

2011 ENGINE

Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - CTS

COMPONENT LOCATOR

DISASSEMBLED VIEWS

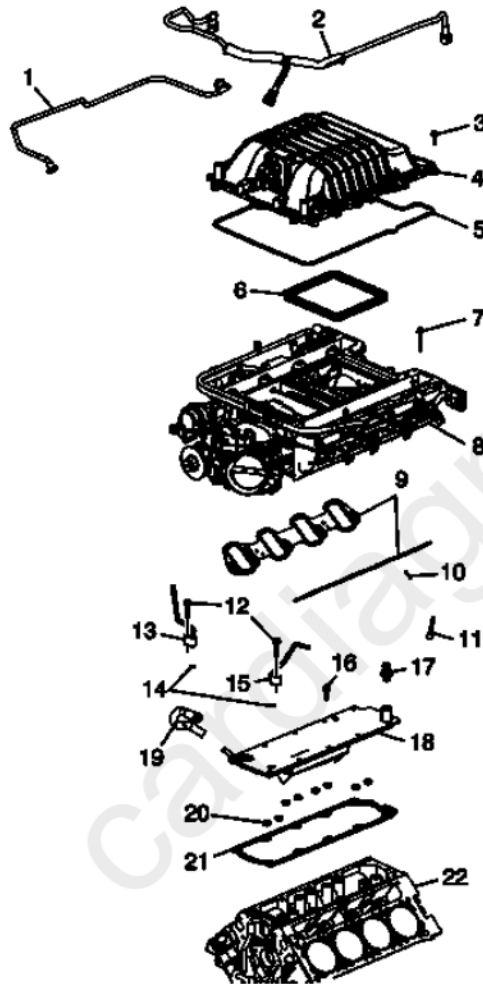


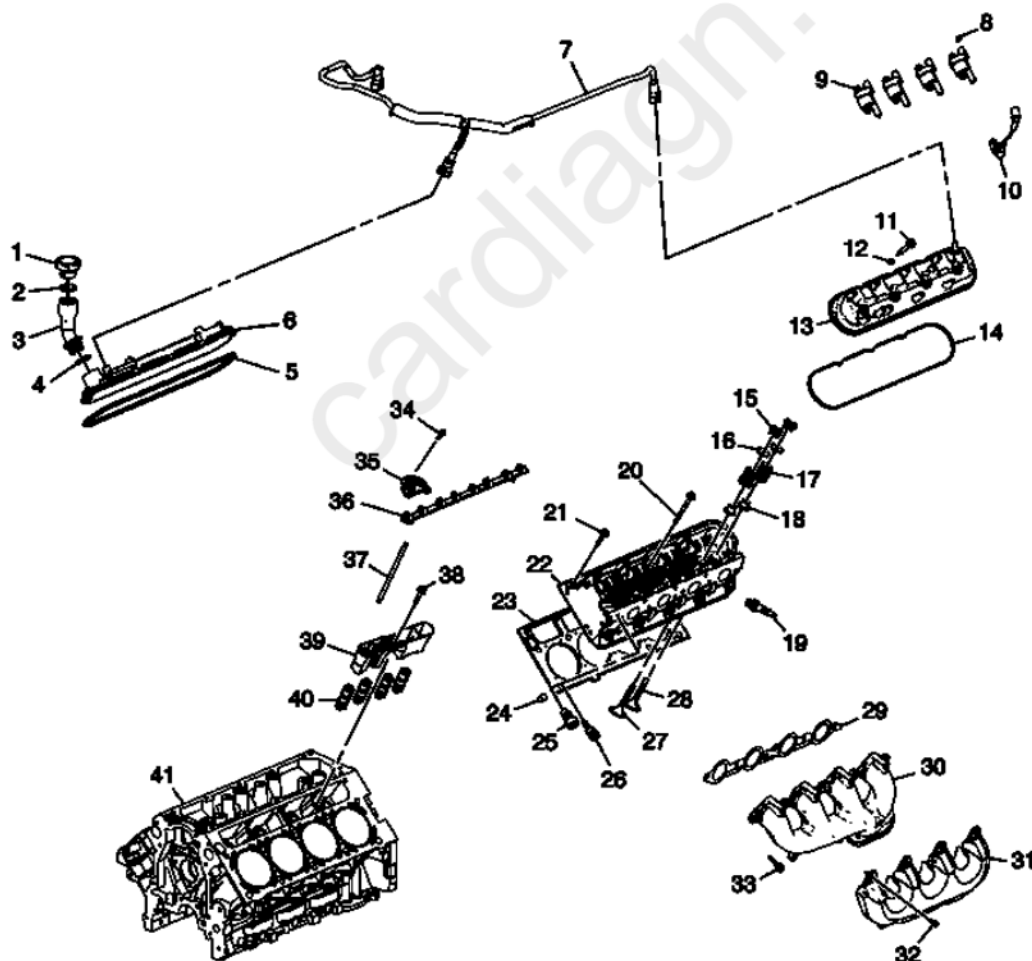
Fig. 1: Supercharger/Upper Engine
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Evaporative (EVAP) Emission Canister Purge Tube
2	Positive Crankcase Ventilation (PCV) Tube - Fresh Air
3	Supercharger Cover Bolts
4	Supercharger Cover
5	Supercharger Cover Seal
6	Supercharger Insulator Seal

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7	Supercharger Bolts
8	Supercharger
9	Supercharger Gasket
10	Supercharger Gasket Rivet
11	Engine Coolant Air Bleed Plug
12	Engine Coolant Air Bleed Pipe Bolt
13	Engine Coolant Air Bleed Pipe
14	Engine Coolant Air Bleed Pipe Seal
15	Engine Coolant Air Bleed Pipe
16	Valley Cover Bolt
17	Engine Oil Pressure Sensor
18	Valley Cover
19	PCV Hose - Dirty Air
20	Valley Cover Seal
21	Valley Cover Gasket
22	Engine Block



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Fig. 2: Cylinder Head/Upper Engine

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Oil Cap
2	Oil Cap O-ring Seal
3	Oil Fill Tube
4	Oil Fill Tube O-ring Seal
5	Valve Rocker Arm Cover Gasket
6	Valve Rocker Arm Cover
7	Positive Crankcase Ventilation (PCV) Tube - Fresh Air
8	Bolt
9	Ignition Coil
10	Spark Plug Wire
11	Bolt
12	Bolt Grommet
13	Valve Rocker Arm Cover
14	Valve Rocker Arm Cover Gasket
15	Valve Stem Key
16	Valve Spring Cap
17	Valve Spring
18	Valve Stem Oil Seal
19	Spark Plug
20	Cylinder Head Bolt - M11
21	Cylinder Head Bolt - M8
22	Cylinder Head
23	Cylinder Head Gasket
24	Cylinder Head Locating Pin
25	Cylinder Head Plug
26	Coolant Temperature Sensor
27	Exhaust Valve
28	Intake Valve
29	Exhaust Manifold Gasket
30	Exhaust Manifold
31	Exhaust Manifold Heat Shield
32	Exhaust Manifold Heat Shield Bolt
33	Exhaust Manifold Bolt
34	Bolt
35	Valve Rocker Arm
36	Valve Rocker Arm Pivot Support
37	Valve Pushrod

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38	Bolt
39	Valve Lifter Guide
40	Valve Lifter
41	Engine Block

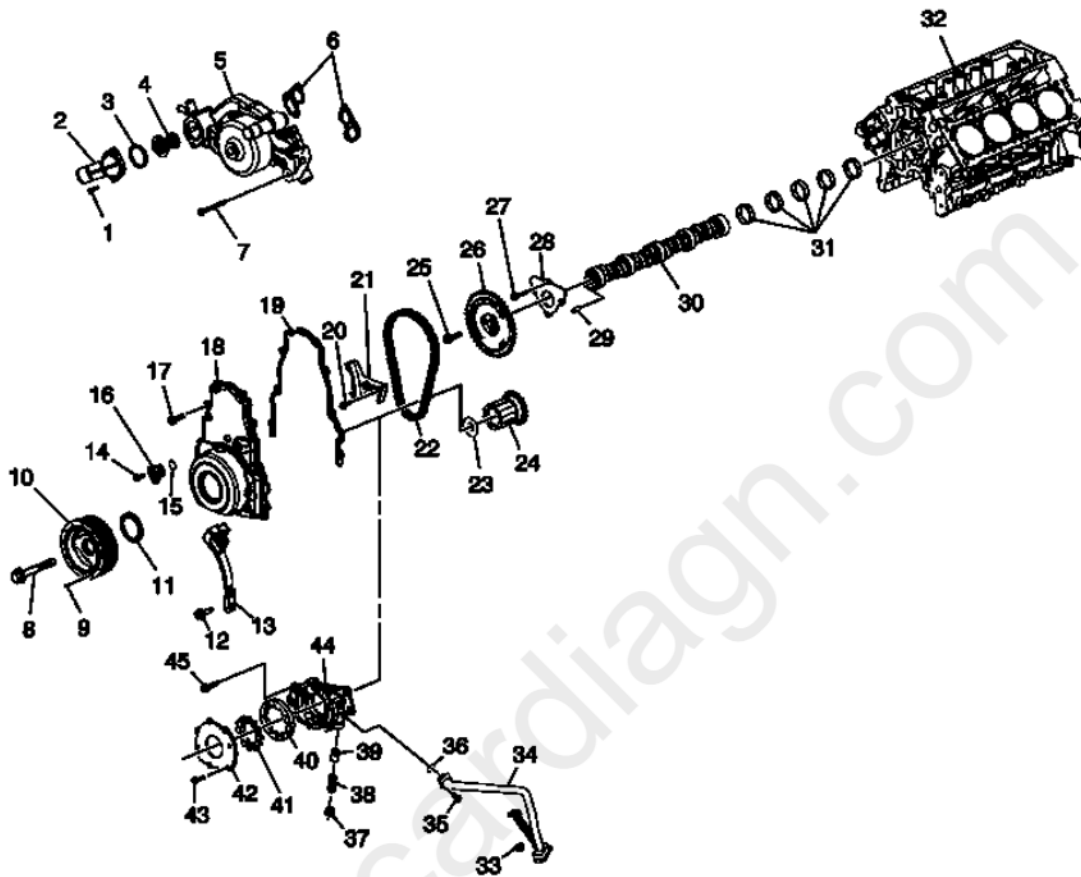


Fig. 3: Front of Engine

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Bolt
2	Water Inlet Housing
3	Water Inlet Seal
4	Engine Coolant Thermostat
5	Water Pump
6	Water Pump Gasket
7	Bolt
8	Bolt

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9	Balancer Weight - Crankshaft Balancer - Manual Transmission
10	Crankshaft Balancer
11	Crankshaft Front Oil Seal
12	Camshaft Position (CMP) Sensor Wire Harness Bolt
13	CMP Sensor Wire Harness
14	CMP Sensor Bolt
15	CMP Sensor Seal
16	CMP Sensor
17	Bolt
18	Engine Front Cover
19	Engine Front Cover Gasket
20	Bolt
21	Timing Chain Tensioner
22	Timing Chain
23	Crankshaft Balancer Washer
24	Crankshaft Sprocket
25	Bolt
26	Camshaft Sprocket
27	Bolt
28	Camshaft Retainer
29	Camshaft Sprocket Locating Pin
30	Camshaft
31	Camshaft Bearings
32	Engine Block
33	Oil Pump Suction Pipe Nut
34	Oil Pump Suction Pipe
35	Oil Pump Suction Pipe Bolt
36	Oil Pump O-ring Seal
37	Oil Pressure Relief Valve Bore Plug
38	Oil Pressure Relief Valve Spring
39	Oil Pressure Relief Valve
40	Oil Pump Driven Gear
41	Oil Pump Drive Gear
42	Oil Pump Cover
43	Oil Pump Cover Bolt
44	Oil Pump
45	Oil Pump Bolt

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Callout	Component Name
1	Engine Block
2	Crankshaft Rear Oil Seal Housing Gasket
3	Crankshaft Rear Oil Seal Housing
4	Bolt
5	Crankshaft Rear Oil Seal
6	Flexplate - Automatic Transmission
7	Transmission Pilot Bearing - Manual Transmission
8	Balance Weight - Flywheel - Manual Transmission
9	Flywheel - Manual Transmission
10	Bolt
11	Clutch Pressure Plate Locating Pin - Manual Transmission
12	Clutch Drive Plate - Manual Transmission
13	Clutch Pressure Plate - Manual Transmission
14	Bolt

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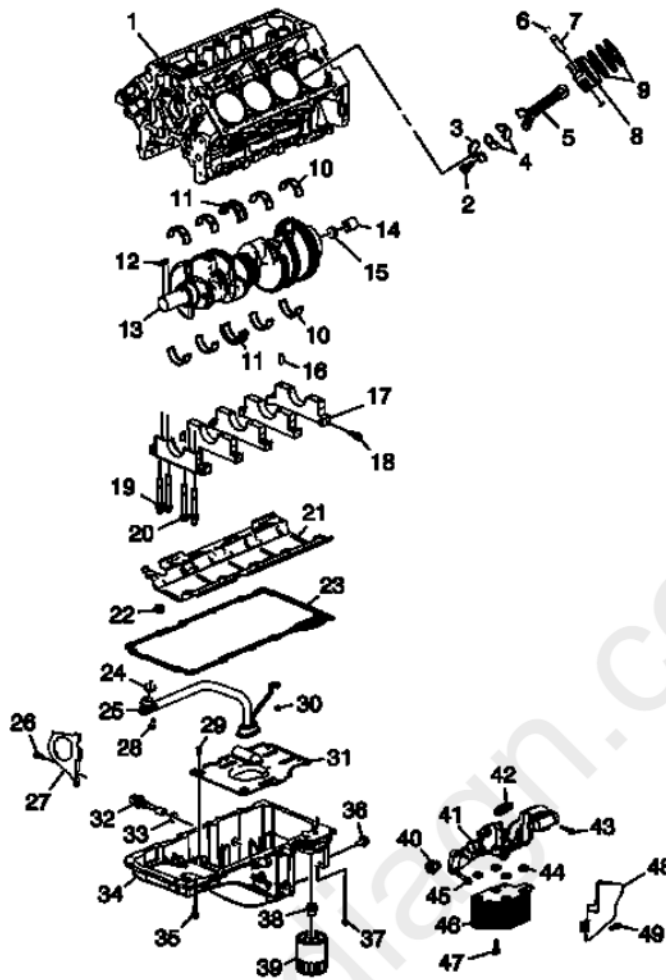


Fig. 5: Identifying Lower Engine Assembly Components
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Block
2	Bolt
3	Connecting Rod Cap
4	Connecting Rod Bearing
5	Connecting Rod
6	Piston Pin Retainer
7	Piston Pin
8	Piston
9	Piston Ring Set
10	Crankshaft Bearing
11	Crankshaft Bearing - Thrust
12	Crankshaft Sprocket Key
13	Crankshaft

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14	Transmission Pilot Bearing - Manual Transmission
15	Crankshaft Hole Plug
16	Crankshaft Bearing Cap Locating Pin
17	Crankshaft Bearing Cap
18	Bolt - M8
19	Stud - M10
20	Bolt - M10
21	Crankshaft Oil Deflector
22	Crankshaft Oil Deflector Nut
23	Oil Pan Gasket
24	Oil Pump Suction Pipe Seal
25	Oil Pump Suction Pipe
26	Bolt
27	Engine Cover - Right
28	Oil Pump Suction Pipe Bolt
29	Oil Pan Baffle Bolt
30	Oil Pump Suction Pipe Nut
31	Oil Pan Baffle
32	Engine Oil Level Sensor
33	Engine Oil Level Sensor Seal
34	Oil Pan
35	Oil Pan Bolt
36	Oil Pan Drain Plug
37	Oil Pan Bolt
38	Oil Filter Fitting
39	Oil Filter
40	Engine Oil Cooler Coolant Fitting
41	Engine Oil Cooler Housing
42	Engine Oil Cooler Gasket
43	Engine Oil Cooler-to-Oil Pan Bolt - M6
44	Engine Oil Cooler Core Seal
45	Engine Oil Cooler-to-Oil Pan Bolt - M8
46	Engine Oil Cooler Core
47	Engine Oil Cooler Core-to-Housing Bolt
48	Oil Pan Cover - Left
49	Bolt

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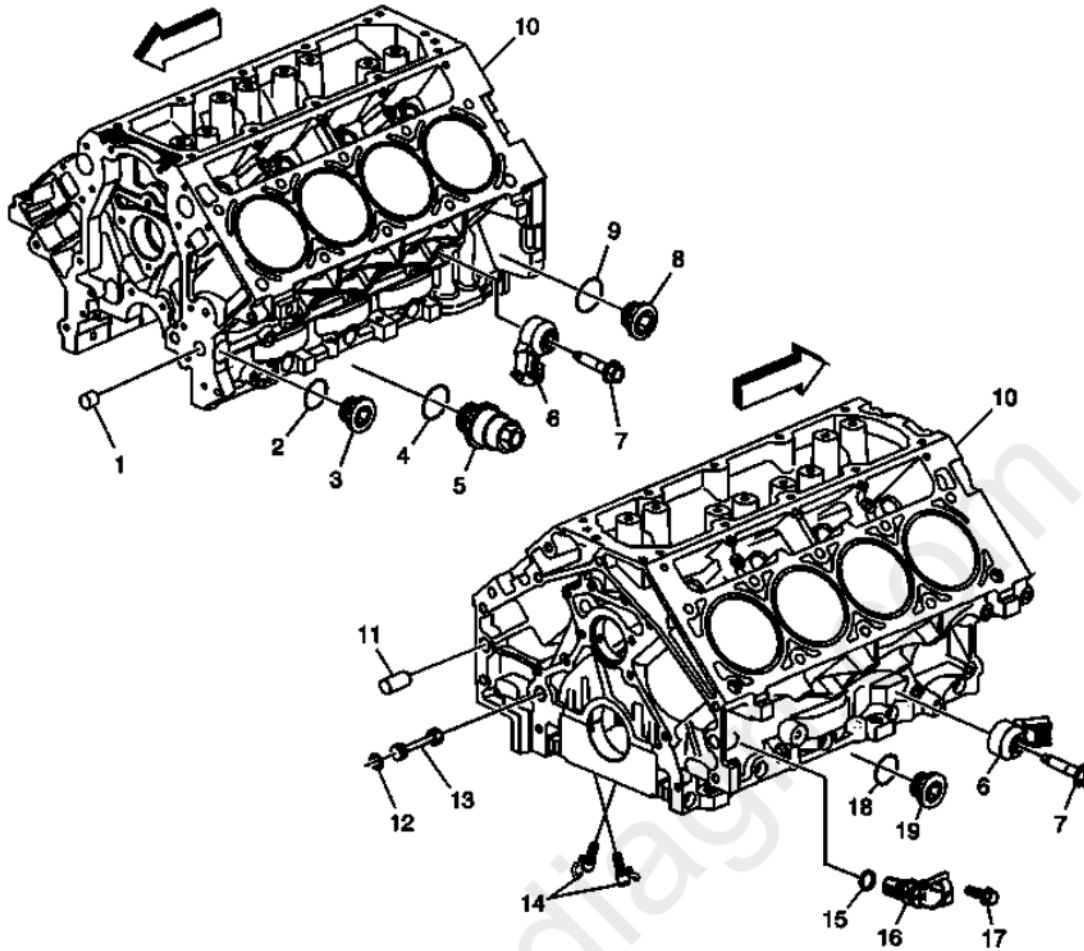


Fig. 6: Engine Block Plugs/Sensors
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Engine Block Oil Gallery Plug - Front
2	Engine Block Oil Gallery Plug Seal
3	Engine Block Oil Gallery Plug - Side
4	Engine Block Coolant Heater Seal
5	Engine Block Coolant Heater
6	Knock Sensor
7	Bolt
8	Engine Block Oil Gallery Plug - Side
9	Engine Block Oil Gallery Plug Seal
10	Engine Block
11	Transmission Locating Pin
12	Engine Block Oil Gallery Plug Seal
13	Engine Block Oil Gallery Plug - Rear

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14	Piston Oil Nozzle
15	Crankshaft Position (CKP) Sensor Seal
16	CKP Sensor
17	CKP Sensor Bolt
18	Engine Block Coolant Drain Hole Plug Seal
19	Engine Block Coolant Drain Hole Plug - Side

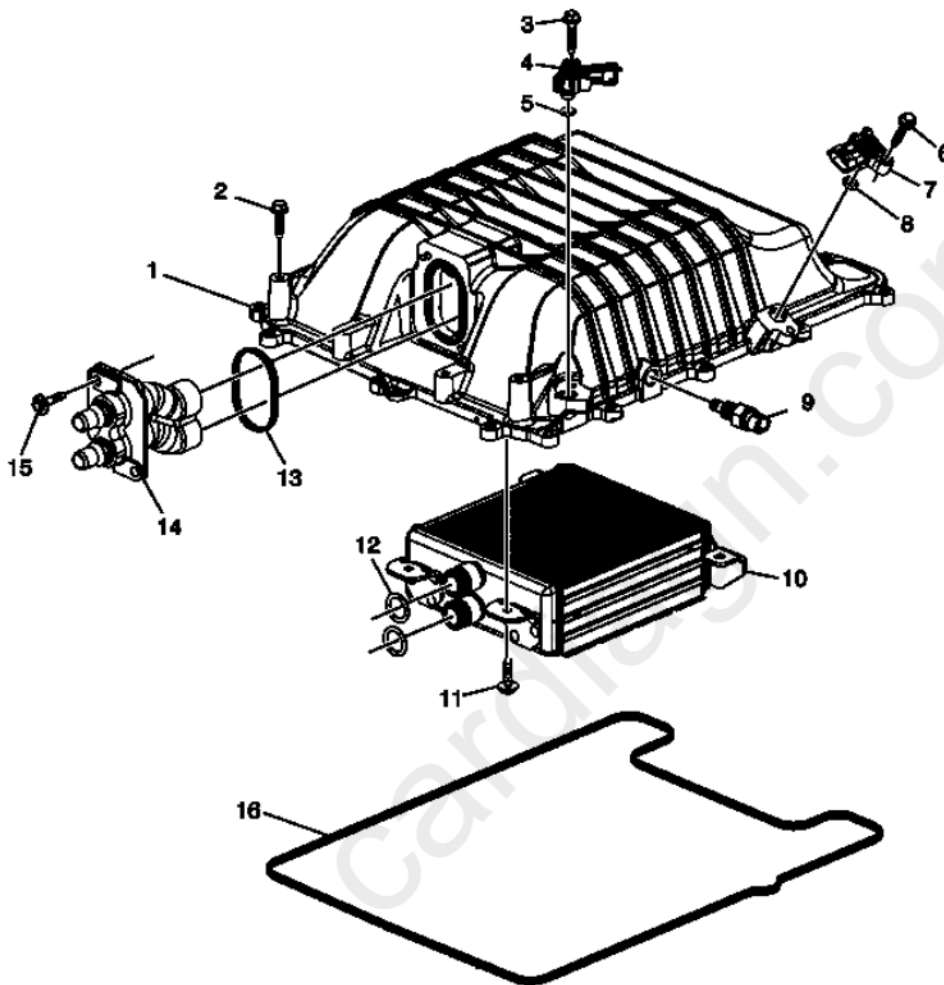


Fig. 7: Identifying Supercharger Cover Assembly Components
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Charge Air Cooler Cover
2	Charge Air Cooler Cover Bolt
3	Barometric Pressure Sensor Bolt
4	Barometric Pressure Sensor
5	Barometric Pressure Sensor Seal
6	Isolator Pad Bolt

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7	Isolator Pad
8	Charge Air Cooler Coolant Pipe Seal
9	Charge Air Cooler Coolant Outlet Pipe Assembly Seal
10	Charge Air Cooler Coolant Outlet Pipe Assembly
11	Charge Air Cooler Coolant Outlet Pipe Assembly Bolt
12	Supercharger Air Outlet Pressure Sensor Bolt
13	Supercharger Air Outlet Pressure Sensor
14	Supercharger Air Outlet Pressure Sensor Seal
15	Intake Air Temperature Sensor
16	Charge Air Cooler
17	Charge Air Cooler Bolt
18	Charge Air Cooler Cover Seal

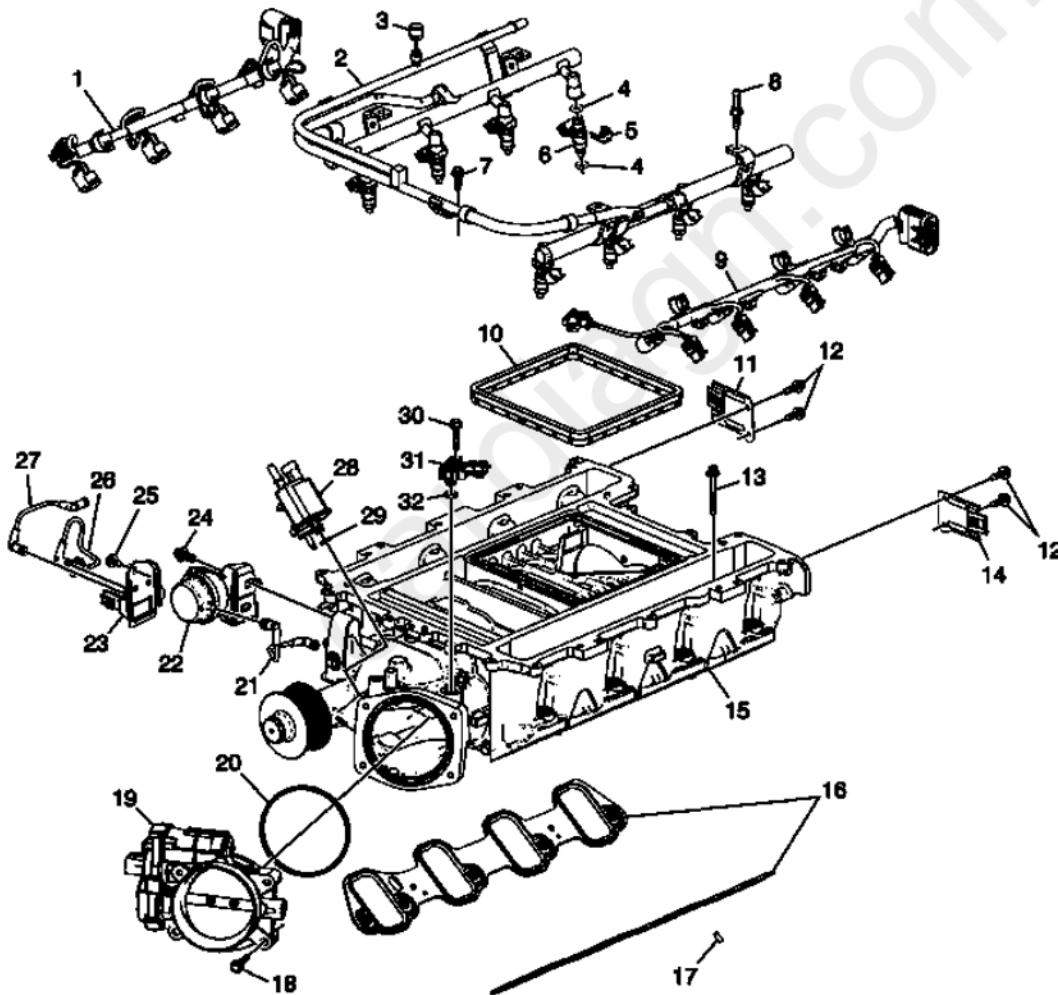


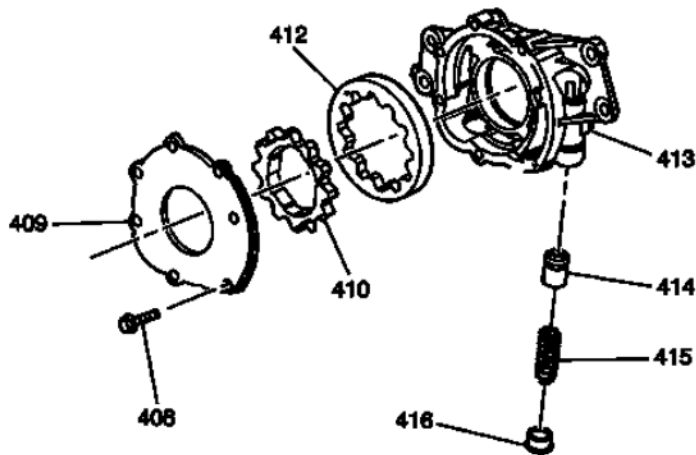
Fig. 8: Identifying Supercharger Assembly Components
 Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
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1	Fuel Injector Wiring Harness
2	Multiport Fuel Injection Fuel Rail
3	Fuel Rail Service Port Cap
4	Fuel Injector Seal
5	Fuel Injector Retainer
6	Fuel Injector
7	Fuel Injection Fuel Rail Bolt
8	Fuel Injector Fuel Rail Stud
9	Fuel Injector Wiring Harness
10	Charge Air Cooler Insulator
11	Fuel Injector Wiring Harness Connector Bracket - Right
12	Fuel Injector Wiring Harness Connector Bracket Bolt
13	Supercharger Bolt
14	Fuel Injector Wiring Harness Connector Bracket - Left
15	Supercharger
16	Intake Manifold Gasket
17	Intake Manifold Gasket Rivet
18	Throttle Body Bolt
19	Throttle Body
20	Throttle Body Seal
21	Charge Air Bypass Valve Vacuum Tube
22	Supercharger Bypass Actuator
23	Charge Air Bypass Valve w/Bracket
24	Supercharger Bypass Actuator Bolt
25	Charge Air Bypass Valve Bolt
26	Charge Air Bypass Valve Tube
27	Bypass Valve Actuator Tube
28	Evaporative Emission Canister Purge Valve
29	Evaporative Emission Canister Purge Valve Seal
30	Supercharger Inlet Air Pressure Sensor Bolt
31	Supercharger Inlet Air Pressure Sensor
32	Supercharger Inlet Air Pressure Sensor Seal

**Fig. 9: Oil Pump Assembly**

Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
408	Bolt
409	Oil Pump Housing Cover
410	Oil Pump Drive Gear
412	Oil Pump Driven Gear
413	Oil Pump
414	Oil Pump Pressure Relief Valve
415	Oil Pump Pressure Relief Valve Spring
416	Oil Pump Housing Plug

ENGINE IDENTIFICATION

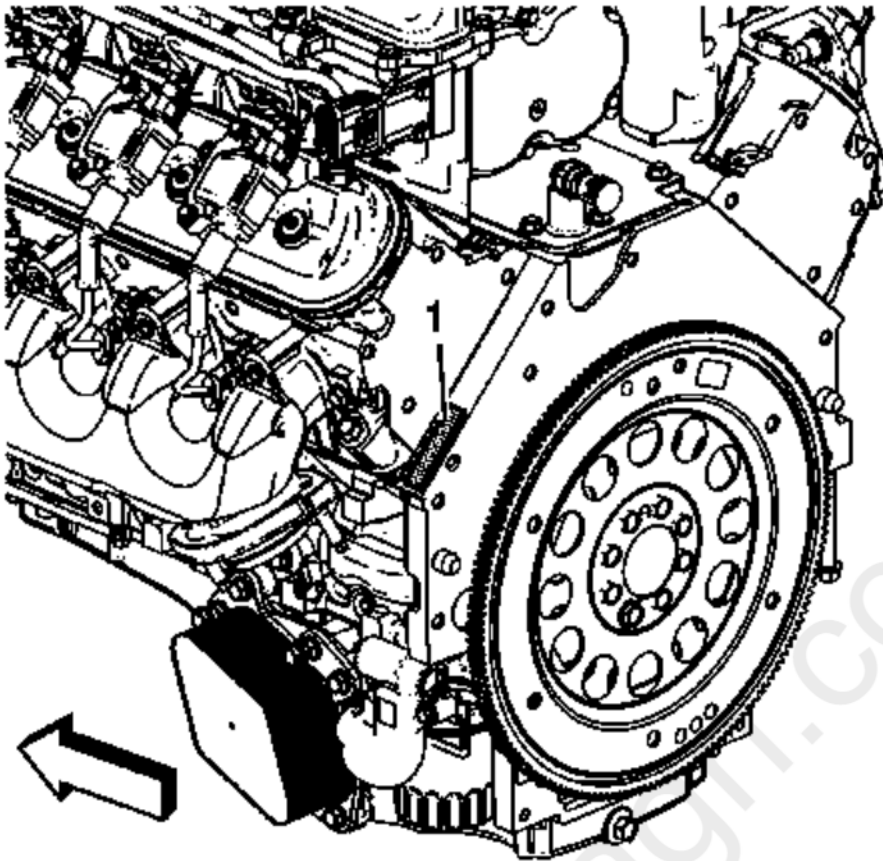


Fig. 10: Vehicle Identification Number
Courtesy of GENERAL MOTORS CORP.

The vehicle identification number (VIN) is located on the left side rear of the engine block (1) and is typically a 9 digit number stamped or laser-etched onto the engine at the vehicle assembly plant.

- The first digit identifies the division.
- The second digit identifies the model year.
- The third digit identifies the assembly plant.
- The fourth through ninth digits are the last 6 digits of the VIN.

2011 ENGINE**Engine Mechanical - 4.8L, 5.3L, 6.0L, 6.2L, or 7.0L - CTS****DESCRIPTION AND OPERATION****CRANKCASE VENTILATION SYSTEM DESCRIPTION (WITH LS9 AND LSA)**

A closed crankcase ventilation system is used in order to provide a more complete scavenging of crankcase vapors. Filtered air from the air induction system duct is supplied to the crankcase, mixed with blow-by vapors, and passes through a crankcase ventilation metering device before entering the supercharger. The primary component in the positive crankcase ventilation (PCV) system is the PCV flow metering device (valve or orifice). Vacuum changes within the supercharger result in flow variations of the blow-by vapors. If abnormal operating conditions occur, the design of the PCV system permits excessive amounts of blow-by vapors to back flow through the crankcase vent tube and into the engine induction system to be consumed during normal combustion. This engine ventilation system design minimizes oil consumption and significantly reduces the potential for oil ingestion during vehicle limit handling maneuvers.

LS9 Engine

The LS9 engine utilizes an integral positive crankcase ventilation (PCV) system which is located in the engine valley cover beneath the intake manifold. The engine valley cover contains composite oil separating baffles and PCV plumbing. Filtered fresh air is routed from up stream of the throttle plate to the engine oil tank where it mixes with crankcase gasses and is passed to both engine rocker arm covers. The design of the rocker cover shields rocker arm oil spray thereby reducing the potential for oil being drawn back into the tank during backflow of the ventilation system. Blow-by vapors are routed from the valley cover through a fixed orifice (2.5 mm) within a steel PCV tube, then through a formed nylon hose before entering the supercharger behind the throttle body.

DRIVE BELT SYSTEM DESCRIPTION

The drive belt system consists of the following components:

- The drive belt
- The drive belt tensioner
- The drive belt idler pulley
- The crankshaft balancer pulley
- The accessory drive component mounting brackets
- The accessory drive components
 - The power steering pump, if belt driven
 - The generator
 - The A/C compressor, if equipped
 - The engine cooling fan, if belt driven
 - The water pump, if belt driven
 - The vacuum pump, if equipped

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- The air compressor, if equipped

The drive belt system may use 1 belt or 2 belts. The drive belt is thin so that it can bend backwards and has several ribs to match the grooves in the pulleys. The drive belts are made of different types of rubbers, chloroprene or EPDM, and have different layers or plys containing either fiber cloth or cords for reinforcement.

Both sides of the drive belt may be used to drive the different accessory drive components. When the back side of the drive belt is used to drive a pulley, the pulley is smooth.

The drive belt is pulled by the crankshaft balancer pulley across the accessory drive component pulleys. The spring loaded drive belt tensioner keeps constant tension on the drive belt to prevent the drive belt from slipping. The drive belt tensioner arm will move when loads are applied to the drive belt by the accessory drive components and the crankshaft.

The drive belt system may have an idler pulley, which is used to add wrap to the adjacent pulleys. Some systems use an idler pulley in place of an accessory drive component when the vehicle is not equipped with the accessory.

ENGINE COMPONENT DESCRIPTION

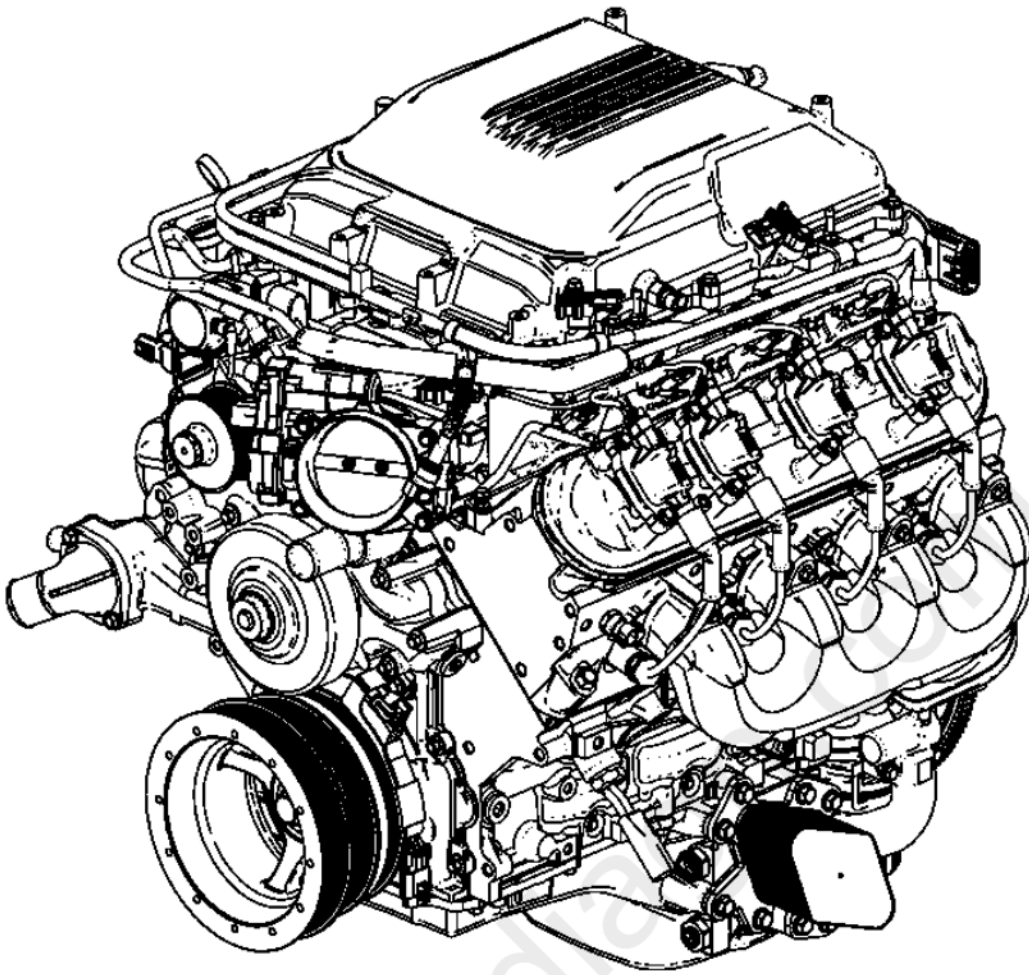


Fig. 1: View Of 6.2L V8 Engine
Courtesy of GENERAL MOTORS CORP.

The 6.2L Liter V8 engine is identified as RPO LSA.

Camshaft and Drive System

A billet steel 1 piece camshaft is supported by 5 bearings pressed into the engine block. The camshaft timing chain sprocket is mounted to the front of the camshaft and is driven by the crankshaft sprocket through the camshaft timing chain. The camshaft position (CMP) sensor lobes are incorporated into the front face of the camshaft sprocket with the CMP sensor mounted to the engine front cover. A timing chain tensioner is mounted to the front of the engine block above the crankshaft sprocket. The externally splined crankshaft sprocket is positioned to the crankshaft by a key and keyway. The crankshaft sprocket external splines drive the gerotor type oil pump drive gear. A retaining plate mounted to the front of the engine block maintains camshaft location.

Crankshaft

The precision-balanced crankshaft is forged steel and is supported by 5 crankshaft bearings. The bearings are retained by forged steel crankshaft bearing caps, which are machined with the engine block for proper

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alignment and clearance. The crankshaft journals are undercut and rolled. The center main journal is the thrust journal. A crankshaft position (CKP) reluctor ring is press-fit mounted at the rear of the crankshaft. The reluctor ring is not serviceable separately.

Cylinder Heads

The cylinder heads are cast aluminum and include pressed-in-place powdered metal valve guides, 55 mm (2.19 in) diameter solid intake valves, 40.4 mm (1.59 in) diameter solid exhaust valves, and 66.85 cubic centimeter combustion chambers. Passages for the engine coolant air bleed system are at the front of each cylinder head. The valve rocker arm covers are retained to the cylinder heads by 4 center mounted rocker arm cover bolts.

Engine Block

The engine block is a cam-in-block deep skirt 90 degree V configuration with 5 forged steel crankshaft bearing caps. The engine block is cast aluminum with press-in-place cast iron cylinder liners. The 5 crankshaft bearing caps each have 4 vertical M10 and 2 horizontal M8 mounting bolts. The camshaft is supported by 5 press-in-place camshaft bearings. Eight piston cooling oil nozzle assemblies are mounted between each of the opposing cylinders. The oil nozzles spray oil up the cylinder bore directing oil to the bottom of the pistons.

Exhaust Manifolds

The exhaust manifolds are a 1 piece cast iron design. The exhaust manifolds direct exhaust gasses from the combustion chambers to the exhaust system. Each manifold also has an externally mounted heat shield that is retained by bolts.

Intake Manifold/Supercharger

Refer to [Supercharger Description and Operation](#).

Oil Pan

The structural rear-sump oil pan is cast aluminum. Incorporated into the design is the oil filter mounting boss, oil level sensor, and drain plug opening. An external oil cooler assembly is mounted directly to the left side of the oil pan. The alignment of the structural oil pan to the rear of the engine block and transmission housing is critical.

Piston and Connecting Rod Assembly

The pistons are cast aluminum. The pistons use 2 compression rings and 1 oil control ring assembly. The piston is a low friction, lightweight design with a flat or recessed top and barrel shaped skirt. The piston pins are chromium steel and are a full-floating design. The connecting rods are powdered metal. The connecting rods are fractured at the connecting rod journal and then machined for the proper clearance. All applications use a piston with a graphite coated skirt. The piston/pin and connecting rod may be serviced as individual components.

Valve Rocker Arm Cover Assemblies

The valve rocker arm covers are cast aluminum and use a pre-molded silicon gasket for sealing. The ignition coils mount directly to the covers with no mounting bracket. Incorporated into the covers are the positive

crankcase ventilation (PCV) system fresh air passages. The right rocker arm cover also includes the oil fill tube and cap.

Valve Train

Motion is transmitted from the camshaft, through the hydraulic roller valve lifters and tubular pushrods, to the roller type rocker arms. The nylon valve lifter guides position and retain the valve lifters. The valve rocker arms for each bank of cylinders are mounted on pedestals or pivot supports. Each rocker arm is retained on the pivot support and cylinder head by a bolt. Valve lash is net build. The intake rocker arms are of an off-set design.

SUPERCHARGER DESCRIPTION AND OPERATION

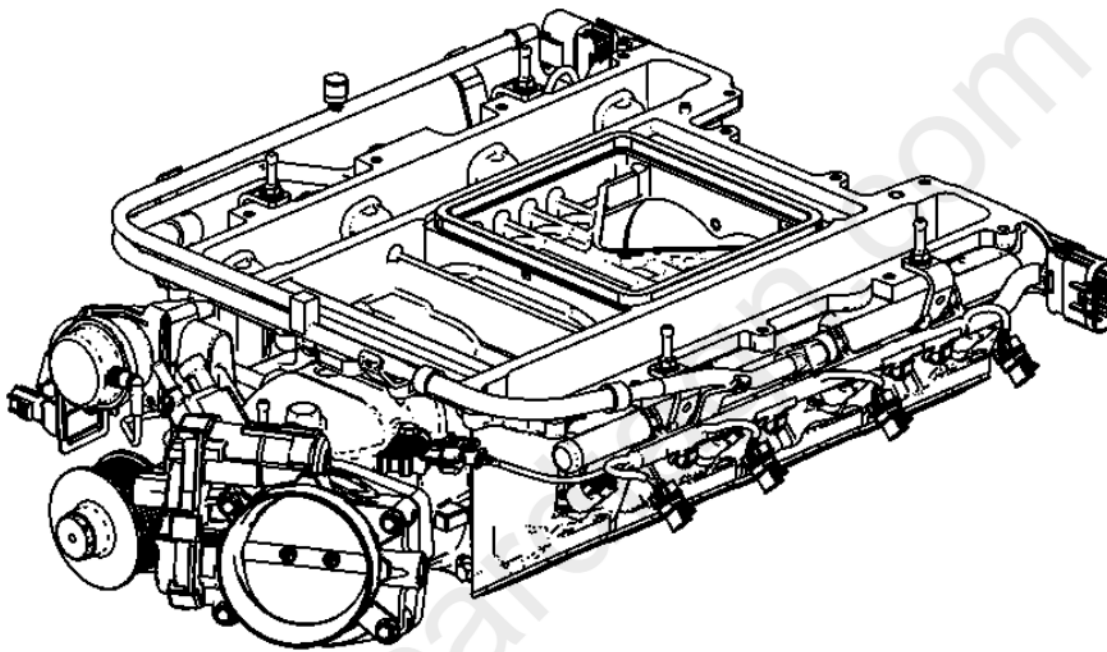


Fig. 2: View Of Intake Manifold/Supercharger Assembly
Courtesy of GENERAL MOTORS CORP.

Intake Manifold/Supercharger Assembly

The LSA Roots-type supercharger is a positive displacement pump that consists of 2 counter-rotating rotors installed into the lower intake manifold housing. The rotors are designed with 4 lobes and a helical twist. The rotors of the supercharger are designed to run at a minimal clearance, not in contact with each other or the housing and are timed to each other by a pair of precision spur gears which are pressed onto the rotor shafts. The rotors are supported at each end by self-lubricating non-serviceable bearings. The drive belt pulley is pressed onto the input shaft. The input shaft is coupled to the rotor shaft. Both the belt pulley and torsional isolator are also non-serviceable.

The lower supercharger assembly consists of the following components:

- Lower Intake Manifold Housing, to include rotors, gears, bearings, torsional isolator, and drive belt pulley
- Bypass Valve
- Bypass Actuator
- Charged Air Bypass Valve
- Fuel Rail with Injectors
- Throttle Body Assembly
- Evaporative Emission Canister Purge Valve
- Inlet Air Pressure Sensor

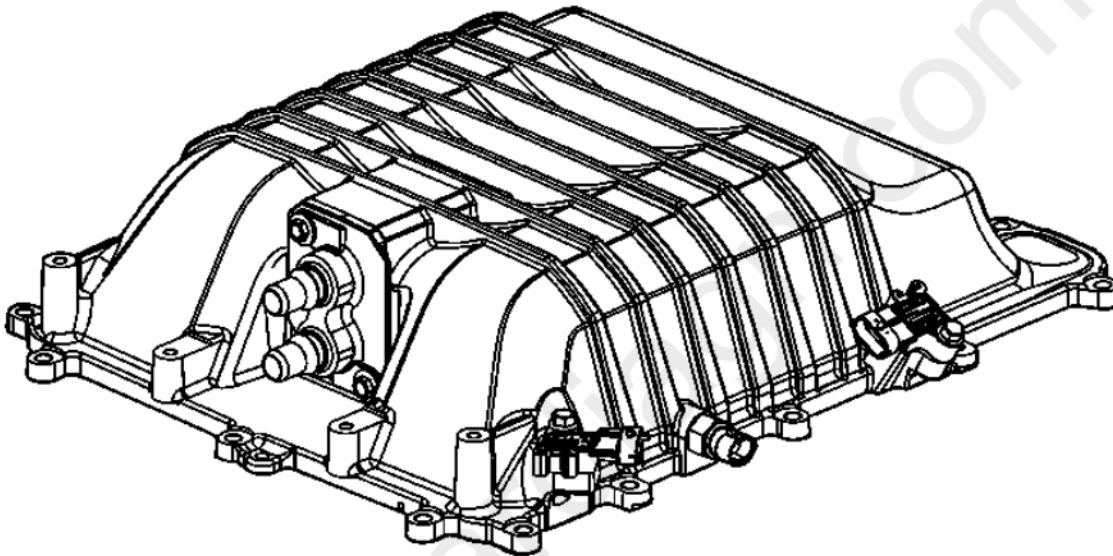


Fig. 3: View Of Cover/Intercooler
Courtesy of GENERAL MOTORS CORP.

Cover/Intercooler

The cover assembly has an integrated intercooler. Cooling the air enhances the effectiveness of the supercharger. The intercooler uses conventional coolant in a system that is separate from the engine cooling system. The intercooler assembly includes the cover, a charge air cooler/heat exchanger and a variety of sensors to monitor air temperature and pressure. The charge air cooler pipe assembly, located at the rear of cover transfers coolant to the intercooler cooling system via vehicle coolant hoses. The charge air cooler pipe assembly is sealed to the charge air cooler with O-rings and a press-in-place seal. Coolant enters the inlet port of the assembly, is directed into and through the charge air cooler/heat exchanger, and exits returning to the separate cooling system.

The cover/intercooler consists of the following components:

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- Charge Air Cooler Pipe Assembly
- Charge Air Cooler Cover
- Charge Air Cooler/Heat Exchanger
- Intake Air Temperature (IAT) Sensor
- Barometric Pressure Sensor
- Air Outlet Pressure Sensor
- Isolator Pad

Operation

The supercharger is designed to increase the air pressure and density in the intake manifold. When this air is mixed with the correct amount of fuel the result is more power from the engine. This excess air creates a boost pressure in the intake manifold with a maximum engine boost of 69.6 kPa (10.1 psi). Because the supercharger is a positive displacement pump and is directly driven from the engine drive belt system, boost pressure is available at all driving conditions.

When boost is not required in situations such as idle or light throttle cruising, the excess air is routed through an internal bypass passage located between the intake manifold and the supercharger inlet. The bypass circuit is regulated by a bypass valve which is similar to a throttle plate. Spring force holds the bypass valve in a normally closed position to create boost.

The bypass actuator is a vacuum operated valve that is connected to the vacuum signal between the throttle and the supercharger inlet. Vacuum to the actuator pulls the bypass valve open during idle and light load conditions to decrease boost.

The charge air bypass valve is a vacuum/electrically operated solenoid valve that is attached to the supercharger housing. The three-way valve is controlled by the engine control module (ECM). The ECM determines when pressure from the manifold is routed to the bypass actuator. The charge air bypass valve allows pressure from the manifold to open the bypass valve and lower boost pressure during specific driving conditions. The open bypass valve reduces the pumping effort of the supercharger, thereby increasing the fuel efficiency in light load operations.

NEW PRODUCT INFORMATION

The purpose of New Product Information is to highlight, or indicate, important product changes from the previous model year.

Changes may include 1 or more of the following items:

- Torque values and/or fastener tightening strategies
- Changed engine specifications
- New sealants and/or adhesives
- Disassembly and assembly procedure revisions
- Engine mechanical diagnostic procedure revisions
- New special tools required

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- A component comparison from the previous year

Torque Values and/or Fastener Tightening Strategies

- All fasteners and threaded holes on the engine utilize metric threads.
- Certain fasteners should not be used again. Bolts, studs, or other fasteners that must be replaced, will be called out in the specific service procedure.
- The crankshaft balancer bolt fastener tightening specification has been revised. Refer to **Fastener Tightening Specifications**.
- The crankshaft bearing cap M8 bolts are now tightened using a 2 step process. Refer to **Fastener Tightening Specifications**.

New Sealants and/or Adhesives

No new sealants and or adhesives for 2010.

Changed Engine Specifications

The camshaft bearing to journal clearance and camshaft journal diameter specifications have changed. Refer to **Engine Mechanical Specifications**.

Disassembly and Assembly Procedure Revisions

No disassembly or assembly procedure revisions for 2010.

Engine Mechanical Diagnostic Procedure Revisions

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

New Special Tools Required

No new special tools required for 2010.

A Component Comparison from the Previous Year

The 2010 6.2L RPO-LSA engine uses a new higher journal polished camshaft. The LSA engine is built with two different camshaft bearing designs: the difference is the composition of the bearing lining material. The first design camshaft bearing is composed of a lining material that uses a lead babbitt with copper matrix backing. The second design camshaft bearing is lead-free, the lining is composed of an aluminum-tin material.

LUBRICATION DESCRIPTION

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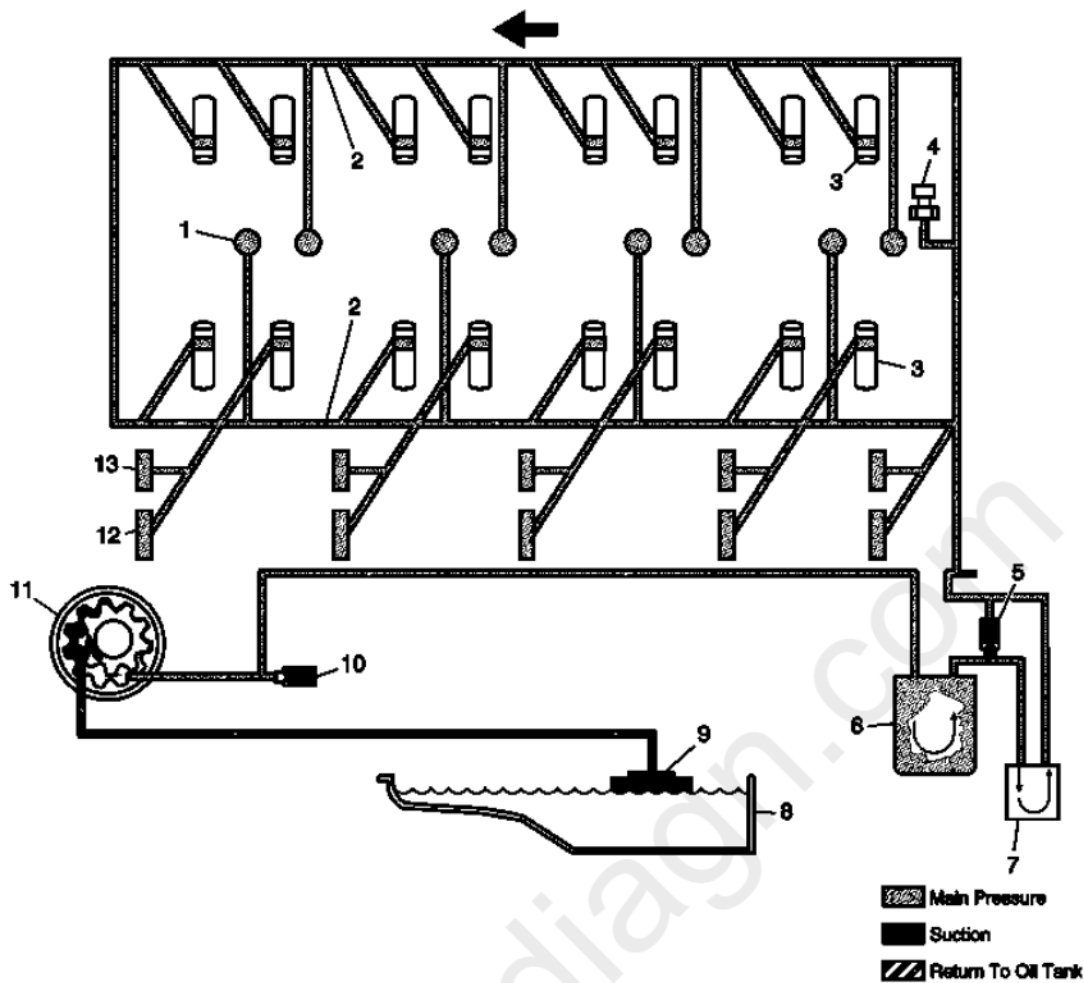


Fig. 4: Identifying Engine Lubrication Components
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
1	Piston Oil Nozzle
2	Upper Main Oil Galleries
3	Valve Lifters
3	Valve Lifters
4	Oil Pressure Sensor
5	Bypass Valve - Oil Cooler
6	Oil Filter
7	Engine Oil Cooler
8	Oil Pan Sump
9	Oil Pump Screen
10	Pressure Relief Valve - Oil Pump
11	Oil Pump
12	Crankshaft Bearings

Engine lubrication is supplied by a gerotor type oil pump assembly (11). The oil pump assembly consists of a pump housing, gear set, and pressure relief valve (10). Refer to Oil Pump Assembly in **Disassembled Views**. The pump assembly is mounted at the front of the engine and driven directly by the crankshaft sprocket. The pump gears rotate and draw oil from the oil pan sump (8) through the oil tank screen (9). The oil is pressurized as it passes through the primary pump and is sent through the engine block lower oil gallery. Contained within the primary pump is a pressure relief valve (10) that maintains oil pressure within a specified range. Pressurized oil is directed through the engine block lower oil gallery to the full flow oil filter (6) where harmful contaminants are removed. A bypass valve is incorporated into the oil filter, which permits oil flow in the event the filter becomes restricted. Oil exits the oil filter and is then directed to the external oil cooler (7). A bypass valve (5) is incorporated into the oil cooler assembly in the event oil flow within the cooler is restricted. Oil returns from the oil cooler and is directed to the upper main oil galleries (2). Oil from the left upper oil gallery is directed to the crankshaft bearings (12), valve lifters 1, 3, 5, and 7, camshaft bearings (13), and piston oil nozzles 1, 3, 5, and 7. Oil from the right upper oil gallery is directed to the valve lifters 2, 4, 6, and 8 and piston oil nozzles 2, 4, 6, and 8. The piston oil nozzle assemblies are designed to provide oil to the bottom side of the piston for cooling purposes. The piston oil nozzles have an internal check ball that is held in the normally closed position by the spring until system oil pressure exceeds 20.7 kPa (43.5 psi). Refer to **Piston Oil Nozzle Cleaning and Inspection**. Oil exits the valve lifters (3) and is then pumped through the pushrods to lubricate the valve rocker arms and valve stems. Oil then returns to the oil pan (8). The engine oil pressure sensor (4) is located at the top rear of the engine assembly.

CLEANLINESS AND CARE

- Throughout this service information, it should be understood that proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice even if not specifically stated.
- When any internal engine parts are serviced, care and cleanliness is important.
- When components are removed for service, they should be marked, organized or retained in a specific order for assembly. Refer to **Separating Parts**.
- At the time of installation, components should be installed in the same location and with the same mating surface as when removed.
- An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in millimeters or thousandths of an inch. These surfaces should be covered or protected to avoid component damage.
- A liberal coating of clean engine oil should be applied to friction areas during assembly.
- Proper lubrication will protect and lubricate friction surfaces during initial operation.

SEPARATING PARTS

IMPORTANT:

- Many internal engine components will develop specific wear patterns on their friction surfaces.
- When disassembling the engine, internal components **MUST** be separated, marked, or organized in a way to ensure installation to their original location and position.

Separate, mark, or organize the following components:

- Piston and the piston pin
- Piston to the specific cylinder bore
- Piston rings to the piston
- Connecting rod location and orientation to the crankshaft journal
- Connecting rod to the bearing cap

A paint stick or etching/engraving type tool are recommended. Stamping the connecting rod or cap near the bearing bore may affect component geometry.

- Crankshaft main and connecting rod bearings
- Camshaft and valve lifters
- Valve lifters, lifter guides, pushrods and rocker arm assemblies
- Valve to the valve guide
- Valve spring to the cylinder head location
- Engine block main bearing cap location and direction
- Oil pump drive and driven gears

REPLACING ENGINE GASKETS

Special Tools

J 28410: Gasket Remover

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

Gasket Use and Applying Sealants

- Do not use any gasket again unless specified.
- Gaskets that can be used again will be identified in the service procedure.
- Do not apply sealant to any gasket or sealing surface unless called out in the service information.

Separating Components

- Use a rubber mallet to separate components.
- Bump the part sideways to loosen the components.
- Bumping should be done at bends or reinforced areas to prevent distortion of parts.

Cleaning Gasket Surfaces

- Remove all gasket and sealing material from the part using the **J 28410:** remover or equivalent.
- Care must be used to avoid gouging or scraping the sealing surfaces.
- Do not use any other method or technique to remove sealant or gasket material from a part.

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- Do not use abrasive pads, sand paper, or power tools to clean the gasket surfaces.
 - These methods of cleaning can cause damage to the component sealing surfaces.
 - Abrasive pads also produce a fine grit that the oil filter cannot remove from the oil.
 - This grit is abrasive and has been known to cause internal engine damage.

Assembling Components

CAUTION: Refer to SEALANT CAUTION .

- When assembling components, use only the sealant specified or equivalent in the service procedure.
- Sealing surfaces should be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
- Components requiring lubrication will be identified in the service procedure.
- When applying sealant to a component, apply the amount specified in the service procedure.
- Tighten bolts to specifications. Do not overtighten.

USE OF ROOM TEMPERATURE VULCANIZING (RTV) AND ANAEROBIC SEALANT

Pipe Joint Compound

NOTE: Three types of sealer are commonly used in engines. These are room temperature vulcanizing (RTV) sealer, anaerobic gasket eliminator sealer, and pipe joint compound. The correct sealer and amount must be used in the proper location to prevent oil leaks. DO NOT interchange the 3 types of sealers. Use only the specific sealer or the equivalent as recommended in the service procedure.

- Pipe joint compound is a pliable sealer that does not completely harden. This type of sealer is used where 2 non-rigid parts, such as the oil pan and the engine block, are assembled together.
- Do not use pipe joint compound in areas where extreme temperatures are expected. These areas include: exhaust manifold, head gasket, or other surfaces where gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container.

To remove the sealant or the gasket material, refer to Replacing Engine Gaskets.

CAUTION: Refer to SEALANT CAUTION .

- Apply the pipe joint compound to a clean surface. Use a bead size or quantity as specified in the procedure. Run the bead to the inside of any bolt holes.
- Apply a continuous bead of pipe joint compound to one sealing surface. Sealing surfaces to be resealed

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must be clean and dry.

- Tighten the bolts to specifications. Do not overtighten.

RTV Sealer

- RTV sealant hardens when exposed to air. This type of sealer is used where 2 non-rigid parts, such as the intake manifold and the engine block, are assembled together.
- Do not use RTV sealant in areas where extreme temperatures are expected. These areas include: exhaust manifold, head gasket, or other surfaces where a gasket eliminator is specified.
- Follow all safety recommendations and directions that are on the container.

To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets**.

CAUTION: Refer to SEALANT CAUTION .

- Apply RTV sealant to a clean surface. Use a bead size as specified in the procedure. Run the bead to the inside of any bolt holes.
- Assemble components while the RTV sealant is still wet, within 3 minutes. Do not wait for the RTV sealant to skin over.
- Tighten bolts to specifications. Do not overtighten.

Anaerobic Sealer

- Anaerobic gasket eliminator hardens in the absence of air. This type of sealer is used where 2 rigid parts, such as castings, are assembled together. When 2 rigid parts are disassembled and no sealer or gasket is readily noticeable, the parts were probably assembled using a gasket eliminator.
- Follow all safety recommendations and directions that are on the container.

To remove the sealant or the gasket material, refer to **Replacing Engine Gaskets**.

- Apply a continuous bead of gasket eliminator to one flange. Surfaces to be sealed must be clean and dry.

CAUTION: Refer to SEALANT CAUTION .

- Spread the sealer evenly with your finger to get a uniform coating on the sealing surface.

NOTE: Anaerobic sealed joints that are partially torqued and allowed to cure more than 5 minutes may result in incorrect shimming and sealing of the joint.

- Tighten bolts to specifications. Do not overtighten.
- After properly tightening the fasteners, remove the excess sealer from the outside of the joint.

TOOLS AND EQUIPMENT

Special tools are listed and illustrated throughout this service information, with a complete listing at the end of the service information. These tools, or their equivalents, are specially designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the proper tightening of various fasteners.

To properly service the engine assembly, the following items should be readily available:

- Approved eye protection and safety gloves
- A clean, well lit, work area
- A suitable parts cleaning tank
- A compressed air supply
- Trays or storage containers to keep parts and fasteners organized
- An adequate set of hand tools
- Approved engine repair stand
- An approved engine lifting device that will adequately support the weight of the components