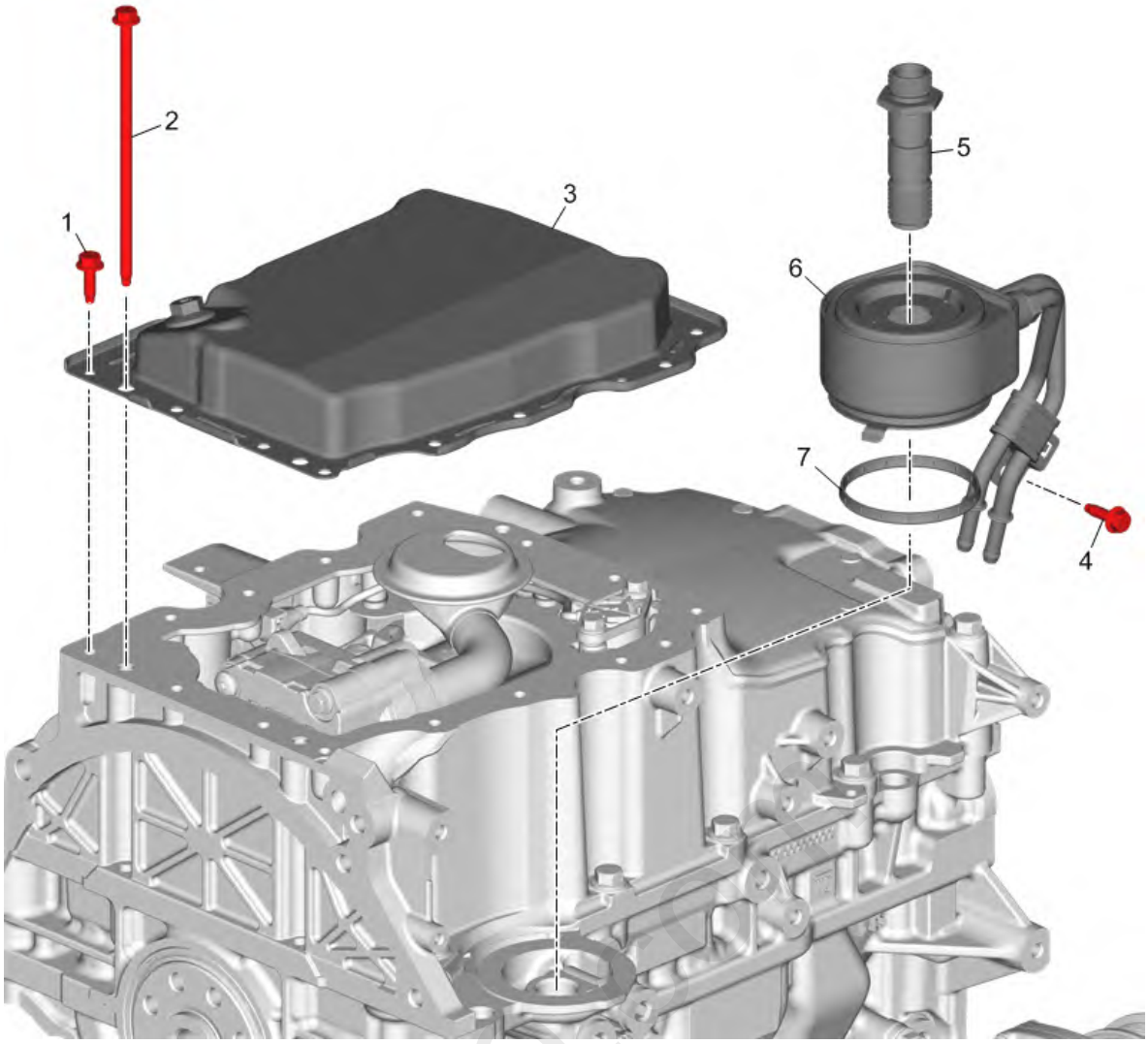


Fig. 355: Lower Oil Pan and Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Pan Bolt
2	Oil Pan Bolt
3	Lower Oil Pan
4	Engine Oil Cooler Bolt
5	Engine Oil Cooler Connector
6	Engine Oil Cooler
7	Engine Oil Cooler Seal **Procedure** DISCARD the seal.

Oil Pan Removal

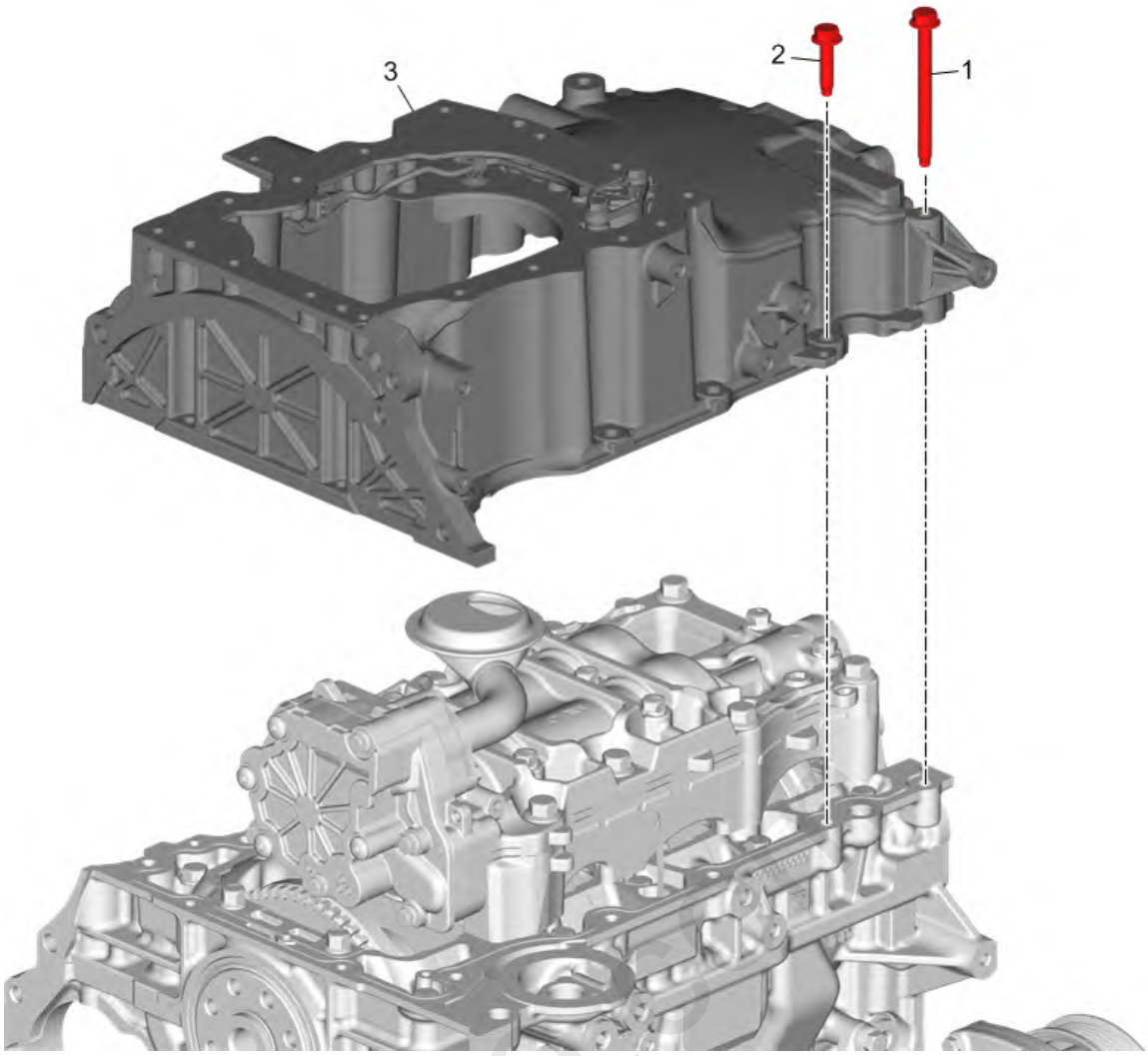


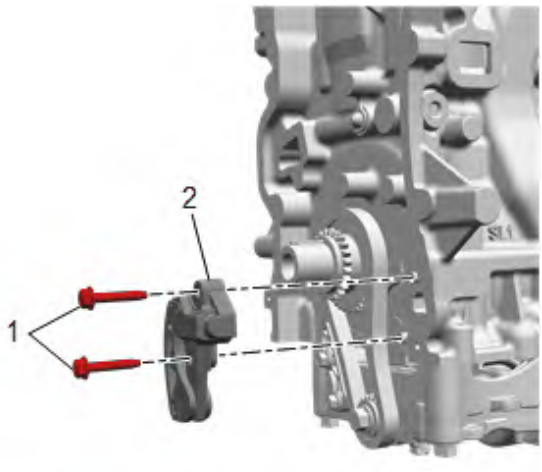
Fig. 356: Oil Pan
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Pan Bolt
2	Oil Pan Bolt
3	Oil Pan

BALANCER CHAIN, SPROCKET, AND TENSIONER REMOVAL

Special Tools

EN-50837 Timing Chain Tensioner Retraction Tool



mcx30.com

Fig. 357: Balancer Chain Tensioner Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the balancer chain tensioner bolt (1).
2. Remove the balancer chain tensioner (2).
3. Compress and lock the tensioner using **EN-50837** retention tool.
    1. Insert **EN-50837** retention tool into the lever arm and push in a clockwise direction.
    2. Compress the tensioner while holding lever arm.
    3. Relax the force on the lever and tensioner slightly, allowing the tensioner to extend 3 ratchet clicks, and then hold in place.
    4. Pull lever counterclockwise using **EN-50837** retention tool until the hole in the lever aligns with the hole in the tensioner assembly. Push the point of **EN-50837** retention tool through the lever and into the tensioner assembly.

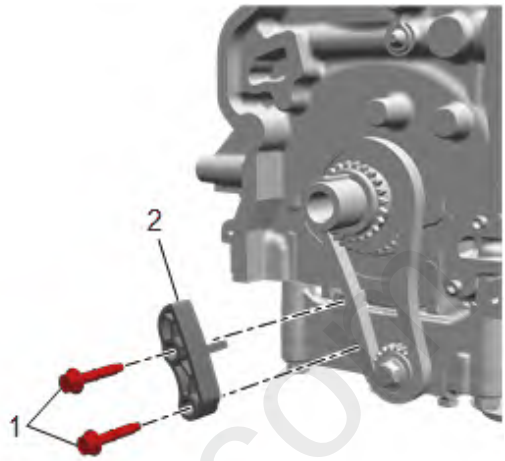


Fig. 358: Balancer Chain Guide Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the balancer chain guide bolt (1).
5. Remove the balancer chain guide (2).

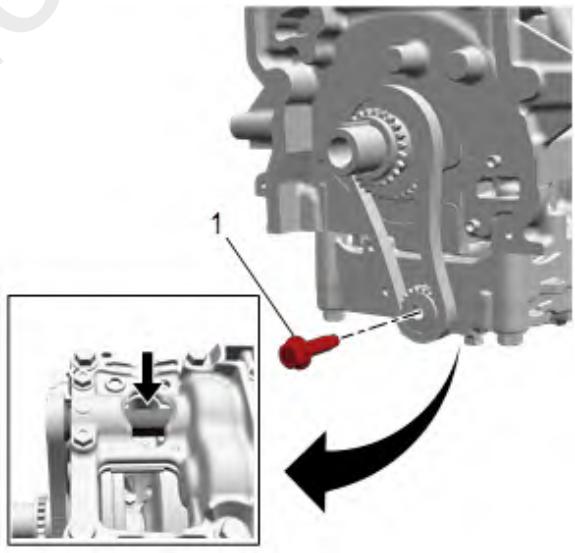


Fig. 359: Balancer Shaft Driven Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Use an open end wrench over flat on balance shaft while loosening balancer shaft sprocket bolt. Remove and discard the balancer shaft driven sprocket bolt (1).

mcx30.com

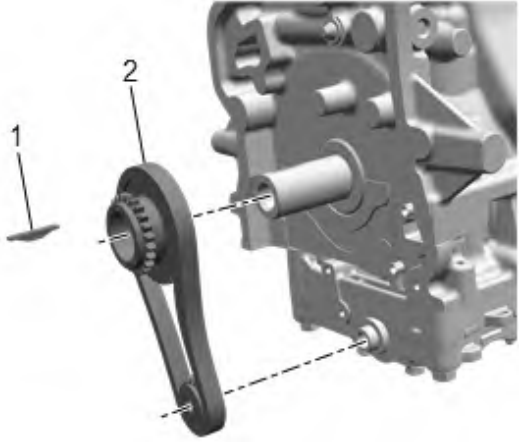


Fig. 360: Balancer Shaft Driven Sprocket And Balancer Chain
Courtesy of GENERAL MOTORS COMPANY

7. Remove the crankshaft key (1).
8. Remove the crankshaft sprocket, balancer shaft driven sprocket, and balancer chain (2) simultaneously.

INTAKE AND EXHAUST CAMSHAFT, BEARING CAP, AND LASH ADJUSTER REMOVAL

Intake Camshaft and Components Removal

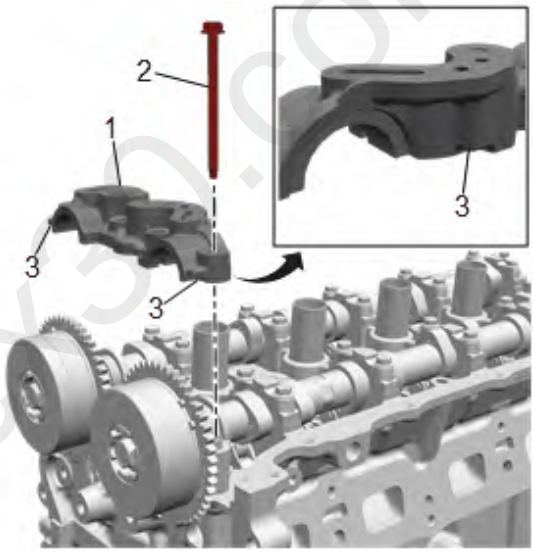


Fig. 361: Camshaft Front Bearing Cap, Bolts And Pry Points
Courtesy of GENERAL MOTORS COMPANY

1. Remove the camshaft front bearing cap bolts (2).

NOTE:

- **Locate the pry points (3) on the camshaft front bearing cap.**
- **When using the pry points to remove the front bearing cap, use a protective material between the camshaft lobes, the cylinder head flange, and pry tool.**
- **Use 2 pry tools simultaneously to pry the upper front bearing cap away from the lower bearing cap evenly.**

2. Using suitable pry tools, remove the camshaft front bearing cap (1)

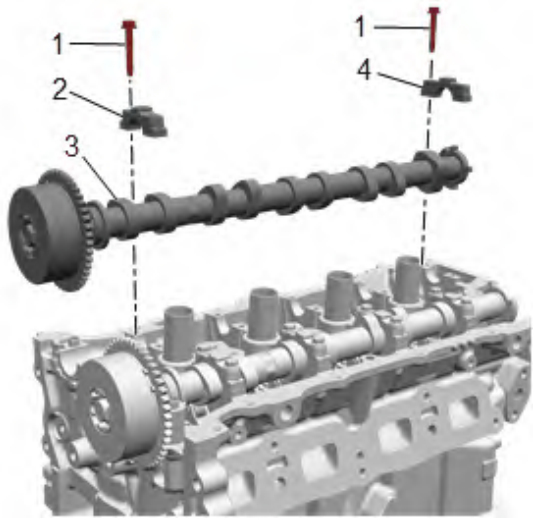


Fig. 362: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

3. Mark the intake camshaft rear cap to ensure it is installed in the same position. Remove the intake camshaft bearing rear cap bolts (1) and cap (4).

NOTE: **Loosen each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.**

4. Mark the camshaft caps (2) to ensure they are installed in the same position.
5. Remove the intake camshaft cap bolts (1).
6. Remove the camshaft caps (2).
7. Remove the intake camshaft (3).

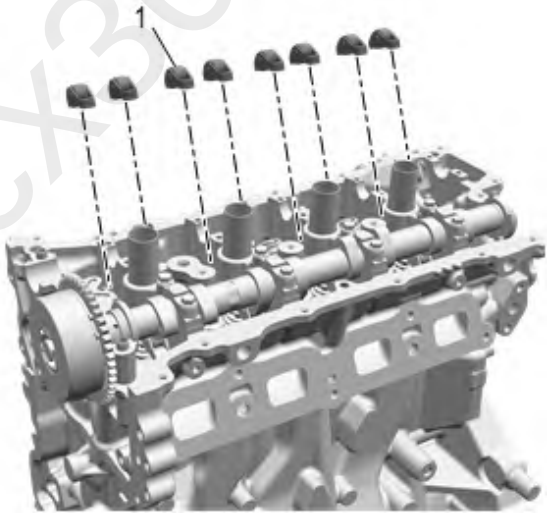


Fig. 363: Intake Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Keep all of the roller finger followers and hydraulic lash adjusters in order so that they can be reinstalled in their respective locations.**

8. Remove the intake camshaft roller finger followers (1).

mcx30.com

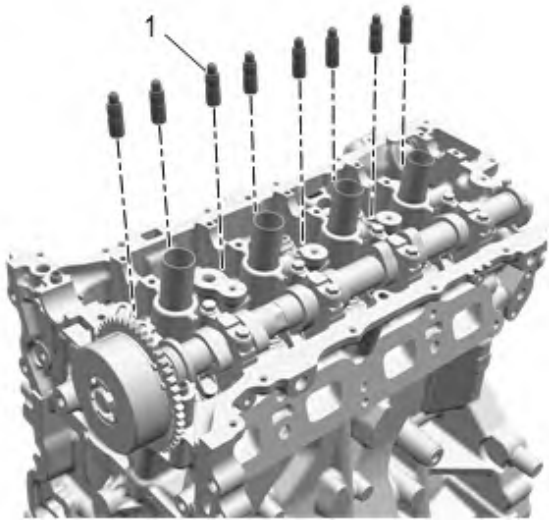


Fig. 364: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

9. Remove the hydraulic lash adjusters (1).

Exhaust Camshaft and Components Removal

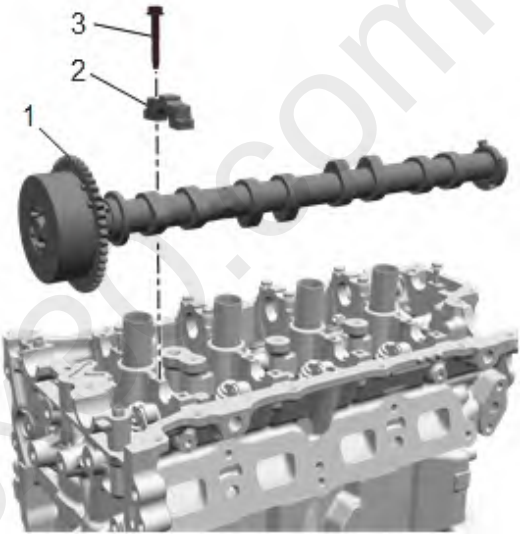


Fig. 365: Camshaft Caps
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Loosen each bolt on each cap one turn at a time until there is no spring tension pushing on the camshaft.**

1. Mark camshaft caps (2) to ensure they are installed in the same position.
2. Remove the exhaust camshaft cap bolts (3).
3. Remove the camshaft caps (2) ensuring they are marked and refitted in same position on assembly.
4. Remove the exhaust camshaft (1).

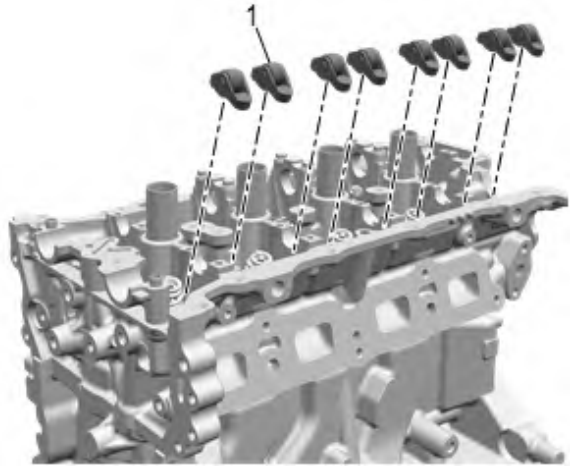


Fig. 366: Exhaust Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Keep all of the roller finger followers and hydraulic lash adjusters in order so that they can be reinstalled in their respective locations.**

5. Remove the exhaust camshaft roller finger followers (1).

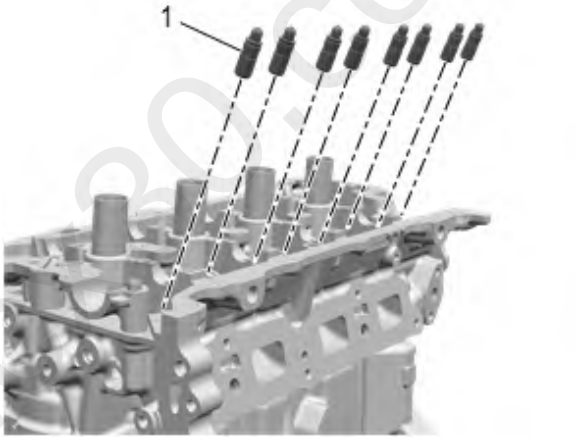


Fig. 367: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

6. Remove the hydraulic lash adjusters (1).

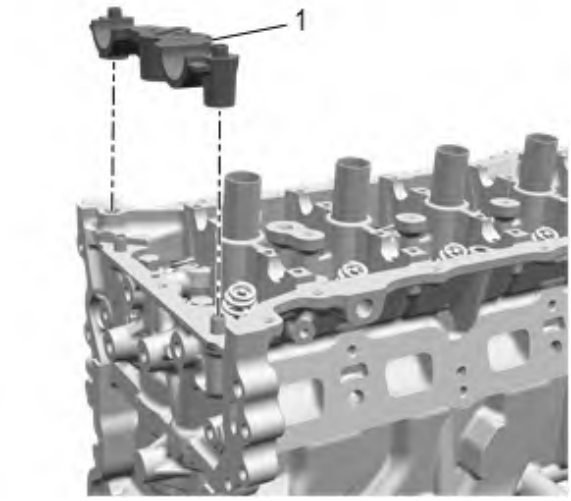


Fig. 368: Camshaft Bearing Lower Front Cap
Courtesy of GENERAL MOTORS COMPANY

7. Remove the camshaft bearing lower front cap (1).

WATER PUMP REMOVAL

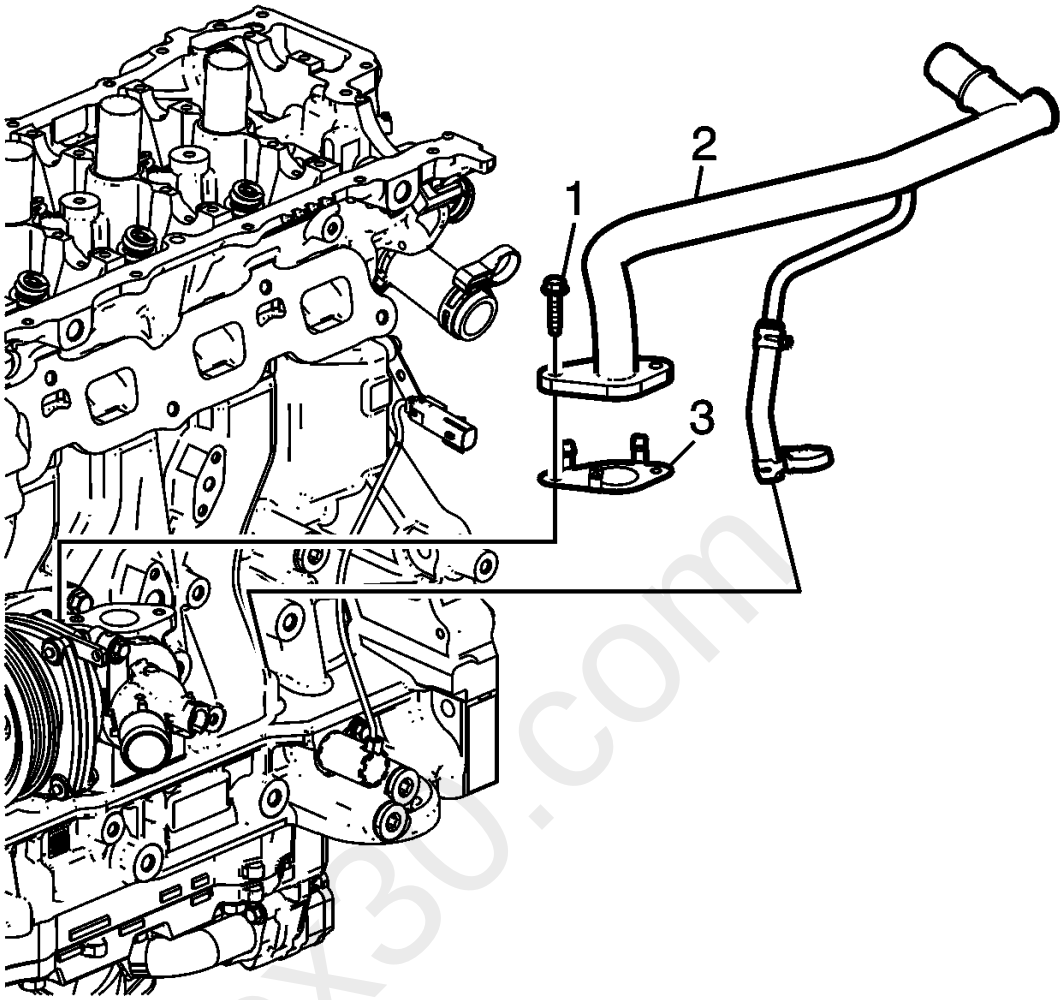


Fig. 369: Thermal Bypass Pipe Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the thermal bypass hose at the engine oil cooler.
2. Remove the thermal bypass pipe bolts (1) at the water pump assembly.
3. Disconnect the pipe from the water outlet assembly.
4. Remove the thermal bypass pipe (2) and gasket (3) from the water pump assembly. Discard the gasket.

mcx30.com

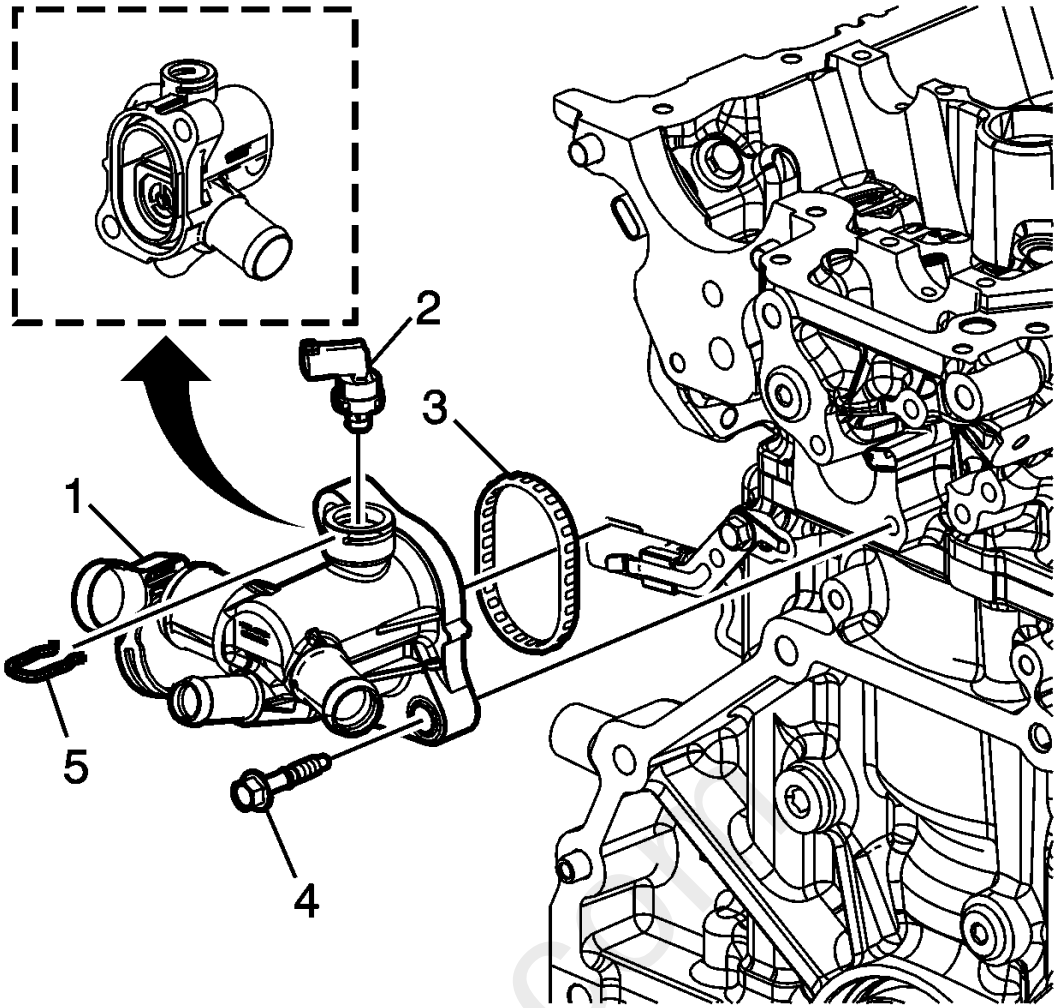


Fig. 370: Retaining Clip And Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

5. Remove the retaining clip (5) and engine coolant temperature sensor (2).
6. Remove the water outlet assembly (1), bolts (4), and gasket seal (3). Discard the gasket.

mc730.com

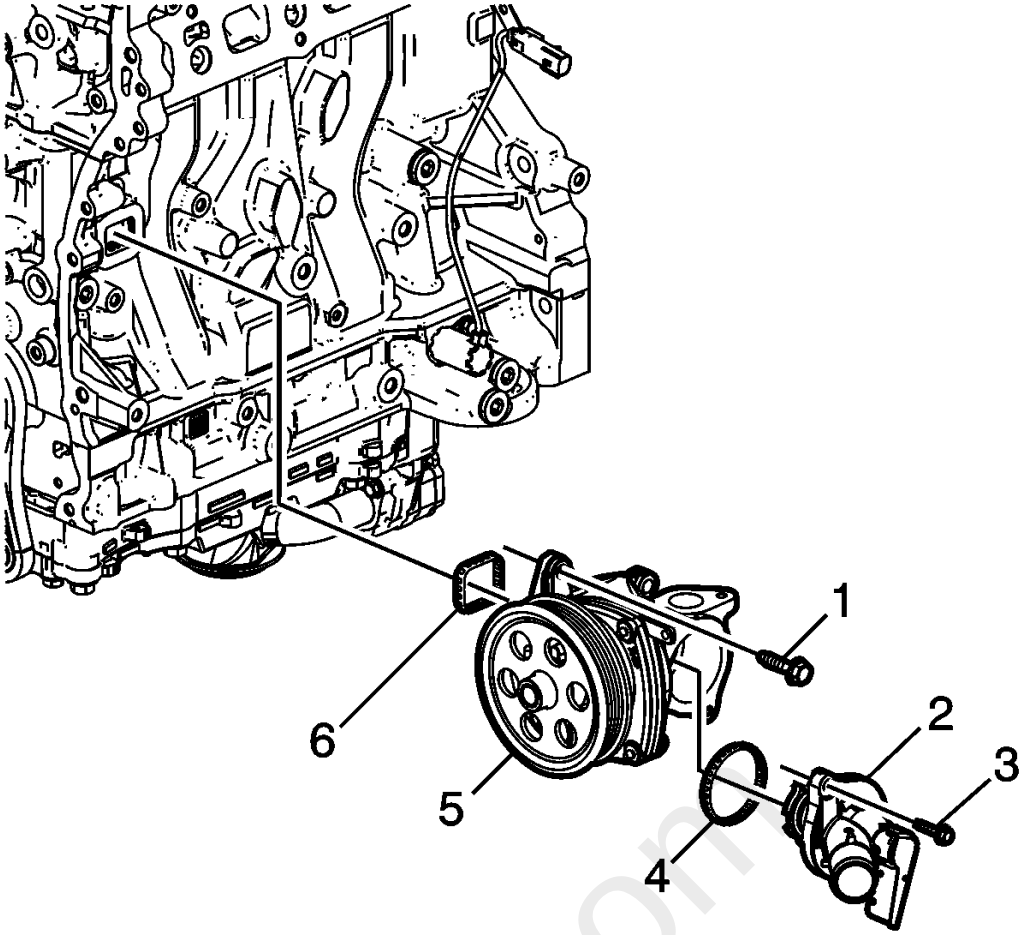


Fig. 371: Thermostat Assembly And Gasket Seal
Courtesy of GENERAL MOTORS COMPANY

7. Remove the thermostat assembly (2), bolts (3), and gasket seal (4). Discard the gasket.
8. Remove the water pump assembly (5), bolts (1), and seal (6). Discard the seal.

CYLINDER HEAD REMOVAL

Special Tools

EN 38188 Cylinder Head Broken Bolt Extractor Kit - or equivalent aftermarket tool

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

mc30.com

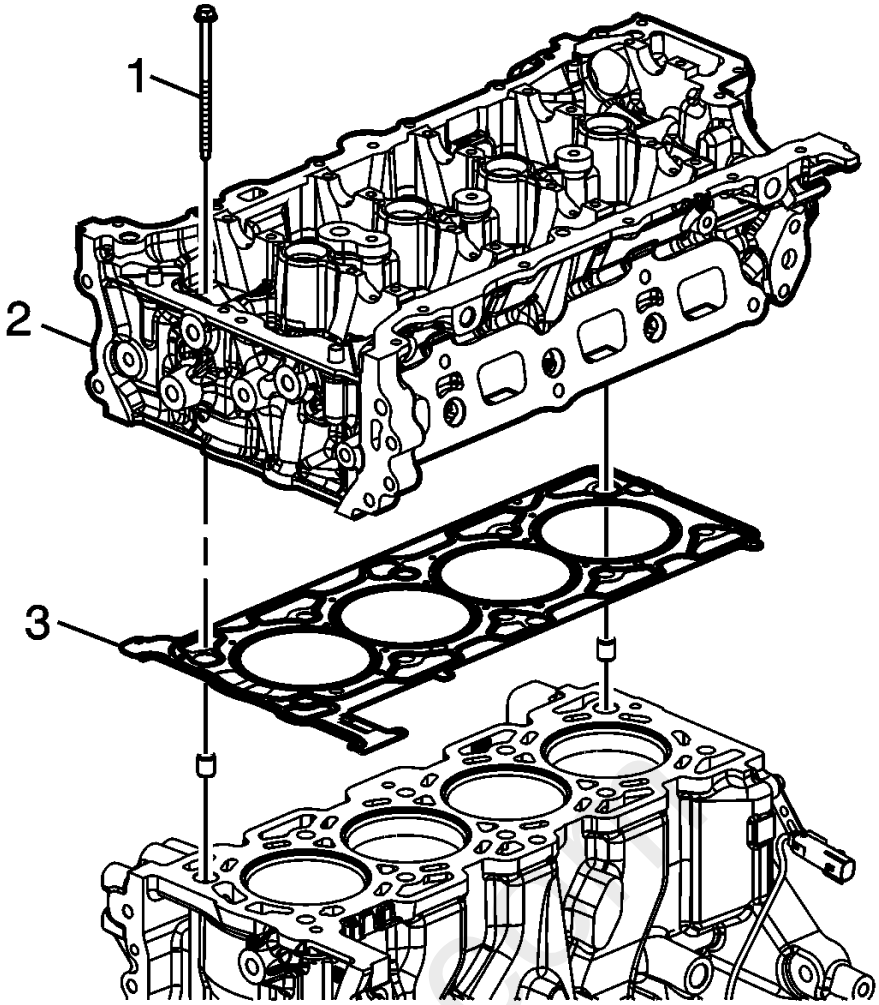


Fig. 372: Cylinder Head Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove and discard the cylinder head bolts (1).

CAUTION: **In order to prevent damage to the valves and injectors during cylinder head removal, set the cylinder head on blocks.**

2. Remove the cylinder head (2).
3. Remove the cylinder head gasket (3).
4. Inspect the cylinder head locating pins. Remove the locating pins and discard, if necessary.
5. Clean all of the gasket surfaces.
6. Use the following procedures when cleaning the cylinder head and cylinder block surfaces:
   - Use a razor blade gasket scraper to clean the cylinder head and cylinder block gasket surfaces. Do not scratch or gouge any surface.

     NOTE: **Do not use any other method or technique to clean these gasket surfaces.**

   - Use a new razor blade for each cylinder head and cylinder block.

     NOTE: **Be careful not to gouge or scratch the gasket surfaces. Do not gouge or scrape the combustion chamber surfaces. The feel of the gasket surface is important, not the appearance. There will be indentations from the gasket left in the cylinder head after all of the gasket material is removed. These small indentations will be filled in by the new gasket.**

   - Hold the razor blade as parallel to the gasket surface as possible.

NOTE: **Do not use a tap to clean the cylinder head bolt holes.**

7. Clean the old sealer/lube and dirt from the bolt holes.
8. Clean the bolt holes with a nylon bristle brush.

WARNING: **Wear safety glasses to avoid injury when using compressed air or any cleaning solvent. Bodily injury may occur if fumes are inhaled or if skin is exposed to chemicals.**

9. When cleaning the cylinder head bolt holes use a suitable commercial spray liquid solvent and compressed air from an extended-tip blow gun to reach the bottom of the holes.
10. Remove any broken long cylinder head bolts using the **EN 38188** kit.

BALANCER SHAFT WITH OIL PUMP REMOVAL

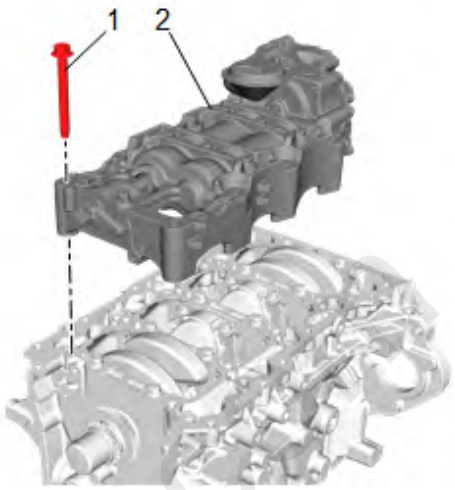


Fig. 373: Balancer And Oil Pump Shaft Assembly Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **DO NOT remove or loosen the balancer assembly bolts that join the two halves of the assembly together. Identify the bolts that retain the balancer assembly to the lower crankcase and ensure only these bolts are removed.**

1. Remove the 8 balancer and oil pump shaft assembly bolts (1) along the perimeter of the assembly.
2. Remove the balancer and oil pump shaft assembly (2).

PISTON, CONNECTING ROD, AND BEARING REMOVAL

mcar

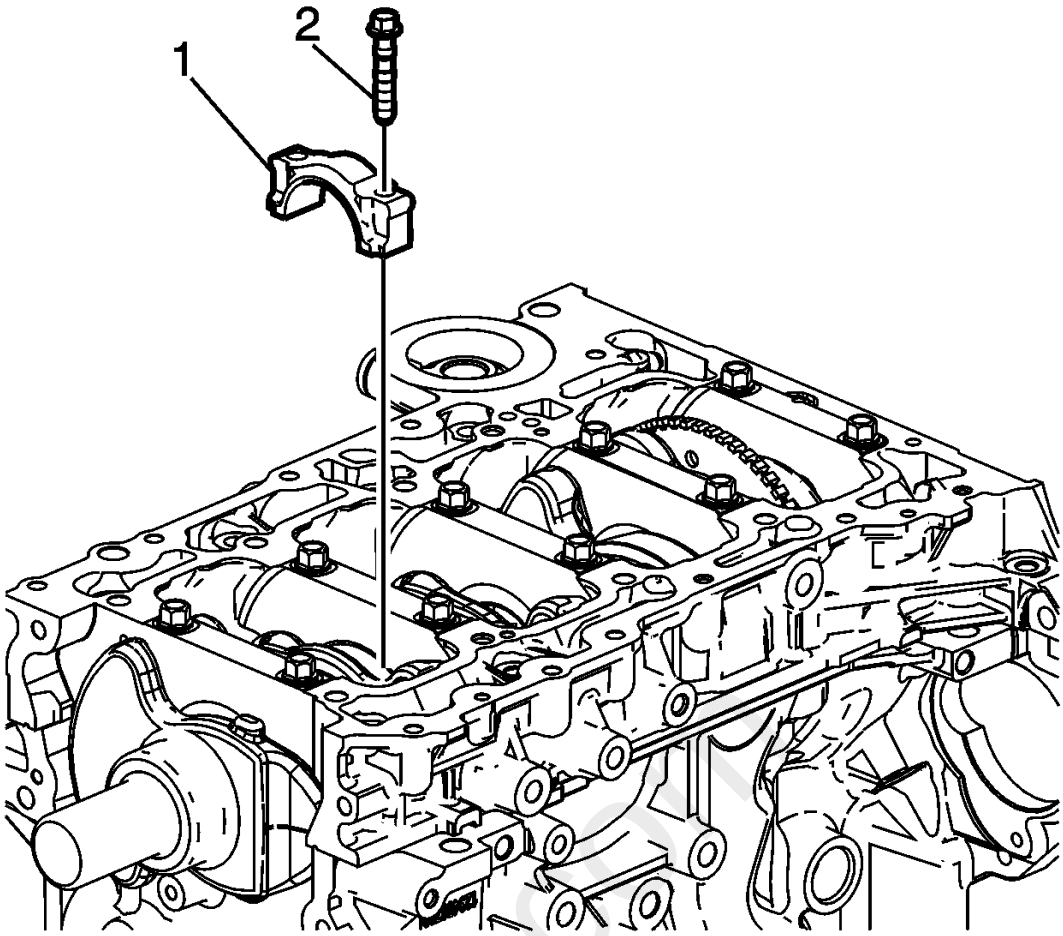


Fig. 374: Connecting Rod Cap
Courtesy of GENERAL MOTORS COMPANY

1. Rotate the crankshaft to a position where the connecting rod bolts are the most accessible.
2. Mark the connecting rod and cap with the cylinder position. Also mark their orientation. This will ensure the caps and connecting rods are re-assembled properly.
3. Remove any ridge at the top of the cylinder bore to avoid damage to the piston ring lands.
4. Remove and discard the connecting rod bolts (2).
5. Remove the connecting rod cap (1).

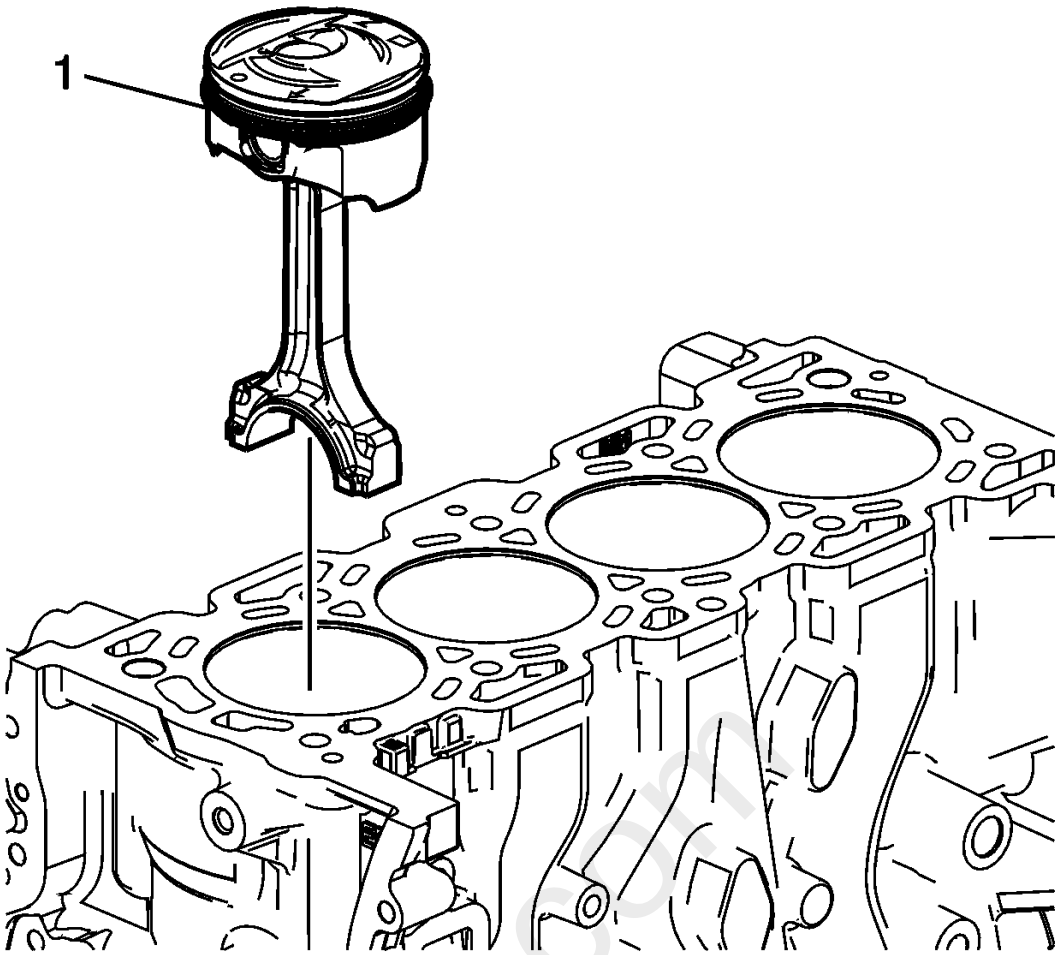


Fig. 375: Piston And Connecting Rod Assembly
Courtesy of GENERAL MOTORS COMPANY

6. Remove the piston and connecting rod assembly (1).

LOWER CRANKCASE REMOVAL

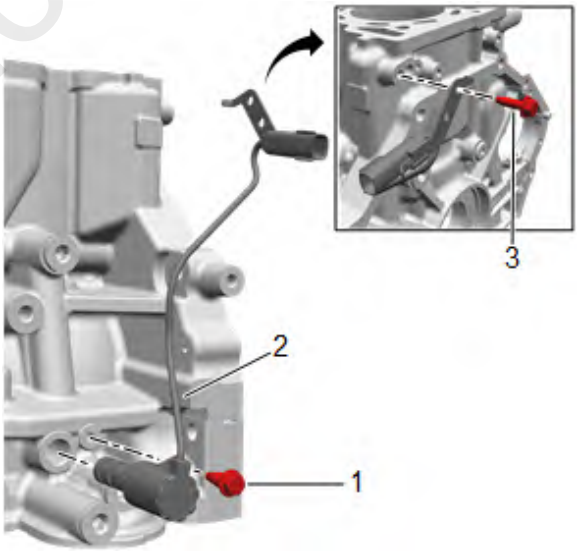


Fig. 376: Oil Pump Flow Control Valve And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pump flow control valve (2) and bolts (1, 3).

mcx30.com

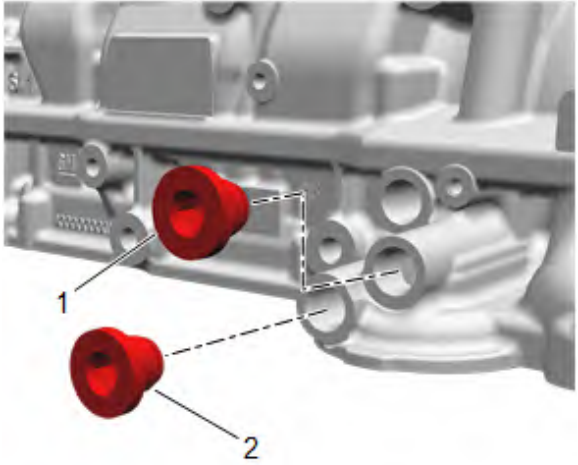


Fig. 377: Oil Gallery Plugs
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil gallery plugs (1, 2).

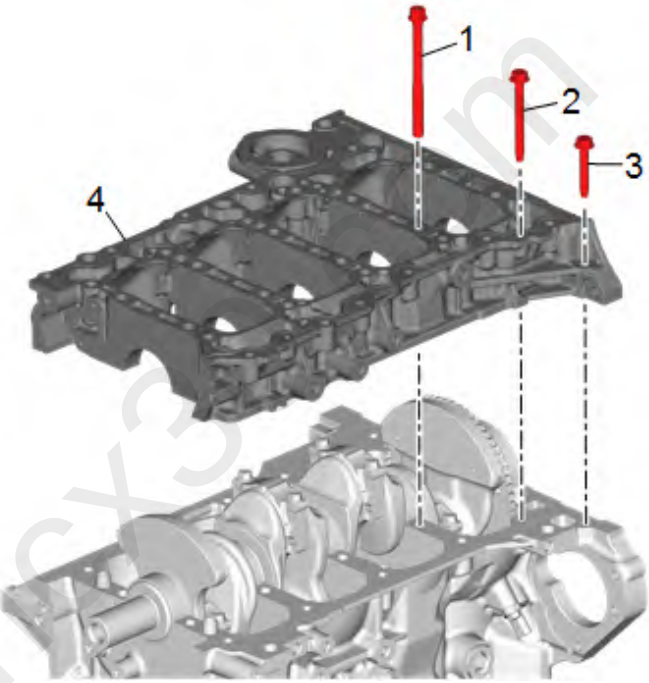


Fig. 378: Lower Crankcase Perimeter Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Separate, mark, and organize all reusable lower crankcase bolts to ensure installation in the correct locations.**

3. Remove the lower crankcase bolts (2, 3) from the perimeter of the lower crankcase.
4. Remove and discard the inner lower crankcase bolts (1).
5. Gently separate the lower crankcase (4) from the block.

CRANKSHAFT AND BEARING REMOVAL

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**.
4. If the specifications are exceeded inspect the thrust bearing and the crankshaft thrust wall for wear. Refer to **Engine Mechanical Specifications**.

5. Replace the thrust bearing or crankshaft as necessary.

Crankshaft and Bearing Removal

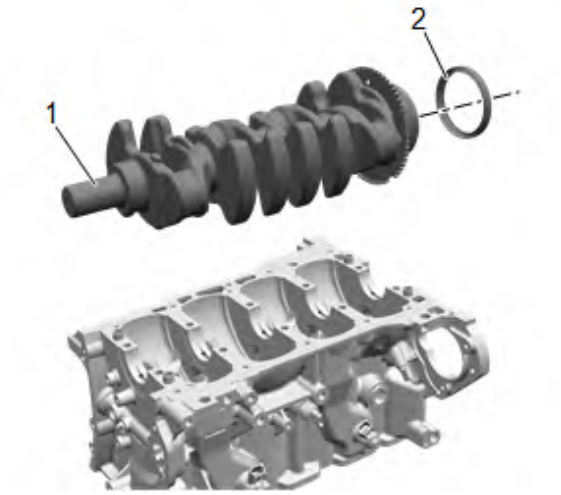


Fig. 379: Crankshaft And Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

1. Remove the crankshaft (1) from the block.
2. Remove the crankshaft rear oil seal (2) from the block and discard.

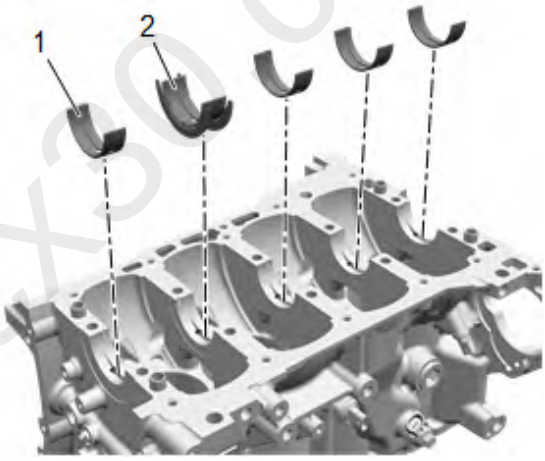


Fig. 380: Crankshaft Upper Bearings
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Crankshaft bearings MUST be separated, marked, or organized in a way to ensure installation to their original location and position, when suitable for use.**

3. Remove the crankshaft upper bearings (1) and the crankshaft upper thrust bearing (2) from the block.

mcx30.com

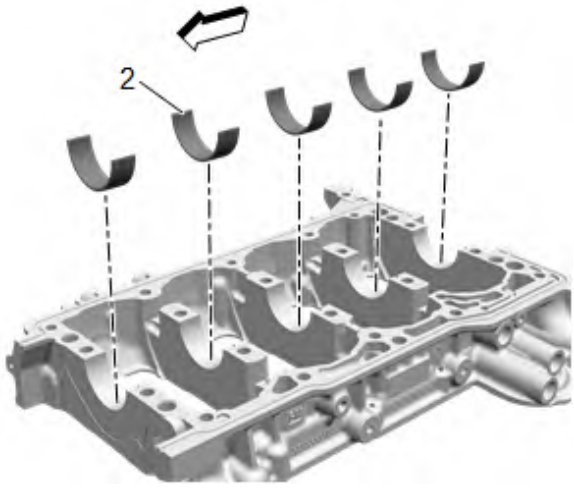


Fig. 381: Crankshaft Lower Bearings
Courtesy of GENERAL MOTORS COMPANY

4. Remove the crankshaft lower bearings (2) from the lower crankcase (1).
5. Clean the oil, sludge, and carbon.
6. Inspect the oil passages for obstructions.
7. Inspect the threads.
8. Inspect the bearing journals and the thrust surfaces for the following conditions:
    - Cracks
    - Chips
    - Gouges
    - Roughness
    - Grooves
    - Overheating (discoloration)
9. Inspect the corresponding bearing inserts for imbedded foreign material. If foreign material exists find the cause and repair it.

    NOTE: **Replace the crankshaft if cracks, severe gouges or burned spots are found. Slight roughness may be removed with a fine polishing cloth soaked in clean engine oil. Burrs may be removed with a fine oil stone.**

10. Measure the crankshaft journals. Use a micrometer or dial indicator to measure the taper and runout. Note the result for the later selection of bearing inserts. If not within limits the crankshaft must be replaced.

    Note the location of the main bearing high spots. If they are not in line, the crankshaft is bent and must be replaced.

ENGINE BLOCK DISASSEMBLE

mx30.com

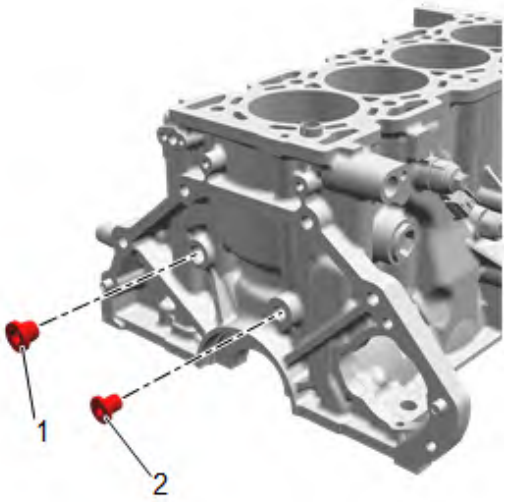


Fig. 382: Engine Oil Gallery Plugs
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine oil gallery plugs (1, 2) from the rear of the block.

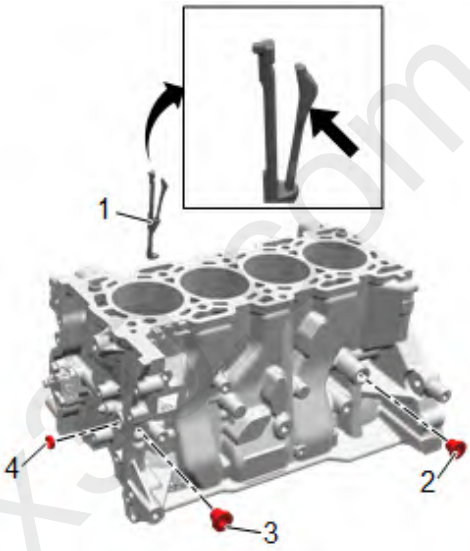


Fig. 383: Engine Oil Gallery Plugs
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine oil gallery plugs (2, 3, 4) from the left side and front of the block.
3. Use a suitable hook tool to catch the clip feature and gently remove the engine block coolant baffle (1).

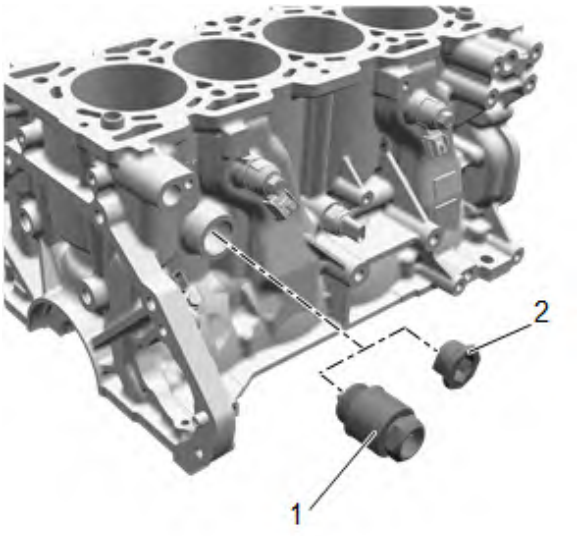


Fig. 384: Engine Coolant Heater
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine coolant heater (1), if equipped. Remove the engine coolant heater hole plug (2) if the heater is not present.

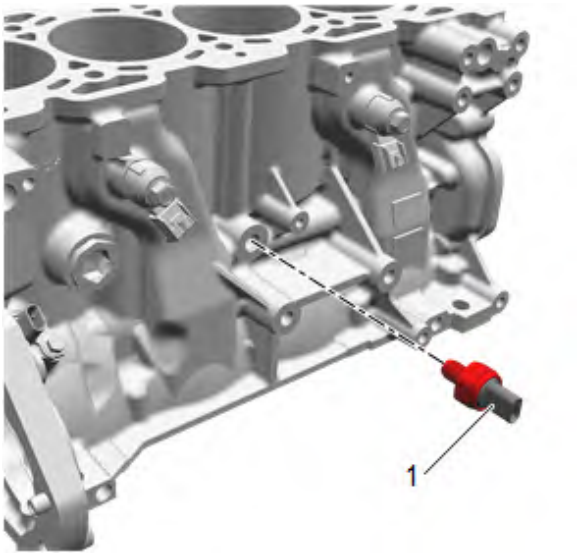


Fig. 385: Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

5. Remove the engine oil pressure sensor (1).

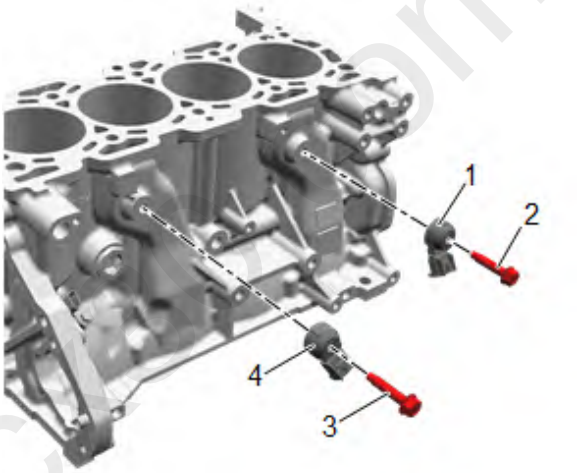


Fig. 386: Knock Sensors And Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the knock sensors (1, 4) and bolts (2, 3).

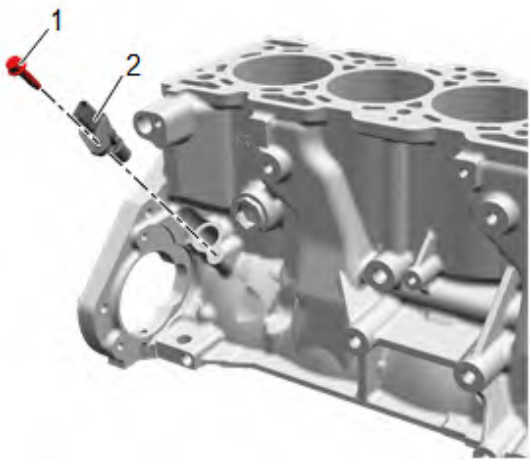


Fig. 387: Crankshaft Position (CKP) Sensor
Courtesy of GENERAL MOTORS COMPANY

7. Remove the crankshaft position (CKP) sensor (2) and bolt (1).

Fig. 388: Piston Oil Nozzle Assembly Bolt
Courtesy of GENERAL MOTORS COMPANY

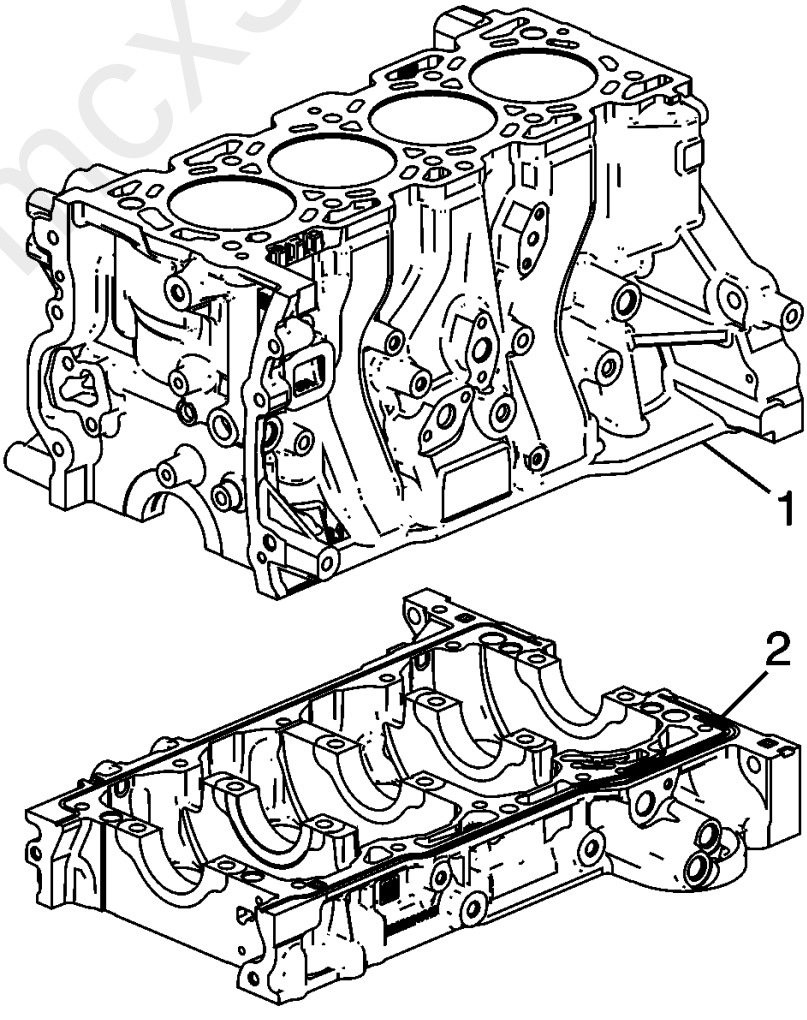
8. Loosen the piston oil nozzle assembly bolt (1) and remove the piston oil nozzle assembly (2).

ENGINE BLOCK CLEANING AND INSPECTION

Special Tools

GE-7872 Magnetic Base Dial Indicator

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



mcx30.com

Fig. 389: Sealing Material And Engine Block
Courtesy of GENERAL MOTORS COMPANY

1. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**
2. Clean the sealing material from the engine block (1) and lower crankcase (2) gasket mating surfaces with a suitable tool.
3. Clean the engine block and lower crankcase in a cleaning tank with solvent appropriate for aluminum.
4. Flush the engine block with clean water or steam.
5. Clean the oil passages.
6. Clean the blind holes.
7. Spray the cylinder bores and the machined surfaces with engine oil.
8. Inspect the threaded holes. Clean the threaded holes with a rifle brush. If necessary, drill out the holes and install thread inserts. Refer to **Thread Repair**.

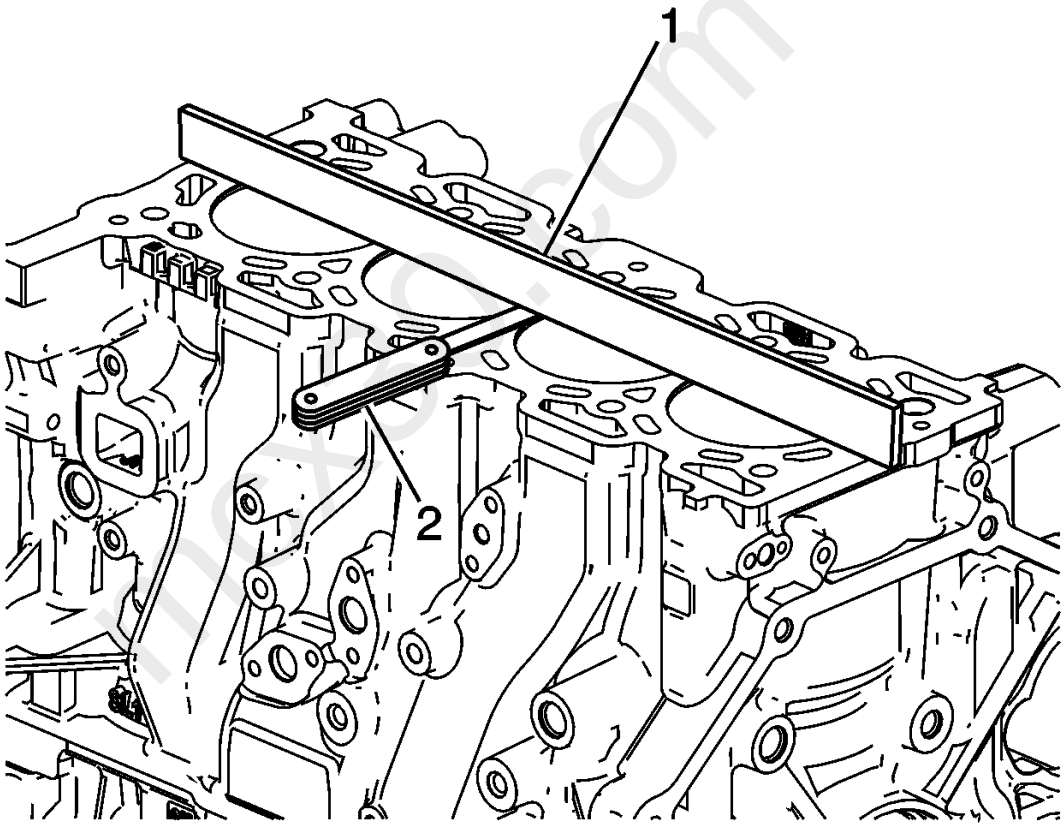


Fig. 390: Using Straight Edge
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not attempt to machine the lower crankcase to engine block surfaces.**

9. Use a straight edge (1) and a feeler gauge (2) to check the deck surface for flatness. Carefully machine minor irregularities. Replace the block if more than 0.254 mm (0.010 in) must be removed.
10. Inspect the oil pan rail for nicks. Inspect the front cover attaching area for nicks. Use a flat mill file to remove any nicks.

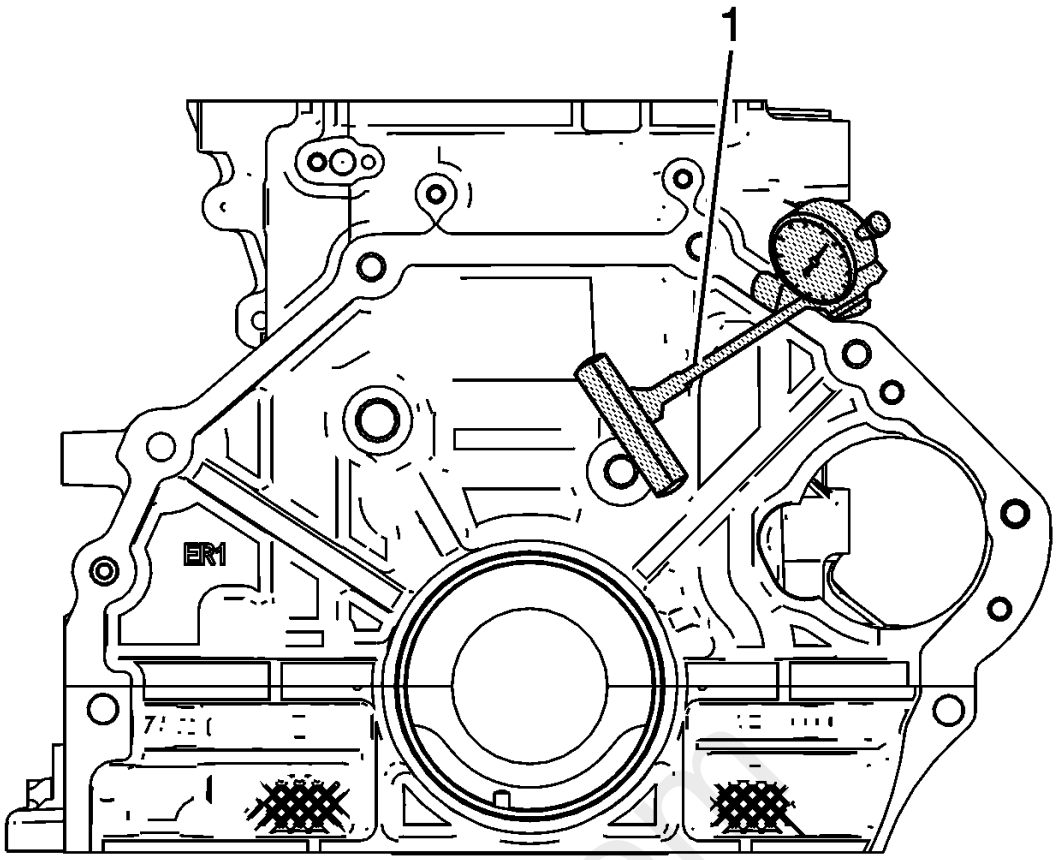


Fig. 391: Measuring Crankshaft Flange Runout Using Dial Indicator
Courtesy of GENERAL MOTORS COMPANY

11. Inspect the mating surfaces of the transmission face.

CAUTION: **A broken flywheel may result if the transmission case mating surface is not flat.**

12. Use the following procedure in order to measure the engine block flange runout at the mounting bolt hole bosses:
    1. Temporarily install the crankshaft and upper bearings. Measure the crankshaft flange runout using the **GE-7872** dial indicator (1)
    2. Hold the gauge plate flat against the crankshaft flange.
    3. Place the dial indicator stem on the transmission mounting bolt hole boss. Set the indicator to 0.
    4. Record the readings obtained from all of the bolt hole bosses. The measurements should not vary more than 0.203 mm (0.008 in).
    5. Recheck the crankshaft flange runout if the readings vary more than 0.203 mm (0.008 in).
    6. Remove the crankshaft and bearings.

mcx30.com

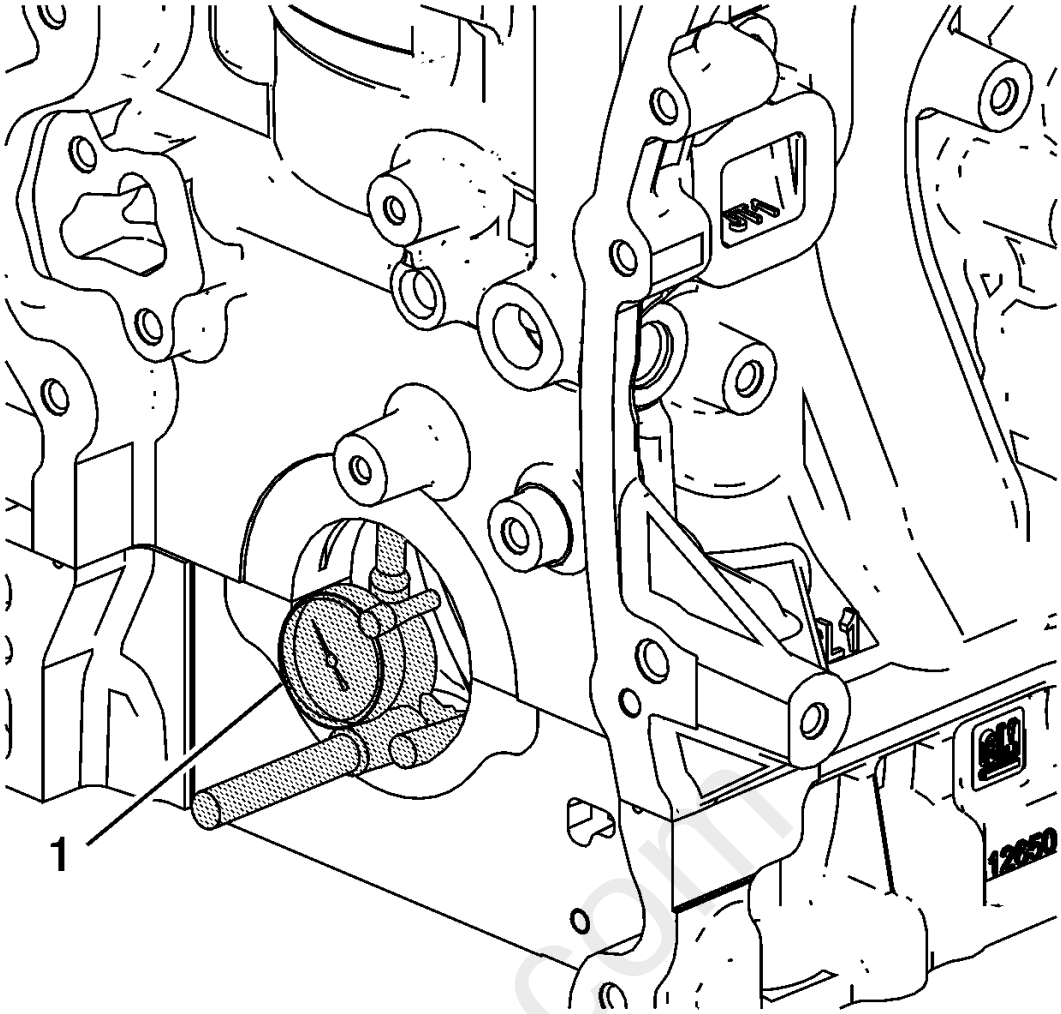


Fig. 392: View Of Cylinder Bore Gauge
Courtesy of GENERAL MOTORS COMPANY

13. Install the bed plate and bolts. tighten the bed plate bolts to specification.

NOTE: **A commercially available bore gauge with dial indicator graduations in ten thousandths inch (0.0001") is necessary for measuring engine specification range.**

14. Inspect the crankshaft main bearing bores. Use a commercially available bore gauge to measure the bearing bore concentricity and alignment. Refer to **Engine Mechanical Specifications**.
15. Replace the engine block and bed plate if the crankshaft bearing bores are out of specification.
16. Remove the bed plate.

Measuring Cylinder Bore Diameter

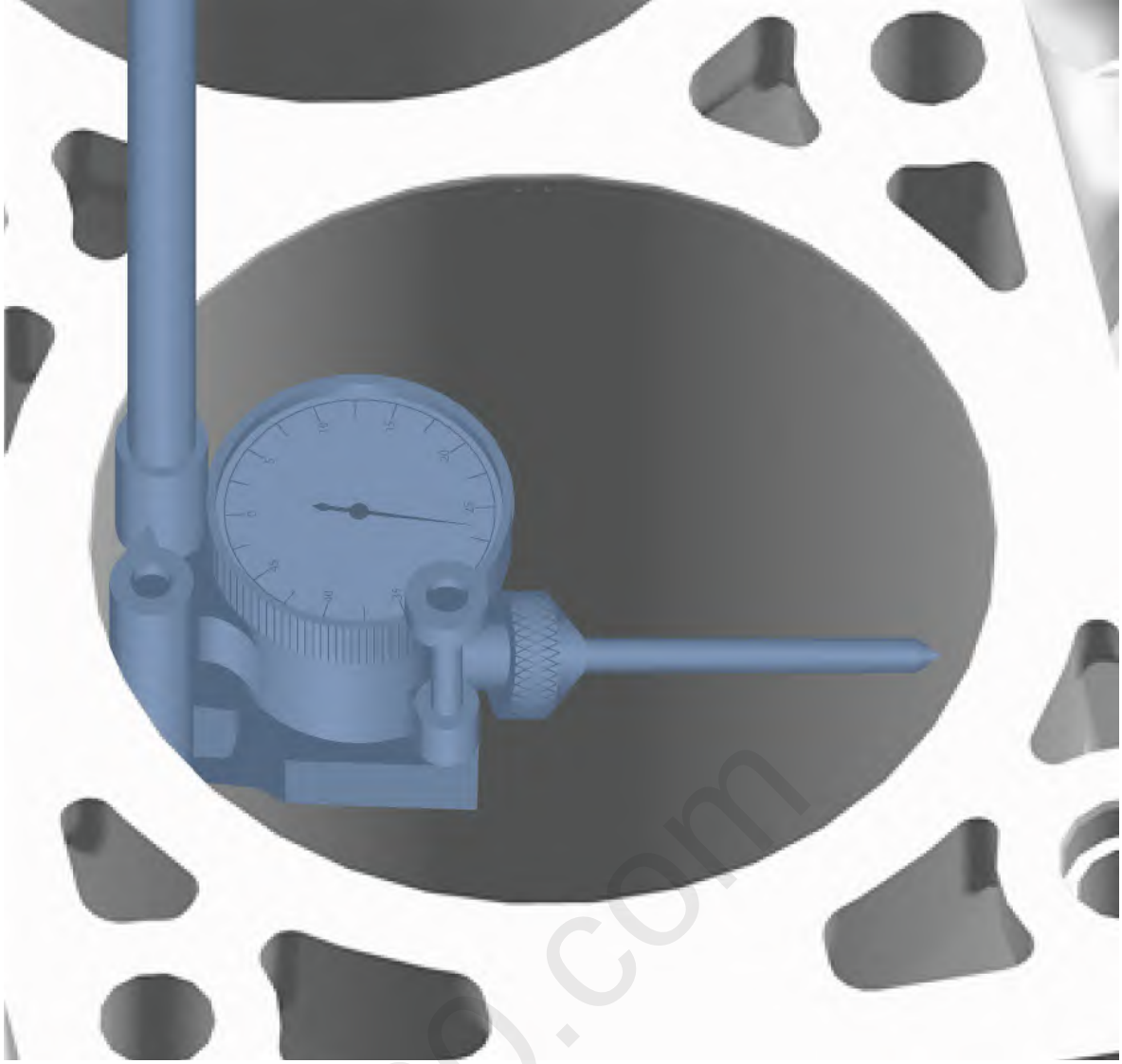


Fig. 393: Measuring Cylinder Bore
Courtesy of GENERAL MOTORS COMPANY

1. Check the cylinder condition. Some light vertical marks may be visible on the cylinder wall. In these areas, check that the honing marks are still visible in this marked area. If they are, the cylinder surface has not been compromised and the engine block can be used.

NOTE: **A commercially available bore gauge with dial indicator graduations in ten thousandths inch (0.0001") is necessary for measuring engine specification range.**

2. Measure the cylinder bore diameter 35 mm (1.378 in) from the deck face using a commercially available bore gauge.
3. Compare your results with the **Engine Mechanical Specifications**. If the cylinder diameter exceeds the specifications, replace the engine block.

Measuring Cylinder Bore Taper

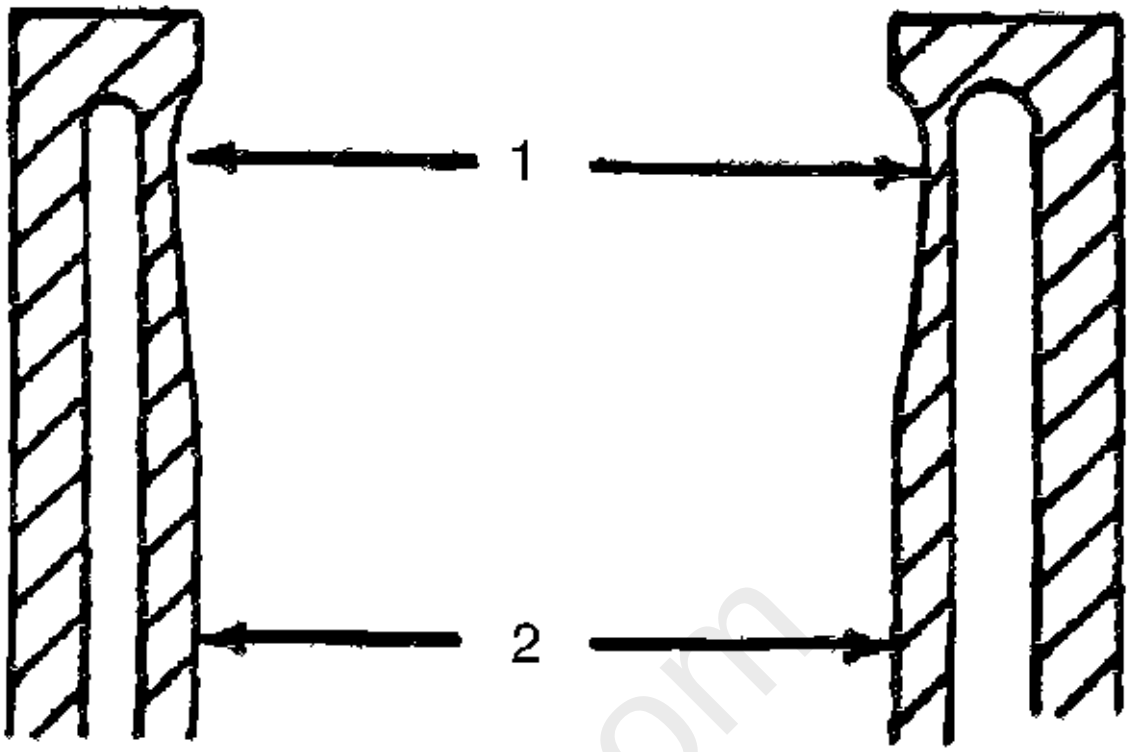


Fig. 394: Measuring Head Gasket Dimensions
Courtesy of GENERAL MOTORS COMPANY

1. Measure the cylinder bore along the thrust surfaces, perpendicular to the crankshaft centerline, at 10 mm (0.394 in) below the deck surface (1) and record your measurement.
2. Measure the cylinder bore along the thrust surfaces, perpendicular to the crankshaft centerline, at 125 mm (4.921 in) below the deck surface (2) 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**. If the cylinders exceed the specifications, replace the engine block.

Measuring Cylinder Bore Out-of-Round

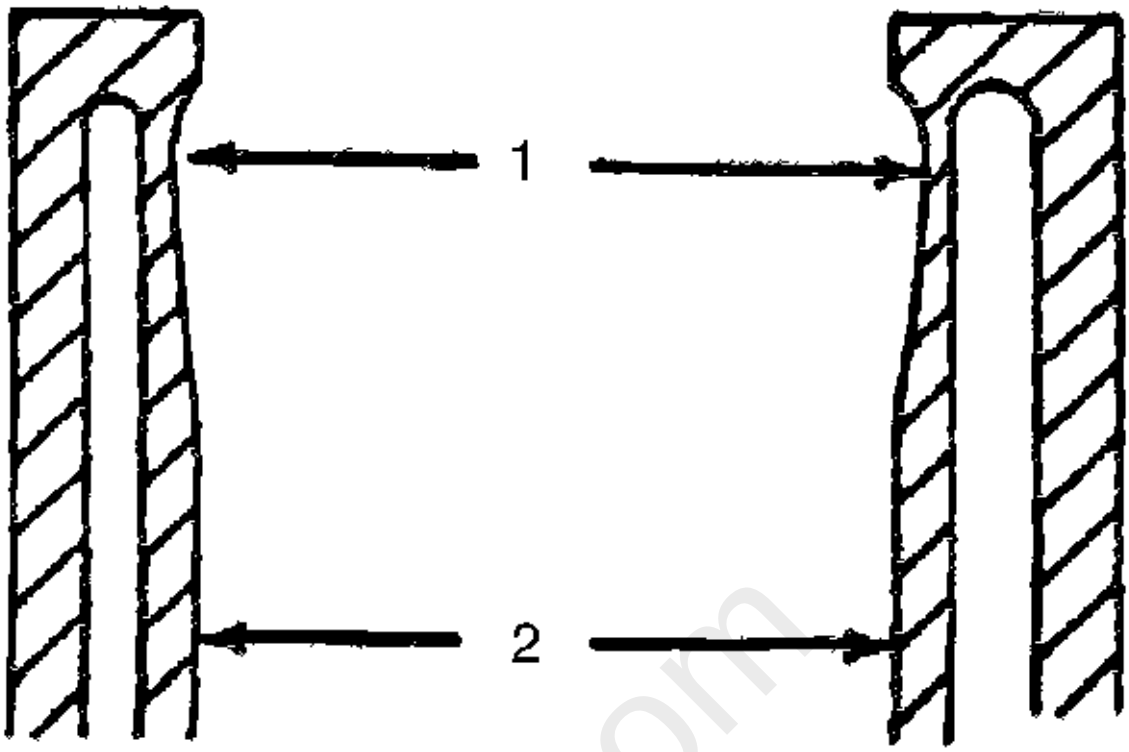


Fig. 395: Measuring Head Gasket Dimensions
Courtesy of GENERAL MOTORS COMPANY

1. Measure both the thrust and non-thrust cylinder diameter at 10 mm (0.394 in) below the deck surface (1). 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 125 mm (4.921 in) below the deck surface (2). 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**. If the cylinders exceed these specifications, replace the engine block.

CRANKSHAFT BALANCER CLEANING AND INSPECTION

mcr30.com

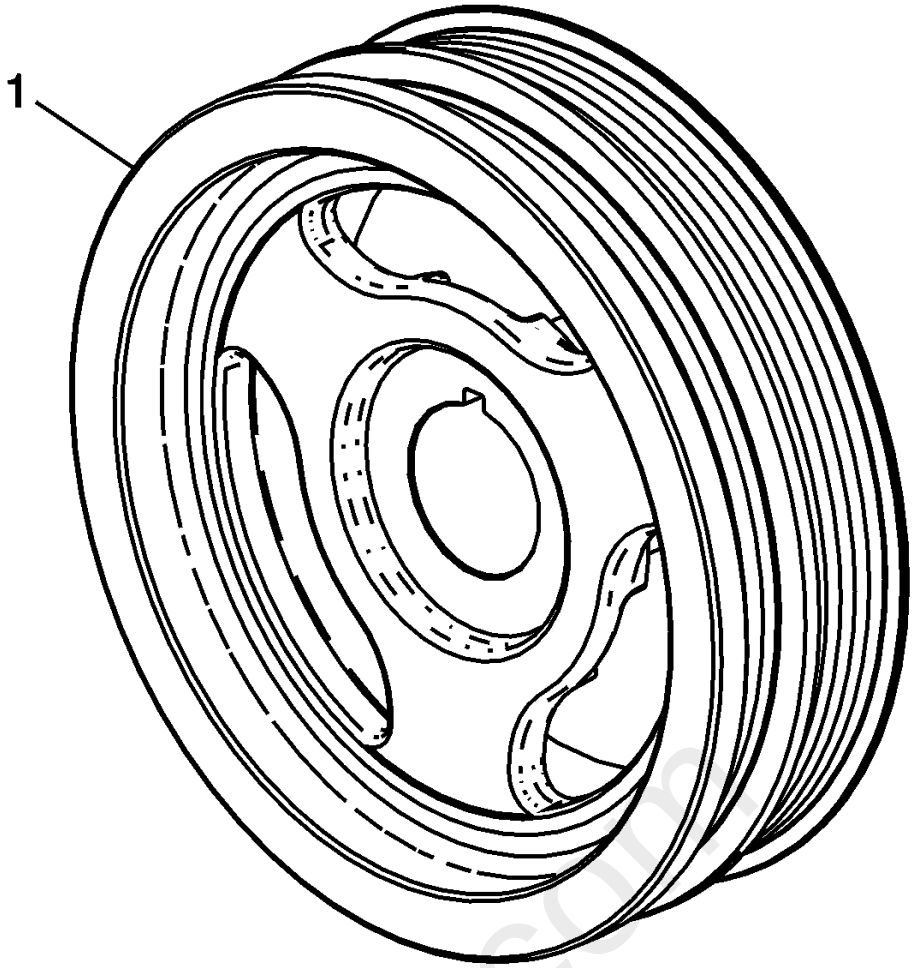


Fig. 396: Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Crankshaft Balancer **WARNING:** **Refer to Safety Glasses Warning .** **Procedure** 1. Clean the crankshaft balancer. 2. Clean the belt grooves of all dirt or debris with a wire brush. 3. Dry the crankshaft balancer with compressed air. 4. Inspect the crankshaft balancer for the following: • Worn, grooved, or damaged hub seal surface - a crankshaft balancer hub seal surface with excessive scoring, grooves, rust or other damage must be replaced. • 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. • Worn, chunking or deteriorated rubber between the hub and pulley. • Minor imperfections may be removed with a fine file.

AUTOMATIC TRANSMISSION FLEX PLATE CLEANING AND INSPECTION

mcx30.com

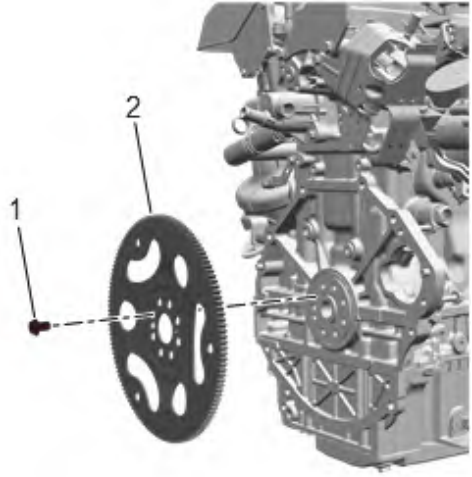


Fig. 397: Automatic Flex Plate Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Clean the flywheel (2) in solvent.

WARNING: **Refer to Safety Glasses Warning .**

2. Dry the flywheel with compressed air.
3. Inspect the flywheel for the following:
    - Damaged ring gear teeth.
    - Stress cracks around the flywheel-to-crankshaft bolt hole locations.
    - Weight saving holes.

CRANKSHAFT AND BEARING CLEANING AND INSPECTION

Special Tools

GE-7872 Magnetic Base Dial Indicator Set

For equivalent regional tools, refer to Special Tools.

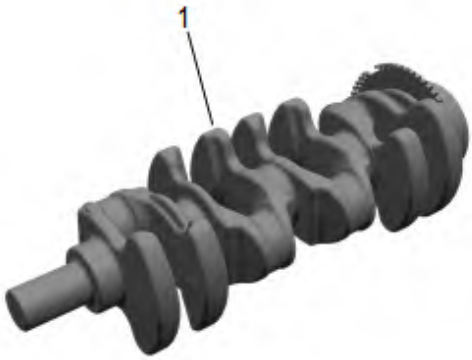


Fig. 398: Measuring Bearing Clearance Using Method A
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Use care when handling the crankshaft. Avoid damage to the bearing surfaces or the lobes of the crankshaft position reluctor ring. Damage to the teeth of the crankshaft position reluctor ring may affect on-board diagnostic (OBD) II system performance.**

1. Clean the crankshaft (1) with solvent.

mcx30.com

2. Thoroughly clean all oil passages and inspect for restrictions or burrs.

WARNING: **Refer to Safety Glasses Warning .**

3. Dry the crankshaft with compressed air.

NOTE: **Reluctor ring teeth should not have imperfections on the rising or falling edges.**

Imperfections of the reluctor ring teeth may effect OBD II system performance.

4. Perform a visual inspection of the crankshaft for damage.
5. Inspect the crankshaft reluctor ring. Replace the crankshaft assembly if damage to the reluctor ring is present.
6. Inspect the crankshaft journals for wear. The journals should be smooth, with no signs of scoring, wear, or damage.
7. Inspect the crankshaft journals for grooves or scoring.
8. Inspect the crankshaft journals for scratches or wear.
9. Inspect the crankshaft journals for pitting or imbedded bearing material.
10. Measure the crankshaft journals for out-of-round.
11. Measure the crankshaft journals for taper.

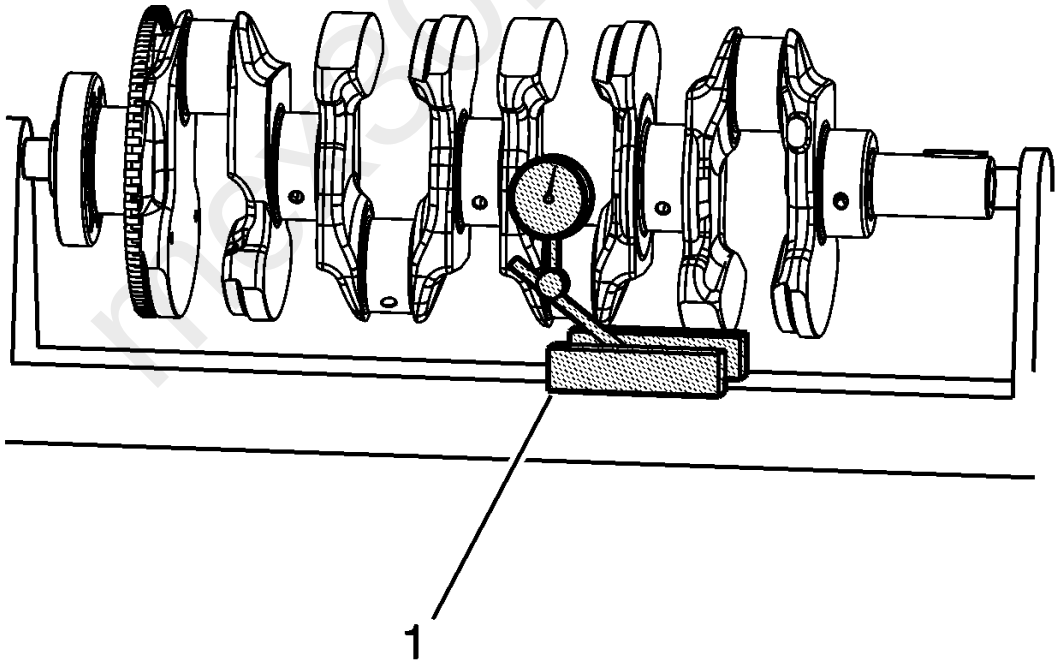


Fig. 399: View Of Magnetic Base Dial Indicator
Courtesy of GENERAL MOTORS COMPANY

12. Measure the crankshaft runout.

Using wooden V-blocks, support the crankshaft on the front and rear journals.

13. Use the **GE-7872** indicator (1) in order to measure the crankshaft runout at the front and rear intermediate journals.

14. Use the **GE-7872** indicator in order to measure the runout of the crankshaft rear flange.
15. Replace the crankshaft if the measurements are not within specifications.

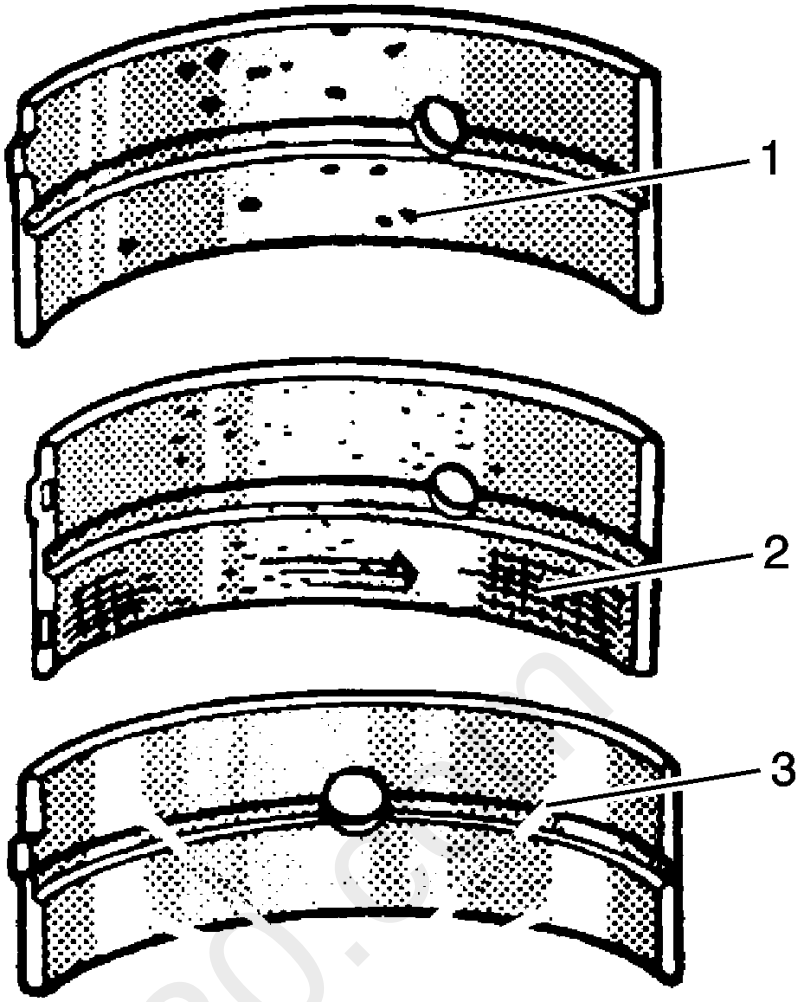


Fig. 400: Identifying Crankshaft Bearings For Craters Or Pockets
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Crankshaft bearings MUST be separated, marked, or organized in a way to ensure installation to their original location and position, when suitable for use.**

16. Inspect crankshaft bearings for craters or pockets (1). Flattened sections on the bearing halves also indicate fatigue.
17. Inspect the crankshaft bearings for excessive scoring or discoloration (2).
18. Inspect the crankshaft bearings for dirt or debris imbedded into the bearing material.
19. Inspect the crankshaft bearings for improper seating indicated by bright, polished sections of the bearing (3).

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.

PISTON AND CONNECTING ROD DISASSEMBLE

Special Tools

- **EN-46745** Piston Pin Clip Remover/Installer
- **EN-46745-4** Piston Pin Clip Remover/Installer Adapter

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

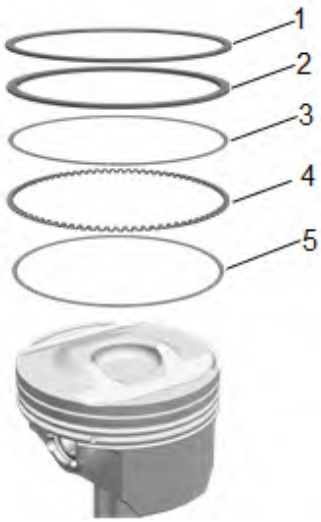


Fig. 401: Piston Rings
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Handle the piston carefully. Worn piston rings are sharp and may cause bodily injury.**

1. Disassemble the piston rings (1, 2, 3, 4, 5). Use a suitable tool to expand the rings. The piston rings must not be reused.

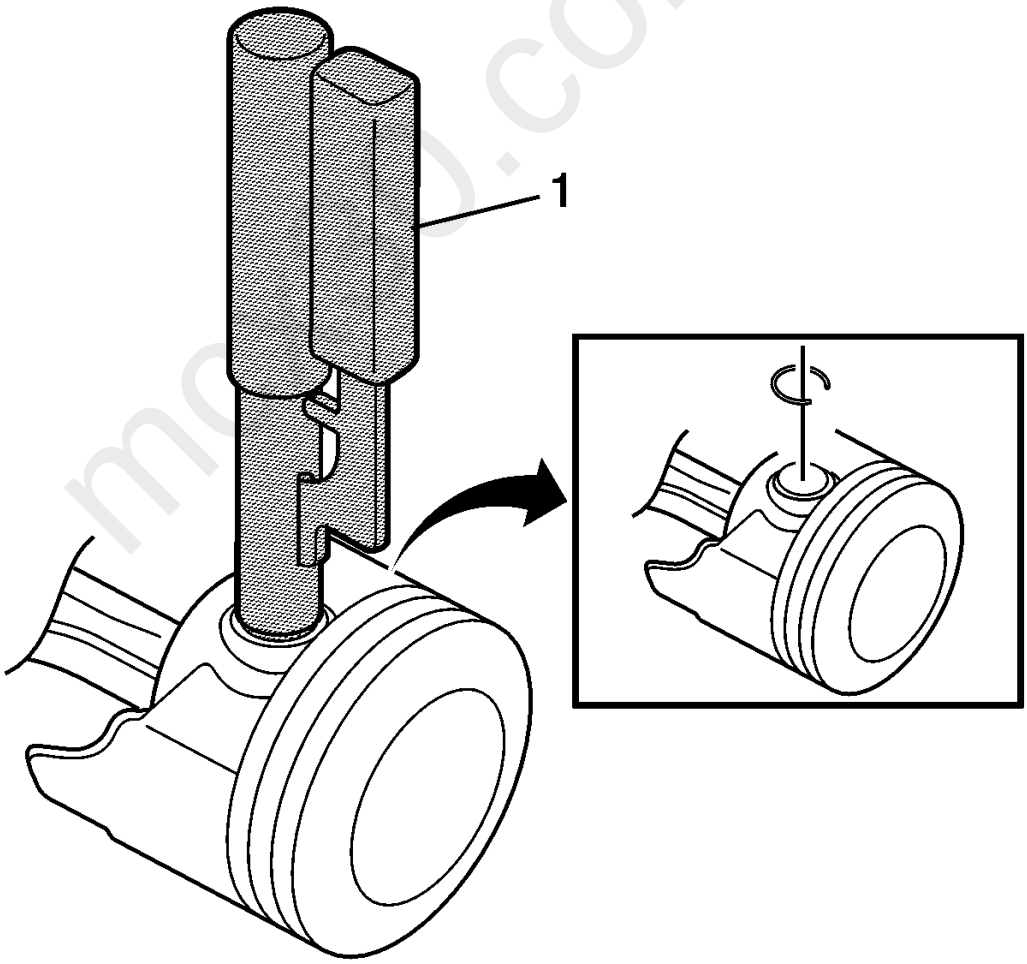


Fig. 402: View of Piston Pin Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Two retainers hold each piston pin in place. Ensure that the piston pin is not damaged. Do not reuse the retainers.**

NOTE: **Use the appropriate adapter for EN-46745 remover to remove the retainers.**

The appropriate adapter will fit the piston pin ID and allow the ring to be removed or installed.

- **For LCV/LKW/LD4 piston pin, use EN-46745-2 adapter.**
- **For LTG piston pin, use EN-46745-4 adapter.**

2. Remove the piston pin retainers using the **EN-46745** remover (1) and the appropriate adapter. Discard the retainer.

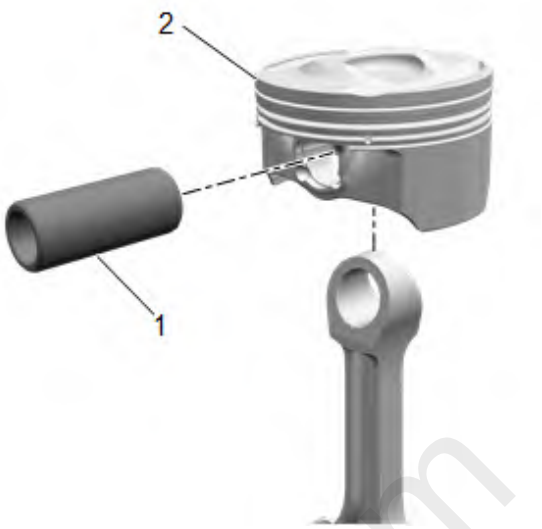


Fig. 403: Piston Pin, Connecting Rod And Piston
Courtesy of GENERAL MOTORS COMPANY

3. Remove the piston pin (1) and the connecting rod (3) from the piston (2).

PISTON, CONNECTING ROD, AND BEARING CLEANING AND INSPECTION

Connecting Rod Measurement

mcx30.com

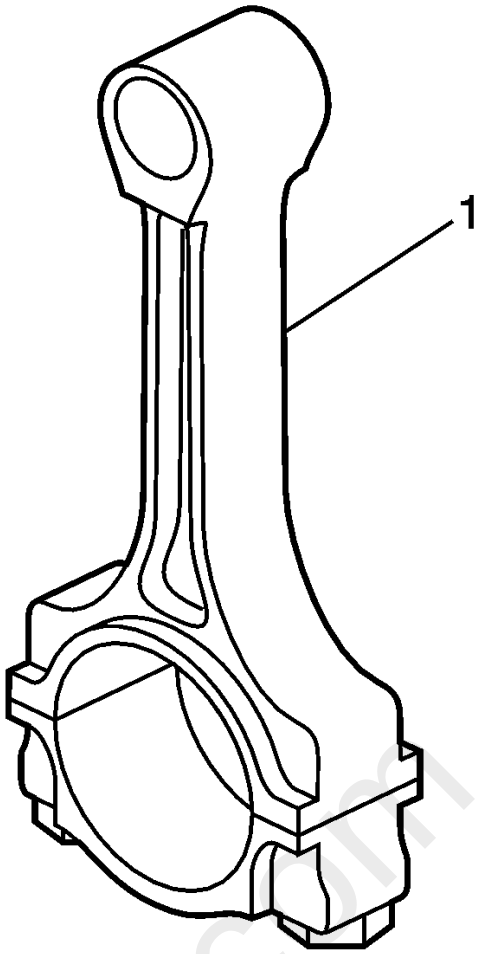


Fig. 404: Connecting Rod
Courtesy of GENERAL MOTORS COMPANY

1. Clean the connecting rods (1) in solvent and dry with compressed air.
2. Inspect the connecting rods for the following:
    - Signs of being twisted, bent, nicked, or cracked
    - Scratches or abrasion on the rod bearing seating surface
3. If the connecting rod bores contain minor scratches or abrasions, clean the bores in a circular direction with a light emery paper. DO NOT scrape the rod or rod cap.
4. If the beam of the rod is scratched or has other damage replace the connecting rod.
5. Measure the piston pin to connecting rod bore using the following procedure:
    1. Using an outside micrometer, take two measurements of the piston pin in the area of the connecting rod contact.
    2. Using an inside micrometer, measure the connecting rod piston pin bore.
    3. Subtract the piston pin diameter from the piston pin bore diameter.
    4. The clearance should not be more than 0.021 mm (0.0008 in).
6. If there is excessive clearance, replace the piston pin.
7. If there is still excessive clearance, replace the connecting rod.

Piston Measurement

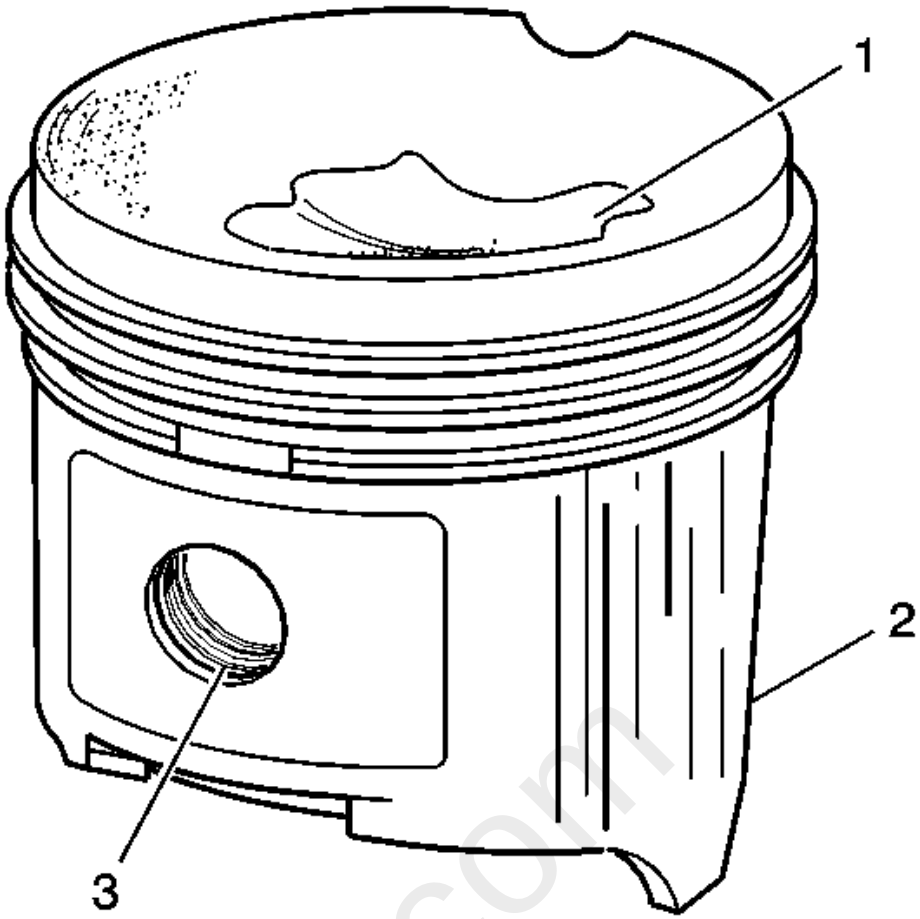


Fig. 405: Identifying Piston Damage Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

1. Clean the piston skirts and the pins with a cleaning solvent. DO NOT wire brush any part of the piston.
2. Clean the piston ring grooves with a groove cleaner. Make sure oil ring holes and slots are clean.
3. Inspect the pistons for the following conditions:
    - Cracked ring lands, skirts, or pin bosses
    - Ring grooves for nicks, burrs that may cause binding
    - Warped or worn ring lands
    - Eroded areas at the top of the piston (1)
    - Scuffed or damaged skirts (2)
    - Worn piston pin bores (3)
4. Replace pistons that show any signs or damage or excessive wear.
5. 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.
    3. Using an inside micrometer, measure the piston pin bore.
    4. Subtract the measurement of the piston pin bore from the piston pin. The clearance should be within 0.002 - 0.012 mm (0.00007 - 0.00047 in).
    5. If the clearance is excessive, determine which component is out of specification.

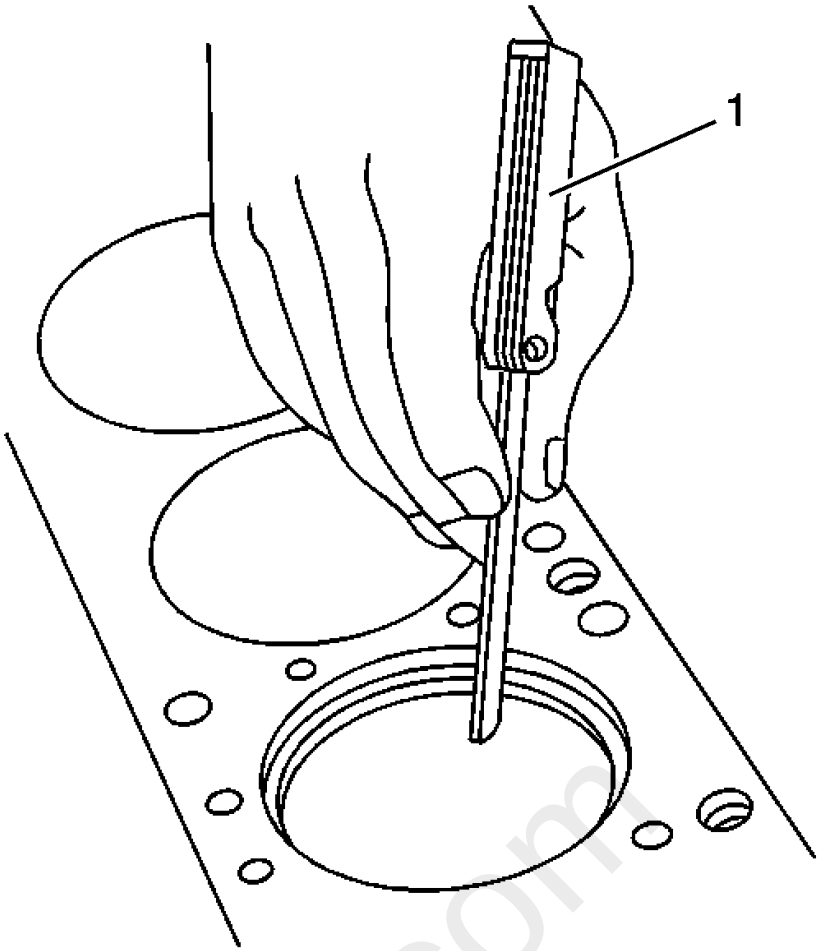


Fig. 406: Measuring Piston Ring End Gap
Courtesy of GENERAL MOTORS COMPANY

6. 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 or 1 inch down from the deck surface). Be sure the ring is square with the cylinder bore by positioning the ring with the piston head.
    2. Measure the end gap of the piston ring with feeler gauges (1). Compare the measurements with those provided below:
        - The top compression ring end gap should be 0.20 - 0.40 mm (0.0060 - 0.015 in).
        - The second compression ring end gap should be 0.35 - 0.55 mm (0.0137 - 0.0216 in).
        - The oil ring end gap should be 0.25 - 0.76 mm (0.0098 - 0.029 in).
    3. If the clearance exceeds the provided specifications, the piston rings must be replaced.
    4. Repeat the procedure for all the piston rings.

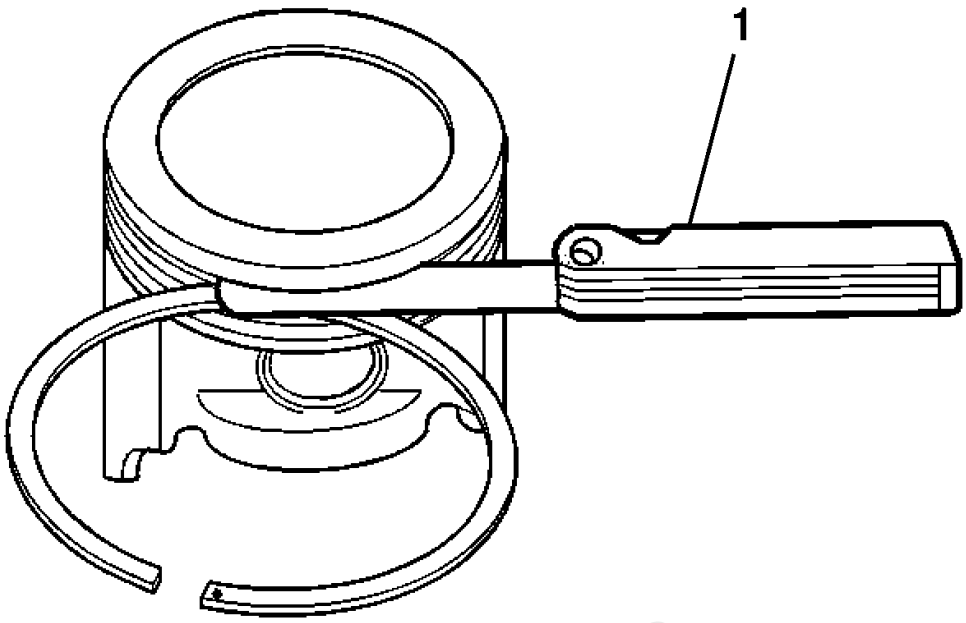


Fig. 407: Measuring Piston Ring Side Clearance
Courtesy of GENERAL MOTORS COMPANY

7. 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 a distorted piston ring, replace the ring.
    2. With the piston ring on the piston, use feeler gauges (1) to check clearance at multiple locations.
    3. The clearance between the surface of the top piston ring and the ring land should be no greater than 0.075 mm (0.0030 in).
    4. If the clearance is greater than specifications, replace the piston ring.
    5. If the new ring does not reduce the top ring side clearance to 0.075 mm (0.0030 in) or less, install a new piston.
8. The top compression ring may be installed with either side up. There is a locating dimple on the 2nd compression ring near the end for identification of the top side. Install the 2nd compression ring with the dimple facing up.
9. The clearance between the surface of the second piston ring and the ring land should be no greater than 0.069 mm (0.0026 in).
10. If the new ring does not reduce the clearance to 0.069 mm (0.0026 in) or less, install a new piston.

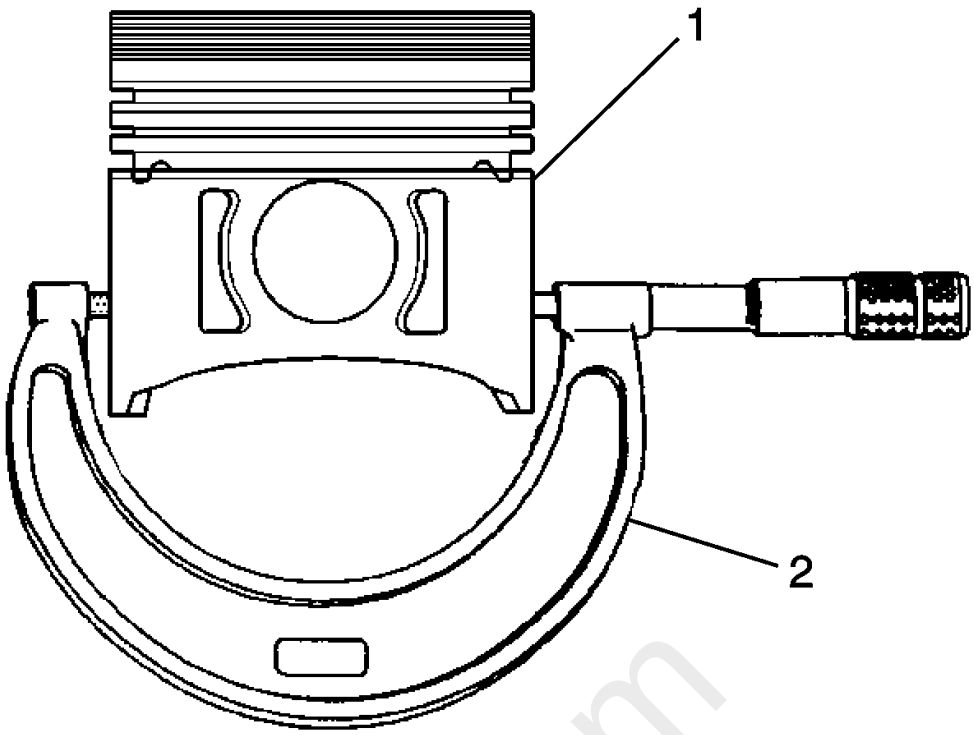


Fig. 408: Measuring Piston Width
Courtesy of GENERAL MOTORS COMPANY

11. Measure piston width using the following procedure:
    1. Using an outside micrometer (2), measure the width of the piston 14.5 mm (0.570 in) above the bottom of the piston skirt at the thrust surface perpendicular to the centerline of the piston pin.
    2. Compare the measurement of the piston to its original cylinder by subtracting the piston width from the cylinder diameter.
    3. The proper clearance specification for the piston is 0.010 - 0.041 mm (0.0004 - 0.0016 in).
12. If the clearance obtained through measurement is greater than these specifications and the cylinder bores are within specification, replace the piston (1).

Piston Selection

mr30.com

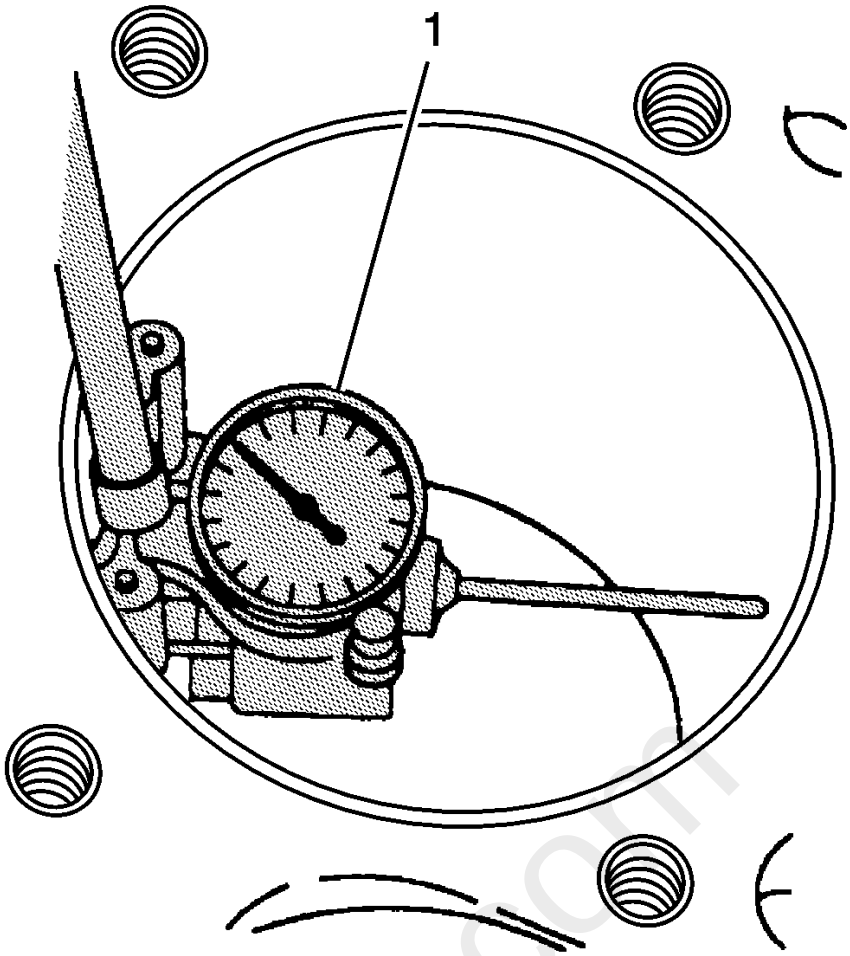


Fig. 409: Measuring Cylinder Bore
Courtesy of GENERAL MOTORS COMPANY

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 and pin set may be reinstalled if, after cleaning and inspection, they are within specifications.

1. Inspect the engine block cylinder bore. Refer to **Engine Block Cleaning and Inspection**.
2. Inspect the piston and the piston pin.
3. Use a bore gauge (1) and measure the cylinder bore diameter. Measure at a point 64 mm (2.5 in) from the top of the cylinder bore.

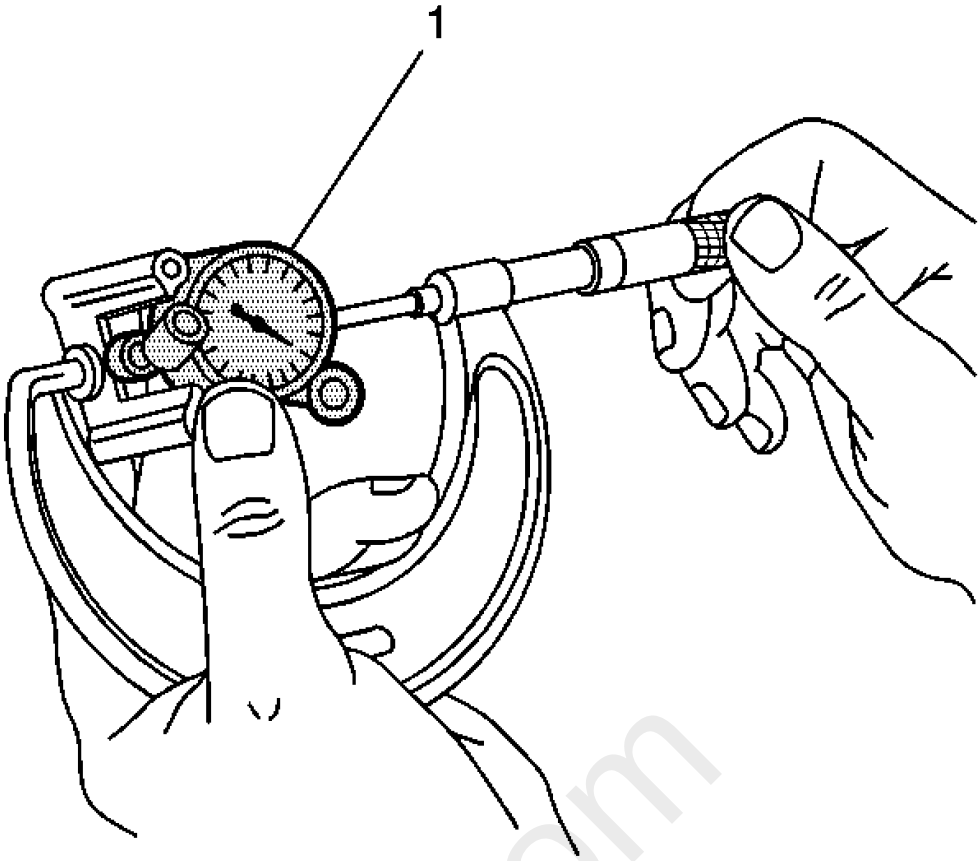


Fig. 410: Measuring Bore Gauge
Courtesy of GENERAL MOTORS COMPANY

4. Measure the bore gauge with a micrometer (1) and record the reading.

mcx30.com

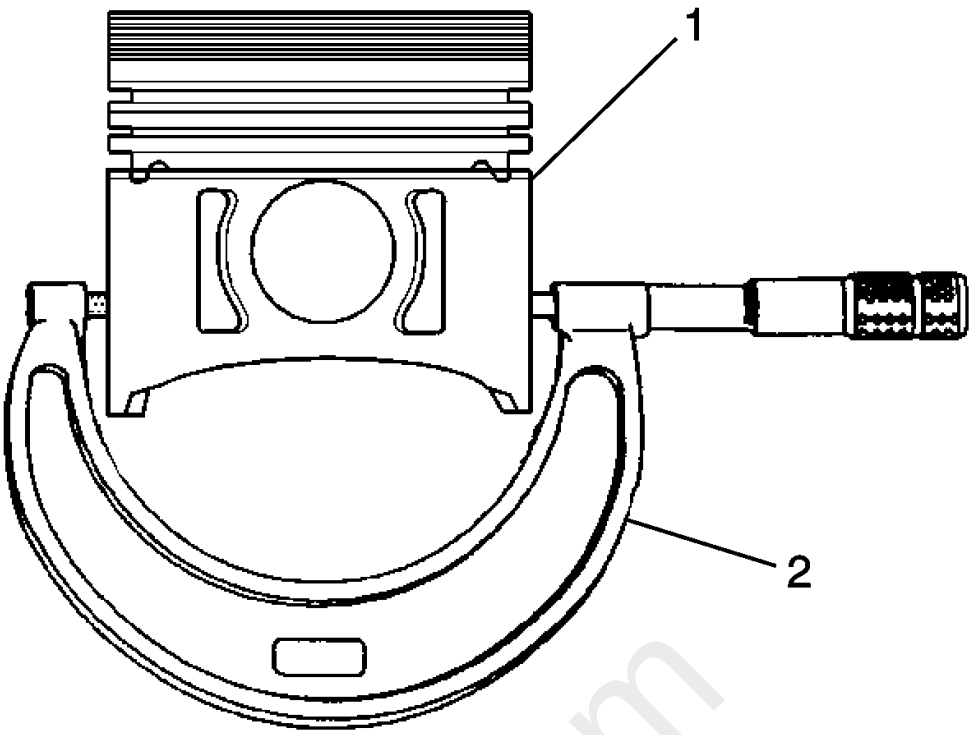


Fig. 411: Measuring Piston Width
Courtesy of GENERAL MOTORS COMPANY

5. With a micrometer (2) or caliper at a right angle to the piston (1), measure the piston 14 mm (0.570 in) from the bottom of the skirt.
6. Subtract the piston diameter from the cylinder bore diameter in order to determine piston-to-bore clearance.
7. For proper piston-to-bore clearance. Refer to **Engine Mechanical Specifications**.
8. If the proper clearance cannot be obtained, select another piston and measure for the clearances.
9. If the proper fit cannot be obtained, hone the cylinder bore or replace the cylinder block.
10. When the piston-to-cylinder bore clearance is within specifications, mark the top of the piston using a permanent marker for installation to the proper cylinder. Refer to **Separating Parts**.

PISTON AND CONNECTING ROD ASSEMBLE

Special Tools

- **EN-46745** Piston Pin Clip Remover/Installer
- **EN-46745-4** Piston Pin Clip Remover/Installer Adapter

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

mc730.com

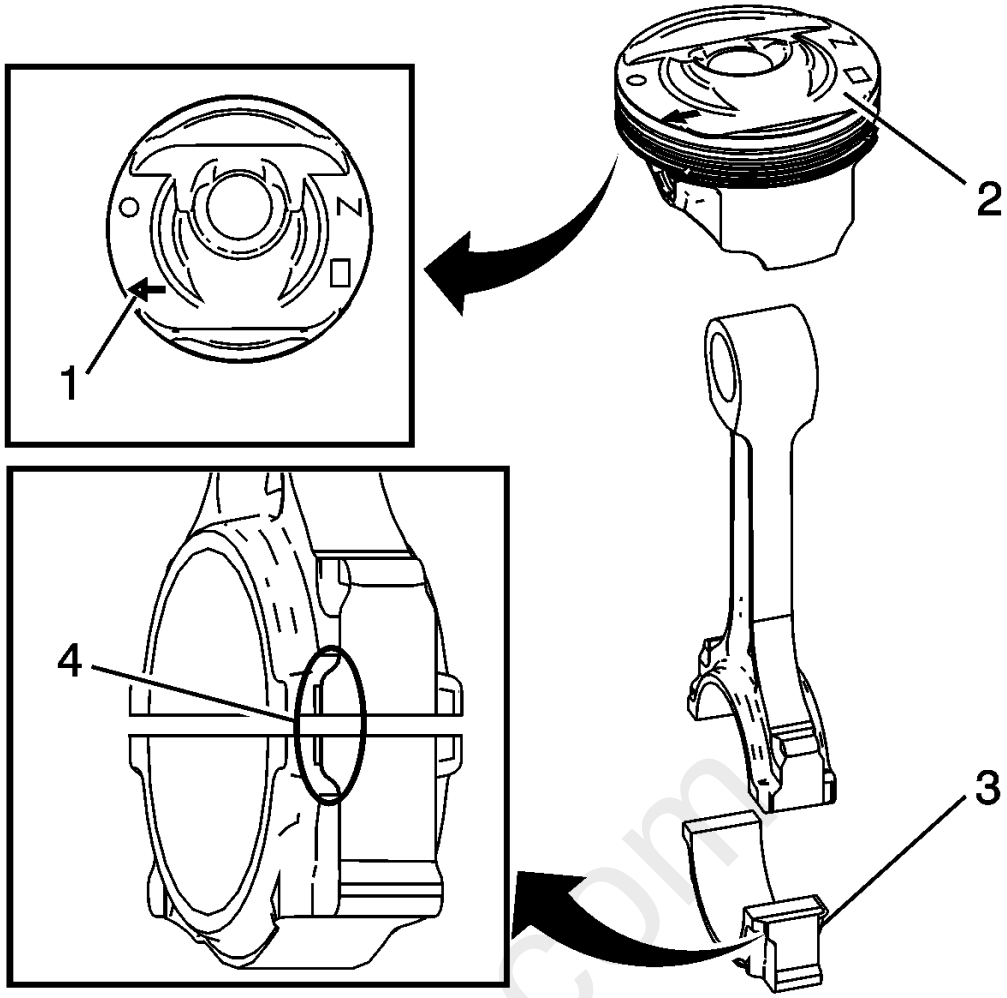


Fig. 412: Connecting Rod And Piston
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install the piston onto the connecting rod with the arrow on top of the piston oriented to the same side as the cast feature at the split line of the connecting rod.**

1. The arrow (1), on the top of the piston, must go to the front of the block.
2. The feature at the split line (4), located on one side of the connecting rod, must go to the front of the block.
3. Assemble the connecting rod (3) and the piston (2).

mc730.com

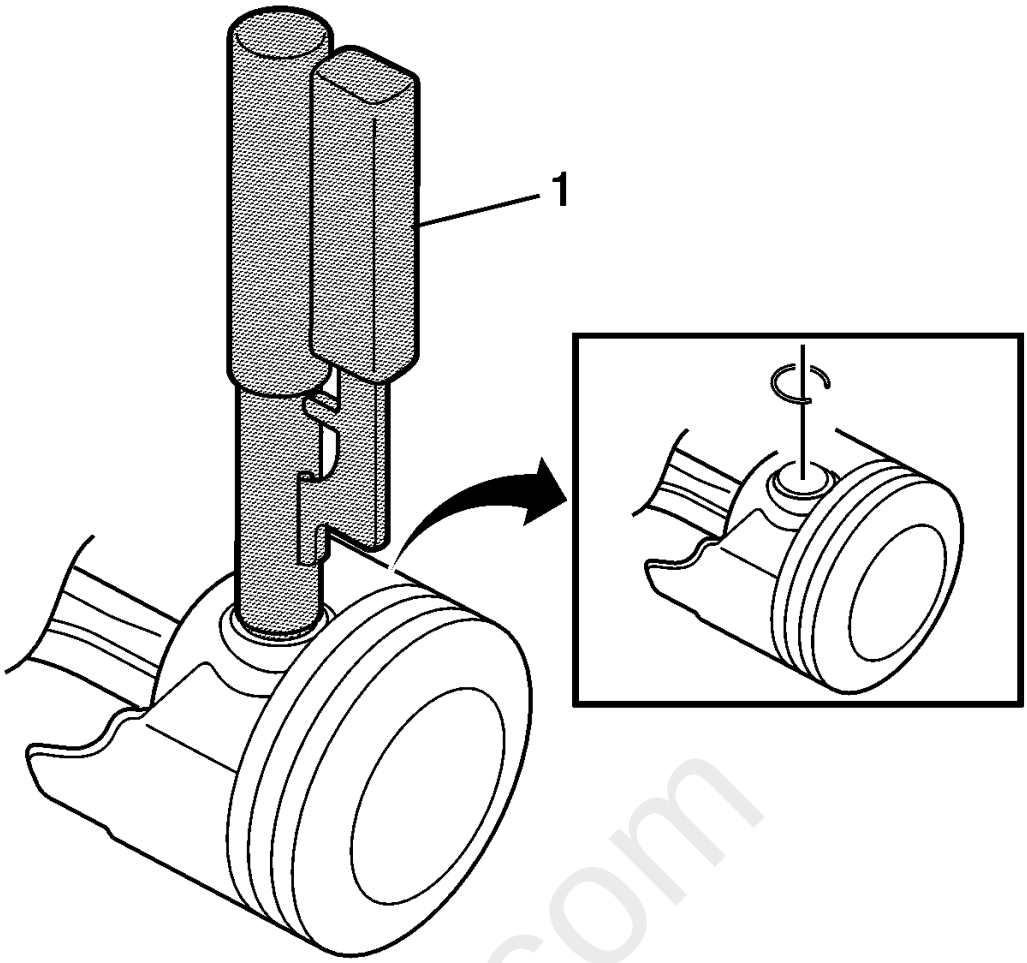


Fig. 413: View of Piston Pin Retainers
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Install the piston pin retainers correctly in the retaining groove during assembly in order to avoid engine damage.**

NOTE: **Use NEW retainers. Two retainers hold each piston pin in place.**

NOTE: **Use the appropriate adapter for EN-46745 installer to install the retainers. The appropriate adapter will fit the piston pin ID and allow the ring to be removed or installed.**

- **For LCV/LKW/LD4 piston pin, use EN-46745-2 adapter.**
- **For LTG piston pin, use EN-46745-4 adapter.**

4. Use the following procedure to assemble the piston pin and the retainer:
    1. Coat the piston pin with oil.
    2. Install one NEW piston pin retainer into the retaining groove using **EN-46745** installer and the appropriate adapter. Rotate the retainer until it is fully seated in the groove.
    3. Install the connecting rod and the piston pin.

       Push the piston pin until it bottoms in the previously installed retainer.

    4. Install the second NEW piston pin retainer, using **EN-46745** installer (1) and the appropriate adapter.
    5. Ensure that the piston moves freely.

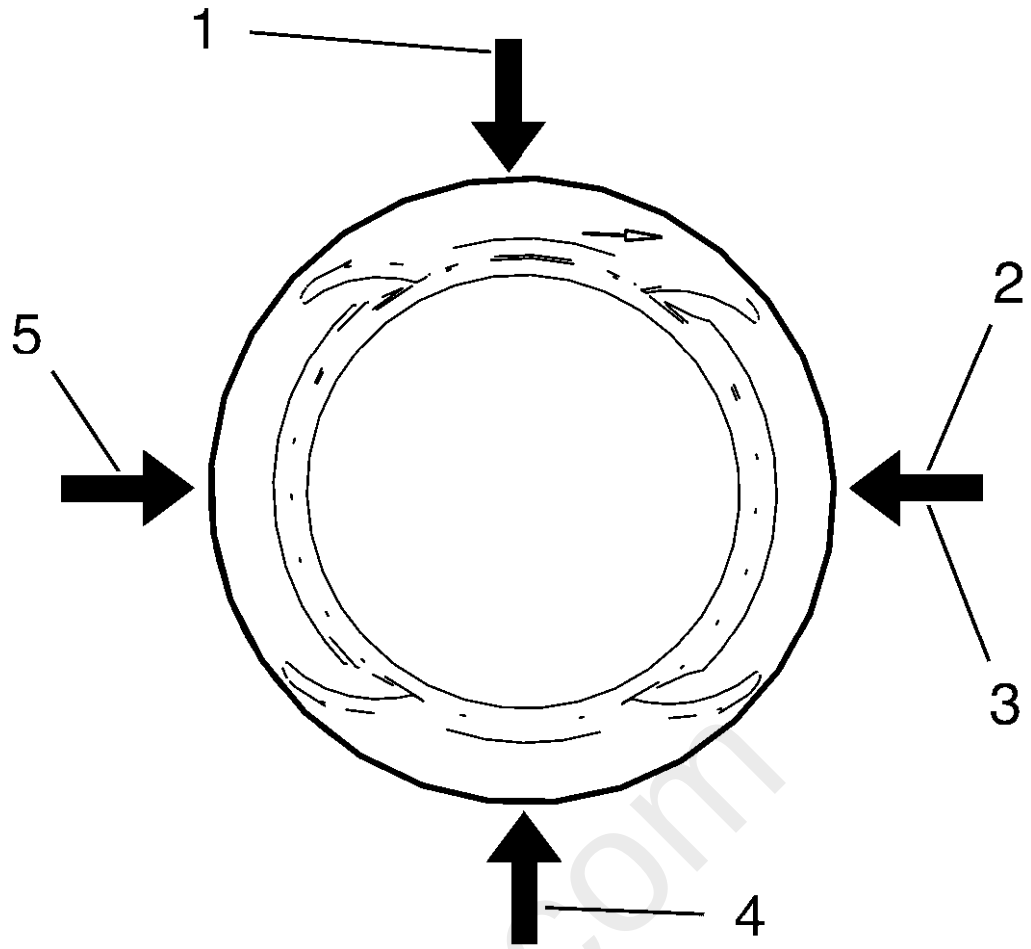


Fig. 414: Oil Ring Joints, Lower Compression Ring Joint, Upper Compression Ring Joint And Oil Ring Spacer Joint
Courtesy of GENERAL MOTORS COMPANY

5. The piston ring end gaps must be positioned 90 degrees to each other.
    - Upper compression ring joint (1)
    - Lower compression ring joint (2)
    - Upper oil ring rail joint (5)
    - Oil ring rail spacer joint (4)
    - Lower oil ring rail joint (3)

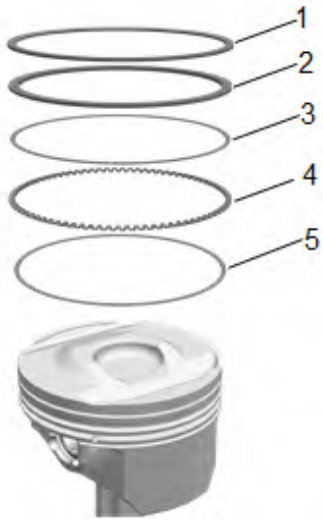


Fig. 415: Piston Rings
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Use a piston ring expander to install the piston rings. The rings may be damaged if expanded more than necessary.**

6. Install the following components of the oil control ring assembly:
    1. The piston oil ring rail (5)
    2. The piston oil ring rail spacer (4)
    3. The second piston oil ring rail (3)
7. Install the piston lower compression ring (2). Place the manufacturer's mark facing up.
8. Install the piston upper compression ring (1).

CAMSHAFT ASSEMBLY DISASSEMBLE

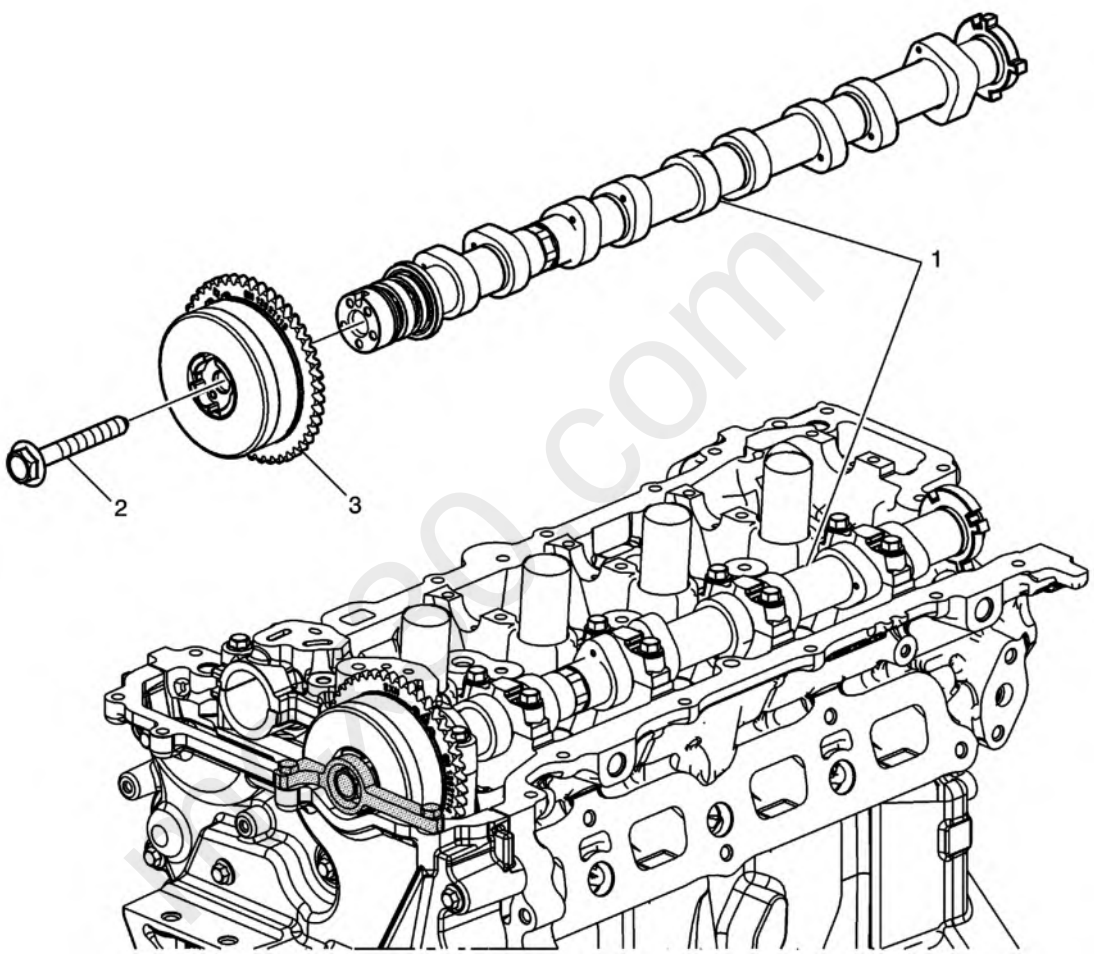


Fig. 416: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Temporarily install the cylinder head to the engine block, with the engine block securely attached to a mounting device. 2. Temporarily install the engine front cover to the cylinder head, using the upper bolts to hold the cover in position. 3. Install one of the camshafts in the exhaust camshaft position on the cylinder head. 4. Install the camshaft bearing front upper cap and bolts. 5. Install the camshaft bearing caps and bolts. 6. Install **EN-50793** locking tool onto the camshaft actuator and engine front cover. 7. The camshaft actuator bolt can now be loosened and the actuator removed from the camshaft. Repeat preliminary procedure for the remaining camshaft assembly.	

Callout	Component Name
1	Camshaft, Intake and Exhaust
2	Camshaft Position Actuator Bolt **NOTE:** **Discard the bolt.** **Special Tools** **EN-50793** Camshaft Actuator Locking Tool For equivalent regional tools, refer to **Special Tools**.
3	Camshaft Position Actuator, Intake and Exhaust

CAMSHAFT CLEANING AND INSPECTION

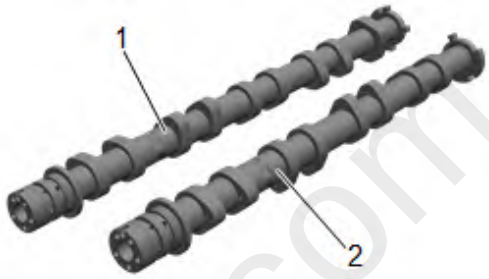


Fig. 417: Camshaft Journals And Lobes
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the camshaft journals and lobes for wear or scoring.
2. Inspect the camshaft sprocket alignment notch for damage.
3. Wash the camshafts (1, 2) in solvent.
4. Oil the camshafts.

CAMSHAFT ASSEMBLY ASSEMBLE

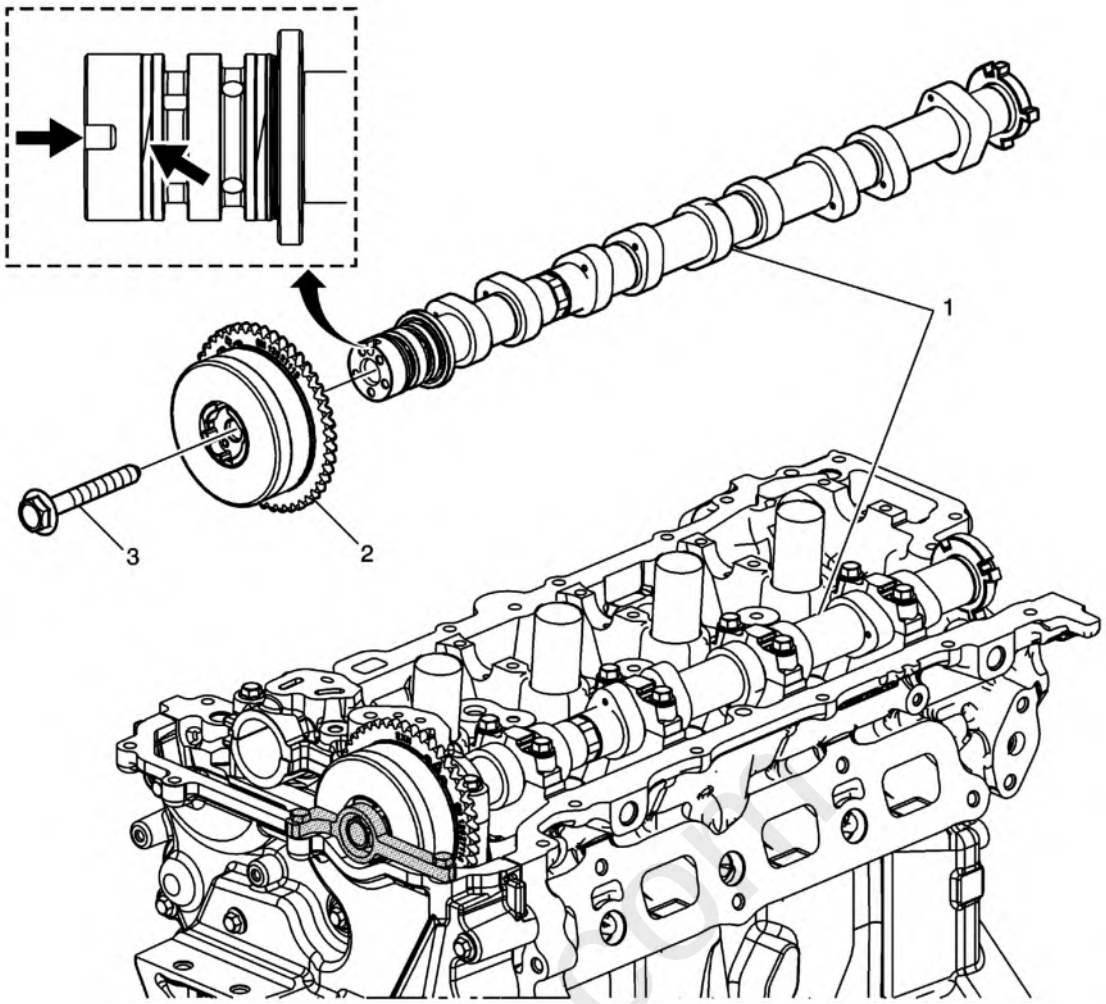


Fig. 418: Camshaft Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Temporarily install the cylinder head to the engine block, with the engine block securely attached to a mounting device. 2. Temporarily install the engine front cover to the cylinder head, using the upper bolts to hold the cover in position. 3. Install one of the camshafts in the exhaust camshaft position on the cylinder head. 4. Install the camshaft bearing front upper cap and bolts. 5. Install the camshaft bearing caps and bolts. 6. Install the appropriate actuator for the camshaft currently installed on the cylinder head. 7. Install **EN-50793** locking tool onto the camshaft actuator and engine front cover. 8. The camshaft actuator bolt can now be installed and tighten ed to final specification. Repeat preliminary procedure for the remaining camshaft assembly.	
1	Camshaft, Intake and Exhaust **NOTE:** **Ensure that the oil seal near the front of the camshaft is rotated so that the split line on the oil seal is aligned with the notch, and both the notch and split line are at 12 O'clock when installed on the cylinder head.**

Callout	Component Name
2	Camshaft Position Actuator, Intake and Exhaust **NOTE:** **Upon camshaft assembly, ensure the camshaft actuator pin aligns with the camshaft notch. The actuator, camshaft, and bolt can be assembled by hand and then placed on the cylinder head for final torque.** **NOTE:** **Lubricate the actuator prior to installation.**
3	Camshaft Position Actuator Bolt **CAUTION:** **Refer to Fastener Caution .** **CAUTION:** **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.** **tighten** 30 N.m (22 lb ft) plus 100 Degrees. **Special Tools** **EN-50793** Camshaft Actuator Locking Tool For equivalent regional tools, refer to Special Tools.

CAMSHAFT TIMING CHAIN, SPROCKET, AND TENSIONER CLEANING AND INSPECTION

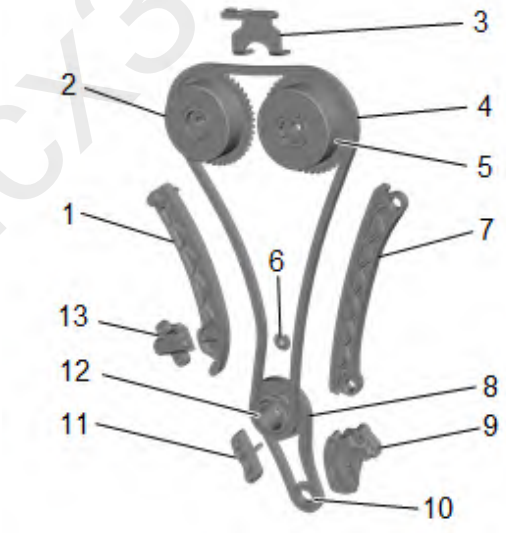


Fig. 419: Camshaft Timing Chain, Sprocket, And Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the timing chain guides (3, 7) and timing chain tensioner pivot arm (1) for cracking or wear.
2. Replace the timing chain guides if wear exceeds 1.12 mm (0.045 in) depth on the chain guide surface.
3. Inspect the timing chain tensioner (13) shoe for wear.
4. Replace the timing chain tensioner if shoe wear exceeds 1.12 mm (0.045 in) depth on the chain guide surface.
5. Inspect the timing chain (4) and actuators (2, 5) for wear.
6. Inspect the camshaft actuator faces for signs of movement.
7. Inspect the camshaft actuator teeth and chain for signs of excessive wear, chipping, or seizure of the timing chain links.

mcx30.com

8. Inspect the timing chain oil nozzle (6) for collapse or cracks at the bolt boss. Discard and replace the oil nozzle body if it is damaged.
9. Verify oil nozzle oil flow with compressed air.
10. Inspect the timing chain tensioner (13) for scoring or free movement.
11. Inspect the timing chain tensioner washer. If damaged, replace the timing chain tensioner.
12. Inspect the crankshaft sprocket (12) for excessive wear or chipping.
13. Inspect the balancer chain (8) for wear.
14. Inspect the balancer chain guide (11) for wear.
15. Inspect the balancer chain tensioner (9) for wear.
16. Inspect the balancer shaft driven sprocket (10) for wear or chipping.

CYLINDER HEAD DISASSEMBLE

Special Tools

- **EN-43963** Valve Spring Compressor (off car)
- **EN-46116** Valve Stem Seal Remover/Installer
- **EN-50717** Valve Spring Compressor

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

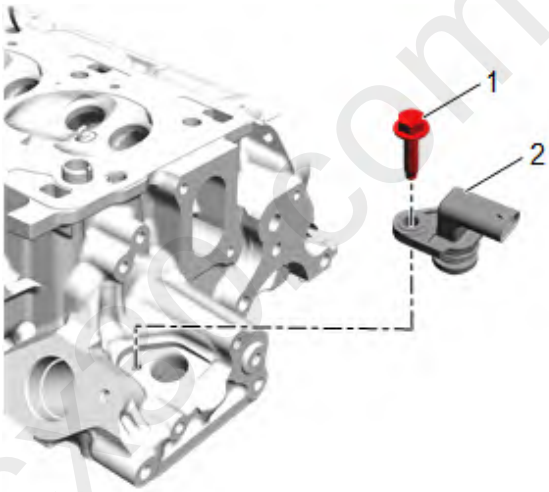


Fig. 420: Intake Camshaft Position Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the intake camshaft position sensor (2) and bolt (1).

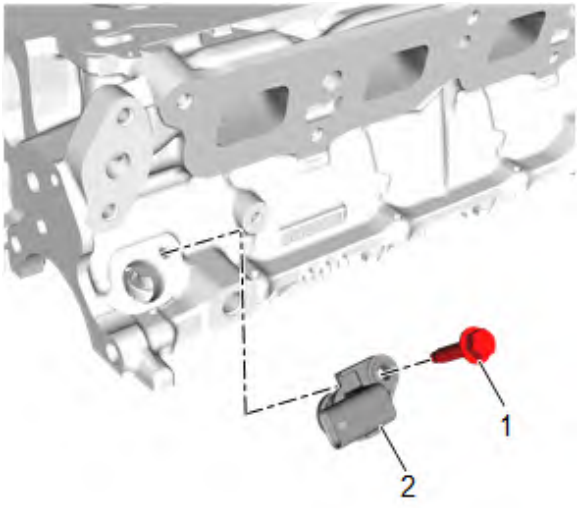


Fig. 421: Exhaust Camshaft Position Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove the exhaust camshaft position sensor (2) and bolt (1).

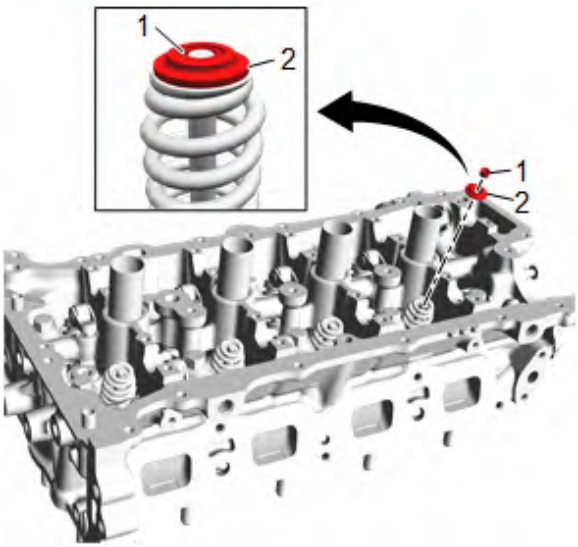


Fig. 422: Valve Keys, Springs, And Retainers
Courtesy of GENERAL MOTORS COMPANY

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 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.**

NOTE: **Ensure that the valve train components are kept together and identified in order for proper installation in their original position.**

3. Perform the following procedure to remove the valve keys, springs, and retainers:
    1. Using the **EN-50717** fixture and the **EN-43963** compressor adapter, compress the valve spring.
    2. Remove the valve keys (1).
    3. Slowly release the compression from the valve spring assembly.
    4. Remove the retainer (2).

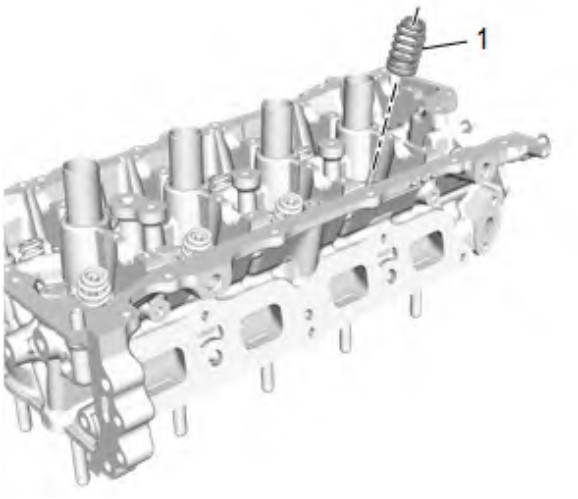


Fig. 423: Valve Springs
Courtesy of GENERAL MOTORS COMPANY

4. Remove the springs (1).

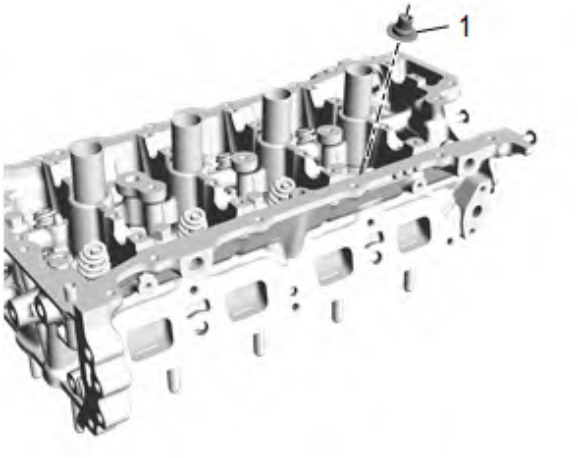


Fig. 424: Valve Seals
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Do not damage the valve guide. Remove any burrs that have formed at the key groove by chamfering the valve stem with an oil stone or a file.**

5. Using **EN-46116** remover, remove the valve seals (1). Discard the seals, do not reuse.

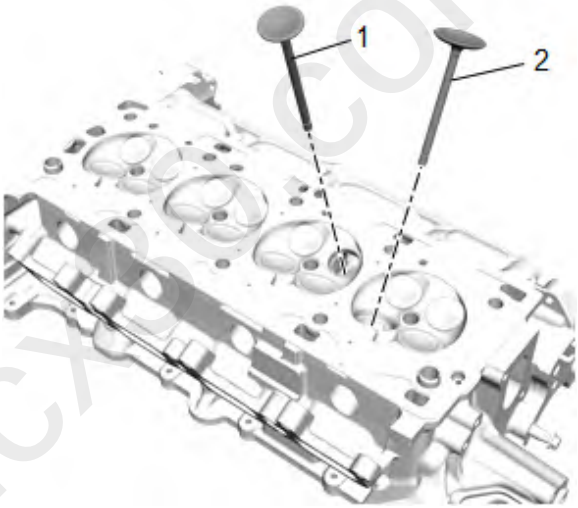


Fig. 425: Valves
Courtesy of GENERAL MOTORS COMPANY

6. Remove the valves (1, 2).

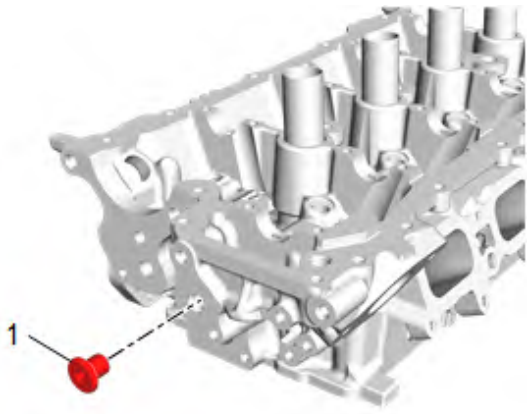


Fig. 426: Cylinder Head Plug
Courtesy of GENERAL MOTORS COMPANY

7. Remove the cylinder head plug (1).

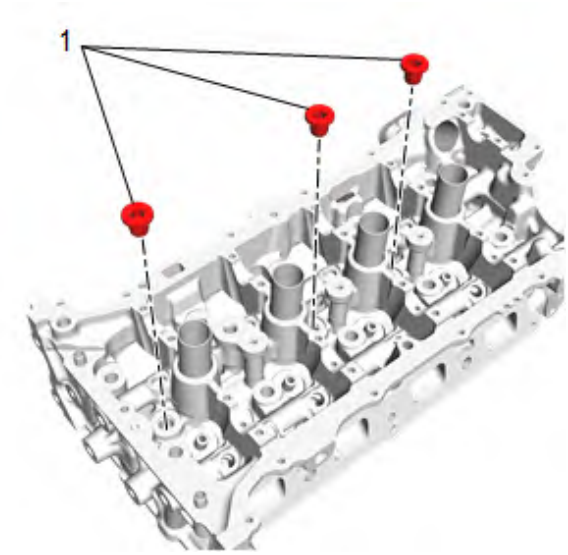


Fig. 427: Cylinder Head Plugs
Courtesy of GENERAL MOTORS COMPANY

8. Remove the cylinder head plugs (1).

CYLINDER HEAD CLEANING AND INSPECTION

Special Tools

- **EN 22738-B** Valve Spring Tester
- **EN-28410** Gasket Remover
- **EN-39358** Spark Plug Socket
- **GE 7872** Magnetic Base Dial Indicator

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

Valve Cleaning and Inspection

mcx30.com

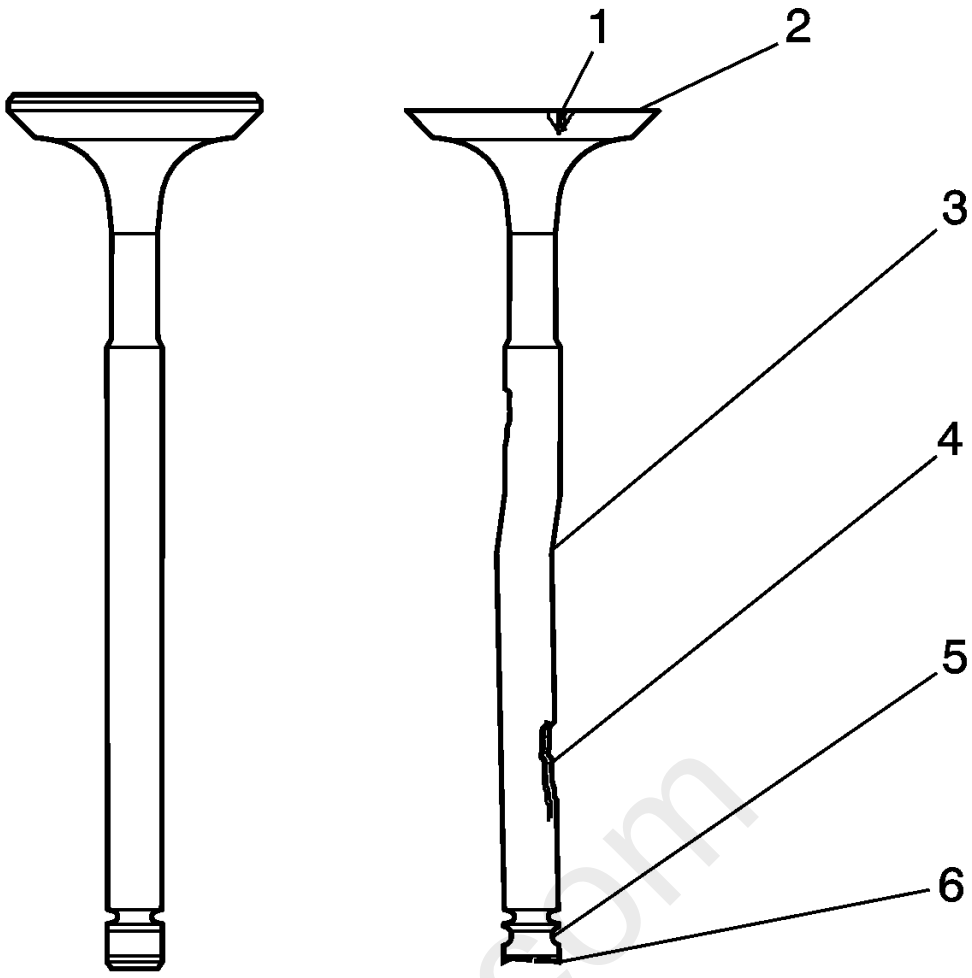


Fig. 428: Valve Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not use a wire brush on any part of the valve stem.**

NOTE: **Do not grind or condition the intake valve. If the intake valve is out of specification, replace the valve.**

1. Clean the valves of carbon, oil and varnish. Use a soft bristle wire brush to clean any carbon build-up from the valve head. Varnish can be removed by soaking in Parts Immersion Solvent. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
2. Clean the valve guides.
3. Inspect the valve stem for pitting or wear (4).
4. Inspect the valve key groove for chipping or wear (5). Replace the valve if chipped or worn.
5. Inspect the valve face for burning or cracking (1). If pieces are broken off, inspect the corresponding piston and cylinder head area for damage.
6. Inspect the valve stem for burrs and scratches. Burrs and minor scratches may be removed with an oil stone.
7. Inspect the valve stem for straightness (3) and the valve head for bending or distortion using V blocks. Bent or distorted valves must be replaced.
8. Clean the deposits from the valve face. Inspect the valve face for grooving.
9. Replace the valve if the face is grooved. Valve faces cannot be machined. If worn, or damaged, the valves must be replaced.
10. Replace the valve if the valve head O.D. and chamfer (2) is worn or out of specification. Refer to **Valve and Seat Grinding**.
11. The valves may be lightly lapped to the valve seats.
12. Replace the valve if the valve tip (6) is worn.
13. If no apparent wear, pitting, grooving, or distortion is present, perform the valve measurement and reconditioning procedure to verify valve specification. Refer to **Valve and Seat Grinding**.

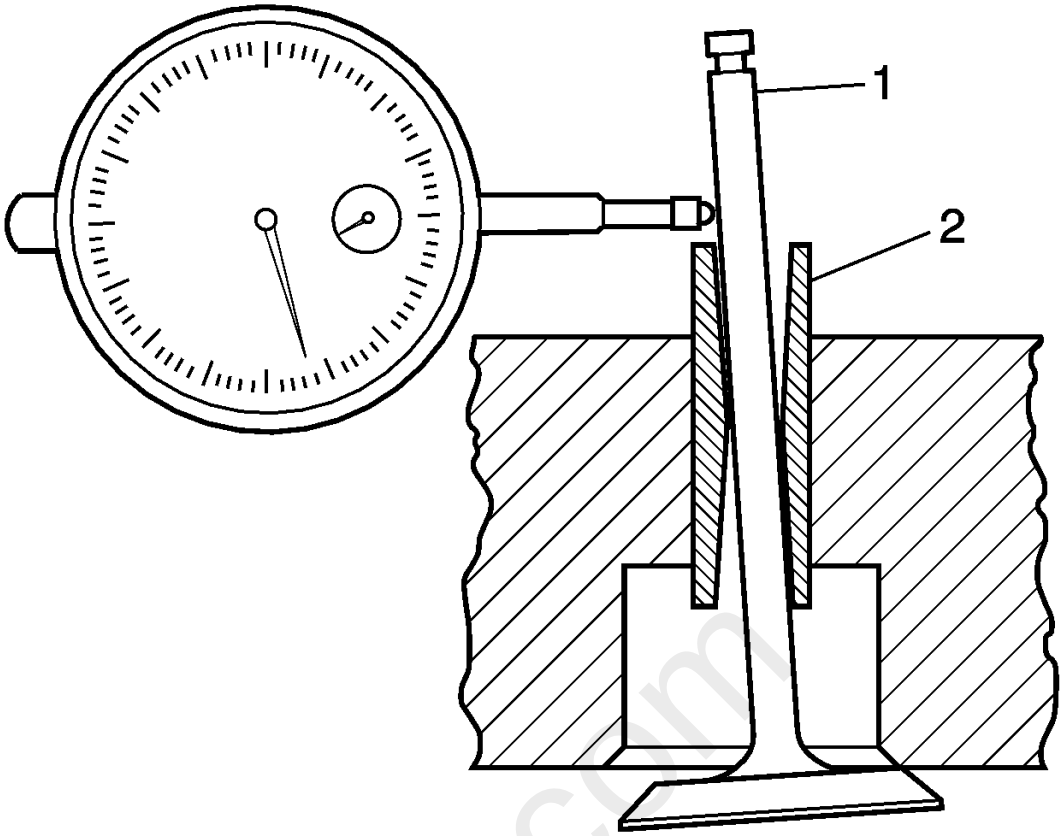


Fig. 429: Inspecting For Excessive Valve Stem To Guide Clearance
Courtesy of GENERAL MOTORS COMPANY

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 **GE 7872** dial indicator 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** for proper clearance.

NOTE: **Valve guide wear at the bottom 10 mm (0.390 in) of the valve guide is not significant to normal operation.**

6. If the clearance for the valve is greater than specifications and a new standard diameter valve stem will not bring the clearance within specifications, replace the cylinder head.

Valve Spring Cleaning and Inspection

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.

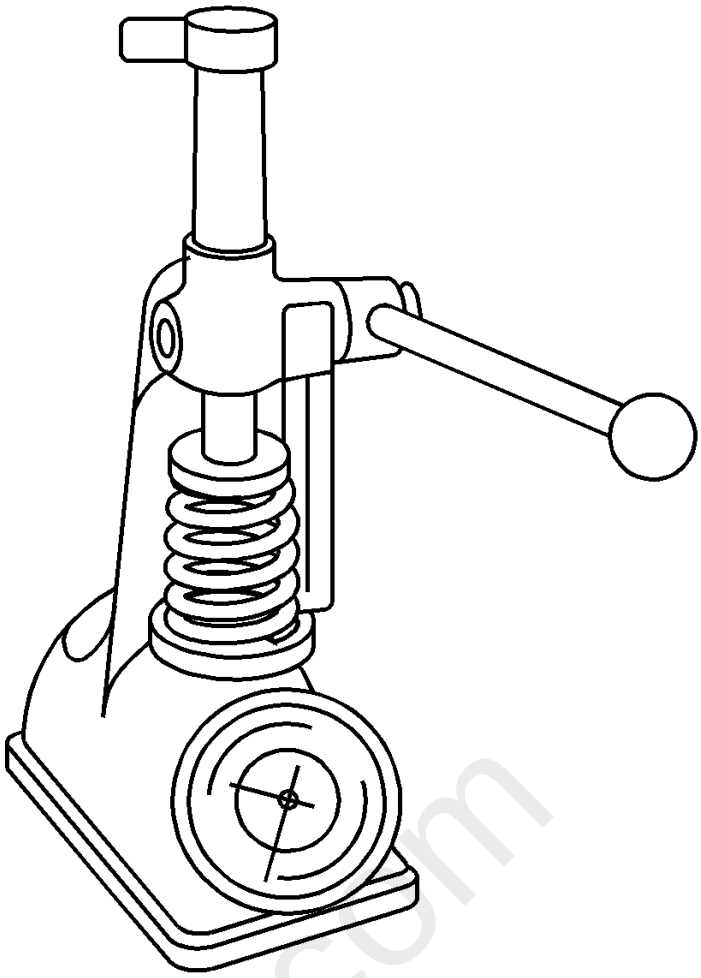


Fig. 430: Measuring Valve Spring Tension
Courtesy of GENERAL MOTORS COMPANY

4. Measure the valve spring tension using the **EN 22738-B** tester. Refer to **Engine Mechanical Specifications**
5. 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.

Valve Rocker Arm Cleaning and Inspection

mc130.com

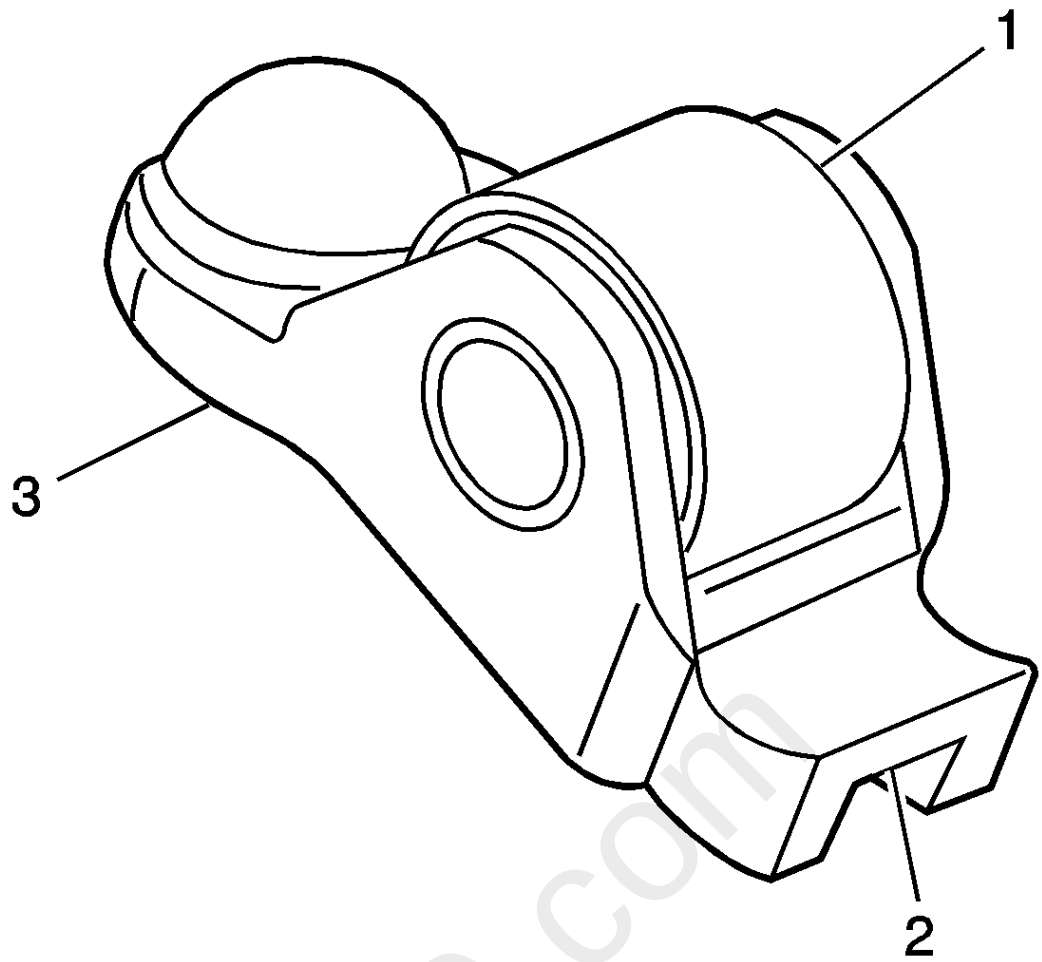
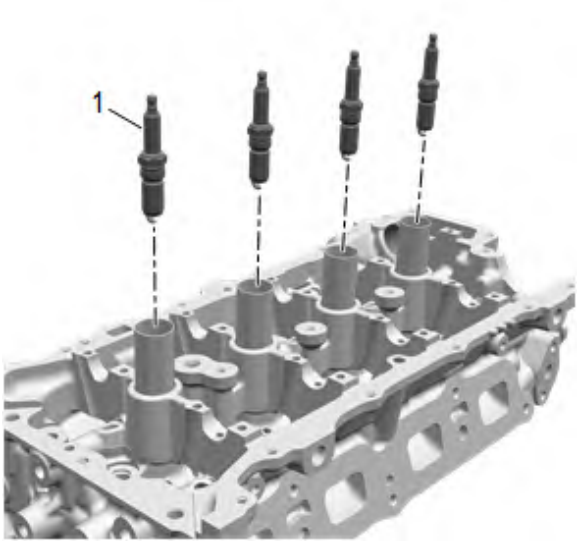


Fig. 431: Inspecting Valve Rocker Arms
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the camshaft follower roller (1) for the following:
    - Flat spots
    - 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.

Cylinder Head and Gasket Surface Cleaning and Inspection



mcx30.com

Fig. 432: Spark Plugs
Courtesy of GENERAL MOTORS COMPANY

1. Remove the spark plugs (1) using **EN-39358** socket.
2. Inspect the cylinder head gasket and mating surfaces for leaks, corrosion and blow-by. If the gasket has failed, use the following faults to determine the cause:
    1. Improper installation
    2. Loose or warped cylinder head
    3. Missing, off location or not fully seated dowel pins
    4. Corrosion in the seal area around the coolant passages
    5. Chips or debris in the cylinder head bolt holes
    6. Bolt holes in the cylinder block not drilled or tapped deep enough

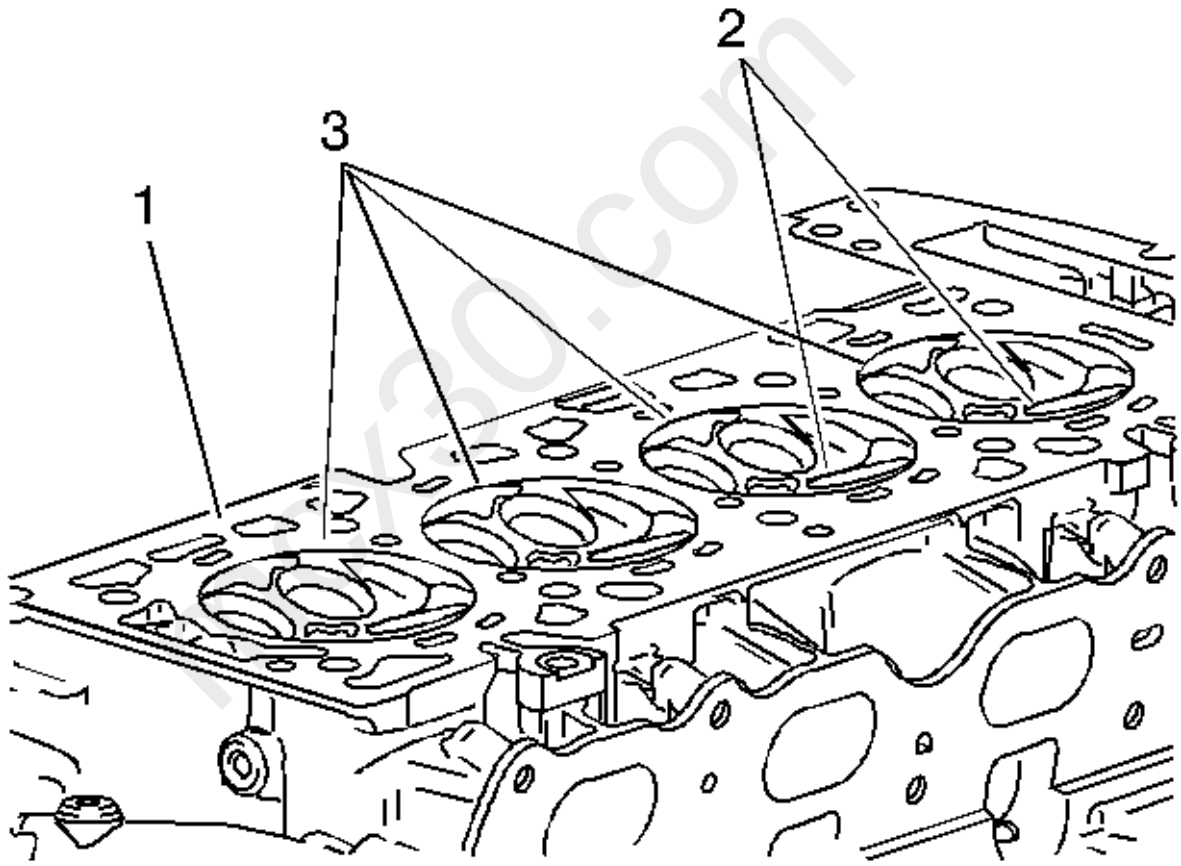


Fig. 433: Locating Combustion Chambers
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the cylinder head gasket surface.
    - Cylinder head may be reused if corrosion is found only outside a 4 mm (0.375 in) band around each combustion chamber (1).
    - Replace the cylinder head if the area between the valve seats is cracked (2).
    - Replace the cylinder head if corrosion has been found inside a 4 mm (0.375 in) band around each combustion chamber (3).
4. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**

NOTE: **Do not use a wire brush on any gasket sealing surface.**

5. Remove the sealant from the rear cap mating surface with **EN-28410** remover. Care must be used to avoid gouging or scraping the sealing surfaces.
6. Clean the cylinder head. Remove all varnish, soot and carbon to the bare metal.
7. Clean the valve guides.
8. Clean the threaded holes. Use a nylon bristle brush.
9. Clean the remains of the sealer from the plug holes.
10. Inspect the cylinder head for cracks. Check between the valve seats and in the exhaust ports.

NOTE: **Do not attempt to weld the cylinder head, replace it.**

11. Inspect the cylinder head deck for corrosion, sand inclusions and blow holes.

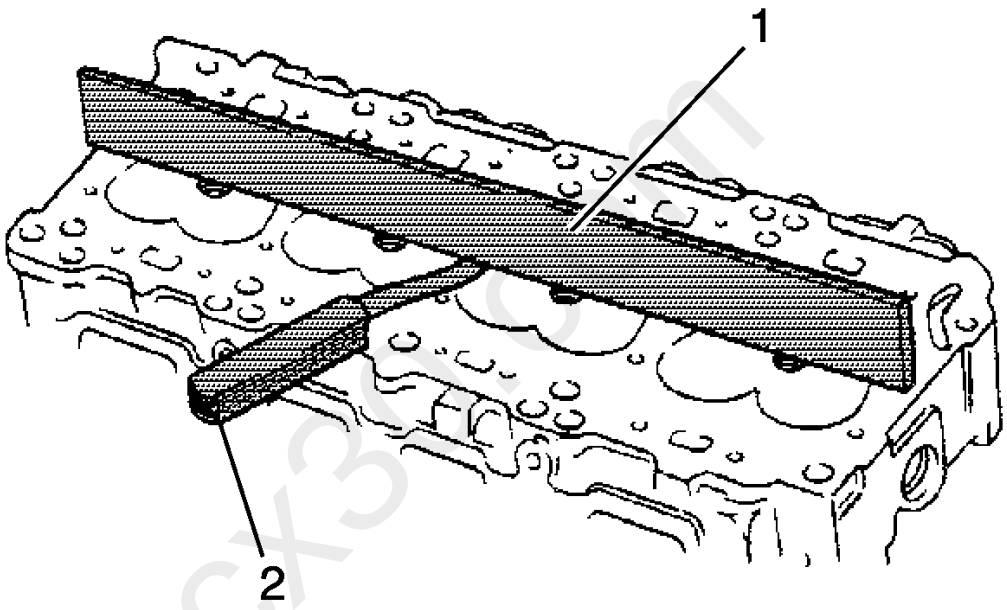


Fig. 434: Checking Cylinder Head Deck Surface For Flatness
Courtesy of GENERAL MOTORS COMPANY

12. Using a straight edge (1) and feeler gauge (2), inspect the cylinder head deck surface for flatness. Refer to **Engine Mechanical Specifications**. If the cylinder head is out of specification, replace the cylinder head. Do not machine the cylinder head.
13. Inspect all the threaded holes for damage. Threads may be reconditioned with thread inserts.
14. Inspect the sealing surfaces.

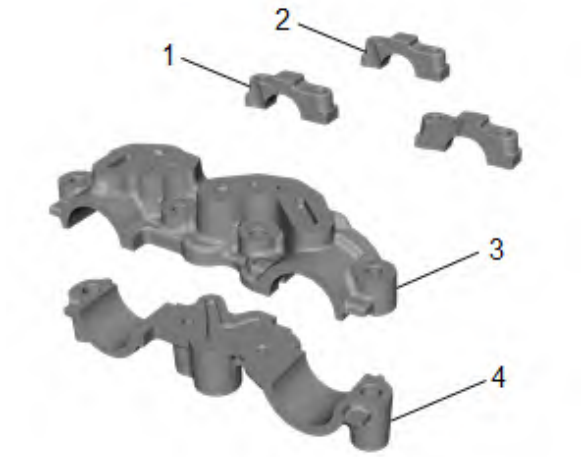


Fig. 435: Intake Camshaft Bearing Rear Cap
Courtesy of GENERAL MOTORS COMPANY

15. Inspect the intake camshaft bearing rear cap (2) for damage.
16. Inspect the camshaft bearing caps (1) for damage.
17. Inspect the camshaft front upper and lower bearing caps (3, 4) for damage.

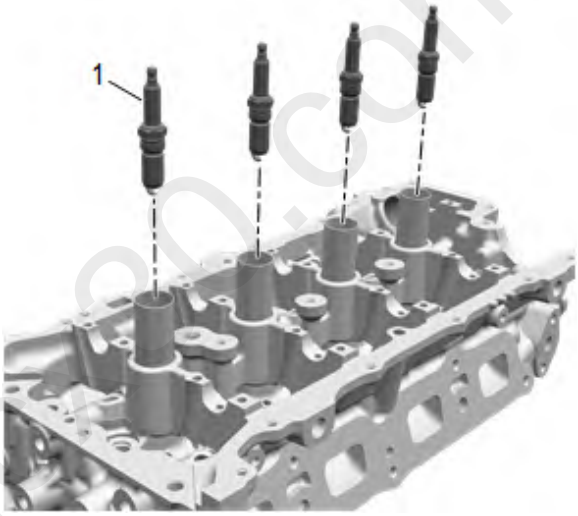


Fig. 436: Spark Plugs
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Component Fastener tightening Caution .**

18. Install the spark plugs (1) using **EN-39358** socket. tighten the plugs to 20 N.m (15 lb ft).

VALVE AND SEAT GRINDING

Valve Measurement and Reconditioning Overview

- Proper valve service is critical to engine performance. Therefore, all detailed measurement procedures must be followed to identify components that are out of specification.
- 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

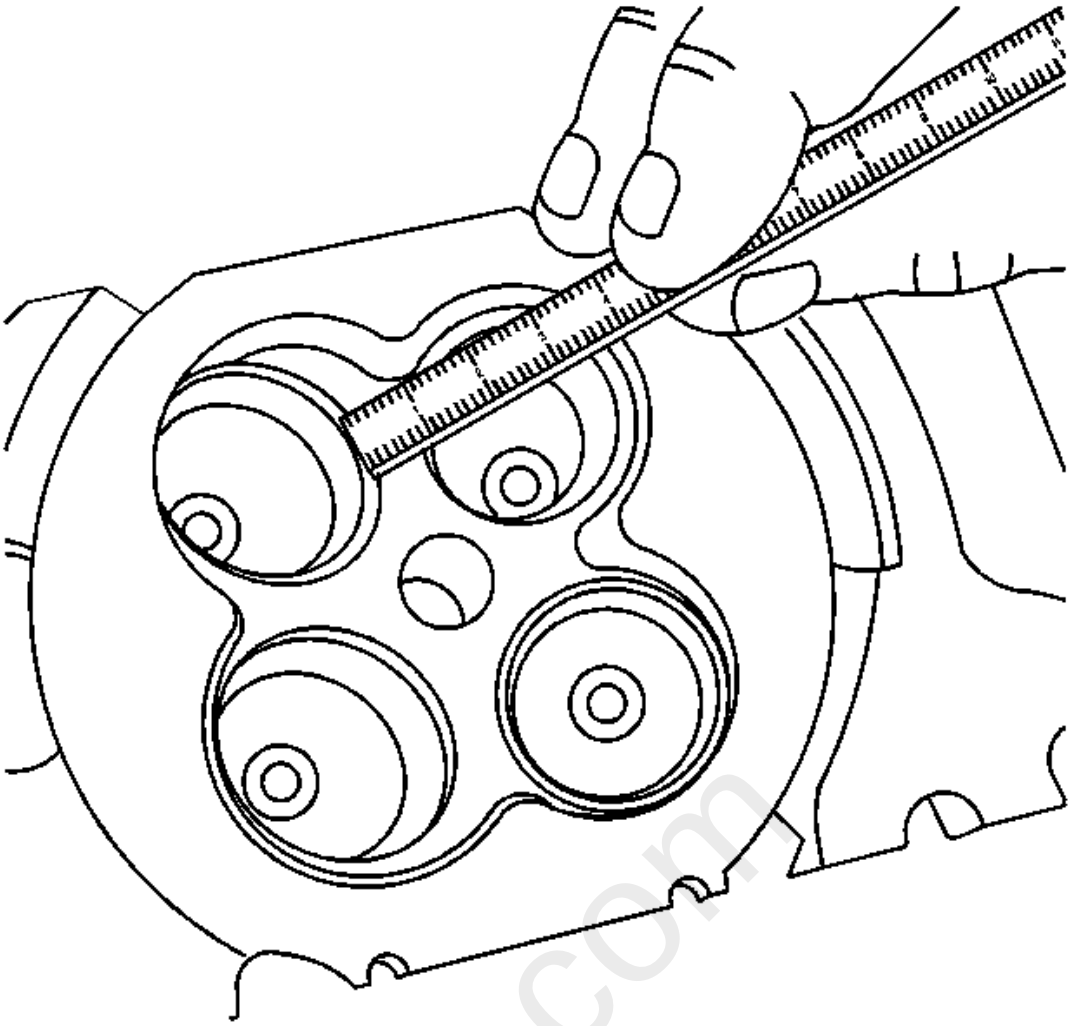


Fig. 437: Checking Valve Seat Width
Courtesy of GENERAL MOTORS COMPANY

1. Measure the valve seat width in the cylinder head using a proper scale.

mc730.com

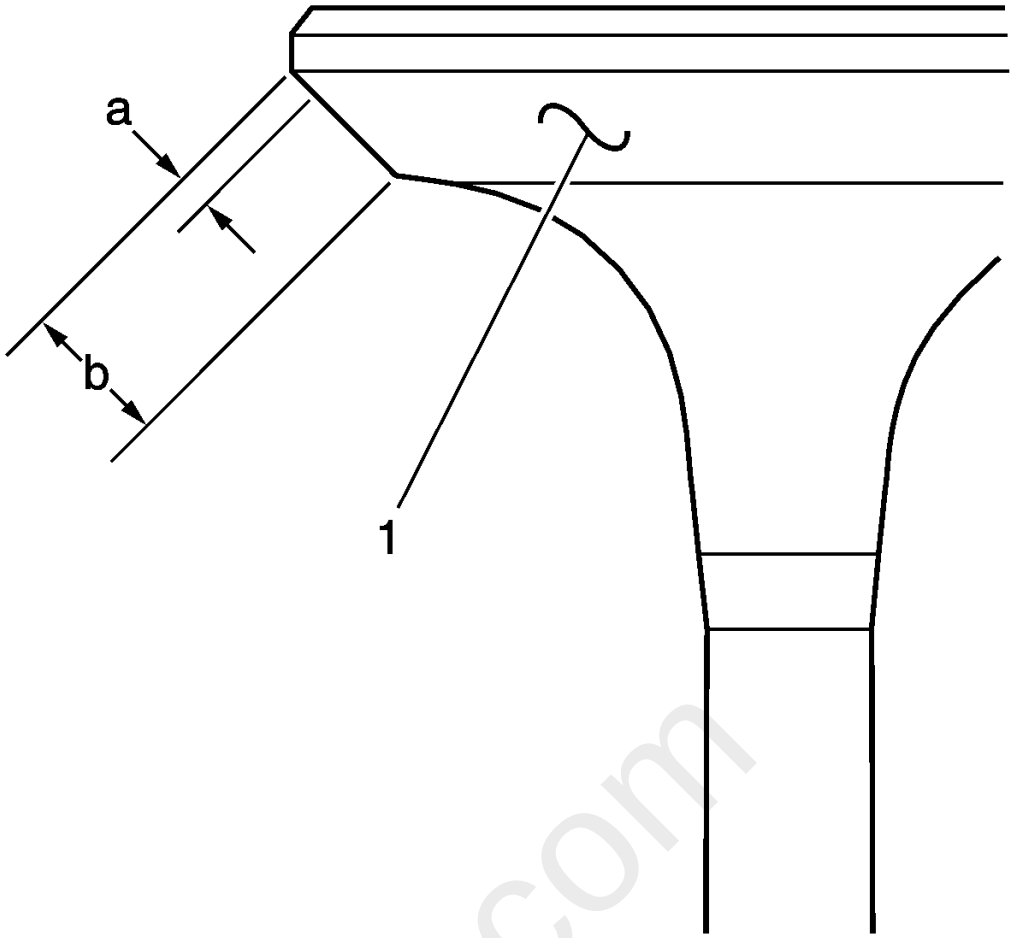


Fig. 438: Valve Face Seat Width
Courtesy of GENERAL MOTORS COMPANY

2. Measure the seat width (b) 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 (a), 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**.
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.

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**.
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 Head O.D. and Chamfer Measurement Procedure

mr-x30.com

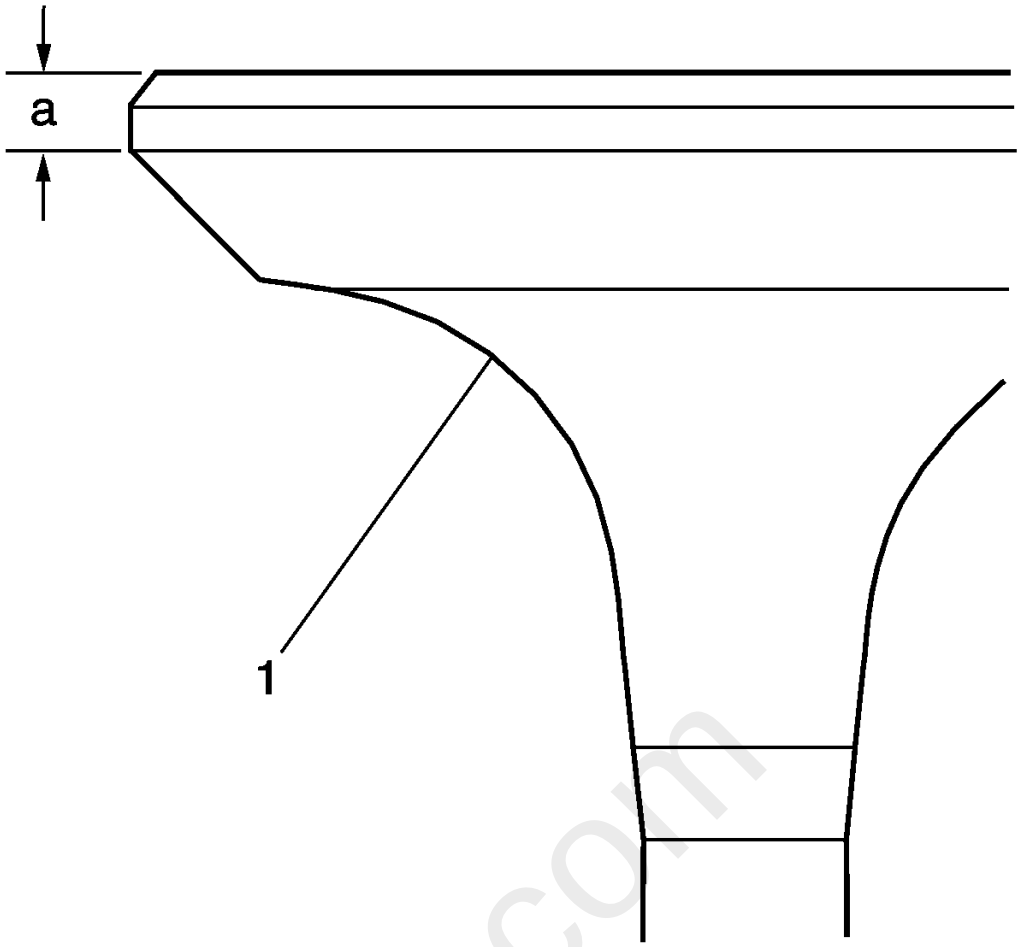


Fig. 439: View Of Valve Head O.D. & Chamfer
Courtesy of GENERAL MOTORS COMPANY

1. Measure the valve head O.D. and chamfer (a) using an appropriate scale. Refer to **Engine Mechanical Specifications**.
2. If the valve head O.D. and chamfer is within specification, test the valve (1) for seat concentricity using the Valve-to-Seat Concentricity Measurement Procedure. Reinspect the valve head O.D. and chamfer after completing the concentricity measurement if valve seat reconditioning is performed.

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.**

mex30.com

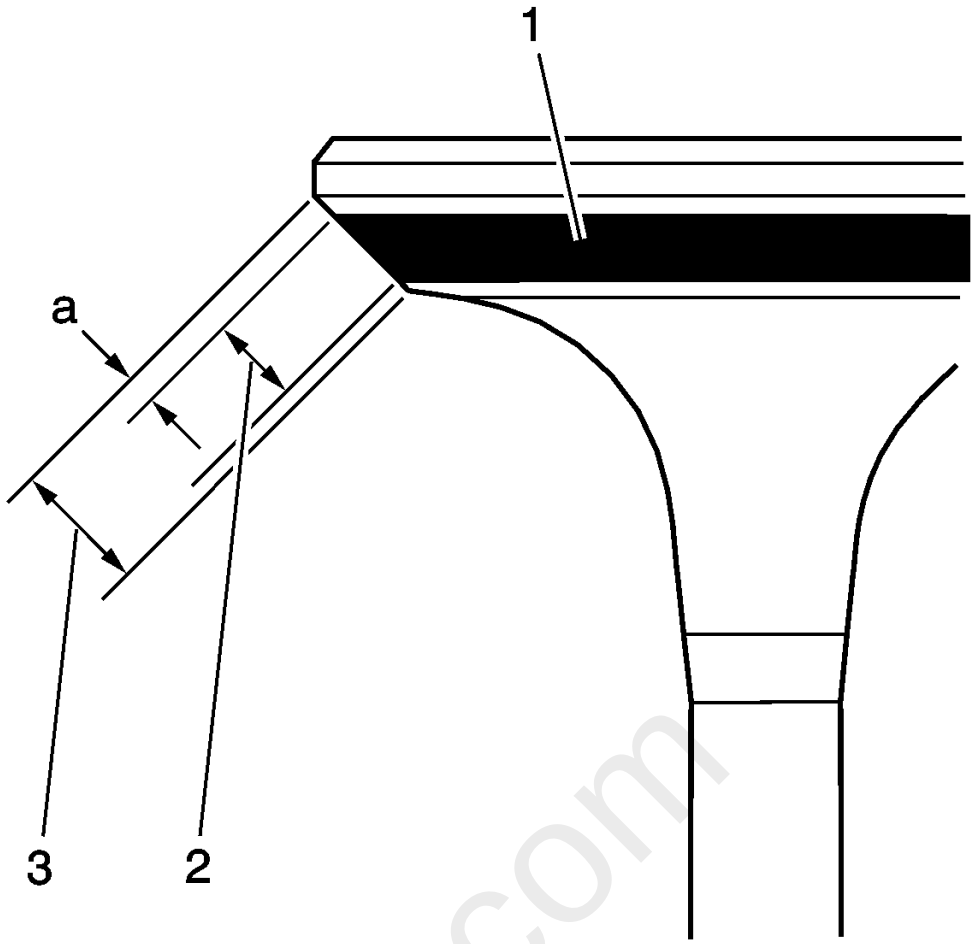


Fig. 440: Inspecting Valve Face
Courtesy of GENERAL MOTORS COMPANY

1. Coat the valve face (3) lightly with blue dye (1).
2. Install the valve in the cylinder head.
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 (2) will be made around the entire face.

     NOTE: The wear mark MUST be at least 0.5 mm (0.020 in) from the outer diameter, the margin (a), 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.

     NOTE: Do not grind or condition the intake valve. If the intake valve is out of specification, replace the valve.

   - 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

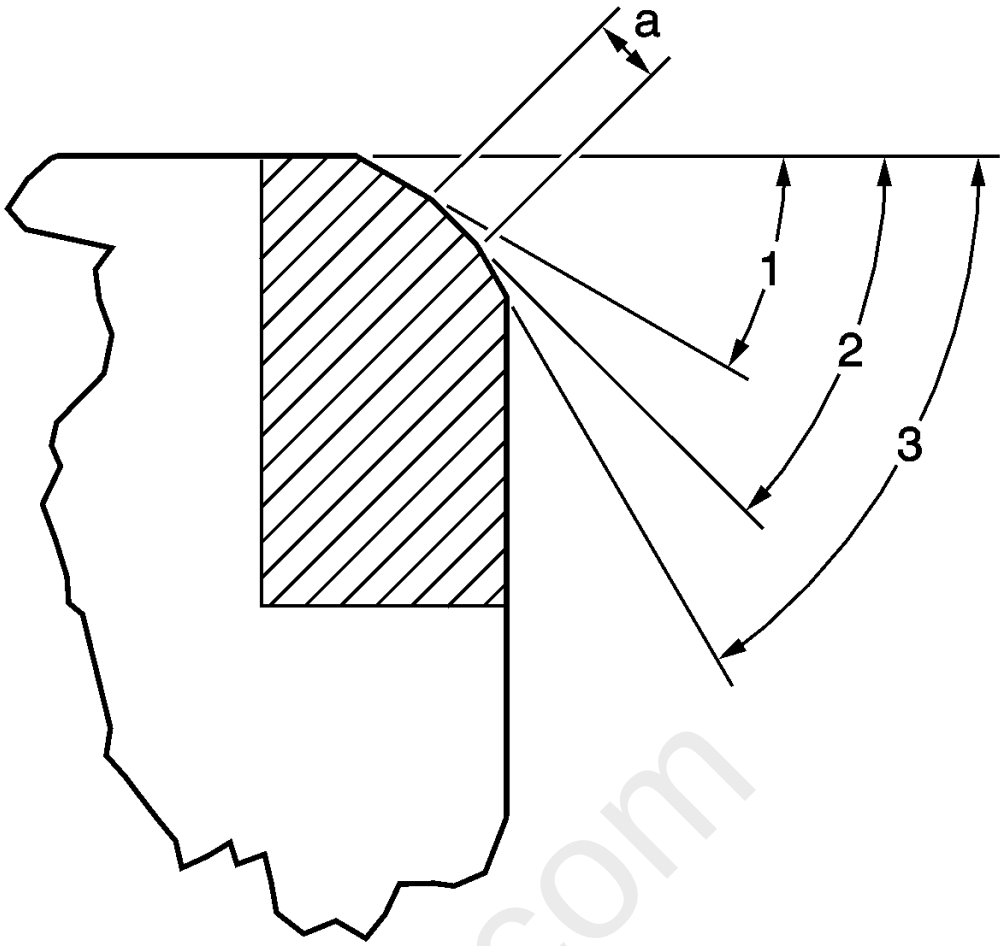


Fig. 441: Valve Seating Surface Angle
Courtesy of GENERAL MOTORS COMPANY

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 seating surface (a) to the proper angle specification (2) listed in **Engine Mechanical Specifications**.
2. Grind the valve relief surface to the proper angle specification (1) listed in **Engine Mechanical Specifications**, to correctly position the valve seating surface (a) to the valve.
3. Grind the valve undercut surface to the proper angle specification (3) listed in **Engine Mechanical Specifications**, to narrow the valve seating surface width (a) to the specifications listed in **Engine Mechanical Specifications**.

NOTE: **Do not grind or condition the intake valve. If the intake valve seat has been reconditioned, replace the corresponding intake valve.**

4. Replace the intake valve if it is out of specification. Refer to **Engine Mechanical Specifications**.
5. If the original exhaust valve is being used, grind the valve to the specifications listed in **Engine Mechanical Specifications**. Measure the valve head O.D. and chamfer again after grinding using the Valve Head O.D. and Chamfer Measurement Procedure. Replace the exhaust valve if it is out of specification. New valves do not require grinding.
6. When grinding the valves and seats, grind off as little material as possible. Cutting valve seat results in lowering the valve spring pressure.
7. Install the valve in the cylinder head.
    - If you are using refaced exhaust 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.

- Be sure to clean any remaining lapping compound from the valve and seat with solvent and compressed air prior to final assembly.

8. 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.
9. 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

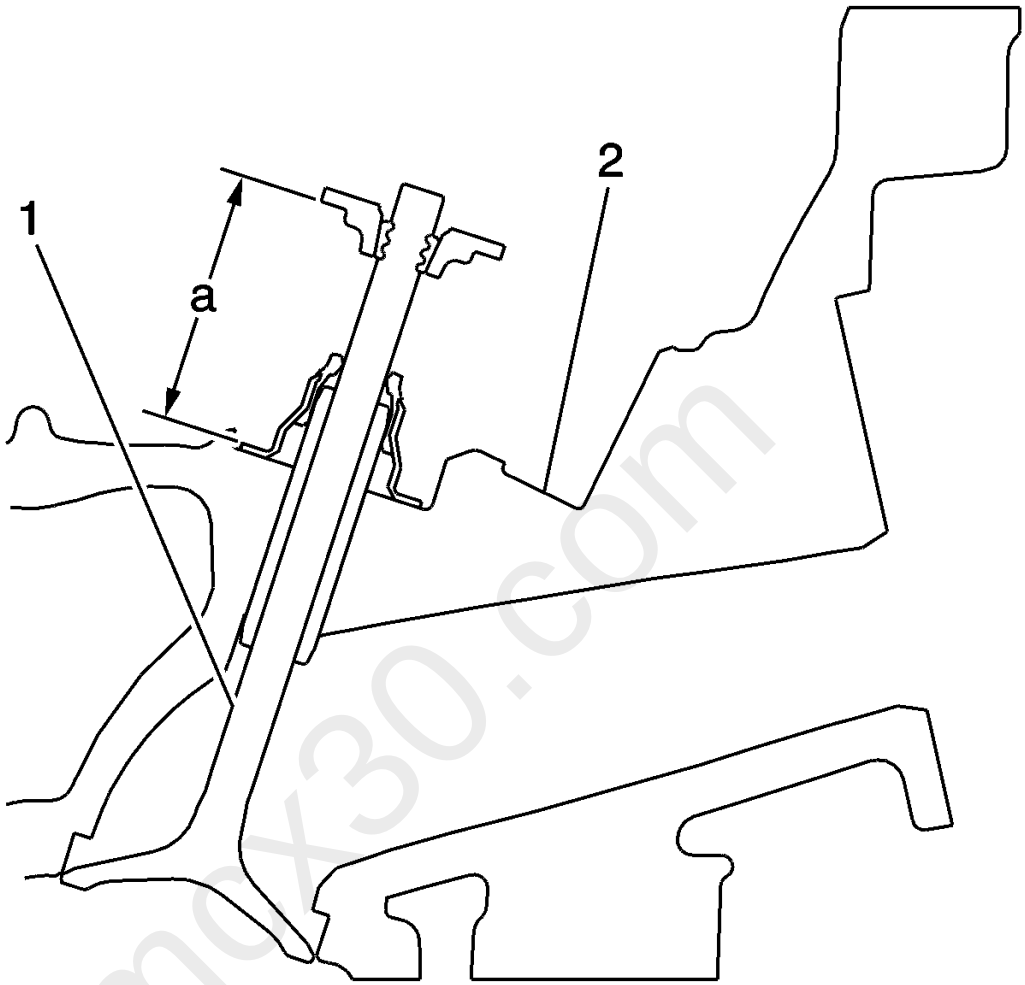


Fig. 442: Valve Stem Height Measurement
Courtesy of GENERAL MOTORS COMPANY

NOTE: To determine the valve stem height measurement, measure from the valve spring seat to the valve spring retainer.

1. Install the valve (1) into the valve guide in the cylinder head (2).
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.
5. Measure the distance (a) between the valve seal lip to the bottom of the valve spring retainer. Refer to **Engine Mechanical Specifications**.
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

mgx30.com

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.

CYLINDER HEAD ASSEMBLE

Special Tools

- **EN-50717** Valve Spring Compressor
- **EN-9666** Valve Spring Tester
- **EN-43963** Valve Spring Compressor (off car)

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

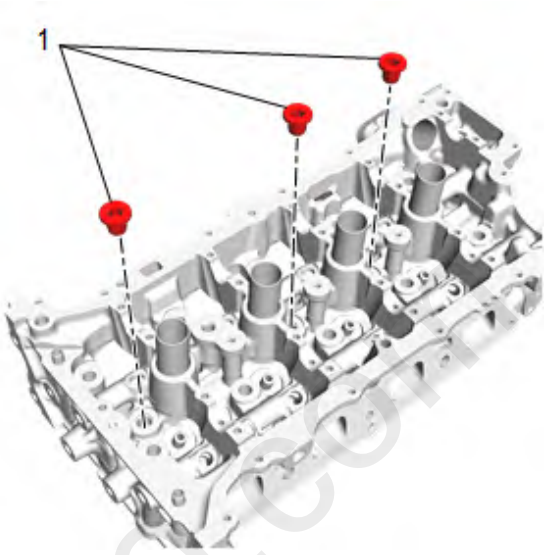


Fig. 443: Cylinder Head Plugs
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Component Fastener tightening Caution .**

CAUTION: **In order to avoid damage, install the spark plugs after the cylinder head has been installed on the engine.**

1. Install NEW cylinder head plugs. Coat the plugs with sealer. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
2. Install the water jacket hole plugs (1) in the top of the cylinder head. tighten the plugs to 50 N.m (37 lb ft).

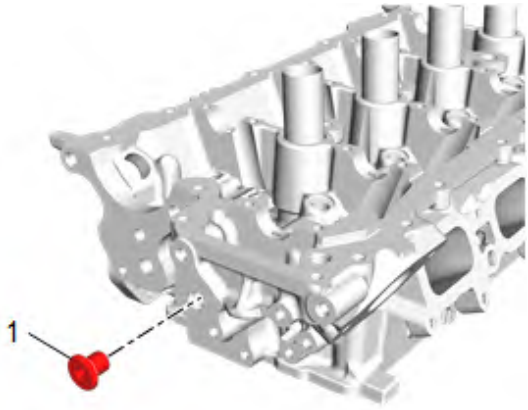


Fig. 444: Cylinder Head Plug
Courtesy of GENERAL MOTORS COMPANY

3. Install the oil gallery plug (1) in the rear of the cylinder head. tighten the plug to 40 N.m (30 lb ft).
4. Inspect the valve springs for the following conditions:
    - Expanded height
    - Unparallel spring ends
    - Spring tension using **EN-9666** tester
    - Any distorted springs should be replaced

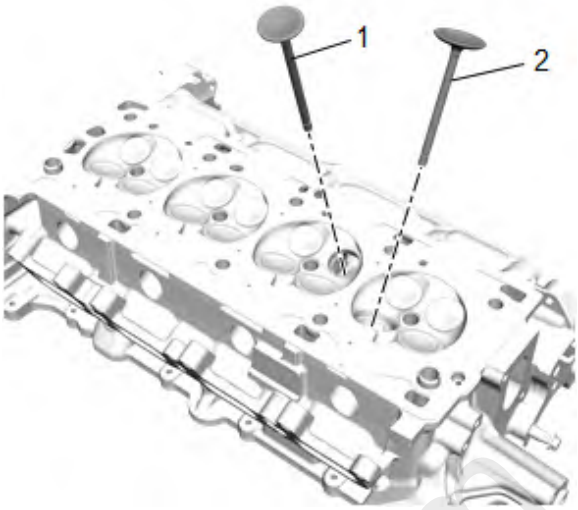


Fig. 445: Valves
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the valves and the valve seats. Refer to **Valve and Seat Grinding**.
6. Lubricate the valves. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
7. Install the valves (1, 2). Replace the valves, if required.

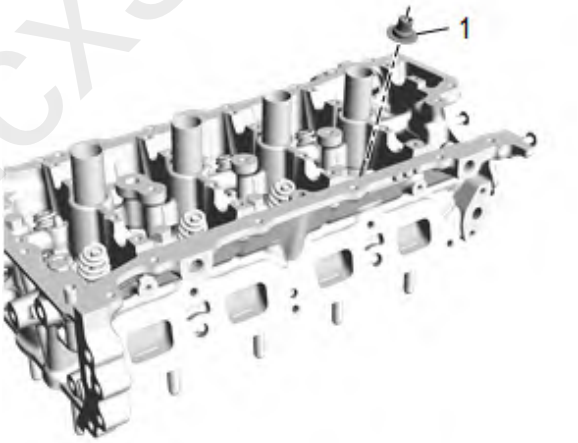


Fig. 446: Valve Seals
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Always use NEW valve stem oil seals when assembling the cylinder head.**

8. Install the NEW valve seals (1). Fully seat the seals on the valve guides.

mcx30.com

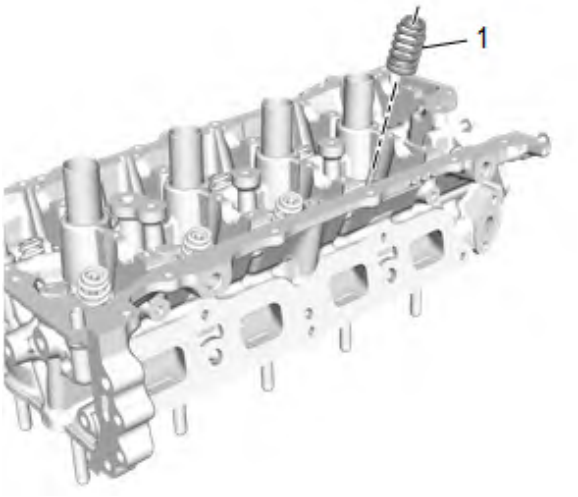


Fig. 447: Valve Springs
Courtesy of GENERAL MOTORS COMPANY

9. Install the springs (1).

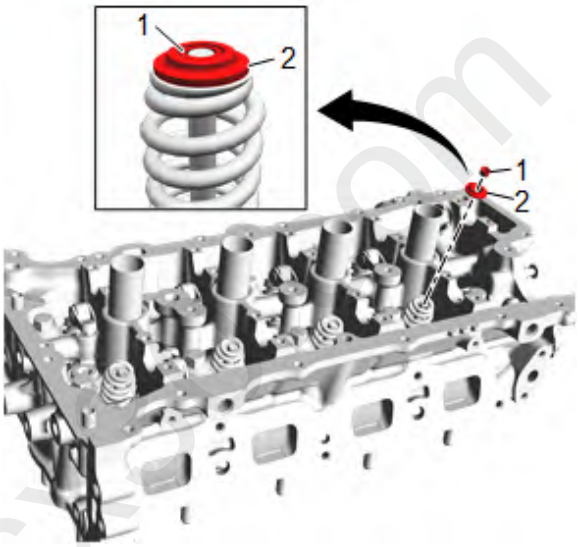


Fig. 448: Valve Keys, Springs, And Retainers
Courtesy of GENERAL MOTORS COMPANY

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 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.**

10. Install the retainers and keys using the following procedure:
    1. Install the retainer (2).
    2. Using the **EN-50717** compressor and the **EN-43963** adapter, compress the valve spring.
    3. Install the valve keys (1).
    4. Slowly release the compression from the valve/spring assembly.
    5. Inspect for proper valve key seating.

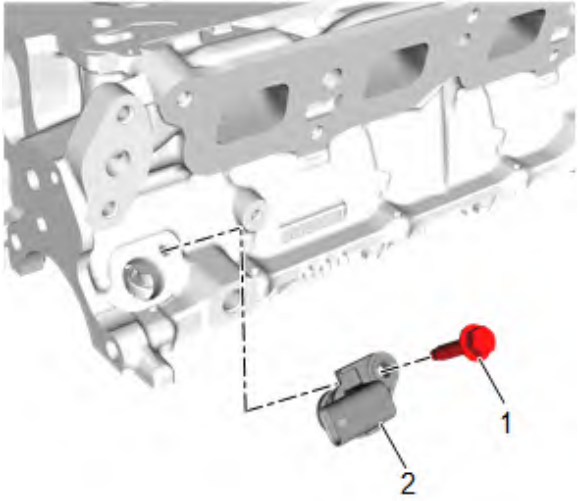


Fig. 449: Exhaust Camshaft Position Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

11. Lubricate the camshaft position sensor O-ring with clean engine oil.

CAUTION: **Refer to Fastener Caution .**

12. Install the exhaust camshaft position sensor (2) and bolt (1). tighten the bolt to 10 N.m (89 lb in).

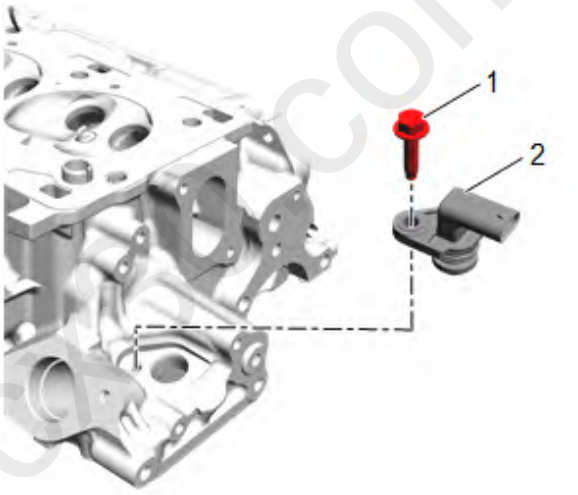


Fig. 450: Intake Camshaft Position Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

13. Lubricate the camshaft position sensor O-ring with clean engine oil.
14. Install the intake camshaft position sensor (2) and bolt (1). tighten the bolt to 10 N.m (89 lb in).

BALANCER SHAFT WITH OIL PUMP DISASSEMBLE

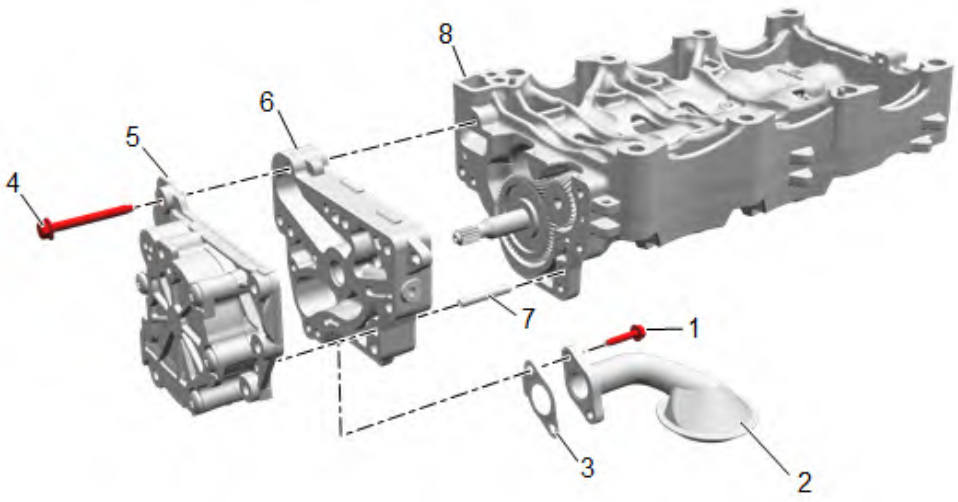


Fig. 451: Oil Pump Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Pump Suction Pipe Bolt
2	Oil Pump Screen Assembly with Suction Pipe
3	Oil Pump Screen Gasket **NOTE:** **Discard the gasket.**
4	Oil Pump Assembly Bolt
5	Oil Pump Assembly
6	Oil Pump Cover
7	Oil Pump Locating Pin
8	Balancer Shaft Module

BALANCER SHAFT WITH OIL PUMP CLEANING AND INSPECTION

mcx30.com

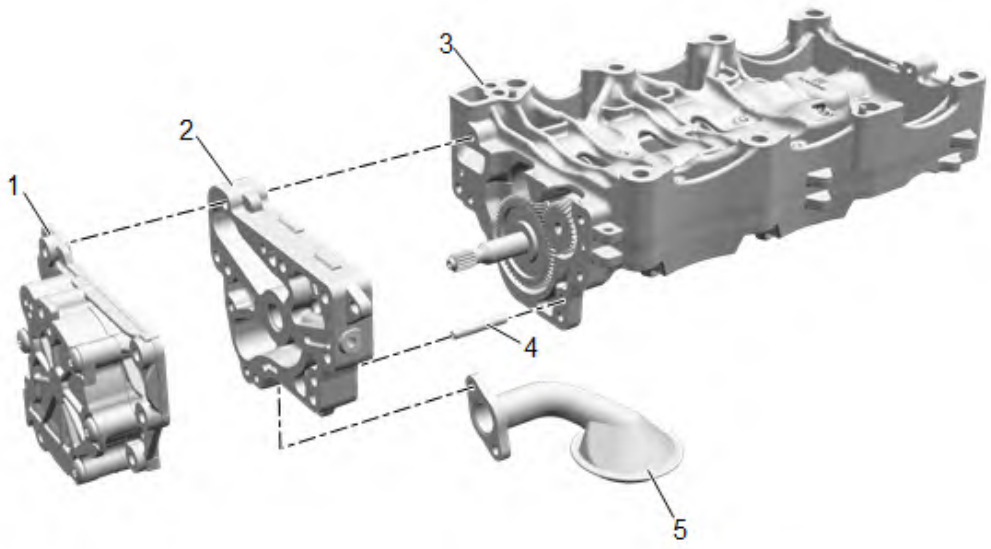


Fig. 452: Oil Pump Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Completely inspect the balancer with oil pump shaft assembly and components. 2. Clean all mating surfaces. 3. Inspect all threaded holes for damage. 4. Inspect the oil pump screen assembly.	
1	Oil Pump Assembly
2	Oil Pump Cover
3	Balancer Shaft Module
4	Oil Pump Locating Pin
5	Oil Pump Screen Assembly with Suction Pipe

BALANCER SHAFT WITH OIL PUMP ASSEMBLE

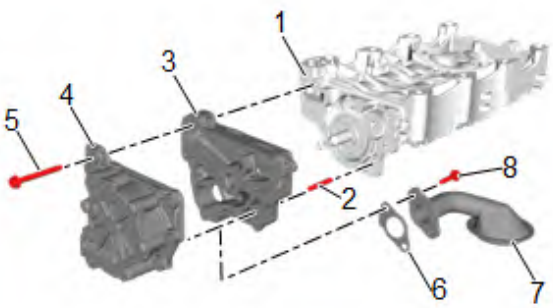


Fig. 453: Balancer Shaft with Oil Pump Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Balancer Shaft Module
2	Oil Pump Locating Pin
3	Oil Pump Cover
4	Oil Pump Assembly
5	Oil Pump Assembly Bolt **CAUTION:** **Refer to Fastener Caution .** **tighten** 10 N.m (89 lb in)
6	Oil Pump Screen Gasket **NOTE:** **Use NEW gasket.**
7	Oil Pump Screen Assembly with Suction Pipe
8	Oil Pump Suction Pipe Bolt **tighten** 10 N.m (89 lb in)

CAMSHAFT COVER AND COMPRESSOR AIR INTAKE TURBOCHARGER CLEANING AND INSPECTION

Positive Crankcase Ventilation System Overview

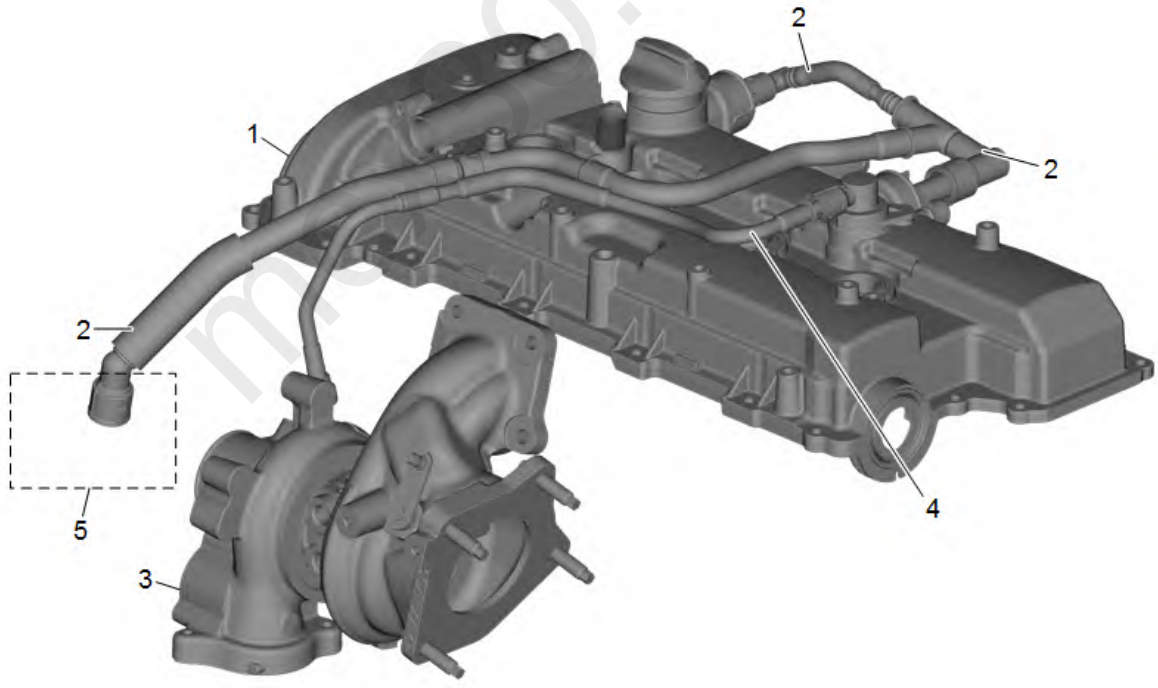


Fig. 454: Positive Crankcase Ventilation System
Courtesy of GENERAL MOTORS COMPANY

Positive Crankcase Ventilation System Overview

Callout	Component Name

Callout	Component Name
Preliminary Procedure The tamper-proof positive crankcase ventilation system includes components that may be replaced if necessary. The system may include an outlet duct connected to the end of the Positive Crankcase Ventilation Tube. If any component is suspect, refer to the inspection procedures and individual replacement procedures before attempting to disassemble the PCV system. Be careful when moving the assembled components with tamper-proof fittings to avoid stress on the connections.	
1	Camshaft Cover **NOTE:** **In the event that the camshaft cover requires replacing, the PCV hose at the air outlet duct and turbocharger will be removed by cutting and/or prying at the connection. The air outlet duct and turbocharger must remain intact in order to reinstall these components.** **Procedure** 1. Thoroughly clean the camshaft cover and mating surfaces. Inspect each component, O-rings, and fasteners, and replace as necessary. 2. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant** 3. Refer to **Camshaft Cover Replacement (1st Design Tamper-Proof PCV System)** if the camshaft cover does not pass inspection.
2	Positive Crankcase Ventilation Tube **NOTE:** **All PCV valves are tamper-proof and cannot be serviced.** **Procedure** Inspect the PCV connection fittings and tubes. Replace the Positive Crankcase Ventilation Tube if suspect. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Inlet)**.
3	Turbocharger **NOTE:** **The PCV fitting is tamper-proof and cannot be serviced. A new PCV tube and valve are included with a new turbocharger assembly.** **NOTE:** **On earlier designs of this system the fastener at the PCV fitting on the turbocharger was not tamper-proof. To aid in disassembly or removal, this fastener can be removed if it is not tamper-proof.** **Procedure** Completely inspect the turbocharger and all other engine components that may cause similar conditions before replacing the turbocharger. Refer to **Symptoms - Engine Mechanical**.
4	Positive Crankcase Ventilation Tube **NOTE:** **All PCV valves and fittings are tamper-proof and cannot be serviced.** **Procedure** Inspect the PCV connection fittings and tubes. Replace the Positive Crankcase Ventilation Tube if suspect. Refer to **Positive Crankcase Ventilation Hose/Pipe/Tube Replacement (Camshaft Cover to Air Inlet)**.

mcx30.com

Callout	Component Name
5	Air Cleaner Outlet Duct - Model Dependent **NOTE:** **The air cleaner outlet duct is equipped with a tamper proof connection that should NOT be removed unless the PCV tube or air cleaner outlet duct is being replaced. Loosening the air cleaner outlet duct clamps will allow the duct to be disconnected from the air cleaner assembly and turbocharger for repositioning without removing the tamper proof connection.** **Procedure** Inspect the duct and hose, or the connection if the duct is not attached to the hose. Replace any components that are suspect. Refer to **Air Cleaner Outlet Duct Replacement (Non-Tamperproof)** **Air Cleaner Outlet Duct Replacement (Tamperproof)** .

Camshaft Cover - Top

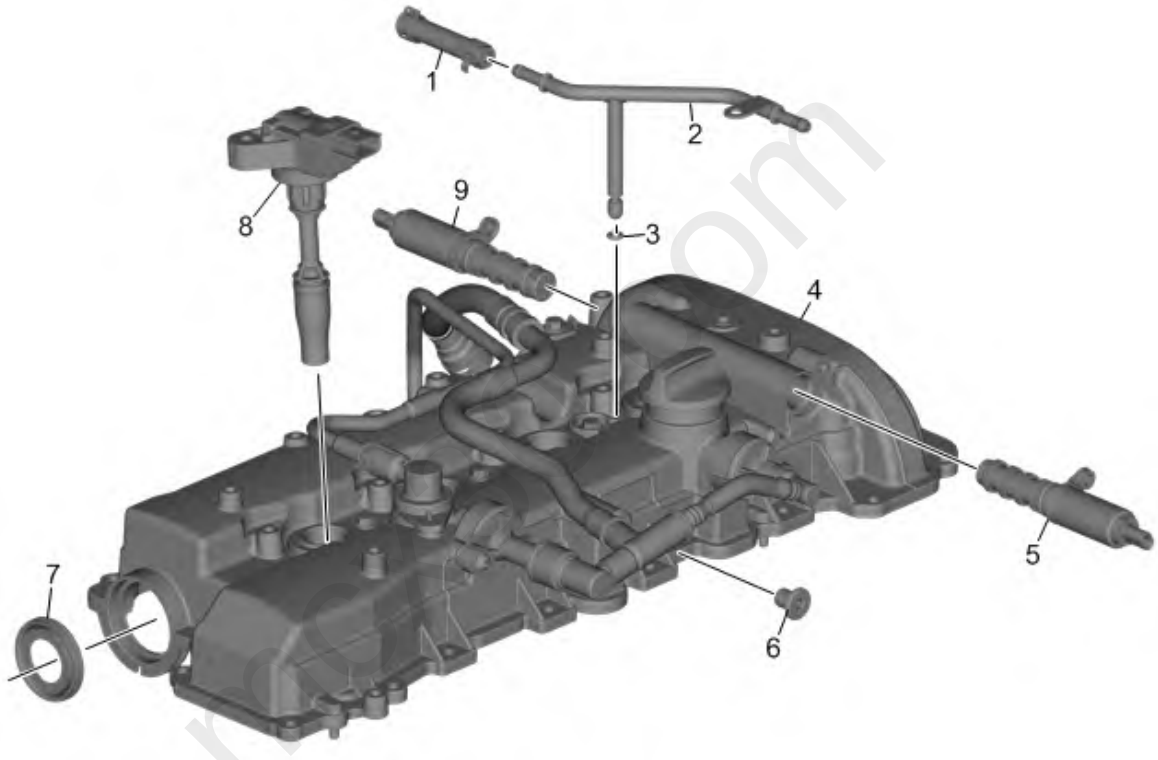


Fig. 455: Camshaft Cover -- Top
Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover - Top

Callout	Component Name
Preliminary Procedure 1. Thoroughly clean the camshaft cover and mating surfaces. Inspect each component, O-rings, and fasteners, and replace as necessary. 2. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**	
1	Engine Coolant Air Bleed Hose
2	Engine Coolant Air Bleed Pipe
3	Engine Coolant Air Bleed Pipe O-Ring
4	Camshaft Cover
5	Camshaft Position Actuator Solenoid Valve - Intake

Callout	Component Name
6	Camshaft Cover Plug **CAUTION:** **Refer to Fastener Caution .** **tighten** 35 N.m (26 lb ft)
7	Vacuum Pump Seal **Special Tools** **DT 45866** Input Shaft Seal Installer Equivalent regional tools: **Special Tools**.
8	Ignition Coil
9	Camshaft Position Actuator Solenoid Valve - Exhaust

Camshaft Cover - Bottom

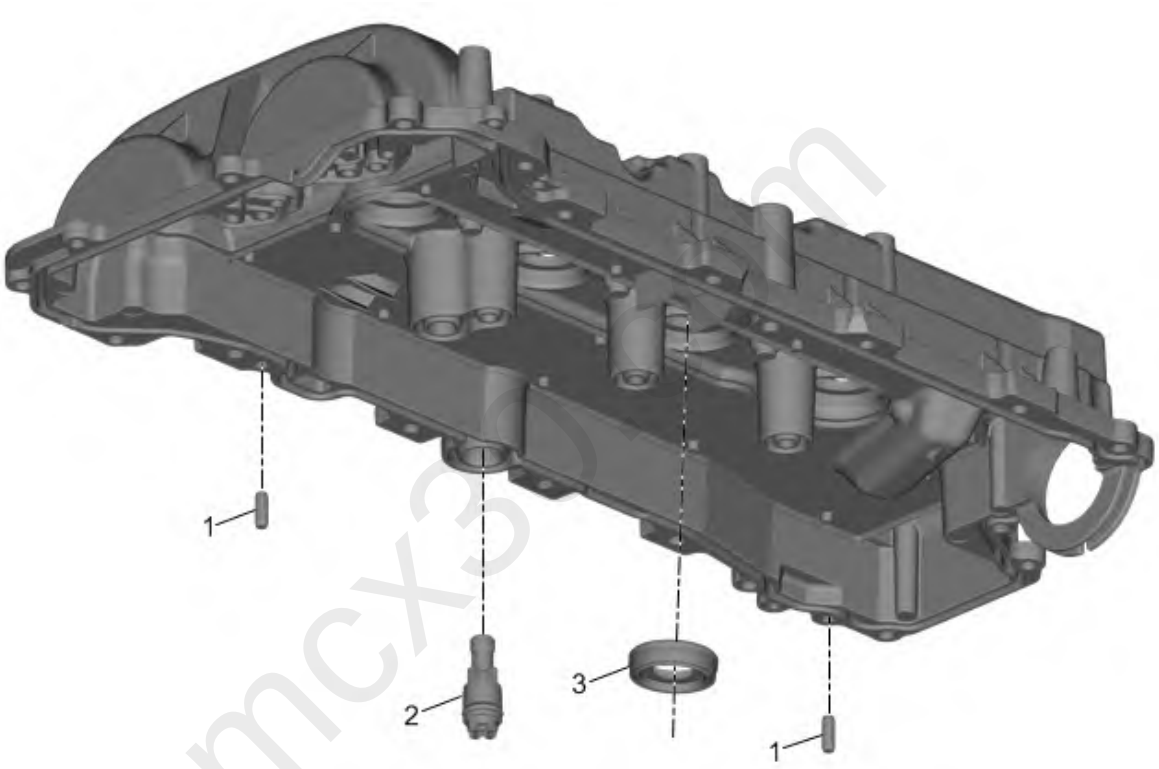


Fig. 456: Camshaft Cover -- Bottom
Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover - Bottom

Callout	Component Name
Preliminary Procedure Inspect each component, O-rings, and fasteners, and replace as necessary.	
1	Camshaft Cover Locating Pin
2	Positive Crankcase Ventilation Valve
3	Spark Plug Shield Seal **Special Tools** **EN 34115** Sprocket Bearing Installer Equivalent regional tools: **Special Tools**.

Turbocharger and Components Cleaning and Inspection

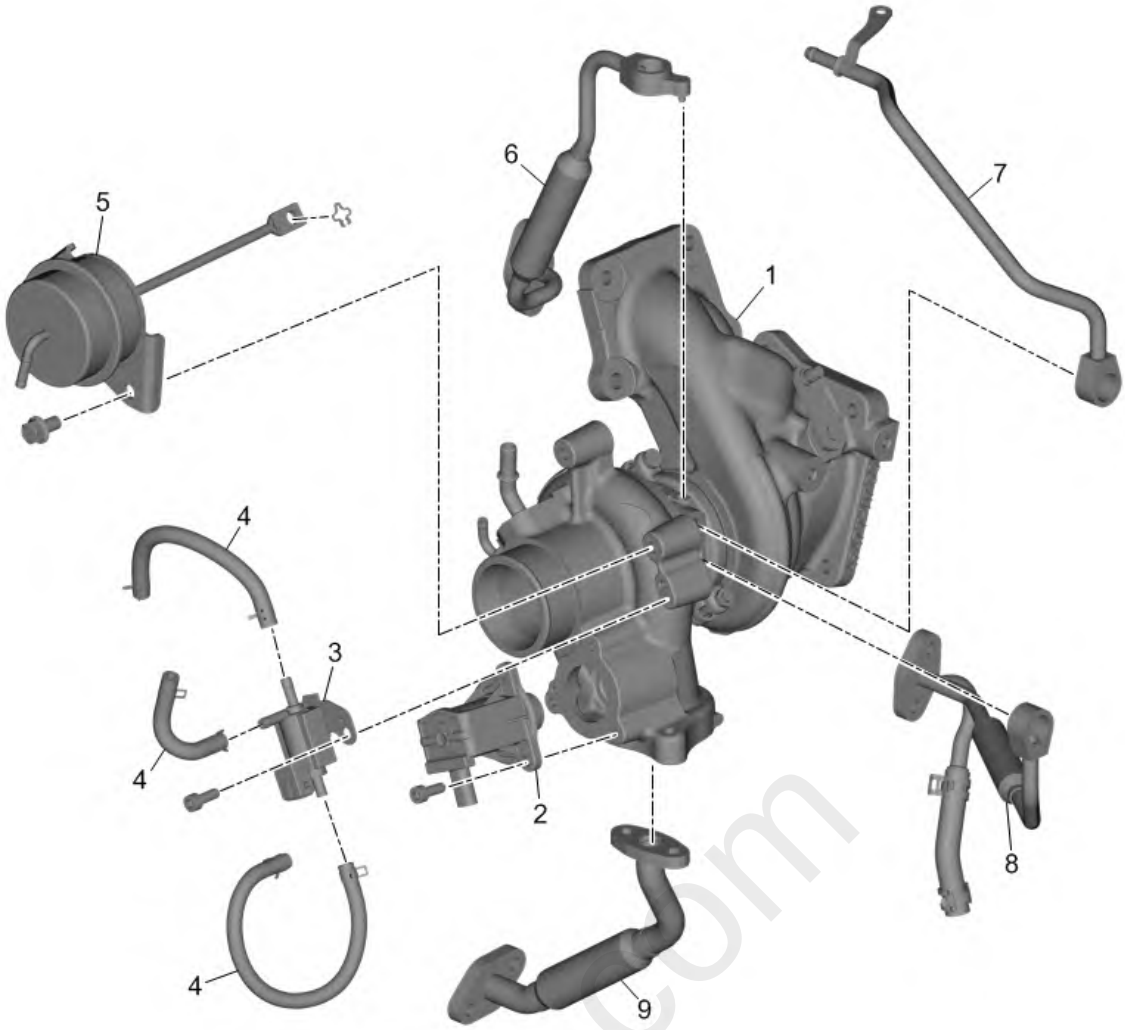


Fig. 457: Turbocharger and Components
Courtesy of GENERAL MOTORS COMPANY

Turbocharger and Components Cleaning and Inspection

Callout	Component Name

mcx30.com

Callout	Component Name
1	Turbocharger **Procedure** 1. Clean all mating surfaces. 2. Inspect all threaded holes for damage. **NOTE:** **PCV fluids and combustion product buildup are common and not a sign of failure.** 3. Inspect the compressor and turbine blades for bent or broken conditions, and foreign material. **NOTE:** **Do not replace the turbocharger if cracks are found on the turbocharger inlet flange partition wall. Replacement should only be performed if external leaks are present or a section is loose or missing.** 4. Inspect the turbocharger compressor inlet, compressor outlet, turbine inlet, and turbine outlet surfaces for damage. Replace the turbocharger if damage is found. **NOTE:** **A new PCV tube and fitting are included with a new turbocharger assembly.** 5. Replace the turbocharger if damage is found. Refer to **Turbocharger Replacement (1st Design Tamper-Proof PCV System)**.
2	Turbocharger Bypass Valve Solenoid **Procedure** Inspect the bypass valve solenoid for damage. Replace if necessary.
3	Turbocharger Wastegate Regulator Solenoid Valve **NOTE:** **Do not disassemble solenoid valve from bracket.** **Procedure** Inspect the solenoid valve and bracket for damage. Replace if necessary.
4	Turbocharger Wastegate Regulator Solenoid Valve Hose **Procedure** Inspect the turbocharger wastegate regulator solenoid hoses for damage. Replace the hoses if necessary.
5	Turbocharger Wastegate Actuator **Procedure** 1. Inspect the turbocharger wastegate actuator. 2. Inspect the wastegate actuator rod for damage or tampering. 3. Replace the wastegate actuator if damage is found.
6	Turbocharger Oil Feed Pipe **Procedure** Inspect the pipe. Replace if necessary.
7	Turbocharger Coolant Return Pipe **Procedure** Inspect the pipe. Replace if necessary.

mcx30.com

Callout	Component Name
8	Turbocharger Coolant Feed Pipe **Procedure** Inspect the pipe. Replace if necessary.
9	Turbocharger Oil Return Pipe **Procedure** Inspect the pipe. Replace if necessary.

FUEL RAIL AND INJECTORS CLEANING AND INSPECTION

Special Tools

- **EN-47909** Injector Bore and Sleeve Cleaning Kit
- **EN-49245** Fuel Injector Seal Install/Sizer
- **EN-50791** Fuel Injector Nozzle Installer
- **EN-51105** Fuel Injector Seal Installer

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

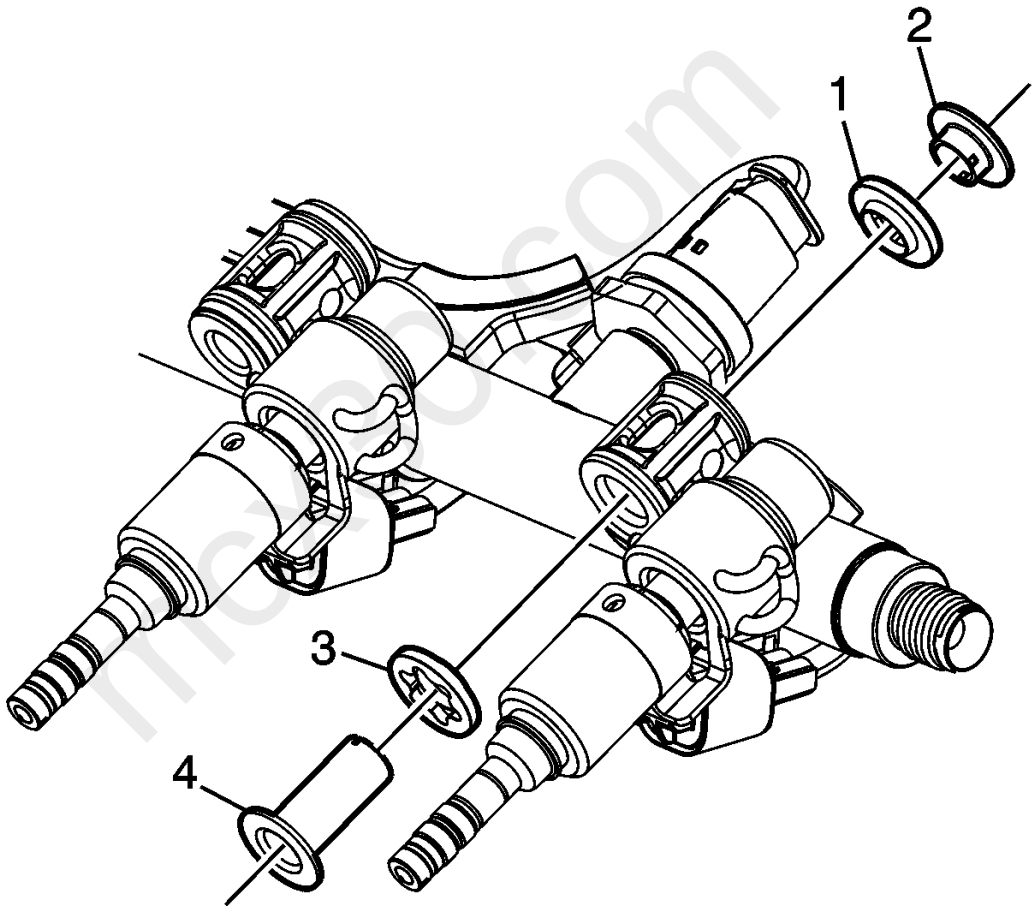


Fig. 458: Fuel Rail Insulator Assemblies
Courtesy of GENERAL MOTORS COMPANY

1. Remove and inspect the fuel rail insulator assemblies (1 - 4). Replace the entire assembly if any components show signs of wear or the insulators (4) show the following conditions:
   - Dry or cracked appearance
   - Flattened or misshapen appearance

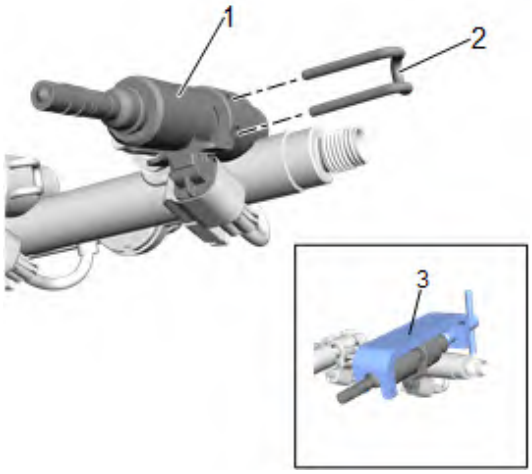


Fig. 459: Fuel Injector And Retaining Pin
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the electrical connections from the fuel injectors.
3. Use **EN-50791** installer (3) to compress the fuel injector (1), and relieve pressure on the retaining pin (2). Remove the fuel injector retaining pin (2). Remove **EN-50791** installer once the retaining pin is removed.

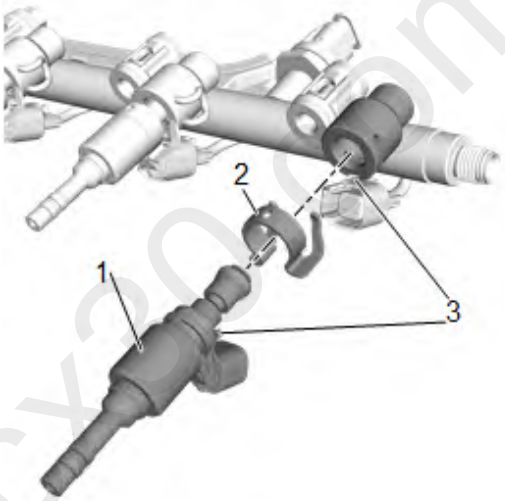


Fig. 460: Injectors And Fuel Rail Slot
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Support the fuel injector at the widest point. Support the fuel rail along the bottom.**

- **DO NOT support or hold the fuel injector by the tip or connector**
- **DO NOT tilt or excessively twist the injector during removal**

4. Remove the injectors (1) from the fuel rail by pulling straight out along the fuel injector axis. Slight rotation of the fuel injector is acceptable as long as excessive force is not applied to the fuel injector tab while engaged in the fuel rail slot (3).
5. Remove the fuel injector holding clamp (2) from the rear of the fuel injector.

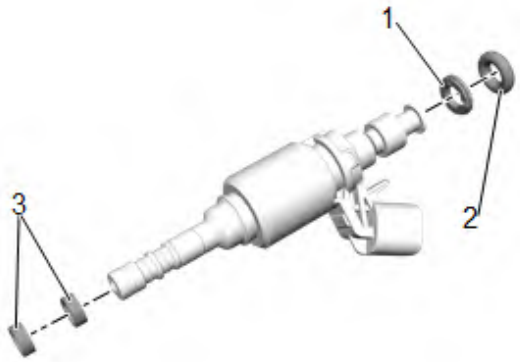


Fig. 461: Fuel Injector O-ring And Plastic Spacer
Courtesy of GENERAL MOTORS COMPANY

6. Remove and discard the fuel injector O-ring (2) and plastic spacer (1).
7. Remove and discard the fuel injector seals (3).

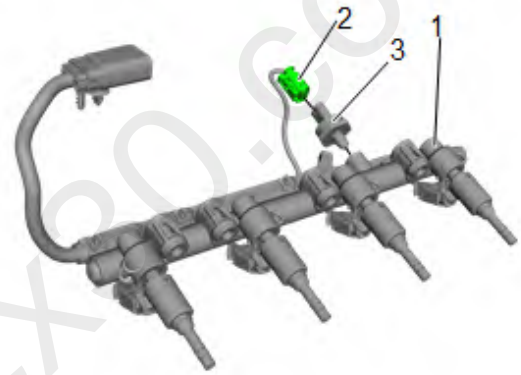


Fig. 462: Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not soak or submerge the fuel rail or injectors in solvent. Do not use solvent on the fuel rail label.**

8. Clean the exterior of the fuel rail (1) and injectors in solvent.
9. Using **EN-47909** cleaning kit, clean the fuel injector bores and sleeves.
10. 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 fuel feed fitting
11. Replace the fuel rail if any damage is found. Do not attempt to repair a fuel rail.

CAUTION: **Refer to Fastener Caution .**

NOTE: **Remove and inspect the fuel pressure sensor only if the sensor is suspect.**

12. Inspect the fuel pressure sensor (3) for damage.

mcx30.com

1. Disconnect the harness connector (2) from the fuel pressure sensor.
2. Remove the fuel pressure sensor. Dry the fuel pressure sensor bore in the fuel rail with a lint free cloth. The bore should be free of fuel, debris, and burrs.
3. Lubricate the fuel rail fuel pressure sensor bore with clean engine oil.
4. Lubricate the threads and sealing area on the fuel pressure sensor with clean engine oil.
5. Install the fuel pressure sensor hand tight.
6. Remove the fuel pressure sensor and re-lubricate the bore, threads, and sealing area.
7. Install the fuel pressure sensor and tighten to 33 N.m (25 lb ft).
8. Connect the harness connector to the fuel pressure sensor.

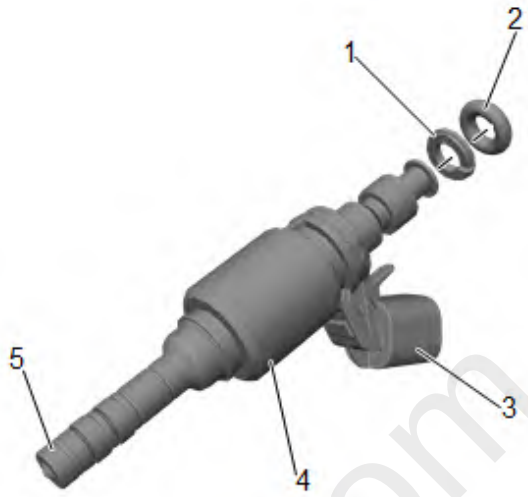


Fig. 463: Fuel Injector Connector
Courtesy of GENERAL MOTORS COMPANY

13. Inspect the fuel injectors for the following conditions:
    - Damage to the fuel injector connector (3)
    - Damage to the fuel injector harness connector
    - Damage to the fuel injector tip (5)
    - Damage to the fuel injector (4)
14. Replace the fuel injector if any damage is found. Do not attempt to repair a fuel injector.
15. Install the a new fuel injector spacer (1).
16. Lubricate the NEW O-ring (2) with one drop of clean engine oil.
17. Install the O-ring on the injector.

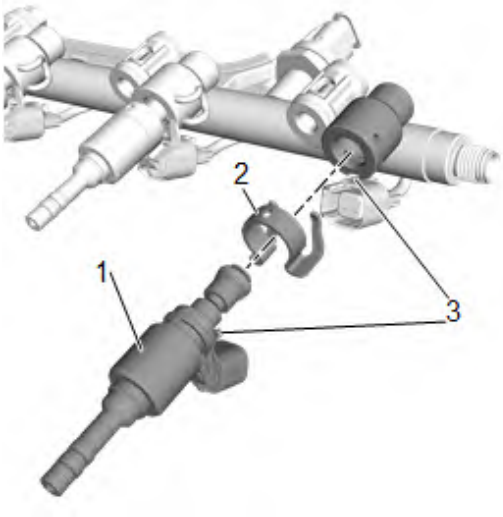


Fig. 464: Injectors And Fuel Rail Slot
Courtesy of GENERAL MOTORS COMPANY

18. Install the fuel injector holding clamp (2) onto the rear of the fuel injector.

19. Hand install fuel injectors (1) to the fuel rail, carefully aligning the fuel injector tab to the slot in the fuel rail (3).

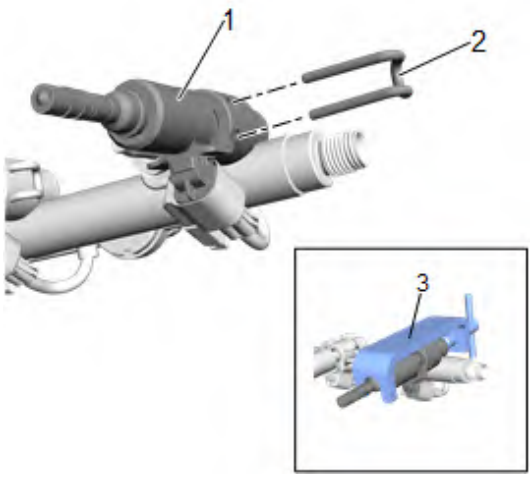


Fig. 465: Fuel Injector And Retaining Pin
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The injector must be fully installed and properly aligned with the fuel rail before installing the retaining pin.**

20. Using **EN-50791** installer (3), compress the fuel injector (1) into the fuel rail.
21. Ensure the fuel injector is fully seated in the fuel rail, and install the fuel injector retaining pin (4).
22. Ensure the fuel injector retaining pin is fully seated in the fuel rail. Remove **EN-50791** installer. Repeat process until all fuel injectors are properly installed to the fuel rail.

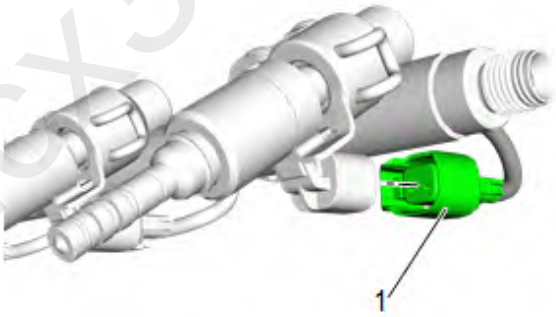


Fig. 466: Fuel Rail Harness Connectors
Courtesy of GENERAL MOTORS COMPANY

23. Connect the electrical connection to the fuel rail.
24. Connect the fuel rail harness connectors (1) to the fuel injectors.

mgx30.com

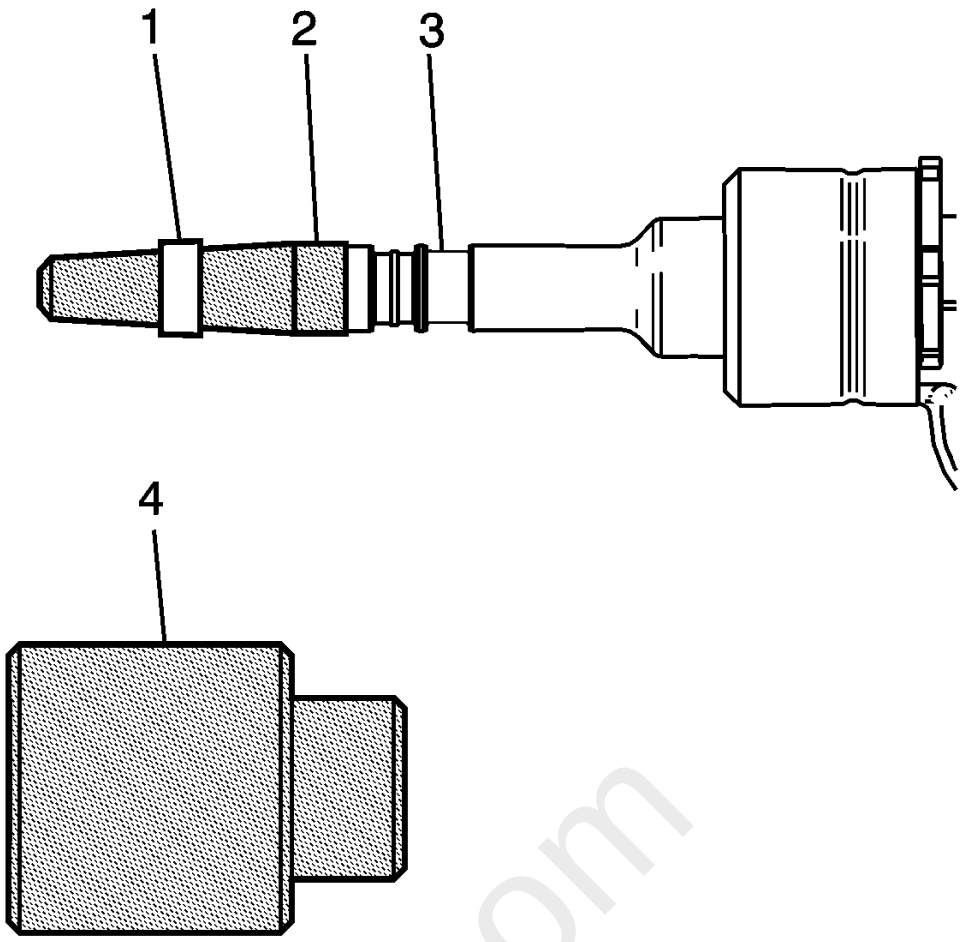


Fig. 467: Second Recessed Area And NEW Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not use any type of lubricant when installing the NEW seals on the fuel injector tip.**

25. Install **EN-51105-1** long protector (2) onto the fuel injector tip. Place a NEW seal (1) on **EN-51105-1** long protector.
26. Using **EN-49245** pusher, install the seal into the second recessed area (3) of the fuel injector, then remove the **EN-51105-1** long protector.
27. Compress the seal with your fingers, then resize the seal using the **EN-49245** sizer (4).
28. Install **EN-51105-2** short protector (2) onto the fuel injector tip. Place a second NEW seal (1) on **EN-51105-2** short protector.
29. Using **EN-49245** pusher, install the seal into the remaining recessed area of the fuel injector, then remove **EN-51105-2** short protector.
30. Compress the seal with your fingers, then resize the seal using the **EN-49245** sizer (4).

INTAKE MANIFOLD CLEANING AND INSPECTION

mcx30.com

Fig. 468: Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

1. Clean the intake manifold (1) mating surfaces.
2. Inspect the intake manifold for damage.
3. Inspect the intake manifold for cracks near metallic inserts.

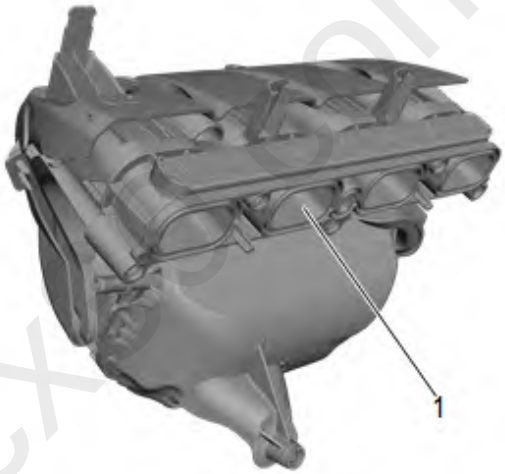


Fig. 469: Crankcase Ventilation Passages
Courtesy of GENERAL MOTORS COMPANY

4. Inspect the crankcase ventilation passages (1) in the intake manifold face for blockage.

WARNING: **Refer to Safety Glasses Warning .**

5. Clean the crankcase ventilation passages with compressed air if necessary. Use a maximum of 172 kPa (25 psi) of air pressure.
6. Replace the intake manifold as necessary.

EXHAUST MANIFOLD CLEANING AND INSPECTION

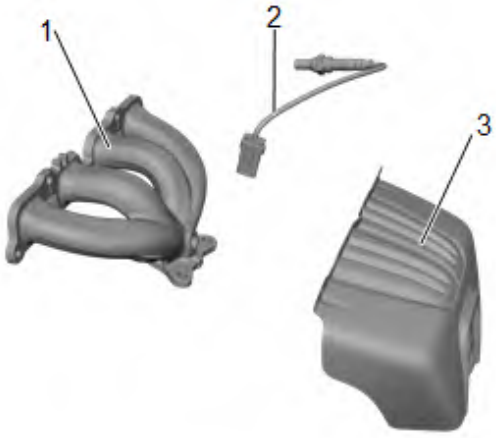


Fig. 470: Exhaust Manifold, Oxygen Sensor And Heat Shield
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Do not reuse the exhaust manifold-to-cylinder head gaskets. 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.**
- **Remove the oxygen sensor prior to cleaning the manifold. Do not submerge the oxygen sensor in cleaning solvent.**

1. Remove the oxygen sensor (2) from the manifold.
2. Clean the exhaust manifold (1) in solvent.

WARNING: **Refer to Safety Glasses Warning .**

3. Dry the exhaust manifold with compressed air.
4. Inspect the exhaust manifold (1) for damage.
5. Inspect the heat shield (3) for damage.

mcx30.com

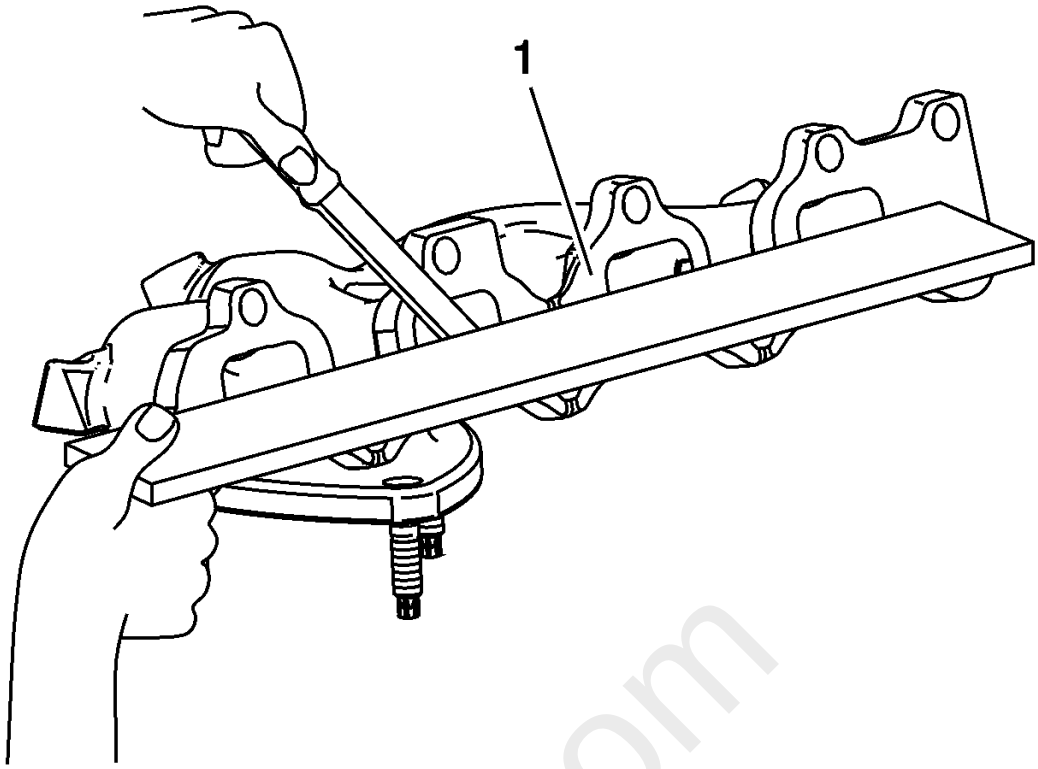
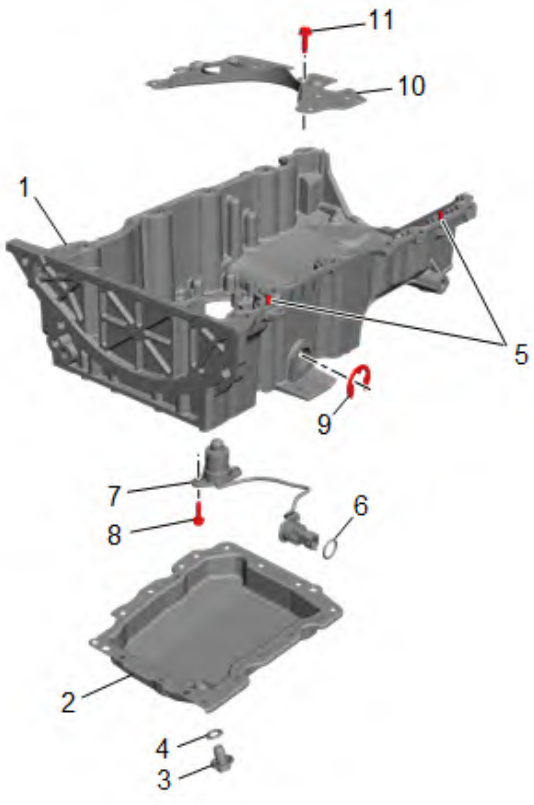


Fig. 471: Measuring Exhaust Manifold Mounting Face
Courtesy of GENERAL MOTORS COMPANY

6. Use a straight edge and a feeler gauge and measure the exhaust manifold mounting face (1) for warpage.

   An exhaust manifold face with warpage in excess of 0.25 mm (0.0100 in) may cause an exhaust leak and may effect OBD II system performance. Exhaust manifolds not within specifications must be replaced.

OIL PAN CLEANING AND INSPECTION



mcx30.com

Fig. 472: Oil Pan Cleaning And Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Ensure proper use of room temperature vulcanizing (RTV) sealant. Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant 2. Thoroughly clean the oil pans and mating surfaces. Inspect each component, O-rings, and fasteners, and replace as necessary. 3. Remove all sludge and oil deposits. 4. Inspect the oil pan for cracking near the pan rail and the transmission mounting points. 5. Inspect the oil pan for cracking resulting from impact or flying road debris.	
1	Upper Oil Pan **NOTE:** **Component may vary depending on model.**
2	Lower Oil Pan **NOTE:** **Component may vary depending on model.**
3	Engine Oil Drain Plug
4	Engine Oil Drain Plug Washer **NOTE:** **It is only necessary to replace the washer if inspection indicates damage is present.**
5	Oil Pan Locating Pins **NOTE:** **It is not necessary to remove the locating pins unless the inspection indicates replacement.**
6	Engine Oil Level Indicator Switch O-ring Seal
7	Engine Oil Level Indicator Switch
8	Engine Oil Level Indicator Switch Bolt **CAUTION:** **Refer to Fastener Caution .** **tighten** 10 N.m (89 lb in)
9	Engine Oil Level Indicator Switch Connector Retainer
10	Oil Pan Baffle
11	Oil Pan Baffle Bolt **tighten** 10 N.m (89 lb in)

THREAD REPAIR

Special Tools

- **EN 42385 - 700** High Feature Thread Repair Kit
- **EN 42385 - 850** Thread Repair Kit

mcx30.com

- **EN 42385 - 880** Head Bolt Thread Repair Adapter Kit

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

General Thread Repair

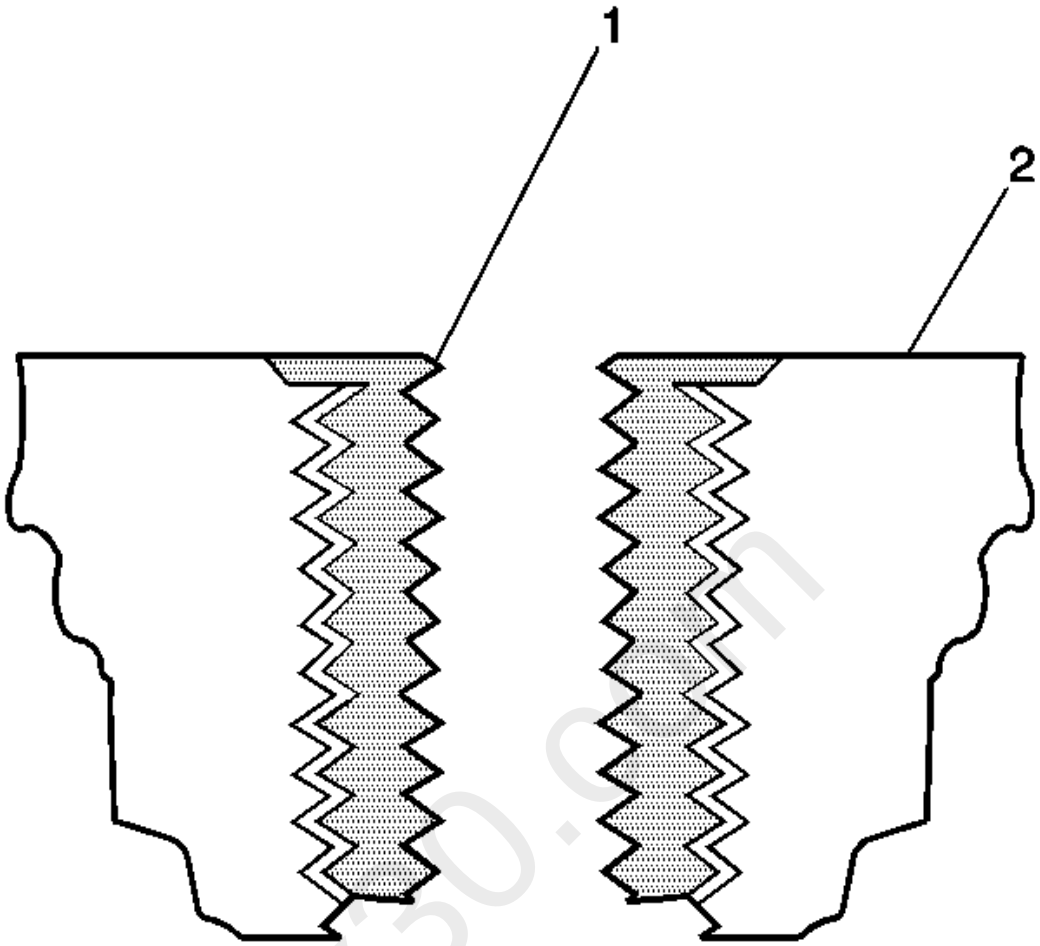


Fig. 473: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS COMPANY

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, the flange of the insert will be seated against the counterbore of the repaired hole.

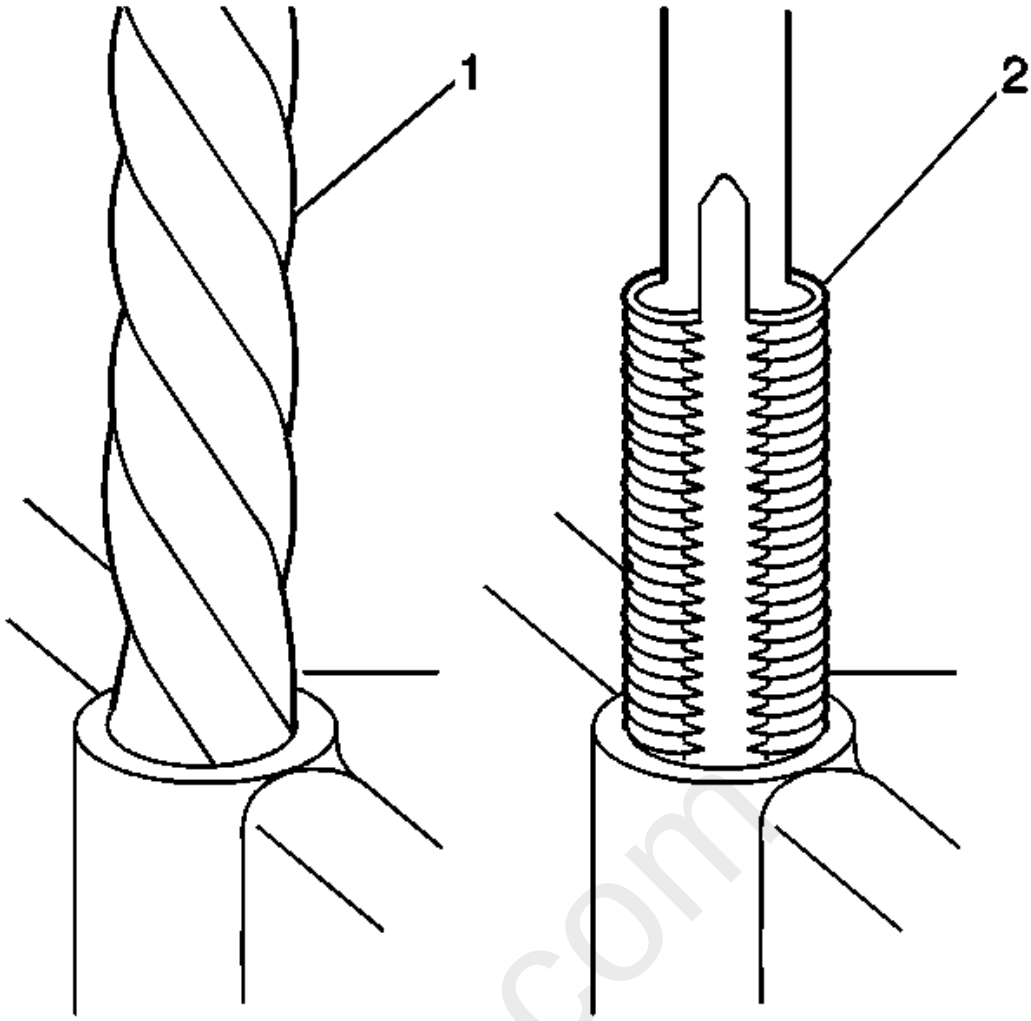


Fig. 474: Drilling & Tapping Threads
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The use of a cutting fluid, WD 40Â®, or equivalent, is recommended when performing the drilling, counterboring, and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers.**

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).

WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

2. Using compressed air, clean out any chips.

mv30.com

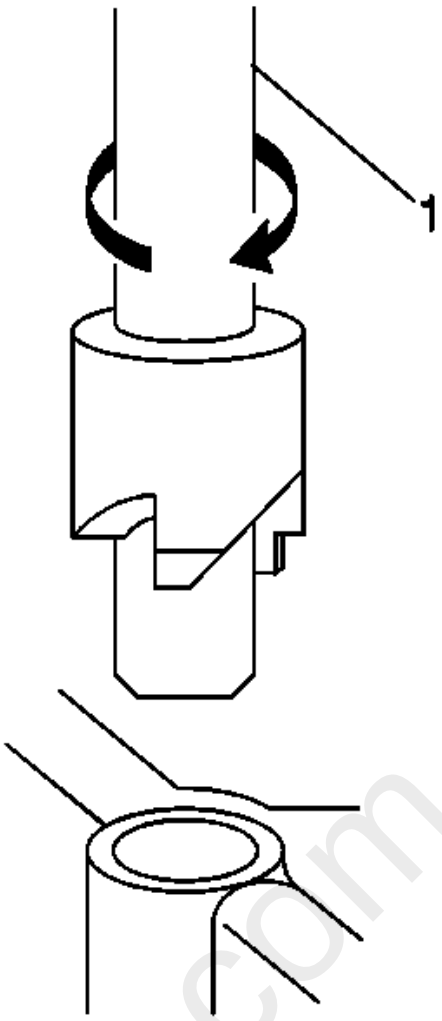


Fig. 475: Identifying Tool Used To Counterbore Hole
Courtesy of GENERAL MOTORS COMPANY

3. Counterbore the hole to the full depth permitted by the tool (1).
4. Using compressed air, clean out any chips.

mc750.com

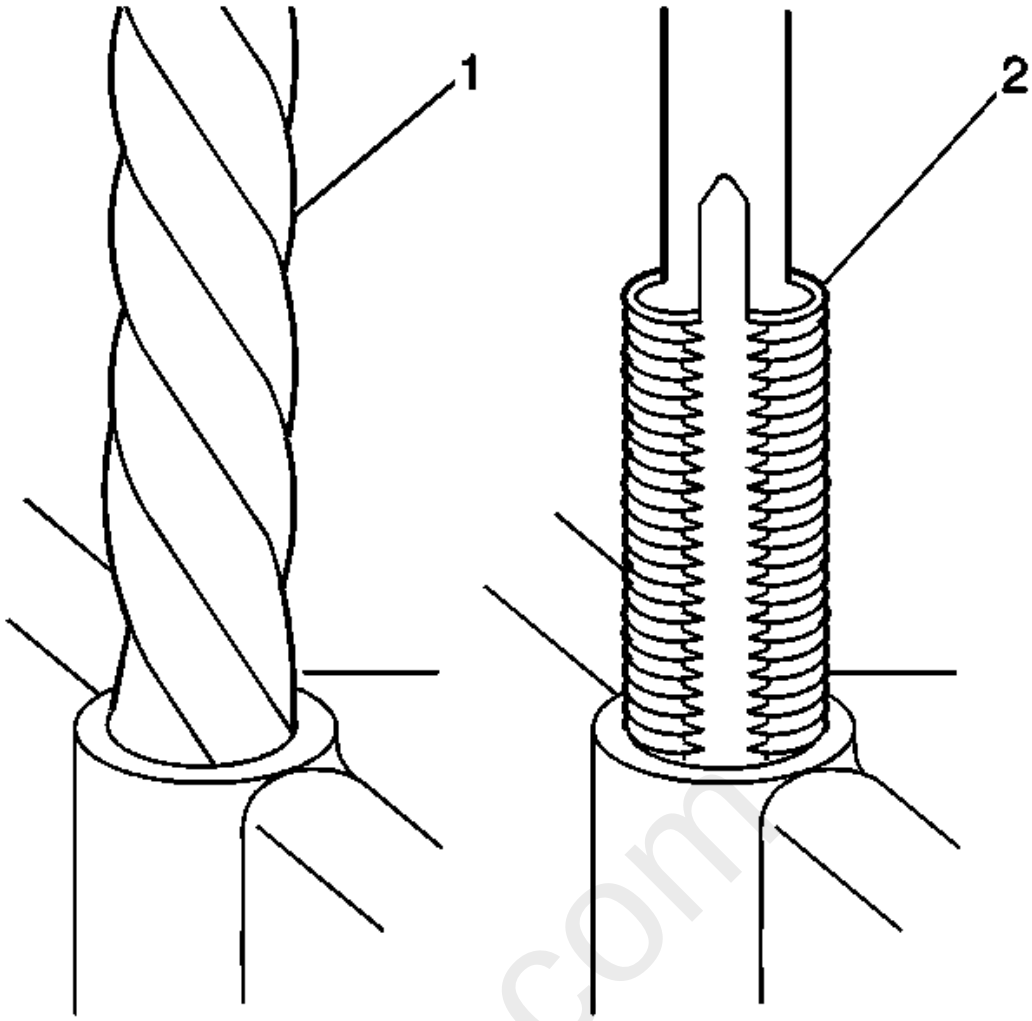


Fig. 476: Drilling & Tapping Threads
Courtesy of GENERAL MOTORS COMPANY

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).

WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

WARNING: **Refer to Cleaning Solvent Warning .**

6. Using compressed air, clean out any chips.
7. Spray cleaner into the hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
8. Using compressed air, clean any cutting oil and chips out of the hole.

mo730.com

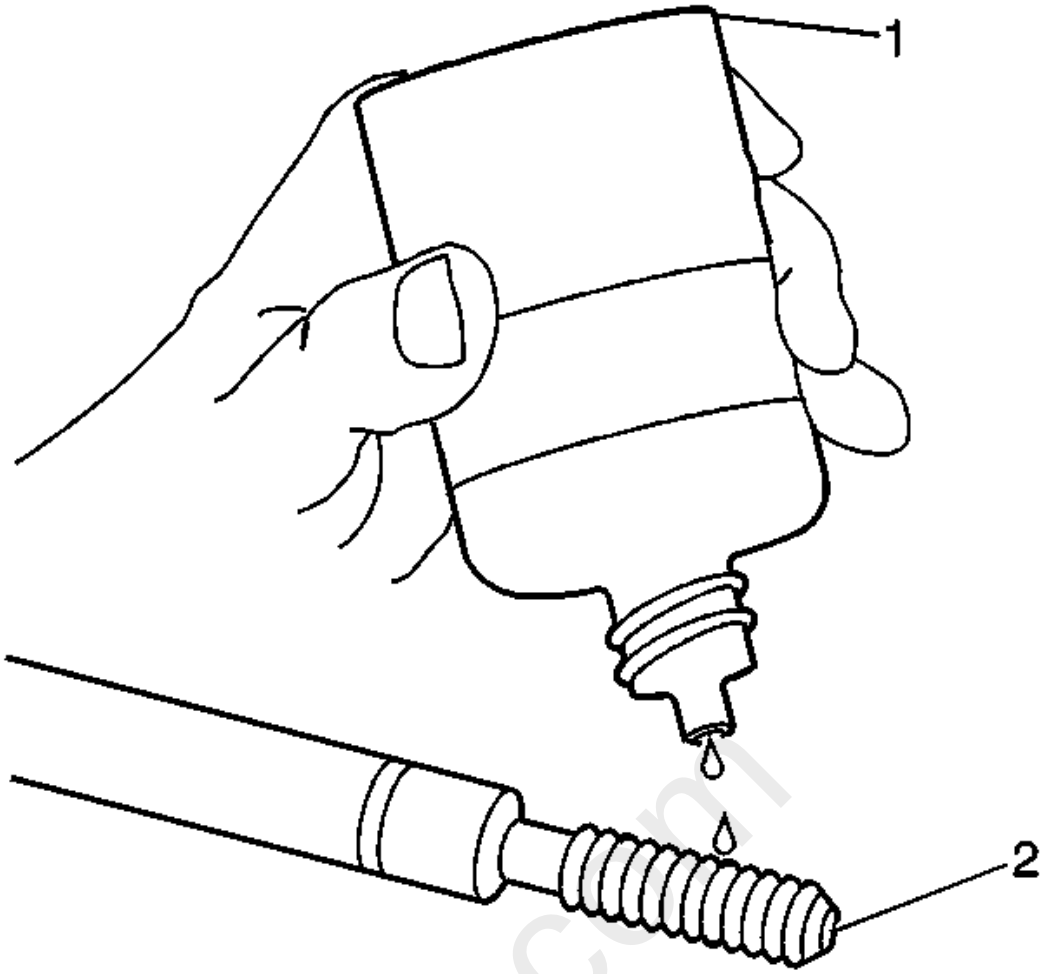


Fig. 477: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

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).

mcy30.com

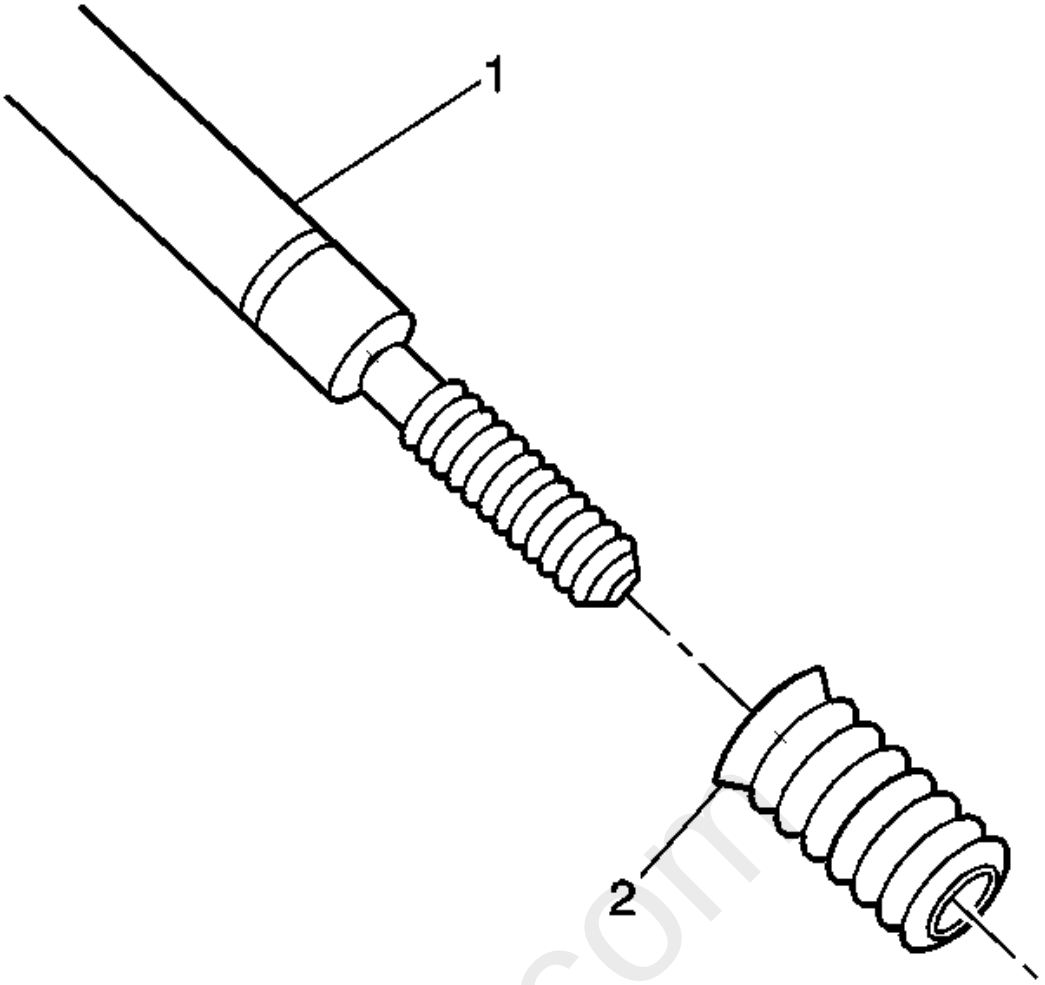


Fig. 478: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

10. Install the insert (2) onto the driver tool (1).

mc730.com

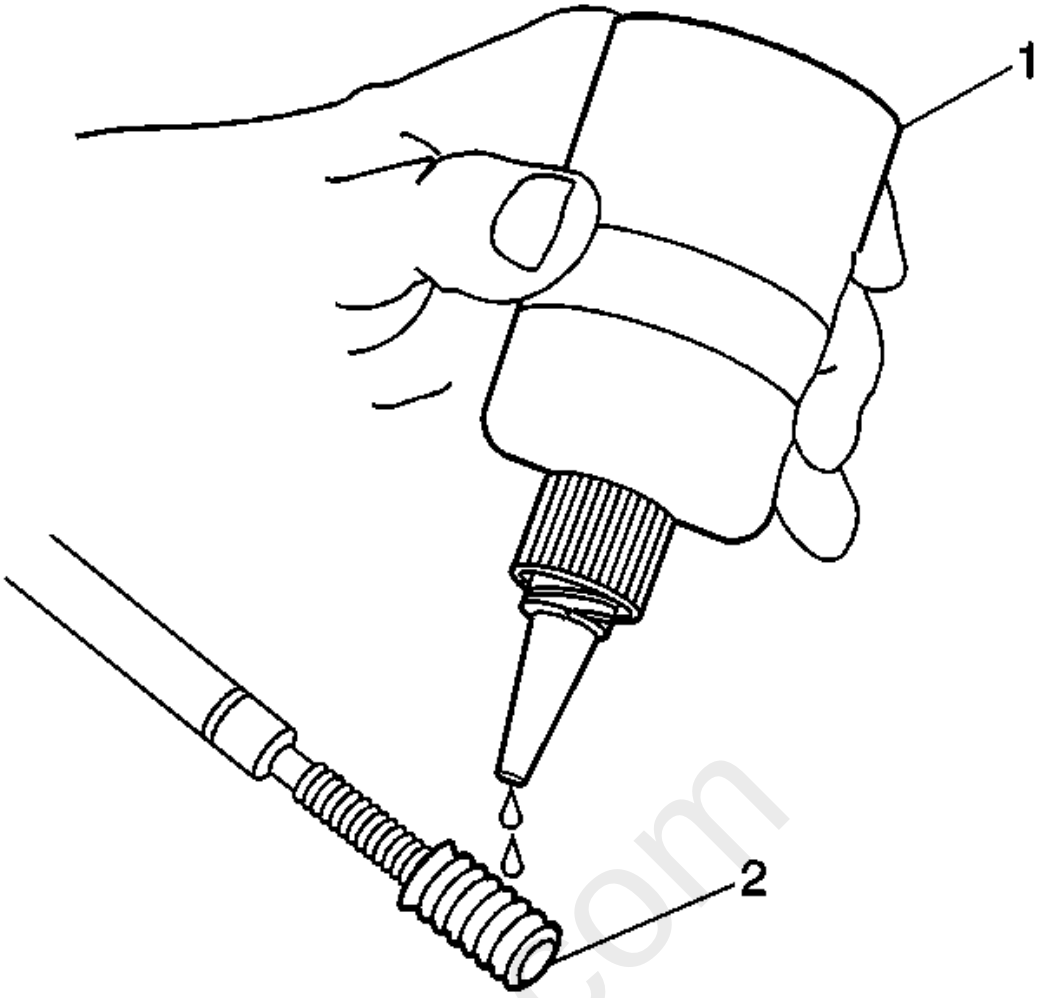


Fig. 479: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

11. Apply threadlock LOCTITE™ 277, **EN 42385 - 109 (1)** loctite, or equivalent to the insert OD threads (2).

mc250.com

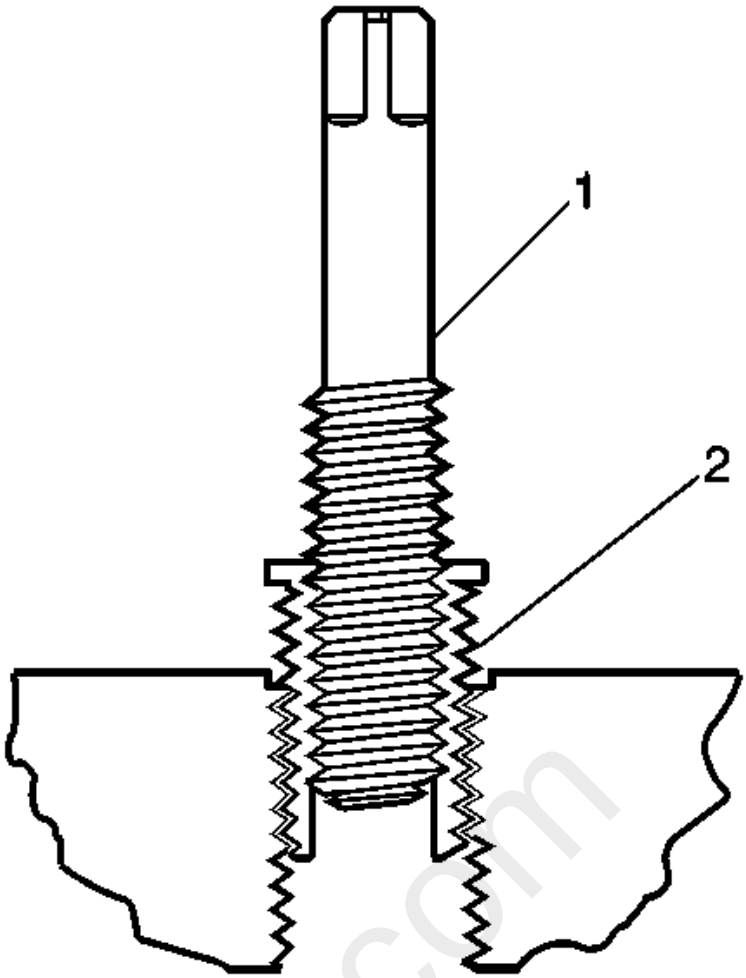


Fig. 480: View Of Insert In Tapped Bolt Hole
Courtesy of GENERAL MOTORS COMPANY

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.

    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.

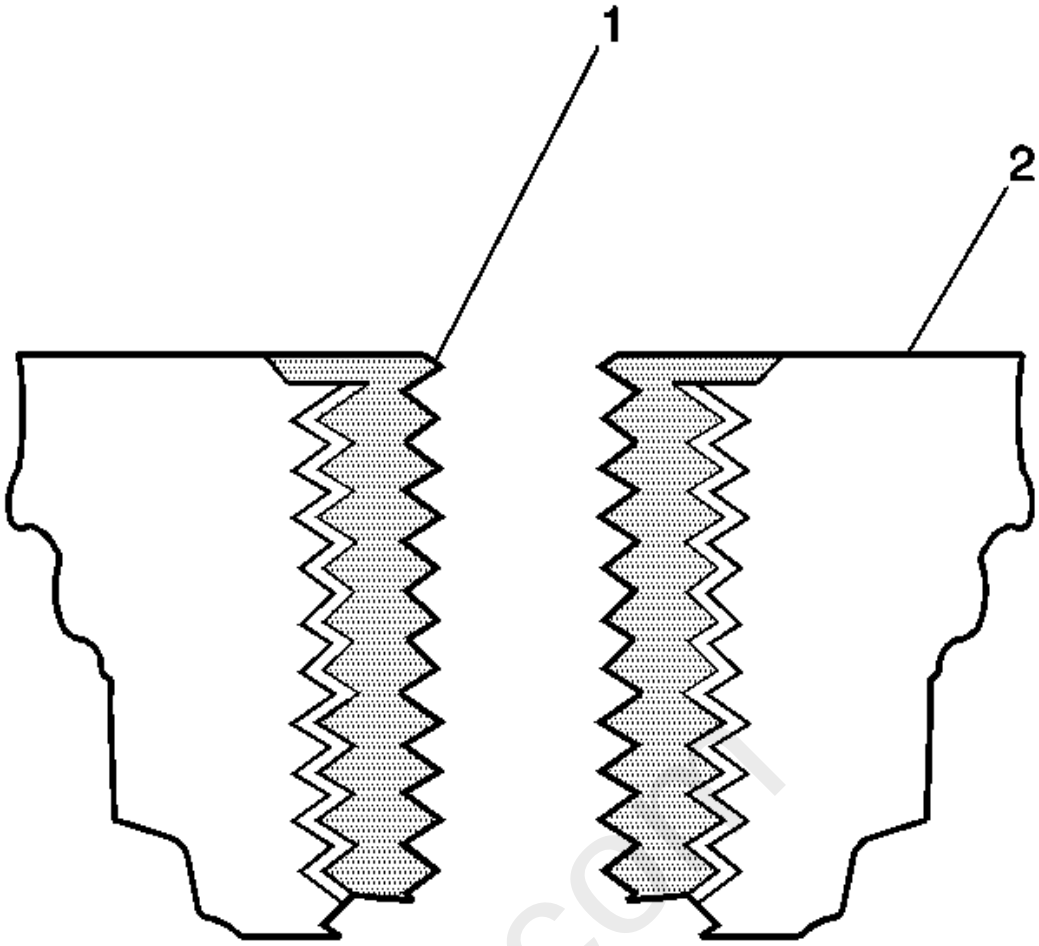


Fig. 481: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS COMPANY

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

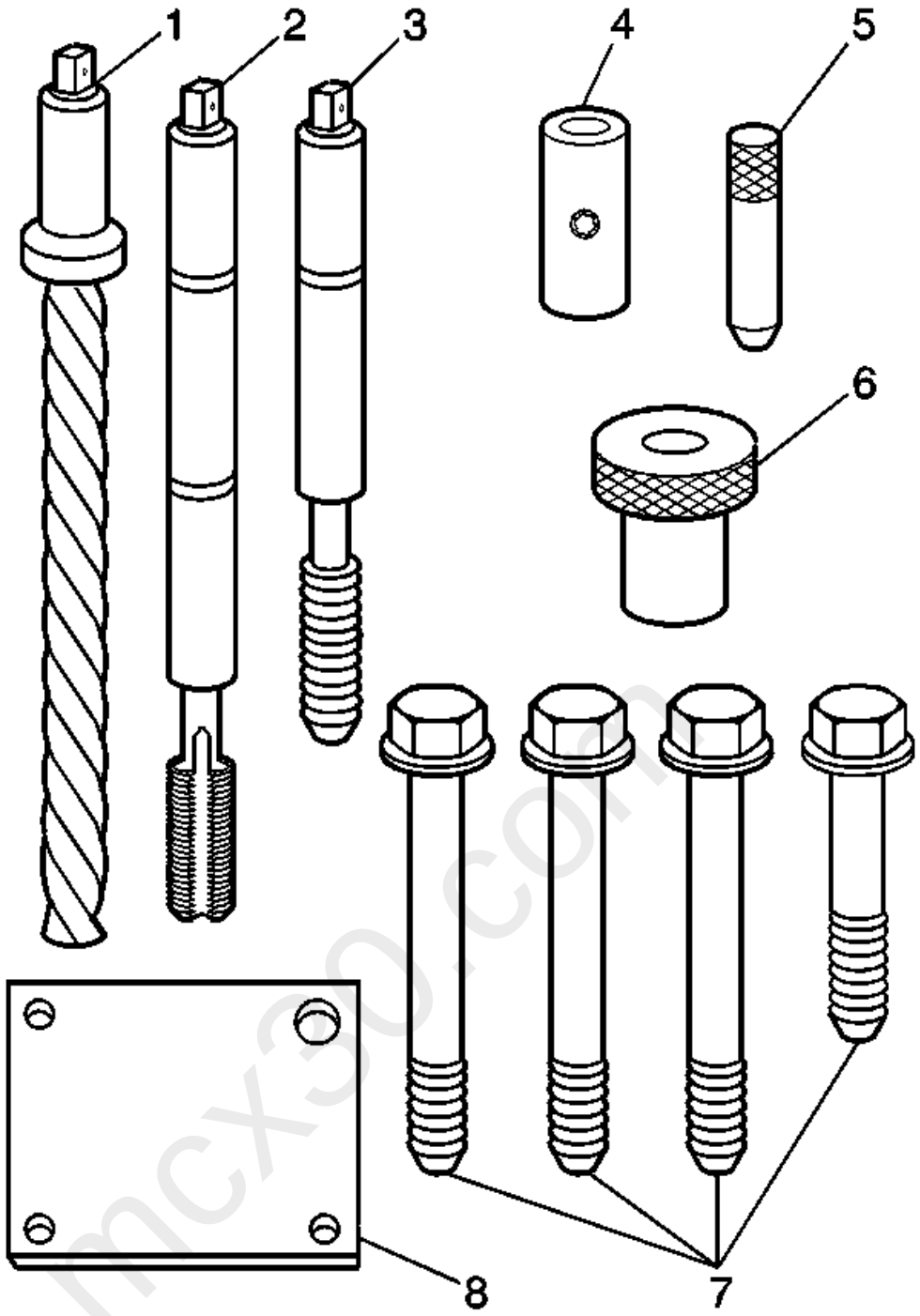


Fig. 482: Identifying Thread Repair Kit Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The tools listed may not necessarily represent the exact tools used for the procedure.**

1. The cylinder head bolt hole thread repair kit consists of the following items:
   - Drill (1)
   - Tap (2)
   - Installer (3)
   - Sleeve (4)
   - Alignment Pin (5)
   - Bushing (6)
   - Bolts (7)
   - Fixture Plate (8)

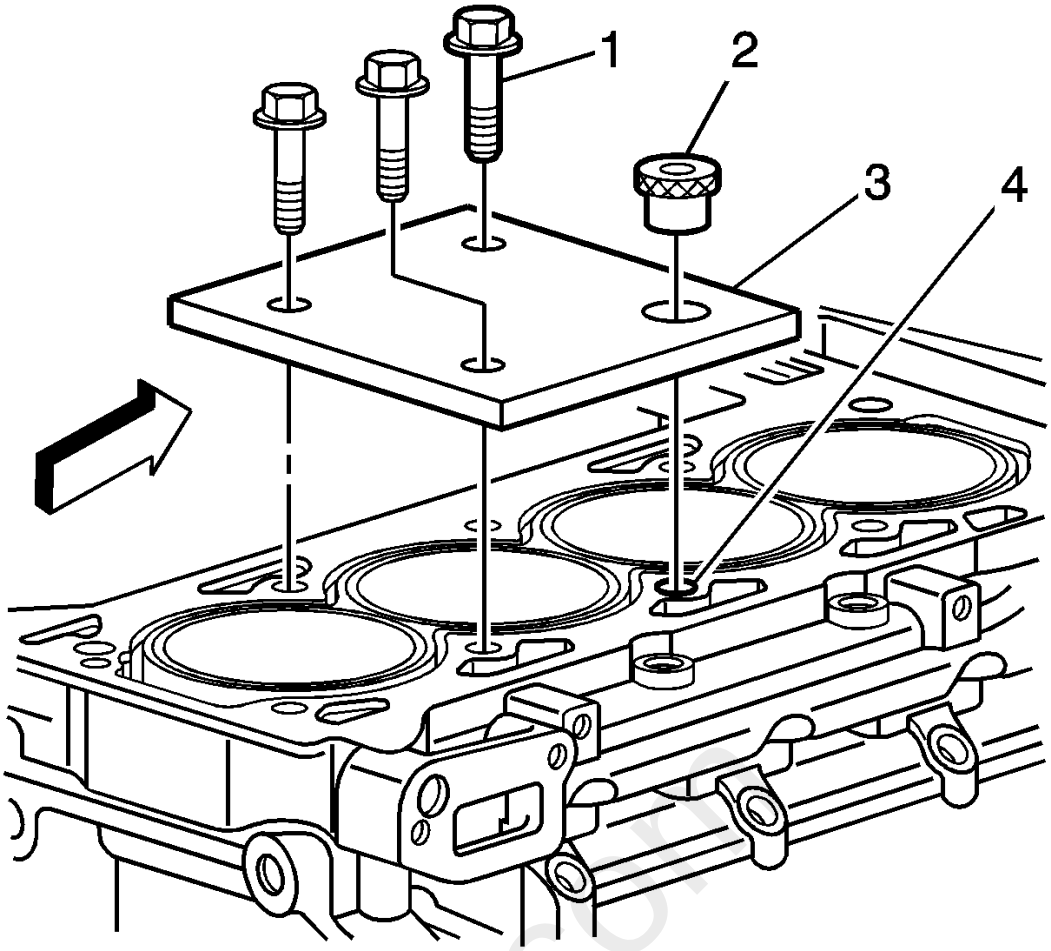


Fig. 483: Identifying Fixture Plate, Bolts, & Bushing
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

NOTE: **The use of a cutting fluid, WD 40Â®, or equivalent, is recommended when performing the drilling and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers.**

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).

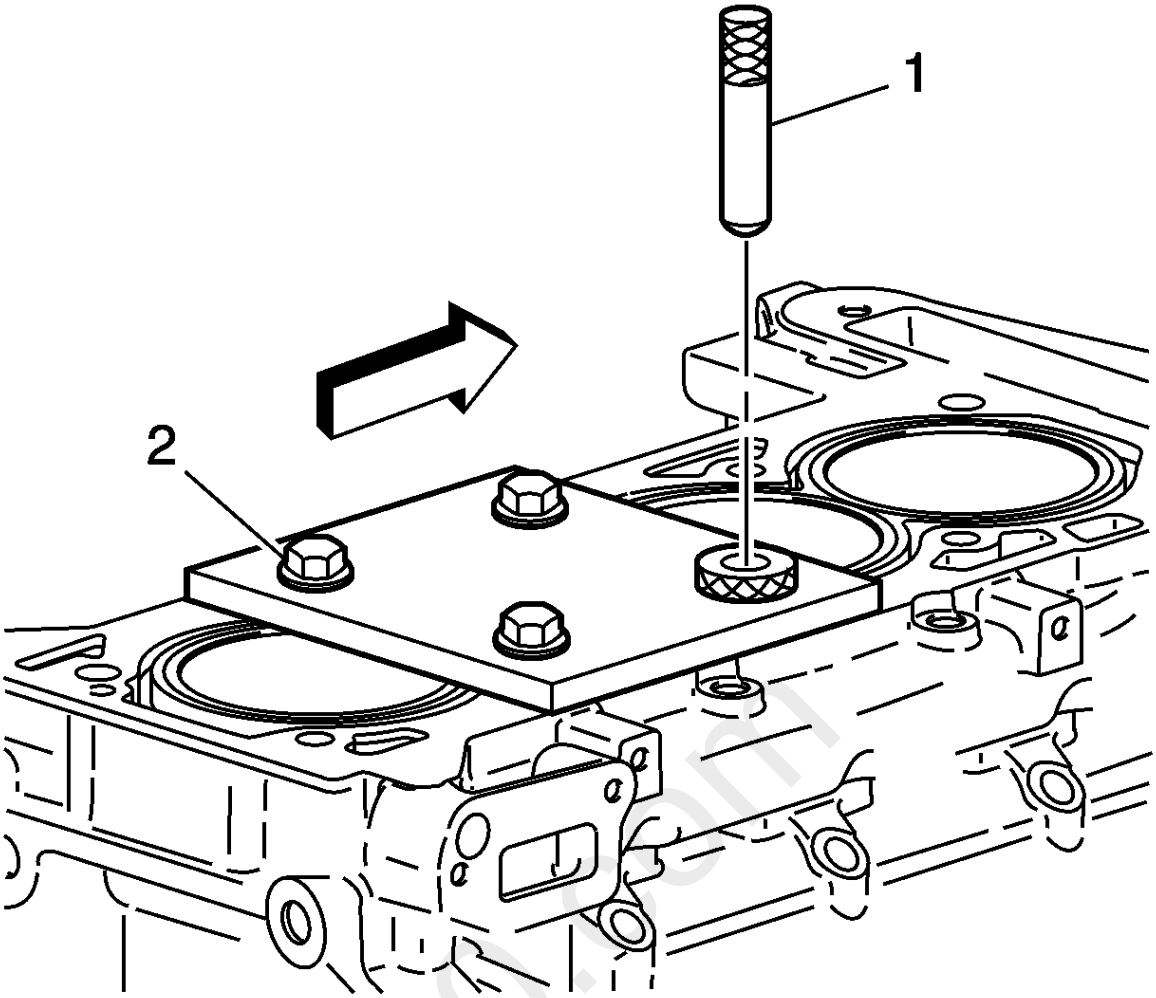


Fig. 484: Identifying Alignment Pin
Courtesy of GENERAL MOTORS COMPANY

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.

mx30.com

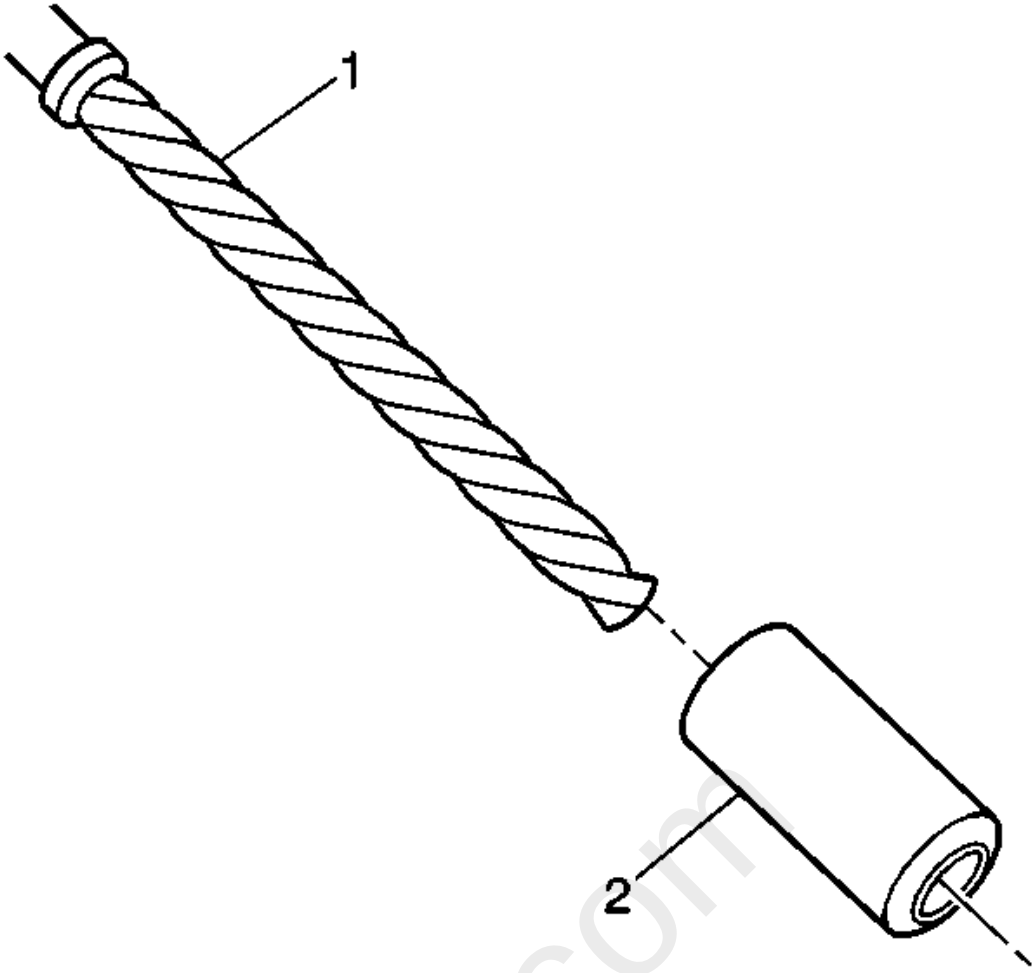


Fig. 485: View Of Stop Collar & Counterbore Drill
Courtesy of GENERAL MOTORS COMPANY

6. Install the sleeve (2) onto the drill (1), if required.

mc50.com

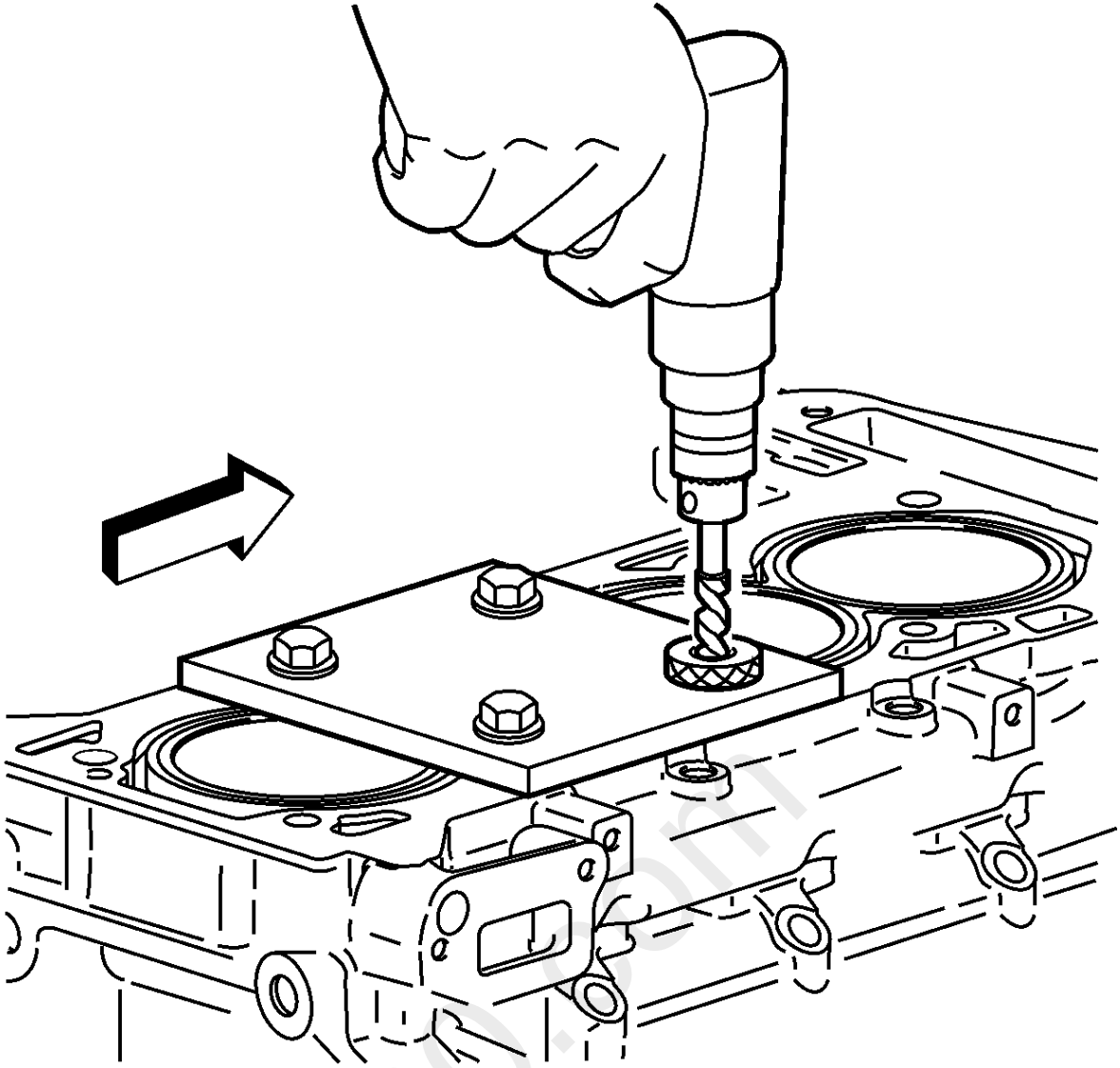


Fig. 486: Drilling Out Threads Of Damaged Hole
Courtesy of GENERAL MOTORS COMPANY

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.

   WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

8. Using compressed air, clean out any chips.

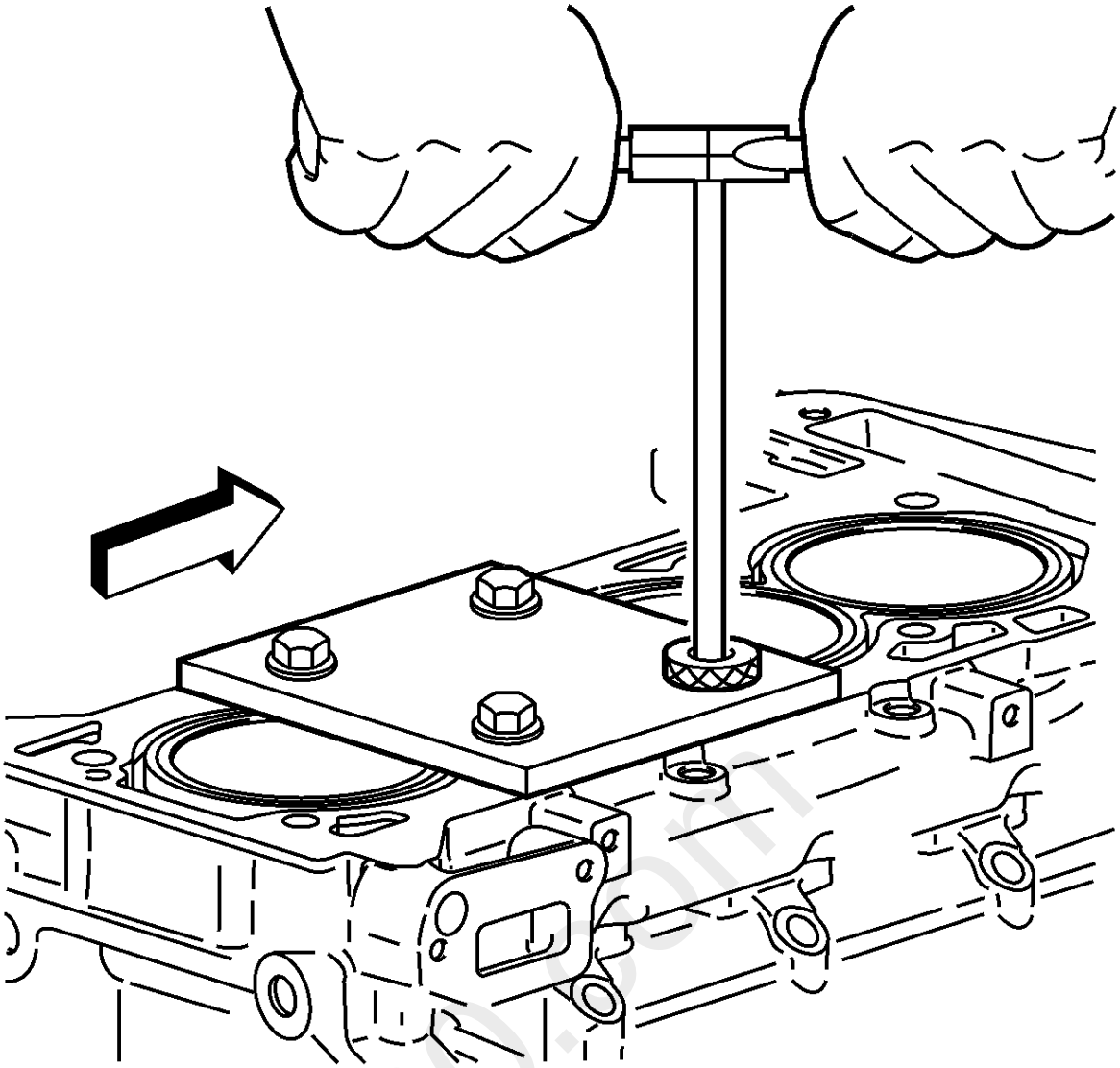


Fig. 487: Tapping Threads Of Drilled Hole With Tap Wrench
Courtesy of GENERAL MOTORS COMPANY

9. Using a tap wrench, tap the threads of the drilled hole.

mcx30.com

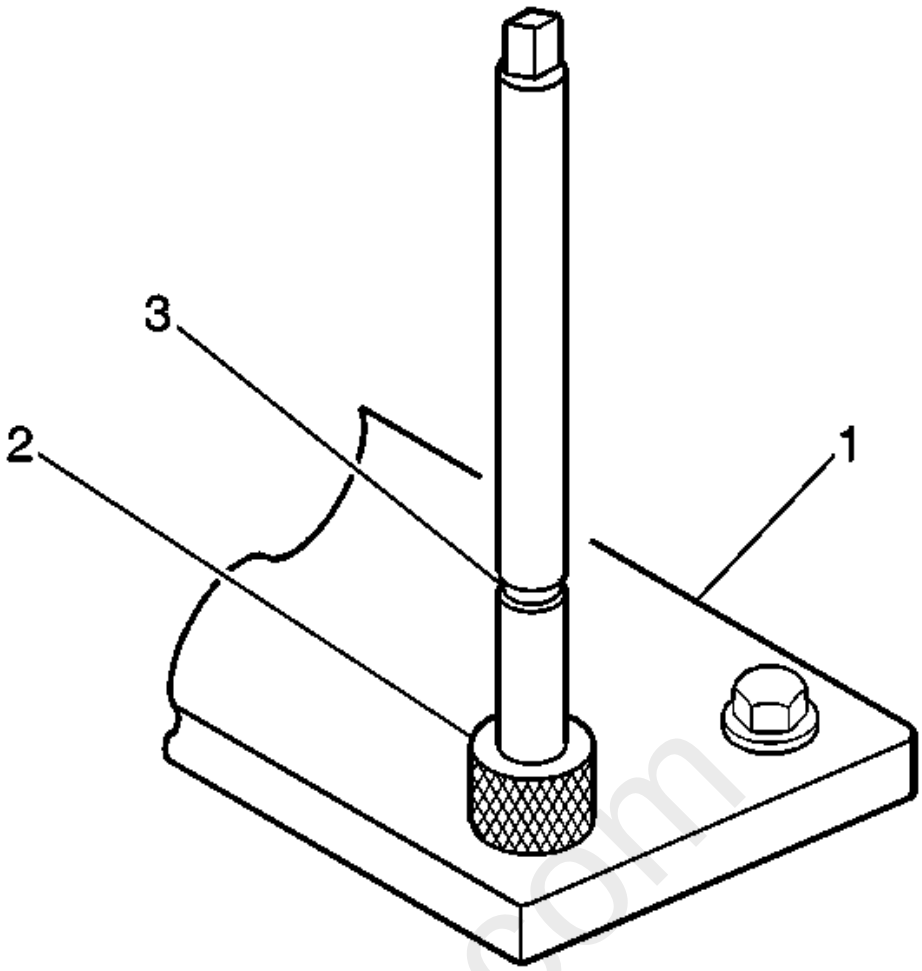


Fig. 488: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS COMPANY

10. 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 (3) on the tap align with the top of the drill bushing (2).

11. Remove the fixture plate (1), bushing (2), and bolts.

    WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

    WARNING: **Refer to Cleaning Solvent Warning .**

12. Using compressed air, clean out any chips.
13. Spray cleaner into the hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
14. Using compressed air, clean any cutting oil and chips out of the hole.

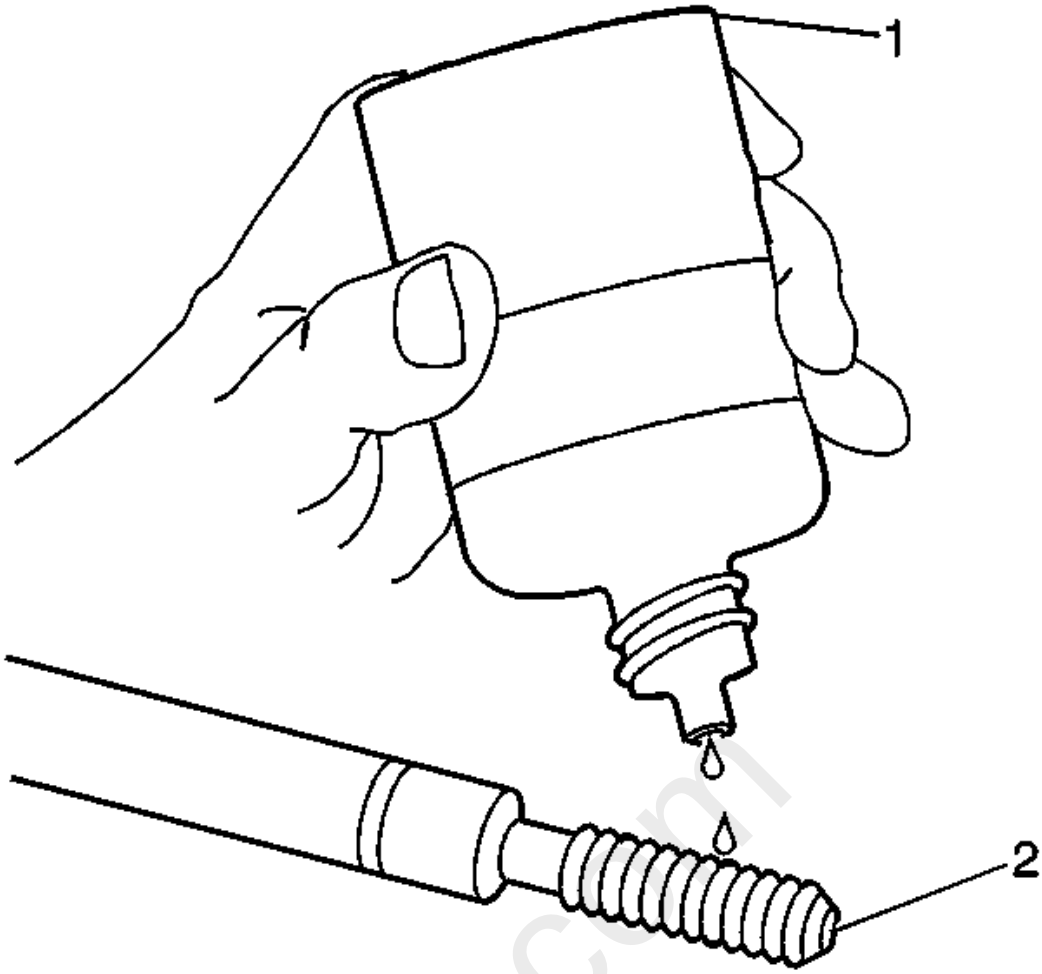


Fig. 489: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.**

15. Lubricate the threads of the installer tool (2) with the driver oil (1).

mc730.com

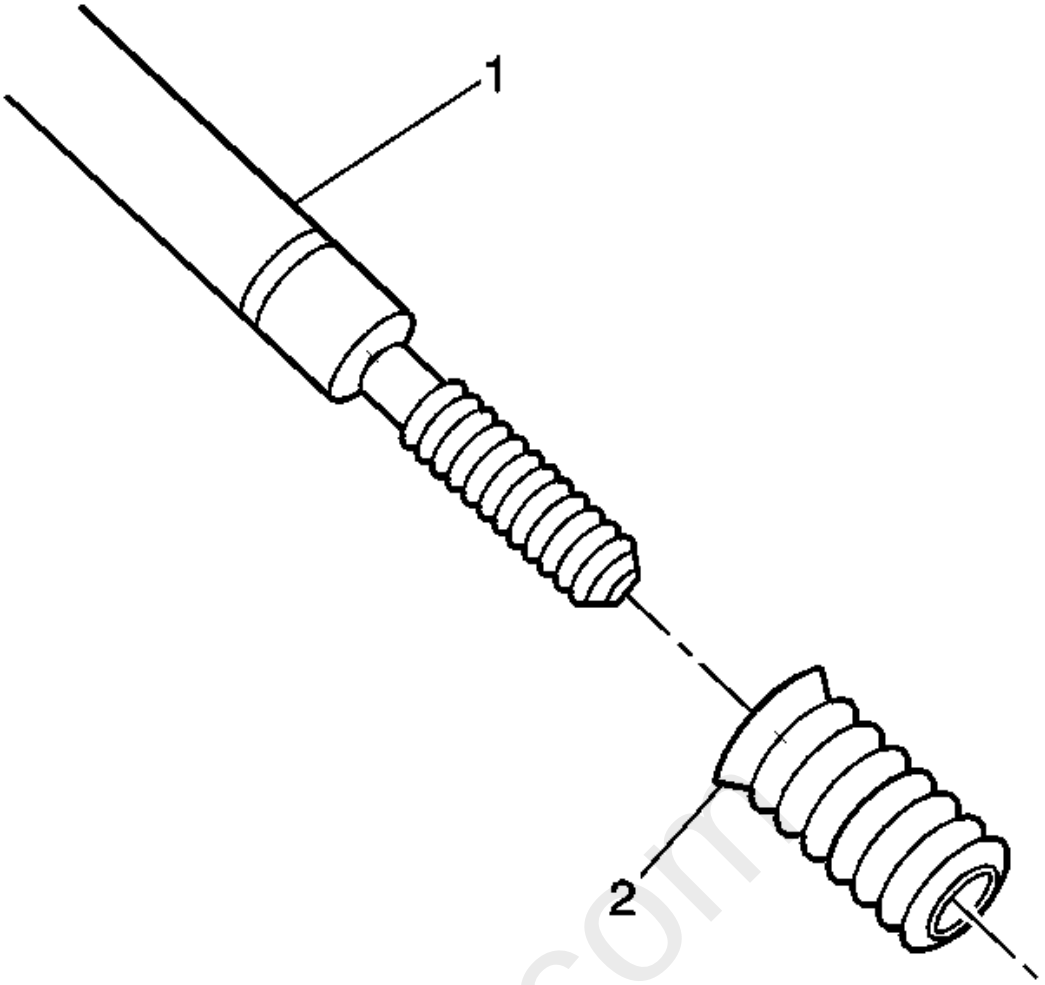


Fig. 490: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

16. Install the insert (2) onto the driver tool (1).

mc730.com

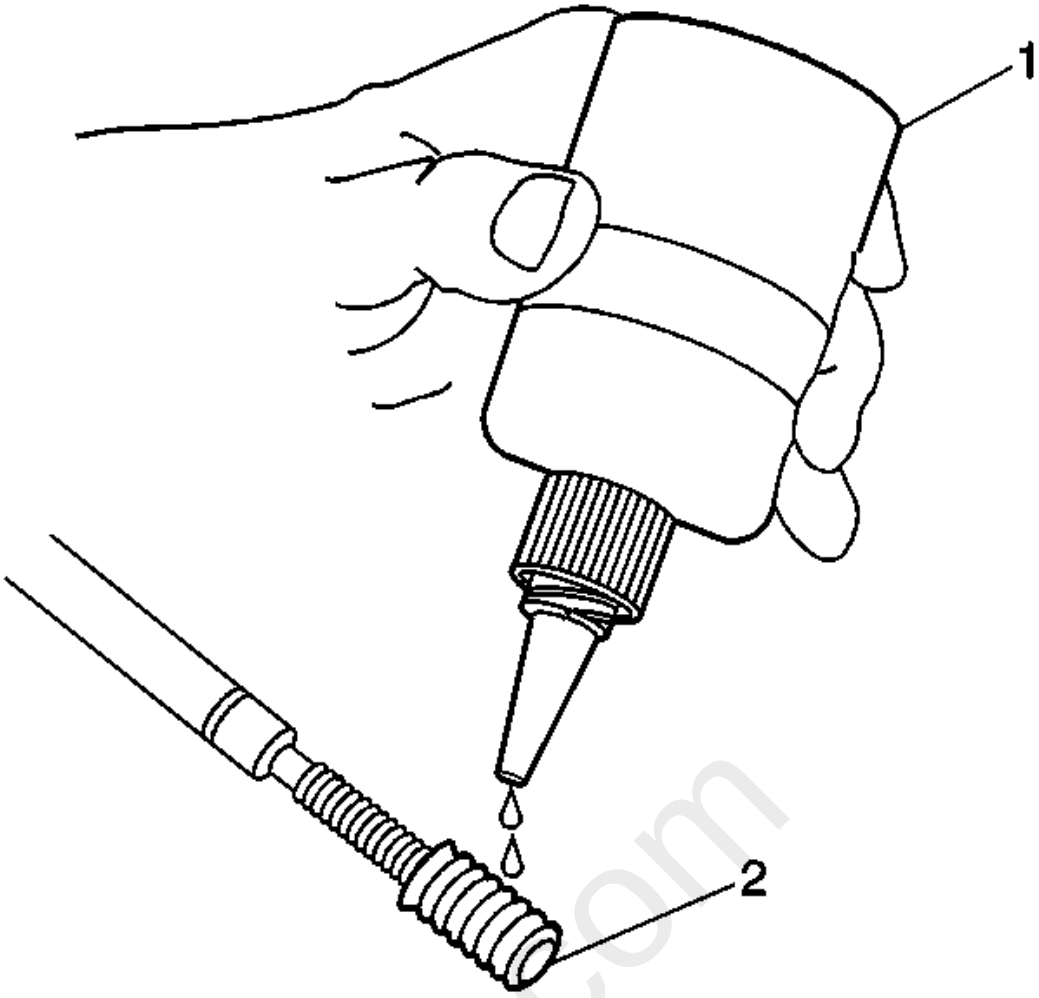


Fig. 491: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

17. Apply threadlock LOCTITE™ 277, **EN 42385 - 109** loctite (1), or equivalent to the insert OD threads (2).

mc50.com

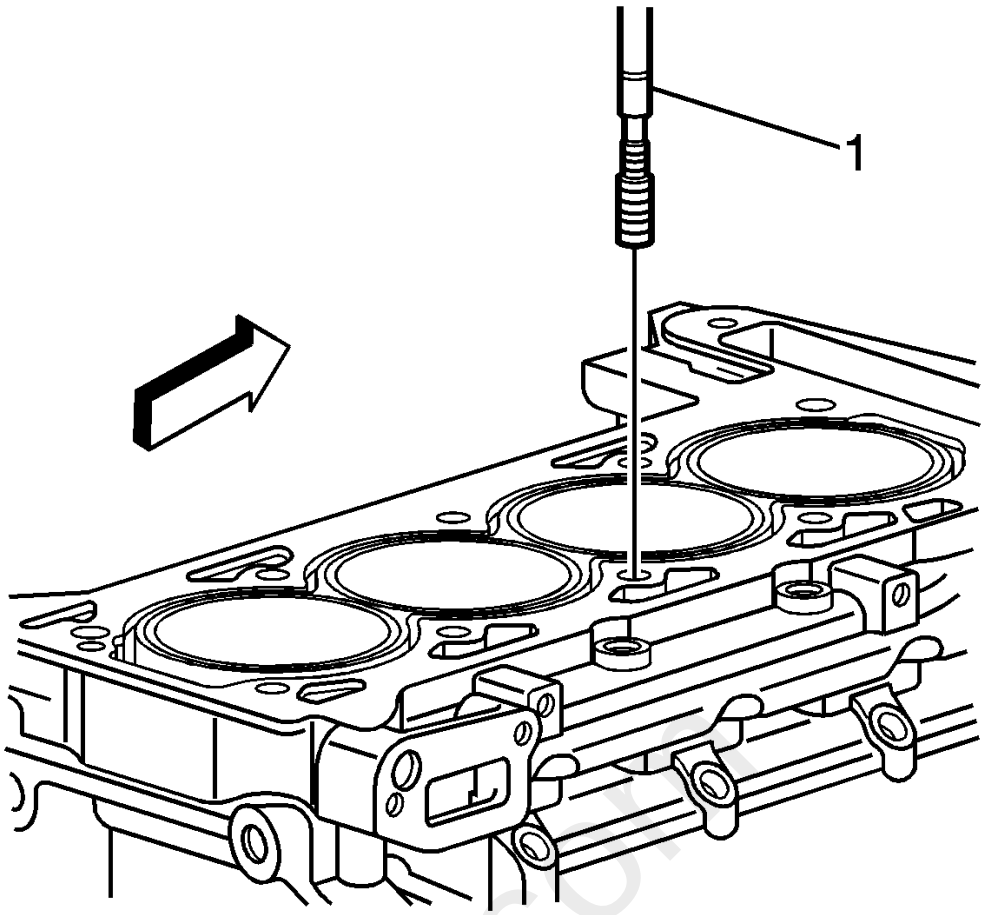


Fig. 492: Installing & Inserting Driver Into Hole
Courtesy of GENERAL MOTORS COMPANY

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.

SERVICE PRIOR TO ASSEMBLY

The importance of cleanliness during assembly cannot be overstated. Dirt or debris will cause engine damage. An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in ten thousandths of an inch. When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of engine oil should be applied to friction areas during assembly in order to protect and lubricate the surfaces on initial operation. Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas are part of the repair procedure. This is considered standard shop practice even if not specifically stated.

Lubricate all moving parts with engine oil or a specified assembly lubricant. This will provide lubrication for initial start up.

ENGINE BLOCK ASSEMBLE

Fig. 493: Piston Oil Nozzle Assembly Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the piston oil nozzle assemblies (2), if equipped.

CAUTION: **Refer to Fastener Caution .**

2. Install the piston oil nozzle bolts (1) and tighten to 10 N.m (89 lb in).

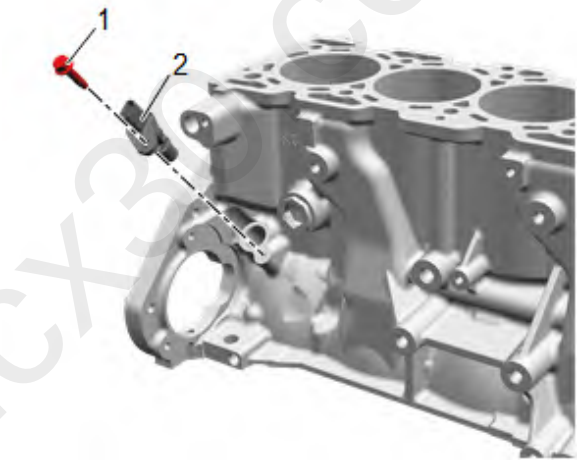


Fig. 494: Crankshaft Position (CKP) Sensor
Courtesy of GENERAL MOTORS COMPANY

3. Lubricate the crankshaft position sensor O-ring with engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

CAUTION: **Refer to Component Fastener tightening Caution .**

4. Install the crankshaft position sensor (2) and bolt (1) and tighten to 10 N.m (89 lb in).

mcx30.com

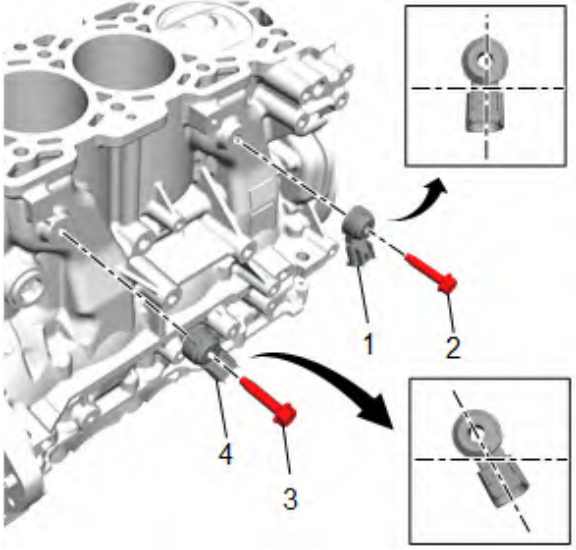


Fig. 495: Knock Sensors And Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the knock sensor (1) at 6 O' clock. Install the bolt (2) and tighten to 25 N.m (18 lb ft).
6. Install the knock sensor (4) at 5 O' clock. Install the bolt (3) and tighten to 25 N.m (18 lb ft).

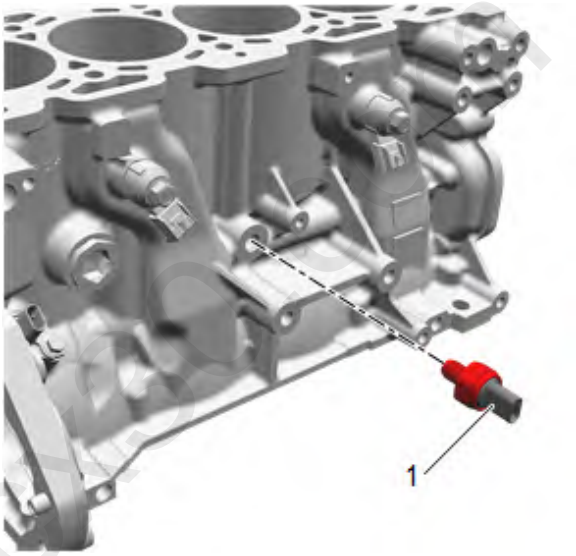


Fig. 496: Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

7. Install the engine oil pressure sensor (1) and tighten to 35 N.m (26 lb ft).

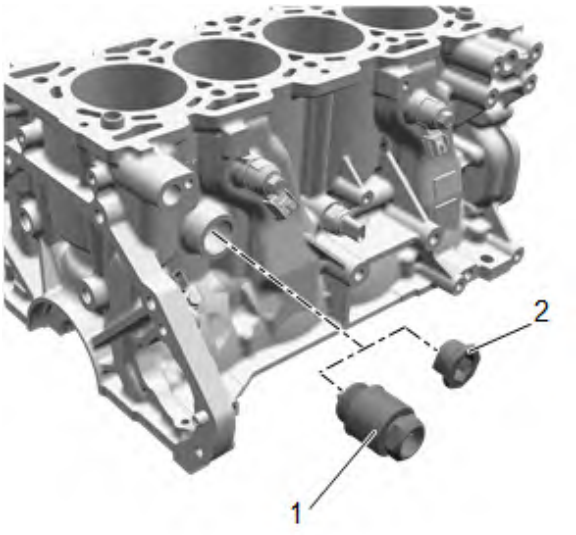


Fig. 497: Engine Coolant Heater
Courtesy of GENERAL MOTORS COMPANY

8. Install the engine coolant heater assembly (1), if equipped. tighten the assembly to 50 N.m (37 lb ft).
9. If the engine coolant heater assembly is not equipped, install the engine coolant heater hole plug (2). tighten the plug to 60 N.m (44 lb ft).

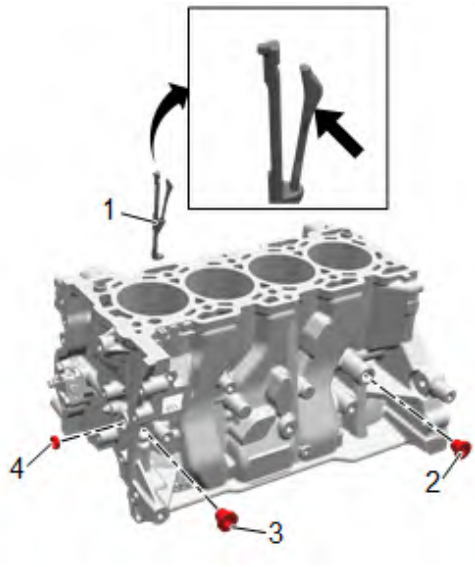


Fig. 498: Engine Oil Gallery Plugs
Courtesy of GENERAL MOTORS COMPANY

10. Apply sealant to all plugs prior to installation. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
11. Install the engine oil gallery cup plug (4).
12. Install the engine oil gallery plugs (2, 3), with sealant, and tighten to 65 N.m (48 lb ft).

NOTE: **Always install the baffle with the forked end pointed up. Do not force the baffle into place. Aligning the shape of the orifice and the baffle, and gently depressing the clip will allow the baffle to easily drop into place.**

13. Carefully align and install the engine block coolant baffle (1).

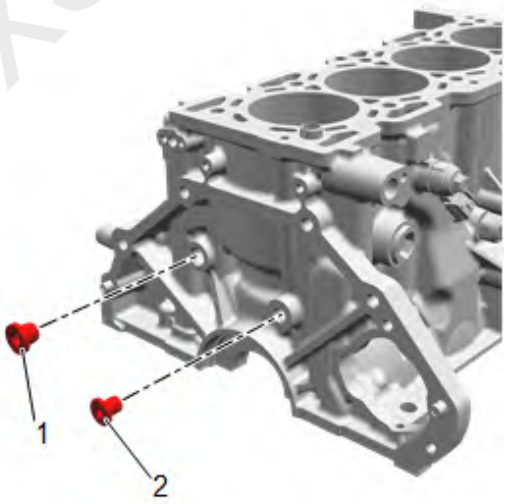


Fig. 499: Engine Oil Gallery Plugs
Courtesy of GENERAL MOTORS COMPANY

14. Install the engine oil gallery plug (1), with sealant, and tighten to 65 N.m (48 lb ft).
15. Install the engine oil gallery plug (2), with sealant, and tighten to 40 N.m (30 lb ft).

CRANKSHAFT AND BEARING INSTALLATION

Special Tools

- **EN-8087** Cylinder Bore Checking Gauge
- **EN 45059** Angle Meter

mcx30.com

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

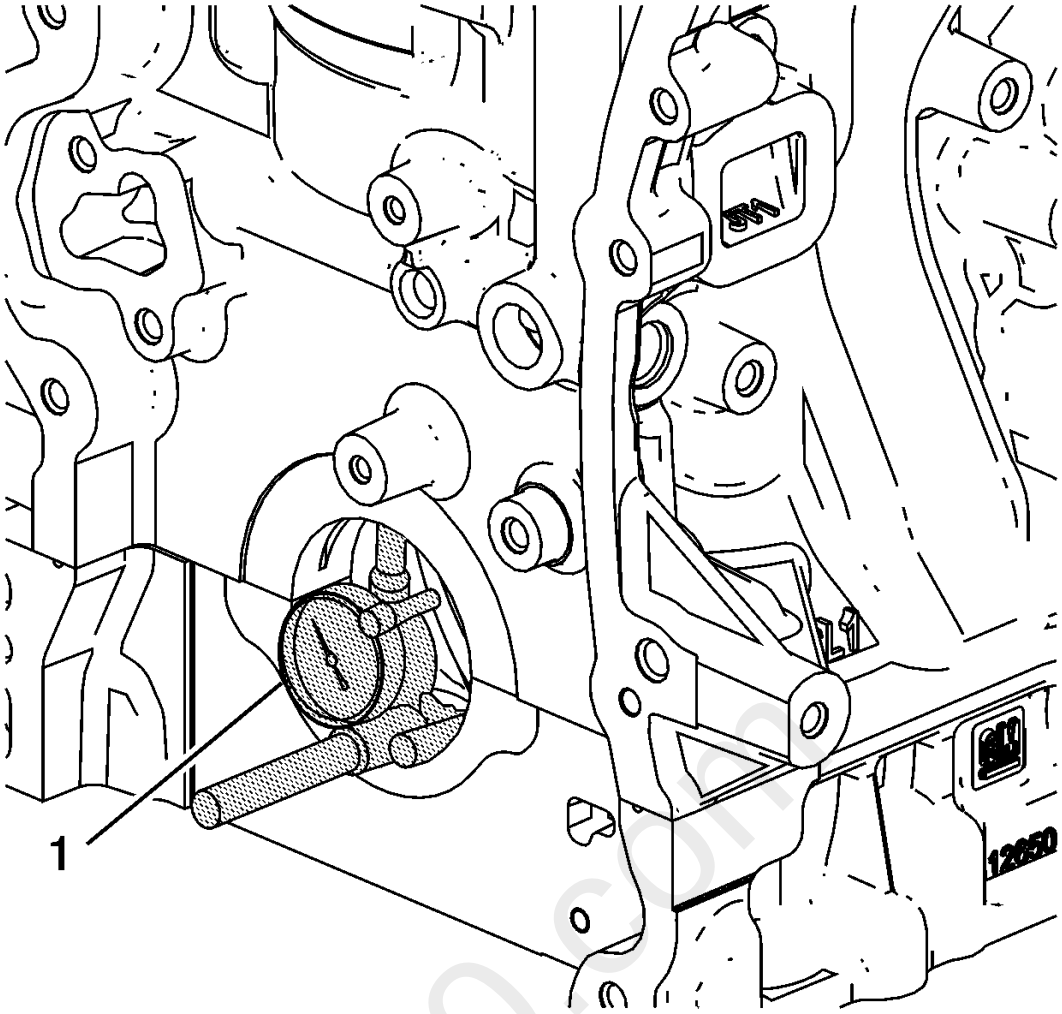


Fig. 500: View Of Cylinder Bore Gauge
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Crankshaft bearings MUST be separated, marked, or organized in a way to ensure installation to their original location and position, when suitable for use.**
- **If crankshaft bearing failure is due to other than normal wear, investigate the cause. Inspect the crankshaft or connecting rod bearing bores.**

Inspect the connecting rod bearing bores or crankshaft main bearing bores using the following procedure:

- tighten the bedplate to specification using the **EN 45059** meter.
- Measure the bearing bore for taper and out-of-round using the **EN-8087** gauge (1).
- No taper or out-of-round should exist.

Bearing Selection

1. Measure the bearing clearance to determine the correct replacement bearing insert size. There are two methods to measure bearing clearance. Method A gives more reliable results and is preferred.
   - Method A yields measurement from which the bearing clearance can be computed.
   - Method B yields the bearing clearance directly. Method B does not give any indication of bearing run-out.

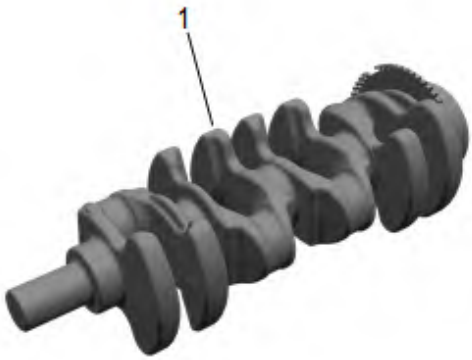


Fig. 501: Measuring Bearing Clearance Using Method A
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not mix inserts of different nominal size in the same bearing bore.**

2. To measure bearing clearance for the crankshaft (1) using Method A, use the following procedure:
    1. Measure the crankshaft bearing journal diameter with a micrometer in several places, 90 degrees apart. Average the measurements.
    2. Measure the crankshaft bearing journal taper and runout.
    3. Install the lower crankcase and tighten the bearing cap bolts to specification.
    4. Measure bearing inside diameter (ID) in several places 90 degrees apart, average measurements.
    5. Subtract journal measurement from bearing ID measurement to determine clearance.
    6. Determine whether clearance is within specification.
    7. If out of specification, choose different inserts.
    8. Measure the connecting rod inside diameter in the same direction as the length of the rod with an inside micrometer.
    9. Measure the crankshaft main bearing inside diameter with an inside micrometer.

mc730.com

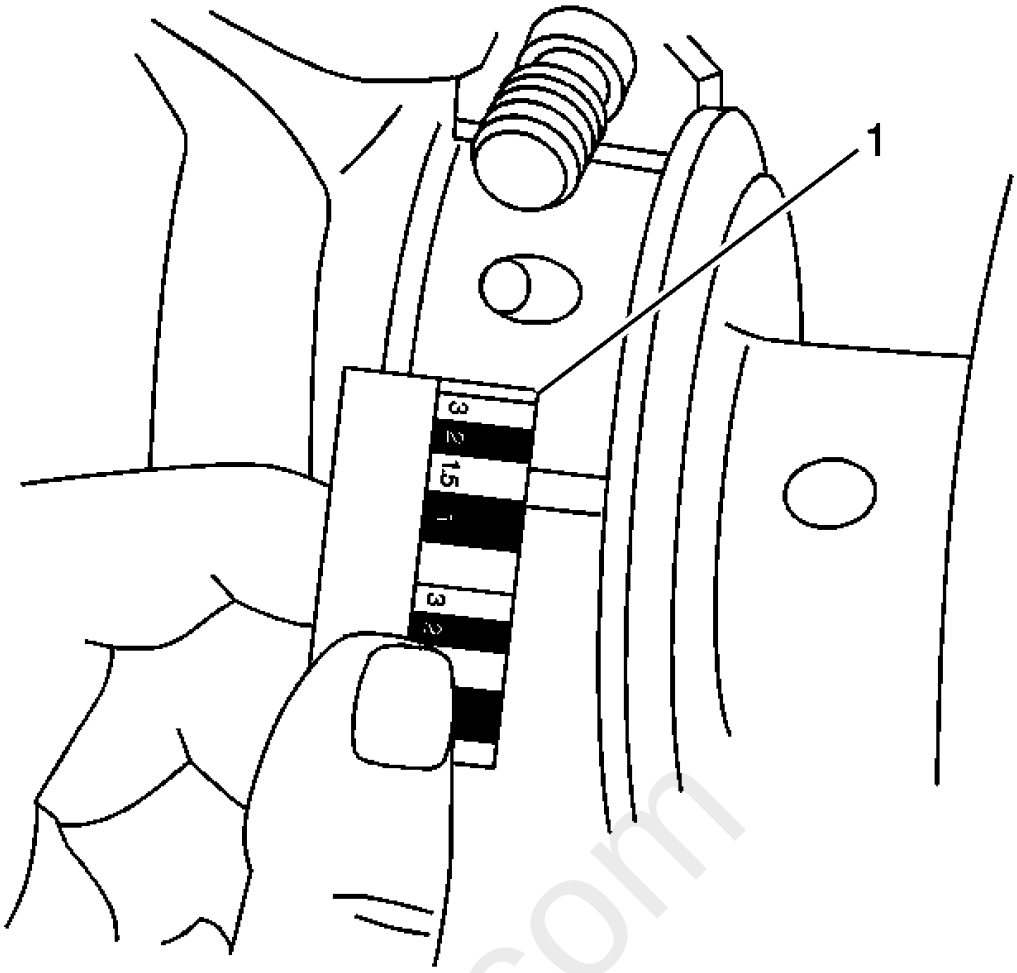


Fig. 502: Measuring Bearing Clearance Using Method B
Courtesy of GENERAL MOTORS COMPANY

3. To measure bearing clearance using Method B, use the following procedure:
    1. Clean the used bearing inserts.
    2. Install the used bearing inserts.
    3. Place a piece of gaging plastic across the entire bearing width at 90 degrees to block/lower crankcase split line.
    4. Install the bearing caps.

    CAUTION: **In order to prevent the possibility of cylinder block or crankshaft bearing cap damage, the crankshaft bearing caps are tapped into the cylinder block cavity using a brass, lead, or a leather mallet before the attaching bolts are installed. Do not use attaching bolts to pull the crankshaft bearing caps into the seats. Failure to use this process may damage a cylinder block or a bearing cap.**

    5. Install the bearing cap bolts to specification.

    NOTE: **Do not rotate the crankshaft.**

    6. Remove the bearing cap, leaving the gauging plastic in place. It does not matter whether the gauging plastic adheres to the journal or to the bearing cap.
    7. Measure the gauging plastic at its widest point with the scale (1) printed on the gauging plastic package.
    8. Remove the gauging plastic.

Crankshaft Installation

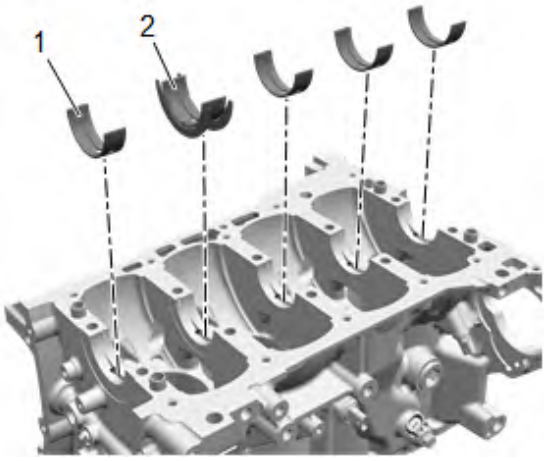


Fig. 503: Crankshaft Upper Bearings
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Crankshaft bearings MUST be separated, marked, or organized in a way to ensure installation to their original location and position, when suitable for use.**

NOTE: **If crankshaft bearing kit has a red bearing in it, install this in the front crankshaft bearing position, closest to the crankshaft balancer.**

1. Install the upper crankshaft bearings (1) and lubricate bearing surfaces with engine oil.
2. Install the crankshaft upper thrust bearing (2) and lubricate bearing surfaces with engine oil.

Fig. 504: Crankshaft
Courtesy of GENERAL MOTORS COMPANY

3. Install the crankshaft (1) on the journals.

LOWER CRANKCASE INSTALLATION

Special Tools

- **EN 45059** Angle Meter
- **EN-51380** Seal Installer

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

mcx30.com

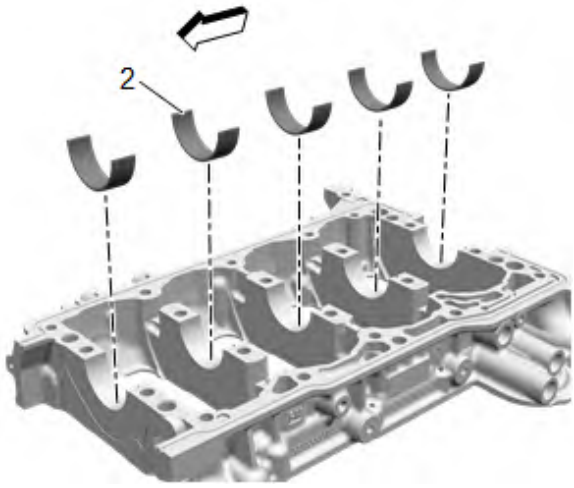


Fig. 505: Crankshaft Lower Bearings
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Crankshaft bearings MUST be separated, marked, or organized in a way to ensure installation to their original location and position, when suitable for use.**

1. Install the lower bearing halves (2), without grooves, into the lower crankcase (1). Apply oil to bearing surfaces.

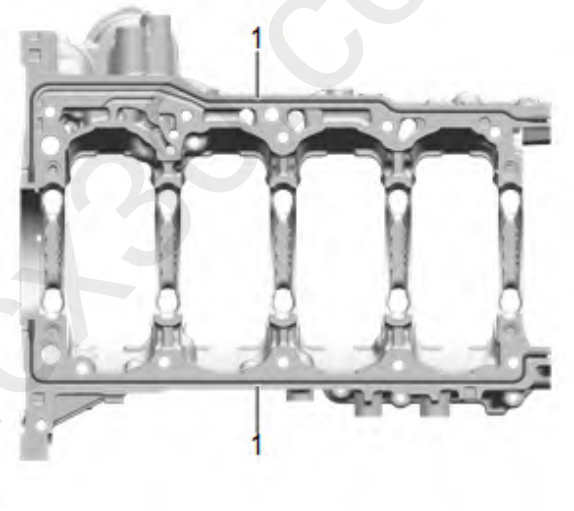


Fig. 506: Applying Bead Of Sealer Directly In Groove
Courtesy of GENERAL MOTORS COMPANY

2. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**

NOTE:

- **The block assembly surface must be free of contamination prior to applying the sealer.**
- **Install and align the bedplate to block within 20 minutes of applying the sealer.**
- **The bedplate must be fastened to final torque specification within 60 minutes of applying the sealer.**

3. Apply a 4.25 mm bead of sealer directly in the groove (1) of the block to bedplate mating surfaces. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

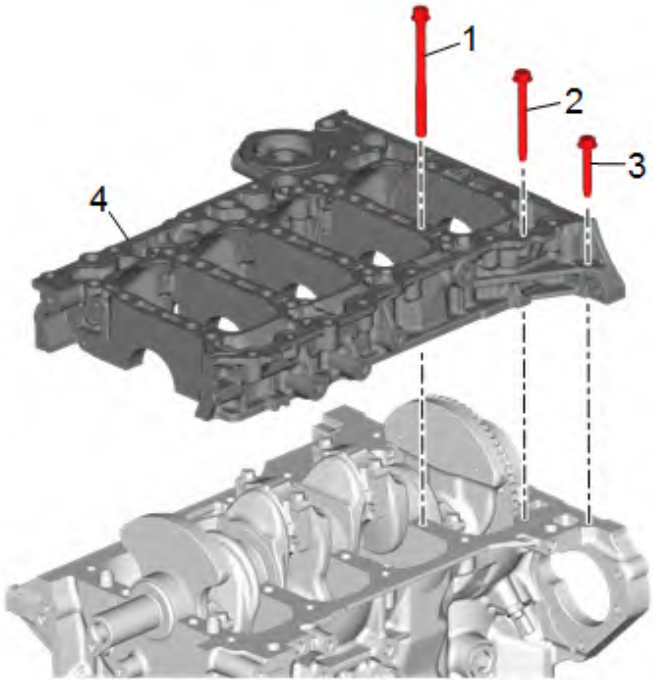


Fig. 507: Lower Crankcase Perimeter Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install the lower crankcase (4). Tap gently into place with a suitable tool if necessary. Ensure it is aligned properly on the dowels.

CAUTION: **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.**

5. Install the NEW M10 x 2.00 x 116 lower crankcase bolts (1) at the inner bolt locations finger tight.
6. Install the single M8 x 1.25 x 50 lower crankcase bolt (3) finger tight.
7. Install the M8 x 1.25 x 80 lower crankcase bolts (2) at the crankcase perimeter finger tight.

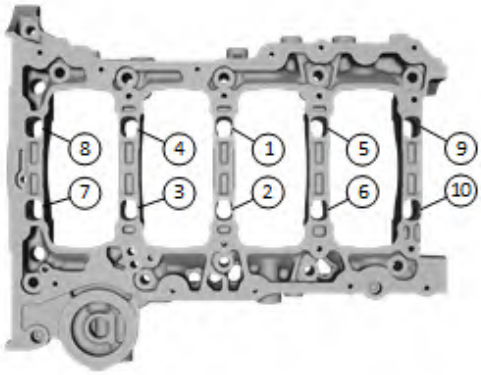


Fig. 508: Crankshaft Bearing Bolts tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

8. tighten the NEW M10 x 2.00 x 116 lower crankcase bolts in sequence using the following procedure:
    1. tighten the lower crankcase bolts a first pass in sequence to 20 N.m (15 lb ft).
    2. tighten the lower crankcase bolts a final pass in sequence using the **EN 45059** meter an additional 140 degrees.

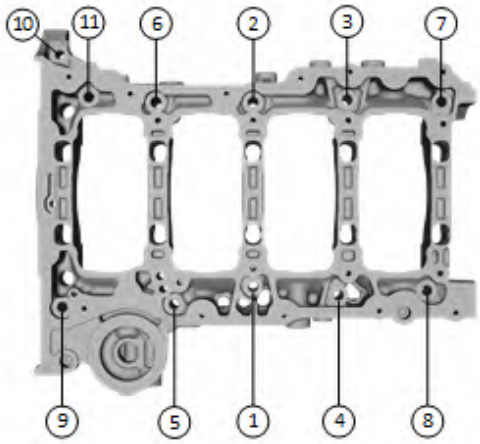


Fig. 509: Lower Crankcase Perimeter Bolts tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

9. tighten the lower crankcase bolts at the crankcase perimeter in sequence to 25 N.m (18 lb ft).

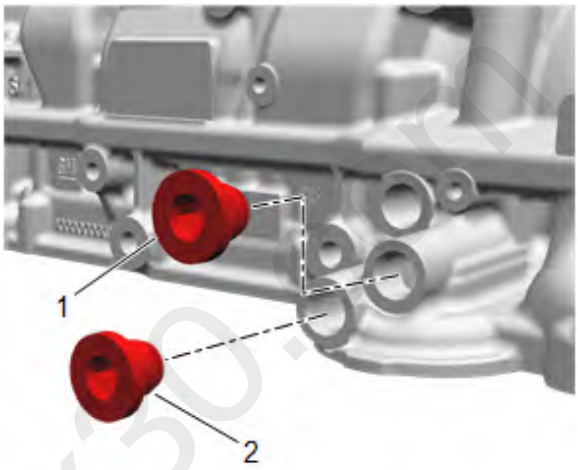


Fig. 510: Oil Gallery Plugs
Courtesy of GENERAL MOTORS COMPANY

10. Install the engine oil gallery plugs (1, 2). tighten the plugs to 65 N.m (48 lb ft).

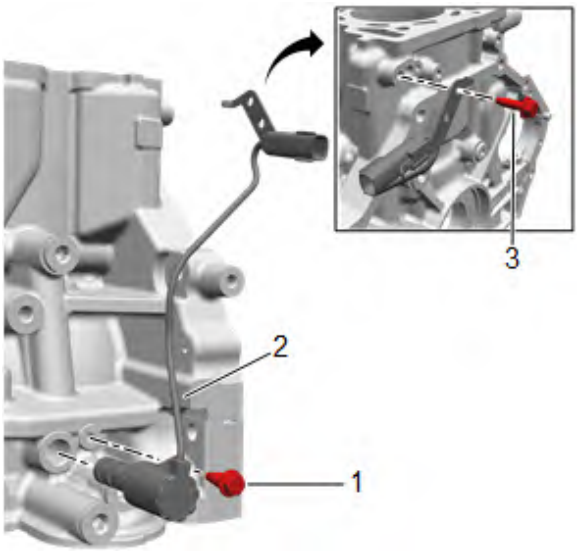


Fig. 511: Oil Pump Flow Control Valve And Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Install the oil pump flow control valve (2) and bolts (1, 3). tighten the bolts to 10 N.m (89 lb in).

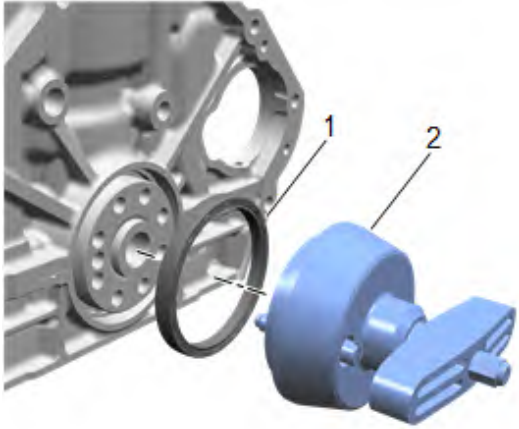


Fig. 512: Crankshaft Rear Oil Seal And Installer
Courtesy of GENERAL MOTORS COMPANY

12. Using **EN-51380** installer (2), install the crankshaft rear oil seal (1) flush or recessed up to 0.5 mm to block.
13. Rotate the crankshaft to ensure that it moves freely and does not bind.
14. Measure and record the crankshaft endplay. Refer to **Engine Mechanical Specifications**.

PISTON, CONNECTING ROD, AND BEARING INSTALLATION

NOTE: **This procedure is not used in Europe.**

Special Tools

- **EN-43953** Ring Compressor - 86 mm
- **EN-43966** Connecting Rod Guides
- **EN 45059** Angle Meter

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

mcx30.com

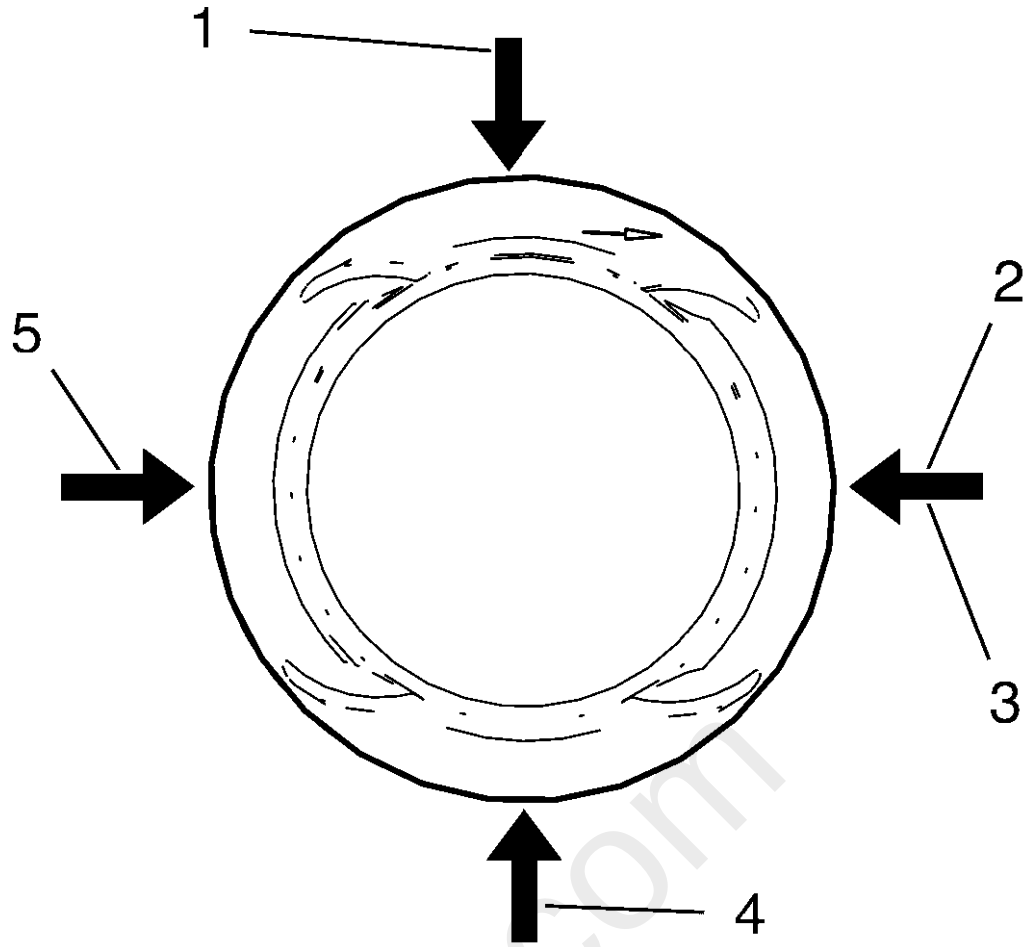


Fig. 513: Oil Ring Joints, Lower Compression Ring Joint, Upper Compression Ring Joint And Oil Ring Spacer Joint
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the piston ring end gaps are positioned 90 degrees to each other.
    - Upper compression ring joint (1)
    - Lower compression ring joint (2)
    - Upper oil ring rail joint (5)
    - Oil ring rail spacer joint (4)
    - Lower oil ring rail joint (3)

mcx30.com

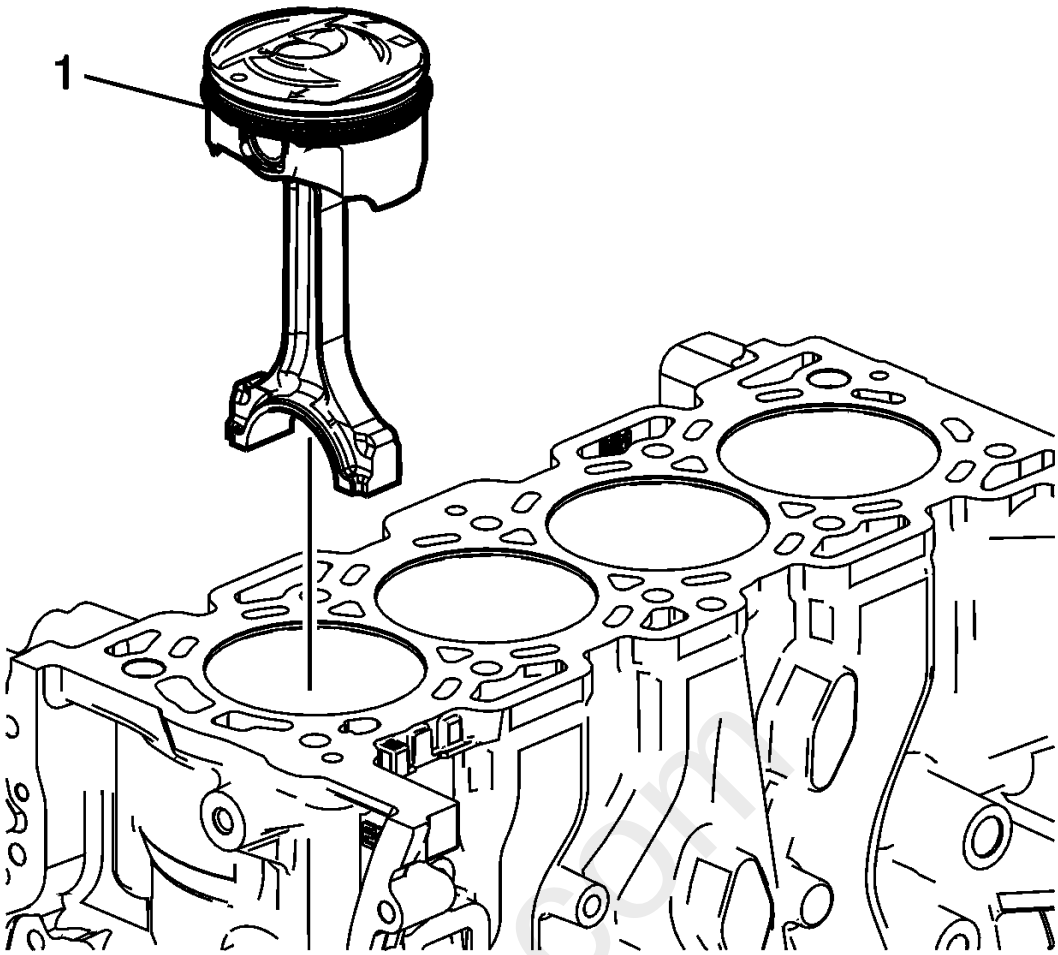


Fig. 514: Piston And Connecting Rod Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The connecting rods and caps must be installed in the same order and orientation in which they were removed. If new connecting rods are required, the connecting rod is provided as an assembly, and the upper rod will need to be disassembled from the lower cap.**

2. Install the connecting rod bearings. Use NEW bearings.

   NOTE: **The connecting rod bearing anti-rotation tab grooves are to point toward the right-hand side of the engine.**

   1. Install the bearing inserts into the connecting rod and the connecting rod cap.
   2. Lubricate the connecting rod bearings with engine oil.
3. Install the **EN-43966** guides (2) into the connecting rod bolt holes. This protects the crankshaft journal during piston and connecting rod installation.
4. Install **EN-43953** compressor, piston (1), and the connecting rod to the correct bore.
   1. Lubricate the piston and the piston rings with engine oil.
   2. Do not disturb the piston ring end gap location.
   3. The piston must be installed so that the arrow mark on the top of the piston points to the front of the engine.
   4. Lubricate the engine bore with engine oil, then place the piston in its matching bore.
   5. Tap the piston into its bore with a hammer handle. Guide the connecting rod to the connecting rod journal while tapping the piston into place.
   6. Hold the **EN-43953** compressor against the engine block until all the rings have entered the cylinder bore.
   7. Remove the connecting rod guides from the connecting rod bolt holes.

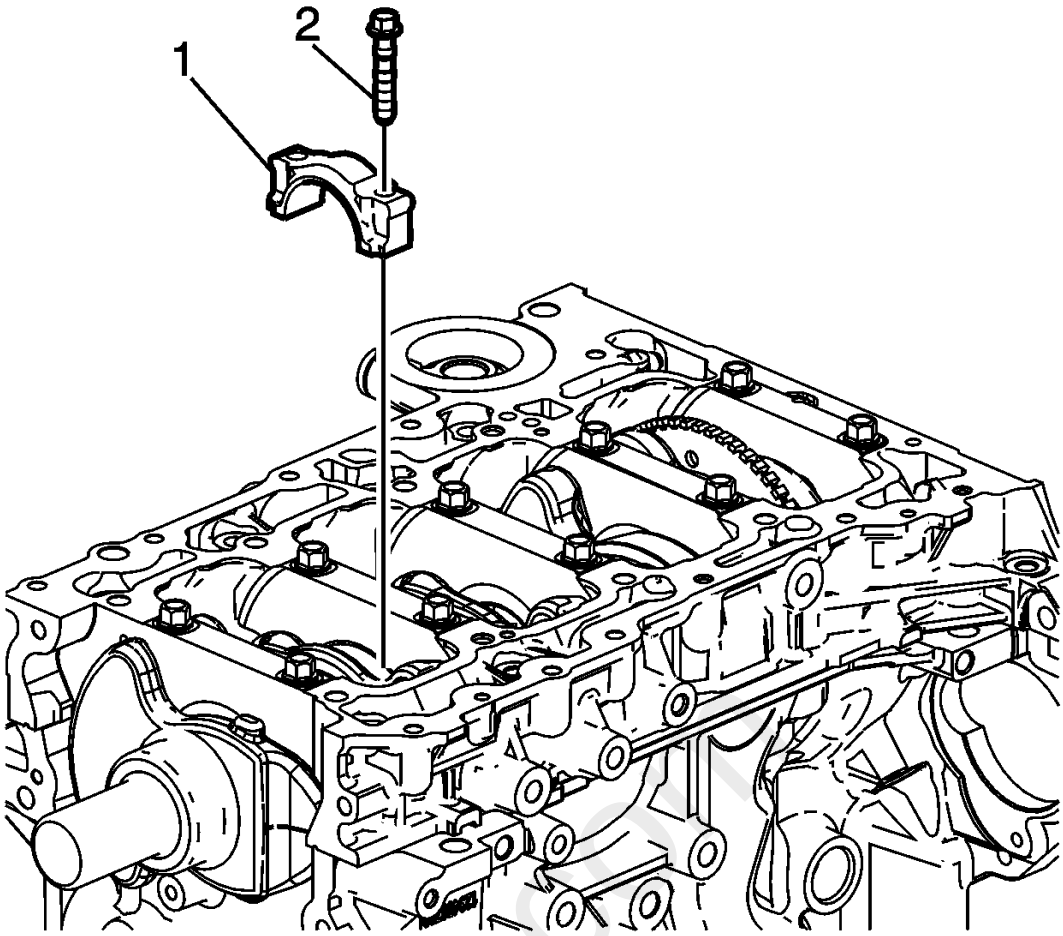


Fig. 515: Connecting Rod Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that the connecting rod cap is properly oriented on the connecting rod.**

5. Install the connecting rod cap (1).

CAUTION: **Refer to Fastener Caution .**

CAUTION: **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.**

6. Install the NEW connecting rod bolts (2).
    1. tighten all the connecting rod bolts a first pass to 25 N.m (18 lb ft).
    2. tighten all the connecting rod bolts a final pass an additional 110 degrees using the **EN 45059** meter.
7. Install the remaining connecting rods and piston assemblies.

mcx30.com

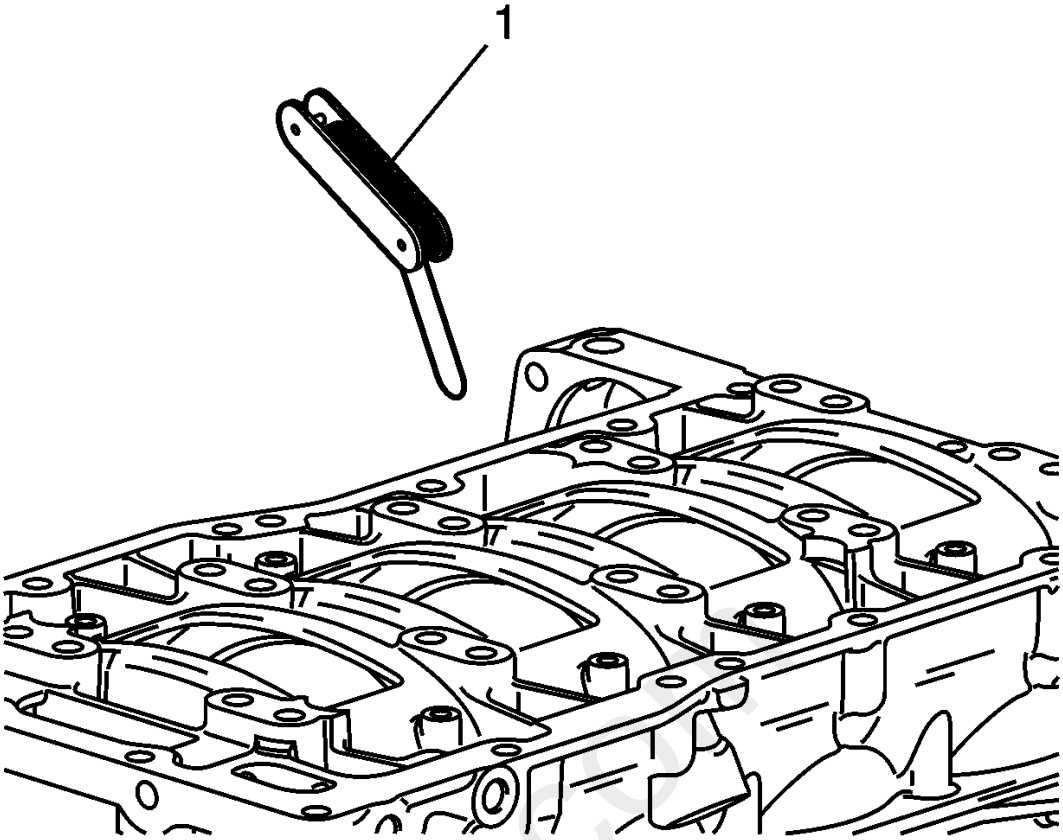


Fig. 516: View of Checking Rod Side Clearance With Feeler Gage
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Rotate the crankshaft to ensure that it moves freely and does not bind.**

8. Measure the connecting rod side clearance with a feeler gauge (1). Refer to **Engine Mechanical Specifications**.
9. Measure the piston deck height. Refer to **Engine Mechanical Specifications**.

BALANCER SHAFT WITH OIL PUMP INSTALLATION

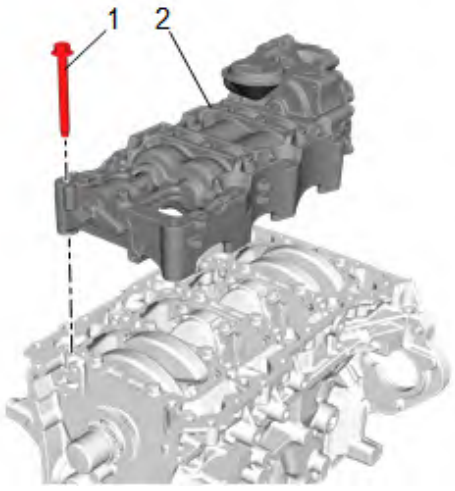


Fig. 517: Balancer And Oil Pump Shaft Assembly Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the balancer and oil pump shaft assembly (2).

2. Install the balancer and oil pump shaft assembly bolts (1) finger tight.

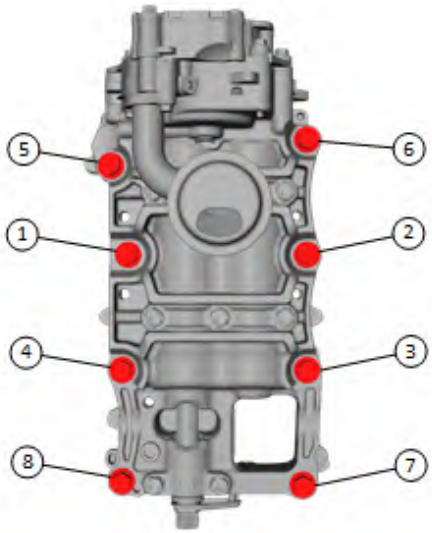


Fig. 518: Bolts Twice In Sequence
Courtesy of GENERAL MOTORS COMPANY

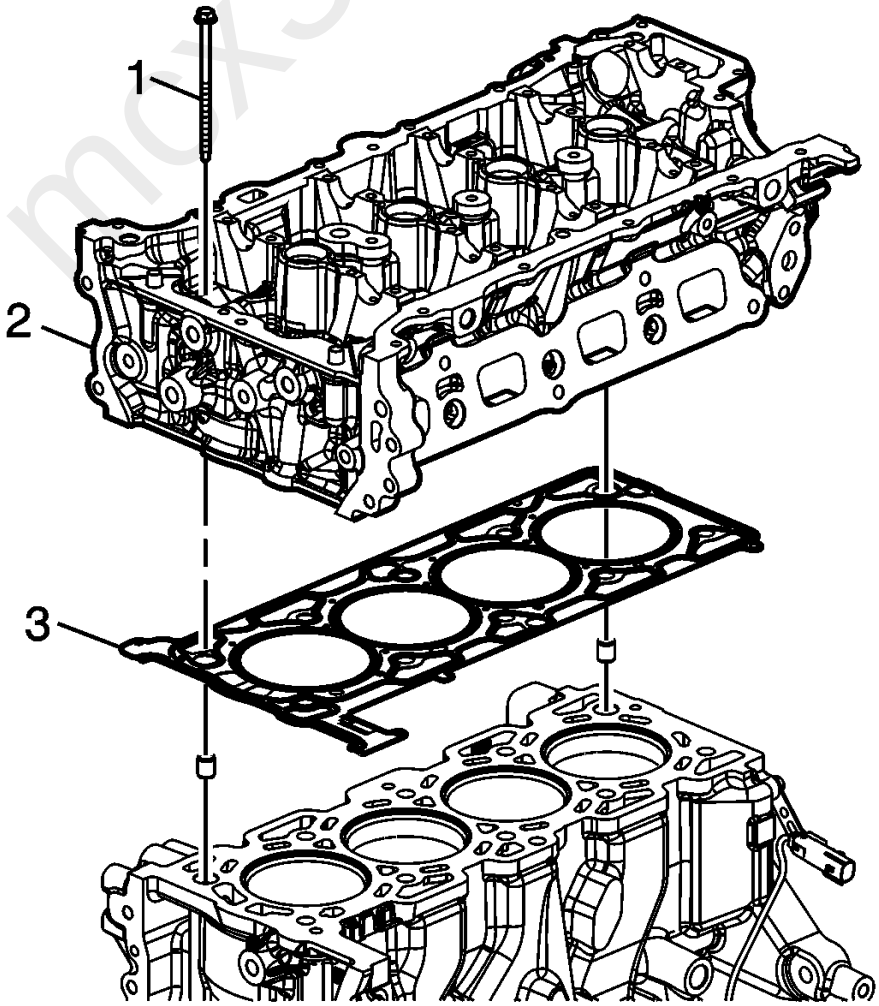
3. tighten the bolts twice in sequence:
    1. tighten the bolts a first pass in sequence to 58 N.m (43 lb ft).
    2. tighten the bolts a final pass in sequence to 58 N.m (43 lb ft).

CYLINDER HEAD INSTALLATION

Special Tools

EN 45059 Angle Meter

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



mgx30.com

Fig. 519: Cylinder Head Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not use any sealing material. Ensure that all mating surfaces are clean and free of debris.**

1. If necessary, install NEW cylinder head locating pins.
2. Install the cylinder head gasket (3) to the block.
3. Install the cylinder head (2). Ensure the number 1 cylinder is at top dead center (TDC). The key on the crankshaft should be on top in the 12 o'clock position.

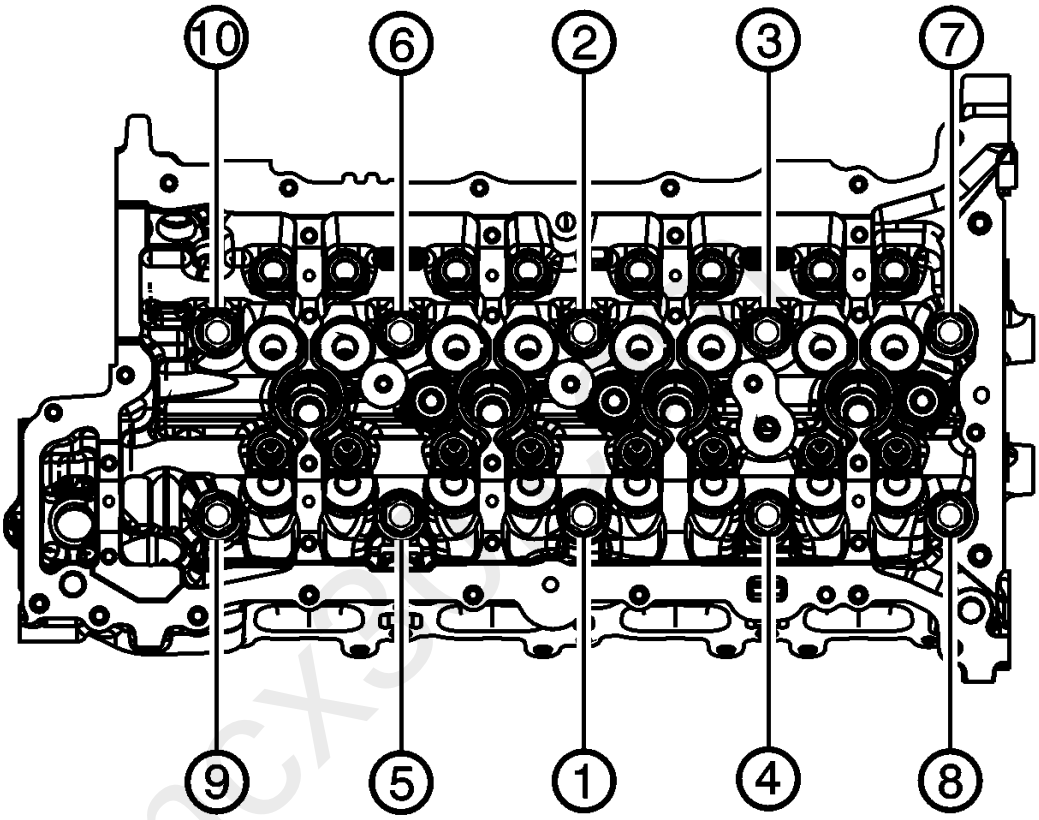


Fig. 520: Cylinder Head Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

CAUTION: **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.**

4. Install the NEW cylinder head bolts.
    1. tighten the bolts in sequence to 30 N.m (22 lb ft).
    2. tighten the bolts an additional 190 degrees in sequence using the **EN 45059** meter.

WATER PUMP INSTALLATION

Prior to installing the water pump, read the entire procedure. Pay special attention to avoid part damage and to ensure proper sealing.

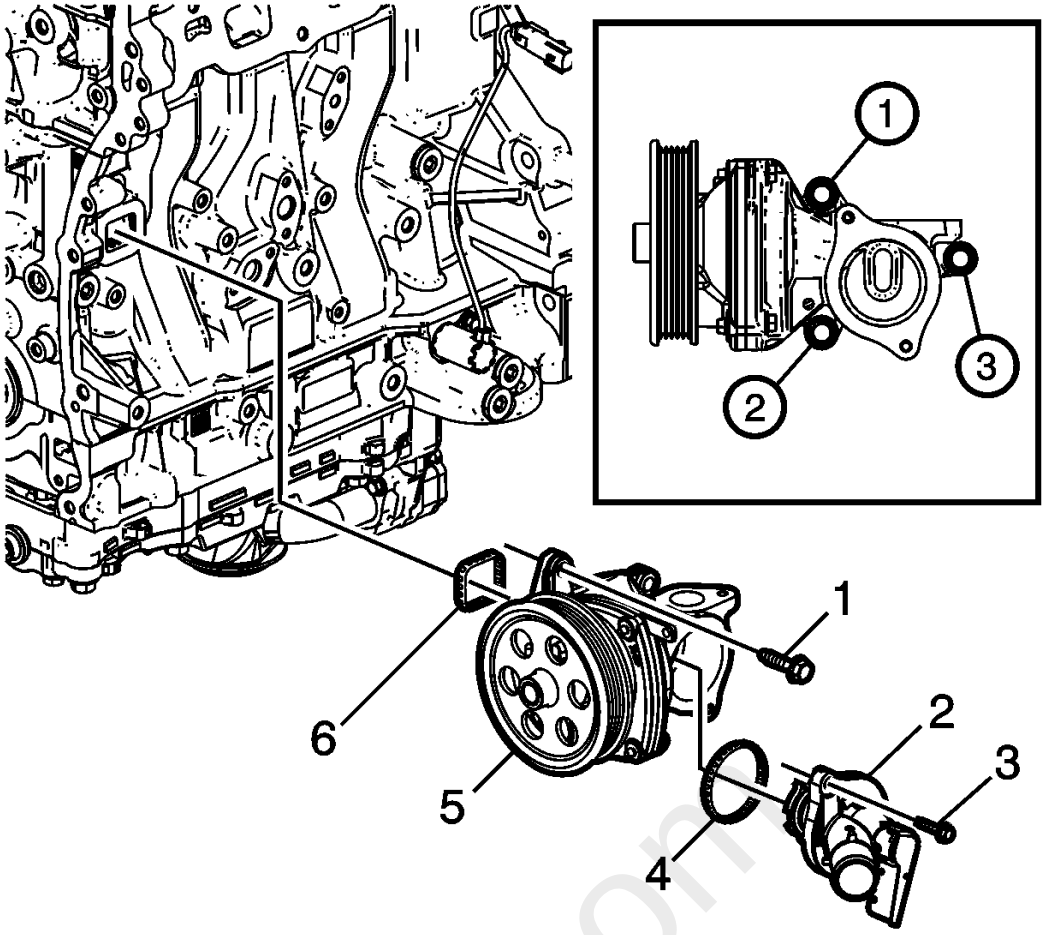


Fig. 521: Water Pump Gasket And Water Pump Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW water pump gasket (6) and the water pump assembly (5).
2. Install the water pump bolts (1). Finger tighten the bolts.

CAUTION: **Refer to Fastener Caution .**

NOTE: **The sequence allows the fasteners closest to compress the seal.**

3. tighten the water pump bolts in sequence to 25 N.m (18 lb ft).
4. Install a NEW thermostat assembly gasket (4) and the thermostat assembly (2).
5. Install the thermostat assembly bolts (3) and tighten to 10 N.m (89 lb in).

mc730.com

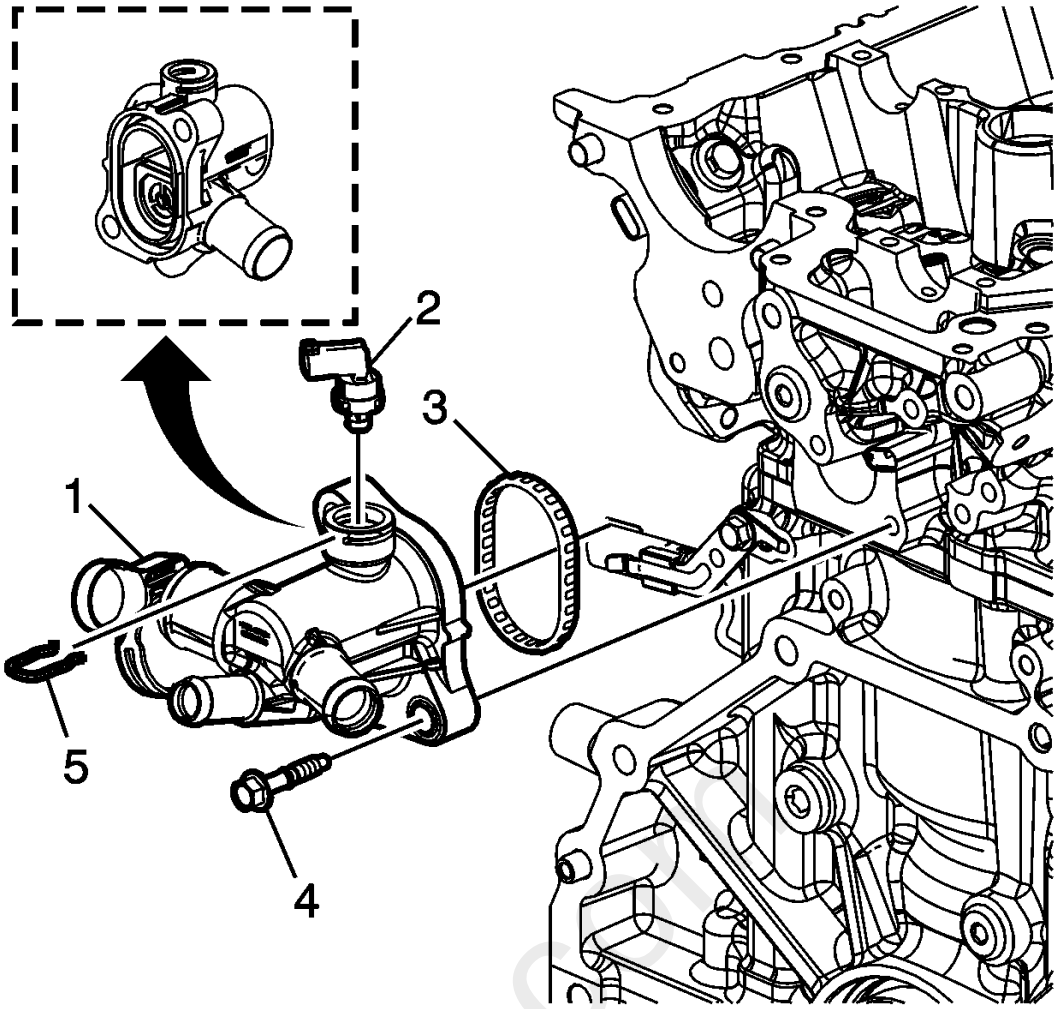


Fig. 522: Retaining Clip And Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

6. Install a NEW water outlet assembly gasket (3), and the water outlet assembly (1).
7. Install the water outlet assembly bolts (4) and tighten to 10 N.m (89 lb in).
8. Install the engine coolant temperature sensor (2).
9. Install the engine coolant temperature sensor retaining clip (5).

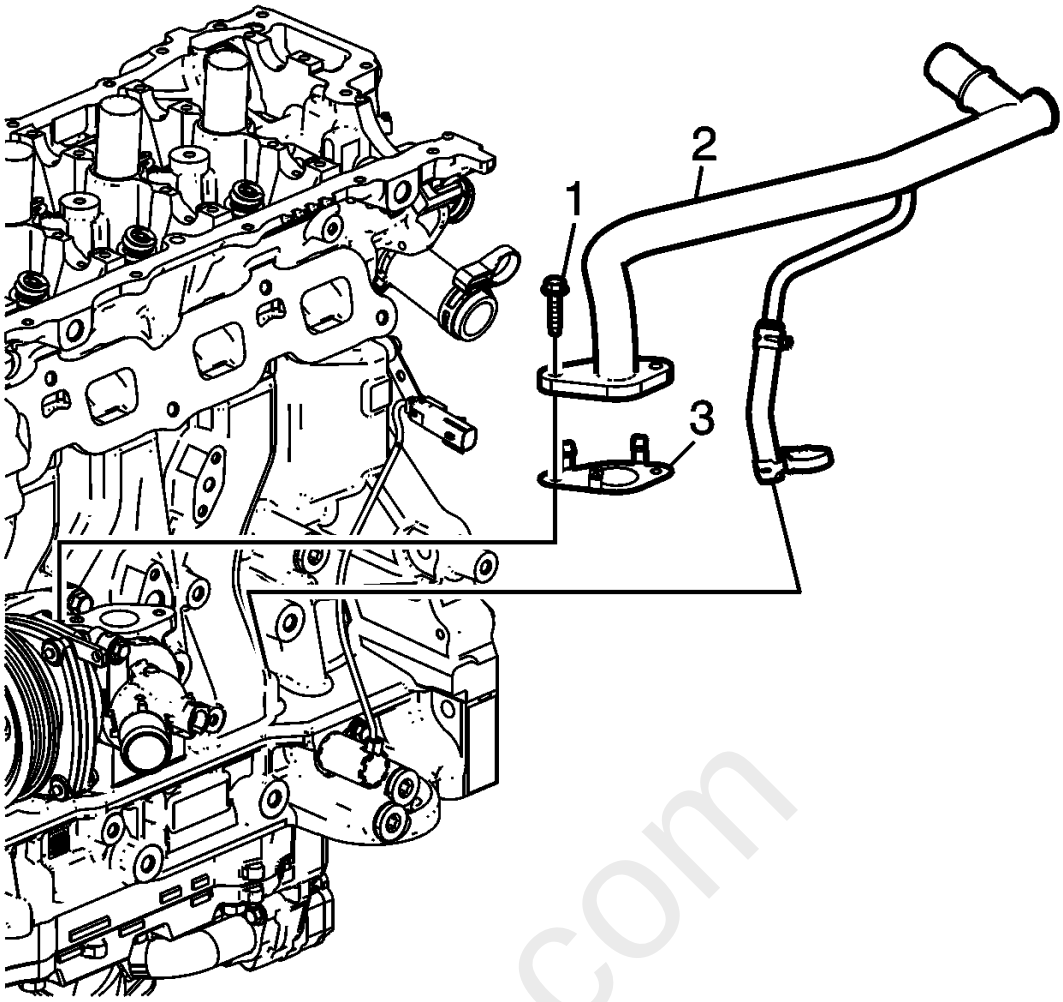


Fig. 523: Thermal Bypass Pipe Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

10. Connect the thermal bypass pipe (2) to the water outlet assembly.
11. Connect the thermal bypass hose to the engine oil cooler.
12. Install a NEW thermal bypass pipe gasket (3) on the thermal bypass pipe. Install the thermal bypass pipe to the water pump assembly. Install the bolts (1) and tighten to 10 N.m (89 lb in).

INTAKE AND EXHAUST CAMSHAFT, BEARING CAP, AND LASH ADJUSTER INSTALLATION

Exhaust Camshaft Installation

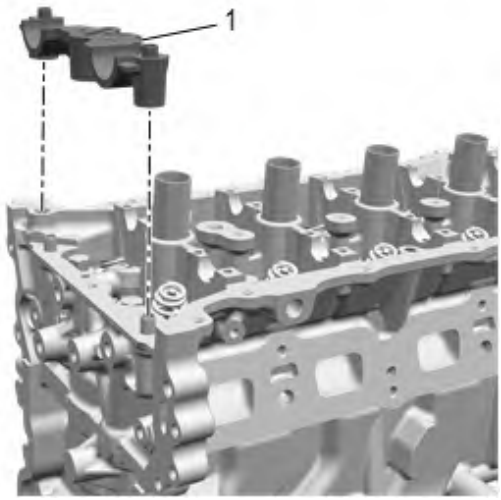


Fig. 524: Camshaft Bearing Lower Front Cap
Courtesy of GENERAL MOTORS COMPANY

1. Install the camshaft bearing lower front cap (1).

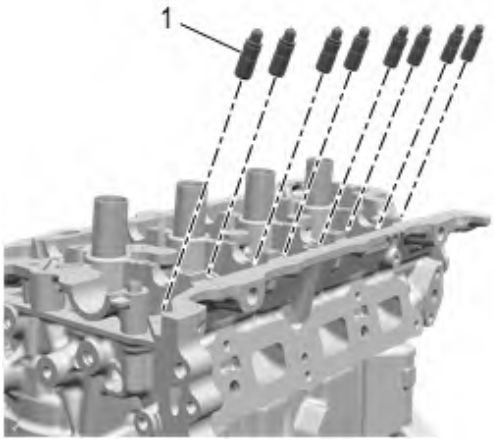


Fig. 525: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Pre-fill the low pressure chamber with engine oil. Maintain a vertical orientation of the assembly to retain the oil in the reservoir and high pressure chamber. Do not install the lash adjusters without pre-filling the low pressure chamber. Apply engine oil to the outer diameter surface of all adjusters.**

2. Lubricate and install the hydraulic valve lash adjusters (1) into their bores in the cylinder head. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

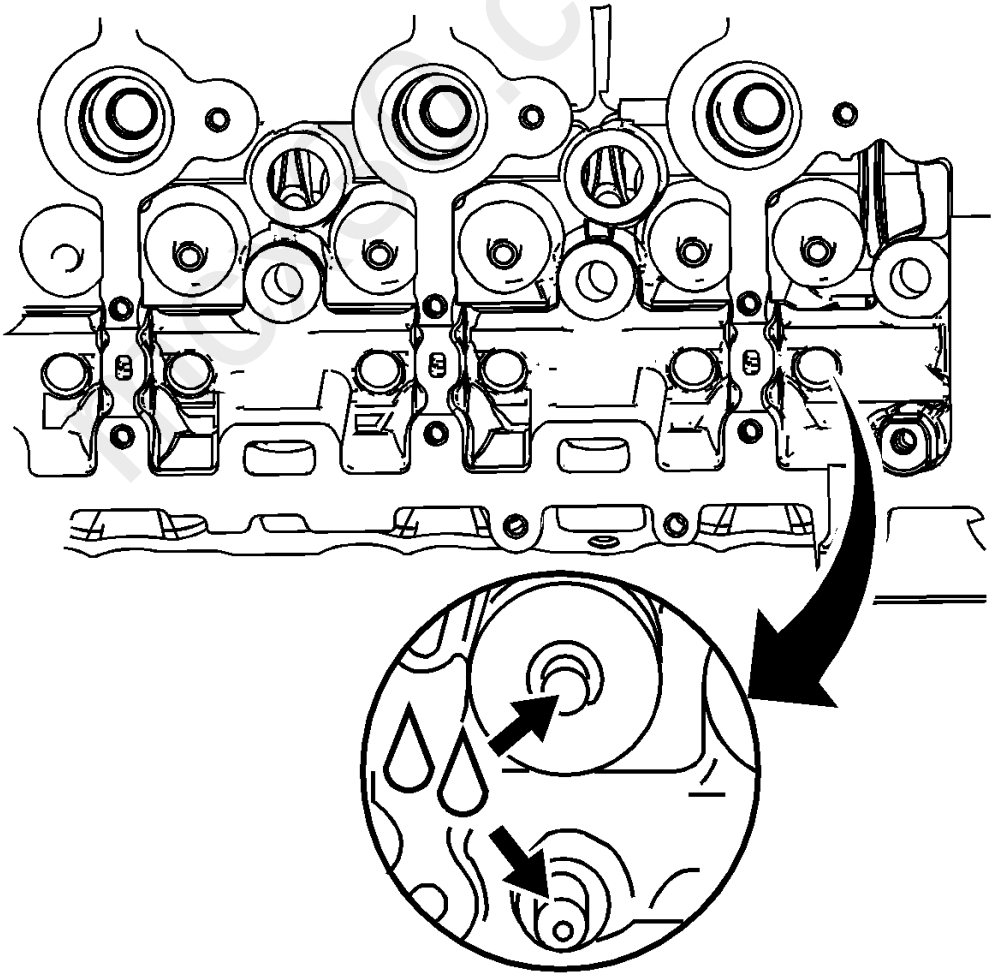


Fig. 526: Valve Tips
Courtesy of GENERAL MOTORS COMPANY

3. Lubricate the valve tips. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

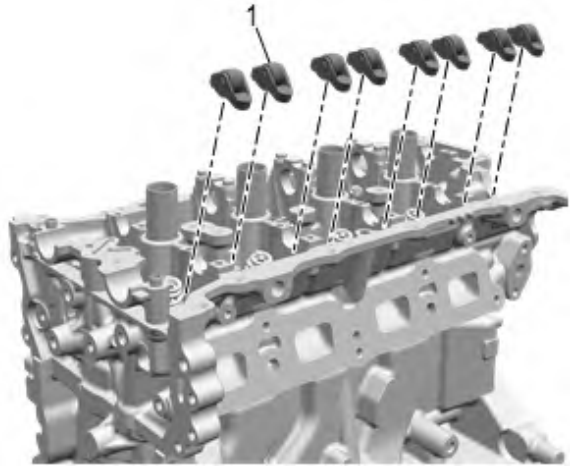


Fig. 527: Exhaust Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Used rocker arms must be returned to the original position on the camshaft. If the camshaft is being replaced, the rocker arms actuated by the camshaft must also be replaced.**

NOTE: **Pre-oil roller bearings before installation.**

4. Lubricate the roller bearings with valve rocker arm lubricant. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
5. Position the valve rocker arm (1) on the tip of the valve stem and on the lash adjuster and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

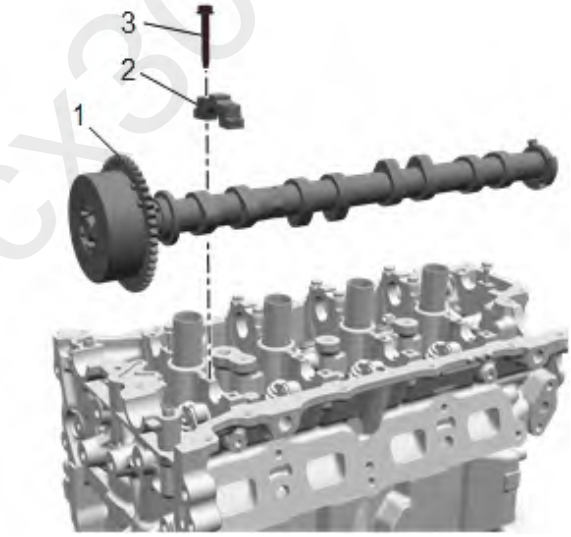


Fig. 528: Camshaft Caps
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Apply lubricant to all lobes and journals prior to installing the camshafts.**

6. Lubricate the exhaust camshaft lobes and journals with camshaft lubricant. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
7. Set the exhaust camshaft (1) on top of the rocker arms in the camshaft bearing journals with the actuator timing mark at approximately the 1 O'clock position.

NOTE:

- **Do not apply final torque at this time. Camshaft cap final torque is applied in sequence when all caps are installed on both intake and exhaust camshafts.**
- **To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the**

mcx30.com

camshafts.

8. Install the camshaft cap bolts (3) into the camshaft caps (2).
9. Install the camshaft caps (2) and hand start the camshaft cap bolts (3).

Intake Camshaft Installation

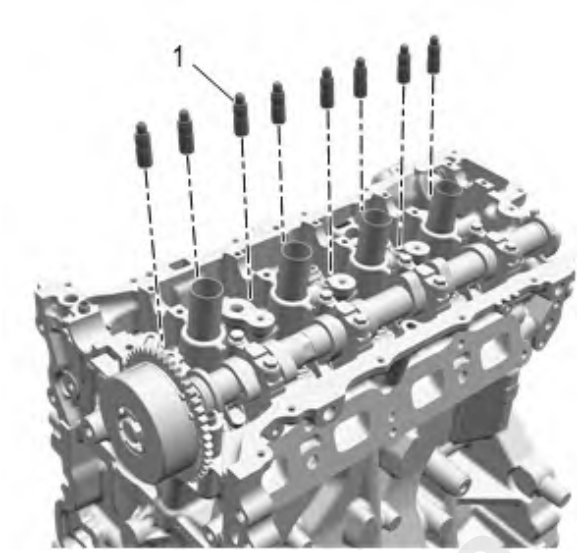


Fig. 529: Hydraulic Lash Adjusters
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Pre-fill the low pressure chamber with engine oil. Maintain a vertical orientation of the assembly to retain the oil in the reservoir and high pressure chamber. Do not install the lash adjusters without pre-filling the low pressure chamber. Apply engine oil to the outer diameter surface of all adjusters.**

1. Lubricate and install the hydraulic valve lash adjusters (1) into their bores in the cylinder head. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

mcx30.com

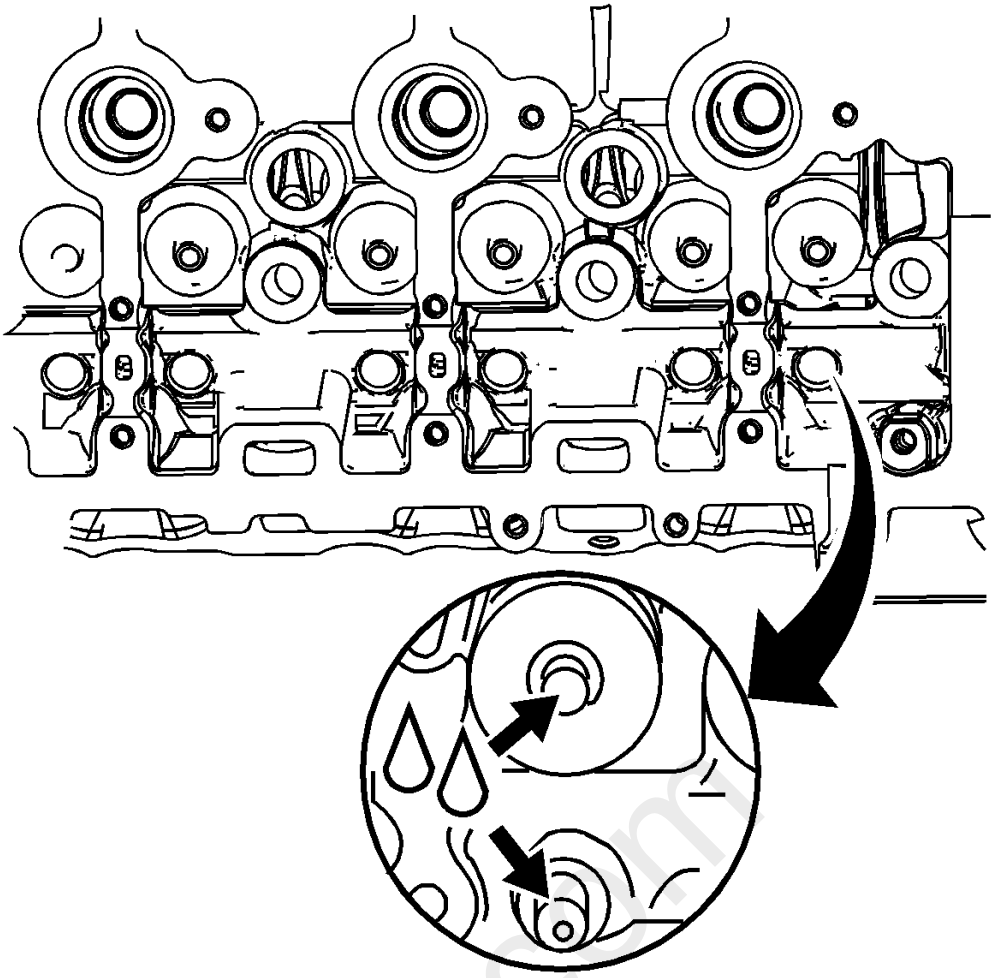


Fig. 530: Valve Tips
Courtesy of GENERAL MOTORS COMPANY

2. Lubricate the valve tips. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

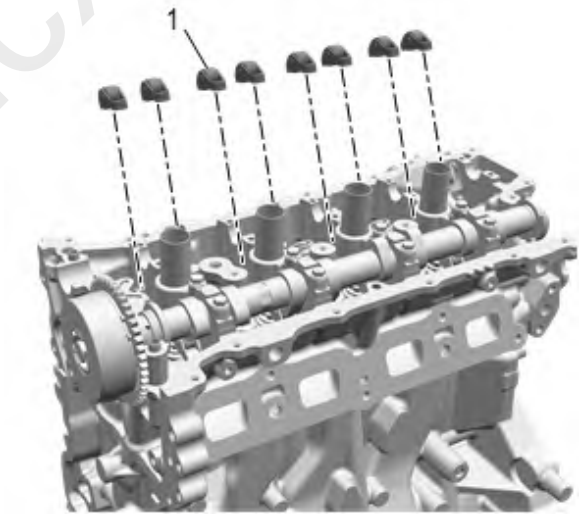


Fig. 531: Intake Camshaft Roller Finger Followers
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Used rocker arms must be returned to the original position on the camshaft. If the camshaft is being replaced, the rocker arms actuated by the camshaft must also be replaced.**

NOTE: **Pre-oil roller bearings before installation.**

3. Lubricate the roller bearings with valve rocker arm lubricant. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

mcx30.com

4. Position the valve rocker arm (1) on the tip of the valve stem and on the lash adjuster and lubricate. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

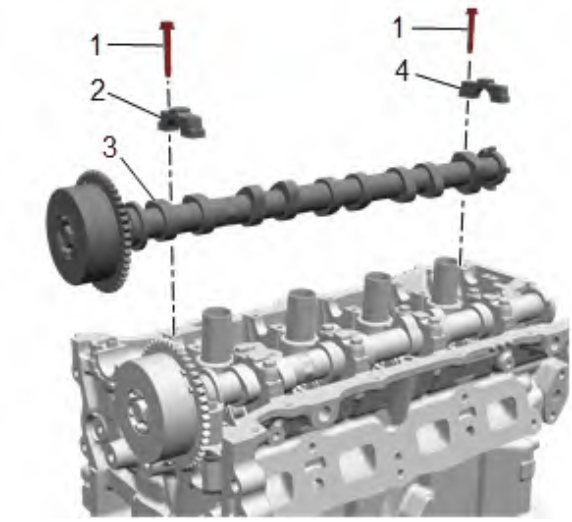


Fig. 532: Intake Camshaft Bearing Rear Cap Bolts And Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Apply lubricant to all lobes and journals prior to installing the camshafts.**

5. Lubricate the intake camshaft lobes and journals with camshaft lubricant. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

   Set the intake camshaft (3) on top of the roller followers in the camshaft bearing journals with the intake actuator timing mark at approximately the 11 O'clock position.

NOTE: **To properly position the camshaft caps, install the camshaft cap bolts into the camshaft caps prior to installing the camshaft caps on the camshafts.**

6. Install the camshaft cap bolts (1) into the camshaft caps (2, 4).
7. Install the camshaft caps (2) and hand start the camshaft cap bolts (1).
8. Install the camshaft rear cap (4) and hand start the camshaft cap bolts (1).

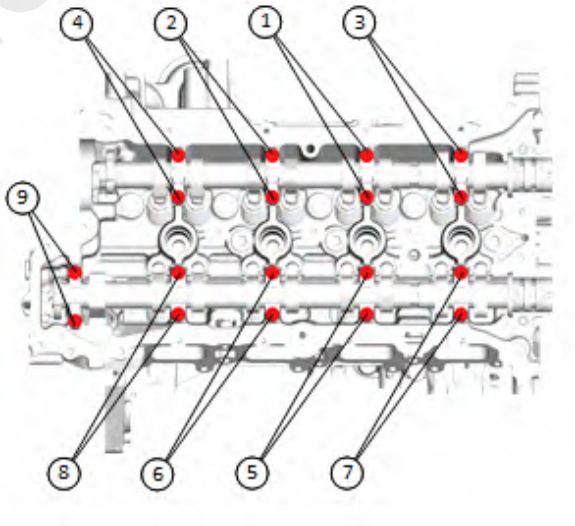


Fig. 533: Camshaft Cap Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

NOTE: **During the tightening sequence, locate and tighten each camshaft cap bolt installed into the circular hole first. Then, tighten the bolt installed into the slotted hole.**

9. tighten the camshaft cap bolts in sequence using the following procedure:
    1. tighten the camshaft cap bolts in sequence to 8 N.m (71 lb in).
    2. Loosen both bolts in each cap in sequence to 180 degrees.
    3. tighten the camshaft cap bolts in sequence to 10 N.m (89 lb in) twice.

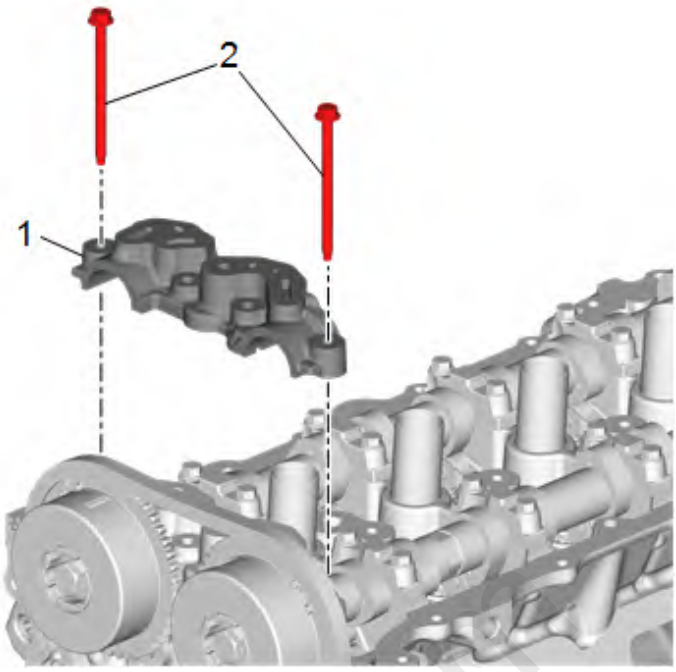


Fig. 534: Front Camshaft Bearing Cap And Outer Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Install the front camshaft bearing cap (1). Install the 2 outer bolts (2) for the front camshaft bearing cap finger tight. Installation of the timing chain guide and bolts, and final torque for the front bearing cap is not performed until after the timing chain is installed.

BALANCER CHAIN, SPROCKET, AND TENSIONER INSTALLATION

Special Tools

EN-50837 Timing Chain Tensioner Retraction Tool

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

mcx30.com

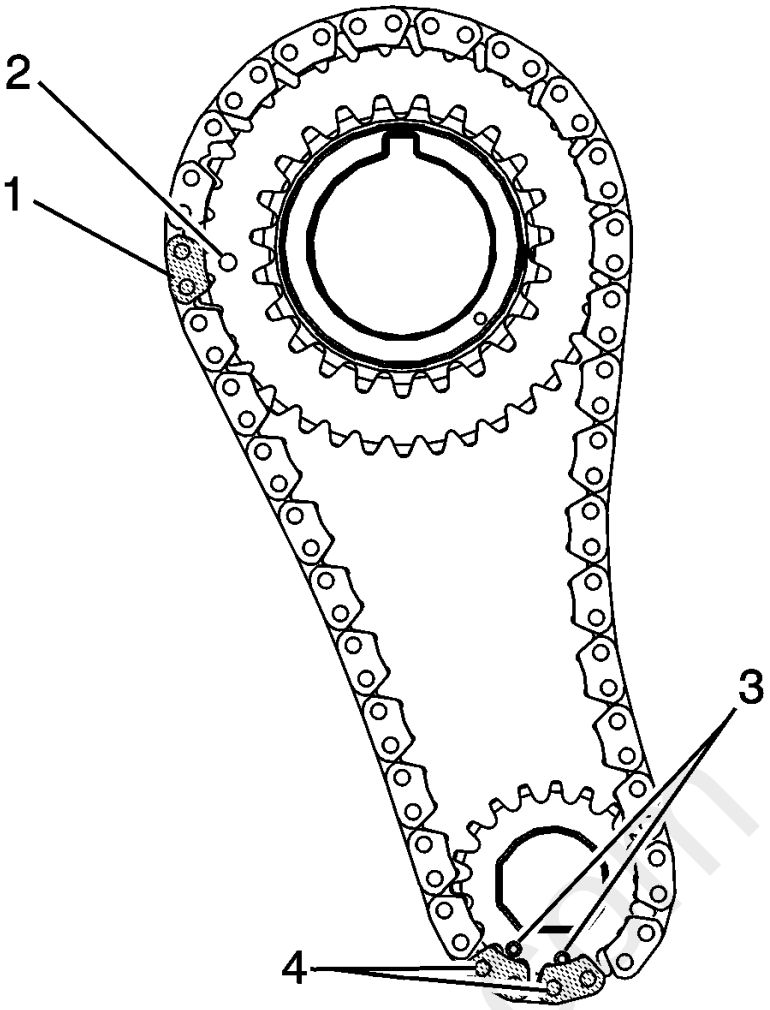


Fig. 535: Timing Link Lines & Timing Mark
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Proper setup is critical to ensure correct timing when installing the sprockets and chain simultaneously onto the shafts. The timing links are heat treated blued steel.**

1. Assemble the crankshaft sprocket, balancer shaft driven sprocket, and balancer chain. Ensure the timing link (1) lines up with the timing mark (2) on the crankshaft sprocket. Ensure that both timing teeth (3) on the balancer shaft driven sprocket line up with the timing links (4).

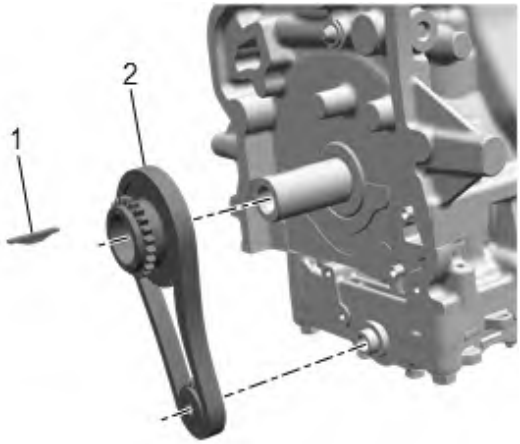


Fig. 536: Balancer Shaft Driven Sprocket And Balancer Chain
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The crankshaft keyway should be in the 12 O'clock position.**

2. Install the sprockets and chain (2) as an assembly to the crankshaft and balancer shaft assembly.
3. Install the crankshaft key (1).

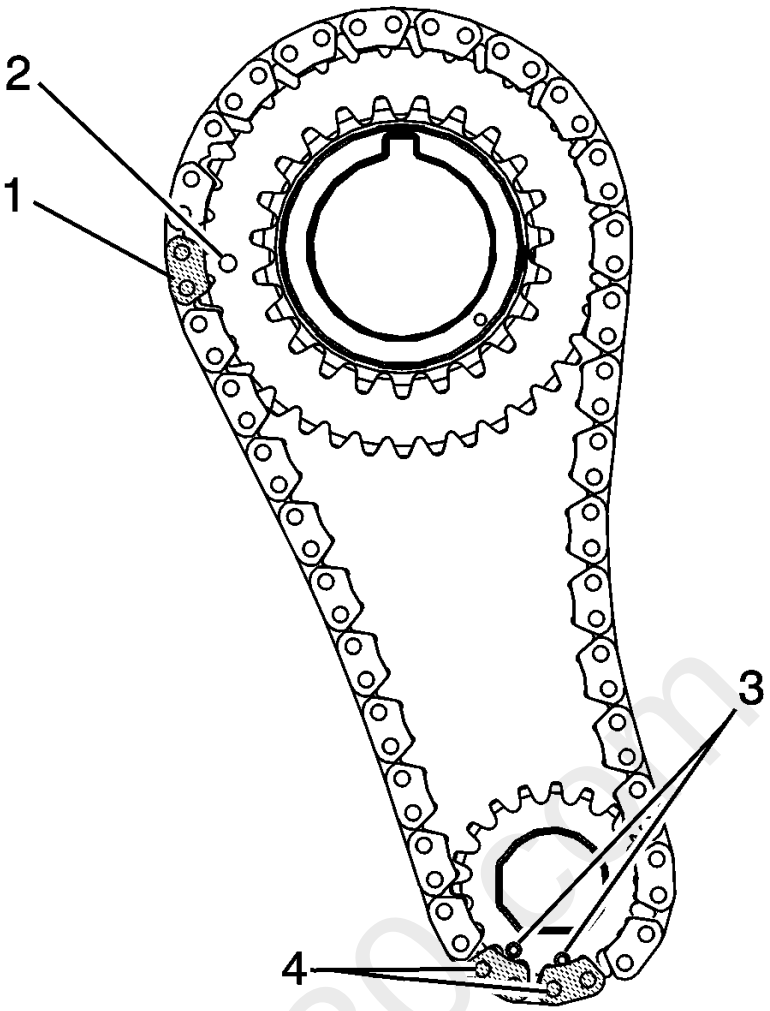


Fig. 537: Timing Link Lines & Timing Mark
Courtesy of GENERAL MOTORS COMPANY

4. Ensure the timing link (1) is aligned with the crankshaft sprocket timing mark (2).
5. Ensure the adjacent timing links (4) are aligned with both of the timing marks (3) on the balancer shaft driven sprocket.

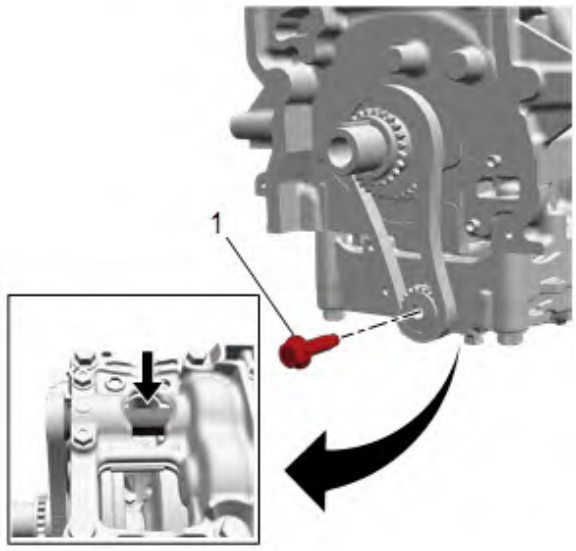


Fig. 538: Balancer Shaft Driven Sprocket Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component.**

Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

6. Install the NEW balancer shaft driven sprocket bolt (1).

CAUTION: **Refer to Fastener Caution .**

7. Use an open end wrench over flat on balance shaft while tightening the balancer shaft sprocket bolt to specification. tighten the balancer shaft driven sprocket bolt to 40 N.m (30 lb ft) plus 50 degrees.

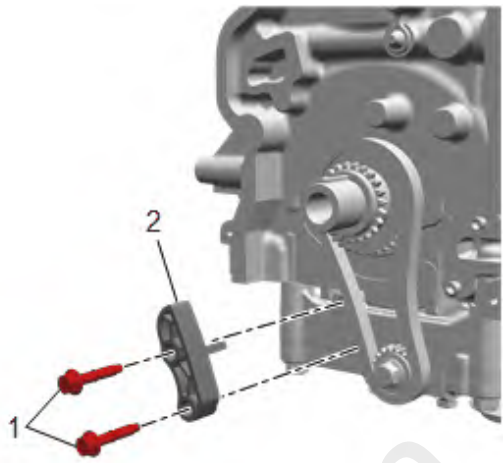


Fig. 539: Balancer Chain Guide Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the guide is installed in the correct orientation. The long end must point toward the crankshaft and the flat edge must be adjacent to the balance chain.**

8. Install the balancer chain guide (2).
9. Install the balancer chain guide bolts (1). tighten the bolts to 10 N.m (89 lb in).

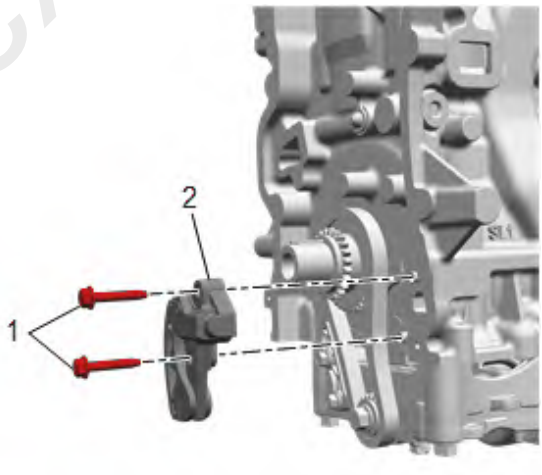


Fig. 540: Balancer Chain Tensioner Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Install the balancer chain tensioner (2).
11. Install the balancer chain tensioner bolts (1). tighten the bolts to 10 N.m (89 lb in).
12. Remove **EN-50837** retention tool to restore the tension to the balancer chain.

OIL PAN INSTALLATION (AWD)

mc130.com

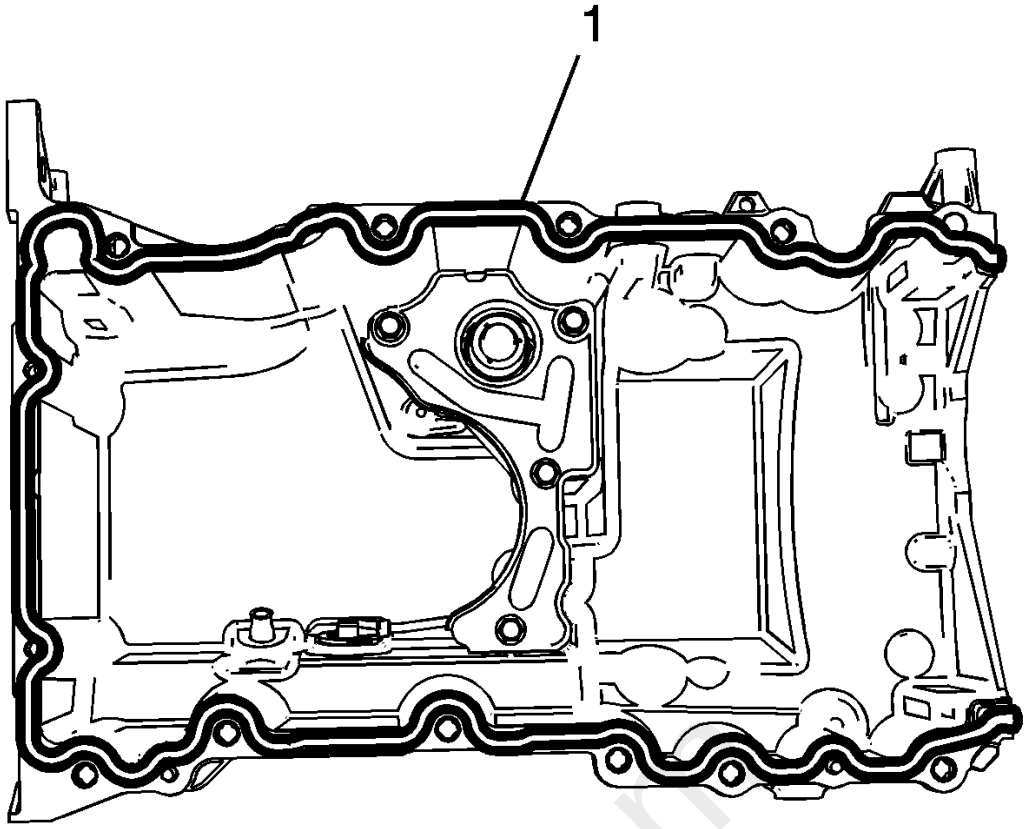


Fig. 541: Engine Oil Pan Sealing Surface
Courtesy of GENERAL MOTORS COMPANY

1. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**

NOTE:

- **The lower crankcase surface must be free of contamination prior to applying the sealer.**
- **Install and align the oil pan to block within 20 minutes of applying the sealer.**
- **The oil pan must be fastened to final torque specification within 60 minutes of applying the sealer.**

2. Apply a 4.25 mm bead of sealer (1) on the level part of the flange around the perimeter of the oil pan. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

mcx30.com

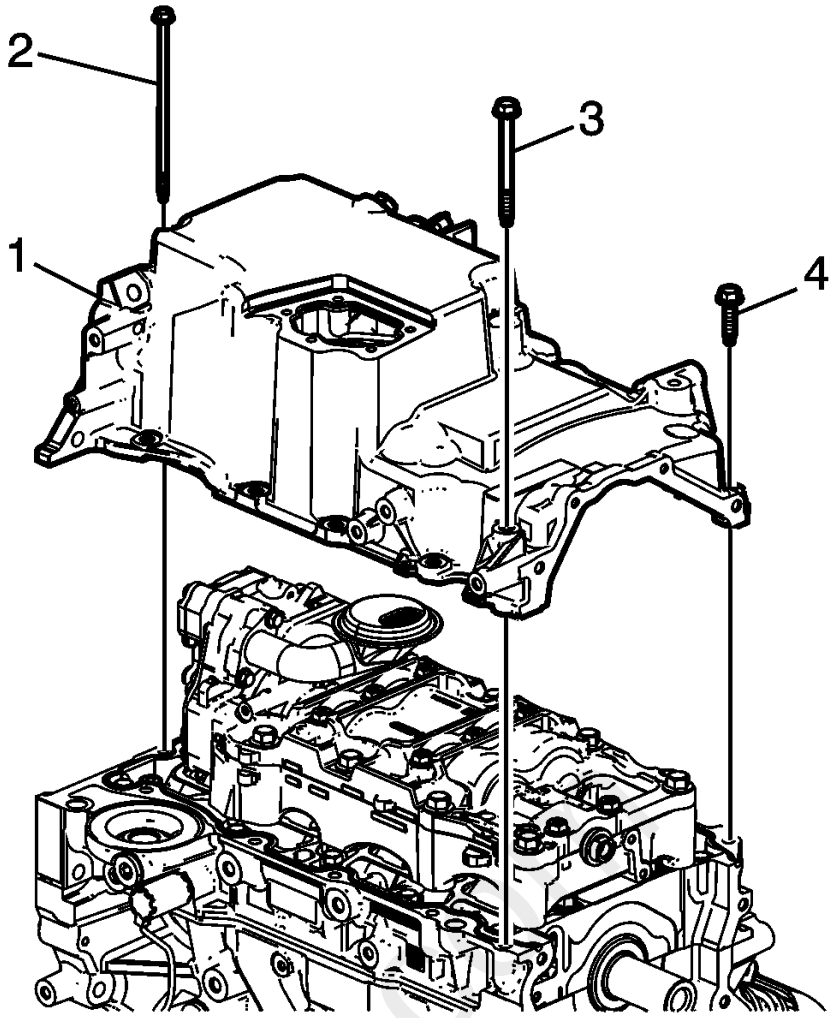


Fig. 542: Upper Oil Pan And Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the oil pan (1).
4. Install the oil pan bolts (2, 3, 4) finger tight.

mc730.com

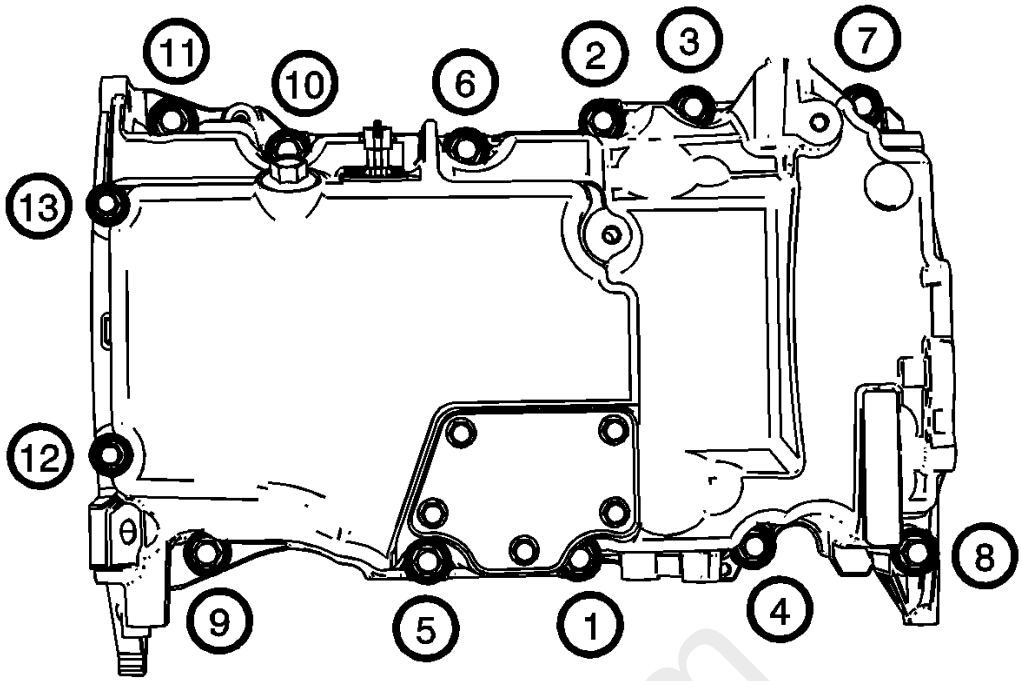


Fig. 543: Oil Pan Bolts Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

5. tighten the oil pan bolts in sequence to final torque twice using the following procedure:
    1. tighten bolts in sequence 1 - 11 to 25 N.m (18 lb ft).
    2. tighten bolts in sequence 12 - 13 to 10 N.m (89 lb in).

mex30.com

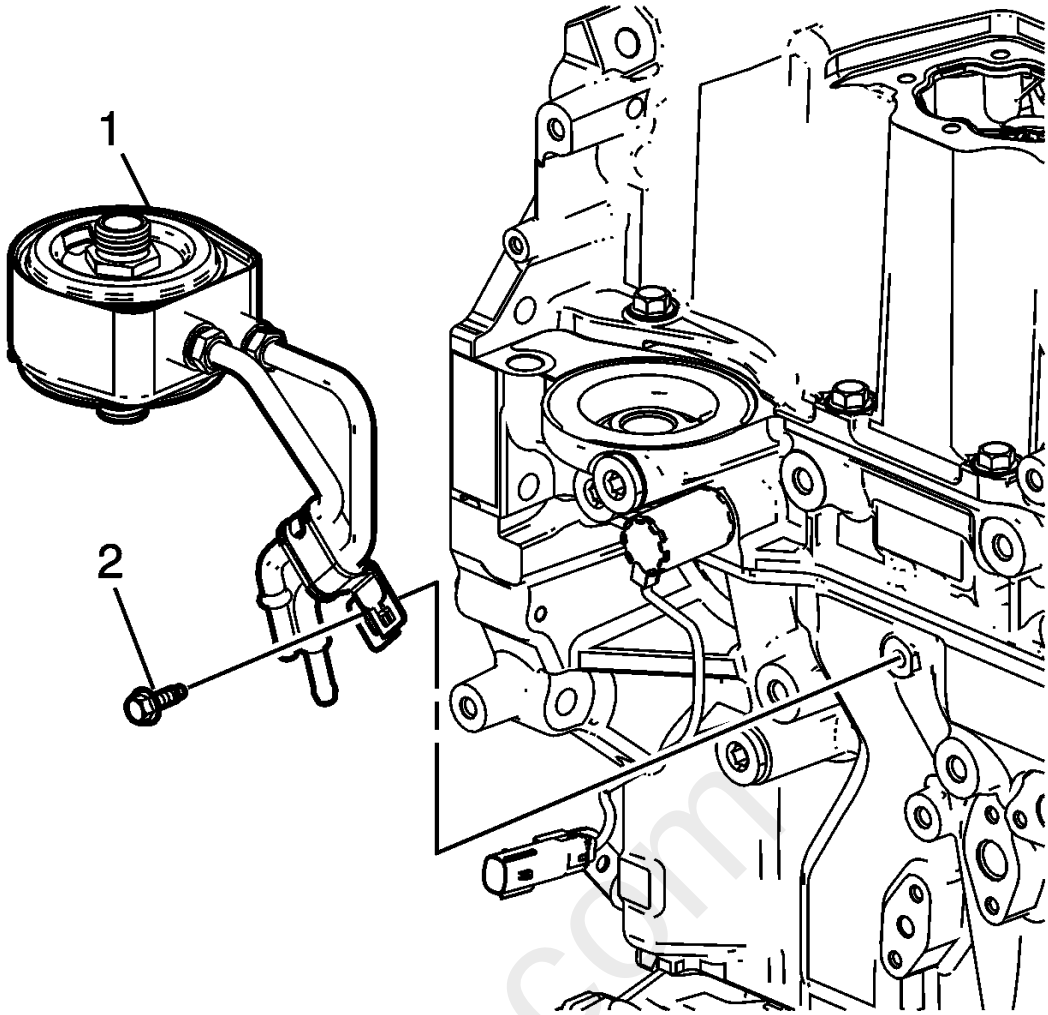


Fig. 544: Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

6. Install the engine oil cooler (1). tighten the engine oil cooler connector to 50 N.m (37 lb ft).
7. Install the engine oil cooler bolt (2) and tighten to 10 N.m (89 lb in).

mc730.com

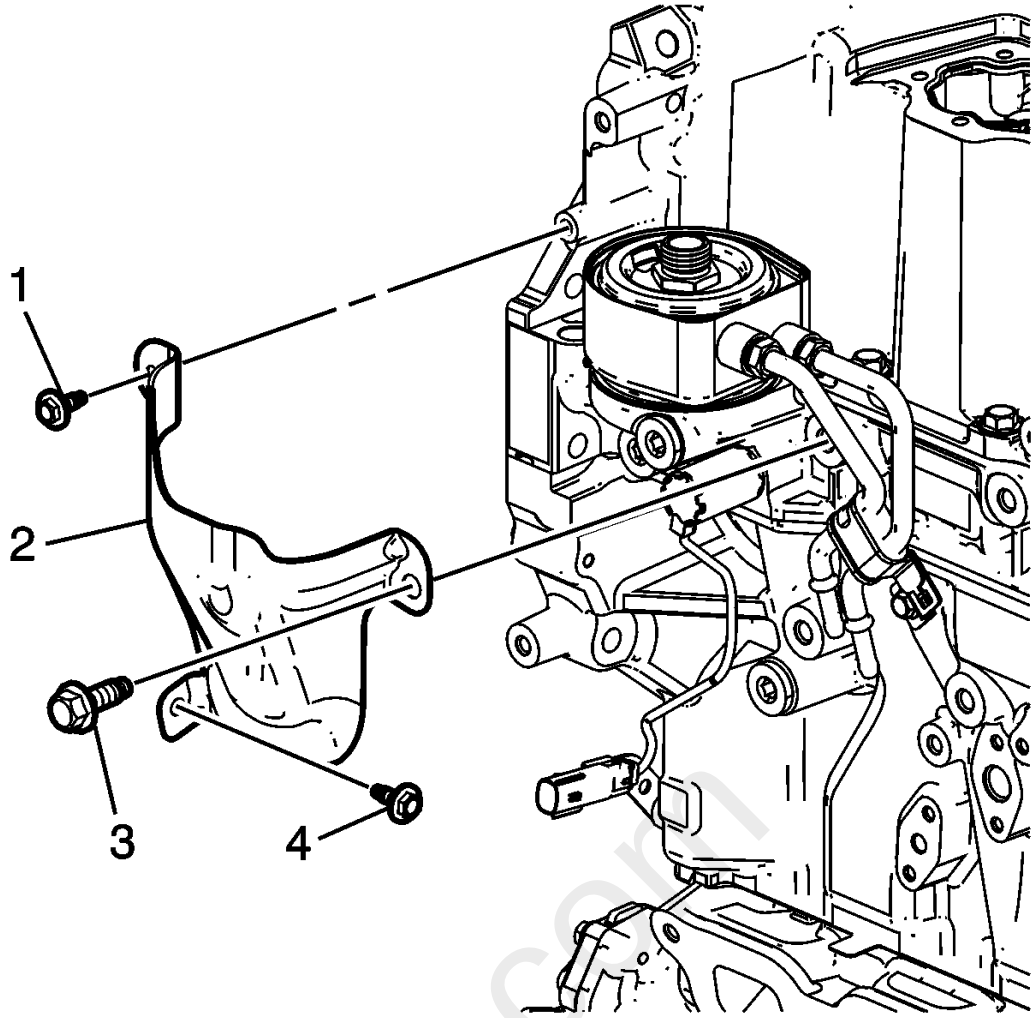


Fig. 545: Oil Pump Flow Control Valve Cover
Courtesy of GENERAL MOTORS COMPANY

8. Install the oil pump flow control valve cover (3).
9. Install the valve cover bolts (1, 4) and tighten to 9 N.m (80 lb in).
10. Install the valve cover bolt (2) and tighten to 58 N.m (43 lb ft).

mo30.com

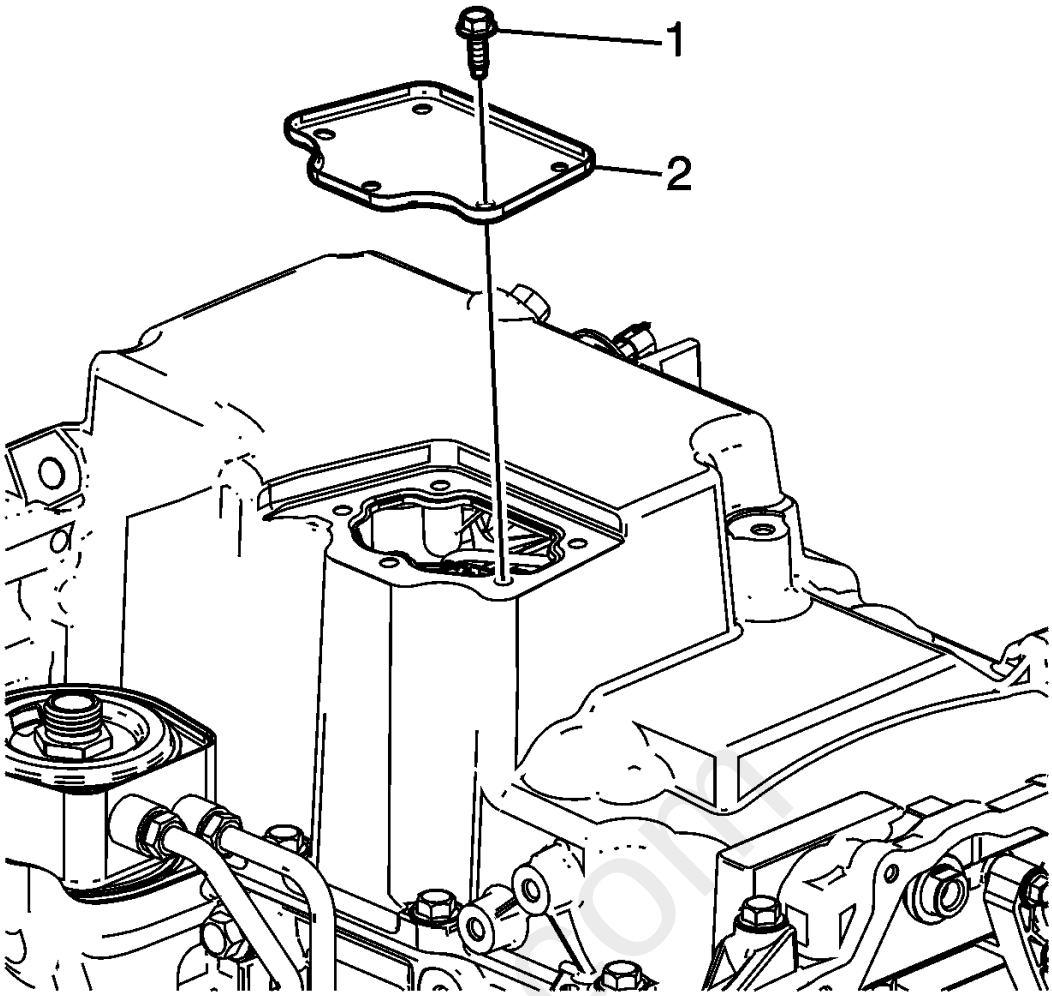


Fig. 546: Oil Pan Cover And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The oil pan sealing surfaces must be free of contamination prior to applying the sealer.**
- **Install and align the oil pans within 20 minutes of applying the sealer.**
- **The oil pans must be fastened to final torque specification within 60 minutes of applying the sealer.**

11. Apply a bead of RTV sealant to the perimeter of the oil pan cover.
12. Install the oil pan cover (2).
13. Install the oil pan cover bolts (1) and tighten to 10 N.m (89 lb in).

OIL PAN INSTALLATION (FWD)

Lower Oil Pan Installation

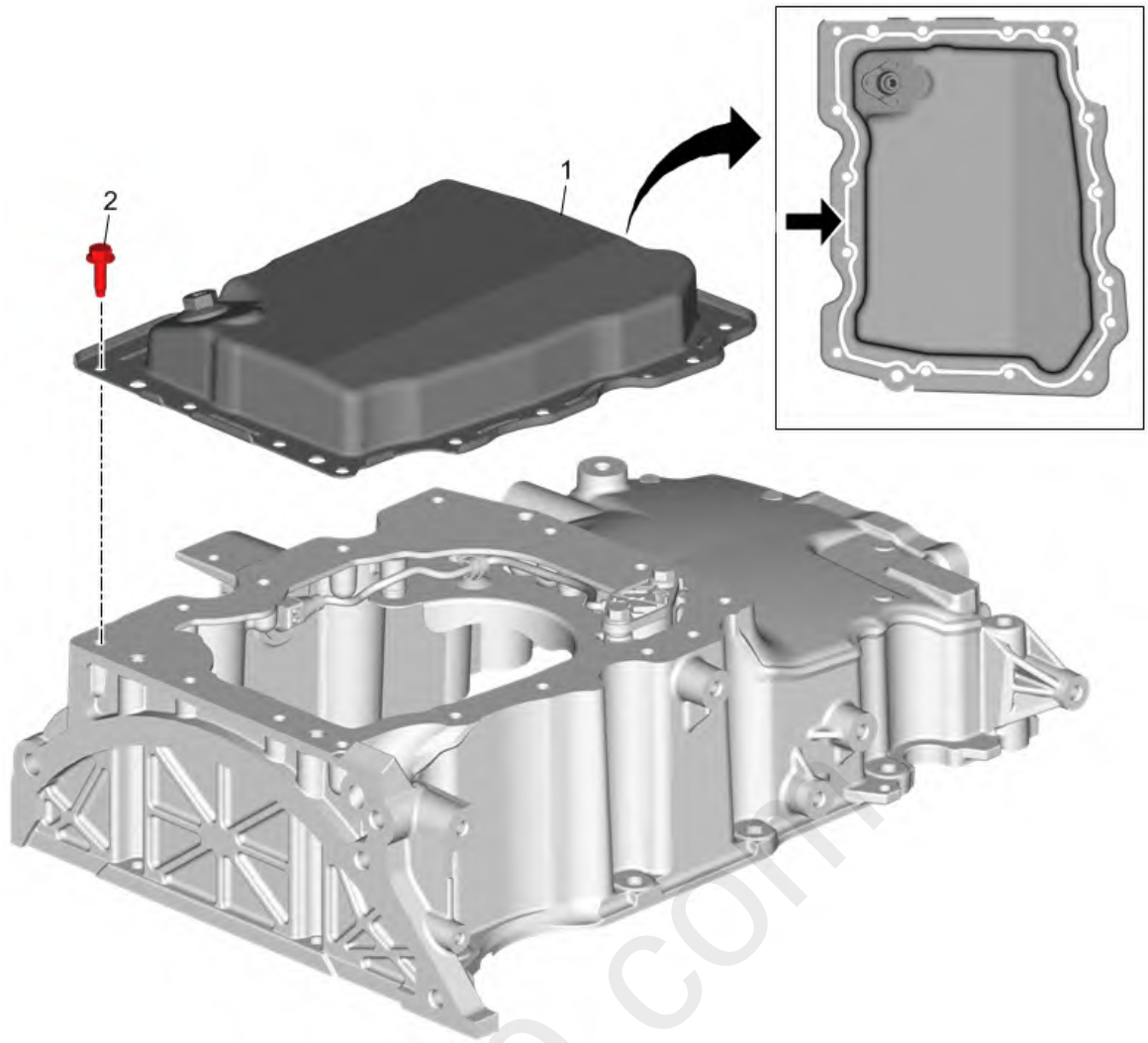


Fig. 547: Lower Oil Pan
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Ensure proper use of room temperature vulcanizing (RTV) sealant: **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**	
1	Lower Oil Pan **Procedure** **NOTE:** • **The oil pan sealing surfaces must be free of contamination prior to applying the sealer.** • **Install and align the oil pans within 20 minutes of applying the sealer.** 1. Apply a bead of RTV sealant to the perimeter of the lower oil pan. Refer to **Adhesives, Fluids, Lubricants, and Sealers**. 2. Install the lower oil pan to the upper oil pan.

mcx30.com

Callout	Component Name
2	Oil Pan Bolt **NOTE:** **Two long bolts secure the lower oil pan and upper oil pan together to the lower crankcase.** **CAUTION:** **Refer to Fastener Caution .** **tighten** 10 N.m (89 lb in)

Oil Pan and Engine Oil Cooler Installation

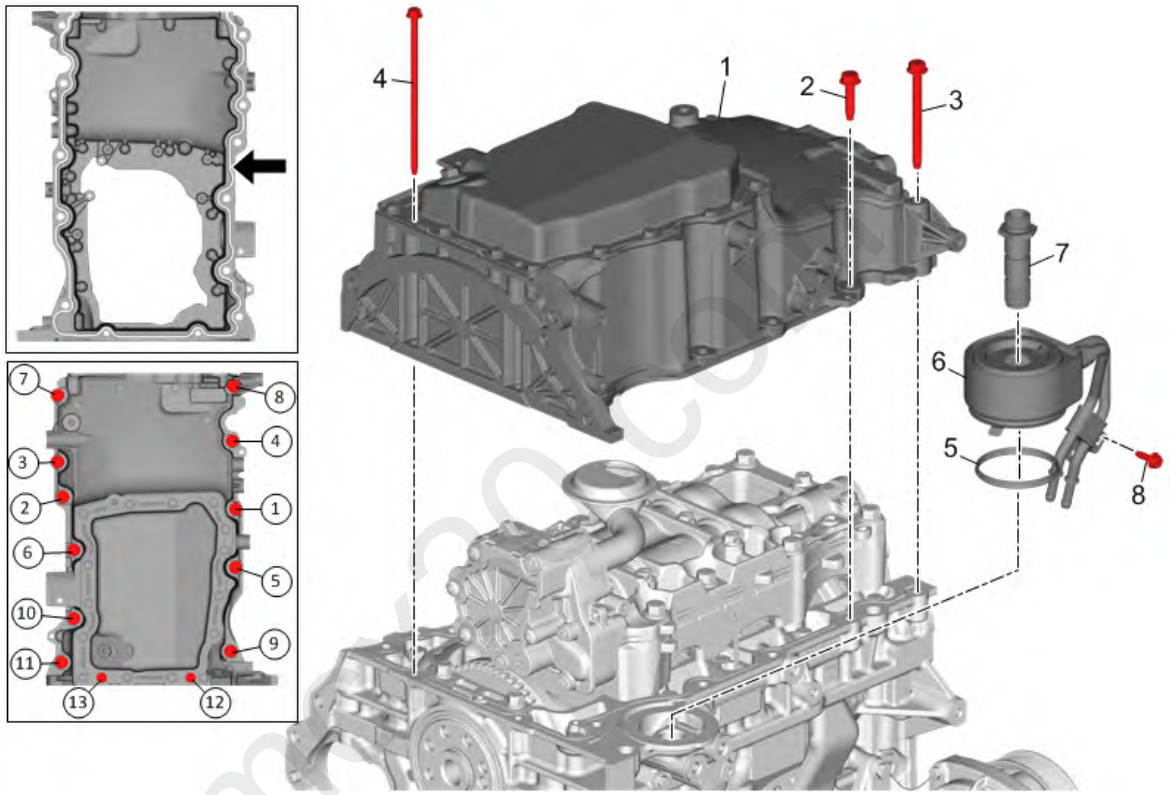


Fig. 548: Oil Pan and Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Ensure proper use of room temperature vulcanizing (RTV) sealant: Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant	
1	Oil Pan **Procedure** **NOTE:** • **The oil pan sealing surface and lower crankcase surface must be free of contamination prior to applying the sealer.** • **Install and align the oil pans within 20 minutes of applying the sealer.** 1. Apply a 4.25 mm bead of sealer on the level part of the flange around the perimeter of the oil pan. Refer to Adhesives, Fluids, Lubricants, and Sealers. 2. Align the locating pins and install the oil pan on the lower crankcase.

Callout	Component Name
2	Oil Pan Bolt **NOTE:** **Install all oil pan bolts finger tight, then tighten in the sequence shown.** **CAUTION:** **Refer to Fastener Caution .** **tighten** 25 N.m (18 lb ft)
3	Oil Pan Bolt **NOTE:** **Install all oil pan bolts finger tight, then tighten in the sequence shown.** **tighten** 25 N.m (18 lb ft)
4	Oil Pan Bolt **NOTE:** **tighten the oil pan bolts in the sequence shown.** **tighten** 10 N.m (89 lb in)
5	Engine Oil Cooler Seal **Procedure** Use a NEW seal.
6	Engine Oil Cooler
7	Engine Oil Cooler Connector **tighten** 50 N.m (37 lb ft)
8	Engine Oil Cooler Bolt **tighten** 10 N.m (89 lb in)

mcx30.com

Oil Pump Flow Control Valve Heat Shield Installation

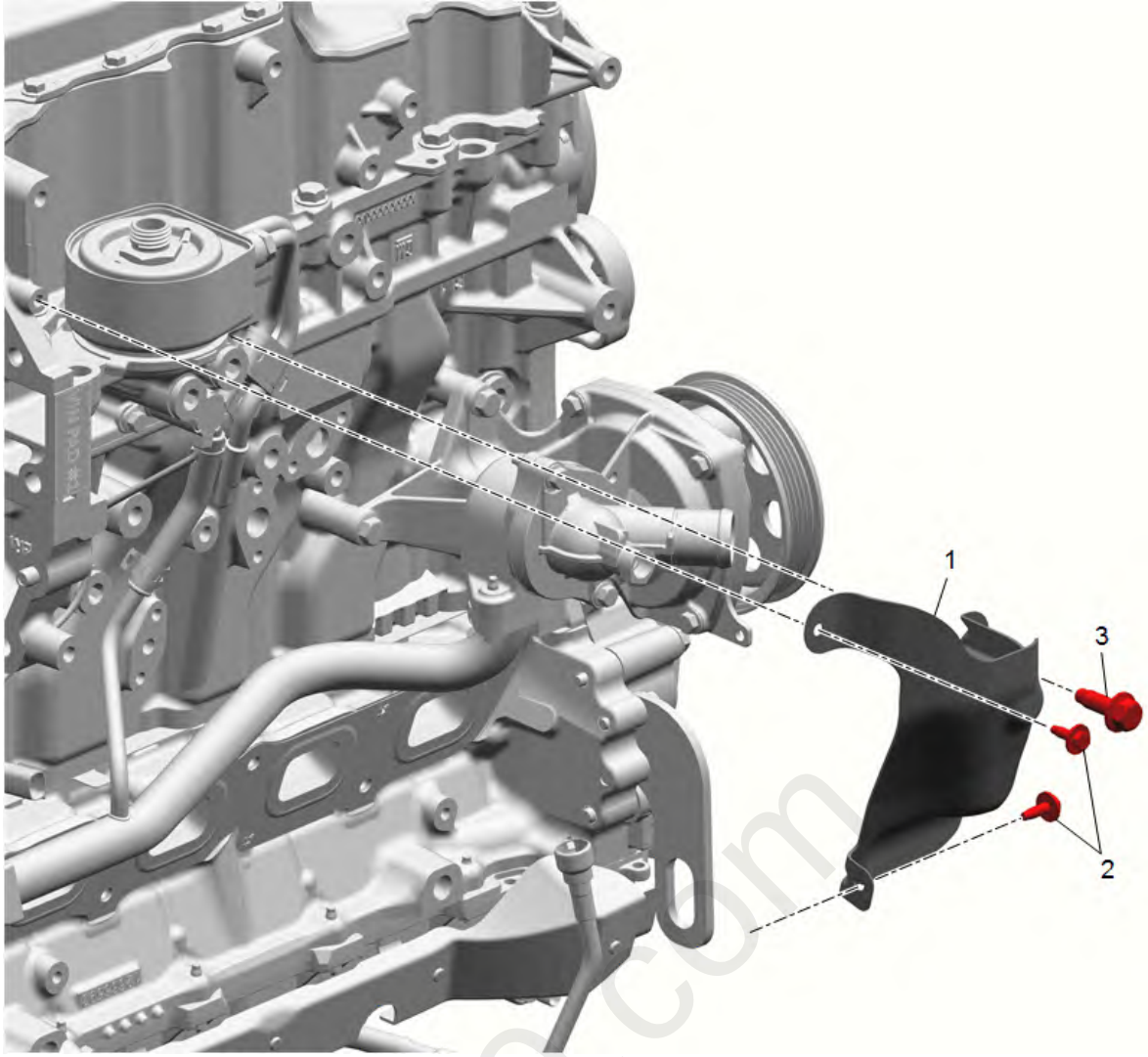


Fig. 549: Oil Pump Flow Control Valve Heat Shield
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Pump Flow Control Valve Heat Shield
2	Pump and Component Oil Heat Shield Bolt **CAUTION:** **Refer to Fastener Caution .** **tighten** 9 N.m (80 lb in)
3	Oil Pump Flow Control Valve Heat Shield Bolt **tighten** 58 N.m (43 lb ft)

CAMSHAFT TIMING CHAIN AND TENSIONER INSTALLATION

Special Tools

- **EN 45059** Angle Meter
- **EN 50837** Timing Chain Tensioner Retraction Tool

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

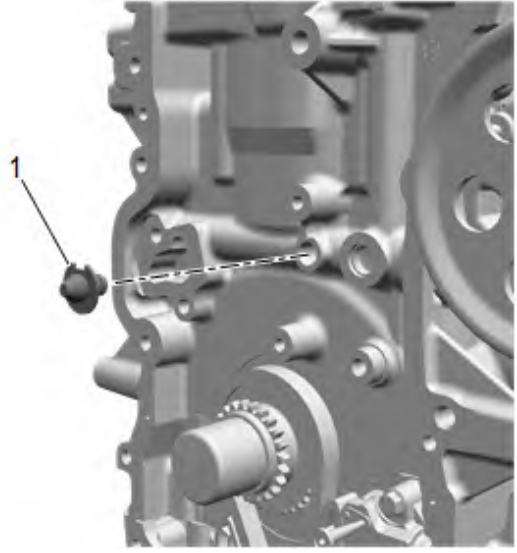


Fig. 550: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the timing chain oil nozzle is rotated with the notch facing upward, and aligned with the tab on the engine block.**

1. Install the timing chain oil nozzle (1).

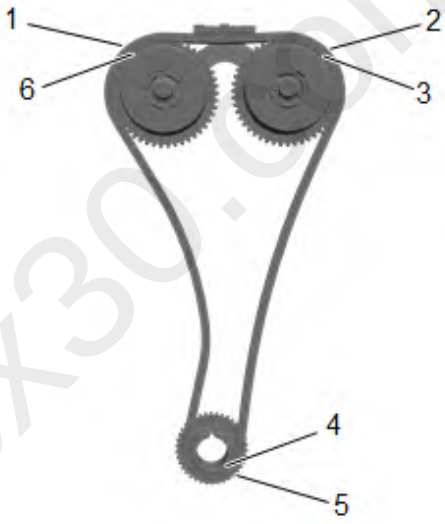


Fig. 551: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

NOTE: **There are three colored links on the timing chain. The two links that align to the timing marks on the actuators are the same color. The timing link that aligns with the timing mark on the crankshaft sprocket is a unique color. Use the following procedure to line up the links with the actuators. Orient the chain so that the colored links are visible.**

2. Loop the timing chain over the intake and exhaust camshaft actuators, aligning one of the same colored links (2) with the timing mark on the exhaust camshaft actuator (3).

NOTE: **The same colored link corresponding to the intake actuator will not initially align with the intake actuator timing mark, nor the unique colored timing chain link align with the crankshaft sprocket timing mark.**

3. Ensure the crankshaft key in the 12 O'clock position. Loop the timing chain onto the crankshaft sprocket.

mcx30.com

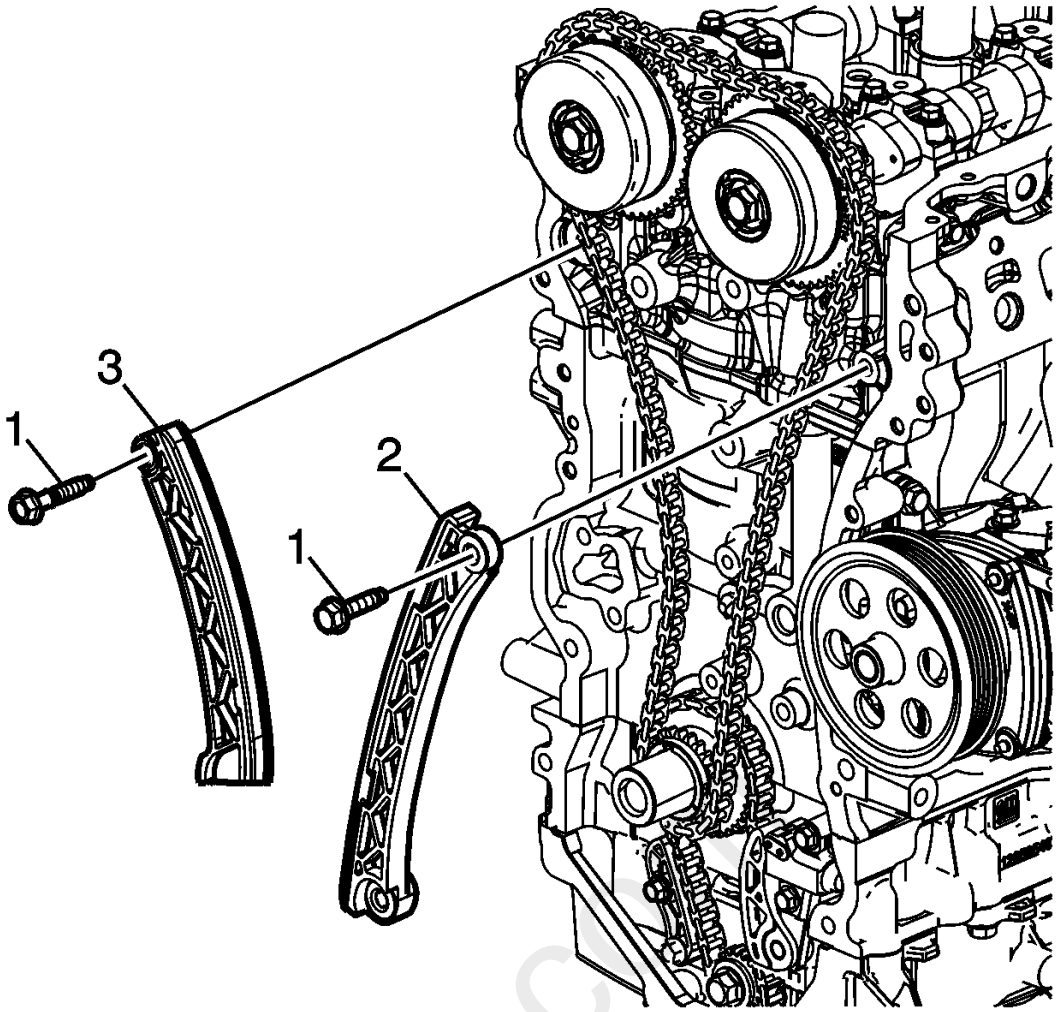


Fig. 552: Timing Chain Guides And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Timing will be established before the final install and torque of the guide bolts.**

4. Install the timing chain guide (2) and upper bolt (1) only, finger tight.
5. Install the timing chain tensioner pivot arm (3).
6. Install the pivot arm bolt (1) finger tight.

mex30.com

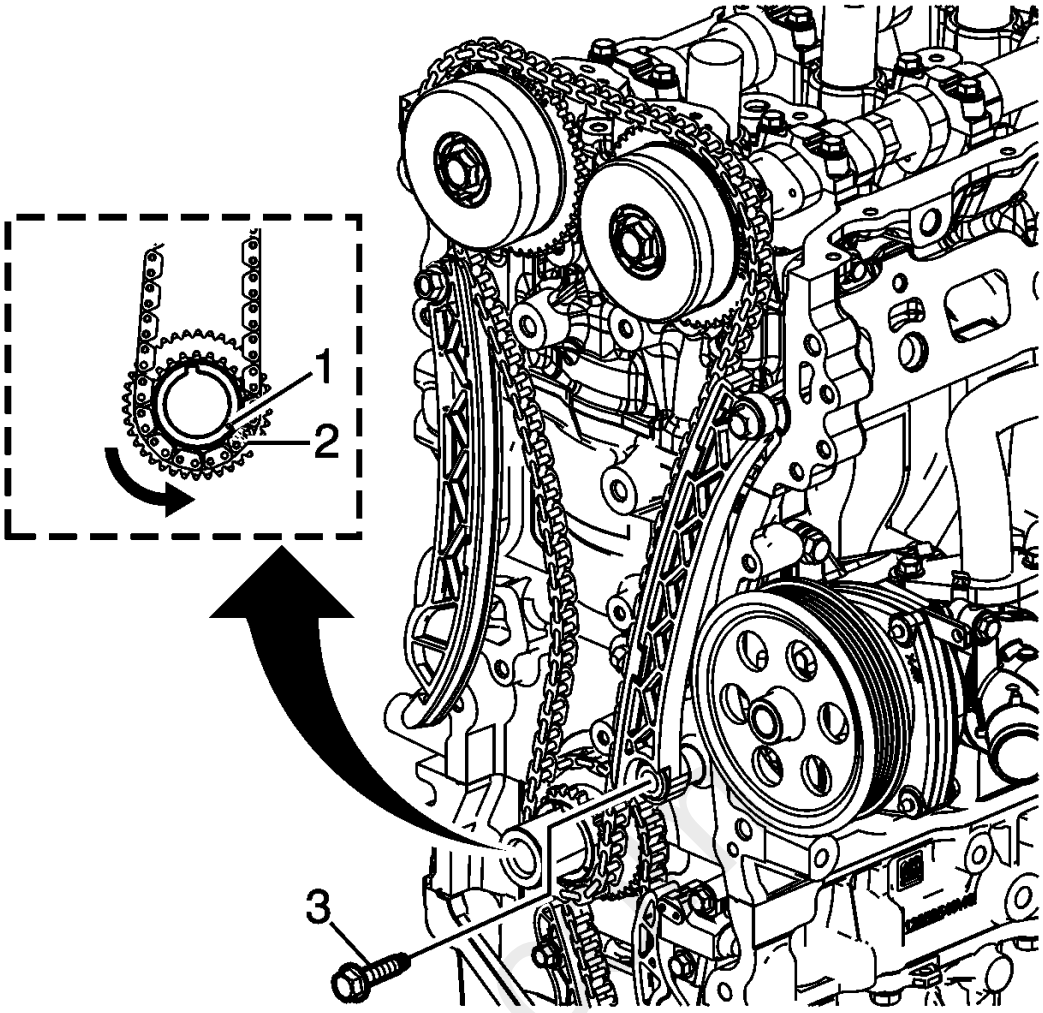


Fig. 553: Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

7. With a suitable tool, rotate the crankshaft counterclockwise to align the timing mark on the crankshaft sprocket (1) with the unique colored timing link (2).

NOTE:

- **Continue to rotate the crankshaft counterclockwise as necessary to maintain timing alignment.**
- **Ensure that the alignment mark on the exhaust camshaft actuator remains aligned with the corresponding same colored timing link.**

8. Rotate the lower end of the fixed timing chain guide into installation position and install the lower bolt (3).

CAUTION: **Refer to Fastener Caution .**

9. tighten the timing chain guide upper and lower bolts to 25 N.m (18 lb ft).

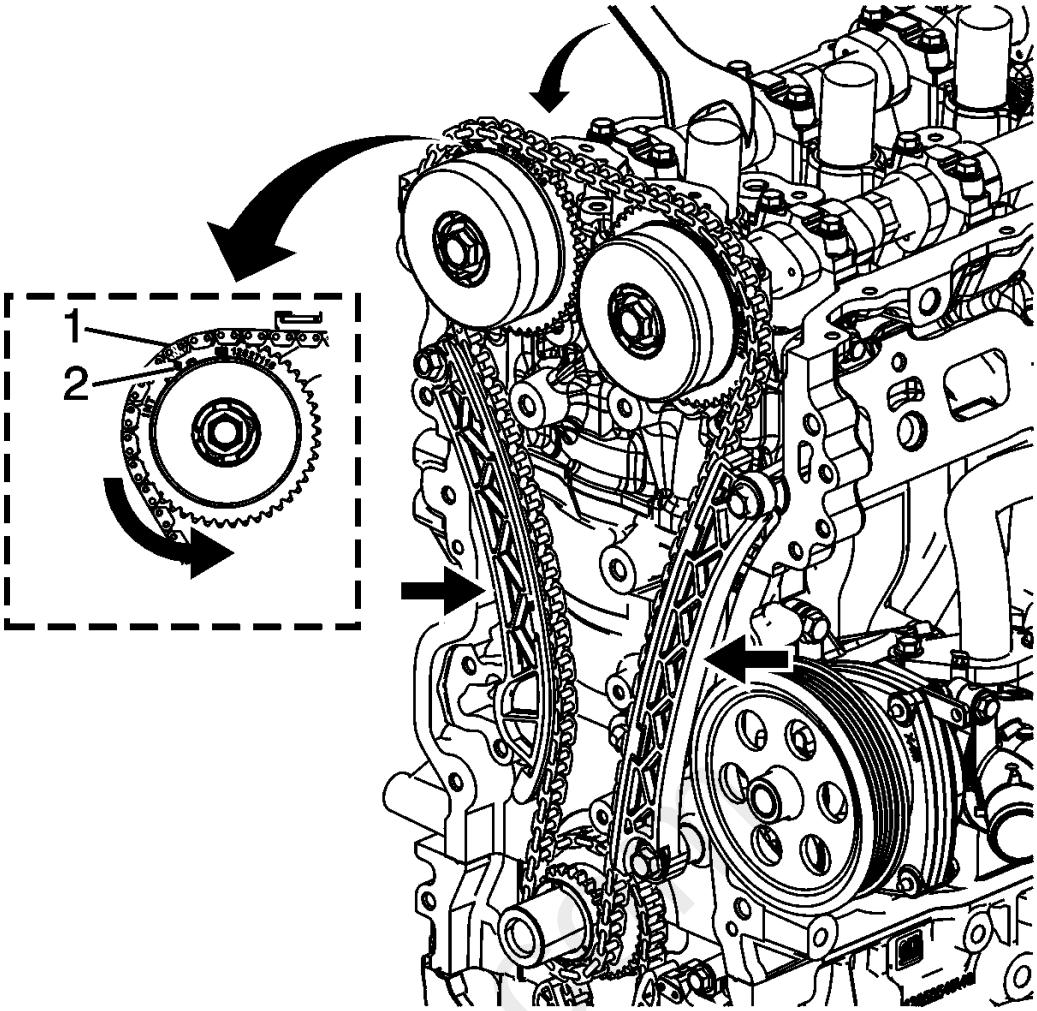


Fig. 554: Timing Mark On Intake Actuator
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The timing for the exhaust camshaft actuator and the crankshaft sprocket has been established.**
- **Applying or loosening pressure by hand between the timing chain guides will allow the chain to slip or bind during counterclockwise rotation of the camshaft.**

10. Using a suitable tool, rotate the intake camshaft counterclockwise until the timing mark on the intake actuator (2) is aligned with the corresponding same colored timing link (1). Maintain tension on intake camshaft until the timing chain tensioner can be installed and activated.

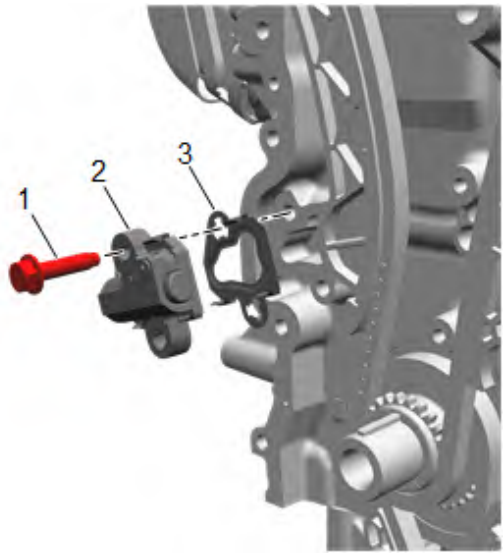


Fig. 555: Timing Chain Tensioner Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure EN-50837 retraction tool is installed and the tensioner is locked in a compressed state before installing.**

11. Install a NEW timing chain tensioner gasket (3) on the timing chain tensioner (2).
12. While maintaining the intake camshaft actuator timing alignment, install the timing chain tensioner (2) and bolts (1) and tighten to 25 N.m (18 lb ft).
13. tighten the pivot arm bolt to 25 N.m (18 lb ft).
14. Remove **EN-50837** retraction tool.

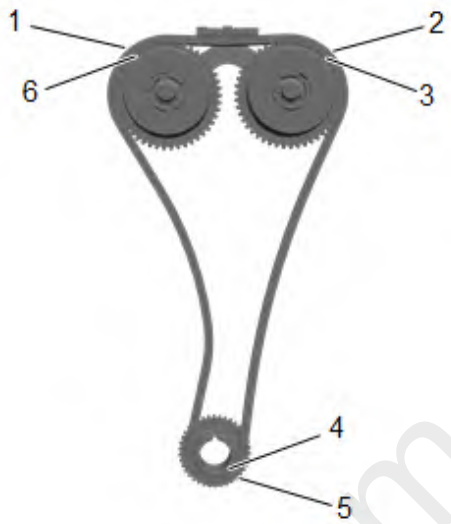


Fig. 556: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

15. Verify the timing links on the timing chain are properly aligned to the timing marks:
    1. The same colored timing links (1, 2) are aligned to the appropriate timing marks on the camshaft actuators (6, 3).
    2. The unique colored link (5) is aligned to the timing mark on the crankshaft sprocket (4).
16. If they are not, repeat the portion of the procedure necessary to align the timing marks.

mcx30.com

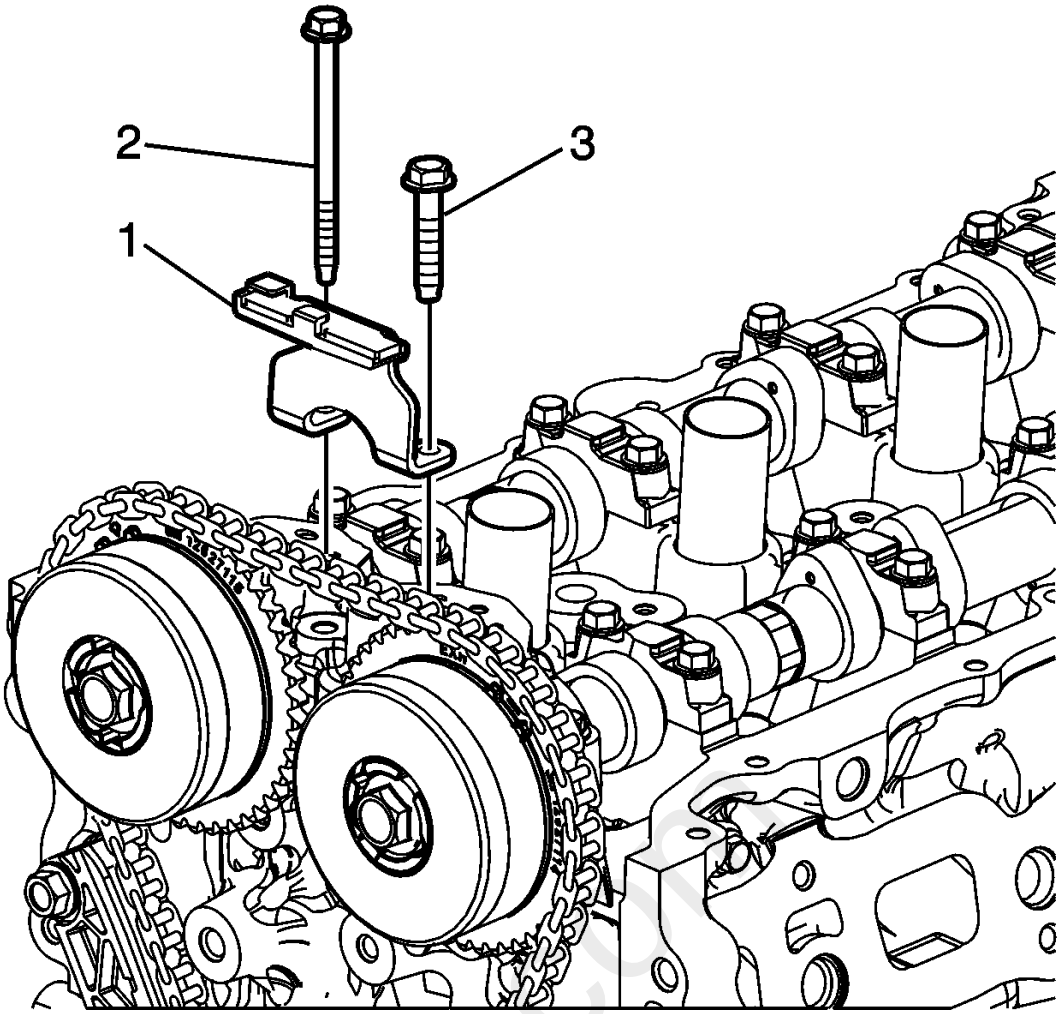


Fig. 557: Upper Timing Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

17. Install the timing chain guide (1) and bolts (2, 3) finger tight.

mcx30.com

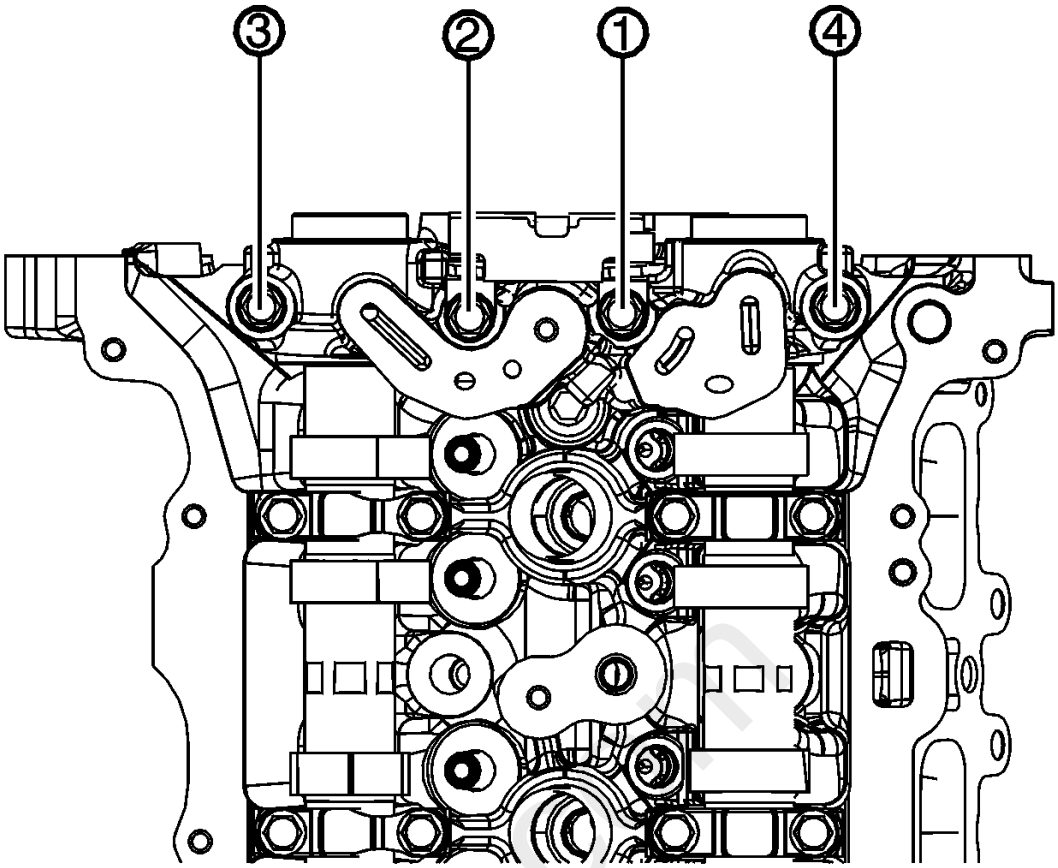


Fig. 558: Front Camshaft Cap Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

18. tighten the front camshaft cap bolts in sequence to 10 N.m (89 lb in) twice.

NOTE: **Rotating the crankshaft will engage the tensioner and remove slack from the timing chain.**

19. Rotate the crankshaft slightly in a clockwise direction. If the timing chain jumps actuator teeth, repeat procedure to align the timing marks.

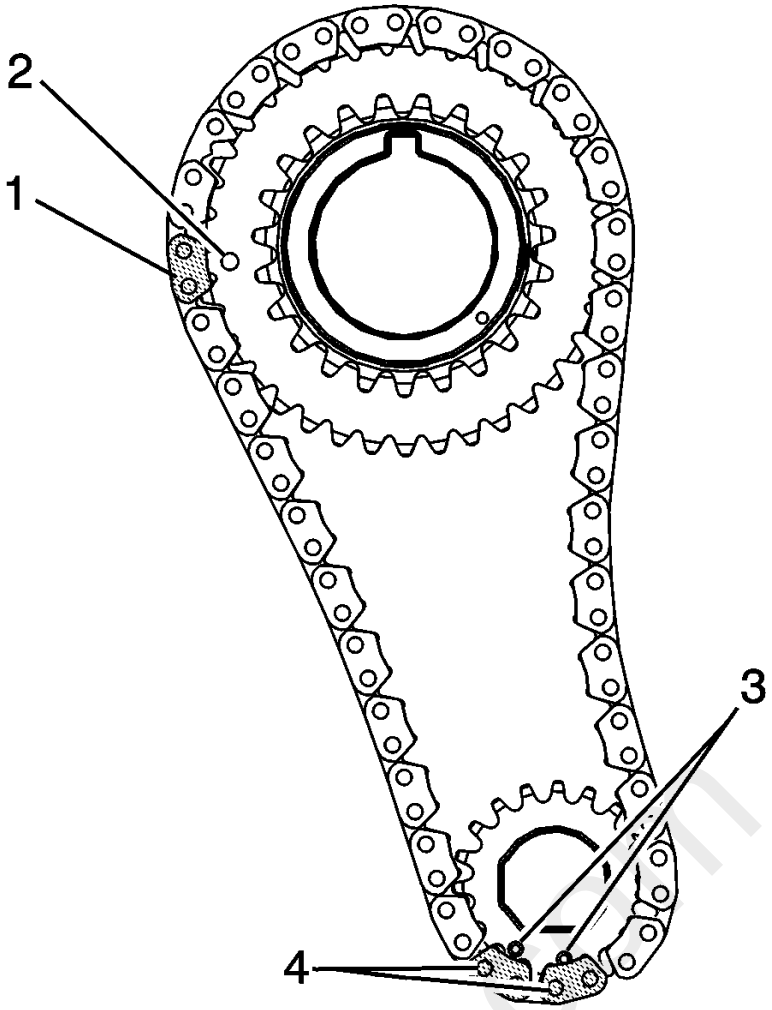


Fig. 559: Timing Link Lines & Timing Mark
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Because of slight clockwise rotation, all chain marks may be advanced slightly in relation to the actuator and sprocket marks, yet still aligned.**

NOTE: **Due to size difference of the crankshaft sprocket and the balance shaft sprocket, timing marks on the chain will not match during every crankshaft revolution. Ensure that the marks on the sprockets are aligned appropriately before installing the timing chain.**

20. Verify the timing links on the balance chain are properly aligned to the timing marks:
    1. The timing link (1) is aligned to the timing mark on the crankshaft sprocket (2).
    2. The adjacent timing links (4) are aligned with both timing marks (3) on the balancer shaft driven sprocket.

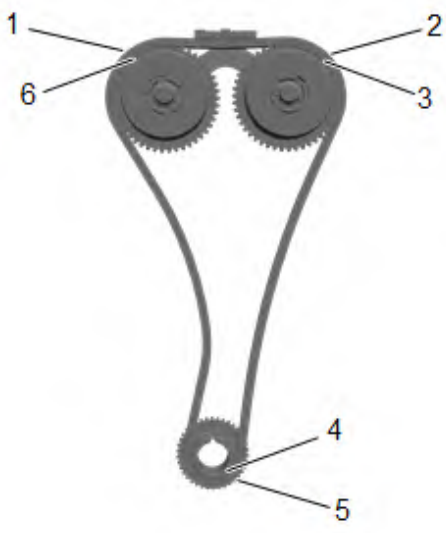


Fig. 560: Timing Chain Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Because of slight clockwise rotation, all chain marks may be advanced slightly in relation to the actuator and sprocket marks, yet still aligned.**

21. Verify the timing links on the timing chain are properly aligned to the timing marks:
    1. The same colored timing links (1, 2) are aligned to the appropriate timing marks on the camshaft actuators (6, 3).
    2. The unique colored link (5) is aligned to the timing mark on the crankshaft sprocket (4).
22. If they are not, repeat the portion of the procedure necessary to align the timing marks.

ENGINE FRONT COVER INSTALLATION

Special Tools

- **EN-45059** Angle Meter
- **EN-50820** Front Crankshaft Seal Installer

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

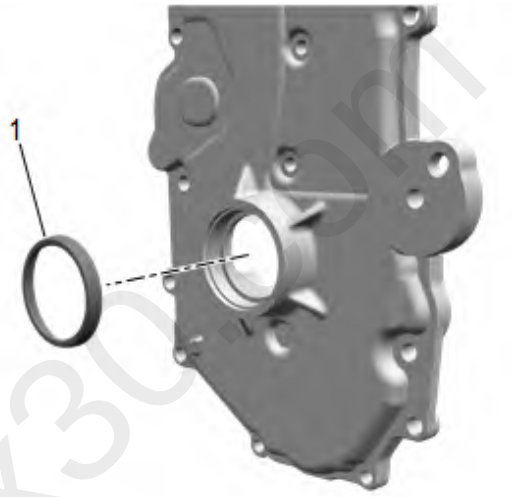


Fig. 561: Front Crankshaft Seal
Courtesy of GENERAL MOTORS COMPANY

1. Using **EN-50820** installer, install the front crankshaft seal (1) into the engine front cover.

mcx30.com

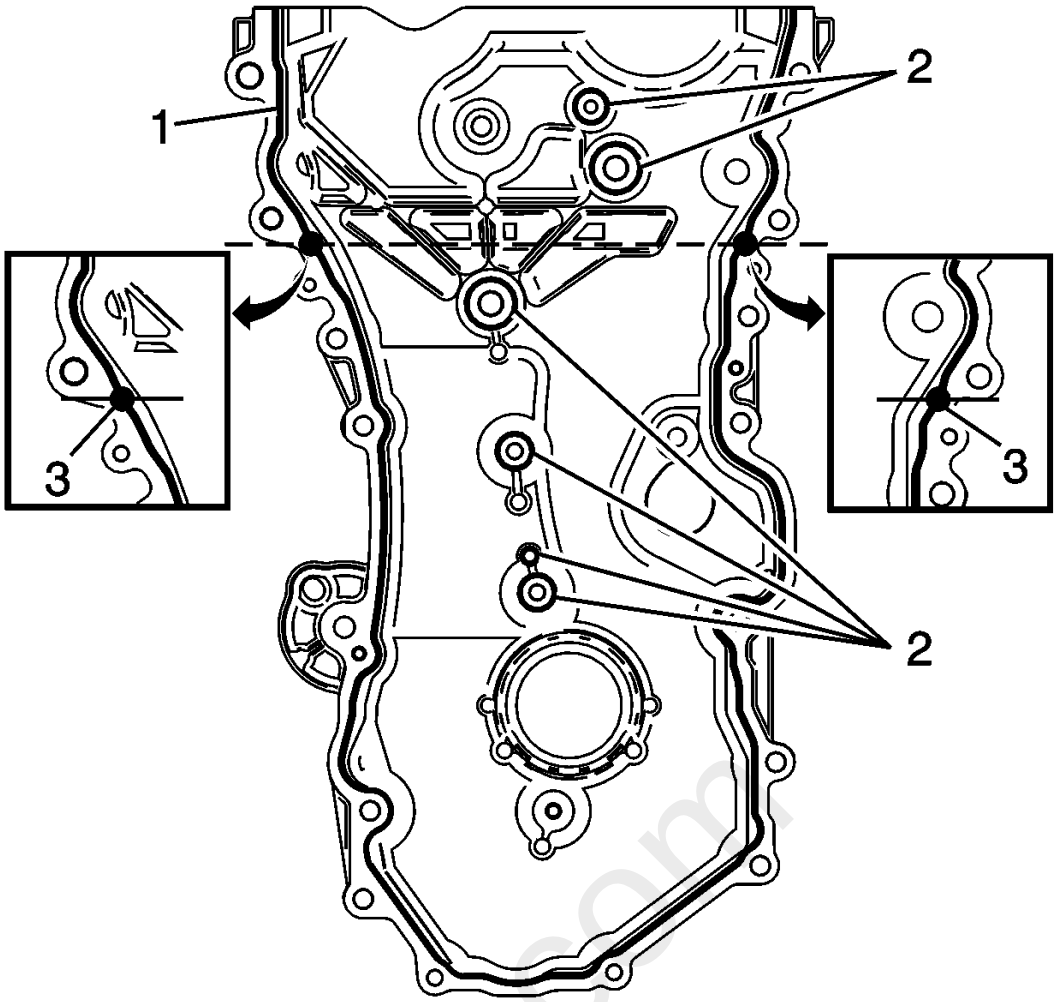


Fig. 562: Appling Bead Of Sealer Directly In Flange
Courtesy of GENERAL MOTORS COMPANY

2. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**

NOTE:

- **The engine front cover surface must be free of contamination prior to applying the sealer.**
- **Install and align the cover within 20 minutes of applying the sealer.**
- **The cover must be fastened to final torque specification within 60 minutes of applying the sealer.**
- **Additional sealant is necessary to reduce the possibility of leakage where the cylinder head to engine block interface along the bead path flange on the front cover.**

3. Apply a 5 mm bead of sealer directly in the flange (1) of the engine front cover perimeter mating surface. Also apply a 5 mm bead of sealer directly to the locations indicated (2). Finally, apply a 14 mm dab of sealant at the locations indicated (3). Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

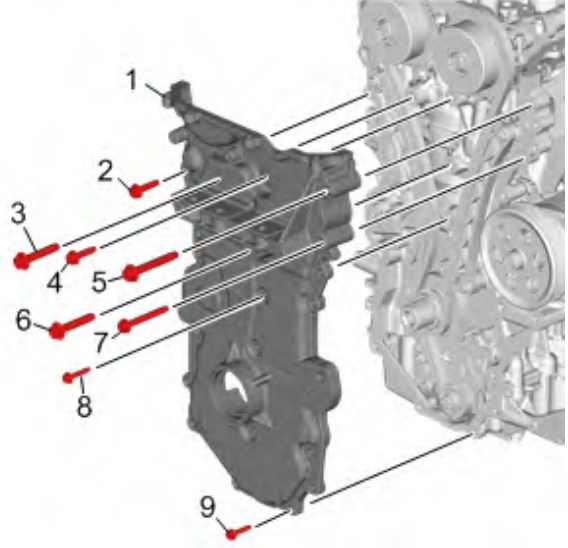


Fig. 563: Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install the engine front cover (1).

CAUTION: **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.**

5. Install by hand 3 NEW M10 bolts (3, 5, 6) in the engine front cover, as shown.
6. Hand start the remaining engine front cover bolts (2, 4, 7, 8, and 9).

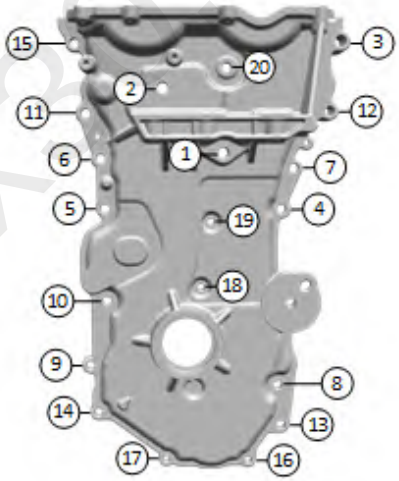


Fig. 564: Engine Front Cover Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

7. tighten the engine front cover bolts in sequence to final torque twice:
    1. tighten the NEW sequence 1 - 3 bolts to 15 N.m (11 lb ft) plus 130 degrees using **EN-45059** meter.
    2. tighten sequence 4 - 11 bolts to 25 N.m (18 lb ft).
    3. tighten sequence 12 bolt to 25 N.m (18 lb ft).
    4. tighten sequence 13 - 15 bolts to 25 N.m (18 lb ft).
    5. tighten sequence 16 - 17 bolts to 10 N.m (89 lb in).
    6. tighten sequence 18 - 19 bolts to 10 N.m (89 lb in).
    7. tighten sequence 20 bolt to 25 N.m (18 lb ft).

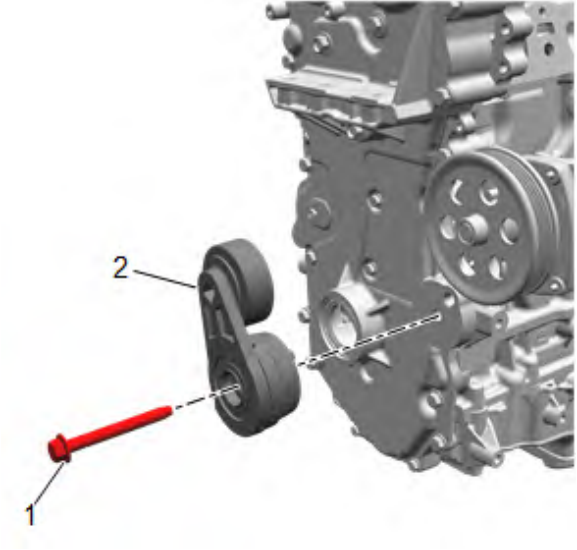


Fig. 565: Accessory Drive Belt Tensioner And Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Install the accessory drive belt tensioner (2).
9. Install the accessory drive belt tensioner bolt (1) and tighten to 58 N.m (43 lb ft).

CAMSHAFT COVER INSTALLATION (1ST DESIGN TAMPER-PROOF PCV SYSTEM)

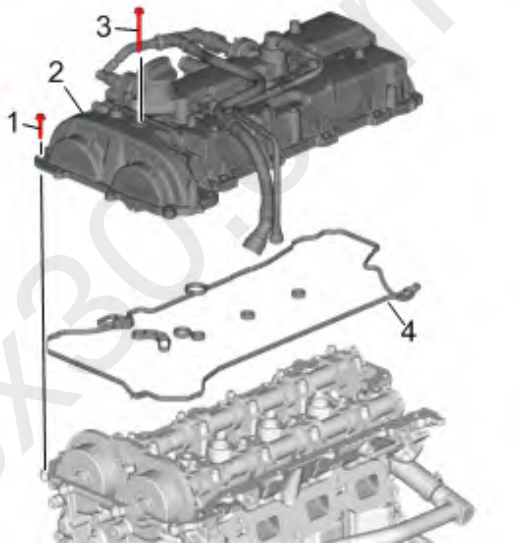


Fig. 566: Camshaft Cover, Bolts And Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure all camshaft cover gaskets are replaced, including the inner gaskets.**

1. Assemble the camshaft cover (2) and NEW gaskets (4). Ensure each gasket is located in the correct retaining groove in the camshaft cover.
2. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**
3. Add a 14 mm bead of sealant at the right and left T-joint where the front cover meets the cylinder head and at the rear of the camshaft cover at the right and left T-joint where the vacuum pump bolts on. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
4. Install the cover on the cylinder head and hand start the bolts (1, 3).

mcx30.com

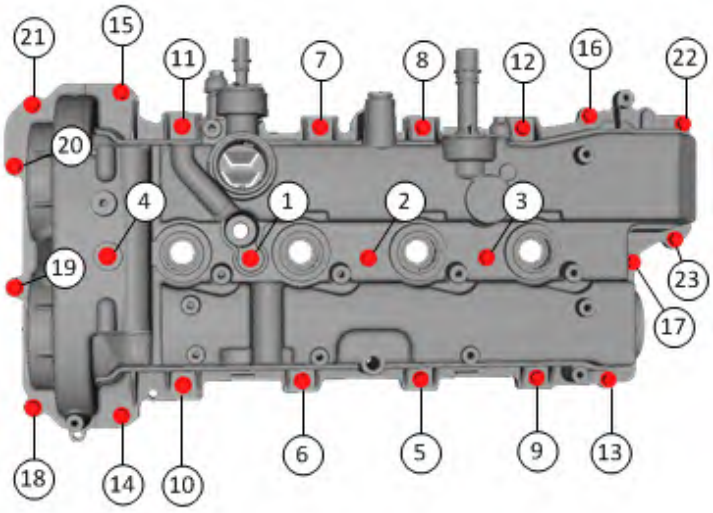


Fig. 567: Camshaft Cover Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

5. tighten the camshaft cover bolts in sequence to 10 N.m (89 lb in).

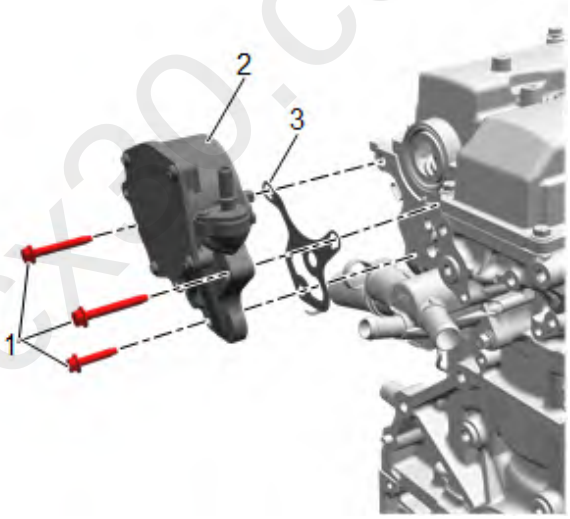


Fig. 568: Vacuum Assembly And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the vacuum pump seal does not need to be replaced, and the sealing surface is clean prior to installing the gasket and pump.**

6. Inspect the vacuum pump seal. Refer to **Camshaft Cover and Compressor Air Intake Turbocharger Cleaning and Inspection**.
7. Install a NEW vacuum pump assembly gasket (3) on the vacuum pump assembly (2).
8. Install the vacuum pump assembly (2) and bolts (1). tighten the bolts to 10 N.m (89 lb in).

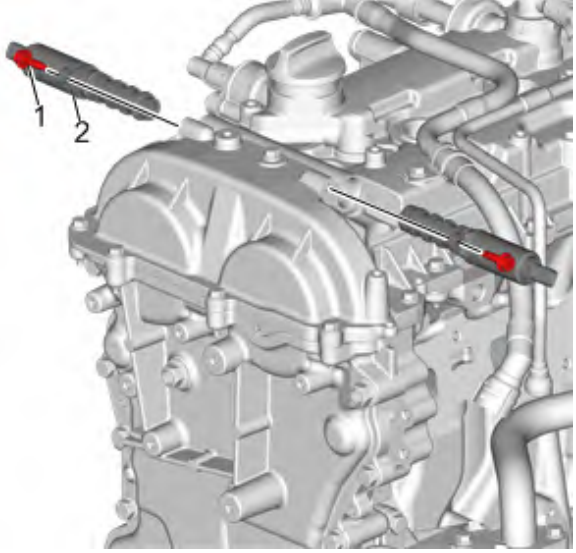


Fig. 569: Camshaft Position Actuator Solenoid Valves And Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Install the camshaft position actuator solenoid valves (2) and bolts (1). tighten the bolts to 10 N.m (89 lb in).

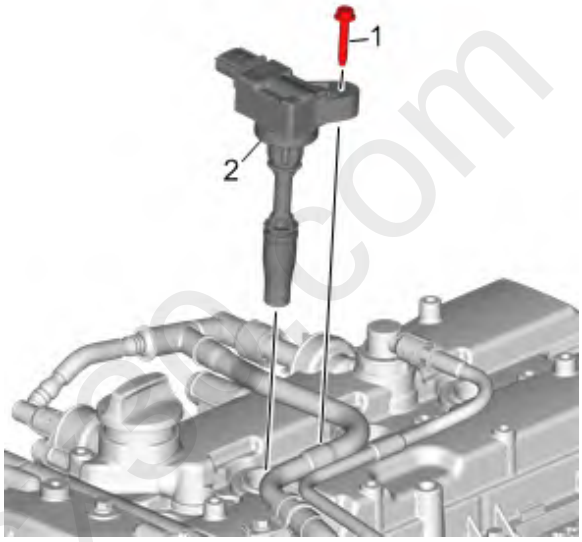


Fig. 570: Ignition Coils And Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Inspect the inside of the ignition coil rubber boot for a thin, even coat of grease. If there is no grease present or additional grease is necessary, complete the following procedure:
    1. Apply a thin coating of dielectric grease evenly to the inside of the ignition coil rubber boot, up to a depth of 15 mm from the end of the boot. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.
    2. Remove any excess grease from around the end of the boot, and ensure there is not an excessive amount within the boot.
11. Install the ignition coils (2) and bolts (1). tighten the bolt to 10 N.m (89 lb in).

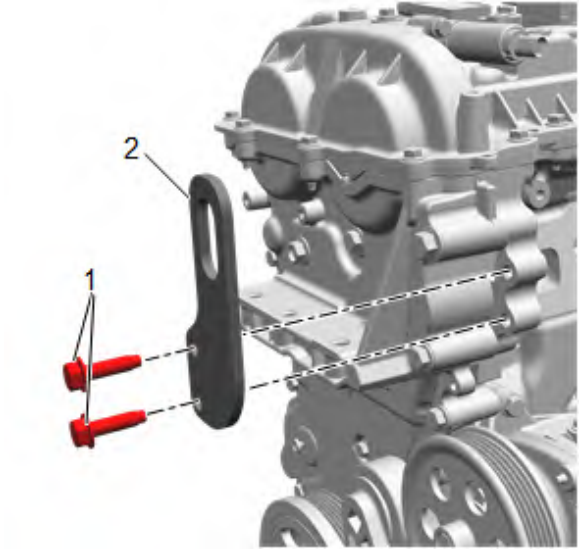


Fig. 571: Front Lift Bracket
Courtesy of GENERAL MOTORS COMPANY

12. Install the front lift bracket (2).
13. Install the front lift bracket bolts (1) and tighten to 25 N.m (18 lb ft).

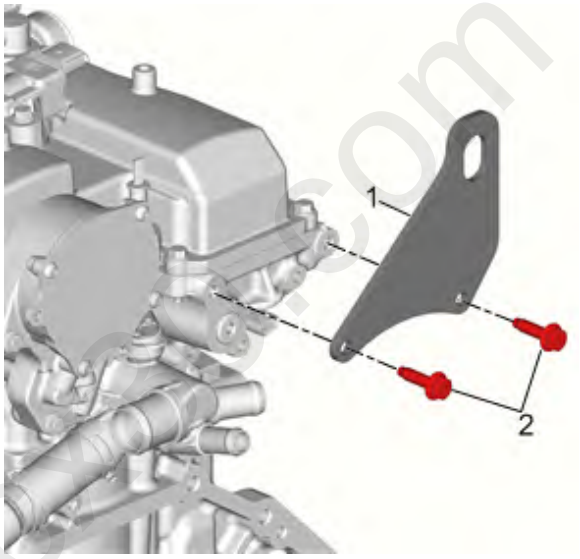


Fig. 572: Rear Lift Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

14. Install the rear lift bracket (1).
15. Install the rear lift bracket bolts (2) and tighten to 25 N.m (18 lb ft).

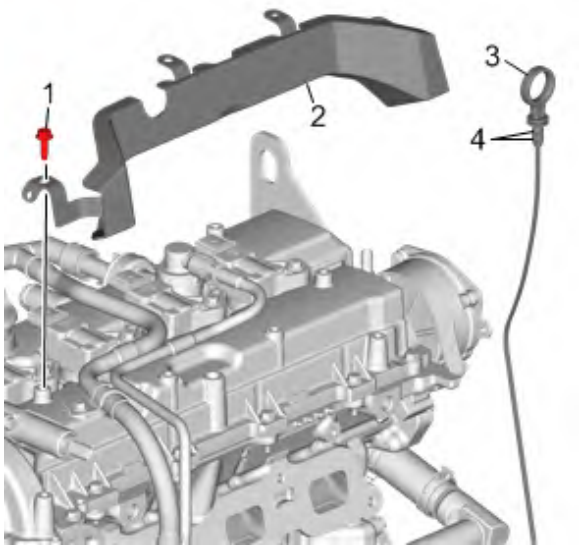


Fig. 573: Oil Level Indicator, O-Rings, Camshaft Cover Heat Shield And Bolts
Courtesy of GENERAL MOTORS COMPANY

16. Install the camshaft cover heat shield (2) and bolts (1). tighten the bolts to 10 N.m (89 lb in).
17. Inspect the oil level indicator O-ring seals (4) and replace if necessary. Install the oil level indicator (3).

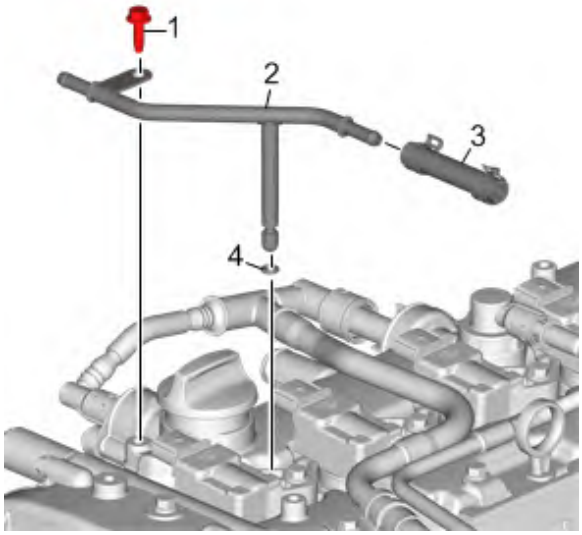


Fig. 574: Engine Coolant Air Bleed Pipe/Hose, Bolt And O-Ring
Courtesy of GENERAL MOTORS COMPANY

18. Inspect the O-ring (4) on the engine coolant air bleed pipe. Replace if necessary.
19. Install the engine coolant air bleed hose (3), if necessary.
20. Install the engine coolant air bleed pipe (2).
21. Install the pipe bolt (1) and tighten to 10 N.m (89 lb in).

FUEL RAIL AND INJECTORS INSTALLATION

Special Tools

EN-47909 Injector Bore and Sleeve Cleaning Kit

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

mcx30.com

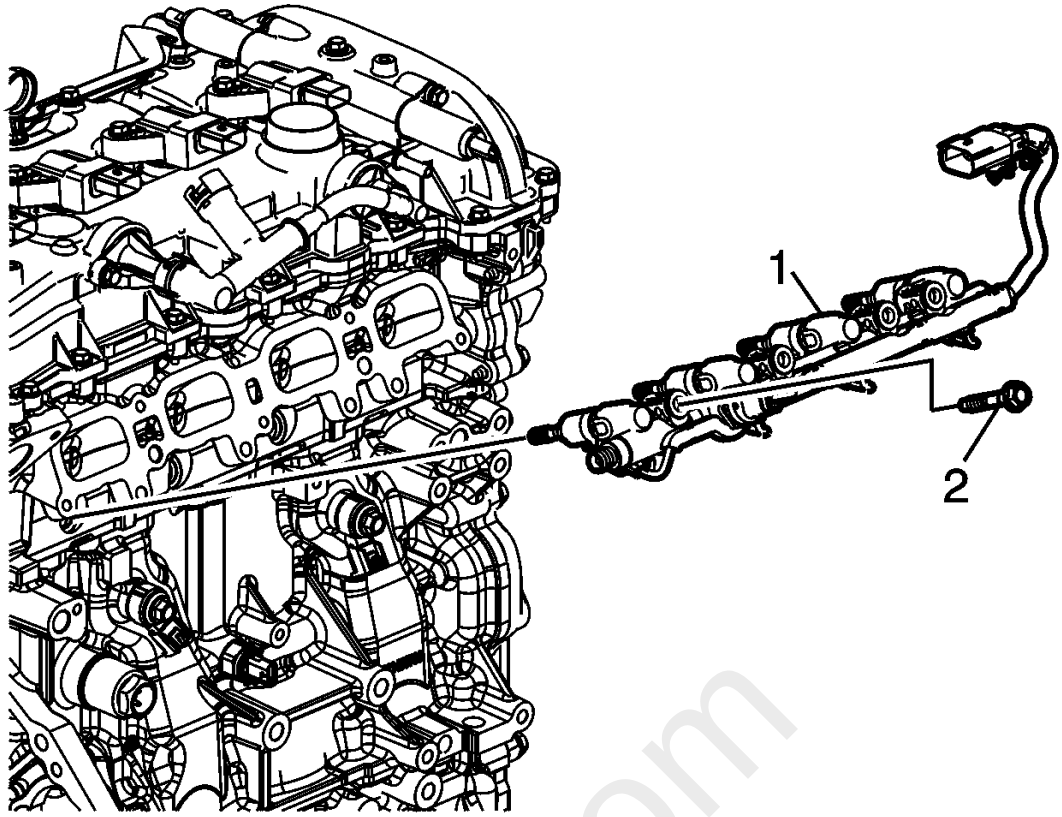


Fig. 575: Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

1. Clean the fuel injector bore in the cylinder head using the **EN-47909** kit.
2. Replace the fuel rail insulators, if necessary. Refer to **Fuel Rail and Injectors Cleaning and Inspection**. Replace the fuel rail bolts, if necessary.
3. Replace fuel injector Teflon seals with NEW when transferring fuel rail and injectors on to service engine assembly. Refer to **Fuel Rail and Injectors Cleaning and Inspection**.
4. Install the fuel rail (1) with injectors into the cylinder head evenly.

NOTE: **Mount the bolts evenly to avoid cocking of the fuel injectors during installation.**

NOTE: **Avoid contamination and contact damage of fuel injectors nozzle tips.**

5. Hand start the 2 outer fuel rail bolts (2) to seat the injectors into the injector bores.
6. Hand start the remaining fuel rail bolts.

mcy30.com

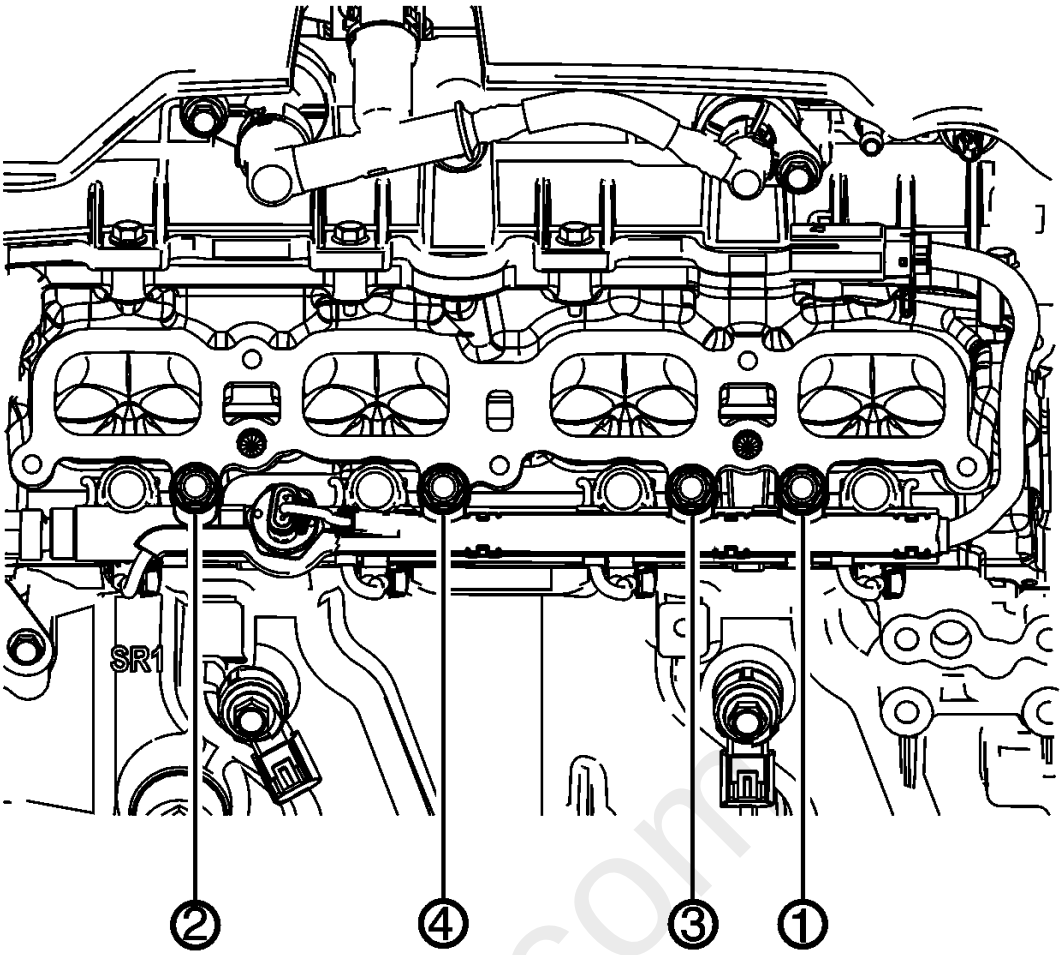


Fig. 576: Fuel Rail Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

7. tighten the fuel rail bolts in sequence to 25 N.m (18 lb ft).
8. Connect the electrical harness to the fuel rail harness connections.

mcx30.com

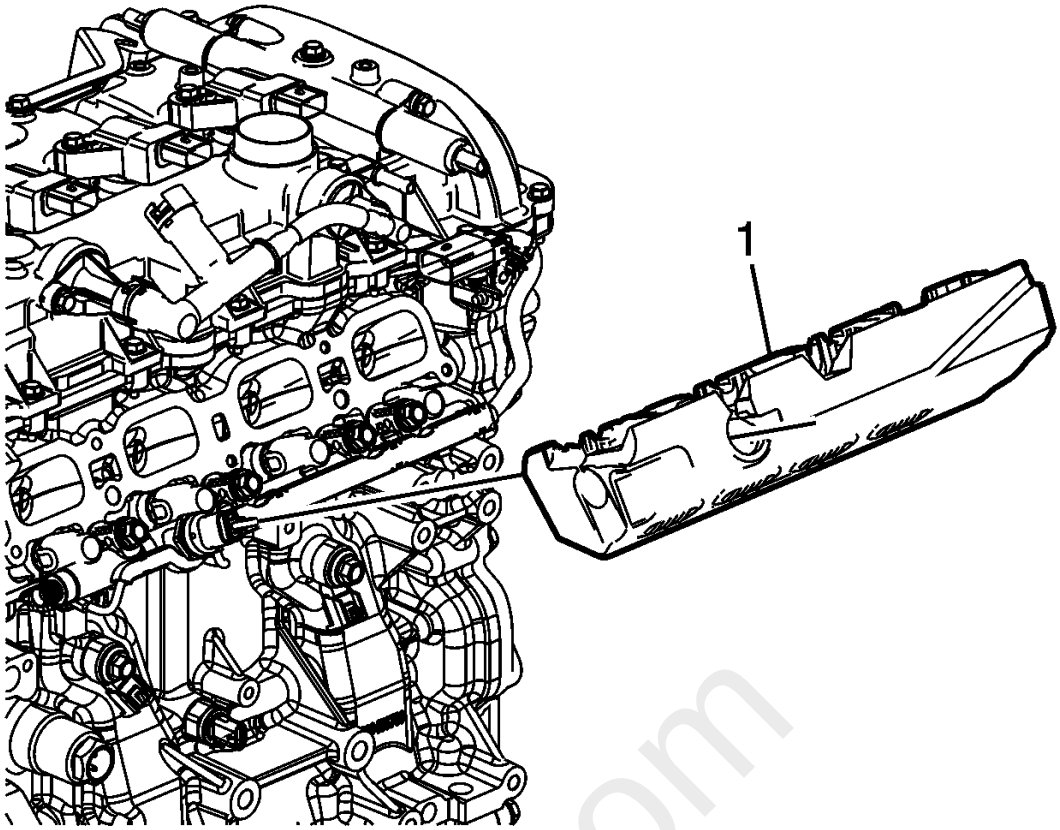


Fig. 577: Fuel Injection Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

WARNING: **The noise cancelling foam component MUST be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.**

9. Install the fuel injection fuel rail noise shield (1).

EXHAUST MANIFOLD INSTALLATION

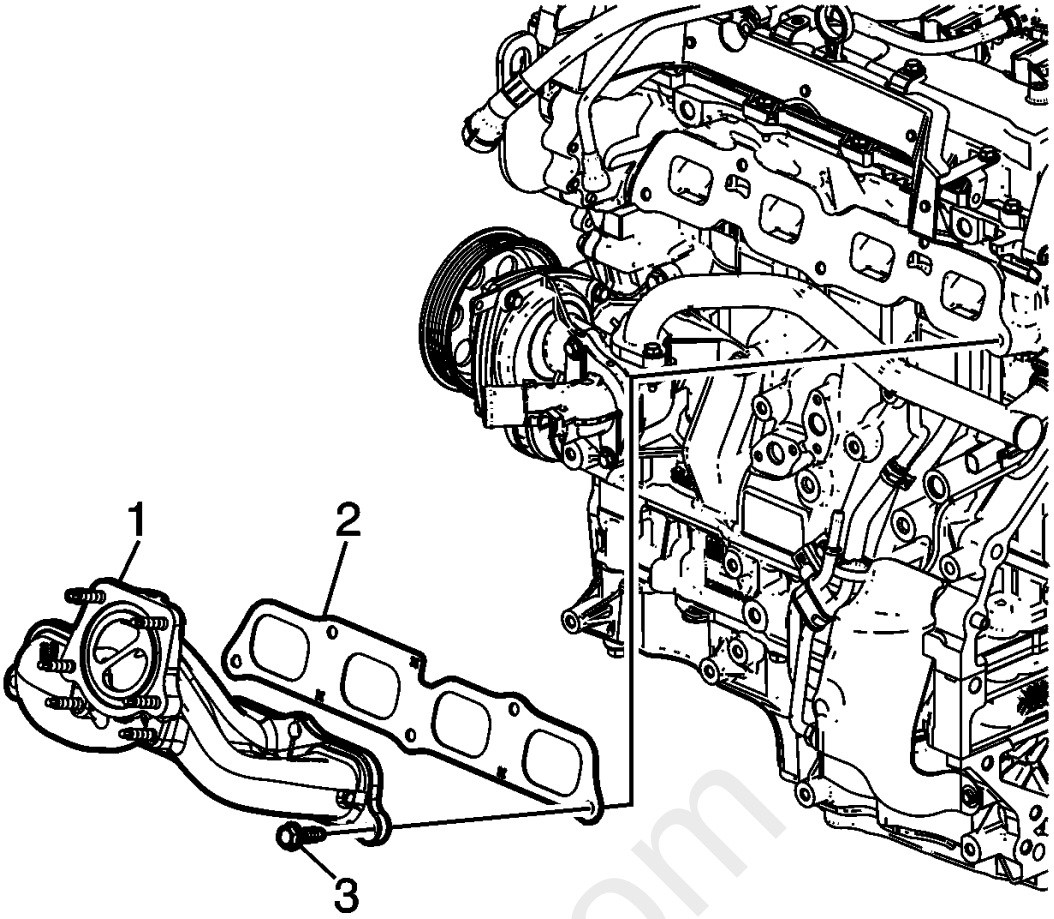


Fig. 578: Exhaust Manifold And Cylinder Head Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW exhaust manifold gasket (2).
2. Install the exhaust manifold (1) to the cylinder head.
3. Hand start NEW exhaust manifold to cylinder head retaining bolts (3).

mc130.com

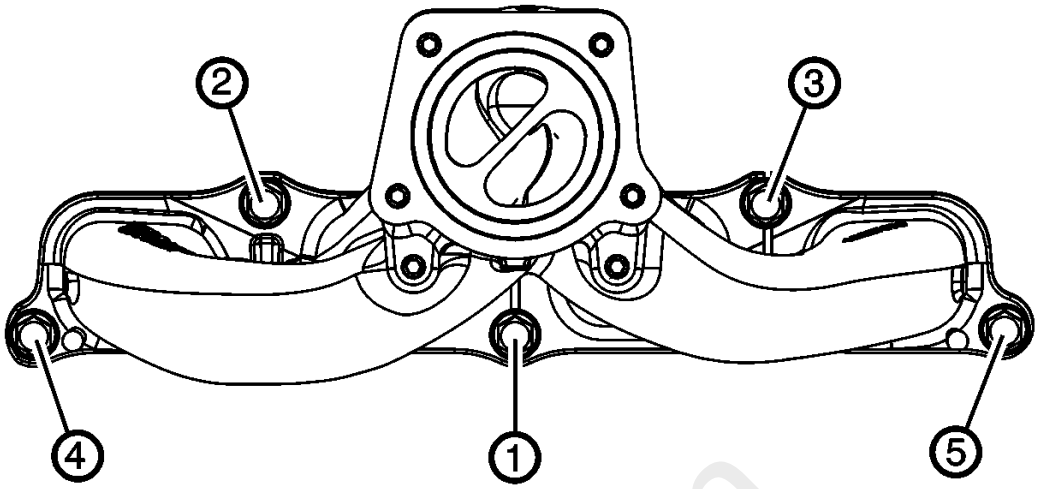


Fig. 579: Exhaust Manifold Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

NOTE: **Fasteners have adhesive patch and must be tighten ed to final torque within 5 minutes.**

4. tighten the NEW exhaust manifold to cylinder head bolts three passes in sequence to 20 N.m (15 lb ft).

mcx30.com

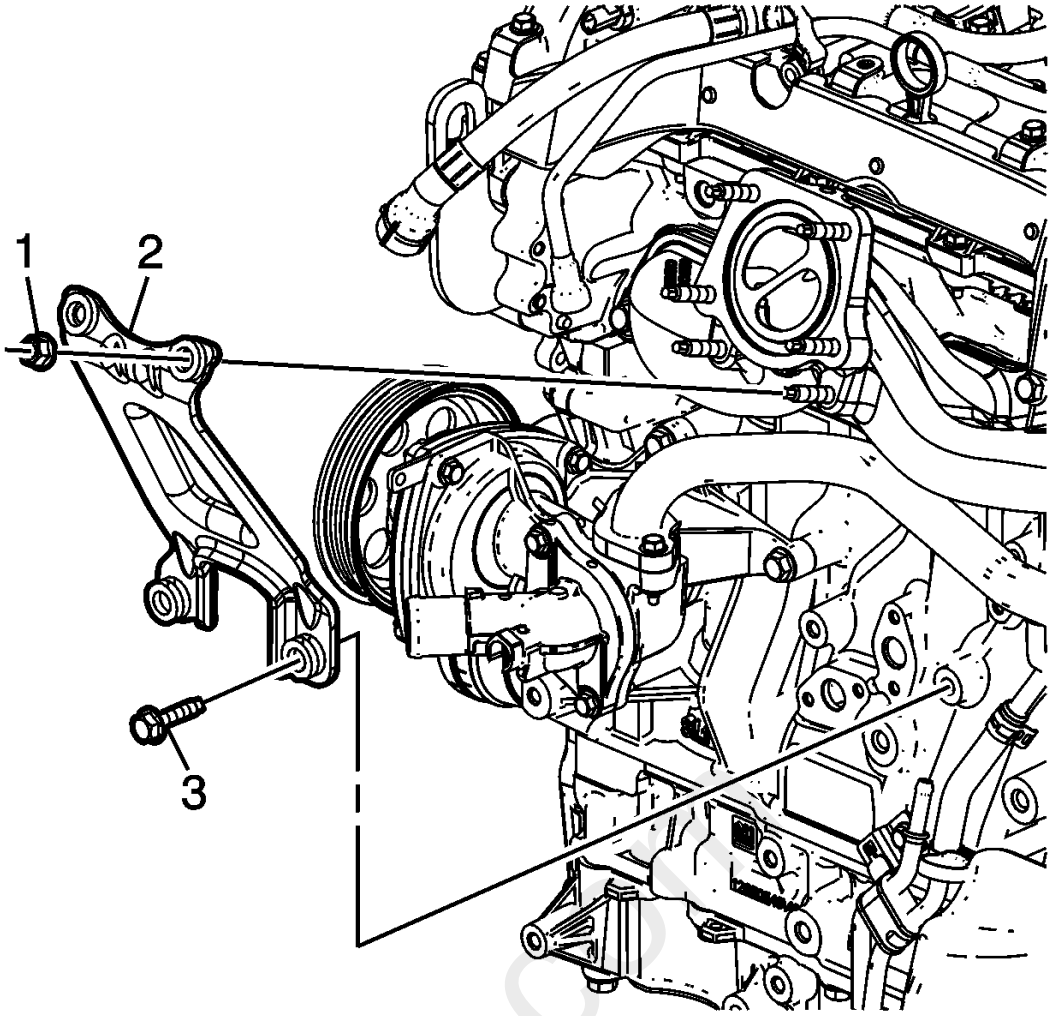


Fig. 580: Exhaust Manifold Brace Nuts
Courtesy of GENERAL MOTORS COMPANY

5. Install the exhaust manifold brace (2).
6. Install the exhaust manifold brace bolts (3) and tighten to 25 N.m (18 lb ft)
7. Install NEW exhaust manifold brace nuts (1) and tighten to 25 N.m (18 lb ft)

mo730.com

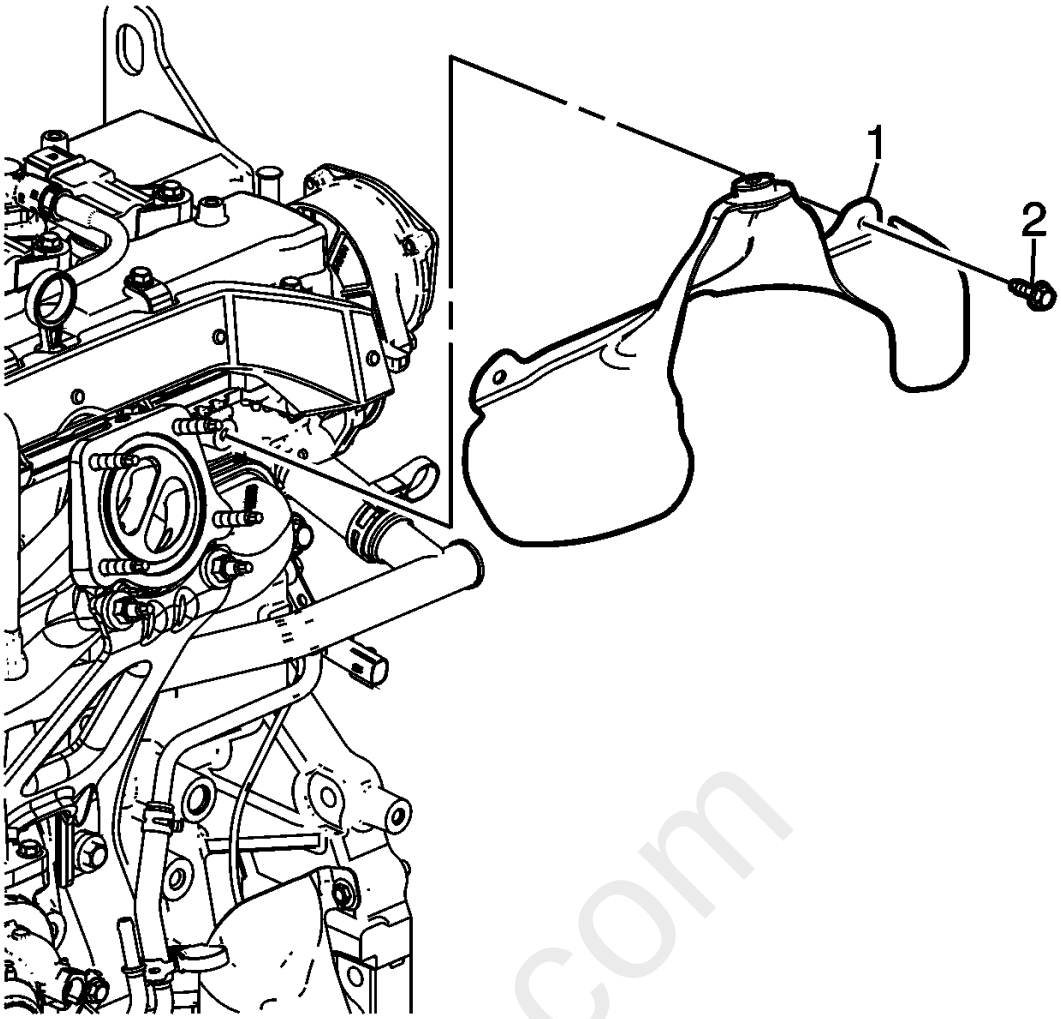


Fig. 581: Exhaust Manifold Heat Shield Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the exhaust manifold heat shield (1).
9. Install the exhaust manifold heat shield bolts (2) and tighten to 14 N.m (124 lb in).

CAMSHAFT COVER AND COMPRESSOR AIR INTAKE TURBOCHARGER INSTALLATION (2ND DESIGN TAMPER-PROOF PCV SYSTEM)

Camshaft Cover and Turbocharger Installation

mr30.com

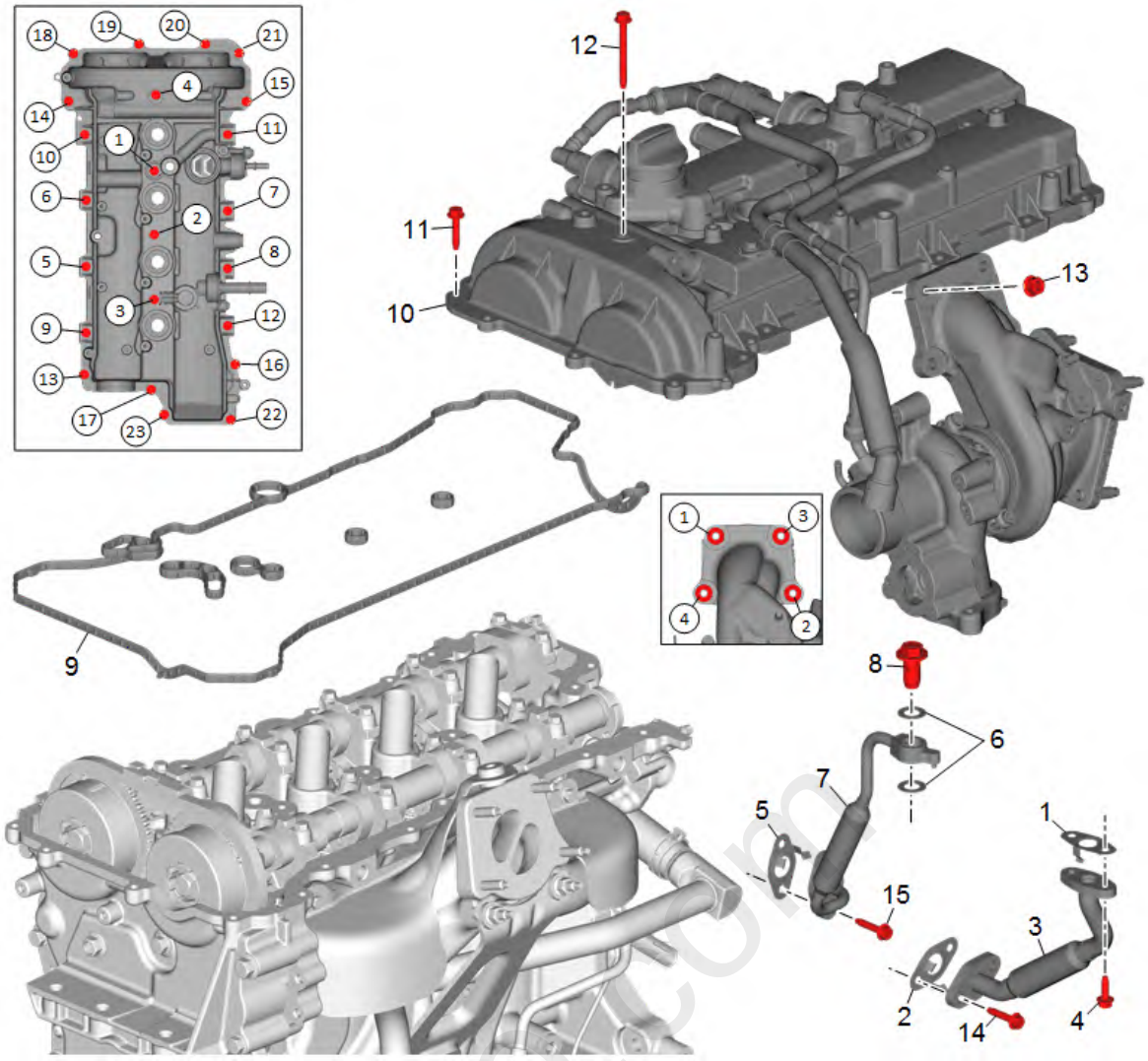


Fig. 582: Camshaft Cover and Turbocharger
Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover and Turbocharger Installation

Callout	Component Name
1	Turbocharger Oil Return Pipe Gasket **NOTE:** **Use a NEW gasket.**
2	Turbocharger Oil Return Pipe Gasket **NOTE:** **Use a NEW gasket.**
3	Turbocharger Oil Return Pipe
4	Turbocharger Oil Return Pipe Bolt **CAUTION:** **Refer to Fastener Caution .** **tighten** 10 N.m (89 lb in)
5	Turbocharger Oil Feed Pipe Gasket **NOTE:** **Use a NEW gasket.**

Callout	Component Name
6	Turbocharger Oil Feed Pipe Washer **NOTE:** **Use NEW washers.**
7	Turbocharger Oil Feed Pipe
8	Turbocharger Oil Feed Pipe Bolt **tighten** 35 N.m (26 lb ft)
9	Camshaft Cover Gasket **NOTE:** **Ensure all camshaft cover gaskets are replaced, including the inner gaskets.** **Procedure** Assemble the camshaft cover and NEW gaskets. Ensure each gasket is located in the correct retaining groove in the camshaft cover.
10	Camshaft Cover Positive Crankcase Ventilation Tube Turbocharger **NOTE:** **The tamper-proof positive crankcase ventilation system includes components that may be replaced if necessary. The system may include an outlet duct connected to the end of the Positive Crankcase Ventilation Tube.** **Procedure** 1. The assistance of a second technician may be necessary to support and move the assembly during installation. 2. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant** 3. Add a 14 mm bead of sealant at the right and left T-joint where the front cover meets the cylinder head and at the rear of the camshaft cover at the right and left T-joint where the vacuum pump bolts on. Refer to **Adhesives, Fluids, Lubricants, and Sealers**. **NOTE:** **Be careful when moving the assembled components with tamper-proof fittings to avoid stress on the connections.** 4. Install the camshaft cover and turbocharger in position.
11	Camshaft Cover Bolt **Procedure** Hand start the bolts. tighten all camshaft cover bolts in sequence.
12	Camshaft Cover Bolt **Procedure** tighten the camshaft cover bolts in sequence to 10 N.m (89 lb in).

mz30.com

Callout	Component Name
13	Turbocharger Nut **CAUTION:** **Refer to Torque-to-Yield Fastener Caution .** **Procedure** 1. tighten the NEW turbocharger nuts a first pass in sequence to 30 N.m (22 lb ft). 2. tighten the NEW turbocharger nuts a final pass in sequence to 90 degrees. **Special Tools** **EN-45059** Angle Meter Equivalent regional tools: **Special Tools**.
14	Turbocharger Oil Return Pipe Bolt **tighten** 10 N.m (89 lb in)
15	Turbocharger Oil Feed Pipe Bolt **tighten** 10 N.m (89 lb in)

Camshaft Cover Component Installation

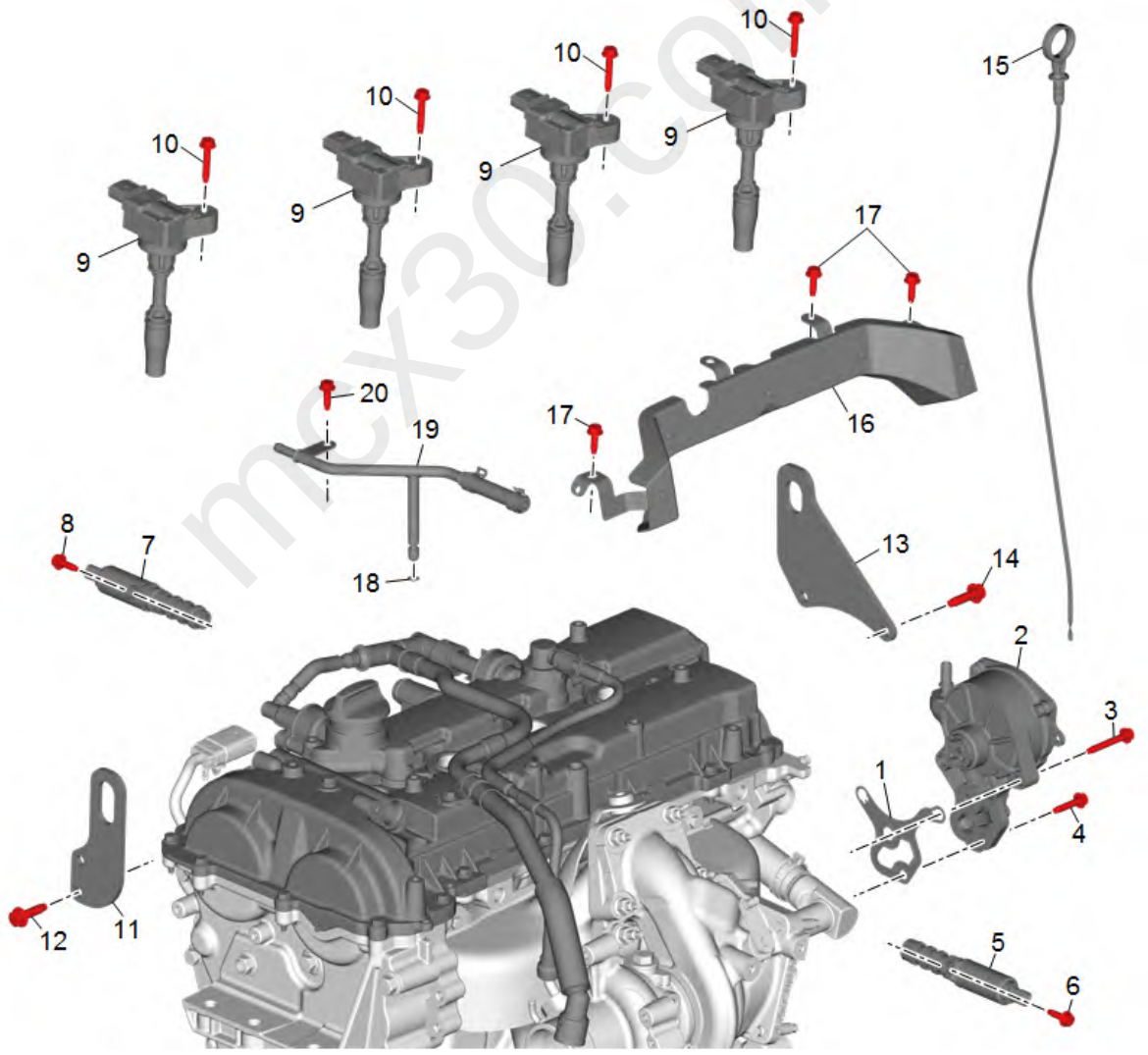


Fig. 583: Camshaft Cover Component
Courtesy of GENERAL MOTORS COMPANY

Camshaft Cover Component Installation

Callout	Component Name

Callout	Component Name
1	Vacuum Pump Gasket **NOTE:** **Use a NEW gasket.**
2	Vacuum Pump
3	Vacuum Pump Bolt **tighten** 10 N.m (89 lb in)
4	Vacuum Pump Bolt **tighten** 10 N.m (89 lb in)
5	Camshaft Position Actuator Solenoid Valve - Exhaust
6	Camshaft Position Actuator Solenoid Valve Bolt **tighten** 10 N.m (89 lb in)
7	Camshaft Position Actuator Solenoid Valve - Intake
8	Camshaft Position Actuator Solenoid Valve Bolt **tighten** 10 N.m (89 lb in)
9	Ignition Coil **Procedure** 1. Inspect the inside of the ignition coil rubber boot for a thin, even coat of grease. 2. If there is no grease present or additional grease is necessary, apply a thin coating of dielectric grease evenly to the inside of the ignition coil rubber boot, up to a depth of 15 mm from the end of the boot. Refer to **Adhesives, Fluids, Lubricants, and Sealers**. 3. Remove any excess grease from around the end of the boot, and ensure there is not an excessive amount within the boot.
10	Ignition Coil Bolt **tighten** 10 N.m (89 lb in)
11	Engine Lift Front Bracket
12	Engine Lift Front Bracket Bolt **tighten** 25 N.m (18 lb ft)
13	Engine Lift Rear Bracket
14	Engine Lift Rear Bracket Bolt **tighten** 25 N.m (18 lb ft)
15	Oil Level Indicator
16	Camshaft Cover Heat Shield
17	Camshaft Cover Heat Shield Bolt **NOTE:** **An additional bolt retains the camshaft cover heat shield and the turbocharger coolant return pipe.** **tighten** 10 N.m (89 lb in)
18	Engine Coolant Air Bleed Pipe O-Ring
19	Engine Coolant Air Bleed Pipe
20	Engine Coolant Air Bleed Pipe Bolt **tighten** 10 N.m (89 lb in)

mcx30.com

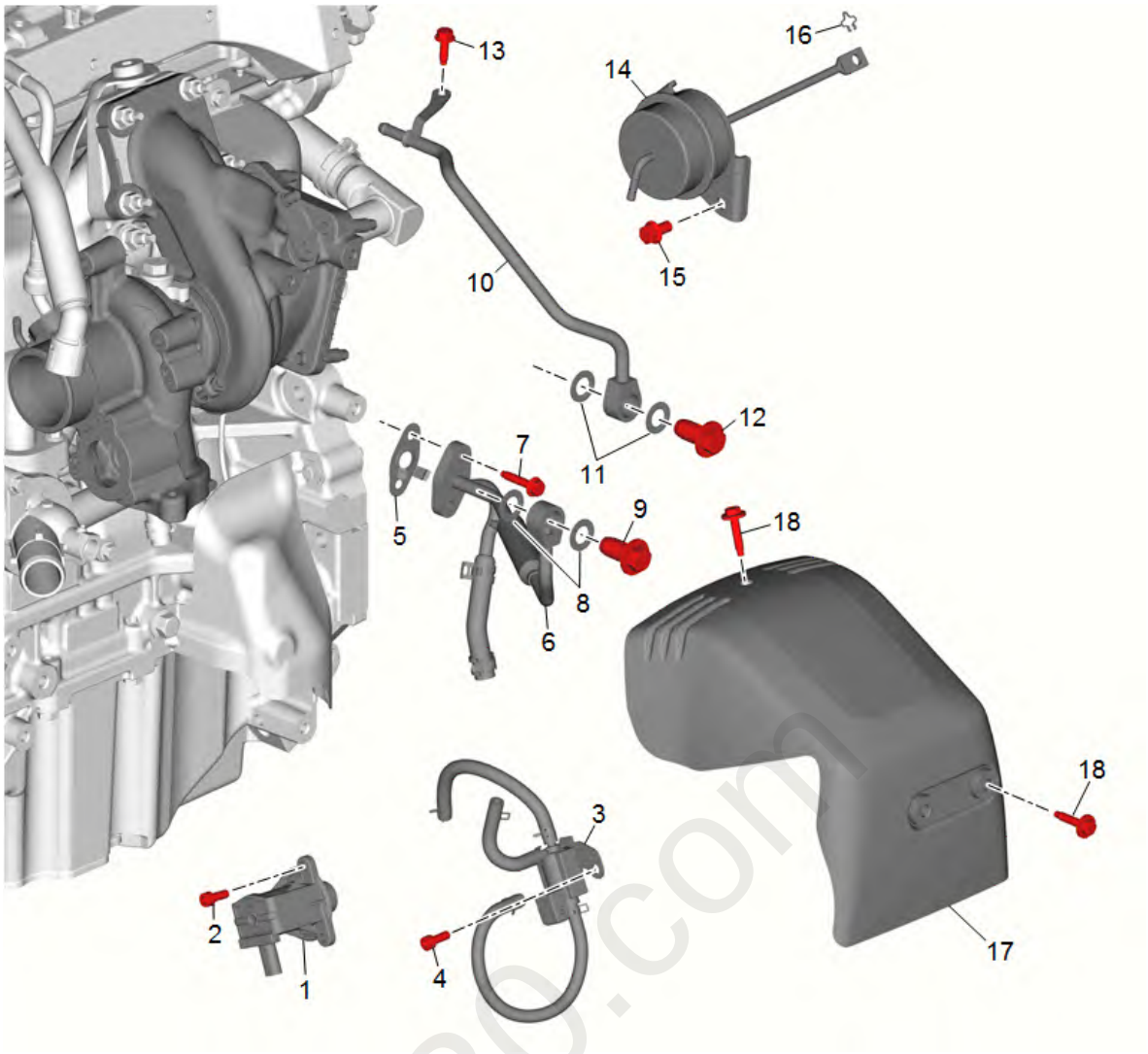


Fig. 584: Turbocharger Component
Courtesy of GENERAL MOTORS COMPANY

Turbocharger Component Installation

Callout	Component Name
1	Turbocharger Air Bypass Valve Solenoid
2	Turbocharger Air Bypass Valve Solenoid Bolt **tighten** 8 N.m (71 lb in)
3	Turbocharger Wastegate Regulator Solenoid Valve **Procedure** Connect the turbocharger wastegate regulator solenoid valve hoses to the turbocharger.
4	Turbocharger Wastegate Regulator Solenoid Valve Bolt **tighten** 8 N.m (71 lb in)
5	Turbocharger Coolant Feed Pipe Gasket **NOTE:** **Use a NEW gasket.**
6	Turbocharger Coolant Feed Pipe
7	Turbocharger Coolant Feed Pipe Bolt **tighten** 10 N.m (89 lb in)

Callout	Component Name
8	Turbocharger Coolant Feed Pipe Washer **NOTE:** **Use NEW washers.**
9	Turbocharger Coolant Feed Pipe Bolt **tighten** 35 N.m (26 lb ft)
10	Turbocharger Coolant Return Pipe
11	Turbocharger Coolant Return Pipe Washer **NOTE:** **Use NEW washers.**
12	Turbocharger Coolant Return Pipe Bolt **tighten** 35 N.m (26 lb ft)
13	Turbocharger Coolant Return Pipe Bolt **NOTE:** **One bolt retains the turbocharger coolant return pipe and the camshaft cover heat shield at the same location.** **tighten** 10 N.m (89 lb in)
14	Turbocharger Wastegate Actuator
15	Turbocharger Wastegate Actuator Bolt **tighten** 8 N.m (71 lb in)
16	Turbocharger Wastegate Actuator Arm Retainer
17	Turbocharger Heat Shield
18	Turbocharger Heat Shield Bolt **tighten** 14 N.m (124 lb in)

INTAKE MANIFOLD INSTALLATION

Special Tools

- **EN-45059** Angle Meter
- **EN-50790** HP Fuel Pump Installation Alignment Gauge

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

mcx30.com

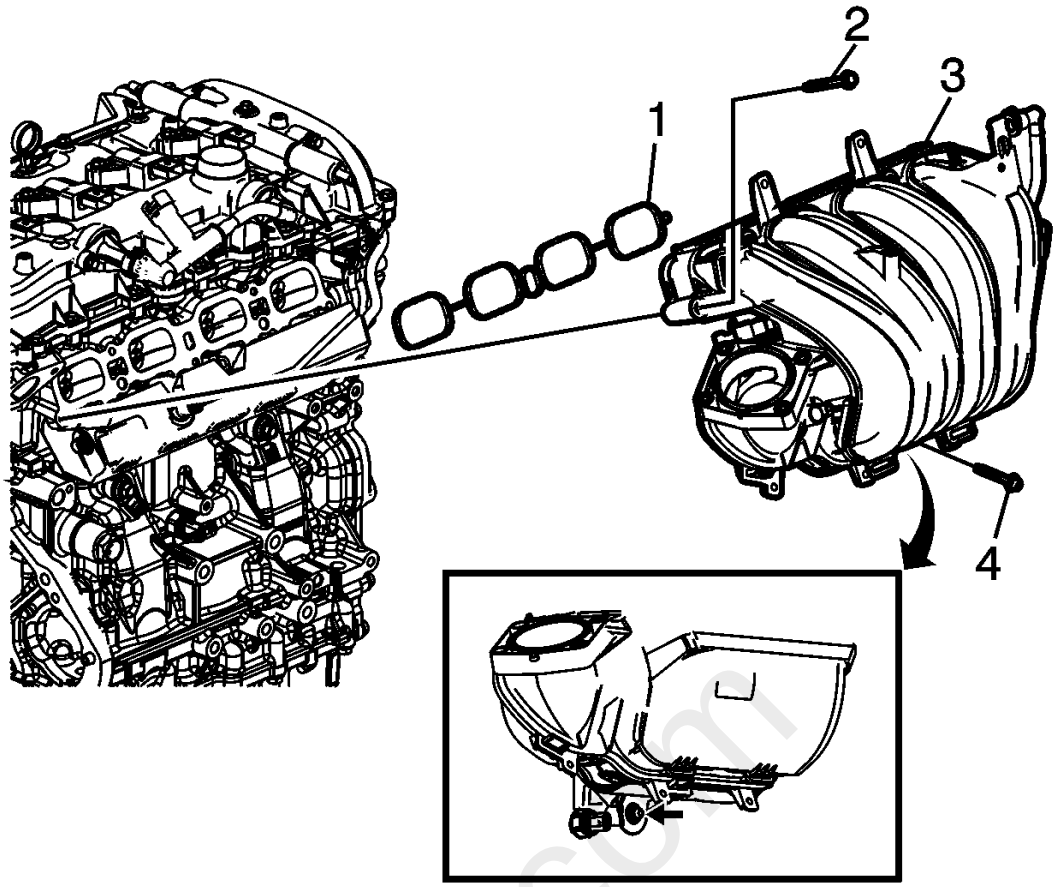


Fig. 585: Intake Manifold And Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW gasket (1) on the intake manifold (3). Install the intake manifold and hand start the intake manifold bolts (2, 4).

mcx30.com

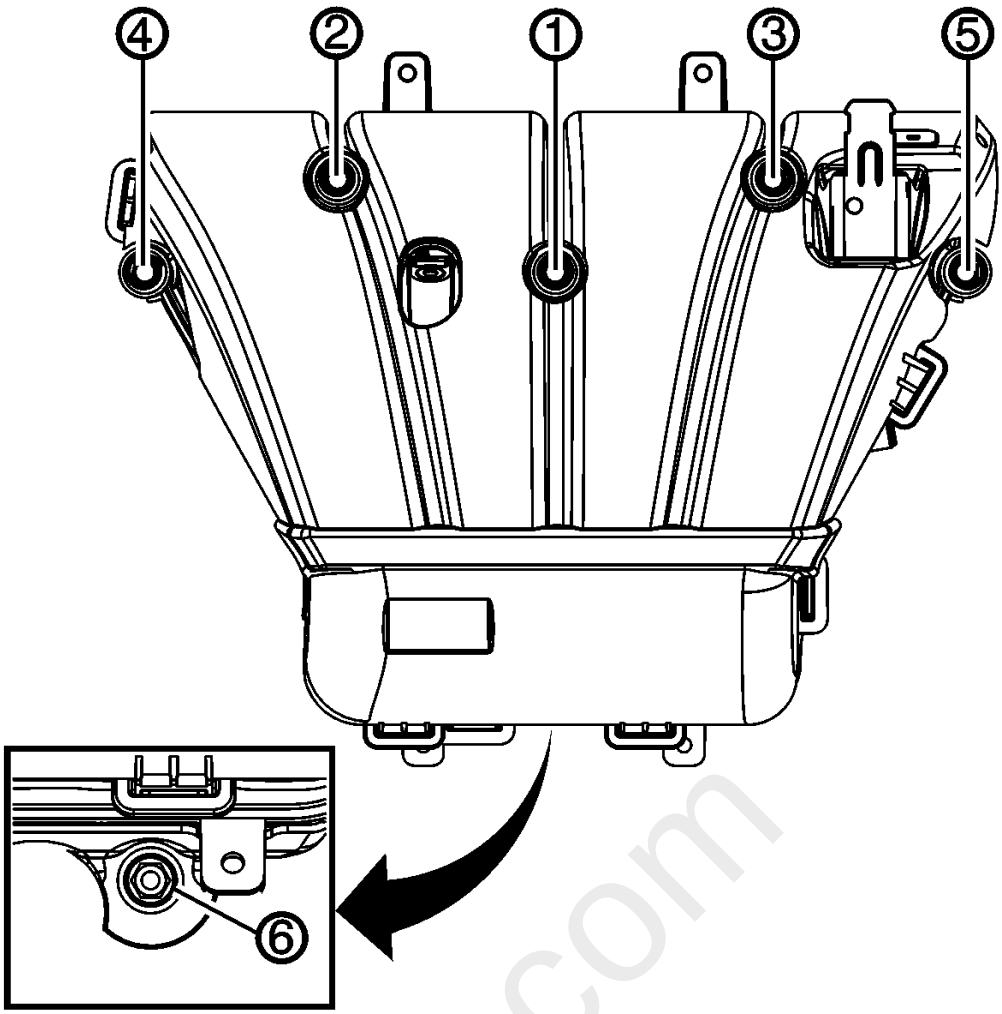


Fig. 586: Intake Manifold Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. tighten the bolts and nuts in sequence twice to 12 N.m (106 lb in).

mcx30.com

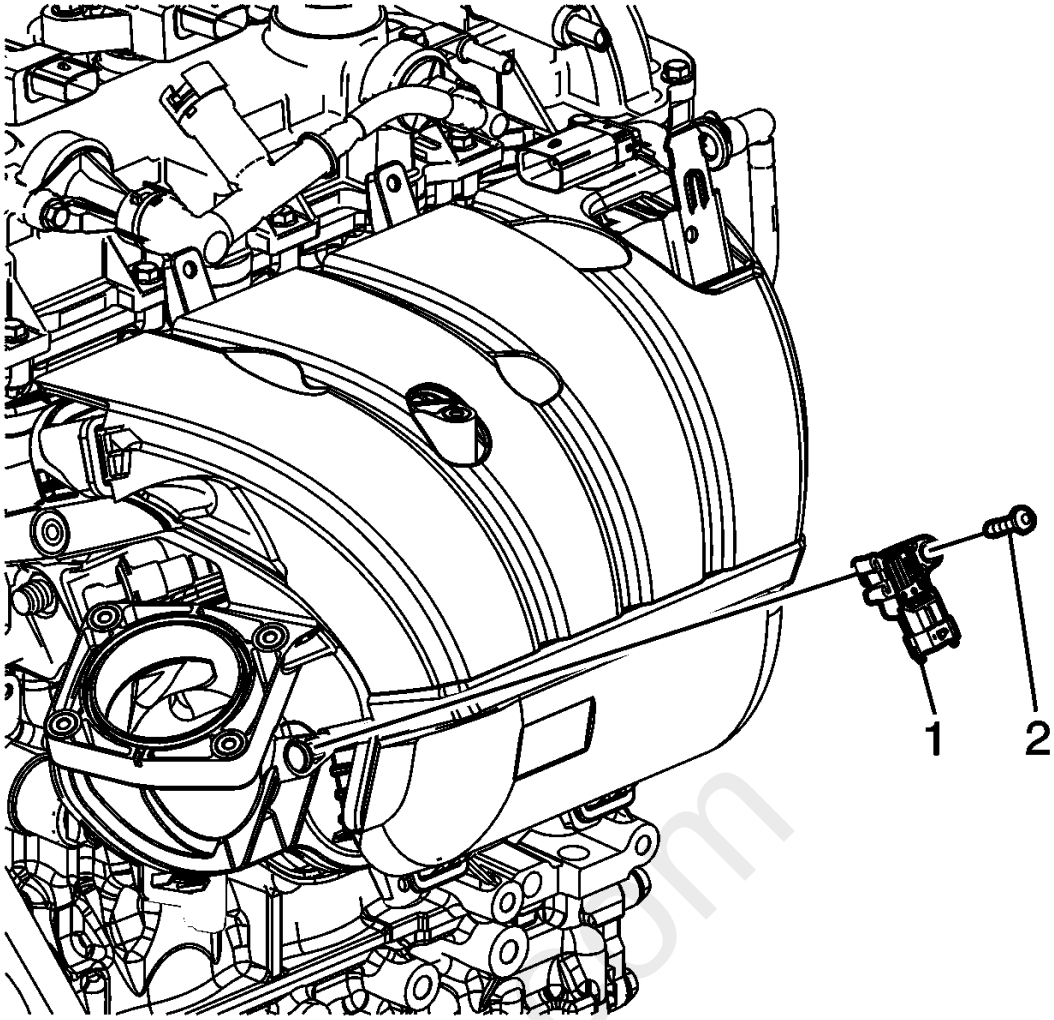


Fig. 587: MAP Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install the MAP sensor (1) and bolt (2). tighten the bolt to 5 N.m (44 lb in).

mcx30.com

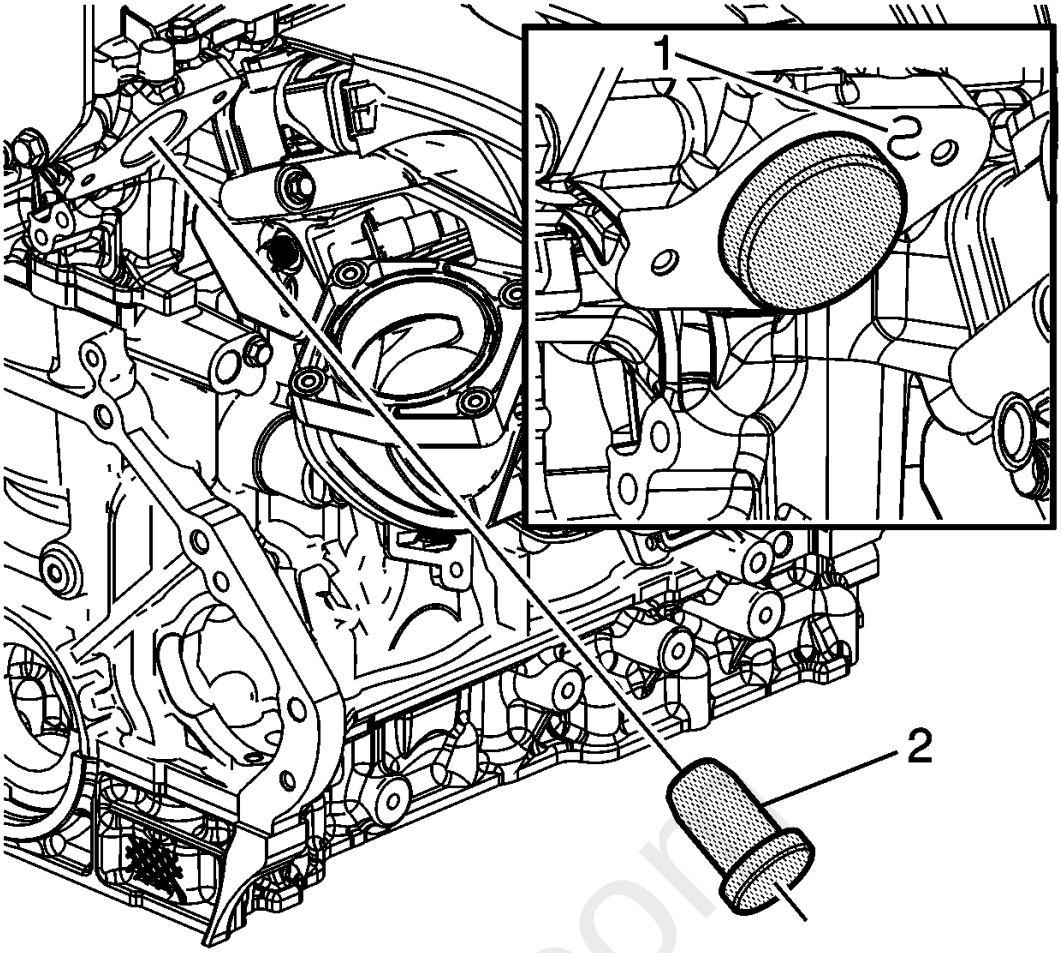


Fig. 588: View Of HP Fuel Pump Installation Alignment Gauge
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The camshaft must be in the base circle position before the high pressure fuel pump is installed.**

4. Use the **EN-50790** 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).

mcx30.com

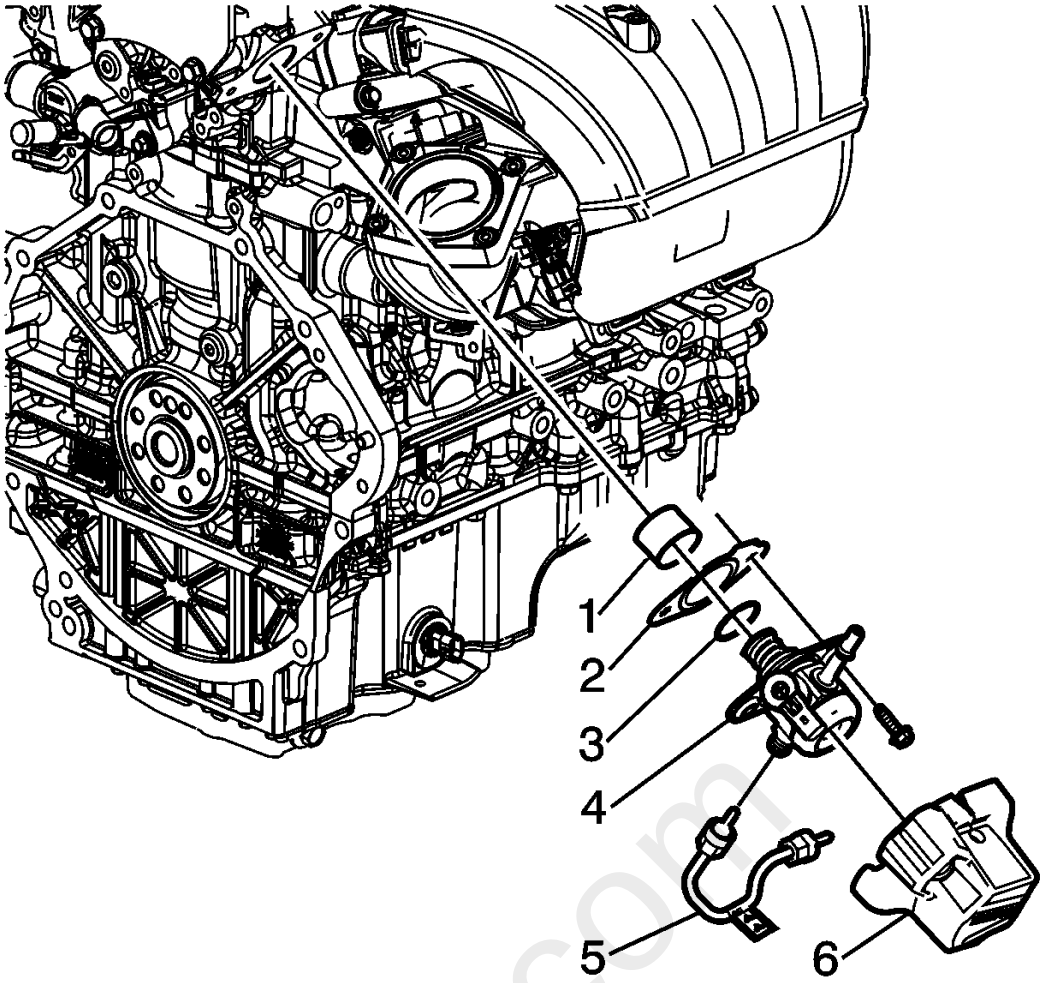


Fig. 589: High Pressure Fuel Pump Assembly
Courtesy of GENERAL MOTORS COMPANY

5. Lubricate the high pressure fuel pump cylinder head bore with clean, silicone-free 5W30 engine oil.

NOTE: **Ensure that the high pressure fuel pump roller lifter is oriented properly, and the camshaft is at base circle.**

6. Lubricate the high pressure fuel pump roller lifter (1) with 5W30 engine oil and install into the cylinder head bore.
7. Lubricate the NEW O-ring (3) with one drop of clean engine oil. Install the NEW fuel pump housing O-ring (3).

NOTE: **Ensure the fuel pump housing gasket (2) is properly aligned with the tab upward at the 2 O'clock position.**

8. Install the NEW fuel pump housing gasket (2).
9. Install the fuel pump assembly (4).

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.**

10. Apply theadlocker to the bolts, refer to **Adhesives, Fluids, Lubricants, and Sealers**.

CAUTION: **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.**

mx30.com

11. Hand start the NEW fuel pump bolts evenly. tighten the fuel pump bolts evenly to 8 N.m (71 lb in) plus 50 degrees using the **EN-45059** meter.
12. Hand start both ends of the NEW fuel feed intermediate pipe (5).
    1. tighten the fitting nut to the fuel rail to 15 N.m (11 lb ft).
    2. tighten the fitting nut to the fuel pump to 15 N.m (11 lb ft).
    3. tighten the fitting nut to the fuel rail a final pass to 30 N.m (22 lb ft).
    4. tighten the fitting nut to the fuel pump a final pass to 30 N.m (22 lb ft).

WARNING: **The noise cancelling foam component MUST be replaced if it has been exposed to engine fluids. Failure to replace the noise cancelling foam component that has been exposed to engine fluids may result in an engine fire resulting in catastrophic engine damage, and possible injury or death.**

13. Install the fuel pump insulator (6).

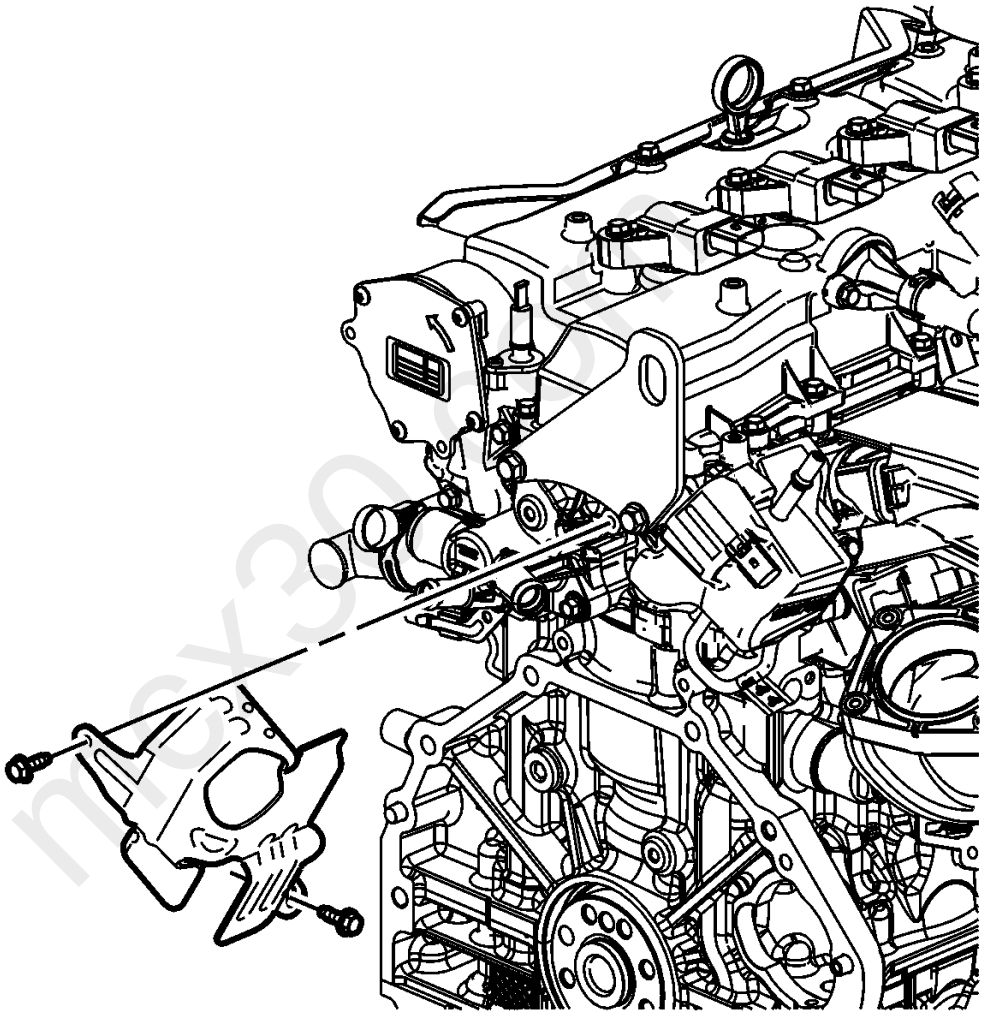


Fig. 590: Fuel Pump Cover Bolts And Cover
Courtesy of GENERAL MOTORS COMPANY

14. Install the fuel pump cover and bolts. tighten the bolts to 10 N.m (89 lb in).

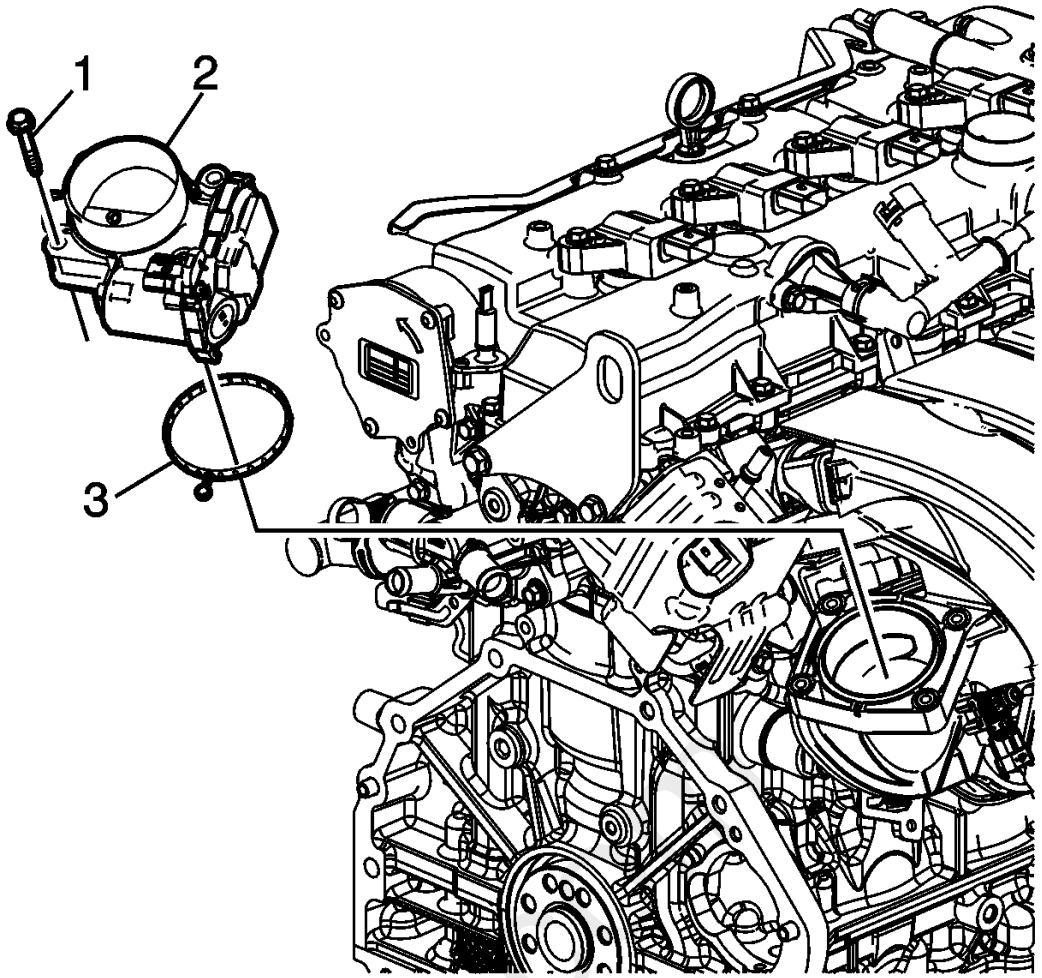


Fig. 591: Throttle Body Bolts
Courtesy of GENERAL MOTORS COMPANY

15. Install a new throttle body gasket (3).
16. Install the throttle body (2).
17. Install the throttle body bolts (1) and tighten to 10 N.m (89 lb in).

mcx30.com

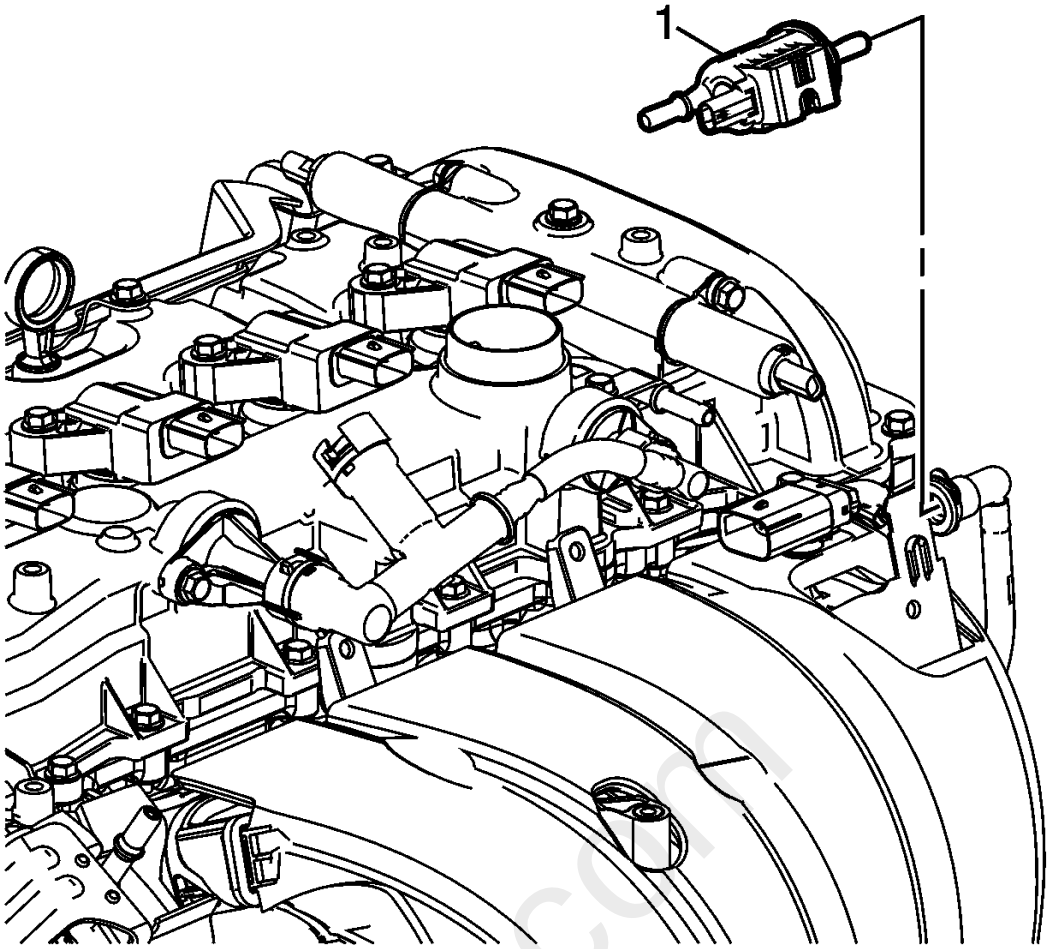


Fig. 592: EVAP Canister Valve
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the quick-connect is clean and free of debris. The latch should move freely prior to installation.**

18. Install the EVAP canister valve (1) and connect the EVAP canister valve tube.

TURBOCHARGER INSTALLATION (1ST DESIGN TAMPER-PROOF PCV SYSTEM)

mc30.com

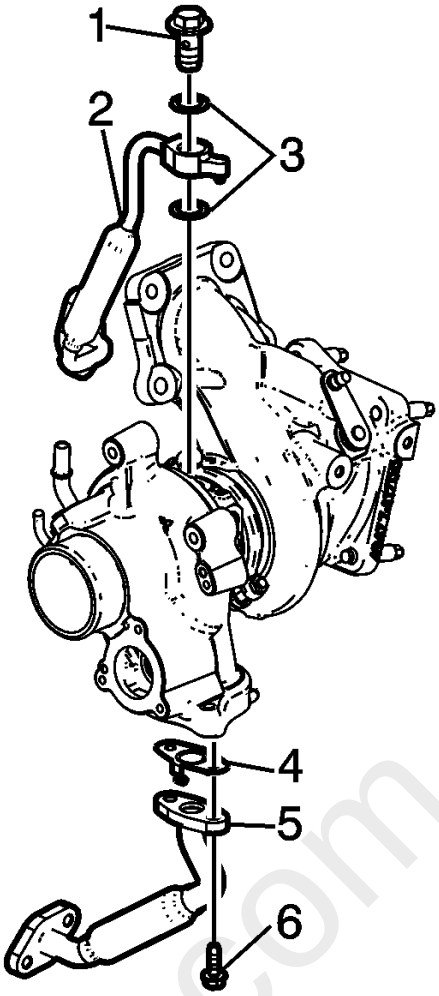


Fig. 593: Turbocharger Oil Feed Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The exhaust pipe studs do not come installed on new turbochargers. If the turbocharger is being replaced, new studs will need to be installed.**

1. Install the turbocharger oil feed pipe (2) and NEW washers (3) onto the turbocharger.

CAUTION: **Refer to Fastener Caution .**

2. Install the turbocharger oil feed pipe bolt (1) and tighten to 35 N.m (26 lb ft).
3. Install a NEW turbocharger oil return pipe gasket (4).
4. Install the turbocharger oil return pipe (5) onto the turbocharger.
5. Install the turbocharger oil return pipe bolts (6) and tighten to 10 N.m (89 lb in).

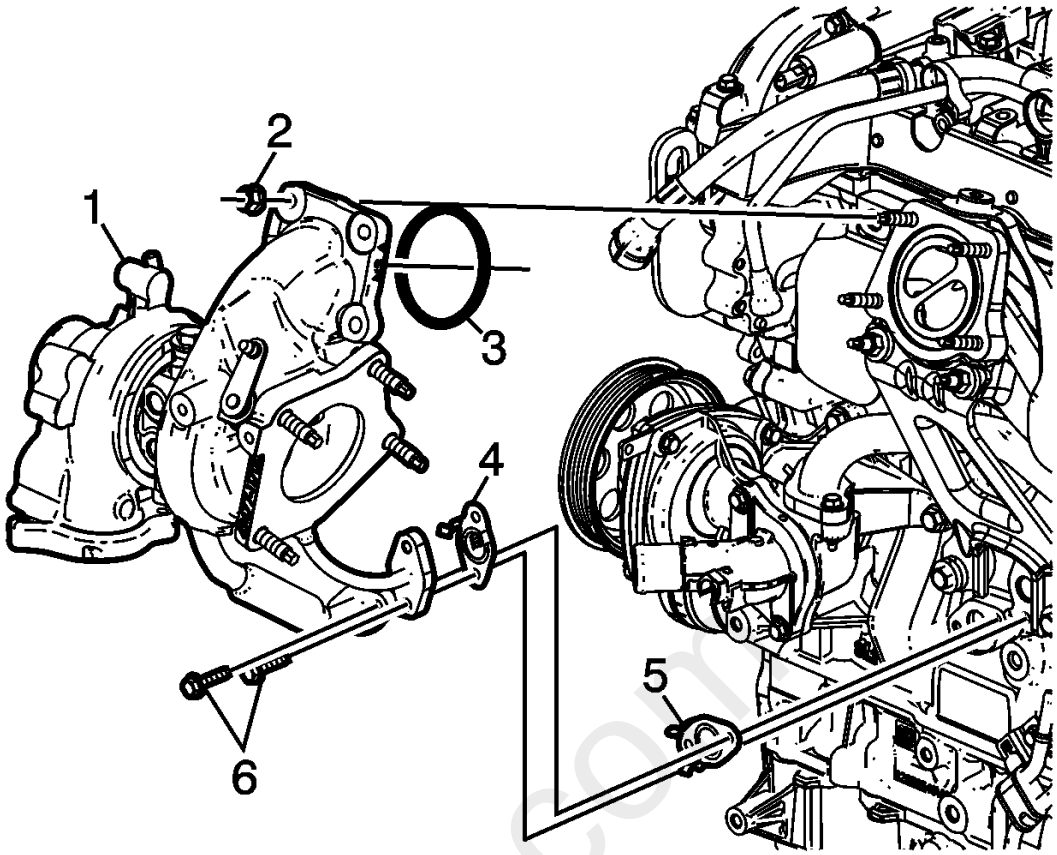


Fig. 594: Exploded View Of Turbocharger
Courtesy of GENERAL MOTORS COMPANY

6. Install a NEW turbocharger gasket (3) on the turbocharger.
7. Install NEW turbocharger oil feed and oil return pipe gaskets (4, 5).
8. Install the turbocharger (1).

CAUTION: **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.**

9. Install NEW turbocharger nuts (2) finger tight.
10. Install the turbocharger oil feed and return pipe bolts (6) at the engine block. tighten the bolts to 10 N.m (89 lb in).

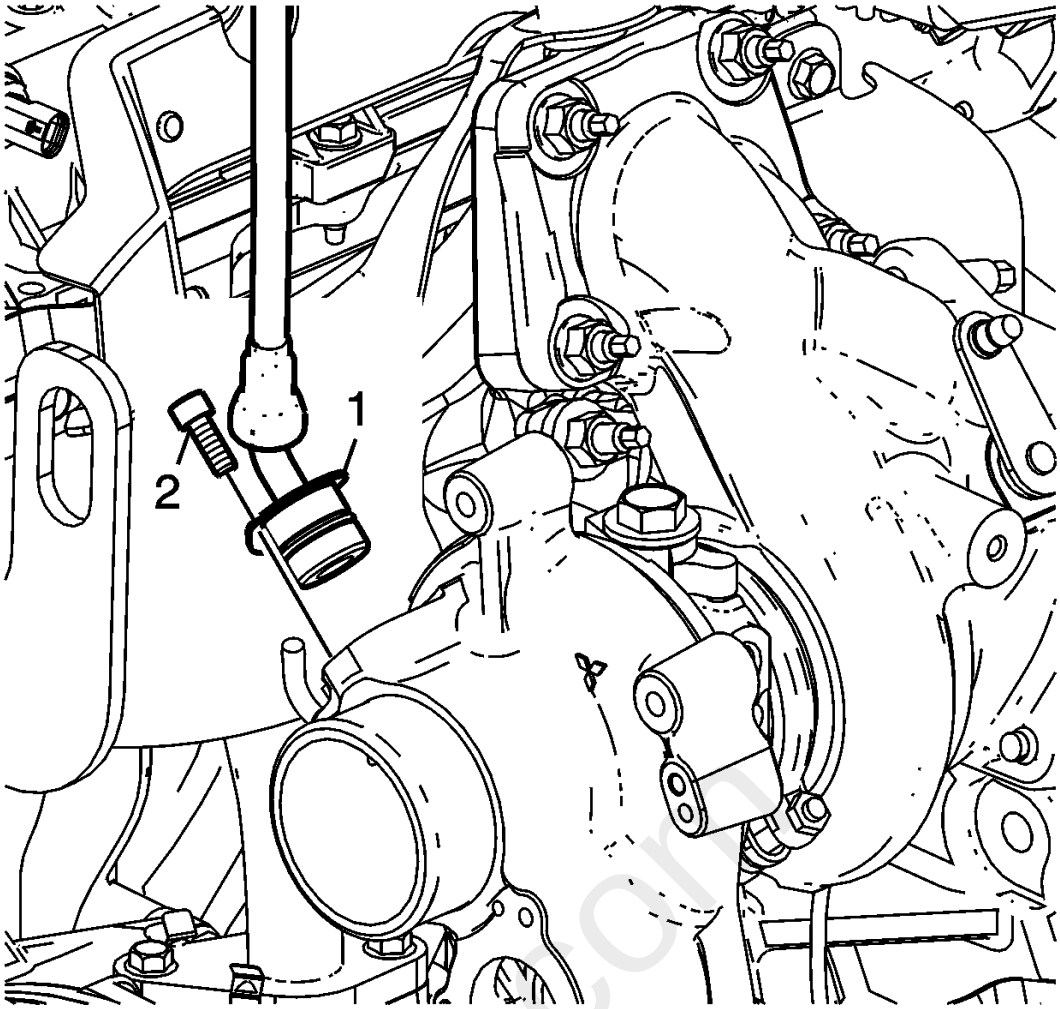


Fig. 595: PCV Hose Fitting Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The PCV hose and fitting assembly connection is permanent. Reinstall these components as an assembly unless new components are being used.**

NOTE: **Always ensure the PCV hose fitting O-Ring seal is free of cuts or abrasions each time the fitting is attached to the turbocharger.**

11. Inspect the PCV hose fitting O-Ring seal and replace if necessary.
12. Install the PCV hose and fitting assembly (1) to the turbocharger. Install the PCV hose fitting assembly bolt (2) and tighten to 8 N.m (71 lb in).

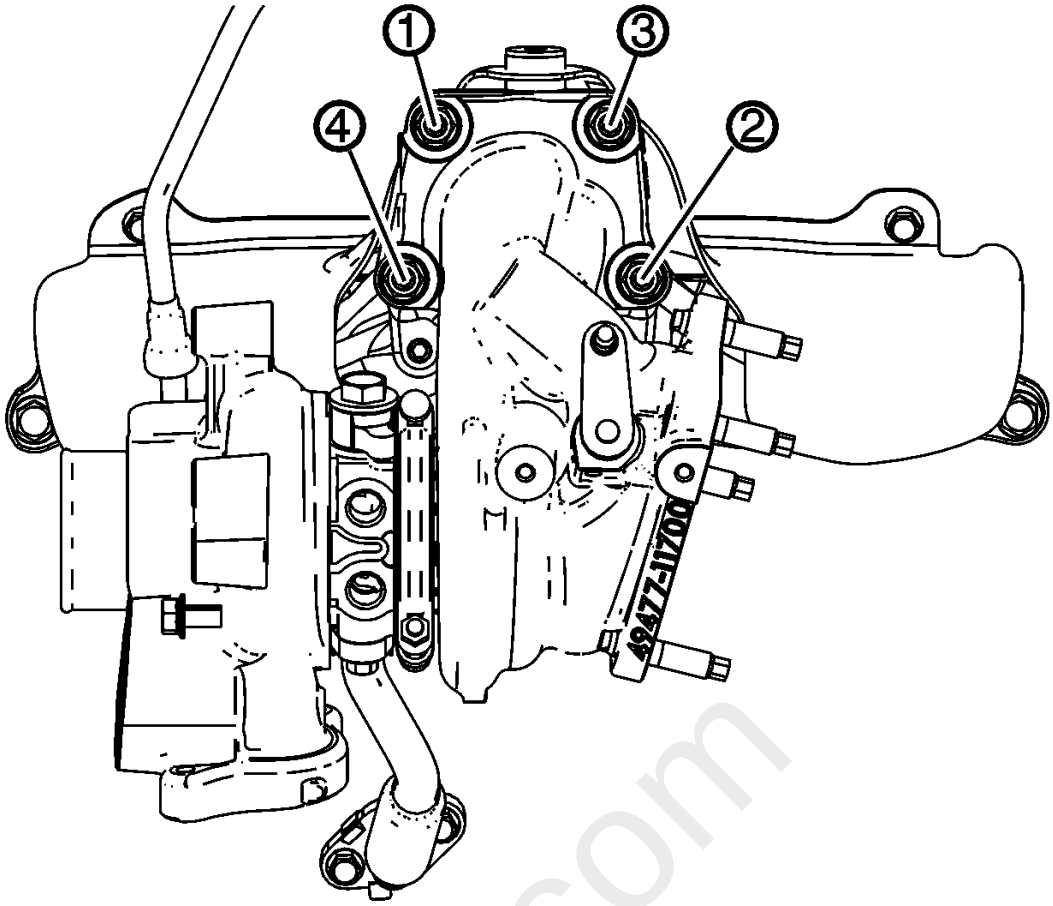


Fig. 596: Turbocharger Nut tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

13. tighten the turbocharger nuts in sequence to 30 N.m (22 lb ft) plus 90 degrees.

mcx30.com

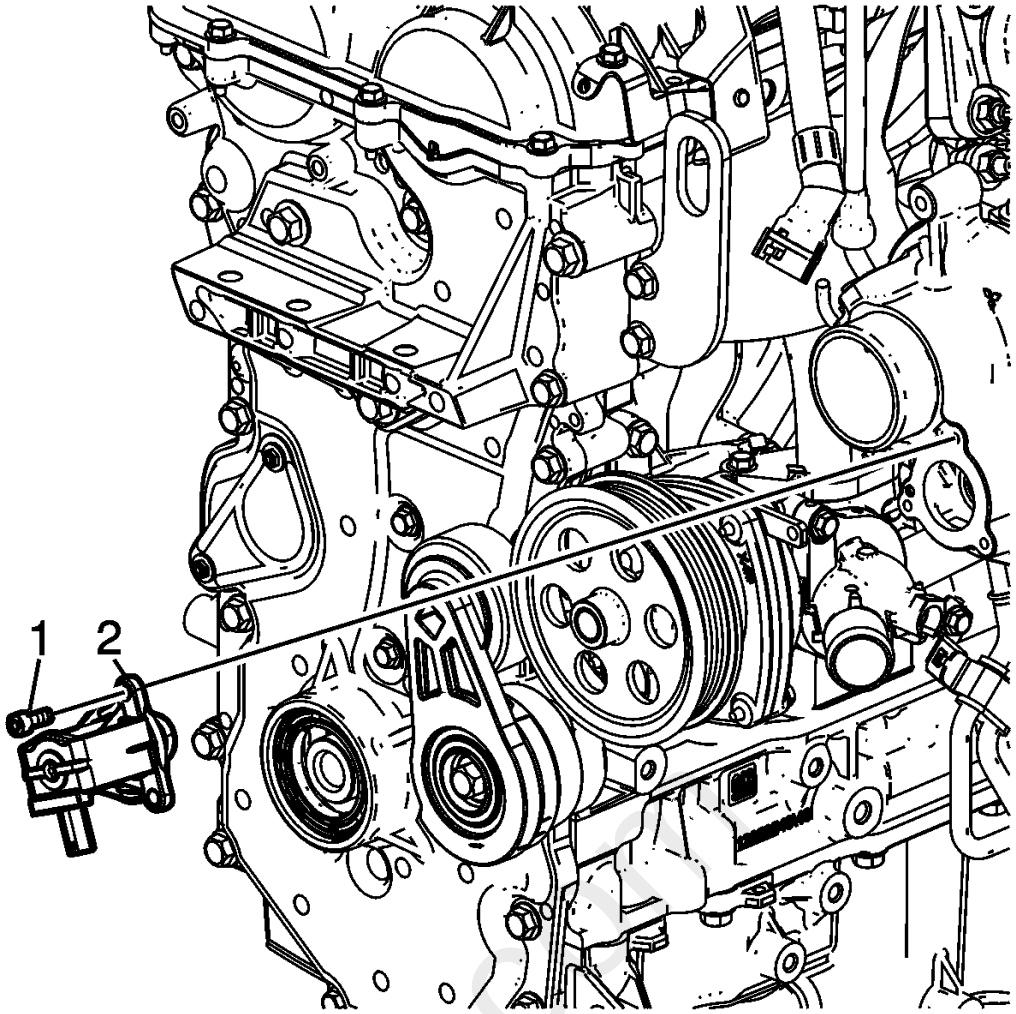


Fig. 597: Turbocharger Bypass Valve Solenoid Bolts
Courtesy of GENERAL MOTORS COMPANY

14. Install the turbocharger bypass valve solenoid (2).
15. Install the turbocharger bypass valve solenoid bolts (1) and tighten to 8 N.m (71 lb in).

mc30.com

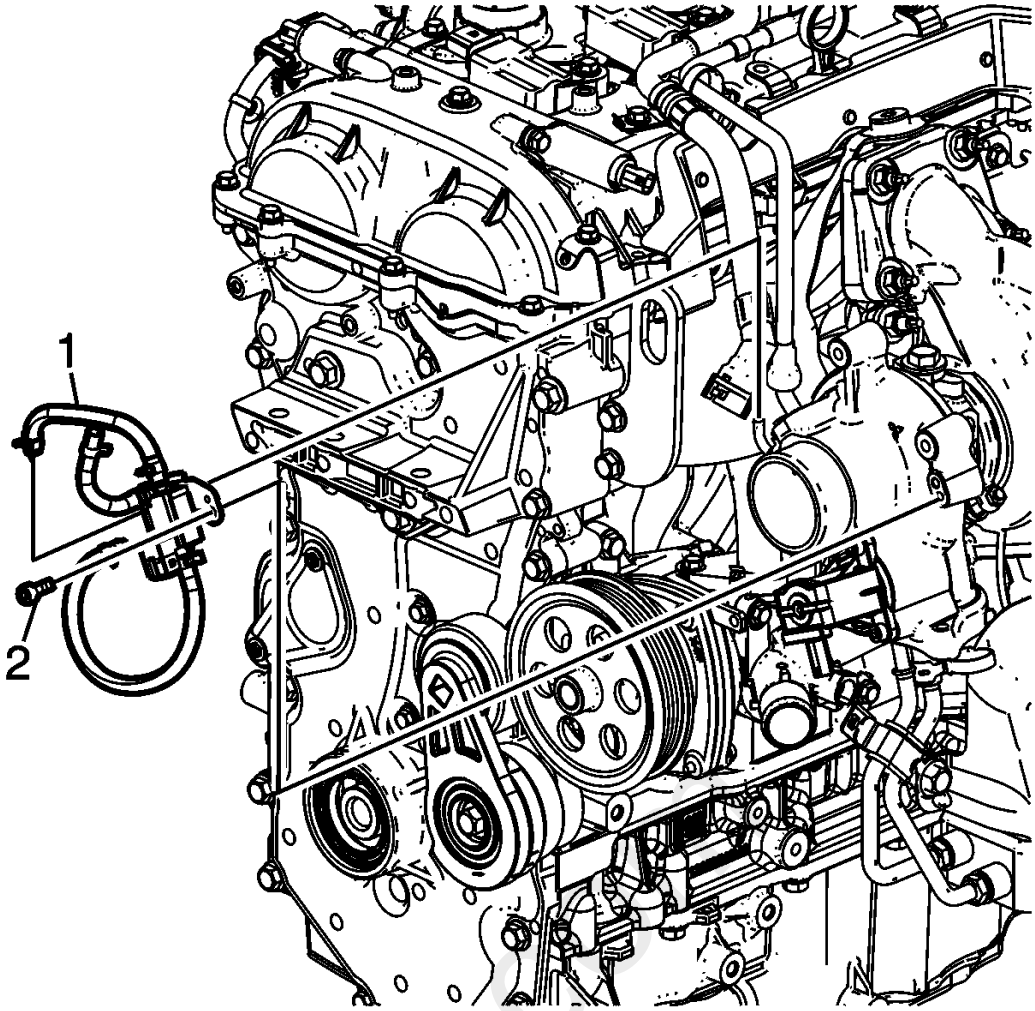


Fig. 598: Turbocharger Wastegate Regulator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

16. Install the turbocharger wastegate regulator solenoid valve (1).
17. Install the turbocharger wastegate regulator solenoid valve bracket bolt (2) and tighten to 8 N.m (71 lb in).
18. Connect the turbocharger wastegate regulator solenoid valve hoses to the turbocharger.

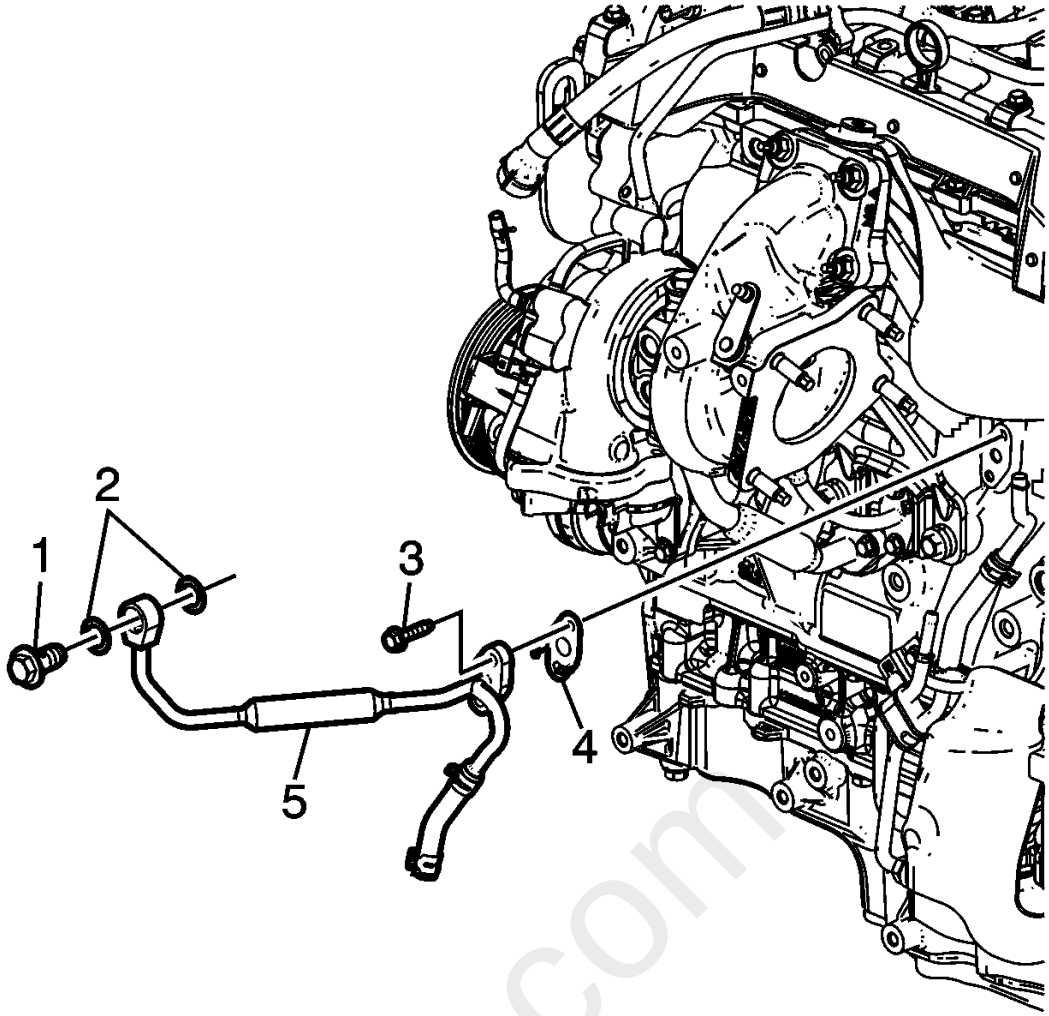


Fig. 599: Turbocharger Coolant Feed Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

19. Install the turbocharger coolant feed pipe (5) and NEW washers (2) on the turbocharger.
20. Install the turbocharger coolant feed pipe bolt (1) and tighten to 35 N.m (26 lb ft).
21. Install a NEW turbocharger coolant feed pipe gasket (4).
22. Install the turbocharger coolant feed pipe bolts (3) and tighten to 10 N.m (89 lb in).
23. Connect the turbocharger coolant feed pipe hose to the engine oil cooler.

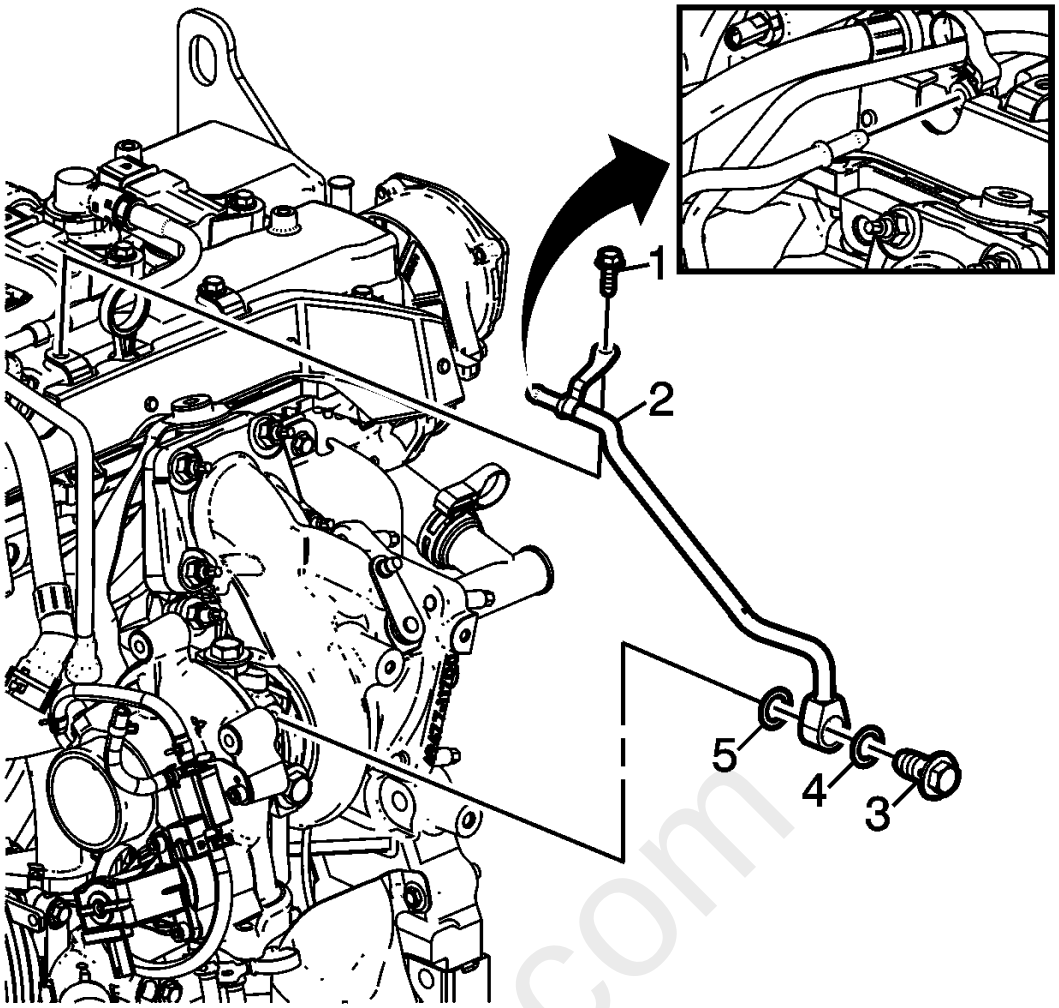


Fig. 600: Camshaft Cover Heat Shield Bolt
Courtesy of GENERAL MOTORS COMPANY

24. Install the turbocharger coolant return pipe (2) and NEW washers (4, 5) on the turbocharger.
25. Install the turbocharger coolant return pipe bolt (3) and tighten to 35 N.m (26 lb ft).
26. Connect the turbocharger coolant return pipe to the air bleed hose.
27. Install the camshaft cover heat shield bolt (1) that retains the turbocharger coolant return pipe (2) at the camshaft cover. tighten the bolt to 10 N.m (89 lb in).

mo30.com

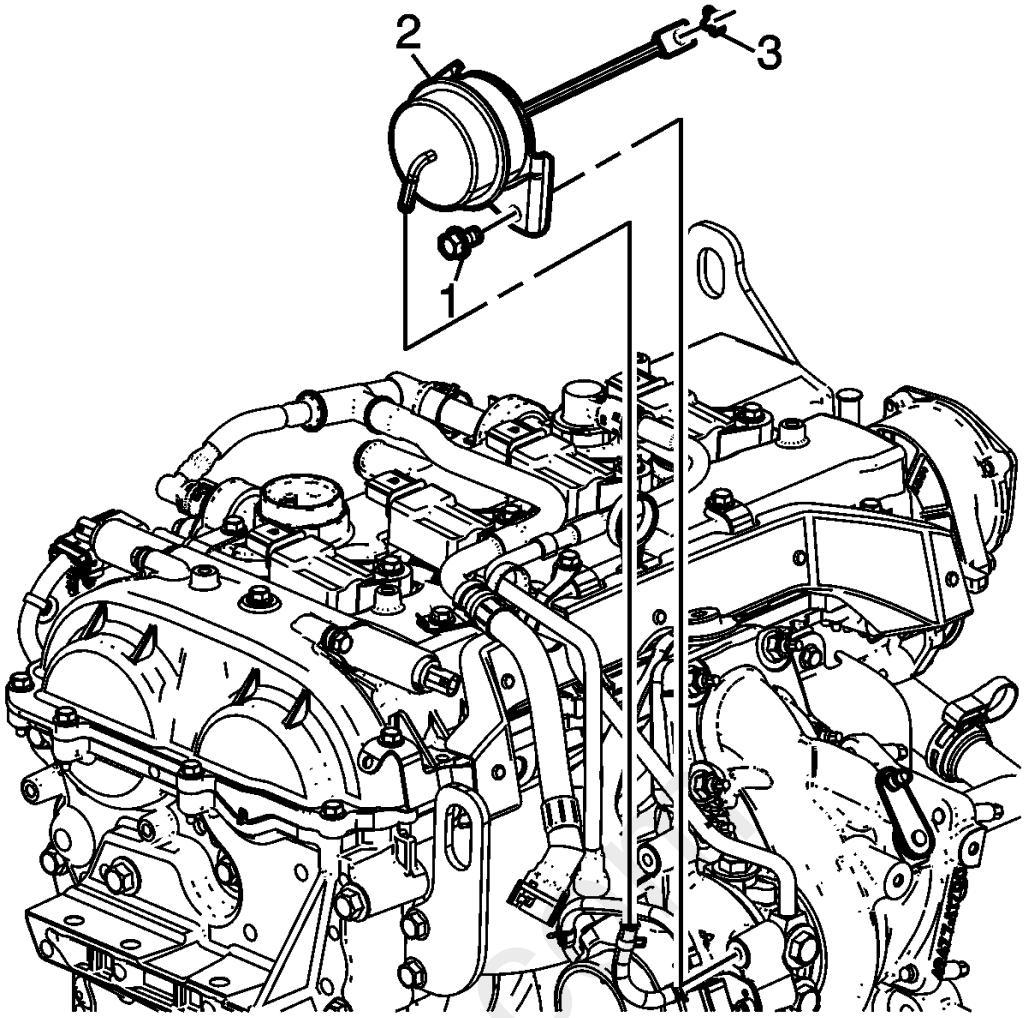


Fig. 601: Turbocharger Wastegate Actuator Arm Retainer
Courtesy of GENERAL MOTORS COMPANY

28. Install the turbocharger wastegate actuator (2) and actuator bolts (1) and tighten to 8 N.m (71 lb in).
29. Install the turbocharger wastegate actuator arm retainer (3).

mc30.com

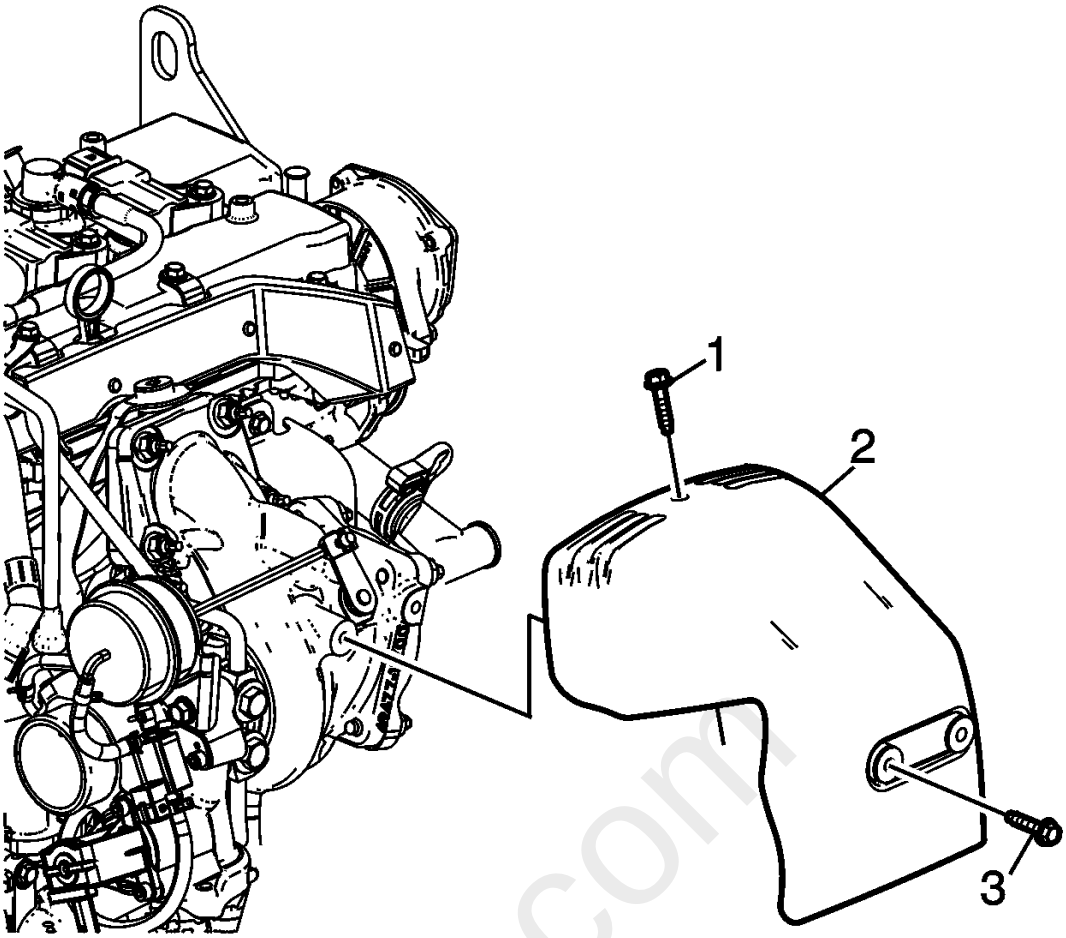


Fig. 602: Turbocharger Heat Shield Bolts
Courtesy of GENERAL MOTORS COMPANY

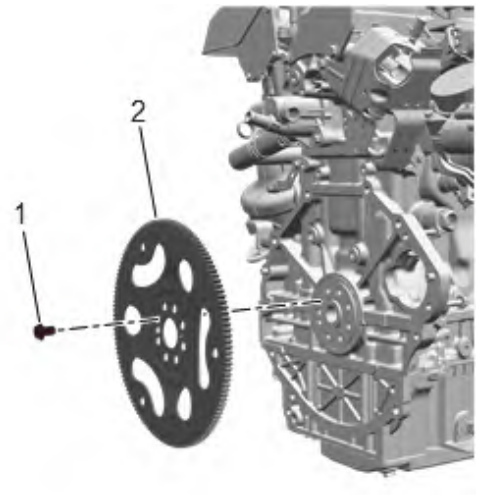
30. Install the turbocharger heat shield (2).
31. Install the turbocharger heat shield bolts (1, 3) and tighten to 14 N.m (124 lb in).

AUTOMATIC TRANSMISSION FLEX PLATE INSTALLATION

Special Tools

- **EN-51760** Flywheel Holding Tool
- **EN-45059** Angle Meter

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



mc730.com

Fig. 603: Automatic Flex Plate Attaching Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.**

NOTE: **Fasteners have adhesive patch and must be tighten ed to final torque within 5 minutes.**

1. Install the flywheel (2) and hand start NEW bolts (1).

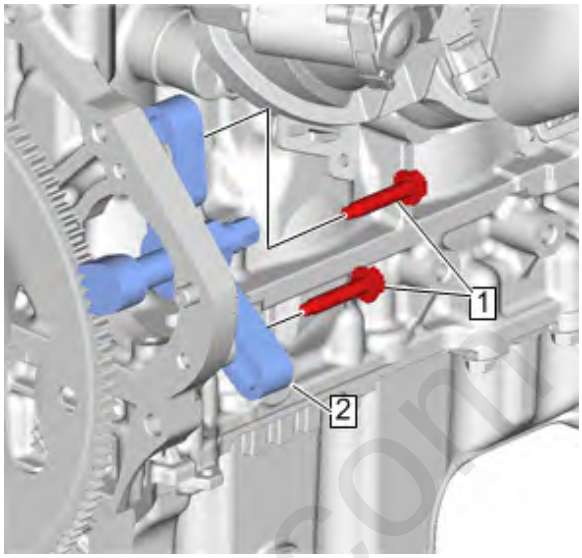


Fig. 604: Starter Motor Bolts
Courtesy of GENERAL MOTORS COMPANY

2. To prevent crankshaft rotation, install **EN-51760** flywheel holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the flywheel.

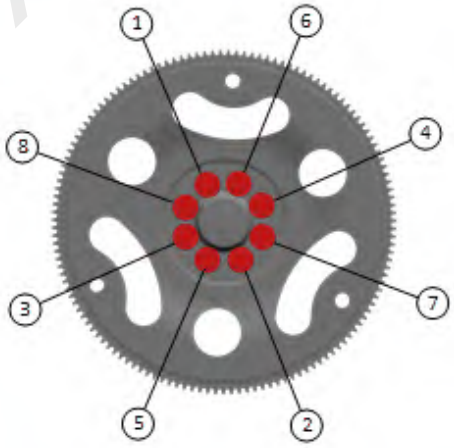


Fig. 605: Flex Plate Bolt tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

3. tighten the bolts evenly using the following procedure:
    1. tighten the bolts a first pass in sequence to 30 N.m (22 lb ft).
    2. tighten the bolts a final pass in sequence 40 degrees using the **EN-45059** meter.
4. Remove **EN-51760** flywheel holding tool.

mcx30.com

CRANKSHAFT BALANCER INSTALLATION

Special Tools

- **EN-45059** Angle Meter
- **EN-48034** Crankshaft Balancer Installer
- **EN-51760** Flywheel Holding Tool

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

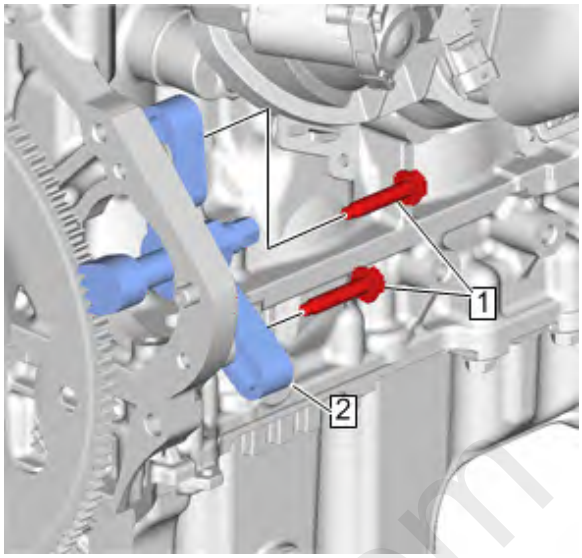


Fig. 606: Starter Motor Bolts
Courtesy of GENERAL MOTORS COMPANY

1. To prevent crankshaft rotation, install **EN-51760** flywheel holding tool (2) and starter motor bolts (1) at the starter motor location and engaging the flywheel.

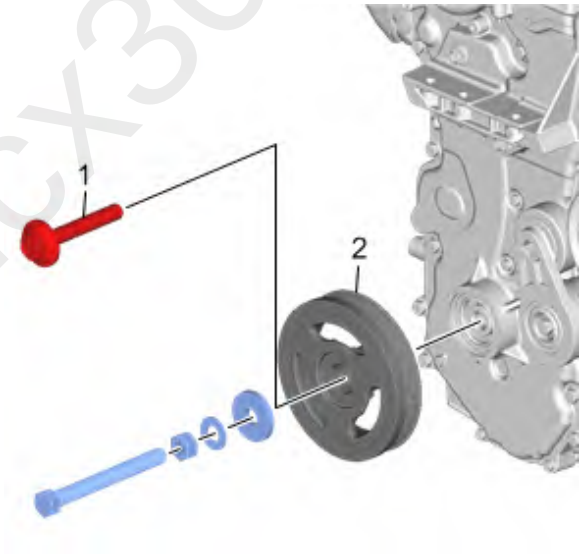


Fig. 607: Crankshaft Balancer, Bolt And Special Tool
Courtesy of GENERAL MOTORS COMPANY

2. Using **EN-48034** installer, install the crankshaft balancer (2).

CAUTION: **Refer to Fastener Caution .**

CAUTION: **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.**

3. Install a NEW crankshaft balancer bolt and washer. tighten the bolt to 150 N.m (111 lb ft) plus 140 degrees using the **EN 45059** meter.

mcx30.com

4. Remove **EN-51760** flywheel holding tool.

OIL FILTER INSTALLATION

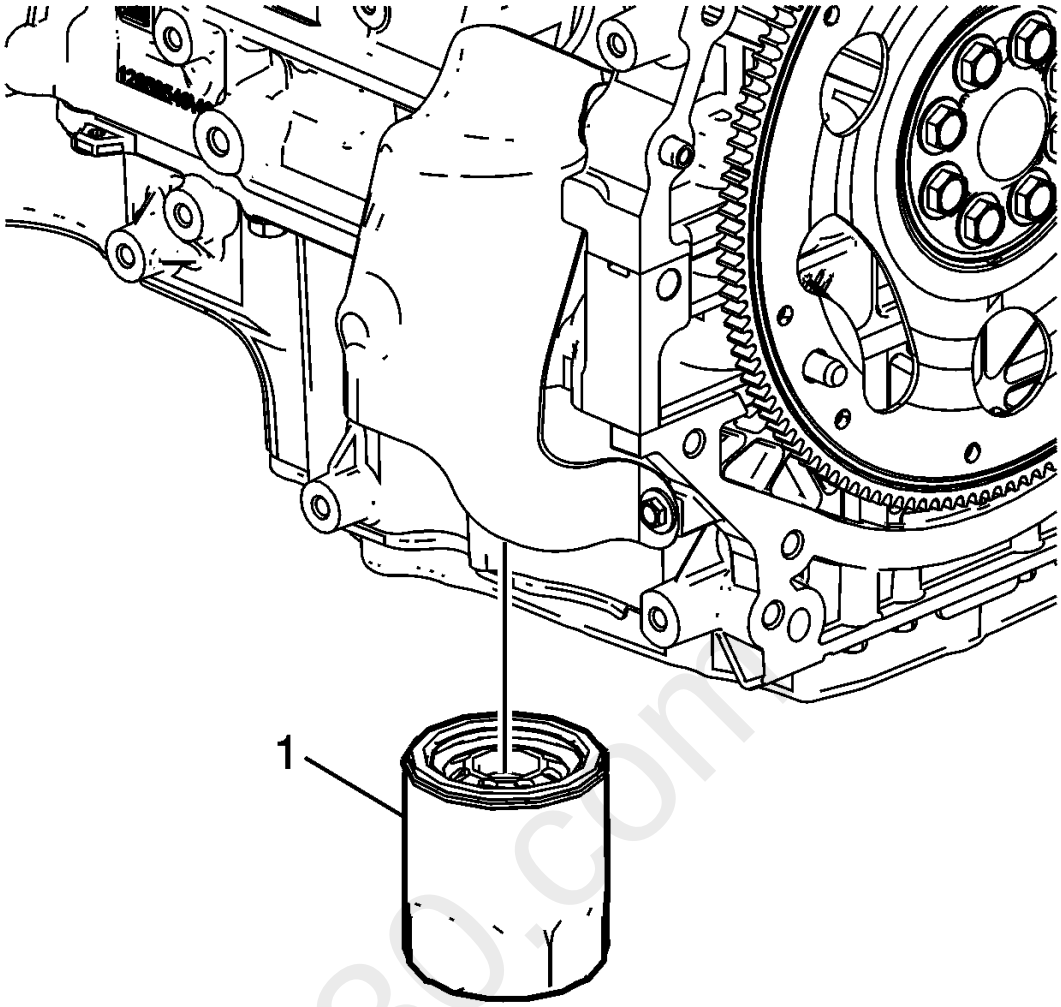


Fig. 608: Engine Oil Filter
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the O-ring on the oil filter with 5W30 engine oil.
2. Install a new oil filter (1).

CAUTION: **Refer to Fastener Caution .**

3. tighten the oil filter 3/4 to 1 full turn after gasket makes contact with the sealing surface on the filter mounting flange.

ENGINE PRELUBING

NOTE: **This procedure is not used in Europe.**

Special Tools

EN-45299 Engine Preluber

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

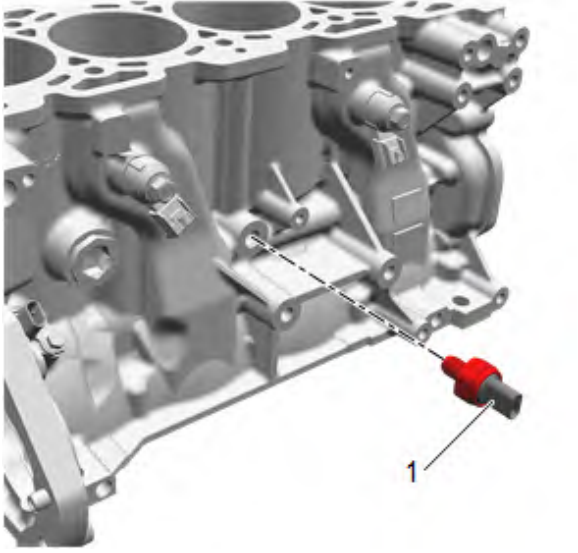


Fig. 609: Engine Oil Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: **A constant and continuous flow of clean engine oil is required in order to properly prime the engine. Ensure an approved engine oil is used, as specified in the owners manual.**

1. Remove the engine oil pressure sensor (1).
2. Install the M12 x 1.75 adapter P/N 509376.

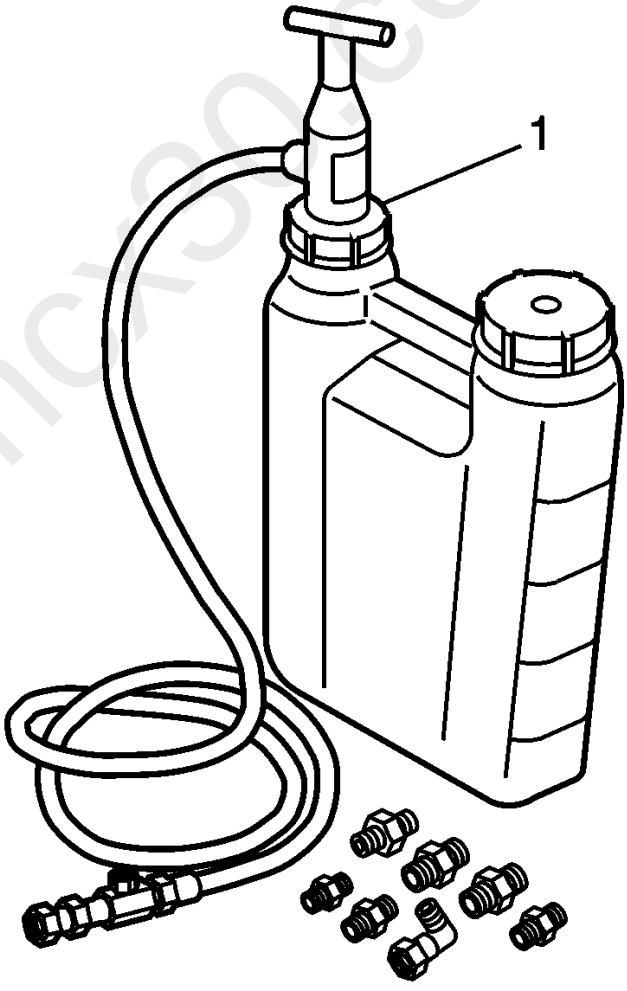


Fig. 610: View of Flexible Hose, Adapter and Preluber
Courtesy of GENERAL MOTORS COMPANY

3. Install the flexible hose to the adapter and open the valve.

4. Pump the handle on the **EN-45299** preluber (1) 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.
5. Close the valve and remove the flexible hose and adapter from the engine.

CAUTION: **Refer to Fastener Caution .**

6. Install the engine oil pressure sensor and tighten to 35 N.m (26 lb ft).
7. Top-off the engine oil to the proper level.

DESCRIPTION AND OPERATION

TURBOCHARGER SYSTEM DESCRIPTION

Turbocharger Description and Operation

A turbocharger is a compressor that is used to increase the power output of an engine by increasing the mass of the oxygen and therefore the fuel entering the engine. A turbocharger is mounted either to the exhaust manifold or directly to the head. The turbine is driven by the energy generated by the flow of the exhaust gases. The turbine is connected by a shaft to the compressor which is mounted in the induction system of the engine. The centrifugal compressor blades compress the intake air above atmospheric pressure, thereby increasing the density of the air entering the engine.

The turbocharger incorporates a wastegate that is controlled by a pressure differential that is determined by the engine control module (ECM) by means of a PWM solenoid, in order to control boost pressure. A compressor recirculation valve, also controlled by the ECM, prevents compressor surging and damage by opening during sudden throttle closures. When the recirculation valve is opened it allows the air to recirculate back to the turbocharger compressor inlet.

The turbocharger is connected to the engine oiling system by a supply and drain pipe. Oil is required for the bearing system function and also serves to carry some heat from the turbocharger. There is a cooling system circuit in the turbocharger that further reduces operating temperatures and passively dissipates bearing housing heat away from the turbocharger on shut down.

Charge Air Cooler Description

The turbocharger engine system is supported by an air-to-air charge air cooler system, which uses fresh air drawn through a heat exchanger to reduce the temperature of the hot compressed air exiting the turbo compressor, prior to delivery to the engine combustion system. Inlet air temperature can be reduced by up to 100Â°C (180Â°F), enhancing performance because cooler air is denser in oxygen and promotes optimal combustion. The charge air cooler is connected to the turbocharger and to the throttle body by flexible ductwork that requires the use of special high torque fastening clamps. In order to prevent any type of air leak when servicing the ductwork, the tightening specifications, cleanliness and proper positioning of the clamps is critical, and must be strictly adhered to.

Benefits of Dual Cam Phasing

The camshafts of the Ecotec 2.0 liter turbocharged engine have camshaft position sensors and camshaft position actuators that the ECM uses to accurately control the continuously variable intake and exhaust valve timing. This allows the combustion process to be optimized by the ECM to increase the response of the turbocharger, providing a more immediate feeling of power to the driver.

Benefits of Gasoline Direct Injection

In the Ecotec 2.0 liter turbocharged engine, the fuel is introduced directly into the combustion chamber during the intake stroke. As the piston approaches top-dead center, the mixture is ignited by the spark plug, thereby giving the name spark ignition direct injection. Direct injection allows the mixture to be leaner, with less fuel and more air at full power, and allows a slightly higher compression ratio, resulting in improved fuel consumption at part and full throttle.

The fact that the fuel is injected after the exhaust valve closes allows particularly high valve overlap values in certain engine operating ranges. This enhances the turbocharger response time. This would not be possible in a port fuel injection engine due to the fact that unburned fuel would escape through the open exhaust valve.

Direct injection's precise fuel delivery enables more complete combustion which reduces emissions particularly on cold starts.

Electronic Vacuum Pump

The purpose of the electronic vacuum pump, if equipped, is to keep the vacuum in the brake booster at an acceptable level under various operating conditions. The ECM monitors the input signal from the brake booster pressure sensor. When the vacuum in the brake booster is not in an acceptable range the control module will command the relay ON that controls the vacuum pump.

Recommendations for Service

The turbocharger is designed so that it does not require any special maintenance, and inspection is limited to a few periodic procedures. To ensure that the turbocharger's lifetime corresponds to that of the engine, the following engine manufacturer's service instructions must be strictly adhered to:

- Oil and filter change intervals
- Air filter change intervals
- Engine coolant change intervals
- Ignition system maintenance
- Injection system maintenance

The following causes are responsible for a majority of all turbocharger failures:

- Misdiagnosis of a non-failed turbocharger
- Penetration of foreign bodies into the turbine or the compressor
- Dirt or contaminants in the oil
- Inadequate oil supply and/or pressure
- Clogged oil return
- Higher than normal exhaust gas temperatures due to improper operation of the following:
    - The ignition system
    - The fuel injection system
    - The exhaust system

These failures can be avoided by regular maintenance.

CRANKCASE VENTILATION SYSTEM DESCRIPTION

General Description

A crankcase ventilation system is used to consume crankcase vapors in the combustion process instead of venting them to atmosphere. Fresh air from the intake system is supplied to the crankcase, mixed with blow by gases and then passed through a calibrated orifice into the intake manifold.

Operation

inc730.com

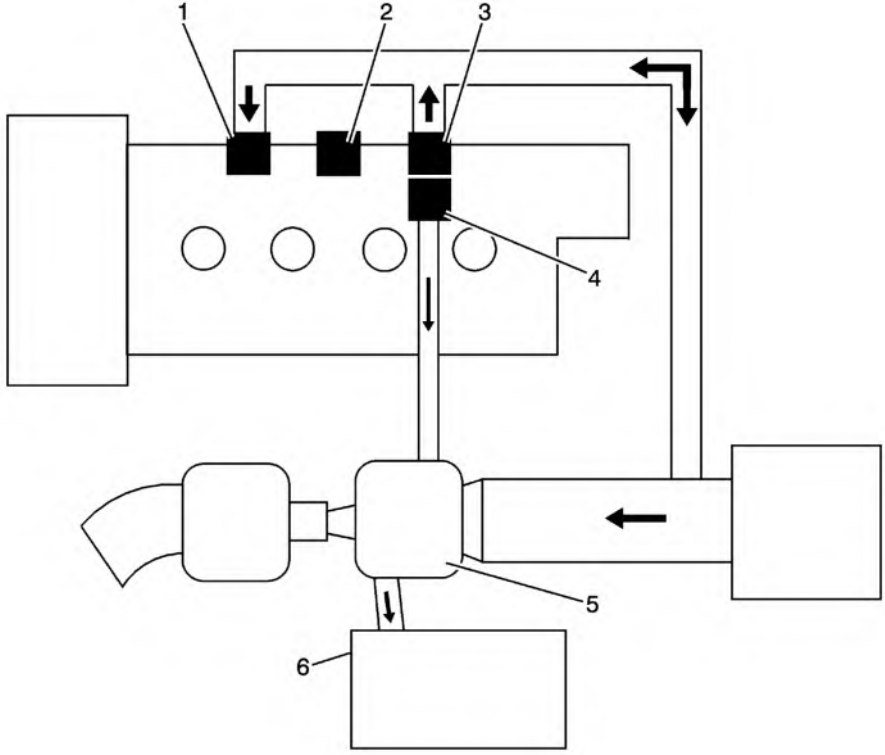


Fig. 611: Crankcase Ventilation System Components And Operational Diagram (LTG)
Courtesy of GENERAL MOTORS COMPANY

The primary control is through the positive crankcase ventilation (PCV) valve (2) which meters the flow at a rate depending on intake manifold vacuum. The PCV valve is an integral part of the camshaft cover. Fresh air is introduced to the engine through PVC (1) under normal operating conditions. If abnormal operating conditions occur, the system is designed to allow excessive amounts of blow by gases to back flow through the crankcase vent valve (3) into the intake system to be consumed by normal combustion.

Only on turbocharged engines, there is a one way valve (2) in the camshaft cover in order to prevent the crankcase from being pressurized by positive pressure in the intake manifold when the turbocharger is in operation. When the turbocharger is operational, the pressure in the intake manifold can exceed atmospheric pressure which, without the one way valve, would force oil and PCV gases out of the camshaft cover and into the induction system, via the hose to the camshaft cover. This can cause coking of the throttle body and induction system, and can reduce the efficiency of both combustion and the intercooler system, in normal operation the PCV gases are drawn into the air stream post intercooler (6). However, when the turbo is spooled up the turbo can become the vacuum source for the vent system. PVC#4 controls the max. flow so the crankcase stays at a normal vacuum during normal operating conditions.

Results of Incorrect Operation

A plugged orifice may cause the following conditions:

- Rough idle
- Stalling or slow idle speed
- Oil leaks
- Sludge in engine

A leaking orifice may cause the following conditions:

- Rough idle
- Stalling
- High idle speed

ENGINE COMPONENT DESCRIPTION

Engine Description

Cylinder Block

The cylinder block is constructed of aluminum alloy by precision sand-casting. The block has 5 crankshaft bearings with the thrust bearing located on the second bearing from the front of the engine. The cylinder block incorporates a

bedplate design that forms an upper and lower crankcase. This design promotes cylinder block rigidity and reduced noise and vibration.

Crankshaft

The crankshaft is cast nodular iron with 8 counterweights. The number 8 counterweight is also the ignition system reluctor wheel. The main bearing journals are cross-drilled, and the upper bearings are grooved. The crankshaft has a slip fit balance shaft drove sprocket. Number 2 main bearing is the thrust bearing. The crankshaft balancer is used to control torsional vibration.

Connecting Rod and Piston

The connecting rods are powdered metal. The connecting rod incorporates the floating piston pin. The pistons are cast aluminum. The piston rings are of a low tension type to reduce friction. The top compression ring is ductile steel with a molybdenum facing and phosphate coated sides. The second compression ring is gray iron. The oil ring is a 3-piece spring construction with chromium plating for applications without a turbocharger. For applications with turbocharger, the oil ring is a 3-piece spring construction with nitride plating.

Engine Block Cooling Baffle

The engine block cooling baffle is essential to proper engine coolant flow. The baffle's presence in the engine block is strategic and acts to direct the engine coolant flow around the bores for uniform cooling.

Oil Pan

The oil pan is die cast aluminum. The oil pan includes an attachment to the transmission to provide additional structural support.

Balance Shaft Assembly

The dual balancer shaft assembly is mounted to the lower crankcase located within the oil pan. The balance shafts are driven by a single inverted tooth chain that also drives the oil pump. The chain is tensioned by a hydraulic tensioner that is supplied pressure by the engine oil pump. This design promotes the maximum effectiveness of the balance shaft system and reduces noise and vibration.

Cylinder Head

The cylinder head is a semi-permanent mold. Pressed-in powdered metal valve guides and valve seat insets are used. The cylinder head incorporates camshaft journals and camshaft caps. The fuel injection nozzle is located in the intake port. The high pressure fuel pump is mounted on intake side.

Valves

There are two intake and two exhaust valves per cylinder. The head of the valve is made of a durable alloy. The valve shaft resists wear. Valve stem oil seals control oil consumption. Valve springs, valve spring retainers, and valve keys are assembled to return each valve to a closed position after each actuation of the rotating camshaft assemblies.

Camshaft

Two camshafts are used, one for all intake valves and high pressure fuel pump, the other for all exhaust valves and mechanical vacuum pump. The camshafts are cast iron.

Valve Lash Adjusters

The valve train uses a roller finger follower acted on by a hydraulic lash adjuster. The roller finger follower reduces friction and noise.

Camshaft Cover

The camshaft cover has a steel crankcase ventilation baffling incorporated. The camshaft cover has mounting locations for the ignition system.

Camshaft Drive

A roller chain is used for camshaft drive. There is a tensioner and active guide used on the slack side of the chain to control chain motion and noise. The chain drive promotes long valve train life and low maintenance.

mx30.com

Intake and Exhaust Manifold

The intake manifold is made of composite plastic. The exhaust manifold is cast iron. The intake manifold incorporates a distribution and control system for positive crankcase ventilation (PCV) gases. The exhaust manifold is a dual plane design that promotes good low end torque and performance.

Mechanical Thermostat

The mechanical thermostat is positioned between the engine and the radiator. Its purpose is to control the flow of coolant to the radiator. The thermostat will not allow coolant flow through the radiator when cold, coolant flow occurs when the engine has warmed up. Once the engine reaches its operating temperature, generally about 95Â°C (203Â°F), the thermostat opens. This actuation of the thermostat starts to occur at 82Â°C (180Â°F), when the heated wax contained within a cylinder melts and rapidly expands, pushing the rod and valve assembly out of the cylinder, opening the valve. The temperature dependent actuation of the thermostat allows the engine to warm up as quickly as possible, the thermostat reduces engine wear, deposits and emissions. The open thermostat now allows the coolant to flow through the engine cooling circuit to maintain optimal operation temperatures, which is achieved by directing the hot coolant through the radiator for cooling and recirculation.

Variable Flow Oil Pump Assembly

The oil pump assembly is located within the oil pan. The oil pump assembly is fastened directly to the rear of the balancer shaft assembly and is driven by the rotation of the balance shaft spline.

The oil pump assembly possesses variable flow capability which is made possible by a shift of the circular vane arrangement and the actuation of an oil control valve assembly guided by the ECM. The variable flow capability of the pump optimizes oil flow to the engine components when needed. During performance maneuvers and acceleration the oil pump operates in a steady high pressure state. However, during steady low load touring speeds on level terrain the oil pump operates in a steady low pressure state.

The ECM guided "on" and "off" actuation of the oil control valve assembly allows the chamber to be pressurized which takes the switch from high to low pressure mode. The high pressure state of the chamber compressing the spring and shifting the center of the circular vane arrangement nearer to that of the balancer drive shaft, decreasing the difference of the volume of oil contained between each vane. It is this small variation in volume which produces the steady low pressure flow. It is in this mode that the pump behaves as a smaller pump.

Advantages of variable flow oil pumping modes:

- The high performance steady pressure mode is where engine temperatures and friction are reduced because the pump only delivers the oil that the engine requires.
- The low load touring steady pressure mode is where the volume of oil flow is reduced to even more efficient levels when engine requirements allow. This efficiency reduces the resistance on reciprocating component, allowing engine revolutions with less power resulting in fuel economy savings.

LUBRICATION DESCRIPTION

mcx30.com

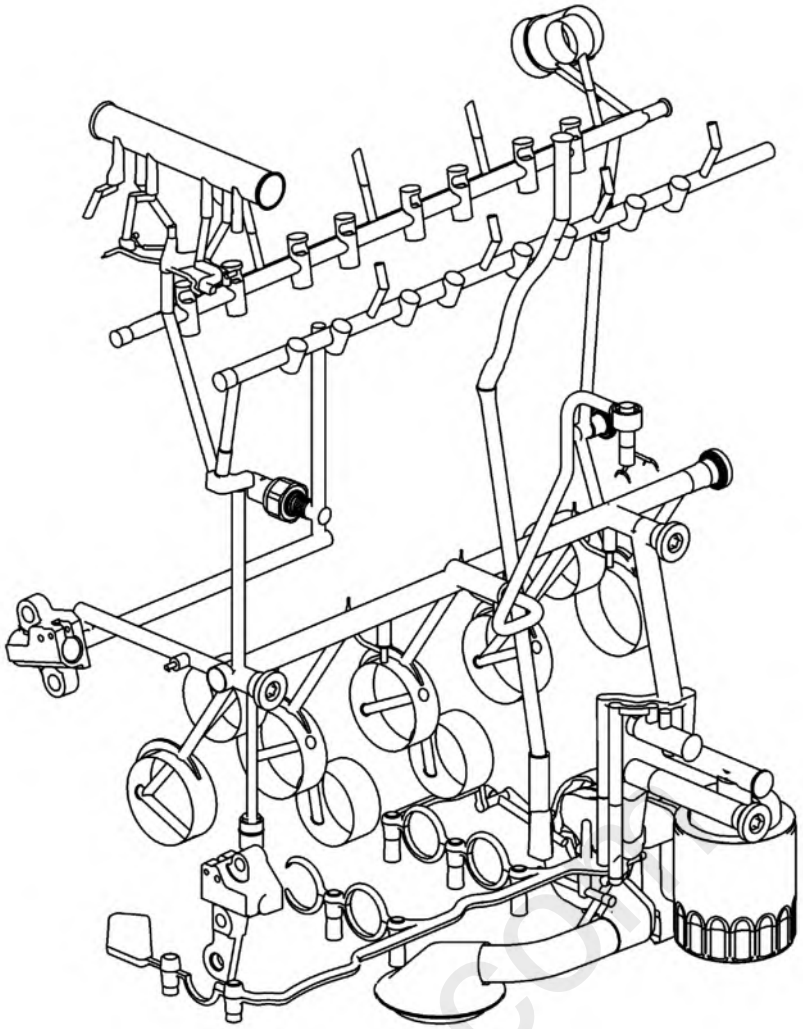


Fig. 612: Lubrication System (LTG)
Courtesy of GENERAL MOTORS COMPANY

Oil is applied under pressure to the crankshaft, connecting rods, balance shaft assembly, camshaft bearing surfaces, rocker arms, valve lash adjusters and timing chain hydraulic tensioner. All other moving parts are lubricated by gravity flow or splash. Oil enters the oil pump through a fixed inlet screen. The oil pump is driven by the balancer shaft assembly's sprocket. The oil pump body is attached to the rear of balancer shaft assembly. The pressurized oil passes through the cylinder head assembly restrictor orifice into the cylinder head's OCV and routed through passages cast into the camshaft cover assembly to each camshaft feed gallery and camshaft drip rail. OCV actuates the 2-Step intake rocker arm assemblies to control valve travel. The oil filter is a metal canister type. A by-pass valve in the filter assembly allows continuous oil flow in case the oil filter should become restricted. Oil then enters the gallery where it is distributed to the balance shafts, crankshaft, camshafts and camshaft timing chain oiler nozzle. The connecting rod bearings are oiled by constant oil flow passages through the crankshaft connecting the main journals to the rod journals. A groove around each upper main bearing furnishes oil to the drilled crankshaft passages. The pressurized oil passes through the cylinder head restrictor orifice into the cylinder head and then into each camshaft feed gallery. Cast passages feed each hydraulic element adjuster and drilled passages feed each camshaft bearing surface, rocker arm, and drip rail. An engine oil pressure switch or sensor is installed at the end. Oil returns to the oil pan through passages cast into the cylinder head. The timing chain lubrication drains directly into the oil pan.

CLEANLINESS AND CARE

An automobile engine is a combination of many machined, honed, polished, and lapped surfaces with tolerances that are measured in ten thousandths of an inch. When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of engine oil should be applied to friction areas during assembly to protect and lubricate the surfaces during initial operation. Throughout this section, it should be understood that proper cleaning and protection of machined surfaces and friction areas are part of the repair procedure. This is considered standard shop practice even if not specifically stated.

When valve train components are removed for service, they should be retained in order. At the time of installation, they should be installed in the same locations and with the same mating surfaces as when removed.

SEPARATING PARTS

NOTE:

- **Disassembly of the piston, press fit design piston pin, and connecting rod may create scoring or damage to the piston pin and piston pin bore. If the piston, pin, and connecting rod have been disassembled, replace the components as an assembly.**
- **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 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 lash adjusters
- Valve lash adjusters, lash adjuster guides, pushrods and rocker arm assemblies
- Valve to the valve guide
- Valve spring and shim to the cylinder head location
- Engine block main bearing cap location and direction
- Oil pump drive and driven gears

REPLACING ENGINE GASKETS

Special Tools

EN-28410 Gasket Remover

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

Gasket Reuse and Applying Sealants

- 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 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 **EN-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.

mcx30.com

- This grit is abrasive and has been known to cause internal engine damage.

Assembling Components

- 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.
- Do not allow the sealant to enter into any blind threaded holes, as it may prevent the bolt from clamping properly or cause component damage when tighten ed.
- tighten bolts to specifications. Do not overtighten.

USE OF ROOM TEMPERATURE VULCANIZING (RTV) AND ANAEROBIC SEALANT

Cleaning Mating Part Surfaces for RTV Joints

RTV sealant depends greatly on adhesion to the mating parts in order to form and maintain a robust sealed joint. As with any adhesion system, proper surface preparation of the bonded parts is extremely important to ensure good adhesion over the life of the product.

CAUTION: **When cleaning the sealing surfaces of engine components, DO NOT use bristle discs, abrasive pads, wire wheels or surface conditioning discs. These types of devices should not be used because they produce a very fine grit that is abrasive and known to cause internal engine damage. The bristle discs and pads are embedded with abrasive material and wear down as they clean, continually exposing fresh abrasive to the surface of the component.**

Abrasive pads, wire wheels and bristle discs can remove enough metal to affect the engine front cover, cylinder head, engine block, oil pan rail, and intake manifold runner surface flatness, which can then result in engine coolant leaks, engine oil leaks and air leaks. It takes about 15 seconds to remove 0.203 mm (0.008 in) of metal with an abrasive pad.

Abrasive pads, wire wheels and bristle discs used with high speed grinders produce airborne debris that can travel throughout the shop contaminating other work being performed outside of the immediate work area.

When cleaning engine gasket sealing surfaces and/or cleaning parts from an engine that are to be reused, surface conditioning discs, typically constructed of woven fiber or molded bristles that contain abrasives, such as a high amount of aluminum oxide, should NOT be used. The use of such surface conditioning discs dislodges aluminum oxide from the disk and metal component particles, which can lead to premature engine bearing failure. The presence of aluminum oxide in engine oil has been shown to cause premature engine bearing failure. In some cases, this failure occurs in as little as 1, 600 km (1, 000 mi) or less after the repair has been made.

Surface conditioning discs may grind the component material and embed it into the disc. This can result when more aggressive grinding of the gasket surface takes place.

General Motors strongly recommends using a plastic razor blade, plastic gasket scraper, a wood scraper or a non-metallic scraper to remove all sealer/gasket material on the surface of engine components that are to be reused. Do not use any other method or technique to remove the sealant or the gasket material from a part.

- Do not gouge or scratch any engine sealing surface during the cleaning process.
- It is not necessary to remove every speck of the old sealer.

To remove the old RTV sealant from the sealing surface, spray GM Low VOC Cleaner or an equivalent, on the mating surfaces and allow it to soak to loosen the old gasket material. Use care to avoid getting GM Low VOC Cleaner in any area other than the mating surface to be cleaned.

Use a plastic razor blade, that mounts in a scraper device or a hand held plastic razor blade, to remove old RTV sealant from a sealing surface. Use a new blade for each corresponding engine component surface. Hold the blade as parallel to the flat surface as possible.

To properly clean the sealing surfaces prior to reassembly, spray GM Low VOC Cleaner on a folded lint free shop cloth. Wipe the mating surfaces on the engine and front cover and rotate the shop cloth until there are no more visible signs of contamination on the cloth.

After the final cleaning of the parts, allow up to 5 minutes for the components to dry before applying new RTV sealant.

NOTE: **After the final cleaning with GM Low VOC Cleaner and before reassembly, DO NOT touch the cleaned surfaces with your hand. Oils from your skin WILL CONTAMINATE the surface and prevent proper bonding of the new RTV sealant.**

Typical Applications

This procedure is intended for use in the following operations:

- Building of engines in a manual low volume build process where the use of assembly lubricants and other typical conditions exist which may contaminate the component sealing surfaces in an RTV joint.
- Cleaning of surfaces contaminated with oil or other substance during the assembly operation as a special case event.

In the typical situation, both the part being assembled, and the assembly to which it is to be sealed will be cleaned. An example is an oil pan assembled to a block/front cover/rear cover assembly using an RTV seal applied to the pan or the block. Both the pan and the block assembly should be cleaned prior to RTV application.

Any loose gaskets that are part of the RTV joint should not be cleaned unless it is known that they have been contaminated during the build process. Examples of loose gaskets are intake side and end seals which contact RTV used to seal a T-joint.

Assemblies supplied to GM with gaskets in place should not be cleaned unless they are known to be contaminated during the build process. Examples are rocker/cam covers with press in place gaskets using RTV at corners or T-joints.

Materials Needed

Use clean dry lint free cloths to wipe surface with approved solvent based cleaner. Examples are:

- GM Good Wrench Service Low VOC Brake Parts Cleaner
- AC Delco Non-Chlorinated Brake Parts Cleaner
- Loctite ODC - Free Cleaner & Degreaser

Procedure:

1. Identify the surfaces to which the RTV will come into contact in the assembled joint.
2. Using an approved solvent based cleaner, thoroughly soak an appropriate portion of a clean, dry cloth. Immediately wipe the surfaces with the cloth to remove any residue of oil, soap, etc.
3. Repeat step 2 using a clean portion of the cloth as many times as required until the cleanliness of the cloth after wiping the surface becomes constant in appearance. There is typically some discoloration of the cloth after wiping however a clean surface should produce the same level of discoloration with successive wiping with a clean cloth and solvent.
4. If crevices exist in the joint such that wiping the surface would not be sufficient to clean the crevice, the approved solvent based cleaner should be directly sprayed on the joint to ensure wetting of the surfaces and removal of the contaminant. DO NOT spray rubber components directly. Care must be used to avoid getting solvent in areas other than necessary to clean the joint. Then continue with step 3.
5. Allow the surfaces to dry for a minimum of 1 minute or longer if necessary for the solvent to evaporate from the surface.
6. Do not touch the cleaned surface with anything prior to RTV application.
7. The surface is now prepared for RTV application.

Sealant Types

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**

mx30.com

interchange the sealants. Use only the sealant, or equivalent, as specified in the service procedure.

The following two major types of sealant are commonly used in engines:

- Room Temperature Vulcanizing (RTV)
- Anaerobic sealant, which include the following:
  - Gasket Eliminator
  - Pipe Sealant
  - Threadlock

Room Temperature Vulcanizing (RTV) Sealer

This type of sealant is used where two 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
- Do not use RTV sealant unless the ambient air temperature is at least 18Â°C (65Â°F) degrees or higher.
- 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 tighten ed. 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 tighten ed. 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.

NOTE: **The bead size is critical and is easier to maintain consistency and application with a RTV dispensing tool. This also helps to eliminate waste.**

- 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.**

- Assemble the components while the RTV sealant is still wet to the touch, within 10 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 two rigid parts, such as castings, are assembled together. When two rigid parts are disassembled and no sealant or gasket is readily noticeable, then the two 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 tighten ed, or lead to component failure.**

- Do not allow the gasket eliminator sealed joint to cure more than 5 minutes before torquing to specification. This will result in an incorrect clamp load of assembled components.
- 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 two 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.
- The threaded surfaces to be sealed must be clean and dry.
- Apply the threadlock sealant as specified on the threadlock sealant container.

NOTE:

- **Do not allow the threadlock sealant to cure more than 5 minutes before torquing to specification. This will result in an 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 two 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 tighten ed, 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 specially designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools will 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:

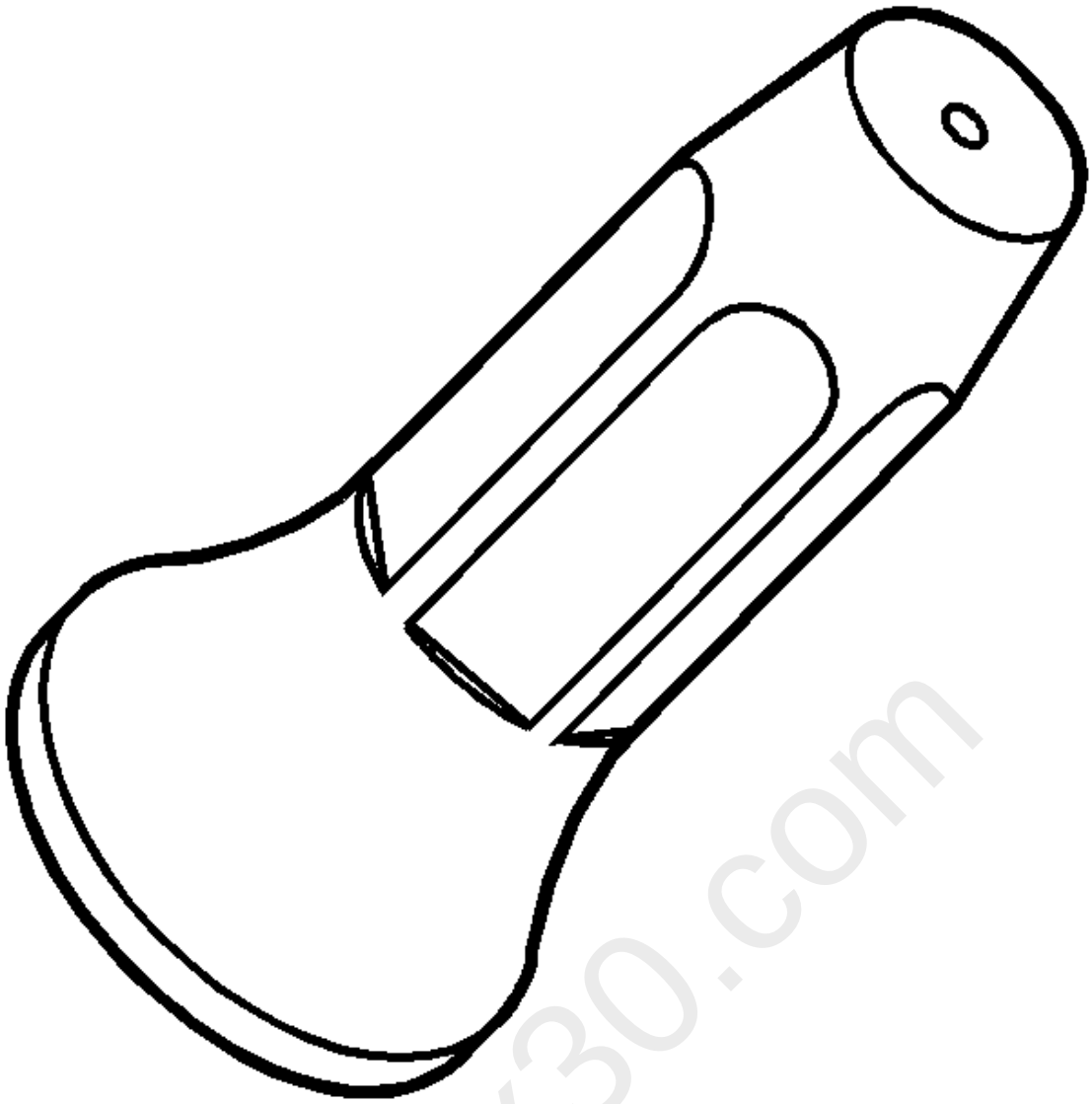
- Approved eye protection and safety gloves
- A clean, well lit, work area
- A suitable parts cleaning tank
- A compressed air supply
- Trays or storage containers to keep parts and fasteners organized
- An adequate set of hand tools
- Approved engine repair stand
- An approved engine lifting device that will adequately support the weight of the components

SPECIAL TOOLS AND EQUIPMENT

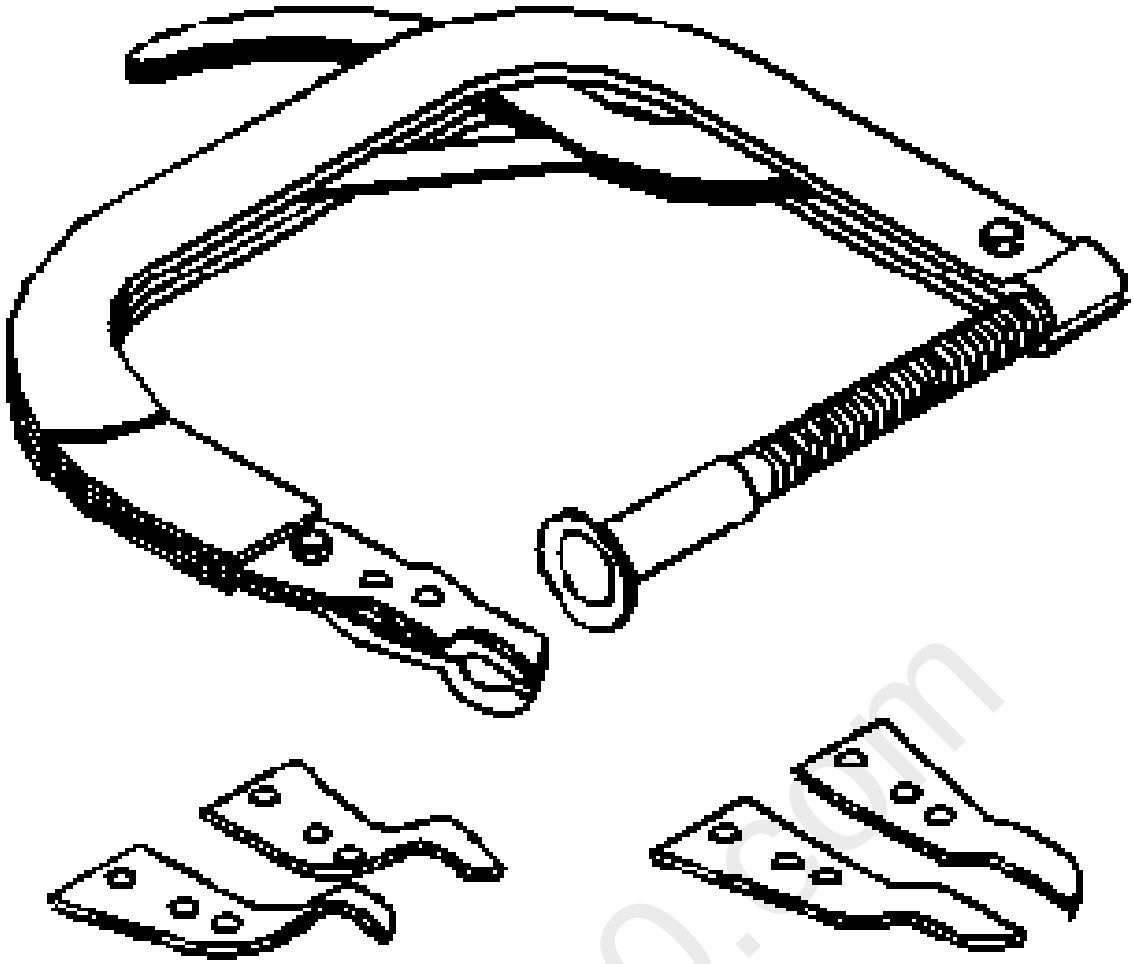
SPECIAL TOOLS

Illustration	Tool Number/Description
	DT-45866 J-45866 Input Shaft Seal Installer

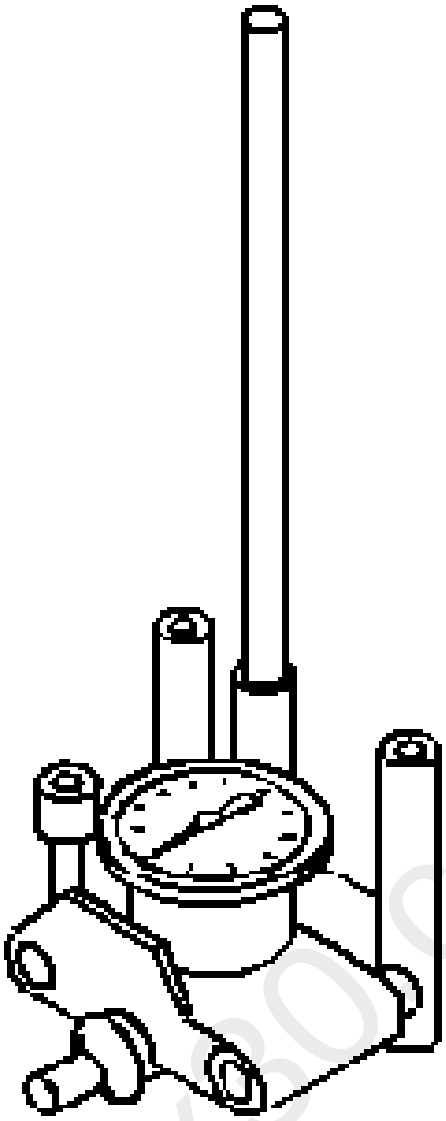
mcx30.com

Illustration	Tool Number/Description
	
	EN-8062 J-8062 KM-348 Valve Spring Compressor - Head Off

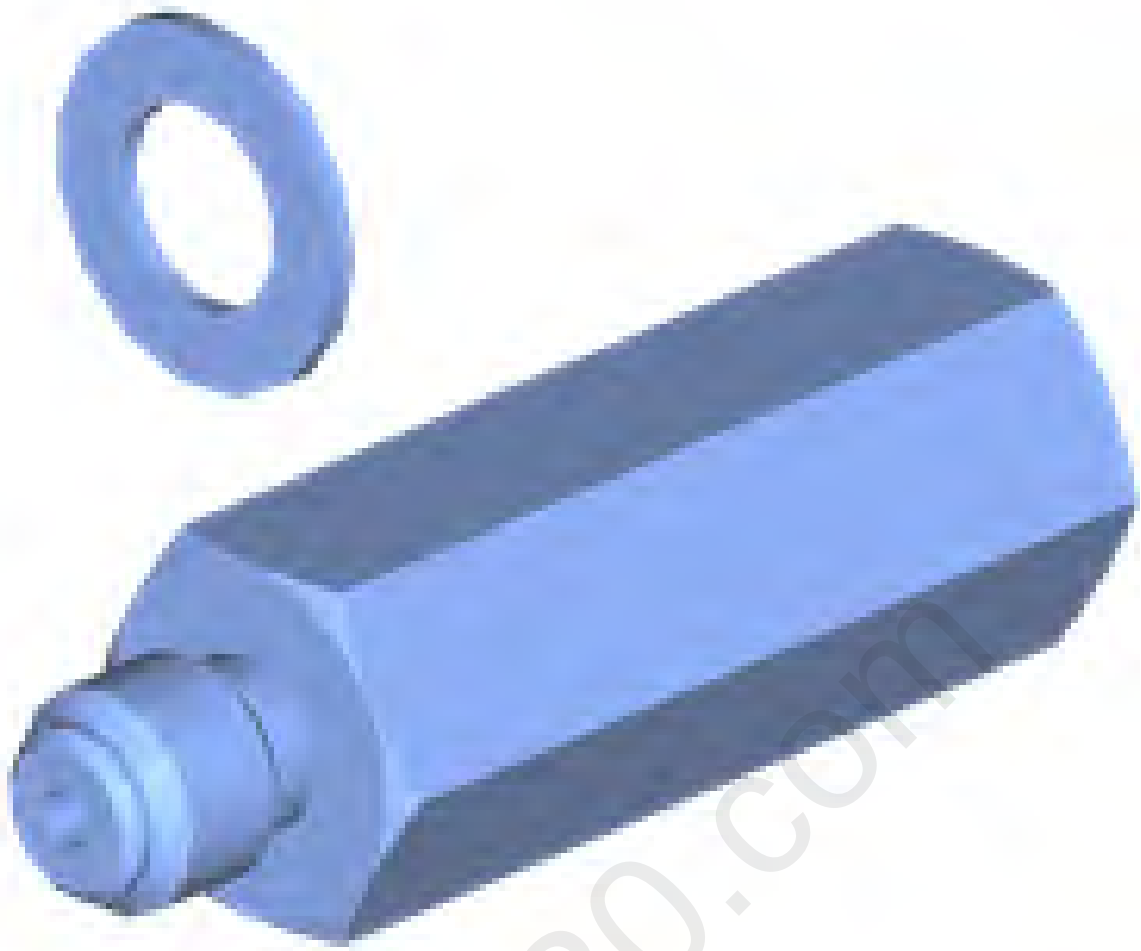
mcx30.com

Illustration	Tool Number/Description
	

mcx30.com

Illustration	Tool Number/Description
	EN-8087 J-8087 Cylinder Bore Gauge

mcx80.com

Illustration	Tool Number/Description
	EN-21867-850 J-21867-850 KM-498-B KM-6106 83 93 852 Oil Pressure Gauge Adapter
	EN-22738-B GE-22738-B J-22738-B J-9666 Valve Spring Tester

mcx30.com

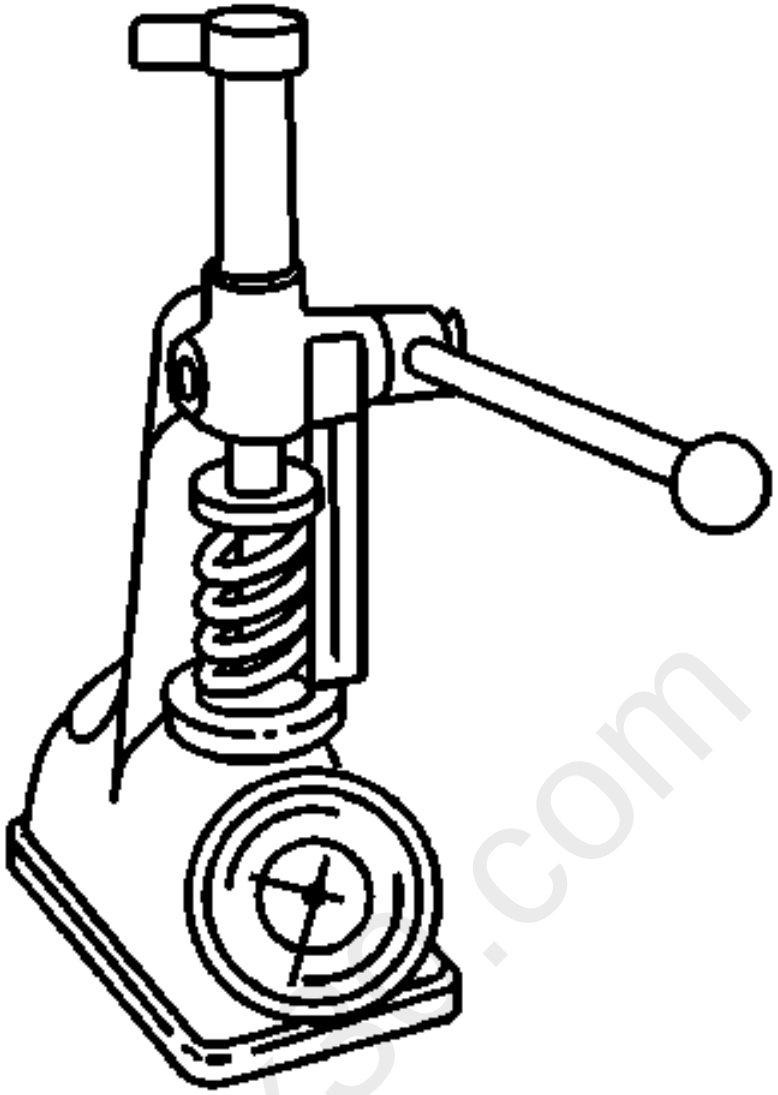
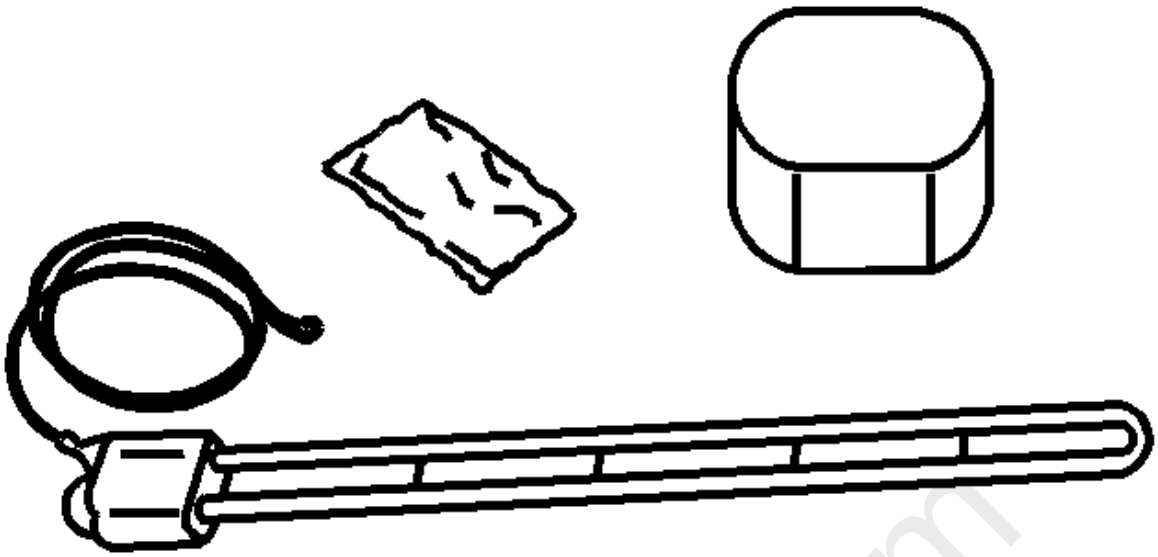
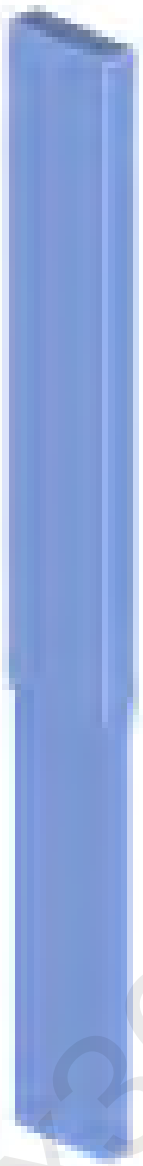
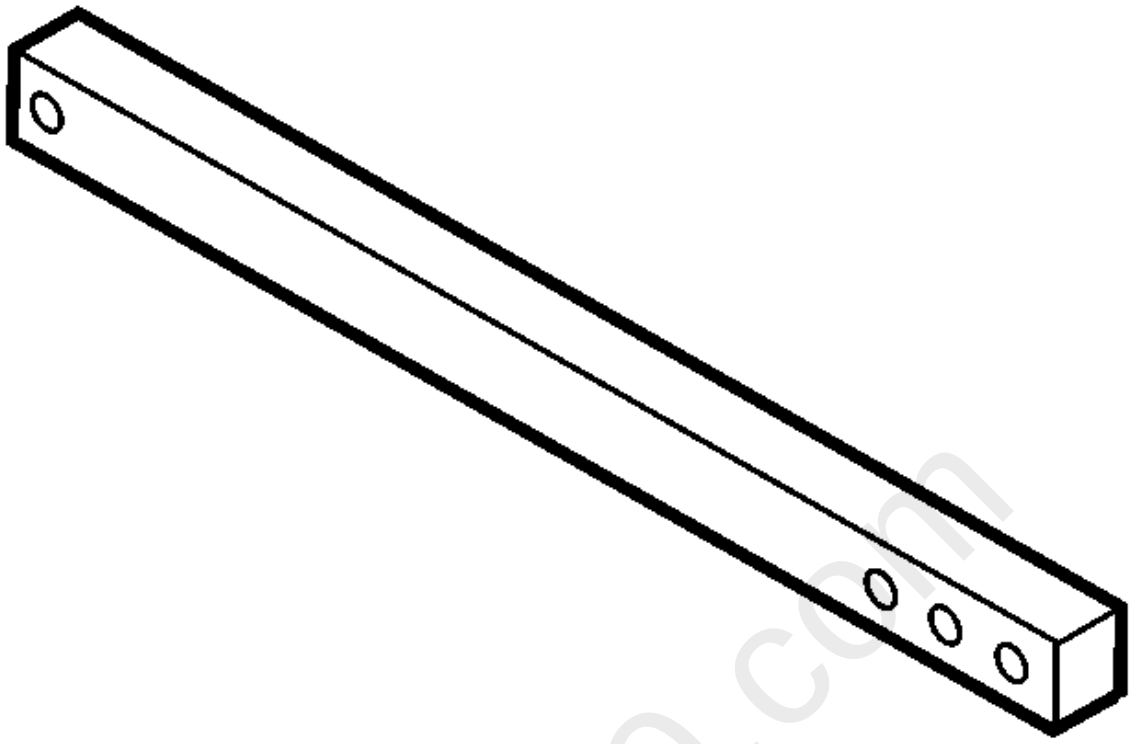
Illustration	Tool Number/Description
	

Illustration	Tool Number/Description
	EN-23951 J-23951 Valve Manometer

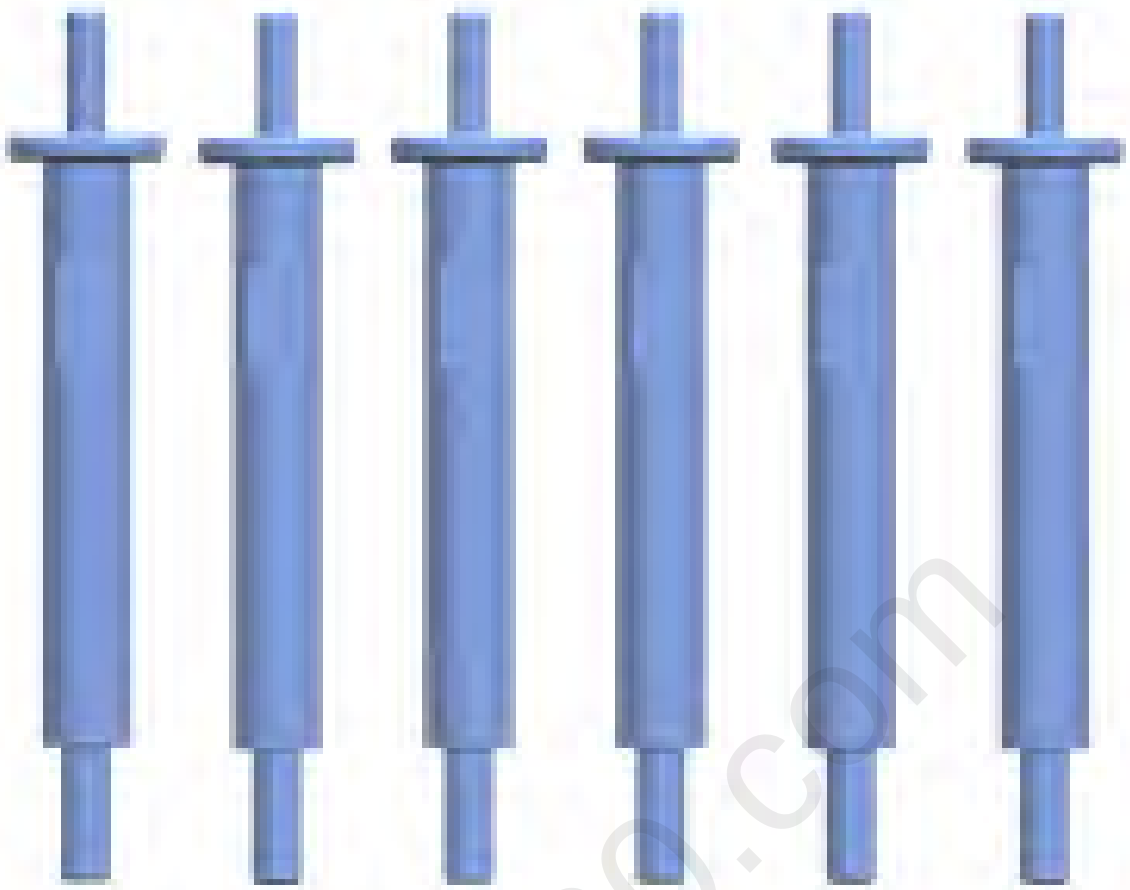
mcx30.com

Illustration	Tool Number/Description
	EN-28410 J-28410 Gasket Remover

mcx30.com

Illustration	Tool Number/Description
	EN-28467-518 J-28467-518 Engine Support Adapter - Main Support Beam

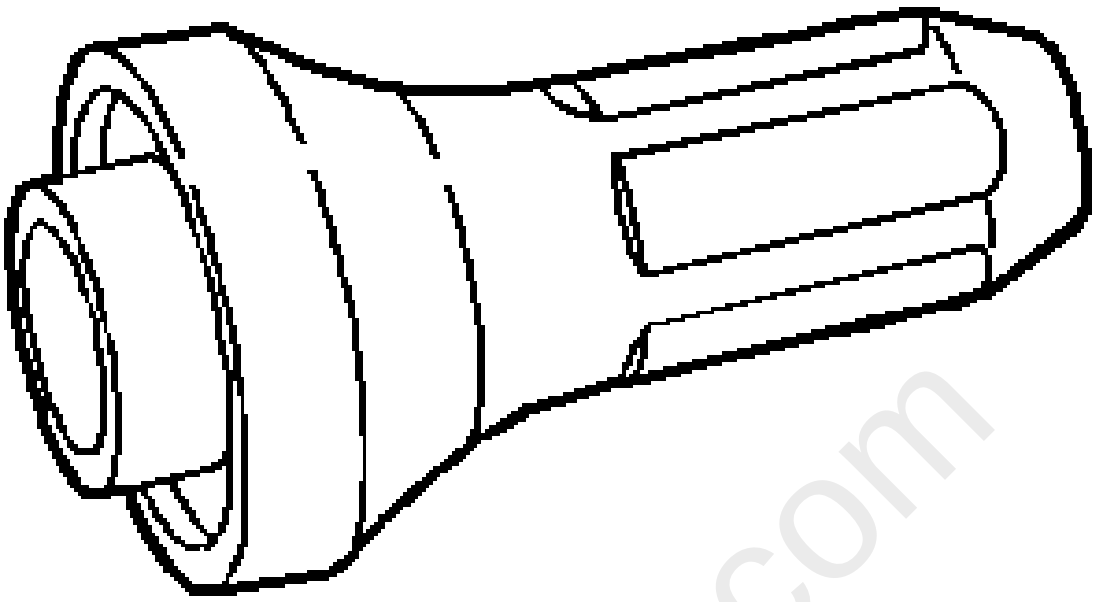
mcx30.com

Illustration	Tool Number/Description
	EN-28467-550 J-28467-550 Engine Support Beam Adapter

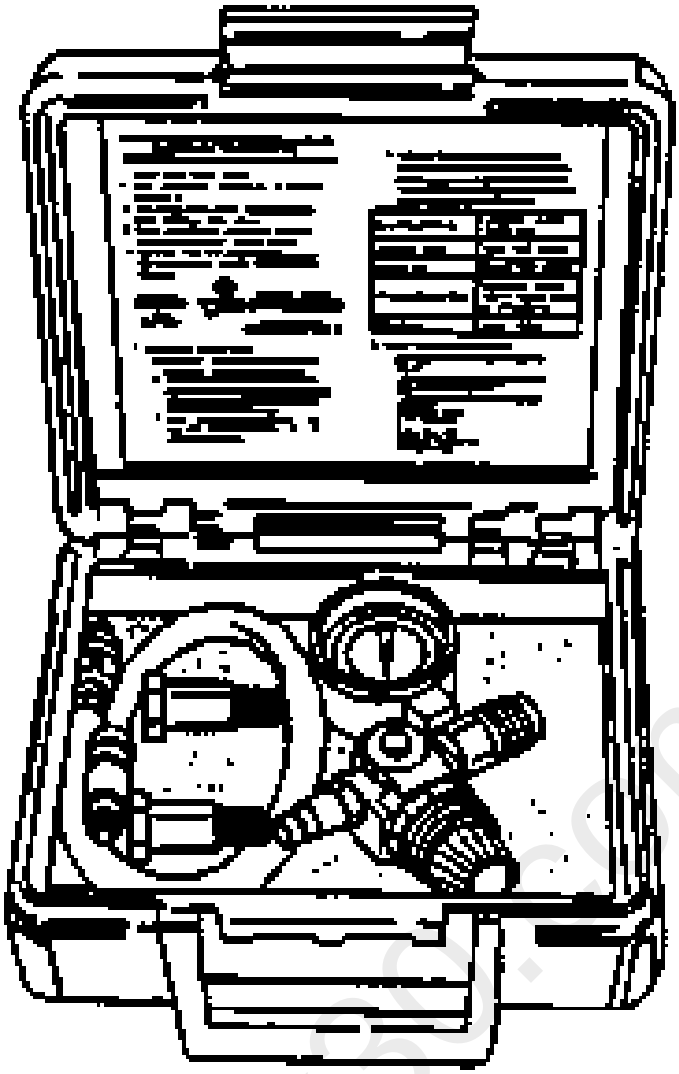
mcx30.com

Illustration	Tool Number/Description
	EN-28467-B J-28467-B EN-51007 Universal Engine Support Fixture
	EN-34115 J-34115 Sprocket Bearing Installer

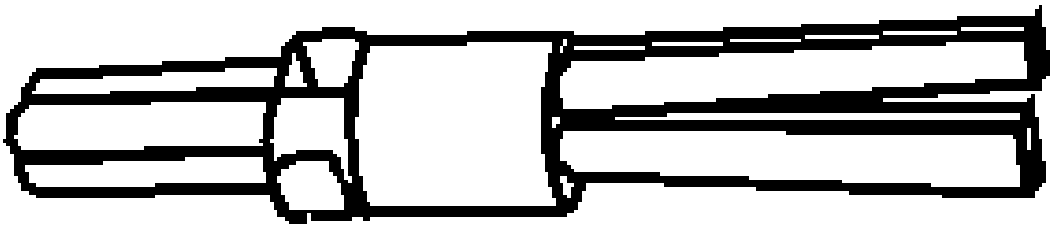
mcx30.com

Illustration	Tool Number/Description
	
	EN-35667-A J-35667-A Cylinder Head Leakdown Tester

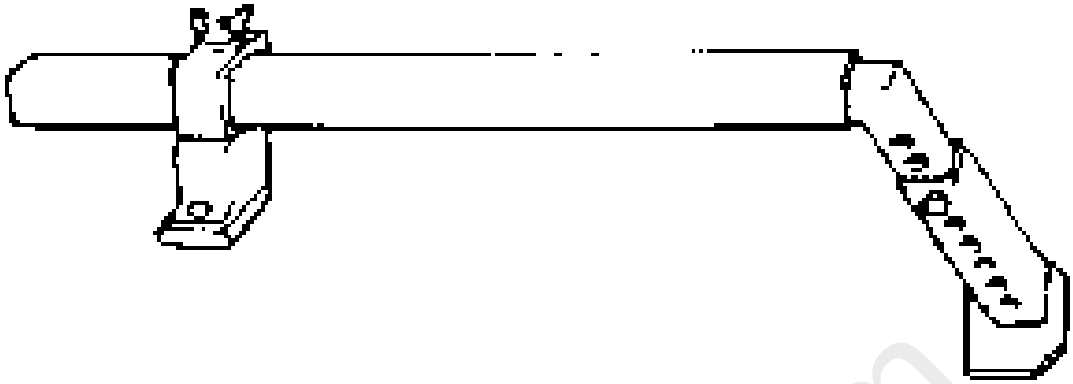
mcx30.com

Illustration	Tool Number/Description
	

mcx3d.com

Illustration	Tool Number/Description
	EN-36017 J-36017 KM-840 - Removal KM-6152 - Installation Valve Seal Remover

mcx30.com

Illustration	Tool Number/Description
	EN-36462-A J-36462-A Engine Support Adapter Leg Set

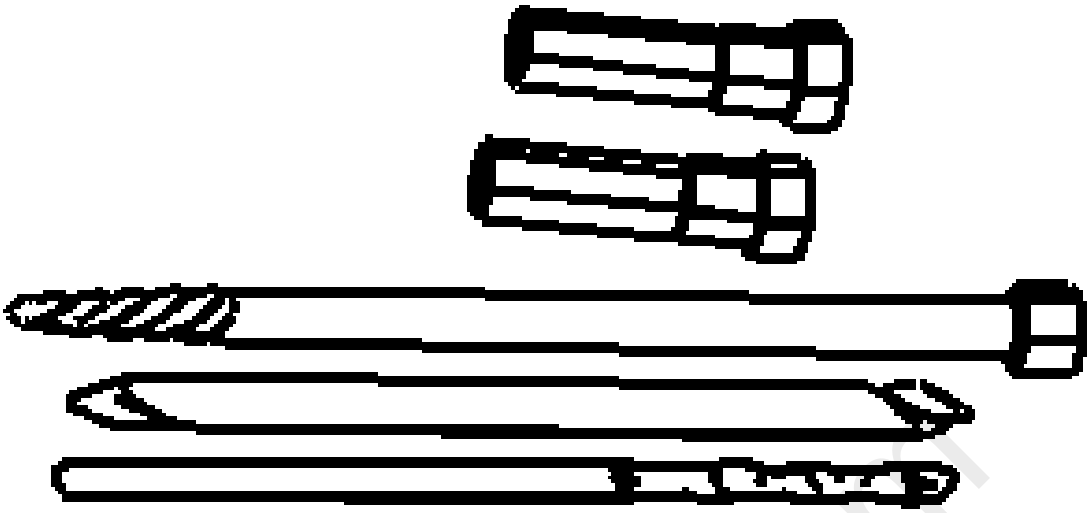
mcx30.com

Illustration	Tool Number/Description
	EN-36857 J-36857 Engine Lift Bracket

mcx30.com

Illustration	Tool Number/Description
	EN-37281-A J-37281-A Injector Remover
	EN-38188 J-38188 Cylinder Head Broken Bolt Extractor Kit

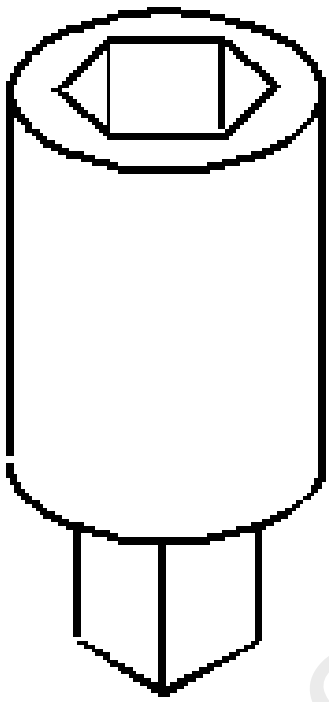
mcx30.com

Illustration	Tool Number/Description
	

mcx30.com

Illustration	Tool Number/Description
	EN-38416-2 J-38416-2 Crankshaft Button
	EN-39358 J-39358 83 94 785 Spark Plug Socket

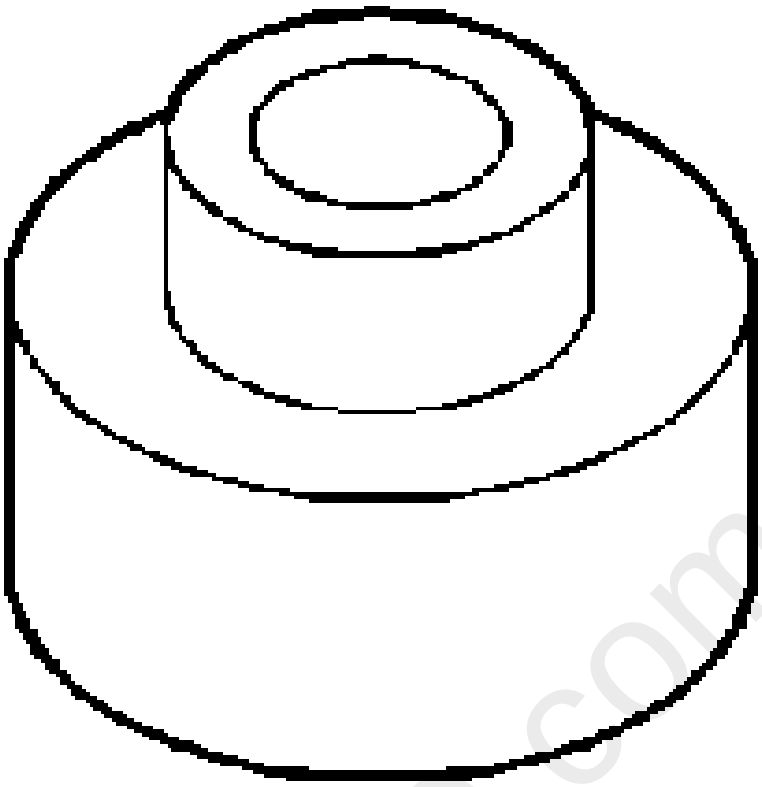
mcx30.com

Illustration	Tool Number/Description
	

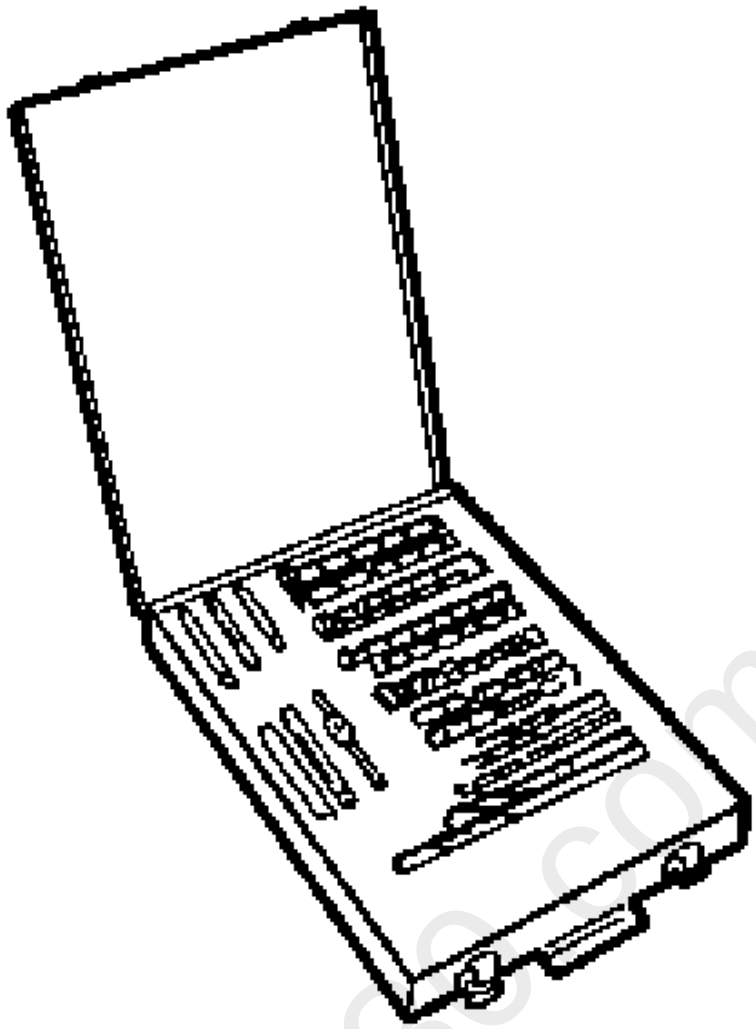
mcx30.com

Illustration	Tool Number/Description
	EN-41816 EN-51577 J-41816 Crankshaft Balancer Remover
	EN-41816-2 J-41816-2 Crankshaft End Protector

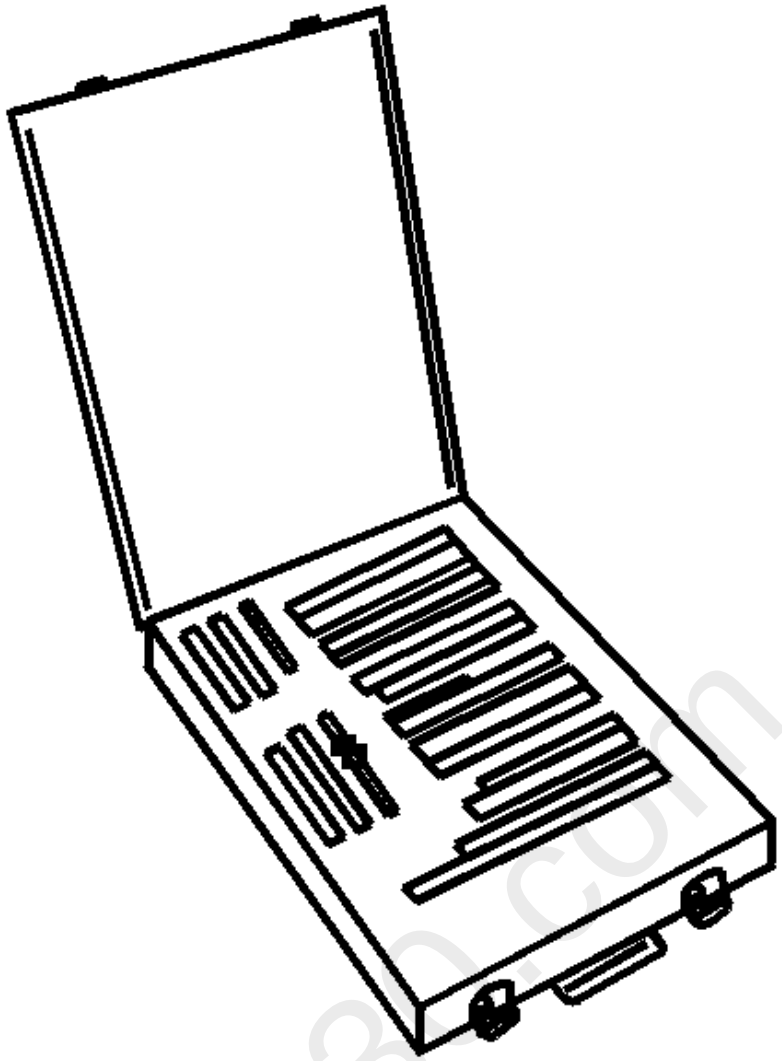
mcx30.com

Illustration	Tool Number/Description
	

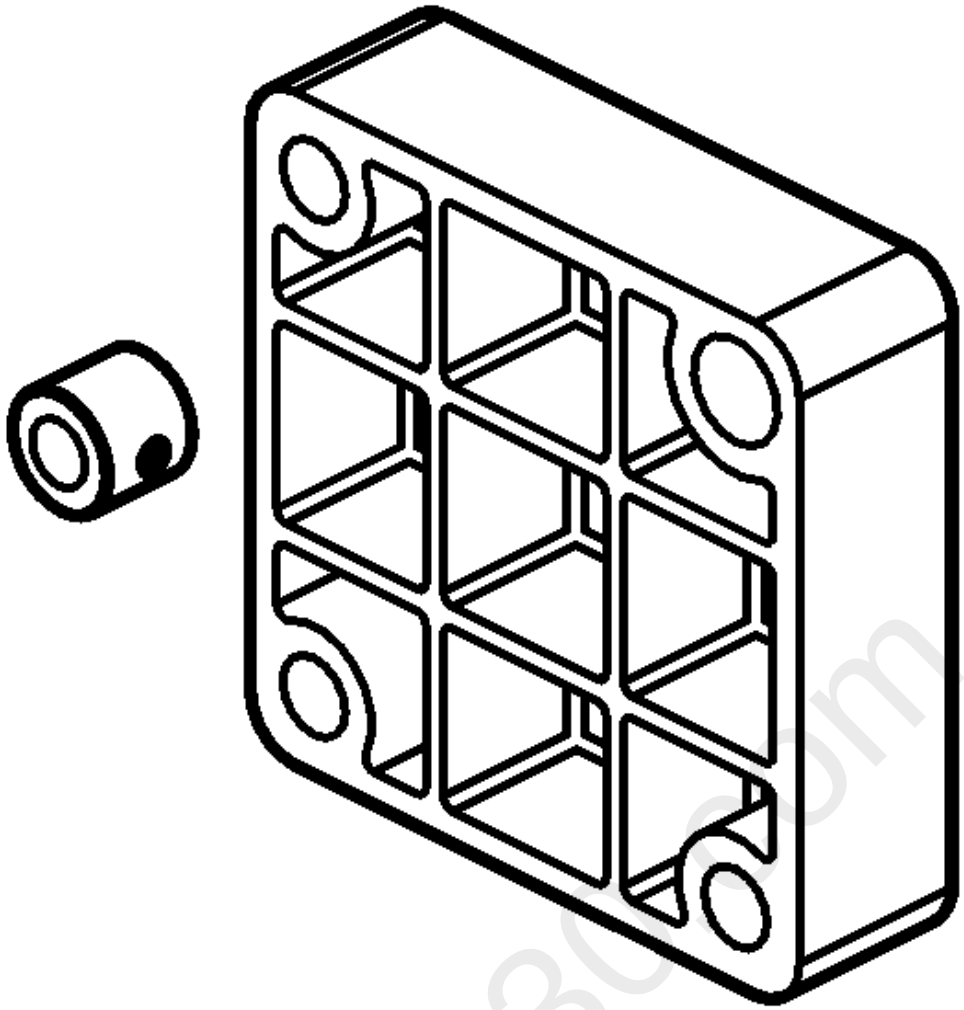
mcx30.com

Illustration	Tool Number/Description
	EN-42385-700 J-42385-700 High Feature Thread Repair Kit

mcx30.com

Illustration	Tool Number/Description
	EN-42385-850 J-42385-850 Thread Repair Kit

mcx30.com

Illustration	Tool Number/Description
	EN-42385-880 Head Bolt Thread Repair Adapter Kit

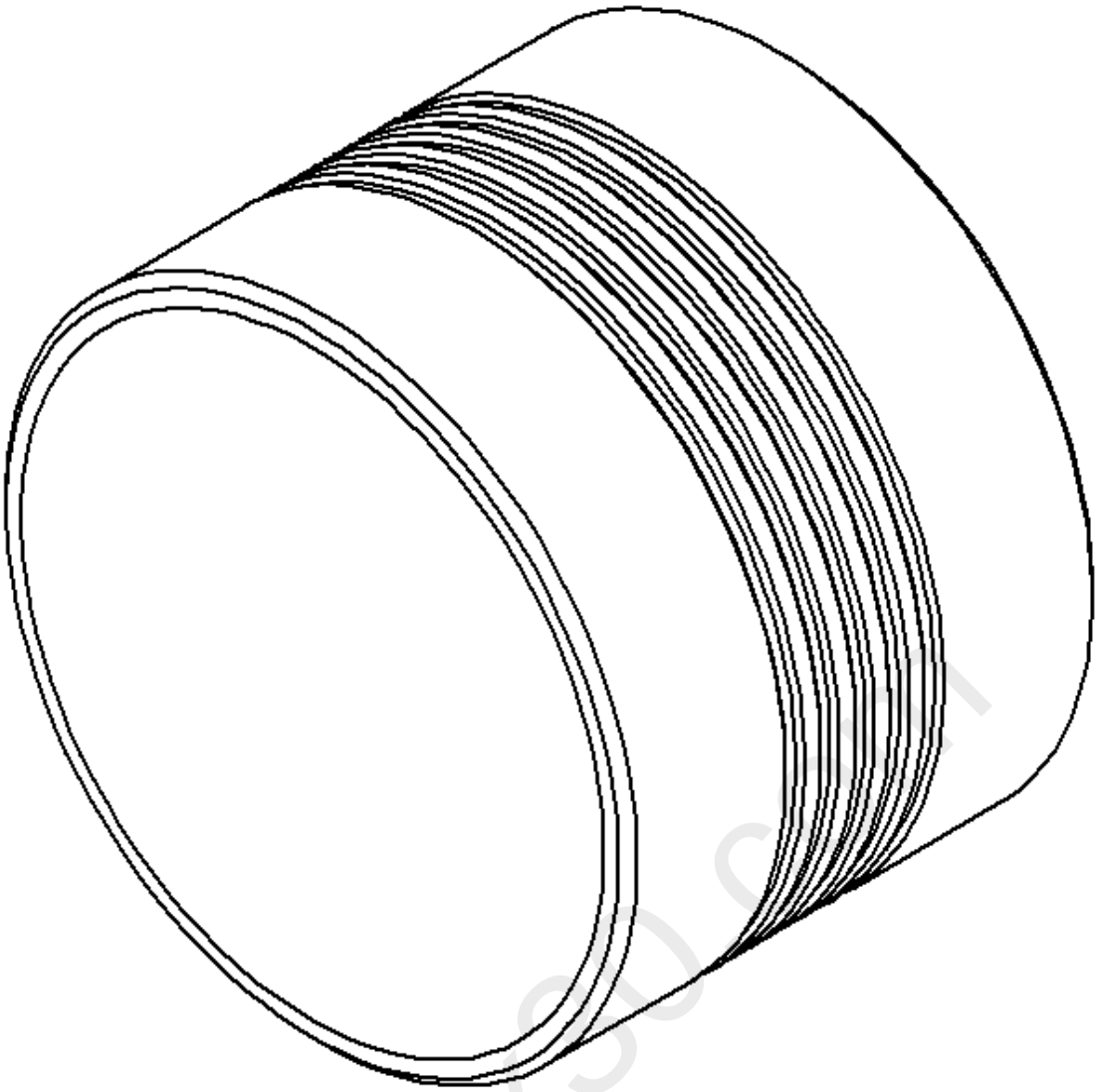
mcx30.com

Illustration	Tool Number/Description
	EN-43405-1 J-43405-1 Engine Support Fixture Adapter - Passenger Side

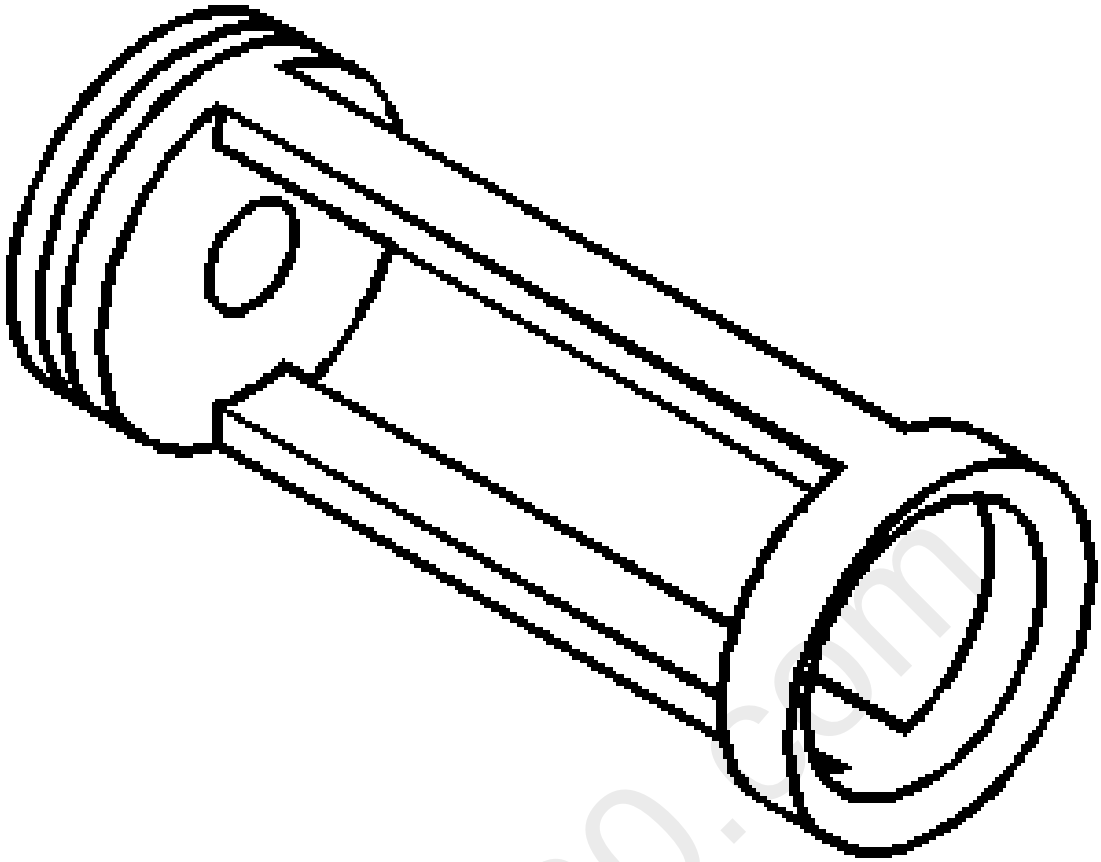
mcx30.com

Illustration	Tool Number/Description
	EN-43405-2 J-43405-2 Engine Support Fixture Adapter - Driver Side

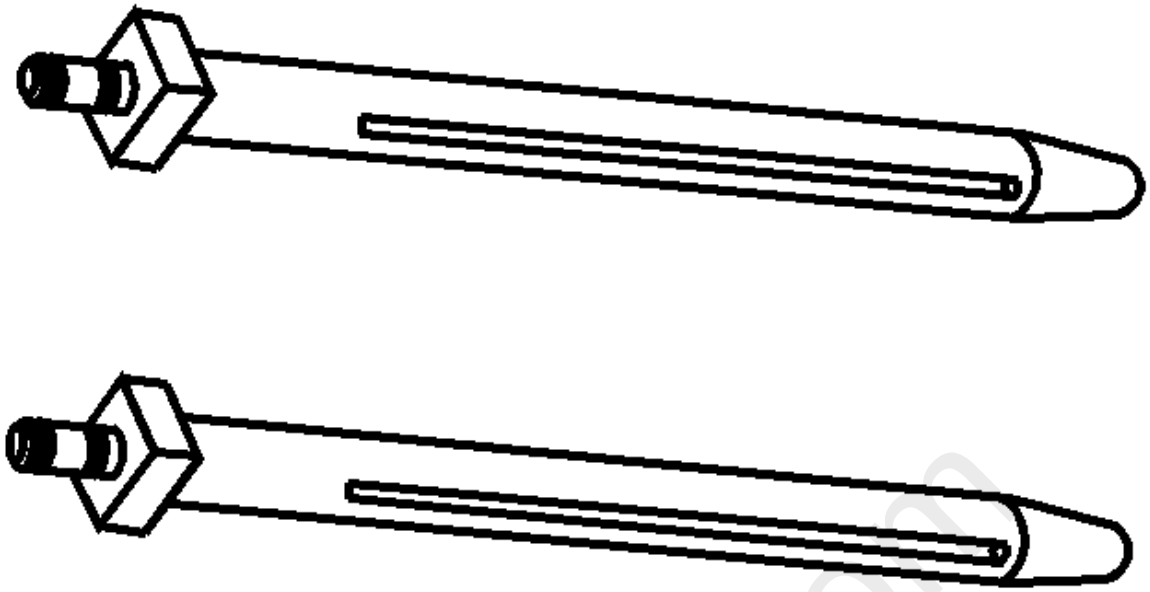
mcx30.com

Illustration	Tool Number/Description
	EN-43953 J-43953 Piston Ring Compressor - 86 mm
	EN-43963 J-43963 KM-6149 Valve Spring Compressor (off car)

mcx30.com

Illustration	Tool Number/Description
	

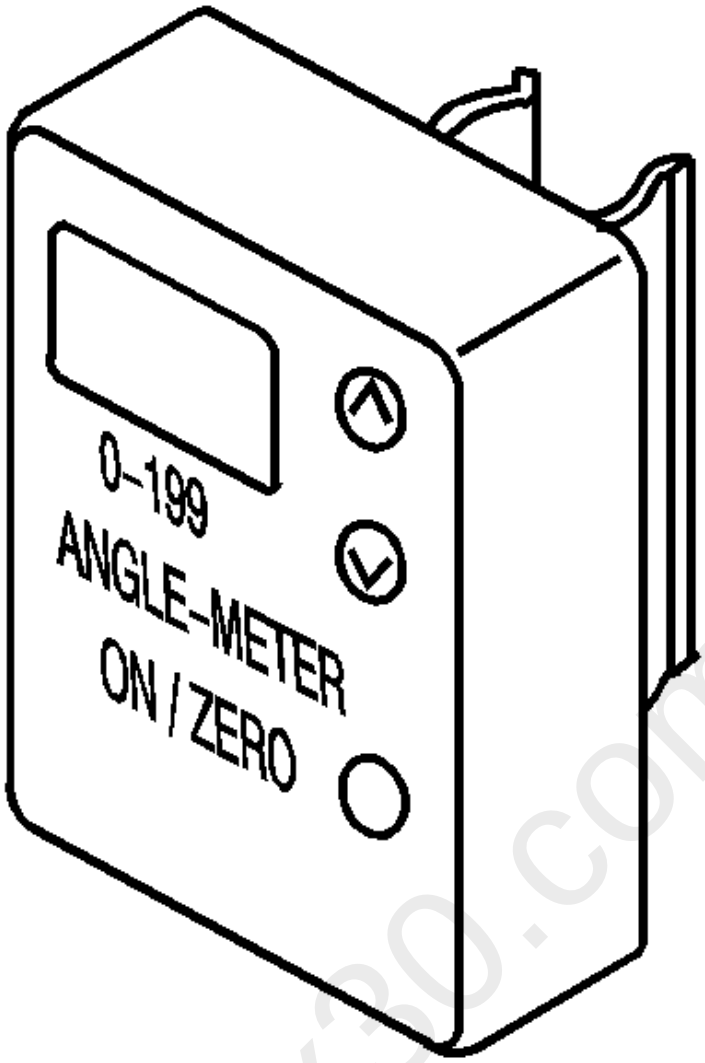
mcx30.com

Illustration	Tool Number/Description
	EN-43966-1 J-43966-1 Connecting Rod Guides

mcx30.com

Illustration	Tool Number/Description
	EN-45025 J-45025 Belt Tensioner Wrench

mcx30.com

Illustration	Tool Number/Description
	EN-45059 J-45059 KM-470-B Angle Meter

mcx30.com

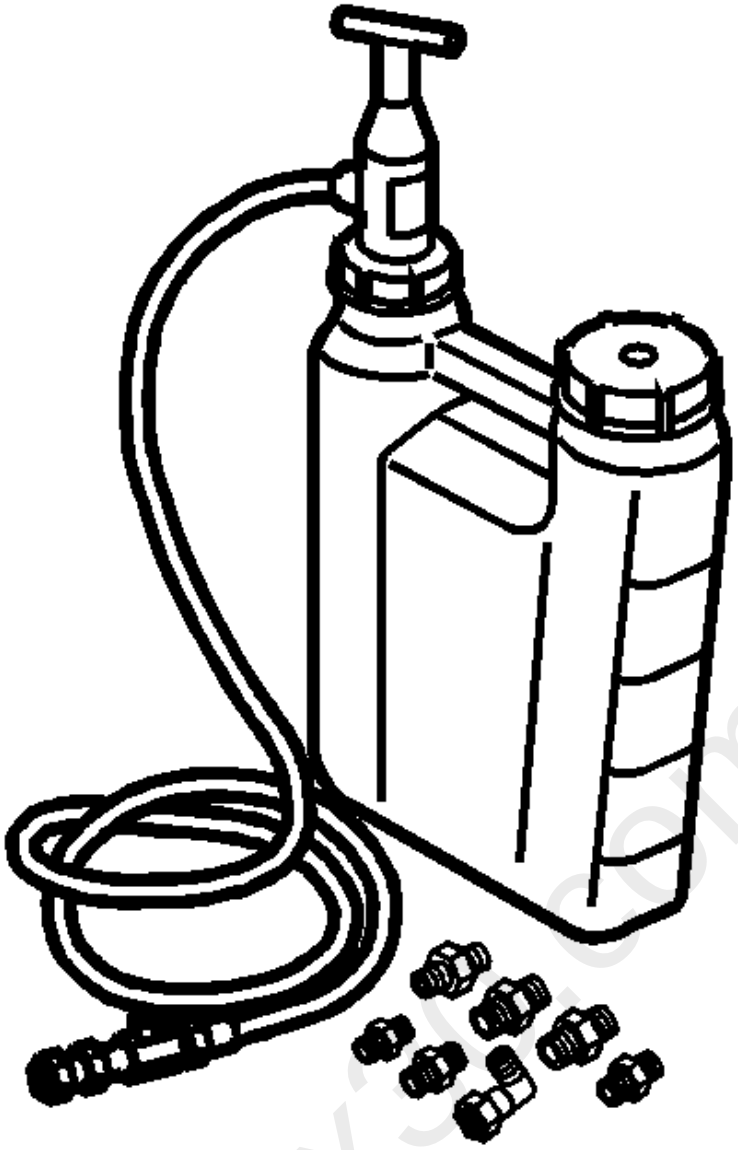
Illustration	Tool Number/Description
	EN-45299 J-45299 Engine Pre-Luber

Illustration	Tool Number/Description
	EN-46116 Valve Stem Seal Remover

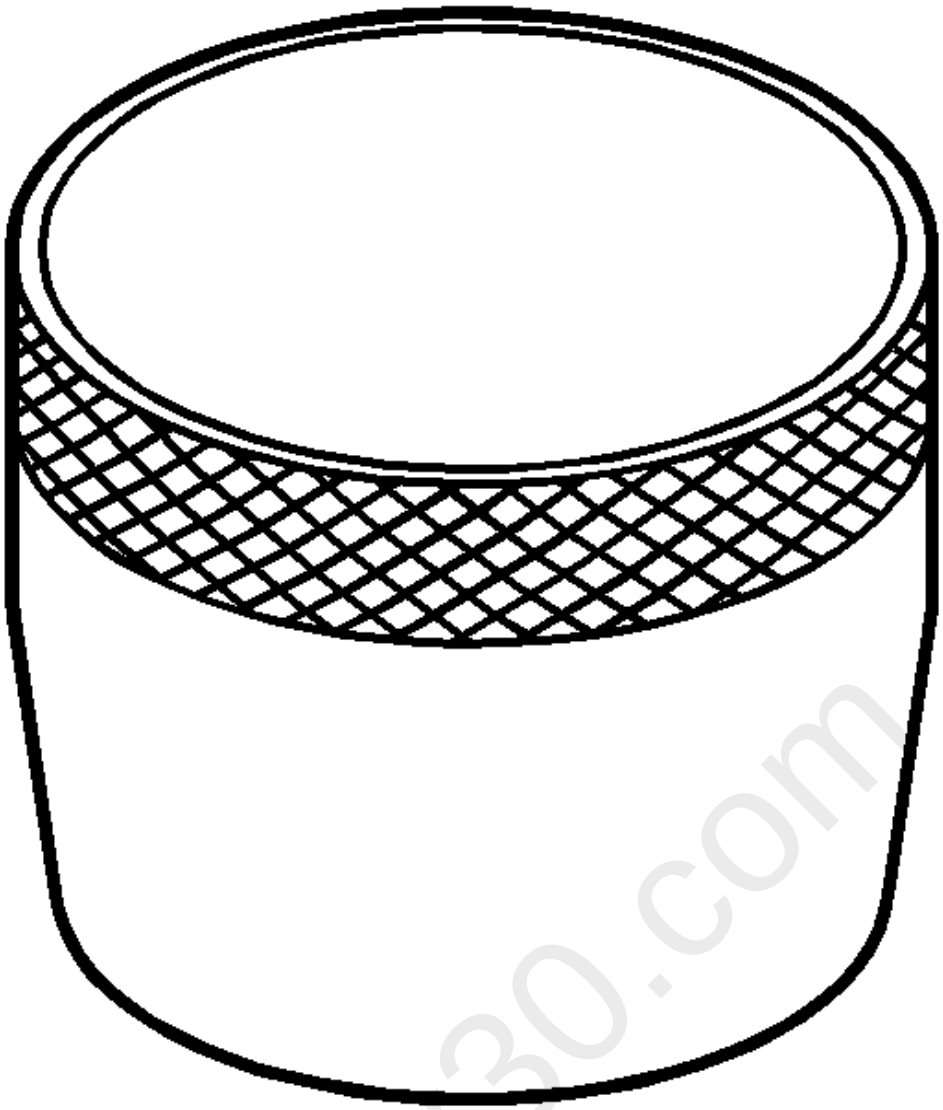
mcx30.com

Illustration	Tool Number/Description
	EN-46745 J-43654 Piston Pin Clip Remover/Installer

mcx30.com

Illustration	Tool Number/Description
	EN-46745-4 Piston Pin Clip Remover/Installer Adapter

mcx30.com

Illustration	Tool Number/Description
	EN-47836 J-47836 Ring Compressor - 88 mm

mcx30.com

Illustration	Tool Number/Description
	EN-47909 Injector Bore and Sleeve Cleaning Kit

mcx30.com

Illustration	Tool Number/Description
	EN-48034 Crankshaft Balancer Installer

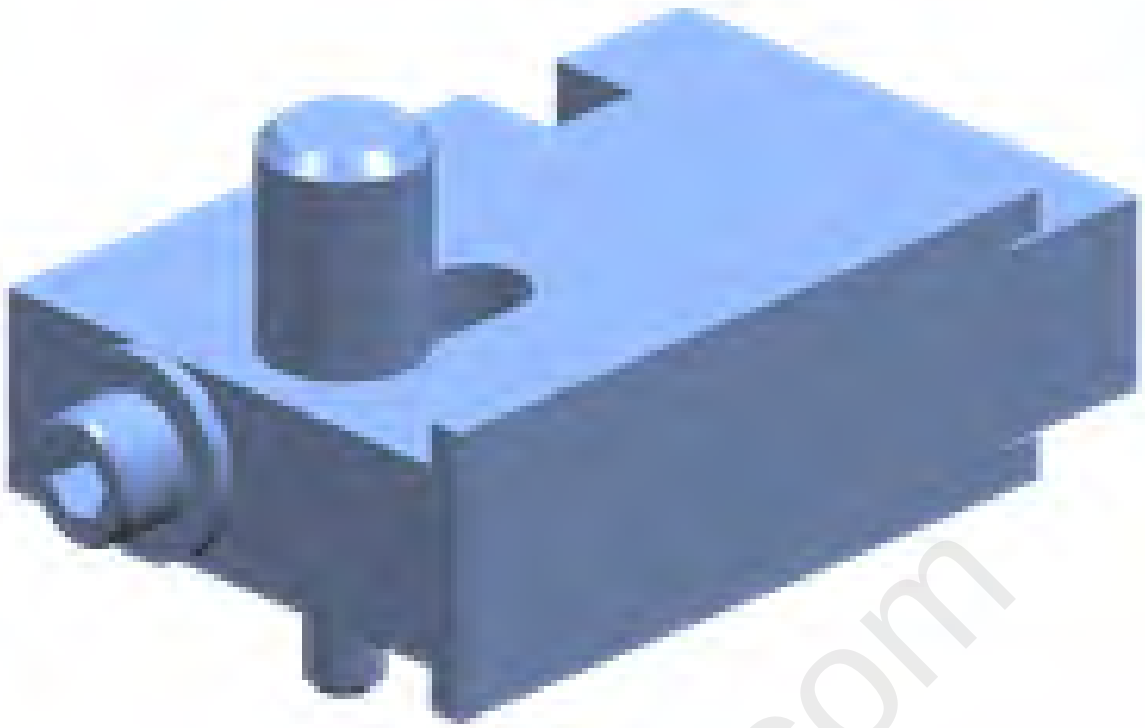
mcx30.com

Illustration	Tool Number/Description
	EN-49245 Injector Seal Installer and Sizer

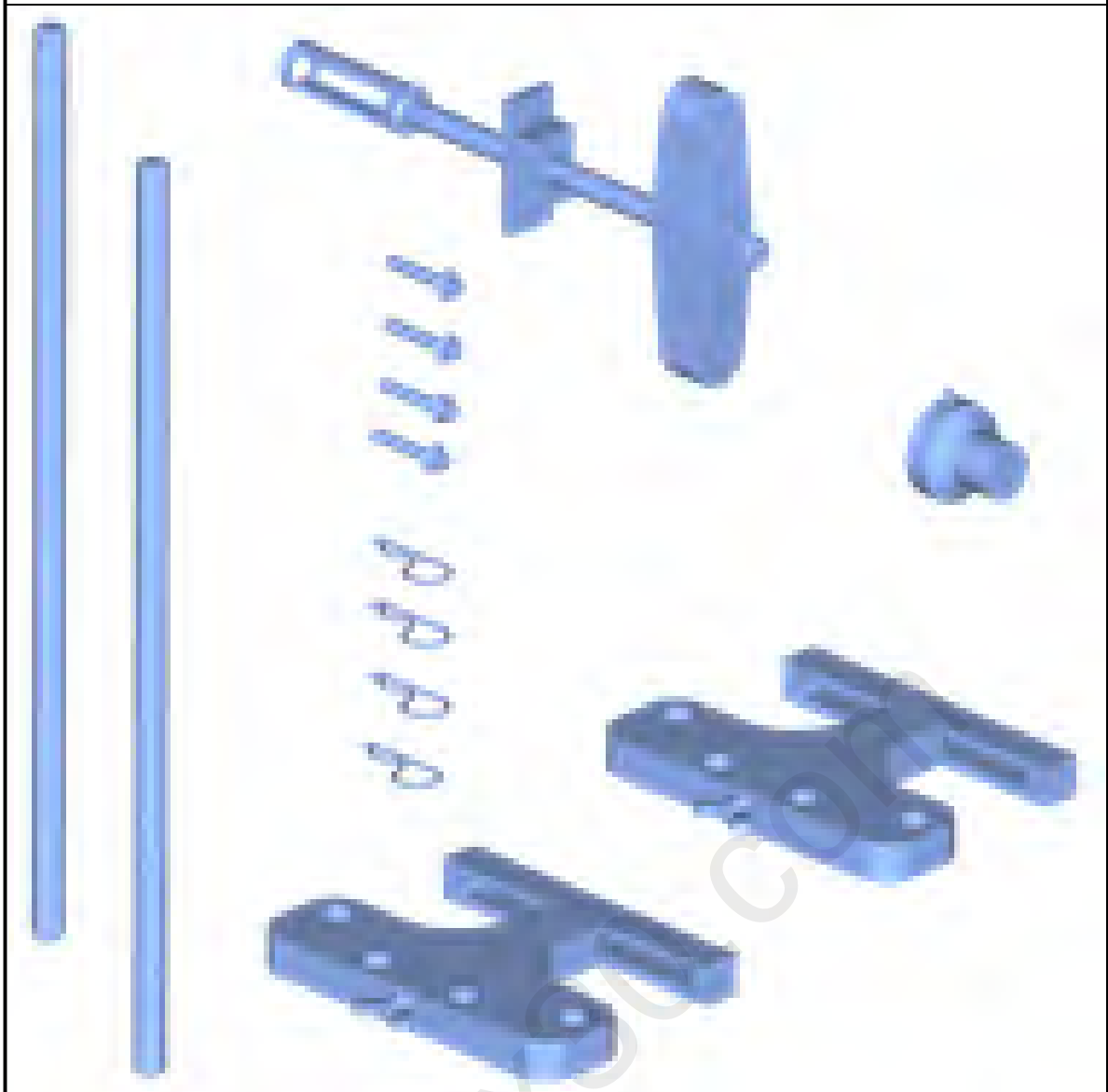
mcx30.com

Illustration	Tool Number/Description
	EN-49248 Fuel Rail Assembly Remover

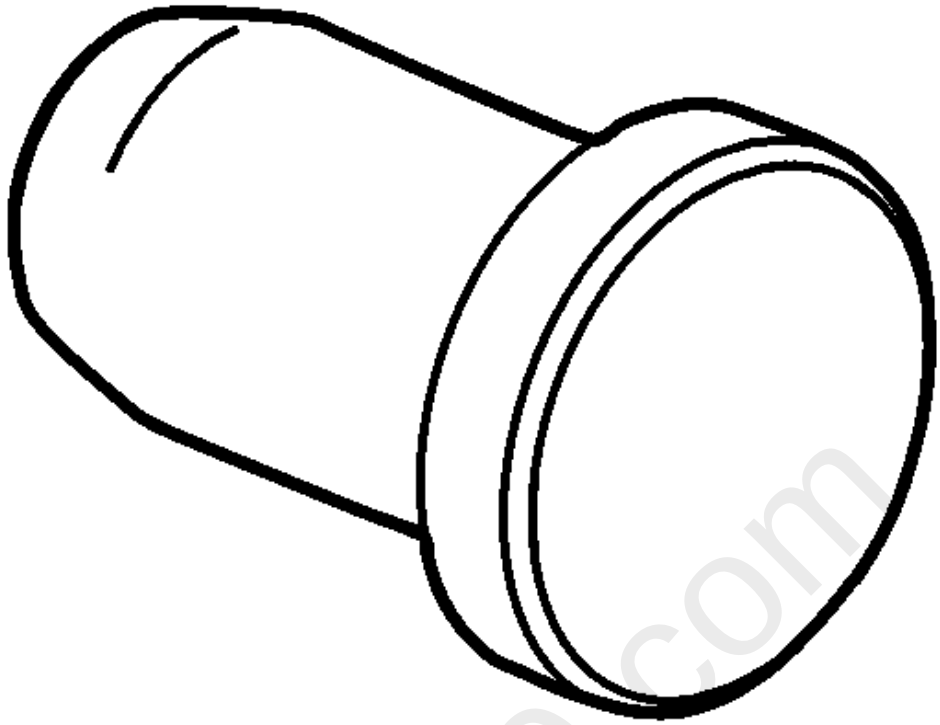
mcx30.com

Illustration	Tool Number/Description
	EN-50656 Timing Chain Retention Tool Kit

mcx30.com

Illustration	Tool Number/Description
	EN-50717 Valve Spring Compressor

mcx8.com

Illustration	Tool Number/Description
	EN-50790 High Pressure Fuel Pump Installation Alignment Gauge

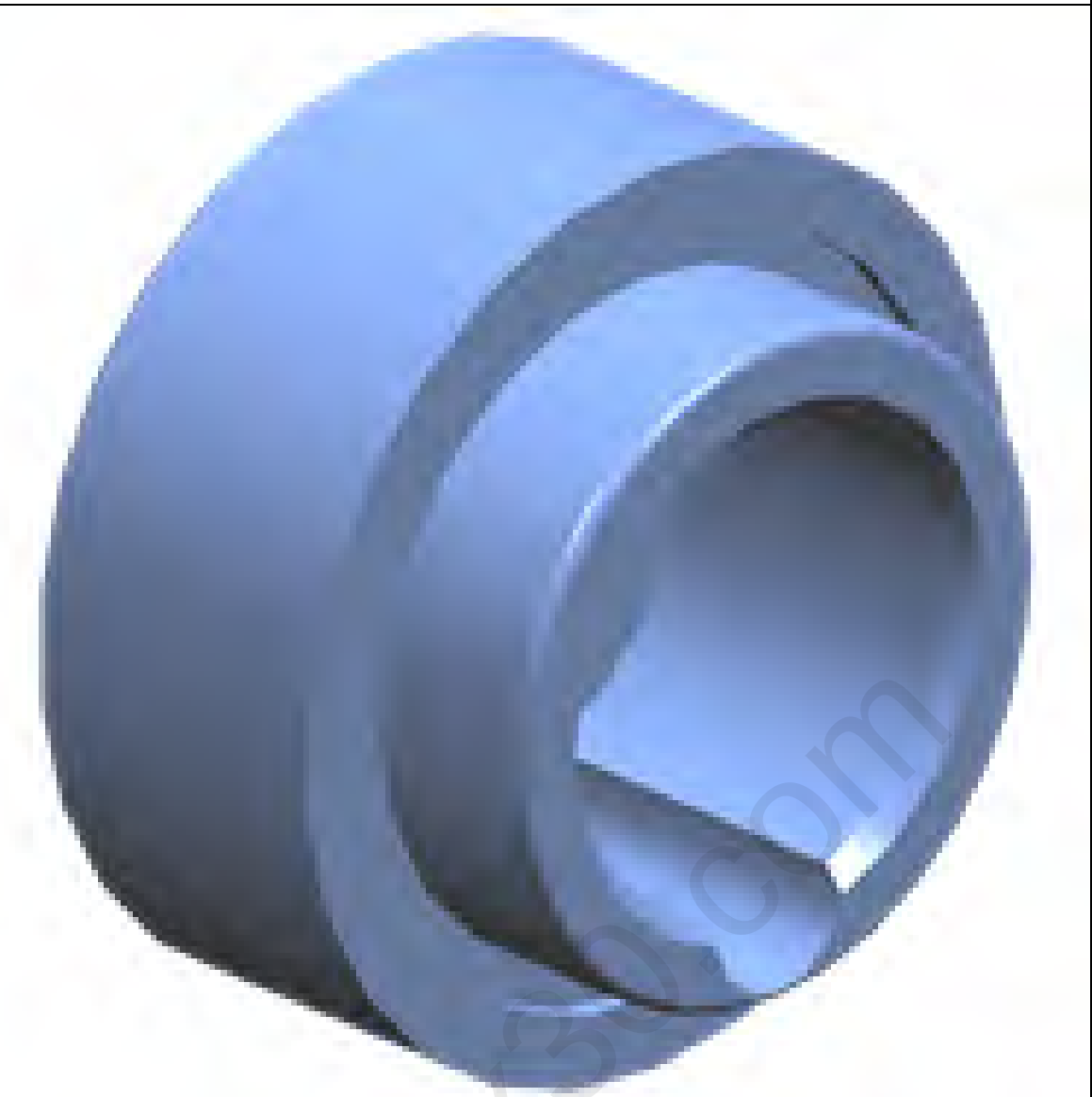
mcx30.com

Illustration	Tool Number/Description
	EN-50791 Fuel Injector Nozzle Installer - to Rail

mcx30.com

Illustration	Tool Number/Description
	EN-50793 Camshaft Actuator Locking Tool

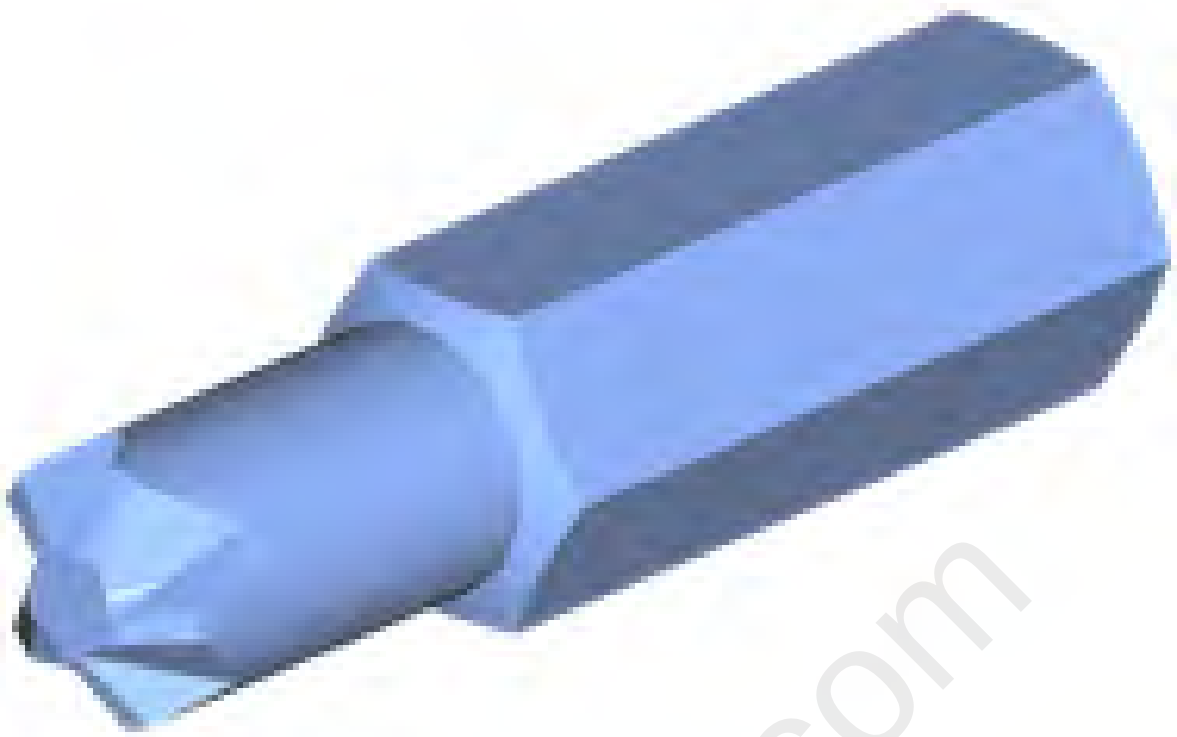
mcx30.com

Illustration	Tool Number/Description
	EN-50820 Front Crankshaft Seal Installer

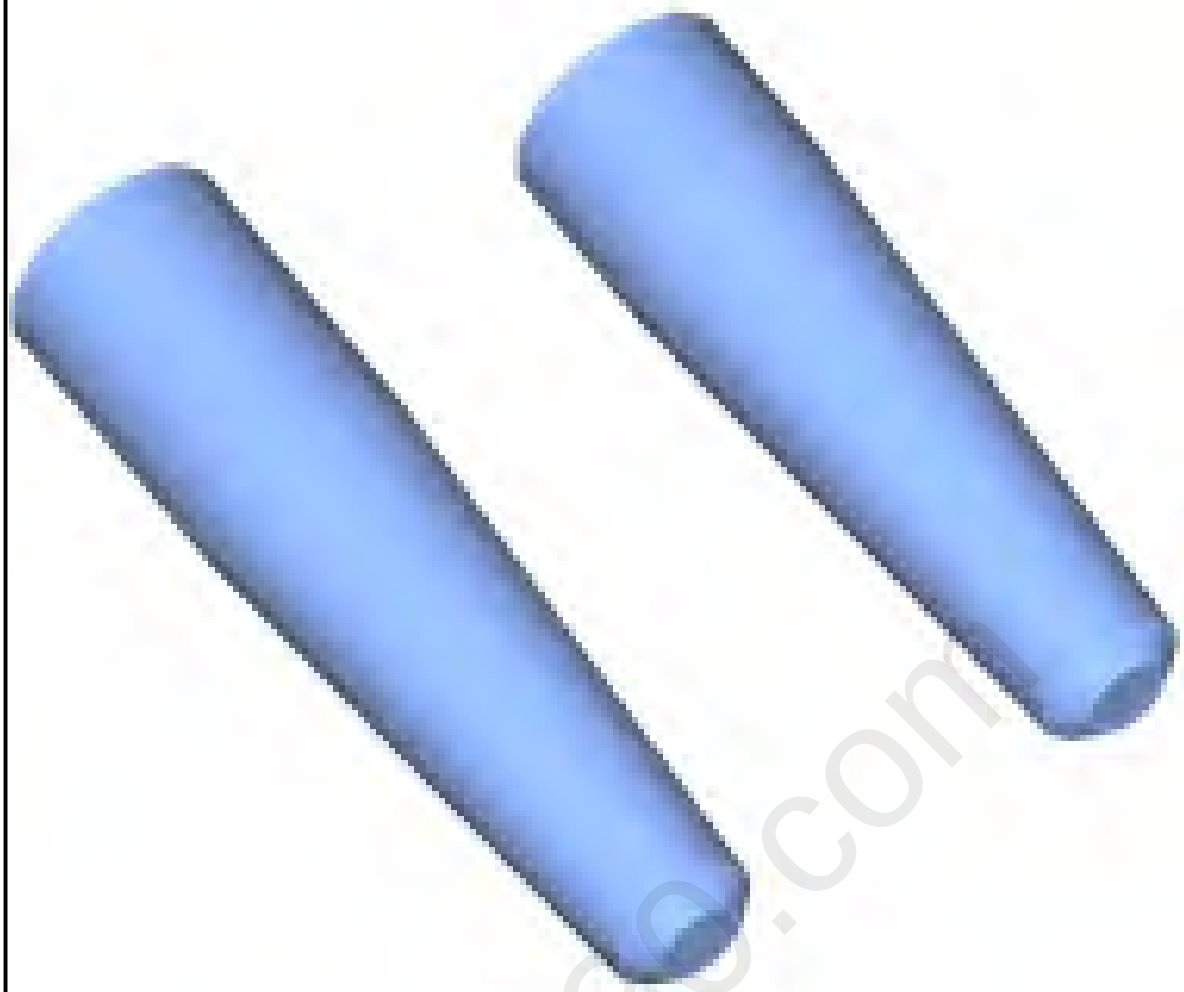
mcx30.com

Illustration	Tool Number/Description
	EN-50837 Timing Chain Tensioner Retraction Tool

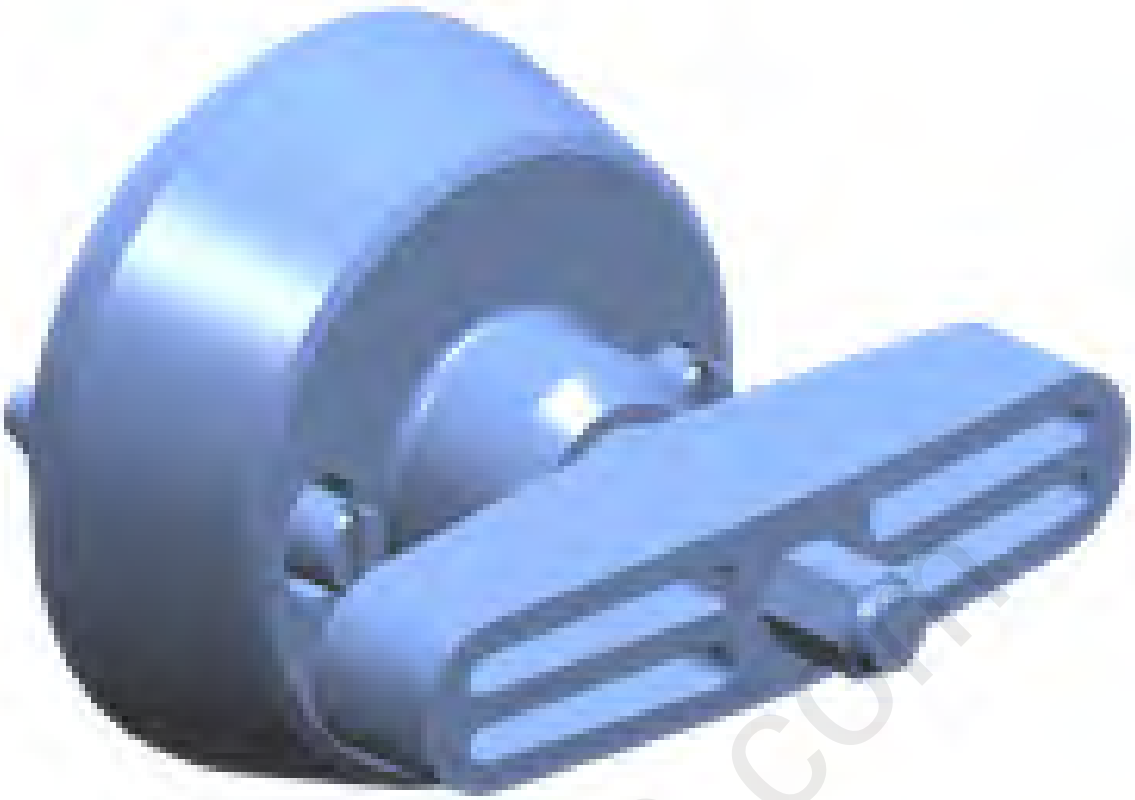
mcx30.com

Illustration	Tool Number/Description
	EN-50956 Tamper Proof Drive Bit

mcx30.com

Illustration	Tool Number/Description
	EN-51105 Injector Seal Installer

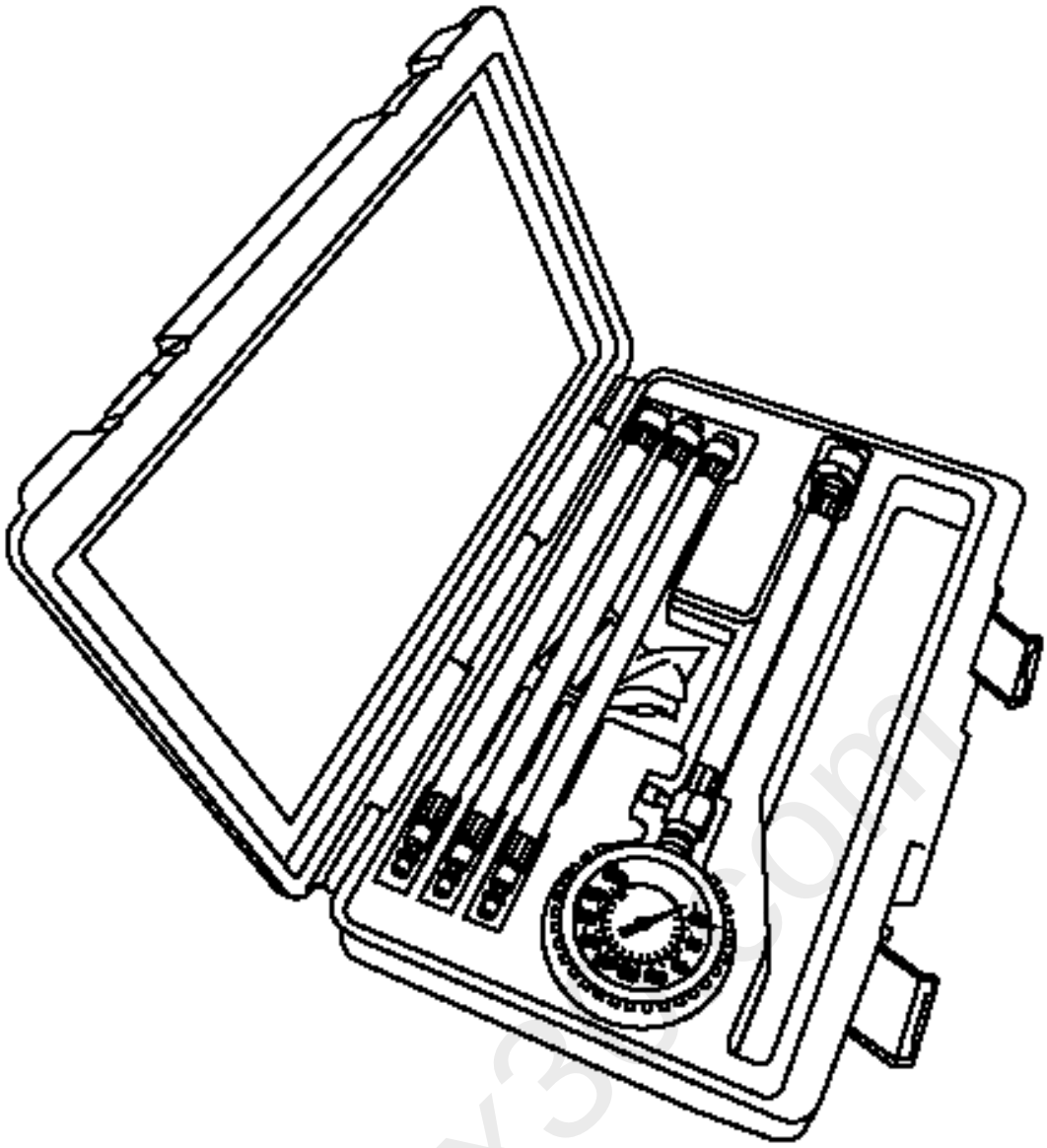
mcx30.com

Illustration	Tool Number/Description
	EN-51380 Seal Installer

mcx30.com

Illustration	Tool Number/Description
	EN-51577 Balancer Holder and Remover

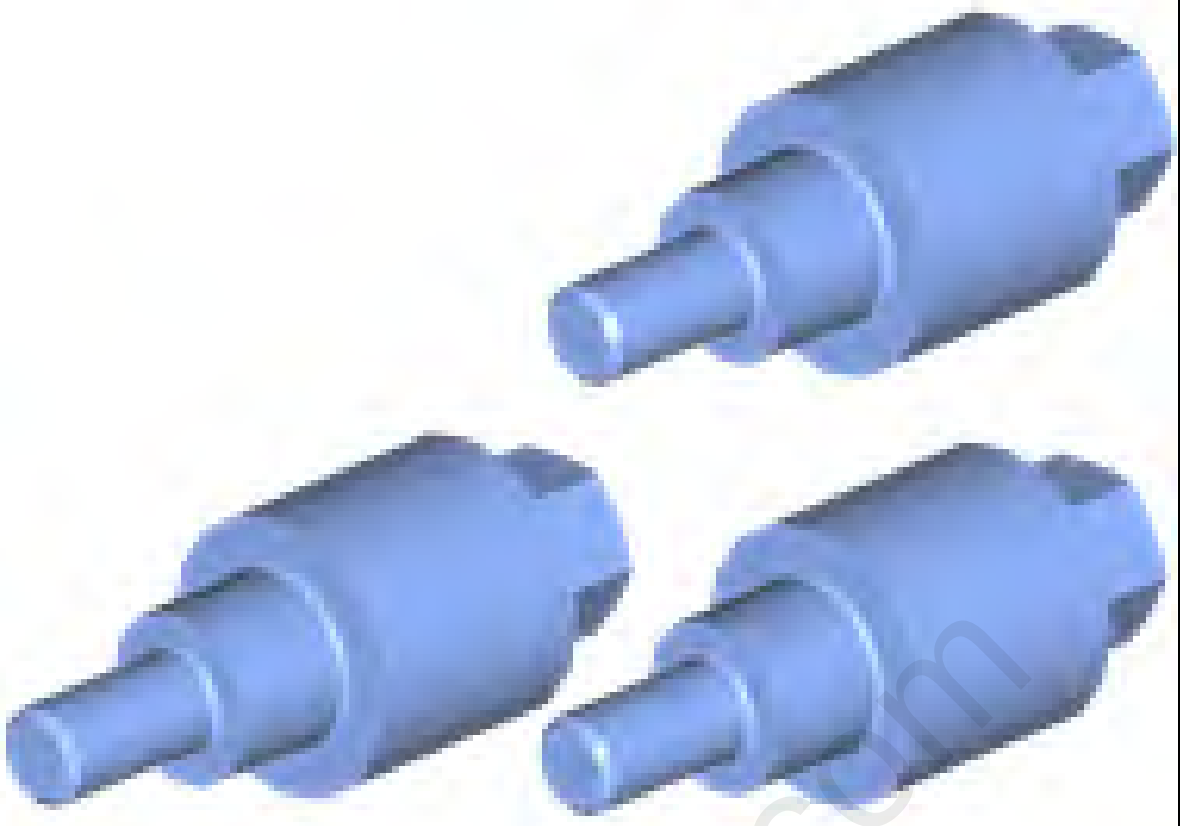
mcx30.com

Illustration	Tool Number/Description
	EN-51749 Compression Gauge Tester Kit

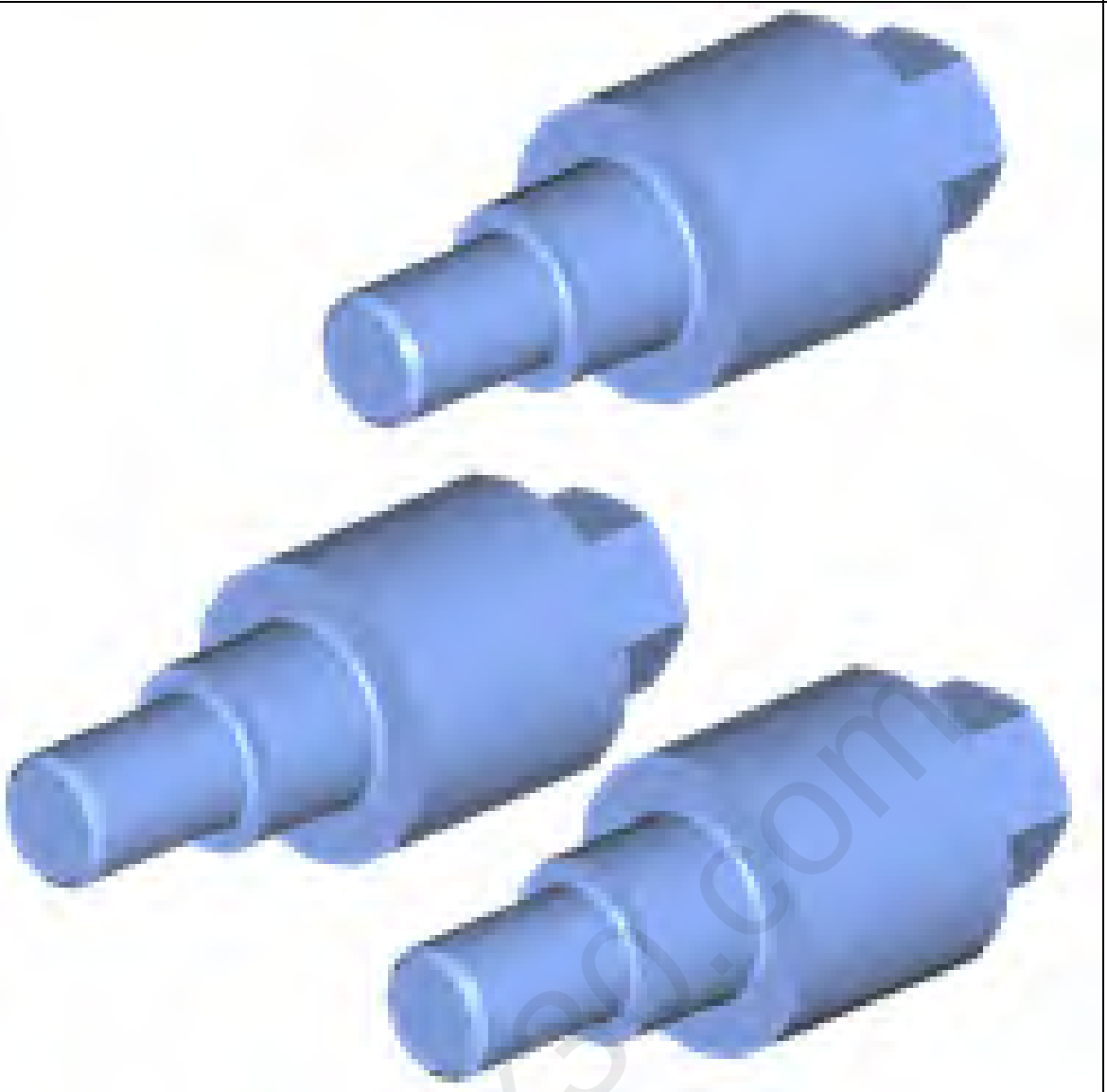
mcx30.com

Illustration	Tool Number/Description
	EN-51760 EN-50792 Flywheel Holder

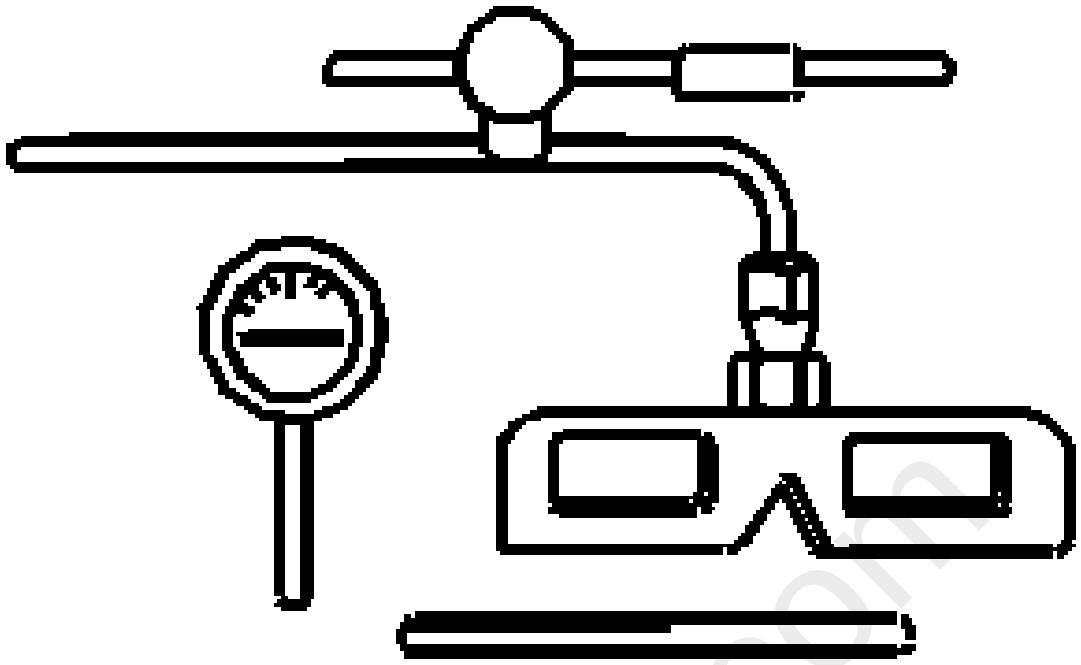
mcx30.com

Illustration	Tool Number/Description
	EN-51768 Engine Support Fixture Adapter Bolts M8

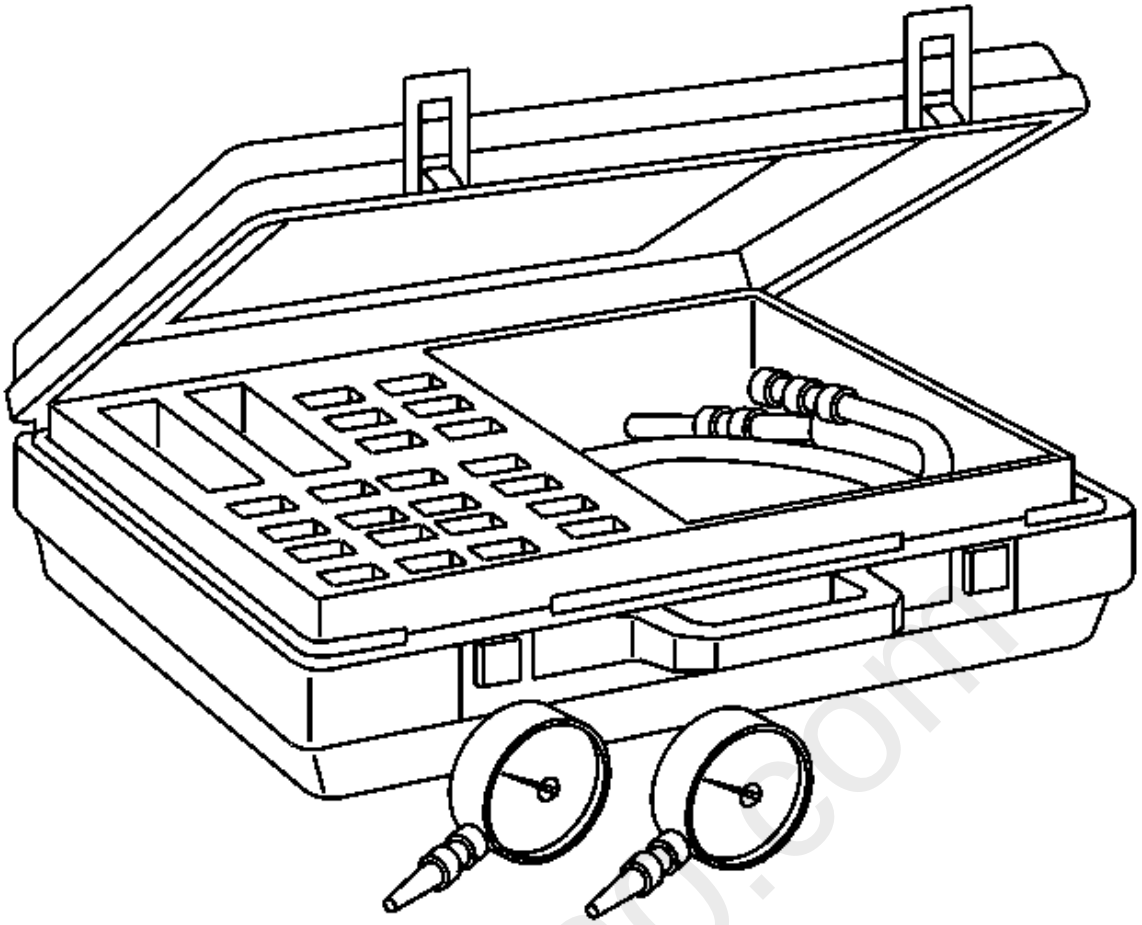
mcx30.com

Illustration	Tool Number/Description
	EN-52059 Engine Support Fixture Adapter Bolts M10
	GE-7872 J-7872 Magnetic Base Dial Indicator Set

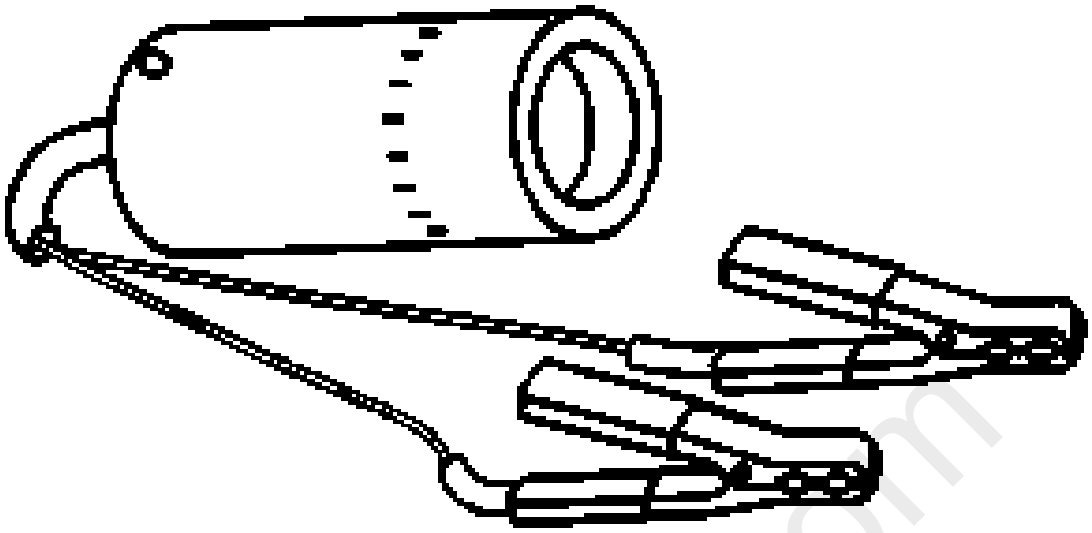
mcx30.com

Illustration	Tool Number/Description
	

mcx30.com

Illustration	Tool Number/Description
	GE-21867-A J-21867-A Oil Pressure Gauge Kit

mcx30.com

Illustration	Tool Number/Description
	GE-42220 J-28428-E J-42220 Universal 12V Leak Detection Lamp

mcx30.com