REPAIR INSTRUCTIONS - OFF VEHICLE

DRAINING FLUIDS AND OIL FILTER REMOVAL

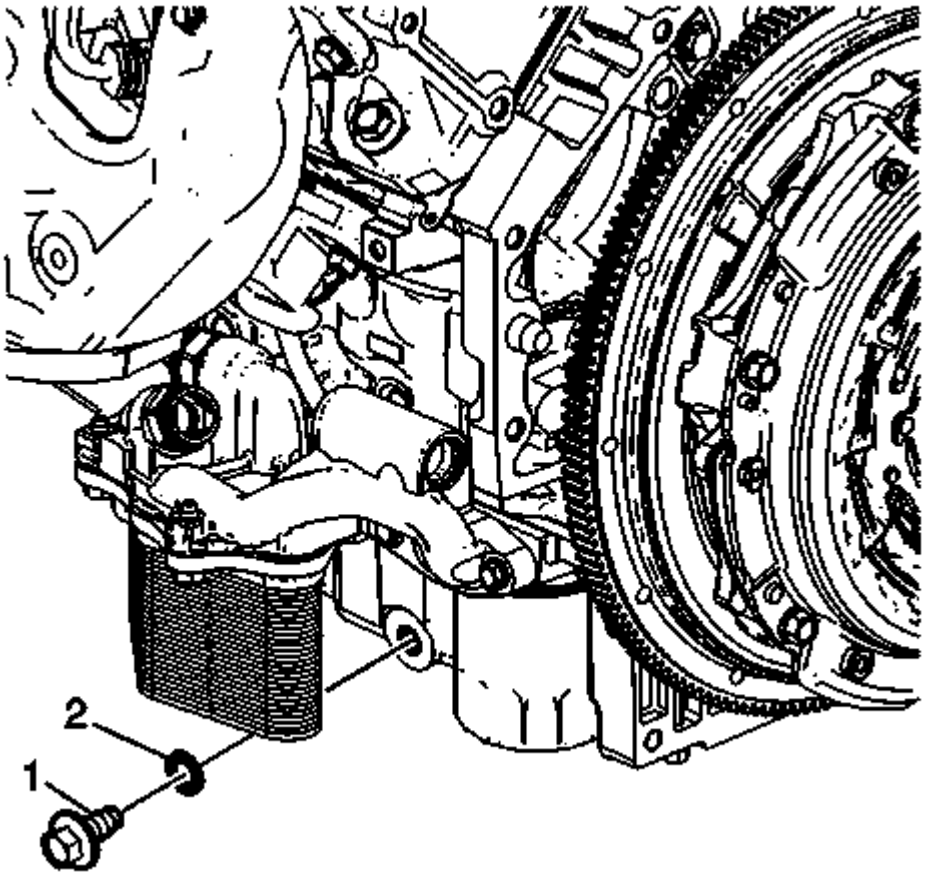


Fig. 1: Oil Pan Drain Plug And O- Ring
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pan drain plug (1) with O-ring (2).

cardiagn.com

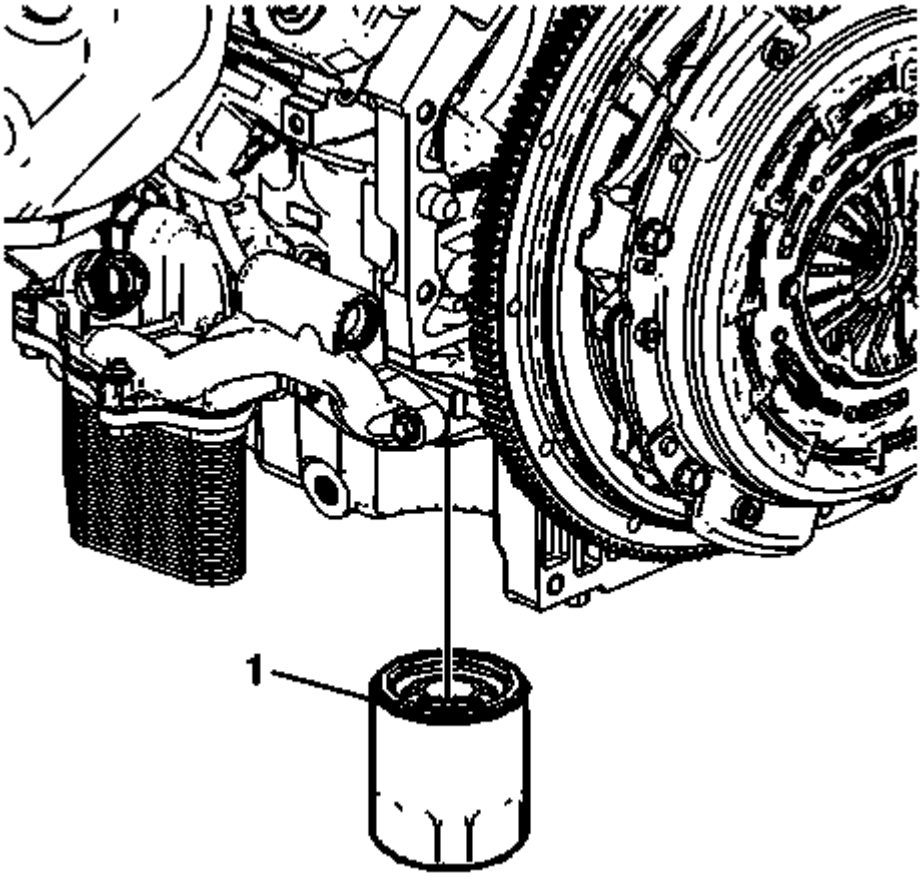


Fig. 2: Engine Oil Filter
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine oil filter (1).

cardiagn.com

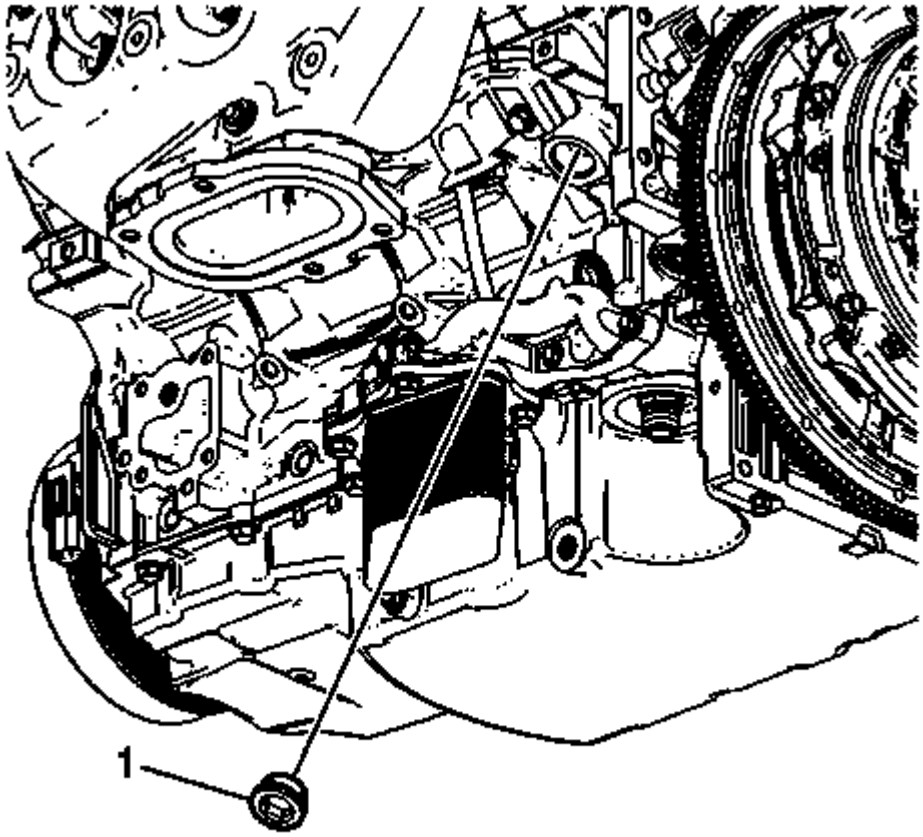


Fig. 3: Left Side Rear Engine Block Coolant Drain Hole Plug
Courtesy of GENERAL MOTORS COMPANY

3. Remove the left side rear engine block coolant drain hole plug (1).

cardiagn.com

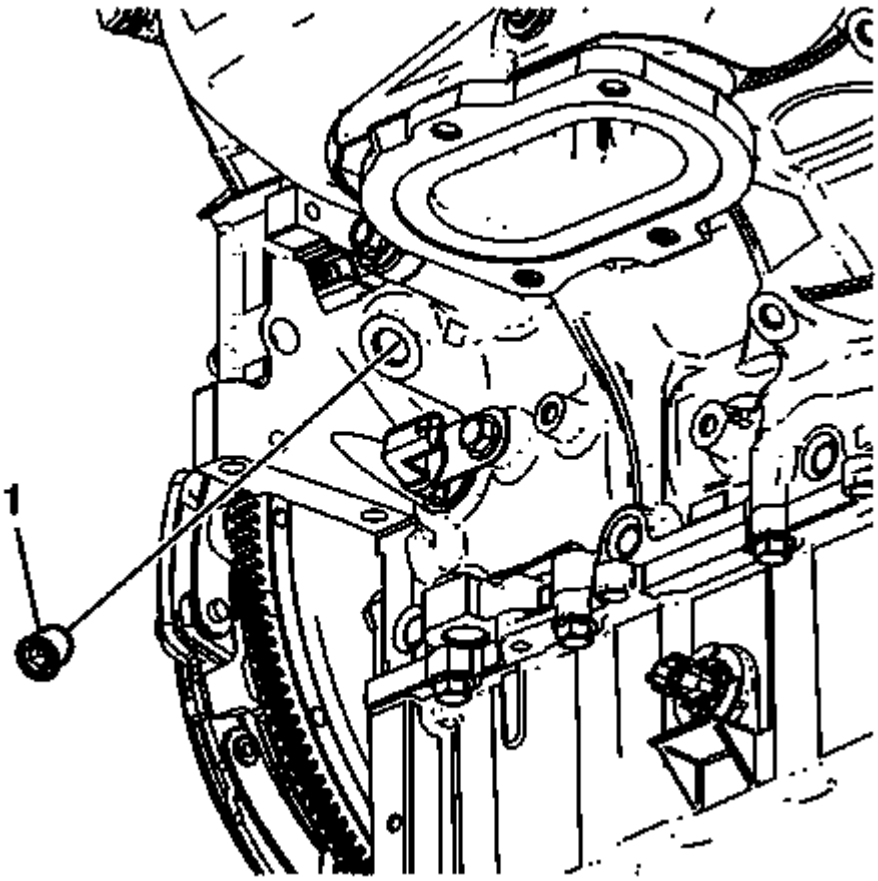


Fig. 4: Right Side Rear Engine Block Coolant Drain Hole Plug
Courtesy of GENERAL MOTORS COMPANY

4. Remove the right side rear engine block coolant drain hole plug (1).

DRAINING FLUIDS AND OIL FILTER REMOVAL (WITH Z52 OPTION)

cardiagn.com

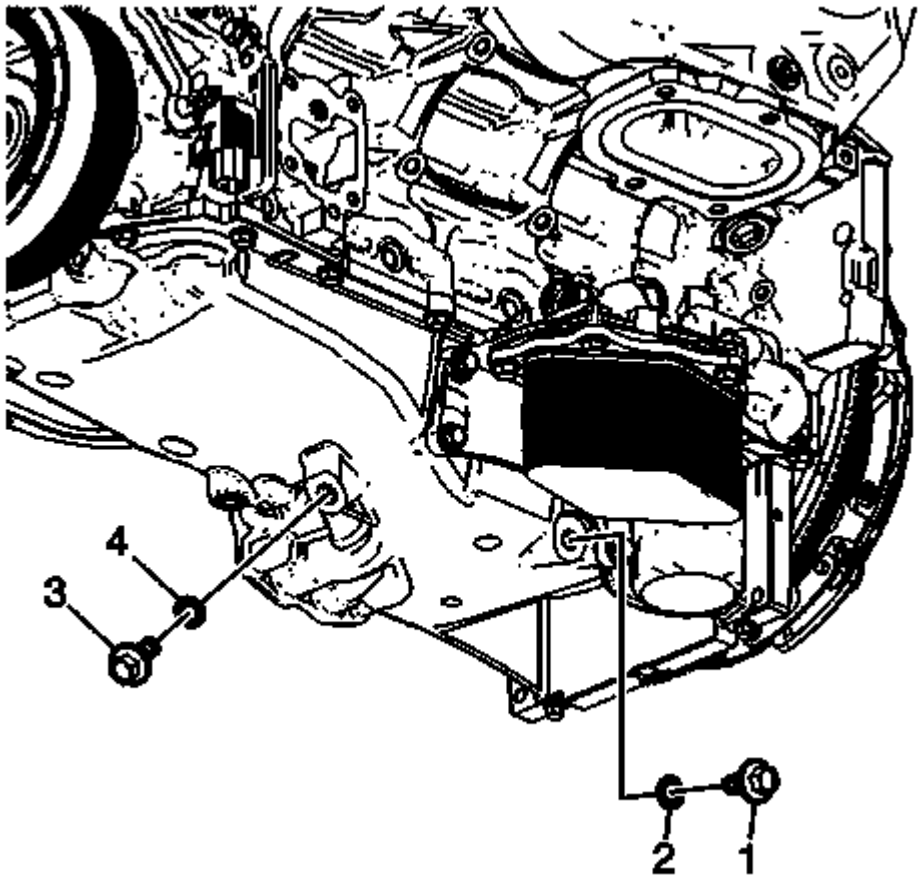


Fig. 5: Oil Pan Drain Plugs With Seals
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pan drain plugs (1 and 3) with seals (2 and 4).
    - The front bottom drain plug (3) will drain oil from the engine oil tank and hoses.
    - The left side drain plug (1) will drain oil from the engine oil pan.

cardiagn.com

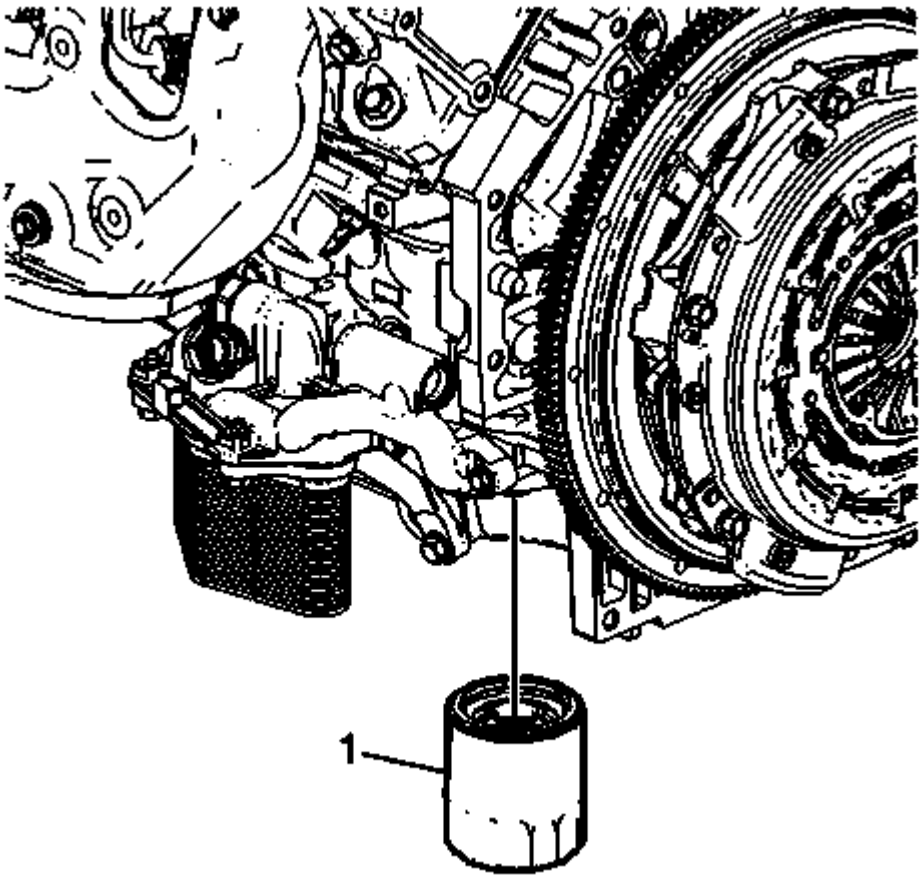


Fig. 6: Engine Oil Filter
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine oil filter (1).

cardiagn.com

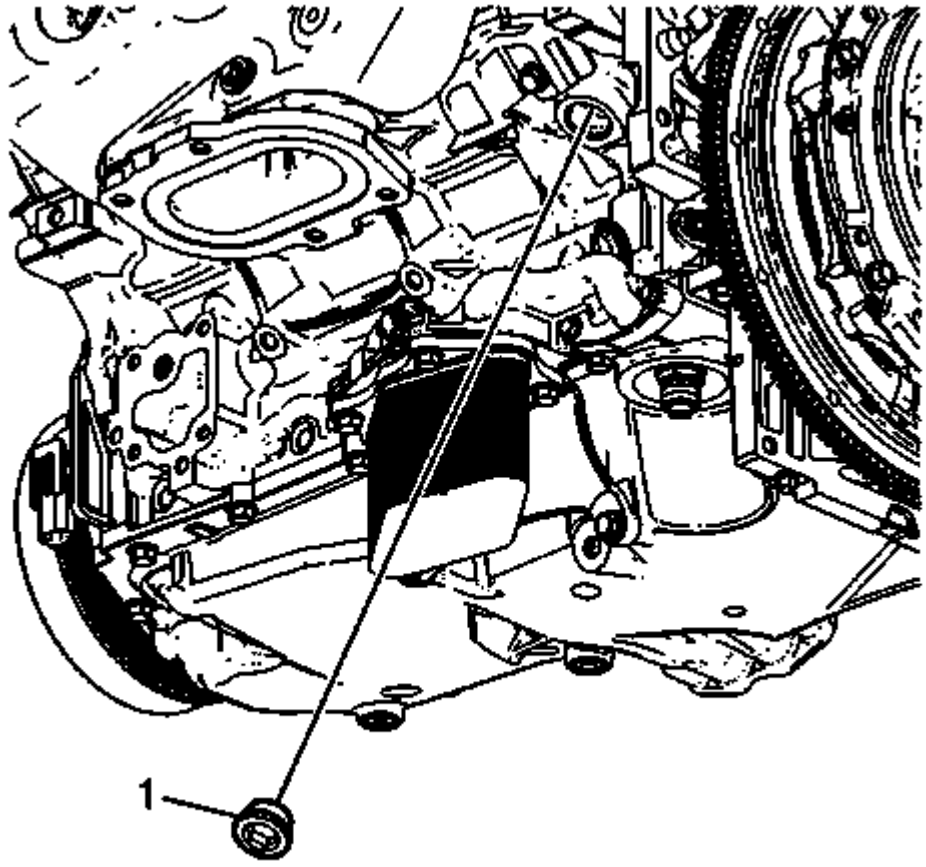


Fig. 7: Left Side Engine Block Coolant Drain Hole Plug
Courtesy of GENERAL MOTORS COMPANY

3. Remove the left side engine block coolant drain hole plug (1).

cardiagn.com

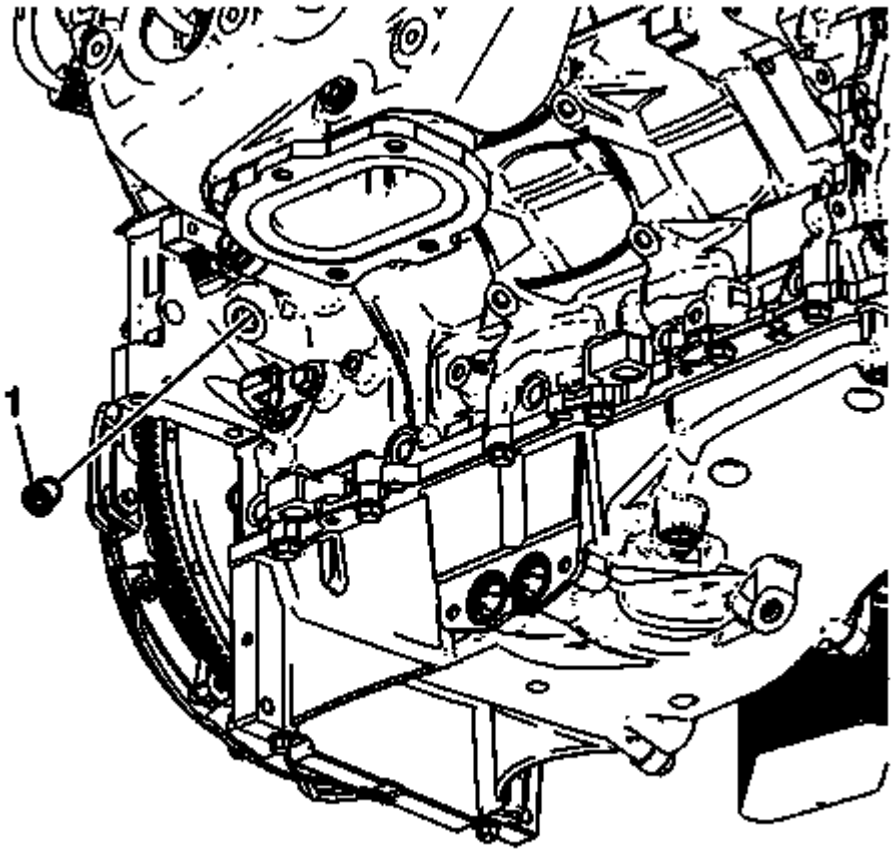


Fig. 8: Right Side Engine Block Coolant Drain Hole Plug
Courtesy of GENERAL MOTORS COMPANY

4. Remove the right side engine block coolant drain hole plug (1).

CRANKSHAFT BALANCER REMOVAL

cardiagn.com

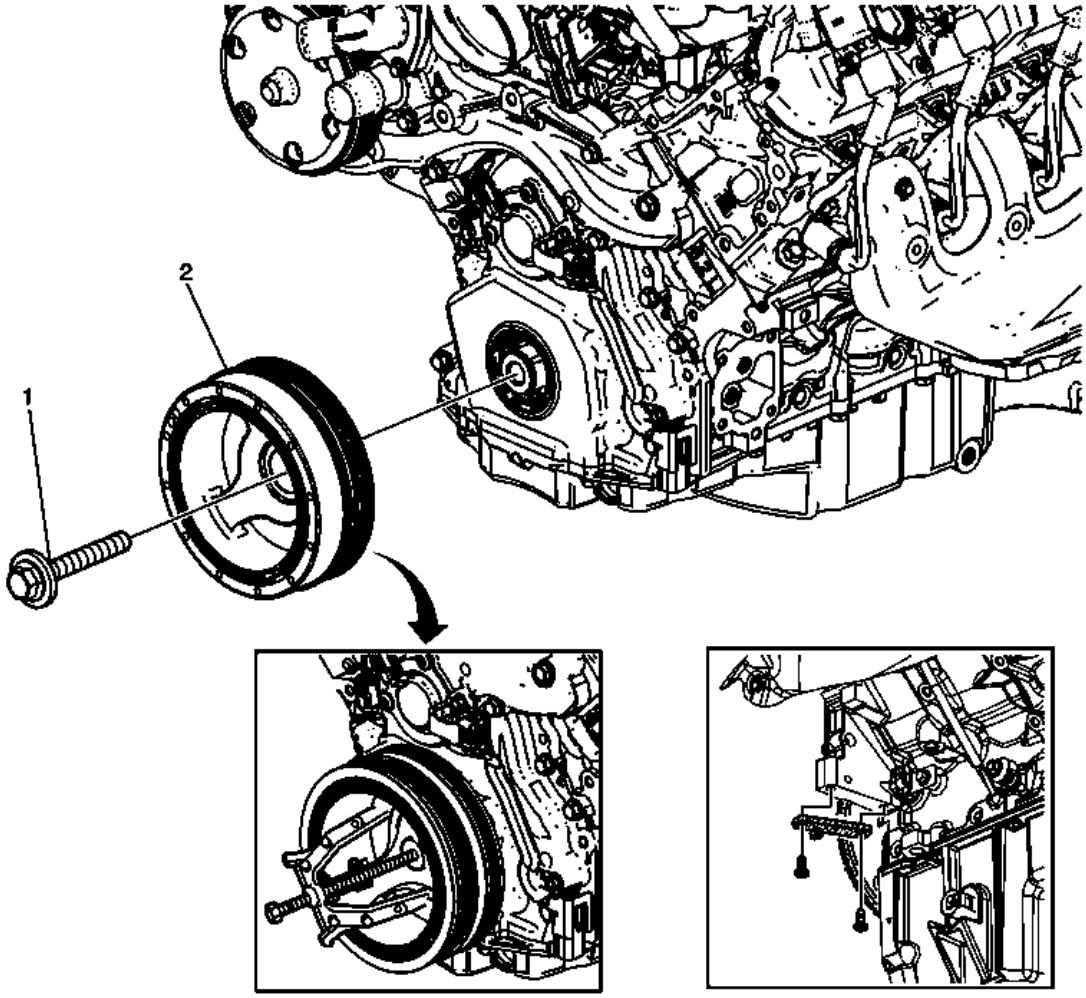


Fig. 9: Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Balancer Removal

Callout	Component Name
1	Crankshaft Balancer Bolt **NOTE:** **Do not discard balancer bolt, it will be used later for installation.** **Procedure** Install the **J-42386-A** flywheel holding tool. Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation and tighten bolts to 50 N.m (37 lb ft). **Special Tools** **J-42386-A** Flywheel Holding Tool For equivalent regional tools, refer to **Special Tools** .

cardiagn.com

2	**Procedure** 1. Install the **EN-41816-2** crankshaft end protector, 2. Install the **EN-41816** crankshaft balancer remover. 3. Using both tools remove the crankshaft balancer. **Special Tools** • **EN-41816** Crankshaft Balancer Remover • **EN-41816-2** Crankshaft End Protector For equivalent regional tools, refer to **Special Tools** .

ENGINE FLYWHEEL REMOVAL

Special Tools

J-42386-A Flywheel Holding Tool

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

cardiagn.com

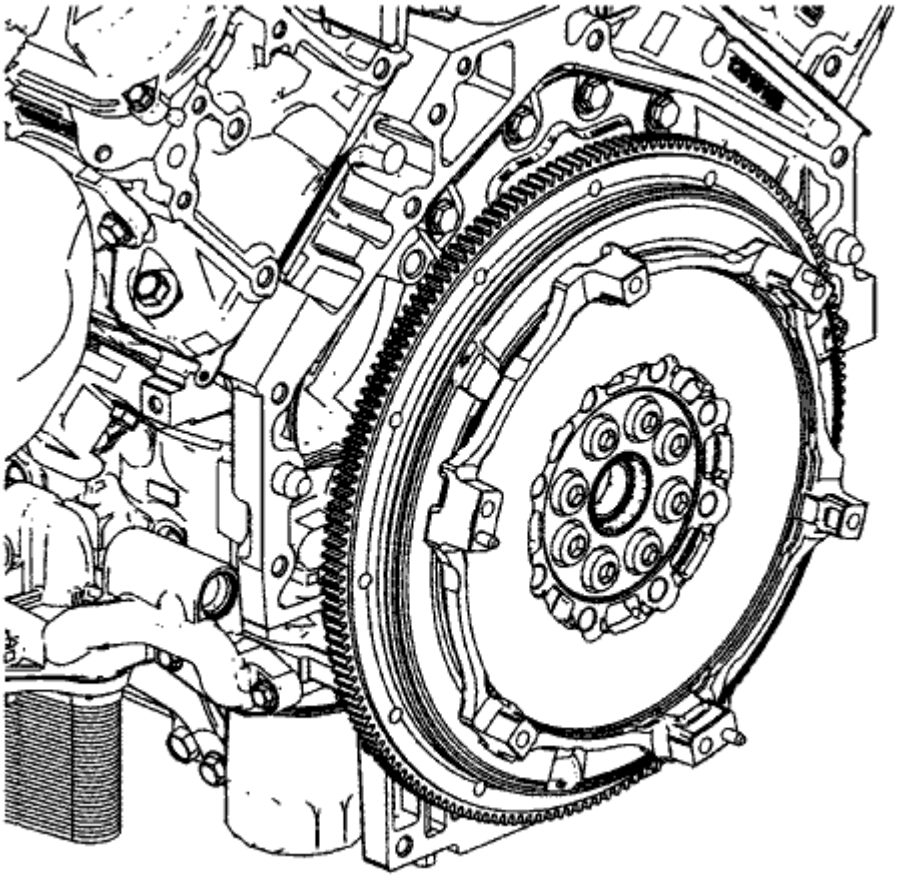


Fig. 10: Engine Flywheel
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the position and direction of the engine flywheel before removal. The flywheel does not use a locating pin for alignment. Mark or scribe the end of the crankshaft and the flywheel before component removal. The existing manual transmission engine flywheel must be installed to the original position and direction.**

1. Mark or scribe the end of the crankshaft and the manual transmission flywheel. Refer to **Engine Balancing** .

cardiagn.com

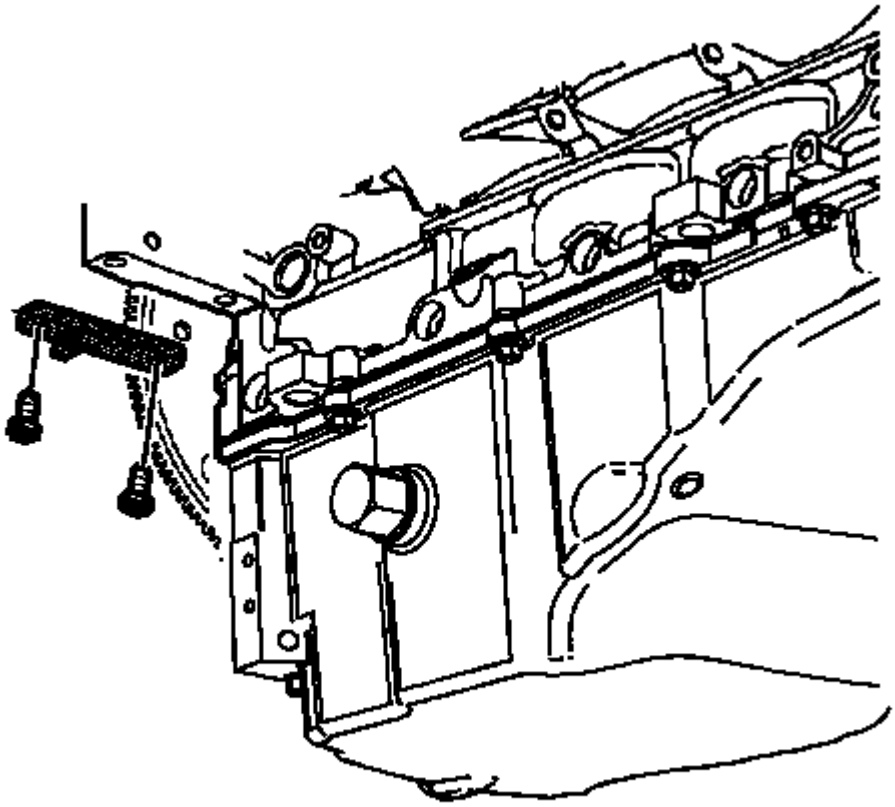


Fig. 11: Identifying J 42386-A
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the **J-42386-A** flywheel holding tool and bolts.

   Use 1 M10 -1.5 x 120 mm and 1 M10 -1.5 x 45 mm bolt for proper tool operation.

   Tighten the **J-42386-A** flywheel holding tool and bolts to 50 N.m (37 lb ft).

cardiagn.com

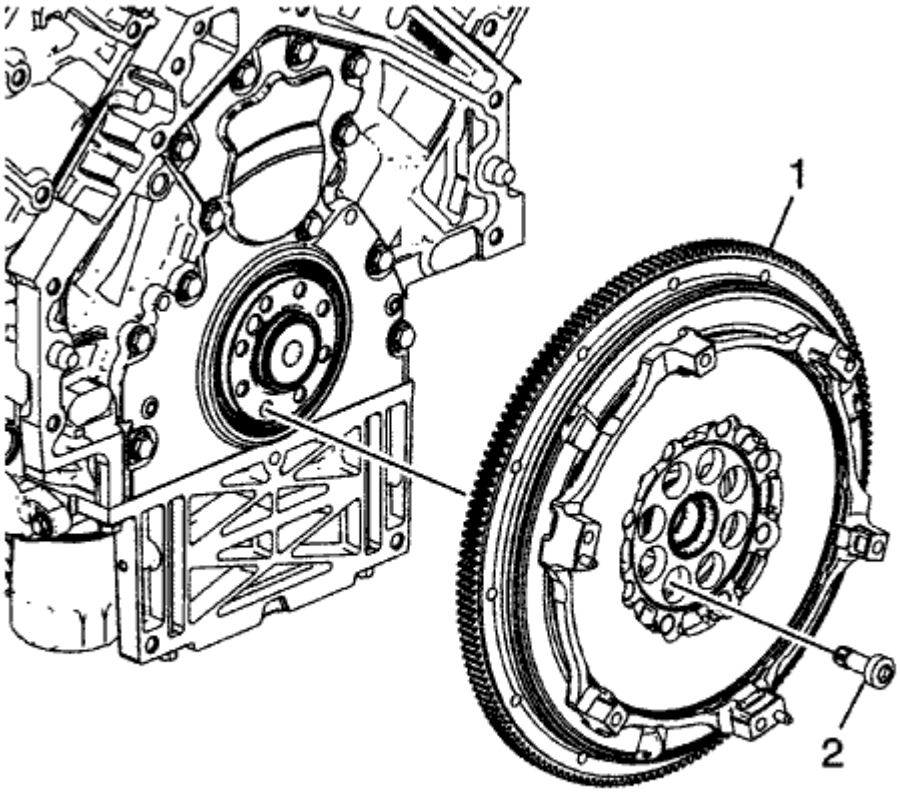


Fig. 12: Manual Transmission Flywheel
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT reuse the flywheel bolts.

3. Remove and discard the flywheel bolts (2).
4. Remove the manual transmission flywheel (1).

cardiagn.com

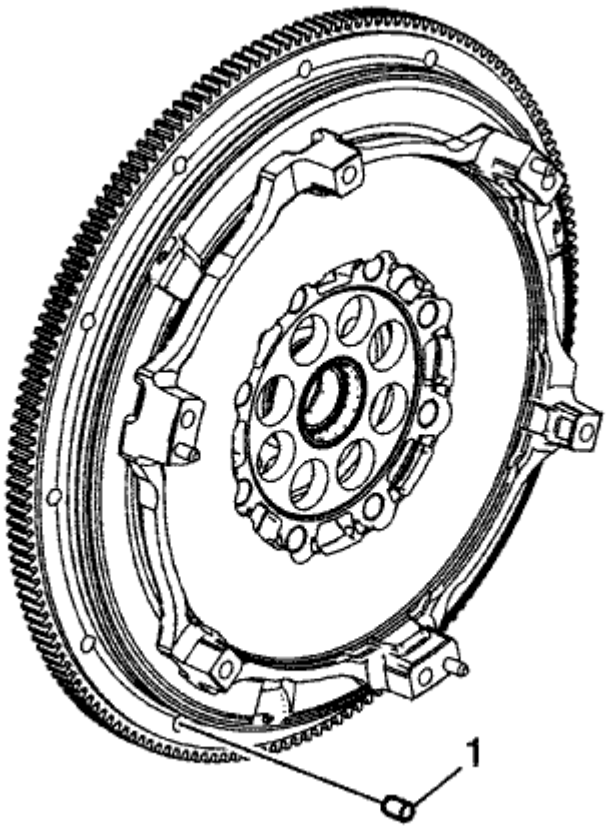


Fig. 13: Manual Transmission Flywheel Balance Weights
Courtesy of GENERAL MOTORS COMPANY

5. Note the location of the manual transmission flywheel balance weights (1), if applicable. Refer to **Engine Balancing** .
6. Remove the **J-42386-A** flywheel holding tool

AUTOMATIC TRANSMISSION FLEX PLATE REMOVAL

cardiagn.com

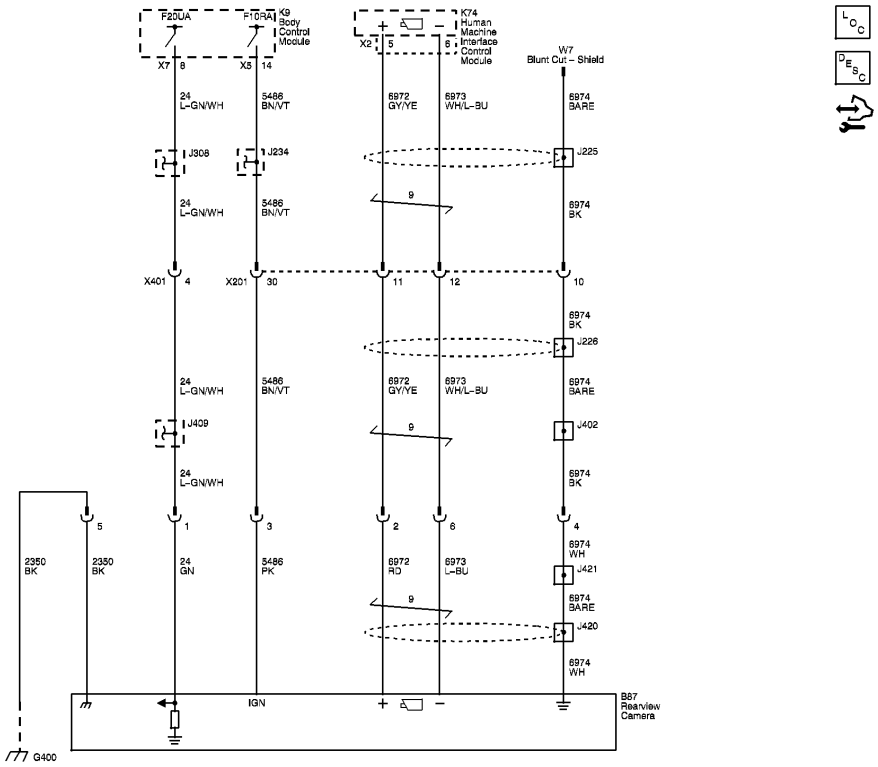


Fig. 14: Engine Flex Plate Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The flex plate does not use a locating pin for alignment and will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the engine flex plate bolts. This procedure requires a 3 stage tightening process.**

1. Remove the engine flex plate bolts (2).

   NOTE: **Mark the flex plate and crankshaft before removal.**

2. Remove the flex plate (1).

CLUTCH PILOT BEARING REMOVAL

Special Tools

- **GE-2619-01** Slide Hammer
- **GE-23907** Slide Hammer with Bearing Adapter
- **GE-23907-1** Slide Hammer

cardiagn.com

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

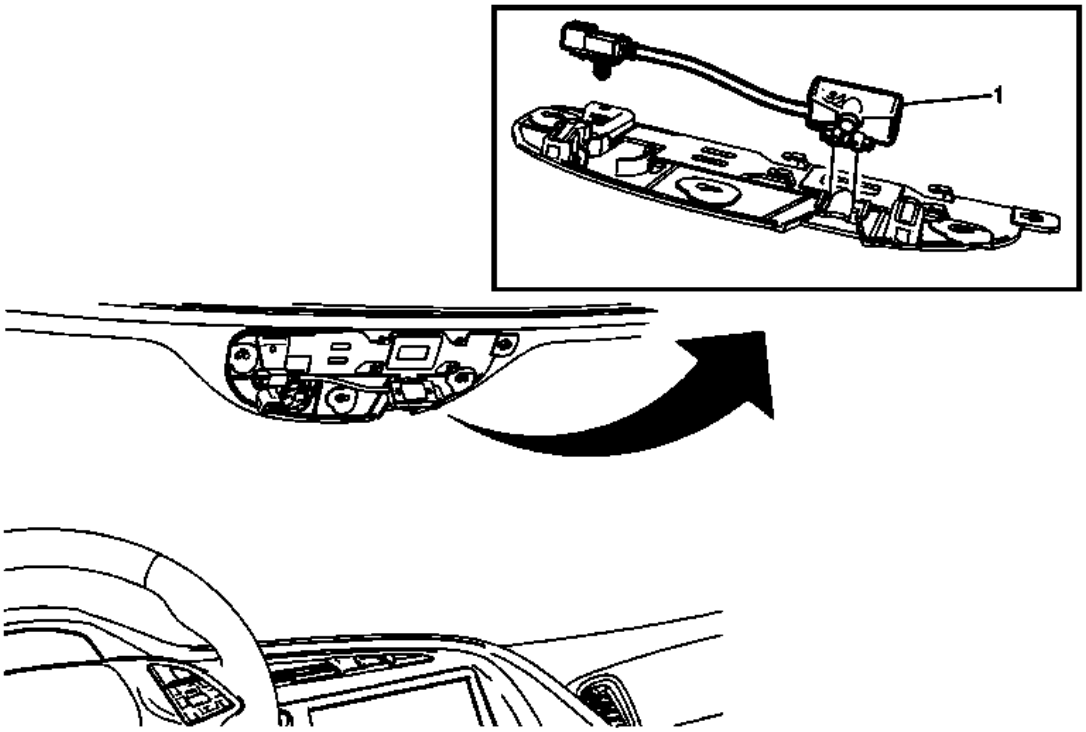


Fig. 15: Removing Clutch Pilot Bearing
Courtesy of GENERAL MOTORS COMPANY

NOTE: **GE-23907-1 slide hammer was part of the GE-23907 slide hammer with bearing adapter set. The adapter is still available as GE-23907 adapter.**

1. Remove the clutch pilot bearing using the **GE-23907** adapter (1) and **GE-23907-1** slide hammer (2).
    1. Install the legs of the **GE-23907** adapter (1) into the clutch pilot bearing.
    2. Rotate the shaft of the tool until the legs of the tool are snug and contacting the I.D. surface of the bearing.
    3. Install the **GE-23907-1** slide hammer (2) to the **GE-23907** adapter (1).
    4. Remove the bearing from the rear of the crankshaft.
    5. Remove the special tools from the bearing.

cardiagn.com

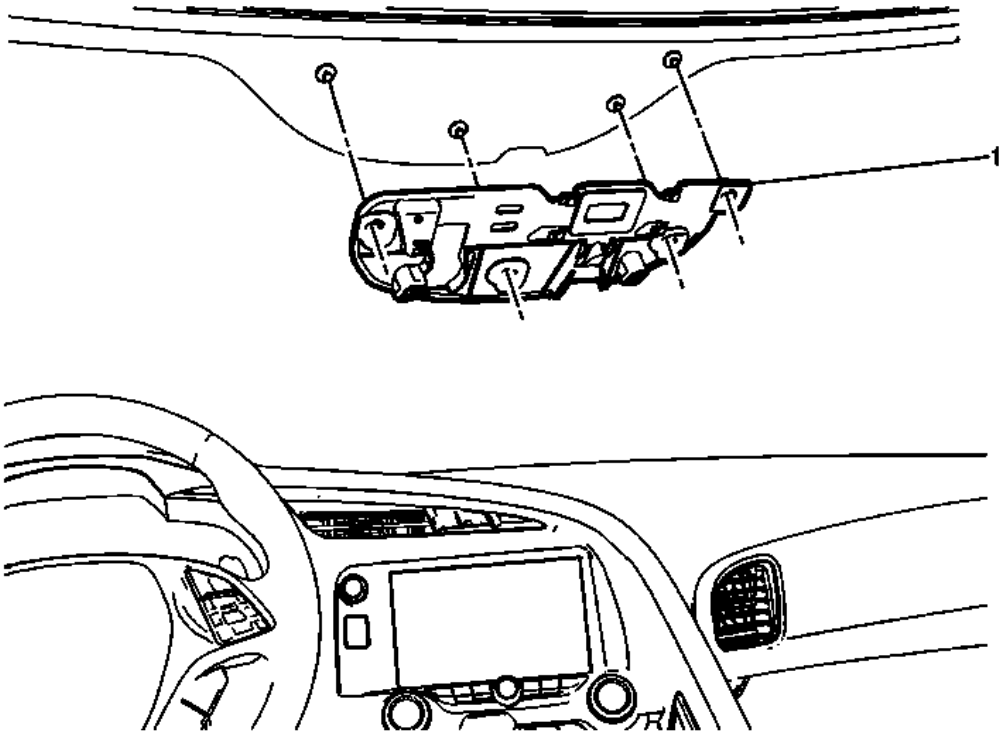


Fig. 16: Locating Clutch Pilot Bearing
Courtesy of GENERAL MOTORS COMPANY

2. Discard the bearing.

EXHAUST MANIFOLD REMOVAL - LEFT SIDE (WITH Z52 OPTION)

cardiagn.com

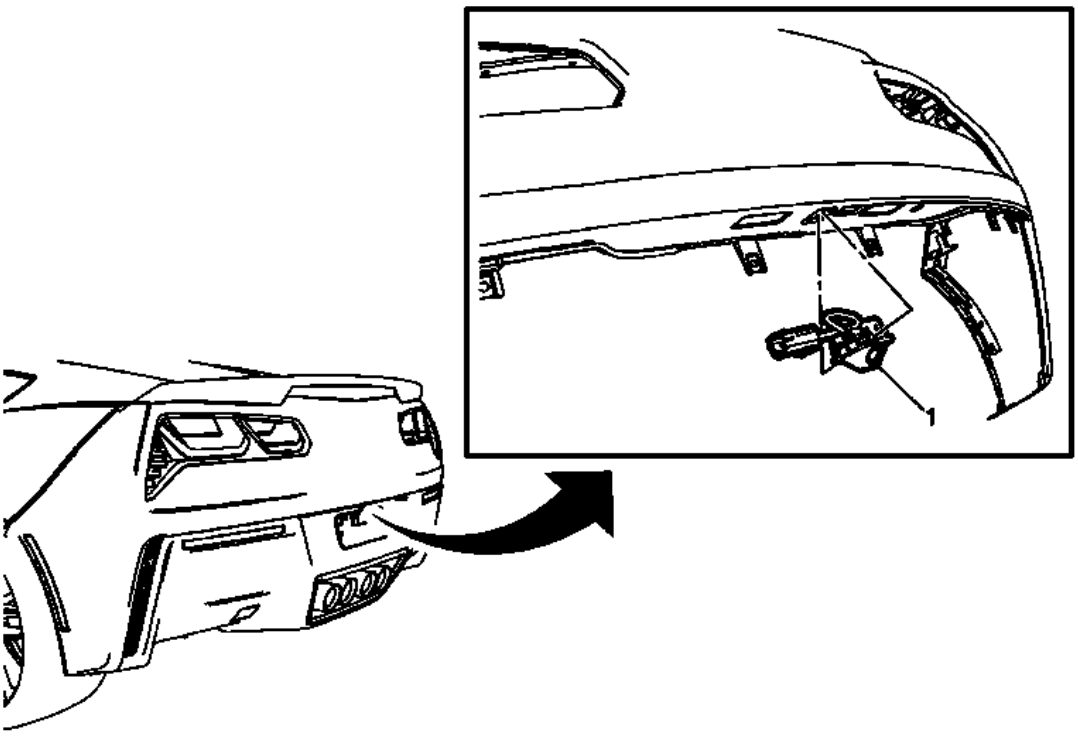


Fig. 17: Exhaust Manifold Removal - Left Side (with Z52 Option)
Courtesy of GENERAL MOTORS COMPANY

Exhaust Manifold Removal - Left Side (with Z52 Option)

Callout	Component Name
1	Spark Plug Wire
2	Heat Shield Bolt
3	Heat Shield
4	Exhaust Manifold Bolt
5	Exhaust Manifold
6	Exhaust Manifold Gasket **NOTE:** **Discard gasket, it is not reusable.** Refer to **Replacing Engine Gaskets** .

EXHAUST MANIFOLD REMOVAL - LEFT SIDE

cardiagn.com

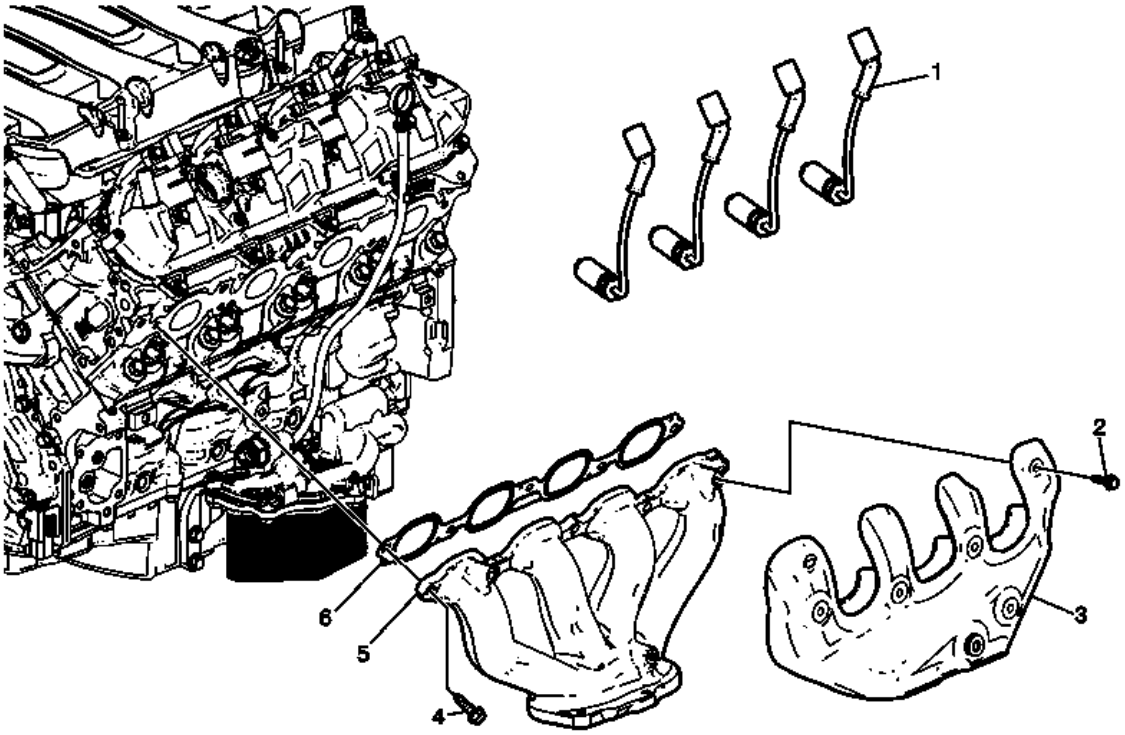


Fig. 18: Exhaust Manifold Removal - Left Side
Courtesy of GENERAL MOTORS COMPANY

Exhaust Manifold Removal - Left Side

Callout	Component Name
1	Spark Plug Wire
2	Heat Shield Bolt
3	Heat Shield
4	Exhaust Manifold Bolt
5	Exhaust Manifold
6	Exhaust Manifold Gasket **NOTE:** **Discard gasket, it is not reusable.** Refer to **Replacing Engine Gaskets** .

EXHAUST MANIFOLD REMOVAL - RIGHT SIDE

cardiagn.com

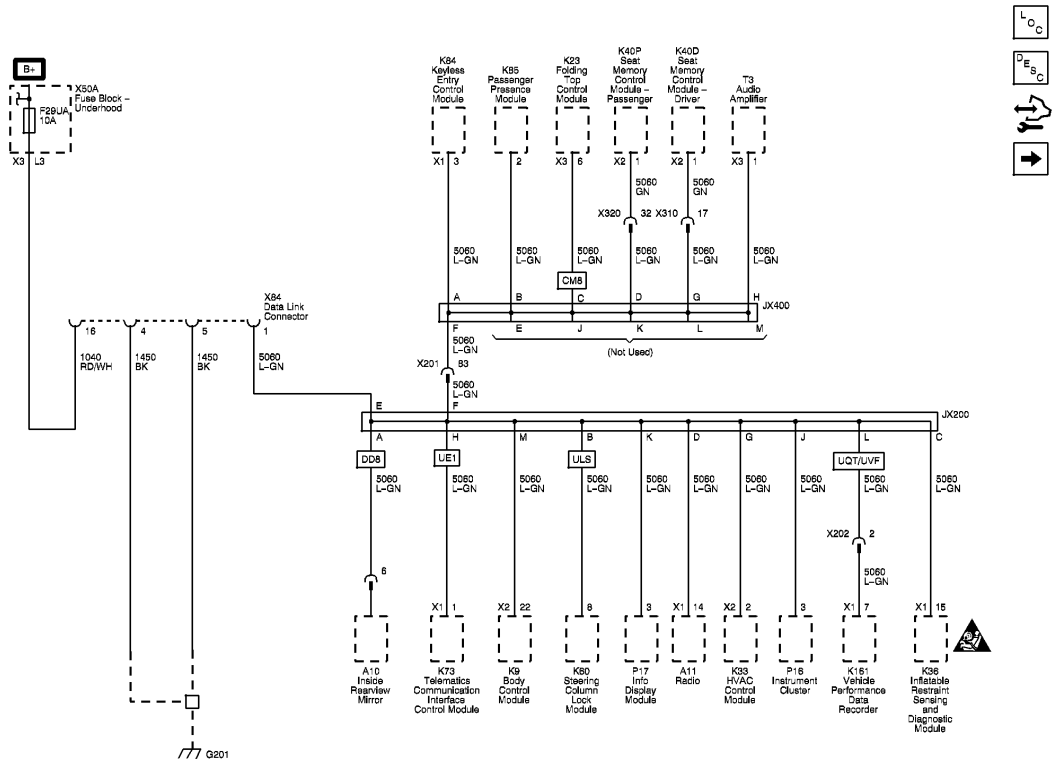


Fig. 19: Exhaust Manifold Removal - Right Side
Courtesy of GENERAL MOTORS COMPANY

Exhaust Manifold Removal - Right Side

Callout	Component Name
1	Spark Plug Wire
2	Exhaust Manifold Heat Shield Bolt
3	Exhaust Manifold Heat Shield
4	Exhaust Manifold Bolt
5	Exhaust Manifold
6	Exhaust Manifold Gasket **NOTE:** **Discard gasket, it is not reusable.** Refer to **Replacing Engine Gaskets** .

OIL LEVEL INDICATOR AND TUBE REMOVAL

cardiagn.com

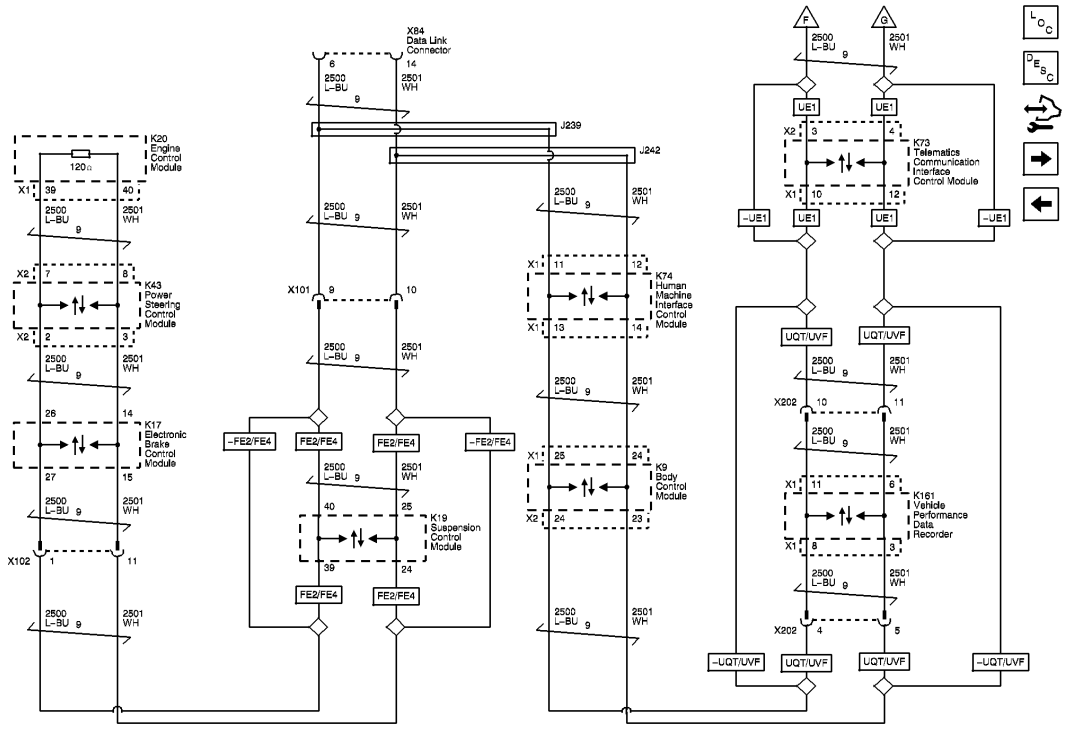


Fig. 20: Oil Level Indicator and Tube Removal
Courtesy of GENERAL MOTORS COMPANY

Oil Level Indicator and Tube Removal

Callout	Component Name
1	Oil Level Indicator
2	Oil Level Indicator Tube Bracket Bolt
3	Oil Level Indicator Tube
4	Oil Level Indicator Tube O-Ring

THROTTLE BODY ASSEMBLY REMOVAL

cardiagn.com

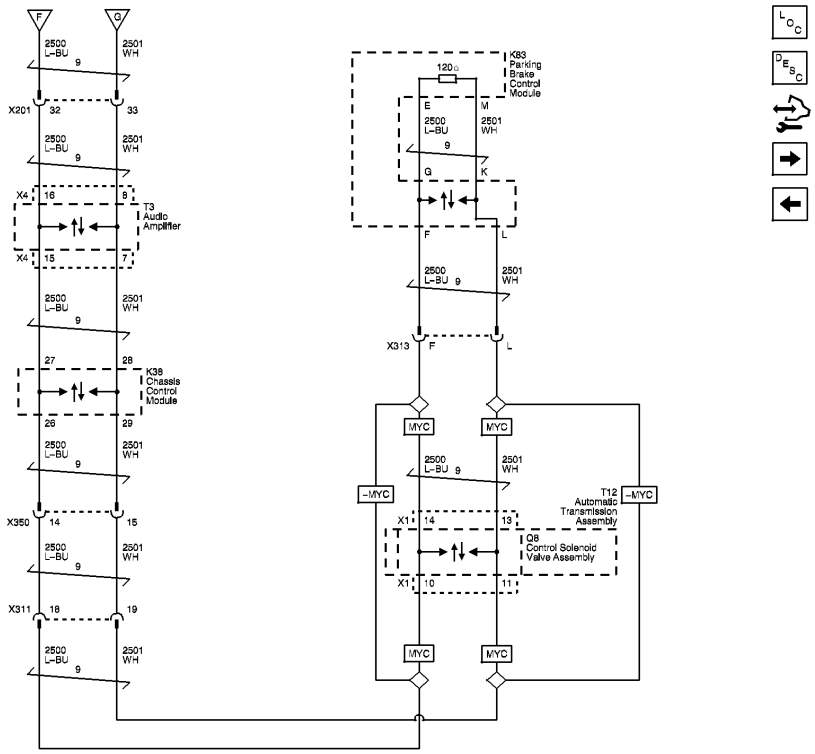


Fig. 21: Throttle Body Assembly
Courtesy of GENERAL MOTORS COMPANY

Throttle Body Assembly Removal

Callout	Component Name
1	Throttle Body Bolt
2	Throttle Body Assembly
3	Throttle Body Gasket **NOTE:** **Discard gasket, it is not reusable.** Refer to **Replacing Engine Gaskets** .

INTAKE MANIFOLD REMOVAL

cardiagn.com

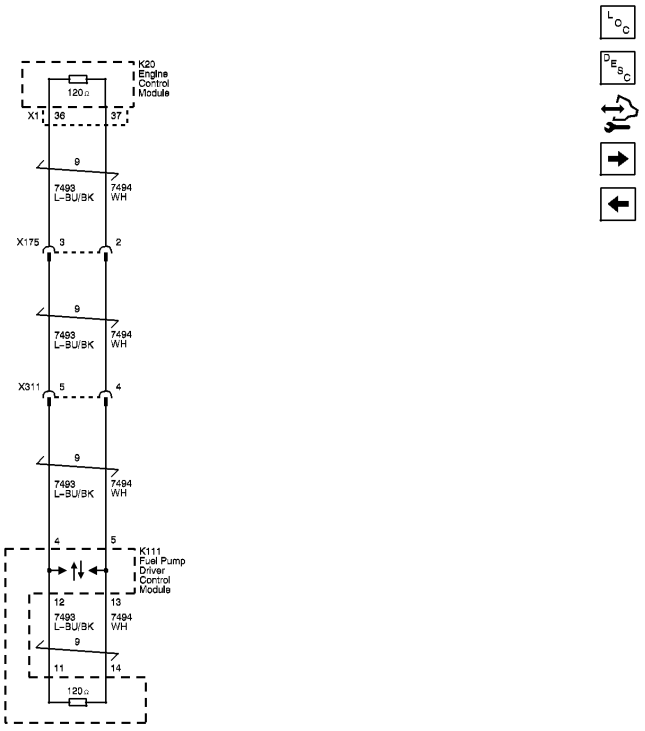


Fig. 22: Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

Intake Manifold Removal

Callout	Component Name
1	Intake Manifold Cover Stud
2	Intake Manifold Cover Assembly
3	Intake Manifold Bolt
4	Intake Manifold Assembly
5	Intake Manifold Gasket **NOTE:** **Discard gasket it is not reusable.** Refer to **Replacing Engine Gaskets** .
6	PCV Tube

ENGINE COOLANT MANIFOLD REMOVAL

cardiagn.com

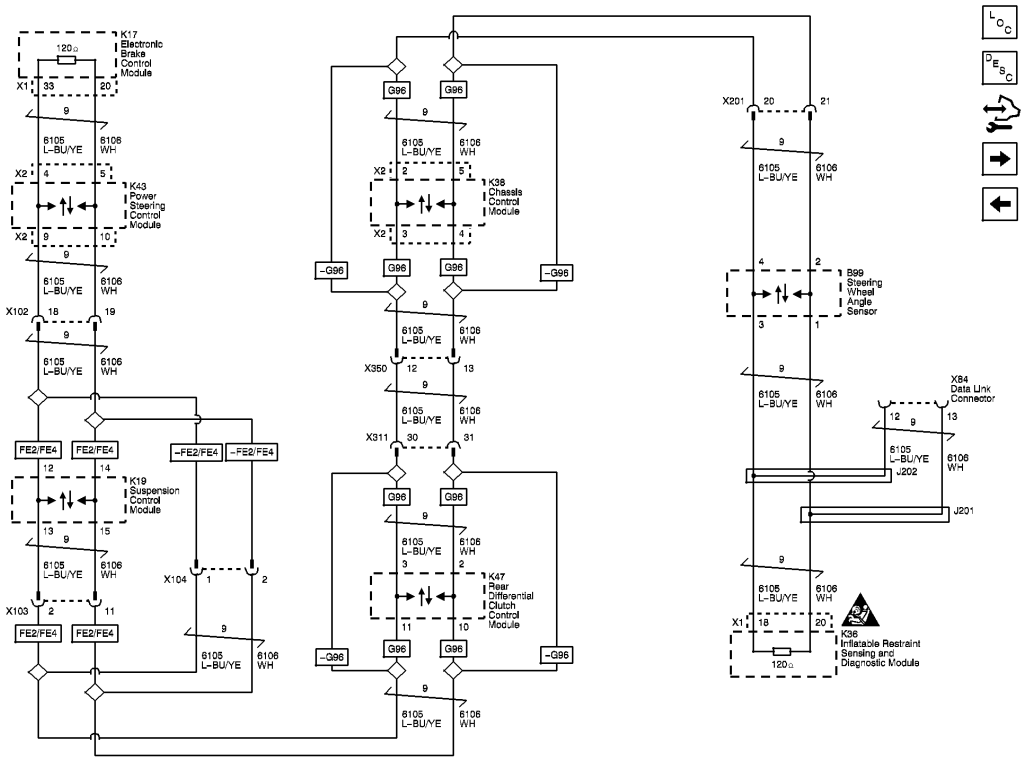


Fig. 23: Engine Coolant Manifold
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Manifold Removal

Callout	Component Name
Preliminary Procedure The oil pressure sensor and valve lifter oil manifold connectors must be removed before the engine coolant manifold can be removed.	
1	Engine Coolant Manifold Bolt
2	Engine Coolant Manifold Bolt
3	Engine Coolant Manifold Bolt
4	Engine Coolant Manifold Assembly
5	Engine Coolant Manifold Gaskets **NOTE:** **Discard gasket, it is not reusable.** Refer to **Replacing Engine Gaskets** .

FUEL PUMP INSULATOR AND FUEL FEED PIPES REMOVAL

cardiagn.com

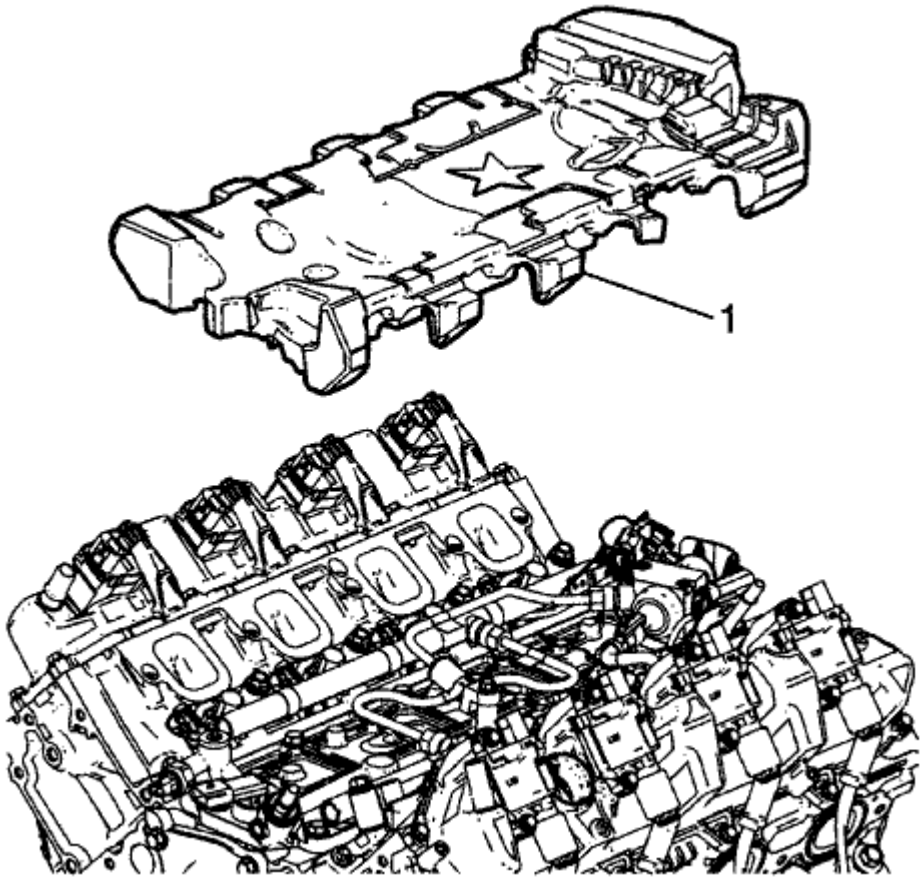


Fig. 24: Fuel Pump Insulator
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel pump insulator (1).

cardiagn.com

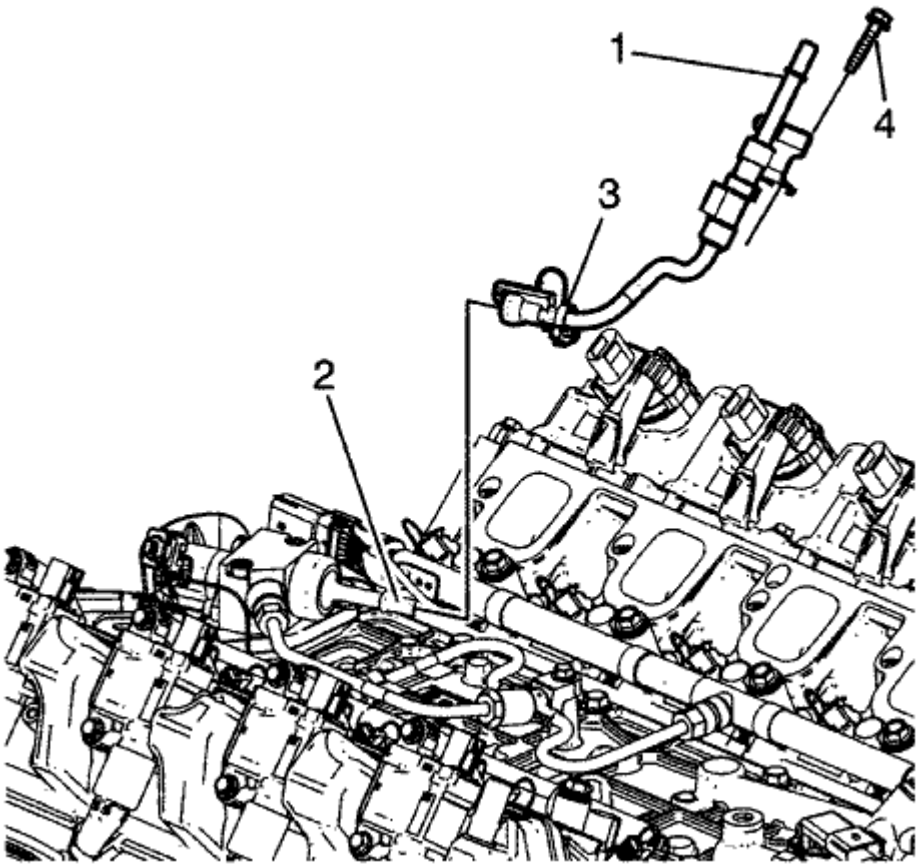


Fig. 25: Low Pressure Fuel Feed Pipe To LH Rocker Cover Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove the low pressure fuel feed pipe to LH rocker cover bolt (4).
3. Remove the redundant clip (3). Remove low pressure fuel feed pipe (1) from the fuel pump (2).

cardiagn.com

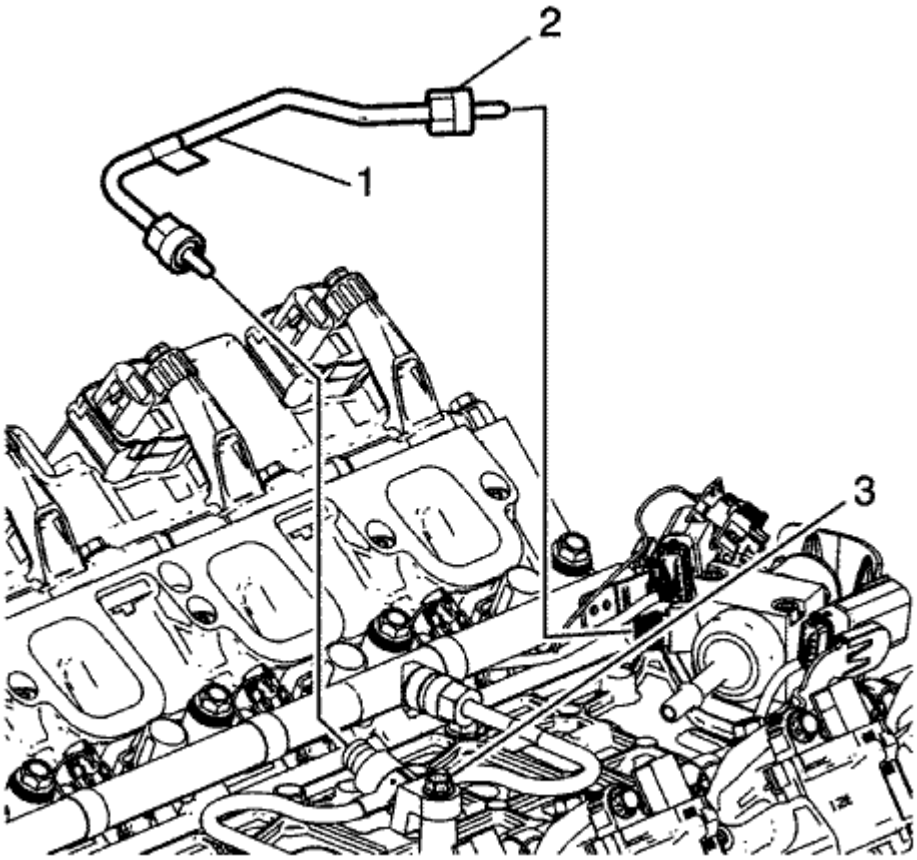


Fig. 26: Crossover Pipe And Fuel Feed Pipe Fittings
Courtesy of GENERAL MOTORS COMPANY

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.

4. Remove the high pressure fuel feed pipe that connects the fuel pump to the crossover pipe (1) by loosening the fuel feed pipe fittings (2).

cardiagn.com

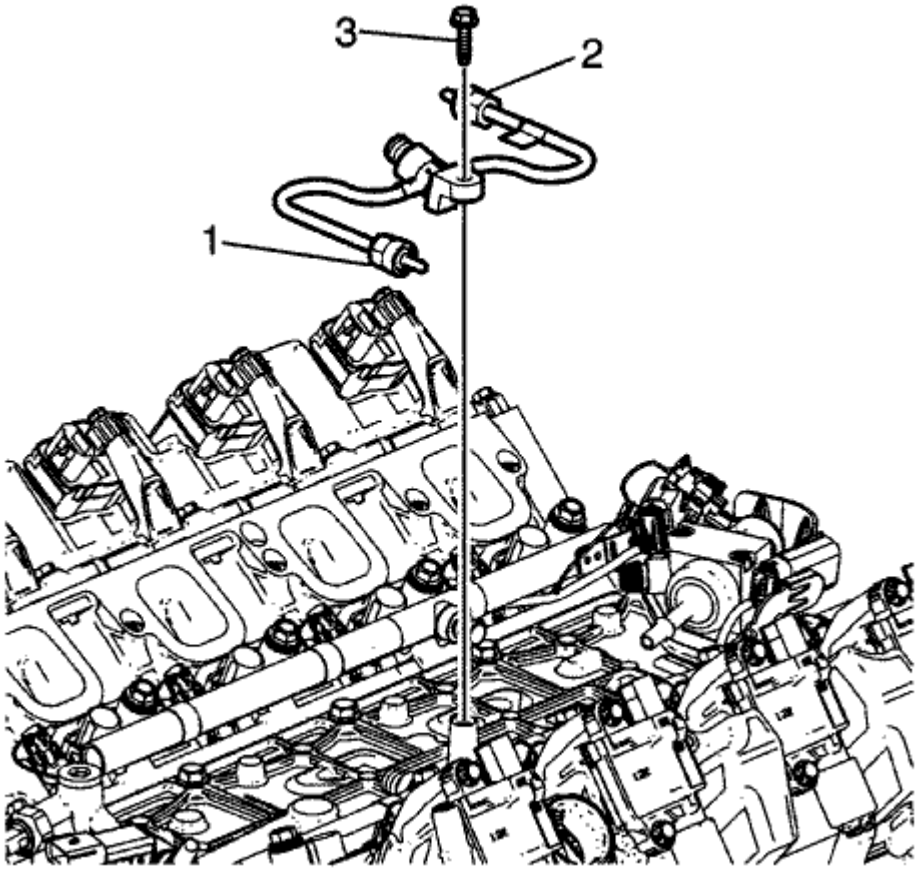


Fig. 27: RH Fuel Rail Crossover Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

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.

NOTE:

- **DO NOT reuse the high pressure fuel rail crossover pipe.**
- **The tightening order and torque are critical to proper fuel system fit and function. Be sure to follow installation and tightening steps exactly.**

5. Remove the high pressure LH to RH fuel rail crossover pipe bolt (3).
6. Remove the fuel rail crossover pipe by loosening the pipe fittings (1 and 2).

FUEL RAIL AND INJECTORS REMOVAL

cardiagn.com

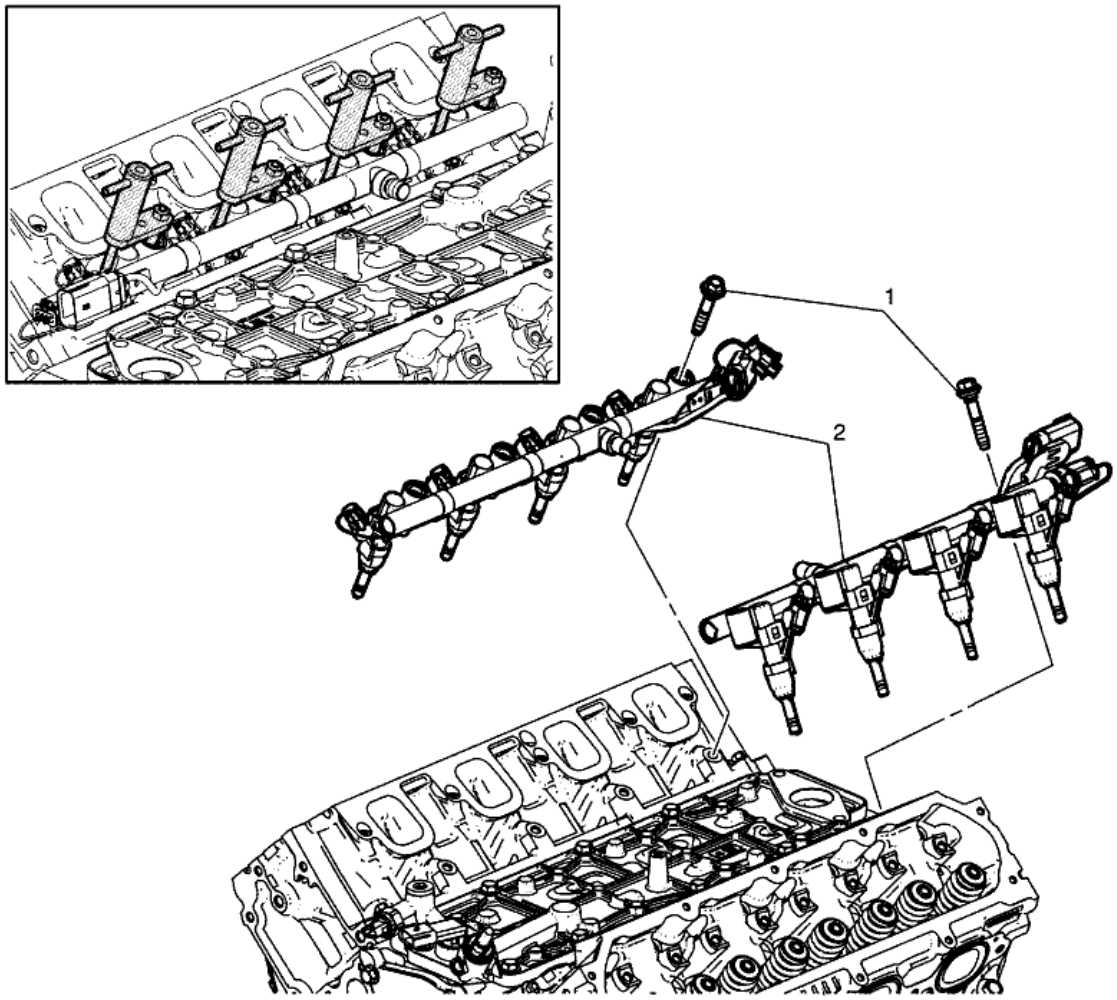


Fig. 28: Fuel Rail and Injectors
Courtesy of GENERAL MOTORS COMPANY

Fuel Rail and Injectors Removal

Callout	Component Name
1	Fuel Injection Fuel Rail Bolt
2	Direct Fuel Injection Fuel Rail Assembly **Procedure** **NOTE:** • **In some cases, the fuel injectors may be difficult to remove because of heavy carbon build-up or other factors. Excessive force with the removal tool can damage the fuel rail, injectors or both. If injectors are difficult to remove, apply solvent to the base of the injector bores, and allow adequate soaking time, to loosen the fuel injectors.** • **Pull the fuel rail and injectors as an assembly.** • **To prevent material from entering the combustions chambers make sure**

cardiagn.com

	are removed from the injector bores. 1. Install two sets of **EN-49248** remover. 2. Install one remover in each of the fuel rail fastener bores. 3. Remove by turning each section of the remover an equal amount to pull the fuel rail and injectors out evenly. **Special Tools** **EN-49248** Injector Rail Assembly Remover For equivalent regional tools, refer to **Special Tools** .
3	Fuel Rail Insulator

FUEL PUMP REMOVAL

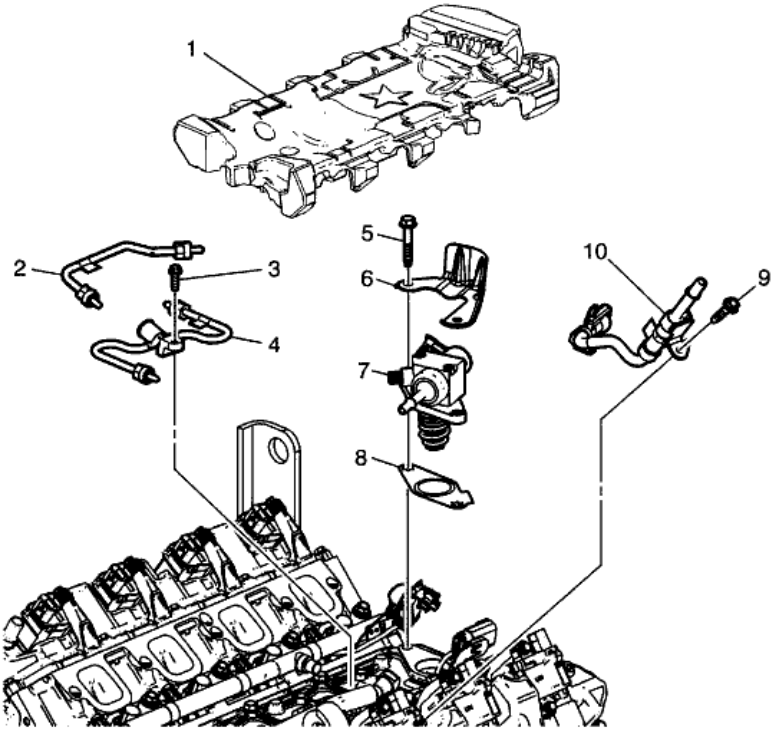


Fig. 29: Fuel Pump
Courtesy of GENERAL MOTORS COMPANY

Fuel Pump Removal

Callout	Component Name
1	Fuel Pump Bolt
2	Fuel Pump Cover
3	Bolt Retainer
4	Fuel Pump Assembly

cardiagn.com

5	Fuel Pump Gasket **NOTE:** **Discard gasket, it is not reusable.** Refer to **Replacing Engine Gaskets** .

VALVE LIFTER OIL FILTER REMOVAL

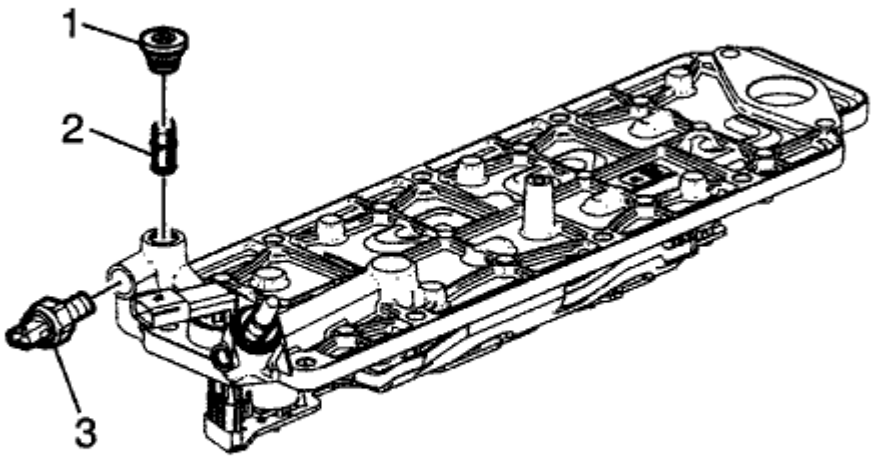


Fig. 30: Valve Lifter Oil Filter
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not allow dirt or debris to enter the oil passages of the manifold. Plug, as required.

1. Remove the oil pressure sensor (3).
2. Remove the valve lifter oil manifold plug (1) and oil filter (2).

VALVE ROCKER ARM COVER REMOVAL - LEFT SIDE

cardiagn.com

Valve Rocker Arm Cover Removal - Left Side

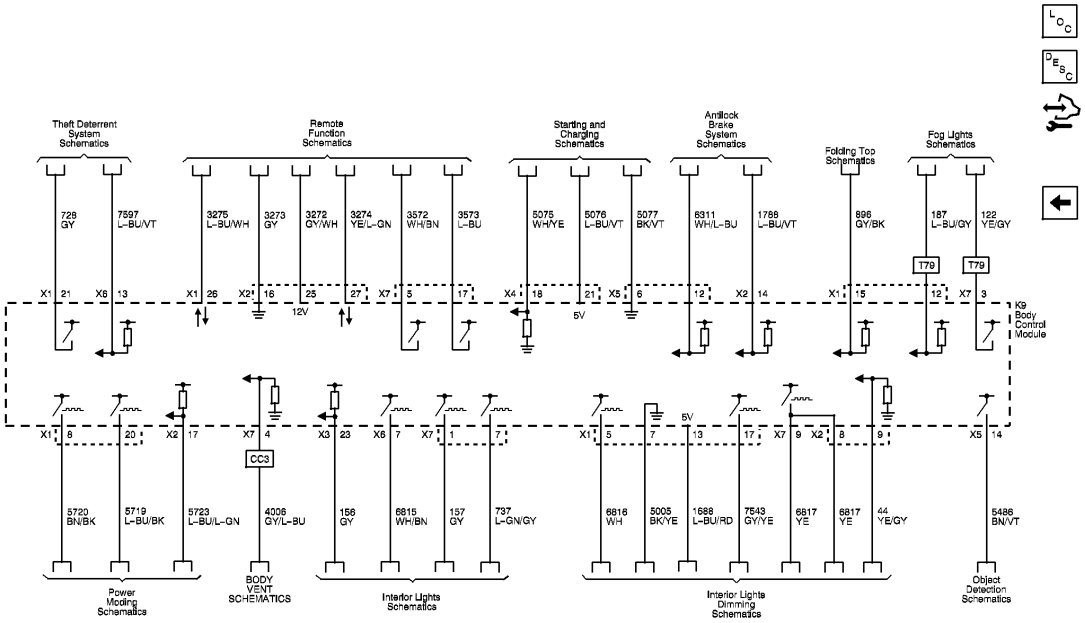


Fig. 31: Valve Rocker Arm Cover Removal - Left Side
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Removal - Left Side

Callout	Component Name
1	Valve Rocker Arm Cover Bolt
2	Valve Rocker Arm Cover - Left Side
3	Valve Rocker Arm Cover Gasket Refer to **Replacing Engine Gaskets** . **NOTE:** **Discard gasket, it is not reusable.**

Valve Rocker Arm Cover Disassemble - Left Side

cardiagn.com

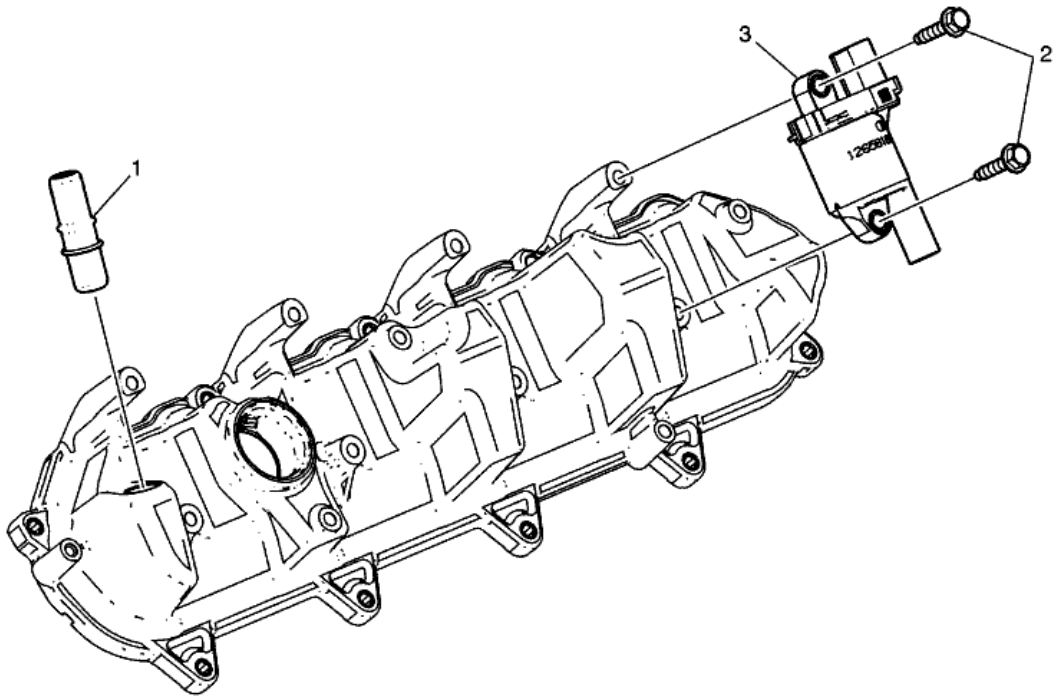


Fig. 32: Valve Rocker Arm Cover Disassemble - Left Side
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Disassemble - Left Side

Callout	Component Name
1	Ignition Coil Bolt
2	Ignition Coil

VALVE ROCKER ARM COVER REMOVAL - RIGHT SIDE

Valve Rocker Arm Cover Removal - Right Side

cardiagn.com

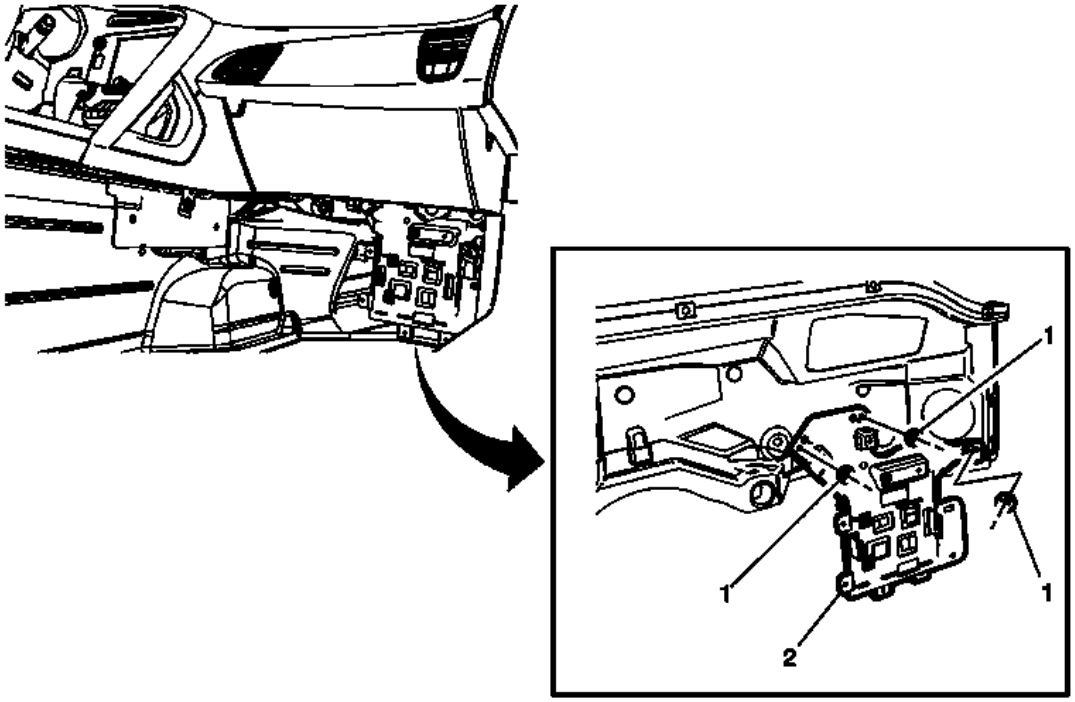


Fig. 33: Valve Rocker Arm Cover Removal - Right Side
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Removal - Right Side

Callout	Component Name
1	Valve Rocker Arm Cover Bolt
2	Valve Rocker Arm Cover - Right Side
3	Valve Rocker Arm Cover Gasket Refer to **Replacing Engine Gaskets** . **NOTE:** **Discard gasket, it is not reusable.**

Valve Rocker Arm Cover Disassemble - Right Side

cardiagn.com

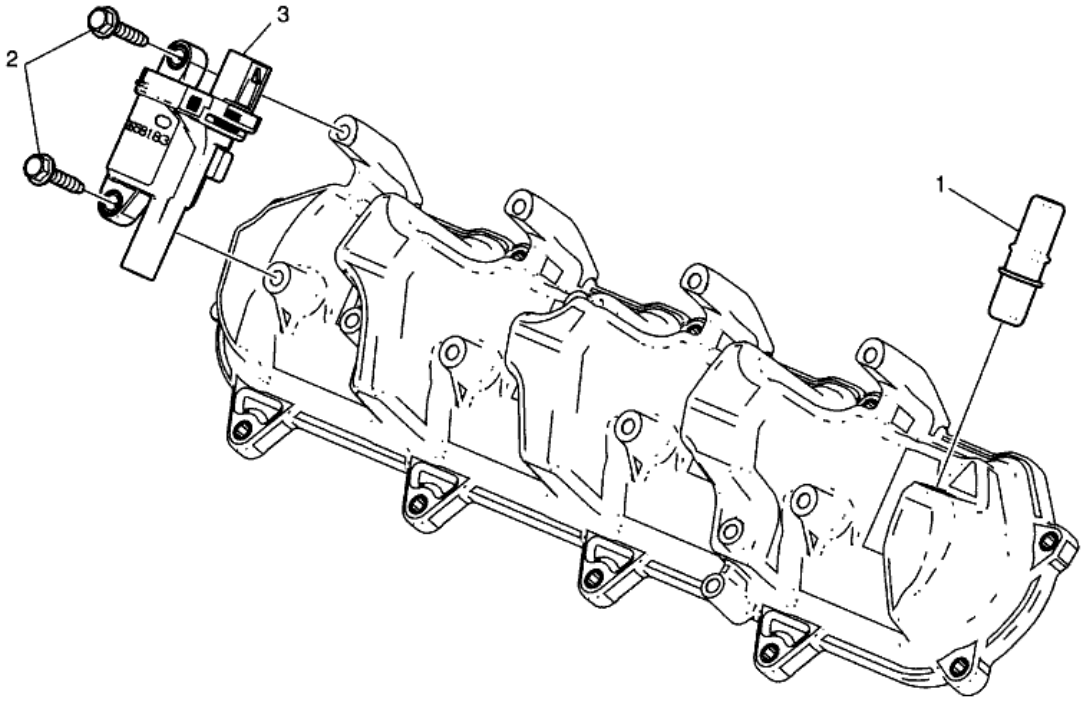


Fig. 34: Valve Rocker Arm Cover Disassemble - Right Side
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Disassemble - Right Side

Callout	Component Name
1	Ignition Coil Bolt
2	Ignition Coil

VALVE ROCKER ARM COVER REMOVAL - RIGHT SIDE (WITH Z52 OPTION)

Valve Rocker Arm Cover Removal - Right Side

cardiagn.com

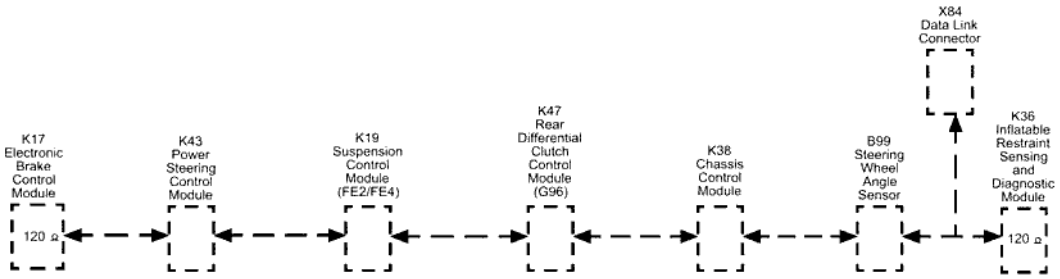


Fig. 35: Valve Rocker Arm Cover Removal - Right Side (with Z52 Option)
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Removal - Right Side

Callout	Component Name
1	Valve Rocker Arm Cover Bolt
2	Valve Rocker Arm Cover - Right Side
3	Valve Rocker Arm Cover Gasket Refer to **Replacing Engine Gaskets** . **NOTE:** **Discard gasket, it is not reusable.**

Valve Rocker Arm Cover Disassemble - Right Side

cardiagn.com

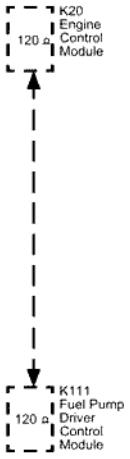


Fig. 36: Valve Rocker Arm Cover Disassemble - Right Side
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Disassemble - Right Side

Callout	Component Name
1	Ignition Coil Bolt
2	Ignition Coil

VALVE ROCKER ARM AND PUSH ROD REMOVAL

cardiagn.com

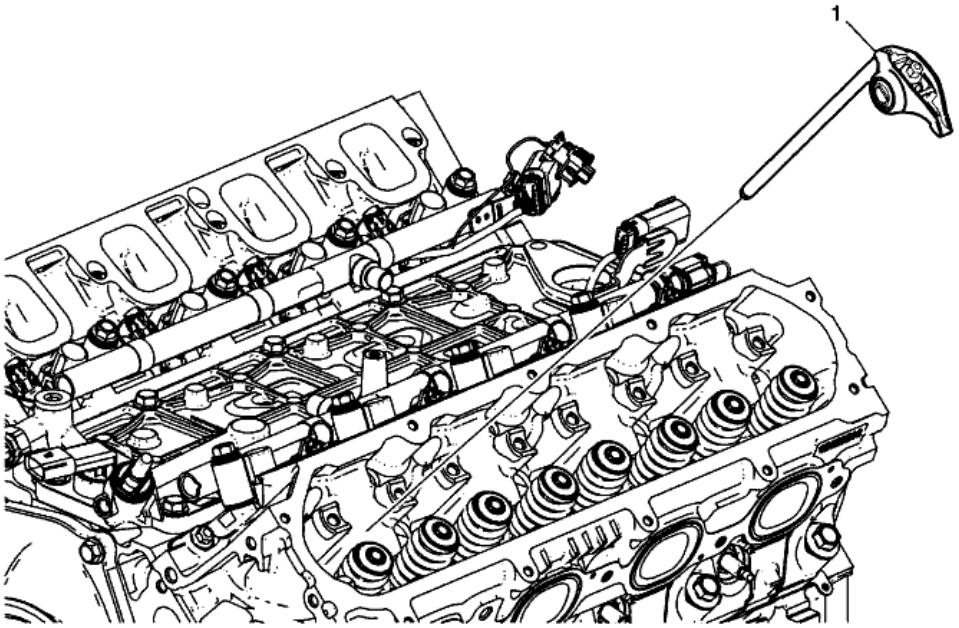


Fig. 37: Valve Rocker Arm and Push Rod
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Place the valve rocker arms and valve pushrods in a rack so they can be installed in the same location from which they were removed.**

Valve Rocker Arm and Push Rod Removal

Callout	Component Name
1	Valve Rocker Arm and Push Rod Assembly **NOTE:** **The rocker arm bolts are not serviced separately.**

CYLINDER HEAD REMOVAL - LEFT SIDE

cardiagn.com

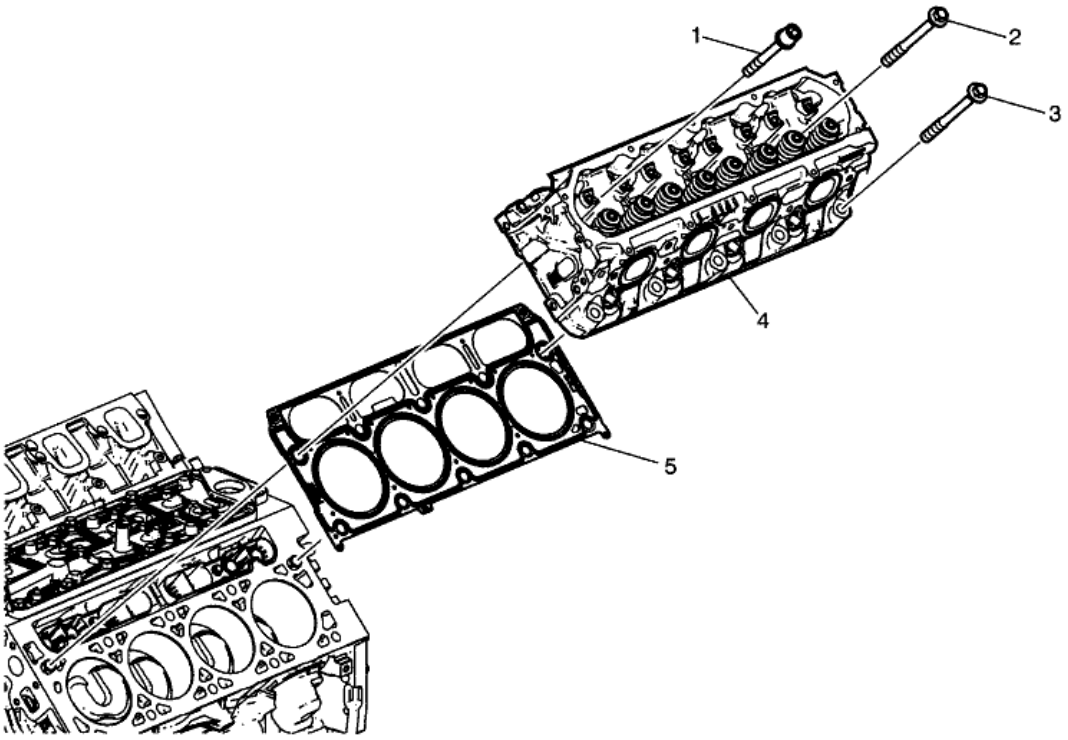


Fig. 38: Cylinder Head Removal - Left Side
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head Removal - Left Side

Callout	Component Name
Preliminary Procedure If camshaft lobe lift measurement is required, perform measurement prior to removal of the cylinder heads. Refer to **Camshaft and Bearings Cleaning and Inspection**.	
1	Cylinder Head Bolt
2	Cylinder Head Bolt
3	Cylinder Head Bolt
4	Cylinder Head Assembly
5	Cylinder Head Gasket Refer to **Replacing Engine Gaskets** .

CYLINDER HEAD REMOVAL - RIGHT SIDE

cardiagn.com

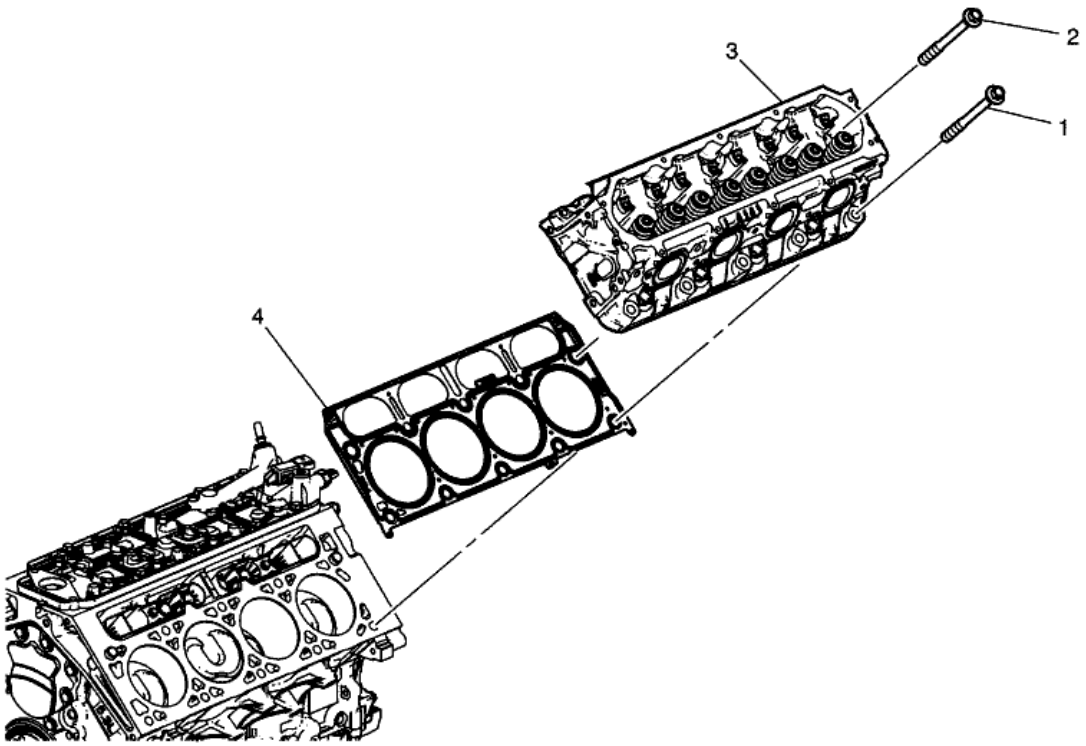


Fig. 39: Cylinder Head Removal - Right Side
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head Removal - Right Side

Callout	Component Name
Preliminary Procedure If camshaft lobe lift measurement is required, perform measurement prior to removal of the cylinder heads. Refer to **Camshaft and Bearings Cleaning and Inspection**.	
1	Cylinder Head Bolt
2	Cylinder Head Bolt
3	Cylinder Head Assembly
4	Cylinder Head Gasket Refer to **Replacing Engine Gaskets** .

VALVE LIFTER OIL MANIFOLD REMOVAL

Valve Lifter Oil Manifold Removal

cardiagn.com

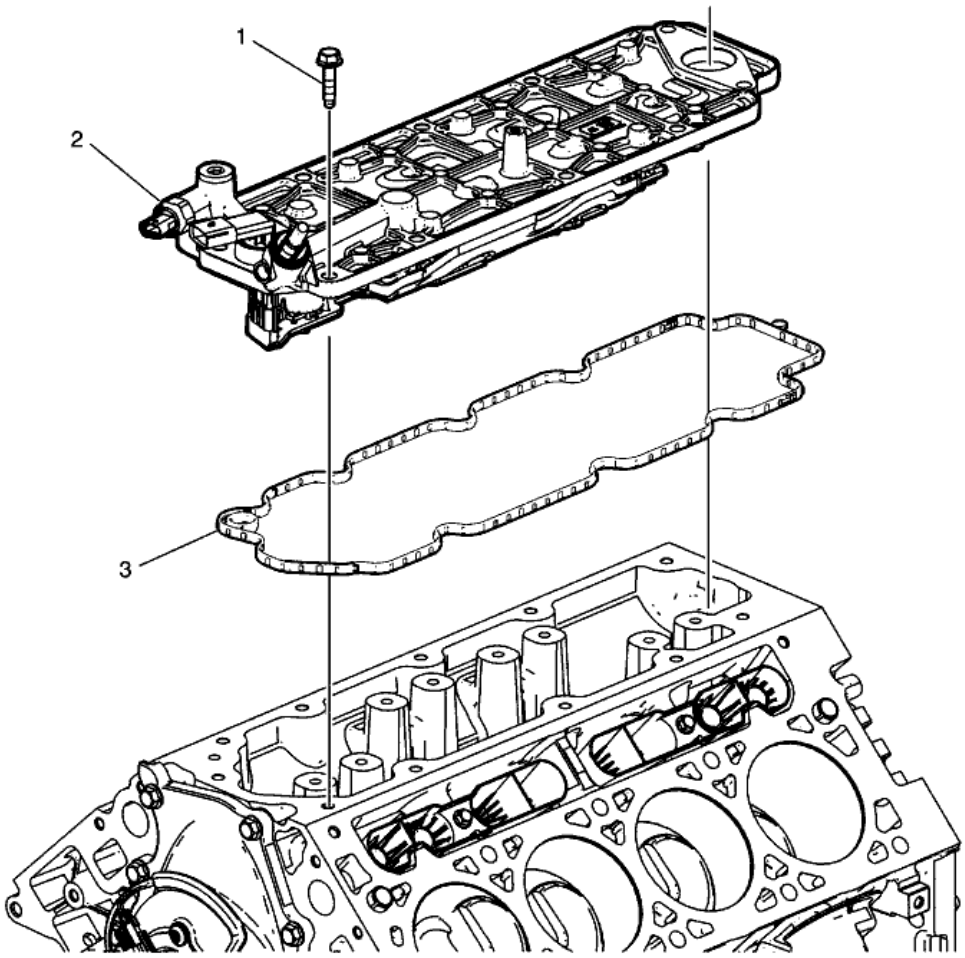


Fig. 40: Valve Lifter Oil Manifold
Courtesy of GENERAL MOTORS COMPANY

Valve Lifter Oil Manifold Removal

Callout	Component Name
1	Valve Lifter Oil Manifold Bolt
2	Valve Lifter Oil Manifold Assembly
3	Valve Lifter Oil Manifold Gasket Refer to **Replacing Engine Gaskets** . **NOTE:** **Discard gasket, it is not reusable.**

Valve Lifter Oil Manifold Disassemble

cardiagn.com

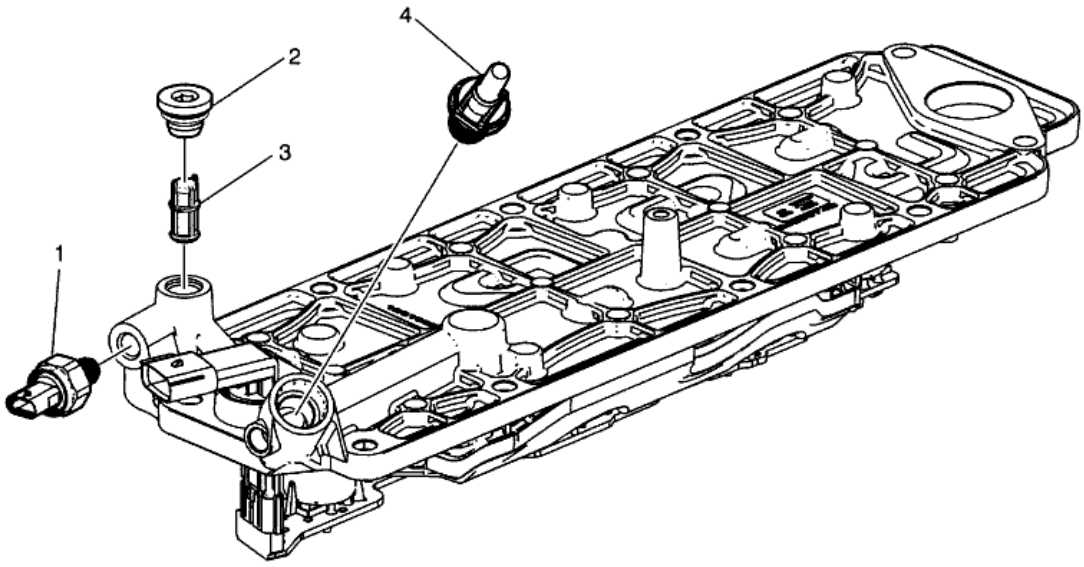


Fig. 41: Valve Lifter Oil Manifold Disassemble
Courtesy of GENERAL MOTORS COMPANY

Valve Lifter Oil Manifold Disassemble

Callout	Component Name
1	Oil Pressure Sensor
2	Valve Lifter Oil Manifold Plug
3	Valve Lifter Oil Filter
4	PCV Valve

VALVE LIFTER FOLLOWER GUIDE REMOVAL

cardiagn.com

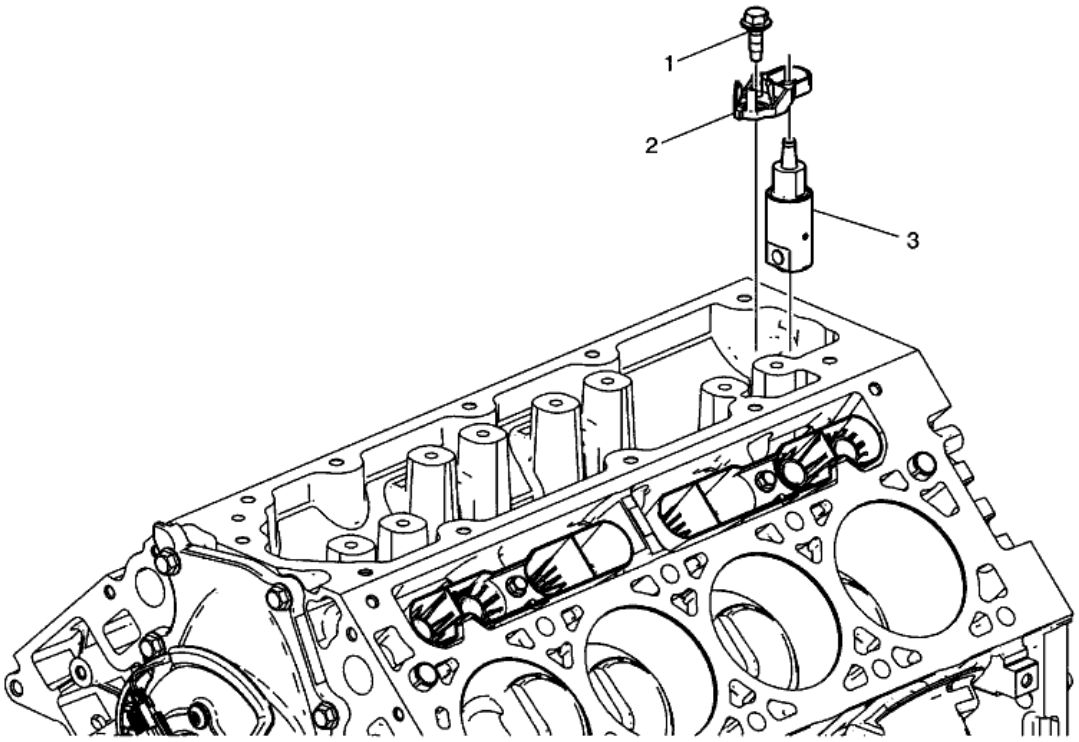


Fig. 42: Valve Lifter Follower Guide
Courtesy of GENERAL MOTORS COMPANY

Valve Lifter Follower Guide Removal

Callout	Component Name
1	Valve Lifter Follower Guide Bolt
2	Valve Lifter Follower Guide
3	Valve Lifter Follower

VALVE LIFTER REMOVAL

cardiagn.com

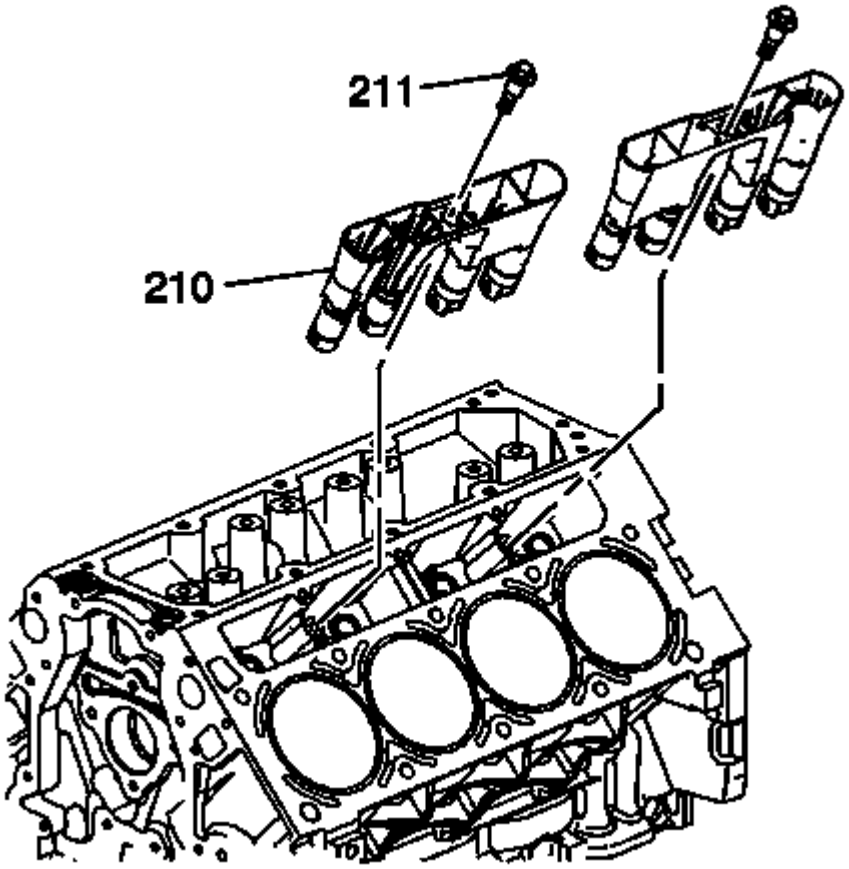


Fig. 43: View Of Lifter Guides & Lifters
Courtesy of GENERAL MOTORS COMPANY

1. Remove the bolts (211).
2. Remove the guides (210) with lifters.

Note the installed position of the guides. The notched area of the guide is to align with the locating tab of the block.

cardiagn.com

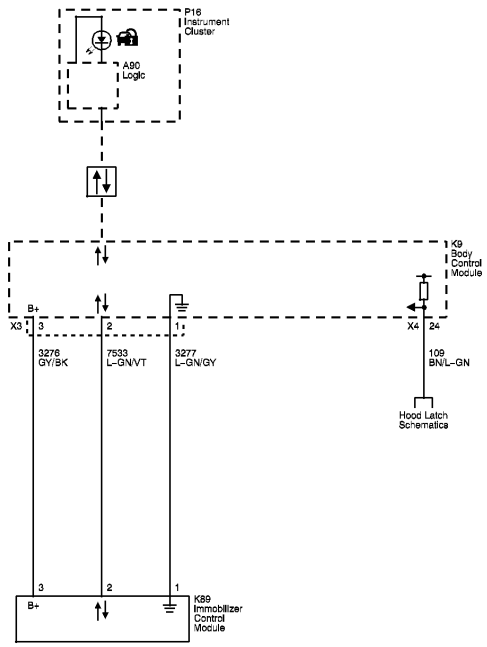


Fig. 44: Exploded View Of Lifter Guides & Lifters
Courtesy of GENERAL MOTORS COMPANY

3. Remove the valve lifters (209, 219) from the guide (210).

cardiagn.com

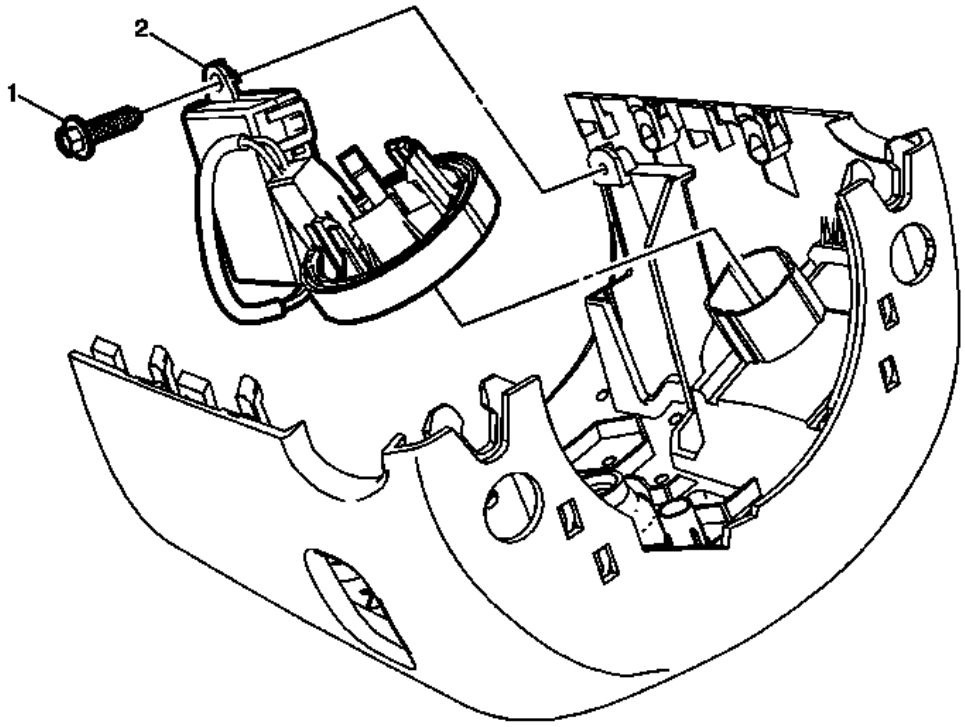


Fig. 45: Inserting Valve Lifters Into Lifter Guides
Courtesy of GENERAL MOTORS COMPANY

4. Organize or mark the components so they can be installed in the same location from which they were removed. The active fuel management lifters (4) are installed into the guide by aligning the notched area of the guide (1) with the raised surface on the side of the lifter (2). Refer to **Separating Parts** .

ENGINE OIL COOLER REMOVAL

cardiagn.com

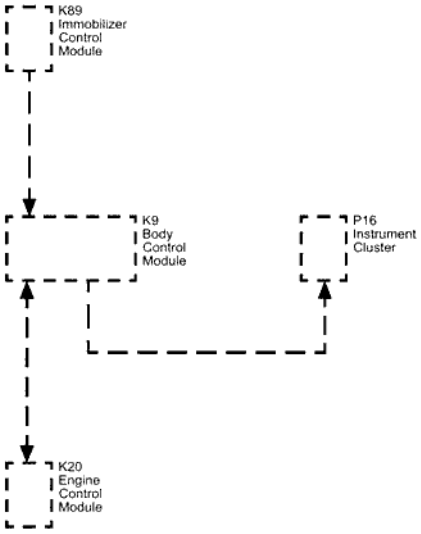


Fig. 46: Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Removal

Callout	Component Name
1	Engine Oil Cooler Bolt
2	Engine Oil Cooler Bolt
3	Engine Oil Cooler
4	Engine Oil Cooler Gasket **NOTE:** **Discard gasket, it is not reusable.** Refer to **Replacing Engine Gaskets** .

ENGINE OIL COOLER REMOVAL (WITH Z52 OPTION)

cardiagn.com

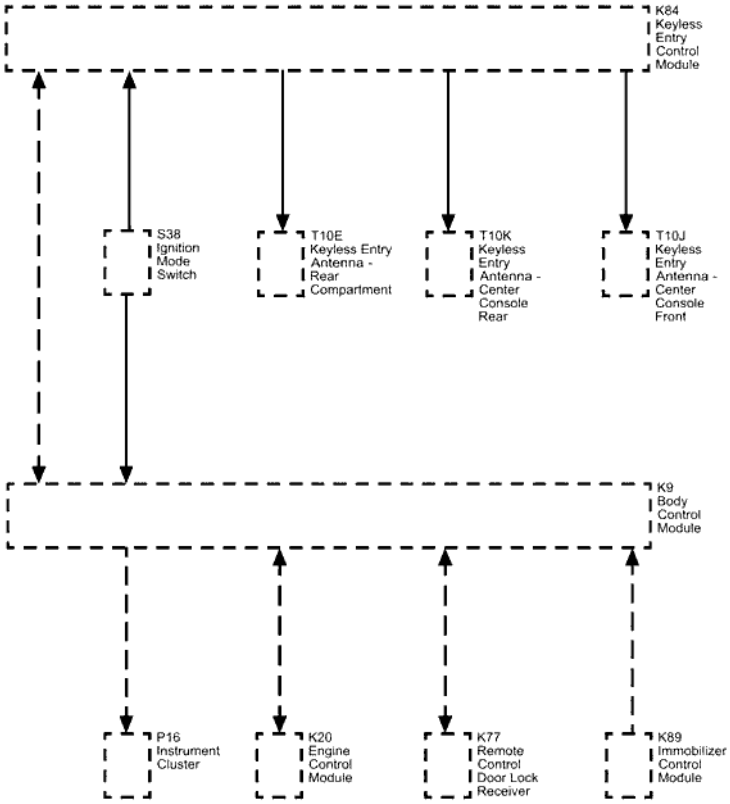


Fig. 47: Engine Oil Cooler (with Z52 Option)
Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Removal (with Z52 Option)

Callout	Component Name
1	Engine Oil Cooler Bolt
2	Engine Oil Cooler Bolt
3	Engine Oil Cooler Bolt
4	Engine Oil Cooler
5	Engine Oil Cooler Gasket **NOTE:** **Discard gasket, it is not reusable.** Refer to **Replacing Engine Gaskets** .

cardiagn.com

OIL PAN REMOVAL

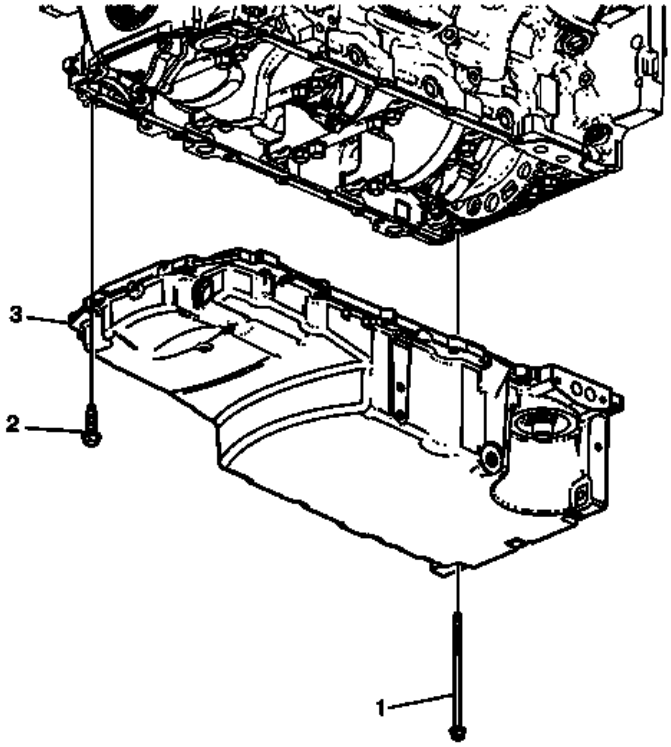


Fig. 48: Oil Pan
Courtesy of GENERAL MOTORS COMPANY

Oil Pan Removal

Callout	Component Name
1	Oil Pan Bolt
2	Oil Pan Bolt
3	Oil Pan Assembly

OIL PAN REMOVAL (WITH Z52 OPTION)

cardiagn.com

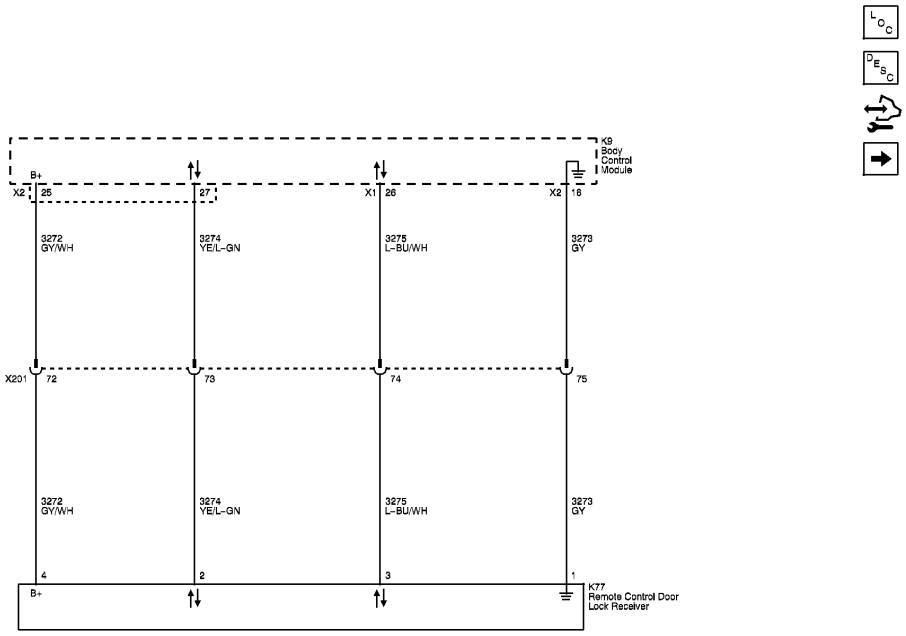


Fig. 49: Oil Pan (with Z52 Option)
Courtesy of GENERAL MOTORS COMPANY

Oil Pan Removal (with Z52 Option)

Callout	Component Name
1	Oil Pan Bolt
2	Oil Pan Bolt
3	Oil Pan Assembly

CRANKSHAFT FRONT OIL SEAL REMOVAL

cardiagn.com

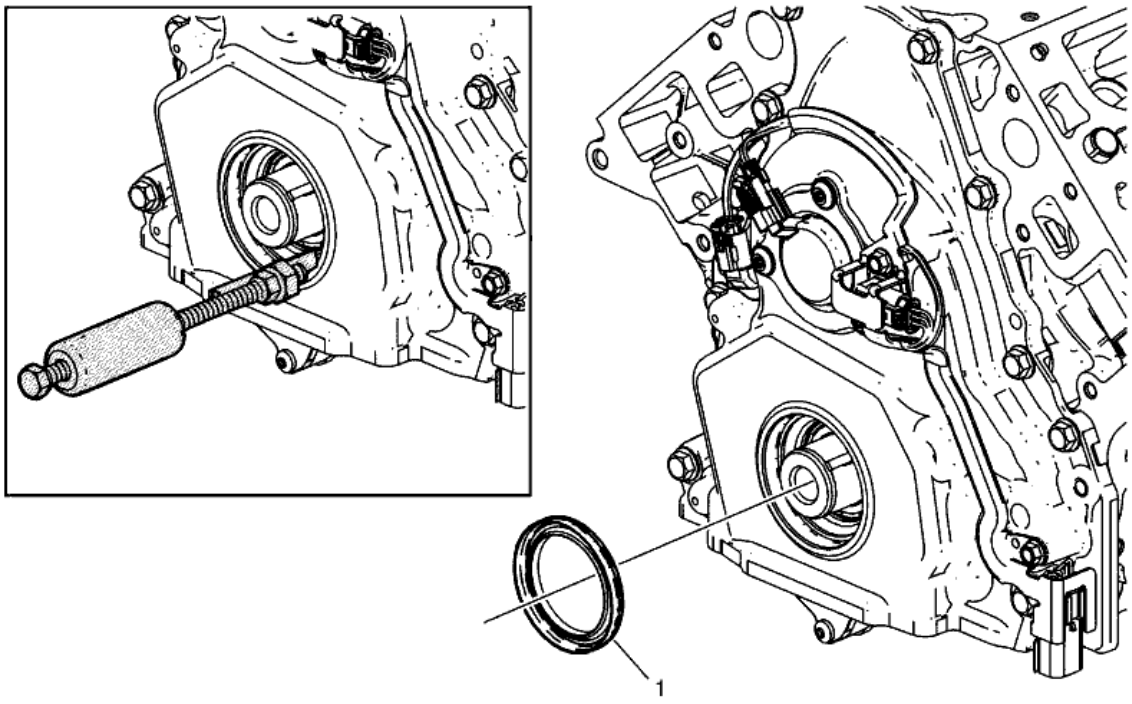


Fig. 50: Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Front Oil Seal Removal

Callout	Component Name
1	Crankshaft Front Oil Seal **Procedure** 1. Install **EN-51096** crankshaft rear seal remover onto **GE-23907-1** slide hammer. **NOTE:** **EN-51096 crankshaft rear seal remover has two ends. The end with the small bend will be used to remove the seal.** 2. Slide the small bend of **EN-51096** crankshaft rear seal remover between the lip of the front seal and crankshaft. Ensure that the small bend of **EN-51096** crankshaft rear seal remover engages the rear side of the front seal (1). While rotating **EN-51096** crankshaft rear seal remover and **GE-23907-1** slide hammer around the seal, use the slide hammer to remove the seal. **Special Tools** • **EN-51096** Crankshaft Rear Seal Remover

cardiagn.com

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

CRANKSHAFT FRONT OIL SEAL REMOVAL (WITH Z52 OPTION)

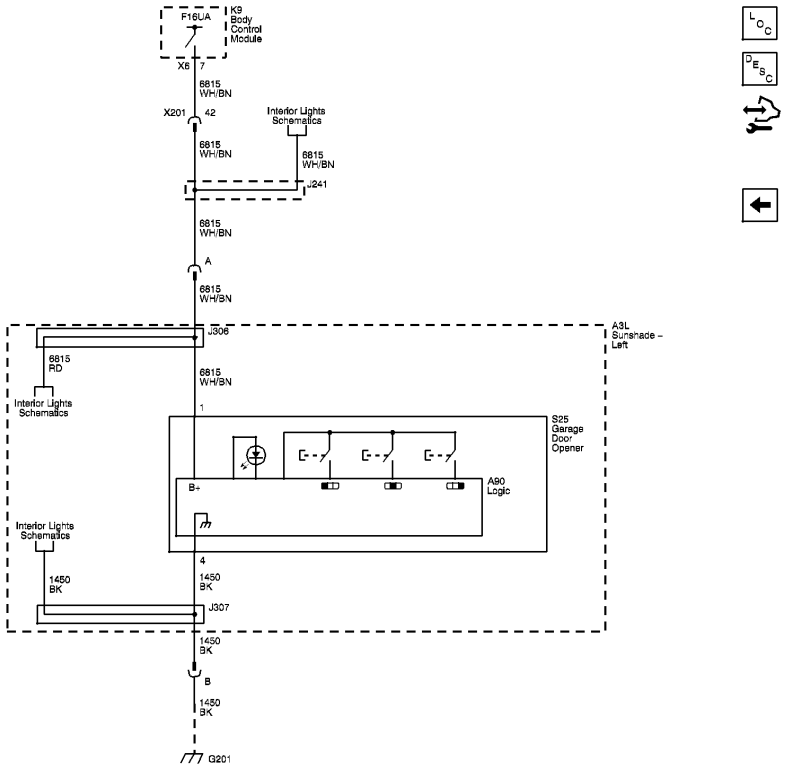


Fig. 51: Crankshaft Front Oil Seal (with Z52 Option)
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Front Oil Seal Removal (with Z52 Option)

Callout	Component Name
	Crankshaft Front Oil Seal **Procedure** 1. Install **EN-51096** crankshaft rear seal remover onto **GE-23907-1** slide hammer. **NOTE:** **EN-51096 crankshaft rear seal remover has two ends. The end with the small bend will be used to remove the seal.** 2. Slide the small bend of **EN-51096** crankshaft rear seal remover between the

cardiagn.com

1	lip of the front seal and crankshaft. Ensure that the small bend of **EN-51096** crankshaft rear seal remover engages the rear side of the front seal (1). While rotating **EN-51096** crankshaft rear seal remover and **GE-23907-1** slide hammer around the seal, use the slide hammer to remove the seal. **Special Tools** • **EN-51096** Crankshaft Rear Seal Remover • **GE-23907-1** Slide Hammer For equivalent regional tools, refer to **Special Tools** .

ENGINE FRONT COVER REMOVAL

Camshaft Position Sensor Harness, Camshaft Position Sensor and Camshaft Actuator Magnet Removal

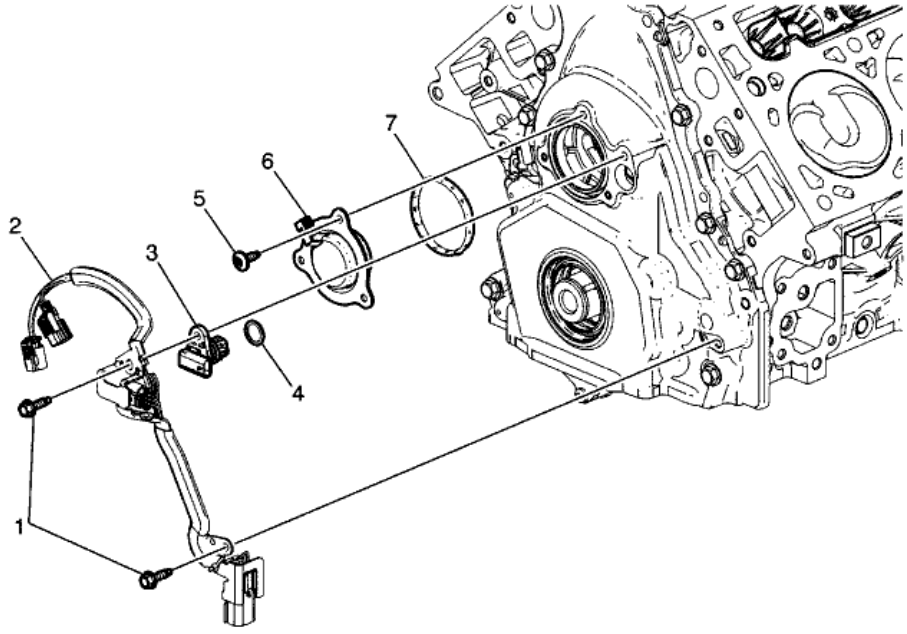


Fig. 52: Camshaft Position Sensor Harness, Camshaft Position Sensor and Camshaft Actuator Magnet
Courtesy of GENERAL MOTORS COMPANY

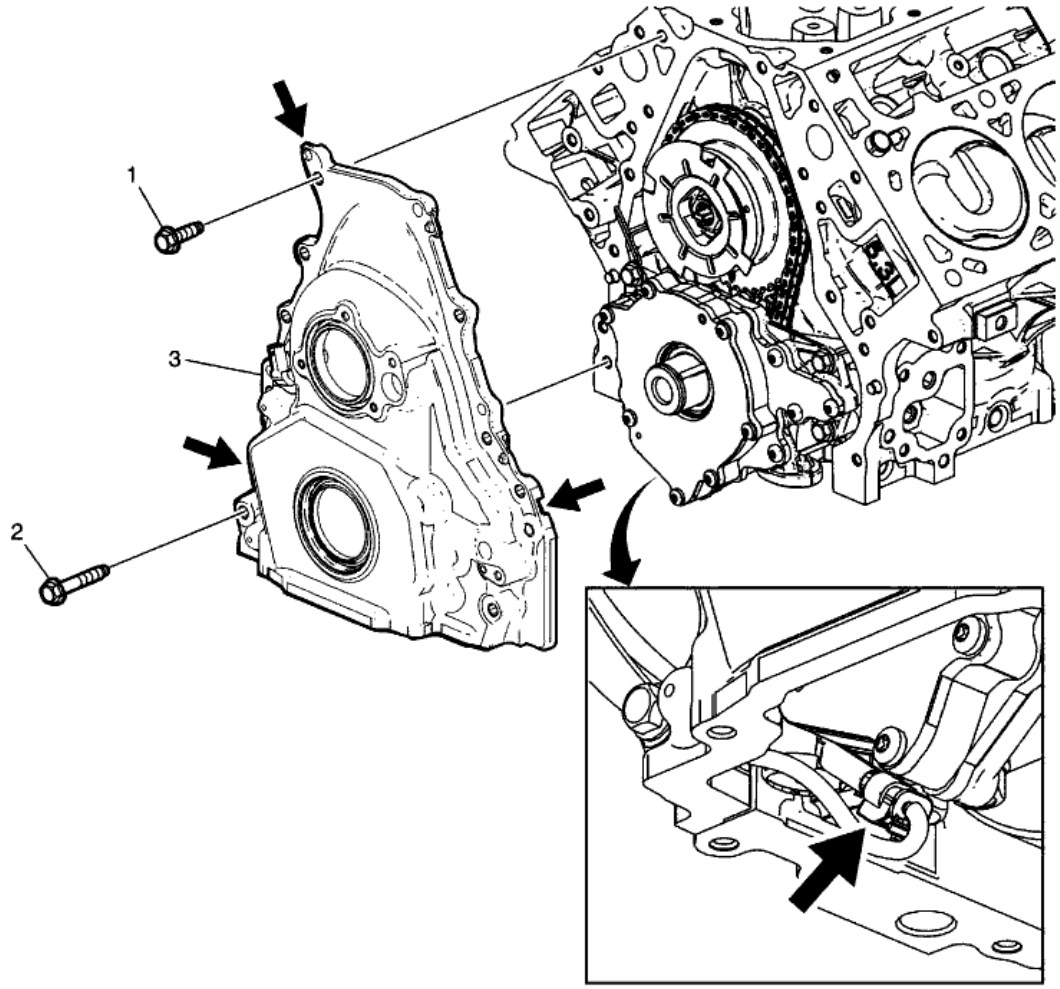
Camshaft Position Sensor Harness, Camshaft Position Sensor and Camshaft Actuator Magnet Removal

Callout	Component Name
1	Camshaft Position Sensor Harness Bolts

cardiagn.com

2	Camshaft Position Sensor Harness
3	Camshaft Position Sensor
4	Camshaft Position Sensor Seal **NOTE:** **Discard seal, it is not reusable.** Refer to **Replacing Engine Gaskets** .
5	Camshaft Actuator Magnet Bolts
6	Camshaft Actuator Magnet
7	Camshaft Actuator Magnet Gasket **NOTE:** **Discard gasket, it is not reusable.**

Front Cover Removal



cardiagn.com

Fig. 53: Front Cover
Courtesy of GENERAL MOTORS COMPANY

Front Cover Removal

Callout	Component Name
Preliminary Procedure The oil pump flow control valve harness must be removed before the front cover can be removed.	
1	Engine Front Cover Bolt
2	Engine Front Cover Bolt
3	Engine Front Cover **NOTE:** **To separate the front cover from the engine, pry at the points that are shown by the arrows.**

Oil Pump Flow Control Valve Harness Removal

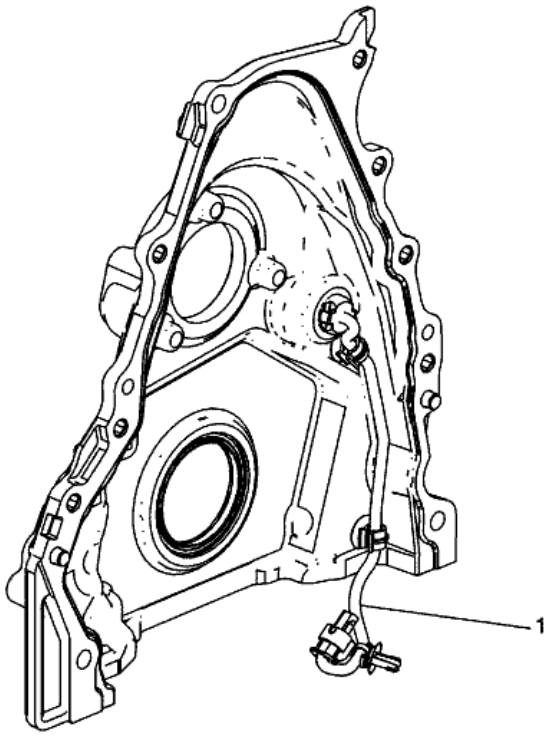


Fig. 54: Oil Pump Flow Control Valve Harness
Courtesy of GENERAL MOTORS COMPANY

Oil Pump Flow Control Valve Harness Removal

Callout	Component Name
	Oil Pump Flow Control Valve Harness

cardiagn.com

	Procedure
1	1. Remove the wire from the 2 retainer clips. 2. Push the tabs in and pull the harness and connector through the front of the engine front cover

ENGINE FRONT COVER REMOVAL (WITH Z52 OPTION)

Camshaft Position Sensor Harness, Camshaft Position Sensor and Camshaft Actuator Magnet Removal

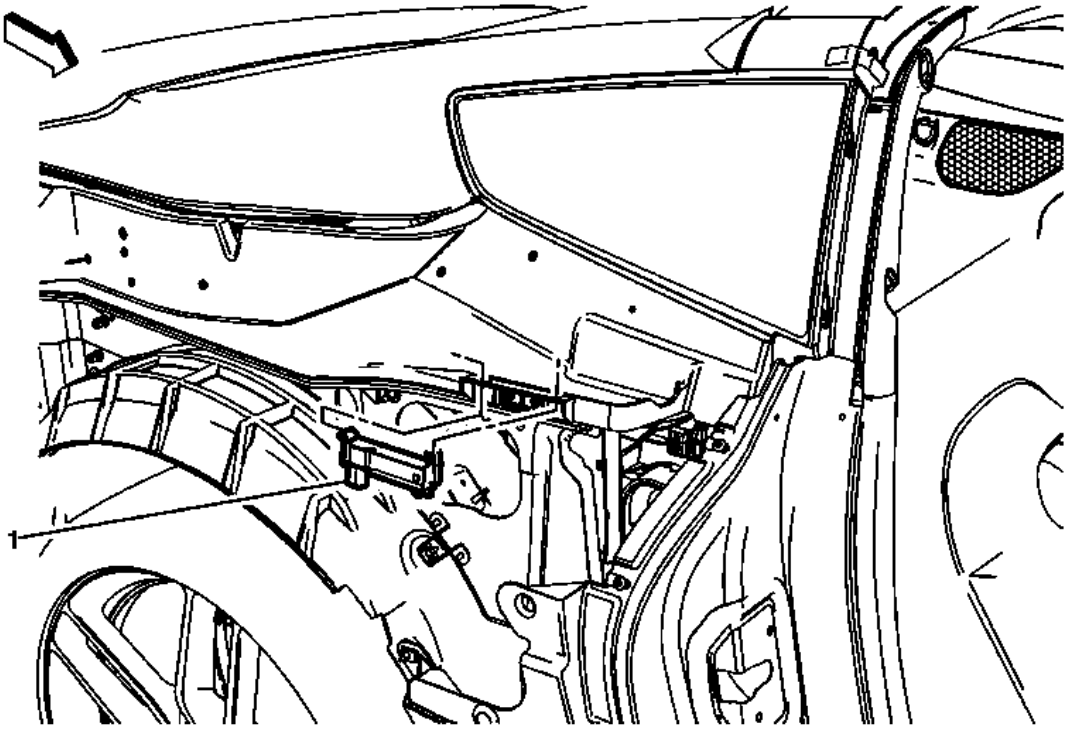


Fig. 55: Camshaft Position Sensor Harness, Camshaft Position Sensor and Camshaft Actuator Magnet
Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Sensor Harness, Camshaft Position Sensor and Camshaft Actuator Magnet Removal

Callout	Component Name
1	Camshaft Position Sensor Harness Bolts
2	Camshaft Position Sensor Harness
3	Camshaft Position Sensor
4	Camshaft Position Sensor Seal **NOTE:**

cardiagn.com

	Refer to **Replacing Engine Gaskets** .
5	Camshaft Actuator Magnet Bolts
6	Camshaft Actuator Magnet
7	Camshaft Actuator Magnet Gasket **NOTE:** **Discard gasket, it is not reusable.**

Front Cover Removal

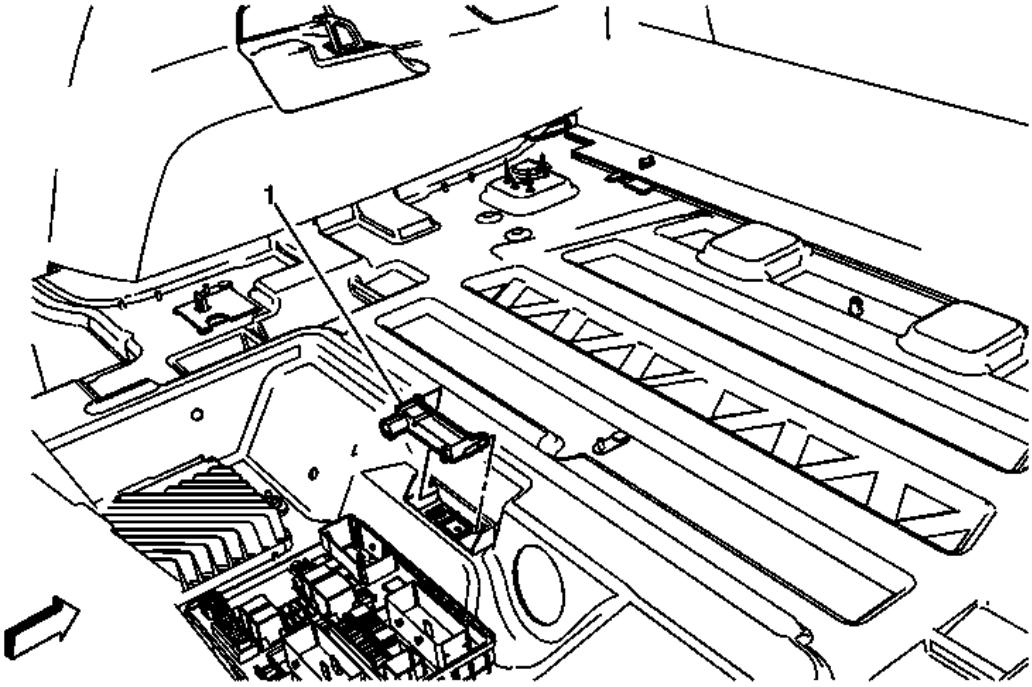


Fig. 56: Front Cover
Courtesy of GENERAL MOTORS COMPANY

Front Cover Removal

Callout	Component Name
Preliminary Procedure The oil pump flow control valve harness must be removed before the front cover can be removed.	
1	Engine Front Cover Bolt
2	Engine Front Cover Bolt
3	Engine Front Cover

cardiagn.com

	To separate the front cover from the engine, pry at the points that are shown by the arrows.

Oil Pump Flow Control Valve Harness Removal

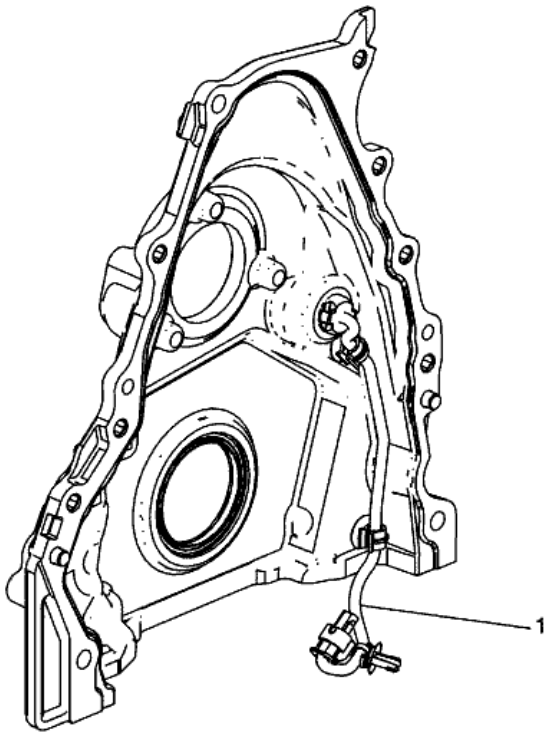


Fig. 57: Oil Pump Flow Control Valve Harness
Courtesy of GENERAL MOTORS COMPANY

Oil Pump Flow Control Valve Harness Removal

Callout	Component Name
1	Oil Pump Flow Control Valve Harness **Procedure** 1. Remove the wire from the 2 retainer clips. 2. Push the tabs in and pull the harness and connector through the front of the engine front cover.

CRANKSHAFT REAR OIL SEAL REMOVAL

cardiagn.com

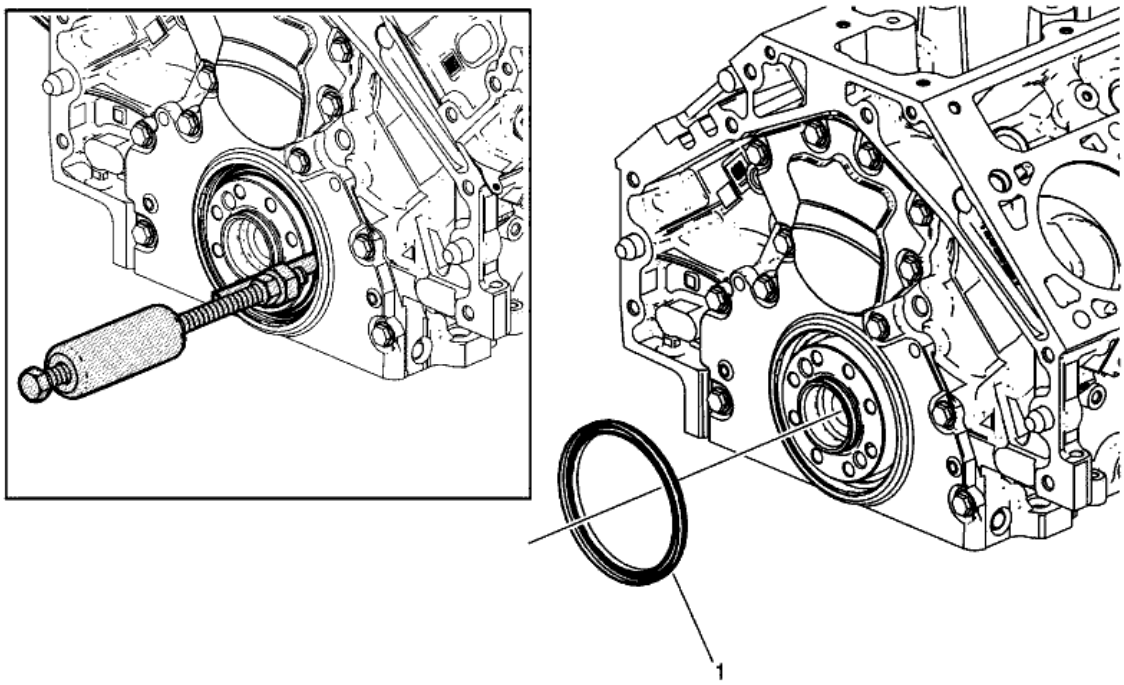


Fig. 58: Crankshaft Rear Oil Seal
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Rear Oil Seal Removal

Callout	Component Name
1	Crankshaft Rear Oil Seal **Procedure** 1. Install **EN-51096** crankshaft rear seal remover onto **GE-23907-1** slide hammer. **NOTE:** **EN-51096 crankshaft rear seal remover has two ends. The end with the small bend will be used to remove the seal.** 2. Slide the small bend of **EN-51096** crankshaft rear seal remover between the lip of the rear seal and crankshaft. Ensure that the small bend of **EN-51096** crankshaft rear seal remover engages the rear side of the rear seal (1). While rotating **EN-51096** crankshaft rear seal remover and **GE-23907-1** slide hammer around the seal and use the slide hammer to remove the seal. **Special Tools** • **EN-51096** Crankshaft Rear Seal Remover

cardiagn.com

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

CRANKSHAFT REAR OIL SEAL HOUSING REMOVAL

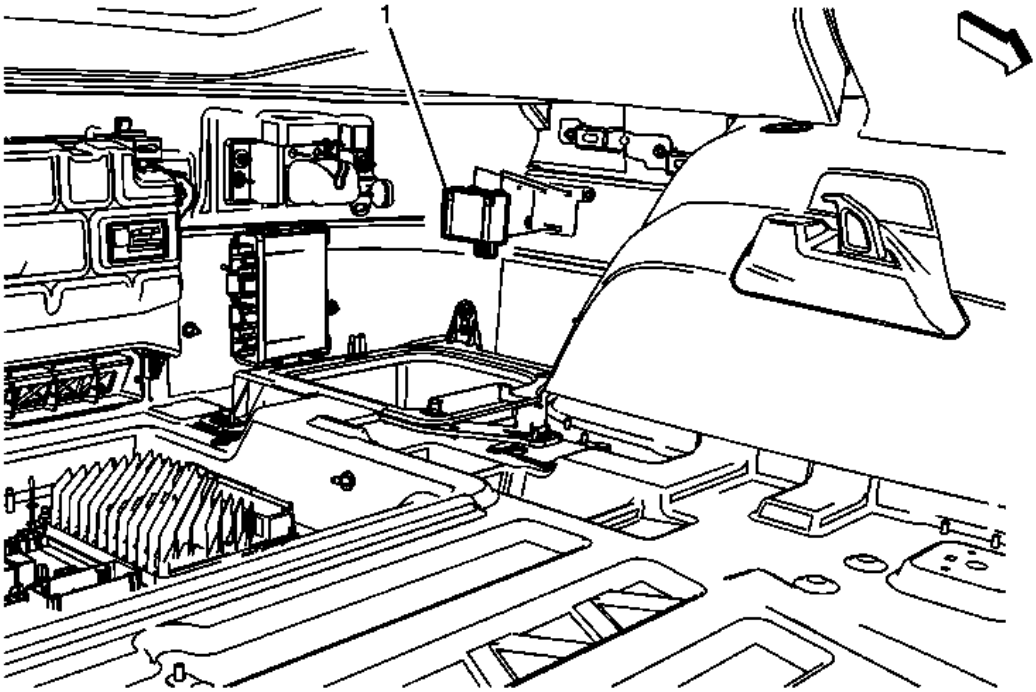


Fig. 59: Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Rear Oil Seal Housing Removal

Callout	Component Name
1	Crankshaft Rear Oil Seal Housing Bolt
2	Crankshaft Rear Oil Seal Housing **NOTE:** **To separate the rear housing from the engine, pry at the points that are shown by the arrows.**
3	Crankshaft Rear Oil Seal Housing Gasket **NOTE:** **Discard gasket, it is not reusable.** Refer to **Replacing Engine Gaskets** .

cardiagn.com

OIL PUMP REMOVAL

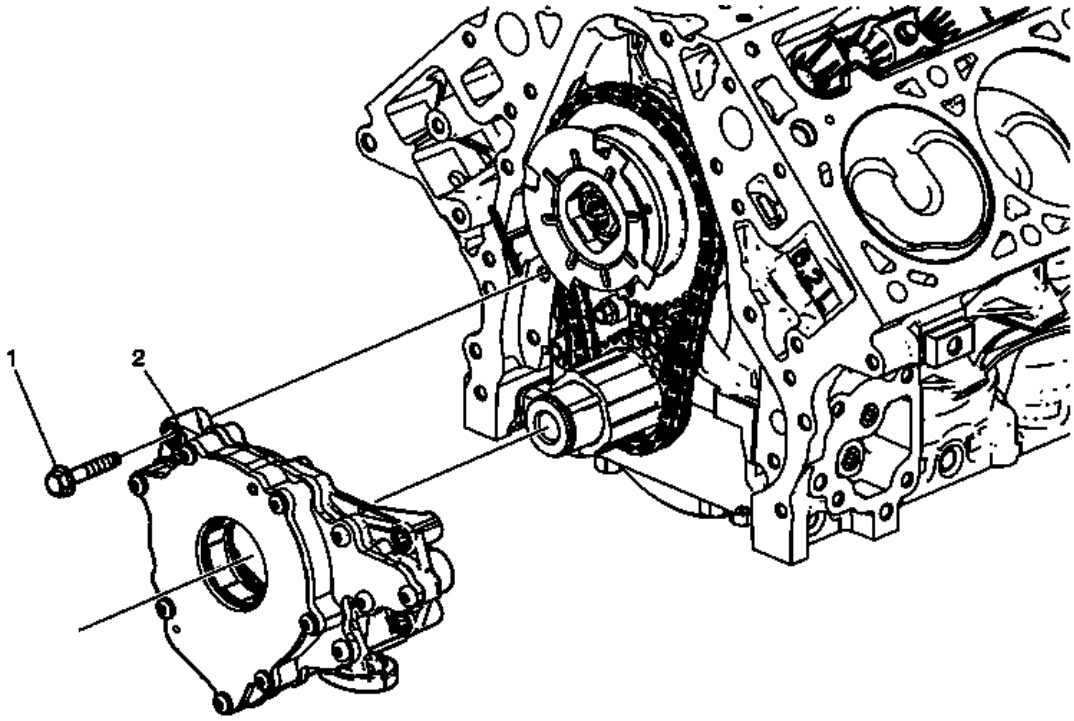


Fig. 60: Oil Pump
Courtesy of GENERAL MOTORS COMPANY

Oil Pump Removal

Callout	Component Name
1	Oil Pump Bolt
2	Oil Pump Assembly

OIL PUMP REMOVAL (WITH Z52 OPTION)

cardiagn.com

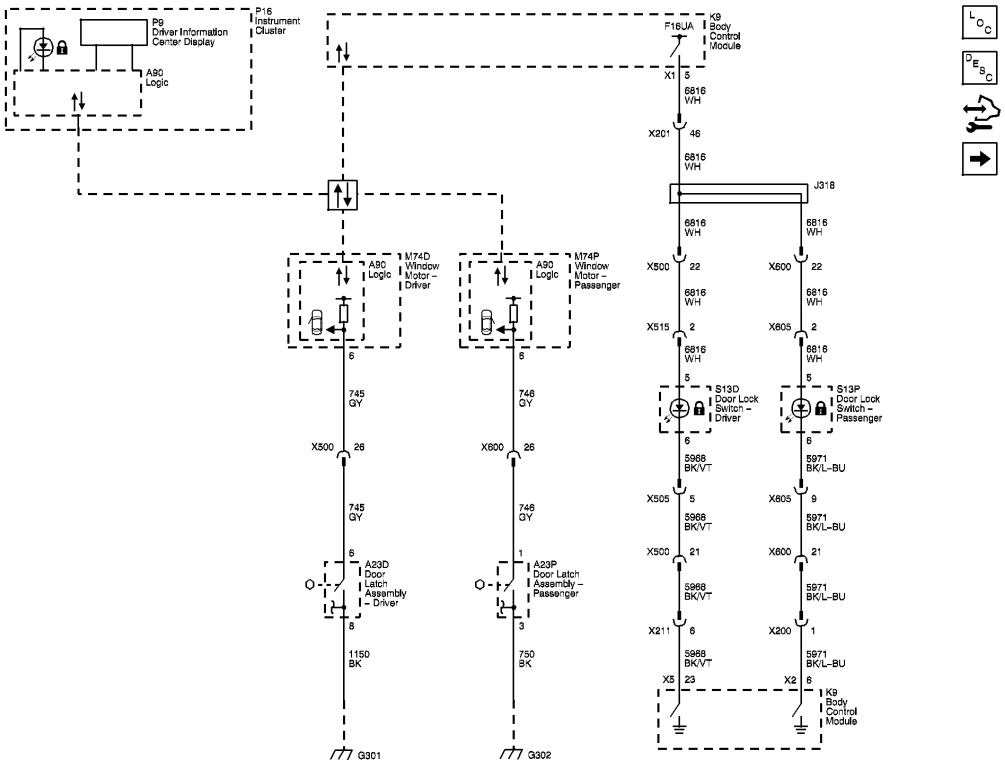


Fig. 61: Oil Pump(with Z52 Option)
Courtesy of GENERAL MOTORS COMPANY

Oil Pump Removal (with Z52 Option)

Callout	Component Name
1	Oil Pump Bolt
2	Oil Pump Assembly

TIMING CHAIN, CRANKSHAFT SPROCKET, CAMSHAFT POSITION ACTUATOR AND SOLENOID VALVE REMOVAL

Special Tools

EN-42386-A Flywheel Holding Tool

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

cardiagn.com

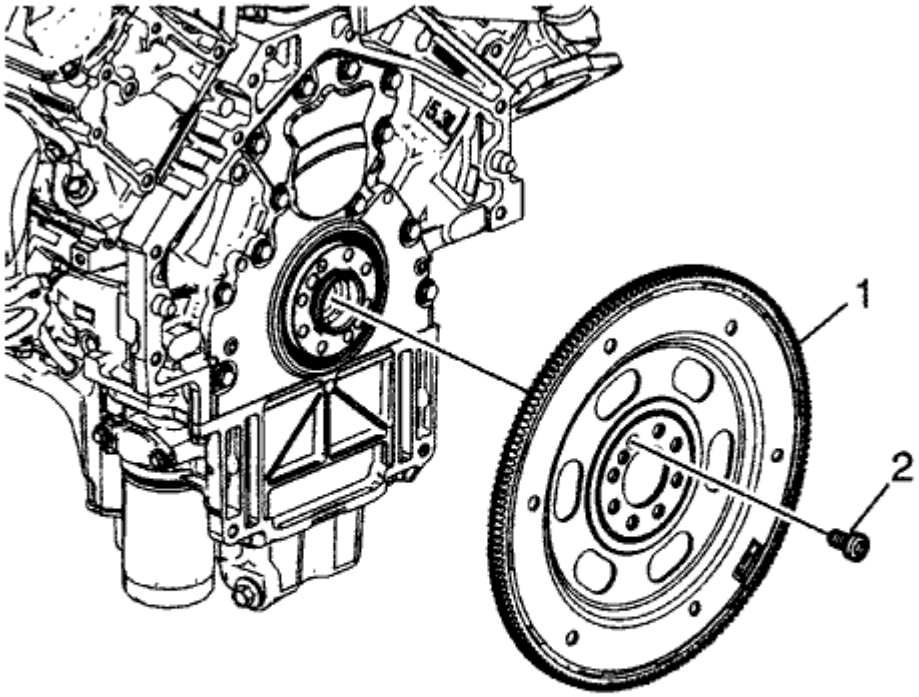


Fig. 62: Automatic Transmission Flex Plate
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Do not use the camshaft position (CMP) actuator solenoid valve again. Upon installation of the CMP actuator and timing chain, install a NEW valve.**
- **Do not apply threadlock to the flex plate bolts at this time.**

1. Temporarily install the automatic transmission flex plate (1) and bolts (2). Refer to **Automatic Transmission Flex Plate Installation**.

cardiagn.com

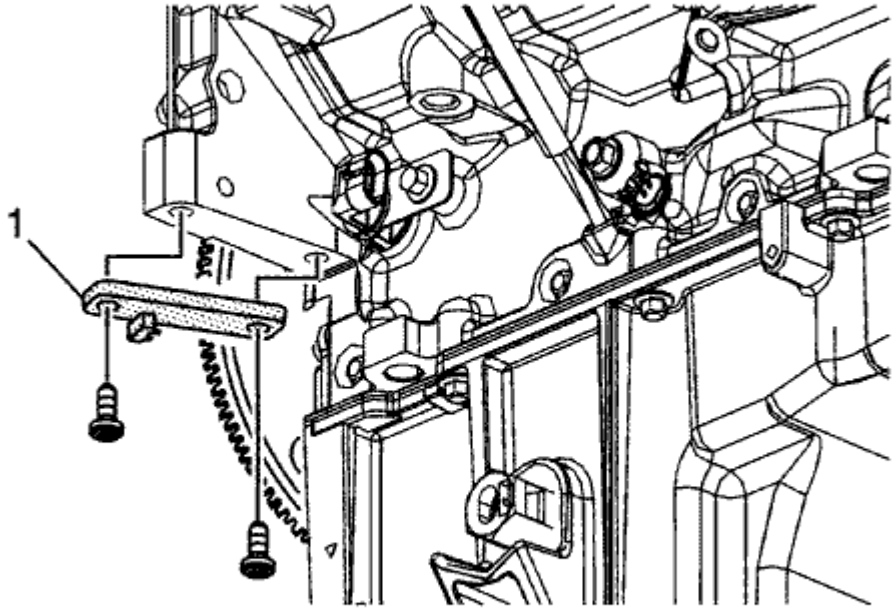


Fig. 63: Automatic Transmission Flex Plate And Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the **EN-42386-A** tool (1) and bolts. Use 1 M10 - 1.5 x 120 mm and 1 M10 - 1.5 x 45 mm bolt for proper tool operation. Tighten the **EN-42386-A** tool bolts to 50 N.m (37 lb ft).

cardiagn.com

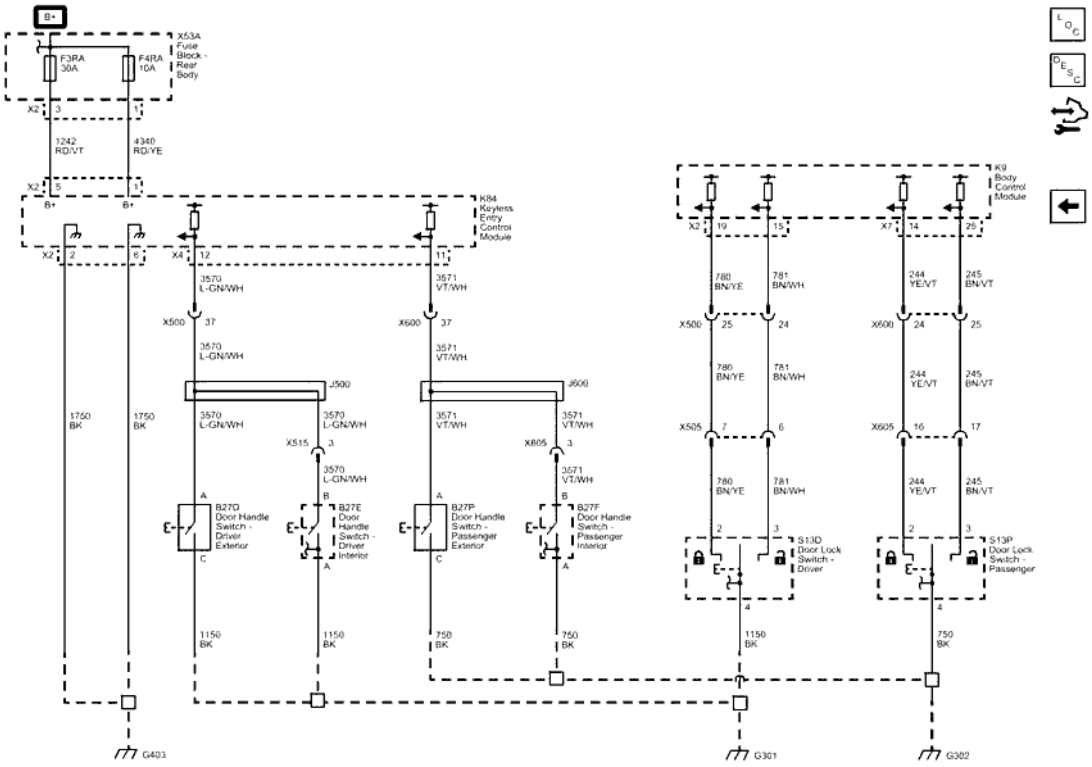


Fig. 64: View Of CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

3. Remove the CMP actuator solenoid valve (234).
4. Discard the solenoid valve.

cardiagn.com

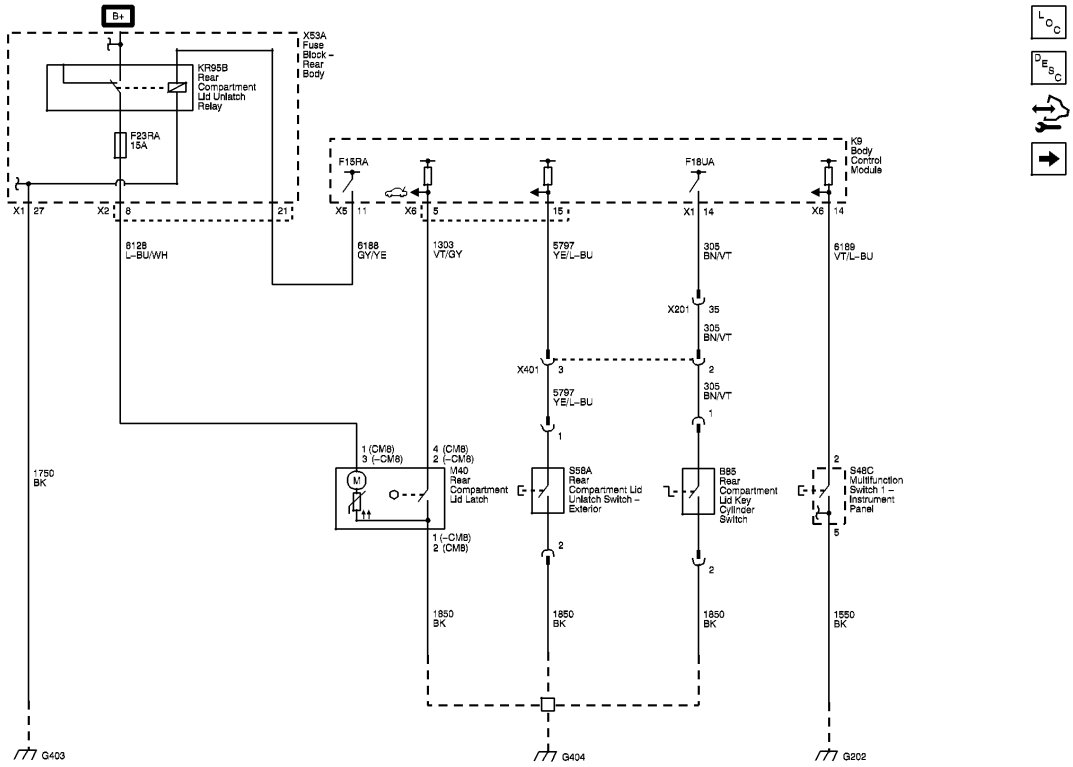


Fig. 65: View Of Proper CMP Actuator Removal
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Camshaft Position Actuator Removal and Installation Warning .

5. Loosen and separate the CMP actuator and timing chain from the camshaft. Position fingers behind the actuator sprocket and pull the actuator away from the front of the camshaft. Never pull on the reluctor wheel when attempting to remove the actuator.

cardiagn.com

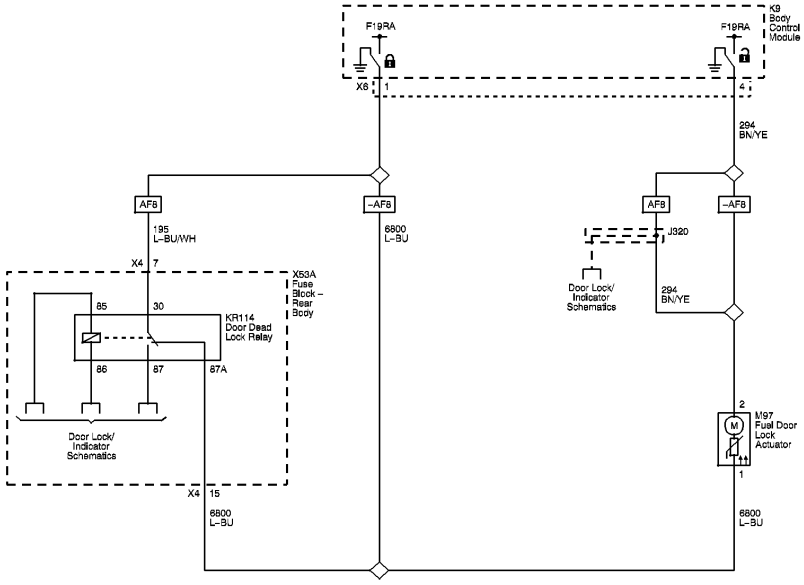


Fig. 66: View Of CMP Actuator & Timing Chain
Courtesy of GENERAL MOTORS COMPANY

6. Remove the CMP actuator (235) and timing chain (208).

cardiagn.com

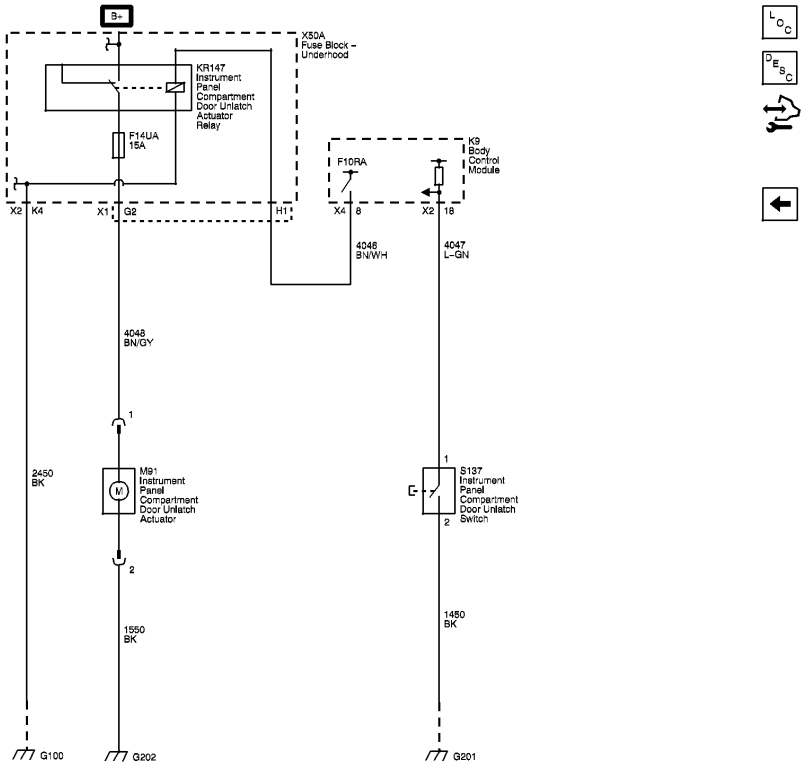


Fig. 67: View Of Tie Strap Through Center Of Actuator
Courtesy of GENERAL MOTORS COMPANY

7. Insert a tie strap (1) through the center of the actuator and over the reluctor wheel.

cardiagn.com

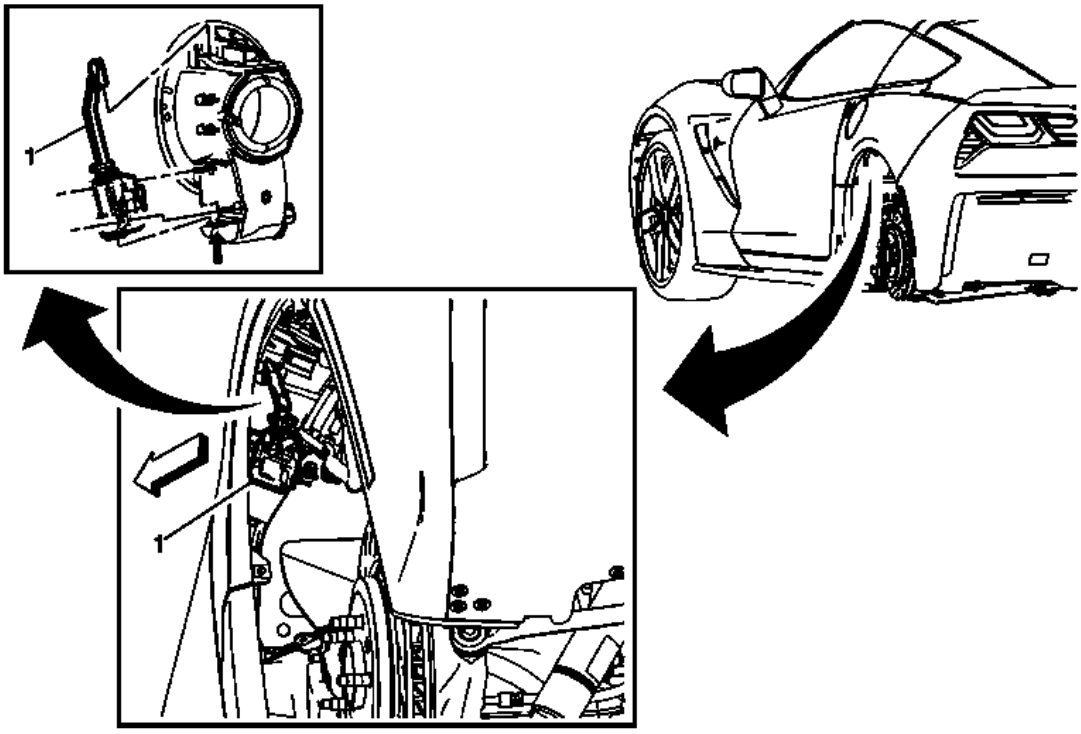
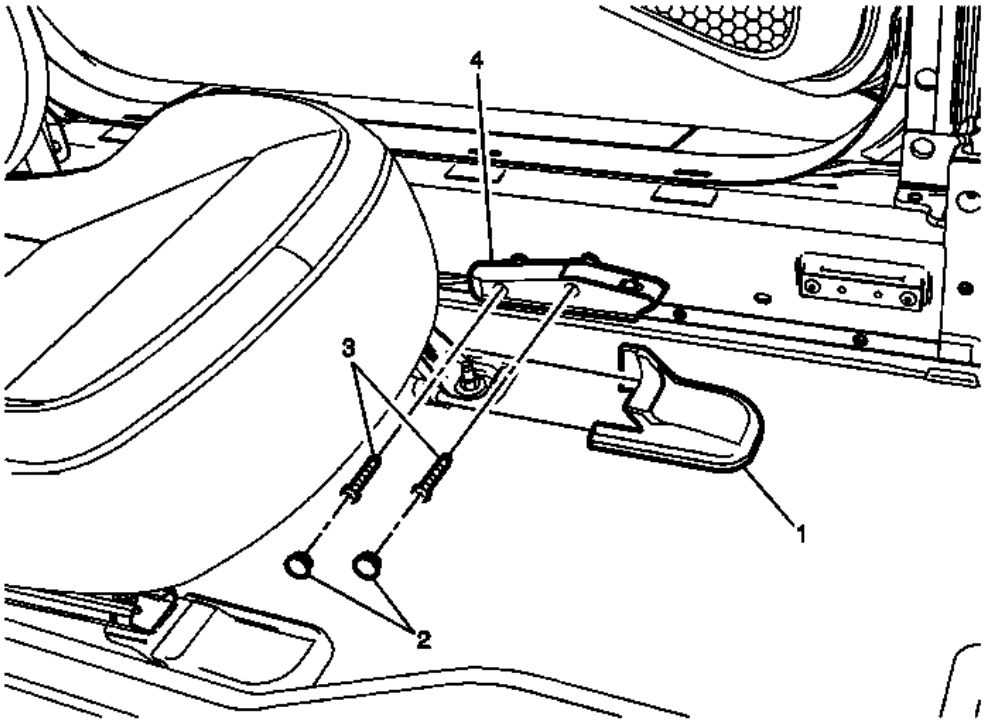


Fig. 68: View Of Timing Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the bolts (231) and timing chain tensioner (232).



cardiagn.com

Fig. 69: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

9. Remove the crankshaft sprocket (207).

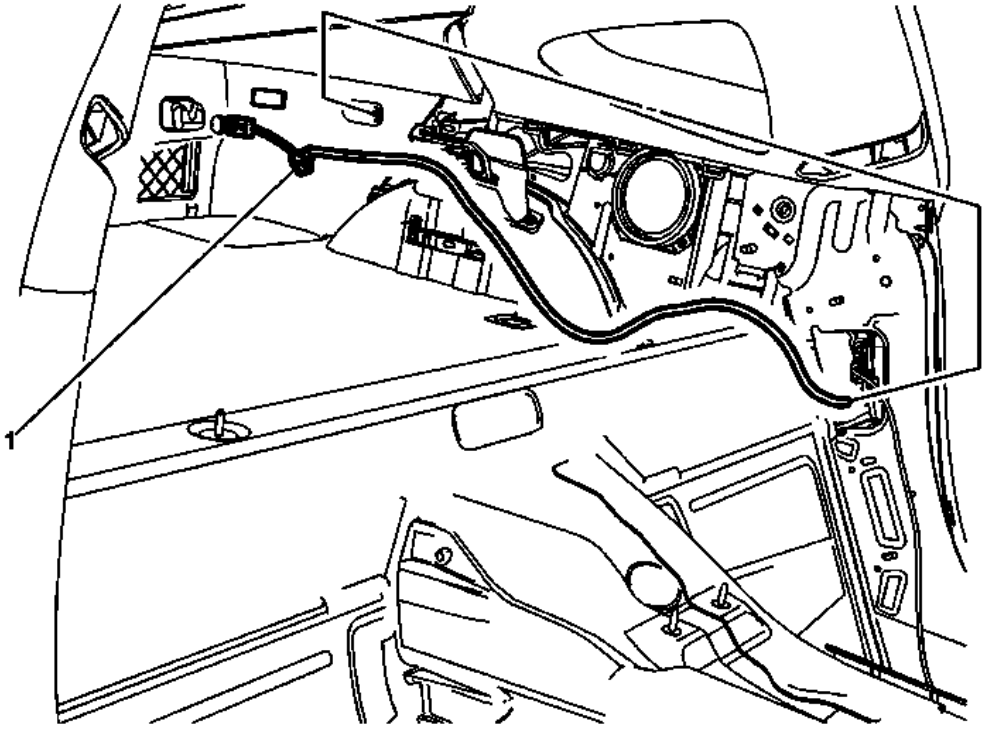


Fig. 70: View Of Crankshaft Key & Keyway
Courtesy of GENERAL MOTORS COMPANY

10. Remove the crankshaft sprocket key, as required.
11. Remove the flex plate and bolts. Refer to **Automatic Transmission Flex Plate Removal**.
12. Remove the **EN-42386-A** tool and bolts.

CAMSHAFT REMOVAL

cardiagn.com

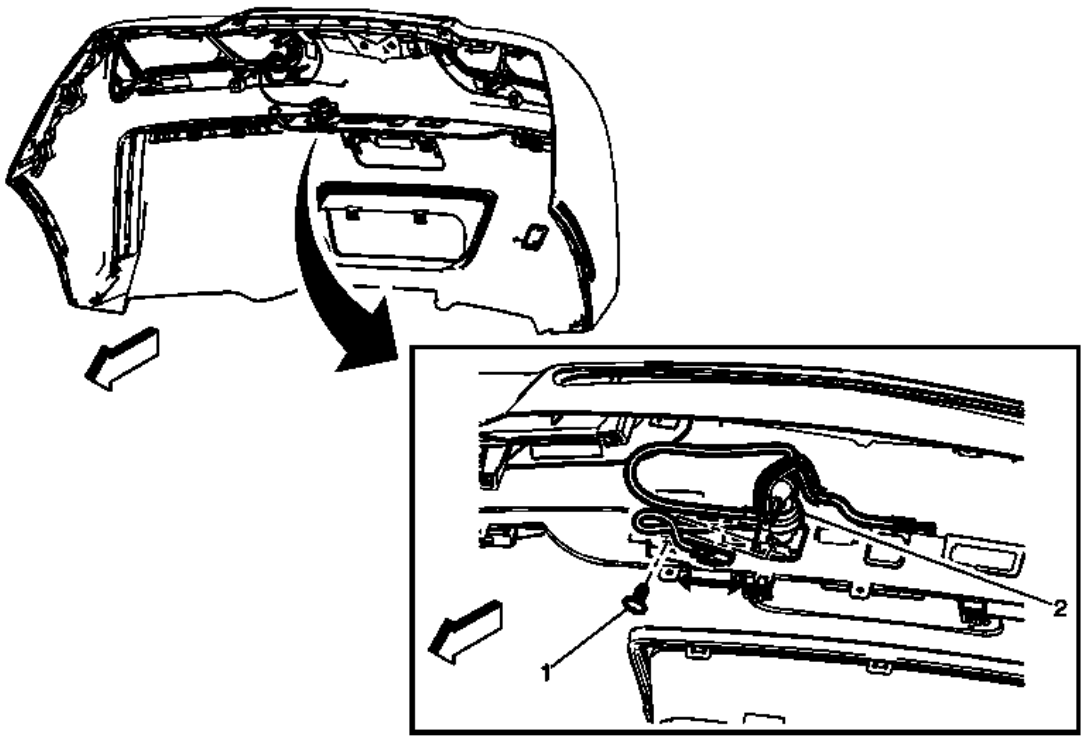


Fig. 71: Camshaft
Courtesy of GENERAL MOTORS COMPANY

Camshaft Removal

Callout	Component Name
1	Camshaft Retainer Bolt
2	Camshaft Retainer
3	Camshaft Assembly

PISTON, CONNECTING ROD AND BEARING REMOVAL

Special Tools

- **EN-24270** Cylinder Bore Ridge Reamer
- **EN-41556** Connecting Rod Guide

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

cardiagn.com

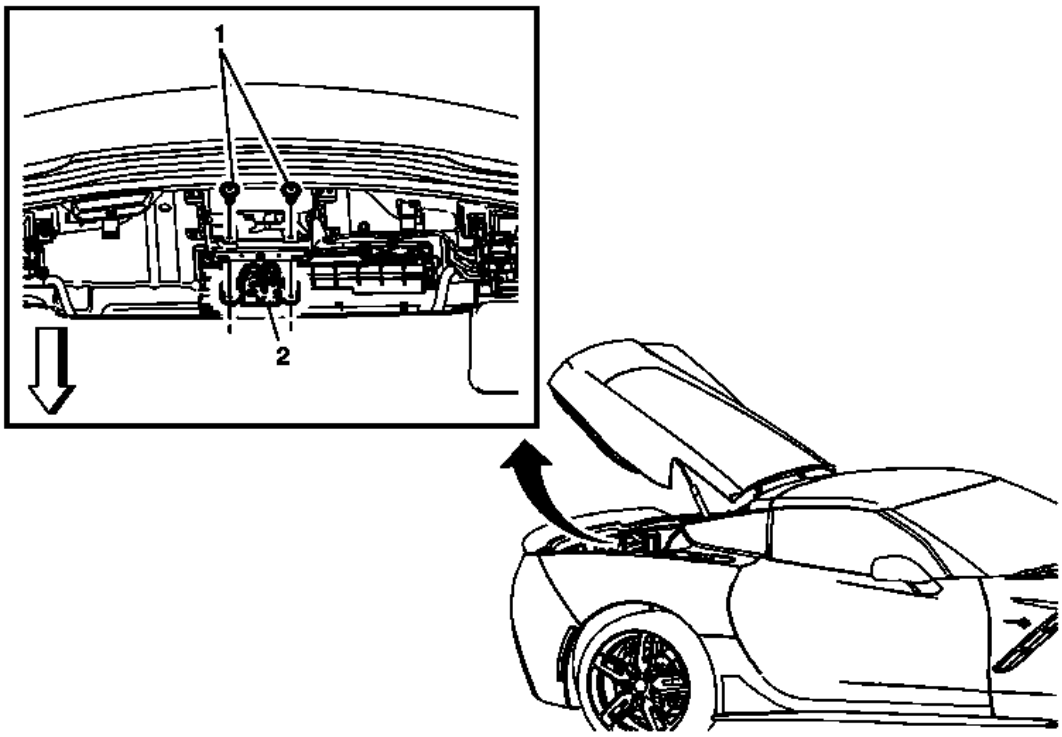


Fig. 72: Removing Cylinder Bore Ring Ridge
Courtesy of GENERAL MOTORS COMPANY

1. Use the **EN-24270** cylinder bore ridge reamer in order to remove the cylinder bore ring ridge, if required.
    1. Turn the crankshaft until the piston is at the bottom of the stroke.
    2. Place a cloth on top of the piston.
    3. Use the **EN-24270** cylinder bore ridge reamer or equivalent, in order to remove a cylinder ring ridge.
    4. Turn the crankshaft so the piston is at the top of the stroke.
    5. Remove the cloth.
    6. Remove the cutting debris from the cylinder and piston.

cardiagn.com

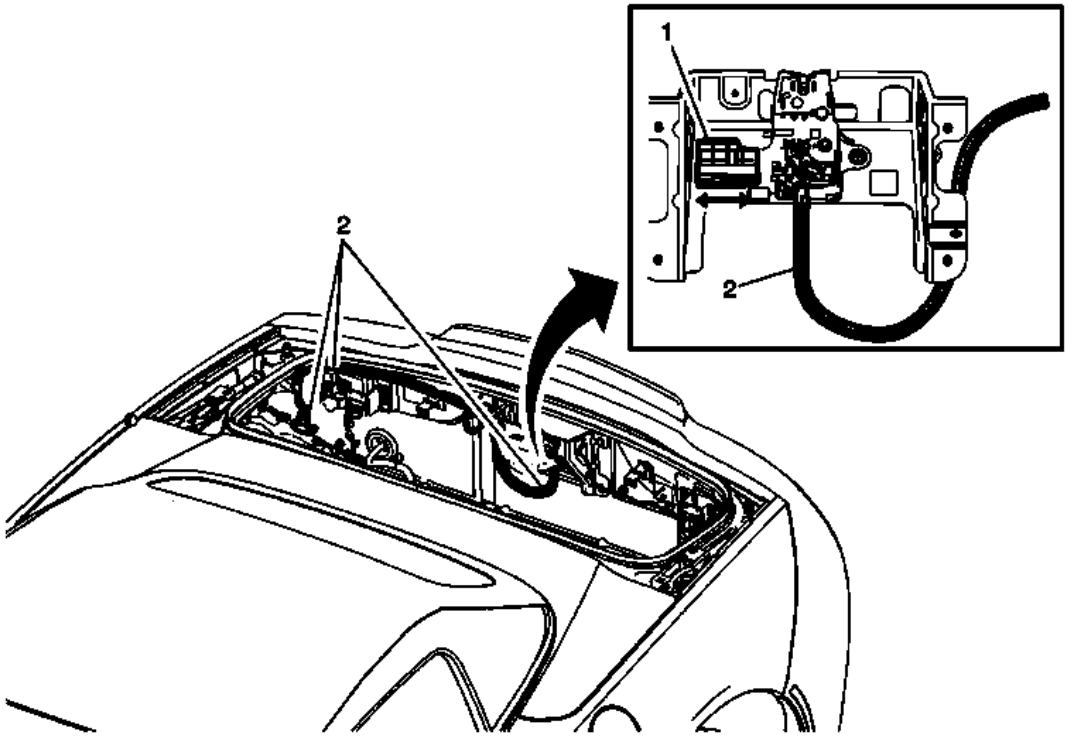


Fig. 73: Matchmarks On Connecting Rods & Caps
Courtesy of GENERAL MOTORS COMPANY

2. Using a paint stick or etching tool, place matchmarks or numbers on the connecting rods and the connecting rod caps. The connecting rods and caps MUST be assembled to their original position and direction.
    - A stamping mark on the side of the connecting rod, at the crankshaft journal, may affect component geometry.
    - Mark the top of the piston to the specific cylinder bore.

cardiagn.com

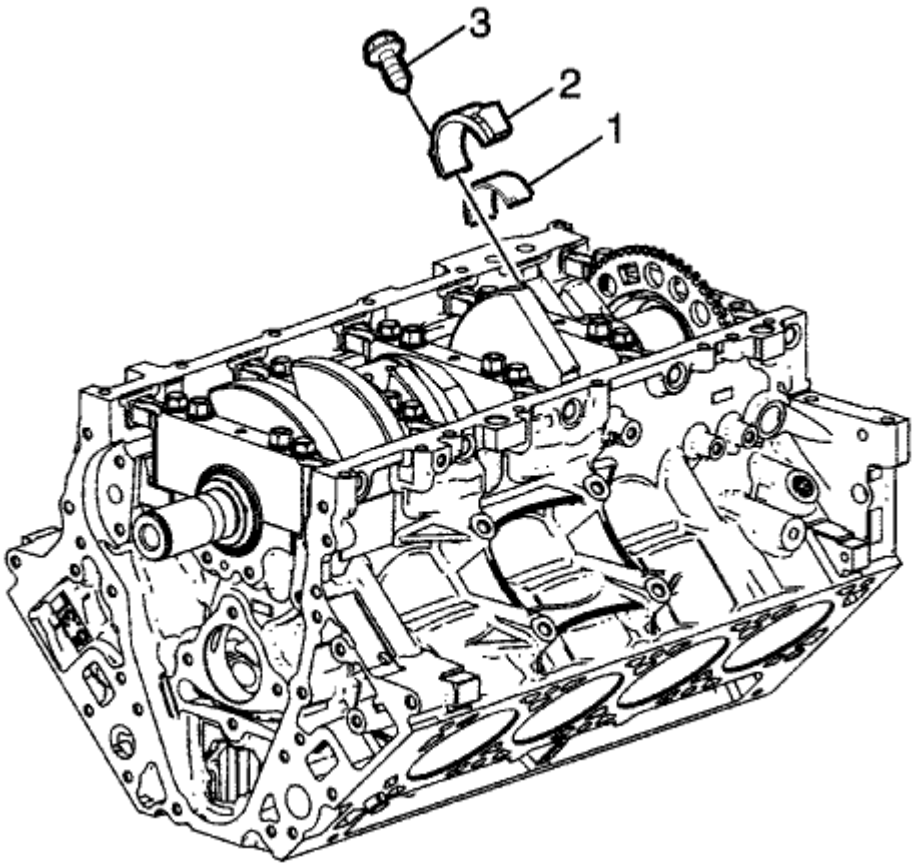


Fig. 74: Connecting Rod Bolts, Cap And Bearing
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Mark, sort or organize the connecting rod bearings so they may be installed to their original position and location. The connecting rods and the bearing caps are NOT interchangeable. Refer to Separating Parts .

3. Remove the connecting rod bolts (3), cap (2) and bearing (1).

cardiagn.com

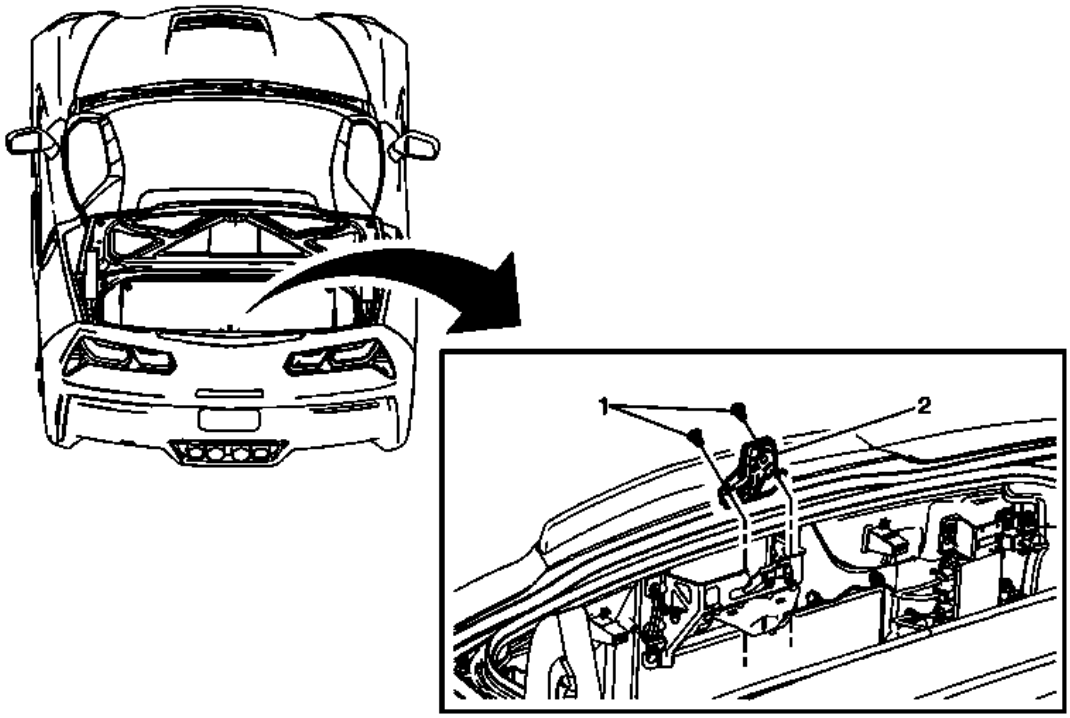
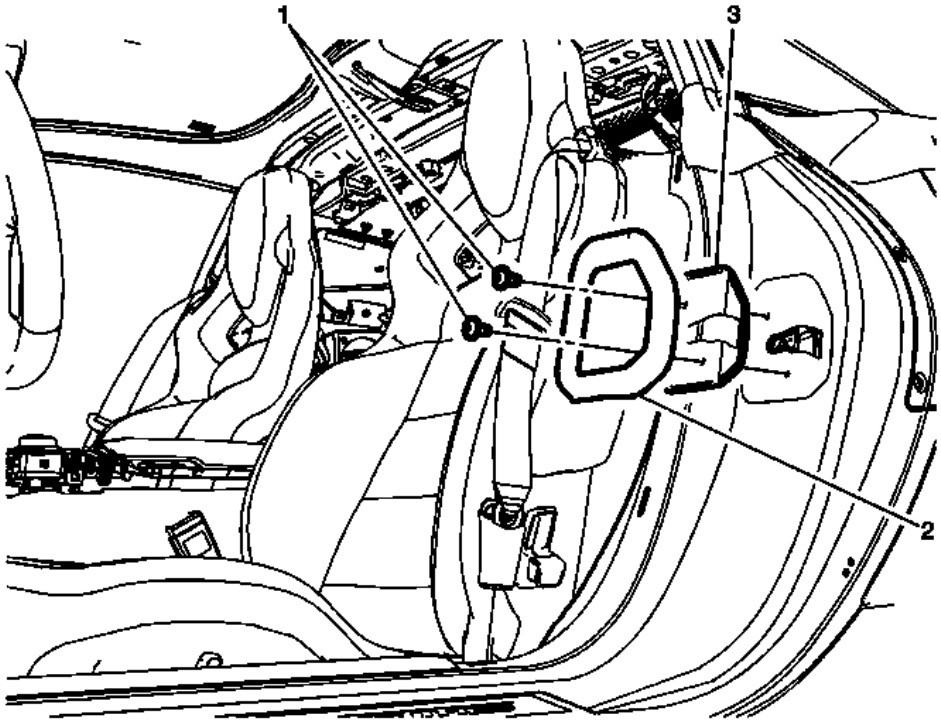


Fig. 75: Installing Piston & Connecting Rod Assembly
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-41556** connecting rod guide to the connecting rod.



cardiagn.com

Fig. 76: Piston, Connecting Rod & Cylinder Bore
Courtesy of GENERAL MOTORS COMPANY

5. Using a hammer, tap lightly on the end of the **EN-41556** connecting rod guide in order to remove the piston and connecting rod assembly from the cylinder bore.
6. Remove the **EN-41556** connecting rod guide.

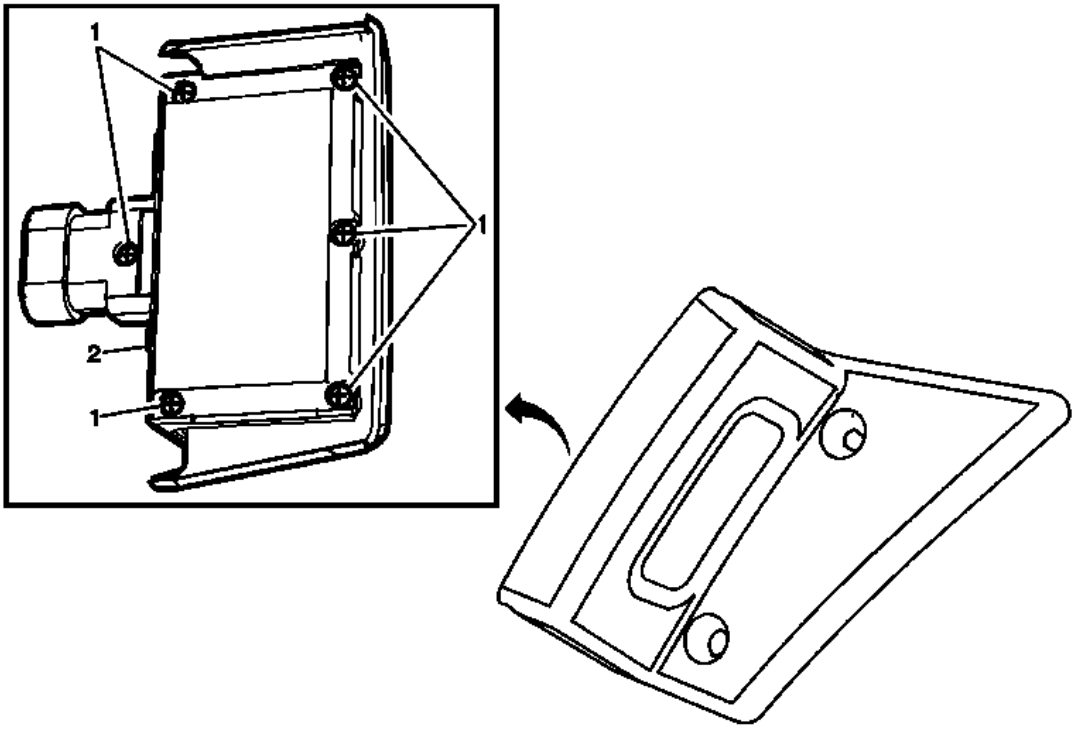


Fig. 77: View Of Piston, Connecting Rod & Bearing Assembly
Courtesy of GENERAL MOTORS COMPANY

7. Upon removal of the piston and connecting rod assembly, assemble the connecting rod cap and bolts onto the matching connecting rod.

CRANKSHAFT AND BEARING REMOVAL

Special Tools

- **J-6125-1B** Slide Hammer
- **J-41818** Crankshaft Bearing Cap Remover

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

cardiagn.com

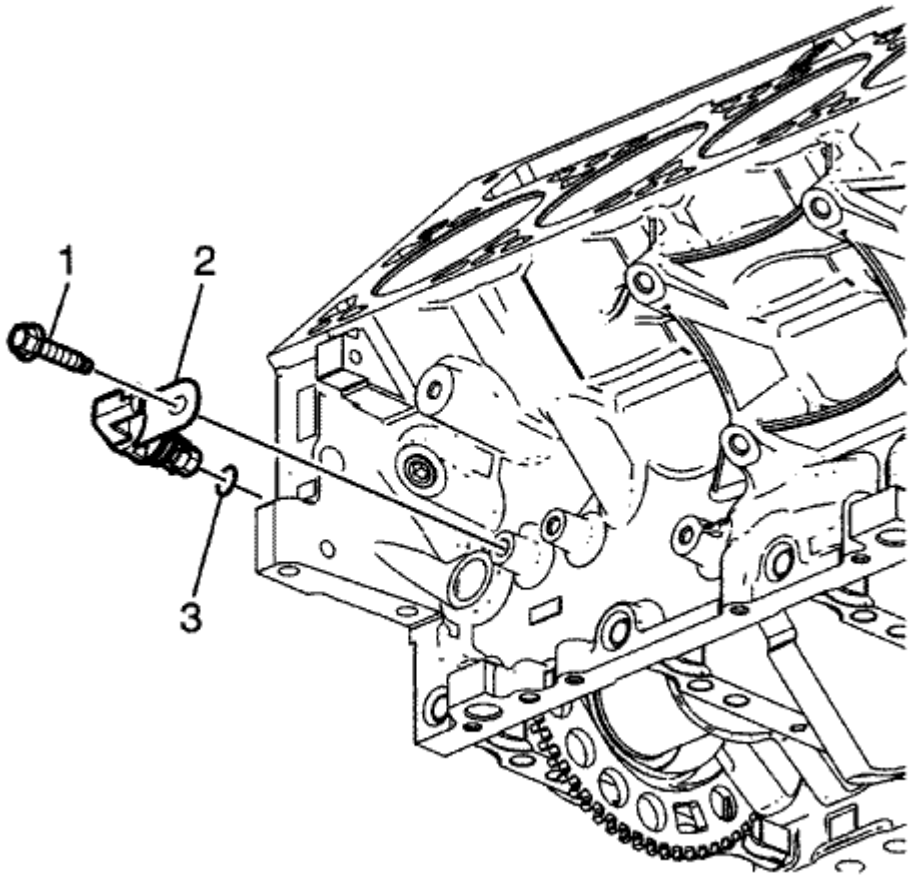


Fig. 78: Crankshaft Position (CKP) Sensor Bolt And CKP Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The crankshaft bearing caps are machined with the engine block, for the proper clearances. Mark or identify each crankshaft bearing cap location and direction before removal. The crankshaft bearing caps MUST be installed to their original position and direction.**
- **All bolts are to be discarded and replaced with NEW.**

1. Remove the crankshaft position (CKP) sensor bolt (1).
2. Remove the CKP sensor (2).
3. Remove the O-ring (3) from the sensor, as required.

cardiagn.com

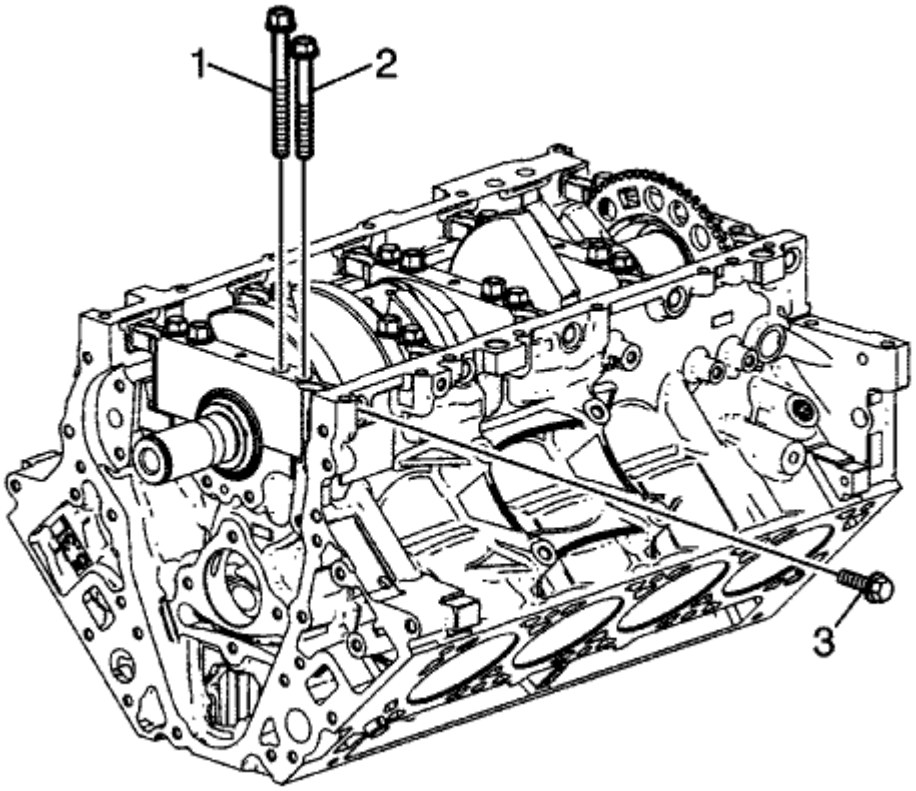


Fig. 79: Crankshaft Inner Bearing Cap Bolts And Outer Bearing Cap Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove and discard the crankshaft inner bearing cap bolts (1) and outer bearing cap bolts (2).
5. Remove and discard the bearing cap side bolts (3).

cardiagn.com

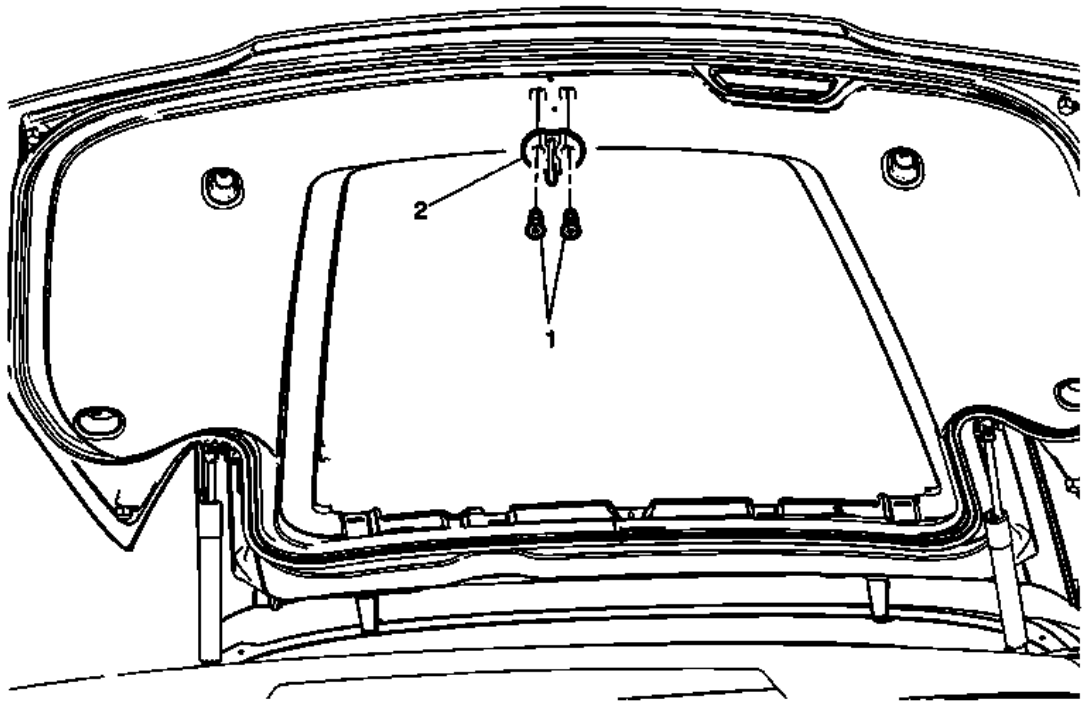


Fig. 80: View Of Crankshaft Bearing Cap Bolts (M10)
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Install the **J-41818** remover (2) and tighten to 11 N.m (100 lb in).
7. Install the **J-6125-1B** hammer (1) to the **J 41818** remover (2) in order to remove the crankshaft bearing caps.

cardiagn.com

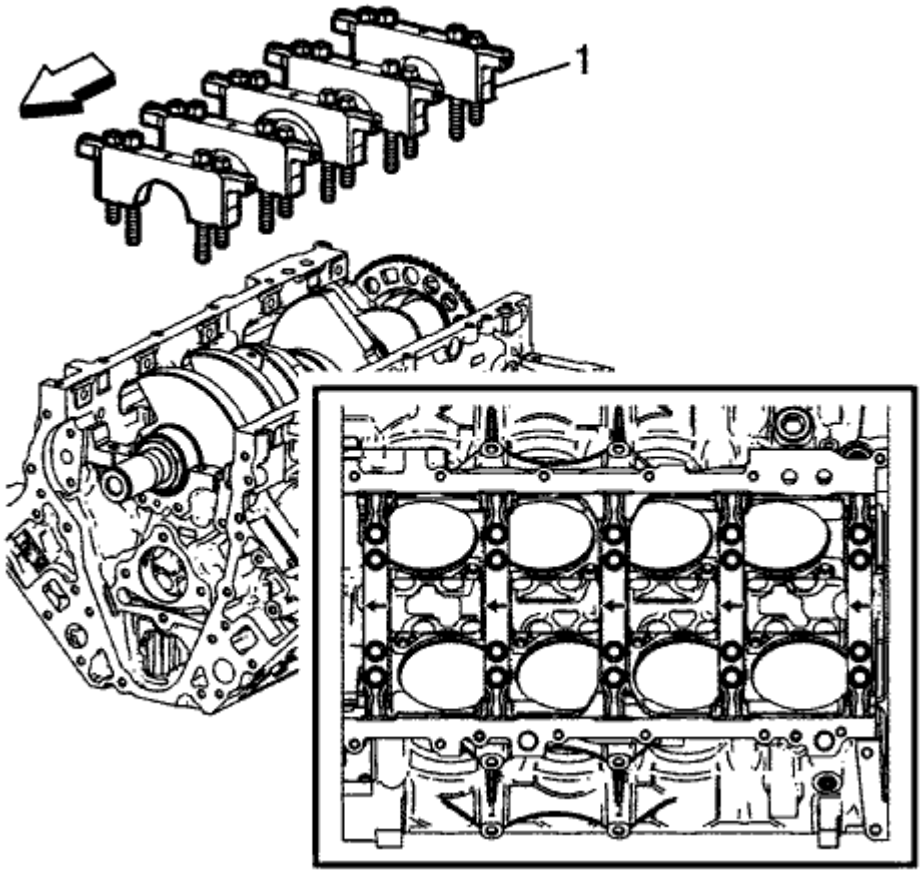


Fig. 81: Crankshaft Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

NOTE: Before removal note the direction of the bearing caps arrows and location.

8. Remove the bearing caps (1).

cardiagn.com

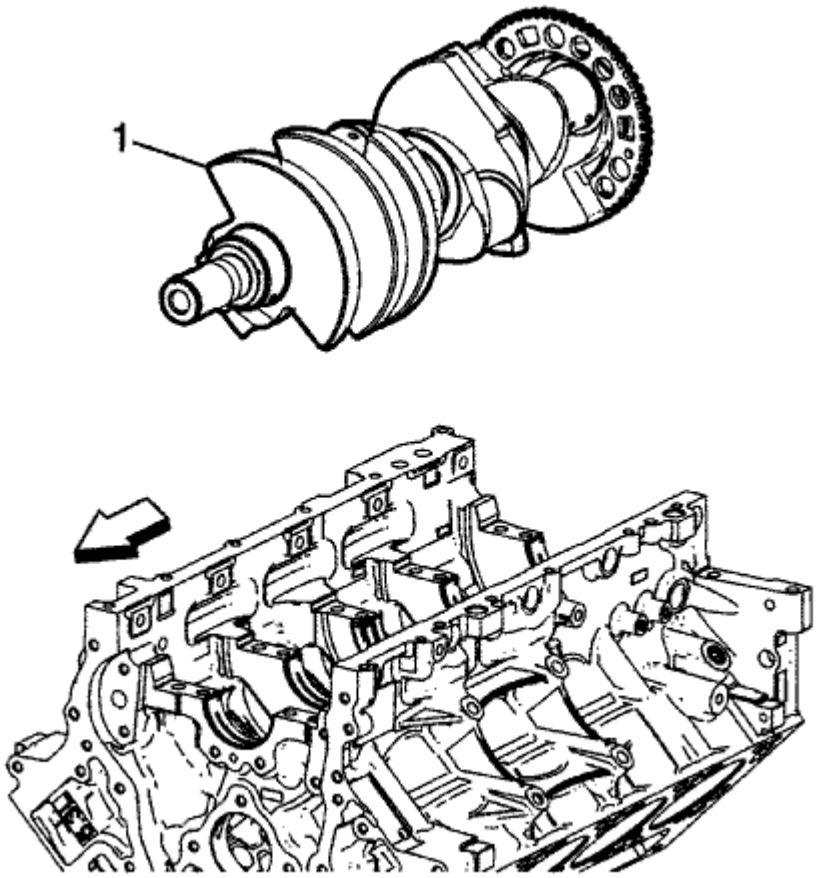


Fig. 82: Crankshaft
Courtesy of GENERAL MOTORS COMPANY

NOTE: Use care when handling the crankshaft. Avoid damage to the CKP sensor reluctor ring teeth. Nicks, burrs or other damage to the teeth may affect on-board diagnostics (OBD) II system performance.

9. Remove the crankshaft (1).
10. Lay the crankshaft onto 2 wooden V-blocks or other protective surface.

cardiagn.com

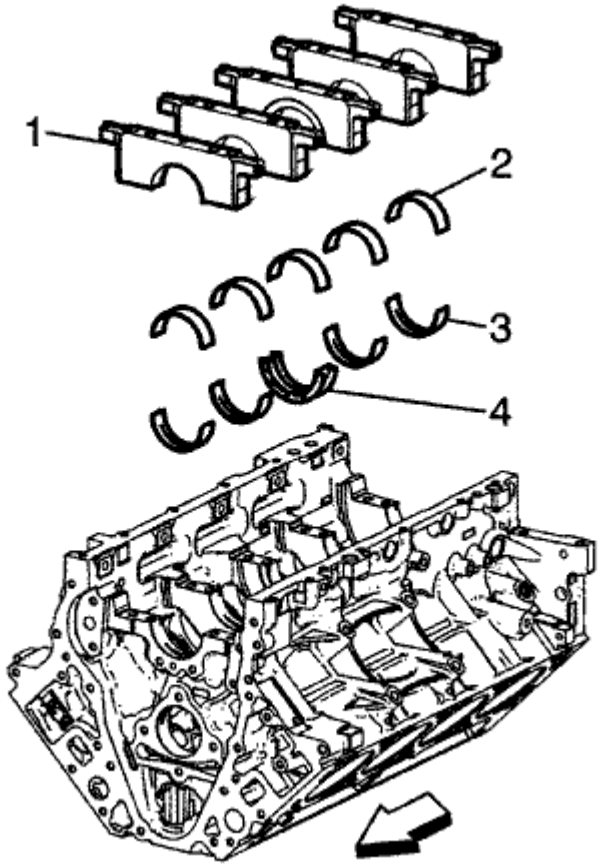


Fig. 83: Crankshaft Bearings And Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

11. Remove the crankshaft bearings (2, 3 and 4) from the bearing caps (1) and the engine block.
12. Mark, sort or organize the crankshaft bearings so they may be installed to their original position and location. Refer to **Separating Parts** .

ENGINE BLOCK PLUG REMOVAL

Knock Sensor Shield, Knock Sensor and Engine Block Oil Gallery Plug Removal

cardiagn.com

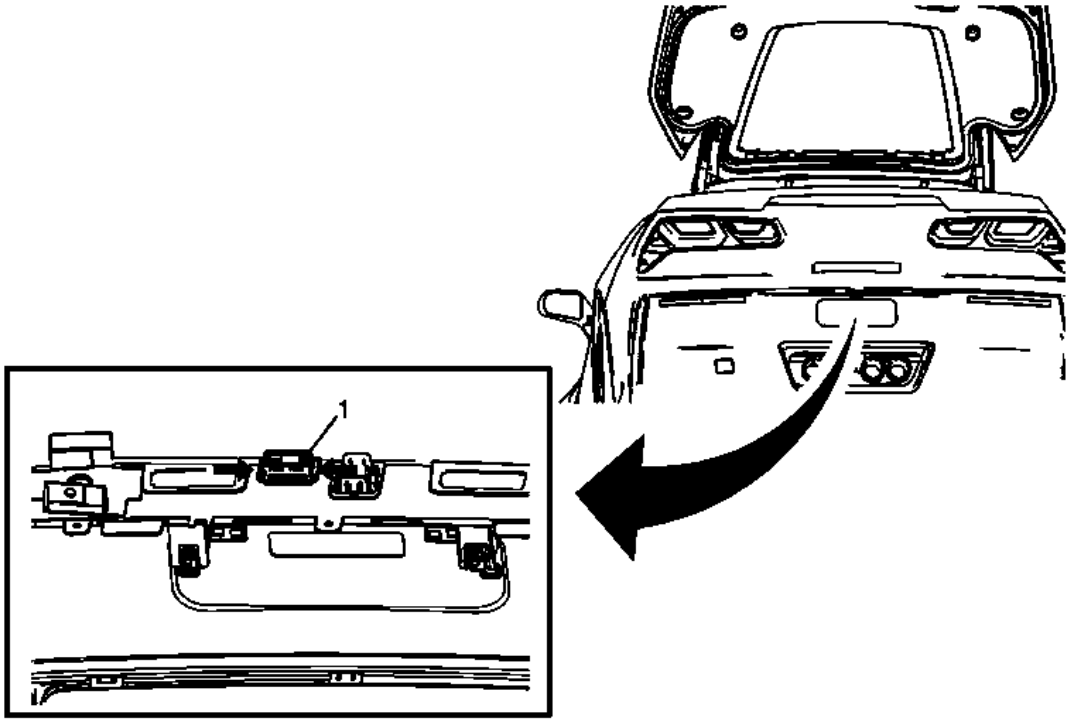


Fig. 84: Knock Sensor Shield, Knock Sensor and Engine Block Oil Gallery Plug
Courtesy of GENERAL MOTORS COMPANY

Knock Sensor Shield, Knock Sensor and Engine Block Oil Gallery Plug Removal

Callout	Component Name
1	Engine Block Oil Gallery Plug
2	Knock Sensor Shield Bolt
3	Knock Sensor Shield
4	Knock Sensor Bolt
5	Knock Sensor Assembly
6	Engine Block Plug
7	Engine Block Plug
8	Engine Block Plug

Crankshaft Position Sensor, Engine Block Plug, Knock Sensor and Piston Oil Nozzle Removal

cardiagn.com

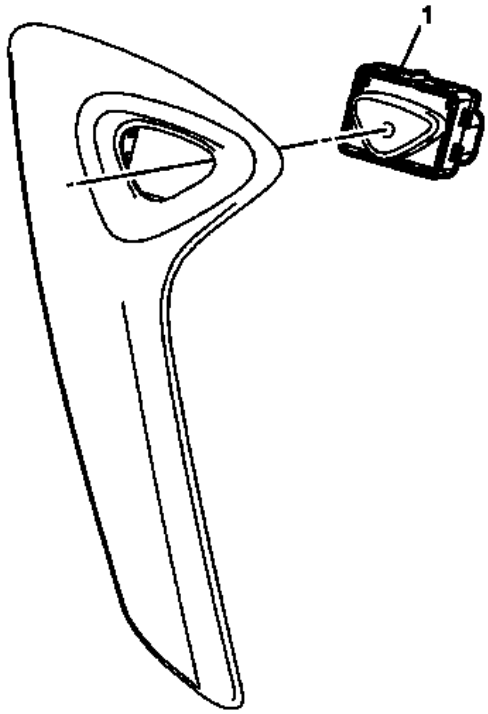


Fig. 85: Crankshaft Position Sensor, Engine Block Plug, Knock Sensor and Piston Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Position Sensor, Engine Block Plug, Knock Sensor and Piston Oil Nozzle Removal

Callout	Component Name
1	Knock Sensor Bolt
2	Knock Sensor Assembly
3	Crankshaft Position Sensor Bolt
4	Crankshaft Position Sensor
5	Piston Oil Nozzle Assembly
6	Engine Block Plug
7	Engine Block Plug

ENGINE BLOCK CLEANING AND INSPECTION

Special Tools

J 8087 Cylinder Bore Gauge

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

Cleaning Procedure

cardiagn.com

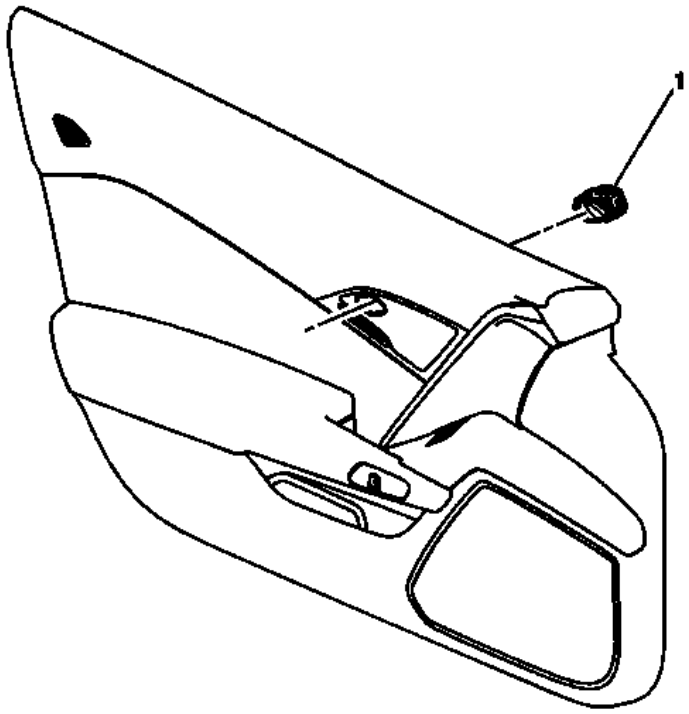


Fig. 86: Main Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not use a caustic solution to clean the aluminum engine block.

NOTE: When cleaning the engine block in a thermal type oven, do not exceed 232°C (450°F).

Clean the following components:

- Remove all sludge, dirt or debris using a cleaning solvent or thermal type oven. Refer to **Cleanliness and Care** .
- Gasket surfaces

  Refer to **Replacing Engine Gaskets** .

- Coolant passages
- Oil galleries
- Main bearing caps
- Cylinder head bolt holes to remove threadlocking material

Inspection Procedure

cardiagn.com

1. Inspect the following components:
    - Cylinder walls for excessive scratches, gouging or ring ridge
    - Cylinder bores for excessive ring ridge at the top of the cylinder
    - Coolant jacket for cracks
    - Valve lifter bores for excessive scoring or wear
    - Crankshaft bearing webs for cracks
    - Gasket sealing surfaces for excessive scratches or gouging

      Refer to **Replacing Engine Gaskets** .

    - Oil galleries for restrictions
    - Threaded bolt holes for damaged threads
    - Cylinder bores for excessive ring ridge at the top of the cylinder
2. Measure the cylinder bores for an oversize condition:

Measuring the Cylinder for Oversize

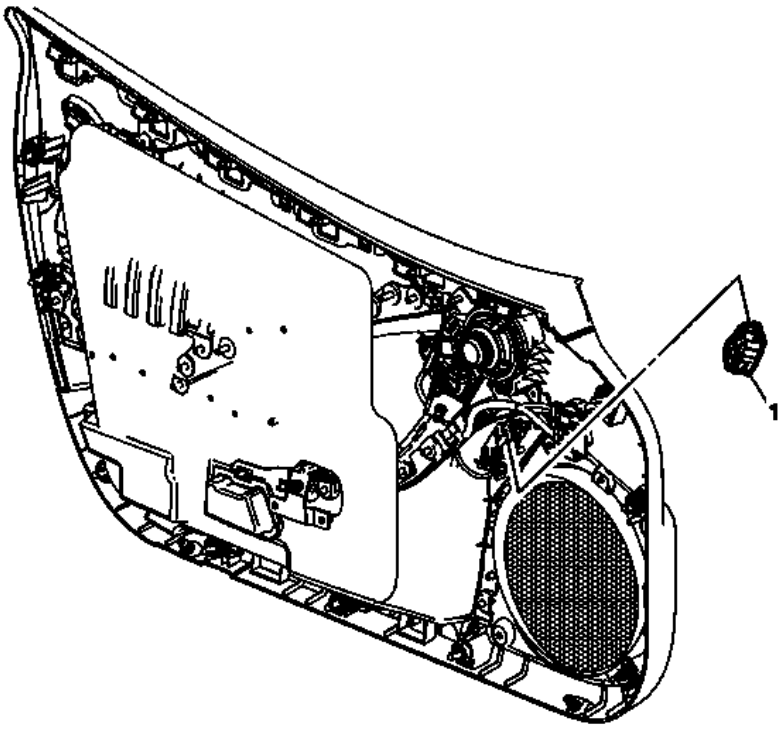


Fig. 87: Measuring Bore Gauge With Micrometer
Courtesy of GENERAL MOTORS COMPANY

1. Adjust the micrometer to a dimension slightly smaller than the bore size. Refer to **Engine Mechanical Specifications** .
2. Insert the **J 8087** gauge into the micrometer and zero the bore gauge dial.

cardiagn.com

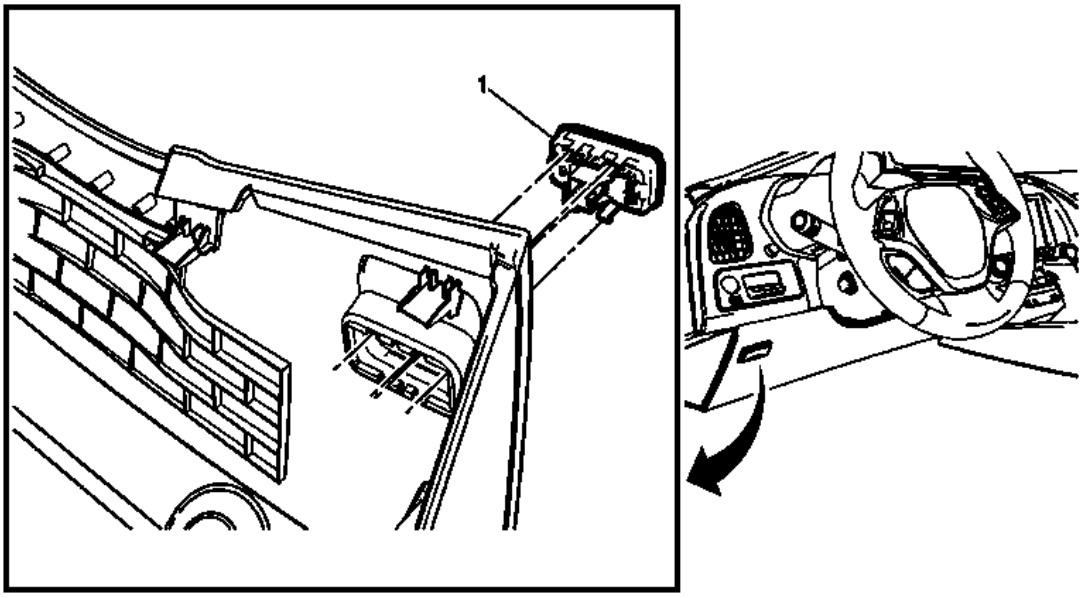


Fig. 88: Measuring Cylinder Bore
Courtesy of GENERAL MOTORS COMPANY

3. Use the **J 8087** gauge and measure the cylinder bore for oversize.

   Slide the bore gauge up and down throughout the length of the cylinder bore. Measure the bore, both parallel and perpendicular to the centerline of the crankshaft, at the top, center and bottom of the bore. A cylinder bore that exceeds the maximum diameter must be serviced with an oversized piston. Refer to **Engine Mechanical Specifications** .

PISTON OIL NOZZLE CLEANING AND INSPECTION

NOTE: **The piston oil nozzle assembly is designed to provide oil to the bottom side of the piston for cooling purposes. The internal check ball is held in the normally closed position by the spring until system oil pressure exceeds 20.7 kPa (43.5 psi).**

cardiagn.com

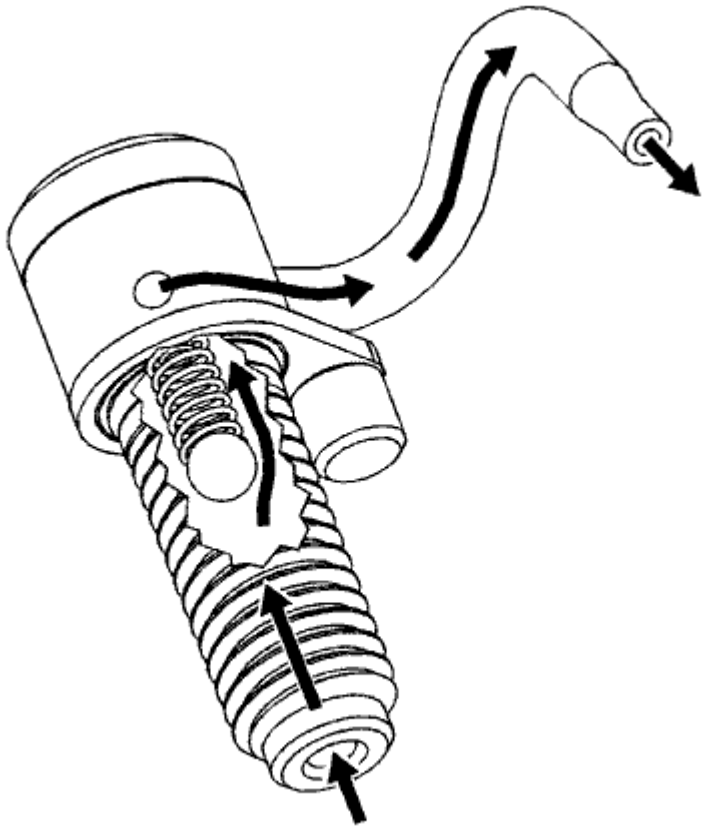


Fig. 89: View Of Piston Oil Nozzle Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Clean the nozzle assembly in solution.
2. Inspect the nozzle assembly for the following:
   - damaged bolt threads
   - damaged or cut O-ring seal
   - bent nozzle
   - A restricted or stuck-open nozzle assembly
3. With no oil pressure, the check ball should be seated and not permit flow through the nozzle tube. Using a blow gun, apply air pressure to the inlet portion of the bolt. Air pressure should unseat the check ball and permit flow through and out of the nozzle tube.

CYLINDER BORING AND HONING

Boring Procedure

IMPORTANT: A 0.5 mm (0.02 in) oversize service piston and a piston ring set are available.

cardiagn.com

1. Measure all pistons with a micrometer to determine the cylinder bore diameter.
2. Before you use any type of boring bar, use a fine file and clean the top of the cylinder block, removing any dirt or burrs. If you do not check the cylinder block, the boring bar may be improperly positioned or tilted and the cylinder bore could be bored at an incorrect angle.
3. Carefully follow the instructions furnished by the manufacturer regarding use of the equipment.
4. When you bore the cylinders, ensure all the crankshaft bearing caps are in place. Tighten the crankshaft bearing caps to the proper torque in order to avoid distortion of the cylinder bores during final assembly.
5. When you take the final cut with a boring bar, leave 0.03 mm (0.001 in) on the cylinder bore diameter for the finish honing and fit of the piston.

Honing Procedure

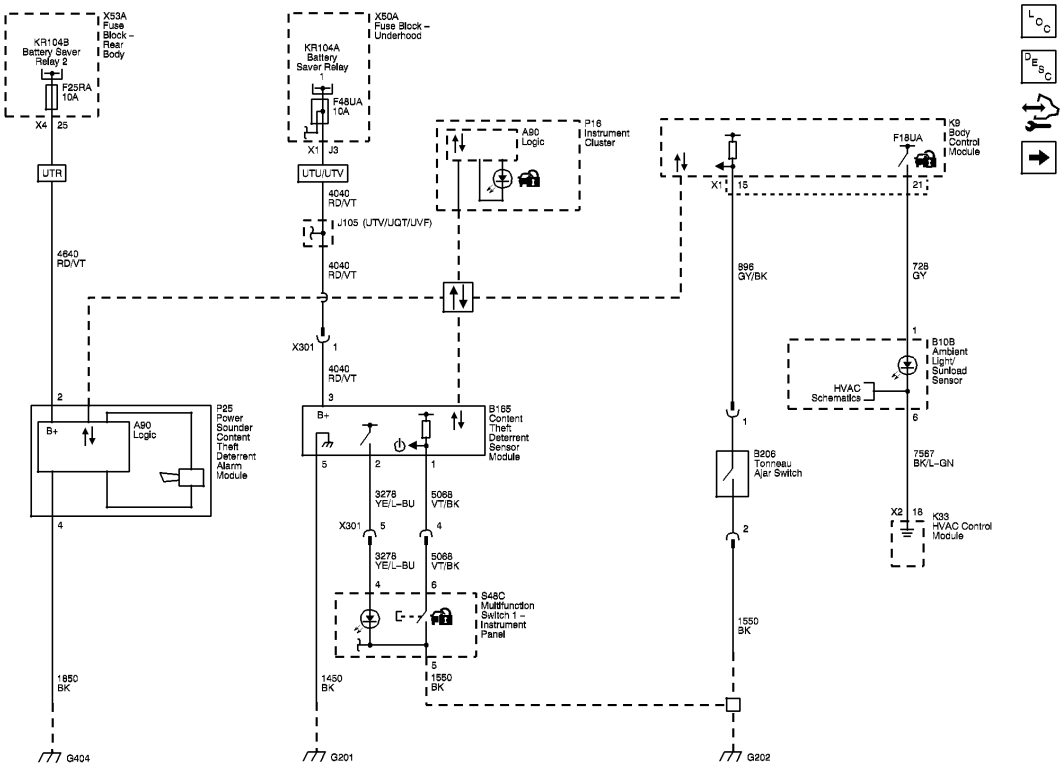


Fig. 90: View Of Honing Of Cylinders
Courtesy of GENERAL MOTORS COMPANY

1. When honing the cylinders, follow the manufacturer's recommendations for equipment use, cleaning and lubrication. Use only clean, sharp stones of the proper grade for the amount of material you remove. Dull, dirty stones cut unevenly and generate excessive heat. Do not hone to final clearance with a coarse or medium-grade stone. Leave sufficient metal so that all stone marks may be removed with fine-grade stones. Perform final honing with a fine-grade stone, honing the cylinder to the proper clearance.

cardiagn.com

2. During the honing operation, thoroughly clean the cylinder bore. Repeatedly check the cylinder bore for fit with the selected piston.

   All measurements of the piston or the cylinder bore should be made with the components at normal room temperature.

3. When honing a cylinder for fit to an oversize piston, first perform the preliminary honing with a 100-grit stone.
4. Perform final cylinder honing with a 240-grit stone and obtain a 45 degree cross hatch pattern.

   A 240-grit stone is preferred for final honing. If a 240-grit stone is not available, a 220-grit stone may be used as a substitute.

5. The finish marks should be clean but not sharp. The finish marks should also be free from imbedded particles and torn or folded metal.
6. By measuring the selected piston at the sizing point and by adding the average of the clearance specification, you can determine the final cylinder honing dimension required.
7. After final honing and before the piston is checked for fit, clean the cylinder bores with hot water and detergent. Scrub the bores with a stiff bristle brush and rinse the bores thoroughly with hot water. Do not allow any abrasive material to remain in the cylinder bores. This abrasive material may cause premature wear of the new piston rings and the cylinder bores. Abrasive material will also contaminate the engine oil and may cause premature wear of the bearings. After washing the cylinder bore, dry the bore with a clean rag.
8. Perform final measurements of the piston and the cylinder bore.
9. Permanently mark the top of the piston for the specific cylinder to which it has been fitted.
10. Apply clean engine oil to each cylinder bore in order to prevent rusting.

Deglazing Procedure

cardiagn.com

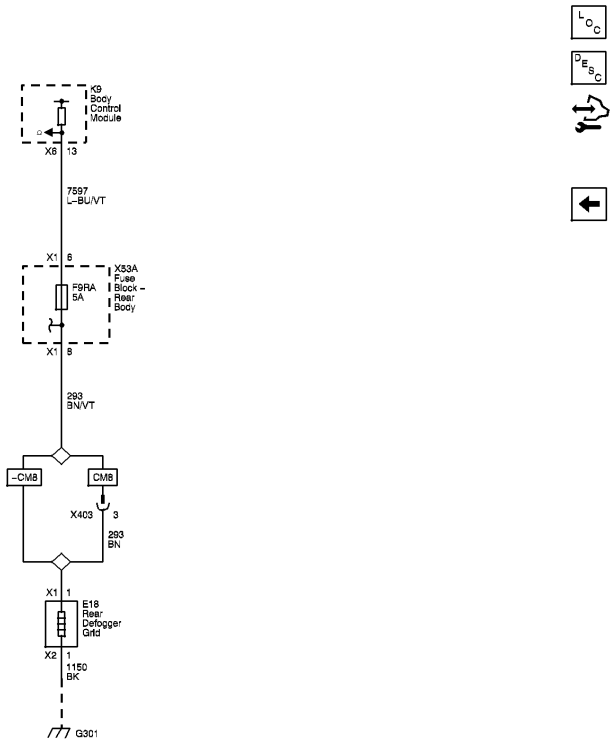


Fig. 91: Illustrating Deglazing Cylinder Bore
Courtesy of GENERAL MOTORS COMPANY

Using a ball type or self centering honing tool, deglaze the cylinder bore lightly. Deglazing should be done only to remove any deposits that may have formed. Use a 240-grit stone of silicone carbide or equivalent, material when performing the deglazing procedure.

A 240-grit stone is preferred for final honing. If a 240-grit stone is not available, a 220-grit stone may be used as a substitute.

CRANKSHAFT AND BEARING CLEANING AND INSPECTION

Special Tools

- **J 7872** Magnetic Base Dial Indicator Set
- **J 43690** Rod Bearing Checking Tool
- **J 43690-100** Rod Bearing Checking Tool - Adapter Kit

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

Cleaning Procedure

cardiagn.com

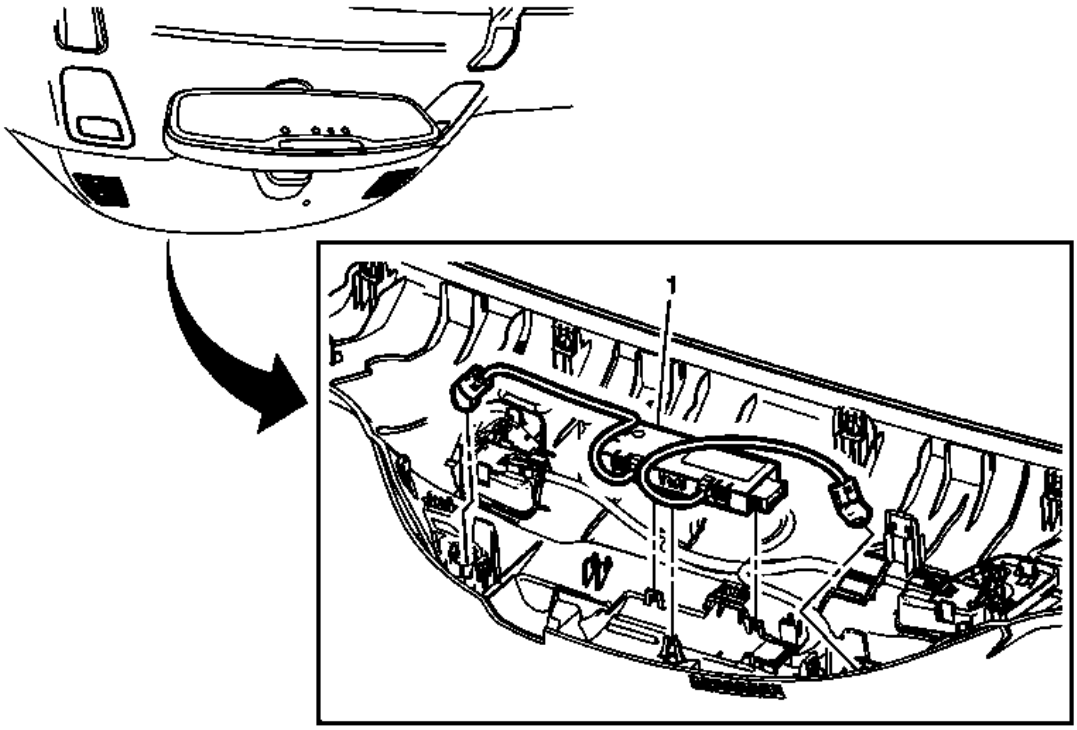


Fig. 92: Oil Passages & CKP Reluctor Ring Teeth
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Use care when handling the crankshaft. Avoid damage to the bearing surfaces or the lobes of the crankshaft position (CKP) reluctor ring. Damage to the teeth of the CKP reluctor ring may affect on-board diagnostics (OBD) II system performance.**

1. Clean the crankshaft with solvent.
2. Thoroughly clean all oil passages (2) and inspect for restrictions or burrs.

WARNING: **Refer to Safety Glasses Warning .**

3. Dry the crankshaft with compressed air.

Inspection Procedure

cardiagn.com

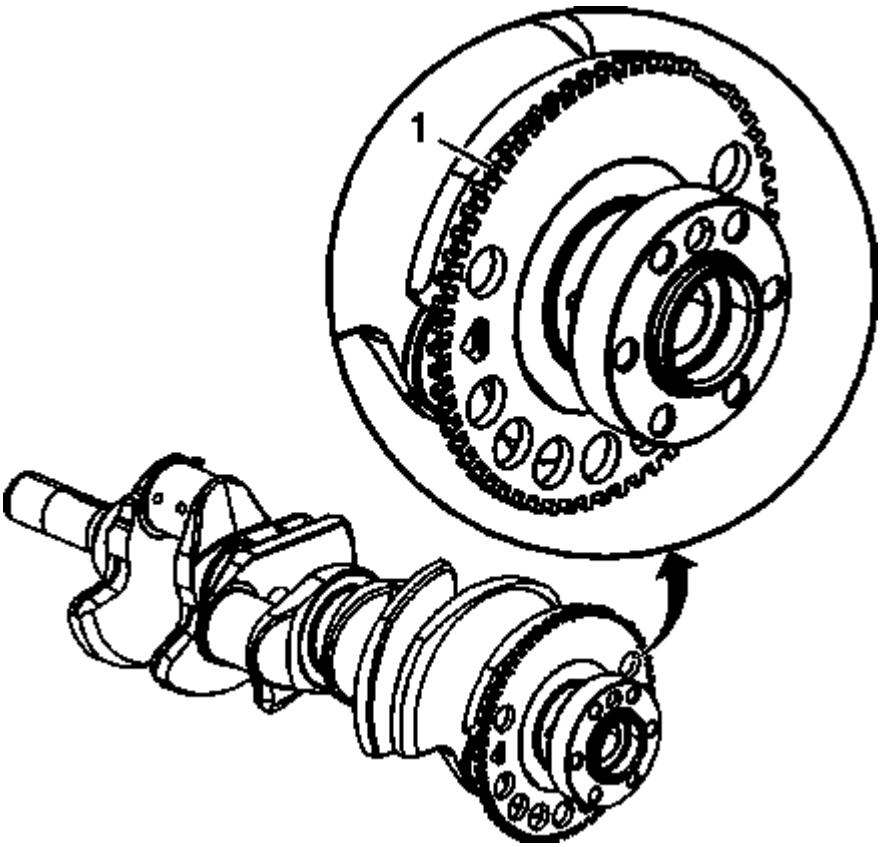


Fig. 93: View Of Reluctor Ring Teeth
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The reluctor ring teeth should not have imperfections on the rising or falling edges. Imperfections of the reluctor ring teeth may affect OBD II system performance.**

1. Inspect the CKP reluctor ring teeth (1) for damage.

cardiagn.com

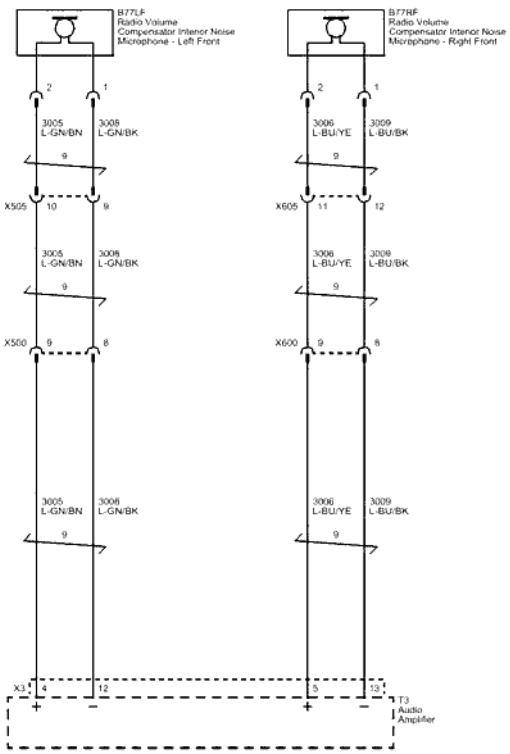


Fig. 94: View Of Crankshaft Journals
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the crankshaft journals for wear.

   Journals should be smooth (1) with no signs of scoring, wear or damage.

3. Inspect the crankshaft journals for grooves or scoring (2).
4. Inspect the crankshaft journals for scratches or wear (3).
5. Inspect the crankshaft journals for pitting or imbedded bearing material (4).
6. Inspect the crankshaft rear oil seal surface (5) for grooves or scoring.

cardiagn.com

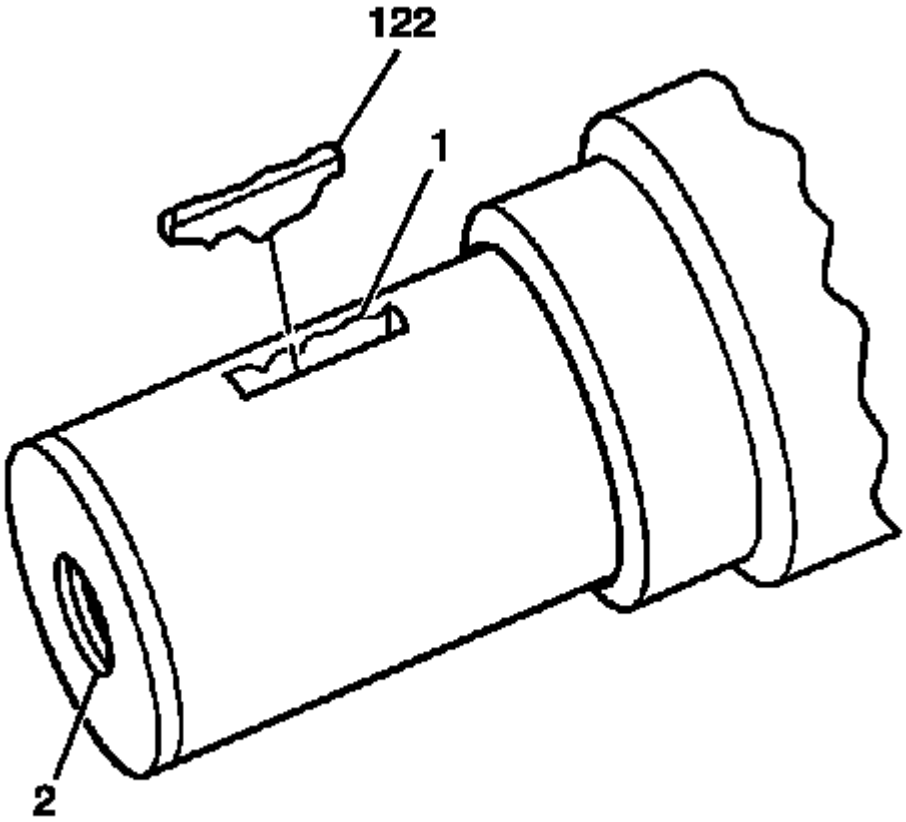


Fig. 95: View Of Crankshaft Key, Keyway & Threaded Hole
Courtesy of GENERAL MOTORS COMPANY

7. Inspect the crankshaft key (122), keyway (1) and threaded hole (2) for damage.

cardiagn.com

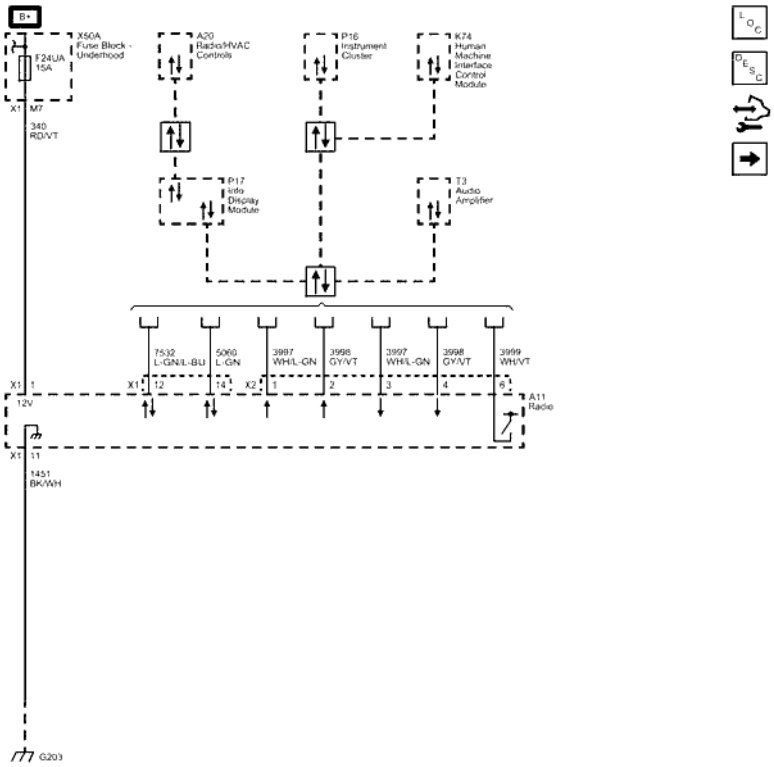


Fig. 96: Measuring Connecting Rod Journals For Out-Of-Round And Taper
Courtesy of GENERAL MOTORS COMPANY

8. Measure the connecting rod journals for out-of-round and taper.

cardiagn.com

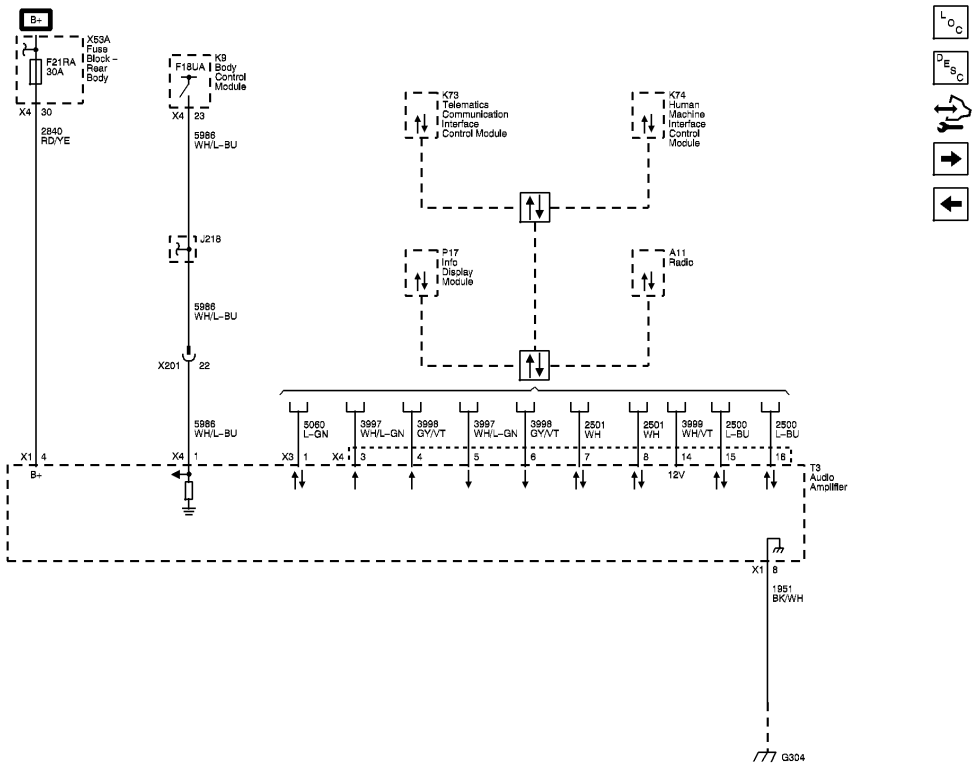


Fig. 97: Measuring Crankshaft Thrust Wall Width
Courtesy of GENERAL MOTORS COMPANY

9. Measure the crankshaft thrust wall width.

   A crankshaft with a thrust wall width in excess of 26.2 mm (1.0315 in) (a) must be replaced.

cardiagn.com

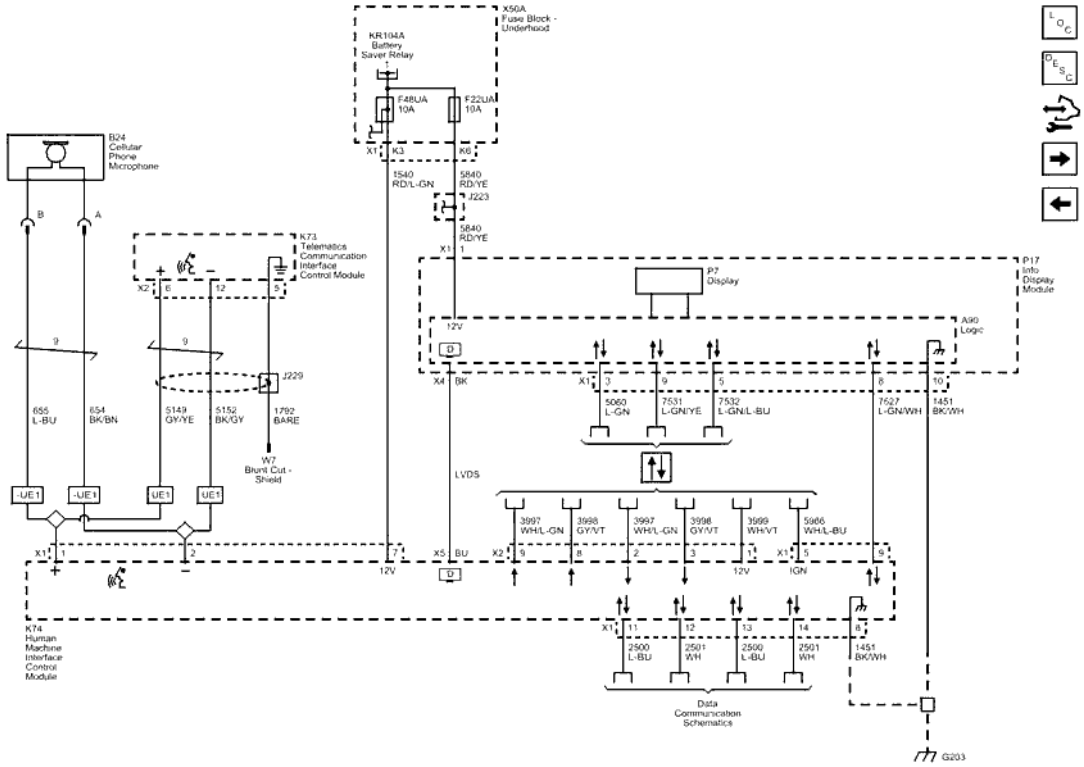


Fig. 98: Measuring Crankshaft Runout
Courtesy of GENERAL MOTORS COMPANY

10. Measure the crankshaft runout.

    Use wooden V-blocks or a fixture to support the crankshaft on the front and rear journals.

11. Use the **J 7872** set in order to measure the crankshaft runout at the front and rear intermediate journals.
12. Use the **J 7872** set in order to measure the runout of the crankshaft rear flange.
13. Use the **J 7872** set in order to measure the runout of the crankshaft position reluctor ring. Reluctor ring runout should be measured 1.0 mm (0.04 in) below the ring teeth.

    If the front and rear intermediate journals, crankshaft rear flange or reluctor ring runout exceeds specification, replace the crankshaft. Refer to **Engine Mechanical Specifications** .

cardiagn.com

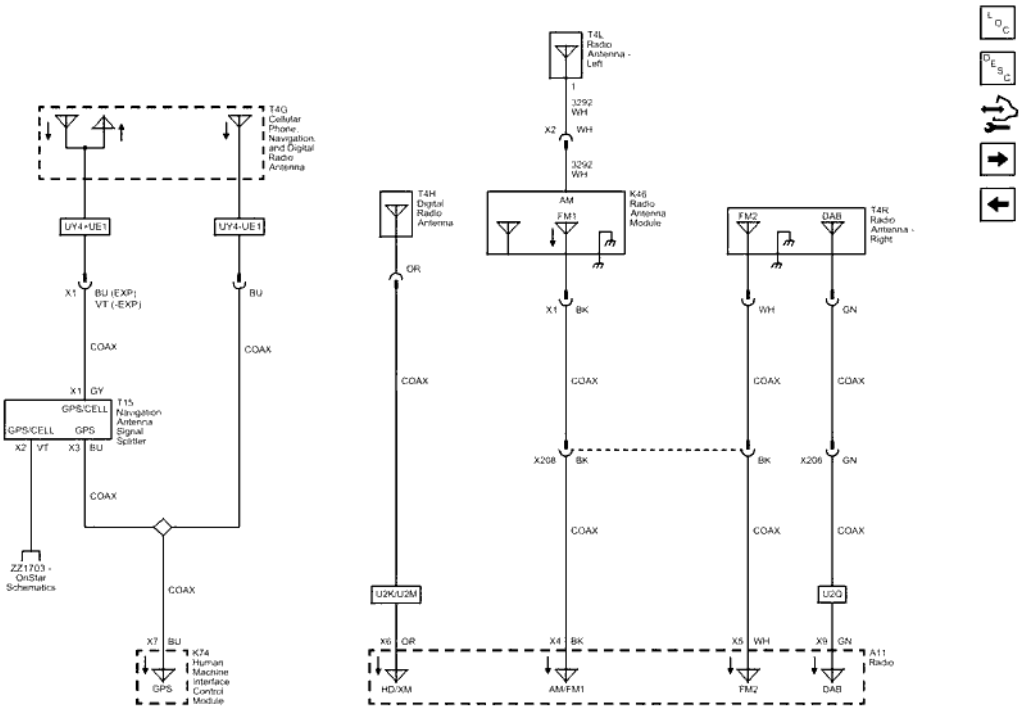


Fig. 99: Identifying Crankshaft Bearing Craters Or Pockets
Courtesy of GENERAL MOTORS COMPANY

14. Inspect crankshaft bearings for craters or pockets. Flattened sections on the bearing halves also indicate fatigue.

cardiagn.com

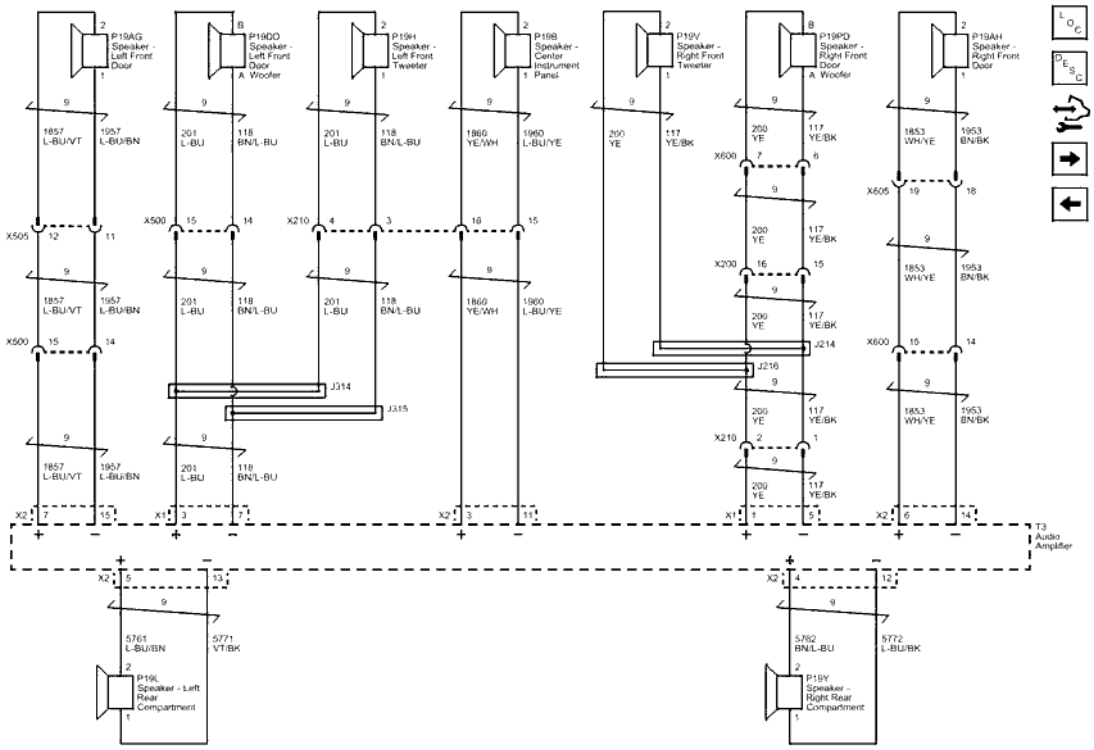


Fig. 100: Identifying Connecting Rod Bearing Scoring Or Discoloration
Courtesy of GENERAL MOTORS COMPANY

15. Inspect the crankshaft bearings for excessive scoring or discoloration.
16. Inspect the crankshaft bearings for dirt or debris imbedded into the bearing material.

cardiagn.com

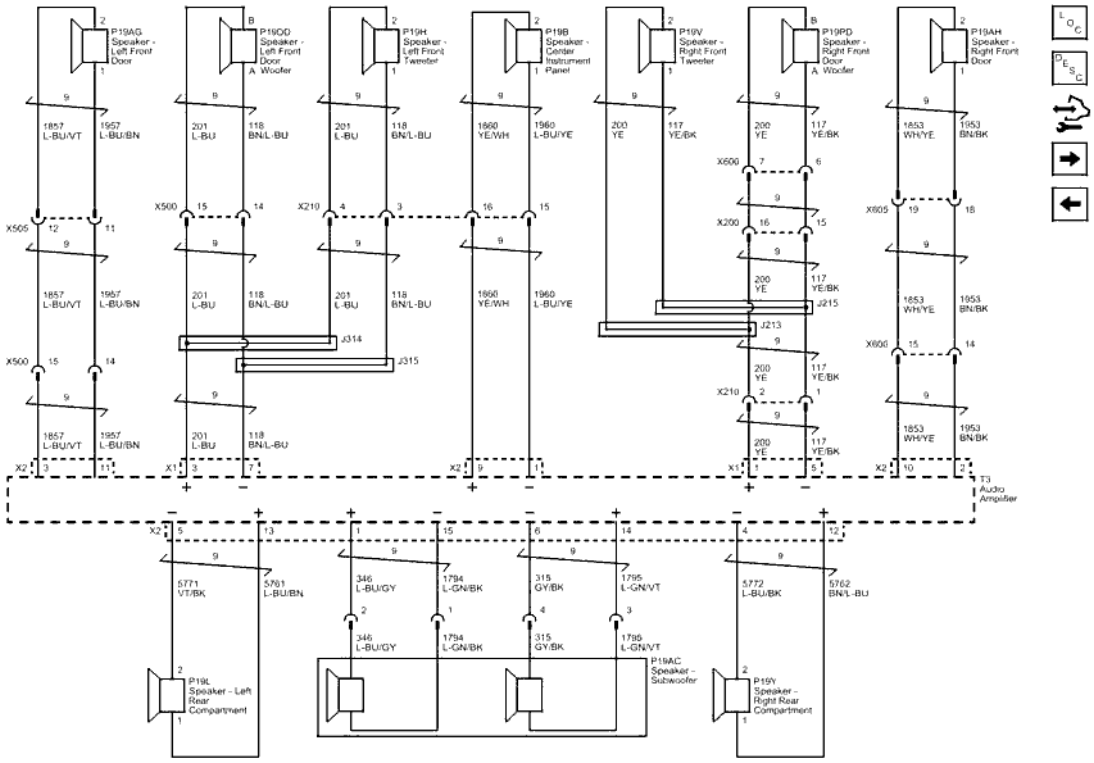


Fig. 101: View Of Improper Seating
Courtesy of GENERAL MOTORS COMPANY

17. Inspect the crankshaft bearings for improper seating, indicated by bright, polished sections of the bearing.

    If the lower half of the bearing is worn or damaged, both upper and lower halves should be replaced.

    Generally, if the lower half is suitable for use, the upper half should also be suitable for use.

Measuring Main Bearing Clearance - Gaging Plastic Method

cardiagn.com

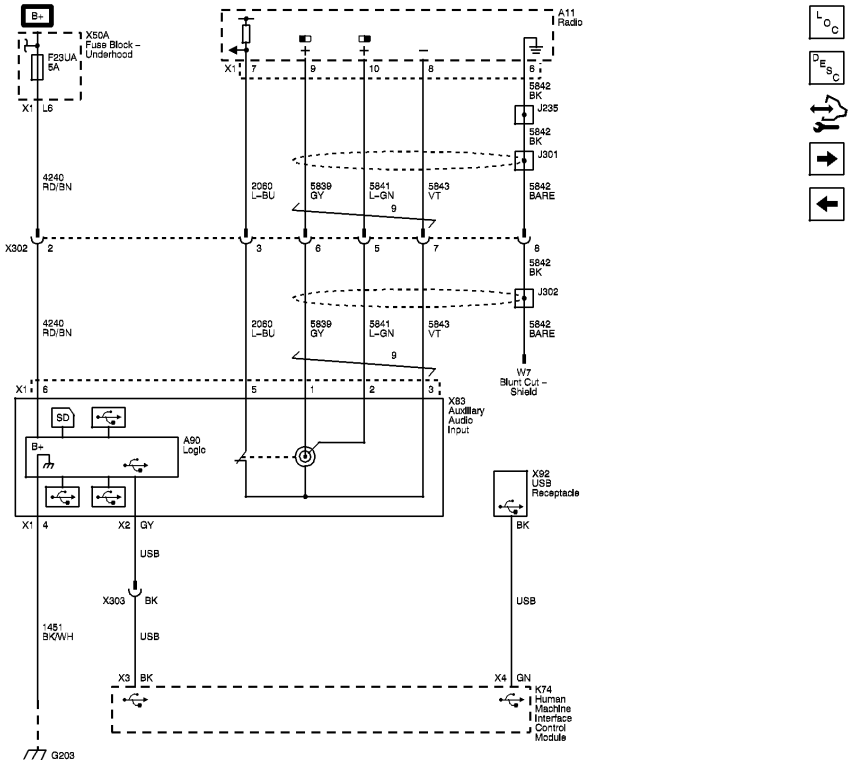


Fig. 102: View Of Gaging Plastic Installed On Crankshaft Journal
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The crankshaft main bearings are a precision insert type. Main bearing caps are machined with the engine block, for proper clearance and cannot be shimmed or filed for bearing fit. If the clearances are found to be excessive, new bearings and/or engine block and cap repair or replacement may be required.**
- **Do not rotate the crankshaft while gaging plastic is between the crankshaft journal and the bearing surface.**
- **The crankshaft bearing clearances are critical. Excessive bearing clearance may affect crankshaft position sensor signals and may affect OBD II system operation.**
- **Remove the bearing cap side bolts prior to cap removal.**

1. Remove the bearing caps, bearing half and bolts. Refer to **Crankshaft and Bearing Removal**.
2. Install gaging plastic onto the crankshaft journal. Install the gaging plastic the full width of the crankshaft bearing journal.
3. Install the bearing caps, bearing half and bolts. Refer to **Crankshaft and Bearing Installation**.
4. Remove the bearing caps, bearing half and bolts. Refer to **Crankshaft and Bearing Removal**.

cardiagn.com

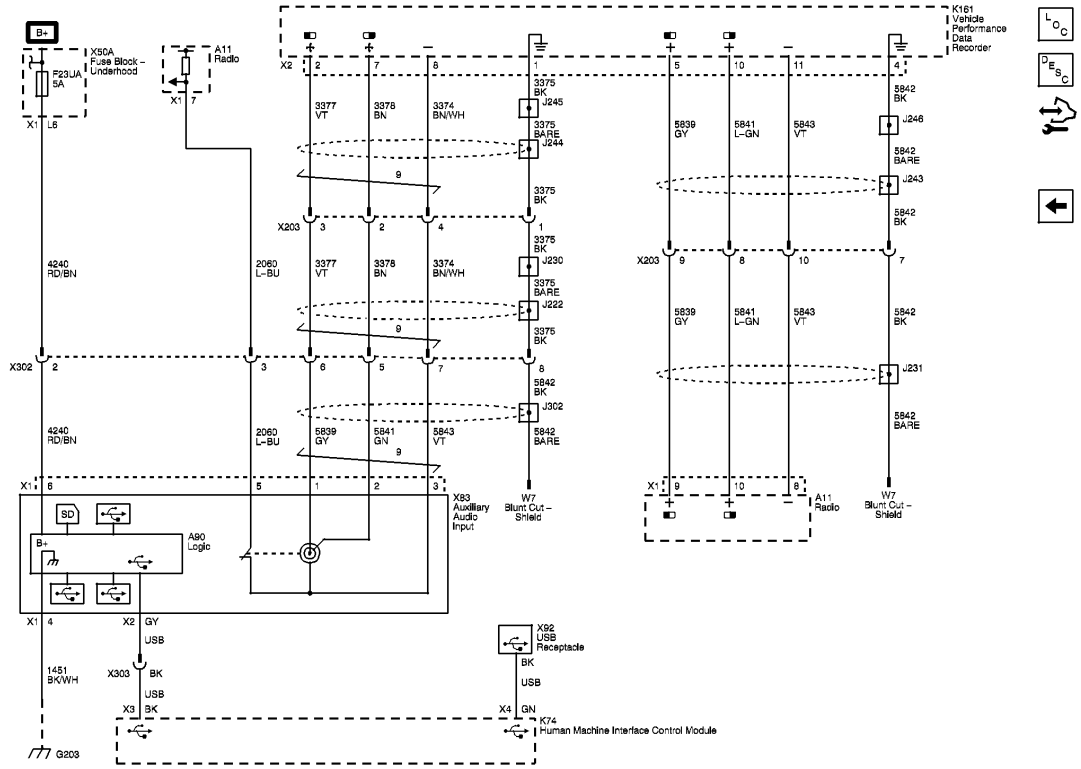


Fig. 103: Measuring Gaging Plastic
Courtesy of GENERAL MOTORS COMPANY

5. Using the scale supplied with the plastic gaging kit, measure the gaging plastic at its widest area.
    - If the gaging plastic shows irregularity in the journal, exceeding 0.025 mm (0.001 in), remove the crankshaft and measure the journal with a micrometer.
    - If clearance cannot be brought to specifications, replace the crankshaft or engine block as required. Refer to **Engine Mechanical Specifications** .

Measuring Connecting Rod Bearing Clearance - Gaging Plastic Method

cardiagn.com

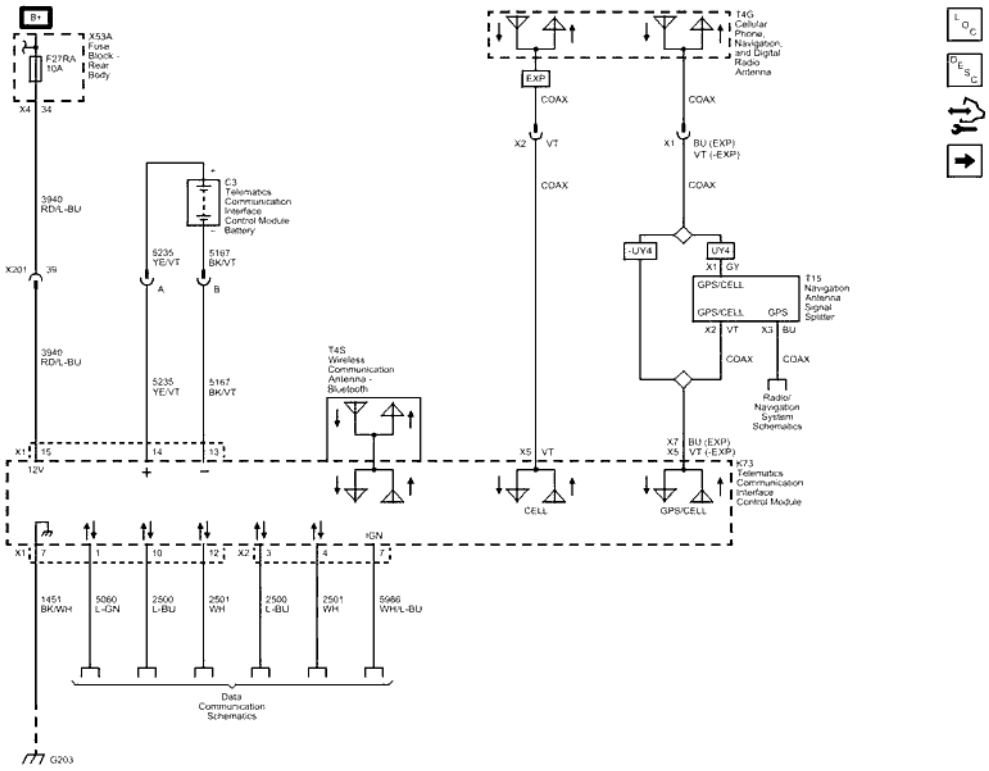


Fig. 104: View Of Gaging Plastic Installed On Crankshaft Journal
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Connecting rod bearings are a precision insert type. Connecting rods are of a powdered metal design and cannot be shimmed or filed for bearing fit. If clearances are found to be excessive, a new bearing and/or connecting rod is required.**
- **Do not rotate the crankshaft while gaging plastic is between the crankshaft journal and the bearing surface.**

1. Remove the bearing cap, bearing half and bolts. Refer to **Piston, Connecting Rod and Bearing Removal**.
2. Install the gaging plastic onto the connecting rod bearing journal. Install the gaging plastic the full width of the journal.
3. Install the bearing cap, bearing half and bolts. Refer to **Piston, Connecting Rod and Bearing Installation**.
4. Remove the bearing cap, bearing half and bolts. Refer to **Piston, Connecting Rod and Bearing Removal**.

cardiagn.com

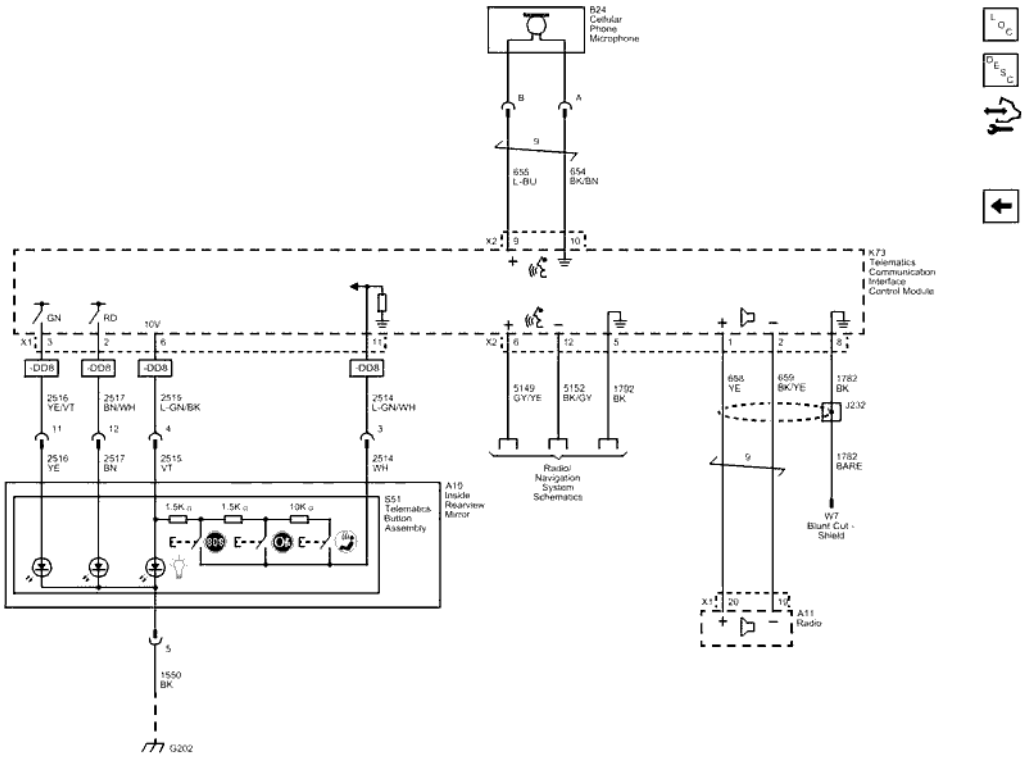


Fig. 105: Measuring Gaging Plastic
Courtesy of GENERAL MOTORS COMPANY

5. Using the scale supplied with the plastic gaging kit, measure the gaging plastic at its widest area. Refer to **Engine Mechanical Specifications** .

Measuring Connecting Rod Bearing Clearance - Using J 43690/J 43690-100

J 43690 tool and **J 43690-100** kit have been developed as a more accurate method to measure connecting rod bearing clearances. The instructions below provide an overview of tool set-up and usage. For more detailed information, refer to the tool instruction sheets supplied by the tool manufacturer.

cardiagn.com

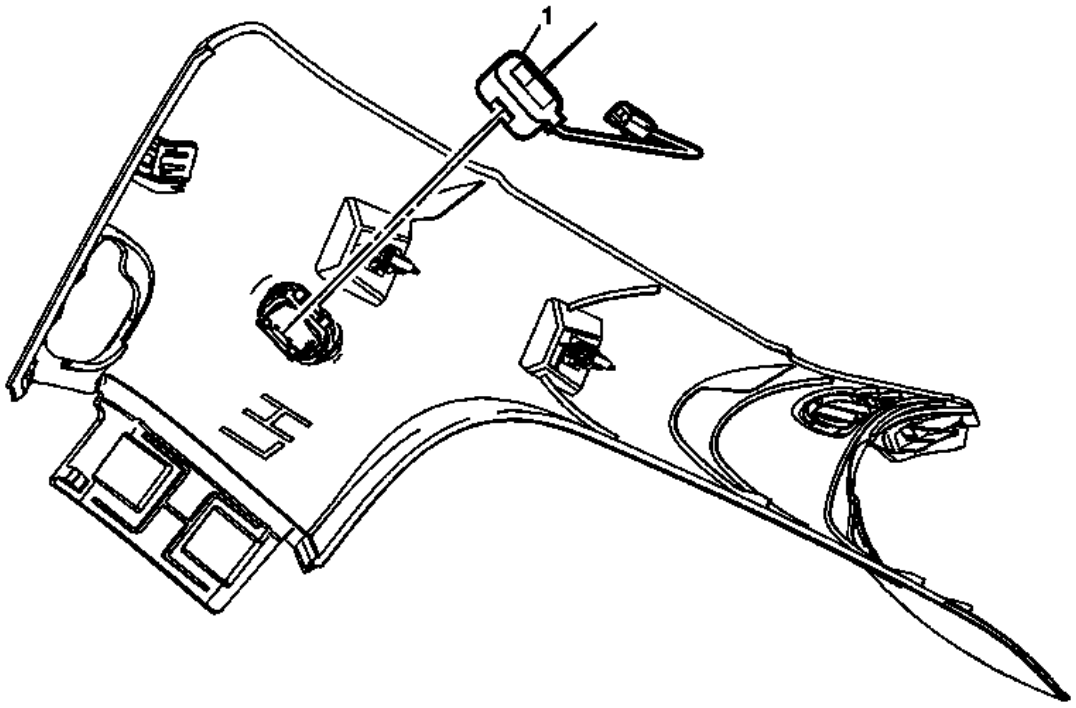


Fig. 106: Identifying Rod Bearing Clearance Checking Tool
Courtesy of GENERAL MOTORS COMPANY

J 43690 tool

- J 43690-20 Swivel Base (1)
- J 43690-19 Dial Indicator (2)
- J 43690-2 Base (3)
- J 43690-5, J 43690-6 Handle (4)
- J 43690-10, J 43690-11 Foot (5)
- 280307 Screw (6)
- J 43690-1 Pivot Arm Assembly (7)
- J 43690-3, J 43690-7, J 43690-8 Screws (8)
- 280319 Screw (9)
- 280311 Screw (10)
- J 43690-17, J 43690-18 Adapter (11)
- 280310 Pin (12)

cardiagn.com

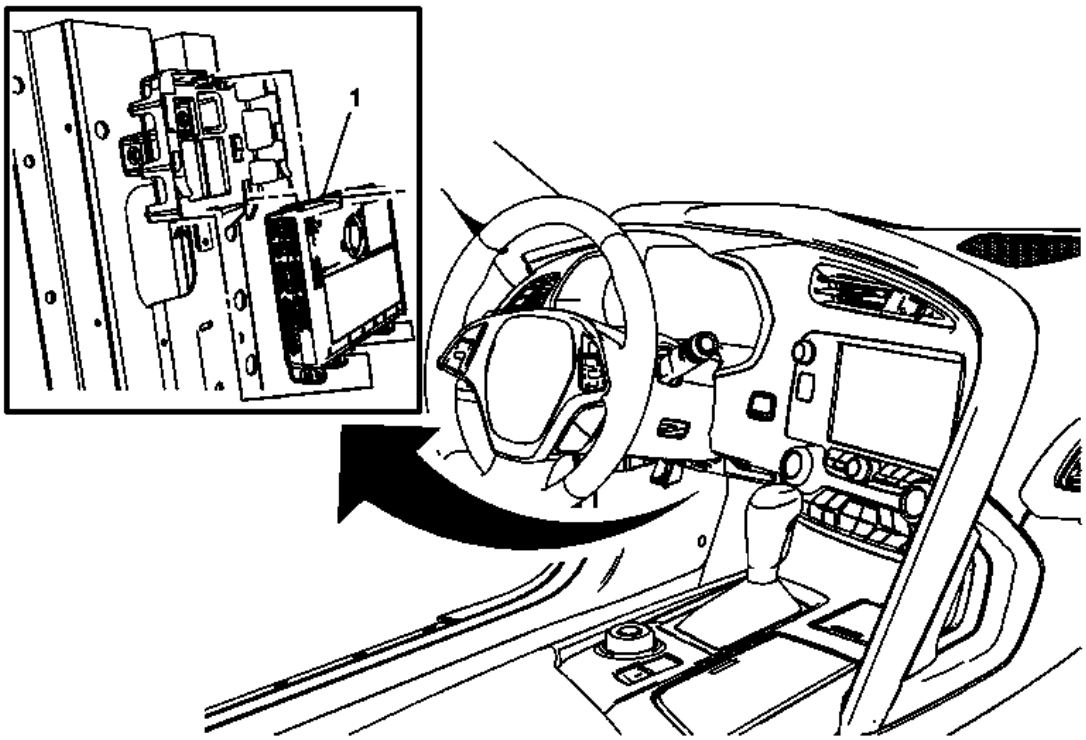


Fig. 107: Identifying Rod Bearing Clearance Tool - Adapter Kit
Courtesy of GENERAL MOTORS COMPANY

J 43690 Rod Bearing Checking Tool

- J 43690-104 Spacer (1)
- J 43690-105 Retainer Plate (2)
- 505478 Bolt (3)
- 511341 Bolt (4)
- J 43690-106 Retainer Plate (5)
- J 43690-107 Cap (6)
- J 43690-102 Foot (7)
- J 43690-101 Pivot Arm Assembly (8)
- J 43690-103 Adapter (9)
- 505439 Adapter (10)

cardiagn.com

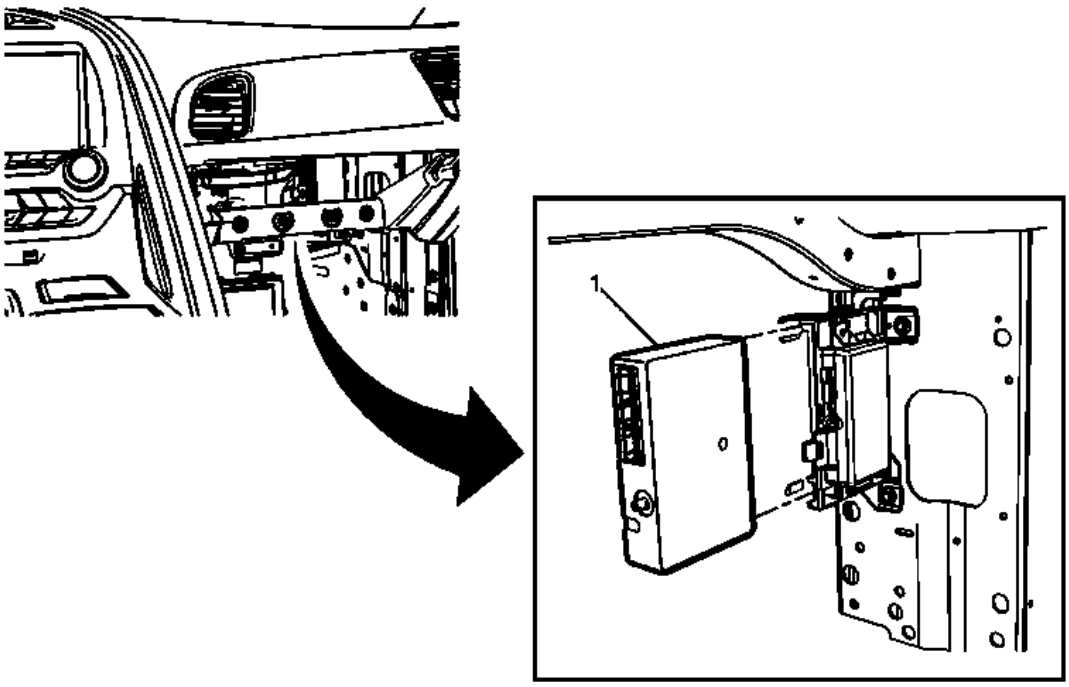


Fig. 108: View Of Bearing Cap, Bolt & Bearing Half
Courtesy of GENERAL MOTORS COMPANY

NOTE: The crankshaft must be secure, with no movement or rotation, in order to obtain an accurate reading.

1. Rotate the crankshaft until the journal/connecting rod to be measured is in the 12 o'clock position.
2. Remove a bearing cap and bolts (1).
3. Remove the bearing half (2).
4. Insert a piece of paper card stock onto the crankshaft journal.
5. Install the bearing half (2) and cap and bolts (1). Refer to **Fastener Tightening Specifications** .

cardiagn.com

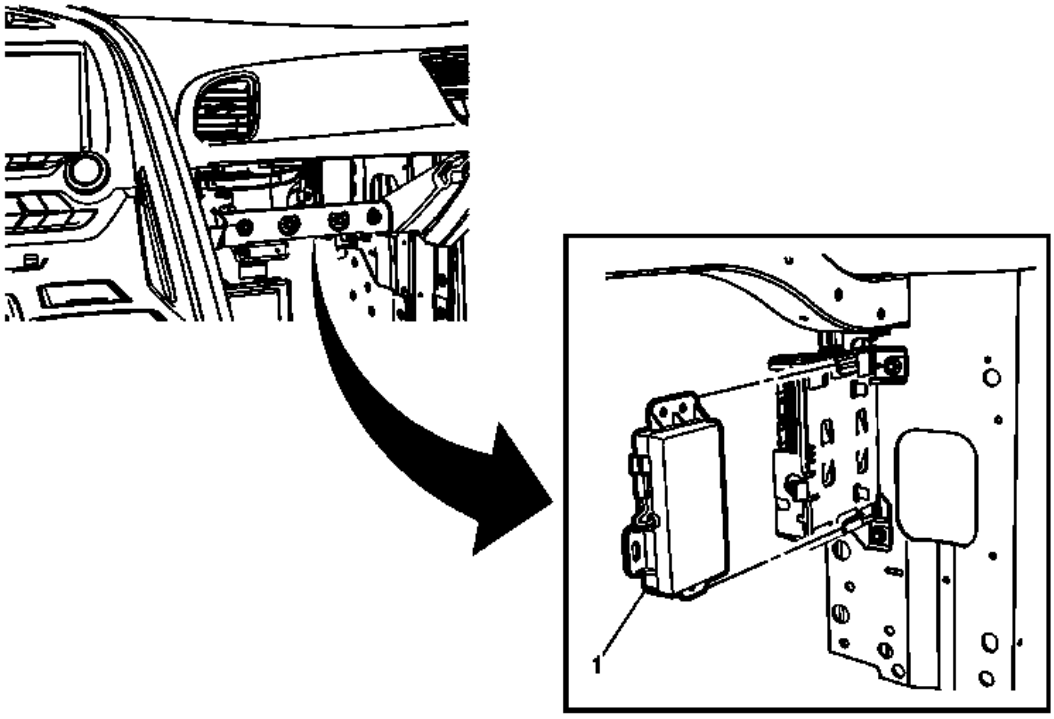


Fig. 109: View Of Special Tool Installed On Engine Block
Courtesy of GENERAL MOTORS COMPANY

6. Install the following:
    1. J 43690-2 (5)
    2. J 43690-3 (4)
    3. J 43690-101 (2)
    4. 280310 (3)
    5. J 43690-5 (1)

cardiagn.com

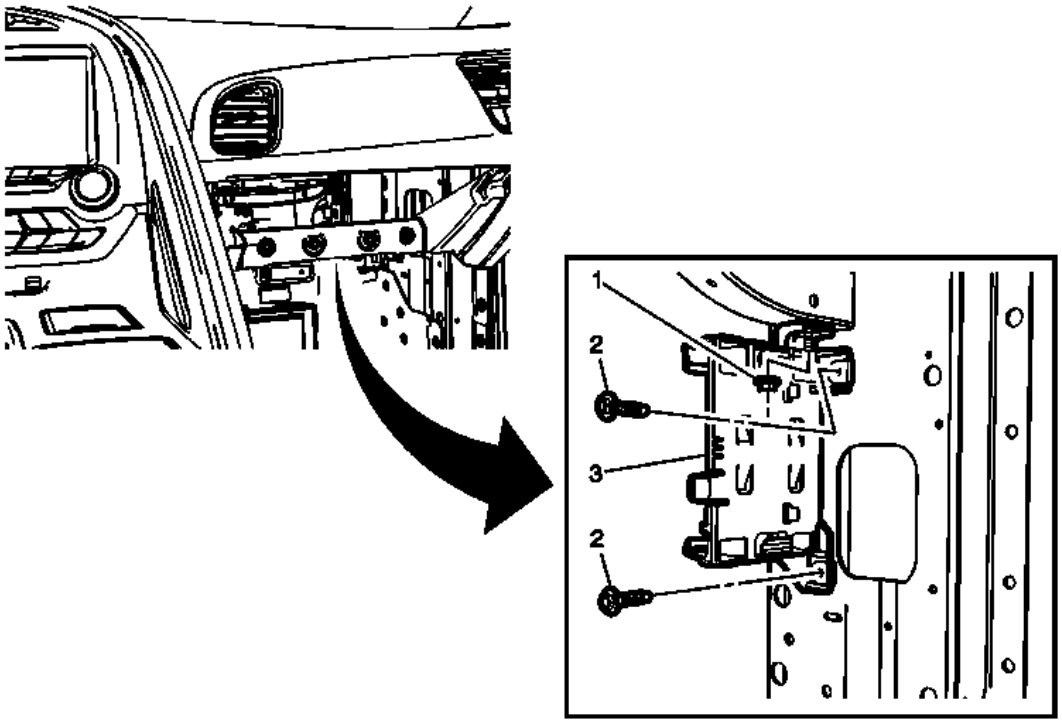


Fig. 110: View Of Swivel Base & Dial Indicator
Courtesy of GENERAL MOTORS COMPANY

7. Install the swivel base (1) and dial indicator (2).
8. Adjust per the manufacturers instructions and measure the connecting rod bearing clearance.

   A connecting rod with a clearance in excess of 0.076 mm (0.003 in) is considered excessive. Service components, as required.

CRANKSHAFT BALANCER CLEANING AND INSPECTION

cardiagn.com

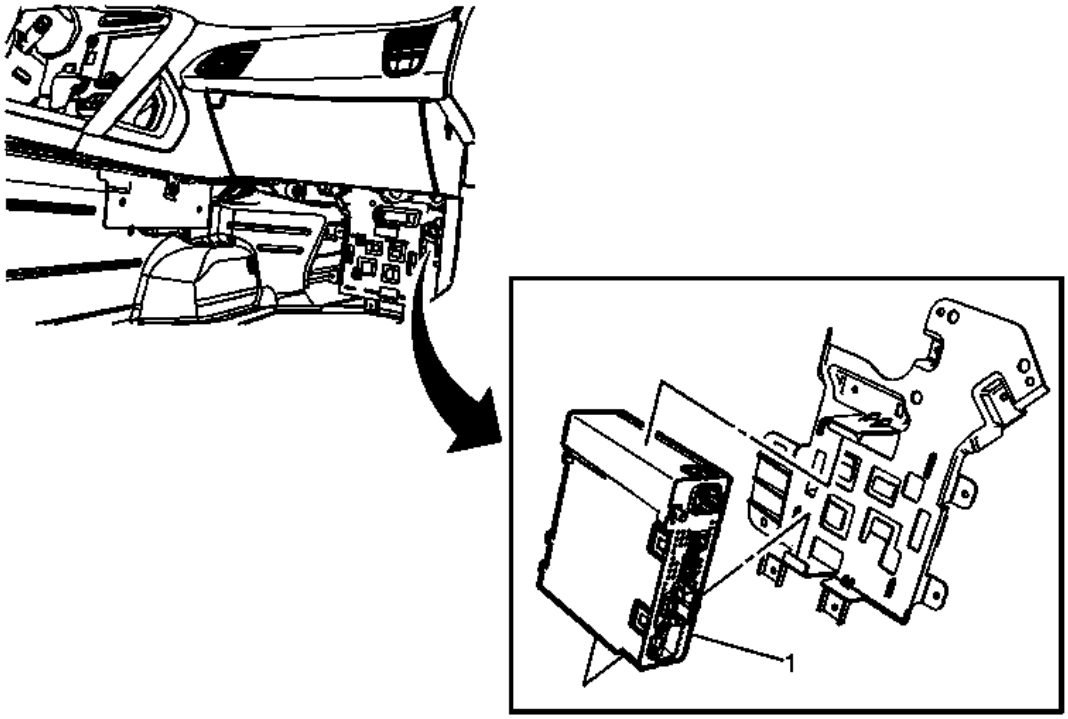


Fig. 111: View Of Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

1. Clean the crankshaft balancer in solvent.
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 conditions:
   - Worn, grooved or damaged hub seal surface

     A crankshaft balancer hub seal surface with excessive scoring, grooves, rust or other damage must be replaced.

     Minor imperfections on the hub seal surface may be removed with polishing compound or fine grade emery cloth.

     IMPORTANT: In order for the belt to track properly, the belt grooves should be free of all dirt or debris.

   - Dirty or damaged belt grooves

     The balancer belt grooves should be free of any nicks, gouges or other damage that may not allow the belt to track properly.

     Minor imperfections may be removed with a fine file.

cardiagn.com

- Worn, chunking or deteriorated rubber between the hub and pulley

AUTOMATIC TRANSMISSION FLEX PLATE CLEANING AND INSPECTION

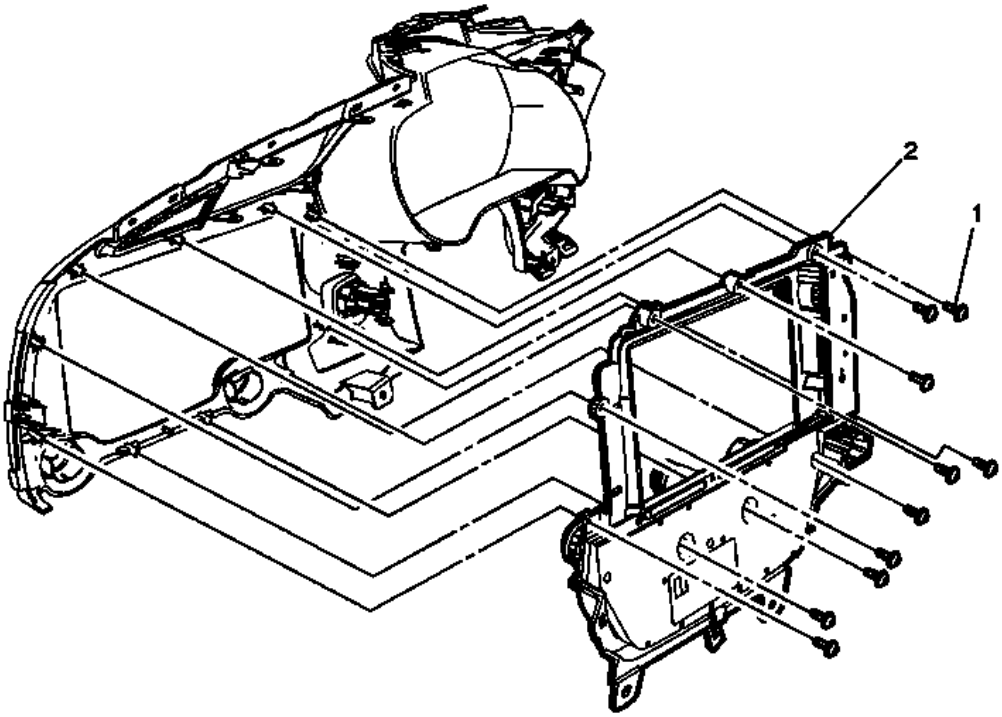


Fig. 112: View Of Ring Gear Teeth
Courtesy of GENERAL MOTORS COMPANY

1. Clean the flex plate in solvent.

WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

2. Dry the flex plate with compressed air.
3. Inspect the flex plate for the following conditions:
   - Damaged ring gear teeth (1)
   - Stress cracks around the flex plate-to-crankshaft bolt hole locations (2)

NOTE: **Do not attempt to repair the welded areas that retain the ring gear to the flex plate. Install a new flex plate.**

   - Welded areas (3) that retain the ring gear onto the flex plate for cracking

PISTON AND CONNECTING ROD DISASSEMBLE

cardiagn.com

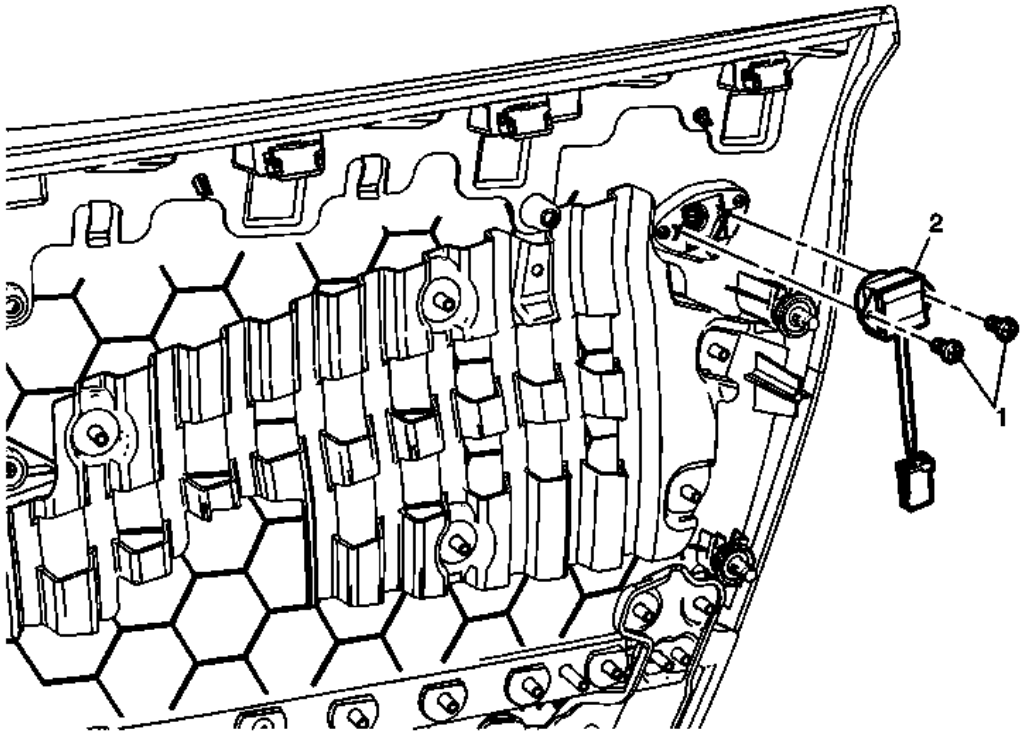


Fig. 113: View Of Piston, Connecting Rod & Bearing Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Remove the connecting rod bearings from the rod and cap.

cardiagn.com

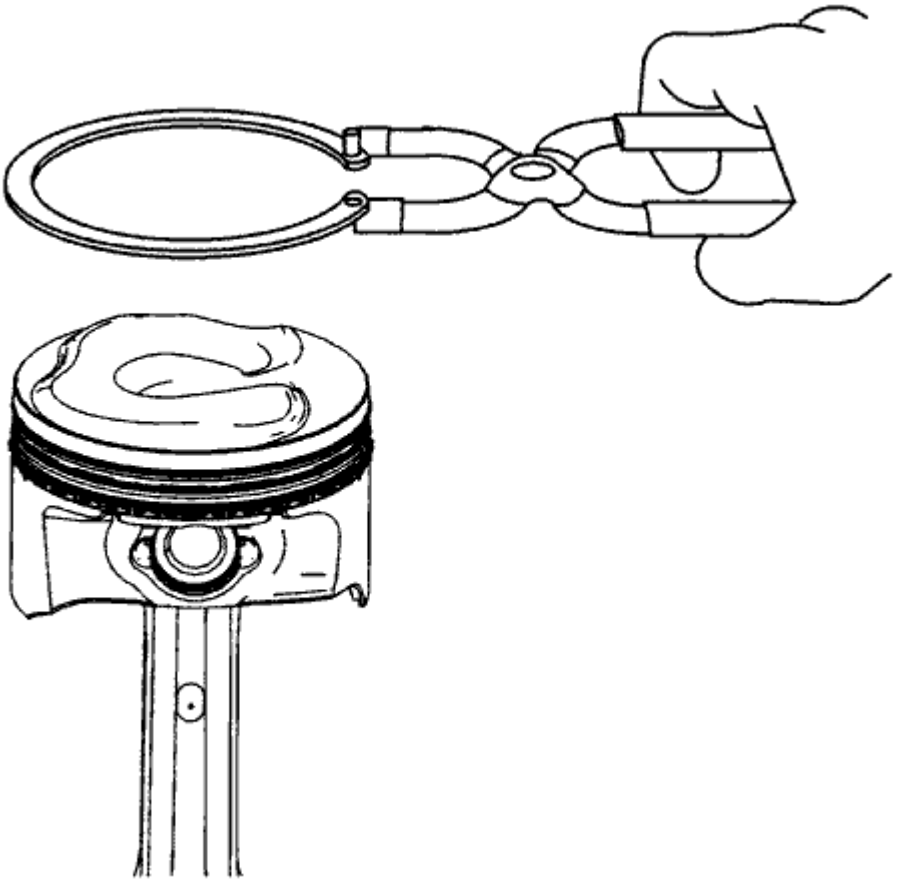


Fig. 114: Remove Piston Rings From Piston Using Piston Ring Pliers
Courtesy of GENERAL MOTORS COMPANY

2. Using piston ring pliers, remove the piston rings from the piston.

cardiagn.com

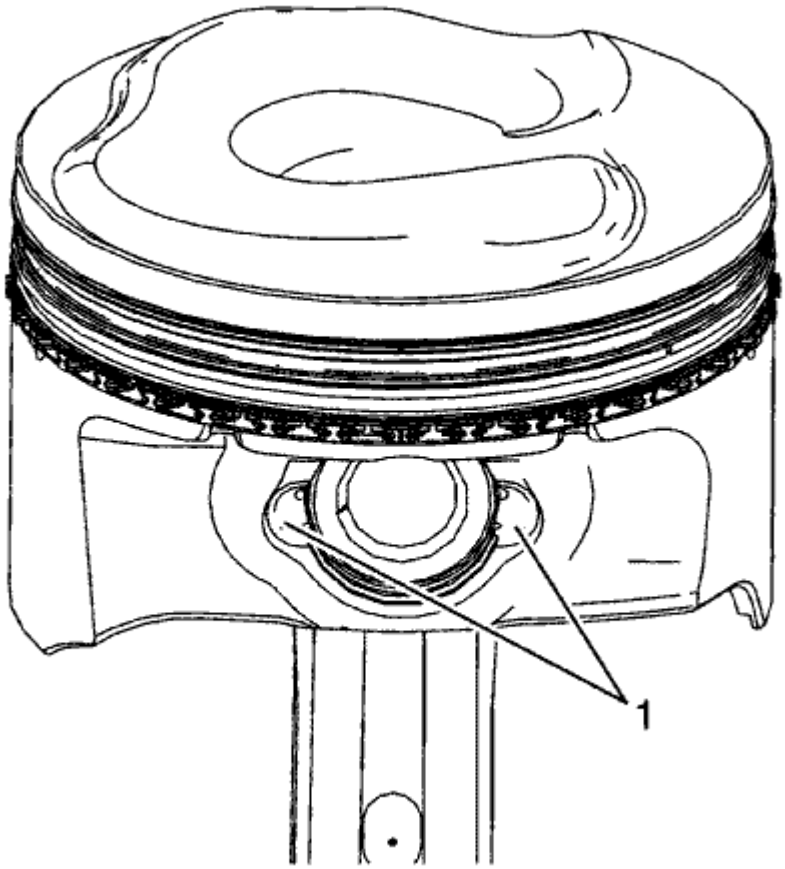


Fig. 115: Rotating Piston Pin Retainers Until Ring End Gaps Are Positioned In Cutout Area
Courtesy of GENERAL MOTORS COMPANY

3. Rotate the piston pin retainers until the ring end gaps are positioned in the cutout area (1) of the pin bore.

cardiagn.com

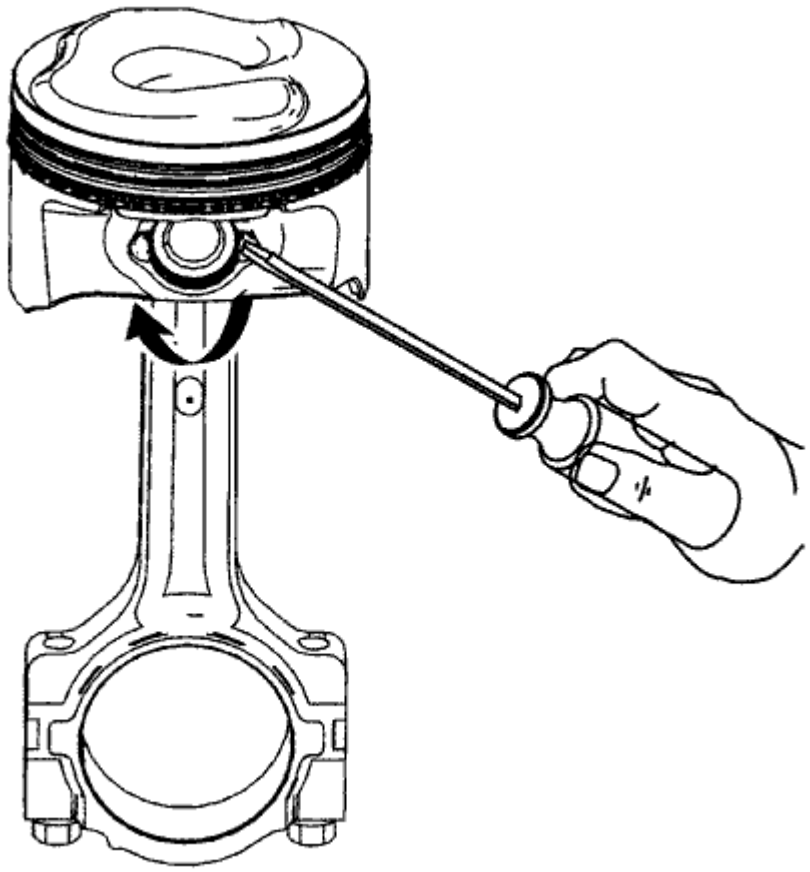


Fig. 116: Removing Retainers Starting In Cutout Area Of Pin Bore
Courtesy of GENERAL MOTORS COMPANY

4. Remove the retainers starting in the cutout area of the pin bore.

cardiagn.com

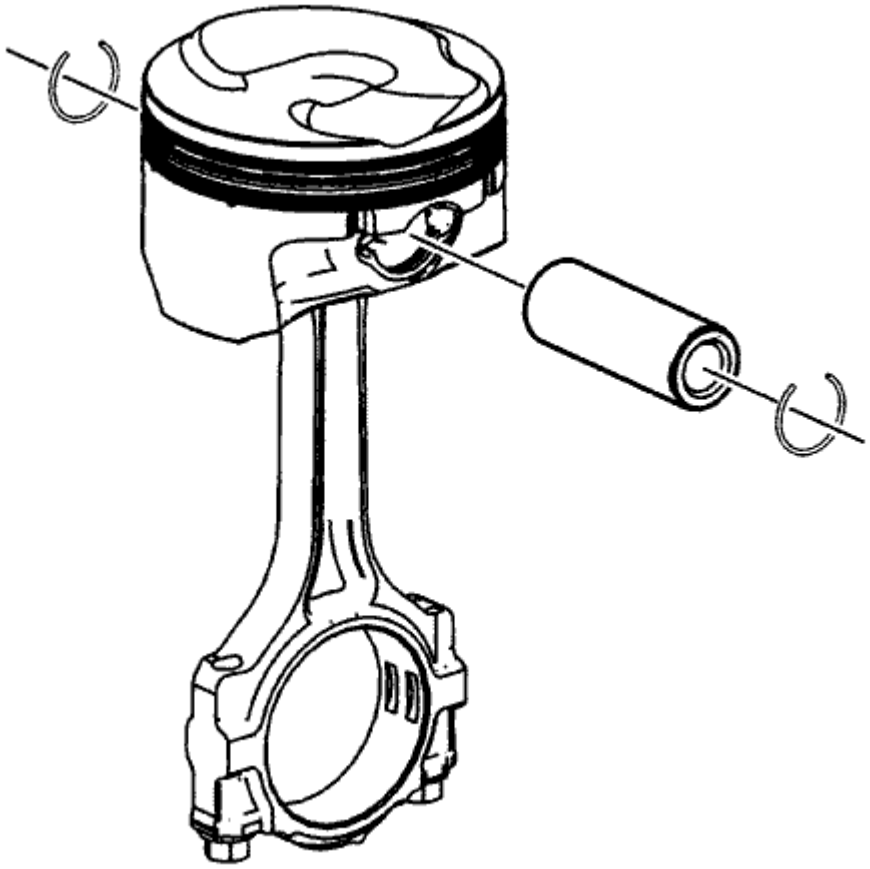


Fig. 117: Removing Pin From Piston And Connecting Rod
Courtesy of GENERAL MOTORS COMPANY

5. Remove the pin from the piston and connecting rod.
6. The piston and pin are a matched set and are not to be serviced separately.

Mark, sort or organize the piston and the matching piston pin.

PISTON, CONNECTING ROD AND BEARING CLEANING AND INSPECTION

Piston, Pin and Piston Rings

cardiagn.com

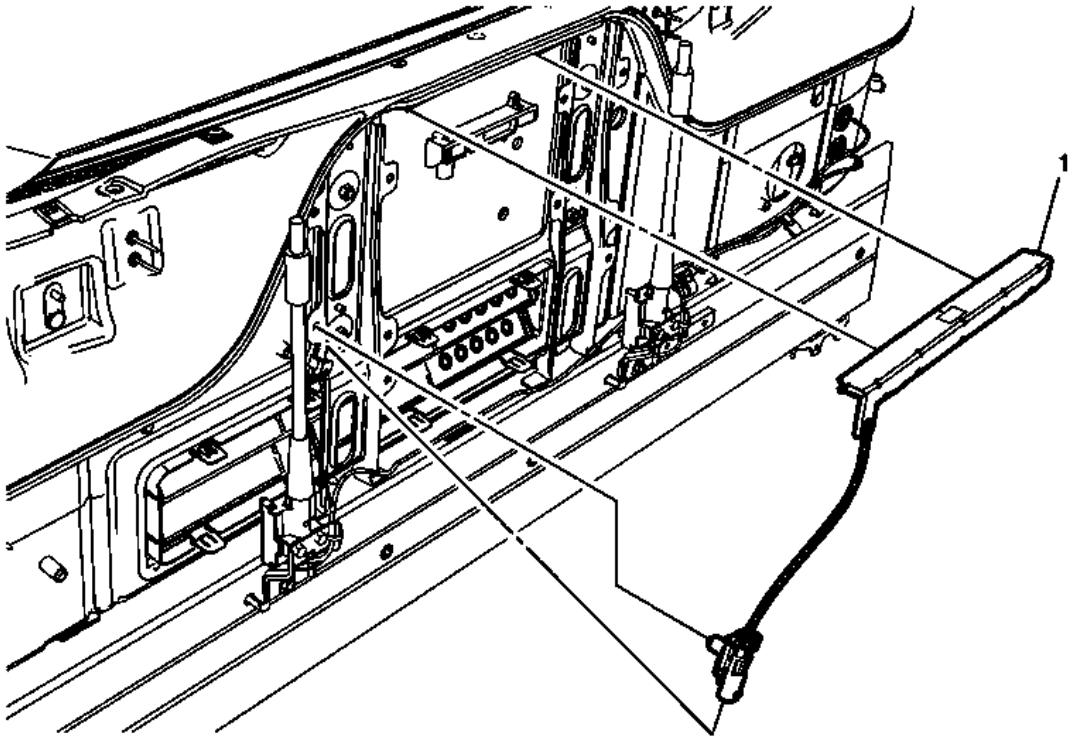


Fig. 118: View Of Piston, Pin & Piston Rings
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Replace pistons, pins and connecting rods that are damaged or show signs of excessive wear.**
- **The piston and pin are to be serviced as an assembly.**
- **Do not wire brush any part of the piston.**
- **Measurement of the components should be taken with the components at normal room temperature.**

1. Clean the varnish and carbon from the piston (107) using cleaning solvent.

   WARNING: Refer to Safety Glasses Warning .

2. Dry the components with compressed air.

cardiagn.com

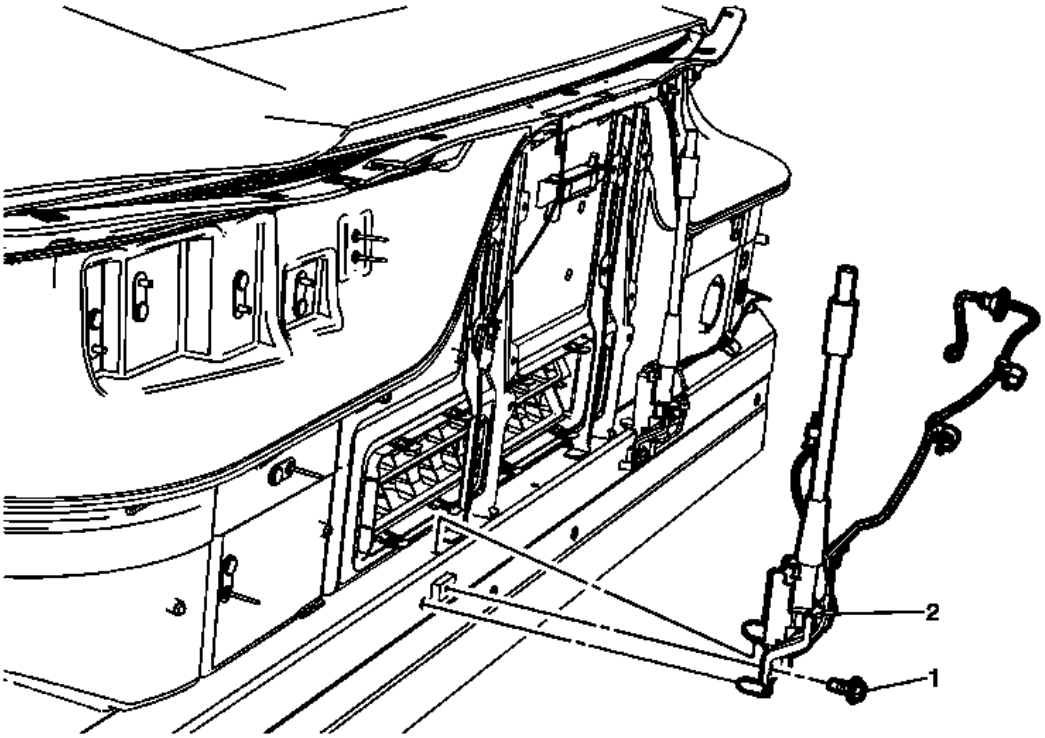


Fig. 119: Cleaning Piston Ring Grooves
Courtesy of GENERAL MOTORS COMPANY

3. Clean the piston ring grooves with a suitable ring groove cleaning tool.
4. Clean the oil lubrication holes and slots.

cardiagn.com

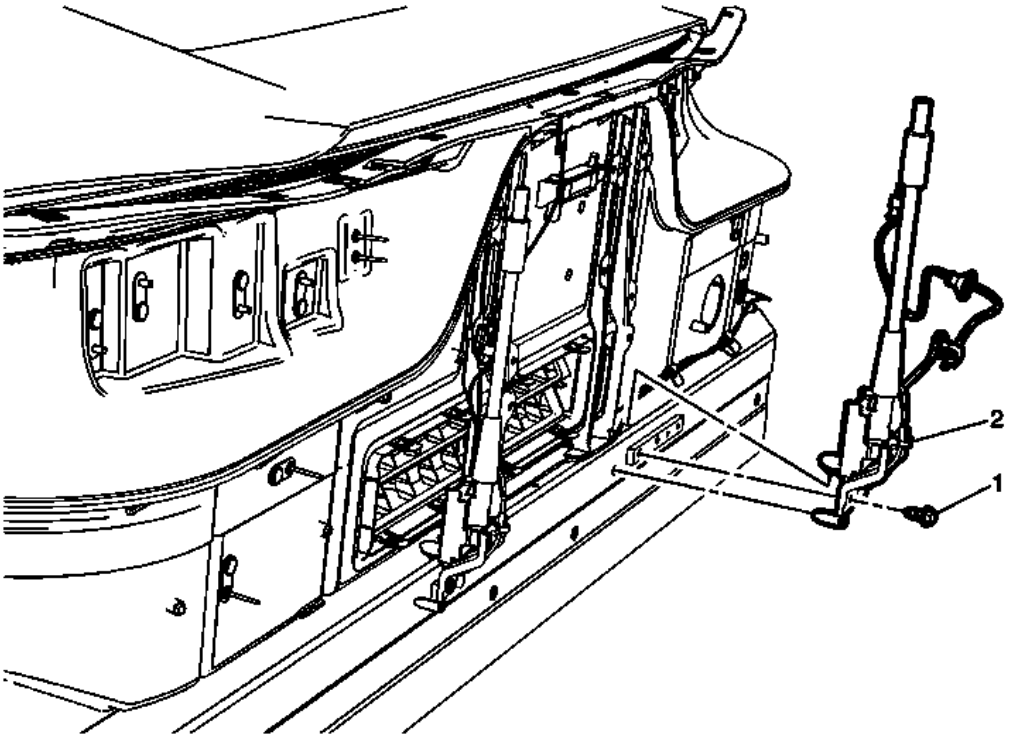


Fig. 120: Identifying Piston Damage Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the piston for the following conditions:
   - Cracks in the piston ring lands, the piston skirt or pin bosses
   - Piston ring grooves for nicks, burrs or warpage which may cause the piston ring to bind

     MINOR imperfections may be removed from the piston with a fine file.

   - Eroded areas at the top of the piston (1)
   - Scuffed or damaged skirts (2)
   - Scoring to the piston pin bore (3) or piston pin

cardiagn.com

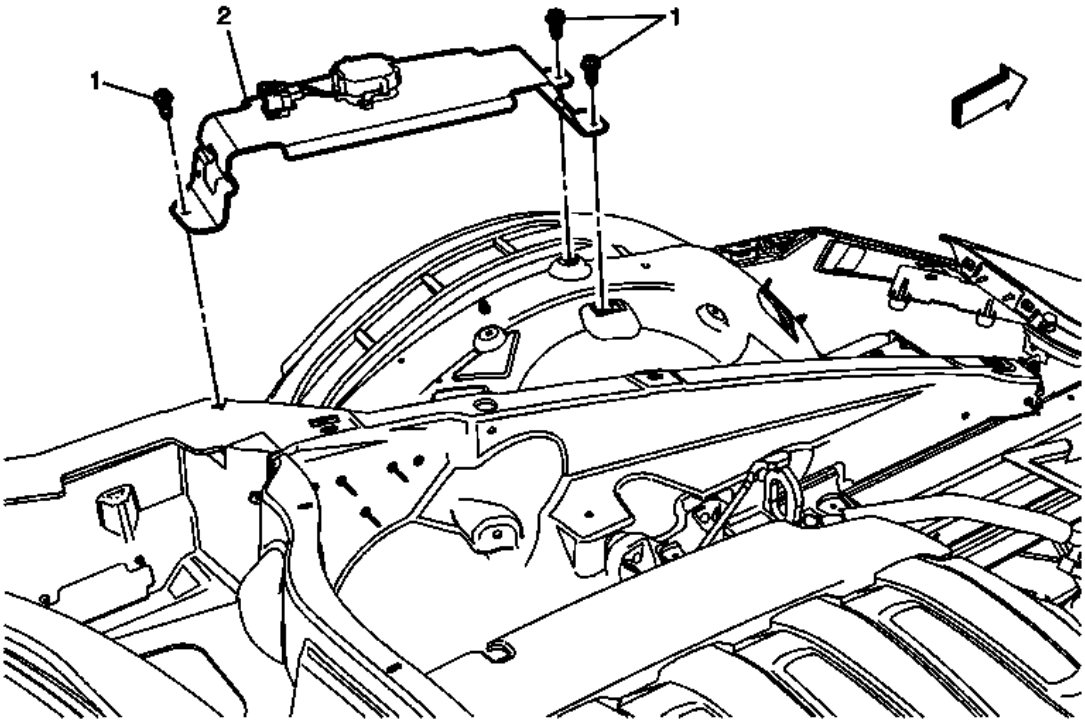


Fig. 121: Inserting Piston Ring Into Ring Groove
Courtesy of GENERAL MOTORS COMPANY

6. Insert the edge of the piston ring into the piston ring groove.

   Roll the piston ring completely around the piston. If binding is caused by a distorted ring groove, MINOR imperfections may be removed with a fine file. If binding is caused by a distorted piston ring, replace the rings, as required.

cardiagn.com

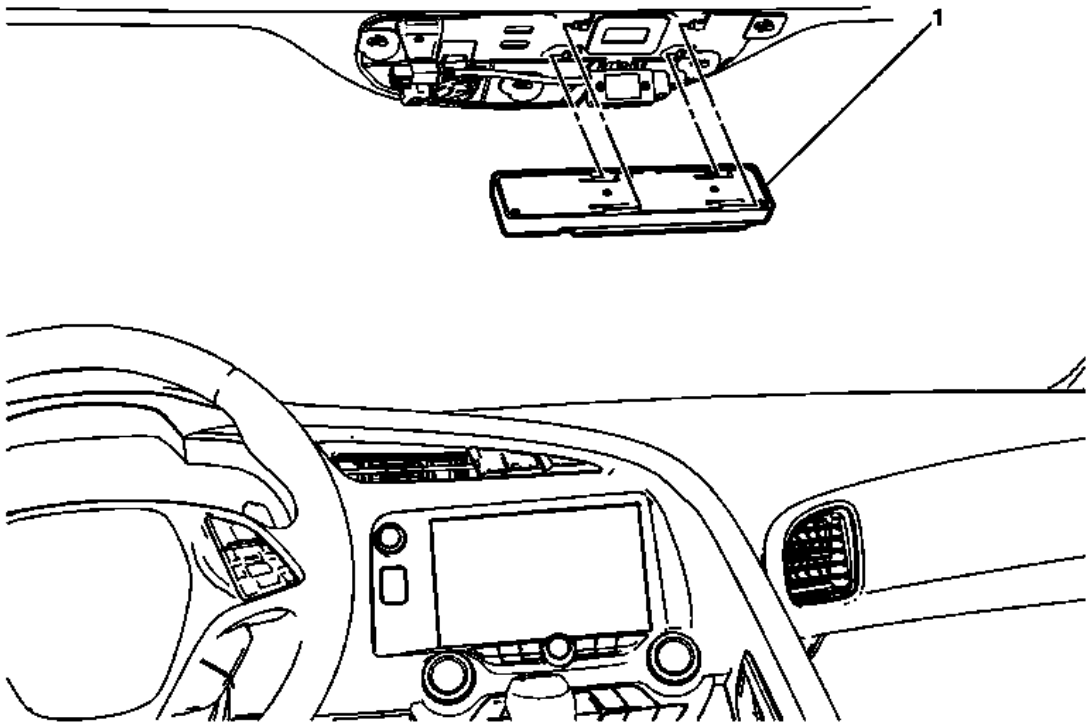


Fig. 122: Measuring Piston Ring Side Clearance
Courtesy of GENERAL MOTORS COMPANY

7. Measure the piston ring side clearance with a feeler gauge. If side clearance is not within specifications, try another piston ring. If the proper ring-to-groove clearance cannot be obtained, replace the piston and pin as an assembly. Refer to **Engine Mechanical Specifications** .

cardiagn.com

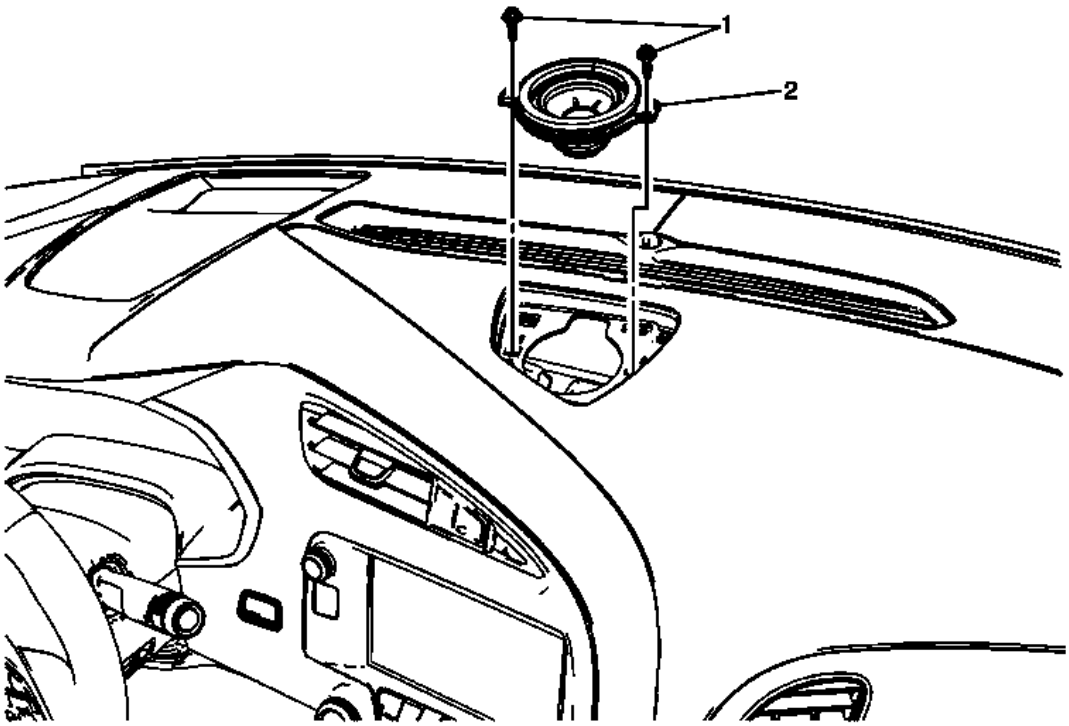


Fig. 123: Measuring Piston Pin Diameter
Courtesy of GENERAL MOTORS COMPANY

8. To determine piston pin-to-bore clearance, use a micrometer and measure the piston pin outside diameter (OD).

cardiagn.com

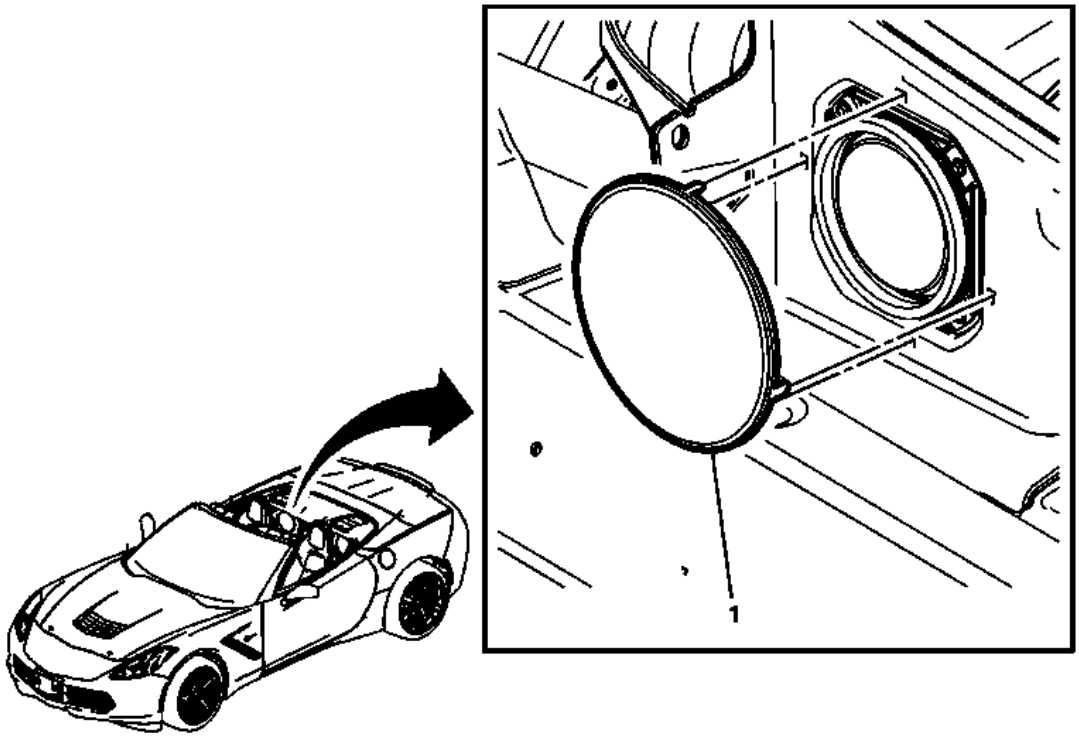


Fig. 124: Measuring Piston Pin-To-Bore Clearance
Courtesy of GENERAL MOTORS COMPANY

9. To determine the piston pin-to-bore clearance, use an inside micrometer and measure the piston pin bore inside diameter (ID).
10. Subtract the piston pin OD measurement from the piston pin bore ID measurement to determine pin-to-bore clearance. Refer to **Engine Mechanical Specifications** .

Measuring Piston Ring End Gap

cardiagn.com

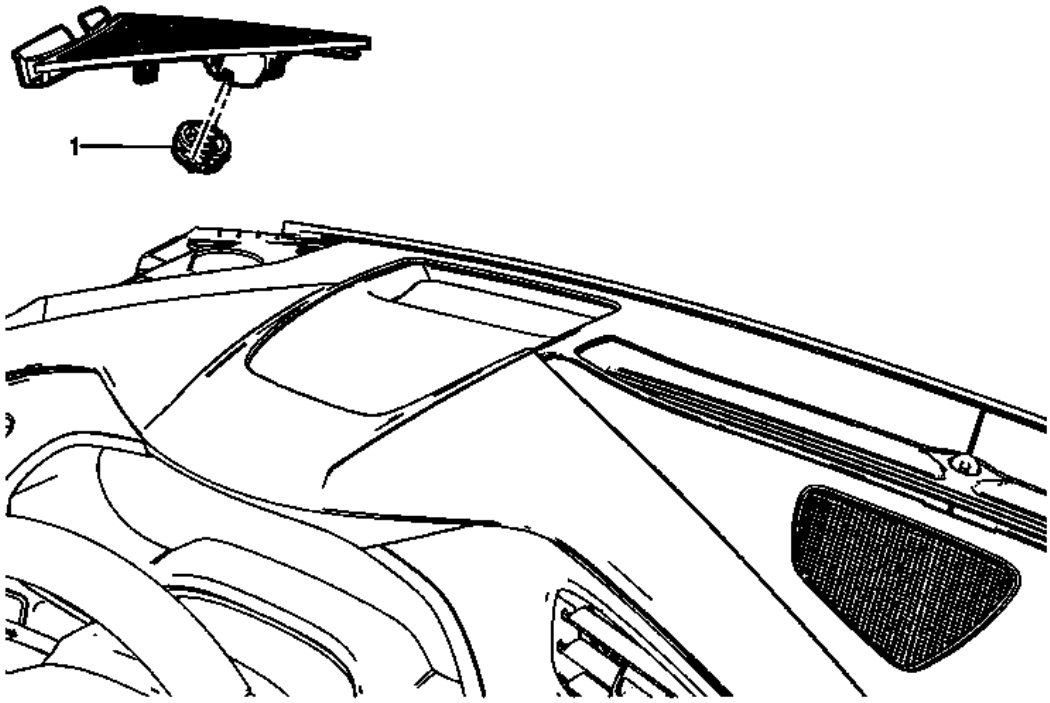


Fig. 125: Measuring Piston Ring End Gap
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Do not attempt to file the end of the piston ring to achieve the proper end gap clearance.**
- **Measure the piston ring in the cylinder in which it will be used.**

1. Place the piston ring into the cylinder bore 6.5 mm (0.25 in) below the top of the ring travel area. Both rings should be installed with the orientation marks facing the top of the piston.
2. Insert a feeler gauge and measure the piston ring end gap. Refer to **Engine Mechanical Specifications** .

Connecting Rod and Bearings

cardiagn.com

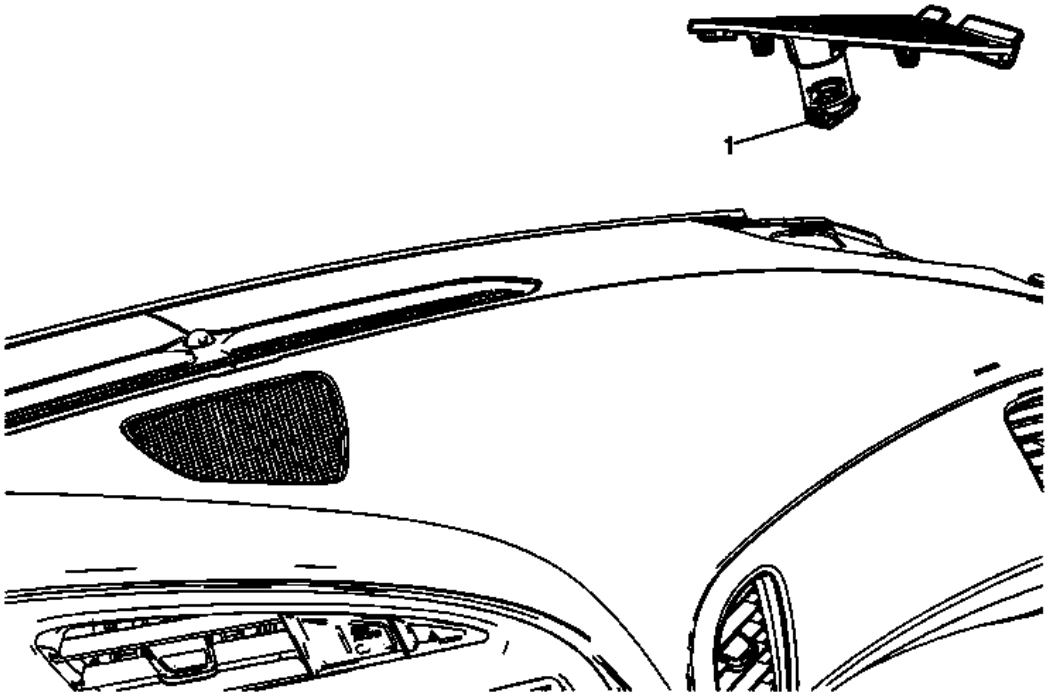


Fig. 126: View Of Piston, Pin & Piston Rings
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The powdered metal connecting rod and cap are machined for proper clearances. The connecting rod and cap must be used as an assembly with no repair or modifications to either mating surface. Do not attempt to repair the rod or cap. If service is required, replace the rod and cap as an assembly.**
- **Do not attempt to repair the bolt hole threads of the connecting rod.**

1. Clean the connecting rod (105) and cap (103) in solvent.

   WARNING: Refer to Safety Glasses Warning .

2. Dry the components with compressed air.

cardiagn.com

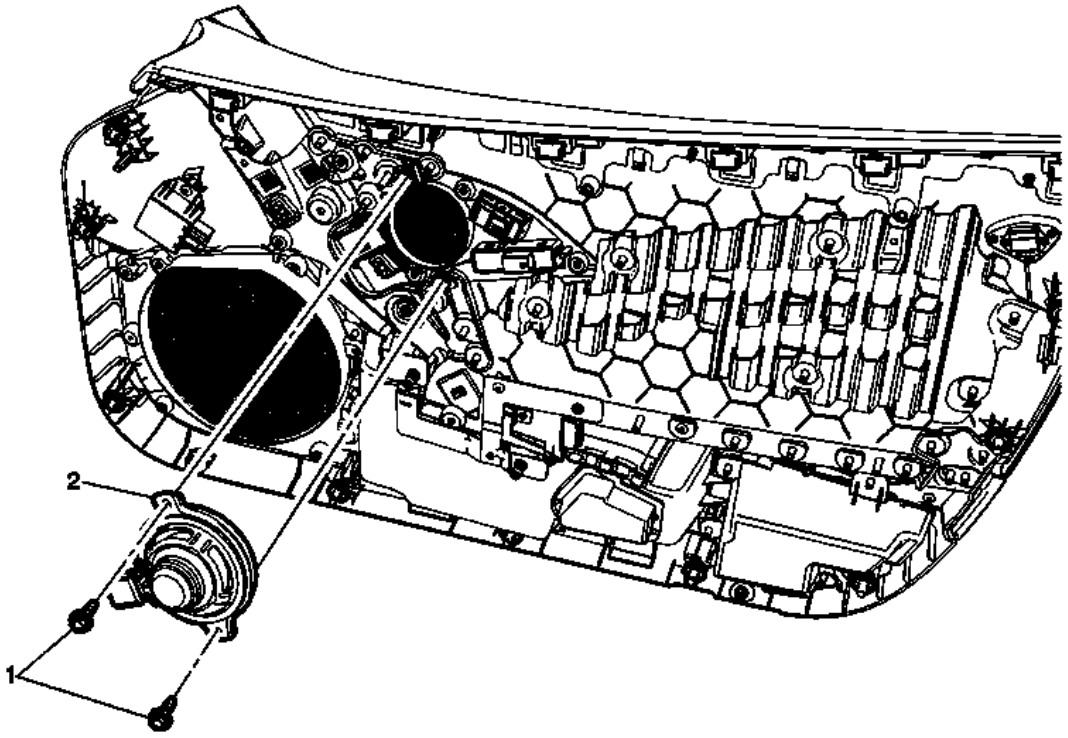


Fig. 127: Identifying Connecting Rod Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the connecting rod for the following conditions:
    - Twisting (1)
    - Proper fit of the connecting rod and cap mating surfaces (2)
    - Nicks or gouges in the bearing bore (3)
    - Damage to the bearing locating slots (4)

cardiagn.com

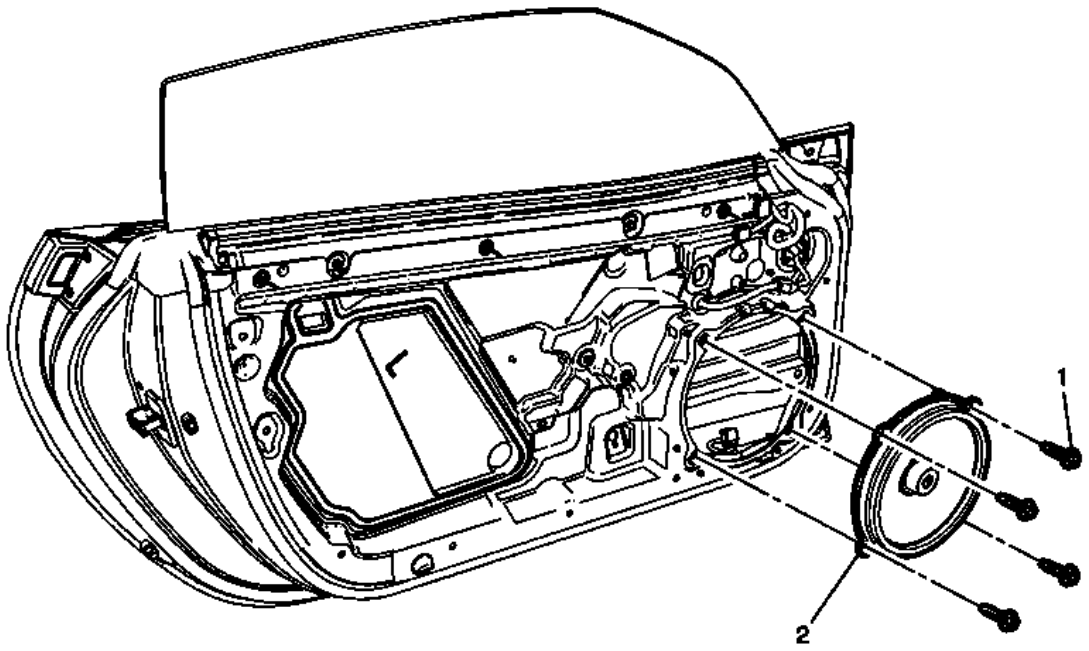


Fig. 128: Identifying Connecting Rod Bearing Bore
Courtesy of GENERAL MOTORS COMPANY

4. Measure the connecting rod bearing bore for an out-of-round condition. Refer to **Engine Mechanical Specifications** .

cardiagn.com

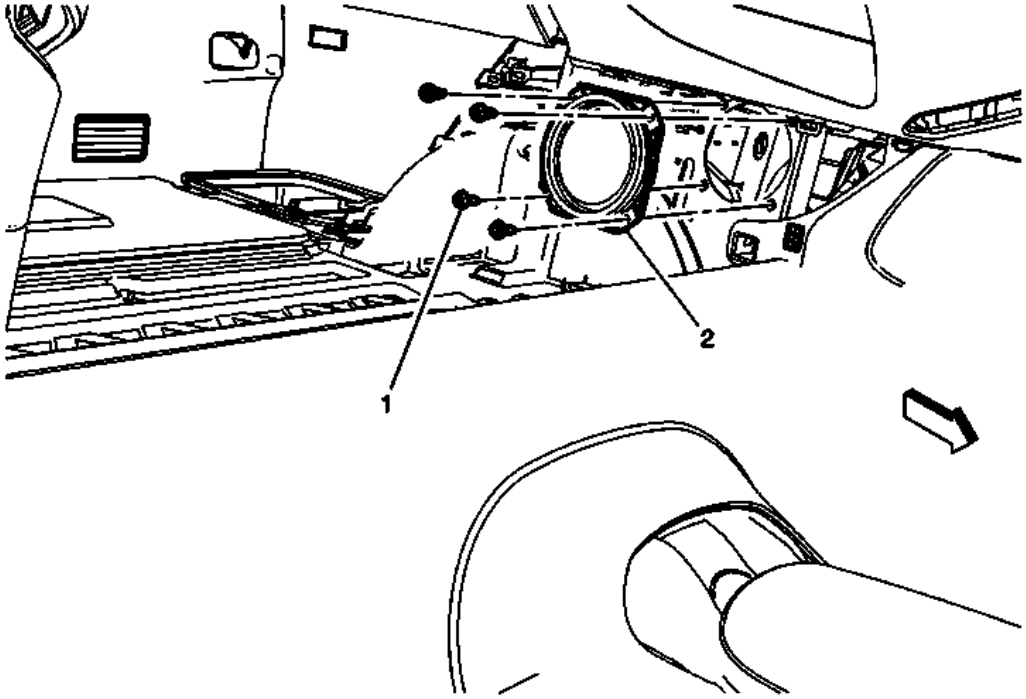


Fig. 129: Measuring Piston Pin Diameter
Courtesy of GENERAL MOTORS COMPANY

5. To determine piston pin-to-connecting rod bore clearance, use a micrometer and measure the piston pin OD.

cardiagn.com

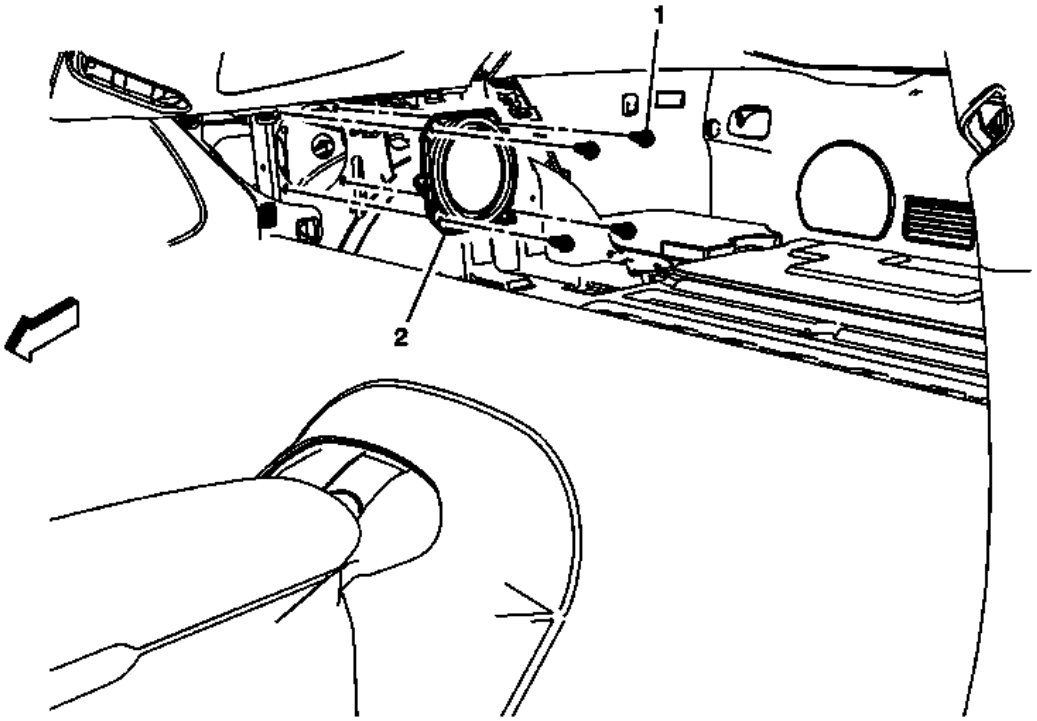


Fig. 130: Measuring Connecting Rod Pin Bore Inside Diameter
Courtesy of GENERAL MOTORS COMPANY

6. To determine the piston pin-to-connecting rod bore clearance, use a micrometer and measure the connecting rod pin bore (1) ID.
7. Subtract the piston pin OD measurement from the connecting rod pin bore ID measurement to determine pin-to-bore clearance. Refer to **Engine Mechanical Specifications** .

cardiagn.com

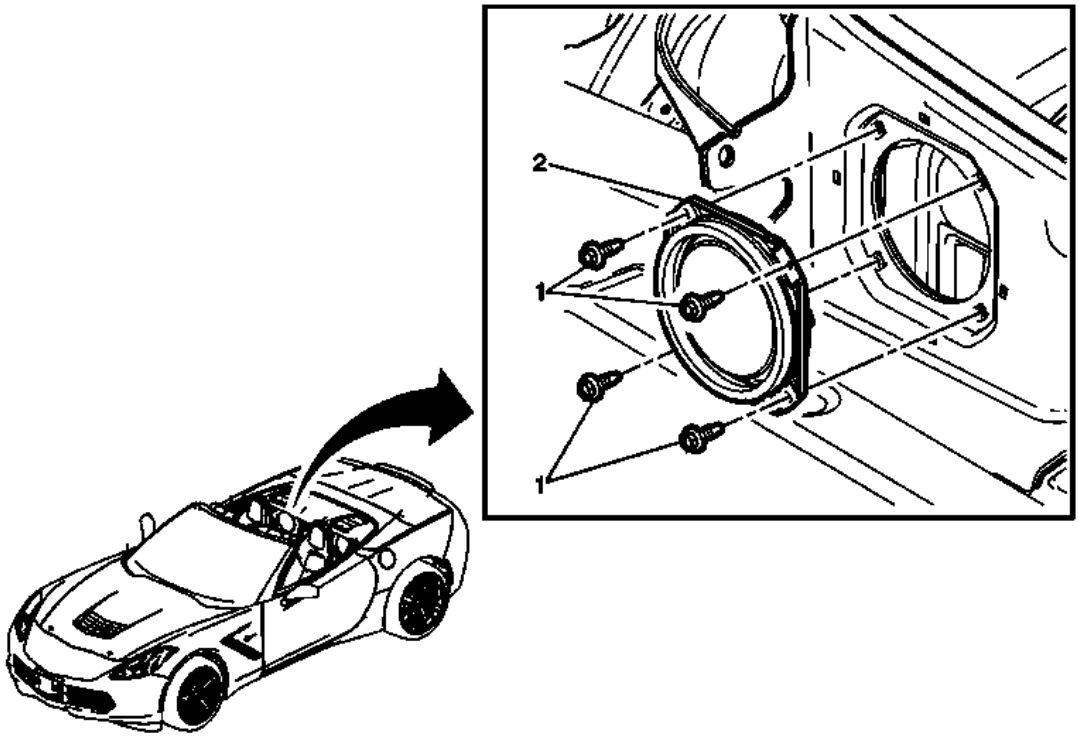


Fig. 131: Identifying Crankshaft Bearing Craters Or Pockets
Courtesy of GENERAL MOTORS COMPANY

8. Inspect the connecting rod bearings for craters or pockets. Flattened sections on the bearing halves indicate fatigue.

cardiagn.com

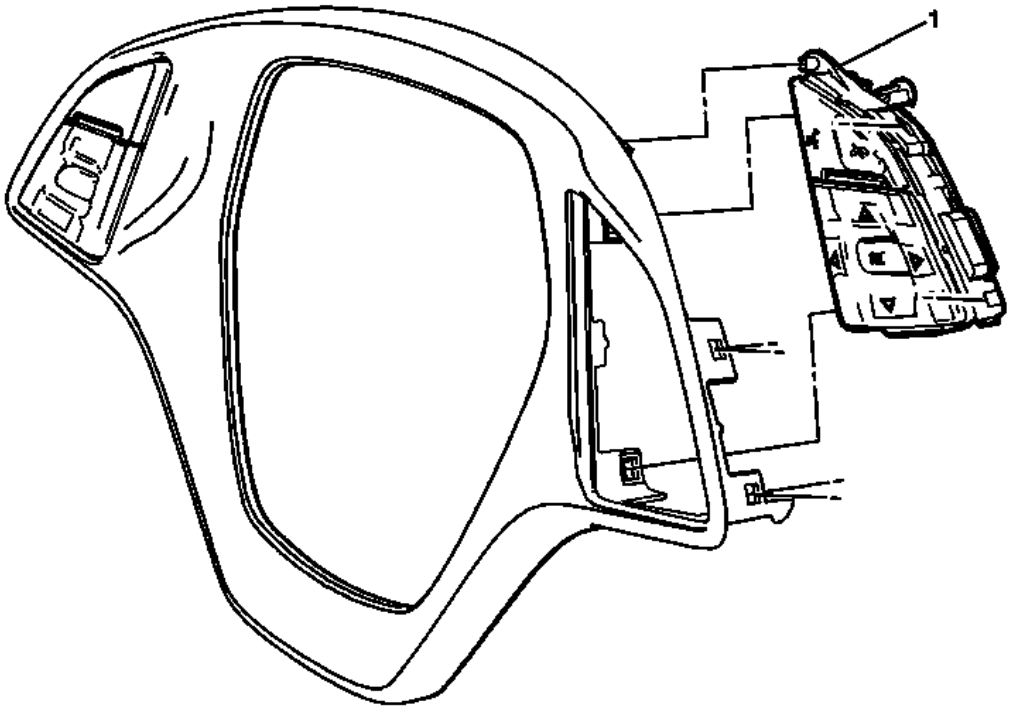


Fig. 132: Identifying Connecting Rod Bearing Scoring Or Discoloration
Courtesy of GENERAL MOTORS COMPANY

9. Inspect the connecting rod bearings for excessive scoring or discoloration.
10. Inspect the connecting rod bearings for dirt or debris imbedded into the bearing material.

cardiagn.com

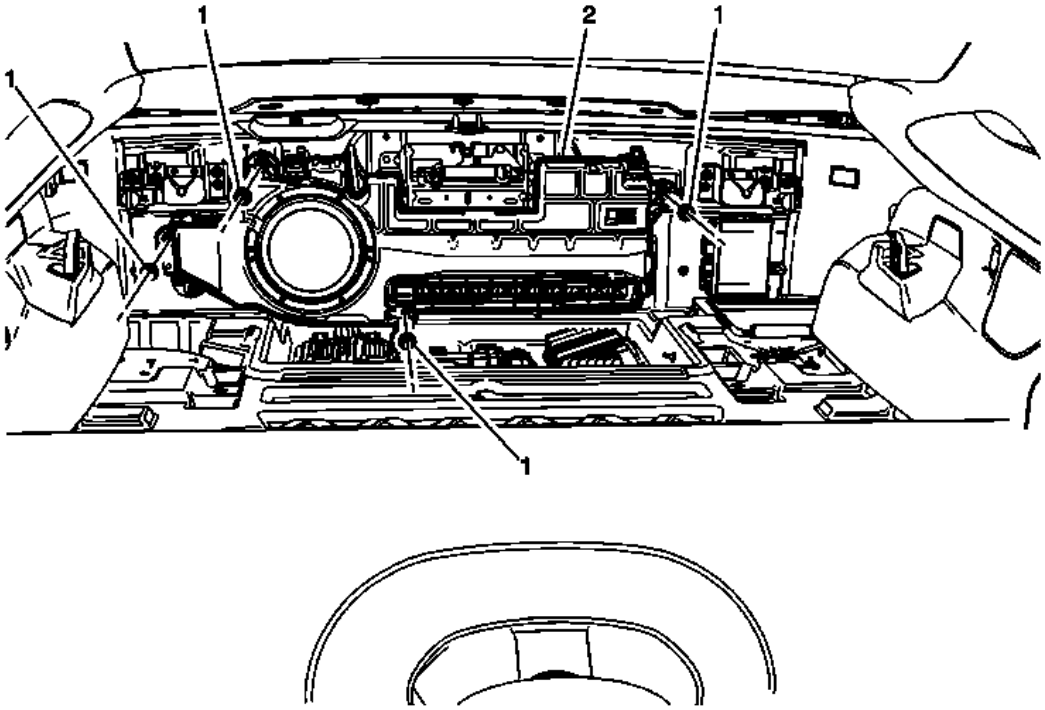


Fig. 133: View Of Improper Seating
Courtesy of GENERAL MOTORS COMPANY

11. Inspect the connecting rod bearings for improper seating indicated by bright, polished sections of the bearing surface.
12. Measure the connecting rod bearings for excessive connecting rod bearing-to-crankshaft journal clearance. Refer to **Crankshaft and Bearing Cleaning and Inspection**.

PISTON AND CONNECTING ROD ASSEMBLE

Special Tools

EN-46745 Piston Pin Clip Remover/Installer

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

1. Lubricate the piston pin bores in the piston, the piston pin and the connecting rod pin bore with clean engine oil.

cardiagn.com

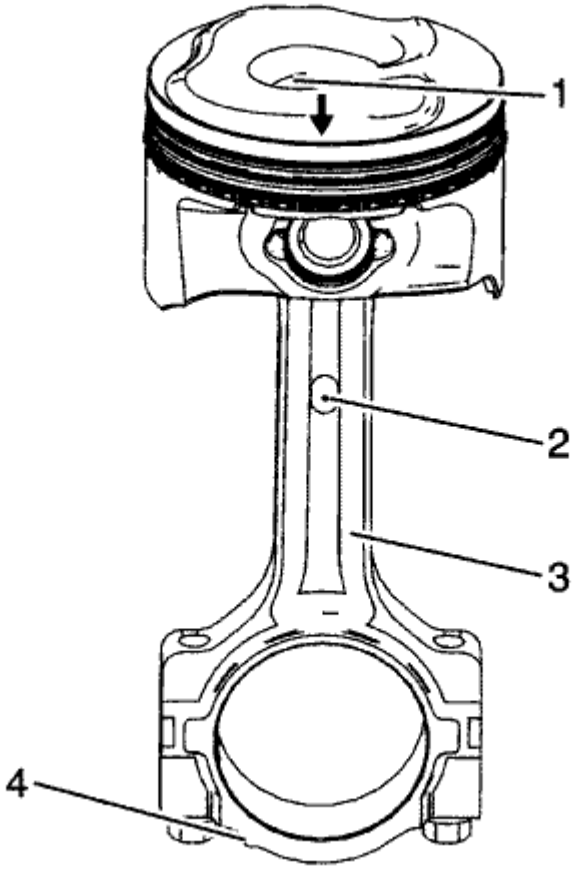


Fig. 134: Top Of Piston And Dimple On Rod
Courtesy of GENERAL MOTORS COMPANY

NOTE: The left side and right side piston and rod assemblies are assembled differently.

2. Ensure that on the right side piston and rod assemblies, the arrow on the top of the piston (1) and the dimple on the rod (2) are facing the same direction.

cardiagn.com

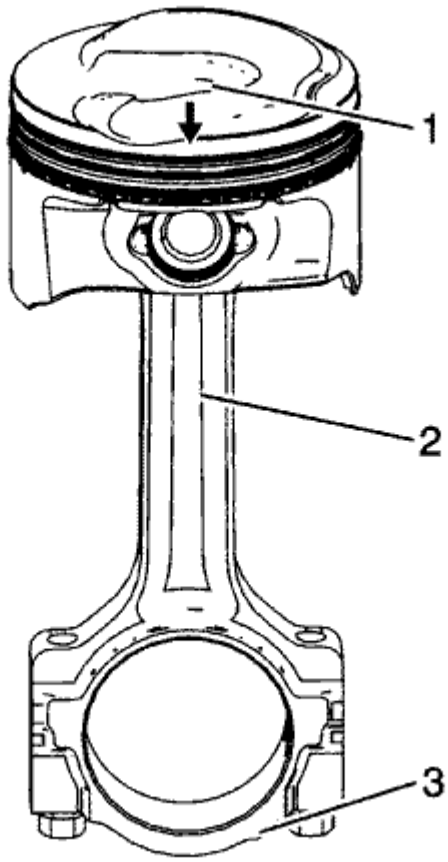


Fig. 135: Top Of Piston And Dimple On Rod
Courtesy of GENERAL MOTORS COMPANY

3. Ensure that on the left side piston and rod assemblies, the arrow on the top of the piston (1) and the dimple on the rod (2) are facing the opposite direction.

cardiagn.com

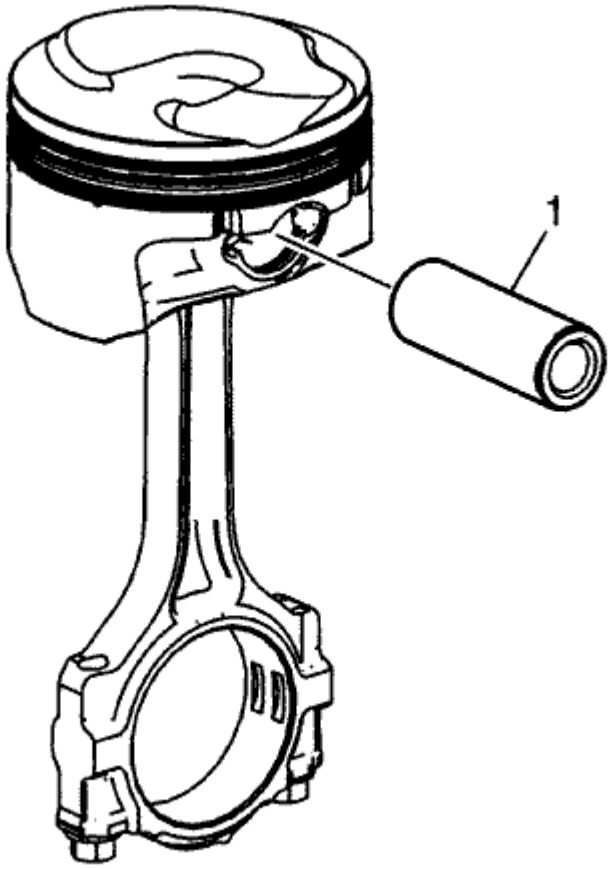


Fig. 136: Piston Pin
Courtesy of GENERAL MOTORS COMPANY

4. Install the piston pin (1) to the piston and connecting rod.

cardiagn.com

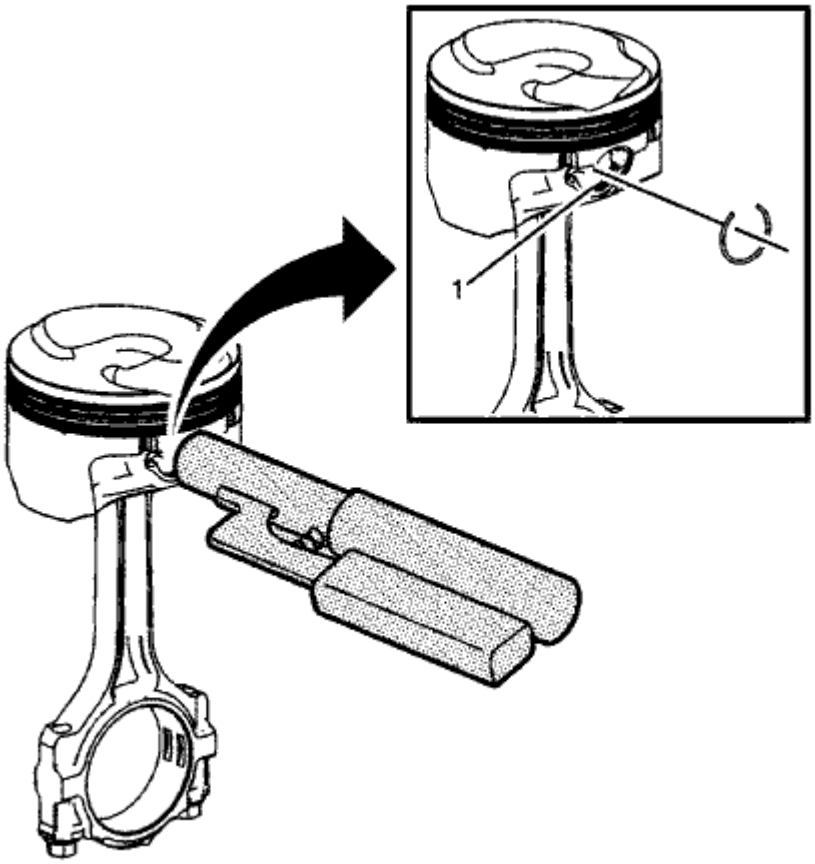


Fig. 137: NEW Piston Pin Retainers Using EN-46745 Remover/Installer
Courtesy of GENERAL MOTORS COMPANY

NOTE: NEW piston pin retainers must be used. Never reuse the piston pin retainers.

5. Install NEW piston pin retainers using the **EN-46745** remover/installer. Align the **EN-46745** remover/installer to one of the notches (1) in the piston.

cardiagn.com

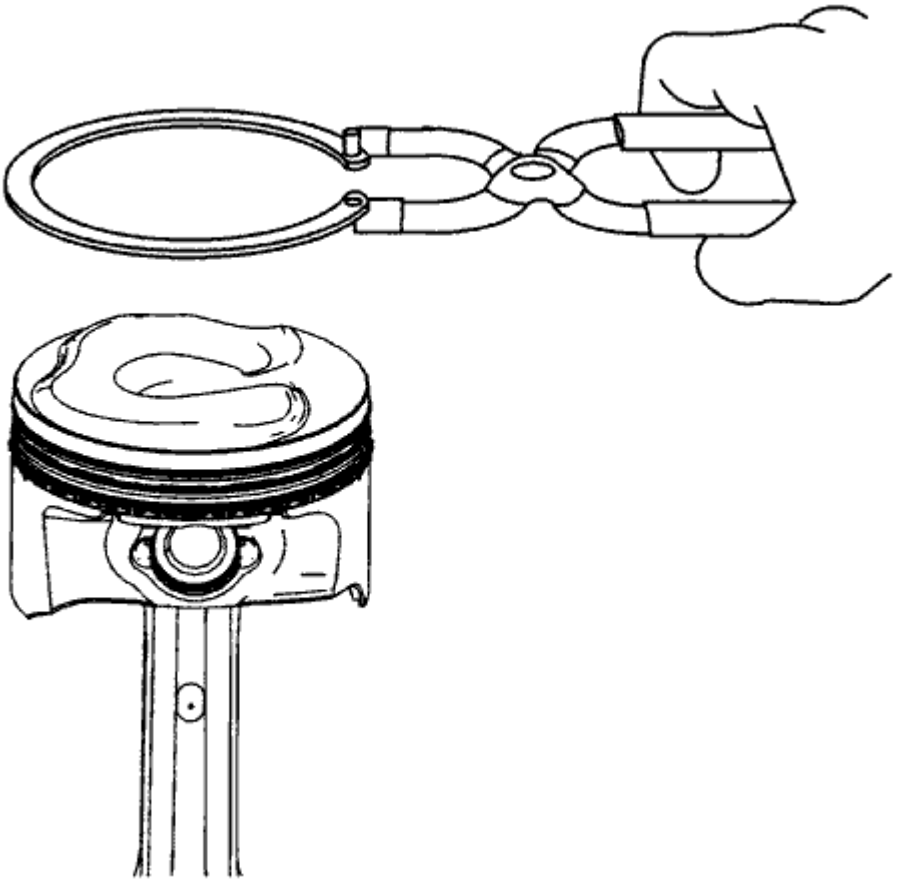


Fig. 138: Remove Piston Rings From Piston Using Piston Ring Pliers
Courtesy of GENERAL MOTORS COMPANY

NOTE: When installing piston rings, use a ring expander plier type tool. Do not roll the rings into the grooves of the piston. Use caution and care to expand the rings only slightly larger than the outside diameter (OD) of the piston.

6. Using piston ring pliers, install the piston rings onto the piston.
7. Position the oil control ring end gaps 180 degrees opposite each other.

cardiagn.com

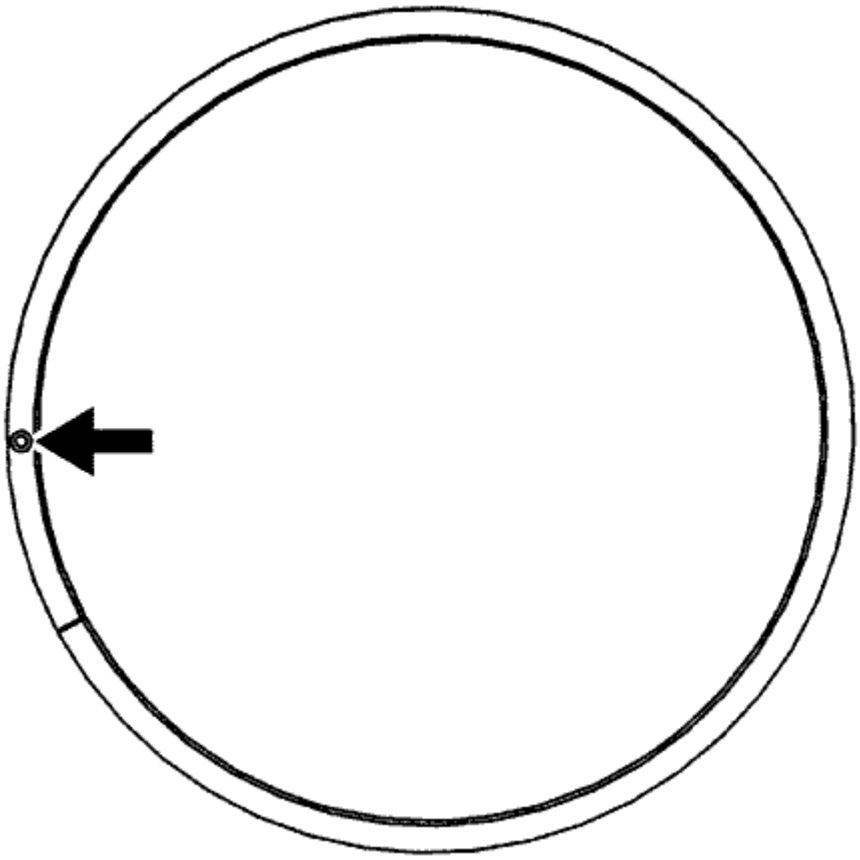


Fig. 139: Positioning Compression Ring End Gaps 180 Degrees Opposite Each Other
Courtesy of GENERAL MOTORS COMPANY

cardiagn.com

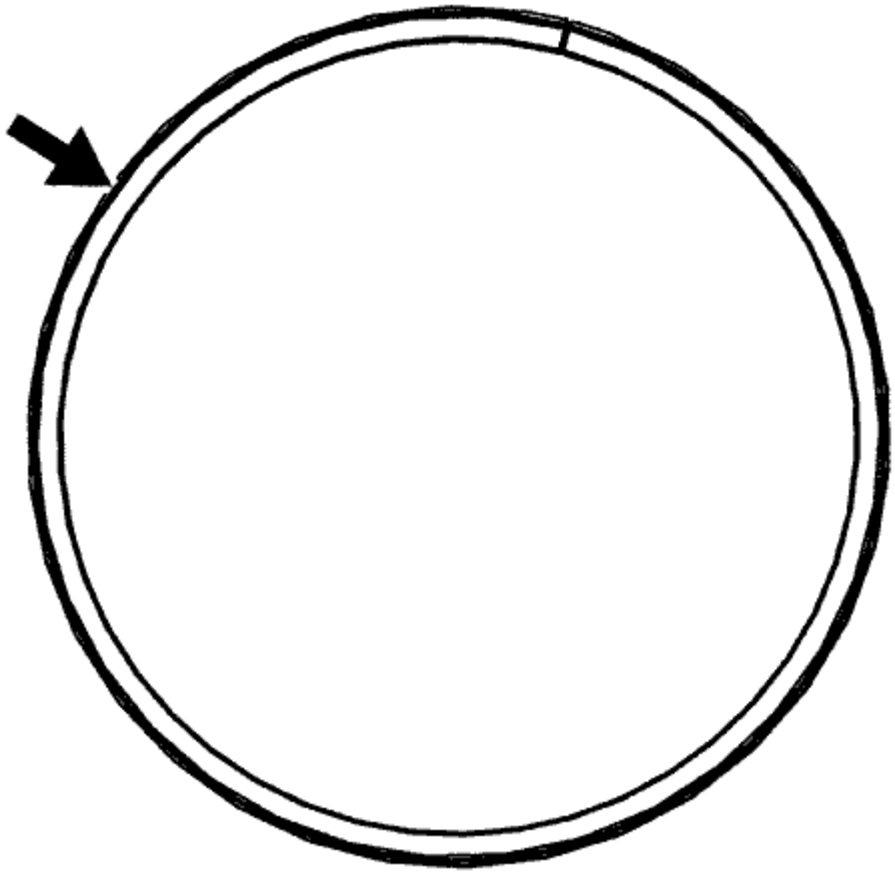


Fig. 140: Positioning Compression Ring End Gaps 180 Degrees Opposite Each Other
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The upper compression ring has a dimple on the top of the ring. The dimple on upper compression ring should face the top of the piston.**
- **The lower compression ring has a groove on the bottom of the ring. The groove on the lower compression ring should face the bottom of the piston.**

8. Position the compression ring end gaps 180 degrees opposite each other.

cardiagn.com

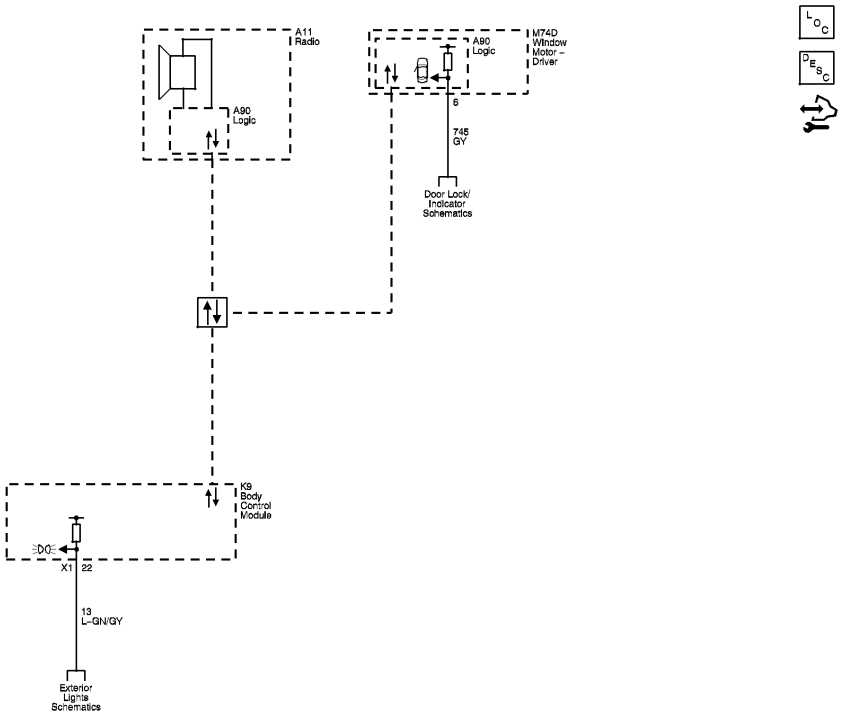


Fig. 141: View Of Piston, Connecting Rod & Bearing Assembly
Courtesy of GENERAL MOTORS COMPANY

9. Install the connecting rod bearings to the rod and cap.

CAMSHAFT BEARING REMOVAL

Special Tools

J 33049 Camshaft Bearing Service Set

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

cardiagn.com

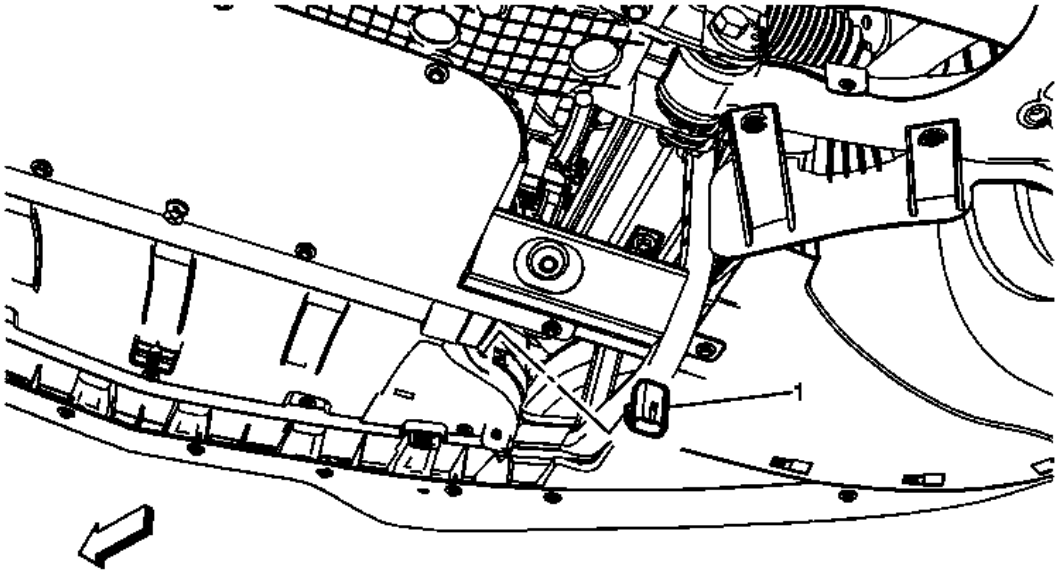


Fig. 142: Camshaft Bearings
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: A loose camshaft bearing may be caused by an enlarged, out of round or damaged engine block bearing bore.

1. Prior to bearing removal, inspect the camshaft bearings for loose fit in the engine block bearing bores. Refer to **Camshaft and Bearings Cleaning and Inspection**.
2. Repair or replace the components, as required.

cardiagn.com

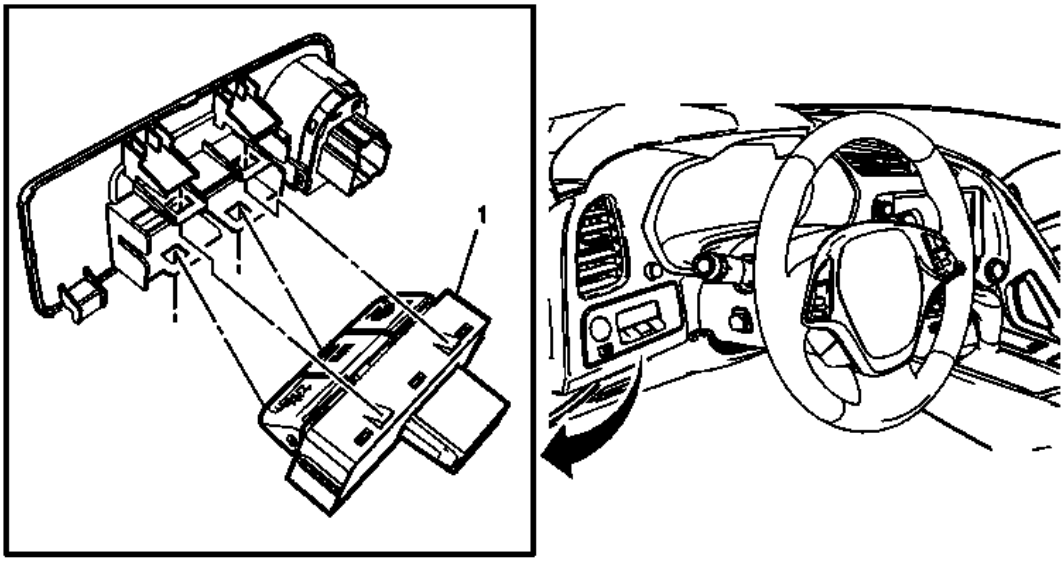


Fig. 143: Camshaft Bearing Service Kit Components
Courtesy of GENERAL MOTORS COMPANY

3. Select the expanding driver (4-8) and washer (2 or 3) from the **J 33049** service set.
4. Assemble the tool.
5. Insert the tool through the front of the engine block and into the bearing.
6. Tighten the expander assembly (15) nut until snug.
7. Push the guide cone (1) into the front camshaft bearing in order to align the tool.

cardiagn.com

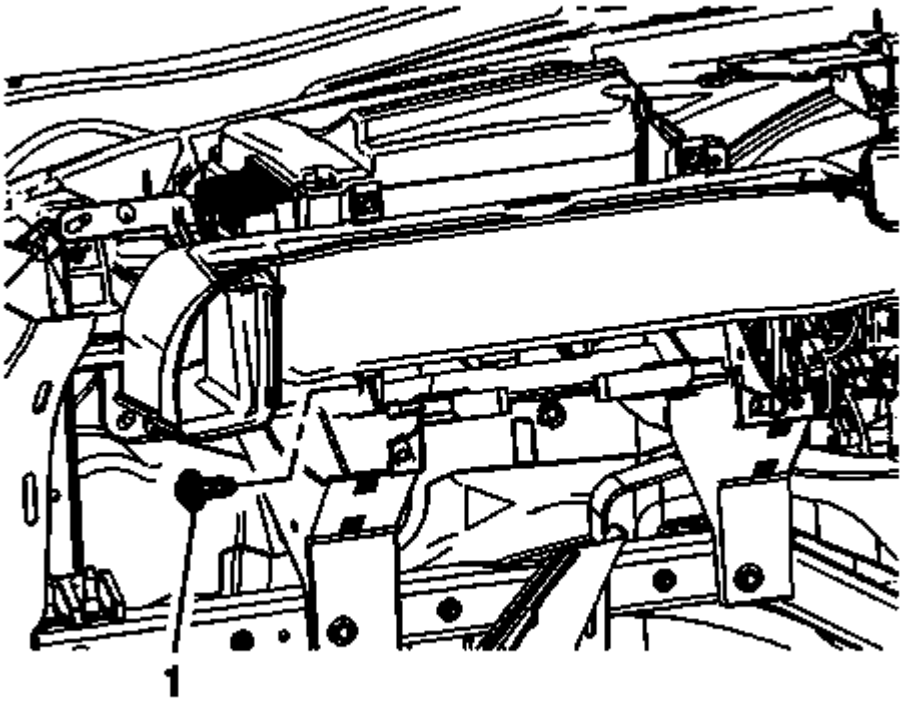


Fig. 144: Driving Bearing Out Of Or Into Engine Block
Courtesy of GENERAL MOTORS COMPANY

8. Drive the bearing from the block bore.

IMPORTANT: In order to remove the inner camshaft bearings, operate the tool from either end of the block, using the driver bar extension and the guide cone in the front or rear camshaft bearing bore.

9. Repeat the above procedures in order to remove the remaining bearings.

Tool Usage Information

Bearing, Expander and Expander Driver Information

cardiagn.com

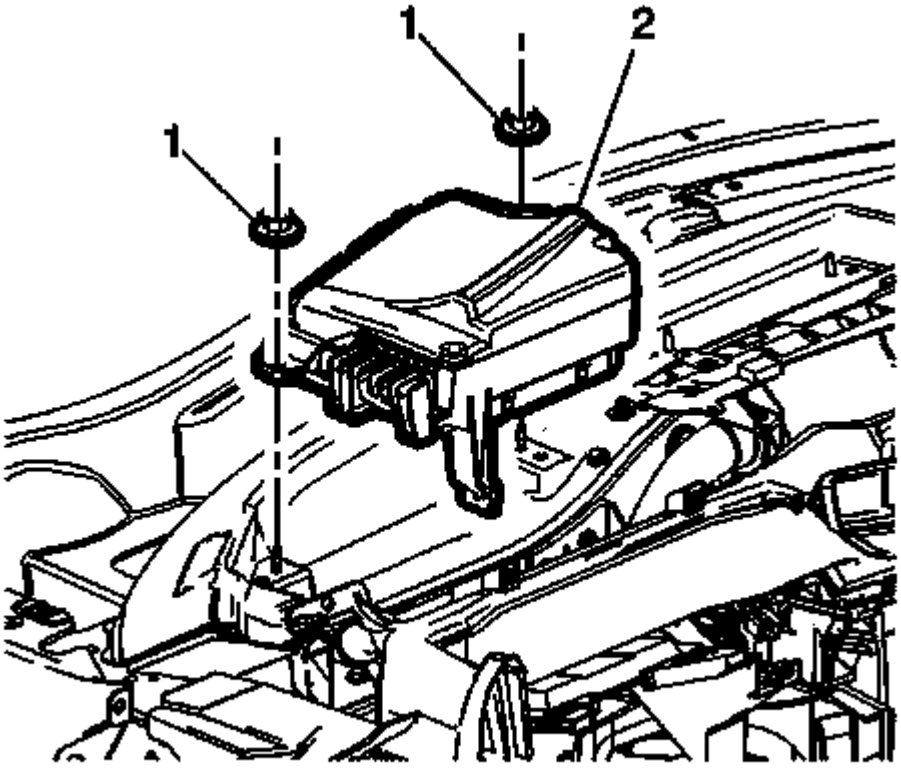


Fig. 145: Camshaft Bearing Service Kit Components
Courtesy of GENERAL MOTORS COMPANY

- The tool consists of a guide cone (1), driving washers (2 or 3), expander bearing drivers (4-8), driver bars (9 or 10), expander jaws (11), expander sleeve (12), expander cone (13), expander shaft (14) and expander assembly (15).

NOTE: The expander bearing drivers (4-8) in the J 33049 service set are stamped with a number (1-5) to assist in identifying the appropriate diameter driver.

- Expander assembly (15) is used as a driver for the bearing when inside diameter is 28.575-37.465 mm (1.125-1.475 in) and is used with the small washer.
- Expander bearing driver number 1 inside diameter is 37.465-43.18 mm (1.475-1.7 in) and is used with the expander assembly (15) and the small washer.
- Expander bearing driver number 2 inside diameter is 43.18-48.895 mm (1.7-1.925 in) and is used with the expander assembly (15) and the large washer.
- Expander bearing driver number 3 inside diameter is 48.895-54.61 mm (1.925-2.15 in) and is used with the expander assembly (15) and the large washer.
- Expander bearing driver number 4 inside diameter is 54.61-60.325 mm (2.150-2.375 in) and is used with expander assembly (15) and the large washer.

cardiagn.com

- Expander bearing driver number 5 inside diameter is 60.325-68.326 mm (2.375-2.69 in) and is used with expander assembly (15) and the large washer.

Tool Assembly and Operation

1. Select the proper expanding driver and washer from the expanding driver and washer information.

   IMPORTANT: To install or remove the expanding driver, always push on or pull from the ends.

   Pressure on the outside diameter may cause a bind against the rubber expanding sleeve.

2. Place the expanding driver onto the expander assembly.
3. Ensure the separation lines between the segments of the expanding driver align with the separation lines of the expander assembly.
4. With the small end of the cone facing the driver assembly, place the guide cone over the driving bar.
5. Place the driving washer over the threaded portion of the expander assembly.
6. Screw the expander assembly, with driving washer, onto the driving bar.

   For removal of the inner bearings, it may be necessary to install the driver bar extension.

cardiagn.com

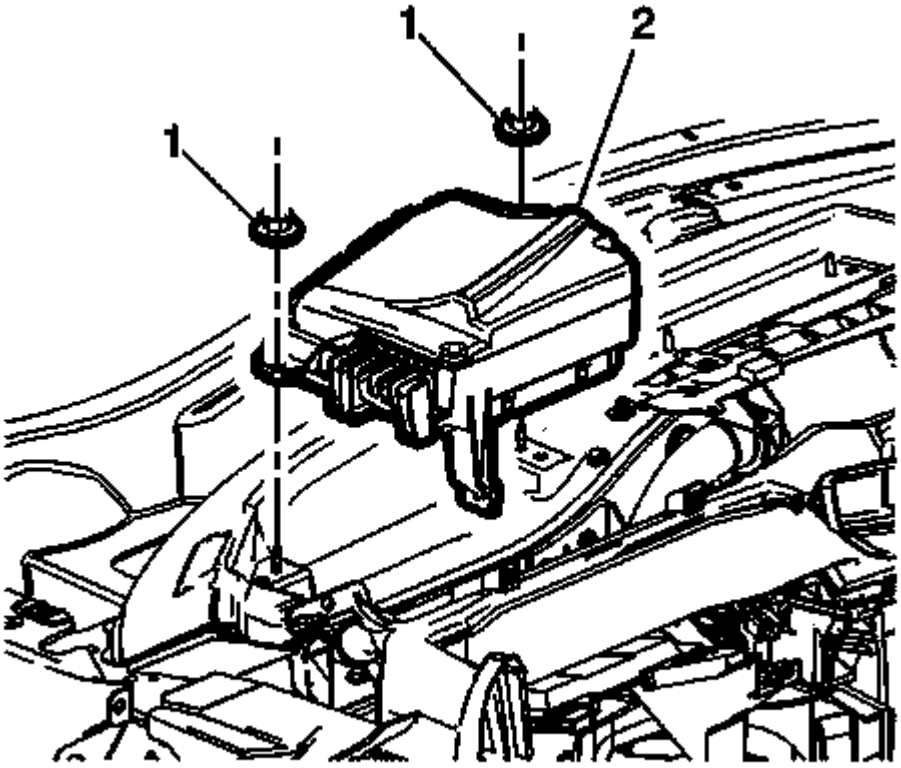


Fig. 146: Driving Bearing Out Of Or Into Engine Block
Courtesy of GENERAL MOTORS COMPANY

7. Insert the tool (1) into an inner camshaft bearing and tighten until snug.

   Operate the tool from the front or rear of the engine block.

   On some engine blocks, the nut on the expander assembly is inaccessible, except from either end. In this case, you must use a socket and extension to enlarge and reduce the expander assembly.

8. Slide the nylon cone (2) into the front or rear camshaft bearing. This will properly align the tool.
9. Drive the bearing out of or into the engine block.
10. Repeat the procedure for the additional inner bearings.

cardiagn.com

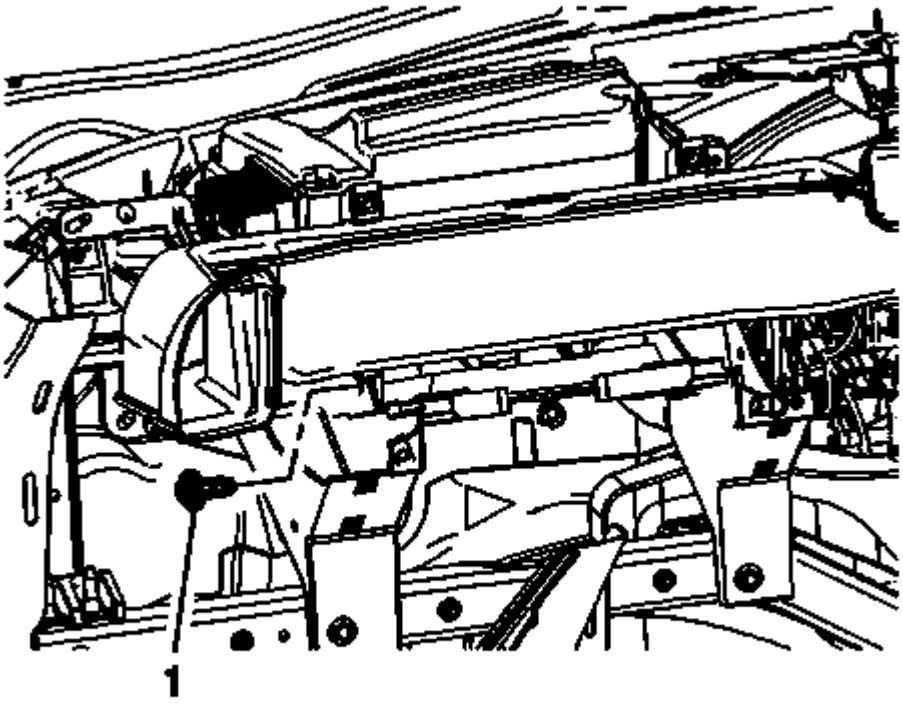


Fig. 147: Driving Bearing Out Of Or Into Engine Block
Courtesy of GENERAL MOTORS COMPANY

11. For the end bearings, front, position number 1 and the rear, position number 5, remove the nylon cone and driver bar extension.
12. Drive the bearings out of or into the engine block.

CAMSHAFT AND BEARINGS CLEANING AND INSPECTION

Special Tools

- **J 7872** Magnetic Base Dial Indicator Set
- **J 8520** Camshaft Lobe Lift Indicator

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

Measuring Camshaft Lobe Lift

cardiagn.com

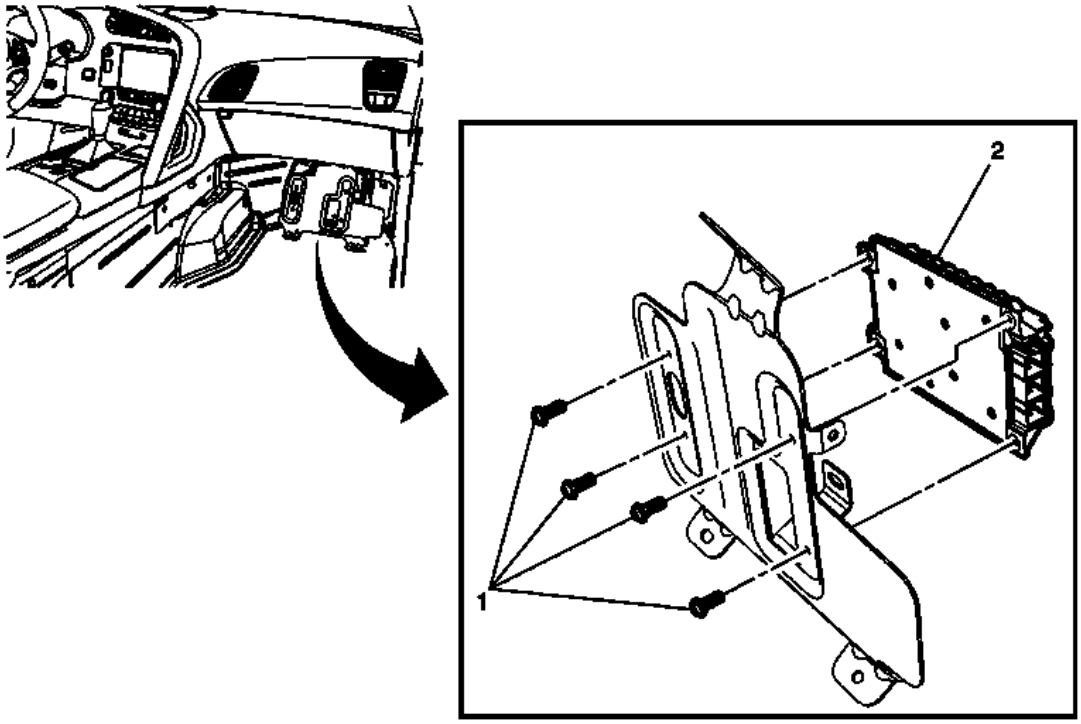


Fig. 148: Measuring Camshaft Lobe Lift
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Measuring camshaft lobe lift is a procedure used to determine if the camshaft lobes have worn. This test is to be performed prior to engine disassembly and with the camshaft and valve train components installed in the engine.**

1. Using the **J 8520** indicator, measure camshaft lobe lift.
2. Remove the valve rocker arms and bolts.
3. Install the dial indicator mounting stud into the valve rocker arm bolt hole.
4. Assemble the components of the **J 8520** indicator and position onto the stud.
5. Position the shaft of the dial indicator onto the end of the pushrod.
6. Rotate the face of the dial indicator to zero.
7. Slowly rotate the crankshaft clockwise, until the dial indicator obtains its highest and lowest readings.
8. Compare the total to specifications. Refer to **Engine Mechanical Specifications** . The total lobe lift is the difference between the highest and lowest reading.

cardiagn.com

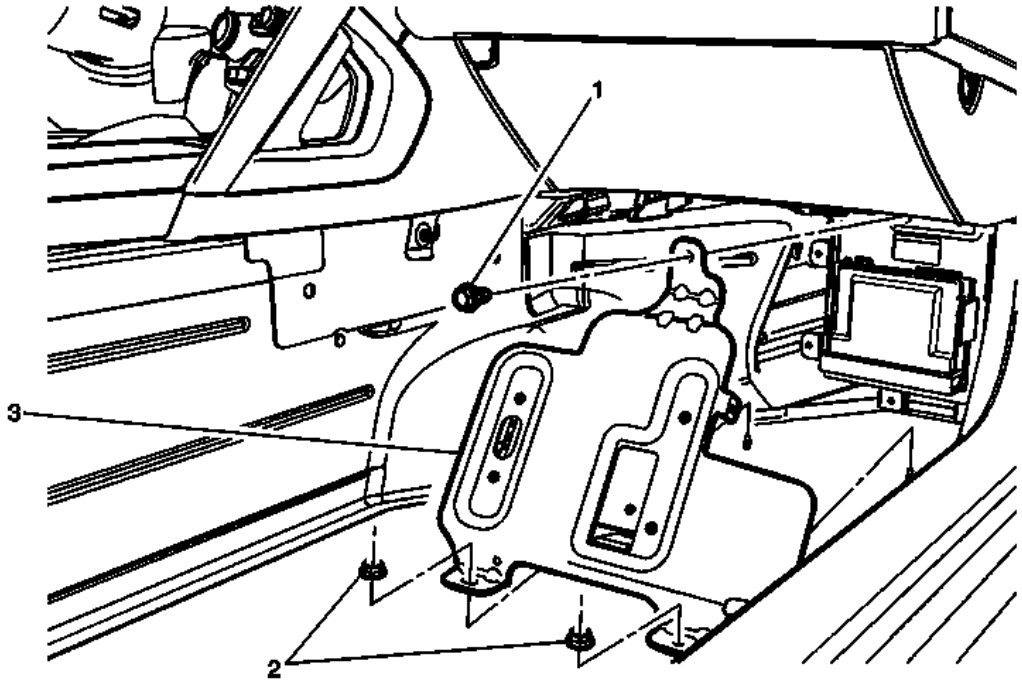


Fig. 149: View Of Camshaft Inspection Points
Courtesy of GENERAL MOTORS COMPANY

1. Clean the components in solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning

2. Dry the components with compressed air.
3. Inspect the camshaft bearing journals (1) for scoring or excessive wear.
4. Inspect the camshaft valve lifter lobes (2) for scoring or excessive wear.
5. Inspect the camshaft position (CMP) actuator oil passages (3) for restrictions.
6. Inspect the threaded bolt hole (4) in the front of the camshaft for damaged threads or debris.
7. Inspect the camshaft sprocket pin (204) for damage.
8. Inspect the camshaft retainer plate for wear or a damaged sealing gasket.

   If the camshaft retainer plate sealing gasket is not cut or damaged, it may be used again.

cardiagn.com

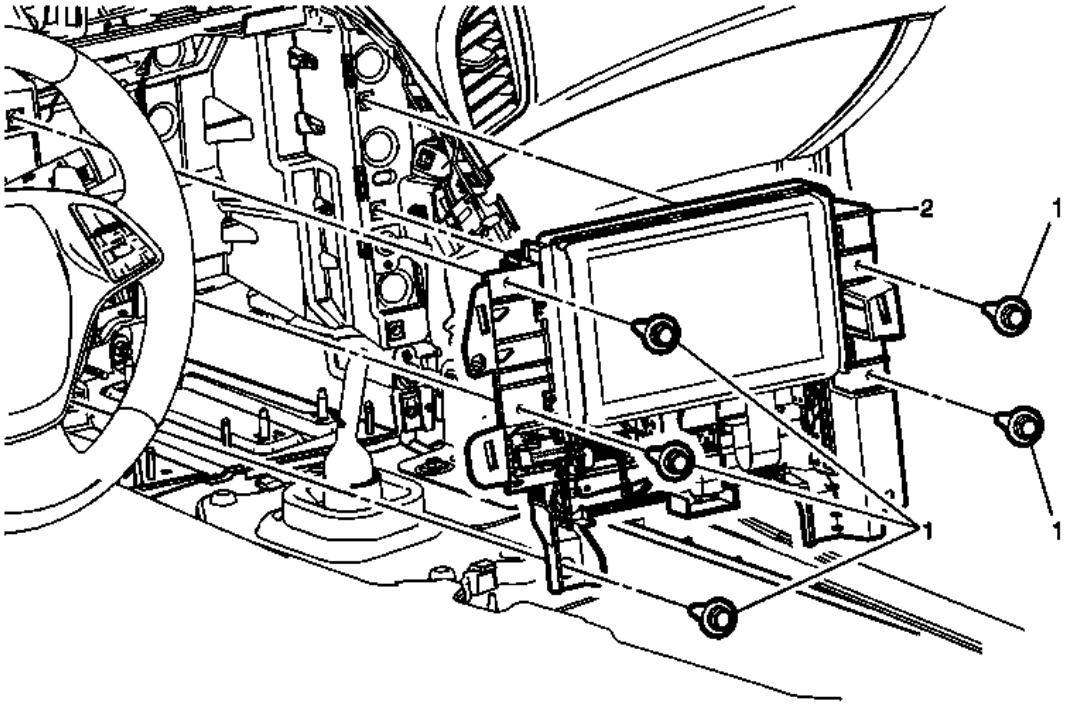


Fig. 150: Measure Camshaft Journals With Micrometer
Courtesy of GENERAL MOTORS COMPANY

9. Using a micrometer, measure the camshaft journals for wear and out-of-round. Refer to **Engine Mechanical Specifications** .
    - If the camshaft bearing journals are out-of-round, replace the camshaft.
    - If the camshaft bearing journal diameter is not within specification, replace the camshaft.

cardiagn.com

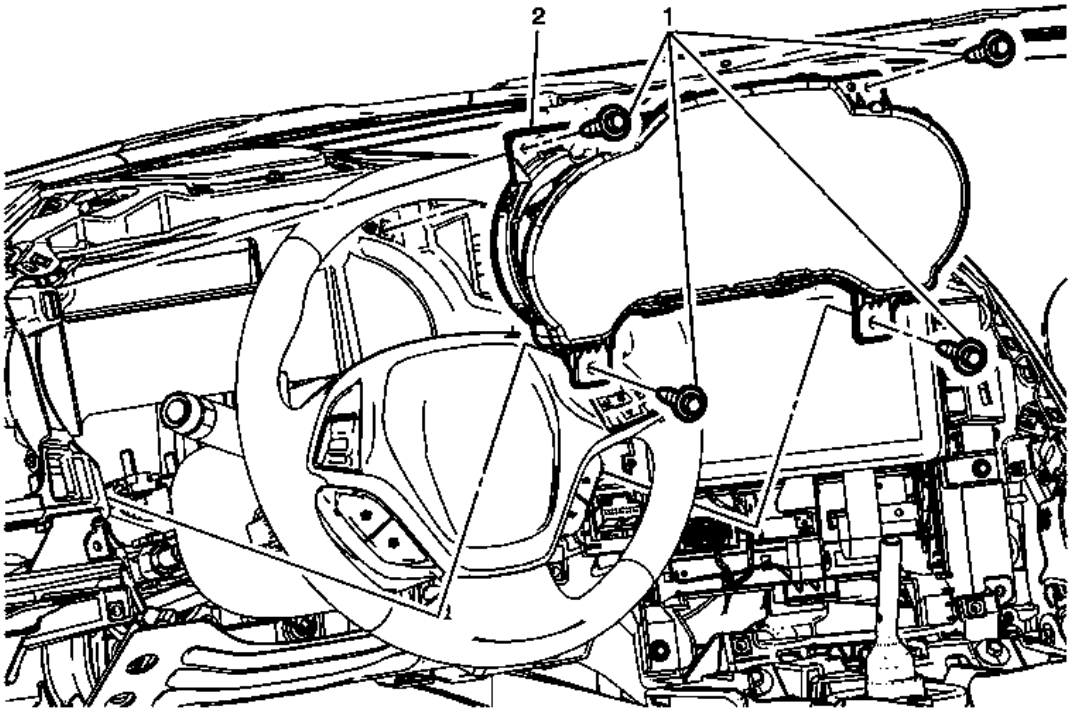


Fig. 151: Measuring Camshaft Lobes
Courtesy of GENERAL MOTORS COMPANY

10. Using a micrometer, measure the camshaft lobes for wear. Refer to **Engine Mechanical Specifications** .

cardiagn.com

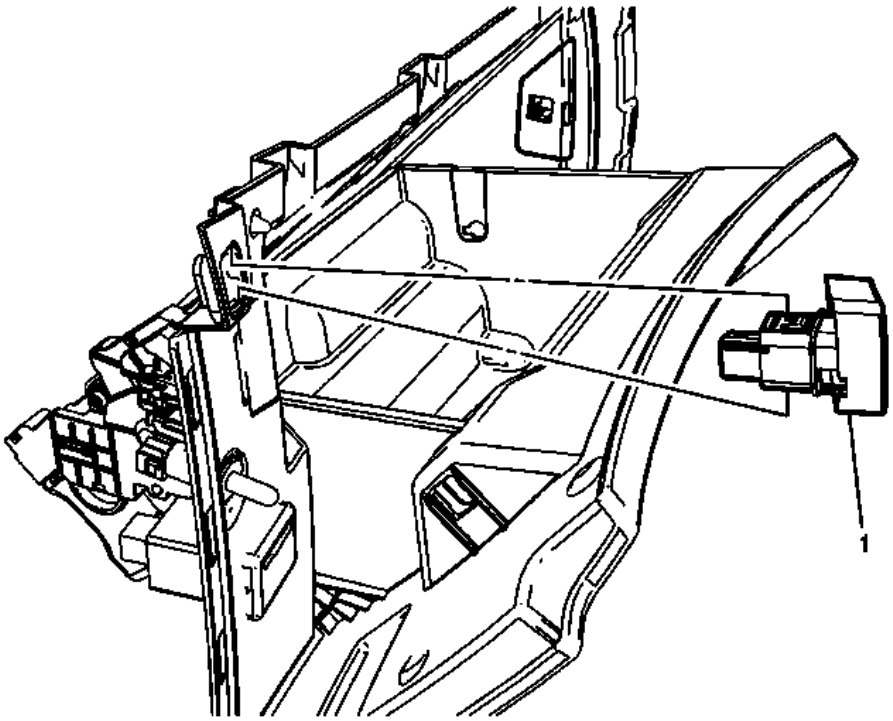


Fig. 152: Measuring Camshaft Runout
Courtesy of GENERAL MOTORS COMPANY

11. Measure the camshaft runout.
    1. Mount the camshaft in wooden V-blocks or between centers on a fixture.
    2. Using the **J 7872** set, measure the runout of the intermediate camshaft bearing journals.
    3. If camshaft runout is not within specification, the camshaft is bent and should be replaced. Refer to **Engine Mechanical Specifications** .

cardiagn.com

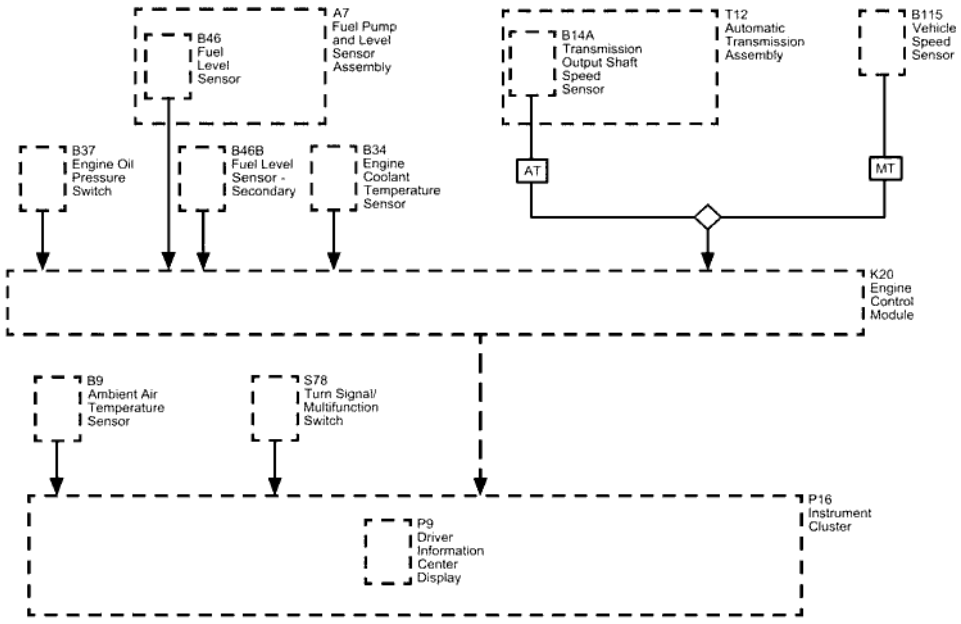


Fig. 153: Camshaft Bearings
Courtesy of GENERAL MOTORS COMPANY

12. Inspect the camshaft bearings for the following:
    - Excessive wear, evidence of galling, pitting, scoring or embedded debris. The appearance of the bearing material being different shades of gray are considered normal and are not guideline for bearing replacement. Measure the bearing inside diameter (ID) as required for an over-sized condition. Refer to **Engine Mechanical Specifications** .
    - Proper fit in the engine block. Camshaft bearings have an interference fit to the engine block and should not be loose in the engine block bearing bores.
    - The oil lubrication feed hole in the bearing must be in alignment with the drilled out passage in the block.
    - The oil lubrication feed hole is not plugged by debris.
    - Bearings with excessive wear or scoring must be replaced.
    - Bearings with excessive wear, galling, pitting, scoring or embedded debris must be replaced.

CAMSHAFT BEARING INSTALLATION

Special Tools

J 33049 Camshaft Bearing Service Set

cardiagn.com

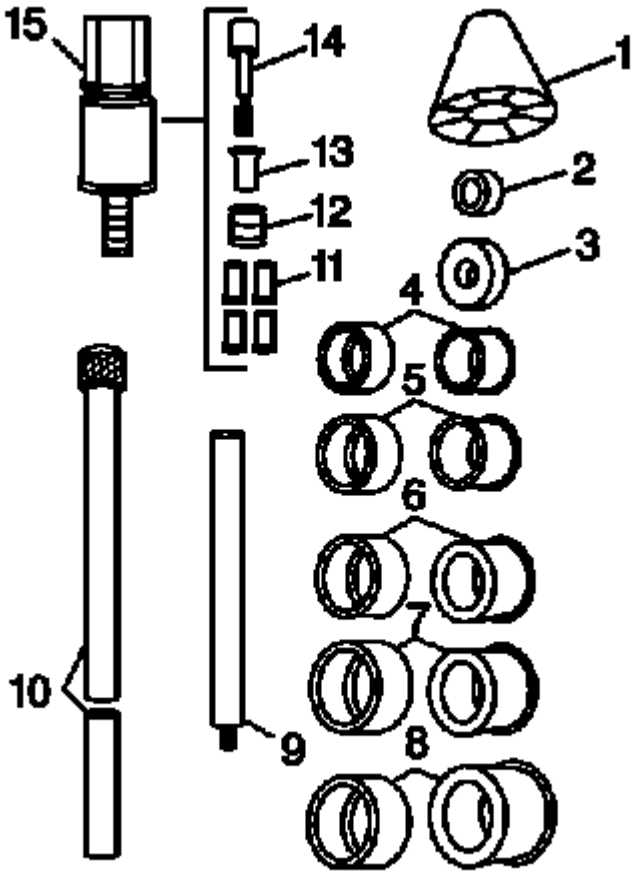


Fig. 154: Camshaft Bearing Service Kit Components
Courtesy of GENERAL MOTORS COMPANY

1. Select the expanding driver (4-8) and washer (2 or 3) from the **J 33049** set. Refer to **Camshaft Bearing Removal**.
2. Assemble the tool.

cardiagn.com

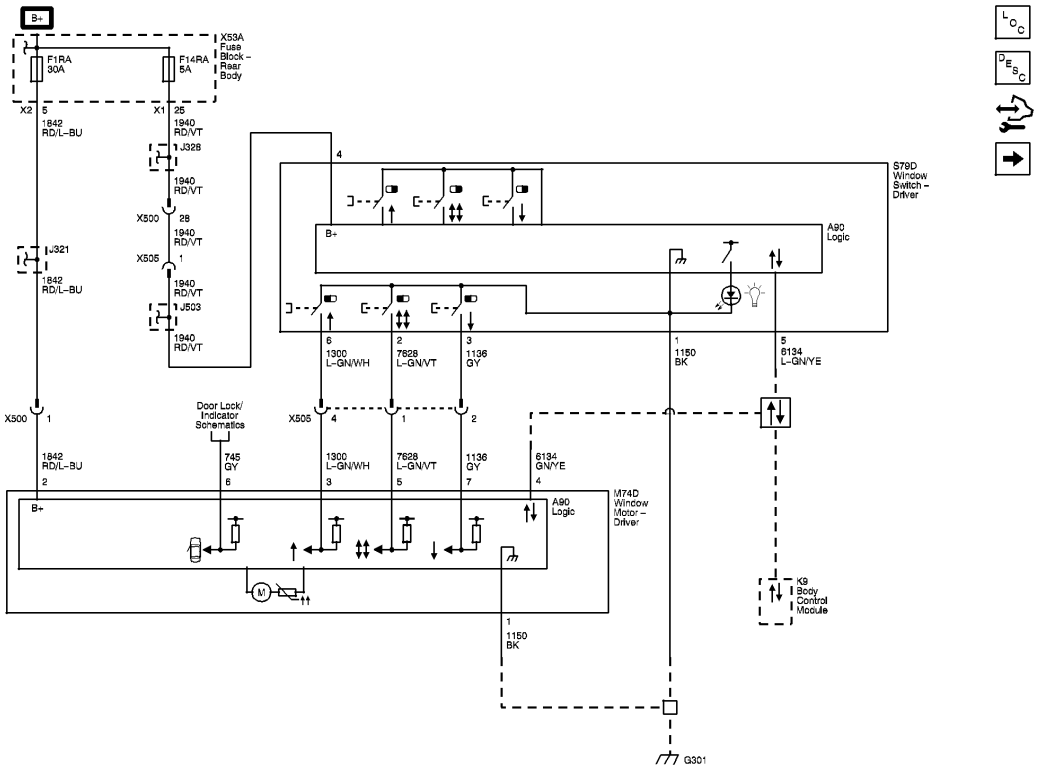


Fig. 155: Driving Bearing Out Of Or Into Engine Block
Courtesy of GENERAL MOTORS COMPANY

3. Insert the tool (1) through the front or rear of the engine block and into the bearing. For installation of inner bearings, it may be necessary to install the driver bar extension.
4. Tighten the expander assembly nut until snug.
5. Push the guide cone (2) into the front camshaft bearing in order to align the tool.

cardiagn.com

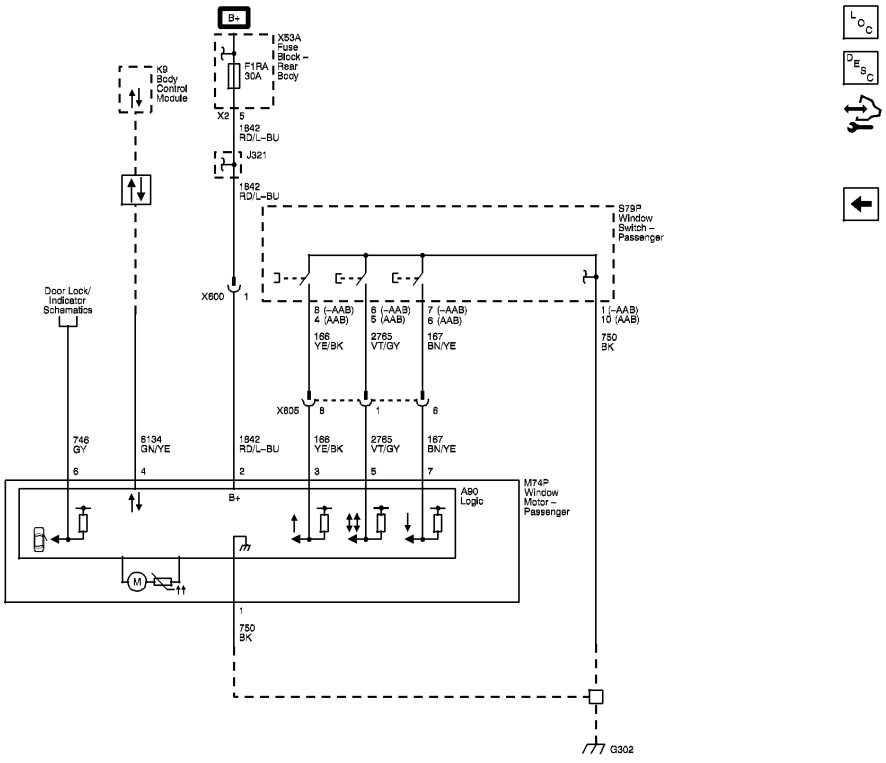


Fig. 156: Positioning Camshaft Bearing With Oil Feed Hole
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Camshaft bearings must be installed with bearing oil feed hole in alignment with the drilled oil passage in the block bore to ensure proper oil flow to the camshaft. The split seam in the bearing must be installed in the 12 o'clock position towards the top of the block. Improperly installed bearings may restrict oil flow causing engine damage.

6. Position the camshaft bearing with oil feed hole (1) in alignment with drilled oil passage in block bore (2).

cardiagn.com

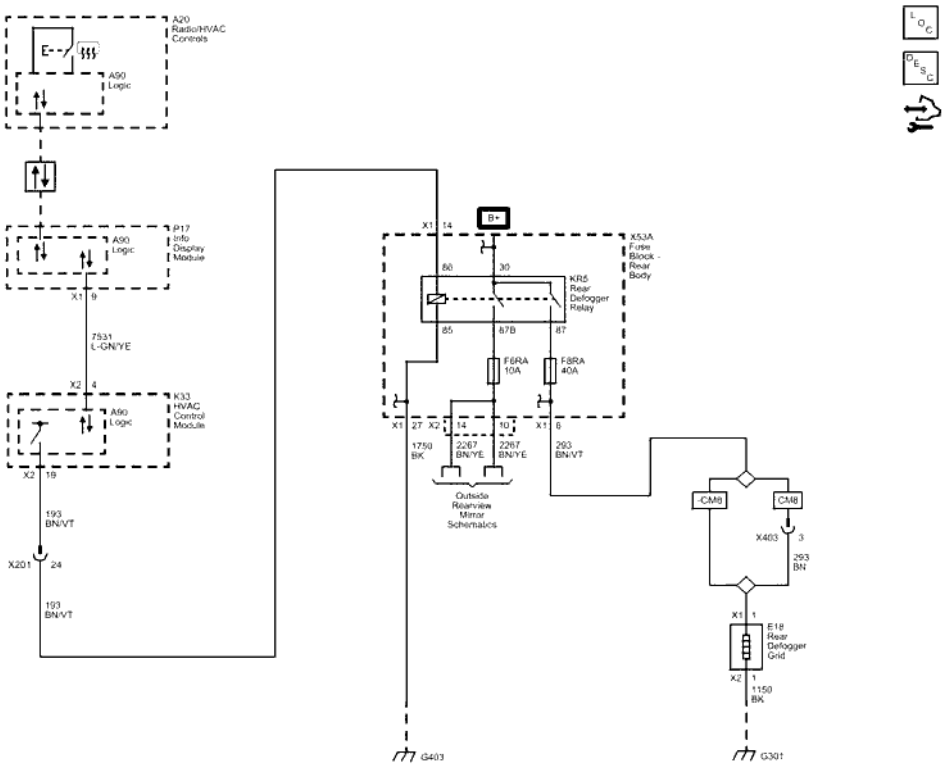


Fig. 157: Driving Bearing Out Of Or Into Engine Block
Courtesy of GENERAL MOTORS COMPANY

7. Drive the bearing into the block bore. During installation, ensure the bearing is installed straight.
8. Remove **J 33049** service set, inspect bearing to confirm the oil hole in the bearing is in alignment with the drilled oil passage in the block bore.
9. Repeat procedure to install the remaining bearings into the block.

CAMSHAFT TIMING CHAIN AND SPROCKET CLEANING AND INSPECTION

cardiagn.com

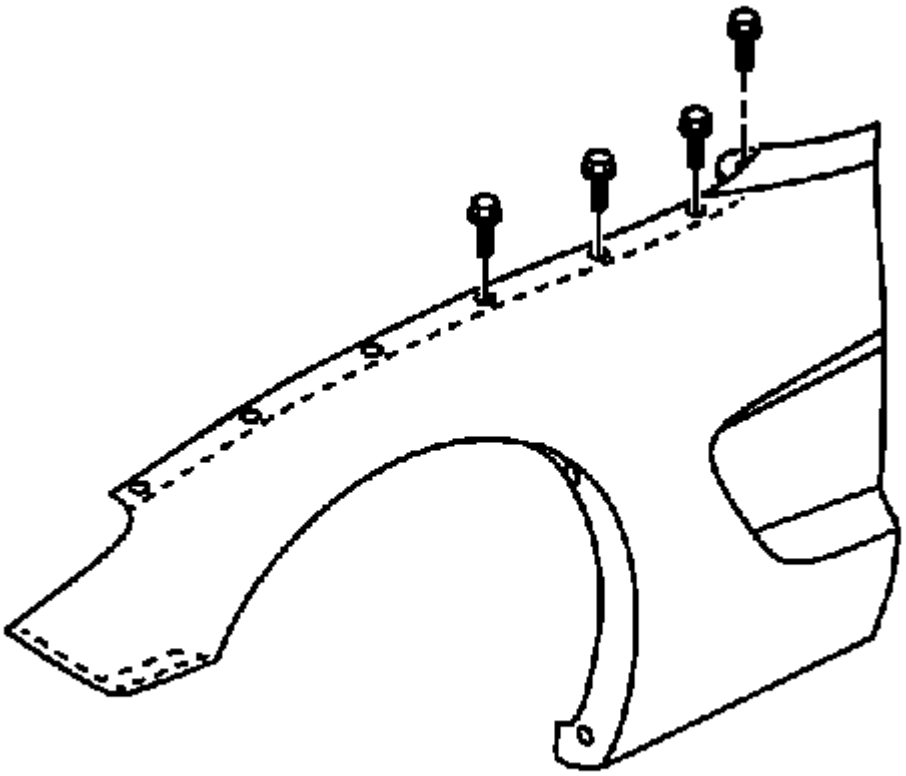


Fig. 158: Identifying Camshaft Timing Chain And Sproket
Courtesy of GENERAL MOTORS COMPANY

1. Clean the components with cleaning solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Dry the components with compressed air.
3. Inspect the timing chain for binding or wear.
4. Inspect the crankshaft sprocket for worn, damaged or chipped teeth.
5. Inspect for a damaged keyway.
6. Inspect for worn oil pump drive splines.

cardiagn.com

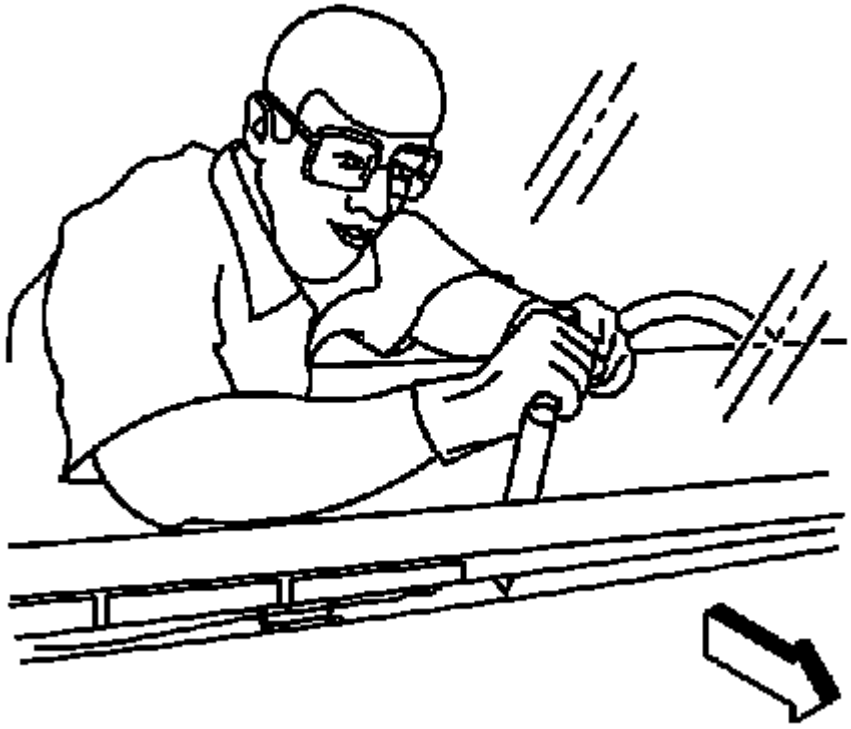


Fig. 159: View Of Timing Chain Tensioner Inspection Points
Courtesy of GENERAL MOTORS COMPANY

7. Inspect the timing chain tensioner for the following conditions:
    - Damaged or broken tension spring (1)
    - Excessive wear or scoring on the chain guide surfaces (2, 3)

CAMSHAFT POSITION ACTUATOR CLEANING AND INSPECTION

cardiagn.com

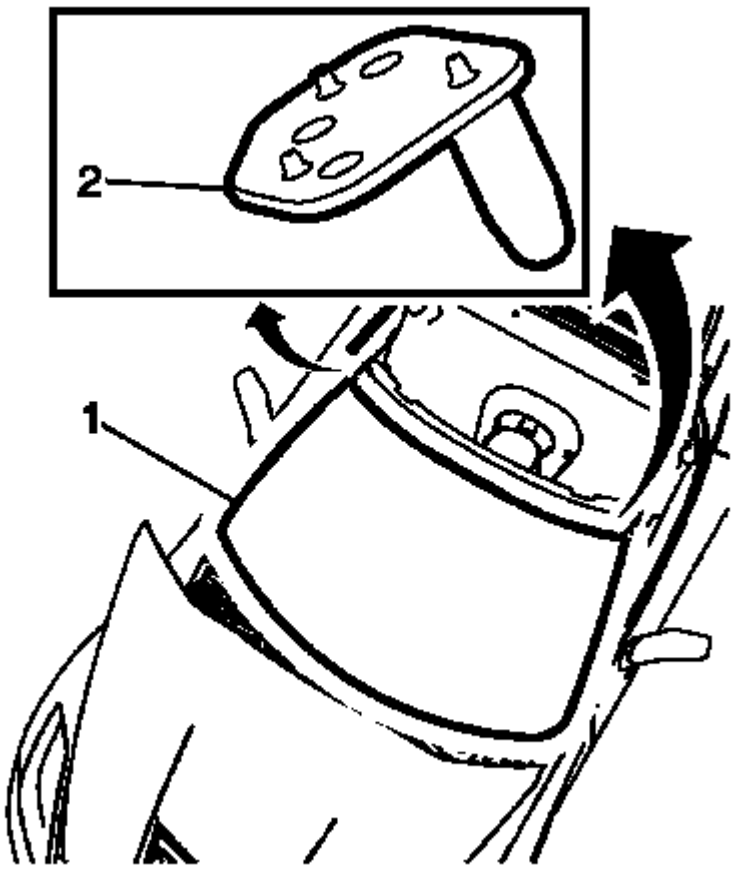


Fig. 160: View Of Tie Strap Through Center Of Actuator
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Camshaft Position Actuator Removal and Installation Warning .

1. Insert a tie strap (1) through the center of the camshaft position (CMP) actuator and over the reluctor wheel.

cardiagn.com

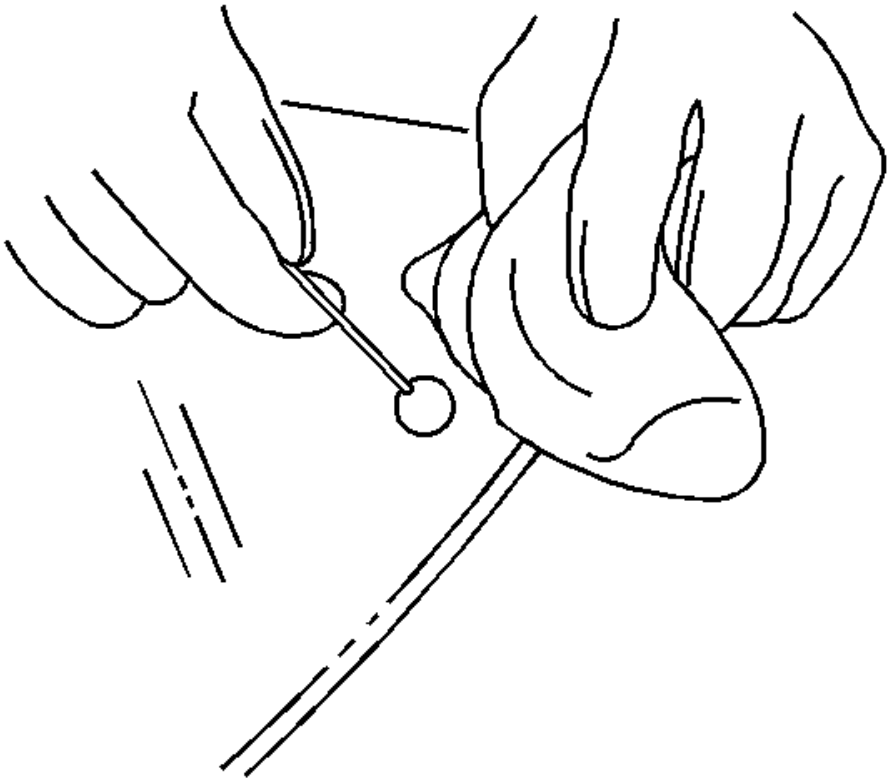


Fig. 161: Inspecting CMP Actuator For Broken Spring
Courtesy of GENERAL MOTORS COMPANY

2. Clean the CMP actuator with cleaning solvent.

WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

3. Dry the components with compressed air.
4. Inspect the CMP actuator for a broken spring (1).

cardiagn.com

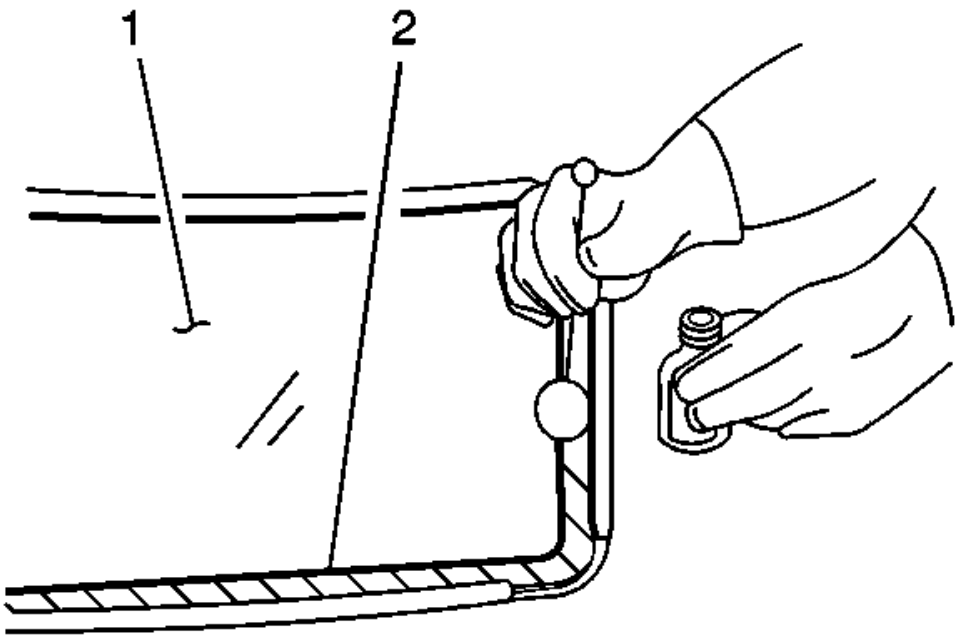


Fig. 162: CMP Actuator Inspection Points
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the CMP actuator for the following conditions:
    - Improper positioning of the CMP reluctor wheel. The actuator return spring should reposition the reluctor wheel to the PARK position. Inspect for proper alignment of the mark on the face of the sprocket (1) with the flat edge of the reluctor wheel (2). If the reluctor wheel is not properly positioned, the internal components of the actuator are sticking or the return spring is broken and the actuator should be replaced as an assembly.
    - Nicked or damaged edges (3) on the CMP reluctor wheel
    - Damaged timing sprocket teeth (4)

cardiagn.com

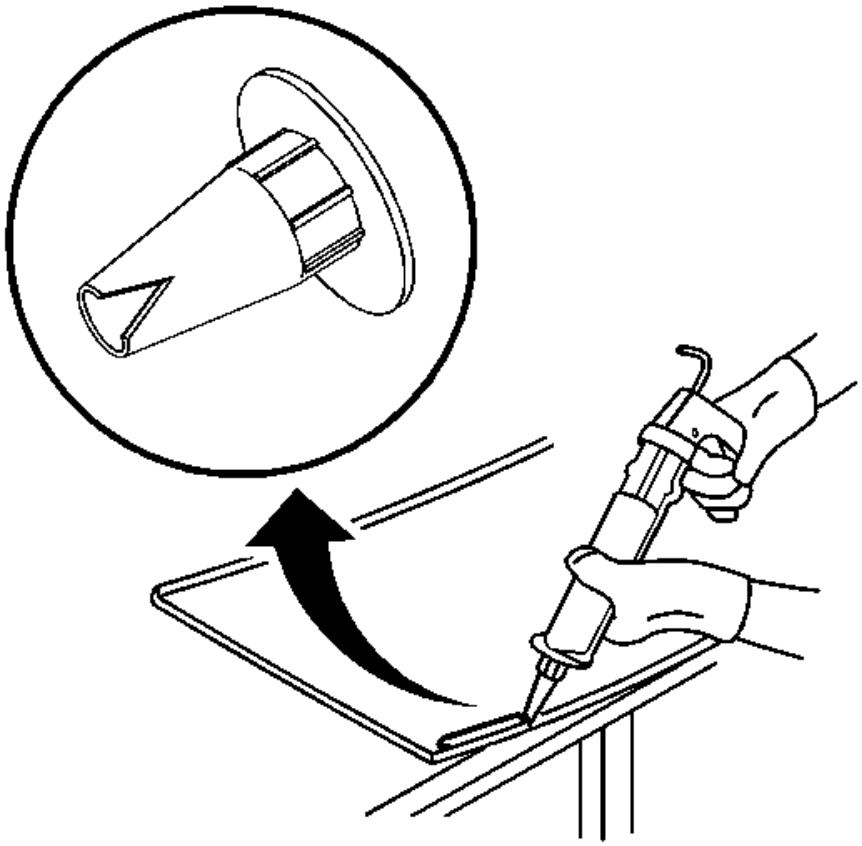


Fig. 163: View Of Oil Passages
Courtesy of GENERAL MOTORS COMPANY

6. Inspect the CMP actuator for dirt, debris or restrictions within the oil passages (1, 2, 3).

cardiagn.com

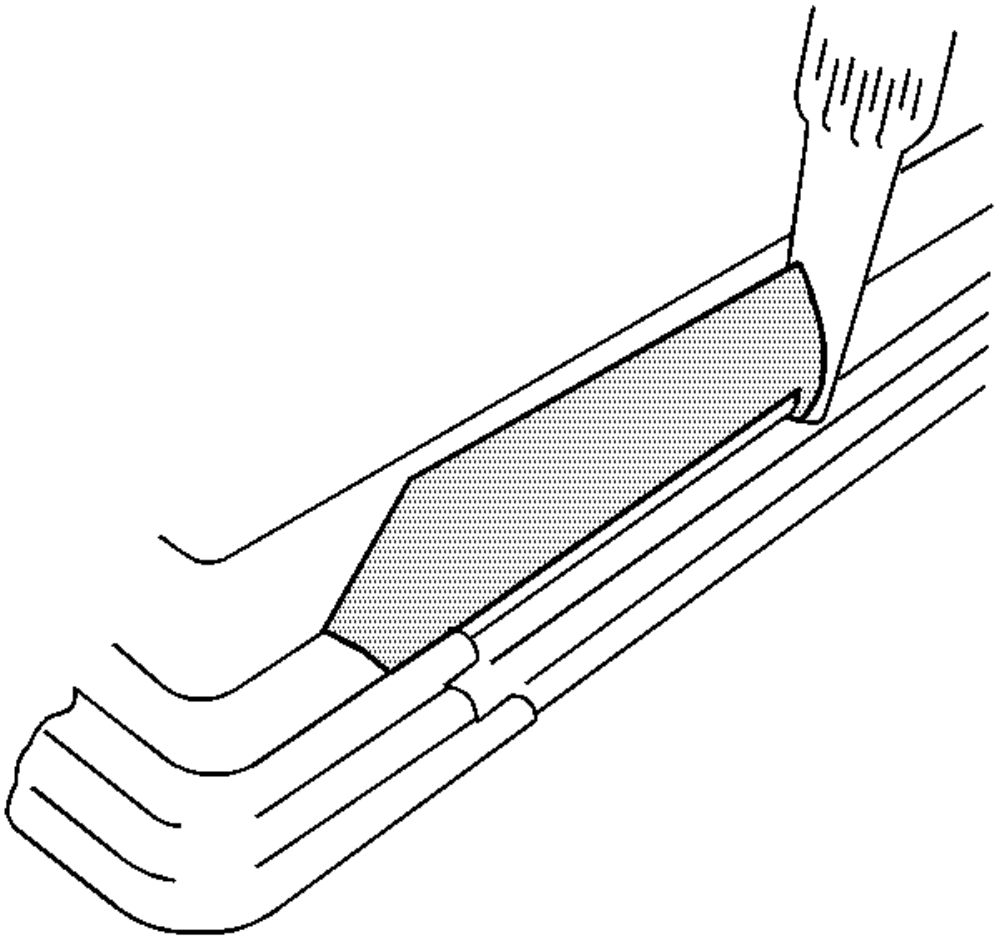


Fig. 164: View Of Timing Chain Tensioner Inspection Points
Courtesy of GENERAL MOTORS COMPANY

7. Inspect the timing chain tensioner for the following conditions:
    - Damaged or broken tension spring (1)
    - Excessive wear or scoring on the chain guide surfaces (2, 3)

CAMSHAFT POSITION ACTUATOR MAGNET CLEANING AND INSPECTION

cardiagn.com

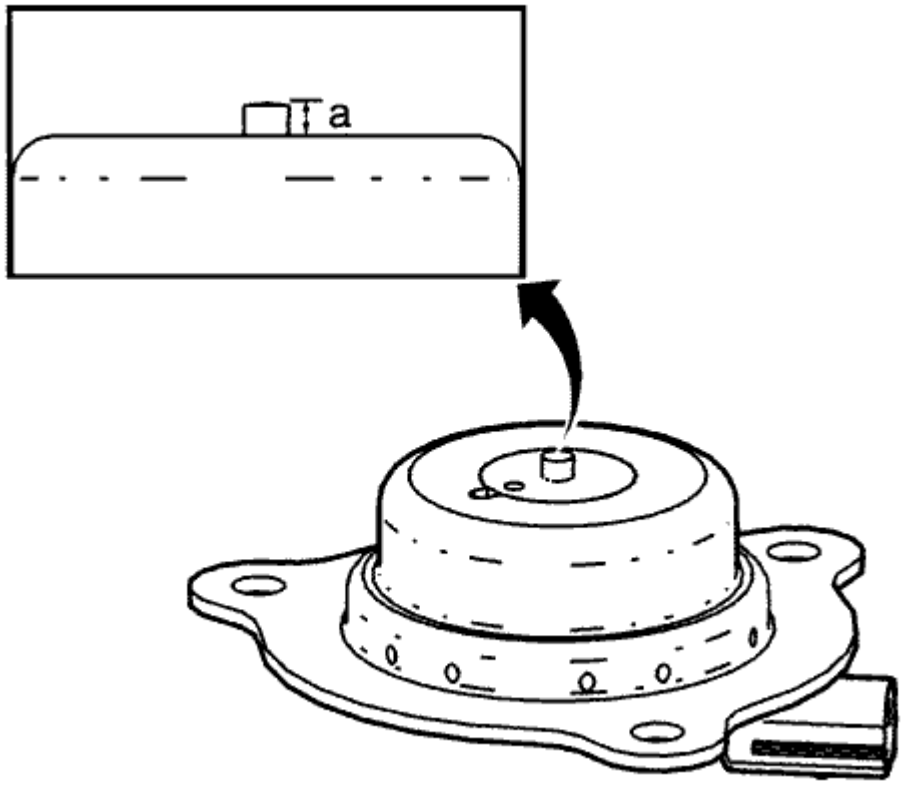


Fig. 165: Camshaft Position Actuator Magnet
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: If checking the operating range of the CMP magnet pintle, DO NOT energize the magnet with a 12V power supply. Use steps 2 thru 5 below to check pintle operating range. To dynamically test the magnet pintle with a power supply, refer to the dynamic test instructions listed under the component testing portion of DTC P0011. Refer to DTC P0011 .

1. Inspect the CMP magnet for the following conditions:
   - A damaged electrical connector
   - An accumulation of dirt or debris in the recessed area around the pintle
   - A build-up of burnt engine oil on the shaft of the pintle which may cause the pintle to stick and not move freely within the proper range of travel
2. Holding the CMP magnet with the pintle facing upward, measure the pintle retracted position (a). Record the dimension.

cardiagn.com

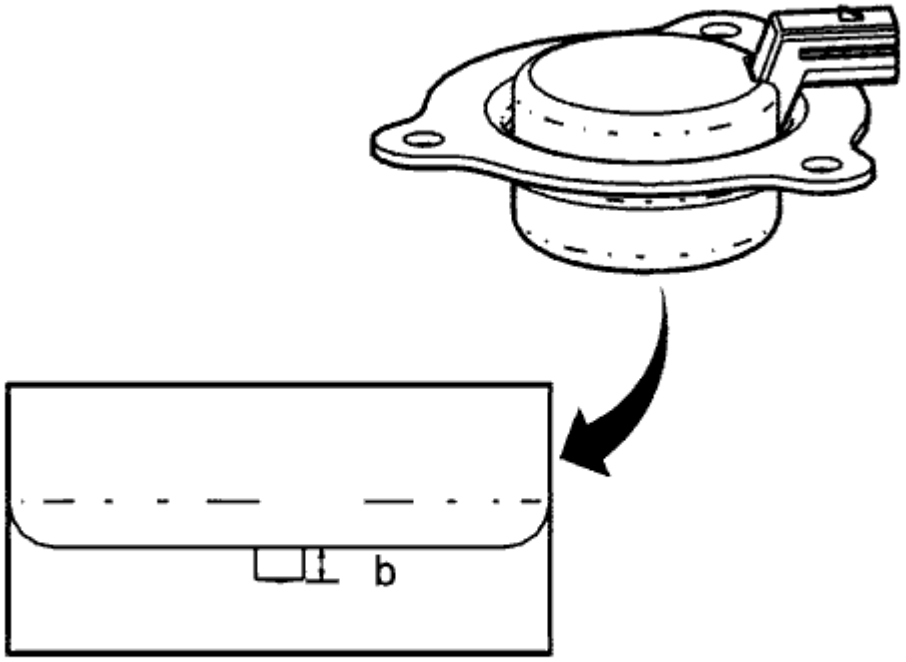


Fig. 166: Measuring Pintle Extended Position
Courtesy of GENERAL MOTORS COMPANY

3. Holding the CMP magnet with the pintle facing downward, measure the pintle extended position (b). Record the dimension.
4. Subtract the retracted dimension (a) from the extended dimension (b) to determine pintle travel. A properly moving pintle will travel 3.0-5.5 mm (0.12-0.22 in).
5. If the pintle of the CMP magnet is binding or does not move within the proper range of travel, replace the CMP magnet as an assembly.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE INSPECTION

cardiagn.com

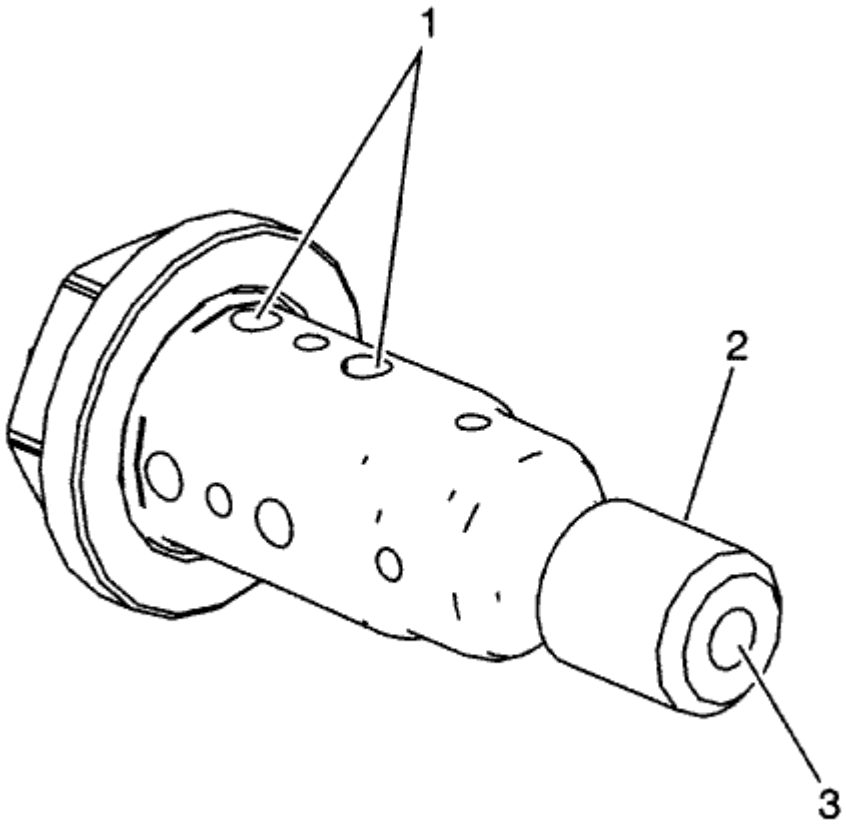


Fig. 167: Camshaft Position Actuator Solenoid Valve Inspection
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Do not use the camshaft position (CMP) actuator solenoid valve again. Install a NEW valve during assembly. The inspection procedure below is provided for off-vehicle diagnostic purposes only.

1. Inspect the CMP valve for the following conditions:
   - Dirt, debris or restrictions within the oil passages (1)
   - Damaged threads (2)

     If the threads of the valve are damaged, also inspect the threads in the front of the camshaft for damage.

   - Dirt, debris or restrictions within the oil inlet (3)

     If debris is detected, the engine assembly should be inspected to determine the source of contamination.

cardiagn.com

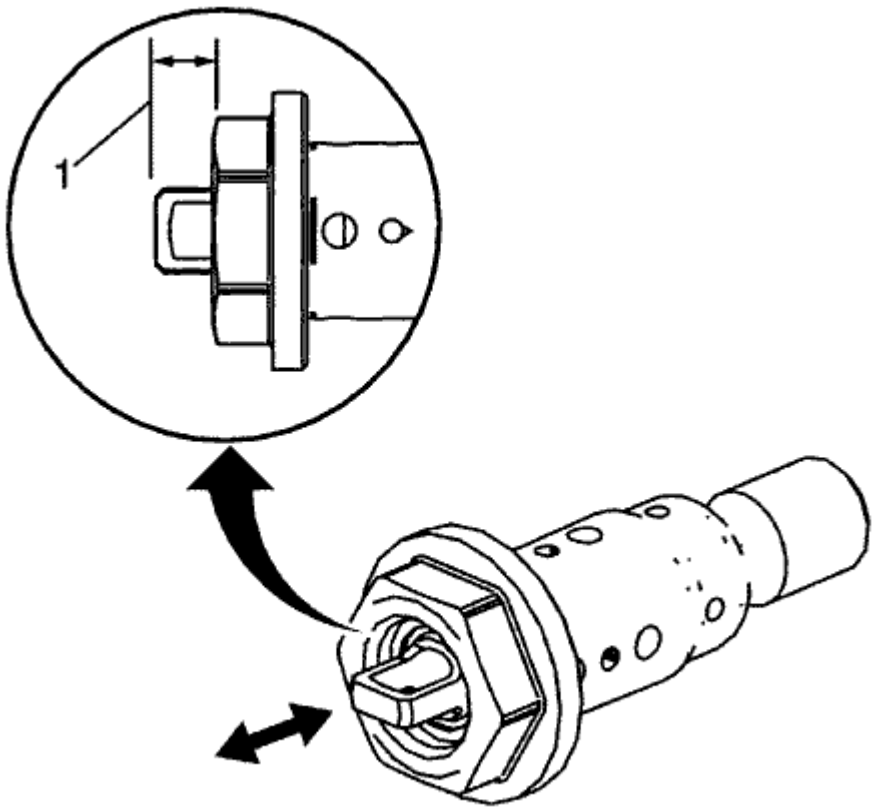


Fig. 168: Camshaft Position Actuator Solenoid Valve Inspection
Courtesy of GENERAL MOTORS COMPANY

2. Inspect for a sticking valve spool or broken valve spool spring.
3. Depress the valve spool into the housing. The valve should move freely with no binding or sticking and minimal resistance inward. When released, the valve spring should return the spool to the proper extended position (1) of 6.52-6.92 mm (0.257-0.272 in).

VALVE ROCKER ARM AND PUSH ROD CLEANING AND INSPECTION

cardiagn.com

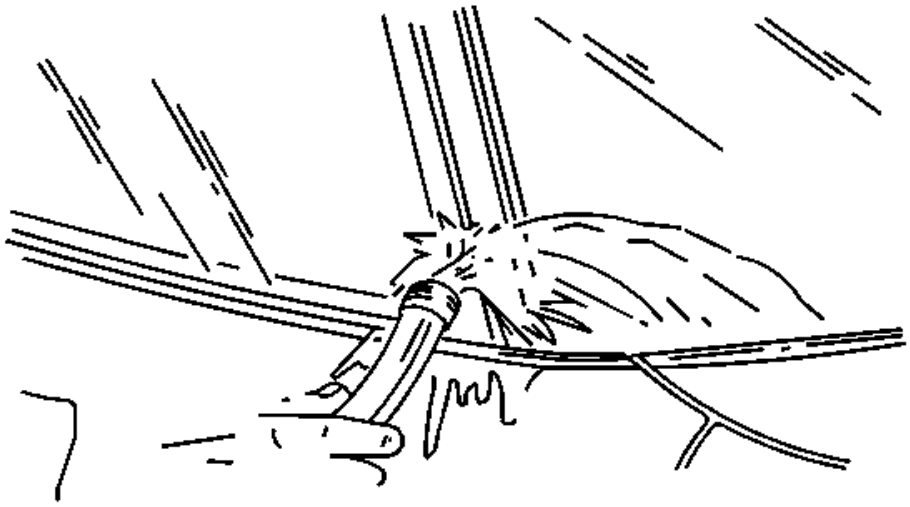


Fig. 169: Identifying Valve Rocker Arm Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Parts that are to be used again must be marked, sorted or organized for assembly.**

1. Mark, sort or organize the components for assembly. Refer to **Separating Parts** .
2. Clean the components with cleaning solvent.

WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

3. Dry the components with compressed air.
4. Inspect the valve rocker arms bearings (2) for binding or roughness.
5. Inspect the valve rocker arm pushrod sockets (3) and valve stem mating surfaces (1). These surfaces should be smooth with no scoring or exceptional wear.

cardiagn.com

6. Inspect the pushrods for worn or scored ends. These surfaces should be smooth with no scoring or exceptional wear.
7. Inspect the pushrods for bends. Roll the pushrod on a flat surface to determine if the pushrod is bent.
8. Inspect the pushrod oil passages for restrictions.
9. Inspect the rocker arm pivot supports for cracks, wear or other damage.

VALVE LIFTER AND GUIDE CLEANING AND INSPECTION

Non Active Fuel Management Valve Lifters

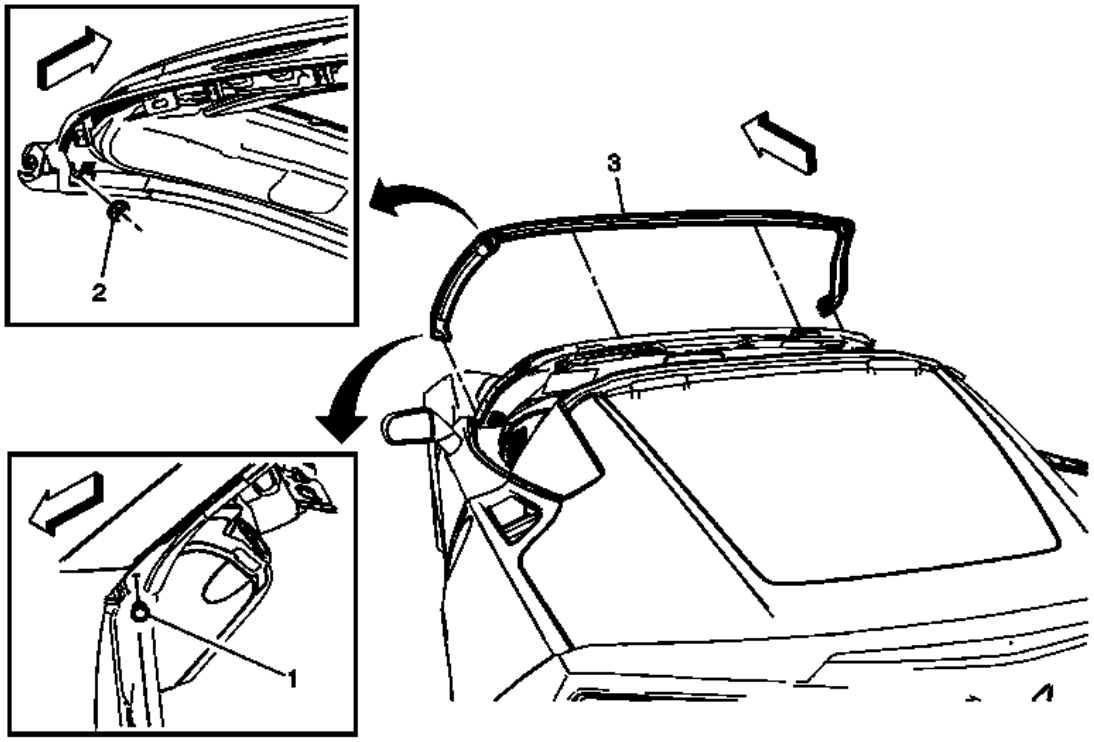


Fig. 170: Identifying Valve Lifter Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

NOTE: Components that are to be used again must be marked, sorted or organized for assembly.

1. Clean the components in cleaning solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Dry the components with compressed air.

cardiagn.com

- Bent or broken clip (1)
- Worn pushrod socket (2)
- Scuffed or worn sides (3)

  If the valve lifter shows wear, inspect the engine block lifter bores for wear or damage.

- Flat spots on the roller (4)
- Loose or damaged pin (5)
- Plugged oil hole (6)
- Worn or damaged roller bearing

  The roller should rotate freely with no binding or roughness.

Active Fuel Management Valve Lifters

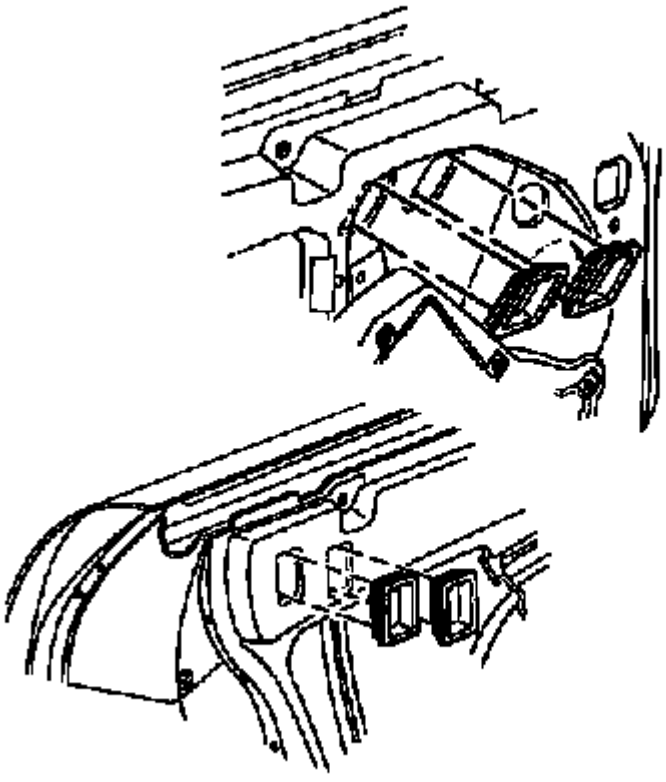


Fig. 171: Displacement On Demand Valve Lifters Assembly
Courtesy of GENERAL MOTORS COMPANY

cardiagn.com

organized for assembly.

1. Clean the components in cleaning solvent.

WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

2. Dry the components with compressed air.
3. Inspect the valve lifters for the following conditions:
    - Broken or collapsed spring (1)
    - Worn pushrod socket (2)
    - Plugged lubrication hole (3)
    - Plugged lifter oil-switching hole (4)
    - Flat spots on the roller (5)
    - Worn or damaged roller bearing (6)

      The roller should rotate freely with no binding or roughness.

    - Scuffed or worn sides (7)

Valve Guides

cardiagn.com

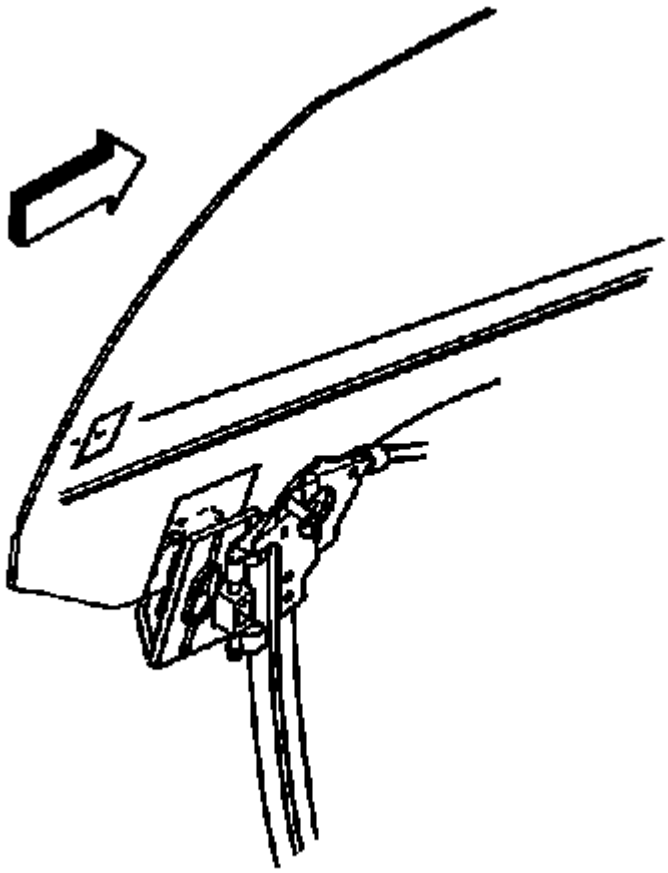


Fig. 172: Inspecting Valve Lifter Guides
Courtesy of GENERAL MOTORS COMPANY

Inspect the valve lifter guides for the following conditions:

- Cracks or damage (1)
- Excessive wear in the lifter mounting bores (2)

CYLINDER HEAD DISASSEMBLE

cardiagn.com

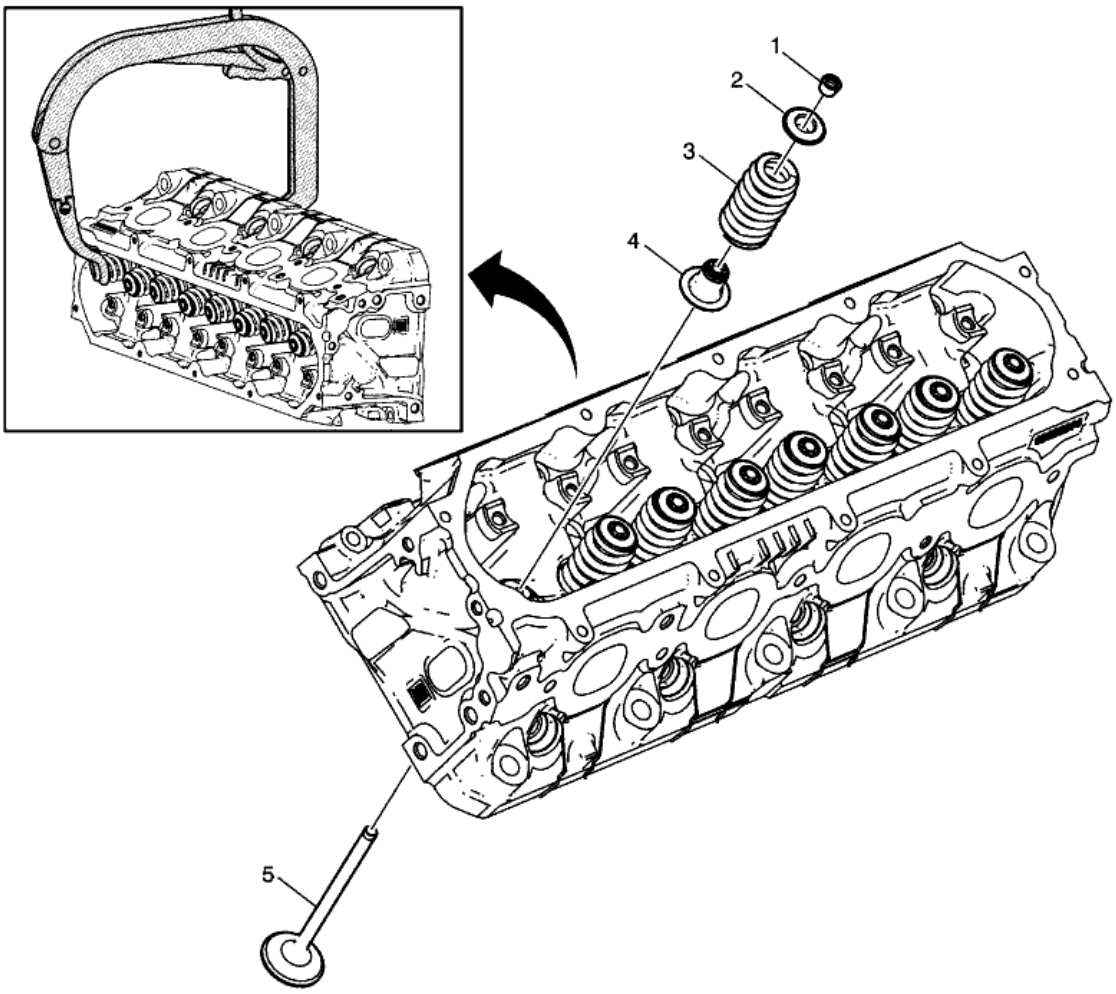


Fig. 173: Cylinder Head Disassemble
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head Disassemble

Callout	Component Name
1	Valve Stem Key **Procedure** 1. Install the **J-8062** compressor (3) onto the head. 2. Remove the valve stem keys. **Special Tools** **J-8062** Valve Spring Compressor For equivalent regional tools, refer to **Special Tools** .
2	Valve Stem Spring Cap
3	Valve Spring

cardiagn.com

4	Valve Stem Oil Seal **NOTE:** **NEVER reuse a valve stem oil seal.**
5	Valve

CYLINDER HEAD CLEANING AND INSPECTION

Special Tools

- **J 8089** Carbon Removal Brush
- **J 9666** Valve Spring Tester

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

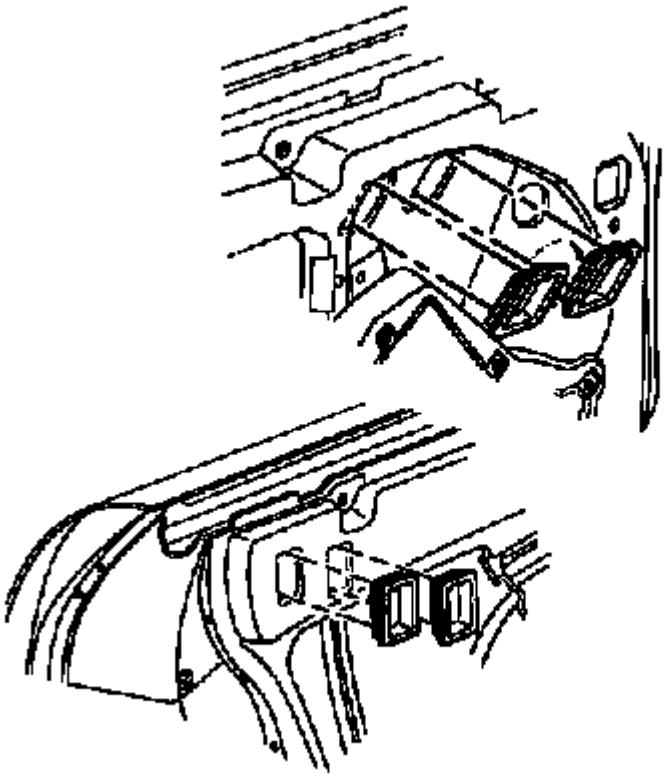


Fig. 174: Cleaning Carbon Using J 8089
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

cardiagn.com

NOTE:

- **When cleaning a cylinder head in a thermal type oven, do not exceed 204°C (400°F).**
- **Be careful not to scuff the chamber.**

1. Clean the following components:
   - Use the **J 8089** brush in order to remove the carbon from the combustion chambers.
   - Gasket surfaces

     Refer to **Replacing Engine Gaskets** .

   - Valve stems and heads on a buffing wheel
   - Bolt hole threads

     Remove all dirt, debris or threadlocking material from the bolt holes.

2. Inspect the cylinder head for the following conditions:
   1. Cracks in the exhaust ports and combustion chambers
   2. External cracks in the water chambers
   3. Gasket surfaces for excessive scratches or gouging

      Refer to **Replacing Engine Gaskets** .

   4. Bolt hole threads for debris or damaged threads

cardiagn.com

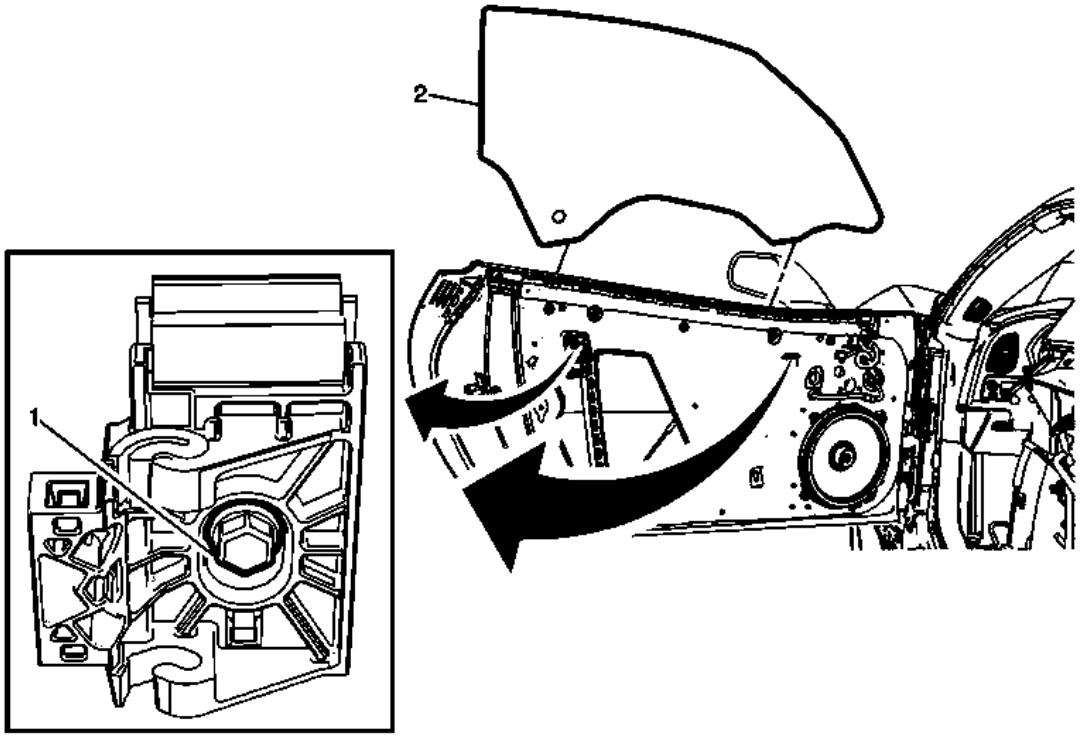


Fig. 175: Inspecting Cylinder Head For Warpage
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the cylinder head for warpage. Refer to **Engine Mechanical Specifications** .

cardiagn.com

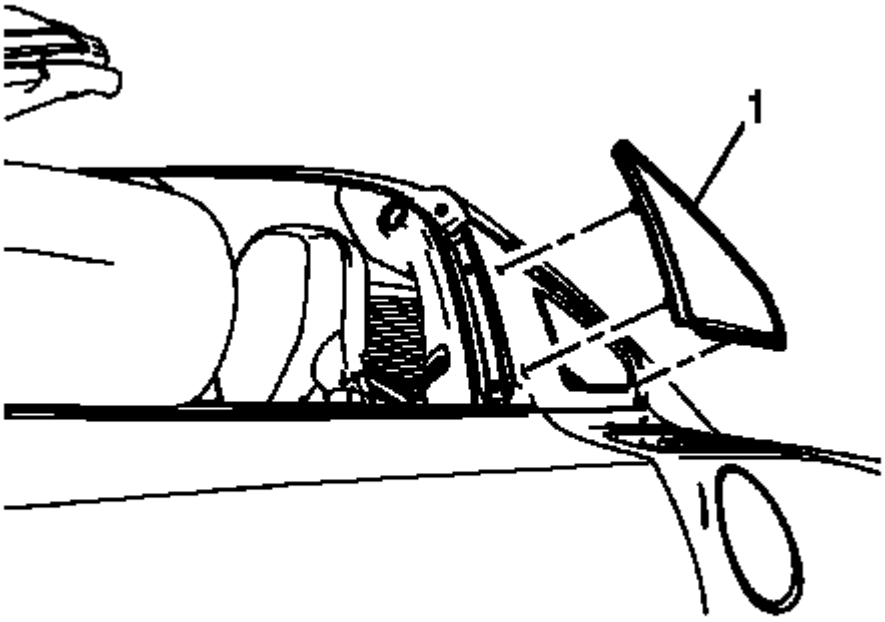


Fig. 176: Measuring Valve Spring Tension
Courtesy of GENERAL MOTORS COMPANY

4. Use the **J 9666** tester in order to measure the valve spring tension. Refer to **Engine Mechanical Specifications** .

VALVE GUIDE REAMING AND VALVE AND SEAT GRINDING

Special Tools

J 8001 Dial Indicator Set

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

Valve Guide Reaming

cardiagn.com

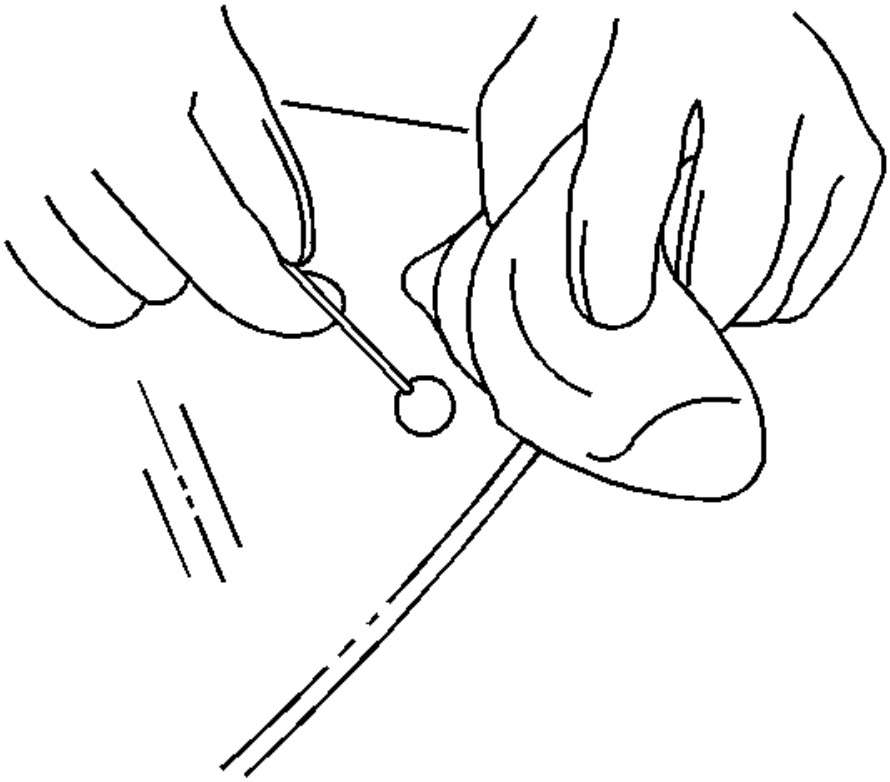


Fig. 177: Measuring Valve Stem-To-Guide Clearance
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Excessive valve stem-to-guide clearance may cause a noisy valve train, premature valve stem oil seal wear, component damage, and/or excessive engine oil consumption.

CAUTION: Insufficient valve stem-to-guide clearance will result in noisy or sticking valves. Valves that are too tight may disturb engine smoothness or lead to component damage.

1. Using the **J 8001** dial indicator, measure the valve stem-to-guide clearance. Position the tip of the dial indicator at the top of the valve guide.

   Valve stem-to-guide clearance may also be obtained by using a micrometer to measure the valve stem diameter and a ball type measuring gauge to measure the guide bore.

cardiagn.com

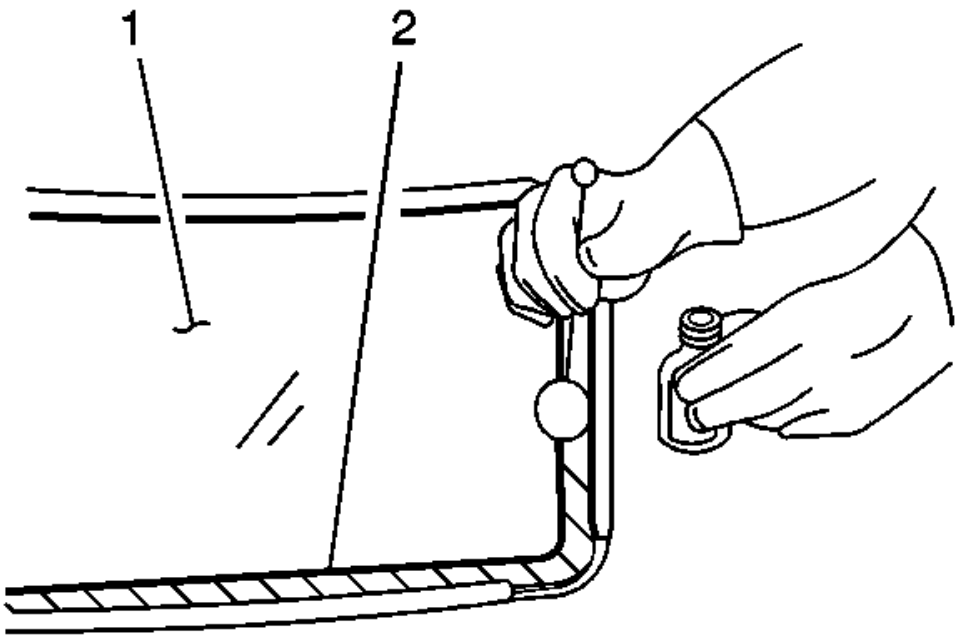


Fig. 178: Inspecting For Excessive Valve Stem To Guide Clearance
Courtesy of GENERAL MOTORS COMPANY

2. If the clearance measurement between the valve stem (1) and guide (2) is not within specification, the valve and/or the cylinder head must be replaced. Refer to **Engine Mechanical Specifications** .

cardiagn.com

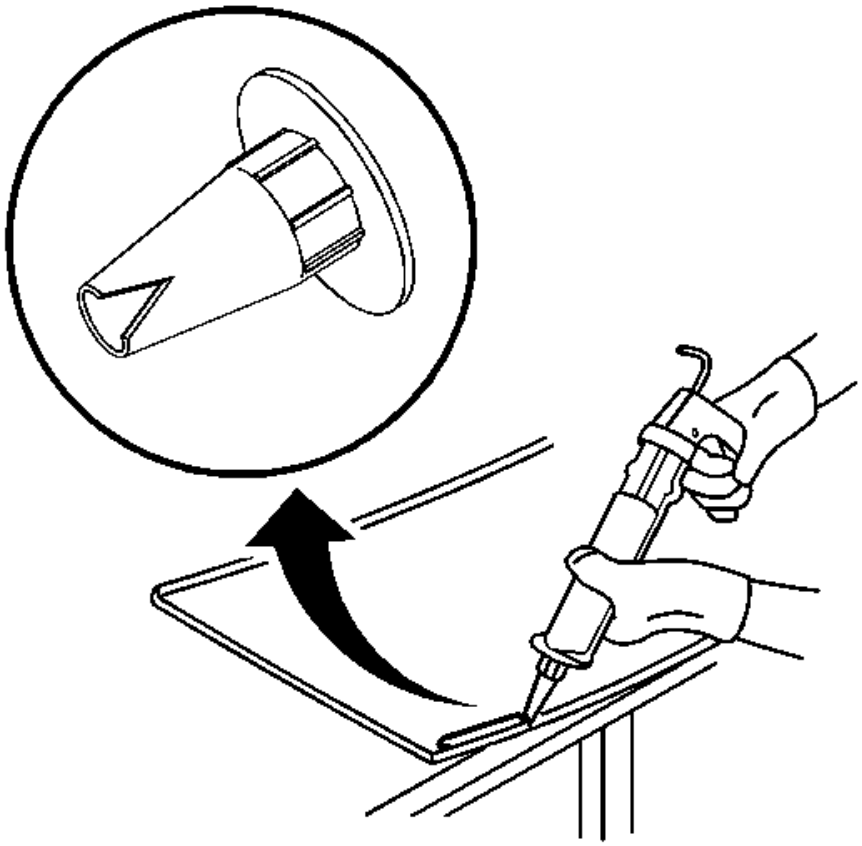


Fig. 179: Identifying Inspection Points For Valves Damage
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the valve stems for excessive scoring, wear or warpage.
    - A valve stem that has excessive scoring (3 or 4) or wear (4 or 6) must be replaced.
    - If a valve guide is worn or has excessive stem-to-guide clearance, the cylinder head should be replaced.
4. Measure the valve stem diameter. If the valve stem diameter is not within specification, the valve must be replaced. Refer to **Engine Mechanical Specifications** .

    If the valve stem diameter is within specifications and the stem-to-guide clearance is excessive, the cylinder head must be replaced.

Valve and Seat Grinding

cardiagn.com

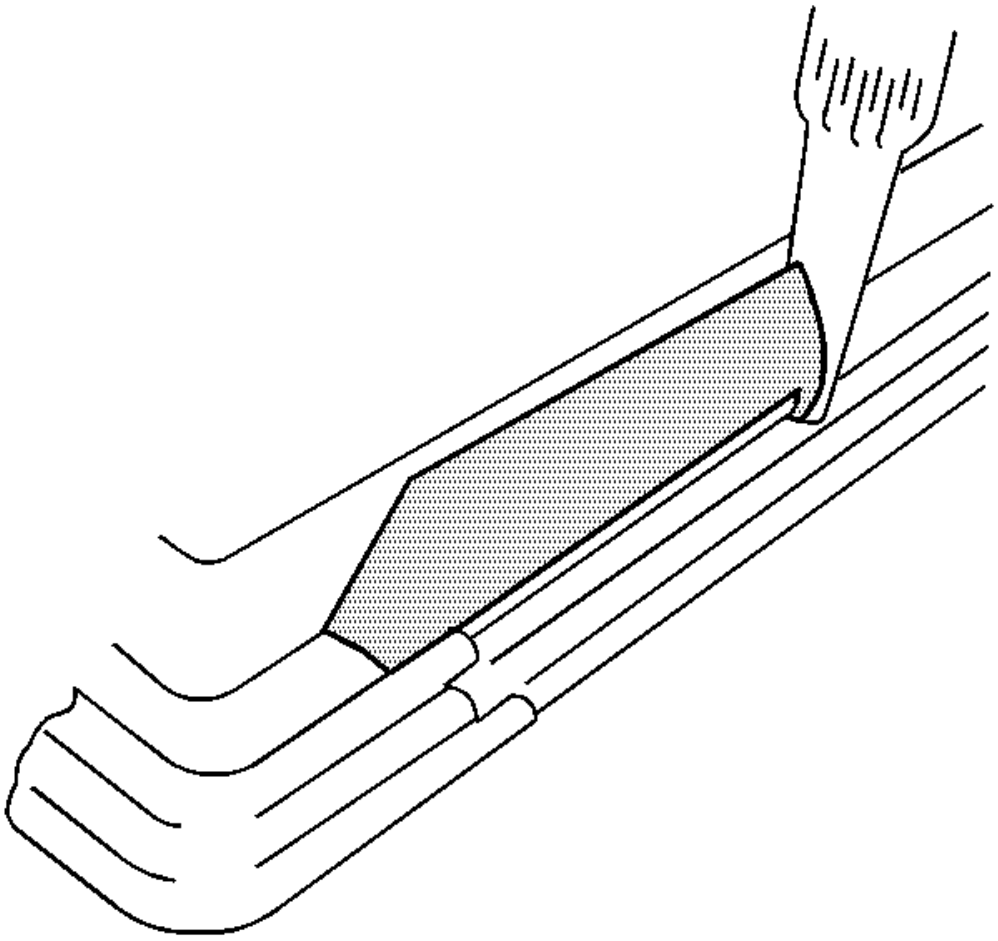


Fig. 180: Identifying Inspection Points For Valves Damage
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Reconditioning the valve seats is very important. The seating of the valves must be perfect for the engine to deliver optimum power and performance. Several different types of equipment are available for grinding valve seats.**
- **Another important factor is the cooling of the valve head. Good contact between the valve and the seat will ensure that heat will be properly dissipated.**
- **The recommendations of the equipment manufacturer should be followed carefully to obtain the proper results. Regardless of the type of equipment used, it is essential that valve guide bores be free of carbon or dirt to ensure proper centering of the tool pilot in the guide.**
- **Valves that are pitted or have stems that stems that show excessive**

cardiagn.com

wear or valves that are warped excessively must be replaced.

- **DO NOT reface valves. Valves with excessive wear or damage MUST be replaced.**

1. Inspect the valve for the following conditions:
   - Burnt or eroded areas (1)
   - A worn margin (2)
   - A bent stem (3)
   - A worn or scored stem (4)
   - A worn key groove (5)
   - A worn stem tip (6)

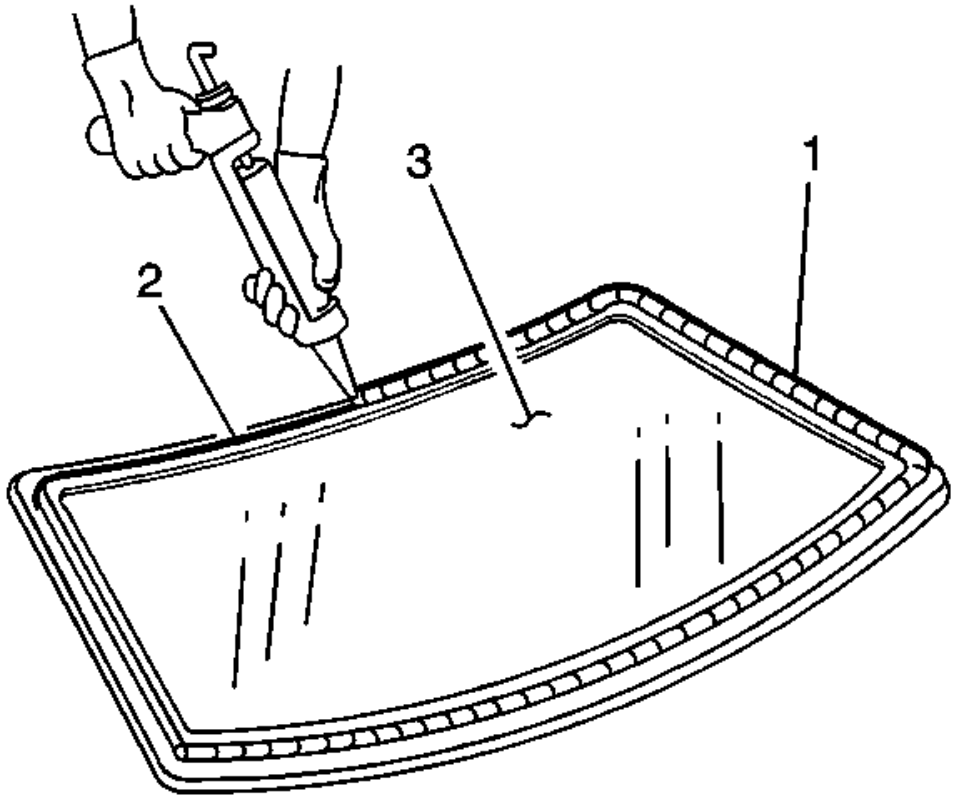


Fig. 181: Inspecting Valve Face For Burning, Pitting & Cracking
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the valve face for the following conditions:

cardiagn.com

- Worn or no margin (1 or 4)
- Pitted surfaces (2)
- Burnt or eroded areas (3)

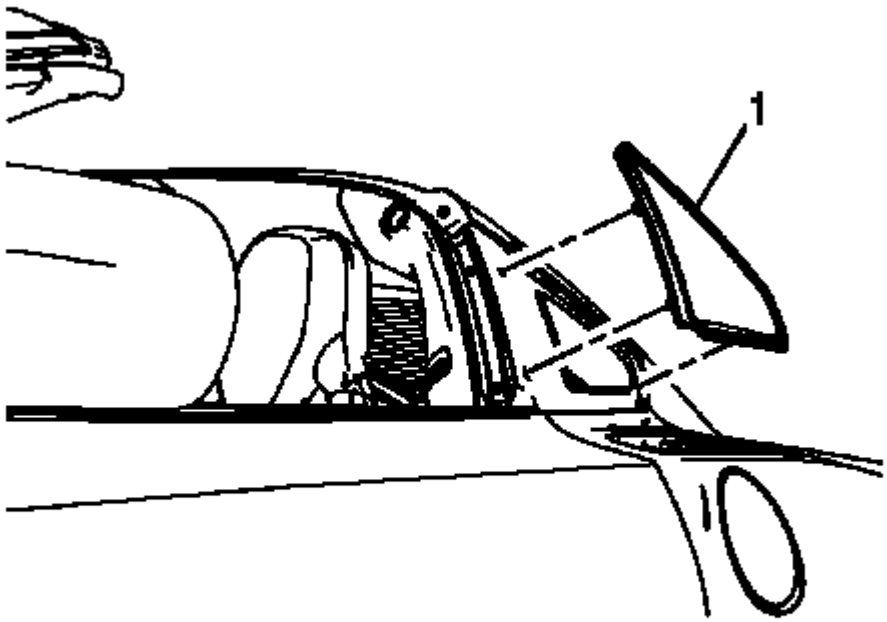


Fig. 182: Inspecting Valve Margin
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the valve margin.

   If the margin has worn away, it can lead to breakage, burning or pre-ignition due to heat localizing on this edge. If the vertical edge of the valve head, margin, is not visible and only a sharp edge remains, replace the valve.

4. Inspect for a loose valve seat in the cylinder head. The valve seat has an interference fit to the cylinder head.
5. Clean the valve guide bores with a suitable tool. Remove all carbon or dirt from the bores.

   The valve guide must be clean for the seat grinding tool to obtain proper results.

6. Grind the valve seat.

cardiagn.com

The recommendations of the equipment manufacturer should be followed carefully to obtain the proper results. Regardless of the type of equipment used, it is essential that valve guide bores be free from carbon or dirt to ensure proper centering of the tool pilot in the guide.

7. Inspect the valve seats.
   - The valve seats should be concentric to the centerline of the guide, measure valve seat runout. The total indicator runout reading must be within specification. Refer to **Engine Mechanical Specifications** .
   - If the valve seat has been ground, measure the valve stem height after reassembly of the cylinder head. The cylinder head, and/or valve must be replaced if the valve stem height is not within specification after seat grinding. Refer **Engine Mechanical Specifications** .

CYLINDER HEAD ASSEMBLE

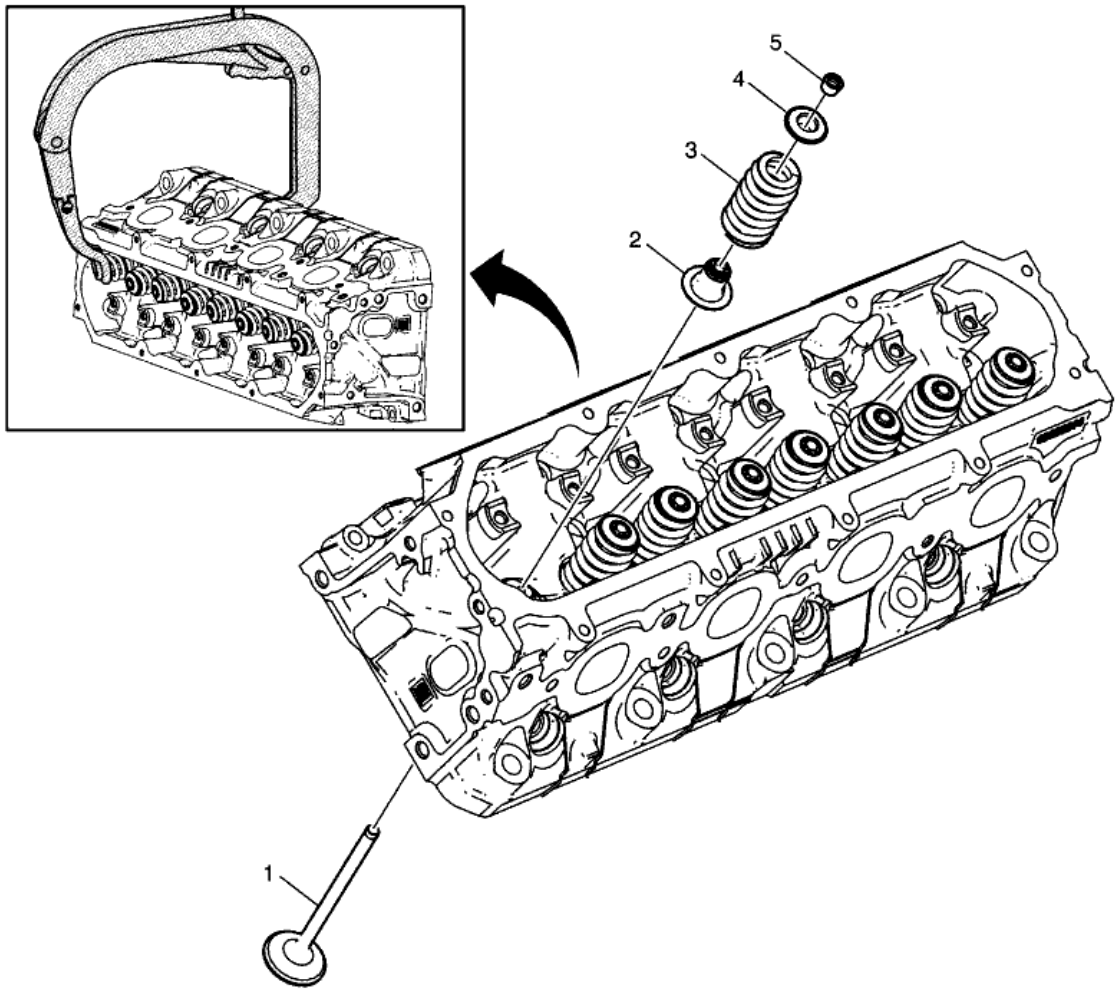


Fig. 183: Cylinder Head Assemble
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head Assemble

cardiagn.com

1	Valve
2	Valve Stem Oil Seal **NOTE:** **NEVER reuse a valve stem oil seal.**
3	Valve Spring
4	Valve Stem Spring Cap
5	Valve Stem Key **Procedure** 1. Install the **J-8062** compressor (3) onto the head. 2. Install the valve stem keys. **Special Tools** **J-8062** Valve Spring Compressor For equivalent regional tools, refer to **Special Tools** .

OIL PUMP CLEANING AND INSPECTION

cardiagn.com

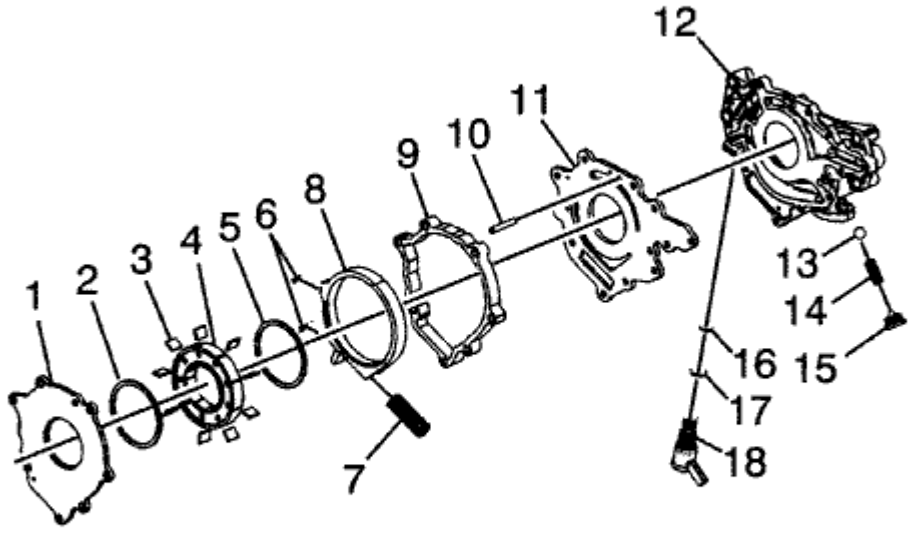


Fig. 184: Exploded View Of Oil Pump Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The internal components of the oil pump assembly are not serviced separately. If the oil pump components are worn or damaged, replace the oil pump as an assembly.**

1. Clean the components in solvent.

WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

2. Dry the components with compressed air.
3. Inspect the oil pump housing (12), intermediate cover (11), intermediate housing (9) and the housing cover (1) for cracks, excessive wear, scoring or casting imperfections.
4. Inspect the oil pump housing-to-oil pan sealing surface for scratches or gouging.
5. Inspect the oil pump base-to-engine block oil gallery surfaces for scratches or gouging.
6. Inspect the oil pump base for damaged bolt hole threads.
7. Inspect the pump slide (8) for excessive wear, scoring or gouges.

cardiagn.com

8. Inspect the oil pump internal oil passages for restrictions.
9. Inspect the oil pump rotor (4) and vanes (3) for cracks, wear or damage.
10. Inspect the oil pump slide spring (7) for breakage.
11. Inspect the oil pump slide (8) and slide seals (6) for cuts or damage.
12. Inspect the Oil Pressure Relief Valve Plug (15) for leaks or damage.
13. Inspect the Oil Flow Control Solenoid O-rings (16, 17) cracks or damage.

ENGINE FRONT COVER CLEANING AND INSPECTION

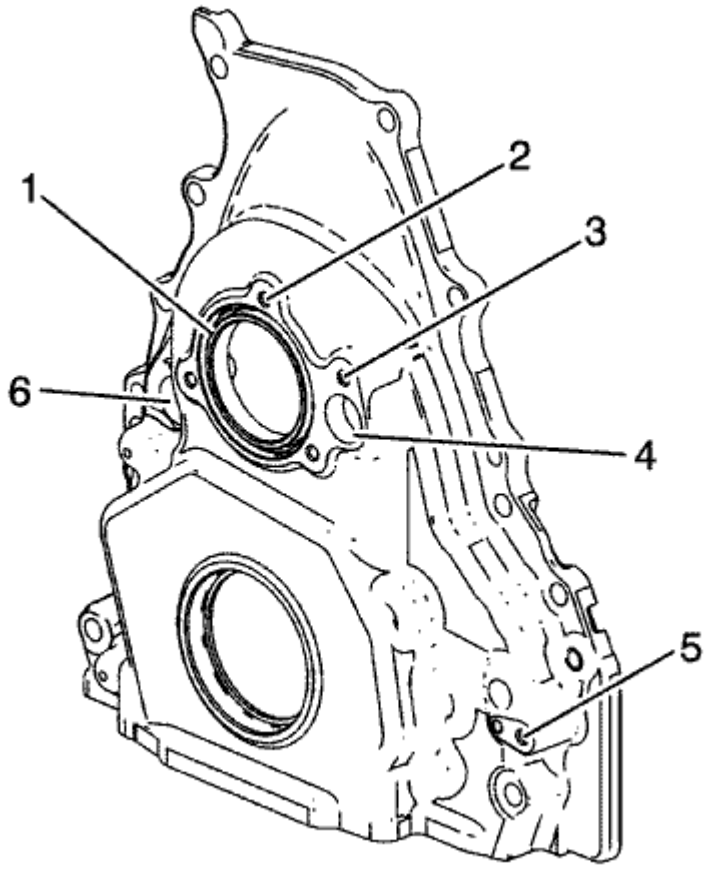


Fig. 185: Engine Front Cover Components
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Do not use the crankshaft front oil seal again. Install a NEW crankshaft front oil seal during assembly.**
- **Do not use the front cover-to-engine block gasket again. Install a NEW gasket during assembly.**
- **Do not use the camshaft position (CMP) actuator magnet gasket again. Install a NEW gasket during assembly.**

cardiagn.com

1. Clean the cover in solvent. Remove the sealant from the cover oil pan surface. Refer to **Replacing Engine Gaskets** .

WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Dry the cover with compressed air.
3. Inspect the gasket sealing surfaces (1) for excessive scratches or gouging.
4. Inspect the threaded bolt holes (2, 3 and 5) for damaged threads or debris.
5. Inspect the camshaft position sensor pass-thru hole and sealing surface (4) for excessive scratches or gouging.
6. Inspect the oil flow control valve connector pass-thru hole and sealing surface (6) for excessive scratches or gouging.

CRANKSHAFT REAR OIL SEAL HOUSING CLEANING AND INSPECTION

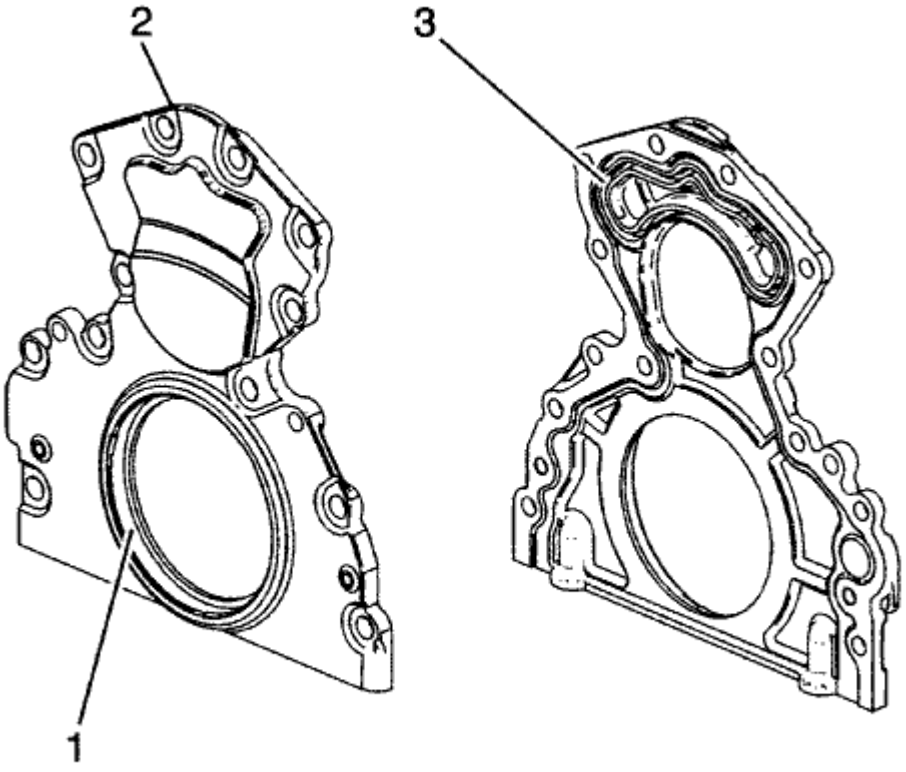


Fig. 186: Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

cardiagn.com

NOTE:

- **Do not use the crankshaft rear oil seal again. Install a NEW crankshaft oil seal during assembly.**
- **Do not use the rear housing-to-engine block gasket again. Install a NEW gasket during assembly.**

1. Clean the housing in solvent. Remove the sealant from the housing oil pan surface. Refer to **Replacing Engine Gaskets** .

   WARNING: Refer to Safety Glasses Warning .

2. Dry the housing with compressed air.
3. Inspect the gasket sealing surfaces (3) for excessive scratches or gouging.
4. Inspect the housing-to-oil pan threaded bolt holes for damaged threads or debris.
5. Inspect the crankshaft oil seal mounting bore for damage (1).

VALVE LIFTER OIL MANIFOLD CLEANING AND INSPECTION

NOTE:

- **DO NOT allow dirt or debris to enter the oil passages of the Valve Lifter Oil Manifold (VLOM). Plug, as required.**
- **DO NOT disassemble the electrical components from the VLOM.**
- **DO NOT submerge the electrical components in cleaning solvent.**
- **DO NOT use the VLOM outer gasket again. Remove the VLOM outer gasket and install a NEW VLOM outer gasket during assembly.**

cardiagn.com

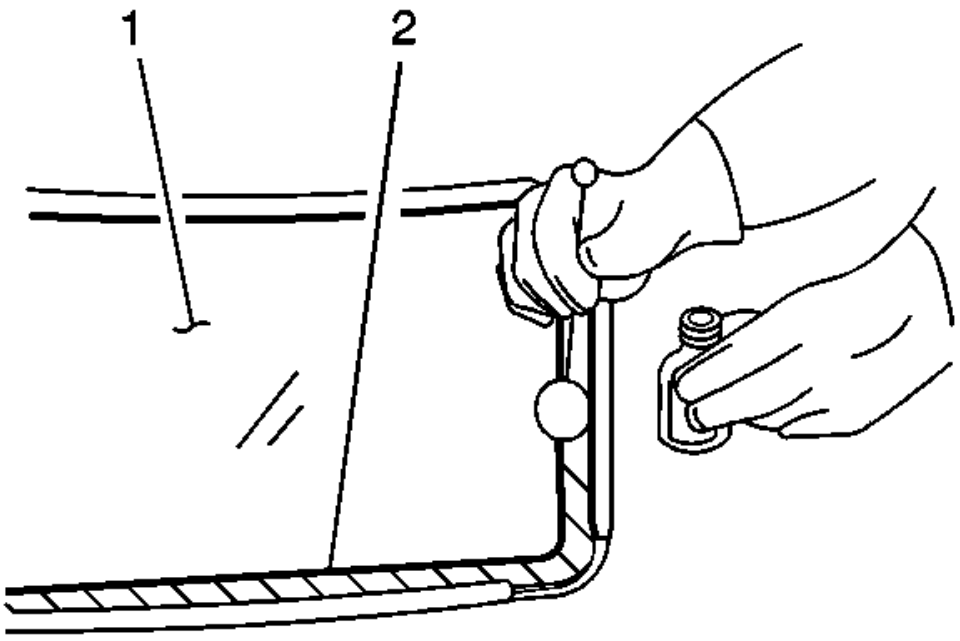


Fig. 187: Identifying Improper Lifting Of VLOM
Courtesy of GENERAL MOTORS COMPANY

1. DO NOT lift the VLOM (2) by the electrical lead frame (1).

cardiagn.com

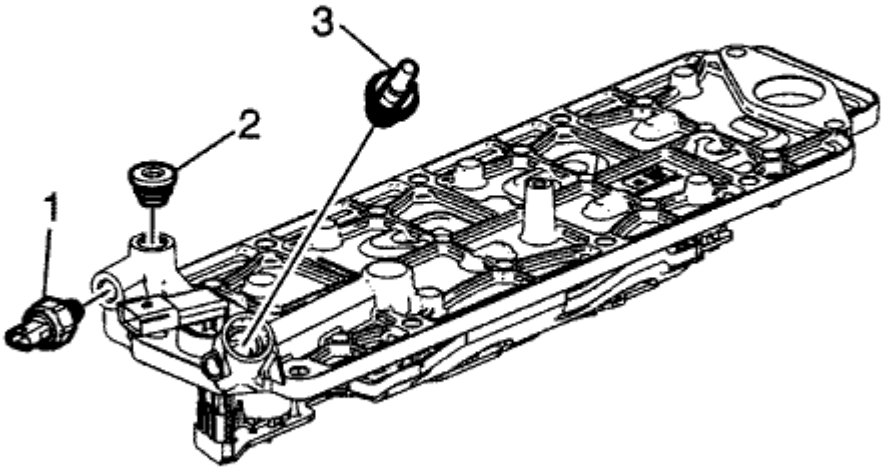


Fig. 188: Oil Pressure Sensor And VLOM
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil pressure sensor (1) from the VLOM.
3. Remove the VLOM plug (2).
4. Remove the PCV assembly (3).

WARNING: Refer to Safety Glasses and Compressed Air Warning .

5. Clean the VLOM with compressed air.

cardiagn.com

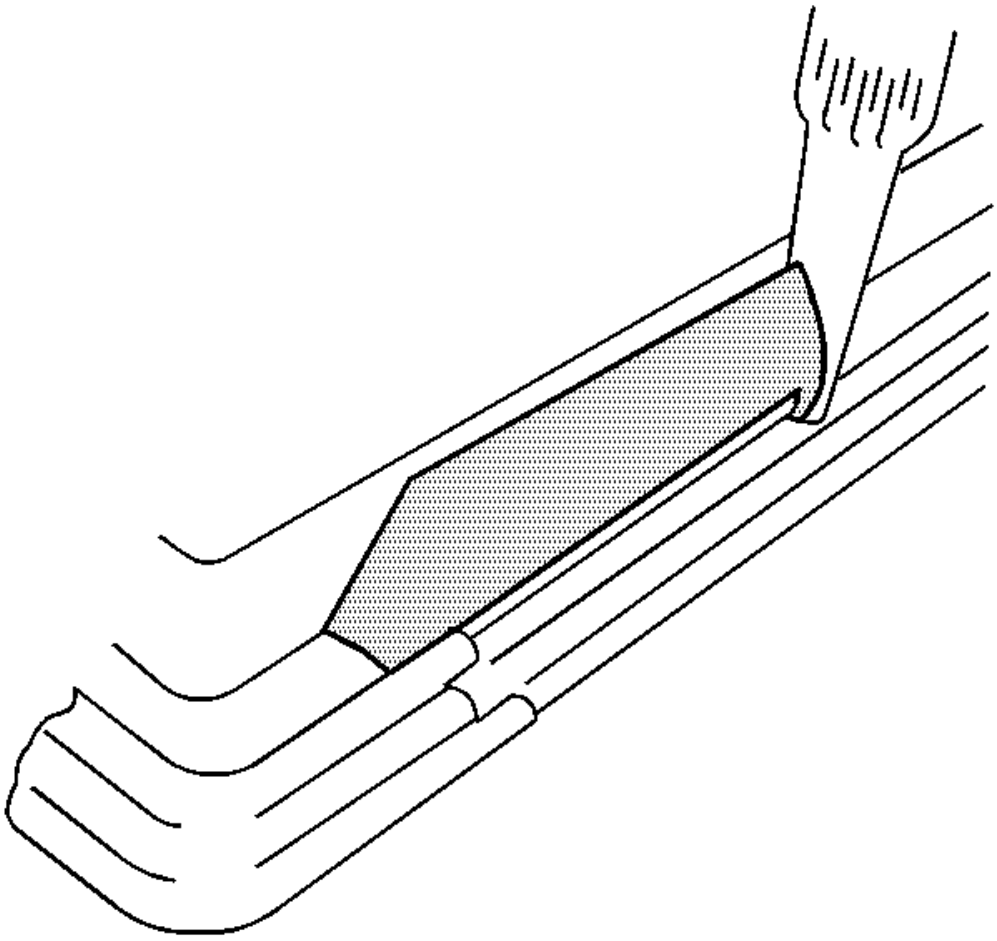


Fig. 189: Electrical Solenoids
Courtesy of GENERAL MOTORS COMPANY

6. Inspect for loose electrical solenoids (1-4) or loose or missing bolts.
7. Inspect for damage to the electrical lead frame (5).
8. Inspect for a damaged electrical connector, for bent or corroded pins.

cardiagn.com

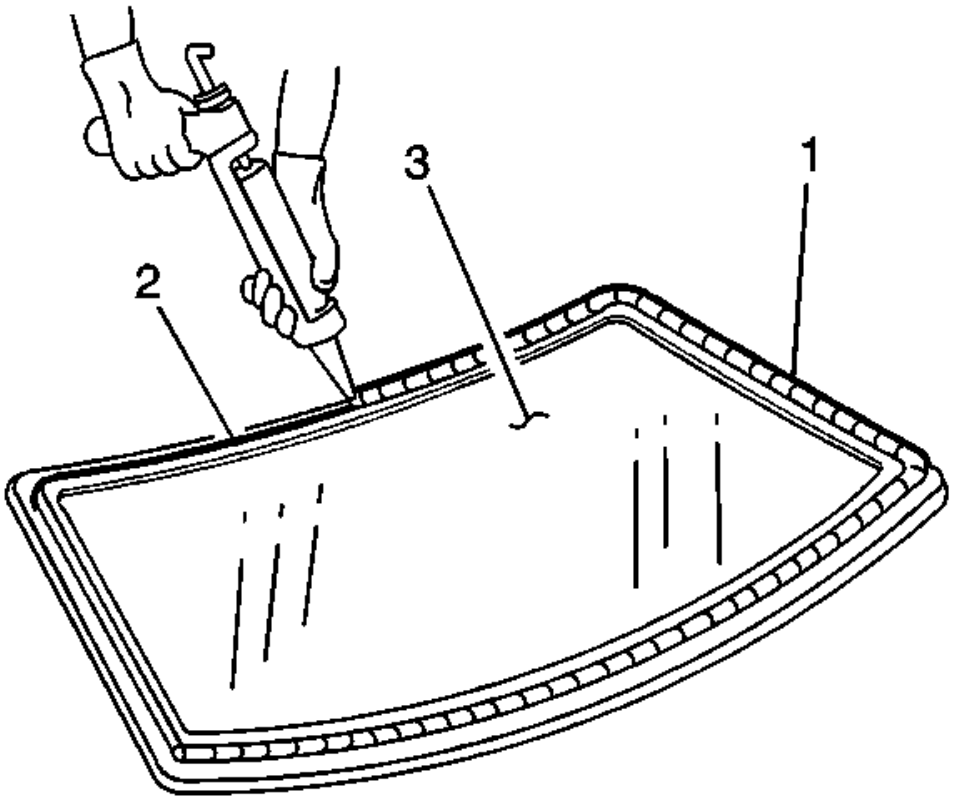


Fig. 190: Sealing Gaskets
Courtesy of GENERAL MOTORS COMPANY

9. Inspect for damaged VLOM inner gaskets (1-8). If the VLOM inner gaskets are damaged, the VLOM must be replaced as an assembly.
10. Inspect for a damaged VLOM outer gasket (9) or scored gasket surfaces.
11. Inspect for debris or restrictions within the oil passages of the VLOM. Refer to **Cylinder Deactivation (Active Fuel Management) Valve Lifter Oil Manifold Diagnosis and Testing** .

VALVE ROCKER ARM COVER CLEANING AND INSPECTION

cardiagn.com

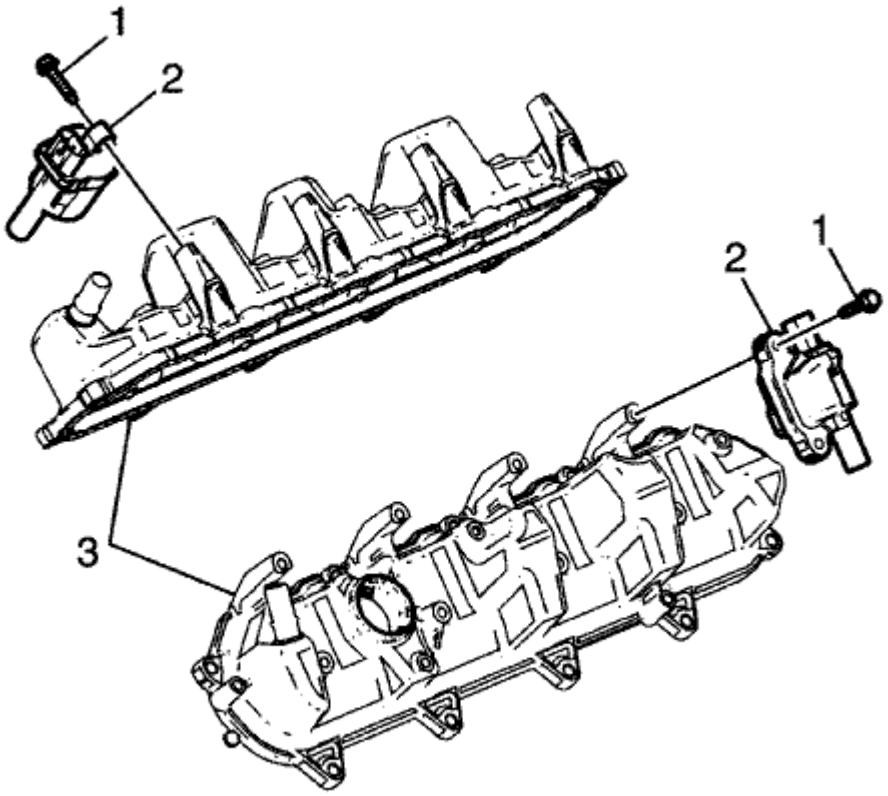


Fig. 191: Valve Rocker Arm Cover Components
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT:

- **Do not use the valve rocker arm cover gasket again. Install a NEW gasket during assembly.**
- **Remove the ignition bolts (1) and coils (2) before cleaning the cover in solvent. Do not submerge the ignition coils in solvent.**

1. Inspect the covers (3) for the following conditions:
   - Scoring or damage to the gasket surfaces
   - Ventilation system passages for restrictions
   - Threaded bolt holes for damage or debris

OIL PAN DISASSEMBLE

Crankshaft Oil Deflector, High Pressure Port Seal and Oil Level Indicator Switch Removal

cardiagn.com

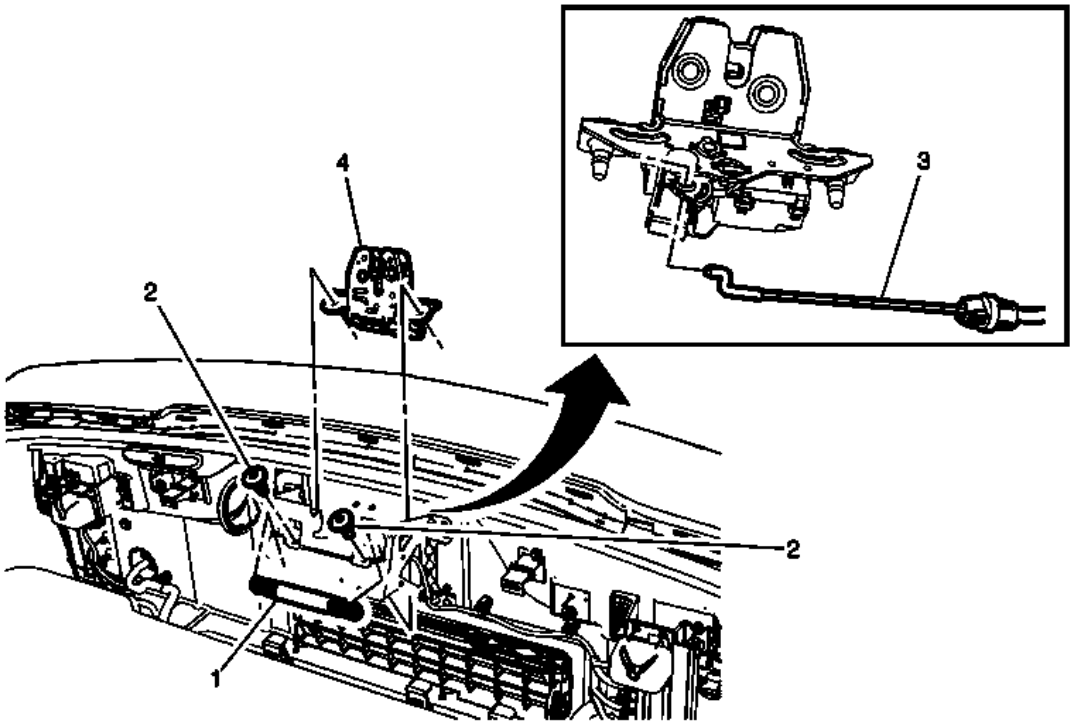


Fig. 192: Crankshaft Oil Deflector, High Pressure Port Seal and Oil Level Indicator Switch
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Oil Deflector, High Pressure Port Seal and Oil Level Indicator Switch Removal

Callout	Component Name
1	Crankshaft Oil Deflector Bolt
2	Crankshaft Oil Deflector
3	Oil Level Sensor Lead Clip
4	Oil Level Indicator Switch Bolt
5	Oil Level Indicator Switch
6	Oil Level Indicator Switch Seal **NOTE:** **Discard seal it is not reusable.**
7	Oil Pan Front Seal **NOTE:** **Discard seal it is not reusable.**
8	Oil Pan Locating Pin
9	Oil Pan High Pressure Port Seal **NOTE:** **Discard seal it is not reusable.**

cardiagn.com

Oil Filter Fitting and Cup Plug Removal

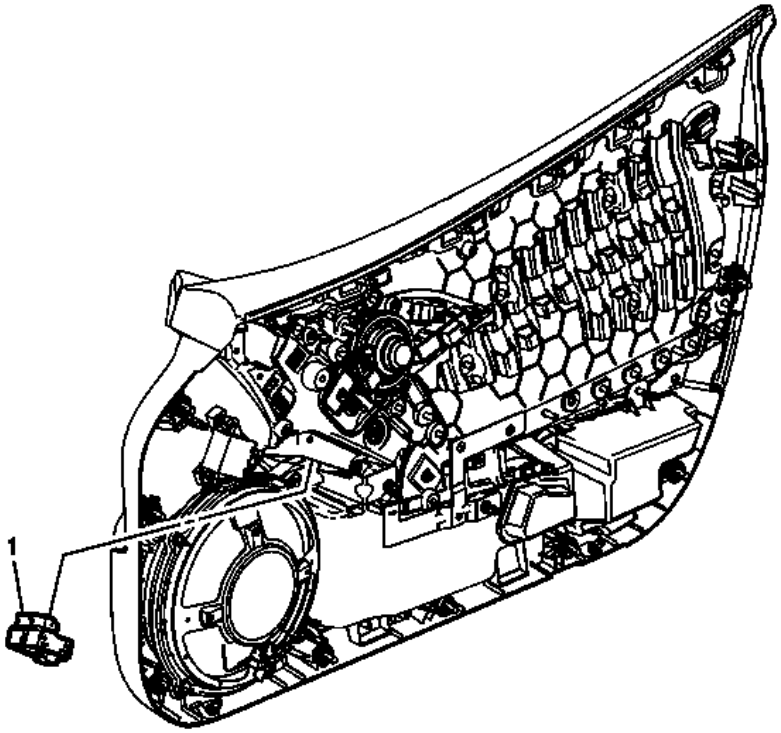


Fig. 193: Oil Filter Fitting and Cup Plug
Courtesy of GENERAL MOTORS COMPANY

Oil Filter Fitting and Cup Plug Removal

Callout	Component Name
1	Oil Pan Cup Plug
2	Oil Filter Fitting

OIL PAN DISASSEMBLE (WITH Z52 OPTION)

Crankshaft Oil Deflector, High Pressure Port Seal and Front Seal Removal

cardiagn.com

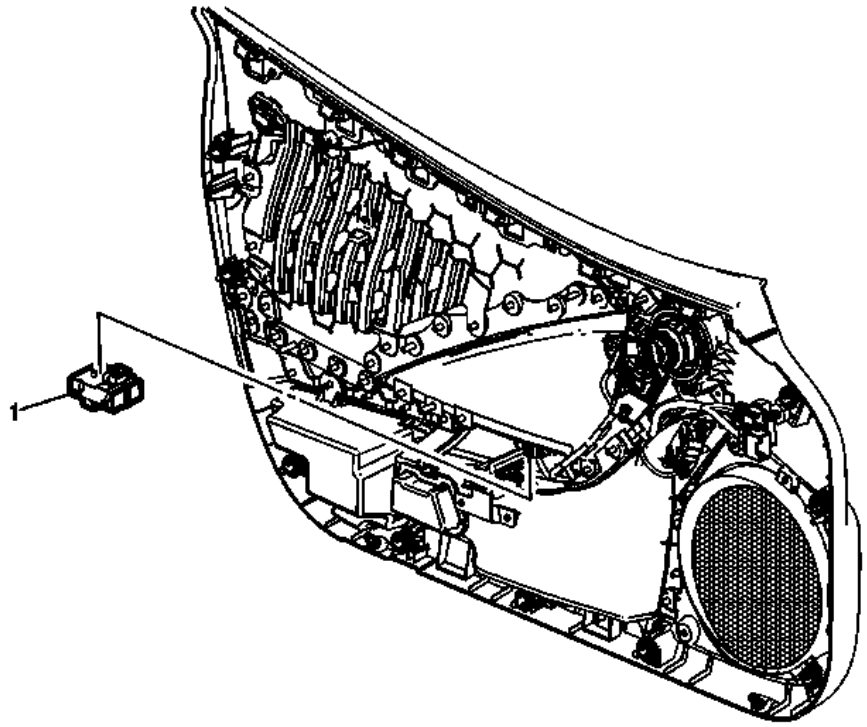


Fig. 194: Crankshaft Oil Deflector, High Pressure Port Seal and Front Seal
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Oil Deflector, High Pressure Port Seal and Front Seal Removal

Callout	Component Name
1	Crankshaft Oil Deflector Bolt
2	Crankshaft Oil Deflector
3	Oil Pan Front Seal **NOTE:** **Discard seal it is not reusable.**
4	Oil Pan Locating Pin
5	Oil Pan High Pressure Port Seal **NOTE:** **Discard seal it is not reusable.**

Oil Filter Fitting and Cup Plug Removal

cardiagn.com

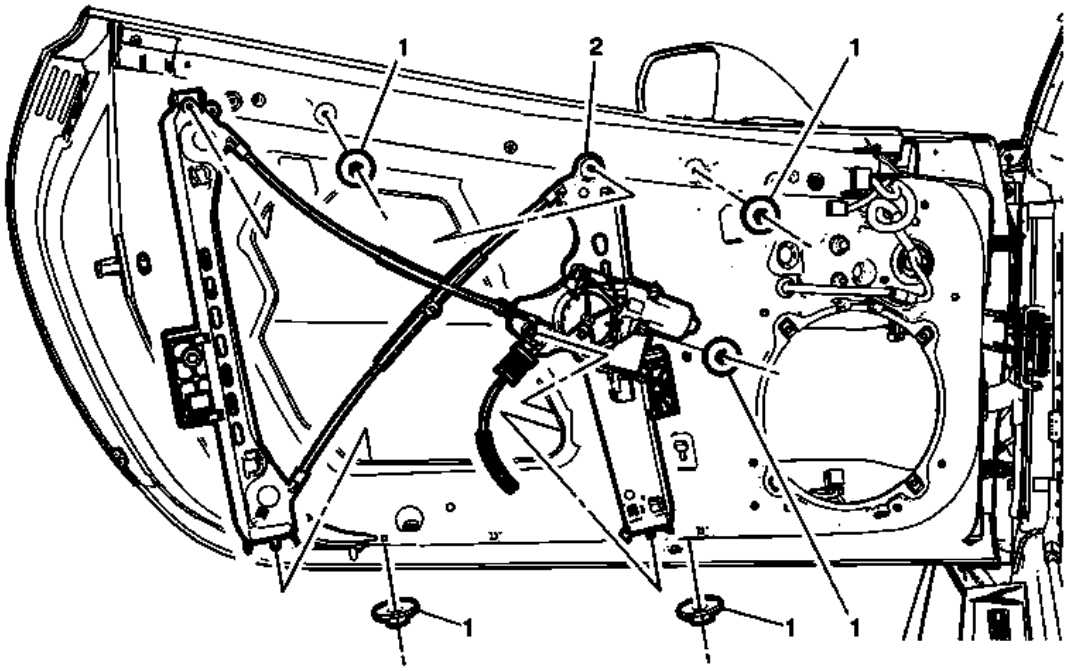


Fig. 195: Oil Filter Fitting and Cup Plug
Courtesy of GENERAL MOTORS COMPANY

Oil Filter Fitting and Cup Plug Removal

Callout	Component Name
1	Oil Pan Cup Plug
2	Oil Pan Cup Plug
3	Oil Filter Fitting

OIL PAN CLEANING AND INSPECTION

cardiagn.com

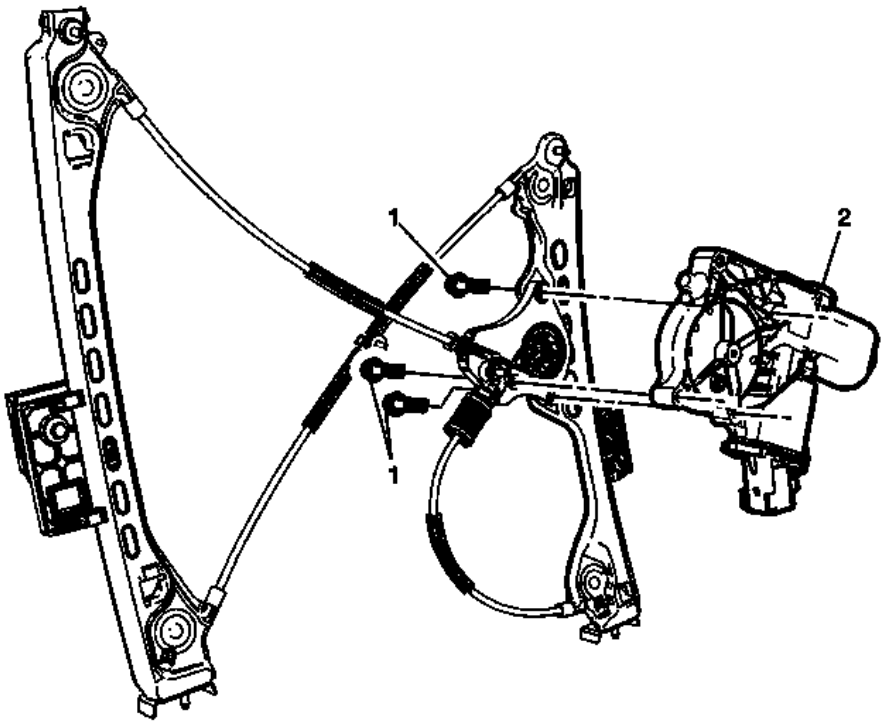


Fig. 196: Oil Pan Cleaning and Inspection
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not remove the pickup tube.

Inspect the oil pan for the following conditions:

- Damaged gasket surfaces
- Restrictions within the oil passages of the pan
- Damaged oil filter seal surface

OIL PAN CLEANING AND INSPECTION (WITH Z52 OPTION)

cardiagn.com

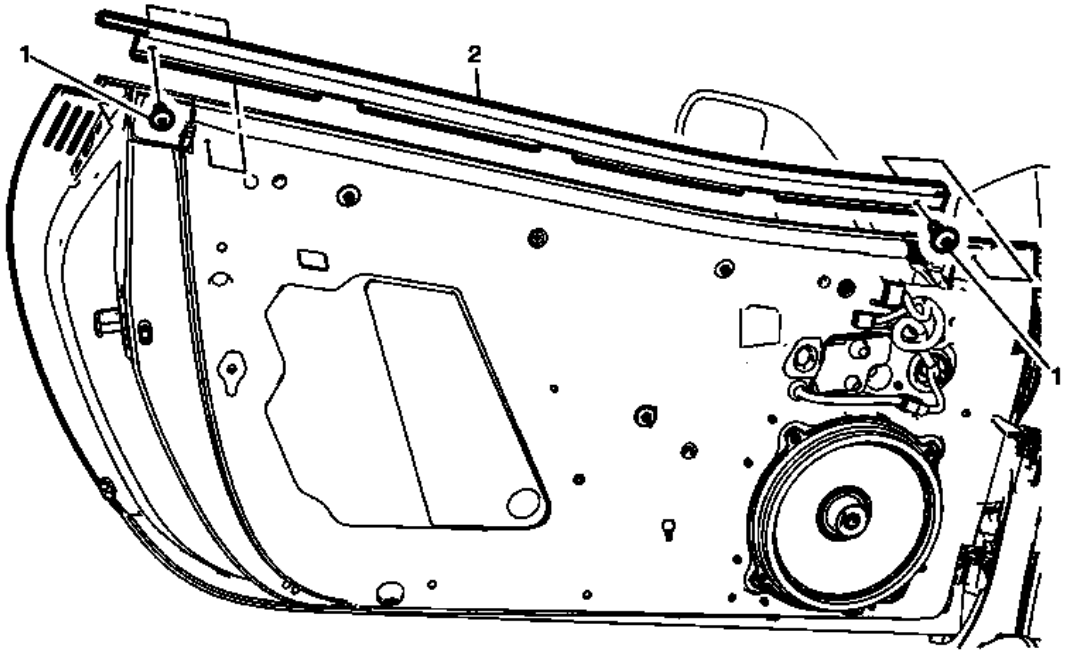


Fig. 197: Oil Pan Cleaning and Inspection (with Z52 Option)
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not remove the pickup tube.

Inspect the oil pan for the following conditions:

- Damaged gasket surfaces
- Restrictions within the oil passages of the pan
- Damaged oil filter seal surface

OIL PAN ASSEMBLE

Oil Filter Fitting and Cup Plug Installation

cardiagn.com

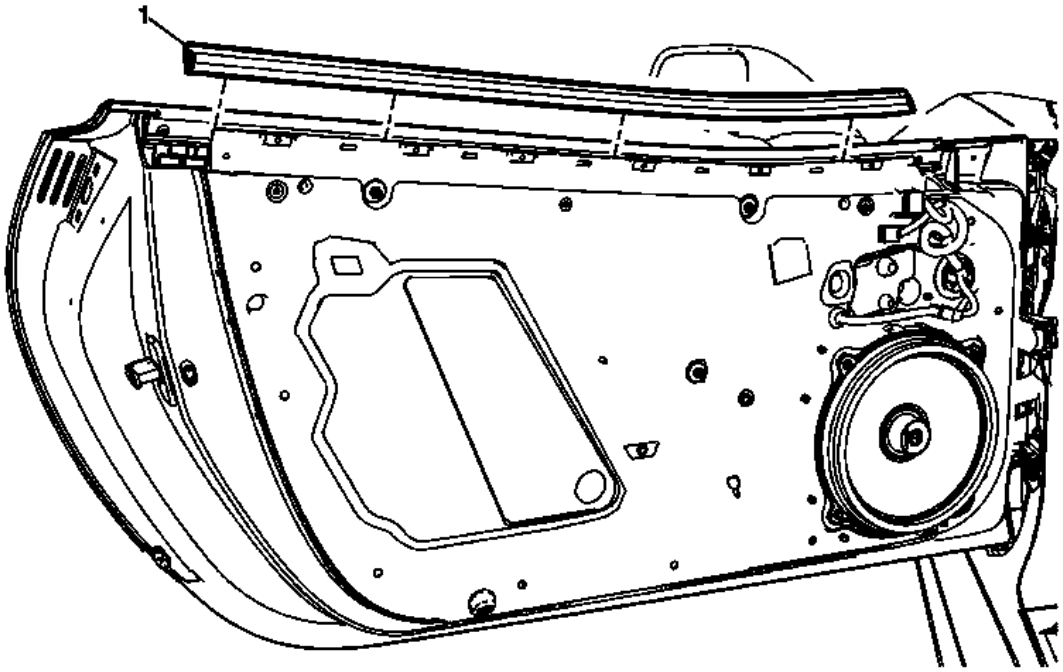


Fig. 198: Oil Filter Fitting and Cup Plug
Courtesy of GENERAL MOTORS COMPANY

Oil Filter Fitting and Cup Plug Installation

Callout	Component Name
1	Oil Filter Fitting **CAUTION:** **Refer to Fastener Caution .** **Tighten** 55 N.m (40 lb ft)
2	Oil Pan Cup Plug

Crankshaft Oil Deflector, High Pressure Port Seal and Oil Level Indicator Switch Installation

cardiagn.com

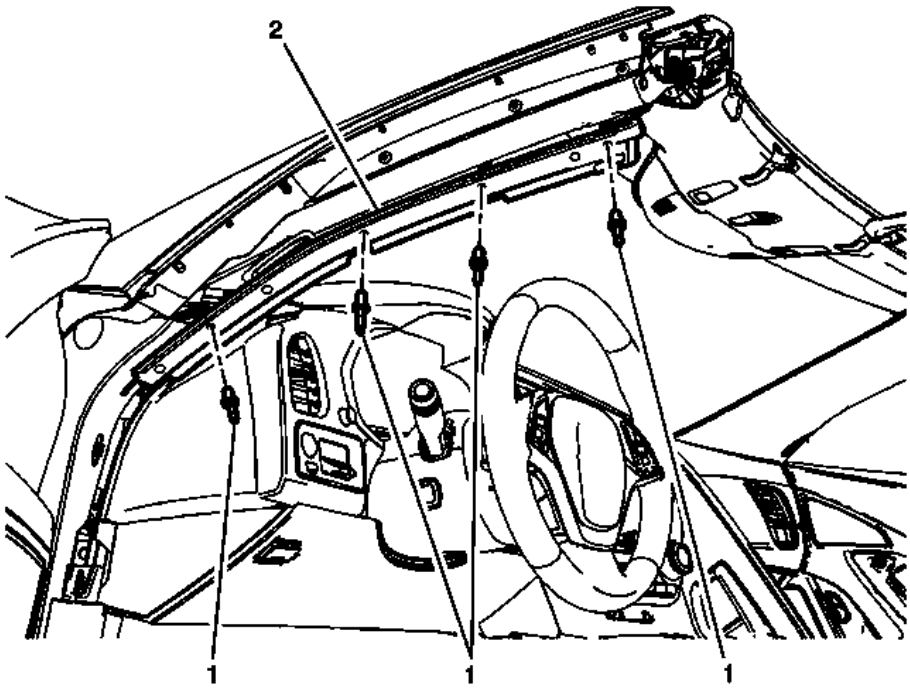


Fig. 199: Crankshaft Oil Deflector, High Pressure Port Seal and Oil Level Indicator Switch
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Oil Deflector, High Pressure Port Seal and Oil Level Indicator Switch Installation

Callout	Component Name
1	Oil Pan High Pressure Port Seal **NOTE:** **Must use a NEW seal.**
2	Oil Pan Locating Pin
3	Oil Pan Front Seal **NOTE:** **Must use a NEW seal.**
4	Oil Level Indicator Switch Seal **NOTE:** **Must use a NEW seal.**
5	Oil Level Indicator Switch
6	Oil Level Indicator Switch Bolt **Tighten** 10 N.m (88 lb in)
7	Oil Level Sensor Lead Clip

cardiagn.com

8	Crankshaft Oil Deflector
9	Crankshaft Oil Deflector Bolt **Tighten** 10 N.m (88 lb in)

OIL PAN ASSEMBLE (WITH Z52 OPTION)

Oil Filter Fitting and Cup Plug Installation

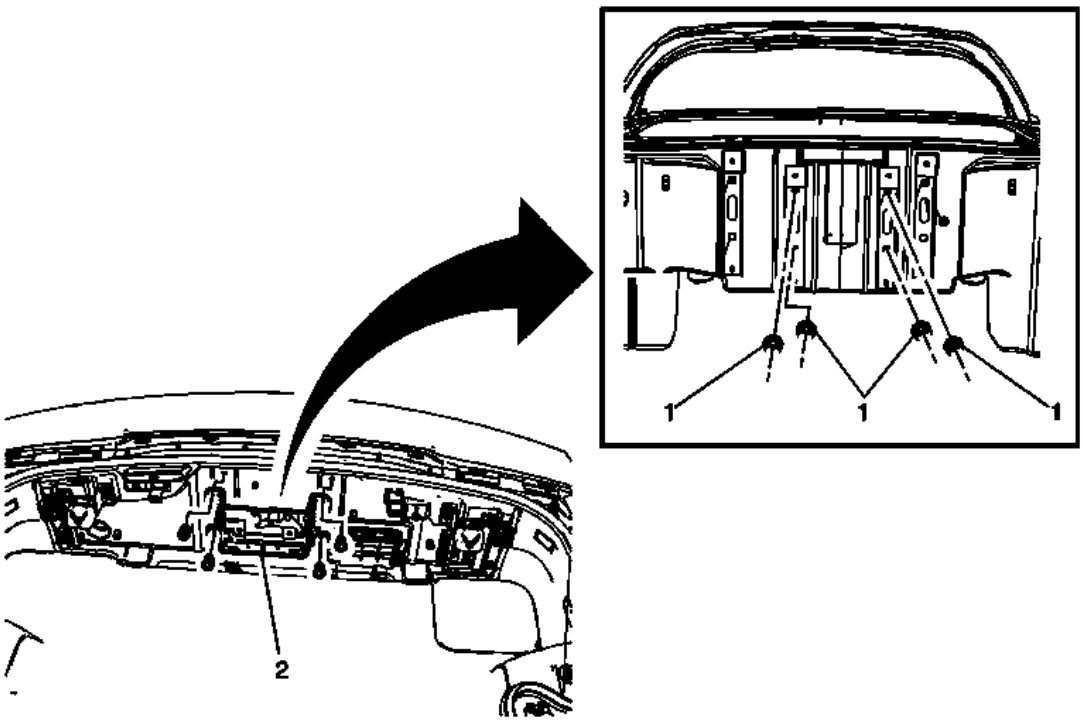


Fig. 200: Oil Filter Fitting and Cup Plug
Courtesy of GENERAL MOTORS COMPANY

Oil Filter Fitting and Cup Plug Installation

Callout	Component Name
1	Oil Pan Cup Plug
2	Oil Pan Cup Plug
3	Oil Filter Fitting **CAUTION:** **Refer to Fastener Caution .** **Tighten** 55 N.m (40 lb ft)

cardiagn.com

Crankshaft Oil Deflector, High Pressure Port Seal and Front Seal Installation

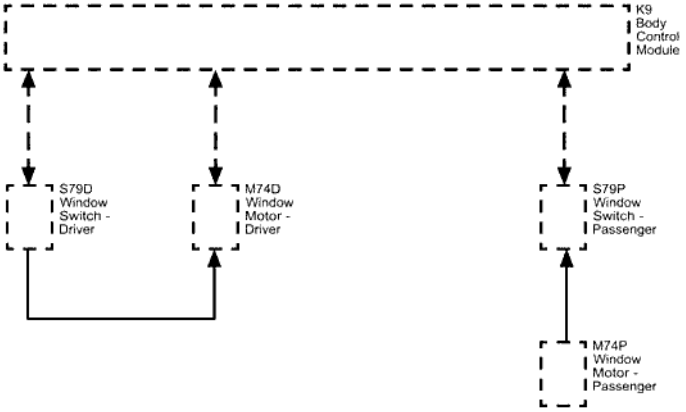


Fig. 201: Crankshaft Oil Deflector, High Pressure Port Seal and Front Seal
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Oil Deflector, High Pressure Port Seal and Front Seal Installation

Callout	Component Name
1	Oil Pan High Pressure Port Seal **NOTE:** **Must use a NEW seal.**
2	Oil Pan Locating Pin
3	Oil Pan Front Seal **NOTE:** **Must use a NEW seal.**
4	Crankshaft Oil Deflector
5	Crankshaft Oil Deflector Bolt **Tighten** 10 N.m (88 lb in)

ENGINE OIL COOLER DISASSEMBLE

cardiagn.com

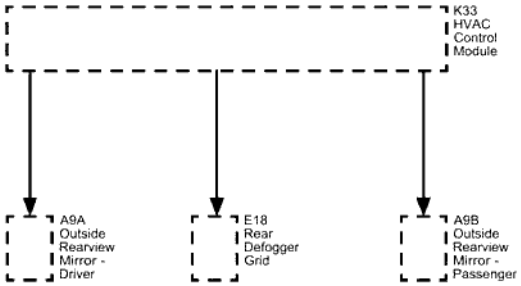


Fig. 202: Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Disassemble

Callout	Component Name
1	Engine Oil Cooler Core Bolt
2	Engine Oil Cooler Core
3	Engine Oil Cooler Core Seal **NOTE:** **Discard seal, it is not reusable.**
4	Coolant Fitting **NOTE:** **If removed, discard fitting. NEW fitting must be used.**
5	Coolant Fitting **NOTE:** **If removed, discard fitting. NEW fitting must be used.**

ENGINE OIL COOLER DISASSEMBLE (WITH Z52 OPTION)

cardiagn.com

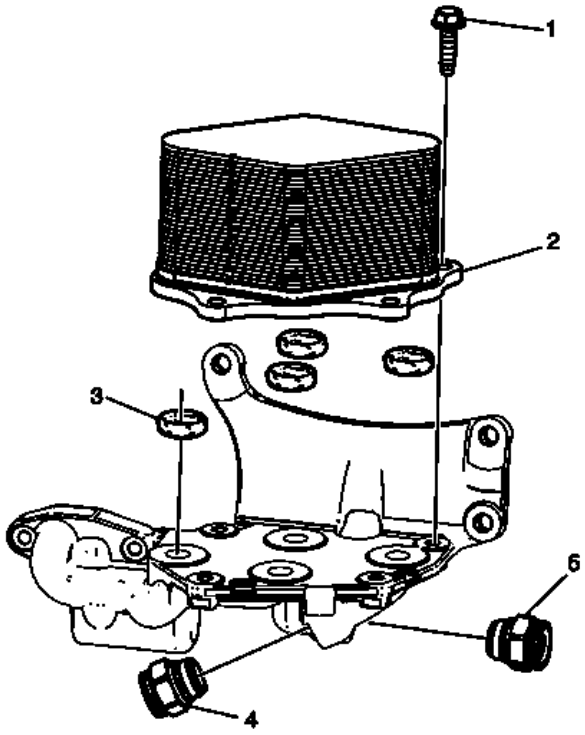


Fig. 203: Engine Oil Cooler Disassemble (with Z52 Option)
Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Disassemble (with Z52 Option)

Callout	Component Name
1	Engine Oil Cooler Core Bolt
2	Engine Oil Cooler Core
3	Engine Oil Cooler Core Seal **NOTE:** **Discard seal, it is not reusable.**
4	Coolant Fitting **NOTE:** **If removed, discard fitting. NEW fitting must be used.**
5	Coolant Fitting **NOTE:** **If removed, discard fitting. NEW fitting must be used.**

ENGINE OIL COOLER CLEANING AND INSPECTION

cardiagn.com

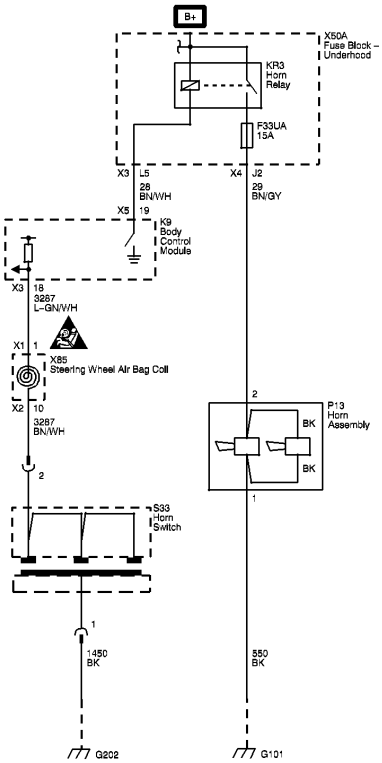


Fig. 204: Inspect Oil Cooler Core And Oil Cooler Housing For Cracks
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Engine Oil Cooler Debris Caution .

1. Inspect the oil cooler core (1) and the oil cooler housing (2) for cracks or casting imperfections.
2. Inspect the oil cooler housing for damaged bolt hole threads.
3. Inspect the oil cooler housing and core for damaged seal surfaces.
4. Inspect the oil cooler core for damaged or broken cooling fins.
5. Inspect for restrictions within the coolant passages of the core or housing.
6. Inspect for restrictions within the oil passages of the core or housing.
7. Inspect for a leaking coolant hose fitting (3).

ENGINE OIL COOLER CLEANING AND INSPECTION (WITH Z52 OPTION)

cardiagn.com

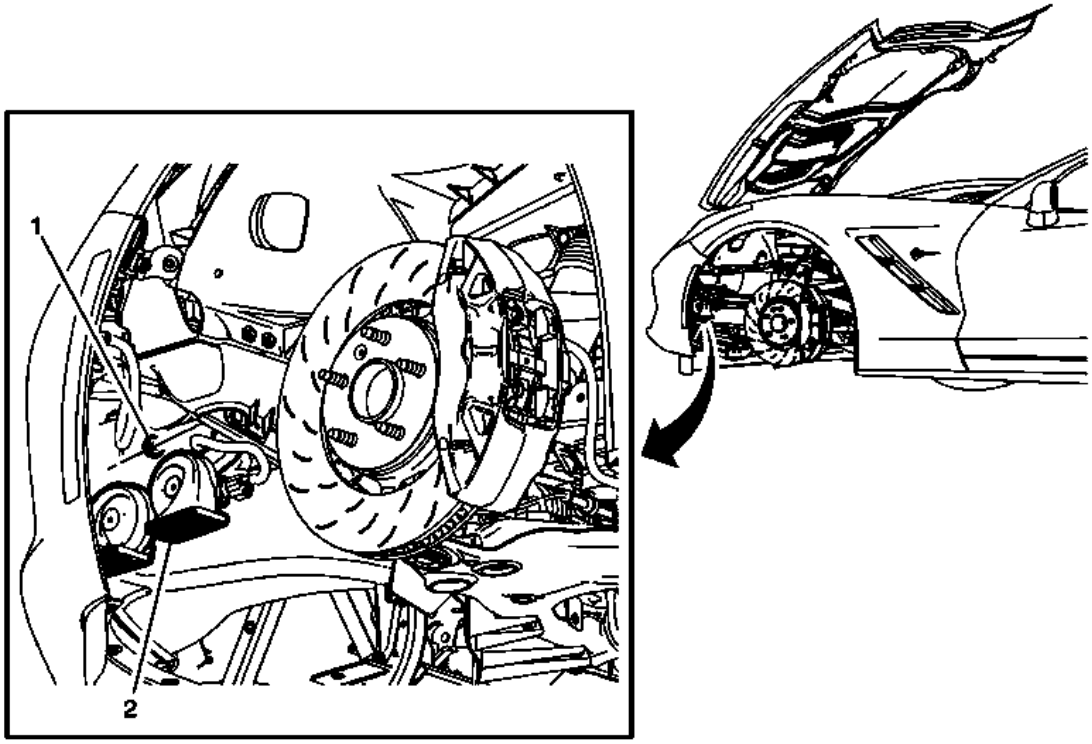


Fig. 205: Inspecting oil cooler core and oil cooler housing for cracks
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Engine Oil Cooler Debris Caution .

1. Inspect the oil cooler core (1) and the oil cooler housing (2) for cracks or casting imperfections.
2. Inspect the oil cooler housing for damaged bolt hole threads.
3. Inspect the oil cooler housing and core for damaged seal surfaces.
4. Inspect the oil cooler core for damaged or broken cooling fins.
5. Inspect for restrictions within the coolant passages of the core or housing.
6. Inspect for restrictions within the oil passages of the core or housing.
7. Inspect for a leaking coolant hose fitting (3).

ENGINE OIL COOLER ASSEMBLE

cardiagn.com

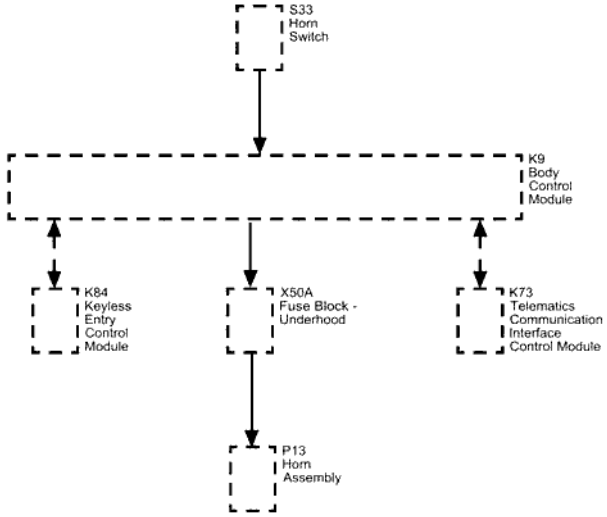


Fig. 206: Identifying Coolant Fitting & Seal
Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Assemble

Callout	Component Name
1	Coolant Fitting **CAUTION:** **Refer to Fastener Caution .** **NOTE:** **If removed, discard fitting. NEW fitting must be used.** **Tighten** 35 N.m (26 lb ft)
2	Coolant Fitting **NOTE:** **If removed, discard fitting. NEW fitting must be used.** **Tighten** 35 N.m (26 lb ft)

cardiagn.com

3	Engine Oil Cooler Core Seal **NOTE:** **Must use NEW seal.**
4	Engine Oil Cooler Core
5	Engine Oil Cooler Core Bolt **Tighten** 25 N.m (18 lb ft)

ENGINE OIL COOLER ASSEMBLE (WITH Z52 OPTION)

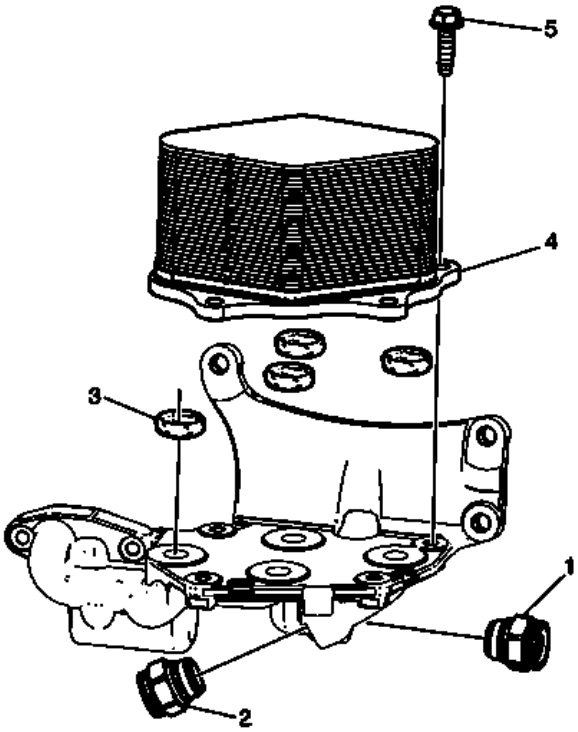


Fig. 207: Identifying Coolant Fitting & Seal
Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Assemble (with Z52 Option)

Callout	Component Name
1	Coolant Fitting **CAUTION:** **Refer to Fastener Caution .** **NOTE:** **If removed, discard fitting. NEW fitting must be used.**

cardiagn.com

	Tighten 35 N.m (26 lb ft)
2	Coolant Fitting **NOTE:** **If removed, discard fitting. NEW fitting must be used.** **Tighten** 35 N.m (26 lb ft)
3	Engine Oil Cooler Core Seal **NOTE:** **Must use NEW seal.**
4	Engine Oil Cooler Core
5	Engine Oil Cooler Core Bolt **Tighten** 25 N.m (18 lb ft)

OIL TANK DISASSEMBLE

cardiagn.com

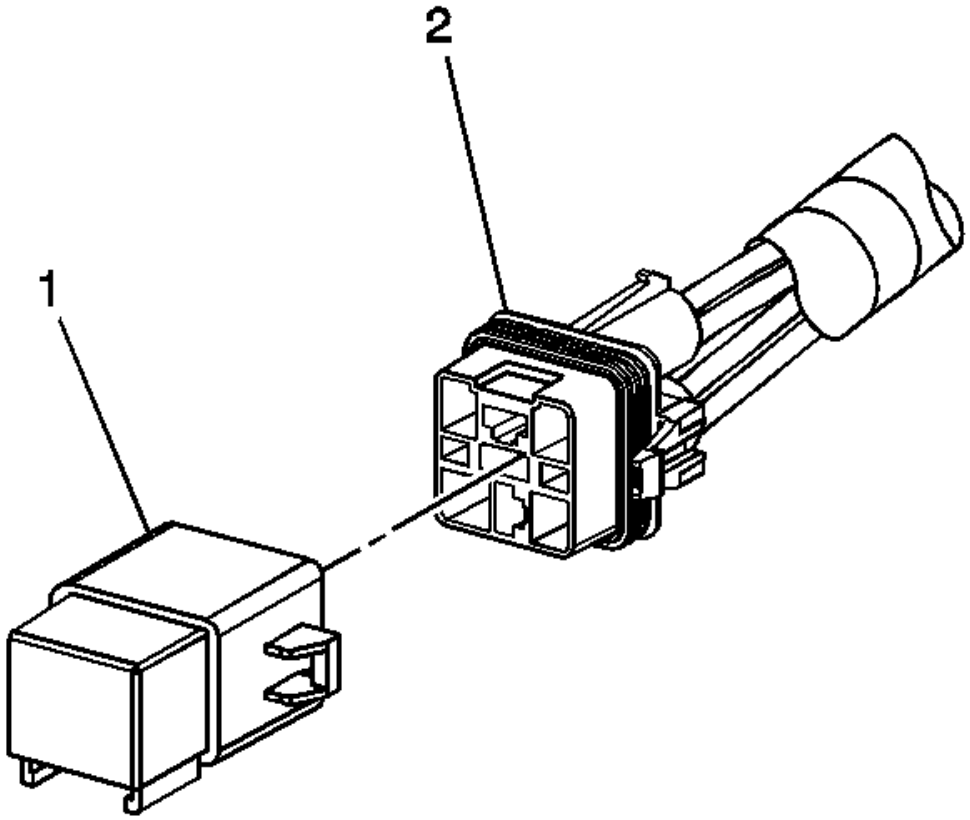


Fig. 208: View Of Oil Tank Assembly
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Engine Oil Tank Debris Caution .

1. Prior to disassembly, mark the upper and lower portions of the large tank for proper reassembly. Mark the tank on the area below the oil filler cap.

cardiagn.com

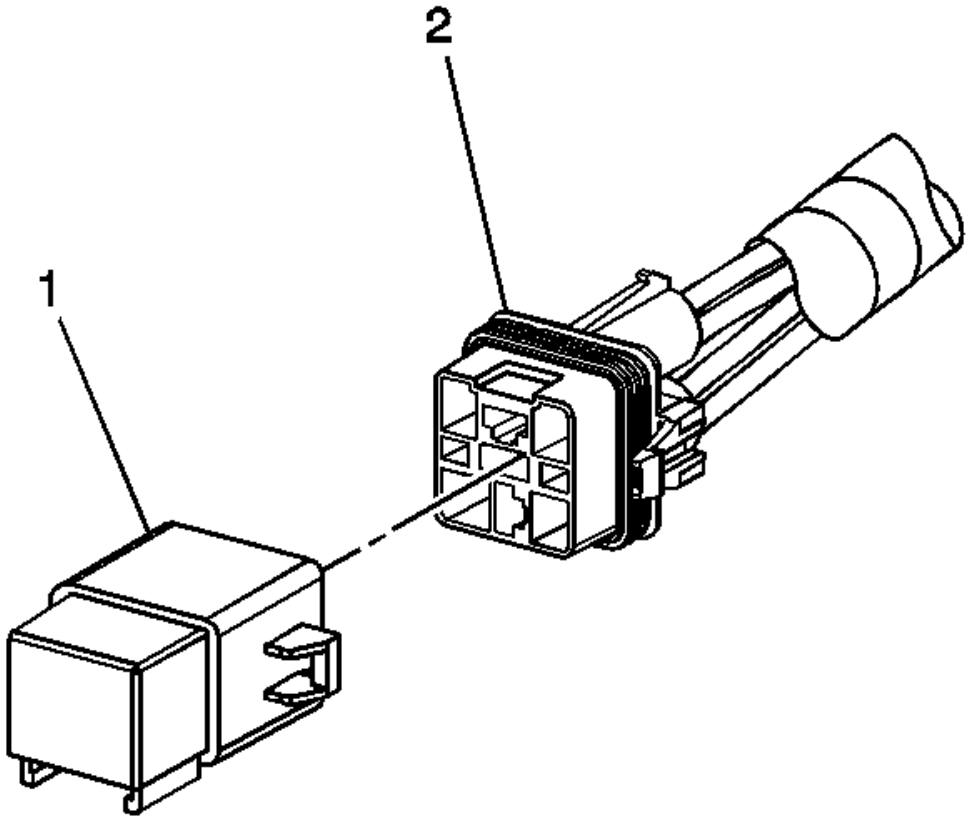


Fig. 209: View Of Oil Level Indicator & Oil Fill Cap
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil level indicator (1) and oil filler cap (2).

cardiagn.com

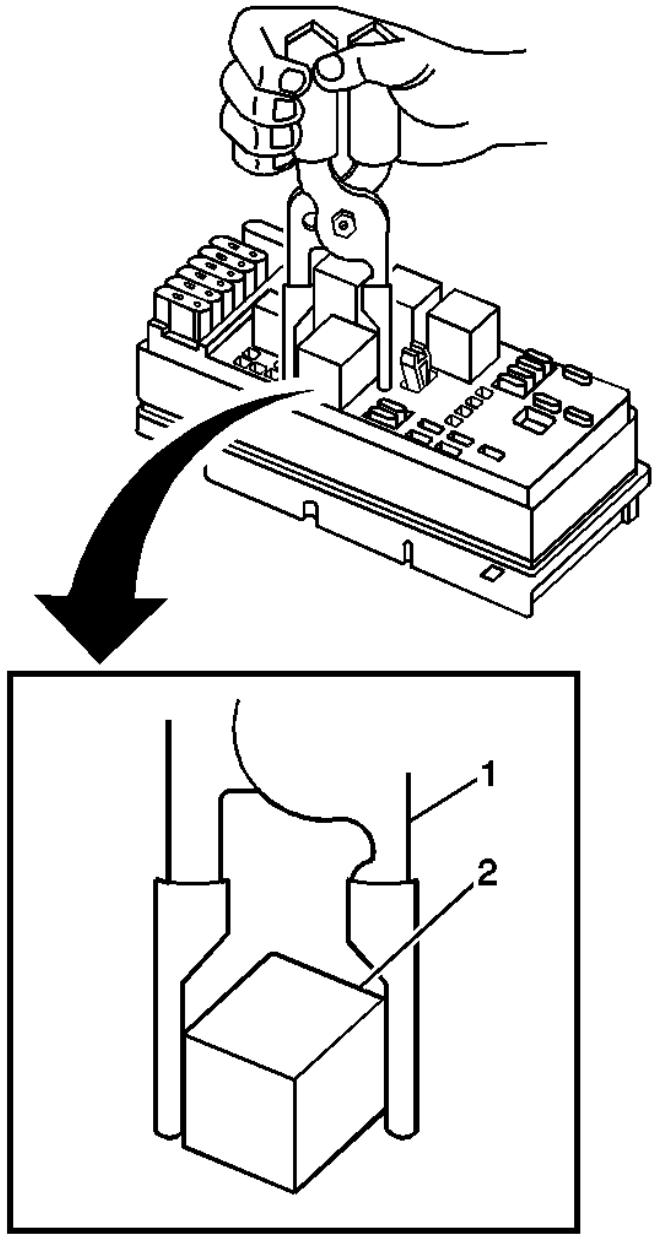


Fig. 210: View Of Oil Tank Components
Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine oil tank bolts (1) and bolt/studs (2) from the large tank. Note the locations of

cardiagn.com

4. Separate the upper (3) and lower (5) portions of the large tank.
5. Remove the engine oil tank gasket (4).

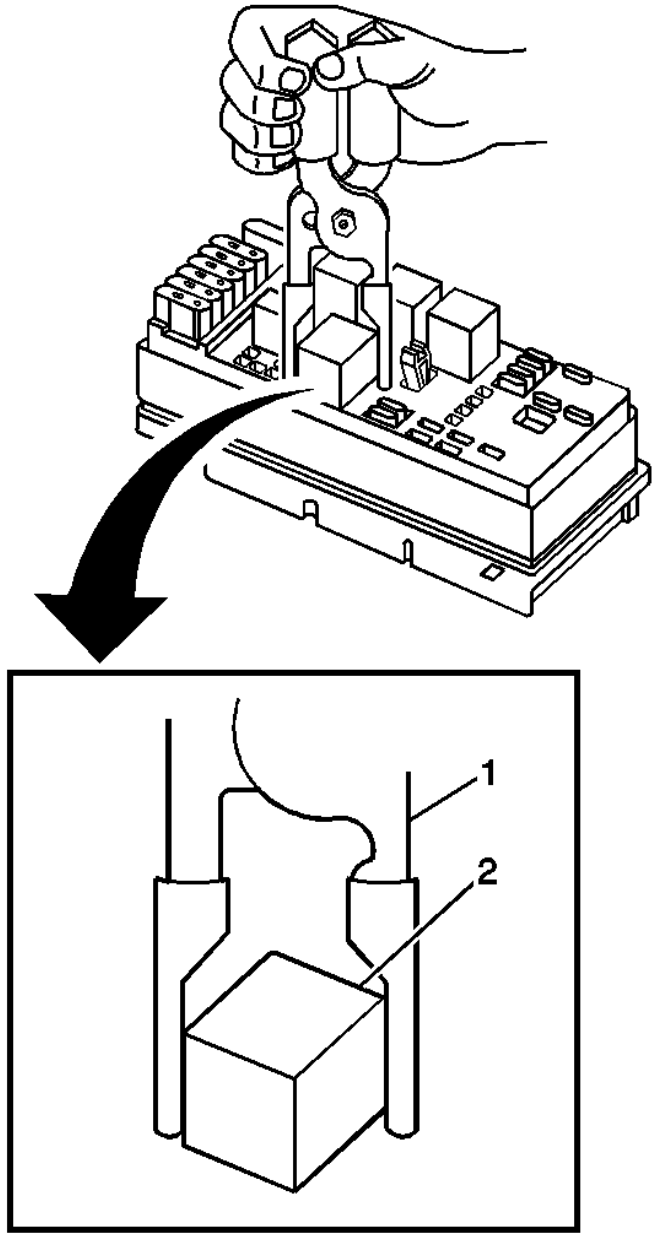


Fig. 211: View Of Large Oil Tank, Tube & O-Ring

cardiagn.com

Courtesy of GENERAL MOTORS COMPANY

6. Remove the oil transfer tube (2) from the lower tank (3).

   NOTE: Discard the gasket, it is not reusable.

7. Remove the engine oil/air separator seal (1) from the oil transfer tube.

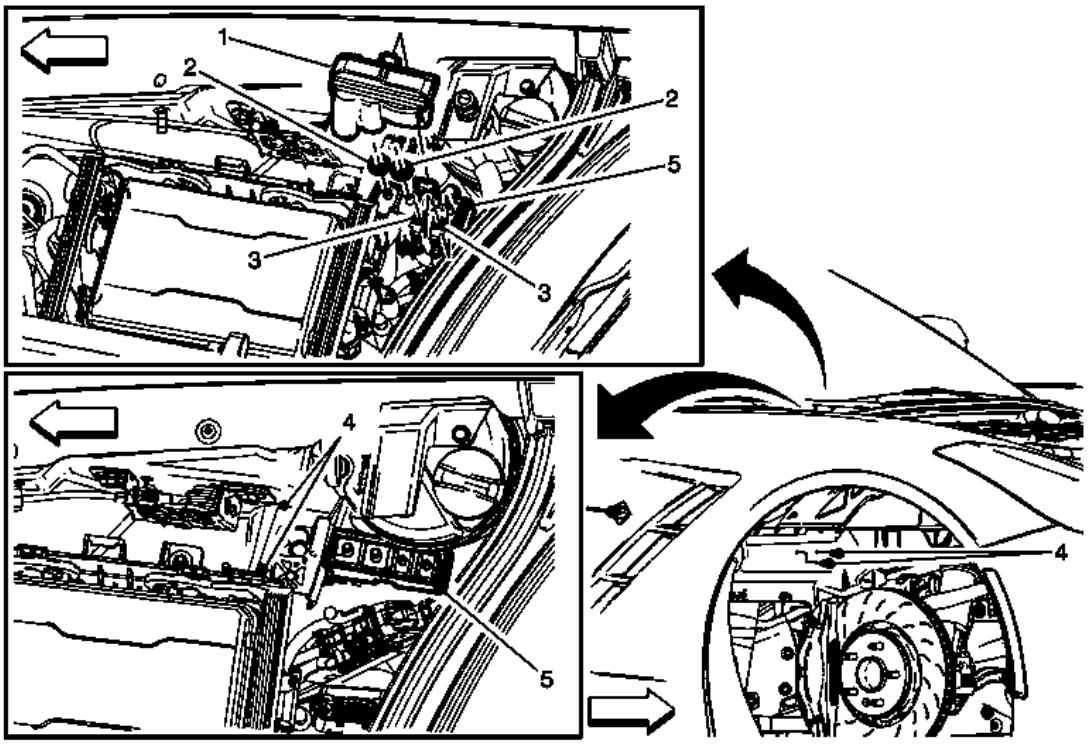


Fig. 212: Oil Pump Screen Fastener And Oil Pump Screen
Courtesy of GENERAL MOTORS COMPANY

8. Remove the oil pump screen fastener (1) and oil pump screen (2) from bottom of the tank (3). Remove and discard the oil pump screen seal (4).

cardiagn.com

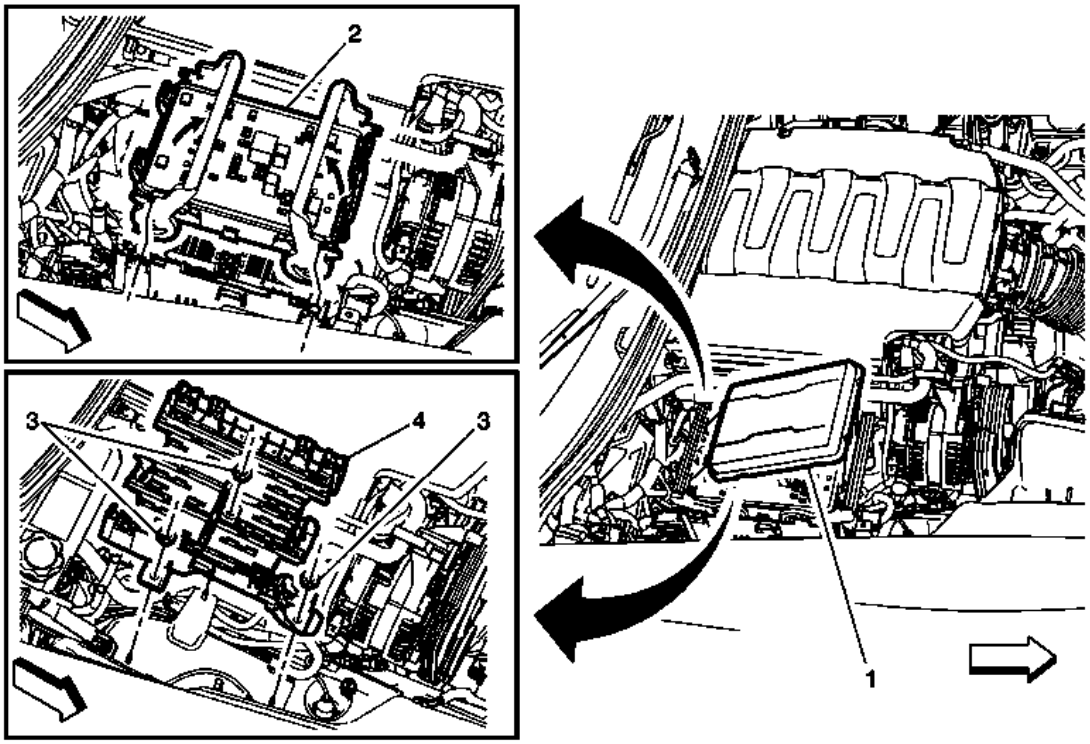


Fig. 213: View Of Large & Small Oil Tank Clamp
Courtesy of GENERAL MOTORS COMPANY

9. Loosen and remove the oil tank clamp (1) in order to separate the lower tank from the auxiliary oil tank.

cardiagn.com

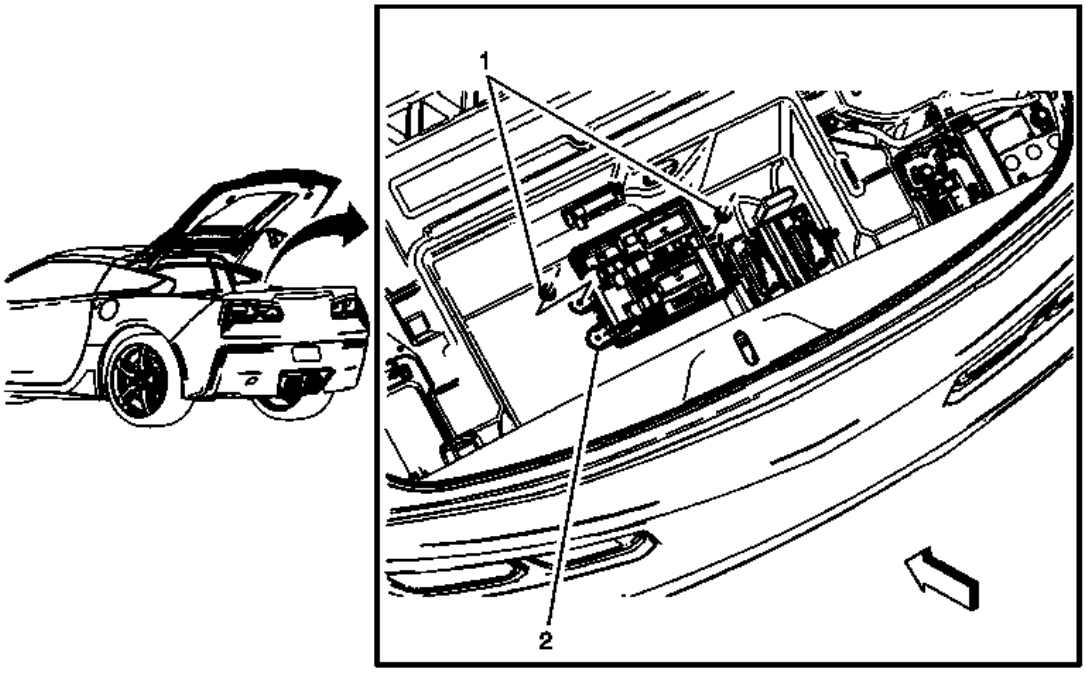


Fig. 214: View Of Transfer Tube Fittings
Courtesy of GENERAL MOTORS COMPANY

10. Remove the retaining clips from the oil transfer tube fittings (2 and 4).
11. Remove the oil transfer tube (3) and separate the lower tank (5) from the auxiliary tank (1).
12. Remove the oil transfer fittings (2 and 4) from the tanks as required.

OIL TANK CLEANING AND INSPECTION

cardiagn.com

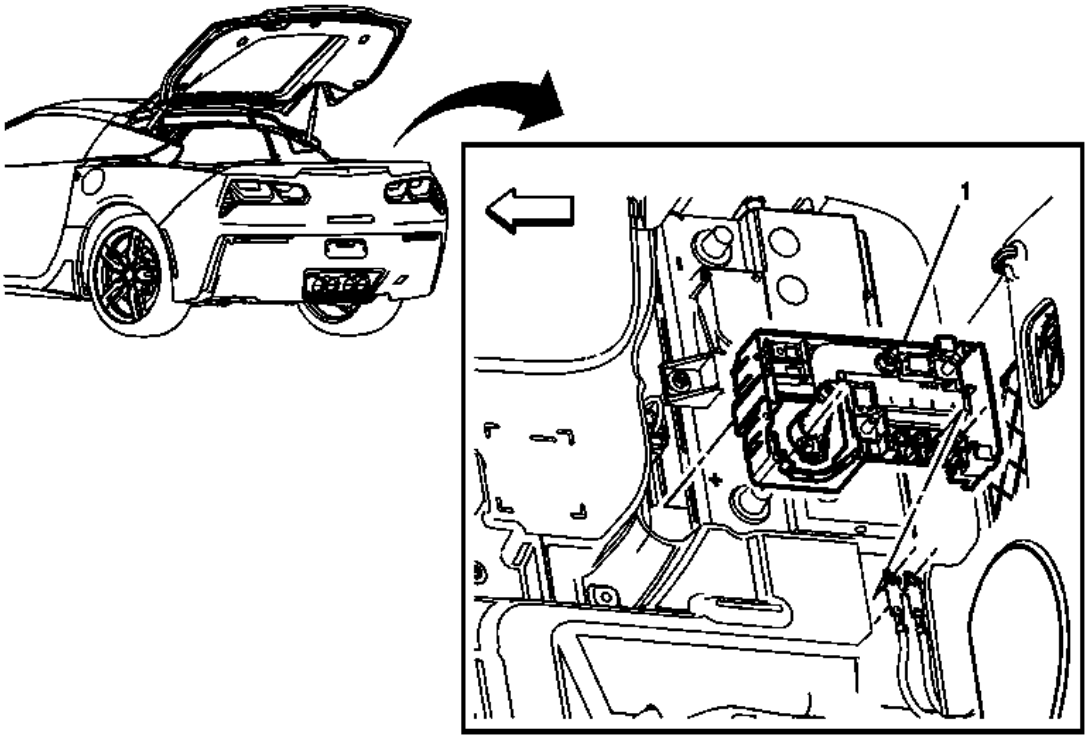


Fig. 215: View Of Transfer Tube Fittings
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

CAUTION: Refer to Engine Oil Tank Debris Caution .

1. Clean the lower and auxiliary oil tanks (1 and 2) in solvent.
2. Clean the oil transfer tube (3) in solvent.

Inspect for the following:

- Dirt or debris
- Damaged seal surfaces
- Oil transfer tube fittings for damaged O-ring seals, replace as required
- Restrictions within the positive crankcase ventilation (PCV) tubes or oil transfer tube
- A dirty or restricted tube (3)

cardiagn.com

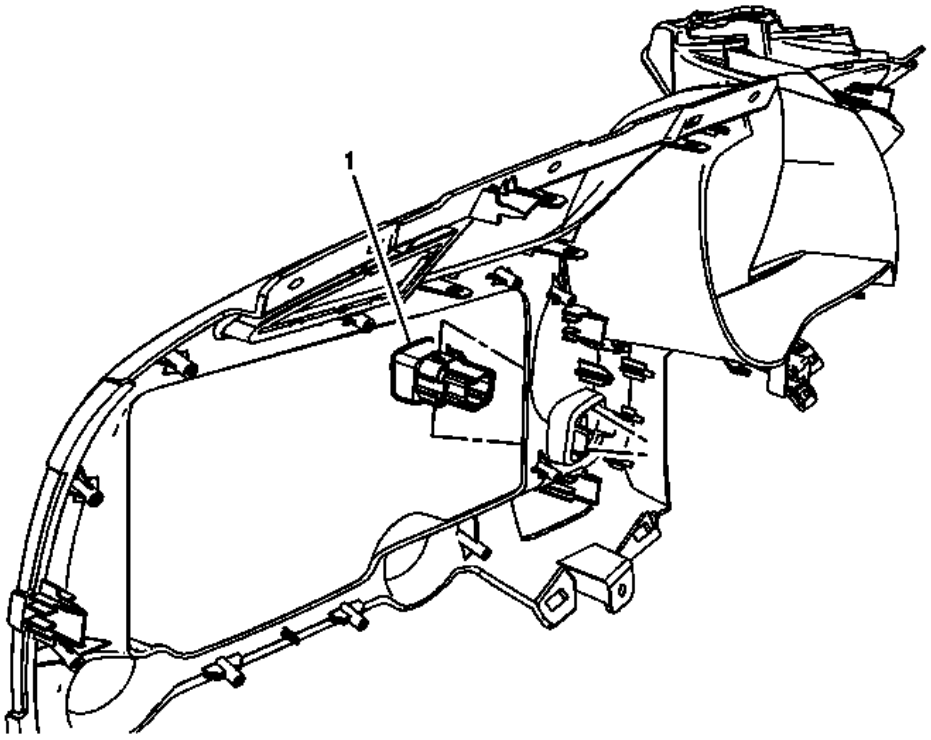


Fig. 216: Cleaning oil pump screen and inspect for debris or blockages
Courtesy of GENERAL MOTORS COMPANY

3. Clean the oil pump screen and inspect for debris or blockages.

OIL TANK ASSEMBLE

cardiagn.com

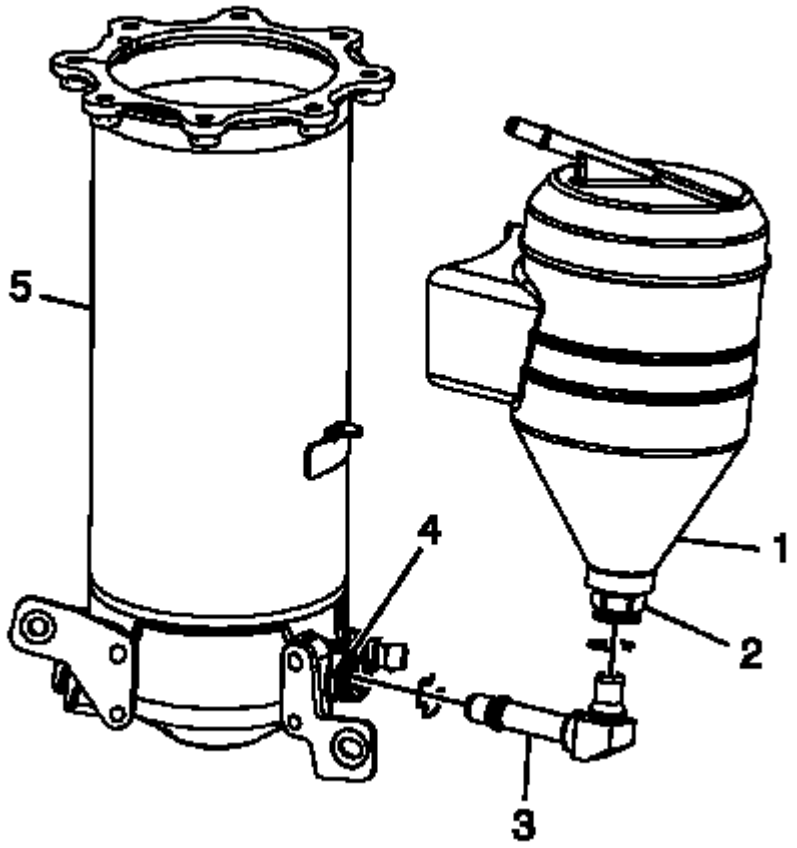


Fig. 217: View Of Transfer Tube Fittings
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Engine Oil Tank Debris Caution .

CAUTION: Refer to Fastener Caution .

1. Install the oil transfer tube fittings (2 and 4) to the lower and auxiliary oil tanks and tighten to 35 N.m (26 lb ft).
2. Assemble the oil transfer tube (3), large tank (5) and auxiliary tank (1).

cardiagn.com

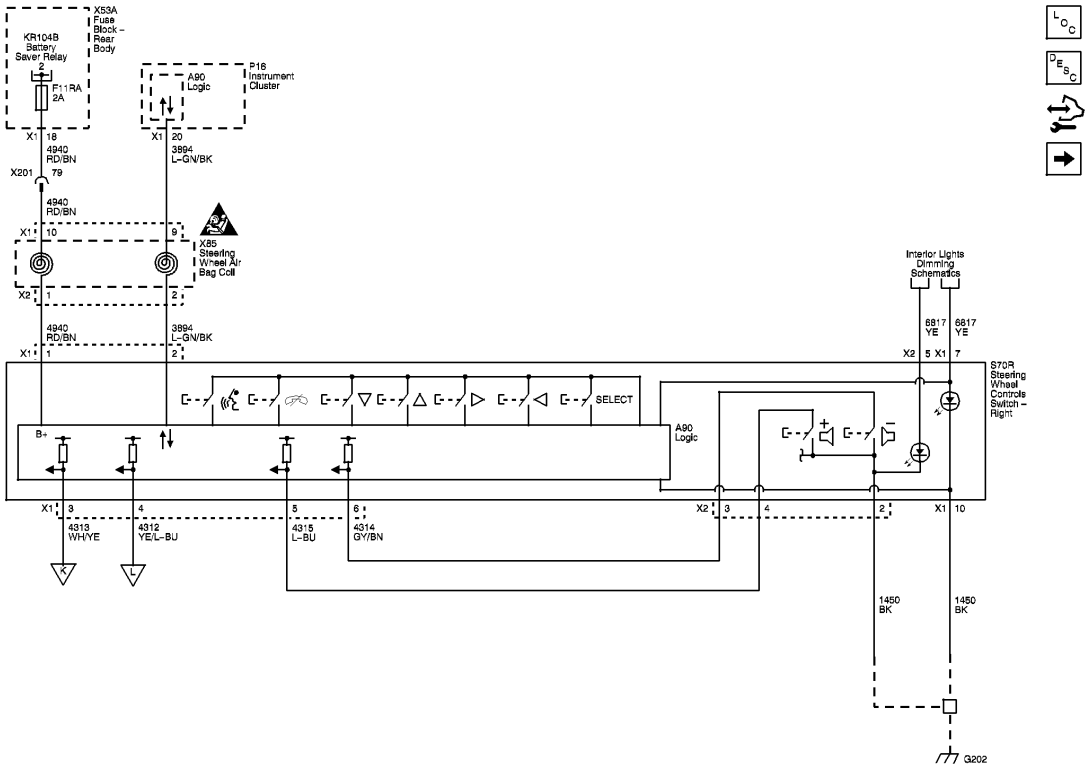


Fig. 218: View Of Large & Small Oil Tank Clamp
Courtesy of GENERAL MOTORS COMPANY

3. Install the engine oil tank clamp (1).

cardiagn.com

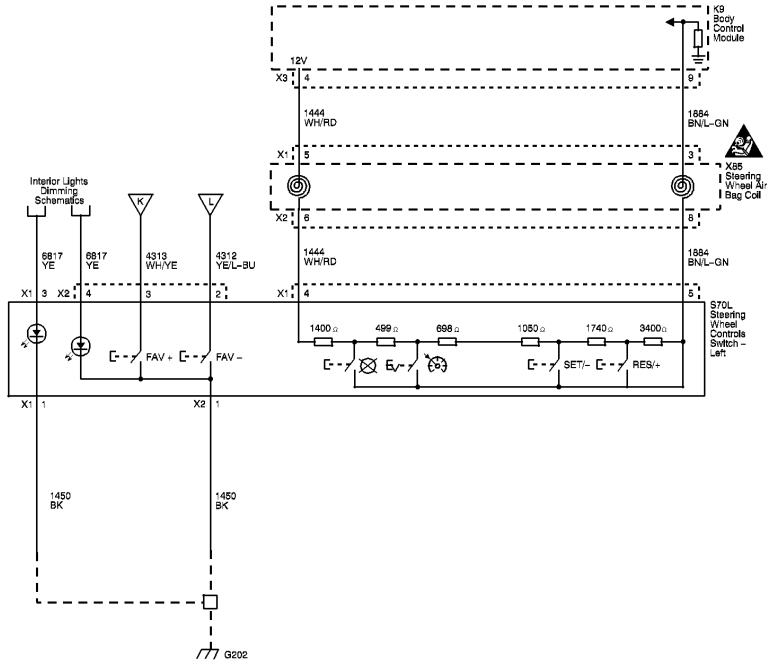


Fig. 219: Identifying Clamp Nut
Courtesy of GENERAL MOTORS COMPANY

4. Tighten the nut (1). With the nut of the engine oil tank clamp positioned so that the face of the nut is flush with the end of the bolt, rotate the nut clockwise 21 complete turns to apply tension to the engine oil tank clamp.

cardiagn.com

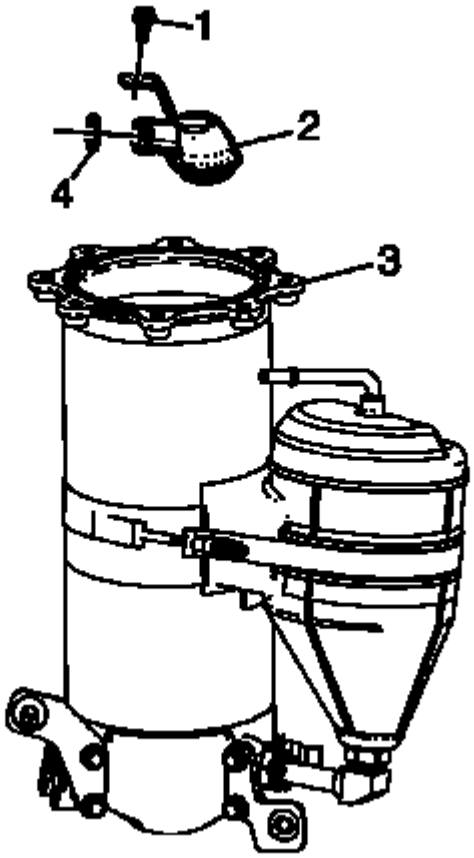


Fig. 220: Oil Pump Screen Fastener And Oil Pump Screen
Courtesy of GENERAL MOTORS COMPANY

5. Install NEW seal (4) on oil pump screen. Install the oil pump screen (2) into the lower tank (3). Tighten bolt (1) to 25 N.m (18 lb ft).

cardiagn.com

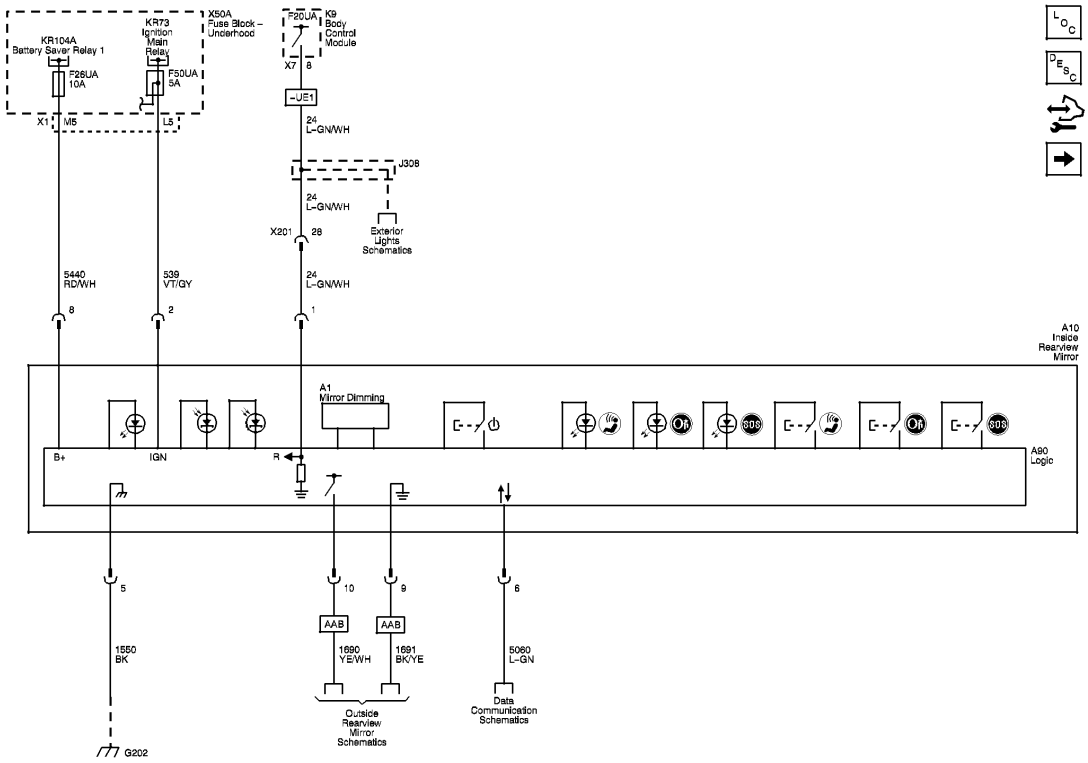


Fig. 221: View Of Large Oil Tank, Tube & O-Ring
Courtesy of GENERAL MOTORS COMPANY

6. Install the NEW engine oil/air separator seal (1) to the oil transfer tube.
7. Install the oil transfer tube (2) to the lower tank (3).

cardiagn.com

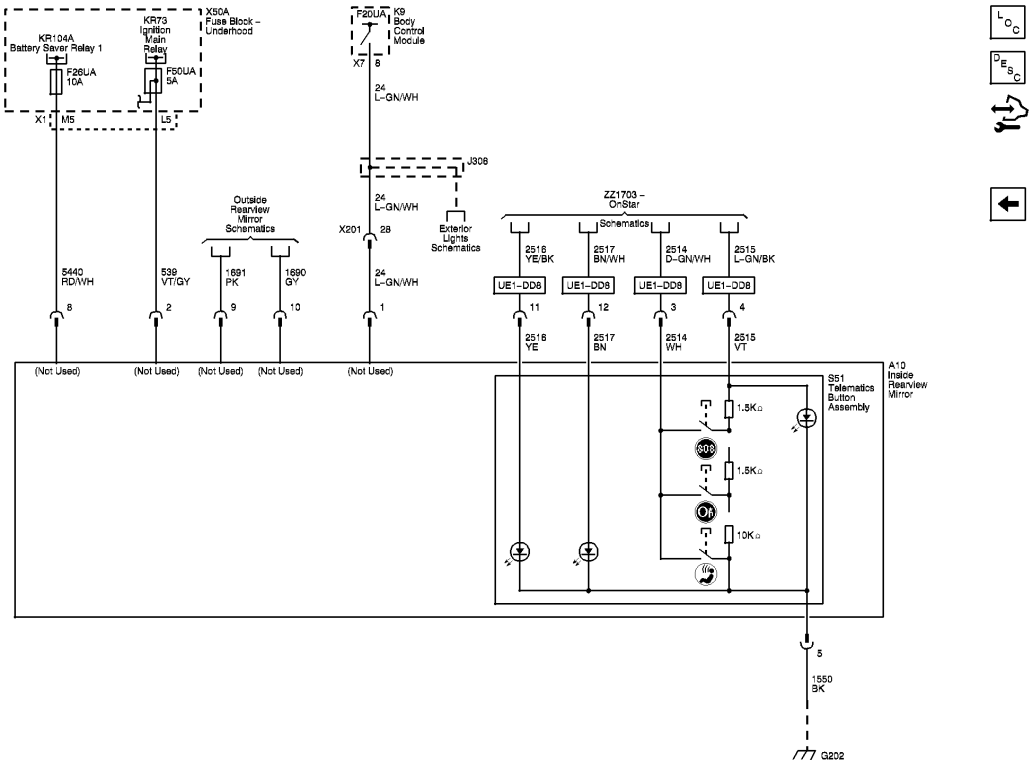


Fig. 222: View Of Oil Tank Components
Courtesy of GENERAL MOTORS COMPANY

8. Install the NEW engine oil tank gasket (4).
9. Assemble the upper (3) and lower (5) portions of the large tank. Aligning the markings made prior to disassembly.

cardiagn.com

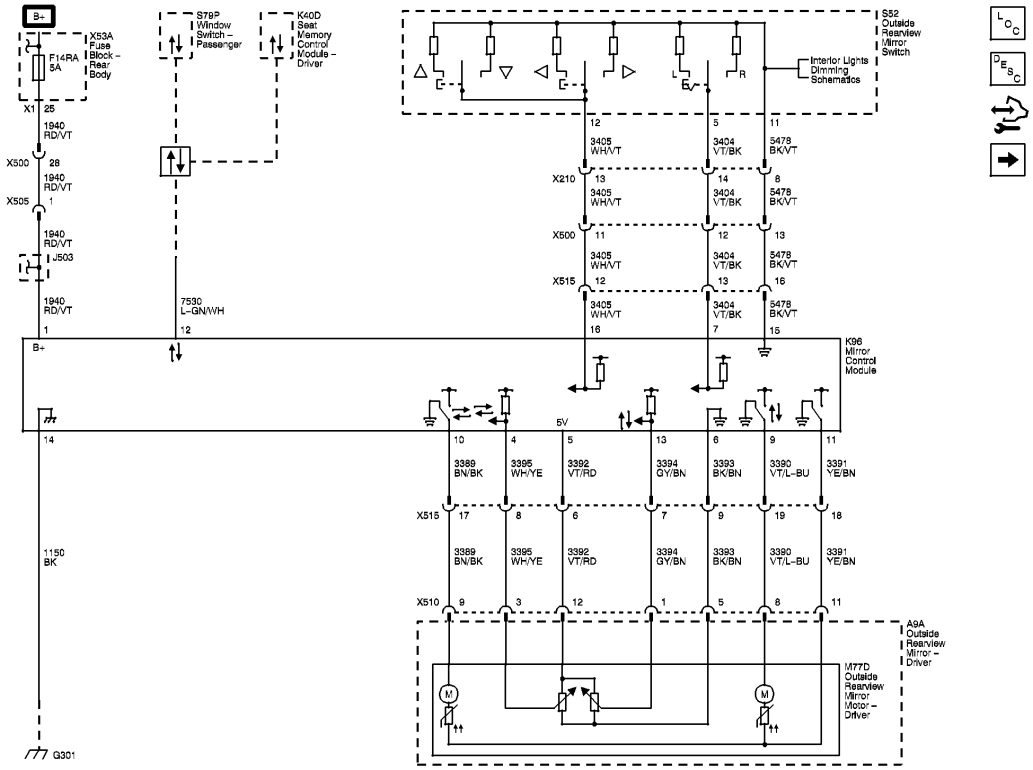


Fig. 223: View Of Tube & Top Tank
Courtesy of GENERAL MOTORS COMPANY

10. Inspect for proper installation of the tube to upper tank. The top of the tube (2) should locate into the opening (1) in the upper portion of the tank.

cardiagn.com

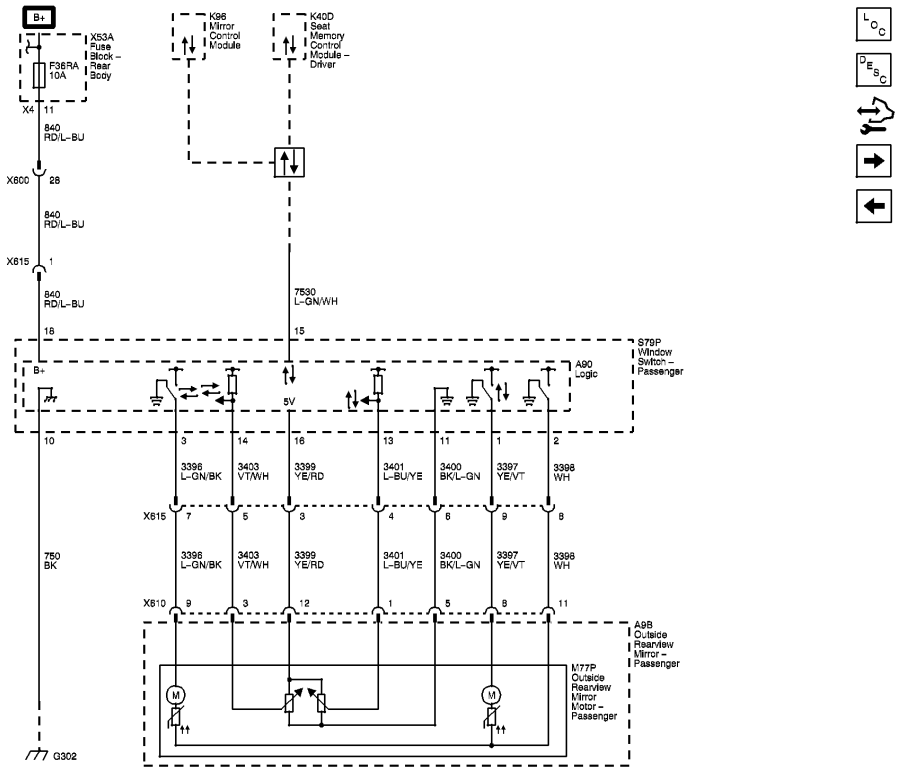


Fig. 224: View Of Oil Tank Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the locations of the bolt/studs during reassembly.

11. Install the engine oil tank bolts (1) and engine oil tank bolt/studs (2) to the tank and tighten to 25 N.m (18 lb ft).

cardiagn.com

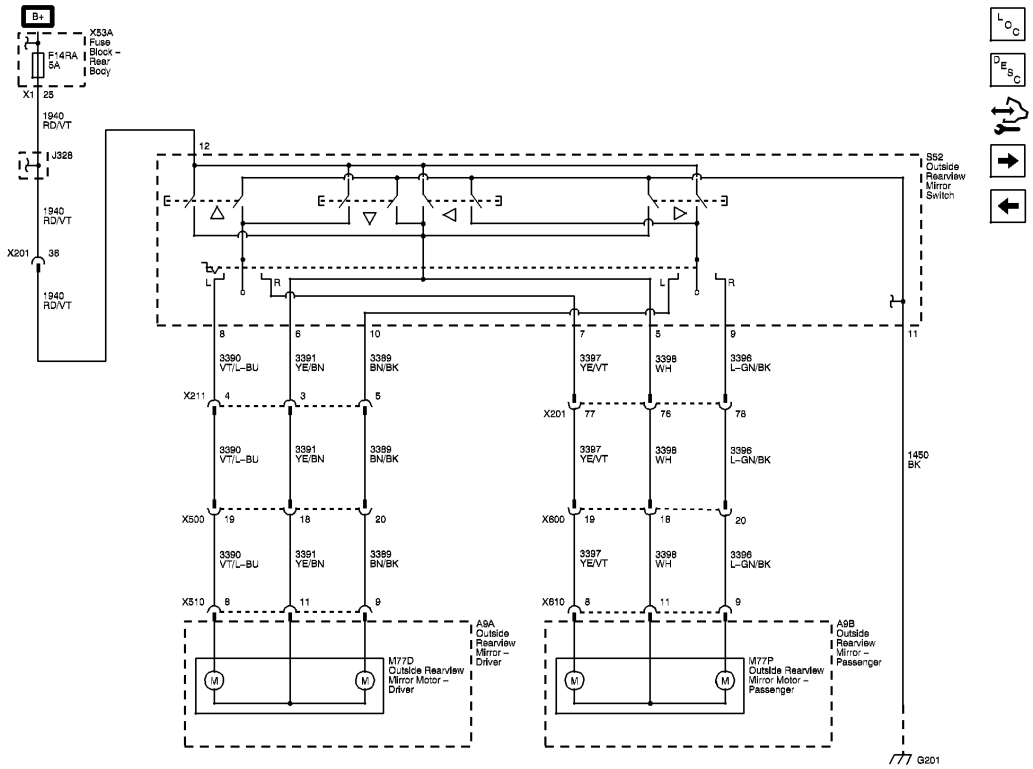


Fig. 225: View Of Oil Level Indicator & Oil Fill Cap
Courtesy of GENERAL MOTORS COMPANY

12. Install the oil level indicator (1) and oil filler cap (2).

INTAKE MANIFOLD CLEANING AND INSPECTION

Cleaning Procedure

cardiagn.com

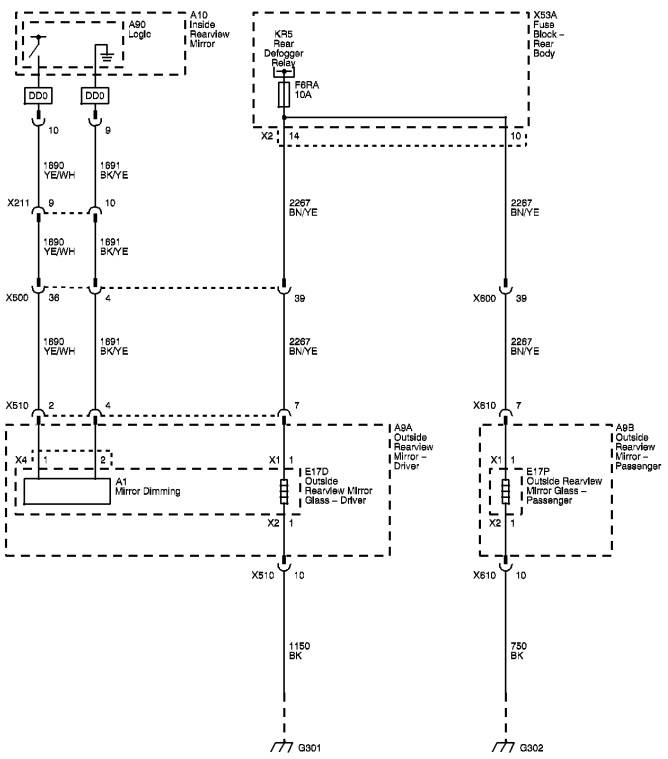


Fig. 226: Intake Manifold-To-Cylinder Head Gaskets
Courtesy of GENERAL MOTORS COMPANY

1. Remove and discard the intake manifold-to-cylinder head gaskets (1).

cardiagn.com

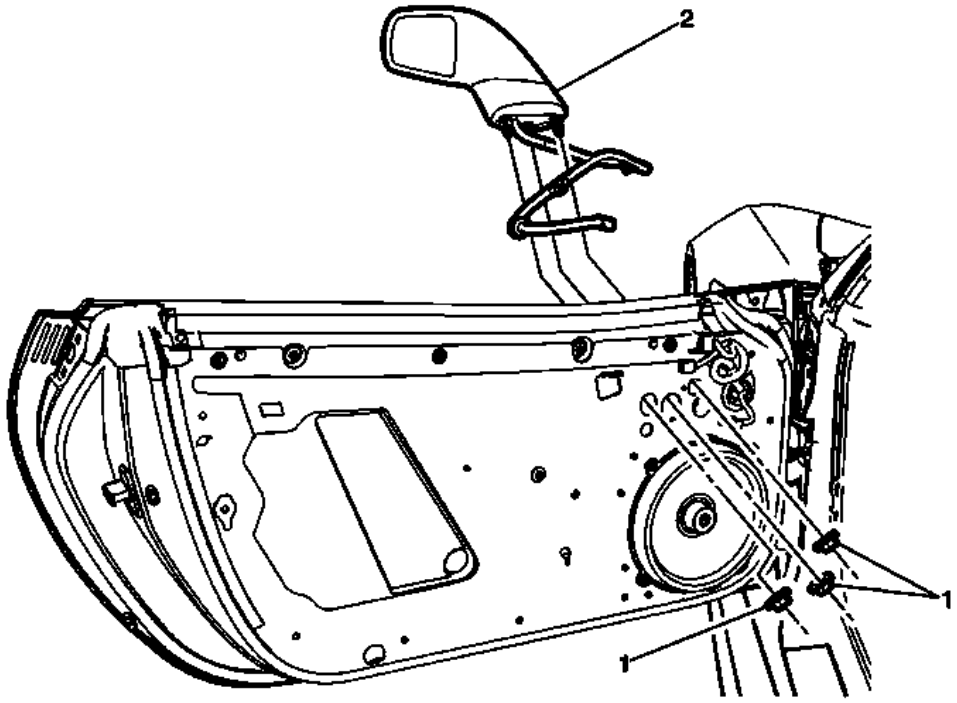


Fig. 227: Manifold Absolute Pressure (MAP) Sensor Bolt, MAP Sensor And Seal
Courtesy of GENERAL MOTORS COMPANY

2. Remove the manifold absolute pressure (MAP) sensor bolt (1), MAP sensor (2) and seal (3).
3. Remove the evaporative emission (EVAP) canister purge solenoid valve bolt (9), EVAP canister purge solenoid valve (8) and seal (7).
4. Remove the PCV Fitting (5).
5. Clean the intake manifold in solvent.

WARNING: Refer to Safety Glasses and Compressed Air Warning .

6. Dry the intake manifold with compressed air.

Inspection Procedure

1. Inspect the manifold for the following conditions:
   - Damaged gasket or sealing surfaces
   - Loose threaded inserts or studs
   - Debris or restrictions within the passages of the manifold
   - Damaged or broken vacuum fittings
   - Inspect the composite intake manifold assembly for cracks or other damage.

cardiagn.com

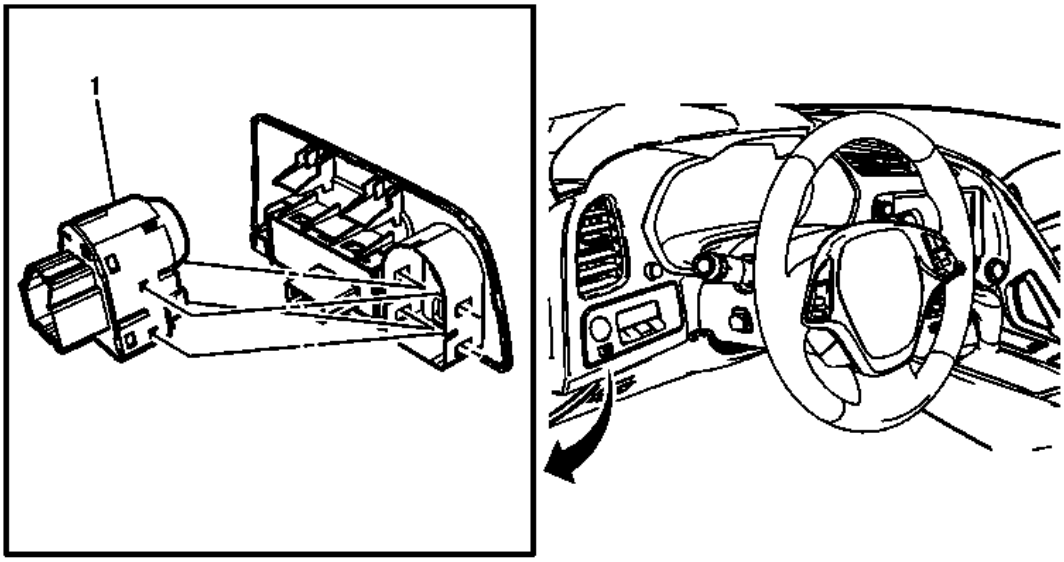


Fig. 228: Inspecting Intake Manifold Cylinder Head Deck For Warpage
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the intake manifold cylinder head deck for warpage.
    1. Locate a straight edge across the intake manifold cylinder head deck surface.

       Position the straight edge across a minimum of two runner port openings.

    2. Insert a feeler gauge between the intake manifold and the straight edge.

       An intake manifold with warpage in excess of 3 mm (0.118 in) over a 200 mm (7.87 in) area is warped and should be replaced.

EXHAUST MANIFOLD CLEANING AND INSPECTION

cardiagn.com

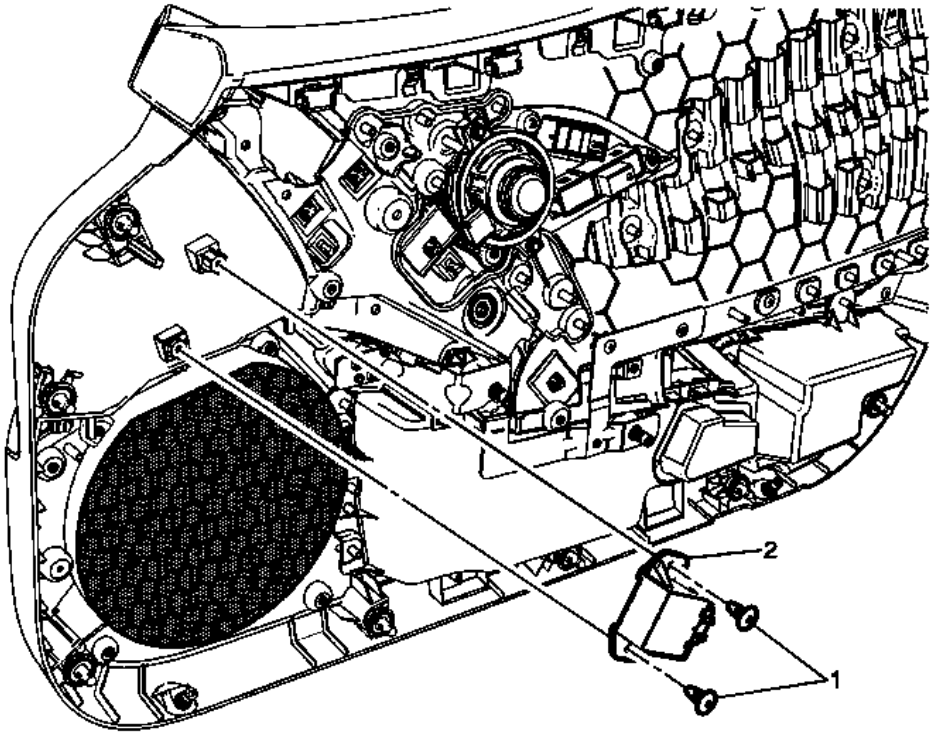


Fig. 229: Exhaust Manifold And Heat Shield In Solvent
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not use the exhaust manifold-to-cylinder head gaskets again. Upon installation of the exhaust manifold, install a NEW gasket. An improperly installed gasket or leaking exhaust system may affect on-board diagnostics (OBD) II system performance.**

1. Clean the exhaust manifold (1) and heat shield (2) in solvent.

WARNING: **Refer to Safety Glasses Warning .**

2. Dry the exhaust manifold with compressed air.
3. Inspect the exhaust manifold-to-cylinder head gasket surface for excessive scratches or gouging.
4. Inspect for a loose, damaged or cracked heat shield (2).
5. Inspect the bolts (3 and 4) for damaged threads.

cardiagn.com

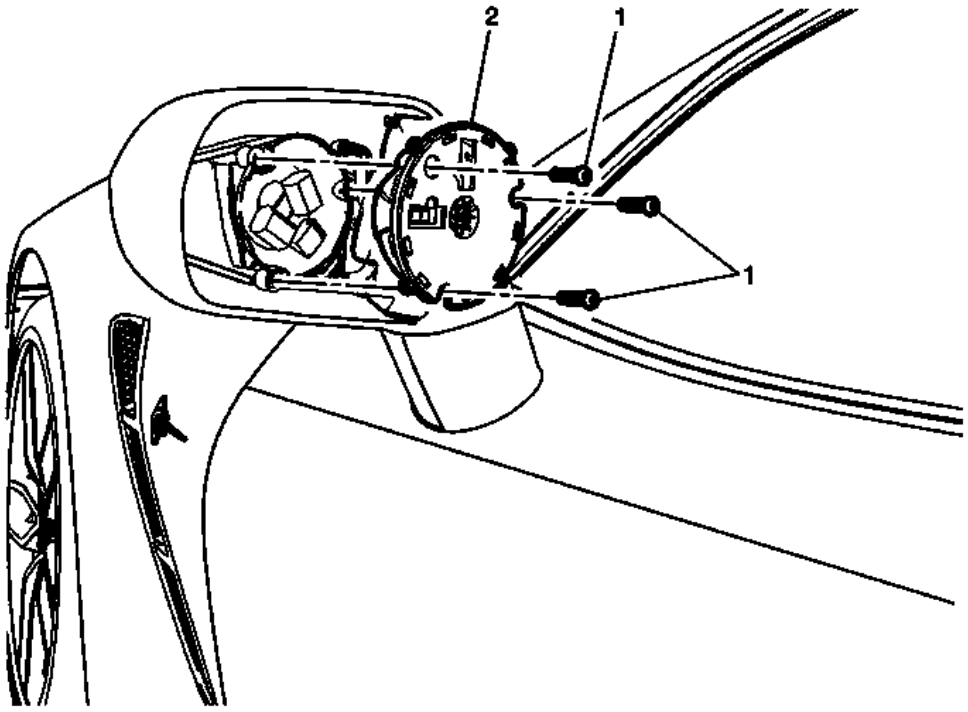


Fig. 230: Measuring Exhaust Manifold Cylinder Head Deck For Warpage
Courtesy of GENERAL MOTORS COMPANY

6. Use a straight edge and a feeler gauge and measure the exhaust manifold cylinder head deck for warpage.

   An exhaust manifold deck with warpage in excess of 0.25 mm (0.01 in) within the 2 front or 2 rear runners or 0.5 mm (0.02 in) overall, may cause an exhaust leak and may affect OBD II system performance. Exhaust manifolds not within specifications must be replaced.

ENGINE COOLANT MANIFOLD DISASSEMBLE

cardiagn.com

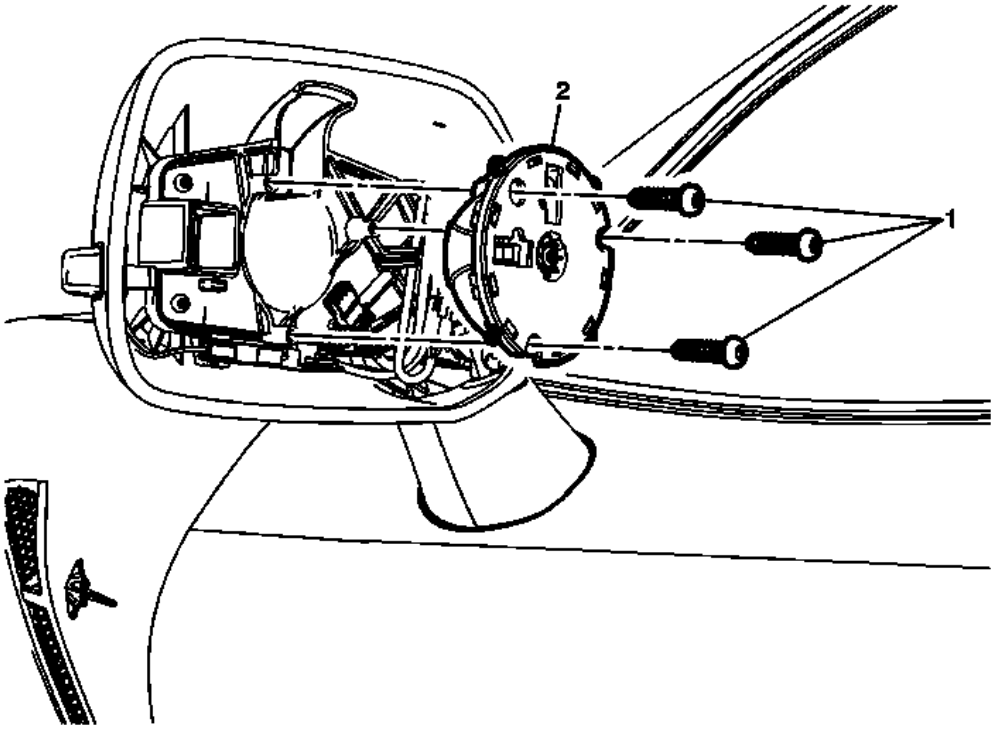


Fig. 231: Engine Coolant Manifold Disassemble
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Manifold Disassemble

Callout	Component Name
1	Engine Coolant Temperature Sensor
2	Thermostat Housing Bolts
3	Thermostat Housing
4	Thermostat Housing Gasket **NOTE:** **Discard gasket, it is not reusable.**
5	Water Pump Impeller Bolts
6	Water Pump Impeller
7	Water Pump Impeller Gasket **NOTE:** **Discard gasket, it is not reusable.**

ENGINE COOLANT MANIFOLD CLEANING AND INSPECTION

cardiagn.com

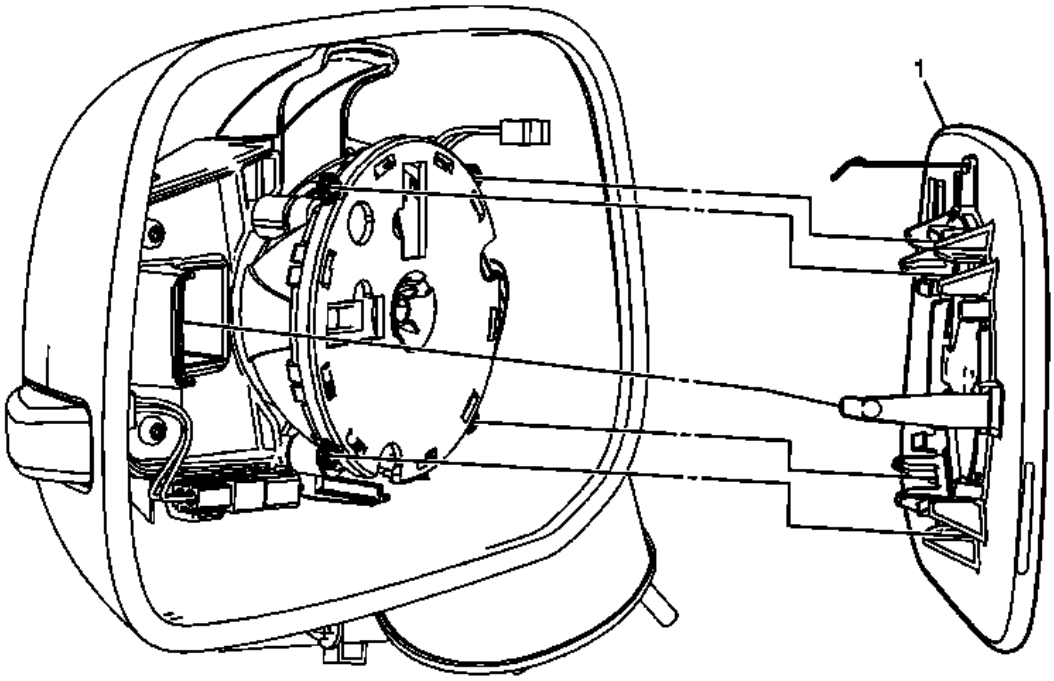


Fig. 232: Engine Coolant Manifold Cleaning and Inspection
Courtesy of GENERAL MOTORS COMPANY

NOTE: Inspect for leakage between the water output flange and the thermostat housing.

1. Clean all excess dirt and debris from the engine coolant manifold housing.
2. Inspect the engine coolant manifold for the following conditions:
   - Gasket and hose sealing surfaces for excessive scratches or gouging
   - Restrictions within the internal coolant passages
   - Excessive side-to-side play in the pulley shaft
   - Leakage at the water inlet housing or rear cover
   - Leakage at the water outlet housing or thermostat housing
   - Leakage at the Engine Coolant Manifold vent hole

     A stain around the vent hole is acceptable. If leakage, dripping, occurs with the engine running and the cooling system pressurized, replace the water pump.

   - Wear or damage in the belt tracking area of the pulley

ENGINE COOLANT MANIFOLD ASSEMBLE

cardiagn.com

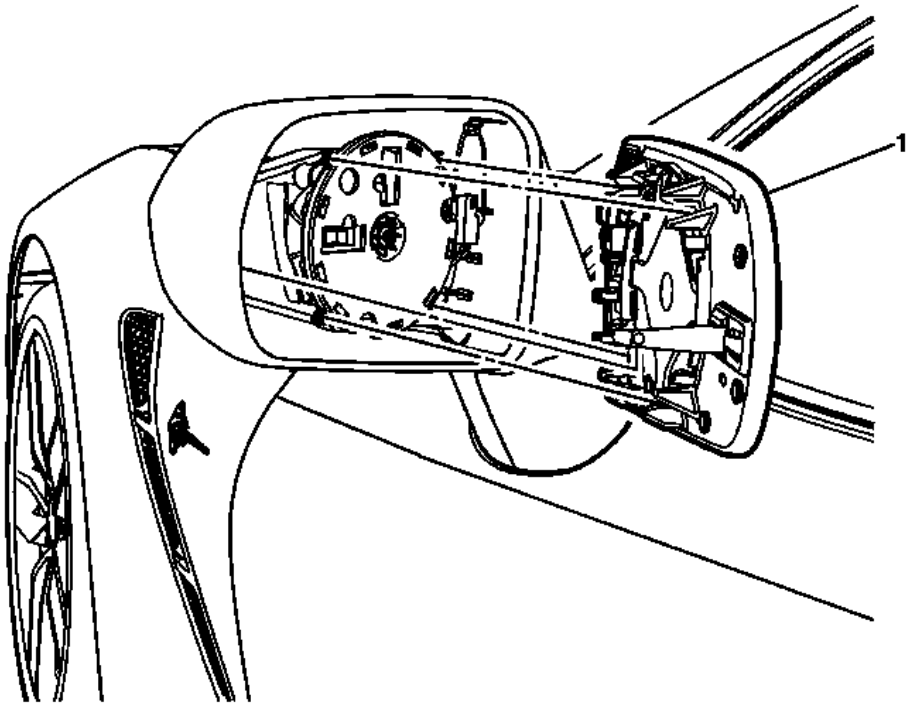


Fig. 233: Engine Coolant Manifold Assemble
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Manifold Assemble

Callout	Component Name
1	Engine Coolant Temperature Sensor **CAUTION:** **Refer to Fastener Caution .** **Tighten** 20 (15 lb ft)
2	Water Pump Impeller Gasket **NOTE:** **Install a NEW Gasket.**
3	Water Pump Impeller
4	Water Pump Impeller Bolts **Tighten** 10 (88 lb in)
5	Thermostat Housing Gasket **NOTE:**

cardiagn.com

	Install a NEW Gasket.
6	Thermostat Housing
7	Thermostat Housing Bolts **Procedure** 1. Install and hand tighten all three bolts. 2. Tighten bolts to final torque. **Tighten** 10 (88 lb in)

FUEL RAIL AND INJECTORS CLEANING AND INSPECTION

Special Tools

- **EN-49245** Injector Seal Installer Kit
- **EN-51097** Injector Retaining Clip Installer and Sizer
- **EN-51105** Injector Seal Installer and Sizer

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

cardiagn.com

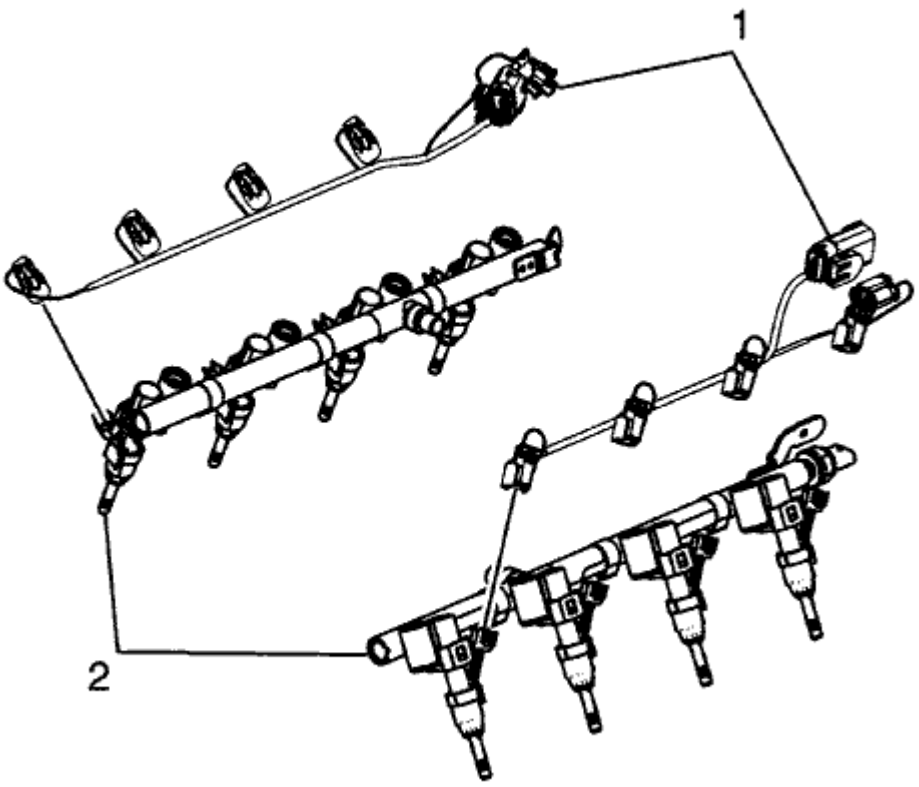


Fig. 234: Fuel Rail Wiring Harnesses
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect and remove the fuel rail wiring harnesses (1).

cardiagn.com

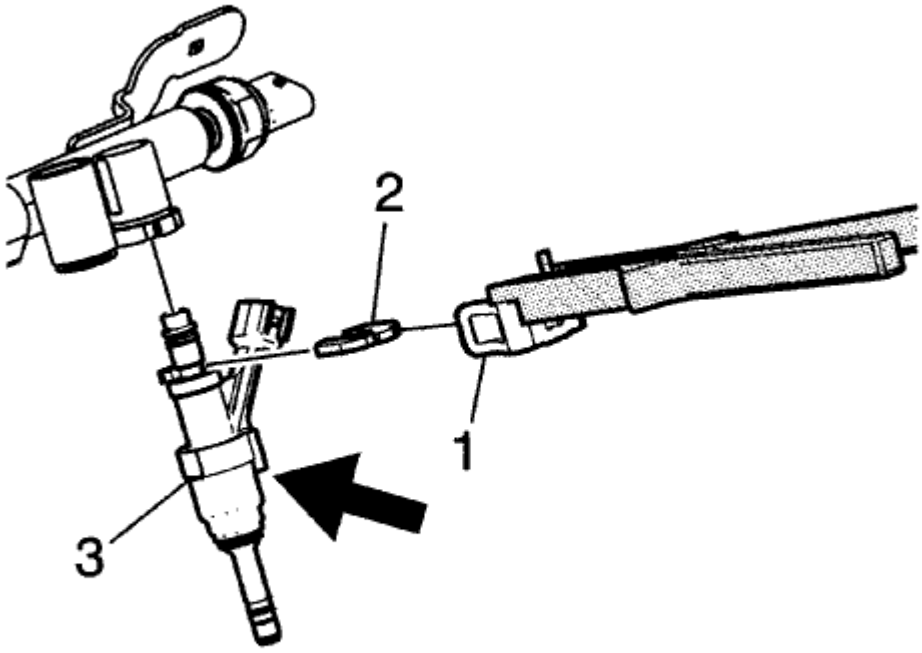


Fig. 235: Fuel Injector Retainer Clips
Courtesy of GENERAL MOTORS COMPANY

2. Remove and discard the fuel injector retainer clips (1) by installing **EN-51097** injector retaining clip installer and spreading both sides of the clip evenly.
3. Remove the fuel injector collars (2).

cardiagn.com

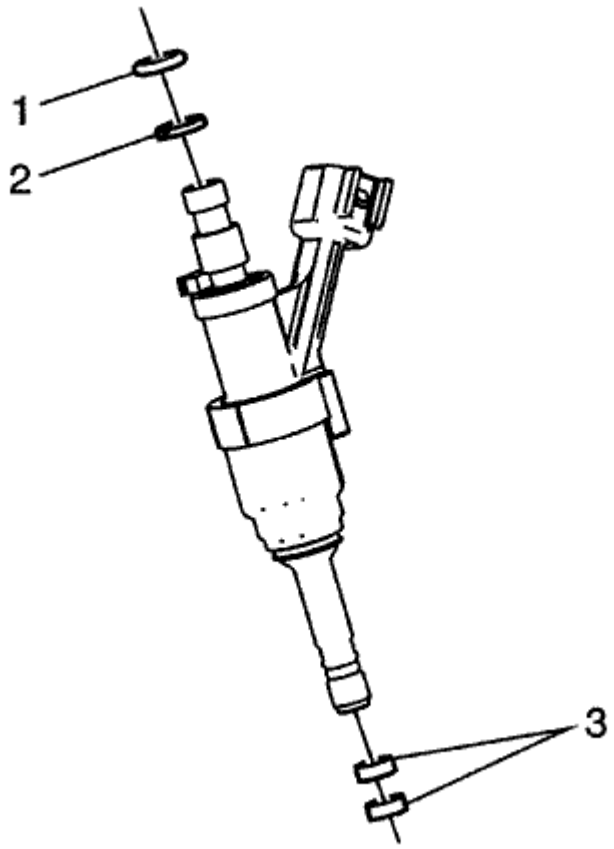


Fig. 236: Fuel Injector O-Ring And Plastic Spacer
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not use a metal tool to remove O-rings, spacers or injector seals. Care must be taken not to scratch or damage the tubes of the injector.

4. Remove and discard the fuel injector O-ring (1) and plastic spacer (2).
5. Remove and discard the fuel injector seals (3).

cardiagn.com

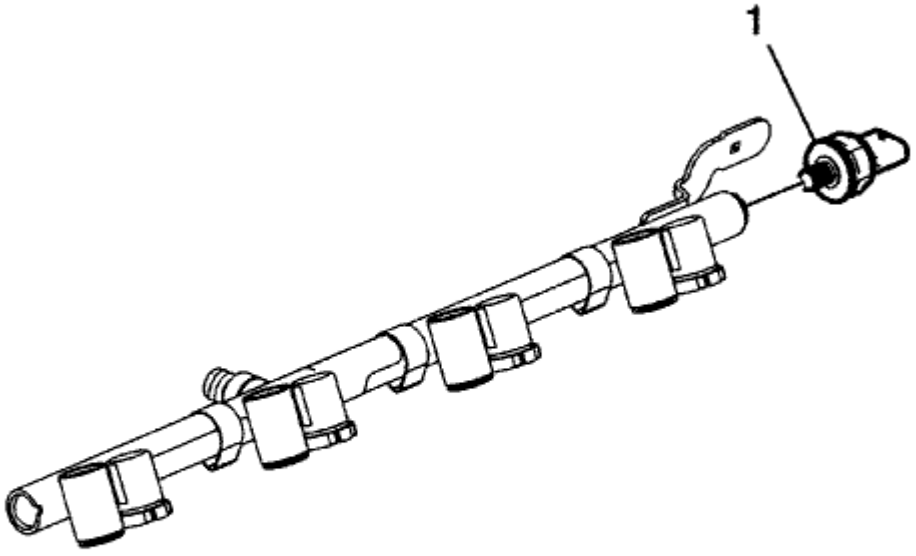


Fig. 237: Fuel Pressure Sensor And LH Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

NOTE: Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.

6. Remove the fuel pressure sensor (1) from the LH fuel rail.

NOTE: Do not soak or submerge the fuel rail or injectors in solvent.

7. Clean the exterior of the fuel rail and injectors with solvent.

cardiagn.com

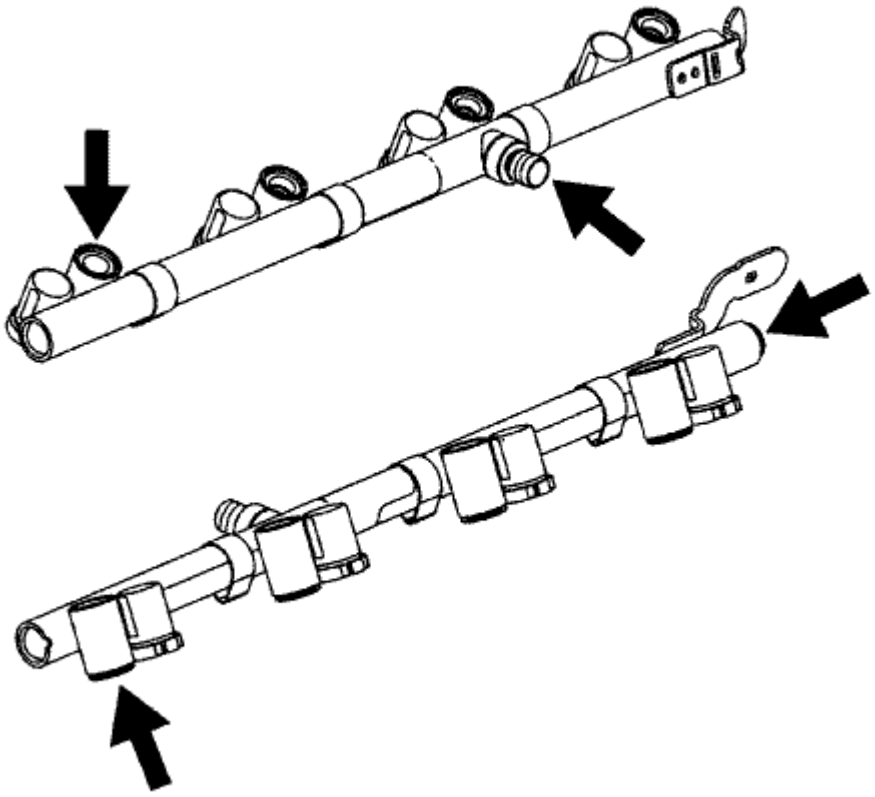


Fig. 238: Inspecting Fuel Rail And Components
Courtesy of GENERAL MOTORS COMPANY

8. 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 or mounting bolt grommets/isolators
    - Damage to the threads on the fuel rail feed fitting
    - Damage to the threads in the fuel pressure sensor bore
    - Damage to the fuel pressure sensor connector, threads or sealing face

cardiagn.com

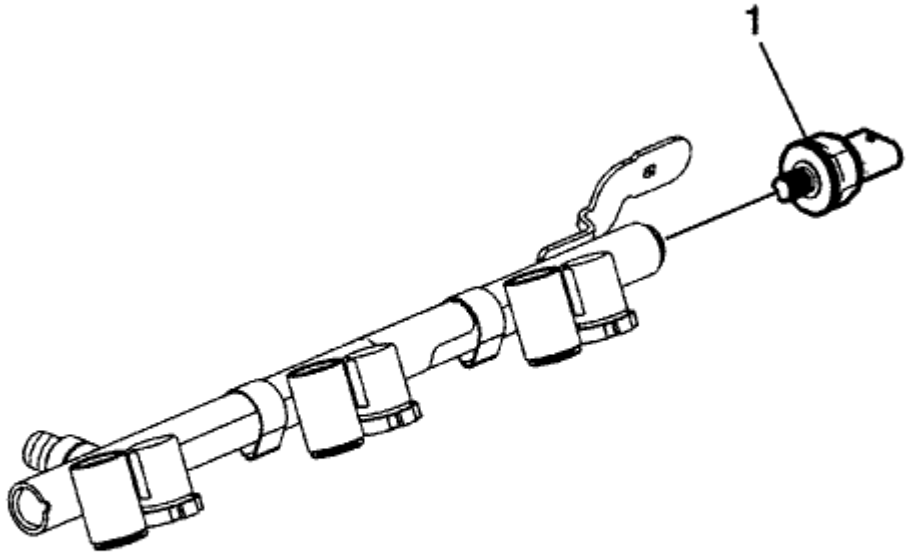


Fig. 239: Fuel Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: Applying force to the plastic housing of the sensor will destroy the sensor. To tighten or loosen, only apply force to the attached hexagon.

9. Install the fuel pressure sensor (1).

NOTE: Ensure that the fuel rail threads have been cleaned of any excess fuel or the fuel pressure sensor will NOT seal properly.

10. Lubricate the threads and the sealing area in the fuel rail with silicon free engine oil. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.
11. Lubricate the threads and the sealing area on the fuel pressure sensor with silicon free engine oil. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.
12. Install the fuel pressure sensor hand tight.
13. Remove the fuel pressure sensor and re-lubricate.

CAUTION: Refer to Fastener Caution .

cardiagn.com

14. Install the fuel pressure sensor and tighten to 33 N.m (24 lb ft)

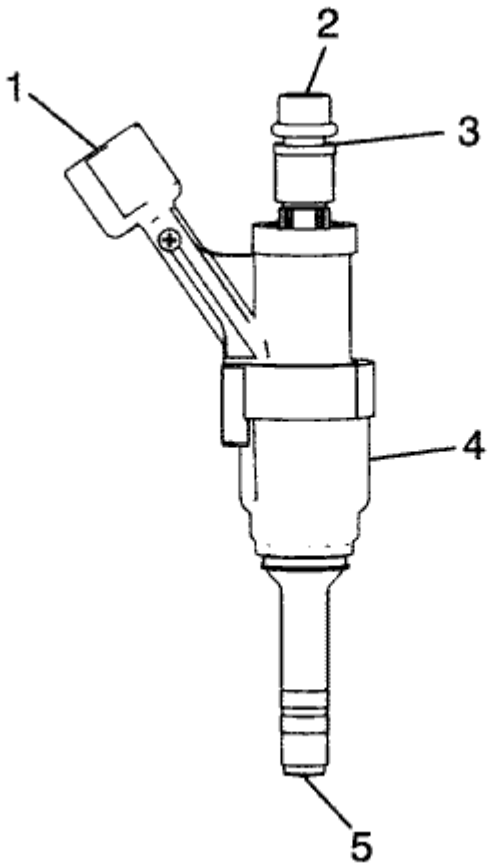


Fig. 240: Fuel Injector Connector Components
Courtesy of GENERAL MOTORS COMPANY

15. Inspect the fuel injectors for the following conditions:
    - Damage to the fuel injector connector (1)
    - Damage to the fuel inlet cone (2)
    - Damage to the O-ring sealing surface (3)
    - Damage to the fuel injector body (4)
    - Damage to the fuel injector tip (5)
16. Replace the fuel rail or injector if any damage is found. Do not attempt to repair a fuel rail or injector.

cardiagn.com

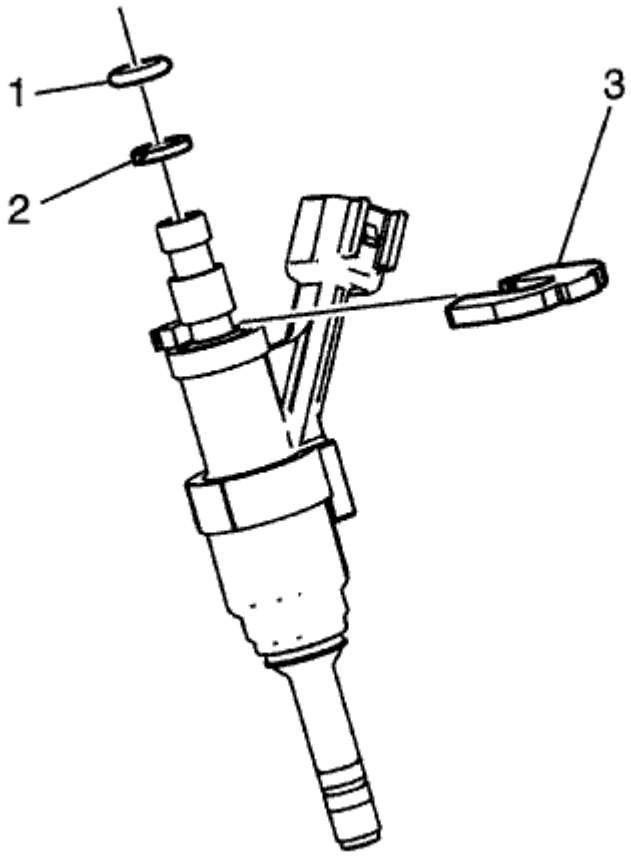


Fig. 241: Installing NEW Spacer On Fuel Injector
Courtesy of GENERAL MOTORS COMPANY

17. Install a NEW spacer (2) on the fuel injector.
18. Lubricate the NEW O-ring (1) with clean engine oil and install on injector.
19. Install injector collar (3) on fuel injector.

cardiagn.com

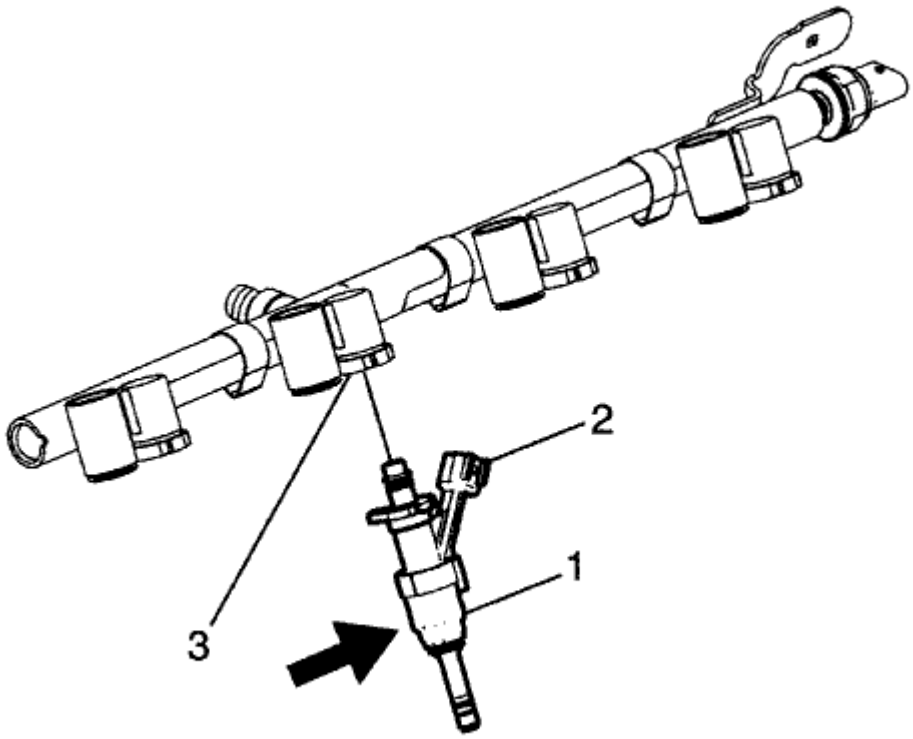


Fig. 242: Injector Assembly And Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do NOT install the injector tip/bore seals until AFTER the injectors are installed on the fuel rail.

20. Lubricate the socket (3) of the fuel rail with clean engine oil. Holding the largest diamenter/body of the injector only, indicated by arrow in graphic, insert the injector assembly (1) into the fuel rail. Ensure correct orientation of the electrical connector (2). LH Rail: Electrical connectors face the front of the engine. RH Rail: Electrical connectors face the rear of the engine.

cardiagn.com

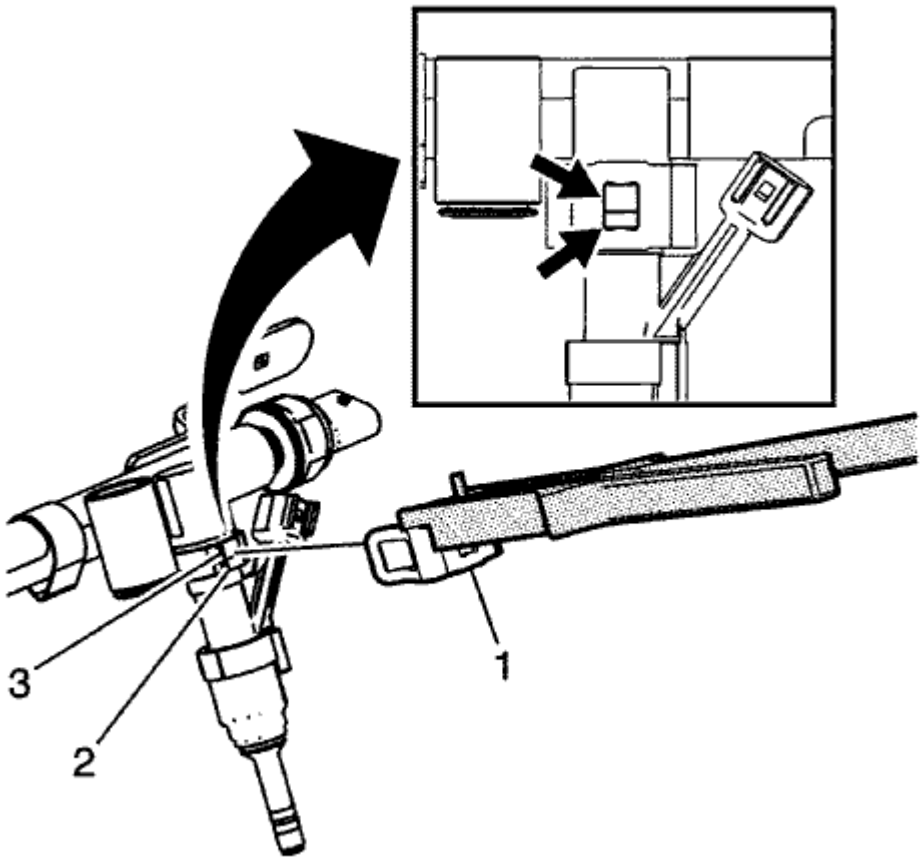


Fig. 243: Installing Fuel Injector Clip Onto EN-51097 Injector Retaining Clip Installer
Courtesy of GENERAL MOTORS COMPANY

21. Install the fuel injector clip onto the **EN-51097** injector retaining clip installer.
22. Using **EN-51097** injector retaining clip installer spread the retainer clip (1) and install onto the fuel rail. Inspect the front and side windows of the retainer clip to ensure that the flange on the rail (3) and the tab on the injector collar (2) are completely captured and firmly seated in the retainer clip (1) as shown.
23. Repeat for remaining injectors until all are installed and retained in fuel rail.

cardiagn.com

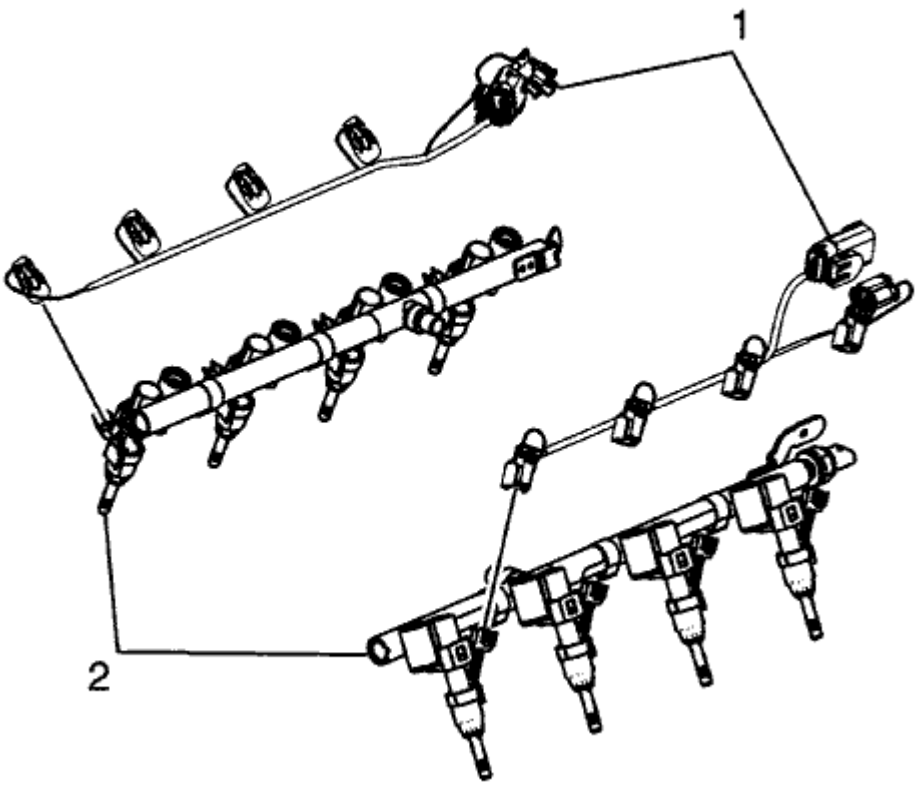


Fig. 244: Fuel Rail Wiring Harnesses
Courtesy of GENERAL MOTORS COMPANY

24. Install the fuel rail wiring harnesses (1).

cardiagn.com

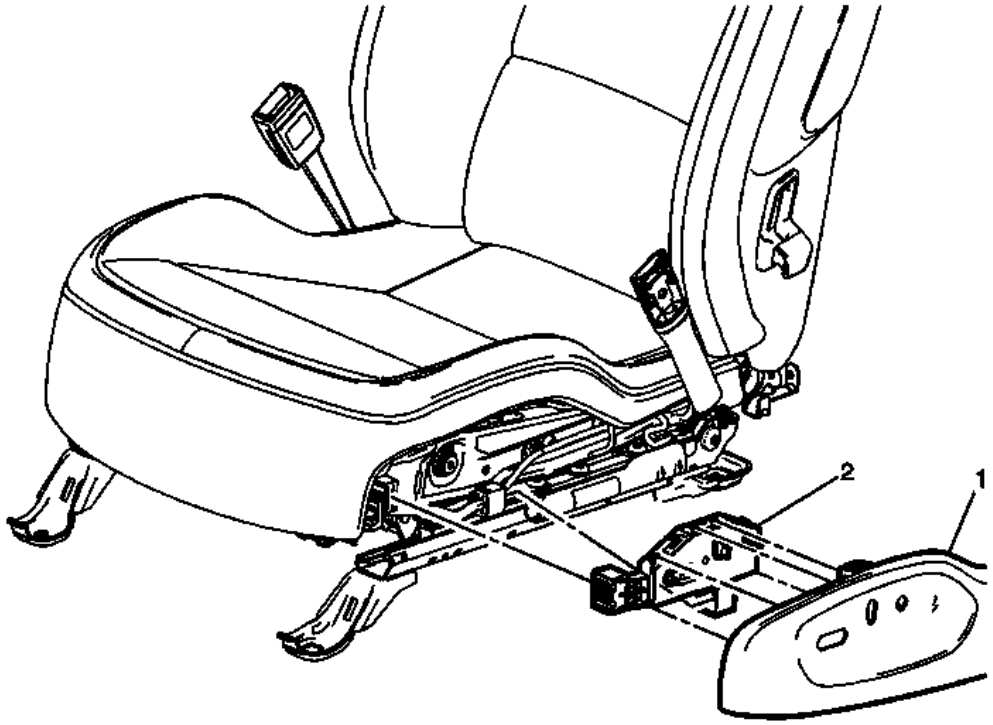


Fig. 245: Installing Seals With Long Protector
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not use any type of lubricant when installing the NEW seals (2) on the fuel injector.

25. Install **EN-51105-1** long protector (3) 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.
26. Using **EN-49245-3** pusher (1), install the seal into the second recessed area (4) of the fuel injector.

NOTE: The EN-49245-4 sizer is two sided and either direction will size the seal correctly.

27. Compress the seal with your fingers, then resize the seal if using the **EN-49245-4** sizer (5).

cardiagn.com

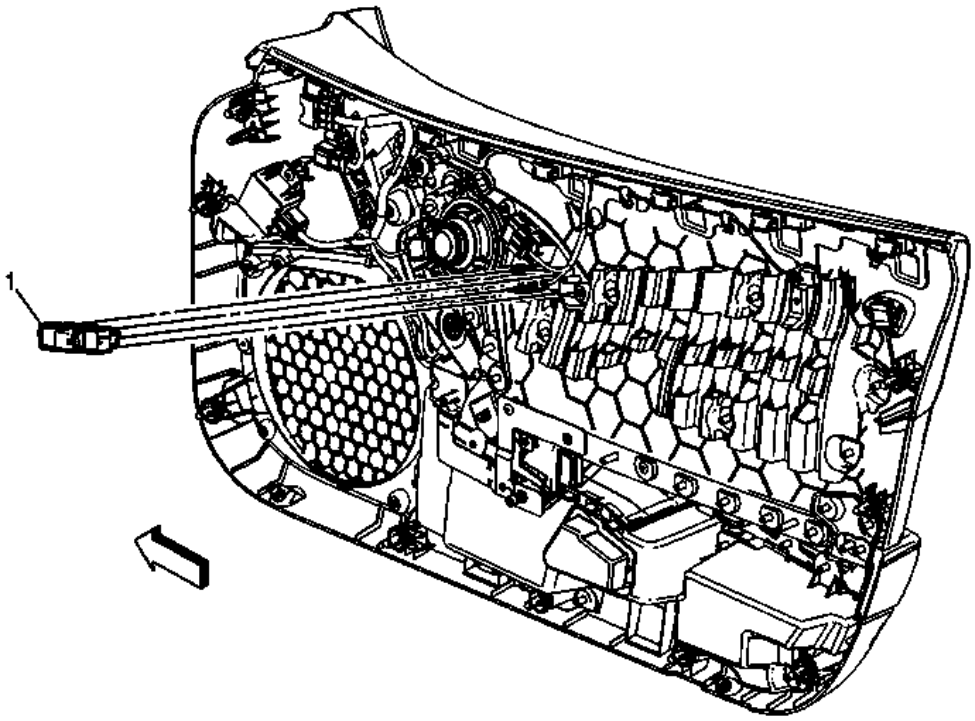


Fig. 246: Installing Seals With Short Protector
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not use any type of lubricant when installing the NEW seals (2) on the fuel injector.

28. Install **EN-51105-2** short protector (3) onto the fuel injector tip. Place a NEW seal (2) on **EN-51105-2** short protector.
29. Using **EN-49245-3** pusher (1), install the seal into the first recessed area (4) of the fuel injector.

NOTE: The EN-49245-4 sizer is two sided and either direction will size the seal correctly.

30. Compress the seal with your fingers, then resize the seal using the **EN-49245-4** sizer (5).

THREAD REPAIR

Special Tools

- **J 42385-100** Head/Main Bolt Thread Repair Kit
- **J 42385-300** Fixtures and Hardware Kit

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

cardiagn.com

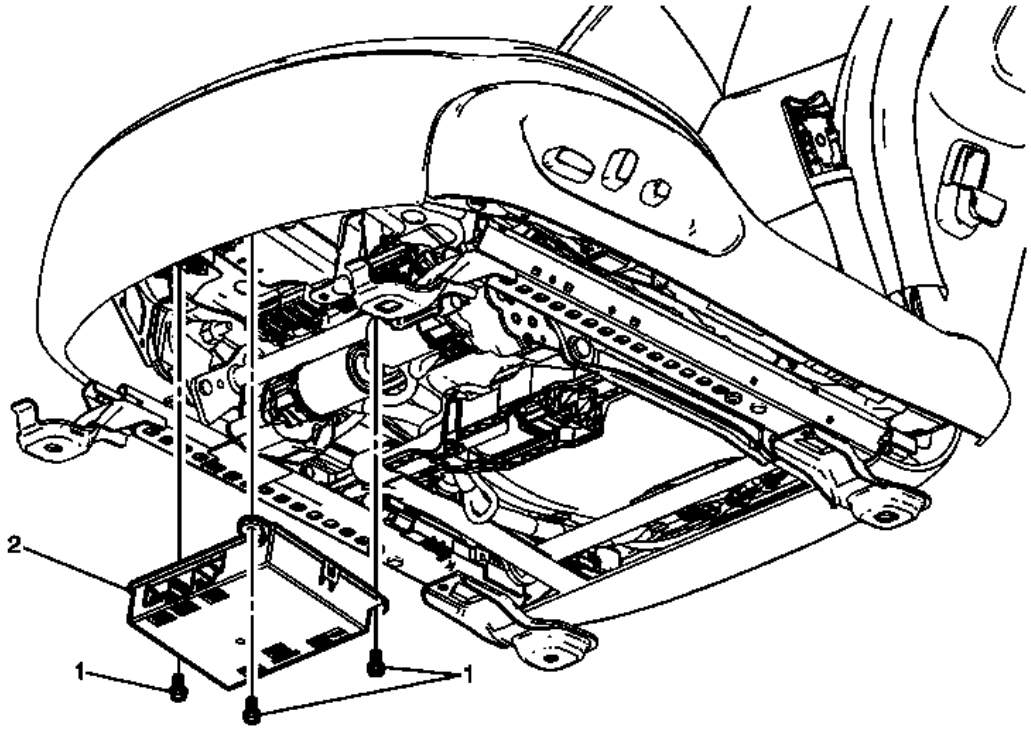


Fig. 247: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS COMPANY

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.

cardiagn.com

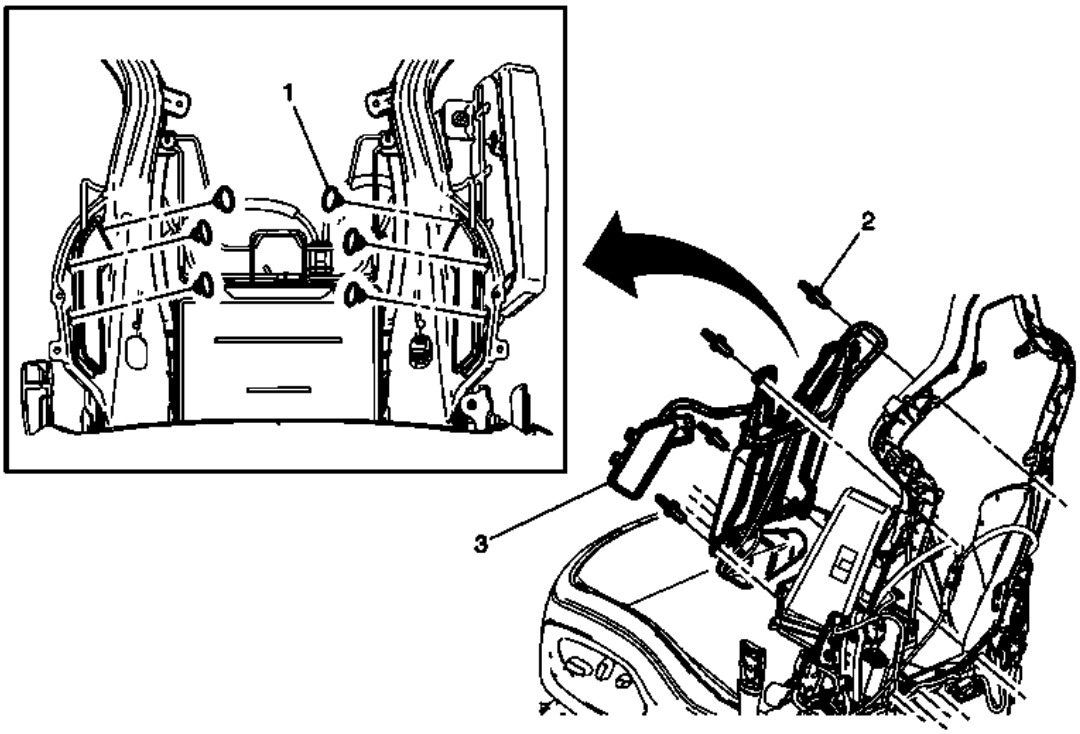


Fig. 248: Drilling & Tapping Threads
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

NOTE:

- **The use of a cutting type fluid GM P/N 1052864 (Canadian P/N 992881), WD 40® or equivalent, is recommended when performing the drilling, counterboring and tapping procedures.**
- **Driver oil MUST be used on the installer driver tool.**
- **The tool kits are designed for use with either a suitable tap wrench or drill motor.**

1. Drill out the threads of the damaged hole (1).
   - M6 inserts require a minimum drill depth of 15 mm (0.59 in).
   - M8 inserts require a minimum drill depth of 20 mm (0.79 in).
   - M10 inserts require a minimum drill depth of 23.5 mm (0.93 in).
2. Using compressed air, clean out any chips.

cardiagn.com

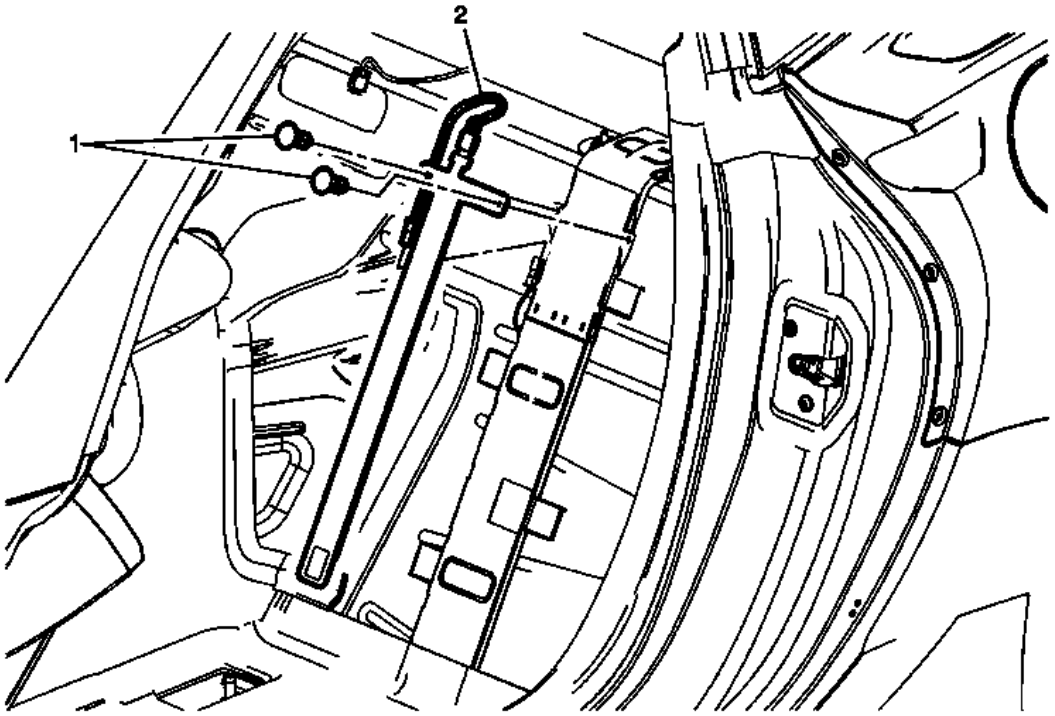


Fig. 249: Identifying Tool Used To Counterbore The Hole
Courtesy of GENERAL MOTORS COMPANY

3. Counterbore the hole to the full depth permitted by the tool (1).
4. Using compressed air, clean out any chips.

cardiagn.com

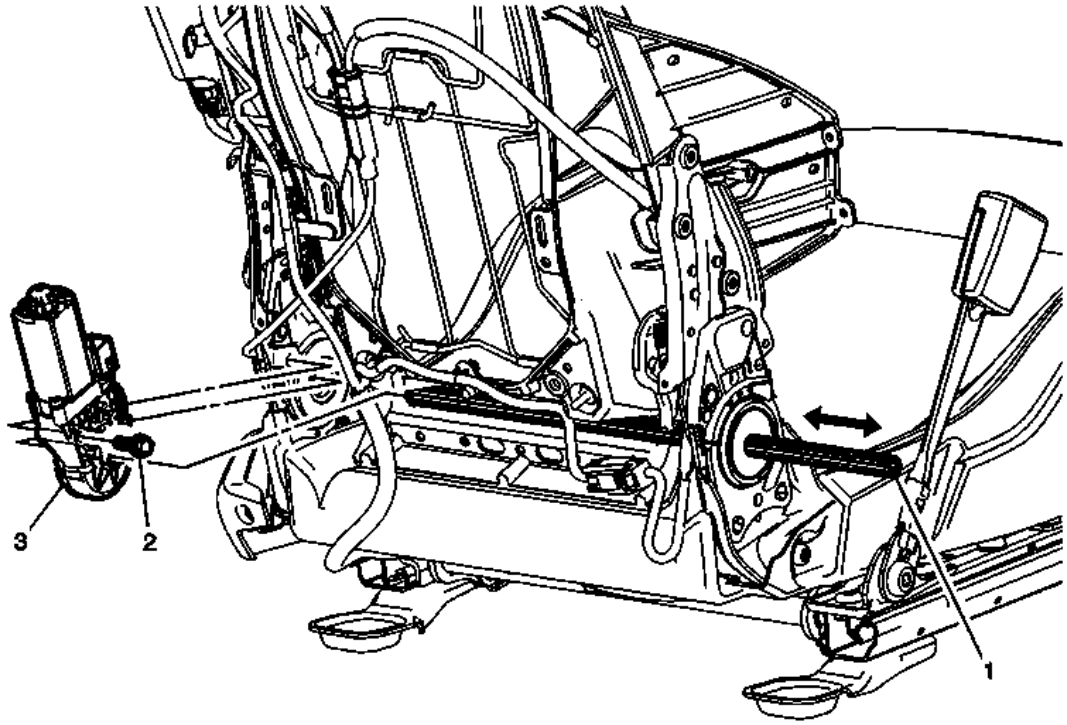


Fig. 250: Drilling & Tapping Threads
Courtesy of GENERAL MOTORS COMPANY

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).
6. Using compressed air, clean out any chips.
7. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463) or equivalent, into the hole.
8. Using compressed air, clean any cutting oil and chips out of the hole.

cardiagn.com

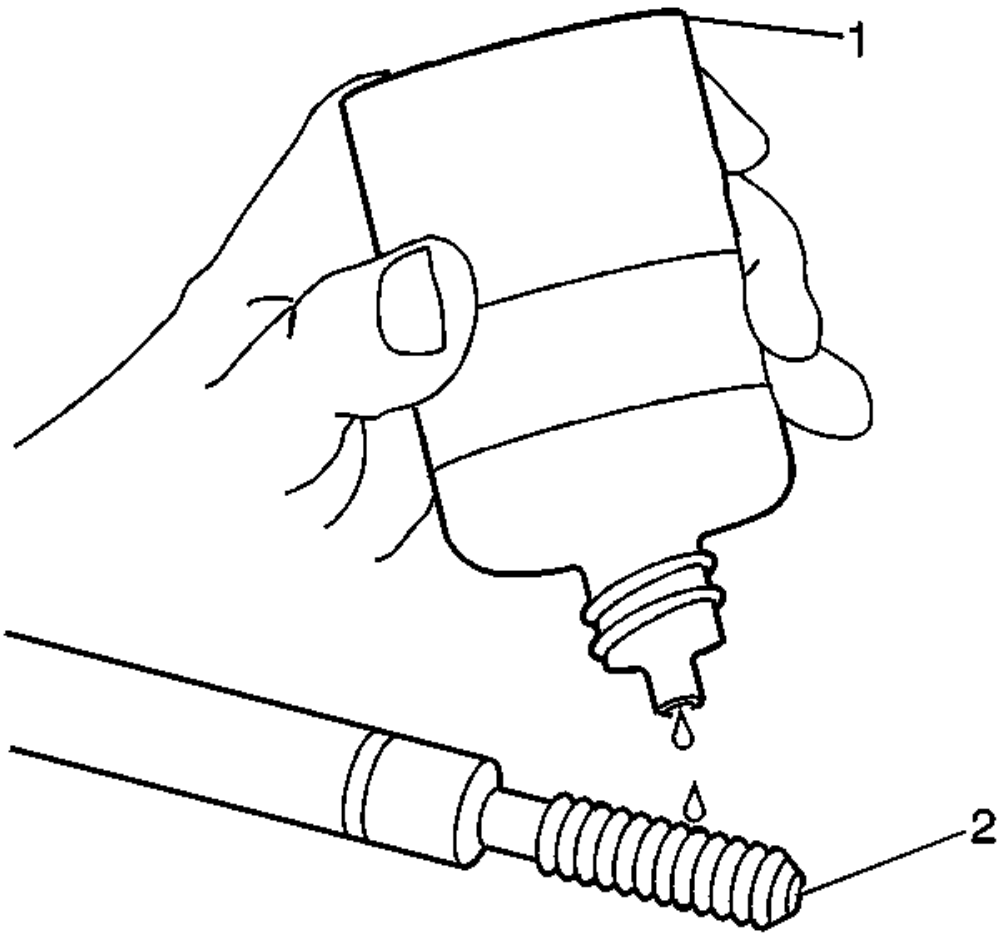


Fig. 251: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

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).

cardiagn.com

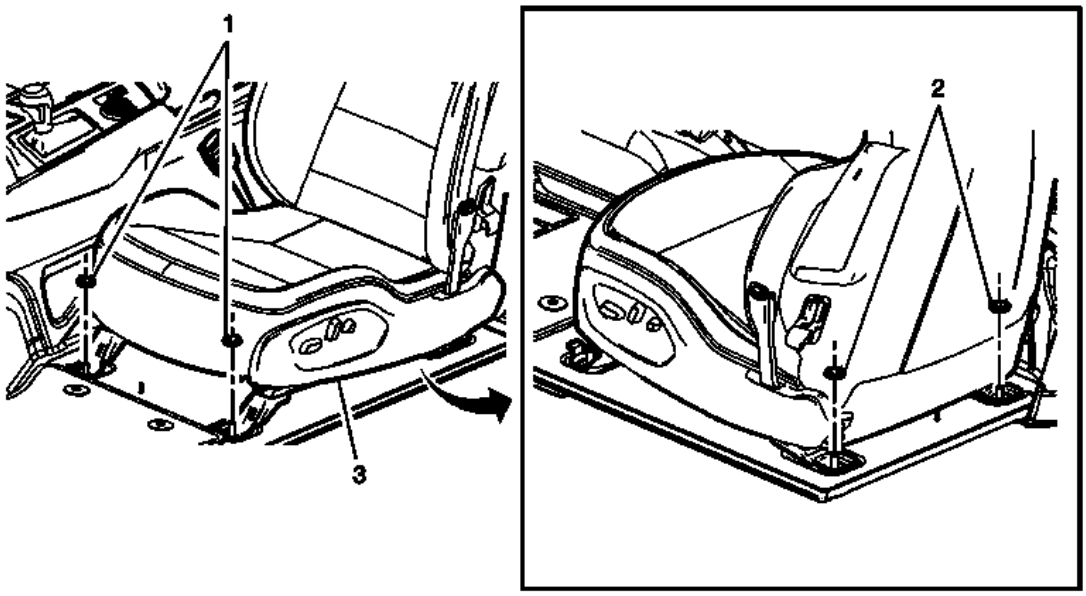
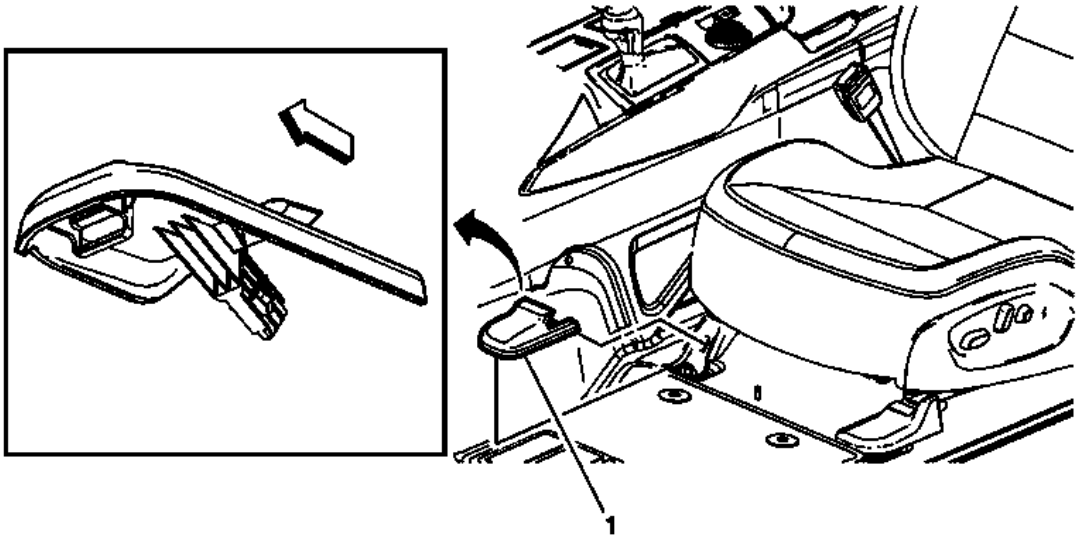


Fig. 252: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

10. Install the insert (2) onto the driver tool (1).



cardiagn.com

Fig. 253: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

11. Apply threadlock LOCTITE™ 277, J 42385-109 (1) or equivalent, to the insert OD threads (2).

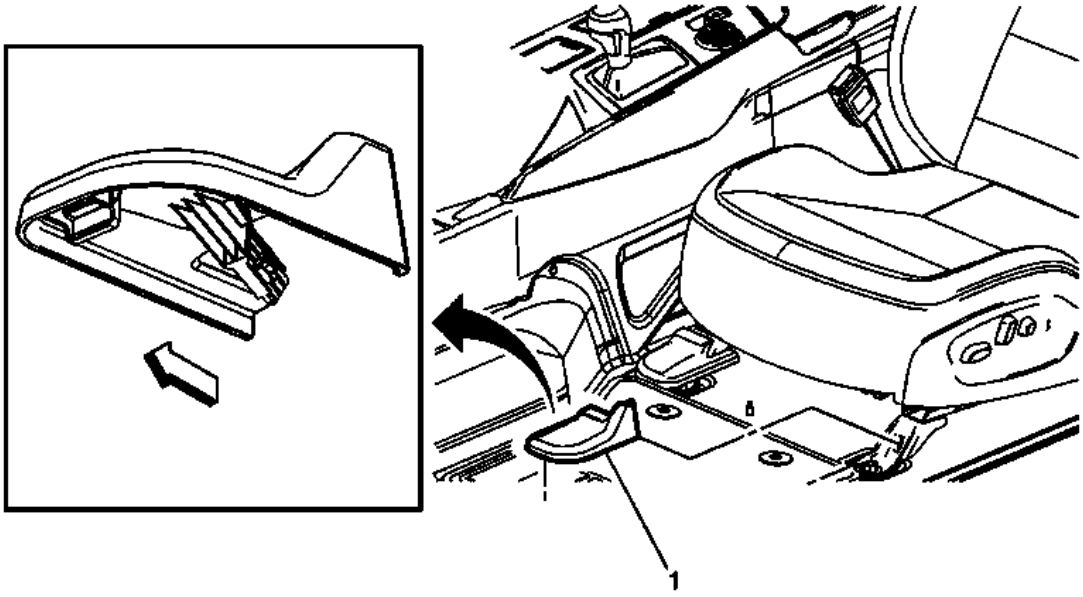


Fig. 254: View Of Insert In Tapped Bolt Hole
Courtesy of GENERAL MOTORS COMPANY

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.

cardiagn.com

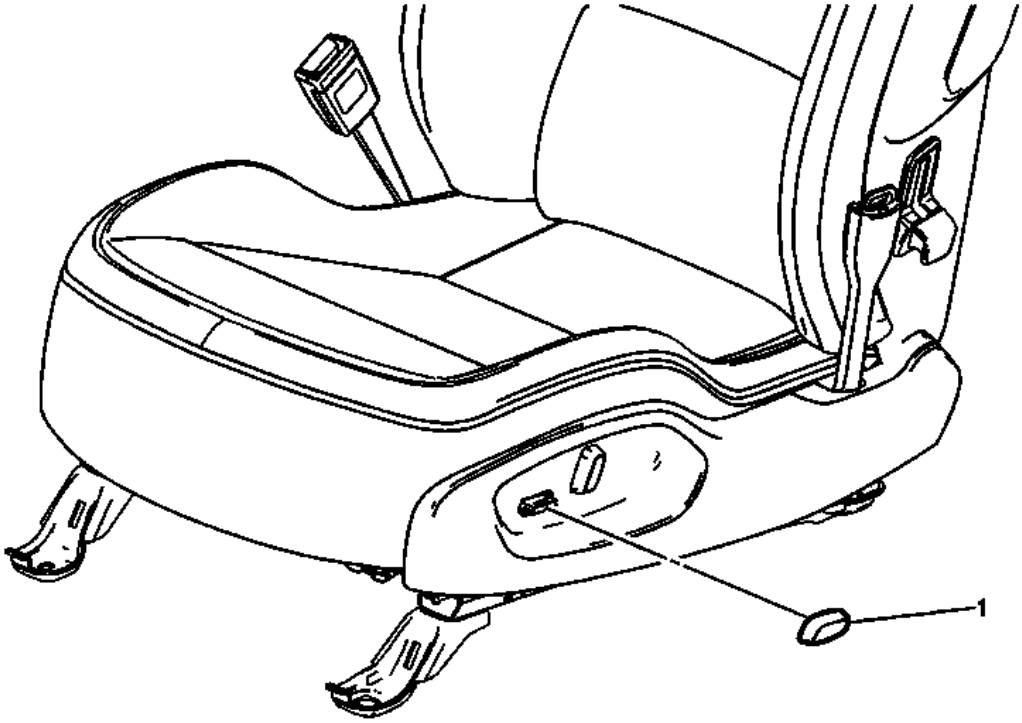


Fig. 255: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS COMPANY

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

cardiagn.com

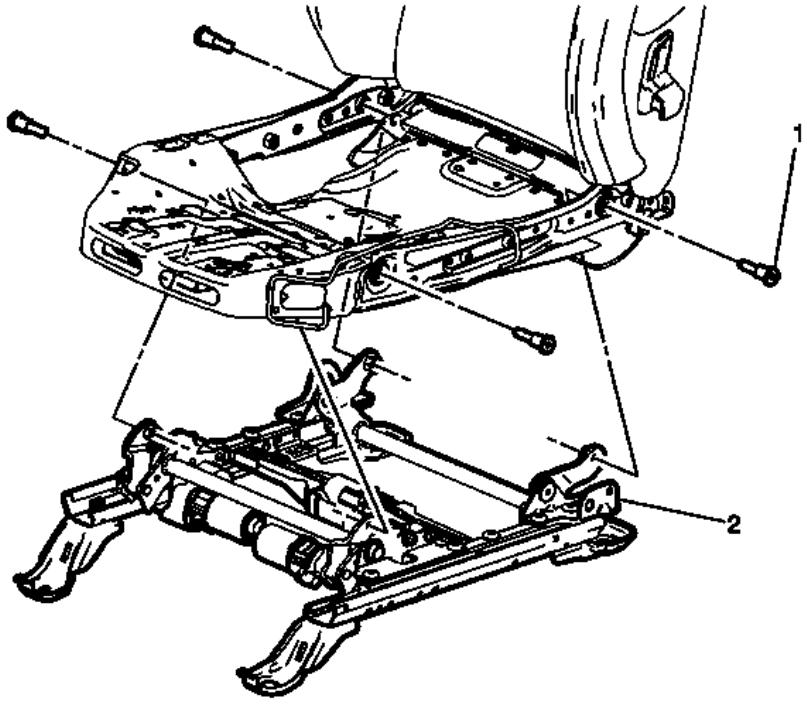


Fig. 256: Identifying Thread Repair Kit Components
Courtesy of GENERAL MOTORS COMPANY

1. The cylinder head bolt hole thread repair kit consists of the following items:
    - The drill (1)
    - The tap (2)
    - The installer (3)
    - The sleeve (4)
    - The alignment pin (5)
    - The bushing (6)
    - The bolts (7)
    - The fixture plate (8)

cardiagn.com

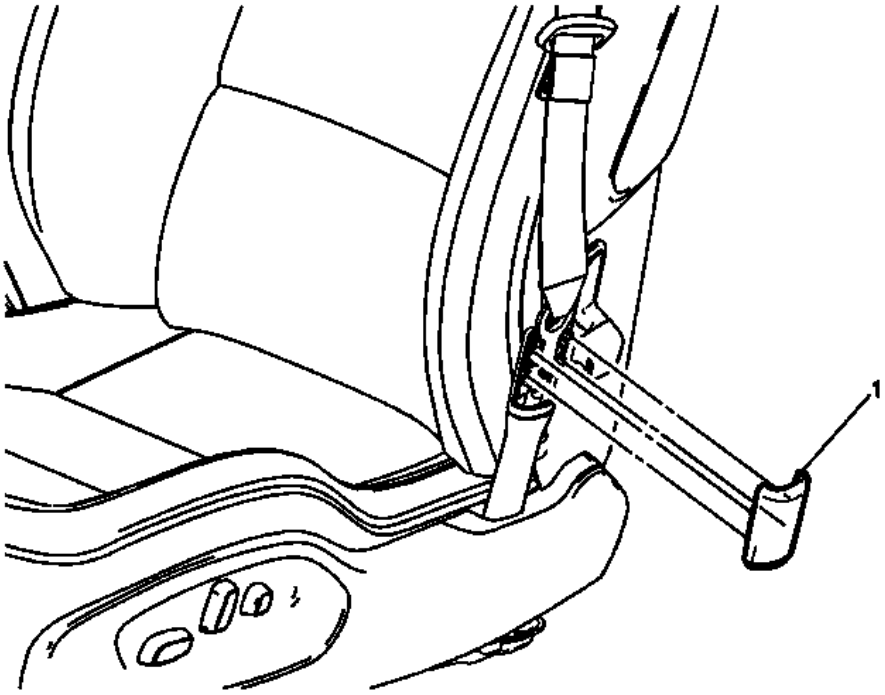


Fig. 257: View Of Fixture Plate, Bolts, Bushing & Cylinder Hole
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

NOTE:

- **The use of a cutting type fluid GM P/N 1052864 (Canadian P/N 992881), WD 40® or equivalent, is recommended when performing the drilling and tapping procedures.**
- **Driver oil MUST be used on the installer driver tool.**
- **The tool kits are designed for use with either a suitable tap wrench or drill motor.**

2. Install the fixture plate (3), bolts (1) and bushing (2) onto the engine block deck.

   Position the fixture plate and bushing over the hole that is to be repaired (4).

cardiagn.com

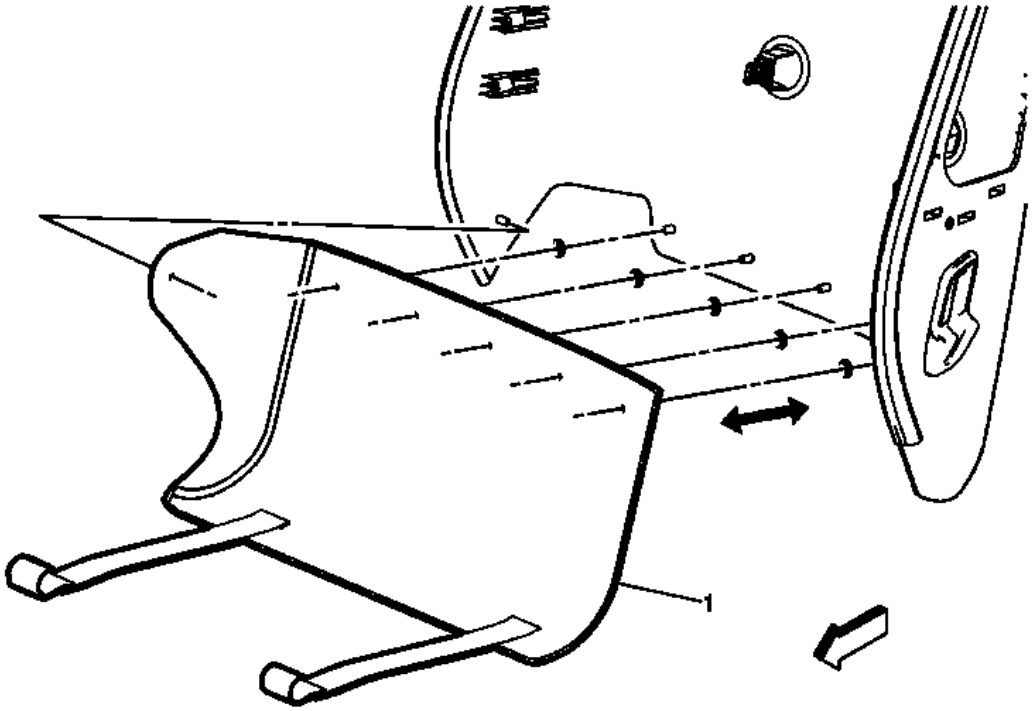


Fig. 258: View Of Alignment Pin & Fixture Retaining Bolts
Courtesy of GENERAL MOTORS COMPANY

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.

cardiagn.com

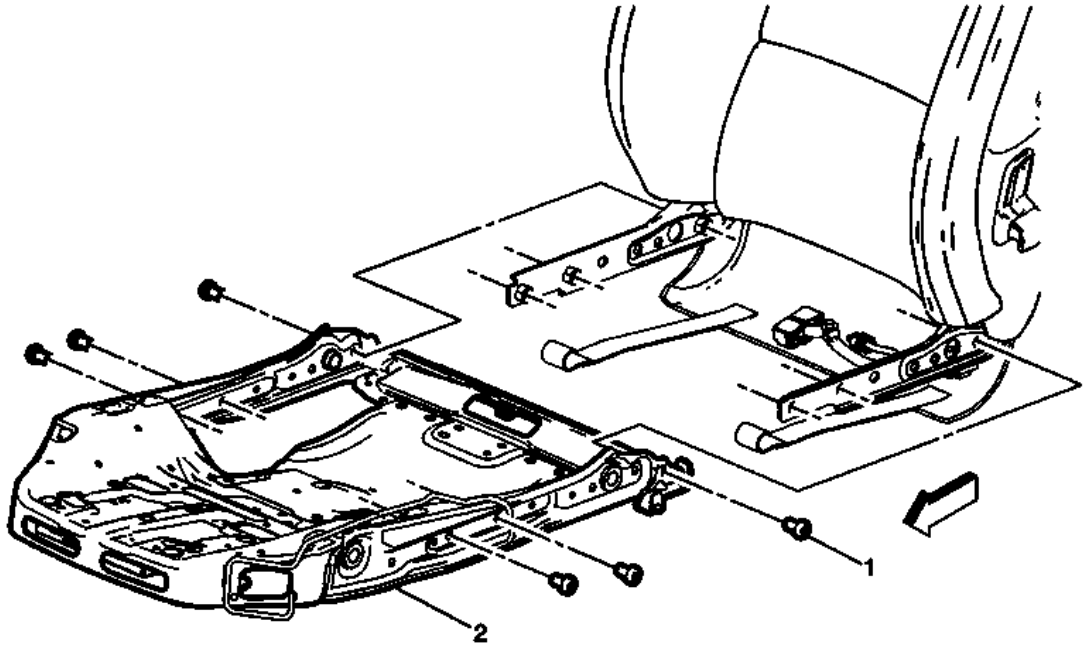
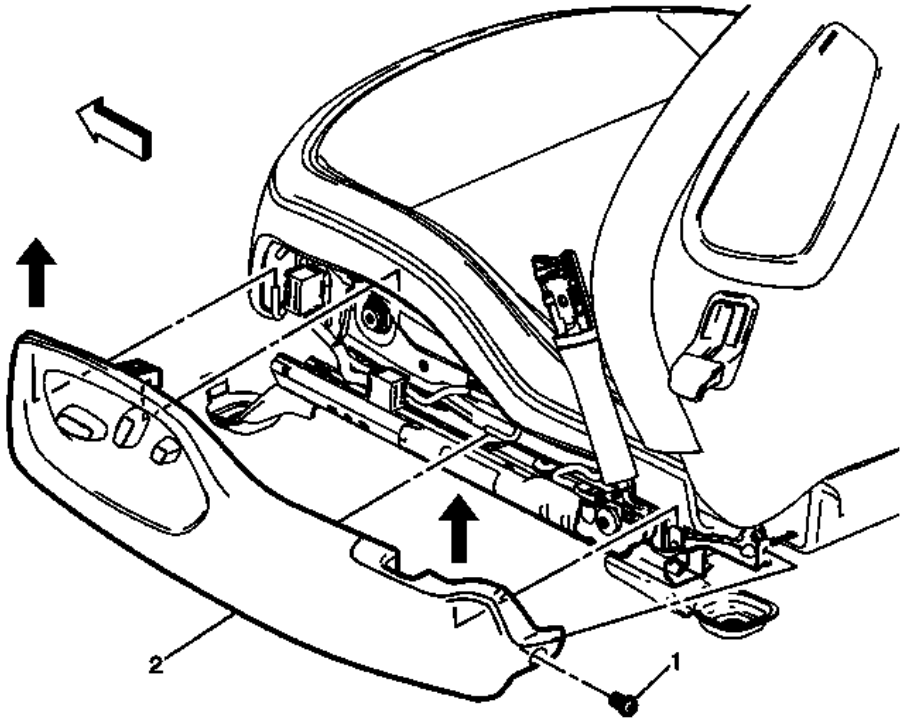


Fig. 259: View Of Stop Collar & Counterbore Drill
Courtesy of GENERAL MOTORS COMPANY

6. Install the sleeve (2) onto the drill (1).



cardiagn.com

Fig. 260: Drilling Cylinder Head Bolt 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.

8. Using compressed air, clean out any chips.

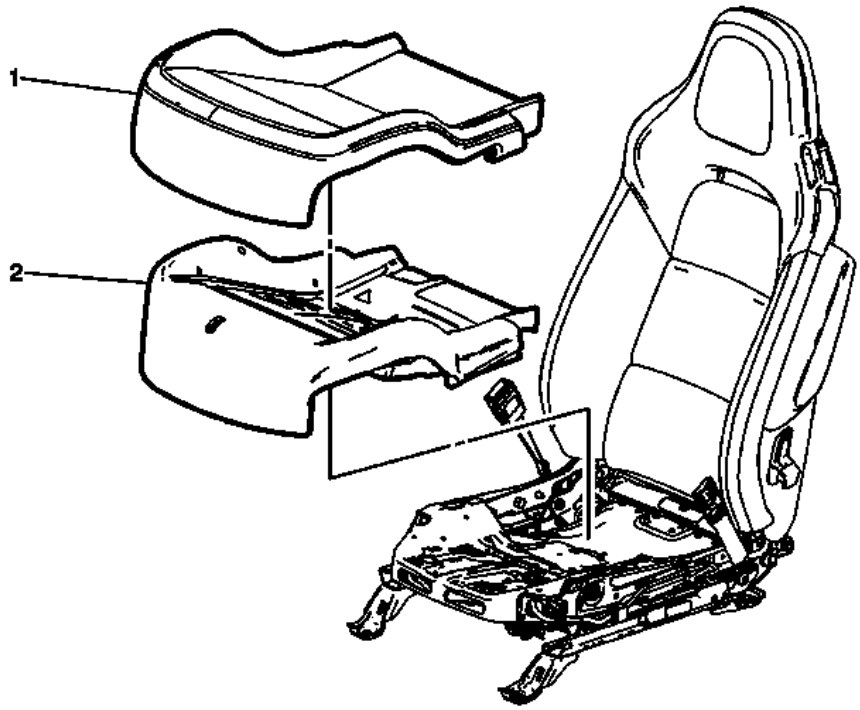


Fig. 261: Tapping Threads Of Drilled Hole Using Tapping Wrench
Courtesy of GENERAL MOTORS COMPANY

9. Using a tap wrench, tap the threads of the drilled hole.

cardiagn.com

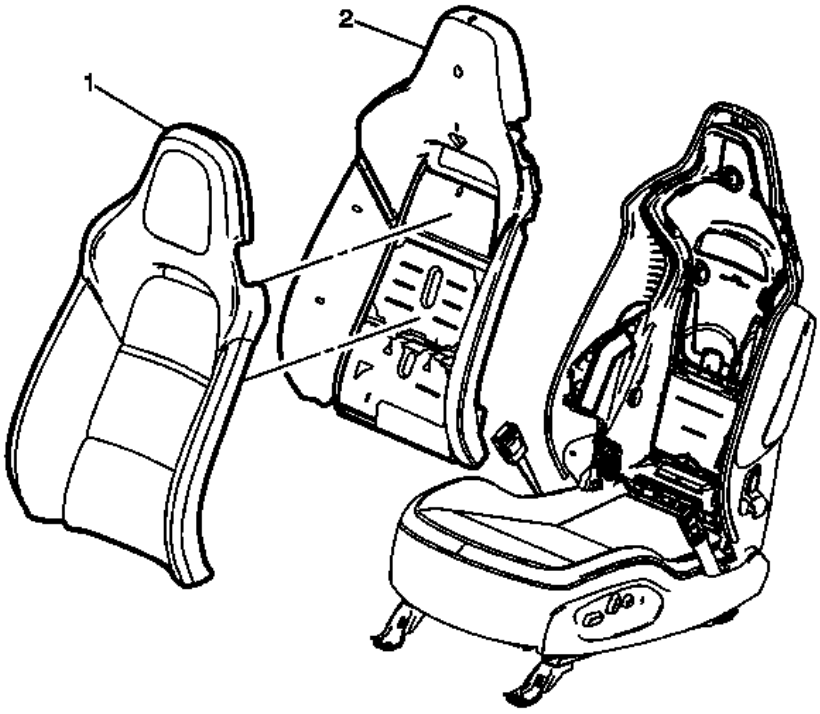


Fig. 262: View Of Tap Upper & Lower Marks, Fixture Plate & Bushing
Courtesy of GENERAL MOTORS COMPANY

10. In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark (1) on the tap aligns with the top of the drill bushing (3).
11. Remove the fixture plate (2), bushing (3) and bolts.
12. Using compressed air, clean out any chips.
13. Spray cleaner GM P/N 12346139, GM P/N 12377981 (Canadian P/N 10953463) or equivalent, into the hole.
14. Using compressed air, clean any cutting oil and chips out of the hole.

cardiagn.com

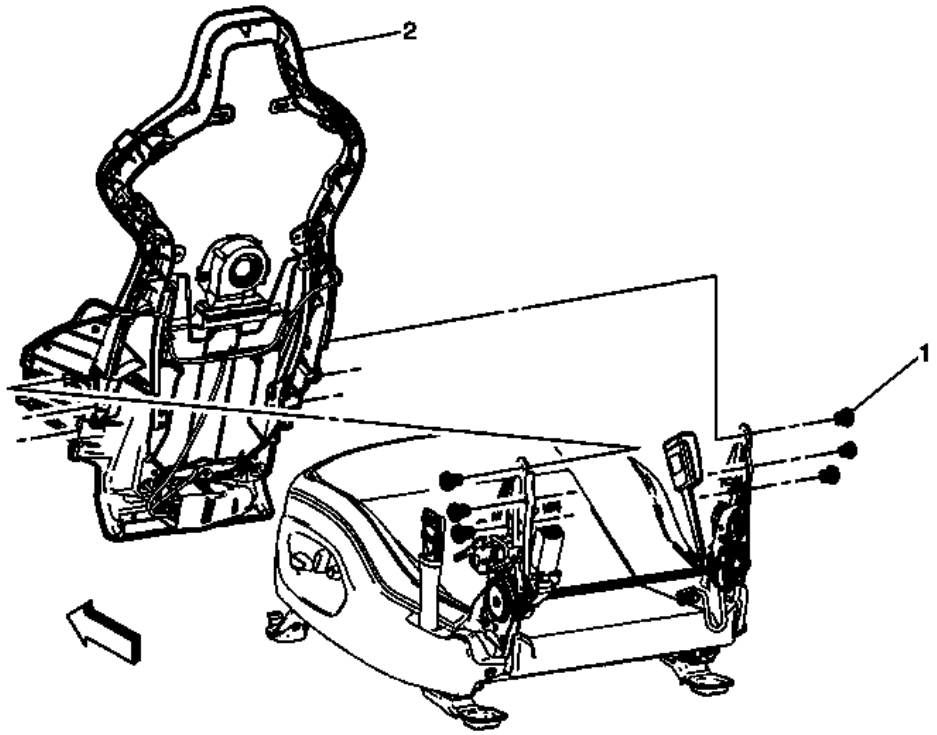


Fig. 263: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not allow oil or foreign material to contact the OD of the insert.

15. Lubricate the threads of the installer tool (2) with the driver oil (1).

cardiagn.com

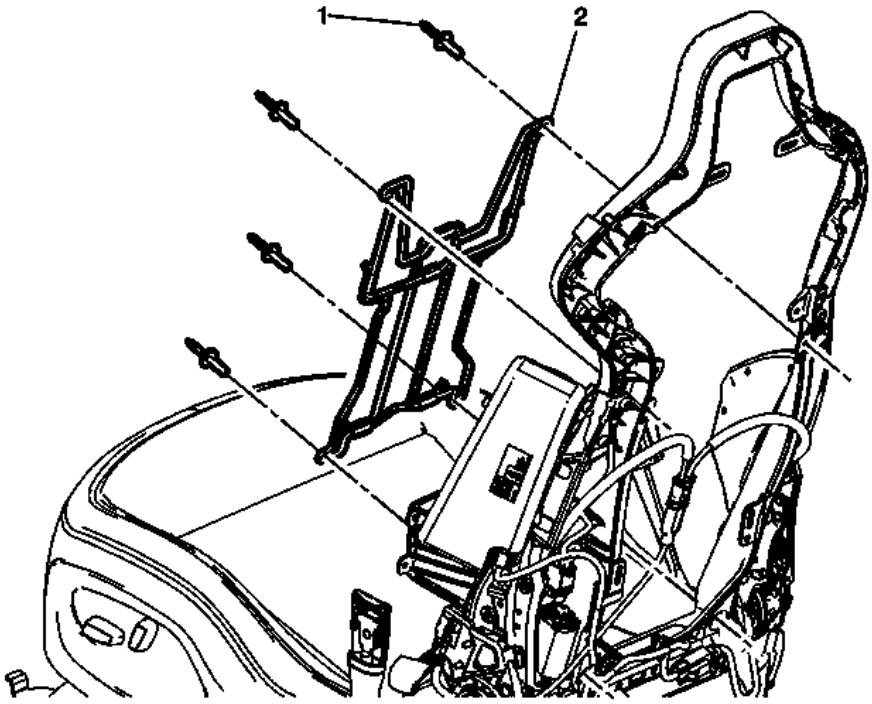
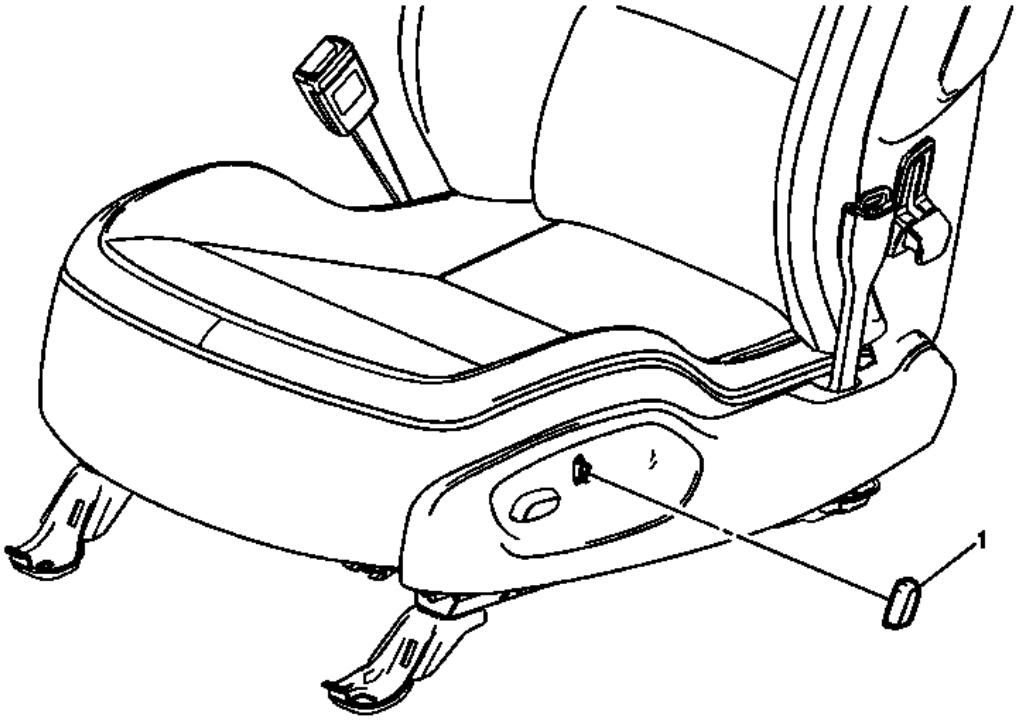


Fig. 264: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

16. Install the insert (2) onto the driver tool (1).



cardiagn.com

Fig. 265: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

17. Apply threadlock LOCTITE™ 277, J 42385-109 (1) or equivalent, to the insert OD threads (2).

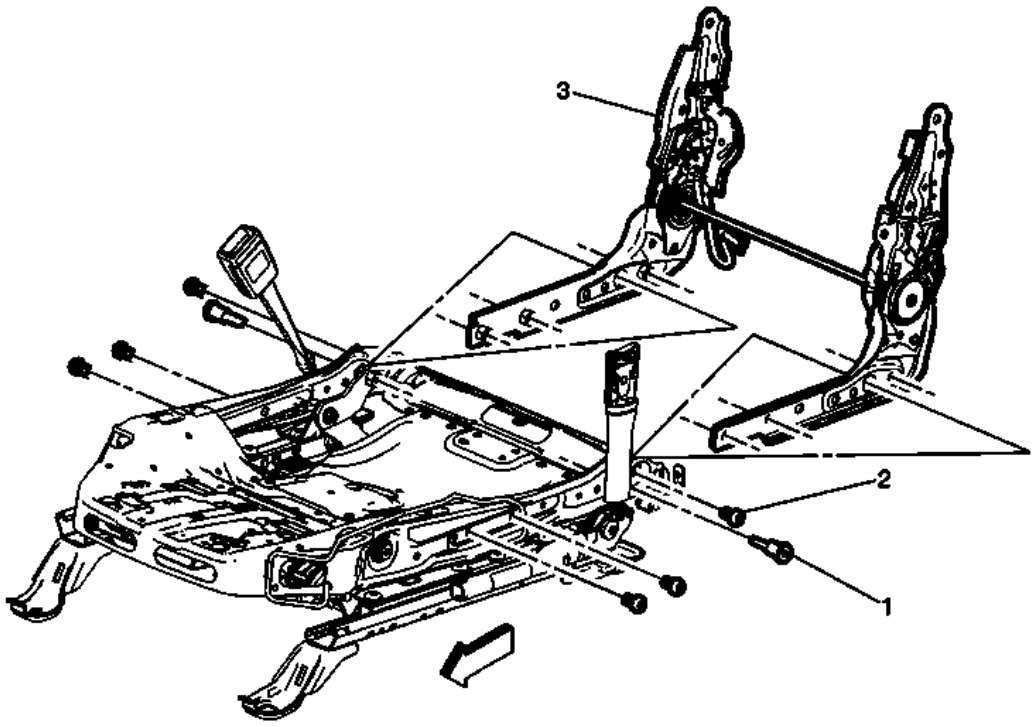


Fig. 266: Installing Insert & Driver Into Cylinder Bolt Hole
Courtesy of GENERAL MOTORS COMPANY

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.

Main Cap Bolt Hole Thread Repair

cardiagn.com

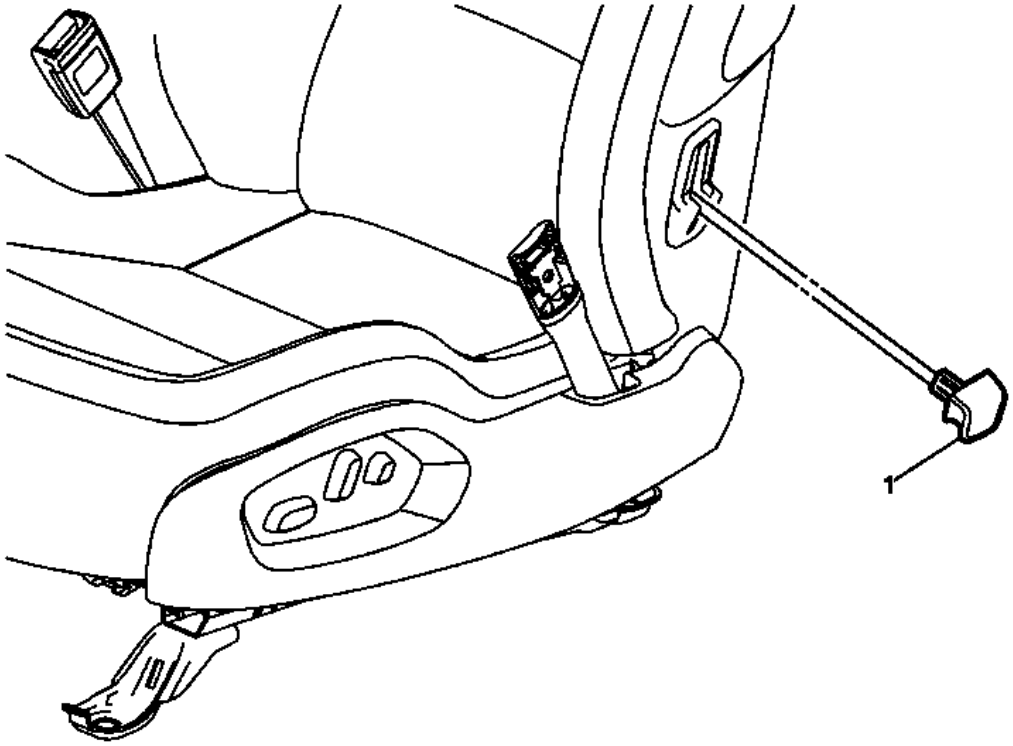


Fig. 267: Identifying Thread Repair Kit Components
Courtesy of GENERAL MOTORS COMPANY

1. The main cap bolt hole thread repair kit consists of the following items:
    - The drill (1)
    - The tap (2)
    - The installer (3)
    - The fixture plate (4)
    - The long bolts (5)
    - The short bolts (6)
    - The alignment pin (7)
    - The bushing (8)

cardiagn.com

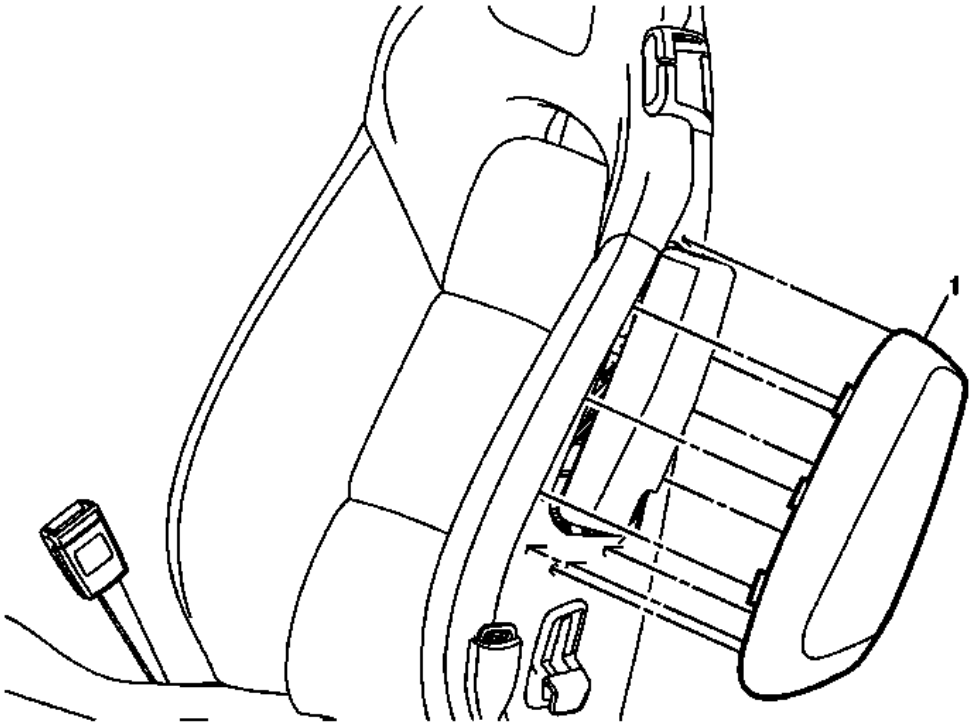


Fig. 268: View Of Fixture Plate, Bolt & Bushing
Courtesy of GENERAL MOTORS COMPANY

2. Install the fixture plate, bolt and bushing onto the engine block.

   Position the fixture plate and bushing over the hole that is to be repaired.

3. Position the alignment pin in the desired hole and tighten the fixture retaining bolts.

cardiagn.com

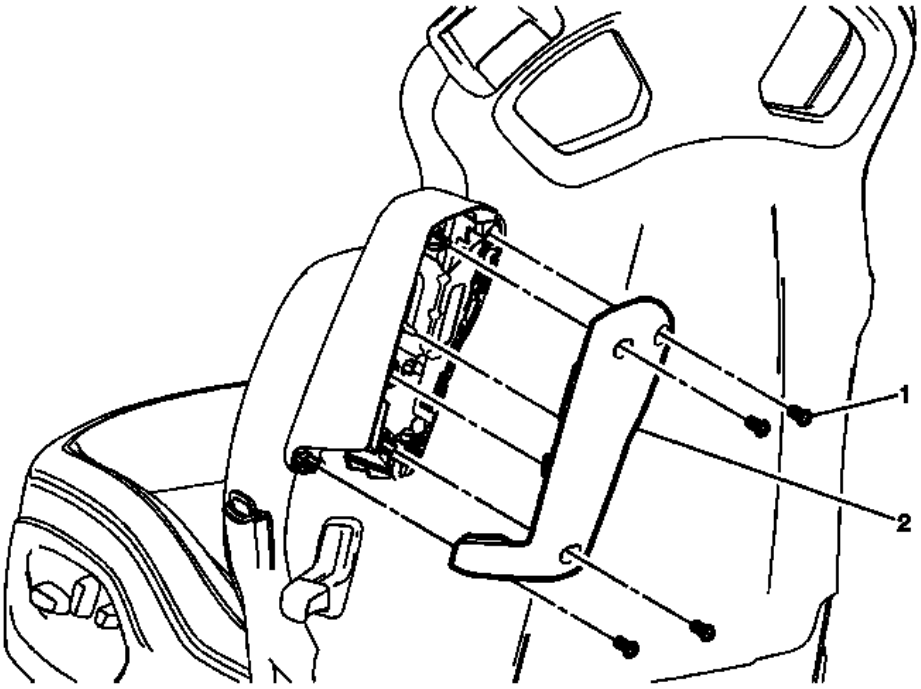


Fig. 269: Crankshaft Main Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

4. Drill out the damaged hole.

   The outer bolt hole locations 11-20 have the shallower counterbores. Use sleeve J 42385-316 with the drill.

   Drill until the stop collar of the drill bit or the sleeve contacts the bushing.

5. Using compressed air, clean out any chips.

cardiagn.com

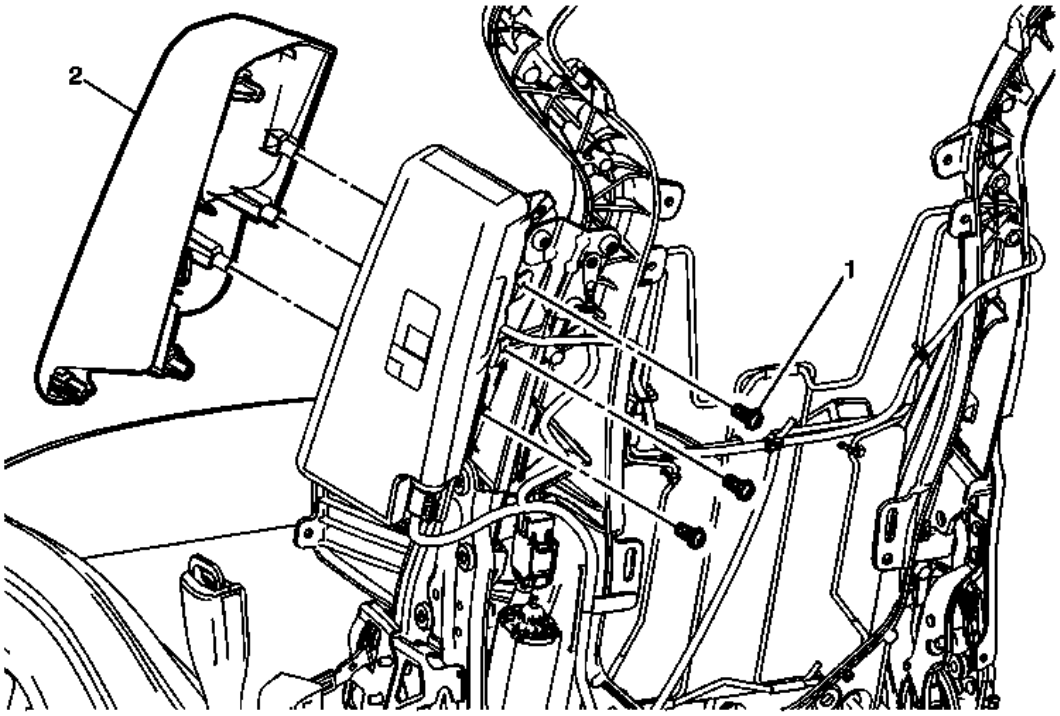


Fig. 270: View Of Tap Upper & Lower Marks, Fixture Plate & Bushing
Courtesy of GENERAL MOTORS COMPANY

6. Using a tap wrench, tap the threads of the drilled hole.

   In order to tap the new threads to the proper depth, rotate the tap into the hole until the mark on the tap aligns with the top of the bushing.

   For the deeper main cap holes 1-10, rotate the tap until the upper mark (4) on the tap aligns with the top of the bushing (3).

   For the shallower main cap holes 11-20, rotate the tap until the lower mark (1) on the tap aligns with top of the bushing (3).

7. Using compressed air, clean out any chips.
8. Spray cleaner GM P/N 12346139 (Canadian P/N 10953463) or equivalent, into the hole.
9. Using compressed air, clean any cutting oil and chips out of the hole.

cardiagn.com

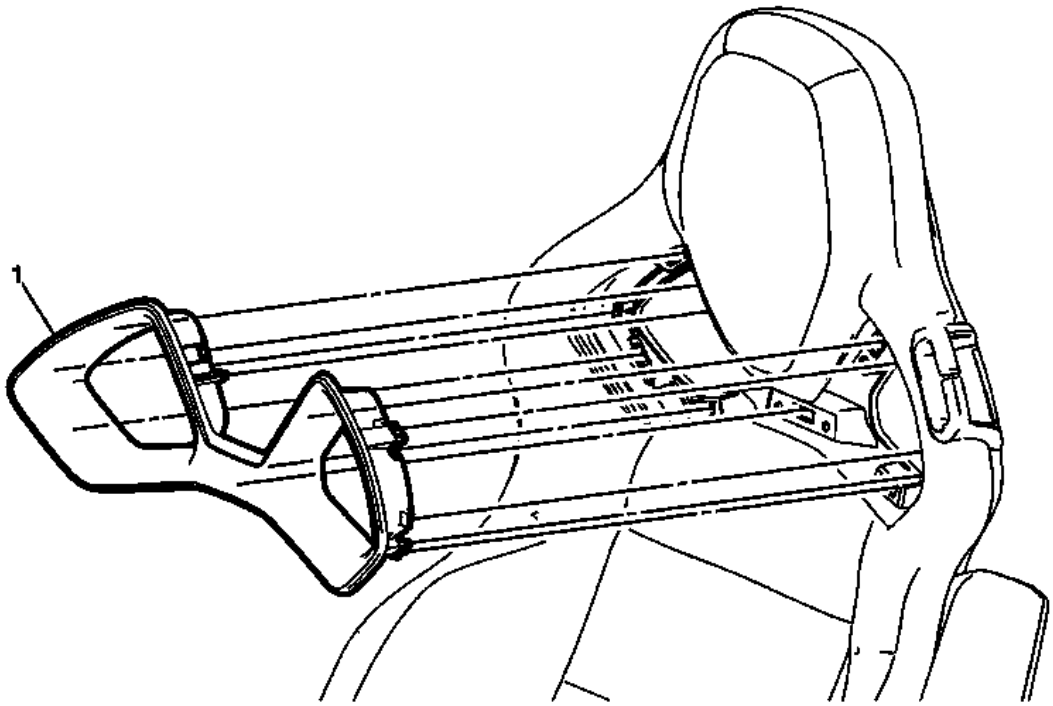


Fig. 271: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not allow oil or foreign material to contact the OD of the insert.

10. Lubricate the threads of the installer tool (2) with the driver oil (1).

cardiagn.com

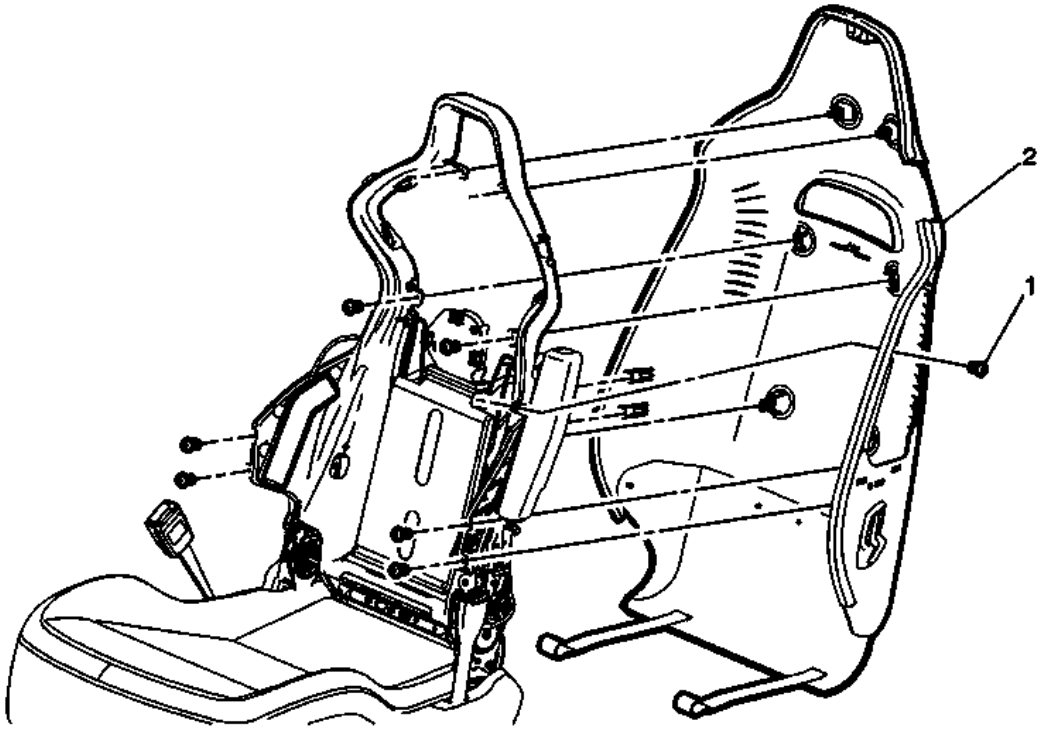
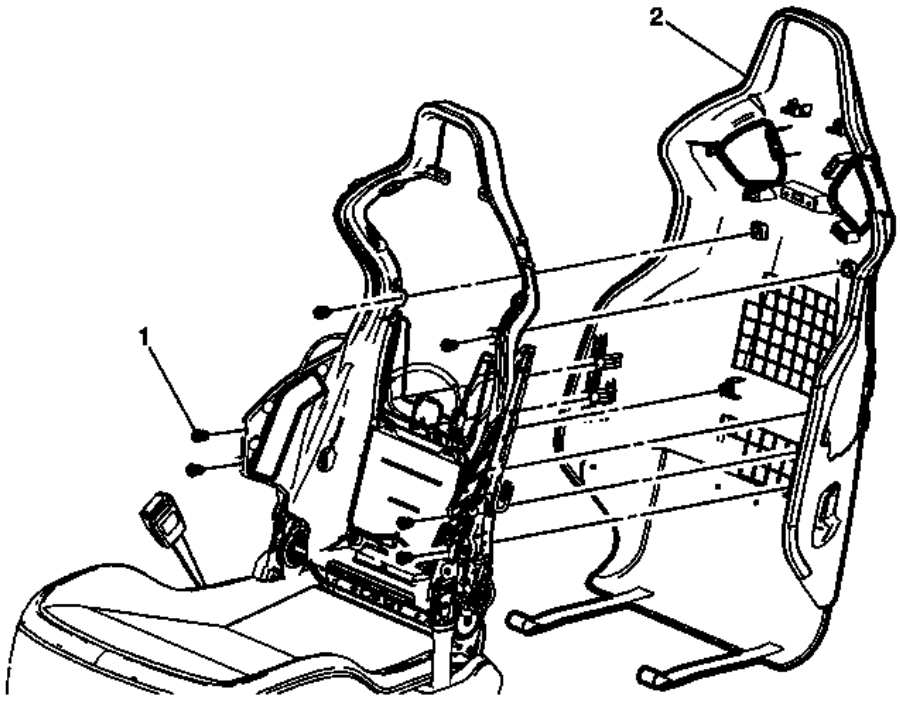


Fig. 272: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

11. Install the insert (2) onto the driver tool (1).



cardiagn.com

Fig. 273: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

12. Apply threadlock LOCTITE™ 277, J 42385-109 (1) or equivalent, to the insert OD threads (2).

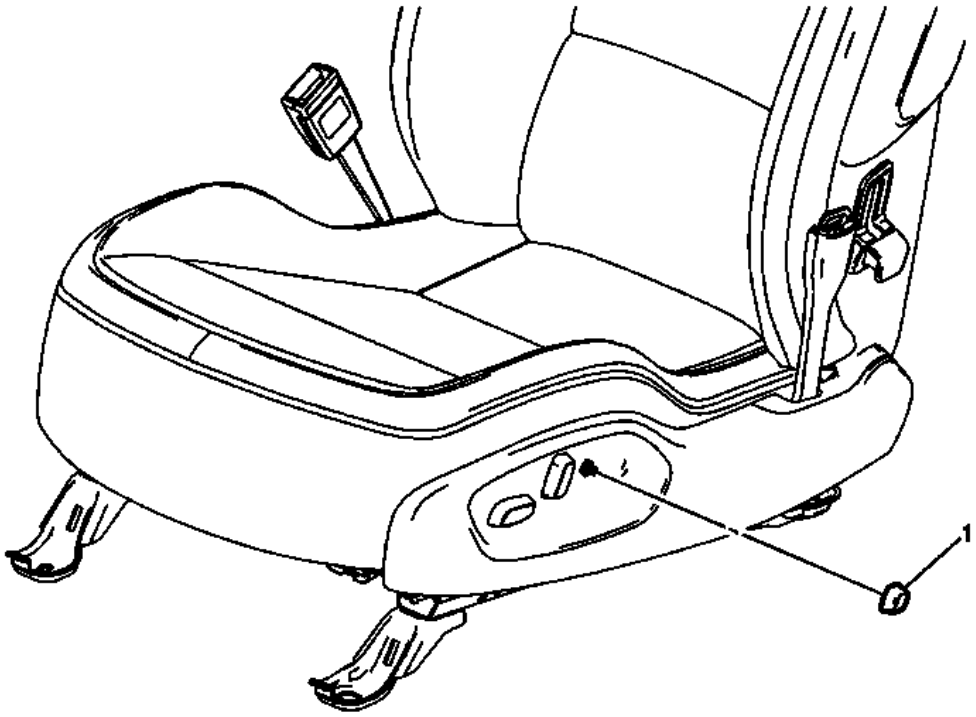


Fig. 274: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS COMPANY

NOTE: The fixture plate and bushing remains installed onto the engine block during the insert installation procedure.

13. Install the insert and driver (1) through the fixture plate and bushing and into the hole.

    Rotate the driver tool until the mark on the tool (3) aligns with the top of the bushing (2).

    The installer tool will tighten up before screwing completely through the insert. This is acceptable. You are forming the bottom threads of the insert and mechanically locking the insert to the base material threads.

SERVICE PRIOR TO ASSEMBLY

- Dirt or debris will cause premature wear of the rebuilt engine. Clean all components. Refer to **Cleanliness and Care** .
- Use the proper tools to measure components when inspecting for excessive wear. Components that are not within the manufacturers specifications must be repaired or replaced.

cardiagn.com

- When the components are installed into an engine, return the components to their original location, position and direction. Refer to **Separating Parts** .
- During assembly, lubricate all moving parts with clean engine oil. This provides initial lubrication when the engine is first started.

ENGINE BLOCK PLUG INSTALLATION

Knock Sensor Shield, Knock Sensor and Engine Block Oil Gallery Plug Installation

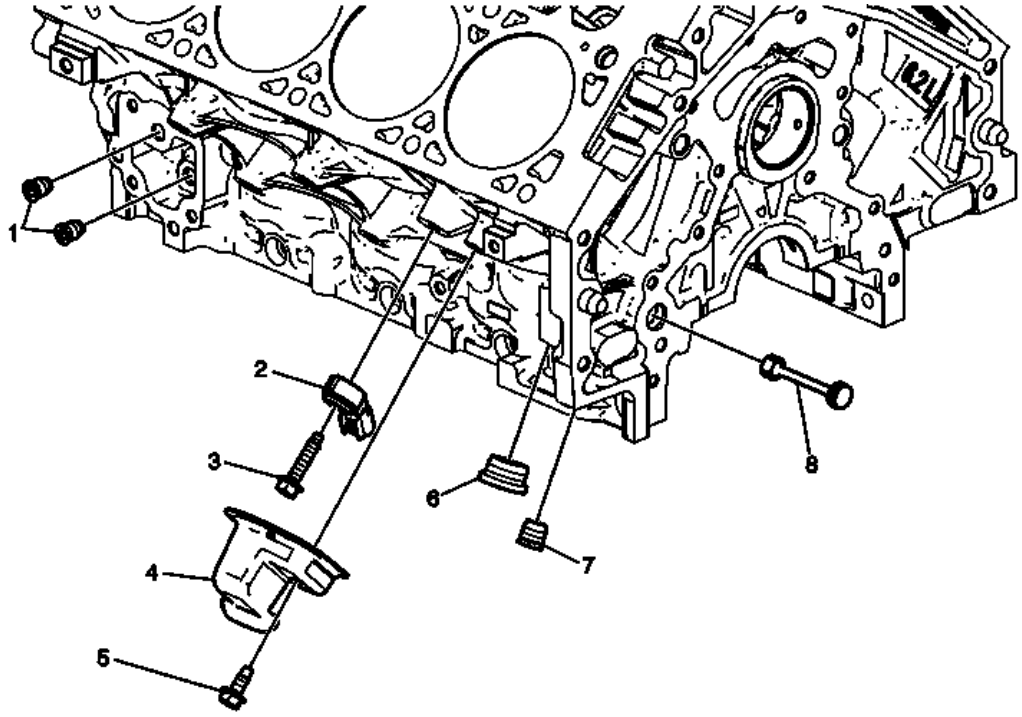


Fig. 275: Knock Sensor Shield, Knock Sensor and Engine Block Oil Gallery Plug
Courtesy of GENERAL MOTORS COMPANY

Knock Sensor Shield, Knock Sensor and Engine Block Oil Gallery Plug Installation

Callout	Component Name
1	Engine Block Oil Gallery Plug
2	Knock Sensor Assembly
3	Knock Sensor Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)
4	Knock Sensor Shield

cardiagn.com

5	Knock Sensor Shield Bolt **Tighten** 25 N.m (18 lb ft)
6	Engine Block Plug **Tighten** 60 N.m (44 lb ft)
7	Engine Block Plug **Tighten** 30 N.m (22 lb ft)
8	Engine Block Plug

Crankshaft Position Sensor, Engine Block Plug, Knock Sensor and Piston Oil Nozzle Installation

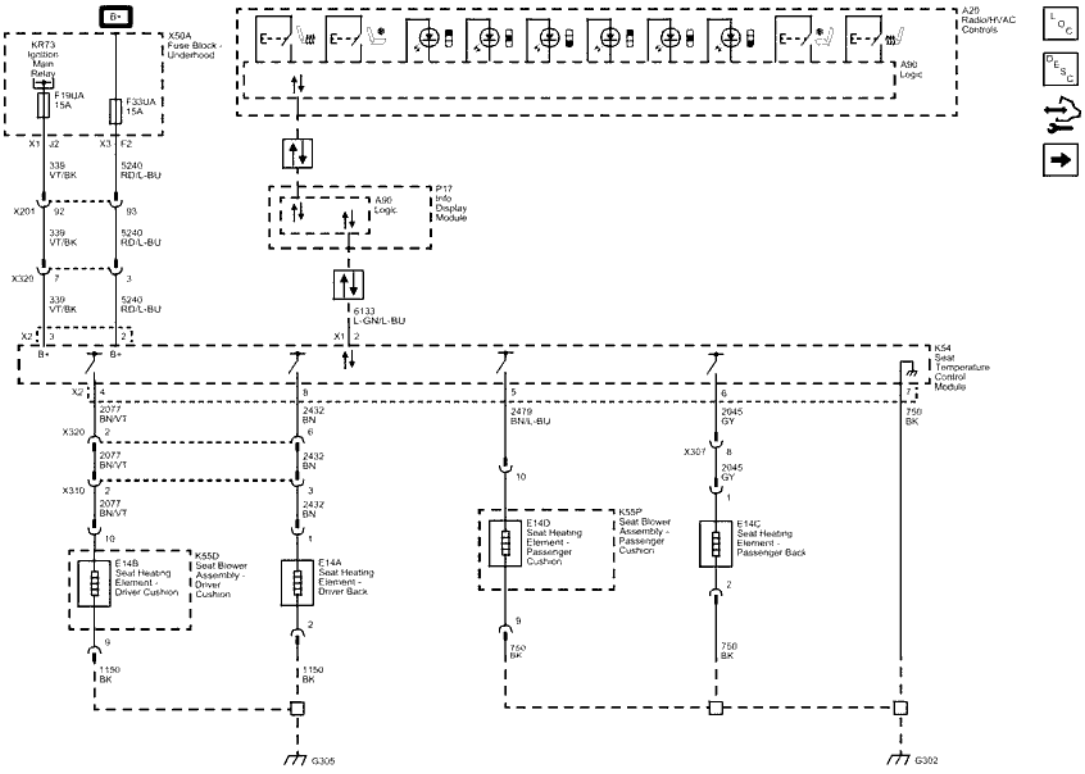


Fig. 276: Crankshaft Position Sensor, Engine Block Plug, Knock Sensor and Piston Oil Nozzle
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Position Sensor, Engine Block Plug, Knock Sensor and Piston Oil Nozzle Installation

Callout	Component Name
1	Knock Sensor Assembly
2	Knock Sensor Bolt

cardiagn.com

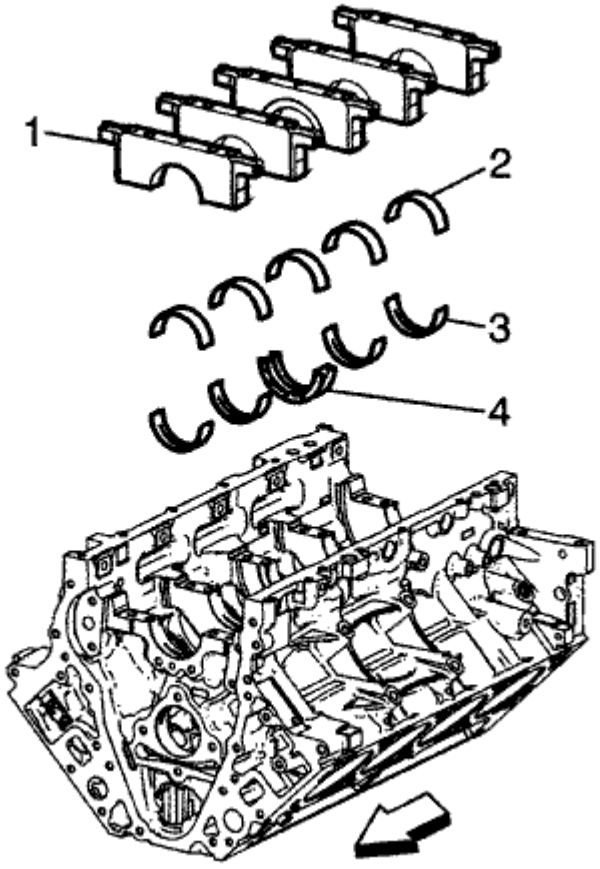
	25 N.m (18 lb ft)
3	Crankshaft Position Sensor
4	Crankshaft Position Sensor Bolt **Tighten** 25 N.m (18 lb ft)
5	Piston Oil Nozzle Assembly **Tighten** 20 N.m (15 lb ft)
6	Engine Block Plug **Tighten** 30 N.m (22 lb ft)
7	Engine Block Plug

CRANKSHAFT AND BEARING INSTALLATION

Special Tools

J-45059 Angle Meter

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



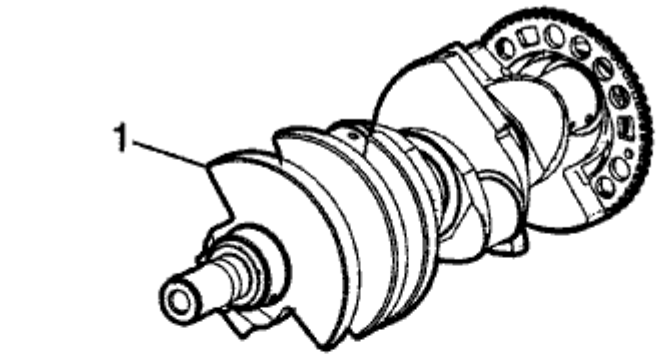
cardiagn.com

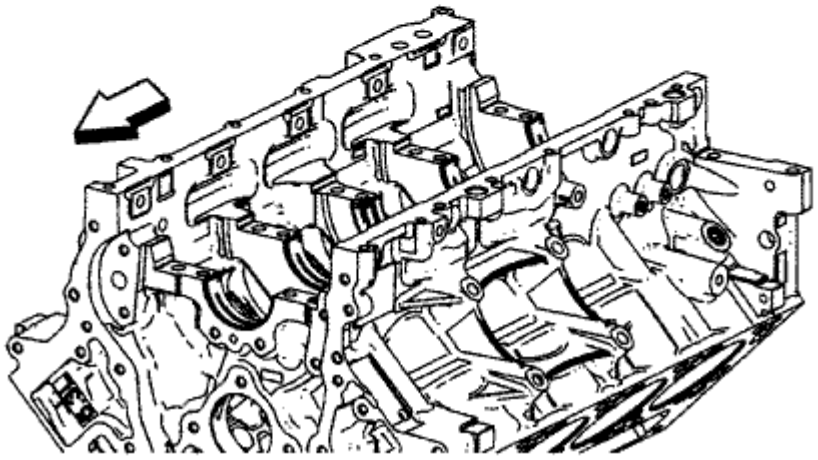
Fig. 277: Crankshaft Bearings And Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Crankshaft bearing clearances are critical. Excessive crankshaft bearing clearance may affect crankshaft position (CKP) sensor signals and/or on-board diagnostic (OBD) II system performance.**
- **Crankshaft bearing caps must be installed to the proper location and direction.**
- **When installing the crankshaft bearings, align the locating tabs on the bearings with the locating notches in the engine block journal bore and the bearing cap.**
- **Always install crankshaft bearings with their machined partner. Do not file bearings or mix bearing halves.**
- **In order to prevent engine block oil leakage, install NEW crankshaft bearing cap side bolts.**

1. Install the crankshaft bearings (2 and 3) to the engine block and bearing caps (1). The thrust bearings (4) are to be installed into center journal.
2. Lubricate the bearing surfaces and crankshaft journals with clean engine oil.





cardiagn.com

Fig. 278: Crankshaft
Courtesy of GENERAL MOTORS COMPANY

CAUTION: To maintain proper crankshaft end play, use extreme care during crankshaft installation. Avoid scoring or damaging the thrust bearing.

3. Install the crankshaft (1).

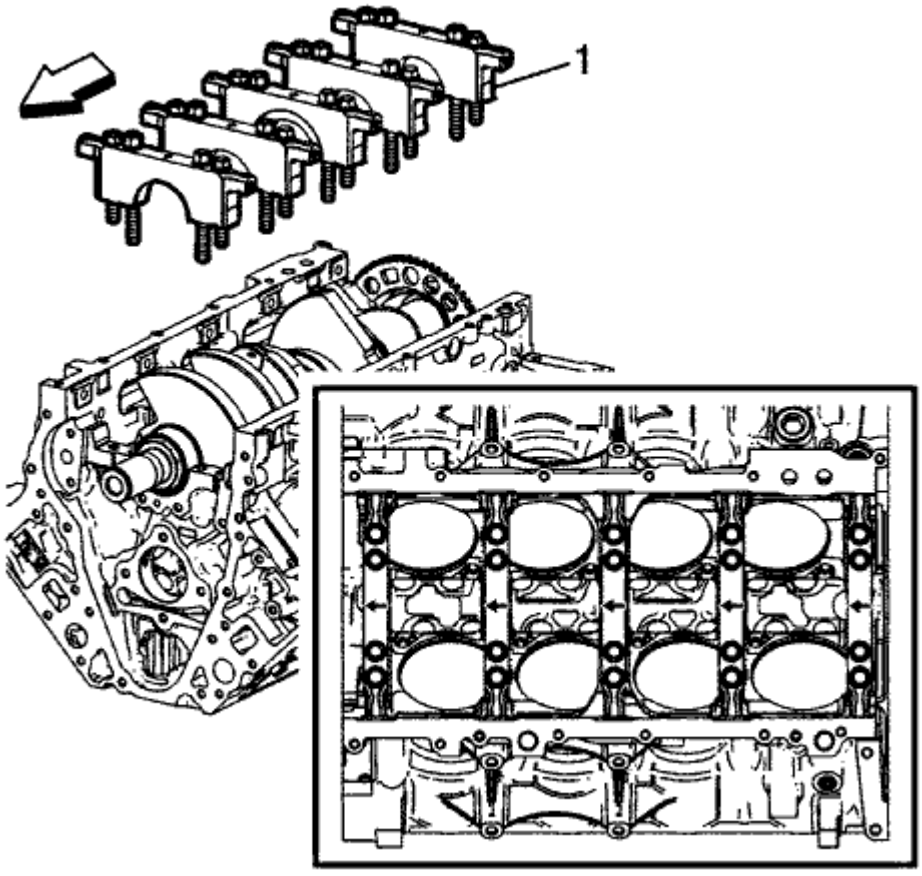


Fig. 279: Crankshaft Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

NOTE: The bearing caps (1) must be installed in the proper location and direction. The arrows on the bearing caps must point toward front of engine.

4. Install the crankshaft bearing caps (1), with bearings, into the engine block.

cardiagn.com

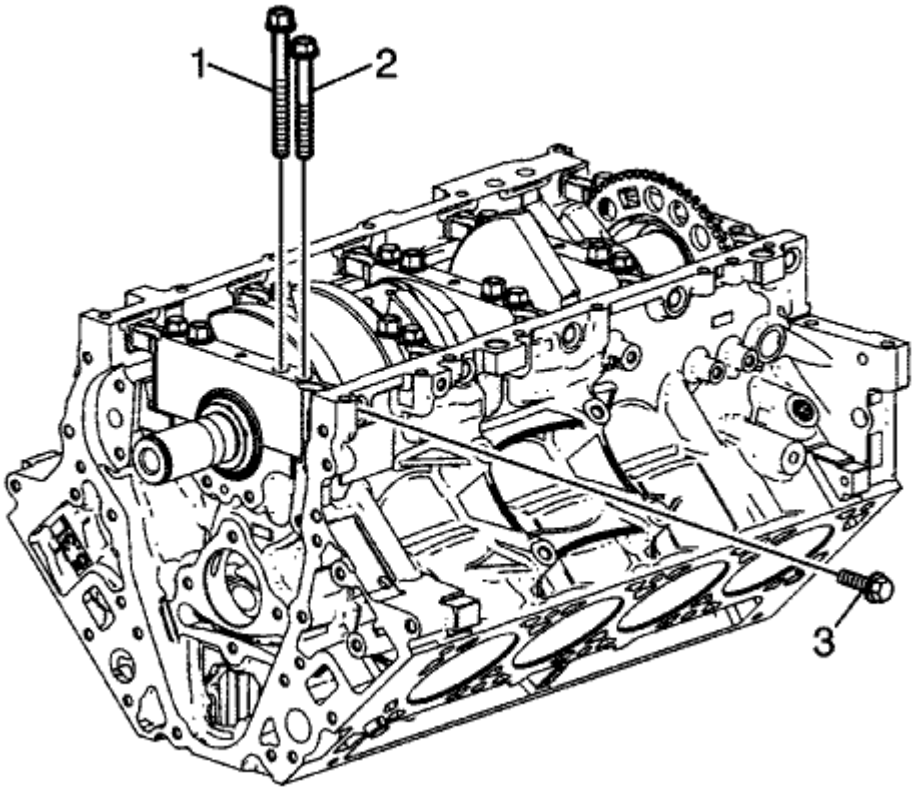


Fig. 280: Crankshaft Inner Bearing Cap Bolts And Outer Bearing Cap Bolts
Courtesy of GENERAL MOTORS COMPANY

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: The inner bearing cap bolts are longer than the outer bearing cap bolts.

5. Install NEW inner bearing cap bolts (1) and NEW outer bearing cap bolts (2)
6. Using a plastic-face hammer, tap the bearing caps into place.
7. Install the NEW bearing cap side bolts (3).

cardiagn.com

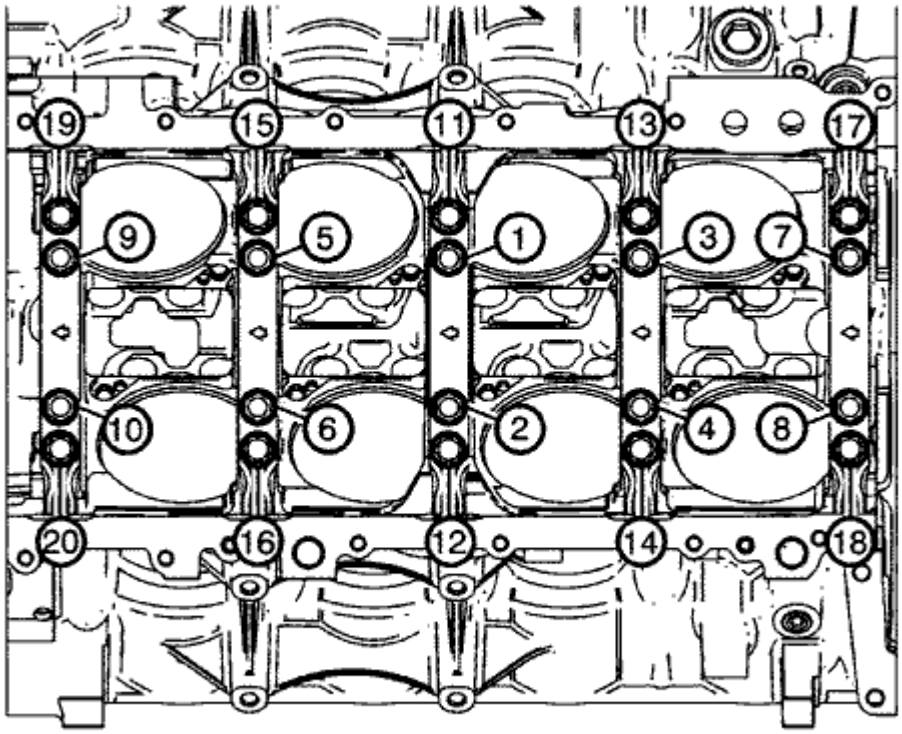


Fig. 281: Inner Bearing Cap Bolts Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

8. Tighten the inner bearing cap bolts (1-10) a first pass in sequence to 20 N.m (22 lb ft).

NOTE: To properly align the crankshaft thrust bearings, the final thrust of the crankshaft MUST be in the forward direction.

9. Using a plastic-face hammer, tap the crankshaft rearward, then forward in order to align the thrust bearings.
   - Tighten the inner bearing cap bolts (1-10) a final pass in sequence 110 degrees using the **J-45059** meter.
   - Tighten the outer bearing cap bolts (11-20) a first pass in sequence to 20 N.m (15 lb ft).
   - Tighten the outer bearing cap bolts (11-20) a final pass in sequence 80 degrees using the **J 45059** meter.

cardiagn.com

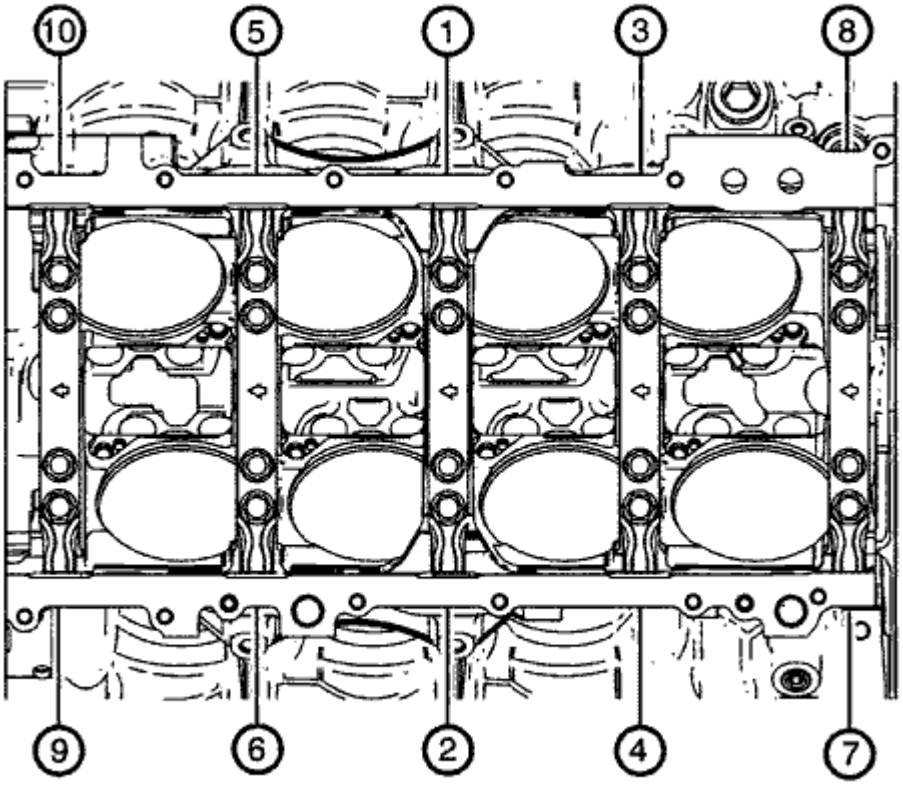


Fig. 282: Crankshaft Main Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

10. Tighten the main bearing cap side bolts (1-10).
    - Tighten the bearing cap side bolts (1-10) a first pass in sequence to 30 N.m (15 lb ft).
    - Tighten the bearing cap side bolts (1-10) a final pass in sequence to 60 degrees using the **J 45059** meter.

cardiagn.com

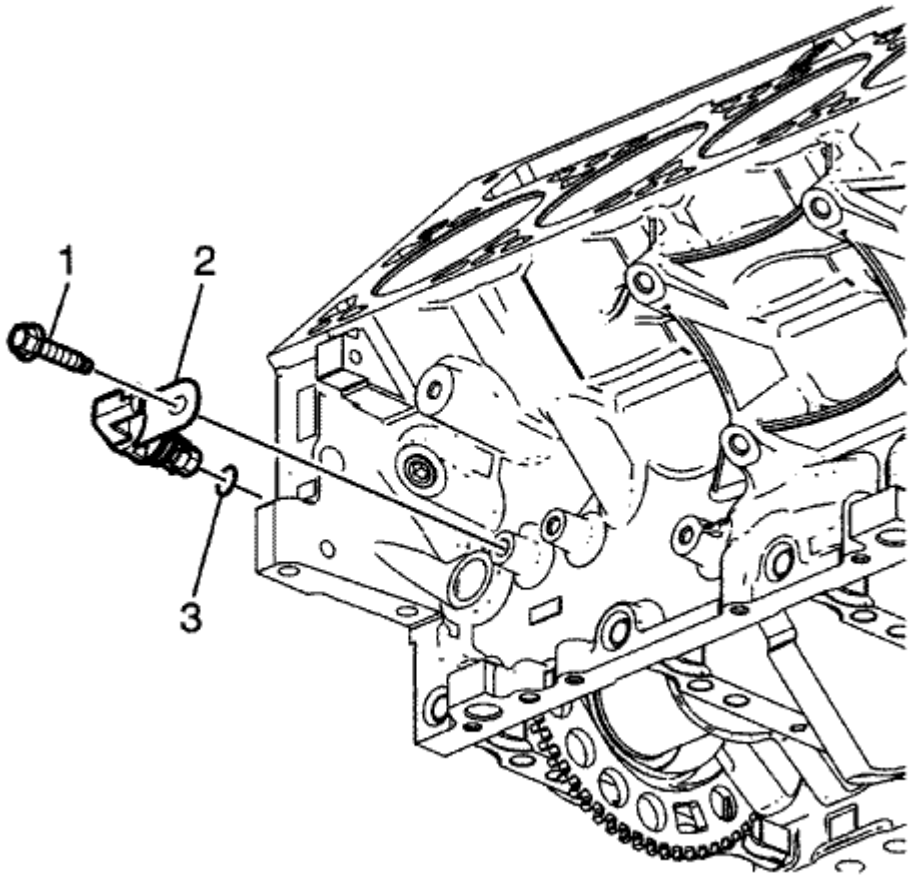


Fig. 283: Crankshaft Position (CKP) Sensor Bolt And CKP Sensor
Courtesy of GENERAL MOTORS COMPANY

11. Install the CKP sensor (2).
    1. Inspect the CKP sensor O-ring seal (3). If the O-ring seal is not cut or damaged, it may be used again.
    2. Coat the O-ring seal (3) with clean engine oil.
    3. Install the O-ring seal (3) onto the sensor.
    4. Install the sensor (2). Rotate the sensor until the locating hole in the bracket aligns with the bolt hole in the block.
    5. Install the sensor bolt (1) and tighten to 25 N.m (18 lb ft).

cardiagn.com

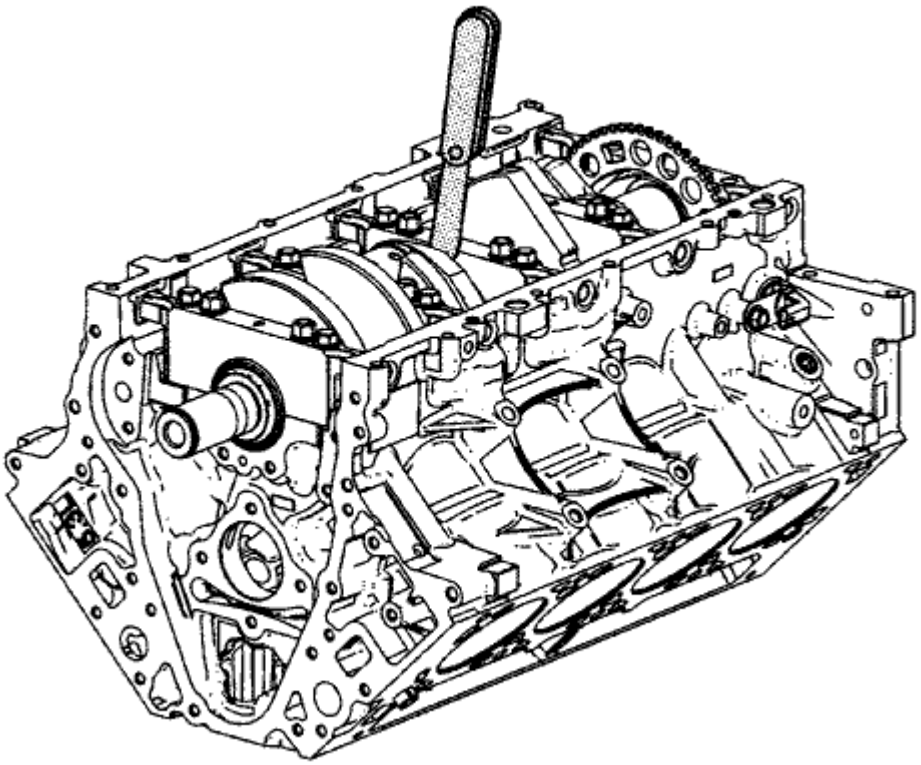


Fig. 284: Measuring Crankshaft End Play
Courtesy of GENERAL MOTORS COMPANY

12. Measure the crankshaft end play.
    1. Thrust the crankshaft forward or rearward.
    2. Insert a feeler gauge between the center crankshaft bearing and the bearing surface of the crankshaft and measure the bearing clearance.

       The proper crankshaft end play clearance is 0.04-0.2 mm (0.0015-0.0078 in).

    3. If the bearing clearance is not within specifications, inspect the thrust surfaces for nicks, gouges or raised metal. Minor imperfections may be removed with a fine stone.

PISTON, CONNECTING ROD AND BEARING INSTALLATION

Special Tools

- **EN-8037** Piston Ring Compressor
- **EN-8087** Cylinder Bore Gauge
- **EN-41556** Connecting Rod Guide

cardiagn.com

- **EN-45059** Angle Meter

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

Piston Selection

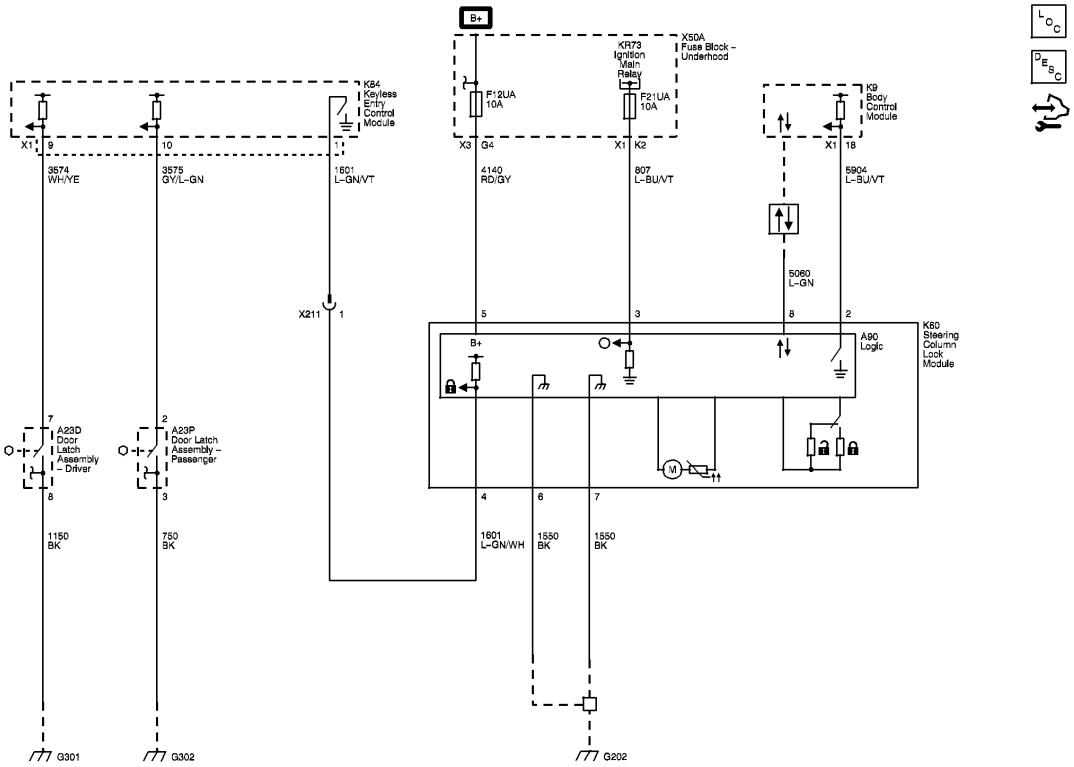


Fig. 285: Measuring Piston Outside Diameter
Courtesy of GENERAL MOTORS COMPANY

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, pin and connecting rod assembly may be installed if, after inspection is within specifications.**

1. With a micrometer at a right angle, measure the piston outside diameter (OD). Measure the diameter 43 mm (1.69 in) from the top of the piston. Refer to **Engine Mechanical Specifications** .
2. Record the piston OD.

cardiagn.com

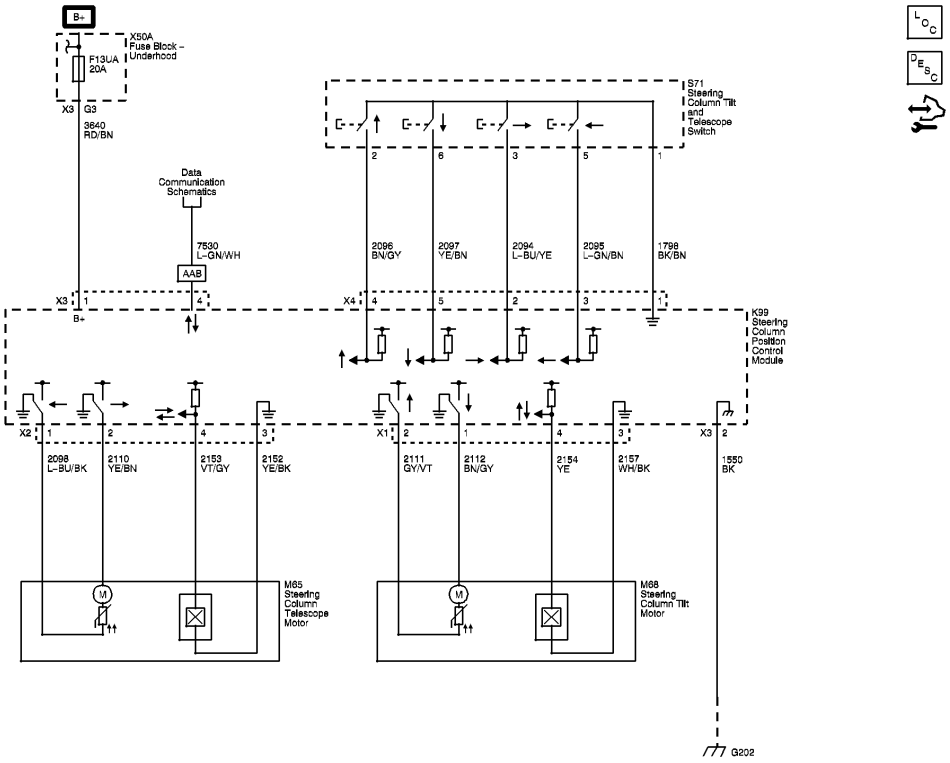


Fig. 286: Measuring Bore Gauge With Micrometer
Courtesy of GENERAL MOTORS COMPANY

3. Adjust the micrometer to the recorded piston OD.
4. Insert the **EN-8087** bore gauge into the micrometer and zero the gauge dial.

cardiagn.com

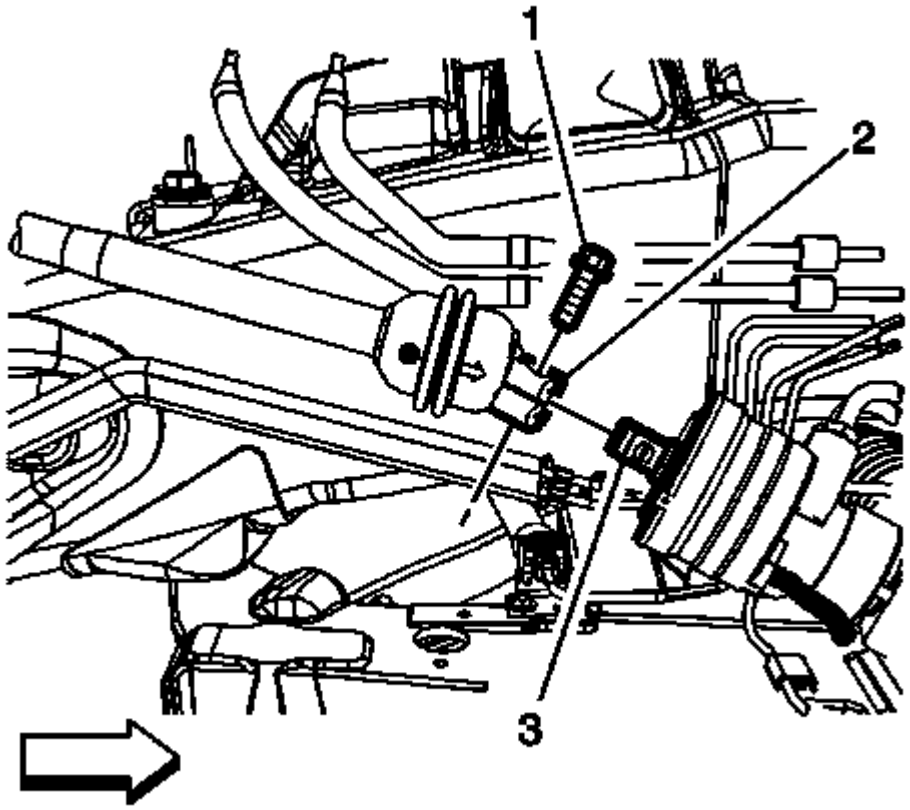


Fig. 287: Measuring Cylinder Bore
Courtesy of GENERAL MOTORS COMPANY

5. Using the **EN-8087** bore gauge, measure the cylinder bore inside diameter (ID). Measure at a point 64 mm (2.5 in) from the top of the cylinder.
6. Record the cylinder bore ID.
7. Subtract the piston OD from the cylinder bore ID in order to determine the piston-to-bore clearance. Refer to **Engine Mechanical Specifications** .
8. If the proper clearance cannot be obtained, select another piston and pin assembly and measure the clearances again. If the proper fit cannot be obtained, the cylinder bore may require honing for an oversize piston.

Piston, Pin and Connecting Rod Installation

cardiagn.com

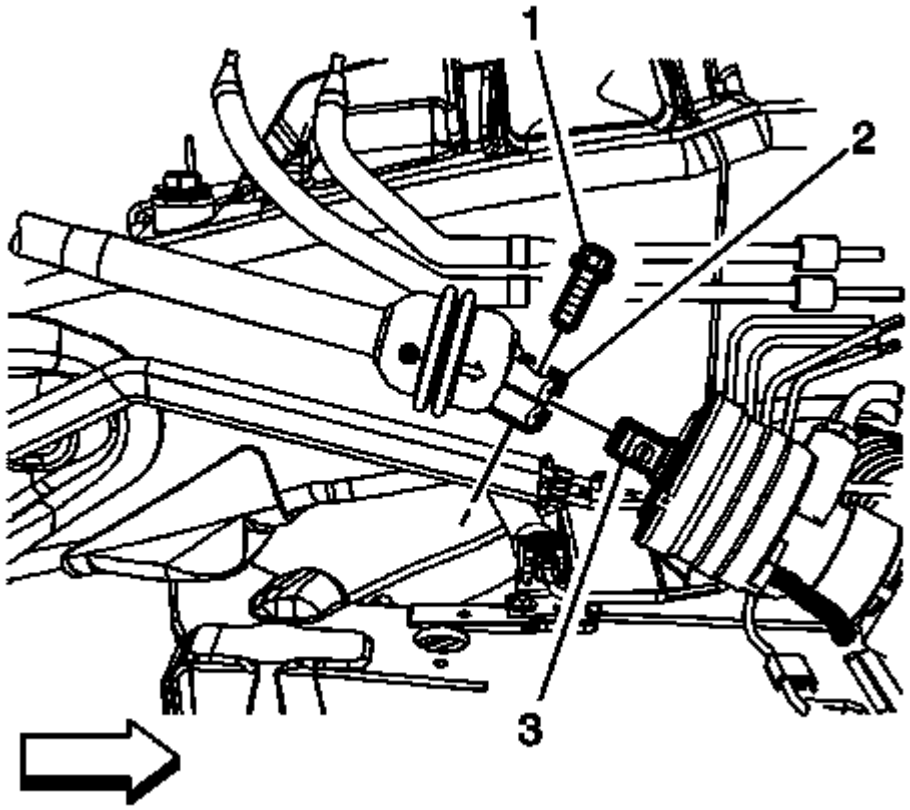


Fig. 288: View Of Piston, Connecting Rod & Bearing Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the following components with clean engine oil:
   - Piston
   - Piston rings
   - Cylinder bore
   - Bearings and bearing surfaces
2. Install the bearings to the connecting rod and cap.
3. Position the oil control ring end gaps a minimum of 25 mm (1.0 in) from each other.
4. Position the compression ring end gaps 180 degrees opposite each other.

cardiagn.com

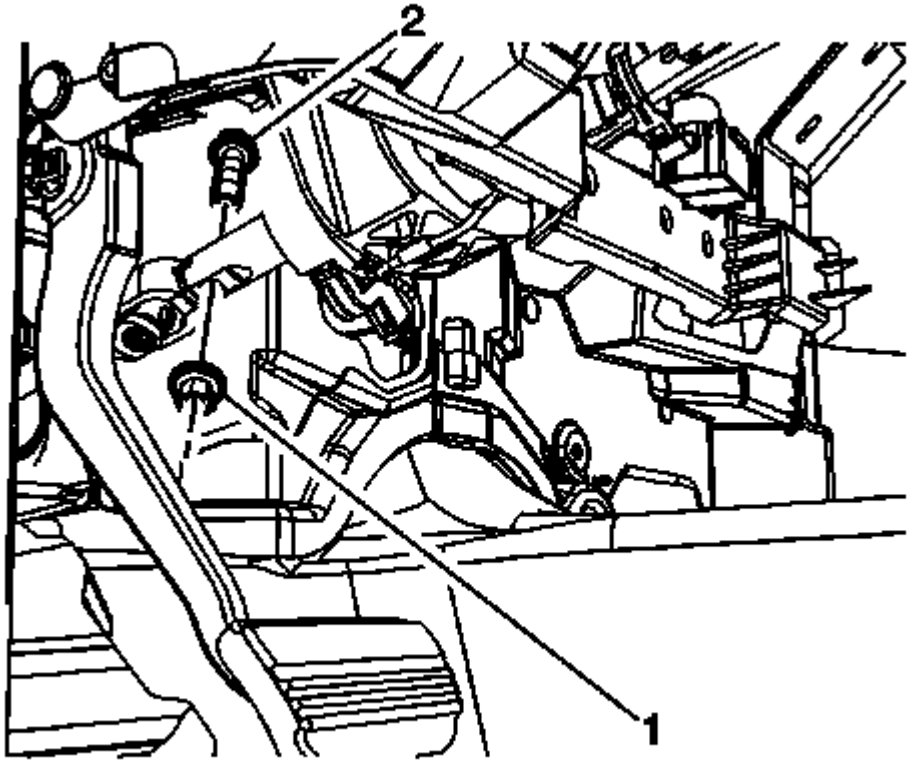


Fig. 289: Installing Piston & Connecting Rod Assembly
Courtesy of GENERAL MOTORS COMPANY

5. Install the **EN-41556** rod guide to the connecting rod.

cardiagn.com

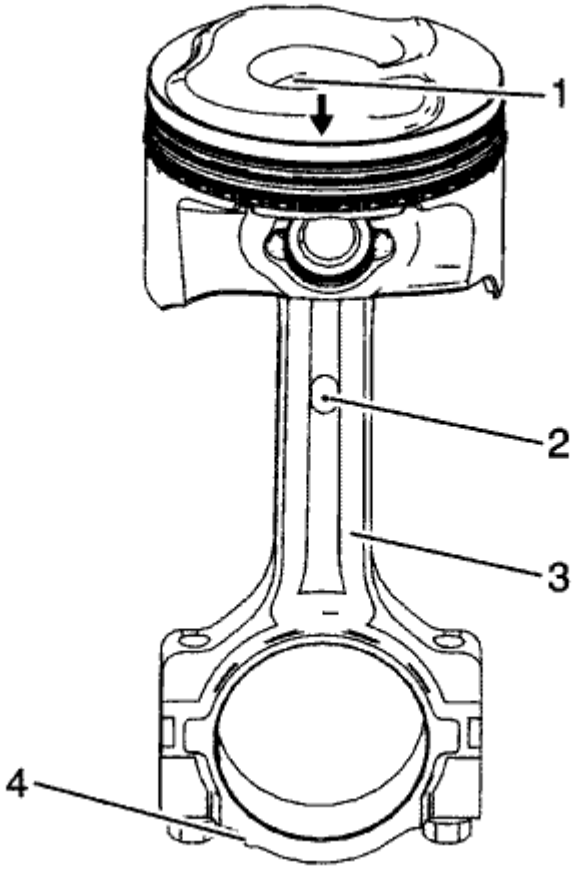


Fig. 290: Top Of Piston And Dimple On Rod
Courtesy of GENERAL MOTORS COMPANY

6. Identify the proper installation direction of the piston and connecting rod assembly. The right and left side are assembled differently. Right Side: The arrow on top of the piston and the dimple (2) on the rod face the same direction. When installing the right side piston and rod (3) assemblies, the arrow on top of the piston and the dimple (2) on the rod face the front of the engine. the raised bump (4) on bottom of rod (3) will be closest to the outside of the engine.

cardiagn.com

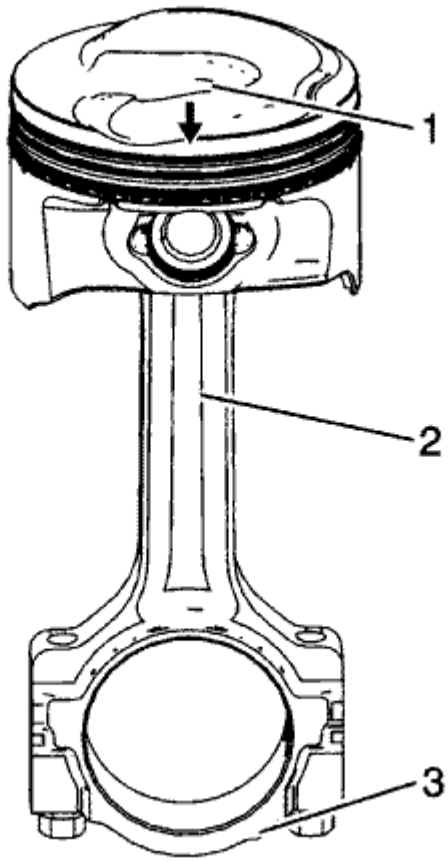


Fig. 291: Top Of Piston And Dimple On Rod
Courtesy of GENERAL MOTORS COMPANY

7. Left Side: the arrow on top of the piston and the dimple on the rod face the opposite direction. When installing the left side piston and rod (2) assemblies, the arrow on top of the piston faces the front of the engine and the dimple on the rod faces the rear of the engine. The raised bump (3) on the bottom of rod will be closest to the outside of engine.

cardiagn.com

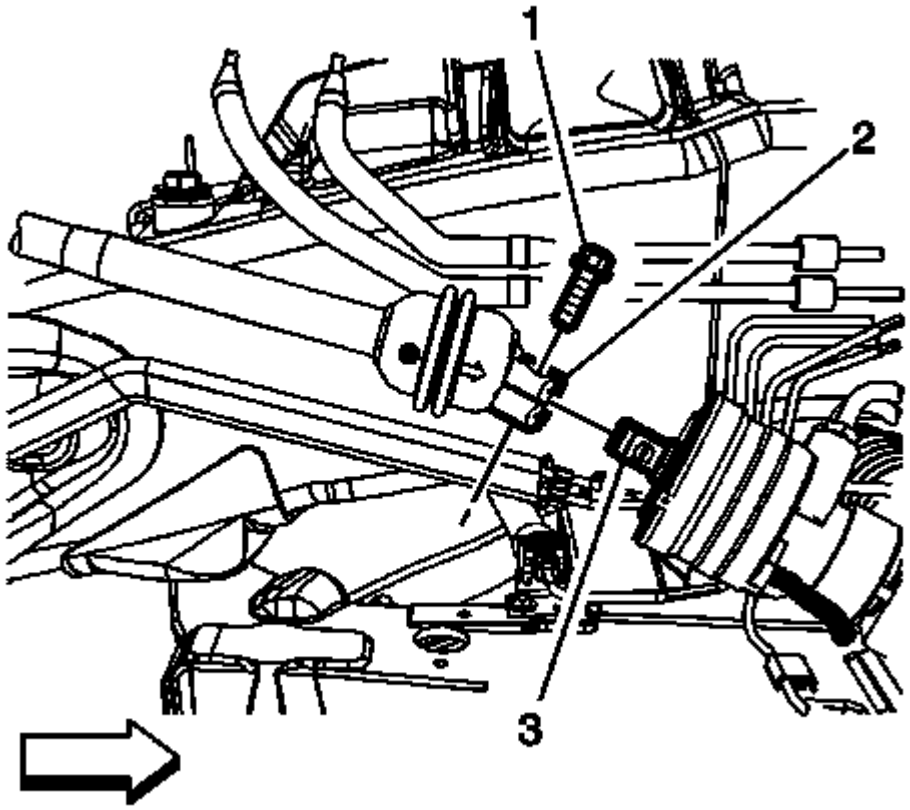


Fig. 292: Installing Piston
Courtesy of GENERAL MOTORS COMPANY

8. Install the **EN-8037** ring compressor onto the piston and compress the piston rings.

cardiagn.com

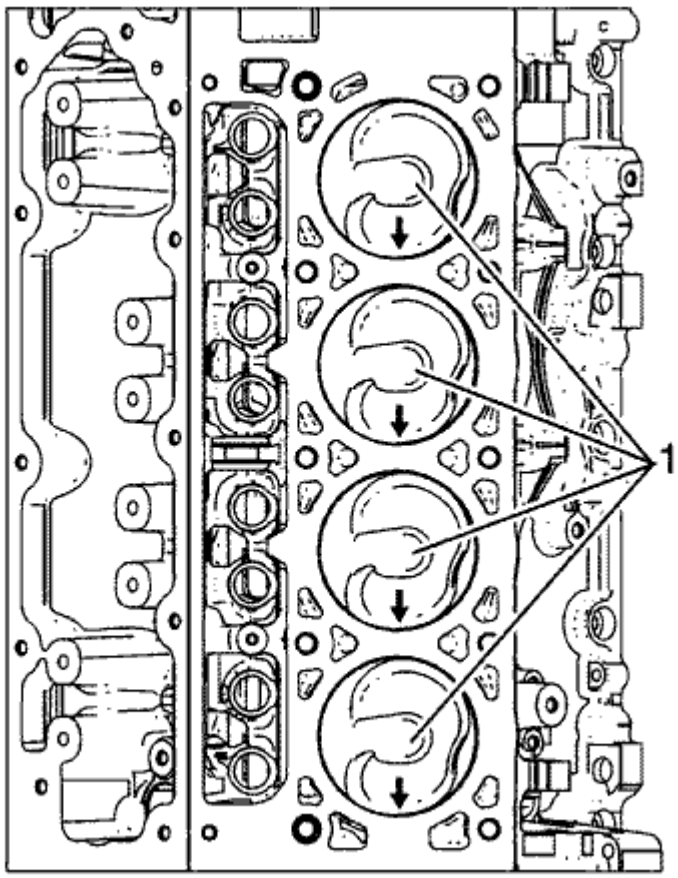


Fig. 293: Fuel Bowls
Courtesy of GENERAL MOTORS COMPANY

NOTE: The arrow on the top of the piston MUST face the front of the engine block. The deepest portion of the fuel bowls (1) must be toward the outside of the engine.

9. Install the piston, pin and connecting rod assembly into the cylinder bore. Hold the piston ring compressor firmly against the engine block. Using a wooden hammer handle, lightly tap the top of the piston until all piston rings have entered the cylinder bore.
10. Use the **EN-41556** rod guide to guide the connecting rod onto the crankshaft journal.
11. Remove the **EN-41556** rod guide from the connecting rod.

cardiagn.com

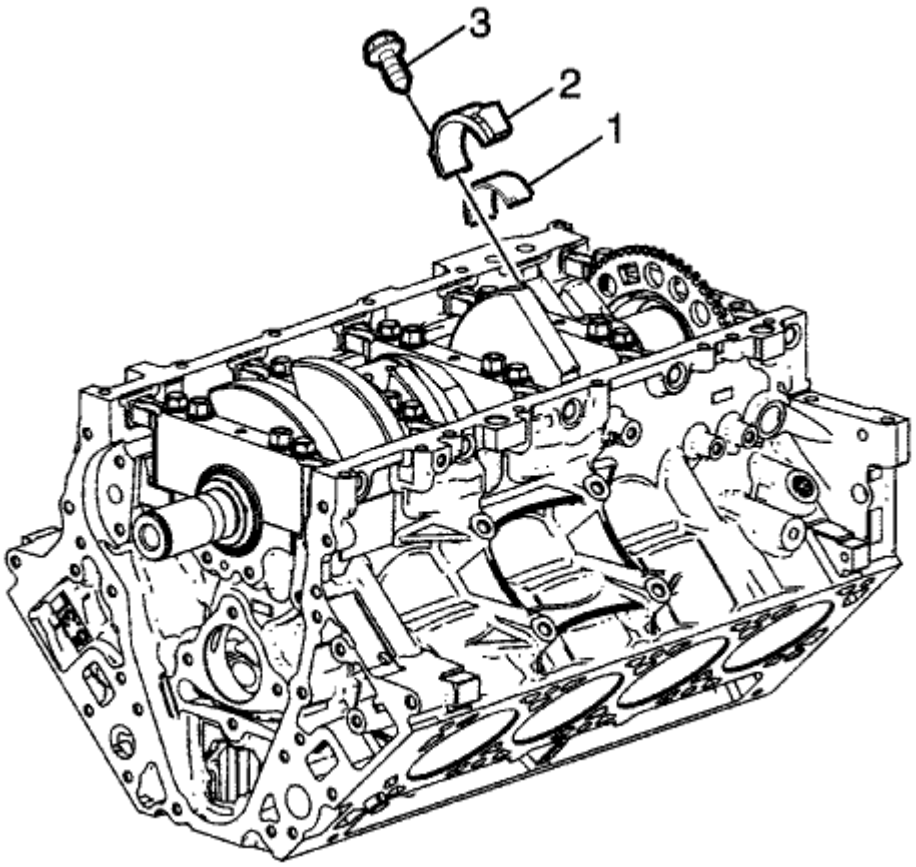


Fig. 294: Connecting Rod Bolts, Cap And Bearing
Courtesy of GENERAL MOTORS COMPANY

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.

CAUTION: Refer to Fastener Caution .

NOTE:

- **The connecting rod and cap must be assembled with the mating surfaces properly aligned.**
- **If re-using connecting rods, DO NOT re-use connecting rod fasteners. During an installation procedure, the new connecting rod bolts can be re-tightened a maximum of 3 times.**

12. Install the bearing (1), bearing cap (2) and bolts (3).
    1. Tighten the bolts a first pass to 20 N.m (15 lb ft).

cardiagn.com

2. Tighten the bolts a final pass to 85 degrees using the **EN-45059** angle meter.

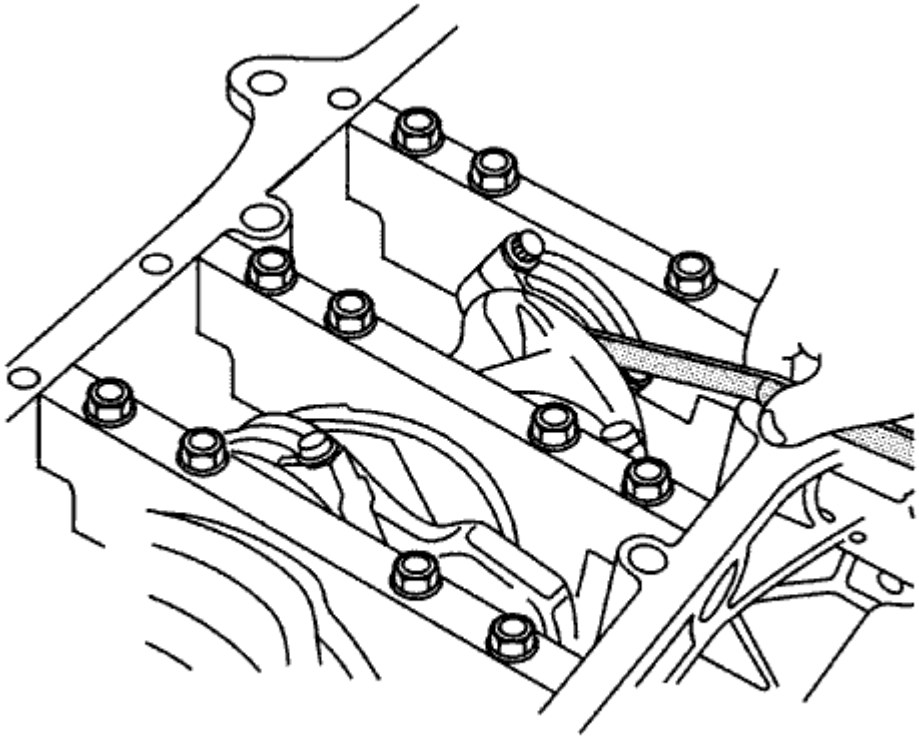


Fig. 295: Measuring Connecting Rods For Proper Side Clearance
Courtesy of GENERAL MOTORS COMPANY

13. Measure the connecting rods for the proper side clearance. Refer to **Engine Mechanical Specifications** .

CAMSHAFT INSTALLATION

cardiagn.com

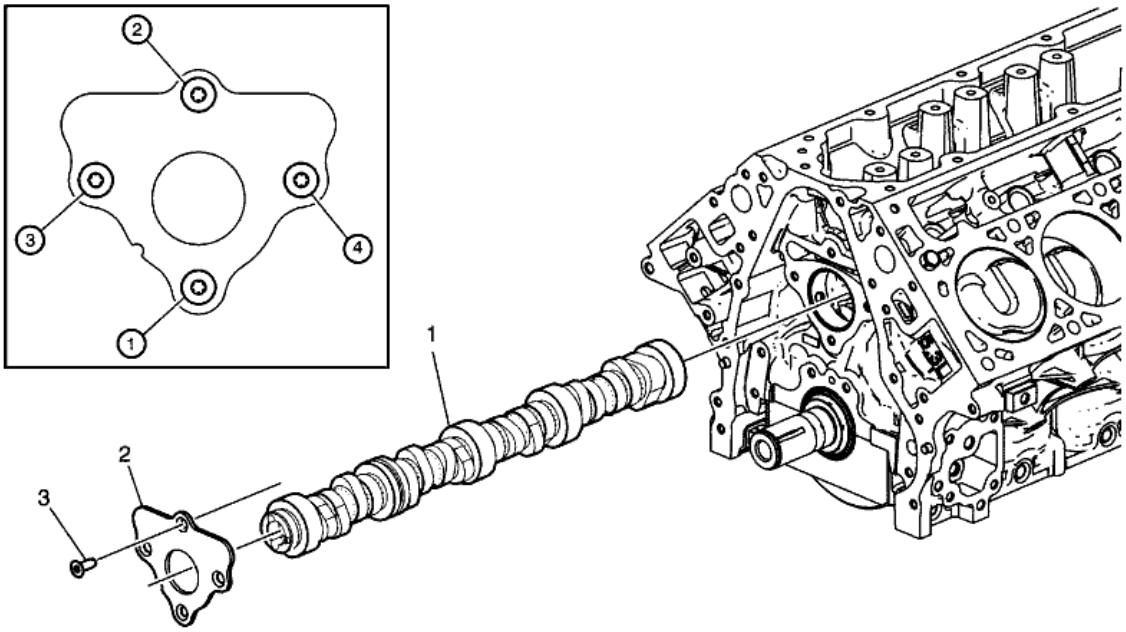


Fig. 296: Camshaft
Courtesy of GENERAL MOTORS COMPANY

Camshaft Installation

Callout	Component Name
1	Camshaft Assembly
2	Camshaft Retainer
3	Camshaft Retainer Bolt (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Procedure** Tighten the retainer bolts in the sequence shown. **NOTE:** **Clean the threads of the cam retainer bolts and apply a sealant.** **Tighten** 15 (11 lb ft) Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

TIMING CHAIN, CRANKSHAFT SPROCKET, CAMSHAFT POSITION ACTUATOR AND

cardiagn.com

SOLENOID VALVE INSTALLATION

Special Tools

- **EN 46330** Timing Belt Tensioner Retaining Pin
- **EN-42386-A** Flywheel Holding Tool
- **EN-45059** Angle Meter

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

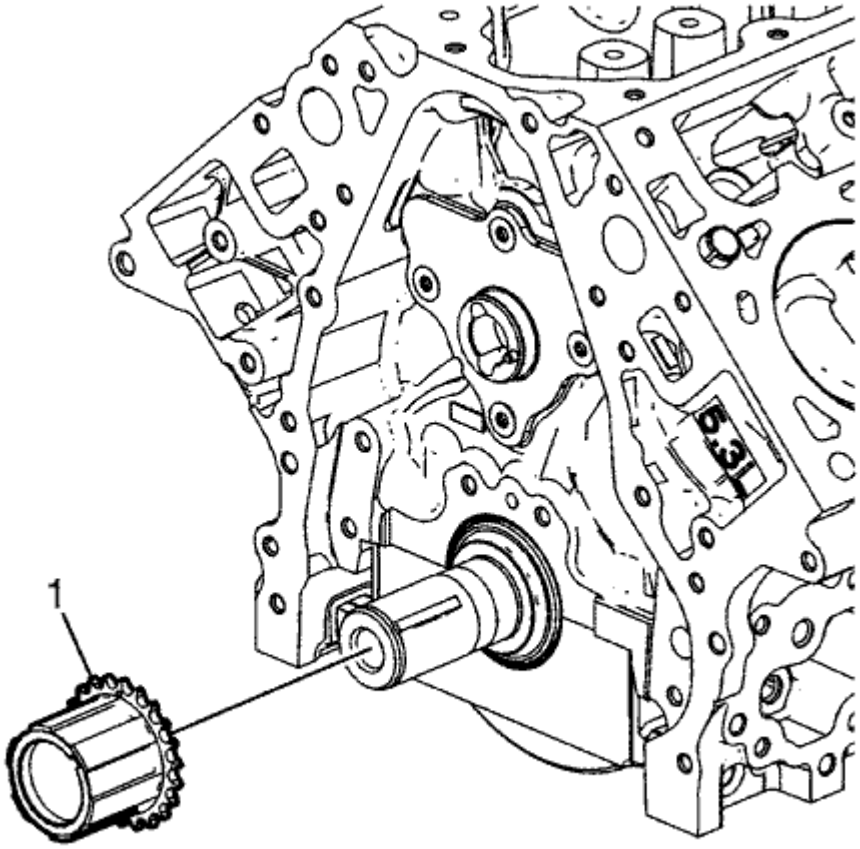


Fig. 297: Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

1. Install the crankshaft sprocket (1) onto the front of the crankshaft. Align the crankshaft key with the crankshaft sprocket keyway.

cardiagn.com

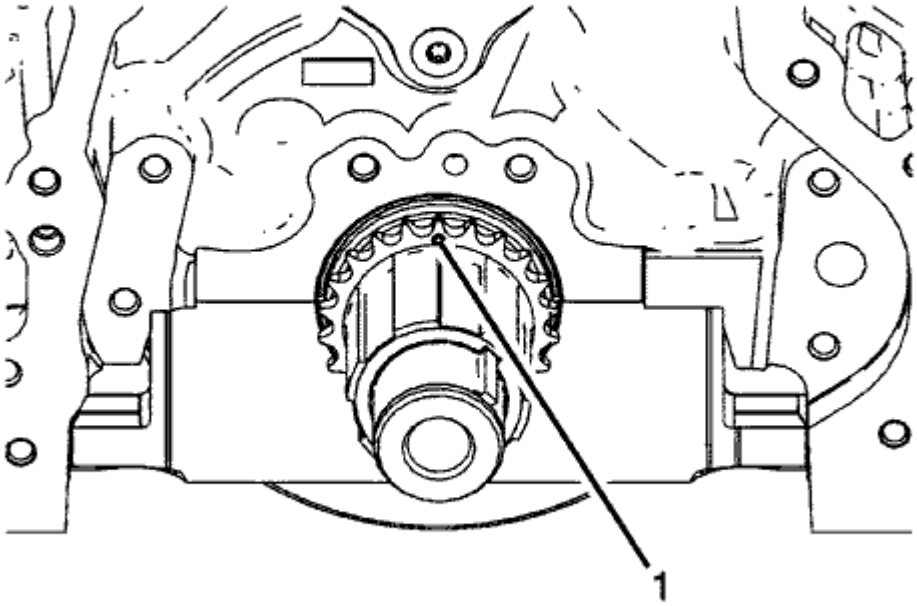


Fig. 298: Rotating Crankshaft Sprocket Until Sprocket Alignment Mark
Courtesy of GENERAL MOTORS COMPANY

2. Rotate the crankshaft sprocket until the sprocket alignment mark (1) is in the 12 o'clock position.

cardiagn.com

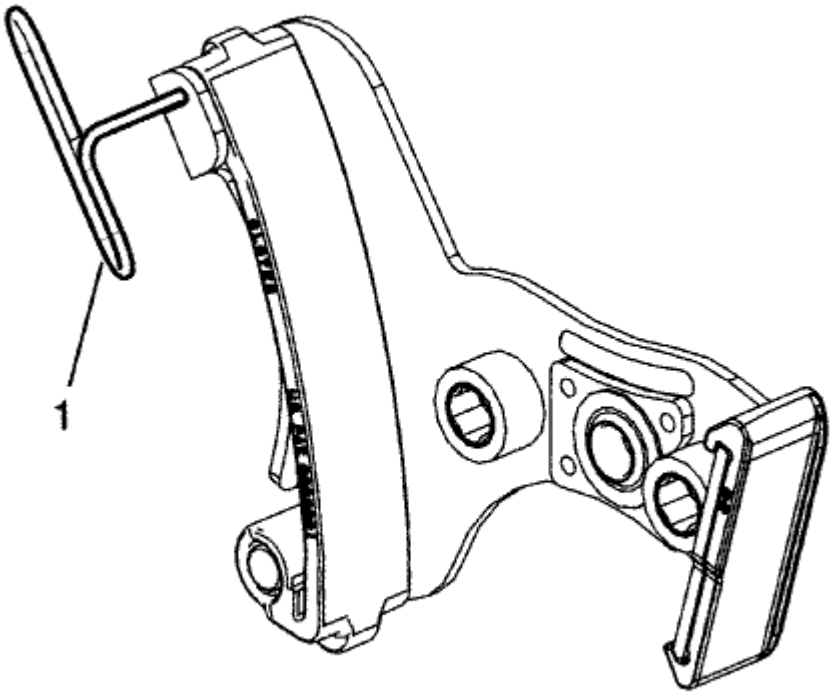


Fig. 299: Timing Chain Tensioner Guide And EN 46330 Pin
Courtesy of GENERAL MOTORS COMPANY

3. Compress the timing chain tensioner guide and install the **EN 46330** pin (1).

cardiagn.com

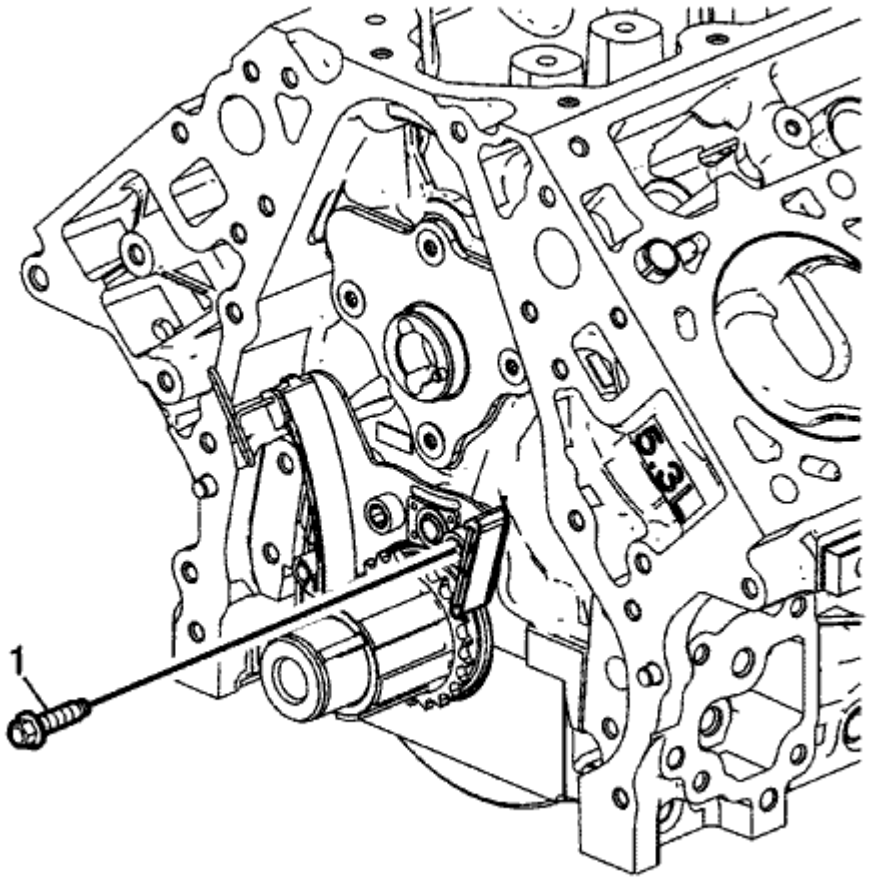


Fig. 300: Timing Chain Tensioner And Left Side Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the timing chain tensioner and left side bolt (1). Do not install the right side bolt at this time. The right side bolt will be installed after the camshaft position (CMP) actuator and chain have been installed onto the engine.

cardiagn.com

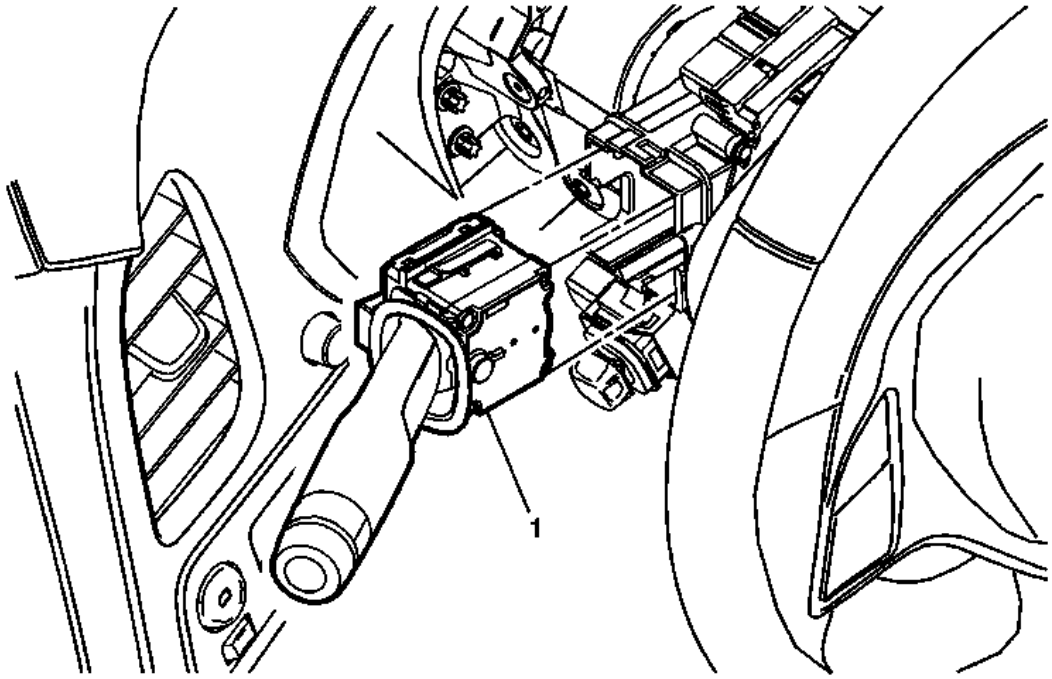


Fig. 301: View Of Tie Strap Through Center Of Actuator
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Camshaft Position Actuator Removal and Installation Warning .

5. Remove the tie strap (1) from the actuator.

cardiagn.com

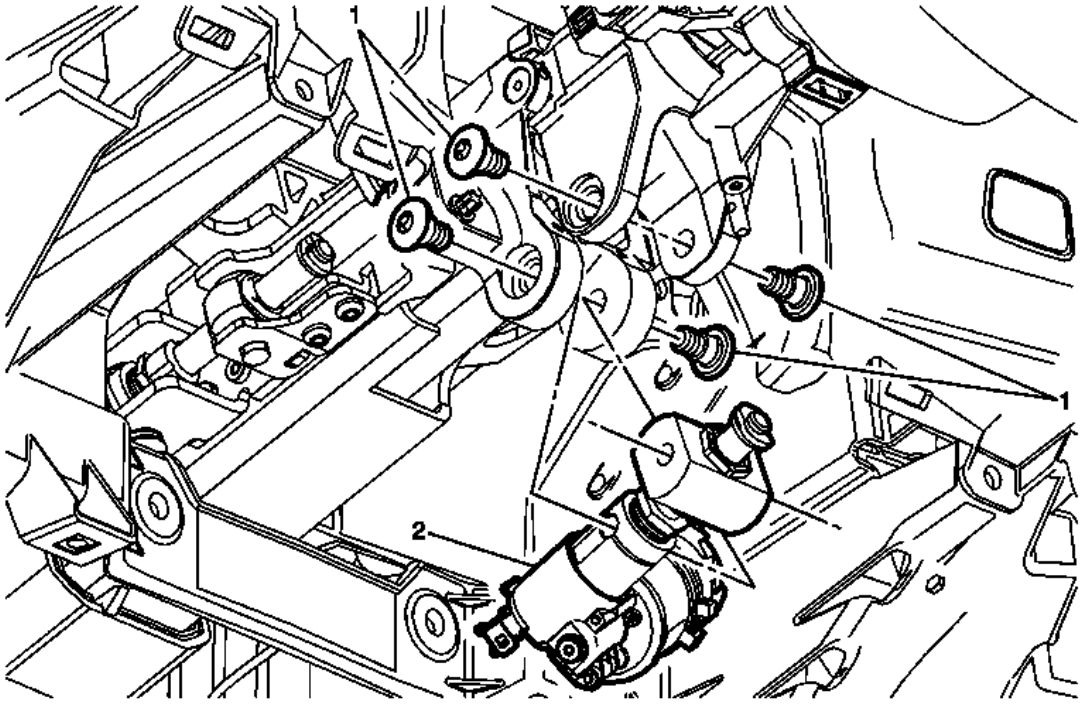


Fig. 302: Identifying Alignment Hole & Locating Pin
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Properly locate the CMP actuator onto the locating pin of the camshaft.**
- **The sprocket teeth and timing chain must mesh.**
- **The camshaft and the crankshaft sprocket alignment marks MUST be aligned properly.**
- **Do not use the CMP solenoid valve again. Install a NEW valve during assembly.**

6. Identify the alignment hole (1) in the rear face of the CMP actuator and the locating pin (2) on the front face of the camshaft.

cardiagn.com

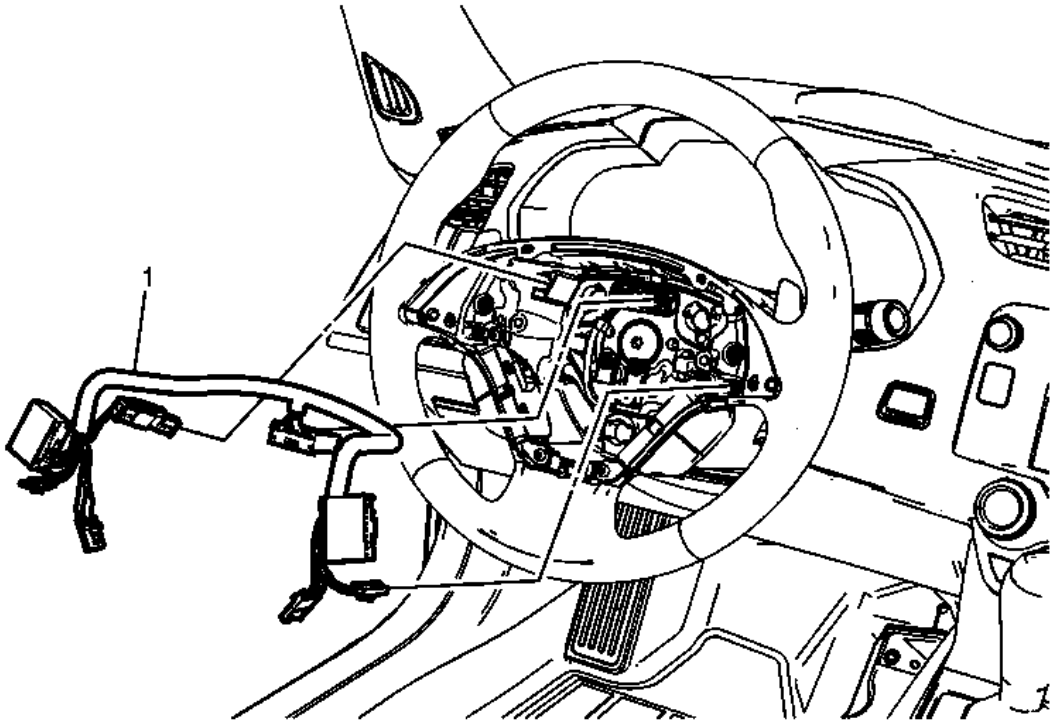


Fig. 303: Proper Installation Of CMP Actuator
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Camshaft Position Actuator Removal and Installation Warning .

7. Install the CMP actuator and timing chain. Align the hole in the rear face of the CMP actuator with the locating pin on the front face of the camshaft. If necessary, rotate the camshaft or crankshaft sprockets in order to align the timing marks. Use care to install the actuator completely onto the front of the camshaft. Position fingers onto the face of the actuator sprocket and push the actuator onto the front of the camshaft. Never push on the reluctor wheel when attempting to install the actuator.

cardiagn.com

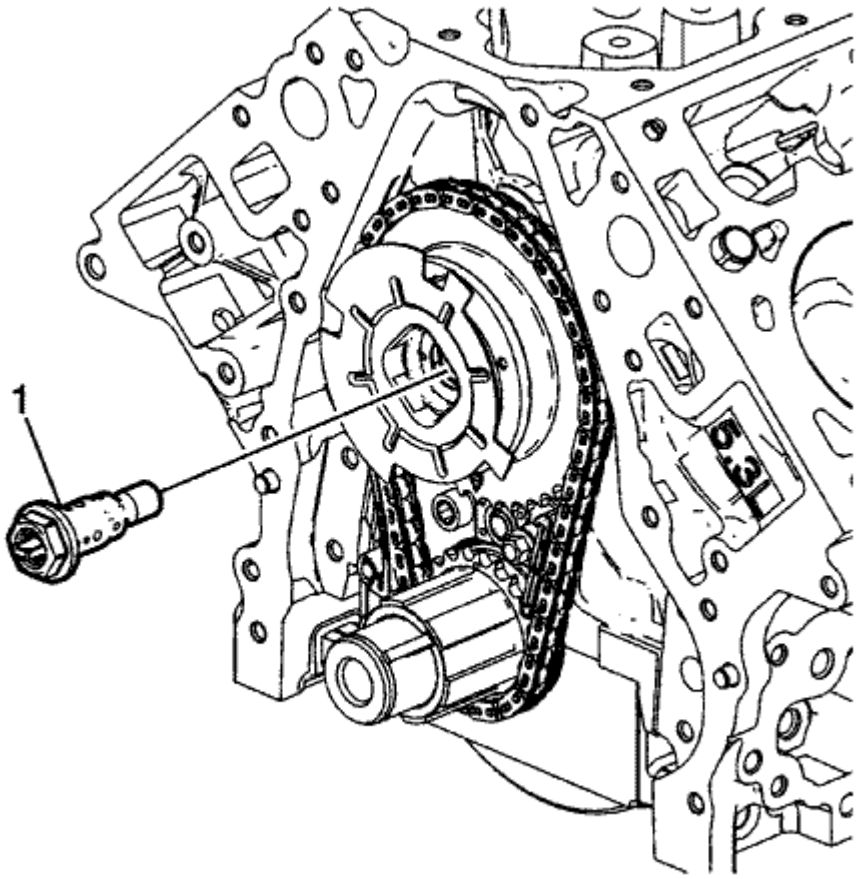


Fig. 304: NEW CMP Actuator Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

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.

8. Install a NEW CMP actuator solenoid valve (1). With the CMP actuator properly positioned onto the camshaft, the CMP actuator solenoid valve can be threaded completely into the camshaft using light hand pressure. Tighten by hand until snug.
    1. Tighten a first pass to 65 N.m (48 lb ft).
    2. Tighten a final pass an additional 90 degrees using **EN-45059** angle meter.

cardiagn.com

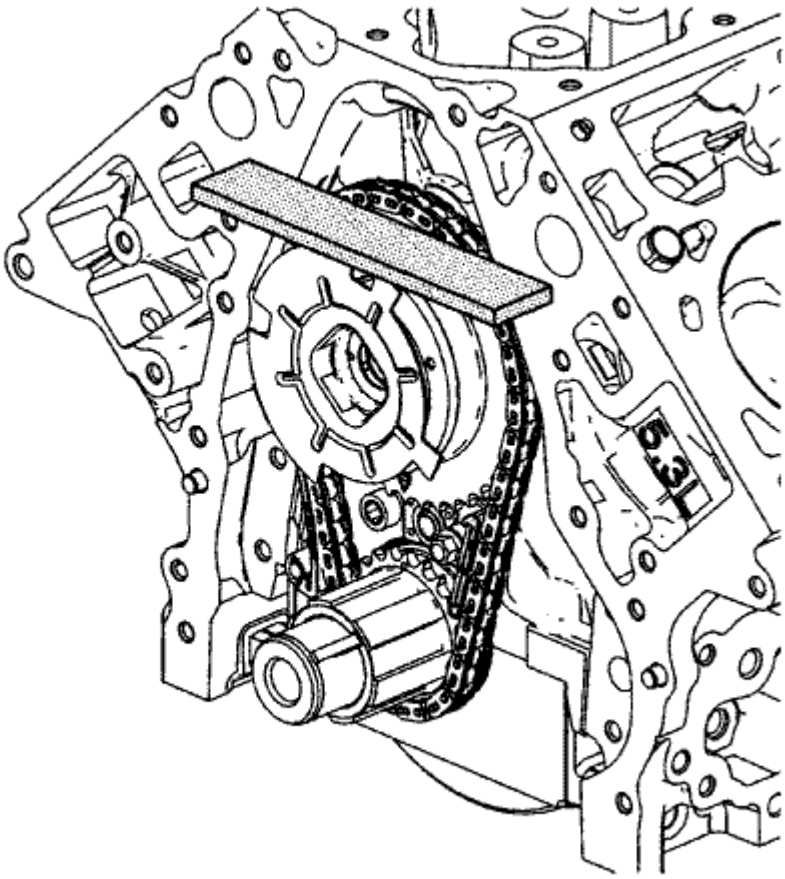


Fig. 305: Inspecting For Proper Installation Of CMP Actuator And Timing Chain
Courtesy of GENERAL MOTORS COMPANY

NOTE: It is possible to push the camshaft rearward when installing the CMP actuator. Verify that the camshaft lobes are centered in the valve lifter bores after the CMP actuator is installed.

9. Locate a straight edge across the front face of the engine block and inspect for proper installation of the CMP actuator and timing chain. With the CMP actuator properly and completely installed onto the front of camshaft, the timing chain will not protrude beyond the front face of engine block.

cardiagn.com

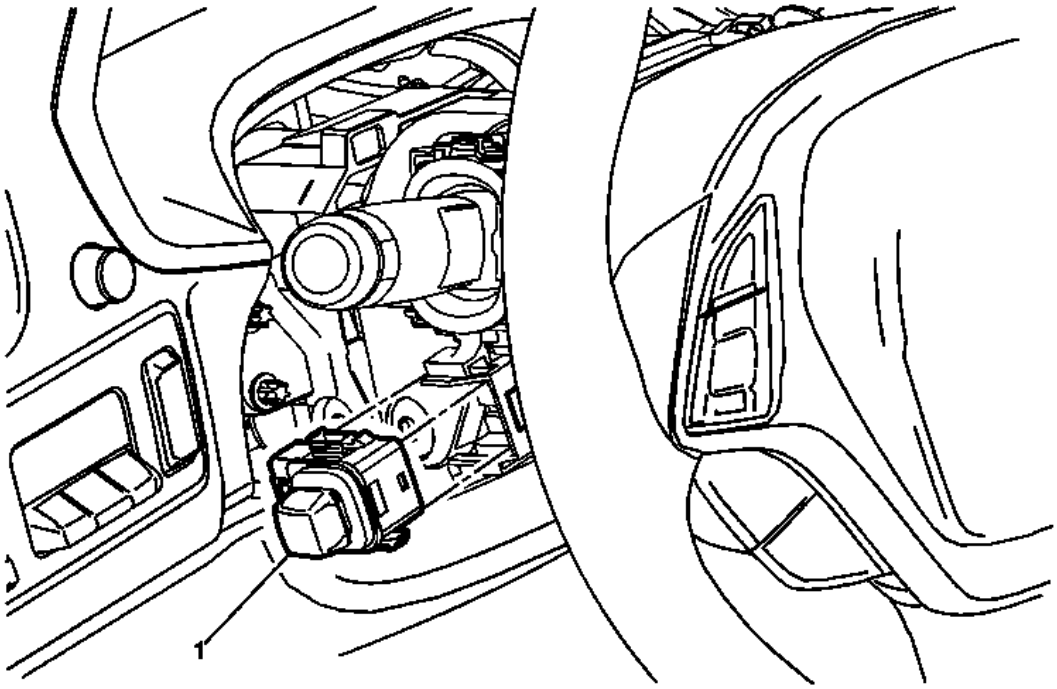


Fig. 306: View Of CMP Actuator Alignment Mark & Crankshaft Sprocket Alignment Mark
Courtesy of GENERAL MOTORS COMPANY

10. Inspect the sprockets for proper alignment. The mark on the CMP actuator sprocket (1) should be located in the 6 o'clock position and the mark on the crankshaft sprocket (2) should be located in the 12 o'clock position.

cardiagn.com

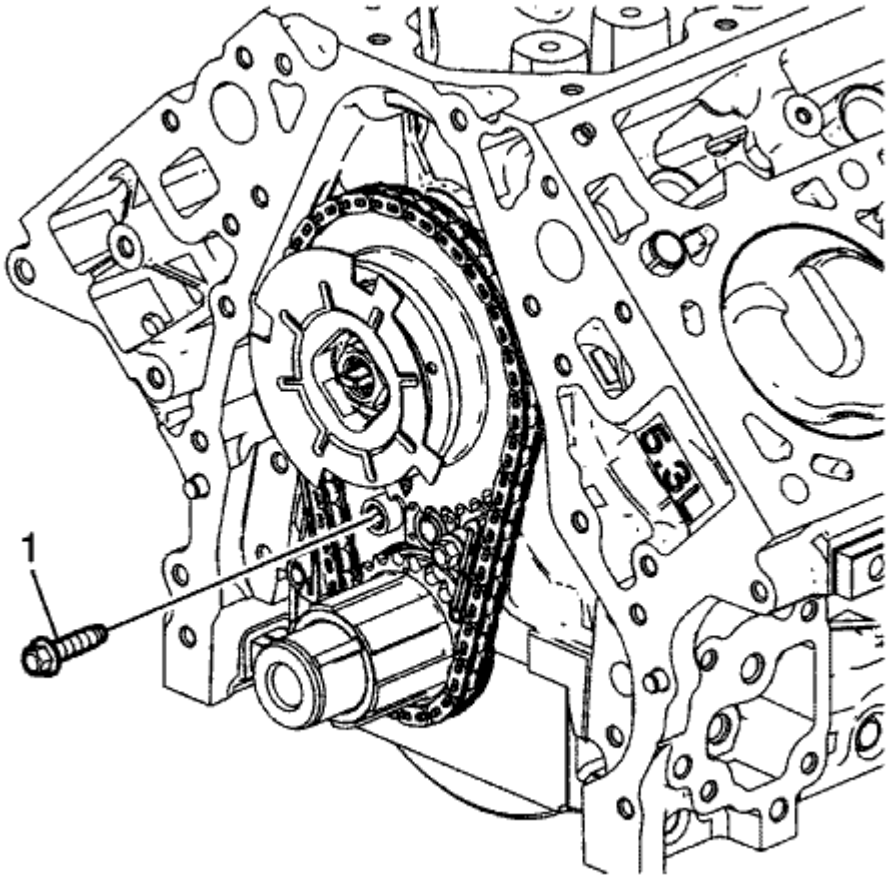


Fig. 307: Timing Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

11. Install the right side bolt (1) into the timing chain tensioner and tighten both bolts to 30 N.m (22 lb ft).

cardiagn.com

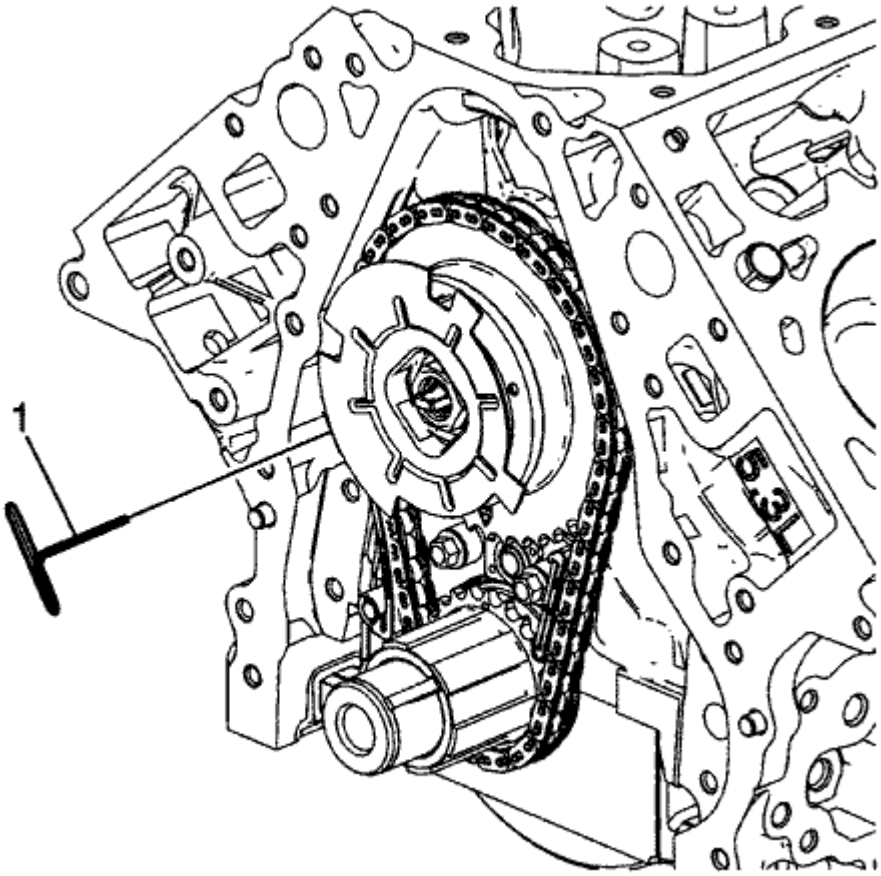


Fig. 308: EN 46330 Pin
Courtesy of GENERAL MOTORS COMPANY

12. Remove the **EN 46330** pin.

OIL PUMP INSTALLATION

cardiagn.com

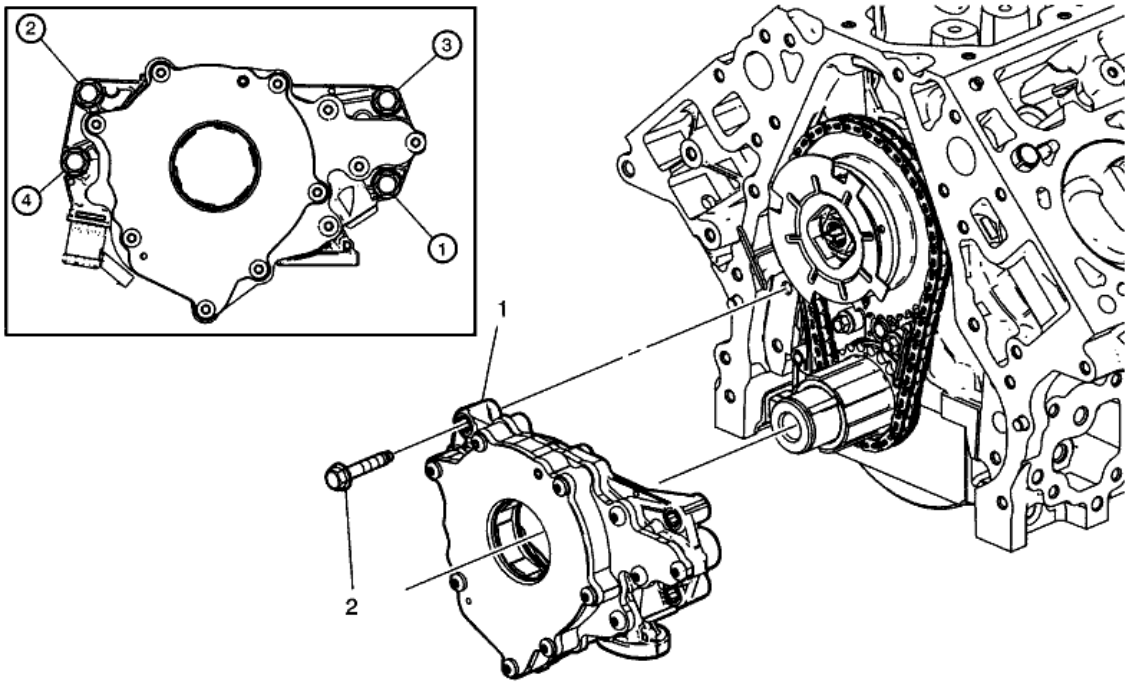


Fig. 309: Oil Pump
Courtesy of GENERAL MOTORS COMPANY

Oil Pump Installation

Callout	Component Name
1	Oil Pump Assembly
2	Oil Pump Bolt **CAUTION:** **Refer to Fastener Caution .** **Procedure** Tighten the oil pump bolts in the sequence shown. **NOTE:** **Upward pressure must be applied to the oil pump while tightening the fasteners.** **Tighten** 25 (18 lb ft)

OIL PUMP INSTALLATION (WITH Z52 OPTION)

cardiagn.com

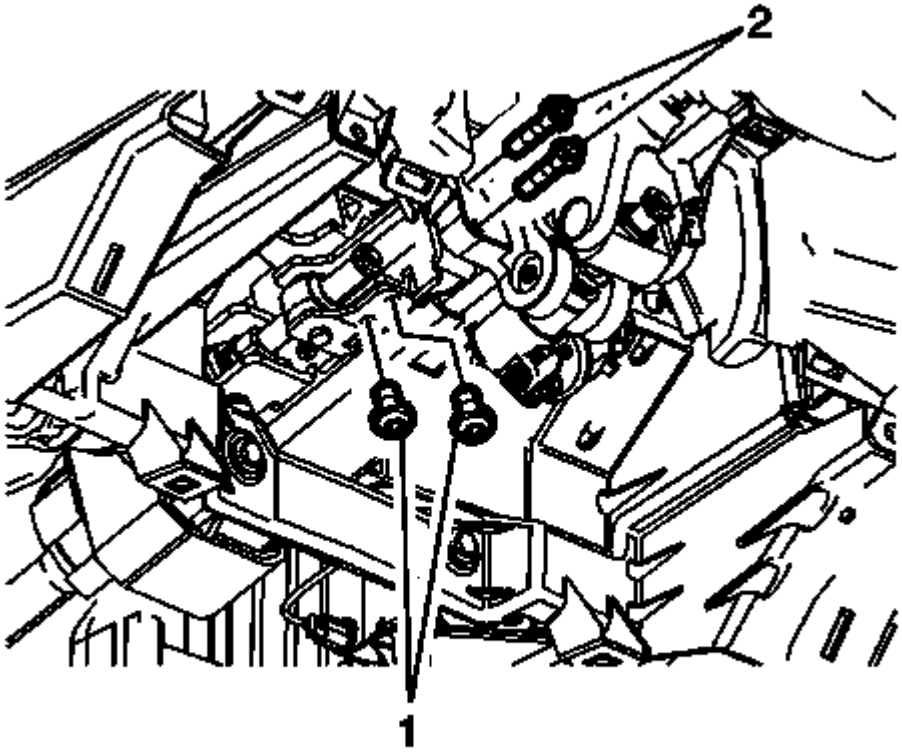


Fig. 310: Oil Pump Installation (with Z52 Option)
Courtesy of GENERAL MOTORS COMPANY

Oil Pump Installation (with Z52 Option)

Callout	Component Name
1	Oil Pump Assembly
	Oil Pump Bolt **CAUTION:** **Refer to Fastener Caution .**
2	**Procedure** Tighten the oil pump bolts in the sequence shown. **NOTE:** **Upward pressure must be applied to the oil pump while tightening the fasteners.**

cardiagn.com

	25 (18 lb ft)

CRANKSHAFT REAR OIL SEAL HOUSING INSTALLATION

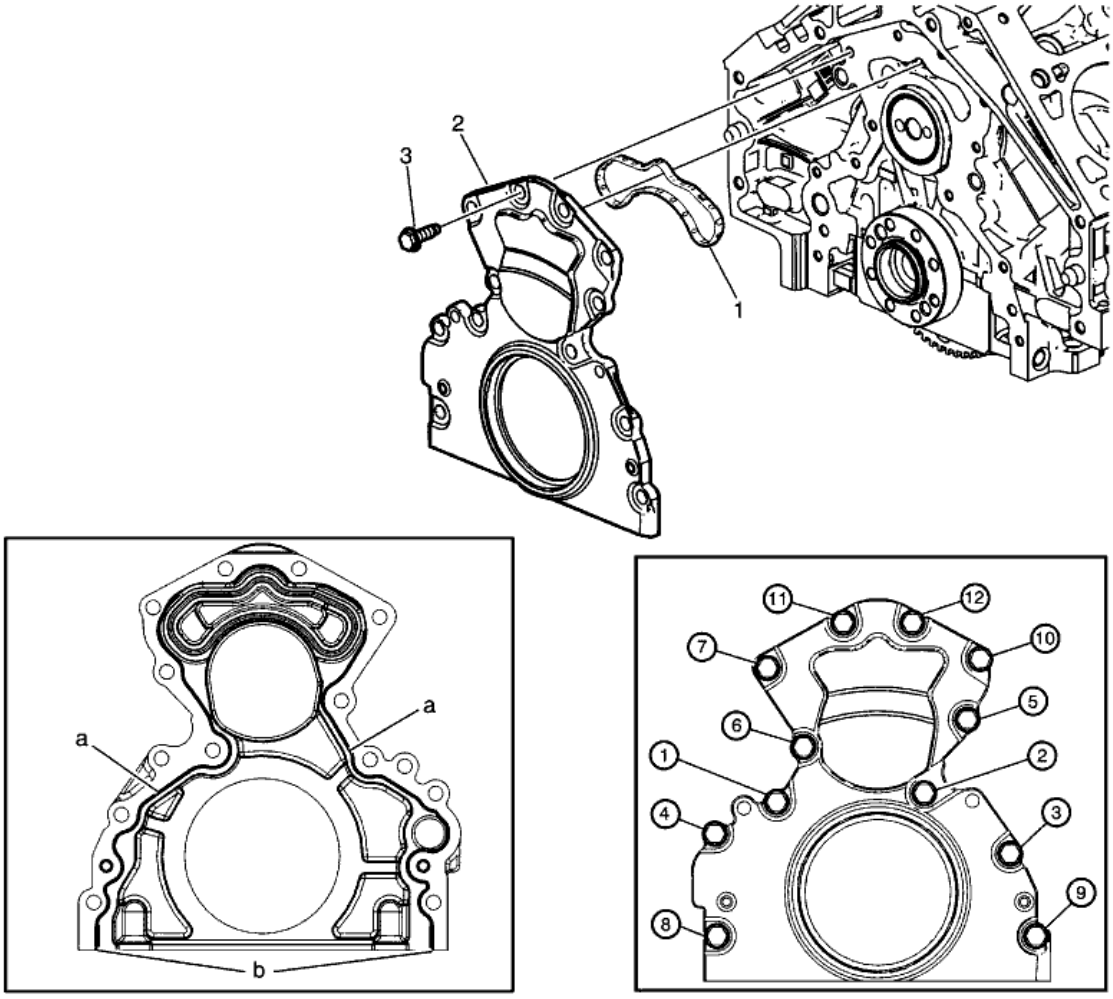


Fig. 311: Crankshaft Rear Oil Seal Housing Installation
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Rear Oil Seal Housing Installation

Callout	Component Name
1	Crankshaft Rear Oil Seal Housing Gasket **NOTE:** **Must use a NEW gasket when installing the rear housing.**
2	Crankshaft Rear Oil Seal Housing **Procedure** Apply a 3 mm (0.118 in) bead of RTV sealant on the engine front cover as shown (a). Apply a 5 mm (0.197 in) bead of RTV sealant on the engine front cover as shown (b). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for

cardiagn.com

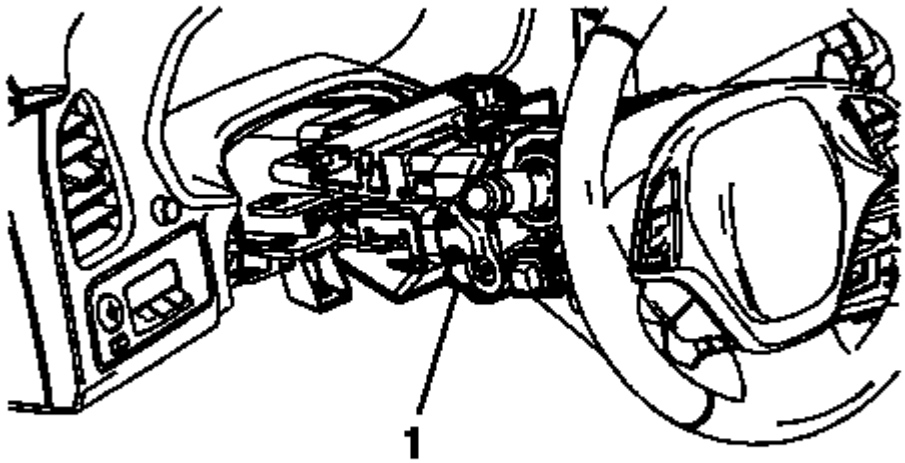
	recommended sealant.
3	Crankshaft Rear Oil Seal Housing Bolt **CAUTION:** **Refer to Fastener Caution .** **Procedure** Tighten the rear oil seal housing bolts in the sequence shown. **Tighten** 25 N.m (18 lb ft)

CRANKSHAFT REAR OIL SEAL INSTALLATION

Special Tools

- **J 41479** Crankshaft Rear Oil Seal Installer
- **J 41479-2A** Crankshaft Rear Oil Seal Installation Guide

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



cardiagn.com

Fig. 312: Identifying Oil Seal
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: For proper orientation, note the installation direction of the oil seal. The oil seal is a reverse-lip design. The part number is applied to the outside face of the seal, as shown.

1. Inspect the seal and identify the part number markings for proper orientation.

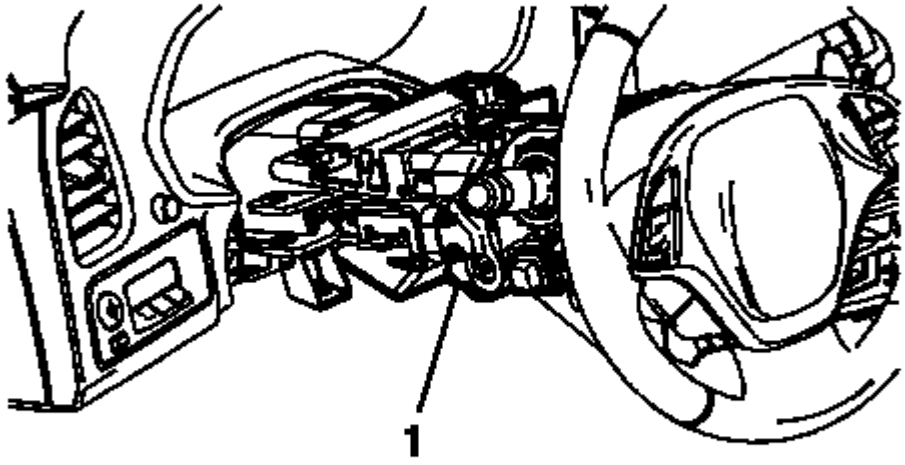


Fig. 313: J 14179 Crankshaft Rear Oil Seal Installer
Courtesy of GENERAL MOTORS COMPANY

2. Install the **J 41479** Crankshaft Rear Oil Seal Installer (3) or the **J 41479-2A** Crankshaft Rear Oil Seal Installation Guide cone (2) and bolts onto the rear of the crankshaft. The **J 41479-2A** Crankshaft Rear Oil Seal Installation Guide may be required for manual transmission applications.
3. Tighten the bolts until snug. Do not overtighten.
4. Install the rear oil seal (1) onto the tapered cone (2) and push the seal to the rear seal bore. Install the oil seal with the part number markings facing away from the engine.
5. Thread the **J 41479** Crankshaft Rear Oil Seal Installer threaded rod into the tapered cone until

cardiagn.com

6. Align the oil seal onto the tool (3).
7. Rotate the handle of the tool (3) clockwise until the seal enters the rear housing and bottoms into the seal bore.
8. Remove the tool.

ENGINE FRONT COVER INSTALLATION

Oil Pump Flow Control Valve Harness Installation

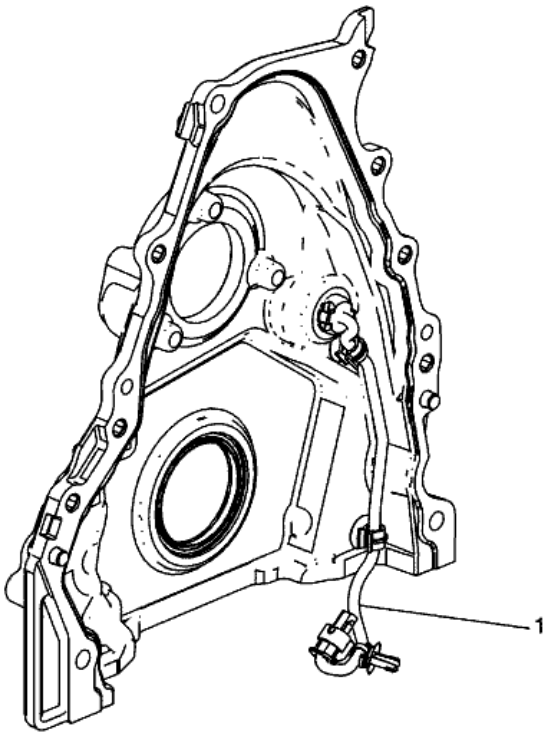


Fig. 314: Oil Pump Flow Control Valve Harness
Courtesy of GENERAL MOTORS COMPANY

Oil Pump Flow Control Valve Harness Installation

Callout	Component Name
1	Oil Pump Flow Control Valve Harness **Procedure** 1. Install the harness through the front of the engine front cover and push connector into engine front cover until it clicks. 2. Install the wire into the 2 retainer clips.

Front Cover Installation

cardiagn.com

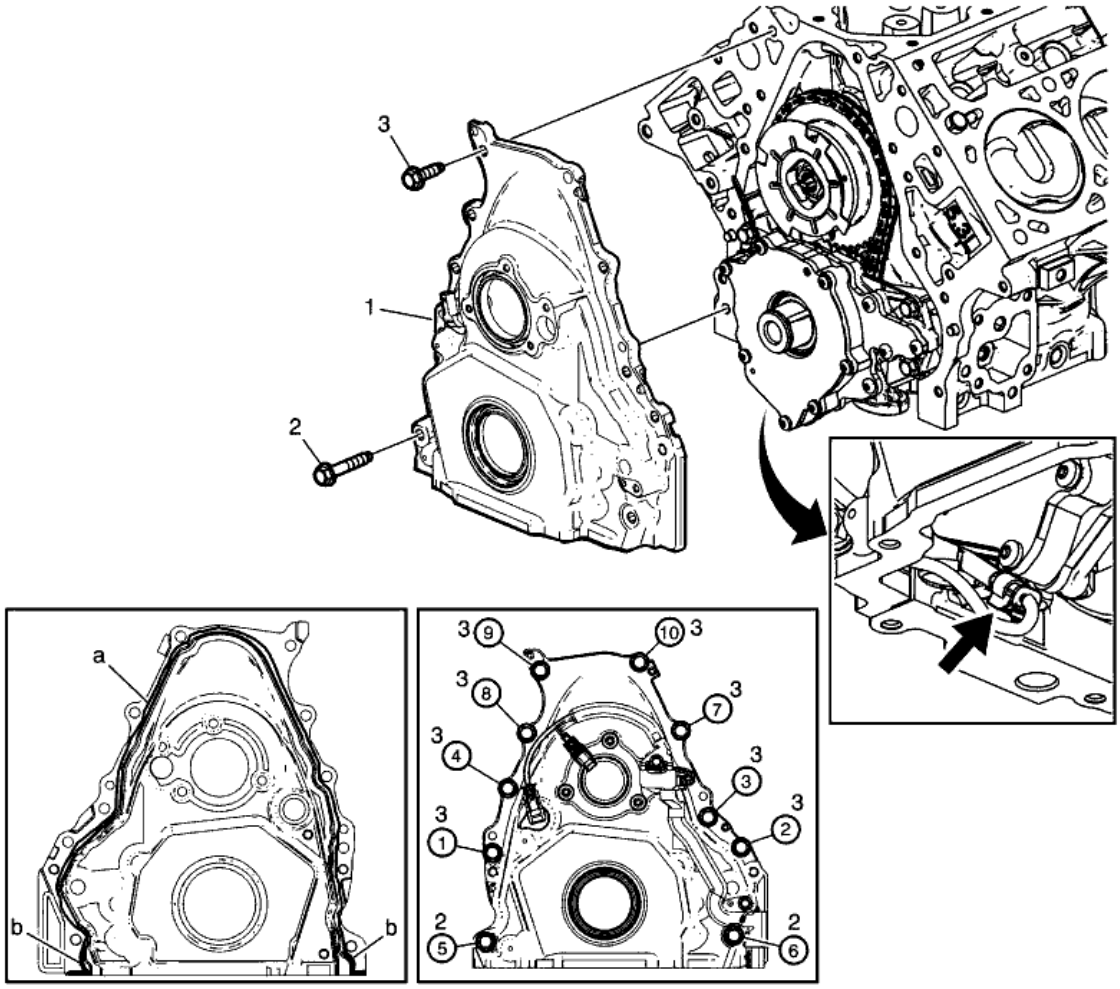


Fig. 315: Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

Front Cover Installation

Callout	Component Name
1	Engine Front Cover **Procedure** 1. Apply a 3 mm (0.118 in) bead of RTV sealant on the engine front cover as shown (a). Apply a 5 mm (0.197 in) bead of RTV sealant on the engine front cover as shown (b). Refer to **Adhesives, Fluids, Lubricants, and Sealers** . 2. Connect the oil pump flow control valve harness connector after installing the engine front cover.
	Engine Front Cover Bolt **CAUTION:**

cardiagn.com

2	**Procedure** Tighten the engine front cover bolts in the sequence shown. **Tighten** 25 N.m (18 lb ft)
3	Engine Front Cover Bolt **Procedure** Tighten the engine front cover bolts in the sequence shown. **Tighten** 25 N.m (18 lb ft)

Camshaft Position Sensor Harness, Camshaft Position Sensor and Camshaft Actuator Magnet Installation

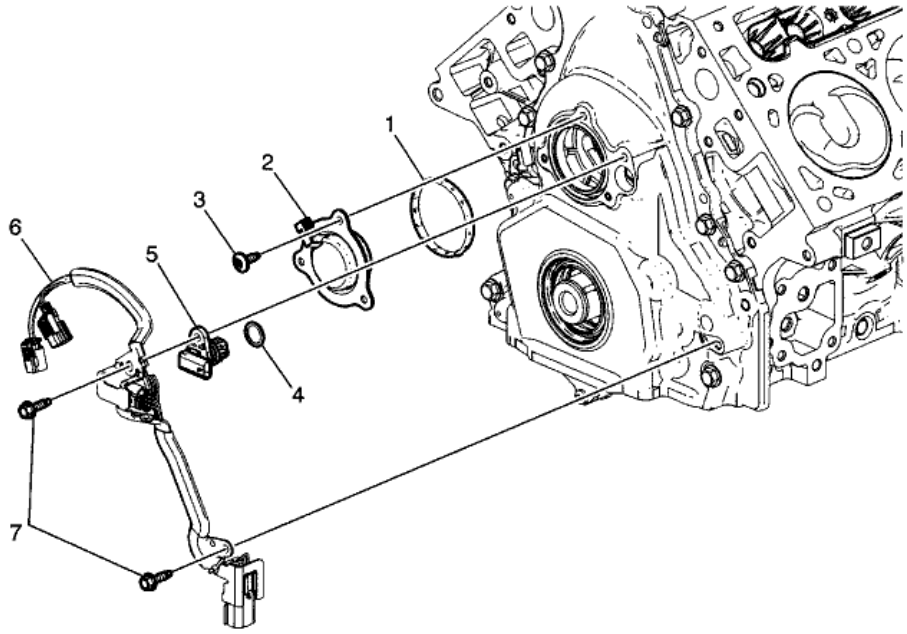


Fig. 316: Camshaft Position Sensor Harness, Camshaft Position Sensor and Camshaft Actuator Magnet
Courtesy of GENERAL MOTORS COMPANY

Camshaft Position Sensor Harness, Camshaft Position Sensor and Camshaft Actuator Magnet Installation

Callout	Component Name
1	Camshaft Actuator Magnet Gasket **NOTE:** **Must use a NEW gasket.**
2	Camshaft Actuator Magnet

cardiagn.com

3	Camshaft Actuator Magnet Bolts **Tighten** 10 N.m (88 lb in)
4	Camshaft Position Sensor Seal **NOTE:** **Must use a NEW seal.**
5	Camshaft Position Sensor
6	Camshaft Position Sensor Harness
7	Camshaft Position Sensor Harness Bolts **Tighten** 25 N.m (18 lb ft)

ENGINE FRONT COVER INSTALLATION (WITH Z52 OPTION)

Oil Pump Flow Control Valve Harness Installation

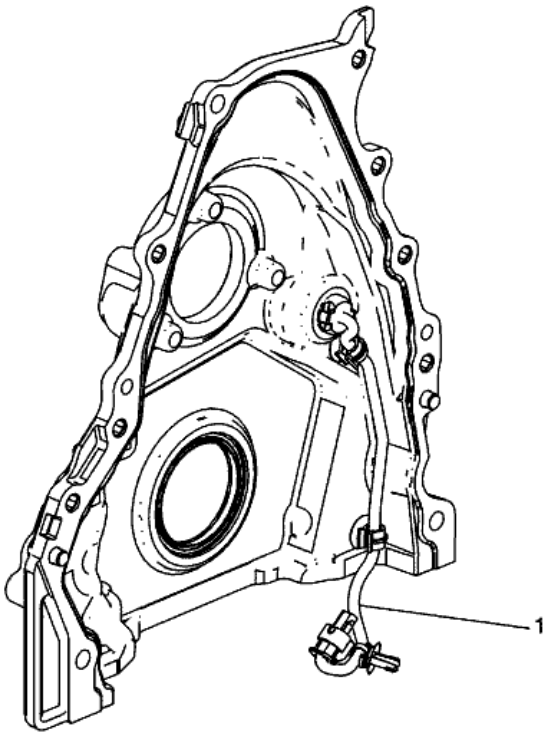


Fig. 317: Oil Pump Flow Control Valve Harness
Courtesy of GENERAL MOTORS COMPANY

Oil Pump Flow Control Valve Harness Installation

Callout	Component Name
	Oil Pump Flow Control Valve Harness **Procedure**

cardiagn.com

1	1. Install the harness through the front of the engine front cover and push connector into engine front cover until it clicks. 2. Install the wire into the 2 retainer clips.

Front Cover Installation

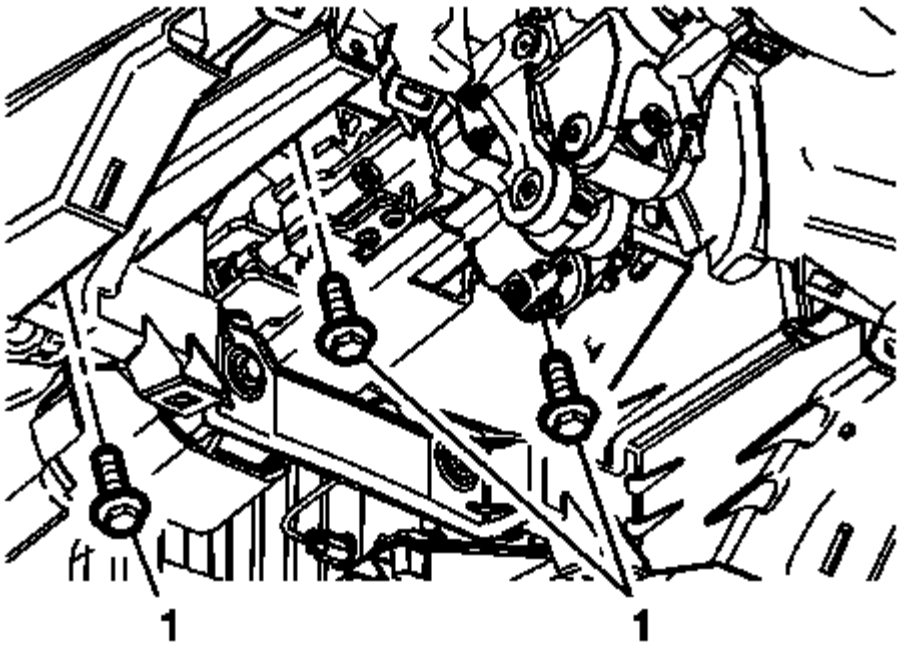


Fig. 318: Front Cover
Courtesy of GENERAL MOTORS COMPANY

Front Cover Installation

Callout	Component Name
1	Engine Front Cover **Procedure** 1. Apply a 3 mm (0.118 in) bead of RTV sealant on the engine front cover as shown (a). Apply a 5 mm (0.197 in) bead of RTV sealant on the engine front cover as shown (b). Refer to **Adhesives, Fluids, Lubricants, and Sealers** . 2. Connect the oil pump flow control valve harness connector after installing the engine front cover.

cardiagn.com

2	Engine Front Cover Bolt **CAUTION:** **Refer to Fastener Caution .** **Procedure** Tighten the engine front cover bolts in the sequence shown. **Tighten** 25 N.m (18 lb ft)
3	Engine Front Cover Bolt **Procedure** Tighten the engine front cover bolts in the sequence shown. **Tighten** 25 N.m (18 lb ft)

Camshaft Position Sensor Harness, Camshaft Position Sensor and Camshaft Actuator Magnet Installation

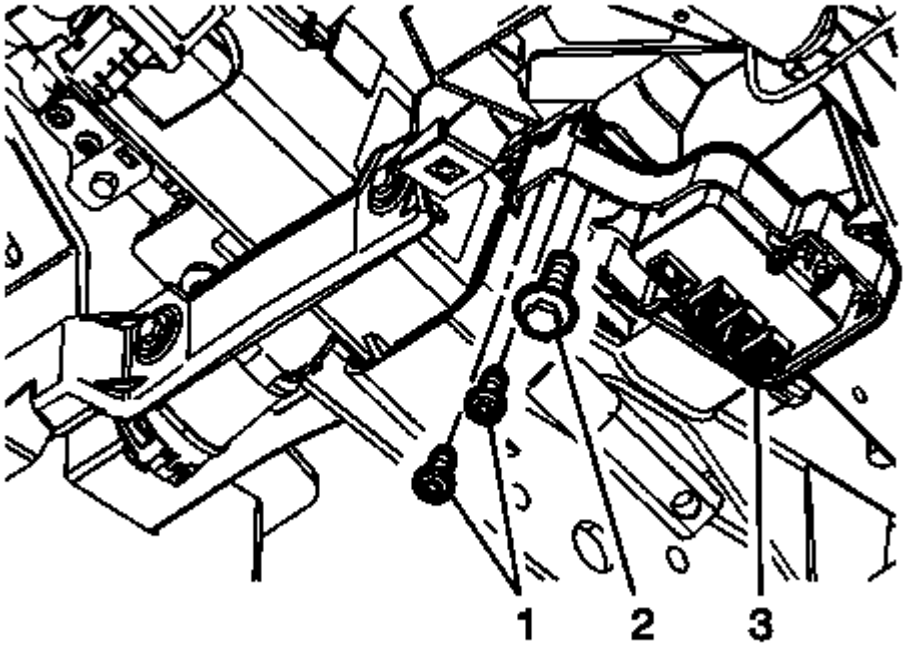


Fig. 319: Camshaft Position Sensor Harness, Camshaft Position Sensor and Camshaft Actuator Magnet
Courtesy of GENERAL MOTORS COMPANY

cardiagn.com

Camshaft Position Sensor Harness, Camshaft Position Sensor and Camshaft Actuator Magnet Installation

Callout	Component Name
1	Camshaft Actuator Magnet Gasket **NOTE:** **Must use a NEW gasket.**
2	Camshaft Actuator Magnet
3	Camshaft Actuator Magnet Bolts **Tighten** 10 N.m (88 lb in)
4	Camshaft Position Sensor Seal **NOTE:** **Must use a NEW seal.**
5	Camshaft Position Sensor
6	Camshaft Position Sensor Harness
7	Camshaft Position Sensor Harness Bolts **Tighten** 25 N.m (18 lb ft)

CRANKSHAFT FRONT OIL SEAL INSTALLATION

Special Tools

- **J-41478-A** Crankshaft Front Oil Seal Installer
- **EN-51091** Crankshaft Front Oil Seal Installer

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

cardiagn.com

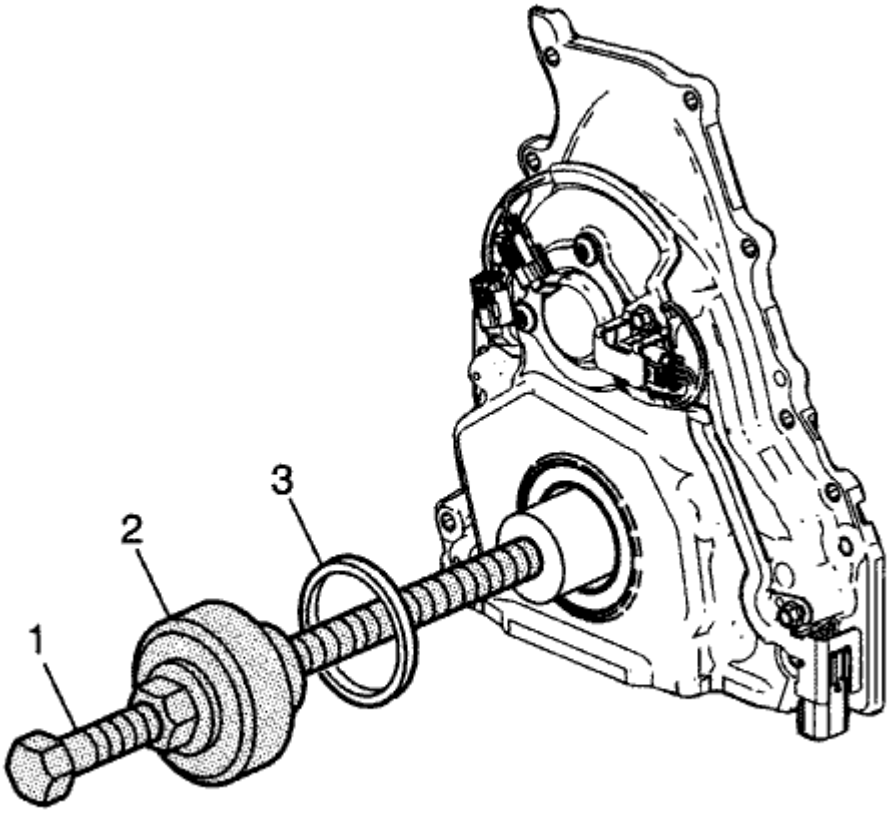


Fig. 320: Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Do not lubricate the oil seal sealing surface.**
- **Do not use the crankshaft front oil seal again.**

1. Install the crankshaft front oil seal (3) onto the threaded rod, nut and washer from **J-41478-A** crankshaft front oil seal installer (1) and **EN-51091** crankshaft front oil seal installer (2).
2. Install the **J-41478-A** crankshaft front oil seal installer threaded rod, nut and washer (1) and **EN-51091** crankshaft front oil seal installer (2) and oil seal (3), into the end of the crankshaft.
3. Use the **J-41478-A** crankshaft front oil seal installer (1) and **EN-51091** crankshaft front oil seal installer (2) in order to install the oil seal (3) into the cover bore.
    1. Use a wrench and hold the hex on the installer bolt.
    2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in the cover bore.
    3. Remove the tool.
    4. Inspect the oil seal for proper installation. The oil seal should be installed evenly and completely into the front cover bore.

cardiagn.com

CRANKSHAFT FRONT OIL SEAL INSTALLATION (WITH Z52 OPTION)

Special Tools

- **J-41478-A** Crankshaft Front Oil Seal Installer
- **EN-51091** Crankshaft Front Oil Seal Installer

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

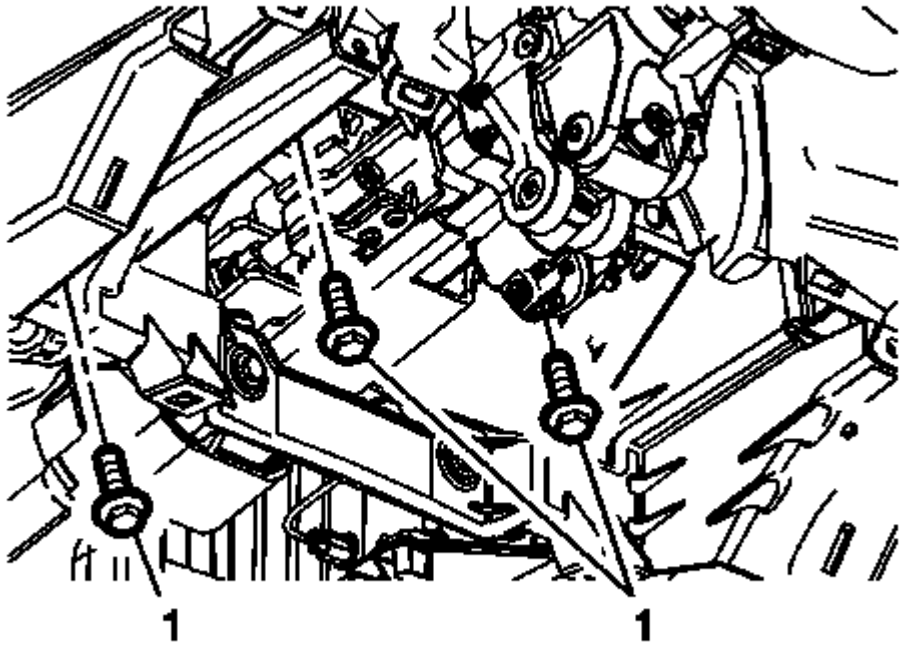


Fig. 321: Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Do not lubricate the oil seal sealing surface.**
- **Do not use the crankshaft front oil seal again.**

1. Install the crankshaft front oil seal (3) onto the threaded rod, nut and washer from **J-41478-A** crankshaft front oil seal installer (1) and **EN-51091** crankshaft front oil seal installer (2).
2. Install the **J-41478-A** crankshaft front oil seal installer threaded rod, nut and washer (1) and **EN-51091** crankshaft front oil seal installer (2) and oil seal (3), into the end of the crankshaft.
3. Use the **J-41478-A** crankshaft front oil seal installer (1) and **EN-51091** crankshaft front oil seal

cardiagn.com

installer (2) in order to install the oil seal (3) into the cover bore.

1. Use a wrench and hold the hex on the installer bolt.
2. Use a second wrench and rotate the installer nut clockwise until the seal bottoms in the cover bore.
3. Remove the tool.
4. Inspect the oil seal for proper installation. The oil seal should be installed evenly and completely into the front cover bore.

OIL PAN INSTALLATION

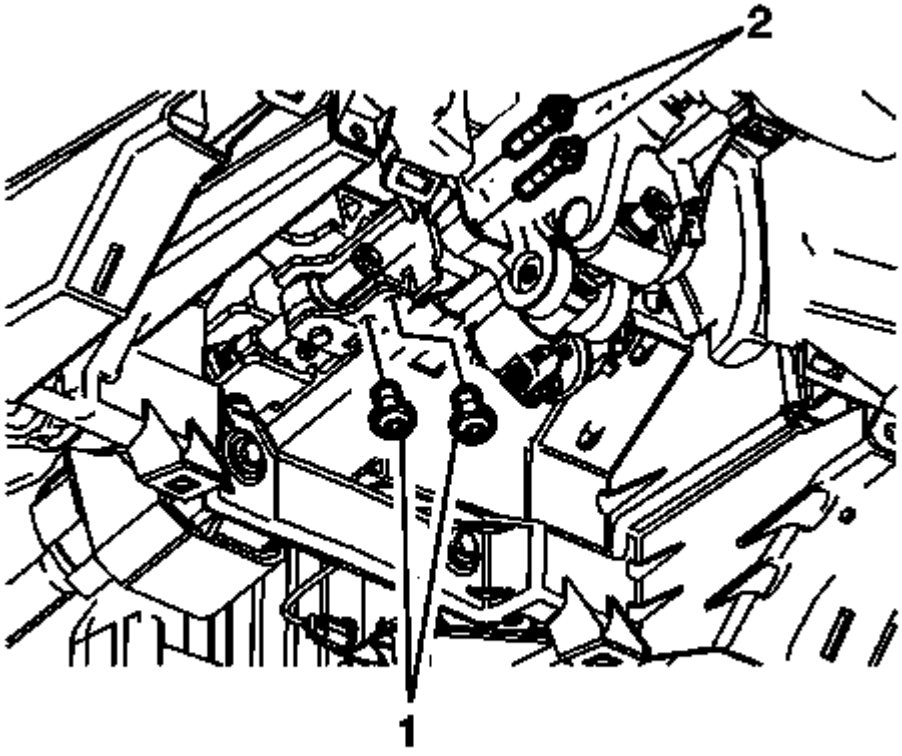


Fig. 322: Oil Pan
Courtesy of GENERAL MOTORS COMPANY

Oil Pan Installation

Callout	Component Name
1	Oil Pan Assembly **Procedure** Apply a 3 mm (0.118 in) bead of RTV sealant on the engine front cover as shown (a). Apply a 5 mm (0.197 in) bead of RTV sealant on the engine front cover as shown (b). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

cardiagn.com

2	Oil Pan Bolt **CAUTION:** **Refer to Fastener Caution .** **Procedure** Tighten the oil pan bolts in the sequence shown. **Tighten** 12 N.m (106 lb in)
3	Oil Pan Bolt **Procedure** Tighten the oil pan bolts in the sequence shown. **Tighten** 25 N.m (18 lb ft)

OIL PAN INSTALLATION (WITH Z52 OPTION)

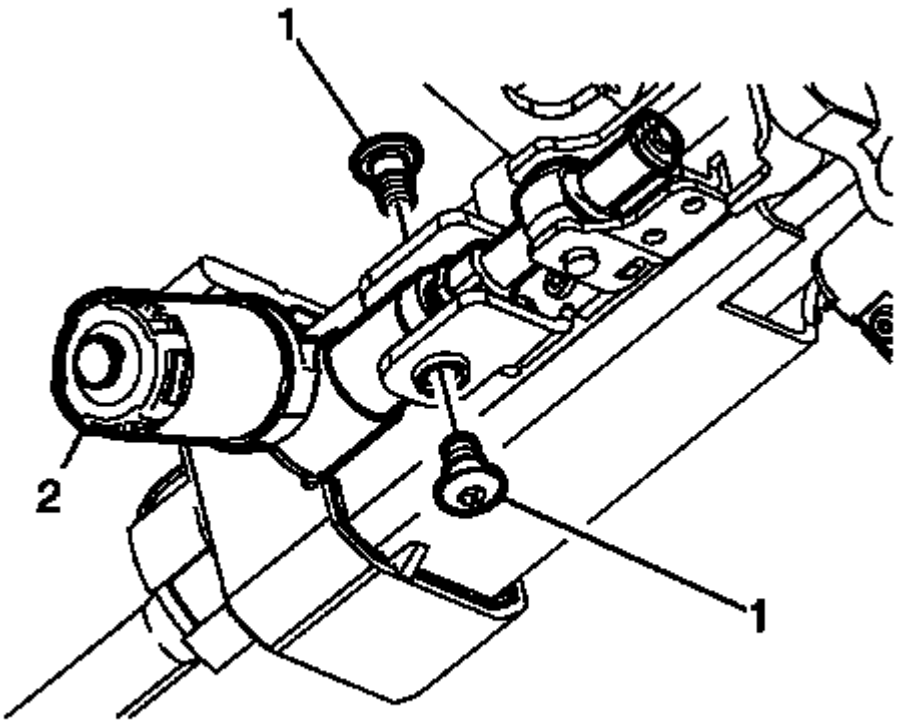


Fig. 323: Oil Pan (with Z52 Option)
Courtesy of GENERAL MOTORS COMPANY

cardiagn.com

Oil Pan Installation (with Z52 Option)

Callout	Component Name
1	Oil Pan Assembly **Procedure** Apply a 3 mm (0.118 in) bead of RTV sealant on the engine front cover as shown (a). Apply a 5 mm (0.197 in) bead of RTV sealant on the engine front cover as shown (b). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
2	Oil Pan Bolt **CAUTION:** **Refer to Fastener Caution .** **Procedure** Tighten the oil pan bolts in the sequence shown. **Tighten** 25 N.m (18 lb ft)
3	Oil Pan Bolt **Procedure** Tighten the oil pan bolts in the sequence shown. **Tighten** 12 N.m (106 lb in)

ENGINE OIL COOLER INSTALLATION

cardiagn.com

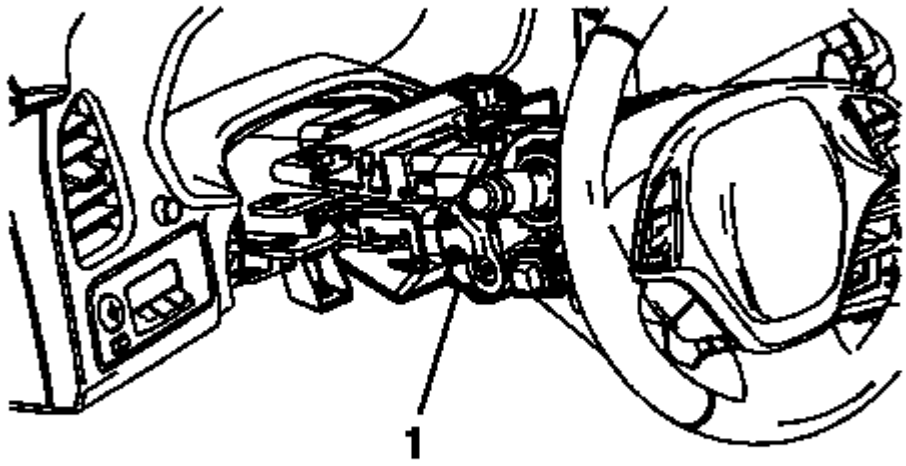


Fig. 324: Engine Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Installation

Callout	Component Name
1	Engine Oil Cooler Gasket
2	Engine Oil Cooler
3	Engine Oil Cooler Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 12 N.m (106 lb in)
4	Engine Oil Cooler Bolt **Tighten** 12 N.m (106 lb in)

ENGINE OIL COOLER INSTALLATION (WITH Z52 OPTION)

cardiagn.com

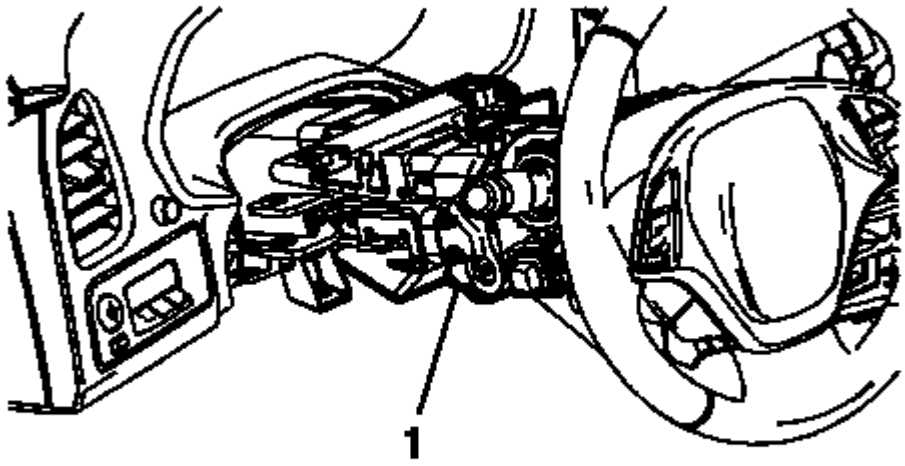


Fig. 325: Engine Oil Cooler (with Z52 Option)
Courtesy of GENERAL MOTORS COMPANY

Engine Oil Cooler Installation (with Z52 Option)

Callout	Component Name
1	Engine Oil Cooler Gasket
2	Engine Oil Cooler
3	Engine Oil Cooler Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 12 N.m (106 lb in)
4	Engine Oil Cooler Bolt **Tighten** 12 N.m (106 lb in)
5	Engine Oil Cooler Bolt

cardiagn.com

	12 N.m (106 lb in)

OIL FILTER INSTALLATION

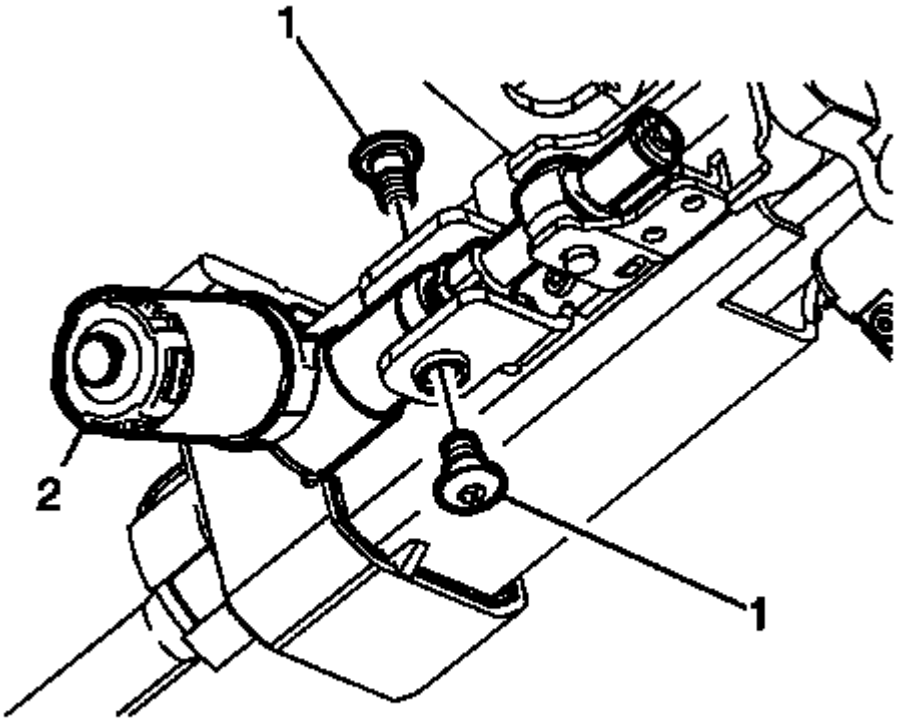


Fig. 326: Oil Filter
Courtesy of GENERAL MOTORS COMPANY

Oil Filter Installation

Callout	Component Name
1	Oil Filter Assembly **CAUTION:** **Refer to Fastener Caution .** **Tighten** 30 (22 lb ft)
2	Oil Pan Drain Plug Seal
3	Oil Pan Drain Plug

cardiagn.com

	25 (18 lb ft)

VALVE LIFTER FOLLOWER GUIDE INSTALLATION

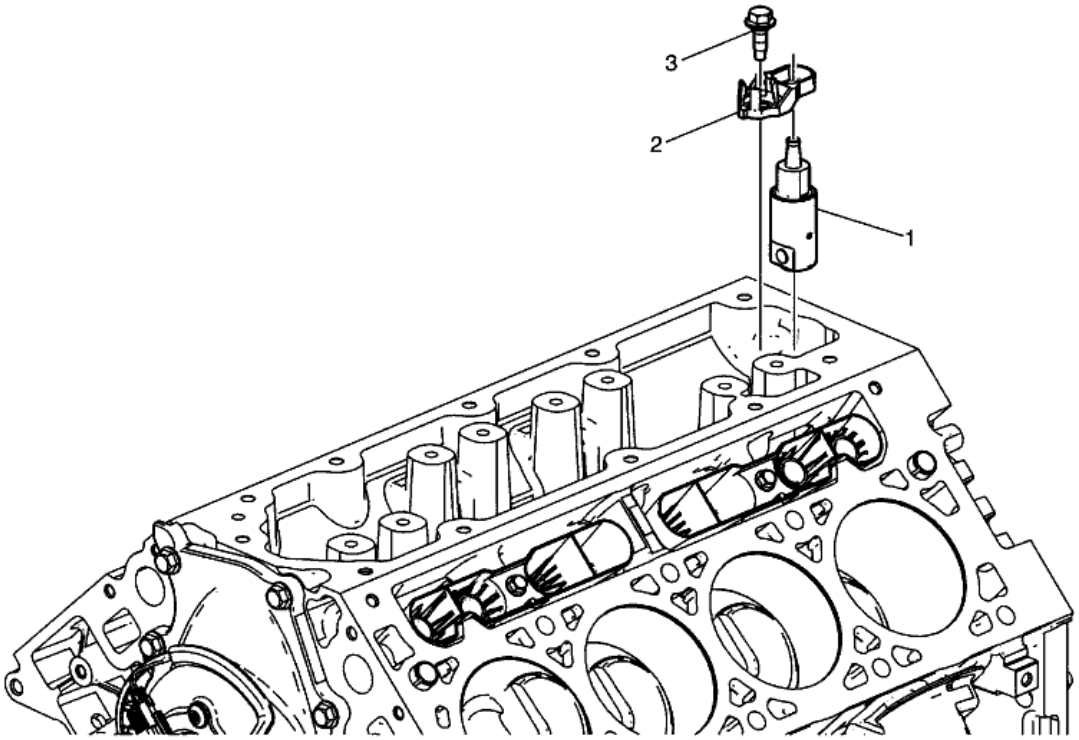


Fig. 327: Valve Lifter Follower Guide
Courtesy of GENERAL MOTORS COMPANY

Valve Lifter Follower Guide Installation

Callout	Component Name
1	Valve Lifter Follower
2	Valve Lifter Follower Guide
3	Valve Lifter Follower Guide Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 12 (106 lb in)

VALVE LIFTER OIL MANIFOLD INSTALLATION

Valve Lifter Oil Manifold Assemble

cardiagn.com

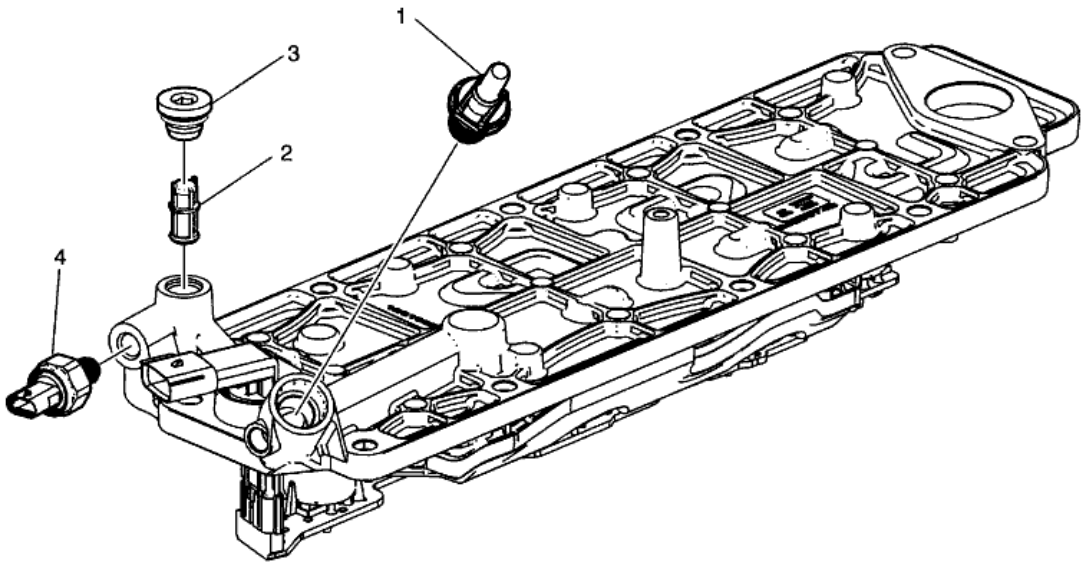


Fig. 328: Valve Lifter Oil Manifold
Courtesy of GENERAL MOTORS COMPANY

Valve Lifter Oil Manifold Assemble

Callout	Component Name
1	PCV Valve
2	Valve LIfter Oil Filter
3	Valve Lifter Oil Manifold Plug **CAUTION:** **Refer to Fastener Caution .** **Procedure** Apply sealant GM P/N 12346004 (Canadian P/N 10953480) to the threads of the sensor. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . **Tighten** 30 N.m (22 lb ft)
4	Oil Pressure Sensor **Procedure** Apply sealant GM P/N 12346004 (Canadian P/N 10953480) to the threads of the sensor. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . **Tighten** 35 N.m (26 lb ft)

cardiagn.com

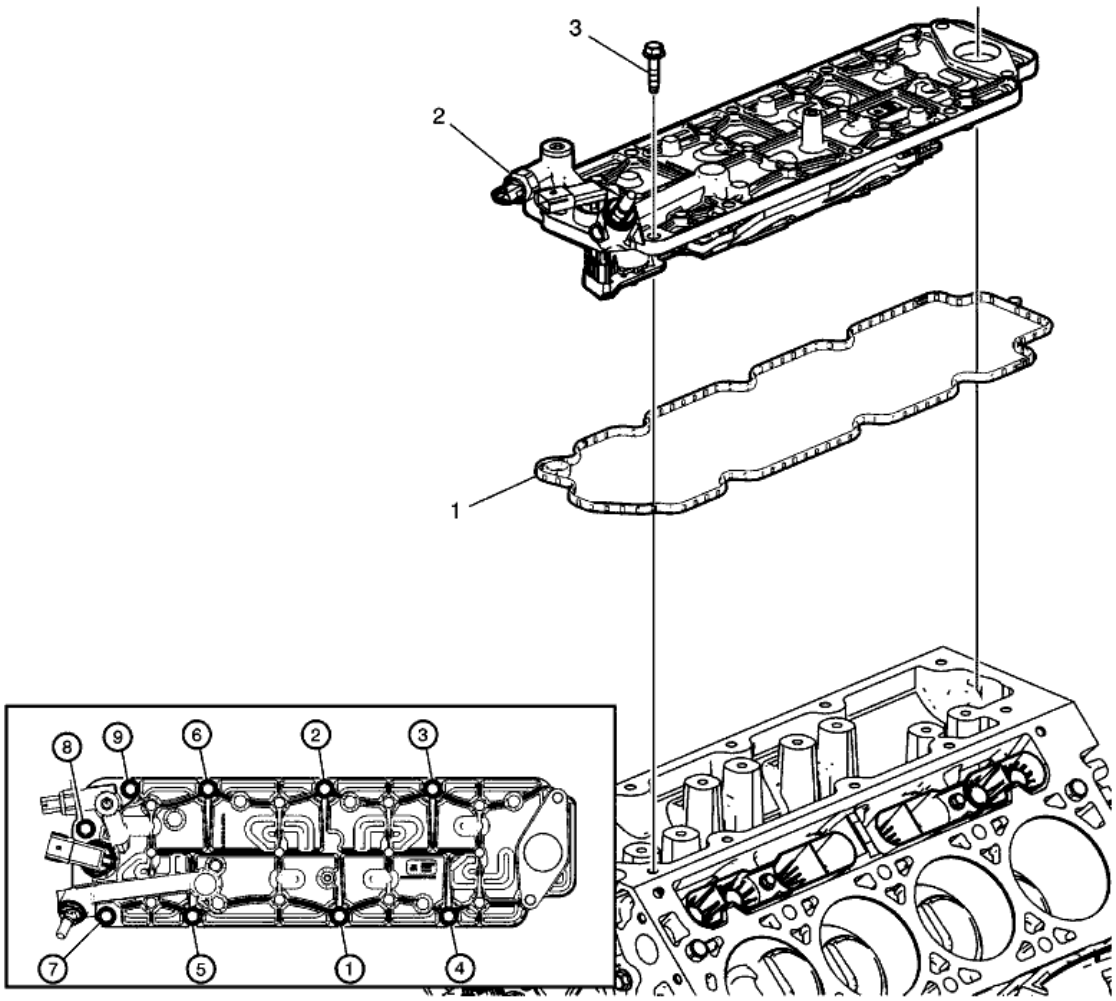


Fig. 329: Valve Lifter Oil Manifold
Courtesy of GENERAL MOTORS COMPANY

Valve Lifter Oil Manifold Installation

Callout	Component Name
1	Valve Lifter Oil Manifold Gasket **NOTE:** **Must use a NEW gasket.**
2	Valve Lifter Oil Manifold Assembly
3	Valve Lifter Oil Manifold Bolt **Procedure** Tighten the valve lifter oil manifold bolts in the sequence shown. **Tighten** 12 N.m (106 lb in)

VALVE LIFTER INSTALLATION

cardiagn.com

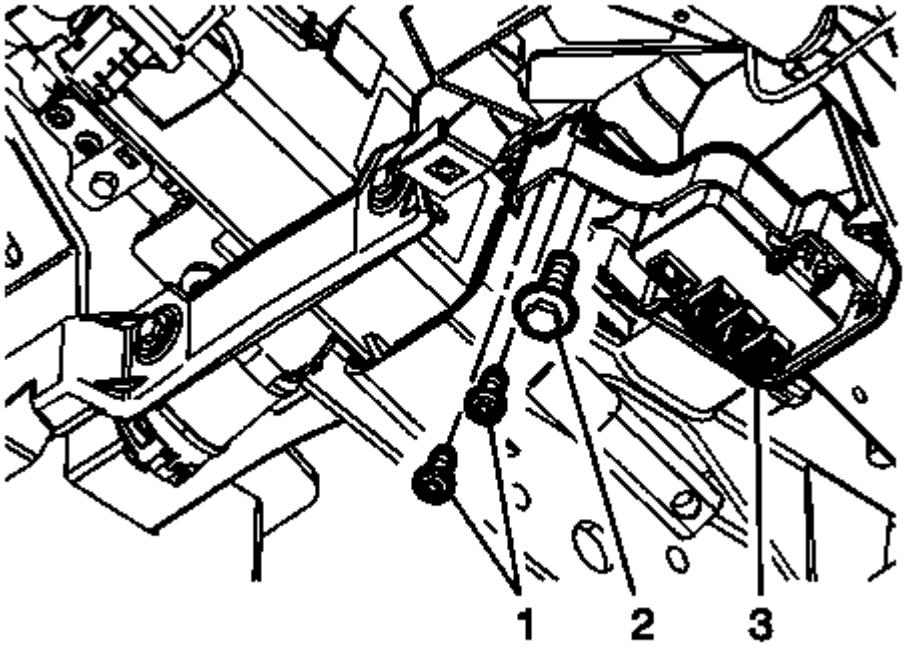


Fig. 330: Exploded View Of Lifter Guides & Lifters
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **When using the valve lifters again, install the lifters to their original locations.**
- **If camshaft replacement is required, the valve lifters must also be replaced.**
- **Each of the 4 valve guide assemblies will contain 2 active fuel management valve lifters and 2 non-active fuel management valve lifters.**
- **With the lifters and guides properly installed, cylinders 1, 4, 6 and 7 lifter bores will each contain 2 active fuel management valve lifters.**

1. Lubricate the valve lifters (209, 219) and engine block valve lifter bores with clean engine oil.

cardiagn.com

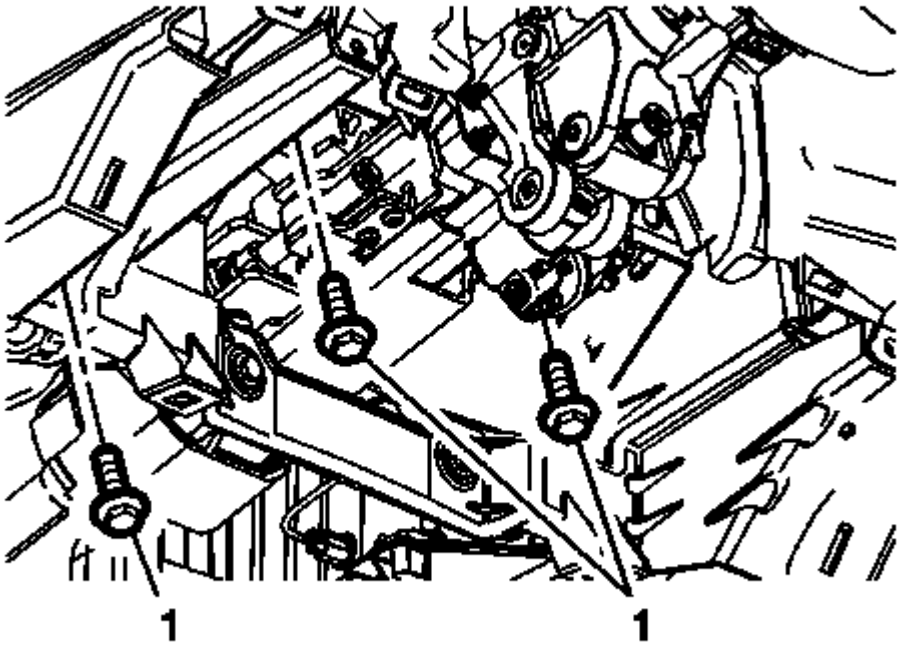


Fig. 331: Inserting Valve Lifters Into Lifter Guides
Courtesy of GENERAL MOTORS COMPANY

2. Insert the valve lifters into the lifter guides.
    - Align the flat area (3) on the top of the non-active fuel management lifter with the flat area in the lifter guide bore. Push the lifter completely into the guide bore.
    - The active fuel management lifters (4) are to be installed into the guide, with the notch in the guide (1) aligned with the raised area (2) of the lifter.

cardiagn.com

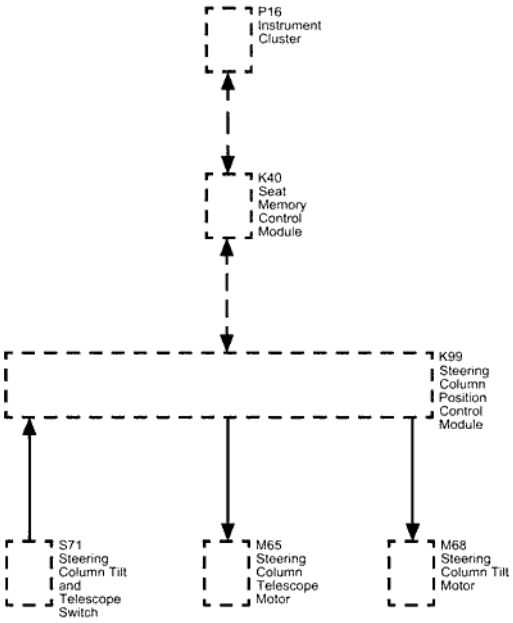


Fig. 332: View Of Lifter Guides & Lifters
Courtesy of GENERAL MOTORS COMPANY

3. Install the valve lifters and guide assembly (210) to the engine block.

CAUTION: Refer to Fastener Caution .

4. Install the valve lifter guide bolts (211) and tighten to 12 N.m (106 lb in).

CYLINDER HEAD INSTALLATION - LEFT SIDE

cardiagn.com

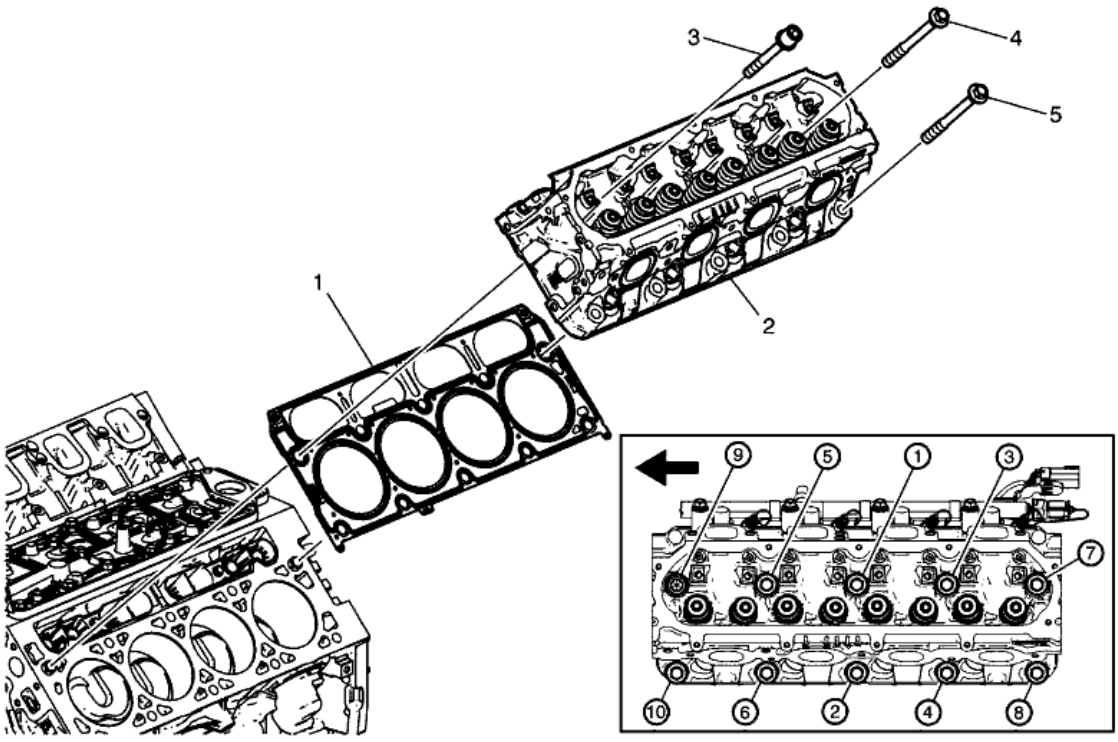


Fig. 333: Cylinder Head - Left Side
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head Installation - Left Side

Callout	Component Name
1	Cylinder Head Gasket **NOTE:** **Must use NEW gasket.**
2	Cylinder Head Assembly
3	Cylinder Head Bolt **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 .** **Procedure** Tighten the cylinder head bolts each pass in the sequence shown.

cardiagn.com

	80 (59 lb ft) + 90° + 40°
4	Cylinder Head Bolt **Procedure** Tighten the cylinder head bolts each pass in the sequence shown. **Tighten** 80 (59 lb ft) + 90° + 60°
5	Cylinder Head Bolt **Procedure** Tighten the cylinder head bolts each pass in the sequence shown. **Tighten** 80 (59 lb ft) + 90° + 60°

CYLINDER HEAD INSTALLATION - RIGHT SIDE

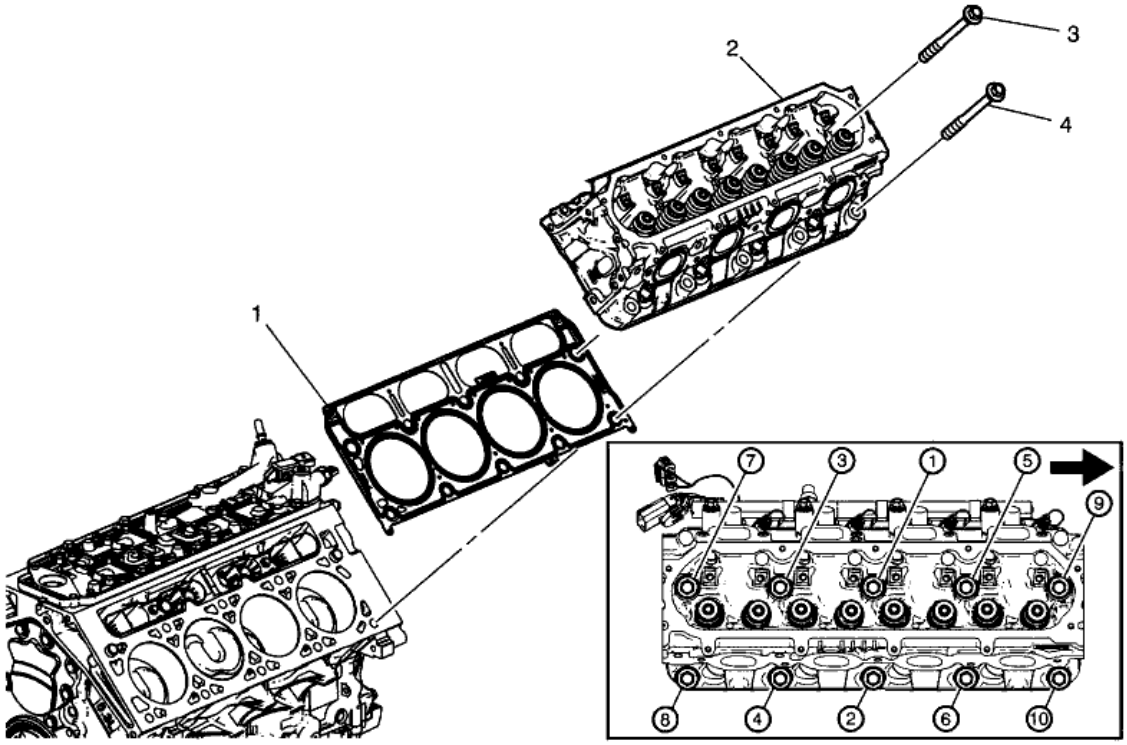


Fig. 334: Cylinder Head - Right Side
Courtesy of GENERAL MOTORS COMPANY

Cylinder Head Installation - Right Side

Callout	Component Name
1	Cylinder Head Gasket **NOTE:** **Must use NEW gasket.**
2	Cylinder Head Assembly

cardiagn.com

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 .** **Procedure** Tighten the cylinder head bolts each pass in the sequence shown. **Tighten** 80 (59 lb ft) + 90° + 60°
4	Cylinder Head Bolt **Procedure** Tighten the cylinder head bolts each pass in the sequence shown. **Tighten** 80 (59 lb ft) + 90° + 60°

VALVE ROCKER ARM AND PUSH ROD INSTALLATION

cardiagn.com

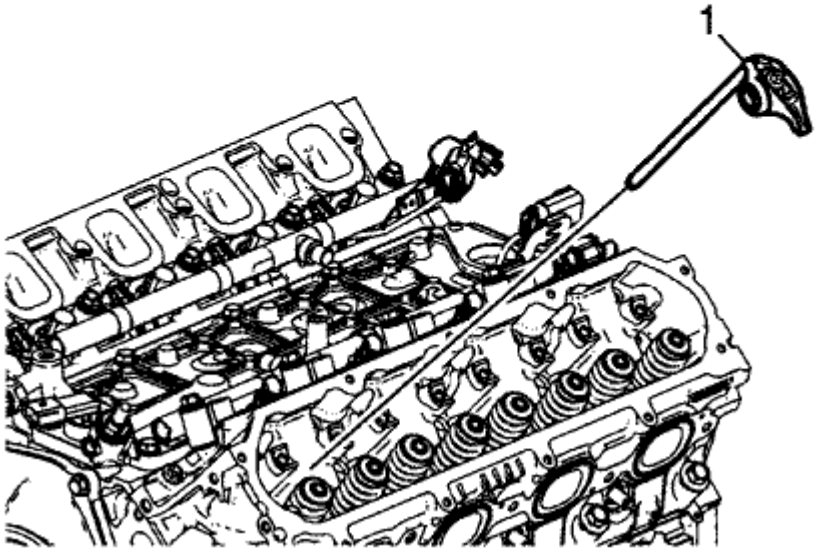


Fig. 335: Valve Rocker Arm And Push Rod
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **When using the valve train components again, always install the components to the original location and position.**
- **Valve lash is net build. No valve adjustment is required.**
- **Lubricate the flange of the valve rocker arm bolts with clean engine oil.**
- **Lubricate the valve rocker arms and pushrods with clean engine oil.**
- **Ensure the pushrods seat properly to the valve lifter sockets.**
- **The rocker arm bolts are not serviced separately.**
- **Ensure the pushrods seat properly to the ends of the rocker arms.**
- **DO NOT tighten the rocker arm bolts at this time.**

1. Install the valve rocker arm and pushrod assemblies (1).

cardiagn.com

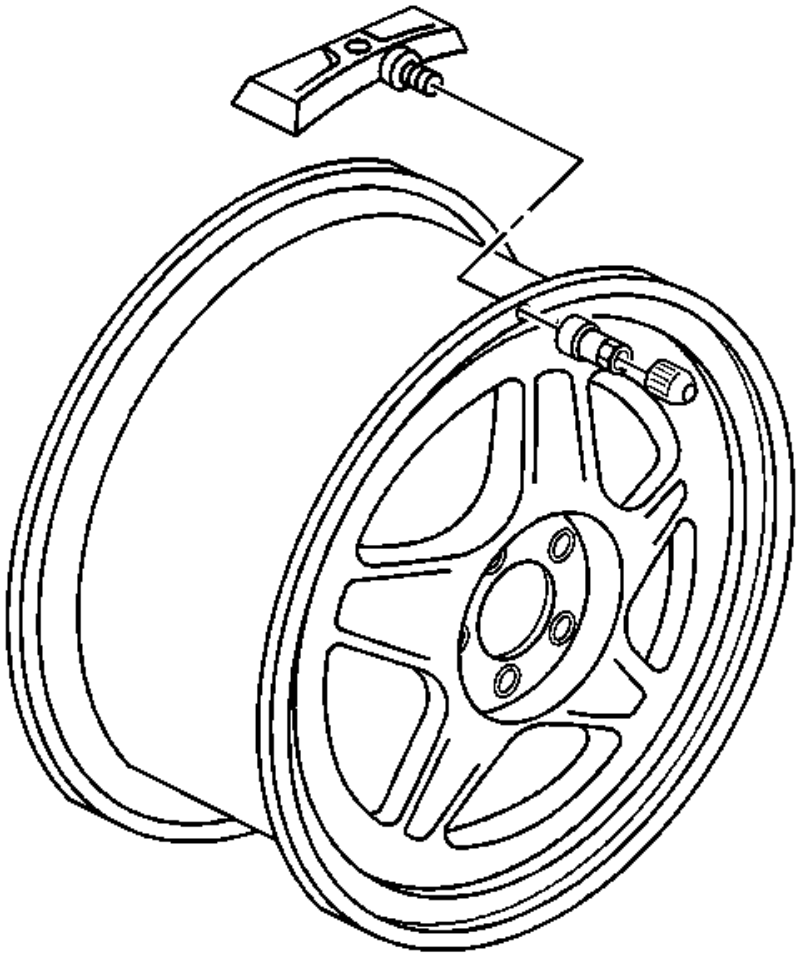


Fig. 336: View Of Camshaft & Crankshaft Sprocket Alignment Marks
Courtesy of GENERAL MOTORS COMPANY

2. Rotate the crankshaft until number 1 piston is at top dead center of compression stroke.

   In this position, cylinder number 1 rocker arms will be off lobe lift and the crankshaft sprocket key will be at the 1:30 position. The camshaft and crankshaft sprocket alignment marks (1, 2) will be in the 12 o'clock position. If viewing from the rear of the engine, the additional crankshaft pilot hole, non-threaded, will be in the 10:30 position.

   The engine firing order is 1, 8, 7, 2, 6, 5, 4, 3.

   Cylinders 1, 3, 5 and 7 are left bank.

   Cylinders 2, 4, 6 and 8 are right bank.

   CAUTION: Refer to Fastener Caution

cardiagn.com

3. With the engine in the number 1 firing position, tighten the following valve rocker arm bolts:
    1. Tighten the exhaust valve rocker arm bolts 1, 2, 7 and 8 to 30 N.m (22 lb ft).
    2. Tighten the intake valve rocker arm bolts 1, 3, 4 and 5 to 30 N.m (22 lb ft).
4. Rotate the crankshaft 360 degrees.
5. Tighten the following valve rocker arm bolts:
    - Tighten the exhaust valve rocker arm bolts 3, 4, 5 and 6 to 30 N.m (22 lb ft).
    - Tighten the intake valve rocker arm bolts 2, 6, 7 and 8 to 30 N.m (22 lb ft).

VALVE ROCKER ARM COVER INSTALLATION - LEFT SIDE

Valve Rocker Arm Cover Assemble - Left Side

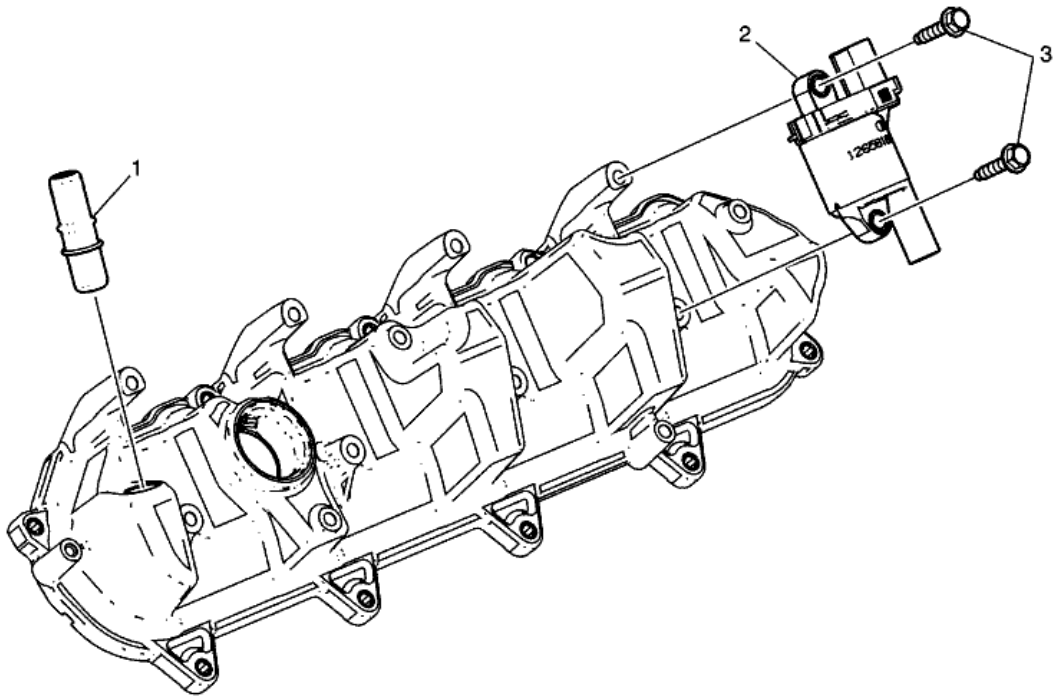


Fig. 337: Valve Rocker Arm Cover - Left Side
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Assemble - Left Side

Callout	Component Name
1	Ignition Coil
2	Ignition Coil Bolt **CAUTION:**

cardiagn.com

	Tighten 10 N.m (89 lb in)

Valve Rocker Arm Cover Installation - Left Side

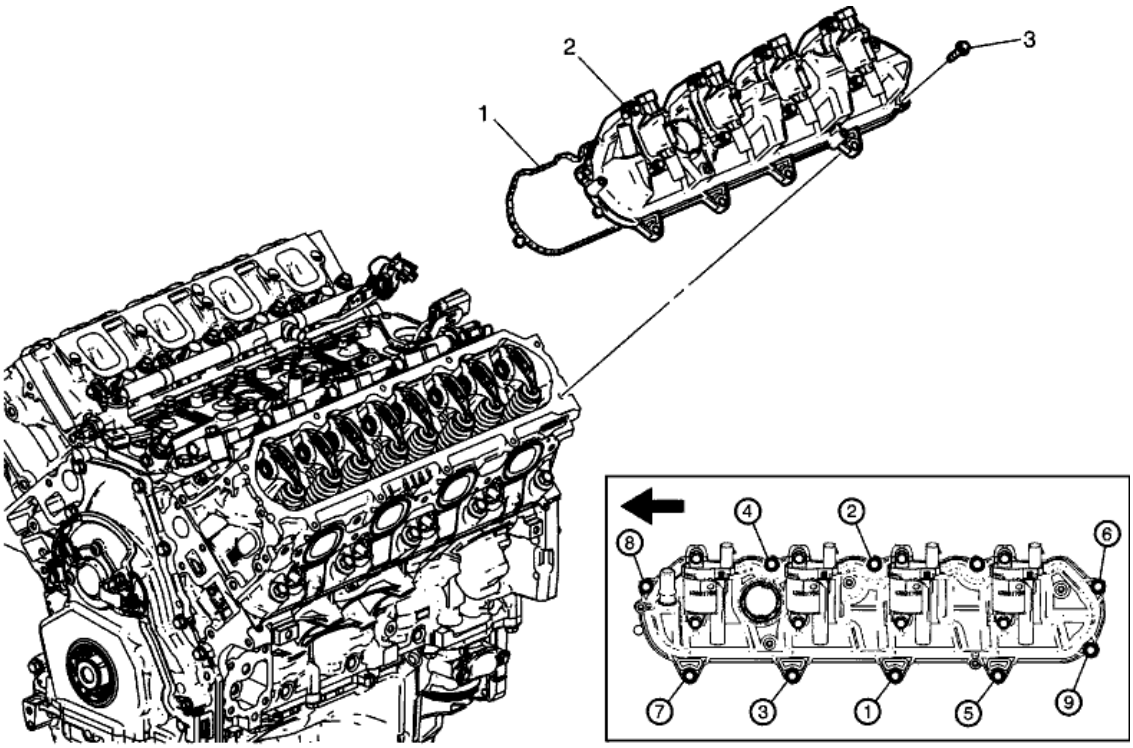


Fig. 338: Valve Rocker Arm Cover - Left Side
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Installation - Left Side

Callout	Component Name
1	Valve Rocker Arm Cover Gasket **NOTE:** **Must use a NEW gasket.**
2	Valve Rocker Arm Cover - Left Side
3	Valve Rocker Arm Cover Bolt **CAUTION:** **Refer to Fastener Caution .** **Procedure** Tighten the valve rocker arm cover bolts in the sequence shown.

cardiagn.com

	10 (89 lb in)

VALVE ROCKER ARM COVER INSTALLATION - RIGHT SIDE

Valve Rocker Arm Cover Assemble - Right Side

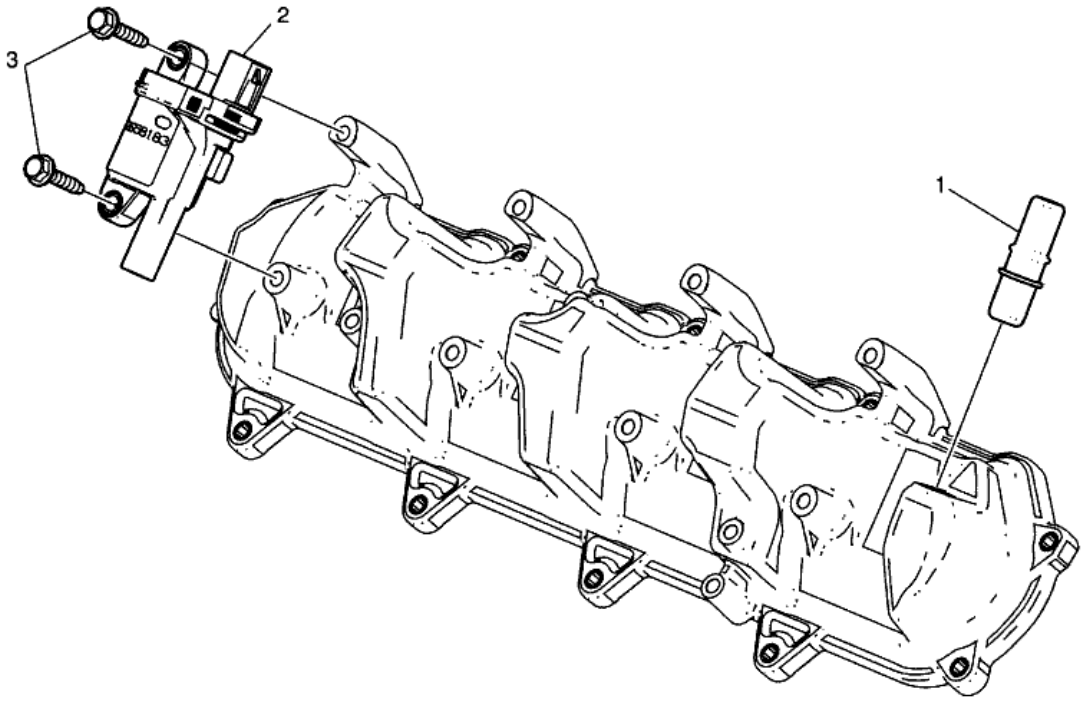


Fig. 339: Valve Rocker Arm Cover - Right Side
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Assemble - Right Side

Callout	Component Name
1	Ignition Coil
2	Ignition Coil Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)

Valve Rocker Arm Cover Installation - Right Side

cardiagn.com

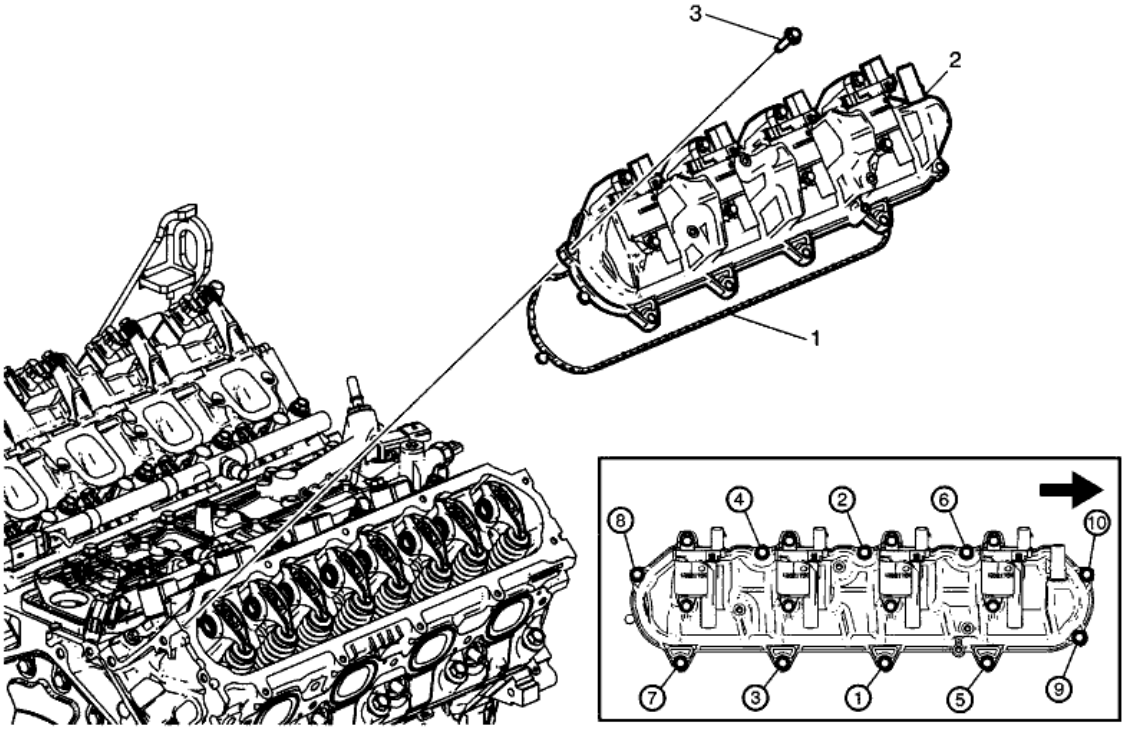


Fig. 340: Valve Rocker Arm Cover - Right Side
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Installation - Right Side

Callout	Component Name
1	Valve Rocker Arm Cover Gasket **NOTE:** **Must use a NEW gasket.**
2	Valve Rocker Arm Cover - Right Side
3	Valve Rocker Arm Cover Bolt **CAUTION:** **Refer to Fastener Caution .** **Procedure** Tighten the valve rocker arm cover bolts in the sequence shown. **Tighten** 10 (89 lb in)

VALVE ROCKER ARM COVER INSTALLATION - RIGHT SIDE (WITH Z52 OPTION)

Valve Rocker Arm Cover Assemble - Right Side

cardiagn.com

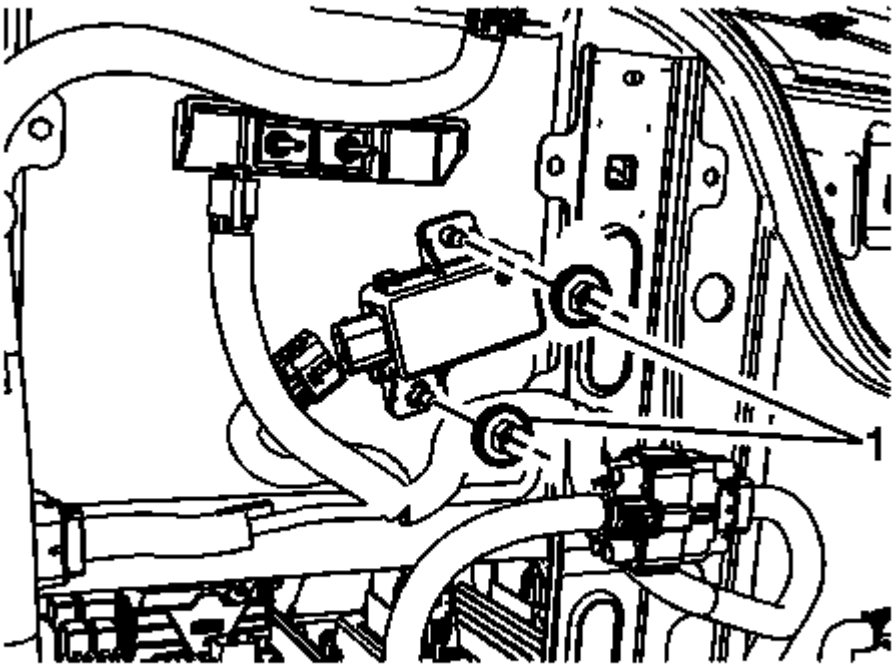


Fig. 341: Valve Rocker Arm Cover - Right Side
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Assemble - Right Side

Callout	Component Name
1	Ignition Coil
2	Ignition Coil Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (88 lb in)

Valve Rocker Arm Cover Installation - Right Side

cardiagn.com

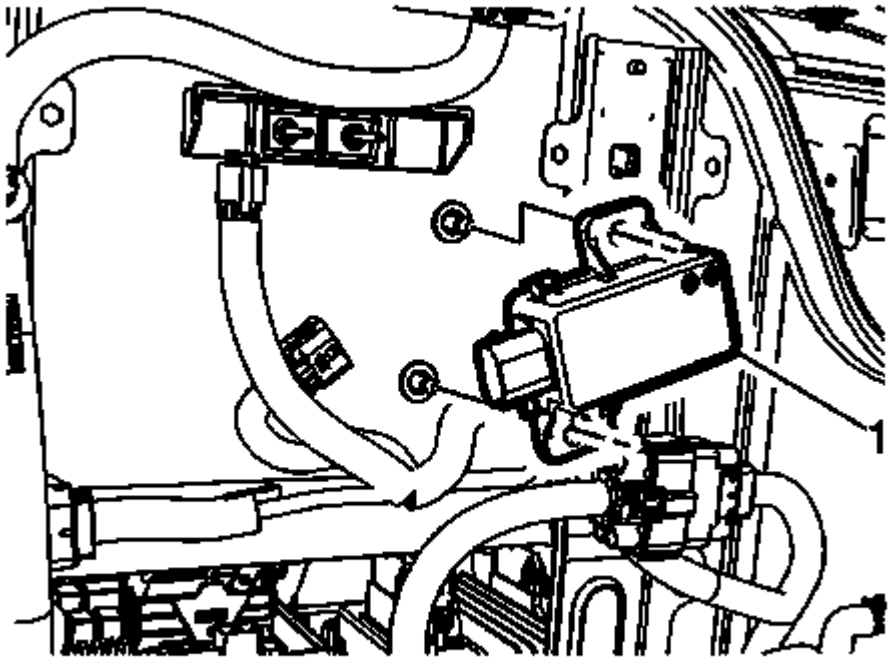


Fig. 342: Valve Rocker Arm Cover - Right Side
Courtesy of GENERAL MOTORS COMPANY

Valve Rocker Arm Cover Installation - Right Side (with Z52 Option)

Callout	Component Name
1	Valve Rocker Arm Cover Gasket **NOTE:** **Must use a NEW gasket.**
2	Valve Rocker Arm Cover - Right Side
3	Valve Rocker Arm Cover Bolt **CAUTION:** **Refer to Fastener Caution .** **Procedure** Tighten the valve rocker arm cover bolts in the sequence shown. **Tighten** 10 (88 lb ft)

cardiagn.com

VALVE LIFTER OIL FILTER INSTALLATION

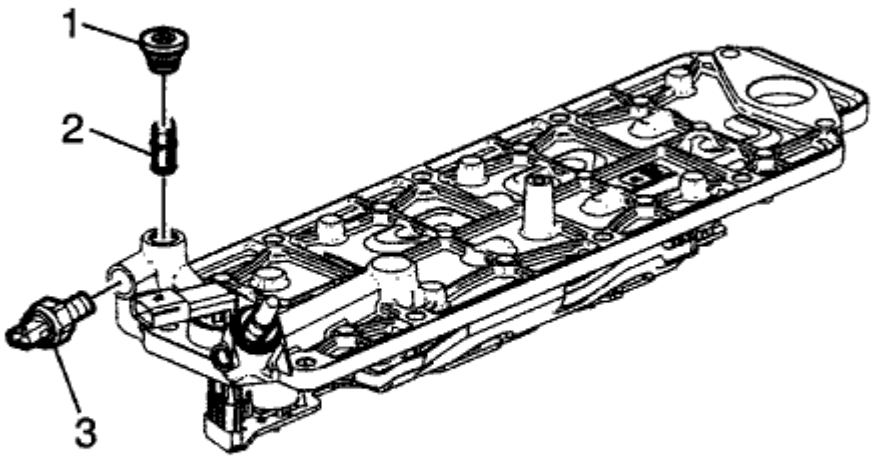


Fig. 343: Valve Lifter Oil Filter
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not allow dirt or debris to enter the oil passages of the manifold. Plug, as required.

1. Install a NEW oil filter (2).
2. Apply sealant GM P/N 12346004 (Canadian P/N 10953480) to the threads of the plug. Refer to **Adhesives, Fluids, Lubricants and Sealers** .

CAUTION: Refer to Fastener Caution .

3. Install the valve lifter oil manifold plug (1). Tighten to 30 N.m (22 lb ft).
4. Apply sealant GM P/N 12346004 (Canadian P/N 10953480) to the threads of the sensor. Install the oil pressure sensor (3).
5. Tighten the oil pressure sensor to 35 N.m (26 lb ft).

cardiagn.com

FUEL PUMP INSTALLATION

Special Tools

EN-51092 Fuel Pump Installation Gauge

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

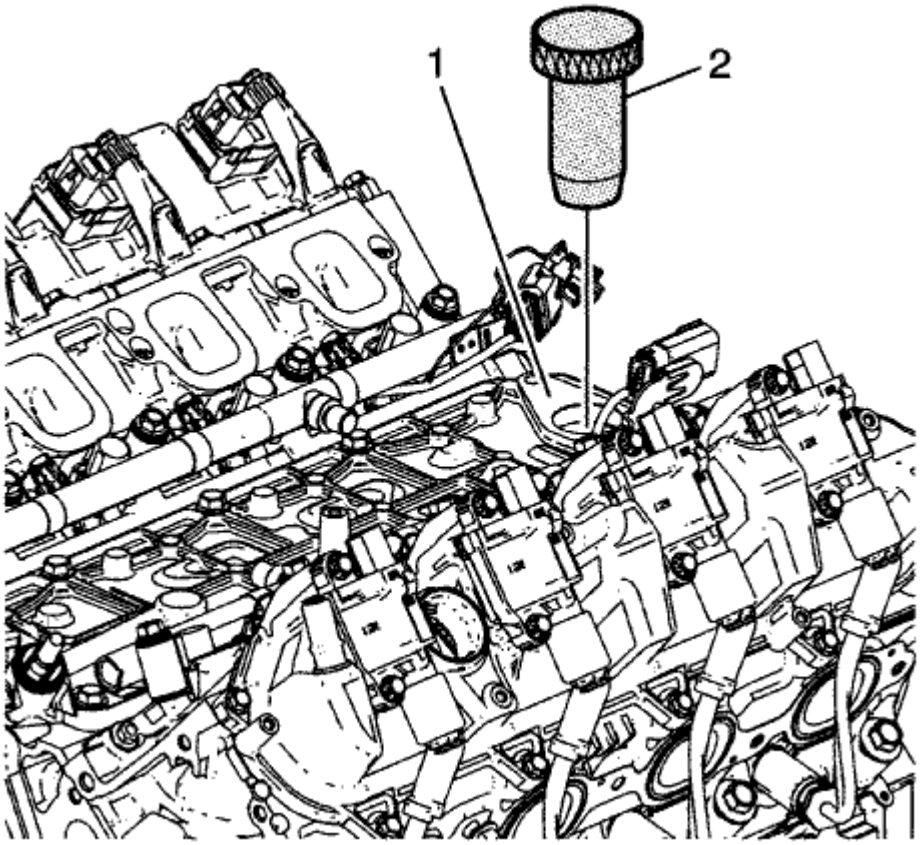


Fig. 344: Lifter Oil Manifold Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: The camshaft must be in the base circle position before the high pressure fuel pump is installed.

1. Use the **EN-51092** 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 top surface of the Lifter Oil Manifold Assembly (1).

cardiagn.com

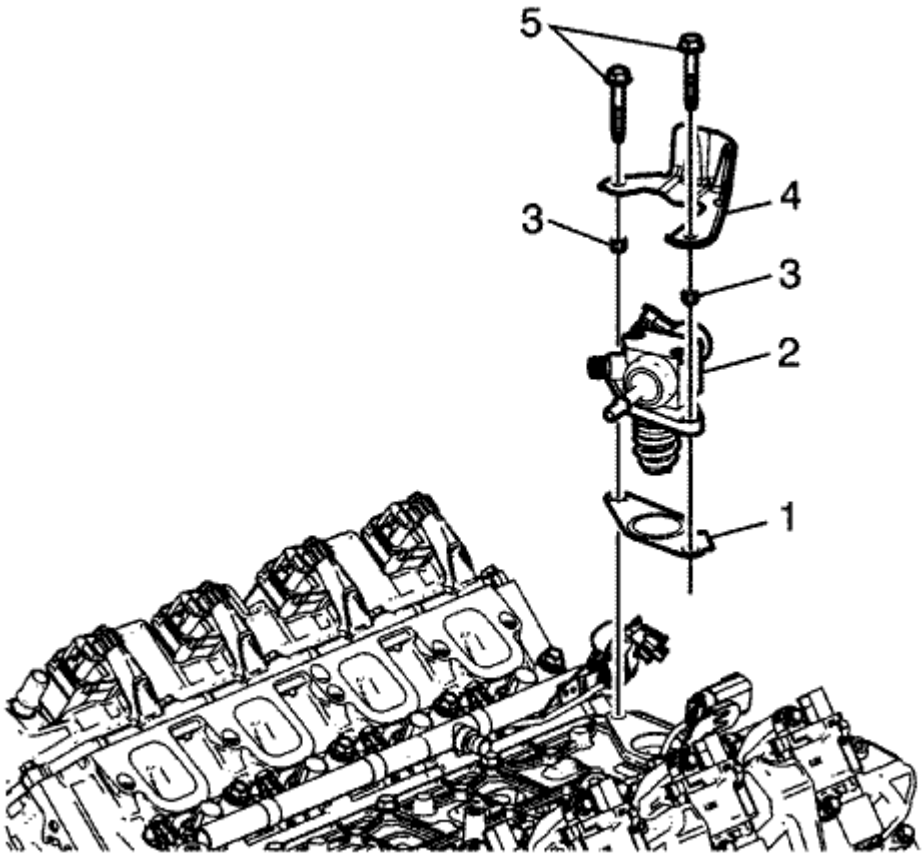


Fig. 345: NEW High Pressure Fuel Pump Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure that the high pressure fuel pump roller lifter is oriented properly, the camshaft is at base circle and the number 1 piston is at top dead center (TDC) on the exhaust stroke.

NOTE: Ensure the plastic bolt retainers (3) are installed in the high pressure fuel pump mounting holes before installing.

2. Install a (1).
3. Install the high pressure fuel pump (2) and high pressure fuel pump cover (4).

CAUTION: Refer to Fastener Caution .

CAUTION: Alternately hand-tighten the fuel pump bolts one turn at a time until the pump is fully seated. Trying to draw down the pump without even side-to-side tightening may result in pump plunger damage.

cardiagn.com

4. Start and hand-tighten the NEW high pressure fuel pump bolts (5) evenly and tighten the high pressure fuel pump bolts to 25 N.m (18 lb ft).

FUEL RAIL AND INJECTORS INSTALLATION

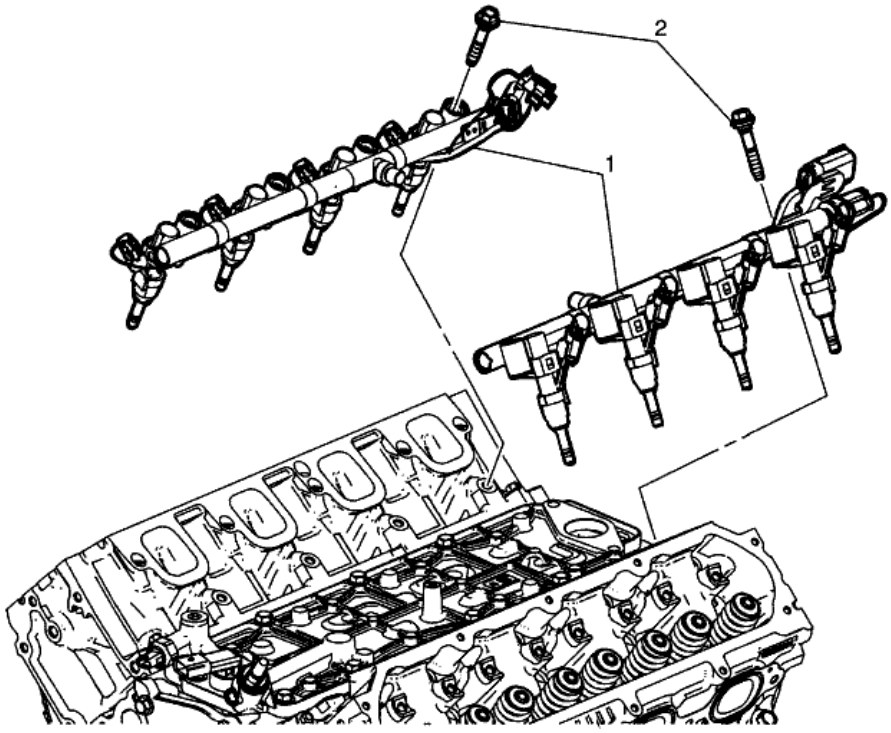


Fig. 346: Fuel Rail and Injectors
Courtesy of GENERAL MOTORS COMPANY

Fuel Rail and Injectors Installation

Callout	Component Name
1	Fuel Rail Insulator
2	Direct Fuel Injection Fuel Rail Assembly **NOTE:** • **If re-using injectors be sure to replace lower compression seals.** • **Do not lubricate the combustion seals when replacing.** • **Make sure the injectors are free from debris and lubricant. Lubricant can burn and ruin seals.** • **The rails must be drawn down evenly before final torque. The lifter bores can become scored if not.** Refer to **Fuel Rail and Injectors Cleaning and Inspection**.
	Fuel Injection Fuel Rail Bolt

cardiagn.com

3	**NOTE:** **Clean the threads and apply a threadlocker.** Refer to **Adhesives, Fluids, Lubricants, and Sealers** . **Tighten** 25 (18 lb ft)

FUEL PUMP INSULATOR AND FUEL FEED PIPES INSTALLATION

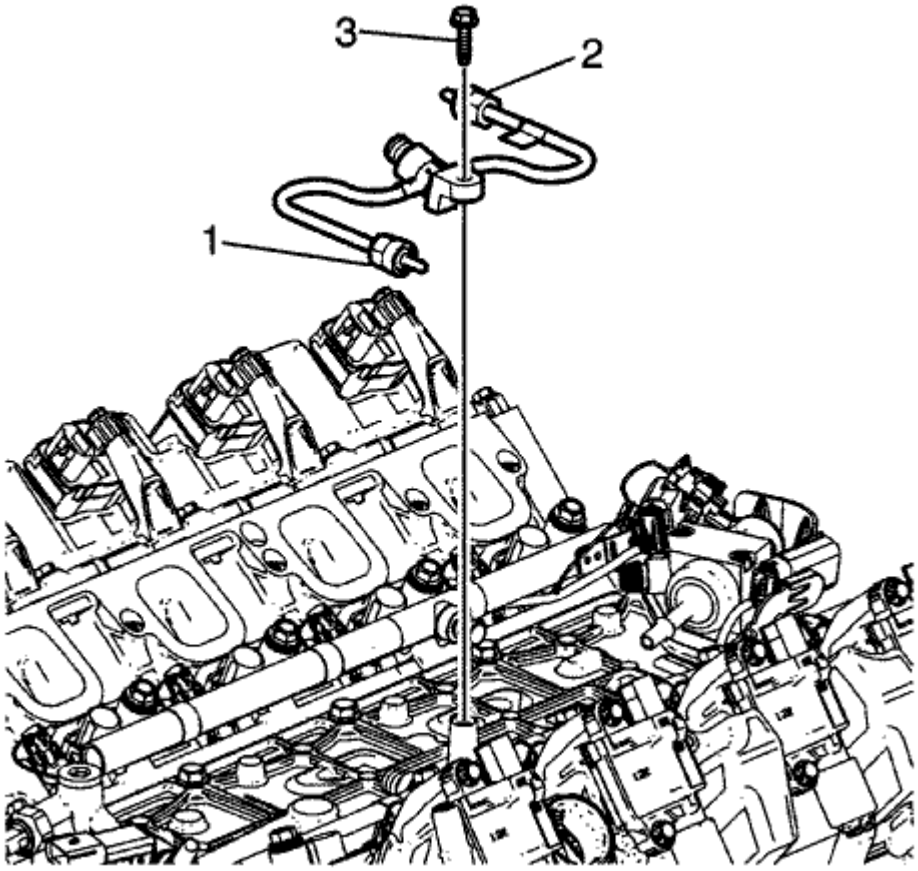


Fig. 347: RH Fuel Rail Crossover Pipe Bolt
Courtesy of GENERAL MOTORS COMPANY

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.

NOTE:

- **DO NOT reuse the high pressure fuel rail crossover pipe.**
- **The tightening order and torque are critical to proper fuel system fit**

cardiagn.com

and function. Be sure to follow installation and tightening steps exactly.

1. Install the NEW high pressure LH to RH fuel rail crossover pipe by starting both fuel crossover pipe fitting nuts (1 and 2) to finger-tight only.
2. Install the high pressure LH to RH fuel rail crossover pipe bolt (3) and hand tighten only.
3. Tighten the fuel rail crossover pipe fittings to 28 N.m (21 lb ft) in the following order: Left Fuel Rail (1) then Right Fuel Rail (2).

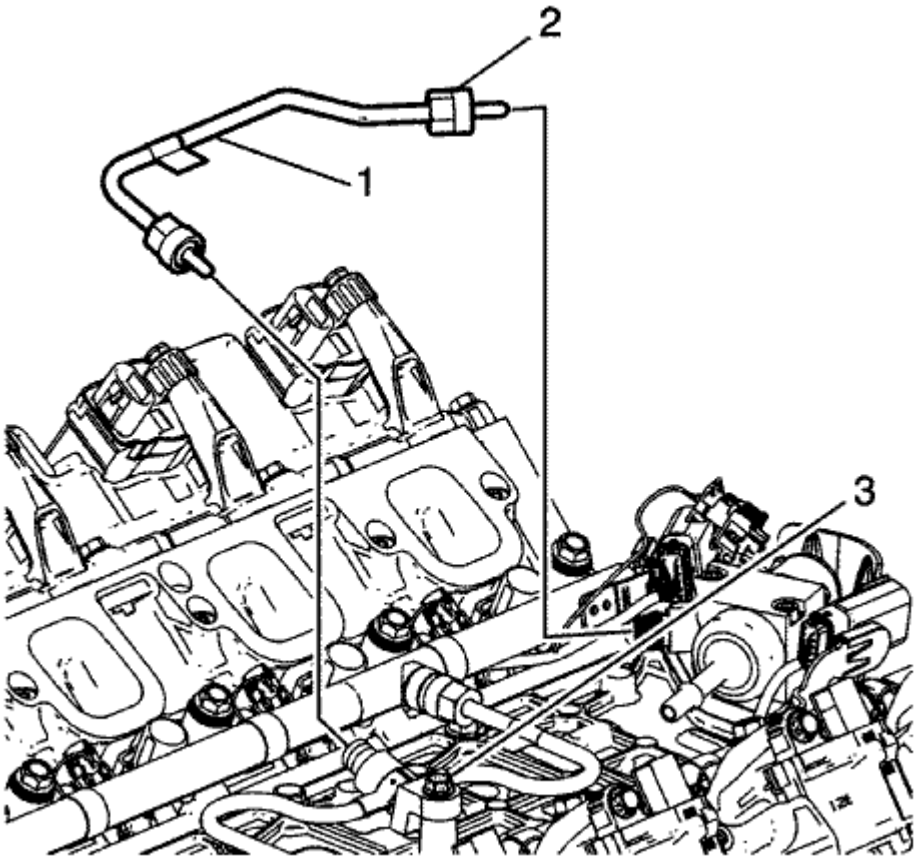


Fig. 348: Crossover Pipe And Fuel Feed Pipe Fittings
Courtesy of GENERAL MOTORS COMPANY

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.

4. Tighten the crossover pipe bolt (3) to 10 N.m (89 lb in).
5. Install the NEW high pressure fuel feed pipe that connects the fuel pump to the crossover pipe (1). Finger-tighten both fuel pipe fitting nuts (2).

cardiagn.com

6. Tighten the high pressure fuel feed pipe fittings to 28 N.m (21 lb ft) in the following order: at the fuel pump (1) then at the crossover (2).

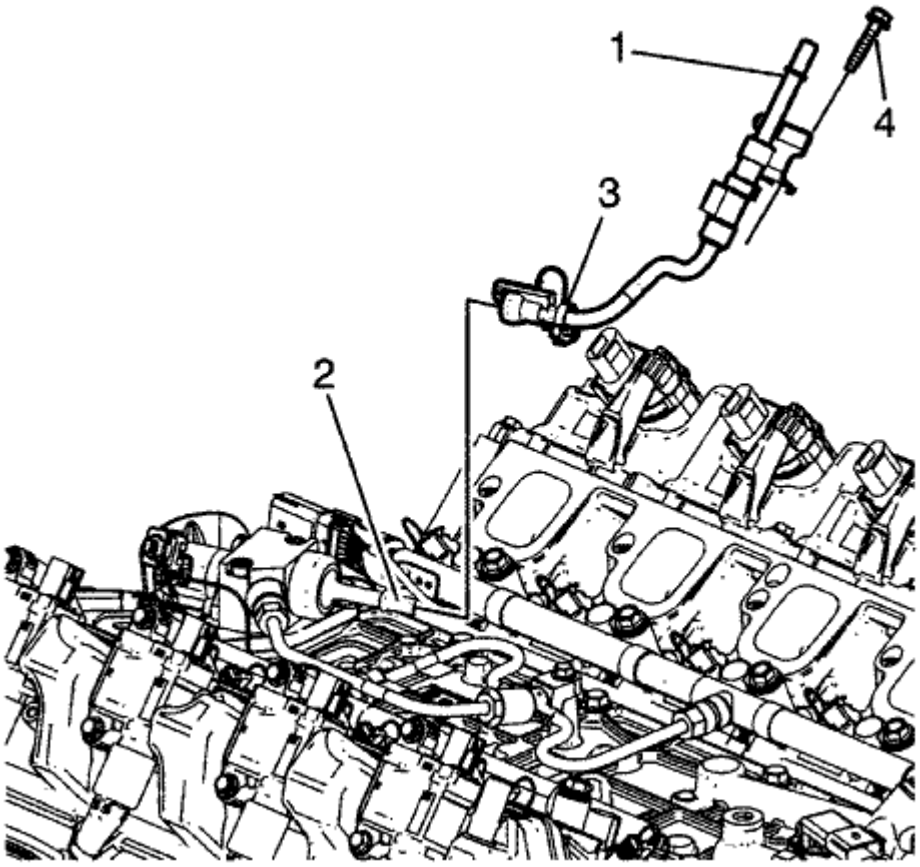


Fig. 349: Low Pressure Fuel Feed Pipe To LH Rocker Cover Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Install low pressure fuel feed pipe (1) to the fuel pump (2). Press fuel pipe until an audible click is heard. Install redundant clip (3).
8. Install low pressure fuel feed pipe to LH rocker cover. Tighten fuel fee bolt (4) to 10 N.m (89 lb in).

cardiagn.com

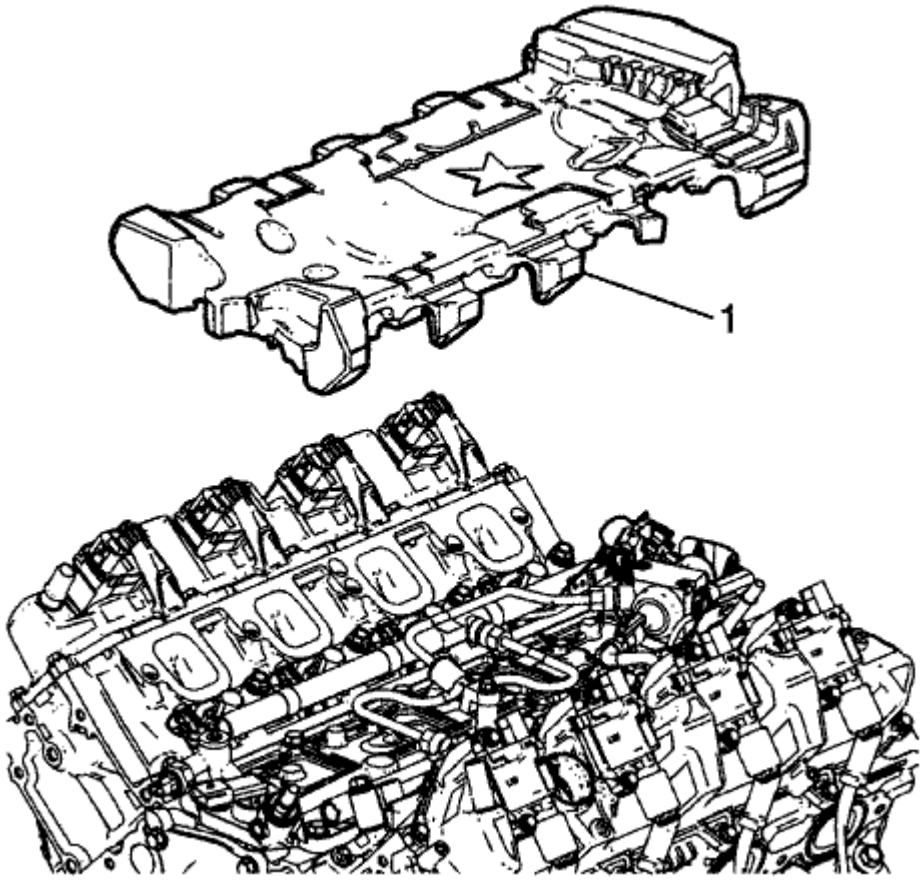


Fig. 350: Fuel Pump Insulator
Courtesy of GENERAL MOTORS COMPANY

9. Install the fuel pump insulator (1).

ENGINE COOLANT MANIFOLD INSTALLATION

cardiagn.com

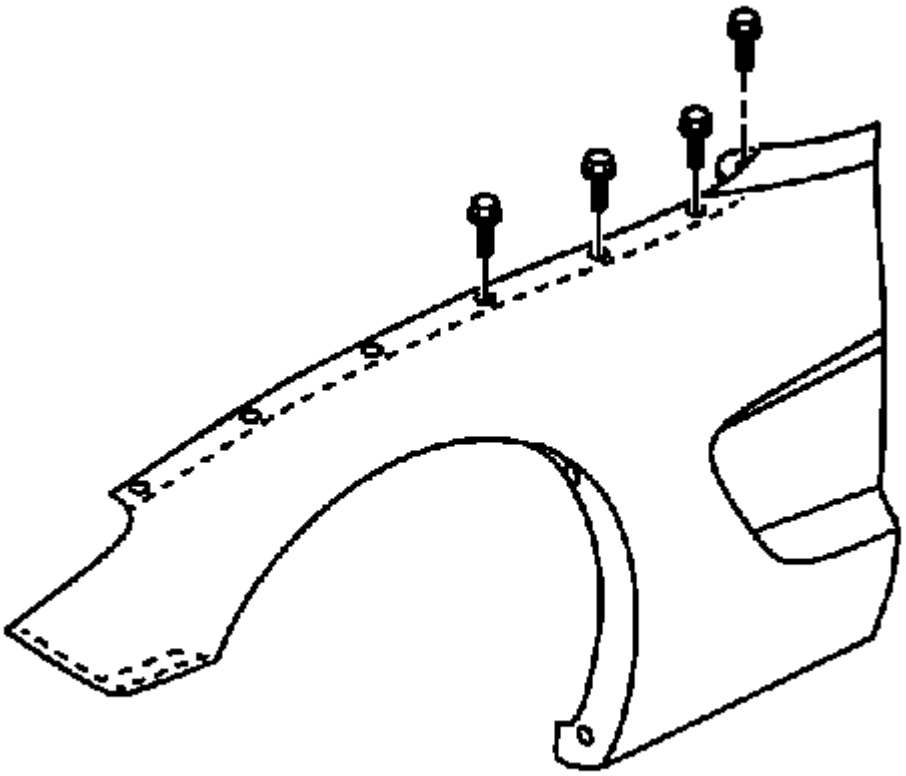


Fig. 351: Engine Coolant Manifold
Courtesy of GENERAL MOTORS COMPANY

Engine Coolant Manifold Installation

Callout	Component Name
1	Engine Coolant Manifold Gaskets **NOTE:** **Must use NEW gaskets when installing engine coolant manifold.**
2	Engine Coolant Manifold Assembly **Procedure** Connect the oil pressure sensor and valve lifter oil manifold connectors after installing the engine coolant manifold assembly.
	Engine Coolant Manifold Bolt **CAUTION:** **Refer to Fastener Caution .**

cardiagn.com

3	**Procedure** Tighten the engine coolant manifold bolts in the sequence shown. **NOTE:** **Clean the threads and apply a threadlocker.** **Tighten** 25 N.m (18 lb ft) Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
4	Engine Coolant Manifold Bolt **Procedure** Tighten the engine coolant manifold bolts in the sequence shown. **NOTE:** **Clean the threads and apply a threadlocker.** **Tighten** 25 N.m (18 lb ft) Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
5	Engine Coolant Manifold Bolt **Procedure** Tighten the engine coolant manifold bolts in the sequence shown. **NOTE:** **Clean the threads and apply a threadlocker.** **Tighten** 25 N.m (18 lb ft) Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

INTAKE MANIFOLD INSTALLATION

cardiagn.com

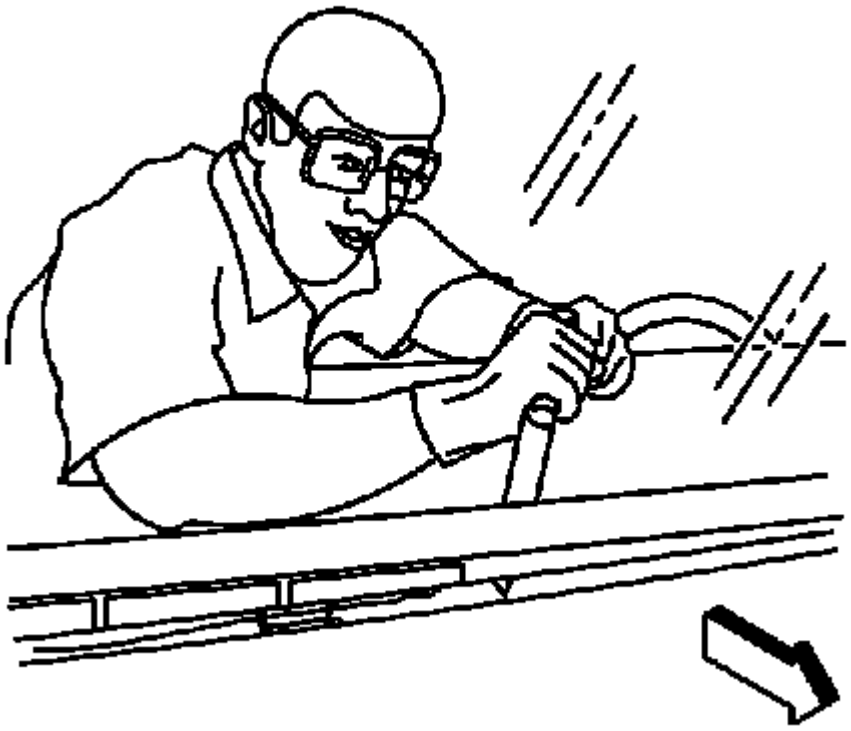


Fig. 352: Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

Intake Manifold Installation

Callout	Component Name
1	Intake Manifold Gasket **NOTE:** **A NEW gasket must be used when installing the intake manifold assembly.**
2	Intake Manifold Assembly
3	Intake Manifold Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten:** • Tighten the bolts a first pass in the sequence shown to 5 N.m (44 lb in). • Tighten the bolts a final pass in the sequence shown to 10 N.m (89 lb in).

cardiagn.com

4	Intake Manifold Cover Assembly
5	Intake Manifold Cover Stud **Tighten** 4.5 N.m (40 lb in)
6	PCV Tube

THROTTLE BODY ASSEMBLY INSTALLATION

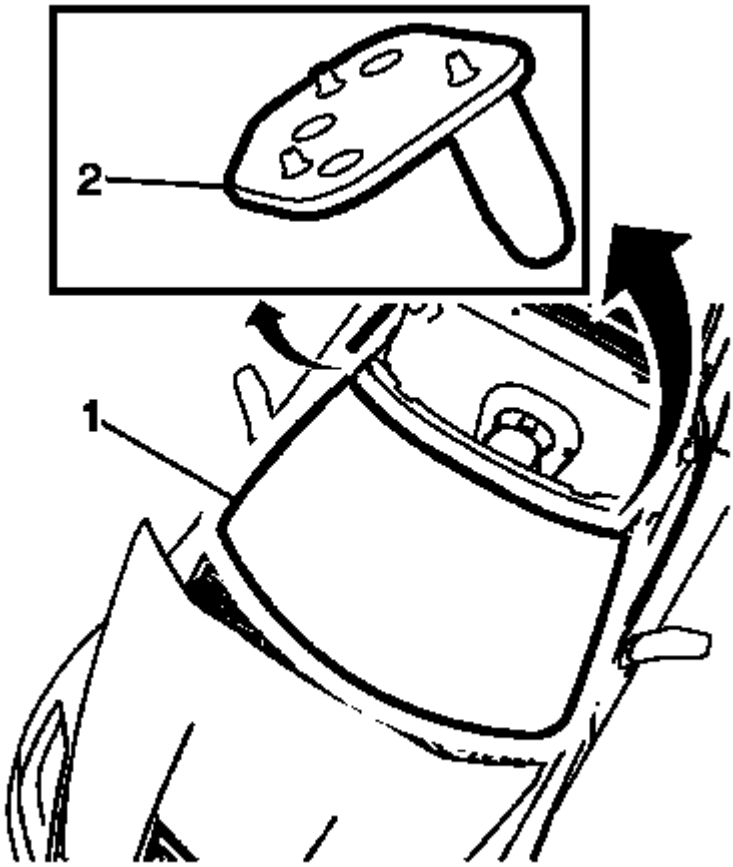


Fig. 353: Throttle Body Assembly
Courtesy of GENERAL MOTORS COMPANY

Throttle Body Assembly Installation

Callout	Component Name
1	Throttle Body Gasket **NOTE:** **Must use a NEW gasket.**
2	Throttle Body Assembly
	Throttle Body Bolt

cardiagn.com

3	**CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (88 lb in)

OIL LEVEL INDICATOR AND TUBE INSTALLATION

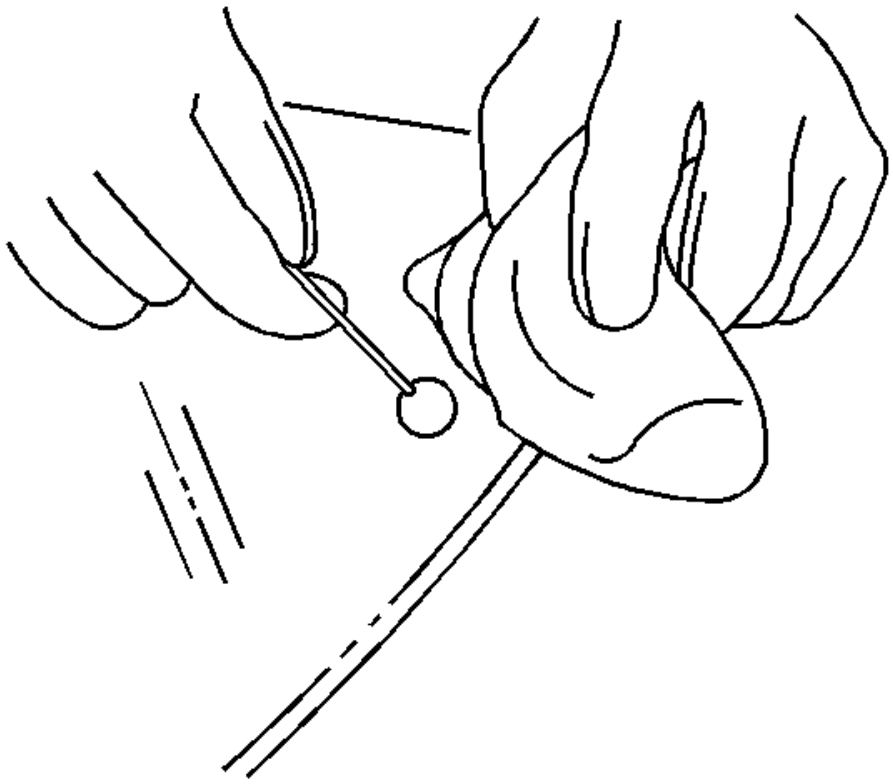


Fig. 354: Oil Level Indicator and Tube
Courtesy of GENERAL MOTORS COMPANY

Oil Level Indicator and Tube Installation

Callout	Component Name
1	Oil Level Indicator Tube O-Ring
2	Oil Level Indicator Tube

cardiagn.com

3	**CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (88 lb in)
4	Oil Level Indicator

EXHAUST MANIFOLD INSTALLATION - LEFT SIDE (WITH Z52 OPTION)

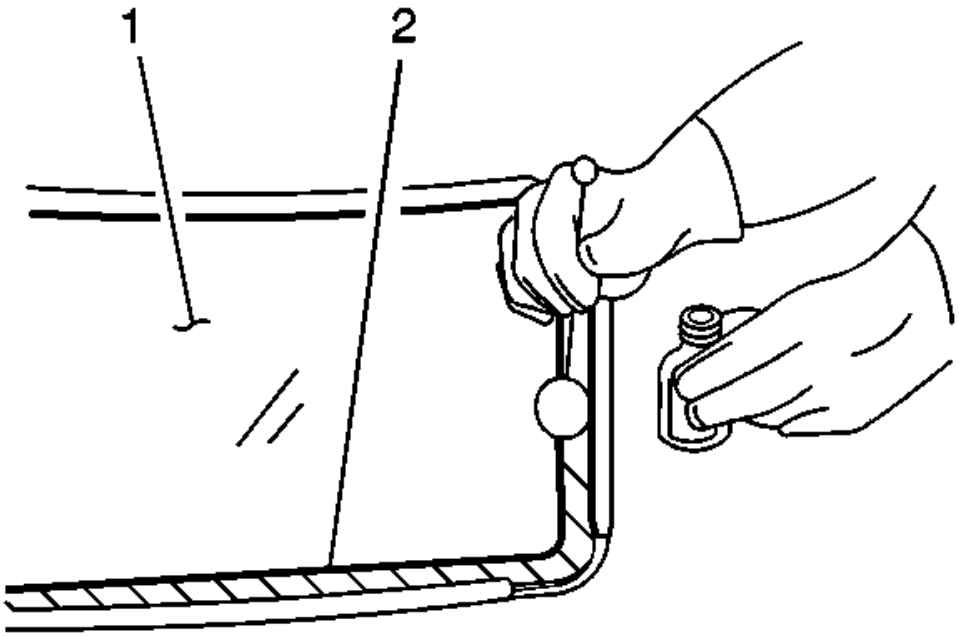


Fig. 355: Exhaust Manifold - Left Side (with Z52 Option)
Courtesy of GENERAL MOTORS COMPANY

Exhaust Manifold Installation - Left Side (with Z52 Option)

Callout	Component Name
1	Exhaust Manifold Gasket
2	Exhaust Manifold

cardiagn.com

3	Exhaust Manifold Bolt **CAUTION:** **Refer to Fastener Caution .** **Procedure** Tighten the exhaust manifold bolts in the sequence shown. 1. If installing on existing cylinder head - Tighten the bolts to 23 (17 lb ft). 2. If installing on NEW cylinder head - Tighten bolts to 27 (20 lb ft)
4	Heat Shield
5	Heat Shield Bolts **Tighten** 12 N.m (106 lb in)
6	Spark Plug Wires **NOTE:** **Only apply dielectric grease to the spark plug side of the spark plug wire boot.** **Procedure** 1. Inspect the inside of the spark plug wire 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 spark plug wire 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.

EXHAUST MANIFOLD INSTALLATION - LEFT SIDE

cardiagn.com

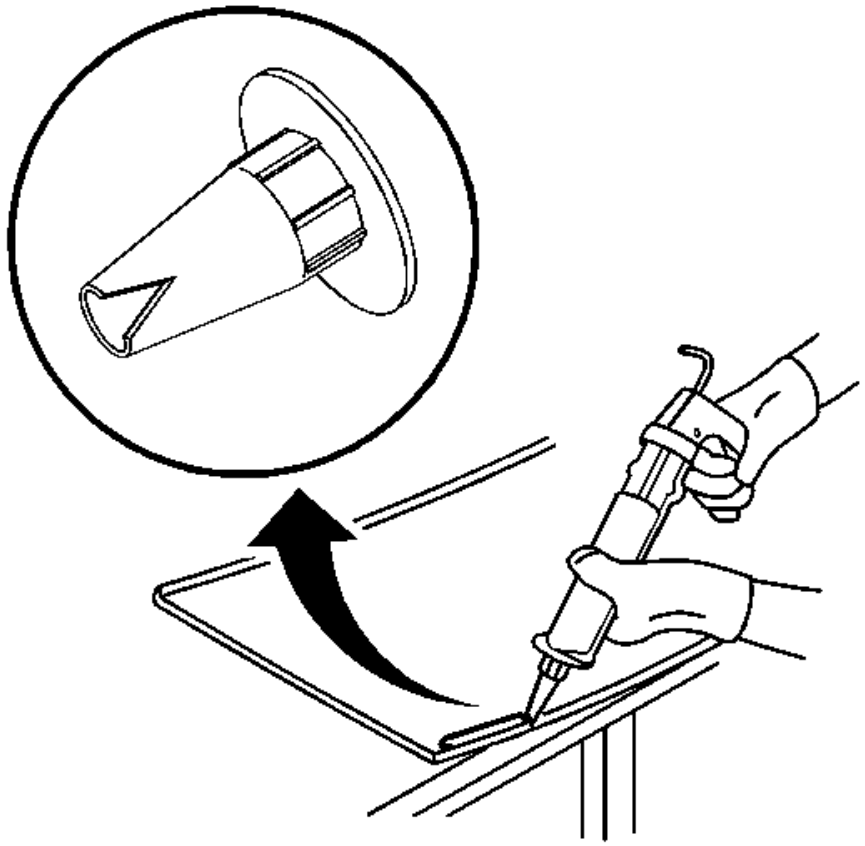


Fig. 356: Exhaust Manifold - Left Side
Courtesy of GENERAL MOTORS COMPANY

Exhaust Manifold Installation - Left Side

Callout	Component Name
1	Exhaust Manifold Gasket
2	Exhaust Manifold
3	Exhaust Manifold Bolt **CAUTION:** **Refer to Fastener Caution .** **Procedure** Tighten the exhaust manifold bolts in the sequence shown. 1. If installing on existing cylinder head - Tighten the bolts to 23 (17 lb ft).

cardiagn.com

4	Heat Shield
5	Heat Shield Bolts **Tighten** 12 N.m (106 lb in)
6	Spark Plug Wires **NOTE:** **Only apply dielectric grease to the spark plug side of the spark plug wire boot.** **Procedure** Inspect the inside of the spark plug wire 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 spark plug wire 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.

EXHAUST MANIFOLD INSTALLATION - RIGHT SIDE

cardiagn.com

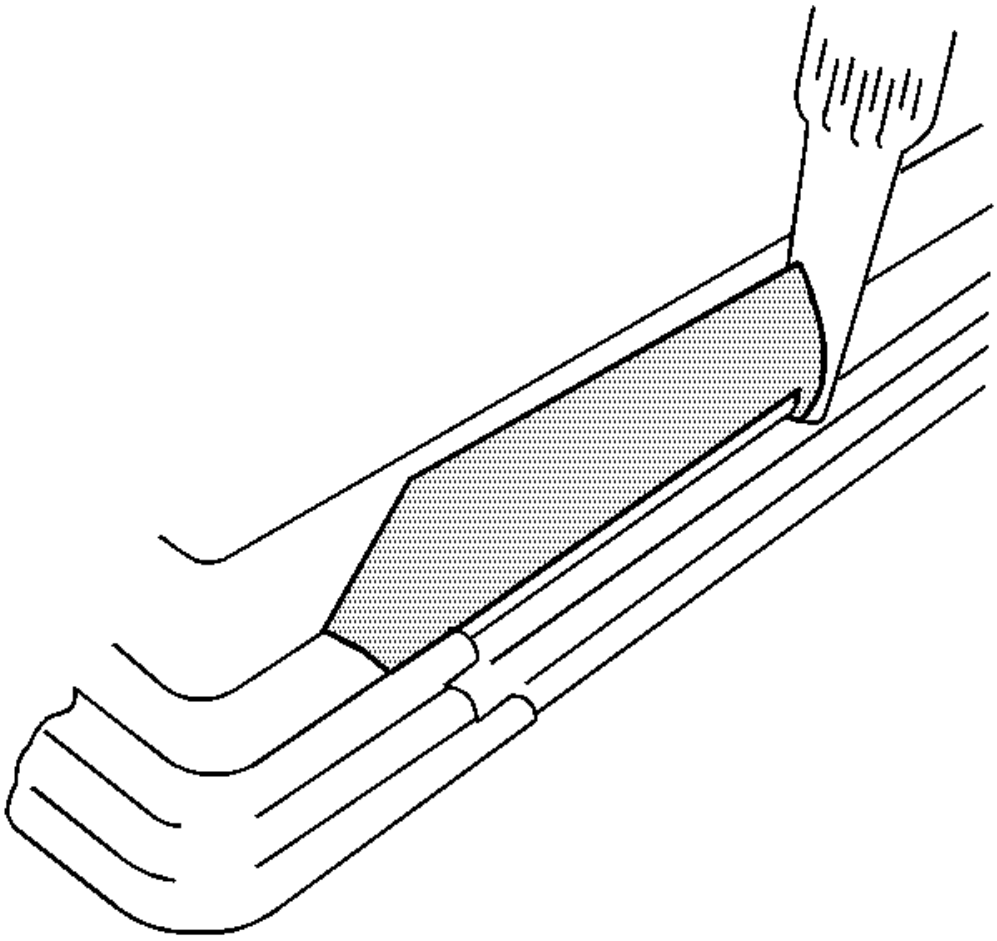


Fig. 357: Exhaust Manifold - Right Side
Courtesy of GENERAL MOTORS COMPANY

Exhaust Manifold Installation - Right Side

Callout	Component Name
1	Exhaust Manifold Gasket
2	Exhaust Manifold
3	Exhaust Manifold Bolt **CAUTION:** **Refer to Fastener Caution .** **Procedure** Tighten the exhaust manifold bolts in the sequence shown.

cardiagn.com

	2. If installing on NEW cylinder head - Tighten bolts to 27 (20 lb ft)
4	Exhaust Manifold Heat Shield
5	Heat Shield Bolt **Tighten** 10 N.m (88 lb in)
6	Spark Plug Wires **NOTE:** **Only apply dielectric grease to the spark plug side of the spark plug wire boot.** **Procedure** Inspect the inside of the spark plug wire 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 spark plug wire 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.

CLUTCH PILOT BEARING INSTALLATION

Special Tools

- **GE-8433** Two Jaw Puller
- **EN-45949** Pilot Bearing and Flywheel Locator Installer

cardiagn.com

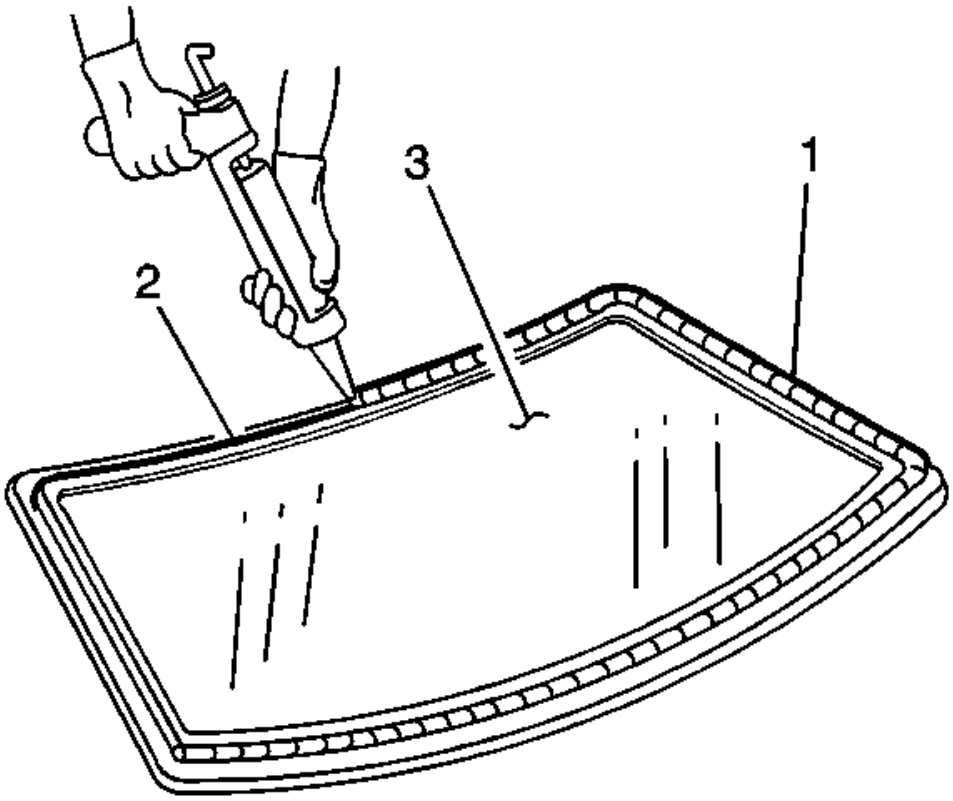


Fig. 358: Identifying Special Tools
Courtesy of GENERAL MOTORS COMPANY

1. Position the bearing to the rear of the crankshaft.
2. Assemble the **GE-8433** two jaw puller (2), the **EN-45949** pilot bearing and flywheel locator installer (1) and bolts to the rear of the crankshaft.

   Tighten the bolts until snug.

3. Rotate the bolt of the **GE-8433** two jaw puller (2) until the bearing is seated in the bore of the crankshaft.
4. Remove the tools.

cardiagn.com

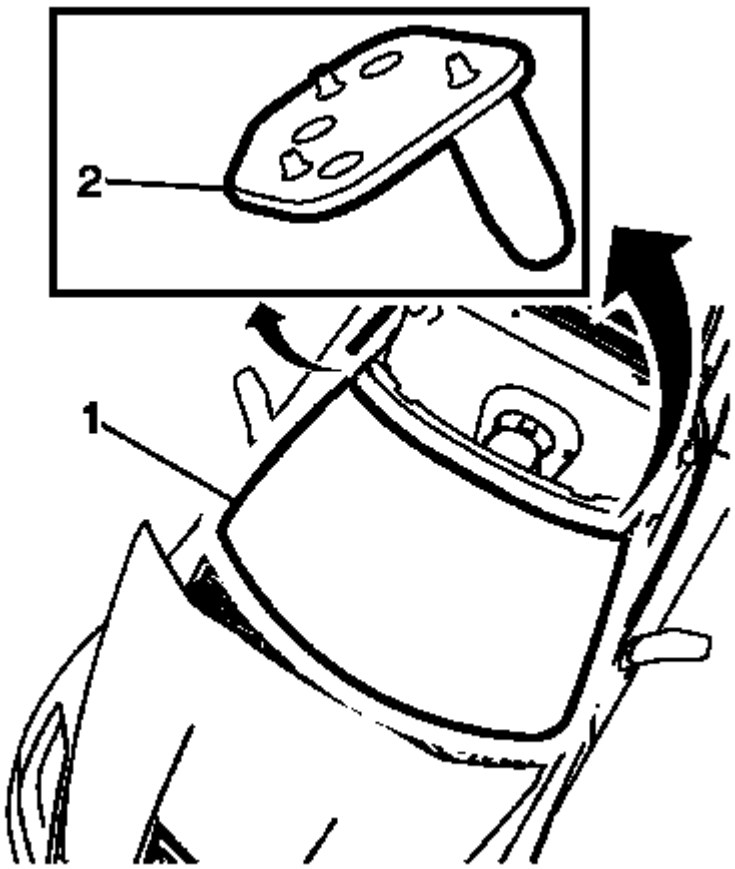


Fig. 359: Locating Clutch Pilot Bearing
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the clutch pilot bearing for proper installation.

ENGINE FLYWHEEL INSTALLATION

Special Tools

J-42386-A Flywheel Holding Tool

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

cardiagn.com

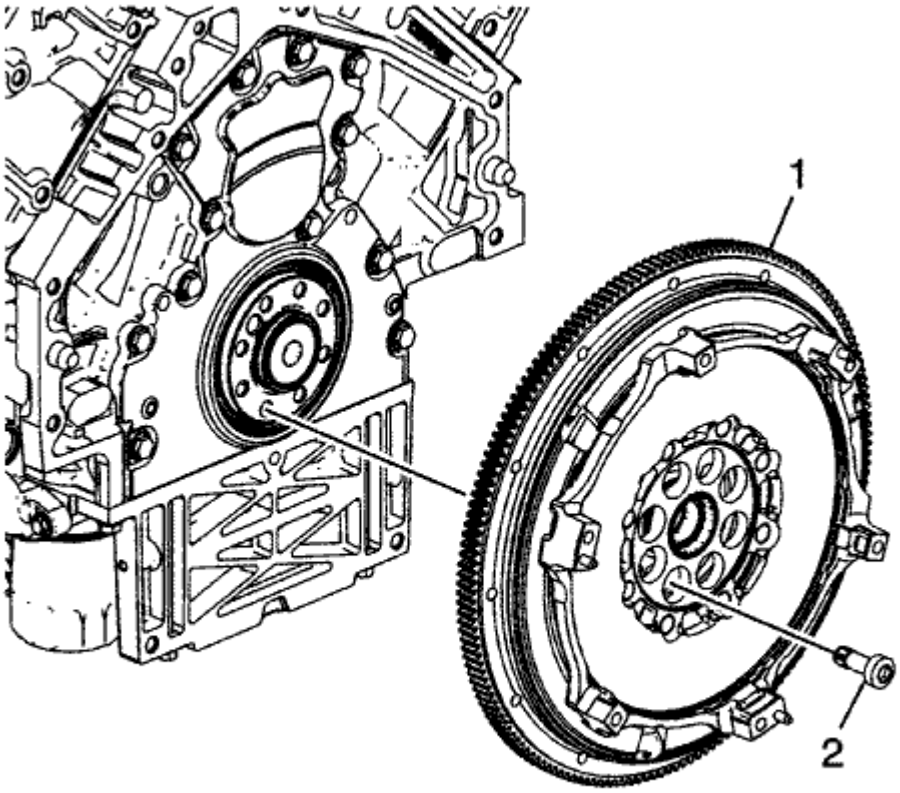


Fig. 360: Manual Transmission Flywheel
Courtesy of GENERAL MOTORS COMPANY

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: The flywheel does not use a locating pin for alignment and will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the engine flywheel bolts.

1. Install the flywheel (1) to the crankshaft.

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.

2. Apply threadlocker to the threads of the flywheel bolts (2). Refer to **Adhesives, Fluids,**

cardiagn.com

3. Install and hand tighten the NEW flywheel bolts (2).

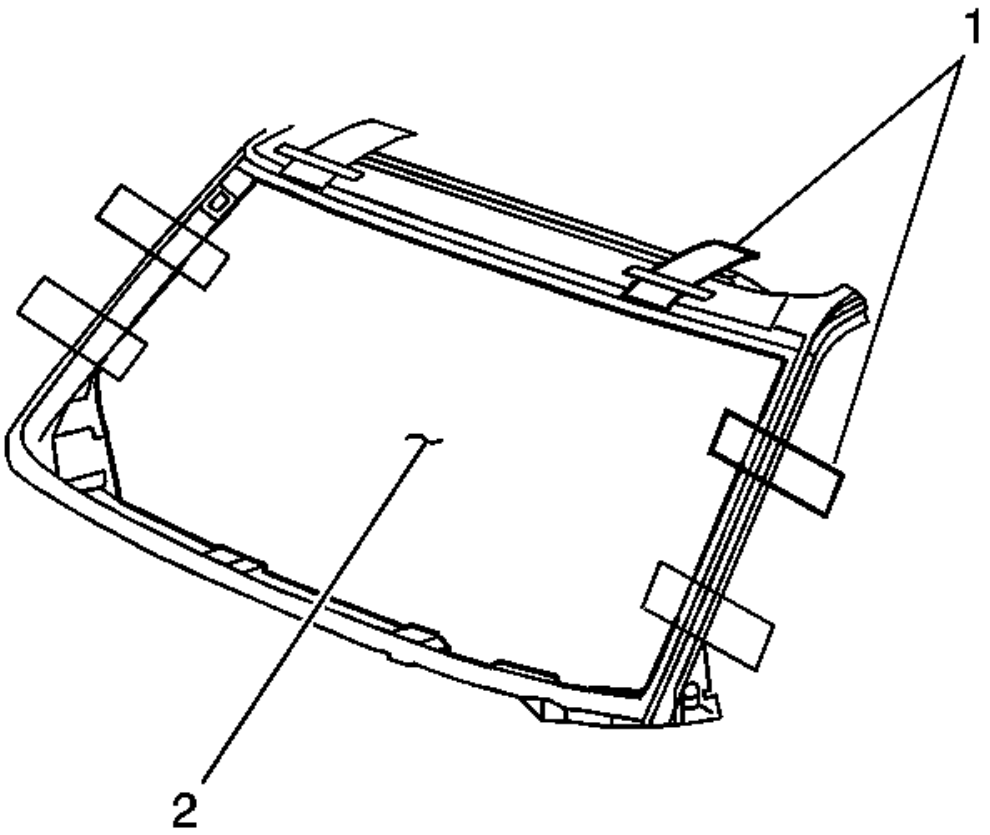


Fig. 361: Identifying J 42386-A
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the **J-42386-A** flywheel holding tool and bolts.

   Use 1 M10 -1.5 x 120 mm and 1 M10 -1.5 x 45 mm bolt for proper tool operation.

   Tighten the **J-42386-A** flywheel holding tool and bolts to 50 N.m (37 lb ft).

cardiagn.com

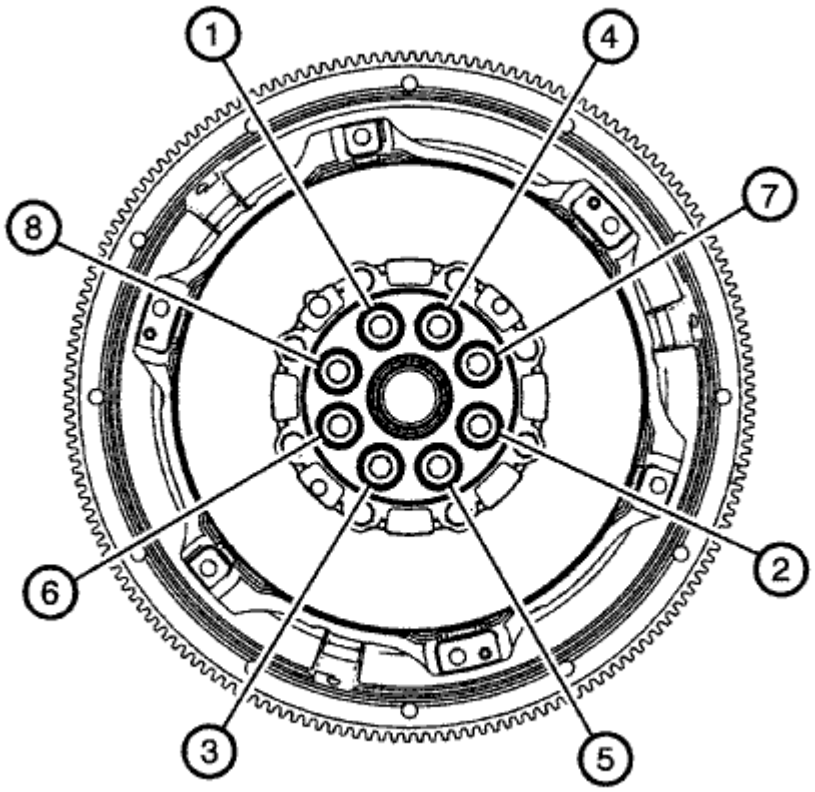


Fig. 362: Tightening Flywheel Bolts In Sequence
Courtesy of GENERAL MOTORS COMPANY

5. Tighten the flywheel bolts (1).
    1. Tighten the bolts (1-8) a first pass in sequence to 15 N.m (11 lb ft).
    2. Tighten the bolts (1-8) a second pass in sequence to 30 N.m (22 lb ft).
    3. Tighten the bolts (1-8) a final pass in sequence an additional 30 degrees using **EN-45059** angle meter.
6. Remove the **J-42386-A** flywheel holding tool

AUTOMATIC TRANSMISSION FLEX PLATE INSTALLATION

Special Tools

EN-45059 Angle Meter

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

cardiagn.com

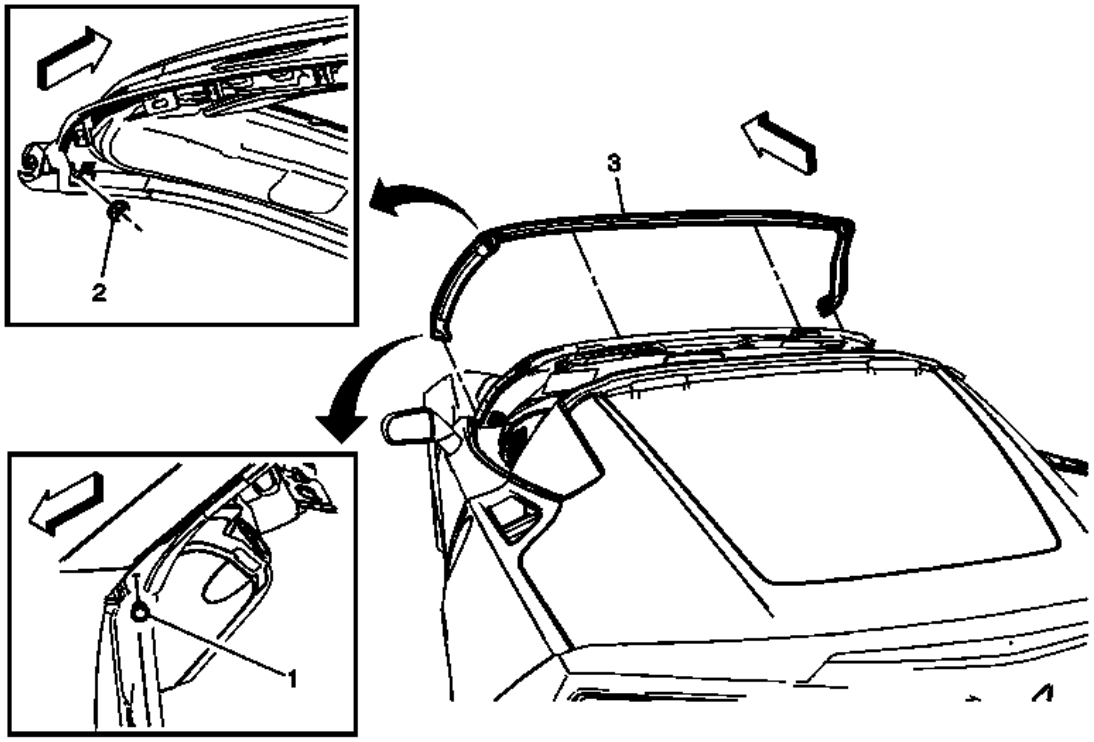


Fig. 363: Flex Plate And Crankshaft
Courtesy of GENERAL MOTORS COMPANY

NOTE: The flex plate does not use a locating pin for alignment and will not initially seat against the crankshaft flange, but will be pulled onto the crankshaft by the engine flex plate bolts. This procedure requires a 3 stage tightening process.

1. Install the flex plate (1) to the crankshaft.

cardiagn.com

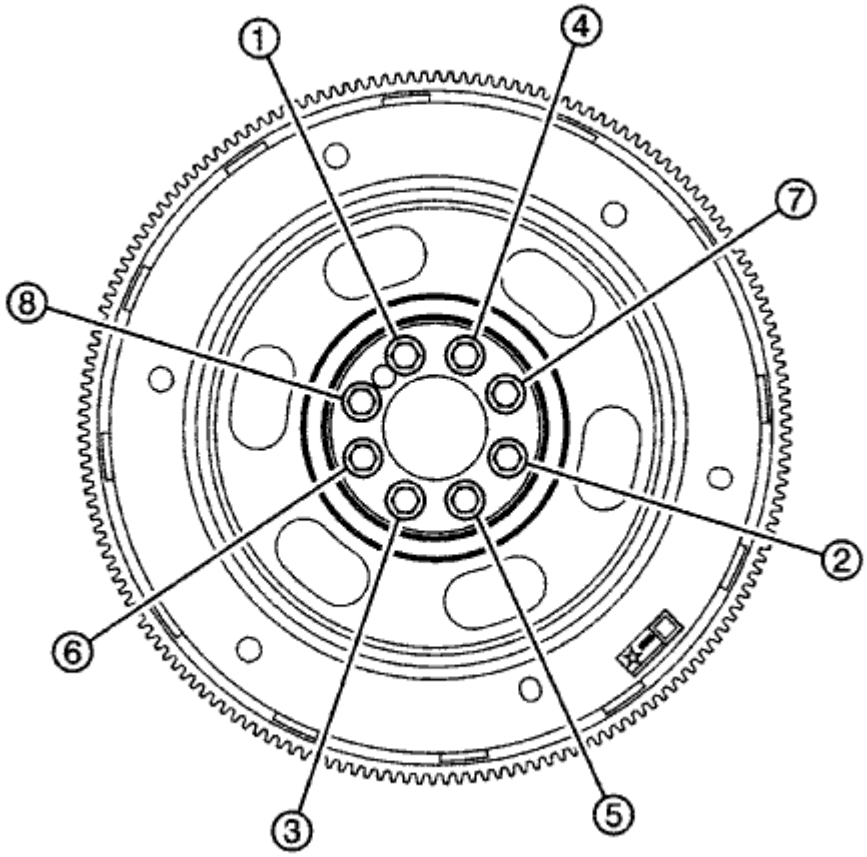


Fig. 364: NEW Engine Flex Plate Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Must use NEW bolts.

2. Install the NEW engine flex plate bolts (2).
    1. Tighten the engine flex plate bolts (1-8) a first pass in sequence to 15 N.m (11 lb ft).
    2. Tighten the engine flex plate bolts (1-8) a second pass in sequence to 30 N.m (22 lb ft).
    3. Tighten the engine flex plate bolts (1-8) a final pass in sequence an additional 45 degrees using **EN-45059** angle meter.

CRANKSHAFT BALANCER INSTALLATION

cardiagn.com

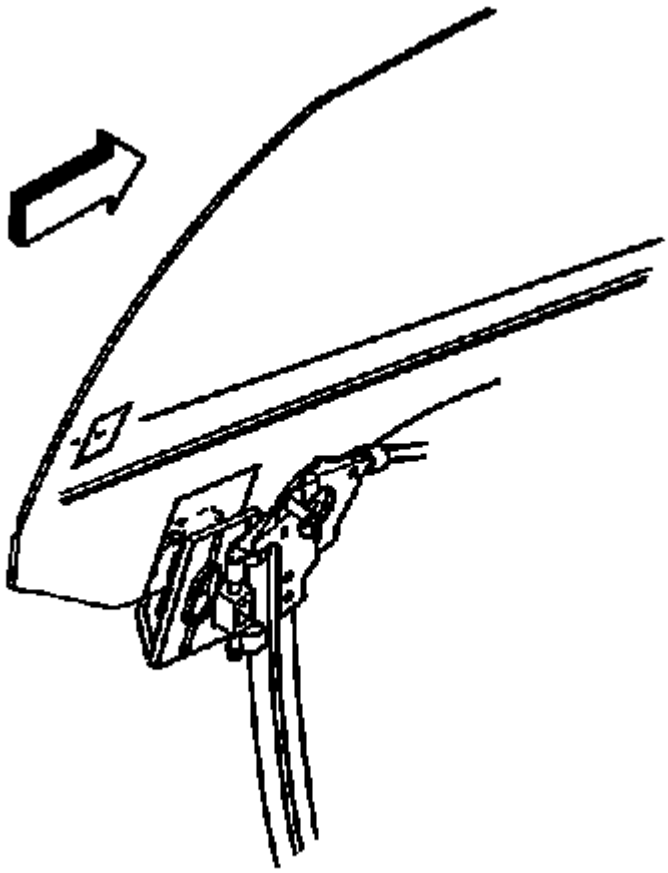


Fig. 365: Crankshaft Balancer Assembly
Courtesy of GENERAL MOTORS COMPANY

Crankshaft Balancer Installation

Callout	Component Name
	Crankshaft Balancer Assembly **CAUTION:** **Refer to Fastener Caution .** **NOTE:** • **Ensure the teeth of the tool engage the engine flywheel teeth.** • **The used crankshaft balancer bolt is used only during the installation procedure. Install a NEW crankshaft balancer bolt during final assembly.** **Procedure** 1. Install the **EN-42386-A** flywheel holding tool. Use 1 M10 - 1.5 x 120 mm and 1

cardiagn.com

1	M10 - 1.5 x 45 mm bolt for proper tool operation and tighten bolts to 50 N.m (37 lb ft). 2. Assemble the **EN-41478** installer threaded rod, nut, washer and the **EN-41665** installer. 3. Insert the smaller end of the installer into the front of the balancer. Use a wrench and hold the hex end of the threaded rod. Use a second wrench and rotate the installation tool nut clockwise until the balancer is started onto the crankshaft. 4. Remove the tool and reverse the installation tool. Position the larger end of the installer against the front of the balancer. Use wrench and hold the hex end of the threaded rod. Use a second wrench and rotate the nut clockwise until the balancer is installed onto the crankshaft. 5. Remove the balancer installation tools. **Special Tools** • **EN-41478** Crankshaft Front Oil Seal Installer • **EN-41665** Crankshaft Balancer and Sprocket Installer • **EN-42386-A** Flywheel Holding Tool For equivalent regional tools, refer to **Special Tools** .
2	Crankshaft Balancer Bolt **NOTE:** **The nose of the crankshaft (a) should be recessed 2.40-4.48 mm (0.094-0.176 in) into the balancer bore.** **Procedure** 1. Install the used crankshaft balancer bolt and tighten to 330 N.m (240 lb ft) to fully seat the balancer. 2. Remove the used crankshaft balancer bolt. 3. Measure for correctly installed balancer. If the balancer is not installed to proper dimensions, install the **EN-41665** installer and repeat the installation procedure. 4. Install the NEW crankshaft balancer bolt: 1. Tighten the crankshaft balancer bolt to 120 N.m (110 lb ft). 2. Loosen the crankshaft balancer bolt 360 degrees. 3. Tighten the crankshaft balance bolt to 80 N.m (59 lb ft). 4. Tighten the crankshaft balancer bolt a final pass to 200 degrees using

cardiagn.com

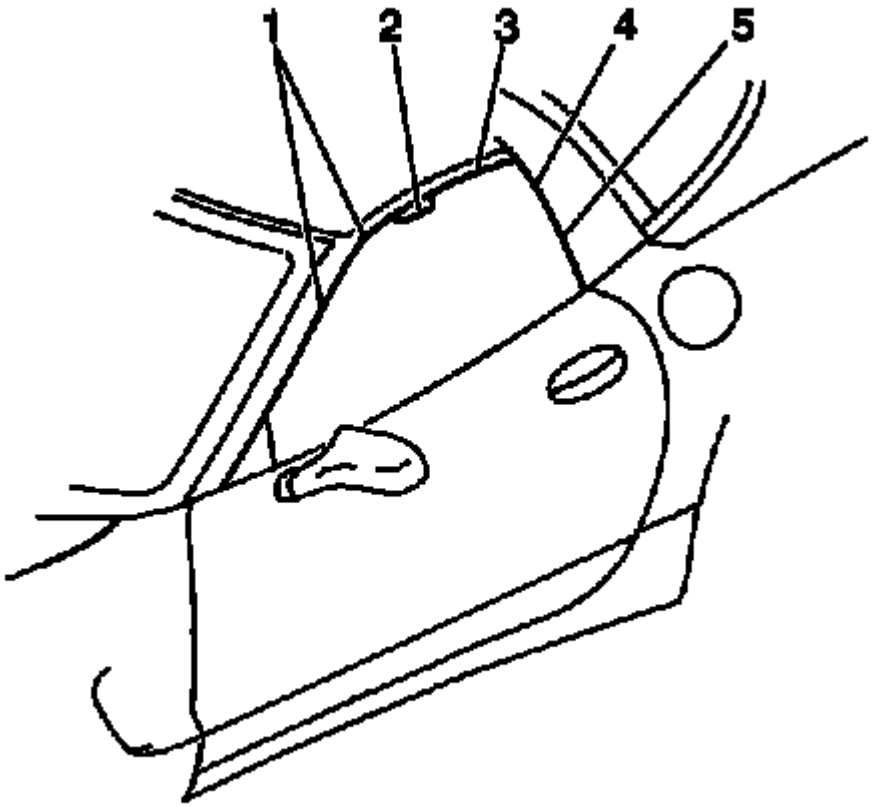
	5. Remove the **EN-42386-A** flywheel holding tool. **Special Tools** • **EN-41665** Crankshaft Balancer and Sprocket Installer • **EN-42386-A** Flywheel Holding Tool • **EN-45059** Angle Meter For equivalent regional tools, refer to **Special Tools** .

ENGINE PRELUBING

Special Tools

J 45299 Engine Preluber

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



cardiagn.com

Fig. 366: Engine Oil Filter
Courtesy of GENERAL MOTORS COMPANY

NOTE: **A constant and continuous flow of clean engine oil is required in order to properly prime the engine. Use an approved engine oil as specified in the owners manual.**

1. Remove the engine oil filter and fill with clean engine oil.

CAUTION: Refer to Fastener Caution .

2. Install the oil filter and tighten to 30 N.m (22 lb ft).
3. Locate the engine block left rear oil gallery plug.
4. Install the M16 x 1.5 adapter P/N 509375.

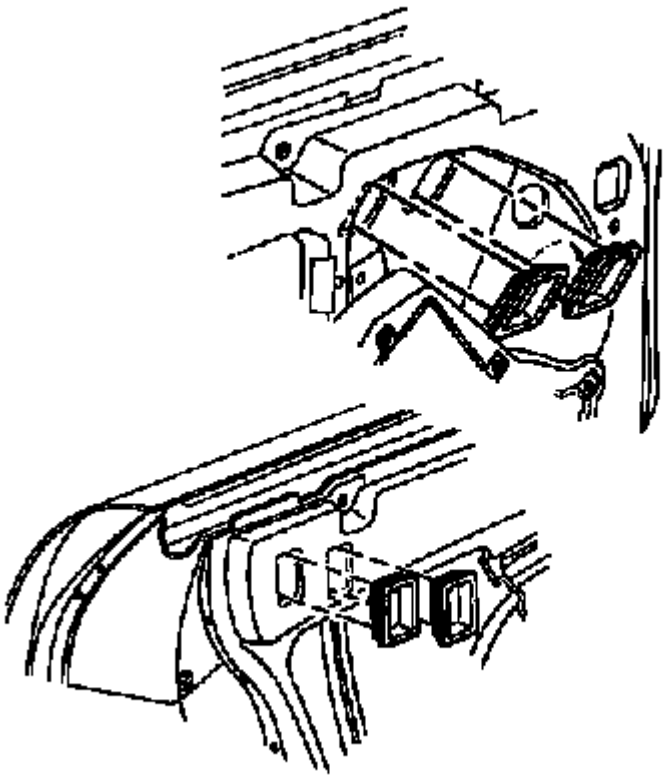


Fig. 367: View Of Engine Preluber
Courtesy of GENERAL MOTORS COMPANY

cardiagn.com

5. Install the flexible hose to the adapter and open the valve.
6. Pump the handle on the **J 45299** preluber in order to flow a minimum of 1-1.9 liters (1-2 quarts) engine oil. Observe the flow of engine oil through the flexible hose and into the engine assembly.
7. Close the valve and remove the flexible hose and adapter from the engine.
8. Install the gallery plug to the engine and tighten to 30 N.m (44 lb ft).
9. Top-off the engine oil to the proper level.

cardiagn.com