ENGINE ELECTRICAL

ENGINE ELECTRICAL

The engine electrical system can be broken down into three inter-related, but distinct systems:

1. The starting system.
2. The charging system.
3. The ignition system.

BATTERY AND STARTING SYSTEM

The battery is the first link in the chain of mechanisms which work together to provide cranking of the automobile engine. In most modern cars, the battery is a lead-acid electrochemical device consisting of six two-volt (2V) subsections connected in series so the unit is capable of producing approximately 12V of electrical pressure. Each subsection, or cell, consists of a series of positive and negative plates held a short distance apart in a solution of sulfuric acid and water. The two types of plates are of dissimilar metals. This causes a chemical reaction to be set up, and it is this reaction which produces current flow from the battery when its positive and negative terminals are connected to an electrical appliance such as a lamp or motor.

The continued transfer of electrons would eventually convert the sulfuric acid in the electrolyte to water and make the two plates identical in chemical composition. As electrical energy is removed from the battery, its voltage output tends to drop. Thus, measuring battery voltage and battery electrolyte composition are two ways of checking the ability of the unit to supply power. During the starting of the engine, electrical energy is removed from the battery. However, if the charging circuit is in good condition and the operating conditions are normal, the power removed from the battery will be replaced by the generator (or alternator) which will force electrons back through the battery, reversing the normal flow, and restoring the battery to its original chemical state.

The battery and starting motor are linked by very heavy electrical cables designed to minimize resistance to the flow of current. Generally, the major power supply cable that leaves the battery goes directly to the starter, while other electrical system needs are supplied by a smaller cable. During the starter operation, power flows from the battery to the starter and is grounded through the car's frame and the battery's negative ground strap.

The starting motor is a specially designed, direct current electric motor capable of producing a very great amount of power for its size. One thing that allows the motor to produce a great deal of power is its tremendous rotating speed. It drives the engine through a tiny pinion gear (attached to the starter's armature), which drives the very large flywheel ring gear at a greatly reduced speed. Another factor allowing it to produce so much power is that only intermittent

cardiagn.com

operation is required of it. Thus, little allowance for air circulation is required, and the windings can be built into a very small space.

The starter solenoid is a magnetic device which employs the small current supplied by the starting switch circuit of the ignition switch. This magnetic action moves a plunger which mechanically engages the starter and electrically closes the heavy switch which connects it to the battery. The starting switch circuit consists of the starting switch contained within the ignition switch, a transmission neutral safety switch or clutch pedal switch, and the wiring necessary to connect these with the starter solenoid or relay.

A pinion, which is a small gear, is mounted to a one-way drive clutch. This clutch is splined to the starter armature shaft. When the ignition switch is moved to the *start* position, the solenoid plunger slides the pinion toward the flywheel ring gear via a collar and spring. If the teeth on the pinion and flywheel match properly, the pinion will engage the flywheel immediately. If the gear teeth butt one another, the spring will be compressed and will force the gears to mesh as soon as the starter turns far enough to allow them to do so. As the solenoid plunger reaches the end of its travel, it closes the contacts that connect the battery and starter and then the engine is cranked.

As soon as the engine starts, the flywheel ring gear begins turning fast enough to drive the pinion at an extremely high rate of speed. At this point, the one-way clutch begins allowing the pinion to spin faster than the starter shaft so that the starter will not operate at excessive speed. When the ignition switch is released from the starter position, the solenoid is de-energized, and a spring contained within the solenoid assembly pulls the gear out of mesh and interrupts the current flow to the starter.

Some starters employ a separate relay, mounted away from the starter, to switch the motor and solenoid current on and off. The relay thus replaces the solenoid electrical switch, but does not eliminate the need for a solenoid mounted on the starter used to mechanically engage the starter drive gears. The relay is used to reduce the amount of current the starting switch must carry.

THE CHARGING SYSTEM

The automobile charging system provides electrical power for operation of the vehicle's ignition and starting systems and all the electrical accessories. The battery serves as an electrical surge or storage tank, storing (in chemical form) the energy originally produced by the engine driven generator. The system also provides a means of regulating alternator output to protect the battery from being overcharged and to avoid excessive voltage to the accessories.

The storage battery is a chemical device incorporating parallel lead plates in a tank containing a sulfuric acid-water solution. Adjacent plates are slightly dissimilar, and the chemical reaction of the two dissimilar plates produces electrical energy when the battery is connected to a load such as the starter motor. The chemical reaction is reversible, so that when the generator is producing a voltage (electrical pressure) greater than that produced by the

cardiagn.com

battery, electricity is forced into the battery, and the battery is returned to its fully charged state.

Alternators are used on the modern automobiles for they are lighter, more efficient, can rotate at higher speeds and have fewer brush problems. In an alternator, the field rotates while all the current produced passes only through the stators windings. The brushes bear against continuous slip rings rather than a commutator. This causes the current produced to periodically reverse the direction of its flow. Diodes (electrical one-way switches) block the flow of current from traveling in the wrong direction. A series of diodes is wired together to permit the alternating flow of the stator to be converted to a pulsating, but unidirectional flow at the alternator output. The alternator's field is wired in series with the voltage regulator.

Please refer to Engine Performance & Tune-up *for ignition system testing procedures.*

IGNITION COIL

REMOVAL & INSTALLATION

INTERNALLY MOUNTED COIL

1. Disconnect and label the wires from cap.
2. Remove the distributor cap from the distributor.
3. On the distributor cap, remove the coil cover attaching screws and the cover.
4. Remove the ignition coil attaching screws and lift the coil from the cap.

To install:

5. Position the coil and secure it with the attaching screws. Be sure to install the carbon button and rubber disc first.
6. Install the coil cover and attaching screws.
7. Install the distributor cap.
8. Connect the wires to the cap.

EXTERNALLY MOUNTED COIL

1. Label and disconnect the wires from the coil.
2. Remove the ignition coil mounting bolts and the coil.

To install:

3. To install, position the coil into place and secure it with the mounting bolts.
4. Connect the wires to the coil.

IGNITION MODULE

cardiagn.com

REMOVAL & INSTALLATION

1. Disconnect the wires from the cap.
2. Remove the distributor cap.
3. Remove the two module attaching screws and capacitor attaching screw. Lift module, capacitor and harness assembly from base.
4. Disconnect wiring harness.

To install:

5. Apply silicone grease underneath the module. This grease is necessary for ignition module cooling.
6. Connect the wiring harness.
7. Install the module and attaching screws.
8. Install the distributor cap and wires.

DISTRIBUTOR

REMOVAL & INSTALLATION

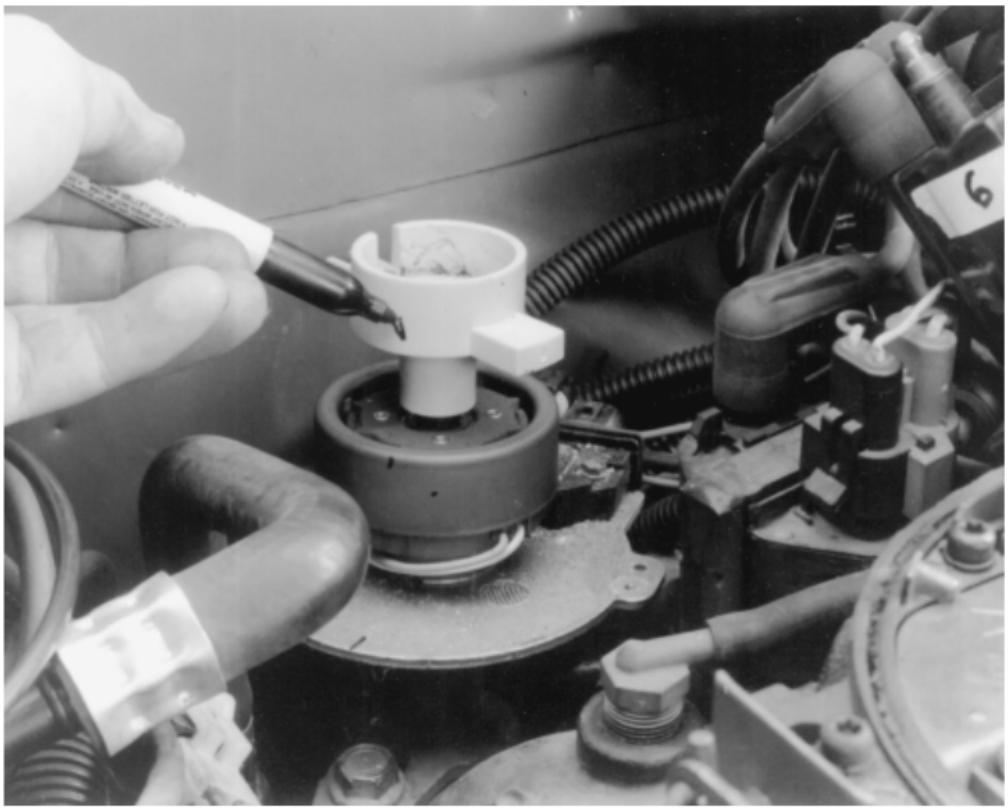


Fig. 1: Matchmarking the rotor

cardiagn.com

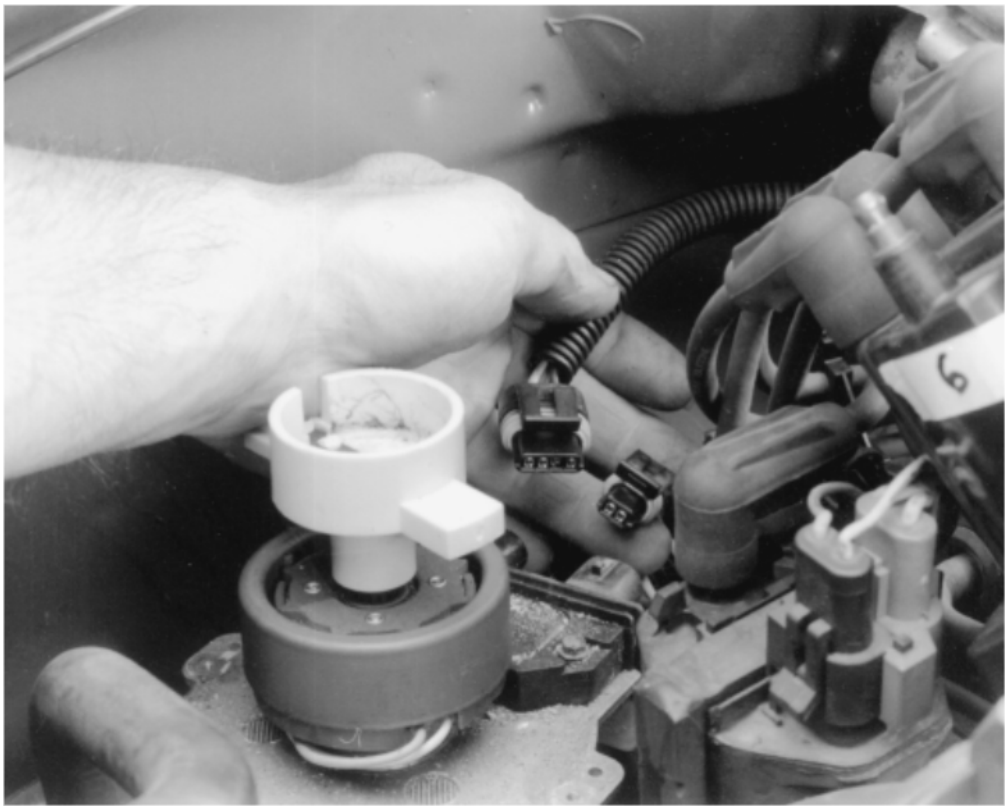


Fig. 2: Unplugging the connector

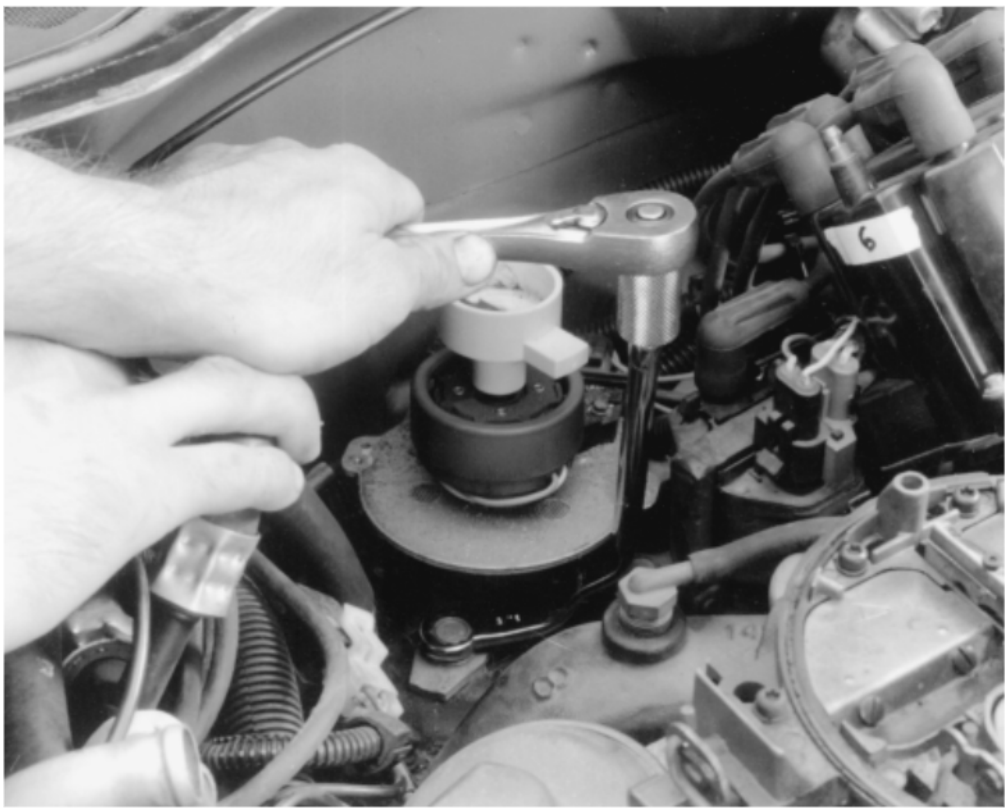


Fig. 3: Loosening the hold-down bolt

cardiagn.com

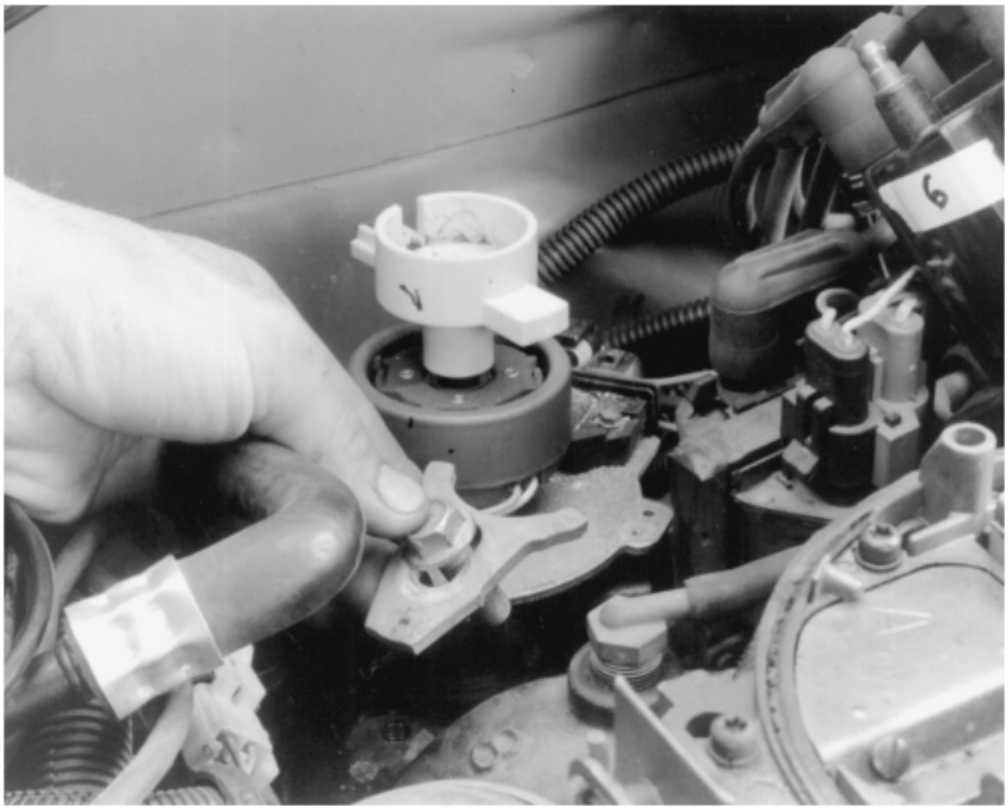


Fig. 4: Removing the hold-down bolt and clamp

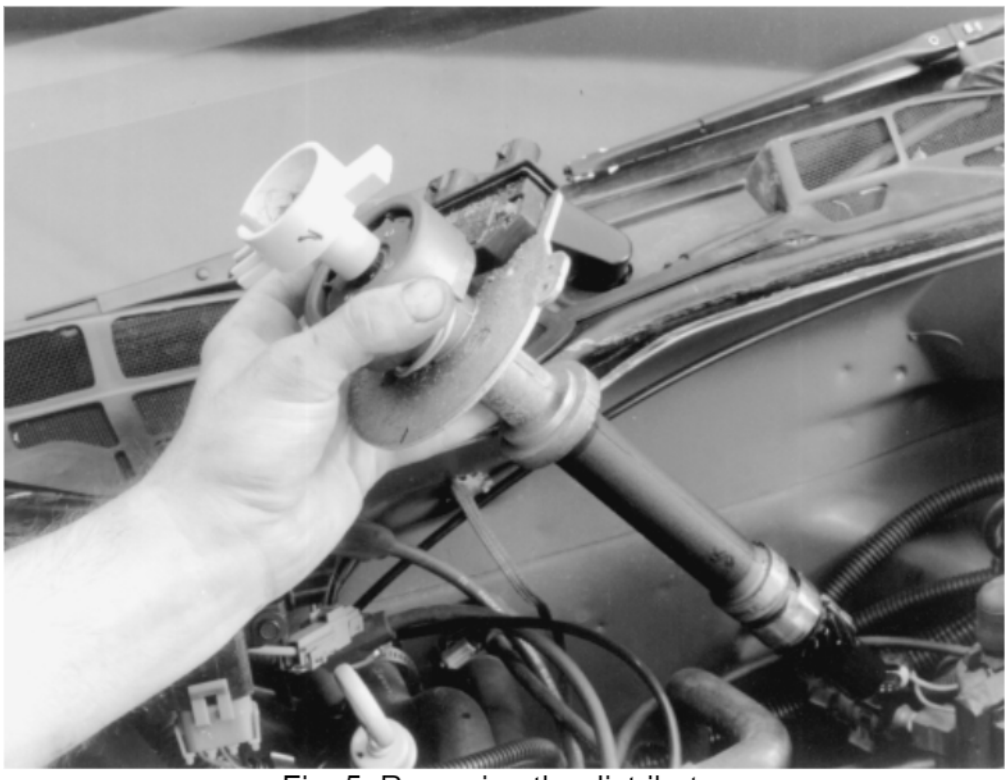


Fig. 5: Removing the distributor

1. Disconnect the negative battery cable.
2. Remove the air cleaner assembly.
3. Unplug and label the electrical connections from the distributor.

cardiagn.com

4. Remove the distributor cover and wire retainer, if equipped. Turn the retaining screws counterclockwise and remove the cap.
5. Mark the relationship of the rotor to the distributor housing and the housing relationship to the engine.
6. Remove the distributor retaining bolt and hold-down clamp.
7. Pull the distributor up until the rotor just stops turning counterclockwise and again note the position of the rotor.
8. Remove the distributor from the engine.

To install:

9. Insert the distributor into the engine, with the rotor aligned to the last mark made, then slowly install the distributor the rest of the way until all marks previously made are aligned.
10. Install the distributor hold-down clamp and retaining bolt.
11. If removed, install the wiring harness retainer and secondary wires.
12. Install the distributor cap.
13. Engage the wire connections on the distributor. Make certain the connectors are fully seated and latched.
14. Reconnect the negative battery cable.

If the engine was accidentally cranked after the distributor was removed, the following procedure can be used during installation.

15. Remove the No. 1 spark plug.
16. Place a finger over the spark plug hole. Have a helper turn the engine slowly using a wrench on the crankshaft bolt until compression is felt.
17. Align the timing mark on the pulley to *0* on the engine timing indicator.
18. Turn the rotor to point to the No. 1 spark plug tower on the distributor cap.
19. Install the distributor assembly in the engine and ensure the rotor is pointing toward the No. 1 spark plug tower.
20. Install the cap and spark plug wires.
21. Check and adjust engine timing.

ALTERNATOR

DESCRIPTION

An alternator differs from a DC shunt generator in that the armature is stationary, and is called the stator, while the field rotates and is called the rotor. The higher current values in the alternator's stator are conducted to the external circuit through fixed leads and connections, rather than through a rotating commutator and brushes as in a DC generator. This eliminates a major point of maintenance.

The rotor assembly is supported in the drive end frame by a ball bearing and at the other end by a roller bearing. These bearings are lubricated during assembly and require no maintenance. There are six diodes in the end frame assembly. These diodes are electrical check valves that also change the

cardiagn.com

alternating current developed within the stator windings to a direct (DC) current at the output (BAT) terminal. Three of these diodes are negative and are mounted flush with the end frame while the other three are positive and are mounted into a strip called a heat sink. The positive diodes are easily identified as the ones within small cavities or depressions.

The alternator charging system is a negative (-) ground system which consists of an alternator, a regulator, a charge indicator, a storage battery and wiring connecting the components, and fuse link wire.

The alternator is belt-driven from the engine. Energy is supplied from the alternator/regulator system to the rotating field through two brushes to two slip-rings. The slip-rings are mounted on the rotor shaft and are connected to the field coil. This energy supplied to the rotating field from the battery is called excitation current and is used to initially energize the field to begin the generation of electricity. Once the alternator starts to generate electricity, the excitation current comes from its own output rather than the battery.

The alternator produces power in the form of alternating current. The alternating current is rectified by 6 diodes into direct current. The direct current is used to charge the battery and power the rest of the electrical system.

When the ignition key is turned ON, current flows from the battery, through the charging system indicator light on the instrument panel, to the voltage regulator, and to the alternator. Since the alternator is not producing any current, the alternator warning light comes on. When the engine is started, the alternator begins to produce current and turns the alternator light off. As the alternator turns and produces current, the current is divided in two ways: part to the battery(to charge the battery and power the electrical components of the vehicle), and part is returned to the alternator (to enable it to increase its output). In this situation, the alternator is receiving current from the battery and from itself. A voltage regulator is wired into the current supply to the alternator to prevent it from receiving too much current which would cause it to put out too much current. Conversely, if the voltage regulator does not allow the alternator to receive enough current, the battery will not be fully charged and will eventually go dead.

The battery is connected to the alternator at all times, whether the ignition key is turned ON or not. If the battery were shorted to ground, the alternator would also be shorted. This would damage the alternator. To prevent this, a fuse link is installed in the wiring between the battery and the alternator. If the battery is shorted, the fuse link melts, protecting the alternator.

An alternator is better that a conventional, DC shunt generator because it is lighter and more compact, because it is designed to supply the battery and accessory circuits through a wide range of engine speeds, and because it eliminates the necessary maintenance of replacing brushes and servicing commutators.

PRECAUTIONS

cardiagn.com

To prevent serious damage to the alternator and the rest of the charging system, the following precautions must be observed:

- Never reverse the battery connections.
- Booster batteries for starting must be connected properly: positive-to-positive and negative-to-ground.
- Disconnect the battery cables before using a fast charger; the charger has a tendency to force current through the diodes in the opposite direction for which they were designed. This burns out the diodes.
- Never use a fast charger as a booster for starting the vehicle.
- Never disconnect the voltage regulator while the engine is running.
- Avoid long soldering times when replacing diodes or transistors. Prolonged heat is damaging to AC alternators.
- Do not use test lamps of more than 12 volts (V) for checking diode continuity.
- Do not short across or ground any of the terminals on the AC alternator.
- The polarity of the battery, alternator, and regulator must be matched and considered before making any electrical connections within the system.
- Never operate the alternator on an open circuit. make sure that all connections within the circuit are clean and tight.
- Disconnect the battery terminals when performing any service on the electrical system. This will eliminate the possibility of accidental reversal of polarity.
- Disconnect the battery ground cable if arc welding is to be done on any part of the car.

CHARGING SYSTEM TROUBLESHOOTING

There are many possible ways in which the charging system can malfunction. Often the source of a problem is difficult to diagnose, requiring special equipment and a good deal of experience. However, when the charging system fails completely and causes the dash board warning light to come on or the battery to become dead the following items may be checked:

1. The battery is known to be good and fully charged.
2. The alternator belt is in good condition and adjusted to the proper tension.
3. All connections in the system are clean and tight.

REMOVAL & INSTALLATION

cardiagn.com

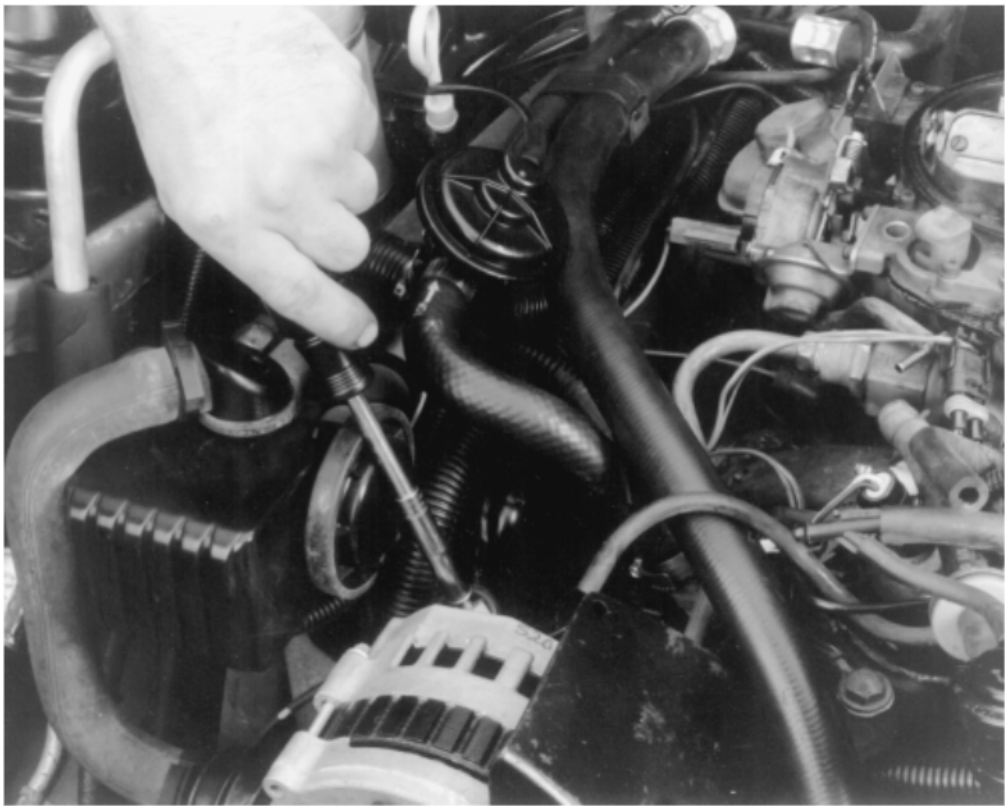


Fig. 1: Loosening the wire connector bolt

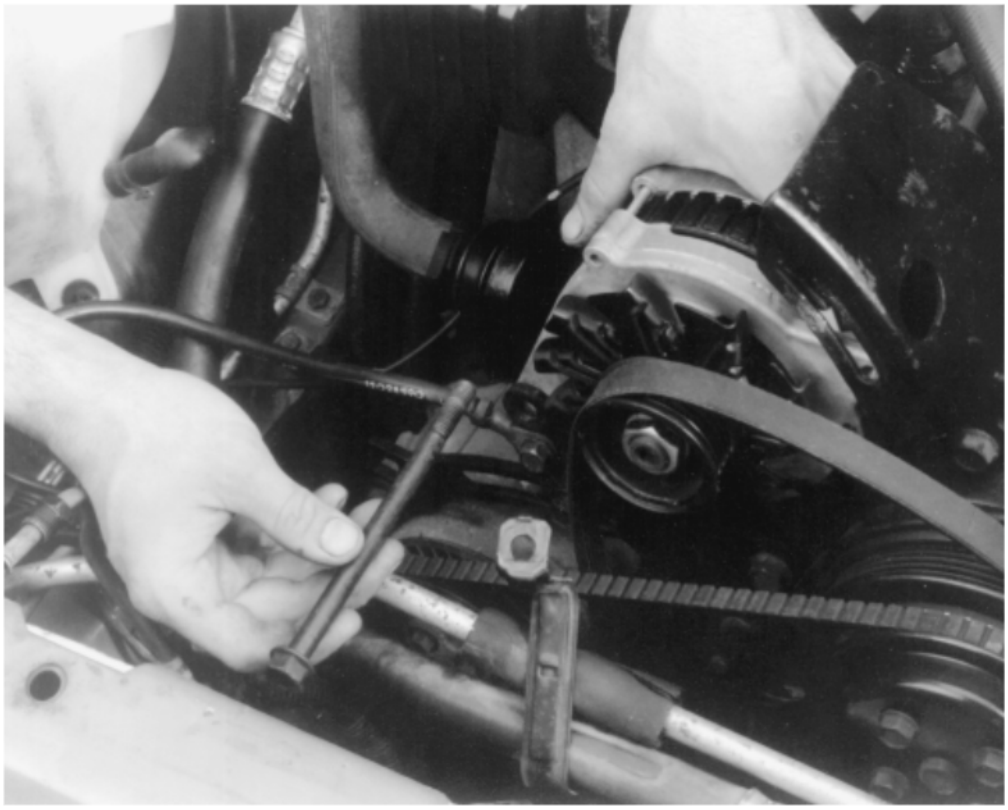


Fig. 2: Removing the through-bolt

cardiagn.com

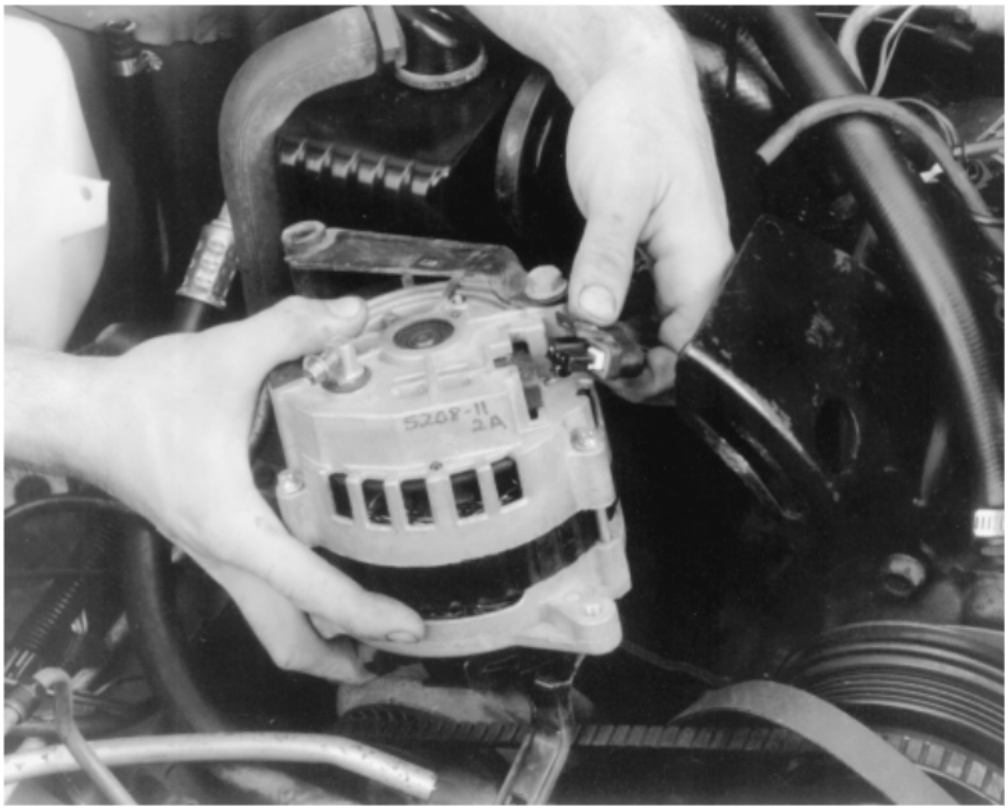


Fig. 3: Unplugging the harness

While internal alternator repairs are possible, they require specialized tools and training. Therefore, it is advisable to replace a defective alternator as an assembly, or have it repaired by a qualified shop.

1. Disconnect the battery ground cable.
2. Tag and disconnect the alternator wiring.
3. Remove any drive belt(s) which may interfere with alternator removal.
4. Support the alternator and remove the mount bolt(s). Remove the unit from the vehicle.

To install:

5. Position the alternator into place and install the mount bolt(s) loosely.
6. Install the drive belt(s). On V-belts, tighten the belt enough to allow approximately $^{1}/_{2}$ in. (13mm) of play on the longest run between pulleys.
7. Connect the alternator wiring.
8. Connect the battery ground cable.

VOLTAGE REGULATOR

REMOVAL & INSTALLATION

cardiagn.com

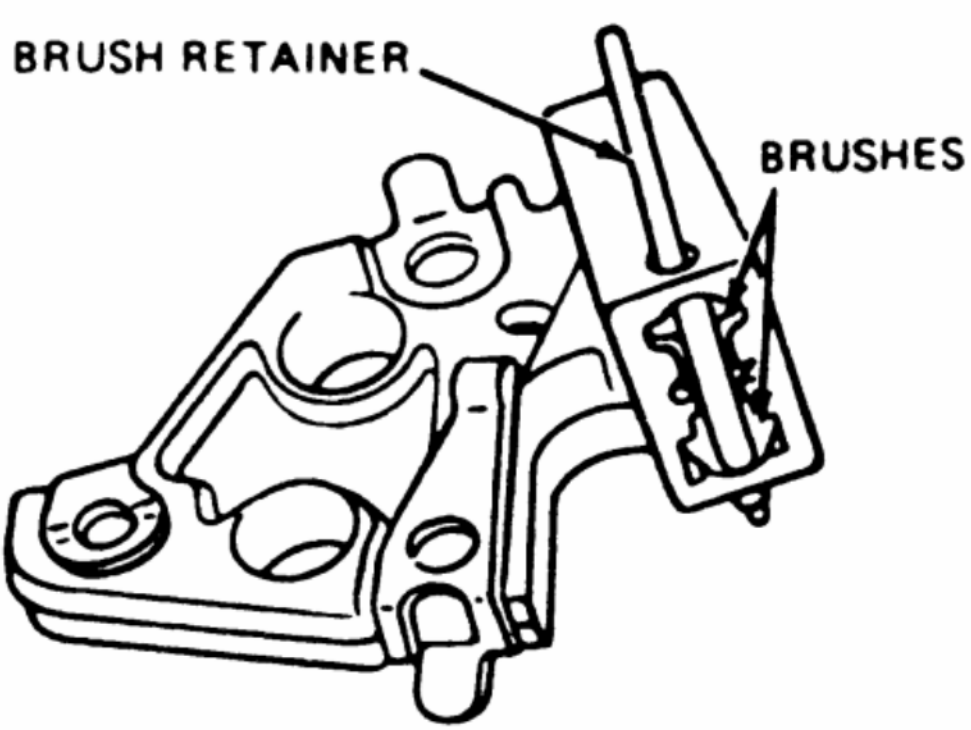


Fig. 1: Voltage regulator with brushes depressed

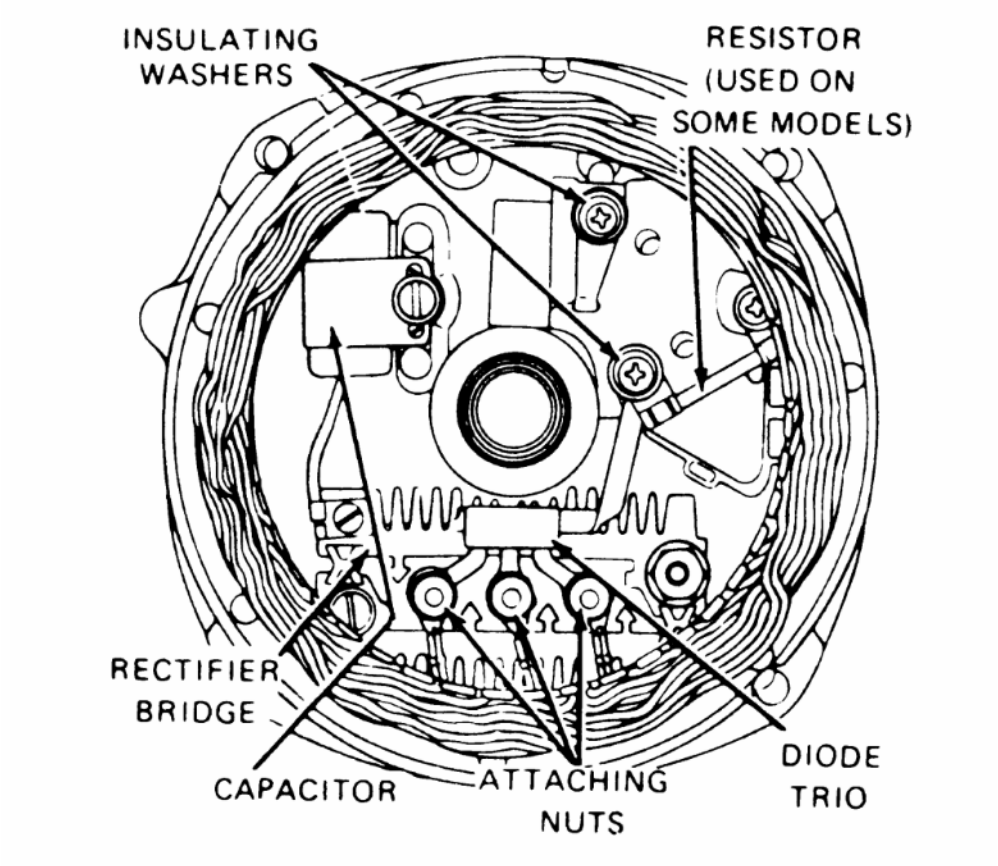


Fig. 2: Alternator end frame

cardiagn.com

This procedure is to be performed with the alternator removed from the vehicle. The new style CS alternators on 1987-92 vehicles are non-serviceable and must be replaced as an assembly.

1. Make scribe marks on the end frames to make reassembly easier.
2. Remove the 4 through-bolts and separate the drive end frame assembly from the rectifier end frame assembly.
3. Remove the 3 diode trio attaching nuts and the 3 regulator attaching screws.
4. Remove the diode trio and the regulator from the end frame.

To install:

5. Push the brushes into the brush holder and install a brush retainer or a tooth pick to hold the brushes in place.
6. Install the regulator into the alternator.
7. Install the diode trio.
8. Install the halves of the alternator and secure the halves with the 4 through-bolts. After the alternator is assembled, remove the brush retainer.

STARTER

REMOVAL & INSTALLATION

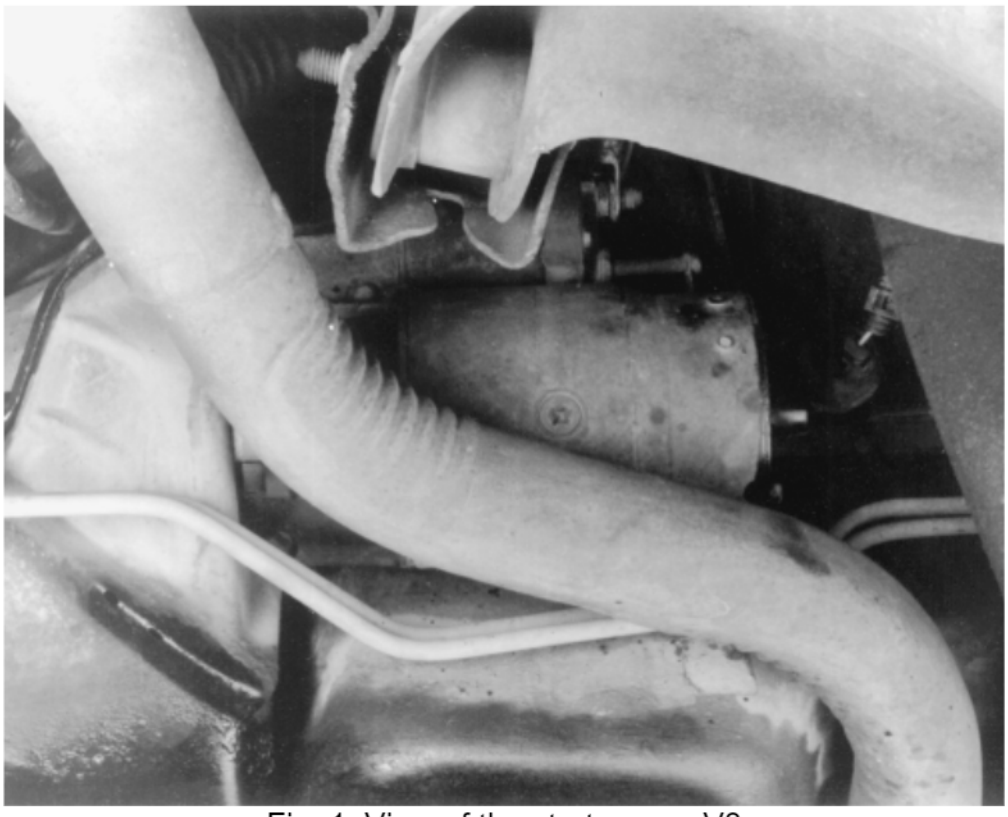


Fig. 1: View of the starter on a V8

cardiagn.com

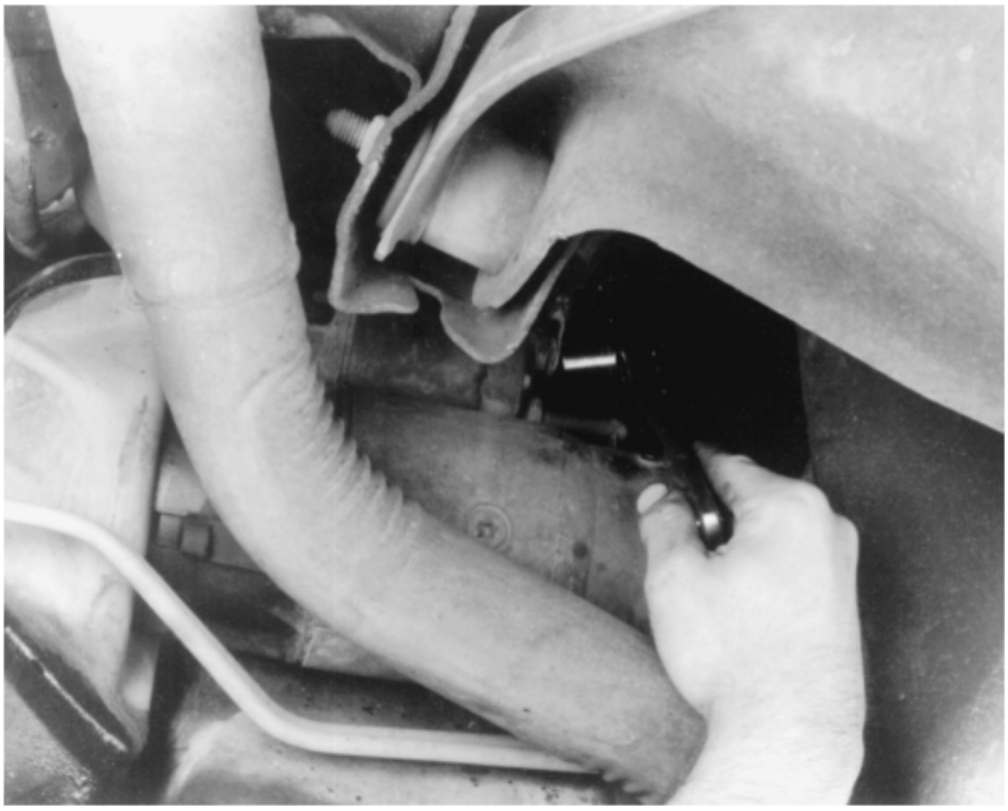


Fig. 2: Disconnecting the starter wires

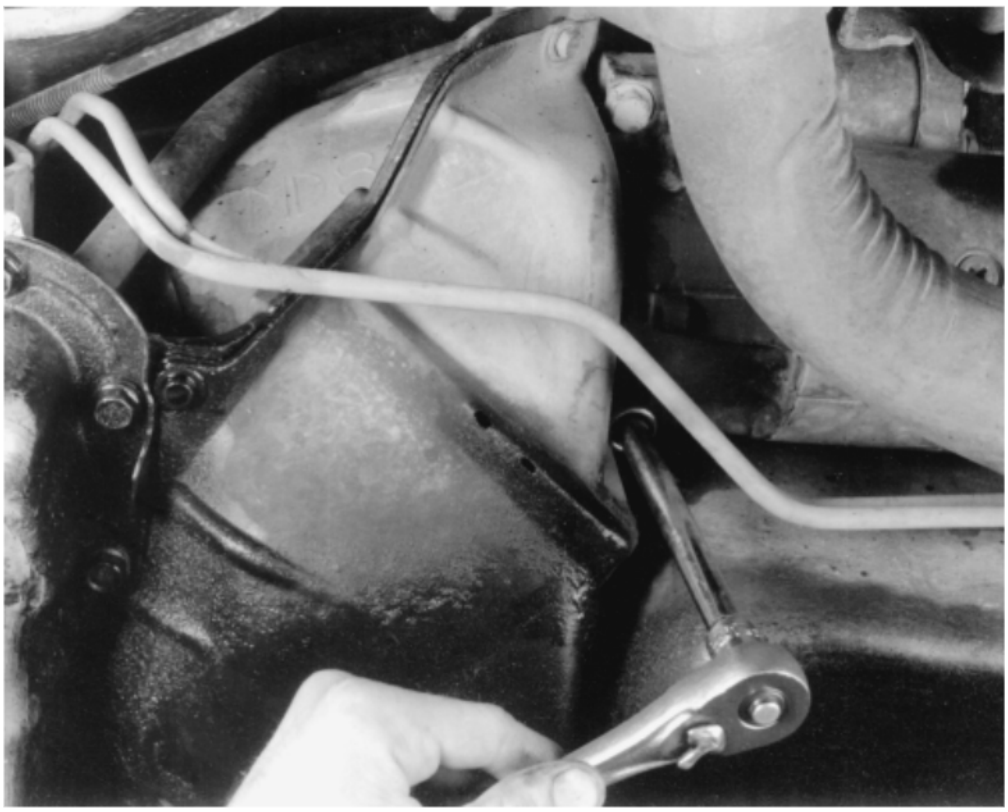


Fig. 3: Loosening the starter mounting bolts

cardiagn.com

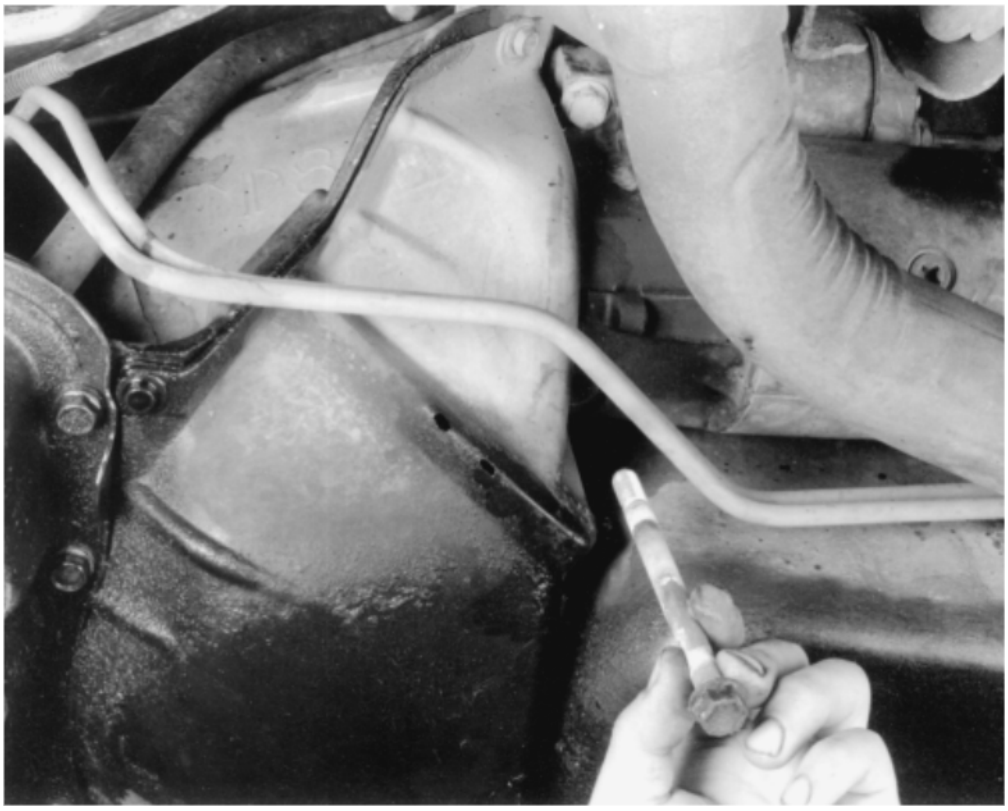


Fig. 4: Removing the starter mounting bolts

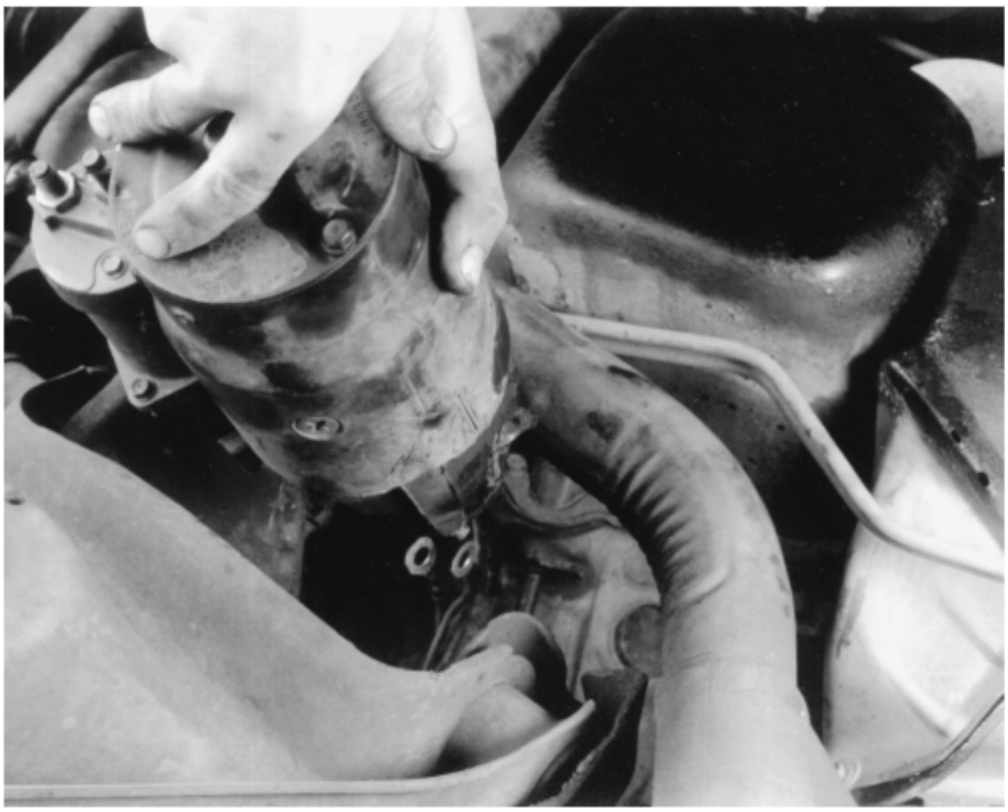


Fig. 5: Removing the starter

1. Disconnect the negative battery cable.
2. Raise and safely support the vehicle.

cardiagn.com

3. Disconnect all wiring from the starter solenoid. Replace each nut as the connector is removed (as thread sizes differ from connector to connector). Note or tag the wiring positions for installation.
4. Remove the bracket from the starter and the two mounting bolts. On engines with a solenoid heat shield, remove the front bracket upper bolt and detach the bracket from the starter.
5. Remove the front bracket bolt or nut. Lower the starter front end first, and then remove the unit from the car.

To install:

6. Position the starter into place and secure it with the front bracket bolt and nut. Torque the two mounting bolts to 25-35 ft. lbs.

CAUTION - If shims were removed, they must be replaced to ensure proper pinion-to-flywheel engagement.

7. On engines with a solenoid heat shield, attach the bracket to the starter. Install the bracket to the starter and the two mounting bolts. Install the front bracket upper bolt.
8. Connect all wiring to the starter solenoid and tighten the nuts.
9. Lower the vehicle.
10. Connect the negative battery cable.

SOLENOID REPLACEMENT

1. Remove the screw and washer from the motor connector strap terminal.
2. Remove the two solenoid retaining screws.
3. Twist the solenoid housing clockwise to remove the flange key from the keyway in the housing. Then remove the housing.
4. To re-install the unit, place the return spring on the plunger and place the solenoid body on the drive housing. Turn counterclockwise to engage the flange key. Place the two retaining screws in position and install the screw and washer which secures the strap terminal. Install the unit on the starter.

SENDING UNITS AND SENSORS

For additional information on engine sensors, refer to Engine Performance & Tune-up *and* Engine Controls *in this repair guide.*

cardiagn.com

REMOVAL & INSTALLATION

SENSORS

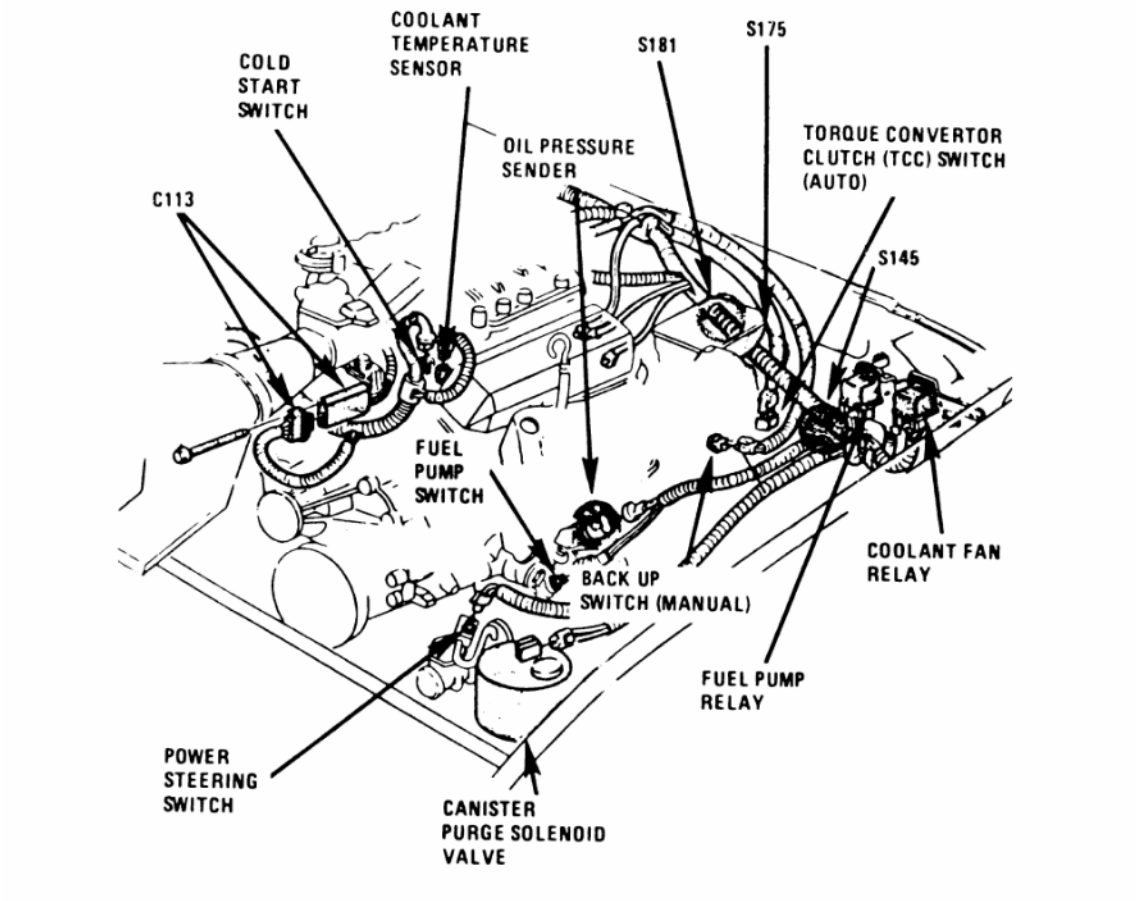


Fig. 1: 2.8L sensor locations

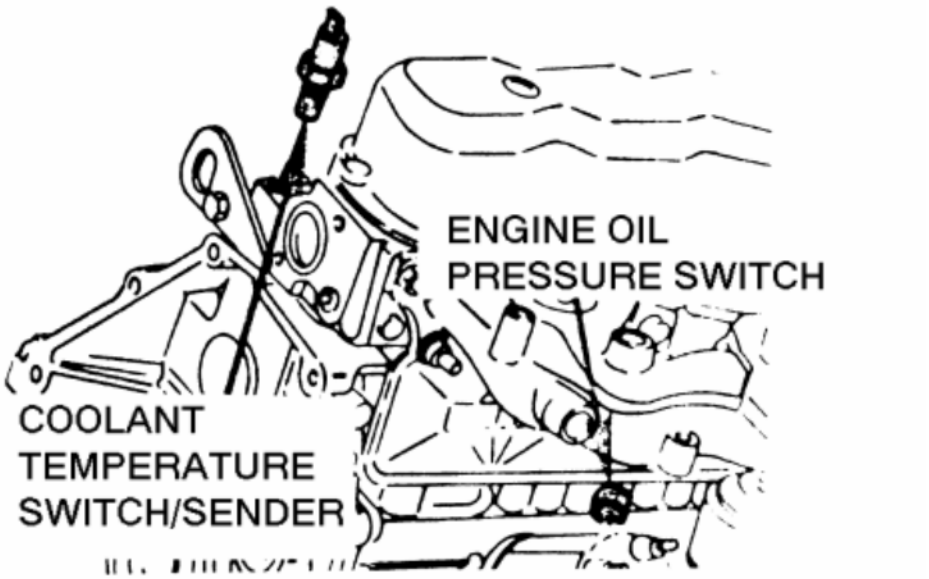


Fig. 2: 2.5L sensor locations

cardiagn.com

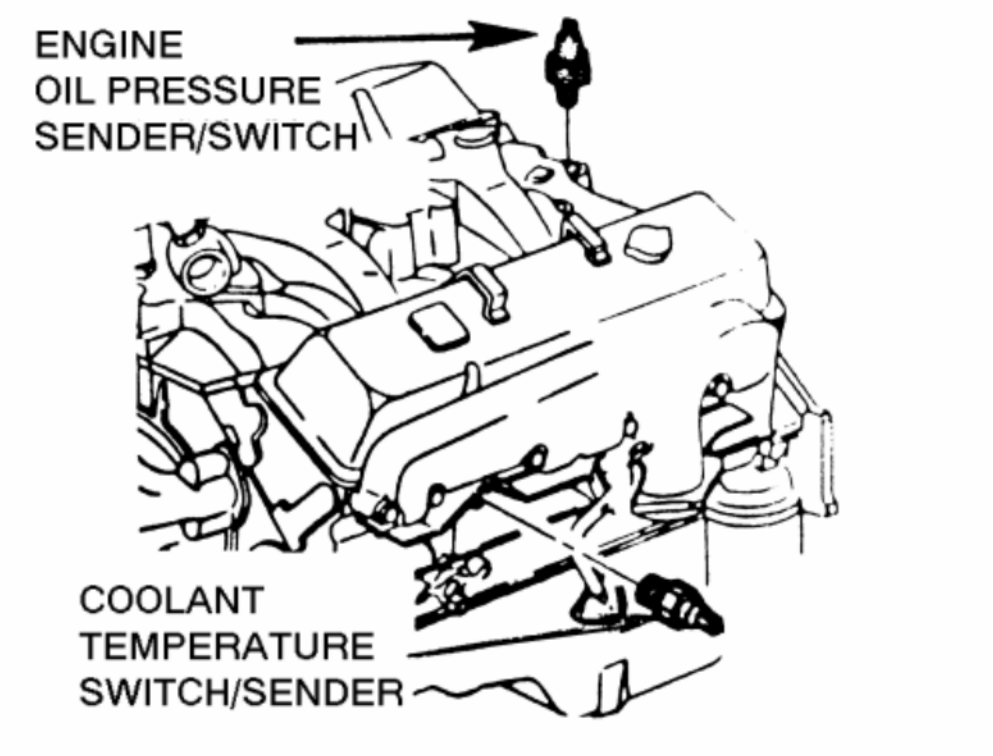


Fig. 3: Sensor locations on 1982-85 V8s

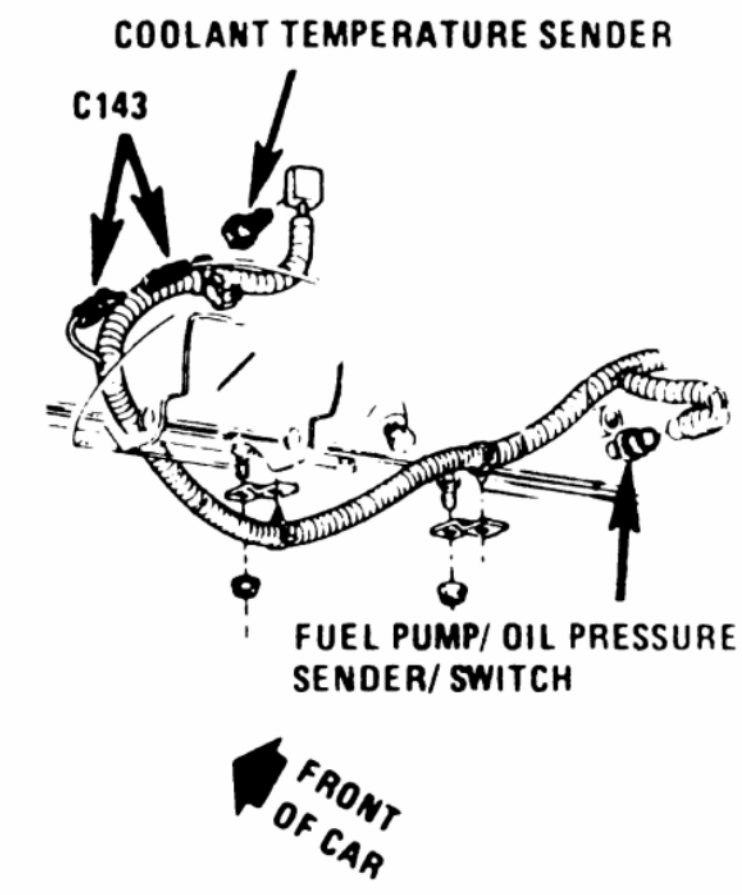


Fig. 4: Sensor locations on 1986-92 V8s

cardiagn.com

OIL PRESSURE SENDING UNIT

Replace the sending unit by disconnecting the electrical connector and using a special socket to remove it.

ENGINE

MECHANICAL ENGINE

REMOVAL & INSTALLATION

In the process of removing the engine, you will come across a number of steps which call for the removal of a separate component or system, such as "disconnect the exhaust system" or "remove the radiator." In most instances, a detailed removal procedure can be found elsewhere in this repair guide.

It is virtually impossible to list each individual wire and hose which must be disconnected, simply because so many different model and engine combinations have been manufactured. Careful observation and common sense are the best possible approaches to any repair procedure.

Removal and installation of the engine can be made easier if you follow these basic points:

- If you have to drain any of the fluids, use a suitable container.
- Always tag any wires or hoses and, if possible, the components they came from before disconnecting them.
- Because there are so many bolts and fasteners involved, store and label the retainers from components separately in muffin pans, jars or coffee cans. This will prevent confusion during installation.
- After unbolting the transmission or transaxle, always make sure it is properly supported.
- If it is necessary to disconnect the air conditioning system, have this service performed by a qualified technician using a recovery/recycling station. If the system does not have to be disconnected, unbolt the compressor and set it aside.
- When unbolting the engine mounts, always make sure the engine is properly supported. When removing the engine, make sure that any lifting devices are properly attached to the engine. It is recommended that if your engine is supplied with lifting hooks, your lifting apparatus be attached to them.
- Lift the engine from its compartment slowly, checking that no hoses, wires or other components are still connected.
- After the engine is clear of the compartment, place it on an engine stand or workbench.
- After the engine has been removed, you can perform a partial or full teardown of the engine using the procedures outlined in this repair guide.

cardiagn.com

2.5L ENGINE

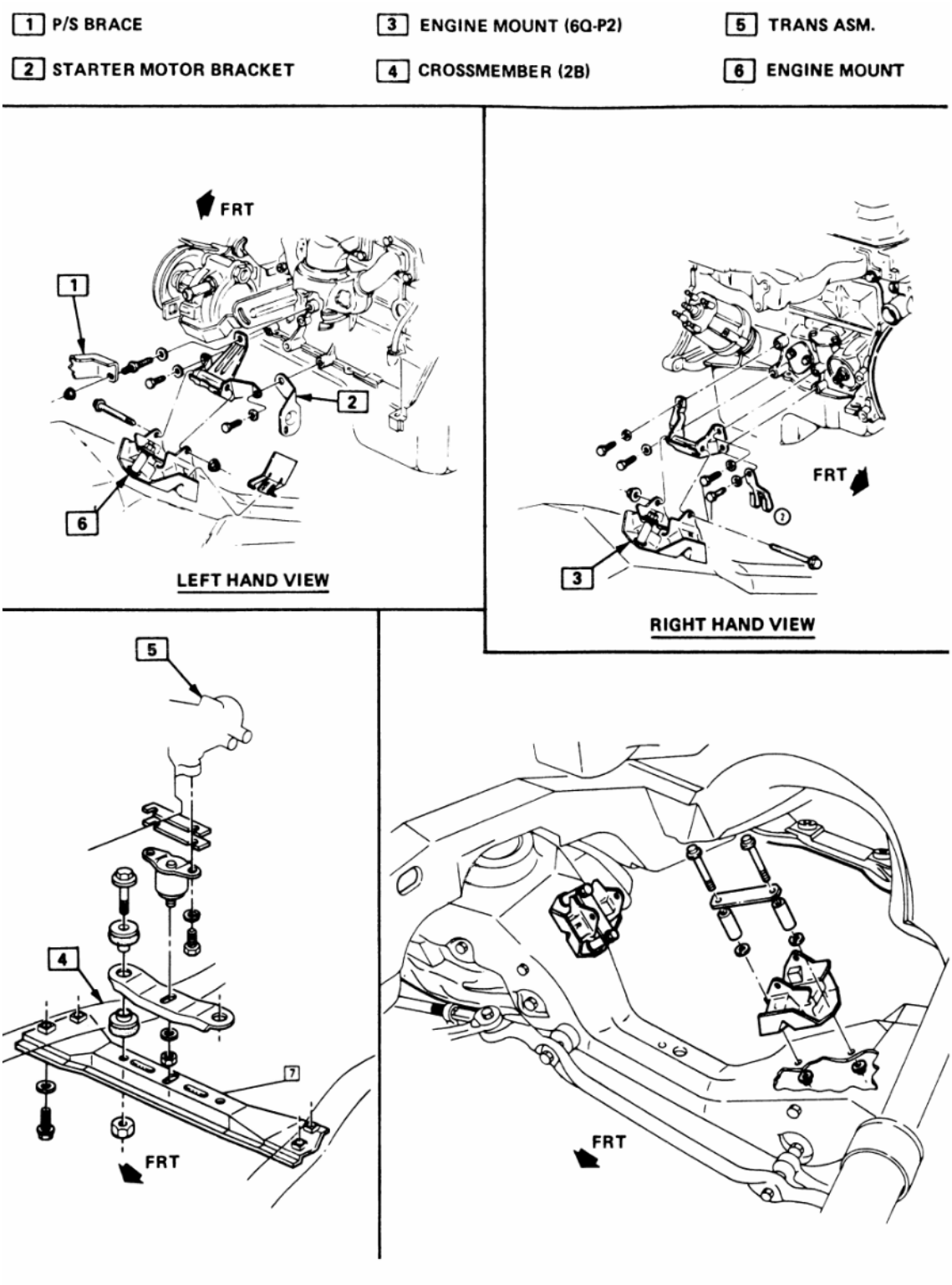


Fig. 1: Engine mounting points for the 2.5L

1. Disconnect the negative battery cable.
2. Remove the air cleaner duct.
3. Mark the hood location on the hood supports and remove the hood.
4. Remove the water pump drive belt.

cardiagn.com

5. Drain the radiator and remove the radiator hoses. Disconnect the heater hoses and the transmission cooler lines.
6. Remove the upper half of the radiator shroud, if equipped with a manual transmission. Remove the radiator and fan shroud assembly, if equipped with an automatic transmission.
7. Disconnect the throttle linkage, including the cruise control detent cable.
8. Remove the air conditioning compressor and lay aside.

Do not disconnect the air conditioning lines.

9. Disconnect the power steering pump and drain the fluid into a suitable container. Remove the vacuum brake booster line.
10. Remove the distributor cap and spark plug wires.
11. Disconnect the engine electrical connection at the bulkhead connection and disconnect any necessary vacuum hoses.
12. Working inside the vehicle, remove the right-hand hush panel and disconnect the ECM harness at the ECM. Raise and safely support the vehicle. Remove the right fenderwell splash shield and feed the harness through the fenderwell.
13. Disconnect the exhaust pipes at the exhaust manifolds and remove exhaust system from the vehicle.
14. Remove the flywheel cover and remove the converter bolts, if equipped with automatic transmission.
15. Disconnect the transmission and starter wire connections.
16. Remove the bellhousing and the motor mount through-bolts.
17. Disconnect the clutch fork return spring, if equipped with a manual transmission. Lower the vehicle.
18. Relieve the fuel system pressure. Disconnect the fuel lines.
19. Support the transmission with a suitable jack. Attach an engine lifting device.
20. Remove the engine assembly.

To install:

21. Position the engine assembly in the vehicle.
22. Attach the motor mount to engine brackets and lower the engine in place. Remove the engine lifting device and the transmission jack.
23. Raise and support the vehicle safely.
24. Install the motor mount through-bolts and tighten the nuts to specification. Install the bellhousing bolts and tighten to 35 ft. lbs. (47 Nm).
25. On vehicles with automatic transmission, install the converter to flywheel attaching bolts to 46 ft. lbs. (63 Nm).
26. Install the flywheel splash shield and tighten to 89 inch lbs. (10 Nm). Install the clutch return spring, if equipped with manual transmission.
27. Connect the starter wires and the fuel lines.
28. Install the exhaust system.
29. Lower the vehicle.
30. Install the power steering pump and the air conditioning compressor.

cardiagn.com

31. Connect the bulkhead harness connector, wires and hoses. Reroute the ECM harness in its original location. Install the hush panel and fenderwell splash panel.
32. Install the radiator, fan and fan shroud. Connect the radiator and heater hoses, along with the transmission cooler lines.
33. Connect the vacuum brake booster line, the throttle linkage and cruise control cable. Install the distributor cap.
34. Fill the cooling system with the proper type and amount of coolant and the crankcase with the proper type of oil to the correct level.
35. Install the water pump drive belt, the air cleaner duct and the hood.
36. Connect the negative battery cable, start the engine and check for leaks.

2.8L AND 3.1L ENGINES

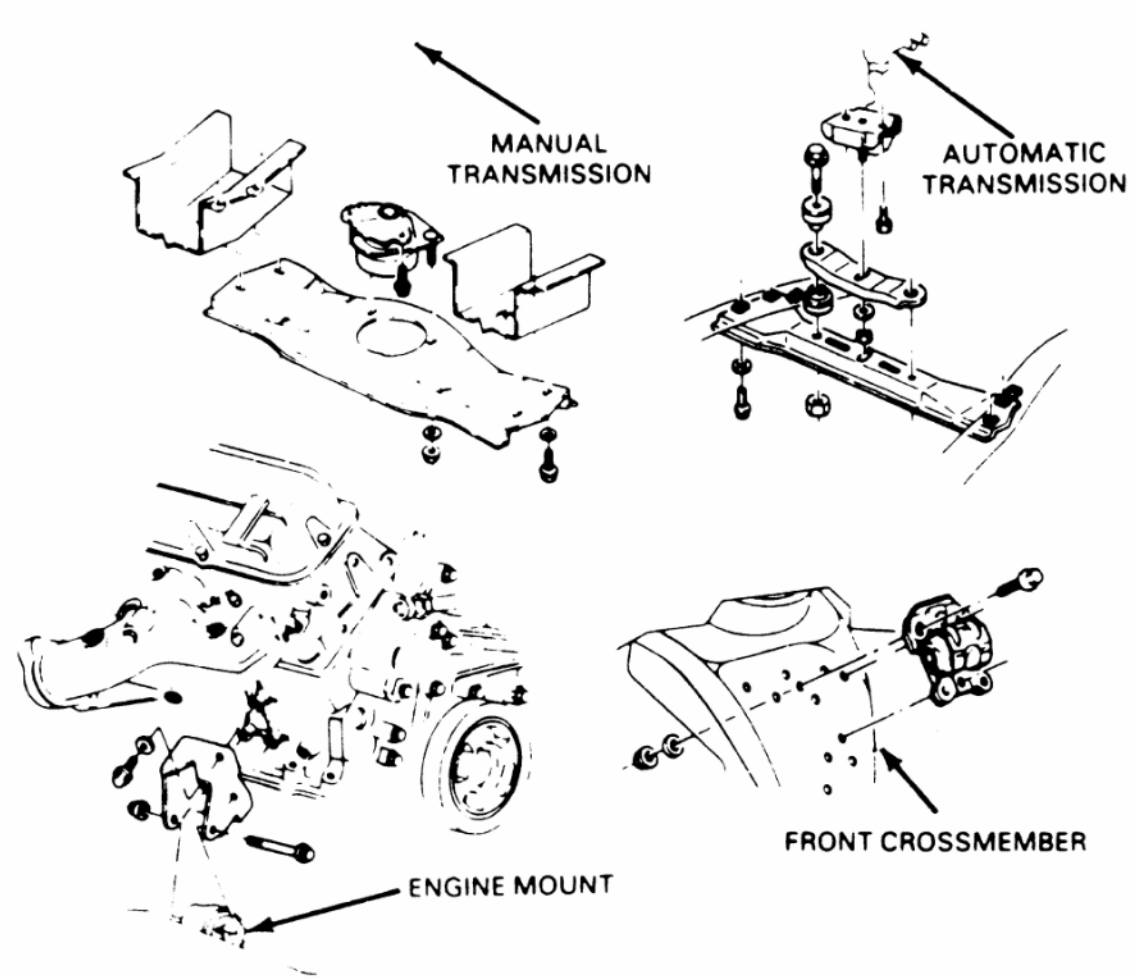


Fig. 2: Engine mounting points for the V6

1. Disconnect the negative battery cable.
2. Remove the air cleaner duct.
3. Mark the hood location on the hood supports and remove the hood.
4. Remove the water pump drive belt.
5. Drain the radiator and remove the radiator hoses. Disconnect the heater hoses and the transmission cooler lines.
6. Remove the fan shroud, fan and radiator.
7. Disconnect the throttle linkage, including the cruise control detent cable.

cardiagn.com

8. Remove the air conditioning compressor and lay aside. Remove the power steering pump and lay aside.

Do not disconnect the air conditioning or power steering lines.

9. Remove the vacuum brake booster line.
10. Remove the distributor cap and spark plug wires.
11. Disconnect the necessary electrical connections and hoses.
12. Raise and safely support the vehicle.
13. Disconnect the exhaust pipes at the exhaust manifolds.
14. Remove the flywheel cover and remove the converter bolts.
15. Disconnect the starter wire connections.
16. Remove the bellhousing and the motor mount through-bolts.
17. Lower the vehicle.
18. Relieve the fuel system pressure. Disconnect the fuel lines.
19. Support the transmission with a suitable jack. Attach an engine lifting device.
20. Remove the engine assembly.

To install:

21. Position the engine assembly in the vehicle.
22. Attach the motor mount to engine brackets and lower the engine in place. Remove the engine lifting device and the transmission jack.
23. Raise and support the vehicle safely.
24. Install the motor mount through-bolts and tighten the nuts to 50 ft. lbs. (68 Nm). Install the bellhousing bolts and tighten to 35 ft. lbs. (47 Nm).
25. On vehicles with automatic transmission, install the converter to flywheel attaching bolts to 46 ft. lbs. (63 Nm).
26. Install the flywheel splash shield and tighten to 89 inch lbs. (10 Nm).
27. Connect the starter wires and the fuel lines.
28. Install the exhaust pipe on the exhaust manifold.
29. Lower the vehicle.
30. Install the power steering pump and the air conditioning compressor.
31. Connect the necessary wires and hoses.
32. Install the radiator, fan and fan shroud. Connect the radiator and heater hoses and the transmission cooler lines.
33. Connect the vacuum brake booster line, the throttle linkage and cruise control cable. Install the distributor cap.
34. Fill the cooling system with the proper type and amount of coolant and the crankcase with the proper type of oil to the correct level.
35. Install the water pump drive belt, the air cleaner duct and the hood.
36. Connect the negative battery cable, start the engine and check for leaks.

cardiagn.com

5.0L AND 5.7L ENGINES

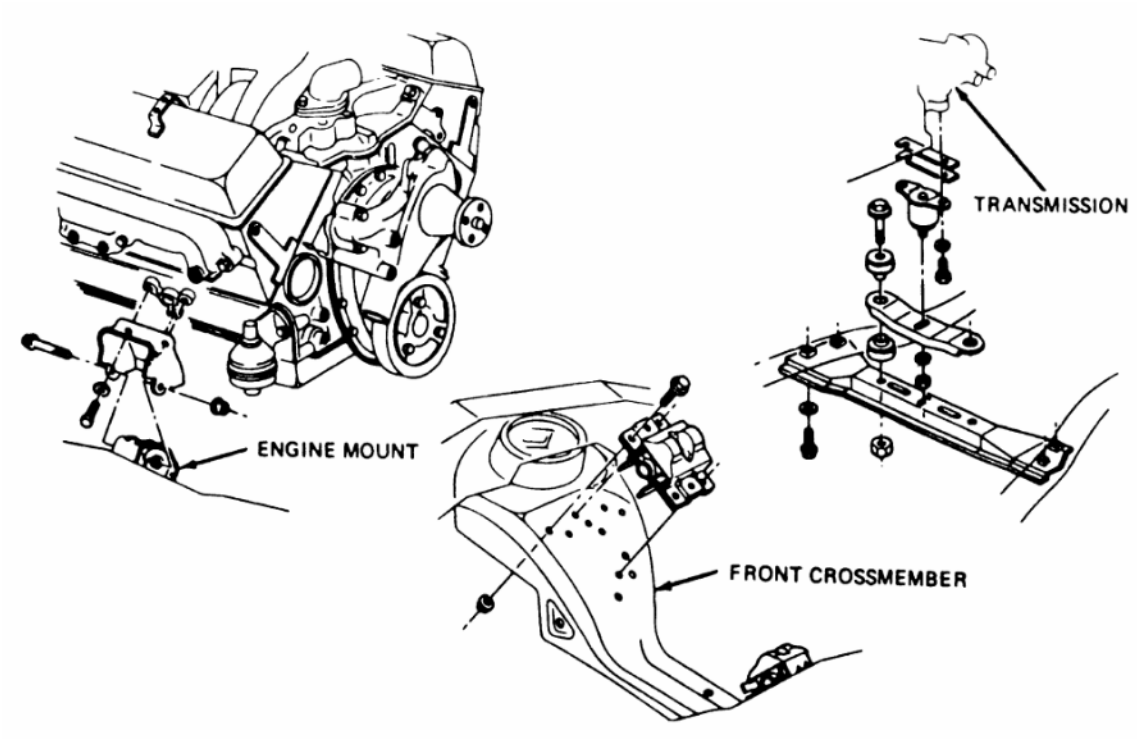


Fig. 3: Engine mounting points for the V8

1. Disconnect the negative battery cable.
2. Mark the location of the hood on the hood hinges and remove the hood.
3. Remove the air cleaner.
4. Drain the cooling system.
5. Remove the radiator hoses.
6. Disconnect the transmission cooler lines, the electrical connectors and retaining clips at the fan and remove the fan and shroud.
7. Remove the radiator.
8. Remove the accessory drive belt.
9. Disconnect the throttle cable.
10. Remove the plenum extension screws and the plenum extension, if equipped.
11. Disconnect the spark plug wires at the distributor and remove the distributor.
12. Disconnect the necessary vacuum hoses and wiring.
13. Disconnect the power steering and air conditioning compressors from their respective brackets and lay them aside.
14. Properly relieve the fuel system pressure. Disconnect the fuel lines.
15. Disconnect the negative battery cable at the engine block.
16. Raise and safely support the vehicle.
17. Remove the exhaust pipes at the exhaust manifolds.
18. Remove the flywheel cover and remove the converter to flywheel bolts.
19. Disconnect the starter wires.
20. Remove the bellhousing bolts and the motor mount through-bolts.
21. Lower the vehicle.
22. Support the transmission with a suitable jack.

cardiagn.com

23. Remove the AIR/converter bracket and ground wires from the rear of the cylinder head.
24. Attach a suitable lifting device and remove the engine assembly.

To install:

25. Position the engine assembly in the vehicle.
26. Attach the motor mount to engine brackets and lower the engine into place.
27. Remove the engine lifting device and the transmission jack.
28. Raise and safely support the vehicle.
29. Install the motor mount through-bolts and tighten to 50 ft. lbs. (68 (Nm).
30. Install the bellhousing bolts and tighten to 35 ft. lbs. (47 Nm).
31. On vehicles with automatic transmission, install the converter to flywheel bolts. Tighten the bolts to 46 ft. lbs. (63 Nm). Install the flywheel cover.
32. Connect the starter wires and the fuel lines.
33. Connect the exhaust pipe at the exhaust manifold.
34. Lower the vehicle.
35. Connect the necessary wires and hoses.
36. Install the power steering pump and air conditioning compressor in their respective brackets.
37. Install the radiator, fan and fan shroud, radiator hoses and heater hoses.
38. Connect the transmission cooler lines and cooling fan electrical connectors.
39. Install the distributor.
40. Install the plenum extension, if equipped.
41. Fill the cooling system with the proper type and quantity of coolant and the crankcase with the proper type of oil to the correct level.
42. Install the air cleaner and the hood.
43. Connect the negative battery cable, start the engine, check for leaks and check timing.

cardiagn.com

ROCKER ARM COVER

REMOVAL & INSTALLATION

2.5L ENGINE

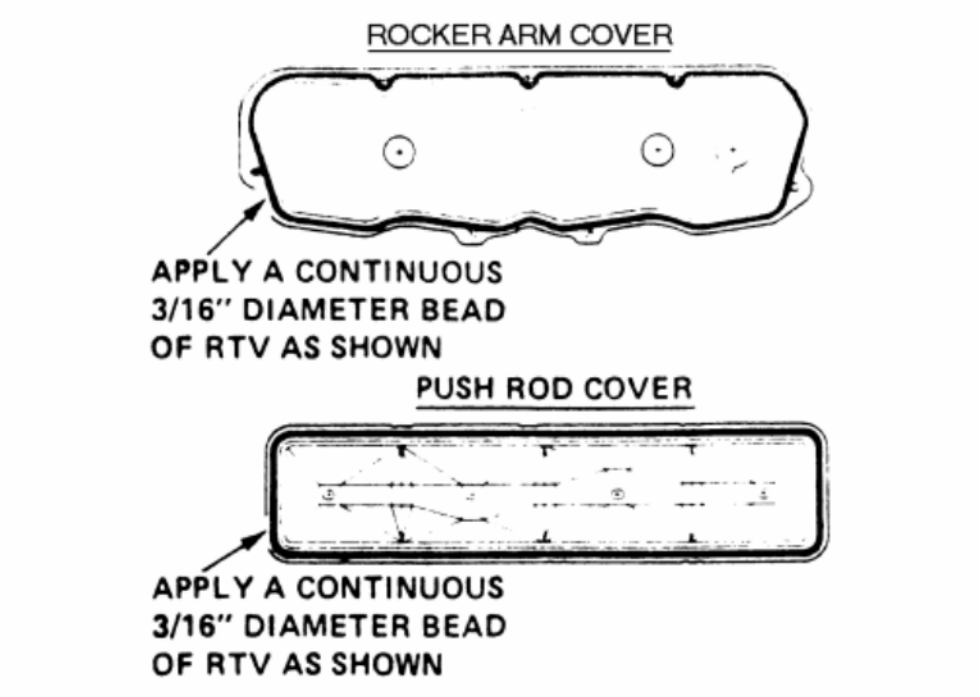


Fig. 1: Valve and pushrod covers for the 2.5L

1. Disconnect the negative battery cable.
2. Remove the air cleaner assembly.
3. Disconnect the throttle cable at the throttle body.
4. Remove the PCV valve from the cover.
5. Remove the spark plug wires from the clips. Remove the clips from the valve cover.
6. Remove the EGR valve. Loosen the throttle body to gain clearance, as required.
7. Remove the valve cover retaining bolts and remove the cover. Tap on the valve cover with the palm of your hand or use a soft mallet to loosen.

To install:

8. Clean the sealing surface on cylinder head and intake manifold of all old RTV or gasket. Make sure no oil or old gasket is present when applying new RTV or gasket.
9. Place a $^{1}/_{16}$ in. (5mm) bead of RTV sealant all around the rocker arm sealing surface or use a cork style gasket. (When going around the attaching bolt holes, always flow the RTV on the inboard side of the holes).
10. Install cover and torque bolts to 8 ft. lbs. (11 Nm).
11. Finish installation by reversing removal procedure.

cardiagn.com

2.8L AND 3.1L ENGINES

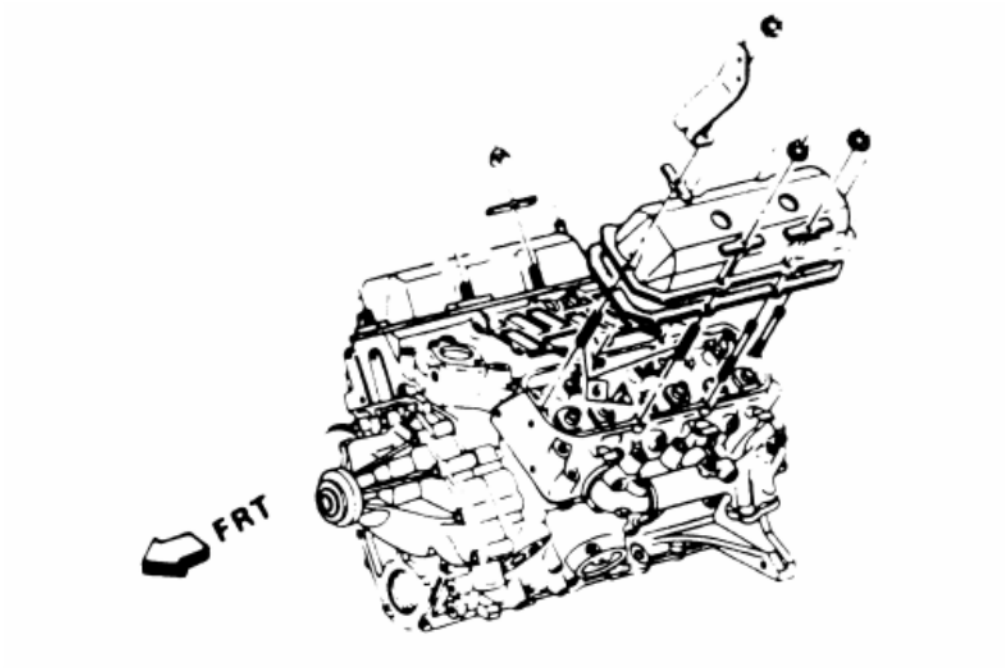


Fig. 2: Valve cover removal for the V6

1. Disconnect the negative battery cable.
2. For the left side valve cover removal, proceed as follows:
    a. Remove the accessory drive belt.
    b. Remove the transmission dipstick, if required.
    c. Remove the air management hose and air conditioning bracket, if equipped.
    d. Remove the intake plenum and throttle body assembly, on fuel injected engines.
    e. Remove the valve cover reinforcements and nuts.
3. For the right side valve cover removal, proceed as follows:

    a. Remove the EGR valve adapter with the EGR valve and shield from the exhaust manifold.
    b. Remove the coil and coil mounting bracket from the cylinder head.
    c. Disconnect the crankcase vent pipe.
    d. Remove the intake plenum and throttle body assembly.
    e. Remove the valve cover reinforcements and nuts.
4. Remove cover. If cover adheres to cylinder head, shear off by bumping end of rocker arm cover with palm of hand or rubber mallet. If cover still will not come loose, CAREFULLY pry until loose. DO NOT DISTORT THE SEALING FLANGE.

To install:

5. Clean the sealing surface on cylinder head and intake manifold of all old RTV or gasket. Make sure no oil or old gasket is present when applying new RTV or gasket.

cardiagn.com

6. Place a $^{1}/_{8}$ in. (3mm) bead of RTV sealant all around the rocker arm sealing surface or use a cork style gasket. (When going around the attaching bolt holes, always flow the RTV on the inboard side of the holes).
7. Install cover and torque bolts to 8 ft. lbs. (10 Nm).
8. Finish installation by reversing removal procedure.

5.0L AND 5.7L ENGINES

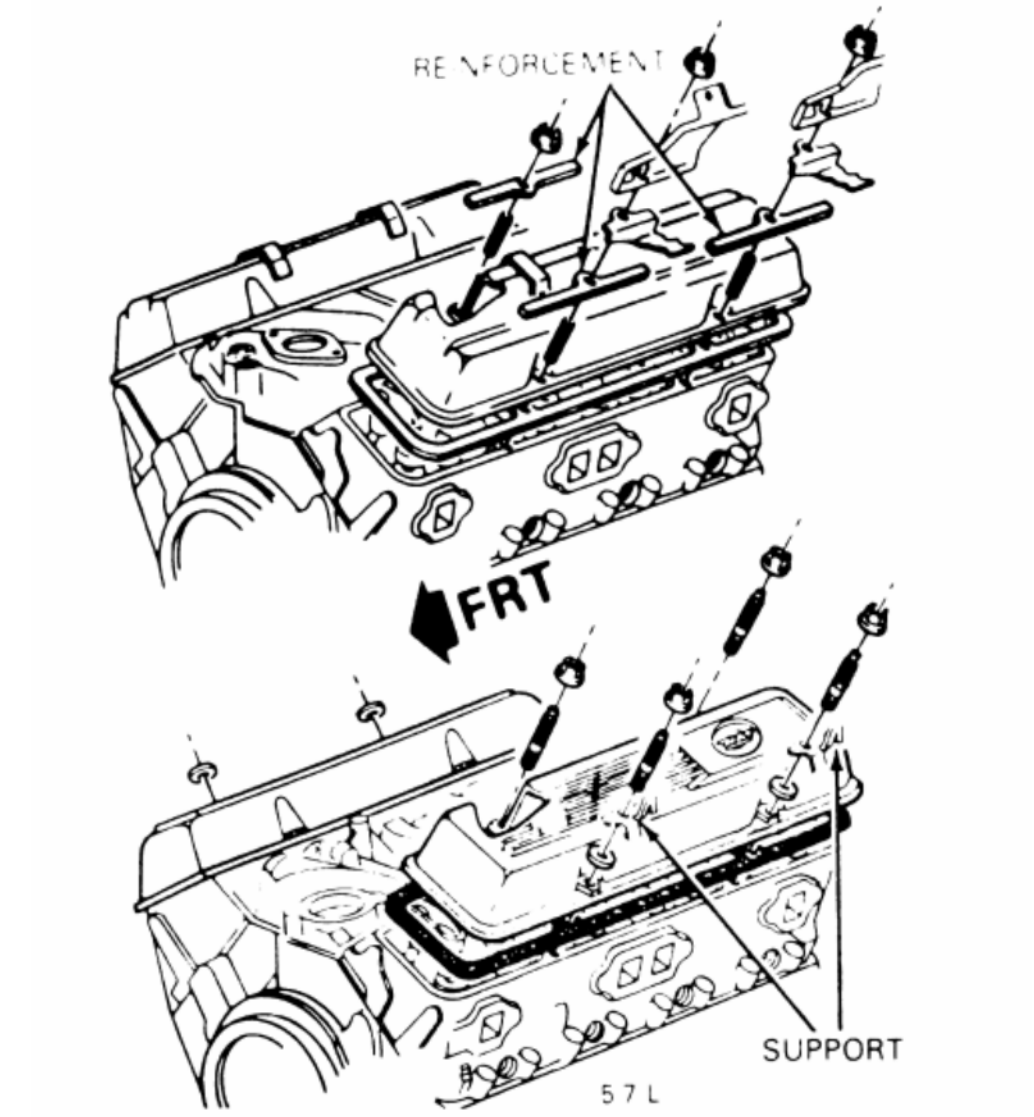


Fig. 3: Valve cover removal for the 1982-86 V8

cardiagn.com

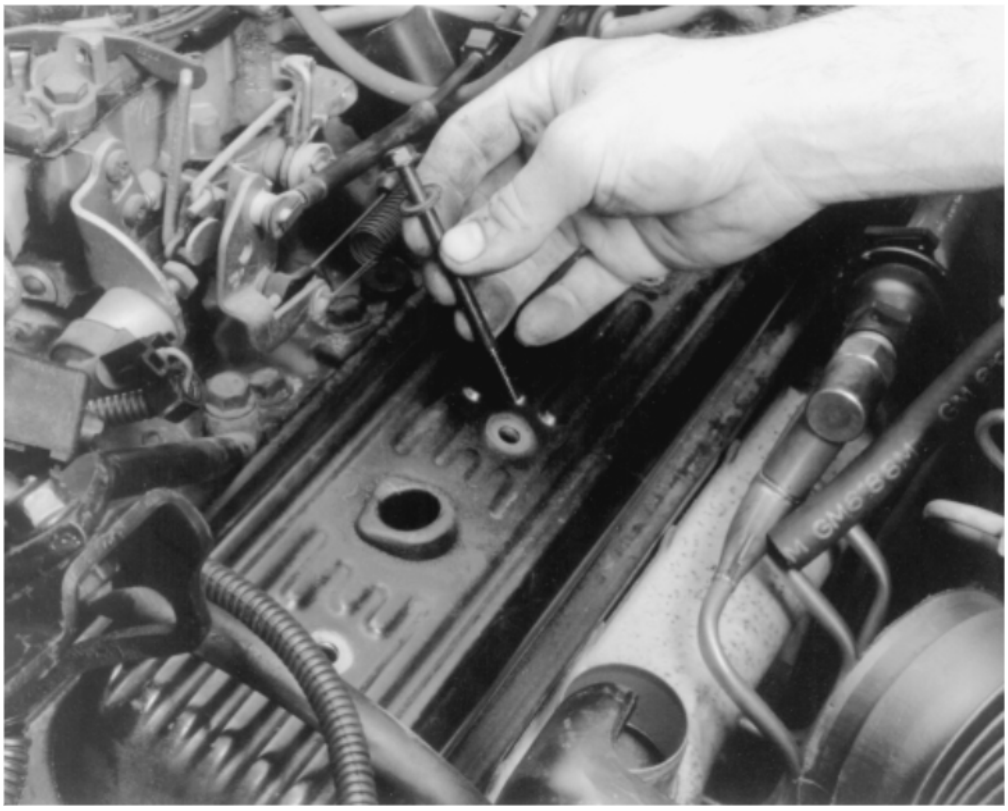


Fig. 4: Valve cover bolt removal for 1987-92 V8



Fig. 5: Valve cover removal for 1987-92 V8

cardiagn.com

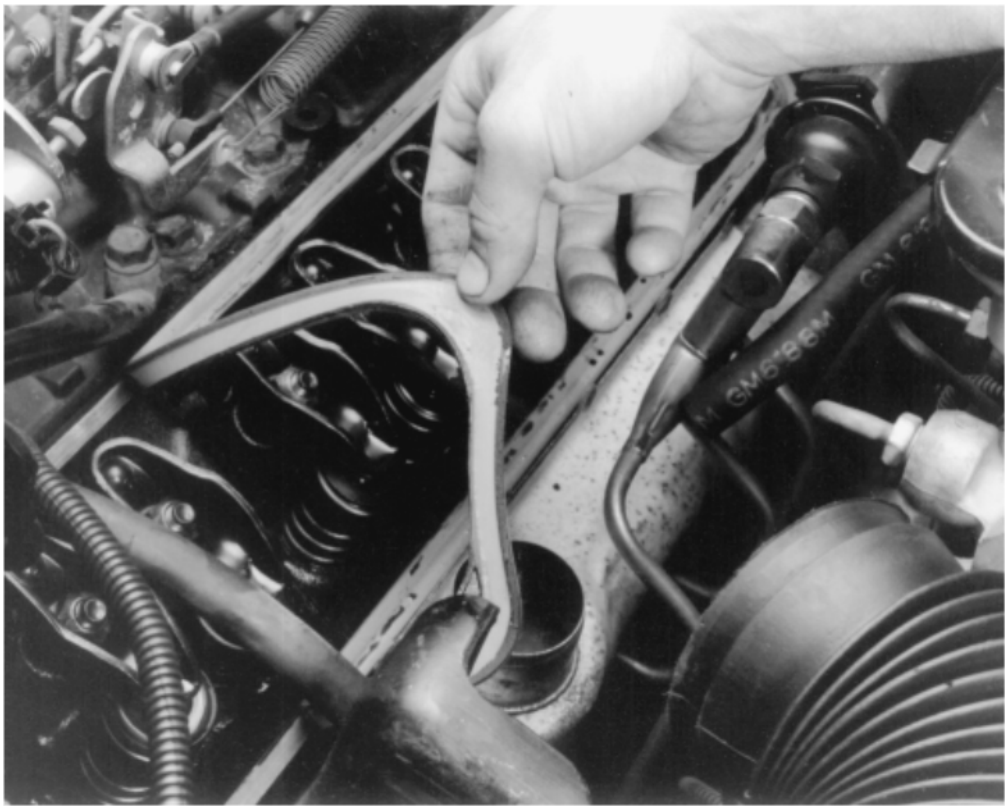


Fig. 6: Removing the valve cover gasket

1. Disconnect the negative battery cable.
2. Remove the air cleaner, if necessary.
3. To remove the right side valve cover, perform the following:
    a. Through 1988: Disconnect the EGR solenoid transfer tube from the plenum. Remove the coil and mounting bracket from the cylinder head. Remove the plenum, runners and throttle body assembly on tuned port injected models. Remove the valve cover retainers and nuts. Remove the valve cover.
    b. 1989-1992 vehicles: Remove the EGR pipe assembly, if necessary. Unplug the electrical connections and wiring harnesses as necessary. Label and disconnect the spark plug wires from the distributor. Remove the crankcase vent hoses and valves. Remove the coil. Remove the AIR control valve, check valve, pipes and hoses. Remove the valve cover bolts and remove the cover.
4. To remove the left side valve cover, perform the following:

    a. Through 1988: Remove the air management hose, if equipped. Remove the plenum and throttle body assembly on tuned port injected models. Remove the air conditioning bracket. Remove the valve cover reinforcements and nuts. Remove the valve cover.
    b. 1989-1992 vehicles: Unplug the electrical connections and the wiring harnesses, as necessary. Remove the alternator and disconnect the crankcase hoses and the PCV valve. Remove the valve cover bolts and remove the valve cover.

cardiagn.com

5. If cover adheres to cylinder head, shear off by bumping end of rocker arm cover with palm of hand or rubber mallet. If cover still will not come loose, CAREFULLY pry until loose. DO NOT DISTORT THE SEALING FLANGE.

To install:

6. Clean the sealing surface of cylinder head and intake manifold of all old RTV or gasket. Make sure no oil or old gasket is present when applying new RTV or gasket.
7. Place a $^{1}/_{8}$ in. (3mm) bead of RTV sealant all around the rocker arm sealing surface or use a cork style gasket. (When going around the attaching bolt holes, always flow the RTV on the inboard side of the holes).
8. Install cover and torque bolts to 8 ft. lbs. (11 Nm).
9. Finish installation by reversing removal procedure.

PUSHROD SIDE COVER

REMOVAL & INSTALLATION

2.5L ENGINE

1. Disconnect the negative battery cable.
2. Mark and remove the distributor assembly.
3. Remove the ignition coil and bracket.
4. Remove the side cover retaining nuts and remove the cover.

To install:

5. Clean the cover sealing surfaces of all RTV or gasket material.
6. Place a $^{1}/_{16}$ in. (5mm) bead of RTV sealant all around the rocker arm sealing surface or use a cork style gasket. (When going around the attaching bolt holes, always flow the RTV on the inboard side of the holes).
7. Install cover and torque bolts to 89 inch lbs. (10 Nm).
8. Finish installation by reversing removal procedure.

cardiagn.com

ROCKER ARMS

REMOVAL & INSTALLATION

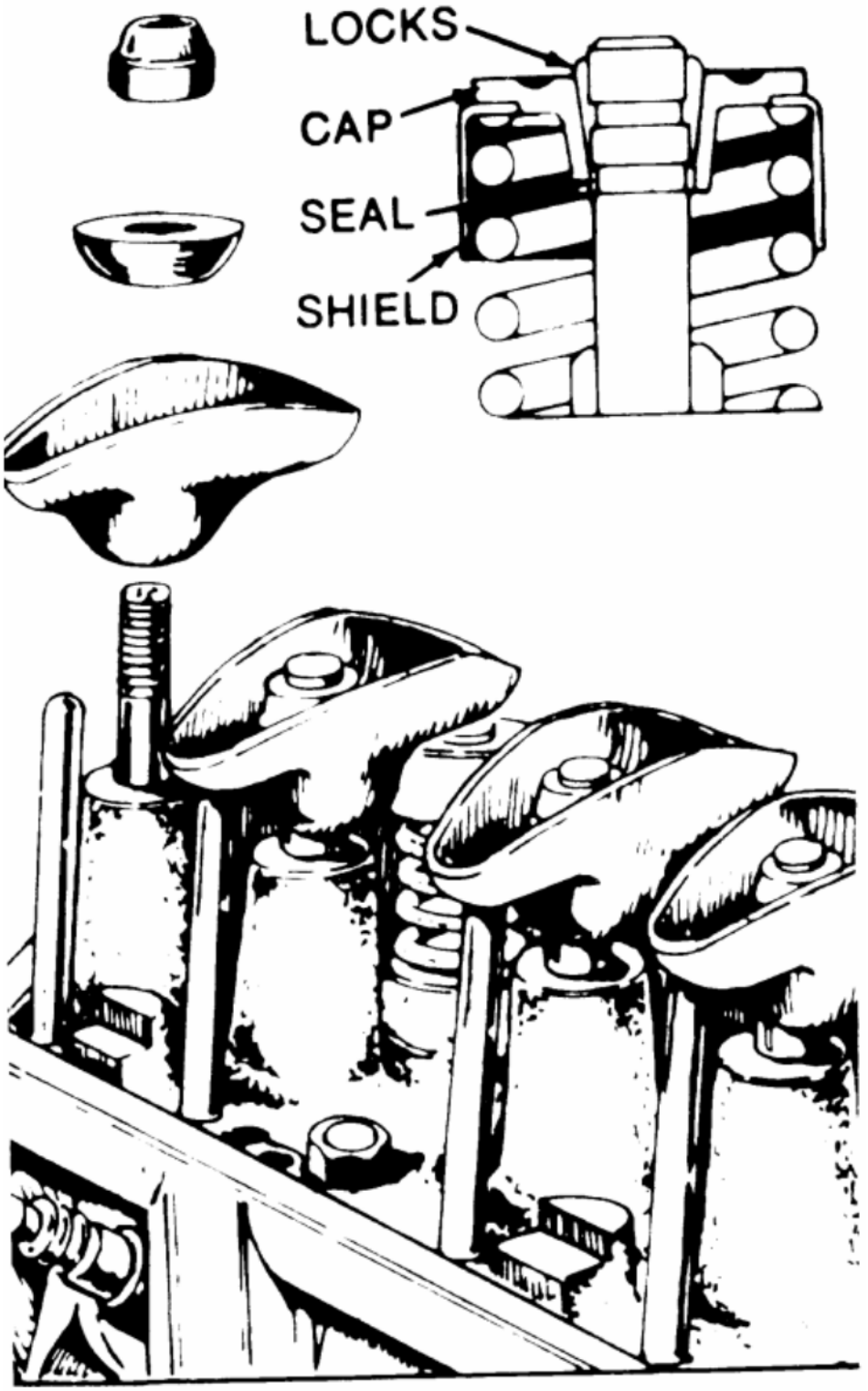


Fig. 1: Common rocker arm components

cardiagn.com

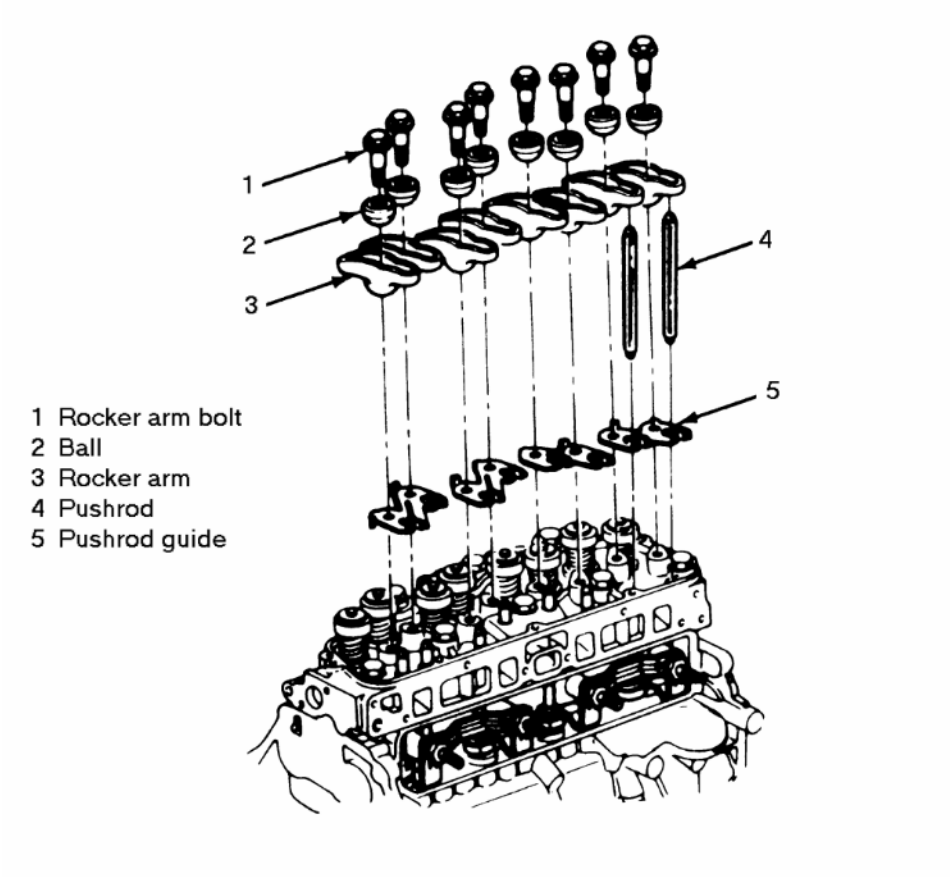


Fig. 2: 2.5L rocker arm components

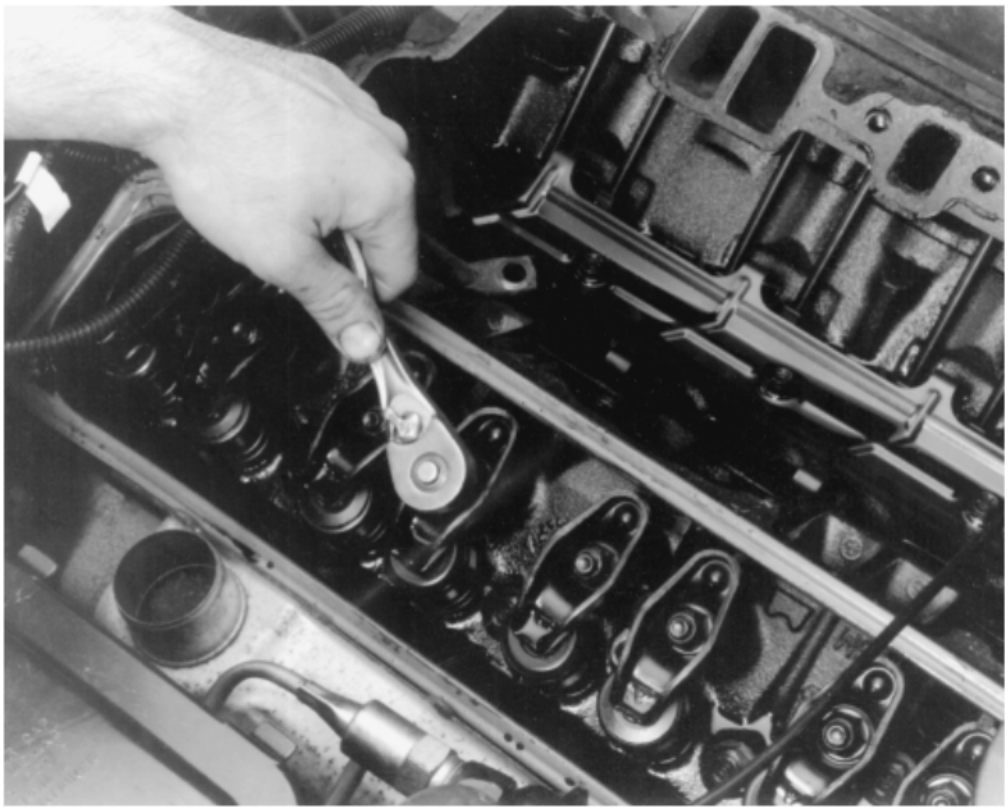


Fig. 3: Remove the rocker arm retaining nut

cardiagn.com

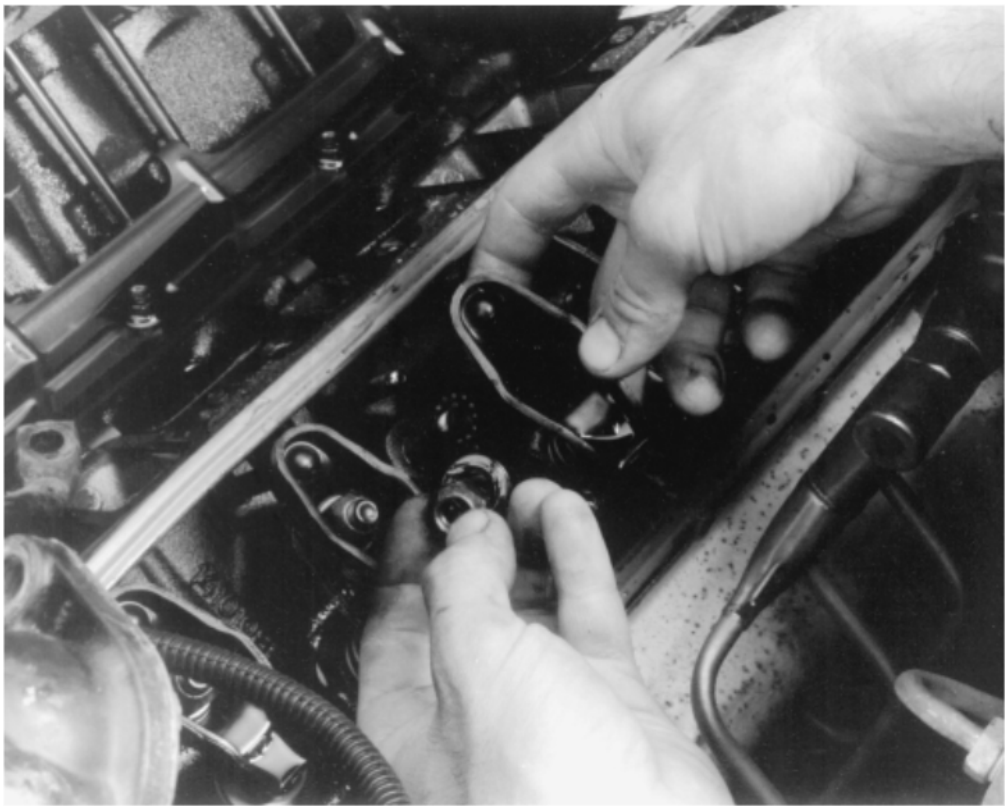


Fig. 4: Then remove the rocker arm pivot

Be sure to keep all the components in the exact order of removal so they may be installed in there original location; adjust the valve lash after replacing the rocker arms. Coat the replacement rocker arm and ball with engine oil before installation.

Rocker arms studs that have damaged threads or are loose in the cylinder heads may be replaced by reaming the bore and installing oversize studs. Oversizes available are 0.003 in. (0.076mm) and 0.013 in (0.33mm). The bore may also be tapped and screw-in studs installed. Several aftermarket companies produce complete rocker arm stud kits with installation tools.

The 2.5L engine use bolts instead of studs, 2.8L and 3.1L engines use threaded studs, the 3.4L, 5.0L and 5.7L engines use press fit studs.

EXCEPT 2.5L ENGINES

1. Disconnect the negative (-) battery cable.
2. Remove the rocker arm cover as outlined in this section
3. Remove the rocker arm nuts, balls and rocker arms. Place components in a rack so they can be reinstalled in the same location.

To install:

4. Coat the bearings surfaces with a thin coating of Molykote® or its equivalent.
5. Install the pushrods and make sure the rod is in the lifter seat.

cardiagn.com

6. Install the rocker arm, balls and nut. Tighten the nut until all lash is eliminated.
7. The engine must be on the No. 1 firing position before proceeding. This may be determined by placing your fingers on the No. 1 rocker arms as the mark crankshaft damper is rotated towards the "0" on the timing tab. If the arms did not move, it is in the No. 1 firing position. If they did move, turn the crankshaft one full revolution to reach the No. 1 position. Remember, the mark on the crankshaft balancer must be aligned with the "0" on the timing tab.
8. Adjust the valves as follows:

V6 ENGINES

With the engine on the number 1 firing position, exhaust valves 1, 2 and 3 and intake valves 1, 5 and 6

may be adjusted. Back out the adjusting nut until lash is felt at the pushrod. Tighten the adjusting nut until all lash is removed, then tighten the nut an additional $1^1/_2$ turns to center the lifter plunger. Turn the engine one revolution until the "0" timing mark is once again aligned. Exhaust valves 4, 5 and 6 and intake valves 2, 3 and 4 may be adjusted.

V8 ENGINES

With the engine on the number 1 firing position, exhaust valves 1, 3, 4 and 8, intake valves 1, 2, 5 and 7 may be adjusted. Back out the adjusting nut until lash is felt at the pushrod. Tighten the adjusting nut until all lash is removed, then tighten an additional 1 turn to center the lifter plunger. Turn the engine one revolution until the 0 timing mark is once again aligned. Exhaust valves 2, 5, 6 and 7, intake valves 3, 4, 6 and 8 may be adjusted.

9. Install the rocker arm cover.

2.5L ENGINE

1. Disconnect the negative battery cable.
2. Remove the valve cover.
3. Remove the rocker arm bolt, ball and rocker arm.
4. Remove the pushrods, if necessary. Place components in a rack so they can be reinstalled in the same location.

To install:

5. Coat the bearings surfaces with a thin coating of Molykote® or its equivalent.
6. Install the pushrod, if removed, through the cylinder head and into the lifter seat.
7. Install the rocker arm, ball and bolt. Torque to 22 ft lbs. (30 Nm).
8. Install the valve cover.

cardiagn.com

THERMOSTAT

REMOVAL & INSTALLATION

CAUTION - When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

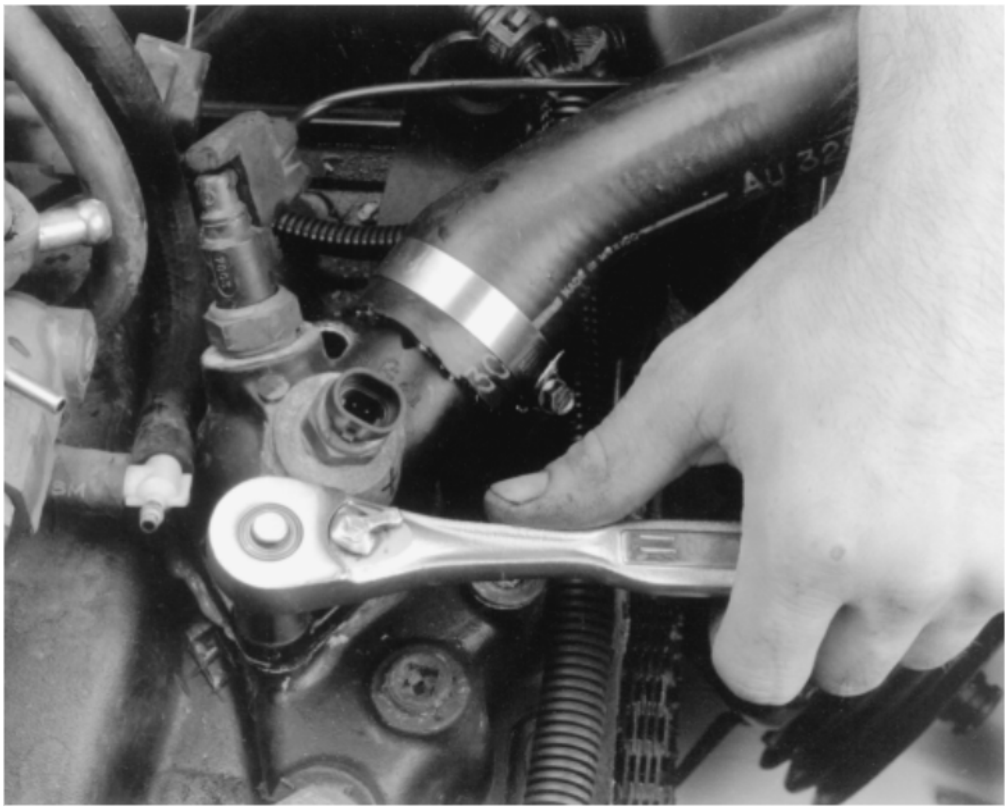


Fig. 1: Removing the thermostat housing bolts

cardiagn.com

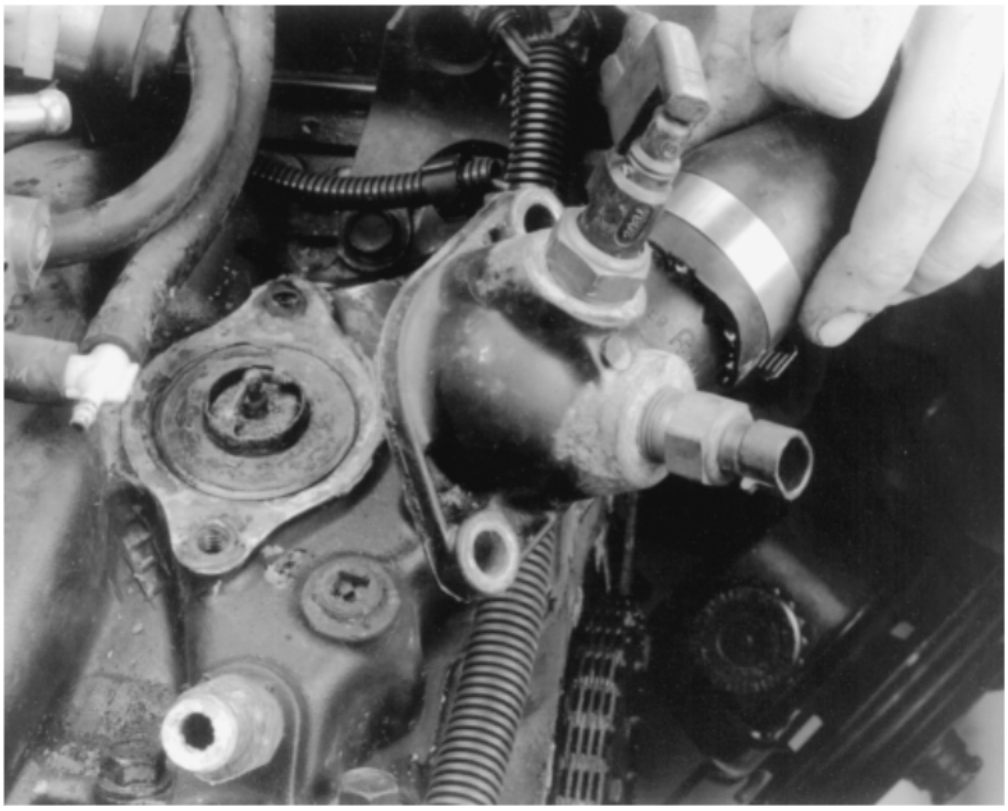


Fig. 2: Removing the thermostat housing



Fig. 3: Removing the thermostat

1. Disconnect the negative battery cable.
2. Remove any components necessary to gain access to the thermostat.
3. Drain the cooling system to below the level of the thermostat.

cardiagn.com

It is not necessary to remove the radiator hose from the thermostat housing.

4. Remove the two retaining bolts from the thermostat housing and remove the thermostat.

To install:

5. Using a new gasket, install the thermostat and housing.
6. Tighten the bolts to 21 ft lbs. (28 Nm).
7. Fill and bleed the cooling system.

INTAKE MANIFOLD

REMOVAL & INSTALLATION

When servicing all vehicles, be absolutely sure to mark vacuum hoses and wiring so that these items may be properly reconnected during installation. Also, when disconnecting fitting lines (fuel lines, power brake vacuum lines, transmission and engine cooler lines, etc.), always use two flare nut (or line) wrenches. Hold the wrench on the large fitting with pressure on the wrench as if you were tightening the fitting (clockwise), THEN loosen and disconnect the smaller fitting from the larger fitting. If this is not done, damage to the line will result. Always relieve fuel system pressure before disconnecting lines.

CAUTION - When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

2.5L ENGINE

Fig. 1: Intake manifold bolt torque sequence for 2.5L engine

1. Disconnect the negative battery cable at the battery.
2. Remove the air cleaner assembly.
3. Remove the PCV valve and hose.
4. Drain the cooling system.
5. Disconnect the fuel lines from the Throttle Body Injection (TBI) unit.
6. Mark and disconnect the vacuum lines and the electrical connections from the TBI unit.
7. Disconnect the linkage from the TBI unit (throttle, downshift, and/or cruise control, as applicable).
8. Disconnect the coolant inlet and outlet hoses from the intake manifold.
9. Remove the air conditioning compressor support brackets and the compressor. DO NOT disconnect the refrigerant lines from the compressor. Lay the compressor aside.
10. Remove the manifold attaching bolts and remove the manifold.

To install:

cardiagn.com

11. Position the manifold into place and install manifold attaching bolts. Torque manifold bolts to specification (see illustration for tightening sequence and torque specifications).
12. Install the air conditioning compressor and compressor support brackets, if so equipped.
13. Connect the coolant inlet and outlet hoses to the intake manifold.
14. Connect the linkage to the TBI unit (throttle, downshift, and/or cruise control, as applicable).
15. Connect the vacuum lines and the electrical connections to the TBI unit.
16. Connect the fuel lines to the Throttle Body Injection (TBI) unit.
17. Install the PCV valve and hose.
18. Install the air cleaner assembly.
19. Connect the negative battery cable at the battery.
20. Fill the cooling system.

2.8L AND 5.0L CARBURETED ENGINES

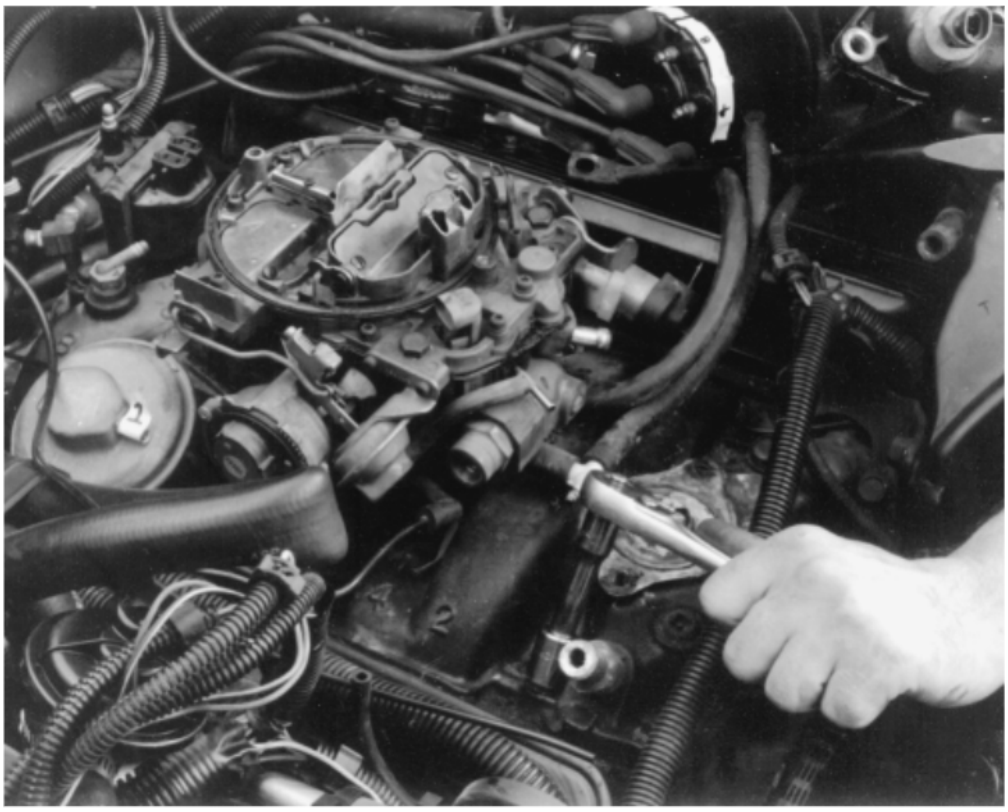


Fig. 2: Intake manifold bolt removal

cardiagn.com

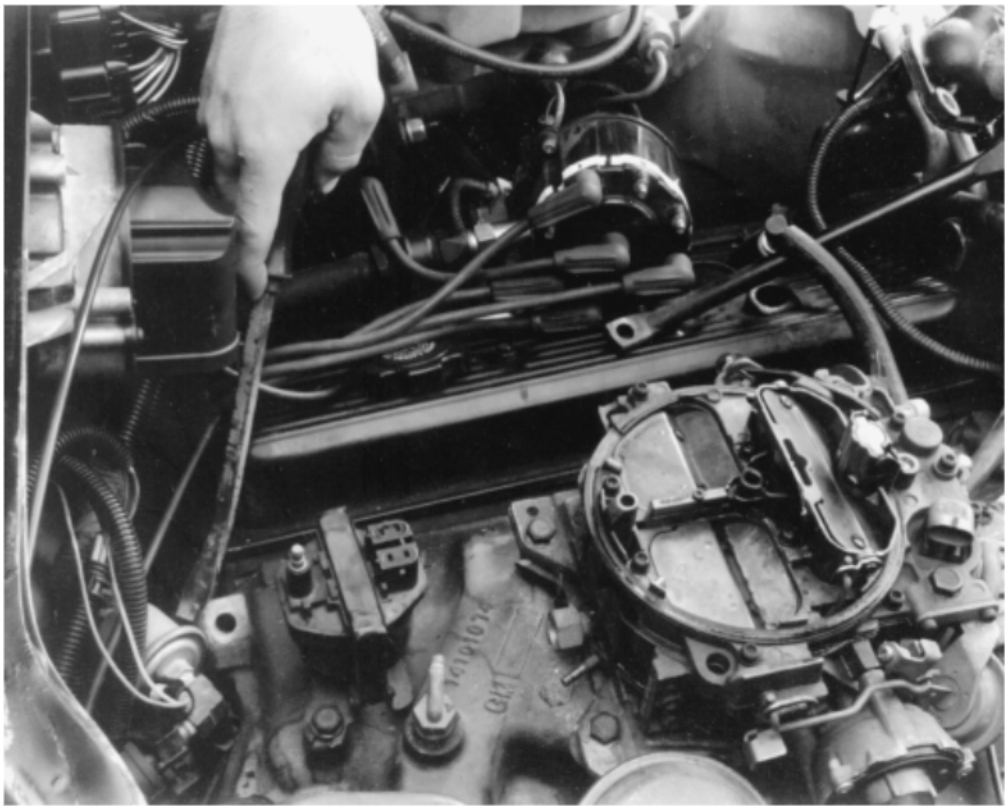


Fig. 3: Prying loose the manifold

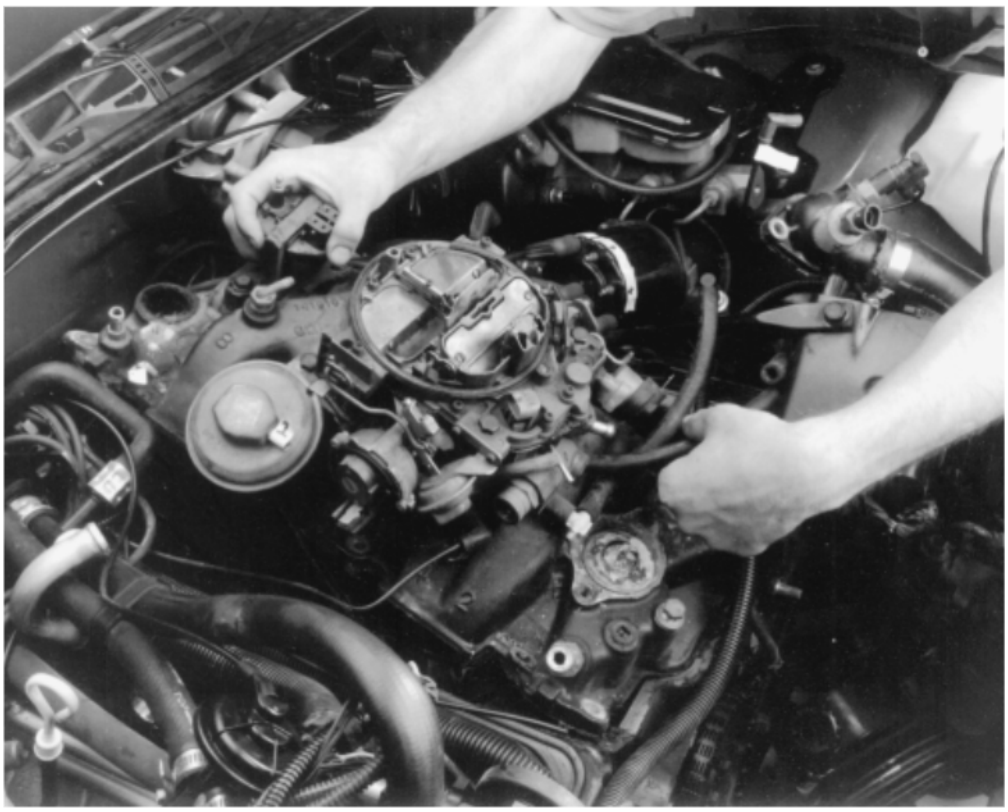


Fig. 4: Lifting off the manifold

cardiagn.com

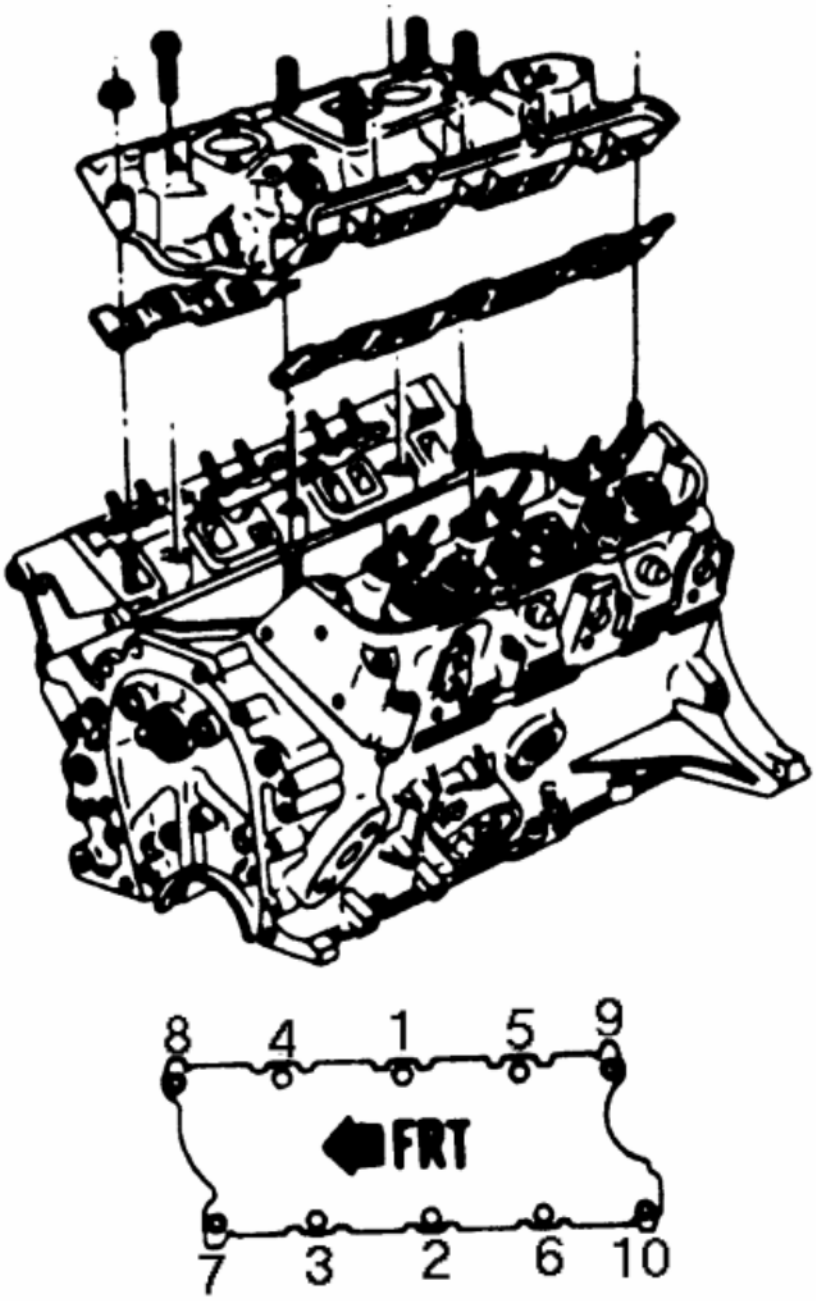


Fig. 5: Intake manifold bolt torque sequence for the carbureted 2.8L

cardiagn.com

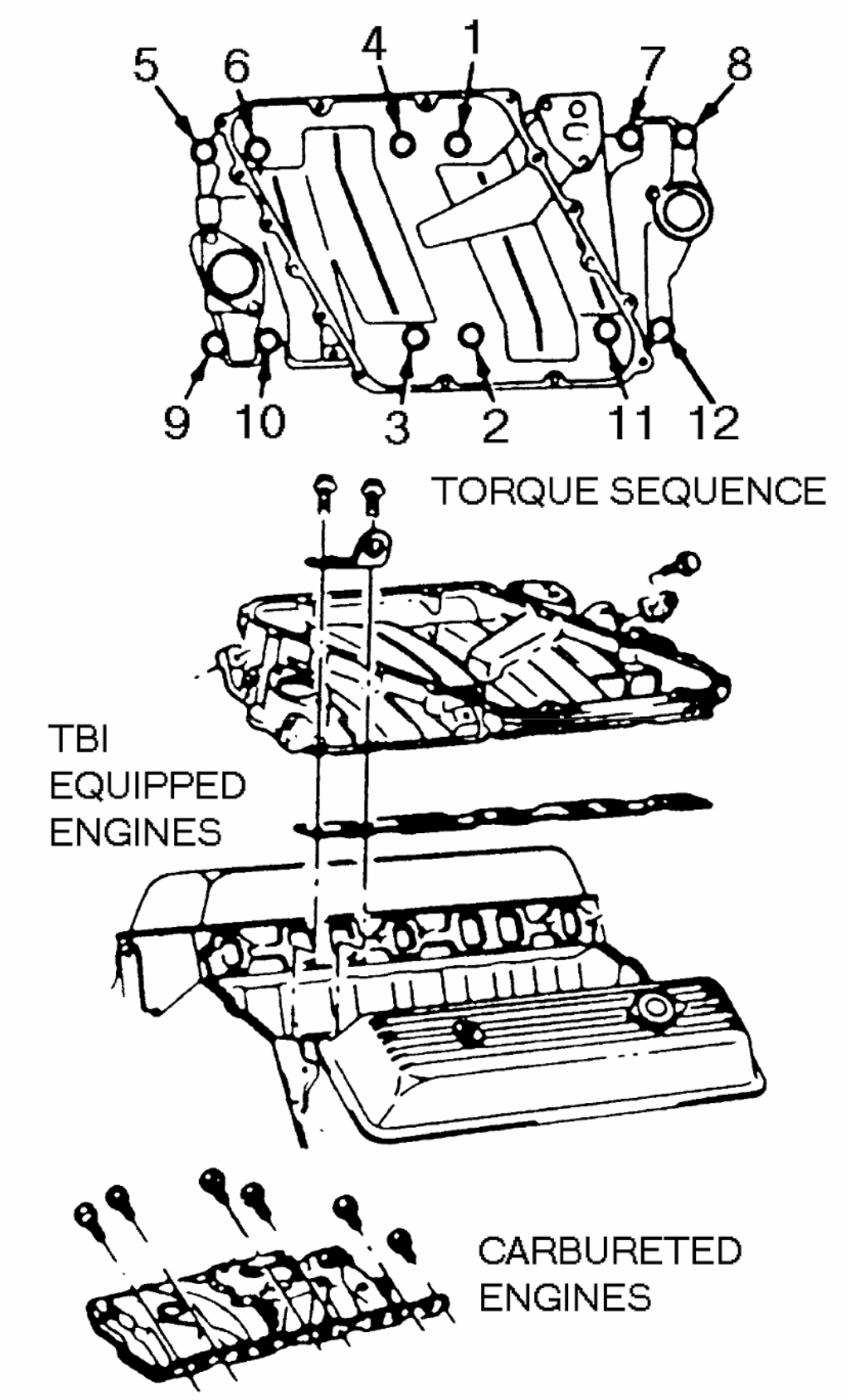


Fig. 6: Intake manifold bolt torque sequence for V8 engines, except Crossfire

cardiagn.com

FUEL INJECTION

1. Remove the air cleaner.
2. Drain the radiator.
3. Disconnect:
    a. Battery cables at the battery.
    b. Upper radiator and heater hoses at the manifold.
    c. Crankcase ventilation hoses as required.
    d. Fuel line at the carburetor.
    e. Accelerator linkage.
    f. Vacuum hose at the distributor, if equipped.
    g. Power brake hose at the carburetor base or manifold, if applicable.
    h. Temperature sending switch wires.
4. Remove the distributor cap and scribe the rotor position relative to the distributor body, and engine.
5. Remove the distributor.
6. If applicable, remove the alternator upper bracket. As required, remove the air cleaner bracket, and accelerator bellcrank.
7. Remove the manifold-to-head attaching bolts, then remove the manifold and carburetor as an assembly.
8. Mark and disconnect all emission related items (e.g.: wiring, vacuum hoses, etc.) which are connected to manifold mounted items.
9. If the manifold is to be replaced, transfer the carburetor (and mounting studs), water outlet and thermostat (use a new gasket) heater hose adapter, EGR valve (use new gasket) and, if applicable, TVS switch(s) and the choke coil.

To install:

10. Before installing the manifold, thoroughly clean the gasket and sealing surfaces of the cylinder heads and manifold.
11. Install the manifold end seals, folding the tabs if applicable, and the manifold/head gaskets, using a sealing compound around the water passages.

Make sure that the new manifold gaskets match the old ones EXACTLY.

12. When installing the manifold, care should be taken not to dislocate the end seals. It is helpful to use a pilot in the distributor opening. Tighten the manifold bolts to 30 ft. lbs. (40 Nm) for 5.0L or 20-25 ft. lbs. (27-34 Nm) for 2.8L in the sequence illustrated.
13. Install the distributor with the rotor in its original location as indicated by the scribe line. If the engine has been disturbed, refer to the previous Distributor Removal and Installation procedure.
14. If applicable, install the alternator upper bracket and adjust the belt tension.
15. Connect all disconnected components at their original locations.
16. Fill the cooling system, start the engine, check for leaks and adjust the ignition timing and carburetor idle speed and mixture.

cardiagn.com

TBI EQUIPPED 5.0L ENGINE

1982-1983 CROSSFIRE FUEL INJECTION MODELS

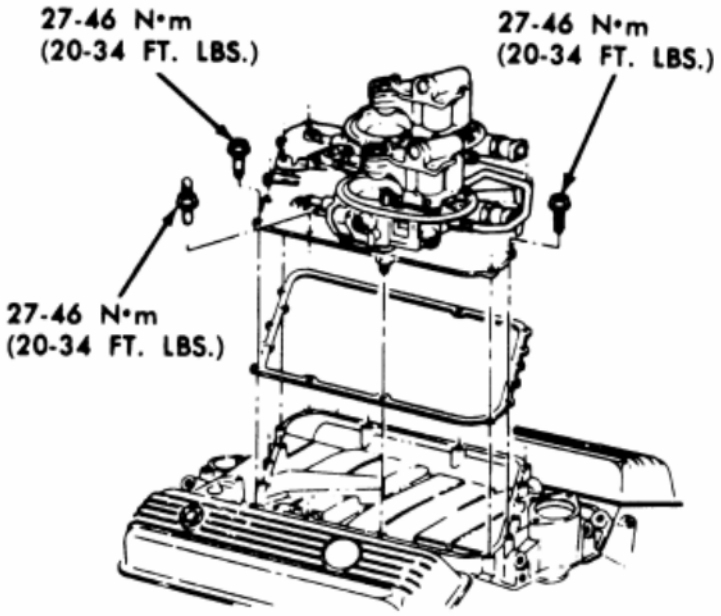


Fig. 7: Crossfire injection upper plenum and gasket

1. Disconnect the negative battery cable at the battery.
2. Remove the air cleaner assembly.
3. Drain the cooling system.
4. Disconnect the fuel inlet line.
5. Remove the exhaust gas recirculation (EGR) solenoid.
6. Disconnect the wiring from the idle air motors, injectors, and the throttle position sensor (TPS).
7. Disconnect the fuel return line at the rear TBI unit.
8. Remove the power brake booster line.
9. Disconnect the accelerator and cruise control cables, unbolt the cable bracket from the manifold and tie the cable and bracket assembly out of the way.
10. Disconnect the positive crankcase ventilation valve hose at the manifold and move the hose aside.
11. Mark and disconnect any vacuum hoses which will interfere with removal of the manifold.
12. If you plan on removing the TBI units from the upper manifold plate, remove the fuel balance tube (connecting the units) at this time.
13. Remove the bolts which attach the upper manifold plate (or TBI plate) to the intake manifold. Lift the TBI and plate assembly off of the intake manifold.
14. Remove the distributor as previously outlined.
15. Disconnect the upper radiator hose from the thermostat housing.
16. Disconnect the heater hose from the intake manifold.
17. Remove the intake manifold-to-cylinder head bolts and lift the intake manifold assembly off of the engine.

cardiagn.com

To install:

18. Clean the sealing surfaces.
19. Install the gaskets and apply a $^{3}/_{16}$ in. (5mm) bead of RTV sealant on the front and rear ridge of the cylinder case.
20. Hold the gaskets in place by extending the RTV bead up onto the gasket ends. Use sealer at the water passages.
21. Position the intake manifold assembly onto the engine and install the intake manifold-to-cylinder head bolts. Torque bolts in sequence to 25-45 ft. lbs. (34-61 Nm).
22. Connect the heater hose to the intake manifold.
23. Connect the upper radiator hose to the thermostat housing.
24. Install the distributor.
25. Position the TBI and plate assembly on the intake manifold with a new gasket. Install the bolts which attach the upper manifold plate (or TBI plate) to the intake manifold and torque to specification.
26. If the TBI units on CFI engines were removed, install the fuel balance tube (connecting the units).
27. Connect vacuum hoses which were disconnected for removal of the manifold.
28. Connect the positive crankcase ventilation valve hose.
29. Install the cable bracket to the manifold and connect the accelerator and cruise control cables.
30. Install the power brake booster line.
31. Connect the fuel return line at the TBI unit.
32. Connect the wiring to the idle air motors, injectors, and the throttle position sensor (TPS).
33. Install the exhaust gas recirculation (EGR) solenoid.
34. Connect the fuel inlet line to the TBI unit.
35. Install the air cleaner assembly.
36. Connect the negative battery cable at the battery.
37. Fill the cooling system.
38. Start the engine and check for leaks.

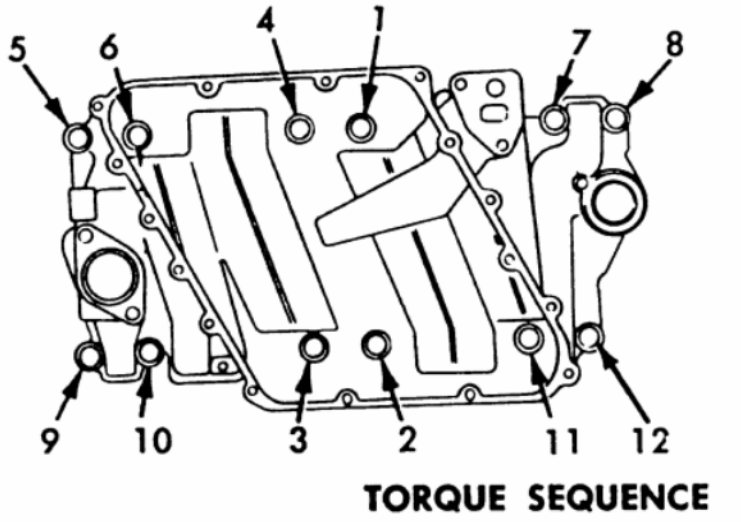


Fig. 8: Crossfire fuel injection intake manifold bolt torque sequence

cardiagn.com

1988-1992 MODELS

1. Disconnect the negative battery cable.
2. Drain the cooling system.
3. Remove the air cleaner.
4. Remove the throttle body.
5. Label and unplug all vacuum hose and electrical connections on the manifold.
6. Disconnect the upper radiator hose from the manifold.
7. Mark the distributor position and remove it.
8. Remove the EGR valve, if necessary.
9. Remove the intake manifold bolts and studs.
10. Remove the manifold and discard the gaskets.

To install:

11. Make sure the sealing surfaces are clean.
12. Install the gaskets and apply a $^{3}/_{16}$ in. (5mm) bead of RTV sealant on the front and rear ridge of the cylinder block.
13. Hold the gaskets in place by extending the RTV bead up onto the gasket ends. Use sealer at the water passages.
14. Install the intake manifold.

Sealing of the intake manifold to the "V" of the engine is obtained by employing an intermediate torque specification to all the attaching bolts, alternately, in the proper sequence. This step is used to rock the manifold into place before applying the final torque figure. Failure to follow this two-step procedure can result in possible leaks.

15. Install the intake manifold attaching bolts. Tighten them, using the proper sequence, to 89 in lbs. (10 Nm).
16. Final torque the bolts, using the proper sequence, to 35 ft lbs. (47 Nm).
17. Install the EGR valve.
18. Install the distributor.
19. Connect the upper radiator hose to the thermostat housing.
20. Install the throttle body.
21. Engage all electrical and hose connections.
22. Fill the cooling system.
23. Connect the negative battery cable.
24. Install the air cleaner.

1985-1992 MFI ENGINES

2.8L AND 3.1L ENGINES

cardiagn.com

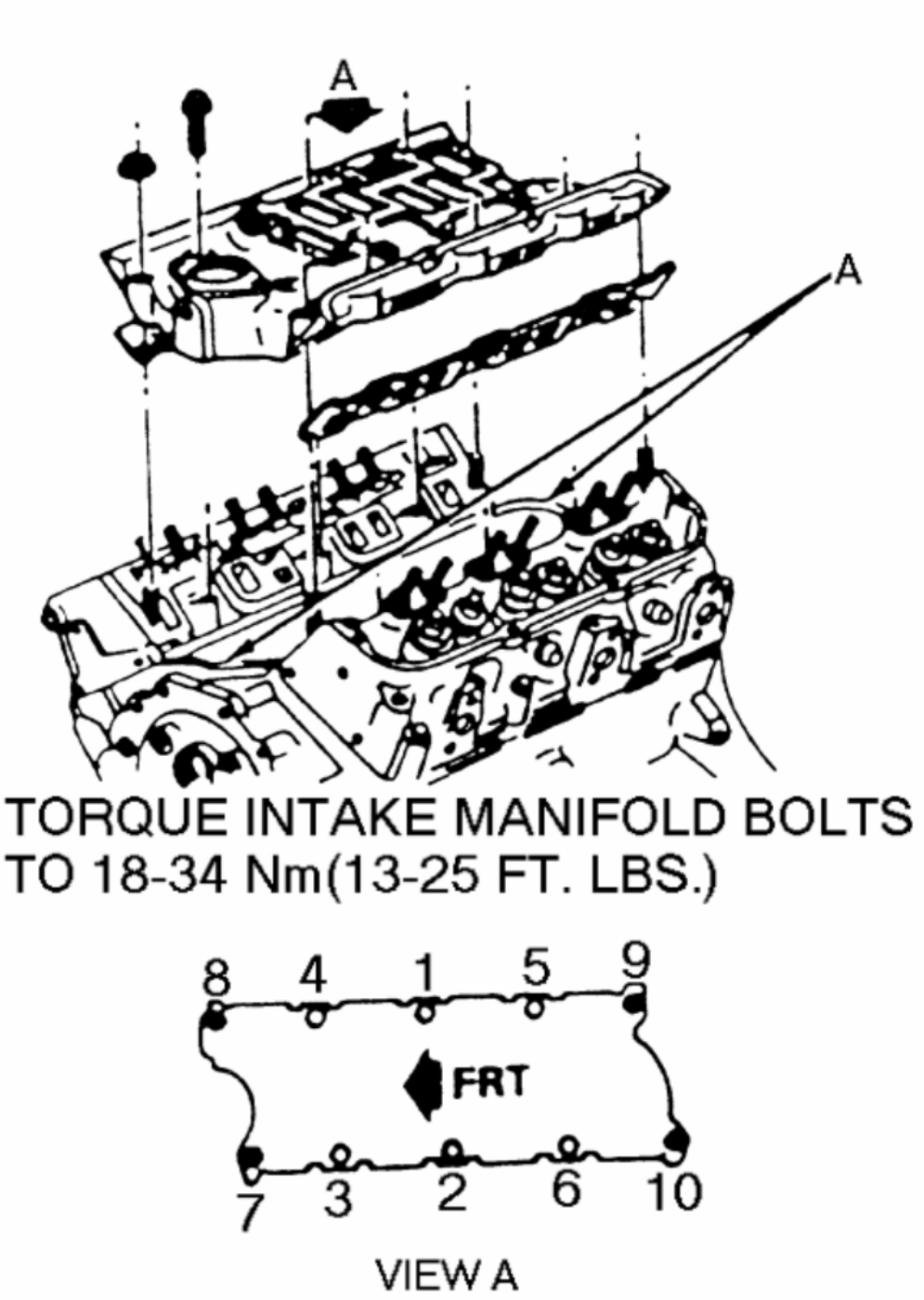


Fig. 9: Intake manifold bolt torque sequence for 2.8L and 3.1L MFI engines

1. Disconnect the negative battery cable.
2. Drain the coolant.
3. Remove the air inlet duct at the throttle body and the crankcase vent pipe.
4. Unplug the vacuum harness from the throttle body.
5. Remove the throttle body.
6. Remove the EGR transfer tube. Discard the gasket.
7. Remove the A/C compressor-to-plenum bracket attaching hardware and bracket.

cardiagn.com

8. Remove the plenum attaching bolts and plenum. Discard the gaskets.
9. Remove the fuel rail.
10. Label and unplug the wires from the spark plugs.
11. Label and unplug the wires at the coil.
12. Remove the distributor cap and spark plug wires.
13. Mark the distributor position and remove it.
14. Label and disconnect the emission canister hoses.
15. Remove the valve covers.
16. Remove the upper radiator hose at the manifold.
17. Unplug the coolant switch and sensor.
18. Remove the heater inlet pipe from the manifold.
19. Remove the center intake manifold bolts.
20. Remove the center intake manifold and gasket. Discard the gasket.
21. Remove the transmission dipstick.
22. Remove the manifold bolts.
23. Remove the manifold. Discard the gaskets and remove the RTV sealant from the front and rear ridges of the block.

To install:

24. Apply a $^{3}/_{16}$ in. (5mm) bead of RTV sealant on the front and rear ridges of the block. Make sure the surfaces are clean.
25. Install the new gaskets on the cylinder heads. Hold the gaskets in place by extending the RTV bead up onto the gasket ends. Certain GM intake gaskets will have to be cut to be install behind the pushrods. Cut these gaskets as required and only where necessary.
26. Install the intake manifold along with the intake manifold bolts. Torque bolts in sequence to 13-25 ft. lbs. (18-34 Nm) on 2.8L engines and 19 ft lbs. (26 Nm) on 3.1L engines.
27. Install the center intake manifold with a new gasket. Tighten the bolts to 15 ft lbs. (21 Nm).
28. Connect the coolant switches.
29. Install the upper radiator hose.
30. Install the valve covers.
31. Install the heater inlet pipe.
32. Connect the emission canister hoses.
33. Install the distributor to the matchmarks, hold down bolt, spark plug wires and distributor cap.
34. Install the spark plug wires to the spark plugs and connect the wires at the coil.
35. Install the fuel rail.
36. Install the plenum with new gaskets. Tighten the bolts to 18 ft lbs. (25 Nm) on 2.8L engines or 15 ft lbs. (21 Nm) on 3.1L engines.
37. Install the A/C compressor-to-plenum bracket and attaching hardware.
38. Install the EGR transfer tube with a new gasket. Tighten the bolts to 19 ft lbs. (26 Nm).
39. Install the throttle body.
40. Connect the vacuum harness and air inlet duct to the throttle body.
41. Install the transmission dipstick.
42. Connect and other remaining hoses or wires.

cardiagn.com

43. Fill the cooling system.
44. Start the engine and check for proper operation.

5.0L AND 5.7L ENGINES

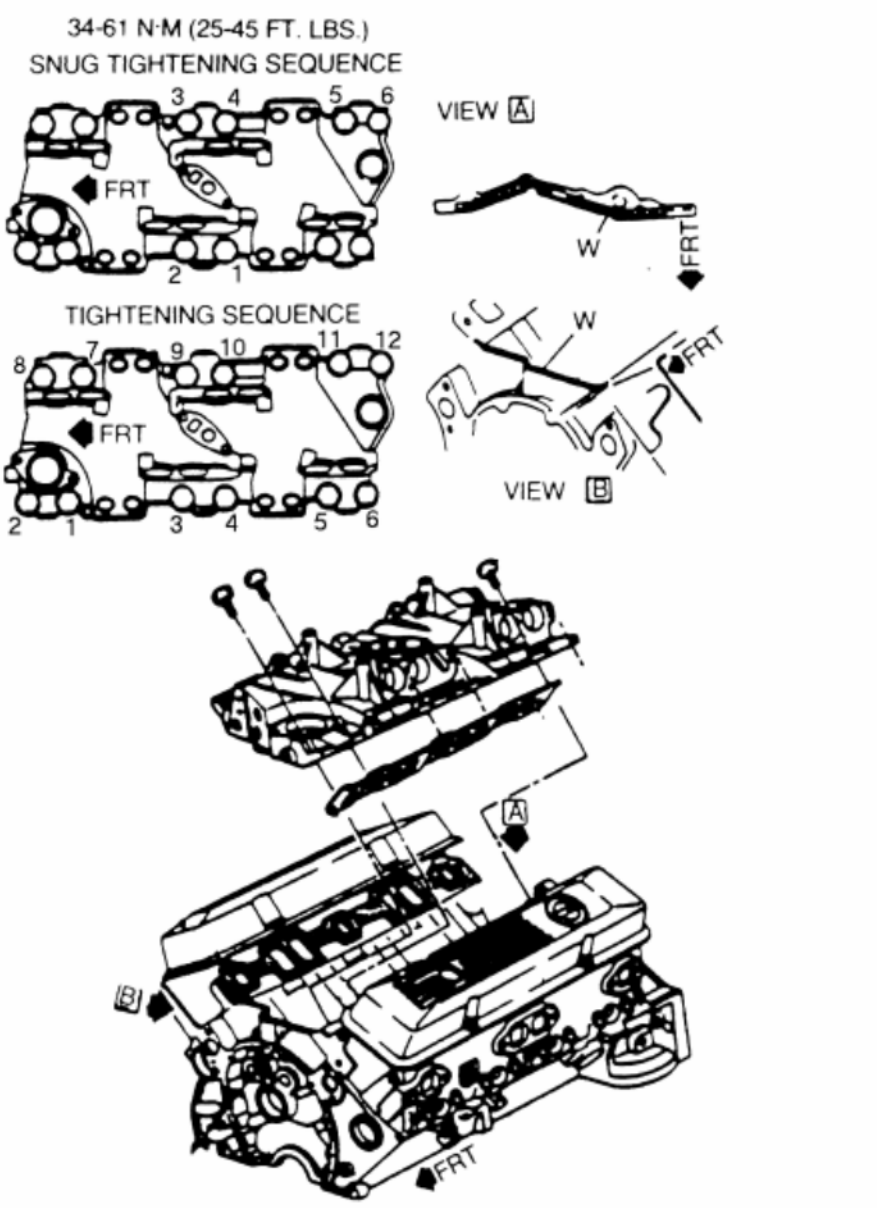


Fig. 10: Intake manifold bolt torque sequence for V8 engines, except Crossfire Fuel Injection

1. Disconnect the negative battery cable.
2. Remove the air intake duct.
3. Drain the cooling system.
4. Disconnect the control cables from the throttle body.
5. Label and unplug all wiring connectors and hoses from the throttle body and plenum.
6. Disconnect the AIR hoses from the air management valve.
7. Disconnect the fuel lines.

cardiagn.com

8. Label and unplug the spark plug wires at the cap.
9. Mark the distributor position and remove it.
10. Unplug the injector wiring harness.
11. Remove the left side runner-to-plenum bolts.
12. Remove the left side runner-to-manifold bolts.
13. Remove the right side runner-to-plenum bolts.
14. Remove the right side runner-to-manifold bolts.
15. Remove the EGR solenoid, if necessary.
16. Remove the right side manifold-to-runner bolt.
17. Remove the plenum, right side runners and gaskets. Discard the gaskets.
18. Remove the left side manifold-to-runner bolt.
19. Remove the left side runners and gaskets. Discard the gaskets.
20. Disconnect the upper radiator hose from the thermostat housing.
21. Remove the EGR valve, if necessary.
22. Unplug any other electrical or hose connections, as necessary.
23. Remove the intake manifold bolts.
24. Remove the intake manifold and gaskets. Discard the gaskets.

To install:

25. Apply a $^{3}/_{16}$ in. (5mm) bead of RTV sealant on the front and rear ridges of the block. Make sure the surfaces are clean.
26. Install the new gaskets on the cylinder heads. Hold the gaskets in place by extending the RTV bead up onto the gasket ends.
27. Install the intake manifold.

Sealing of the intake manifold to the "V" of the engine is obtained by employing an intermediate torque specification to all the attaching bolts, alternately, in the proper sequence. This step is used to rock the manifold into place before applying the final torque figure. Failure to follow this two-step procedure can result in possible leaks.

28. Install the intake manifold attaching bolts. Tighten them, using the proper sequence, to 89 in lbs. (10 Nm).
29. Final torque the bolts, using the proper sequence, to 35 ft lbs. (47 Nm).
30. Install the EGR valve using a new gasket.
31. Connect the upper radiator hose to the thermostat housing.
32. Install new gaskets on the runners and intake manifold. Make sure the gasket sealing surfaces are clean.
33. Install the left side runners and finger-tighten the runner-to-manifold bolts.
34. Install the left side manifold-to-runner bolt. Torque to 25 ft lbs. (34 Nm).
35. Install the right side runners. Finger-tighten the runner-to-manifold and manifold-to-runner bolts.
36. Install the plenum and the runner-to-plenum bolts.
37. Tighten the runner-to-manifold bolts to 25 ft lbs. (34 Nm). Start in the center and work outwards.
38. Tighten the right side manifold-to-runner bolt to 25 ft lbs. (34 Nm).

cardiagn.com

39. Tighten the runner to plenum bolts to 25 ft lbs. (34 Nm). Start in the center and work outwards.
40. Install the distributor.
41. Connect the fuel lines.
42. Install the EGR valve solenoid.
43. Connect the control cables to the throttle body.
44. Connect all remaining hose and wiring connections.
45. Fill the cooling system.
46. Connect the negative battery cable.

EXHAUST MANIFOLD

REMOVAL & INSTALLATION

EXCEPT 2.5L ENGINES

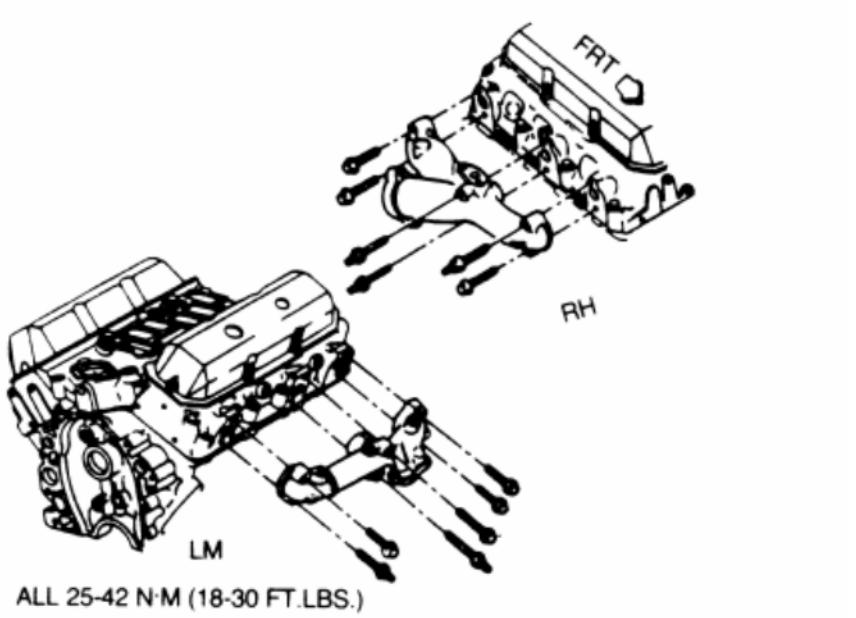
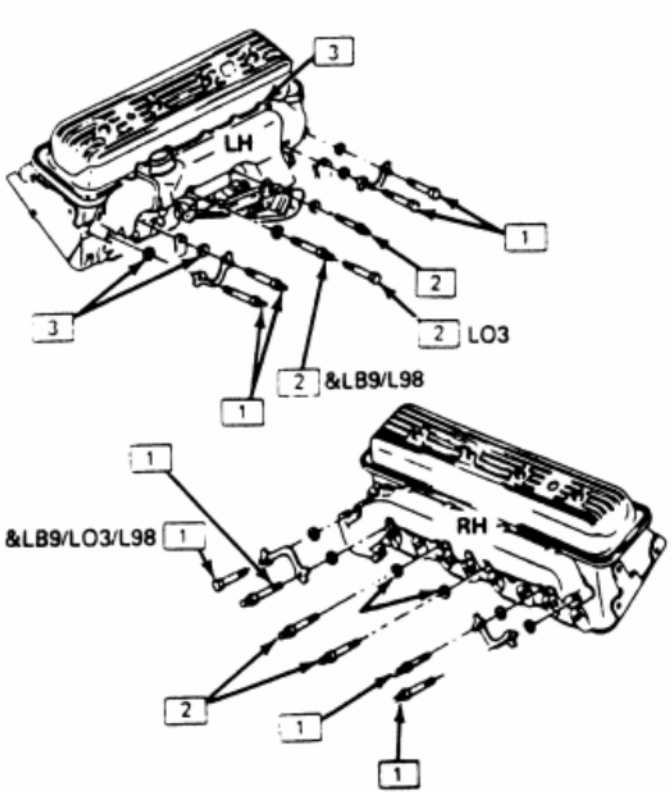


Fig. 1: Exhaust manifold bolts for most V6 engines up to 1992

cardiagn.com



1. 19–35 N·m (14–26 ft. lbs.)
2. 27–43 N·m (20–32 ft. lbs.)
3. Heat stove (LO3)

Fig. 2: Exhaust manifold bolts for most V8 engines up to 1992

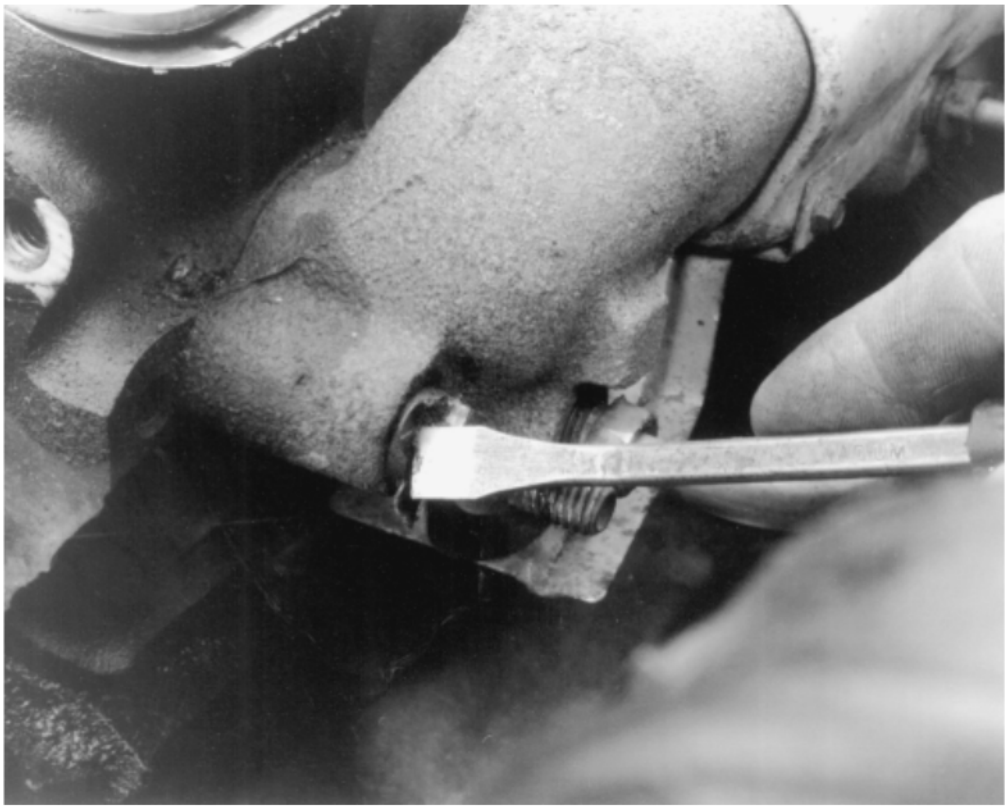


Fig. 3: On some engines, the bolts are held by lock tabs

cardiagn.com

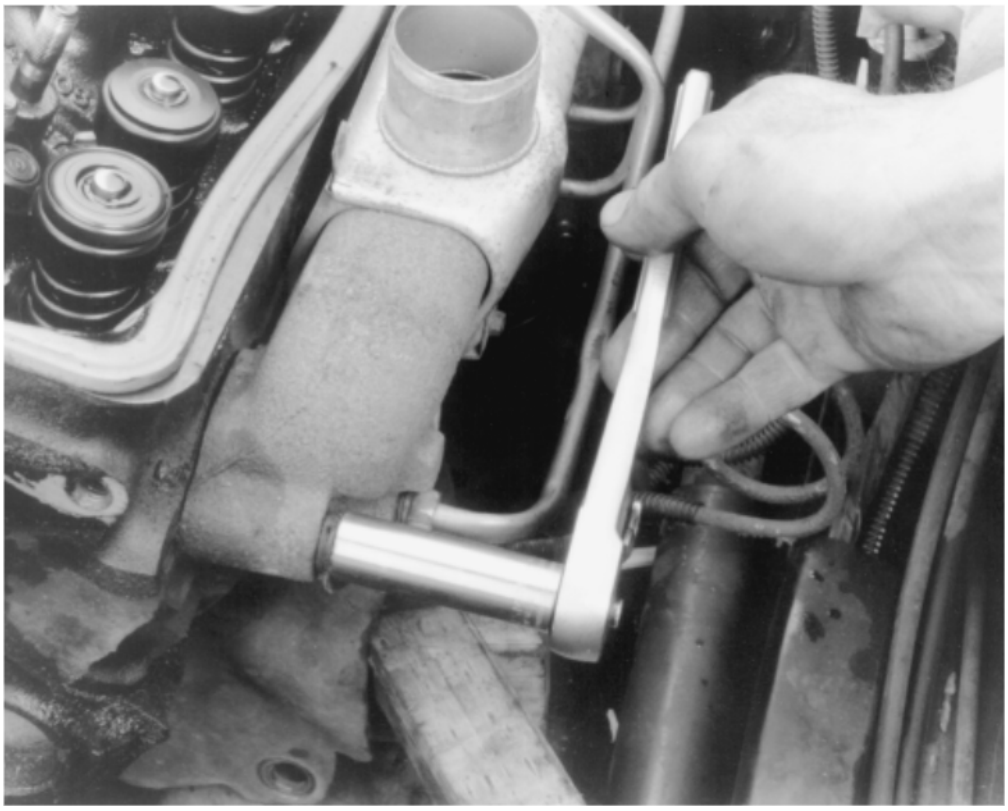


Fig. 4: Removing the attaching bolts

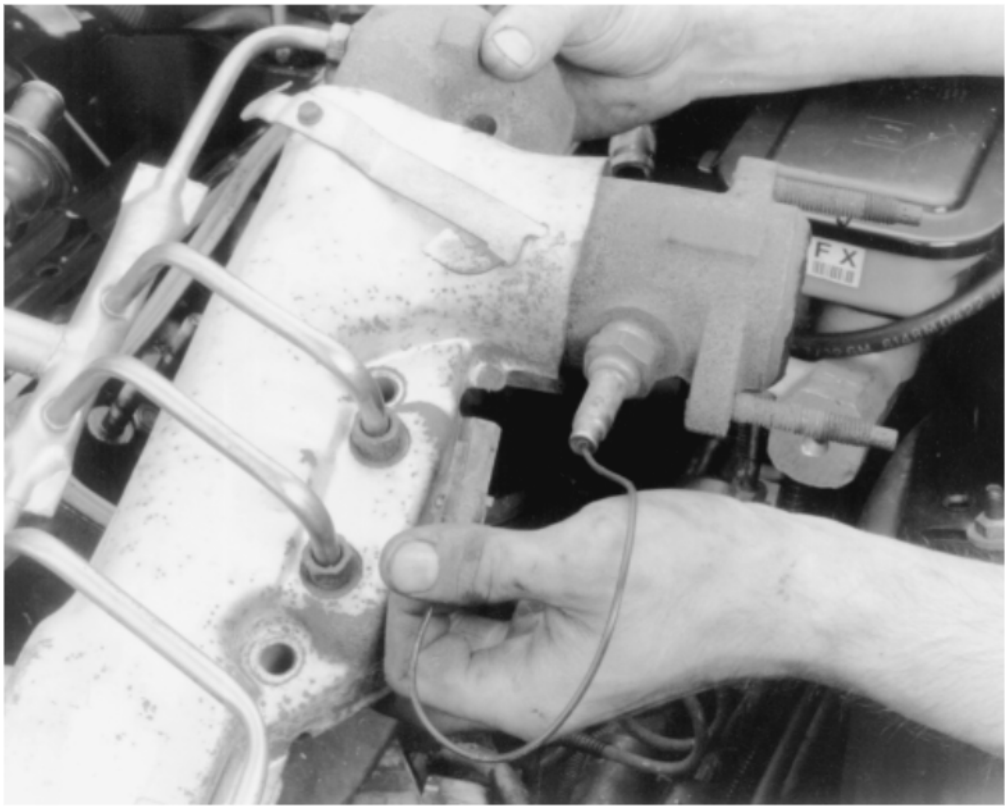


Fig. 5: Disconnecting the oxygen sensor

cardiagn.com

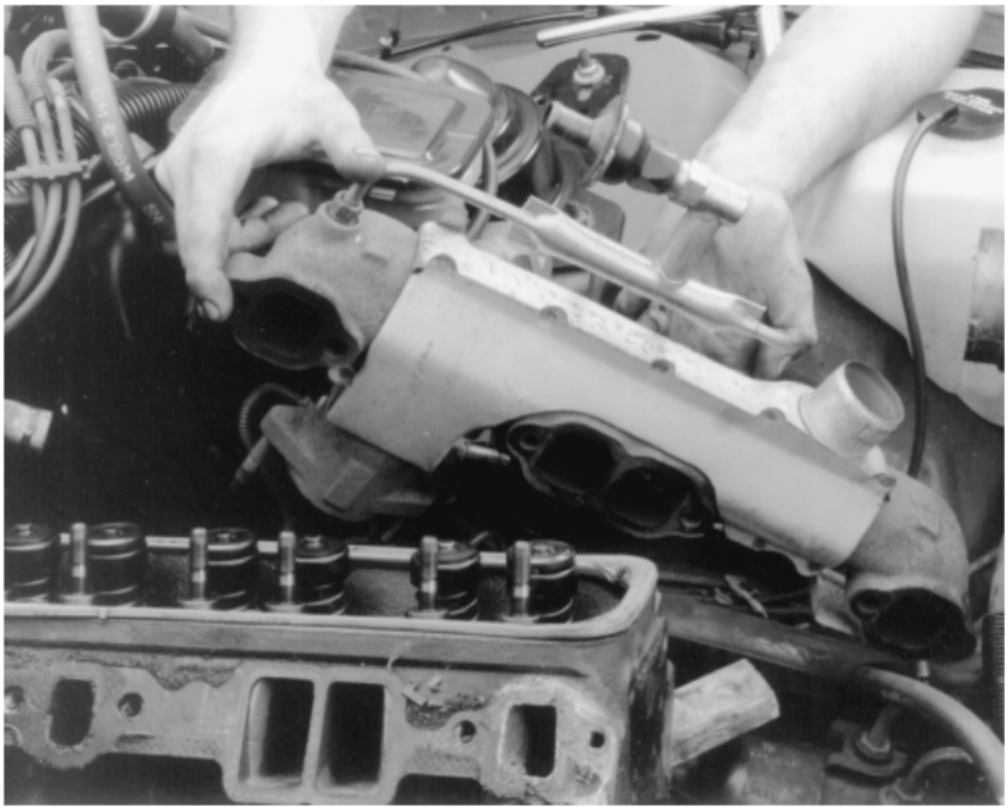


Fig. 6: Removing the exhaust manifold

1. Disconnect the negative battery cable.
2. Remove the air cleaner on carbureted engines.
3. If applicable, remove the air cleaner pre-heater shroud.
4. Disconnect the air injection reaction pipes, if equipped.
5. Unplug the oxygen sensor connector.
6. Label and unplug the spark plug wires.
7. Remove the spark plug wire heat shields, if equipped.
8. Remove any components which may interfere with removal.
9. Disconnect the exhaust pipe from the manifold and hang it from the frame out of the way.
10. On some engines, it will be necessary to bend the locktabs from the bolt. Remove the end bolts, then the center bolts. Remove the manifold.

A thin wall 6-point socket, sharpened at the leading edge and tapped onto the head of the bolt, simplifies bending the locktabs.

To install:

11. Make sure the mating surfaces are clean.
12. Install a new gasket, if applicable.
13. Position the exhaust manifold onto the engine. Torque the attaching bolts to:
    - 1982-1992 V6 engines: 25 ft lbs. (34 Nm)
    - 1982-1992 V8 engines: 26 ft lbs. (35 Nm)
14. Bend the locktabs over the bolts.
15. Connect the exhaust pipe to the manifold.

cardiagn.com

16. Install all components removed.
17. Connect the oxygen sensor.
18. Install the spark plug wire heat shields.
19. Connect the spark plug wires.
20. If equipped, install the air cleaner pre-heater shroud.
21. If equipped, connect the air injection reaction pipes.
22. Connect the battery.

2.5L ENGINE

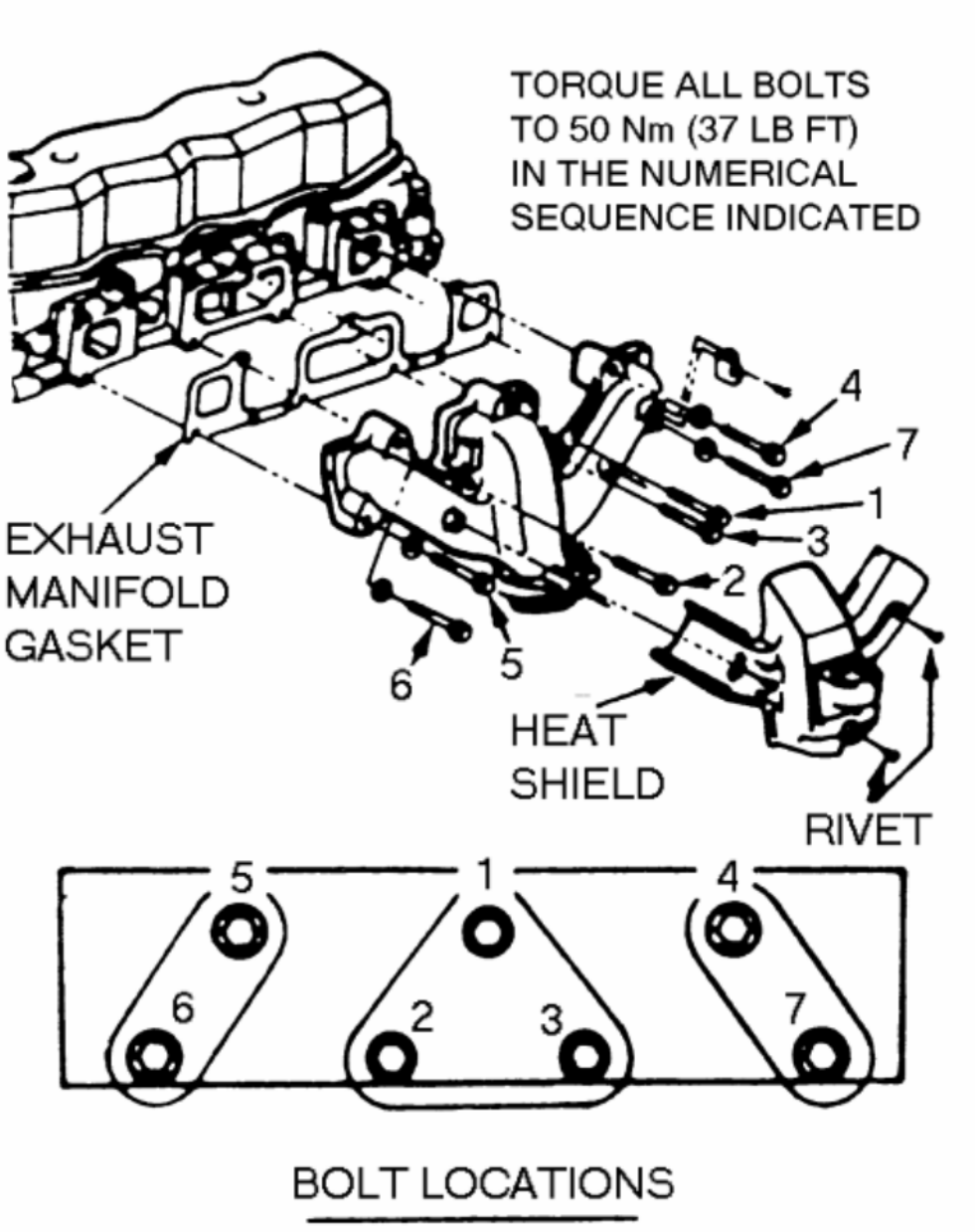


Fig. 7: Exhaust manifold bolt torque sequence for 2.5L engine

1. Disconnect the negative battery cable at the battery.
2. Remove the air cleaner assembly, be sure to mark any disconnected hoses for proper reinstallation.

cardiagn.com

3. Unplug the oxygen sensor and disconnect the exhaust pipe from the exhaust manifold.
4. Remove the engine oil level dipstick and tube.
5. Remove the exhaust manifold attaching bolts and remove the manifold.

To install:

6. Position the exhaust manifold onto the engine with a new gasket. Torque the bolts, following the correct sequence, to 44 ft lbs. (60 Nm).
7. Install the engine oil level dipstick tube and dipstick.
8. Connect the exhaust pipe to the exhaust manifold.
9. Engage the oxygen sensor connector.
10. Install the air cleaner assembly and connecting hoses.
11. Connect the negative battery cable at the battery.

RADIATOR

REMOVAL & INSTALLATION

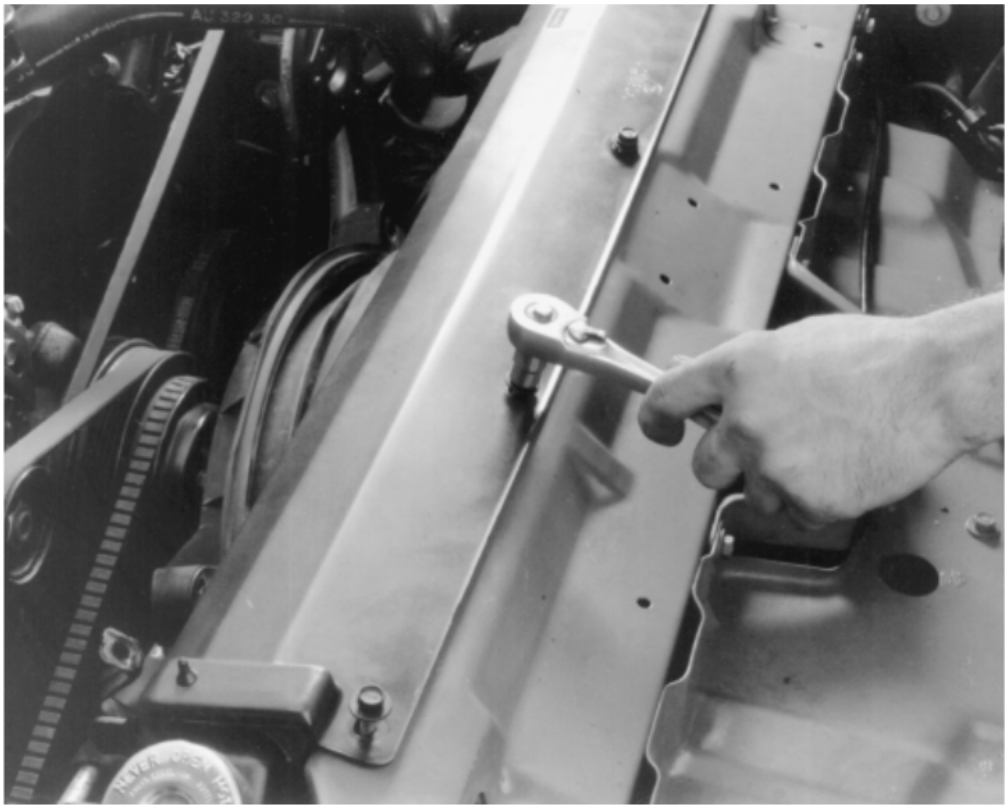


Fig. 1: Removing radiator upper shield bolts

cardiagn.com

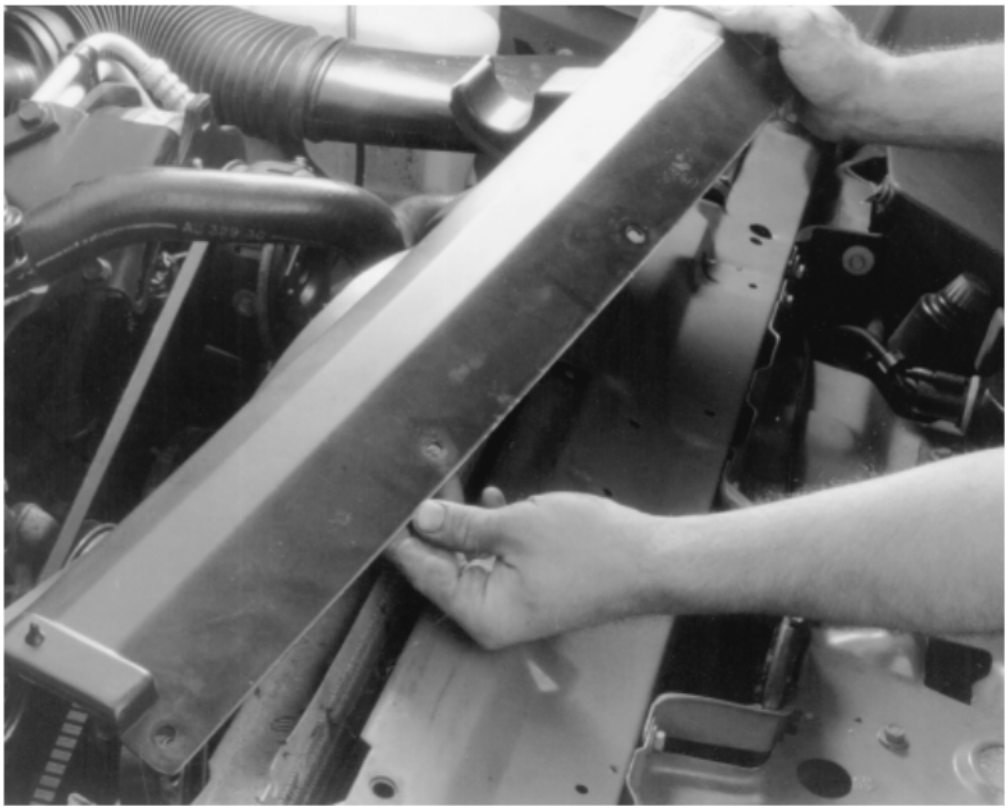


Fig. 2: Removing radiator upper shield



Fig. 3: Unplugging the fan connector

cardiagn.com

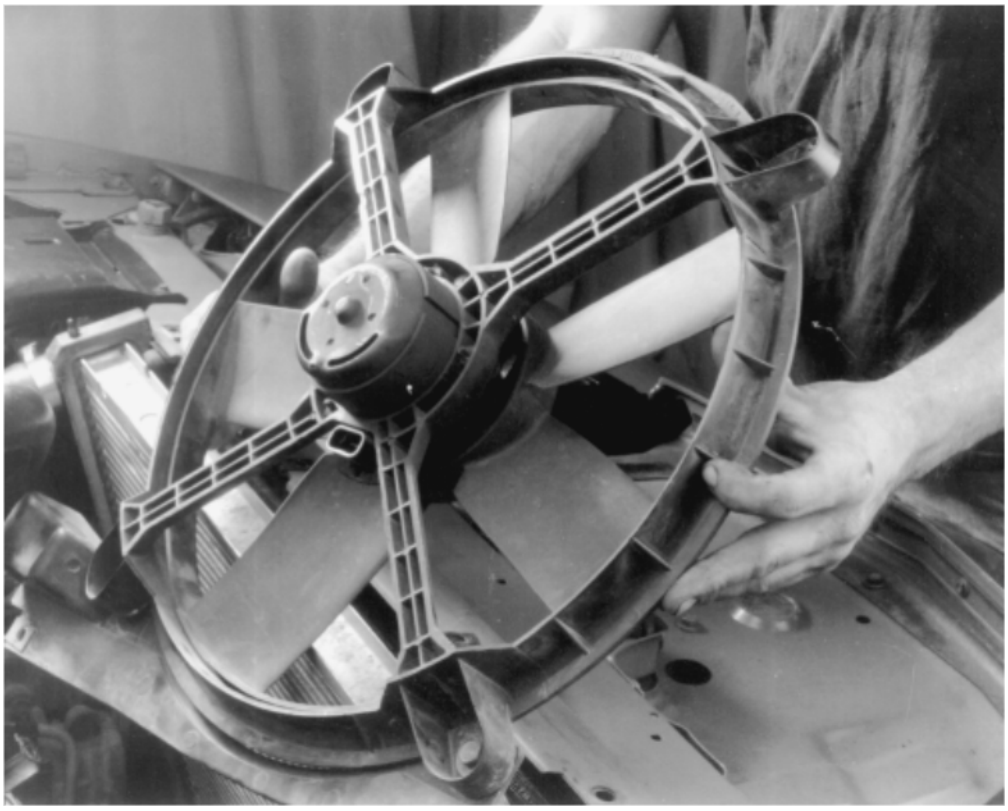


Fig. 4: Removing the electric fan

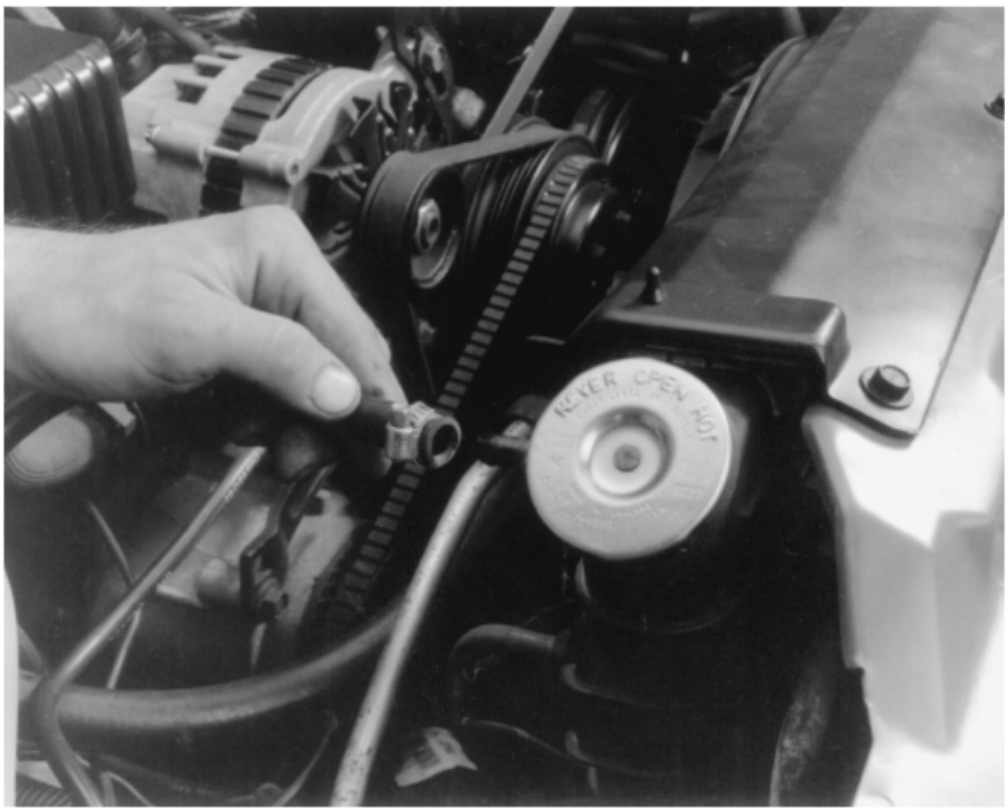


Fig. 5: Disconnecting the overflow hose

cardiagn.com

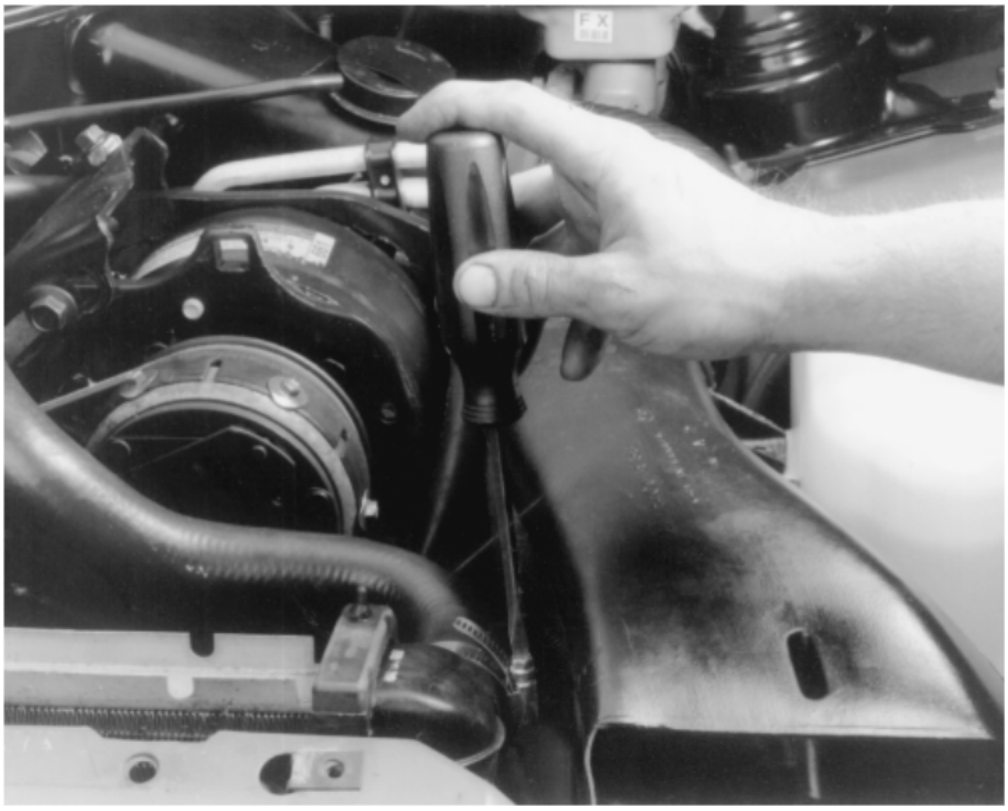


Fig. 6: Disconnecting the upper hose

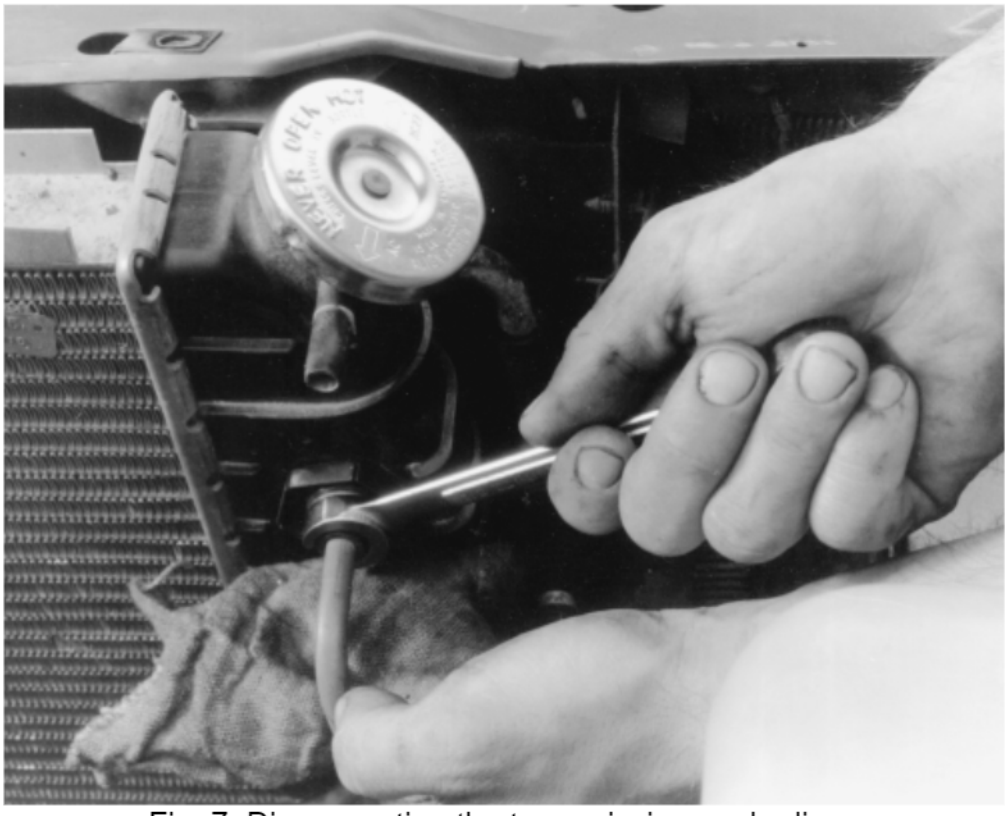


Fig. 7: Disconnecting the transmission cooler lines

cardiagn.com

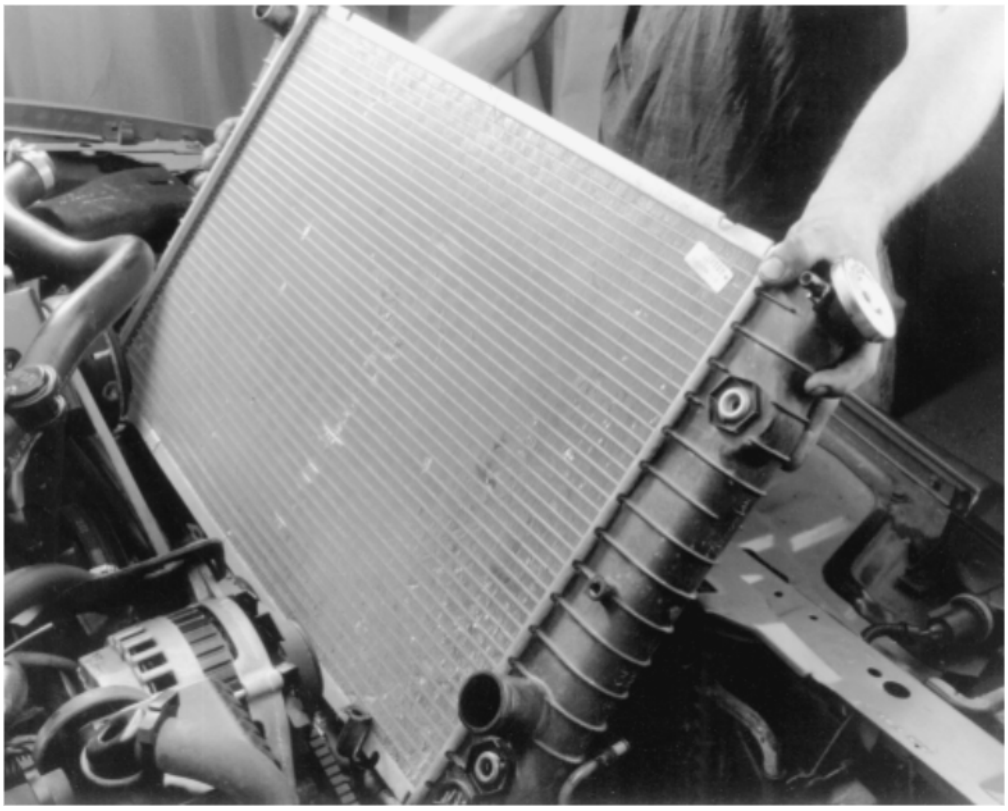


Fig. 8: Lifting out the radiator

1. Disconnect the negative battery cable.
2. Drain the cooling system.

CAUTION - When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

3. Remove the air inlet ducts and air cleaner, if necessary.
4. Remove the electric cooling fan, if equipped.
5. Disconnect the coolant overflow tank hose.
6. Disconnect upper and lower radiator hoses.
7. On vehicles equipped with automatic transmission, disconnect and plug the transmission fluid cooler lines.
8. Disconnect and plug the engine oil cooler lines, if equipped.
9. Remove fan shroud assembly, if applicable.
10. Remove the upper radiator mount screws.
11. Remove the radiator assembly by lifting straight up.

The radiator assembly is held at the bottom by two cradles secured to the radiator support.

12. If installing a new radiator, transfer the fittings from the old radiator to the new radiator.

cardiagn.com

13. Replace the radiator assembly by reversing the above steps. Check that radiator lower cradles are located properly in radiator recess.
14. Refill the cooling system. Check the engine oil and transmission fluid levels, if necessary. Run engine for a short period of time and check for leaks.

ENGINE OIL COOLER

The engine oil cooler consists of an adapter, bolted to the engine block, to which the oil filter is screwed onto. The adapter has 2 hoses which attach to the oil cooler and the radiator, these hoses are the inlet and return lines.

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable. Drain the cooling system into a suitable container.

CAUTION - When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

2. Remove the radiator, if the oil cooler is to be repaired or replaced, otherwise remove the engine oil cooler from the radiator as necessary.
3. Remove the oil filter.
4. Remove the hoses from the oil cooler adapter.
5. Unscrew the oil cooler adapter retainer and remove the assembly. Discard the gasket.
6. Installation is the reverse of the removal procedure. Use new gaskets.

ELECTRIC COOLING FAN

REMOVAL & INSTALLATION

1. Disconnect the battery ground cable.
2. Remove the air cleaner and ducts, if necessary.
3. Unplug the fan harness connector.
4. Remove the fan frame to radiator support mounting bolts and remove the fan assembly. Some models are retained by clips. Remove these, then slide the fan assembly from the radiator.
5. Install the cooling fan frame to the radiator support bolt. Reconnect the wiring harness, the negative battery cable and check fan operation.

BELT-DRIVEN COOLING FAN

REMOVAL & INSTALLATION

1. Disconnect the negative battery cable.
2. Remove the fan shroud, as required.

cardiagn.com

3. Remove the fan-to-water pump attaching bolts or nuts.
4. Remove the fan belts.
5. Remove the cooling fan and clutch assembly. Separate the clutch assembly from the fan.

Store the clutch in an upright position to prevent seal leakage.

6. Installation is the reverse of the removal procedure.

WATER PUMP

REMOVAL & INSTALLATION

CAUTION - When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

2.5L ENGINE

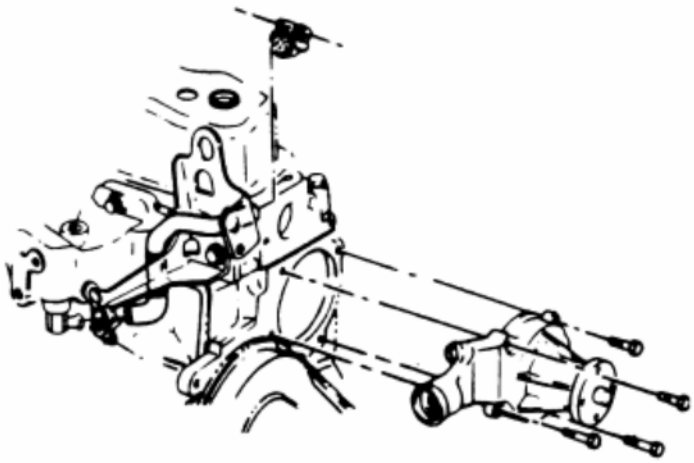


Fig. 1: Water pump - 2.5L

1. Drain the cooling system.
2. Remove the accessory drive belts.
3. Remove the fan and pump pulley.
4. Remove the heater hose and lower radiator hose from the water pump.
5. Remove the pump from the block.

To install:

6. Coat the new gasket with RTV sealer. Install the pump and torque bolts to 25 ft lbs. (34 Nm).
7. Install the hose and lower radiator hose to the water pump.
8. Install the pump pulley and fan.
9. Install the accessory drive belts.

cardiagn.com

10. Fill the cooling system, start the engine and check for leaks.

V6 ENGINES

1. Disconnect the negative battery cable.
2. Drain the cooling system.
3. Remove the air intake duct and air cleaner, if necessary.
4. Remove the drive belt.
5. Disconnect the heater and radiator hoses from the water pump.
6. Remove the power steering pump bracket and swing aside.
7. Remove the water pump bolts. Mark the bolts to their corresponding locations for proper installation.

To install:

8. Clean the gasket surface.
9. Install the water pump with a new gasket. Apply sealer to the bolt threads.
10. Tighten the large bolts to 25 ft lbs. (34 Nm), medium bolts to 15 ft lbs. (21 Nm) and the small bolts to 88 inch lbs. (10 Nm).
11. Install the power steering pump bracket.
12. Connect the heater and radiator hoses.
13. Install the drive belt.
14. Install the air cleaner and duct.
15. Fill the cooling system. Start the engine and check for leaks.

V8 ENGINES

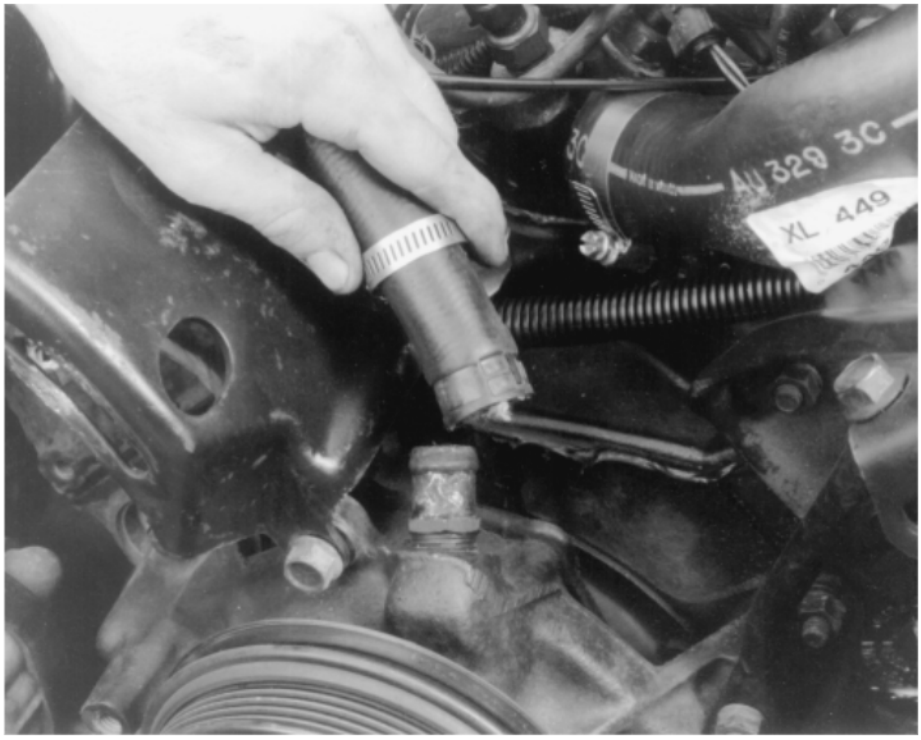


Fig. 2: Removing the heater hoses

cardiagn.com

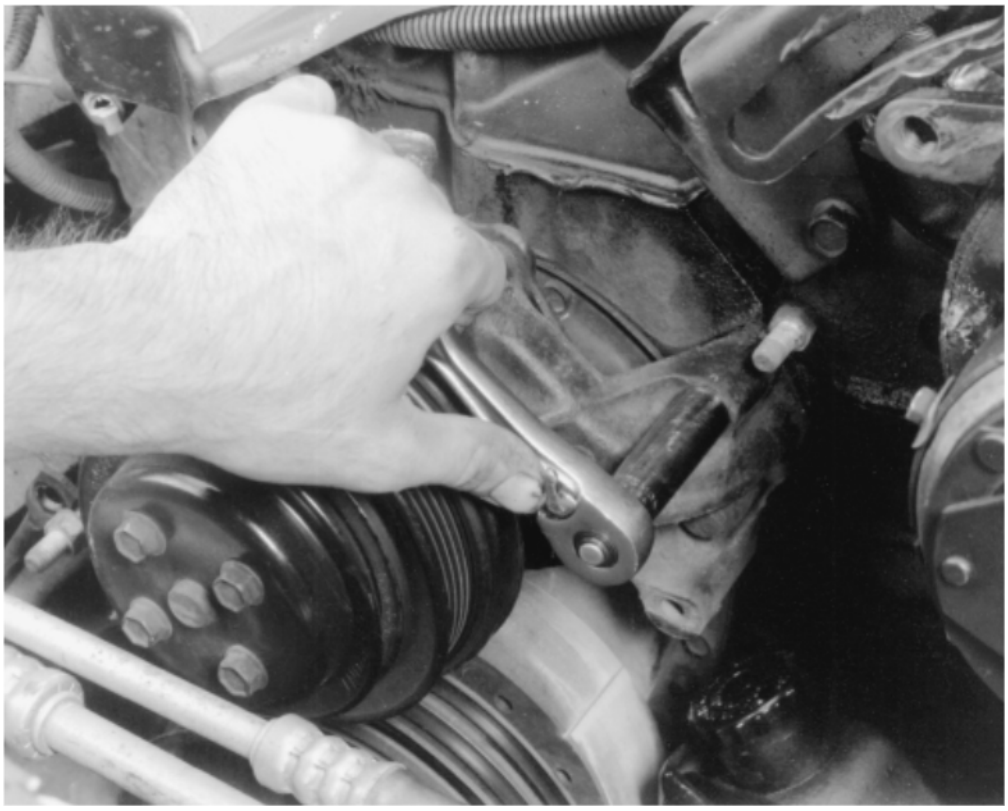


Fig. 3: Removing the attaching bolts



Fig. 4: Removing the water pump from the engine

cardiagn.com

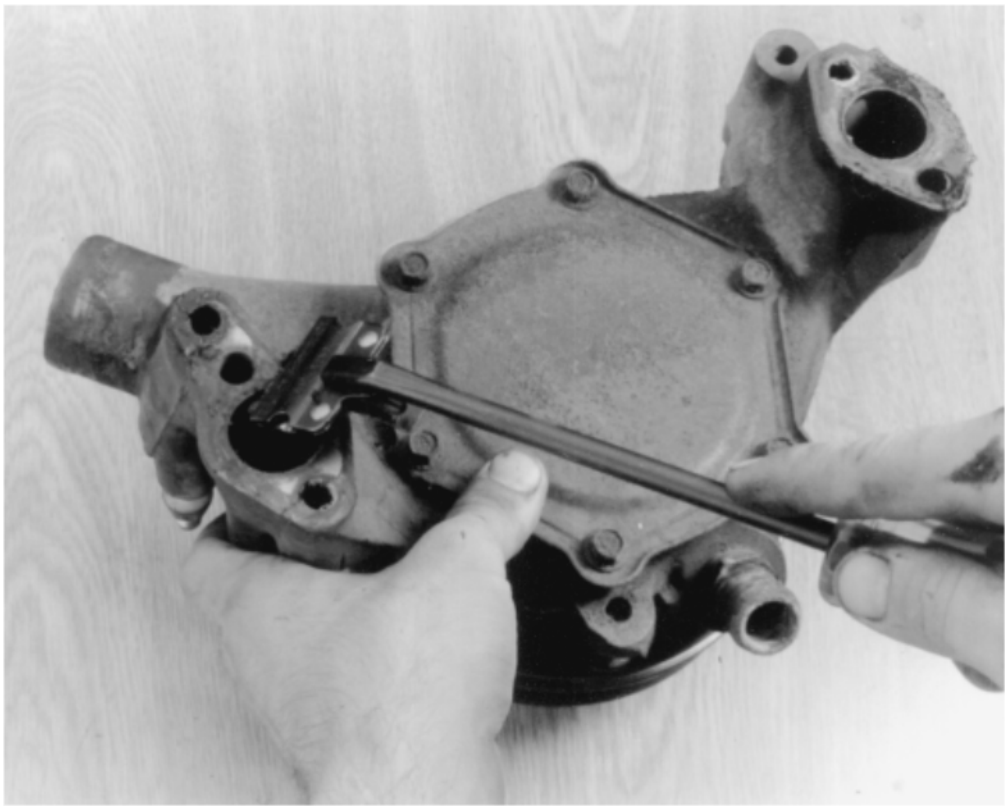


Fig. 5: Scraping off the old gasket material

1. Disconnect the negative battery cable.
2. Drain the cooling system.
3. Remove the air intake duct and air cleaner, if necessary.
4. Remove the drive belt(s) and the water pump pulley.
5. Disconnect the heater and radiator hoses from the water pump.
6. Remove the water pump attaching bolts, then remove the pump. Mark the bolts to their corresponding locations for proper installation.

To install:

7. Clean the gasket mating surfaces.
8. Install the water pump with a new gasket.
9. Install the coolant pump and bolts to the front cover using the dowel pins as a guide.
10. Tighten the bolts to 30 ft lbs. (41 Nm).
11. Connect the heater and radiator hoses to the water pump.
12. Install the water pump pulley and the drive belt(s).
13. Fill the cooling system. Start the engine and check for leaks.

CYLINDER HEAD

REMOVAL & INSTALLATION

CAUTION - Properly relieve the fuel system pressure before disconnecting any lines.

cardiagn.com

When servicing the engine, be absolutely sure to mark vacuum hoses and wiring so that these items may be properly reconnected during installation. Also, when disconnecting fittings of metal lines (fuel, power brake vacuum), always use two flare nut (or line) wrenches. Hold the wrench on the large fitting with pressure on the wrench as if you were tightening the fitting (clockwise), THEN loosen and disconnect the smaller fitting from the larger fitting. If this is not done, damage to the line will result.

CAUTION - When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

2.5L ENGINE

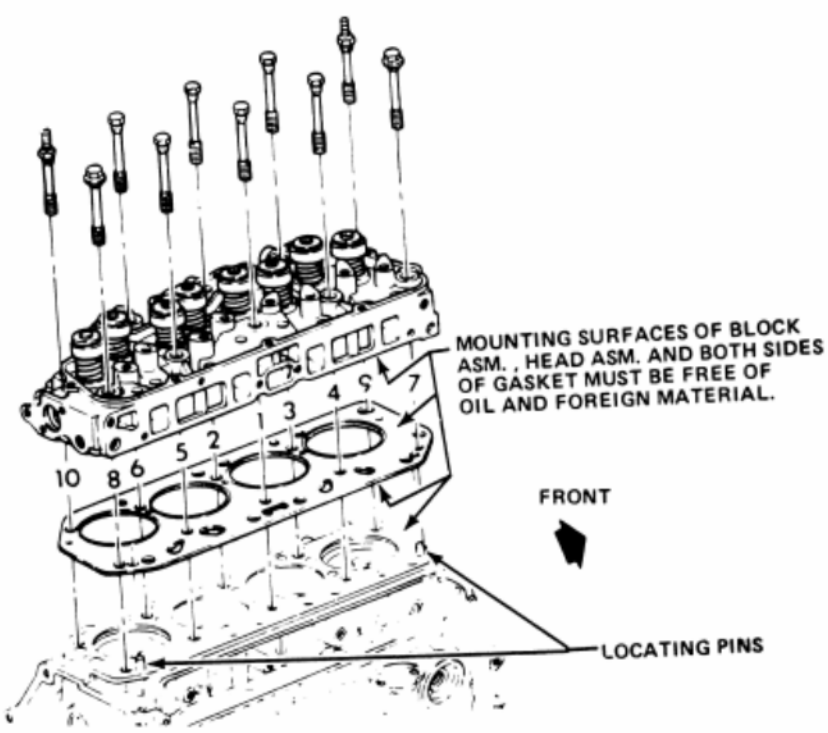


Fig. 1: Cylinder head bolt torque sequence for 2.5L engine

1. Disconnect the negative battery cable.
2. Drain the engine block and radiator of coolant.
3. Raise and safely support the vehicle. Remove the exhaust pipe and lower the vehicle.
4. Remove the oil level indicator tube.
5. Remove the air cleaner.
6. Unplug the electrical and vacuum connections and disconnect the linkage from the TBI unit.
7. Disconnect the fuel lines.
8. Remove the EGR valve.
9. Disconnect the heater hoses from the intake manifold.
10. Remove the ignition coil.

cardiagn.com

11. Disconnect all electrical connections from the intake manifold and cylinder head.
12. If the vehicle has air conditioning, remove the compressor and position it out of the way. Do not disconnect the refrigerant lines.
13. Remove the alternator and lay the unit aside. If necessary, remove the alternator brackets.
14. Remove any other brackets or components mounted on the cylinder head.
15. Remove the upper radiator hose.
16. Remove the rocker arm cover and back off the rocker arm nuts/bolts and pivot the rocker arms out of the way so that the pushrods can be removed. Identify the pushrods so that they can be reinstalled in their original locations.
17. Remove the cylinder head bolts and cylinder head. Remove the intake and exhaust manifolds, as required.

To install:

18. Thoroughly clean all mating surfaces of oil, grease and old gasket material. Clean the head bolts and cylinder block threads, otherwise an accurate torque specification will not be attained.
19. Install a new gasket on the block mating surface. Position the cylinder head on the block.

Clean the bolt threads, apply sealing compound and install the bolts finger-tight.

20. Tighten the head bolts a little at a time using the correct sequence and torque to 92 ft lbs. (125 Nm).
21. Install the pushrods and rocker arms. Refer to the procedures described earlier in this section.
22. Refill the cooling system and check for leaks. The remaining installation is the reverse of the removal procedure.

2.8L AND 3.1L ENGINES

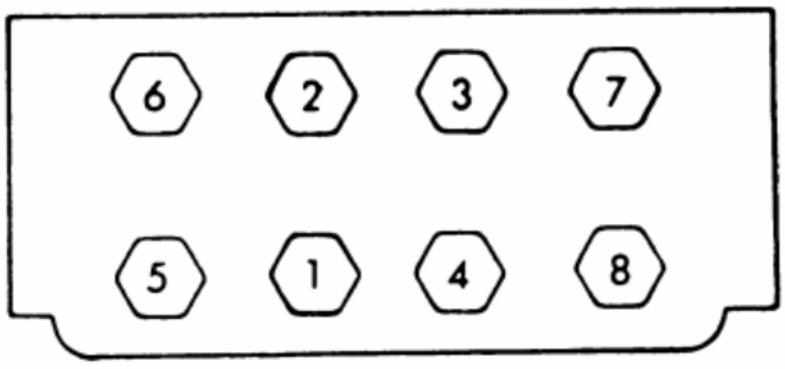


Fig. 2: Cylinder head bolt torque sequence for all V6 engines

cardiagn.com

1. Disconnect the negative battery cable.
2. Relieve the fuel system pressure and drain the engine coolant from the radiator into a suitable container.
3. Remove the intake manifold and the spark plugs.
4. Remove the dipstick tube and bracket. Raise and support the vehicle safely. Drain the oil and remove the oil filter. Lower the vehicle.
5. Remove the exhaust manifolds.
6. Remove the drive belt(s).
7. Remove the air conditioning compressor and bracket, reposition it aside. Do not disconnect the lines.
8. Remove the power steering pump and bracket, reposition it aside.
9. Remove the alternator and bracket, reposition it aside.
10. Remove the ground cable from the rear of the cylinder head and remove the engine lift bracket.
11. Remove the rocker arm covers.
12. Loosen the rocker arms until the pushrods can be removed.
13. Remove the cylinder head bolts and remove the cylinder heads.

To install:

14. Clean the gasket mating surfaces of all components. Be careful not to nick or scratch any surfaces as this will allow leak paths. Clean the bolt threads in the cylinder block and on the head bolts. Dirt will affect bolt torque.
15. Place the head gaskets in position over the dowel pins.
16. Install the cylinder heads.
17. Coat the cylinder head bolts threads with GM sealer 1052080 or equivalent, and install the bolts. Tighten the bolts in the proper sequence to:
    - 1982-1987 engines: 70 ft lbs. (90 Nm)
    - 1988-1992 engines: 1st step: 40 ft lbs. (55 Nm); 2nd step: tighten an additional $^{1}/_{4}$ (90 degree) turn
18. Install the pushrods and loosely retain them with the rocker arms. Make sure the lower ends of the pushrods are in the lifter seats. Refer to the rocker arm procedures outlined earlier in this section.
19. Install the power steering pump bracket and pump. Do the same for the air conditioning compressor bracket and compressor.
20. Install the ground cable to the rear of the cylinder head.
21. Install the exhaust manifolds.
22. Install the dipstick tube and bracket.
23. Install the intake manifold.
24. Install the alternator bracket and alternator.
25. Install the drive belt(s).
26. Install the spark plugs.
27. Fill the cooling system with the proper type and quantity of coolant. Install a new oil filter and fill the crankcase with the proper type and quantity of oil.
28. Connect the negative battery cable, start the vehicle and check for leaks.

cardiagn.com

5.0L AND 5.7L ENGINES

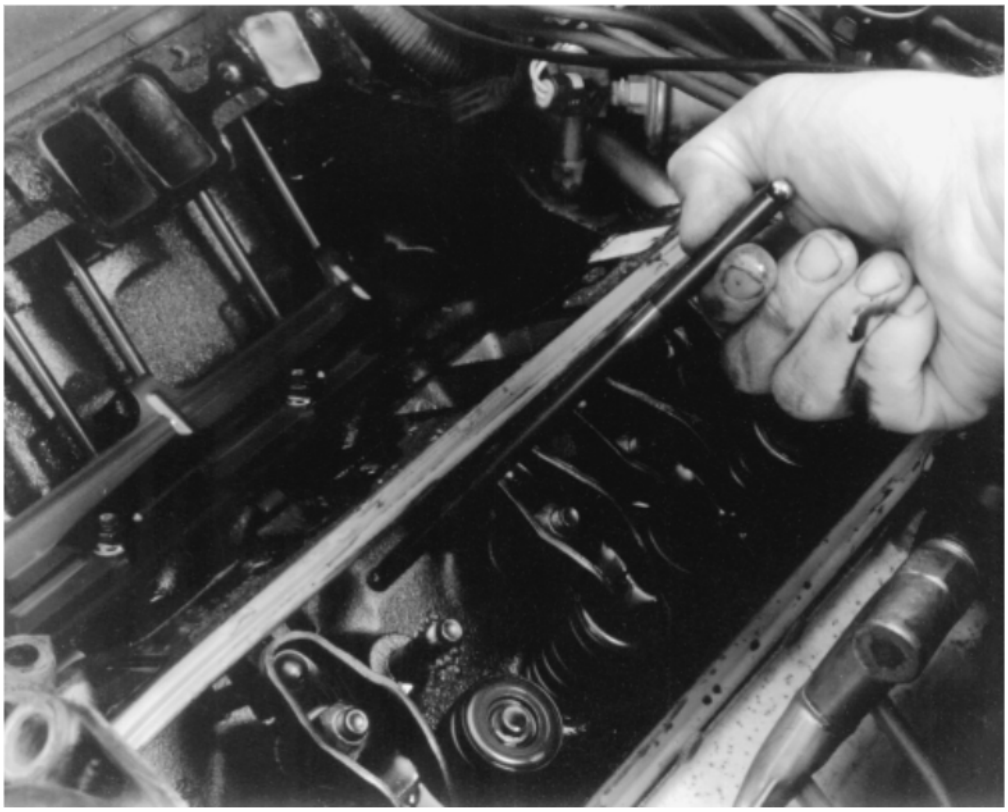


Fig. 3: Pushrod removal - V8 engines

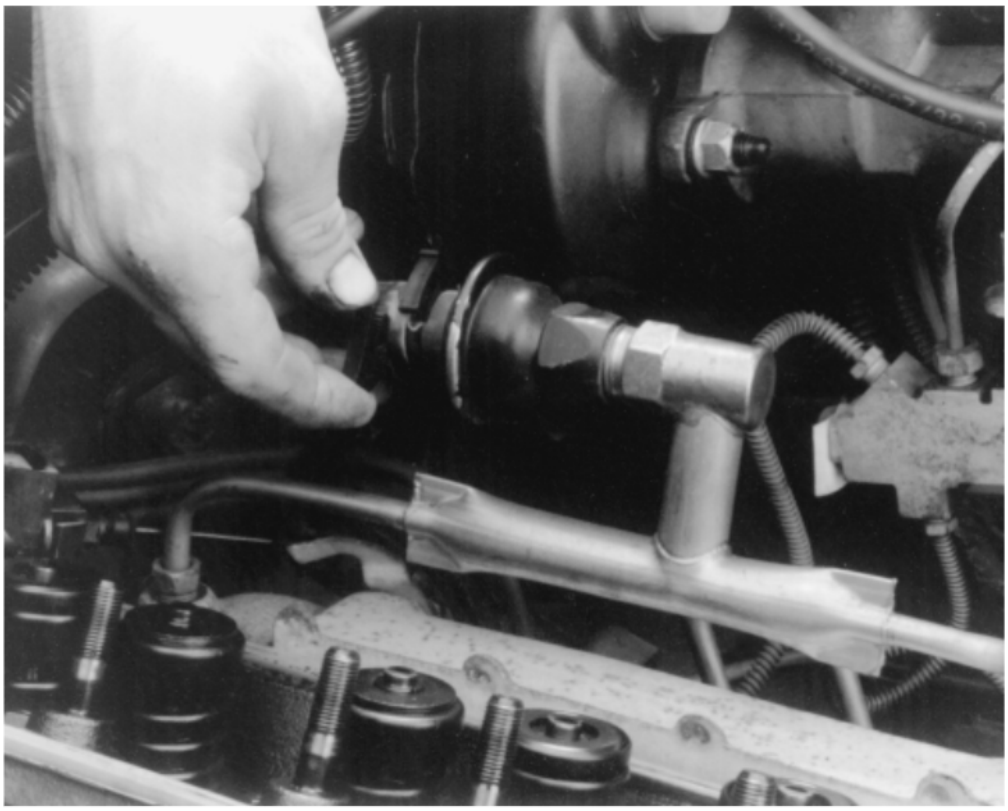


Fig. 4: Removing the AIR tube clamp - V8 engines

cardiagn.com

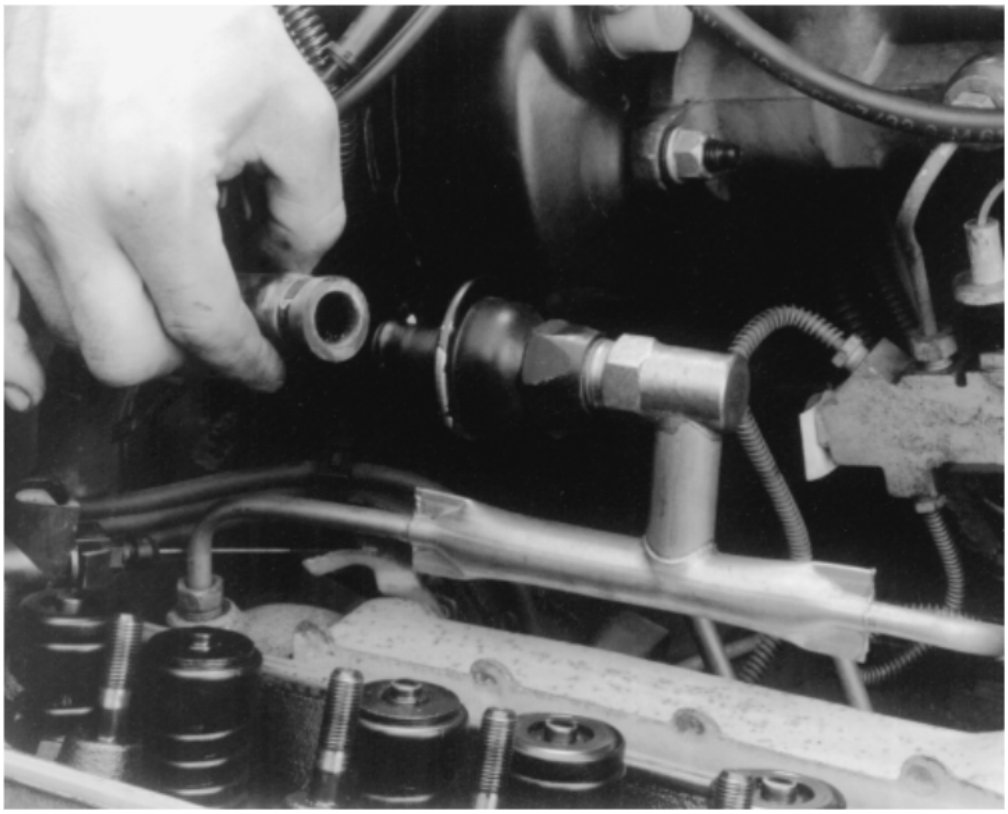


Fig. 5: Air hose removal - V8 engines

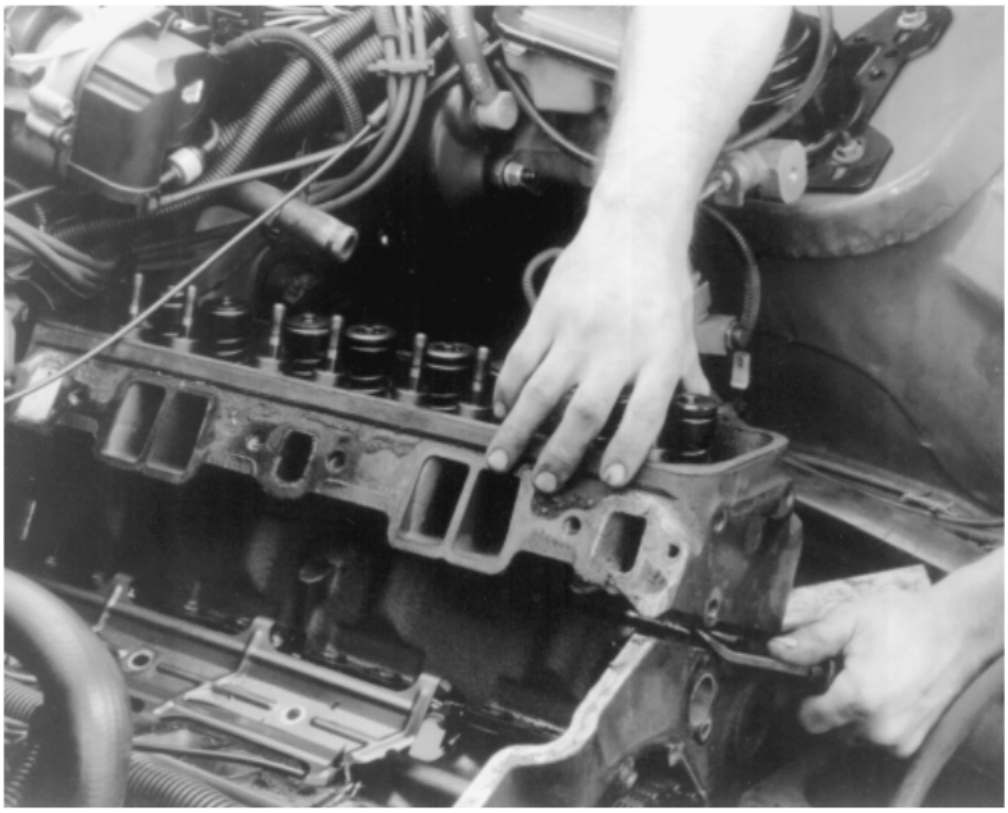


Fig. 6: Prying loose the head;V8 engines

cardiagn.com

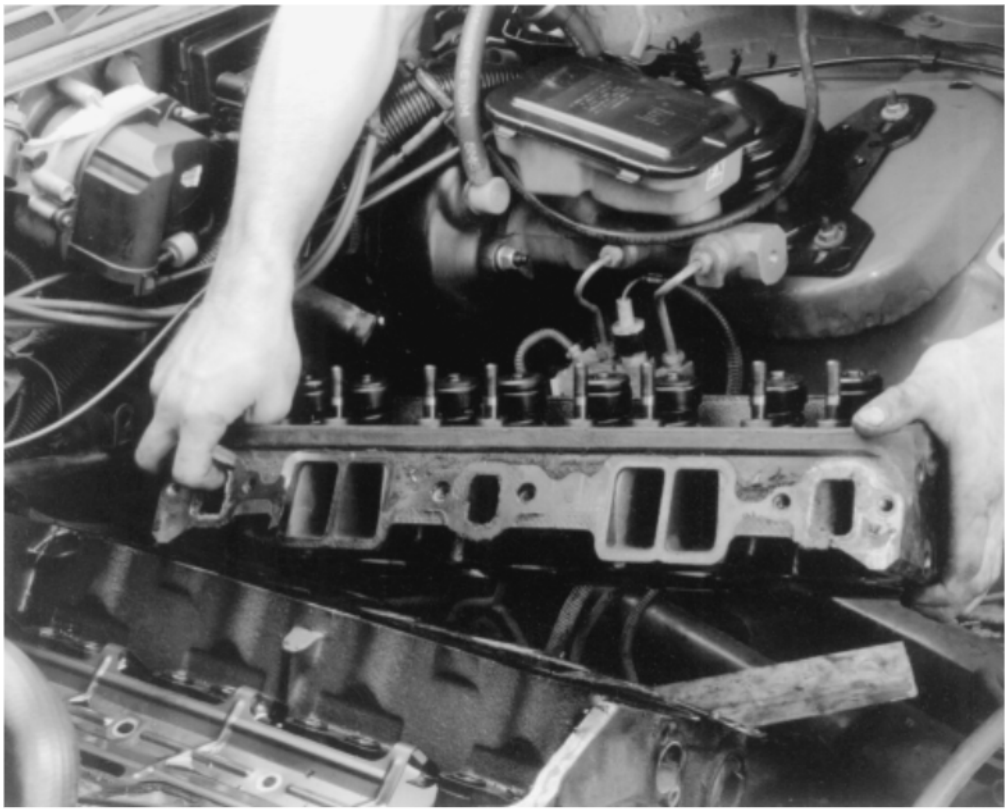


Fig. 7: Lifting off the head - V8 engines

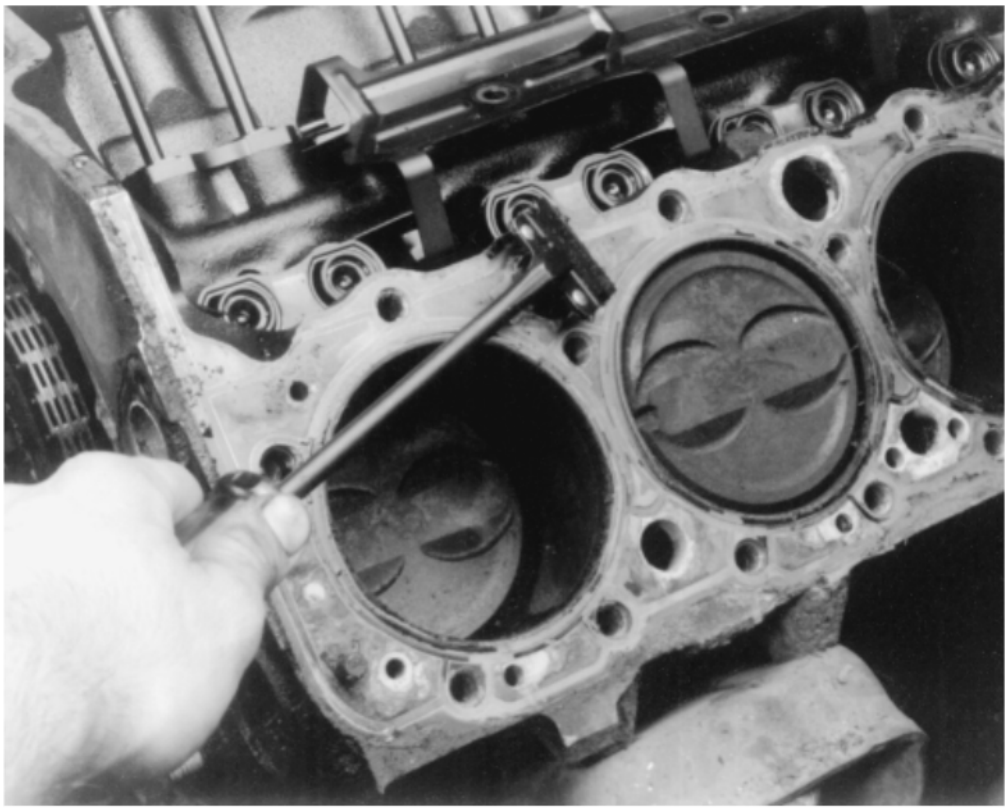


Fig. 8: Scraping off the old gasket material - V8 engines

cardiagn.com

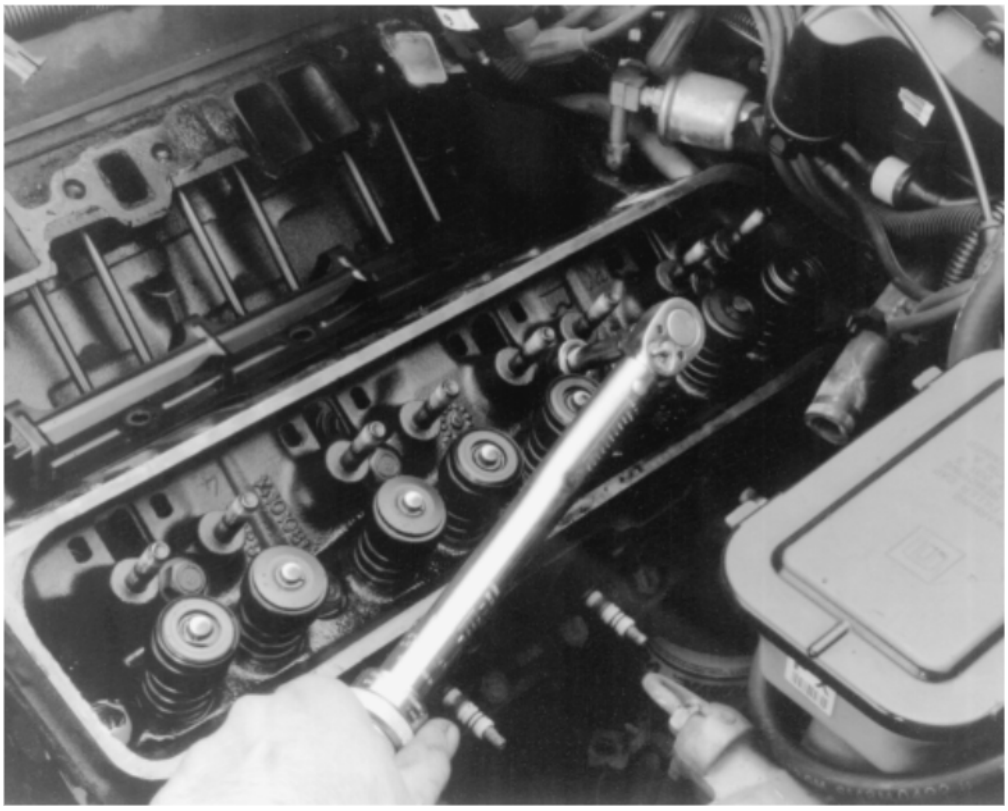


Fig. 9: Torquing the upper head bolts - V8 engines

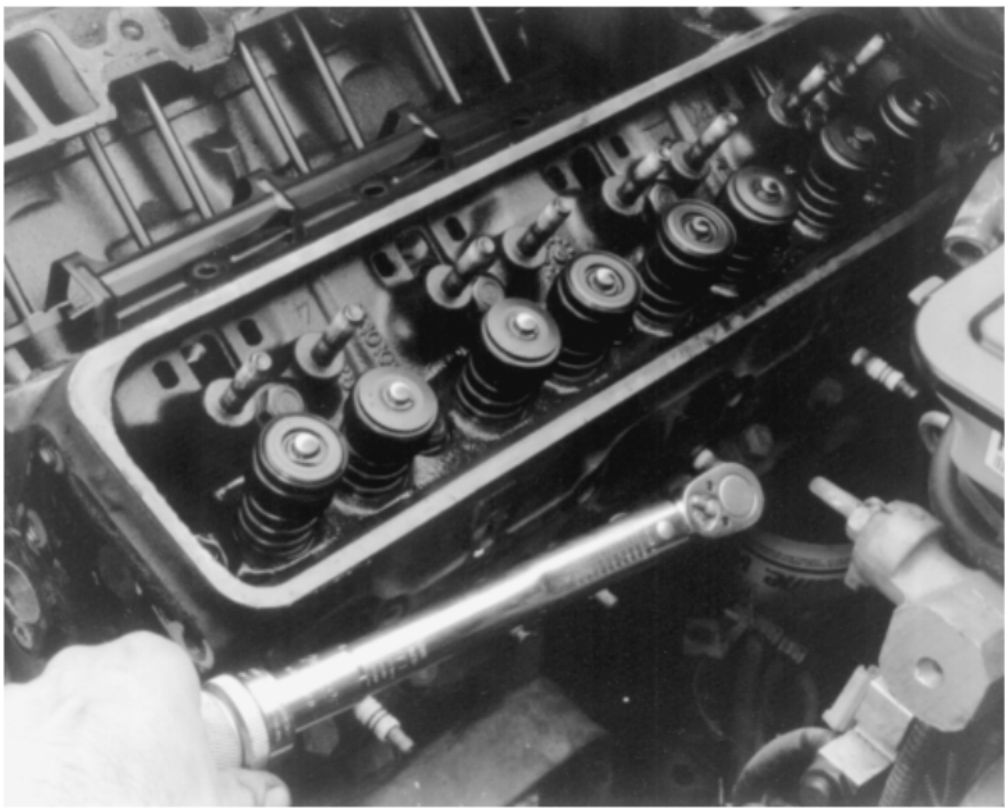


Fig. 10: Torquing the lower head bolts - V8 engines

cardiagn.com

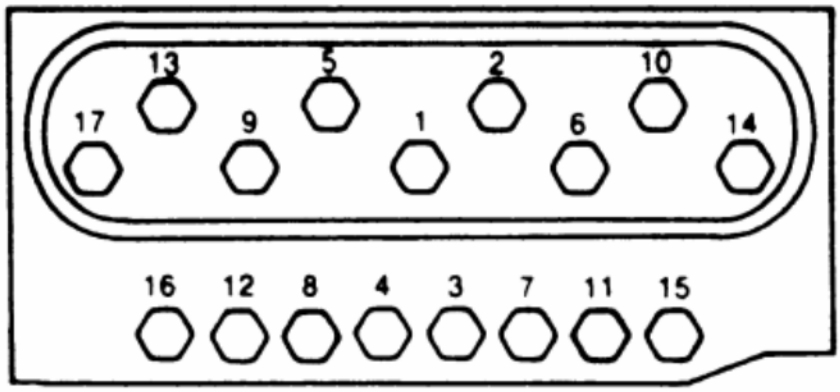


Fig. 11: Cylinder head bolt torque sequence - V8 engines

1. Disconnect the negative battery cable. Drain the cooling system and relieve the fuel system pressure.
2. Raise and support the vehicle safely. Drain the engine oil and remove the oil filter. Lower the vehicle.
3. Remove the drive belt(s) and remove the intake manifold.
4. Remove the power steering pump, alternator bracket or the air conditioning compressor mounting bracket and position aside. Do not disconnect the lines from the air conditioning compressor.
5. Remove the exhaust manifolds and the valve covers.
6. Remove the rocker arms and pushrods.
7. Remove the cylinder head bolts and the cylinder head.

To install:

8. Clean the gasket mating surfaces of all components. Be careful not to nick or scratch any surfaces as this will allow leak paths. Clean the bolt threads in the cylinder block and on the head bolts. Dirt will affect bolt torque.

When using a steel gasket, coat both sides of the new gasket with a thin even coat of sealer. If using a composition gasket, do not use any sealer.

9. Position the head gasket over the dowel pins with the bead up. Install the cylinder head over the dowel pins and gasket.
10. Coat the threads of the head bolts with GM 1052080 thread sealer or equivalent. Install the head bolts and tighten in sequence, in three passes, to 65 ft lbs. (92 Nm).
11. Install the exhaust manifolds.
12. Install the pushrods and rocker arms, refer to the procedures outlined earlier in this section. Install the valve covers.
13. Install the power steering pump and alternator bracket or air conditioning compressor mounting bracket, as necessary.
14. Install the intake manifold.
15. Install the accessory drive belt(s).

cardiagn.com

16. Fill the cooling system with the proper type and amount of coolant. Connect the negative battery cable.
17. Raise and support the vehicle safely. Install a new oil filter, lower the vehicle. Fill the crankcase with the proper type and quantity of engine oil.
18. Start the engine, check for leaks and check the ignition timing.

OIL PAN

REMOVAL & INSTALLATION

CAUTION - The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

EXCEPT 2.5L ENGINE

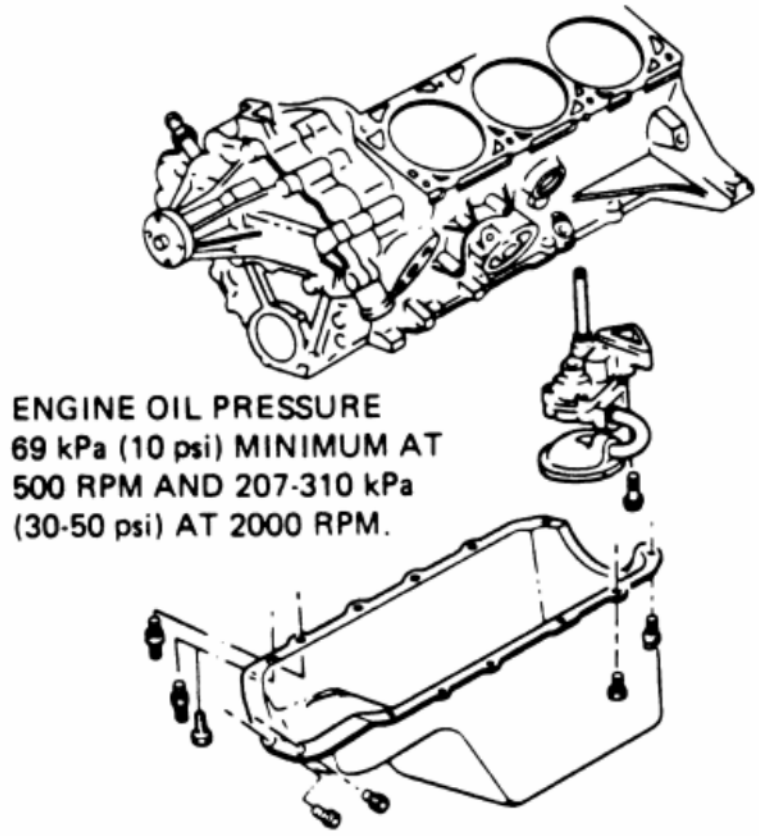


Fig. 1: Oil pan - 1982-86 V6

cardiagn.com

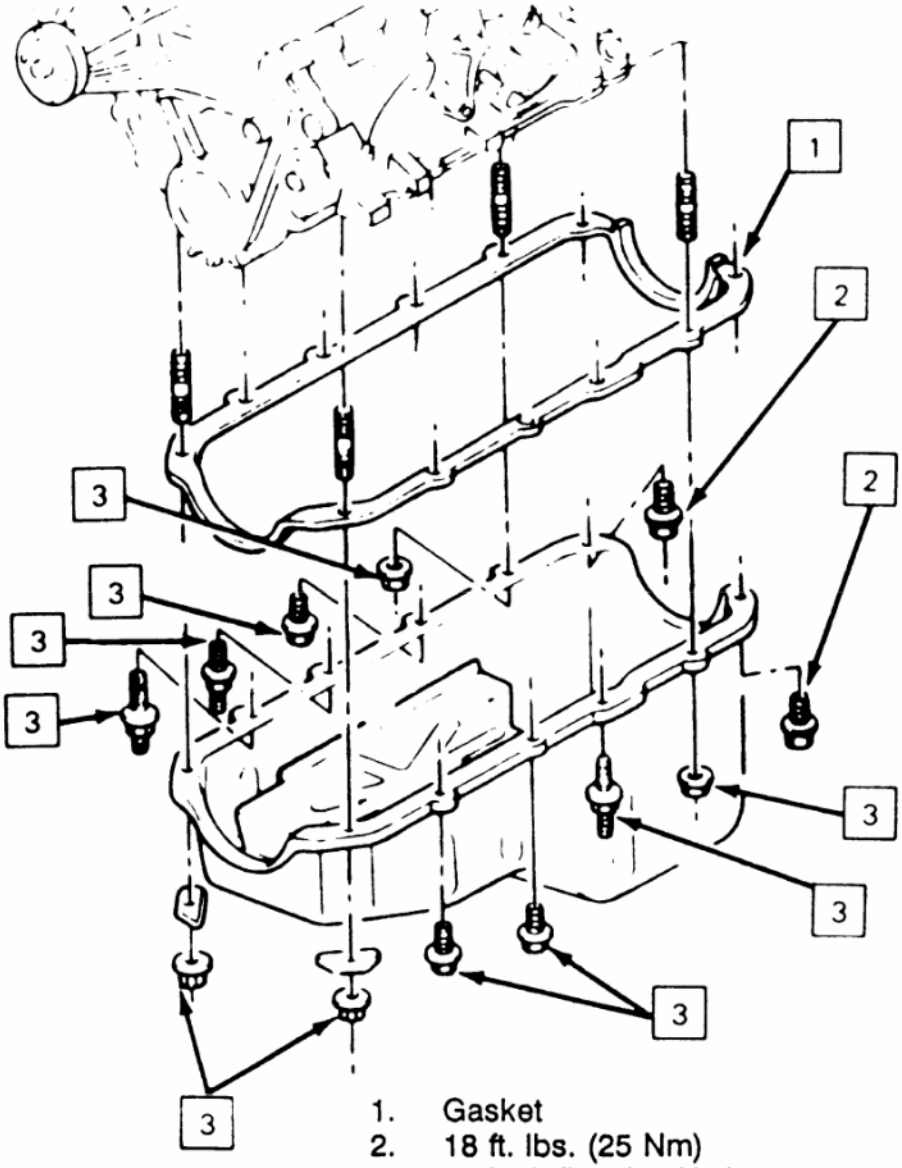


Fig. 2: Oil pan - 1987-92 V6

cardiagn.com

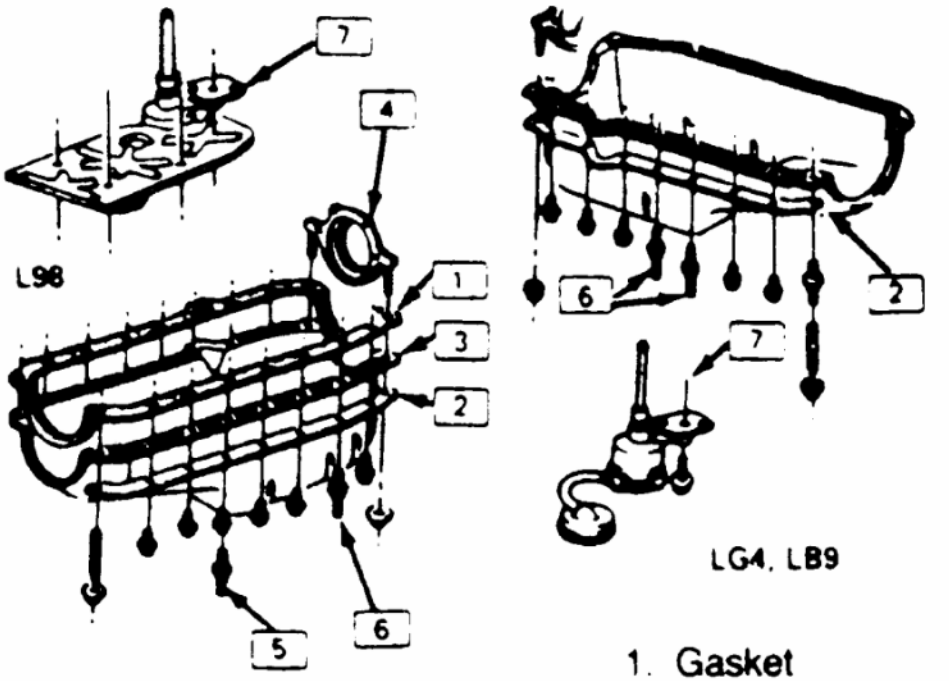


Fig. 3: Oil pan - V8

cardiagn.com

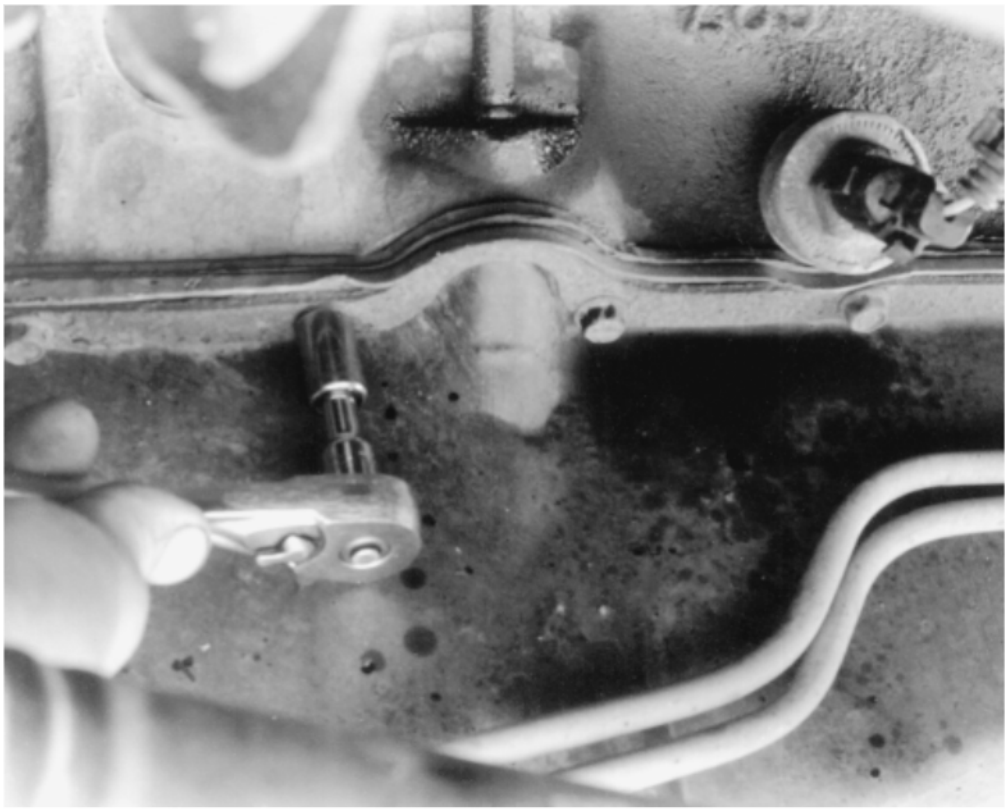


Fig. 4: Removing the oil pan bolts

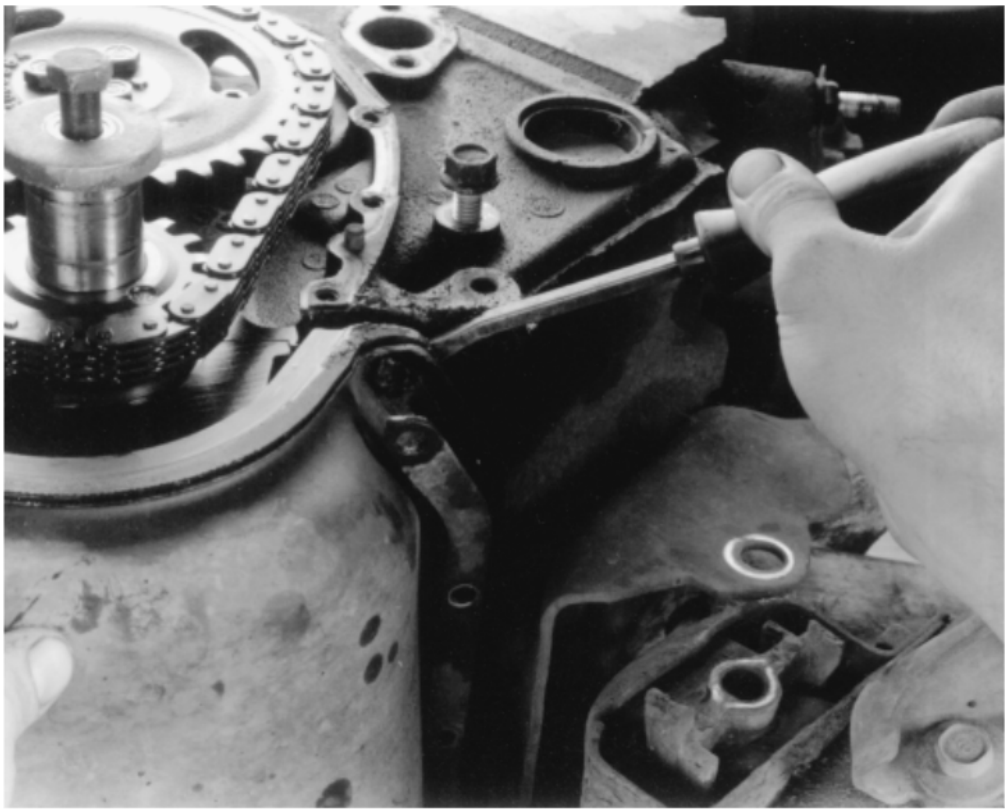


Fig. 5: Prying loose the oil pan

cardiagn.com

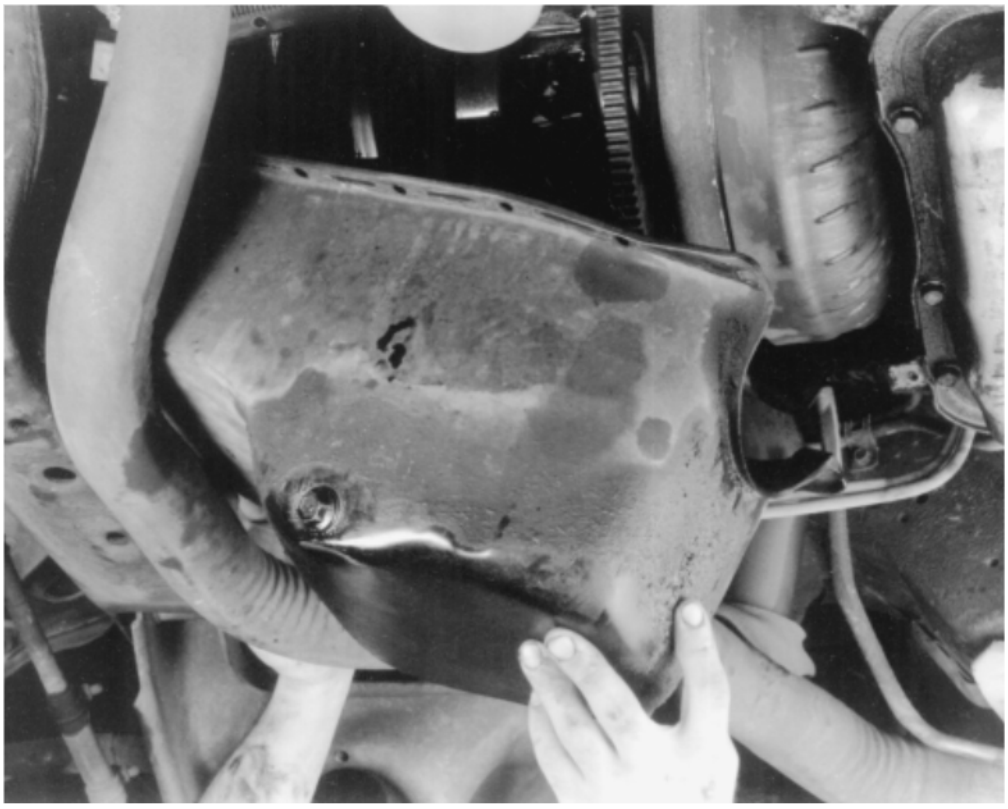


Fig. 6: Removing the pan

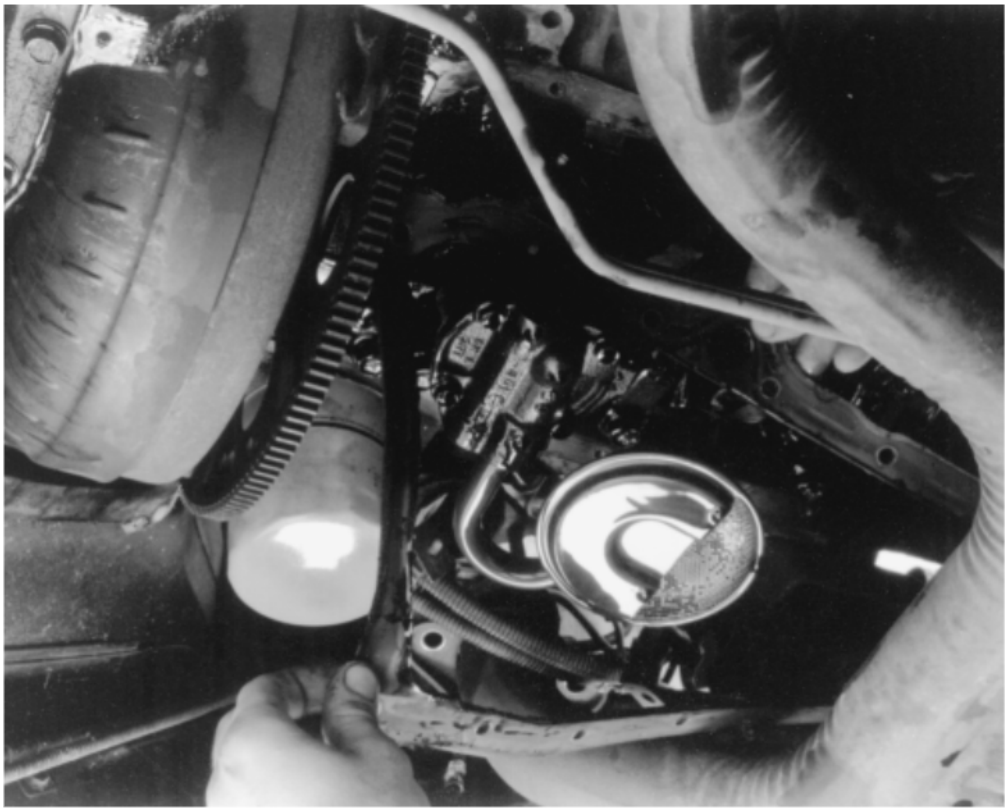


Fig. 7: Removing the pan gasket

1. Disconnect the negative battery cable. Remove the air cleaner.
2. Remove the distributor cap. Remove the fan shroud assembly.
3. Raise the vehicle and support it safely with jackstands.

cardiagn.com

4. Drain the engine oil.

CAUTION - Be sure that the catalytic converter is cool before proceeding.

5. Remove the air injection pipe at the catalytic converter, if applicable.
6. Remove the catalytic converter hanger bolts. Disconnect the exhaust pipe at the manifold.
7. Remove the starter bolts, loosen the starter brace, then lay the starter aside.
8. Remove the front engine mount through-bolts.
9. Raise the engine enough to provide sufficient clearance for oil pan removal.
10. Remove the oil pan bolts.

If the front crankshaft throw prohibits removal of the pan, turn the crankshaft to position the throw horizontally.

11. Remove the oil pan from the vehicle.
12. Remove the old RTV sealant or gasket from the oil pan and engine block.

To install:

13. Run a $^{1}/_{8}$ in. (3mm) bead of RTV around the oil pan sealing surface or install a new gasket. Remember to keep the RTV on the INSIDE of the bolt holes.
14. Install the pan and pan bolts. Torque the pan bolts to:
    - 2.8L & 3.1L V6 (M6 x 1 X 16.0 bolts): 6-9 ft. lbs. (8-12 Nm)
    - 2.8L & 3.1L V6 (M8 x 1.25 x 14.0 bolts): 15-22 ft. lbs. (20-30 Nm)
    - 1982-84 V8 engine ($^{5}/_{16}$-18 bolts): 165 inch lbs. (10 Nm)
    - 1982-84 V8 engine ($^{1}/_{4}$-20 bolts): 80 inch lbs. (8 Nm)
    - 1985 V8 engine ($^{5}/_{16}$-18 x 1.44 studs): minimum of 10 inch lbs.
    - 1985 V8 engine (stud nuts): 150-180 inch lbs. (17-20 Nm)
    - 1985 V8 engine ($^{1}/_{4}$-20 x 0.56 bolts): 72-90 inch lbs. (8-10 Nm)
    - 1985 V8 engine ($^{1}/_{4}$-20 x 0.50 x 0.56 studs): 72-90 inch lbs. (8-10 Nm)
    - 1986-92 V8 engine (stud nuts): 150-250 inch lbs. (17-28 Nm)
    - 1986-92 V8 engine ($^{1}/_{4}$-20 x 0.56 bolts): 72-130 inch lbs. (8-14 Nm)
    - 1986-92 V8 engine ($^{1}/_{4}$-20 x 0.50 x 0.56 studs): 72-130 inch lbs. (8-14 Nm)
15. Lower the engine and install the front engine mount through-bolts. Torque bolts to 48 ft. lbs. (65 Nm).
16. Install the starter and starter brace, then secure using starter bolts.
17. Connect the exhaust pipe at the manifold. Install the catalytic converter hanger bolts.
18. Install the air injection pipe at the catalytic converter.
19. Lower the vehicle.
20. Install the fan shroud assembly. Install the distributor cap.
21. Connect the negative battery cable at the battery and air cleaner.

cardiagn.com

22. Fill the engine with engine oil.
23. Start the engine and check for leaks.

2.5L ENGINE

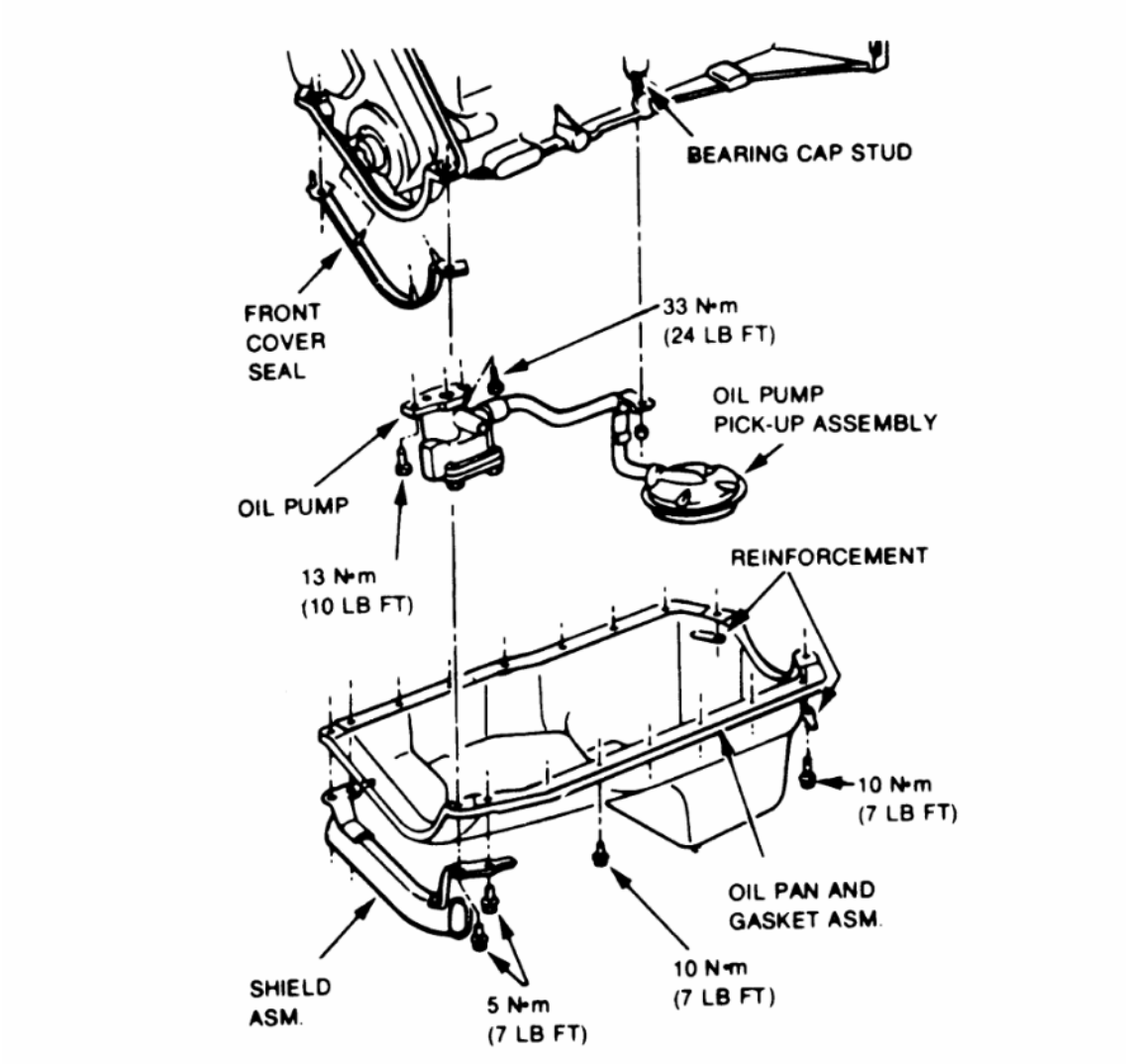


Fig. 8: Oil pan - 2.5L

1. Disconnect the negative battery cable at the battery.
2. Raise the vehicle and support it safely with jackstands.
3. Drain the engine oil.
4. Disconnect the exhaust pipe at the manifold.
5. Loosen the exhaust pipe hanger bracket.
6. Remove the starter assembly.
7. Remove the flywheel dust cover.
8. Remove the front engine mount through-bolts.
9. Carefully raise the engine enough to provide sufficient clearance to lower the oil pan.
10. Remove the oil pan retaining bolts and remove the oil pan.

To install:

cardiagn.com

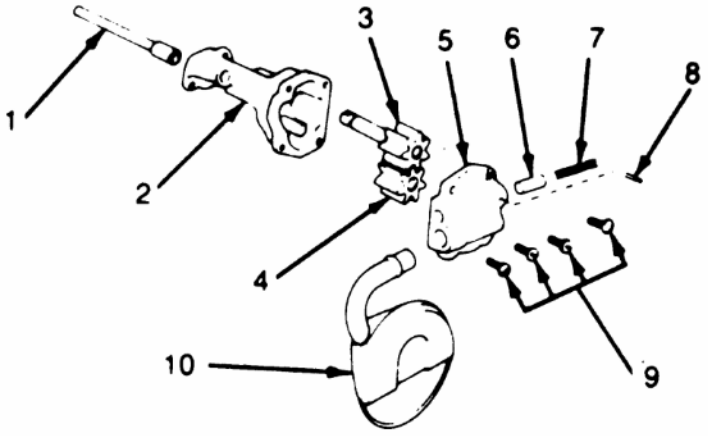
11. Clean all old RTV from the mating surfaces.
12. Install the rear gasket into the rear main bearing cap and apply a small amount of RTV where the gasket engages into the engine block.
13. Install the front gasket.
14. Install the side gaskets, using grease as a retainer. Apply a small amount of RTV where the side gaskets meet the front gasket.
15. Install the oil pan.

Install the oil pan-to-timing cover bolts last, as these holes will not align until the other pan bolts are snug.

16. Torque the pan bolts to 53 inch lbs. (6 Nm) for 1982-1985 models and 90 inch lbs. (10 Nm) for 1986 models.
17. Lower the engine and install the front mount through-bolts. Torque bolts to 48 ft lbs. (65 Nm).
18. Install the flywheel dust cover.
19. Install the starter assembly.
20. Connect the exhaust pipe at the manifold.
21. Tighten the exhaust pipe hanger bracket.
22. Lower the vehicle.
23. Connect the negative battery cable at the battery.
24. Fill the engine with engine oil and start engine. Check for leaks.

OIL PUMP

REMOVAL & INSTALLATION



1. Shaft extension
2. Pump body
3. Drive gear and shaft
4. Idler gear
5. Pump cover
6. Pressure regulator valve
7. Pressure regulator spring
8. Retaining pin
9. Screws
10. Pickup screen and pipe

Fig. 1: Oil pump - V8

cardiagn.com

1. Drain and remove the oil pan.

CAUTION - The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

2. Remove the oil pump-to-rear main bearing cap bolt. Remove the pump and the extension shaft.
3. Remove the cotter pin, spring and pressure regulator valve.

Place your thumb over the pressure regulators bore before removing the cotter pin, as the spring is under pressure.

To install:

4. Assemble pump and extension shaft to rear main bearing cap, aligning slot on top end of extension shaft with drive tang on lower end of distributor driveshaft.

When assembling the driveshaft extension to the driveshaft, the end of the extension nearest the washers must be inserted into the driveshaft.

5. Insert the driveshaft extension through the opening in the main bearing cap and block until the shaft mates into the distributor drive gear.
6. Install the pump onto the rear main bearing cap and install the attaching bolts. Torque the bolts to specifications:
    - L4 engines: 22 ft lbs. (30 Nm)
    - V6 engines: 25-35 ft lbs. (35-47 Nm)
    - V8 engines: 65 ft lbs. (88 Nm)
7. Install the oil pan and fill the crankcase with engine oil.

CRANKSHAFT DAMPER

REMOVAL & INSTALLATION

cardiagn.com

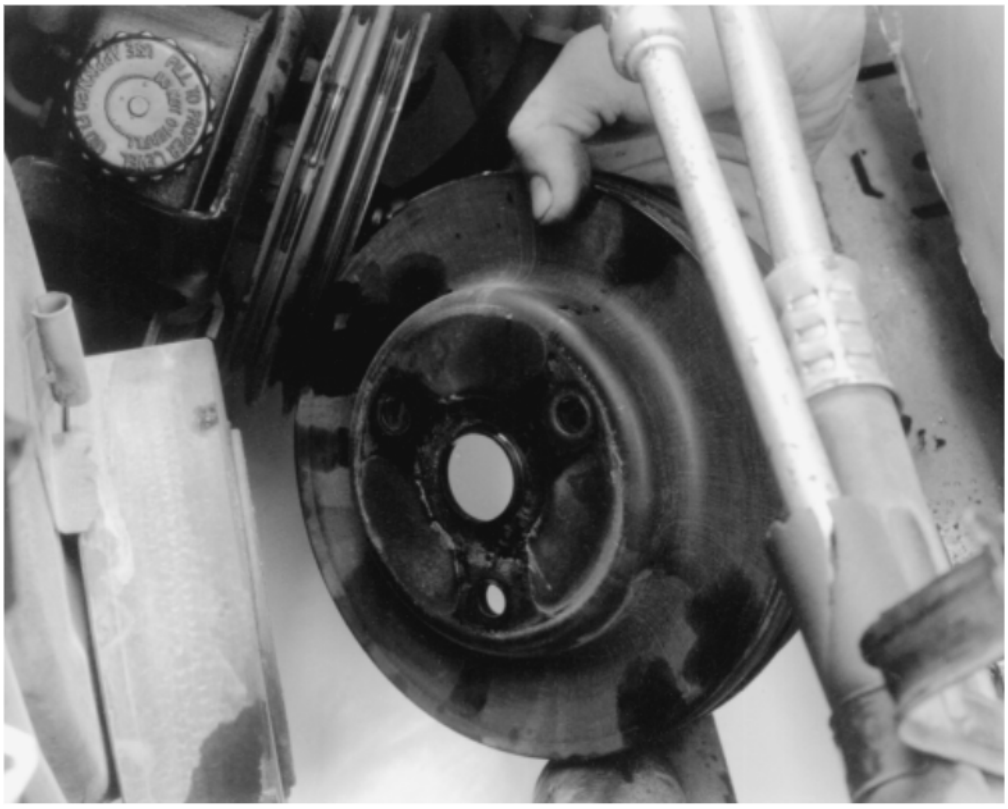


Fig. 1: Removing the pulley

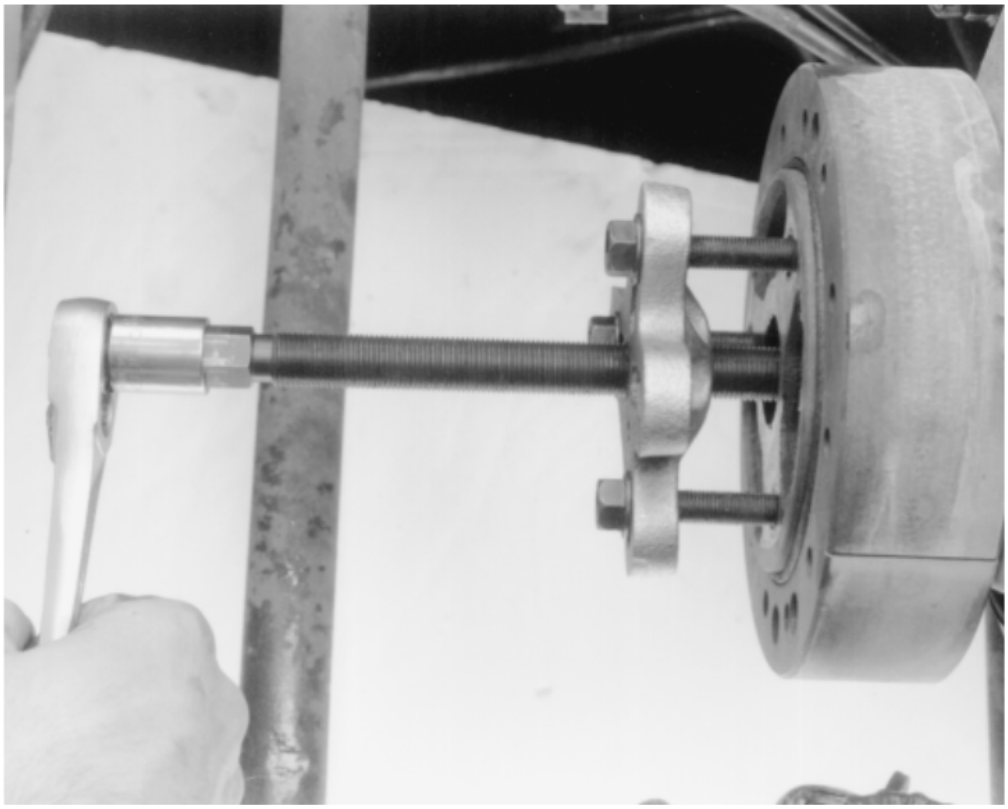


Fig. 2: Removing the damper

1. Disconnect the negative battery cable.
2. Remove the fan and shroud, if necessary.
3. Remove the drive belt(s), then remove the crankshaft pulley bolts.

cardiagn.com

4. Remove the damper center bolt. Install a suitable damper removing tool, then remove the damper from the crankshaft.

If the damper is to be replaced, new balance weights of the same size must be installed on the new balancer assembly in the same hole locations as the old assembly.

5. Installation is the reverse of removal.

TIMING CHAIN AND GEAR COVER

REMOVAL & INSTALLATION

EXCEPT 2.5L ENGINE

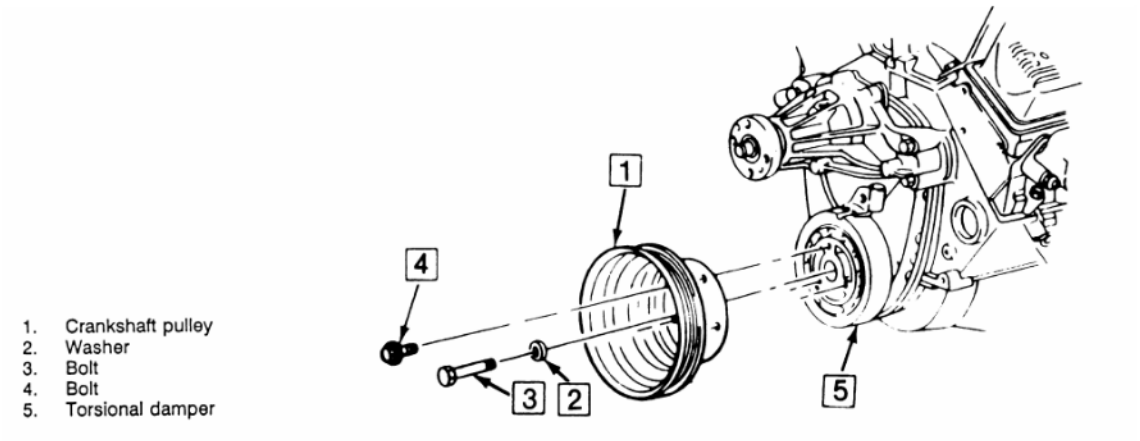


Fig. 1: Damper removal - V8



Fig. 2: Removing the timing cover bolts

cardiagn.com

1. Disconnect the battery ground cable. Drain the cooling system.
2. Remove the fan shroud or the upper radiator support and drive belts. Remove the fan and pulley from the water pump.
3. Remove the alternator upper and lower brackets, air brace with brackets, and power steering lower bracket (move it aside).
4. Remove the radiator lower hose and the heater hose from the water pump. Remove the water pump bolts and the water pump.
5. If A/C equipped, remove the compressor and move aside. Remove the compressor mounting bracket.
6. Remove the damper pulley retaining bolt and the damper pulley.
7. Remove the timing gear cover bolts and the timing gear cover.

With the timing gear cover removed, use a large screwdriver to pry the oil seal from the cover. To install the new oil seal, lubricate it with engine oil and drive it into place.

To install:

8. Prepare the mating surfaces for reinstallation of the timing gear cover. Coat the new gasket with RTV sealer.
9. Install the timing gear cover and timing gear cover bolts. Torque the cover bolts to specifications:
    - V6 engines (M8 x 1.25 bolts): 13-22 ft. lbs. (18-30 Nm)
    - V6 engines (M10 x 1.5 bolts): 20-35 ft. lbs. (27-48 Nm)
    - V8 engines (all bolts): 69-130 inch lbs. (8-14 Nm)
10. Install the damper pulley by pulling the damper onto the crankshaft. Use tool J-23523 or equivalent. Install the damper pulley retaining bolt and torque bolts to 67-85 ft lbs. (90-110 Nm).
11. If A/C equipped, install the compressor mounting bracket and compressor.
12. Install the water pump and the water pump bolts.
13. Install the radiator lower hose and the heater hose to the water pump.
14. Install the alternator upper and lower brackets, air brace with brackets and the power steering lower bracket.
15. Install the fan and pulley to the water pump. Install the fan shroud or the upper radiator support and drive belts and adjust.
16. Connect the battery ground cable.
17. Fill the cooling system, start the engine and check for leaks.

cardiagn.com

2.5L ENGINE

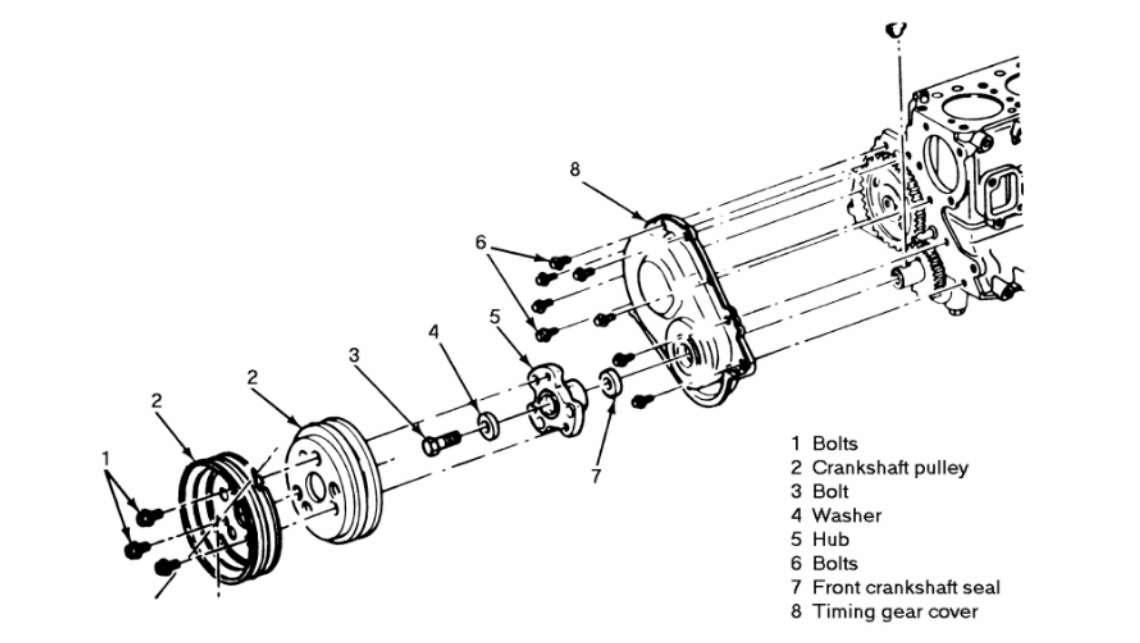


Fig. 3: Timing cover removal - 2.5L

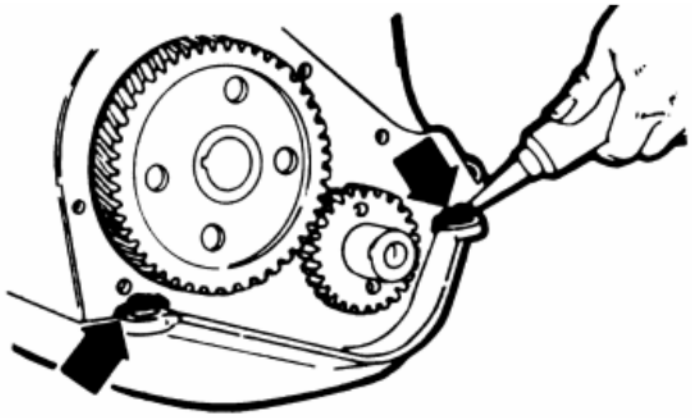


Fig. 4: Apply sealer to these points prior to assembly

1. Remove the drive belts. Remove the hub center bolt, then slide the hub and pulleys from the crankshaft.

If only removing the oil seal, simply pry the oil seal from the front cover using a large screwdriver. Be careful not to distort the sheet metal timing gear cover.

2. Remove the oil pan-to-front cover screws and the front cover-to-block screws. Pull the cover forward enough to permit the cutting of the oil pan front seal. Using a sharp knife, cut the seal close to the block at both corners.
3. Remove the front cover and clean any portion of old gasket from the sealing surfaces. Clean portions of the old gasket from the block.

To install:

cardiagn.com

4. Use a new front oil pan gasket, cut the tabs from the gasket. Replace the crankshaft oil seal.
5. Place RTV sealer in the corners of the new oil pan gasket and the new timing gear cover gasket.
6. Install the front cover and install the oil pan-to-front cover screws and the front cover-to-block screws. Torque screws to 90 inch lbs. (10 Nm).
7. Install the hub and pulleys onto the crankshaft. Install the hub center bolt and torque to 162 ft lbs. (220 Nm).
8. Install the drive belts and adjust.

TIMING GEAR COVER OIL SEAL REPLACEMENT

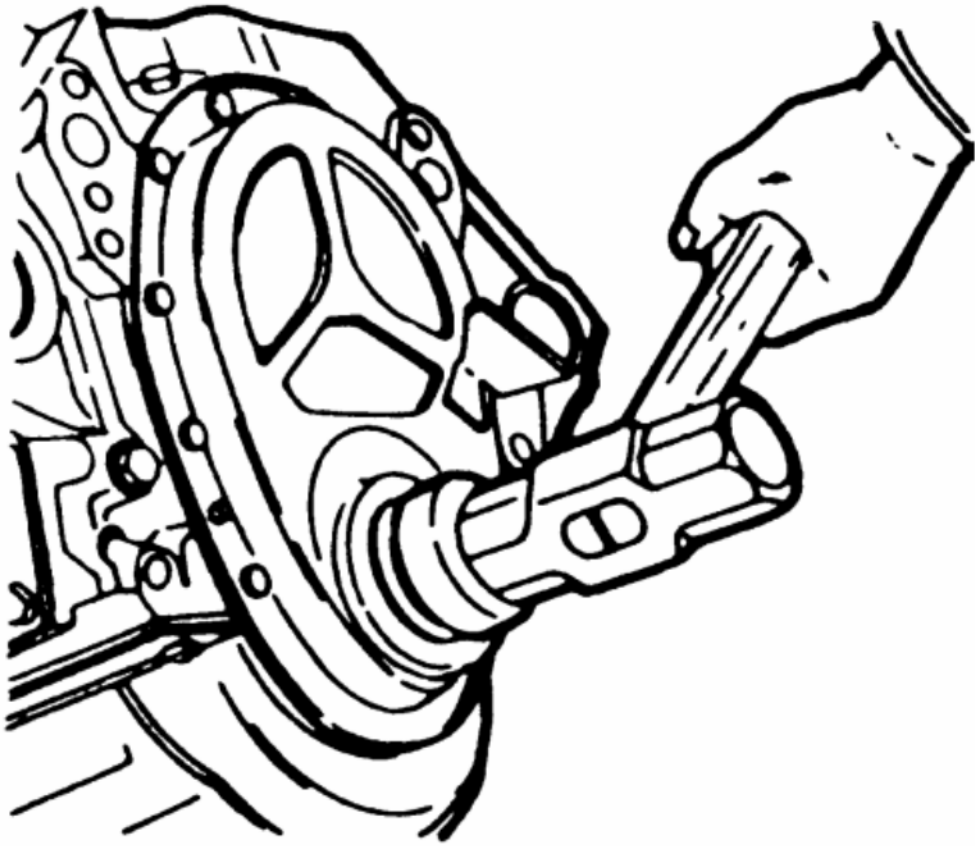


Fig. 5: Installing the oil seal with the cover installed

cardiagn.com

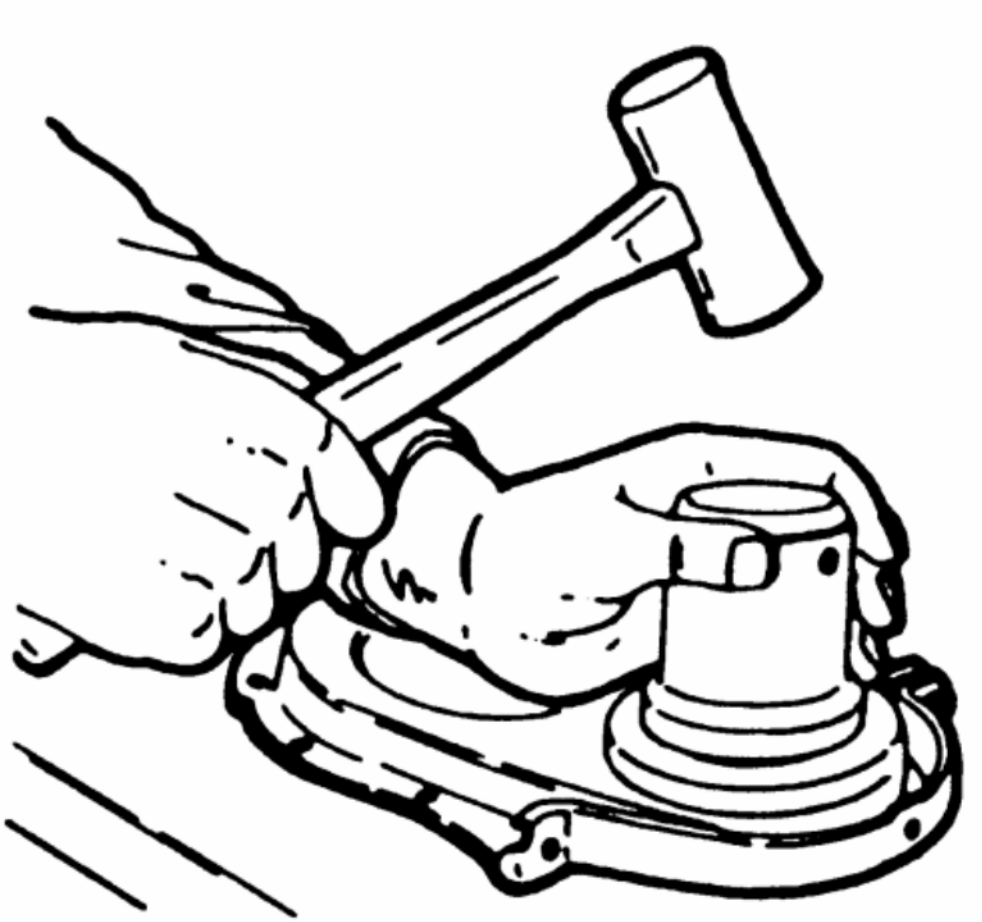


Fig. 6: Installing the oil seal with the cover removed

1. After removing the gear cover, pry or drive the oil seal out of the cover with a small prybar or an oil seal removal tool.
2. Install a new lip seal with the lip (open side of seal) inside and drive or press the seal into place.
3. Lightly coat seal with engine oil before installing cover on block.

cardiagn.com

TIMING CHAIN OR GEAR

REMOVAL & INSTALLATION

EXCEPT 2.5L ENGINE

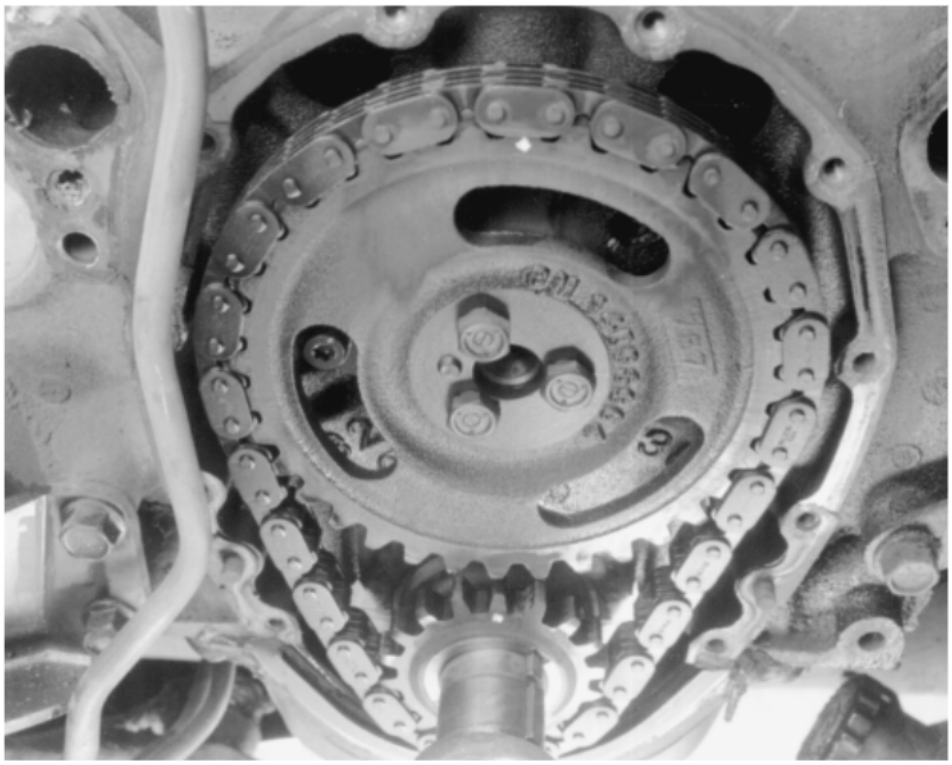


Fig. 1: Timing marks aligned with No.1 piston at TDC

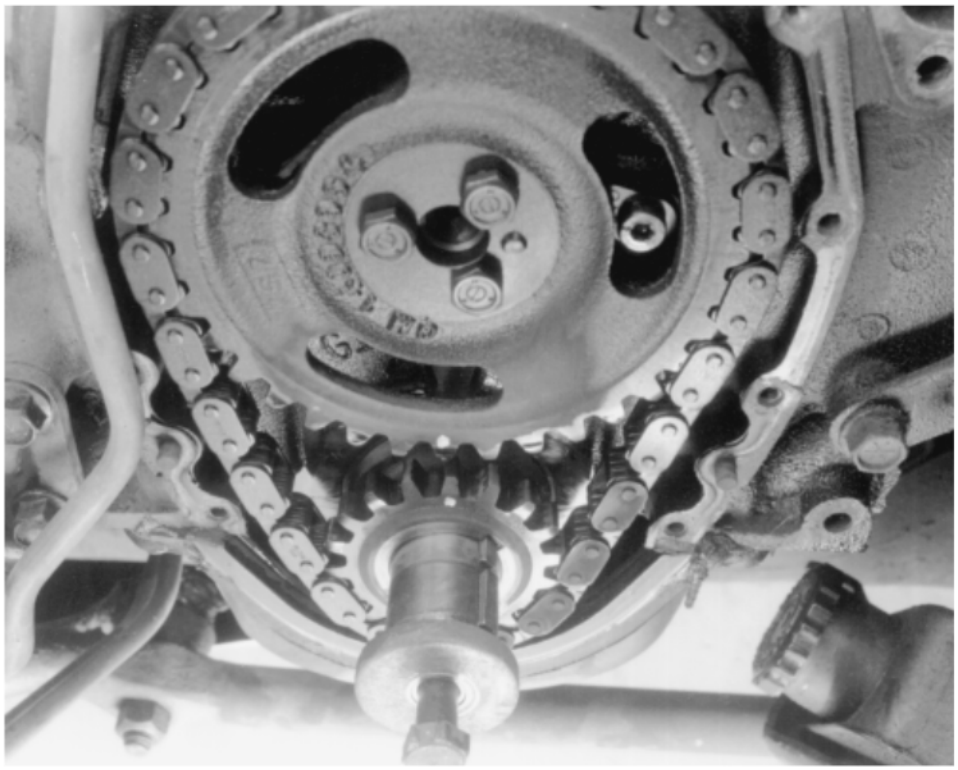


Fig. 2: Timing marks aligned with No.4 (V6) or No.6 (V8) piston at TDC

cardiagn.com

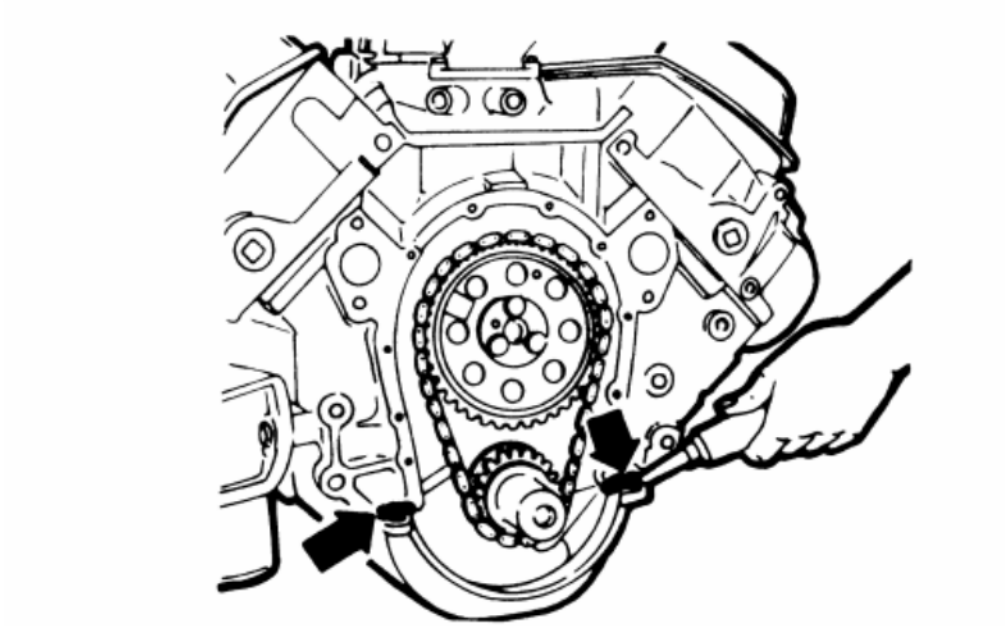


Fig. 3: Apply sealer to these points prior to assembly

1. Remove the timing gear cover.
2. With the timing gear cover removed, rotate the engine as follows:
    a. Place the #1 piston at T.D.C with the marks on the camshaft sprocket at 6 O'clock and the crankshaft sprocket at 12 0:clock.
    b. Make sure the #1 cylinder is on the compression stroke with both valves closed.
3. Remove the bolts holding the camshaft sprocket to the camshaft. Pull the camshaft sprocket forward.
4. If the camshaft sprocket will not move, give the sprocket a light blow with a plastic mallet, on the lower edge. Remove the sprocket and timing chain.
5. Remove the crankshaft gear using a gear puller. Make sure the keyway does not fall into the oil pan.

To install:

6. Install the crankshaft gear about $^1/_2$ inch from the crankshaft stop.
7. Position the chain onto the cam gear, then slide the chain and cam gear onto the crank gear and camshaft, keeping the timing marks aligned at all times.
8. Install the camshaft gear retaining bolts and tighten.
9. Turn the crankshaft over two revolutions with the crankshaft bolt to check to see if the timing marks are perfectly aligned. If not, remove the cam gear and realign.

2.5L ENGINE

cardiagn.com

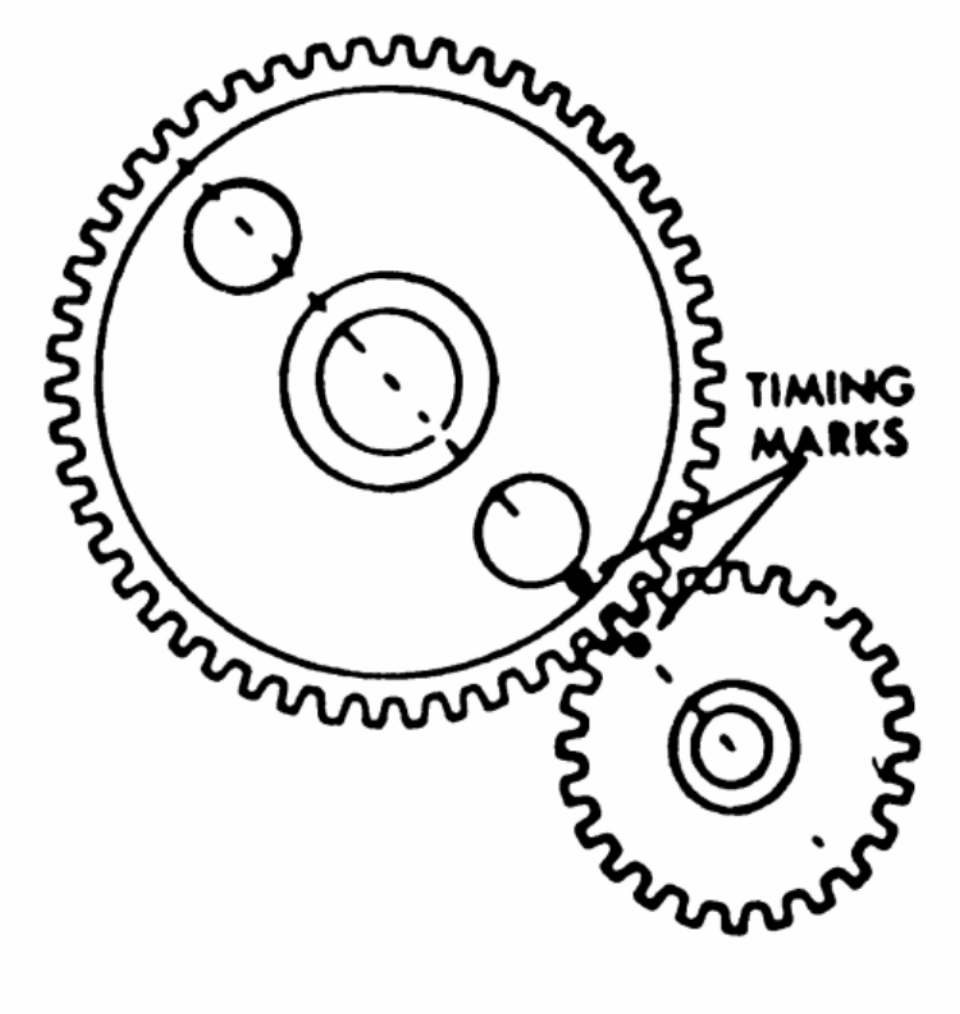


Fig. 4: Timing gear alignment - 2.5L

The 4-cylinder engine uses a gear driven camshaft. To remove the timing gear, refer to the camshaft removal section. The camshaft must be removed from the engine so that the timing gear may be pressed from the shaft.

WARNING - The thrust plate must be positioned so that the woodruff key in the shaft does not damage it when the shaft is pressed out of the gear. Properly support the hub of the gear or the gear will be seriously damaged. The crankshaft gear may be removed with a gear puller while in place in the block.

CRANKSHAFT SPROCKET

REMOVAL & INSTALLATION

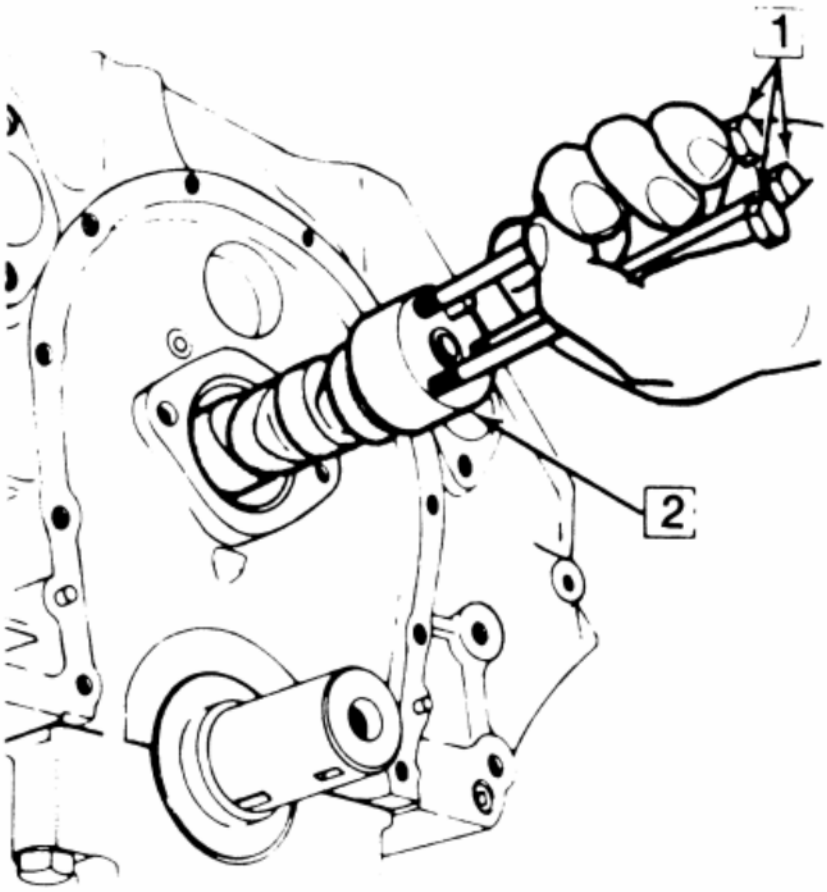
1. Remove the front cover and timing chain.
2. To remove the crankshaft sprocket, it may be necessary to remove the radiator to gain sufficient clearance.
3. Using a puller, remove the crankshaft sprocket.
4. To install, pay attention to the position of the woodruff key. Slide the sprocket onto the crankshaft.
5. To complete the installation, reverse the removal procedures.

cardiagn.com

CAMSHAFT AND BEARINGS

REMOVAL & INSTALLATION

CAUTION - When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.



1. Bolts
2. Camshaft

Fig. 1: Using bolts to aid in camshaft removal and installation

cardiagn.com

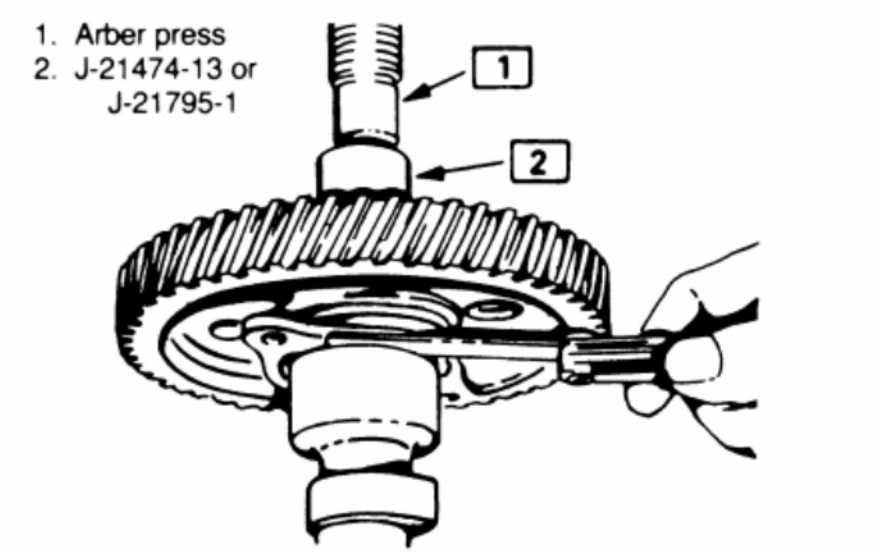


Fig. 2: Checking thrust plate clearance

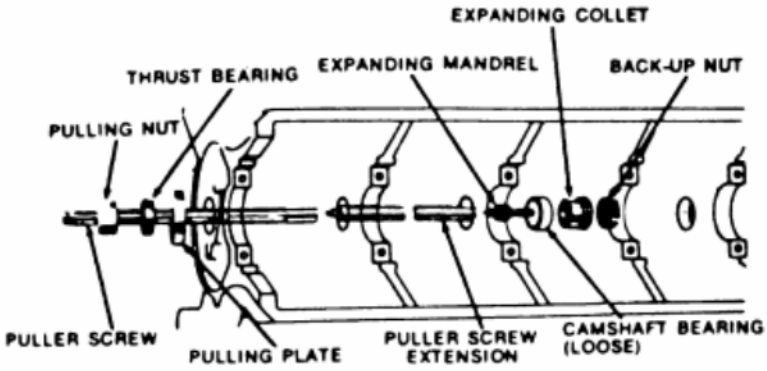


Fig. 3: Camshaft bearing removal and installation

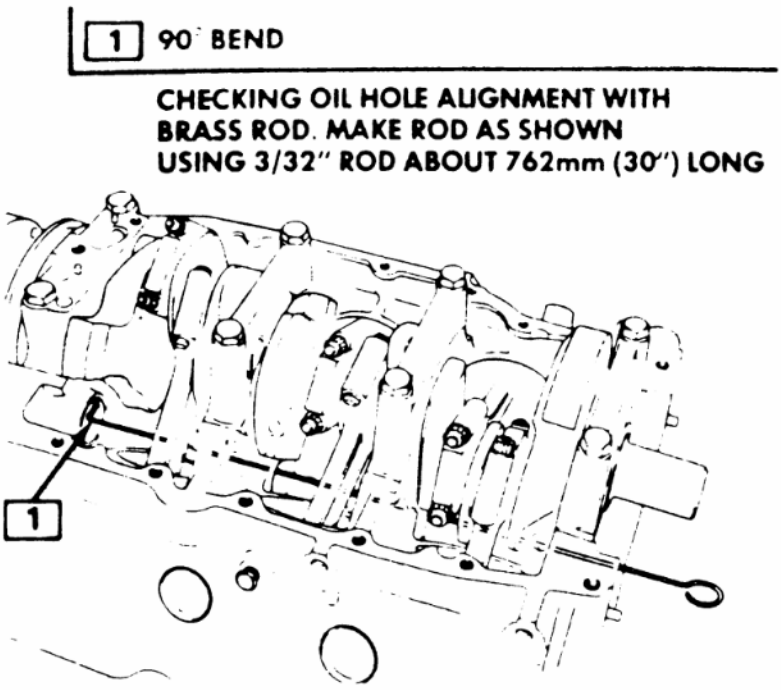


Fig. 4: Checking camshaft bearing oil hole alignment

cardiagn.com

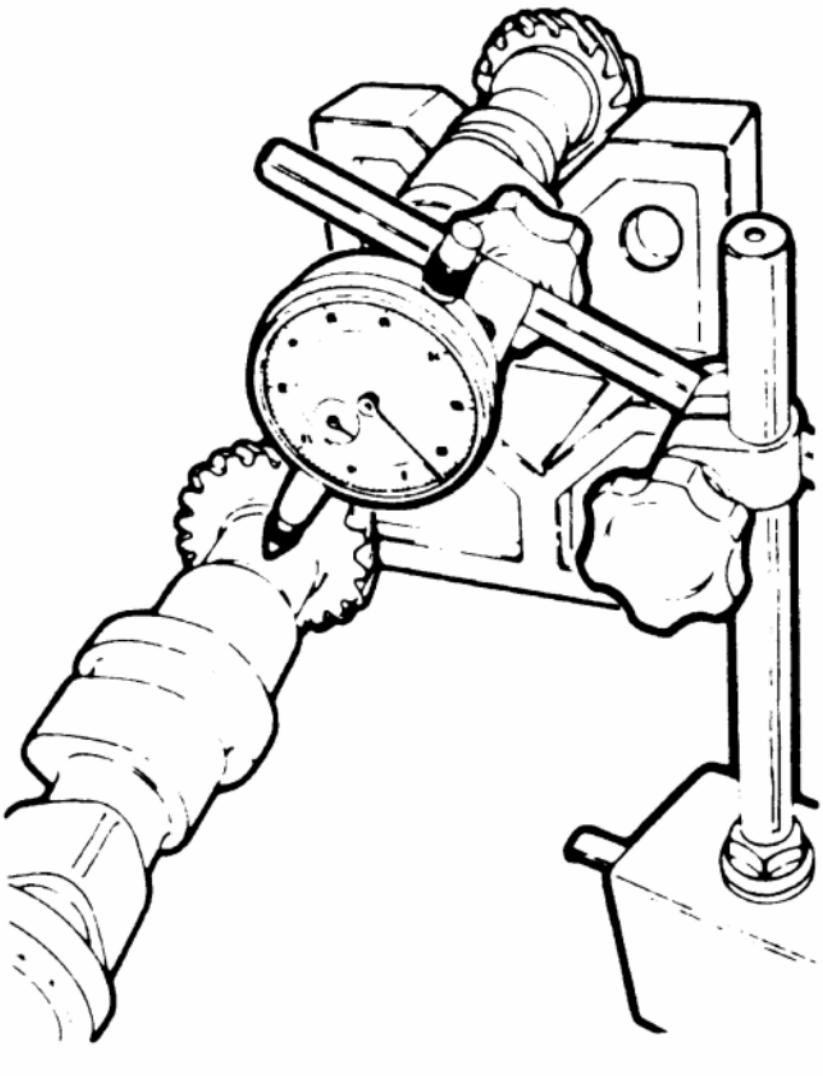


Fig. 5: Checking camshaft straightness

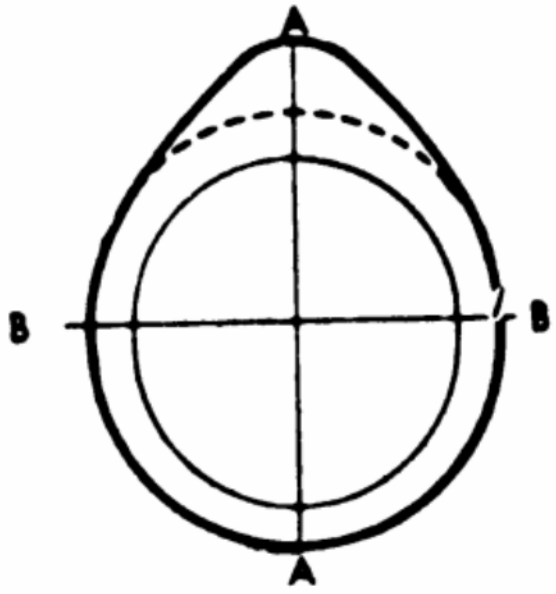


Fig. 6: Camshaft lobe measurement

cardiagn.com

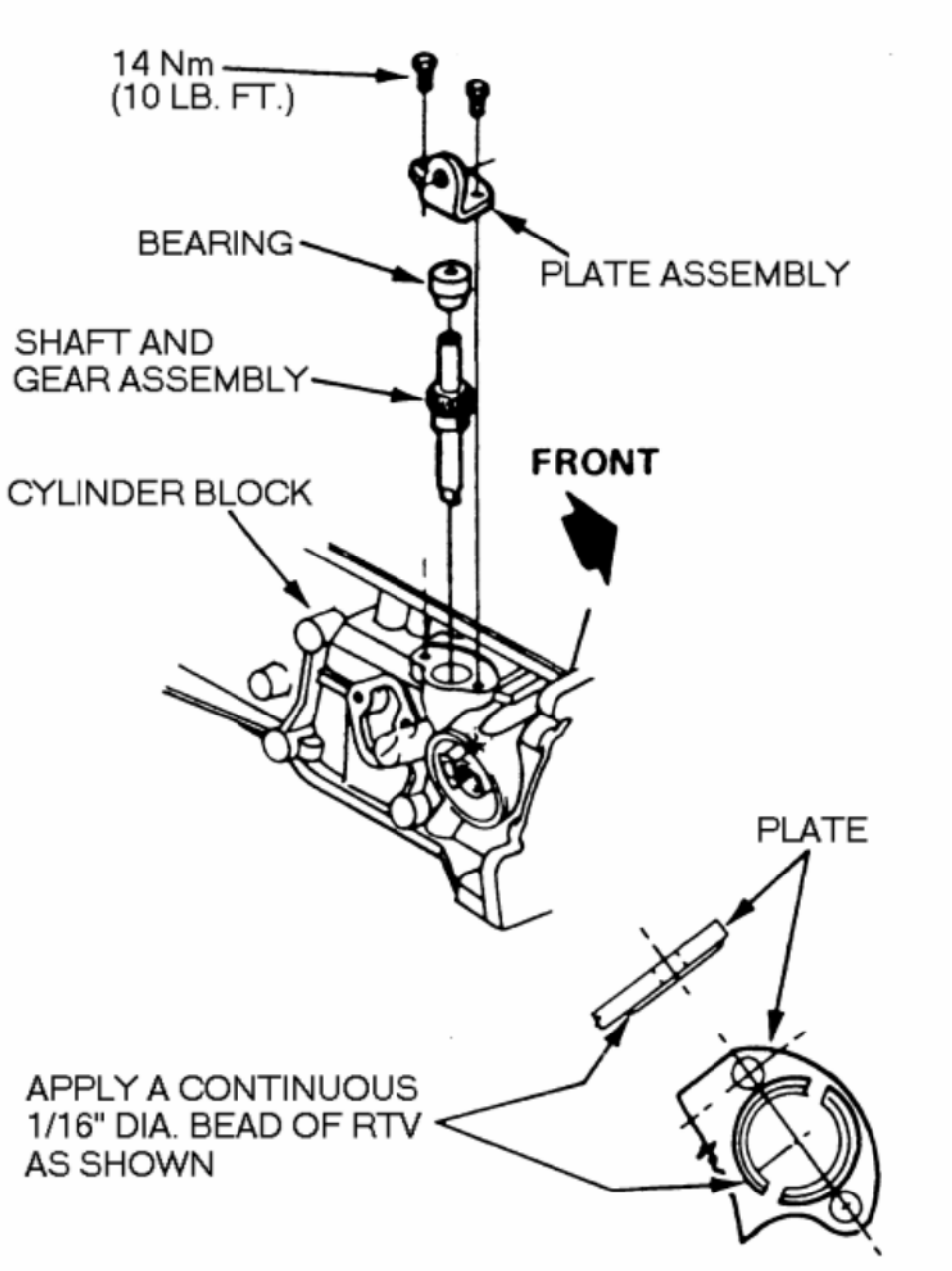
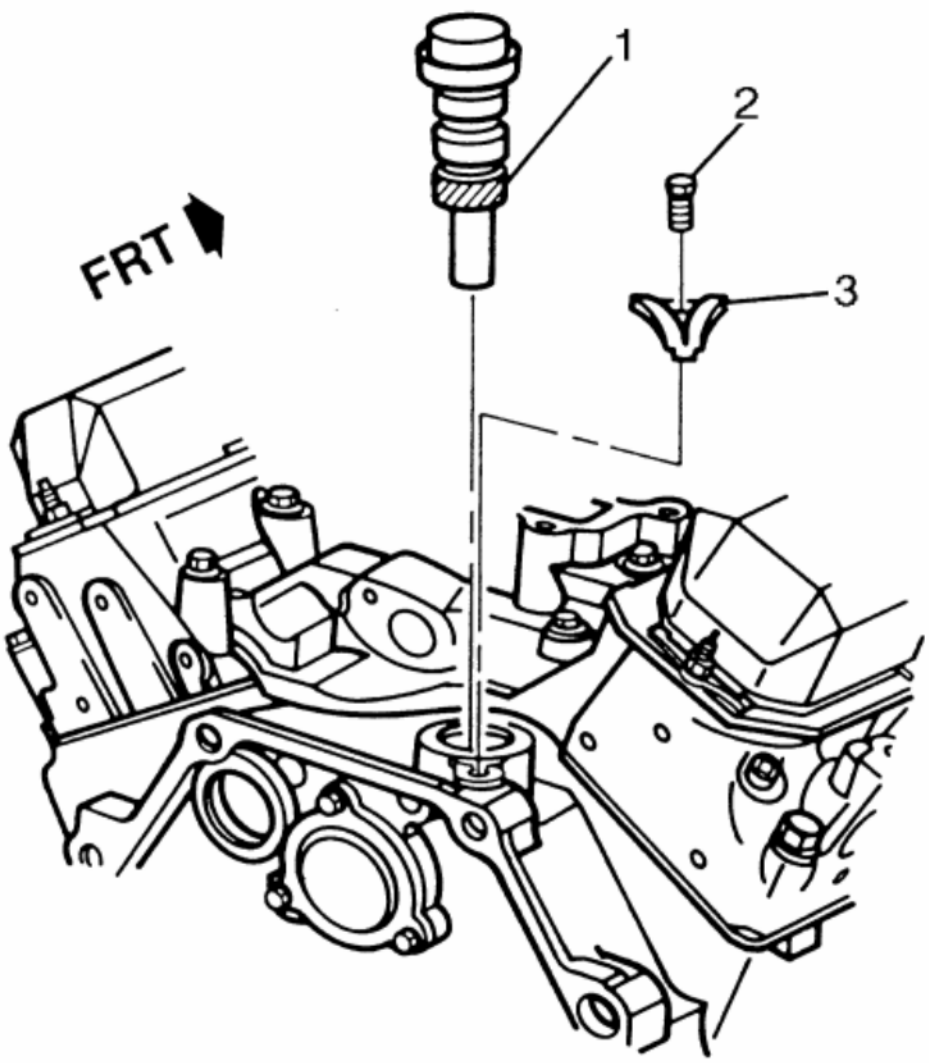


Fig. 7: Oil pump drive found on 2.5L engine

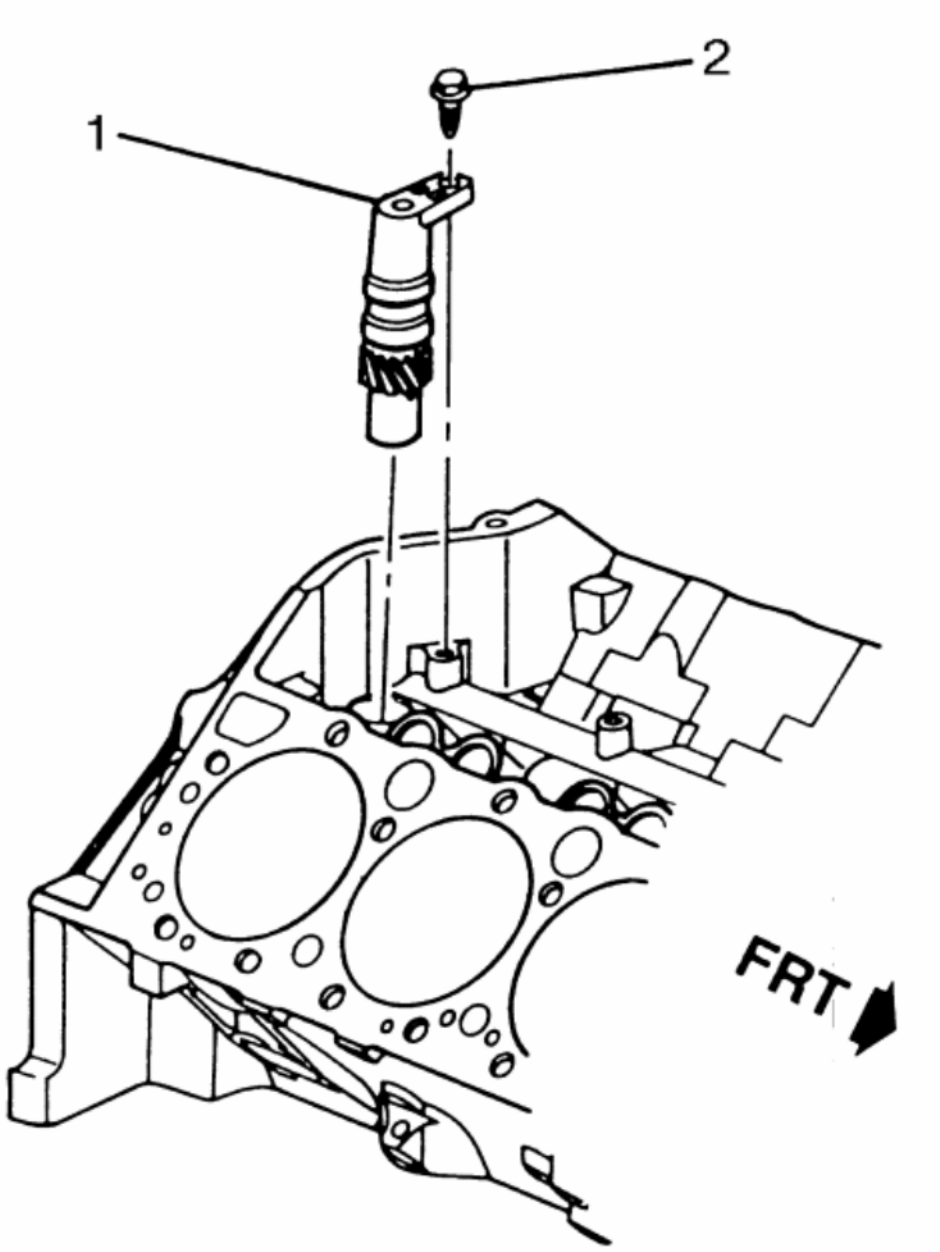
cardiagn.com



1. Oil pump drive assembly
2. Oil pump drive clamp bolt/screw
3. Oil pump drive clamp

Fig. 8: A common oil pump drive found on V6 engines

cardiagn.com



1. Oil pump driveshaft assembly
2. Oil pump driveshaft bolt/screw

Fig. 9: A common oil pump drive location on V8 engines

4-CYLINDER ENGINES

There are two ways to go about this task: either remove the engine from the car, or remove the radiator, grill and any other supports which are directly in front of the engine. If the second alternative is chosen, you may have to disconnect the motor mounts, and raise the front of the engine. This will give you the necessary clearance to remove the camshaft from the engine.

1. Drain the engine oil and the cooling system. Remove the radiator.

cardiagn.com

2. Remove the fan, drive belts and water pump pulley. Remove the valve cover. Loosen the rocker arms and pivot them, then remove the pushrods.
3. Remove the oil pump driveshaft and gear assembly. This is located under a small plate secured by two bolts near the oil filter. Remove the spark plugs.
4. Mark the position of the distributor rotor, housing, and engine block. Remove the distributor.
5. Remove the valve lifters. They are located behind the pushrod cover.
6. Remove the timing gear cover.
7. Insert a screwdriver through the holes in the timing gear and remove the 2 camshaft thrust plate screws.
8. Pull the camshaft and gear assembly out through the front of the engine block.

When removing the camshaft, be careful not to damage the camshaft bearings.

9. If the camshaft is to be removed from the timing gear, place the assembly in an arbor press and separate. CAUTION When removing the timing gear from the camshaft, the thrust plate must be positioned so that the woodruff key does not damage it.

To install:

10. To install the timing gear to the camshaft, press the assembly together and measure the end clearance. There should be 0.0015-0.0050 in. (0.038-0.127mm) between the thrust plate and the camshaft.

If the clearance is less than 0.0015 in. (0.038mm), replace the spacer ring; if more than 0.0050 in. (0.127mm), replace the thrust ring.

11. Lubricate the camshaft, bearings, and lifters. Slide the camshaft assembly into the engine and align the timing marks of the camshaft gear and crankshaft gear.
12. Complete the installation by reversing the removal procedure.

V6 AND V8 ENGINES

1. Remove the engine from the vehicle or remove all components from the front of the engine (radiator, grille, etc.).
2. Remove the timing gear cover and chain.
3. Mark the distributor rotor, housing and engine block, then remove the distributor. Remove the fuel pump and fuel pump pushrod on carbureted engines.
4. Remove the intake manifold and valve covers. Loosen the rocker arms and pivot out of way. Remove the pushrods and valve lifters.
5. Remove the oil pump drive.
6. Slide the camshaft toward the front of the engine (be careful not to damage the camshaft bearings).

cardiagn.com

To install:

7. Lubricate all parts. Slide the camshaft onto the camshaft bearings.
8. Install the fuel pump and fuel pump pushrod.
9. Install the distributor and align all matchmarks.
10. Install the oil pump drive.
11. Install the valve lifters, pushrods and rocker arms.
12. Install the intake manifold and valve covers.
13. Install the timing and timing chain cover.
14. Install the radiator.
15. Fill the cooling system, start the engine and check for leaks.

BEARING

REMOVAL & INSTALLATION

It is recommended for a machine shop to perform these procedures.

To remove the camshaft bearings, the camshaft lifters, flywheel, rear camshaft expansion plug, and crankshaft must be removed.

Camshaft bearings can be replaced with engine completely or partially disassembled. To replace bearings without complete disassembly remove the camshaft and crankshaft leaving cylinder heads attached and pistons in place. Before removing crankshaft, tape threads of connecting rod bolts to prevent damage to crankshaft. Fasten connecting rods against sides of engine so they will not be in the way while replacing camshaft bearings.

If excessive wear is indicated, or if the engine is being completely rebuilt, camshaft bearings should be replaced as follows: Drive the camshaft rear plug from the block. Assemble the removal puller with its shoulder on the bearing to be removed. Gradually tighten the puller nut until bearing is removed. Remove remaining bearings, leaving the front and rear for last. To remove front and rear bearings, reverse position of the tool, so as to pull the bearings in toward the center of the block. Leave the tool in this position, pilot the new front and rear bearings on the installer, and pull them into position as follows:

- 4 cylinder engines: Ensure oil holes are properly aligned.
- V6 engines: Ensure the rear and intermediate bearing oil holes are aligned between the 2 and 3 o'clock positions and the front bearing oil holes are at 1:00 and between 2 and 3 o'clock positions.
- V8 engines: Ensure the No. 1 (front) camshaft bearing holes are an equal distance from the 6 o'clock position. The No. 2 through 4 inner bearing holes must be positioned at the 5 o'clock position towards the left side (drivers) of the engine, even with the bottom of the cylinder bore. The No. 5 bearing oil holes must be positioned at 12 o'clock.

Return the tool to its original position and pull remaining bearings into position.

cardiagn.com

Ensure that oil holes are properly aligned. Replace camshaft rear plug, and stake it into position to aid retention.

INSPECTION

CAMSHAFT LOBE LIFT

Check the lift of each lobe in consecutive order and make a note of the reading.

1. Remove the fresh air inlet tube and the air cleaner. Remove the heater hose and crankcase ventilation hoses. Remove valve rocker arm cover(s).
2. Remove the rocker arm stud nut or fulcrum bolts, fulcrum seat and rocker arm.
3. Make sure the pushrod is in the valve tappet socket. Install a dial indicator so that the actuating point of the indicator is in the pushrod socket (or the indicator ball socket adapter tool is on the end of the pushrod) and in the same plane as the pushrod movement.
4. Disable the ignition and fuel systems.
5. Install a remote starter switch. Crank the engine with the ignition and fuel system disabled. Turn the crankshaft over until the tappet is on the base circle of the camshaft lobe. At this position, the pushrod will be in its lowest position.
6. Zero the dial indicator. Continue to rotate the crankshaft slowly until the pushrod is in the fully raised position.
7. Compare the total lift recorded on the dial indicator with the specification shown on the Camshaft Specification chart.

To check the accuracy of the original indicator reading, continue to rotate the crankshaft until the indicator reads zero. If the lift on any lobe is below specified wear limits listed, the camshaft and the valve tappet operating on the worn lobe(s) must be replaced.

8. Install the rocker arm, fulcrum seat and stud nut or fulcrum bolts. Adjust the valves, if required (refer to the valves procedure in this section).
9. Install the valve rocker arm cover(s) and the air cleaner.

CAMSHAFT END PLAY

On all gasoline V8 engines, prying against the aluminum-nylon camshaft sprocket, with the valve train load on the camshaft, can break or damage the sprocket. Therefore, the rocker arm adjusting nuts must be backed off, or the rocker arm and shaft assembly must be loosened sufficiently to free the camshaft. After checking the camshaft end play, check the valve clearance. Adjust if required (refer to procedure in this section).

1. Push the camshaft toward the rear of the engine. Install a dial indicator or equivalent so that the indicator point is on the camshaft sprocket attaching screw.

cardiagn.com

2. Zero the dial indicator. Position a prybar between the camshaft gear and the block. Pull the camshaft forward and release it. Compare the dial indicator reading with the specifications.
3. If the end play is excessive, check the spacer for correct installation before it is removed. If the spacer is correctly installed, replace the thrust plate.
4. Remove the dial indicator.

VALVE LIFTERS

REMOVAL & INSTALLATION

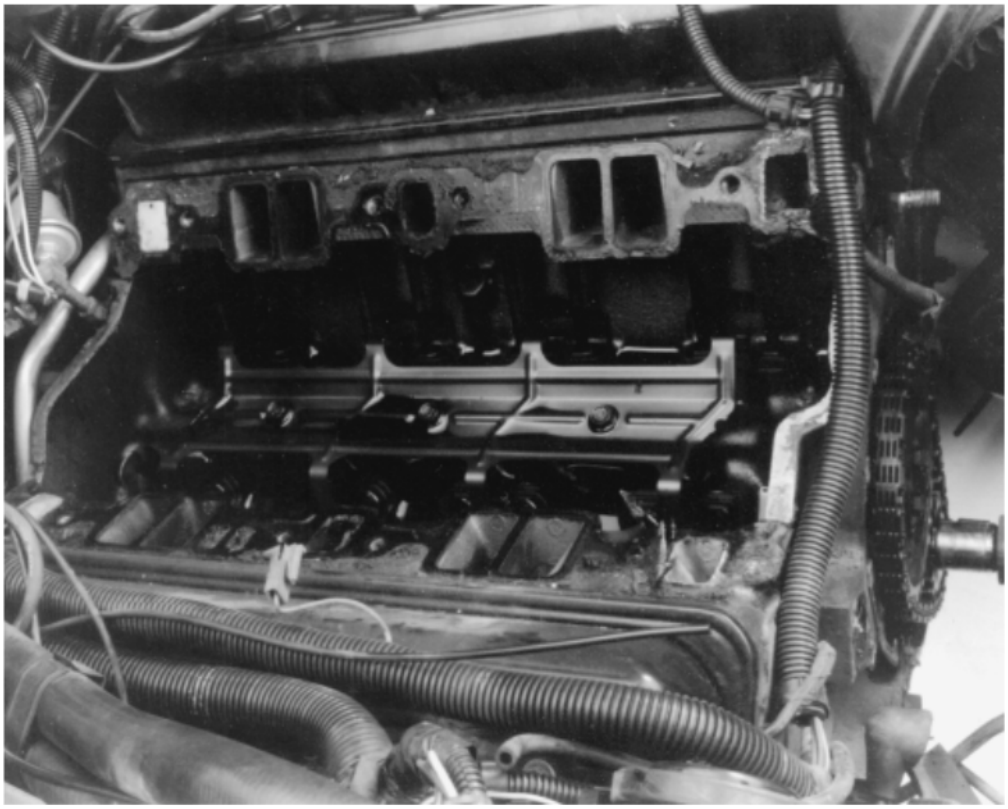


Fig. 1: View of the intake removed

cardiagn.com

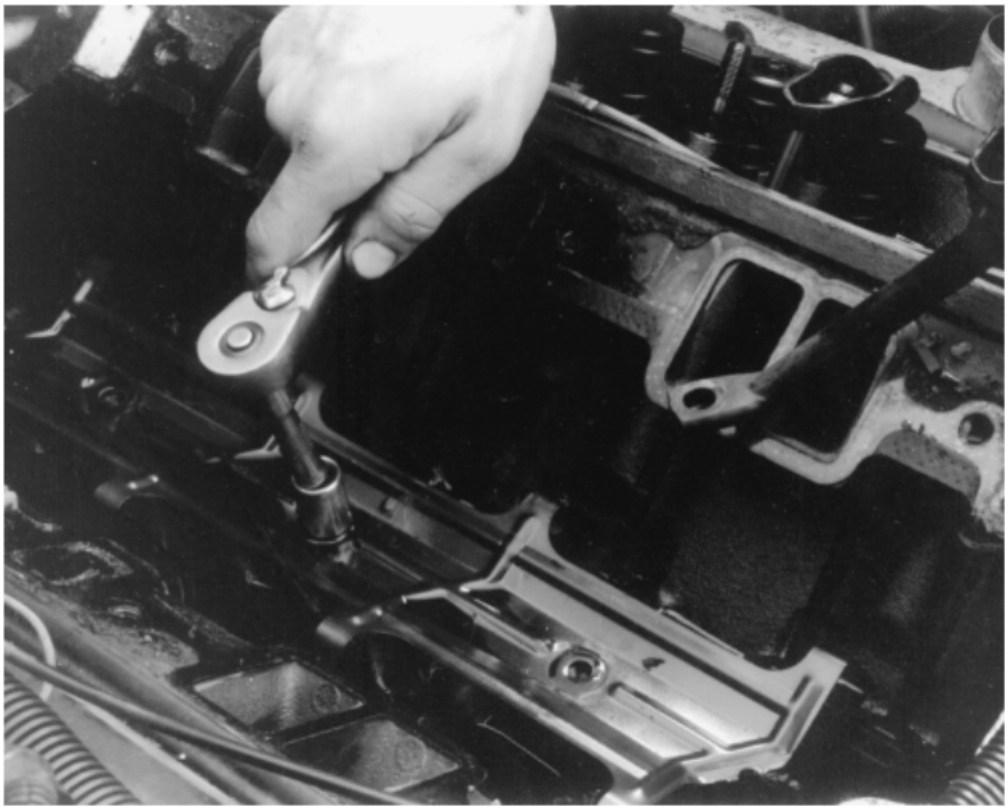


Fig. 2: Removing the lifter retainer hold-down bolts - roller cam models

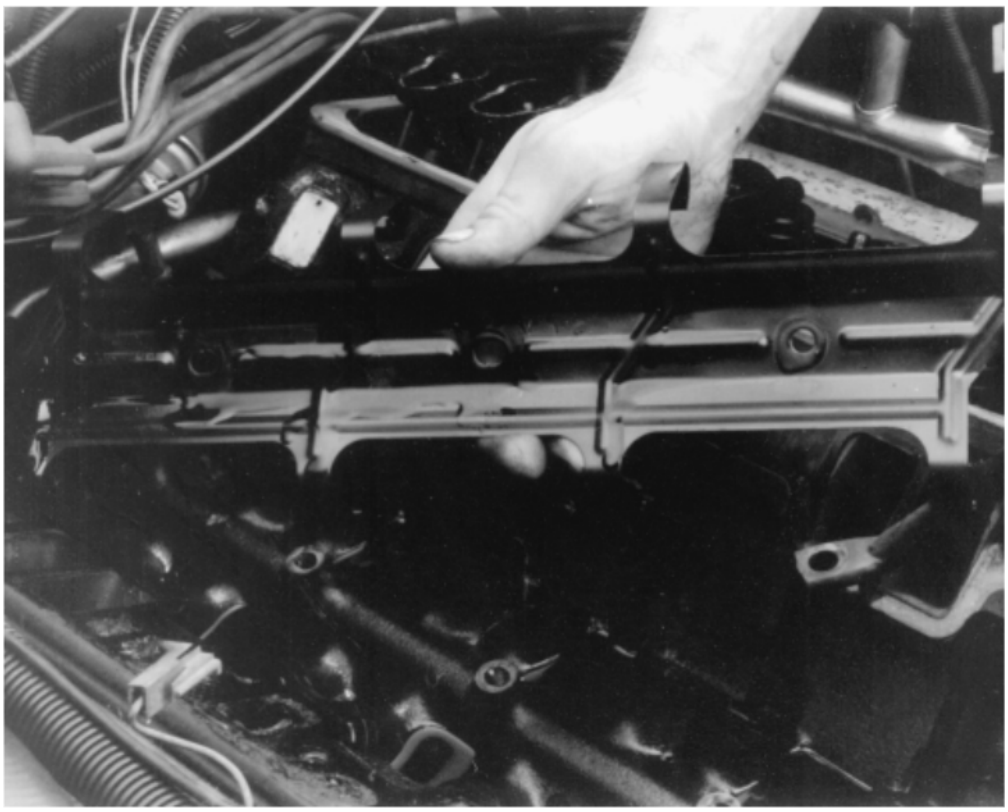


Fig. 3: Removing the lifter retainer hold-down - roller cam models

cardiagn.com

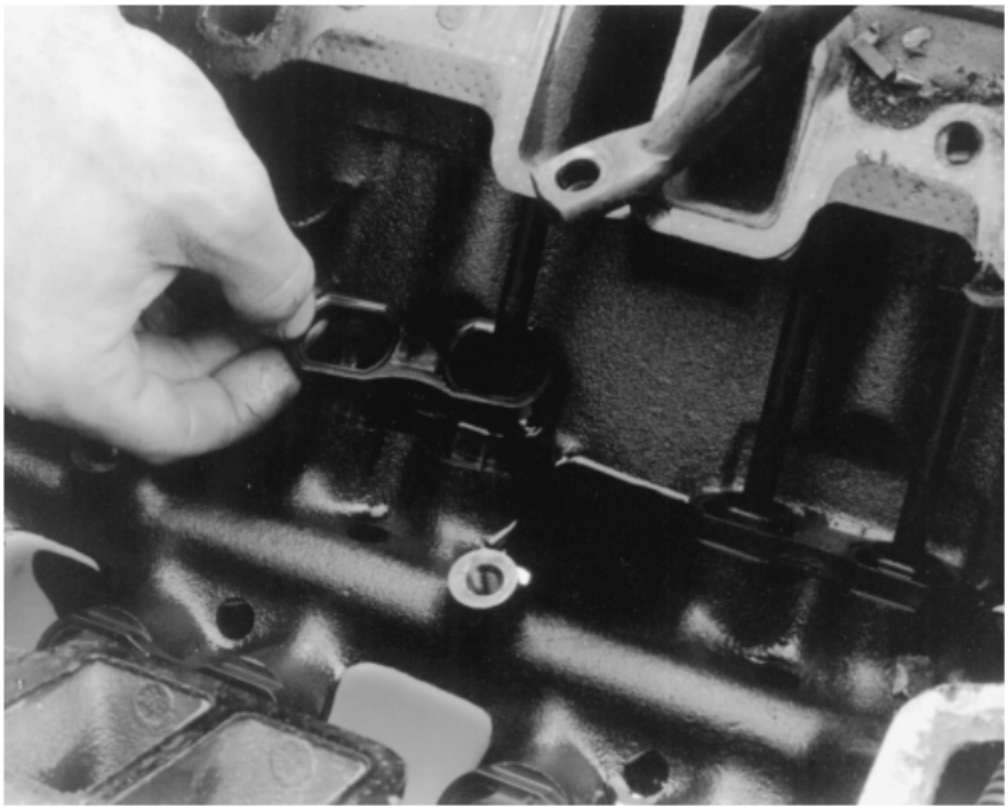


Fig. 4: Removing the lifter retainers - roller cam models

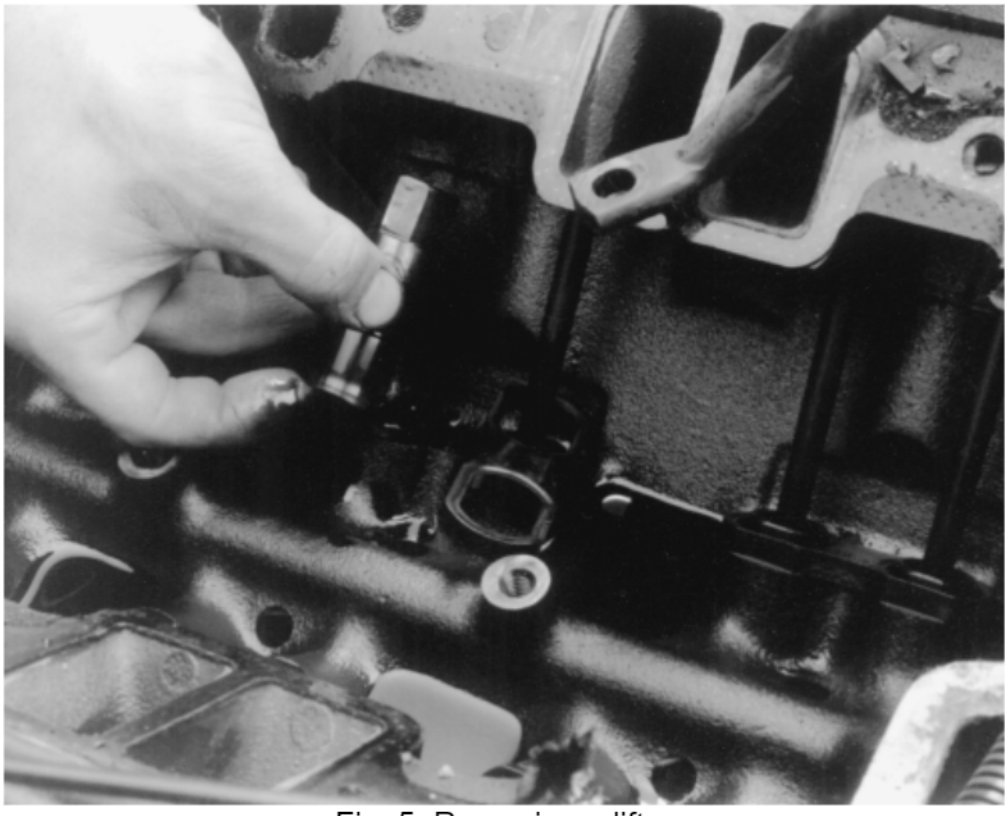


Fig. 5: Removing a lifter

cardiagn.com

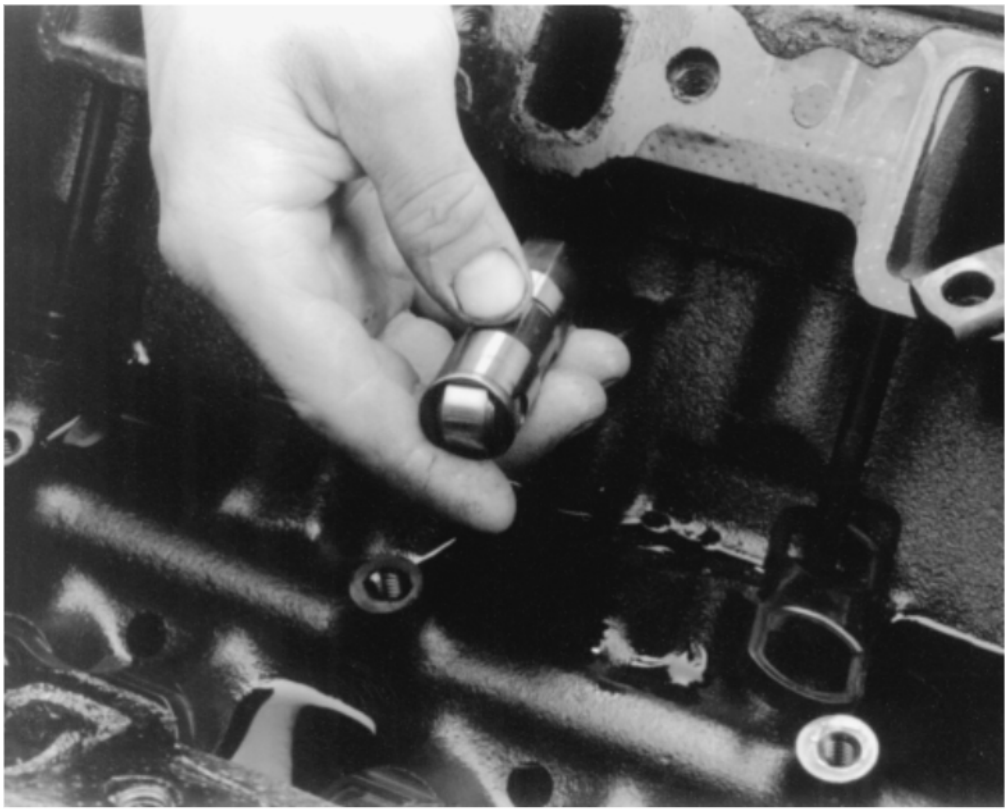
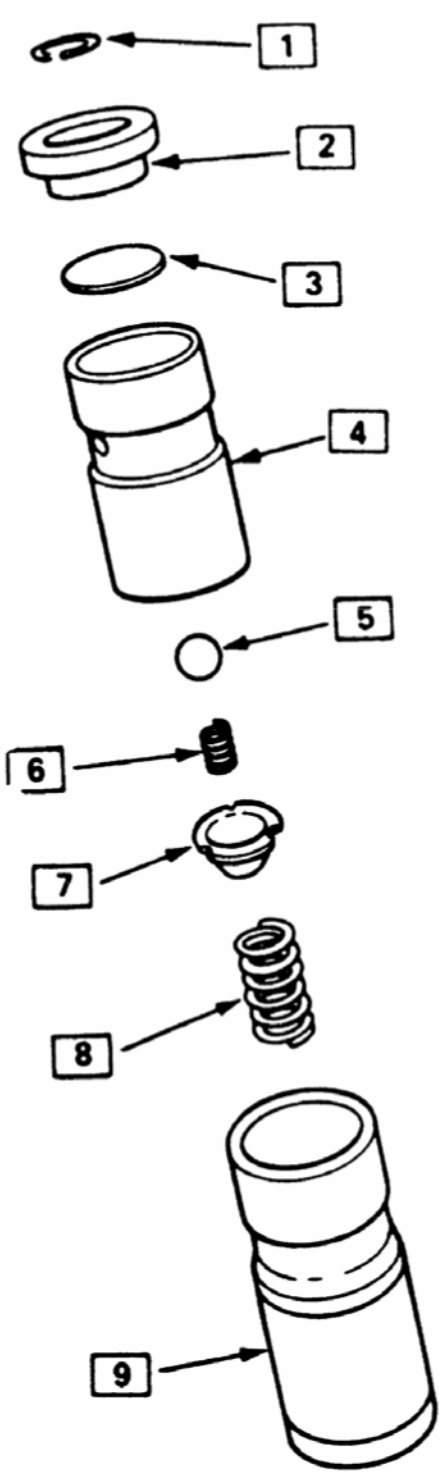


Fig. 6: This is a roller-type lifter - V8 engines

cardiagn.com



1. Retainer spring
2. Push rod seat
3. Rocker feed metering valve
4. Plunger
5. Ball check valve
6. Ball check valve spring (high ball lifter only)
7. Ball check valve retainer
8. Plunger spring
9. Lifter body

Fig. 7: Exploded view of a lifter, non-roller type

cardiagn.com

1. Remove the intake manifold, valve cover and pushrod cover (4-cylinder). Disassemble the rocker arms and remove the pushrods.
2. Remove the lifters. If they are coated with varnish, clean with carburetor cleaning solvent.
3. If installing new lifters or you have disassembled the lifters, they must be primed before installation. Submerge the lifters in SAE 10 oil and carefully push down on the plunger with a $^{1}/_{8}$ in. (3mm) drift. Hold the plunger down (DO NOT pump), then release the plunger slowly. The lifter is now primed.
4. Coat the bottoms of the lifters with Molykote® before installation. Install the lifters and pushrods into the engine in their original position.
5. Install the rocker arms and adjust the valves. Complete the installation by reversing the removal procedure.

FREEZE PLUGS

REMOVAL & INSTALLATION

CAUTION - When draining the coolant, keep in mind that cats and dogs are attracted by the ethylene glycol antifreeze, and are quite likely to drink any that is left in an uncovered container or in puddles on the ground. This will prove fatal in sufficient quantity. Always drain the coolant into a sealable container. Coolant should be reused unless it is contaminated or several years old.

1. Disconnect the negative battery cable.
2. Drain the cooling system.
3. Raise and support the vehicle safely.
4. Remove the coolant drain plug on the side of the block, if equipped. If not you can use a punch to put a small hole in the center of the freeze plug that is being replaced.
5. Remove all components in order to gain access to the freeze plug(s).
6. Using a punch, tap the bottom corner of the freeze plug to cock it in the bore. Remove the plug using pliers.
7. Clean the freeze plug hole and coat the new plug with sealer.
8. Using a suitable tool, install the freeze plug into the block.
9. Connect the negative battery cable, fill the cooling system, start the engine and check for leaks.

REAR MAIN OIL SEAL

REMOVAL & INSTALLATION

CAUTION - The EPA warns that prolonged contact with used engine oil may cause a number of skin disorders, including cancer! You should make every effort to minimize your exposure to used engine oil. Protective gloves should be worn when changing the oil. Wash your hands and any other exposed skin areas as soon as possible after exposure to used engine oil. Soap and water, or waterless hand cleaner should be used.

1-PIECE NEOPRENE SEAL

cardiagn.com

The rear main seal is a one piece unit. It can be removed or installed without removing the oil pan or crankshaft.

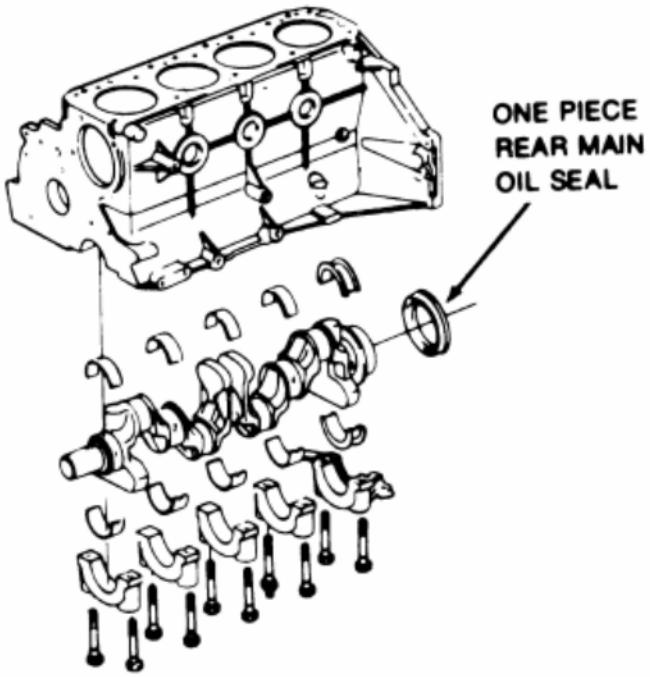


Fig. 1: The one-piece seal

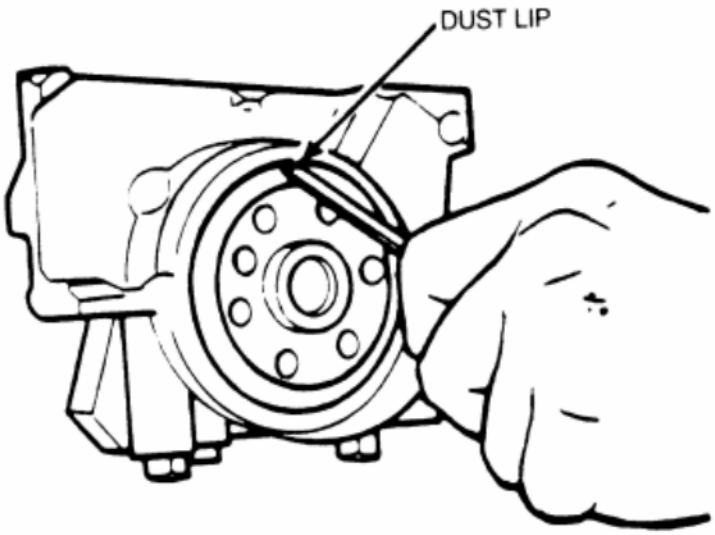


Fig. 2: One-piece seal removal

cardiagn.com

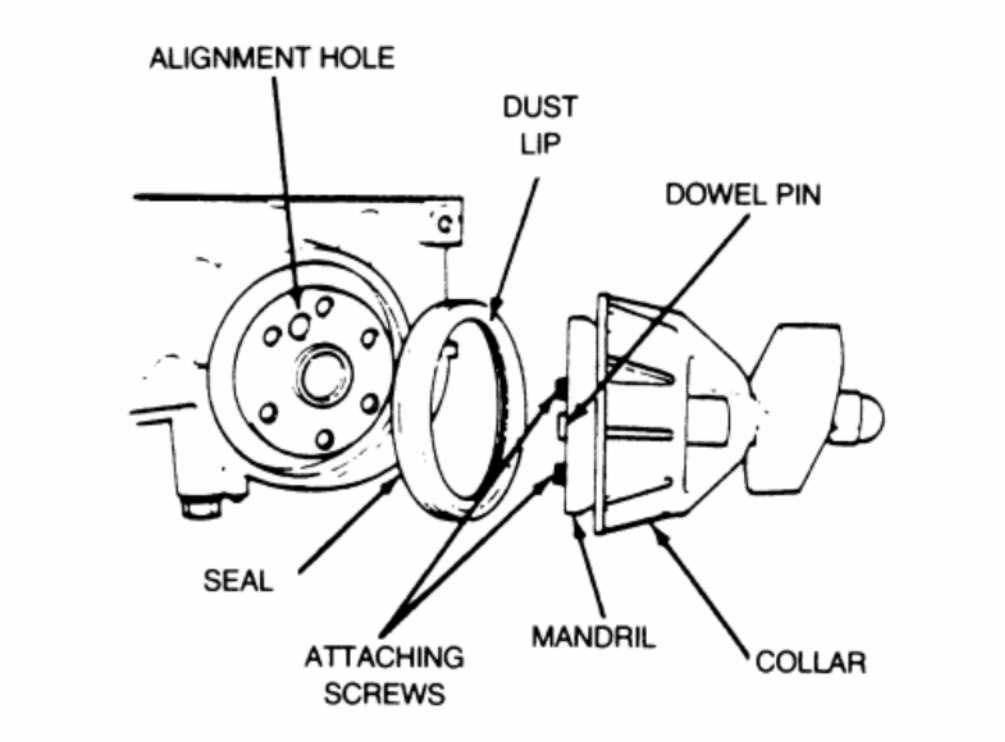


Fig. 3: One-piece seal installation

1. Jack up your vehicle and support it with jackstands.
2. Remove the transmission.
3. If equipped with a manual transmission, remove the clutch and pressure plate.
4. Remove the flywheel assembly.
5. Using a suitable tool, pry the old seal out.
6. Inspect the crankshaft for nicks or burrs, correct as required.

To install:

7. Clean the area and coat the seal with engine oil. Install the seal onto tool J-34686 or equivalent. Install the seal into the engine.
8. Install the flywheel and torque to specification.
9. Install the transmission. (If equipped with a manual transmission, install the clutch and pressure plate first.)
10. Check the fluid levels, start the engine and check for leaks.

cardiagn.com

2-PIECE NEOPRENE SEAL

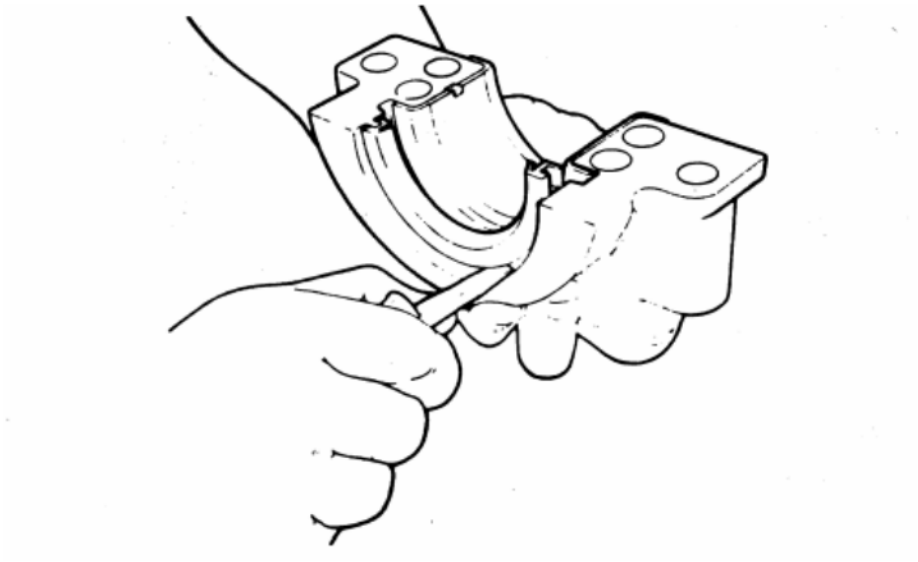


Fig. 4: Two-piece seal lower half removal

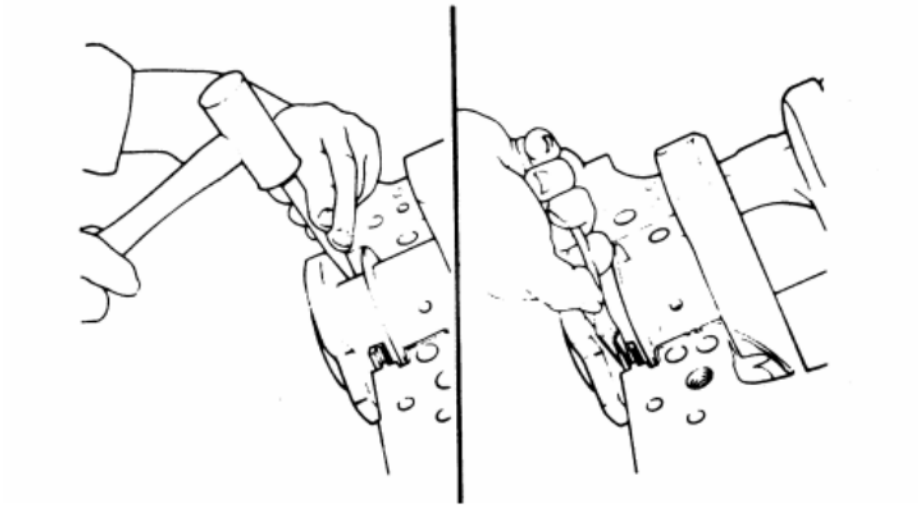


Fig. 5: Two-piece seal upper half removal

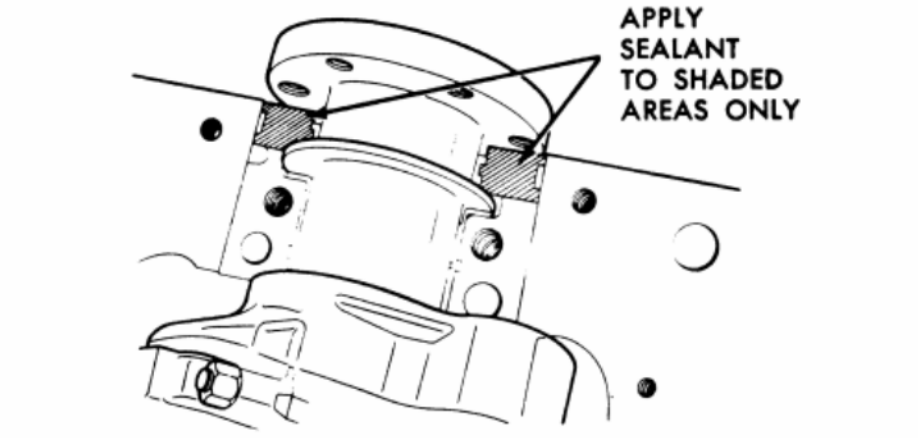


Fig. 6: Applying sealer to main bearing cap

cardiagn.com

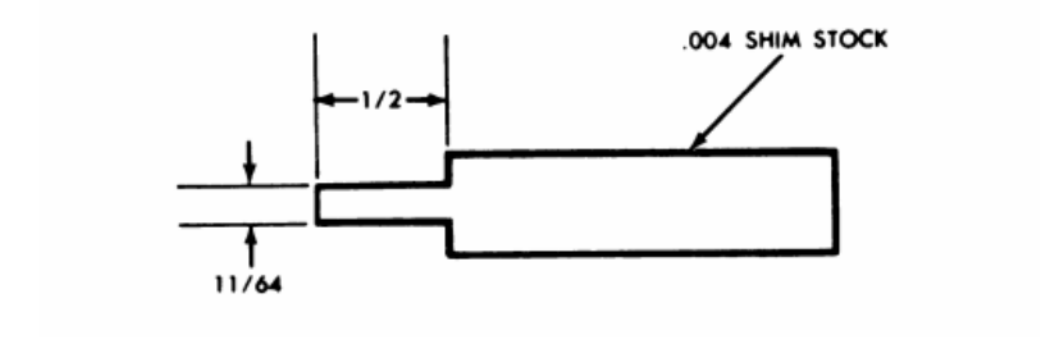


Fig. 7: Fabricated seal installation tool

Both halves of the rear main oil seal can be replaced without removing the crankshaft. Always replace the upper and lower seal together. The lip should face the front of the engine. Be very careful that you do not break the sealing bead in the channel on the outside portion of the seal while installing it. An installation tool can be fabricated to protect the seal bead.

1. Remove the oil pan, oil pump and rear main bearing cap.
2. Remove the oil seal from the bearing cap by prying it out.
3. Remove the upper half of the seal with a small punch. Drive it around far enough to be gripped with pliers.
4. Clean the crankshaft and bearing cap.
5. Coat the lips and bead of the seal with light engine oil, keeping oil from the ends of the seal.
6. Position the fabricated tool between the crankshaft and seal seat.
7. Position the seal between the crankshaft and tip of the tool so that the seal bead contacts the tip of the tool. The oil seal lip should face the FRONT of the engine.
8. Roll the seal around the crankshaft using the tool to protect the seal bead from the sharp corners of the crankcase.
9. The installation tool should be left installed until the seal is properly positioned with both ends flush with the block.
10. Remove the tool.
11. Install the other half of the seal in the bearing cap using the tool in the same manner as before. Light thumb pressure should install the seal.
12. Install the bearing cap with sealant applied to the mating areas of the cap and block. Keep sealant from the ends of the seal.
13. Torque the rear main bearing cap to specifications.
14. Install the oil pump and oil pan.
15. Fill the engine with engine oil, start the engine and check for leaks.

cardiagn.com

ROPE SEAL

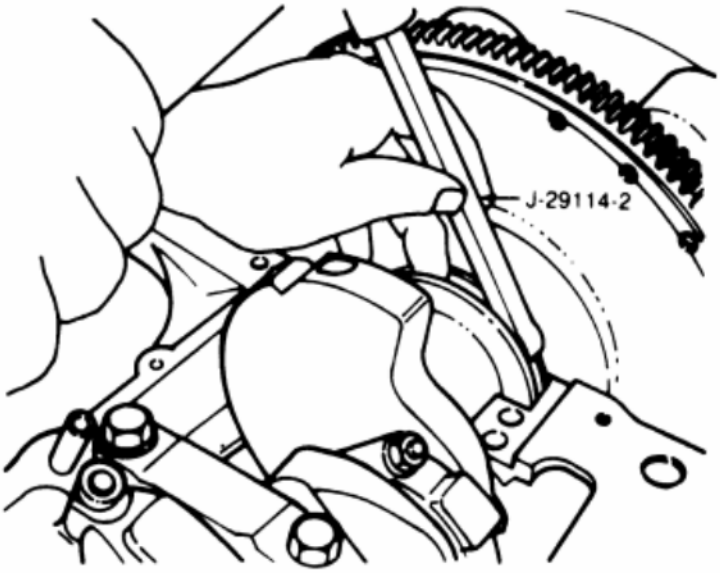


Fig. 8: Using the rope seal packing tool

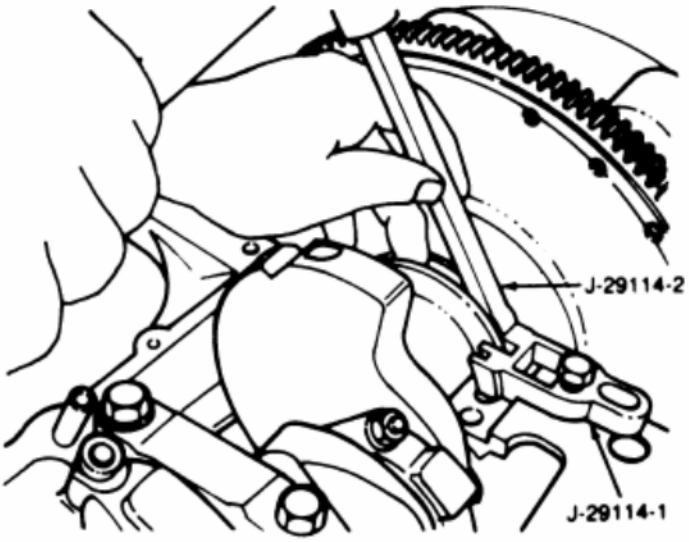


Fig. 9: Using the rope seal guide tool

cardiagn.com

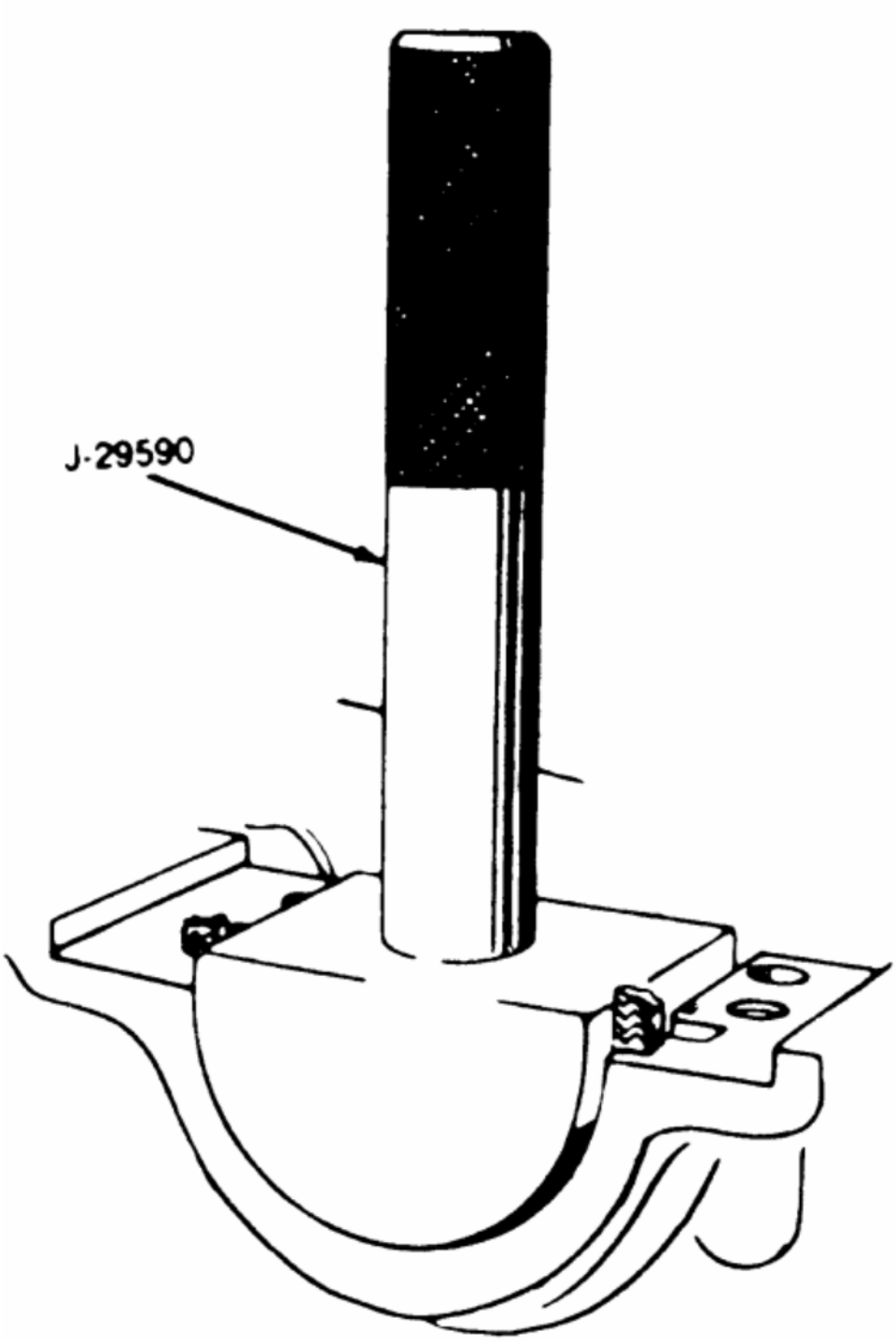


Fig. 10: Install the rope seal in the cap using tool J-29590 and cut the seals ends flush with the main cap

The following procedure is only to be used as an oil seal repair while the engine is in the vehicle. Whenever possible the crankshaft should be removed and a new complete rope seal installed.

1. Disconnect the negative battery cable.

cardiagn.com

2. Drain the engine oil and remove the oil pan.
3. Remove the rear main bearing cap.
4. Insert packing tool J-29114-2 or equivalent, against 1 end of the seal in the cylinder block. Drive the old seal gently into the groove until it is packed tight. This will vary from $^{1}/_{4}$ in. (6mm) to $^{3}/_{4}$ in. (19mm) depending on the amount of pack required.
5. Repeat the procedure on the other end of the seal.
6. Measure the amount the seal was driven up on one side and add $^{1}/_{16}$ in. (1.6mm). Using a suitable cutting tool, cut that length from the old seal removed from the rear main bearing cap. Repeat the procedure for the other side. Use the rear main bearing cap as a holding fixture when cutting the seal.
7. Install guide tool J-29114-1 or equivalent, onto the cylinder block.
8. Using the packing tool, work the short pieces cut in Step 6 into the guide tool and then pack into the cylinder block. The guide tool and packing tool are machined to provide a built in stop. Use this procedure for both sides. It may help to use oil on the short pieces of the rope seal when packing them into the cylinder block.
9. Remove the guide tool.
10. Apply Loctite® 414 or equivalent, to the seal groove in the rear main bearing cap. Within 1 minute, insert a new seal into the groove and push into place with tool J-29590 until the seal is flush with the block. Cut the excess seal material with a sharp cutting tool at the bearing cap parting line.
11. Apply a thin film of chassis grease to the rope seal. Apply a thin film of RTV sealant on the bearing cap mating surface around the seal groove. Use the sealer sparingly.
12. Plastigage® the rear main bearing cap as outlined in MEASURING REAR MAIN CLEARANCE in this section and check with specification. If out of specification, check for frying of the rope seal which may be causing the cap to not seat properly.
13. Install all remaining components and inspect for leaks.

FLYWHEEL AND RING GEAR

REMOVAL & INSTALLATION

The ring gear is an integral part of the flywheel and is not replaceable.

1. Remove the transmission.
2. Remove the six bolts attaching the flywheel to the crankshaft flange. Remove the flywheel.
3. Inspect the flywheel for cracks, and inspect the ring gear for burrs or worn teeth. Replace the flywheel if any damage is apparent. Remove burrs with a mill file.
4. Install the flywheel. The flywheel will only attach to the crankshaft in one position, as the bolt holes are unevenly spaced. Install the bolts and torque to specification. Tighten bolts in crisscross pattern.

cardiagn.com

EXHAUST SYSTEM

INSPECTION

Safety glasses should be worn at all times when working on or near the exhaust system. Older exhaust systems will almost always be covered with loose rust particles which will shower you when disturbed. These particles are more than a nuisance and could injure your eye.

CAUTION - Do NOT perform exhaust repairs or inspection with the engine or exhaust hot. Allow the system to cool completely before attempting any work. Exhaust systems are noted for sharp edges, flaking metal and rusted bolts. Gloves and eye protection are required. A healthy supply of penetrating oil and rags is highly recommended.

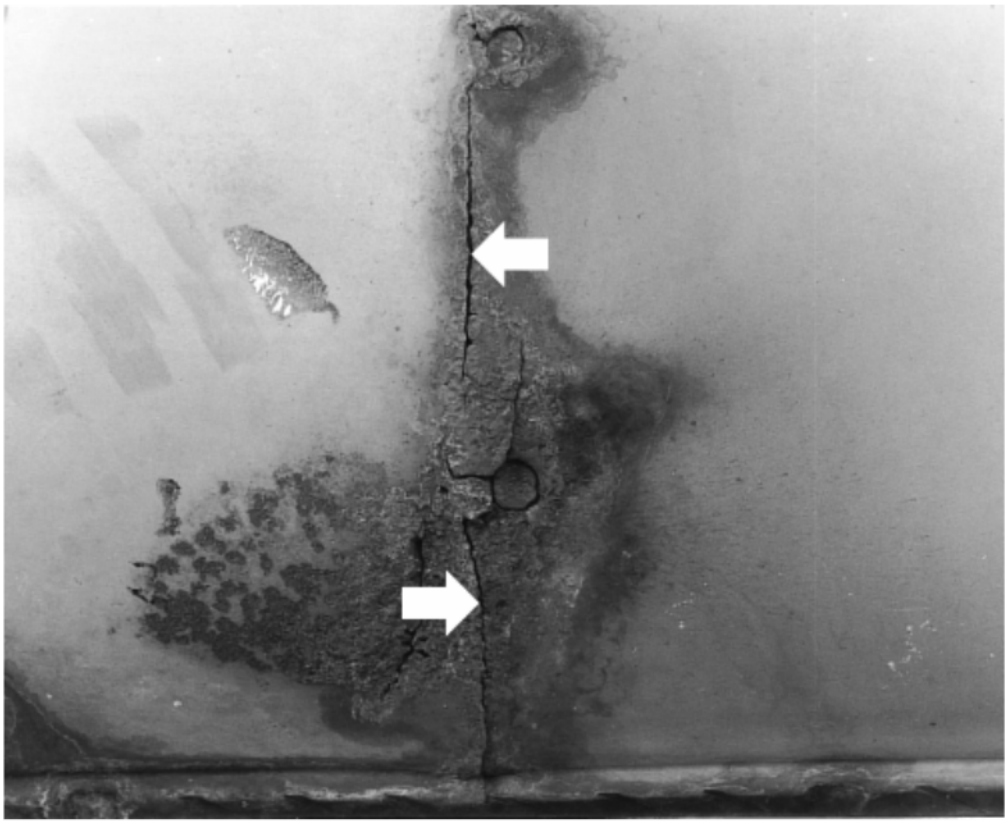


Fig. 1: Cracks in the muffler are a guaranteed leak

cardiagn.com

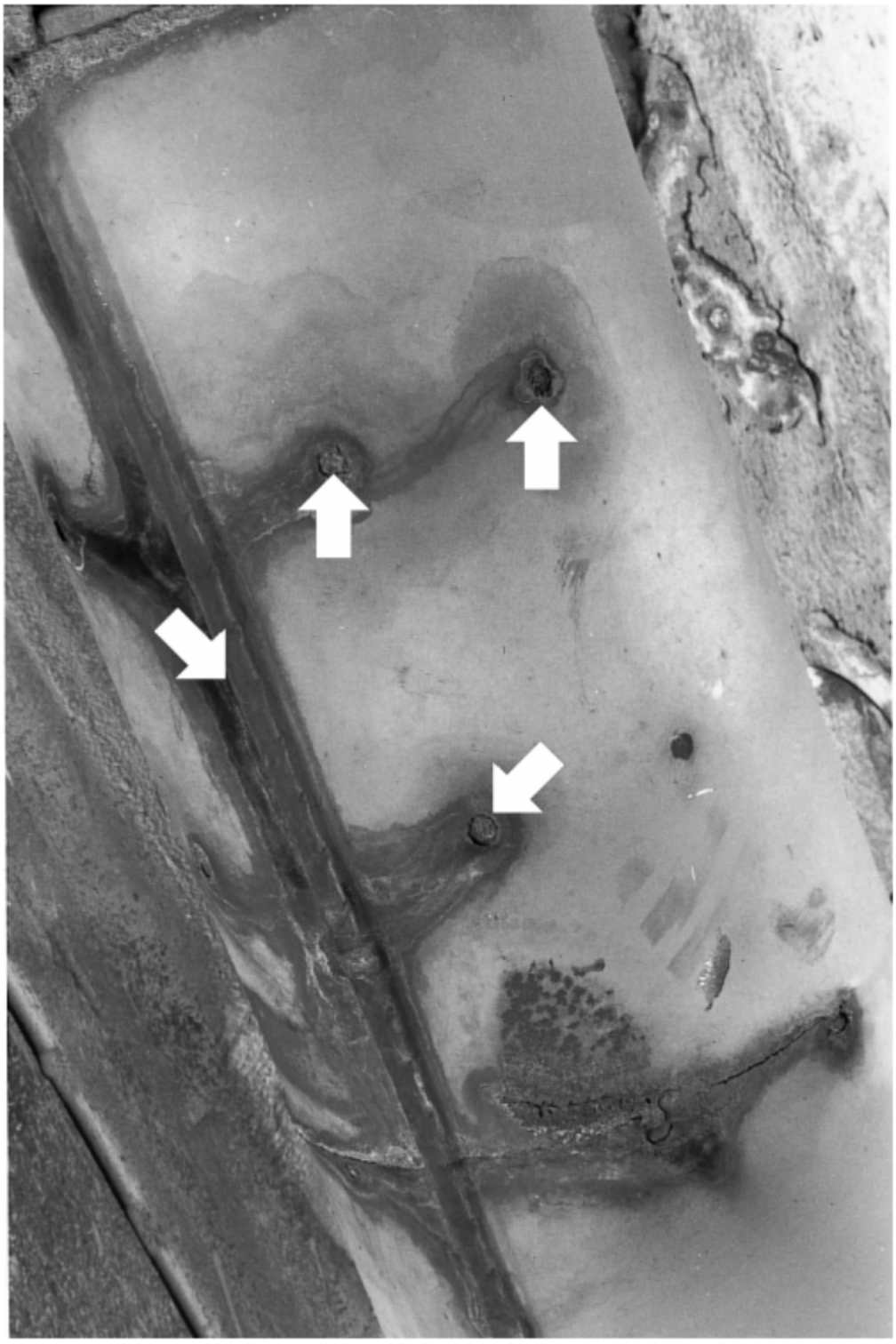


Fig. 2: Check the muffler for rotted spot welds and seams

Your vehicle must be raised and supported safely to inspect the exhaust system properly. By placing 4 safety stands under the vehicle for support should provide enough room for you to slide under the vehicle and inspect the system completely. Start the inspection at the exhaust manifold where the header pipe is attached and work your way to the back of the vehicle. On dual exhaust systems, remember to inspect both sides of the vehicle. Check the complete exhaust system for open seams, holes loose connections, or other deterioration

cardiagn.com

which could permit exhaust fumes to seep into the passenger compartment. Inspect all mounting brackets and hangers for deterioration, some models may have rubber O-rings that can be overstretched and non-supportive. These components will need to be replaced if found. It has always been a practice to use a pointed tool to poke up into the exhaust system where the deterioration spots are to see whether or not they crumble. Some models may have heat shield covering certain parts of the exhaust system , it will be necessary to remove these shields to have the exhaust visible for inspection also.

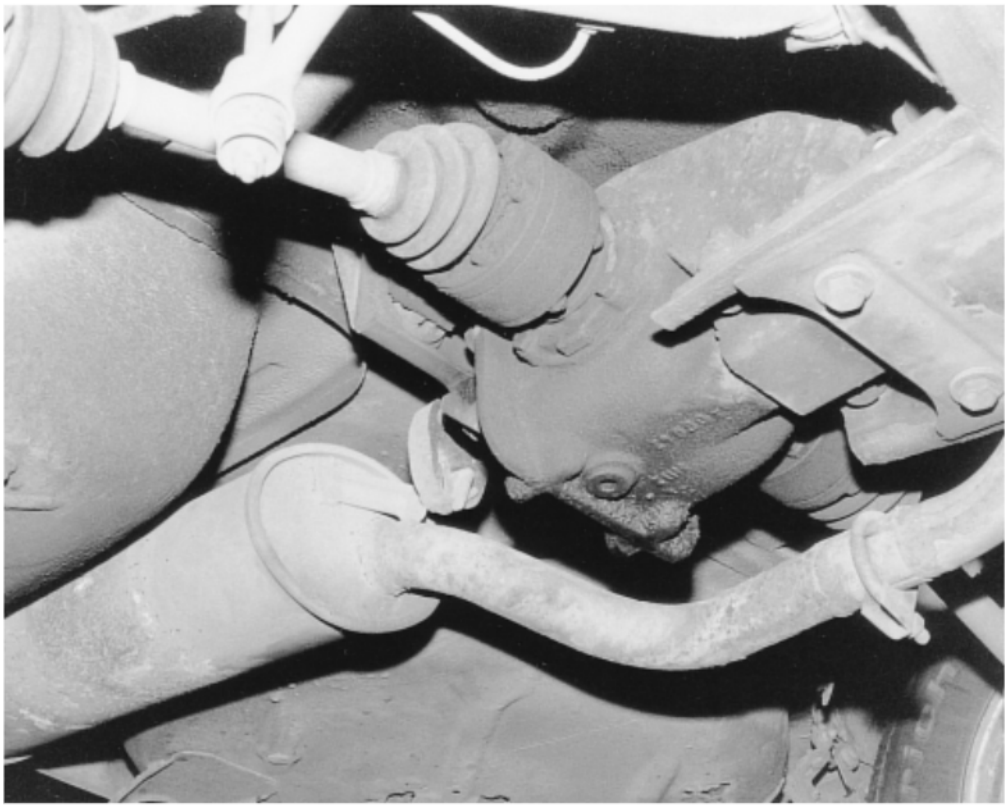


Fig. 3: Make sure the exhaust components are not contacting the body or suspension

cardiagn.com



Fig. 4: Check for overstretched or torn exhaust hangers



Fig. 5: Example of a badly deteriorated exhaust pipe

cardiagn.com

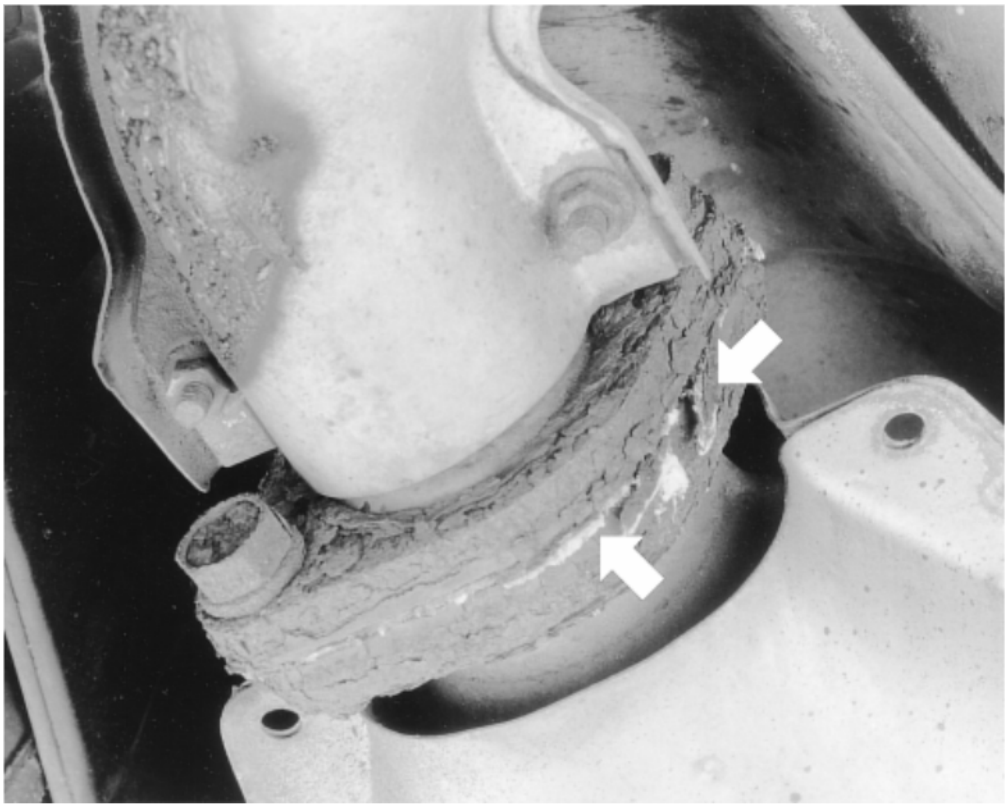


Fig. 6: Inspect flanges for gaskets that have deteriorated and need replacement

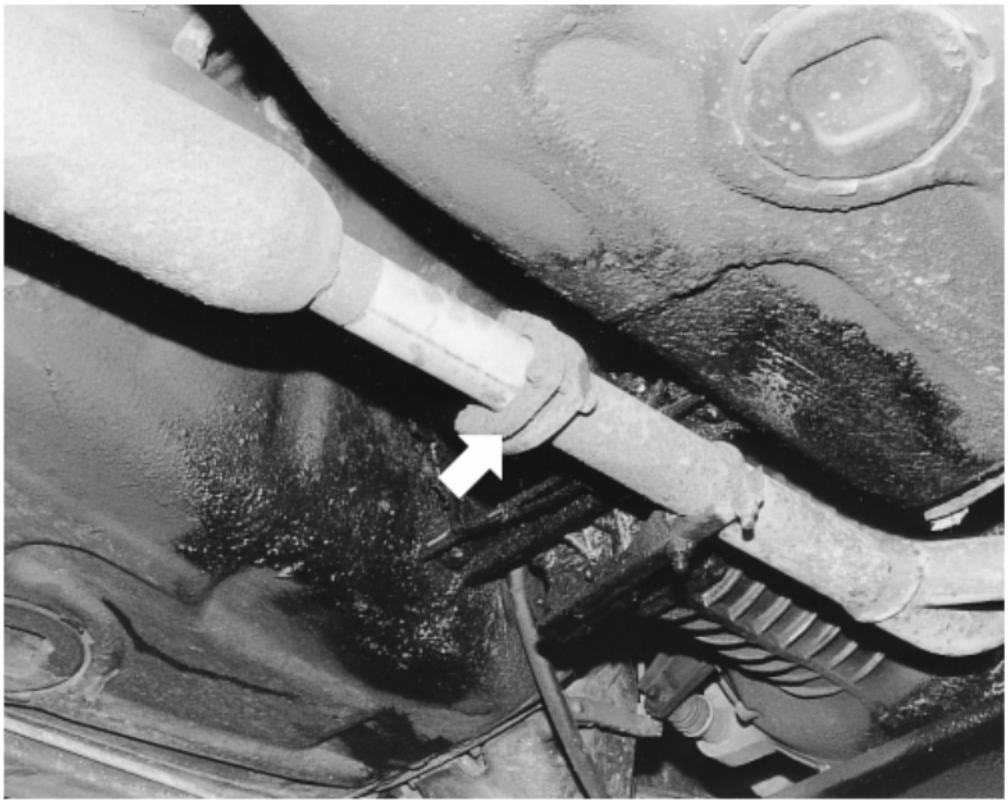


Fig. 7: Some systems, like this one, use large O-rings (donuts) in between the flanges

cardiagn.com

REPLACEMENT

There are basically two types of exhaust systems. One is the flange type where the component ends are attached with bolts and a gasket in-between. The other exhaust system is the slip joint type. These components slip into one another using clamps to retain them together.

CAUTION - Allow the exhaust system to cool sufficiently before spraying a solvent exhaust fasteners. Some solvents are highly flammable and could ignite when sprayed on hot exhaust components.

Before removing any component of the exhaust system, ALWAYS squirt a liquid rust dissolving agent onto the fasteners for ease of removal. A lot of knuckle skin will be saved by following this rule. It may even be wise to spray the fasteners and allow them to sit overnight.

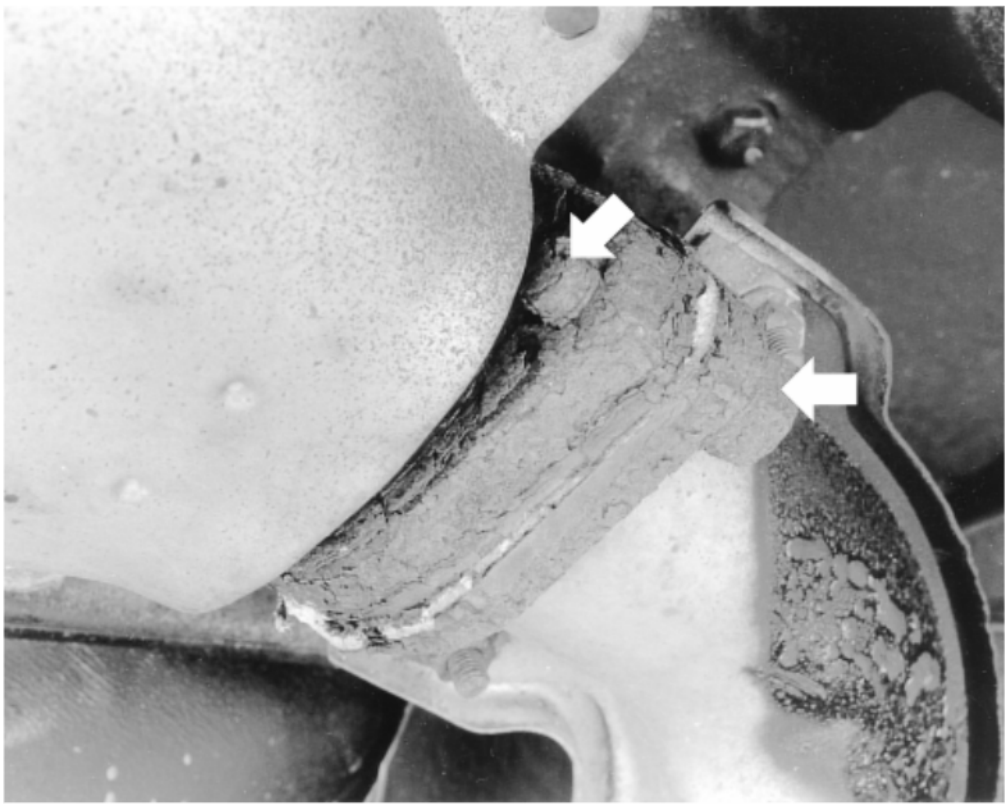


Fig. 8: Nuts and bolts will be extremely difficult to remove when deteriorated with rust

FLANGE TYPE

CAUTION - Do NOT perform exhaust repairs or inspection with the engine or exhaust hot. Allow the system to cool completely before attempting any work. Exhaust systems are noted for sharp edges, flaking metal and rusted bolts. Gloves and eye protection are required. A healthy supply of penetrating oil and rags is highly recommended. Never spray liquid rust dissolving agent onto a hot exhaust component.

cardiagn.com

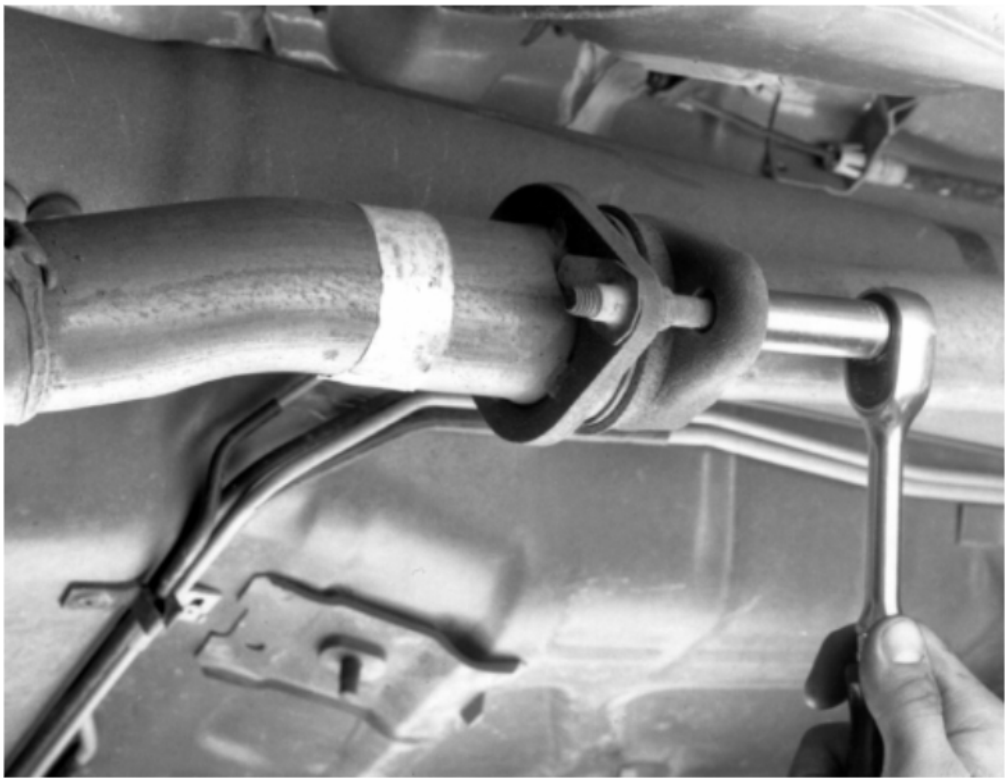


Fig. 9: Example of a flange type exhaust system joint

Before removing any component on a flange type system, ALWAYS squirt a liquid rust dissolving agent onto the fasteners for ease of removal. Start by unbolting the exhaust piece at both ends (if required). When unbolting the headpipe from the manifold, make sure that the bolts are free before trying to remove them. if you snap a stud in the exhaust manifold, the stud will have to be removed with a bolt extractor, which often means removal of the manifold itself. Next, disconnect the component from the mounting; slight twisting and turning may be required to remove the component completely from the vehicle. You may need to tap on the component with a rubber mallet to loosen the component. If all else fails, use a hacksaw to separate the parts. An oxy-acetylene cutting torch may be faster but the sparks are DANGEROUS near the fuel tank, and at the very least, accidents could happen, resulting in damage to the under-car parts, not to mention yourself.

cardiagn.com

SLIP JOINT TYPE

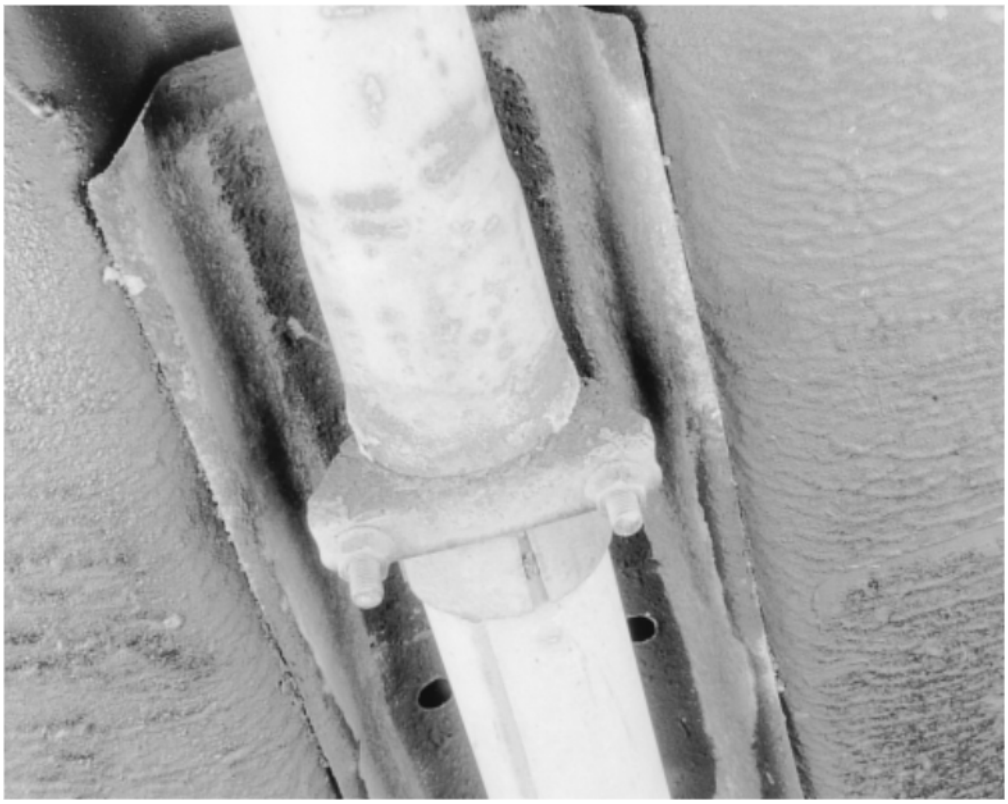


Fig. 10: Example of a common slip joint type system

Before removing any component on the slip joint type exhaust system, ALWAYS squirt a liquid rust dissolving agent onto the fasteners for ease of removal. Start by unbolting the exhaust piece at both ends (if required). When unbolting the headpipe from the manifold, make sure that the bolts are free before trying to remove them. if you snap a stud in the exhaust manifold, the stud will have to be removed with a bolt extractor, which often means removal of the manifold itself. Next, remove the mounting U-bolts from around the exhaust pipe you are extracting from the vehicle. Don't be surprised if the U-bolts break while removing the nuts. Loosen the exhaust pipe from any mounting brackets retaining it to the floor pan and separate the components.

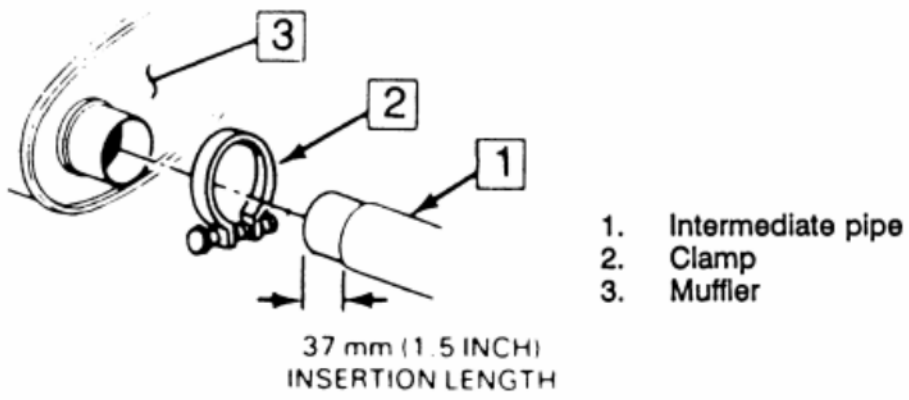


Fig. 11: Intermediate pipe attachment at muffler

cardiagn.com

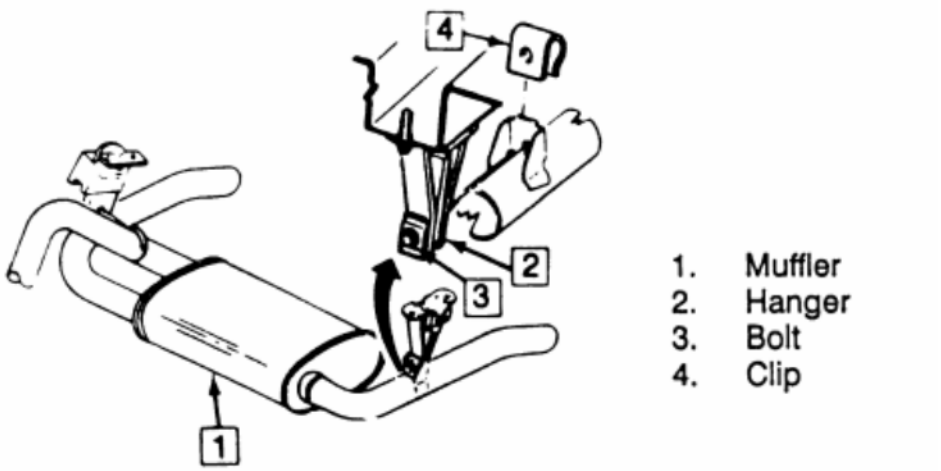


Fig. 12: Muffler hanger attachment

ENGINE RECONDITIONING DETERMINING ENGINE CONDITION

Anything that generates heat and/or friction will eventually burn or wear out (i.e. a light bulb generates heat, therefore its life span is limited). With this in mind, a running engine generates tremendous amounts of both; friction is encountered by the moving and rotating parts inside the engine and heat is created by friction and combustion of the fuel. However, the engine has systems designed to help reduce the effects of heat and friction and provide added longevity. The oiling system reduces the amount of friction encountered by the moving parts inside the engine, while the cooling system reduces heat created by friction and combustion. If either system is not maintained, a break-down will be inevitable. Therefore, you can see how regular maintenance can affect the service life of your vehicle. If you do not drain, flush and refill your cooling system at the proper intervals, deposits will begin to accumulate in the radiator, thereby reducing the amount of heat it can extract from the coolant. The same applies to your oil and filter; if it is not changed often enough it becomes laden with contaminates and is unable to properly lubricate the engine. This increases friction and wear.

There are a number of methods for evaluating the condition of your engine. A compression test can reveal the condition of your pistons, piston rings, cylinder bores, head gasket(s), valves and valve seats. An oil pressure test can warn you of possible engine bearing, or oil pump failures. Excessive oil consumption, evidence of oil in the engine air intake area and/or bluish smoke from the tail pipe may indicate worn piston rings, worn valve guides and/or valve seals. As a general rule, an engine that uses no more than one quart of oil every 1000 miles is in good condition. Engines that use one quart of oil or more in less than 1000 miles should first be checked for oil leaks. If any oil leaks are present, have them fixed before determining how much oil is consumed by the engine, especially if blue smoke is not visible at the tail pipe.

COMPRESSION TEST

A noticeable lack of engine power, excessive oil consumption and/or poor fuel mileage measured over an extended period are all indicators of internal engine

cardiagn.com

wear. Worn piston rings, scored or worn cylinder bores, blown head gaskets, sticking or burnt valves, and worn valve seats are all possible culprits. A check of each cylinder's compression will help locate the problem.

A screw-in type compression gauge is more accurate than the type you simply hold against the spark plug hole. Although it takes slightly longer to use, it's worth the effort to obtain a more accurate reading.

1. Make sure that the proper amount and viscosity of engine oil is in the crankcase, then ensure the battery is fully charged.
2. Warm-up the engine to normal operating temperature, then shut the engine *OFF*.
3. Disable the ignition system.
4. Label and disconnect all of the spark plug wires from the plugs.
5. Thoroughly clean the cylinder head area around the spark plug ports, then remove the spark plugs.
6. Set the throttle plate to the fully open (wide-open throttle) position. You can block the accelerator linkage open for this, or you can have an assistant fully depress the accelerator pedal.

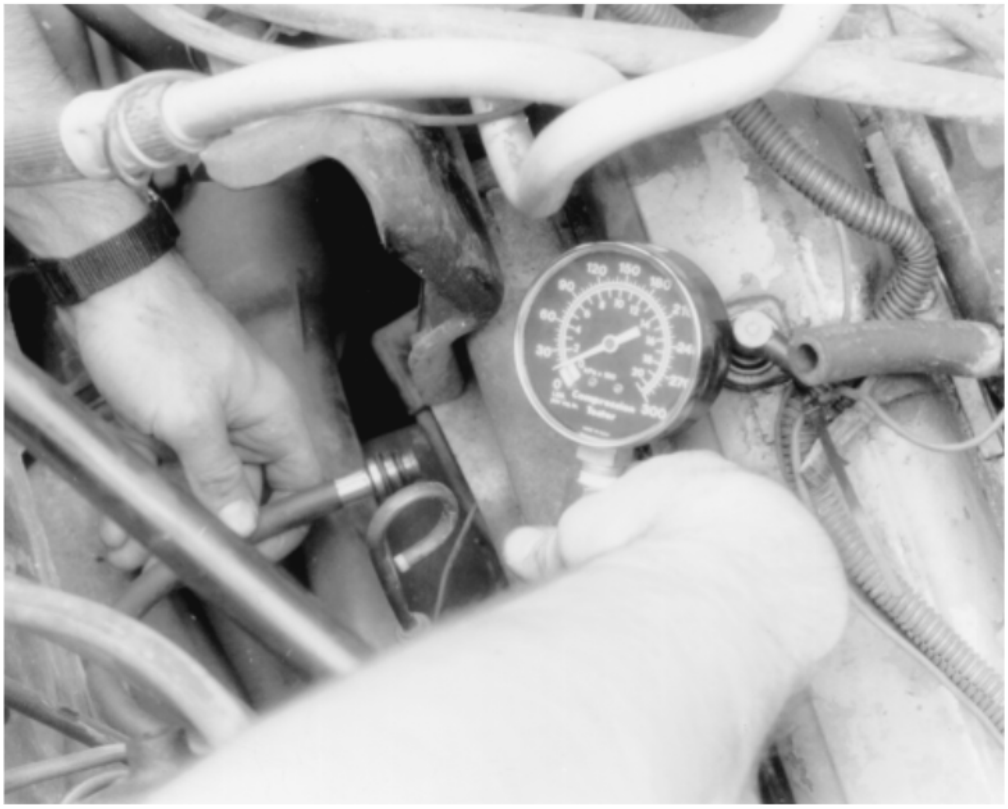


Fig. 1: A screw-in type compression gauge is more accurate and easier to use without an assistant

7. Install a screw-in type compression gauge into the No. 1 spark plug hole until the fitting is snug.

WARNING - Be careful not to crossthread the spark plug hole.

cardiagn.com

8. According to the tool manufacturer's instructions, connect a remote starting switch to the starting circuit.
9. With the ignition switch in the *OFF* position, use the remote starting switch to crank the engine through at least five compression strokes (approximately 5 seconds of cranking) and record the highest reading on the gauge.
10. Repeat the test on each cylinder, cranking the engine approximately the same number of compression strokes and/or time as the first.
11. Compare the highest readings from each cylinder to that of the others. The indicated compression pressures are considered within specifications if the lowest reading cylinder is within 75 percent of the pressure recorded for the highest reading cylinder. For example, if your highest reading cylinder pressure was 150 psi (1034 kPa), then 75 percent of that would be 113 psi (779 kPa). So the lowest reading cylinder should be no less than 113 psi (779 kPa).
12. If a cylinder exhibits an unusually low compression reading, pour a tablespoon of clean engine oil into the cylinder through the spark plug hole and repeat the compression test. If the compression rises after adding oil, it means that the cylinder's piston rings and/or cylinder bore are damaged or worn. If the pressure remains low, the valves may not be seating properly (a valve job is needed), or the head gasket may be blown near that cylinder. If compression in any two adjacent cylinders is low, and if the addition of oil doesn't help raise compression, there is leakage past the head gasket. Oil and coolant in the combustion chamber, combined with blue or constant white smoke from the tail pipe, are symptoms of this problem. However, don't be alarmed by the normal white smoke emitted from the tail pipe during engine warm-up or from cold weather driving. There may be evidence of water droplets on the engine dipstick and/or oil droplets in the cooling system if a head gasket is blown.

OIL PRESSURE TEST

Check for proper oil pressure at the sending unit passage with an externally mounted mechanical oil pressure gauge (as opposed to relying on a factory installed dash-mounted gauge). A tachometer may also be needed, as some specifications may require running the engine at a specific rpm.

1. With the engine cold, locate and remove the oil pressure sending unit.
2. Following the manufacturer's instructions, connect a mechanical oil pressure gauge and, if necessary, a tachometer to the engine.
3. Start the engine and allow it to idle.
4. Check the oil pressure reading when cold and record the number. You may need to run the engine at a specified rpm, so check the specifications chart located earlier in this section.
5. Run the engine until normal operating temperature is reached (upper radiator hose will feel warm).
6. Check the oil pressure reading again with the engine hot and record the number. Turn the engine *OFF*.

cardiagn.com

7. Compare your hot oil pressure reading to that given in the chart. If the reading is low, check the cold pressure reading against the chart. If the cold pressure is well above the specification, and the hot reading was lower than the specification, you may have the wrong viscosity oil in the engine. Change the oil, making sure to use the proper grade and quantity, then repeat the test.

Low oil pressure readings could be attributed to internal component wear, pump related problems, a low oil level, or oil viscosity that is too low. High oil pressure readings could be caused by an overfilled crankcase, too high of an oil viscosity or a faulty pressure relief valve.

BUY OR REBUILD?

Now that you have determined that your engine is worn out, you must make some decisions. The question of whether or not an engine is worth rebuilding is largely a subjective matter and one of personal worth. Is the engine a popular one, or is it an obsolete model? Are parts available? Will it get acceptable gas mileage once it is rebuilt? Is the car it's being put into worth keeping? Would it be less expensive to buy a new engine, have your engine rebuilt by a pro, rebuild it yourself or buy a used engine from a salvage yard? Or would it be simpler and less expensive to buy another car? If you have considered all these matters and more, and have still decided to rebuild the engine, then it is time to decide how you will rebuild it.

The editors of this information feel that most engine machining should be performed by a professional machine shop. Don't think of it as wasting money, rather, as an assurance that the job has been done right the first time. There are many expensive and specialized tools required to perform such tasks as boring and honing an engine block or having a valve job done on a cylinder head. Even inspecting the parts requires expensive micrometers and gauges to properly measure wear and clearances. Also, a machine shop can deliver to you clean, and ready to assemble parts, saving you time and aggravation. Your maximum savings will come from performing the removal, disassembly, assembly and installation of the engine and purchasing or renting only the tools required to perform the above tasks. Depending on the particular circumstances, you may save 40 to 60 percent of the cost doing these yourself.

A complete rebuild or overhaul of an engine involves replacing all of the moving parts (pistons, rods, crankshaft, camshaft, etc.) with new ones and machining the non-moving wearing surfaces of the block and heads. Unfortunately, this may not be cost effective. For instance, your crankshaft may have been damaged or worn, but it can be machined undersize for a minimal fee.

So, as you can see, you can replace everything inside the engine, but, it is wiser to replace only those parts which are really needed, and, if possible, repair the more expensive ones. Later in this section, we will break the engine down into its two main components: the cylinder head and the engine block. We will discuss each component, and the recommended parts to replace during a rebuild on each.

cardiagn.com

ENGINE OVERHAUL TIPS

Most engine overhaul procedures are fairly standard. In addition to specific parts replacement procedures and specifications for your individual engine, this section is also a guide to acceptable rebuilding procedures. Examples of standard rebuilding practice are given and should be used along with specific details concerning your particular engine.

Competent and accurate machine shop services will ensure maximum performance, reliability and engine life. In most instances it is more profitable for the do-it-yourself mechanic to remove, clean and inspect the component, buy the necessary parts and deliver these to a shop for actual machine work.

Much of the assembly work (crankshaft, bearings, piston rods, and other components) is well within the scope of the do-it-yourself mechanic's tools and abilities. You will have to decide for yourself the depth of involvement you desire in an engine repair or rebuild.

TOOLS

The tools required for an engine overhaul or parts replacement will depend on the depth of your involvement. With a few exceptions, they will be the tools found in a mechanic's tool kit (see General Information & Maintenance in this repair guide). More in-depth work will require some or all of the following:

- A dial indicator (reading in thousandths) mounted on a universal base
- Micrometers and telescope gauges
- Jaw and screw-type pullers
- Scraper
- Valve spring compressor
- Ring groove cleaner
- Piston ring expander and compressor
- Ridge reamer
- Cylinder hone or glaze breaker
- Plastigage®
- Engine stand

The use of most of these tools is illustrated in this section. Many can be rented for a one-time use from a local parts jobber or tool supply house specializing in automotive work.

Occasionally, the use of special tools is called for. See the information on Special Tools and the Safety Notice in General Information & Maintenance before substituting another tool.

OVERHAUL TIPS

Aluminum has become extremely popular for use in engines, due to its low weight. Observe the following precautions when handling aluminum parts:

cardiagn.com

- Never hot tank aluminum parts (the caustic hot tank solution will eat the aluminum.
- Remove all aluminum parts (identification tag, etc.) from engine parts prior to the tanking.
- Always coat threads lightly with engine oil or anti-seize compounds before installation, to prevent seizure.
- Never overtighten bolts or spark plugs especially in aluminum threads.

When assembling the engine, any parts that will be exposed to frictional contact must be prelubed to provide lubrication at initial start-up. Any product specifically formulated for this purpose can be used, but engine oil is not recommended as a prelube in most cases.

When semi-permanent (locked, but removable) installation of bolts or nuts is desired, threads should be cleaned and coated with Loctite® or another similar, commercial non-hardening sealant.

CLEANING

Before the engine and its components are inspected, they must be thoroughly cleaned. You will need to remove any engine varnish, oil sludge and/or carbon deposits from all of the components to insure an accurate inspection. A crack in the engine block or cylinder head can easily become overlooked if hidden by a layer of sludge or carbon.

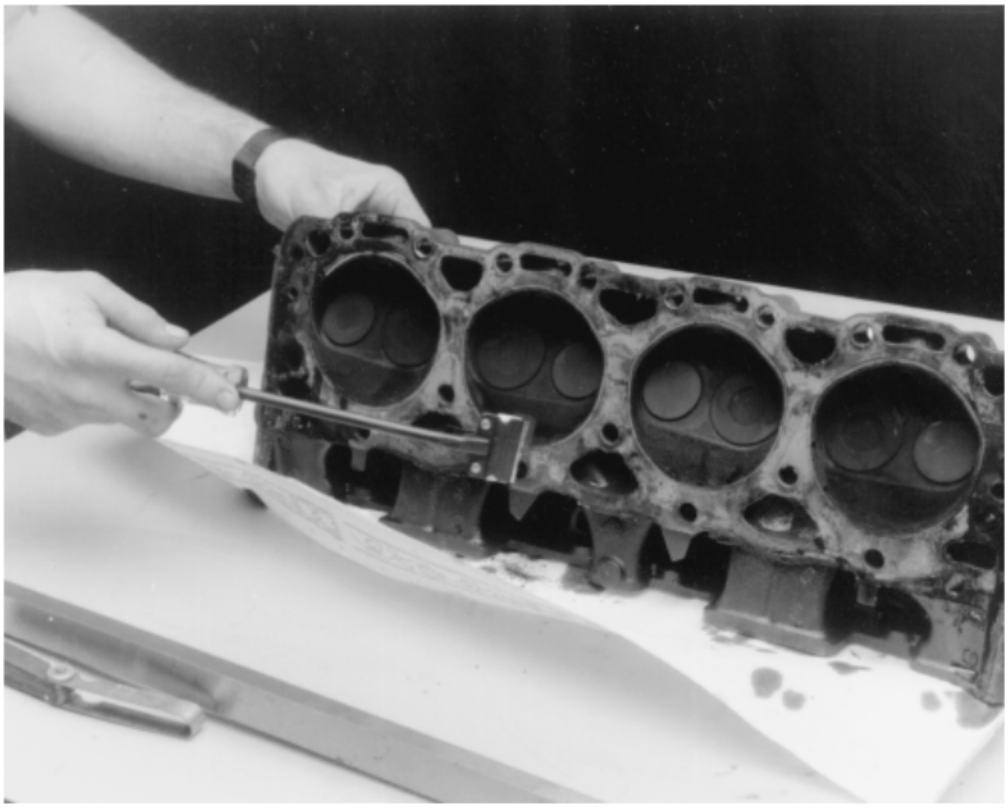


Fig. 1: Use a gasket scraper to remove the old gasket material from the mating surfaces

cardiagn.com

Most of the cleaning process can be carried out with common hand tools and readily available solvents or solutions. Carbon deposits can be chipped away using a hammer and a hard wooden chisel. Old gasket material and varnish or sludge can usually be removed using a scraper and/or cleaning solvent. Extremely stubborn deposits may require the use of a power drill with a wire brush. If using a wire brush, use extreme care around any critical machined surfaces (such as the gasket surfaces, bearing saddles, cylinder bores, etc.). Use of a wire brush is NOT RECOMMENDED on any aluminum components. Always follow any safety recommendations given by the manufacturer of the tool and/or solvent. You should always wear eye protection during any cleaning process involving scraping, chipping or spraying of solvents.

An alternative to the mess and hassle of cleaning the parts yourself is to drop them off at a local garage or machine shop. They will, more than likely, have the necessary equipment to properly clean all of the parts for a nominal fee.

CAUTION - Always wear eye protection during any cleaning process involving scraping, chipping or spraying of solvents.

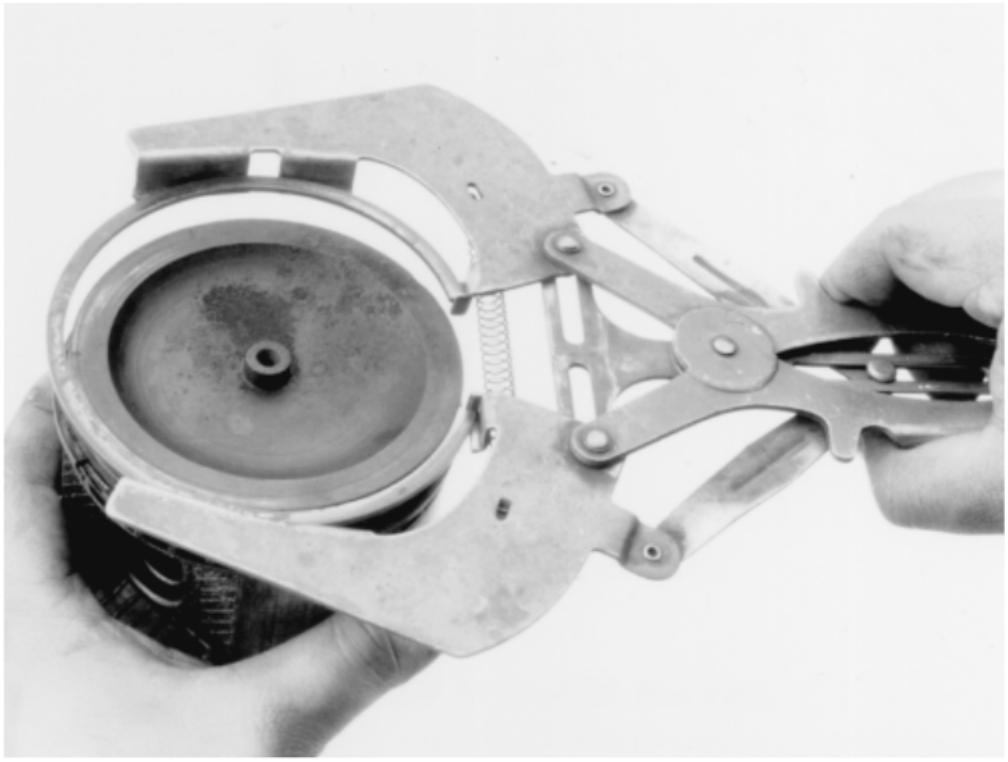


Fig. 2: Use a ring expander tool to remove the piston rings

Remove any oil galley plugs, freeze plugs and/or pressed-in bearings and carefully wash and degrease all of the engine components including the fasteners and bolts. Small parts such as the valves, springs, etc., should be placed in a metal basket and allowed to soak. Use pipe cleaner type brushes, and clean all passageways in the components. Use a ring expander and remove the rings from the pistons. Clean the piston ring grooves with a special tool or a piece of broken ring. Scrape the carbon off of the top of the piston. You should never use a wire brush on the pistons. After preparing all of the piston assemblies in this manner, wash and degrease them again.

cardiagn.com



Fig. 3: Clean the piston ring grooves using a ring groove cleaner tool, or ...



Fig. 4: ... use a piece of an old ring to clean the grooves. Be careful, the ring can be quite sharp

When cleaning the cylinder head, remove carbon from the combustion chamber with the valves installed. This will avoid damaging the valve seats.

cardiagn.com

REPAIRING DAMAGED THREADS

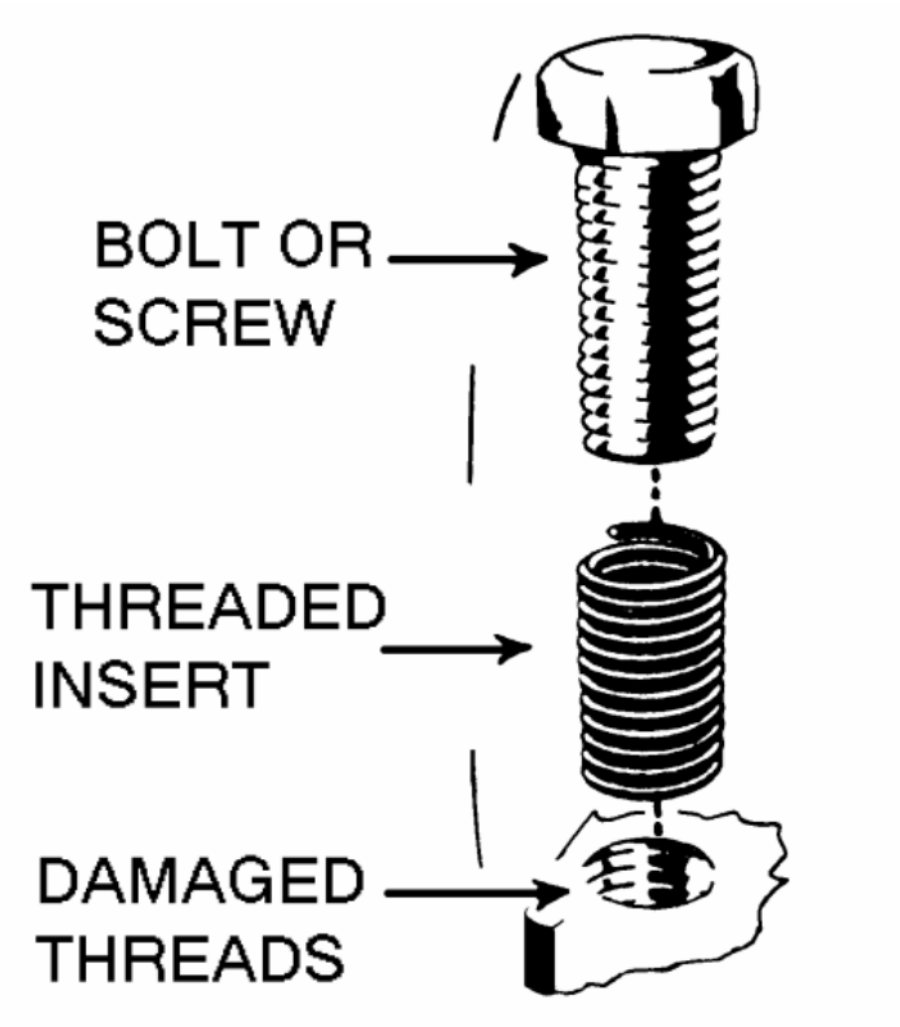


Fig. 5: Damaged bolt hole threads can be replaced with thread repair inserts

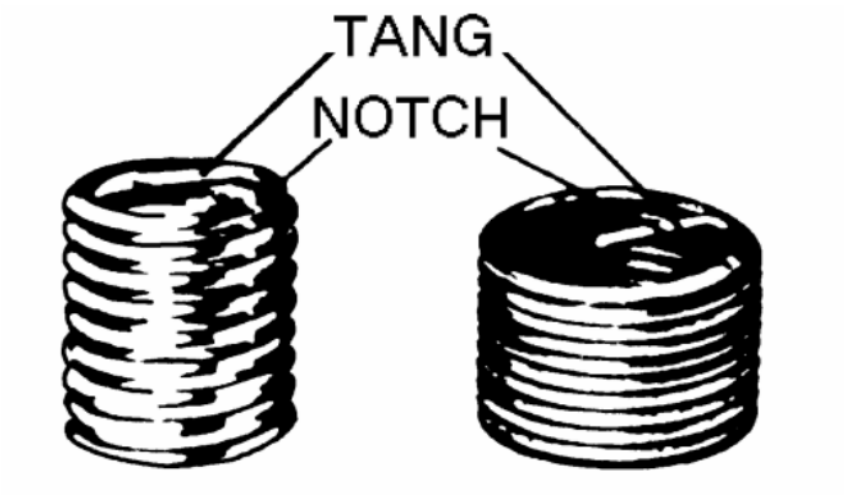


Fig. 6: Standard thread repair insert (left), and spark plug thread insert

cardiagn.com

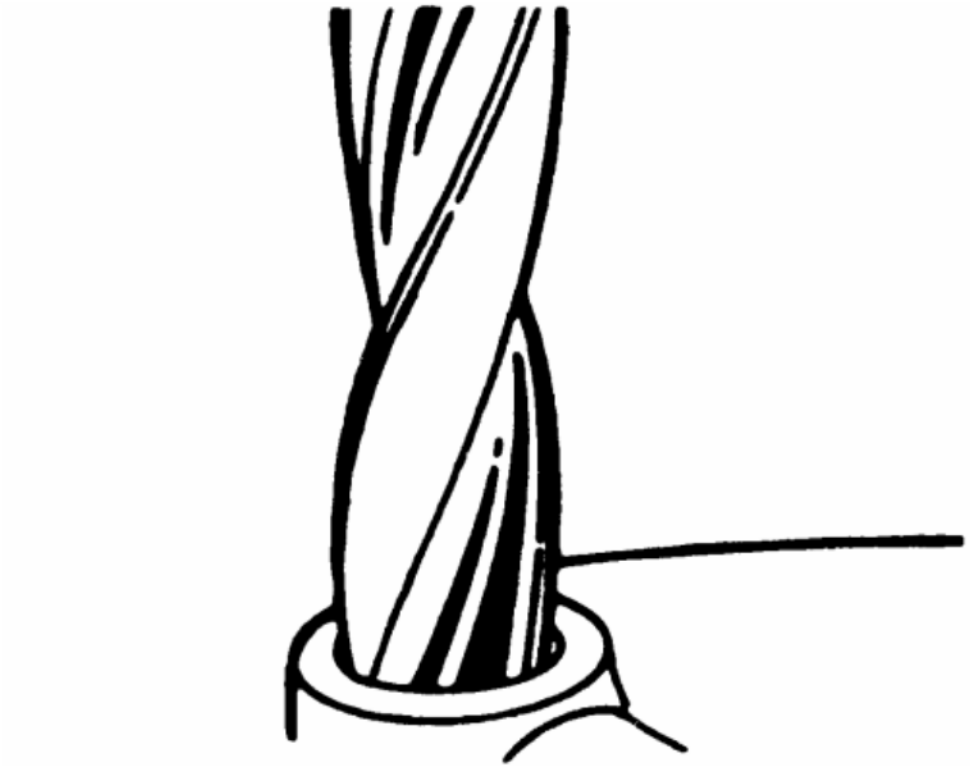


Fig. 7: Drill out the damaged threads with the specified size bit. Be sure to drill completely through the hole or to the bottom of a blind hole

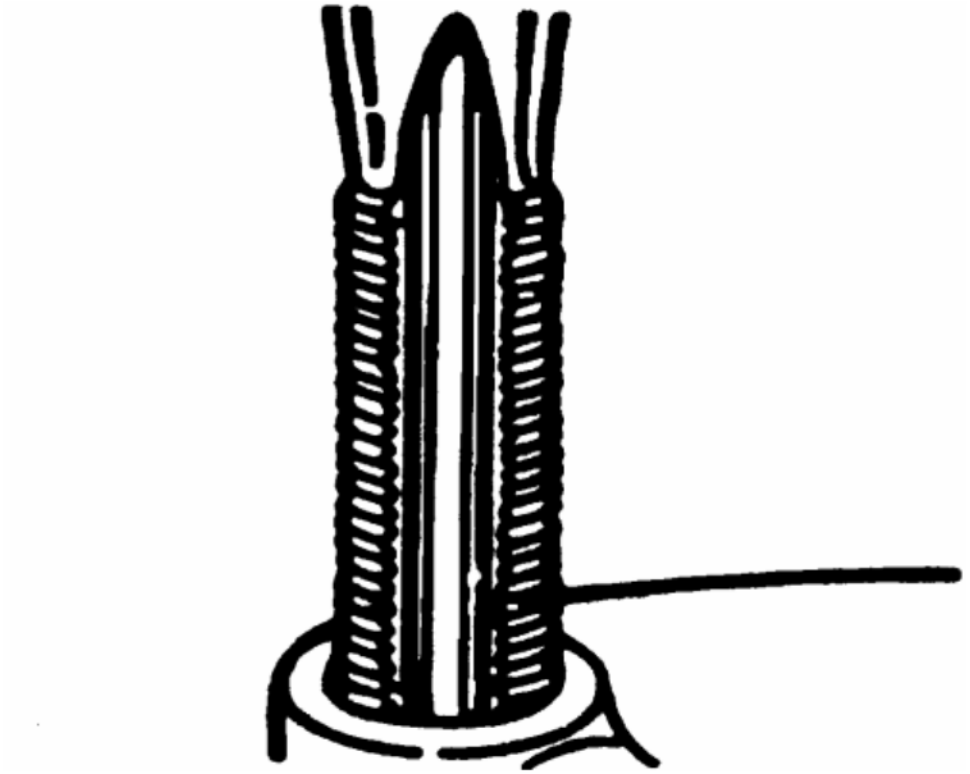


Fig. 8: Using the kit, tap the hole in order to receive the thread insert. Keep the tap well oiled and back it out frequently to avoid clogging the threads

cardiagn.com

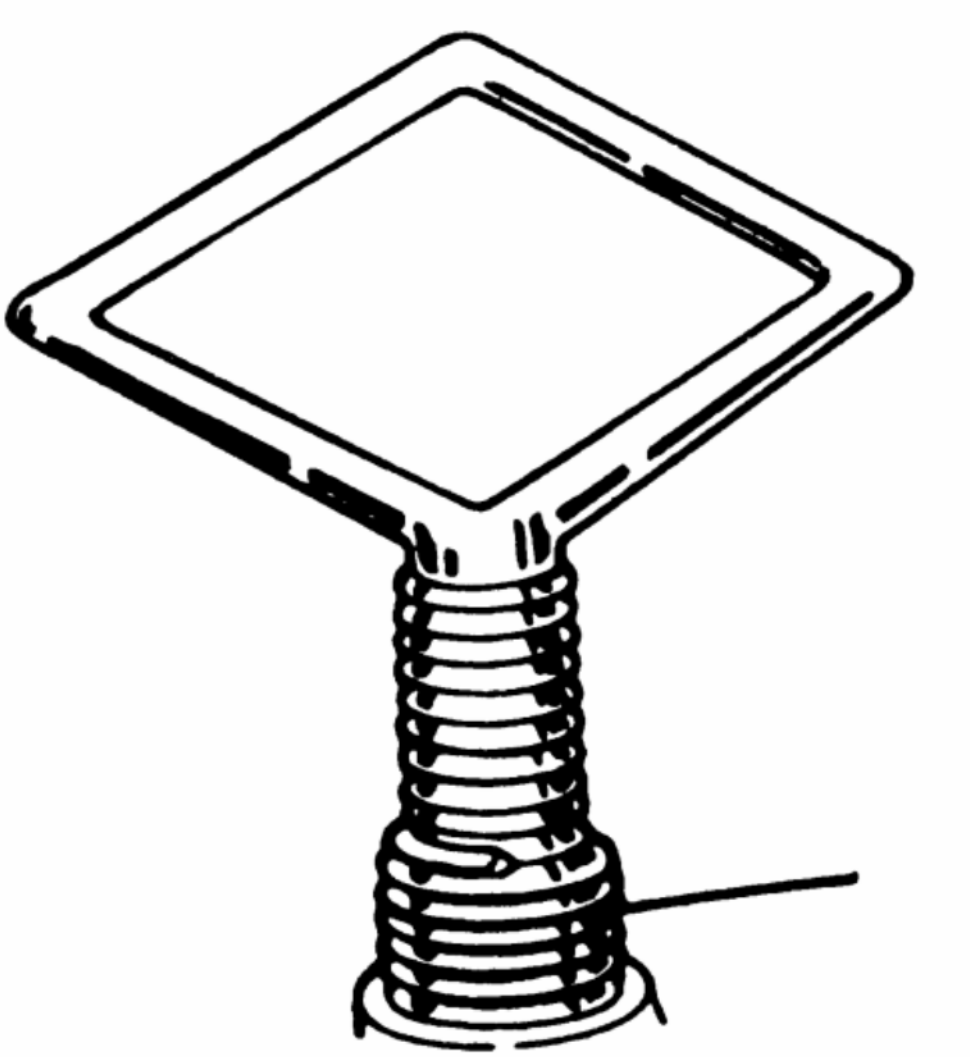


Fig. 9: Screw the insert onto the installer tool until the tang engages the slot. Thread the insert into the hole until it is 1/4-1/2 turn below the top surface, then remove the tool and break off the tang using a punch

Several methods of repairing damaged threads are available. Heli-Coil® (shown here), Keenserts® and Microdot® are among the most widely used. All involve basically the same principle - drilling out stripped threads, tapping the hole and installing a prewound insert - making welding, plugging and oversize fasteners unnecessary.

Two types of thread repair inserts are usually supplied: a standard type for most inch coarse, inch fine, metric course and metric fine thread sizes and a spark lug type to fit most spark plug port sizes. Consult the individual tool manufacturer's catalog to determine exact applications. Typical thread repair kits will contain a selection of prewound threaded inserts, a tap (corresponding to the outside diameter threads of the insert) and an installation tool. Spark plug inserts usually differ because they require a tap equipped with pilot threads and a combined reamer/tap section. Most manufacturers also supply blister-packed thread repair inserts separately in addition to a master kit containing a variety of taps and inserts plus installation tools.

cardiagn.com

Before attempting to repair a threaded hole, remove any snapped, broken or damaged bolts or studs. Penetrating oil can be used to free frozen threads. The offending item can usually be removed with locking pliers or using a screw/stud extractor. After the hole is clear, the thread can be repaired, as shown in the series of accompanying illustrations and in the kit manufacturer's instructions.

ENGINE PREPARATION

To properly rebuild an engine, you must first remove it from the vehicle, then disassemble and diagnose it. Ideally you should place your engine on an engine stand. This affords you the best access to the engine components. Follow the manufacturer's directions for using the stand with your particular engine. Remove the flywheel or flexplate before installing the engine to the stand.

Now that you have the engine on a stand, and assuming that you have drained the oil and coolant from the engine, it's time to strip it of all but the necessary components. Before you start disassembling the engine, you may want to take a moment to draw some pictures, or fabricate some labels or containers to mark the locations of various components and the bolts and/or studs which fasten them. Modern day engines use a lot of little brackets and clips which hold wiring harnesses and such, and these holders are often mounted on studs and/or bolts that can be easily mixed up. The manufacturer spent a lot of time and money designing your vehicle, and they wouldn't have wasted any of it by haphazardly placing brackets, clips or fasteners on the vehicle. If it's present when you disassemble it, put it back when you assemble, you will regret not remembering that little bracket which holds a wire harness out of the path of a rotating part.

You should begin by unbolting any accessories still attached to the engine, such as the water pump, power steering pump, alternator, etc. Then, unfasten any manifolds (intake or exhaust) which were not removed during the engine removal procedure. Finally, remove any covers remaining on the engine such as the rocker arm, front or timing cover and oil pan. Some front covers may require the vibration damper and/or crank pulley to be removed beforehand. The idea is to reduce the engine to the bare necessities (cylinder head(s), valve train, engine block, crankshaft, pistons and connecting rods), plus any other 'in block' components such as oil pumps, balance shafts and auxiliary shafts.

Finally, remove the cylinder head(s) from the engine block and carefully place on a bench. Disassembly instructions for each component follow later in this section.

CYLINDER HEAD

There are two basic types of cylinder heads used on todayâ€™s automobiles: the Overhead Valve (OHV) and the Overhead Camshaft (OHC). The latter can also be broken down into two subgroups: the Single Overhead Camshaft (SOHC) and the Dual Overhead Camshaft (DOHC). Generally, if there is only a single camshaft on a head, it is just referred to as an OHC head. Also, an engine with a OHV cylinder head is also known as a pushrod engine.

cardiagn.com

Most cylinder heads these days are made of an aluminum alloy due to its light weight, durability and heat transfer qualities. However, cast iron was the material of choice in the past, and is still used on many vehicles today. Whether made from aluminum or iron, all cylinder heads have valves and seats. Some use two valves per cylinder, while the more hi-tech engines will utilize a multi-valve configuration using 3, 4 and

even 5 valves per cylinder. When the valve contacts the seat, it does so on precision machined surfaces, which seals the combustion chamber. All cylinder heads have a valve guide for each valve. The guide centers the valve to the seat and allows it to move up and down within it. The clearance between the valve and guide can be critical. Too much clearance and the engine may consume oil, lose vacuum and/or damage the seat. Too little, and the valve can stick in the guide causing the engine to run poorly if at all, and possibly causing severe damage. The last component all cylinder heads have are valve springs. The spring holds the valve against its seat. It also returns the valve to this position when the valve has been opened by the valve train or camshaft. The spring is fastened to the valve by a retainer and valve locks (sometimes called keepers). Aluminum heads will also have a valve spring shim to keep the spring from wearing away the aluminum.

An ideal method of rebuilding the cylinder head would involve replacing all of the valves, guides, seats, springs, etc. with new ones. However, depending on how the engine was maintained, often this is not necessary. A major cause of valve, guide and seat wear is an improperly tuned engine. An engine that is running too rich, will often wash the lubricating oil out of the guide with gasoline, causing it to wear rapidly. Conversely, an engine which is running too lean will place higher combustion temperatures on the valves and seats allowing them to wear or even burn. Springs fall victim to the driving habits of the individual. A driver who often runs the engine rpm to the redline will wear out or break the springs faster then one that stays well below it. Unfortunately, mileage takes it toll on all of the parts. Generally, the valves, guides, springs and seats in a cylinder head can be machined and re-used, saving you money. However, if a valve is burnt, it may be wise to replace all of the valves, since they were all operating in the same environment. The same goes for any other component on the cylinder head. Think of it as an insurance policy against future problems related to that component.

Unfortunately, the only way to find out which components need replacing, is to disassemble and carefully check each piece. After the cylinder head(s) are disassembled, thoroughly clean all of the components.

DISASSEMBLY

Before disassembling the cylinder head, you may want to fabricate some containers to hold the various parts, as some of them can be quite small (such as keepers) and easily lost. Also keeping yourself and the components organized will aid in assembly and reduce confusion. Where possible, try to maintain a components original location; this is especially important if there is not going to be any machine work performed on the components.

cardiagn.com

1. If you havenâ€™t already removed the rocker arms and/or shafts, do so now.
2. Position the head so that the springs are easily accessed.

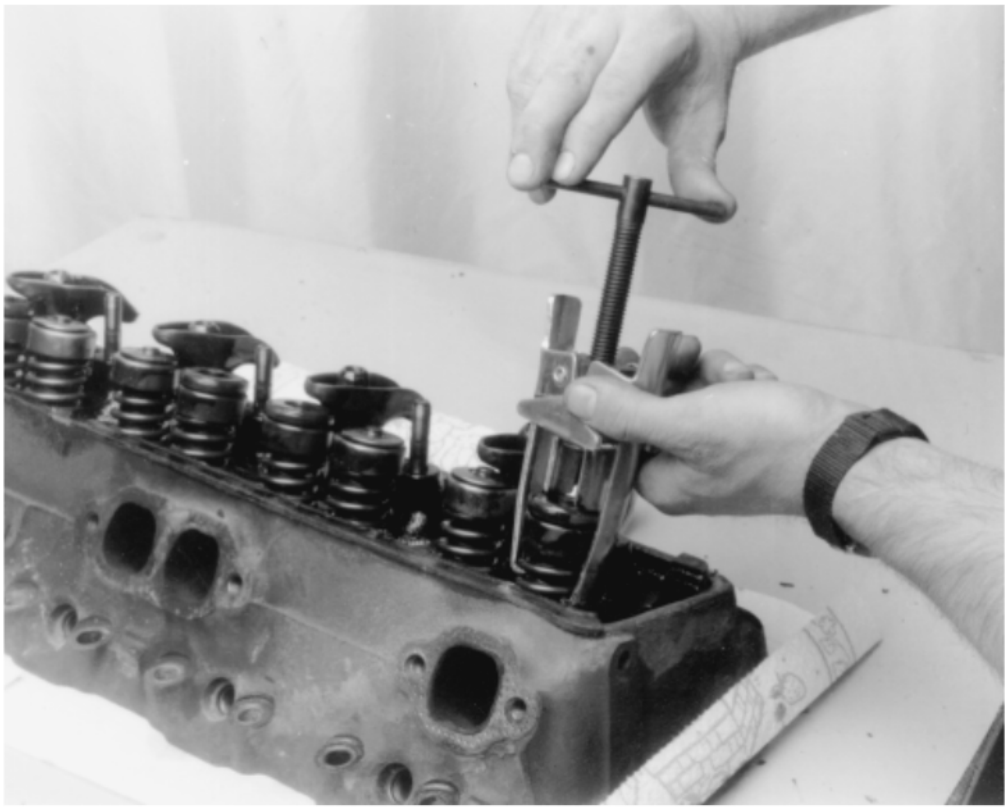


Fig. 1: When removing an OHV valve spring, use a compressor tool to relieve the tension from the retainer

3. Use a valve spring compressor tool, and relieve spring tension from the retainer.

Due to engine varnish, the retainer may stick to the valve locks. A gentle tap with a hammer may help to break it loose.

cardiagn.com

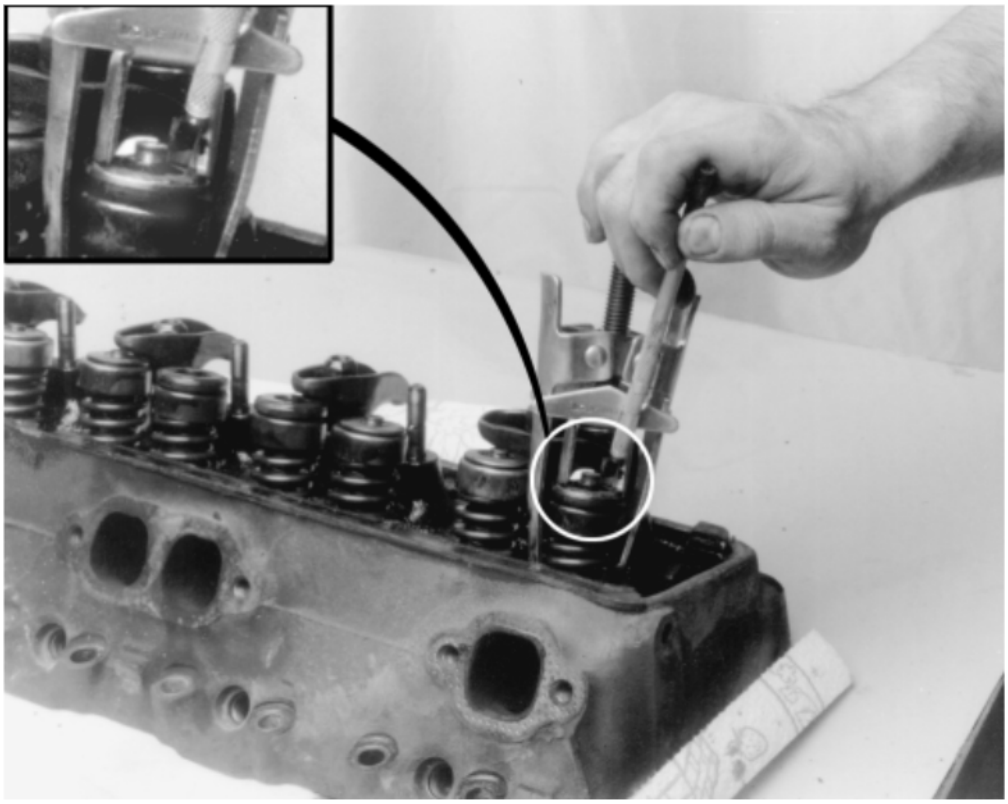


Fig. 2: A small magnet will help in removal of the valve locks

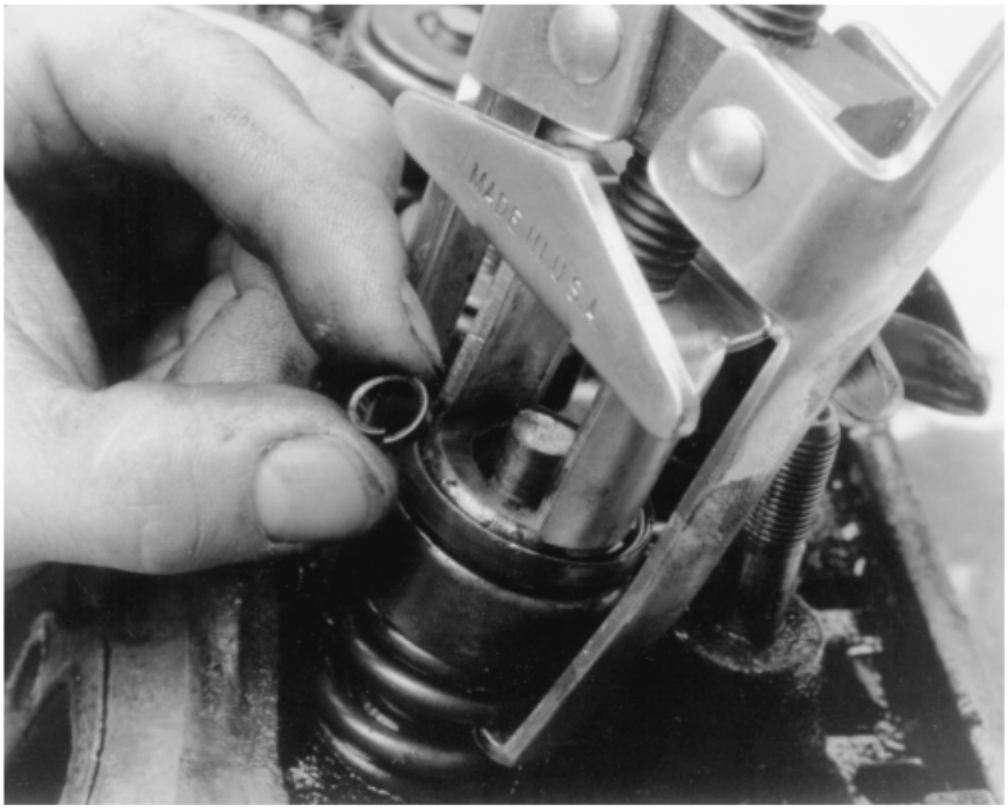


Fig. 3: Be careful not to lose the small valve locks (keepers)

cardiagn.com

4. Remove the valve locks from the valve tip and/or retainer. A small magnet may help in removing the locks.
5. Lift the valve spring, tool and all, off of the valve stem.

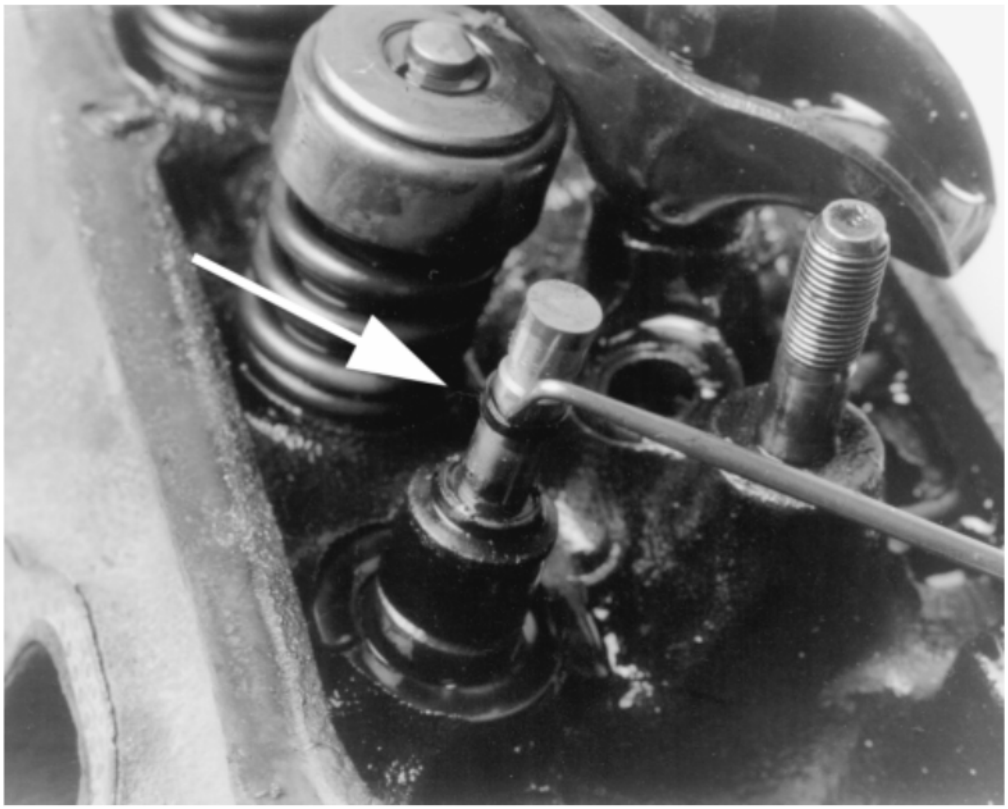


Fig. 4: Remove the valve seal from the valve stem - O-ring type seal shown



Fig. 5: Removing an umbrella/positive type seal

cardiagn.com

6. If equipped, remove the valve seal. If the seal is difficult to remove with the valve in place, try removing the valve first, then the seal. Follow the steps below for valve removal.

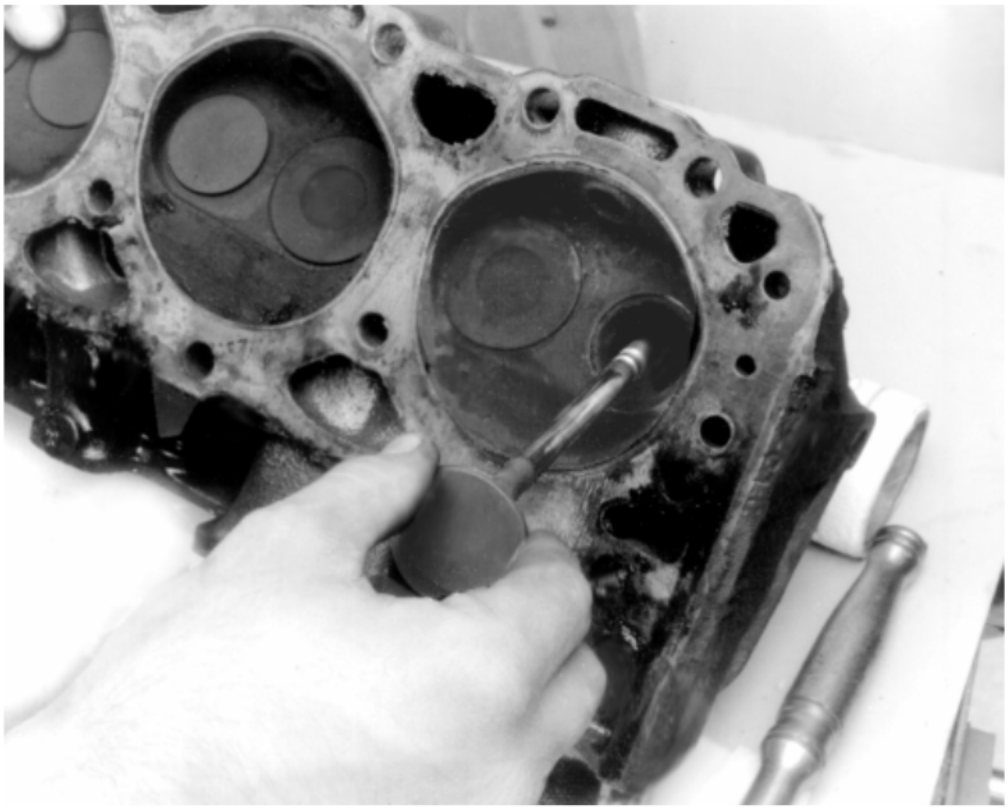


Fig. 6: Invert the cylinder head and withdraw the valve from the valve guide bore

7. Position the head to allow access for withdrawing the valve.

Cylinder heads that have seen a lot of miles and/or abuse may have mushroomed the valve lock grove and/or tip, causing difficulty in removal of the valve. If this has happened, use a metal file to carefully remove the high spots around the lock grooves and/or tip. Only file it enough to allow removal.

8. Remove the valve from the cylinder head.
9. If equipped, remove the valve spring shim. A small magnetic tool or screwdriver will aid in removal.
10. Repeat Steps 3 though 9 until all of the valves have been removed.

INSPECTION

Now that all of the cylinder head components are clean, itâ€™s time to inspect them for wear and/or damage. To accurately inspect them, you will need some specialized tools:

- A 0-1 inch micrometer for the valves
- A dial indicator or inside diameter gauge for the valve guides
- A spring pressure test gauge

cardiagn.com

If you do not have access to the proper tools, you may want to bring the components to a shop that does.

VALVES

The first thing to inspect are the valve heads. Look closely at the head, margin and face for any cracks, excessive wear or burning. The margin is the best place to look for burning. It should have a squared edge with an even width all around the diameter. When a valve burns, the margin will look melted and the edges rounded. Also inspect the valve head for any signs of tulipping. This will show as a lifting of the edges or dishing in the center of the head and will usually not occur to all of the valves. All of the heads should look the same, any that seem dished more than others are probably bad. Next, inspect the valve lock grooves and valve tips. Check for any burrs around the lock grooves, especially if you had to file them to remove the valve. Valve tips should appear flat, although slight rounding with high mileage engines is normal. Slightly worn valve tips will need to be machined flat. Last, measure the valve stem diameter with the micrometer. Measure the area that rides within the guide, especially towards the tip where most of the wear occurs. Take several measurements along its length and compare them to each other. Wear should be even along the length with little to no taper. If no minimum diameter is given in the specifications, then the stem should not read more than 0.001 in. (0.025mm) below the specification. Any valves that fail these inspections should be replaced.



Fig. 7: Valve stems may be rolled on a flat surface to check for bends

cardiagn.com

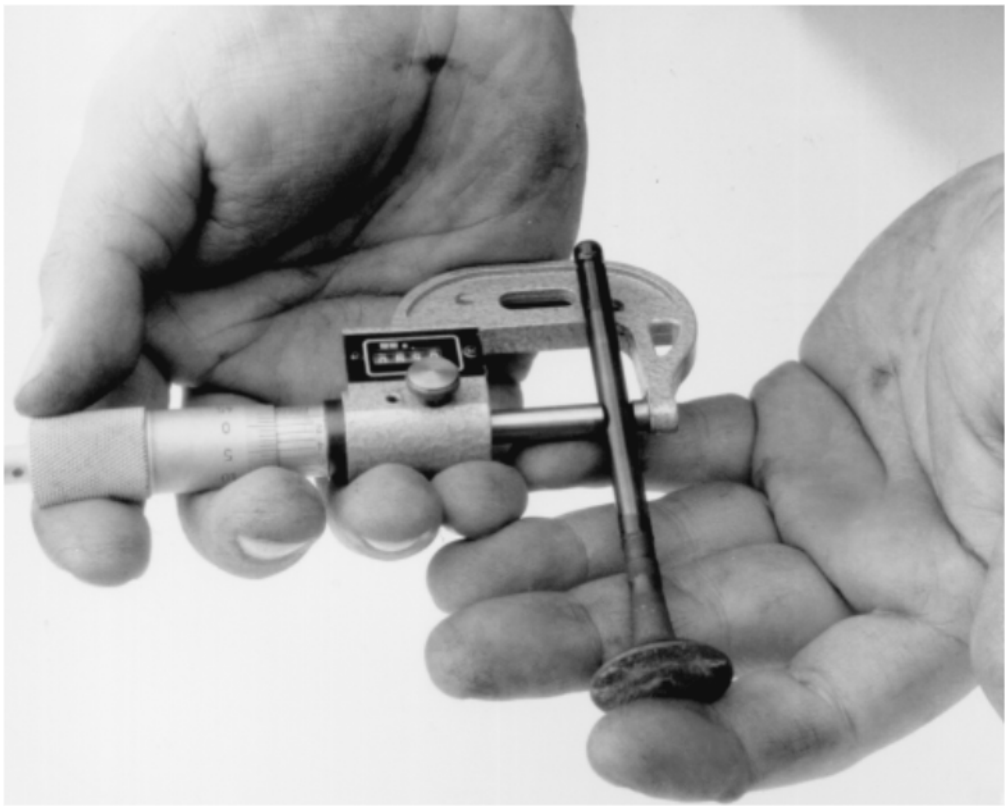


Fig. 8: Use a micrometer to check the valve stem diameter

SPRINGS, RETAINERS AND VALVE LOCKS

The first thing to check is the most obvious, broken springs. Next check the free length and squareness of each spring. If applicable, insure to distinguish between intake and exhaust springs. Use a ruler and/or carpenters square to measure the length. A carpenters square should be used to check the springs for squareness. If a spring pressure test gauge is available, check each springs rating and compare to the specifications chart. Check the readings against the specifications given. Any springs that fail these inspections should be replaced.

The spring retainers rarely need replacing, however they should still be checked as a precaution. Inspect the spring mating surface and the valve lock retention area for any signs of excessive wear. Also check for any signs of cracking. Replace any retainers that are questionable.

Valve locks should be inspected for excessive wear on the outside contact area as well as on the inner notched surface. Any locks which appear worn or broken and its respective valve should be replaced.

cardiagn.com

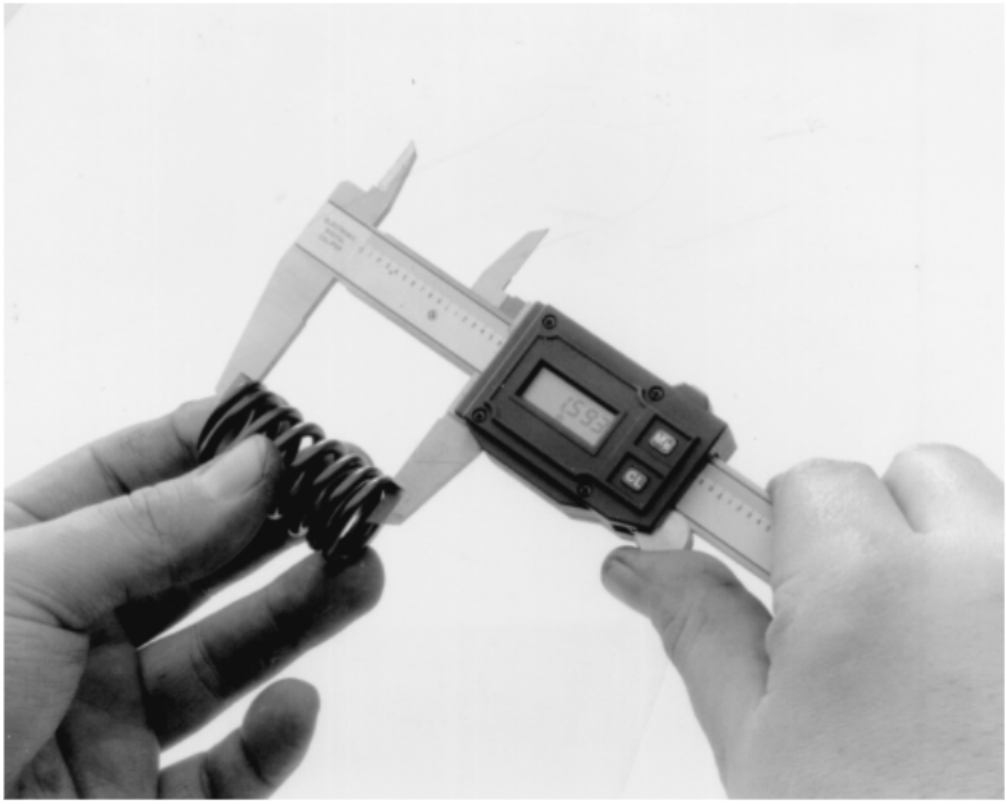


Fig. 9: Use a caliper to check the valve spring free-length



Fig. 10: Check the valve spring for squareness on a flat surface; a carpenterâ€™s square can be used

cardiagn.com

CYLINDER HEAD

There are several things to check on the cylinder head: valve guides, seats, cylinder head surface flatness, cracks and physical damage.

VALVE GUIDES

Now that you know the valves are good, you can use them to check the guides, although a new valve, if available, is preferred. Before you measure anything, look at the guides carefully and inspect them for any cracks, chips or breakage. Also if the guide is a removable style (as in most aluminum heads), check them for any looseness or evidence of movement. All of the guides should appear to be at the same height from the spring seat. If any seem lower (or higher) from another, the guide has moved. Mount a dial indicator onto the spring side of the cylinder head. Lightly oil the valve stem and insert it into the cylinder head. Position the dial indicator against the valve stem near the tip and zero the gauge. Grasp the valve stem and wiggle towards and away from the dial indicator and observe the readings. Mount the dial indicator 90 degrees from the initial point and zero the gauge and again take a reading. Compare the two readings for a out of round condition. Check the readings against the specifications given. An Inside Diameter (I.D.) gauge designed for valve guides will give you an accurate valve guide bore measurement. If the I.D. gauge is used, compare the readings with the specifications given. Any guides that fail these inspections should be replaced or machined.

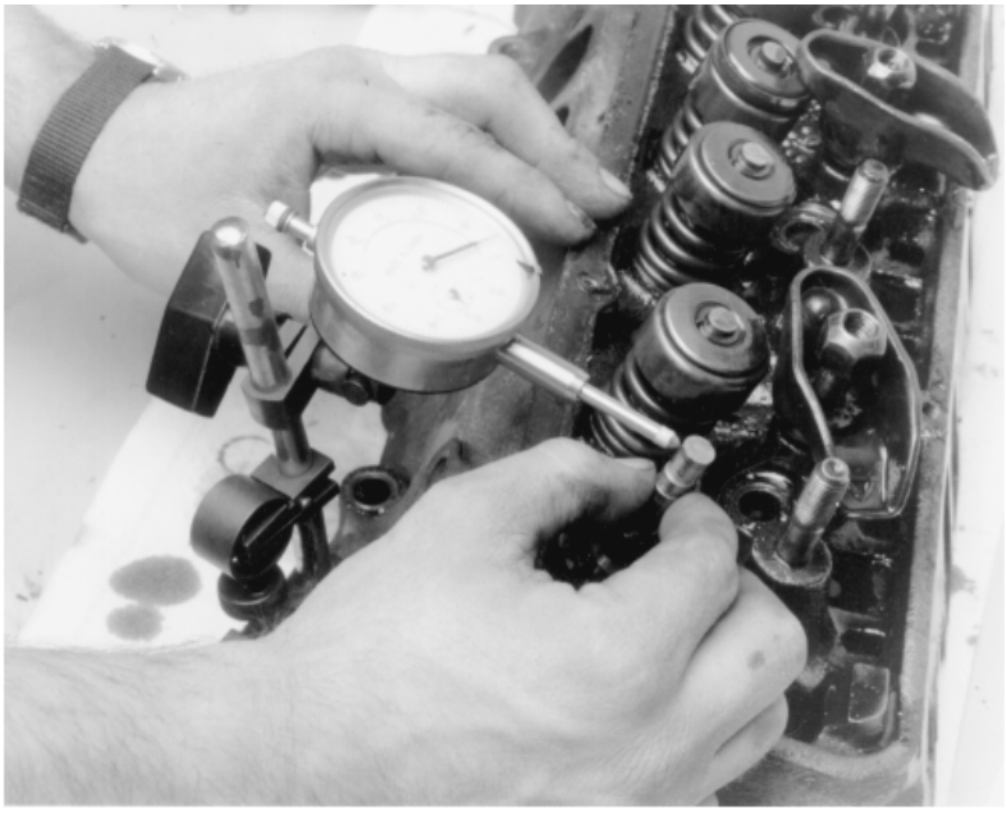


Fig. 11: A dial gauge may be used to check valve stem-to-guide clearance; read the gauge while moving the valve stem

cardiagn.com

VALVE SEATS

A visual inspection of the valve seats should show a slightly worn and pitted surface where the valve face contacts the seat. Inspect the seat carefully for severe pitting or cracks. Also, a seat that is badly worn will be recessed into the cylinder head. A severely worn or recessed seat may need to be replaced. All cracked seats must be replaced. A seat concentricity gauge, if available, should be used to check the seat run-out. If run-out exceeds specifications the seat must be machined (if no specification is given use 0.002 in. or 0.051mm).

CYLINDER HEAD SURFACE FLATNESS

After you have cleaned the gasket surface of the cylinder head of any old gasket material, check the head for flatness.

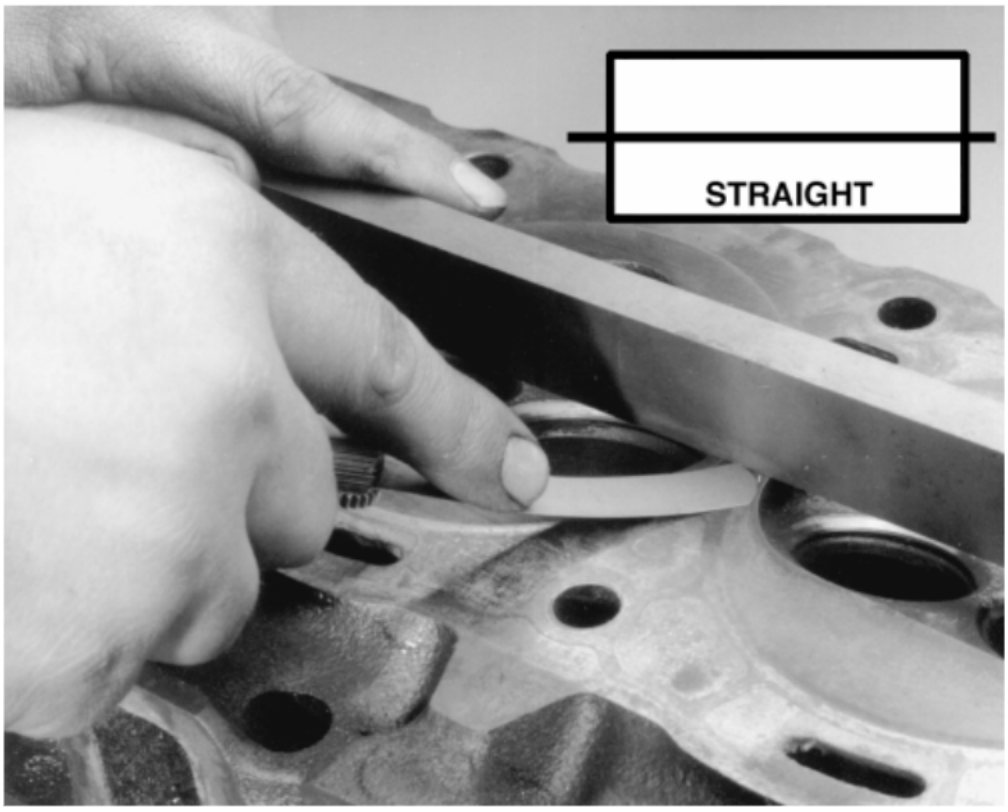


Fig. 12: Check the head for flatness across the center of the head surface using a straightedge and feeler gauge

cardiagn.com

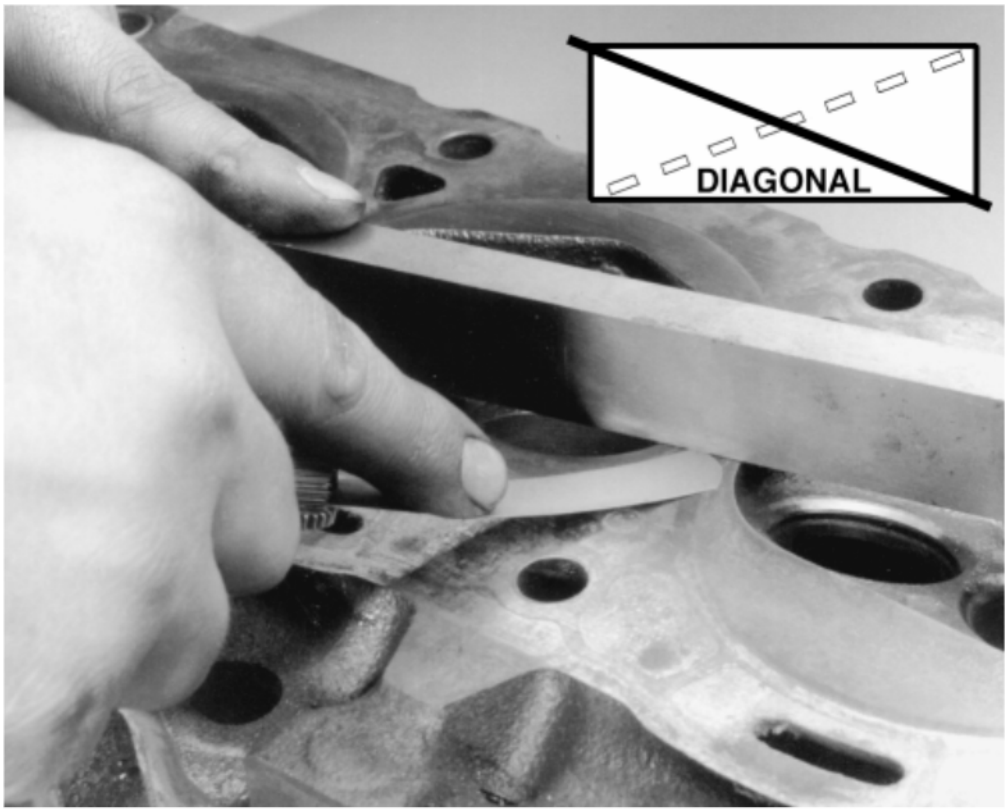


Fig. 13: Checks should also be made along both diagonals of the head surface

Place a straightedge across the gasket surface. Using feeler gauges, determine the clearance at the center of the straightedge and across the cylinder head at several points. Check along the centerline and diagonally on the head surface. If the warpage exceeds 0.003 in. (0.076mm) within a 6.0 in. (15.2cm) span, or 0.006 in. (0.152mm) over the total length of the head, the cylinder head must be resurfaced. After resurfacing the heads of a V-type engine, the intake manifold flange surface should be checked, and if necessary, milled proportionally to allow for the change in its mounting position.

CRACKS AND PHYSICAL DAMAGE

Generally, cracks are limited to the combustion chamber, however, it is not uncommon for the head to crack in a spark plug hole, port, outside of the head or in the valve spring/rocker arm area. The first area to inspect is always the hottest: the exhaust seat/port area.

A visual inspection should be performed, but just because you donâ€™t see a crack does not mean it is not there. Some more reliable methods for inspecting for cracks include Magnaflux, a magnetic process or Zyglo, a dye penetrant. Magnaflux is used only on ferrous metal (cast iron) heads. Zyglo uses a spray on fluorescent mixture along with a black light to reveal the cracks. It is strongly recommended to have your cylinder head checked professionally for cracks, especially if the engine was known to have overheated and/or leaked or consumed coolant. Contact a local shop for availability and pricing of these services.

cardiagn.com

Physical damage is usually very evident. For example, a broken mounting ear from dropping the head or a bent or broken stud and/or bolt. All of these defects should be fixed or, if irrepairable, the head should be replaced.

REFINISHING & REPAIRING

Many of the procedures given for refinishing and repairing the cylinder head components must be performed by a machine shop. Certain steps, if the inspected part is not worn, can be performed yourself inexpensively. However, you spent a lot of time and effort so far, why risk trying to save a couple bucks if you might have to do it all over again?

VALVES

Any valves that were not replaced should be refaced and the tips ground flat. Unless you have access to a valve grinding machine, this should be done by a machine shop. If the valves are in extremely good condition, as well as the valve seats and guides, they may be lapped in without performing machine work.

It is a recommended practice to lap the valves even after machine work has been performed and/or new valves have been purchased. This insures a positive seal between the valve and seat.

LAPPING THE VALVES

Before lapping the valves to the seats, read the rest of the cylinder head information to insure that any related parts are in acceptable enough condition to continue.

Before any valve seat machining and/or lapping can be performed, the guides must be within factory recommended specifications.

1. Invert the cylinder head.
2. Lightly lubricate the valve stems and insert them into the cylinder head in their numbered order.
3. Raise the valve from the seat and apply a small amount of fine lapping compound to the seat.
4. Moisten the suction head of a hand-lapping tool and attach it to the head of the valve.
5. Rotate the tool between the palms of both hands, changing the position of the valve on the valve seat and lifting the tool often to prevent grooving.
6. Lap the valve until a smooth, polished circle is evident on the valve and seat.
7. Remove the tool and the valve. Wipe away all traces of the grinding compound and store the valve to maintain its lapped location.

SPRINGS, RETAINERS AND VALVE LOCKS

cardiagn.com

There is no repair or refinishing possible with the springs, retainers and valve locks. If they are found to be worn or defective, they must be replaced with new (or known good) parts.

CYLINDER HEAD

Most refinishing procedures dealing with the cylinder head must be performed by a machine shop. Read the information below and review your inspection data to determine whether or not machining is necessary.

VALVE GUIDE

If any machining or replacements are made to the valve guides, the seats must be machined.

Unless the valve guides need machining or replacing, the only service to perform is to thoroughly clean them of any dirt or oil residue.

There are only two types of valve guides used on automobile engines: the replaceable-type (all aluminum heads) and the cast-in integral-type (most cast iron heads). There are four recommended methods for repairing worn guides.

- Knurling
- Inserts
- Reaming oversize
- Replacing

Knurling is a process in which metal is displaced and raised, thereby reducing clearance, giving a true center, and providing oil control. It is the least expensive way of repairing the valve guides. However, it is not necessarily the best, and in some cases, a knurled valve guide will not stand up for more than a short time. It requires a special knurler and precision reaming tools to obtain proper clearances. It would not be cost effective to purchase these tools, unless you plan on rebuilding several of the same cylinder head.

Installing a guide insert involves machining the guide to accept a bronze insert. One style is the coil-type which is installed into a threaded guide. Another is the thin-walled insert where the guide is reamed oversize to accept a split-sleeve insert. After the insert is installed, a special tool is then run through the guide to expand the insert, locking it to the guide. The insert is then reamed to the standard size for proper valve clearance.

Reaming for oversize valves restores normal clearances and provides a true valve seat. Most cast-in type guides can be reamed to accept an valve with an oversize stem. The cost factor for this can become quite high as you will need to purchase the reamer and new, oversize stem valves for all guides which were reamed. Oversizes are generally 0.003 to 0.030 in. (0.076 to 0.762mm), with 0.015 in. (0.381mm) being the most common.

cardiagn.com

To replace cast-in type valve guides, they must be drilled out, then reamed to accept replacement guides. This must be done on a fixture which will allow centering and leveling off of the original valve seat or guide, otherwise a serious guide-to-seat misalignment may occur making it impossible to properly machine the seat.

Replaceable-type guides are pressed into the cylinder head. A hammer and a stepped drift or punch may be used to install and remove the guides. Before removing the guides, measure the protrusion on the spring side of the head and record it for installation. Use the stepped drift to hammer out the old guide from the combustion chamber side of the head. When installing, determine whether or not the guide also seals a water jacket in the head, and if it does, use the recommended sealing agent. If there is no water jacket, grease the valve guide and its bore. Use the stepped drift, and hammer the new guide into the cylinder head from the spring side of the cylinder head. A stack of washers the same thickness as the measured protrusion may help the installation process.

VALVE SEATS

Before any valve seat machining can be performed, the guides must be within factory recommended specifications.

If any machining or replacements were made to the valve guides, the seats must be machined.

If the seats are in good condition, the valves can be lapped to the seats, and the cylinder head assembled. See the valves information for instructions on lapping.

If the valve seats are worn, cracked or damaged, they must be serviced by a machine shop. The valve seat must be perfectly centered to the valve guide, which requires very accurate machining.

CYLINDER HEAD SURFACE

If the cylinder head is warped, it must be machined flat. If the warpage is extremely severe, the head may need to be replaced. In some instances, it may be possible to straighten a warped head enough to allow machining. In either case, contact a professional machine shop for service.

CRACKS AND PHYSICAL DAMAGE

Certain cracks can be repaired in both cast iron and aluminum heads. For cast iron, a tapered threaded insert is installed along the length of the crack. Aluminum can also use the tapered inserts, however welding is the preferred method. Some physical damage can be repaired through brazing or welding. Contact a machine shop to get expert advice for your particular dilemma.

ASSEMBLY

cardiagn.com

The first step for any assembly job is to have a clean area in which to work. Next, thoroughly clean all of the parts and components that are to be assembled. Finally, place all of the components onto a suitable work space and, if necessary, arrange the parts to their respective positions.

1. Lightly lubricate the valve stems and insert all of the valves into the cylinder head. If possible, maintain their original locations.
2. If equipped, install any valve spring shims which were removed.
3. If equipped, install the new valve seals, keeping the following in mind:
    - If the valve seal presses over the guide, lightly lubricate the outer guide surfaces.
    - If the seal is an O-ring type, it is installed just after compressing the spring but before the valve locks.
4. Place the valve spring and retainer over the stem.
5. Position the spring compressor tool and compress the spring.
6. Assemble the valve locks to the stem.
7. Relieve the spring pressure slowly and insure that neither valve lock becomes dislodged by the retainer.
8. Remove the spring compressor tool.
9. Repeat Steps 2 through 8 until all of the springs have been installed.

ENGINE BLOCK

GENERAL INFORMATION

A thorough overhaul or rebuild of an engine block would include replacing the pistons, rings, bearings, timing belt/chain assembly and oil pump. For OHV engines also include a new camshaft and lifters. The block would then have the cylinders bored and honed oversize (or if using removable cylinder sleeves, new sleeves installed) and the crankshaft would be cut undersize to provide new wearing surfaces and perfect clearances. However, your particular engine may not have everything worn out. What if only the piston rings have worn out and the clearances on everything else are still within factory specifications? Well, you could just replace the rings and put it back together, but this would be a very rare example. Chances are, if one component in your engine is worn, other components are sure to follow, and soon. At the very least, you should always replace the rings, bearings and oil pump. This is what is commonly called a "freshen up".

CYLINDER RIDGE REMOVAL

Because the top piston ring does not travel to the very top of the cylinder, a ridge is built up between the end of the travel and the top of the cylinder bore.

Pushing the piston and connecting rod assembly past the ridge can be difficult, and damage to the piston ring lands could occur. If the ridge is not removed before installing a new piston or not removed at all, piston ring breakage and piston damage may occur.

cardiagn.com

It is always recommended that you remove any cylinder ridges before removing the piston and connecting rod assemblies. If you know that new pistons are going to be installed and the engine block will be bored oversize, you may be able to forego this step. However, some ridges may actually prevent the assemblies from being removed, necessitating its removal.

There are several different types of ridge reamers on the market, none of which are inexpensive. Unless a great deal of engine rebuilding is anticipated, borrow or rent a reamer.

1. Turn the crankshaft until the piston is at the bottom of its travel.
2. Cover the head of the piston with a rag.
3. Follow the tool manufacturers instructions and cut away the ridge, exercising extreme care to avoid cutting too deeply.
4. Remove the ridge reamer, the rag and as many of the cuttings as possible. Continue until all of the cylinder ridges have been removed.

DISASSEMBLY

The engine disassembly instructions following assume that you have the engine mounted on an engine stand. If not, it is easiest to disassemble the engine on a bench or the floor with it resting on the bellhousing or transmission mounting surface. You must be able to access the connecting rod fasteners and turn the crankshaft during disassembly. Also, all engine covers (timing, front, side, oil pan, whatever) should have already been removed. Engines which are seized or locked up may not be able to be completely disassembled, and a core (salvage yard) engine should be purchased.

If not done during the cylinder head removal, remove the pushrods and lifters, keeping them in order for assembly. Remove the timing gears and/or timing chain assembly, then remove the oil pump drive assembly and withdraw the camshaft from the engine block. Remove the oil pick-up and pump assembly. If equipped, remove any balance or auxiliary shafts. If necessary, remove the cylinder ridge from the top of the bore. See the cylinder ridge removal procedure earlier in this section.

Rotate the engine over so that the crankshaft is exposed. Use a number punch or scribe and mark each connecting rod with its respective cylinder number. The cylinder closest to the front of the engine is always number 1. However, depending on the engine placement, the front of the engine could either be the flywheel or damper/pulley end. Generally the front of the engine faces the front of the vehicle. Use a number punch or scribe and also mark the main bearing caps from front to rear with the front most cap being number 1 (if there are five caps, mark them 1 through 5, front to rear).

cardiagn.com

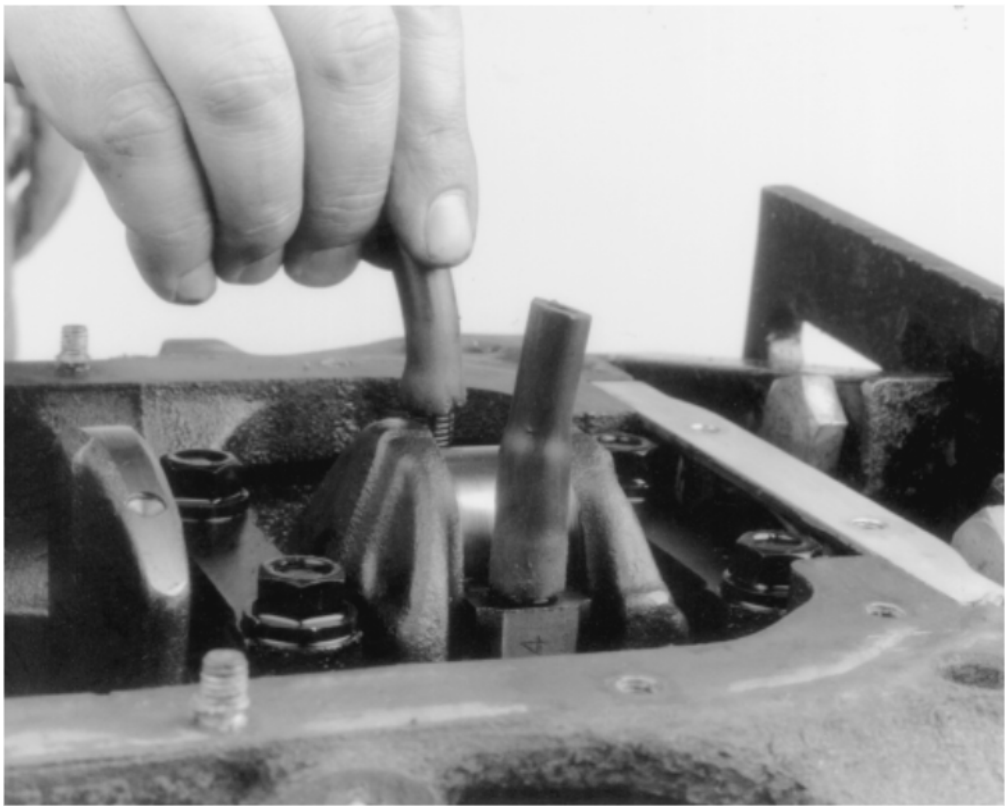


Fig. 1: Place rubber hose over the connecting rod studs to protect the crankshaft and cylinder bores from damage

WARNING - Take special care when pushing the connecting rod up from the crankshaft because the sharp threads of the rod bolts/studs will score the crankshaft journal. Insure that special plastic caps are installed over them, or cut two pieces of rubber hose to do the same.

cardiagn.com



Fig. 2: Carefully tap the piston out of the bore using a wooden dowel

cardiagn.com

Again, rotate the engine, this time to position the number one cylinder bore (head surface) up. Turn the crankshaft until the number one piston is at the bottom of its travel, this should allow the maximum access to its connecting rod. Remove the number one connecting rods fasteners and cap and place two lengths of rubber hose over the rod bolts/studs to protect the crankshaft from damage. Using a sturdy wooden dowel and a hammer, push the connecting rod up about 1 in. (25mm) from the crankshaft and remove the upper bearing insert. Continue pushing or tapping the connecting rod up until the piston rings are out of the cylinder bore. Remove the piston and rod by hand, put the upper half of the bearing insert back into the rod, install the cap with its bearing insert installed, and hand-tighten the cap fasteners. If the parts are kept in order in this manner, they will not get lost and you will be able to tell which bearings came form what cylinder if any problems are discovered and diagnosis is necessary. Remove all the other piston assemblies in the same manner. On V-style engines, remove all of the pistons from one bank, then reposition the engine with the other cylinder bank head surface up, and remove that banks piston assemblies.

The only remaining component in the engine block should now be the crankshaft. Loosen the main bearing caps evenly until the fasteners can be turned by hand, then remove them and the caps. Remove the crankshaft from the engine block. Thoroughly clean all of the components.

INSPECTION

Now that the engine block and all of its components are clean, it's time to inspect them for wear and/or damage. To accurately inspect them, you will need some specialized tools:

- Two or three separate micrometers to measure the pistons and crankshaft journals
- A dial indicator
- Telescoping gauges for the cylinder bores
- A rod alignment fixture to check for bent connecting rods

If you do not have access to the proper tools, you may want to bring the components to a shop that does.

Generally, you shouldn't expect cracks in the engine block or its components unless it was known to leak, consume or mix engine fluids, it was severely overheated, or there was evidence of bad bearings and/or crankshaft damage. A visual inspection should be performed on all of the components, but just because you don't see a crack does not mean it is not there. Some more reliable methods for inspecting for cracks include Magnaflux, a magnetic process or Zyglo, a dye penetrant. Magnaflux is used only on ferrous metal (cast iron). Zyglo uses a spray on fluorescent mixture along with a black light to reveal the cracks. It is strongly recommended to have your engine block checked professionally for cracks, especially if the engine was known to have overheated and/or leaked or consumed coolant. Contact a local shop for availability and pricing of these services.

cardiagn.com

ENGINE BLOCK

ENGINE BLOCK BEARING ALIGNMENT

Remove the main bearing caps and, if still installed, the main bearing inserts. Inspect all of the main bearing saddles and caps for damage, burrs or high spots. If damage is found, and it is caused from a spun main bearing, the block will need to be align-bored or, if severe enough, replacement. Any burrs or high spots should be carefully removed with a metal file.

Place a straightedge on the bearing saddles, in the engine block, along the centerline of the crankshaft. If any clearance exists between the straightedge and the saddles, the block must be align-bored.

Align-boring consists of machining the main bearing saddles and caps by means of a flycutter that runs through the bearing saddles.

DECK FLATNESS

The top of the engine block where the cylinder head mounts is called the deck. Insure that the deck surface is clean of dirt, carbon deposits and old gasket material. Place a straightedge across the surface of the deck along its centerline and, using feeler gauges, check the clearance along several points. Repeat the checking procedure with the straightedge placed along both diagonals of the deck surface. If the reading exceeds 0.003 in. (0.076mm) within a 6.0 in. (15.2cm) span, or 0.006 in. (0.152mm) over the total length of the deck, it must be machined.

CYLINDER BORES

The cylinder bores house the pistons and are slightly larger than the pistons themselves. A common piston-to-bore clearance is 0.0015-0.0025 in. (0.0381mm-0.0635mm). Inspect and measure the cylinder bores. The bore should be checked for out-of-roundness, taper and size. The results of this inspection will determine whether the cylinder can be used in its existing size and condition, or a rebore to the next oversize is required (or in the case of removable sleeves, have replacements installed).

cardiagn.com

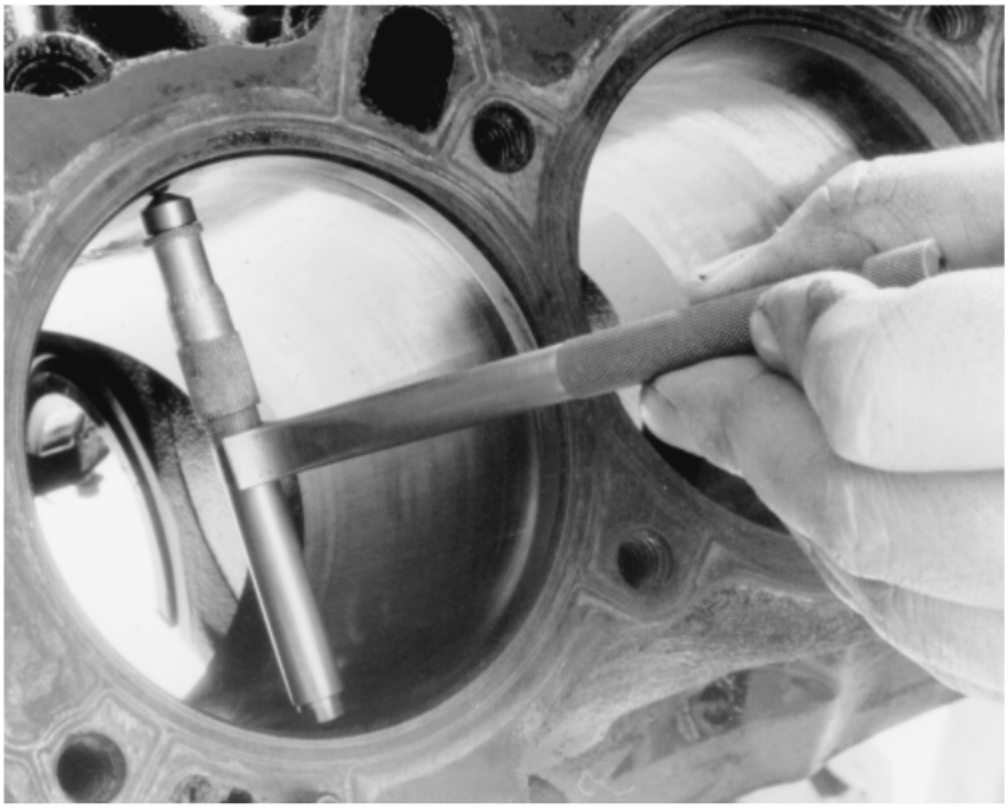


Fig. 3: Use a telescoping gauge to measure the cylinder bore diameter - take several readings within the same bore

The amount of cylinder wall wear is always greater at the top of the cylinder than at the bottom. This wear is known as taper. Any cylinder that has a taper of 0.0012 in. (0.305mm) or more, must be rebored. Measurements are taken at a number of positions in each cylinder: at the top, middle and bottom and at two points at each position; that is, at a point 90 degrees from the crankshaft centerline, as well as a point parallel to the crankshaft centerline. The measurements are made with either a special dial indicator or a telescopic gauge and micrometer. If the necessary precision tools to check the bore are not available, take the block to a machine shop and have them mike it. Also if you don't have the tools to check the cylinder bores, chances are you will not have the necessary devices to check the pistons, connecting rods and crankshaft. Take these components with you and save yourself an extra trip.

For our procedures, we will use a telescopic gauge and a micrometer. You will need one of each, with a measuring range which covers your cylinder bore size.

1. Position the telescopic gauge in the cylinder bore, loosen the gauges lock and allow it to expand.

Your first two readings will be at the top of the cylinder bore, then proceed to the middle and finally the bottom, making a total of six measurements.

2. Hold the gauge square in the bore, 90 degrees from the crankshaft centerline, and gently tighten the lock. Tilt the gauge back to remove it from the bore.

cardiagn.com

3. Measure the gauge with the micrometer and record the reading.
4. Again, hold the gauge square in the bore, this time parallel to the crankshaft centerline, and gently tighten the lock. Again, you will tilt the gauge back to remove it from the bore.
5. Measure the gauge with the micrometer and record this reading. The difference between these two readings is the out-of-round measurement of the cylinder.
6. Repeat steps 1 through 5, each time going to the next lower position, until you reach the bottom of the cylinder. Then go to the next cylinder, and continue until all of the cylinders have been measured.

The difference between these measurements will tell you all about the wear in your cylinders. The measurements which were taken 90 degrees from the crankshaft centerline will always reflect the most wear. That is because at this position is where the engine power presses the piston against the cylinder bore the hardest. This is known as thrust wear. Take your top, 90 degree measurement and compare it to your bottom, 90 degree measurement. The difference between them is the taper. When you measure your pistons, you will compare these readings to your piston sizes and determine piston-to-wall clearance.

CRANKSHAFT

Inspect the crankshaft for visible signs of wear or damage. All of the journals should be perfectly round and smooth. Slight scores are normal for a used crankshaft, but you should hardly feel them with your fingernail. When measuring the crankshaft with a micrometer, you will take readings at the front and rear of each journal, then turn the micrometer 90 degrees and take two more readings, front and rear. The difference between the front-to-rear readings is the journal taper and the first-to-90 degree reading is the out-of-round measurement. Generally, there should be no taper or out-of-roundness found, however, up to 0.0005 in. (0.0127mm) for either can be overlooked. Also, the readings should fall within the factory specifications for journal diameters.

If the crankshaft journals fall within specifications, it is recommended that it be polished before being returned to service. Polishing the crankshaft insures that any minor burrs or high spots are smoothed, thereby reducing the chance of scoring the new bearings.

PISTONS AND CONNECTING RODS

PISTONS

The piston should be visually inspected for any signs of cracking or burning (caused by hot spots or detonation), and scuffing or excessive wear on the skirts. The wristpin attaches the piston to the connecting rod. The piston should move freely on the wrist pin, both sliding and pivoting. Grasp the connecting rod securely, or mount it in a vise, and try to rock the piston back and forth along the centerline of the wristpin. There should not be any excessive play evident between the piston and the pin. If there are C-clips retaining the pin in the piston

cardiagn.com

then you have wrist pin bushings in the rods. There should not be any excessive play between the wrist pin and the rod bushing. Normal clearance for the wrist pin is approx. 0.001-0.002 in. (0.025mm-0.051mm).



Fig. 4: Measure the piston's outer diameter, perpendicular to the wrist pin, with a micrometer

Use a micrometer and measure the diameter of the piston, perpendicular to the wrist pin, on the skirt. Compare the reading to its original cylinder measurement obtained earlier. The difference between the two readings is the piston-to-wall clearance. If the clearance is within specifications, the piston may be used as is. If the piston is out of specification, but the bore is not, you will need a new piston. If both are out of specification, you will need the cylinder rebored and oversize pistons installed. Generally if two or more pistons/bores are out of specification, it is best to rebore the entire block and purchase a complete set of oversize pistons.

CONNECTING ROD

You should have the connecting rod checked for straightness at a machine shop. If the connecting rod is bent, it will unevenly wear the bearing and piston, as well as place greater stress on these components. Any bent or twisted connecting rods must be replaced. If the rods are straight and the wrist pin clearance is within specifications, then only the bearing end of the rod need be checked. Place the connecting rod into a vice, with the bearing inserts in place, install the cap to the rod and torque the fasteners to specifications. Use a telescoping gauge and carefully measure the inside diameter of the bearings. Compare this reading to the rods original crankshaft journal diameter measurement. The difference is the oil clearance. If the oil clearance is not

cardiagn.com

within specifications, install new bearings in the rod and take another measurement. If the clearance is still out of specifications, and the crankshaft is not, the rod will need to be reconditioned by a machine shop.

You can also use Plastigage to check the bearing clearances. The assembling section has complete instructions on its use.

CAMSHAFT

Inspect the camshaft and lifters/followers as described earlier in this section.

BEARINGS

All of the engine bearings should be visually inspected for wear and/or damage. The bearing should look evenly worn all around with no deep scores or pits. If the bearing is severely worn, scored, pitted or heat blued, then the bearing, and the components that use it, should be brought to a machine shop for inspection. Full-circle bearings (used on most camshafts, auxiliary shafts, balance shafts, etc.) require specialized tools for removal and installation, and should be brought to a machine shop for service.

OIL PUMP

The oil pump is responsible for providing constant lubrication to the whole engine and so it is recommended that a new oil pump be installed when rebuilding the engine.

Completely disassemble the oil pump and thoroughly clean all of the components. Inspect the oil pump gears and housing for wear and/or damage. Insure that the pressure relief valve operates properly and there is no binding or sticking due to varnish or debris. If all of the parts are in proper working condition, lubricate the gears and relief valve, and assemble the pump.

REFINISHING

Almost all engine block refinishing must be performed by a machine shop. If the cylinders are not to be rebored, then the cylinder glaze can be removed with a ball hone. When removing cylinder glaze with a ball hone, use a light or penetrating type oil to lubricate the hone. Do not allow the hone to run dry as this may cause excessive scoring of the cylinder bores and wear on the hone. If new pistons are required, they will need to be installed to the connecting rods. This should be performed by a machine shop as the pistons must be installed in the correct relationship to the rod or engine damage can occur.

cardiagn.com

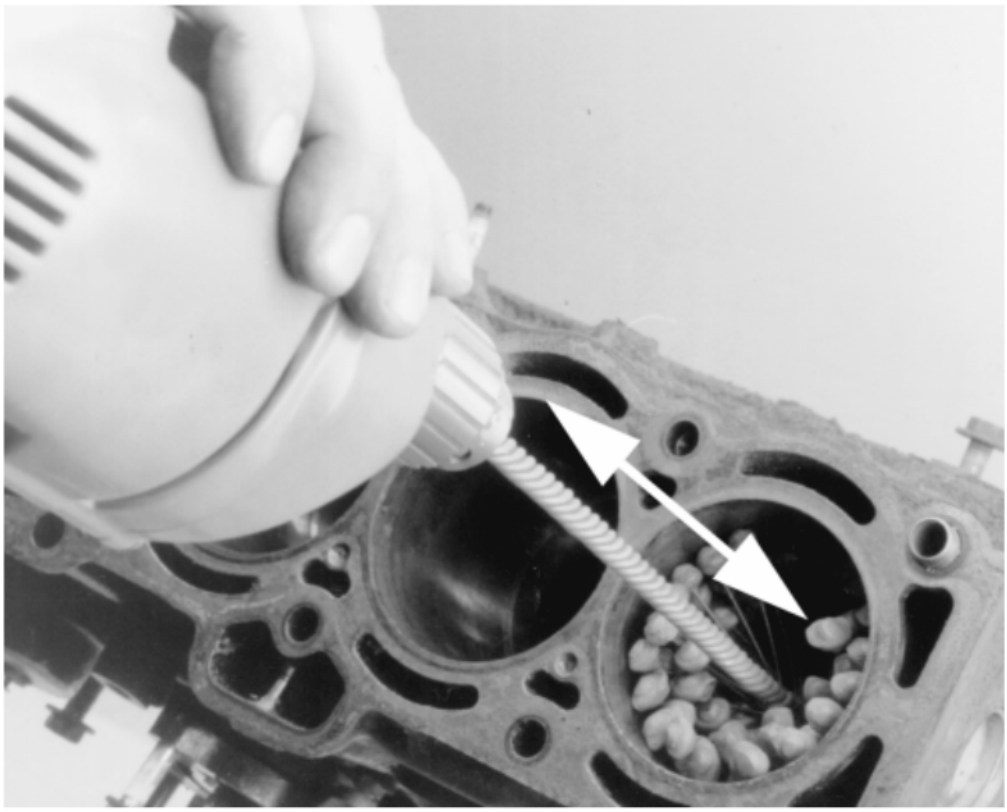


Fig. 5: Use a ball type cylinder hone to remove any glaze and provide a new surface for seating the piston rings

PISTONS AND CONNECTING RODS

Only pistons with the wrist pin retained by C-clips are serviceable by the home-mechanic. Press fit pistons require special presses and/or heaters to remove/install the connecting rod and should only be performed by a machine shop.

All pistons will have a mark indicating the direction to the front of the engine and the must be installed into the engine in that manner. Usually it is a notch or arrow on the top of the piston, or it may be the letter F cast or stamped into the piston.

cardiagn.com



Fig. 6: Most pistons are marked to indicate positioning in the engine (usually a mark means the side facing the front)

C-CLIP TYPE PISTONS

1. Note the location of the forward mark on the piston and mark the connecting rod in relation.
2. Remove the C-clips from the piston and withdraw the wrist pin.

Varnish build-up or C-clip groove burrs may increase the difficulty of removing the wrist pin. If necessary, use a punch or drift to carefully tap the wrist pin out.

3. Insure that the wrist pin bushing in the connecting rod is usable, and lubricate it with assembly lube.
4. Remove the wrist pin from the new piston and lubricate the pin bores on the piston.
5. Align the forward marks on the piston and the connecting rod and install the wrist pin.
6. The new C-clips will have a flat and a rounded side to them. Install both C-clips with the flat side facing out.
7. Repeat all of the steps for each piston being replaced.

ASSEMBLY

Before you begin assembling the engine, first give yourself a clean, dirt free work area. Next, clean every engine component again. The key to a good assembly is cleanliness.

cardiagn.com

Mount the engine block into the engine stand and wash it one last time using water and detergent (dishwashing detergent works well). While washing it, scrub the cylinder bores with a soft bristle brush and thoroughly clean all of the oil passages. Completely dry the engine and spray the entire assembly down with an anti-rust solution such as WD-40 or similar product. Take a clean lint-free rag and wipe up any excess anti-rust solution from the bores, bearing saddles, etc. Repeat the final cleaning process on the crankshaft. Replace any freeze or oil galley plugs which were removed during disassembly.

CRANKSHAFT

1. Remove the main bearing inserts from the block and bearing caps.
2. If the crankshaft main bearing journals have been refinished to a definite undersize, install the correct undersize bearing. Be sure that the bearing inserts and bearing bores are clean. Foreign material under inserts will distort bearing and cause failure.
3. Place the upper main bearing inserts in bores with tang in slot.

The oil holes in the bearing inserts must be aligned with the oil holes in the cylinder block.

4. Install the lower main bearing inserts in bearing caps.
5. Clean the mating surfaces of block and rear main bearing cap.
6. Carefully lower the crankshaft into place. Be careful not to damage bearing surfaces.
7. Check the clearance of each main bearing by using the following procedure:
    a. Place a piece of Plastigage® or its equivalent, on bearing surface across full width of bearing cap and about $^{1}/_{4}$ in. off center.

cardiagn.com

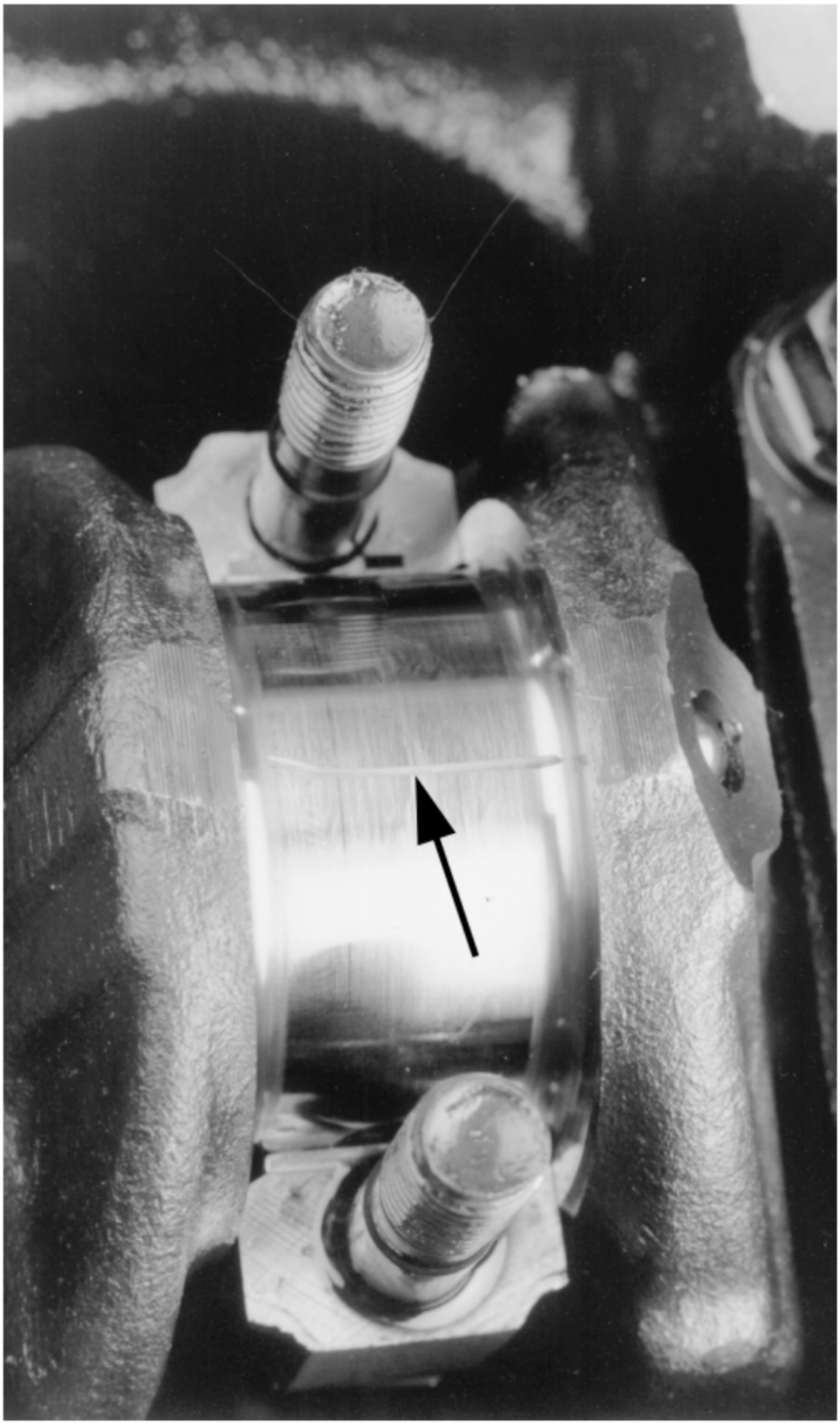


Fig. 7: Apply a strip of gauging material to the bearing journal, then install and torque the cap

cardiagn.com

b. Install cap and tighten bolts to specifications. Do not turn crankshaft while Plastigage® is in place.
c. Remove the cap. Using the supplied Plastigage® scale, check width of Plastigage® at widest point to get maximum clearance. Difference between readings is taper of journal.

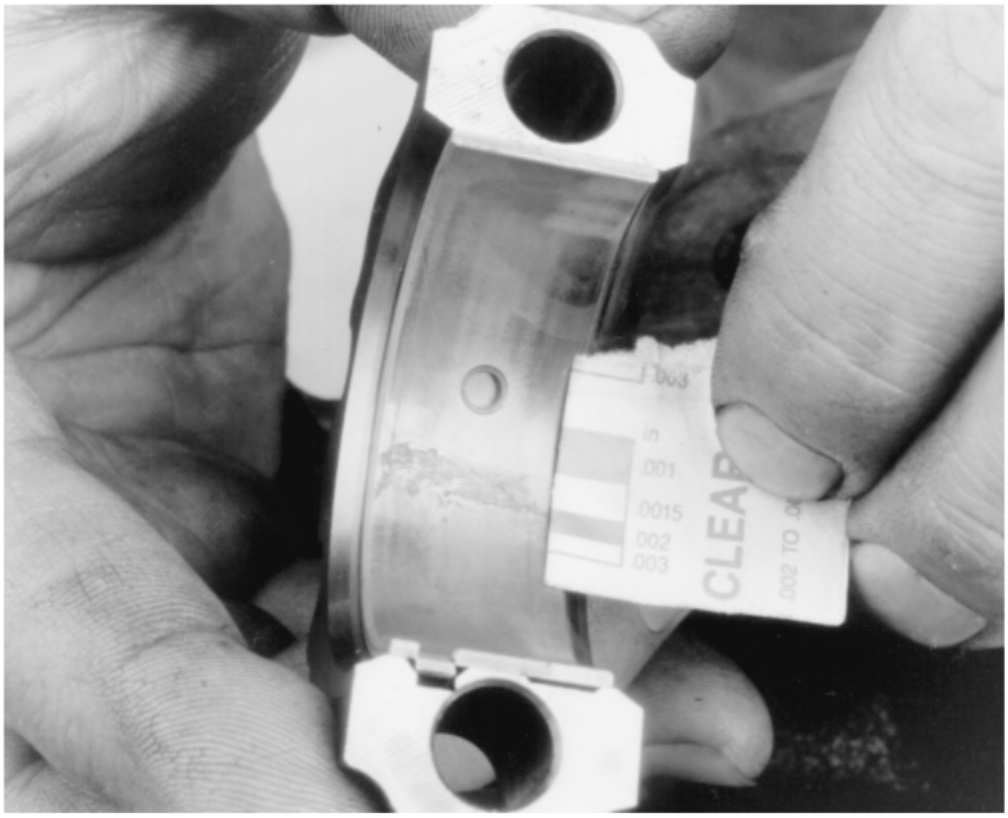


Fig. 8: After the cap is removed again, use the scale supplied with the gauging material to check the clearance

d. If clearance exceeds specified limits, try a 0.001 in. or 0.002 in. undersize bearing in combination with the standard bearing. Bearing clearance must be within specified limits. If standard and 0.002 in. undersize bearing does not bring clearance within desired limits, refinish crankshaft journal, then install undersize bearings.

5. If equipped with a rope or two-piece rear main seal, Install it now.
6. After the bearings have been fitted, apply a light coat of engine oil to the journals and bearings. Install the rear main bearing cap. Install all bearing caps except the thrust bearing cap. Be sure that main bearing caps are installed in original locations. Tighten the bearing cap bolts to specifications.
7. Install the thrust bearing cap with bolts finger-tight.
8. Pry the crankshaft forward against the thrust surface of upper half of bearing.
9. Hold the crankshaft forward and pry the thrust bearing cap to the rear. This aligns the thrust surfaces of both halves of the bearing.
10. Retain the forward pressure on the crankshaft. Tighten the cap bolts to specifications.

cardiagn.com

11. Measure the crankshaft end-play as follows:
    a. Mount a dial gauge to the engine block and position the tip of the gauge to read from the crankshaft end.
    b. Carefully pry the crankshaft toward the rear of the engine and hold it there while you zero the gauge.
    c. Carefully pry the crankshaft toward the front of the engine and read the gauge.
    d. Confirm that the reading is within specifications. If not, install a new thrust bearing and repeat the procedure. If the reading is still out of specifications with a new bearing, have a machine shop inspect the thrust surfaces of the crankshaft, and if possible, repair it.

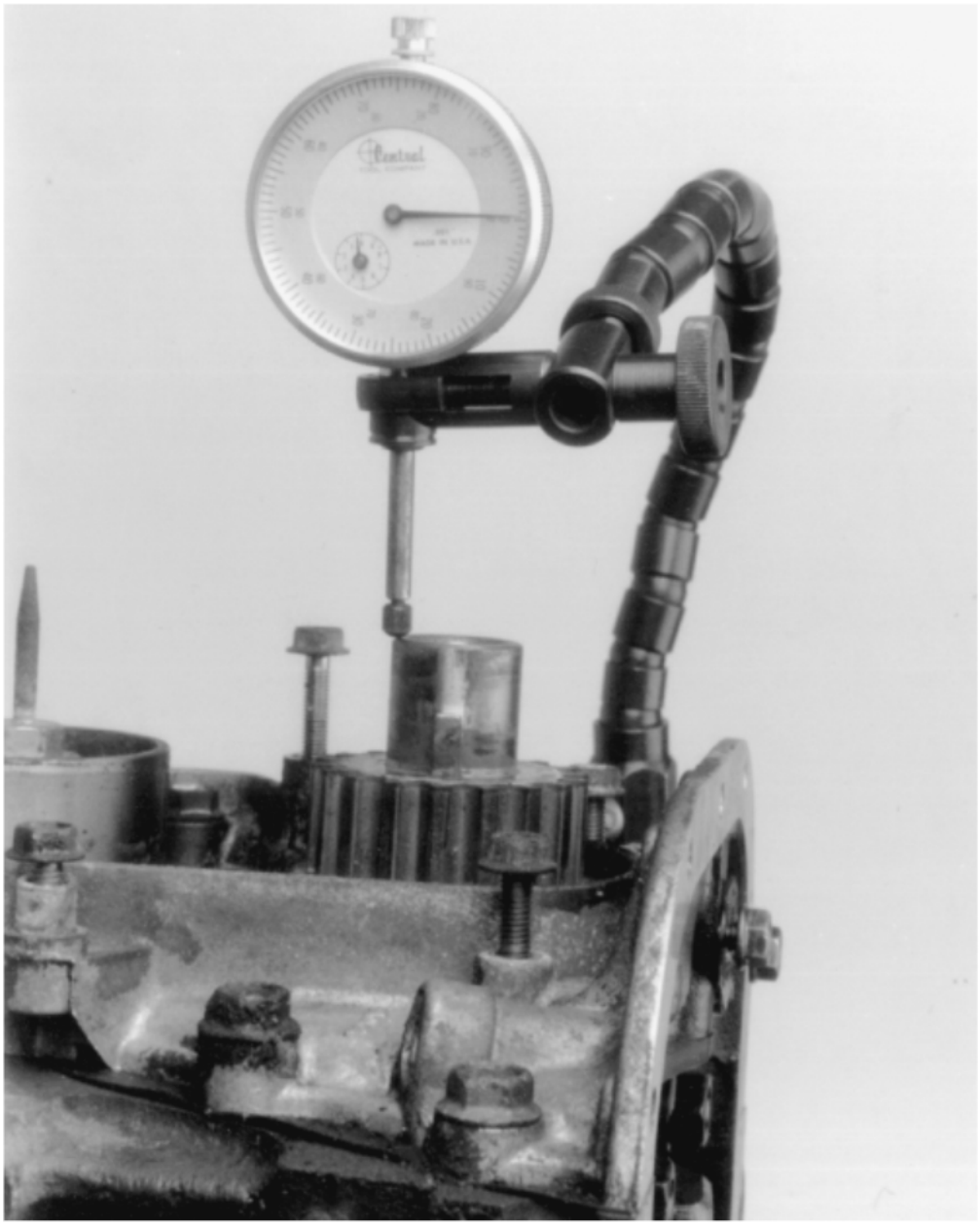


Fig. 9: A dial gauge may be used to check crankshaft endplay

cardiagn.com

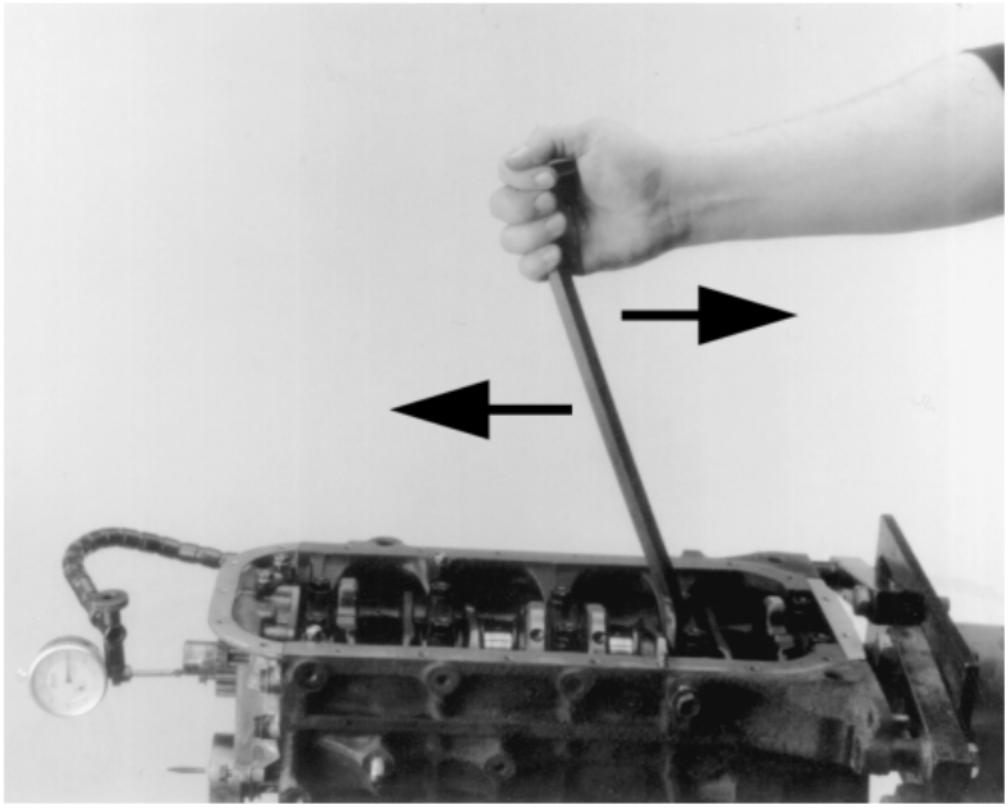


Fig. 10: Carefully pry the crankshaft back and forth while reading the dial gauge for endplay

13. Carefully pry the crankshaft toward the front of the engine and read the gauge.
14. Confirm that the reading is within specifications. If not, install a new thrust bearing and repeat the procedure. If the reading is still out of specifications with a new bearing, have a machine shop inspect the thrust surfaces of the crankshaft, and if possible, repair it.

15. If equipped with a one piece rear main seal, install it now.
16. Rotate the crankshaft so as to position the first rod journal to the bottom of its stroke.

PISTONS AND CONNECTING RODS

cardiagn.com

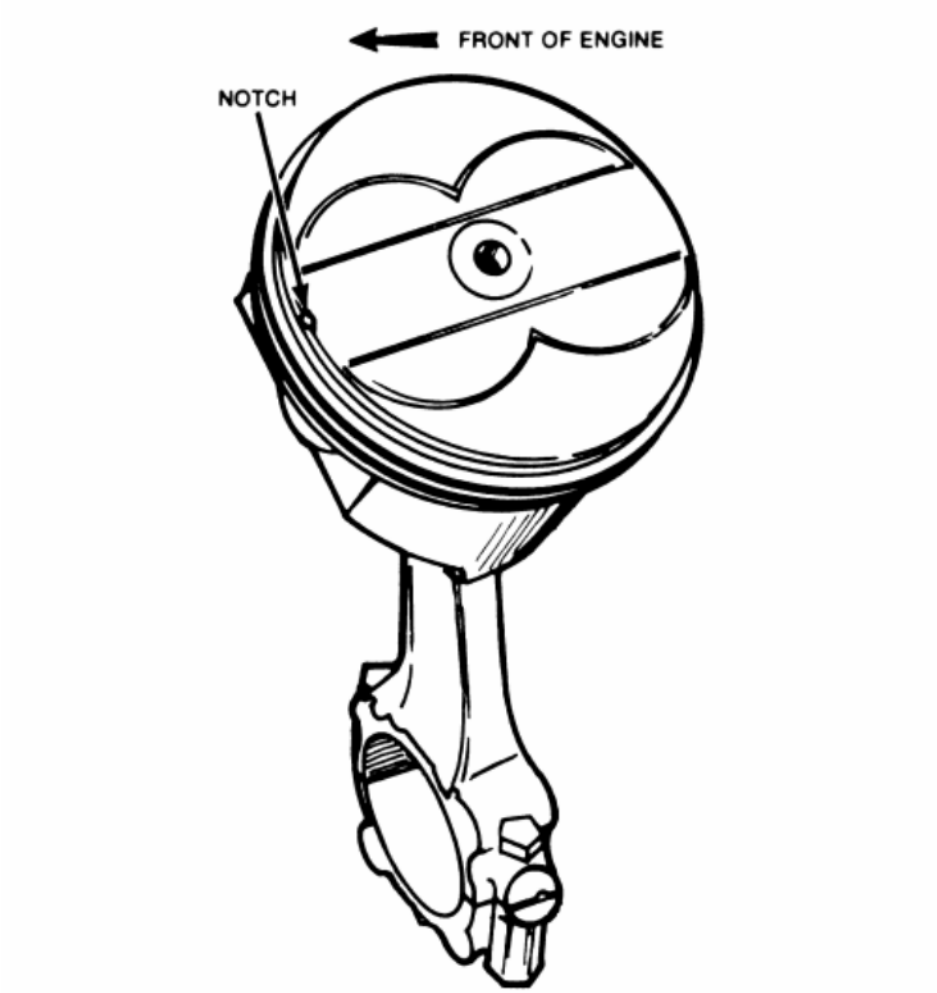


Fig. 11: Install the pistons with the notch facing forward and the oil bearing tang slots facing the opposite side of the camshaft

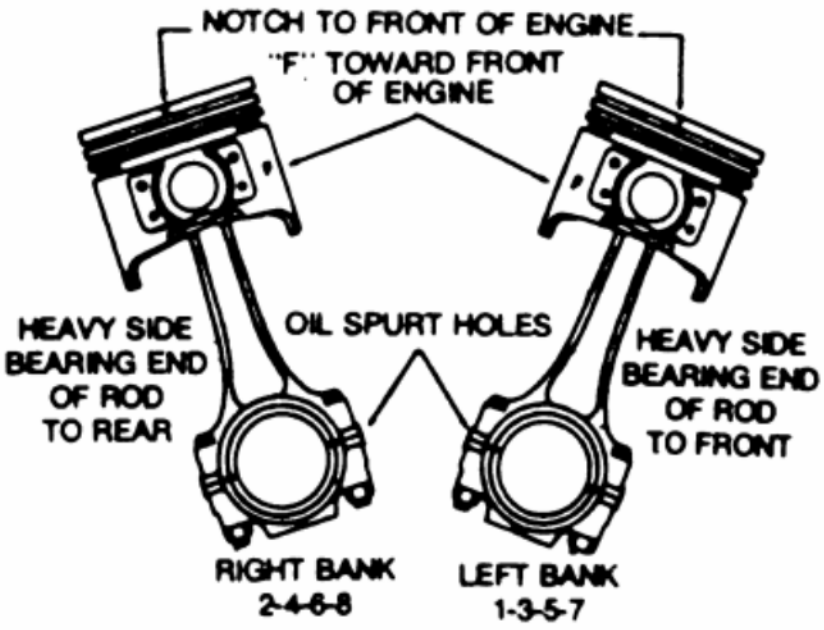


Fig. 12: Piston-to-rod relationship; V6 & V8 engines

cardiagn.com

1. Before installing the piston/connecting rod assembly, oil the pistons, piston rings and the cylinder walls with light engine oil. Install connecting rod bolt protectors or rubber hose onto the connecting rod bolts/studs. Also perform the following:
    a. Select the proper ring set for the size cylinder bore.
    b. Position the ring in the bore in which it is going to be used.
    c. Push the ring down into the bore area where normal ring wear is not encountered.
    d. Use the head of the piston to position the ring in the bore so that the ring is square with the cylinder wall. Use caution to avoid damage to the ring or cylinder bore.
    e. Measure the gap between the ends of the ring with a feeler gauge. Ring gap in a worn cylinder is normally greater than specification. If the ring gap is greater than the specified limits, try an oversize ring set.



Fig. 13: Checking the piston ring-to-ring groove side clearance using the ring and a feeler gauge

cardiagn.com

f. Check the ring side clearance of the compression rings with a feeler gauge inserted between the ring and its lower land according to specification. The gauge should slide freely around the entire ring circumference without binding. Any wear that occurs will form a step at the inner portion of the lower land. If the lower lands have high steps, the piston should be replaced.

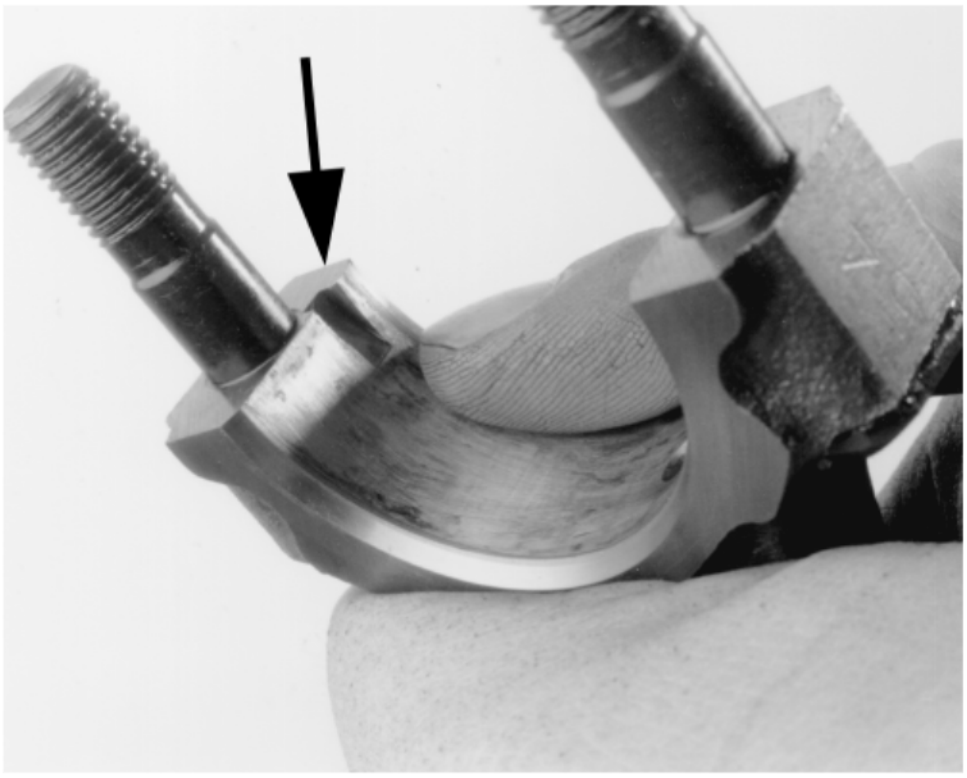


Fig. 14: The notch on the side of the bearing cap matches the tang on the bearing insert

2. Unless new pistons are installed, be sure to install the pistons in the cylinders from which they were removed. The numbers on the connecting rod and bearing cap must be on the same side when installed in the cylinder bore. If a connecting rod is ever transposed from one engine or cylinder to another, new bearings should be fitted and the connecting rod should be numbered to correspond with the new cylinder number. The notch on the piston head goes toward the front of the engine.
3. Install all of the rod bearing inserts into the rods and caps.

cardiagn.com

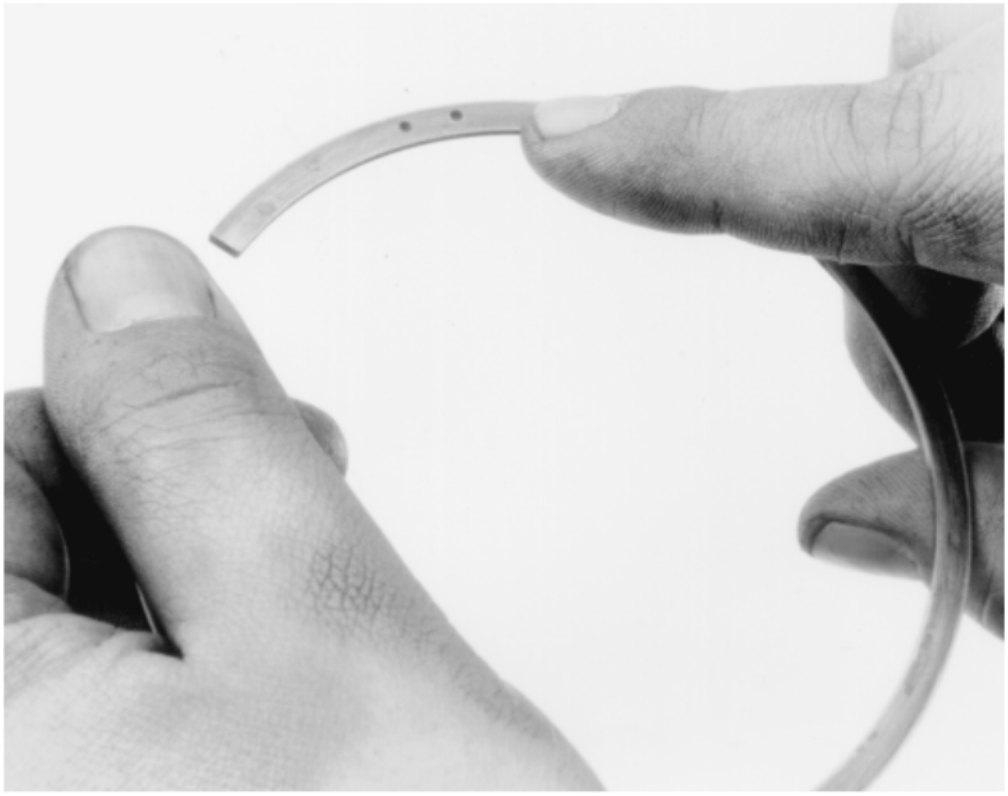


Fig. 15: Most rings are marked to show which side of the ring should face up when installed to the piston

4. Install the rings to the pistons. Install the oil control ring first, then the second compression ring and finally the top compression ring. Use a piston ring expander tool to aid in installation and to help reduce the chance of breakage.

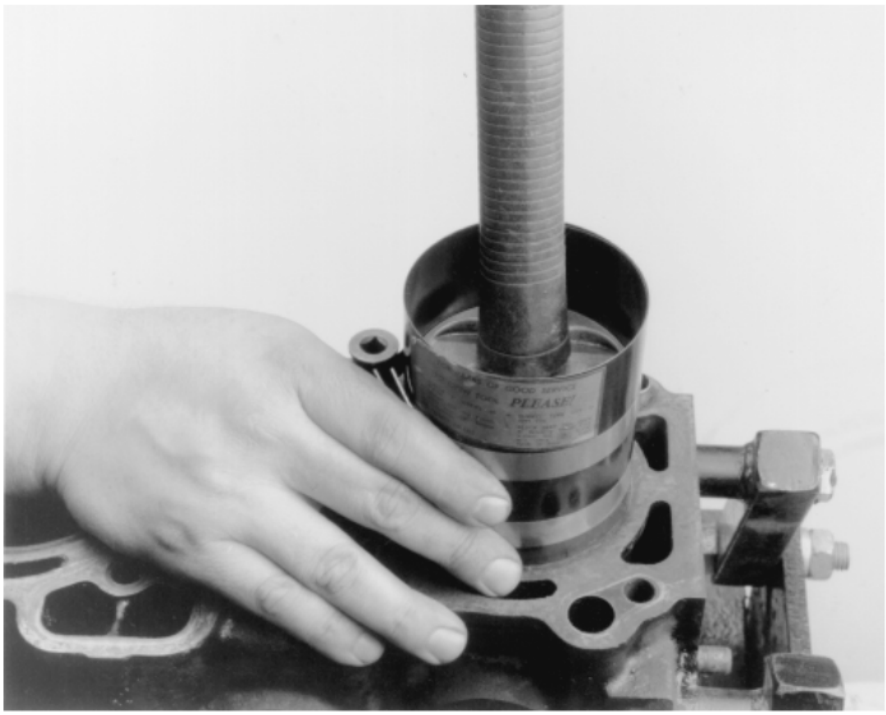


Fig. 16: Install the piston and rod assembly into the block using a ring compressor and the handle of a hammer

cardiagn.com

5. Make sure the ring gaps are properly spaced around the circumference of the piston. Fit a piston ring compressor around the piston and slide the piston and connecting rod assembly down into the cylinder bore, pushing it in with the wooden hammer handle. Push the piston down until it is only slightly below the top of the cylinder bore. Guide the connecting rod onto the crankshaft bearing journal carefully, to avoid damaging the crankshaft.
6. Check the bearing clearance of all the rod bearings, fitting them to the crankshaft bearing journals. Follow the procedure in the crankshaft installation above.
7. After the bearings have been fitted, apply a light coating of assembly oil to the journals and bearings.
8. Turn the crankshaft until the appropriate bearing journal is at the bottom of its stroke, then push the piston assembly all the way down until the connecting rod bearing seats on the crankshaft journal. Be careful not to allow the bearing cap screws to strike the crankshaft bearing journals and damage them.
9. After the piston and connecting rod assemblies have been installed, check the connecting rod side clearance on each crankshaft journal.
10. Prime and install the oil pump and the oil pump intake tube.

CAMSHAFT, LIFTERS AND TIMING ASSEMBLY

1. Install the camshaft.
2. Install the lifters/followers into their bores.
3. Install the timing gears/chain assembly.

CYLINDER HEAD(S)

1. Install the cylinder head(s) using new gaskets.
2. Assemble the rest of the valve train (pushrods and rocker arms and/or shafts).

ENGINE COVERS AND COMPONENTS

Install the timing cover(s) and oil pan. Refer to your notes and drawings made prior to disassembly and install all of the components that were removed. Install the engine into the vehicle.

ENGINE START-UP AND BREAK-IN

STARTING THE ENGINE

Now that the engine is installed and every wire and hose is properly connected, go back and double check that all coolant and vacuum hoses are connected. Check that you oil drain plug is installed and properly tightened. If not already done, install a new oil filter onto the engine. Fill the crankcase with the proper amount and grade of engine oil. Fill the cooling system with a 50/50 mixture of coolant/water.

cardiagn.com

1. Connect the vehicle battery.
2. Start the engine. Keep your eye on your oil pressure indicator; if it does not indicate oil pressure within 10 seconds of starting, turn the vehicle off.

WARNING - Damage to the engine can result if it is allowed to run with no oil pressure. Check the engine oil level to make sure that it is full. Check for any leaks and if found, repair the leaks before continuing. If there is still no indication of oil pressure, you may need to prime the system.

3. Confirm that there are no fluid leaks (oil or other).
4. Allow the engine to reach normal operating temperature (the upper radiator hose will be hot to the touch).
5. If necessary, set the ignition timing.
6. Install any remaining components such as the air cleaner (if removed for ignition timing) or body panels which were removed.

BREAKING IT IN

Make the first miles on the new engine, easy ones. Vary the speed but do not accelerate hard. Most importantly, do not lug the engine, and avoid sustained high speeds until at least 100 miles. Check the engine oil and coolant levels frequently. Expect the engine to use a little oil until the rings seat. Change the oil and filter at 500 miles, 1500 miles, then every 3000 miles past that.

KEEP IT MAINTAINED

Now that you have just gone through all of that hard work, keep yourself from doing it all over again by thoroughly maintaining it. Not that you may not have maintained it before, heck you could have had one to two hundred thousand miles on it before doing this. However, you may have bought the vehicle used, and the previous owner did not keep up on maintenance. Which is why you just went through all of that hard work. See?

cardiagn.com

SPECIFICATIONS CHARTS

Troubleshooting Basic Starting System Problems

Problem	Cause	Solution
Starter motor rotates engine slowly	• Battery charge low or battery defective	• Charge or replace battery
	• Defective circuit between battery and starter motor	• Clean and tighten, or replace cables
	• Low load current	• Bench-test starter motor. Inspect for worn brushes and weak brush springs.
	• High load current	• Bench-test starter motor. Check engine for friction, drag or coolant in cylinders. Check ring gear-to-pinion gear clearance.
Starter motor will not rotate engine	• Battery charge low or battery defective	• Charge or replace battery
	• Faulty solenoid	• Check solenoid ground. Repair or replace as necessary.
	• Damaged drive pinion gear or ring gear	• Replace damaged gear(s)
	• Starter motor engagement weak	• Bench-test starter motor
	• Starter motor rotates slowly with high load current	• Inspect drive yoke pull-down and point gap, check for worn end bushings, check ring gear clearance
	• Engine seized	• Repair engine
Starter motor drive will not engage (solenoid known to be good)	• Defective contact point assembly	• Repair or replace contact point assembly
	• Inadequate contact point assembly ground	• Repair connection at ground screw
	• Defective hold-in coil	• Replace field winding assembly
Starter motor drive will not disengage	• Starter motor loose on flywheel housing	• Tighten mounting bolts
	• Worn drive end busing	• Replace bushing
	• Damaged ring gear teeth	• Replace ring gear or driveplate
	• Drive yoke return spring broken or missing	• Replace spring
Starter motor drive disengages prematurely	• Weak drive assembly thrust spring	• Replace drive mechanism
	• Hold-in coil defective	• Replace field winding assembly
Low load current	• Worn brushes	• Replace brushes
	• Weak brush springs	• Replace springs

cardiagn.com

Troubleshooting Basic Charging System Problems

Problem	Cause	Solution
Noisy alternator	• Loose mountings • Loose drive pulley • Worn bearings • Brush noise • Internal circuits shorted (High pitched whine)	• Tighten mounting bolts • Tighten pulley • Replace alternator • Replace alternator • Replace alternator
Squeal when starting engine or accelerating	• Glazed or loose belt	• Replace or adjust belt
Indicator light remains on or ammeter indicates discharge (engine running)	• Broken belt • Broken or disconnected wires • Internal alternator problems • Defective voltage regulator	• Install belt • Repair or connect wiring • Replace alternator • Replace voltage regulator/alternator
Car light bulbs continually burn out—battery needs water continually	• Alternator/regulator overcharging	• Replace voltage regulator/alternator
Car lights flare on acceleration	• Battery low • Internal alternator/regulator problems	• Charge or replace battery • Replace alternator/regulator
Low voltage output (alternator light flickers continually or ammeter needle wanders)	• Loose or worn belt • Dirty or corroded connections • Internal alternator/regulator problems	• Replace or adjust belt • Clean or replace connections • Replace alternator/regulator

cardiagn.com

ENGINE MECHANICAL SPECIFICATIONS

Component	U.S.	Metric
Bore × Stroke		
2.5L	4.0000 in. × 3.0000 in.	101.6mm × 76.2mm
2.8L	3.5039 in. × 2.9921 in.	89.0mm × 76.0mm
3.1L	3.5030 in. × 3.3122 in.	88.9mm × 84.1mm
3.4L	3.6220 in. × 3.3122 in.	91.9mm × 84.1mm
5.0L	3.7360 in. × 3.4800 in.	94.9mm × 88.4mm
5.7L	4.0000 in. × 3.4800 in.	101.6mm × 88.4mm
Displacement		
2.5L	150.8 cu. in.	2471.1 cc
2.8L	173.1 cu. in.	2836.8 cc
3.1L	191.5 cu. in.	3138.6 cc
3.4L	204.8 cu. in.	3355.5 cc
5.0L	305.2 cu. in.	5001.2 cc
5.7L	349.8 cu. in.	5732.9 cc
Camshaft bearing ID		
2.5L	1.8697–1.8717 in.	47.4904–47.5411mm
2.8L	1.8687–1.8737 in.	47.4660–47.5910mm
3.4L	1.8710–1.8720 in.	47.5230–47.5490mm
Camshaft end-play		
2.5L	0.0015–0.0050 in.	0.0381–0.1270mm
5.0L	0.0040–0.0120 in.	0.1016–0.3048mm
5.7L	0.0040–0.0120 in.	0.1016–0.3048mm
Camshaft journal-to-bearing clearance		
2.5L	0.0007–0.0027 in.	0.0178–0.0686mm
2.8L	0.0010–0.0040 in.	0.0254–0.1016mm
3.1L	0.0010–0.0040 in.	0.0254–0.1016mm
3.4L	0.0010–0.0040 in.	0.0254–0.1016mm
Camshaft journal diameter		
2.5L	1.8690 in.	47.4726mm
2.8L	1.8677–1.8697 in.	47.4400–47.4900mm
3.1L	1.8677–1.8697 in.	47.4400–47.4900mm
3.4L	1.8710–1.8720 in.	47.5230–47.5490mm
5.0L	1.8682–1.8692 in.	47.4523–47.4777mm
5.7L	1.8682–1.8692 in.	47.4523–47.4777mm
Camshaft lobe lift		
2.5L		
Intake	0.3980 in.	10.3124mm
Exhaust	0.3980 in.	10.3124mm
2.8L		
1982–84		
Intake	0.2311 in.	5.8700mm
Exhaust	0.2626 in.	6.6700mm
1985–89		
Intake	0.2626 in.	6.6700mm
Exhaust	0.2732 in.	6.9400mm
3.1L		
Intake	0.2626 in.	6.6700mm
Exhaust	0.2732 in.	6.9400mm
3.4L		
Intake	0.2626 in.	6.6700mm
Exhaust	0.2732 in.	6.9400mm

cardiagn.com

ENGINE MECHANICAL SPECIFICATIONS

Component	U.S.	Metric
5.0L		
1982		
Intake		
LU5	0.2600 in.	6.6040mm
LG4	0.2380 in.	6.0452mm
Exhaust		
LU5	0.2730 in.	6.9342mm
LG4	0.2600 in.	6.6040mm
1983–84		
Intake		
L69	0.2690 in.	6.8326mm
LG4	0.2380 in.	6.0452mm
Exhaust		
L69	0.2760 in.	7.0104mm
LG4	0.2600 in.	6.6040mm
1985		
Intake		
L69	0.2690 in.	6.8326mm
LG4	0.2340 in.	5.9436mm
LB9	0.2690 in.	6.8326mm
Exhaust		
L69	0.2760 in.	7.0104mm
LG4	0.2570 in.	6.5278mm
LB9	0.2760 in.	7.0104mm
1986		
Intake		
L69	0.2690 in.	6.8326mm
LG4	0.2340 in.	5.9436mm
LB9	0.2690 in.	6.8326mm
Exhaust		
L69	0.2760 in.	7.0104mm
LG4	0.2570 in.	6.5278mm
LB9	0.2760 in.	7.0104mm
1987		
Intake		
LG4	0.2340 in.	5.9436mm
LB9	0.2690 in.	6.8326mm
Exhaust		
LG4	0.2570 in.	6.5278mm
LB9	0.2760 in.	7.0104mm
1988–90		
Intake		
LO3	0.2340 in.	5.9436mm
LB9	0.2690 in.	6.8326mm
Exhaust		
LO3	0.2570 in.	6.5278mm
LB9	0.2760 in.	7.0104mm
1991–92		
Intake		
LO3	0.2340 in.	5.9436mm
LB9	0.2750 in.	6.9850mm
Exhaust		
LO3	0.2570 in.	6.5278mm
LB9	0.2850 in.	7.2390mm

cardiagn.com

ENGINE MECHANICAL SPECIFICATIONS

Component	U.S.	Metric
5.7L		
1986–90		
Intake	0.2730 in.	6.9342mm
Exhaust	0.2820 in.	7.1628mm
1991–92		
Intake	0.2750 in.	6.9850mm
Exhaust	0.2850 in.	7.2390mm
1993–94		
Intake	0.3000 in.	7.6200mm
Exhaust	0.3000 in.	7.6200mm
Connecting rod bearing bore ID		
2.5L	2.0005–2.0026 in.	50.8127–50.8660mm
2.8L		
1982–84	2.0008–2.0020 in.	50.8200–50.8500mm
1985–89	2.0007–2.0021 in.	50.8190–50.8530mm
3.1L	1.9997–2.0030 in.	50.7924–50.8762mm
3.4L	1.9998–2.0026 in.	50.7949–50.8660mm
5.0L	2.1006–2.1028 in.	53.3552–53.4111mm
5.7L		
1986–92	2.1006–2.1028 in.	53.3552–53.4111mm
1993–94	2.0906–2.1033 in.	53.1012–53.4238mm
Connecting rod lower end bearing clearance		
2.5L	0.0005–0.0026 in.	0.0127–0.0660mm
2.8L		
1982–84	0.0014–0.0036 in.	0.0360–0.0910mm
1985–89	0.0014–0.0037 in.	0.0350–0.0950mm
3.1L		
1990	0.0014–0.0036 in.	0.0350–0.0930mm
1991–92	0.0011–0.0033 in.	0.0279–0.0838mm
3.4L	0.0011–0.0032 in.	0.0279–0.0813mm
5.0L		
1982–85	0.0020–0.0030 in.	0.0005–0.0008mm
1986–89	0.0018–0.0039 in.	0.0457–0.0991mm
1990–92	0.0013–0.0035 in.	0.0330–0.0889mm
5.7L	0.0013–0.0035 in.	0.0330–0.0889mm
Connecting rod-to-crankshaft side clearance		
2.5L	0.0060–0.0220 in.	0.1524–0.5588mm
2.8L	0.0063–0.0173 in.	0.1600–0.4400mm
3.1L		
1990	0.0140–0.0270 in.	0.3556–0.6858mm
1991	0.0140–0.0290 in.	0.3556–0.7366mm
1992	0.0080–0.0170 in.	0.2932–0.4400mm
3.4L	0.0070–0.0170 in.	0.1778–0.4400mm
5.0L		
1982–89	0.0080–0.0140 in.	0.2032–0.3556mm
1990–92	0.0060–0.0140 in.	0.1524–0.3556mm
5.7L	0.0060–0.0140 in.	0.1524–0.3556mm

cardiagn.com

ENGINE MECHANICAL SPECIFICATIONS

Component	U.S.	Metric
Connecting rod journal diameter		
2.5L	2.0000 in.	50.8000mm
2.8L	1.9983–1.9994 in.	50.7840–50.7580mm
3.1L	1.9983–1.9994 in.	50.7840–50.7580mm
3.4L	1.9987–1.9994 in.	50.7670–50.7580mm
5.0L		
1982–89	2.0986–2.0998 in.	53.3044–53.3350mm
1990–92	2.0893–2.0998 in.	53.0682–53.3349mm
5.7L		
1986–89	2.0986–2.0998 in.	53.3044–53.3350mm
1990–94	2.0893–2.0998 in.	53.0682–53.3349mm
Connecting rod journal taper (max.)		
2.5L	0.0005 in.	0.0127mm
2.8L	0.0002 in.	0.0050mm
3.1L	0.0002 in.	0.0050mm
3.4L	0.0002 in.	0.0050mm
5.0L	0.0010 in.	0.0254mm
5.7L	0.0010 in.	0.0254mm
Crankshaft end-play		
2.5L	0.0035–0.0085 in.	0.0889–0.2159mm
2.8L		
1982–85	0.0020–0.0067 in.	0.0500–0.1700mm
1986–89	0.0024–0.0087 in.	0.0600–0.2209mm
3.1L	0.0024–0.0083 in.	0.0600–0.2108mm
3.4L	0.0024–0.0083 in.	0.0600–0.2108mm
5.0L		
1982–89	0.0020–0.0060 in.	0.0500–0.1524mm
1990–92	0.0010–0.0070 in.	0.0254–0.1778mm
5.7L		
1986–89	0.0020–0.0060 in.	0.0500–0.1524mm
1990–94	0.0010–0.0070 in.	0.0254–0.1778mm
Cylinder bore diameter		
2.5L	4.0000 in.	101.6mm
2.8L	3.5036–3.5067 in.	88.9920–89.0700mm
3.1L	3.5046–3.5053 in.	89.0168–89.0346mm
3.4L	3.6228–3.6235 in.	92.0190–92.0369mm
5.0L	3.7350–3.7385 in.	94.8690–94.9579mm
5.7L	3.9995–4.0026 in.	101.5873–101.6635mm
Cylinder bore max. taper		
2.5L	0.0005 in.	0.0127mm
2.8L	0.0008 in.	0.0200mm
3.1L	0.0005 in.	0.0127mm
3.4L	0.0003 in.	0.0076mm
5.0L	0.0010 in.	0.0254mm
5.7L	0.0010 in.	0.0254mm
Cylinder bore out-of-round (max.)		
2.5L		
1982	0.0014 in.	0.0356mm
1983–86	0.0010 in.	0.0254mm
2.8L	0.0008 in.	0.0200mm
3.1L	0.0005 in.	0.0127mm
3.4L	0.0003 in.	0.0076mm
5.0L	0.0020 in.	0.0508mm
5.7L	0.0020 in.	0.0508mm

cardiagn.com

ENGINE MECHANICAL SPECIFICATIONS

Component	U.S.	Metric
Main bearing bore diameter		
2.5L	2.3005–2.3022 in.	58.4327–58.4759mm
2.8L		
1982–84	2.4954–2.4976 in.	63.3840–63.4400mm
1985–89	2.6489–2.6514 in.	67.2820–67.3460mm
3.1L	2.6485–2.6510 in.	67.2719–67.3354mm
3.4L	2.6485–2.6513 in.	67.2719–67.3430mm
5.0L		
No. 1	2.4492–2.4513 in.	62.2097–62.2630mm
Nos. 2, 3, 4	2.4491–2.4510 in.	62.2071–62.2554mm
No. 5	2.4504–2.4518 in.	62.2402–62.2757mm
5.7L		
No. 1	2.4492–2.4513 in.	62.2097–62.2630mm
Nos. 2, 3, 4	2.4491–2.4510 in.	62.2071–62.2554mm
No. 5	2.4504–2.4518 in.	62.2402–62.2757mm
Main bearing clearance		
2.5L	0.0005–0.0022 in.	0.0127–0.0559mm
2.8L		
1982–84	0.0017–0.0030 in.	0.0440–0.0760mm
1985–86	0.0021–0.0033 in.	0.0540–0.0840mm
1987–89	0.0016–0.0032 in.	0.0410–0.0810mm
3.1L		
1990	0.0012–0.0027 in.	0.0302–0.0686mm
1991–92	0.0012–0.0030 in.	0.0302–0.0760mm
3.4L	0.0012–0.0030 in.	0.0302–0.0760mm
5.0L		
1982–88		
No. 1	0.0010–0.0015 in.	0.0254–0.0381mm
Nos. 2, 3, 4	0.0010–0.0020 in.	0.0254–0.0508mm
No. 5	0.0025–0.0030 in.	0.0635–0.0762mm
1989–92		
No. 1	0.0010–0.0015 in.	0.0254–0.0381mm
Nos. 2, 3, 4	0.0010–0.0025 in.	0.0254–0.0635mm
No. 5	0.0025–0.0035 in.	0.0635–0.0889mm
5.7L		
1986–88		
No. 1	0.0010–0.0015 in.	0.0254–0.0381mm
Nos. 2, 3, 4	0.0010–0.0020 in.	0.0254–0.0508mm
No. 5	0.0025–0.0030 in.	0.0635–0.0762mm
1989–94		
No. 1	0.0010–0.0015 in.	0.0254–0.0381mm
Nos. 2, 3, 4	0.0010–0.0025 in.	0.0254–0.0635mm
No. 5	0.0025–0.0035 in.	0.0635–0.0889mm
Main bearing journal diameter		
2.5L	2.3000 in.	59.1820mm
2.8L		
1982	2.4937–2.4946 in.	63.3400–63.3640mm
1983–84		
LE2 and LH7	2.4937–2.4946 in.	63.3400–63.3640mm
LL1 and LC1		
Nos. 1, 2, 4	2.4937–2.4946 in.	63.3400–63.3640mm
No. 3	2.4930–2.4941 in.	63.3220–63.3510mm
1985–89	2.6473–2.6482 in.	67.2410–67.2650mm
3.1L	2.6473–2.6482 in.	67.2410–67.2650mm
3.4L	2.6473–2.6483 in.	67.2410–67.2668mm

cardiagn.com

ENGINE MECHANICAL SPECIFICATIONS

Component	U.S.	Metric
5.0L	2.6473–2.6483 in.	67.2410–67.2668mm
No. 1	2.4484–2.4493 in.	62.1894–62.2122mm
Nos. 2, 3, 4	2.4481–2.4490 in.	62.1817–62.2046mm
No. 5	2.4479–2.4488 in.	62.1766–62.1995mm
5.7L		
No. 1	2.4484–2.4493 in.	62.1894–62.2122mm
Nos. 2, 3, 4	2.4481–2.4490 in.	62.1817–62.2046mm
No. 5	2.4479–2.4488 in.	62.1766–62.1995mm
Main bearing journal runout (max.)		
2.5L	0.0005 in.	0.0127mm
2.8L	0.0002 in.	0.0050mm
3.1L	0.0002 in.	0.0050mm
3.4L	0.0002 in.	0.0050mm
5.0L	0.0010 in.	0.0254mm
5.7L	0.0010 in.	0.0254mm
Main bearing journal taper (max.)		
2.5L	0.0005 in.	0.0127mm
2.8L	0.0002 in.	0.0050mm
3.1L	0.0002 in.	0.0050mm
3.4L	0.0002 in.	0.0050mm
5.0L	0.0010 in.	0.0254mm
5.7L	0.0010 in.	0.0254mm
Oil pump gear backlash		
2.5L	0.0090–0.0150 in.	0.2286–0.3810mm
3.4L	0.0037–0.0077 in.	0.0940–0.1956mm
5.0L	0.0004–0.0007 in.	0.0102–0.0178mm
5.7L	0.0004–0.0007 in.	0.0102–0.0178mm
Oil pump gear diameter		
2.5L	1.4960–1.5000 in.	37.9984–38.1000mm
2.8L	1.4980–1.5000 in.	38.0500–38.1000mm
3.4L	1.4980–1.5000 in.	38.0500–38.1000mm
5.0L	1.5290–1.5310 in.	38.8366–38.8874mm
5.7L	1.5290–1.5310 in.	38.8366–38.8874mm
Oil pump gear length		
2.5L	0.9990–1.0020 in.	25.3746–25.4508mm
2.8L	1.1988–1.2000 in.	30.4800–30.4500mm
3.4L	1.1988–1.2000 in.	30.4800–30.4500mm
5.0L	1.5075–1.5095 in.	38.2905–38.3413mm
5.7L	1.5075–1.5095 in.	38.2905–38.3413mm
Oil pump gear side clearance		
2.5L	0.0040 in. max.	0.1016mm max.
2.8L	0.0031–0.0039 in.	0.0800–0.1000mm
3.4L	0.0031–0.0039 in.	0.0800–0.1000mm
5.0L	0.0015–0.0045 in.	0.0381–0.1143mm
5.7L	0.0015–0.0045 in.	0.0381–0.1143mm

cardiagn.com

ENGINE MECHANICAL SPECIFICATIONS

Component	U.S.	Metric
Oil pump gear end clearance		
2.5L	0.0020–0.0051 in.	0.0500–0.1300mm
2.8L	0.0020–0.0051 in.	0.0500–0.1300mm
3.4L	0.0020–0.0060 in.	0.0500–0.1524mm
5.0L	0.0015–0.0085 in.	0.0381–0.2159mm
5.7L	0.0015–0.0085 in.	0.0381–0.2159mm
Oil pump gear pocket depth		
2.5L	0.9950–0.9980 in.	25.2730–25.3492mm
2.8L	1.1953–1.1984 in.	30.3600–30.4400mm
3.4L	1.2029–1.2051 in.	30.5131–30.6100mm
5.0L	1.5010–1.5060 in.	38.1254–38.2524mm
5.7L	1.5010–1.5060 in.	38.1254–38.2524mm
Oil pump gear pocket diameter		
2.5L	1.5031–1.5059 in.	38.1800–38.2500mm
2.8L	1.5031–1.5059 in.	38.1800–38.2500mm
3.4L	1.5040–1.5059 in.	38.2016–38.2500mm
5.0L	1.5340–1.5390 in.	38.9636–39.0906mm
5.7L	1.5340–1.5390 in.	38.9636–39.0906mm
Oil pump relief valve-to-housing clearance		
2.8L	0.0015–0.0035 in.	0.0380–0.0890mm
3.4L	0.0015–0.0035 in.	0.0380–0.0890mm
5.0L	0.0025–0.0050 in.	0.0635–0.1270mm
5.7L	0.0025–0.0050 in.	0.0635–0.1270mm
Piston diameter (centerline)		
2.5L		
1982–84	3.9971–3.9975 in.	101.5260–101.5360mm
1985–86	3.9986–3.9978 in.	101.5644–101.5441mm
2.8L		
1982–84	3.4990–3.5040 in.	88.8750–89.0010mm
1985–89	3.4656–3.5030 in.	88.0270–88.9750mm
3.1L	3.5024–3.5034 in.	88.9610–88.9864mm
3.4L	3.6211–3.6217 in.	91.9770–91.9920mm
5.0L		
1982	3.7357–3.7402 in.	94.8868–95.0011mm
1983–92	3.7323–3.7358 in.	94.8004–94.8893mm
5.7L	3.9970–3.9990 in.	101.5238–101.5746mm
Piston-to-bore or liner clearance		
2.5L		
1982–84	0.0025–0.0033 in.	0.0635–0.0838mm
1985–86	0.0015–0.0022 in.	0.0356–0.0559mm
2.8L		
1982–84	0.0017–0.0027 in.	0.0430–0.0690mm
1985–89	0.0007–0.0017 in.	0.0700–0.0430mm
3.1L		
1990–91	0.0012–0.0029 in.	0.0305–0.0737mm
1992	0.0012–0.0026 in.	0.0305–0.0660mm
3.4L	0.0011–0.0024 in.	0.0279–0.0690mm
5.0L		
1982–89	0.0007–0.0017 in.	0.0178–0.0432mm
1990–92	0.0007–0.0021 in.	0.0178–0.0533mm
5.7L		
1986–89	0.0025–0.0035 in.	0.0635–0.0889mm
1990–92	0.0007–0.0021 in.	0.0178–0.0533mm
1993–94	0.0010–0.0027 in.	0.0254–0.0686mm

cardiagn.com

ENGINE MECHANICAL SPECIFICATIONS

Component	U.S.	Metric
Piston pin bore diameter in piston		
2.5L	0.9383–0.9425 in.	23.8328–23.9395mm
2.8L	0.9055–0.9059 in.	23.0002–23.0106mm
3.1L	0.9056–0.9062 in.	23.0022–23.0175mm
3.4L	0.9057–0.9063 in.	23.0048–23.0200mm
5.0L	0.9273–0.9308 in.	23.5534–23.6423mm
5.7L		
1986–92	0.9273–0.9308 in.	23.5534–23.6423mm
1993–94	0.9275–0.9279 in.	23.5585–23.5687mm
Piston pin diameter		
2.5L	0.9380–0.9420 in.	23.8252–23.9268mm
2.8L	0.9053–0.9056 in.	22.9937–23.0015mm
3.1L	0.9052–0.9054 in.	22.9921–22.9972mm
3.4L	0.9052–0.9054 in.	22.9921–22.9972mm
5.0L	0.9270–0.9273 in.	23.5458–23.5534mm
5.7L		
1982–92	0.9270–0.9273 in.	23.5458–23.5534mm
1993–94	0.9270–0.9271 in.	23.5458–23.5483mm
Piston pin-to-piston bore clearance		
2.5L		
1982	0.0003–0.0005 in.	0.0076–0.0127mm
1983–86	0.0002–0.0004 in.	0.0051–0.0091mm
2.8L	0.0003–0.004 in.	0.0065–0.0091mm
3.1L		
1990–91	0.0004–0.0008 in.	0.0091–0.0203mm
1992	0.0002–0.0007 in.	0.0051–0.0178mm
3.4L	0.0005–0.0009 in.	0.0127–0.0229mm
5.0L		
1982–90	0.0003–0.0004 in.	0.0065–0.0091mm
1991–92	0.0002–0.0006 in.	0.0051–0.0152mm
5.7L		
1986–90	0.0003–0.0004 in.	0.0065–0.0091mm
1991–94	0.0005–0.0008 in.	0.0127–0.0203mm
Piston pin-to-rod clearance		
2.5L	press fit	
2.8L	press fit	
3.1L	press fit	
3.4L	press fit	
5.0L	0.0008–0.0016 in.	0.0203–0.0406mm
5.7L	0.0008–0.0016 in.	0.0203–0.0406mm
Piston ring end gap		
2.5L		
1982		
Top	0.0100–0.0220 in.	0.2540–0.5589mm
Middle	0.0100–0.0270 in.	0.2540–0.6858mm
Oil	0.0150–0.0550 in.	0.3810–1.3970mm
1983–86		
Top	0.0100–0.0200 in.	0.2540–0.5100mm
Middle	0.0100–0.0200 in.	0.2540–0.5100mm
Oil	0.0200–0.0600 in.	0.5100–1.5240mm

cardiagn.com

ENGINE MECHANICAL SPECIFICATIONS

Component	U.S.	Metric
2.8L		
Top	0.0098–0.0197 in.	0.2500–0.5000mm
Middle	0.0098–0.0197 in.	0.2500–0.5000mm
Oil	0.0200–0.0551 in.	0.5100–1.4000mm
3.1L		
1990		
Top	0.0098–0.0197 in.	0.2500–0.5000mm
Middle	0.0098–0.0197 in.	0.2500–0.5000mm
Oil	0.0100–0.0300 in.	0.5100–0.7620mm
1991		
Top	0.0098–0.0197 in.	0.2500–0.5000mm
Middle	0.0200–0.0280 in.	0.5100–0.7112mm
Oil	0.0100–0.0300 in.	0.2540–0.7620mm
1992		
Top	0.0070–0.0160 in.	0.1778–0.4064mm
Middle	0.0200–0.0280 in.	0.5100–0.7112mm
Oil	0.0100–0.0300 in.	0.2540–0.7620mm
3.4L		
Top	0.0070–0.0160 in.	0.1800–0.4100mm
Middle	0.0190–0.0290 in.	0.4800–0.7400mm
Oil	0.0100–0.0300 in.	0.2540–0.7620mm
5.0L		
1982		
Top	0.0100–0.0200 in.	0.2540–0.5589mm
Middle	0.0100–0.0250 in.	0.2540–0.6350mm
Oil	0.0150–0.0550 in.	0.3810–1.3970mm
1983–84		
Top	0.0100–0.0200 in.	0.2540–0.5589mm
Middle	0.0100–0.0200 in.	0.2540–0.5589mm
Oil	0.0150–0.0550 in.	0.3810–1.3970mm
1985–90		
Top	0.0100–0.0200 in.	0.2540–0.5589mm
Middle	0.0100–0.0250 in.	0.2540–0.6350mm
Oil	0.0150–0.0550 in.	0.3810–1.3970mm
1991		
Top	0.0100–0.0200 in.	0.2540–0.5589mm
Middle	0.0100–0.0250 in.	0.2540–0.6350mm
Oil	0.0100–0.0300 in.	0.2540–0.7620mm
1992		
Top	0.0100–0.0200 in.	0.2540–0.5589mm
Middle	0.0180–0.0260 in.	0.4572–0.6604mm
Oil	0.0100–0.0300 in.	0.2540–0.7620mm
5.7L		
1986–90		
Top	0.0100–0.0200 in.	0.2540–0.5589mm
Middle	0.0100–0.0250 in.	0.2540–0.6350mm
Oil	0.0150–0.0550 in.	0.3810–1.3970mm
1991–94		
Top	0.0100–0.0200 in.	0.2540–0.5589mm
Middle	0.0180–0.0260 in.	0.4572–0.6604mm
Oil	0.0100–0.0300 in.	0.2540–0.7620mm

cardiagn.com

ENGINE MECHANICAL SPECIFICATIONS

Component	U.S.	Metric
Piston ring side clearance		
2.5L		
1982		
Top	0.0015–0.0030 in.	0.0381–0.0762mm
Middle	0.0015–0.0030 in.	0.0381–0.0762mm
Oil	snug	
1983–86		
Top	0.0020–0.0030 in.	0.0510–0.0762mm
Middle	0.0010–0.0030 in.	0.0254–0.0762mm
Oil	0.0150–0.0550 in.	0.3810–1.3970mm
2.8L		
1982		
Top	0.0012–0.0028 in.	0.0300–0.0700mm
Middle	0.0016–0.0037 in.	0.0400–0.0950mm
Oil	0.0078 in. max.	0.1990mm max.
1983–84		
Top	0.0012–0.0031 in.	0.0300–0.0800mm
Middle	0.0012–0.0031 in.	0.0300–0.0800mm
Oil	0.0078 in. max.	0.1990mm max.
1985–89		
Top	0.0012–0.0028 in.	0.0300–0.0700mm
Middle	0.0016–0.0037 in.	0.0400–0.0950mm
Oil	0.0078 in. max.	0.1990mm max.
3.1L		
Top	0.0020–0.0035 in.	0.0508–0.0889mm
Middle	0.0020–0.0035 in.	0.0508–0.0889mm
Oil	0.0078 in. max.	0.1990mm max.
3.4L		
Top	0.0020–0.0035 in.	0.0508–0.0889mm
Middle	0.0020–0.0035 in.	0.0508–0.0889mm
Oil	0.0078 in. max.	0.1990mm max.
5.0L		
Top	0.0012–0.0032 in.	0.0300–0.0813mm
Middle	0.0012–0.0032 in.	0.0300–0.0813mm
Oil	0.0020–0.0070 in.	0.0508–0.1778mm
5.7L		
Top	0.0012–0.0032 in.	0.0300–0.0813mm
Middle	0.0012–0.0032 in.	0.0300–0.0813mm
Oil	0.0020–0.0070 in.	0.0508–0.1778mm
Rocker arm lift ratio		
2.5L	1.75:1	
2.8L	1.50:1	
3.1L	1.50:1	
3.4L	1.50:1	
5.0L	1.50:1	
5.7L	1.50:1	
Valve face angle		
2.5L	45 degrees	
2.8L	45 degrees	
3.1L	45 degrees	
3.4L	45 degrees	
5.0L	45 degrees	
5.7L	45 degrees	

cardiagn.com

ENGINE MECHANICAL SPECIFICATIONS

Component	U.S.	Metric
Valve face minimum margin		
All engines	0.03125 in.	0.7938mm
Valve seat angle		
2.5L	46 degrees	
2.8L	46 degrees	
3.1L	46 degrees	
3.4L	46 degrees	
5.0L	46 degrees	
5.7L	46 degrees	
Valve seat runout (max.)		
2.8L	0.0020 in.	0.0500mm
3.1L	0.0020 in.	0.0500mm
3.4L	0.0010 in.	0.0254mm
5.0L	0.0020 in.	0.0500mm
5.7L	0.0020 in.	0.0500mm
Valve seat width		
2.5L		
Intake	0.0353–0.0747 in.	0.8966–1.8974mm
Exhaust	0.0580–0.0971 in.	1.4732–2.4663mm
2.8L		
Intake	0.0492–0.0591 in.	0.2500–1.5000mm
Exhaust	0.0630–0.0750 in.	1.6000–1.9000mm
3.1L		
Intake	0.0492–0.0591 in.	0.2500–1.5000mm
Exhaust	0.0630–0.0750 in.	1.6000–1.9000mm
3.4L		
Intake	0.0610–0.0730 in.	1.5494–1.8542mm
Exhaust	0.0670–0.0790 in.	1.7018–1.0066mm
5.0L		
Intake	0.0313–0.0625 in.	0.7938–1.5875mm
Exhaust	0.0625–0.0938 in.	1.5875–2.3813mm
5.7L		
1986–92		
Intake	0.0313–0.0625 in.	0.7938–1.5875mm
Exhaust	0.0625–0.0938 in.	1.5875–2.3813mm
1993–94		
Intake	0.0300–0.0500 in.	0.7620–1.2700mm
Exhaust	0.0600–0.0800 in.	1.5240–2.0320mm
Valve spring compression pressure		
2.5L		
1982–84	122–180 lbs. @ 1.254 in.	55–82 kg @ 31.85mm
1985–86	170–180 lbs. @ 1.260 in.	77–82 kg @ 32mm
2.8L	195 lbs. @ 1.181 in.	88 kg @ 30mm
3.1L		
1990	195 lbs. @ 1.181 in.	88 kg @ 30mm
1991–92	189 lbs. @ 1.200 in.	86 kg @ 30mm
3.4L	190 lbs. @ 1.200 in.	86 kg @ 30mm

cardiagn.com

ENGINE MECHANICAL SPECIFICATIONS

Component	U.S.	Metric
5.0L		
1982–85	194–206 lbs. @ 1.25 in.	88–93 kg @ 31.75mm
1986–92	194–206 lbs. @ 1.25 in.	88–93 kg @ 31.75mm
Intake	194–206 lbs. @ 1.25 in.	88–93 kg @ 31.75mm
Exhaust	194–206 lbs. @ 1.15 in.	88–93 kg @ 29.46mm
5.7L		
1986–92		
Intake	194–206 lbs. @ 1.25 in.	88–93 kg @ 31.75mm
Exhaust	194–206 lbs. @ 1.16 in.	88–93 kg @ 29.46mm
1993–94		
Intake	252–272 lbs. @ 1.31 in.	114–123 kg @ 33mm
Exhaust	252–272 lbs. @ 1.31 in.	114–123 kg @ 33mm
Valve spring free length (approx.)		
2.5L	2.0800 in.	52.8mm
2.8L	1.9094 in.	48.5mm
3.1L	1.9094 in.	48.5mm
3.4L	1.9094 in.	48.5mm
5.0L	2.0300 in.	51.6mm
5.7L		
1986–92	2.0300 in.	51.6mm
1993–94	2.0100 in.	51.1mm
Valve spring installed height		
2.5L		
1982	1.6600 in.	42.1640mm
1983–86	1.6900 in.	42.9260mm
2.8L	1.5748 in.	40.0000mm
3.1L		
1990	1.5748 in.	40.0000mm
1991–92	1.6100 in.	40.8940mm
3.4L	1.6100 in.	40.8940mm
5.0L		
1982–85	1.7188 in.	43.6563mm
1986–91		
Intake	1.7188 in.	43.6563mm
Exhaust	1.5938 in.	40.4813mm
1992	1.7000 in.	43.1800mm
5.7L		
1986–91		
Intake	1.7188 in.	43.6563mm
Exhaust	1.5938 in.	40.4813mm
1992	1.7000 in.	43.1800mm
1993–94	1.7800 in.	45.2120mm
Valve stem-to-guide clearance		
2.5L	0.0010–0.0027 in.	0.0254–0.6858mm
2.8L	0.0010–0.0027 in.	0.0260–0.0680mm
3.1L		
1990	0.0010–0.0027 in.	0.0260–0.0680mm
1991–92		
Intake	0.0014–0.0025 in.	0.0356–0.0635mm
Exhaust	0.0016–0.0029 in.	0.0406–0.0737mm
3.4L		
Intake	0.0014–0.0027 in.	0.0356–0.0680mm
Exhaust	0.0015–0.0029 in.	0.0381–0.0737mm
5.0L	0.0010–0.0027 in.	0.0260–0.0680mm
5.7L	0.0010–0.0027 in.	0.0260–0.0680mm

cardiagn.com

TORQUE SPECIFICATIONS

Component	U.S.	Metric
Alternator adjusting bolt	25 ft. lbs.	34 Nm
Alternator bracket-to-block or head		
2.8L	40 ft. lbs.	54 Nm
3.1L		
nut	18 ft. lbs.	25 Nm
bolt	37 ft. lbs.	50 Nm
Alternator pivot bolt	30 ft. lbs.	41 Nm
Camshaft position sensor	89 inch lbs.	10 Nm
Camshaft retainer plate		
All	9 ft. lbs.	12 Nm
Camshaft sprocket-to-camshaft		
2.8L		
1982–87	20 ft. lbs.	27 Nm
1988–89	25 ft. lbs.	35 Nm
3.1L	21 ft. lbs.	28 Nm
5.0L		
1982–84	20 ft. lbs.	27 Nm
1985–88	23 ft. lbs.	31 Nm
1989–92	21 ft. lbs.	28 Nm
5.7L		
1986–88	23 ft. lbs.	31 Nm
1989–92	21 ft. lbs.	28 Nm
Camshaft thrust plate bolts		
2.5L		
1982–85	85 inch lbs.	9 Nm
1986	90 inch lbs.	10 Nm
Connecting rod nuts		
2.5L	32 ft. lbs.	44 Nm
2.8L		
1982–84	40 ft. lbs.	54 Nm
1985–89	45 ft. lbs.	60 Nm
3.1L	39 ft. lbs.	53 Nm
5.0L	45 ft. lbs.	61 Nm
5.7L	45 ft. lbs.	61 Nm
Crankshaft pulley		
2.8L	30 ft. lbs.	41 Nm
3.1L	37 ft. lbs.	50 Nm
5.0L, 5.7L	43 ft. lbs.	58 Nm
Cylinder head bolts		
2.5L		
1982–83		
Step 1	25 ft. lbs.	34 Nm
Step 2	50 ft. lbs.	68 Nm
Step 3	85 ft. lbs.	115 Nm
1984–85		
Step 1	30 ft. lbs.	40 Nm
Step 2	60 ft. lbs.	82 Nm
Step 3	92 ft. lbs.	125 Nm

cardiagn.com

TORQUE SPECIFICATIONS

Component	U.S.	Metric
Cylinder head bolts		
1986		
Step 1	18 ft. lbs.	25 Nm
Step 2 exc. No. 9	22 ft. lbs.	30 Nm
No. 9	29 ft. lbs.	40 Nm
Step 3 exc. No. 9	+ 120 degree turn	
No. 9	+ 90 degree turn	
2.8L		
1982–84		
Step 1	25 ft. lbs.	34 Nm
Step 2	50 ft. lbs.	68 Nm
Step 3	75 ft. lbs.	102 Nm
1985–87		
Step 1	30 ft. lbs.	40 Nm
Step 2	60 ft. lbs.	82 Nm
Step 3	90 ft. lbs.	122 Nm
1988–89		
Step 1	40 ft. lbs.	55 Nm
Step 2	+ 90 turn	
3.1L		
Step 1	40 ft. lbs.	55 Nm
Step 2	+ 90 turn	
5.0L		
1982–84		
Step 1	25 ft. lbs.	34 Nm
Step 2	50 ft. lbs.	68 Nm
Step 3	65 ft. lbs.	88 Nm
1985–88		
Step 1	25 ft. lbs.	34 Nm
Step 2	50 ft. lbs.	68 Nm
Step 3	75 ft. lbs.	102 Nm
1989–92		
Step 1	25 ft. lbs.	34 Nm
Step 2	50 ft. lbs.	68 Nm
Step 3	68 ft. lbs.	92 Nm
5.7L		
1986–88		
Step 1	25 ft. lbs.	34 Nm
Step 2	50 ft. lbs.	68 Nm
Step 3	75 ft. lbs.	102 Nm
1989–92		
Step 1	25 ft. lbs.	34 Nm
Step 2	50 ft. lbs.	68 Nm
Step 3	68 ft. lbs.	92 Nm

cardiagn.com

TORQUE SPECIFICATIONS

Component	U.S.	Metric
Damper-to-crankshaft		
2.5L		
1982–83	160 ft. lbs.	212 Nm
1984–85	200 ft. lbs.	260 Nm
1986	162 ft. lbs.	220 Nm
2.8L	85 ft. lbs.	115 Nm
3.1L		
1990	76 ft. lbs.	103 Nm
1991–92	70 ft. lbs.	95 Nm
5.0L		
1982–88	60 ft. lbs.	82 Nm
1989–92	70 ft. lbs.	95 Nm
5.7L		
1986–88	60 ft. lbs.	82 Nm
1989–92	70 ft. lbs.	95 Nm
Distributor clamp bolt		
2.5L		
1982–85	22 ft. lbs.	30 Nm
1986	15 ft. lbs.	20 Nm
2.8L	30 ft. lbs.	41 Nm
3.1L	25 ft. lbs.	34 Nm
5.0L		
1982–84	20 ft. lbs.	27 Nm
1985–92	35 ft. lbs.	48 Nm
5.7L		
1986–92	35 ft. lbs.	48 Nm
Electric cooling fan-to-radiator support		
All	20 ft. lbs.	27 Nm
Engine fan clutch-to-water pump hub		
All	18 ft. lbs.	24 Nm
Engine front cover		
2.8L		
1982–84		
1.25	18 ft. lbs.	24 Nm
1.50	30 ft. lbs.	41 Nm
1985–89		
1.25 × 40	22 ft. lbs.	30 Nm
1.25 × 70	22 ft. lbs.	30 Nm
1.25 × 27	24 ft. lbs.	32 Nm
1.50 × 75	35 ft. lbs.	48 Nm
3.1L	15 ft. lbs.	21 Nm

cardiagn.com

TORQUE SPECIFICATIONS

Component	U.S.	Metric
Engine front cover		
5.0L		
1982–84	80 inch lbs.	9 Nm
1985	94 inch lbs.	11 Nm
1986–88	11 ft. lbs.	14 Nm
1989–92	8 ft. lbs.	11 Nm
5.7L		
1986–88	11 ft. lbs.	14 Nm
1989–92	8 ft. lbs.	11 Nm
Engine mounting bracket		
2.8L	92 ft. lbs.	125 Nm
5.0L, 5.7L	38 ft. lbs.	52 Nm
Engine mount nuts		
All	30 ft. lbs.	41 Nm
Engine mount through-bolts		
3.1L	50 ft. lbs.	68 Nm
5.0L, 5.7L		
1982–92	50 ft. lbs.	68 Nm
Engine mount torque strut		
2.8L	40 ft. lbs.	54 Nm
Engine rear cover		
2.8L	9 ft. lbs.	12 Nm
3.1L	89 inch lbs.	10 Nm
Engine side cover		
2.5L	90 inch lbs.	10 Nm
Exhaust manifold-to-cylinder head		
2.5L		
1982–85	44 ft. lbs.	60 Nm
1986		
4 outer bolts	32 ft. lbs.	43 Nm
3 center bolts	37 ft. lbs.	50 Nm
2.8L		
1982–84	28 ft. lbs.	38 Nm
1985–89	31 ft. lbs.	42 Nm
3.1L	25 ft. lbs.	34 Nm
5.0L		
1982–84	20 ft. lbs.	27 Nm
1985–88		
4 outer bolts	26 ft. lbs.	35 Nm
2 inner bolts	32 ft. lbs.	44 Nm
1988–92		
Center bolts	20 ft. lbs.	27 Nm
Outer	26 ft. lbs.	35 Nm

cardiagn.com

TORQUE SPECIFICATIONS

Component	U.S.	Metric
Cylinder head bolts		
5.7L		
1986–88		
4 outer bolts	26 ft. lbs.	35 Nm
2 inner bolts	32 ft. lbs.	44 Nm
1988–92		
Center bolts	20 ft. lbs.	27 Nm
Outer	26 ft. lbs.	35 Nm
Flywheel-to-crankshaft		
2.5L		
1982–85	44 ft. lbs.	60 Nm
1986	55 ft. lbs.	75 Nm
2.8L		
1982–88		
Automatic	35 ft. lbs.	47 Nm
Manual	55 ft. lbs.	75 Nm
1989	59 ft. lbs.	80 Nm
3.1L	52 ft. lbs.	71 Nm
5.0L		
1982–84	60 ft. lbs.	82 Nm
1985	70 ft. lbs.	95 Nm
1986–88	85 ft. lbs.	115 Nm
1989–92	74 ft. lbs.	100 Nm
5.7L		
1986–88	85 ft. lbs.	115 Nm
1989–92	74 ft. lbs.	100 Nm
Fuel pump mounting bolts		
2.5L, 2.8L	18 ft. lbs.	25 Nm
Intake manifold-to-cylinder head		
2.5L		
1982–85	29 ft. lbs.	40 Nm
1986		
Cap bolts	28 ft. lbs.	38 Nm
Stud-head bolts		
Except upper left	25 ft. lbs.	34 Nm
Upper left	37 ft. lbs.	50 Nm
2.8L		
1982–87	25 ft. lbs.	34 Nm
1988		
Lower	25 ft. lbs.	34 Nm
Upper	22 ft. lbs.	30 Nm
1989		
Lower	25 ft. lbs.	34 Nm
Upper	18 ft. lbs.	24 Nm
3.1L		
Lower	19 ft. lbs.	26 Nm
Upper	15 ft. lbs.	21 Nm

cardiagn.com

TORQUE SPECIFICATIONS

Component	U.S.	Metric
Intake manifold-to-cylinder head		
5.0L		
1982–84	30 ft. lbs.	41 Nm
1985–88	45 ft. lbs.	61 Nm
1989–91	35 ft. lbs.	47 Nm
1992		
Step 1	89 inch lbs.	10 Nm
Step 2	35 ft. lbs.	47 Nm
5.7L		
1986–88	45 ft. lbs.	61 Nm
1989–91	35 ft. lbs.	47 Nm
1992		
Step 1	89 inch lbs.	10 Nm
Step 2	35 ft. lbs.	47 Nm
Main bearing cap bolts		
2.5L	70 ft. lbs.	95 Nm
2.8L		
1982–84	74 ft. lbs.	100 Nm
1985–89	83 ft. lbs.	112 Nm
3.1L	73 ft. lbs.	99 Nm
5.0L		
1982–84	70 ft. lbs.	95 Nm
1985	75 ft. lbs.	102 Nm
1986		
outer	75 ft. lbs.	102 Nm
inner	85 ft. lbs.	115 Nm
1987–88	85 ft. lbs.	115 Nm
1989–92	77 ft. lbs.	105 Nm
5.7L		
1986		
outer	75 ft. lbs.	102 Nm
inner	85 ft. lbs.	115 Nm
1987–88	85 ft. lbs.	115 Nm
1989–92	77 ft. lbs.	105 Nm

cardiagn.com

TORQUE SPECIFICATIONS

Component	U.S.	Metric
Oil filter stud		
2.8L		
1982–88	34 ft. lbs.	46 Nm
1989	70 ft. lbs.	95 Nm
3.1L, 5.0L, 5.7L		
1990–92	63 ft. lbs.	85 Nm
Oil pan bolts		
2.5L		
1982–84	75 inch lbs.	8 Nm
1985	53 inch lbs.	6 Nm
1986	90 inch lbs.	10 Nm
2.8L		
1.00	9 ft. lbs.	12 Nm
1.25	22 ft. lbs.	30 Nm
1985–86		
1.25 × 14	30 ft. lbs.	40 Nm
1.00 × 16	15 ft. lbs.	20 Nm
1987–89		
1.25 × 14	22 ft. lbs.	30 Nm
1.00 × 16	9 ft. lbs.	12 Nm
3.1L		
Rear 2 bolts	18 ft. lbs.	25 Nm
All the rest	89 inch lbs.	10 Nm
5.0L		
1982–84		
5/16-18	14 ft. lbs.	10 Nm
1/4-20	80 inch lbs.	9 Nm
1985–88		
5/16-18 stud	10 inch lbs.	1 Nm
5/16-18 nut	15 ft. lbs.	11 Nm
1/4-20 bolt	90 inch lbs.	5 Nm
1989–92		
Bolts	8 ft. lbs.	11 Nm
Nuts	17 ft. lbs.	23 Nm
5.7L		
1986–88		
5/16-18 stud	10 inch lbs.	1 Nm
5/16-18 nut	15 ft. lbs.	11 Nm
1/4-20 bolt	90 inch lbs.	5 Nm
1989–92		
Bolts	8 ft. lbs.	11 Nm
Nuts	17 ft. lbs.	23 Nm

cardiagn.com

TORQUE SPECIFICATIONS

Component	U.S.	Metric
Oil pan drain plug		
2.5L	25 ft. lbs.	34 Nm
2.8L	20 ft. lbs.	27 Nm
5.0L, 5.7L	16 ft. lbs.	22 Nm
Oil pickup tube-to-pump		
2.5L	37 ft. lbs.	50 Nm
Oil pump cover		
2.5L	10 ft. lbs.	14 Nm
2.8L	9 ft. lbs.	12 Nm
5.0L	80 inch lbs.	9 Nm
5.7L	80 inch lbs.	9 Nm
Oil pump-to-block		
2.5L	22 ft. lbs.	30 Nm
2.8L	35 ft. lbs.	47 Nm
3.1L	30 ft. lbs.	41 Nm
5.0L		
1982–84	65 ft. lbs.	88 Nm
1985–88	70 ft. lbs.	95 Nm
1989–92	65 ft. lbs.	88 Nm
5.7L		
1986–88	70 ft. lbs.	95 Nm
1989–92	65 ft. lbs.	88 Nm
Rear oil seal retainer		
3.1L, 5.0L, 5.7L	11 ft. lbs.	15 Nm
Rocker arm cover		
2.5L	72 inch lbs.	8 Nm
2.8L		
1982–84	9 ft. lbs.	12 Nm
1985–89	15 ft. lbs.	20 Nm
3.1L	10 ft. lbs.	14 Nm
5.0L		
1982–84	45 inch lbs.	5 Nm
1985–86		
Nuts	65 inch lbs.	4 Nm
Studs	10 inch lbs.	1 Nm
1987–88	9 ft. lbs.	12 Nm
1989	72 inch lbs.	8 Nm
1990	89 inch lbs.	10 Nm
1991–92	95 inch lbs.	11 Nm
5.7L		
1986		
Nuts	65 inch lbs.	4 Nm
Studs	10 inch lbs.	1 Nm
1987–88	9 ft. lbs.	12 Nm
1989	72 inch lbs.	8 Nm
1990	89 inch lbs.	10 Nm
1991–92	95 inch lbs.	10.5 Nm

cardiagn.com

TORQUE SPECIFICATIONS

Component	U.S.	Metric
Rocker arm stud/nut		
2.5L	20 ft. lbs.	27 Nm
2.8L		
1982–84	49 ft. lbs.	66 Nm
1985–89	11 inch lbs.	14 Nm
3.1L	89 inch lbs.	10 Nm
5.0L		
1982–87	11 ft. lbs.	14 Nm
5.7L		
1986–87	11 ft. lbs.	14 Nm
Spark plugs		
2.8L		
1982–88	15 ft. lbs.	20 Nm
1989	25 ft. lbs.	34 Nm
3.1L	25 ft. lbs.	34 Nm
5.0L, 5.7L		
1982–92	22 ft. lbs.	30 Nm
Starter mounting bolts		
All	37 ft. lbs.	50 Nm
Thermostat housing bolts		
2.5L	20 ft. lbs.	27 Nm
2.8L		
1982–84	30 ft. lbs.	41 Nm
1985–88	18 ft. lbs.	24 Nm
1989	22 ft. lbs.	30 Nm
3.1L	18 ft. lbs.	25 Nm
5.0L		
1982	25 ft. lbs.	34 Nm
1983–87		
Carbureted engines	23 ft. lbs.	17 Nm
Fuel injected engines	30 ft. lbs.	22 Nm
1988	30 ft. lbs.	22 Nm
1989–92	21 ft. lbs.	28 Nm
5.7L		
1986–88	30 ft. lbs.	22 Nm
1989–92	25 ft. lbs.	34 Nm
Timing chain tensioner-to-block		
2.8L	19 ft. lbs.	24 Nm
3.1L	15 ft. lbs.	21 Nm
Timing gear case		
2.5L	90 inch lbs.	10 Nm
Valve lifter retainer		
5.0L, 5.7L		
1990	12 ft. lbs.	16 Nm
1991–92	15 ft. lbs.	20 Nm

cardiagn.com