DRIVE BELT TENSIONER REMOVAL

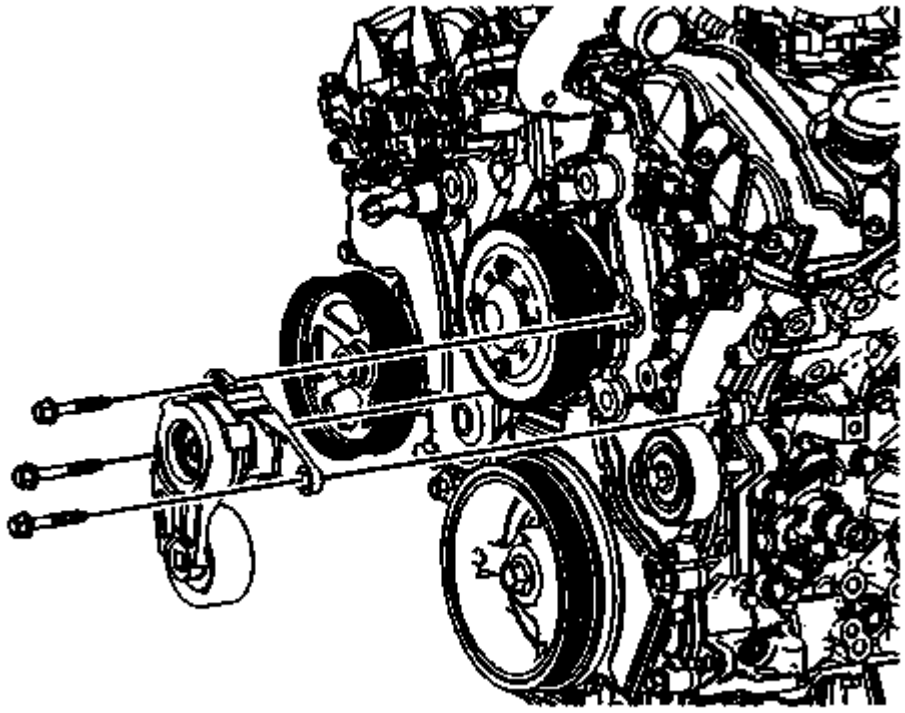


Fig. 1: Identifying Drive Belt Tensioner Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the drive belt tensioner bracket bolts.
2. Remove the drive belt tensioner assembly.

DRIVE BELT IDLER PULLEY REMOVAL

cardiagn.com

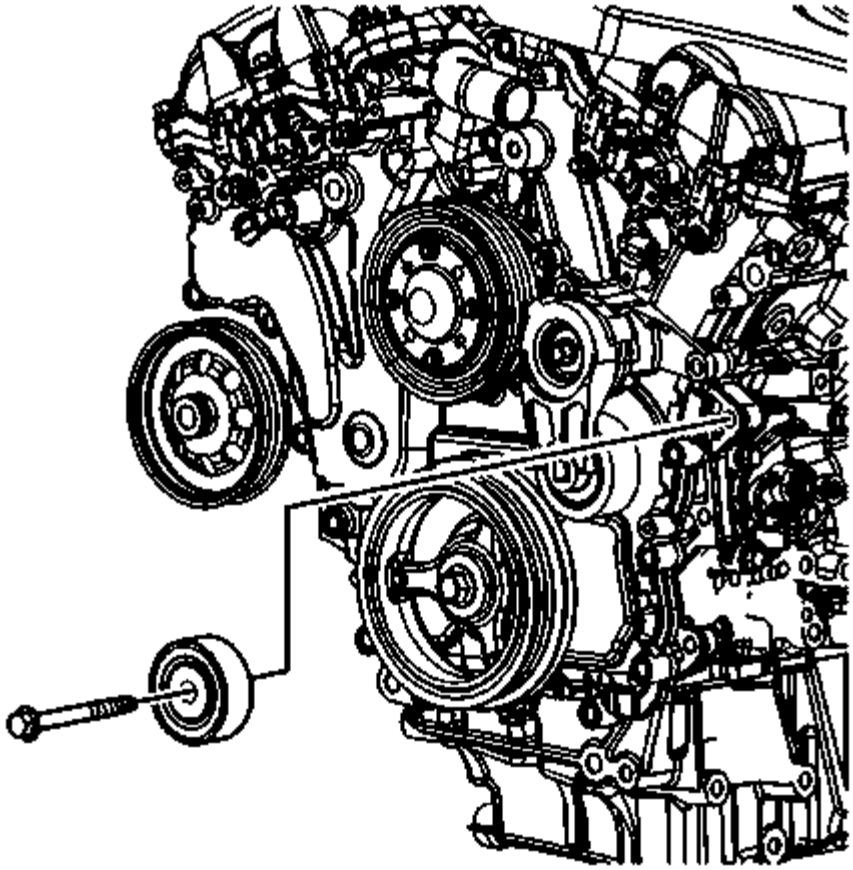


Fig. 2: Identifying Drive Belt Idler Pulley & Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the drive belt idler pulley bolt.
2. Remove the drive belt idler pulley.

OIL LEVEL INDICATOR AND TUBE REMOVAL

cardiagn.com

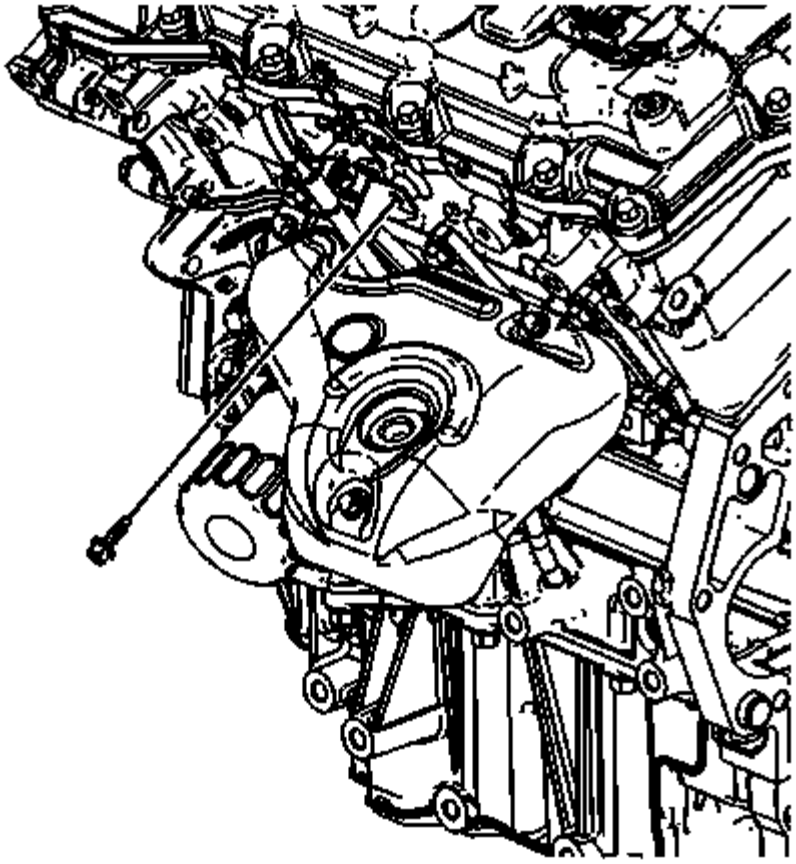


Fig. 3: View Of Oil Level Indicator Tube Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil level indicator tube bracket bolt.

cardiagn.com

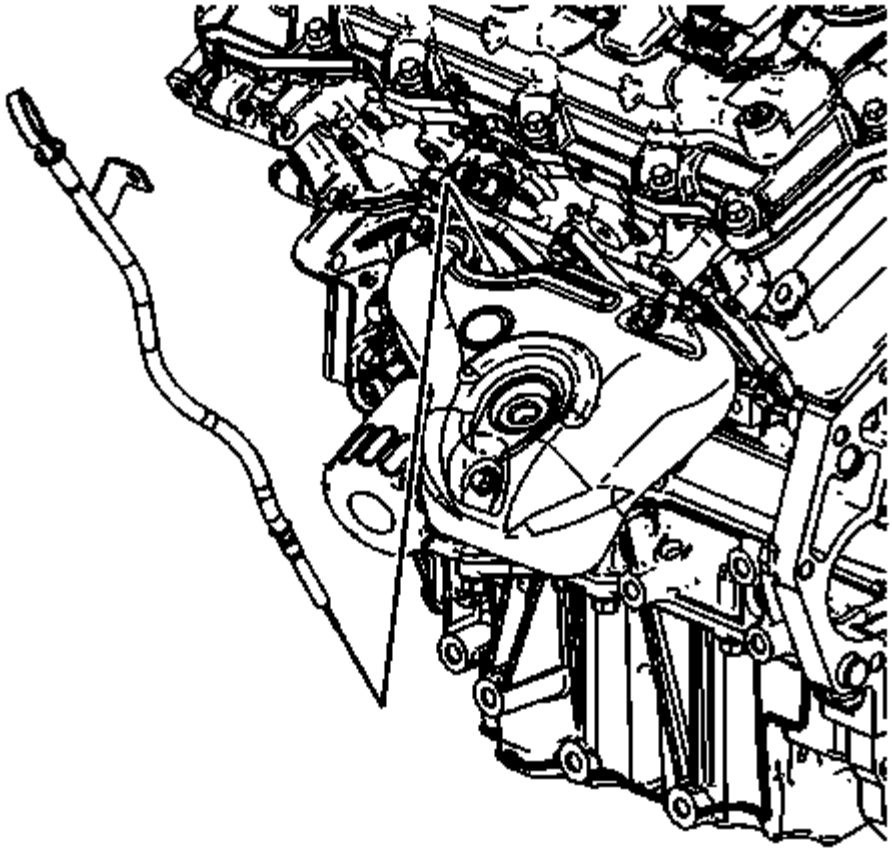


Fig. 4: Identifying Oil Level Indicator & Tube
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil level indicator and tube by sliding the tube out from the lower crankcase hole.

cardiagn.com

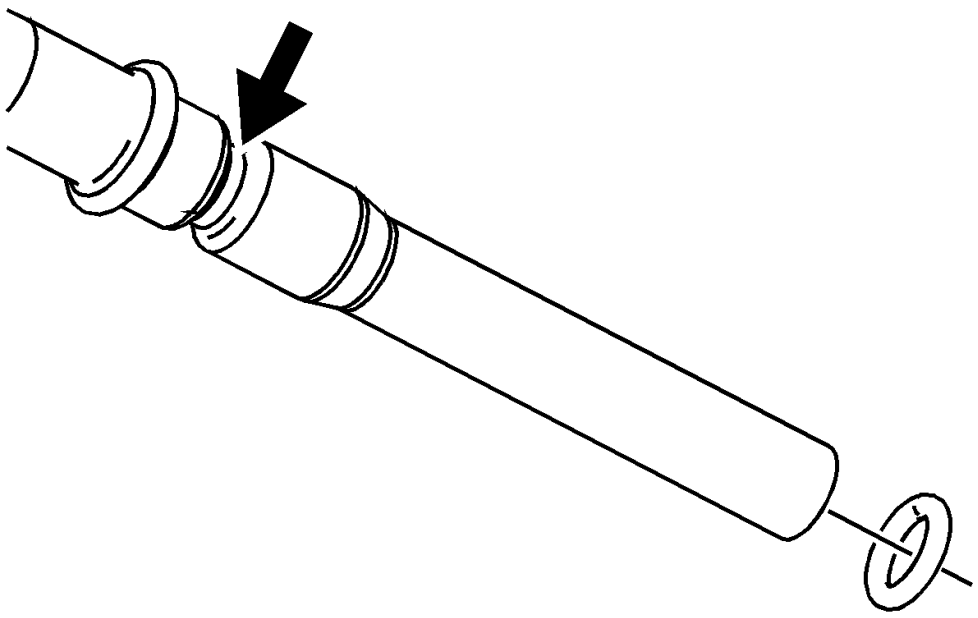


Fig. 5: View Of Oil Level Indicator Tube O-Ring
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the O-ring from the oil level indicator tube.

EXHAUST MANIFOLD REMOVAL - LEFT SIDE

cardiagn.com

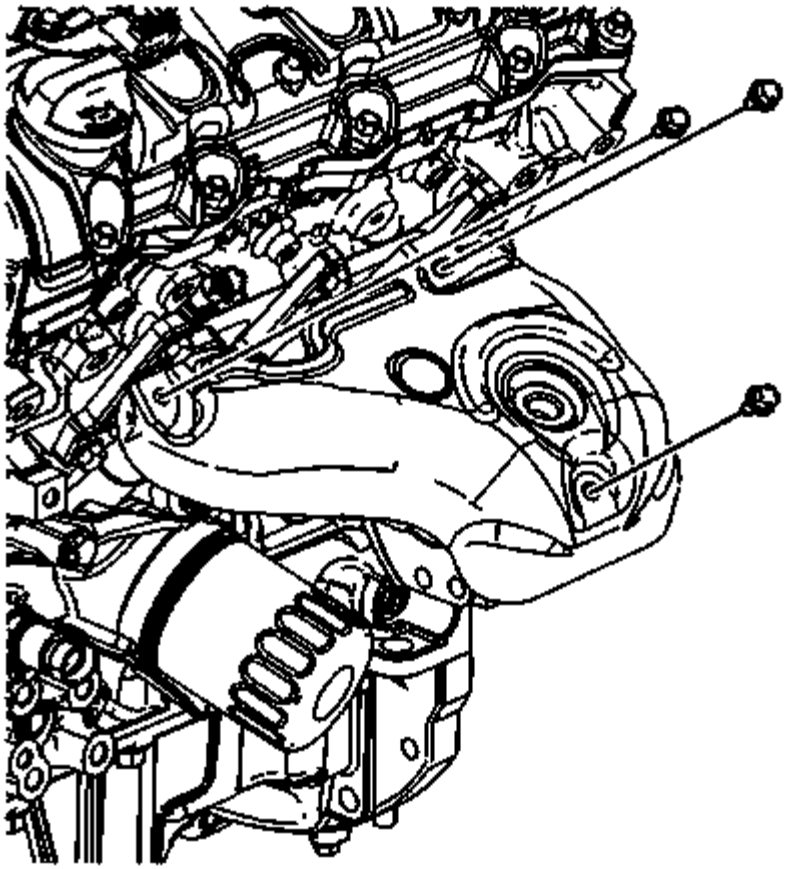


Fig. 6: Locating Exhaust Manifold Heat Shield Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the left exhaust manifold heat shield bolts.

cardiagn.com

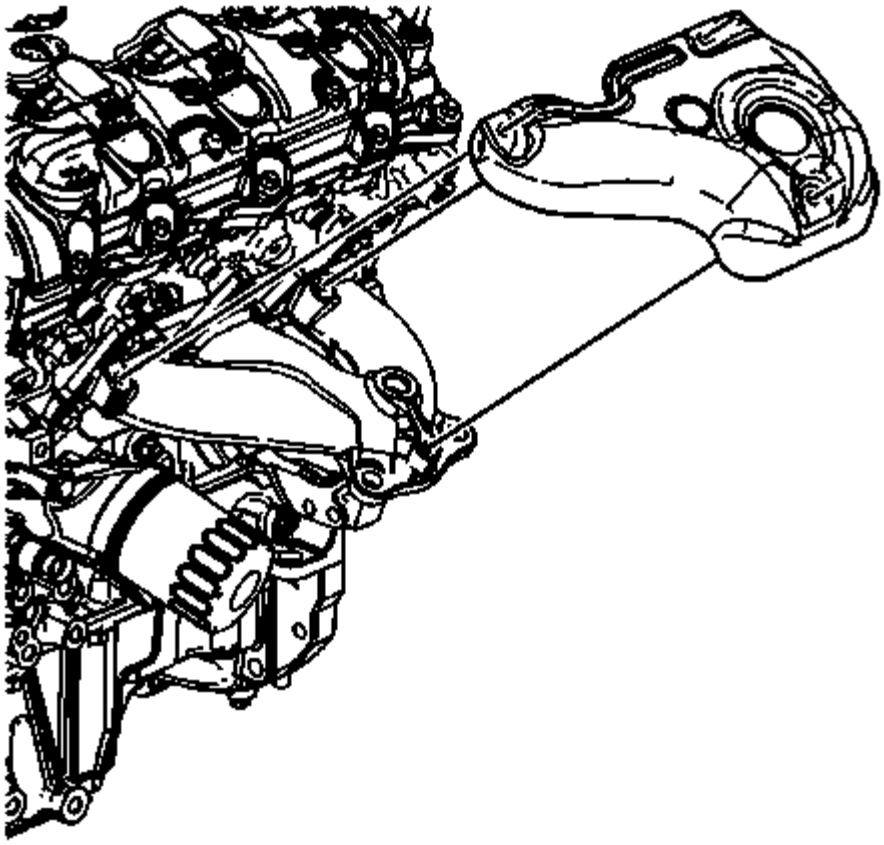


Fig. 7: Removing/Installing Exhaust Manifold Heat Shield
Courtesy of GENERAL MOTORS COMPANY

2. Remove the left exhaust manifold heat shield.

cardiagn.com

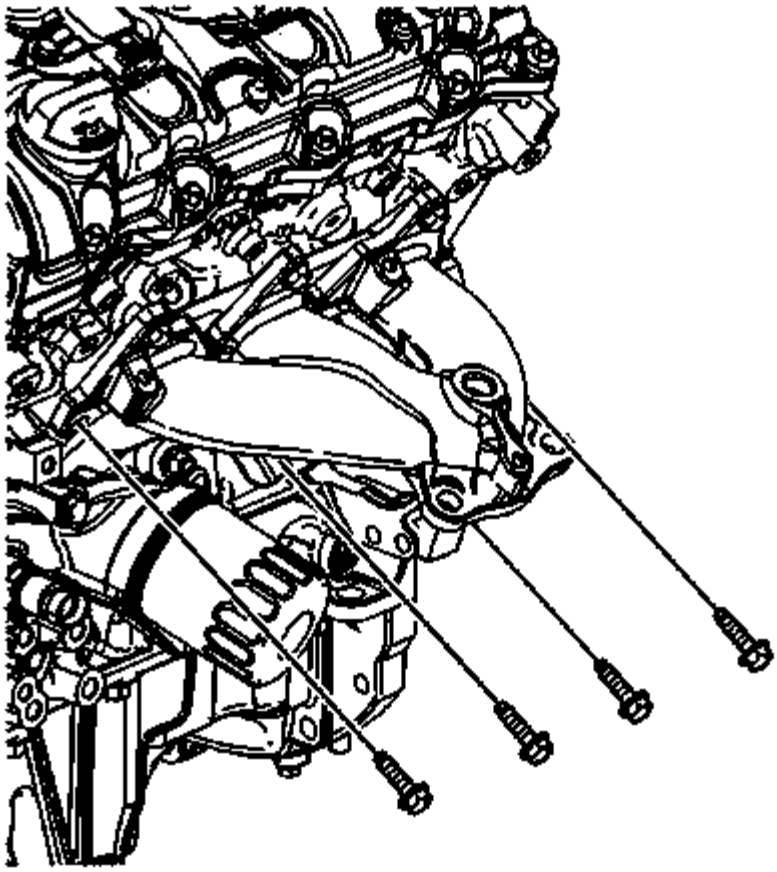


Fig. 8: Identifying Exhaust Manifold Lower Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the left exhaust manifold lower bolts from the left cylinder head.

cardiagn.com

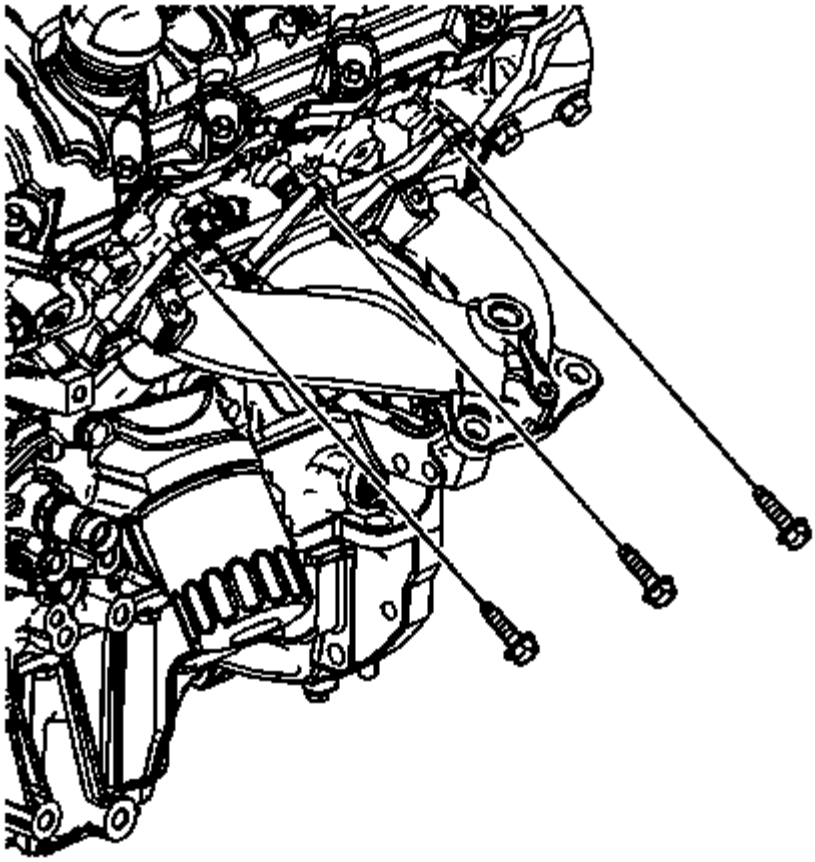


Fig. 9: Identifying Exhaust Manifold Upper Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the left exhaust manifold upper bolts from the left cylinder head.

cardiagn.com

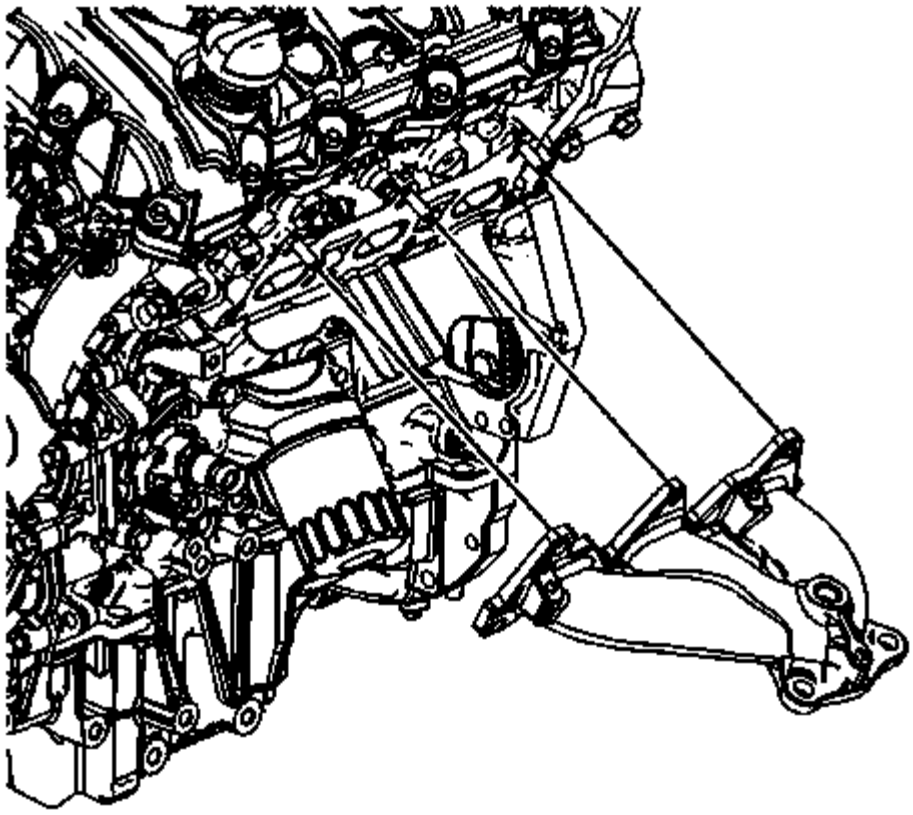


Fig. 10: Removing/Installing Exhaust Manifold
Courtesy of GENERAL MOTORS COMPANY

5. Remove the left exhaust manifold.

cardiagn.com

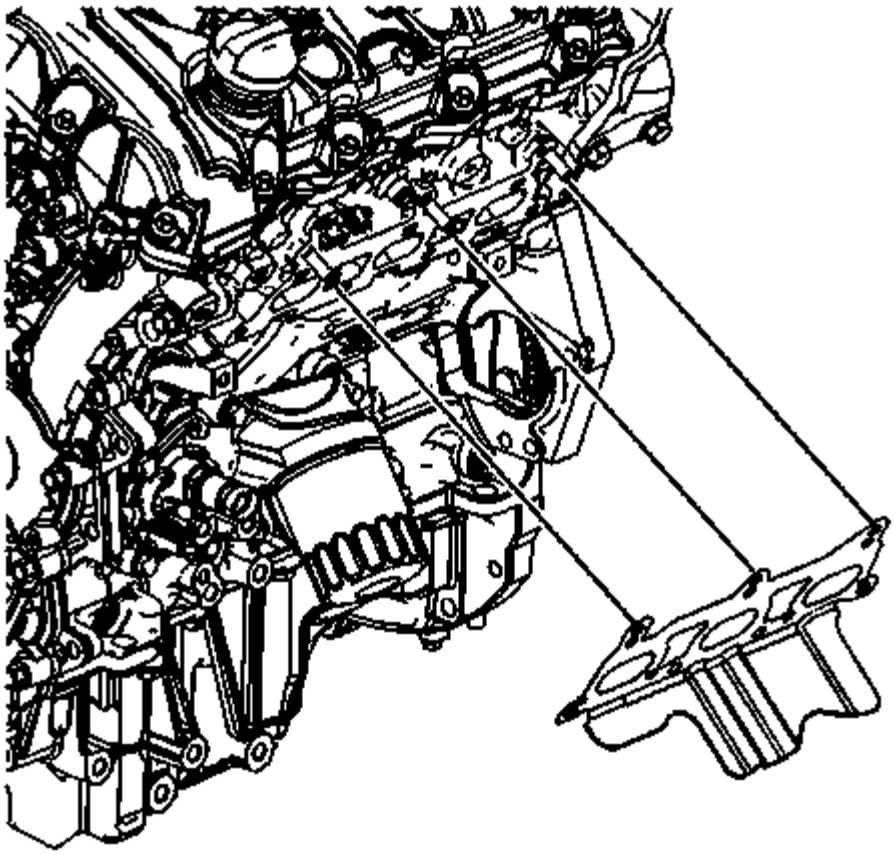


Fig. 11: View Of Exhaust Manifold Gasket
Courtesy of GENERAL MOTORS COMPANY

6. Remove and discard the left exhaust manifold gasket.

OIL FILTER ADAPTER REMOVAL

cardiagn.com

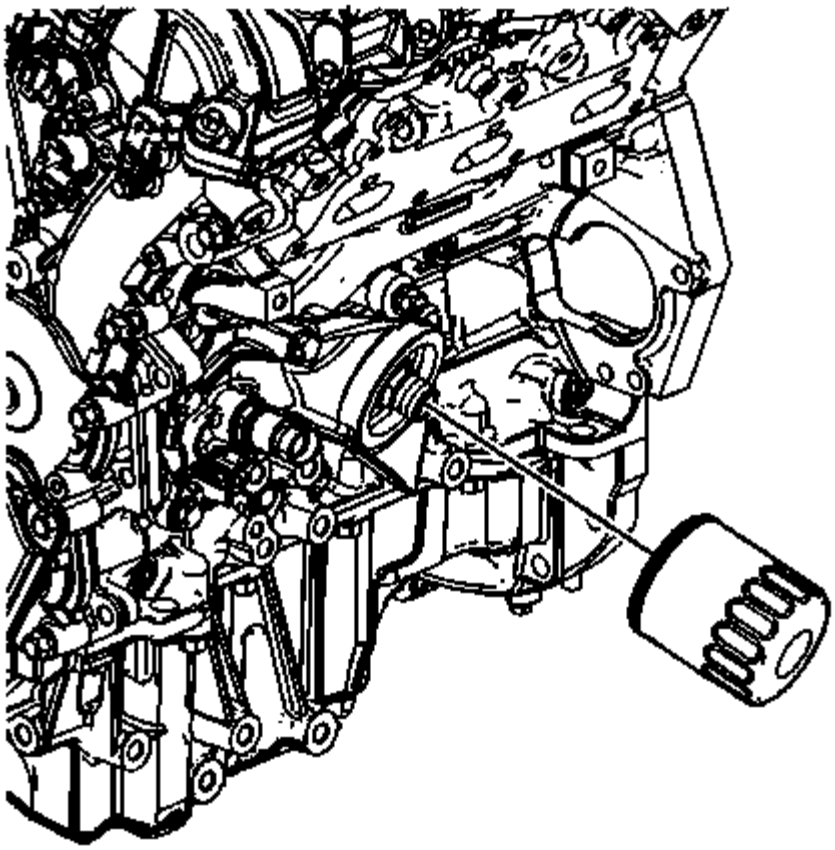


Fig. 12: Removing/Installing Oil Filter
Courtesy of GENERAL MOTORS COMPANY

1. Remove and properly dispose of the oil filter.

cardiagn.com

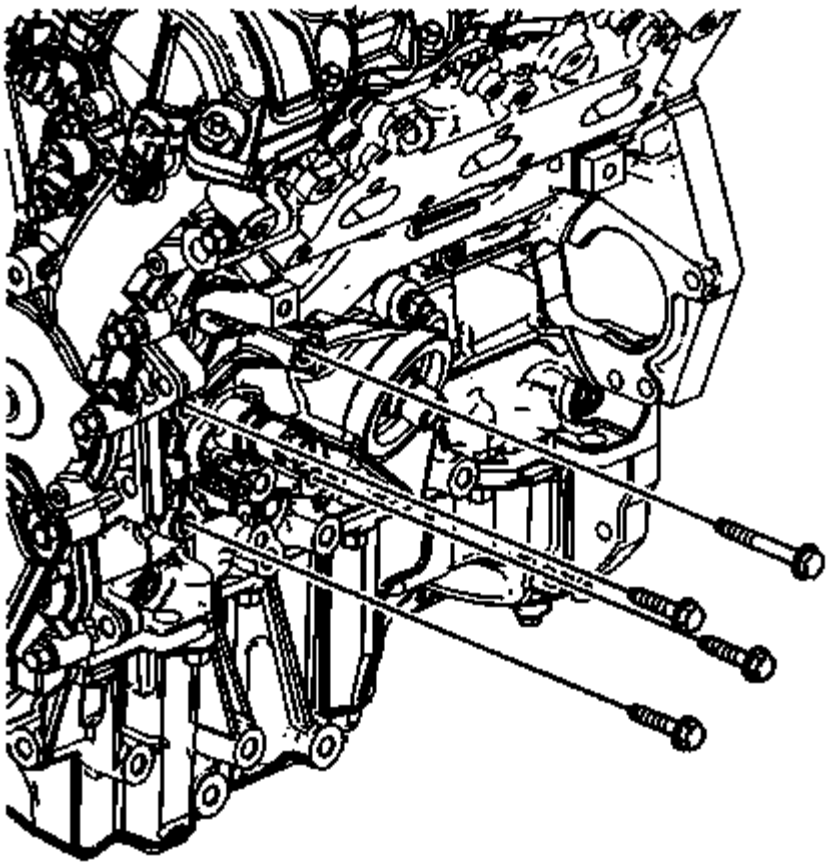


Fig. 13: View Of Oil Filter Adapter Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil filter adapter bolts from the engine block.

cardiagn.com

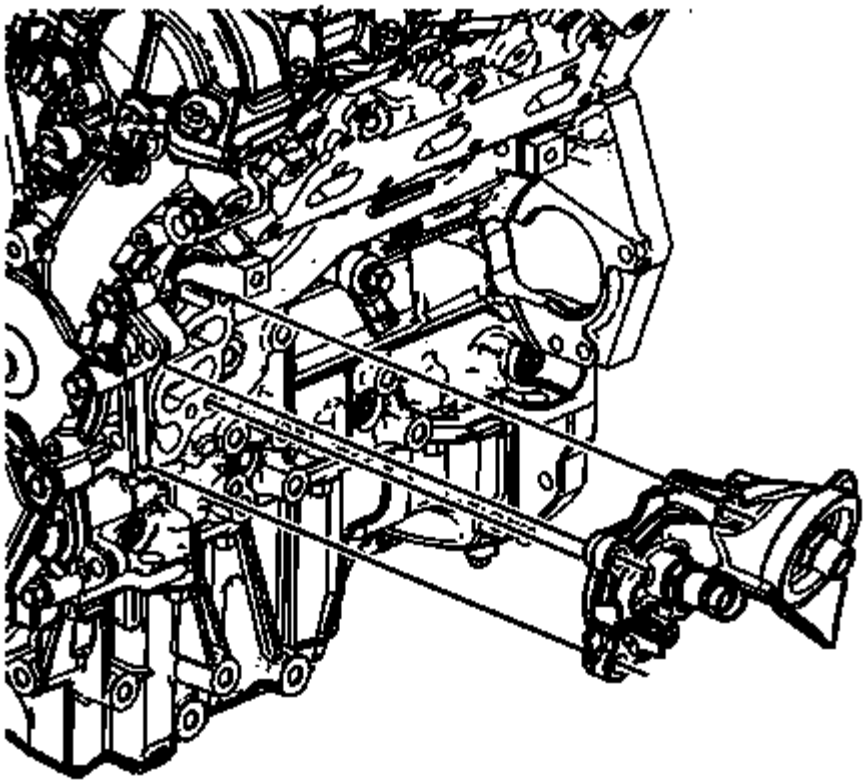


Fig. 14: Removing/Installing Oil Filter Adapter
Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil filter adapter.

cardiagn.com

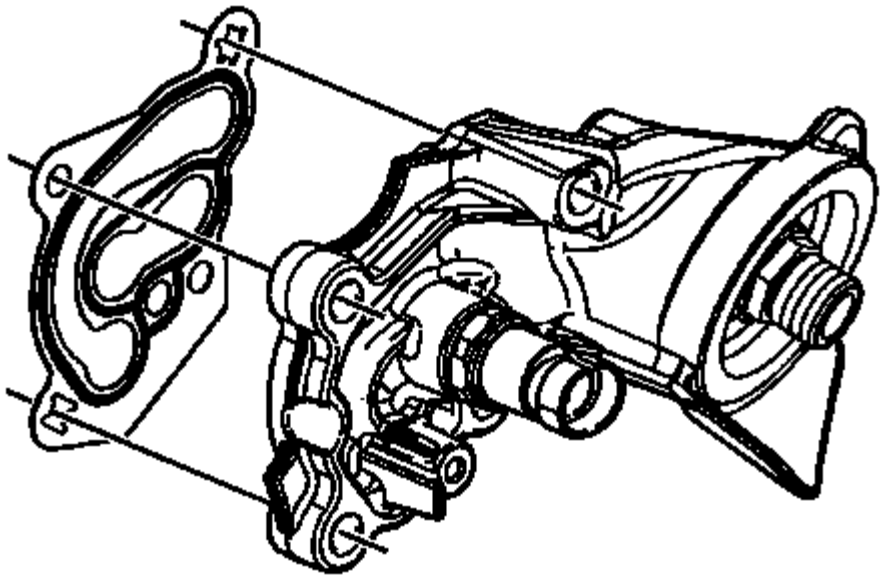


Fig. 15: Identifying Oil Filter Adapter & Gasket
Courtesy of GENERAL MOTORS COMPANY

4. Remove and discard the oil filter adapter gasket.

EXHAUST MANIFOLD REMOVAL - RIGHT SIDE

cardiagn.com

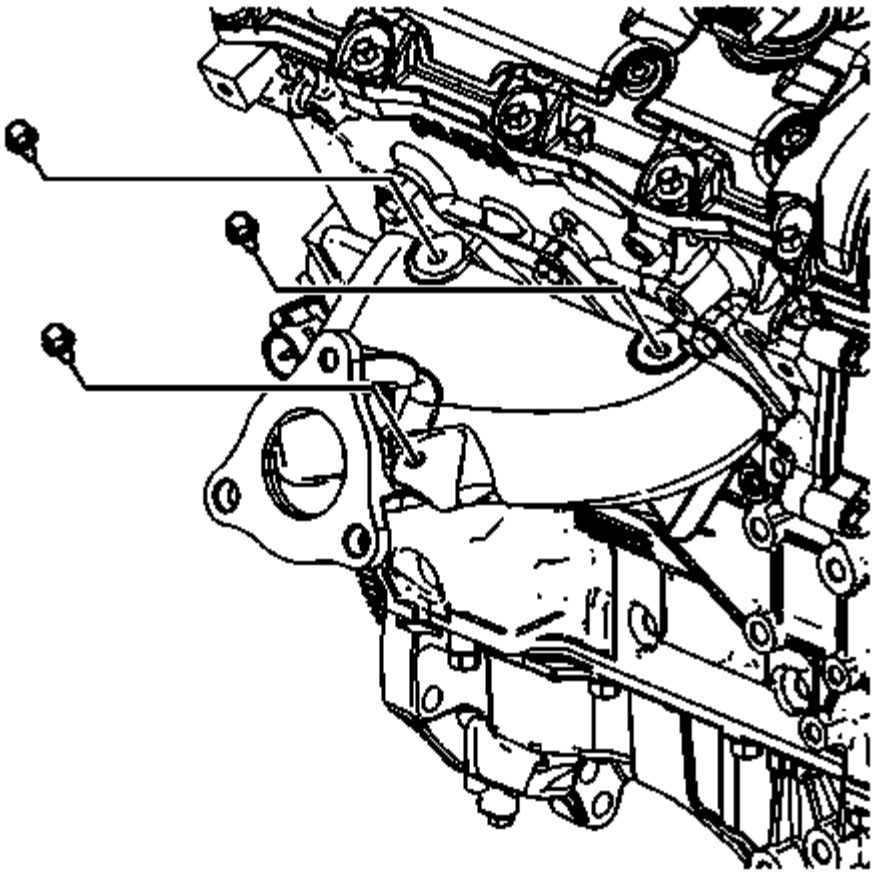


Fig. 16: View Of Exhaust Manifold Heat Shield Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the right exhaust manifold heat shield bolts.

cardiagn.com

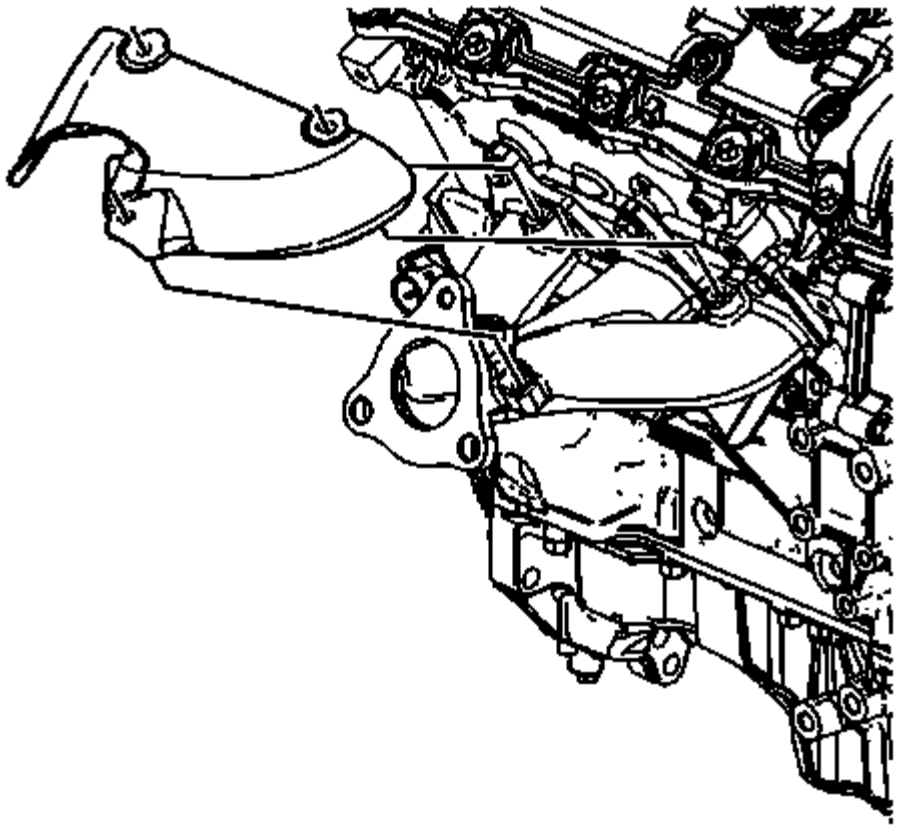


Fig. 17: Identifying Exhaust Manifold Heat Shield
Courtesy of GENERAL MOTORS COMPANY

2. Remove the right exhaust manifold heat shield.

cardiagn.com

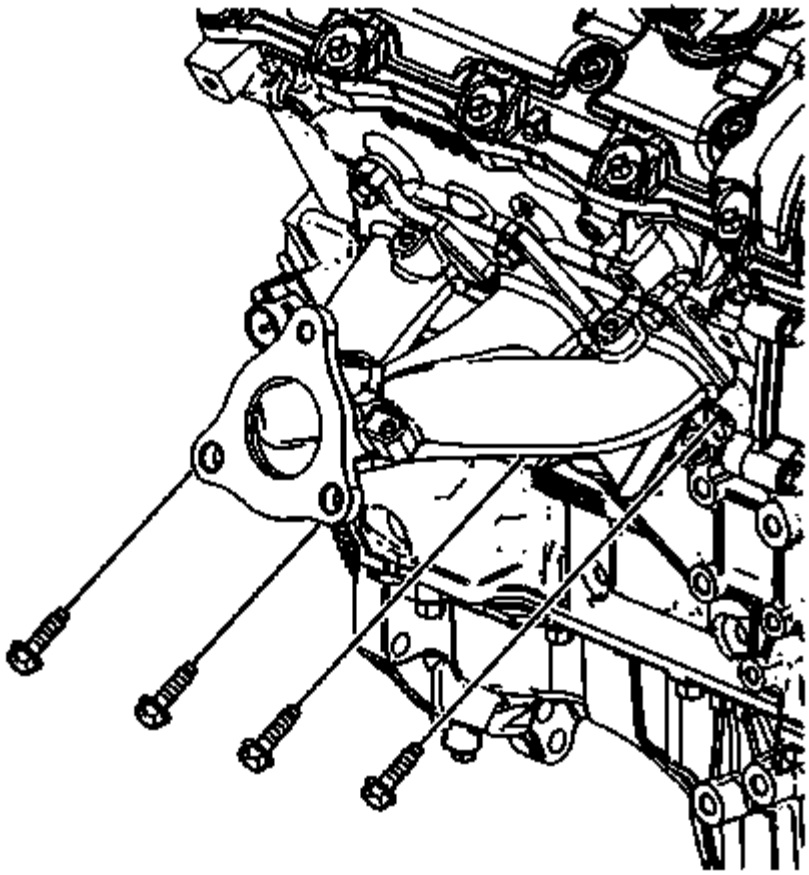


Fig. 18: Locating Exhaust Manifold Lower Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the right exhaust manifold lower bolts from the right cylinder head.

cardiagn.com

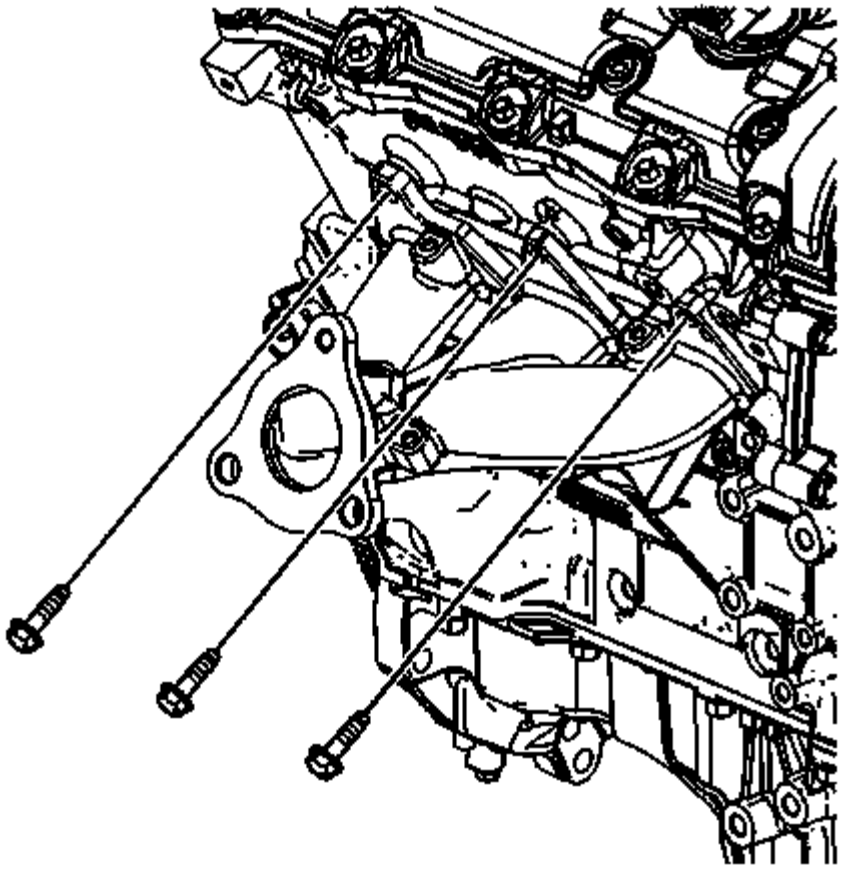


Fig. 19: Locating Exhaust Manifold Upper Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the right exhaust manifold upper bolts from the right cylinder head.

cardiagn.com

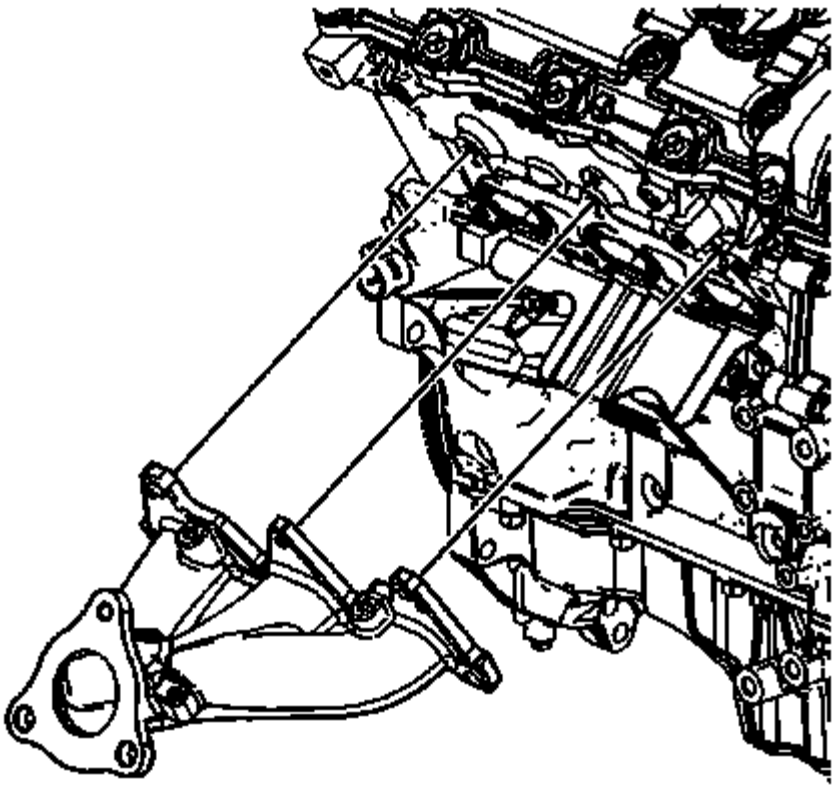


Fig. 20: Removing/Installing Exhaust Manifold
Courtesy of GENERAL MOTORS COMPANY

5. Remove the right exhaust manifold.

cardiagn.com

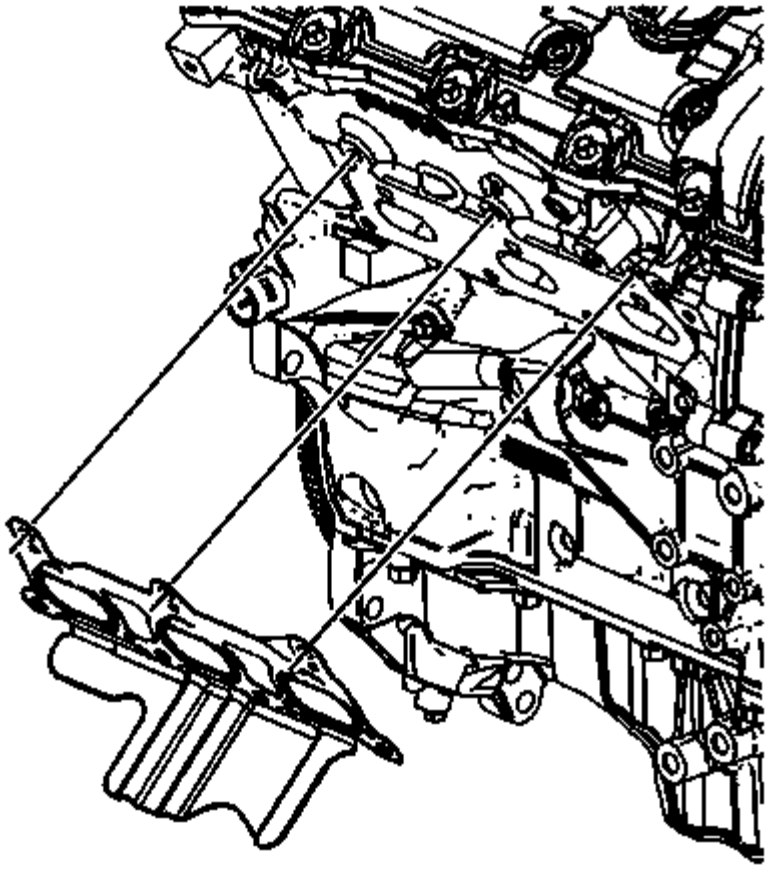


Fig. 21: Identifying Exhaust Manifold Gasket
Courtesy of GENERAL MOTORS COMPANY

6. Remove and discard the right exhaust manifold gasket.

INTAKE MANIFOLD REMOVAL

cardiagn.com

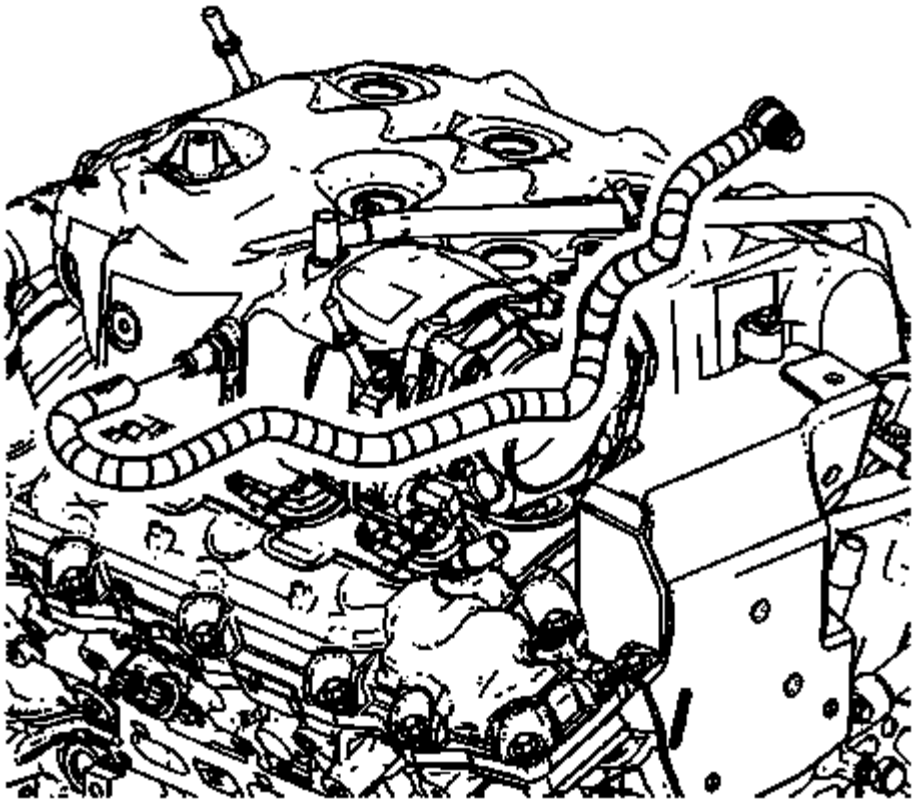


Fig. 22: View Of Brake Booster Hose
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect and remove the brake booster hose from the intake manifold.

cardiagn.com

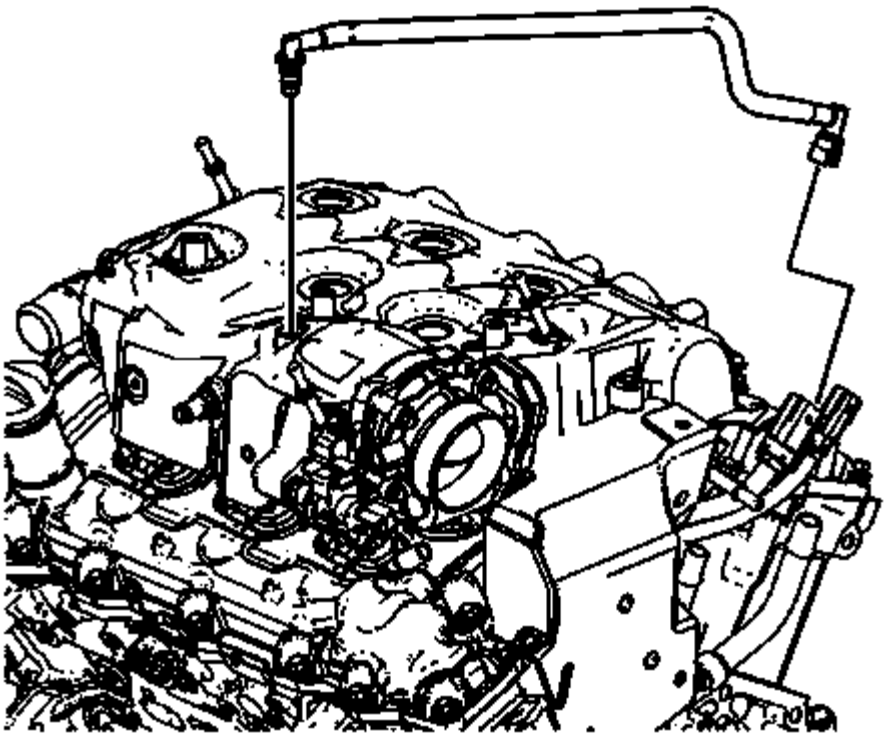


Fig. 23: View Of Positive Crankcase Ventilation (PCV) Tube
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect and remove the positive crankcase ventilation (PCV) tube from the intake manifold and right camshaft cover.

cardiagn.com

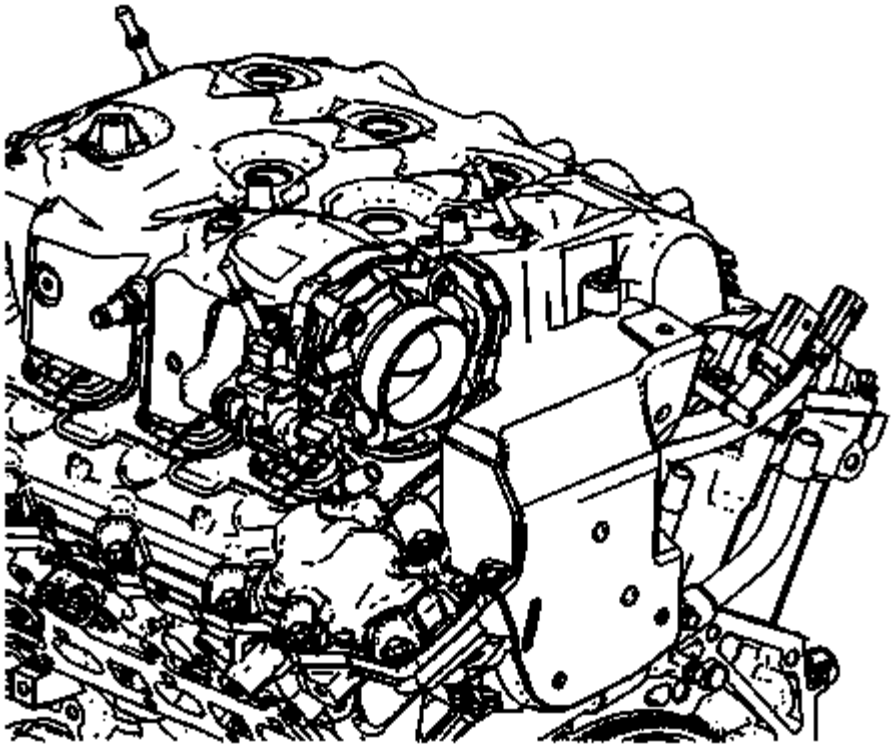


Fig. 24: View Of Evaporative (EVAP) Hose
Courtesy of GENERAL MOTORS COMPANY

3. Remove the evaporative (EVAP) hose from the intake manifold and EVAP solenoid.

cardiagn.com

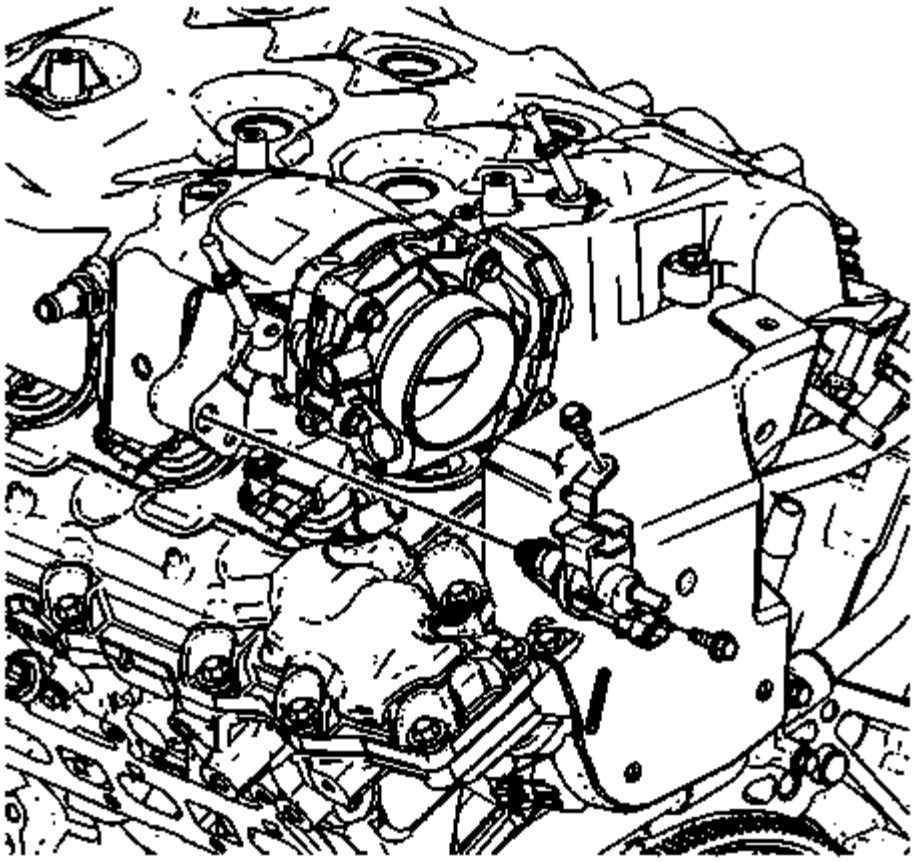


Fig. 25: Identifying EVAP Solenoid & Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the EVAP solenoid bolts
5. Remove the EVAP solenoid.

cardiagn.com

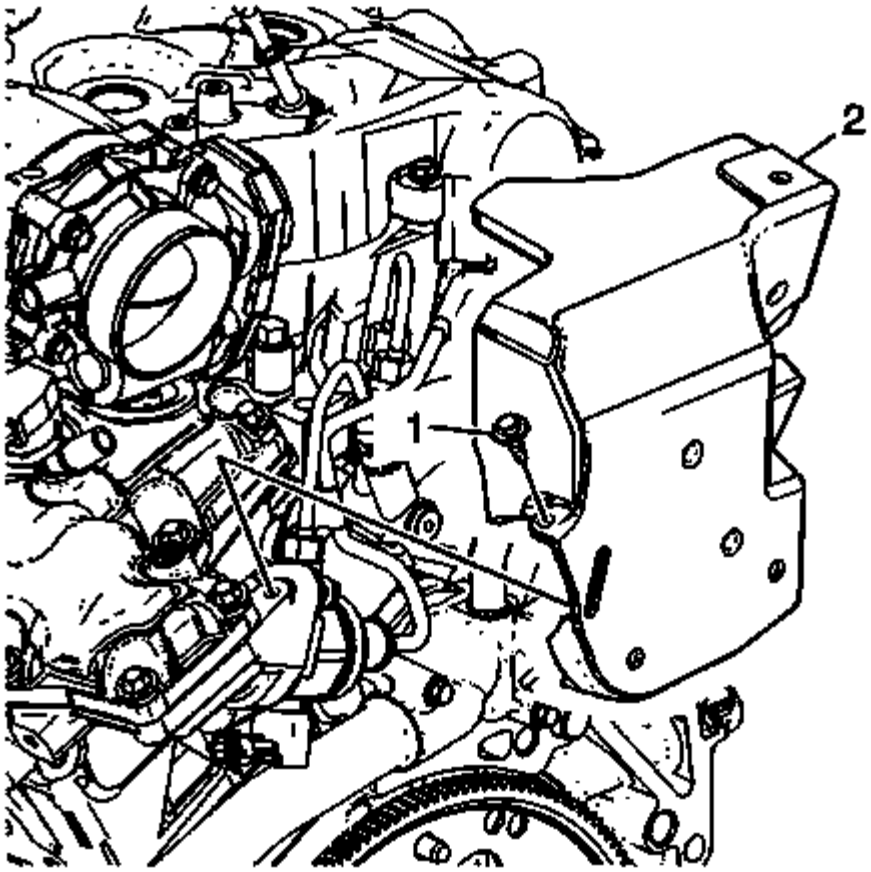


Fig. 26: Identifying Fuel Pump Cover & Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the fuel pump cover bolts (1).
7. Remove the fuel pump cover (2).

cardiagn.com

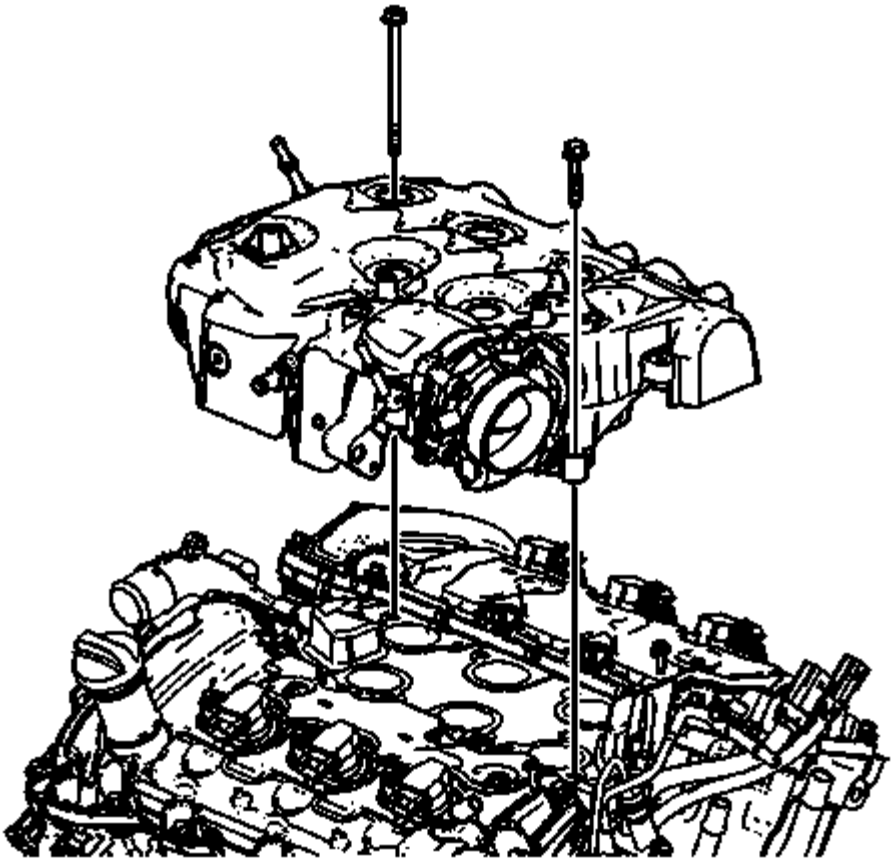


Fig. 27: View Of Intake Manifold & Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the intake manifold bolts.
9. Remove the intake manifold assembly.

cardiagn.com

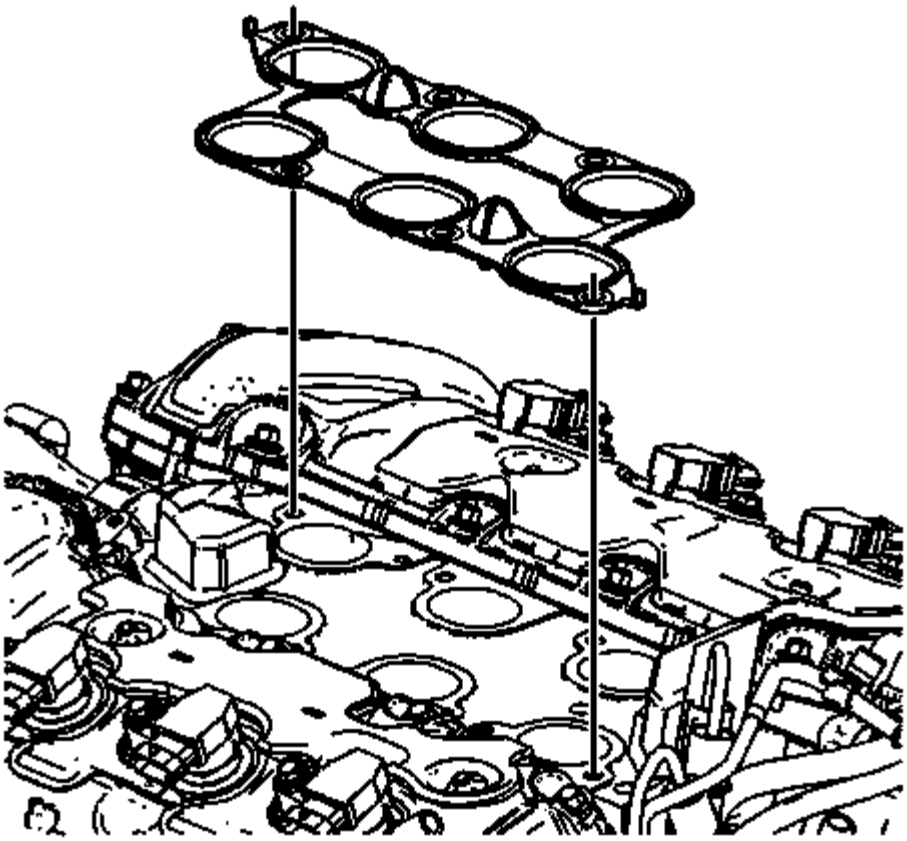


Fig. 28: View Of Lower Intake Manifold Gasket
Courtesy of GENERAL MOTORS COMPANY

10. Remove and discard the lower intake manifold gasket.

WATER OUTLET REMOVAL

cardiagn.com

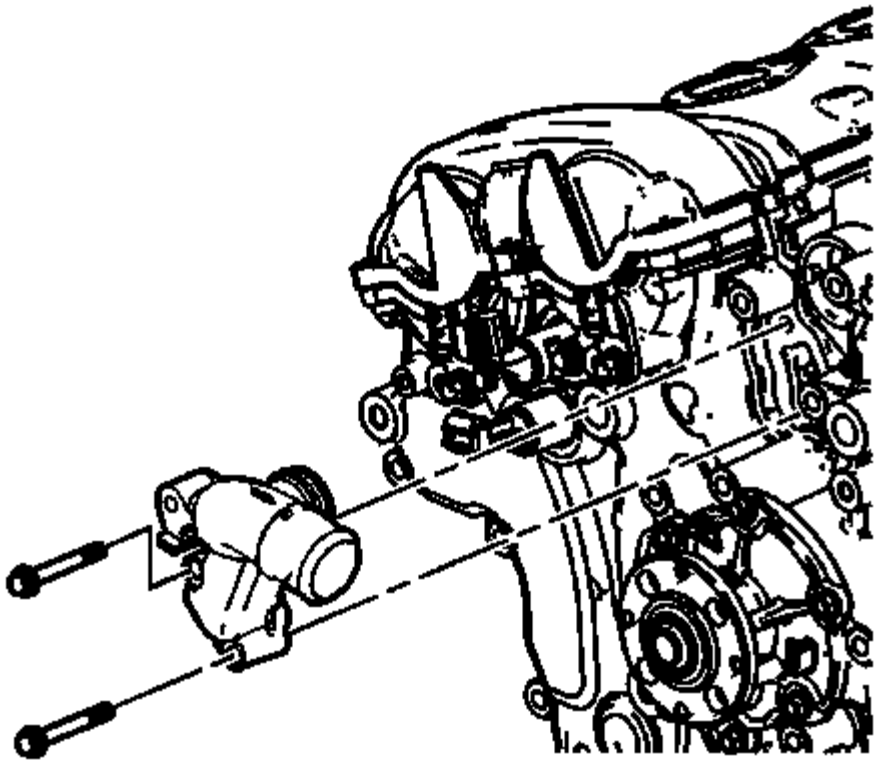


Fig. 29: Locating Water Outlet Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the water outlet bolts.
2. Remove the water outlet.

cardiagn.com

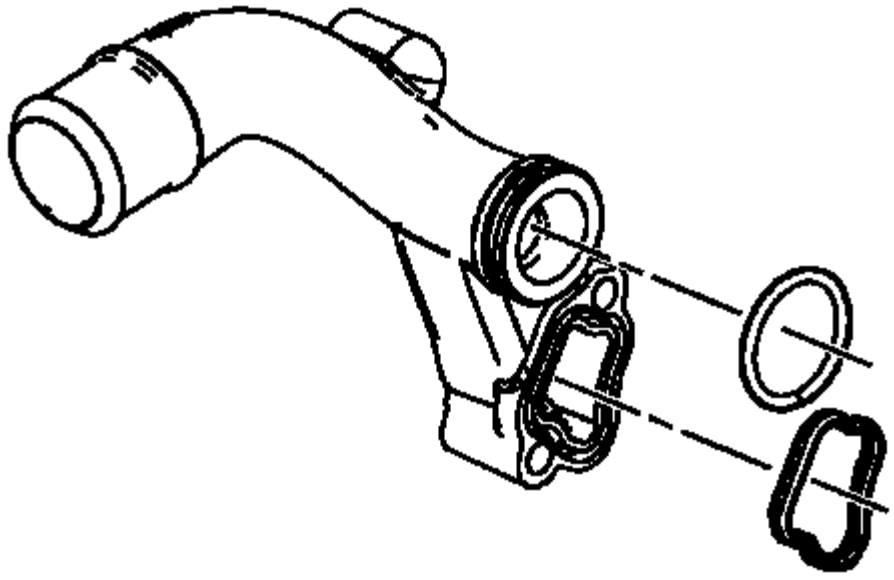


Fig. 30: Identifying Water Outlet Gasket & O-Ring
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the water outlet gasket and O-ring.

ENGINE COOLANT THERMOSTAT HOUSING REMOVAL

cardiagn.com

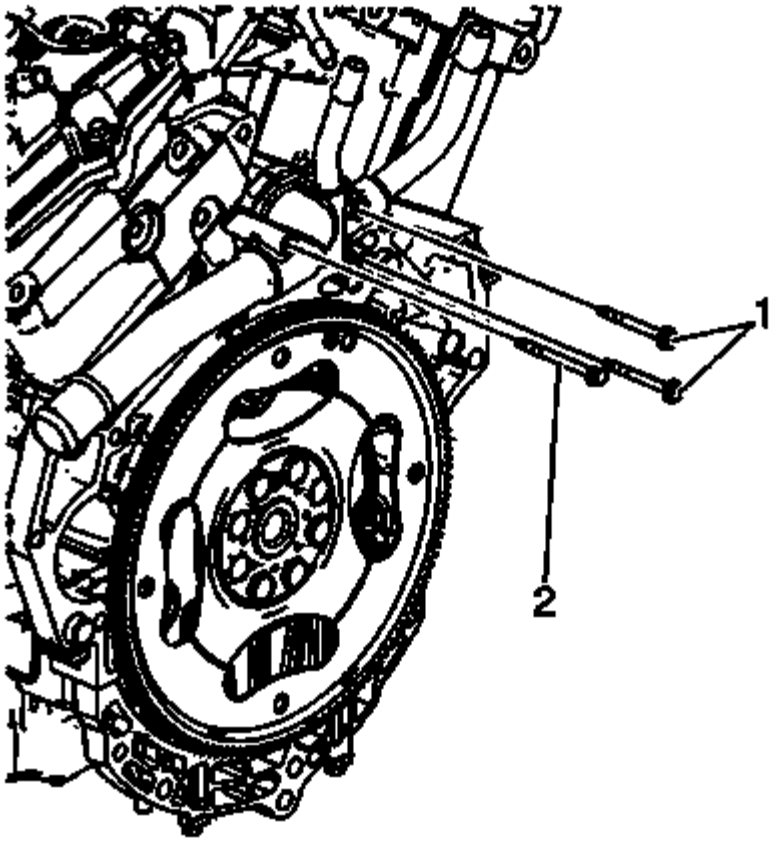


Fig. 31: Locating Thermostat Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the thermostat housing bolts (1, 2).

cardiagn.com

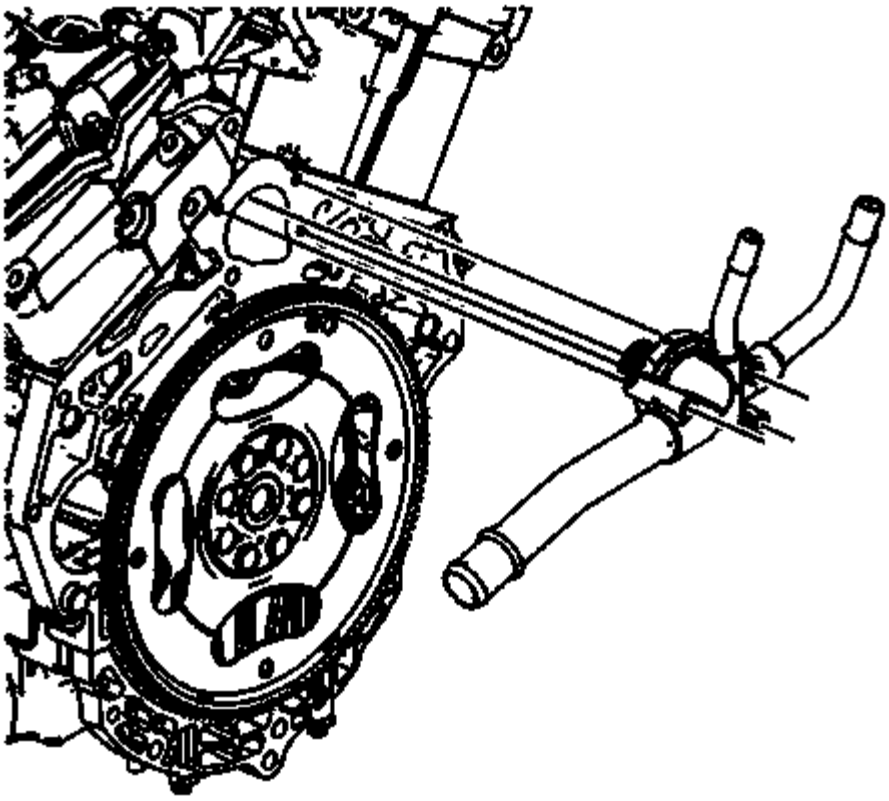


Fig. 32: Removing/Installing Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

2. Remove the thermostat housing.

cardiagn.com

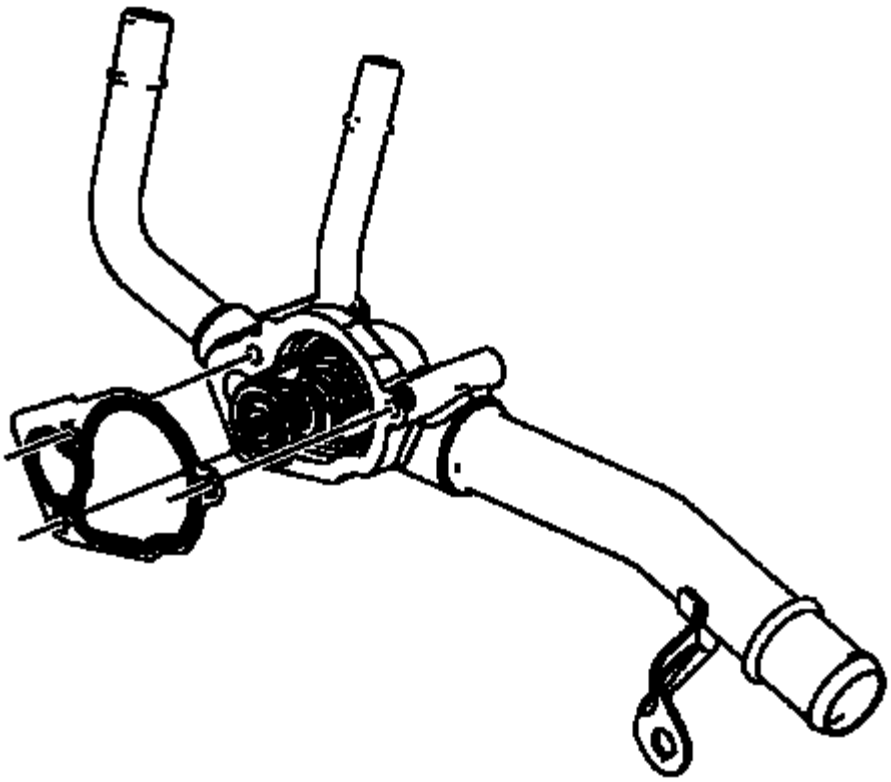


Fig. 33: Identifying Thermostat Housing Gasket
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the thermostat housing gasket.

CRANKSHAFT BALANCER REMOVAL

Tools Required

- **EN 46106** Flywheel Holding Tool
- **J 38416-2** Crankshaft Button
- **J 41816** Crankshaft Balancer Remover

cardiagn.com

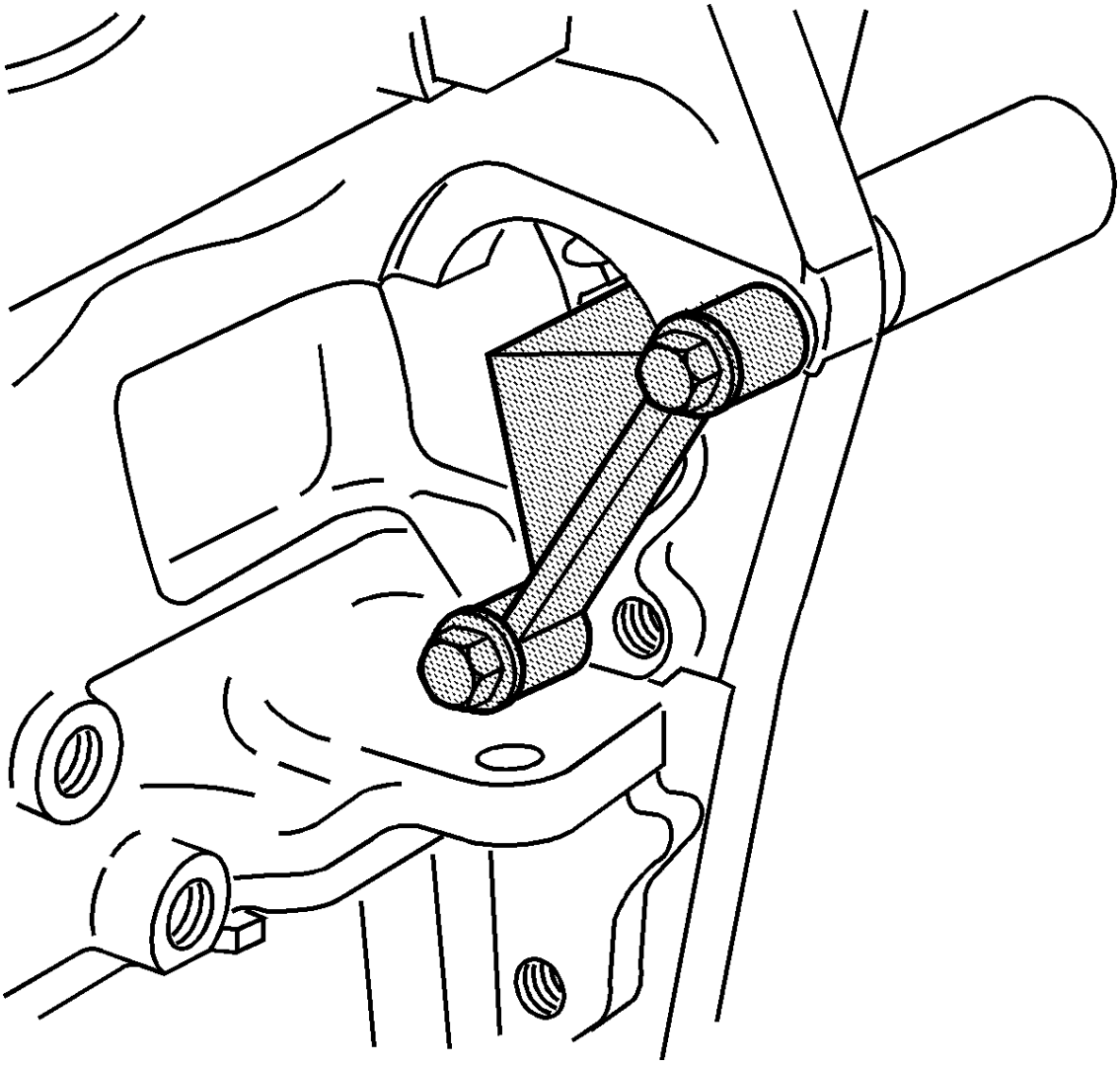


Fig. 34: Identifying Special Tool - EN 46106
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN 46106** flywheel holding tool through the starter mounting hole.

cardiagn.com

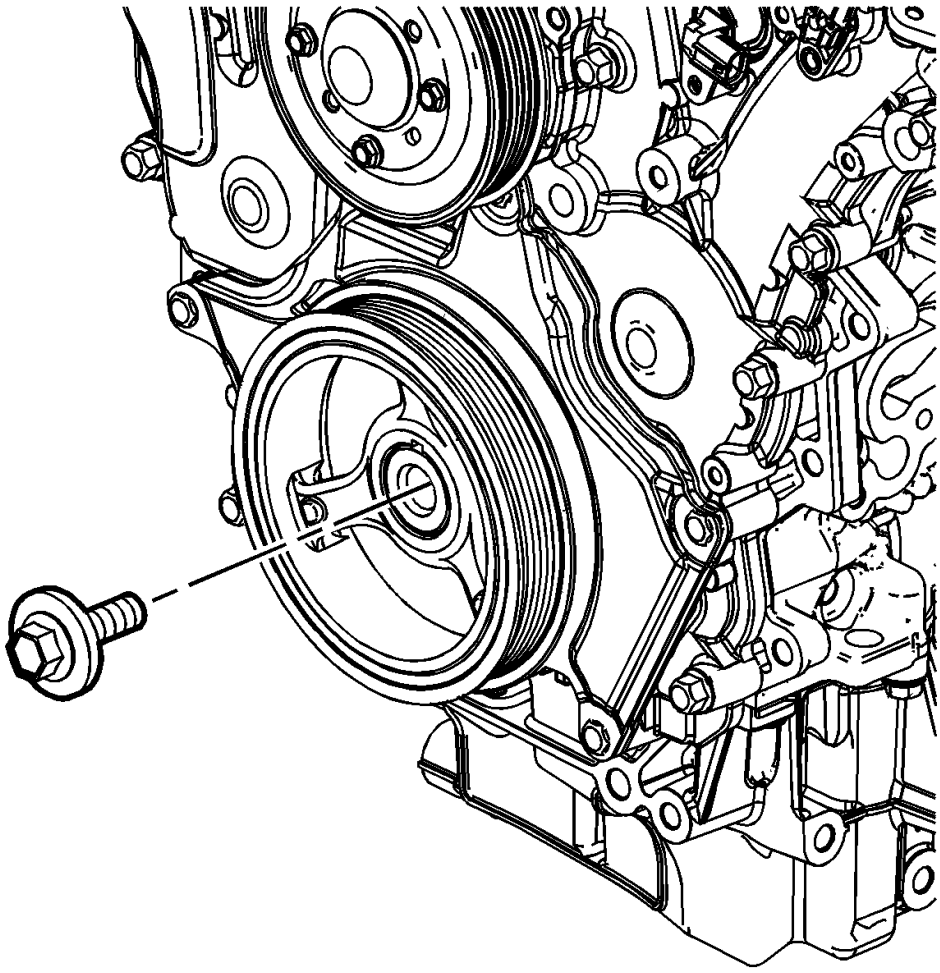


Fig. 35: View Of Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove and discard the crankshaft balancer bolt.

cardiagn.com

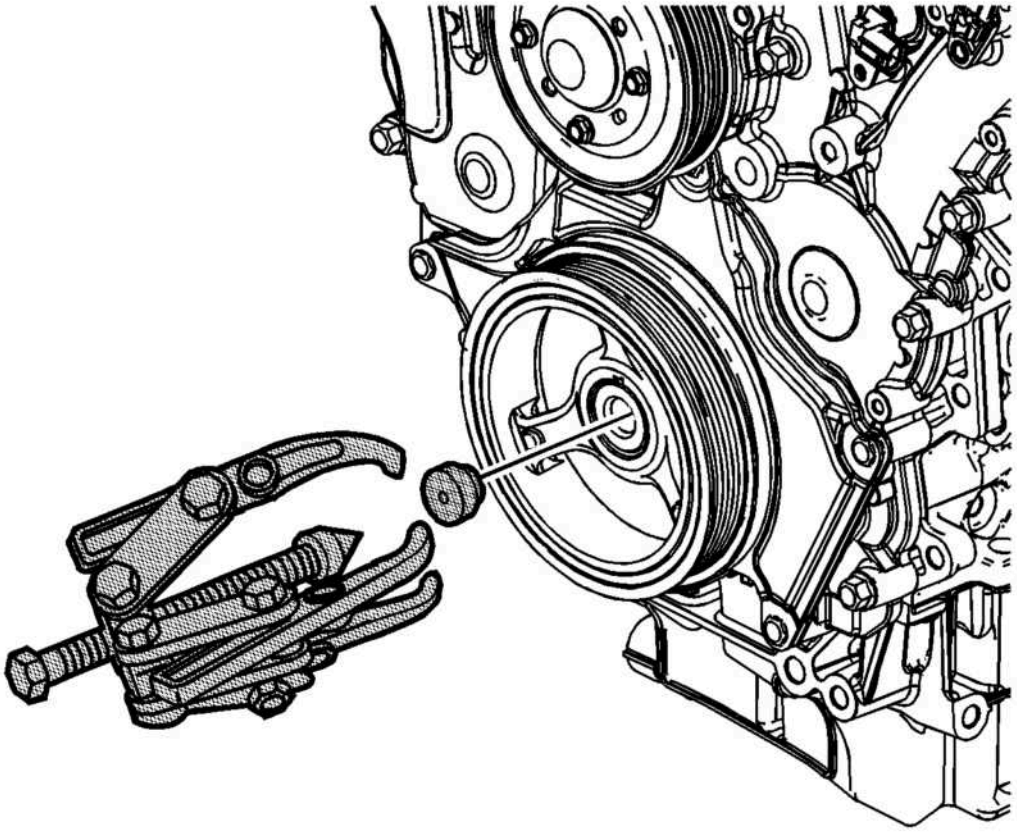


Fig. 36: Identifying Crankshaft Balancer Remover
Courtesy of GENERAL MOTORS COMPANY

3. Install the **J 38416-2** crankshaft button in the nose of the crankshaft.
4. Install the **J 41816** crankshaft balancer remover in order to remove the crankshaft balancer.
5. Tighten the center bolt of the **J 41816** crankshaft balancer remover in order to pull the crankshaft balancer off of the crankshaft.
6. Remove the **J 41816** crankshaft balancer remover from the crankshaft balancer.

cardiagn.com

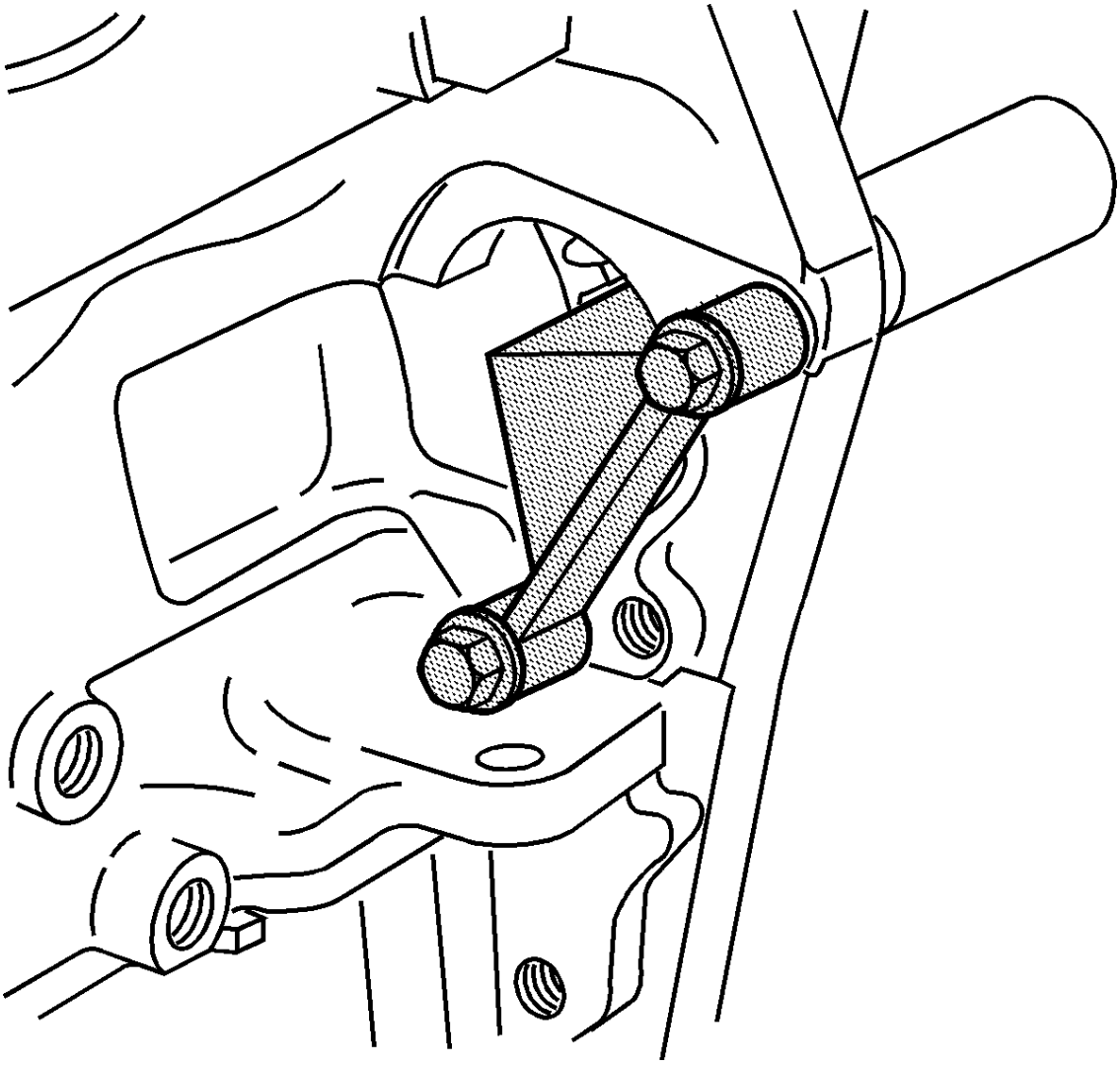


Fig. 37: Identifying Special Tool - EN 46106
Courtesy of GENERAL MOTORS COMPANY

7. Remove the **EN 46106** flywheel holding tool.

AUTOMATIC TRANSMISSION FLEX PLATE REMOVAL

Special Tools

EN 46106 Flywheel Holding Tool

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

cardiagn.com

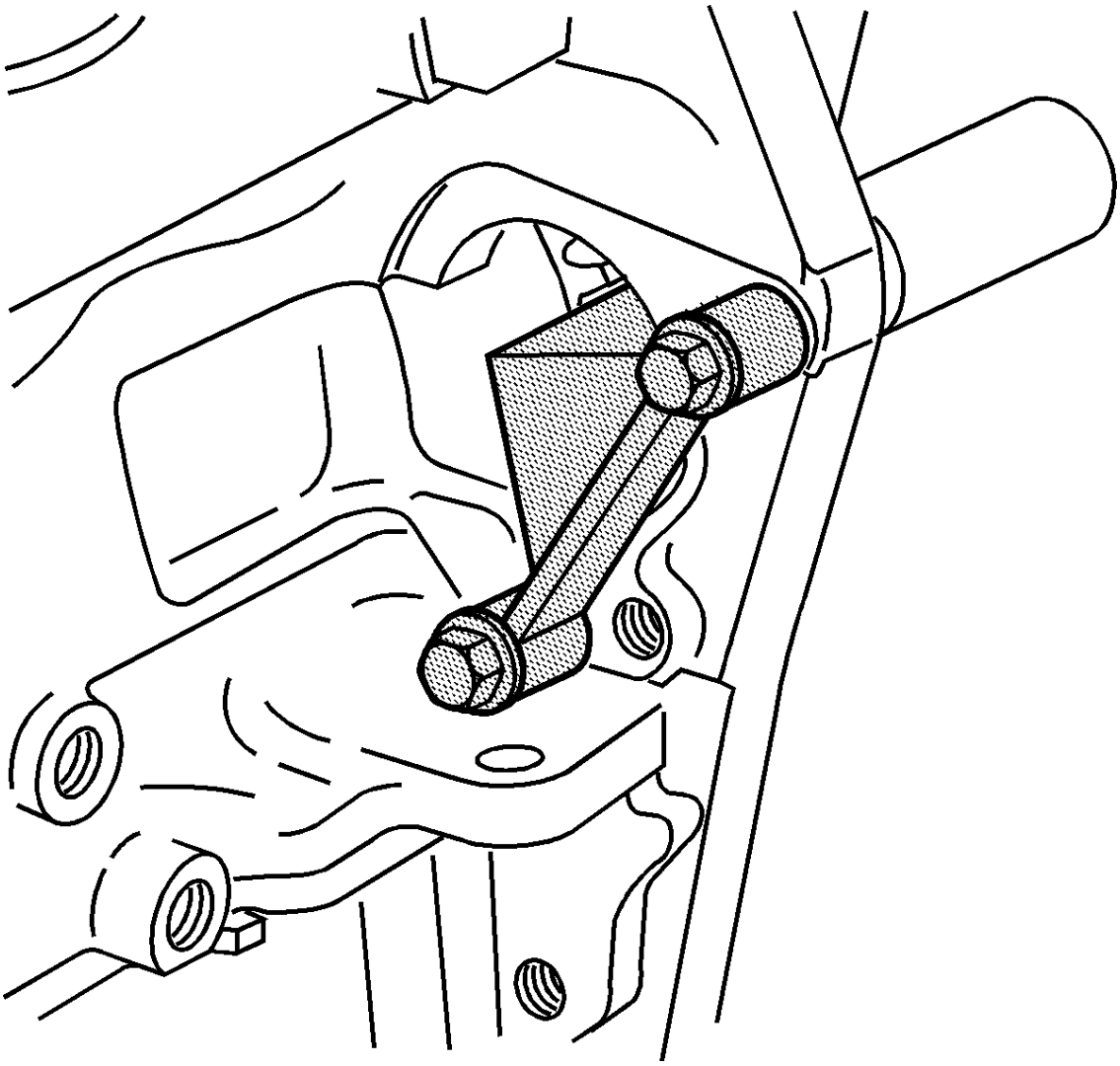


Fig. 38: Identifying Special Tool - EN 46106
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN 46106** tool through the starter mounting hole.

cardiagn.com

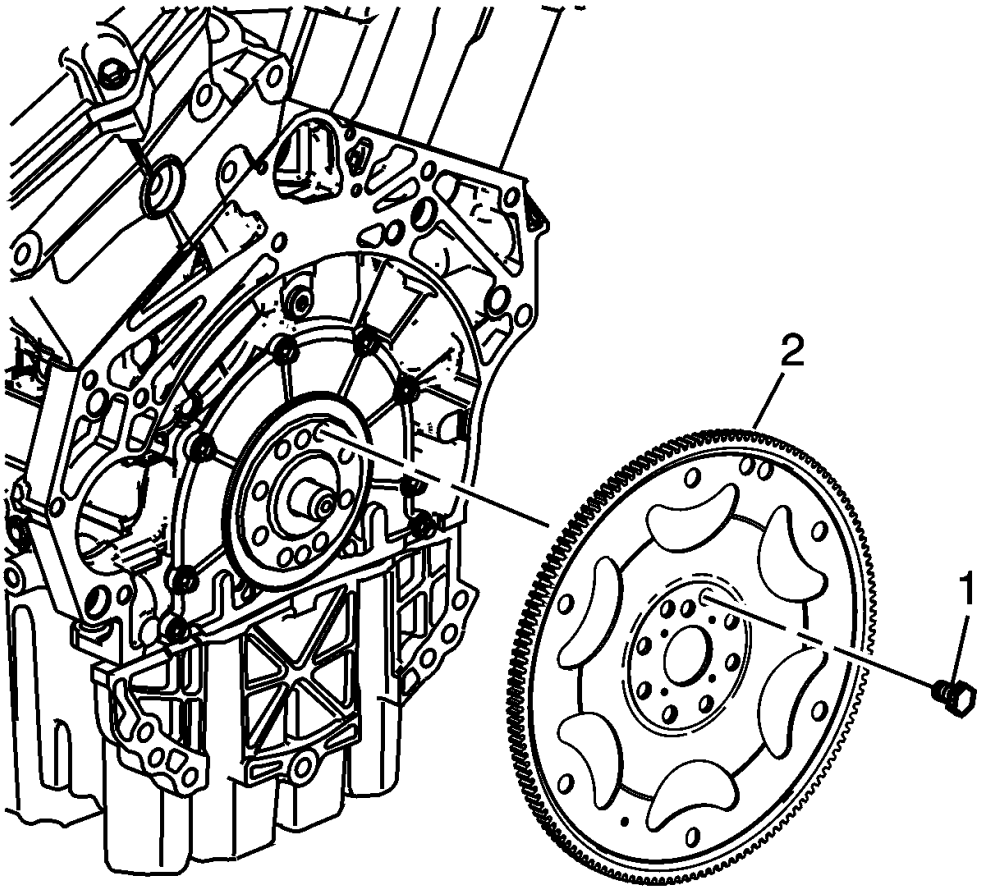


Fig. 39: View Of Engine Flywheel Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the flex plate bolts (1) and discard.
3. Remove the flex plate (2) from the crankshaft.

cardiagn.com

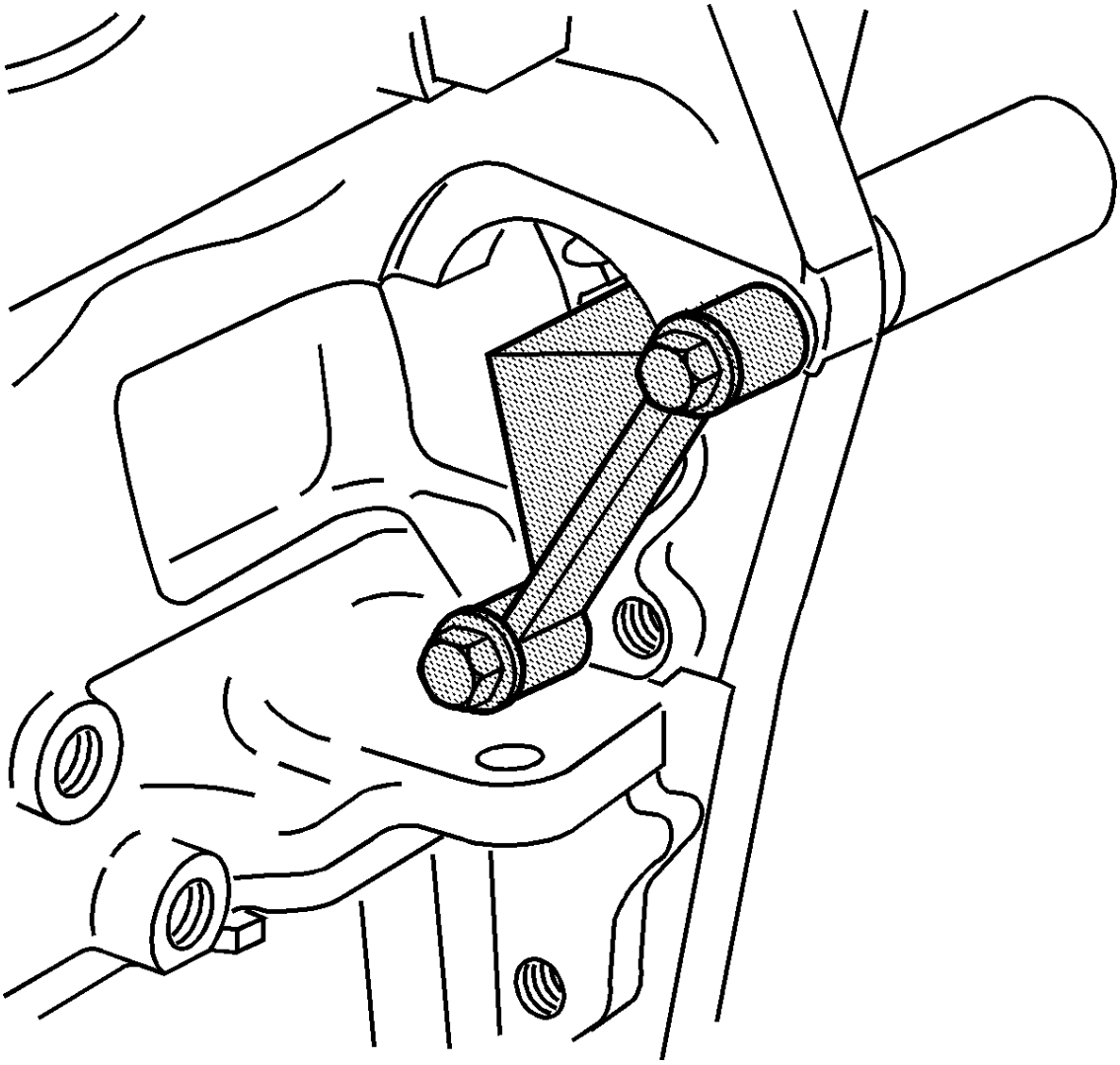


Fig. 40: Identifying Special Tool - EN 46106
Courtesy of GENERAL MOTORS COMPANY

4. Remove the **EN 46106** tool.

CAMSHAFT COVER REMOVAL - LEFT SIDE (LLT)

cardiagn.com

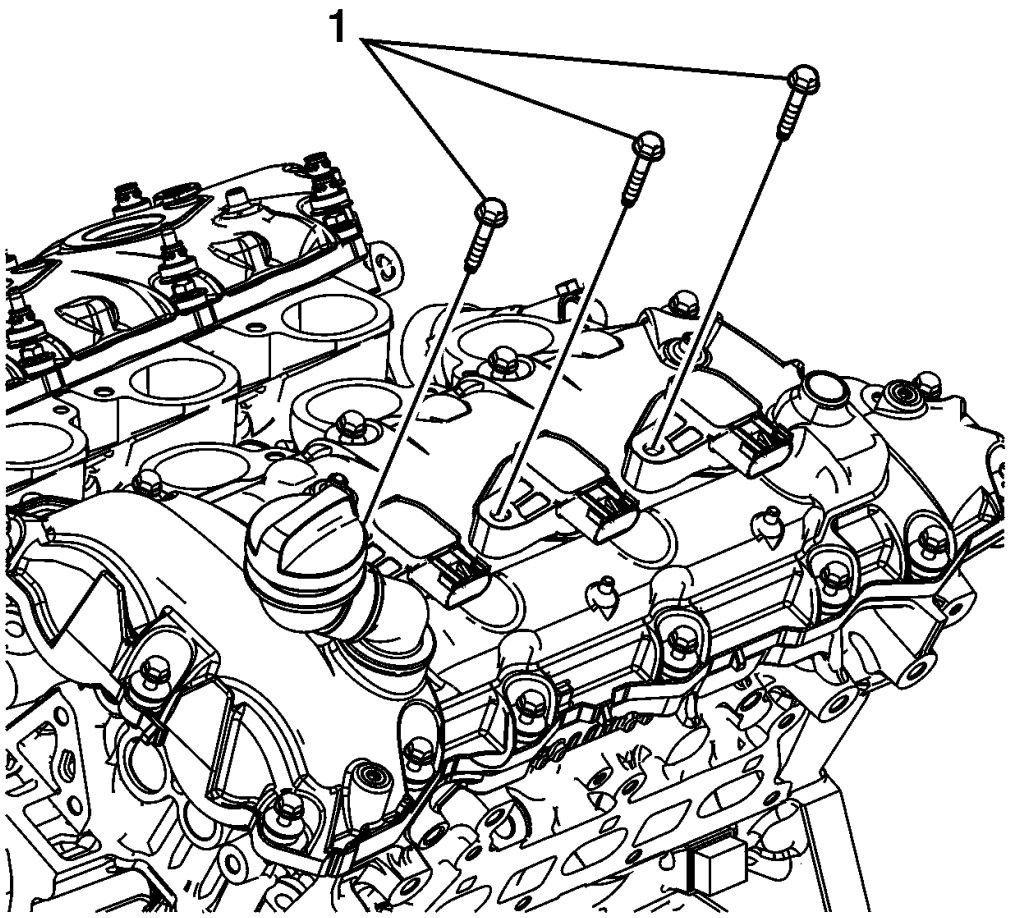


Fig. 41: View of Ignition Coil Bolts and Cylinder Heads
Courtesy of GENERAL MOTORS COMPANY

1. Remove the ignition coil bolts.

cardiagn.com

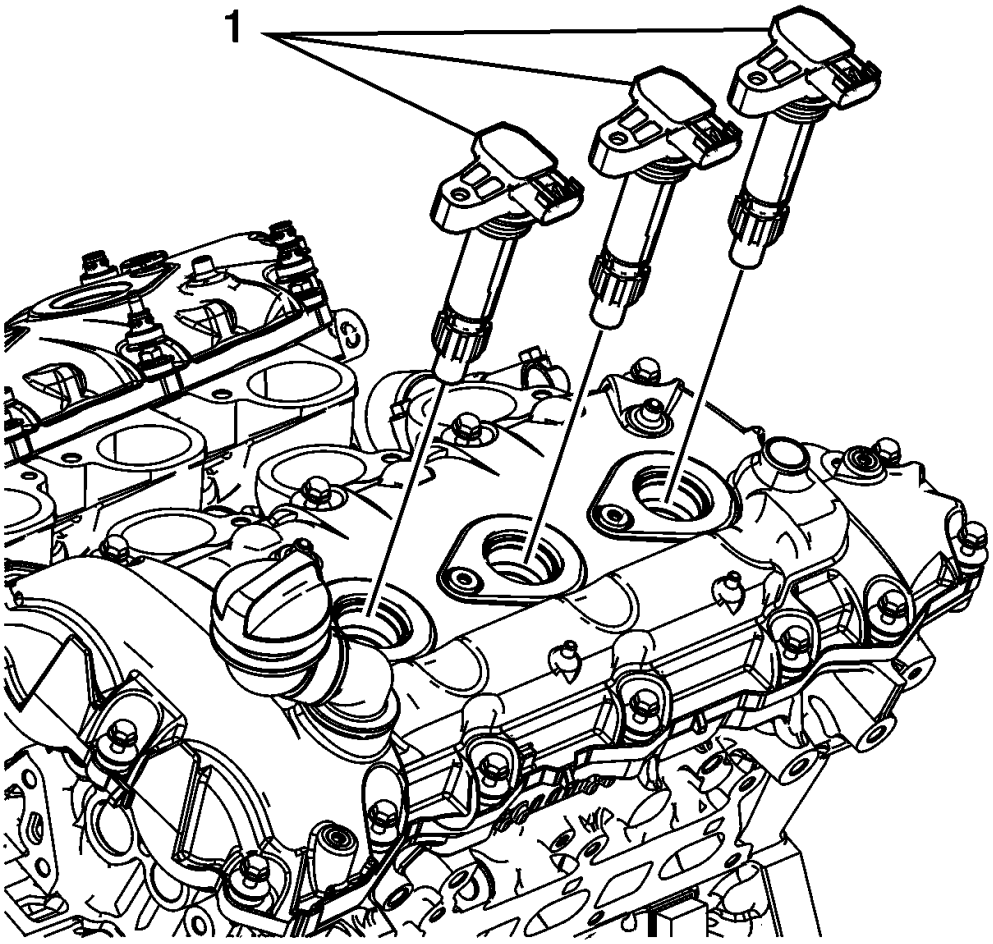


Fig. 42: View of Ignition Coils and Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

2. Remove the ignition coils.

cardiagn.com

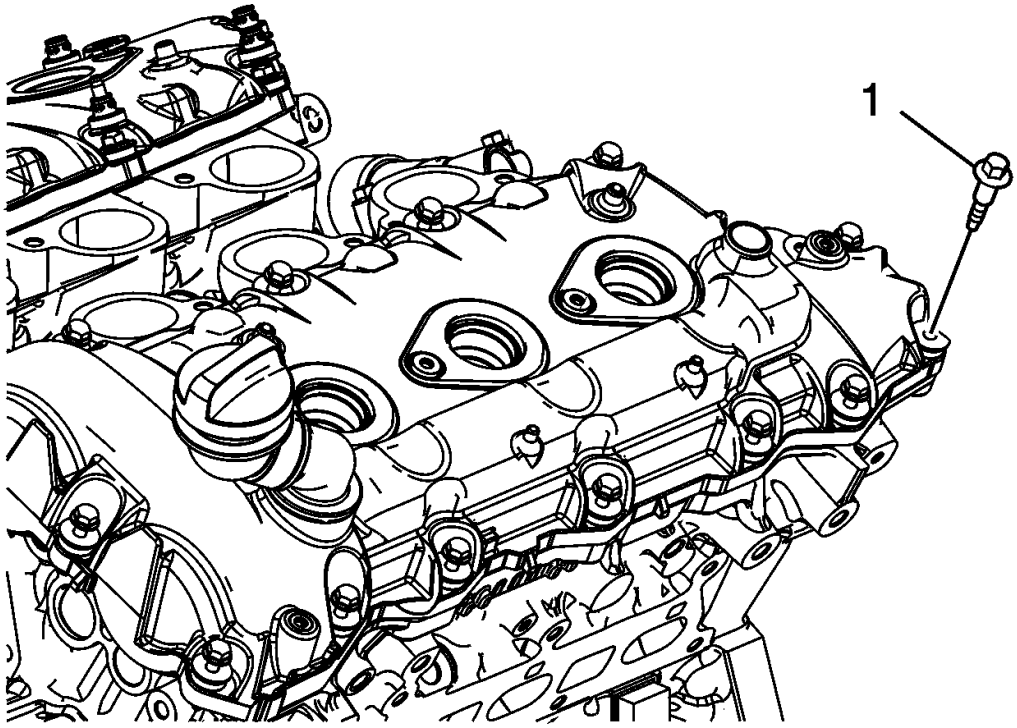


Fig. 43: View of Camshaft Cover and Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the left camshaft cover bolts.
4. Remove and discard the camshaft cover grommets and camshaft cover bolts if they are serviced with the grommet.

cardiagn.com

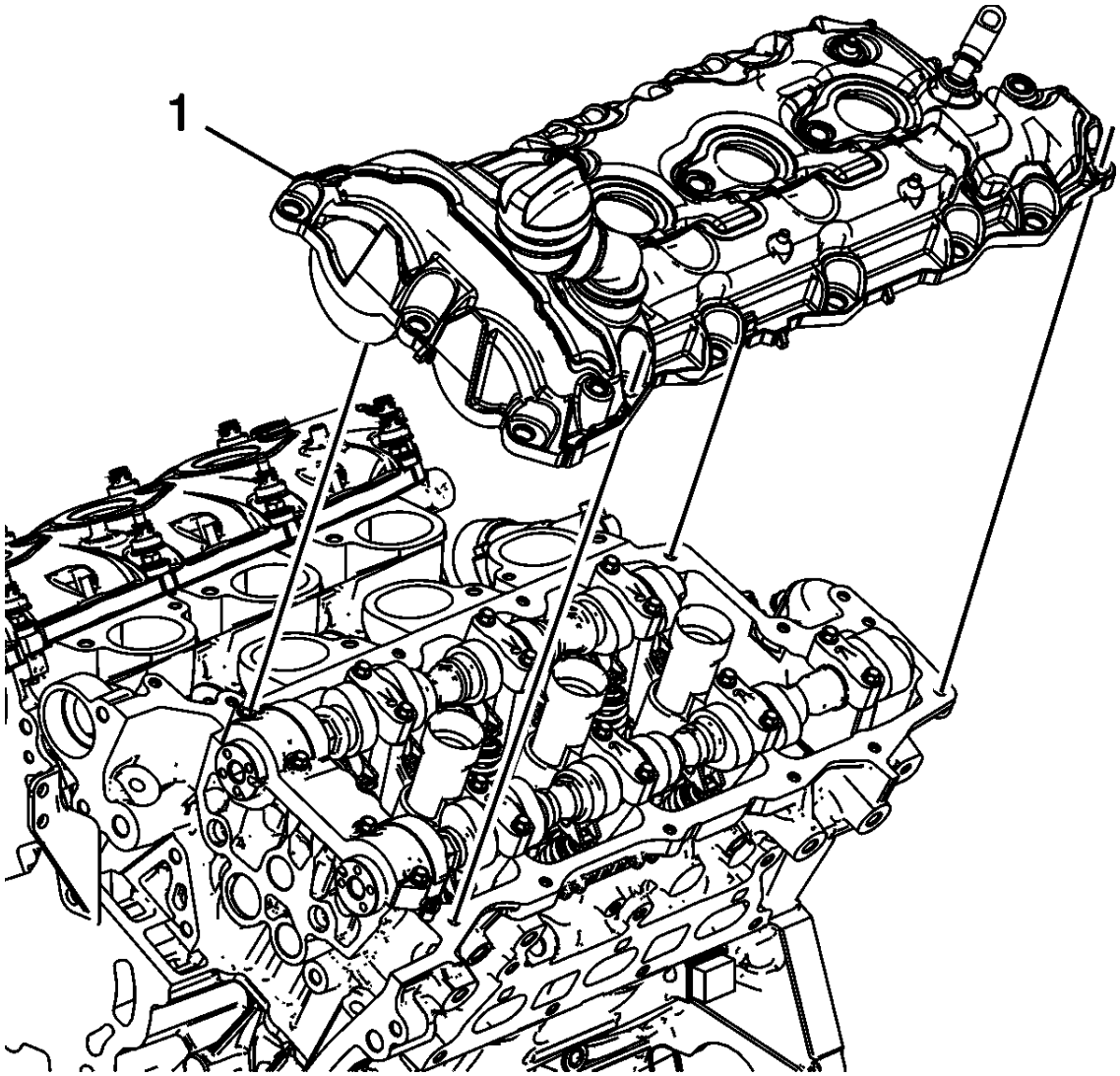


Fig. 44: View Of Left Camshaft Cover & Left Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

5. Remove the left camshaft cover from the left cylinder head.

CAMSHAFT COVER REMOVAL - RIGHT SIDE

cardiagn.com

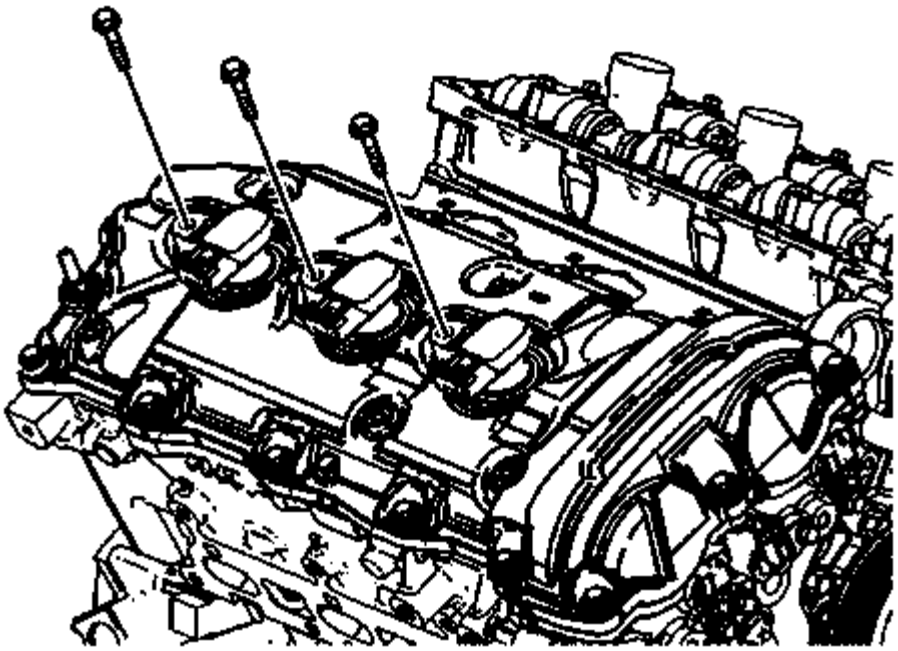


Fig. 45: View Of Ignition Coil Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the ignition coil bolts.

cardiagn.com

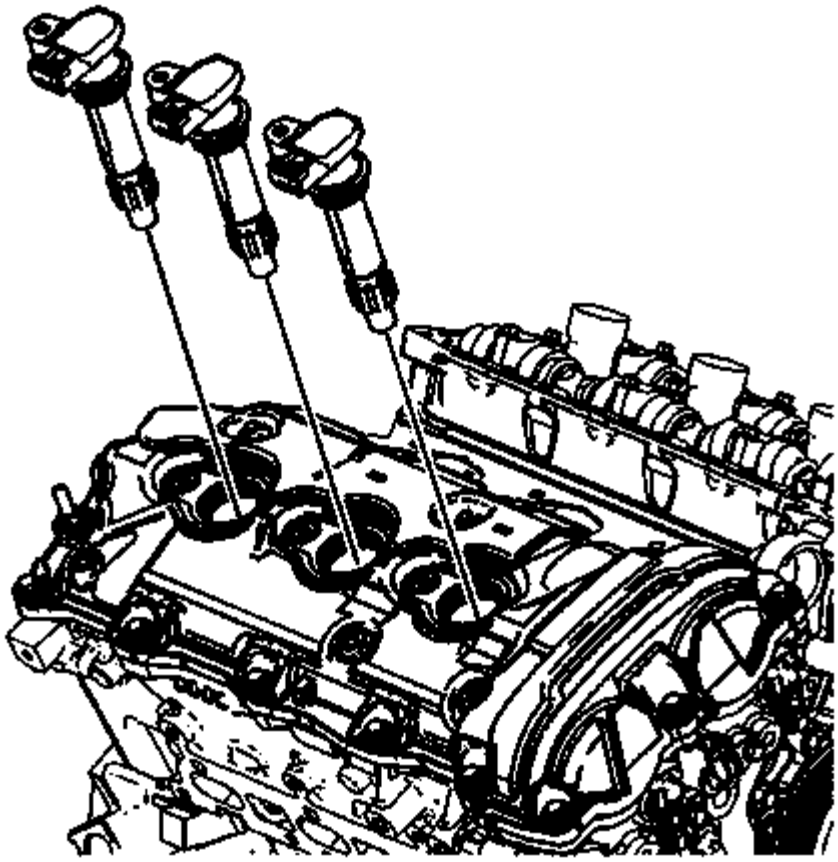


Fig. 46: View Of Ignition Coils
Courtesy of GENERAL MOTORS COMPANY

2. Remove the ignition coils.

cardiagn.com

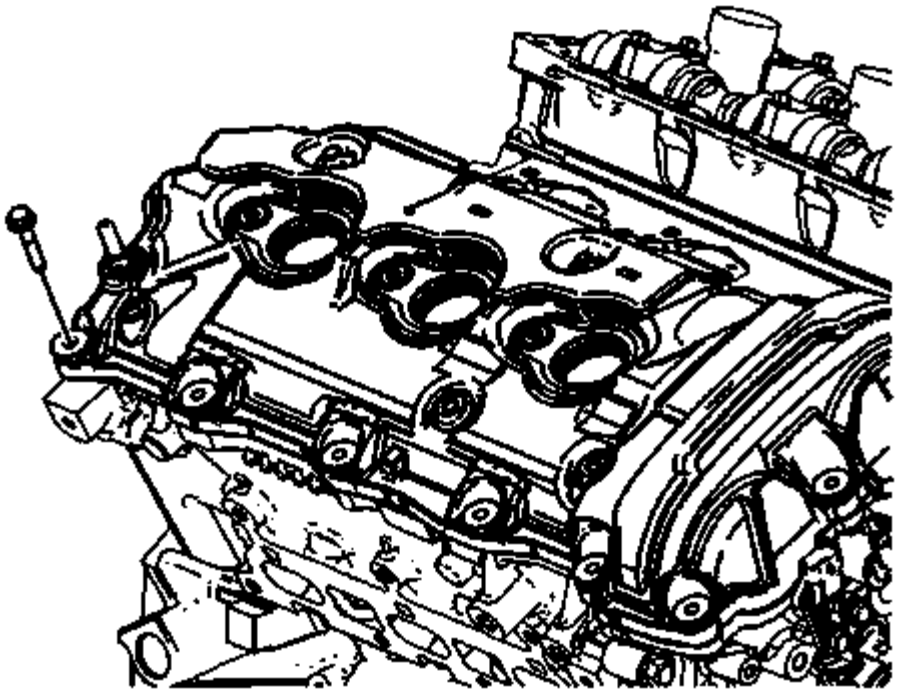


Fig. 47: View Of Right Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the right camshaft cover bolts.
4. Remove and discard the camshaft cover grommets and camshaft cover bolts if they are serviced with the grommet.

cardiagn.com

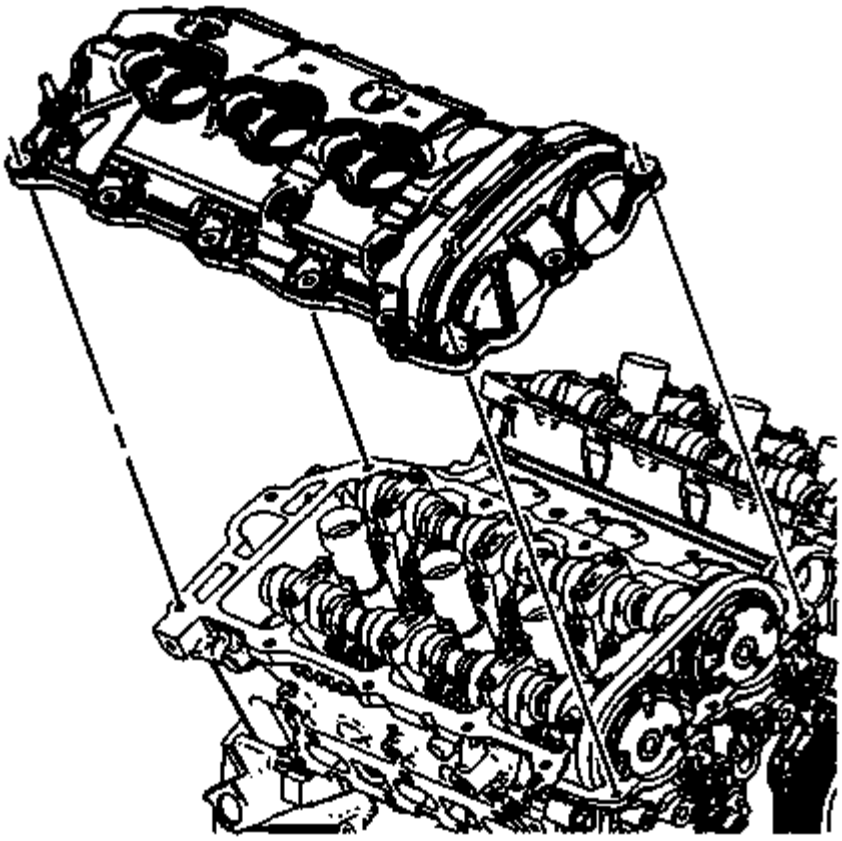


Fig. 48: Identifying Right Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

5. Remove the right camshaft cover from the right cylinder head.

WATER PUMP REMOVAL

Special Tools

EN-46104 Water Pump Pulley Holding Tool

cardiagn.com

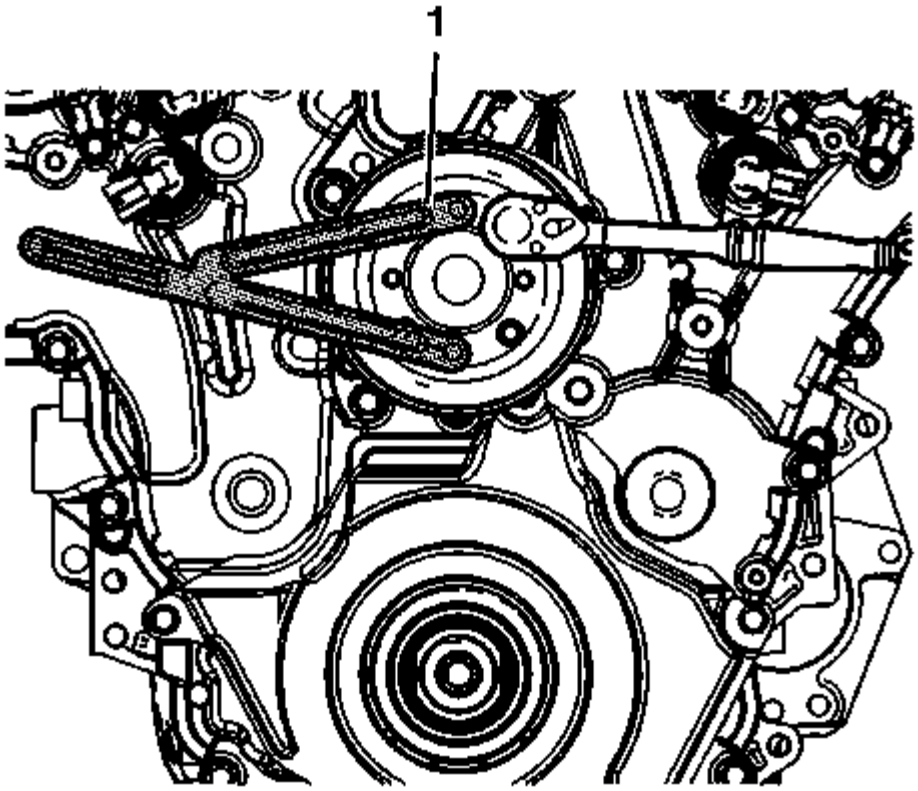


Fig. 49: Identifying Special Tool - EN 46104
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-46104** water pump pulley holding tool (1) onto the water pump pulley.

cardiagn.com

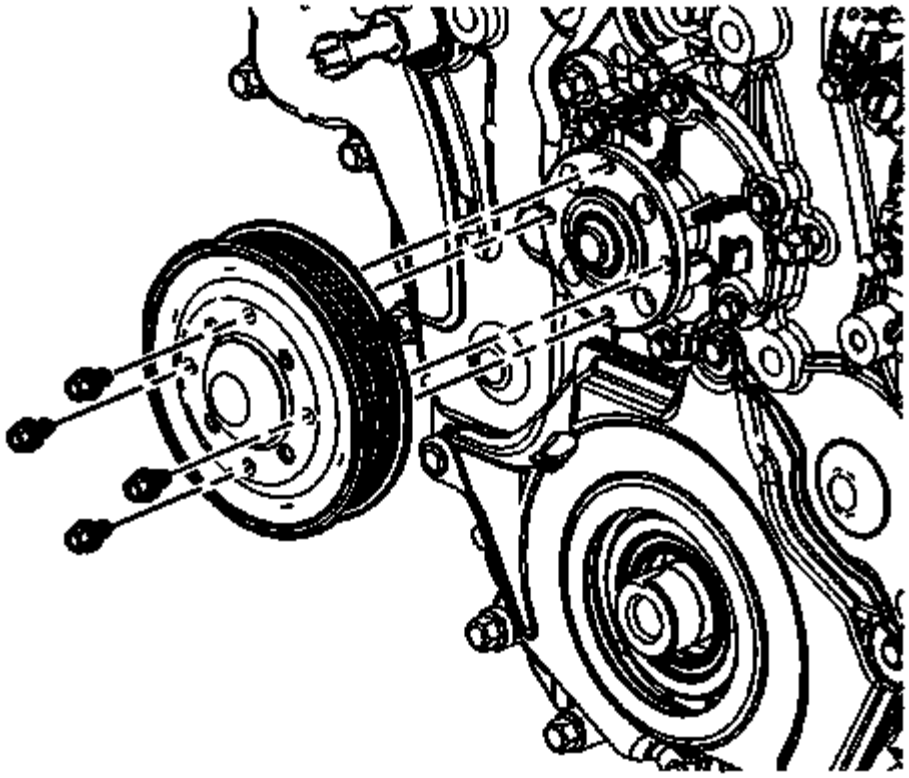


Fig. 50: View Of Water Pump Pulley & Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the water pump pulley bolts.
3. Remove the water pump pulley.

cardiagn.com

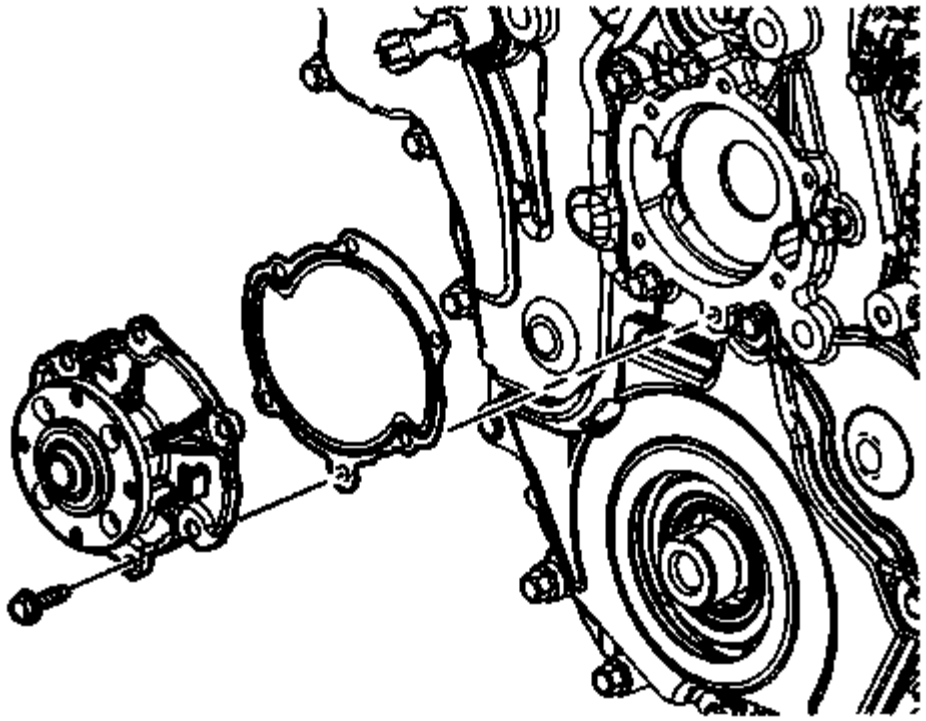


Fig. 51: View Of Water Pump, Gasket & Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the water pump bolts and DISCARD the bolts.
5. Remove the water pump from the front cover.
6. Remove and DISCARD the water pump gasket.

ENGINE FRONT COVER REMOVAL

cardiagn.com

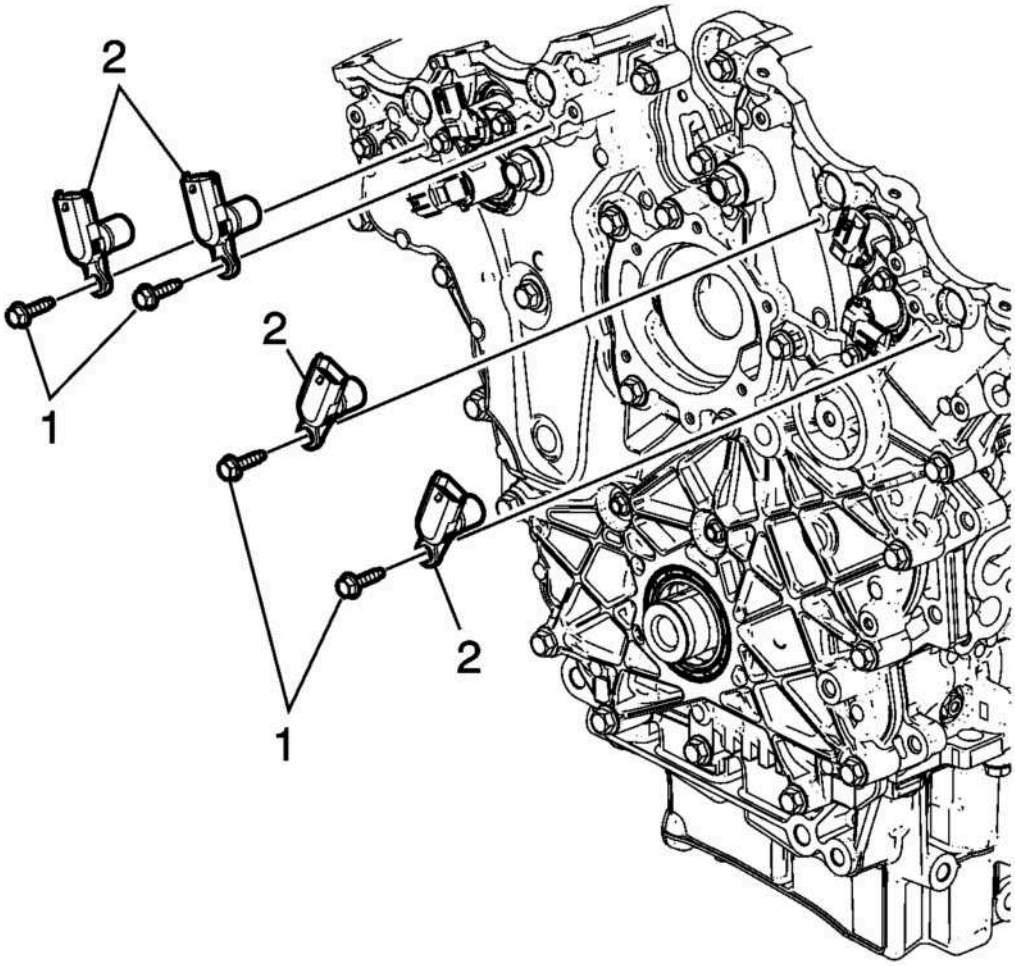


Fig. 52: Placing Camshaft Position Sensors
Courtesy of GENERAL MOTORS COMPANY

1. Remove the camshaft position sensor bolts (1).
2. Remove the camshaft position sensors (2).

cardiagn.com

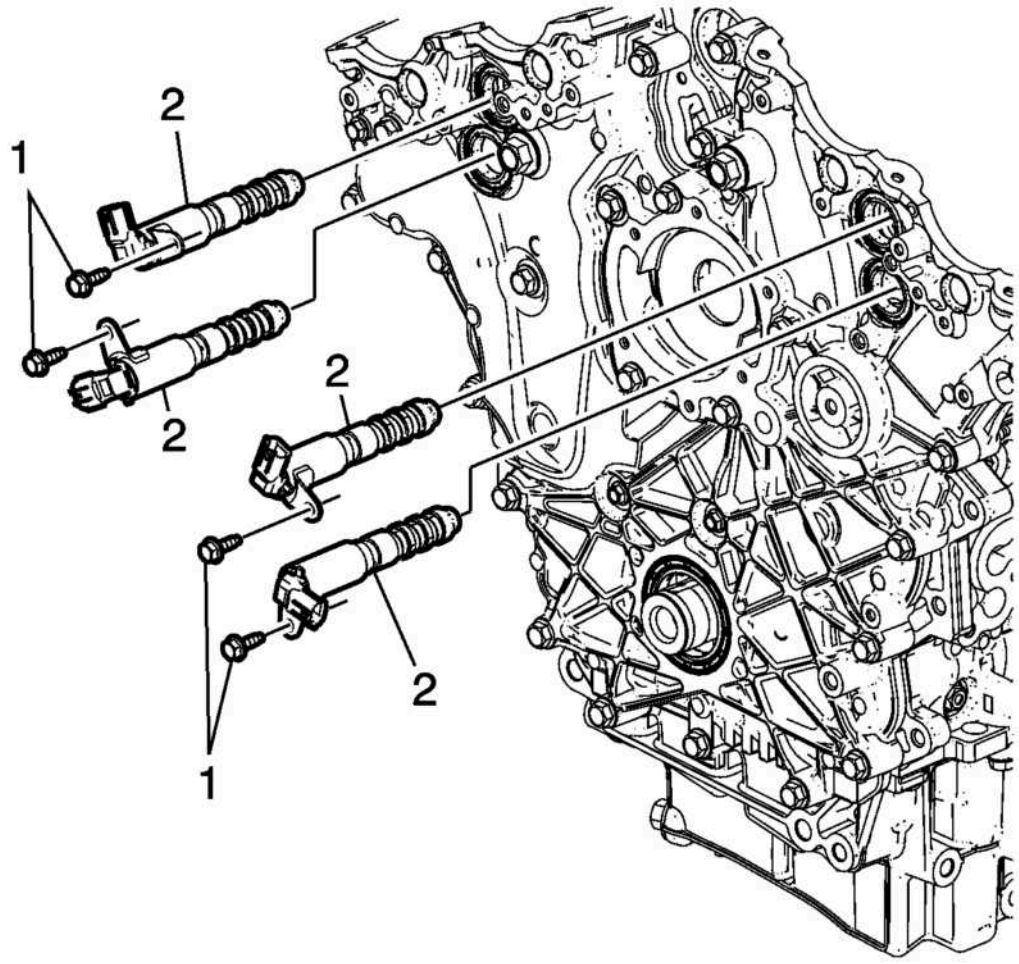


Fig. 53: Placing Camshaft Position Actuator Valves
Courtesy of GENERAL MOTORS COMPANY

3. Remove the camshaft position actuator valve bolts (1).
4. Remove the camshaft position actuator valves (2) from the front cover.

CAUTION: The camshaft position actuator valves must be removed from the front cover prior to front cover removal or damage to the valves may occur.

5. Remove the engine front cover bolts (1-3).

cardiagn.com

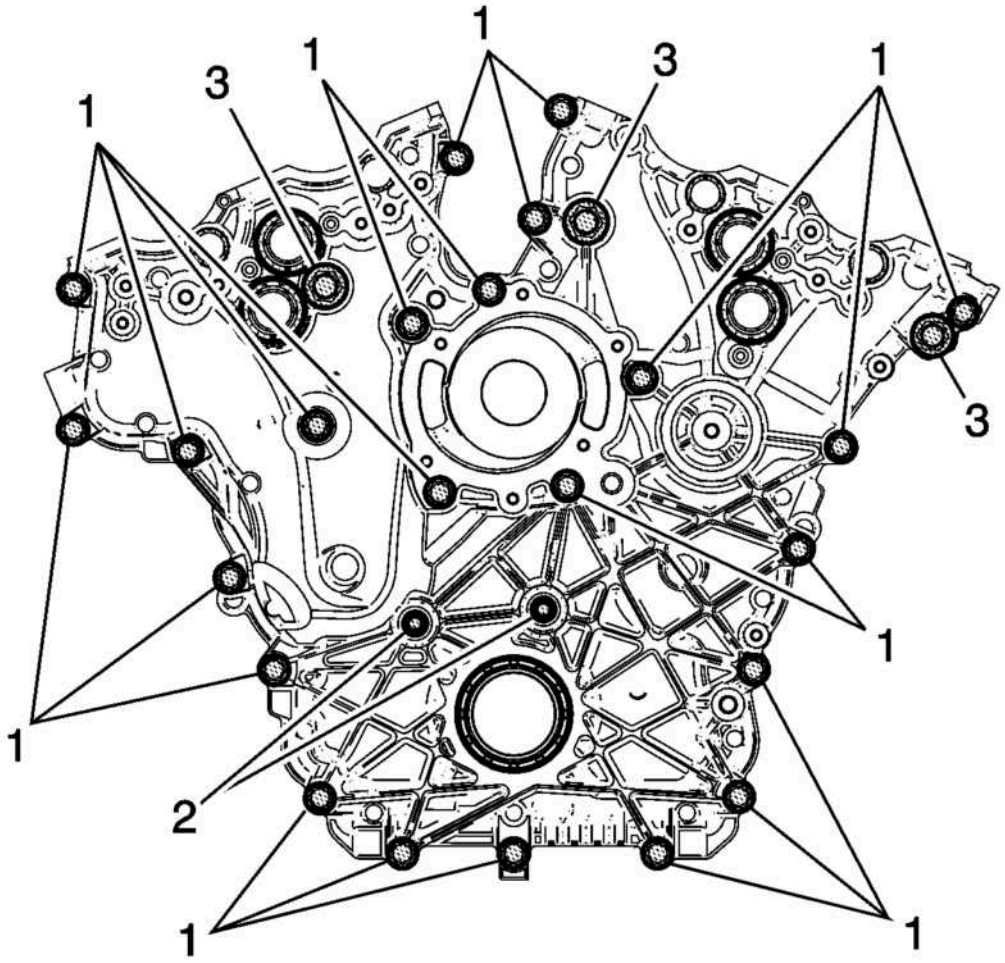


Fig. 54: Identifying Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: Engine front cover bolts in the number (3) location are model dependent and may have already been removed.

NOTE: There are a total of 23 M8 bolts (1) and 2 M6 bolts (2) that must be removed and 3 optional M12 bolts (3) that may need to be removed before the front cover will separate from the engine block.

6. Loosely install a 10 x 1.5 mm bolt in the jackscrew hole (1).

cardiagn.com

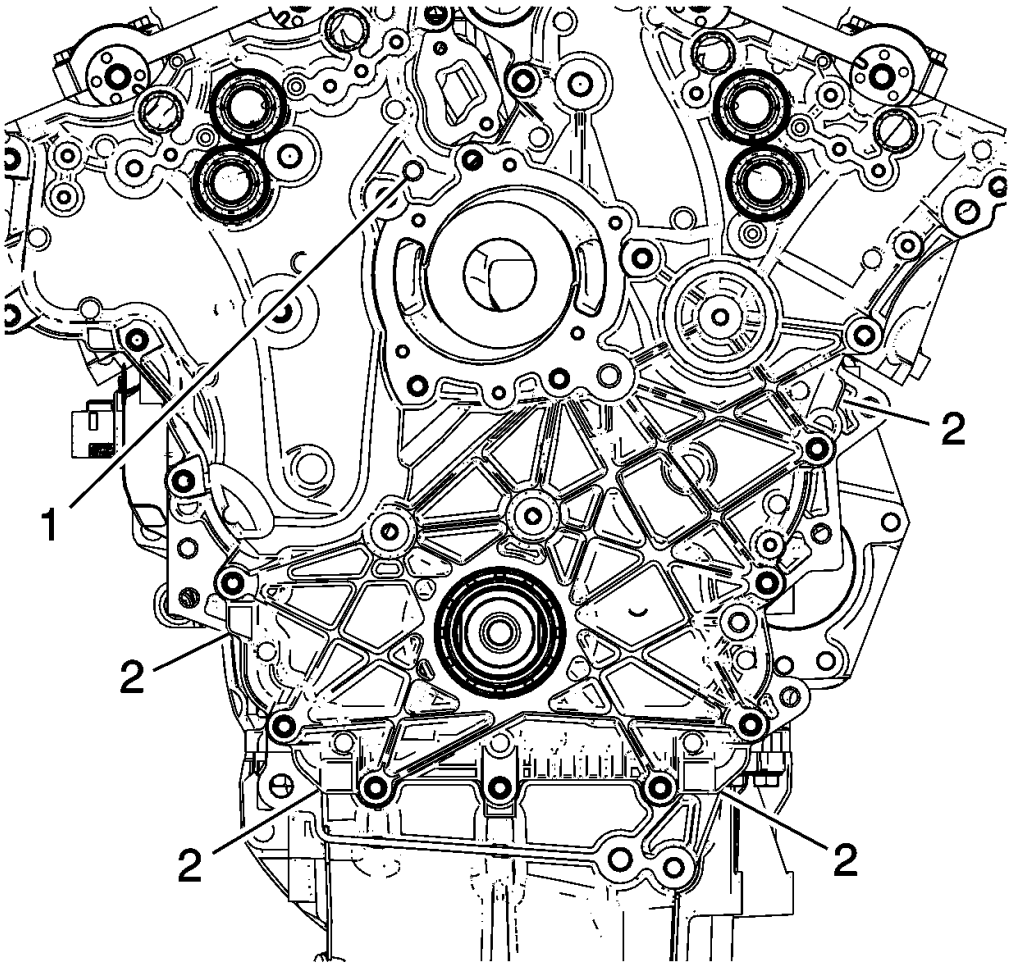


Fig. 55: Locating Jackscrew Hole
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not use the jackscrew hole without first removing all engine front cover bolts. Failure to remove all engine front cover bolts before using the jackscrew hole could result in damage to components.

CAUTION: Do not pry between the engine front cover and the camshaft position sensors or the camshaft position actuators in order to separate the RTV. Use the pry points and a bolt in the jackscrew hole in order to remove the engine front cover. Damage to the camshaft position sensors or the camshaft position actuators may occur if the camshaft position sensors or the camshaft position actuators are used to pry against in order to remove the engine front cover.

7. Using the pry points (2) located at the edge of the front cover and the jackscrew, separate the room temperature vulcanizing (RTV) sealant.

cardiagn.com

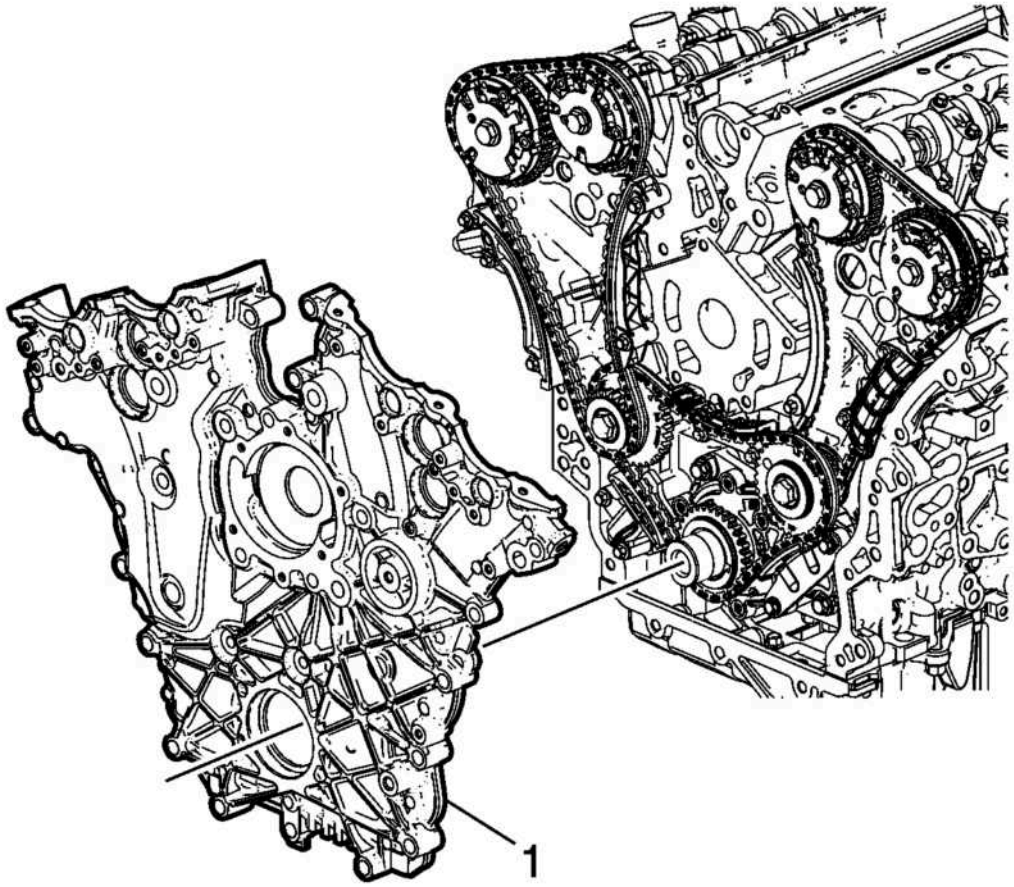


Fig. 56: View Of Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

8. Remove the engine front cover (1).

CAMSHAFT TIMING CHAIN COMPONENTS REMOVAL

Secondary Camshaft Drive Chain Components Removal - Right Side

cardiagn.com

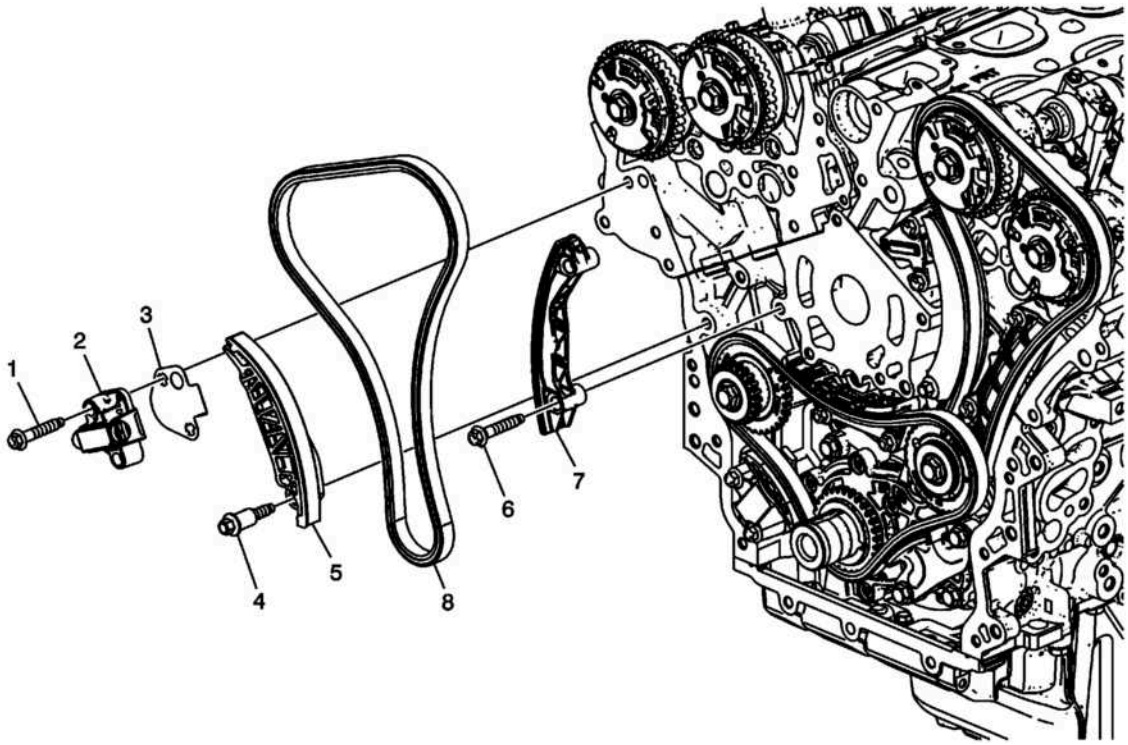


Fig. 57: Secondary Camshaft Drive Chain Components - Right Side
Courtesy of GENERAL MOTORS COMPANY

Secondary Camshaft Drive Chain Components Removal - Right Side

Callout	Component Name
1	Right Secondary Camshaft Drive Chain Tensioner Bolt
2	Right Secondary Camshaft Drive Chain Tensioner
3	Right Secondary Camshaft Drive Chain Tensioner Gasket **NOTE:** **Discard the gasket.**
4	Right Secondary Camshaft Drive Chain Shoe Bolt
5	Right Secondary Camshaft Drive Chain Shoe
6	Right Secondary Camshaft Drive Chain Guide Bolt
7	Right Secondary Camshaft Drive Chain Guide
8	Right Secondary Camshaft Drive Chain

Primary Camshaft Drive Chain Components Removal

cardiagn.com

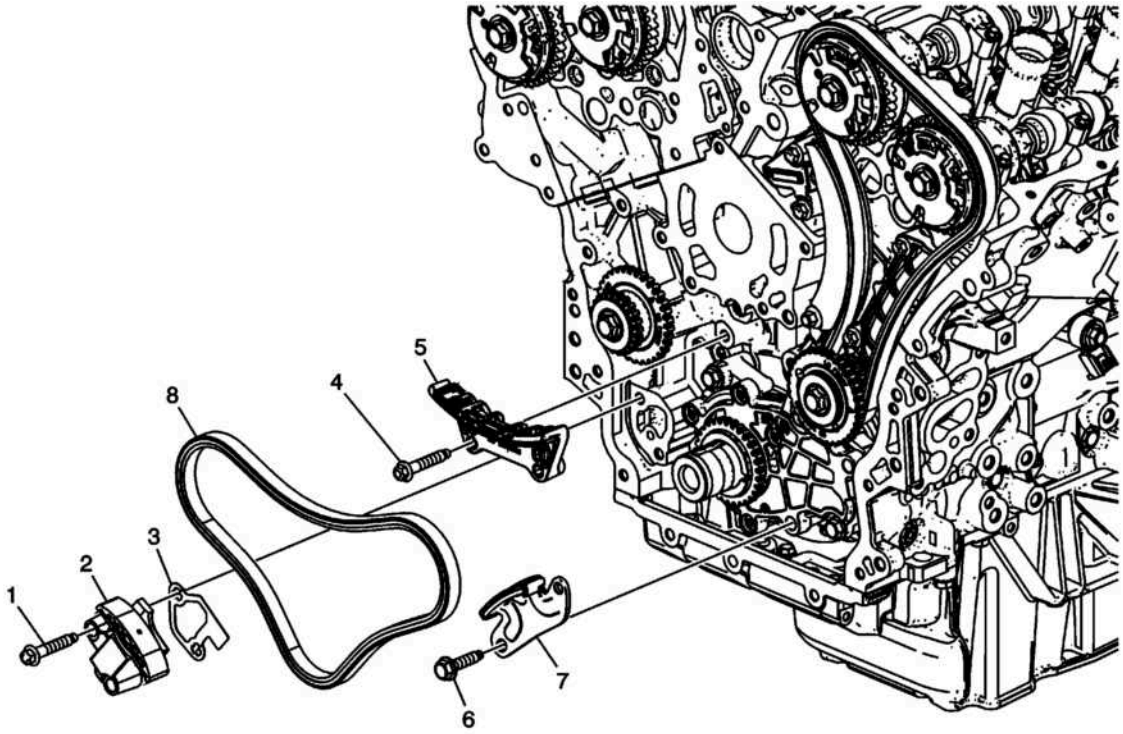


Fig. 58: Primary Camshaft Drive Chain Components
Courtesy of GENERAL MOTORS COMPANY

Primary Camshaft Drive Chain Components Removal

Callout	Component Name
1	Primary Camshaft Drive Chain Tensioner Bolt
2	Primary Camshaft Drive Chain Tensioner
3	Primary Camshaft Drive Chain Tensioner Gasket **NOTE:** **Discard the gasket.**
4	Primary Camshaft Drive Chain Upper Guide Bolt
5	Primary Camshaft Drive Chain Upper Guide
6	Primary Camshaft Drive Chain Lower Guide Bolt
7	Primary Camshaft Drive Chain Lower Guide
8	Primary Camshaft Drive Chain

Secondary Camshaft Drive Chain Components Removal - Left Side

cardiagn.com

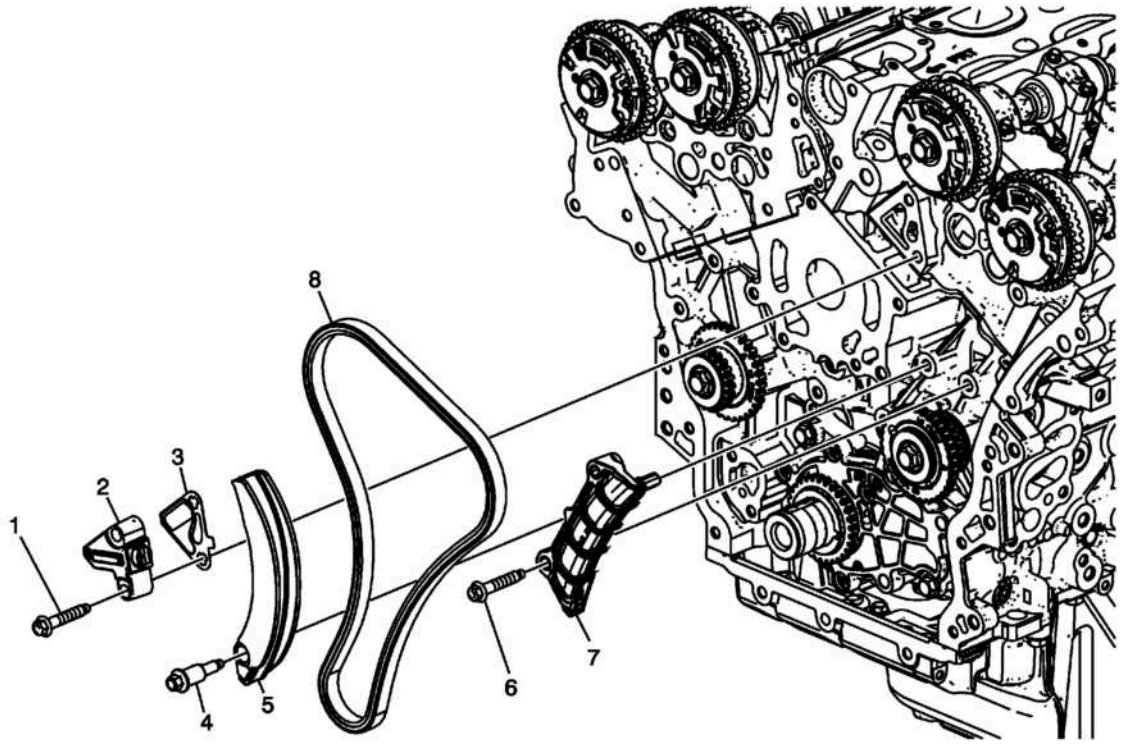


Fig. 59: Secondary Camshaft Drive Chain Components - Left Side
Courtesy of GENERAL MOTORS COMPANY

Secondary Camshaft Drive Chain Components Removal - Left Side

Callout	Component Name
1	Left Secondary Camshaft Drive Chain Tensioner Bolt
2	Left Secondary Camshaft Drive Chain Tensioner
3	Left Secondary Camshaft Drive Chain Tensioner Gasket **NOTE:** **Discard the gasket.**
4	Left Secondary Camshaft Drive Chain Shoe Bolt
5	Left Secondary Camshaft Drive Chain Shoe
6	Left Secondary Camshaft Drive Chain Guide Bolt
7	Left Secondary Camshaft Drive Chain Guide
8	Left Secondary Camshaft Drive Chain

SECONDARY TIMING CHAIN TENSIONER REMOVAL - RIGHT SIDE

cardiagn.com

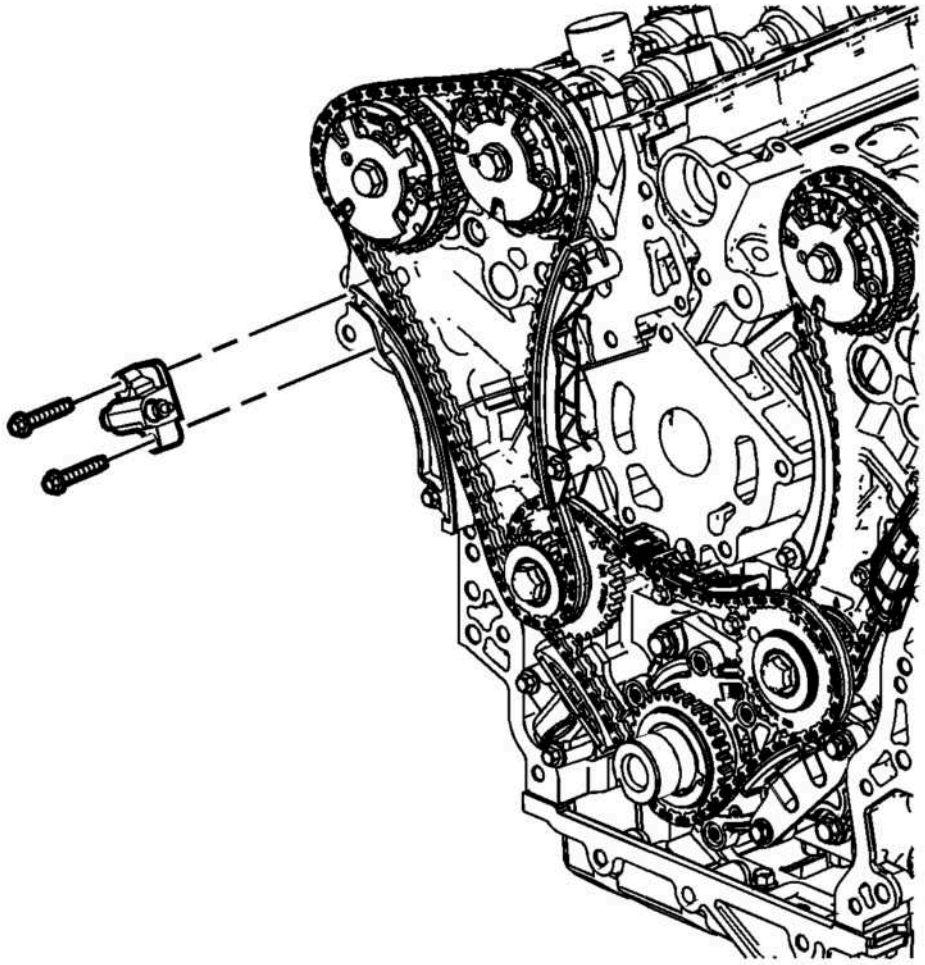


Fig. 60: View Of Secondary Camshaft Drive Chain Tensioner And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the right secondary camshaft drive chain tensioner bolts.
2. Remove the right secondary camshaft drive chain tensioner.

cardiagn.com

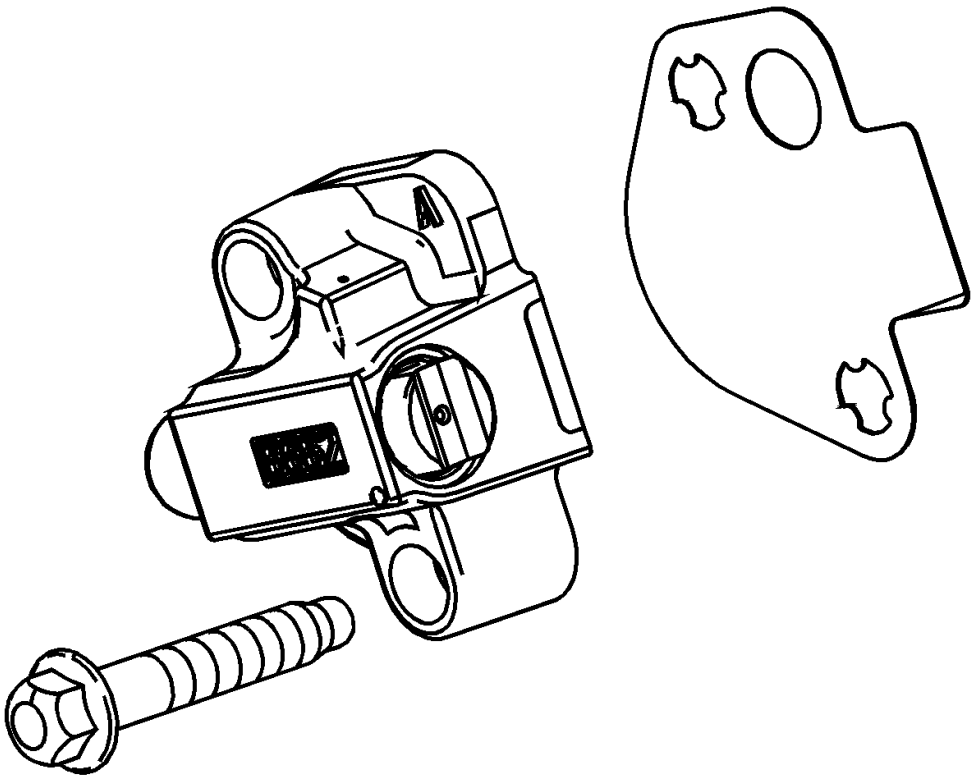


Fig. 61: Identifying Right Secondary Camshaft Drive Chain Tensioner Gasket
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the right secondary camshaft drive chain tensioner gasket.
4. Inspect the right secondary camshaft drive chain tensioner mounting surface on the right cylinder head for burrs or any defects that would degrade the sealing of the NEW right secondary camshaft drive chain tensioner gasket.

SECONDARY CAMSHAFT DRIVE CHAIN SHOE REMOVAL - RIGHT SIDE

cardiagn.com

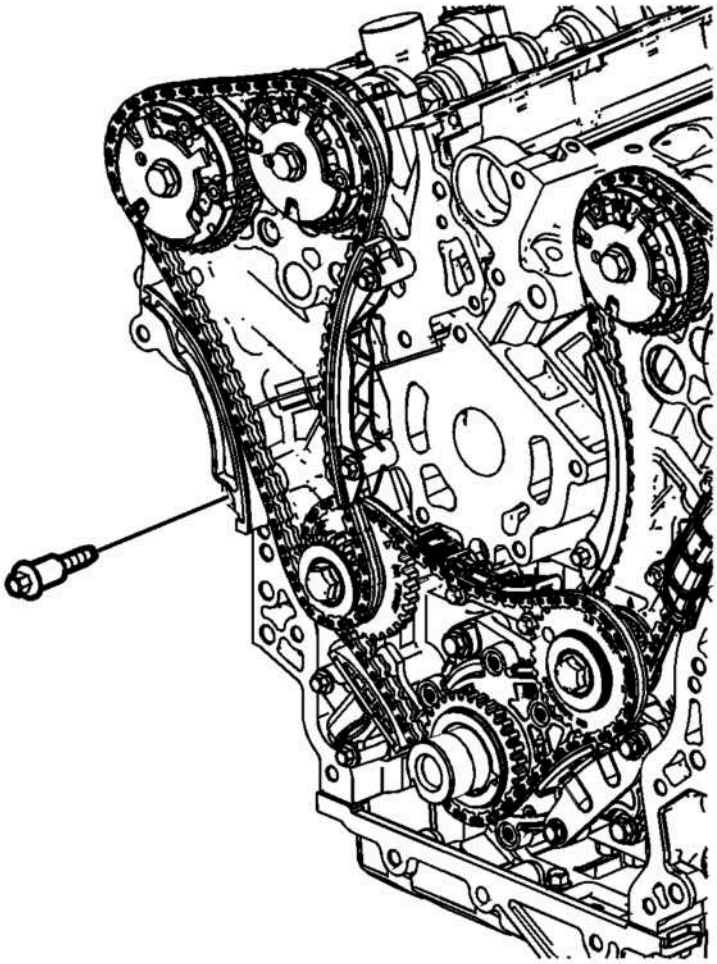


Fig. 62: View Of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

1. Remove the right secondary camshaft drive chain shoe bolt.

cardiagn.com

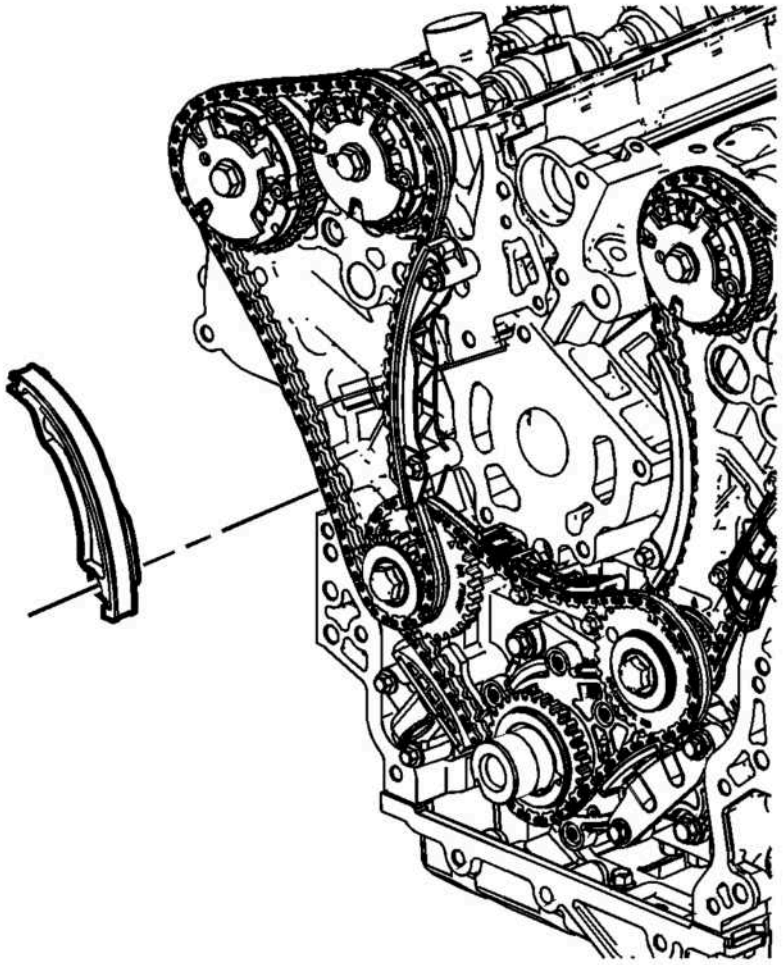


Fig. 63: View Of Right Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

2. Remove the right secondary camshaft drive chain shoe.

SECONDARY TIMING CHAIN GUIDE REMOVAL - RIGHT SIDE

cardiagn.com

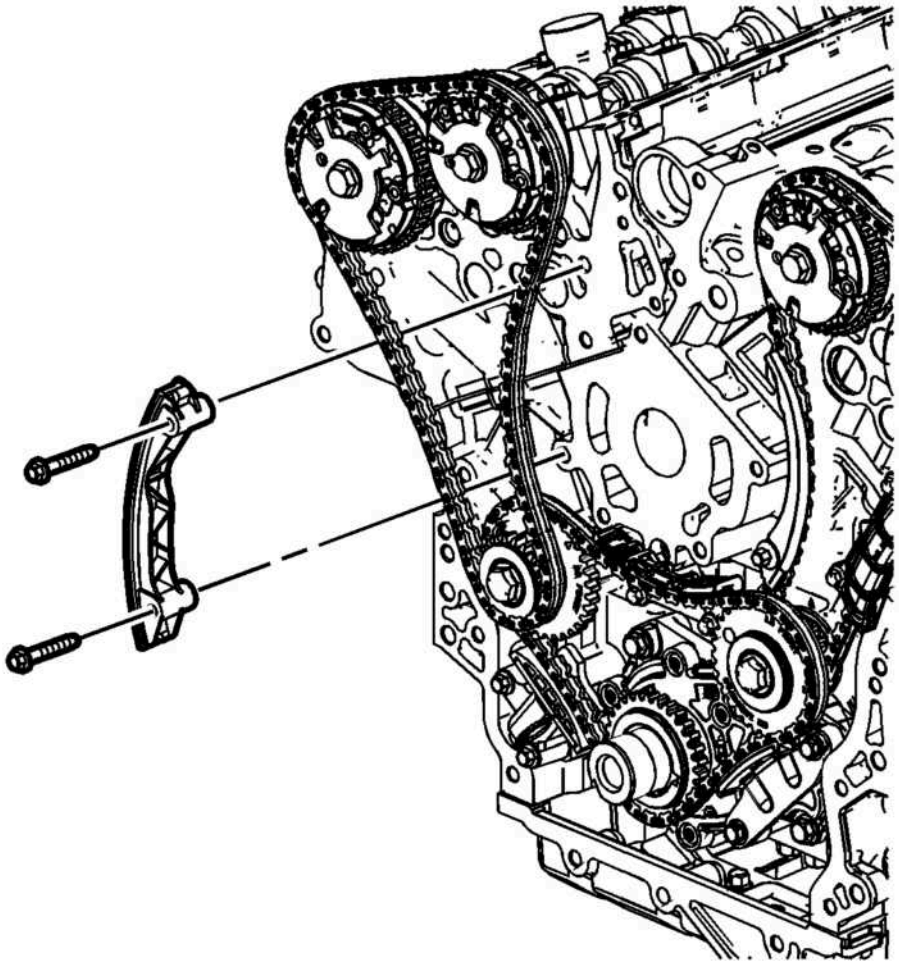


Fig. 64: Identifying Secondary Camshaft Drive Chain Guide And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the right secondary camshaft drive chain guide bolts.
2. Remove the right secondary camshaft drive chain guide.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REMOVAL - RIGHT SIDE

cardiagn.com

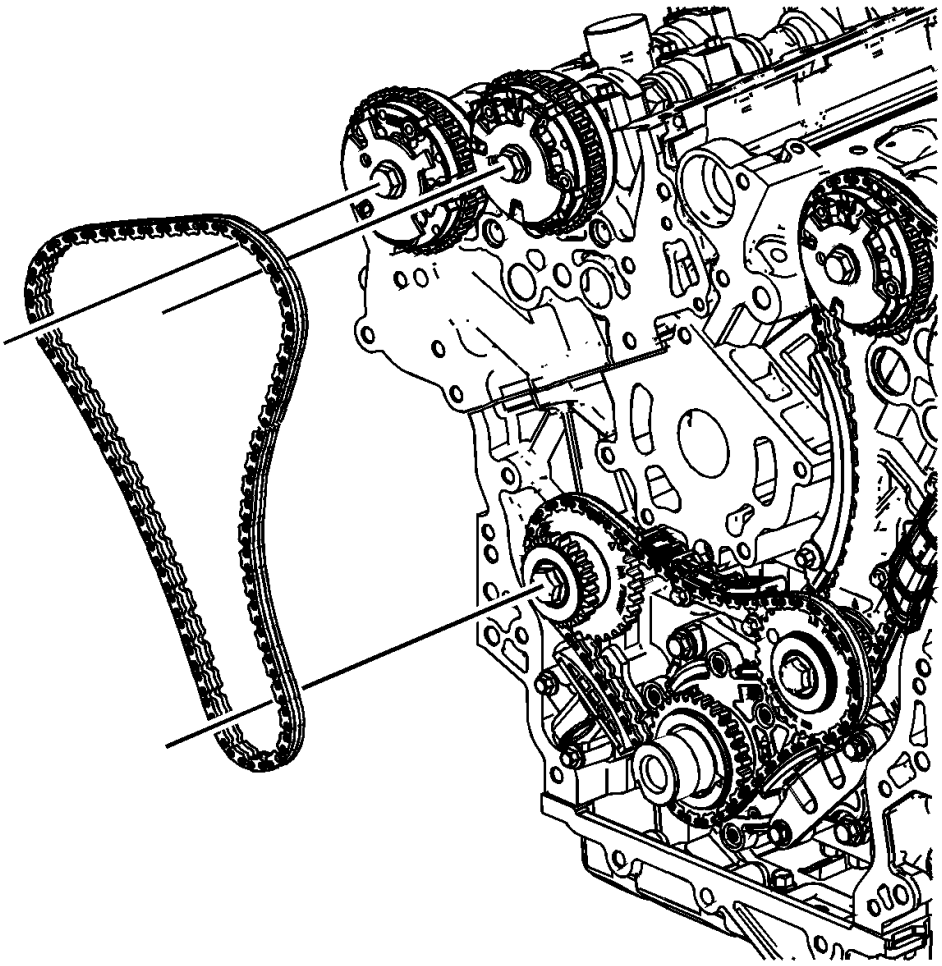


Fig. 65: View Of Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

Remove the right secondary camshaft drive chain from the right camshaft position actuators and the right camshaft intermediate drive chain idler sprocket.

PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REMOVAL

cardiagn.com

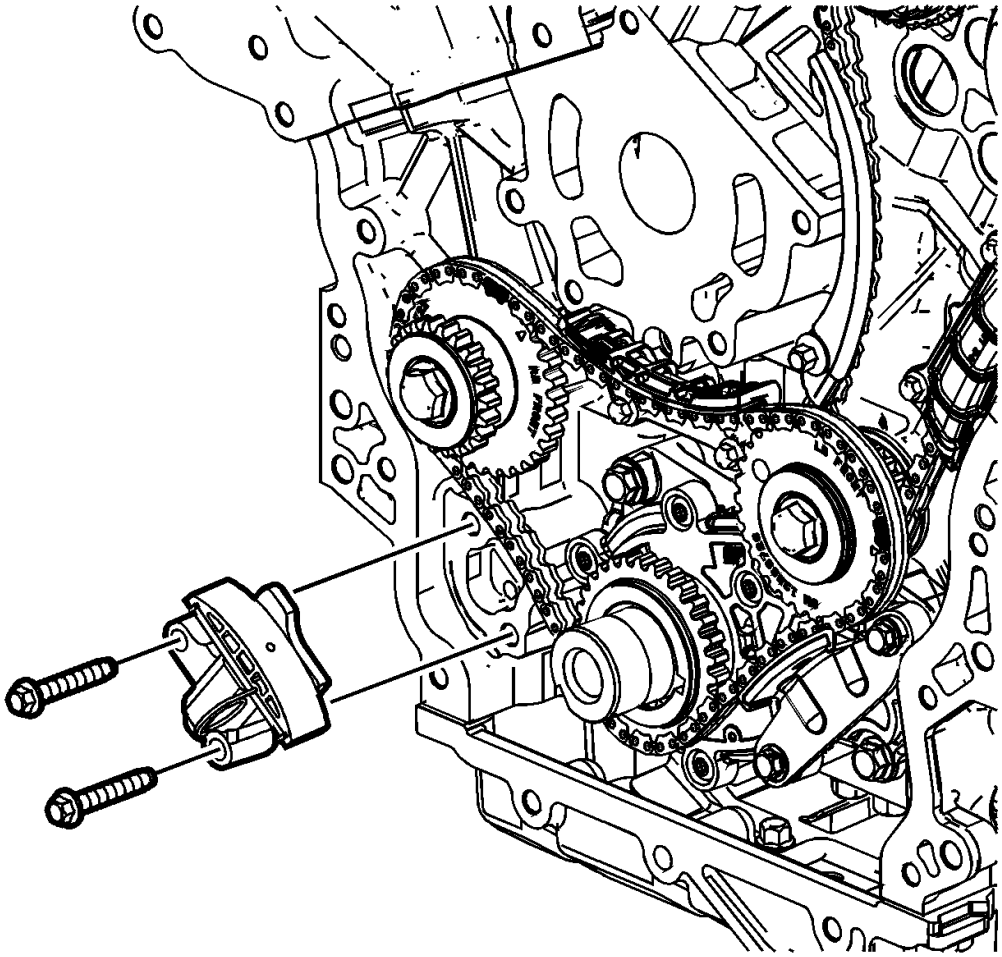


Fig. 66: View Of Primary Camshaft Drive Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the primary camshaft drive chain tensioner bolts.
2. Remove the primary camshaft drive chain tensioner.

cardiagn.com

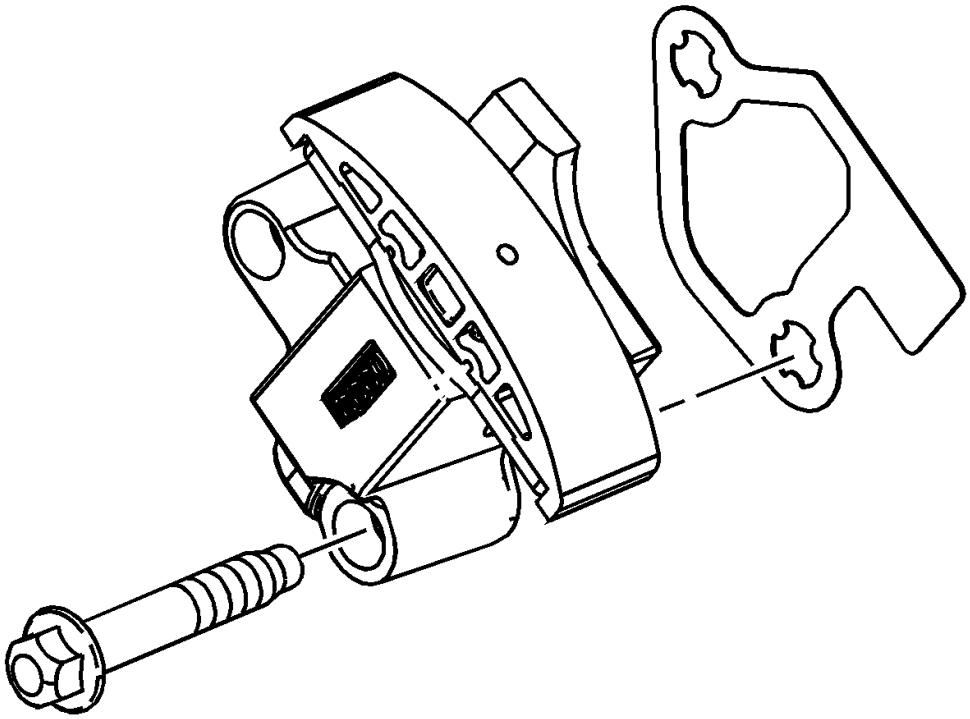


Fig. 67: Identifying Primary Camshaft Drive Chain Tensioner Gasket
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the primary camshaft drive chain tensioner gasket.
4. Inspect the primary camshaft drive chain tensioner mounting surface on the engine block for burrs or any defects that would degrade the sealing of the NEW primary camshaft drive chain tensioner gasket.

PRIMARY TIMING CHAIN GUIDE REMOVAL - UPPER

cardiagn.com

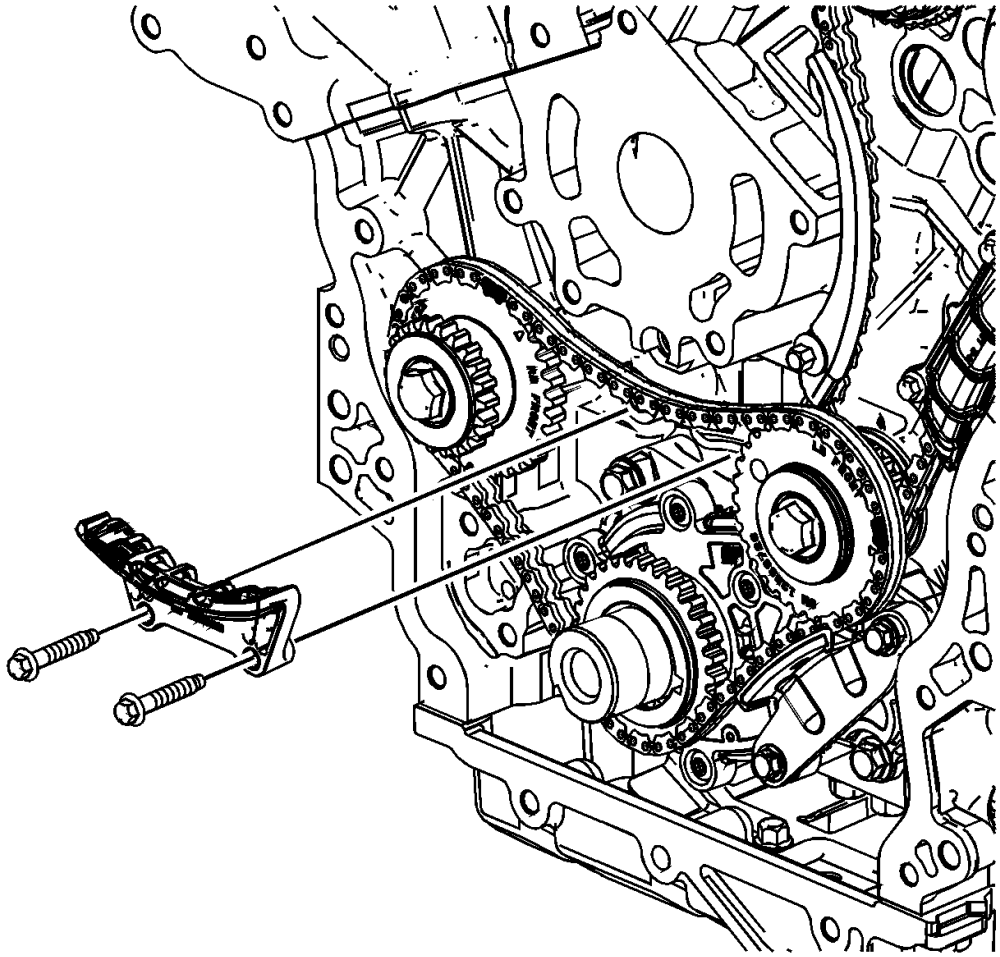


Fig. 68: Identifying Primary Camshaft Drive Chain Upper Guide & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the primary camshaft drive chain upper guide bolts.
2. Remove the primary camshaft drive chain upper guides.

PRIMARY TIMING CHAIN GUIDE REMOVAL - LOWER

cardiagn.com

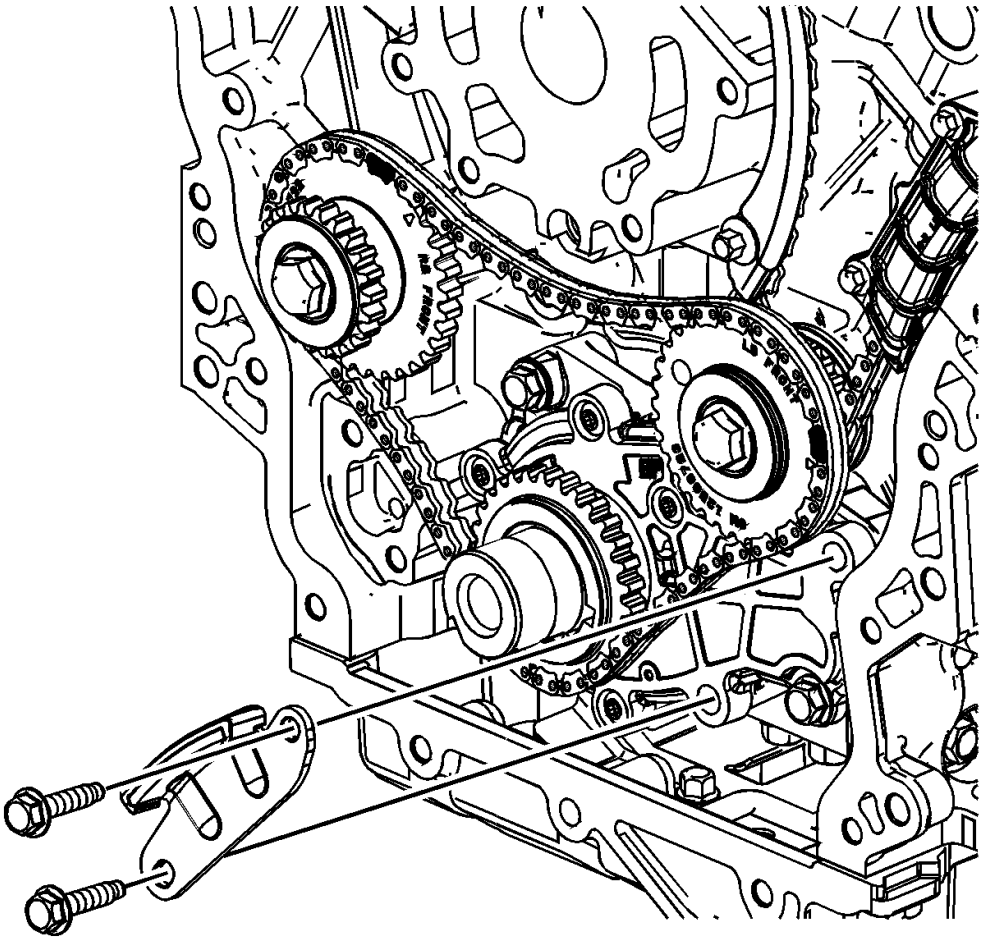


Fig. 69: View Of Primary Camshaft Drive Chain Lower Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the primary camshaft drive chain lower guide bolts.
2. Remove the primary camshaft drive chain lower guide.

PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REMOVAL

cardiagn.com

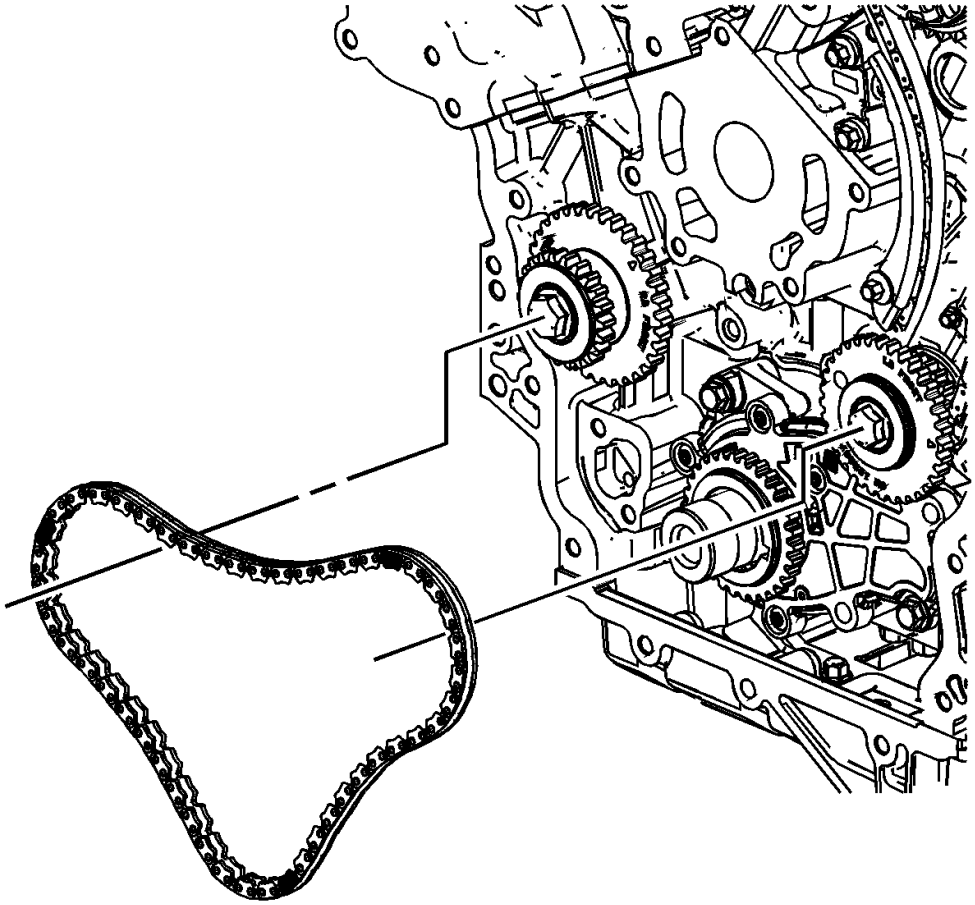


Fig. 70: Identifying Primary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

Remove the primary camshaft drive chain.

TIMING CHAIN IDLER SPROCKET REMOVAL - RIGHT SIDE

cardiagn.com

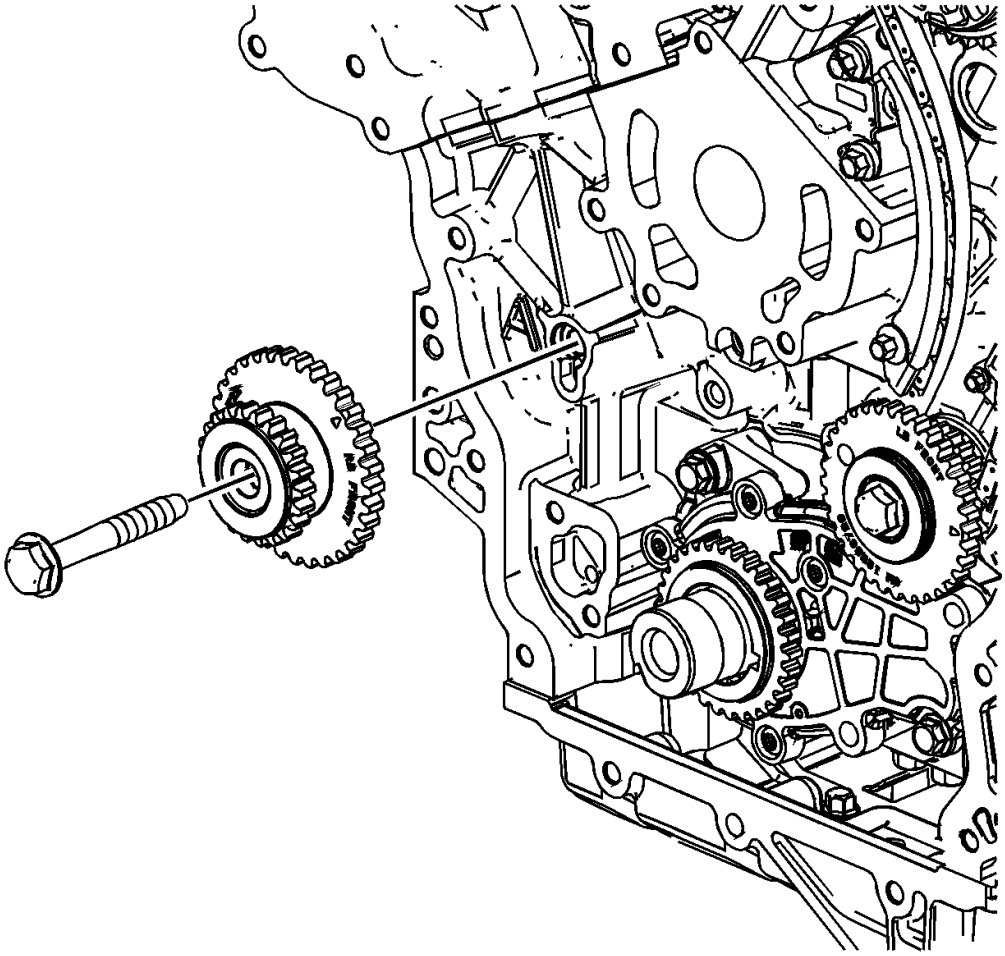


Fig. 71: Identifying Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the right camshaft intermediate drive chain idler bolt.
2. Remove the right camshaft intermediate drive chain idler.

SECONDARY TIMING CHAIN TENSIONER REMOVAL - LEFT SIDE

cardiagn.com

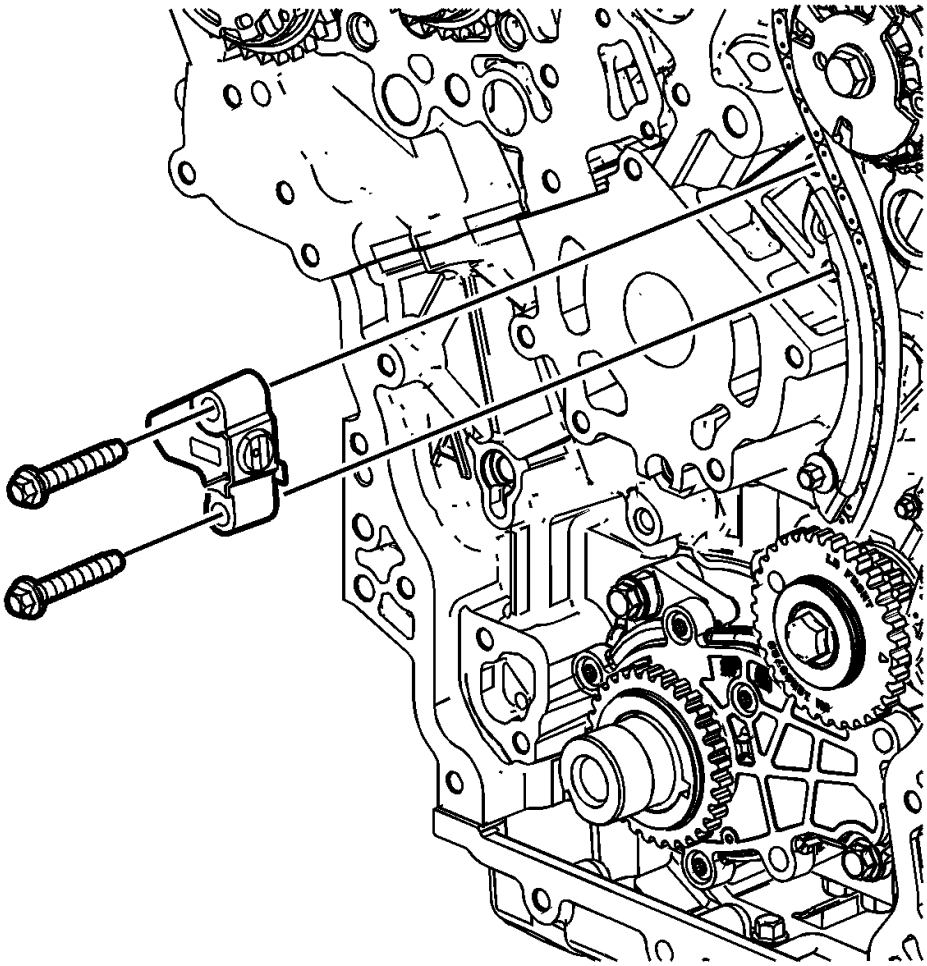


Fig. 72: View Of Secondary Camshaft Drive Chain Tensioner & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the left secondary camshaft drive chain tensioner bolts.
2. Remove the left secondary camshaft drive chain tensioner.

cardiagn.com

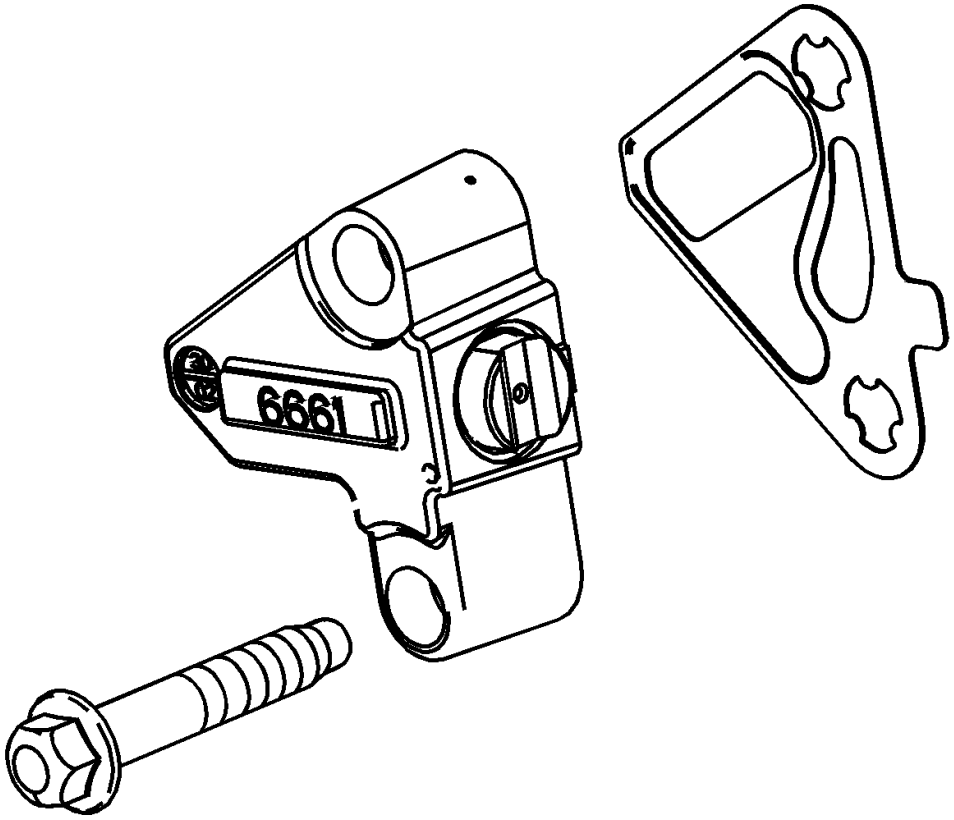


Fig. 73: Identifying Left Secondary Camshaft Drive Chain Tensioner & Gasket
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the left secondary camshaft drive chain tensioner gasket.
4. Inspect the left secondary camshaft drive chain tensioner mounting surface on the left cylinder head for burrs or any defects that would degrade the sealing of the NEW left secondary camshaft drive chain tensioner gasket.

SECONDARY CAMSHAFT DRIVE CHAIN SHOE REMOVAL - LEFT SIDE

cardiagn.com

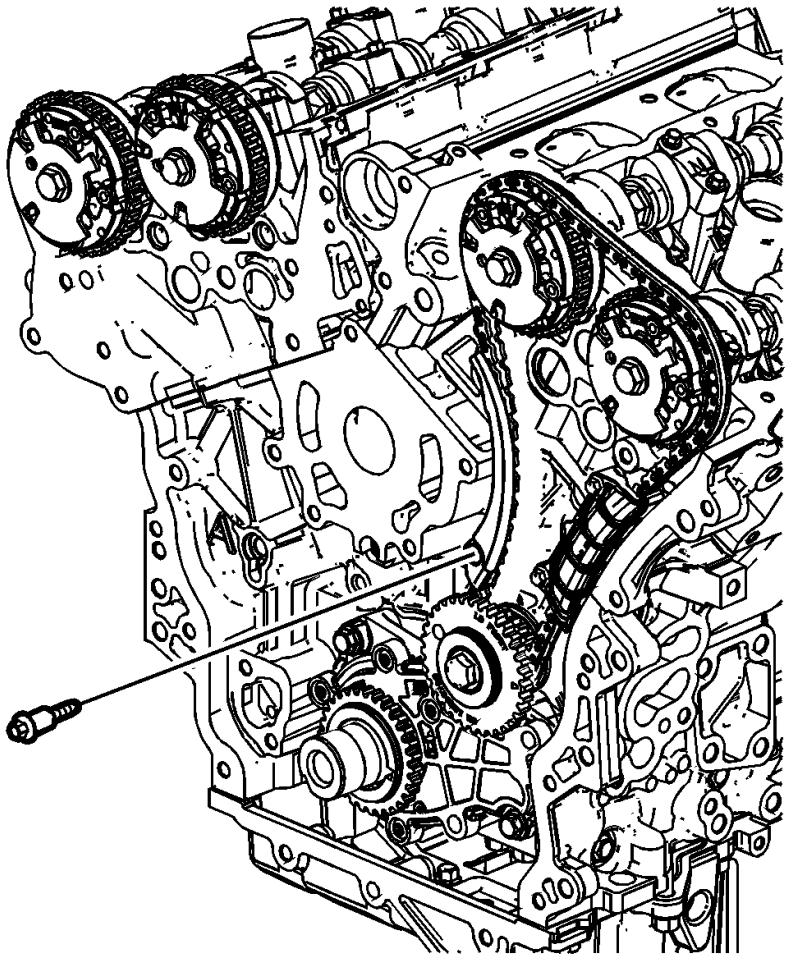


Fig. 74: Identifying Secondary Camshaft Drive Chain Shoe Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the left secondary camshaft drive chain shoe bolt.

cardiagn.com

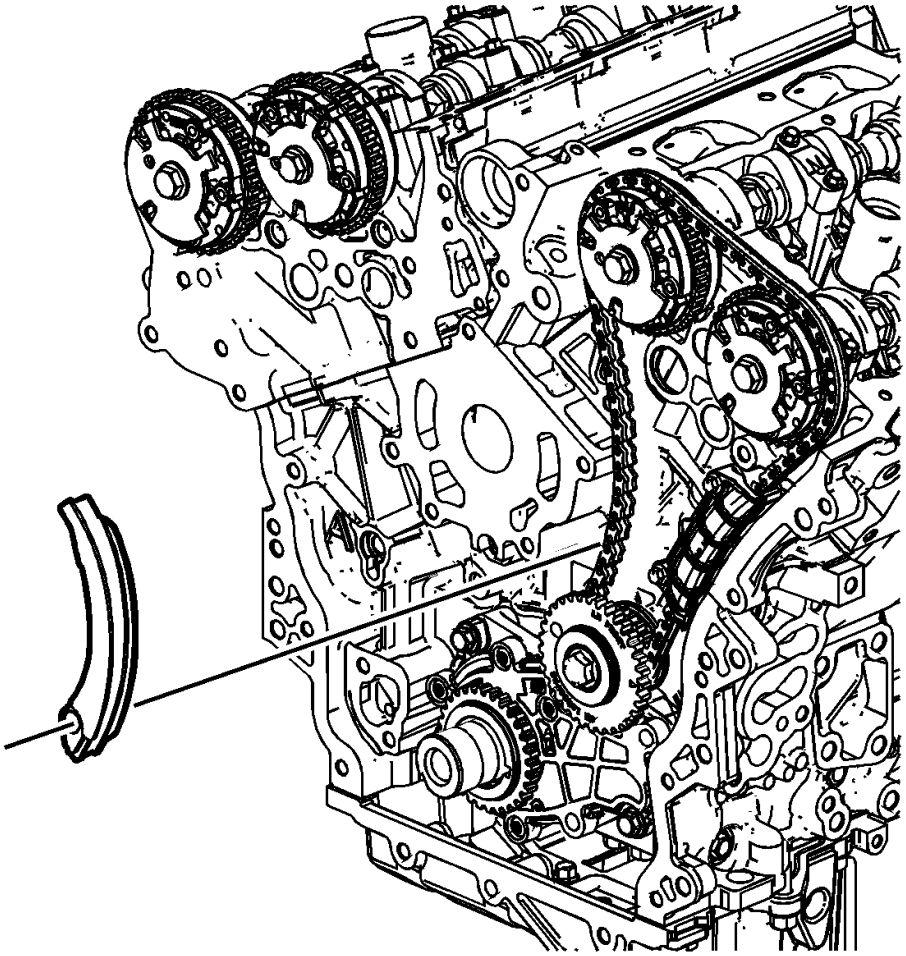


Fig. 75: View Of Secondary Camshaft Drive Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

2. Remove the left secondary camshaft drive chain shoe.

SECONDARY TIMING CHAIN GUIDE REMOVAL - LEFT SIDE

cardiagn.com

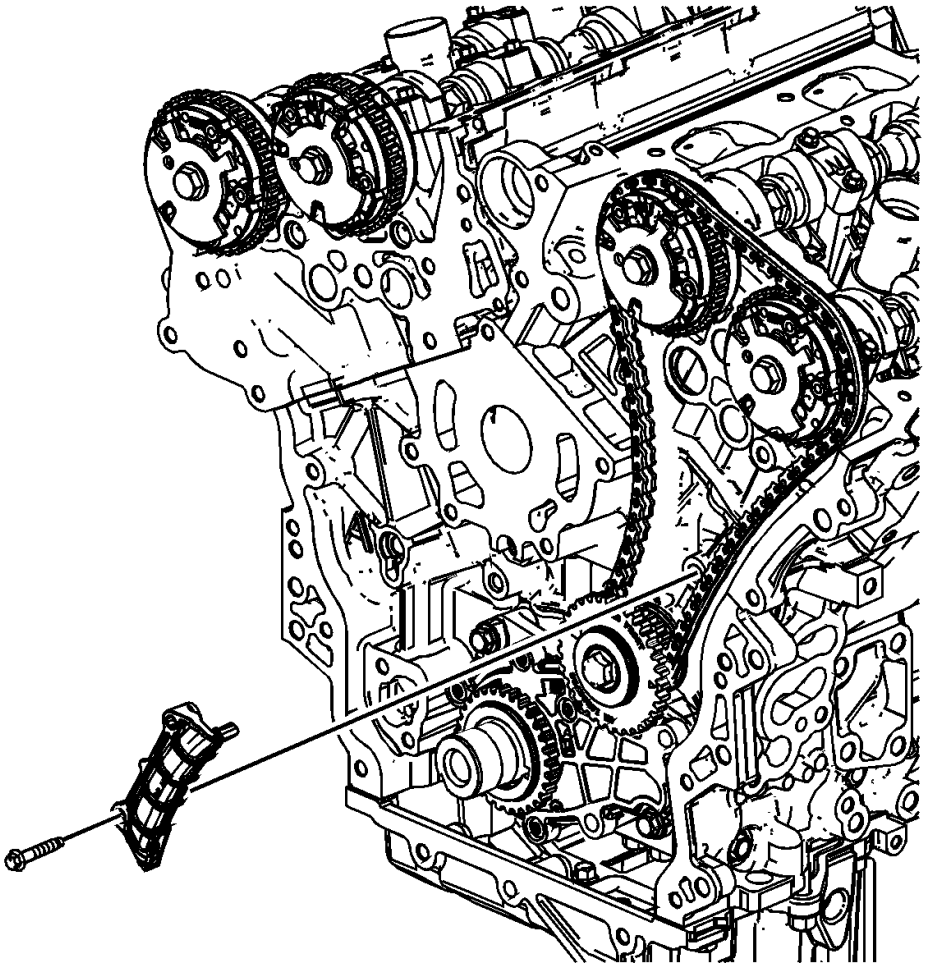


Fig. 76: View Of Secondary Camshaft Drive Chain Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the left secondary camshaft drive chain guide bolts.
2. Remove the left secondary camshaft drive chain guide.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REMOVAL - LEFT SIDE

cardiagn.com

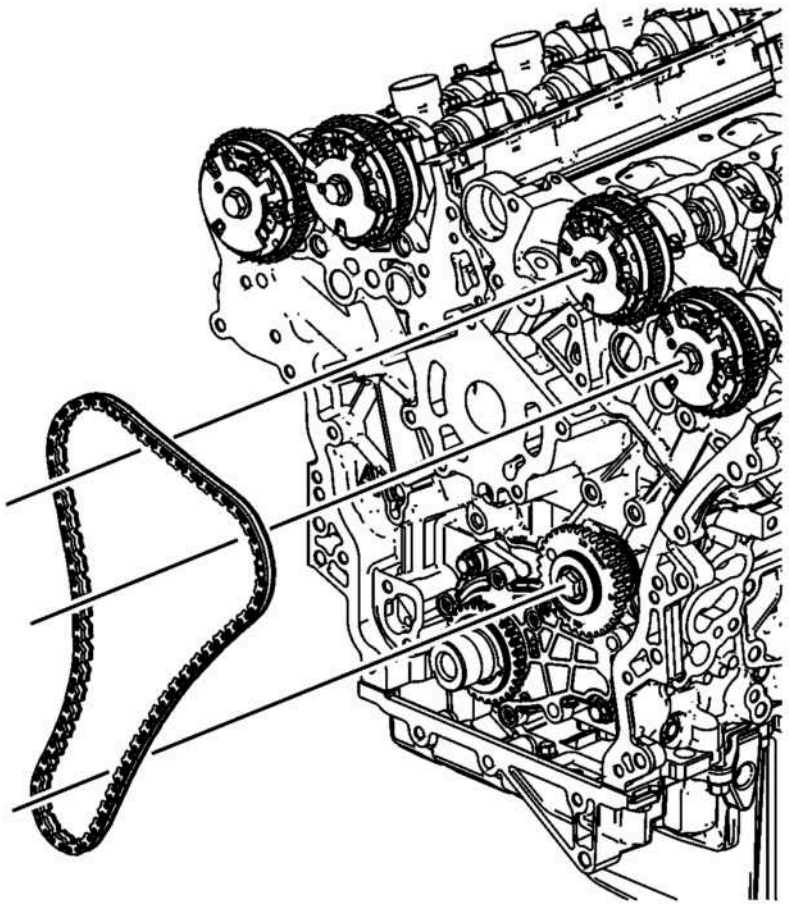


Fig. 77: Identifying Secondary Camshaft Drive Chain
Courtesy of GENERAL MOTORS COMPANY

Remove the left secondary camshaft drive chain from the left camshaft position actuators and the left camshaft intermediate drive chain idler sprocket.

TIMING CHAIN IDLER SPROCKET REMOVAL - LEFT SIDE

cardiagn.com

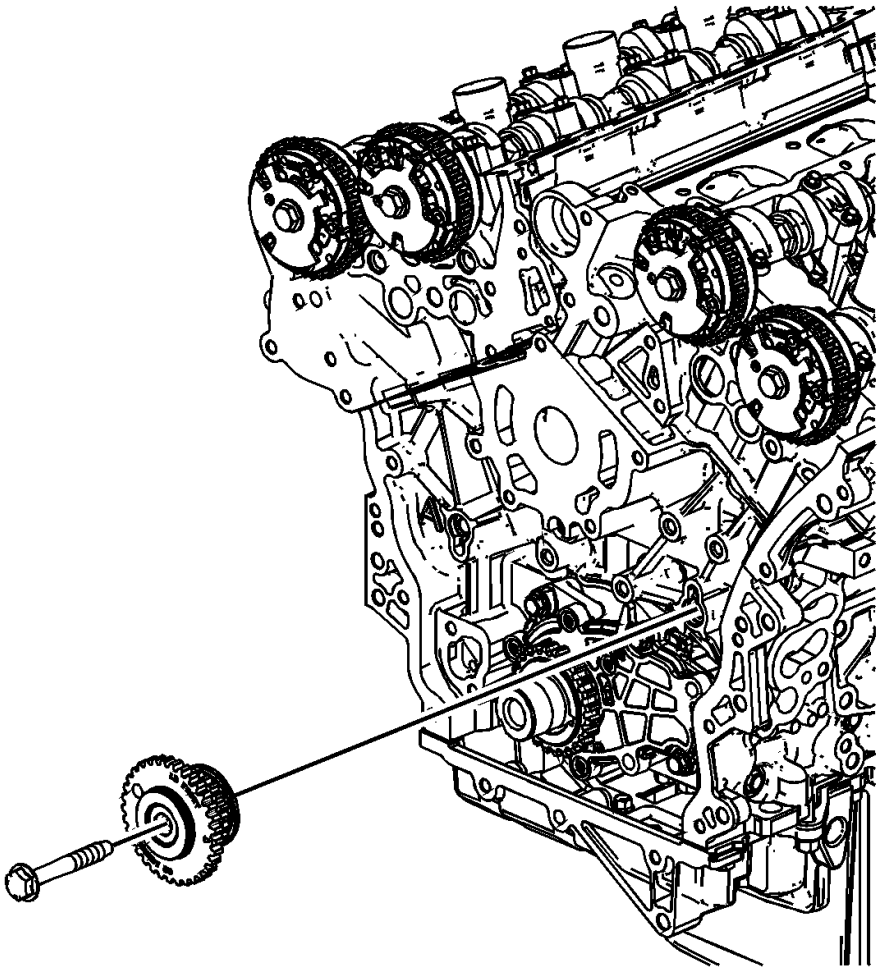


Fig. 78: View Of Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the left camshaft intermediate drive chain idler bolt.
2. Remove the left camshaft intermediate drive chain idler.

CRANKSHAFT SPROCKET REMOVAL

cardiagn.com

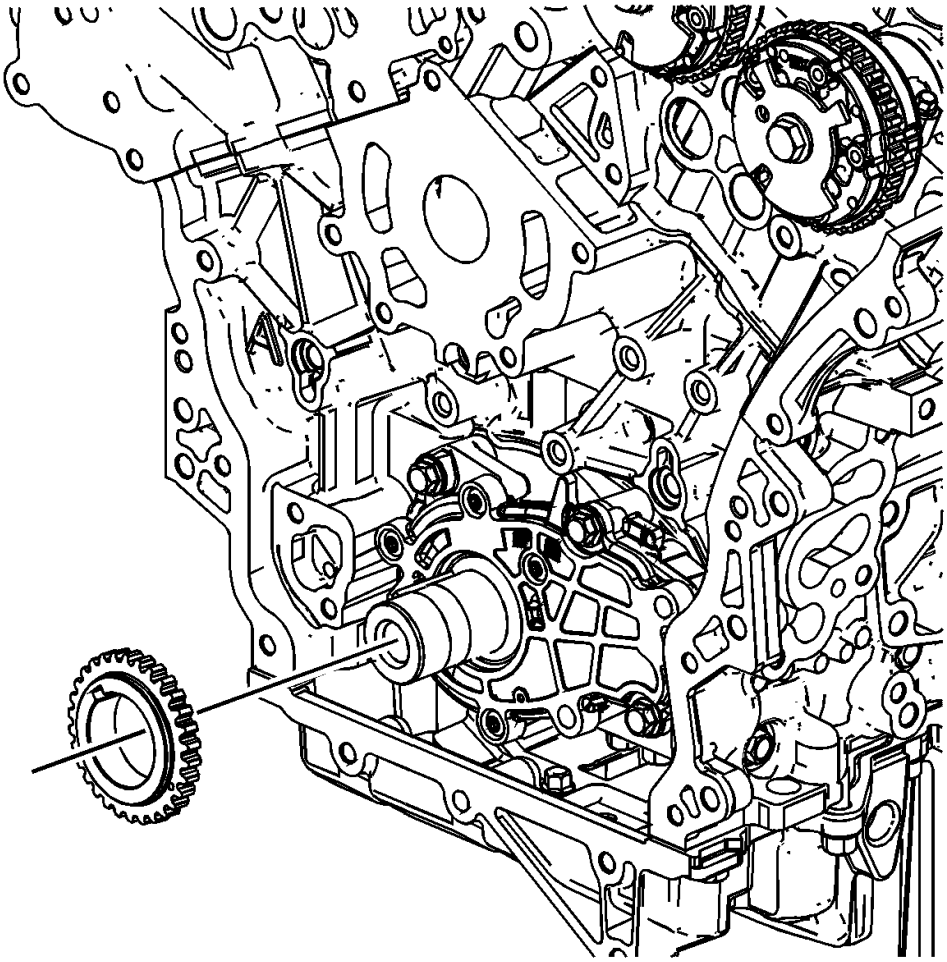


Fig. 79: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

Remove the crankshaft sprocket from the nose of the crankshaft.

CAMSHAFT POSITION ACTUATOR REMOVAL - LEFT SIDE EXHAUST

1. Use an open wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.

cardiagn.com

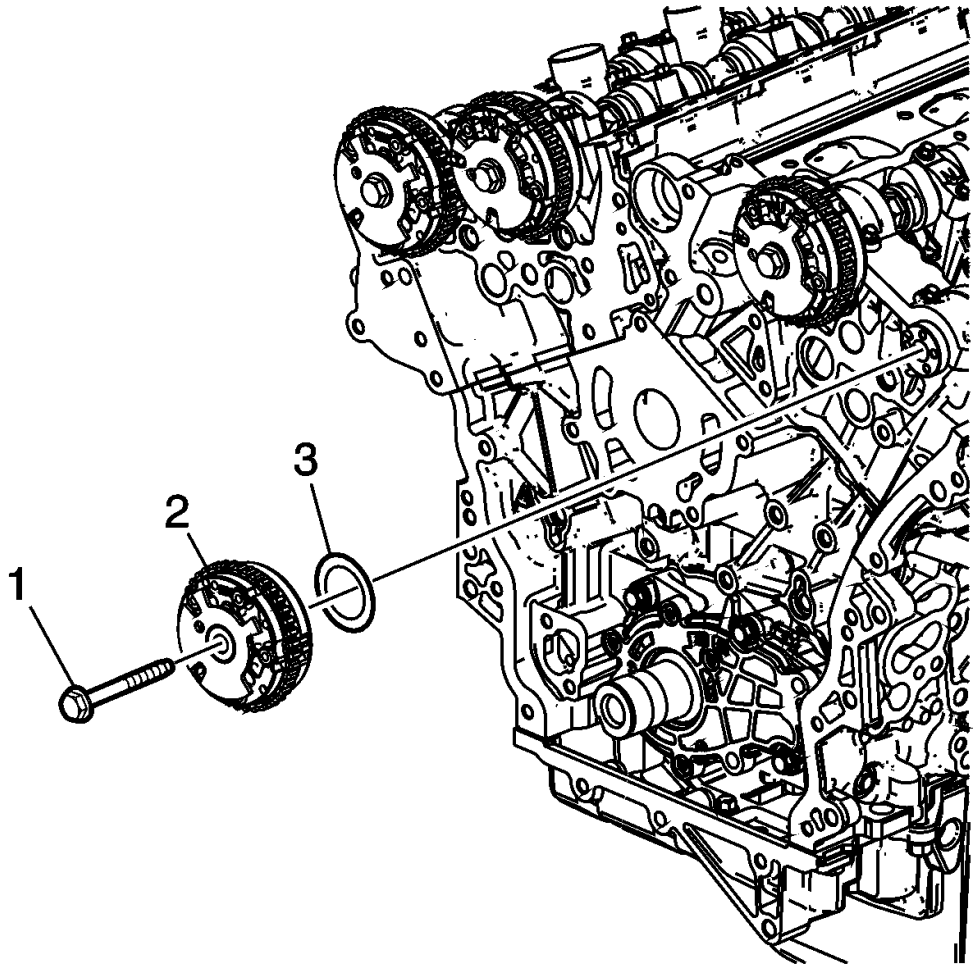


Fig. 80: Locating Exhaust Camshaft Position Actuator & Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

2. Remove the left exhaust camshaft position actuator bolt (1).
3. Remove the left exhaust camshaft position actuator (2).
4. Remove the camshaft thrust washer if applicable (3).

CAMSHAFT POSITION ACTUATOR REMOVAL - LEFT SIDE INTAKE

1. Use an open wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.

cardiagn.com

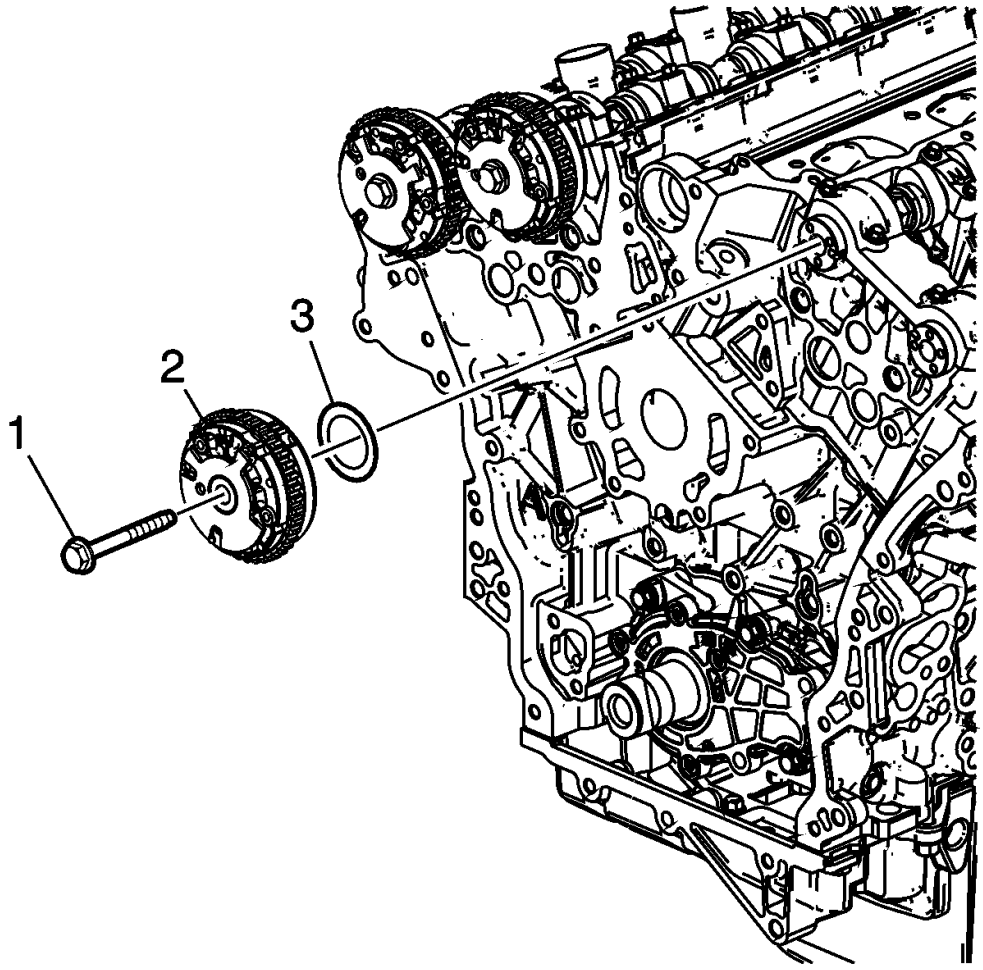


Fig. 81: View Of Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

2. Remove the left intake camshaft position actuator bolt (1).
3. Remove the left intake camshaft position actuator (2).
4. Remove the camshaft thrust washer if applicable (3).

CAMSHAFT POSITION ACTUATOR REMOVAL - RIGHT SIDE EXHAUST

1. Use an open wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.

cardiagn.com

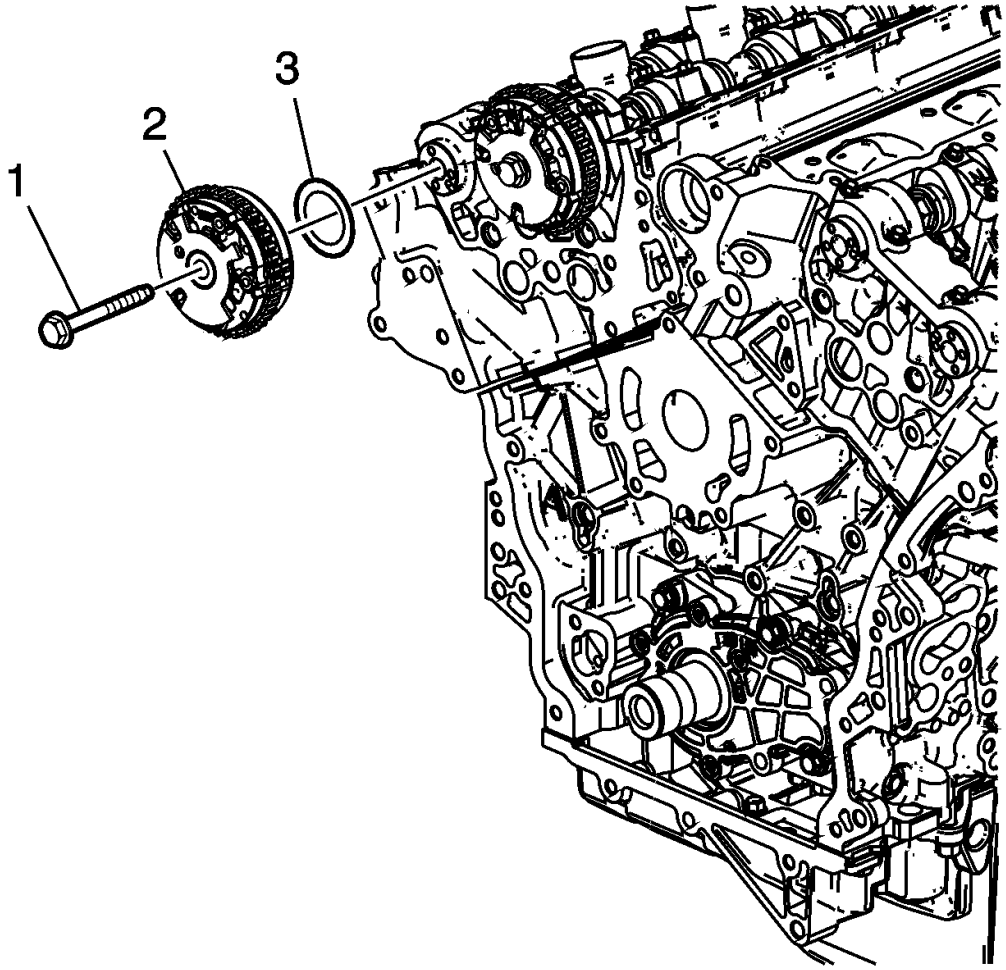


Fig. 82: Identifying Camshaft Position Actuator & Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

2. Remove the right exhaust camshaft position actuator bolt (1).
3. Remove the right exhaust camshaft position actuator (2).
4. Remove the camshaft thrust washer if applicable (3).

CAMSHAFT POSITION ACTUATOR REMOVAL - RIGHT SIDE INTAKE

1. Use an open wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.

cardiagn.com

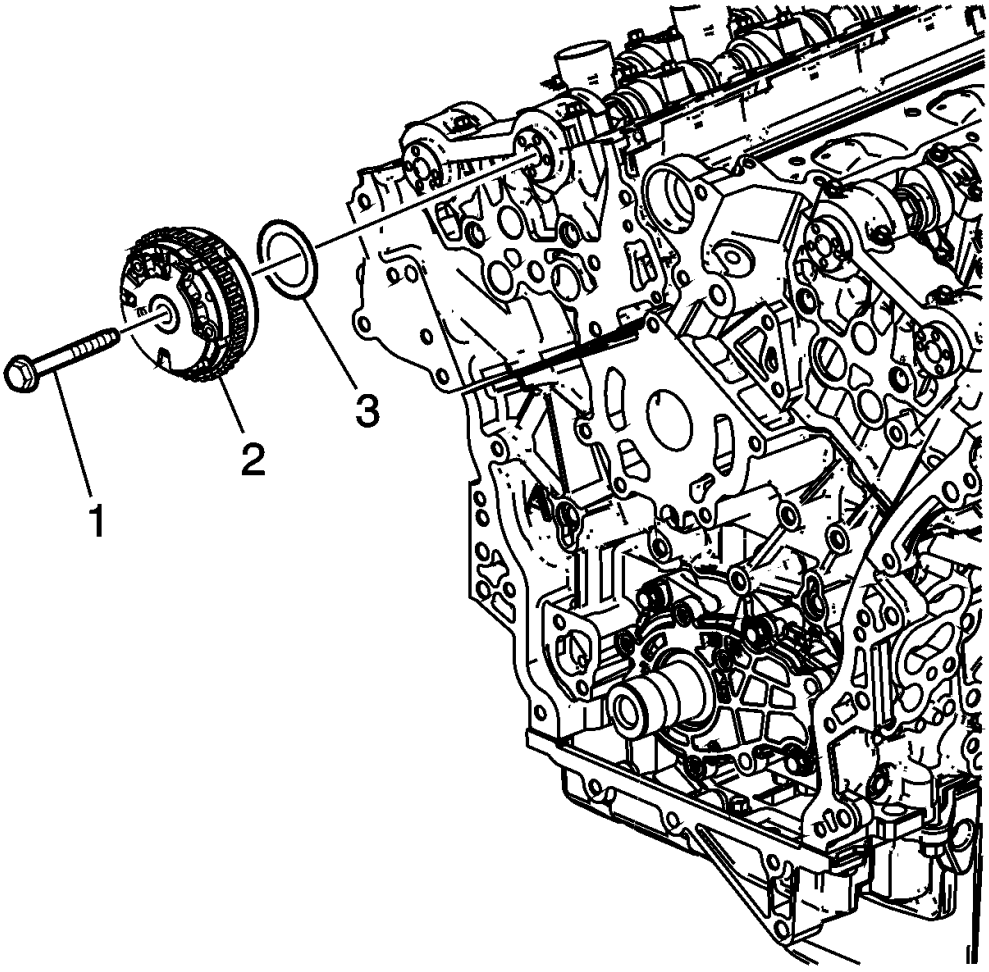


Fig. 83: Identifying Intake Camshaft Position Actuator & Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

2. Remove the right intake camshaft position actuator bolt (1).
3. Remove the right intake camshaft position actuator (2).
4. Remove the camshaft thrust washer if applicable (3).

FUEL PUMP REMOVAL

cardiagn.com

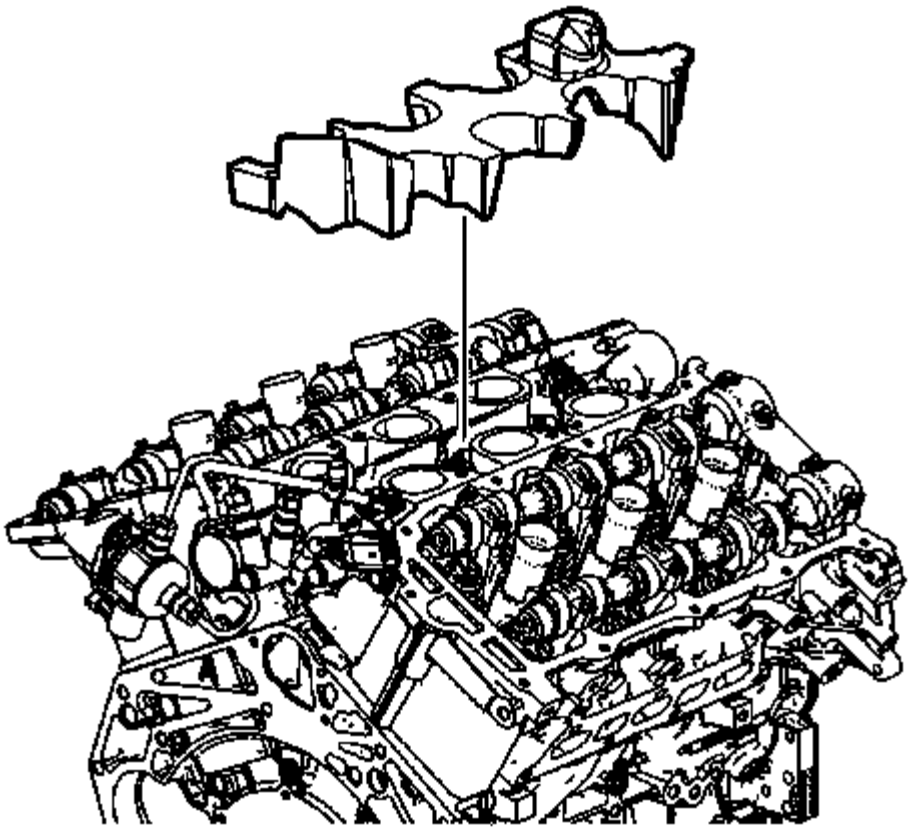


Fig. 84: View of Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel rail noise shield.

cardiagn.com

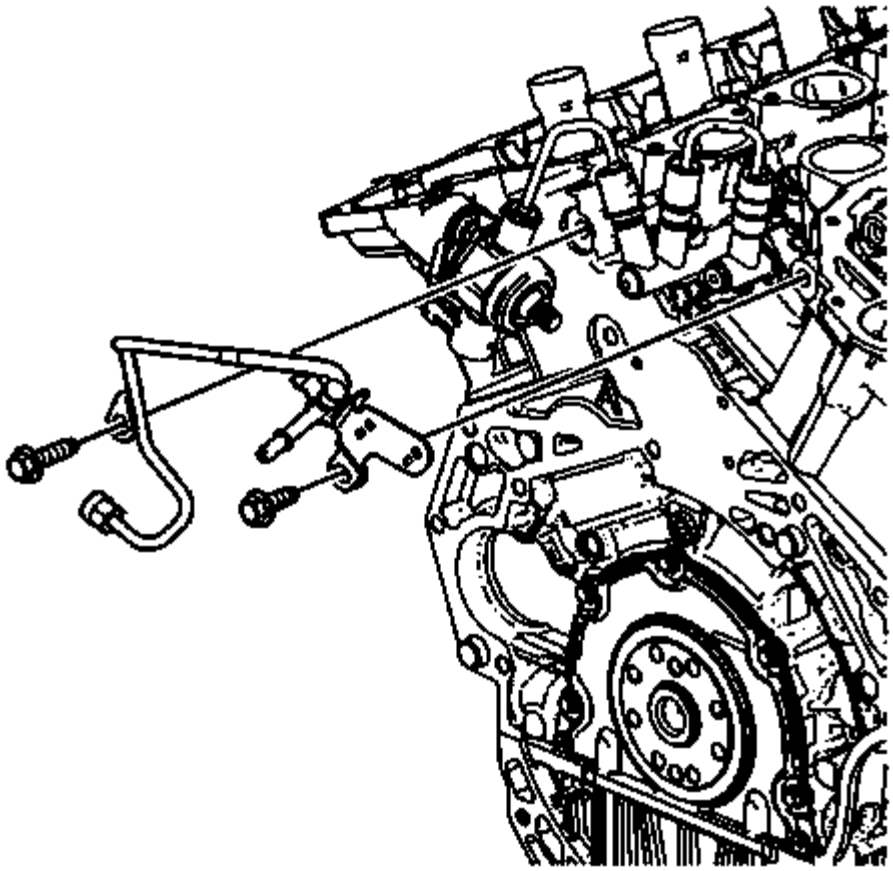


Fig. 85: Identifying Fuel Feed Pipe & Bracket
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fuel rail wiring connectors from the fuel feed pipe bracket.
3. Remove the fuel feed pipe bolts.
4. Remove and discard the fuel feed pipe.

cardiagn.com

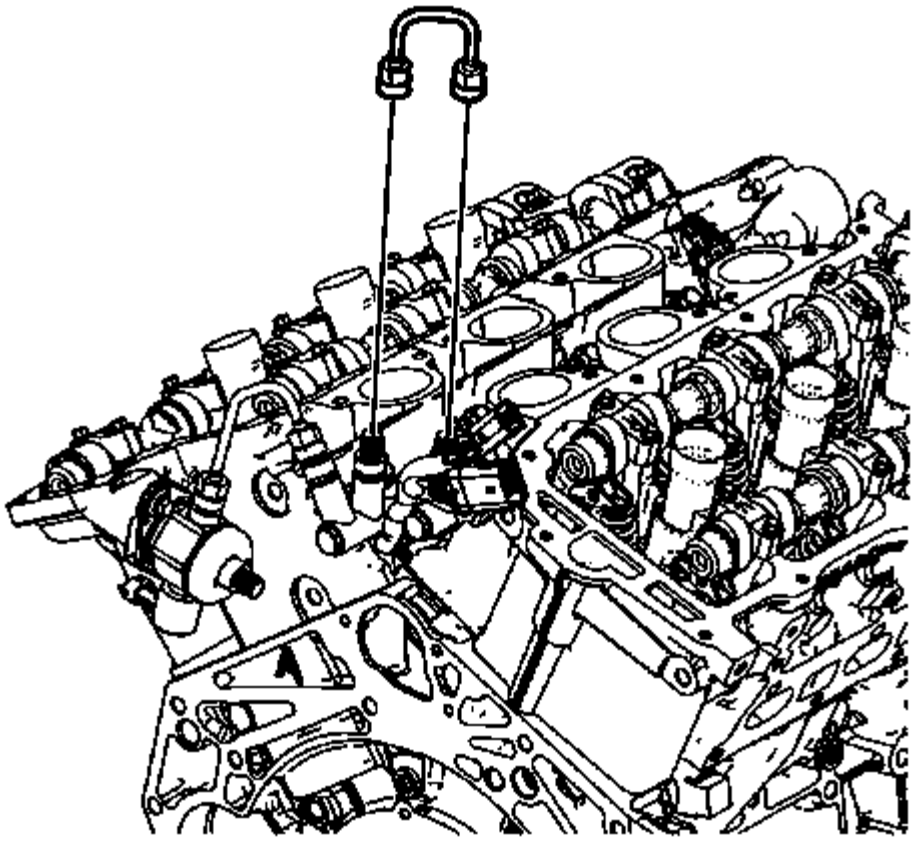


Fig. 86: Identifying Fuel Rail Crossover Pipe
Courtesy of GENERAL MOTORS COMPANY

5. Remove and discard the LH to RH fuel rail crossover pipe.

cardiagn.com

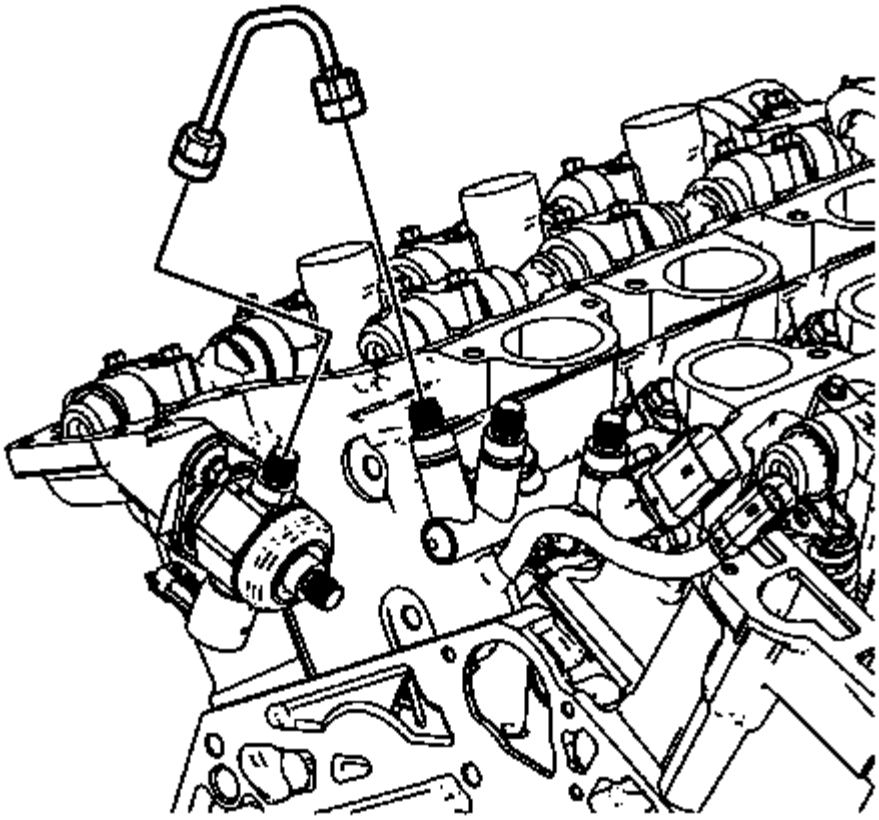


Fig. 87: View of Fuel Line & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

6. Remove and discard the high pressure fuel line. - LH Cylinder Head

cardiagn.com

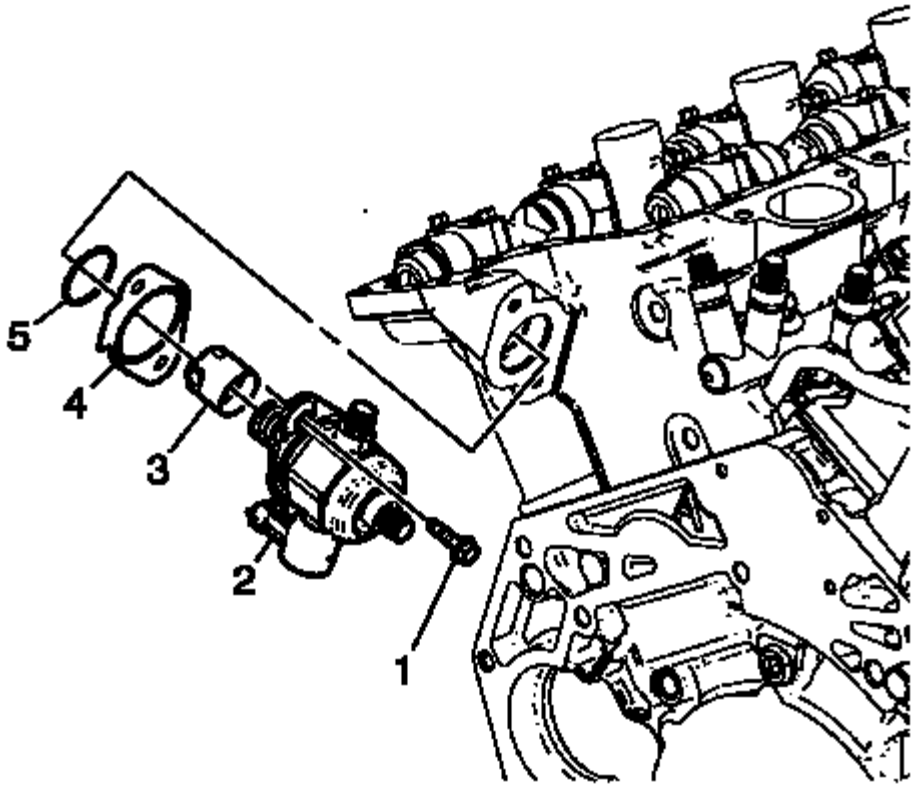


Fig. 88: View of Fuel Pump Bolts and Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

7. Remove and discard high pressure fuel pump bolts (1). - LH Cylinder Head
8. Remove the high pressure fuel pump (2). - LH Cylinder Head
9. Remove the valve lifter follower (3). - LH Cylinder Head
10. Remove and discard the high pressure fuel pump gasket (4). - LH Cylinder Head
11. Remove and discard the high pressure fuel pump O-ring (5). - LH Cylinder Head

CAMSHAFT REMOVAL - LEFT SIDE

cardiagn.com

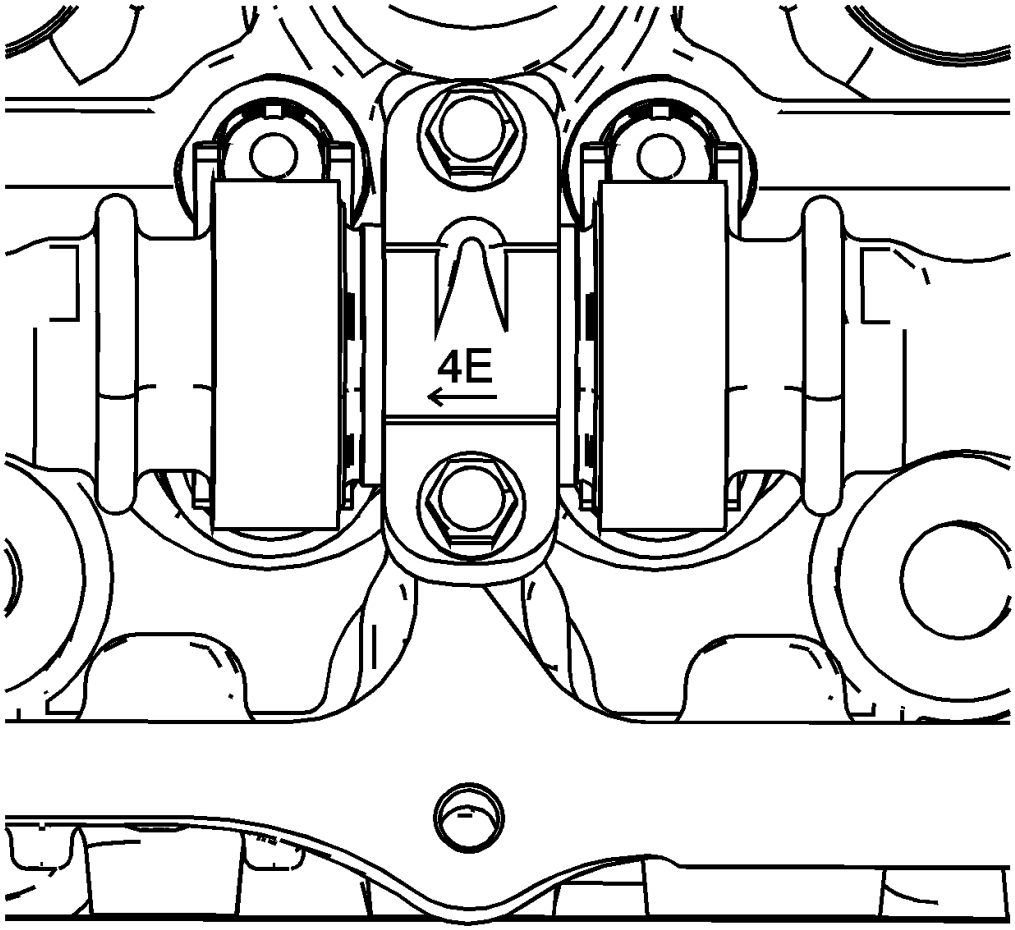


Fig. 89: Identifying Markings On Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

1. Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
    - The raised feature must always be oriented toward the center of the cylinder head.
    - The I indicates the intake camshaft.
    - The E indicates the exhaust camshaft.
    - The number indicates the journal position from the front of the engine.

cardiagn.com

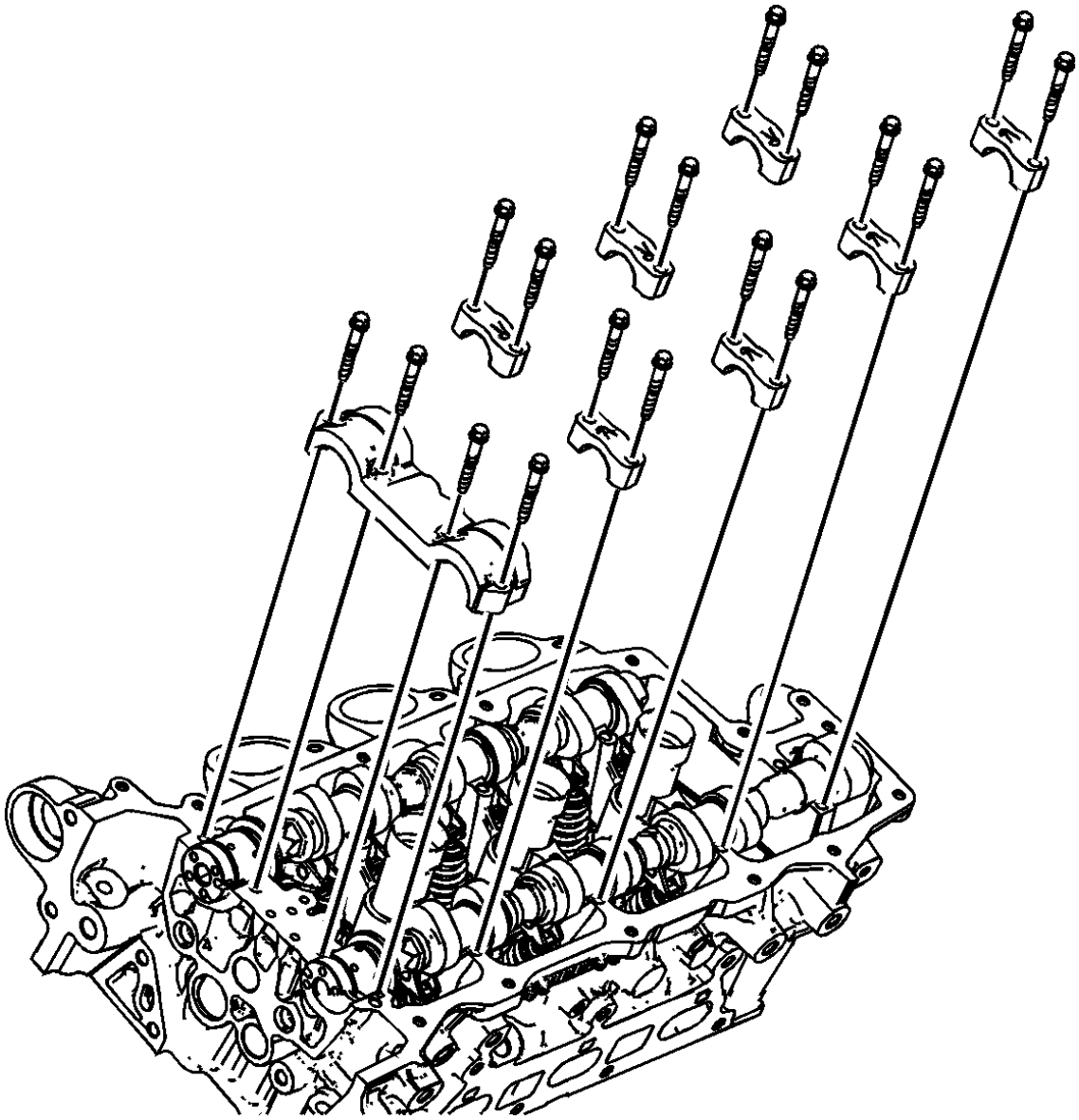


Fig. 90: Removing/Installing Camshaft Bearing Thrust Caps
Courtesy of GENERAL MOTORS COMPANY

2. Remove the camshaft bearing cap bolts.
3. Remove the camshaft bearing caps.
4. Remove the camshafts.

cardiagn.com

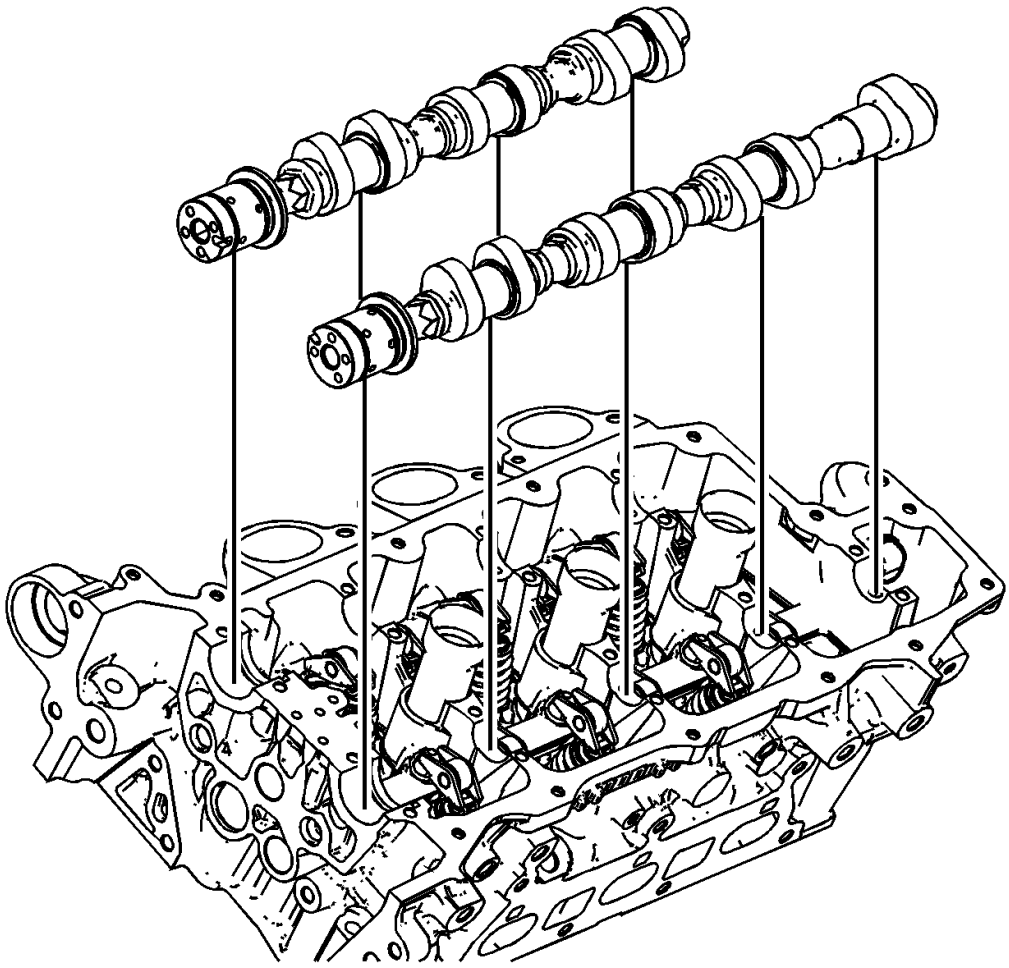


Fig. 91: View of Camshafts and Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Mark the camshafts upon removal to ensure installation is in the correct position.

FUEL RAIL REMOVAL

Refer to **Cylinder Head Disassemble**.

VALVE ROCKER ARM REMOVAL - LEFT SIDE

cardiagn.com

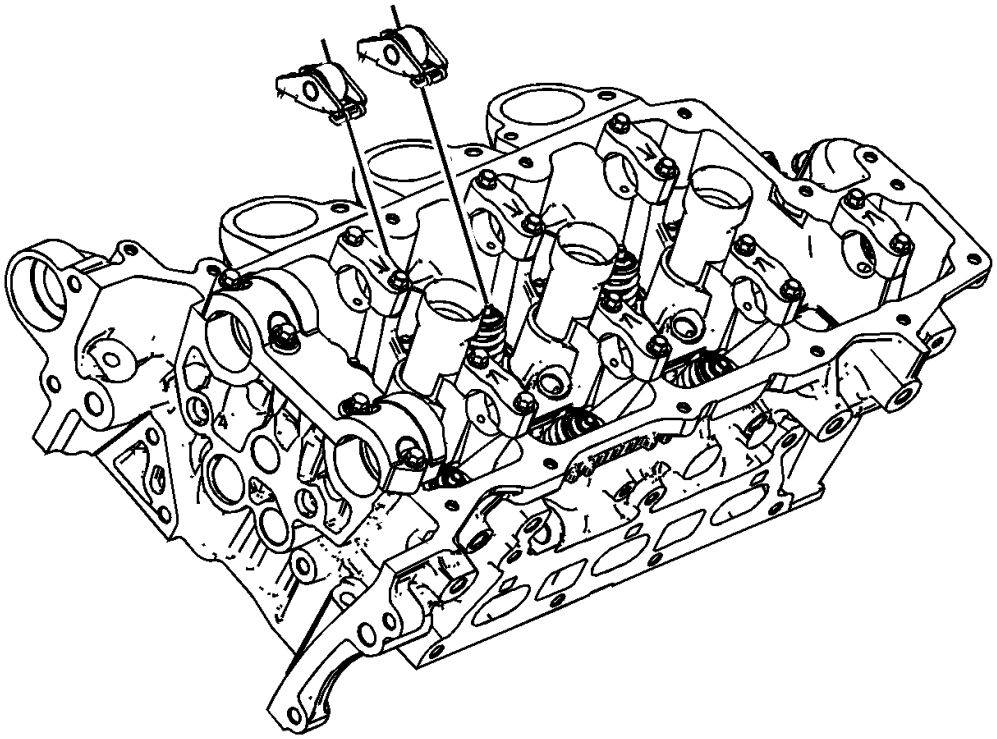


Fig. 92: View Of Valve Rocker Arm - Left Side (LLT)
Courtesy of GENERAL MOTORS COMPANY

Remove the valve rocker arms from the cylinder head. If the rocker arms are to be reused, keep in order so they can be reinstalled in the same position.

VALVE LIFTER REMOVAL - LEFT SIDE

cardiagn.com

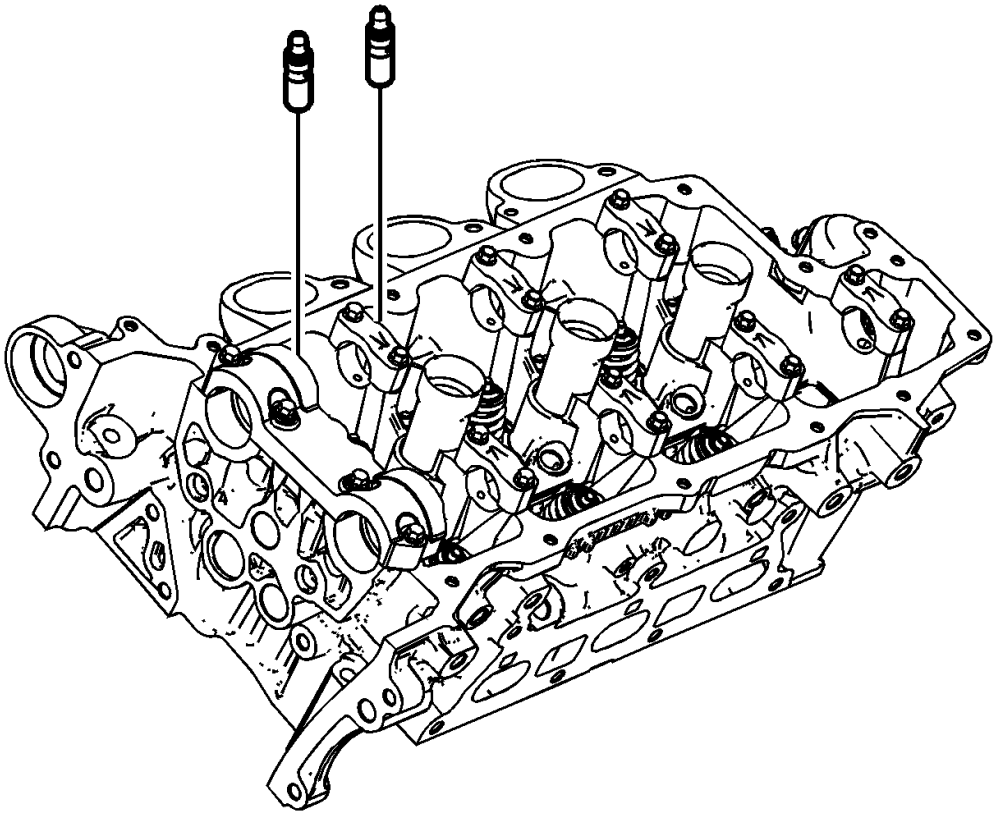


Fig. 93: Valve Lifter Removal - Left Side (LLT)
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT:

- **Do not stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.**
- **Do not allow the stationary hydraulic lash adjuster to tip over, plunger down, after the oil fill.**

Remove the valve lifters (SHLAs) from the cylinder head. If the lifters are to be reused, keep in order so they can be reinstalled in the same position.

CYLINDER HEAD REMOVAL - LEFT SIDE

cardiagn.com

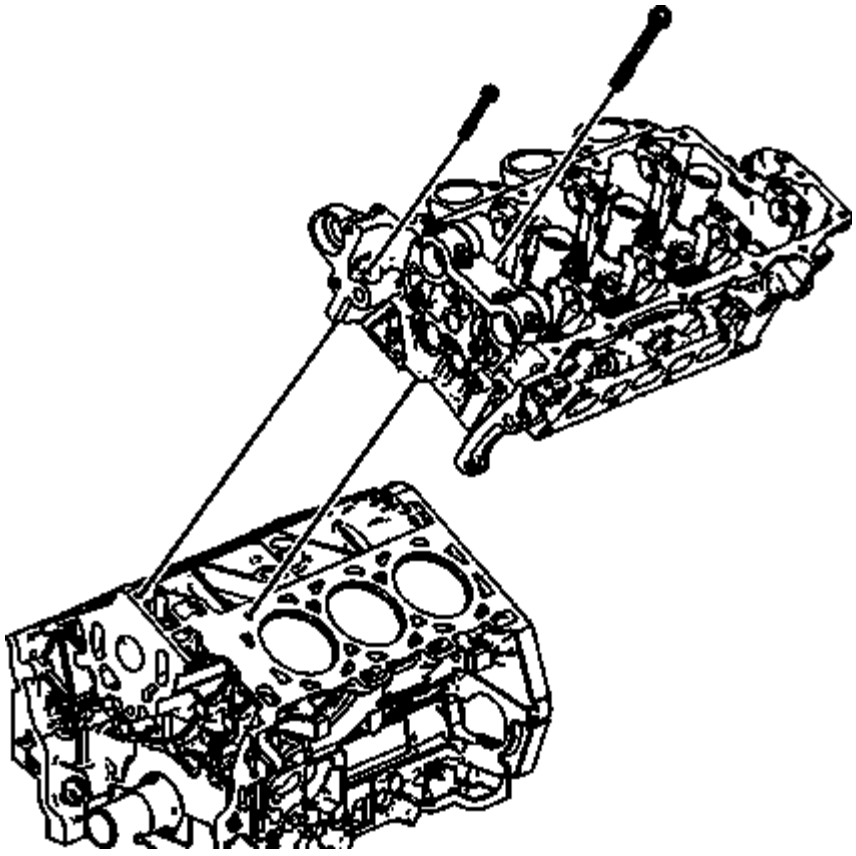


Fig. 94: View Of Left Cylinder Head & Bolts (LLT)
Courtesy of GENERAL MOTORS COMPANY

1. Remove the two front M8 left cylinder head bolts.
2. Remove the left cylinder head bolts.
3. Remove the left cylinder head.

cardiagn.com

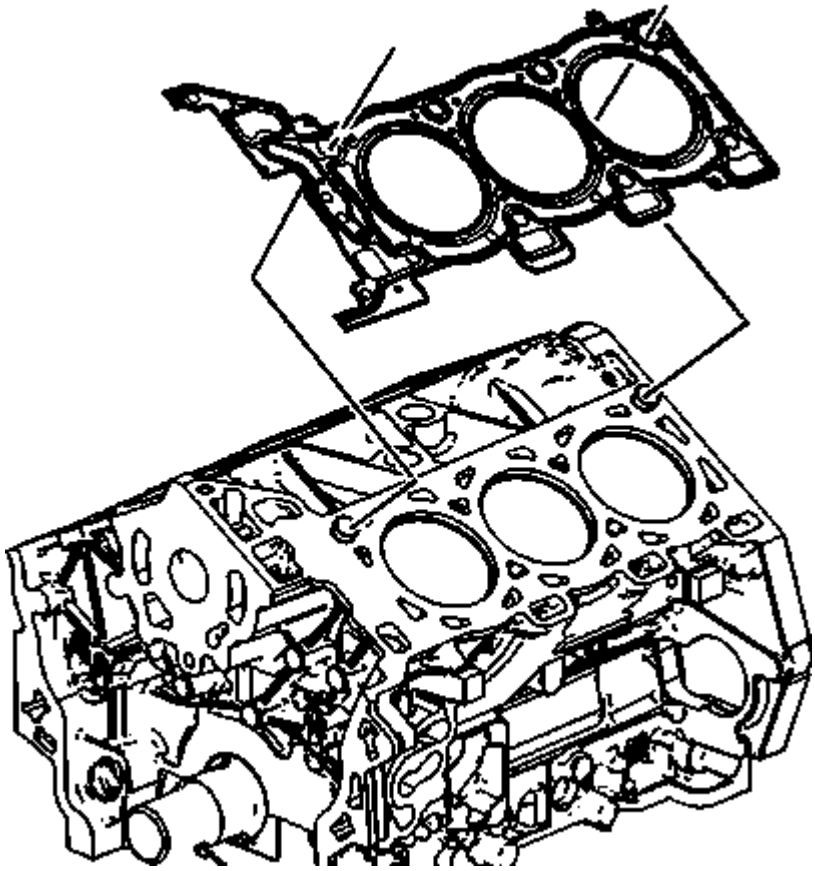


Fig. 95: View Of Left Cylinder Head Gasket (LLT)
Courtesy of GENERAL MOTORS COMPANY

4. Remove and discard the left cylinder head gasket.

CAMSHAFT REMOVAL - RIGHT SIDE

cardiagn.com

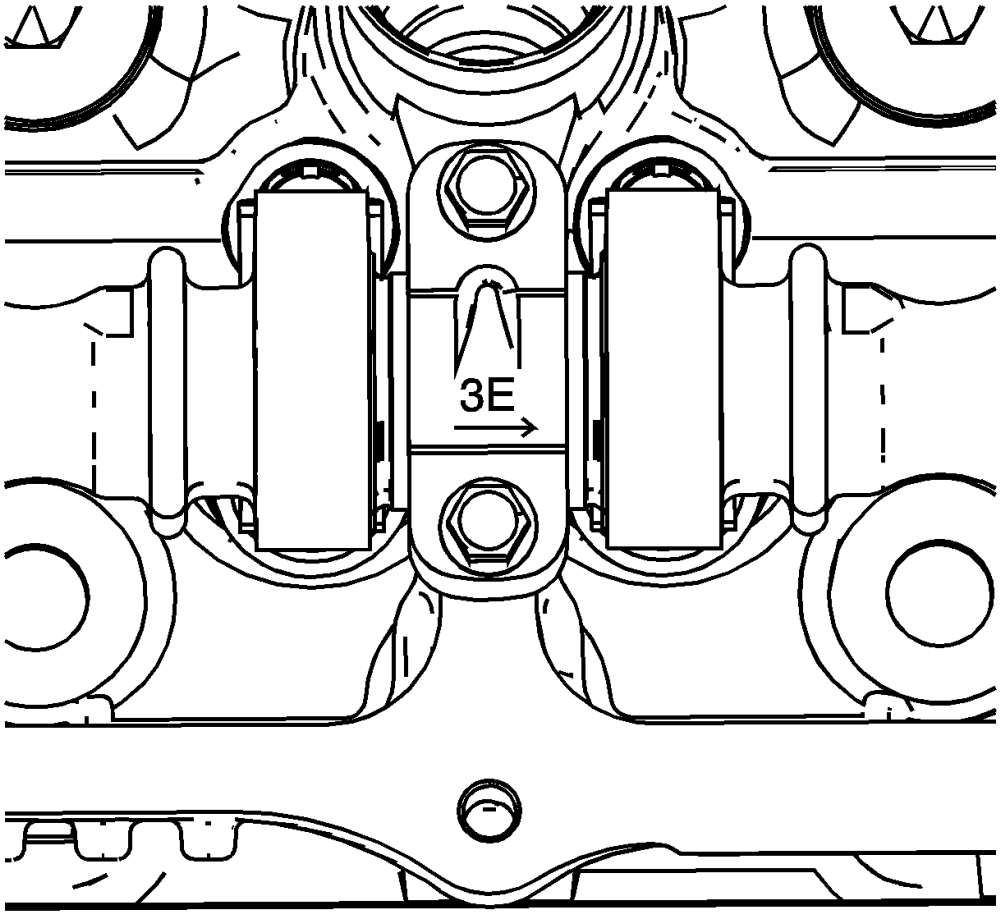


Fig. 96: Identifying Markings On Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

1. Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
    - The raised feature must always be oriented toward the center of the cylinder head.
    - The I indicates the intake camshaft.
    - The E indicates the exhaust camshaft.
    - The number indicates the journal position from the front of the engine.

cardiagn.com

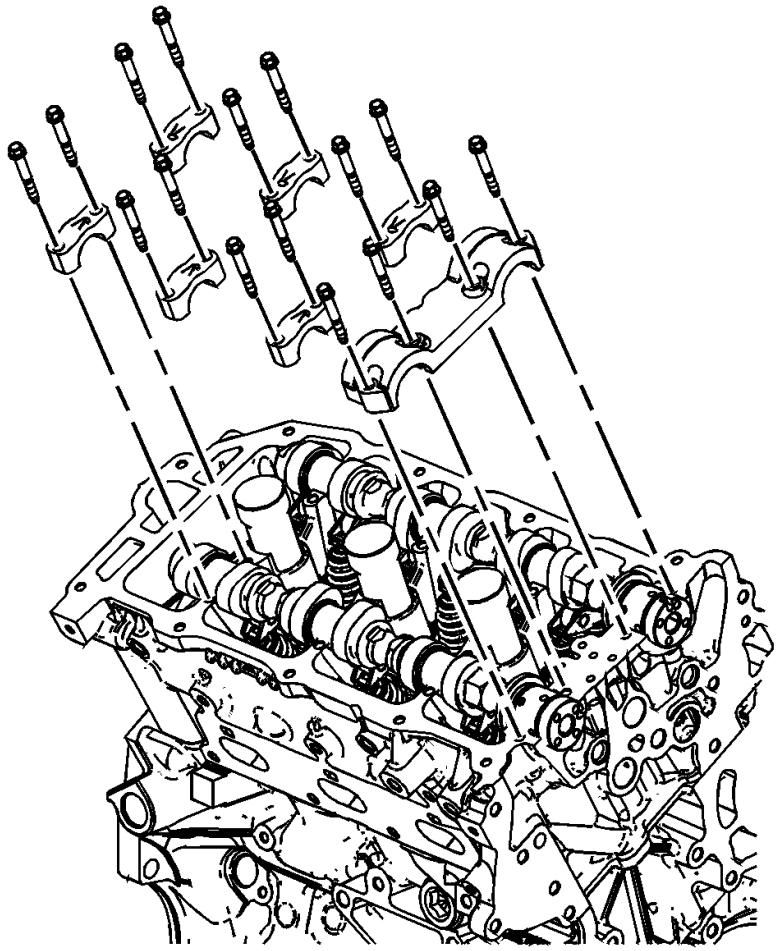


Fig. 97: View Of Camshaft Bearing Caps & Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the camshaft bearing cap bolts.
3. Remove the camshaft bearing caps.
4. Remove the camshafts.

cardiagn.com

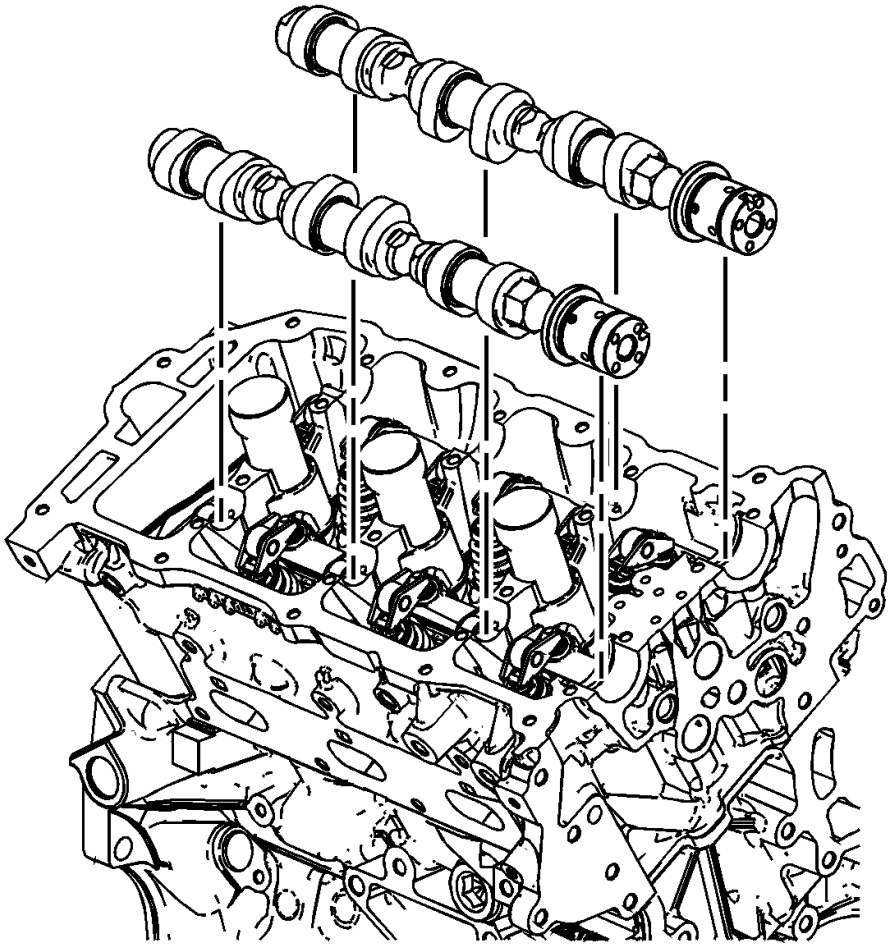


Fig. 98: Locating Camshafts
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Mark the camshafts upon removal to ensure installation is in the correct position.

VALVE ROCKER ARM REMOVAL - RIGHT SIDE

cardiagn.com

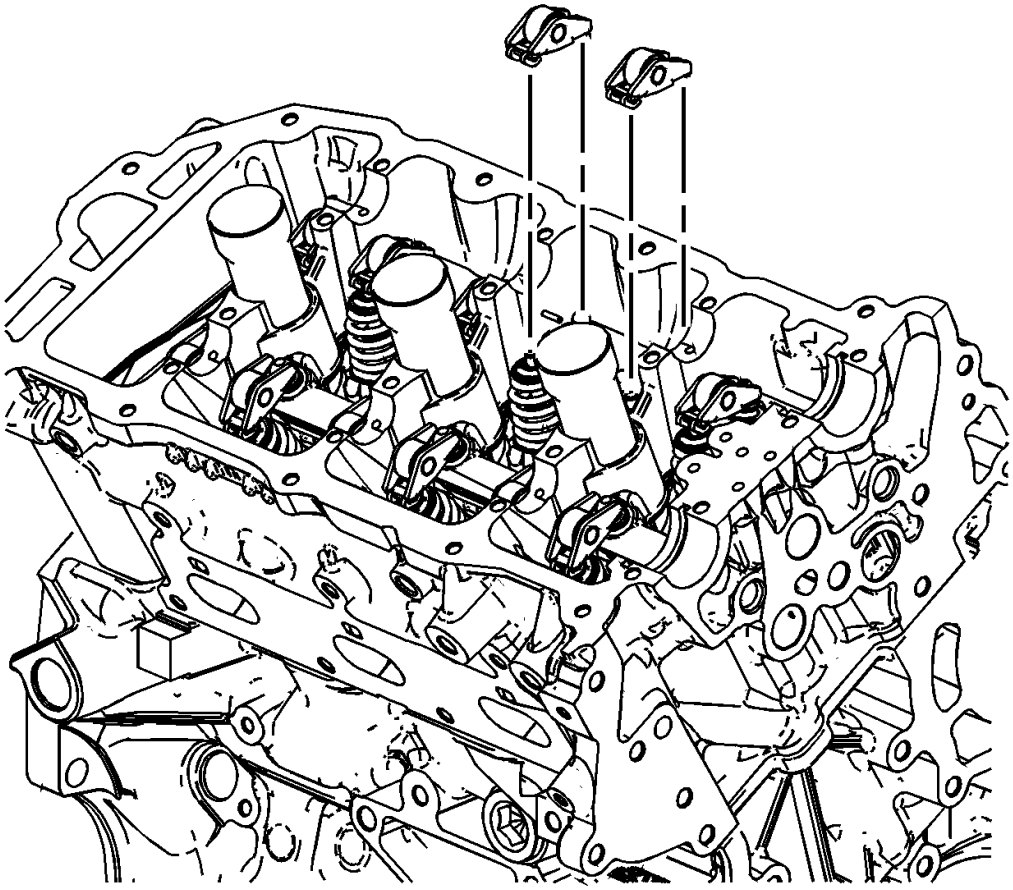


Fig. 99: Identifying Valve Rocker Arms
Courtesy of GENERAL MOTORS COMPANY

Remove the valve rocker arms from the cylinder head. If the rocker arms are to be reused, keep in order so they can be reinstalled in the same position.

VALVE LIFTER REMOVAL - RIGHT SIDE

cardiagn.com

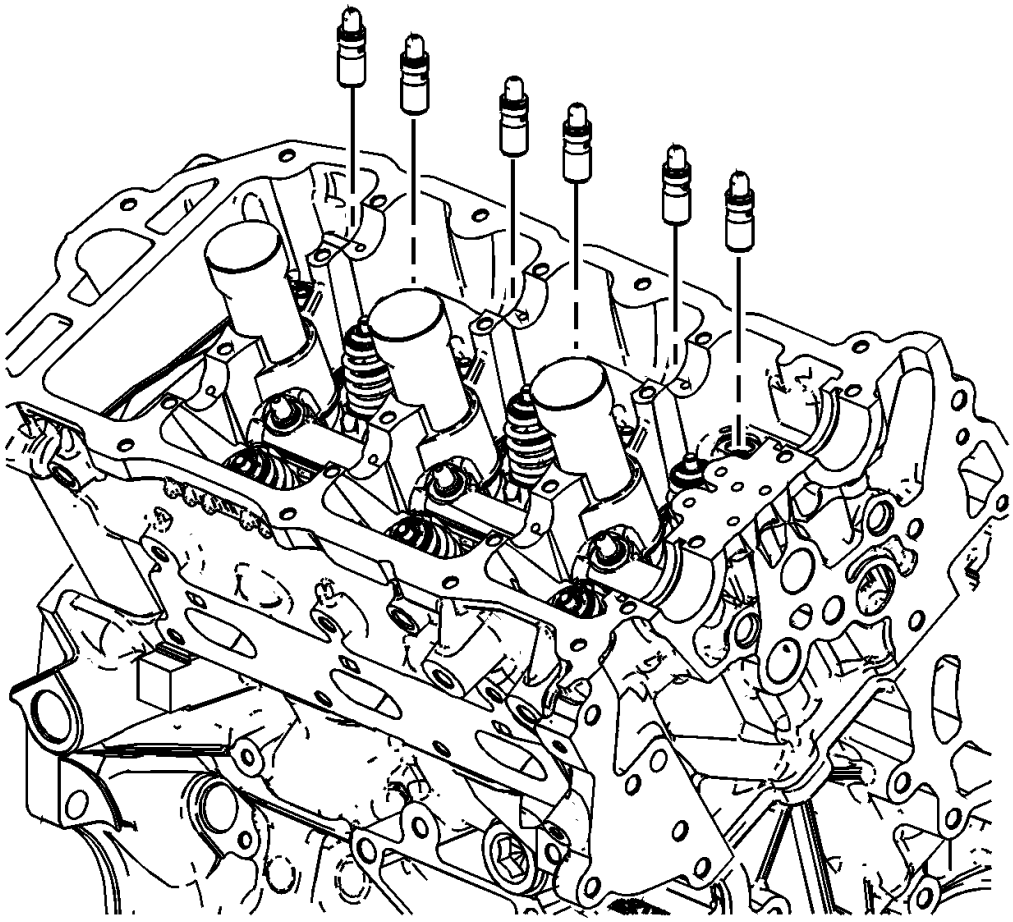


Fig. 100: Identifying Stationary Hydraulic Lash Adjuster (SHLA)
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT:

- **Do not stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.**
- **Do not allow the stationary hydraulic lash adjuster to tip over, plunger down, after the oil fill.**

Remove the valve lifters (SHLAs) from the cylinder head. If the lifters are to be reused, keep in order so they can be reinstalled in the same position.

CYLINDER HEAD REMOVAL - RIGHT SIDE

cardiagn.com

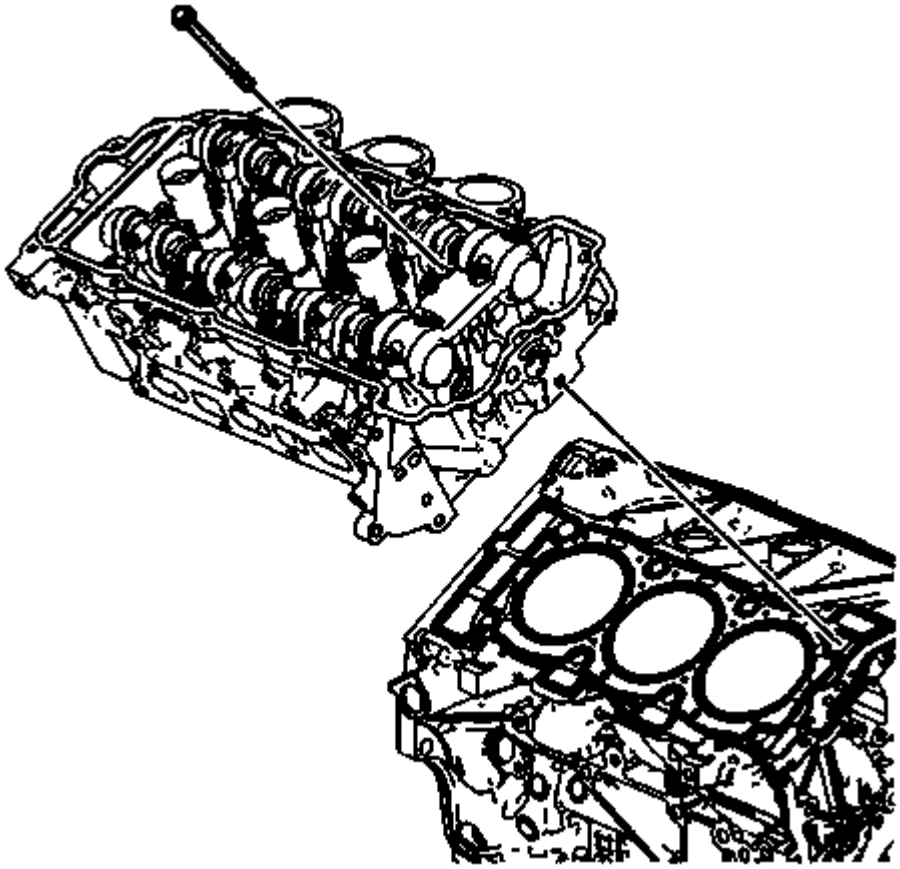


Fig. 101: View Of Right Cylinder Head (LLT)
Courtesy of GENERAL MOTORS COMPANY

1. Remove the right cylinder head bolts.
2. Remove the right cylinder head.

cardiagn.com

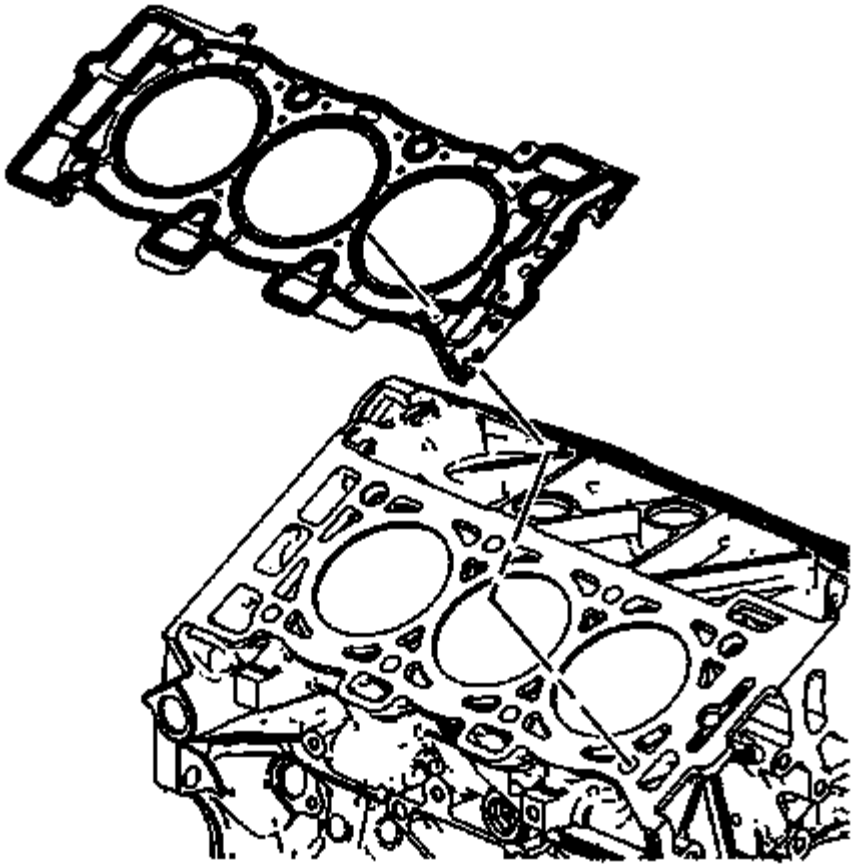


Fig. 102: View Of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the right cylinder head gasket.

cardiagn.com

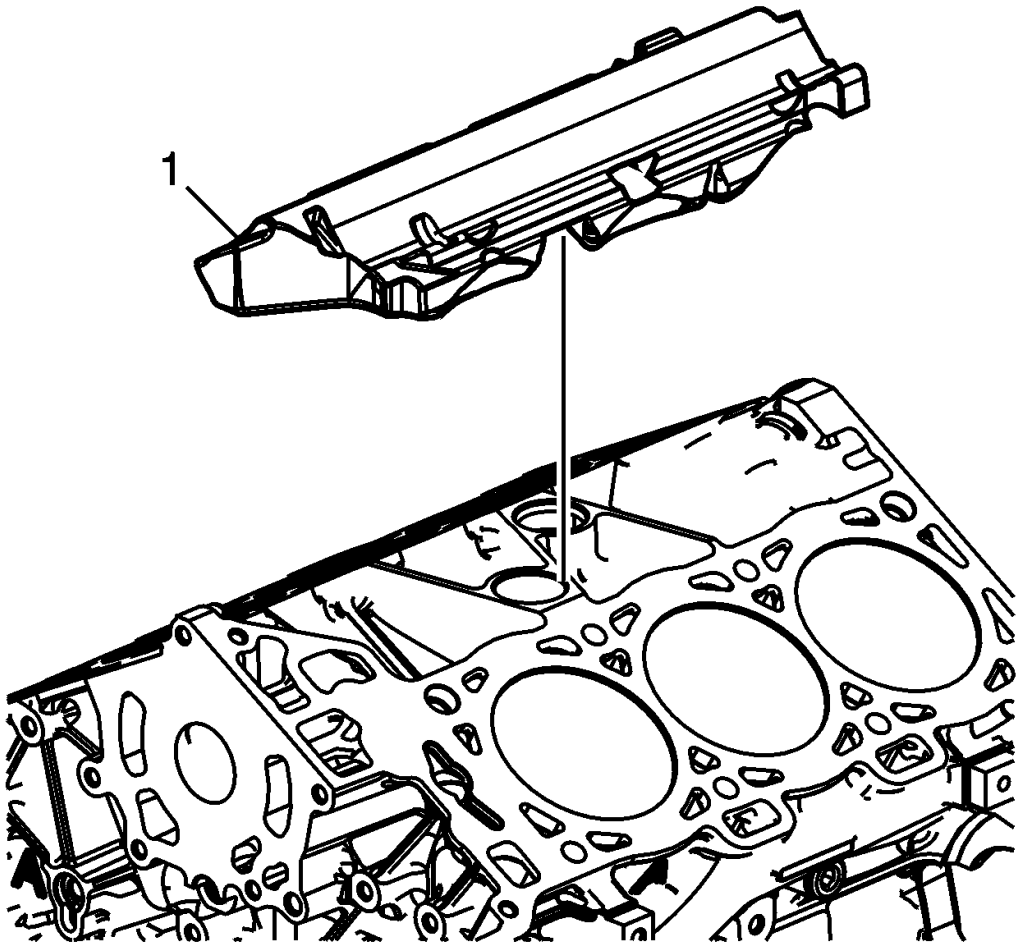


Fig. 103: Fuel Injection Fuel Rail Noise Shield-Lower
Courtesy of GENERAL MOTORS COMPANY

4. Remove the fuel injection fuel rail noise shield-lower (1).

OIL PAN REMOVAL

cardiagn.com

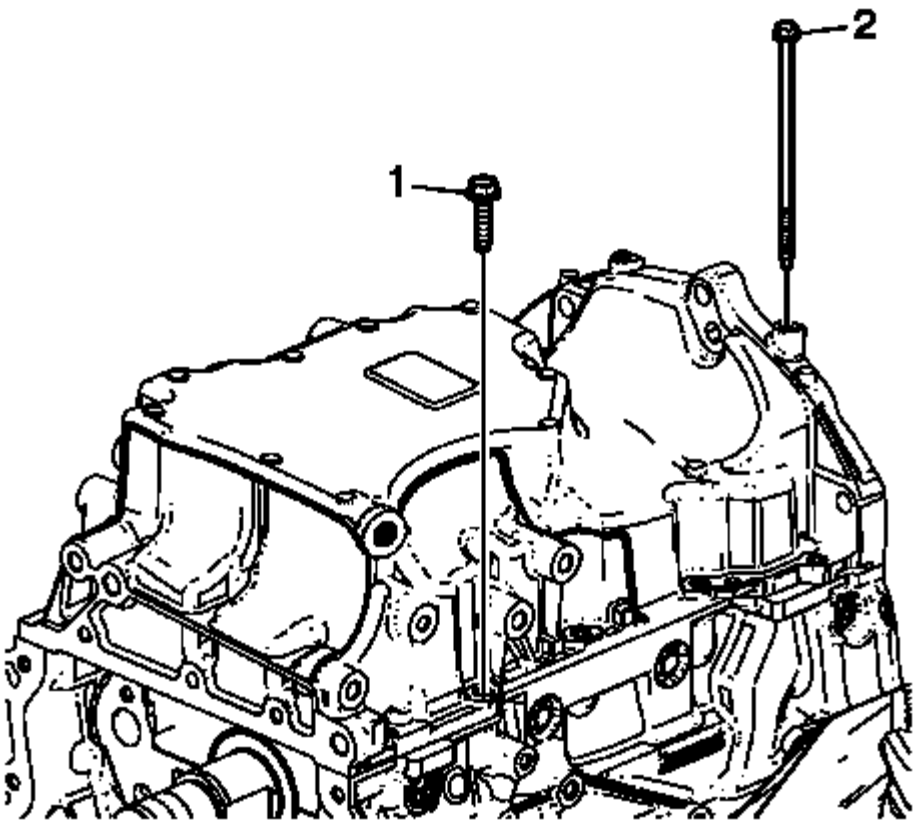


Fig. 104: Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pan bolts (1) and (2).
2. Using the pry points located at the edge of the oil pan separate the RTV sealant.

cardiagn.com

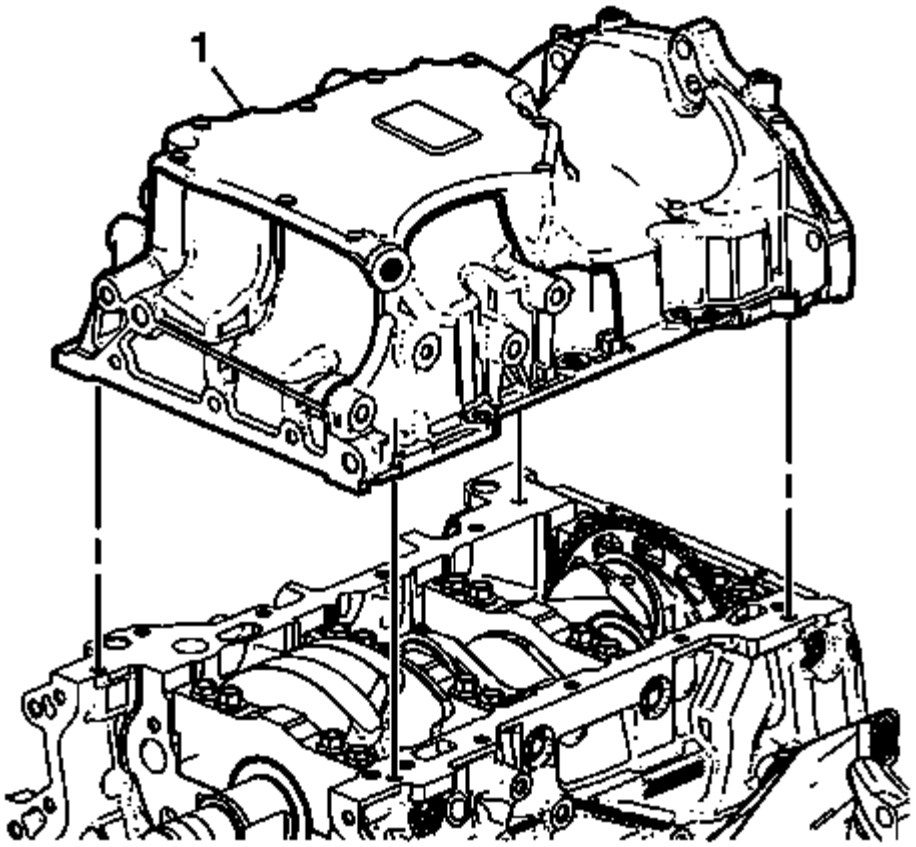


Fig. 105: View Of Oil Pan
Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil pan (1) from the block.

OIL PUMP REMOVAL

cardiagn.com

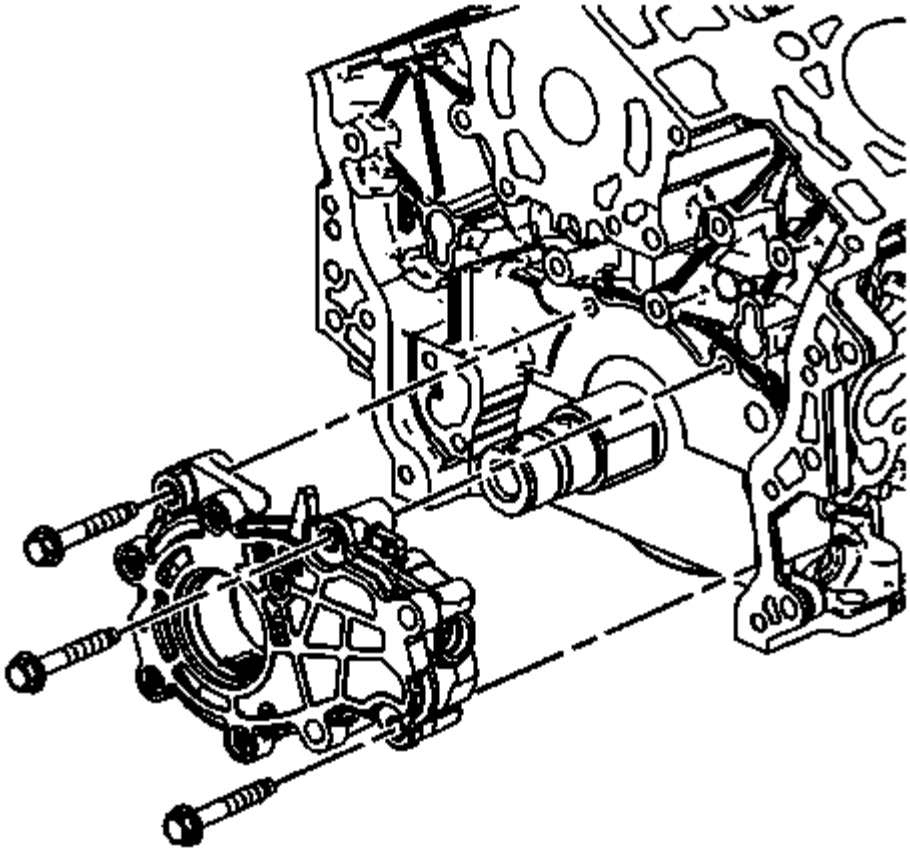


Fig. 106: Identifying Oil Pump & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pump bolts.
2. Remove the oil pump.

CRANKSHAFT REAR OIL SEAL AND HOUSING REMOVAL

cardiagn.com

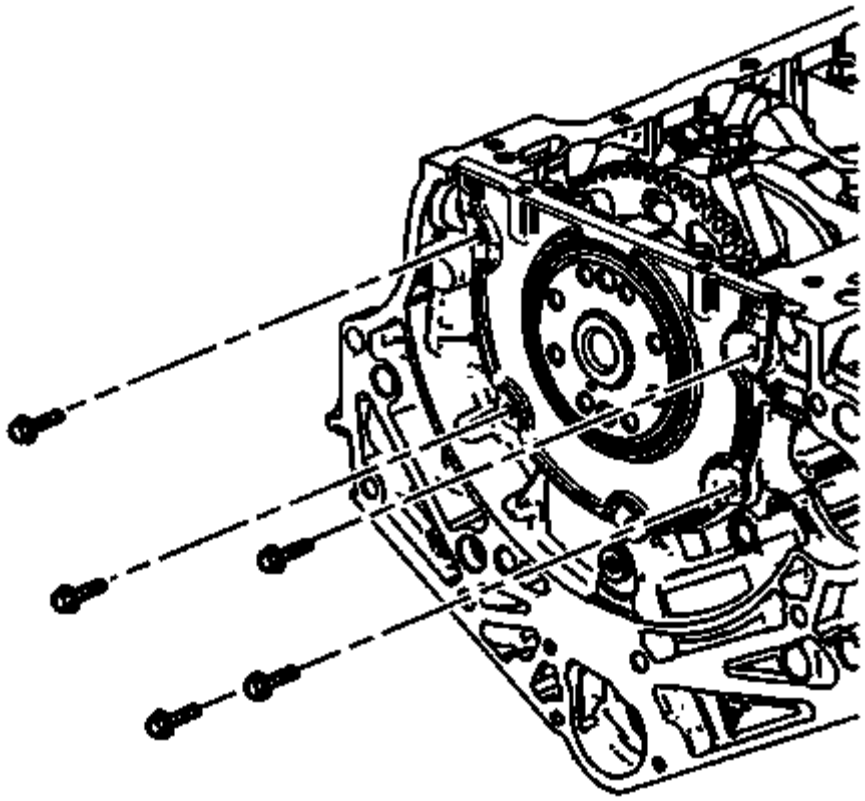


Fig. 107: Identifying Crankshaft Rear Oil Seal Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the crankshaft rear oil seal housing bolts.

cardiagn.com

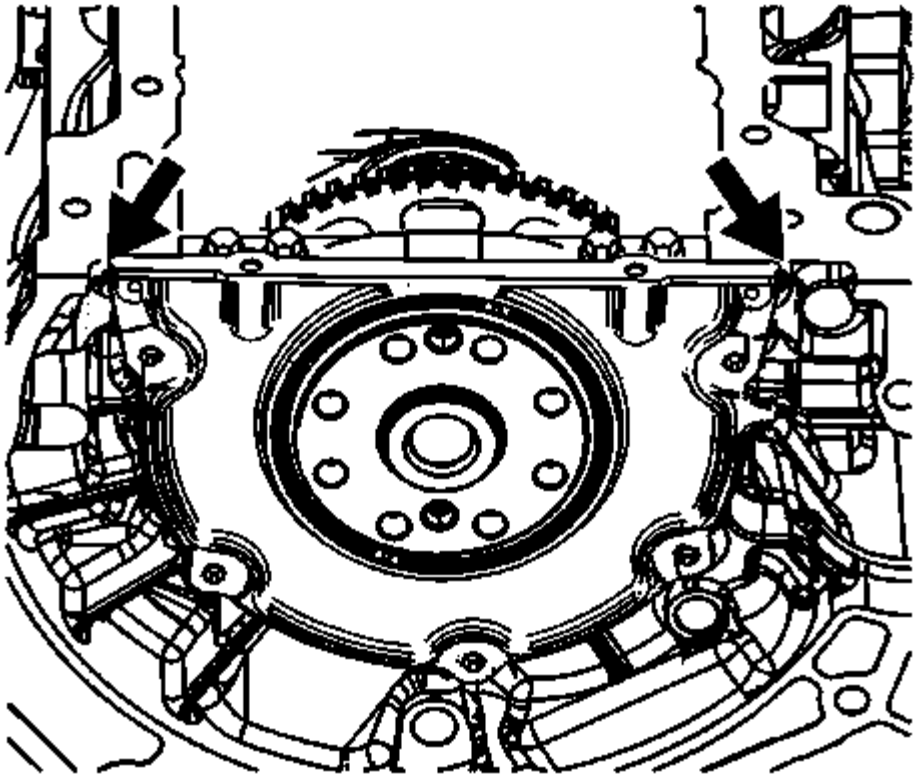


Fig. 108: Identifying Pry Points Of Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

2. Using the pry points located at the edge of the crankshaft rear oil seal housing separate the RTV sealant.

cardiagn.com

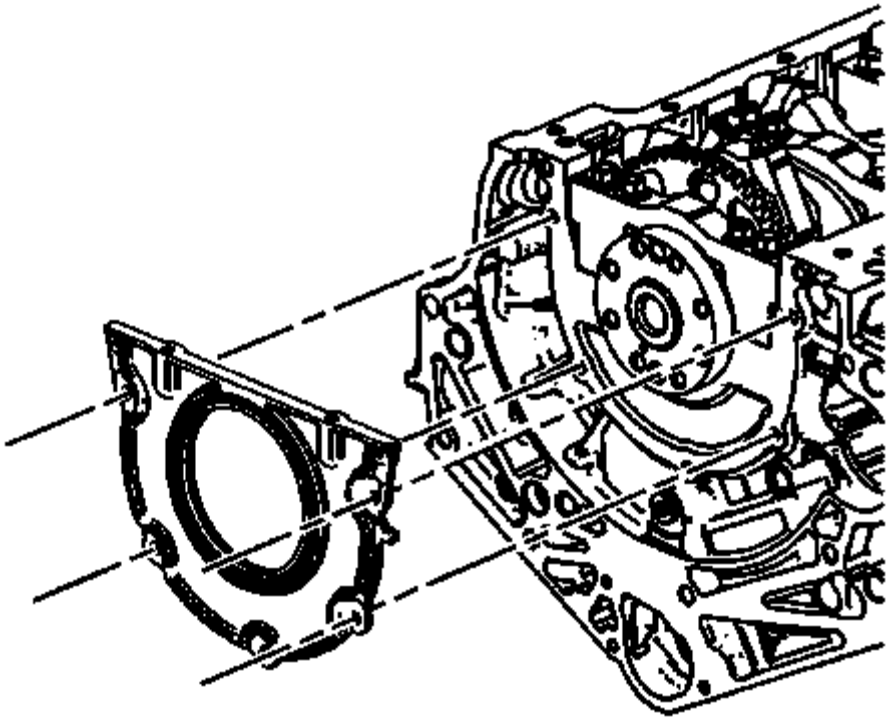


Fig. 109: Identifying Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the crankshaft rear oil seal housing.

PISTON, CONNECTING ROD AND BEARING REMOVAL

Special Tools

EN 46121 Connecting Rod Guide Pin Set

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

1. Before removing the connecting rods, check the connecting rod side clearance using the following procedure:

NOTE:

- **An arrow/dot showing proper piston orientation is located on the top of the piston.**
- **If the connecting rod bearings have been used in a running engine, you must replace them with NEW connecting rod bearings for reassembly.**

cardiagn.com

1. Tap the connecting rod to one end of the crankshaft journal with a dead-blow or wooden hammer.
2. Using feeler gauges, measure the clearance between the crankshaft counterweight and the connecting rod.
3. The connecting rod side clearance should not exceed specifications. Refer to **Engine Mechanical Specifications** .
4. If the end play exceeds the specified limits, measure the width of the crankpin end of the connecting rod. Refer to **Piston, Connecting Rod and Bearing Cleaning and Inspection**.
5. If the connecting rod width is significantly smaller than specified and severe wear is present on the side of the connecting rod, replace the connecting rod.
6. If the connecting rod width is within specification and excessive scoring is present on the crankshaft journals, replace the crankshaft.

2. Using a marker, number each piston face. Draw an arrow along the centerline of the piston pointing toward the front of the engine.
3. Mark the cylinder number on the connecting rod and the connecting rod cap with a scribe, paint stick or permanent marker.

CAUTION: Do not use a stamp, punch or any other method that may distort or stress the connecting rod or connecting rod cap. Extensive engine damage may result from a connecting rod that is distorted or stressed.

4. Remove the connecting rod bolts.

cardiagn.com

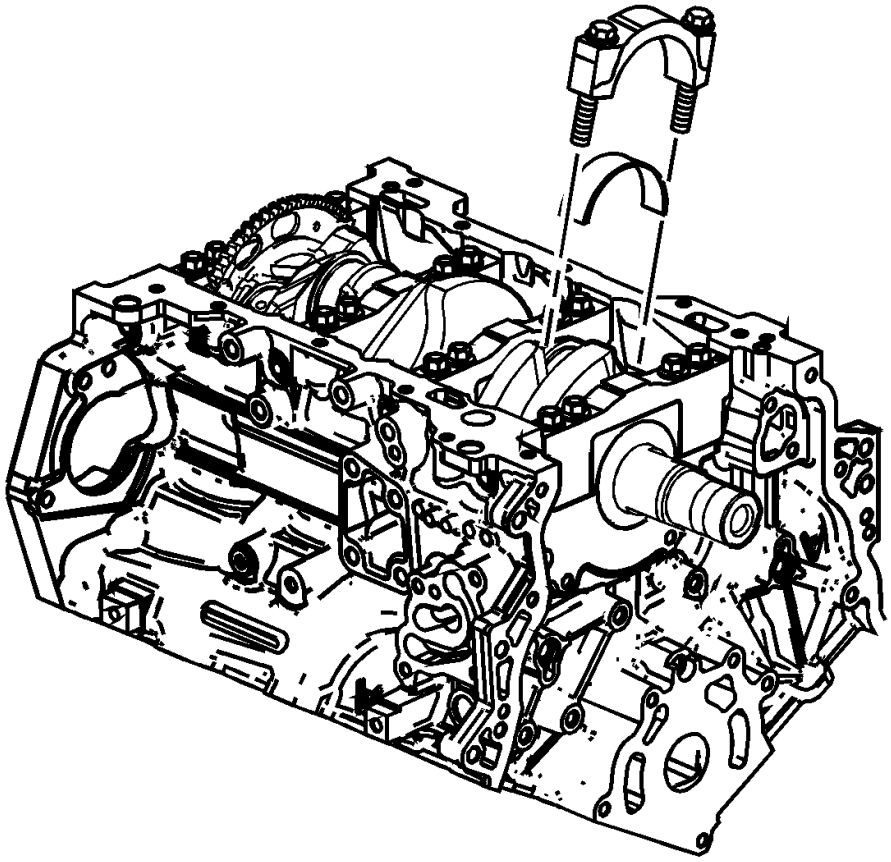


Fig. 110: View Of Connecting Rod Bearing & Cap
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Powdered metal connecting rods have rod bolts which yield when torqued. If the rod bolts are loosened or removed the rod bolts must be replaced. Rod bolts that are not replaced will not torque to the correct clamp load and can lead to serious engine damage.

5. Remove the connecting rod cap.

NOTE: The connecting rod caps must remain with the original connecting rod.

cardiagn.com

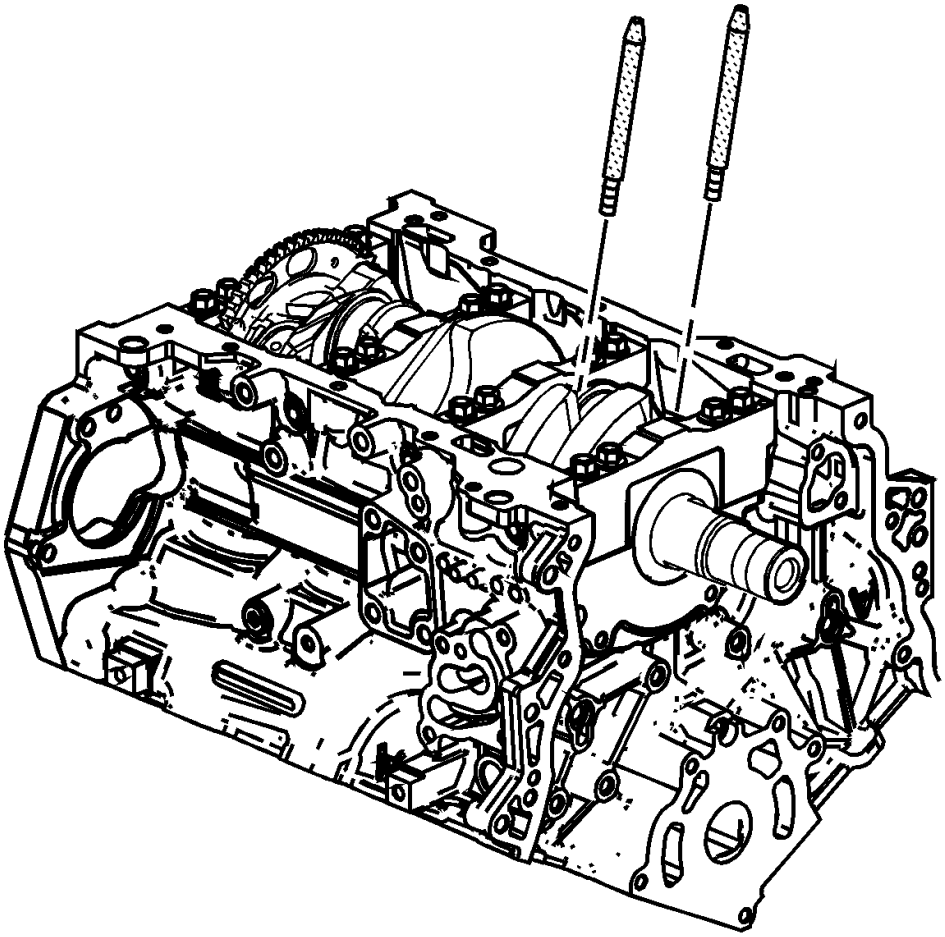


Fig. 111: Identifying Special Tool - EN 46121
Courtesy of GENERAL MOTORS COMPANY

6. Install the **EN 46121** set into the connecting rod bolt holes.

cardiagn.com

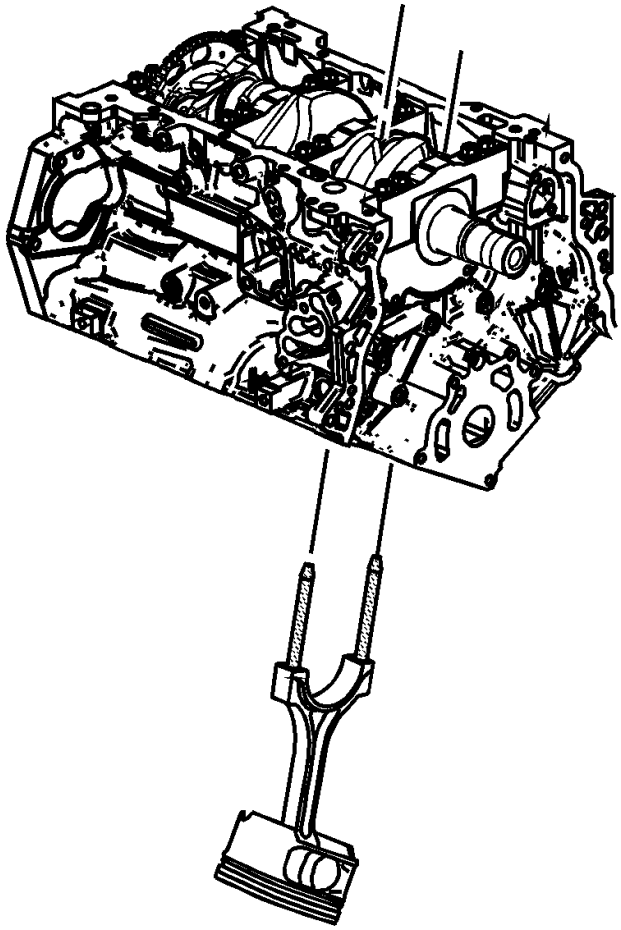


Fig. 112: View Of Connecting Rod & Piston Assembly
Courtesy of GENERAL MOTORS COMPANY

7. Using the **EN 46121** set, push the connecting rod and piston assembly through the top of the cylinder. DO NOT scratch the crankshaft journal or cylinder wall and DO NOT damage the oil jets when removing the connecting rod and piston assembly.

cardiagn.com

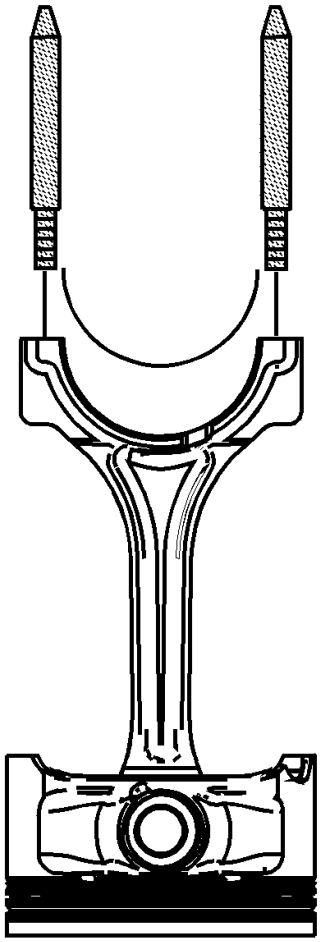


Fig. 113: View Of Piston/Connecting Rod Installation Tool
Courtesy of GENERAL MOTORS COMPANY

8. Remove the **EN 46121** set from the connecting rod bolt holes.
9. Remove the upper connecting rod bearing from the connecting rod.

cardiagn.com

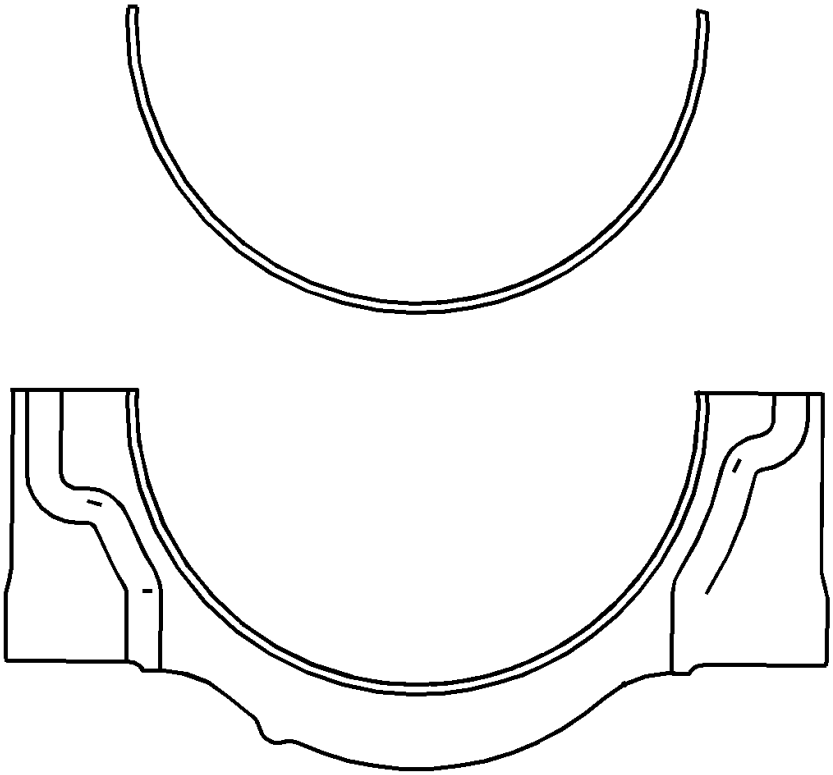


Fig. 114: View Of Lower Connecting Rod Cap & Bearing
Courtesy of GENERAL MOTORS COMPANY

10. Remove the lower connecting rod bearing from the connecting rod cap.

cardiagn.com

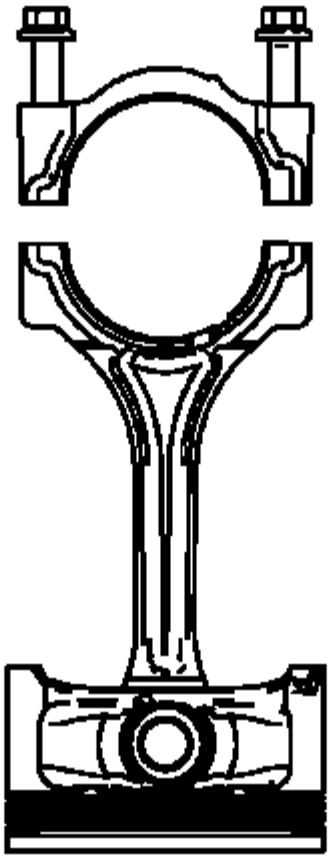


Fig. 115: View Of Connecting Rod Cap, Connecting Rod & Piston Assembly
Courtesy of GENERAL MOTORS COMPANY

11. Reattach the connecting rod cap to the connecting rod to prevent damage to their mating surfaces. The cap and rod are a matched set and must be kept together.

CRANKSHAFT AND BEARING REMOVAL

Tools Required

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

Crankshaft End Play Measurement

1. Place a dial indicator at the crankshaft nose.
2. Gently force the crankshaft to the extreme front and rear positions with a pry tool while monitoring the movement of the dial indicator.
3. The crankshaft end play should not exceed specifications. Refer to **Engine Mechanical Specifications** .
4. If the specifications are exceeded inspect the thrust bearing thrust OD and the crankshaft thrust wall for

cardiagn.com

wear and/or excessive runout. Refer to **Engine Mechanical Specifications** .

5. Replace the thrust bearing or crankshaft as necessary.

Crankshaft Removal

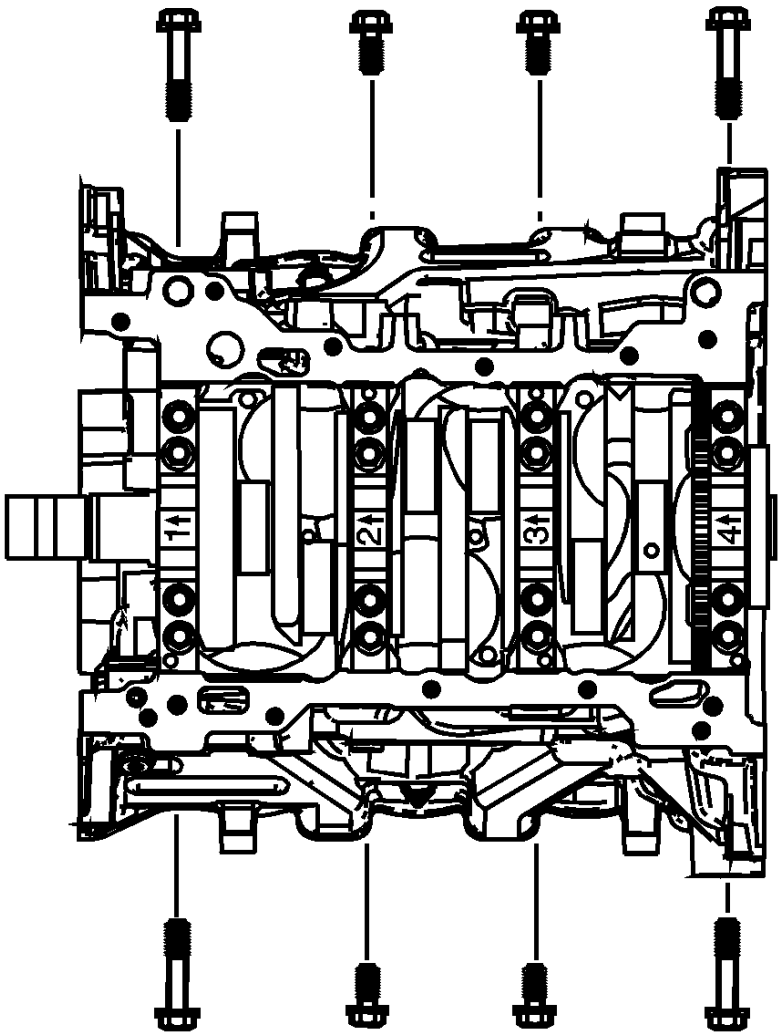


Fig. 116: Identifying Crankshaft Main Bearing Cap Side Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the crankshaft bearing cap side bolts.
2. Remove the crankshaft bearing cap outer bolts.
3. Remove the crankshaft bearing cap inner bolts.

cardiagn.com

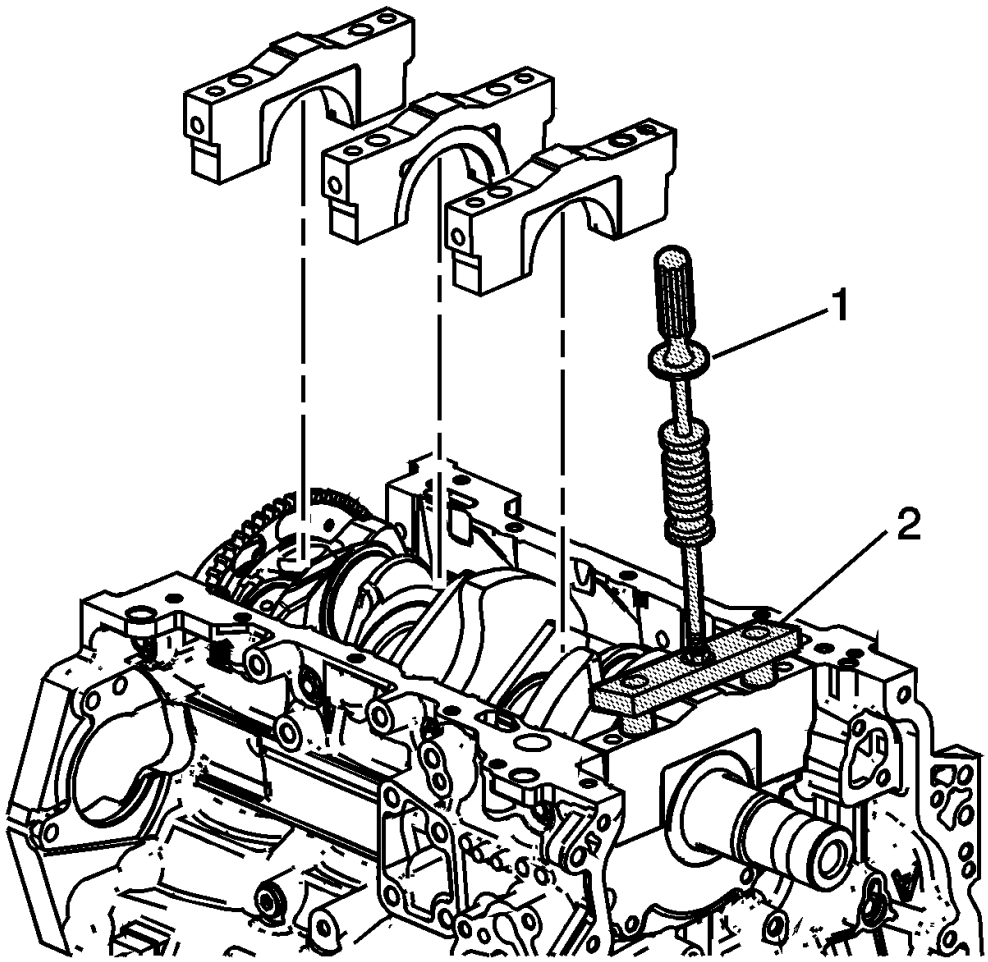


Fig. 117: View Of Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

4. Remove the crankshaft bearing caps using the **J 6125-1B** slide hammer adapter (1) and **J 41818** crankshaft bearing cap remover (2).

cardiagn.com

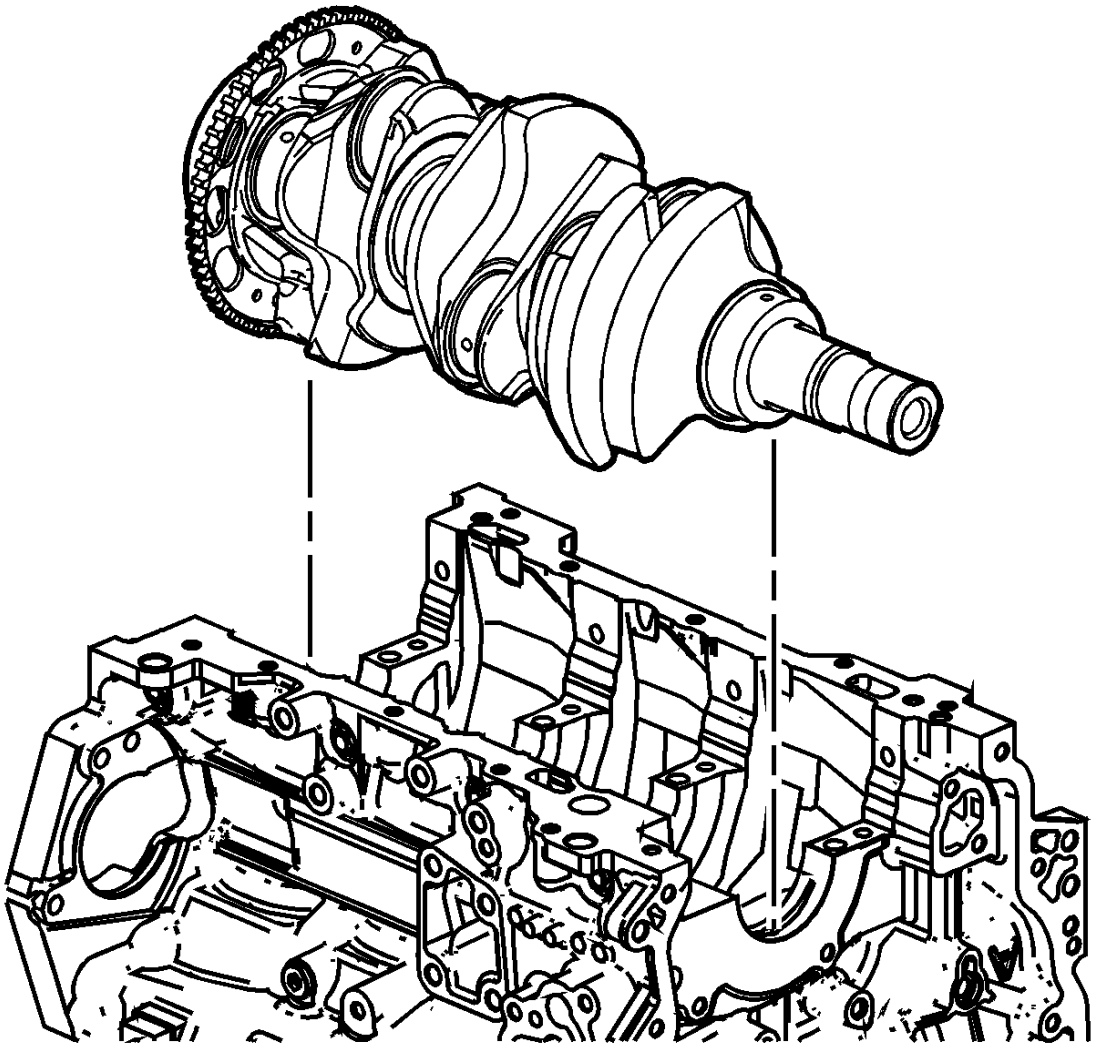


Fig. 118: View Of Crankshaft
Courtesy of GENERAL MOTORS COMPANY

5. Using two hands, lift the crankshaft straight up from the engine block.
6. Place the crankshaft in a secure place.

cardiagn.com

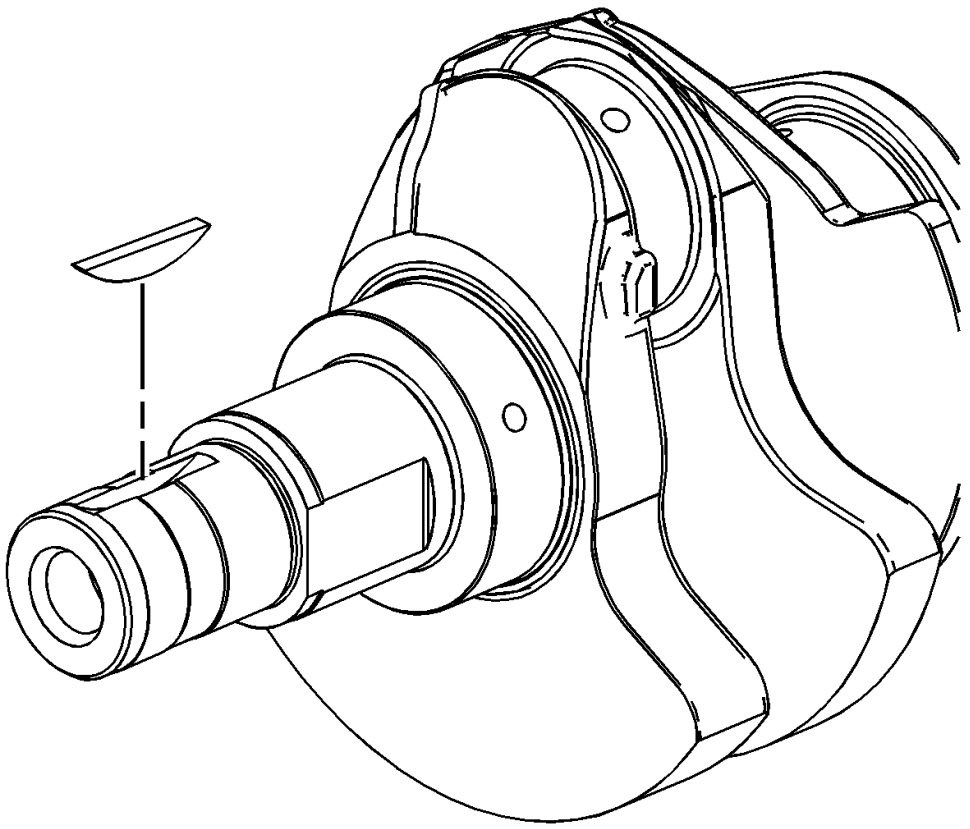


Fig. 119: Locating Crankshaft Sprocket Drive Pin
Courtesy of GENERAL MOTORS COMPANY

7. Remove the crankshaft sprocket drive pin from the nose of the crankshaft, if damaged.

Crankshaft Bearing Removal

1. Prepare a piece of cardboard or equivalent, numbered 1-4 for bearing identification. Main bearing journals are numbered from the front of the engine.

cardiagn.com

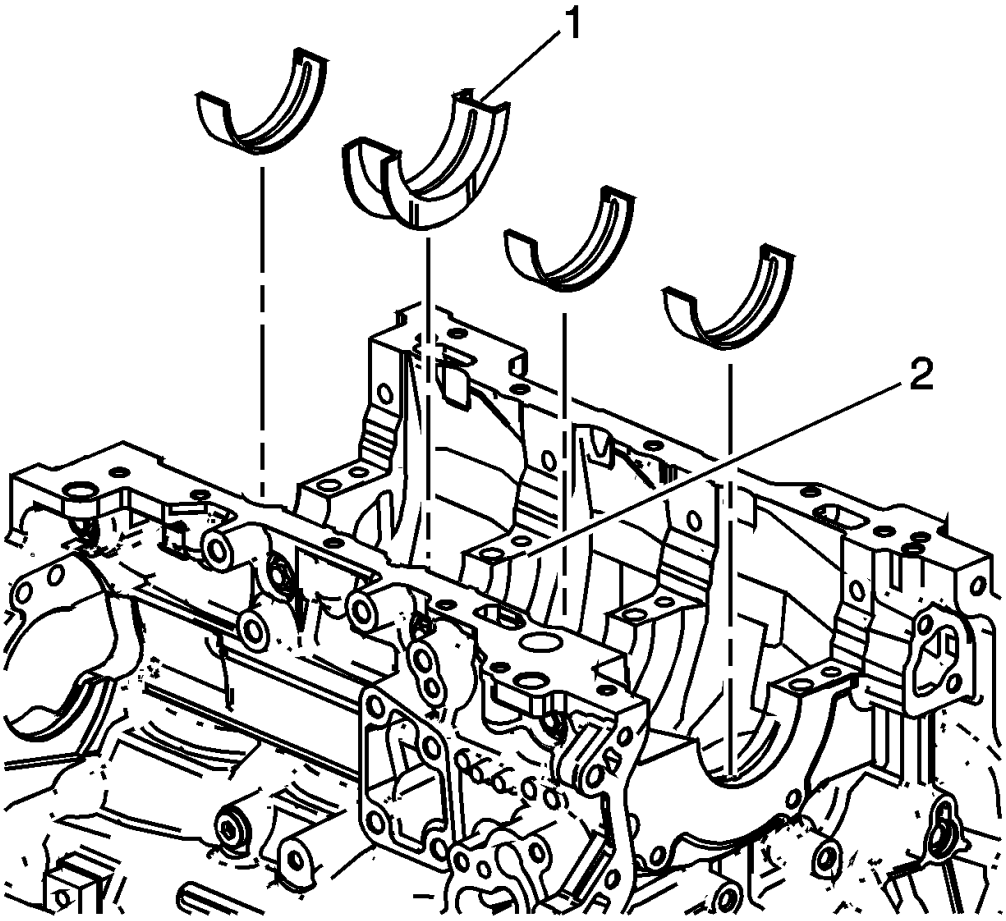


Fig. 120: Locating Thrust Bearing In Number 3 Journal
Courtesy of GENERAL MOTORS COMPANY

2. Remove the crankshaft upper bearing halves from the cylinder block. Note the position of the thrust bearing (1) at the number 3 journal (2).
3. Place the crankshaft upper bearing halves on the cardboard in the correct positions. Note that the number 3 bearing is the thrust bearing.

cardiagn.com

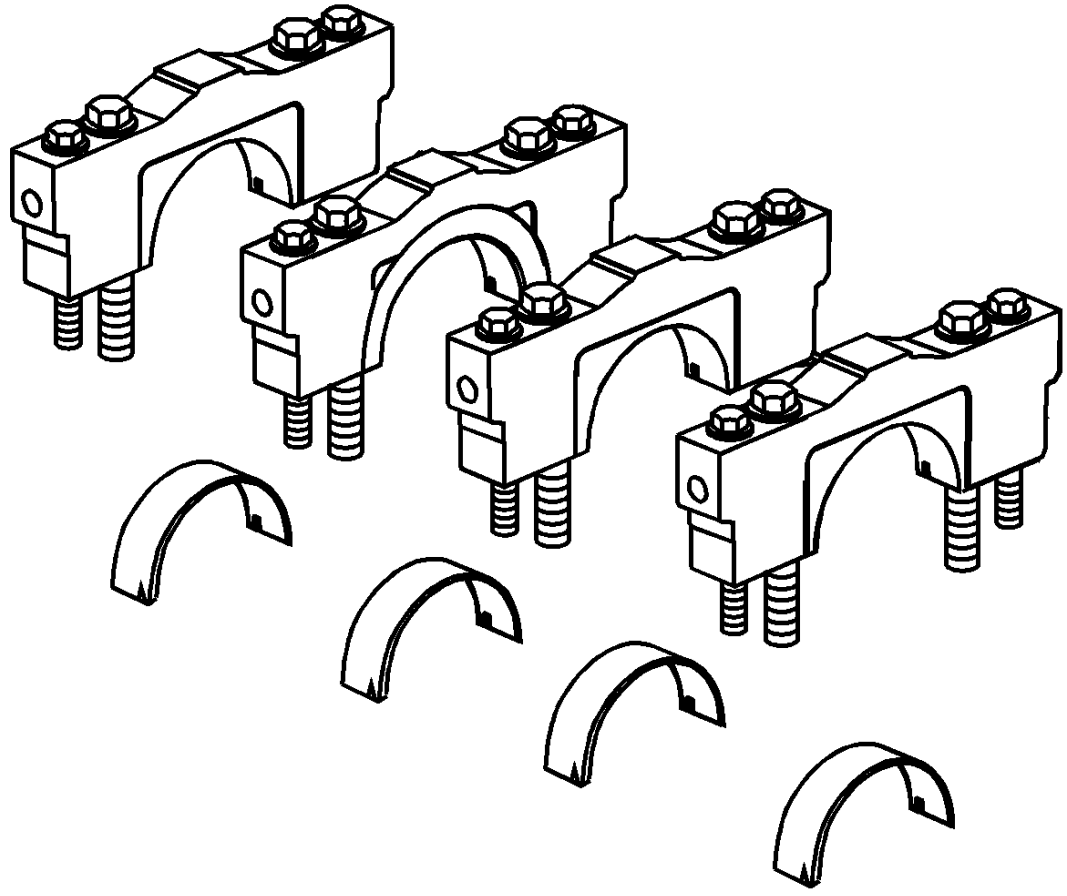


Fig. 121: View Of Crankshaft Bearing Caps & Lower Bearing Halves
Courtesy of GENERAL MOTORS COMPANY

4. Remove the crankshaft lower bearing halves from the crankshaft bearing caps.
5. Place the crankshaft lower bearing halves in the correct positions on the cardboard.

ENGINE BLOCK DISASSEMBLE

cardiagn.com

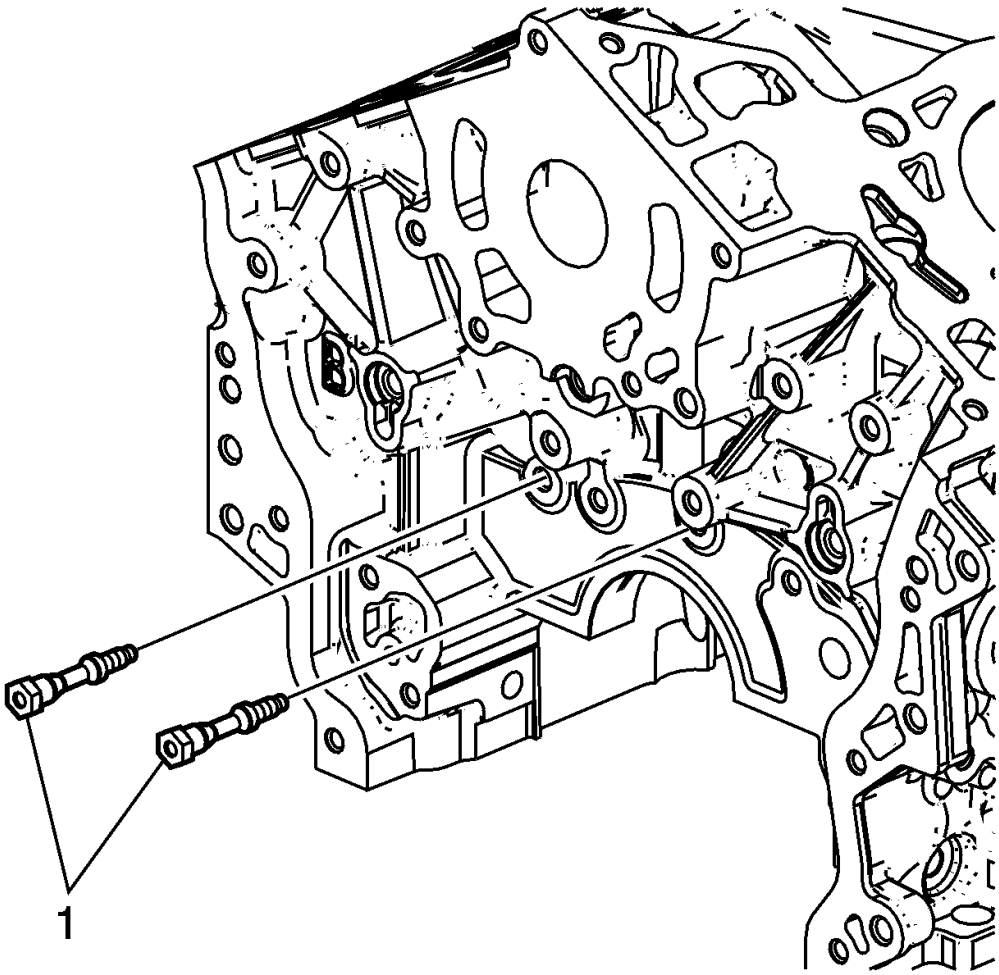


Fig. 122: Identifying Engine Front Cover Studs
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine front cover studs (1).

cardiagn.com

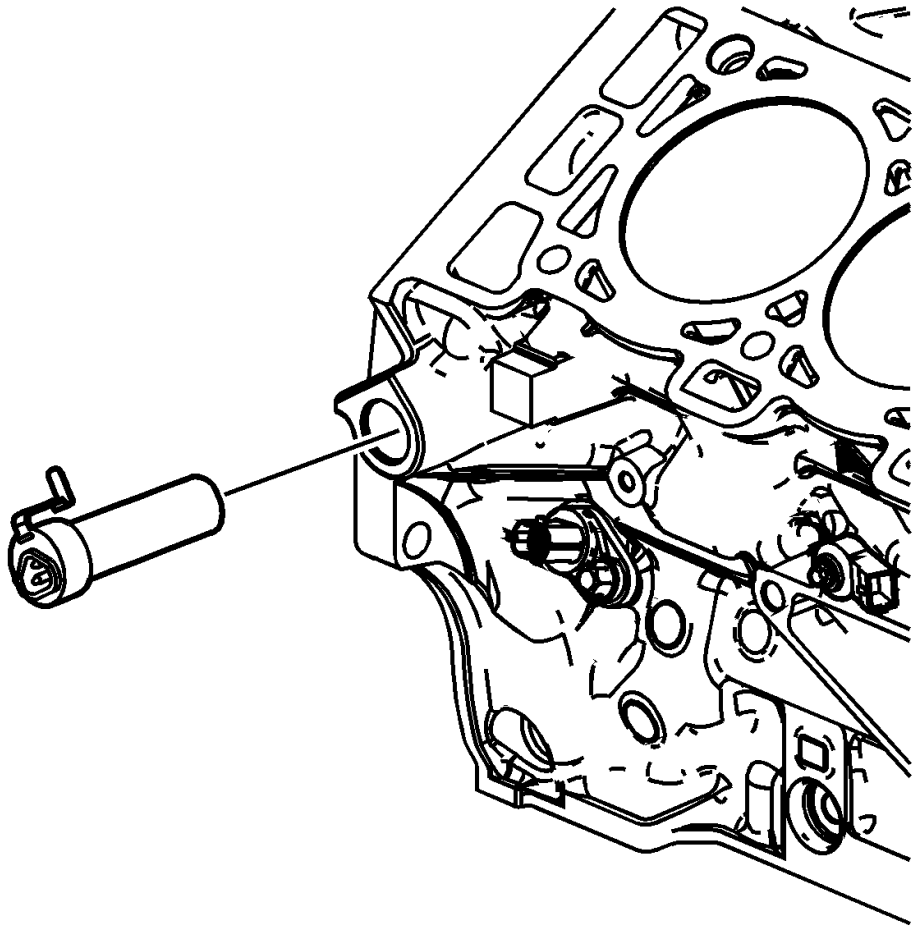


Fig. 123: View Of Block Heater Cartridge
Courtesy of GENERAL MOTORS COMPANY

2. Remove the block heater cartridge, if equipped.

cardiagn.com

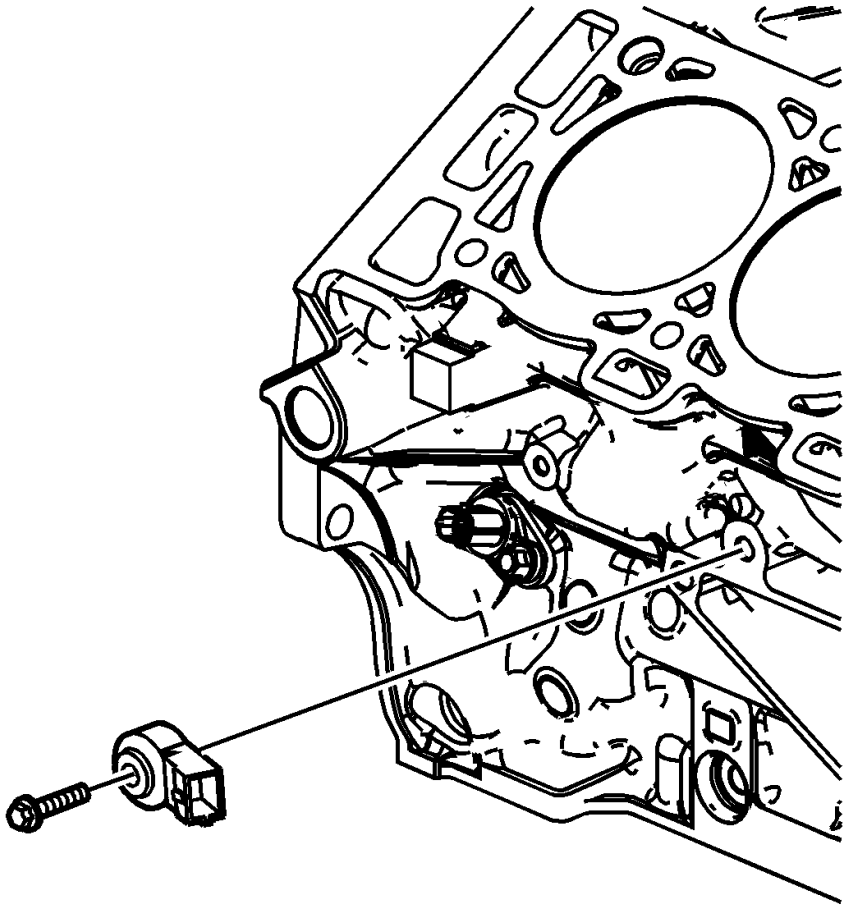


Fig. 124: View Of Right Knock Sensor
Courtesy of GENERAL MOTORS COMPANY

3. Remove the right knock sensor bolt.
4. Remove the right knock sensor.

cardiagn.com

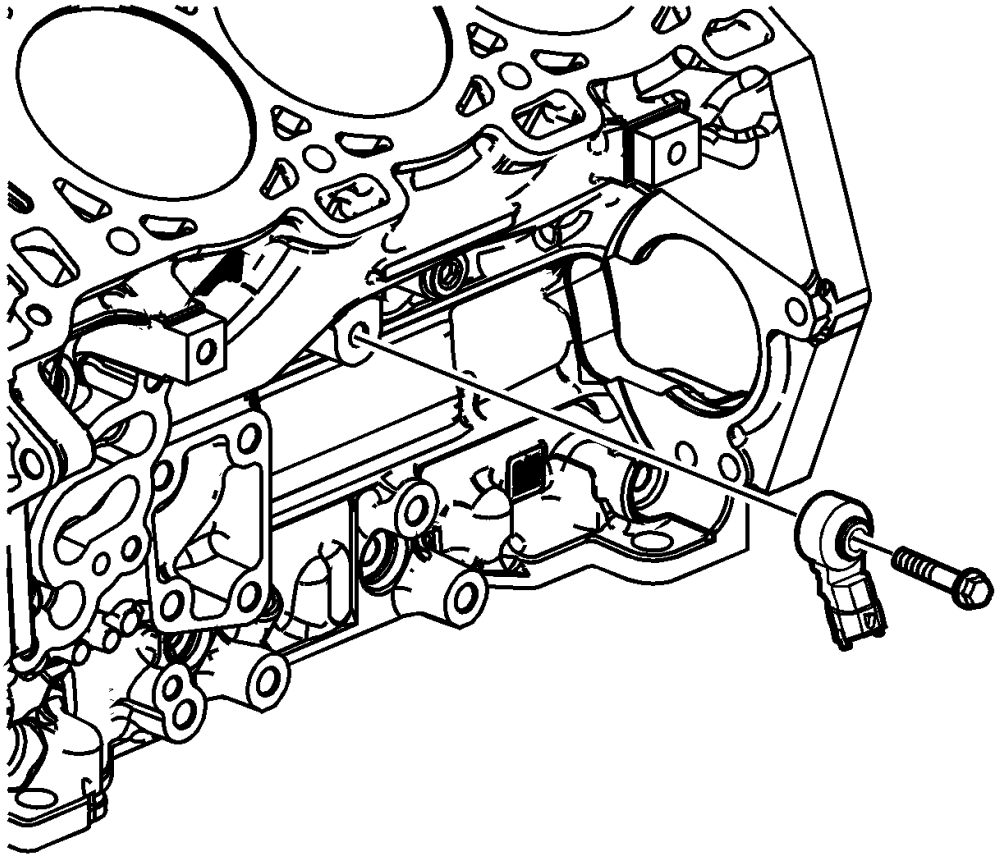


Fig. 125: Identifying Left Knock Sensor & Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the left knock sensor bolt.
6. Remove the left knock sensor.

cardiagn.com

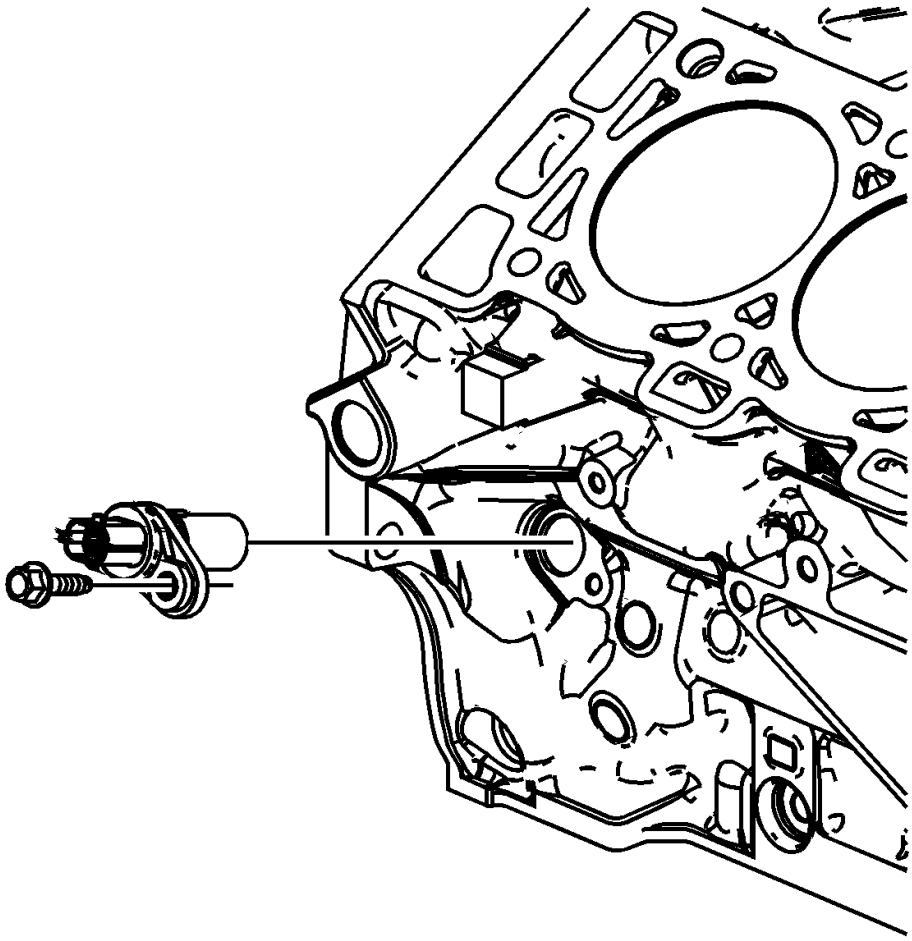


Fig. 126: View Of Crankshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

7. Remove the crankshaft position sensor bolt.
8. Remove the crankshaft position sensor.

cardiagn.com

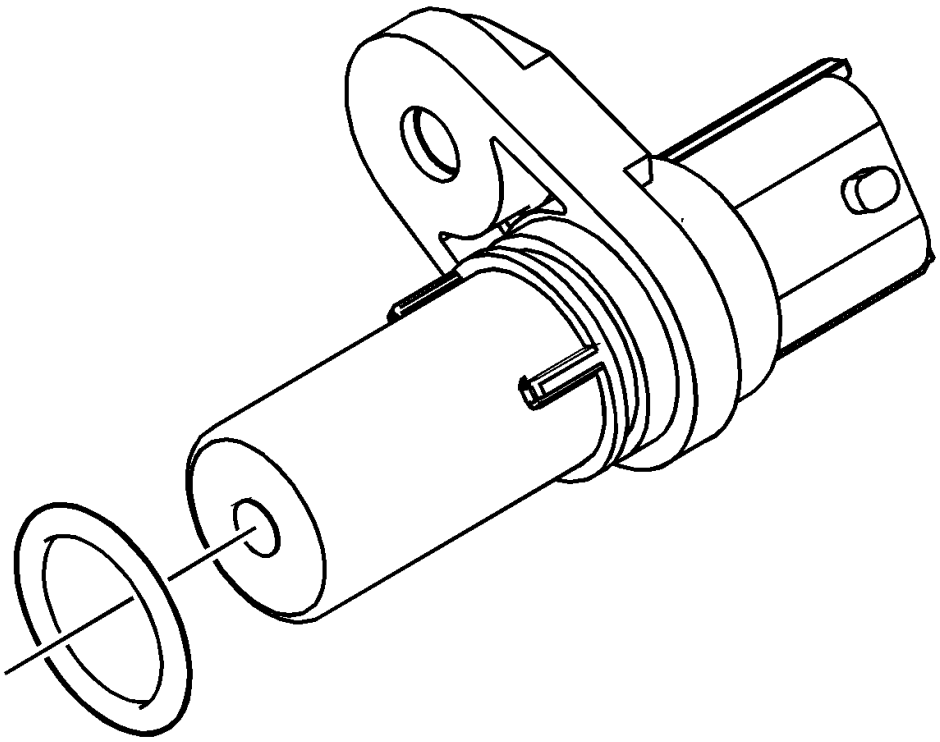


Fig. 127: View Of Crankshaft Position Sensor O-Ring
Courtesy of GENERAL MOTORS COMPANY

9. Remove the crankshaft position sensor O-ring, if damaged.

cardiagn.com

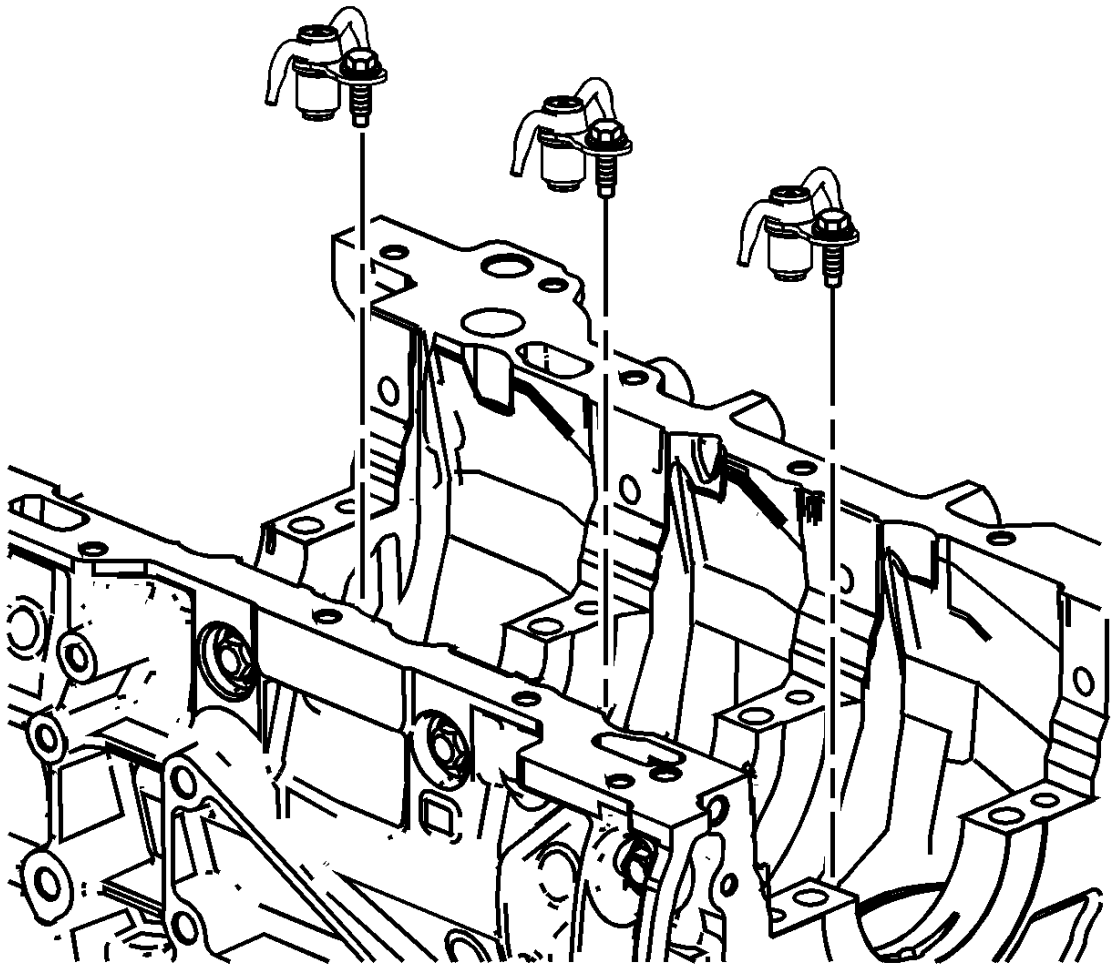


Fig. 128: Identifying Oil Jets & Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Remove oil jet bolts.
11. Remove oil jets.

cardiagn.com

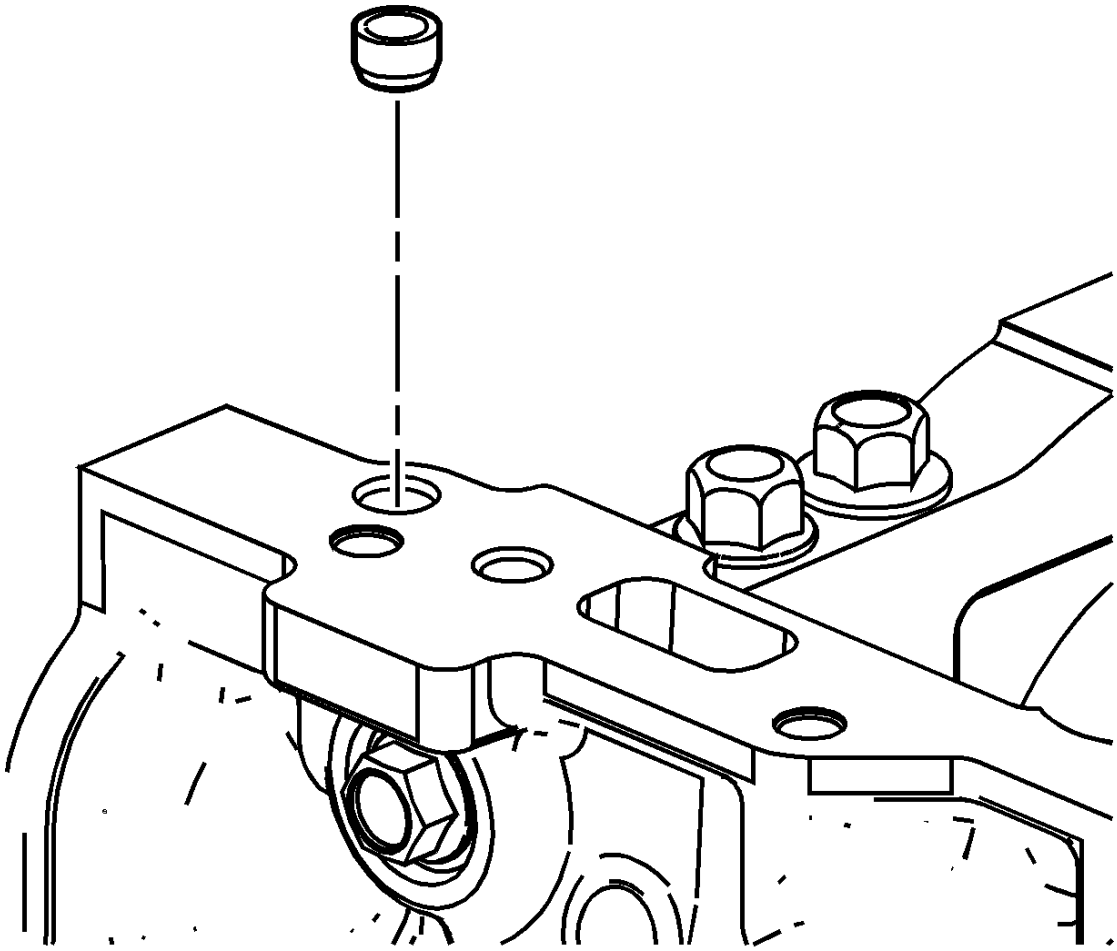


Fig. 129: Locating Right Front Oil Pan Rail Oil Gallery Expansion Plug
Courtesy of GENERAL MOTORS COMPANY

12. Remove the right front oil pan rail oil gallery expansion plug.

cardiagn.com

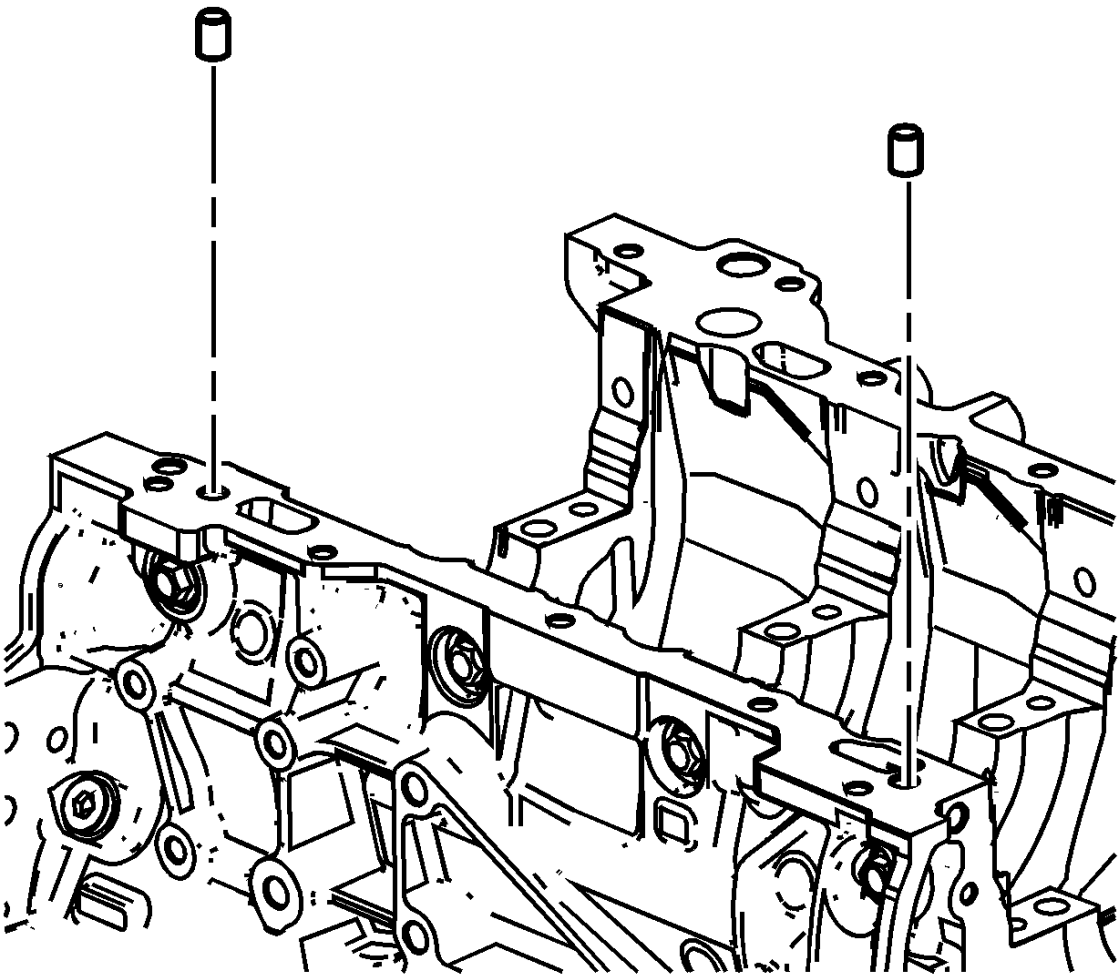


Fig. 130: Identifying Cylinder Block-To-Oil Pan Alignment Dowels
Courtesy of GENERAL MOTORS COMPANY

13. Remove the cylinder block-to-oil pan alignment dowels.

cardiagn.com

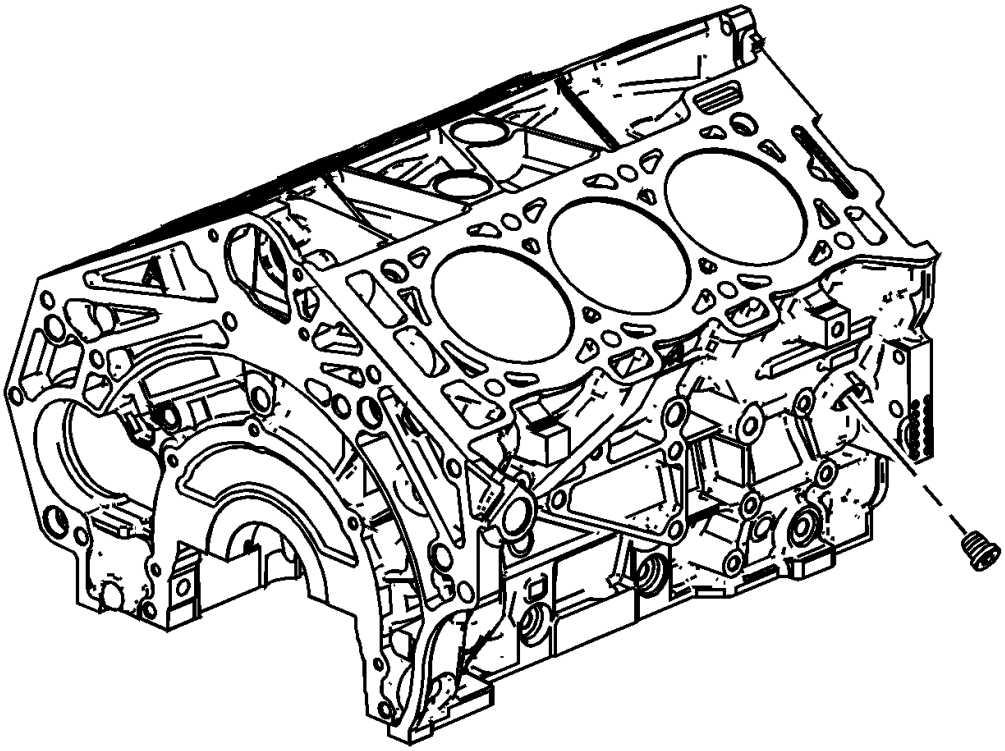


Fig. 131: Identifying M14 Right Side Oil Gallery Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

14. Remove the M14 right side oil gallery threaded plug.

cardiagn.com

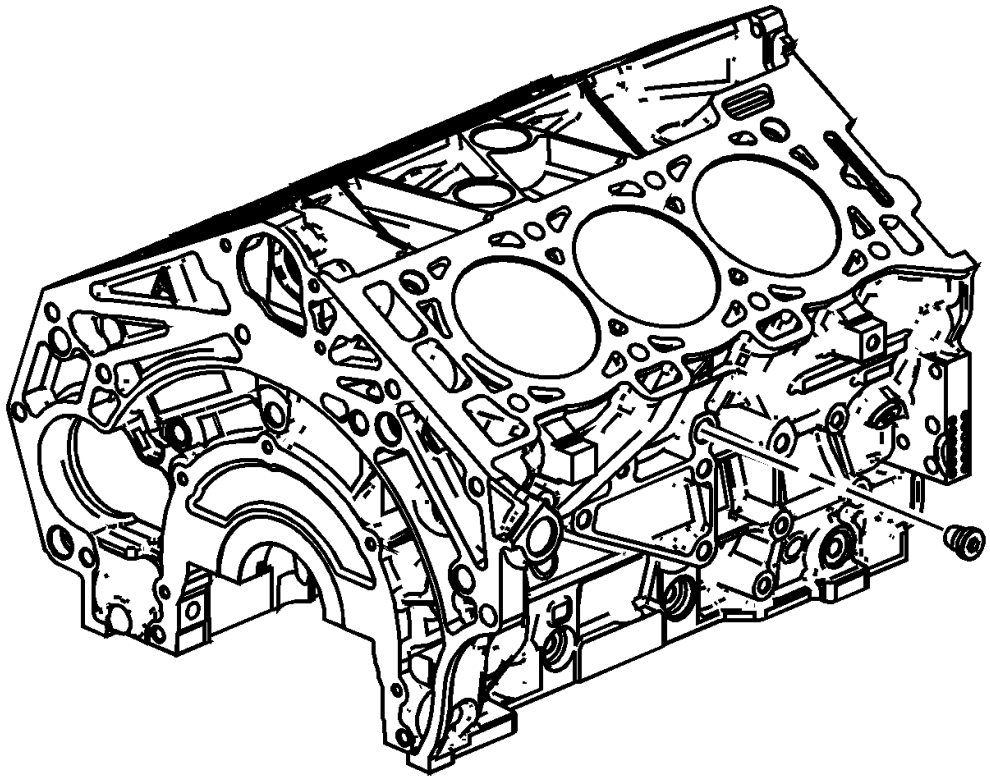


Fig. 132: Identifying M14 Right Side Coolant Drain Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

15. Remove the M14 right side coolant drain threaded plug.

cardiagn.com

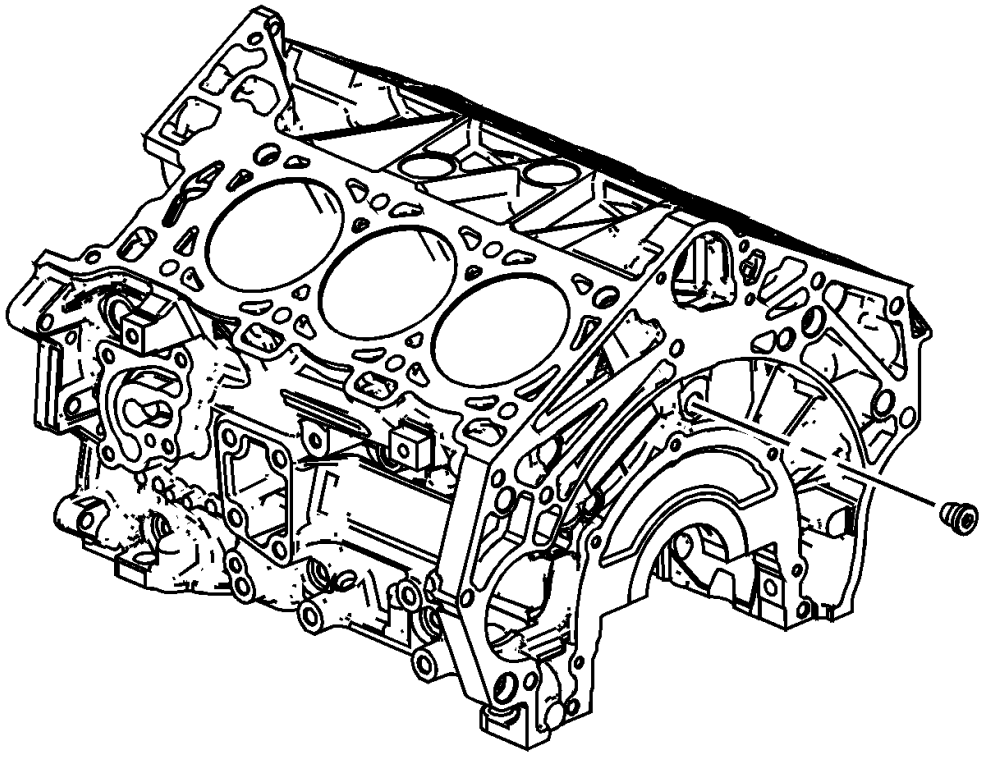


Fig. 133: Identifying M14 Rear Oil Gallery Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

16. Remove the M14 rear oil gallery threaded plug.

cardiagn.com

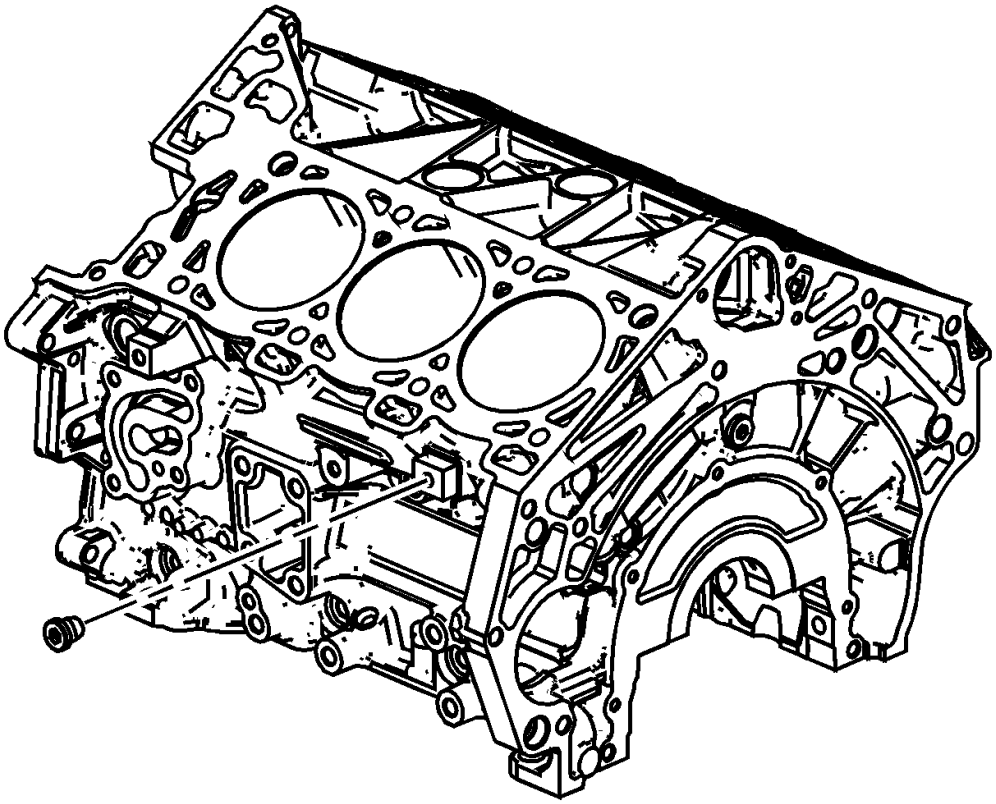


Fig. 134: View Of M14 Left Side Coolant Drain Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

17. Remove the M14 left side coolant drain threaded plug.

cardiagn.com

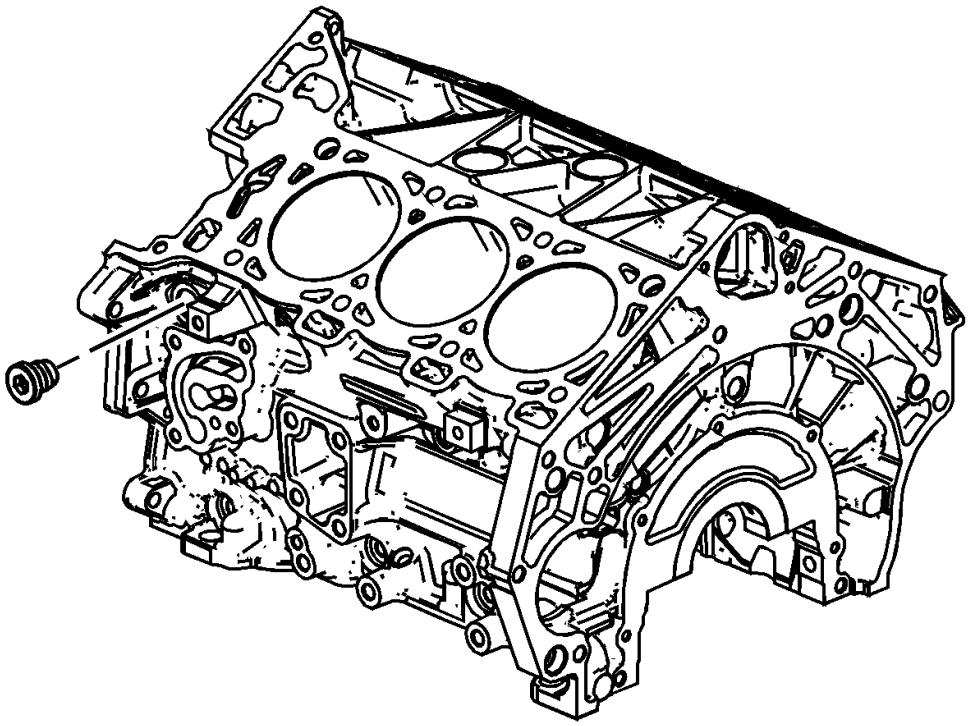


Fig. 135: Removing/Installing M20 Left Side Oil Gallery Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

18. Remove the M20 left side oil gallery threaded plug.

cardiagn.com

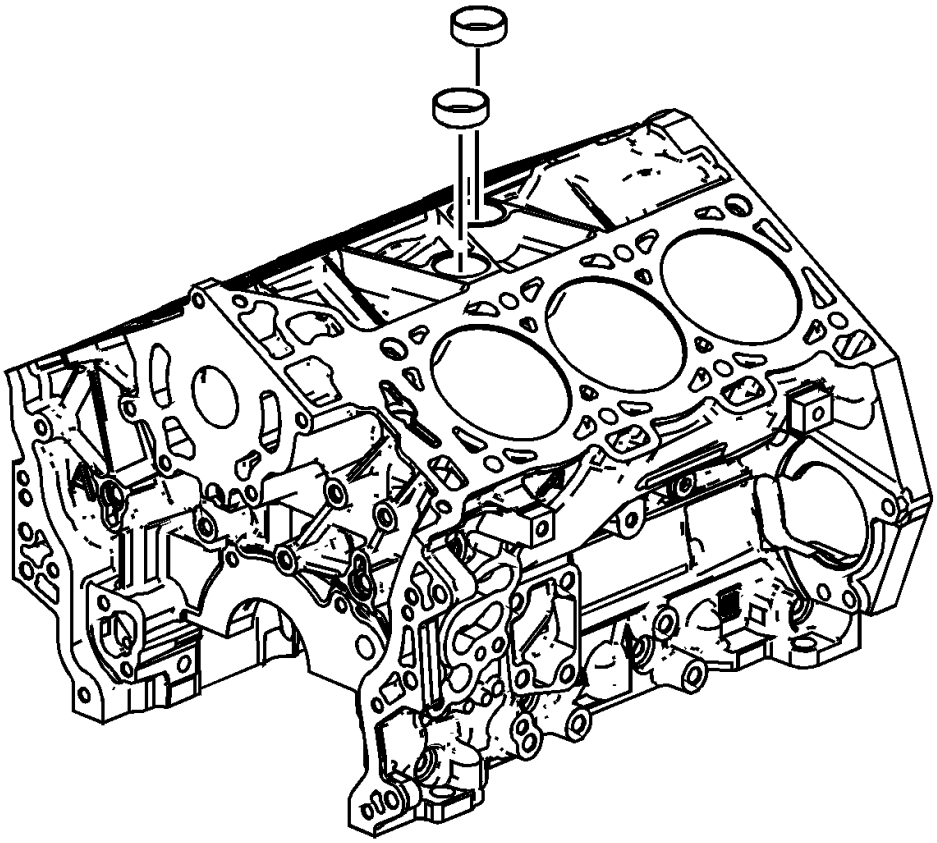


Fig. 136: Identifying Coolant Expansion Plugs
Courtesy of GENERAL MOTORS COMPANY

19. Remove the coolant expansion plugs.

cardiagn.com

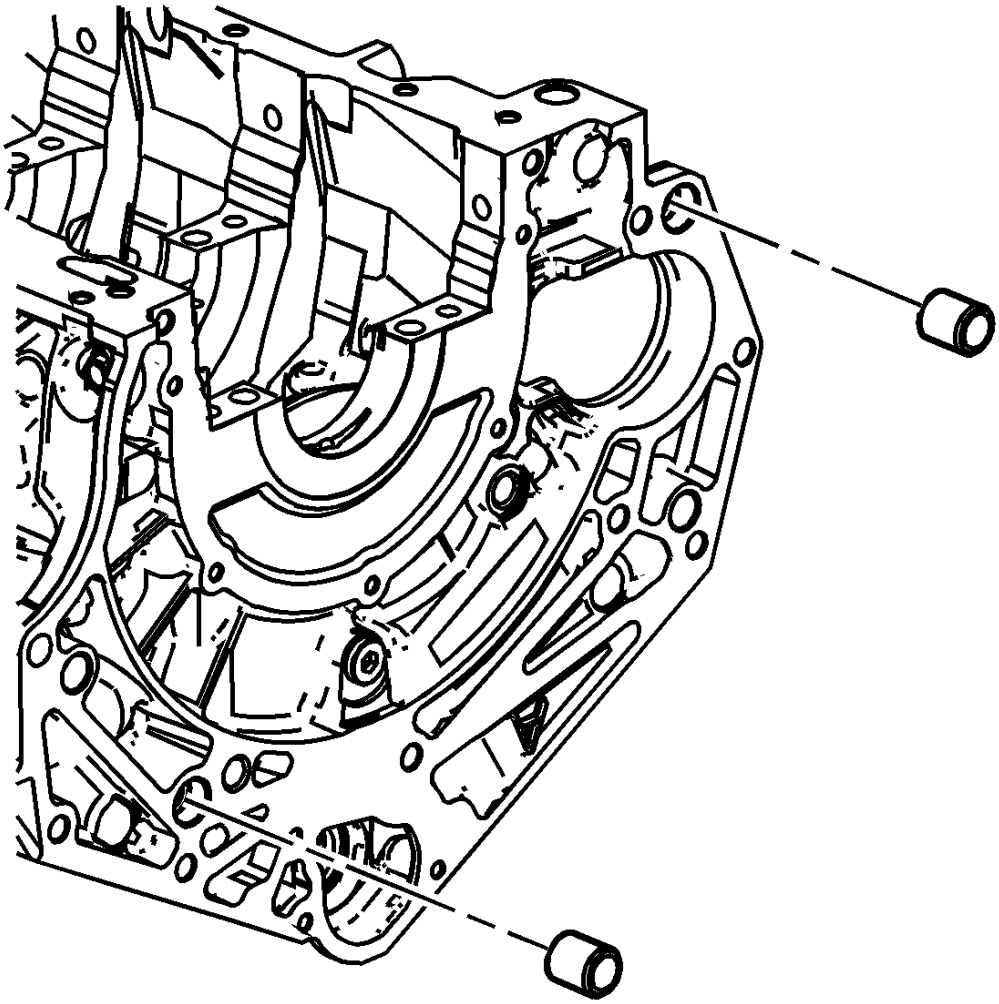


Fig. 137: Identifying Cylinder Block-To-Transmission Alignment Dowels
Courtesy of GENERAL MOTORS COMPANY

20. Remove the cylinder block-to-transmission alignment dowels.

cardiagn.com

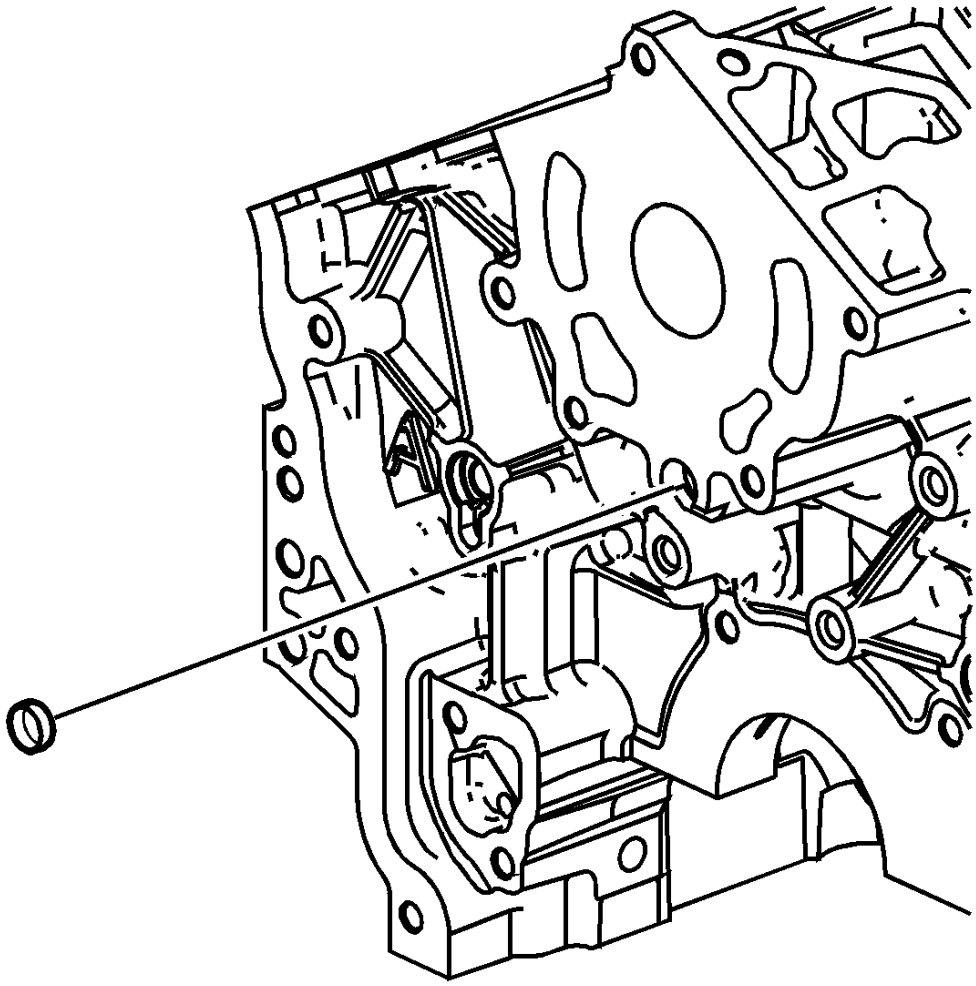


Fig. 138: View Of Front Oil Gallery Expansion Plug
Courtesy of GENERAL MOTORS COMPANY

21. Remove the front oil gallery expansion plug.

cardiagn.com

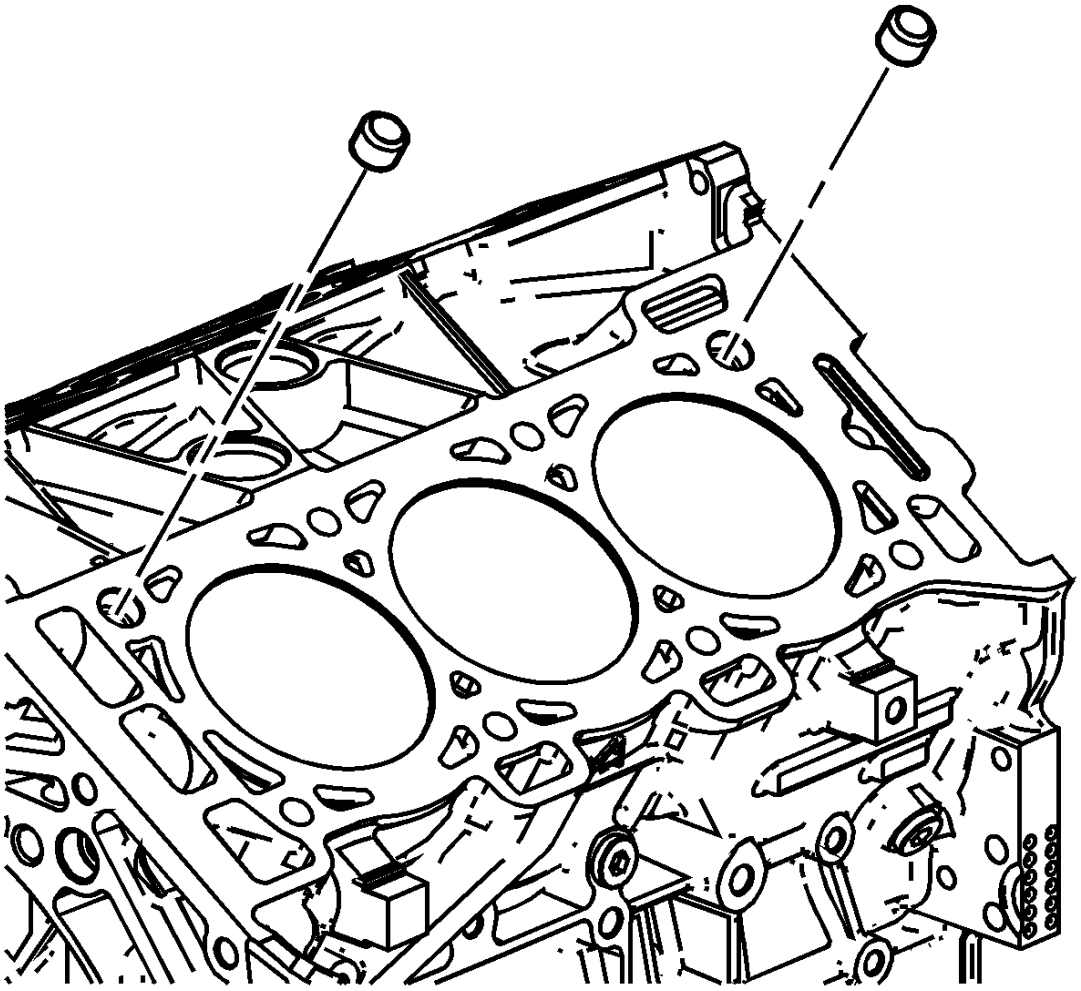


Fig. 139: Cylinder Block-To-Cylinder Head Alignment Dowels
Courtesy of GENERAL MOTORS COMPANY

22. Remove the cylinder block-to-cylinder head alignment dowels.

ENGINE BLOCK CLEANING AND INSPECTION

Special Tools

- **EN 8087** Cylinder Bore Gauge
- **EN 28410** Gasket Remover

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

Cleaning Procedure

cardiagn.com

1. Remove any old thread sealant, gasket material or sealant using **EN 28410** remover.
2. Clean all the following areas with solvent:
   - Sealing surfaces
   - Cooling passages
   - Oil passages
   - Bearing journals
3. Clean all threaded and through holes with solvent.
4. Dry the engine block with compressed air.

WARNING: Refer to Safety Glasses Warning .

Visual Inspection

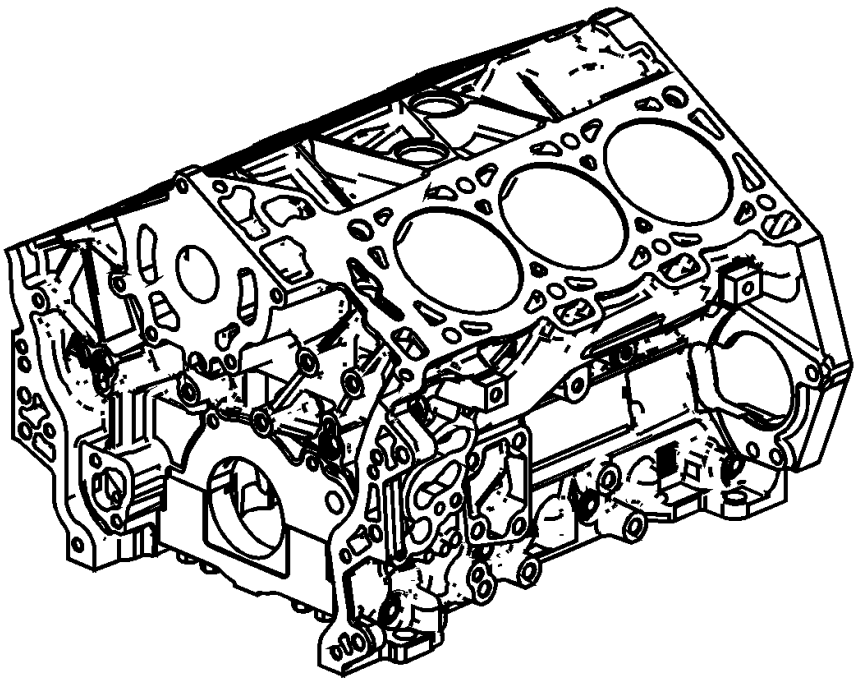


Fig. 140: View Of Engine Block
Courtesy of GENERAL MOTORS COMPANY

cardiagn.com

1. Inspect the crankshaft bearings journals for damage or spun bearings. The crankshaft bearing journals are not repairable, if the crankshaft bearing journals are damaged the cylinder block assembly must be replaced.
2. Inspect the primary camshaft drive chain tensioner mounting surface on the engine block for burrs or any defects that would degrade the sealing of the NEW primary camshaft drive chain tensioner gasket.
3. Inspect all sealing and mating surfaces for damage, repair or replace the cylinder block assembly if necessary.
4. Inspect all threaded and through holes for damage or excessive debris.
5. Inspect all bolts for damage, if damaged replace with NEW bolts only.
6. Inspect the cylinder walls for cracks or damage. The cylinder sleeves are not serviced separately, if the cylinders are damaged the cylinder block assembly must be replaced.
7. Inspect the engine block for cracks. Do not repair any cracks. If cracks are found, the cylinder block assembly must be replaced.
8. Repair any damaged threaded holes. Refer to **Thread Repair Specifications** and **Thread Repair**.

Measuring Cylinder Bore Diameter

cardiagn.com

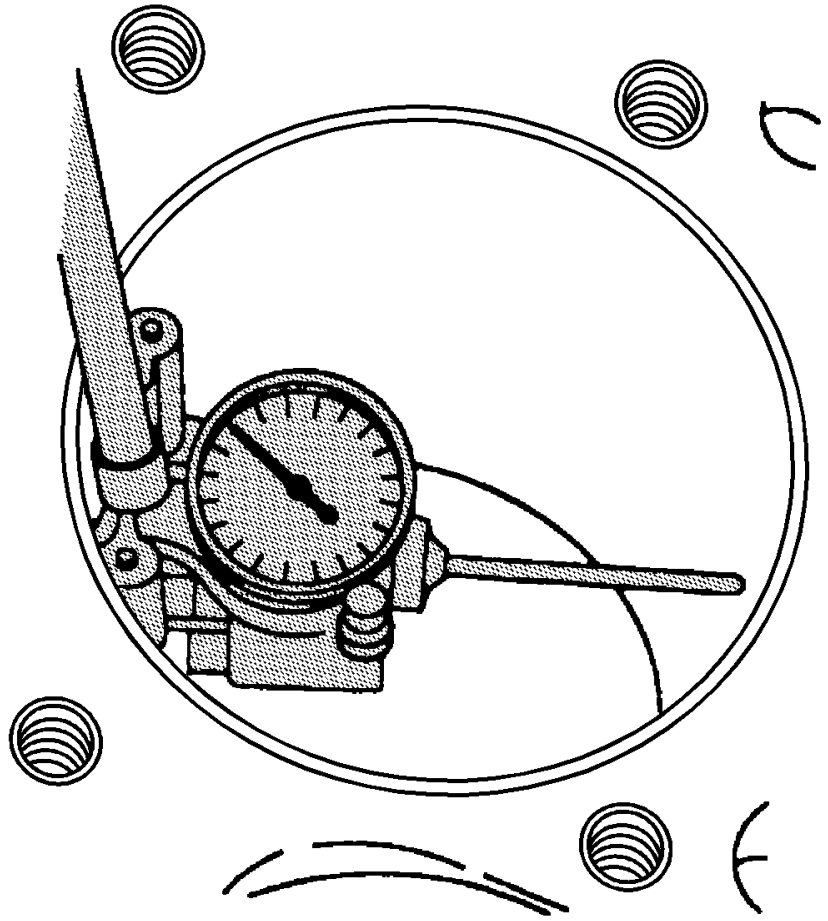


Fig. 141: Measuring Cylinder Bore
Courtesy of GENERAL MOTORS COMPANY

Measure the cylinder bore diameter 37 mm (1.457 in) from the deck face using the **EN 8087** gauge.

Compare your results with the **Engine Mechanical Specifications** . If the cylinder diameter exceeds the specifications, the cylinder block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

Measuring Cylinder Bore Taper

1. Measure the cylinder bore along the thrust surfaces, perpendicular to the crankshaft centerline, at 10 mm (0.397 in) below the deck surface and record your measurement.
2. Measure the cylinder bore along the thrust surfaces, perpendicular to the crankshaft centerline, at 100 mm (3.976 in) below the deck surface and record your measurement.
3. Calculate the difference between the 2 measurements. The result will be the cylinder taper.
4. Compare your results with the **Engine Mechanical Specifications** . If the cylinders exceed the

cardiagn.com

specifications, the cylinder block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

Measuring Cylinder Bore Out-of-Round

1. Measure both the thrust and non-thrust cylinder diameter at 10 mm (0.397 in) below the deck. Record your measurements.
2. Calculate the difference between the 2 measurements. The result will indicate out-of-round at the upper end of the cylinder.
3. Measure both the thrust and non-thrust cylinder diameter at 100 mm (3.976 in) below the deck surface. Record your measurements.
4. Calculate the difference between the 2 measurements. The result will indicate out-of-round at the lower end of the cylinder.
5. Compare your results with the **Engine Mechanical Specifications** . If the cylinders exceed these specifications, the cylinder block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

Deck Flatness Inspection

1. Ensure the engine block decks are clean and free of gasket material.

cardiagn.com

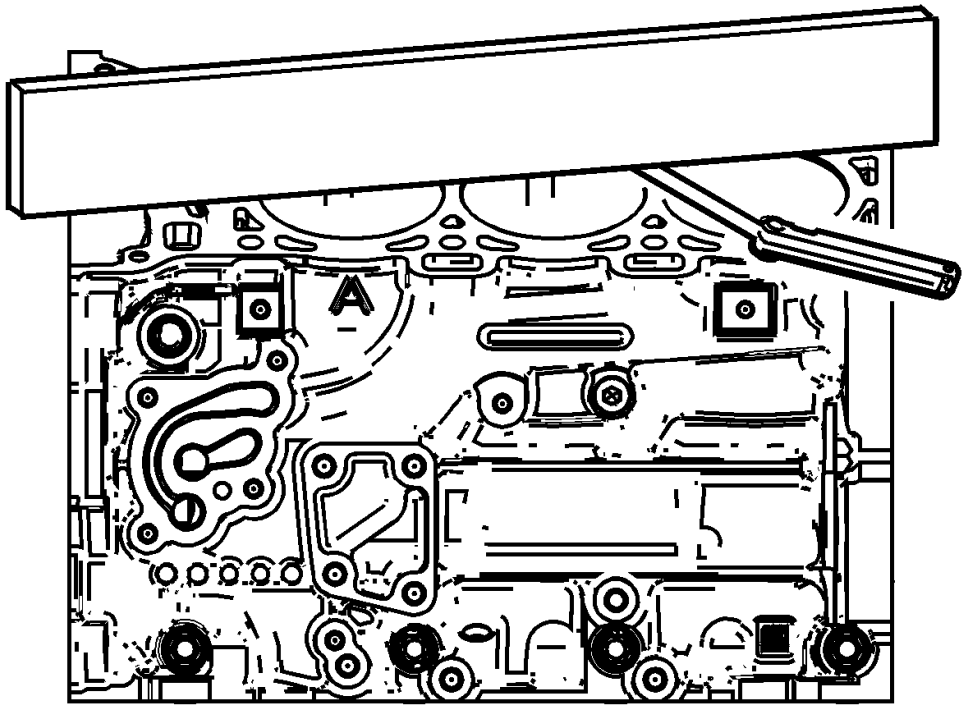


Fig. 142: Measuring Deck Flatness
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the surface for any imperfections or scratches that could inhibit proper cylinder head gasket sealing.
3. Place a straight-edge diagonally across the cylinder block deck face surface.
4. Measure the clearance between the straight-edge and the cylinder block deck face using a feeler gauge at 4 points along the straight-edge.
5. If the warpage is less than 0.05 mm (0.002 in), the cylinder block deck surface does not require resurfacing.
6. If the warpage is between 0.05-0.20 mm (0.002-0.008 in) or any imperfections or scratches that could inhibit proper cylinder head gasket sealing are present, the cylinder block deck surface requires resurfacing.
7. If resurfacing is required the maximum amount that can be removed is 0.25 mm (0.010 in).
8. If the cylinder block deck surface requires more than 0.25 mm (0.010 in) material removal the block must be replaced.

cardiagn.com

CRANKSHAFT AND BEARING CLEANING AND INSPECTION

Cleaning Procedure

1. Clean the following components in solvent:
    - Crankshaft bearings
    - Connecting rod bearings
    - Crankshaft journals
    - Crankpin journals
    - Crankshaft oil passages
    - Crankshaft threaded holes
2. Dry the following components with compressed air:

WARNING: Refer to Safety Glasses Warning .

    - Crankshaft bearings
    - Connecting rod bearings
    - Crankshaft journals
    - Crankpin journals
    - Crankshaft oil passages
    - Crankshaft threaded holes

Visual Inspection

1. Perform the following visual inspections:

cardiagn.com

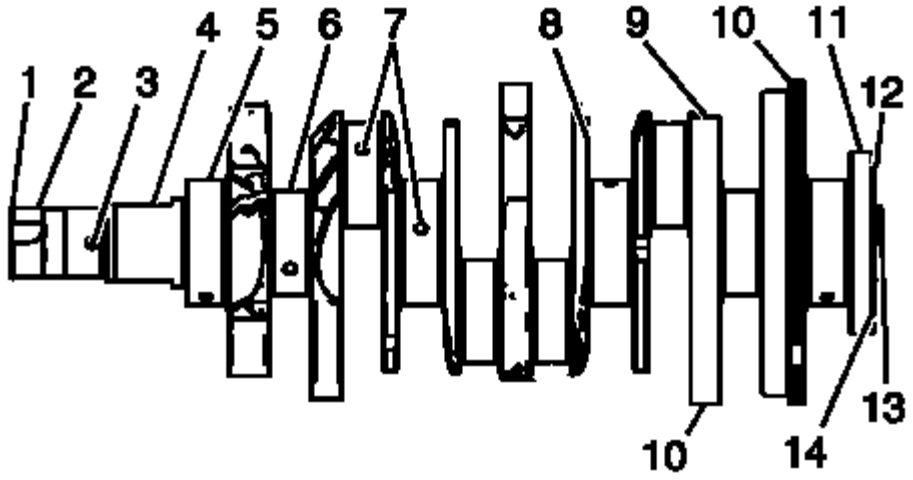


Fig. 143: Inspecting Crankshaft
Courtesy of GENERAL MOTORS COMPANY

- Inspect the crankshaft balancer bolt hole (1) for thread damage.
- Inspect the crankshaft balancer mounting area (2) for damage.
- Inspect the crankshaft sprocket pin hole (3) for damage.
- Inspect the oil pump drive flats (4) for damage.
- Inspect the crankshaft main journals (5) for damage.
- Inspect the crankshaft connecting rod journals (6) for damage.
- Inspect the crankshaft oil passages (7) for obstructions.
- Inspect the crankshaft main bearing thrust wall surfaces (8) for damage.
- Inspect the crankshaft counterweights (9) for damage.
- Inspect the crankshaft reluctor ring teeth (10) for damage.
- Inspect the crankshaft rear main oil seal surface (11) for damage.
- Inspect the crankshaft engine flywheel mounting surface (12) for damage.
- Inspect the crankshaft pilot hole (13) for damage.
- Inspect the crankshaft engine flywheel bolt holes (14) for thread damage.

2. Repair or replace the crankshaft as necessary.

cardiagn.com

Crankshaft Bearing Inspection

1. Inspect for fatigue indicated by craters or pockets. Flattened sections on the bearing halves also indicate fatigue.

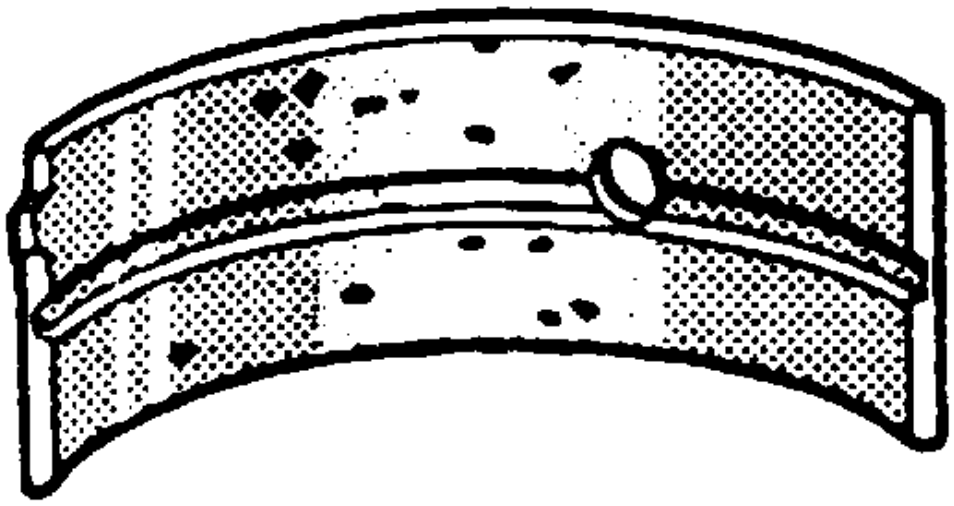


Fig. 144: Identifying Crankshaft Bearing Craters Or Pockets
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **All connecting rod and main journal bearings that have been used in a running engine must be replaced. Never re-use the crankshaft or connecting rod bearings.**
- **The following bearing wear conditions should be used to diagnose engine operating conditions or root cause of a condition.**

cardiagn.com

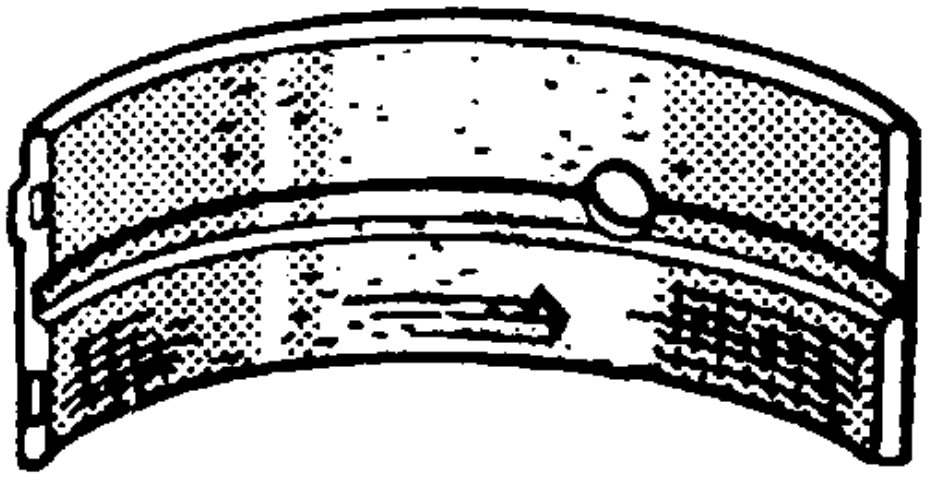


Fig. 145: Identifying Connecting Rod Bearing Scoring Or Discoloration
Courtesy of GENERAL MOTORS COMPANY

2. Inspect for excessive scoring or discoloration on both front and back of the bearing halves.
3. Inspect the main bearings for dirt embedded into the bearing material.

cardiagn.com

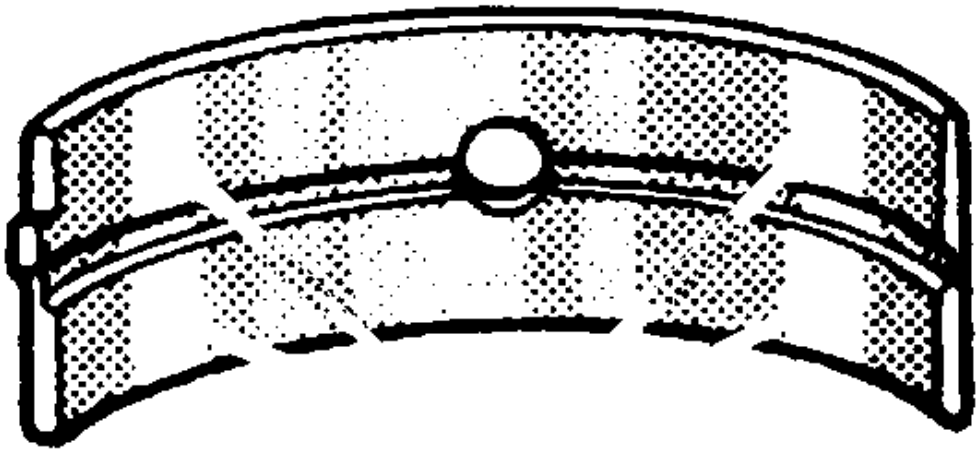


Fig. 146: View Of Improper Seating
Courtesy of GENERAL MOTORS COMPANY

4. Inspect for improper seating indicated by bright, polished sections.

Crankshaft Measurement

Special Tools

J 7872 Magnetic Base Dial Indicator

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

cardiagn.com

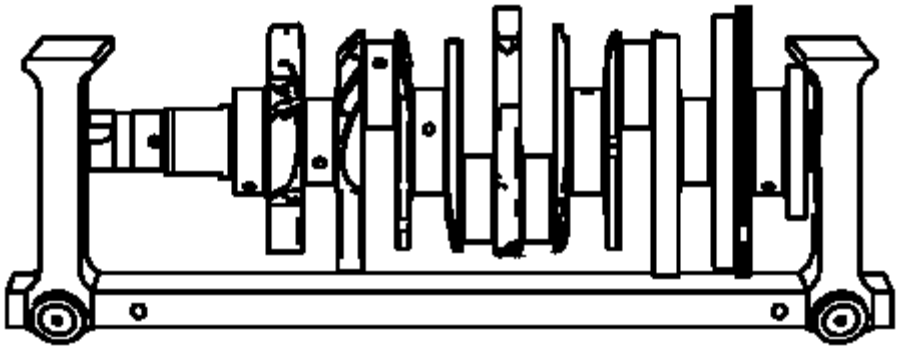


Fig. 147: View Of Crankshaft In Fixture
Courtesy of GENERAL MOTORS COMPANY

1. Using a suitable fixture, support the crankshaft.

cardiagn.com

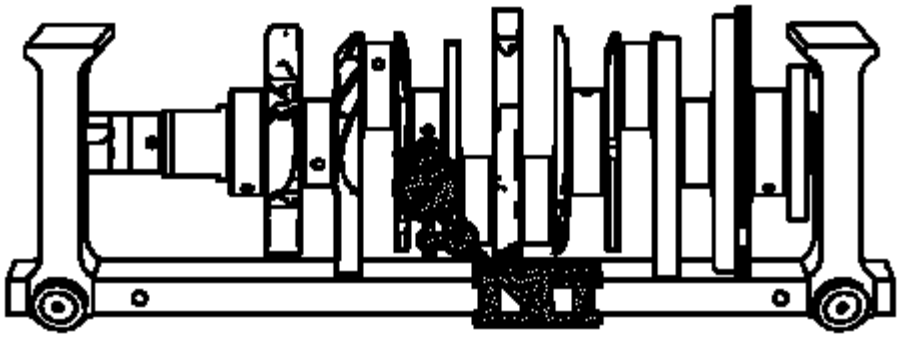


Fig. 148: Identifying J 7872
Courtesy of GENERAL MOTORS COMPANY

2. Install the **J 7872** indicator.
3. Measure the crankshaft runout using the **J 7872** indicator. Refer to **Engine Mechanical Specifications** .

cardiagn.com

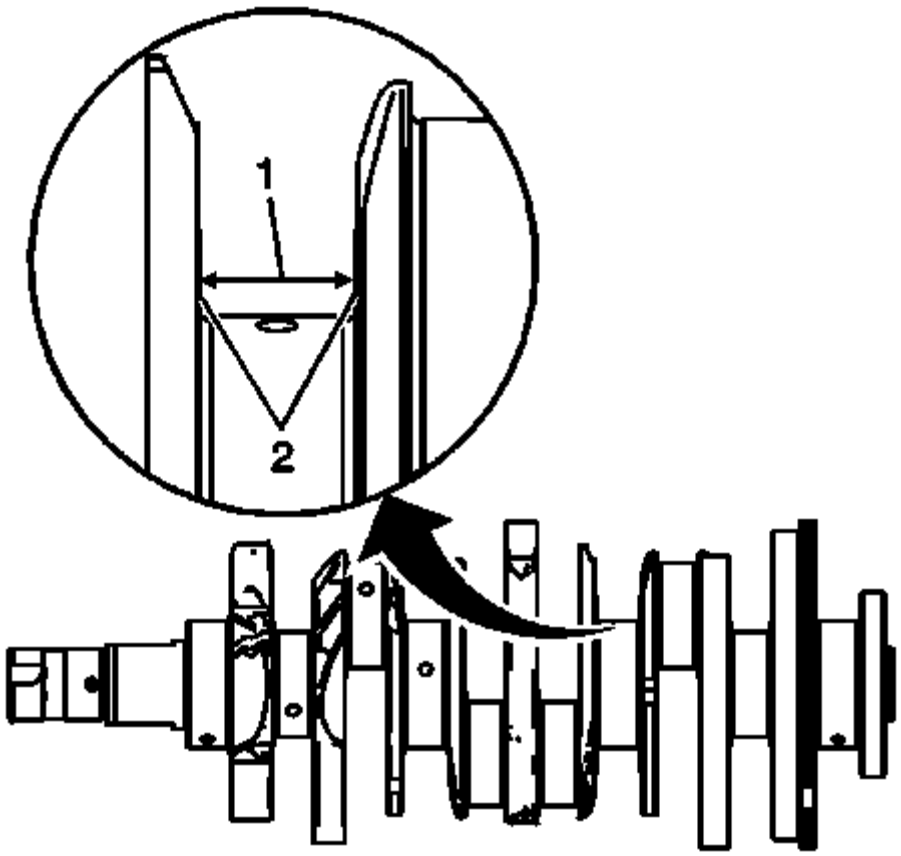


Fig. 149: Measuring Crankshaft Thrust Wall Width For Wear
Courtesy of GENERAL MOTORS COMPANY

4. Measure the crankshaft thrust wall width (1) for wear using an inside micrometer. Refer to **Engine Mechanical Specifications** .
5. Measure the crankshaft thrust wall surface (2) for runout using the **J 7872** indicator. Refer to **Engine Mechanical Specifications** .
6. If the crankshaft journals are damaged or worn beyond specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized main bearings available for service.

cardiagn.com

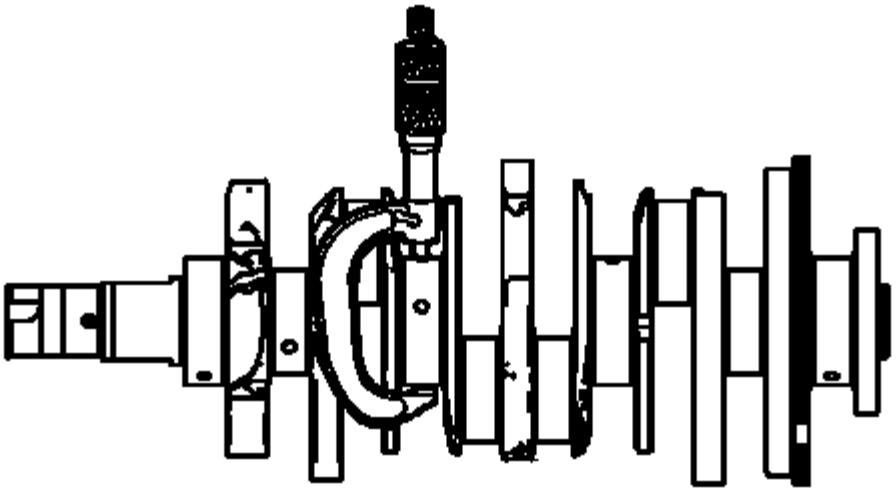


Fig. 150: Inspecting Crankshaft Main Journals For Undersize
Courtesy of GENERAL MOTORS COMPANY

7. Inspect the crankshaft main journals for undersize, using an outside micrometer.
8. Inspect the crankpins for undersize using an outside micrometer.

cardiagn.com

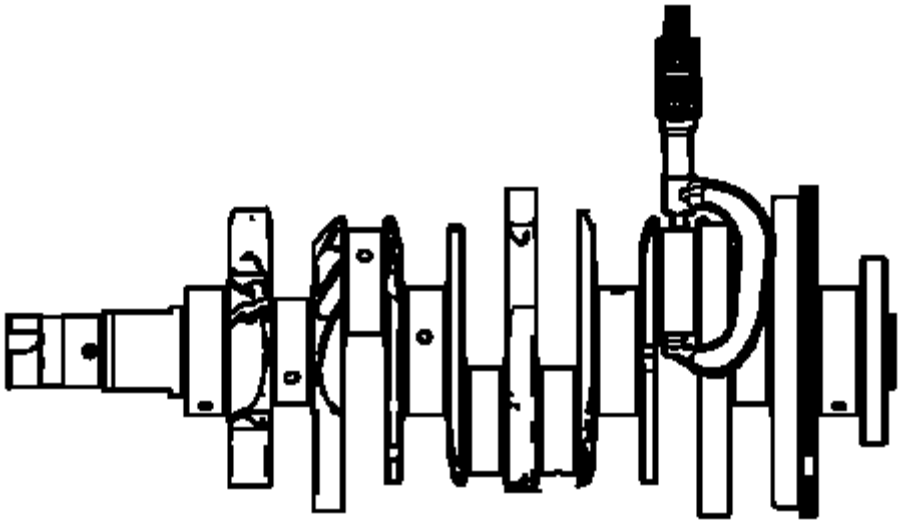


Fig. 151: Using An Outside Micrometer To Inspect Crankpins For Undersize
Courtesy of GENERAL MOTORS COMPANY

9. Compare your measurements with those listed in the **Engine Mechanical Specifications** . If the crankpin journals are worn beyond the specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized connecting rod bearings available for service.
10. Measure the main bearing and crankpin journals for out-of-round using the following procedure:

cardiagn.com

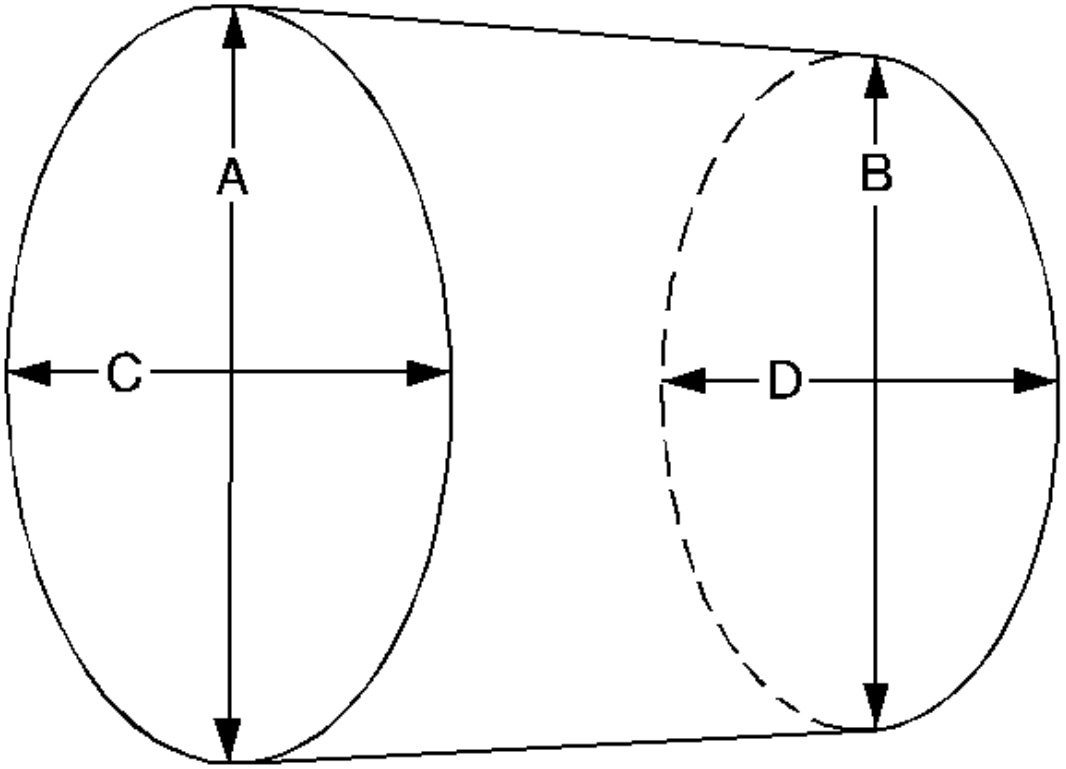


Fig. 152: Identifying Out-Of-Round Measurements
Courtesy of GENERAL MOTORS COMPANY

1. Using an outside micrometer, measure the journal at the extreme front and rear locations on the journal. Call these points A and B.
2. Measure the journal in 2 new locations exactly 90° from the first points. Call these points C and D.
3. Subtract A from C and B from D. The differences will indicate journal out-of-round.
4. The out-of-round should not exceed 0.004 mm (0.00016 in) maximum.
5. If the journals are worn beyond the specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized crankshaft and connecting rod bearings available for service.

11. Measure the main bearing and crankpin journals for taper using the following procedure:
    1. Using an outside micrometer, measure the journal at the extreme front (A) and rear (B) of the journal parallel to the crankshaft centerline.
    2. Subtract the smallest from the largest measurement. The result will be the journal taper.

cardiagn.com

3. If the main bearing journal taper exceeds 0.004 mm (0.00016 in), replace the crankshaft.
4. If the journals are worn beyond the specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized crankshaft and connecting rod bearings available for service.

AUTOMATIC TRANSMISSION FLEX PLATE CLEANING AND INSPECTION

Cleaning Procedure

1. Clean the flex plate in solvent.
2. Dry the flex plate with compressed air.

WARNING: Refer to Safety Glasses Warning .

Inspection Procedure

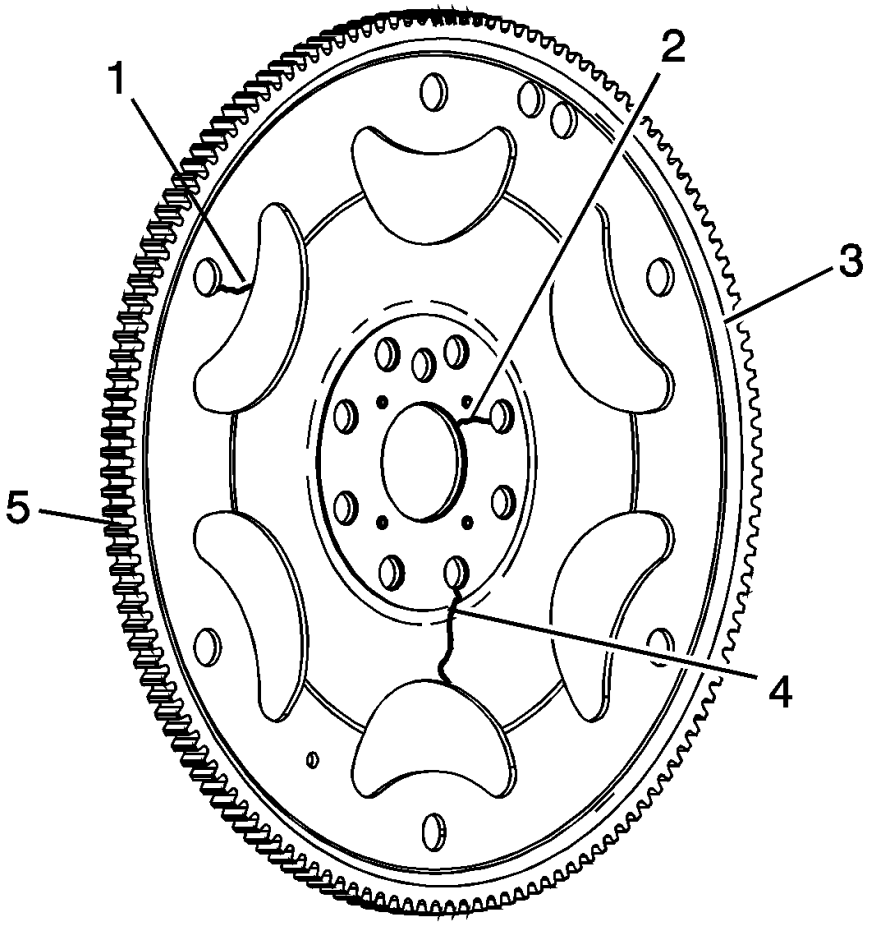


Fig. 153: Identifying Engine Flywheel Inspection Areas

cardiagn.com

Courtesy of GENERAL MOTORS COMPANY

1. Inspect the flex plate for the following conditions:
   - Stress cracks around the flex plate-to-torque converter mounting bolt hole locations (1) and/or flex plate-to-crankshaft (2, 4)
   - Cracks at welded areas that retain the ring gear onto the flex plate (3)

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

   - Damaged or missing ring gear teeth (5)
2. Replace the flex plate as necessary.

CRANKSHAFT BALANCER CLEANING AND INSPECTION

Cleaning Procedure

1. Clean the crankshaft balancer in solvent that is compatible with the rubber (3).
2. Dry the crankshaft balancer with compressed air.

WARNING: Refer to Safety Glasses Warning .

Inspection Procedure

1. Inspect the crankshaft balancer for the following:

cardiagn.com

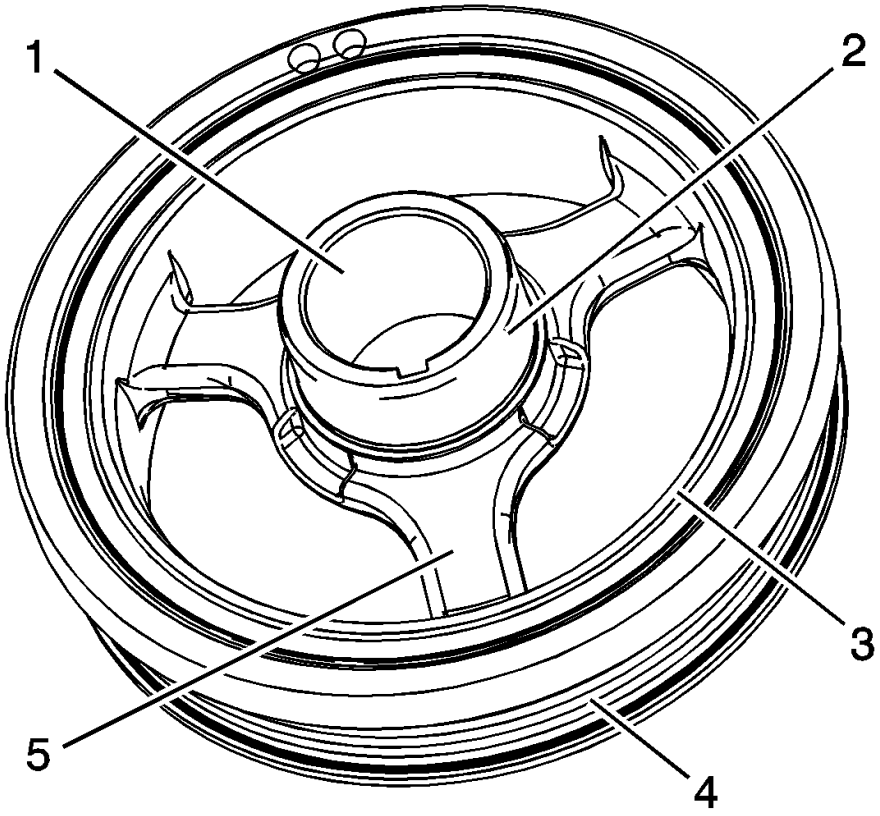


Fig. 154: Identifying Crankshaft Balancer Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

- Worn or damaged hub-to-crankshaft surface (1)
- Worn, grooved or damaged hub seal surface (2)

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

- Worn, chunking or deteriorated rubber between the hub and pulley (3)
- Damaged drive belt ribs (4)
- Damaged webs (5)

2. Repair or replace the crankshaft balancer as necessary.

PISTON AND CONNECTING ROD DISASSEMBLE

Special Tools

cardiagn.com

EN-46745 Piston Pin Clip Remover/Installer

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

1. Remove the piston rings using a piston ring expander. Place each ring in a clean shop towel for storage.

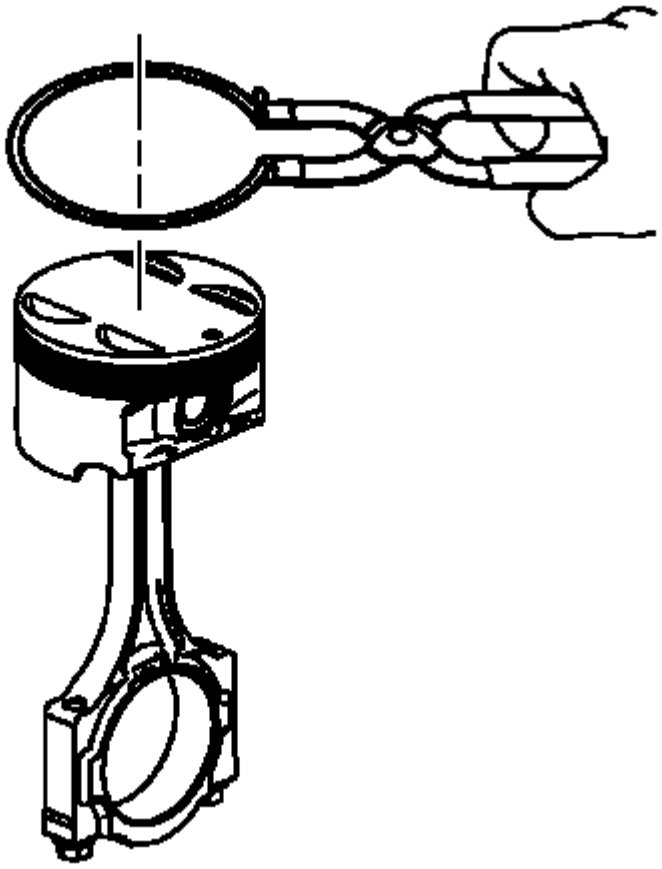


Fig. 155: View Of Piston Ring Expander
Courtesy of GENERAL MOTORS COMPANY

CAUTION: You must use a piston ring expander to remove and install the piston rings. Only expand the rings far enough to fit over the piston lands. If the rings are overexpanded, the top ring will shatter and the others will distort.

2. Using the **EN-46745** remover/installer, remove the piston pin retainers by using the removal access notch (1) in the side of the piston. Discard the piston pin retainers.

cardiagn.com

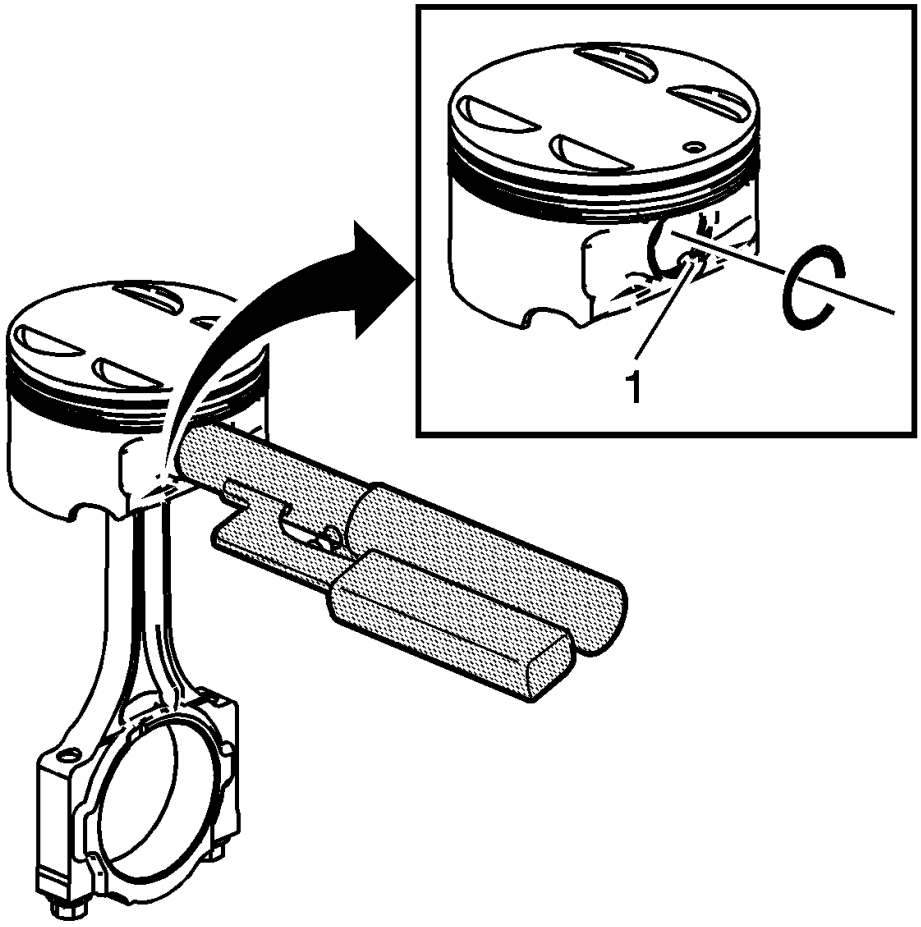


Fig. 156: Identifying Piston Pin Retainers Removal Access Notch
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The connecting rod is non-directional and may be assembled/reassembled to the piston in either direction.**
- **DO NOT reuse the piston pin retainers.**

cardiagn.com

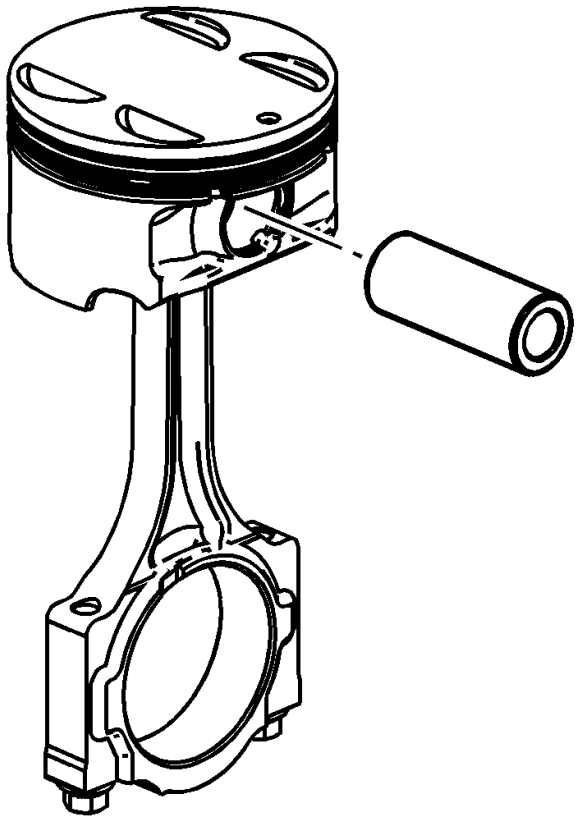


Fig. 157: View Of Piston Pin
Courtesy of GENERAL MOTORS COMPANY

3. Slide the piston pin out of the piston. The piston will disconnect from the connecting rod.

PISTON, CONNECTING ROD AND BEARING CLEANING AND INSPECTION

Cleaning Procedure

1. Clean the piston skirts and the pins with a cleaning solvent.

NOTE: DO NOT wire brush any part of the piston.

2. Clean the piston ring grooves with a groove cleaner. Ensure that the oil ring holes and slots are clean.
3. Dry the piston with compressed air.

WARNING: Refer to Safety Glasses Warning .

cardiagn.com

Piston Inspection Procedure

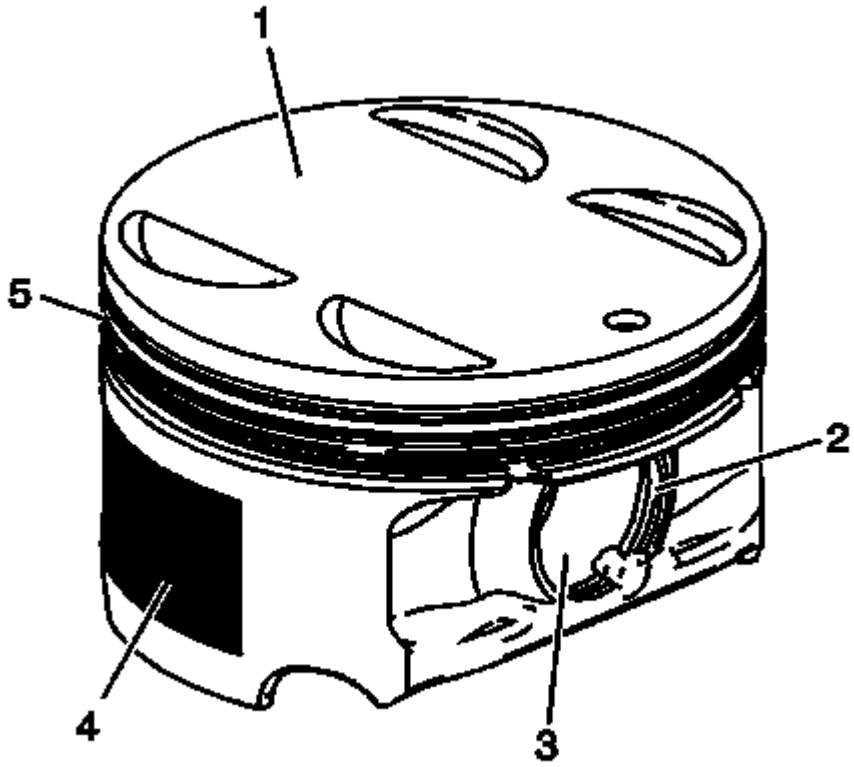


Fig. 158: Piston Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the pistons for the following conditions:
   - Cracked ring lands, skirts or pin bosses
   - Ring grooves for nicks, burrs that may cause binding (5)
   - Warped or worn ring lands (5)
   - Piston pin retainer grooves for burrs (2)
   - Eroded areas at the top of the piston (1)
   - Scuffed or damaged skirt coating (4)
   - Worn piston pin bores or worn piston pins (3)
2. Replace pistons that show any signs of damage or excessive wear.

Piston Measurement Procedure

cardiagn.com

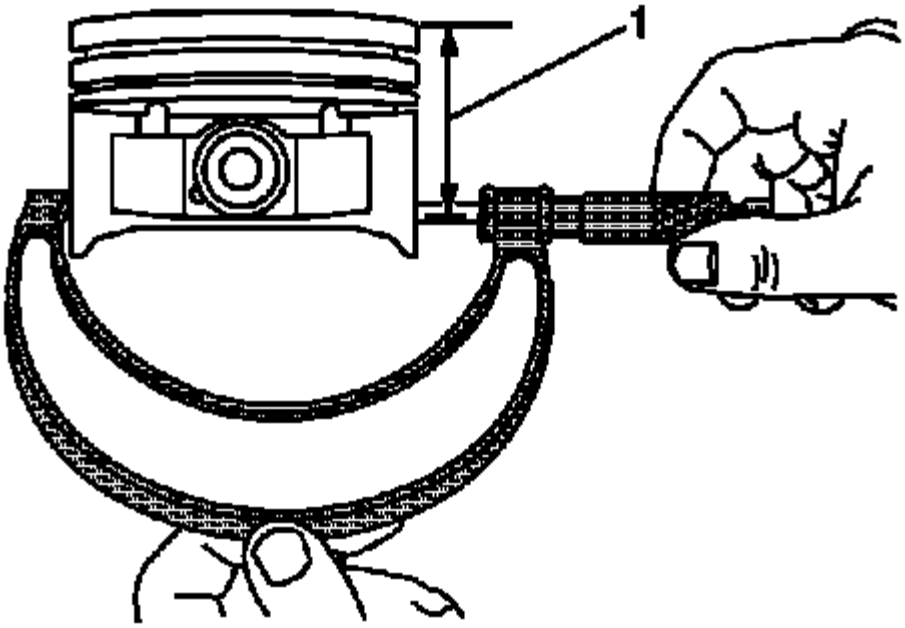


Fig. 159: Measuring Piston Width
Courtesy of GENERAL MOTORS COMPANY

1. Measure piston width using the following procedure:
    1. Using an outside micrometer, measure the width of the piston at 30 mm (1.181 in) below the crown, top (1), at the thrust surfaces of the piston, perpendicular to the piston pin centerline.
    2. Compare the measurement of the piston to its original cylinder by subtracting the piston width from the cylinder diameter.
    3. Check your measurements with the **Engine Mechanical Specifications** .
    4. If the clearance obtained through measurement is greater than the provided specifications and the cylinder bores are within specification, replace the piston.

cardiagn.com

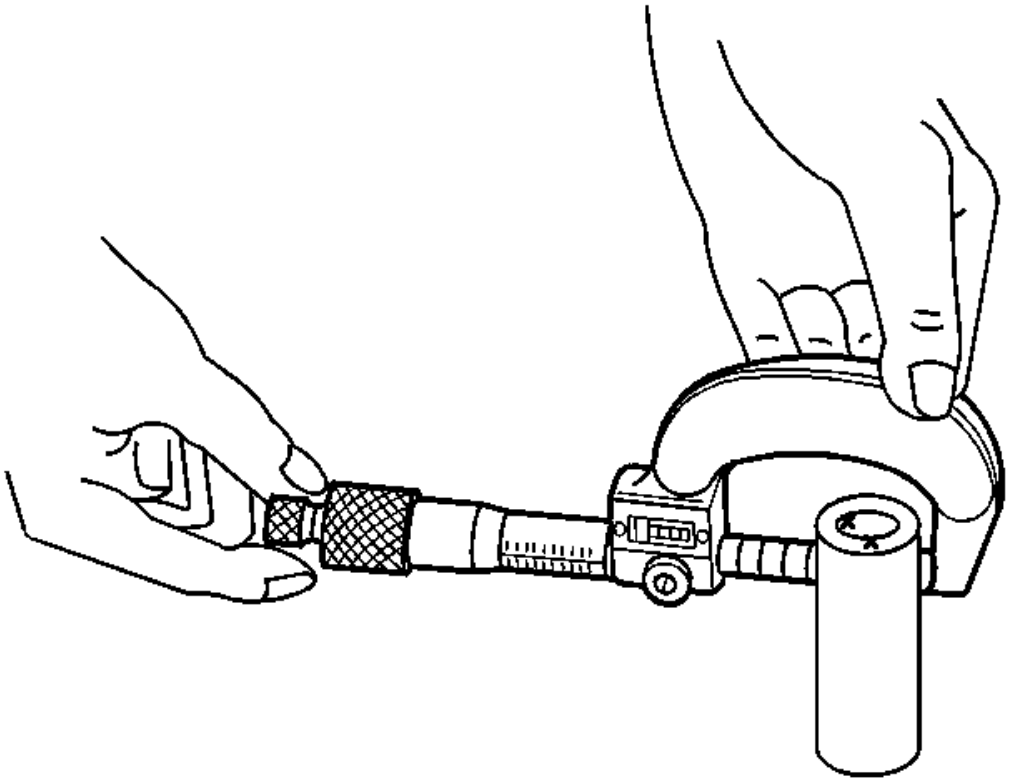


Fig. 160: Measuring Piston Pin Diameter
Courtesy of GENERAL MOTORS COMPANY

2. Measure the piston pin bore to piston pin clearances using the following procedure:
    1. Piston pin bores and pins must be free of varnish or scuffing.
    2. Use an outside micrometer to measure the piston pin in the piston contact areas.

cardiagn.com

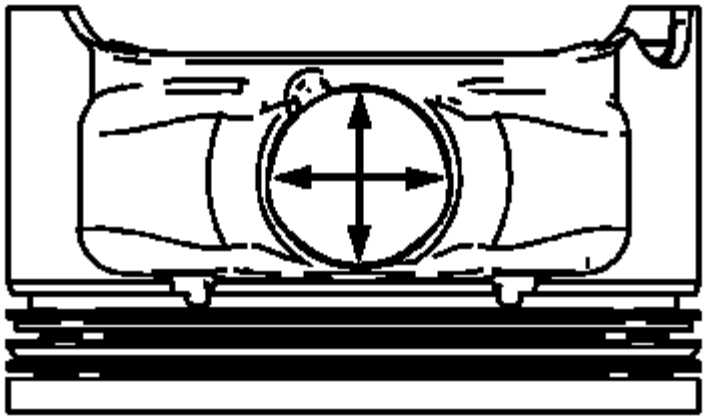


Fig. 161: Checking Piston Pin Bore Dimensions
Courtesy of GENERAL MOTORS COMPANY

3. Using an inside micrometer, measure the piston pin bore. Compare your result with the piston pin diameter and piston pin to piston pin bore clearance listed in the **Engine Mechanical Specifications** .
4. If the clearance is excessive, determine which piece is out of specification and replace as necessary.
5. You must replace the piston if any of its dimensions are out of specification.
6. If the new piston does not meet clearance specifications, the cylinder block may need to be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

Piston Ring Measurement Procedure

cardiagn.com

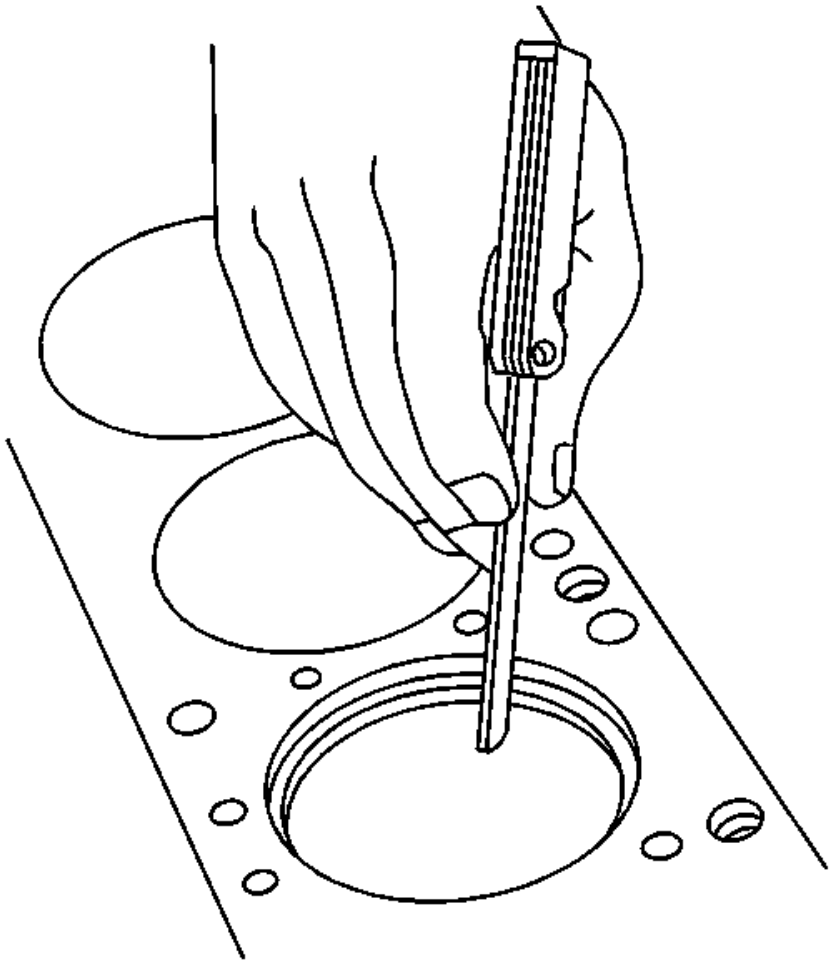


Fig. 162: Measuring Piston Ring End Gap
Courtesy of GENERAL MOTORS COMPANY

1. Measure the piston ring end gap using the following procedure:
    1. Place the piston ring in the area of the bore where the piston ring will travel approximately 25 mm (1 in) down from the deck surface. Ensure that the ring is square with the cylinder bore by positioning the ring with the piston head.
    2. Measure the end gap of the piston ring with feeler gauges. Refer to **Engine Mechanical Specifications** .
    3. If the clearance exceeds the provided specifications, the piston rings must be replaced.
    4. Repeat the procedure for all the piston rings.

cardiagn.com

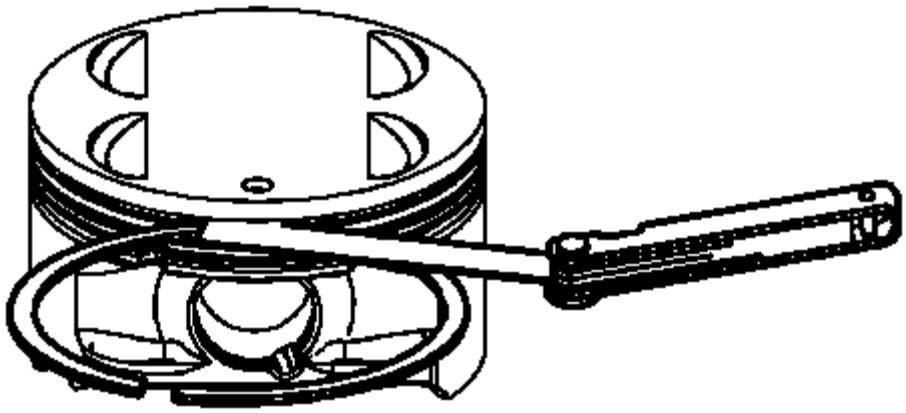


Fig. 163: Using Feeler Gage To Measure Piston Ring Side Clearance
Courtesy of GENERAL MOTORS COMPANY

2. Measure the piston ring side clearance using the following procedure:
    1. Roll the piston ring entirely around the piston ring groove. If any binding is caused by the ring groove, dress the groove with a fine file. If any binding is caused by a distorted piston ring, replace the ring.
    2. With the piston ring on the piston, use feeler gauges to check clearance at multiple locations.
    3. Compare the measurements with piston ring side clearance listed in the **Engine Mechanical Specifications** .
    4. If the clearance is greater than specifications, replace the piston rings.

cardiagn.com

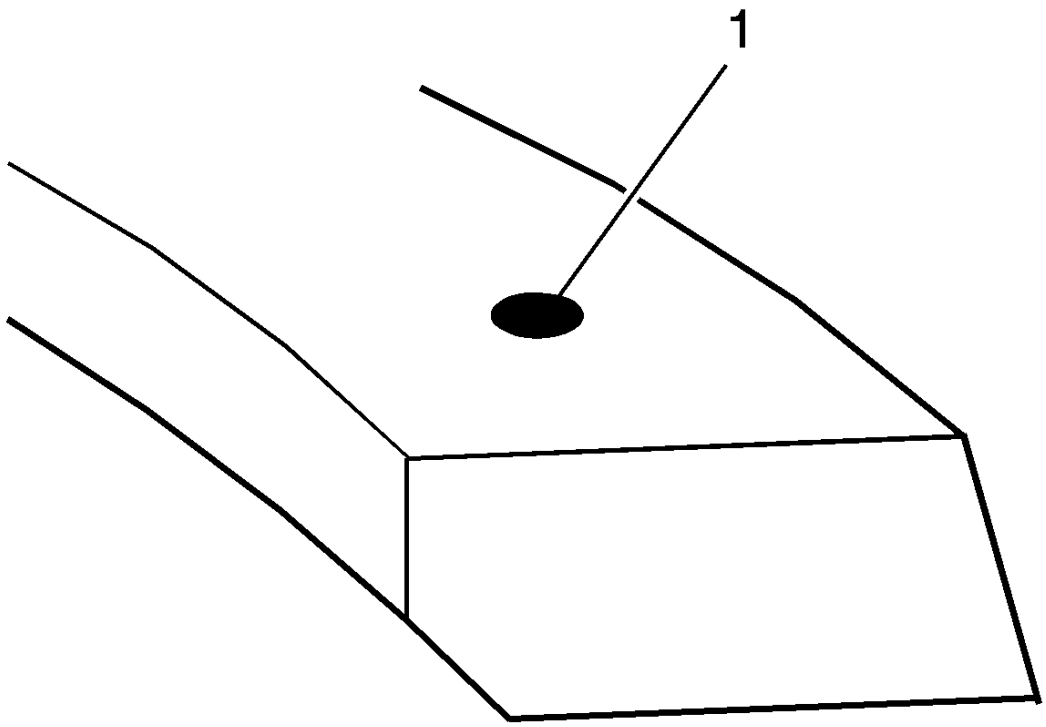


Fig. 164: View Of Lower Compression Piston Ring Mark
Courtesy of GENERAL MOTORS COMPANY

3. There is a locating dimple (1) on the compression rings near the end for identification. Install the compression rings with the dimple facing up.
4. If the new ring does not reduce the clearance to the proper specification, install a new piston.
5. If the new piston does not meet clearance specifications, the cylinder block may need to be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

Connecting Rod Cleaning Procedure

1. Clean the connecting rods in solvent.
2. Dry the connecting rod using compressed air.

WARNING: Refer to Safety Glasses Warning .

cardiagn.com

3. Remove the connecting rod cap and clean the threads.
4. Remove the connecting rod bearing and discard. Never reuse a connecting rod bearing used in a running engine.

Connecting Rod Visual Inspection Procedure

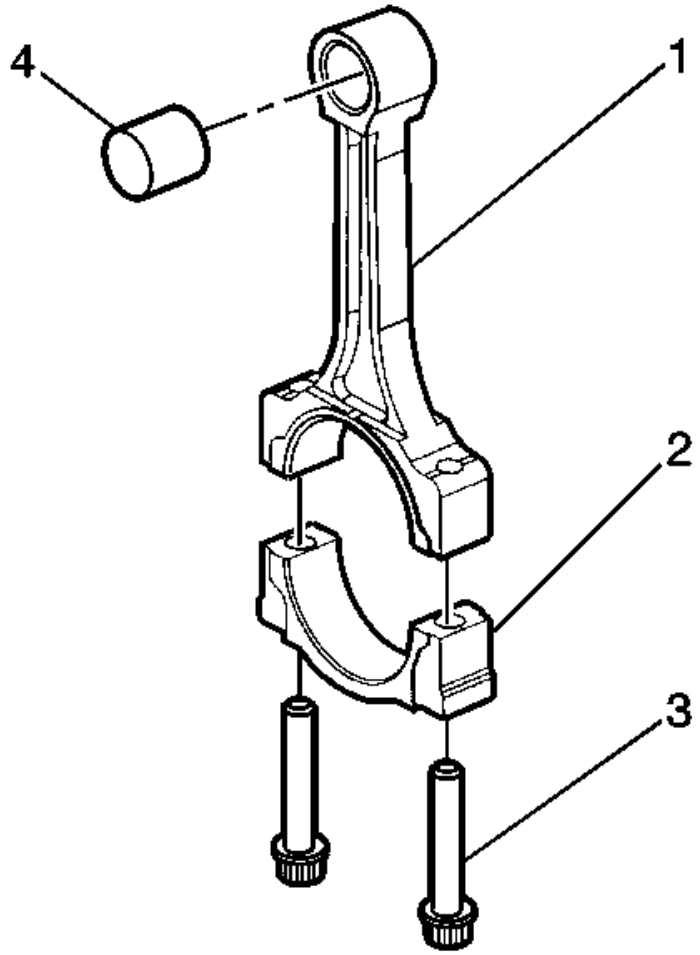


Fig. 165: Inspecting Connecting Rod Components
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the piston pin bushing (4) for scoring or damage.
2. Inspect the connecting rod beam (1) for twisting or bending.
3. Inspect the rod cap (2) for any nicks or damage caused by possible interference.
4. Inspect for scratches or abrasion on the rod bearing seating surface.
5. If the connecting rod bores contain minor scratches or abrasions, clean the bores in a circular direction with a light emery paper.

cardiagn.com

NOTE: DO NOT scrape the rod or rod cap.

Connecting Rod Measurement Procedure

Piston Pin End

1. Using an outside micrometer, take 2 measurements of the piston pin in the area of the connecting rod contact.

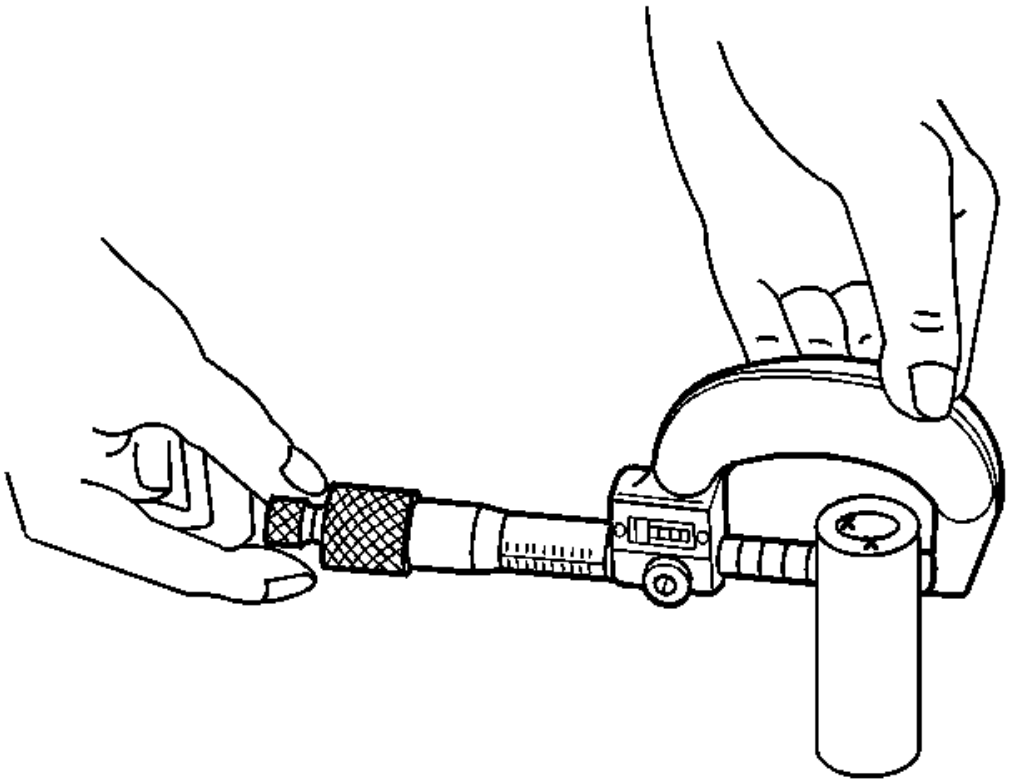


Fig. 166: Measuring Piston Pin Diameter
Courtesy of GENERAL MOTORS COMPANY

NOTE: Measurements of all components should be taken with the components at normal room temperature.

cardiagn.com

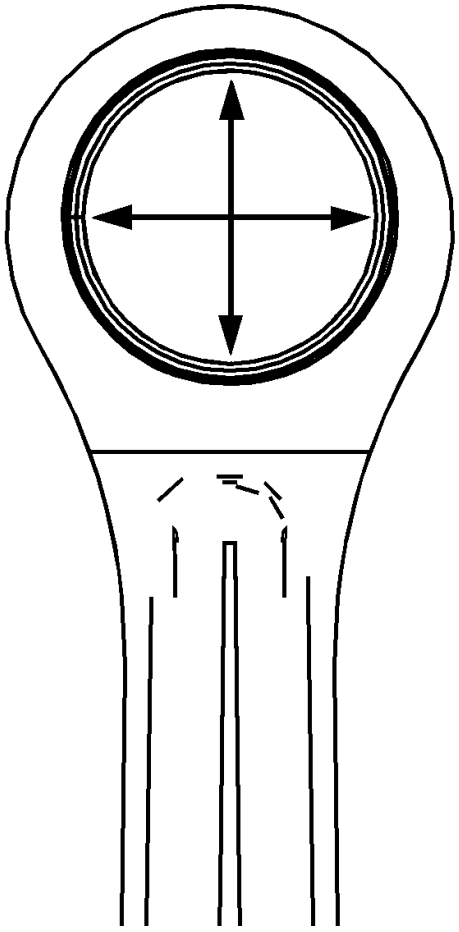


Fig. 167: Checking Connecting Rod Piston Pin Bore Dimensions
Courtesy of GENERAL MOTORS COMPANY

2. Using an inside micrometer, measure the connecting rod piston pin bore.
3. Subtract the piston pin diameter from the piston pin bore.
4. Compare the clearance measurements with the **Engine Mechanical Specifications** .
5. If the clearance is excessive, replace the piston pin. If a new pin does not resolve the clearance problem, replace the connecting rod.

Connecting Rod Crankshaft Bearing End

1. Using an inside micrometer, measure the connecting rod crankshaft bearing bore.

cardiagn.com

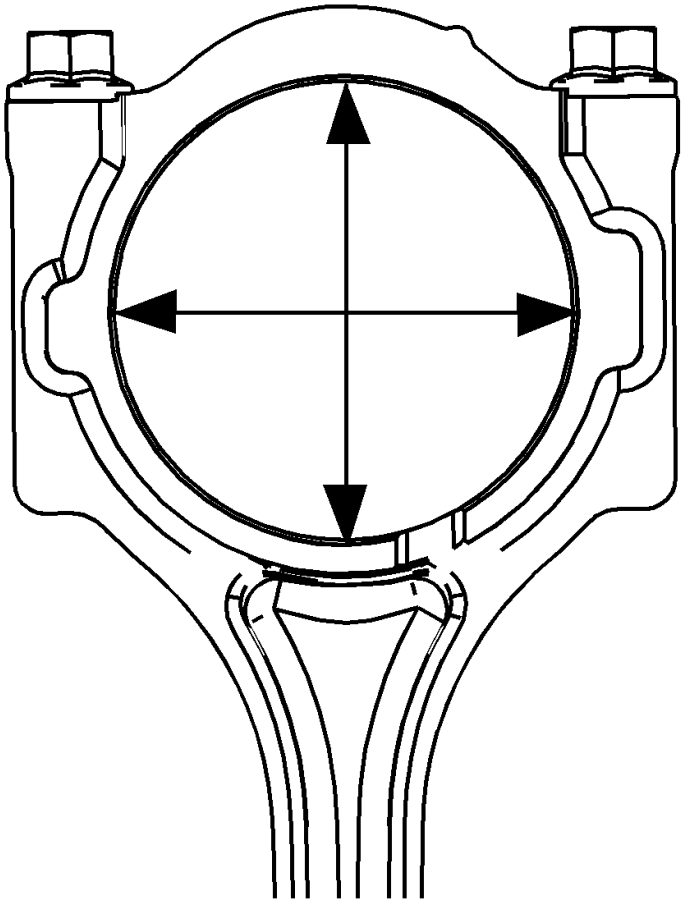


Fig. 168: Measuring Connecting Rod Crankshaft Bearing Bore
Courtesy of GENERAL MOTORS COMPANY

NOTE: Measurements of all components should be taken with the components at normal room temperature.

2. Compare the bore measurements with the **Engine Mechanical Specifications** .
3. Replace the connecting rod if the bore is out of specifications. DO NOT recondition the connecting rod.

PISTON AND CONNECTING ROD ASSEMBLE

Special Tools

- **EN-46121** Connecting Rod Guide Pin Set
- **EN-46745** Piston Pin Clip Remover/Installer

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

cardiagn.com

Piston and Piston Pin Installation Procedure

1. Lubricate the piston pin bores in the piston and the connecting rod with GM prelube lubricant. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.

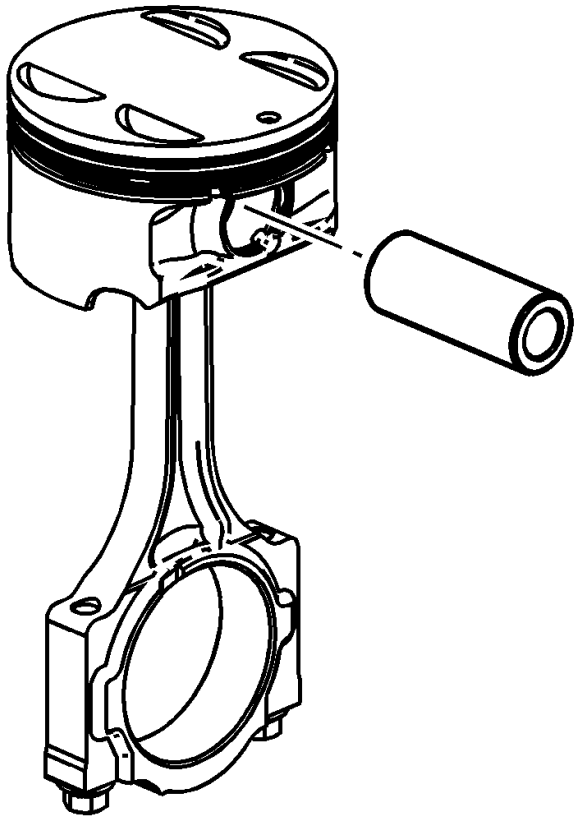


Fig. 169: View Of Piston Pin
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The piston is directional and must be installed in the engine block in the proper direction. The dot on the top of the piston must face the front of the engine.**
- **The piston is model dependent and may not appear exactly as shown.**

2. Assemble the piston and piston pin to the connecting rod. Properly orient the piston when reusing a marked connecting rod.
3. Align the piston pin bore with the connecting rod pin bore.

cardiagn.com

4. Slide the piston pin into the piston and the connecting rod.
5. Install NEW piston pin retainers using the **EN-46745** remover/installer. Align the **EN-46745** remover/installer to the notch (1) in the piston.

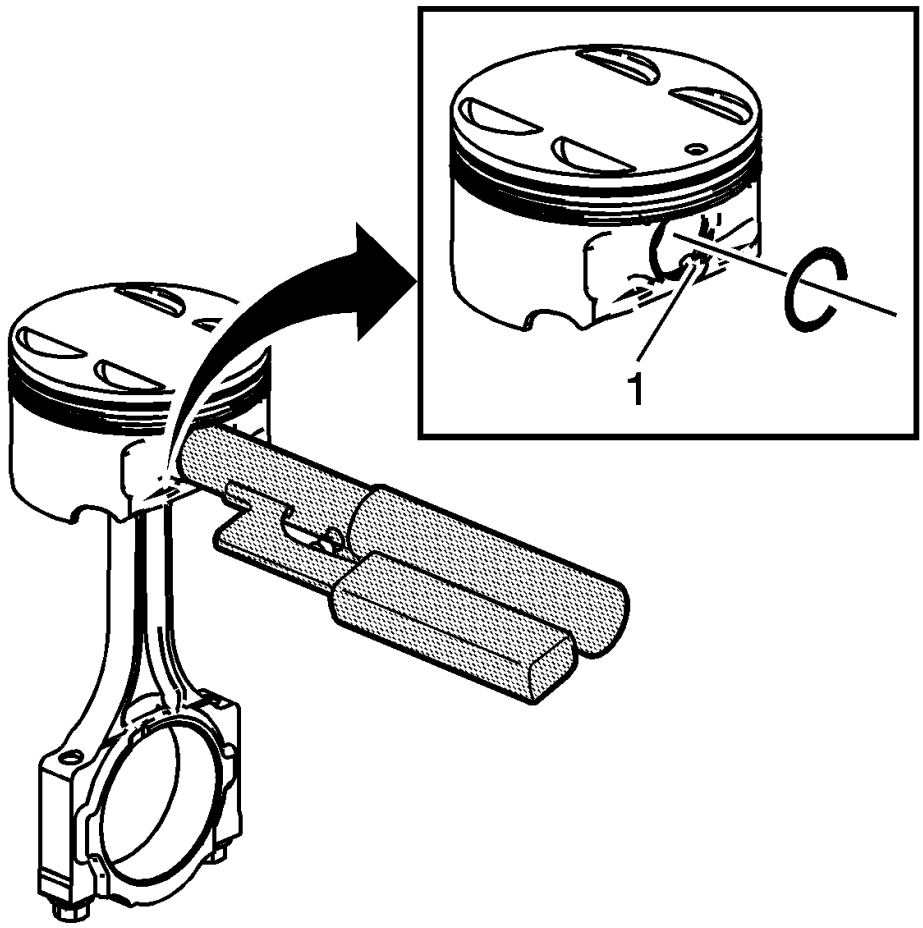


Fig. 170: Identifying Piston Pin Retainers Removal Access Notch
Courtesy of GENERAL MOTORS COMPANY

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

6. Ensure that the piston pin retainers are fully seated in their grooves.
7. Repeat these procedures for the remaining pistons.

Piston Ring Installation Procedure

cardiagn.com

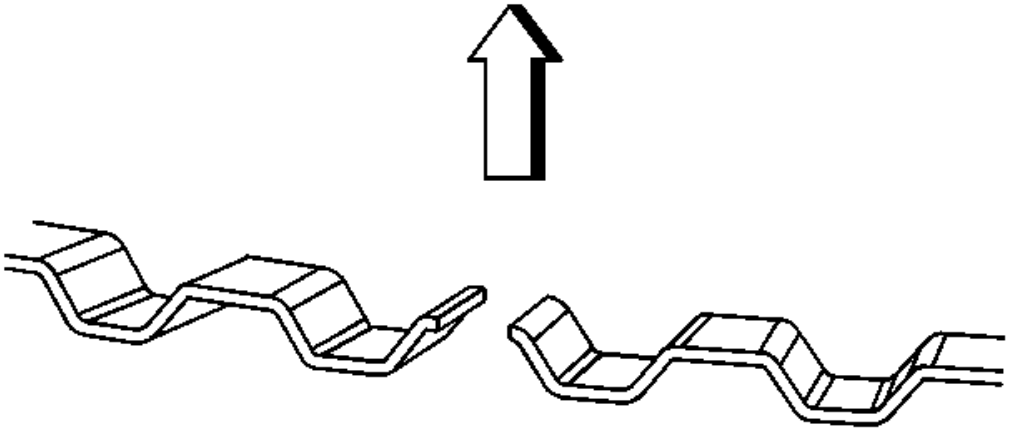


Fig. 171: Aligning Oil Control Ring Expander
Courtesy of GENERAL MOTORS COMPANY

1. Properly orient the oil control ring expander as shown before installation. The ends of the expander must be facing toward the top of the piston.

cardiagn.com

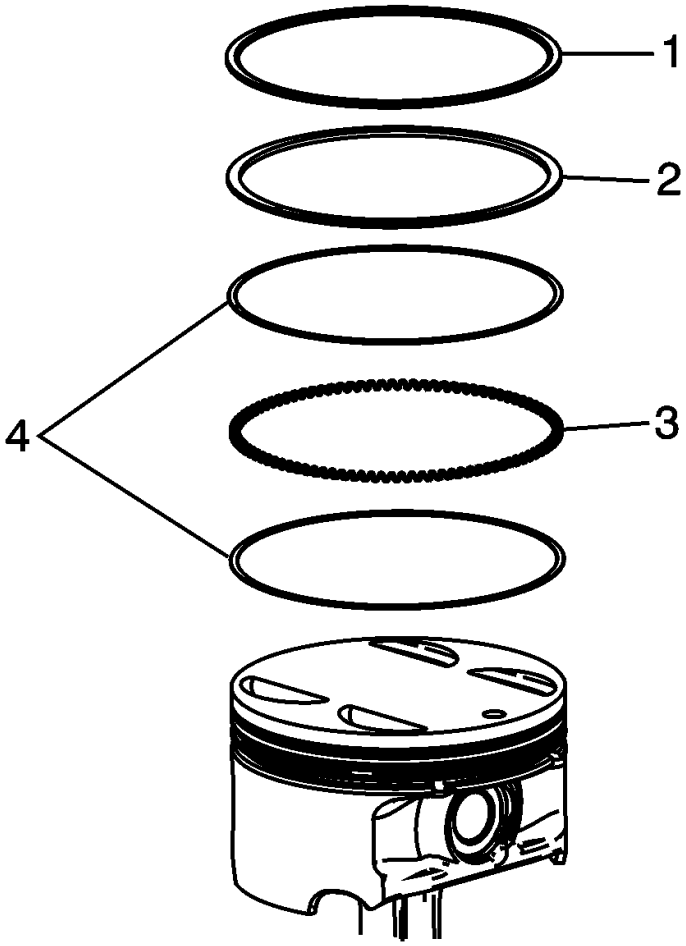


Fig. 172: Identifying Piston Rings
Courtesy of GENERAL MOTORS COMPANY

2. Using a piston ring expander, install the oil control ring assembly using the following procedure:
    1. Install the expander ring (3).
    2. Install the 2 oil scraper rings (4). Expand the rings only enough to clear the piston diameter. Overexpanding the piston rings will distort or crack the rings.
3. Install the lower compression piston ring (2) onto the piston with the mark facing the top of the piston.

NOTE: The lower compression piston ring (2) is thicker and will not fit in the upper compression rings (1) position.

NOTE: For the LY7, the upper compression ring is symmetrical and may be installed either side up. For all other RPO's, the mark on the piston ring should face the top of the piston.

4. Install the upper compression piston ring (1) onto the piston with the mark facing the top of the piston, if

cardiagn.com

required.

5. Once the rings are installed, set the ring gaps for the oil control, second and top ring as follows. Use the piston location arrow for reference.

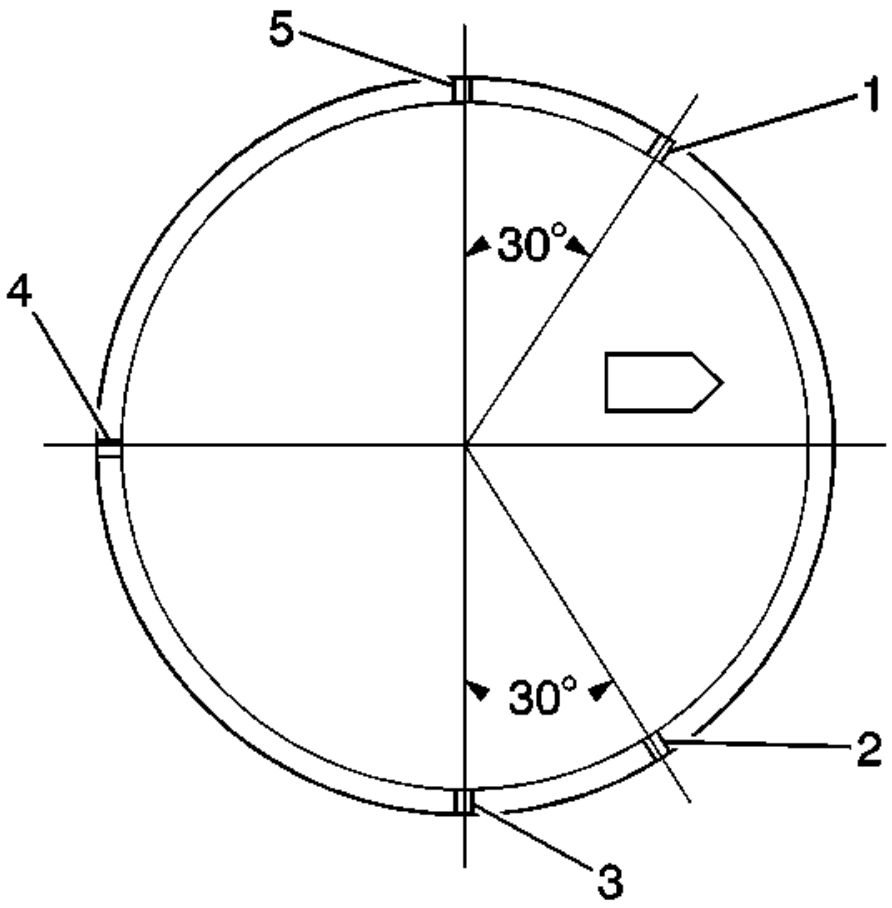


Fig. 173: Illustrating Ring Gap Positions
Courtesy of GENERAL MOTORS COMPANY

1. Lower oil control ring - position 1
2. Upper oil control ring - position 2
3. Top Ring - position 3
4. Oil control ring expander - position 4
5. Second ring - position 5

Connecting Rod Bearing Installation Procedure

1. Clean the connecting rod and the connecting rod cap bearing bore with a lint-free cloth.

cardiagn.com

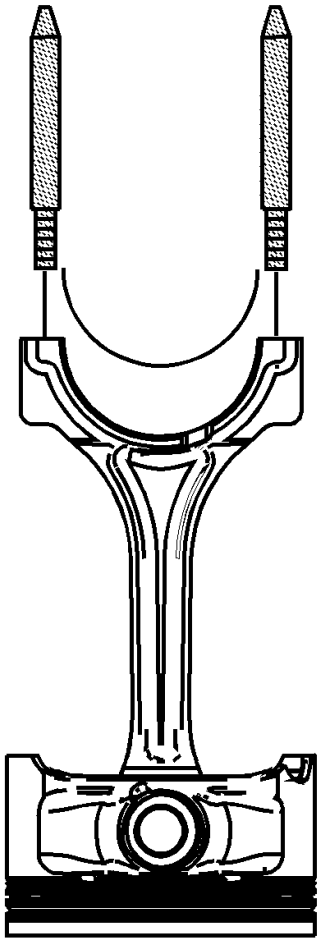


Fig. 174: View Of Piston/Connecting Rod Installation Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: If the connecting rod bearings have been used in a running engine, you must replace them with NEW connecting rod bearings for reassembly.

2. Clean all the oil from behind the connecting rod bearing halves.
3. Install NEW upper connecting rod bearings into position. Roll the bearing into position so that the lock tang engages the alignment slot. The bearing must fit flush in the connecting rod.
4. Install the **EN-46121** set into the connecting rod bolt holes.

cardiagn.com

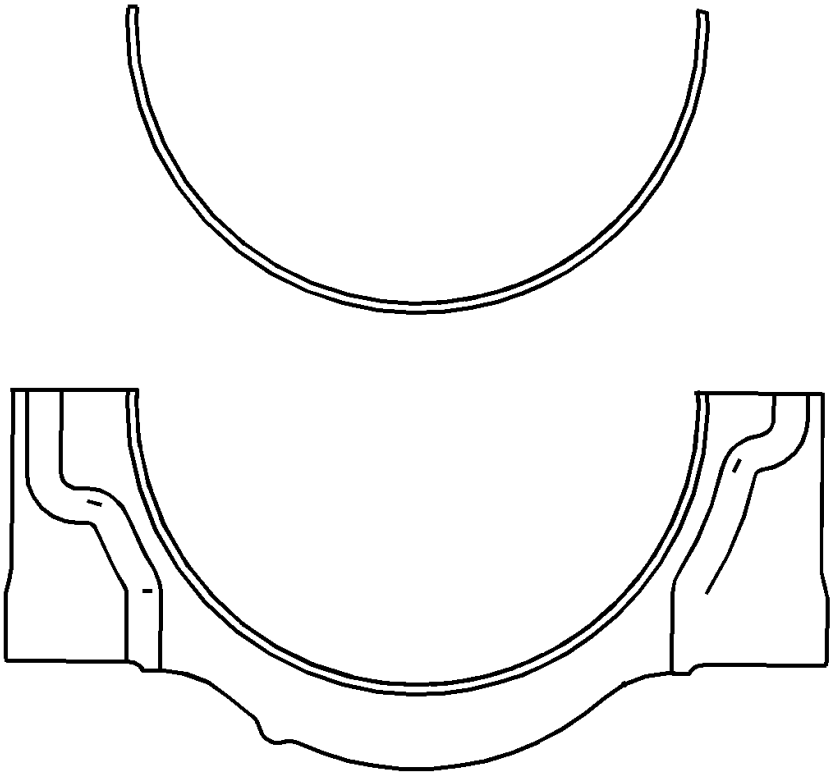


Fig. 175: View Of Lower Connecting Rod Cap & Bearing
Courtesy of GENERAL MOTORS COMPANY

5. Install NEW lower connecting rod bearings into position in the connecting rod cap. Roll the bearing into position so that the lock tang engages the alignment slot. The bearings must fit flush with the connecting rod cap.

CYLINDER HEAD DISASSEMBLE

Special Tools

- **EN 46116** Valve Stem Seal Remover/Installer
- **EN 46117** Valve Stem Key Remover/Installer
- **EN 46119** Off-Vehicle Valve Spring Compressor Adapter
- **EN 46122** Camshaft Position Actuator Check-Ball Valve Remover/Installer
- **J 8062** Valve Spring Compressor - Head Off
- **J 2619-01** Slide Hammer

cardiagn.com

- **J 37281-A** Injector Remover

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

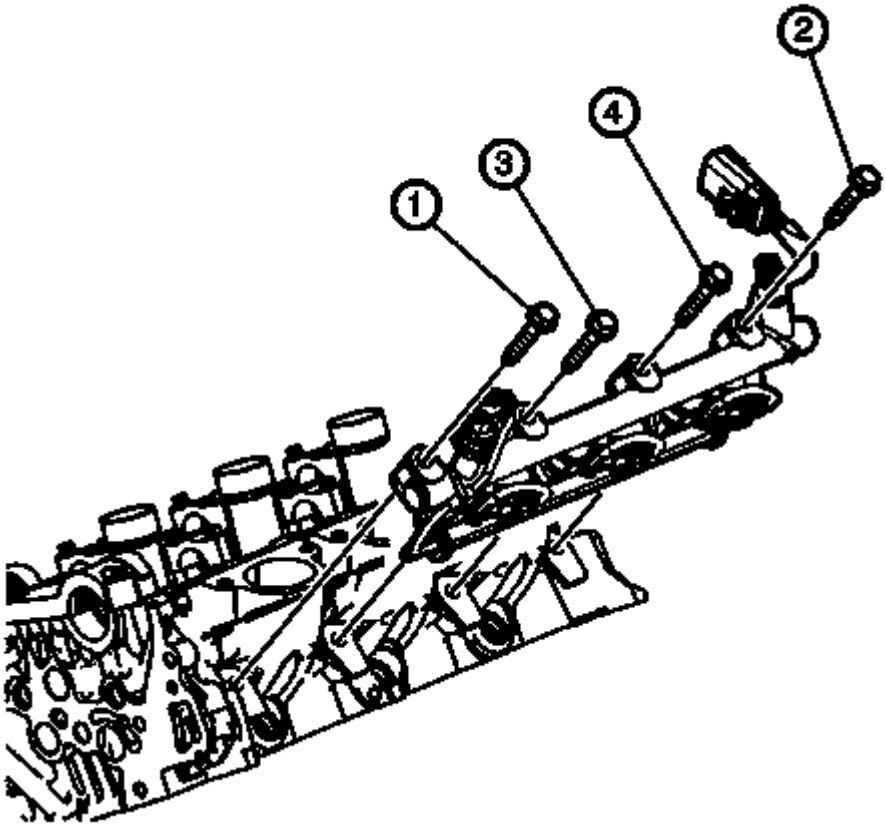


Fig. 176: View of Fuel Rail, Bolts & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel rail bolts.
2. Remove the fuel rail and injectors.

cardiagn.com

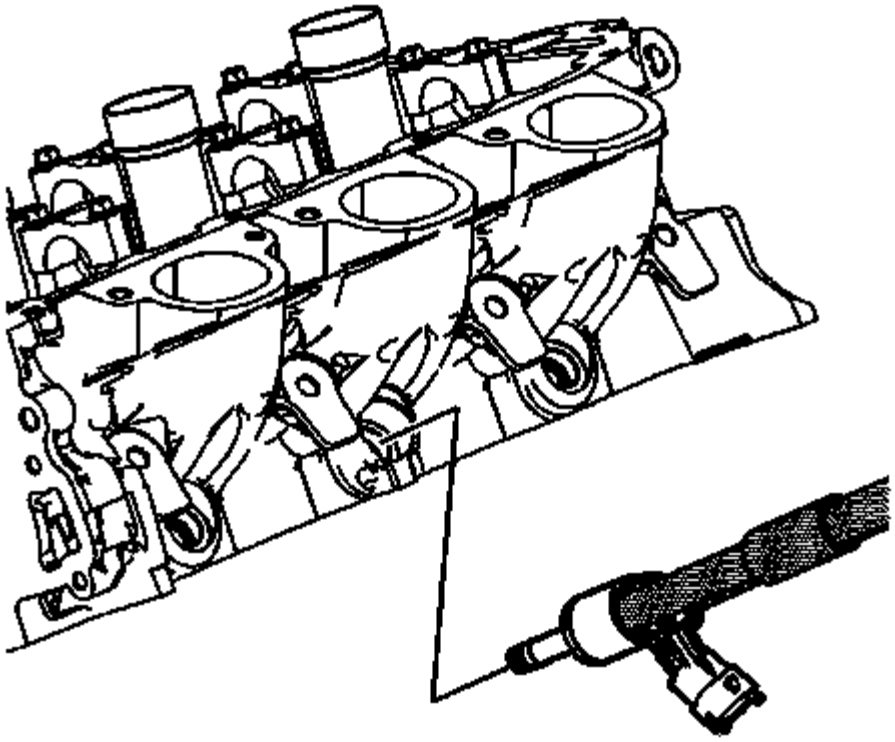


Fig. 177: View Of Fuel Injector Hold-Down Clamp
Courtesy of GENERAL MOTORS COMPANY

3. The injectors may stay in the cylinder head. Remove the fuel injector hold-down clamp before removing the injector.
4. Use the **J 37281-A** remover and the **J 2619-01** hammer to remove the injector.

cardiagn.com

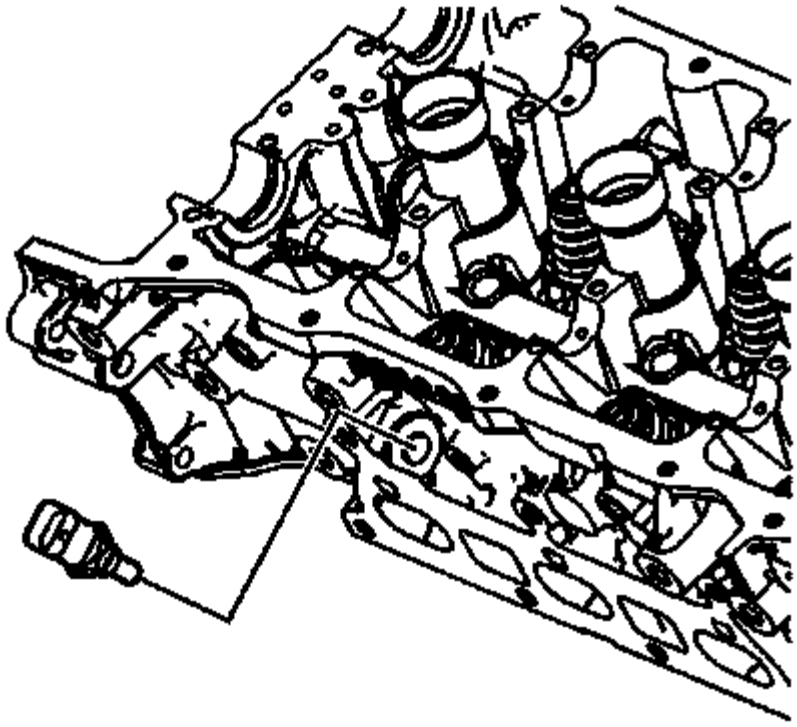


Fig. 178: View of Engine Coolant Temperature Sensor & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

5. Remove the engine coolant temperature (ECT) sensor.

cardiagn.com

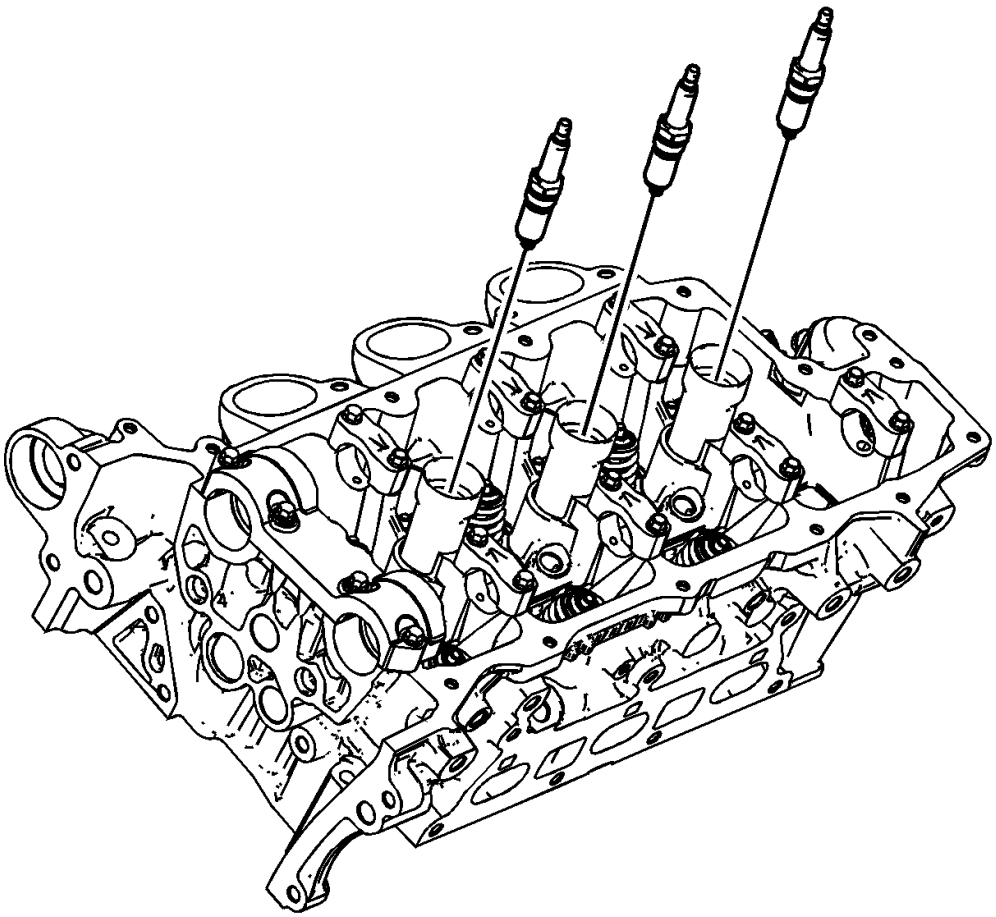


Fig. 179: View Of Spark Plugs
Courtesy of GENERAL MOTORS COMPANY

6. Remove the spark plugs.
7. Using an appropriately sized deep socket and a plastic hammer, lightly tap on the valve spring retainer to loosen the valve keepers.

cardiagn.com

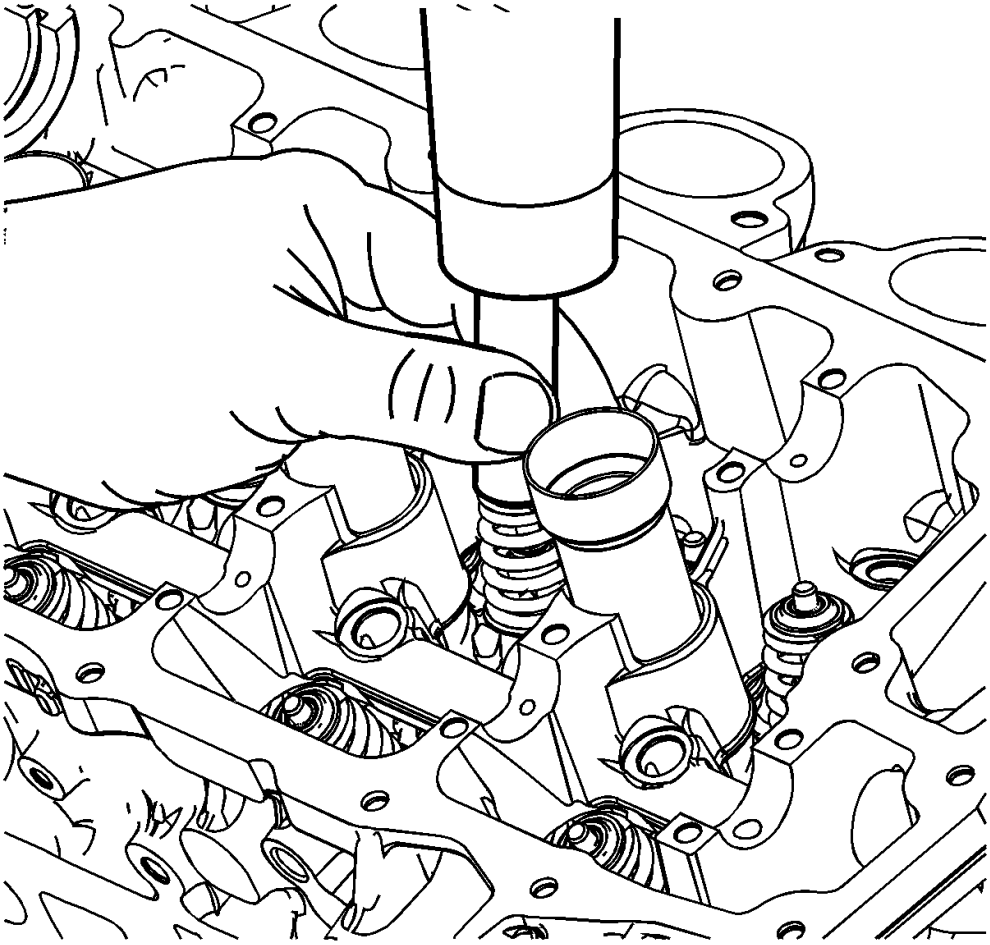


Fig. 180: View of Keeper & Special Tool EN 46119
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure valve heads will not contact anything during the following step in order to avoid bending or damage.

8. Compress the valve spring using the **J 8062** compressor and the **EN 46119** adapter.

cardiagn.com

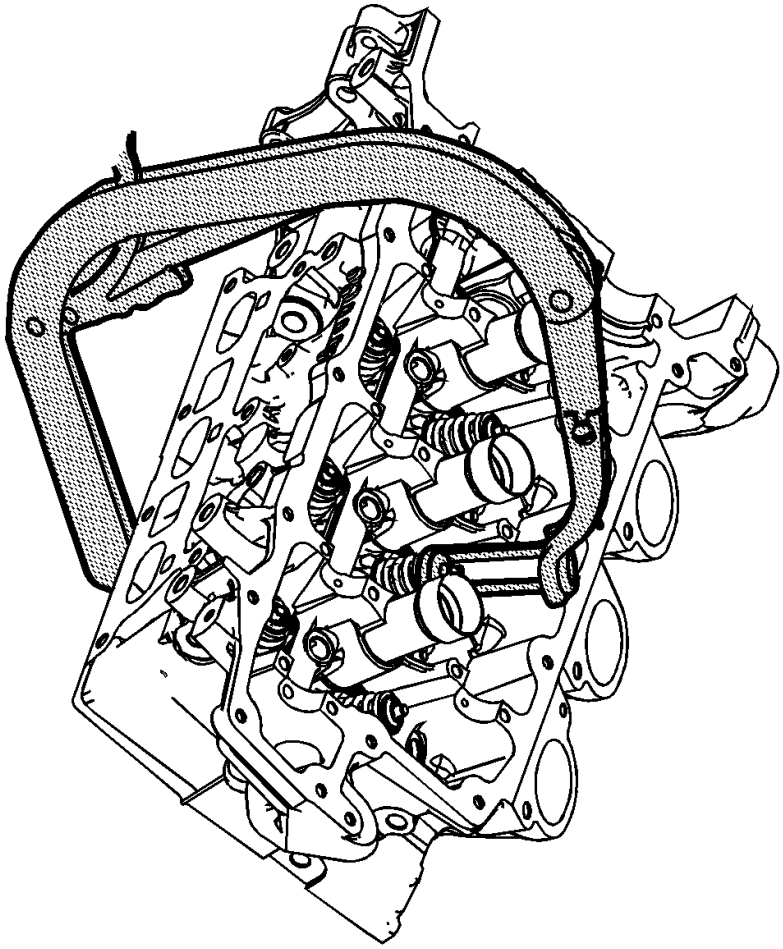


Fig. 181: Compressing Valve Spring
Courtesy of GENERAL MOTORS COMPANY

WARNING: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

CAUTION: Do not compress the valve springs to less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

cardiagn.com

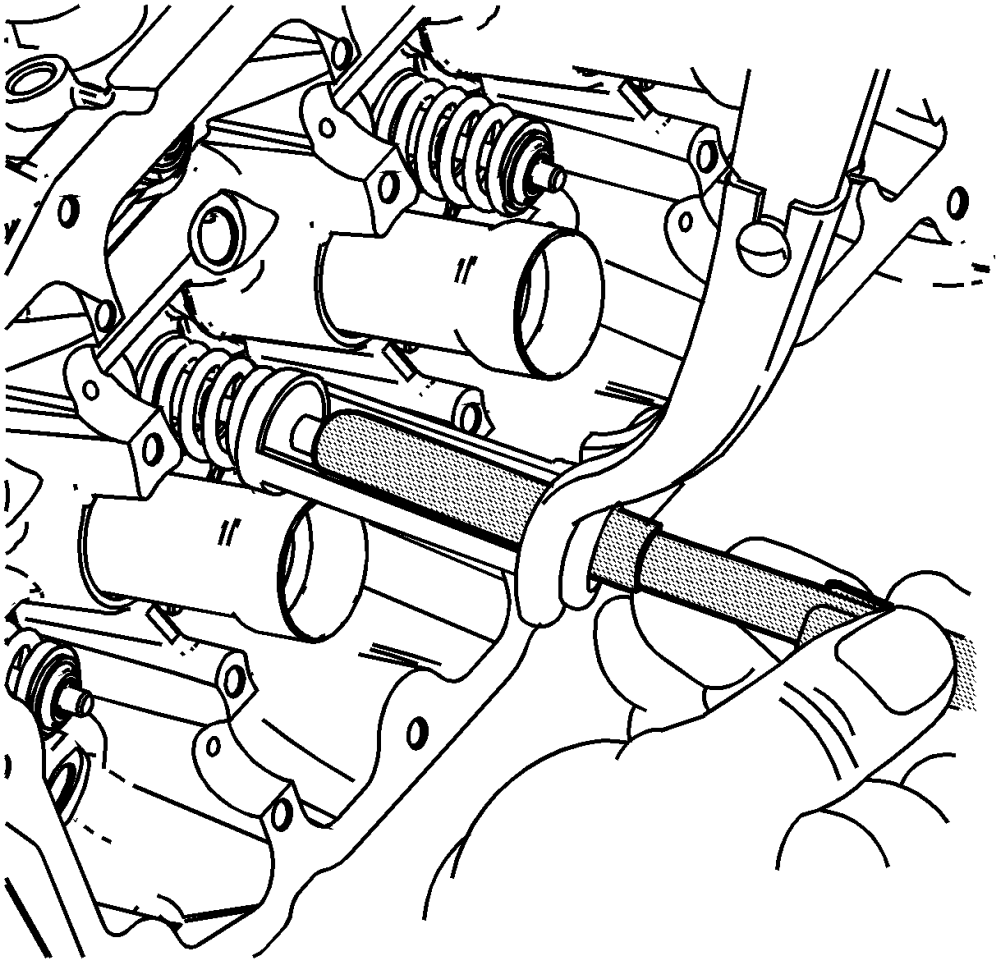


Fig. 182: View of Tool EN 46117 & Valve Keepers
Courtesy of GENERAL MOTORS COMPANY

9. Use the magnet of the **EN 46117** remover/installer in order to remove the valve keepers.
10. Remove the valve spring compressor and the adapter.

cardiagn.com

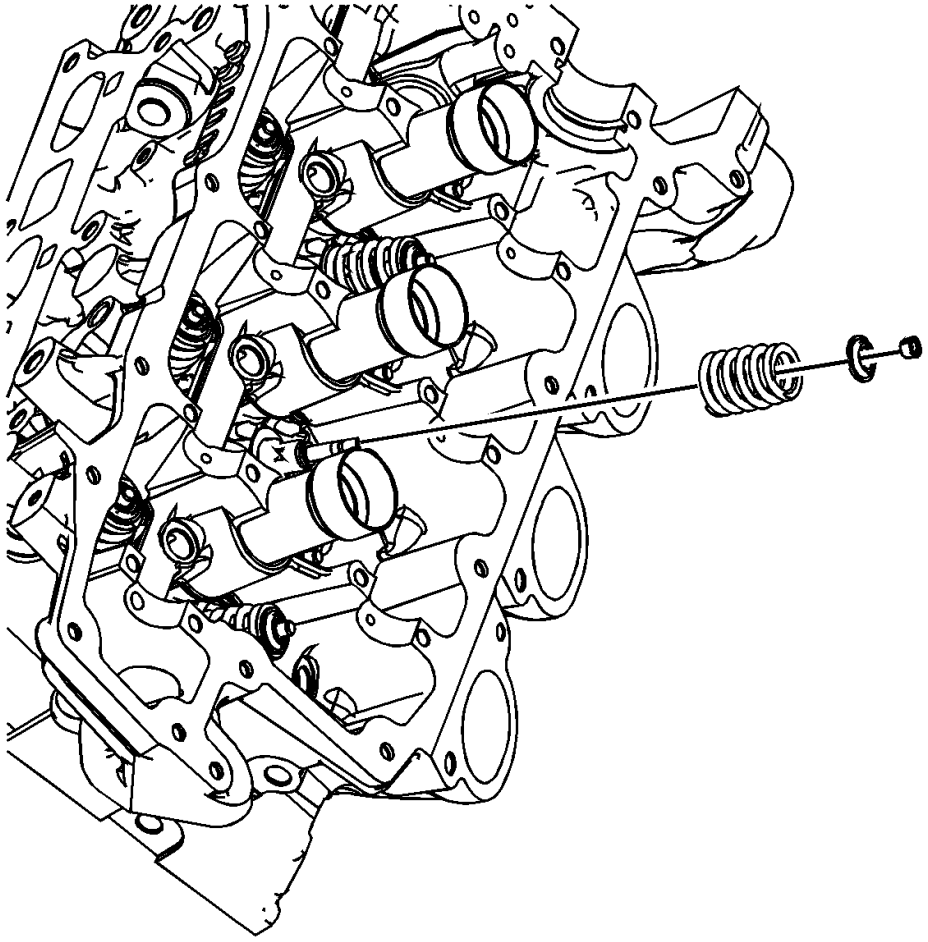


Fig. 183: View Of Valve Spring & Retainer
Courtesy of GENERAL MOTORS COMPANY

11. Remove the valve spring retainer.
12. Remove the valve spring.

cardiagn.com

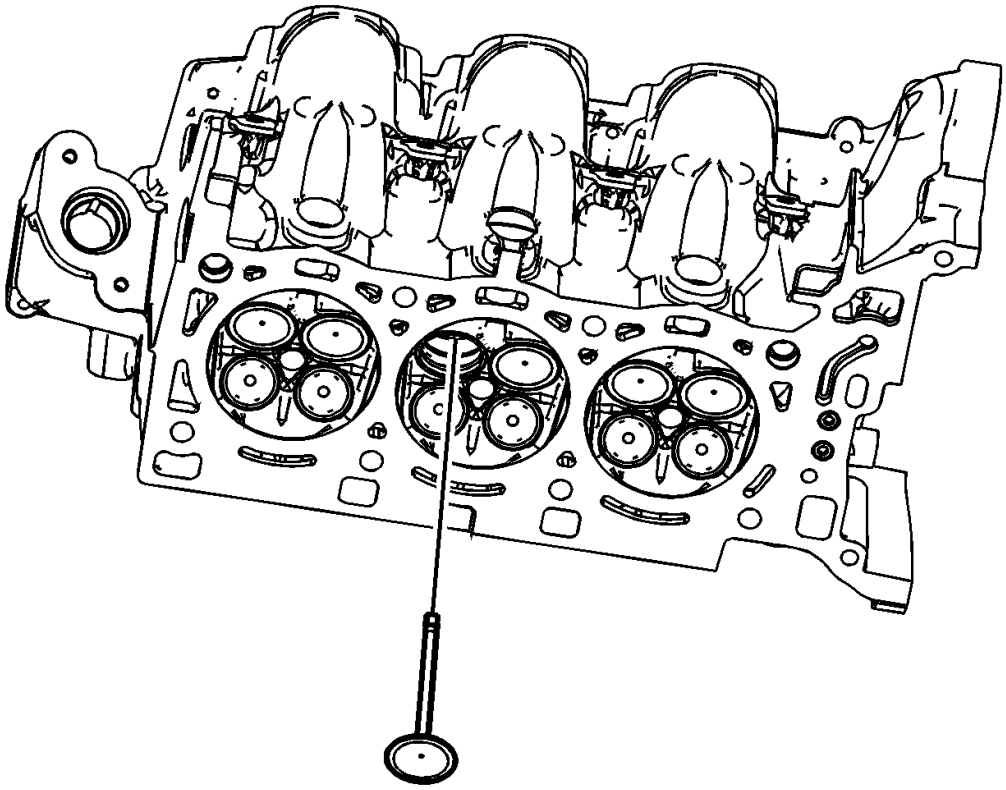


Fig. 184: View of Oil Seal and Valve Guide
Courtesy of GENERAL MOTORS COMPANY

13. Remove the valve.
14. Remove the valve stem oil seal using the **EN 46116** remover/installer and discard.

cardiagn.com

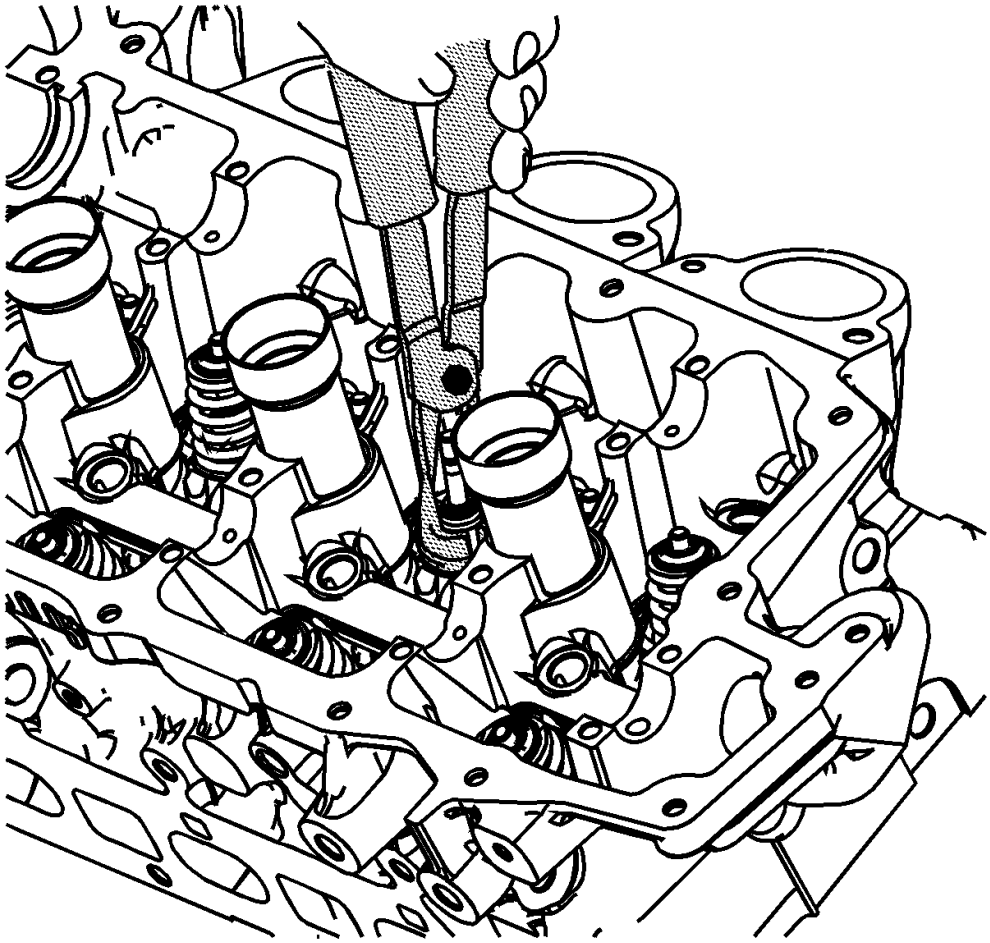


Fig. 185: View of Special Tool EN 46116 & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

NOTE: NEVER reuse a valve stem oil seal.

15. Repeat these procedures for the remaining valves.

cardiagn.com

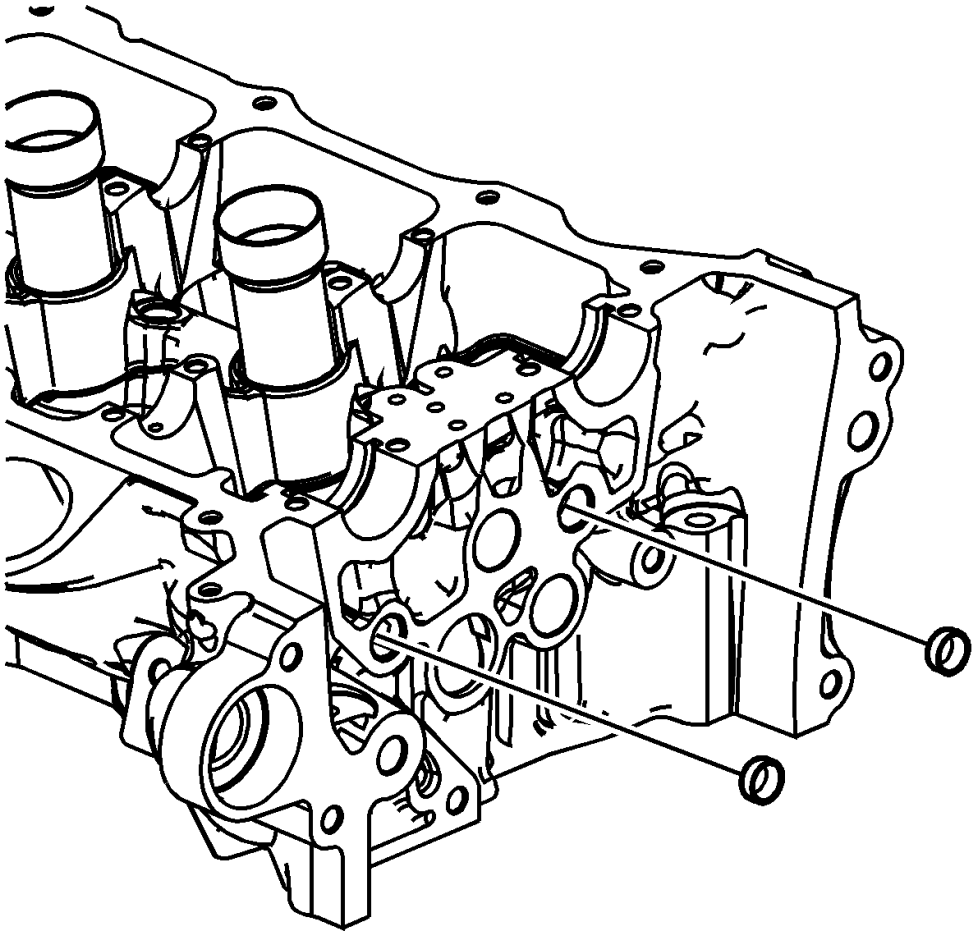


Fig. 186: View Of Cylinder Head Oil Gallery Expansion Plugs
Courtesy of GENERAL MOTORS COMPANY

16. Remove the cylinder head oil gallery expansion plugs.

cardiagn.com

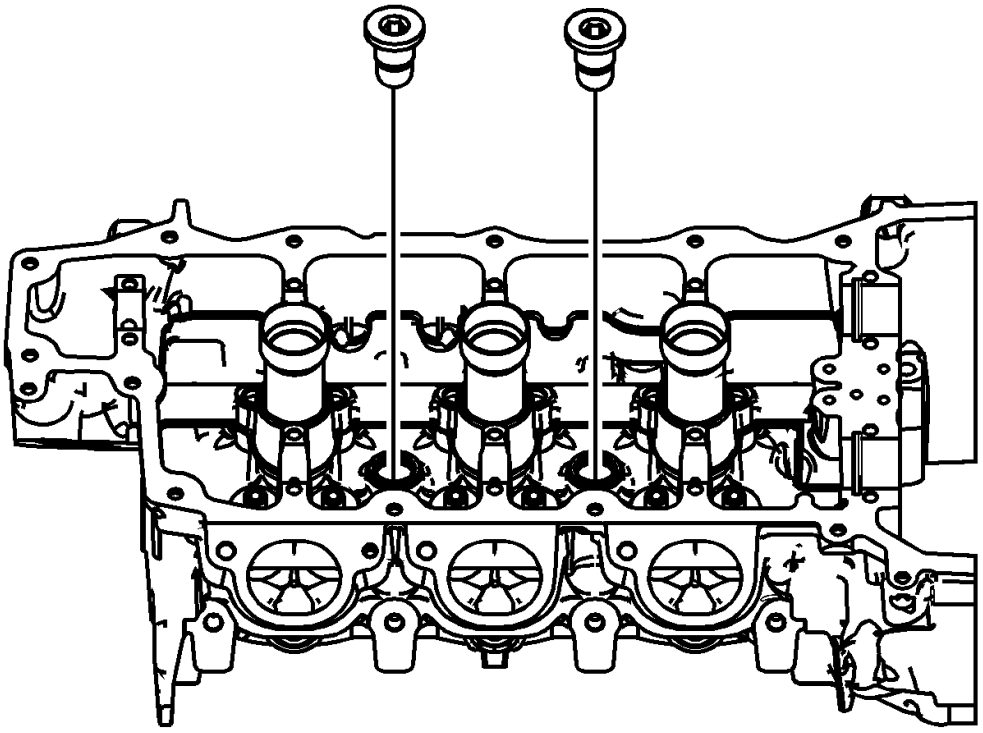


Fig. 187: View Of Cylinder Head Coolant Threaded Plugs
Courtesy of GENERAL MOTORS COMPANY

17. Remove the cylinder head coolant threaded plugs.

cardiagn.com

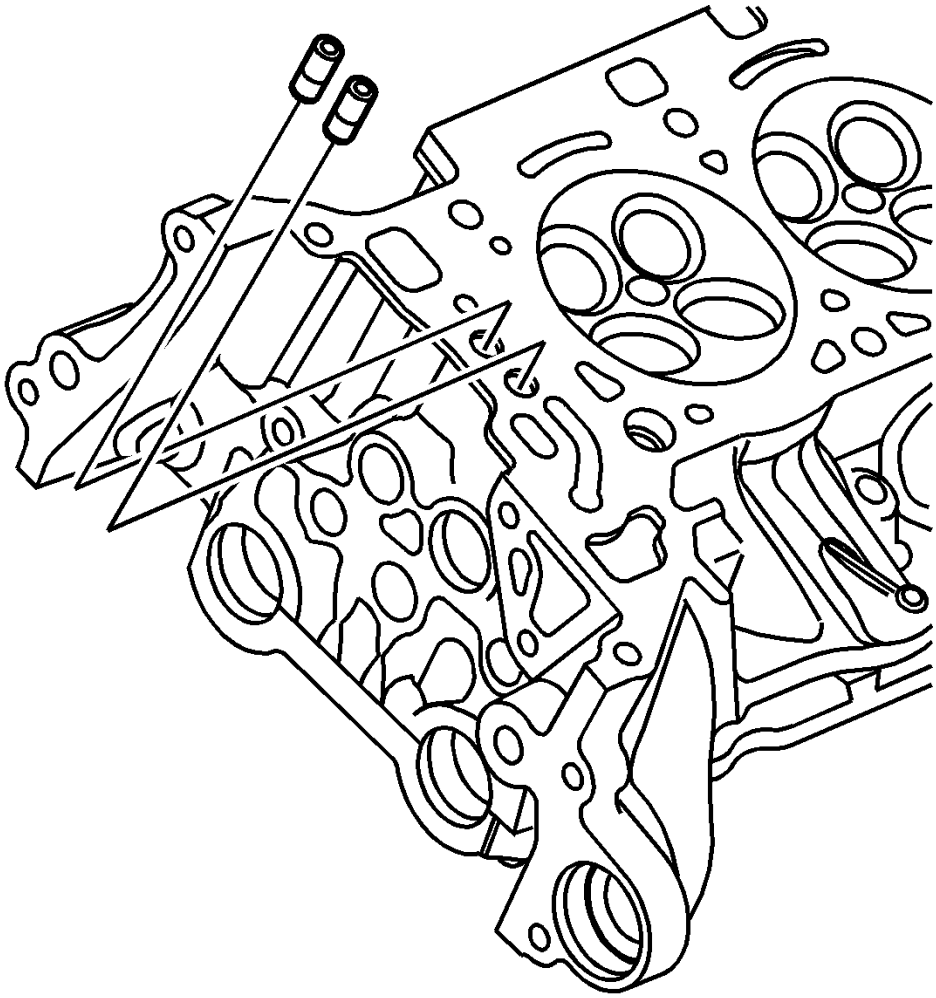


Fig. 188: View Of Camshaft Position Actuator Oil Feed Check Valve
Courtesy of GENERAL MOTORS COMPANY

18. Inspect the camshaft position actuator oil feed check valves. Damaged, restricted or clogged check valves must be replaced.

cardiagn.com

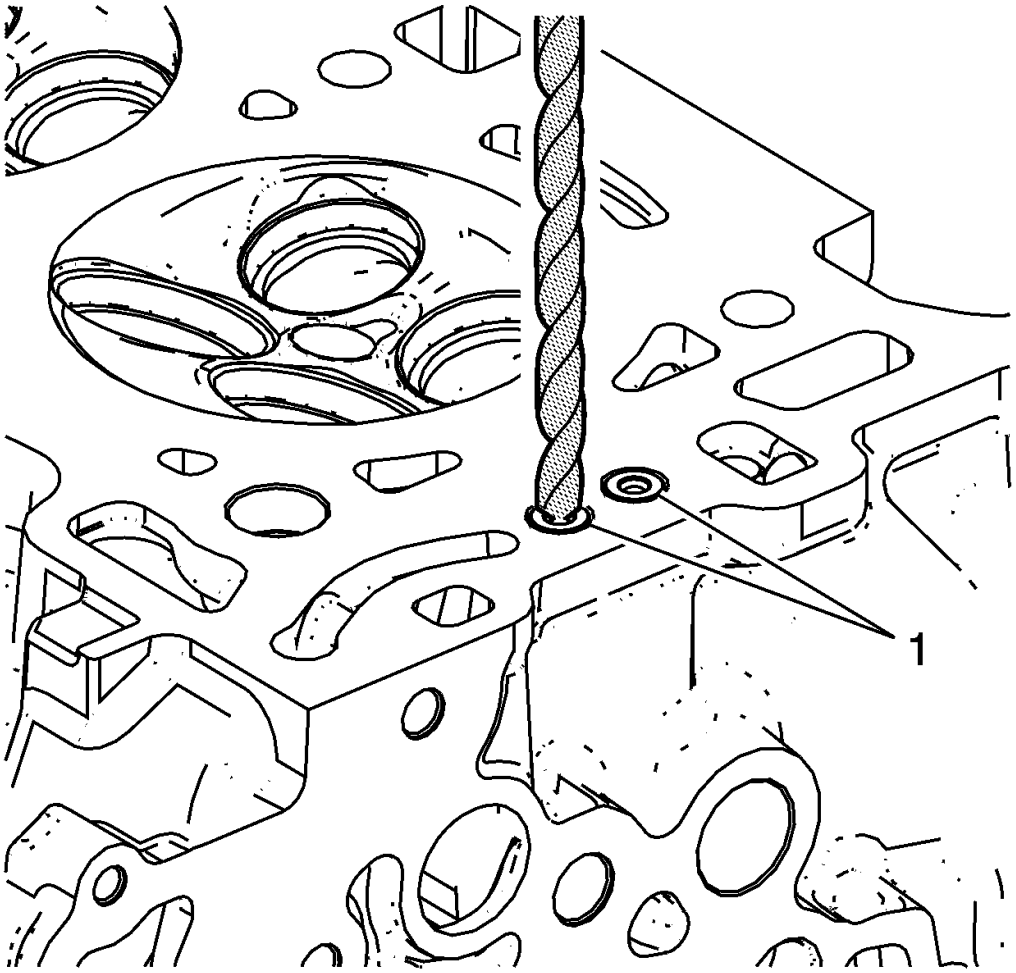


Fig. 189: Drill Out Top Portion Of Check Valve To Expose Internal Check Ball
Courtesy of GENERAL MOTORS COMPANY

19. Place cylinder head on firm surface with check valves (1) facing up. Protect all cylinder head components and machined surfaces.
20. Using drill bit EN 46122-3, drill out top portion of check valve to expose internal check ball.

cardiagn.com

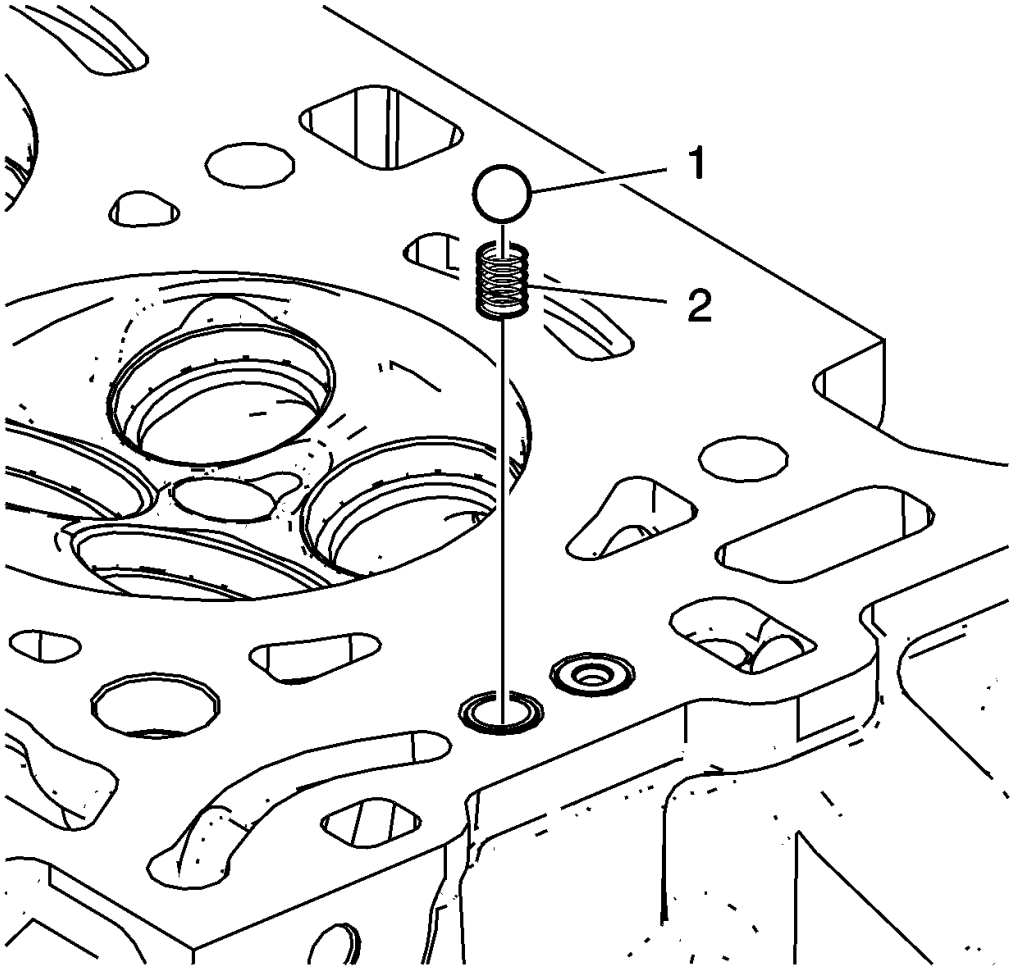


Fig. 190: Identifying Check Ball & Check Ball Spring
Courtesy of GENERAL MOTORS COMPANY

21. Remove check ball (1) and check ball spring (2) from inside of check valve.

cardiagn.com

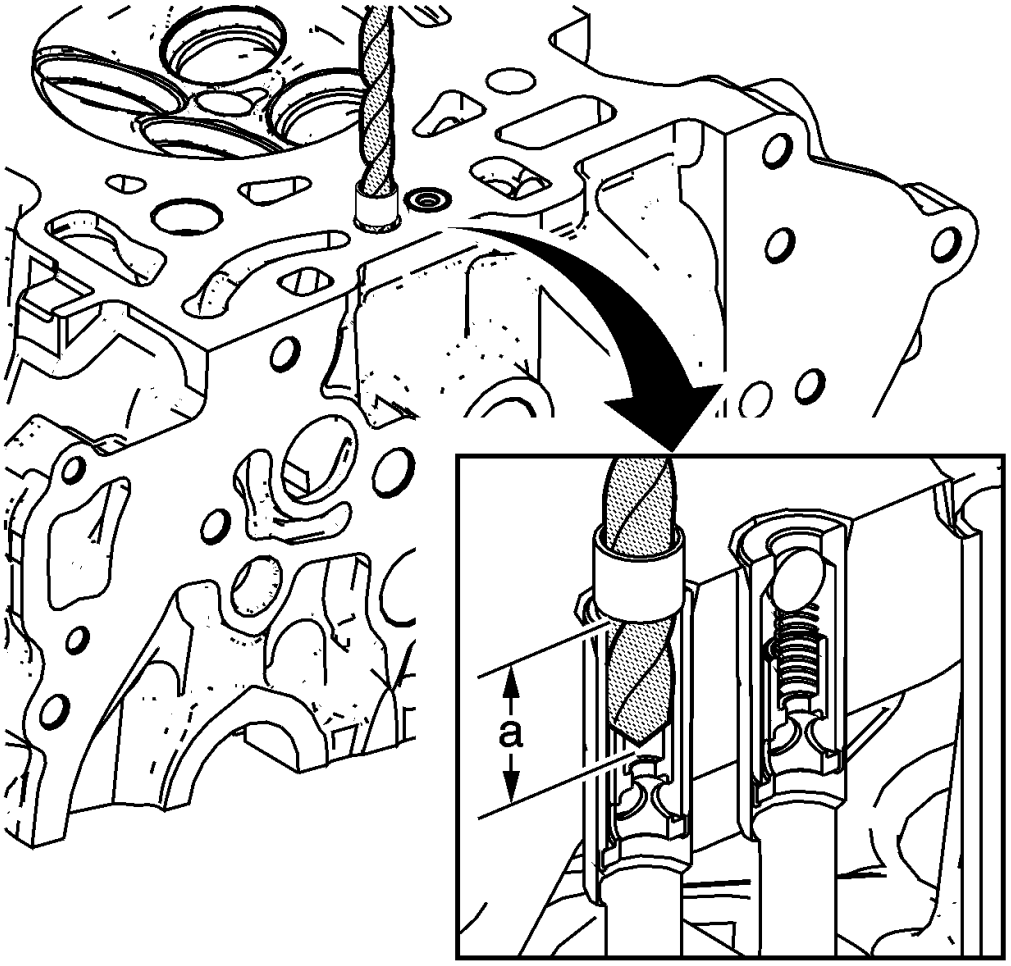


Fig. 191: Drill Remainder Of Check Valve Sleeve To A Depth Of Approximately 19 mm (0.75 In)
Courtesy of GENERAL MOTORS COMPANY

22. Continue drilling remainder of check valve sleeve to a depth of approximately 19 mm (0.75 in) (a) by placing tape on drill bit as a depth gauge. It is not necessary or desirable to drill completely through the bottom of the check valve.

cardiagn.com

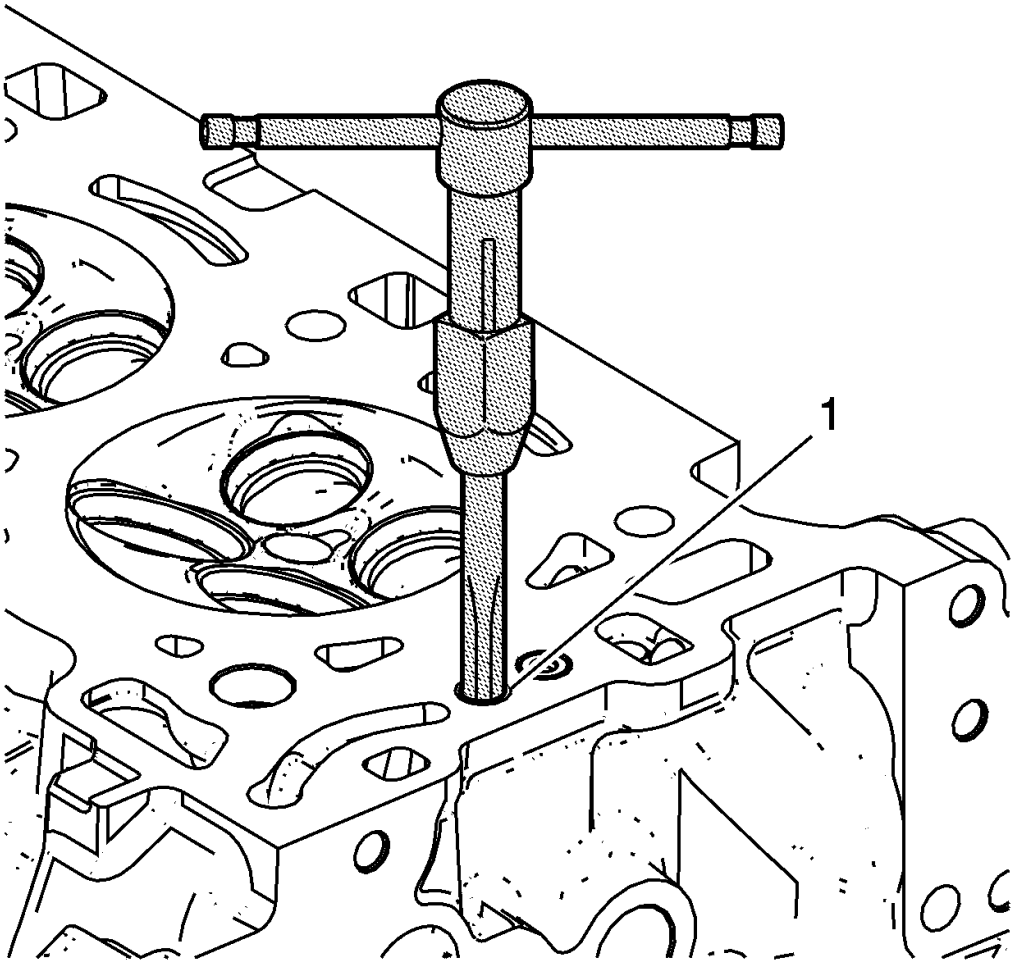


Fig. 192: Tapping Drilled Out Portion Of Check Valve
Courtesy of GENERAL MOTORS COMPANY

23. Lubricate tap EN 46122-4 with lubricant included in **EN 46122** remover/installer. Tap drilled out portion of check valve (1) remaining in cylinder head. Tap to full depth possible until tap bottoms out in head.

cardiagn.com

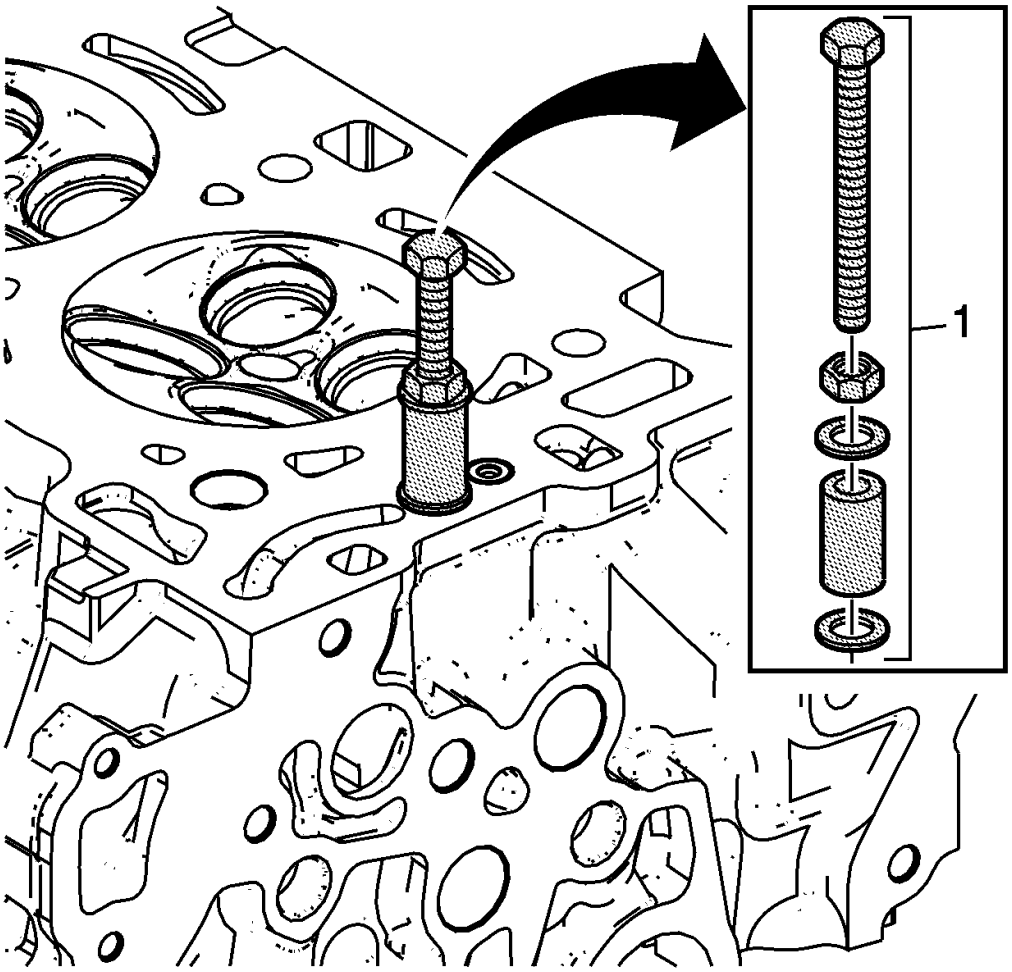


Fig. 193: Assembling Bolt, Nut, Washers & Collar EN-46122-2
Courtesy of GENERAL MOTORS COMPANY

24. Assemble bolt, nut, washers and collar EN 46122-2 (1) as shown. Position collar with slightly-larger inside diameter DOWN toward the cylinder head.
25. Screw bolt by hand fully down into threaded check valve sleeve, then lightly tighten nut against washer.

cardiagn.com

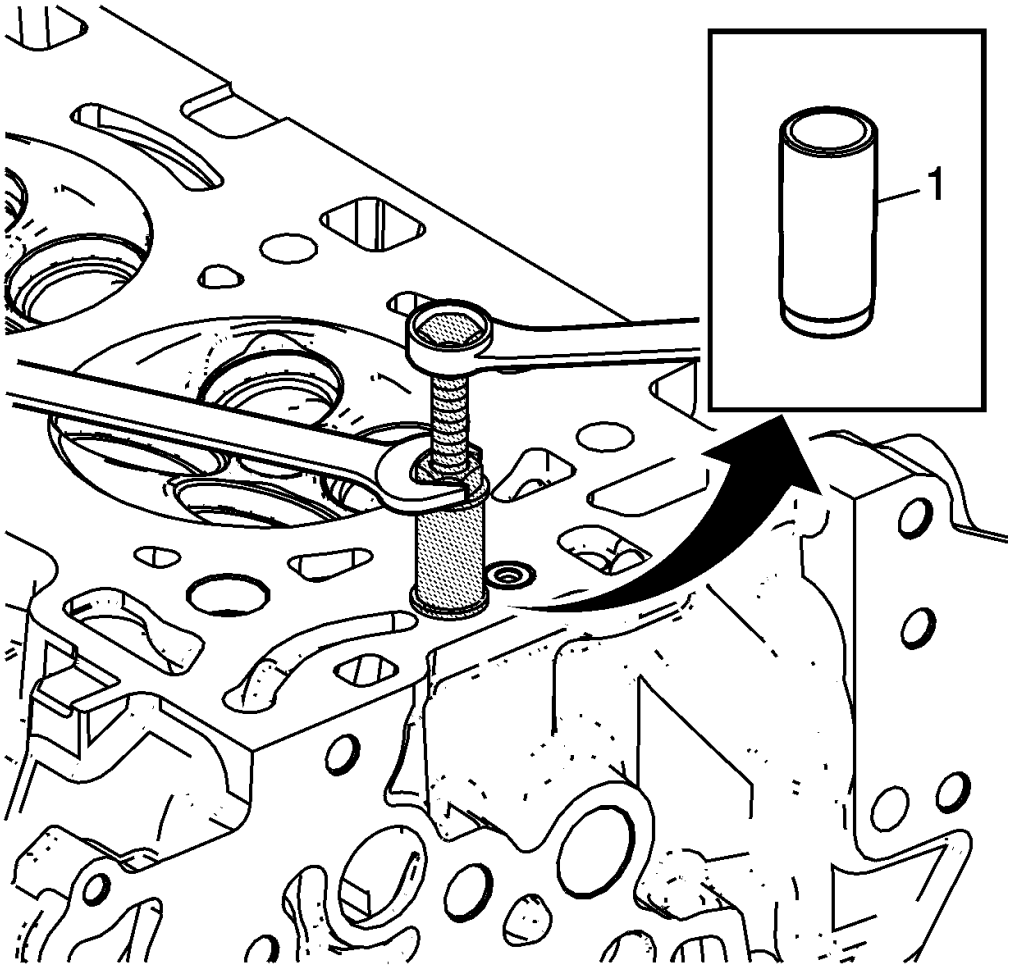


Fig. 194: Hold Bolt With One Wrench And Use Another To Tighten The Nut Until The Check Valve Sleeve Is Removed From Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

26. Hold bolt with one wrench and use another to tighten the nut until the check valve sleeve (1) is removed from the cylinder head.
27. Clean check valve bore and related passages thoroughly to remove any drilling chips or other debris.

CYLINDER HEAD CLEANING AND INSPECTION

Special Tools

- **EN-47909** Injector Bore and Sleeve Cleaning Kit
- **J 8001** Dial Indicator Set
- **J 8358** Carbon Removal Brush
- **J 28410** Gasket Remover
- **J 42096** Valve Guide Reamer

cardiagn.com

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

Cleaning Procedure

1. Remove any old thread sealant, gasket material or sealant using **J 28410** remover.
2. Clean all cylinder head surfaces with non-corrosive solvent.
3. Blow out all the oil galleries using compressed air.

WARNING: Refer to Safety Glasses Warning .

4. Remove any carbon deposits from the combustion chambers using the **J 8358** brush.
5. Clean any debris or build-up from the lifter pockets.

Visual Inspection

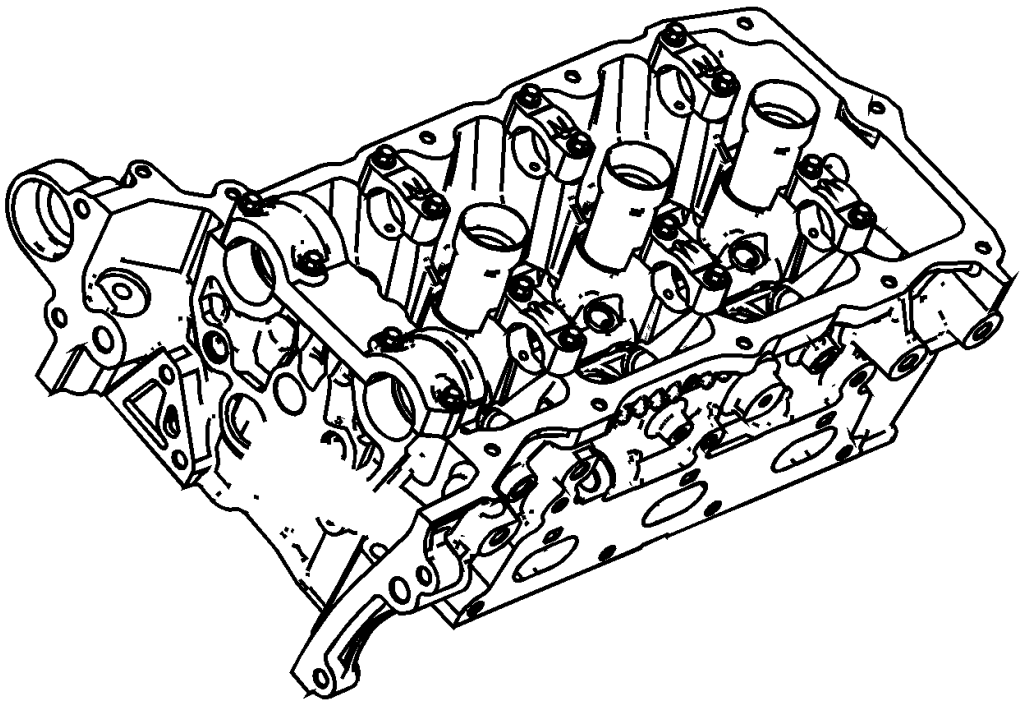


Fig. 195: View Of Cylinder Head

cardiagn.com

Courtesy of GENERAL MOTORS COMPANY

1. Inspect the cylinder head camshaft bearing surfaces for the following conditions:
   - Excessive scoring or pitting
   - Discoloration from overheating
   - Deformation from excessive wear
   - If the camshaft bearing journals appear to be scored or damaged, you must replace the cylinder head. DO NOT machine the camshaft bearing journals.
2. If any of the above conditions exist on the camshaft bearing surfaces, replace the cylinder head.
3. Inspect the cylinder head for the following:
   - Cracks, damage or pitting in the combustion chambers
   - Debris in the oil galleries - Continue to clean the galleries until all debris is removed.
   - Coolant leaks or damage to the deck face sealing surface - If coolant leaks are present, measure the surface warpage as described under Cylinder Head Measurement - Deck Flatness Inspection.
   - Burrs or any defects that would degrade the sealing of the NEW secondary camshaft drive chain tensioner gasket
   - Damage to any gasket surfaces
   - Damage to any threaded bolt holes
   - Burnt or eroded areas in the combustion chamber
   - Cracks in the exhaust ports and combustion chambers
   - External cracks in the water passages
   - Restrictions in the intake or exhaust passages
   - Restrictions in the cooling system passages
   - Rusted, damaged or leaking core plugs
4. If the cylinder head is cracked or damaged, it must be replaced. No welding or patching of the cylinder head is recommended.

cardiagn.com

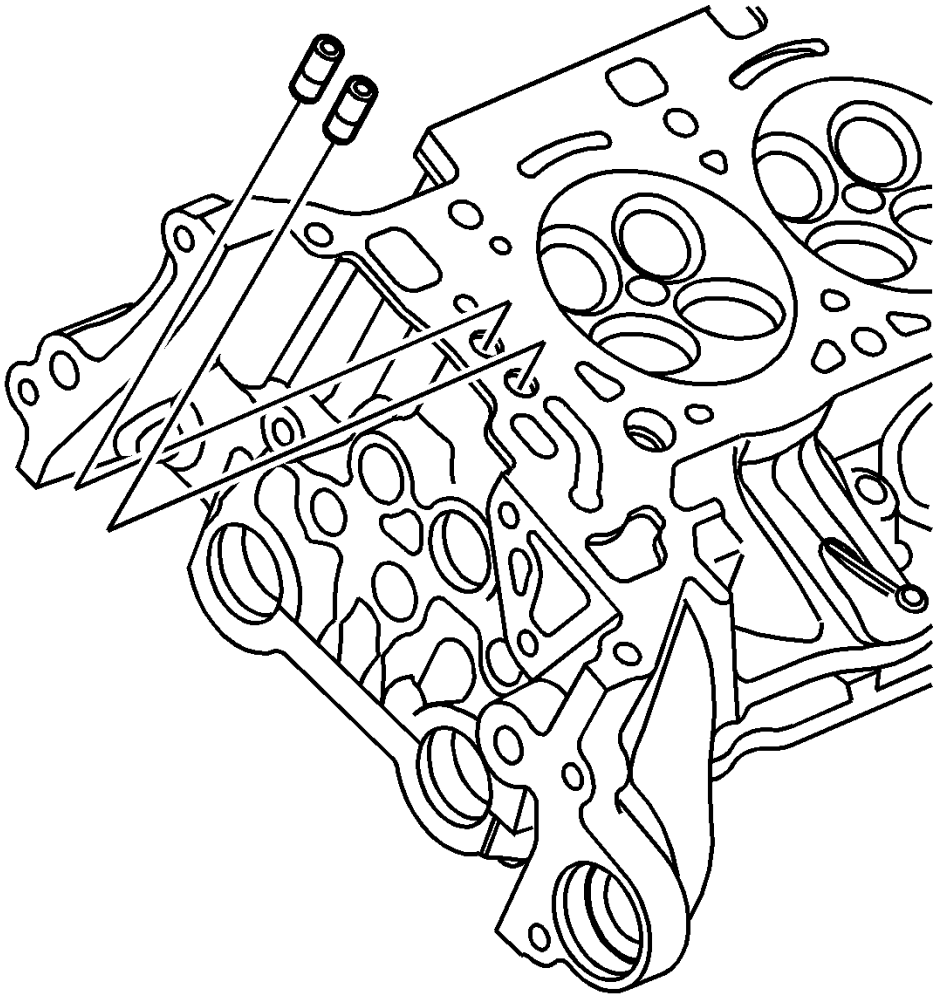


Fig. 196: View Of Camshaft Position Actuator Oil Feed Check Valve
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the camshaft position actuator oil feed check valves. Damaged, restricted or clogged check valves must be replaced. Refer to **Cylinder Head Disassemble**.

cardiagn.com

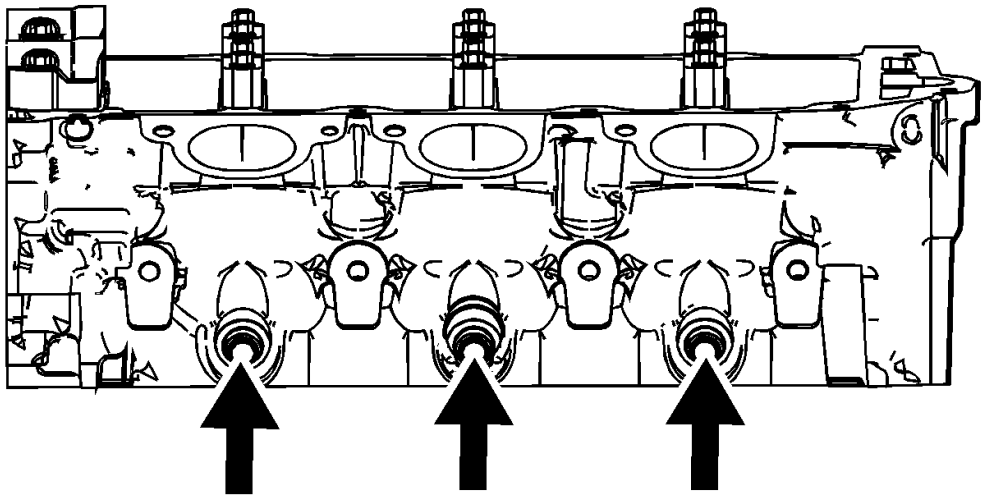


Fig. 197: View of Fuel Rail injector Bores
Courtesy of GENERAL MOTORS COMPANY

6. Inspect the fuel rail injector bores and clean with **EN-47909** kit, if required.

Cylinder Head Measurement

Camshaft Journal Clearance

1. Install the camshaft bearing cap in the cylinder head without the camshaft.
2. Install the camshaft cap bolts and tighten to 10 N.m (89 lb in).

CAUTION: Refer to Fastener Caution .

3. Measure the camshaft bearings using an inside micrometer.
4. Subtract the camshaft journal diameter from the camshaft bearing diameter. This will provide the running

cardiagn.com

clearance. If the running clearance exceeds specifications and the camshaft journals are within specification, replace the cylinder head.

Camshaft Journal Alignment

1. Ensure the camshafts are serviceable.
2. Inspect the cylinder head camshaft bearing surfaces for any imperfections or scratches that could inhibit proper camshaft clearances. Repair minor imperfections or scratches.
3. Install the camshafts in the cylinder head.
4. Install the camshaft bearing caps.
5. Install the camshaft cap bolts and tighten to 10 N.m (89 lb in).
6. Ensure the camshafts spin freely in the cylinder head. If the camshaft does not run freely, replace the cylinder head.

Deck Flatness Inspection

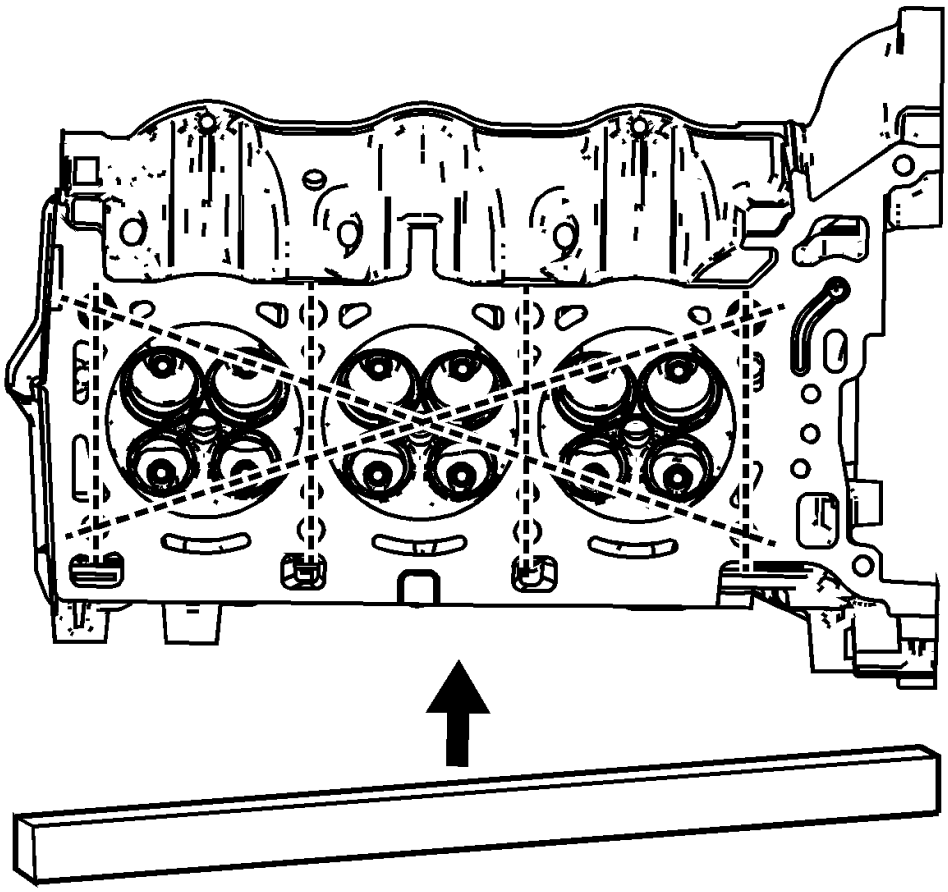


Fig. 198: Measuring Deck Flatness

cardiagn.com

Courtesy of GENERAL MOTORS COMPANY

1. Ensure the cylinder head decks are clean and free of gasket material.
2. Inspect the surface for any imperfections or scratches that could inhibit proper cylinder head gasket sealing.
3. Place a straight-edge diagonally across the cylinder head deck face surface.
4. Measure the clearance between the straight-edge and the cylinder head deck face using a feeler gauge at 4 points along the straight-edge.
5. If the warpage is less than 0.05 mm (0.002 in), the cylinder head deck surface does not require resurfacing.
6. If the warpage is between 0.05-0.20 mm (0.002-0.008 in) or any imperfections or scratches that could inhibit proper cylinder head gasket sealing are present, the cylinder head deck surface requires resurfacing.
7. If resurfacing is required the maximum amount that can be removed is 0.25 mm (0.010 in).
8. If the cylinder head deck surface requires more than 0.25 mm (0.010 in) material removal the head must be replaced.

Valve Guide Measurement

cardiagn.com

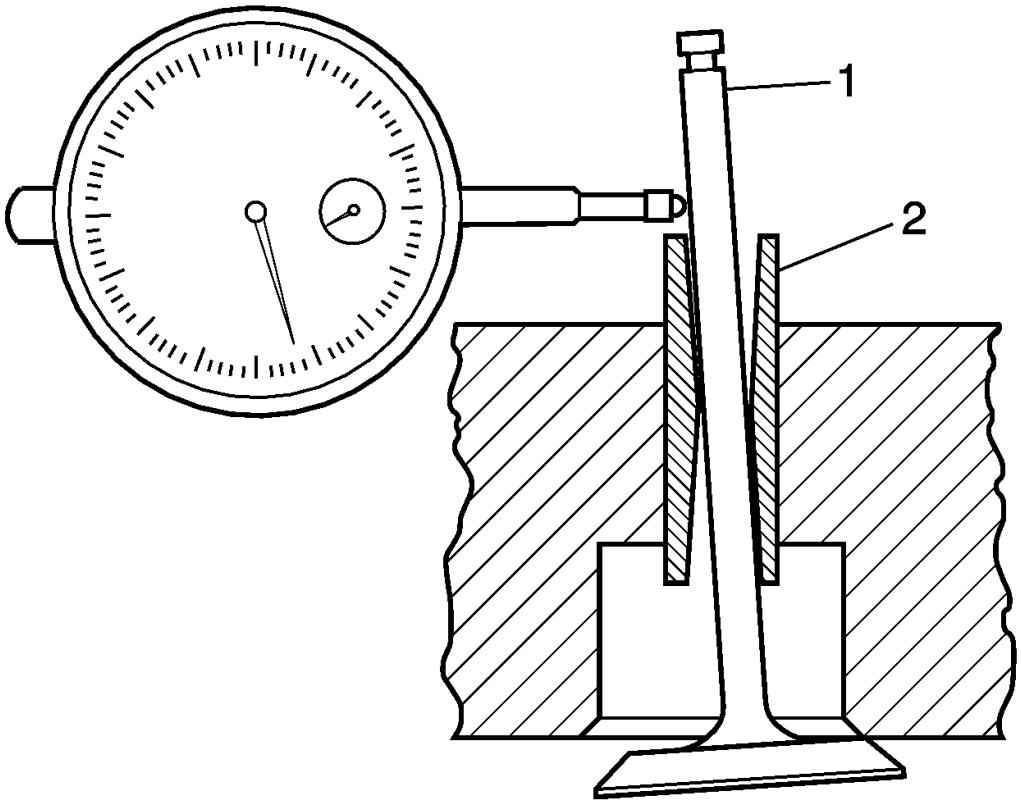


Fig. 199: Inspecting For Excessive Valve Stem To Guide Clearance
Courtesy of GENERAL MOTORS COMPANY

1. Measure the valve stem (1)-to-guide (2) clearance. Excessive valve stem-to-guide clearance may cause an excessive oil consumption and may also cause a valve to break. Insufficient clearance will result in noisy and sticky functioning of the valve and will disturb the engine assembly smoothness.
2. Clamp the **J 8001** set to the cylinder head at the camshaft cover rail.
3. Locate the dial indicator so that the movement of the valve stem from side to side, crossways to the cylinder head, will cause a direct movement of the indicator stem. The dial indicator stem must contact the side of the valve stem just above the valve guide.
4. Drop the valve head about 0.064 mm (0.0025 in) off the valve seat.
5. Use light pressure when moving the valve stem from side to side in order to obtain a clearance reading. Refer to **Engine Mechanical Specifications** for proper clearance.
    - If the clearance for the valve is greater than specifications and a new standard diameter valve stem will not bring the clearance within specifications, the valve guide may be oversized by 0.075 mm (0.003 in) using the **J 42096** reamer. There is 1 size of oversized valve stem available for service.
    - Valve guide wear at the bottom 10 mm (0.390 in) of the valve guide is not significant to normal

cardiagn.com

operation.

- If oversizing the guide does not bring the clearance within specifications, replace the cylinder head.

VALVE SPRING INSPECTION AND MEASUREMENT

Special Tools

EN 22738-B Valve Spring Tester

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

Inspection Procedure

1. Clean the valve springs in solvent.
2. Dry the valve springs with compressed air.

WARNING: Refer to Safety Glasses Warning .

3. Inspect the valve springs for broken coils or coil ends.

Measurement Procedure

1. Measure the valve spring tension using the **EN 22738-B** tester. Refer to **Engine Mechanical Specifications** .

cardiagn.com

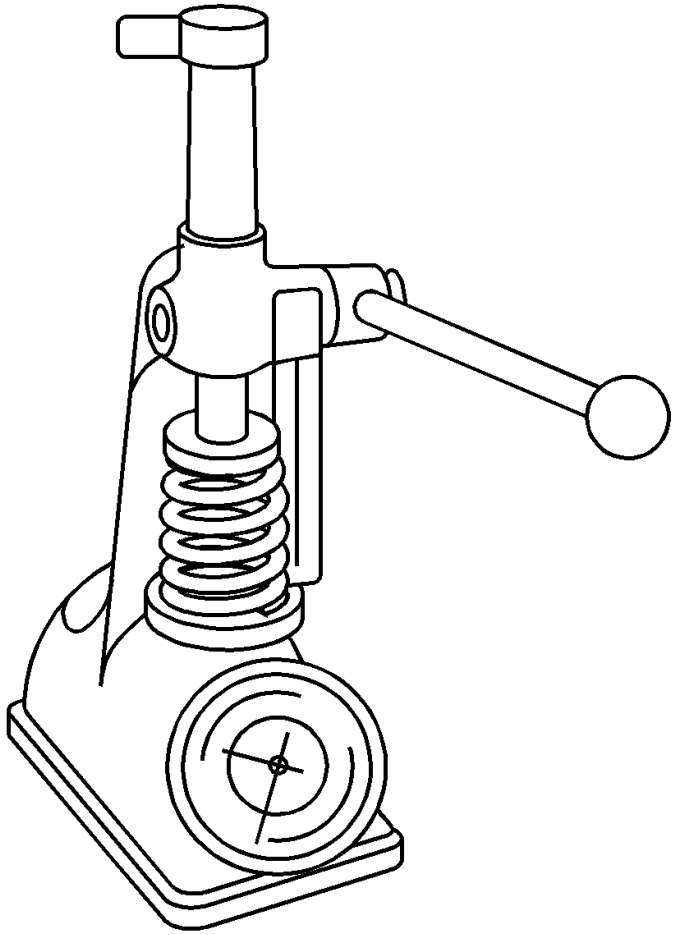


Fig. 200: Measuring Valve Spring Tension
Courtesy of GENERAL MOTORS COMPANY

2. If low valve spring load is found, replace the valve springs. DO NOT use shims to increase spring load. The use of shims can cause the valve spring to bottom out before the camshaft lobe is at peak lift.

VALVE AND SEAT GRINDING

Valve Cleaning Procedure

1. Use soft bristle wire brush to clean any carbon build-up from the valve head. DO NOT use a wire brush on any part of the valve stem. The valve stem is chrome plated to provide enhanced wear characteristics. Wire brushing the stem could remove the chrome plating.
2. Thoroughly clean the valve with solvent and wipe dry.

Valve Visual Inspection Procedure

1. Inspect the valve for damage from the head to tip for the following conditions:

cardiagn.com

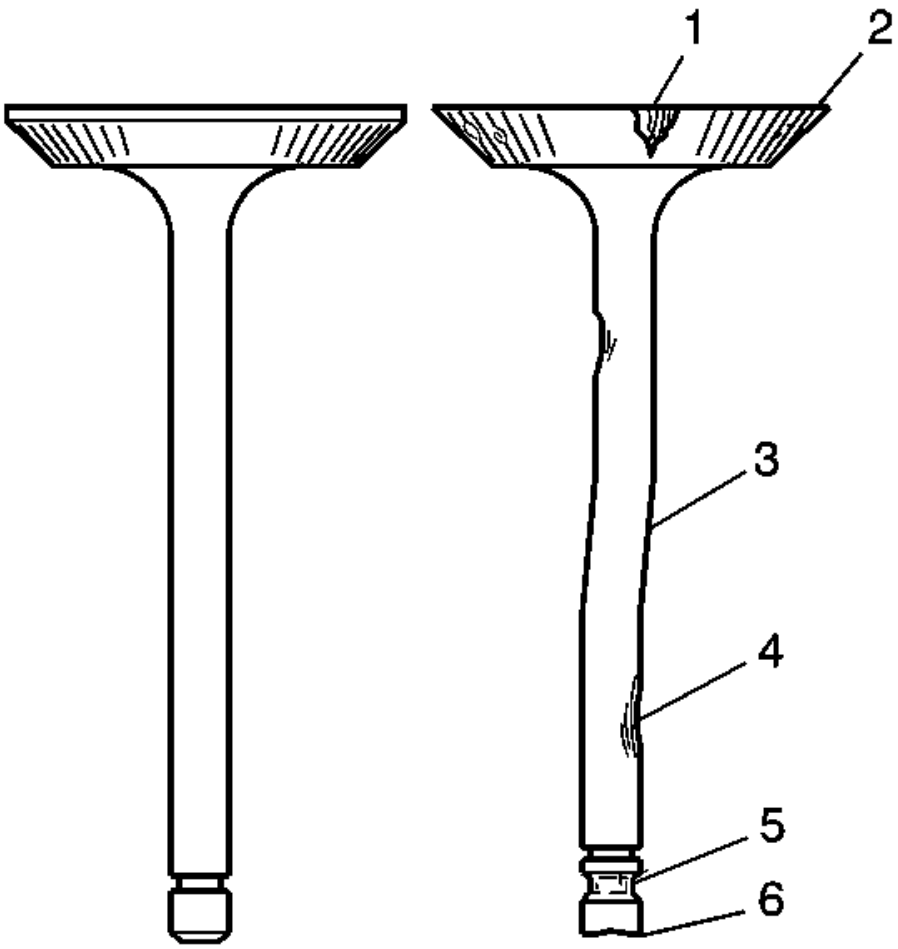


Fig. 201: Identifying Inspection Points For Valves Damage
Courtesy of GENERAL MOTORS COMPANY

- Pitting in the valve seat area (1)
- Lack of valve margin (2)
- Bending in the valve stem (3)
- Pitting or excessive wear in the stem (4)
- Worn valve key grooves (5)
- Worn valve tip (6)

2. Replace the valve if any of these conditions exist.

Valve Measurement Overview

1. Proper valve service is critical to engine performance. Therefore, all detailed measurement procedures must be followed to identify components that are out of specification.

cardiagn.com

NOTE: The following measurement and reconditioning procedures must be followed to ensure proper engine performance.

2. If the measurement procedures reveal that the valve seat must be reconditioned, it is critical to perform the measurement procedures after reconditioning. Valves for E85-compatible engines CANNOT be reconditioned. Any grinding, lapping, wire-brushing or other similar procedure will damage or destroy the coating that gives the valve the E-85 compatible features. If an E85-compatible valve is out of specification in any area, replace it.

Valve Seat Width Measurement Procedure

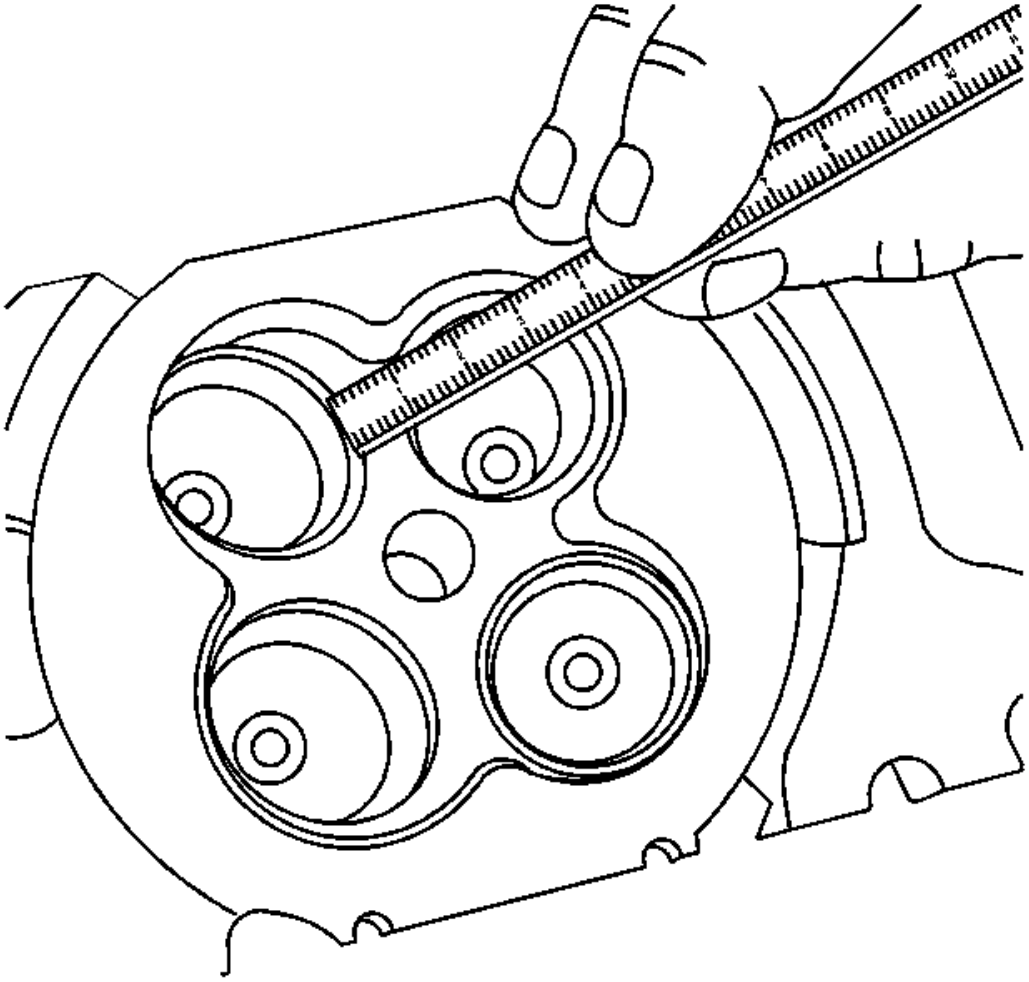


Fig. 202: Checking Valve Seat Width
Courtesy of GENERAL MOTORS COMPANY

1. Measure the valve seat width in the cylinder head using a proper scale.

cardiagn.com

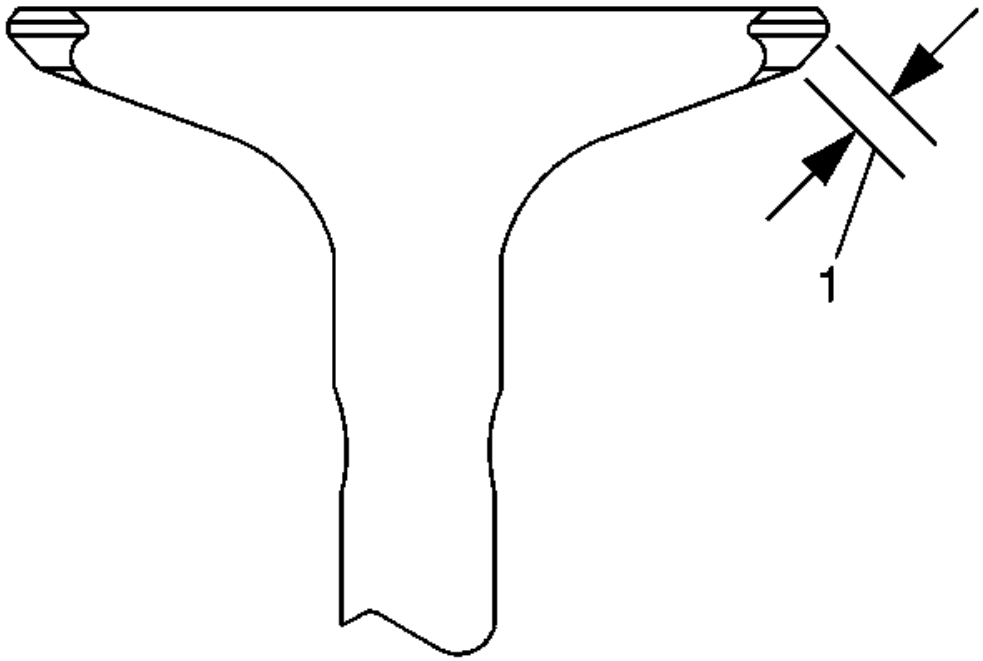


Fig. 203: Measuring Seat Width On Valve Face
Courtesy of GENERAL MOTORS COMPANY

2. Measure the seat width on the valve face (1) using a proper scale.
3. Compare your measurements with the specifications listed in **Engine Mechanical Specifications** .

NOTE: The seat contact area must be at least 0.5 mm (0.020 in) from the outer diameter (margin) of the valve. If the contact area is too close to the margins, the valve must be replaced.

4. If the seat widths are acceptable, check the valve seat roundness using the Valve Seat Roundness Measurement Procedure.
5. If the seat width is not acceptable, you must replace the valve. Proper valve seat width is critical to providing the correct amount of valve heat dissipation.

Valve Seat Roundness Measurement Procedure

cardiagn.com

1. Measure the valve seat roundness using a dial indicator attached to a tapered pilot installed in the guide. The pilot should have a slight bind when installed in the guide.
2. Compare your measurements with the specifications listed in **Engine Mechanical Specifications** .

CAUTION: The correct size pilot must be used. Do not use adjustable diameter pilots. Adjustable pilots may damage the valve guides.

3. If the valve seat exceeds the roundness specification, you must replace the valve.
4. If new valves are being used, the valve seat roundness must be within 0.05 mm (0.002 in).

Valve Margin Measurement Procedure

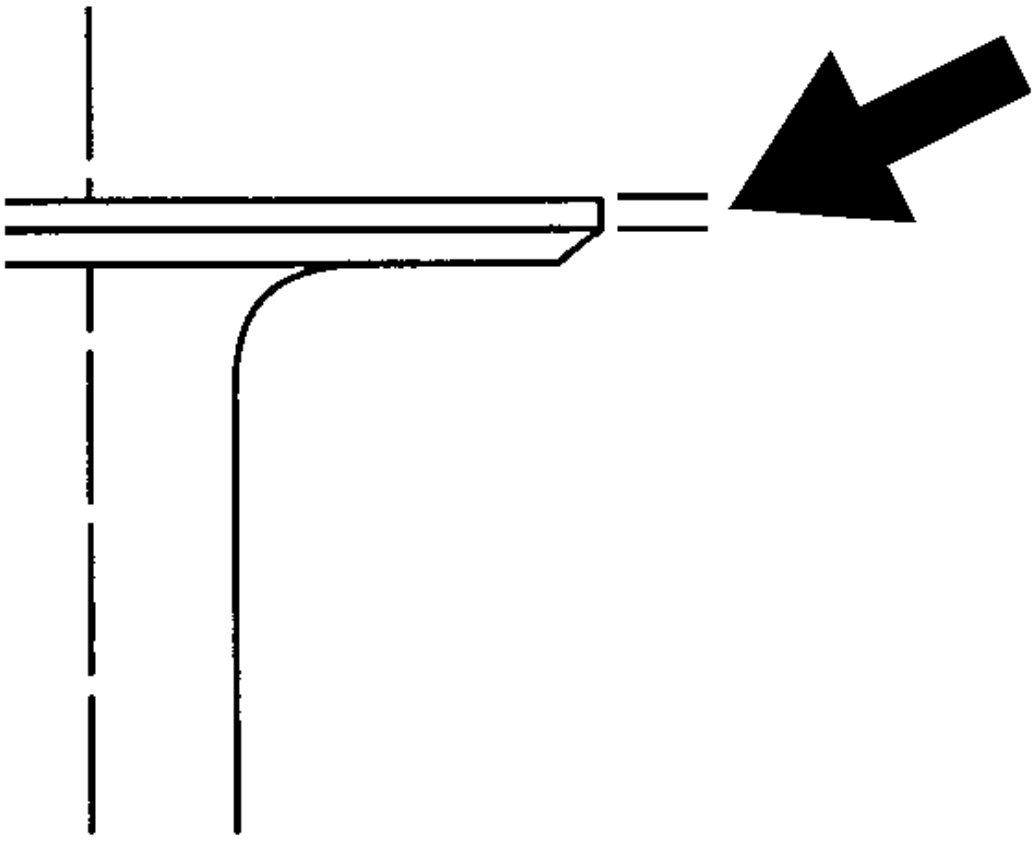


Fig. 204: View Of Valve Margin Measurement
Courtesy of GENERAL MOTORS COMPANY

cardiagn.com

1. Measure the valve margin using an appropriate scale.
2. Reference the specifications in this section for minimum valve margin and compare them to your measurements.
3. If the valve margins are beyond specification, replace the valves.
4. If the valve margins are within specification, test the valve for seat concentricity using **Valve-to-Seat Concentricity Measurement Procedure**.

Valve-to-Seat Concentricity Measurement Procedure

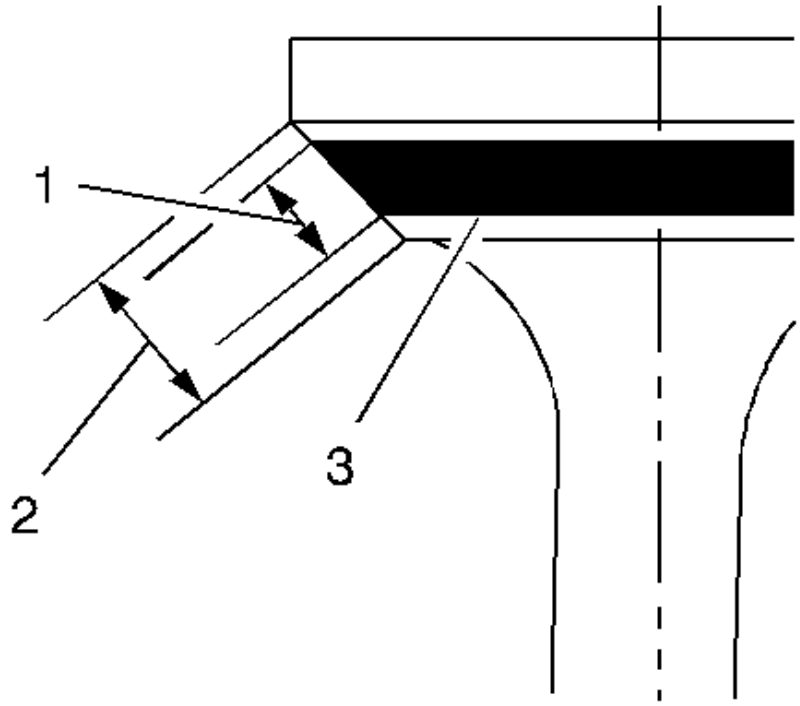


Fig. 205: View Of Valve Contact Face Measurements
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Checking the valve-to-seat concentricity determines whether the valve and seat are sealing properly.**

cardiagn.com

- **You must measure the valve face and the valve seat to ensure proper valve sealing.**

1. Coat the valve face lightly with blue dye (3).
2. Install the valve in the cylinder head.
3. Turn the valve against the seat with enough pressure to wear off the dye.
4. Remove the valve from the cylinder head.
5. Inspect the valve face.
    - If the valve face is concentric, providing a proper seal-with the valve stem, a continuous mark will be made around the entire face (1).

NOTE: **The wear mark MUST be at least 0.5 mm (0.020 in) from the outer diameter, the margin, of the valve. If the wear mark is too close to the margin, the seat must be reconditioned to move the contact area away from the margin.**

    - If the face is not concentric with the stem, the mark will NOT be continuous around the valve face. The valve should be replaced and the seat must be reconditioned using **Valve and Seat Reconditioning Procedure**.

Valve and Seat Reconditioning Procedure

cardiagn.com

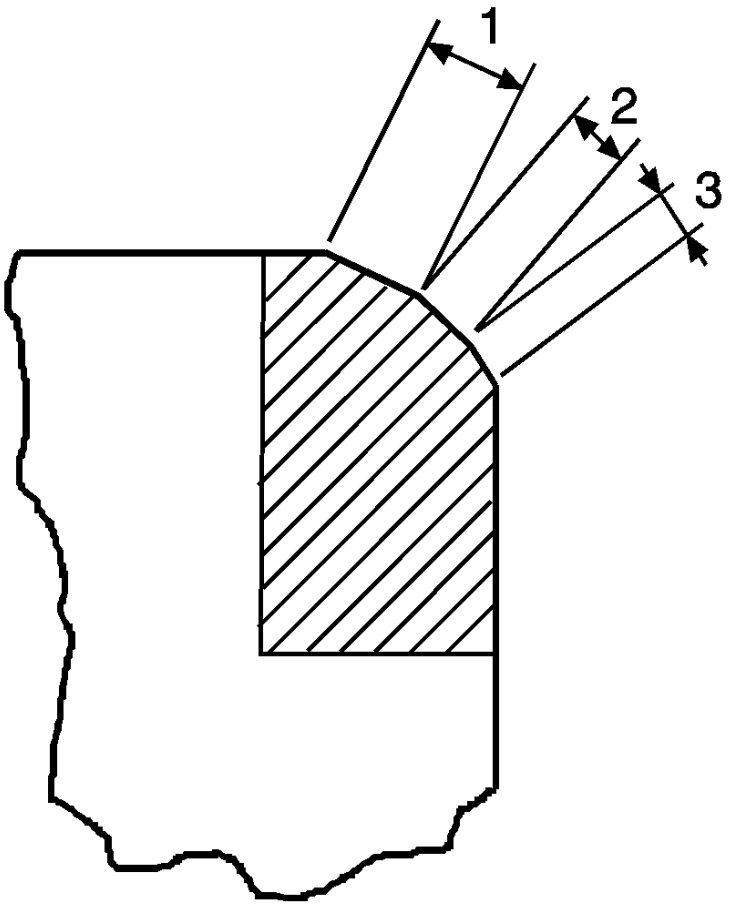


Fig. 206: View Of Valve Seat Proper Angles
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **If the valve seat width, roundness or concentricity is beyond specifications, you must grind the seats in order to ensure proper heat dissipation and prevent the buildup of carbon on the seats.**
- **A NEW valve must be used with any reconditioned seat.**

1. Grind the valve seats (2) to the proper angle specification listed in **Engine Mechanical Specifications** .
2. Using the proper angle specification listed in **Engine Mechanical Specifications** , grind, relieve, the valve seats (1) to correctly position the valve seating surface (2) to the valve.
3. Using the proper angle specification listed in **Engine Mechanical Specifications** , grind, undercut, the valve seats (3) to narrow the valve seat widths to the specifications listed in **Engine Mechanical Specifications** .
4. When grinding the seats, grind off as little material as possible. Cutting valve seat results in lowering the

cardiagn.com

valve spring pressure.

5. Install the valve in the cylinder head. Do not lap the valves under any condition, whether the valves are new or used.
6. After obtaining the proper valve seat width in the cylinder head, you must re-measure the valve stem height using **Valve Stem Height Measurement Procedure**.
7. If the valve stem height is acceptable, test the seats for concentricity using **Valve-to-Seat Concentricity Measurement Procedure**.

Valve Stem Height Measurement Procedure

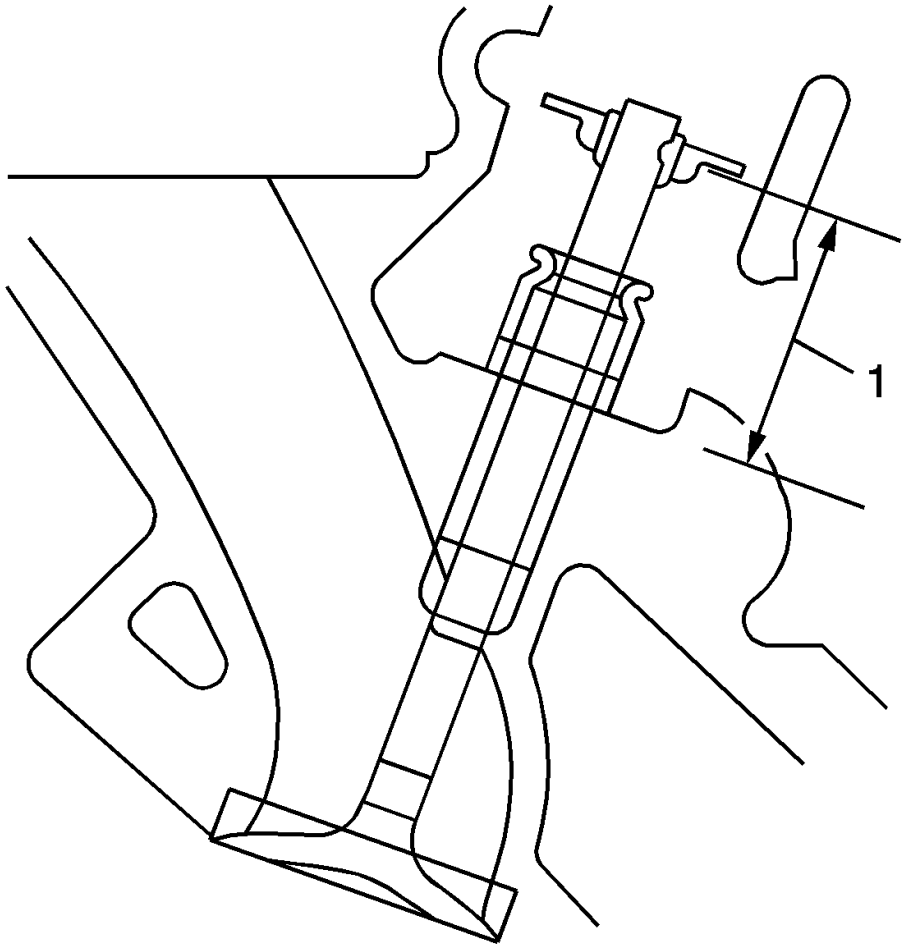


Fig. 207: Measuring Valve Stem Height
Courtesy of GENERAL MOTORS COMPANY

NOTE: To determine the valve stem height measurement, measure from the valve spring seat to the valve spring retainer.

1. Install the valve into the valve guide.

cardiagn.com

2. Ensure the valve is seated to the cylinder head valve seat.
3. Install the valve stem oil seal.
4. Install the valve spring retainer and valve stem locks.
5. Measure the distance (1) between the cylinder head to the bottom of the valve spring retainer. Refer to **Engine Mechanical Specifications** .
6. If the maximum height specification is exceeded, a new valve should be installed and the valve stem height re-measured.
7. If the valve stem height still exceeds the maximum height specification, the cylinder head must be replaced.

CAUTION: DO NOT grind the valve stem tip. The tip of the valve is hardened and grinding the tip will eliminate the hardened surface causing premature wear and possible engine damage.

CAUTION: DO NOT use shims in order to adjust valve stem height. The use of shims will cause the valve spring to bottom out before the camshaft lobe is at peak lift and engine damage could result.

FUEL RAIL AND INJECTORS CLEANING AND INSPECTION

Special Tools

- **EN-47909** Injector Bore and Sleeve Cleaning Kit
- **EN-48266** Injector Seal Installer and Sizer

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

cardiagn.com

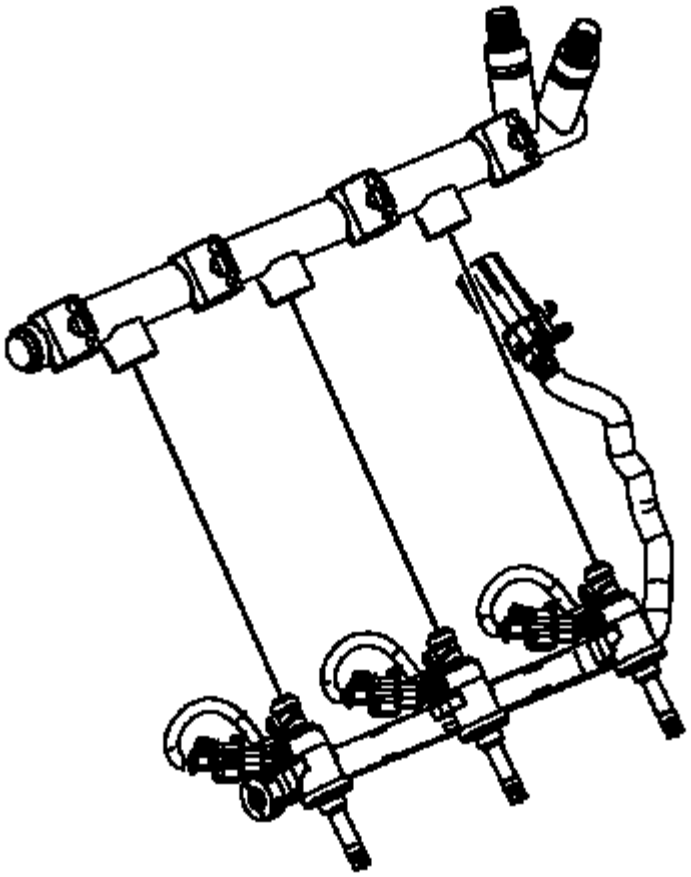


Fig. 208: View of Injector Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Remove the injectors from the fuel rail.

cardiagn.com

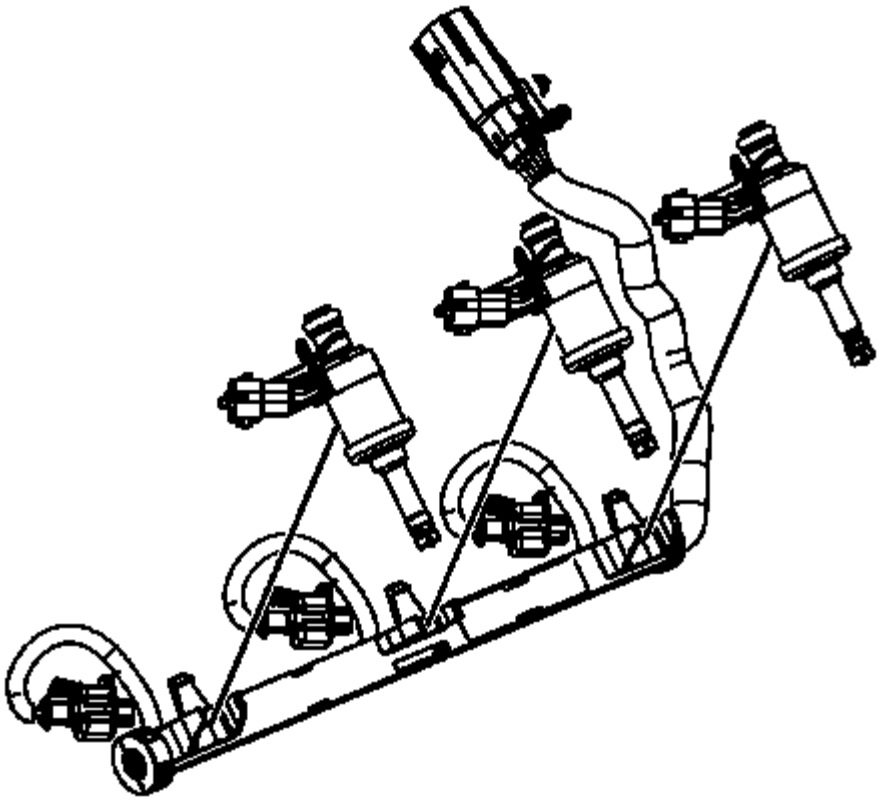


Fig. 209: View Of Wiring Harness & Injectors
Courtesy of GENERAL MOTORS COMPANY

2. Remove the wiring harness from the fuel injectors.

cardiagn.com

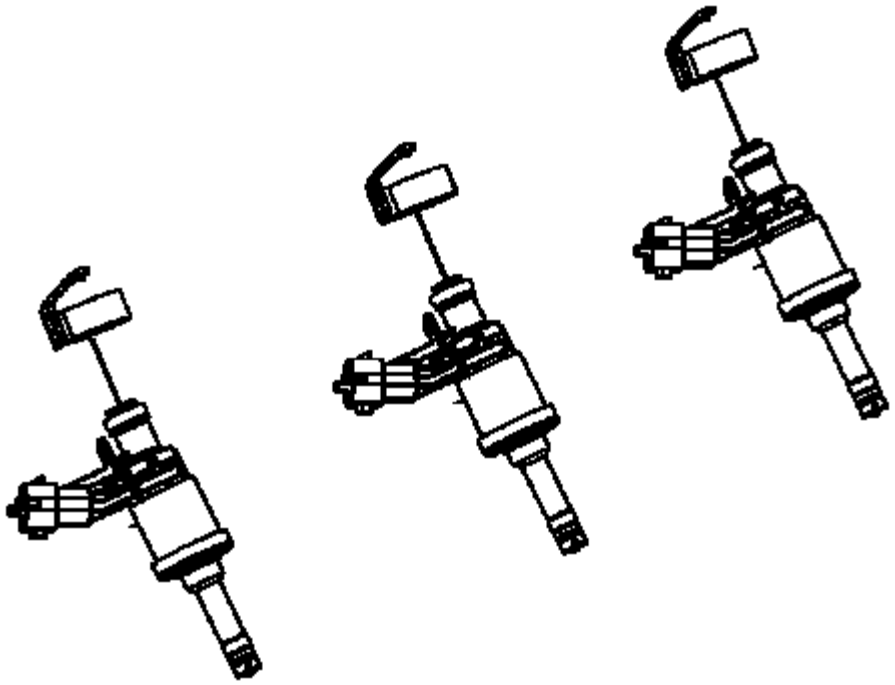


Fig. 210: View of Fuel Injector Clamp
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the fuel injector hold-down clamp.

cardiagn.com

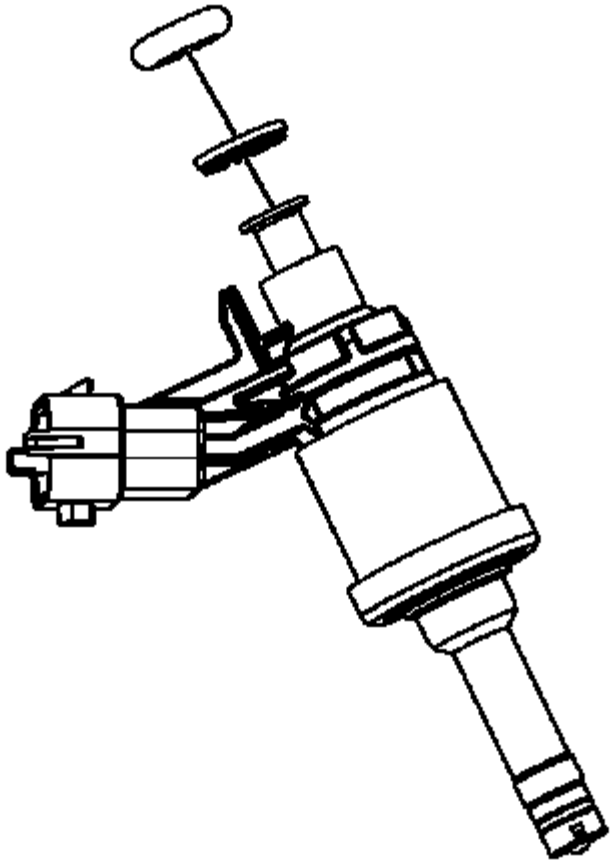


Fig. 211: View Of Fuel Injector O-ring & Plastic Spacer
Courtesy of GENERAL MOTORS COMPANY

4. Remove and discard the fuel injector O-ring and plastic spacer.

cardiagn.com

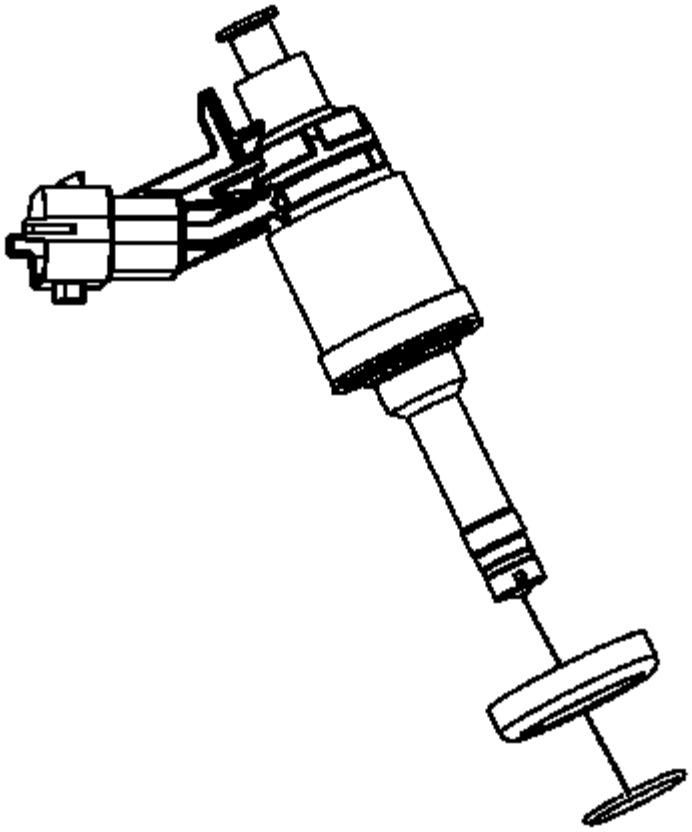


Fig. 212: View Of Isolator Cup & Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Remove and discard the isolator cup and retainer.

cardiagn.com

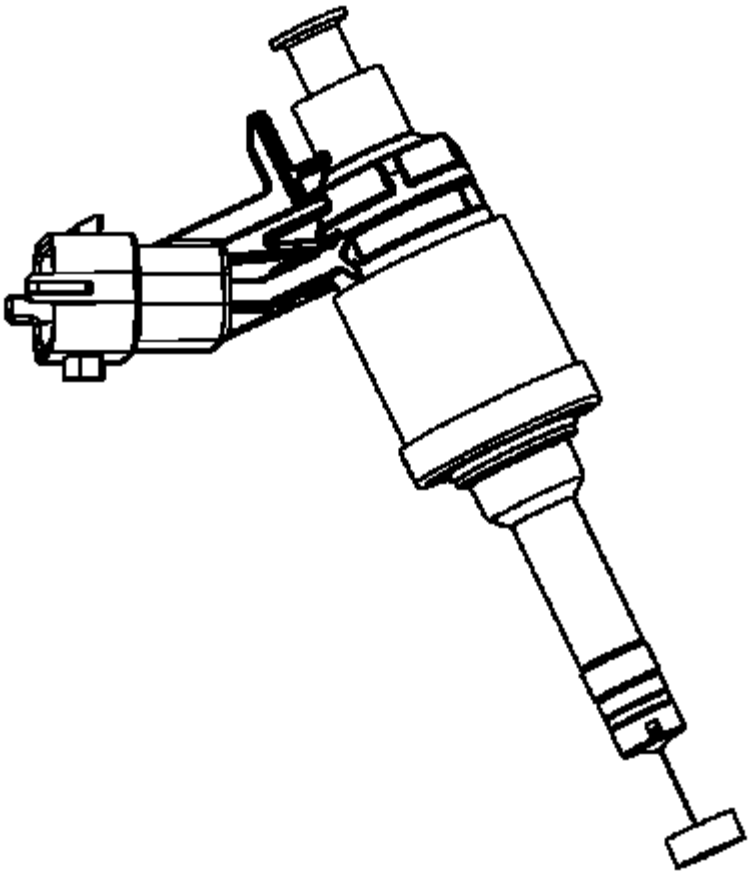


Fig. 213: View of Injector Seal and Assembly
Courtesy of GENERAL MOTORS COMPANY

6. Remove and discard the fuel injector seal.

cardiagn.com

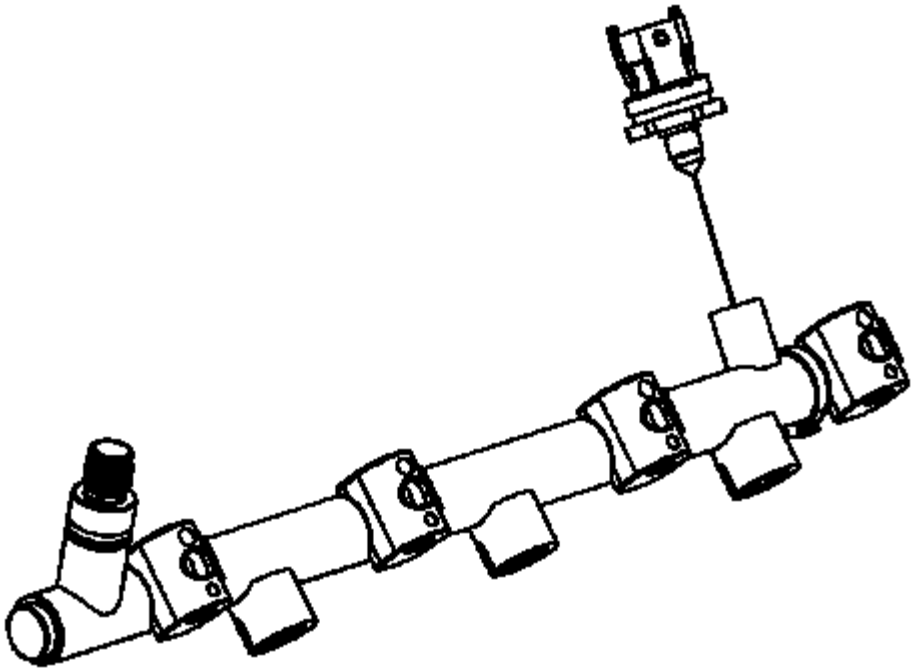


Fig. 214: View of Plastic Housing & Sensor
Courtesy of GENERAL MOTORS COMPANY

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.

7. Remove and discard the fuel pressure sensor.
8. Clean the exterior of the fuel rail and injectors with solvent.

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

cardiagn.com

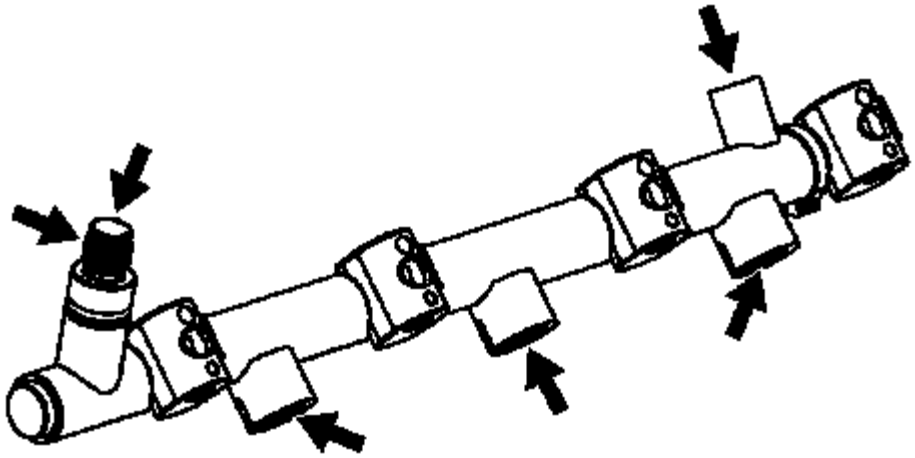


Fig. 215: View Of Fuel Rail & Components
Courtesy of GENERAL MOTORS COMPANY

9. Inspect the fuel rail and components for the following conditions:
   - Damage, debris or restrictions to the fuel rail
   - Damage, debris or restrictions to the fuel ports in the fuel rail
   - Damage to the mounting area for the fuel rail
   - Damage to the fuel rail mounting bolts
   - Damage to the threads on the fuel rail feed fitting
   - Damage to the threads in the fuel pressure sensor bore
10. Install the fuel pressure sensor.

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.

- Lubricate the threads and the sealing cone in the fuel rail with silicon free engine oil. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.

NOTE: Ensure that the fuel rail threads have been cleaned of any excess fuel

cardiagn.com

or the NEW fuel injection fuel rail fuel pressure sensor will NOT seal properly.

- Lubricate the threads and the sealing cone on the NEW fuel injection fuel rail fuel pressure sensor with silicon free engine oil. Refer to **Adhesives, Fluids, Lubricants and Sealers** for recommended lubricant.
- Install the NEW fuel injection fuel rail fuel pressure sensor hand tight.
- Remove the NEW fuel injection fuel rail fuel pressure sensor, re-lubricate following steps 1 and 2 above.
- Install the NEW fuel injection fuel rail fuel pressure sensor and tighten to 33 N.m (25 lb ft).

CAUTION: Refer to Fastener Caution .

11. Inspect the fuel injectors for the following conditions:

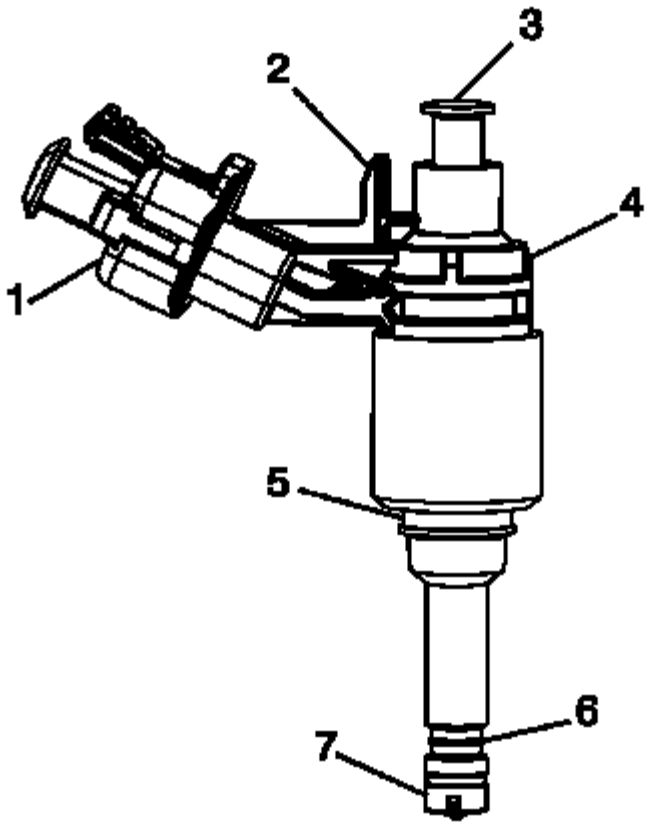


Fig. 216: Identifying Fuel Injector Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

cardiagn.com

- Damage to the fuel injector connector (1)
- Damage to the injector locator tab (2)
- Damage to the fuel inlet cone (3)
- Damage the plastic fuel injector body (4)
- Damage to the isolator cup retainer groove (5)
- Damage to the teflon seal (6)
- Damage to the fuel injector tip (7)

12. Replace the fuel rail or injector if any damage is found. Do not attempt to repair a fuel rail or injector.

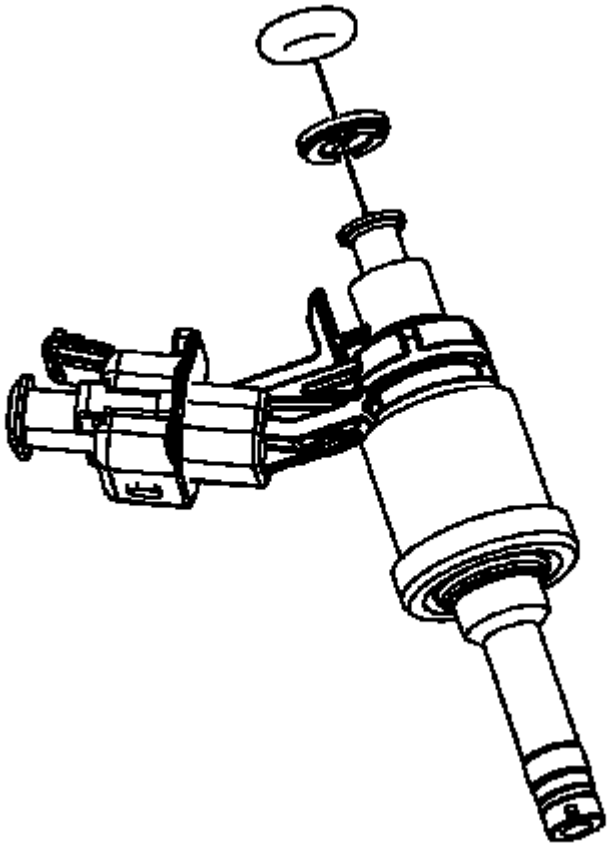


Fig. 217: View Of Fuel Injector Plastic Spacer & O-Ring
Courtesy of GENERAL MOTORS COMPANY

13. Lubricate the NEW O-ring with 5W-30 engine oil.
14. Install the NEW plastic spacer and O-ring on the injector.

NOTE: The plastic spacer has a top and a bottom. The top, O-ring sealing area, is wider.

cardiagn.com

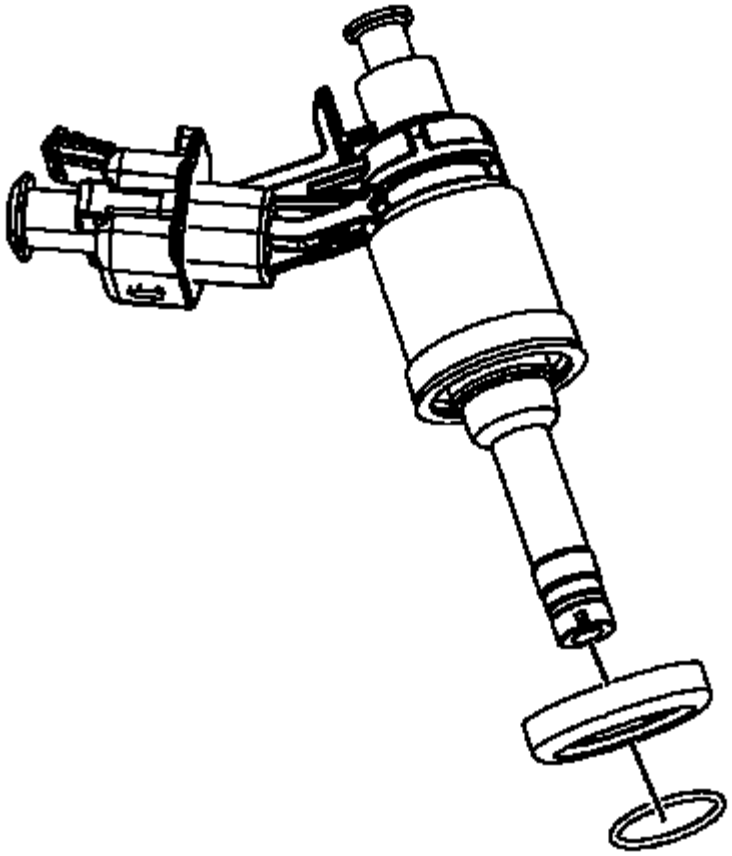


Fig. 218: View of Isolator Cup, Retainer and Injector
Courtesy of GENERAL MOTORS COMPANY

15. Install the isolator cup and retainer.

cardiagn.com

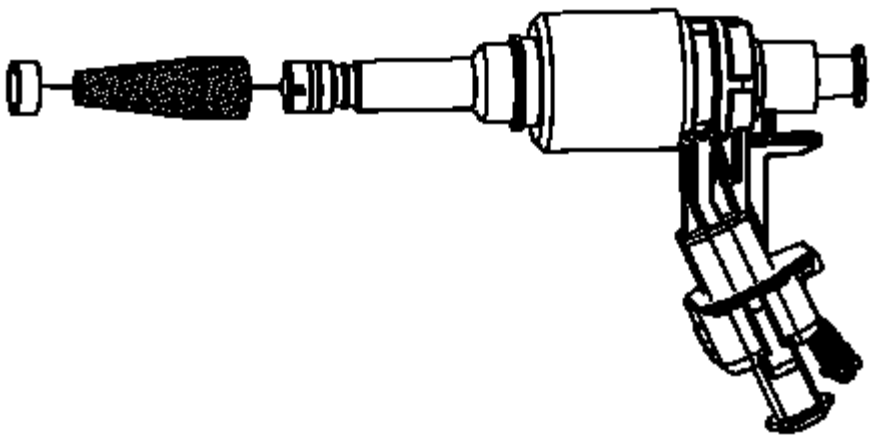


Fig. 219: View of Seal & Injector
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not use any type of lubricant when installing the NEW seal.

16. Install a NEW seal on the injector using the EN-48266-1. The seal must be installed/slid into the recessed area of the fuel injector.

cardiagn.com

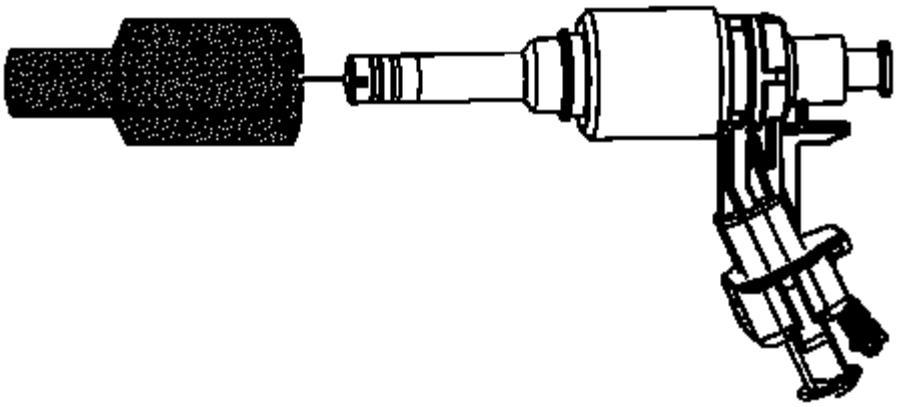


Fig. 220: View of special Tool EN-4866-2 & Injector
Courtesy of GENERAL MOTORS COMPANY

17. Compress the seal with your fingers before resizing the seal using the EN-48266-2.

cardiagn.com

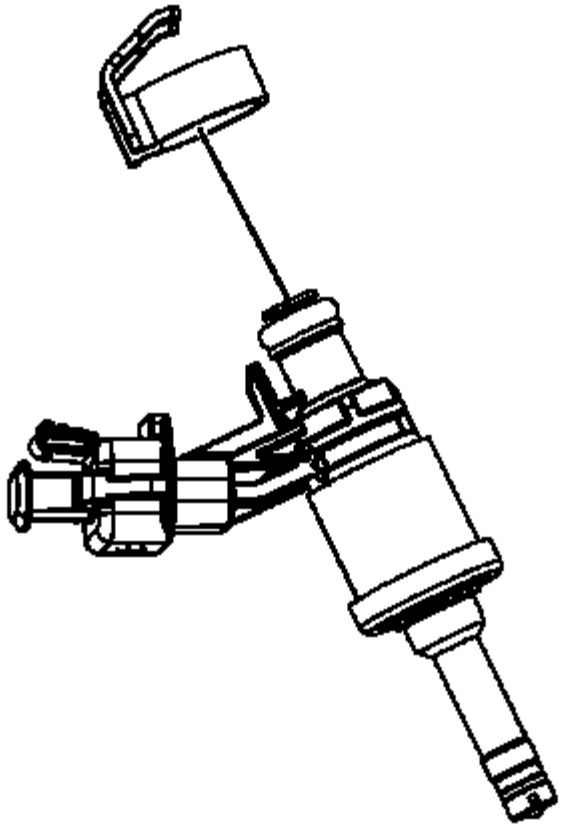


Fig. 221: View of Injector Assembly
Courtesy of GENERAL MOTORS COMPANY

18. Install a NEW fuel injector hold-down clamp.

CYLINDER HEAD ASSEMBLE

Special Tools

- **EN 46116** Valve Stem Seal Remover/Installer
- **EN 46117** Valve Stem Key Remover/Installer
- **EN 46119** Off-Vehicle Valve Spring Compressor Adapter
- **EN 46122** Camshaft Position Actuator Check-Ball Valve Remover/Installer
- **J 8062** Valve Spring Compressor - Head Off

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

cardiagn.com

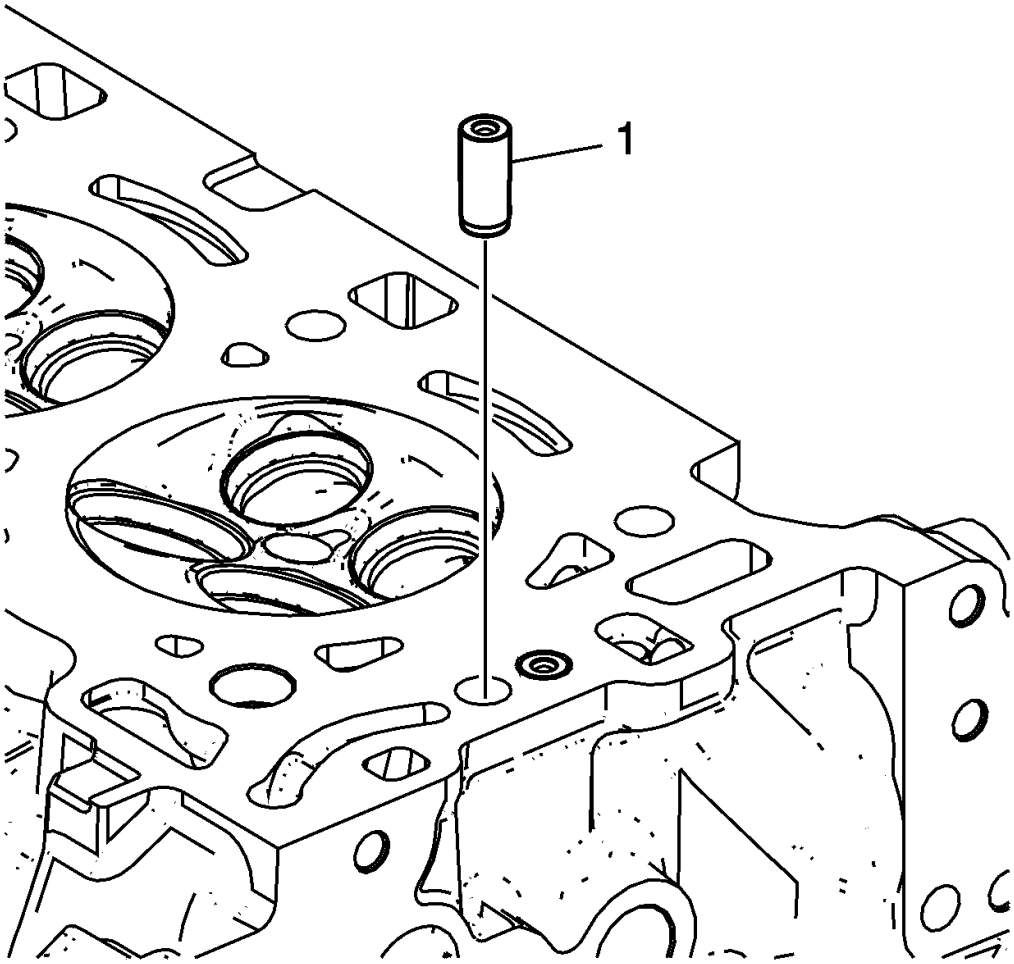


Fig. 222: Lubricate Outside Of New Check Valve
Courtesy of GENERAL MOTORS COMPANY

1. Use lubricant included with **EN 46122** remover/installer to lubricate outside of new check valve (1).
2. With the check ball end of the check valve facing UP, away from the head, insert the NEW check valve into the check valve bore in the cylinder head.

cardiagn.com

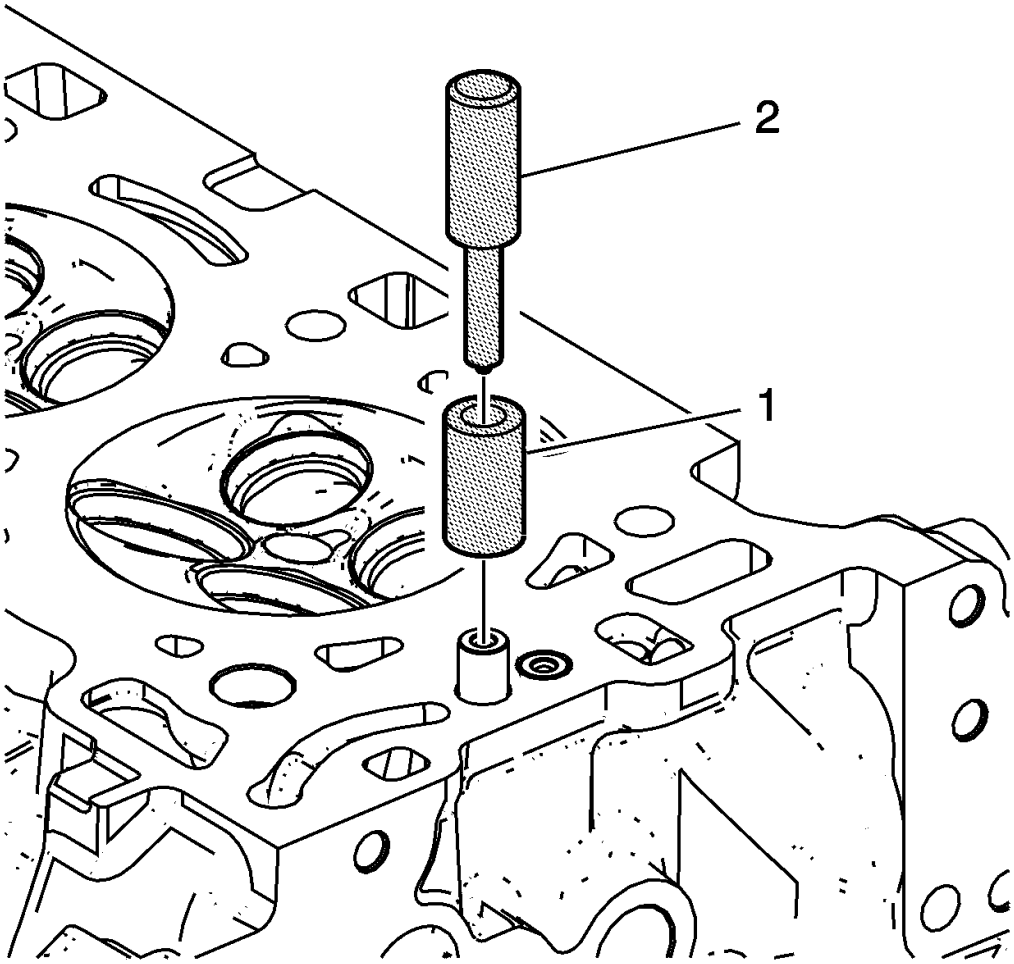


Fig. 223: Identifying Special Tools EN-46122-2 & EN-46122-1 Over New Check Valve
Courtesy of GENERAL MOTORS COMPANY

3. Place collar EN 46122-2 (1) over the new check valve with the slightly-larger inside diameter of the collar DOWN toward the cylinder head.
4. Using the driver EN 46122-1 (2), lightly tap the new check valve into place until the driver stops against the top of the collar.

cardiagn.com

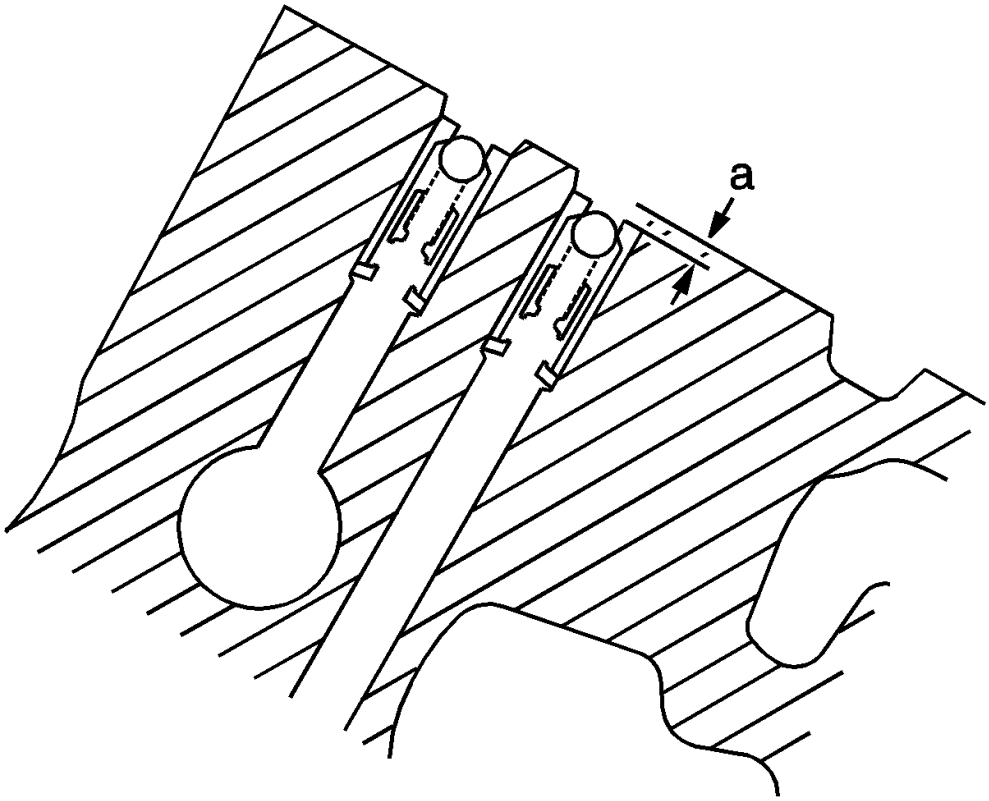


Fig. 224: Inspecting Camshaft Position Actuator Oil Feed Check Valve
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the camshaft position actuator oil feed check valves in order to ensure they are properly installed in the cylinder head. The camshaft position actuator oil feed check valve should be flush to 2 mm (0.0787 in) below the cylinder head deck surface (a).

cardiagn.com

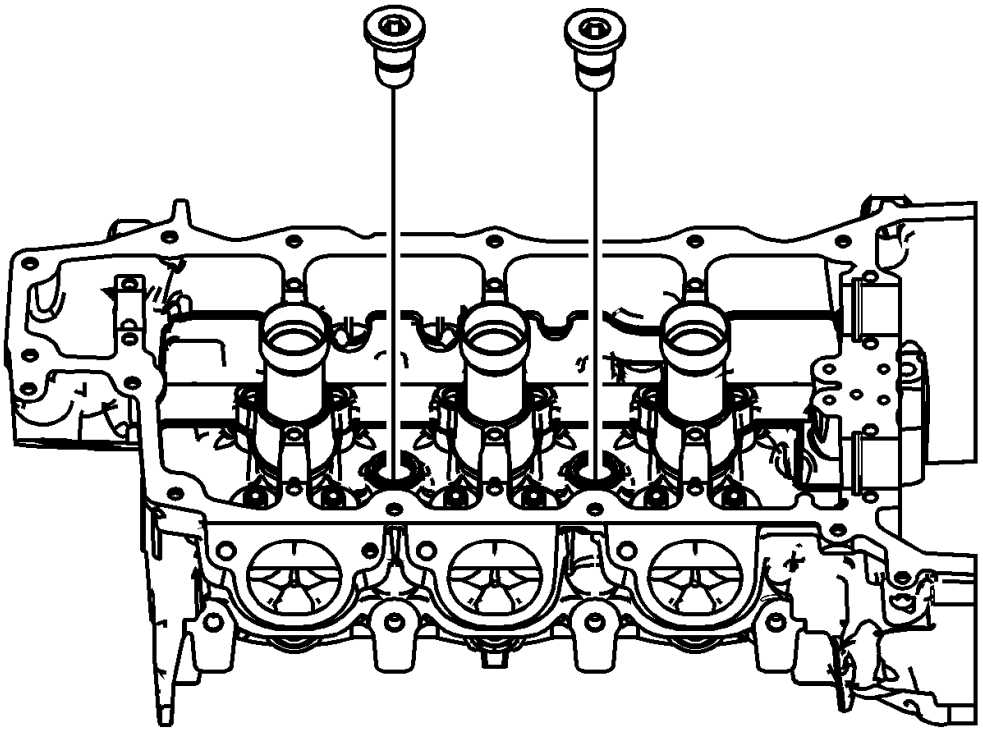


Fig. 225: View Of Cylinder Head Coolant Threaded Plugs
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Install the cylinder head coolant threaded plugs and tighten to 31 N.m (23 lb ft).

cardiagn.com

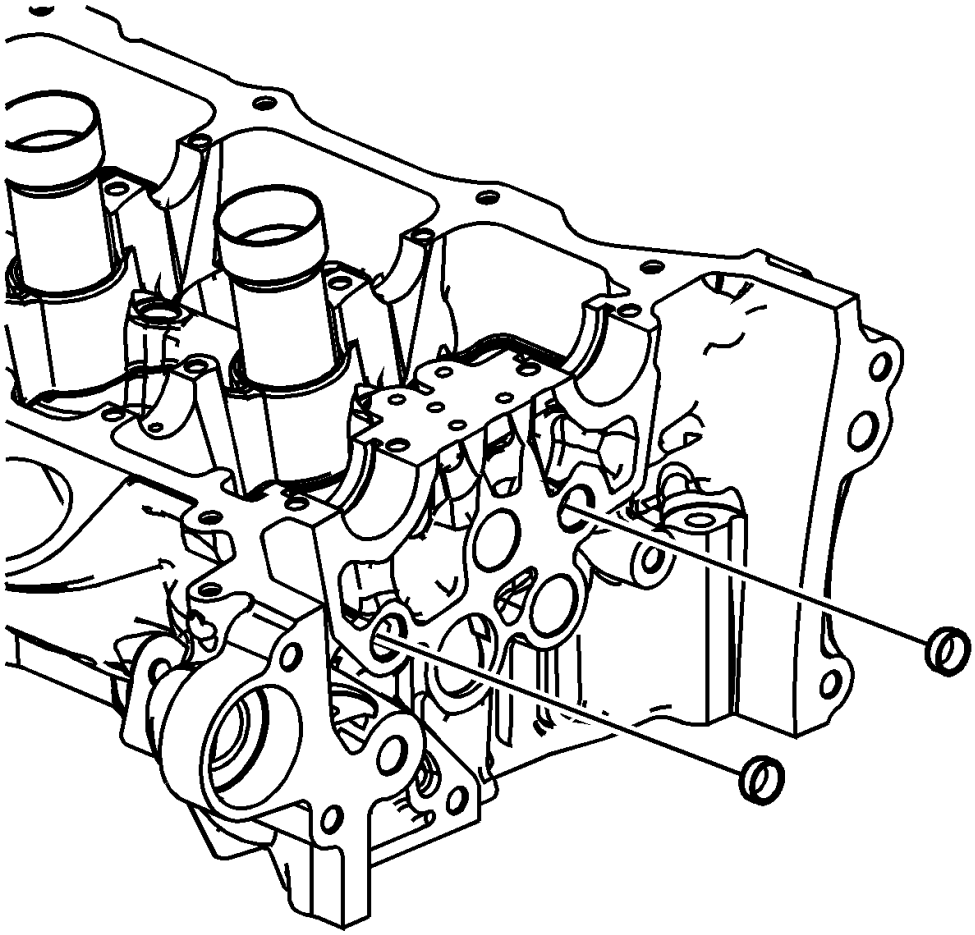


Fig. 226: View Of Cylinder Head Oil Gallery Expansion Plugs
Courtesy of GENERAL MOTORS COMPANY

7. Install the NEW cylinder head oil gallery expansion plugs.

cardiagn.com

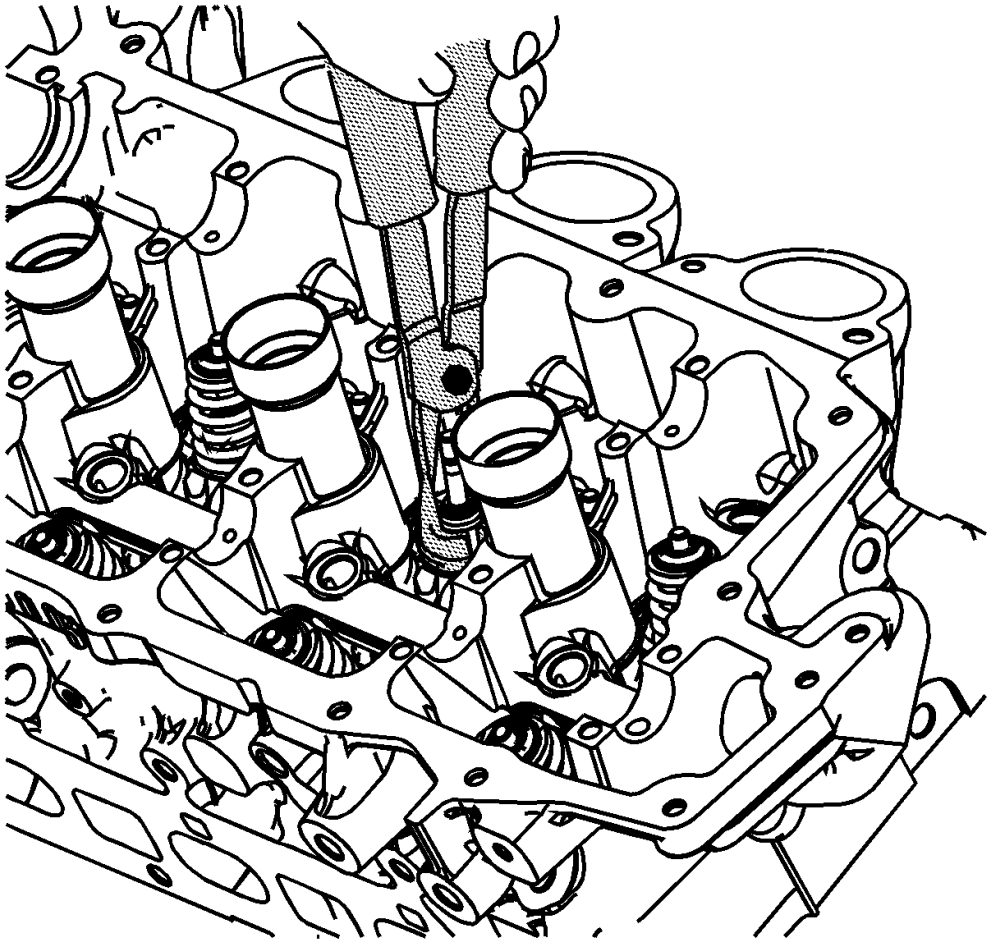


Fig. 227: View of Special Tool EN 46116 & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

8. Place the valve stem oil seals onto the guides.
9. Mount a new valve stem oil seal using the **EN 46116** remover/installer.

NOTE: NEVER reuse a valve stem oil seal. Always use new seals when assembling the cylinder head.

10. Push and twist the valve stem oil seal into position on the valve guide until the seal positively locks on the guide using the **EN 46116** remover/installer.

NOTE: Force should only be applied to the valve spring contact area of the new valve stem oil seal during installation.

11. Lubricate the valve stem and valve guide ID with clean engine oil GM P/N 12345501 (Canadian P/N 992704) or equivalent.

cardiagn.com

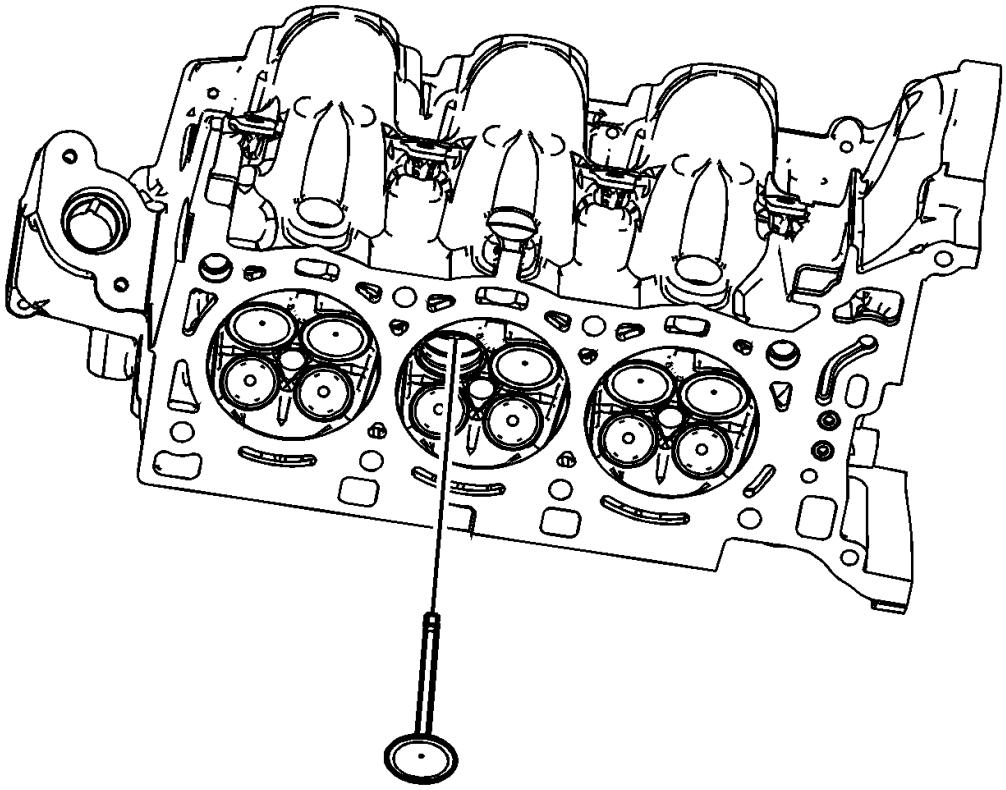


Fig. 228: View of Oil Seal and Valve Guide
Courtesy of GENERAL MOTORS COMPANY

NOTE: The valve stem oil seal must not come loose from the valve guide when the valve is installed.

12. Insert the valve into the valve guide until it bottoms on the valve seat.

cardiagn.com

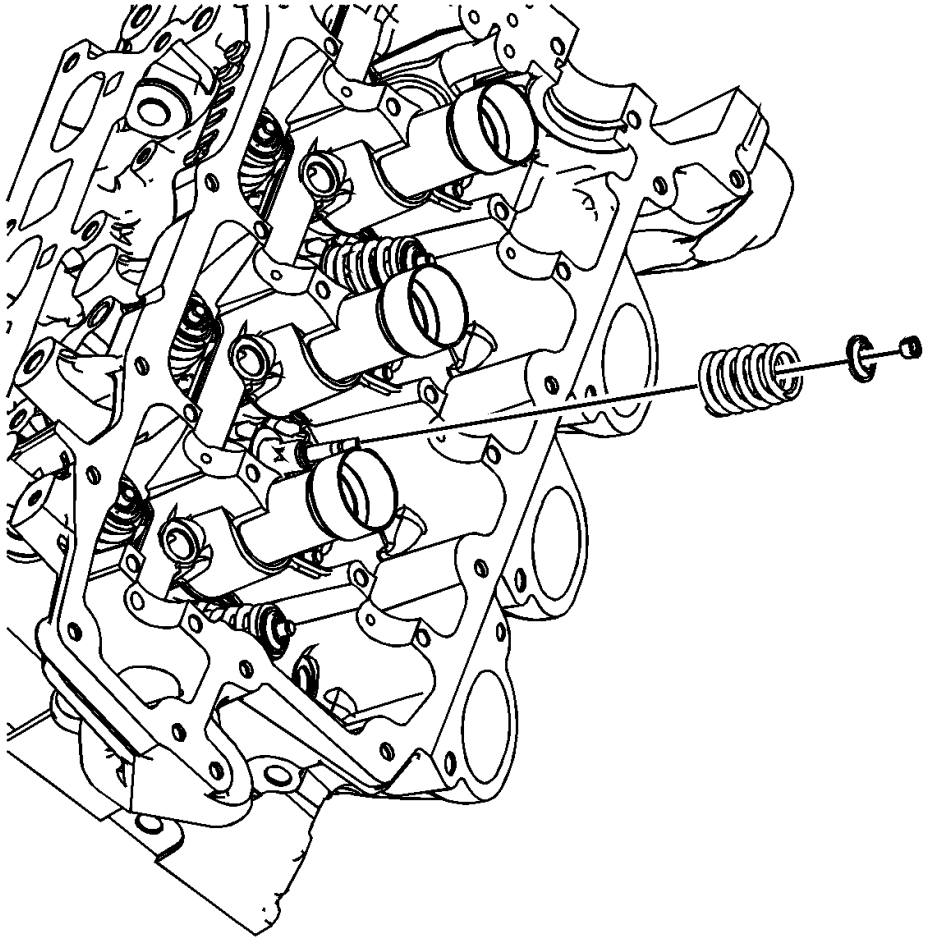


Fig. 229: View Of Valve Spring & Retainer
Courtesy of GENERAL MOTORS COMPANY

13. Position the valve spring on the spring seat.
14. Place the valve spring retainer onto the valve spring.

cardiagn.com

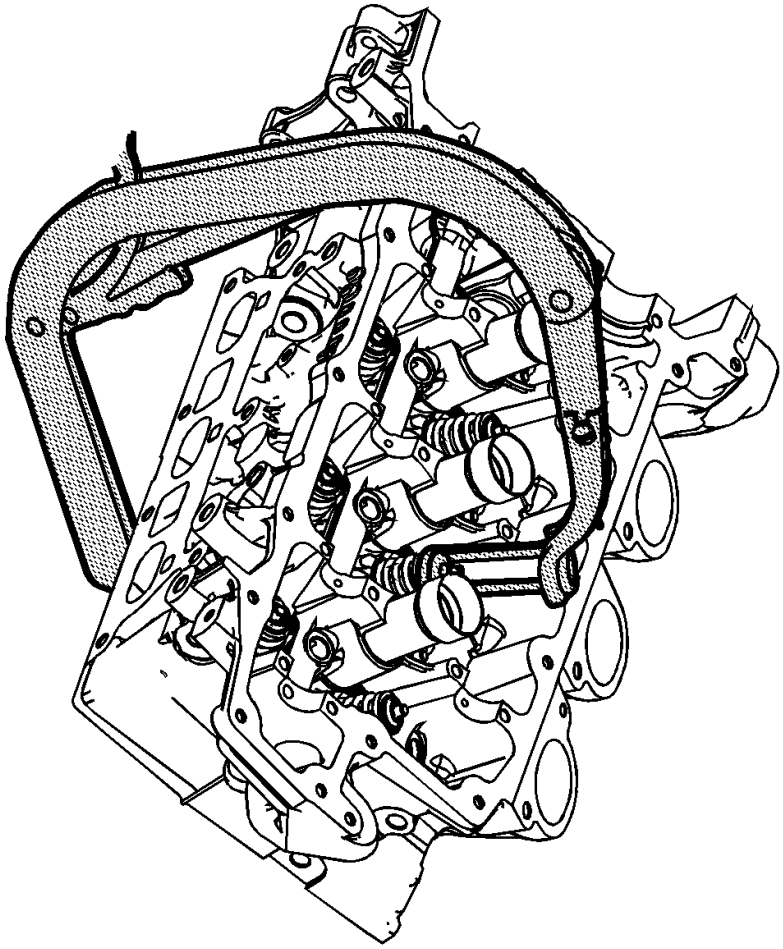


Fig. 230: Compressing Valve Spring
Courtesy of GENERAL MOTORS COMPANY

WARNING: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

CAUTION: Do not compress the valve springs to less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

15. Compress the valve spring using the **J 8062** compressor and the **EN 46119** adapter.

cardiagn.com

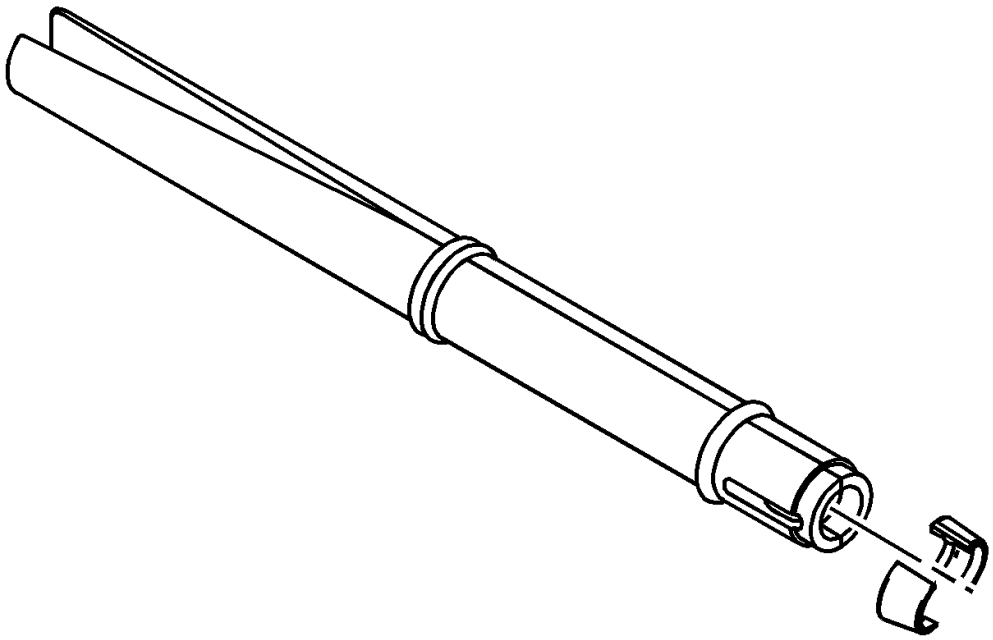


Fig. 231: View Of Valve Keepers With Special Tool EN 46117
Courtesy of GENERAL MOTORS COMPANY

NOTE: Ensure proper directional placement of valve keepers in the EN 46117 remover/installer. The valve keepers must be installed with the tapered end towards the valve stem seal.

16. With the spring compressed, install the valve keepers into the **EN 46117** remover/installer.

cardiagn.com

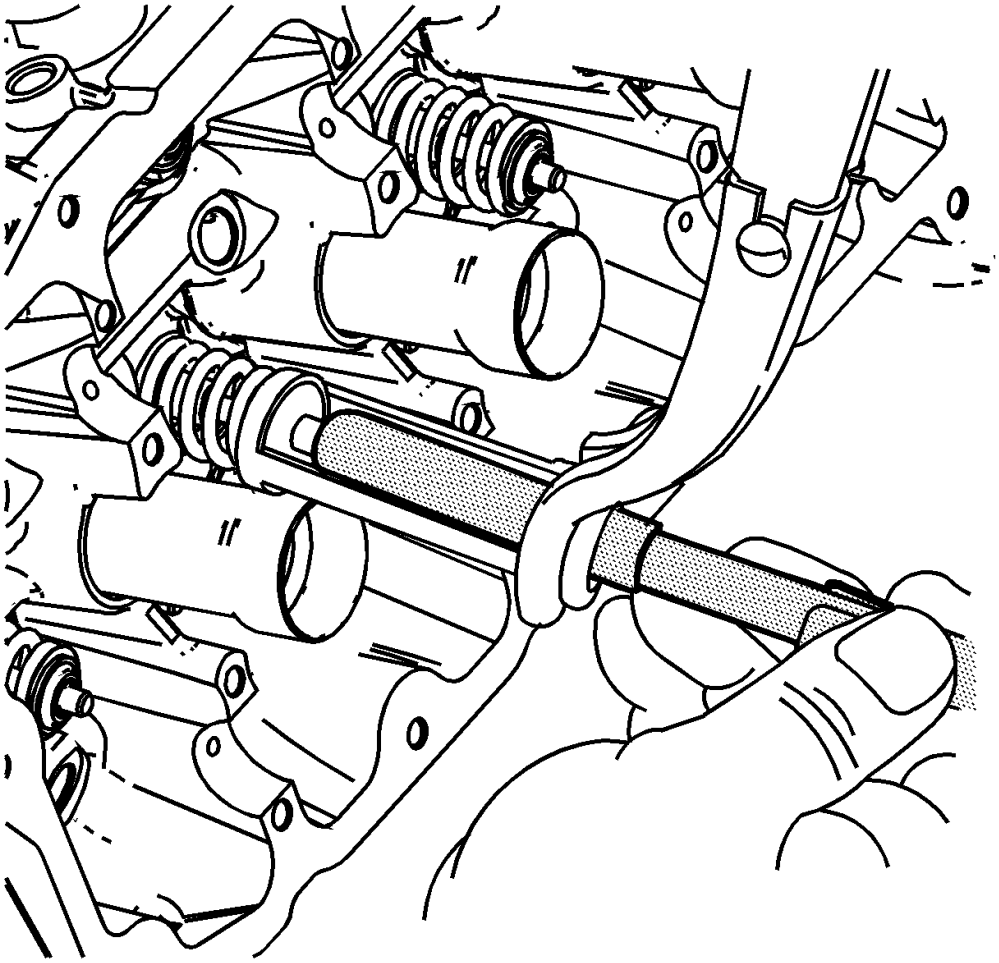


Fig. 232: View Of EN 46117
Courtesy of GENERAL MOTORS COMPANY

17. Place the keepers into position by pushing the tool downward. While holding the tool lightly together in the area between the O-rings, using the thumb and forefinger, release tension on the **EN-46119** adapter and the **J 8062** compressor. This will slowly push the **EN-46117** remover/installer off the valve stem, leaving the keepers in place.
18. Verify that the valve keepers are installed by placing a rag over the valve tip and tapping with a dead-blow hammer.

cardiagn.com

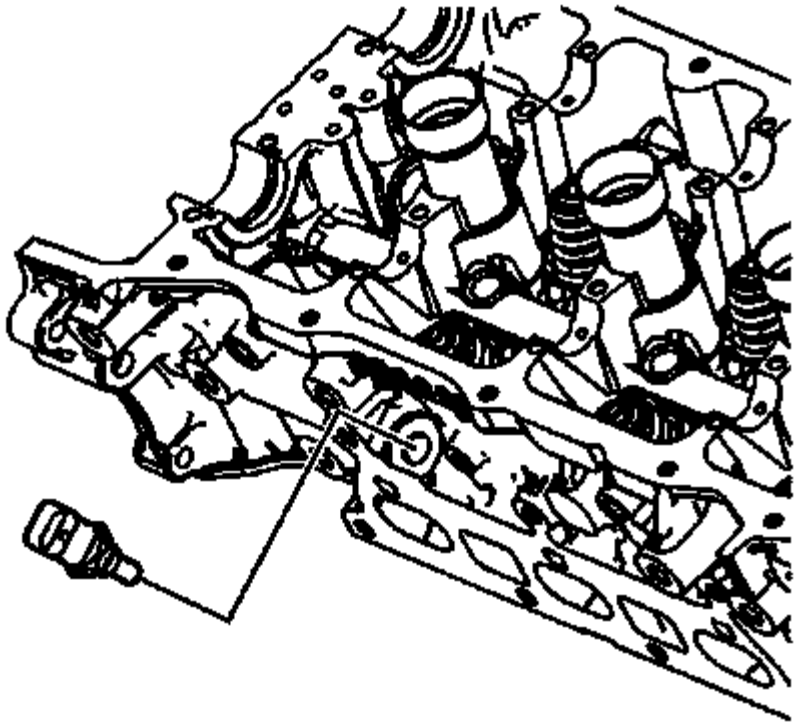


Fig. 233: View of Engine Coolant Temperature Sensor & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

19. Install the engine coolant temperature (ECT) sensor and tighten the ECT sensor to 30 N.m (22 lb ft).

cardiagn.com

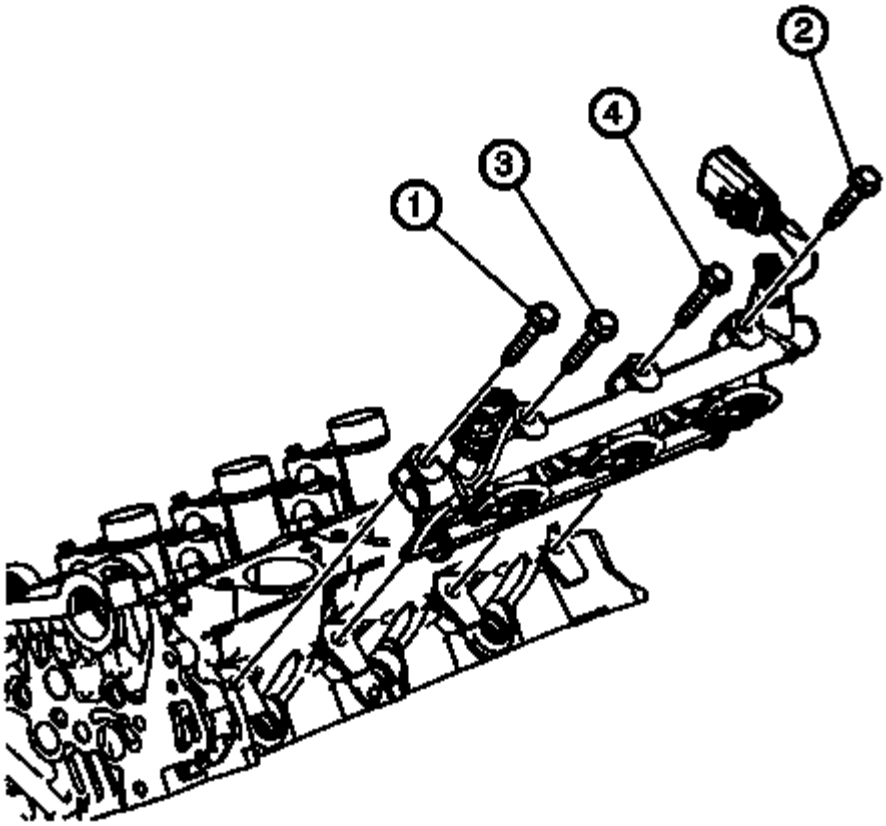


Fig. 234: View of Fuel Rail, Bolts & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

NOTE: If the fuel rail was removed from the cylinder head, the fuel injector tip seals must be replaced. Refer to Fuel Rail and Injectors Cleaning and Inspection.

20. Install the fuel rail with injectors into the cylinder head evenly.
21. Hand tighten the two outer fuel rail bolts to seat the injector in the injector bores.
22. Start and hand tighten the remaining fuel rail bolts.
23. Tighten the fuel rail bolts in sequence to 25 N.m (18 lb ft).

CAMSHAFT CLEANING AND INSPECTION

Special Tools

J 7872 Magnetic Base Dial Indicator

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

cardiagn.com

Cleaning Procedure

1. Clean the camshaft in solvent.
2. Dry the camshaft with compressed air.

WARNING: Refer to Safety Glasses Warning .

Visual Inspection

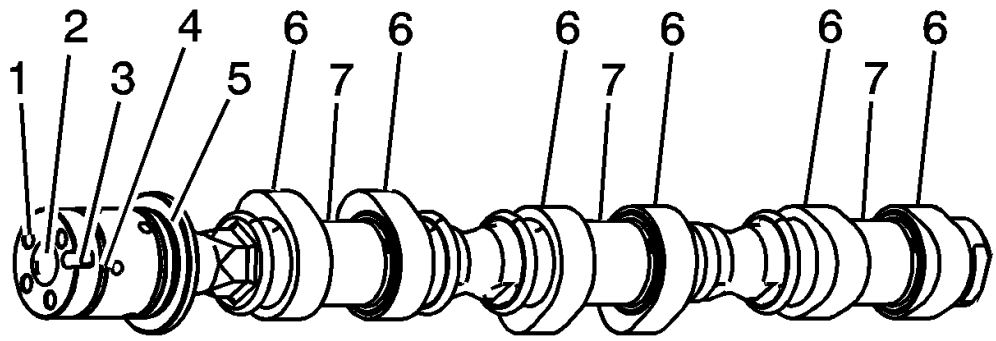


Fig. 235: Identifying Camshaft Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the camshaft oil feed holes (1) to the camshaft position actuator for dirt, debris or blockage.
2. Inspect the threaded hole (2) for damage.
3. Inspect the camshaft position actuator locating notch (3) for damage or wear.
4. Inspect the camshaft sealing grooves (4) for damage.

cardiagn.com

5. Inspect the camshaft thrust surface (5) for damage.
6. Inspect the camshaft lobes (6) and journals (7) for the following conditions:
    - Excessive scoring or pitting
    - Discoloration from overheating
    - Deformation from excessive wear, especially the camshaft lobes
7. If any of the above conditions exist on the camshaft, replace the camshaft.

Camshaft Measurement

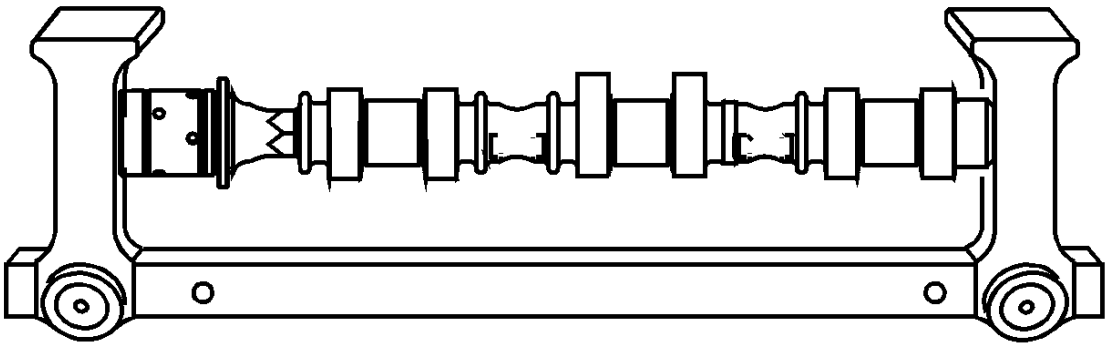


Fig. 236: Supporting Camshaft In Fixture
Courtesy of GENERAL MOTORS COMPANY

1. With the camshaft in a suitable fixture, measure the camshaft for wear.

cardiagn.com

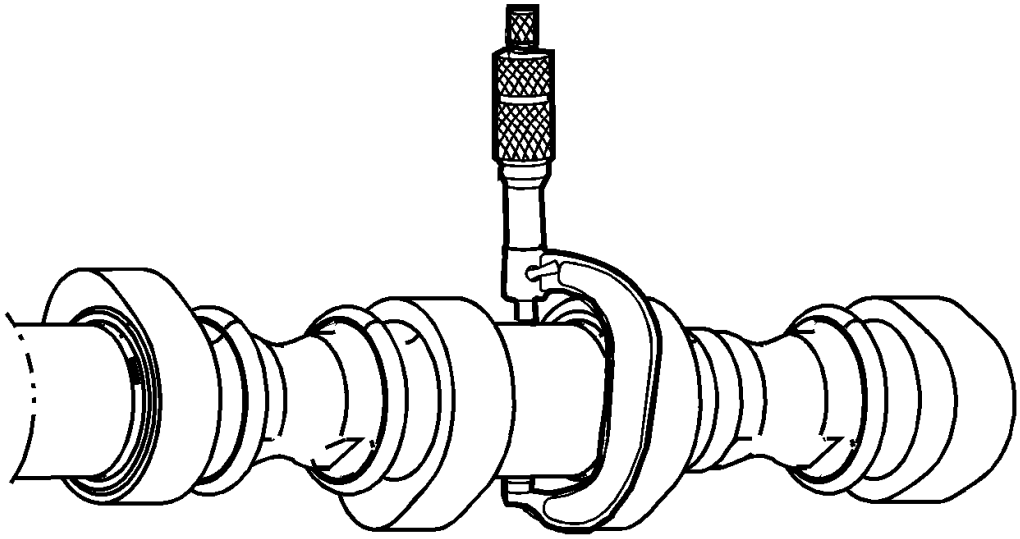


Fig. 237: Measuring Camshaft Journals
Courtesy of GENERAL MOTORS COMPANY

2. Measure the camshaft journals for diameter and out-of-round using an outside micrometer. Refer to **Engine Mechanical Specifications** .
    - If the diameter is smaller than specifications, replace the camshaft.
    - If the out-of-round exceeds specifications, replace the camshaft.

cardiagn.com

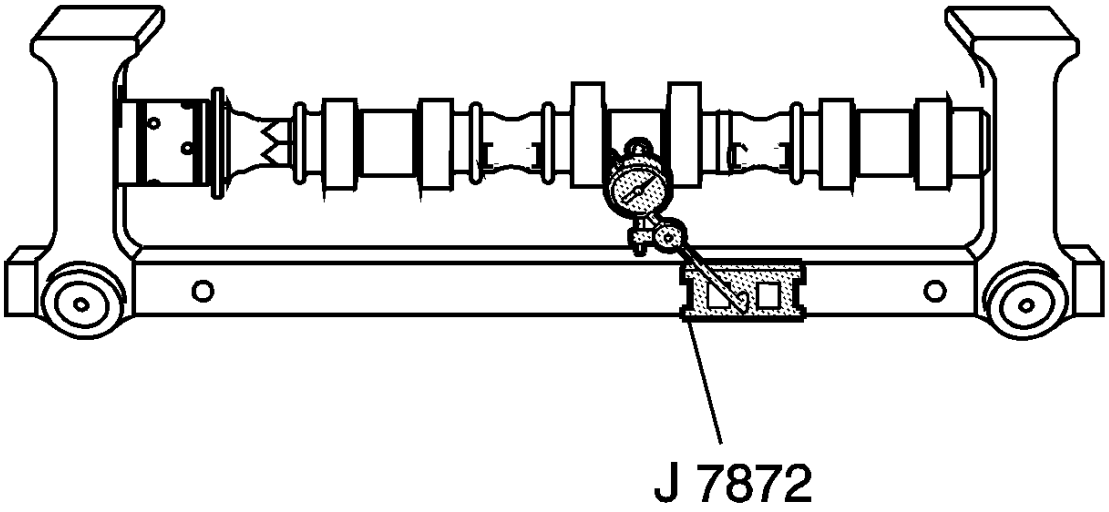


Fig. 238: Checking Camshaft Runout
Courtesy of GENERAL MOTORS COMPANY

3. Measure the camshaft runout using the **J 7872** indicator. Refer to **Engine Mechanical Specifications** .

cardiagn.com

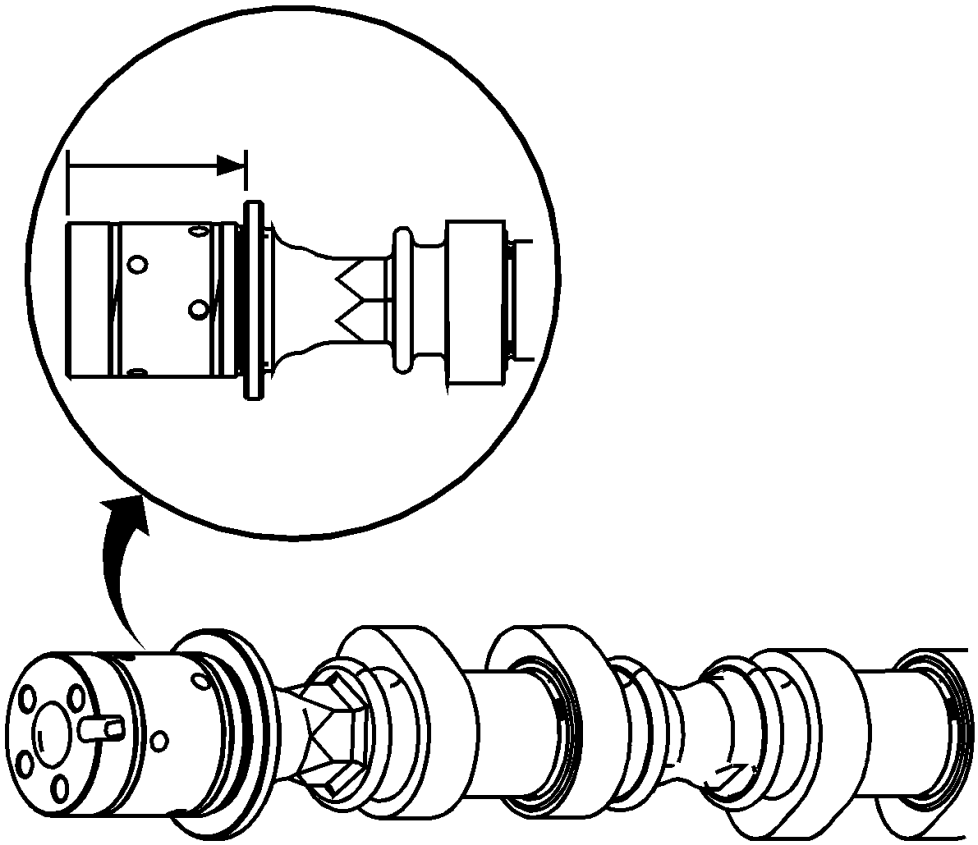


Fig. 239: Measuring Camshaft Thrust Width
Courtesy of GENERAL MOTORS COMPANY

4. Measure the camshaft thrust width for wear using a depth micrometer. Refer to **Engine Mechanical Specifications** .

cardiagn.com

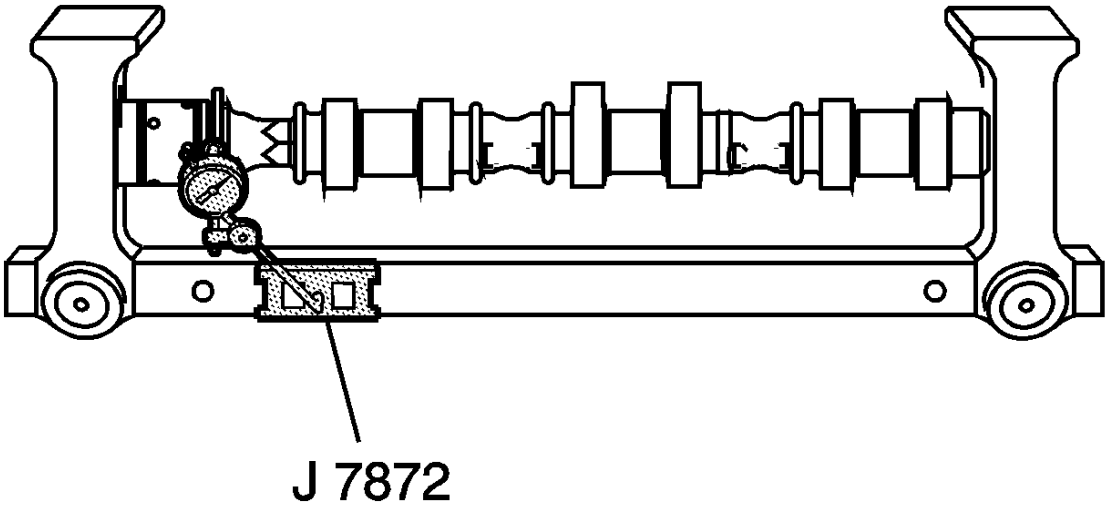


Fig. 240: Identifying Special Tool - J 7872
Courtesy of GENERAL MOTORS COMPANY

5. Measure the camshaft thrust wall surface for runout using **J 7872** indicator. Refer to **Engine Mechanical Specifications** .
6. If the camshaft is damaged or worn beyond specifications, replace the camshaft. No machining of the camshaft is allowed.

cardiagn.com

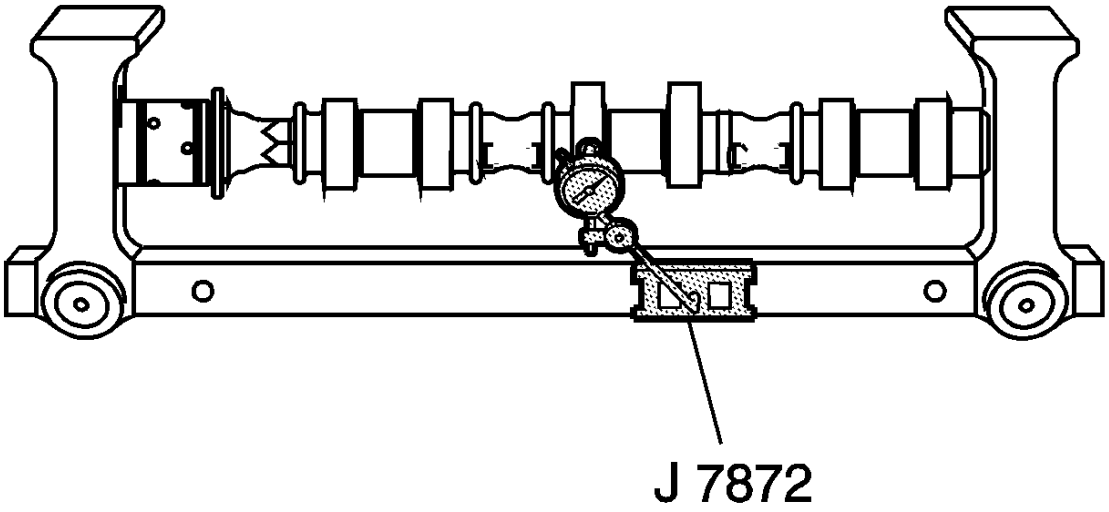


Fig. 241: Measuring Camshaft Lobes For Wear
Courtesy of GENERAL MOTORS COMPANY

7. Measure the camshaft lobes for wear using the **J 7872** indicator.

cardiagn.com

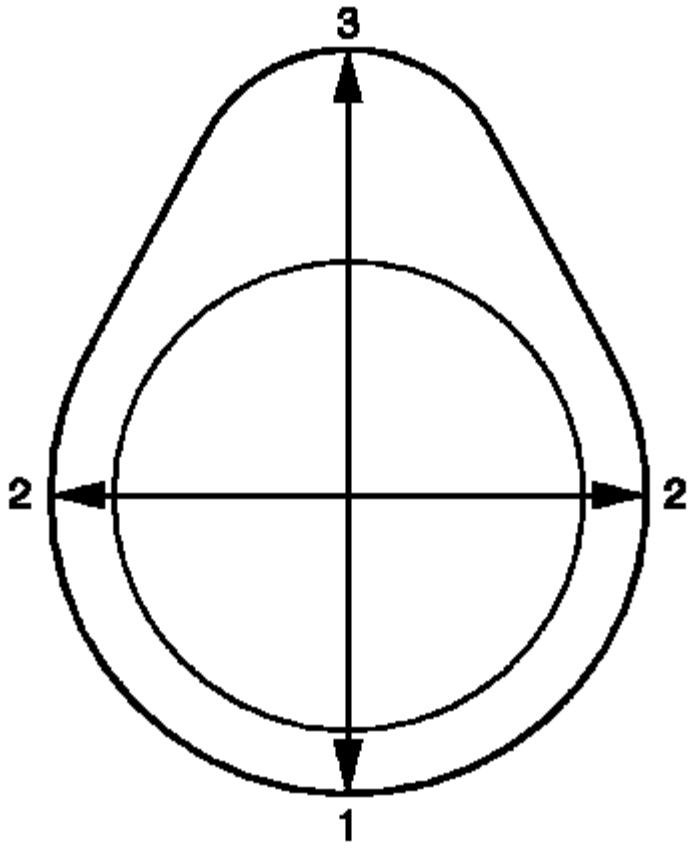


Fig. 242: View Of Camshaft Lobe, Base Circle & Lift
Courtesy of GENERAL MOTORS COMPANY

8. Place the **J 7872** indicator with the indicator tip on the base circle (1) of the camshaft lobe.
    1. Place the **J 7872** indicator at zero.
    2. Rotate the camshaft until the indicator tip is at the highest point (3) on the lobe. This reading is the lift of the camshaft lobe. Refer to **Engine Mechanical Specifications** .
    3. If the indicated measurement is significantly lower than these specifications, replace the camshaft or engine performance will be reduced.

VALVE LIFTER CLEANING AND INSPECTION

cardiagn.com

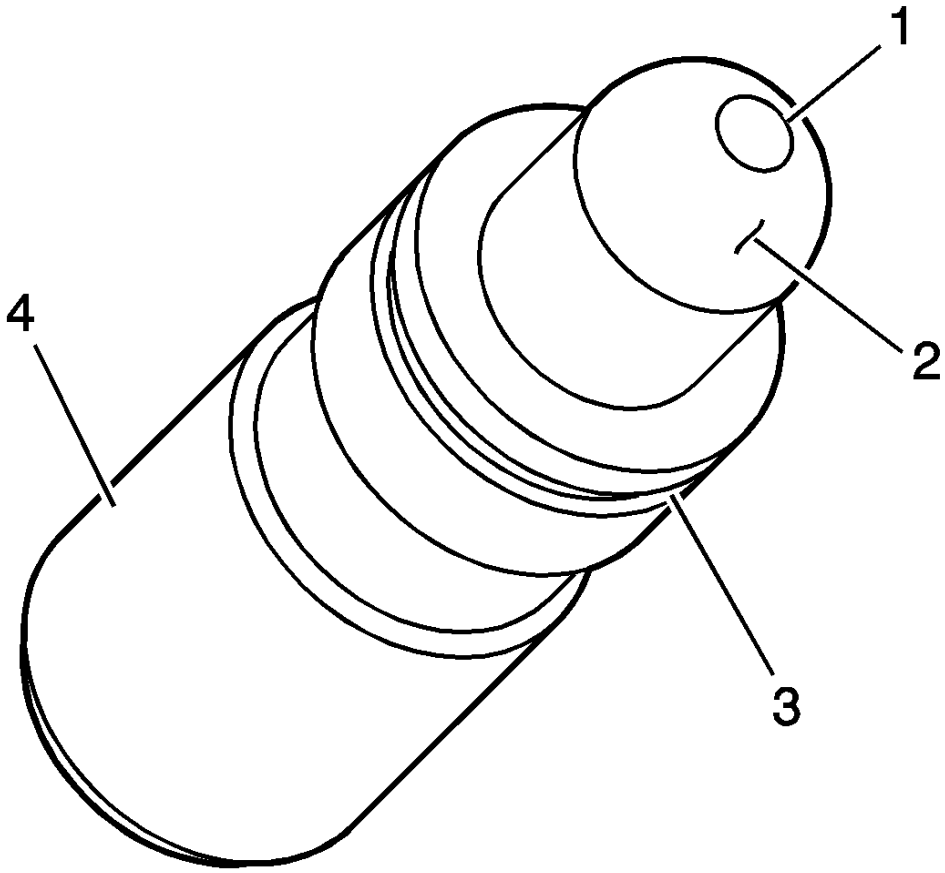


Fig. 243: Identifying Valve Lifter Inspection Points
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Valve Lifter Priming Caution .

1. Inspect the stationary hydraulic lash adjuster (SHLA) in the following areas:
   - A plugged oil passage (1)
   - A scored or worn camshaft follower pivot area (2)
   - A damaged or broken retainer (3), some applications
   - A severely scuffed or worn SHLA body (4)
2. Replace the SHLA or SHLAs as necessary.

VALVE ROCKER ARM CLEANING AND INSPECTION

cardiagn.com

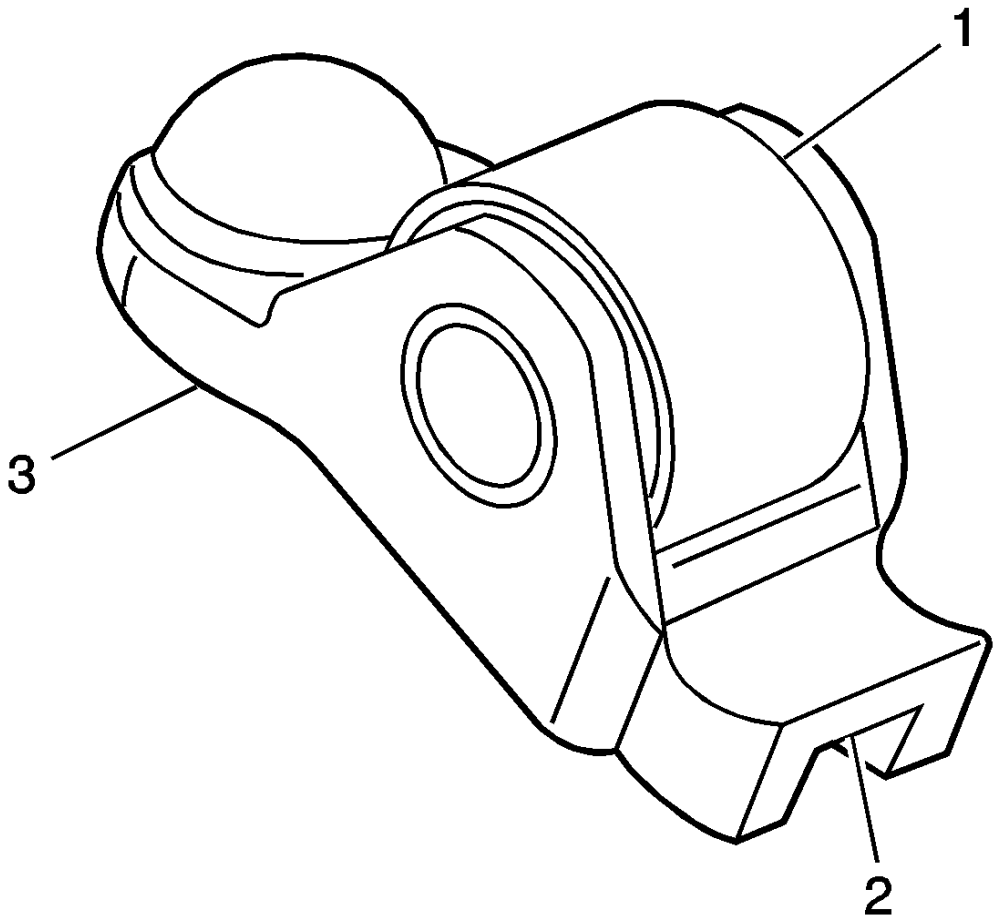


Fig. 244: Inspecting Valve Rocker Arms
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the camshaft follower roller (1) for the following:
   - Flat spots
   - Excessive scoring and pitting
   - Ensure the roller spins freely
2. Inspect the camshaft follower valve tip area (2).
3. Inspect the camshaft follower stationary hydraulic lash adjuster (SHLA) pivot area (3).
4. Replace the camshaft follower or followers as necessary.

CAMSHAFT TIMING DRIVE COMPONENTS CLEANING AND INSPECTION

Cleaning Procedure

cardiagn.com

1. Clean all the following components with solvent:
   - Crankshaft sprocket
   - Primary timing drive chain
   - Primary timing drive chain shoe
   - Primary timing drive chain guides
   - Primary timing drive chain tensioner
   - Secondary timing drive chains
   - Secondary timing drive chain shoes
   - Secondary timing drive chain guides
   - Secondary timing drive chain tensioners
   - Timing component fastening bolts
2. Clean each camshaft position actuator's exterior with solvent.
3. Dry the timing components with compressed air.

WARNING: Refer to Safety Glasses Warning .

Visual Inspection

Camshaft Thrust Washers (If Equipped)

cardiagn.com

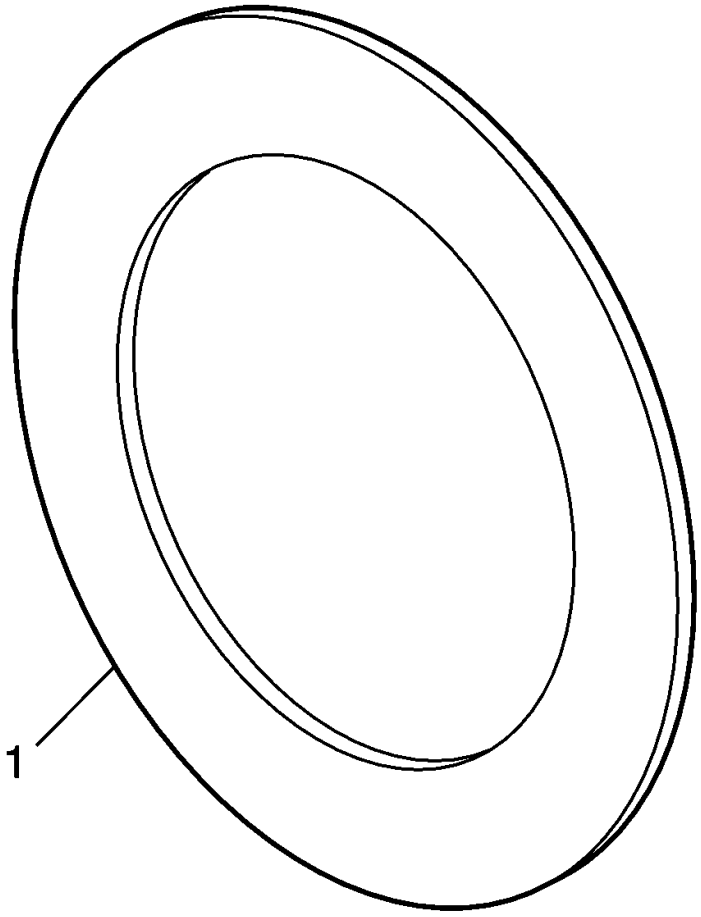


Fig. 245: Identifying Camshaft Thrust Washer
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the camshaft thrust washers for deep scoring or uneven wear (1).
2. Replace as necessary.

Camshaft Position Actuators

cardiagn.com

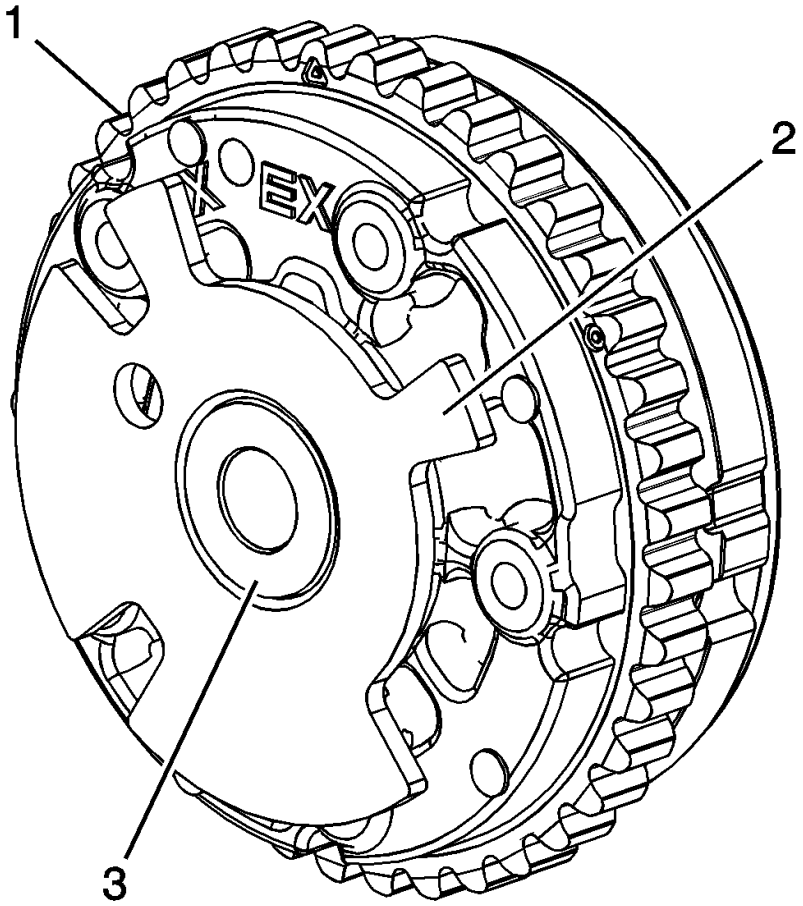


Fig. 246: View Of Camshaft Position Actuators Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the front of the exhaust camshaft position actuators for the following:
    - Sprocket damage (1)
    - Reluctor/sensor wheel damage (2)
    - Camshaft position actuator bolt seating/sealing inner hub flange damage (3)

cardiagn.com

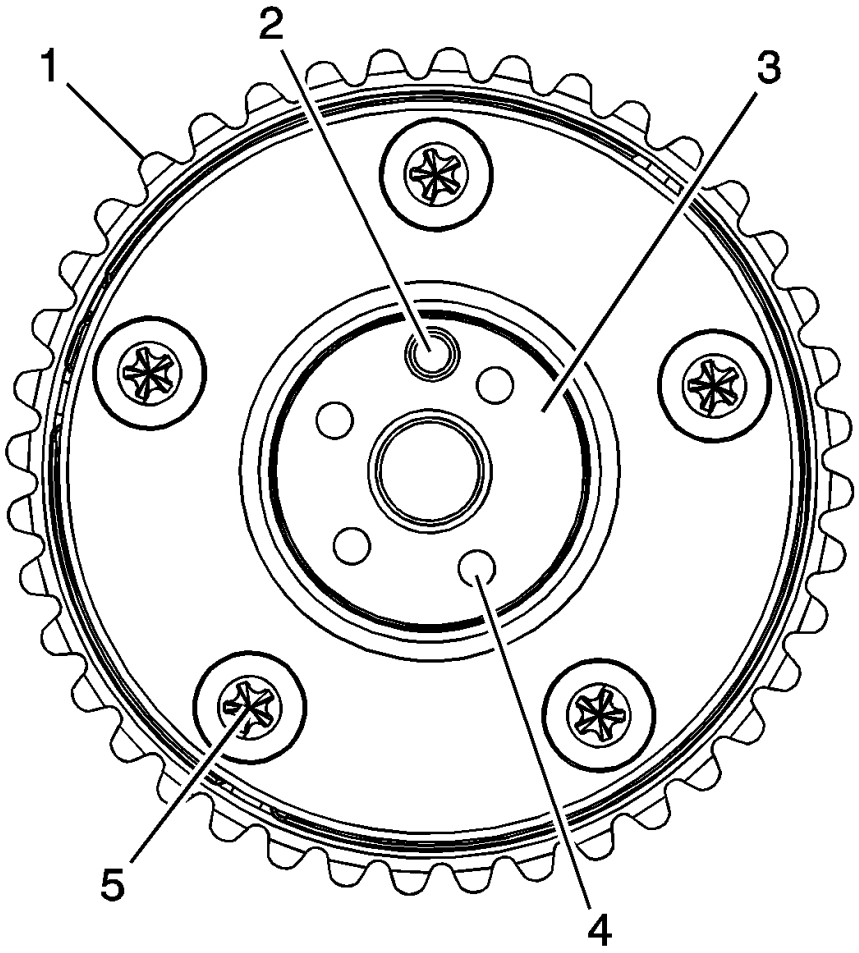


Fig. 247: View Of Exhaust Camshaft Position Actuators Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the back of the exhaust camshaft position actuators for the following:
    - Sprocket damage (1)
    - Camshaft locating pin damage (2)
    - Camshaft seating/sealing inner hub flange damage (3)
    - Blockage to the oil passages (4)
    - Loose or missing housing bolts (5)

cardiagn.com

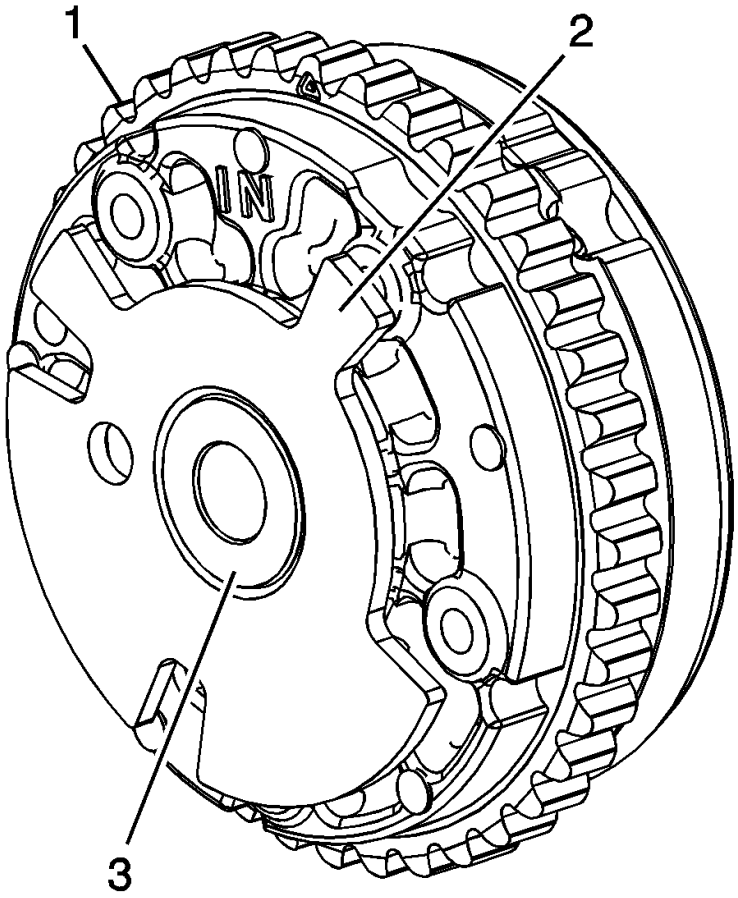


Fig. 248: View Of Left Intake Camshaft Position Actuators Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the front of the left intake camshaft position actuators for the following:
    - Sprocket damage (1)
    - Reluctor/sensor wheel damage (2)
    - Camshaft position actuator oil control valve bolt seating/sealing inner hub flange damage (3)

cardiagn.com

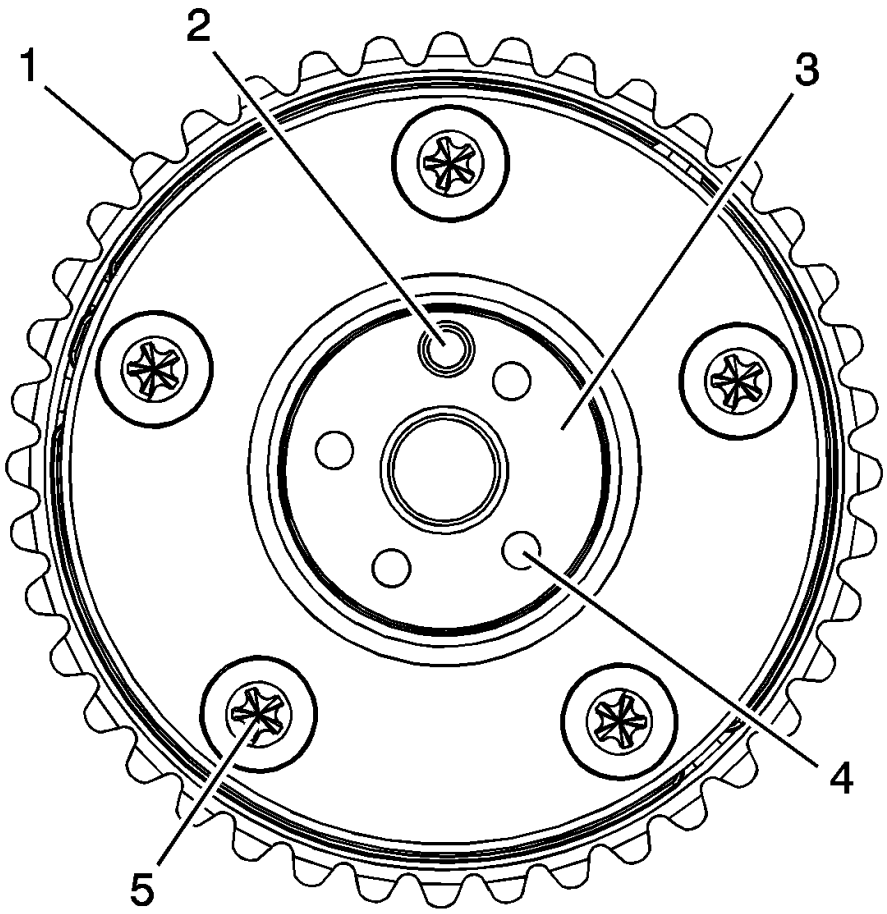


Fig. 249: View Of Left Intake Camshaft Position Actuators Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

4. Inspect the back of the left intake camshaft position actuators for the following:
    - Sprocket damage (1)
    - Camshaft locating pin damage (2)
    - Camshaft seating/sealing inner hub flange damage (3)
    - Blockage to the oil passages (4)
    - Loose or missing housing bolts (5)

cardiagn.com

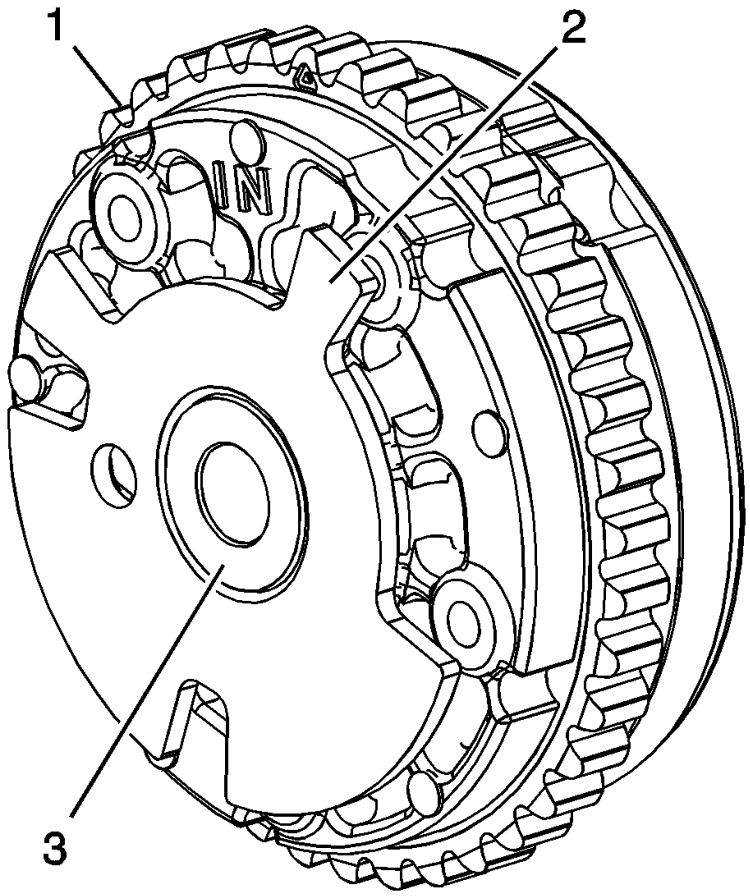


Fig. 250: View Of Right Intake Camshaft Position Actuators Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the front of the right intake camshaft position actuators for the following:
    - Sprocket damage (1)
    - Reluctor/sensor wheel damage (2)
    - Camshaft position actuator oil control valve bolt seating/sealing inner hub flange damage (3)

cardiagn.com

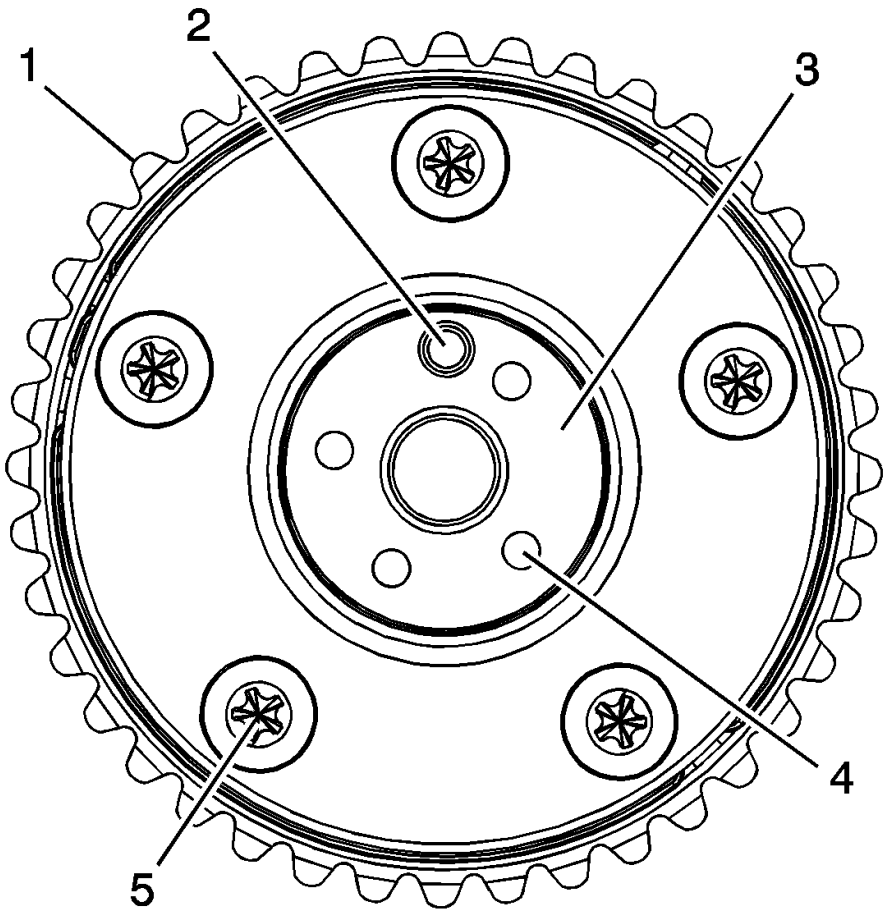


Fig. 251: View Of Left Intake Camshaft Position Actuators Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

6. Inspect the back of the right intake camshaft position actuators for the following:
    - Sprocket damage (1)
    - Camshaft locating pin damage (2)
    - Camshaft seating/sealing inner hub flange damage (3)
    - Blockage to the oil passages (4)
    - Loose or missing housing bolts (5)
7. Replace a damaged camshaft position actuator.

Camshaft Position Actuator Oil Control Valves

cardiagn.com

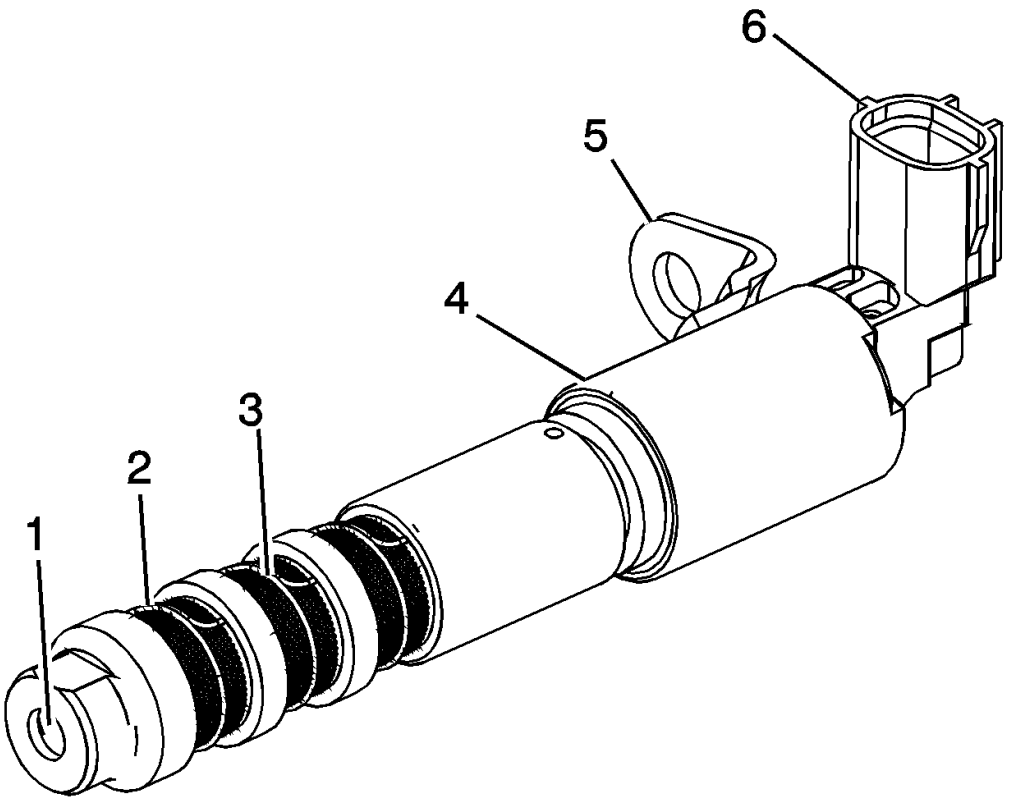


Fig. 252: Identifying Camshaft Position Actuator Oil Control Valves Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the camshaft position actuator oil control valves for the following:
   - Blockage to the oil passage (1)
   - Missing or damaged oil screen clip (2)
   - Blockage or damage to the oil screen (3)
   - Damage to the sealing surface for the camshaft position actuator oil control valve solenoid oil seal (4)
   - Damage to the bracket (5)
   - Damage to the wiring harness connection and/or terminals (6)
2. Replace a damaged camshaft position actuator oil control valve.

Left Intermediate Sprocket with Primary and Secondary Inverted Tooth (IT) Chain

cardiagn.com

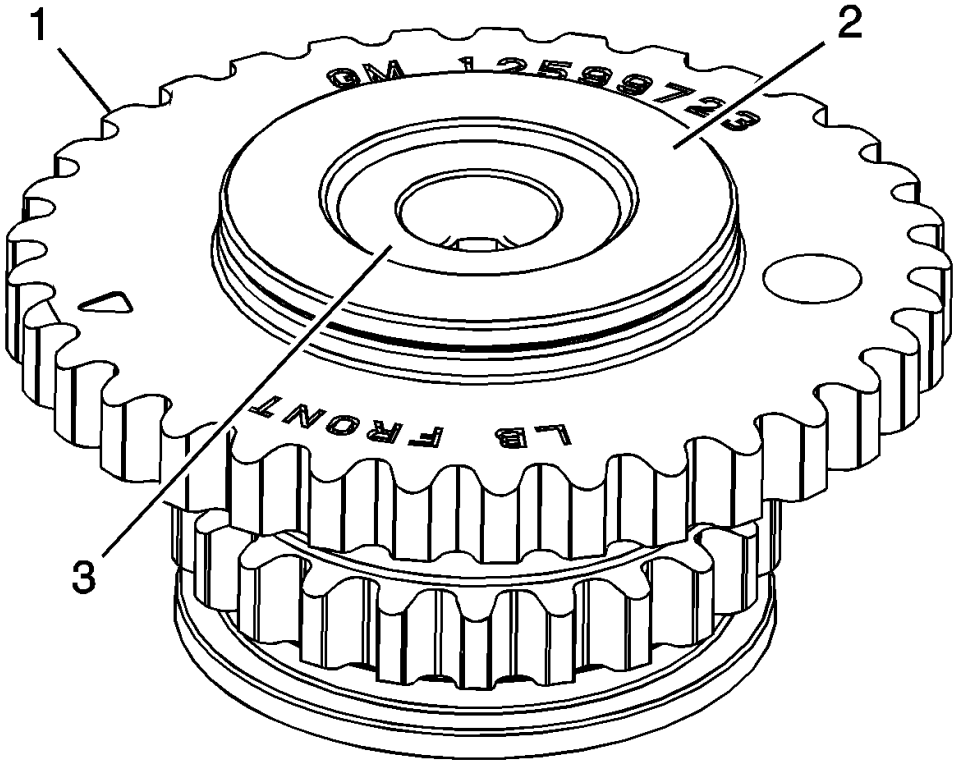


Fig. 253: View Of Left Intermediate Sprocket Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the front of the left intermediate sprocket for the following:
   - Damage to the primary camshaft drive chain sprocket (1)
   - Damage to the hub bearing (2)-Ensure the hub bearing spins freely. If the hub bearing wobbles, is noisy or feels rough when rotated, replace the intermediate sprocket.
   - Damage to the bolt flange seating/sealing surface (3)

cardiagn.com

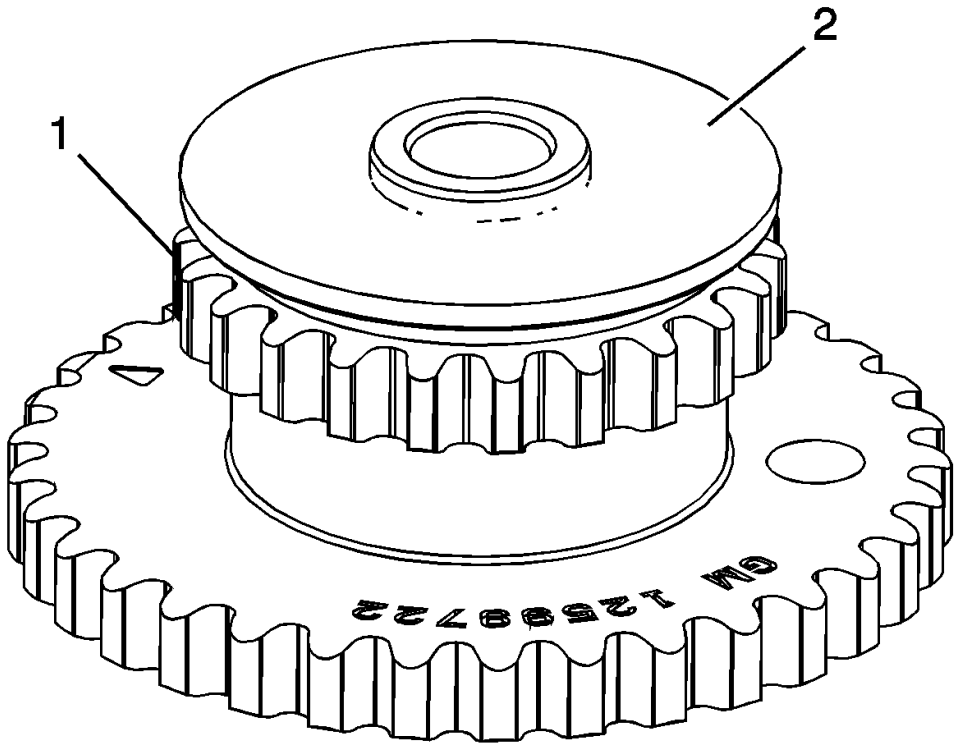


Fig. 254: View Of Left Intermediate Sprocket Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the back of the left intermediate sprocket for the following:
    - Damage to the left secondary camshaft drive chain sprocket (1)
    - Damage to the bearing hub-to-engine block sealing surface (2)
3. Replace a damaged left intermediate sprocket.

Right Intermediate Sprocket with Primary and Secondary Inverted Tooth (IT) Chain

cardiagn.com

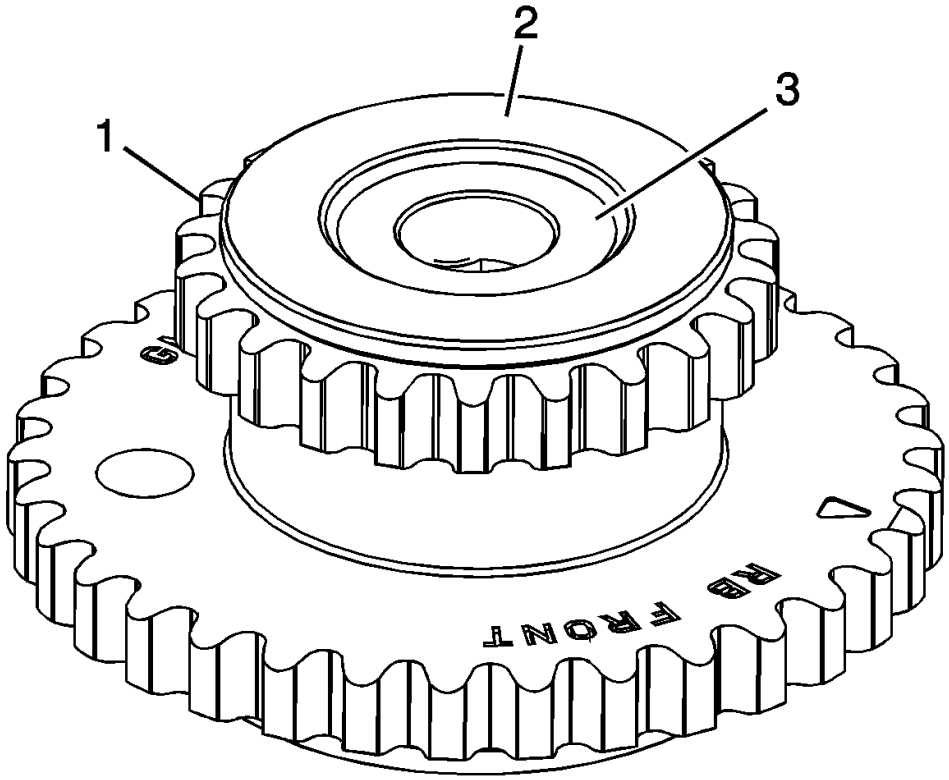


Fig. 255: View Of Right Intermediate Sprocket Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the front of the right intermediate sprocket for the following:
   - Damage to the right secondary camshaft drive chain sprocket (1)
   - Damage to the hub bearing (2)-Ensure the hub bearing spins freely. If the hub bearing wobbles, is noisy or feels rough when rotated, replace the intermediate sprocket.
   - Damage to the bolt flange seating/sealing surface (3)

cardiagn.com

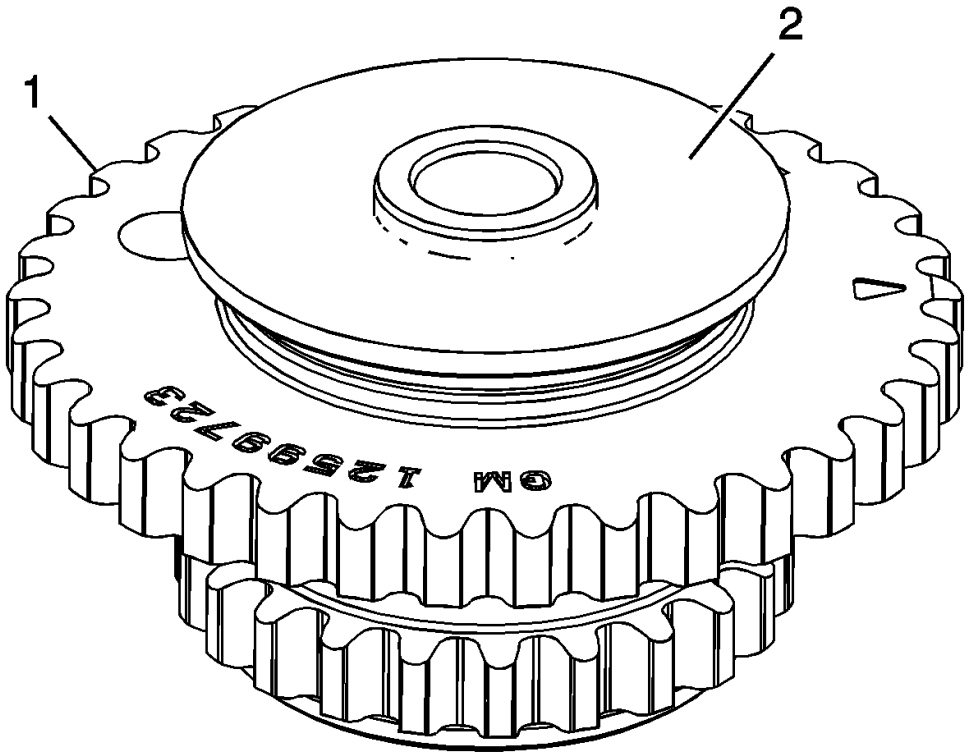


Fig. 256: View Of Right Intermediate Sprocket Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the back of the right intermediate sprocket for the following:
    - Damage to the primary camshaft drive chain sprocket (1)
    - Damage to the bearing hub-to-engine block sealing surface (2)
3. Replace a damaged right intermediate sprocket.

Crankshaft Sprocket with Second Version Primary Inverted Tooth (IT) Chain

cardiagn.com

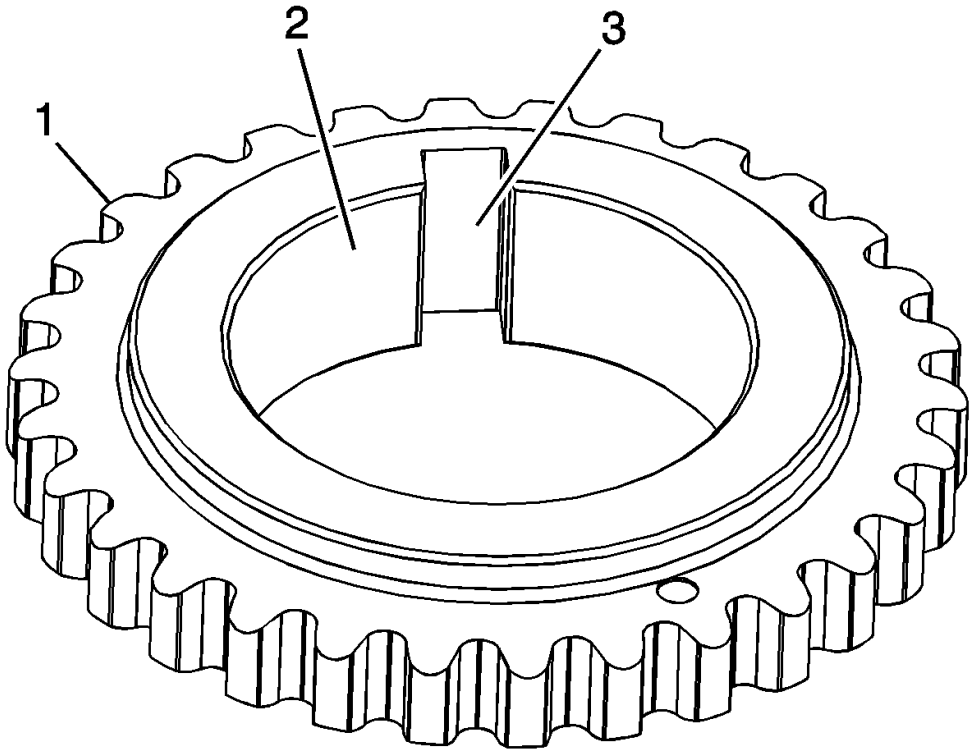


Fig. 257: View Of Crankshaft Sprocket Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the crankshaft sprocket for the following:
    - Sprocket damage (1)
    - Bore damage (2)
    - Keyway damage (3)
2. Replace a damaged crankshaft sprocket.

Secondary Timing Chains with Inverted Tooth (IT) Chain

cardiagn.com

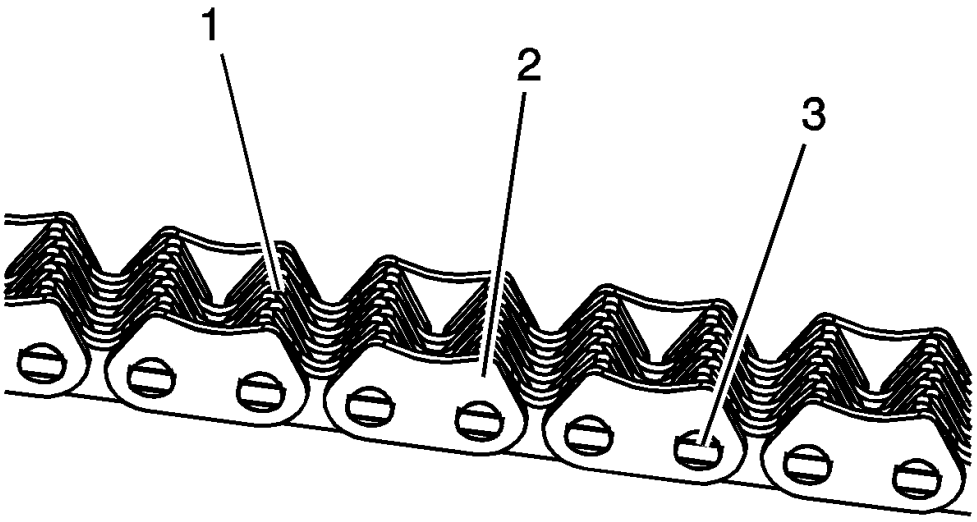


Fig. 258: Identifying Primary & Secondary Timing Chain Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the secondary timing chain for the following:
   - Binding or worn links (1)
   - Loose links (2)
   - Loose pins (3)
2. Replace a damaged secondary timing chain.

Primary Timing Chain with Inverted Tooth (IT) Chain

cardiagn.com

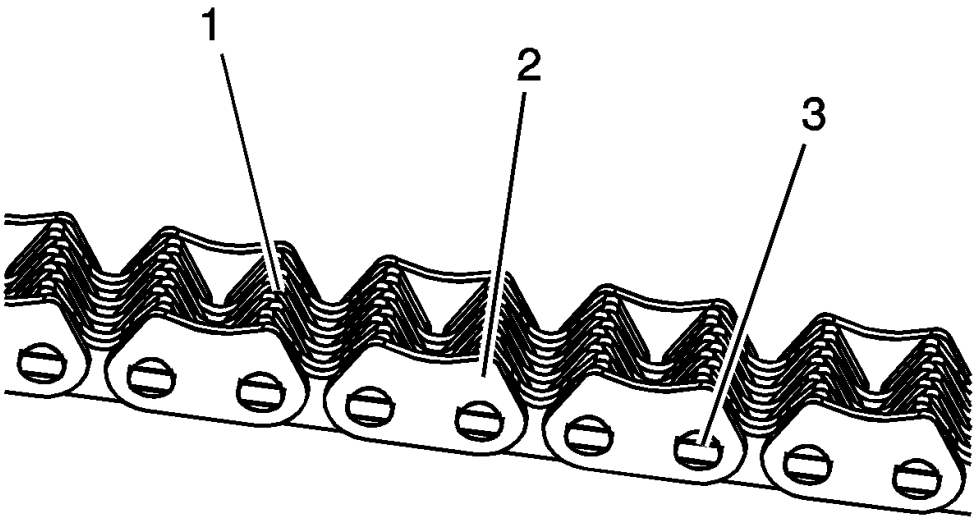


Fig. 259: Identifying Primary & Secondary Timing Chain Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the primary timing chain for the following:
   - Binding or worn links (1)
   - Loose links (2)
   - Loose pins (3)
2. Replace a damaged primary timing chain.

Primary Timing Chain Upper Guide

cardiagn.com

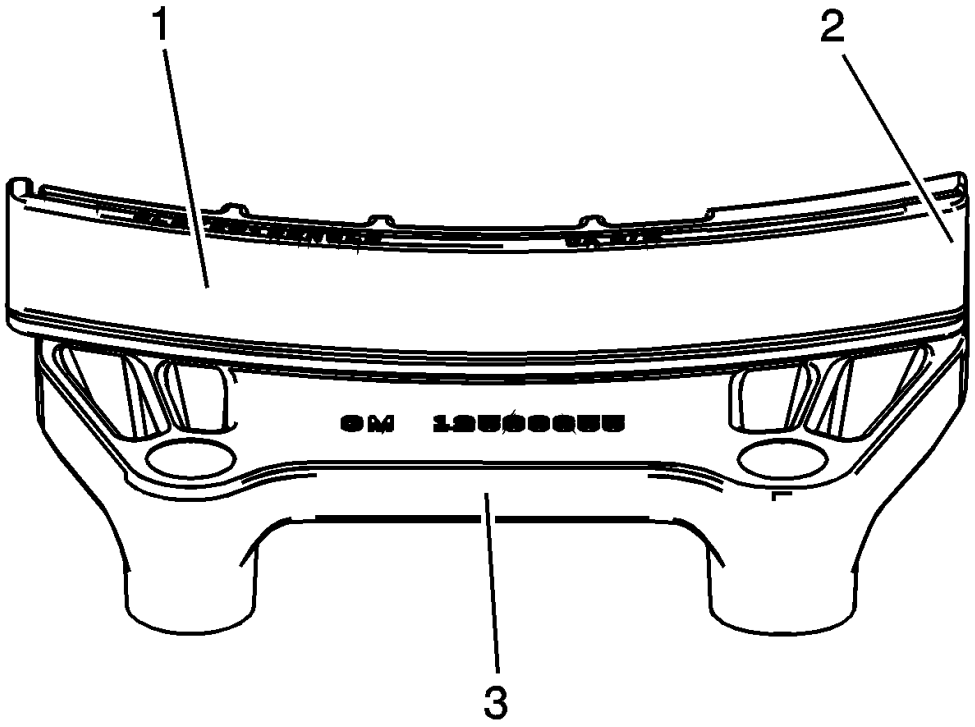


Fig. 260: View Of Primary Timing Chain Upper Guide Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the primary timing chain upper guide for the following:
   - Worn guide surface (1)
   - Cracked or broken guide surface (2)
   - Cracked or damaged guide base (3)
2. Replace a damaged primary timing chain upper guide.

Primary Timing Chain Lower Guide

cardiagn.com

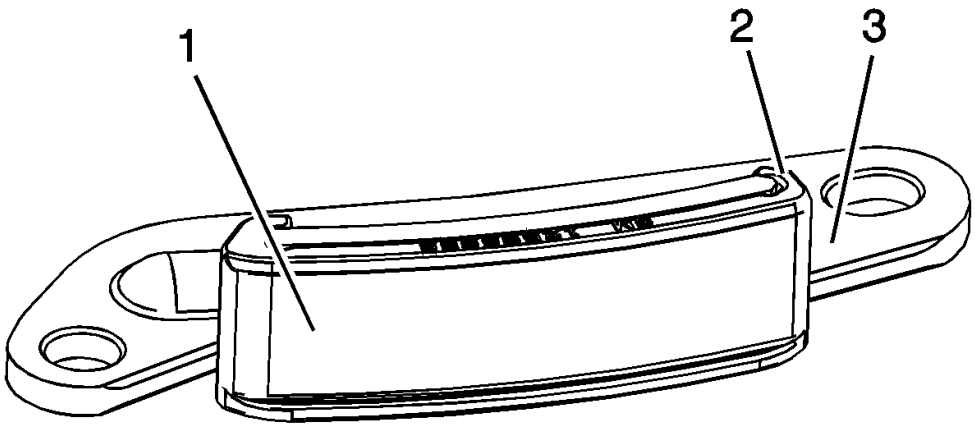


Fig. 261: View Of Primary Camshaft Drive Chain Lower Guide Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the primary timing chain lower guide for the following:
   - Worn guide surface (1)
   - Cracked or broken guide surface (2)
   - Cracked or damaged guide base (3)
2. Replace a damaged primary timing chain lower guide.

Left Secondary Timing Chain Guide

cardiagn.com

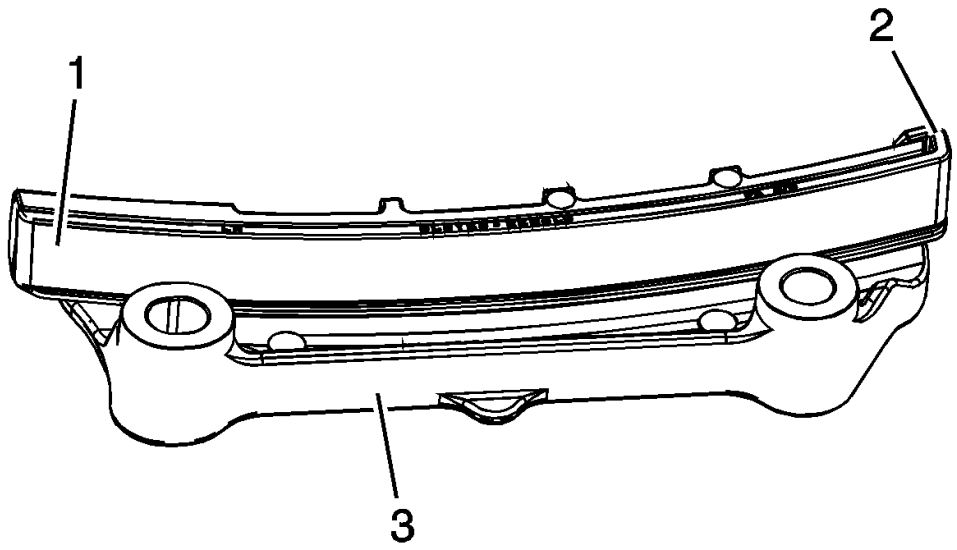


Fig. 262: View Of Left Secondary Timing Chain Guide Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the left secondary timing chain guides for the following:
   - Worn guide surface (1)
   - Cracked or broken guide surface (2)
   - Cracked or damaged guide base (3)
2. Replace a damaged left secondary timing chain guide.

Right Secondary Timing Chain Guide

cardiagn.com

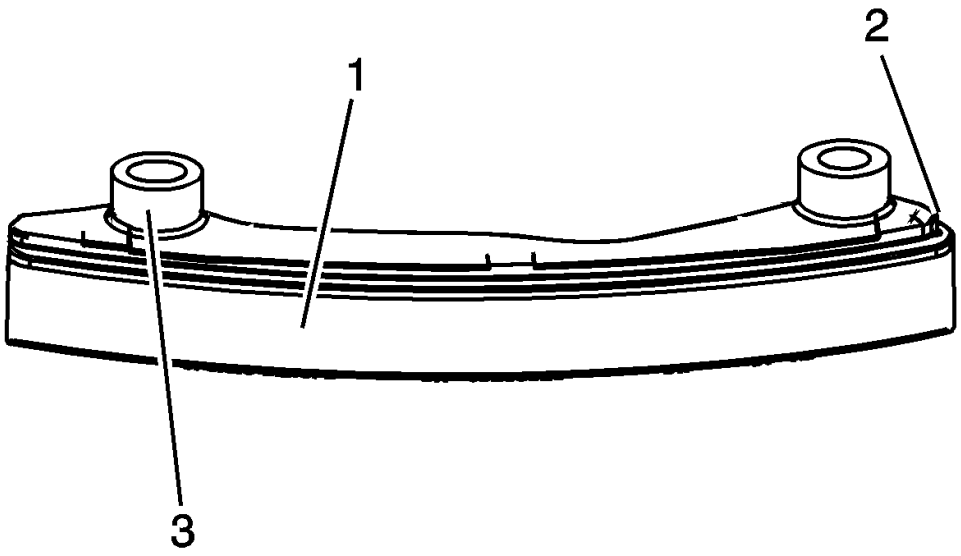


Fig. 263: Identifying Right Secondary Timing Chain Guide Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the right secondary timing chain guides for the following:
   - Worn guide surface (1)
   - Cracked or broken guide surface (2)
   - Cracked or damaged guide base (3)
2. Replace a damaged right secondary timing chain guide.

Left Secondary Timing Chain Shoe

cardiagn.com

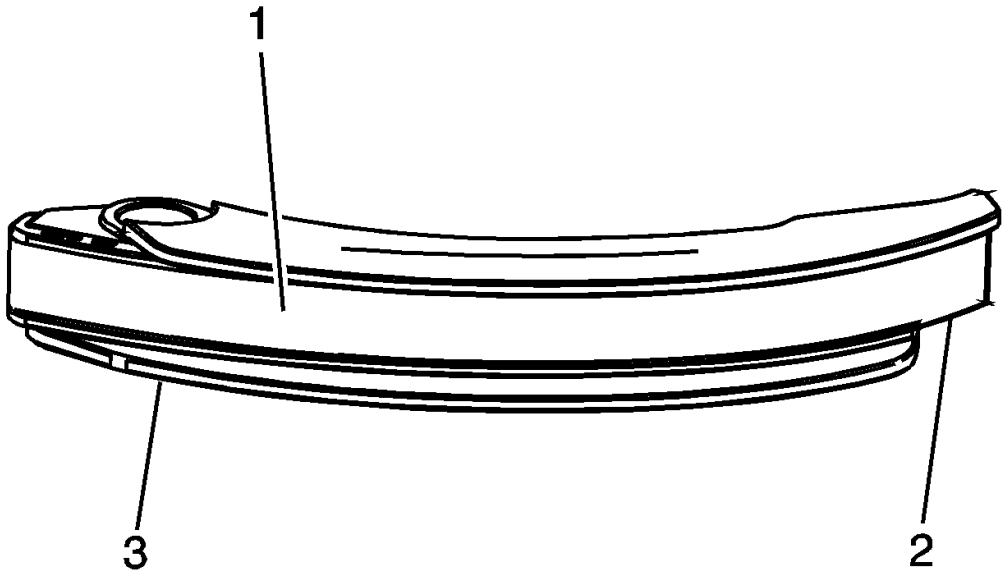


Fig. 264: View Of Left Secondary Timing Chain Shoe Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the front of the left secondary timing chain shoe for the following:
    - Worn shoe surface (1)
    - Cracked or broken shoe surface (2)
    - Cracked or damaged shoe (3)

cardiagn.com

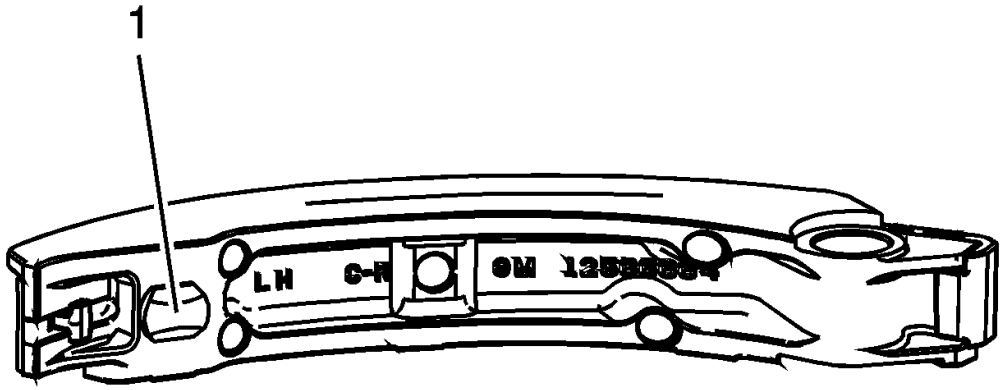


Fig. 265: View of Left Secondary Timing Chain Tensioner Contact Pad
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the back of the left secondary timing chain shoe for a damaged, worn or missing left secondary timing chain tensioner contact pad (1).
3. Replace a damaged left secondary timing chain shoe.

Right Secondary Timing Chain Shoe

cardiagn.com

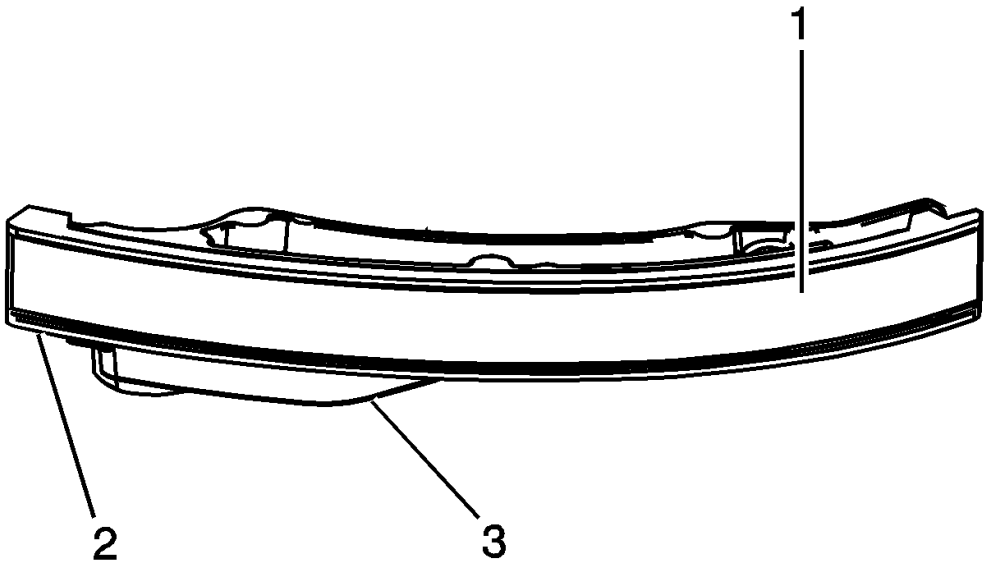


Fig. 266: Identifying Right Secondary Timing Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the front of the right secondary timing chain shoe for the following:
    - Worn shoe surface (1)
    - Cracked or broken shoe surface (2)
    - Cracked or damaged shoe (3)

cardiagn.com

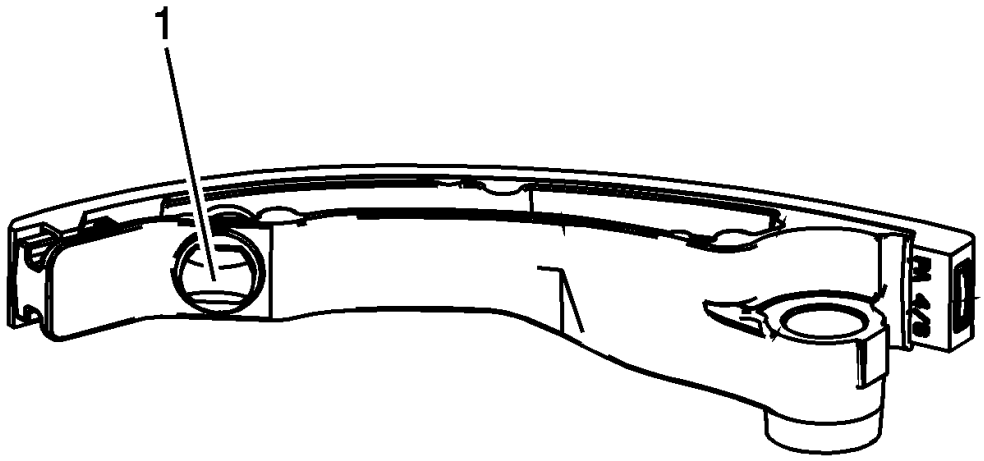


Fig. 267: Inspecting Right Secondary Timing Chain Tensioner Contact Pad
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the back of the right secondary timing chain shoe for a damaged, worn or missing right secondary timing chain tensioner contact pad (1).
3. Replace a damaged right secondary timing chain shoe.

Primary Timing Chain Tensioner

cardiagn.com

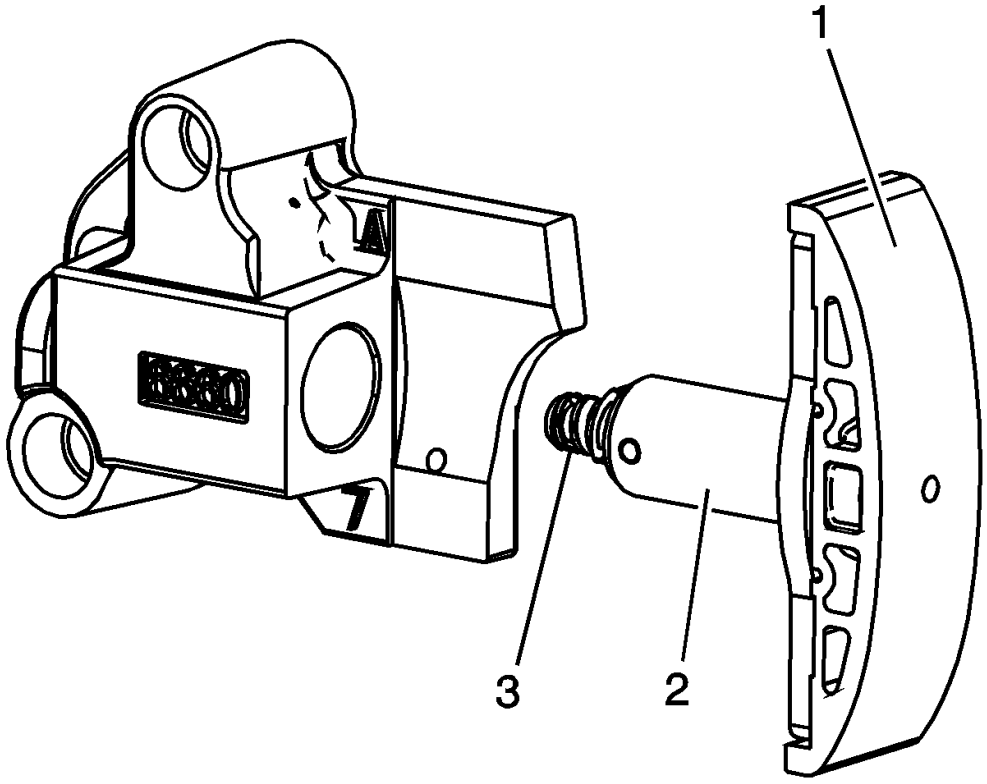


Fig. 268: View Of Primary Timing Chain Tensioner Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the primary timing chain tensioner for worn primary timing chain tensioner shoe surface (1).
2. Inspect the primary timing chain tensioner for locked or binding timing chain tensioner. Reset the plunger (3) and ensure the plunger moves freely (2) in and out of the body of the tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Installation**.
3. Replace a damaged primary timing chain tensioner.

Left Secondary Timing Chain Tensioner

cardiagn.com

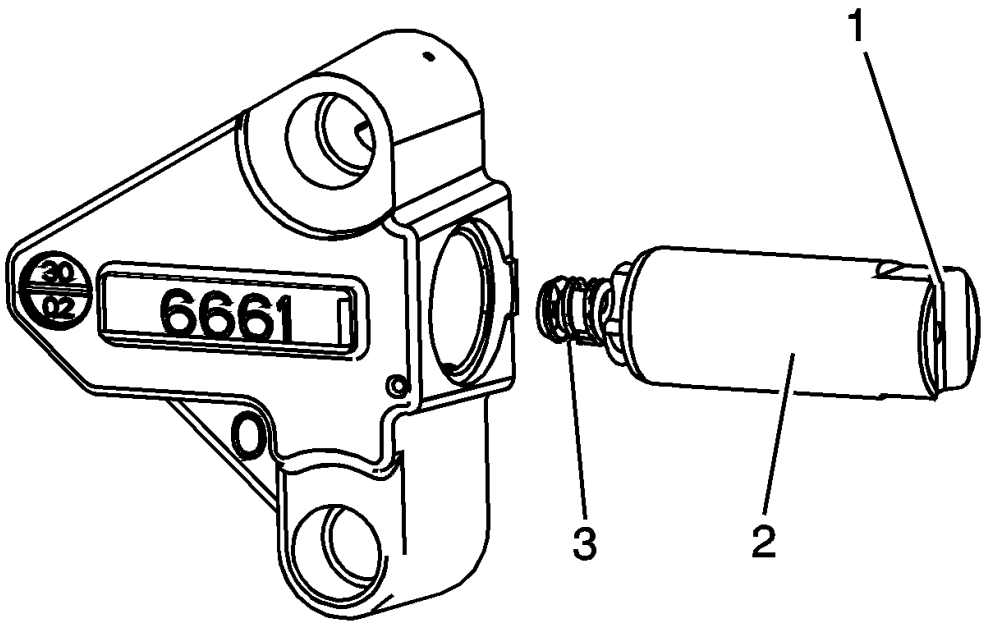


Fig. 269: View Of Left Secondary Timing Chain Tensioner Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the left secondary timing chain tensioner for damaged plunger-to-shoe contact surface (1).
2. Inspect the left secondary timing chain tensioner for locked or binding timing chain tensioner. Reset the plunger (3) and ensure the plunger moves freely (2) in and out of the body of the tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Left Side**.
3. Replace a damaged left secondary timing chain tensioner.

Right Secondary Timing Chain Tensioner

cardiagn.com

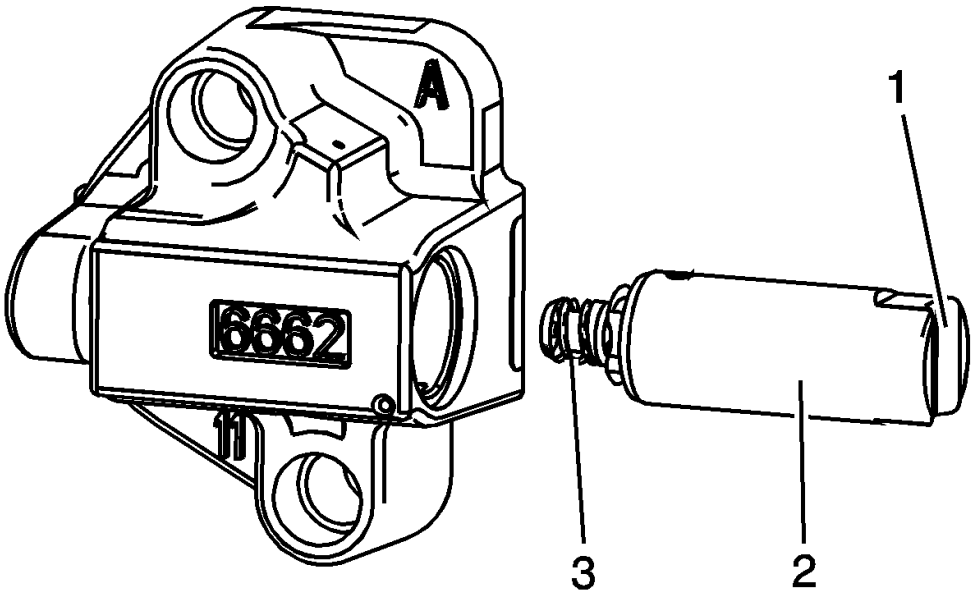


Fig. 270: View Of Right Secondary Timing Chain Tensioner Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the right secondary timing chain tensioner for damaged plunger-to-shoe contact surface (1).
2. Inspect the right secondary timing chain tensioner for locked or binding timing chain tensioner. Reset the plunger (3) and ensure the plunger moves freely (2) in and out of the body of the tensioner. Refer to **Secondary Timing Chain Tensioner Installation - Right Side**.
3. Replace a damaged right secondary timing chain tensioner.

OIL PUMP DISASSEMBLE

IMPORTANT: There are no serviceable components within the oil pump. Disassemble the pump only to diagnose an oiling concern. A disassembled oil pump must not be reused. A disassembled oil pump must be replaced.

cardiagn.com

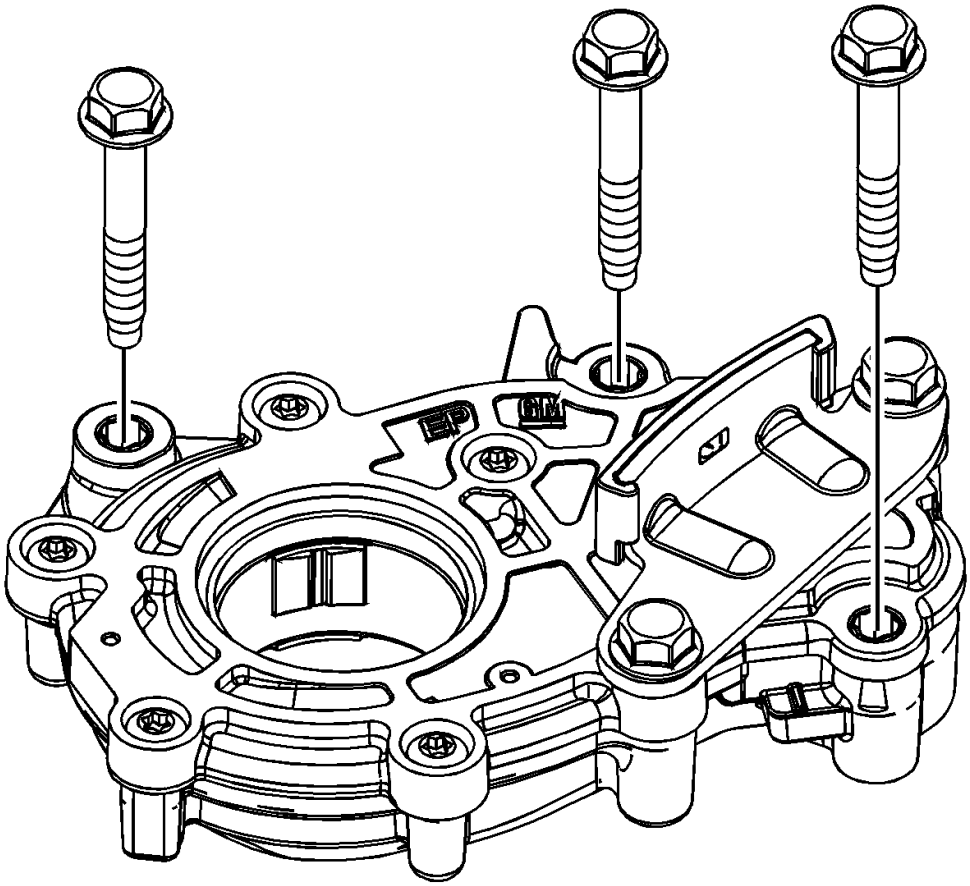


Fig. 271: Identifying Oil Pump Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pump mounting bolts.

cardiagn.com

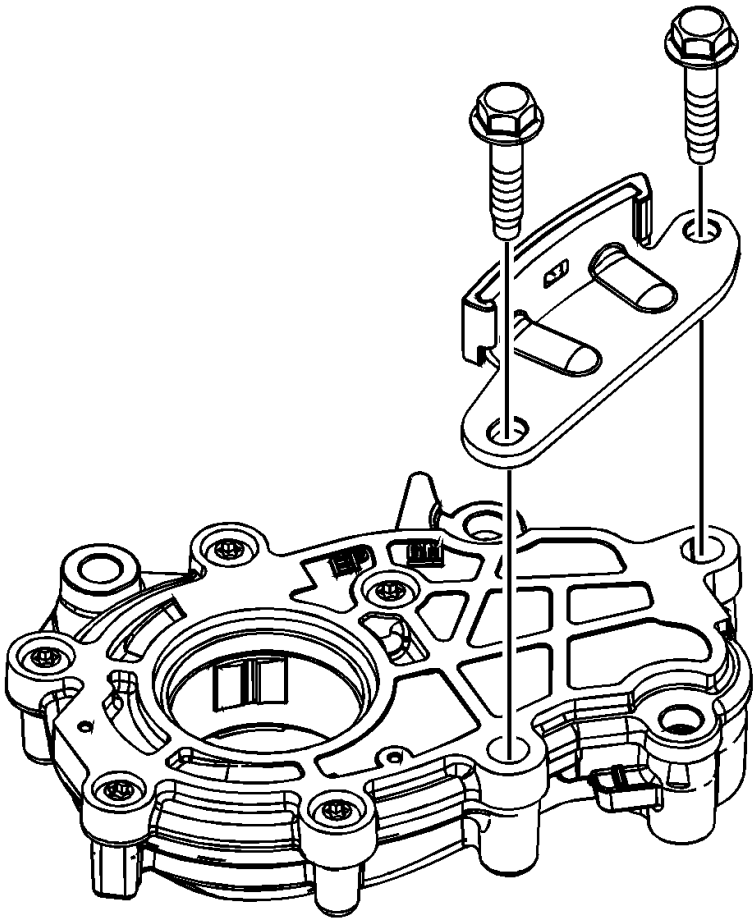


Fig. 272: View Of Oil Pump Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the primary camshaft drive chain lower guide bolts.
3. Remove the primary camshaft drive chain lower guide.

cardiagn.com

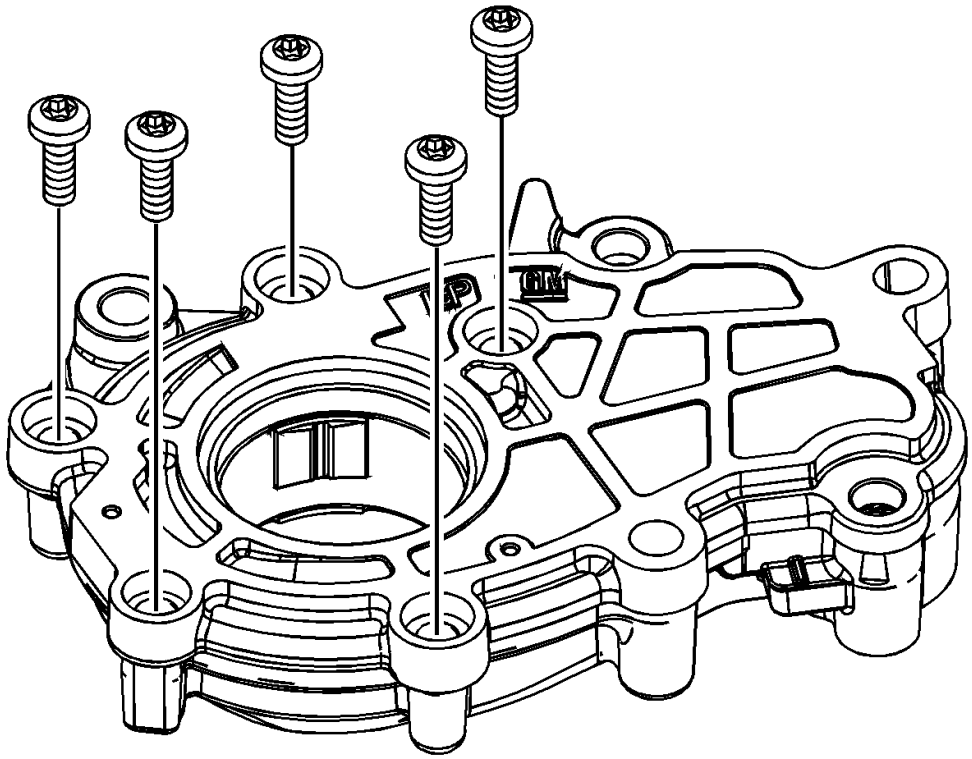


Fig. 273: View Of Oil Pump Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the bolts holding the oil pump cover to the oil pump housing.

cardiagn.com

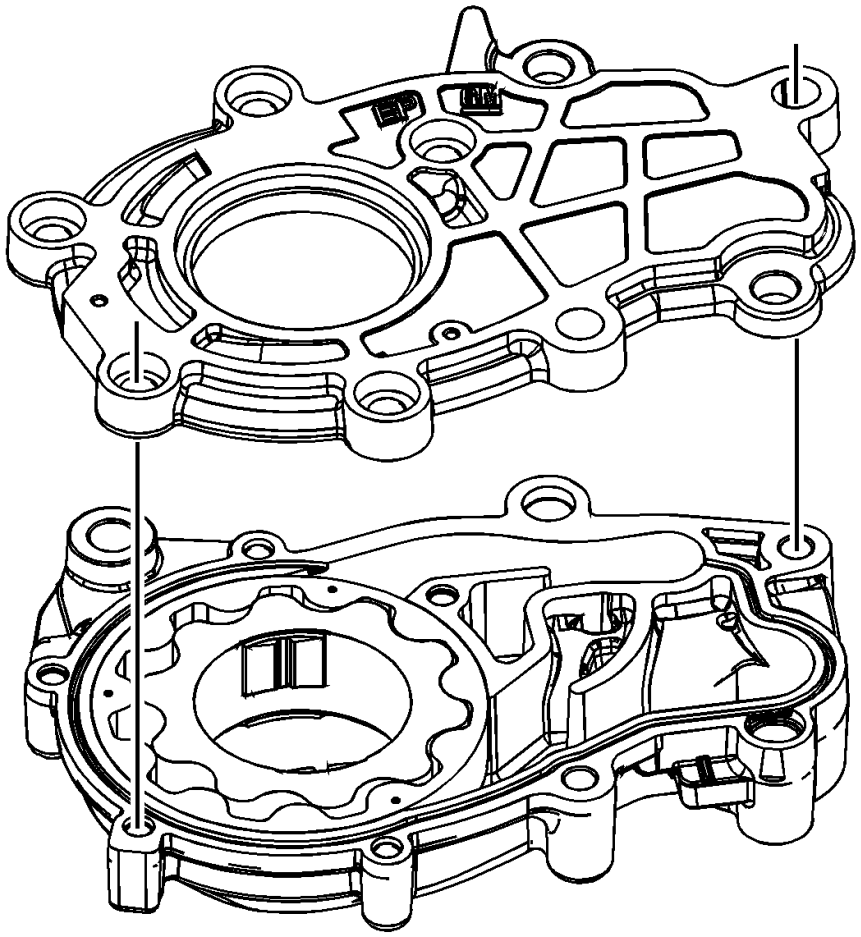


Fig. 274: View Of Oil Pump Housing & Cover
Courtesy of GENERAL MOTORS COMPANY

5. Remove the oil pump cover from the oil pump housing.

cardiagn.com

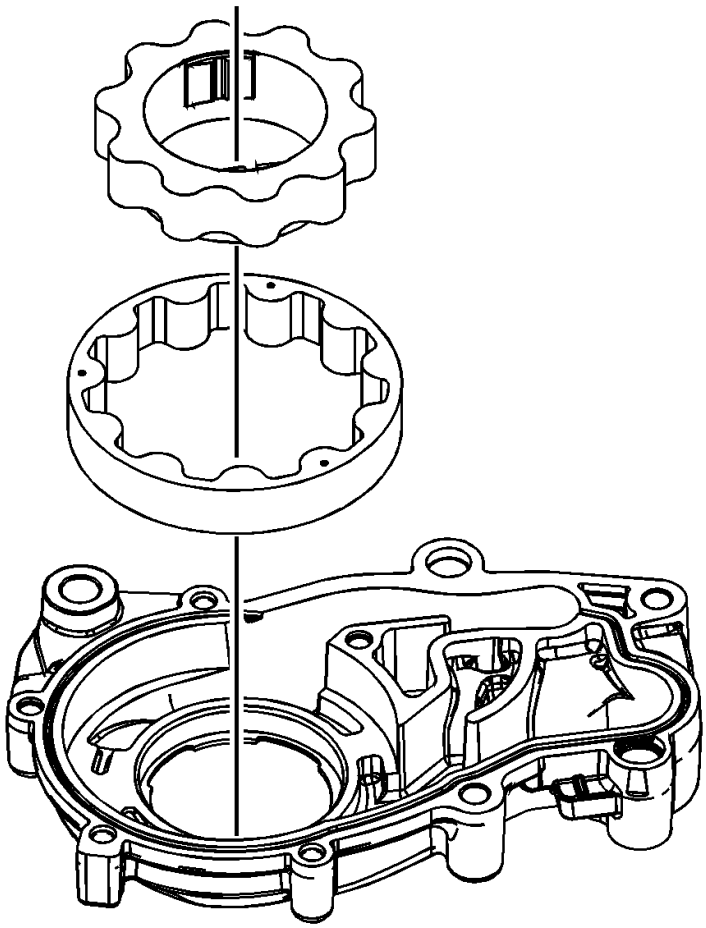


Fig. 275: Inner & Outer Rotors In Oil Pump Cover
Courtesy of GENERAL MOTORS COMPANY

6. Remove the inner oil pump drive gear.
7. Remove the outer oil pump driven gear.

cardiagn.com

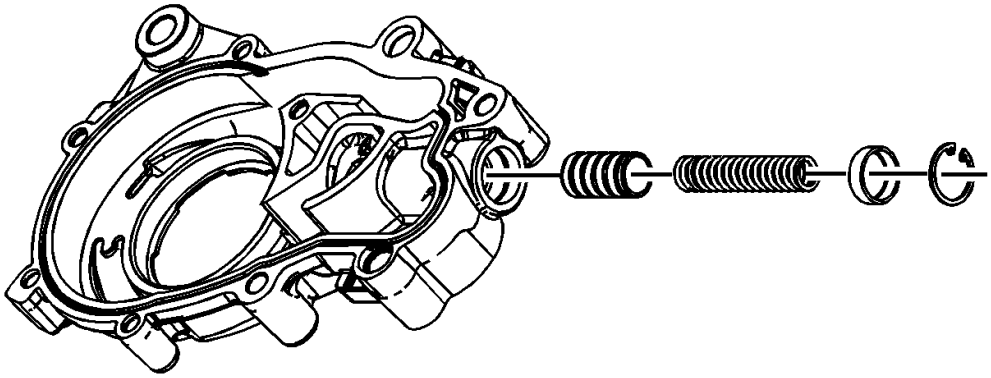


Fig. 276: Identifying Oil Pressure Relief Valve Components
Courtesy of GENERAL MOTORS COMPANY

8. Remove the clip, holding the cap, for the oil relief valve components.
9. Remove the cap, spring and plunger from the oil pump housing.

OIL PUMP CLEANING AND INSPECTION

Cleaning Procedure

1. Clean the oil pump components with non-corrosive solvent.
2. Dry the oil pump components with compressed air.

WARNING: Refer to Safety Glasses Warning .

Inspection Procedure

cardiagn.com

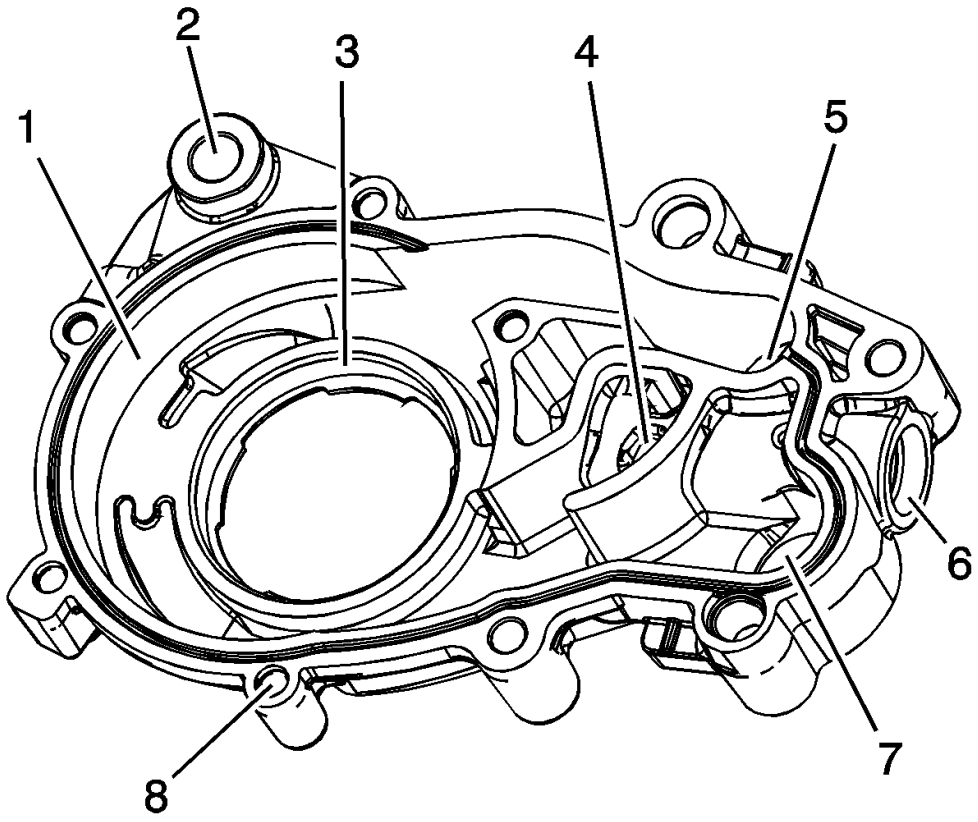


Fig. 277: Identifying Oil Pump Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

NOTE: There are no serviceable components within the oil pump. Disassemble the pump only to diagnose an oiling concern. A disassembled oil pump must not be reused. A disassembled oil pump must be replaced.

1. Inspect the oil pump housing for the following:
   - Damage, scoring or debris on the housing surface for the driven gear (1)
   - Damage to the oil pump mounting bosses (2)
   - Damage, scoring or debris on the housing surface for the drive gear (3)
   - Damage, scoring or debris in the oil pump relief valve port (4)
   - Damage, scoring or debris in the oil pump intake port (5)
   - Damage, scoring or debris in the oil pump relief valve bore (6)
   - Damage, scoring or debris in the oil pump output port (7)
   - Damage to the threads in the oil pump housing for the oil pump cover bolts (8)

cardiagn.com

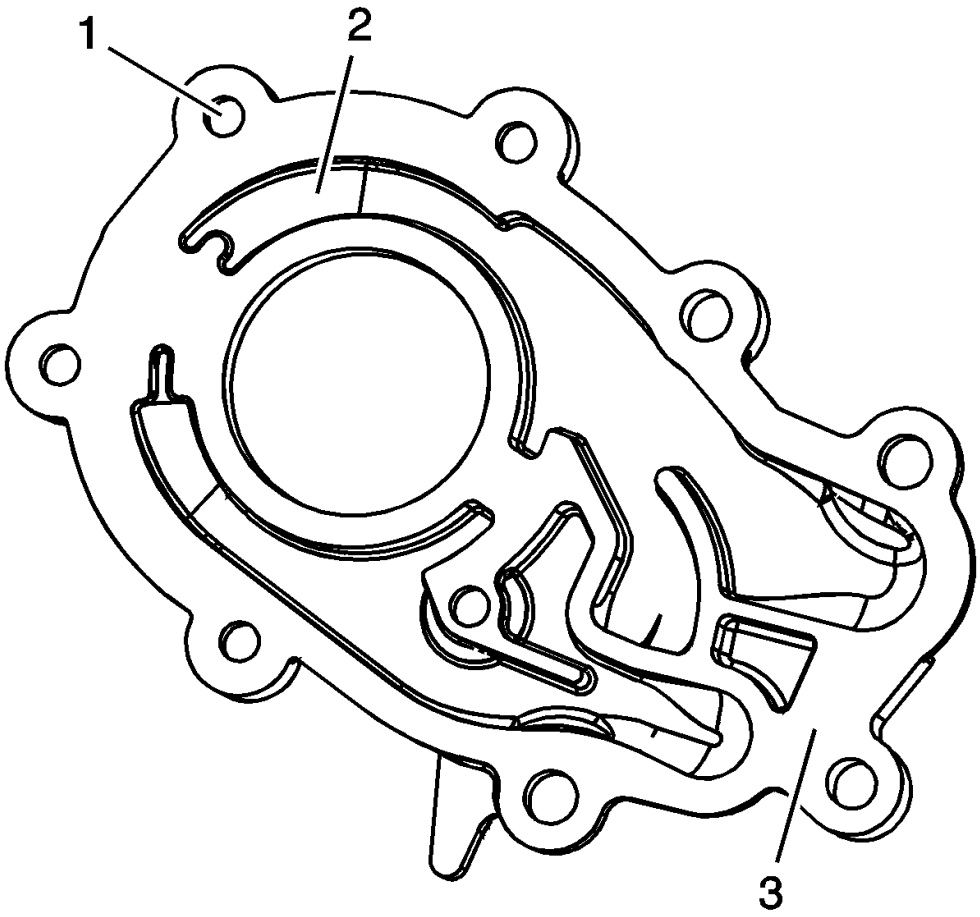


Fig. 278: View Of Oil Pump Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the oil pump cover for the following conditions:
    - Damage to the oil pump cover mounting bosses (1)
    - Damage, scoring or debris in the oil pump cover oil passages (2)
    - Damage to the sealing surface between the oil pump cover and the oil pump housing (3)

cardiagn.com

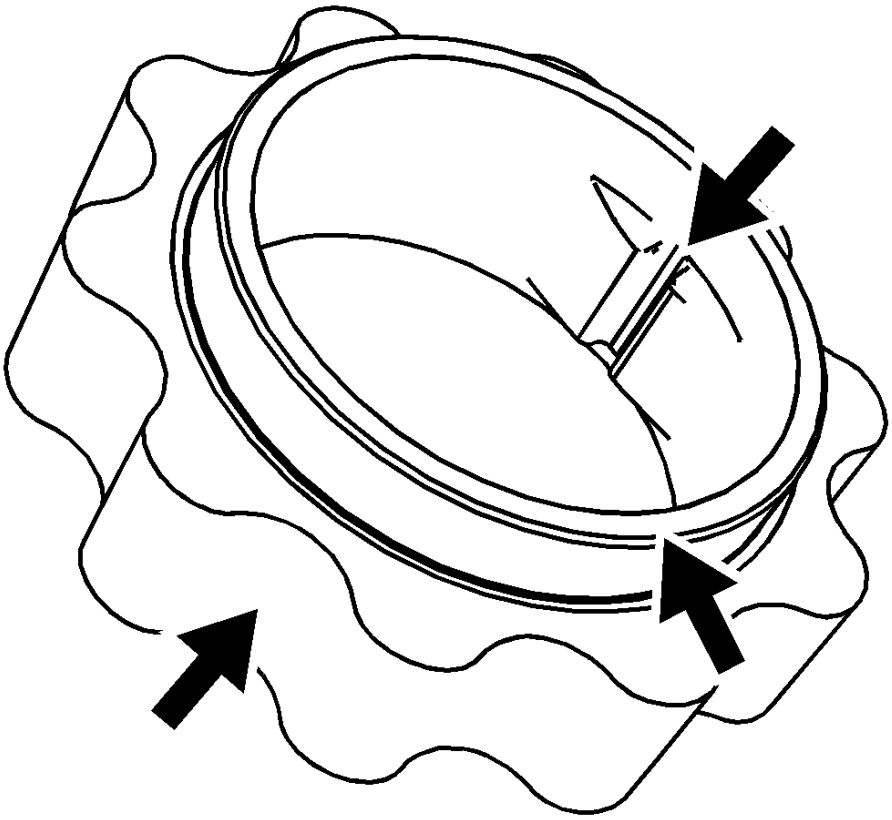


Fig. 279: View Of Inner Drive Gear Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the inner drive gear for damage. If inner diameter damage is found, ensure the crankshaft is also inspected.

cardiagn.com

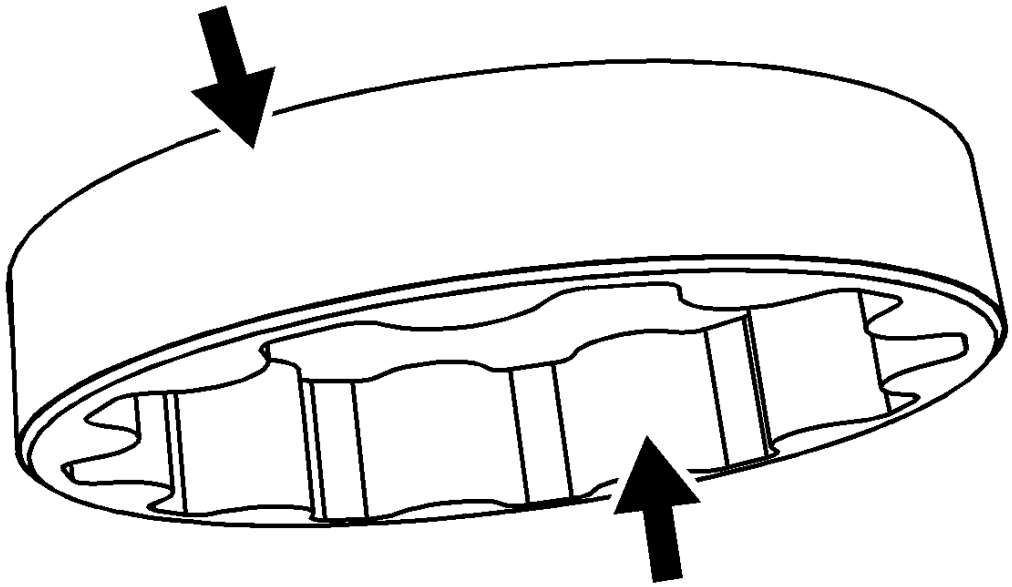


Fig. 280: Identifying Inspection Areas Inner/Outer Driven Gear
Courtesy of GENERAL MOTORS COMPANY

4. Inspect the outer driven gear for damage.

cardiagn.com

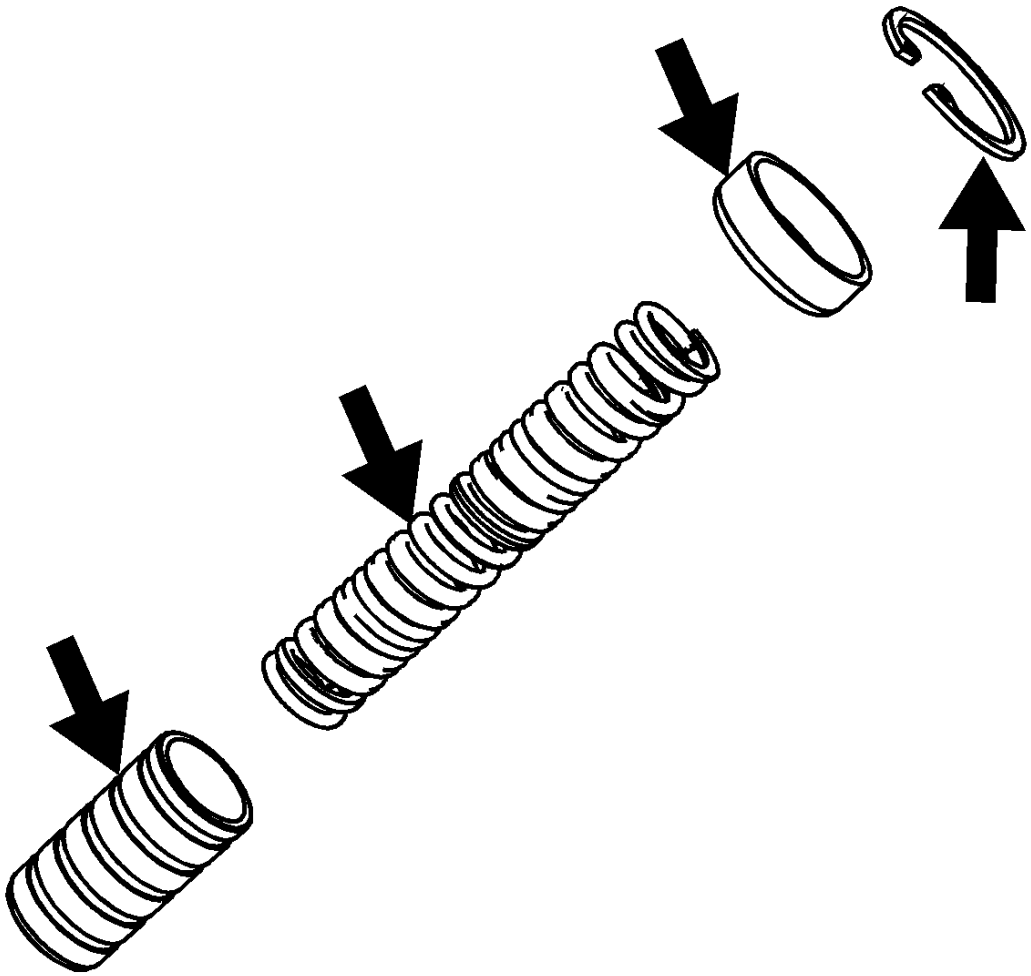


Fig. 281: Inspecting Oil Pump Relief Valve Components
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the oil pump relief valve components for debris or damage.

cardiagn.com

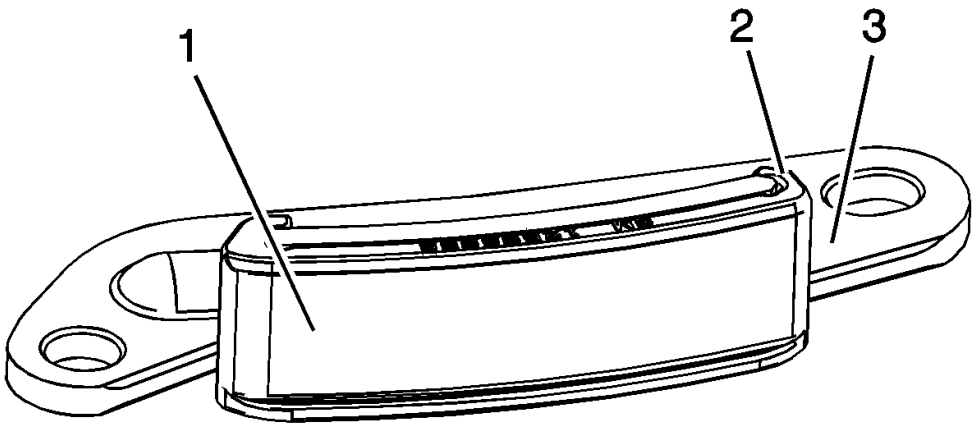


Fig. 282: View Of Primary Camshaft Drive Chain Lower Guide Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

6. Inspect the primary camshaft drive chain lower guide for damage (1-3).
7. If debris or damage is present within the oil pump, further inspection of all of the engine components is necessary.

OIL FILTER ADAPTER DISASSEMBLE

cardiagn.com

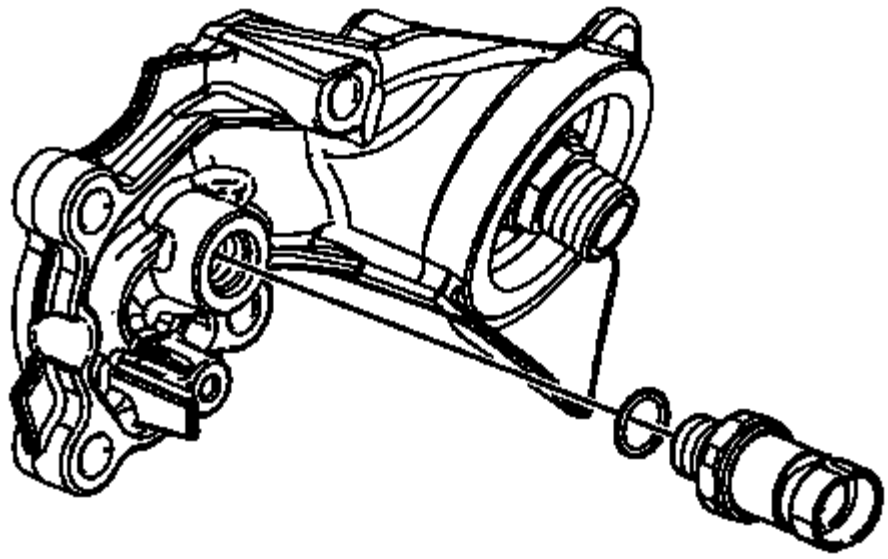


Fig. 283: Identifying Oil Pressure Sender
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pressure sender.

cardiagn.com

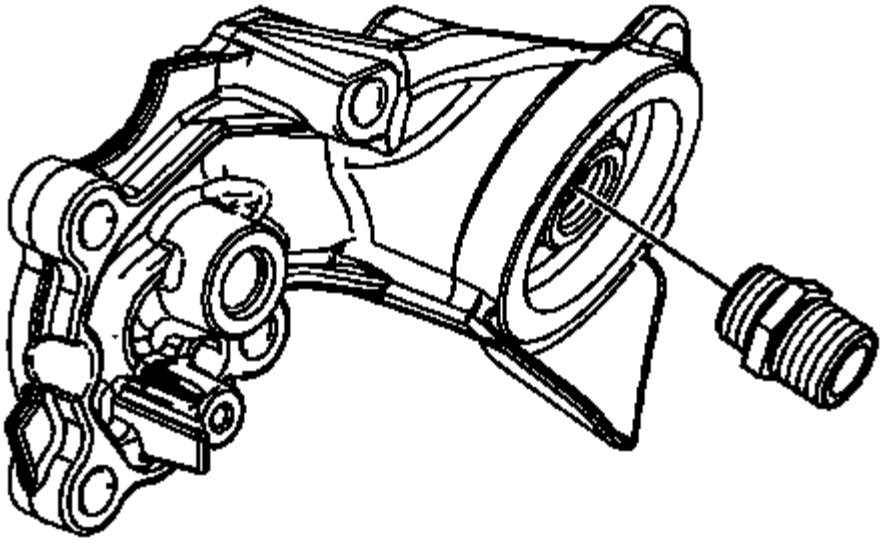


Fig. 284: Identifying Oil Filter Fitting
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil filter fitting.

OIL FILTER ADAPTER CLEANING AND INSPECTION

Cleaning Procedure

1. Clean the oil filter adapter components with non-corrosive solvent.
2. Dry the oil filter adapter components with compressed air.

WARNING: Refer to Safety Glasses Warning .

Inspection Procedure

cardiagn.com

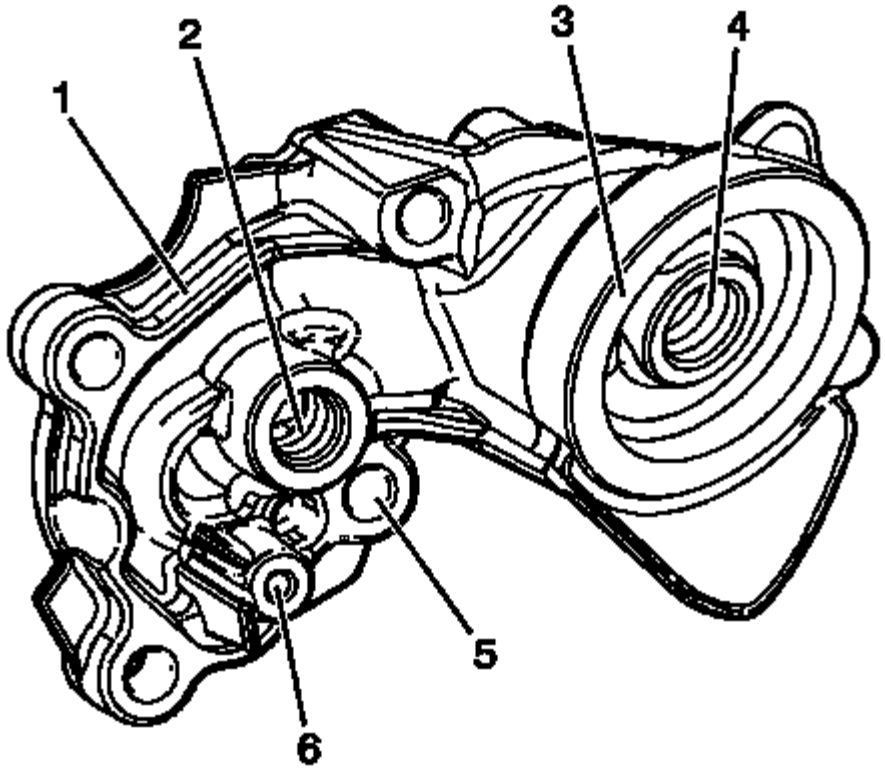


Fig. 285: Identifying Oil Filter Adapter Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: The internal parts of the oil filter adapter housing are not serviced separately. If wear or damage is noted, replace the entire oil filter adapter assembly.

1. Inspect the oil filter adapter housing for cracks, casting imperfections or damage (1).
2. Inspect the threads for the oil pressure sender (2) or the bracket (6) for damage.
3. Inspect the oil filter sealing surface (3) for damage.
4. Inspect the threads for the oil filter fitting (4) for damage.
5. Inspect the mounting holes (5) for damage.

cardiagn.com

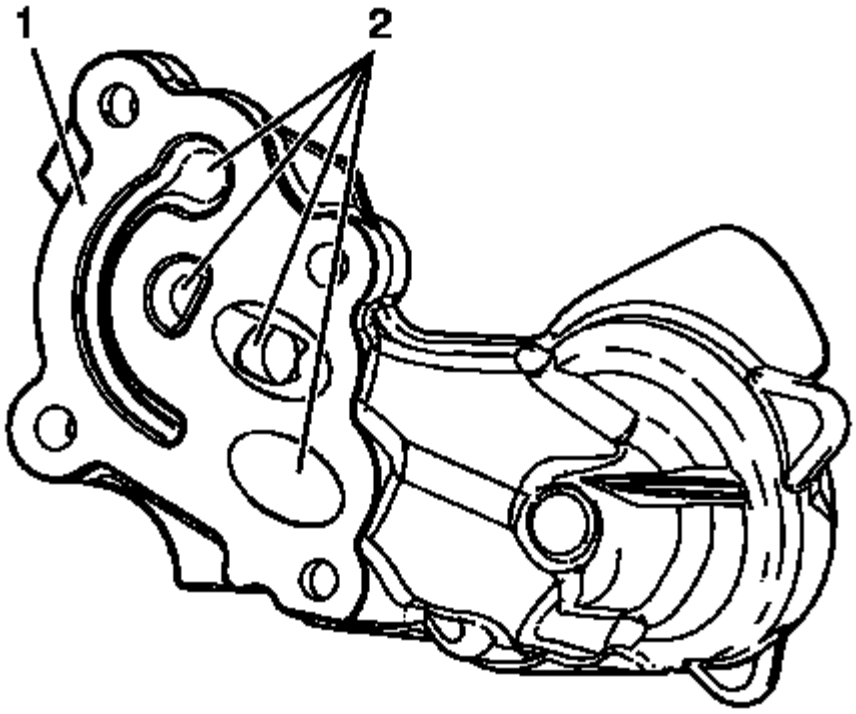


Fig. 286: Identifying Inspection Areas Of Oil Filter Adapter Housing Surfaces
Courtesy of GENERAL MOTORS COMPANY

6. Inspect the oil filter adapter housing gasket sealing surface (1) for damage.
7. Inspect the oil filter adapter housing passages (2) for damage or blockage.
8. Repair or replace the oil filter adapter housing as necessary.

OIL FILTER ADAPTER ASSEMBLE

cardiagn.com

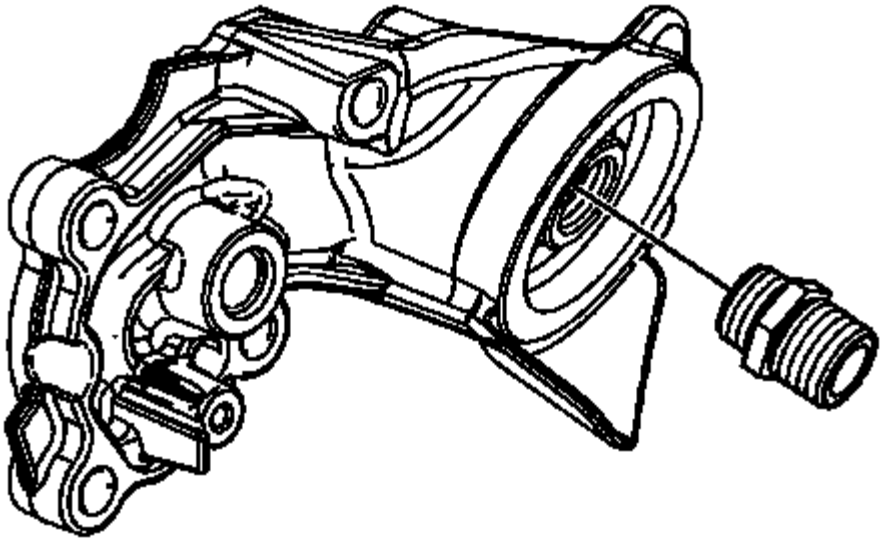


Fig. 287: Identifying Oil Filter Fitting
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the oil filter fitting and tighten to 50 N.m (37 lb ft).

cardiagn.com

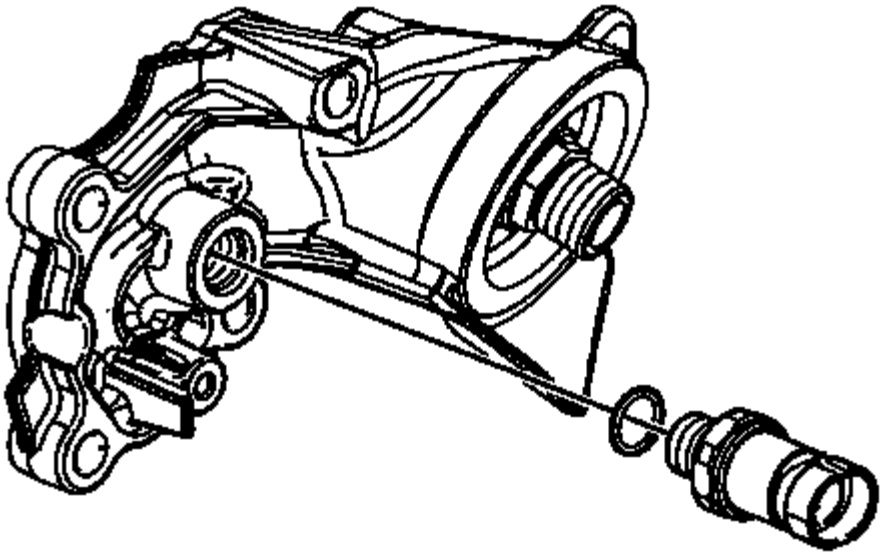


Fig. 288: Identifying Oil Pressure Sender
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil pressure sender and tighten to 20 N.m (15 lb ft).

OIL PAN DISASSEMBLE

cardiagn.com

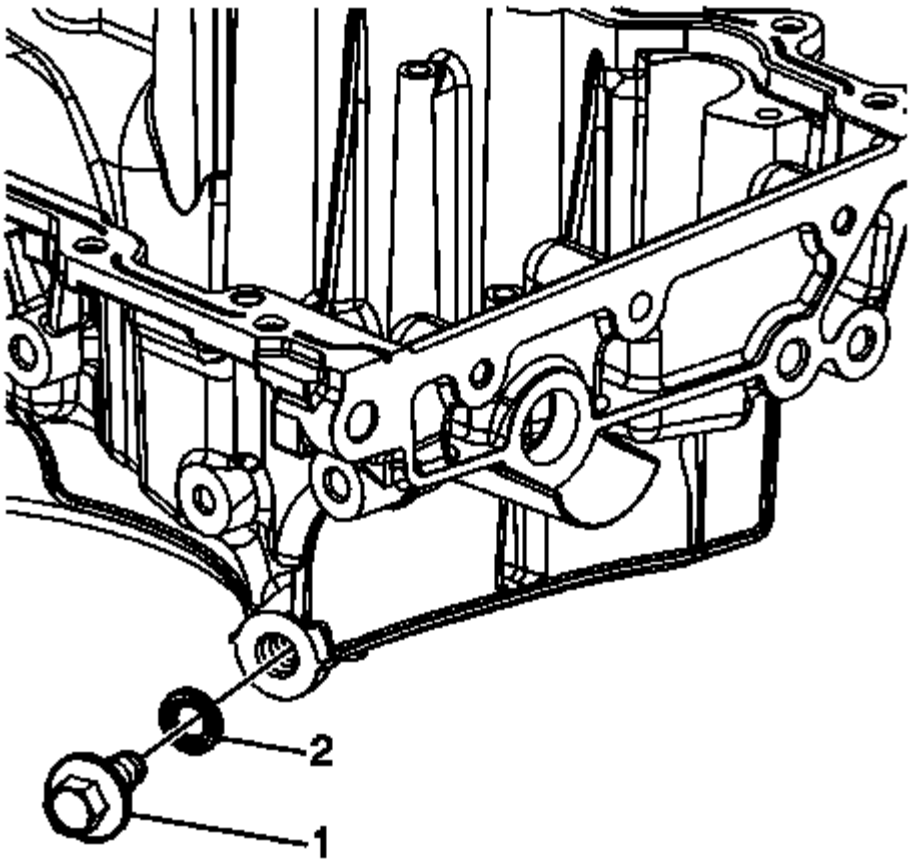


Fig. 289: Oil Pan Drain Plug And Seal
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pan drain plug (1) and seal (2).

cardiagn.com

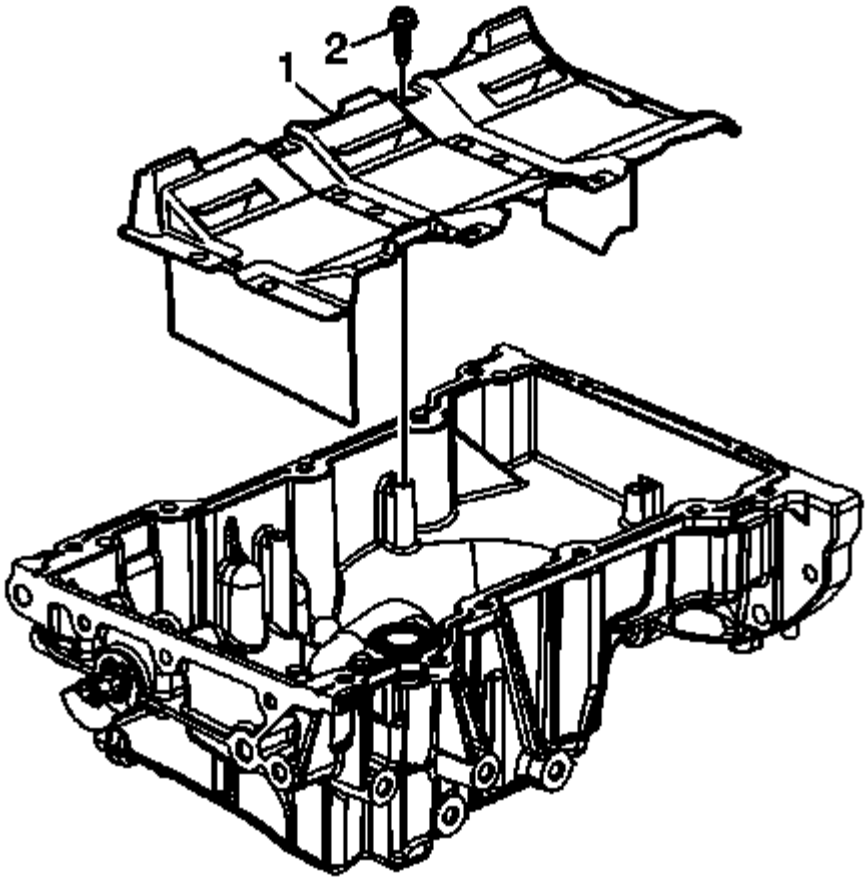


Fig. 290: Oil Pan Scraper
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil pan scraper bolts (2).
3. Remove the oil pan scraper (1).

cardiagn.com

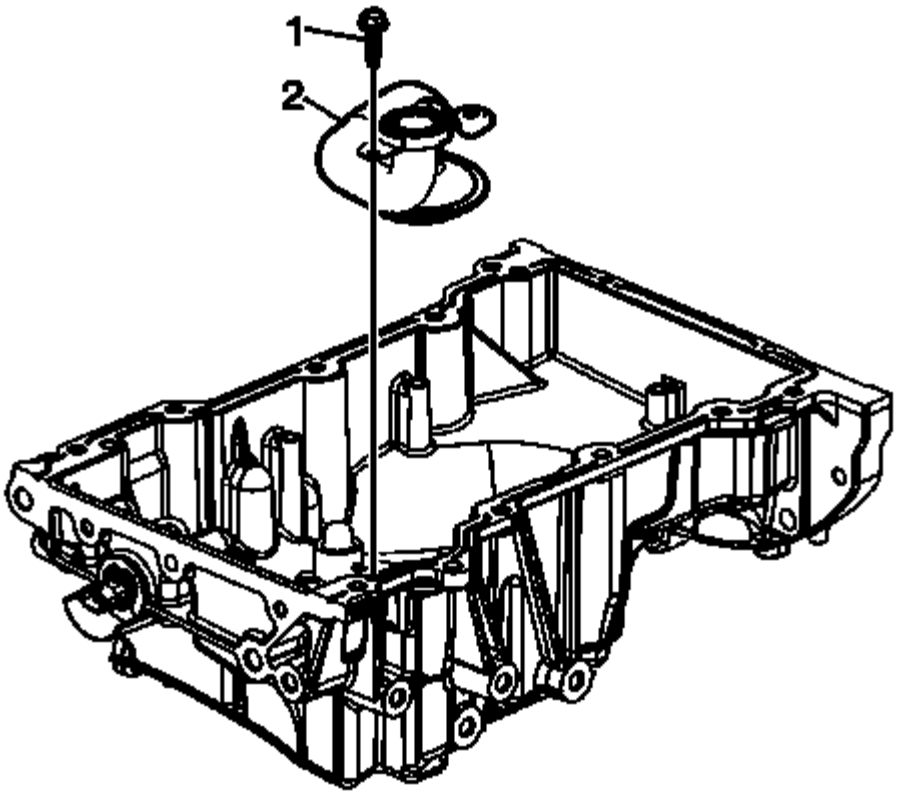


Fig. 291: Oil Suction Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the oil suction pipe bolts (1).
5. Remove the oil suction pipe (2).

cardiagn.com

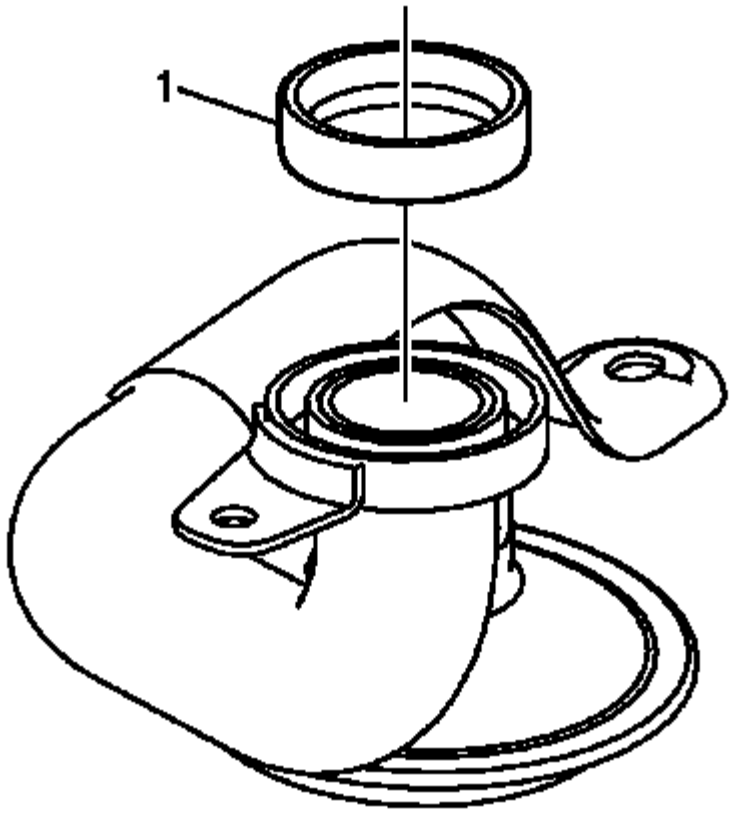


Fig. 292: Oil Suction Pipe Seal
Courtesy of GENERAL MOTORS COMPANY

6. Remove the oil suction pipe seal (1).

cardiagn.com

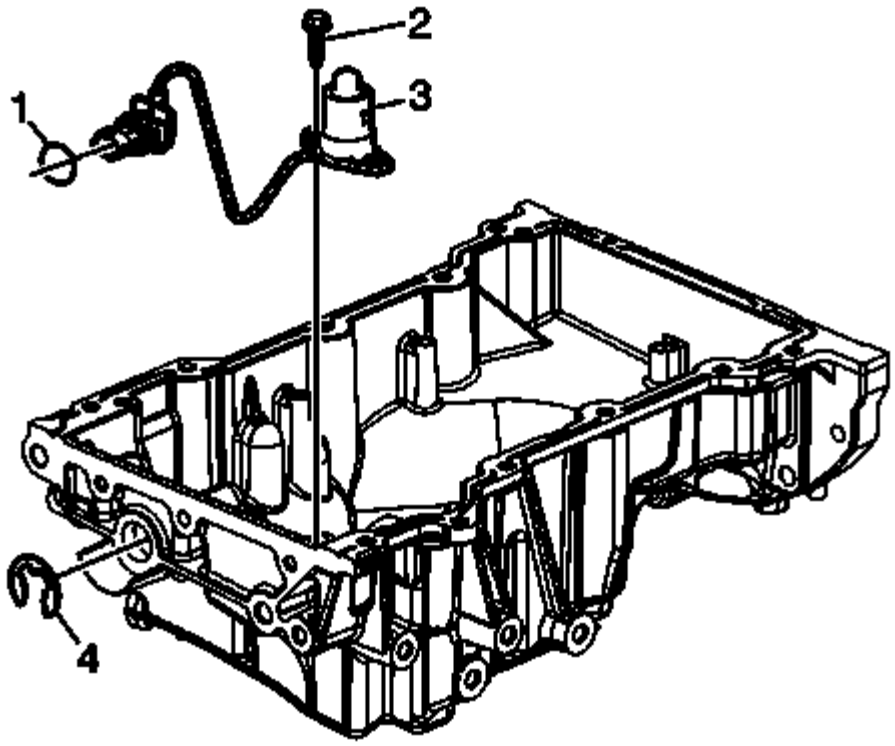


Fig. 293: Engine Oil Level Switch Seal
Courtesy of GENERAL MOTORS COMPANY

7. Remove the engine oil level switch clip (4)
8. Remove the engine oil level switch bolt (2).
9. Remove the engine oil level switch (3).
10. Remove the engine oil level switch seal (1).

OIL PAN CLEANING AND INSPECTION

Special Tools

EN 28410 Gasket Remover

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

Cleaning Procedure

1. Remove any old thread sealant, gasket material or sealant using **EN 28410** remover.
2. Clean the oil pan and oil pan components in solvent.

cardiagn.com

3. Clean out debris from the bolt holes.
4. Dry the oil pan and oil pan components with compressed air.

WARNING: Refer to Safety Glasses Warning .

Inspection Procedure

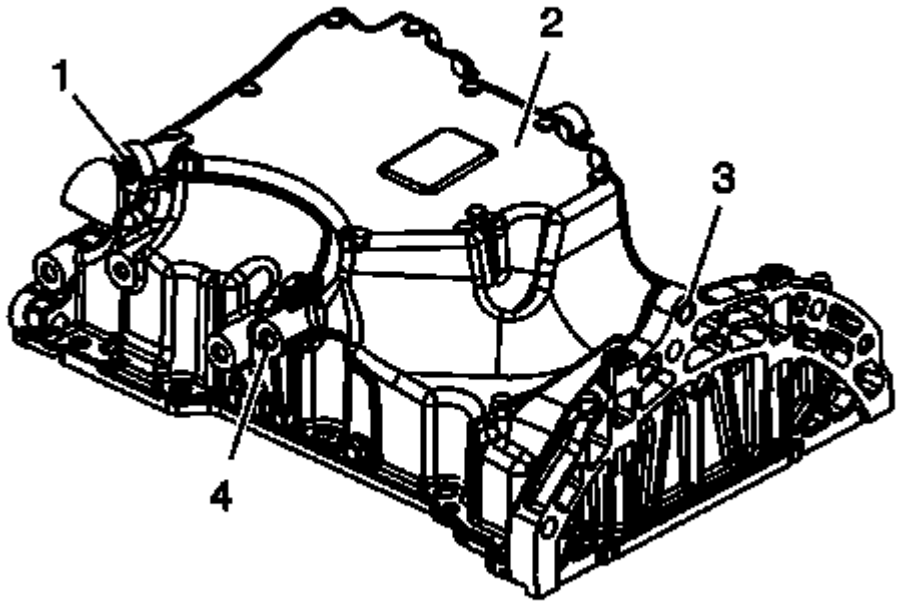


Fig. 294: Oil Pan Inspection Points
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the exterior of the oil pan for the following conditions:
   - Dents or damage to the exterior (2)
   - Damage to the drain plug or drain plug hole (1)
   - Damage to the brace mounting bosses (4)
   - Damage to the mounting bosses (3)

cardiagn.com

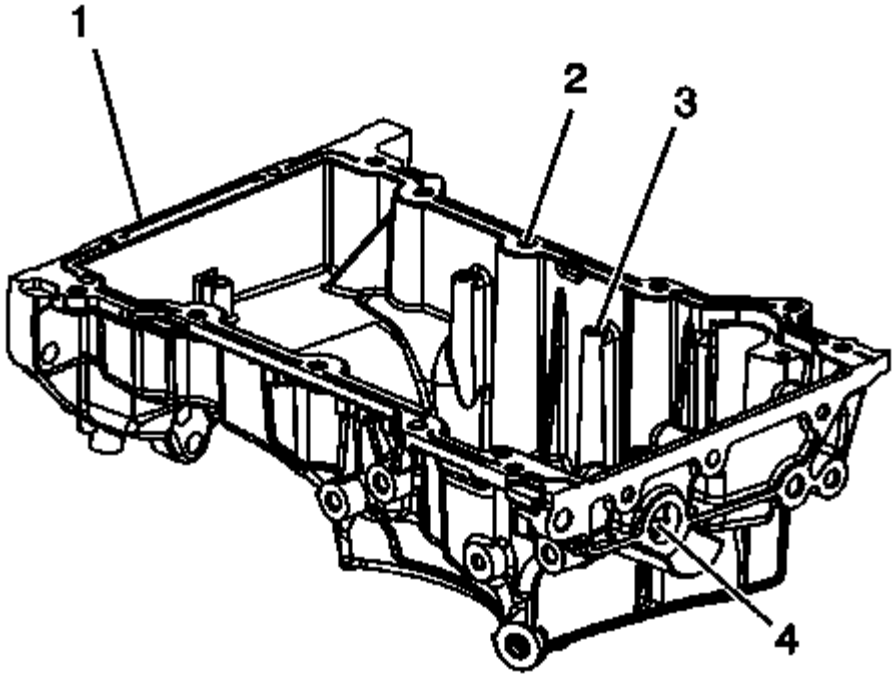


Fig. 295: Oil Pan Scraper Mounting Holes
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the interior of the oil pan for the following conditions:
   - Gouges or damage to the oil pan sealing surfaces (1)
   - Damage to the oil pan scraper mounting holes (2)
   - Damage to the bolt holes (3)
   - Damage to the engine oil level switch hole (4)
3. Repair or replace the oil pan and/or oil pan components as necessary.

OIL PUMP SUCTION PIPE AND SCREEN CLEANING AND INSPECTION

Cleaning Procedure

1. Clean the oil pump pipe and screen with solvent.
2. Dry the oil pump pipe and screen with compressed air.

WARNING: Refer to Safety Glasses Warning .

cardiagn.com

Inspection Procedure

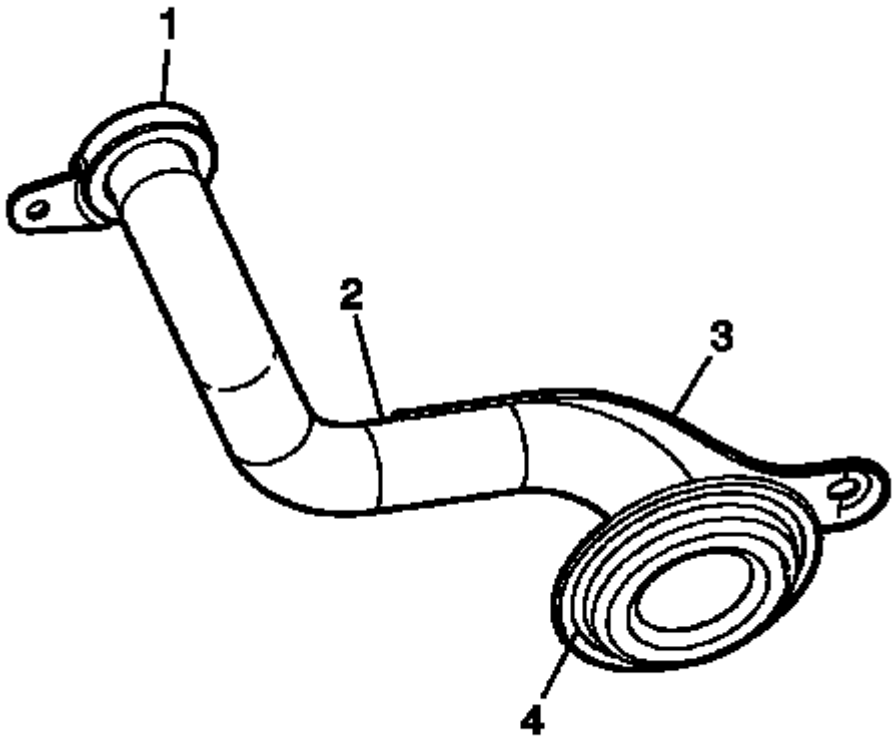


Fig. 296: Inspecting Oil Pump Pipe Tube
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the mounting surface (1) for possible leakage paths.
2. Inspect the oil pump pipe tube (2) for cracks, imperfections and/or damage.
3. Inspect the oil pump pipe support bracket (3) for cracks or damage.
4. Inspect the oil pump screen (4) for blockage, foreign material, tears, cracks and/or damage.

OIL PAN ASSEMBLE

CAUTION: Refer to Fastener Caution .

cardiagn.com

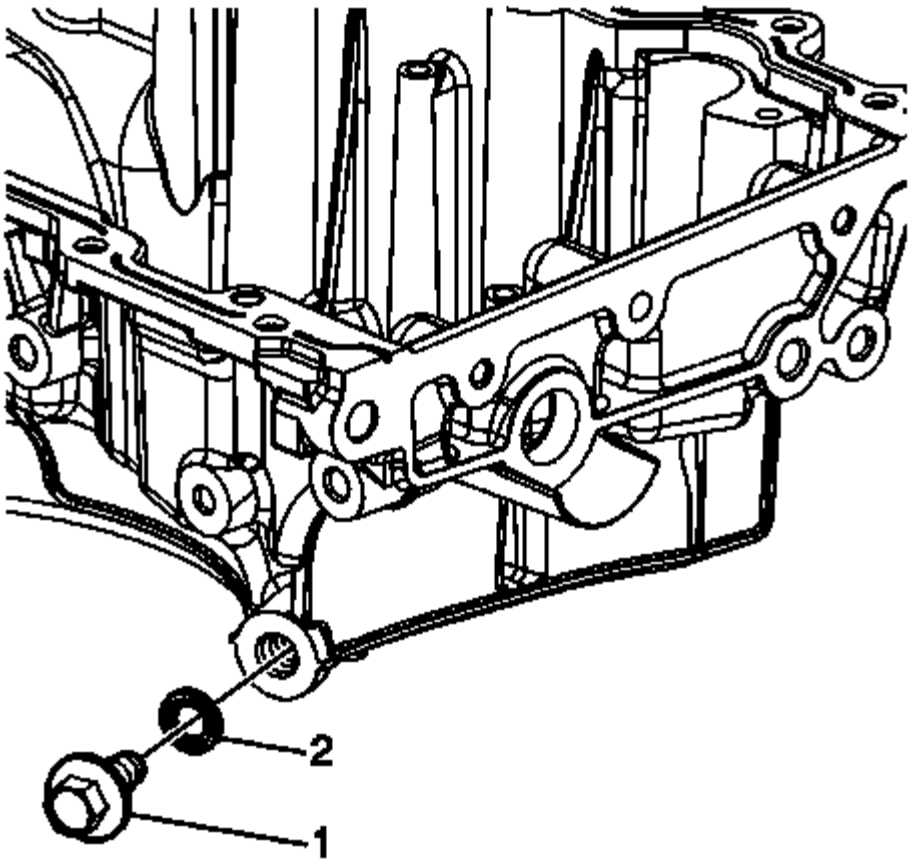


Fig. 297: Oil Pan Drain Plug And Seal
Courtesy of GENERAL MOTORS COMPANY

1. Install the oil pan drain plug (1) and NEW O-ring seal (2) and tighten to 25 N.m (18 lb ft).

cardiagn.com

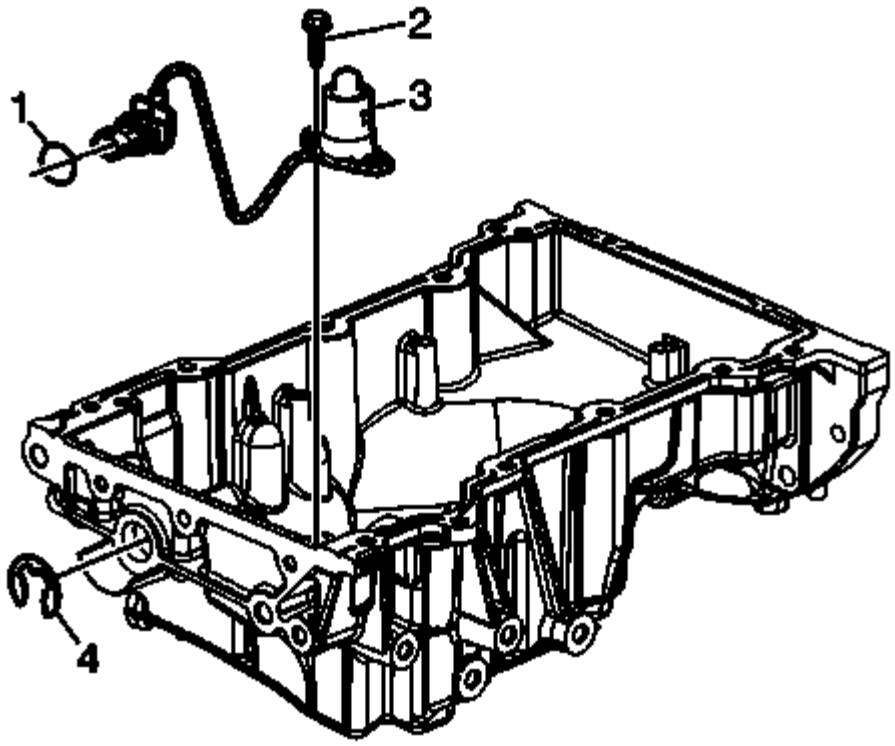


Fig. 298: Engine Oil Level Switch Seal
Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW engine oil level switch seal (1).
3. Install the engine oil level switch (3).
4. Install the engine oil level switch bolts (2) and tighten to 10 N.m (89 lb in).
5. Install NEW engine oil level switch clip (4).

cardiagn.com

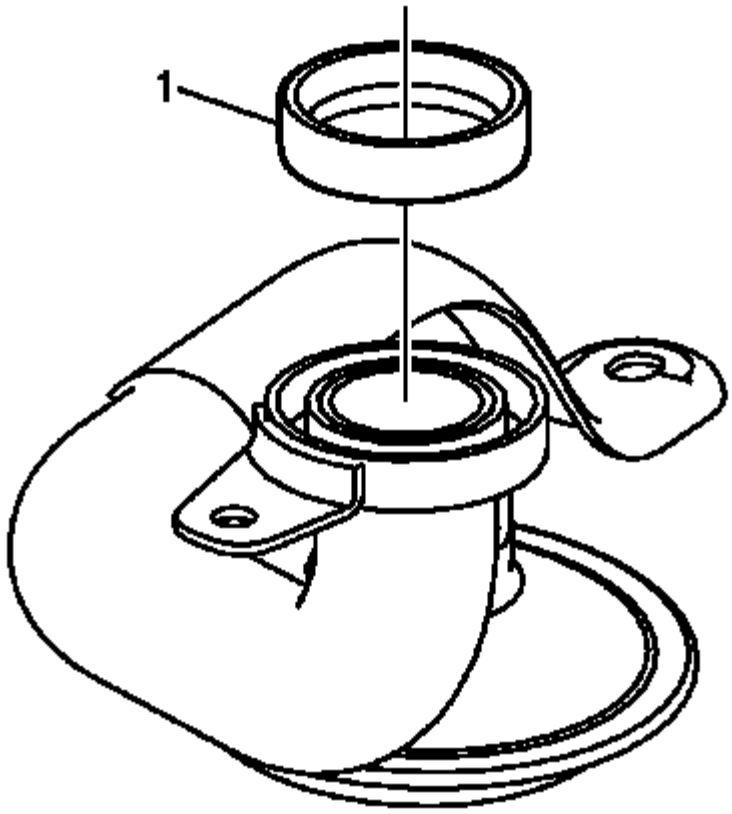


Fig. 299: Oil Suction Pipe Seal
Courtesy of GENERAL MOTORS COMPANY

6. Install the NEW oil suction pipe seal (1).

cardiagn.com

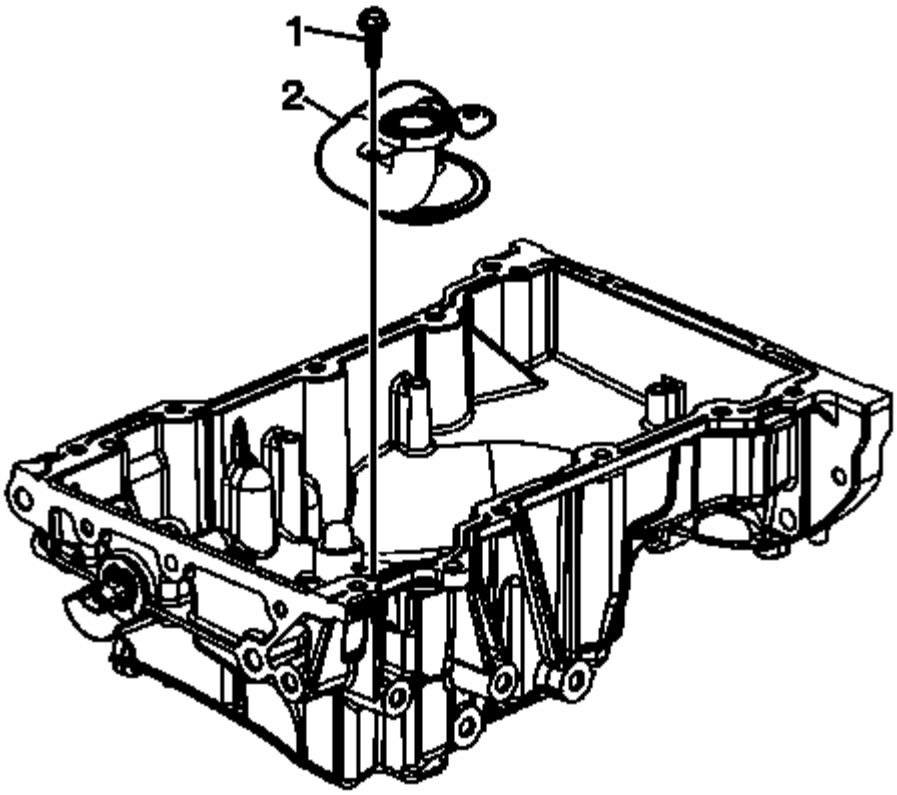


Fig. 300: Oil Suction Pipe Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install the oil suction pipe (2).
8. Install the oil suction pipe bolts (1) and tighten to 10 N.m (89 lb in).

cardiagn.com

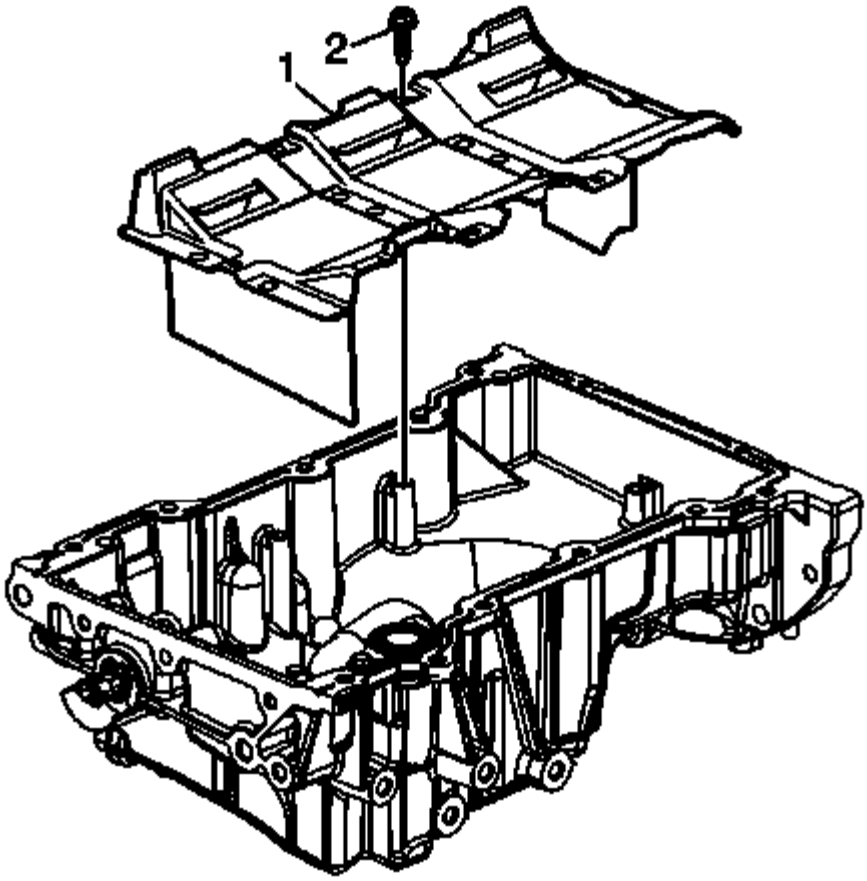


Fig. 301: Oil Pan Scraper
Courtesy of GENERAL MOTORS COMPANY

9. Install the oil pan scraper (1).
10. Install the oil pan scraper bolts (2) and tighten to 10 N.m (89 lb in).

cardiagn.com