IGNITION SYSTEM

CONTENTS

DESCRIPTION AND OPERATION

IGNITION SYSTEM

DESCRIPTION

Two different ignition systems are used. One type of system is for the 4.0L 6–cylinder engine. The other is for the 4.7L V-8 engine.

OPERATION

The 4.0L 6–cylinder engine uses a one-piece coil rail containing three independent coils. Although cylinder firing order is the same as 4.0L engines of previous years, spark plug firing is not. The 3 coils dual-fire the spark plugs on cylinders 1–6, 2–5 and/or 3–4. When one cylinder is being fired (on compression stroke), the spark to the opposite cylinder is being wasted (on exhaust stroke). The one-piece coil bolts directly to the cylinder head. Rubber boots seal the secondary terminal ends of the coils to the top of all 6 spark plugs. One electrical connector (located at the rear end of the coil rail) is used for all three coils.

The 4.7L V-8 engine uses 8 dedicated and individually fired coil for each spark plug. Each coil is mounted directly to the top of each spark plug. A separate electrical connector is used for each coil.

Because of coil design, spark plug cables (secondary cables) are not used on either engine. A **distributor is not used** with either the 4.0L or 4.7L engines.

The ignition system is controlled by the powertrain control module (PCM) on all engines.

The ignition system consists of:

- Spark Plugs
- Ignition Coil(s)
- Powertrain Control Module (PCM)
- Crankshaft Position Sensor
- Camshaft Position Sensor
- The MAP, TPS, IAC and ECT also have an effect on the control of the ignition system.

DESCRIPTION AND OPERATION (Continued)

POWERTRAIN CONTROL MODULE (PCM)

DESCRIPTION

The Powertrain Control Module (PCM) is located in the engine compartment behind the coolant overflow tank (Fig. 1).

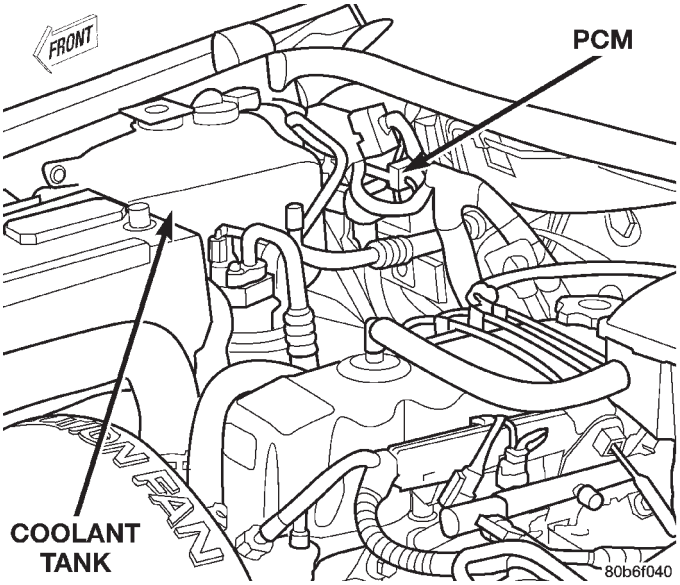

Fig. 1 Powertrain Control Module (PCM) Location

OPERATION

The ignition system is controlled by the PCM.

The PCM opens and closes the ignition coil ground circuit to operate the ignition coil(s). This is done to adjust ignition timing, both initial (base) and advance, and for changing engine operating conditions.

The amount of electronic spark advance provided by the PCM is determined by five input factors: engine coolant temperature, engine rpm, intake manifold temperature, manifold absolute pressure and throttle position.

SPARK PLUGS

DESCRIPTION

Both the 4.0L 6–cylinder and the 4.7L V-8 engine use resistor type spark plugs. 4.7L V-8 engines are equipped with “fired in suppressor seal” type spark plugs using a copper core ground electrode.

Because of the use of an aluminum cylinder head on the 4.7L engine, spark plug torque is very critical.

To prevent possible pre-ignition and/or mechanical engine damage, the correct type/heat range/number spark plug must be used.

OPERATION

Plugs on both engines have resistance values ranging from 6,000 to 20,000 ohms (when checked with at least a 1000 volt spark plug tester). **Do not use an ohmmeter to check the resistance values of the spark plugs. Inaccurate readings will result.** Remove the spark plugs and examine them for burned electrodes and fouled, cracked or broken porcelain insulators. Keep plugs arranged in the order in which they were removed from the engine. A single plug displaying an abnormal condition indicates that a problem exists in the corresponding cylinder. Replace spark plugs at the intervals recommended in Group O, Lubrication and Maintenance.

Spark plugs that have low mileage may be cleaned and reused if not otherwise defective, carbon or oil fouled. Also refer to Spark Plug Conditions.

CAUTION: Never use a motorized wire wheel brush to clean the spark plugs. Metallic deposits will remain on the spark plug insulator and will cause plug misfire.

IGNITION COIL—4.0L ENGINE

DESCRIPTION

A one-piece coil rail assembly containing three individual coils is used on the 4.0L 6–cylinder engine (Fig. 2). The coil rail must be replaced as one assembly. The bottom of the coil is equipped with 6 individual rubber boots (Fig. 2) to seal the 6 spark plugs to the coil. Inside each rubber boot is a spring. The spring is used for a mechanical contact between the coil and the top of the spark plug. These rubber boots and springs are a permanent part of the coil and are not serviced separately.

(1) The coil is bolted directly to the cylinder head (Fig. 3). One electrical connector (located at rear of coil) is used for all three coils.

OPERATION

Although cylinder firing order is the same as 4.0L Jeep engines of previous years, spark plug firing is not. The 3 coils dual-fire the spark plugs on cylinders 1–6, 2–5 and/or 3–4. When one cylinder is being fired (on compression stroke), the spark to the opposite cylinder is being wasted (on exhaust stroke).

Battery voltage is supplied to the three ignition coils from the ASD relay. The Powertrain Control Module (PCM) opens and closes the ignition coil ground circuit for ignition coil operation.

Base ignition timing is not adjustable. By controlling the coil ground circuit, the PCM is able to set the base timing and adjust the ignition timing advance. This is done to meet changing engine operating conditions.

The ignition coil is not oil filled. The windings are embedded in an epoxy compound. This provides heat

DESCRIPTION AND OPERATION (Continued)

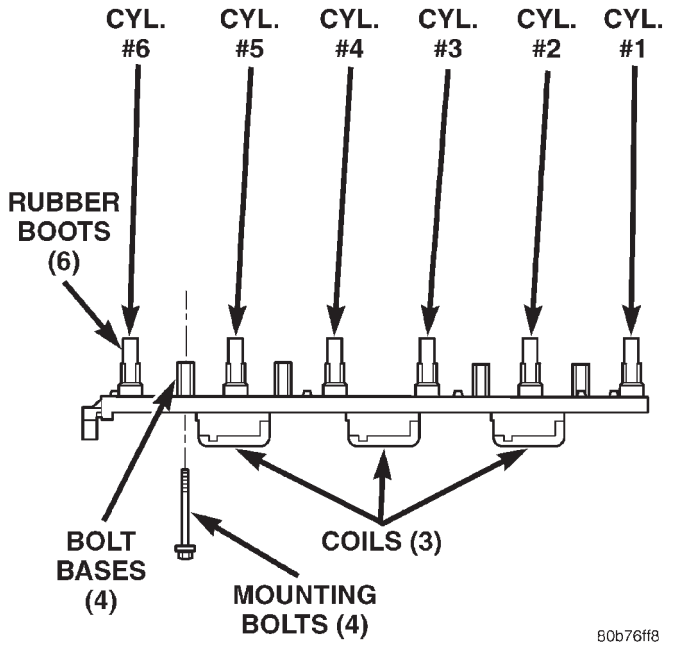

Fig. 2 Ignition Coil Assembly—4.0L 6–Cylinder Engine

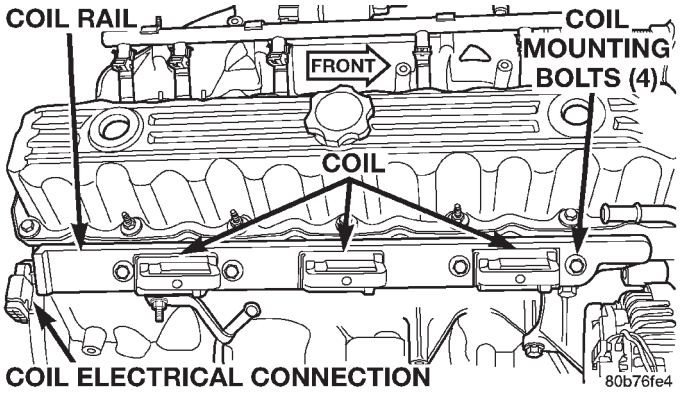

Fig. 3 Coil Location—4.0L Engine

and vibration resistance that allows the ignition coil to be mounted on the engine.

Because of coil design, spark plug cables (secondary cables) are not used. The cables are integral within the coil rail.

IGNITION COIL—4.7L ENGINE

DESCRIPTION

The 4.7L V–8 engine uses 8 dedicated, and individually fired coil (Fig. 4) for each spark plug. Each coil is mounted directly to the top of each spark plug (Fig. 5).

OPERATION

Battery voltage is supplied to the 8 ignition coils from the ASD relay. The Powertrain Control Module

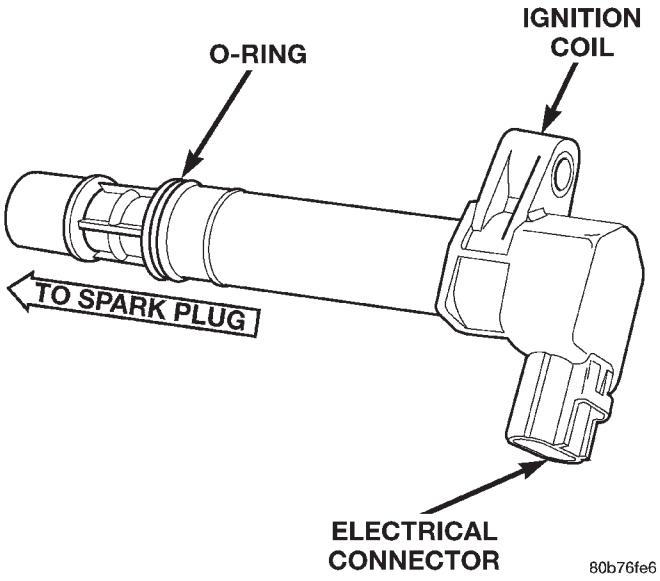

Fig. 4 Ignition Coil—4.7L Engine

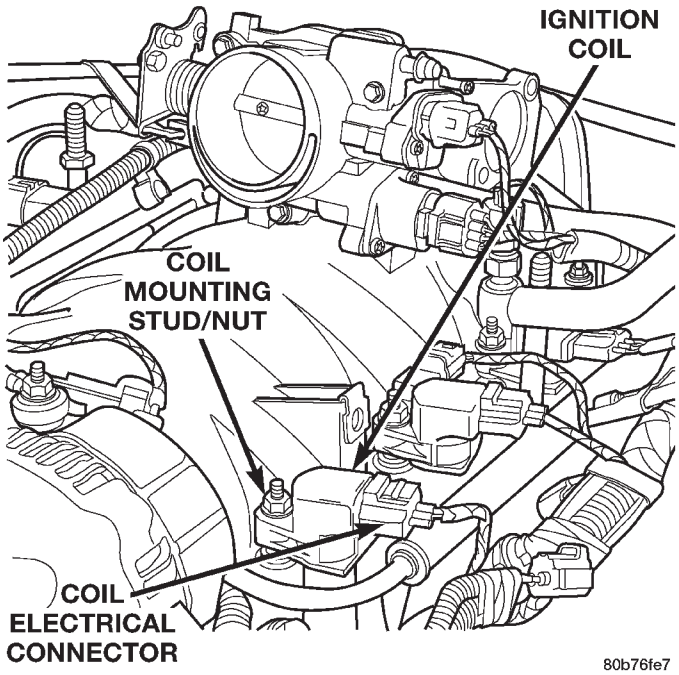

Fig. 5 Ignition Coil Location—4.7L Engine

(PCM) opens and closes each ignition coil ground circuit at a determined time for ignition coil operation.

Base ignition timing is not adjustable. By controlling the coil ground circuit, the PCM is able to set the base timing and adjust the ignition timing advance. This is done to meet changing engine operating conditions.

The ignition coil is not oil filled. The windings are embedded in an epoxy compound. This provides heat and vibration resistance that allows the ignition coil to be mounted on the engine.

Because of coil design, spark plug cables (secondary cables) are not used.

DESCRIPTION AND OPERATION (Continued)

AUTOMATIC SHUTDOWN (ASD) RELAY

DESCRIPTION

The ASD relay is located in the Power Distribution Center (PDC). Refer to label on PDC cover for relay location.

OPERATION

As one of its functions, the ASD relay will supply battery voltage to the ignition coil(s). The ground circuit to operate the ASD relay is controlled by the Powertrain Control Module (PCM). The PCM regulates ASD relay operation by switching its ground circuit on-and-off.

CRANKSHAFT POSITION SENSOR—4.0L ENGINE

DESCRIPTION

The Crankshaft Position Sensor (CKP) is mounted to the transmission bellhousing at the left/rear side of the engine block (Fig. 6).

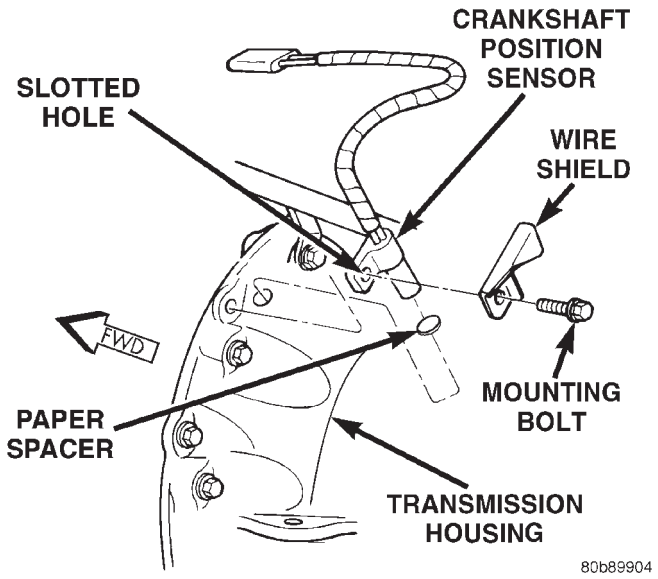

Fig. 6 CKP Sensor Location—4.0L 6-Cyl. Engine

OPERATION

Engine speed and crankshaft position are provided through the crankshaft position sensor. The sensor generates pulses that are the input sent to the powertrain control module (PCM). The PCM interprets the sensor input to determine the crankshaft position. The PCM then uses this position, along with other inputs, to determine injector sequence and ignition timing.

The sensor is a hall effect device combined with an internal magnet. It is also sensitive to steel within a certain distance from it.

On 4.0L 6-cylinder engines, the flywheel/drive plate has 3 sets of four notches at its outer edge (Fig. 7).

The notches cause a pulse to be generated when they pass under the sensor. The pulses are the input to the PCM. For each engine revolution there are 3 sets of four pulses generated.

The trailing edge of the fourth notch, which causes the pulse, is four degrees before top dead center (TDC) of the corresponding piston.

The engine will not operate if the PCM does not receive a crankshaft position sensor input.

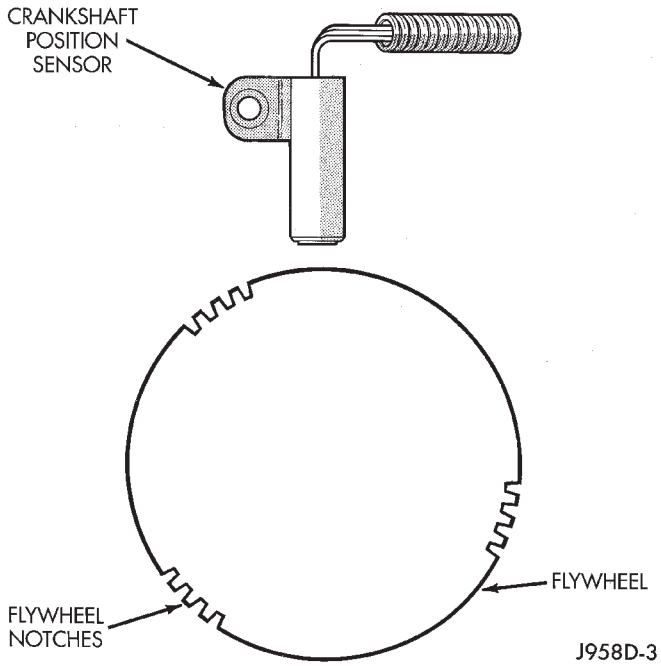

Fig. 7 CKP Sensor Operation—4.0L 6-Cyl. Engine

CRANKSHAFT POSITION SENSOR—4.7L ENGINE

DESCRIPTION

The Crankshaft Position Sensor (CKP) is mounted into the engine block above the starter motor (Fig. 8).

OPERATION

Engine speed and crankshaft position are provided through the crankshaft position sensor. The sensor generates pulses that are the input sent to the powertrain control module (PCM). The PCM interprets the sensor input to determine the crankshaft position. The PCM then uses this position, along with other inputs, to determine injector sequence and ignition timing.

The sensor is a hall effect device combined with an internal magnet. It is also sensitive to steel within a certain distance from it.

DESCRIPTION AND OPERATION (Continued)

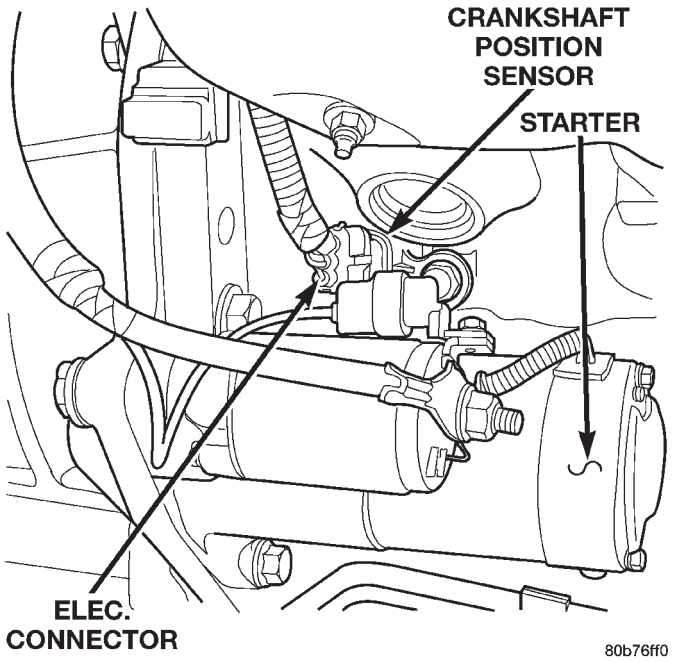

Fig. 8 CKP Sensor Location—4.7L V–8 Engine

On the 4.7L V–8 engine, a tonewheel is bolted to the engine crankshaft (Fig. 9). This tonewheel has sets of notches at its outer edge (Fig. 9).

The notches cause a pulse to be generated when they pass under the sensor. The pulses are the input to the PCM.

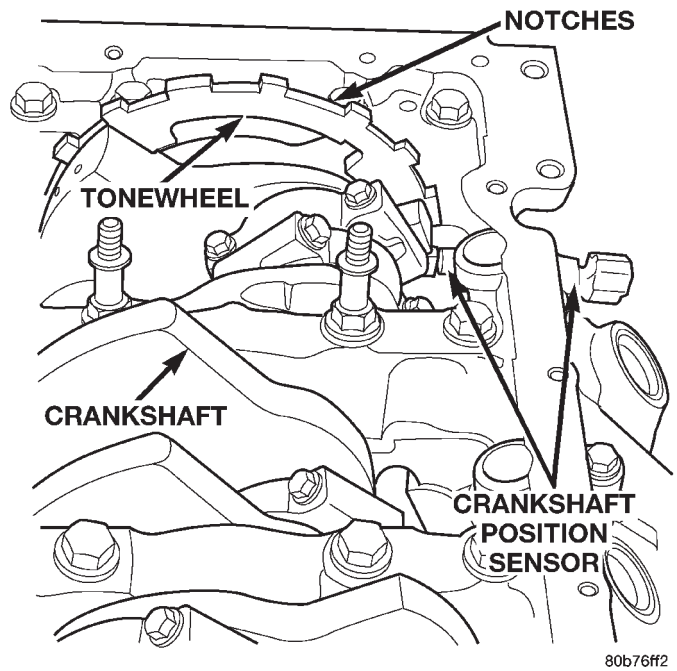

Fig. 9 CKP Sensor Operation and Tonewheel—4.7L V–8 Engine

CAMSHAFT POSITION SENSOR—4.0L ENGINE

DESCRIPTION

The Camshaft Position Sensor (CMP) on the 4.0L 6–cylinder engine is bolted to the top of the oil pump drive shaft assembly (Fig. 10). The sensor and drive shaft assembly is located on the right side of the engine near the oil filter (Fig. 11).

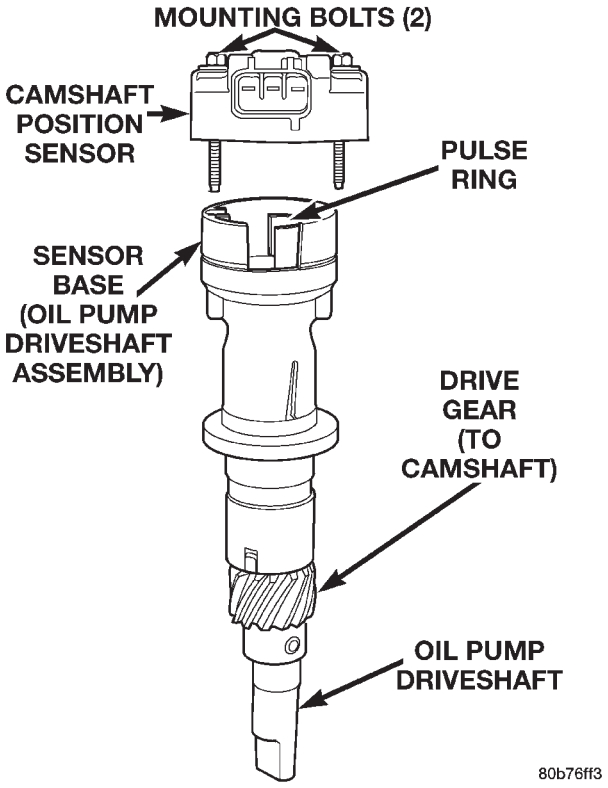

Fig. 10 CMP and Oil Pump Drive Shaft—4.0L Engine

OPERATION

The CMP sensor contains a hall effect device called a sync signal generator to generate a fuel sync signal. This sync signal generator detects a rotating pulse ring (shutter) on the oil pump drive shaft (Fig. 10). The pulse ring rotates 180 degrees through the sync signal generator. Its signal is used in conjunction with the crankshaft position sensor to differentiate between fuel injection and spark events. It is also used to synchronize the fuel injectors with their respective cylinders.

When the leading edge of the pulse ring (shutter) enters the sync signal generator, the following occurs: The interruption of magnetic field causes the voltage to switch high resulting in a sync signal of approximately 5 volts.

DESCRIPTION AND OPERATION (Continued)

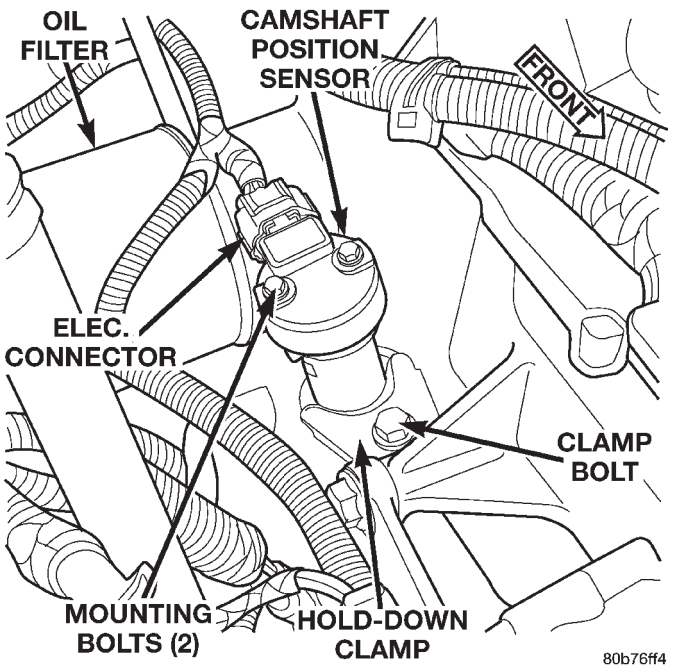

Fig. 11 CMP Location—4.0L Engine

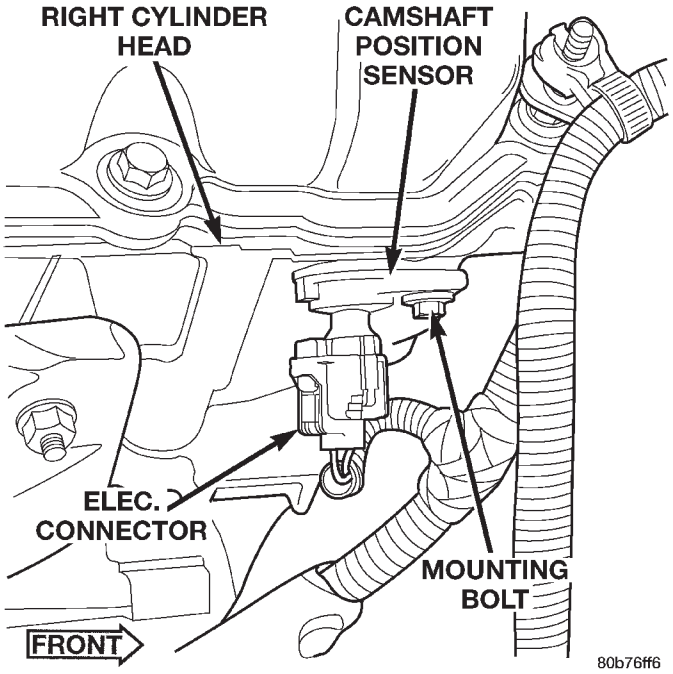

Fig. 12 CMP Location—4.7L Engine

When the trailing edge of the pulse ring (shutter) leaves the sync signal generator, the following occurs: The change of the magnetic field causes the sync signal voltage to switch low to 0 volts.

CAMSHAFT POSITION SENSOR—4.7L ENGINE

DESCRIPTION

The Camshaft Position Sensor (CMP) on the 4.7L V–8 engine is bolted to the front/top of the right cylinder head (Fig. 12).

OPERATION

The CMP sensor contains a hall effect device called a sync signal generator to generate a fuel sync signal. This sync signal generator detects notches located on a tonewheel. The tonewheel is located at the front of the camshaft for the right cylinder head (Fig. 13). As the tonewheel rotates, the notches pass through the sync signal generator. The pattern of the notches (viewed counter-clockwise from front of engine) is: 1 notch, 2 notches, 3 notches, 3 notches, 2 notches 1 notch, 3 notches and 1 notch. The signal from the CMP sensor is used in conjunction with the crankshaft position sensor to differentiate between fuel injection and spark events. It is also used to synchronize the fuel injectors with their respective cylinders.

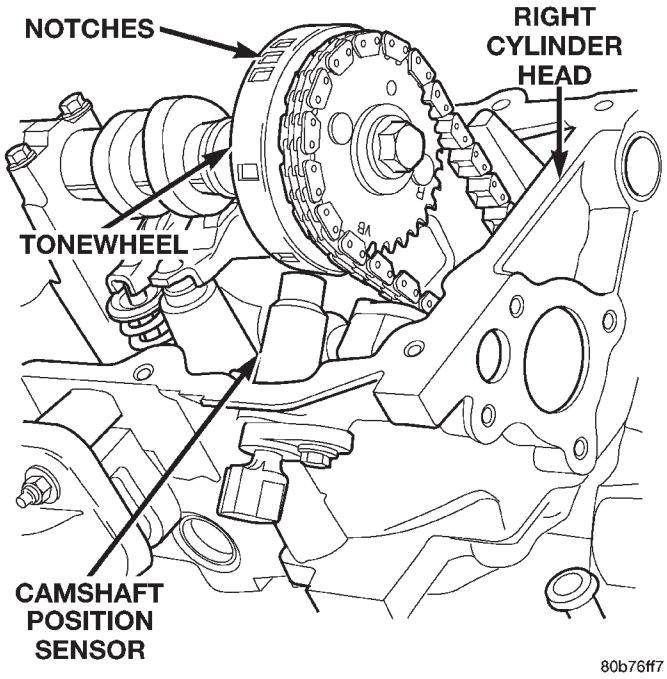

Fig. 13 CMP Sensor and Tonewheel—4.7L Engine

IGNITION SWITCH AND KEY LOCK CYLINDER

DESCRIPTION

The electrical ignition switch is located on the steering column. It is used as the main on/off switching device for most electrical components. The mechanical key lock cylinder is used to engage/disengage the electrical ignition switch.

OPERATION

Vehicles equipped with an automatic transmission and a floor mounted shifter: a cable connects the interlock device within the steering column assembly, to the transmission floor shift lever. This interlock device is used to lock the transmission

DESCRIPTION AND OPERATION (Continued)

shifter in the PARK position when the key lock cylinder is in the LOCKED or ACCESSORY position. The interlock device within the steering column is not serviceable. If repair is necessary, the steering column assembly must be replaced. Refer to Group 19, Steering for procedures. The shifter interlock cable can be adjusted or replaced. Refer to Group 21, Transmissions for procedures.

Vehicles equipped with an automatic transmission and a steering column mounted shifter: an interlock device is located within the steering column. This interlock device is used to lock the transmission shifter in the PARK position when the key lock cylinder is in the LOCKED or ACCESSORY position. The interlock device within the steering column is not serviceable. If repair is necessary, the steering column assembly must be replaced. Refer to Group 19, Steering for procedures.

Vehicles equipped with a manual transmission and a floor mounted shifter: a lever is located on the steering column behind the ignition key lock cylinder. The lever must be manually operated to allow rotation of the ignition key lock cylinder for key removal (turning switch to off position). The lever mechanism is not serviced separately. If repair is necessary, the steering column assembly must be replaced. Refer to Group 19, Steering for procedures.

DIAGNOSIS AND TESTING

IGNITION COIL TEST—4.0L ENGINE

To perform a complete test of the ignition coil rail assembly including the three coils and their circuitry, refer to the DRB scan tool. Also refer to the appropriate Powertrain Diagnostics Procedures manual. To do an individual test of the coil assembly only, refer to the following:

Inspect the ignition coil for cracks and for any arcing. Arcing at the secondary end will carbonize the rubber spark plug boots, which if it is reconnected, may cause the coil to fail. Replace coil if any cracks or arcing is found.

(1) Disconnect coil primary electrical connector by pushing slide tab upward (Fig. 14). After slide tab has been positioned upward, push in on secondary release lock (Fig. 14) on side of connector and pull connector from coil.

One of the 4 coil primary pins is used as a common battery feed (+) to all coils. The other 3 pins are used for (-) coil control for each individual coil. The coils are paired for cylinders 1–6, 2–5 and 3–4. Test the resistance (in ohms) of the primary side of the coil by attaching an ohmmeter across the battery feed (+) to any of the other (–) 3 pins. For pin identification, refer to Wiring Diagrams. Refer to the IGNITION COIL RESISTANCE—4.0L ENGINE chart for resistance values. Replace coil if resistance values are incorrect.

The secondary circuit cannot be checked using an ohmmeter.

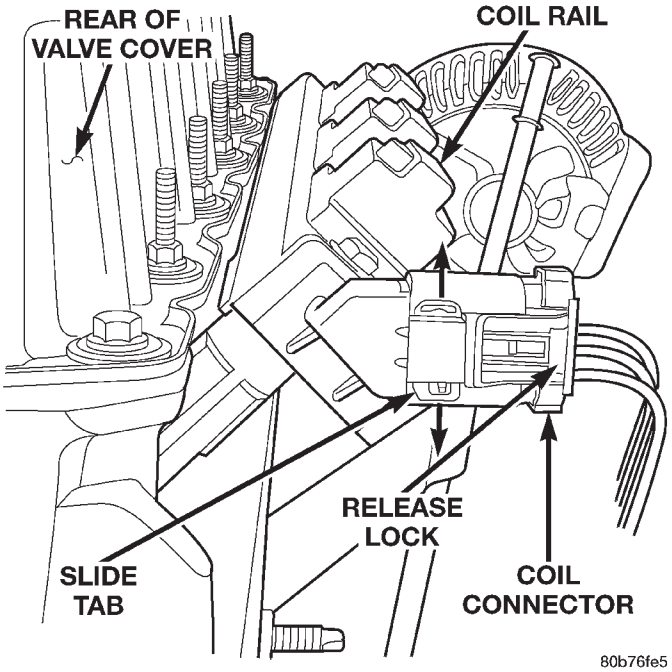

Fig. 14 Ignition Coil Connector Removal—4.0L 6–Cylinder Engine

IGNITION COIL RESISTANCE—4.0L ENGINE

PRIMARY RESISTANCE AT 21-27°C (70-80°F)
0.71 - 0.88 Ohms

IGNITION COIL TEST—4.7L ENGINE

To perform a complete test of the 8 ignition coils and their circuitry, refer to the DRB scan tool. Also refer to the appropriate Powertrain Diagnostics Procedures manual. To do an individual test of the coil only, refer to the following:

Inspect the ignition coil for cracks and for any arcing. Arcing at the secondary end will carbonize the

DIAGNOSIS AND TESTING (Continued)

rubber spark plug boot, which if it is reconnected, may cause the coil to fail. Replace coil if any cracks or arcing is found.

Test the resistance (in ohms) of the primary side of the coil by attaching an ohmmeter across the two pins at the electrical connector end of the coil (Fig. 15). Refer to the IGNITION COIL RESISTANCE—4.7L ENGINE chart for resistance values. Replace coil if resistance values are incorrect.

Test the resistance (in ohms) of the secondary side of the coil by attaching an ohmmeter from either of the two primary pins to the spring inside the rubber boot at the spark plug opening. Refer to the IGNITION COIL RESISTANCE—4.7L ENGINE chart for resistance values. Replace coil if resistance values are incorrect.

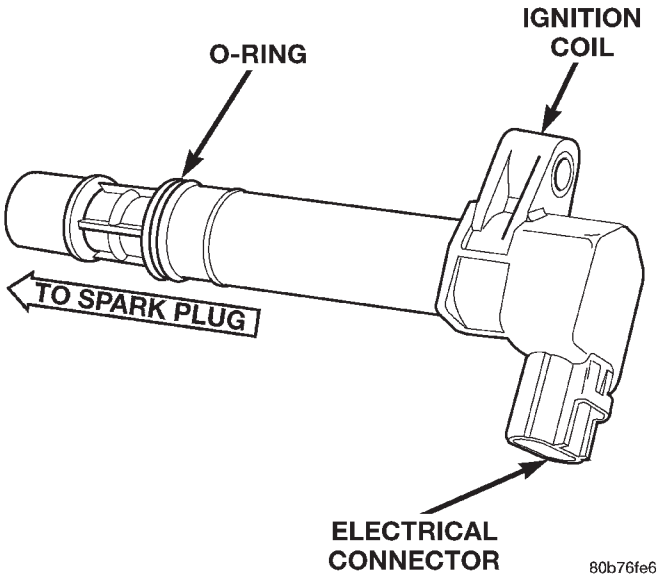

Fig. 15 Ignition Coil—4.7L V-8 Engine

IGNITION COIL RESISTANCE—4.7L ENGINE

PRIMARY RESISTANCE AT 21-27°C (70-80°F)	SECONDARY RESISTANCE AT 21-27°C (70-80°F)
0.6 - 0.9 Ohms	6,000 - 9,000 Ohms

SPARK PLUG CONDITIONS

NORMAL OPERATING

The few deposits present on the spark plug will probably be light tan or slightly gray in color. This is evident with most grades of commercial gasoline (Fig. 16). There will not be evidence of electrode burning. Gap growth will not average more than approximately 0.025 mm (.001 in) per 3200 km (2000 miles) of operation. Spark plugs that have normal wear can usually be cleaned, have the electrodes filed, have the gap set and then be installed.

Some fuel refiners in several areas of the United States have introduced a manganese additive (MMT) for unleaded fuel. During combustion, fuel with MMT causes the entire tip of the spark plug to be coated with a rust colored deposit. This rust color can be misdiagnosed as being caused by coolant in the combustion chamber. Spark plug performance may be affected by MMT deposits.

COLD FOULING/CARBON FOULING

Cold fouling is sometimes referred to as carbon fouling. The deposits that cause cold fouling are basically carbon (Fig. 16). A dry, black deposit on one or two plugs in a set may be caused by sticking valves

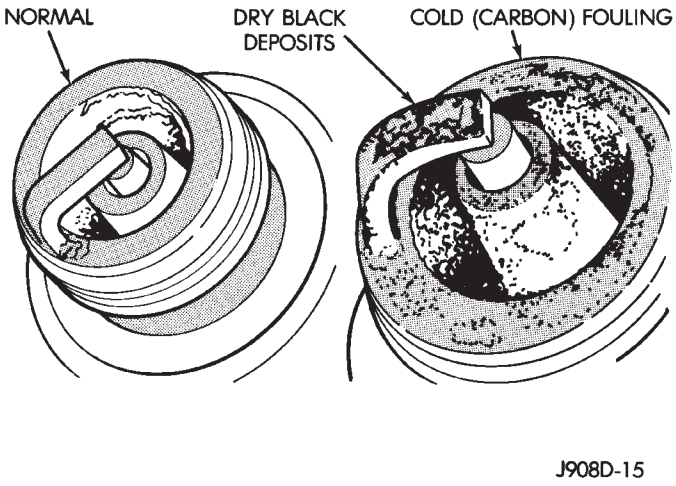

Fig. 16 Normal Operation and Cold (Carbon) Fouling

or defective spark plug cables. Cold (carbon) fouling of the entire set of spark plugs may be caused by a clogged air cleaner element or repeated short operating times (short trips).

WET FOULING OR GAS FOULING

A spark plug coated with excessive wet fuel or oil is wet fouled. In older engines, worn piston rings, leaking valve guide seals or excessive cylinder wear

DIAGNOSIS AND TESTING (Continued)

can cause wet fouling. In new or recently overhauled engines, wet fouling may occur before break-in (normal oil control) is achieved. This condition can usually be resolved by cleaning and reinstalling the fouled plugs.

OIL OR ASH ENCRUSTED

If one or more spark plugs are oil or oil ash encrusted (Fig. 17), evaluate engine condition for the cause of oil entry into that particular combustion chamber.

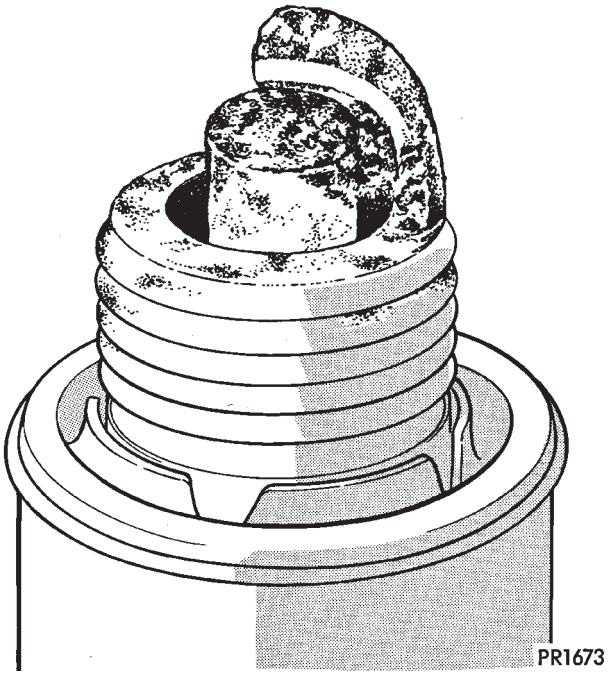

Fig. 17 Oil or Ash Encrusted

ELECTRODE GAP BRIDGING

Electrode gap bridging may be traced to loose deposits in the combustion chamber. These deposits accumulate on the spark plugs during continuous stop-and-go driving. When the engine is suddenly subjected to a high torque load, deposits partially liquefy and bridge the gap between electrodes (Fig. 18). This short circuits the electrodes. Spark plugs with electrode gap bridging can be cleaned using standard procedures.

SCAVENGER DEPOSITS

Fuel scavenger deposits may be either white or yellow (Fig. 19). They may appear to be harmful, but this is a normal condition caused by chemical additives in certain fuels. These additives are designed to change the chemical nature of deposits and decrease spark plug misfire tendencies. Notice that accumulation on the ground electrode and shell area may be heavy, but the deposits are easily removed. Spark plugs with scavenger deposits can be considered normal in condition and can be cleaned using standard procedures.

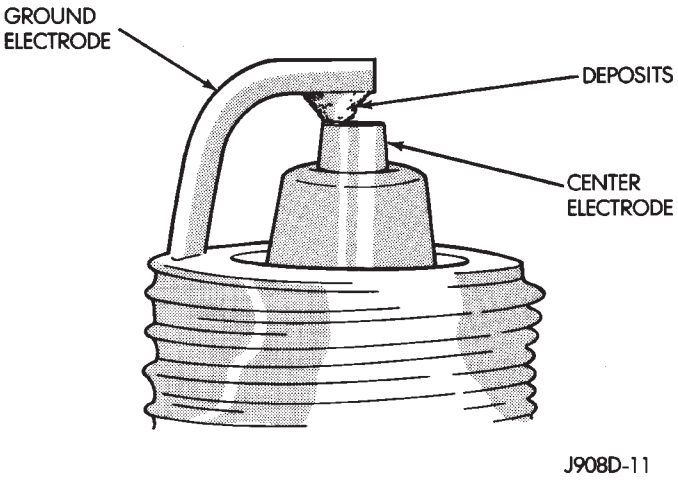

Fig. 18 Electrode Gap Bridging

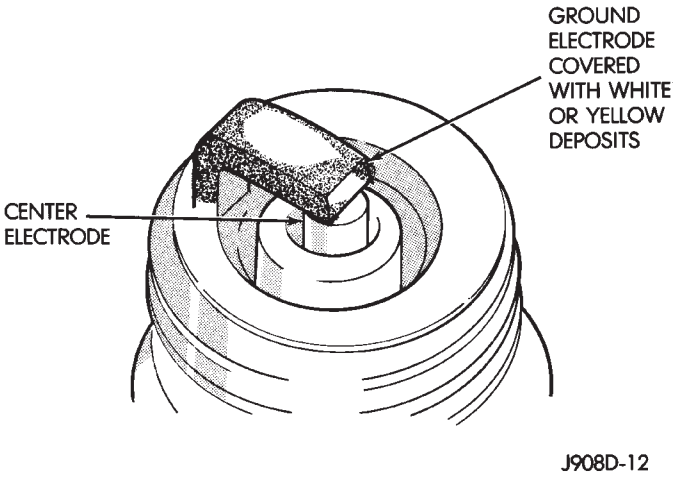

Fig. 19 Scavenger Deposits

CHIPPED ELECTRODE INSULATOR

A chipped electrode insulator usually results from bending the center electrode while adjusting the spark plug electrode gap. Under certain conditions, severe detonation can also separate the insulator from the center electrode (Fig. 20). Spark plugs with this condition must be replaced.

PRE-IGNITION DAMAGE

Pre-ignition damage is usually caused by excessive combustion chamber temperature. The center electrode dissolves first and the ground electrode dissolves somewhat latter (Fig. 21). Insulators appear relatively deposit free. Determine if the spark plug has the correct heat range rating for the engine. Determine if ignition timing is over advanced or if other operating conditions are causing engine overheating. (The heat range rating refers to the operating temperature of a particular type spark plug.

DIAGNOSIS AND TESTING (Continued)

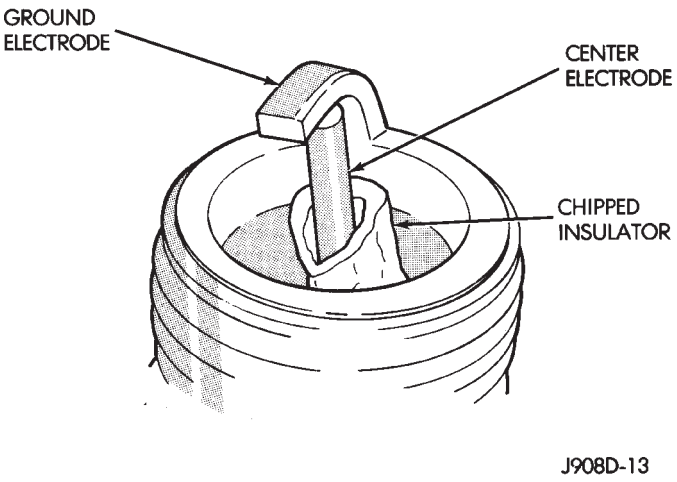

Fig. 20 Chipped Electrode Insulator

Spark plugs are designed to operate within specific temperature ranges. This depends upon the thickness and length of the center electrodes porcelain insulator.)

CAUTION: If the engine is equipped with copper core ground electrode spark plugs, they must be replaced with the same type/number spark plug as the original. If another spark plug is substituted, pre-ignition will result.

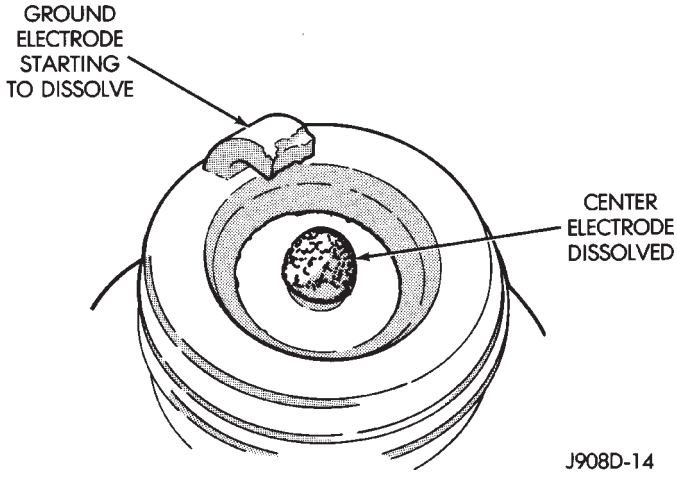

Fig. 21 Pre-ignition Damage

SPARK PLUG OVERHEATING

Overheating is indicated by a white or gray center electrode insulator that also appears blistered (Fig. 22). The increase in electrode gap will be considerably in excess of 0.001 inch per 2000 miles of operation. This suggests that a plug with a cooler heat range rating should be used. Over advanced ignition timing, detonation and cooling system malfunctions can also cause spark plug overheating.

CAUTION: If the engine is equipped with copper core ground electrode spark plugs, they must be replaced with the same type/number spark plug as the original. If another spark plug is substituted, pre-ignition will result.

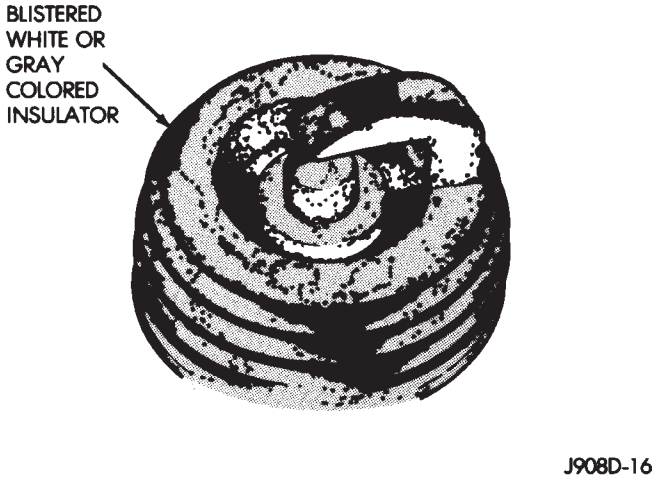

Fig. 22 Spark Plug Overheating

REMOVAL AND INSTALLATION

SPARK PLUGS

REMOVAL

On the 4.0L 6–cylinder engine, the spark plugs are located below the coil rail assembly. On the 4.7L V–8 engine, each individual spark plug is located under each ignition coil.

(1) 4.0L 6–Cylinder Engine: Prior to removing spark plug, spray compressed air around spark plug hole and area around spark plug. This will help prevent foreign material from entering combustion chamber.

(2) 4.7L V–8 Engine: Prior to removing spark plug, spray compressed air around base of ignition coil at cylinder head. This will help prevent foreign material from entering combustion chamber.

(3) On the 4.0L engine the coil rail assembly must be removed to gain access to any/all spark plug. Refer to Ignition Coil Removal/Installation. On the 4.7L V-8 engine each individual ignition coil must be removed to gain access to each spark plug. Refer to Ignition Coil Removal/Installation.

(4) Remove spark plug from cylinder head using a quality socket with a rubber or foam insert.

(5) Inspect spark plug condition. Refer to Spark Plug Conditions.

REMOVAL AND INSTALLATION (Continued)

CLEANING

The plugs may be cleaned using commercially available spark plug cleaning equipment. After cleaning, file center electrode flat with a small point file or jewelers file before adjusting gap.

CAUTION: Never use a motorized wire wheel brush to clean spark plugs. Metallic deposits will remain on spark plug insulator and will cause plug misfire.

ADJUSTMENT

Check spark plug gap with a gap gauge tool. If the gap is not correct, adjust it by bending ground electrode (Fig. 23). **Never attempt to adjust gap by bending center electrode.**

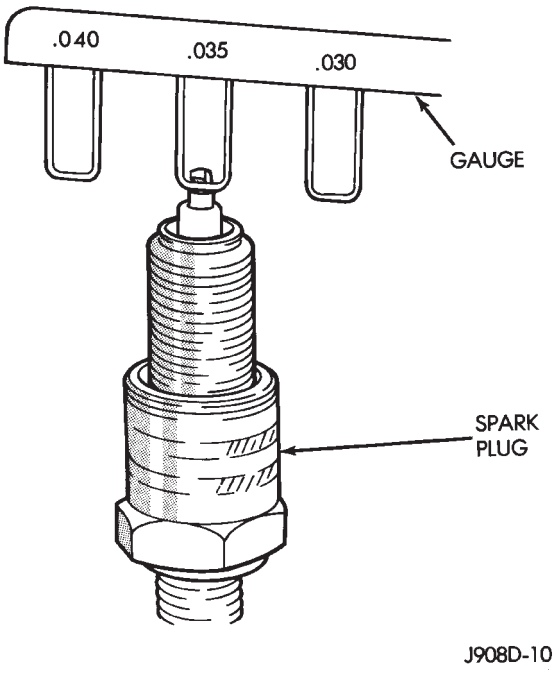

Fig. 23 Setting Spark Plug Gap—Typical

INSTALLATION

CAUTION: The 4.7L V–8 engine is equipped with copper core ground electrode spark plugs. They must be replaced with the same type/number spark plug as the original. If another spark plug is substituted, pre-ignition will result.

Special care should be taken when installing spark plugs into cylinder head spark plug wells. Be sure plugs do not drop into plug wells as ground straps may be bent resulting in a change in plug gap, or electrodes can be damaged.

Always tighten spark plugs to specified torque. Over tightening can cause distortion resulting in a change in spark plug gap or a cracked porcelain insulator.

(1) Start spark plug into cylinder head by hand to avoid cross threading.

(2) 4.0L 6–Cylinder Engine: Tighten spark plugs to 35-41 N·m (26-30 ft. lbs.) torque.

(3) 4.7L V–8 Engine: Tighten spark plugs to 27 N·m (20 ft. lbs.) torque.

(4) Install ignition coil(s). Refer to Ignition Coil Removal/Installation.

IGNITION COIL—4.0L ENGINE

REMOVAL

A one-piece coil rail assembly containing three individual coils is used on the 4.0L engine (Fig. 24). The coil rail must be replaced as one assembly. The bottom of the coil is equipped with 6 individual rubber boots (Fig. 24) to seal the 6 spark plugs to the coil. Inside each rubber boot is a spring. The spring is used for an electrical contact between the coil and the top of the spark plug. These rubber boots and springs are a permanent part of the coil and are not serviced separately.

(1) The coil is bolted directly to the cylinder head. Remove 4 coil mounting bolts (Fig. 25).

(2) Carefully pry up coil assembly from spark plugs. Do this by prying alternately at each end of coil until rubber boots have disengaged from all spark plugs. If boots will not release from spark plugs, use a commercially available spark plug boot removal tool. Twist and loosen a few boots from a few spark plugs to help remove coil.

(3) After coil has cleared spark plugs, position coil for access to primary electrical connector. Disconnect connector from coil by pushing slide tab upward (Fig. 26). After slide tab has been positioned upward, push in on secondary release lock (Fig. 26) on side of connector and pull connector from coil.

(4) Remove coil from vehicle.

INSTALLATION

(1) Position ignition coil rubber boots to all spark plugs. Push down on coil assembly until bolt bases have contacted cylinder head

(2) Install 4 coil mounting bolts. Loosely tighten 4 bolts just enough to allow bolt bases to contact cylinder head. Do a final tightening of each bolt in steps down to 29 N·m (250 in. lbs.) torque. Do not apply full torque to any bolt first.

(3) Connect engine harness connector to coil by snapping into position. Move slide tab downward (Fig. 26) for a positive lock.

REMOVAL AND INSTALLATION (Continued)

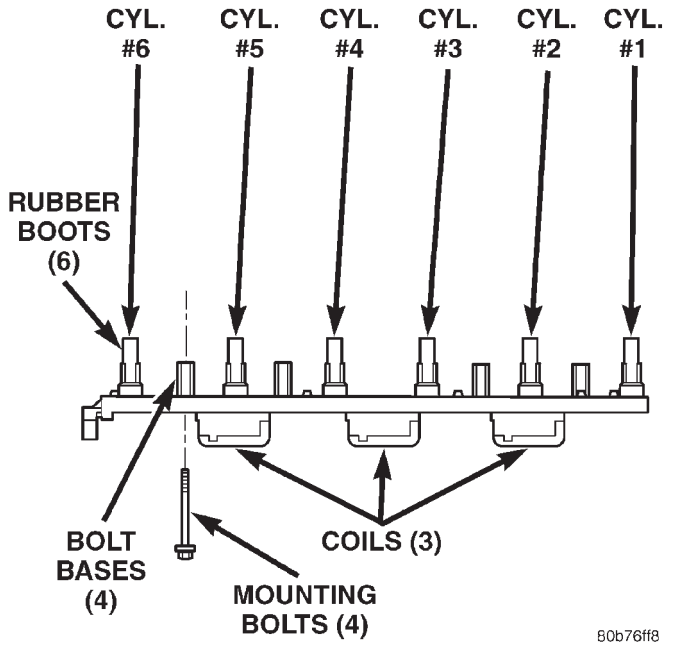

Fig. 24 Ignition Coil Assembly—4.0L 6–Cylinder Engine

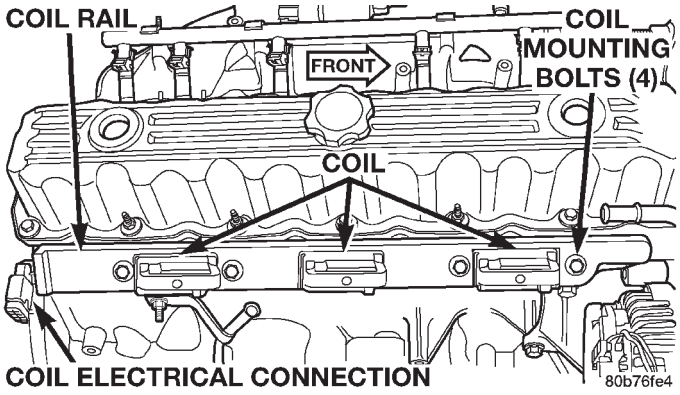

Fig. 25 Ignition Coil Rail Location—4.0L 6–Cylinder Engine

IGNITION COIL—4.7L ENGINE

REMOVAL

An individual ignition coil is used for each spark plug (Fig. 27). The coil fits into machined holes in the cylinder head. A mounting stud/nut secures each coil to the top of the intake manifold (Fig. 28). The bottom of the coil is equipped with a rubber boot to seal the spark plug to the coil. Inside each rubber boot is a spring. The spring is used for a mechanical contact between the coil and the top of the spark plug. These rubber boots and springs are a permanent part of the coil and are not serviced separately. An o-ring (Fig. 27) is used to seal the coil at the opening into the cylinder head.

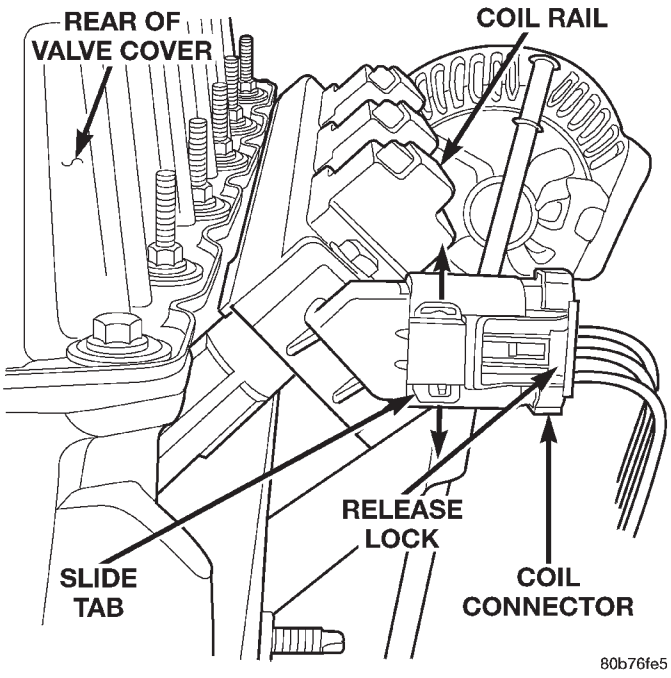

Fig. 26 Ignition Coil Electrical Connector—4.0L 6–Cylinder Engine

(1) Depending on which coil is being removed, the throttle body air intake tube or intake box may need to be removed to gain access to coil.

(2) Disconnect electrical connector (Fig. 28) from coil by pushing downward on release lock on top of connector and pull connector from coil.

(3) Clean area at base of coil with compressed air before removal.

(4) Remove coil mounting nut from mounting stud (Fig. 28).

(5) Carefully pull up coil from cylinder head opening with a slight twisting action.

(6) Remove coil from vehicle.

INSTALLATION

(1) Using compressed air, blow out any dirt or contaminants from around top of spark plug.

(2) Clean coil o-ring but do not apply any lubricant.

(3) Position ignition coil into cylinder head opening and push onto spark plug. Do this while guiding coil base over mounting stud.

(4) Install mounting stud nut and tighten to 8 N·m (70 in. lbs.) torque.

(5) Connect electrical connector to coil by snapping into position.

(6) If necessary, install throttle body air tube or box.

REMOVAL AND INSTALLATION (Continued)

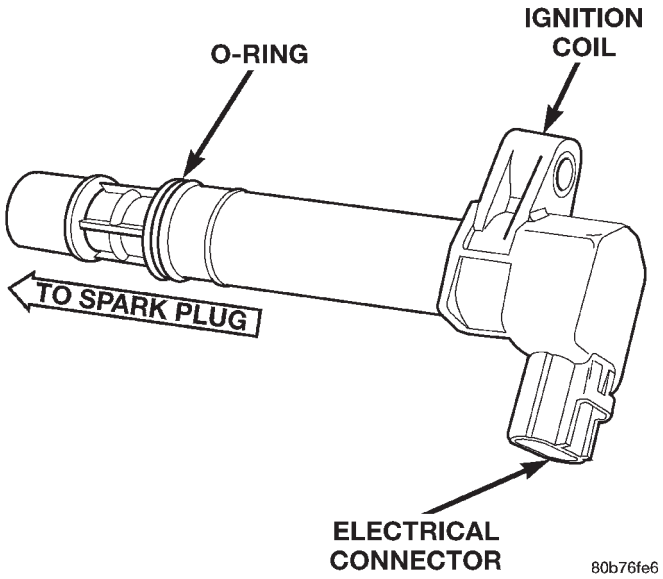

Fig. 27 Ignition Coil—4.7L V–8 Engine

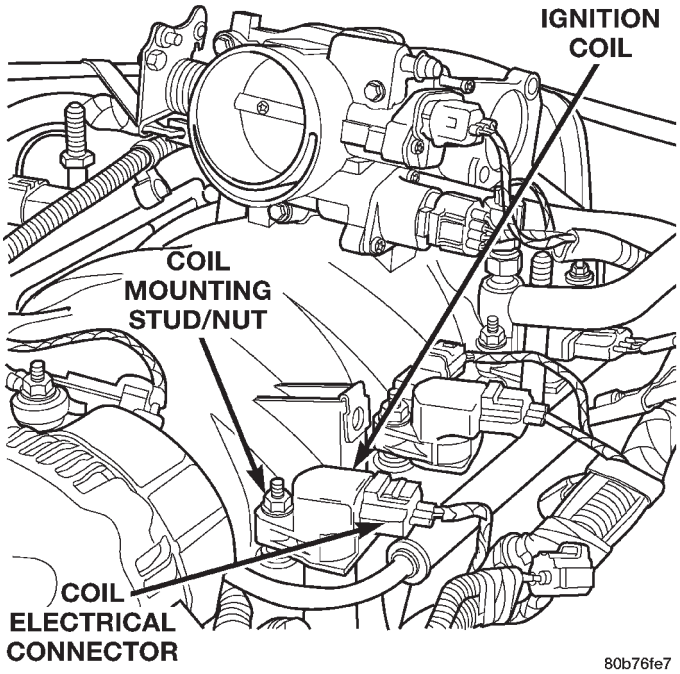

Fig. 28 Ignition Coil Location—4.7L V–8 Engine

CRANKSHAFT POSITION SENSOR—4.0L ENGINE

The Crankshaft Position (CKP) sensor is mounted to the transmission bellhousing at the left/rear side of the engine block (Fig. 29). The sensor **is adjustable** and is attached with one bolt. A wire shield/router is attached to the sensor (Fig. 29).

REMOVAL

(1) Disconnect sensor pigtail harness (3–way connector) from main engine wiring harness.
(2) Remove sensor mounting bolt.
(3) Remove wire shield and sensor.

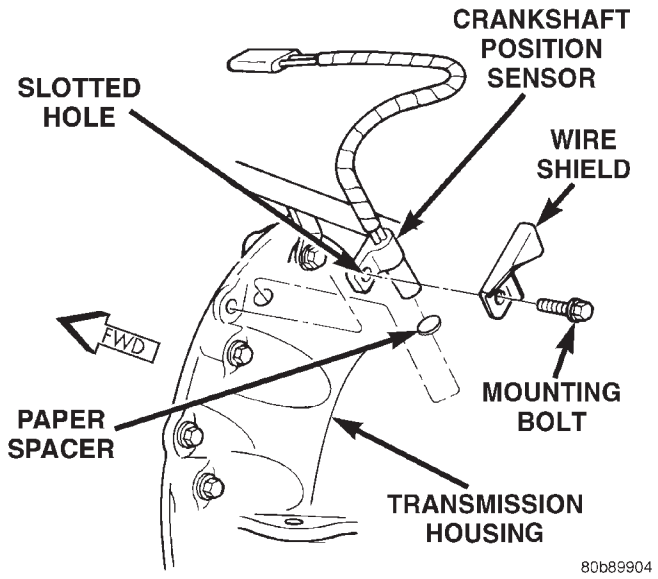

Fig. 29 CKP Sensor—4.0L 6-Cylinder Engine

INSTALLATION

4.0L engines with automatic transmission:

New replacement sensors will be equipped with a paper spacer glued to bottom of sensor. If installing (returning) a **used** sensor to vehicle, a new paper spacer must be installed to bottom of sensor. This spacer will be ground off the first time engine is started. If spacer is not used, sensor will be broken the first time engine is started.

(1) New Sensors: Be sure paper spacer is installed to bottom of sensor. If not, obtain spacer PN05252229.
(2) Used Sensors: Clean bottom of sensor and install spacer PN05252229.
(3) Install sensor into transmission bellhousing hole.
(4) Position sensor wire shield to sensor (Fig. 29).
(5) Push sensor against flywheel/drive plate. With sensor pushed against flywheel/drive plate, tighten mounting bolt to 7 N·m (60 in. lbs.) torque.
(6) Route sensor wiring harness into wire shield.
(7) Connect sensor pigtail harness electrical connector to main wiring harness.

CRANKSHAFT POSITION SENSOR—4.7L V-8 ENGINE

REMOVAL

The Crankshaft Position (CKP) sensor is bolted to the side of the engine cylinder block above the starter motor (Fig. 30). It is positioned into a machined hole at the side of the engine block.

(1) Remove starter motor. Refer to Starter Removal/Installation.

REMOVAL AND INSTALLATION (Continued)

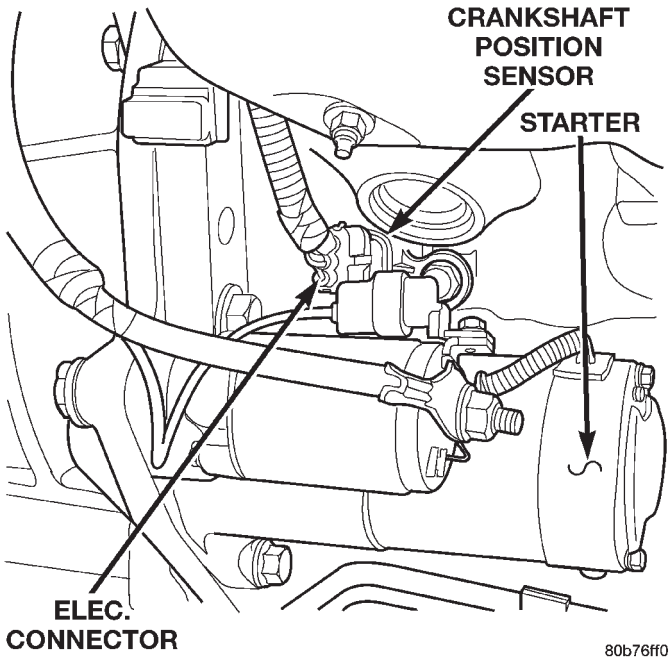

Fig. 30 CKP Sensor Location—4.7L V–8 Engine

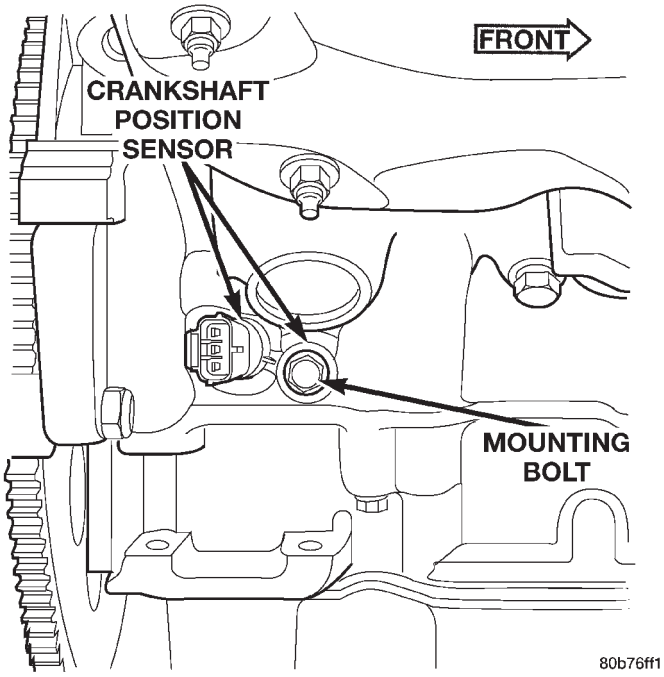

Fig. 31 CKP Sensor Removal/Installation—4.7L V–8 Engine

(2) Disconnect CKP electrical connector at sensor (Fig. 30).

(3) Remove CKP mounting bolt (Fig. 31).

(4) Carefully pry sensor from cylinder block in a rocking action with two small screwdrivers.

(5) Remove sensor from vehicle.

(6) Check condition of sensor o-ring.

INSTALLATION

(1) Clean out machined hole in engine block.

(2) Apply a small amount of engine oil to sensor o-ring.

(3) Install sensor into engine block with a slight rocking action. Do not twist sensor into position as damage to o-ring may result.

CAUTION: Before tightening sensor mounting bolt, be sure sensor is completely flush to cylinder block. If sensor is not flush, damage to sensor mounting tang may result.

(4) Install mounting bolt and tighten to 28 N·m (21 ft. lbs.) torque.

(5) Connect electrical connector to sensor.

(6) Install starter motor. Refer to Starter Removal/Installation.

CAMSHAFT POSITION SENSOR—4.0L ENGINE

The Camshaft Position Sensor (CMP) on the 4.0L 6–cylinder engine is bolted to the top of the oil pump drive shaft assembly (Fig. 32). The sensor and drive shaft assembly is located on the right side of the engine near the oil filter (Fig. 33).

The rotational position of oil pump drive determines fuel synchronization only. It does not determine ignition timing.

NOTE: Do not attempt to rotate the oil pump drive to modify ignition timing.

Two different procedures are needed for removal and installation. The first procedure will detail removal and installation of the sensor only. The second procedure will detail removal and installation of the sensor and oil pump drive shaft assembly. The second procedure is to be used if the engine has been disassembled.

An internal oil seal is used in the drive shaft housing that prevents engine oil at the bottom of the sensor. The seal is not serviceable.

REMOVAL—SENSOR ONLY

(1) Disconnect electrical connector at CMP sensor (Fig. 33).

(2) Remove 2 sensor mounting bolts (Fig. 32) or (Fig. 33).

(3) Remove sensor from oil pump drive.

INSTALLATION—SENSOR ONLY

(1) Install sensor to oil pump drive.

(2) Install 2 sensor mounting bolts and tighten to 2 N·m (15 in. lbs.) torque.

(3) Connect electrical connector to CMP sensor.

REMOVAL AND INSTALLATION (Continued)

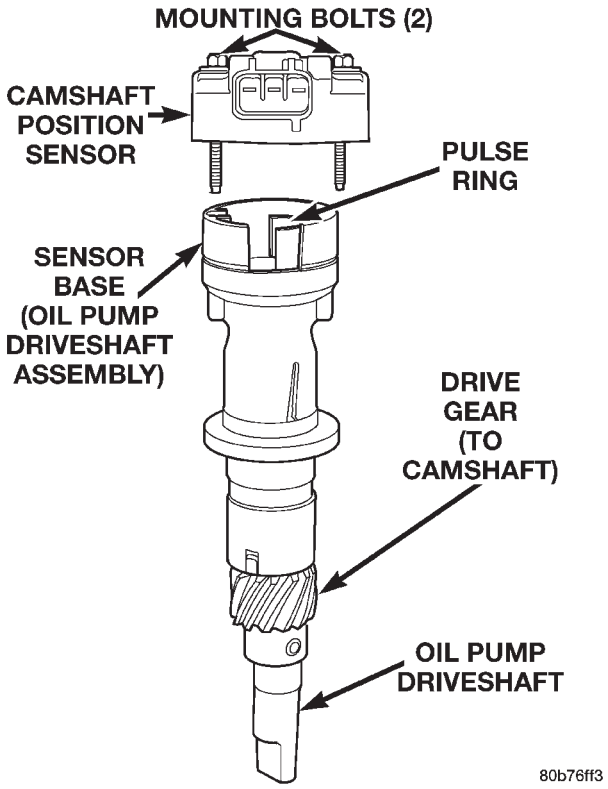

Fig. 32 CMP and Oil Pump Drive Shaft—4.0L Engine

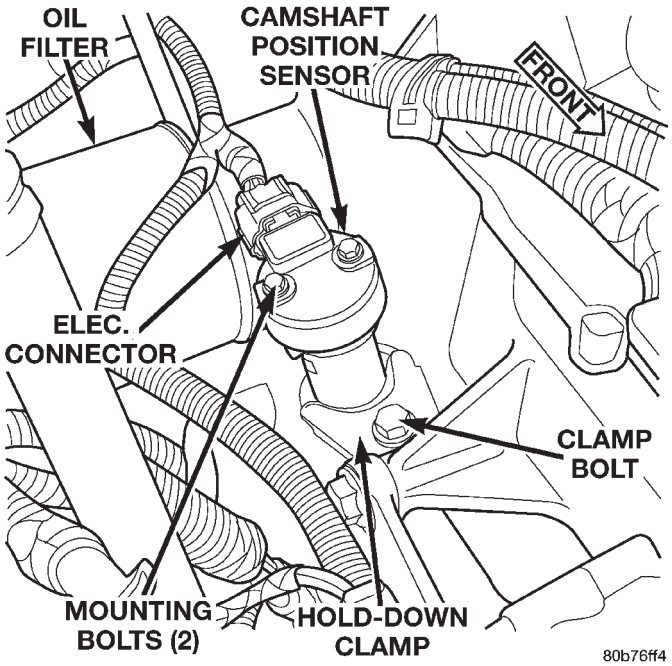

Fig. 33 CMP Location—4.0L Engine

REMOVAL—OIL PUMP DRIVE AND SENSOR

If the CMP and oil pump drive are to be removed and installed, do not allow engine crankshaft or camshaft to rotate. CMP sensor relationship will be lost.

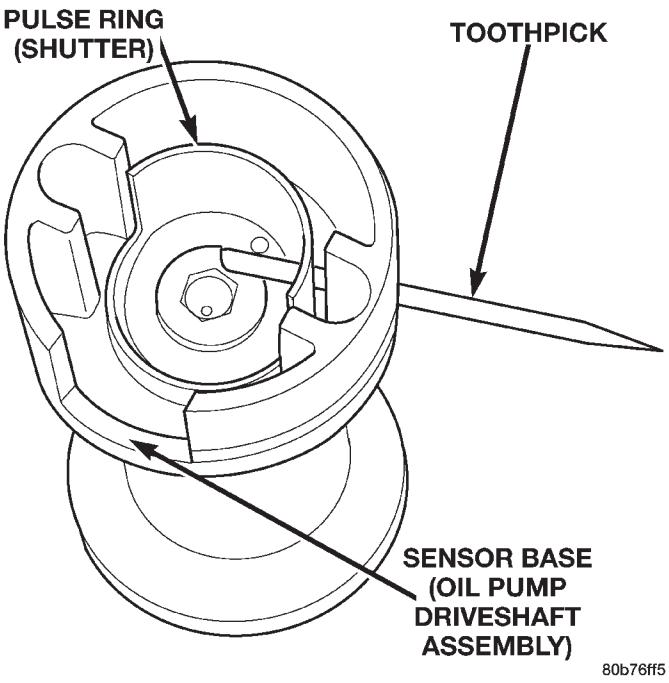

Fig. 34 CMP Pulse Ring Alignment—4.0L Engine

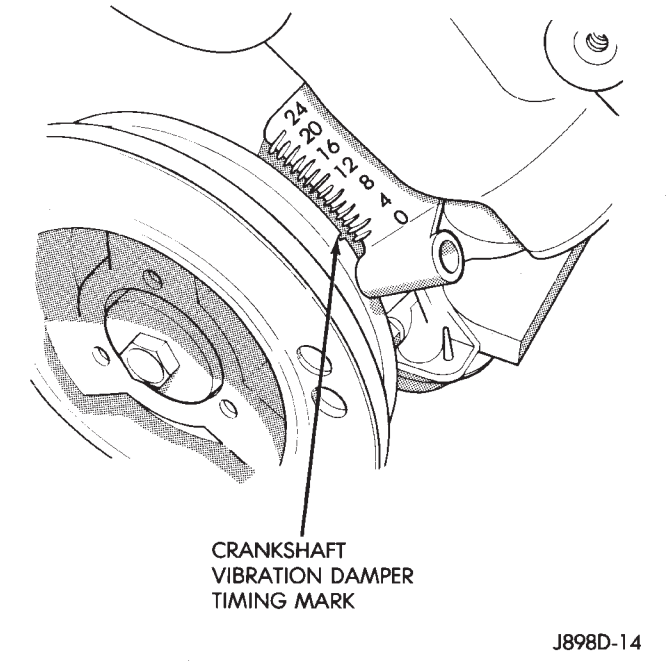

Fig. 35 Align Timing Marks—4.0L Engine

(1) Disconnect electrical connector at CMP sensor (Fig. 33).

(2) Remove 2 sensor mounting bolts (Fig. 32) or (Fig. 33).

(3) Remove sensor from oil pump drive.

(4) Before proceeding to next step, mark and note rotational position of oil pump drive in relationship to engine block. After installation, the CMP sensor should face rear of engine 0°.

(5) Remove hold-down bolt and clamp (Fig. 33).

REMOVAL AND INSTALLATION (Continued)

(6) While pulling assembly from engine, note direction and position of pulse ring (Fig. 32). After removal, look down into top of oil pump and note direction and position of slot at top of oil pump gear.

(7) Remove and discard old oil pump drive-to-engine block gasket.

INSTALLATION—OIL PUMP DRIVE AND SENSOR

(1) Clean oil pump drive mounting hole area of engine block.

(2) Install new oil pump drive-to-engine block gasket.

(3) Temporarily install a toothpick or similar tool through access hole at side of oil pump drive housing. Align toothpick into mating hole on pulse ring (Fig. 34).

(4) Install oil pump drive into engine while aligning into slot on oil pump. Rotate oil pump drive back to its original position and install hold-down clamp and bolt. Finger tighten bolt. Do not do a final tightening of bolt at this time.

(5) If engine crankshaft or camshaft has been rotated, such as during engine tear-down, CMP sensor relationship must be reestablished.

(a) Remove ignition coil rail assembly. Refer to Ignition Coil Removal/Installation.

(b) Remove cylinder number 1 spark plug.

(c) Hold a finger over the open spark plug hole. Rotate engine at vibration dampener bolt until compression (pressure) is felt.

(d) Slowly continue to rotate engine. Do this until timing index mark on vibration damper pulley aligns with top dead center (TDC) mark (0 degree) on timing degree scale (Fig. 35). Always rotate engine in direction of normal rotation. Do not rotate engine backward to align timing marks.

(e) Install oil pump drive into engine while aligning into slot on oil pump. If pump drive will not drop down flush to engine block, the oil pump slot is not aligned. Remove oil pump drive and align slot in oil pump to shaft at bottom of drive. Install into engine. Rotate oil pump drive back to its original position and install hold-down clamp and bolt. Finger tighten bolt. Do not do a final tightening of bolt at this time.

(f) Remove toothpick from housing.

(6) Install sensor to oil pump drive. After installation, the CMP sensor should face rear of engine 0°.

(7) Install 2 sensor mounting bolts and tighten to 2 N·m (15 in. lbs.) torque.

(8) Connect electrical connector to CMP sensor.

(9) If removed, install spark plug and ignition coil rail.

To verify correct rotational position of oil pump drive, the DRB scan tool must be used.

WARNING: WHEN PERFORMING THE FOLLOWING TEST, THE ENGINE WILL BE RUNNING. BE CAREFUL NOT TO STAND IN LINE WITH THE FAN BLADES OR FAN BELT. DO NOT WEAR LOOSE CLOTHING.

(10) Connect DRB scan tool to data link connector. The data link connector is located in passenger compartment, below and to left of steering column.

(11) Gain access to SET SYNC screen on DRB.

(12) Follow directions on DRB screen and start engine. Bring to operating temperature (engine must be in “closed loop” mode).

(13) With engine running at **idle speed**, the words IN RANGE should appear on screen along with 0°. This indicates correct position of oil pump drive.

(14) If a plus (+) or a minus (-) is displayed next to degree number, and/or the degree displayed is not zero, loosen but do not remove hold-down clamp bolt. Rotate oil pump drive until IN RANGE appears on screen. Continue to rotate oil pump drive until achieving as close to 0° as possible.

The degree scale on SET SYNC screen of DRB is referring to fuel synchronization only. **It is not referring to ignition timing.** Because of this, do not attempt to adjust ignition timing using this method. Rotating oil pump drive will have no effect on ignition timing. All ignition timing values are controlled by powertrain control module (PCM).

(15) Tighten hold-down clamp bolt to 23 N·m (17 ft. lbs.) torque.

CAMSHAFT POSITION SENSOR—4.7L ENGINE

The Camshaft Position Sensor (CMP) on the 4.7L V–8 engine is bolted to the front/top of the right cylinder head (Fig. 36).

REMOVAL

It is easier to remove/install sensor from under vehicle.

(1) Raise and support vehicle.

(2) Disconnect electrical connector at CMP sensor (Fig. 36).

(3) Remove sensor mounting bolt (Fig. 36).

(4) Carefully pry sensor from cylinder head in a rocking action with two small screwdrivers.

(5) Check condition of sensor o-ring.

INSTALLATION

(1) Clean out machined hole in cylinder head.

(2) Apply a small amount of engine oil to sensor o-ring.

(3) Install sensor into cylinder head with a slight rocking action. Do not twist sensor into position as damage to o-ring may result.

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REMOVAL AND INSTALLATION (Continued)

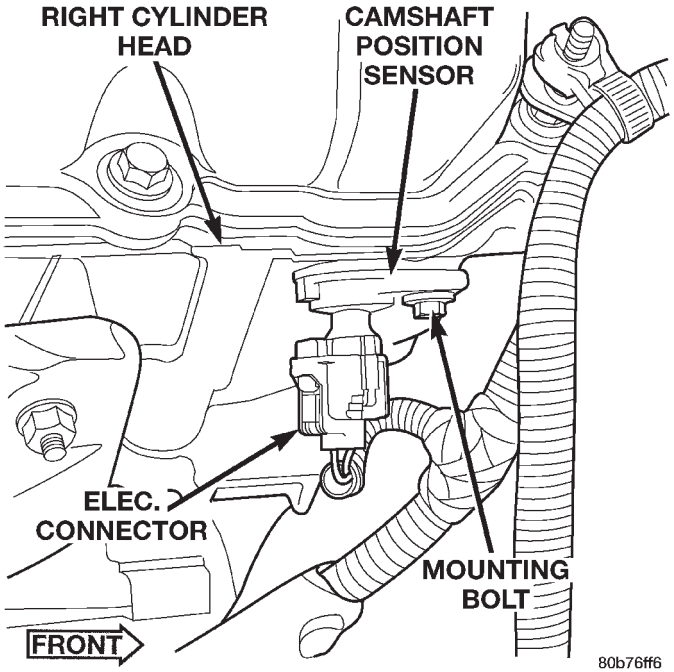

Fig. 36 CMP Location—4.7L Engine

CAUTION: Before tightening sensor mounting bolt, be sure sensor is completely flush to cylinder head. If sensor is not flush, damage to sensor mounting tang may result.

(4) Install mounting bolt and tighten to 12 N·m (106 in. lbs.) torque.
(5) Connect electrical connector to sensor.
(6) Lower vehicle.

IGNITION SWITCH AND KEY CYLINDER

The ignition key must be in key lock cylinder for cylinder removal.

REMOVAL

If removing **key lock cylinder only,** refer to first 6 steps. If removing **ignition switch only,** refer to steps 1 and 2 and proceed to steps 7 through 13.
(1) Disconnect negative cable from battery.
(2) Place transmission shifter in PARK position.
(3) Place tilt steering wheel in full up position.
(4) A retaining pin (Fig. 37) is located at bottom of key lock cylinder housing.
(5) Rotate key to RUN position.
(6) Press in on retaining pin while pulling key cylinder from housing. After removal, note position of alignment tang at end of cylinder. When installing lock cylinder, key must be rotated back to RUN position.
(7) Remove steering column lower opening cover. Refer to Steering Column Opening Cover in Group 8E, Instrument Panel.
(8) Remove upper and lower covers (shrouds) from steering column (Fig. 38).
(9) Remove upper fixed column shroud (2 screws) (Fig. 39).
(10) Remove SKIM (Sentry Key Immobilizer Module) (1 screw) (Fig. 40).
(11) Disconnect electrical connectors at switch.
(12) Remove ignition switch mounting screw (Fig. 41). Use tamper proof torx bit (Snap-On® TTXR10E or equivalent) to remove screw.
(13) Using needle-nose pliers, squeeze both switch lock tabs (Fig. 42) and gently pull switch away from column. **Do not rotate key lock cylinder when ignition switch is being removed or has been removed from steering column.**

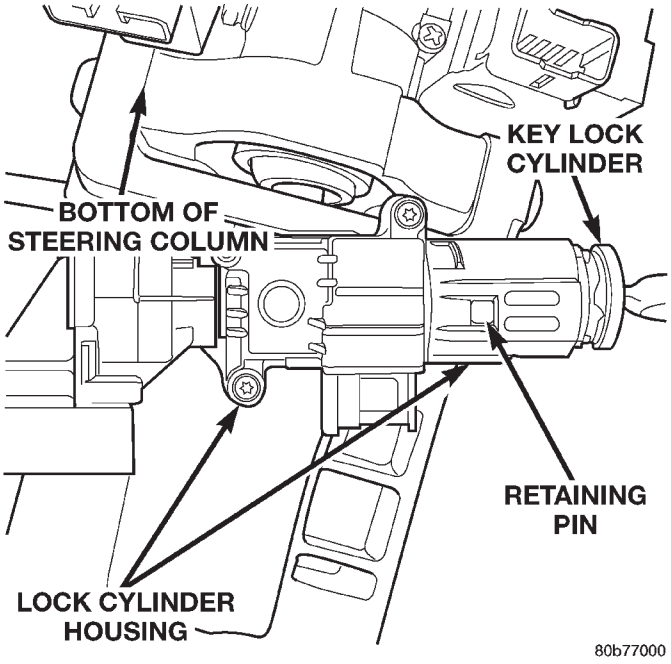

Fig. 37 Retaining Pin

INSTALLATION

If installing **key lock cylinder only,** refer to steps 1 through 4 then proceed to steps 10 through 14. If installing **ignition switch only,** refer to steps 5 through 14.
(1) Be sure transmission shifter is still in PARK position.
(2) Rotate key in lock cylinder to RUN position.
(3) Install key cylinder into housing by aligning retaining pin into retaining pin slot. Push key cylinder into housing until retaining pin engages. After pin engages, rotate key to OFF or LOCK position.
(4) Check for proper retention of key cylinder by attempting to pull cylinder from housing.
(5) Place ignition switch into opening on steering column housing. If switch will not fit into housing, do not force it. Remove switch from housing and rotate

REMOVAL AND INSTALLATION (Continued)

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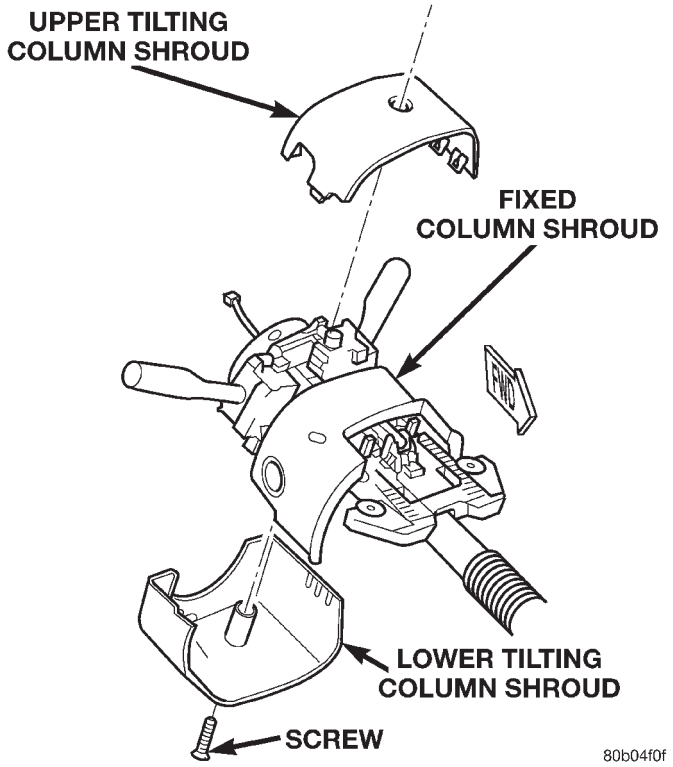


Fig. 38 Shroud Removal/Installation

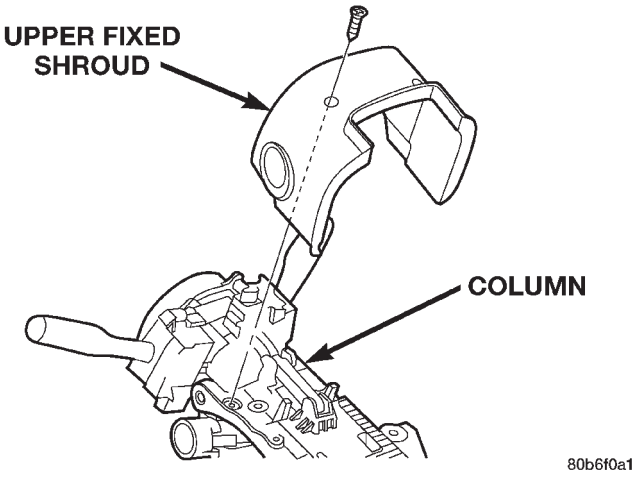


Fig. 39 Fixed Column Shroud Removal/Installation

key cylinder (slightly) for alignment. Push switch into column housing until 2 lock tabs have engaged.

(6) Install ignition switch mounting screw. Tighten screw to 3 N·m (30 in. lbs.) torque.

(7) Connect electrical connectors to ignition switch. Make sure that switch locking tabs are fully seated in wiring connectors.

(8) Install SKIM (Sentry Key Immobilizer Module) (1 screw). Tighten screw to 3 N·m (30 in. lbs.) torque.

(9) Install steering column covers (shrouds).

(10) Connect negative cable to battery.

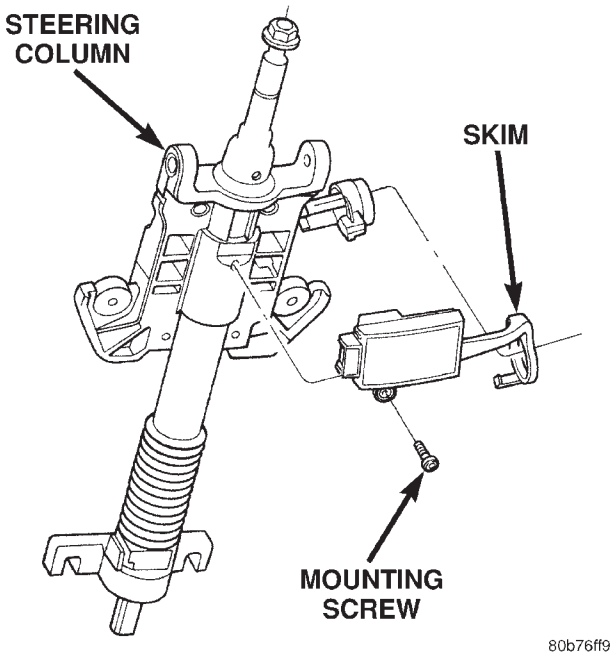


Fig. 40 Sentry Key Immobilizer Module and Mounting Screw

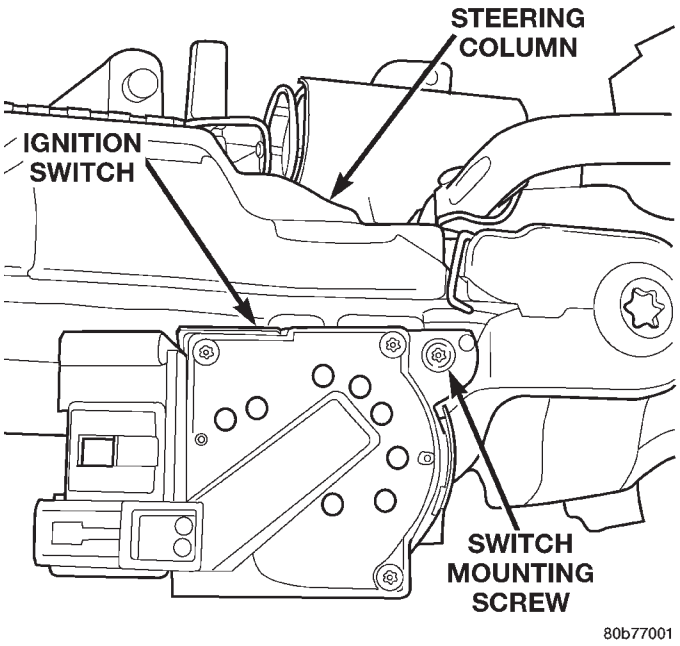


Fig. 41 Ignition Switch Mounting Screw

(11) Shifter should lock in PARK position when key is in LOCK position. Shifter should unlock when key rotated to ON position.

(12) With engine running, shifter should not be unable to be moved from PARK position until brake pedal has been depressed.

(13) Check for proper operation of ignition switch in ACCESSORY, LOCK, OFF, ON, RUN, and START positions.

REMOVAL AND INSTALLATION (Continued)

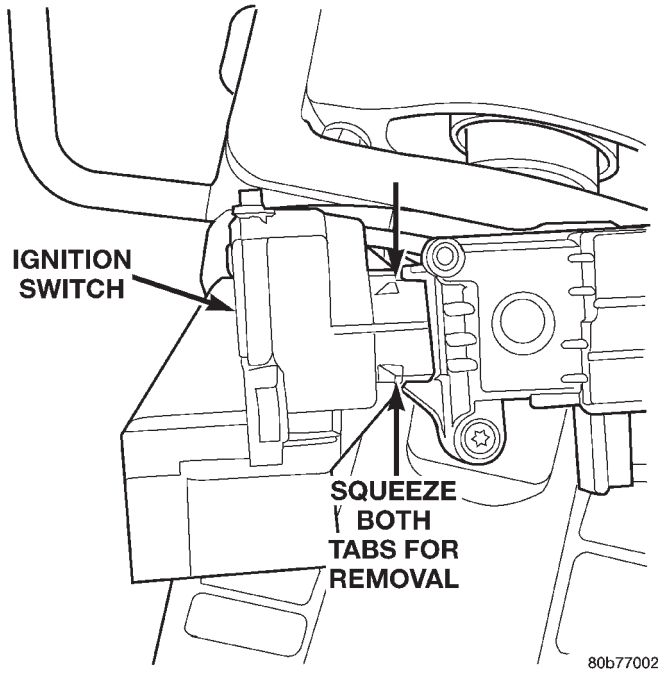


Fig. 42 Ignition Switch Lock Tabs

(14) Steering wheel should lock when key is in LOCK position. Rotate steering wheel to verify. Steering wheel should unlock when key is rotated to ON position.

SHIFTER/IGNITION INTERLOCK

On models equipped with an automatic transmission, a cable connects the ignition switch with the floor shift lever. The shifter will be locked in the PARK position when the ignition key is in the LOCK or ACCESSORY positions. The cable can be adjusted or replaced. Refer to Group 21, Transmissions for procedures. The ignition interlock device within the steering column is not serviceable. If service is necessary, the steering column must be replaced. Refer to Group 19, Steering for procedures.

SPECIFICATIONS

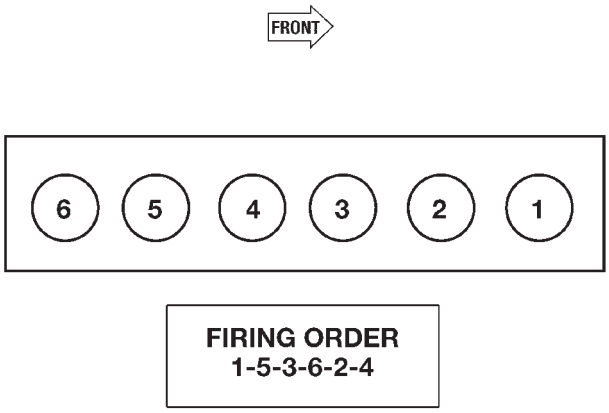
IGNITION TIMING

All ignition timing functions are controlled by the Powertrain Control Module (PCM). Mechanical adjustments are not needed and can't be made.

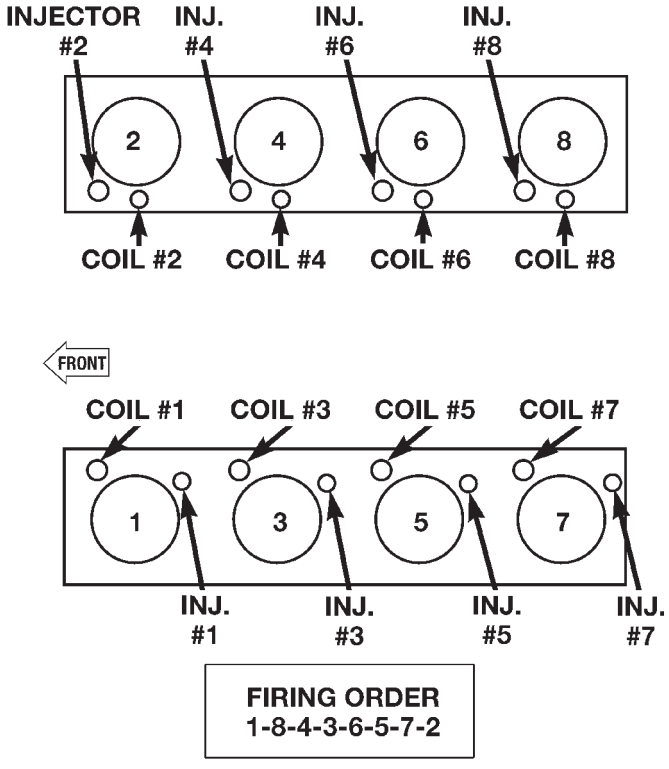
On the 4.0L 6–cylinder engine, do not attempt to rotate the oil pump drive to adjust timing. This adjustment is used for fuel synchronization after camshaft position sensor replacement.

SPECIFICATIONS (Continued)

ENGINE FIRING ORDER—4.0L 6-CYLINDER ENGINE



ENGINE FIRING ORDER—4.7L V-8 ENGINE



SPARK PLUGS

ENGINE	PLUG TYPE	ELECTRODE GAP
4.0L 6-CYL.	RC12ECC	0.89 mm (.035 in.)
4.7L V-8	RC12MCC4	1.01 mm (.040 in.)

IGNITION COIL RESISTANCE—4.0L ENGINE

PRIMARY RESISTANCE 21-27°C (70-80°F)
0.71 - 0.88 Ohms

IGNITION COIL RESISTANCE—4.7L V-8 ENGINE

PRIMARY RESISTANCE 21-27°C (70-80°F)	SECONDARY RESISTANCE 21-27°C (70-80°F)
0.6 - 0.9 Ohms	6,000 - 9,000 Ohms

TORQUE CHART

DESCRIPTION	TORQUE
Crankshaft Position Sensor Bolts— 4.0L Engine	7 N·m (60 in. lbs.)
Crankshaft Position Sensor Bolt— 4.7L V-8 Engine	28 N·m (21 ft. lbs.)
Camshaft Position Sensor–to–base bolts— 4.0L Engine	28 N·m (15 in. lbs.)
Camshaft Position Sensor Bolt— 4.7L V-8 Engine	12 N·m (106 in. lbs.)
Oil Pump Drive Hold-down Bolt— 4.0L Engine	23 N·m (17 ft. lbs.)
Ignition Coil Rail Mounting Bolts— 4.0L Engine	29 N·m (250 in. lbs.)
Ignition Coil Mounting Nut— 4.7L V-8 Engine	8 N·m (70 in. lbs.)
Spark Plugs—4.0L Engine	35–41 N·m (26–30 ft. lbs.)
Spark Plugs—4.7L V-8 Engine	27 N·m (20 ft. lbs.)