

# IGNITION SYSTEMS

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## 2.5L AND 3.0L IGNITION SYSTEMS—SYSTEM OPERATION

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### GENERAL INFORMATION

This section describes the ignition systems of the 2.5L and 3.0L engines.

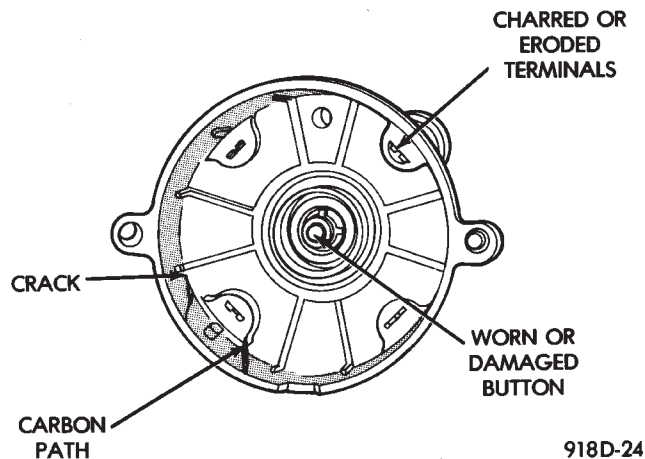
On Board Diagnostics is described in the Fuel Injection Sections of Group 14.

Group 0, Lubrication and Maintenance, contains general maintenance information for ignition related items. The Owner's Manual also contains maintenance information.

### DISTRIBUTOR CAP

Remove the distributor cap and inspect the inside for flashover, cracking of carbon button, lack of spring tension on carbon button, cracking of cap, and burned, worn terminals (Fig. 1). Also check for broken distributor cap towers. If any of these conditions are present the distributor cap and/or cables should be replaced.

When replacing the distributor cap, transfer spark plug wires from the original cap to the new cap one at a time. Ensure that each wire is installed into the tower of the new cap that corresponds to its tower position in the original cap. Fully seat the wires into the towers. If necessary, refer to the appropriate engine firing order diagram (Fig. 2 or Fig. 3).



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**Fig. 1 Distributor Cap Inspection—Typical**

Light scaling of the terminals can be cleaned with a sharp knife. If the terminals are heavily scaled, replace the distributor cap.

A cap that is greasy, dirty or has a powder-like substance on the inside should be cleaned with a solution of warm water and a mild detergent. Scrub the cap with a soft brush. Thoroughly rinse the cap and dry it with a clean soft cloth.

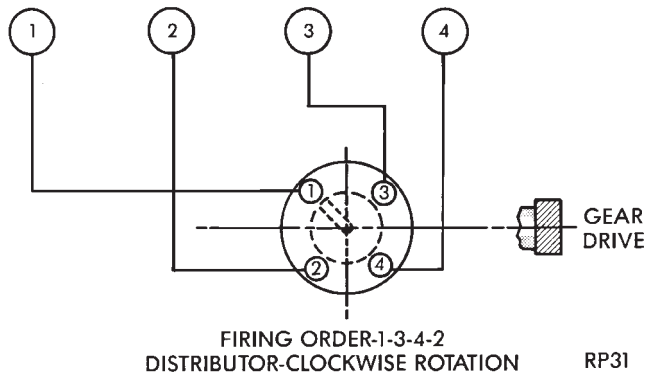


Fig. 2 Engine Firing Order—2.5L Engine

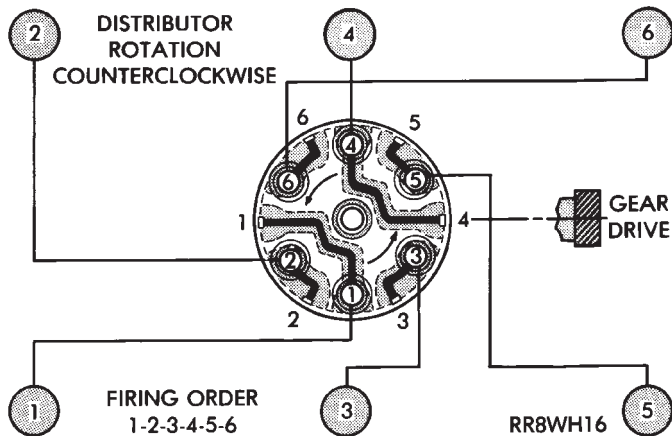


Fig. 3 Engine Firing Order—3.0L Engine

**ROTOR—2.5L TBI AND 3.0L ENGINES**

Replace the rotor if it is cracked, the tip is excessively burned or heavily scaled (Fig. 4). If the spring terminal does not have adequate tension, replace the rotor.

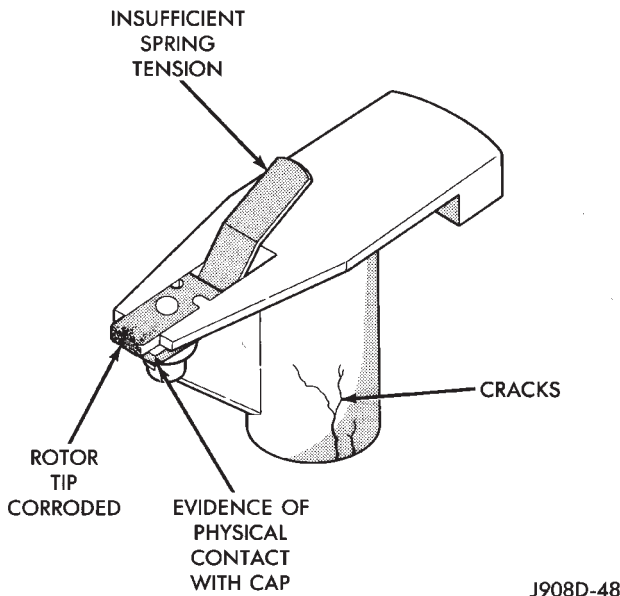


Fig. 4 Rotor Inspection—Typical

**SPARK PLUG CABLES**

Spark Plug cables are sometimes referred to as secondary ignition wires. They transfer electrical current from the distributor to individual spark plugs at each cylinder. 2.5L and 3.0L engines use suppression type cables. The cables suppress radio frequency emissions from the ignition system.

Check the spark plug cable connections for good contact at the coil and distributor cap towers and at the spark plugs. Terminals should be fully seated. The nipples and spark plug covers should be in good condition. Nipples should fit tightly on the coil and distributor cap towers and spark plug cover should fit tight around spark plug insulators. Cable connections that are loose will corrode and increase the resistance and permit water to enter the towers causing ignition malfunction. **To maintain proper sealing at the terminal connections, the connections should not be broken unless testing indicates high resistance, an open circuit or other damage.**

**CAUTION:** Do not pull spark plug cables from distributor cap of four cylinder engines. The cables must be released from inside the distributor cap (Fig. 5).

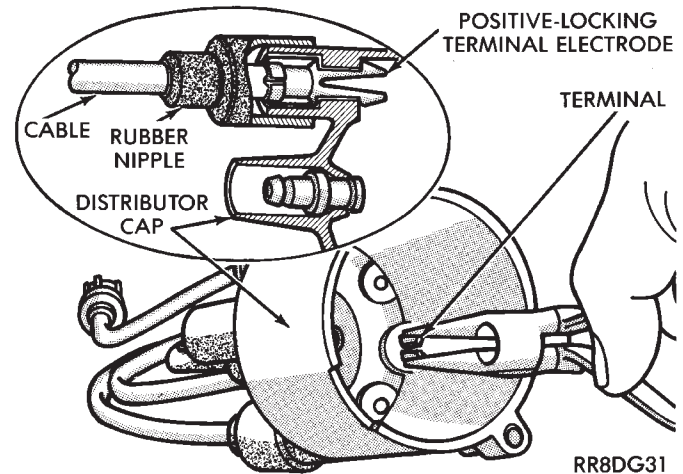


Fig. 5 Spark Plug Cable Removal/Installation—2.5L Engines

Clean high tension cables with a cloth moistened with a non-flammable solvent and wipe dry. Check for brittle or cracked insulation.

When testing secondary cables for punctures and cracks with an oscilloscope and an inductive probe, follow the equipment manufacturers instructions.

**WARNING: THE IGNITION SYSTEM GENERATES APPROXIMATELY 35,000 VOLTS. PERSONAL INJURY COULD RESULT FROM CONTACT WITH THIS SYSTEM.**

If an oscilloscope is not available, secondary cables can be tested as follows:

**CAUTION: Do not leave any one spark plug cable disconnected any longer than necessary during testing. Excessive heat could damage the catalytic converter. Total test time must not exceed ten minutes.**

(a) With the engine not running, connect one end of a test probe (i.e. a piece of wire with insulated alligator clips on each end) to a good ground, other end free for probing.

(b) With engine running, move test probe along entire length of all cables (approximately 0 to 1/8 inch gap). If punctures or cracks are present there will be a noticeable spark jump from the faulty area to the probe. Check the coil cable the same way. Replace cracked, leaking or faulty cables.

**When replacing the cables, install the ignition cable and nipple assembly over cap or coil tower. When entering the terminal into the tower, push lightly, then pinch the large diameter of nipple to release air trapped between the nipple and tower. Continue pushing on the cable and nipple until cables are properly seated in the cap towers. Snap should be heard as terminal goes into place.**

Use the same procedure to install cable in coil tower. Wipe the spark plug insulator clean before re-installing cable and cover.

Use the following procedure when removing the ignition cable from the spark plug. First, remove the cable from the retaining bracket. Then grasp the terminal as close as possible to the spark plug. Rotate the cover and pull the cable straight back. **Pulling on the cable itself will damage the conductor and terminal connection. Do not use pliers and do not pull the cable at an angle. Doing so will damage the insulation, cable terminal or the spark plug insulator. Wipe spark plug insulator clean before reinstalling cable and cover.**

Resistance type cable is identified by the words **Electronic Suppression** printed on the cable jacket.

Use an ohmmeter to check resistance type cable for open circuits, loose terminals or high resistance as follows:

- (a) Remove cable from spark plug.
- (b) Lift distributor cap from distributor with cables intact. **Do not remove cables from cap.** The cables must be removed from the spark plugs.
- (c) Connect the ohmmeter between spark plug end terminal and the corresponding electrode inside the cap, make sure ohmmeter probes are in good contact. Resistance should be within tolerance shown in the cable resistance chart. If resistance is not within tolerance, remove cable at cap tower

and check the cable. If resistance is still not within tolerance, replace cable assembly. Test all spark plug cables in same manner.

CABLE RESISTANCE CHART

MINIMUM	MAXIMUM
250 Ohms Per Inch	1000 Ohms Per Inch
3000 Ohms Per Foot	12,000 Ohms Per Foot

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To test coil to distributor cap ignition, remove distributor cap with the cable intact. **Do not remove cable from the cap.** Connect the ohmmeter between center contact in the cap and remove the cable at coil tower and check cable resistance. If resistance is not within tolerance, replace the cable. Also, check for a loose connection at the tower or for a faulty coil.

Inspect coil tower for cracks or carbon tracking.

**SPARK PLUGS**

Resistor spark plugs are used in all engines and have resistance values of 6,000 to 20,000 ohms when checked with at least a 1000 volt tester.

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. An isolated plug displaying an abnormal condition indicates that a problem exists in the corresponding cylinder. Replace spark plugs at the intervals recommended in Group O.

Undamaged low milage spark plugs can be cleaned and reused. Refer to the Spark Plug Condition section of this group. After cleaning, file the center electrode flat with a small point file or jewelers file. Adjust the gap between the electrodes (Fig. 6) to the dimensions specified in the chart at the end of this section.

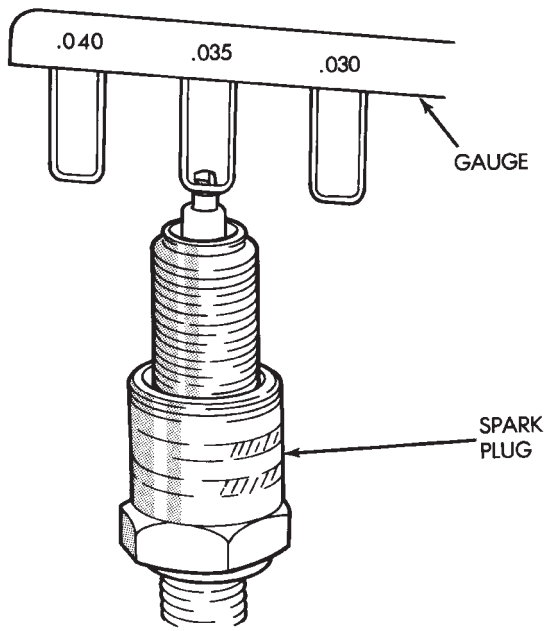
Always tighten spark plugs to the specified torque. Over tightening can cause distortion resulting in a change in the spark plug gap. Tighten 2.5L and 3.0L engine spark plugs to 28 N·m (20 ft. lbs.) torque.

*SPARK PLUG CONDITION*

**NORMAL OPERATING CONDITIONS**

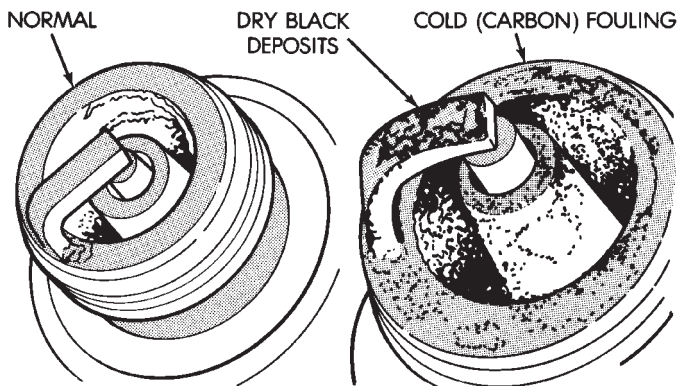
The few deposits present will be probably light tan or slightly gray in color with most grades of commercial gasoline (Fig. 7). There will not be evidence of electrode burning. Gap growth will not average more than approximately 0.025 mm (.001 in) per 1600 km (1000 miles) of operation. Spark plugs that have normal wear can usually be cleaned, have the electrodes filed and regapped, and then reinstalled.

Some fuel refiners in several areas of the United States have introduced a manganese additive (MMT)



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**Fig. 6 Setting Spark Plug Electrode Gap—Typical**



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**Fig. 7 Normal Operation and Cold (Carbon) Fouling**

for unleaded fuel. During combustion, fuel with MMT coats the entire tip of the spark plug with a rust color deposit. The rust color deposits could be misdiagnosed as being caused by coolant in the combustion chamber. MMT deposits do not effect spark plug performance.

#### COLD FOULING (CARBON FOULING)

Cold fouling is sometimes referred to as carbon fouling. The deposits that cause cold fouling are basically carbon (Fig. 7). A dry, black deposit on one or two plugs in a set may be caused by sticking valves or defective spark plug cables. Cold (carbon) fouling of the entire set may be caused by a clogged air cleaner. A clogged air cleaner can cause over-rich fuel/air mixtures.

Cold fouling is normal after short operating periods. The spark plugs do not reach a high enough operating temperature to burn off conductive deposits during short operating periods. Carbon fouled spark plugs with low mileage can be cleaned and reused.

#### FUEL FOULING

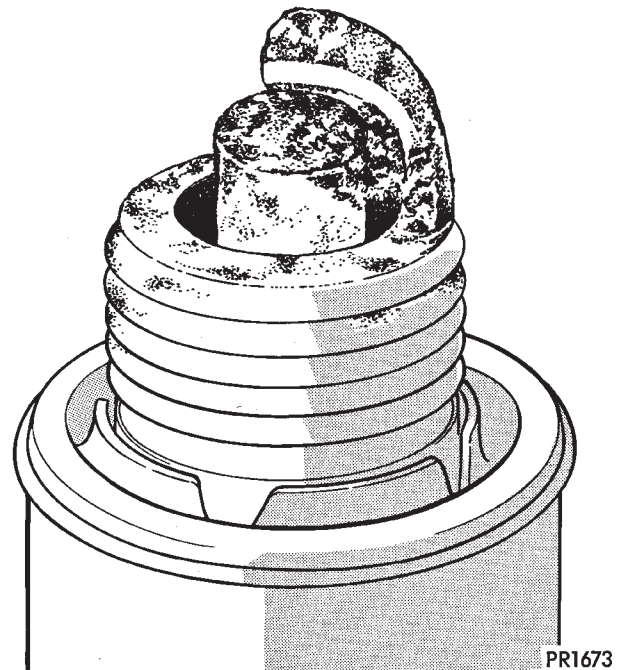
A spark plug that is coated with excessive wet fuel is called fuel fouled. This condition is normally observed during hard start periods. Clean fuel fouled spark plugs with compressed air and reinstall them in the engine.

#### OIL FOULING

A spark plug that is coated with excessive wet oil is oil fouled. In older engines, wet fouling can be caused by worn rings or excessive cylinder wear. Break-in fouling of new engines may occur before normal oil control is achieved. Replace oil fouled spark plugs with new ones.

#### OIL OR ASH ENCRUSTED

If one or more plugs are oil or ash encrusted, evaluate the engine for the cause of oil entering the combustion chambers (Fig. 8). Sometimes fuel additives can cause ash encrustation on an entire set of spark plugs. Clean ash encrusted spark plugs using a spark plug cleaning machine.



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**Fig. 8 Oil or Ash Encrusted**

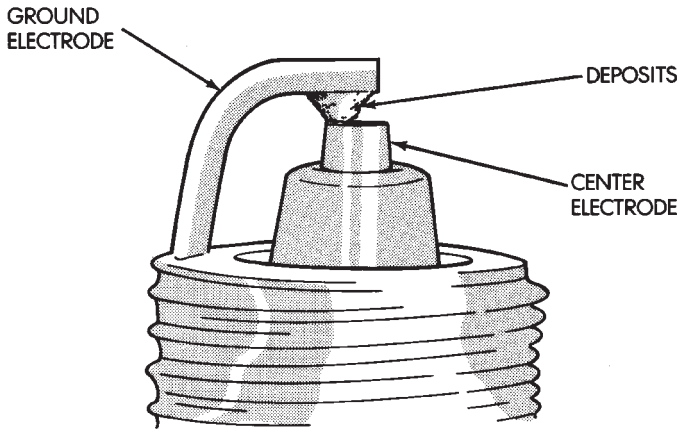
#### HIGH SPEED MISS

When replacing spark plugs because of a high speed miss condition; **wide open throttle operation should be avoided for approximately 80 km (50 miles) after installation of new plugs.** This will allow deposit shifting in the combustion chamber

to take place gradually and avoid plug destroying splash fouling shortly after the plug change.

**ELECTRODE GAP BRIDGING**

Loose deposits in the combustion chamber can cause electrode gap bridging. The deposits accumulate on the spark plugs during continuous stop-and-go driving. When the engine is suddenly subjected to a high torque load, the deposits partially liquefy and bridge the gap between the electrodes (Fig. 9). This short circuits the electrodes. Spark plugs with electrode gap bridging can be cleaned using a spark plug cleaning machine.

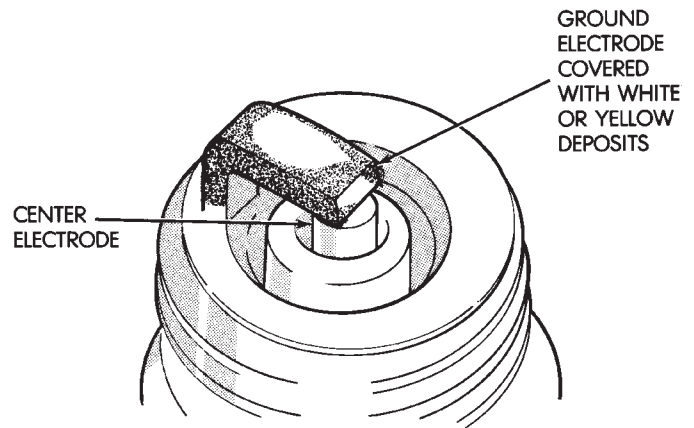


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**Fig. 9 Electrode Gap Bridging**

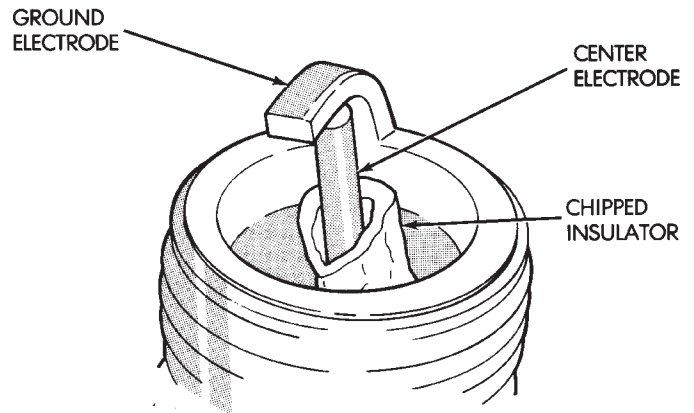
**SCAVENGER DEPOSITS**

Fuel scavenger deposits may be either white or yellow (Fig. 10). They may appear to be harmful, but are 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 be cleaned using a spark plug cleaning machine.



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**Fig. 10 Scavenger Deposits**



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**Fig. 11 Chipped Electrode Insulator**

**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 also can separate the insulator from the center electrode (Fig. 11). Replace spark plugs with chipped electrode insulators.

**PREIGNITION DAMAGE**

Excessive combustion chamber temperature can cause preignition damage. The center electrode dissolves first and the ground electrode dissolves somewhat later (Fig. 12). Insulators appear relatively deposit free. Determine if the spark plug has the cor-

rect heat range rating for the engine, 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. Spark plugs are designed to operate within specific temperature ranges depending upon the thickness and length of the center electrode and porcelain insulator.)

**SPARK PLUG OVERHEATING**

Overheating is indicated by a white or gray center electrode insulator that also appears chalky or blistered (Fig. 13). The increase in electrode gap will be considerably in excess of 0.001 in per 1000 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 also can cause spark plug overheating.

**SPARK PLUG SERVICE**

When replacing the spark plug and coil cables, route the cables correctly and secure them in the appropriate retainers. Failure to route the cables prop-

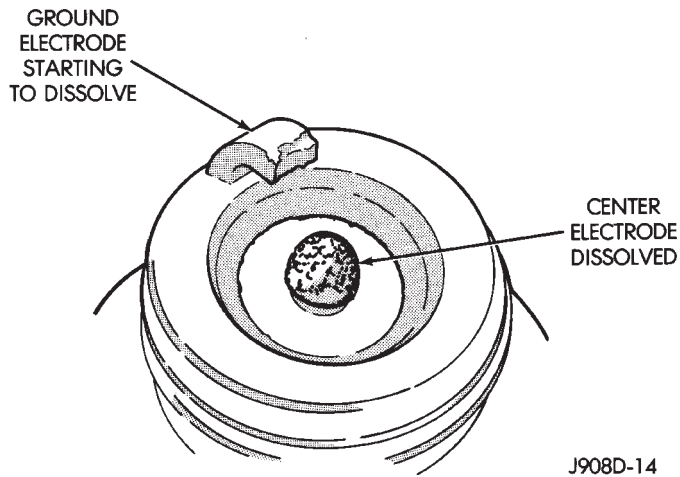


Fig. 12 Preignition Damage

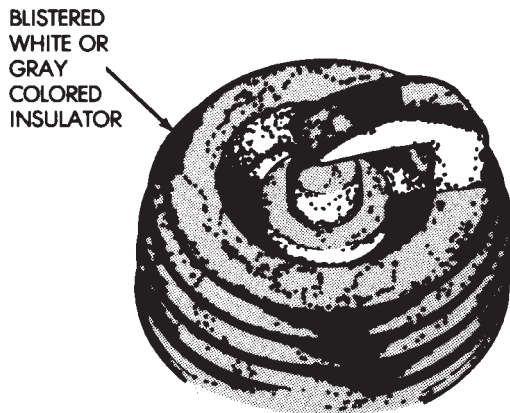


Fig. 13 Spark Plug Overheating

erly can cause the radio to reproduce ignition noise, cross ignition of the spark plugs or short circuit the cables to ground.

**Never Wire Brush Spark Plugs.** The spark plug insulator tip is harder than the bristles of wire brushes. Bristles of wire brushes can leave a conductive, metallic film on the insulator which could lead to conductive deposits. Conductive deposits can cause spark plug failure and engine misfire. Use a jeweler's file to remove deposits from the electrode gap. Use a spark plug cleaning machine to clean spark plugs.

#### SPARK PLUG REMOVAL

Always remove the ignition cable by grasping at the spark plug boot turning, the boot 1/2 turn and pulling straight back in a steady motion.

(1) Prior to removing the spark plug spray compressed air around the spark plug hole and the area around the spark plug.

(2) Remove the spark plug using a quality socket with a rubber or foam insert.

(3) Inspect the spark plug condition. Refer to Spark Plug Condition in this section.

#### SPARK PLUG GAP ADJUSTMENT

Check the spark plug gap with a gap gauge. If the gap is not correct, adjust it by bending the ground electrode (Fig. 6).

#### SPARK PLUG INSTALLATION

(1) To avoid cross threading, start the spark plug into the cylinder head by hand.

(2) Tighten spark plugs to 28 N·m (20 ft. lbs.) torque.

(3) Install ignition cables over spark plugs.

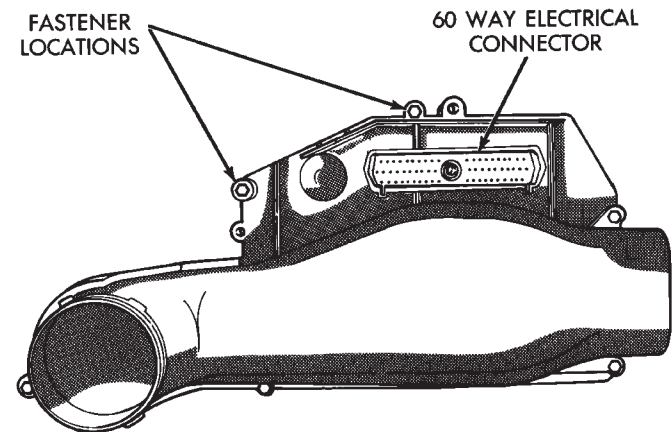
#### POWERTRAIN CONTROL MODULE (PCM)

The ignition system is regulated by the powertrain control module (PCM) (Fig. 14). The PCM supplies battery voltage to the ignition coil through the Auto Shutdown (ASD) Relay. The controller also controls the ground circuit for the ignition coil. By switching the ground path for the coil on and off, the PCM adjusts ignition timing to meet changing engine operating conditions.

During the crank-start period the controller advances ignition timing a set amount. During engine operation, the amount of spark advance provided by the PCM is determined by three input factors:

- engine coolant temperature
- engine RPM
- available manifold vacuum

The PCM also regulates the fuel injection system. Refer to the Fuel Injection sections of Group 14.

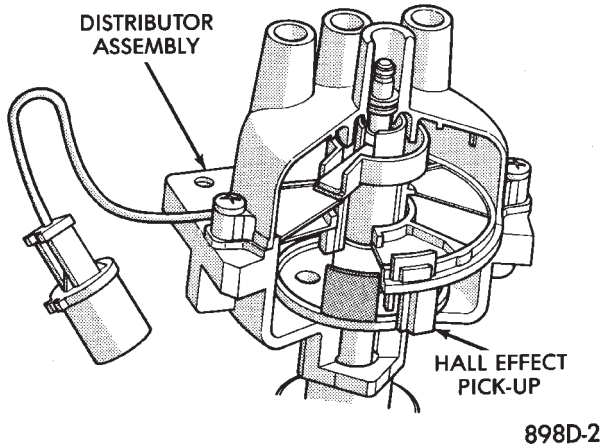


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Fig. 14 Powertrain Control Module

#### HALL EFFECT PICK-UP—2.5L ENGINES

The hall effect pick-up (Fig. 15) is located in the distributor assembly. It supplies engine rpm and ignition timing data to the powertrain control module (PCM). This allows the PCM to advance or retard the ignition spark as required by different operating conditions.



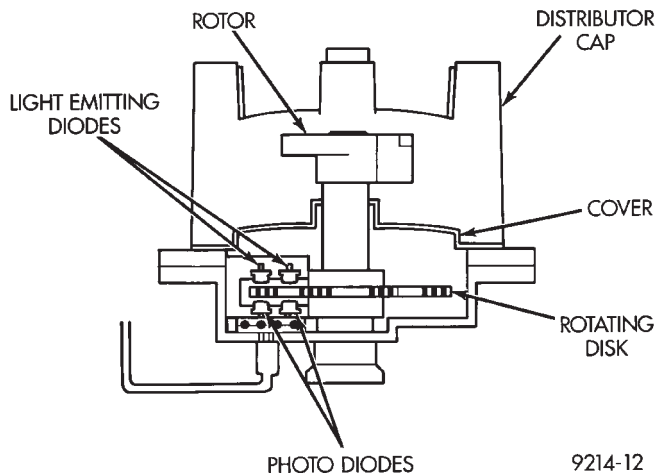
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**Fig. 15 Hall Effect Distributor—2.5L Engines**

### DISTRIBUTOR PICK-UP—3.0L ENGINE

The distributor pick-up provides two inputs to the powertrain control module (PCM). From one input the PCM determines RPM (engine speed). From the other input it derives crankshaft position. The PCM regulates injector synchronization and adjusts ignition timing and engine speed based on these inputs.

The distributor pick-up contains two signal generators. The pick-up unit consists of 2 light emitting diodes (LED), 2 photo diodes, and a separate timing disk. The timing disk contains two sets of slots. Each set of slots rotates between a light emitting diode and a photo diode (Fig. 16). The inner set contains 6 large slots, one for each cylinder. The outer set contains several smaller slots.



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**Fig. 16 Distributor Pick-up—3.0L Engine**

The outer set of slots on the rotating disk represents 2 degrees of crankshaft rotation. Up to 1200 engine RPM, the controller uses the input from the outer set of slots to increase ignition timing accuracy.

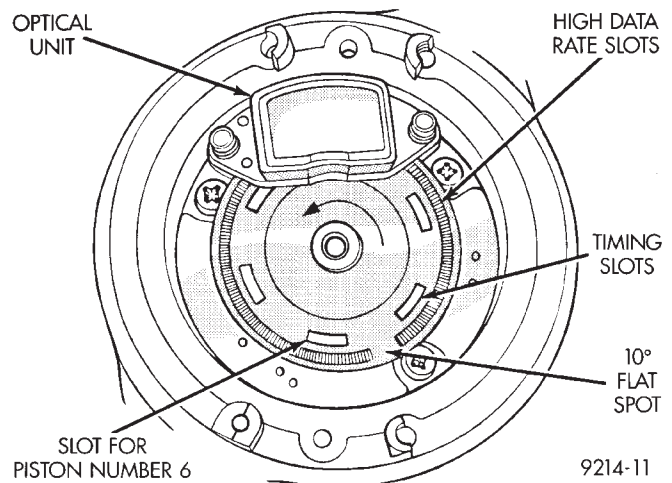
The outer set of slots contains a 10 degree flat spot. This area is not slotted (Fig. 17). The flat spot tells

the PCM that the next piston at TDC will be number 6. Each piston's position is referenced by one of the six inner slots (Fig. 17).

As each slot on the timing disk passes between the diodes, they interrupt the beam from the light emitting diode. This creates an alternating voltage in each photo diode which is converted into on-off pulses. The pulses are the input to the PCM.

During cranking, the PCM cannot determine which cylinder will be at TDC until the 10 degree flat spot on the outer set of slots rotates through the optical unit. Once the flat spot is detected, the controller knows piston in cylinder number 6 will be the next piston at TDC.

Since the disk rotates at half crankshaft speed, it may take up to 2 engine revolutions during cranking before the PCM determines the position of piston number 6. For this reason the PCM energizes all six injectors at the same time until it senses the position of piston number 6.



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**Fig. 17 Inner and Outer Slots of Rotating Disk—3.0L Engine**

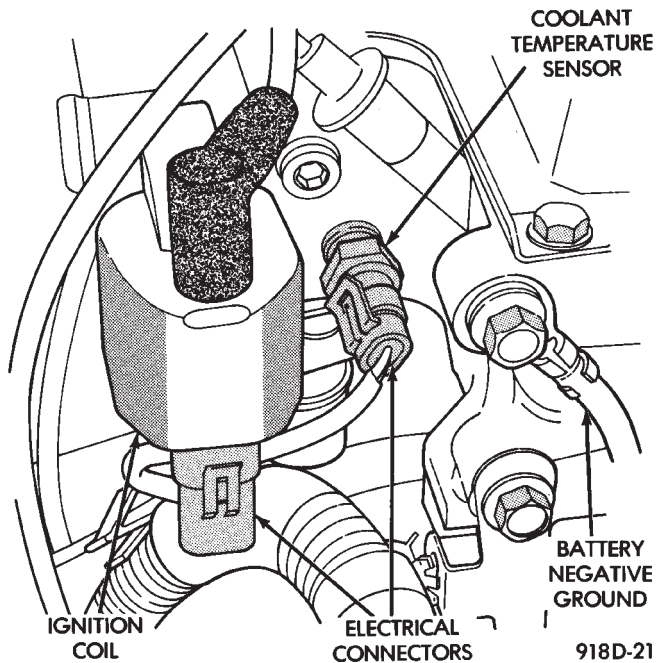
### ENGINE COOLANT TEMPERATURE SENSOR

On 2.5L engines, the engine coolant temperature (ECT) sensor is installed behind the thermostat housing and ignition coil in the hot box (Fig. 18). On 3.0L engines the sensor is located next to the thermostat housing (Fig. 19). The sensor provides an input voltage to the powertrain control module (PCM). The sensor is a variable resistance (thermistor) with a range of  $-40^{\circ}\text{F}$  to  $265^{\circ}\text{F}$ . As coolant temperature varies, the sensors resistance changes, resulting in a different input voltage to the PCM.

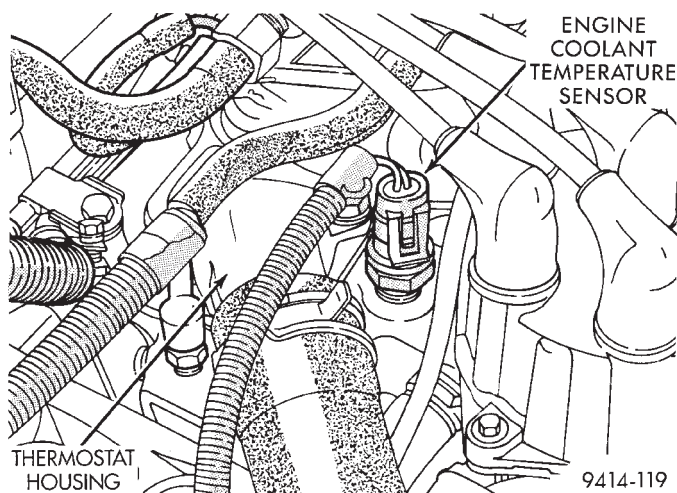
The PCM contains different spark advance schedules for cold and warm engine operation. The schedules reduce engine emissions and improve driveability. Because spark advance changes at different engine operating temperatures during warm-up, all spark advance testing should be done with the engine fully warmed.

When the engine is cold, the PCM demands slightly richer air-fuel mixtures and higher idle speeds until normal operating temperatures are reached.

The engine coolant sensor input is also used for cooling fan control.



**Fig. 18 Engine Coolant Temperature Sensor—2.5L Engines**



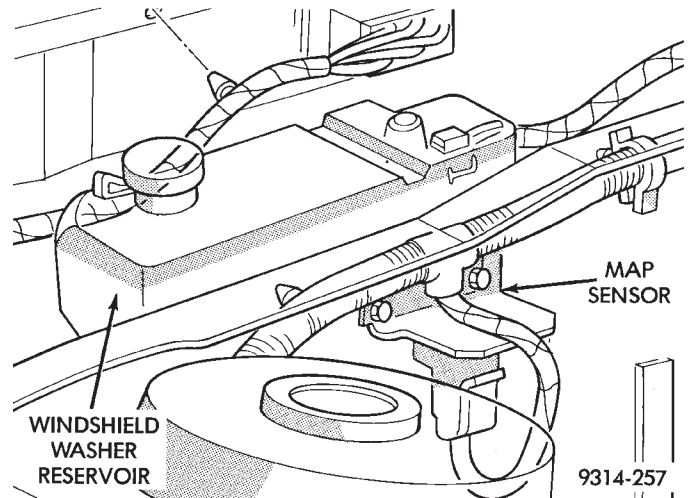
**Fig. 19 Engine Coolant Temperature Sensor—3.0L Engines**

### MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

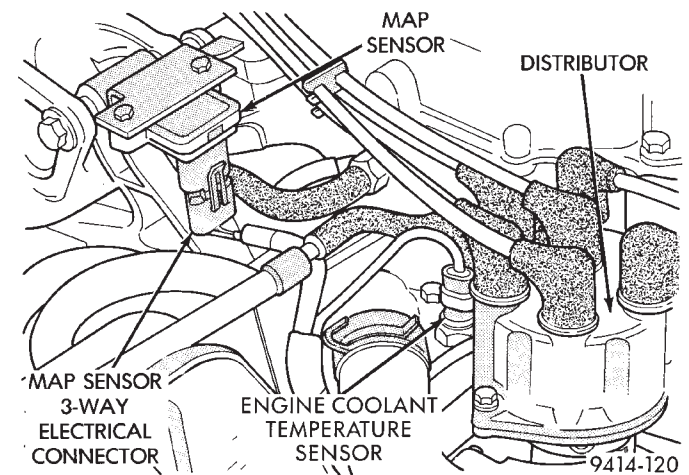
The MAP sensor reacts to absolute pressure in the intake manifold and provides an input voltage to the powertrain control module (PCM). As engine load changes, manifold pressure varies. The changes in engine load causes the MAP sensors resistance to change. The change in MAP sensor resistance results in a different input voltage to the PCM.

The input voltage level supplies the PCM with information relating to ambient barometric pressure during engine start-up (cranking) and engine load while its operating. The PCM uses this input along with inputs from other sensors to adjust air-fuel mixture.

On 2.5L engines, the MAP sensor is mounted to the dash panel (Fig. 20). On 3.0L engines, the sensor is mounted to a bracket across from the distributor (Fig. 21). The sensor is connected to the throttle body with a vacuum hose and to the PCM electrically.



**Fig. 20 MAP Sensor—2.5L TBI Engines**



**Fig. 21 MAP Sensor—3.0L Engine**

### AUTOMATIC SHUTDOWN (ASD) RELAY AND FUEL PUMP RELAY

The powertrain control module (PCM) operates the auto shutdown (ASD) relay and fuel pump relay through one ground path. The controller operates the relays by switching the ground path on and off. Both relays turn on and off at the same time.

The ASD relay connects battery voltage to the fuel injector and ignition coil. The fuel pump relay connects battery voltage to the fuel pump and oxygen sensor heating element.

The PCM turns the ground path off when the ignition switch is in the Off position. Both relays are off. When the ignition switch is in the On or Crank position, the PCM monitors the distributor pick-up signal to determine engine speed and ignition timing (coil dwell). If the PCM does not receive a distributor signal when the ignition switch is in the Run position, it will de-energize both relays. When the relays are de-energized, battery voltage is not supplied to the fuel injector, ignition coil, fuel pump and oxygen sensor heating element.

The ASD and fuel pump relays are located in the power distribution center (PDC). The PDC is located in the engine compartment above the PCM (Fig. 22). A label affixed to the underside of the PDC cover identifies the relays and fuses in the PDC.

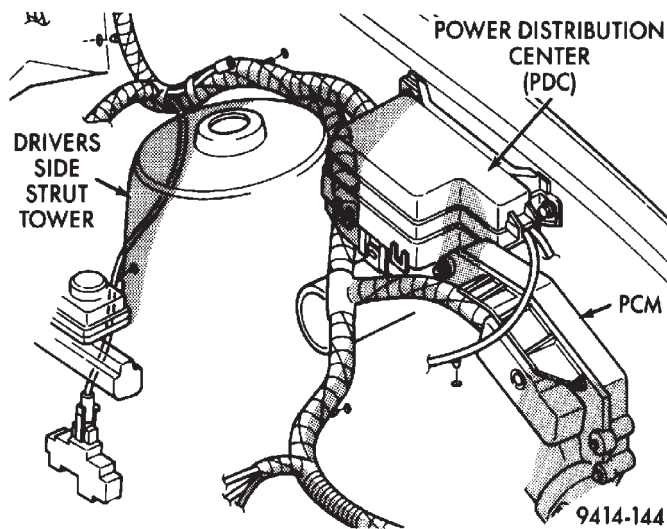


Fig. 22 Auto Shutdown Relay and Fuel Pump Relay

#### IGNITION COIL

The 2.5L and 3.0L engines use an epoxy type coil. The coils are not oil filled. The windings are embedded in a heat and vibration resistant epoxy compound.

The powertrain control module (PCM) operates the ignition coil through the auto shutdown (ASD) relay. When the relay is energized by the PCM, battery voltage is connected to the ignition coil positive terminal. The PCM will de-energize the ASD relay if it

does not receive an input from the distributor pick-up. Refer to Auto Shutdown (ASD) Relay and Fuel Pump Relay in this section.

On 2.5L engines the ignition coil is mounted to the thermostat housing (Fig. 23). On 3.0L engines the coil is mounted on the rear of the intake manifold next to the air cleaner (Fig. 24).

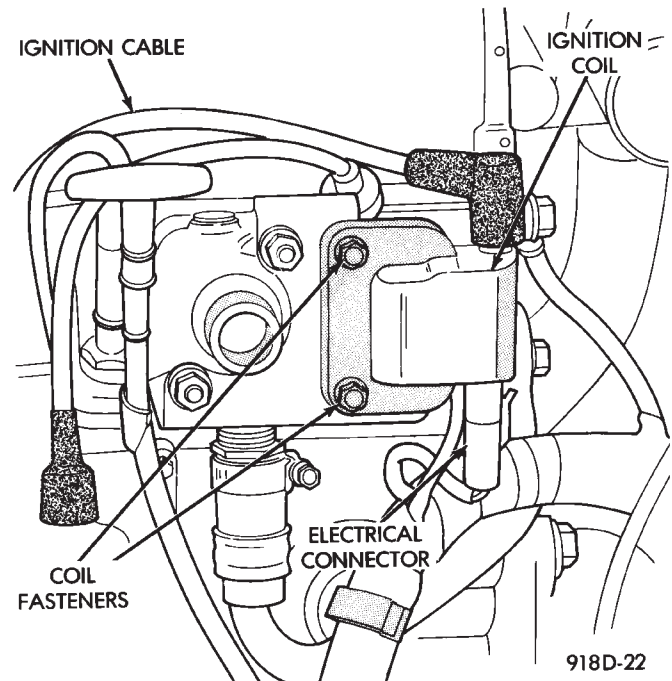


Fig. 23 Ignition Coil—2.5L Engine

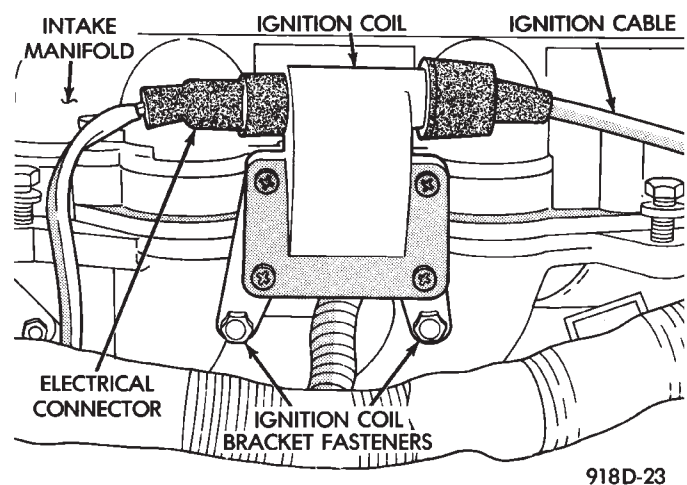


Fig. 24 Ignition Coil—3.0L Engine

## 2.5L AND 3.0L IGNITION SYSTEMS—DIAGNOSTIC PROCEDURES

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## GENERAL INFORMATION

For additional information, refer to On Board Diagnostics sections of Group 14.

## SPARK PLUGS

Faulty or fouled spark plugs may perform well at idle speed, but frequently fail at higher engine speeds. Faulty plugs can be identified in a number of ways: poor fuel economy, power loss, decrease in engine speed, hard starting and, in general, poor engine performance.

Spark plugs also malfunction because of carbon fouling, excessive electrode air gap, or a broken insulator. Refer to the General Information Section of this group for spark plug diagnosis.

## IGNITION COIL

The ignition coil is designed to operate without an external ballast resistor.

Inspect the coil for arcing. Test the coil according to coil tester manufacturer's instructions. Test coil primary and secondary resistance. Replace any coil that does not meet specifications. Refer to the Ignition Coil chart in the Specifications section at the end of this group.

If the ignition coil is replaced due to a burned tower, carbon tracking, arcing at the tower, or damage to the terminal or boot on the coil end of the secondary cable, the cable must be replaced. Arcing at the tower will carbonize the nipple which, if it is connected to a new coil, will cause the coil to fail.

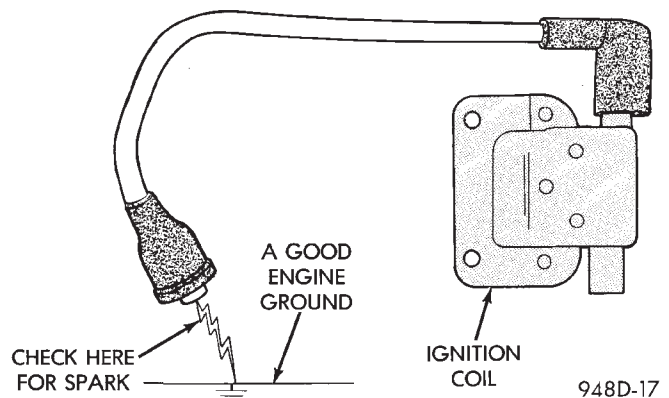
If a secondary cable shows any signs of damage, the cable should be replaced with a new cable and new terminal. Carbon tracking on the old cable can cause arcing and the failure of a new coil.

## TESTING FOR SPARK AT COIL

**WARNING: APPLY PARKING BRAKE AND/OR BLOCK THE WHEELS BEFORE PERFORMING ANY TEST WITH THE ENGINE RUNNING.**

**CAUTION: Spark plug cables may be damaged if this test is performed with more than 1/4 inch clearance between the cable and engine ground.**

Remove the coil secondary cable from the distributor cap. Hold the end of cable about 6 mm (1/4-inch) away from a good engine ground using non-conductive ignition pliers (Fig. 1). Crank the engine and inspect for spark at the coil secondary cable.



**Fig. 1 Checking for Spark**

There must be a constant spark at the coil secondary cable. If the spark is constant, have a helper continue to crank engine and, while slowly moving coil secondary cable away from ground, look for arcing at the coil tower. If arcing occurs at the tower, replace the coil. If spark is not constant or there is no spark, proceed to the failure to start test.

If a constant spark is present and no arcing occurs at the coil tower, the ignition system is producing the necessary high secondary voltage. However, make sure that the spark plugs are firing. Inspect the distributor rotor, cap, spark plug cables, and spark plugs. If they are in proper working order, the ignition system is not the reason why the engine will not start. Inspect the fuel system and engine for proper operation.

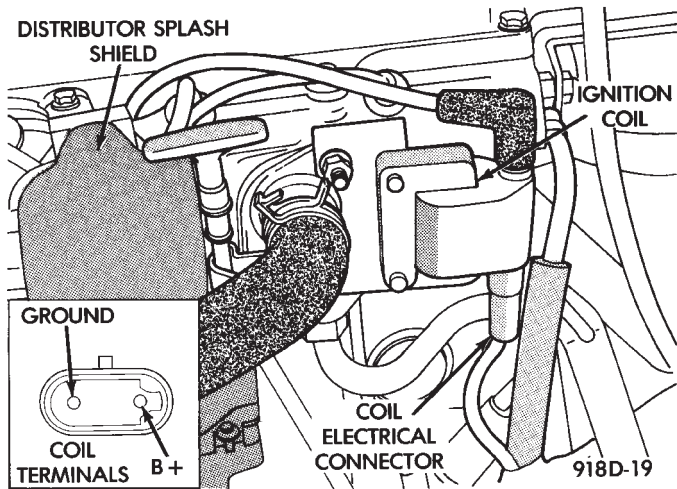
## FAILURE TO START TEST—2.5L TBI AND 3.0L ENGINES

**Before proceeding with this test make sure Testing For Spark At Coil has been performed. Failure to do this may lead to unnecessary diagnostic time and wrong test results.**

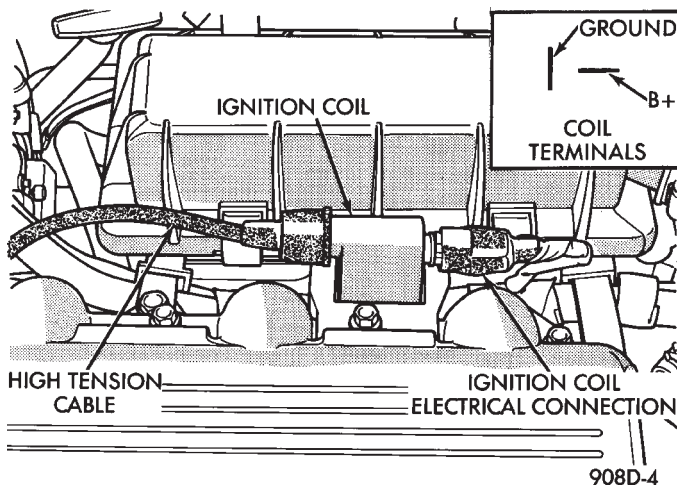
**WARNING: BE SURE TO APPLY PARKING BRAKE AND/OR BLOCK WHEELS BEFORE PERFORMING ANY TEST WITH THE ENGINE RUNNING.**

(1) Battery voltage must be at least 12.4 volts to perform test.

(2) Crank the engine for 5 seconds while monitoring the voltage at the coil positive (+) terminal (Fig. 2 or Fig. 3). If the voltage remains near zero during the entire period of cranking, refer to Group 14 for On-Board Diagnostic checks. These checks will help diagnose problems with the PCM and auto shutdown relay.



**Fig. 2 Coil Terminals—2.5L Engines**



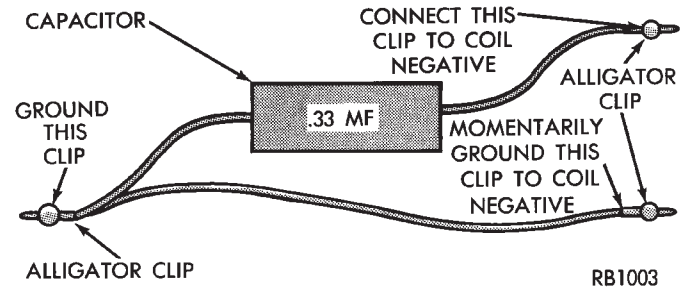
**Fig. 3 Coil Terminals—3.0L Engine**

(3) If voltage is at near-battery voltage and drops to zero after 1-2 seconds of cranking, see Group 14 for On-Board Diagnostic check for the distributor reference pickup circuit to the PCM.

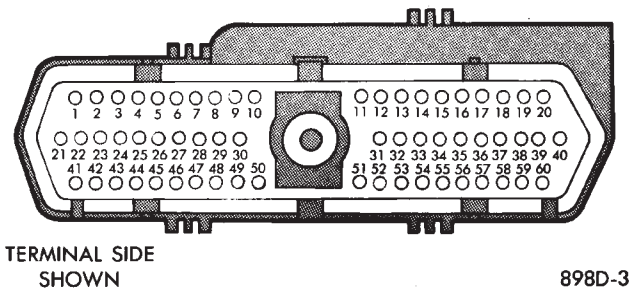
(4) If voltage remains at near battery voltage during the entire 5 seconds, **with the key off**, remove the PCM 60-way connector. Check the 60-way connector for any terminals that are pushed out or loose.

(5) Remove the connector to coil (+) and connect a jumper wire between battery (+) and coil (+).

(6) Using the special jumper (Fig. 4), momentarily ground terminal #19 of the 60-way connector (Fig. 5). A spark should be generated when the ground is removed.



**Fig. 4 Special Jumper to Ground Coil Negative**



**Fig. 5 PCM 60-Way Electrical Connector**

- (7) If spark is generated, replace the PCM.
- (8) If no spark is seen, use the special jumper to ground the coil (-) terminal directly.
- (9) If spark is produced, inspect wiring harness for an open condition.
- (10) If no spark is produced, replace the ignition coil.

**POOR PERFORMANCE TEST**

**To prevent unnecessary diagnostic time and possible incorrect results, the Testing For Spark At Coil procedure should be performed before this test.**

**WARNING: APPLY PARKING BRAKE AND/OR BLOCK THE WHEELS BEFORE PERFORMING ANY ENGINE RUNNING TESTS.**

Check and adjust basic timing (refer to the specification section of this group and see service procedures).  
Refer to Group 14, On-Board Diagnostics sections.

**ENGINE COOLANT TEMPERATURE SENSOR TEST**

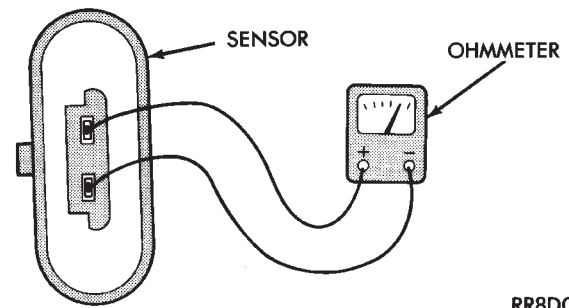
- (1) With key off, disconnect wire connector from coolant engine temperature (ECT) sensor (Fig. 6).
- (2) Connect one lead of ohmmeter to one terminal of engine coolant temperature sensor.

(3) Connect the other lead of ohmmeter to remaining connector of coolant temperature sensor. The ohmmeter should read as follows;

- Engine/Sensor at normal operating temperature around 200°F should read approximately 700 to 1,000 ohms.
- Engine/Sensor at room temperature around 70°F, ohmmeter should read approximately 7,000 to 13,000 ohms.
- **See On Board Diagnostics section of Group 14, or refer to the appropriate diagnostic manual for further test procedures.**

#### MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR TEST

Refer to On-Board Diagnostics sections of Group 14 and the appropriate Powertrain Diagnostic Proce-



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*Fig. 6 Engine Coolant Temperature Sensor Test*  
dures manual for further test procedures.

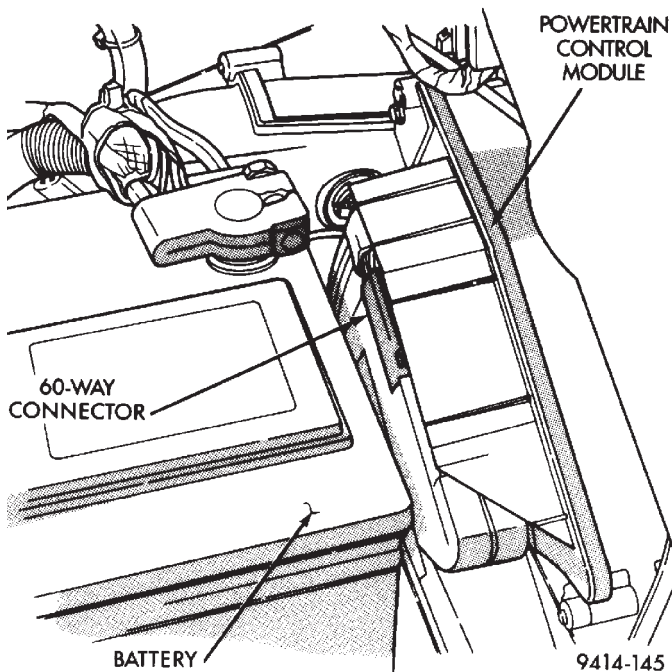
## 2.5L AND 3.0L IGNITION SYSTEMS—SERVICE PROCEDURES

### INDEX

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Distributor—2.5L Engine	16	Powertrain Control Module	13
Engine Coolant Temperature Sensor	13	Spark Plug Service	14
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Ignition Coil—2.5L TBI Engines	14		
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### POWERTRAIN CONTROL MODULE

The powertrain control module (PCM) is located next to the battery (Fig. 1).



**Fig. 1 Powertrain Control Module**

#### REMOVAL

- (1) Remove air cleaner duct or air cleaner assembly.
- (2) Remove battery.
- (3) Remove PCM mounting screws.
- (4) Remove 60-way wiring connector from the PCM.
- (5) Remove controller.

#### INSTALLATION

- (1) Connect 60-Way electrical connector to PCM (Fig. 1).
- (2) Install PCM. Tighten mounting screws.
- (3) Install battery.
- (4) Install air cleaner duct or air cleaner assembly.

### ENGINE COOLANT TEMPERATURE SENSOR

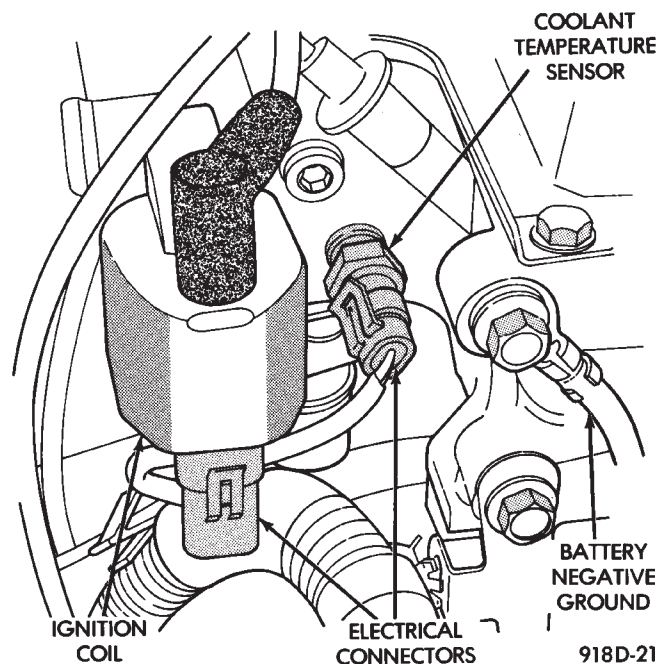
On 2.5L engines the engine coolant temperature (ECT) sensor is located behind the ignition coil (Fig. 2). On 3.0L engines the sensor is located next to the thermostat housing (Fig. 3).

#### REMOVAL

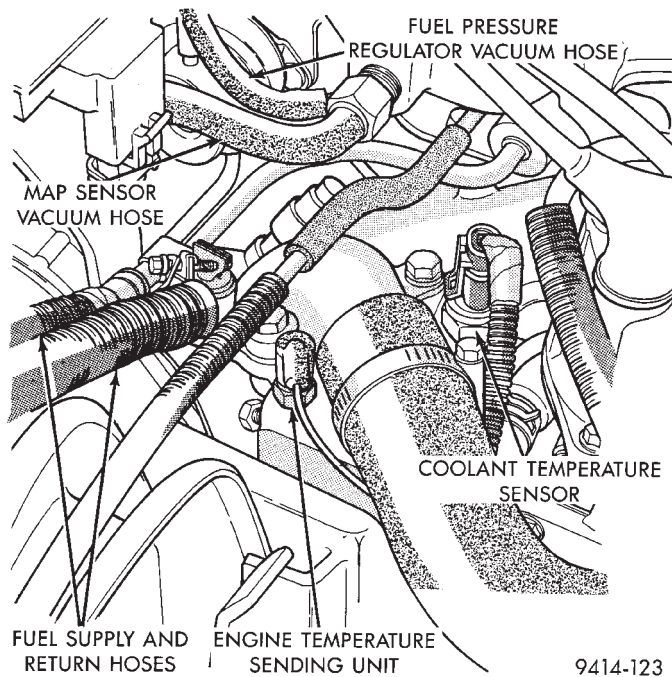
- (1) Drain cooling system until coolant level is below coolant sensor. Refer to Group 7, Cooling System.
- (2) Disconnect electrical connector from sensor.
- (3) Remove sensor from engine.

#### INSTALLATION

- (1) Install coolant sensor. Tighten 2.5L engine coolant sensor to 28 N·m (20 ft. lbs.) torque. Tighten the 3.0L engine coolant sensor to 7 N·m (60 in. lbs.) torque.
- (2) Connect electrical connector to sensor.
- (3) Fill cooling system. Refer to Group 7, Cooling System.



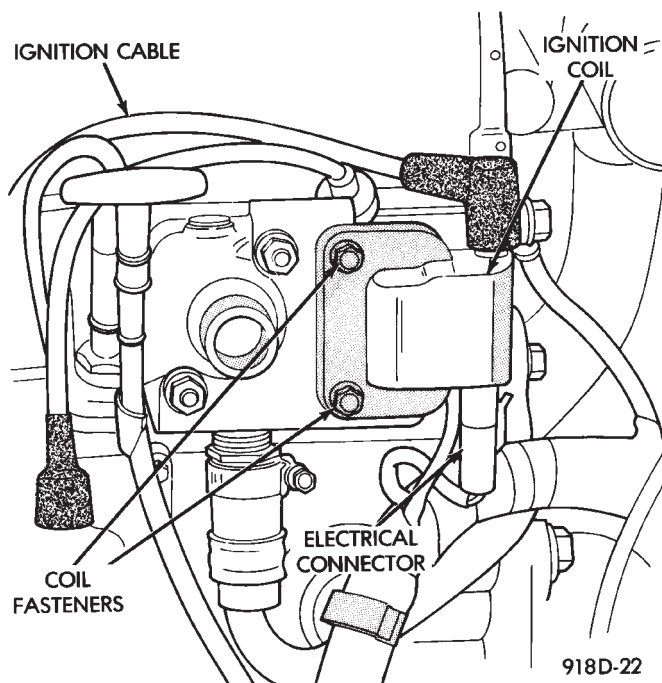
**Fig. 2 Engine Coolant Temperature Sensor—2.5L TBI Engines**



**Fig. 3 Engine Coolant Temperature Sensor—3.0L Engine**

#### IGNITION COIL—2.5L TBI ENGINES

The ignition coil mounts to the thermostat housing (Fig. 4).



**Fig. 4 Ignition Coil—2.5L Engines**

#### REMOVAL

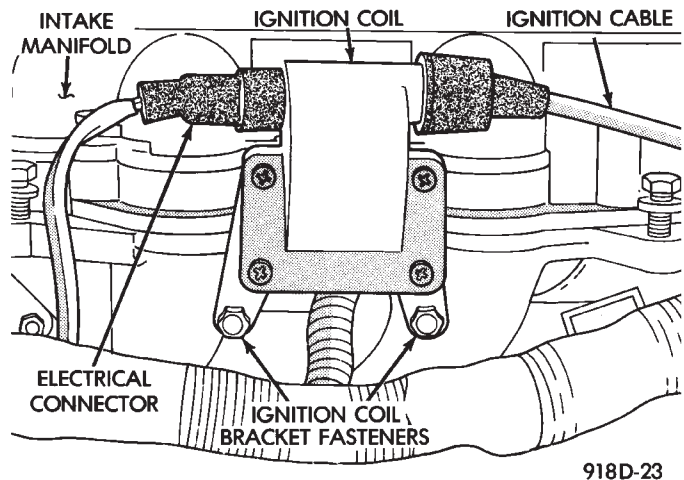
- (1) Disconnect the coil to distributor ignition cable (Fig. 4).
- (2) Disconnect the wiring harness connector from the coil.
- (3) Remove ignition coil mounting screws.

#### INSTALLATION

- (1) Install ignition coil onto the bracket. Tighten the screws to 9.5 N·m (85 in. lbs.) torque.
- (2) Connect the wiring harness connector.
- (3) Connect the coil to distributor ignition cable.

#### IGNITION COIL—3.0L ENGINES

The ignition coil is located at the back of the intake manifold (Fig. 5).



**Fig. 5 Ignition Coil—3.0L Engine**

#### REMOVAL

- (1) Remove air cleaner assembly.
- (2) Disconnect ignition cable from coil.
- (3) Disconnect wiring harness connector from coil.
- (4) Remove coil mounting screws.

#### INSTALLATION

- (1) Loosely install ignition coil on intake manifold. Tighten the intake manifold fastener to 13 N·m (115 in. lbs.) torque. Tighten ignition coil bracket fasteners to 10 N·m (96 in. lbs.) torque.
- (2) Connect the wiring harness connector.
- (3) Connect the coil to distributor ignition cable.
- (4) Install the air cleaner assembly. Tighten the air cleaner fasteners to 25 N·m (225 in. lbs.) torque.

#### SPARK PLUG SERVICE

When replacing the spark plug and coil cables, route the cables correctly and secure them in the appropriate retainers. Failure to route the cables properly can cause the radio to reproduce ignition noise, cause cross ignition of the spark plugs or short circuit the cables to ground.

**Never Wire Brush Spark Plugs.** The spark plug insulator tip is harder than the bristles of wire brushes. Bristles of wire brushes can leave a conductive, metallic film on the insulator which could lead to conductive deposits. Conductive deposits can cause spark plug failure and engine misfire. Use a jewelers file to remove deposits from the electrode gap. Use a spark plug cleaning machine to clean spark plugs.

### SPARK PLUG REMOVAL

Always remove cables by grasping at boot, rotating the boot 1/2 turn, and pulling straight back in a steady motion.

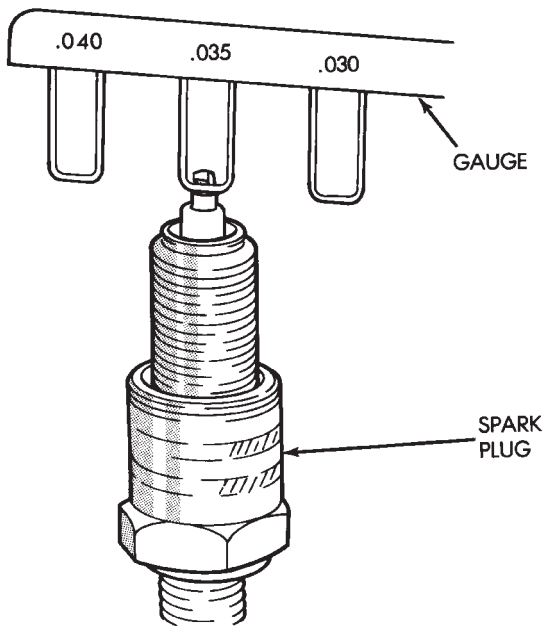
(1) Prior to removing the spark plug spray compressed air around the spark plug hole and the area around the spark plug.

(2) Remove the spark plug using a quality socket with a rubber or foam insert.

(3) Inspect the spark plug condition. Refer to Spark Plug Condition in this section.

### SPARK PLUG GAP ADJUSTMENT

Check the spark plug gap with a gap gauge. If the gap is not correct, adjust it by bending the ground electrode (Fig. 6).



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**Fig. 6 Setting Spark Plug Gap—Typical**

### SPARK PLUG INSTALLATION

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

(2) Tighten spark plugs to 28 N·m (20 ft. lbs.) torque.

(3) Install spark plug cables over spark plugs. A click will be heard and felt when the cable properly attaches to the spark plug.

### IDLE RPM TEST—2.5L AND 3.0L ENGINES

**WARNING: APPLY PARKING BRAKE AND/OR BLOCK WHEELS BEFORE PERFORMING IDLE CHECK OR ADJUSTMENT, OR ANY TESTS WITH A RUNNING ENGINE.**

Engine idle set rpm should be tested and recorded when the vehicle is first brought into

**shop for testing.** This will assist in diagnosing complaints of engine stalling, creeping and hard shifting on vehicles equipped with automatic transmissions.

Proceed to the Throttle Body Minimum Airflow procedures in Group 14.

### IGNITION TIMING PROCEDURE—2.5L TBI AND 3.0L ENGINES

**WARNING: BE SURE TO APPLY PARKING BRAKE AND/OR BLOCK WHEELS BEFORE PERFORMING SETTING IGNITION TIMING OR PERFORMING ANY TEST ON AN OPERATING ENGINE.**

Proper ignition timing is required to obtain optimum engine performance. The distributor must be correctly indexed to provide correct initial ignition timing.

(1) Set the gearshift selector in park or neutral and apply the parking brake. All lights and accessories must be off.

(2) If using a magnetic timing light, insert the pickup probe into the open receptacle next to the timing scale window. If a magnetic timing unit is not available, use a conventional timing light connected to the number one cylinder spark plug cable.

**Do not puncture cables, boots or nipples with test probes. Always use proper adapters. Puncturing the spark plug cables with a probe will damage the cables. The probe can separate the conductor and cause high resistance. In addition breaking the rubber insulation may permit secondary current to arc to ground.**

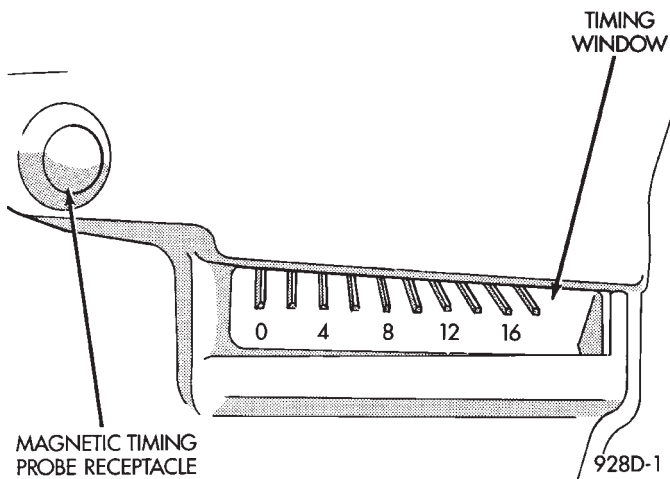
(3) Turn selector switch to the appropriate cylinder position.

(4) Start engine and run until operating temperature is obtained.

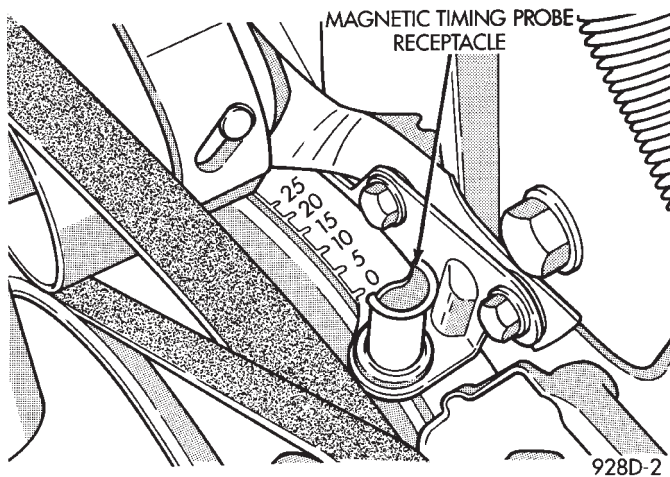
(5) With the engine at normal operating temperature, connect the DRB scan tool to the data link connector. Access the State Display screen. Refer to the appropriate Powertrain Diagnostics Procedures Manual. **If not using the DRB scan tool, disconnect the engine coolant temperature sensor electrical connector.** The electric radiator fan will operate and the malfunction indicator lamp (Check Engine lamp) will turn on after disconnecting the engine coolant sensor or starting the DRB scan tool procedure.

(6) Aim Timing Light at timing scale (Fig. 7 or Fig. 8) or read magnetic timing unit. If flash occurs when timing mark is before specified degree mark, timing is advanced. To adjust, turn distributor housing in direction of rotor rotation.

If flash occurs when timing mark is after specified degree mark, timing is retarded. To adjust, turn distributor housing against direction of rotor rotation. Refer to Vehicle Emission Control Information label for correct timing specification. If timing is within  $\pm$



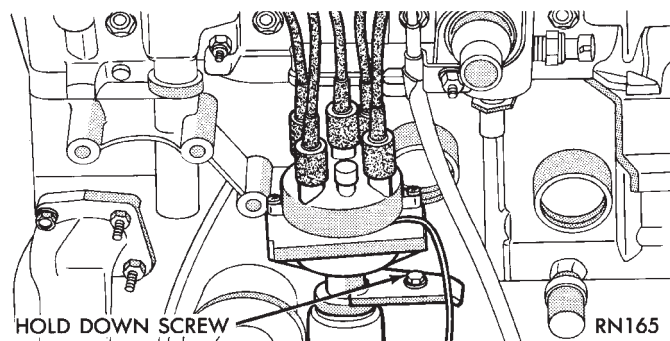
**Fig. 7 Timing Scale—2.5L Engine**



**Fig. 8 Timing Scale—3.0L Engine**

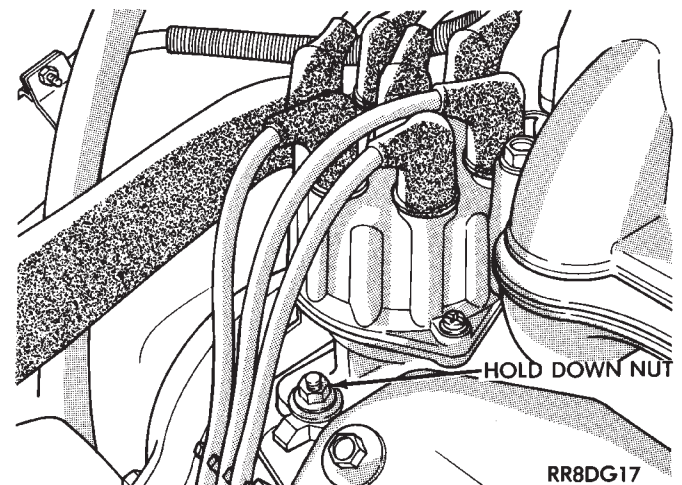
2° of value specified on the label, proceed to step (8). If outside specified tolerance, proceed to next step.

(7) Loosen distributor hold-down arm screw enough to rotate the distributor housing (Fig. 9 or Fig. 10). Turn distributor housing to adjust timing. Tighten the hold-down arm screw and recheck timing.



**Fig. 9 Distributor Holddown—2.5L Engine**

(8) Turn the engine off. Remove timing light or magnetic timing unit and tachometer. If the engine



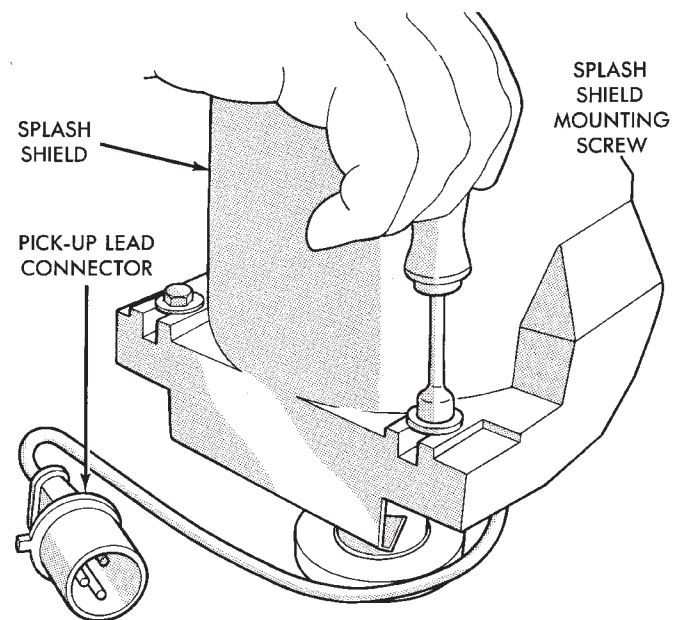
**Fig. 10 Distributor Holddown—3.0L Engine**

coolant temperature sensor was disconnected, connect the sensor and **erase diagnostic trouble codes using the DRB scan tool**. Refer to Group 14, On Board Diagnostics.

## DISTRIBUTOR—2.5L ENGINE

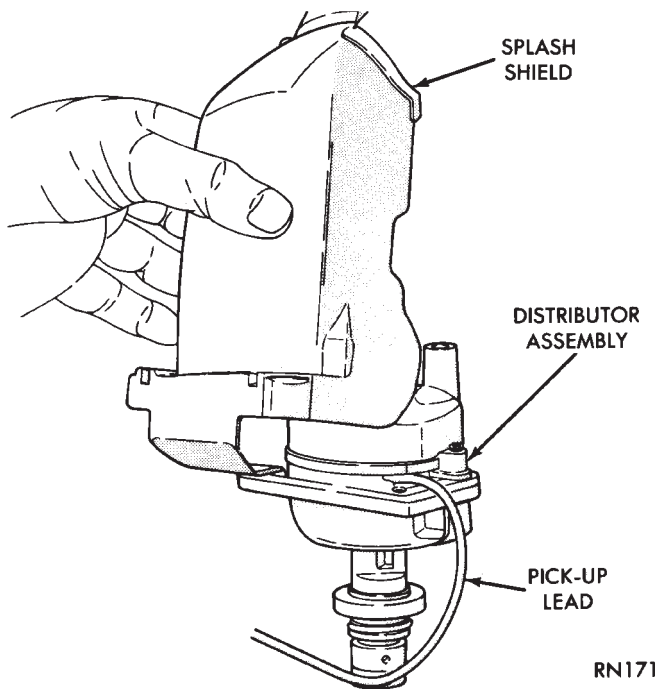
### REMOVAL

(1) Disconnect distributor pick-up connector from wiring harness connector (Fig. 11).

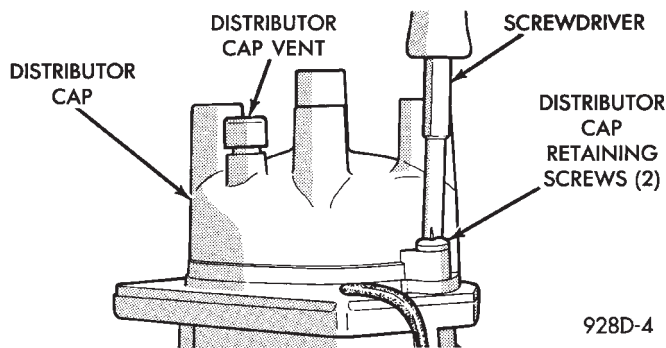


**Fig. 11 Distributor Pickup Connector—2.5L Engine**

- (2) Remove splash shield retaining screws (Fig. 12).
- (3) Remove splash shield (Fig. 12).
- (4) Loosen distributor cap retaining screws (Fig. 13).
- (5) Lift cap off of distributor (Fig. 14).



**Fig. 12 Splash Shield—2.5L Engine**



**Fig. 13 Distributor Cap Retaining Screws—2.5L Engine**

(6) Rotate engine crankshaft until the distributor rotor is pointing toward the cylinder block. Use this as reference when reinstalling distributor.

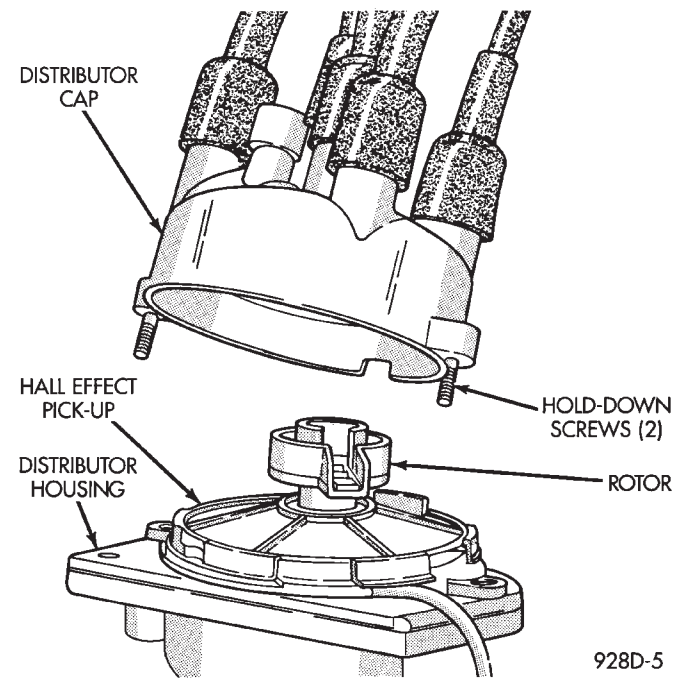
(7) Remove distributor hold-down screw (Fig. 9).

(8) Carefully lift the distributor from the engine.

#### INSTALLATION

(1) Position distributor in engine. Make certain that the O-ring is properly seated on distributor. If O-ring is cracked or nicked, replace it with new one.

(2) Carefully engage distributor drive with auxiliary shaft drive. When distributor is installed properly, rotor will be pointing toward cylinder block. **If engine has been cranked while distributor is removed, it will be necessary to establish proper relationship between the distributor shaft and Number 1 piston position as follows:**



**Fig. 14 Distributor Cap—2.5L Engine**

(a) Rotate the crankshaft until number one piston is at top of compression stroke. Pointer on clutch housing should be in line with the **O(TDC)** mark on flywheel.

(b) Rotate rotor to a position just ahead of the number one distributor cap terminal.

(c) Lower the distributor into the opening, engaging distributor drive with drive on auxiliary shaft. With distributor fully seated on engine, rotor should be under the cap number 1 tower.

(3) Install the distributor cap. Ensure all high tension wires snap firmly in the cap towers.

(4) Install hold-down arm screw and finger tighten.

(5) Install splash shield.

(6) Connect distributor pick-up connector lead wire at wiring harness connector.

(7) Set ignition timing to specification. Refer to Ignition Timing.

#### DISTRIBUTOR PICK-UP—2.5L ENGINE

##### REMOVAL

(1) Remove splash shield and cap. Refer to Distributor Removal.

(2) Remove rotor from shaft (Fig. 15).

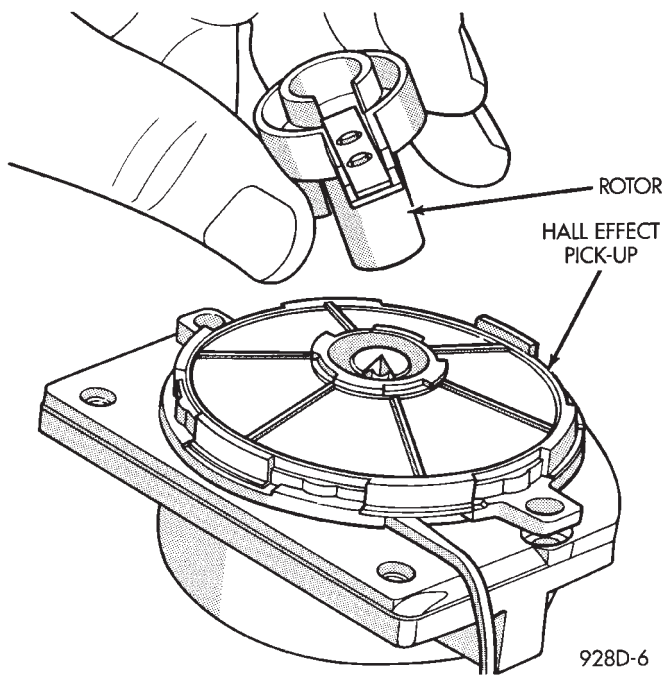
(3) Remove **Hall effect pick-up assembly** (Fig. 16).

##### INSTALLATION

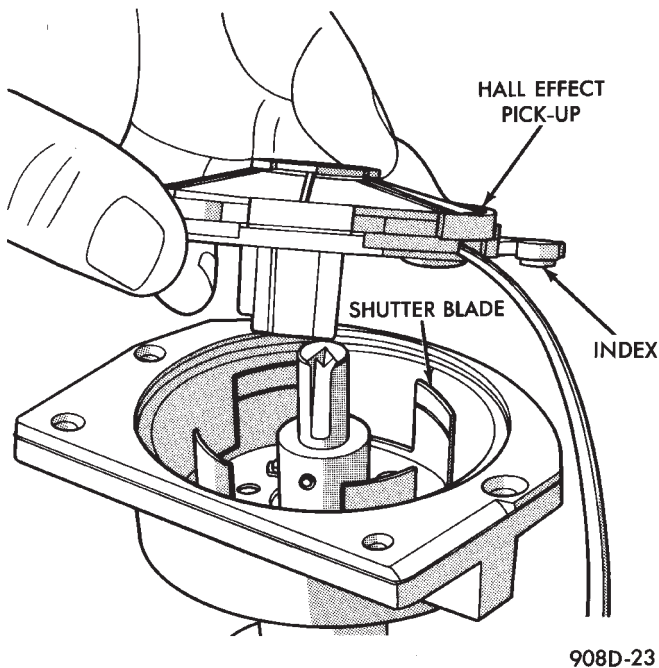
(1) Place pick-up assembly into distributor housing (Fig. 16).

**The distributor pick-up wires may be damaged if not properly reinstalled.**

(2) Install rotor (Fig. 15).



**Fig. 15 Ignition Rotor—2.5L Engine**



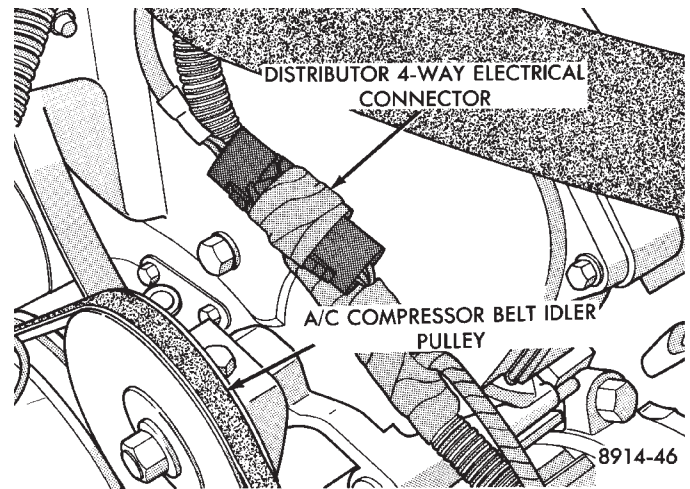
**Fig. 16 Hall Effect Pickup Assembly—2.5L Engine**

(3) Install cap and splash shield. Refer to Distributor Installation.

## DISTRIBUTOR SERVICE—3.0L ENGINE

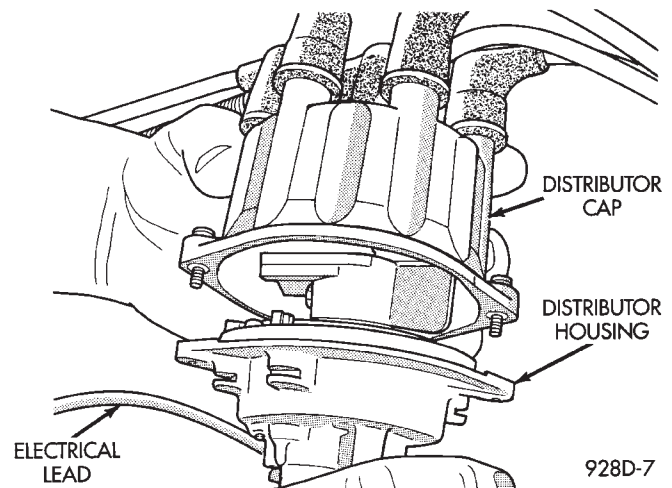
### REMOVAL

- (1) Disconnect distributor connector from wiring harness connector (Fig. 17).
- (2) Loosen distributor cap retaining screws.
- (3) Lift cap off distributor (Fig. 18).



**Fig. 17 Distributor Electrical Connector—3.0L Engine**

(4) Rotate engine crankshaft until the distributor rotor points the intake manifold plenum. Scribe a mark on the plenum in line with the rotor. The scribe line indicates where to position the rotor when reinstalling the distributor.



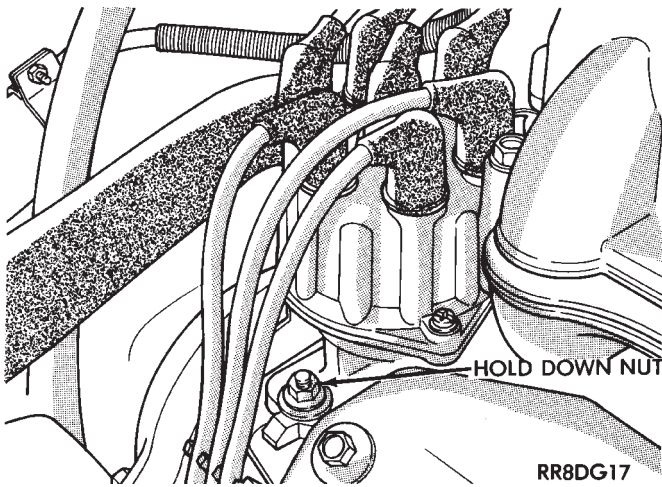
**Fig. 18 Distributor Cap—3.0L Engine**

- (5) Remove distributor hold down nut (Fig. 19).
- (6) Carefully lift the distributor from the engine.

### INSTALLATION

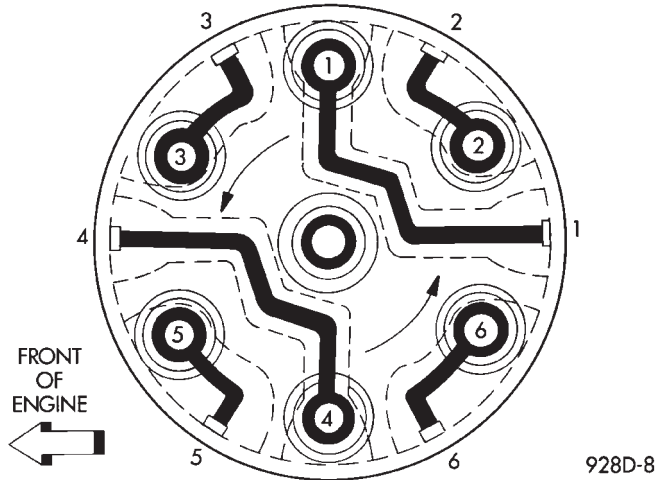
(1) Position distributor in engine. Make certain that the O-ring is properly seated on distributor. If O-ring is cracked or nicked replace with new one.

(2) Carefully engage distributor drive with gear on camshaft. When the distributor is installed properly, the rotor will be in line with previously scribe line on air intake plenum. **If engine was cranked while distributor was removed, it will be necessary to establish proper relationship between the distributor shaft and Number 1 piston position as follows:**



**Fig. 19 Distributor Hold-Down—3.0L Engine**

- (a) Rotate the crankshaft until number one piston is at top of compression stroke.
- (b) Rotate rotor to number one rotor terminal (Fig. 20).
- (c) Lower the distributor into the opening, engaging distributor drive with drive on camshaft. With distributor fully seated on engine, rotor should be under the number 1 terminal (Fig. 20).



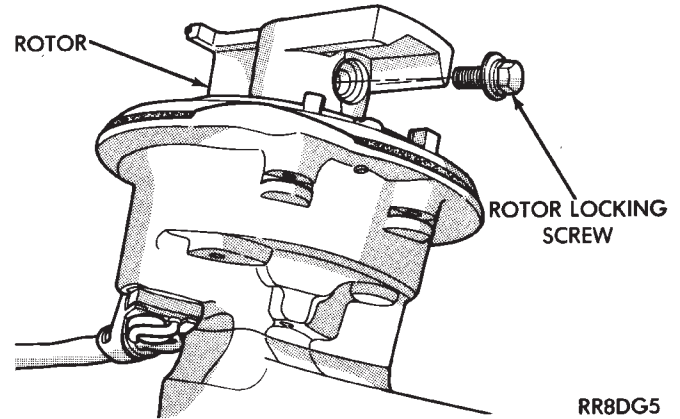
**Fig. 20 Distributor Cap Terminal Routing, View from Top of Cap—3.0L Engine**

- (3) Install the distributor cap (Fig. 18). Ensure sure all high tension wires are firmly in the cap towers.
- (4) Install hold-down nut and finger tighten (Fig. 19).
- (5) Connect distributor electrical connector to wiring harness connector (Fig. 17).
- (6) Set ignition timing to specification. Refer to Ignition Timing in this section.

**DISASSEMBLY**

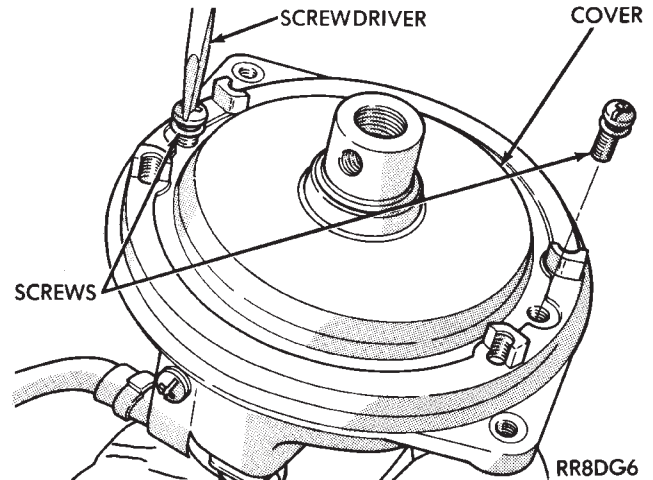
- (1) Remove distributor cap mounting screws (Fig. 18).
- (2) Remove distributor cap and inspect for flashover, cracked carbon button, cracked cap, or burned terminals. If any of these conditions exist, replace cap.

- (3) Remove rotor screw (Fig. 21). Inspect rotor for cracks or burned electrode. If any of these conditions exist, replace rotor.



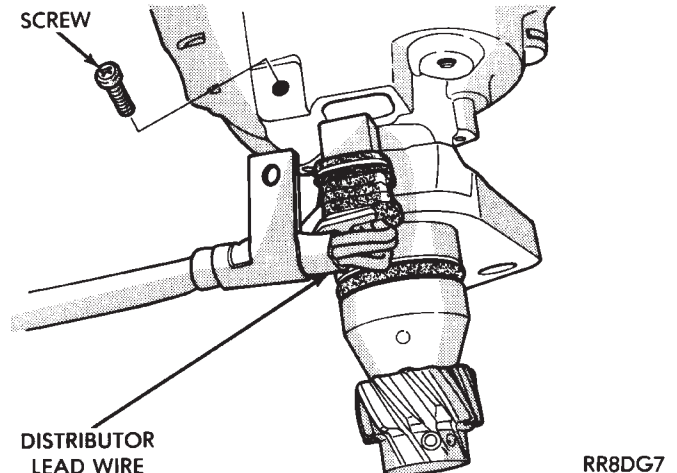
**Fig. 21 Rotor Screw**

- (4) Remove protective cover from distributor housing (Fig. 22).



**Fig. 22 Protective Cover**

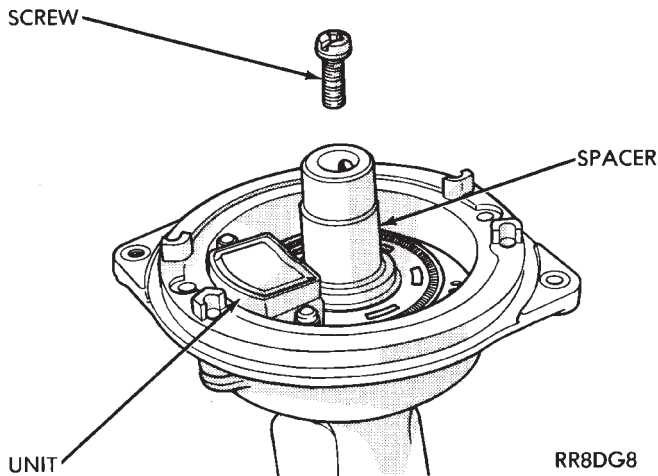
- (5) Remove lead wire clamp screw and remove lead wire (Fig. 23).



**Fig. 23 Lead Wire Clamp**

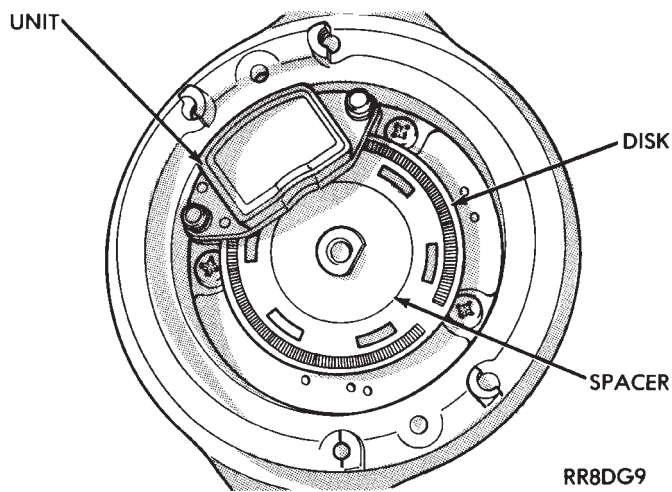


(6) Remove disk assembly screw (Fig. 24).

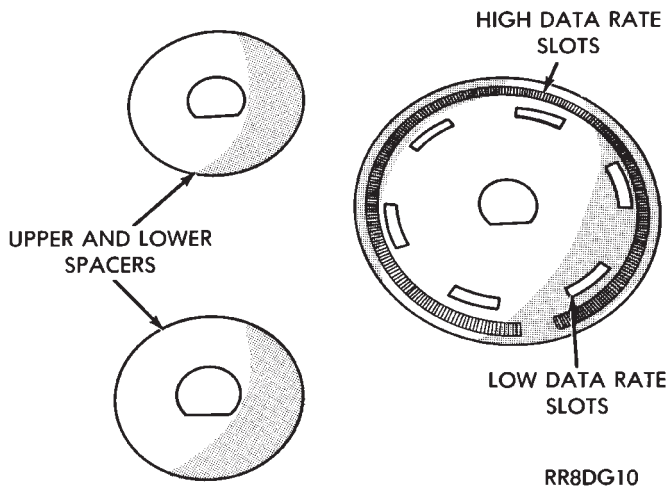


**Fig. 24 Disk Assembly Screw**

(7) Remove disk spacers and disk (Fig. 25). Disk and spacers are keyed. Check disk for warpage, cracks or damaged slots (Fig. 26).

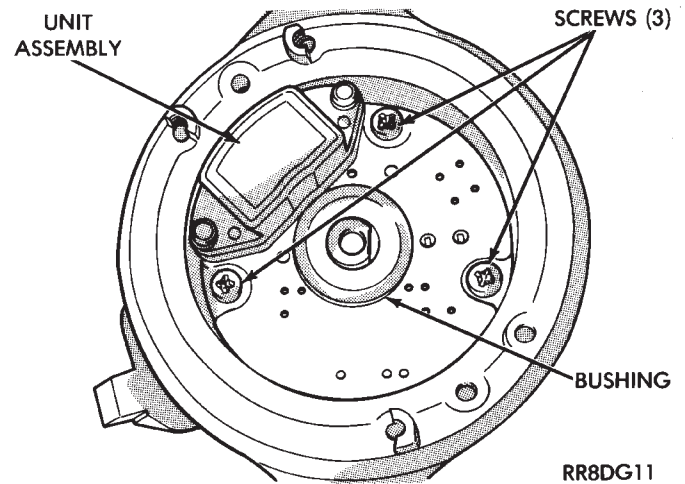


**Fig. 25 Disk and Spacers Installed**



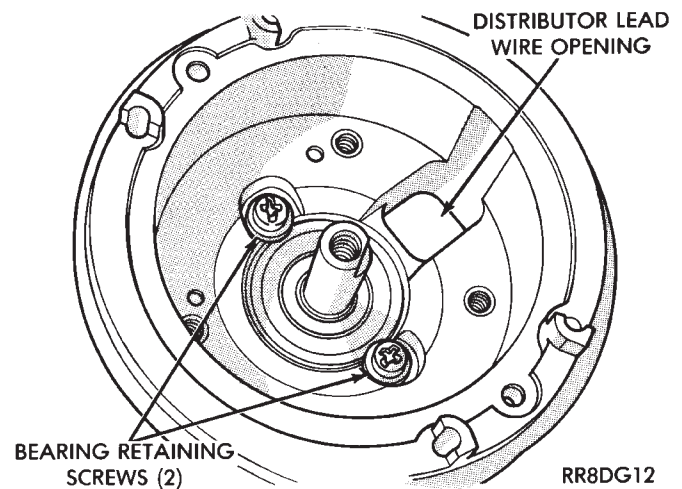
**Fig. 26 Disk and Spacers**

(8) Remove bushing and photo optic sensing unit fasteners. Remove unit from distributor housing (Fig. 27).



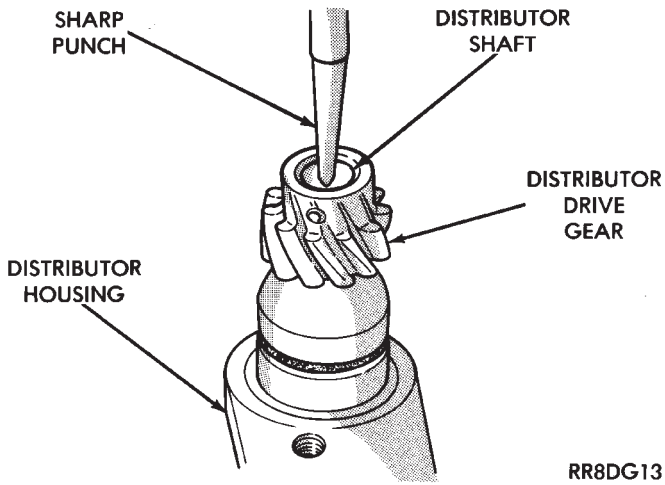
**Fig. 27 Photo Optic Sensing Unit Assembly and Bushing**

(9) Remove bearing retainer screws (Fig. 28).

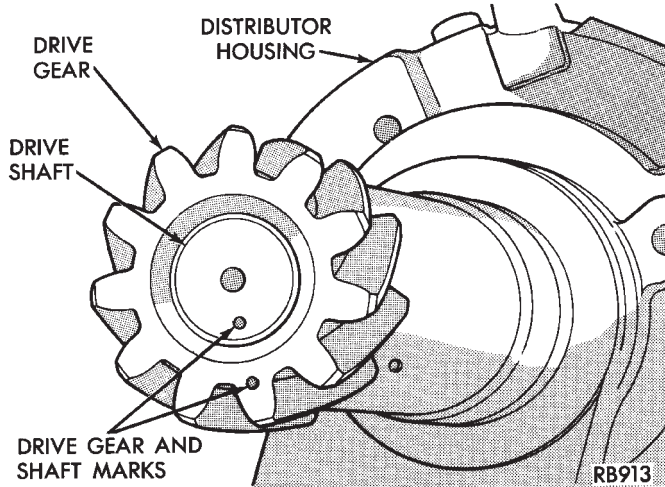


**Fig. 28 Bearing Retainer Screws**

(10) Make reassembly alignment marks on gear and shaft (Figs. 29 and 30).

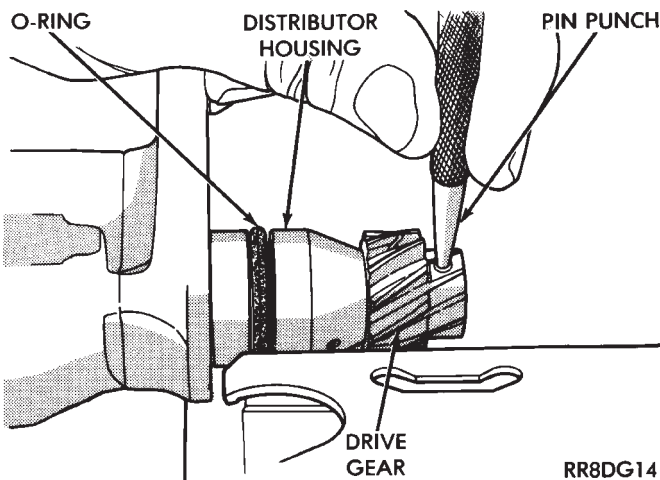


**Fig. 29 Marking Drive Gear and Shaft**



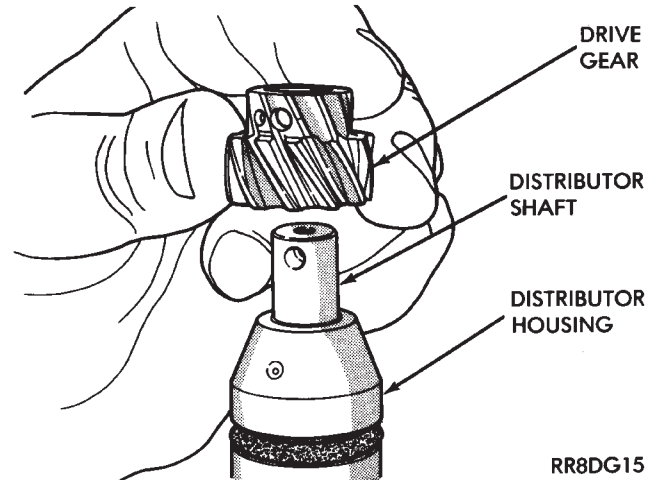
**Fig. 30 Marks on Drive Gear and Shaft**

(11) With a pin punch drive out distributor drive gear roll pin (Fig. 31).



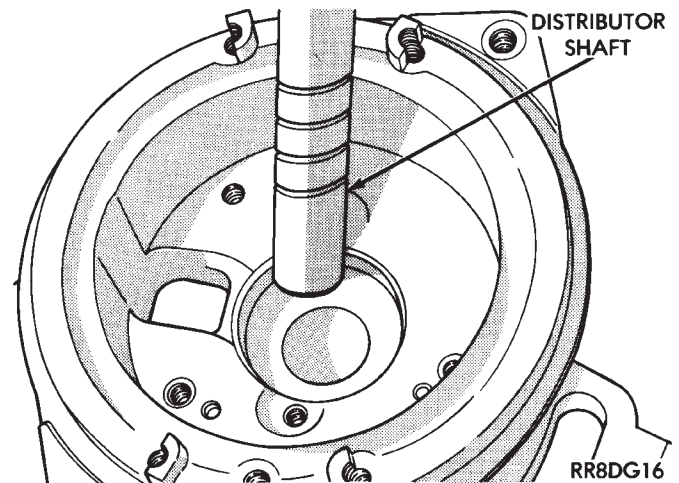
**Fig. 31 Drive Gear Roll Pin**

(12) Remove distributor drive gear (Fig. 32).



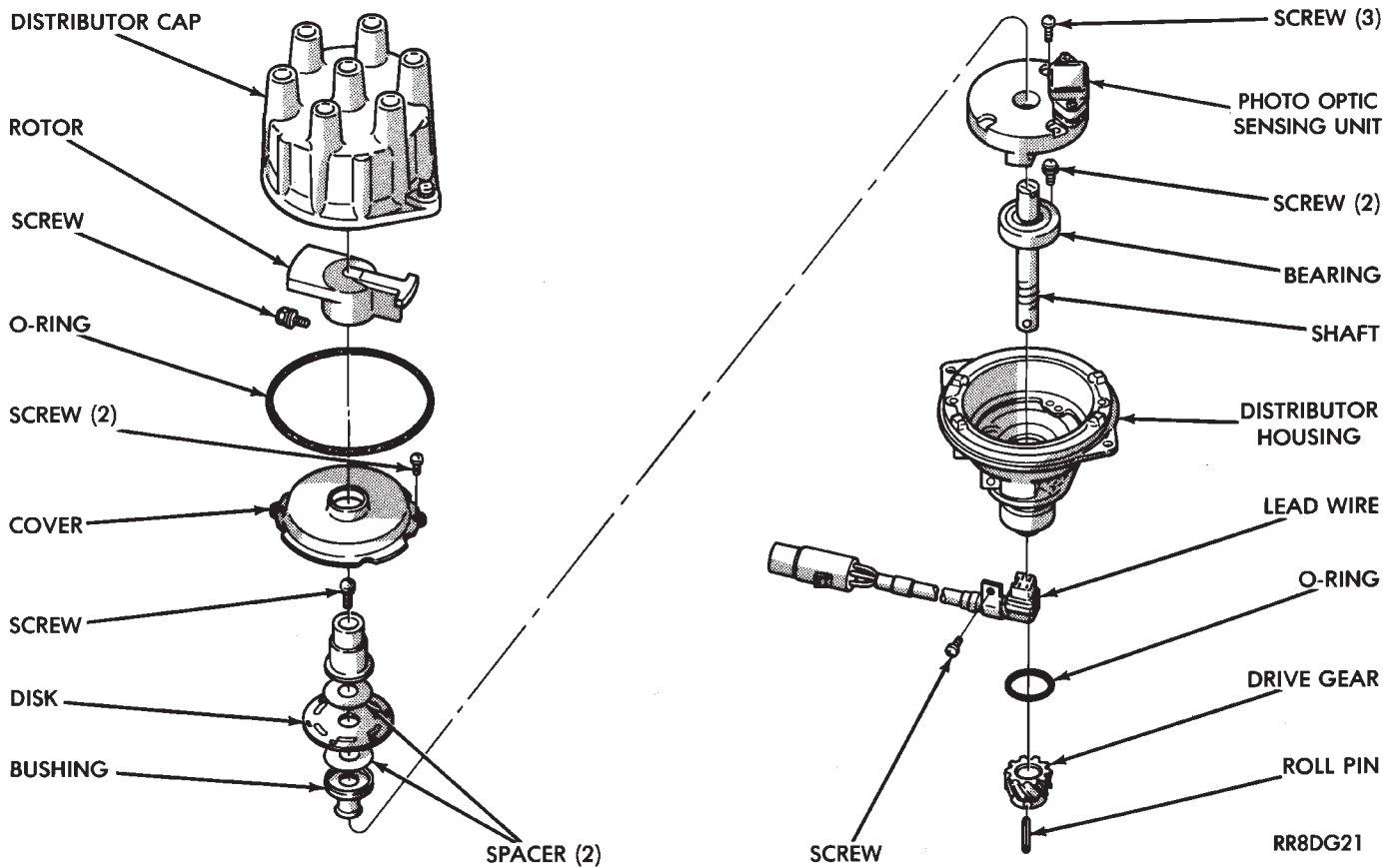
**Fig. 32 Drive Gear**

(13) Remove distributor shaft and bearing assembly (Fig. 33).



**Fig. 33 Distributor Shaft**

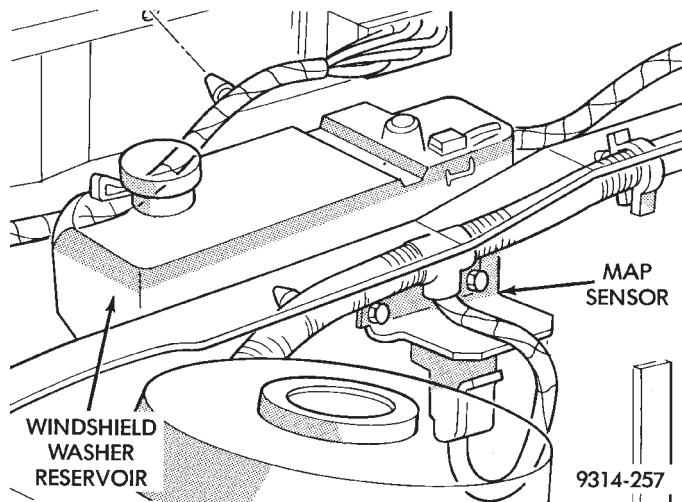
(14) To reassemble, reverse preceding procedure. Refer to Fig. 34.



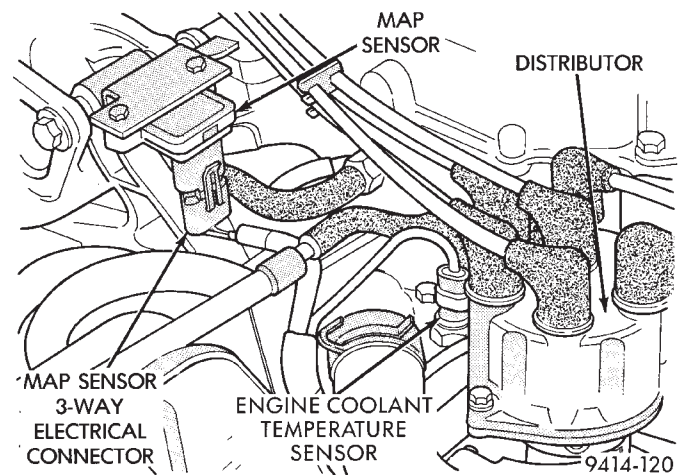
**Fig. 34 Distributor—3.0L Engine**

**MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR SERVICE—2.5L TBI AND 3.0L ENGINES**

- (1) Remove vacuum hose and remove mounting screws from sensor (Fig. 35 and Fig. 36).
- (2) Remove wiring harness and remove sensor.
- (3) Reverse the above procedure for installation.



**Fig. 35 Manifold Absolute Pressure (MAP) Sensor—2.5L TBI Engines**



**Fig. 36 Manifold Absolute Pressure (MAP) Sensor—3.0L Engine**

Check that vacuum hose is attached to vacuum source.

### 3.3L AND 3.8L DIRECT IGNITION SYSTEM—SYSTEM OPERATION

#### INDEX

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		Spark Plugs	24

#### GENERAL INFORMATION

This section describes the ignition systems for the 3.3L and 3.8L engines.

On Board Diagnostics is described in the Fuel Injection Sections of Group 14.

Group 0, Lubrication and Maintenance, contains general maintenance information for ignition related items. The Owner's Manual also contains maintenance information.

**Both the 3.3L and 3.8L engines use a fixed ignition timing system. Basic ignition timing is not adjustable. All spark advance is determined by the powertrain control module (PCM).**

The distributorless ignition system used on 3.3L and 3.8L engines is referred to as the Direct Ignition System. The system's three main components are the coil pack, crankshaft position sensor, and camshaft position sensor. The crankshaft position sensor and camshaft position sensor are hall effect devices.

#### FIRING ORDER

The firing order of 3.3L and 3.8L engines direct ignition system is 1-2-3-4-5-6 (Fig. 1).

#### POWERTRAIN CONTROL MODULE

The ignition system is regulated by the powertrain control module (Fig. 2). The controller supplies battery voltage to the ignition coil through the Auto Shutdown (ASD) Relay. The controller also controls ground circuit for the ignition coil. By switching the ground path for the coil on and off, the PCM adjusts ignition timing to meet changing engine operating conditions.

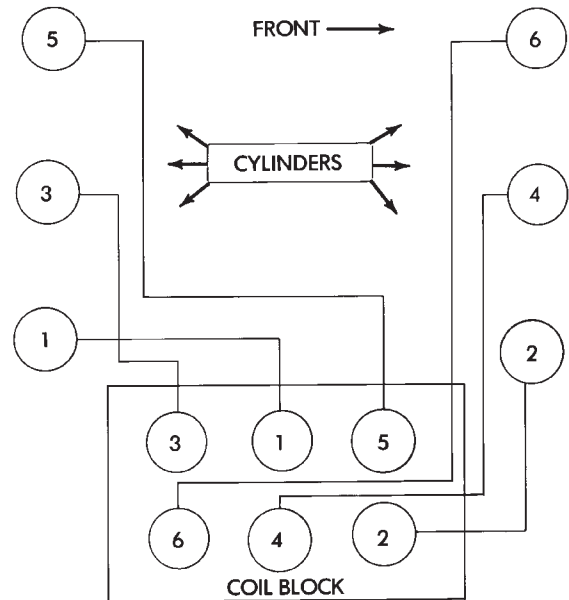
During the crank-start period the controller advances ignition timing a set amount. During engine operation, the amount of spark advance provided by the PCM is determined by three input factors:

- engine coolant temperature
- engine RPM
- available manifold vacuum

The PCM also regulates the fuel injection system. Refer to the Fuel Injection sections of Group 14.

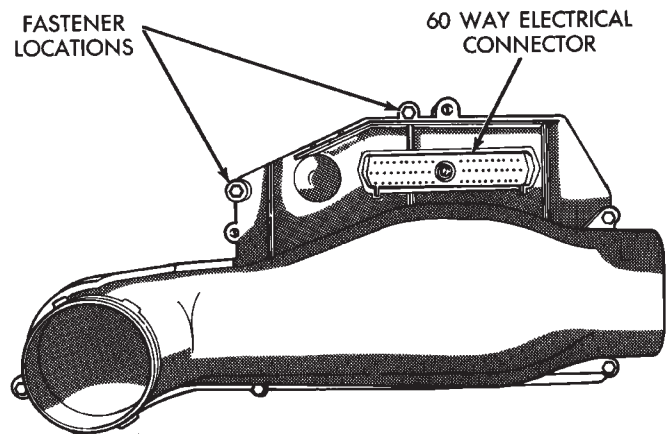
#### SPARK PLUG CABLES

Spark Plug cables are sometimes referred to as secondary ignition wires. The wires transfer electrical



918D-2

**Fig. 1 Spark Plug Wire Routing—3.3L Engine**



918D-48

**Fig. 2 Powertrain Control Module**

current from the ignition coil pack to individual spark plugs at each cylinder. The spark plug cables are of nonmetallic construction and have a built in resistance. The cables provide suppression of radio frequency emissions from the ignition system.

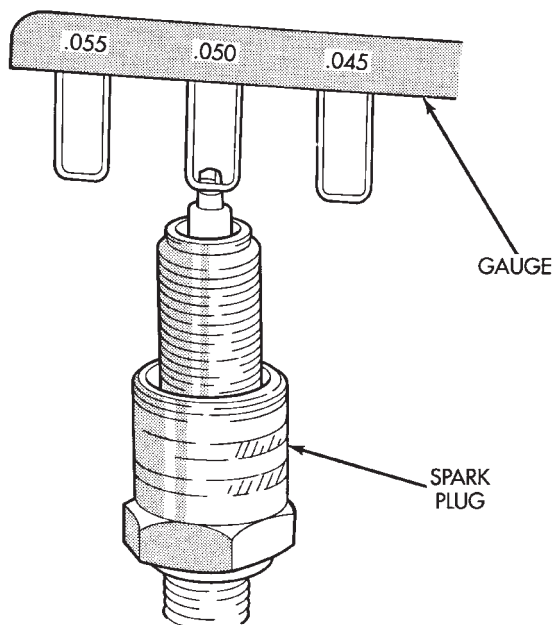
Check the spark plug cable connections for good contact at the coil and distributor cap towers and at the spark plugs. Terminals should be fully seated. The nipples and spark plug covers should be in good condition. Nipples should fit tightly on the coil and spark plug covers should fit tight around spark plug insulators.

### SPARK PLUGS

3.3L and 3.8L engines use resistor spark plugs. They have resistance values of 6,000 to 20,000 ohms when checked with at least a 1000 volt tester.

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. An isolated plug displaying an abnormal condition indicates that a problem exists in the corresponding cylinder. Replace spark plugs at the intervals recommended in Group O.

Spark plugs that have low milage may be cleaned and reused if not otherwise defective. Refer to the Spark Plug Condition section of this group. After cleaning, file the center electrode flat with a small point file or jewelers file. Adjust the gap between the electrodes (Fig. 3) to the dimensions specified in the chart at the end of this section.



928D-11

**Fig. 3 Setting Spark Plug Electrode Gap—Typical**

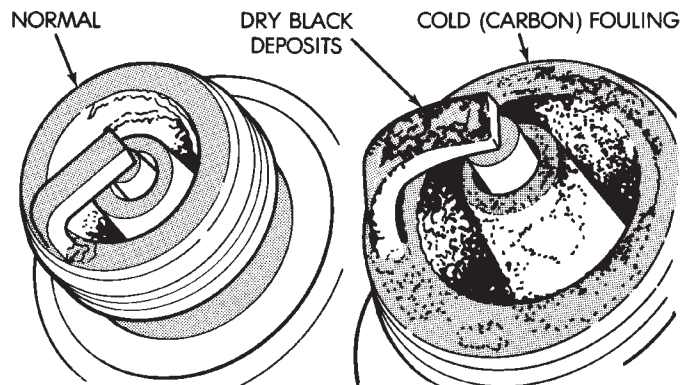
Always tighten spark plugs to the specified torque. Over tightening can cause distortion resulting in a

change in the spark plug gap. Tighten 3.3L engine spark plugs to 28 N·m (20 ft. lbs.) torque.

### SPARK PLUG CONDITION

#### NORMAL OPERATING CONDITIONS

The few deposits present will be probably light tan or slightly gray in color with most grades of commercial gasoline (Fig. 4). There will not be evidence of electrode burning. Gap growth will not average more than approximately 0.025 mm (.001 in) per 1600 km (1000 miles) of operation. Spark plugs that have normal wear can usually be cleaned, have the electrodes filed and regapped, and then reinstalled.



J908D-15

**Fig. 4 Normal Operation and Cold (Carbon) Fouling**

Some fuel refiners in several areas of the United States have introduced a manganese additive (MMT) for unleaded fuel. During combustion, fuel with MMT may coat the entire tip of the spark plug with a rust colored deposit. The rust color deposits can be misdiagnosed as being caused by coolant in the combustion chamber. Spark plug performance is not affected by MMT deposits.

#### COLD FOULING (CARBON FOULING)

Cold fouling is sometimes referred to as carbon fouling because the deposits that cause cold fouling are basically carbon (Fig. 4). A dry, black deposit on one or two plugs in a set may be caused by sticking valves or defective spark plug cables. Cold (carbon) fouling of the entire set may be caused by a clogged air cleaner.

Cold fouling is normal after short operating periods. The spark plugs do not reach a high enough operating temperature during short operating periods.

#### FUEL FOULING

A spark plug that is coated with excessive wet fuel is called fuel fouled. This condition is normally ob-

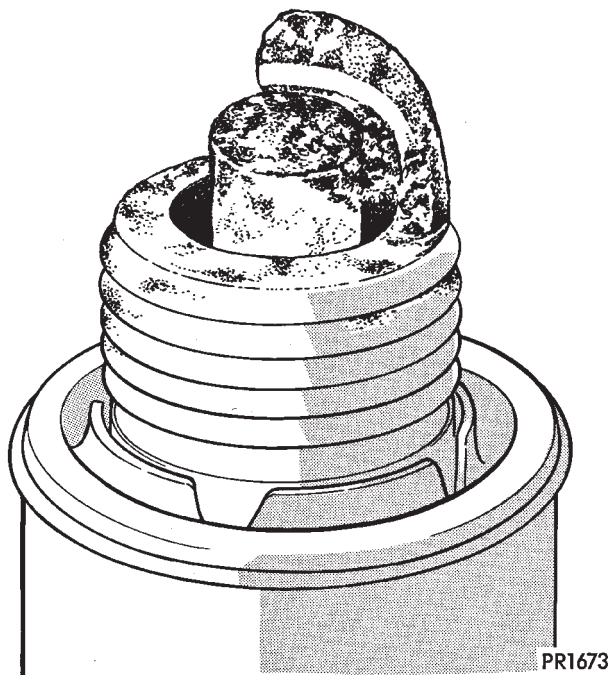
served during hard start periods. Clean fuel fouled spark plugs with compressed air and reinstall them in the engine.

**OIL FOULING**

A spark plug that is coated with excessive wet oil is oil fouled. In older engines, wet fouling can be caused by worn rings or excessive cylinder wear. Break-in fouling of new engines may occur before normal oil control is achieved. Replace oil fouled spark plugs with new ones.

**OIL OR ASH ENCRUSTED**

If one or more plugs are oil or ash encrusted, evaluate the engine for the cause of oil entering the combustion chambers (Fig. 5). Sometimes fuel additives can cause ash encrustation on an entire set of spark plugs. Ash encrusted spark plugs can be cleaned and reused.



**Fig. 5 Oil or Ash Encrusted**

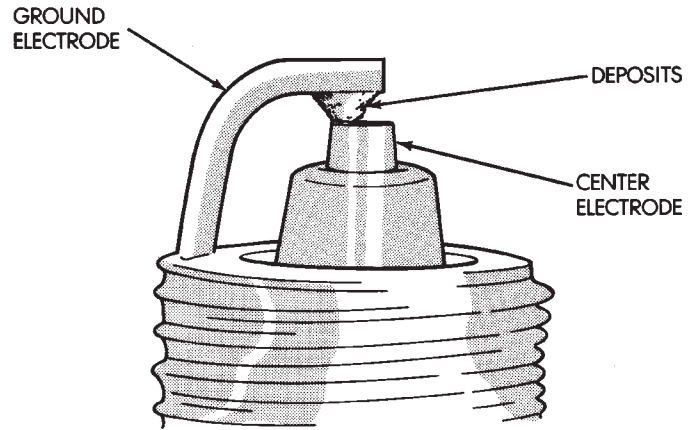
**HIGH SPEED MISS**

When replacing spark plugs because of a high speed miss condition; **wide open throttle operation should be avoided for approximately 80 km (50 miles) after installation of new plugs.** This will allow deposit shifting in the combustion chamber to take place gradually and avoid plug destroying splash fouling shortly after the plug change.

**ELECTRODE GAP BRIDGING**

Loose deposits in the combustion chamber can cause electrode gap bridging. The deposits accumulate on the spark plugs during continuous stop-and-go driving. When the engine is suddenly subjected to a high torque load, the deposits partially

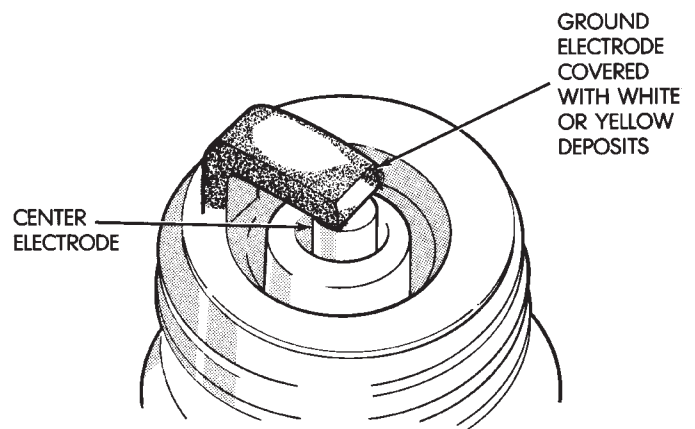
liquefy and bridge the gap between the electrodes (Fig. 6). This short circuits the electrodes. Spark plugs with electrode gap bridging can be cleaned and reused.



**Fig. 6 Electrode Gap Bridging**

**SCAVENGER DEPOSITS**

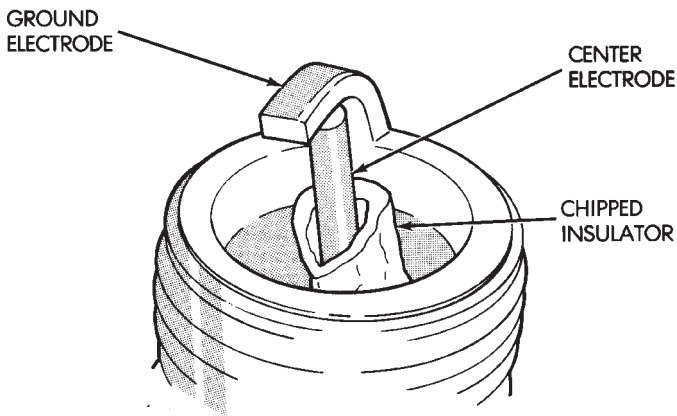
Fuel scavenger deposits may be either white or yellow (Fig. 7). They may appear to be harmful, but are a normal condition caused by chemical additives in certain fuels. These additives are designed to change the chemical nature of deposits and decrease spark plug misfire tendencies. Notice that accumulation 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, cleaned and reused.



**Fig. 7 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 also can separate the insulator from the center electrode (Fig. 8). Spark plugs with chipped electrode insulators must be replaced.

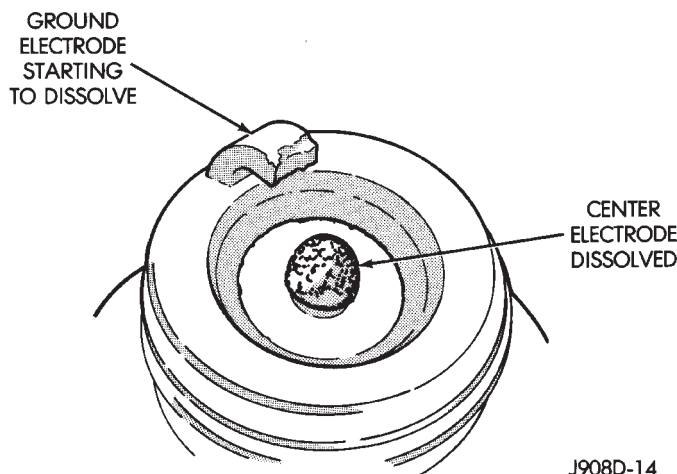


J908D-13

**Fig. 8 Chipped Electrode Insulator**

**PREIGNITION DAMAGE**

Excessive combustion chamber temperature can cause preignition damage. First, the center electrode dissolves and the ground electrode dissolves somewhat later (Fig. 9). Insulators appear relatively deposit free. Determine if the spark plug has the correct heat range rating for the engine, 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. Spark plugs are designed to operate within specific temperature ranges depending upon the thickness and length of the center electrode and porcelain insulator.)



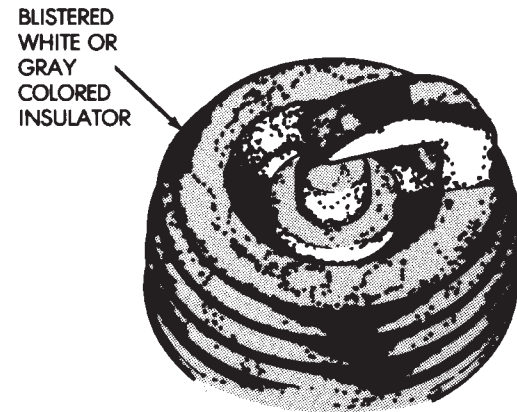
J908D-14

**Fig. 9 Preignition Damage**

**SPARK PLUG OVERHEATING**

Overheating is indicated by a white or gray center electrode insulator that also appears blistered (Fig. 10). The increase in electrode gap will be considerably in excess of 0.001 in per 1000 miles of operation. This suggests that a plug with a cooler heat range rating should be used. Over advanced ignition tim-

ing, detonation and cooling system malfunctions also can cause spark plug overheating.



J908D-16

**Fig. 10 Spark Plug Overheating**

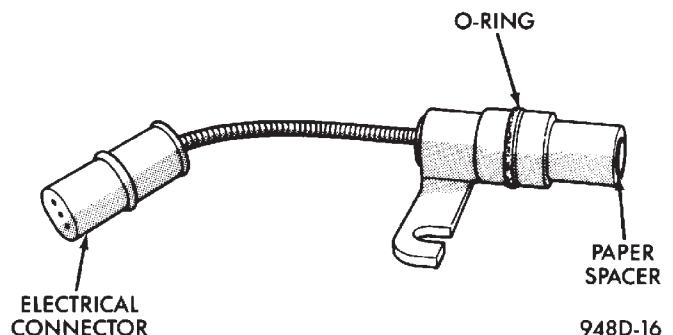
**SPARK PLUG SERVICE**

When replacing the spark plug and coil cables, route the cables correctly and secure them in the appropriate retainers. Failure to route the cables properly can cause the radio to reproduce ignition noise, cross ignition of the spark plugs or short circuit the cables to ground.

**Never Wire Brush Spark Plugs.** The spark plug insulator tip is harder than the bristles of wire brushes. Bristles of wire brushes can leave a conductive, metallic film on the insulator which could lead to conductive deposits. Conductive deposits can cause spark plug failure and engine misfire. Use a jewelers file to remove deposits from the electrode gap. Use a spark plug cleaning machine to clean spark plugs.

**CAMSHAFT POSITION SENSOR**

The camshaft position sensor provides cylinder identification to the powertrain control module (PCM) (Fig. 11). The sensor generates pulses as groups of notches on the camshaft sprocket pass underneath it (Fig. 12). The PCM keeps track of crankshaft rotation and identifies each cylinder by the pulses generated by the notches on the camshaft sprocket. Four crankshaft pulses follow each group of camshaft pulses.



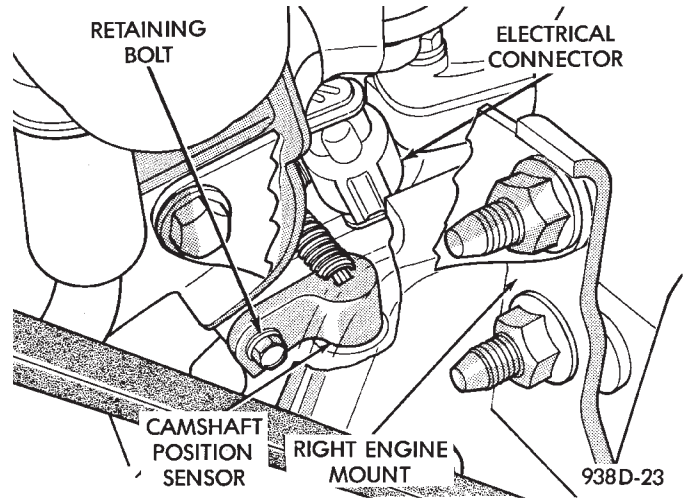
948D-16

**Fig. 11 Camshaft Position Sensor**

When the PCM receives two cam pulses followed by the long flat spot on the camshaft sprocket, it knows that the crankshaft timing marks for cylinder one are next (on driveplate). When the PCM receives one camshaft pulse after the long flat spot on the sprocket, cylinder number two crankshaft timing marks are next. After 3 camshaft pulses, the PCM knows cylinder four crankshaft timing marks follow. One camshaft pulse after the three pulses indicates cylinder five. The two camshaft pulses after cylinder 5 signals cylinder six (Fig. 12). The PCM can synchronize on cylinders 1 or 4.

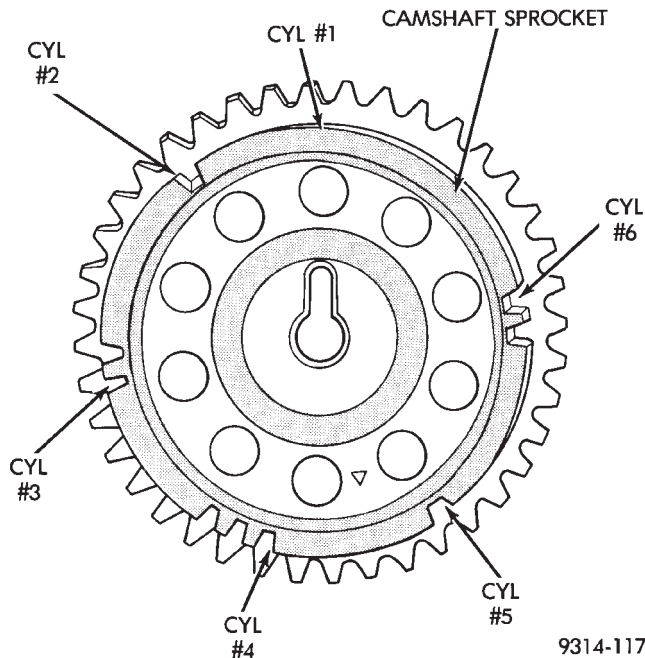
When metal aligns with the sensor, voltage goes low (less than 0.3 volts). When a notch aligns with the sensor, voltage spikes high (5.0 volts). As a group of notches pass under the sensor, the voltage switches from low (metal) to high (notch) then back to low. The number of notches determine the amount of pulses. If available, an oscilloscope can display the square wave patterns of each timing event.

Top dead center (TDC) does not occur when notches on the camshaft sprocket pass below the cylinder. TDC occurs after the camshaft pulse (or pulses) and after the 4 crankshaft pulses associated with the particular cylinder. The arrows and cylinder call outs on Figure 12 represent which cylinder the flat spot and notches identify, they do not indicate TDC position.



**Fig. 13 Camshaft Sensor Location**

for a total of 12 slots (Fig. 15). Basic timing is set by the position of the last slot in each group. Once the powertrain control module (PCM) senses the last slot, it determines crankshaft position (which piston will next be at TDC) from the camshaft position sensor input. The 4 pulses generated by the crankshaft position sensor represent the 69°, 49°, 29°, and 9° BTDC marks. It may take the PCM one engine revolution to determine crankshaft position.

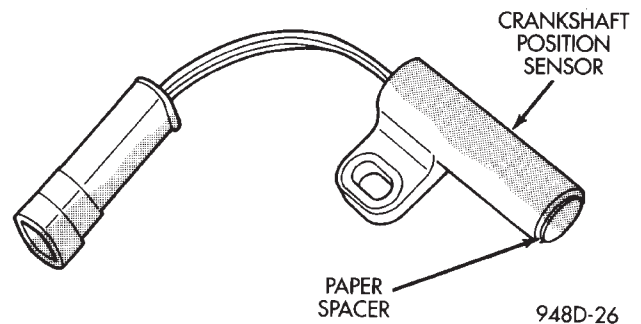


**Fig. 12 Camshaft Sprocket—3.3L and 3.8L Engines**

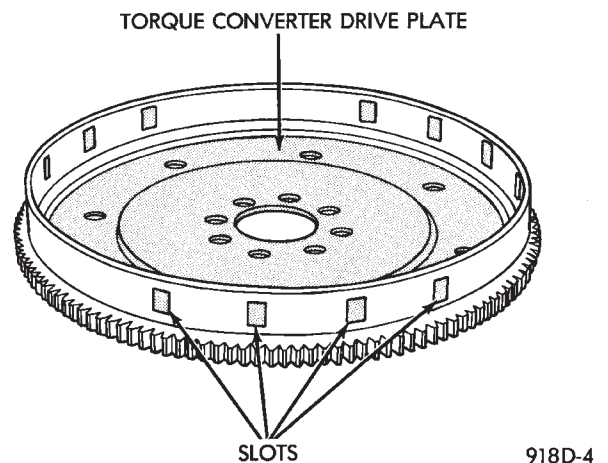
The camshaft position sensor is mounted in the front of the timing case cover (Fig. 13).

**CRANKSHAFT POSITION SENSOR**

The crankshaft position sensor detects slots cut into the transmission driveplate extension (Fig. 14). There are 3 sets of slots. Each set contains 4 slots,



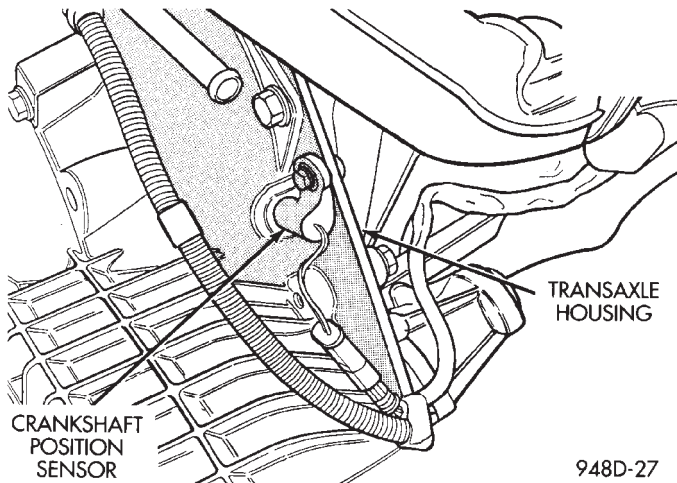
**Fig. 14 Crankshaft Position Sensor**



**Fig. 15 Timing Slots**

The PCM uses crankshaft position reference to determine injector sequence and ignition timing. Once the PCM determines crankshaft position, it begins energizing the injectors in sequence.

The crankshaft sensor is located on the passenger side of the transmission housing, above the differential housing (Fig. 16). The bottom of the sensor is positioned next to the drive plate.



**Fig. 16 Crankshaft Position Sensor Location**

#### IGNITION COIL

**WARNING: THE DIRECT IGNITION SYSTEM GENERATES APPROXIMATELY 40,000 VOLTS. PERSONAL INJURY COULD RESULT FROM CONTACT WITH THIS SYSTEM.**

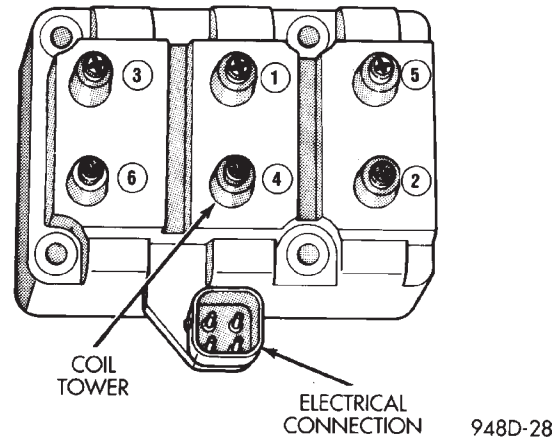
The coil assembly consists of 3 coils independent molded together (Fig. 17). The coil assembly is mounted on the intake manifold. High voltage ignition cables route to each cylinder from the coil. The coil fires two spark plugs every power stroke. One plug is the cylinder under compression, the other cylinder fires on the exhaust stroke. The powertrain control module (PCM) determines which of the coils to charge and fire at the correct time.

Coils one fires cylinders 1 and 4, coil two fires cylinders 2 and 5, coil three fires cylinders three and six.

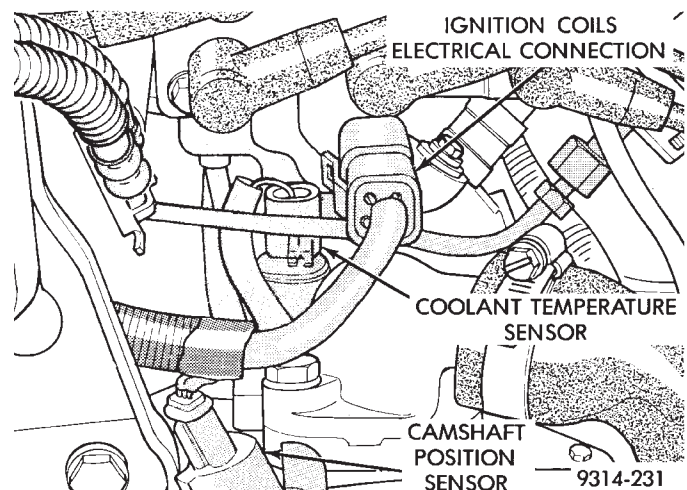
#### ENGINE COOLANT TEMPERATURE SENSOR

The engine coolant temperature (ECT) sensor is located next to the thermostat housing (Fig. 18). The sensor provides an input voltage to the powertrain control module (PCM). The sensor is a variable resistance (thermistor) with a range of  $-40^{\circ}\text{F}$  to  $265^{\circ}\text{F}$ . As coolant temperature varies, the sensors resistance changes, resulting in a different input voltage to the PCM.

The PCM contains different spark advance schedules for cold and warm engine operation. The schedules reduce engine emission and improve driveability.



**Fig. 17 Coil Pack—3.3L Engine**



**Fig. 18 Engine Coolant Temperature Sensor**

When the engine is cold, the PCM will demand slightly richer air-fuel mixtures and higher idle speeds until normal operating temperatures are reached.

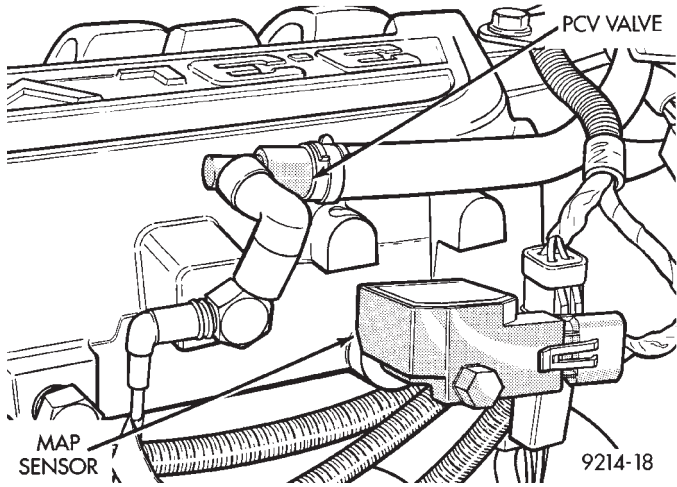
The engine coolant sensor input is also used for cooling fan control.

#### MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The MAP sensor reacts to absolute pressure in the intake manifold and provides an input voltage to the powertrain control module (PCM). As engine load changes, manifold pressure varies. The changes in engine load cause the MAP sensors resistance to change. The change in MAP sensor resistance results in a different input voltage to the PCM.

The input voltage level supplies the PCM with information relating to ambient barometric pressure during engine start-up (cranking) and engine load while its operating. The PCM uses this input along with inputs from other sensors to adjust air-fuel mixture.

The MAP sensor (Fig. 19) is mounted to the side of the intake manifold, below the positive crankcase ventilation (PCV) valve. The sensor is connected to the PCM electrically.



**Fig. 19 Map Sensor**

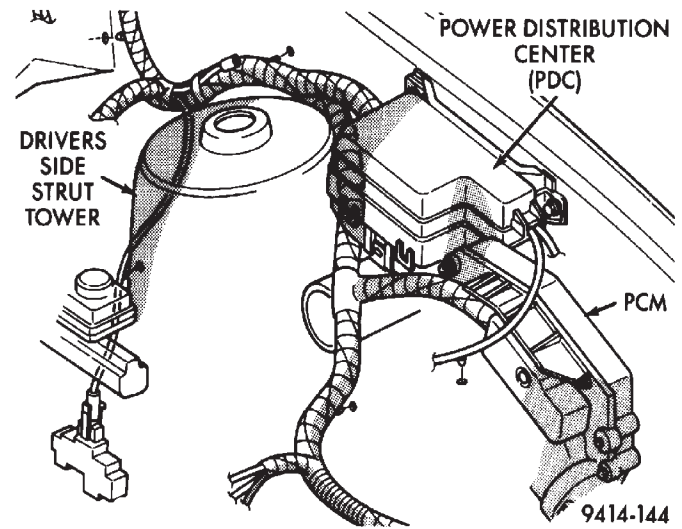
**AUTOMATIC SHUT DOWN (ASD) RELAY AND FUEL PUMP RELAY**

The powertrain control module (PCM) operates the automatic shut down (ASD) relay and fuel pump relay through one ground path. The PCM operates the relays by switching the ground path on and off. Both relays turn on and off at the same time.

The ASD relay connects battery voltage to the fuel injector and ignition coil. The fuel pump relay connects battery voltage to the fuel pump and oxygen sensor heating element.

The PCM turns the ground path off when the ignition switch is in the Off position. Both relays are off. When the ignition switch is in the On or Crank position, the PCM monitors the distributor pick-up signal to determine engine speed and ignition timing (coil dwell). If the PCM does not receive a distributor signal when the ignition switch is in the Run position, it will de-energize both relays. When the relays are de-energized, battery voltage is not supplied to the fuel injector, ignition coil, fuel pump and oxygen sensor heating element.

The ASD and fuel pump relays are located in the power distribution center (PDC). The PDC is located in the engine compartment above the PCM (Fig. 20). A label affixed to the underside of the PDC cover identifies the relays and fuses in the PDC.



**Fig. 20 Power Distribution Center**

3.3L AND 3.8L DIRECT IGNITION SYSTEM—DIAGNOSTIC PROCEDURES

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Crankshaft Position Sensor and Camshaft Position Sensor Tests	32	Manifold Absolute Pressure (MAP) Sensor Test	32
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TESTING FOR SPARK AT COIL

**WARNING: THE 3.3L AND 3.8L DIRECT IGNITION SYSTEMS GENERATES APPROXIMATELY 40,000 VOLTS. PERSONAL INJURY COULD RESULT FROM CONTACT WITH THIS SYSTEM.**

The coil pack contains 3 independent coils. Each coil must be checked individually.

**CAUTION: Spark plug wire damage may occur if the spark plug is moved more than 1/4 inch away from the engine ground.**

Remove the cable from number 2 spark plug. Insert a clean spark plug into the spark plug boot, and ground plug to the engine (Fig. 1).

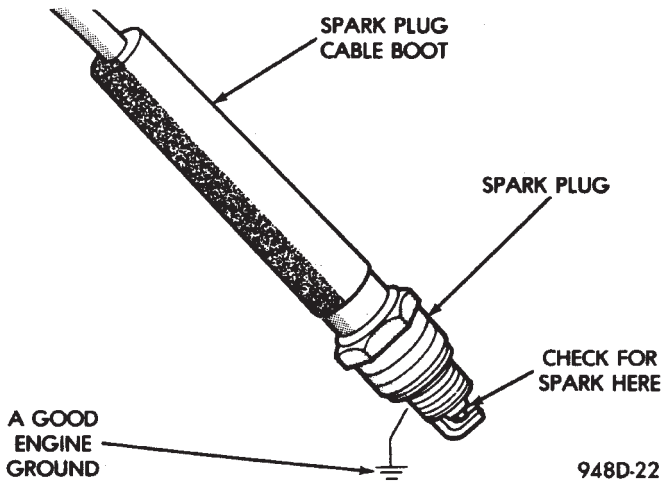


Fig. 1 Testing For Spark

Crank the engine and look for spark across the electrodes of the spark plug. Repeat the above test for the five remaining cylinders. If there is no spark during all cylinder tests, proceed to the failure to start test.

If one or more tests indicate irregular, weak, or no spark, proceed to Check Coil Test.

CHECK COIL TEST—3.3L ENGINE

Coils one fires cylinders 1 and 4, coil two fires cylinders 2 and 5, coil three fires cylinders three and six.

Each coil tower is labeled with the number of the corresponding cylinder.

(1) Remove the ignition cables and measure the resistance of the cables. Resistance must be between 3,000 to 12,000 ohms per foot of cable. Replace any cable not within tolerance.

(2) Disconnect the electrical connector from the coil pack (Fig. 2).

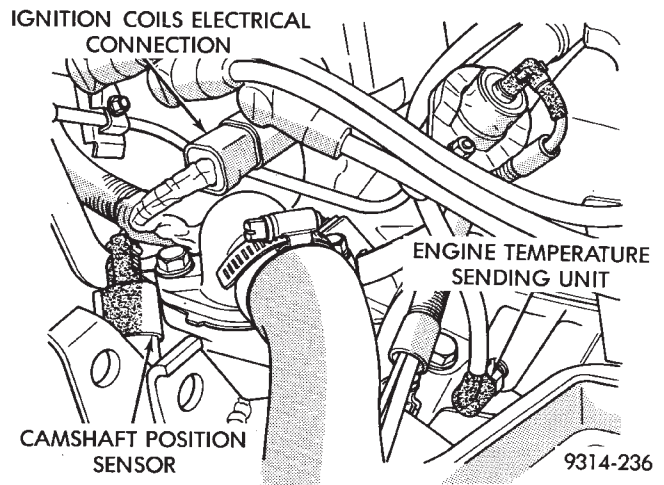


Fig. 2 Ignition Coil Electrical Connection

(3) Measure the primary resistance of each coil. At the coil, connect an ohmmeter between the B+ pin and the pin corresponding to the cylinders in question (Fig. 3). Resistance on the primary side of each coil should be 0.45 - 0.65 ohm at 21° to 27°C (70° to 80°F). Replace the coil if resistance is not within tolerance.

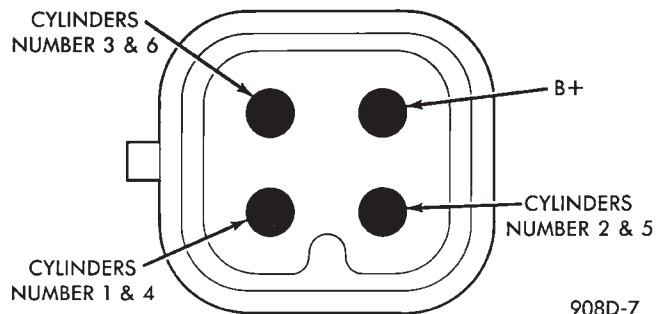
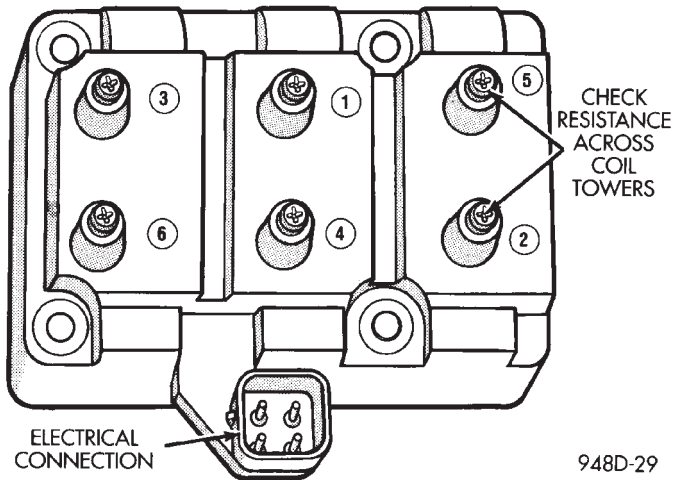


Fig. 3 Ignition Coil Terminal Identification

(4) Remove ignition cables from the secondary towers of the coil. Measure the secondary resistance of the coil between the towers of each individual coil (Fig. 4). Secondary resistance should be 7,000 to 15,800 ohms. Replace the coil if resistance is not within tolerance.



**Fig. 4 Checking Ignition Coil Secondary Resistance FAILURE TO START TEST**

This no-start test checks the camshaft position sensor and crankshaft position sensor.

The powertrain control module (PCM) supplies 8 volts to the camshaft position sensor and crankshaft position sensor through one circuit. If the 8-volt supply circuit shorts to ground, neither sensor will produce a signal (output voltage to the PCM).

When the ignition key is turned and left in the On position, the PCM automatically energizes the auto shutdown (ASD) relay. However, the controller de-energizes the relay within one second because it has not received a camshaft position sensor signal indicating engine rotation.

During cranking, the ASD relay will not energize until the PCM receives a camshaft position sensor signal. Secondly, the ASD relay remains energized only if the controller senses a crankshaft position sensor signal immediately after detecting the camshaft position sensor signal.

(1) Check battery voltage. Voltage should approximately 12.66 volts or higher to perform failure to start test.

(2) Disconnect the harness connector from the coil pack (Fig. 2).

(3) Connect a test light to the B+ (battery voltage) terminal of the coil electrical connector and ground. The wire for the B+ terminal is dark green with a black tracer.

(4) Turn the ignition key to the **ON position**. The test light should flash On and then Off. **Do not turn the Key to off position, leave it in the On position.**

(a) If the test light flashes momentarily, the

PCM grounded the auto shutdown (ASD) relay. Proceed to step 5.

(b) If the test light did not flash, the ASD relay did not energize. The cause is either the relay or one of the relay circuits. Use the DRB scan tool to test the ASD relay and circuits. Refer to the appropriate Powertrain Diagnostics Procedure Manual. Refer to the wiring diagrams section for circuit information.

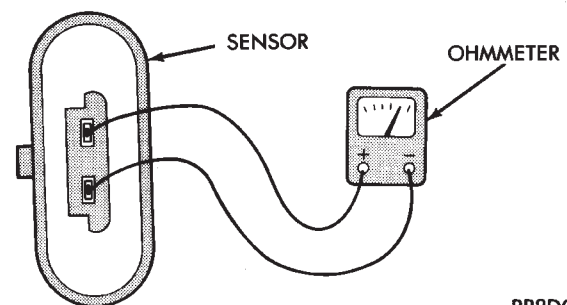
(5) Crank the engine. (If the key was placed in the off position after step 4, place the key in the On position before cranking. Wait for the test light to flash once, then crank the engine.)

(a) If the test light momentarily flashes during cranking, the PCM is not receiving a crankshaft position sensor signal. Use the DRB scan tool to test the crankshaft position sensor and sensor circuits. Refer to the appropriate Powertrain Diagnostics Procedure Manual. Refer to the wiring diagrams section for circuit information.

(b) If the test light did not flash during cranking, unplug the crankshaft position sensor connector. Turn the ignition key to the off position. Turn the key to the On position, wait for the test light to momentarily flash once, then crank the engine. If the test light momentarily flashes, the crankshaft position sensor is shorted and must be replaced. If the light did not flash, the cause of the no-start is in either the crankshaft position sensor/camshaft position sensor 8-volt supply circuit, or the camshaft position sensor output or ground circuits. Use the DRB scan tool to test the camshaft position sensor and the sensor circuits. Refer to the appropriate Powertrain Diagnostics Procedure Manual. Refer to the wiring diagrams section for circuit information.

#### ENGINE COOLANT TEMPERATURE SENSOR TEST

(1) With key off, disconnect wire connector from engine coolant temperature sensor (Fig. 5).



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**Fig. 5 Engine Coolant Temperature Sensor Test**

(2) Connect one lead of ohmmeter to one terminal of engine coolant temperature sensor.

(3) Connect the other lead of ohmmeter to remaining connector of engine coolant temperature sensor. The ohmmeter should read as follows;

- Engine/Sensor hot at normal operating temperature around 200°F should read approximately 700 to 1,000 ohms.
- Engine/Sensor at room temperature around 70°F, ohmmeter should read approximately 7,000 to 13,000 ohms.

**See On Board Diagnostics section of Group 14, or refer to the appropriate diagnostic manual for further test procedures.**

#### MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR TEST

Refer to the appropriate Powertrain Diagnostic Procedure manual.

#### CRANKSHAFT POSITION SENSOR AND CAMSHAFT POSITION SENSOR TESTS

Refer to the appropriate Powertrain Diagnostic Procedure manual.



3.3L AND 3.8L DIRECT IGNITION SYSTEMS—SERVICE PROCEDURES

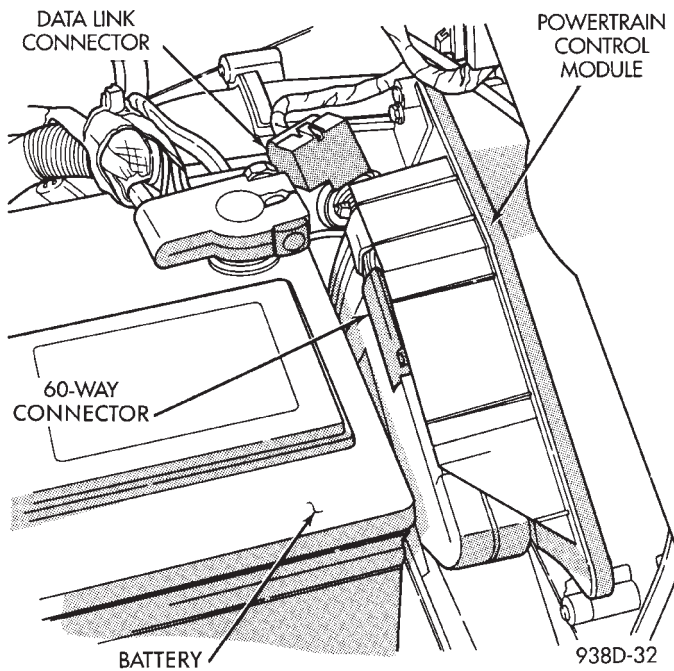
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**POWERTRAIN CONTROL MODULE**

**REMOVAL**

- (1) Remove air cleaner duct or air cleaner assembly.
- (2) Remove battery.
- (3) Remove PCM mounting screws (Fig. 1).
- (4) Remove 60-way connector from PCM. Remove controller.



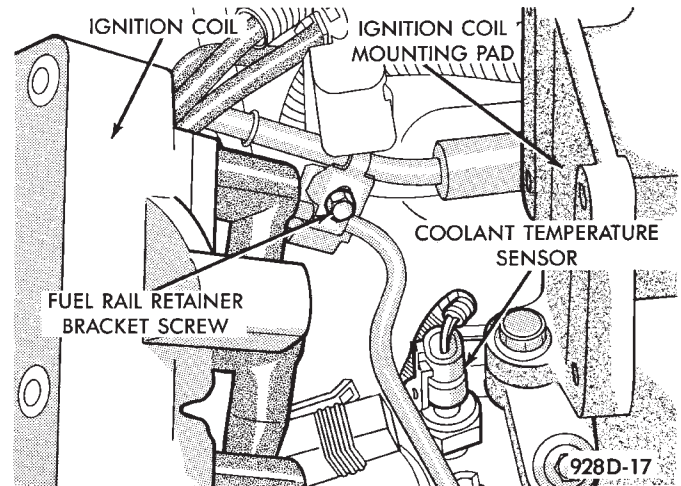
**Fig. 1 Powertrain Control Module**

**INSTALLATION**

- (1) Connect 60-Way connector to PCM (Fig. 1).
- (2) Install PCM on inside left front fender (Fig. 1). Install and tighten mounting screws.
- (3) Install the battery.
- (4) Install air cleaner duct or air cleaner assembly.

**ENGINE COOLANT TEMPERATURE SENSOR**

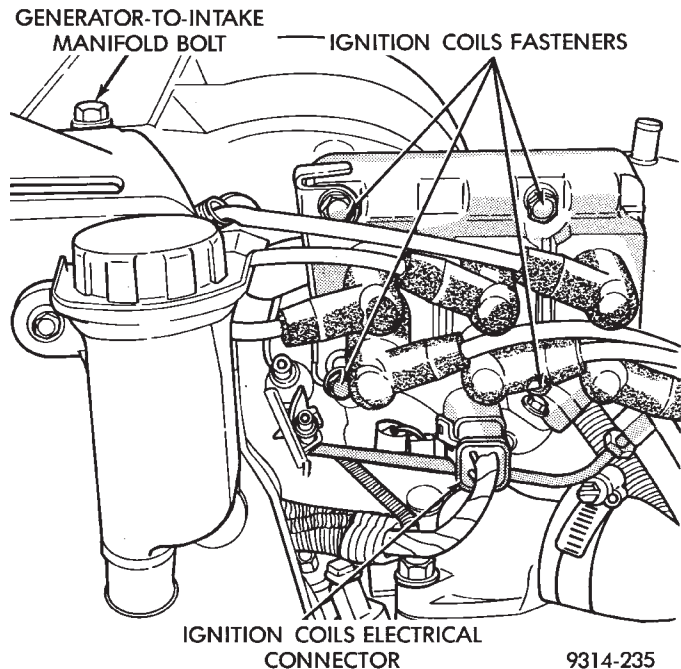
The engine coolant temperature (ECT) sensor is located below the ignition coil (Fig. 2).



**Fig. 2 Engine Coolant Temperature Sensor**

**REMOVAL**

- (1) Drain cooling system until coolant level is below sensor. Refer to Group 7, Cooling System.
- (2) Remove electrical connector from coil (Fig. 3).



**Fig. 3 Ignition Coil Removal**

- (3) Remove coil mounting screws.
- (4) Rotate coil away from engine coolant temperature sensor.
- (5) Disconnect electrical connector from engine coolant temperature sensor.
- (6) Remove sensor from engine.

#### INSTALLATION

- (1) Tighten the sensor to 7 N·m (60 in. lbs.) torque.
- (2) Connect electrical connector to sensor.
- (3) Fill cooling system. Refer to Group 7, Cooling System.
- (4) Install coil. Tighten coil mounting screws to 12 N·m (105 in. lbs.) torque.
- (5) Connect electrical connector to coil.

#### SPARK PLUG CABLE SERVICE

Clean high voltage ignition cables with a cloth moistened with a non-flammable solvent. Wipe the cables dry. Check for brittle or cracked insulation.

When testing cables for punctures and cracks with an oscilloscope and an inductive voltage probe, follow the instructions of the equipment manufacturers.

**CAUTION: Do not leave any one spark plug cable disconnected any longer than necessary during test or possible heat damage to catalytic converter will occur. Total test time must not exceed ten minutes.**

If an oscilloscope and inductive probe are not available, cables can be tested as follows:

- (1) With the engine not running, connect one end of a test probe (i.e. a piece of wire with insulated alligator clips on each end) to a good ground, other end free for probing.

**WARNING: THE DIRECT IGNITION SYSTEM GENERATES APPROXIMATELY 40,000 VOLTS. PERSONAL INJURY COULD RESULT FROM CONTACT WITH THIS SYSTEM.**

- (2) With the engine running, move test probe along entire length of all cables (approximately 0 to 1/8 inch gap). If punctures or cracks are present there will be a noticeable spark jump from the faulty area to the probe. Cracked, leaking or faulty cables should be replaced.

Use the following procedure when removing the high voltage ignition cable from the spark plug. First, remove the cable from the retaining bracket. **Then grasp the terminal as close as possible to the spark plug. Rotate the cover (boot) slightly and pull straight back. Do not use pliers and do not pull the cable at an angle.** Doing so will damage the insulation, cable terminal or the spark plug insulator. **Wipe spark plug insulator clean before re-installing cable and cover.**

Resistance cables are identified by the words **Electronic Suppression**.

Use an ohmmeter to check cables for opens, loose terminals or high resistance.

- (a) Remove cable from spark plug.
- (b) Remove cable from the coil tower.
- (c) Connect the ohmmeter between spark plug end terminal and the coil end terminal. Resistance should be within tolerance shown in the cable resistance chart. If resistance is not within tolerance, replace cable assembly. Test all spark plug cables in same manner.

#### CABLE RESISTANCE CHART

MINIMUM	MAXIMUM
250 Ohms Per Inch	1000 Ohms Per Inch
3000 Ohms Per Foot	12,000 Ohms Per Foot

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#### SPARK PLUG SERVICE

When replacing the spark plug cables, route the cables correctly and secure them in the appropriate retainers. Failure to route the cables properly can cause the radio to reproduce ignition noise, cross ignition of the spark plugs or short circuit the cables to ground.

**Never Wire Brush Spark Plugs.** The spark plug insulator tip is harder than the bristles of wire brushes. Bristles of wire brushes can leave a conductive, metallic film on the insulator which could lead to conductive deposits. Conductive deposits can cause spark plug failure and engine misfire. Use a jewelers file to remove deposits from the electrode gap. Use a spark plug cleaning machine to clean spark plugs.

#### SPARK PLUG REMOVAL

Always remove the spark plug cable by **grasping at the spark plug boot, turning the boot 1/2 turn and pulling straight back in a steady motion.**

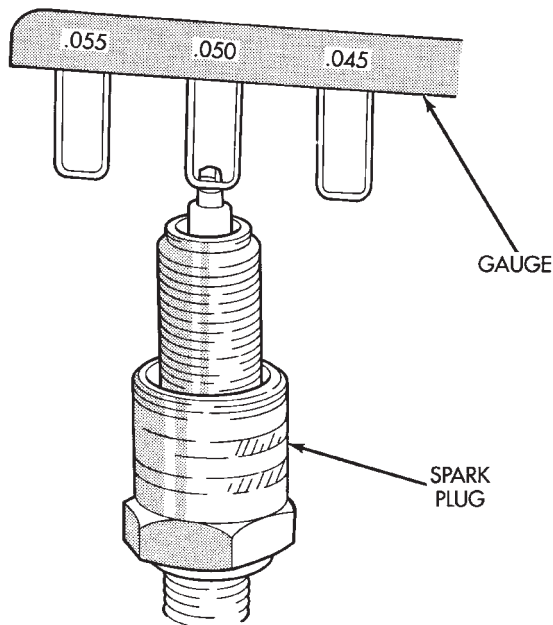
- (1) Prior to removing the spark plug spray compressed air around the spark plug hole and the area around the spark plug.
- (2) Remove the spark plug using a quality socket with a rubber or foam insert.
- (3) Inspect the spark plug condition. Refer to Spark Plug Condition in this section.

#### SPARK PLUG GAP ADJUSTMENT

Check the spark plug gap with a gap gauge. If the gap is not correct, adjust it by bending the ground electrode (Fig. 4).

#### SPARK PLUG INSTALLATION

- (1) To avoid cross threading, **start the spark plug into the cylinder head by hand.**
- (2) Tighten spark plugs to 28 N·m (20 ft. lbs.) torque.



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**Fig. 4 Setting Spark Plug Gap—Typical**

(3) Install spark plug cables over spark plugs. The cable will make a click sound when the terminal end properly attaches to the spark plug.

#### IDLE RPM TEST

**WARNING: BE SURE TO APPLY PARKING BRAKE AND/OR BLOCK WHEELS BEFORE PERFORMING ANY ENGINE RUNNING TESTS.**

Engine idle set rpm should be tested and recorded as it is when the vehicle is first brought into shop for testing. This will assist in diagnosing complaints of engine stalling, creeping and hard shifting on vehicles equipped with automatic transmissions.

Proceed to the Throttle Body Minimum Airflow procedures.

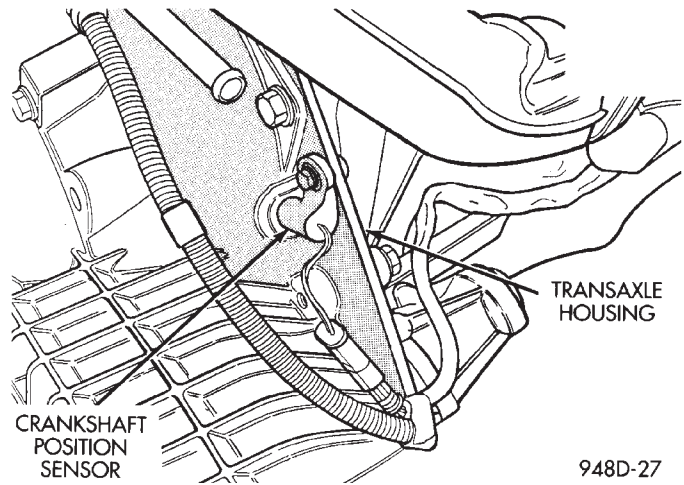
#### IGNITION TIMING PROCEDURE

The 3.3L and 3.8L engines use a fixed ignition system. Basic ignition timing is not adjustable. The powertrain control module (PCM) regulates ignition timing.

#### CRANKSHAFT POSITION SENSOR

##### REMOVAL

- (1) Disconnect crankshaft position sensor electrical connector from the wiring harness connector (Fig. 5).
- (2) Remove crankshaft position sensor retaining bolt.
- (3) Pull crankshaft position sensor straight up out of the transaxle housing.

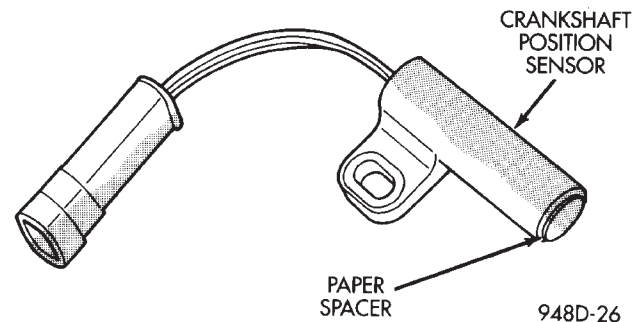


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**Fig. 5 Crankshaft Position Sensor**

##### INSTALLATION

If the removed sensor is to be reinstalled, clean off the old spacer on the sensor face. A **NEW SPACER** must be attached to the sensor face before installation. If the sensor is being replaced, confirm that the paper spacer is attached to the face of the new sensor (Fig. 6).



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**Fig. 6 Crankshaft Position Sensor and Spacer**

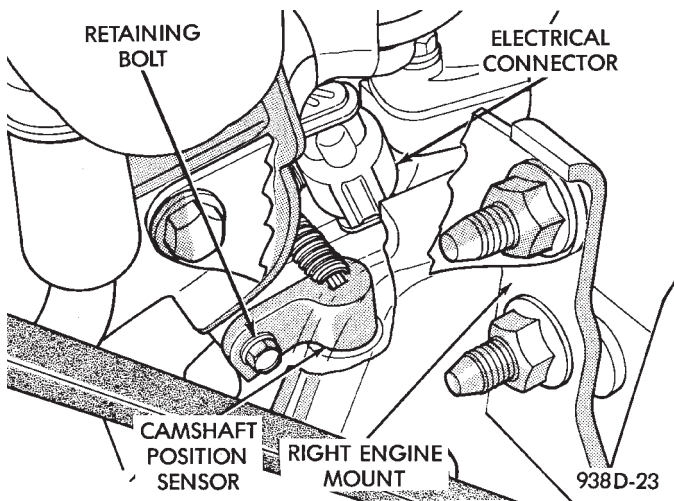
(1) Install sensor in transaxle and push sensor down until contact is made with the drive plate. While holding the sensor in this position, and install and tighten the retaining bolt to 11.9 N·m (105 in. lbs.) torque.

(2) Connect crankshaft position sensor electrical connector to the wiring harness connector.

#### CAMSHAFT POSITION SENSOR

##### REMOVAL

- (1) Disconnect camshaft position sensor electrical connector from the wiring harness connector (Fig. 7).
- (2) Remove engine mount support bracket.



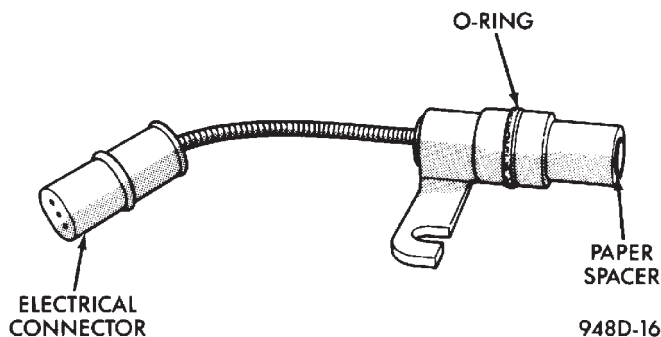
**Fig. 7 Camshaft Position Sensor**

(3) Loosen camshaft position sensor retaining bolt enough to allow slot in sensor to slide past the bolt.

(4) Pull sensor up out of the chain case cover. **Do not pull on the sensor lead.** There is an O-ring on the sensor case. The O-ring may make removal difficult. A light tap to top of sensor prior to removal may reduce force needed for removal.

#### INSTALLATION

**If the removed sensor is reinstalled, clean off the old spacer on the sensor face. A NEW SPACER must be attached to the face before installation.** Inspect O-ring for damage, replace if necessary. If the sensor is being replaced, confirm that the paper spacer is attached to the face and O-ring is positioned in groove of the new sensor (Fig. 8).



**Fig. 8 Camshaft Position Sensor and Spacer**

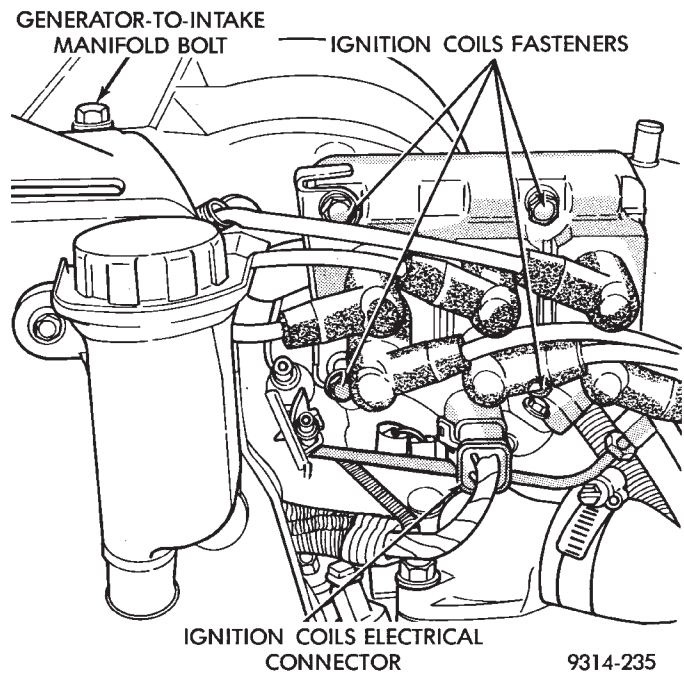
(1) Apply a couple drops of clean engine oil to the O-ring prior to installation. Install sensor in the chain case cover and push sensor down until contact is made with the camshaft gear. While holding the sensor in this position, install and tighten the retaining bolt 14 N·m (125 in. lbs.) torque.

(2) Connect camshaft position sensor electrical connector to harness connector. Position connector away from the accessory belt.

(3) Install engine mount support bracket.

#### IGNITION COIL

(1) Remove spark plug cables from coil (Fig. 9).



**Fig. 9 Ignition Coil Removal and Installation**

(2) Remove ignition coil electrical connector.

(3) Remove ignition coil mounting screws.

(4) Remove ignition coil.

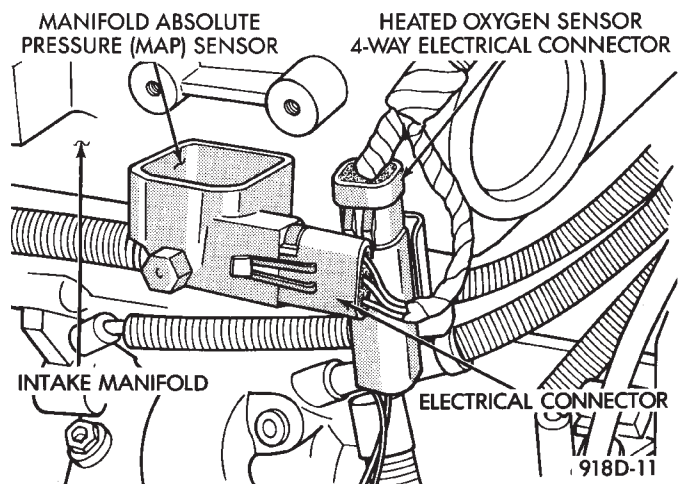
Reverse the above procedure for installation. Tighten mounting screws to 12 N·m (105 in. lbs.) torque.

#### MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

(1) Disconnect electrical connector from MAP sensor.

(2) Remove sensor by unscrewing from the intake manifold (Fig. 10).

(3) Reverse the above procedure for installation.



**Fig. 10 Manifold Absolute Pressure Sensor**



## IGNITION SWITCH

### IGNITION SWITCH AND KEY CYLINDER SERVICE

The ignition switch is located on the steering column. The Key In Switch is located in the ignition switch module. For diagnosis of the Key In Switch, refer to Section 8M.

#### IGNITION SWITCH DESIGNATIONS



IGNITION SWITCH CONNECTOR  
 LOOKING INTO SWITCH

WIRE CAVITY	WIRE COLOR	APPLICATION
1	YELLOW	STARTER RELAY
2	DARK BLUE	IGNITION RUN/START
3	GRAY/BLACK	BRAKE WARNING LAMP
4	PINK/BLACK	IGNITION SWITCH BATTERY FEED
5	BLACK/ORANGE	RUN ACCESSORY
6	BLACK/WHITE	ACCESSORY
7	RED	IGNITION SWITCH BATTERY FEED

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#### REMOVAL

- (1) Disconnect negative cable from battery.
- (2) If the vehicle has a tilt column, remove the tilt lever by turning it counterclockwise.
- (3) Remove upper and lower covers from steering column.
- (4) Remove ignition switch mounting screws. Use tamper proof torx bit Snap-on TTXR15A2, TTXR20A2 or equivalent to remove the screws (Fig. 1).
- (5) Gently pull switch away from the column. Release connector locks on the 7 terminal wiring connector, then remove the connector from the ignition switch.
- (6) Release connector lock on the 4 terminal connector, then remove the connector from the ignition switch.

#### TYPE I WITH RETAINING PIN

(7) To remove the lock cylinder with retaining pin from the ignition switch:

- (a) Insert key in the lock cylinder. Turn the key to the LOCK position. Using a small screwdriver, depress the lock cylinder retaining pin until it is flush with the lock cylinder surface (Fig. 2).

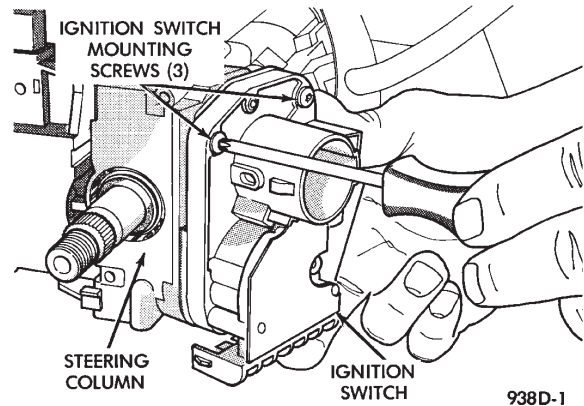


Fig. 1 Ignition Switch Screw Removal

(b) Rotate the key clockwise to the OFF position.

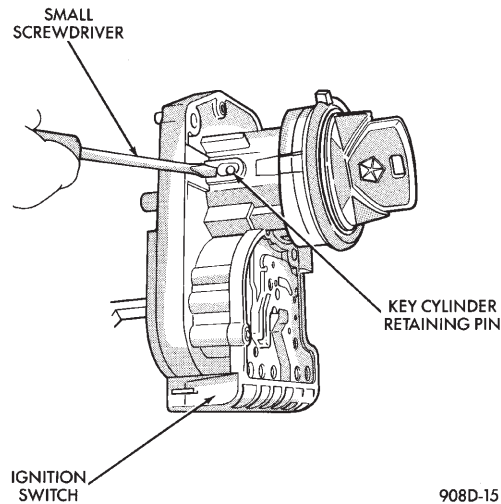


Fig. 2 Lock Cylinder with Retaining Pin Type I

The lock cylinder will unseat from the ignition switch (Fig. 3). When the lock cylinder is unseated, it will be approximately 1/8 inch away from the ignition switch halo light ring. **Do not attempt to remove the lock cylinder at this time.**

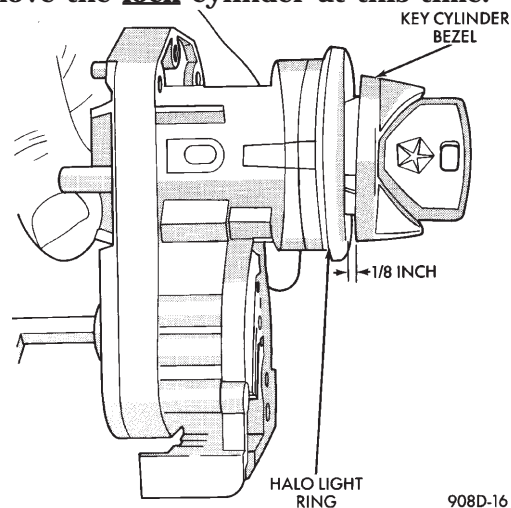
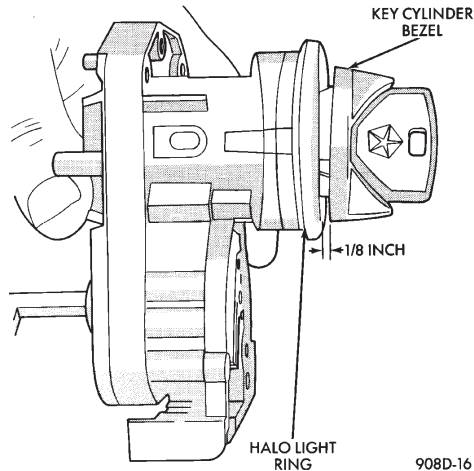


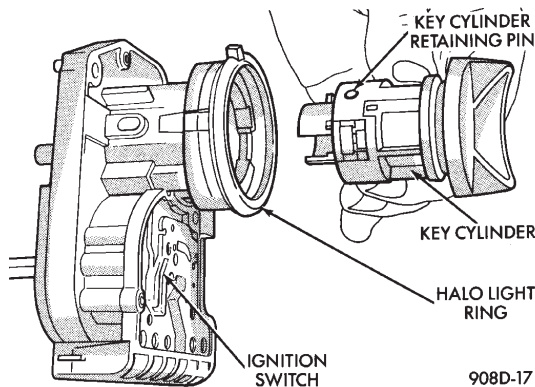
Fig. 3 Unseated Key Cylinder



**Fig. 4 Unseated Key Cylinder**

(c) With the lock cylinder in the unseated position, rotate the key counterclockwise to the lock position and remove the key.

(d) Remove lock cylinder from ignition switch (Fig. 5).

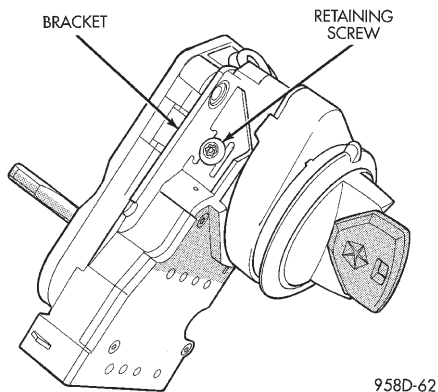


**Fig. 5 Key Cylinder Removal**

**TYPE II WITH RETAINING SCREW**

(7) To remove lock cylinder with retaining screw from ignition switch:

(a) Insert key in ignition switch. Turn key to LOCK position. Using a TTXR20A2 or equivalent torx bit, remove lock cylinder retaining screw and bracket (Fig 6).

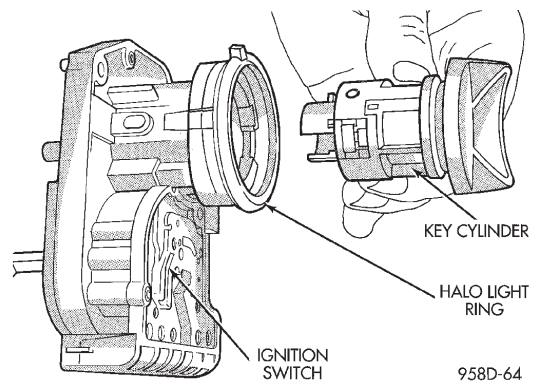


**Fig. 6 Lock Cylinder with Retaining Screw Type II**

(b) Rotate key clockwise to the OFF position. Lock cylinder will unseat from ignition switch (Fig. 4). When lock cylinder is unseated, it will be approximately 1/8 inch away from ignition switch halo light ring. **Do not attempt to remove lock cylinder at this time.**

(c) With lock cylinder in unseated position, rotate key counterclockwise to the lock position and remove key.

(d) Remove lock cylinder from ignition switch (Fig. 7).



**Fig. 7 Key Cylinder Removal**

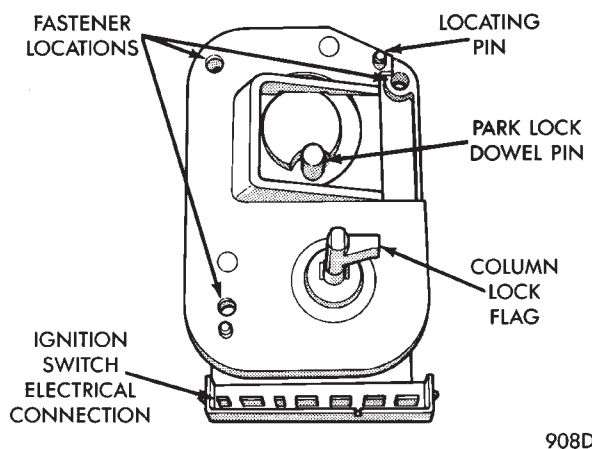
**INSTALLATION TYPE I**

If the vehicle has a floor mounted gear shifter, place the selector in the Park position.

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

(2) Before attaching the ignition switch to a tilt steering column, the transaxle shifter must be in the Park position. Also the park lock dowel pin and the column lock flag must be properly indexed before installing the switch (Fig. 8).

(a) Place the transaxle shifter in the PARK position.



**Fig. 8 Ignition Switch View From Column**

(b) Place the ignition switch in the lock position. The switch is in the lock position when the column lock flag is parallel to the ignition switch terminals (Fig. 8).

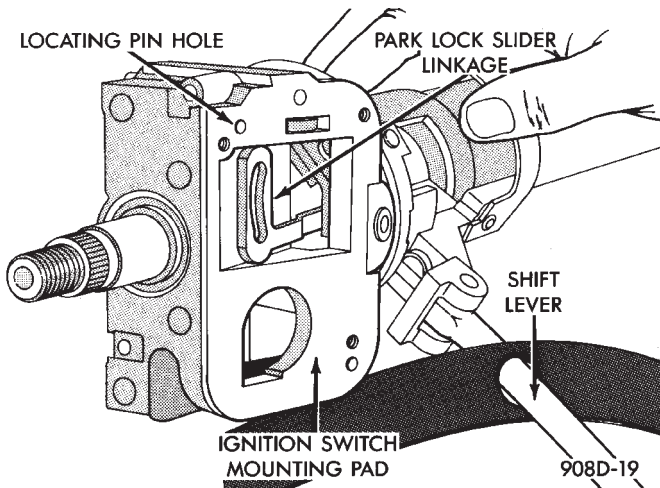
(c) Position ignition switch park lock dowel pin so it will engage the steering column park lock slider linkage (Fig. 9).



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TSB 23-44-94 June 3, 1994



**Fig. 8 Ignition Switch Mounting Pad**

- (d) Apply a light coating of grease to the column lock flag and the park lock dowel pin.
- (3) Place the ignition switch against the lock housing opening on the steering column. Ensure ignition switch park lock dowel pin enters the slot in the park lock slider linkage in the steering column.
- (4) Install ignition switch mounting screws. Tighten screws to 2 N·m (17 in. lbs.) torque.
- (5) Install steering column covers. Tighten screws to 2 N·m (17 in. lbs.) torque.
- (6) If the vehicle is equipped with a tilt steering column, install the tilt lever.
- (7) To install the **lock** in the lock cylinder **with retaining pin**:
  - (a) With the **lock** cylinder and the ignition switch in the Lock position, insert the **lock** cylinder into the ignition switch until it bottoms.
  - (b) Insert ignition key into lock cylinder. While gently pushing the **lock** cylinder in toward the ignition switch, rotate the ignition key to the end of travel.
  - (c) Connect negative cable to battery.
- (8) Check for proper operation of the halo light, shift lock (if applicable), and column lock. Also check for proper operation of the ignition switch accessory, lock, off, run, and start positions.

### INSTALLATION TYPE II

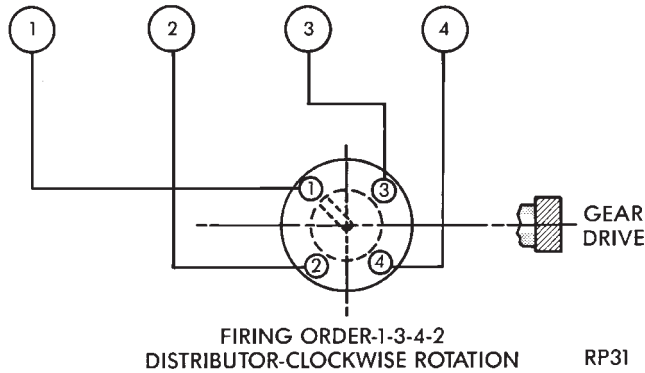
- (1) Connect electrical connectors to ignition switch. Make sure that switch locking tabs are fully seated in wiring connectors.
- (2) Before attaching ignition switch to a tilt steering column, the transmission shifter must be in Park position. Also the park lock dowel pin and column lock flag must be properly indexed before installing switch (Fig. 8).
  - (a) Place transmission shifter in PARK position.
  - (b) Place ignition switch in lock position. The switch is in the lock position when column lock flag is parallel to ignition switch terminals (Fig. 7).
  - (c) Position ignition switch park lock dowel pin so it will engage steering column park lock slider linkage (Fig. 8).
  - (d) Apply a light coating of grease to column lock flag and park lock dowel pin.
- (3) Place ignition switch against lock housing opening on steering column. Ensure that ignition switch park lock dowel pin enters slot in park lock slider linkage in steering column.
- (4) Install retaining bracket and ignition switch mounting screws. Tighten screws to 3±.5 N·m (26±4 in. lbs.) torque.
- (5) Install ignition lock cylinder:
  - (a) With lock cylinder and ignition switch in Lock position, insert lock cylinder into ignition switch until it bottoms.
  - (b) Insert ignition key into lock cylinder. While gently pushing lock cylinder in toward ignition switch, rotate ignition key to end of travel.
- (6) Install retaining screw into bracket and lock cylinder. Tighten screw to 3±.5 N·m (26±4 in. lbs.) torque.
- (7) Install steering column covers. Tighten screws to 2 N·m (17 in. lbs.) torque.
- (8) If vehicle is equipped with a tilt steering column, install tilt lever.
- (9) Connect negative cable to battery.
- (10) Check for proper operation of halo light, shift lock (if applicable), and column lock. Also check for proper operation of ignition switch accessory, lock, off, run, and start positions.

SPECIFICATIONS

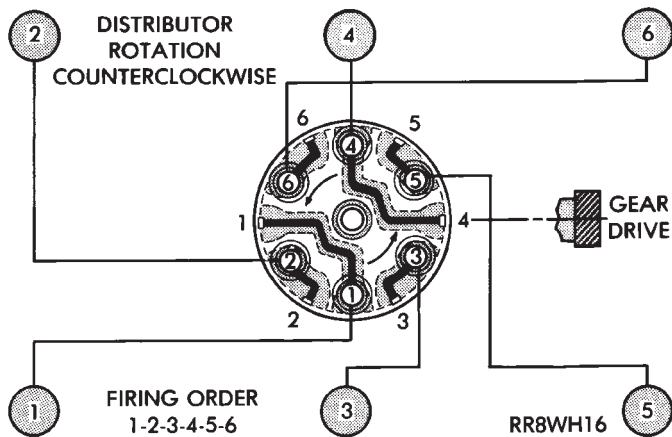
GENERAL INFORMATION

The following specifications are published from the latest information available at the time of publication. If anything differs from the specifications on the Vehicle Emission Control Information Label, use the specifications on the label.

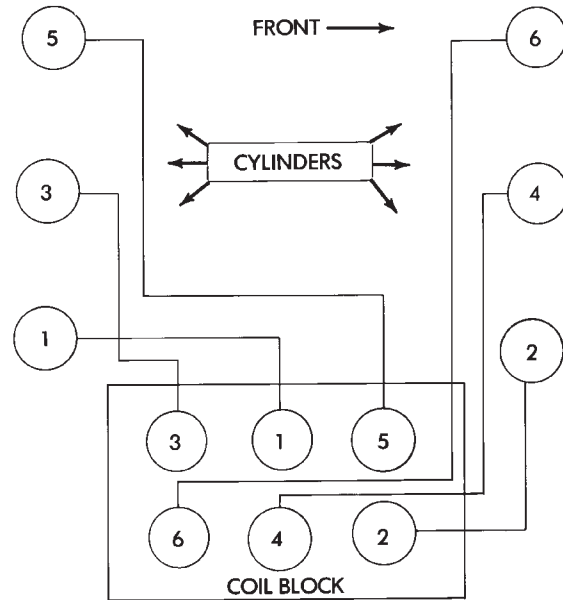
SPARK PLUG WIRE ROUTING—2.5L ENGINES



SPARK PLUG WIRE ROUTING—3.0L ENGINE



SPARK PLUG WIRE ROUTING—3.3L AND 3.8L ENGINES



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3.3L ENGINE DIRECT IGNITION SYSTEM

Ignition Timing is <b>not</b> adjustable for the Direct Ignition System (DIS)	
Engine	3.3L/3.8L
Engine Code	EGA/EGH
Transmission	Automatic
Firing Order	1-2-3-4-5-6

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DISTRIBUTORS

Engine	Transmission	Rotation	Basic Timing	Spark Advance at 2000 RPM	Shaft Side Play	Shaft End Play
2.5L	Manual and Automatic	Clockwise	12° BTDC ± 2° Manual and Automatic Trans.	21° ± 4° Manual and Automatic Trans.	Not to Exceed 0.1 mm (0.004 in.)	0.03 to 0.75 mm (0.001 to 0.030 in.)
3.0L	Automatic	Clockwise	12° BTDC ± 2°	38° ± 4° Automatic Trans.		

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IGNITION COILS

Engine	Coil Manufacturer	Primary Resistance at 21°C - 27°C (70°F - 80°F)	Secondary Resistance at 21°C - 27°C (70°F - 80°F)
2.5L	Diamond	0.95 to 1.20 Ohms	8,500 to 15,300 Ohms
2.5L	Toyodenso	0.95 to 1.20 Ohms	8,500 to 15,300 Ohms
3.0L	Diamond	0.95 to 1.20 Ohms	8,500 to 15,300 Ohms
3.3L	Diamond (Brass Towers)	0.45 to 0.65 Ohms	7,000 to 15,800 Ohms
3.3L	Toyodenso (Aluminum Towers)	0.45 to 0.65 Ohms	7,000 to 15,800 Ohms

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SPARK PLUGS

Engine	Spark Plug	Gap	Thread Size
2.5L	RN12YC	0.033 to 0.038 in.	14 mm (3/4 in.) reach
3.0L	RN11YC4	0.039 to 0.044 in.	14 mm (3/4 in.) reach
3.0L	BPR5ES-11	0.039 to 0.044 in.	14 mm (3/4 in.) reach
3.3L	RN14MC5	0.048 to 0.053 in.	14 mm (3/4 in.) reach
3.8L	RN14MC5	0.048 to 0.053 in.	14 mm (3/4 in.) reach

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TORQUE

DESCRIPTION	TORQUE
2.5L Engine Coolant Sensor .....	28 N•m (20 ft. lbs.)
2.5L Ignition Coil Screws.....	9.5 N•m (85 in. lbs.)
3.0L Engine Coolant Sensor .....	7 N•m (60 in. lbs.)
3.0L Ignition Coil Bracket .....	10 N•m (96 in. lbs.)
3.3L Camshaft Position Sensor Screw.....	12 N•m (105 in. lbs.)

DESCRIPTION	TORQUE
3.3L Engine Coolant Sensor .....	7 N•m (60 in. lbs.)
3.3L Crankshaft Position Sensor Screw.....	12 N•m (105 in. lbs.)
3.3L/3.8L Ignition Coil.....	12 N•m (105 in. lbs.)
Ignition Switch.....	2 N•m (17 in. lbs.)
Spark Plugs .....	28 N•m (20 ft. lbs.)

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