# IGNITION SYSTEMS

## CONTENTS



## COMPONENT IDENTIFICATION/SYSTEM OPERATION

### INDEX



### GENERAL INFORMATION

Throughout this group, references are made to particular vehicle models by alphabetical designation (XJ or YJ) or by the particular vehicle nameplate. A chart showing a breakdown of alphabetical designations is included in the Introduction group at the beginning of this manual.

This section of the group, Component Identification/System Operation, will discuss ignition system operation and will identify ignition system components.

For diagnostic procedures and adjustments, refer to the Diagnostics/Service Procedures section of this group.

For removal and installation of ignition system components, refer to the Component Removal/Installation section of this group.

For other useful information, refer to On-Board Diagnostics in the General Diagnosis sections of Group 14, Fuel System in this manual.

For operation of the DRB Scan Tool, refer to the appropriate Powertrain Diagnostic Procedures service manual.

An Ignition specifications section is included at the end of this group. A general Maintenance Schedule (mileage intervals) for ignition related items can be found in Group 0, Lubrication and Maintenance. This schedule can also be found in the Owners Manual.

*IGNITION SYSTEMS*

A multi-port, fuel injected engine is used on all models. The ignition system is controlled by the powertrain control module (PCM) on all engines. The PCM was formerly referred to as the SBEC or engine controller.

The ignition system consists of:

- Spark plugs
- Ignition coil
- Secondary ignition cables
- Distributor (contains rotor and camshaft position sensor)
- Powertrain control module (PCM)
- Crankshaft position sensor

### AUTOMATIC SHUTDOWN (ASD) RELAY

The automatic shutdown (ASD) relay is located in the power distribution center (PDC) near the battery (Fig. 1 or 2). As one of its functions, it will supply battery voltage to the ignition coil.

The ground circuit for the ASD relay is controlled by the powertrain control module (PCM). This is done through pin/cavity number 51 of the PCM 60-way connector. The PCM then regulates ASD relay operation by switching this ground circuit on-and-off.

Also refer to Ignition Coil for additional information.

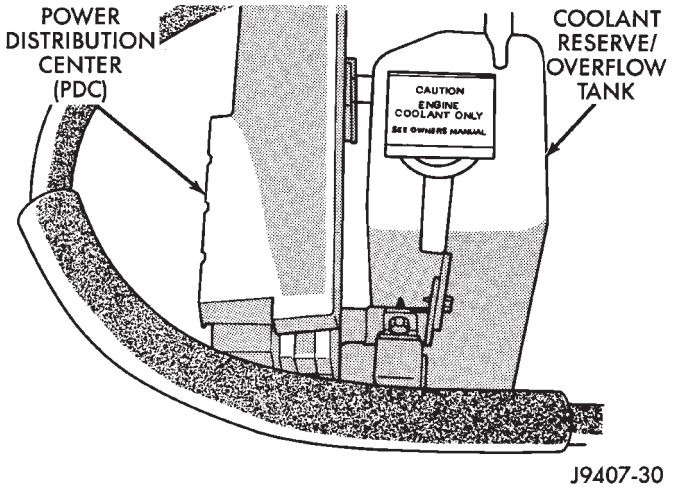


*Fig. 1 PDC—XJ Models*

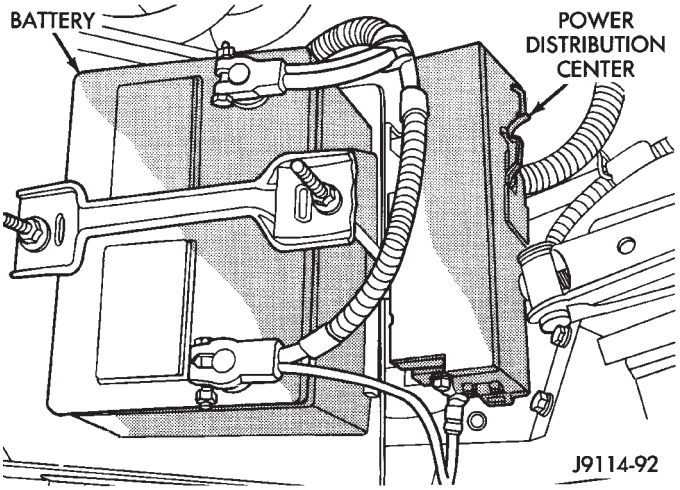


*Fig. 2 PDC—YJ Models*

## CAMSHAFT POSITION SENSOR

The camshaft position sensor is located in the distributor (Figs. 3 or 4) on all engines.

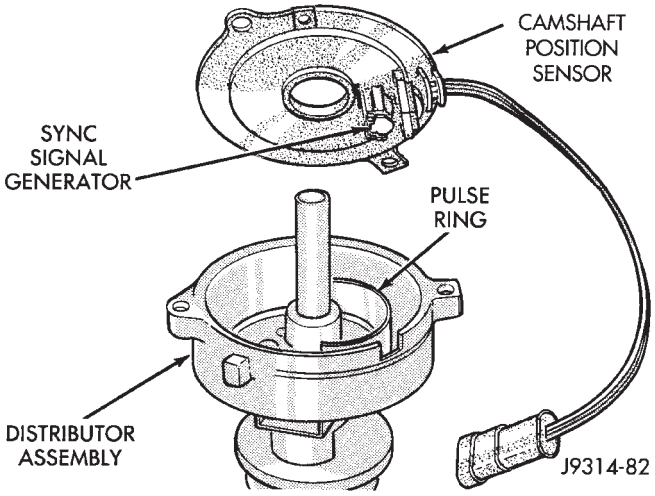


*Fig. 3 Camshaft Position Sensor—Typical*

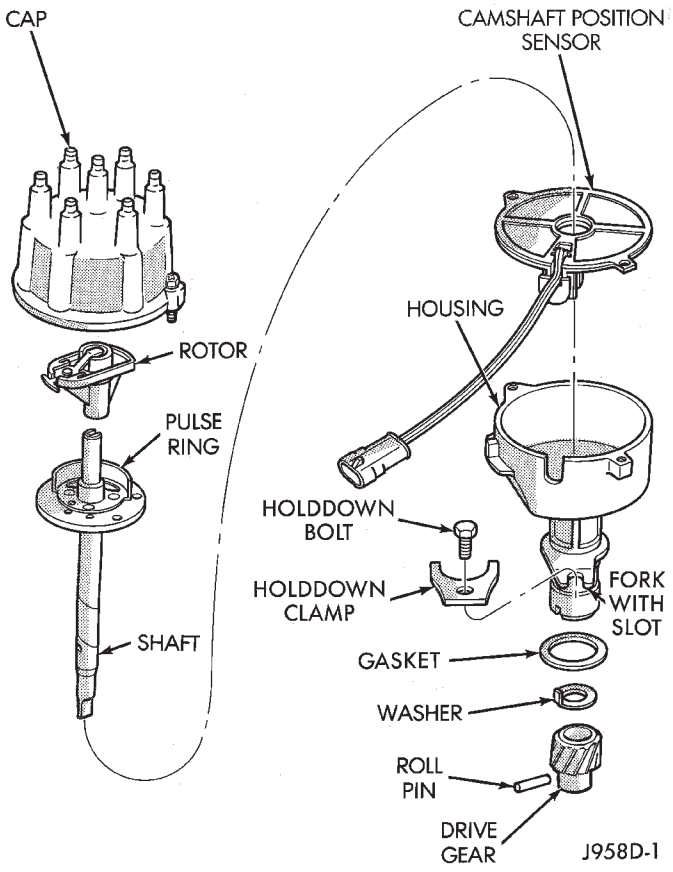


*Fig. 4 Distributor Assembly—Typical*

The camshaft position sensor contains a hall effect device called a sync signal generator to generate a fuel sync signal. This sync signal generator detects a rotating pulse ring (shutter) on the distributor shaft (Fig. 4). The pulse ring rotates 180 degrees through the sync signal generator. Its signal is used in conjunction with the crankshaft position sensor to differentiate between fuel injection and spark events. It is also used to synchronize the fuel injectors with their respective cylinders.

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

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

For component testing, refer to the Diagnostics/Service Procedures section of this group.

For removal and installation of this component, refer to the Component Removal/Installation section of this group.

## CRANKSHAFT POSITION SENSOR

The crankshaft position sensor is mounted to the transmission bellhousing at the left/rear side of the engine block (Figs. 5, 6 or 7).

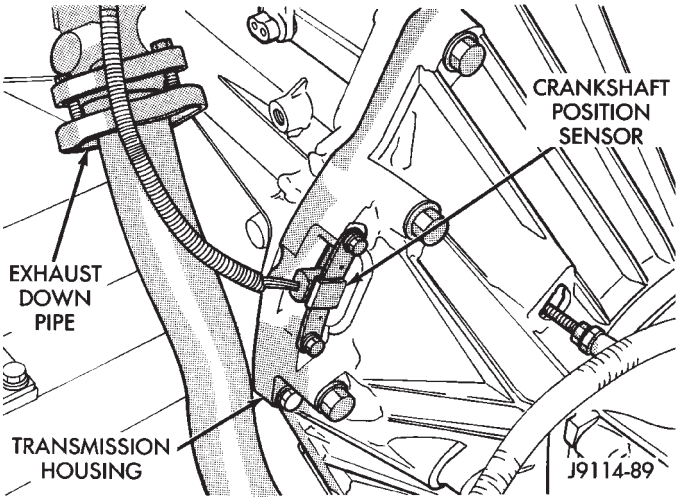


***Fig. 5 Crankshaft Position Sensor—2.5L 4-Cyl. Engine—Typical***

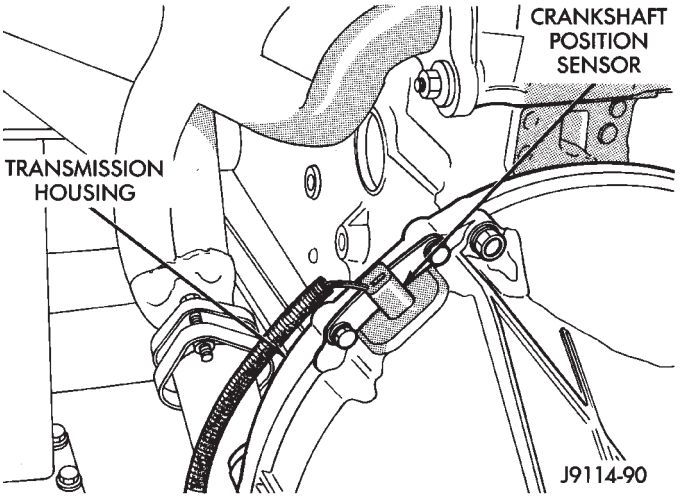


***Fig. 6 Crankshaft Position Sensor—4.0L 6-Cyl. Engine—All Except YJ models With Automatic Transmission***

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

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

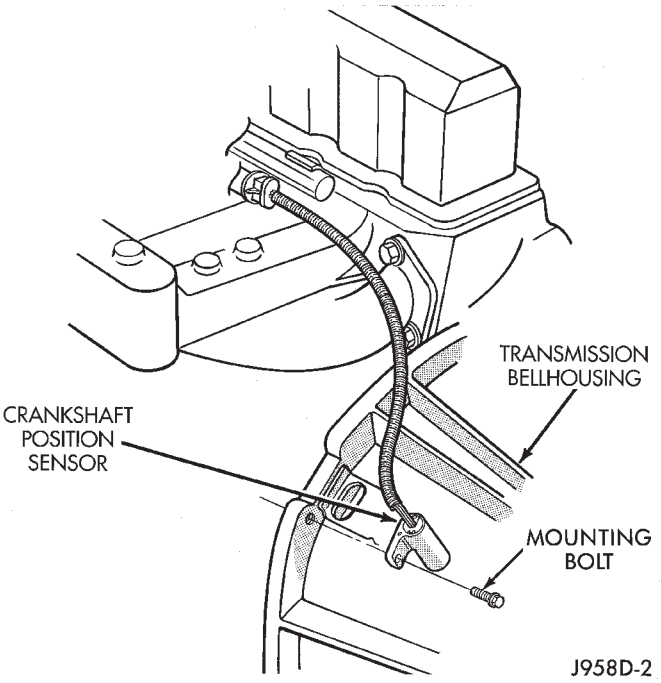


***Fig. 7 Crankshaft Position Sensor—4.0L 6-Cyl. Engine—YJ models With Automatic Transmission***

### *SENSOR OPERATION*

The flywheel/drive plate has groups of four notches at its outer edge. On 4.0L 6-cylinder engines there are three sets of notches (Figs. 9 or 10). On 2.5L 4-cylinder engines there are two sets of notches (Fig. 8).

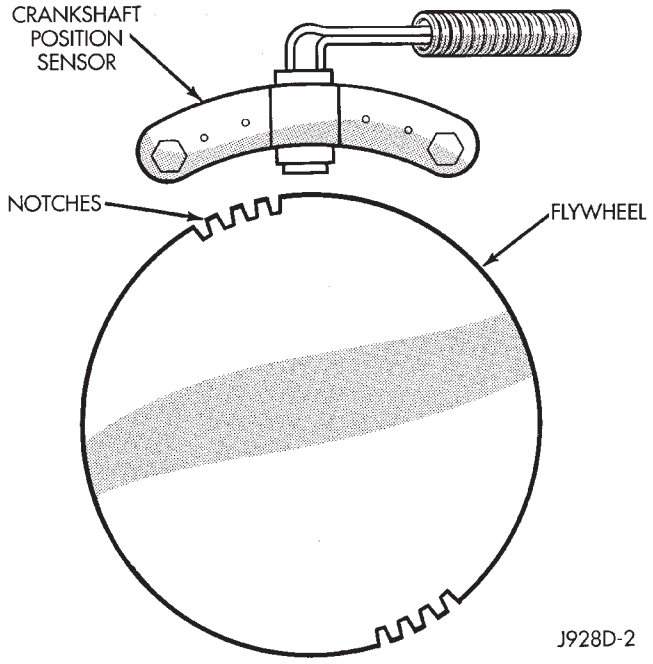


***Fig. 8 Sensor Operation—2.5L 4-Cyl. Engine***

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

groups of four pulses generated on 2.5L 4-cylinder engines. There are 3 groups of four pulses generated on 4.0L 6-cylinder engines.

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

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

For component testing, refer to the Diagnostics/Service Procedures section of this group.

For removal and installation of this sensor, refer to the Component Removal/Installation section of this group.

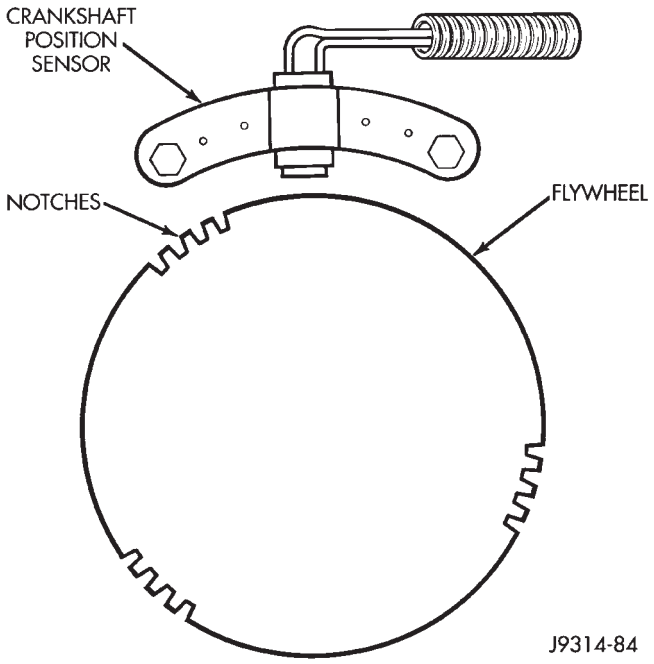


*Fig. 9 Sensor Operation—4.0L 6-Cyl. Engine—All Except YJ Models With Automatic Transmission*

## DISTRIBUTORS

All engines are equipped with a camshaft driven mechanical distributor containing a shaft driven distributor rotor. All distributors are equipped with an internal camshaft position (fuel sync) sensor. This sensor provides fuel injection synchronization and cylinder identification.

The distributors on both the 2.5L 4-cylinder and the 4.0L-6 cylinder engines do not have built in centrifugal or vacuum assisted advance. Base ignition timing and all timing advance is controlled by the powertrain control module (PCM). Because ignition timing is controlled by the PCM, **base ignition timing is not adjustable on any of these engines.**

The distributor is locked in place by a fork with a slot located on the distributor housing base. The distributor holddown clamp bolt passes through this slot when installed. Because the distributor position is locked when installed, its rotational position can not be changed. **Do not attempt to modify the distributor housing to get distributor rotation. Distributor position will have no effect on ignition timing. The position of the distributor will determine fuel synchronization only.**

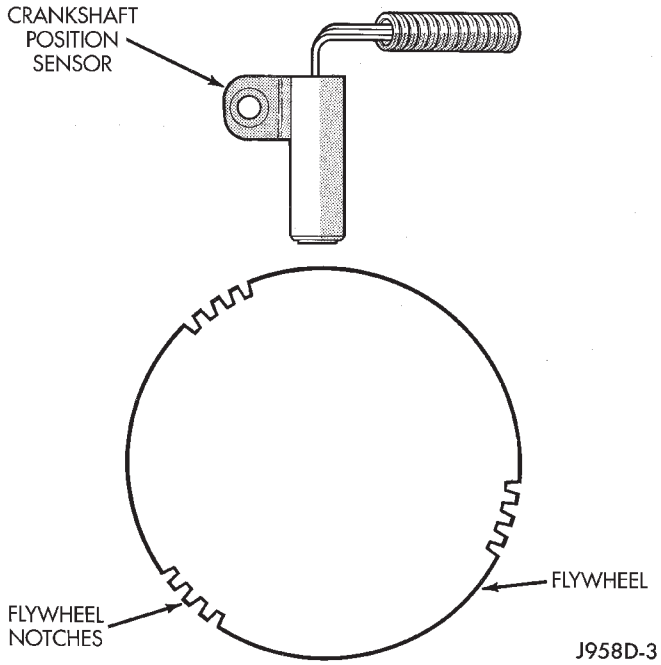


*Fig. 10 Sensor Operation—4.0L 6-Cyl. Engine—YJ Models With Automatic Transmission*

All distributors contain an internal oil seal that prevents oil from entering the distributor housing. The seal is not serviceable.

Distributor removal and installation procedures have changed for the 1995 model year. Refer to Distributor in the Component Removal/Installation section of this group.

## IGNITION COIL

Battery voltage is supplied to the ignition coil positive terminal from the ASD relay.

The powertrain control module (PCM) opens and closes the ignition coil ground circuit for ignition coil operation. This is done through pin/cavity number 19 of the PCM 60-way connector.

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

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

On the 2.5L 4-cylinder engine, the ignition coil is mounted to a bracket on the side of the engine (to the rear of the distributor).

On the 4.0L 6-cylinder engine, the ignition coil is mounted to a bracket on the side of the engine (to the front of the distributor) (Fig. 11).

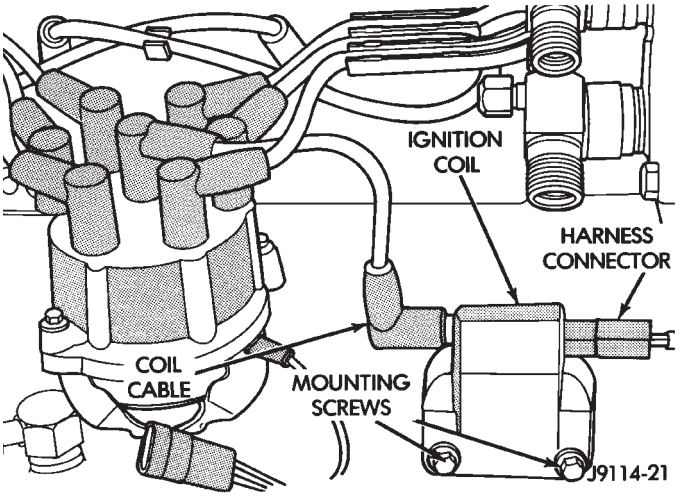


*Fig. 11 Ignition Coil—Typical*

For component testing, refer to the Diagnostics/Service Procedures section of this group.

For removal and installation of this component, refer to the Component Removal/Installation section of this group.

## ENGINE COOLANT TEMPERATURE SENSOR

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

## INTAKE MANIFOLD AIR TEMPERATURE SENSOR

For an operational description, diagnosis or removal/ installation procedures, refer to Group 14, Fuel Systems.

## MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

## POWERTRAIN CONTROL MODULE (PCM)

The PCM was formerly referred to as the SBEC or engine controller. On XJ models, the PCM is located in the engine compartment next to the air cleaner (Fig. 12). On YJ models, the PCM is located in the engine compartment behind the windshield washer fluid reservoir (Fig. 13).

The ignition system is controlled by the PCM.

**Base ignition timing by rotation of distributor is not adjustable.** The PCM opens and closes the ignition coil ground circuit to operate the ignition coil. This is done to adjust ignition timing, both initial (base) and advance, for changing engine operating conditions.

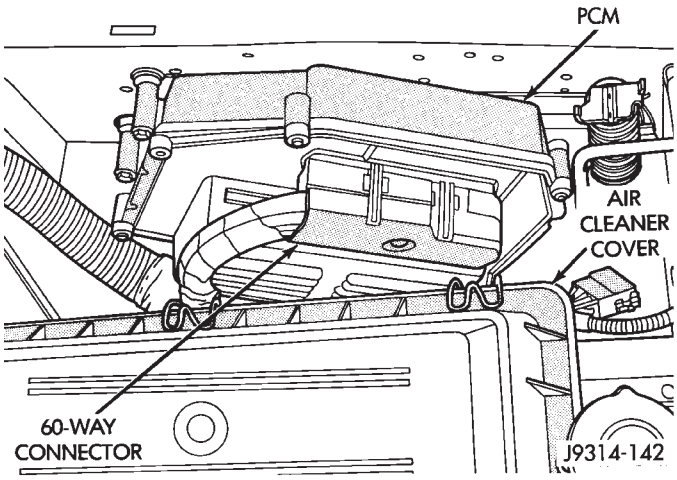


*Fig. 12 PCM Location—XJ Models*

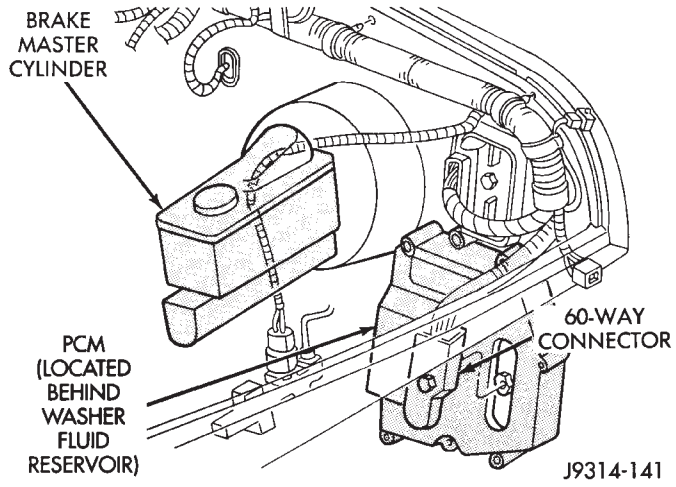


*Fig. 13 PCM Location—YJ Models*

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

For removal and installation of this component, refer to the Component Removal/Installation section of this group.

For PCM diagnostics, refer to the appropriate Powertrain Diagnostic Procedures service manual for operation of the DRB scan tool.

## THROTTLE POSITION SENSOR

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

## OXYGEN (O2S) SENSOR

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

## DIAGNOSTICS/SERVICE PROCEDURES

### INDEX



### GENERAL INFORMATION

This section of the group, Diagnostics/Service Procedures, will discuss basic ignition system diagnostics and service adjustments.

For system operation and component identification, refer to the Component Identification/System Operation section of this group.

For removal or installation of ignition system components, refer to the Component Removal/Installation section of this group.

For other useful information, refer to the On-Board Diagnostics section.

For operation of the DRB Scan Tool, refer to the appropriate Powertrain Diagnostic Procedures service manual.

### AUTOMATIC SHUTDOWN (ASD) RELAY TEST

To perform a complete test of this relay and its circuitry, refer to the DRB scan tool. Also refer to the appropriate Powertrain Diagnostics Procedures manual. To test the relay only, refer to Relays—Operation/Testing in the Group 14, Fuel Systems section.

### CAMSHAFT POSITION SENSOR TEST

To perform a complete test of this sensor and its circuitry, refer to the DRB scan tool. Also refer to the appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

The camshaft position sensor is located in the distributor (Fig. 1).

To perform a complete test of this sensor and its circuitry, refer to the DRB scan tool. Also refer to the appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

**For this test, an analog (non-digital) voltmeter is needed.** Do not remove the distributor connector from the distributor. Using small paper clips, insert them into the backside of the distributor wire harness connector to make contact with the terminals. Be sure that the connector is not damaged when inserting the paper clips. Attach voltmeter leads to these paper clips.

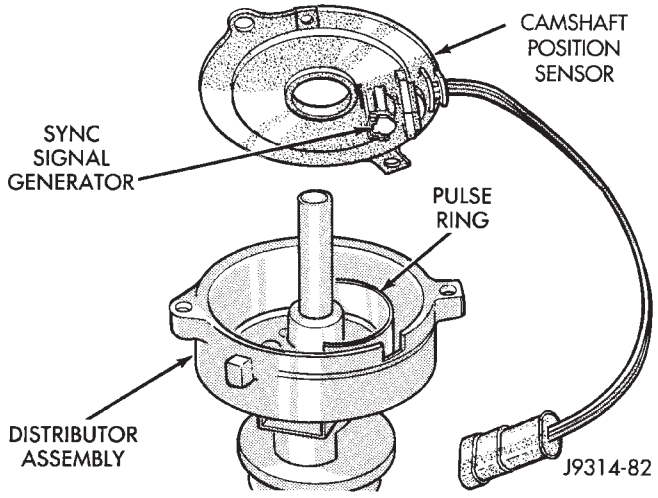


*Fig. 1 Camshaft Position Sensor—Typical*

(1) Connect the positive (+) voltmeter lead into the sensor output wire. This is at done the distributor wire harness connector. For wire identification, refer to Group 8W, Wiring Diagrams.

(2) Connect the negative (-) voltmeter lead into the ground wire. For wire identification, refer to Group 8W, Wiring Diagrams.

(3) Set the voltmeter to the 15 Volt DC scale.

(4) Remove distributor cap from distributor (two screws). Rotate (crank) the engine until the distributor rotor is pointed to approximately the 11 o'clock position. The movable pulse ring should now be within the sensor pickup.

(5) Turn ignition key to ON position. The voltmeter should read approximately 5.0 volts.

(6) If voltage is not present, check the voltmeter leads for a good connection.

(7) If voltage is still not present, check for voltage at the supply wire. For wire identification, refer to Group 8W, Wiring Diagrams.

(8) If voltage is not present at supply wire, check for voltage at pin-7 of powertrain control module (PCM) 60-way connector. Leave the PCM connector connected for this test.

(9) If voltage is still not present, perform vehicle test using the DRB scan tool.

(10) If voltage is present at pin-7, but not at the supply wire:

(a) Check continuity between the supply wire. This is checked between the distributor connector and pin-7 at the PCM. If continuity is not present, repair the harness as necessary.

(b) Check for continuity between the camshaft position sensor output wire and pin-44 at the PCM. If continuity is not present, repair the harness as necessary.

(c) Check for continuity between the ground circuit wire at the distributor connector and ground. If continuity is not present, repair the harness as necessary.

(11) While observing the voltmeter, crank the engine with ignition switch. The voltmeter needle should fluctuate between 0 and 5 volts while the engine is cranking. This verifies that the camshaft position sensor in the distributor is operating properly and a sync pulse signal is being generated.

If sync pulse signal is not present, replacement of the camshaft position sensor is necessary.

For removal or installation of ignition system components, refer to the Component Removal/Installation section of this group.

For system operation and component identification, refer to the Component Identification/System Operation section of this group.

## CRANKSHAFT POSITION SENSOR TEST

To perform a complete test of this sensor and its circuitry, refer to the DRB scan tool. Also refer to the appropriate Powertrain Diagnostics Procedures manual. To test the sensor only, refer to the following:

The sensor is located on the transmission bellhousing at the left/rear side of the engine block (Figs. 2, 3 or 4).

(1) Near the rear of the intake manifold, disconnect sensor pigtail harness connector from main wiring harness.

(2) Place an ohmmeter across terminals B and C (Fig. 5). Ohmmeter should be set to 1K-to-10K scale for this test. The meter reading should be open (no resistance). Replace sensor if a low resistance is indicated.

For removal or installation of ignition system components, refer to the Component Removal/Installation section of this group.

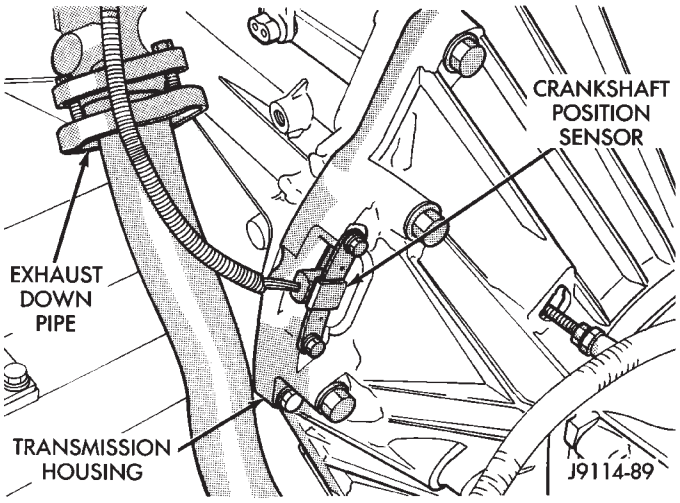


***Fig. 2 Crankshaft Position Sensor—2.5L 4-Cyl. Engine—Typical***

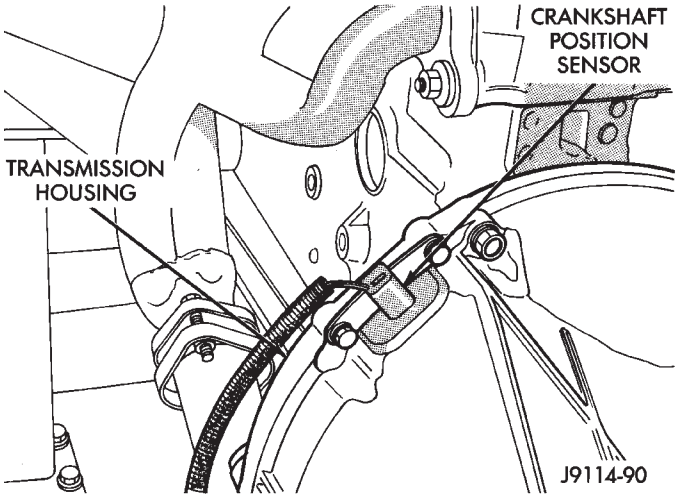


***Fig. 3 Crankshaft Position Sensor—4.0L 6-Cyl. Engine—All Except YJ models With Auto. Trans.***

## DISTRIBUTOR CAP

### *INSPECTION*

Remove the distributor cap and wipe it clean with a dry lint free cloth. Visually inspect the cap for cracks, carbon paths, broken towers, or damaged rotor button (Figs. 6 and 7). Also check for white deposits on the inside (caused by condensation entering the cap through cracks). Replace any cap that displays charred or eroded terminals. The inside flat surface of a terminal end (faces toward rotor) will indicate some evidence of erosion from normal operation. Examine the terminal ends for evidence of mechanical interference with the rotor tip.

If replacement of the distributor cap is necessary, transfer spark plug cables from the original cap to the new cap. This should be done one cable at a time. Each cable is installed onto the tower of the new cap that corresponds to its tower position on the original

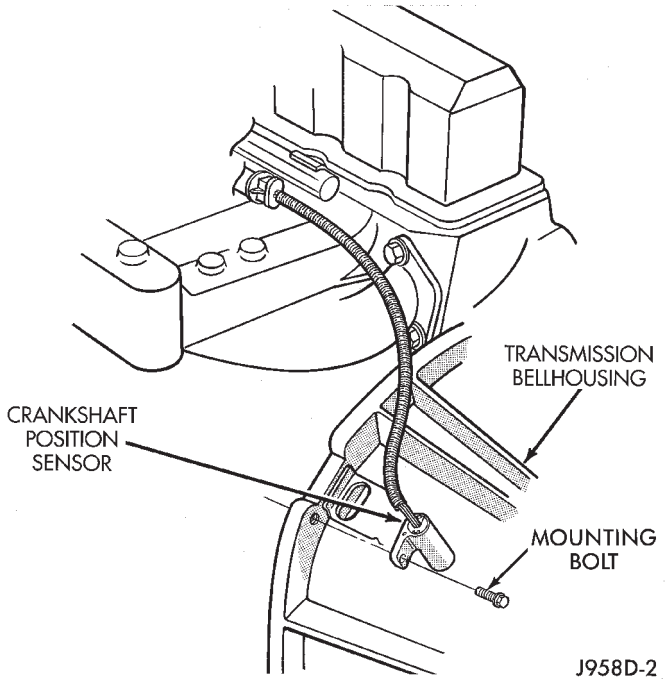


*Fig. 4 Crankshaft Position Sensor—4.0L 6-Cyl. Engine—YJ models With Auto. Trans.*

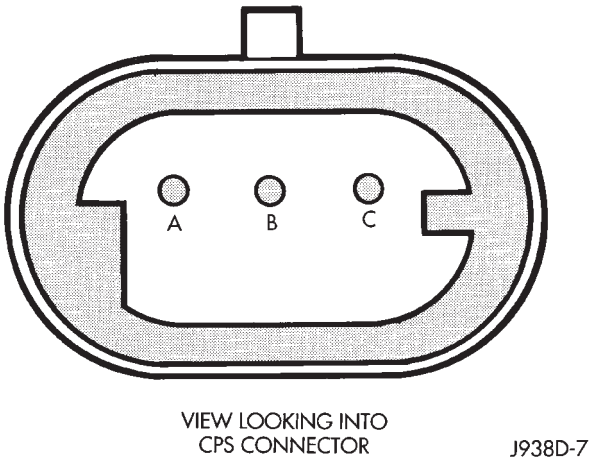


*Fig. 5 Crankshaft Position Sensor Connector*

cap. Fully seat the cables onto the towers. If necessary, refer to the engine Firing Order diagrams (Figs. 8 or 9).

## DISTRIBUTOR ROTOR

Visually inspect the rotor (Fig. 10) for cracks, evidence of corrosion, or the effects of arcing on the metal tip. Also check for evidence of mechanical interference with the cap. Some charring is normal on the end of the metal tip. The silicone-dielectric-varnish-compound applied to the rotor tip for radio interference noise suppression, will appear charred. This is normal. **Do not remove the charred compound.** Test the spring for insufficient tension. Replace a rotor that displays any of these adverse conditions.

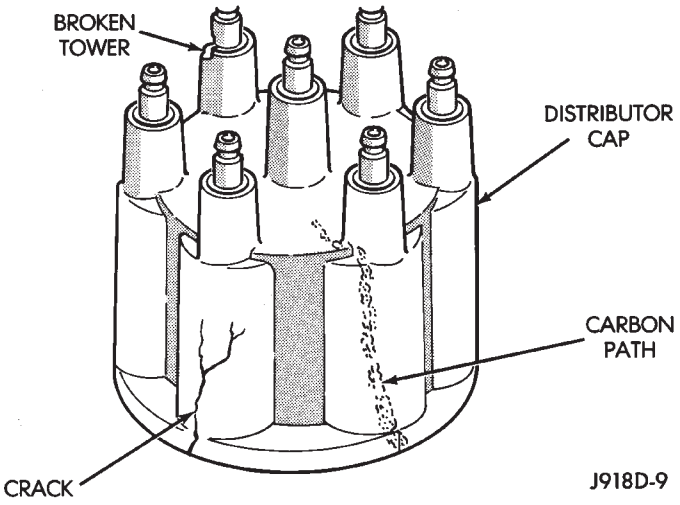


*Fig. 6 Cap Inspection—External—Typical*

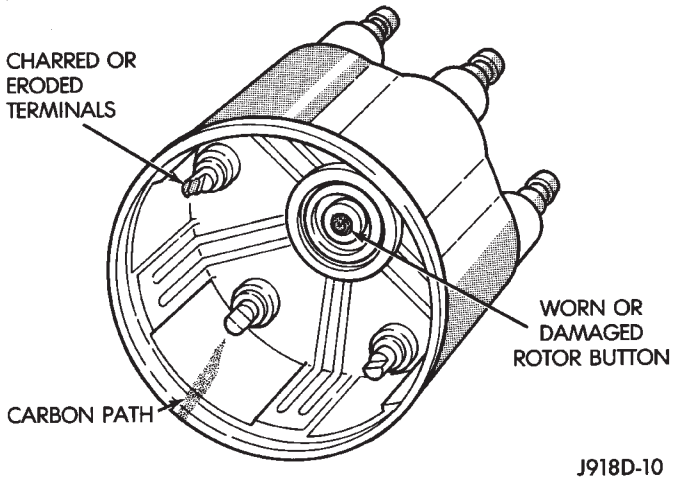


*Fig. 7 Cap Inspection—Internal—Typical*

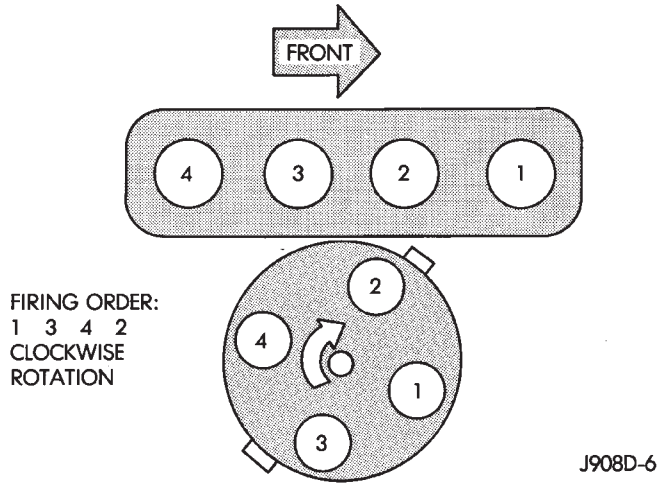


*Fig. 8 Firing Order—2.5L 4-Cylinder Engine*

## DRB SCAN TOOL

For operation of the DRB scan tool, refer to the appropriate Powertrain Diagnostic Procedures service manual.

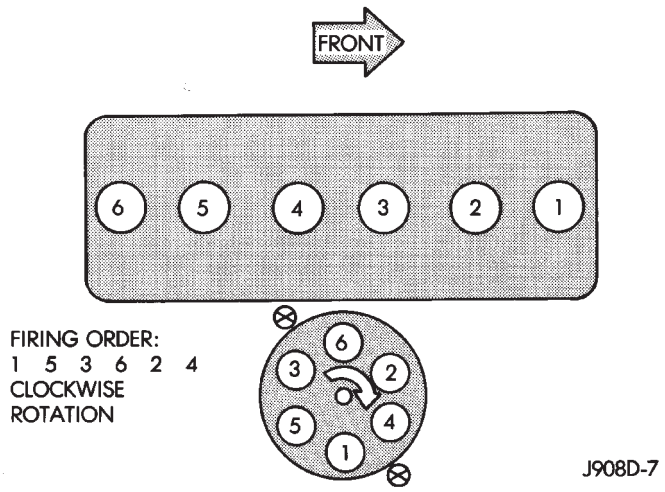


*Fig. 9 Firing Order—4.0L 6-Cylinder Engine*

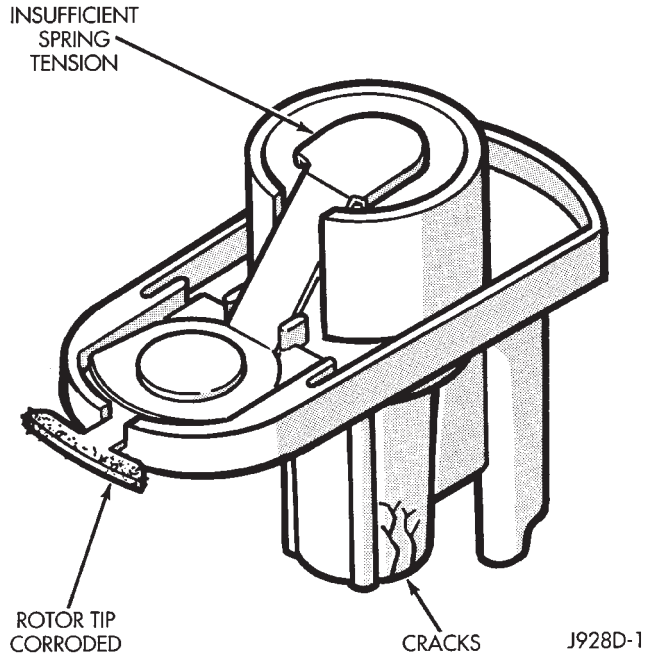


*Fig. 10 Rotor Inspection—Typical*

## IGNITION COIL

To perform a complete test of the ignition coil and its circuitry, refer to the DRB scan tool. Also refer to the appropriate Powertrain Diagnostics Procedures manual. To test the coil only, refer to the following:

The ignition coil (Fig. 11) is designed to operate without an external ballast resistor.

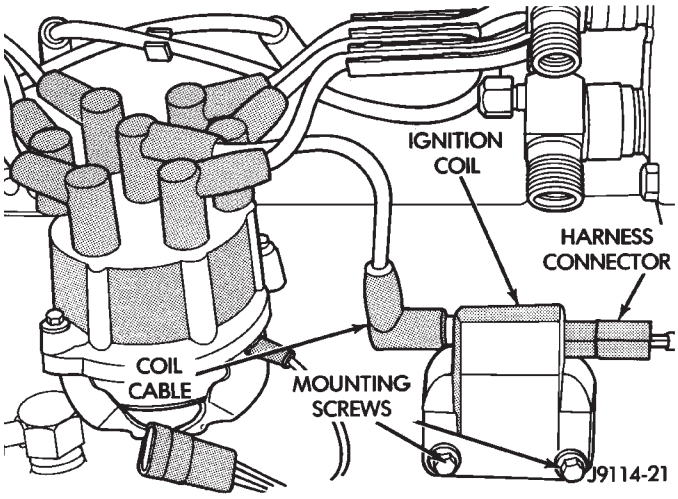


*Fig. 11 Ignition Coil—Typical (4.0L Shown)*

Inspect the ignition coil for arcing. Test the coil according to coil tester manufacturer's instructions. Test the coil primary and secondary resistance. Replace any coil that does not meet specifications. Refer to the Ignition Coil Resistance chart.

If the ignition coil is being replaced, the secondary spark plug cable must also be checked. Replace cable if it has been burned or damaged.

Arcing at the tower will carbonize the cable nipple, which if it is connected to a new ignition coil, will cause the coil to fail.

If the secondary coil cable shows any signs of damage, it 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 ignition coil.

## ENGINE COOLANT TEMPERATURE SENSOR TEST

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

*IGNITION COIL RESISTANCE*

| COIL (MANUFACTURER) | PRIMARY RESISTANCE 21–27°C (70–80°F) | SECONDARY RESISTANCE 21–27°C (70–80°F) |
|---|---|---|
| Diamond | 0.97 - 1.18 Ohms | 11,300 - 15,300 Ohms |
| Toyodenso | 0.95 - 1.20 Ohms | 11,300 - 13,300 Ohms |

J918D-2

## IGNITION SECONDARY CIRCUIT DIAGNOSIS

### CHECKING FOR SPARK

**CAUTION: When disconnecting a high voltage cable from a spark plug or from the distributor cap, twist the rubber boot slightly (1/2 turn) to break it loose (Fig. 12). Grasp the boot (not the cable) and pull it off with a steady, even force.**

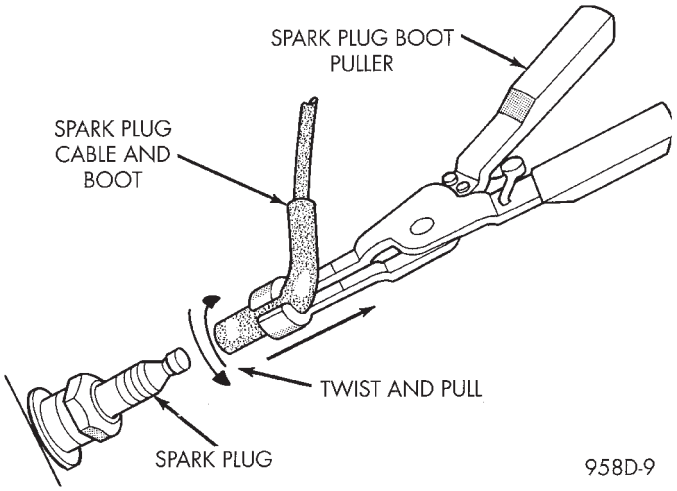


***Fig. 12 Cable Removal***

(1) Disconnect the ignition coil secondary cable from center tower of the distributor cap. Hold the cable terminal approximately 12 mm (1/2 in.) from a good engine ground (Fig. 13).

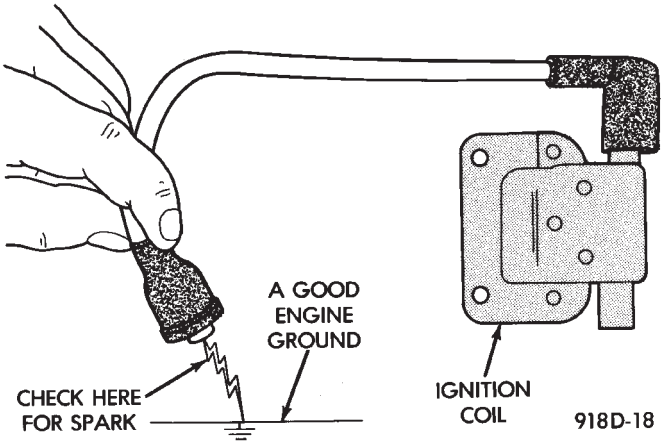


***Fig. 13 Checking for Spark—Typical***

**WARNING: BE VERY CAREFUL WHEN THE ENGINE IS CRANKING. DO NOT PUT YOUR HANDS NEAR THE PULLEYS, BELTS OR THE FAN. DO NOT WEAR LOOSE FITTING CLOTHING.**

(2) Rotate (crank) the engine with the starter motor and observe the cable terminal for a steady arc. If steady arcing does not occur, inspect the secondary coil cable. Refer to Spark Plug Cables in this group. Also inspect the distributor cap and rotor for cracks or burn marks. Repair as necessary. If steady arcing occurs, connect ignition coil cable to the distributor cap.

(3) Remove a cable from one spark plug.

(4) Using insulated pliers, hold the cable terminal approximately 12 mm (1/2 in.) from the engine cylinder head or block while rotating the engine with the starter motor. Observe the spark plug cable terminal for an arc. If steady arcing occurs, it can be expected that the ignition secondary system is operating correctly. **(note that if the ignition coil cable is removed for this test, instead of a spark plug cable, the spark intensity will be much higher.)** If steady arcing occurs at the spark plug cables, but the engine will not start, connect the DRB scan tool. Refer to the Powertrain Diagnostic Procedures service manual.

### FAILURE TO START TEST

To prevent unnecessary diagnostic time and wrong test results, the previous Checking For Spark test should be performed prior to this test.

**WARNING: SET PARKING BRAKE OR BLOCK THE DRIVE WHEELS BEFORE PROCEEDING WITH THIS TEST.**

(1) Unplug the ignition coil harness connector at the coil (Fig. 14).

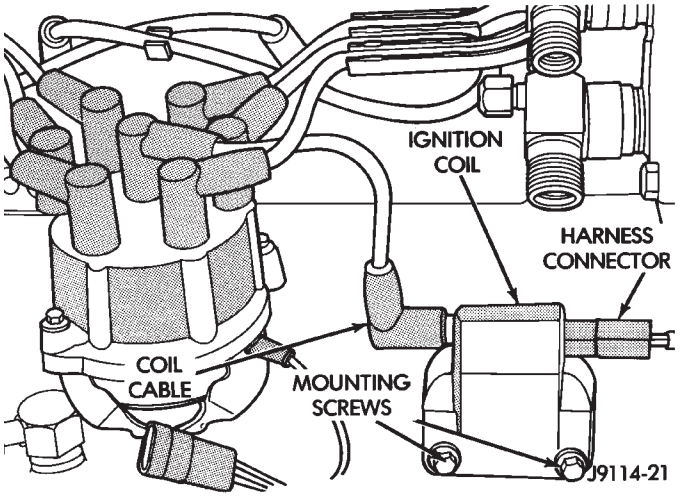


***Fig. 14 Coil Harness Connector—Typical (4.0L Shown)***

(2) Connect a set of small jumper wires (18 gauge or smaller) between the disconnected harness terminals and the ignition coil terminals. To determine polarity at connector and coil, refer to the Wiring Diagrams section.

(3) Attach one lead of a voltmeter to the positive (12 volt) jumper wire. Attach the negative side of voltmeter to a good ground. Determine that sufficient battery voltage (12.4 volts) is present for the starting and ignition systems.

(4) Crank the engine for 5 seconds while monitoring the voltage at the coil positive terminal:
- If the voltage remains near zero during the entire period of cranking, refer to On-Board Diagnostics in Group 14, Fuel Systems. Check the powertrain control module (PCM) and auto shutdown relay.
- If voltage is at or near battery voltage and drops to zero after 1-2 seconds of cranking, check the camshaft position sensor-to-PCM circuit. Refer to On-Board Diagnostics in Group 14, Fuel Systems.
- If voltage remains at or near battery voltage during the entire 5 seconds, turn the key off. Remove the 60-way connector (Fig. 15) from the PCM. Check 60-way connector for any spread terminals.

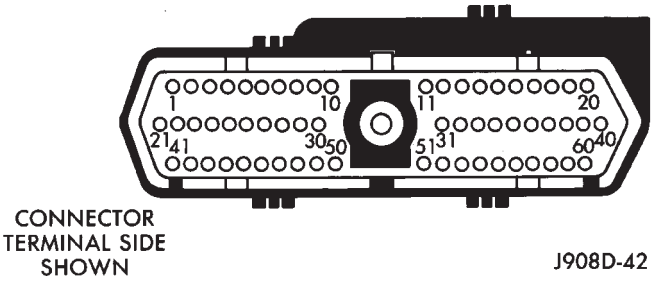


*Fig. 15 PCM 60-Way Connector*

(5) Remove test lead from the coil positive terminal. Connect an 18 gauge jumper wire between the battery positive terminal and the coil positive terminal.

(6) Make the special jumper shown in figure 16. Using the jumper, **momentarily** ground pin/cavity number 19 of the PCM 60-way connector. A spark should be generated at the coil cable when the ground is removed.

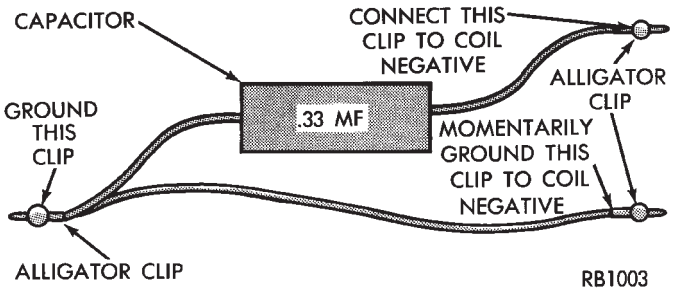


*Fig. 16 Special Jumper Ground-to-Coil Negative Terminal*

(7) If spark is generated, replace the powertrain control module (PCM).

(8) If spark is not seen, use the special jumper to ground the coil negative terminal directly.

(9) If spark is produced, repair wiring harness for an open condition.

(10) If spark is not produced, replace the ignition coil.

## IGNITION TIMING

**Base (initial) ignition timing is NOT adjustable on any of the 2.5L 4-cylinder or 4.0L 6-cylinder engines. Do not attempt to adjust ignition timing by rotating the distributor.**

**Do not attempt to modify the distributor housing to get distributor rotation. Distributor position will have no effect on ignition timing.**

All ignition timing functions are controlled by the powertrain control module (PCM). Refer to On-Board Diagnostics in the Multi-Port Fuel Injection—General Diagnosis section of Group 14, Fuel Systems for more information. Also refer to the appropriate Powertrain Diagnostics Procedures service manual for operation of the DRB Scan Tool.

## INTAKE MANIFOLD AIR TEMPERATURE SENSOR TEST

For an operational description, diagnosis or removal/ installation procedures, refer to Group 14, Fuel Systems.

## MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR TEST

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

## POWERTRAIN CONTROL MODULE (PCM)

The PCM (formerly referred to as the SBEC or engine controller) is located in the engine compartment behind the windshield washer fluid tank on YJ models (Fig. 17). It is located in the engine compartment next to the air cleaner on XJ models (Fig. 18).

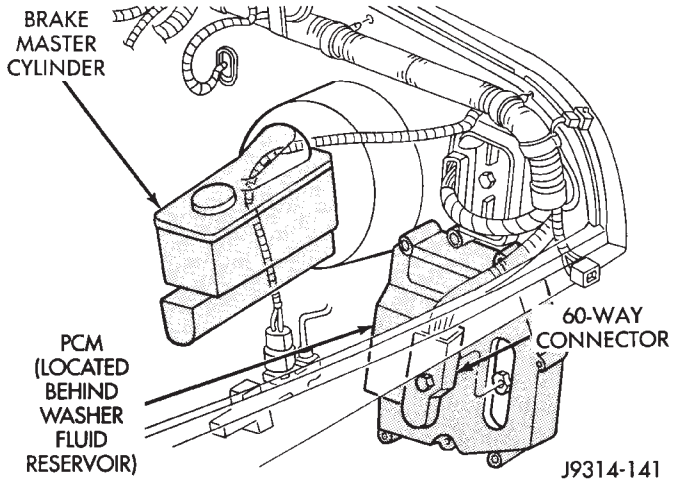


*Fig. 17 PCM Location—YJ Models*

The ignition system is controlled by the PCM.

For removal and installation of this component, refer to the Component Removal/Installation section of this group.

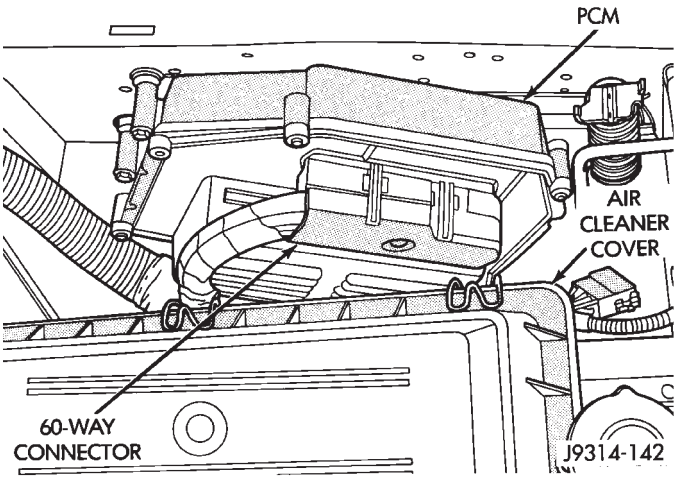


*Fig. 18 PCM Location—XJ Models*

For diagnostics, refer to the appropriate Powertrain Diagnostic Procedures service manual for operation of the DRB scan tool.

## SPARK PLUGS

For spark plug removal, cleaning, gap adjustment and installation, refer to the Component Removal/Installation section of this group.

Faulty carbon and/or gas fouled plugs generally cause hard starting, but they will clean up 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.

Remove the spark plugs and examine them for burned electrodes and fouled, cracked or broken porcelain insulators. For identification, 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 the maintenance chart in Group 0, Lubrication and Maintenance.

Spark plugs that have low mileage may be cleaned and reused if not otherwise defective. Refer to the following Spark Plug Condition section of this group.

### *CONDITION*

#### NORMAL OPERATING

The few deposits present on the spark plug will probably be light tan or slightly gray in color. This is evident with most grades of commercial gasoline (Fig. 19). 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, have the gap set and then be installed.

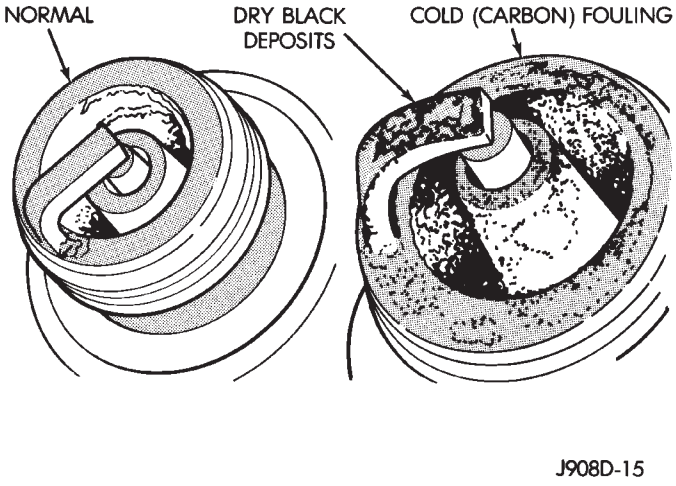


*Fig. 19 Normal Operation and Cold (Carbon) Fouling*

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

#### COLD FOULING/CARBON FOULING

Cold fouling is sometimes referred to as carbon fouling. The deposits that cause cold fouling are basically carbon (Fig. 19). 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 of spark plugs may be caused by a clogged air cleaner element or repeated short operating times (short trips).

#### WET FOULING OR GAS FOULING

A spark plug coated with excessive wet fuel or oil is wet fouled. In older engines, worn piston rings, leaking valve guide seals or excessive cylinder wear can cause wet fouling. In new or recently overhauled engines, wet fouling may occur before break-in (normal oil control) is achieved. This condition can usually be resolved by cleaning and reinstalling the fouled plugs.

#### OIL OR ASH ENCRUSTED

If one or more spark plugs are oil or oil ash encrusted (Fig. 20), evaluate engine condition for the cause of oil entry into that particular combustion chamber.

#### ELECTRODE GAP BRIDGING

Electrode gap bridging may be traced to loose deposits in the combustion chamber. These deposits accumulate on the spark plugs during continuous stop-and-go driving. When the engine is suddenly

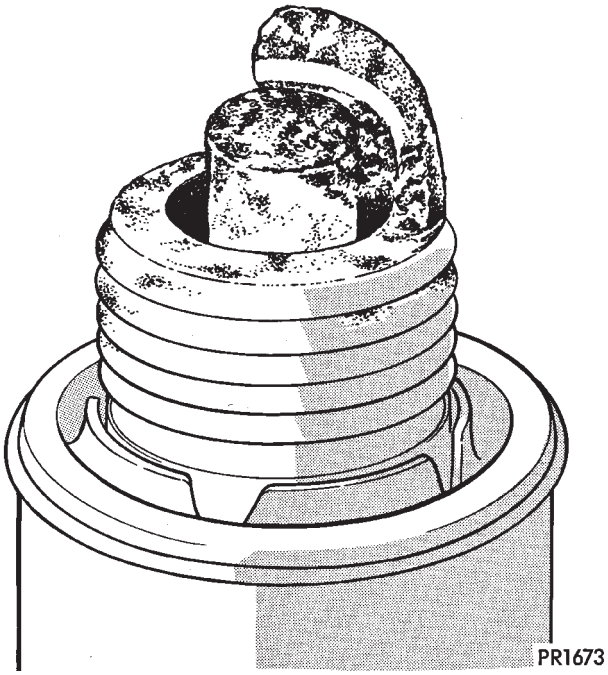


*Fig. 20 Oil or Ash Encrusted*

subjected to a high torque load, deposits partially liquefy and bridge the gap between electrodes (Fig. 21). This short circuits the electrodes. Spark plugs with electrode gap bridging can be cleaned using standard procedures.

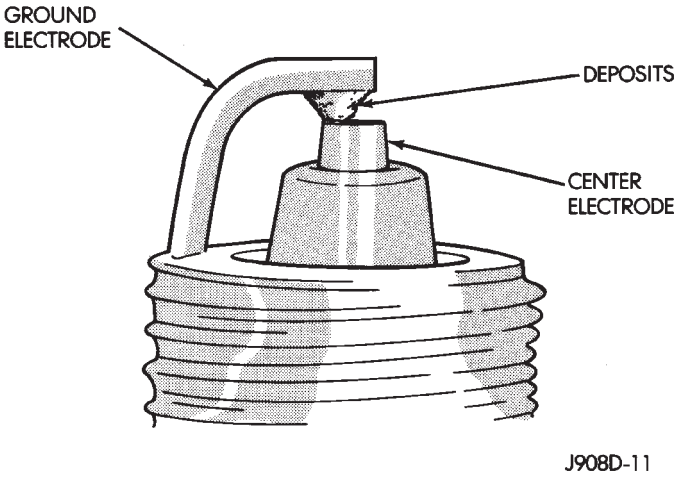


*Fig. 21 Electrode Gap Bridging*

**SCAVENGER DEPOSITS**

Fuel scavenger deposits may be either white or yellow (Fig. 22). They may appear to be harmful, but this is a normal condition caused by chemical additives in certain fuels. These additives are designed to change the chemical nature of deposits and decrease spark plug misfire tendencies. Notice that accumulation on the ground electrode and shell area may be heavy, but the deposits are easily removed. Spark plugs with scavenger deposits can be considered normal in condition and can be cleaned using standard procedures.

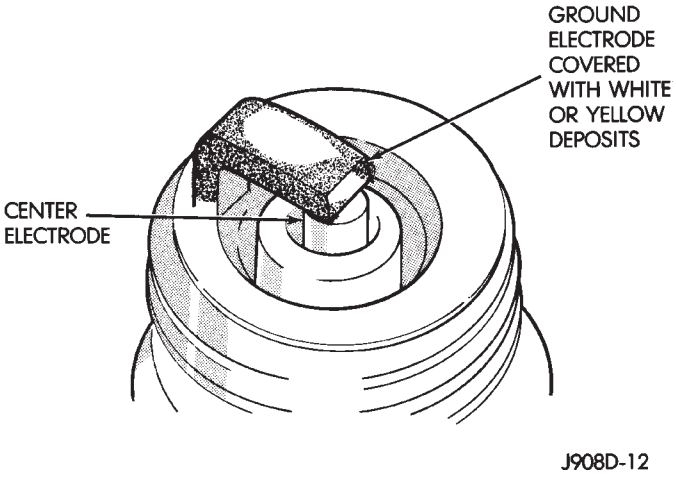


*Fig. 22 Scavenger Deposits*

**CHIPPED ELECTRODE INSULATOR**

A chipped electrode insulator usually results from bending the center electrode while adjusting the spark plug electrode gap. Under certain conditions, severe detonation can also separate the insulator from the center electrode (Fig. 23). Spark plugs with this condition must be replaced.

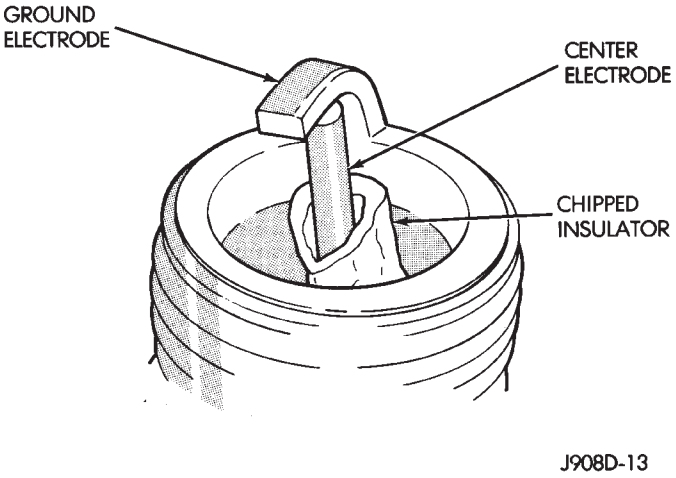


*Fig. 23 Chipped Electrode Insulator*

**PREIGNITION DAMAGE**

Preignition damage is usually caused by excessive combustion chamber temperature. The center electrode dissolves first and the ground electrode dissolves somewhat latter (Fig. 24). Insulators appear relatively deposit free. Determine if the spark plug has the correct heat range rating for the engine. Determine if ignition timing is over advanced, or if other operating conditions are causing engine overheating. (The heat range rating refers to the operating temperature of a particular type spark plug. Spark plugs are designed to operate within specific

temperature ranges. This depends upon the thickness and length of the center electrodes porcelain insulator.)

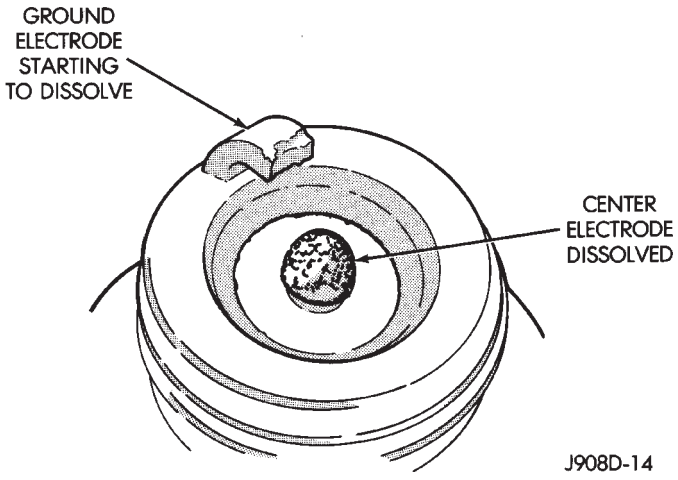


*Fig. 24 Preignition Damage*

**SPARK PLUG OVERHEATING**

Overheating is indicated by a white or gray center electrode insulator that also appears blistered (Fig. 25). The increase in electrode gap will be considerably in excess of 0.001 inch 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 can also cause spark plug overheating.

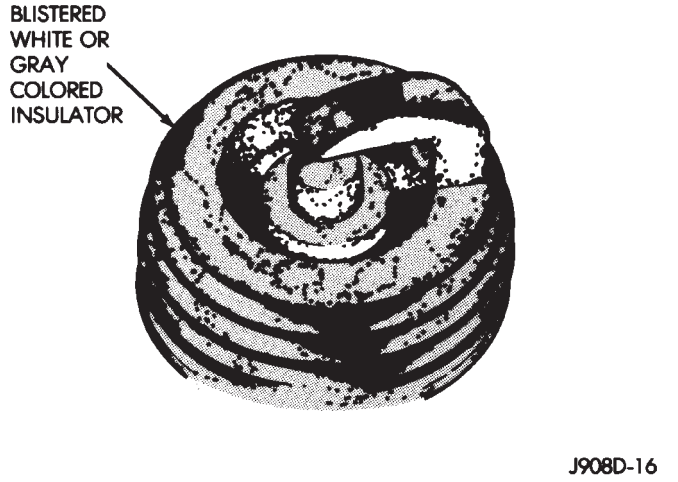


*Fig. 25 Spark Plug Overheating*

## SPARK PLUG SECONDARY CABLES

*TESTING*

Spark plug cables are sometimes referred to as secondary ignition cables or secondary wires. The cables transfer electrical current from the distributor 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 high-tension cable connections for good contact at the ignition coil, distributor cap towers and spark plugs. Terminals should be fully seated. The terminals and spark plug covers should be in good condition. Terminals should fit tightly to the ignition coil, distributor cap and spark plugs. The spark plug cover (boot) of the cable should fit tight around the spark plug insulator. Loose cable connections can cause corrosion and increase resistance, resulting in shorter cable service life.

Clean the high tension cables with a cloth moistened with a nonflammable solvent and wipe dry. Check for brittle or cracked insulation.

When testing secondary cables for damage with an oscilloscope, follow the instructions of the equipment manufacturer.

If an oscilloscope is not available, spark plug cables may be tested as follows:

**CAUTION: Do not leave any one spark plug cable disconnected for longer than necessary during testing. This may cause possible heat damage to the catalytic converter. Total test time must not exceed ten minutes.**

With the engine not running, connect one end of a test probe to a good ground. Start the engine and run the other end of the test probe along the entire length of all spark plug cables. If cables are cracked or punctured, there will be a noticeable spark jump from the damaged area to the test probe. The cable running from the ignition coil to the distributor cap can be checked in the same manner. Cracked, damaged or faulty cables should be replaced with resistance type cable. This can be identified by the words ELECTRONIC SUPPRESSION printed on the cable jacket.

Use an ohmmeter to test for open circuits, excessive resistance or loose terminals. Remove the distributor cap from the distributor. **Do not remove cables from cap.** Remove cable from spark plug. Connect ohmmeter to spark plug terminal end of cable and to corresponding electrode in distributor cap. Resistance should be 250 to 1000 Ohms per inch of cable. If not, remove cable from distributor cap tower and connect ohmmeter to the terminal ends of cable. If resistance is not within specifications as found in the Spark Plug Cable Resistance chart, replace the cable. Test all spark plug cables in this manner.

*SPARK PLUG CABLE RESISTANCE*

| 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 ignition coil-to-distributor cap cable, do not remove the cable from the cap. Connect ohmmeter to rotor button (center contact) of distributor cap and terminal at ignition coil end of cable. If resistance is not within specifications as found in the Spark Plug Cable Resistance chart, remove the cable from the distributor cap. Connect the ohmmeter to the terminal ends of the cable. If resistance is not within specifications as found in the Spark Plug Cable Resistance chart, replace the cable. Inspect the ignition coil tower for cracks, burns or corrosion.

For removal and installation of spark plug cables, refer to Spark Plug Secondary Cables in the Component Removal/Installation section.

## THROTTLE POSITION SENSOR TEST

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

## OXYGEN (O2S) SENSOR TESTS

For an operational description, diagnosis or removal/ installation procedures, refer to Group 14, Fuel Systems.

## ON-BOARD DIAGNOSTICS

### *FOR CERTAIN IGNITION SYSTEM COMPONENTS*

The powertrain control module (PCM) performs an On-Board Diagnostic (OBD) check for certain ignition system components on all vehicles. This is done by setting a diagnostic trouble code (DTC).

A DTC can be obtained in two different ways. One of the ways is by connecting the DRB scan tool to the data link connector. This connector is located in the engine compartment (Figs. 26 or 27). Refer to the appropriate Powertrain Diagnostic Procedures service manual for operation of the DRB scan tool. The other way is to cycle the ignition key and observe the malfunction indicator lamp (MIL). The MIL lamp is displayed on the instrument panel as the CHECK ENGINE lamp (Figs. 28 or 29). This lamp will flash a numeric code. If a numeric code number 11 (for the crankshaft position sensor) or 42 (for the ASD relay) is observed, a problem has been found in the ignition system.

Note that the CHECK ENGINE lamp will illuminate initially for approximately two seconds each time the ignition key is turned to the ON position. This is done for a bulb test.

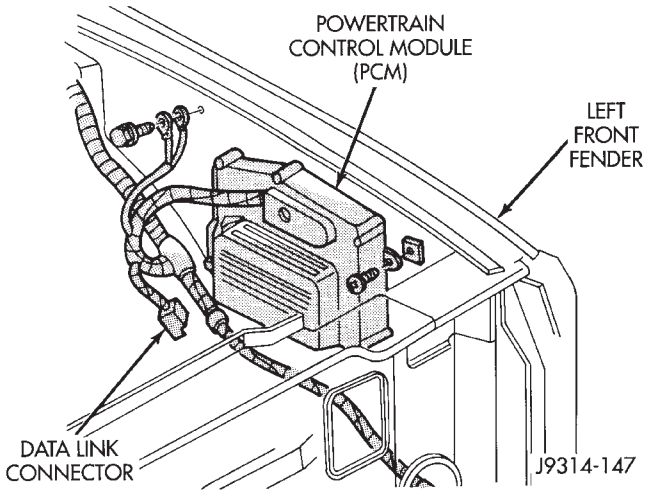


***Fig. 26 Data Link Connector—XJ Models—Typical***

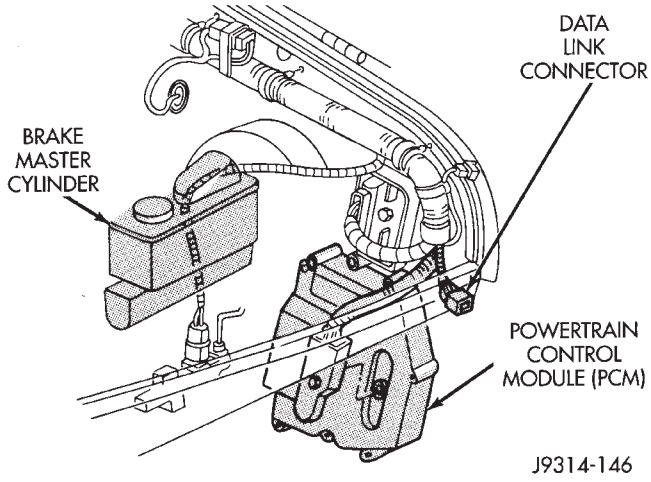


***Fig. 27 Data Link Connector—YJ Models—Typical***

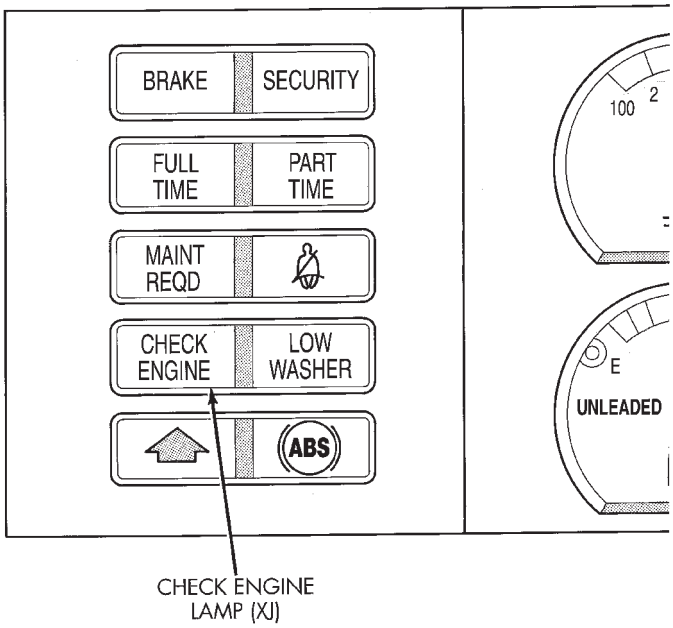


*Fig. 28 Check Engine Lamp—XJ Models—Typical*

**For a complete operational description of all DTC's, for accessing a DTC and for erasing a DTC, refer to On-Board Diagnostics. This can be found in the General Diagnosis sections of Group 14, Fuel System. For numeric flash lamp code charts, refer to Diagnostic Trouble Code (DTC). This can also be found in the General Diagnosis sections of Group 14, Fuel System.**

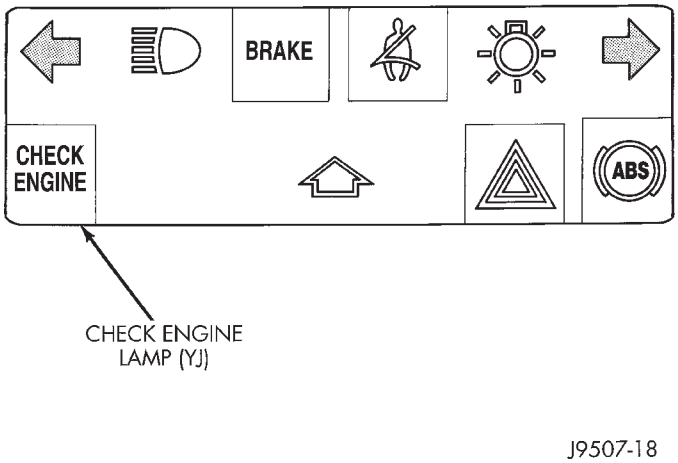


*Fig. 29 Check Engine Lamp—YJ Models—Typical*

# COMPONENT REMOVAL/INSTALLATION

## INDEX



## GENERAL INFORMATION

This section of the group, Component Removal/Installation, will discuss the removal and installation of ignition system components.

For basic ignition system diagnostics and service adjustments, refer to the Diagnostics/Service Procedures section of this group.

For system operation and component identification, refer to the Component Identification/System Operation section of this group.

## AUTOMATIC SHUTDOWN (ASD) RELAY

The ASD relay is installed in the power distribution center (PDC) (Figs. 1 or 2). Relay location is printed on the PDC cover.

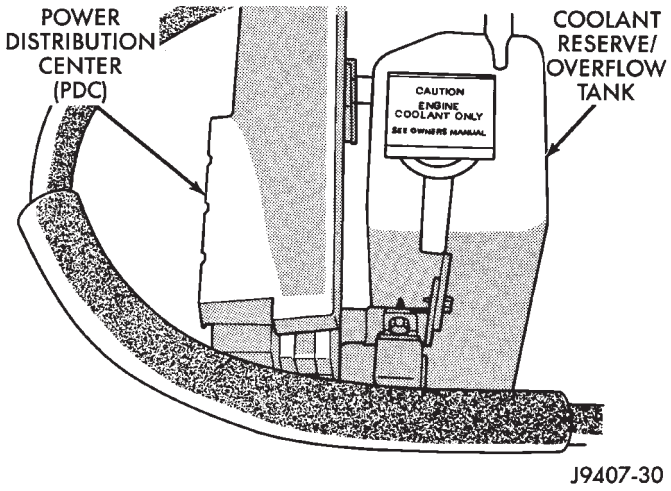


***Fig. 1 PDC—XJ Models***

*REMOVAL*

(1) Remove the PDC cover.
(2) Remove the relay by lifting straight up.

*INSTALLATION*

(1) Check the condition of relay wire terminals at PDC before installing relay. Repair as necessary.
(2) Push the relay into the connector.
(3) Install the relay cover.

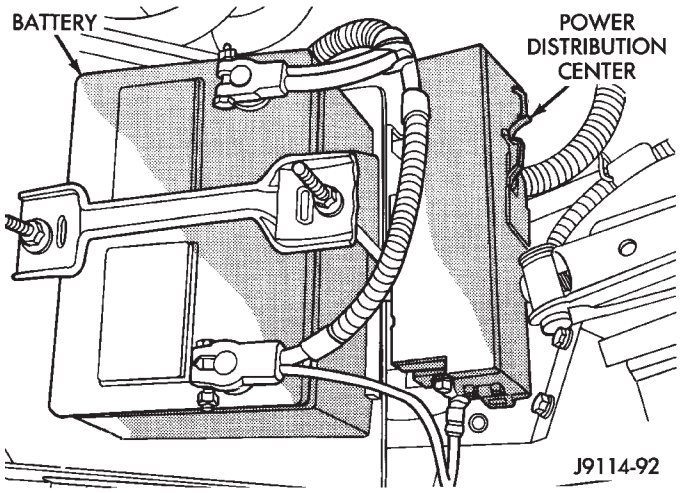


***Fig. 2 PDC—YJ Models***

## CAMSHAFT POSITION SENSOR

The camshaft position sensor is located in the distributor (Fig. 3).

*REMOVAL*

Distributor removal is not necessary to remove camshaft position sensor.

(1) Disconnect negative battery cable at battery.
(2) Remove distributor cap from distributor (two screws).
(3) Disconnect camshaft position sensor wiring harness from main engine wiring harness.
(4) Remove distributor rotor from distributor shaft.
(5) Lift the camshaft position sensor assembly from the distributor housing (Fig. 3).

*INSTALLATION*

(1) Install camshaft position sensor to distributor. Align sensor into notch on distributor housing.
(2) Connect wiring harness.
(3) Install rotor.
(4) Install distributor cap. Tighten mounting screws.

## CRANKSHAFT POSITION SENSOR

The crankshaft position sensor is mounted in the

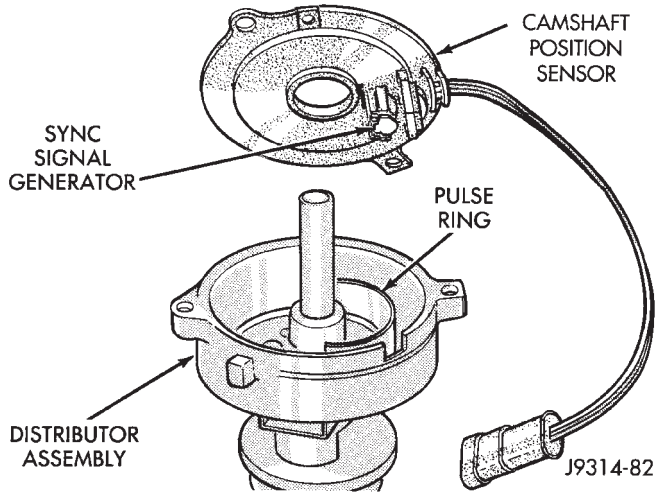


***Fig. 3 Camshaft Position Sensor***

transmission bellhousing at the left/rear side of the engine block (Figs. 4, 5 or 6).

On all 2.5L 4-cylinder and 4.0L 6-cylinder engines (except YJ models with an automatic transmission and 4.0L 6-cylinder engine) the sensor is attached with two bolts. The 2.5L 4-cylinder engine, when equipped with an automatic transmission, will have the sensor mounted with two nuts.

On YJ models with a 4.0L 6-cylinder engine and automatic transmission, the sensor is attached with a single bolt (Fig. 6).

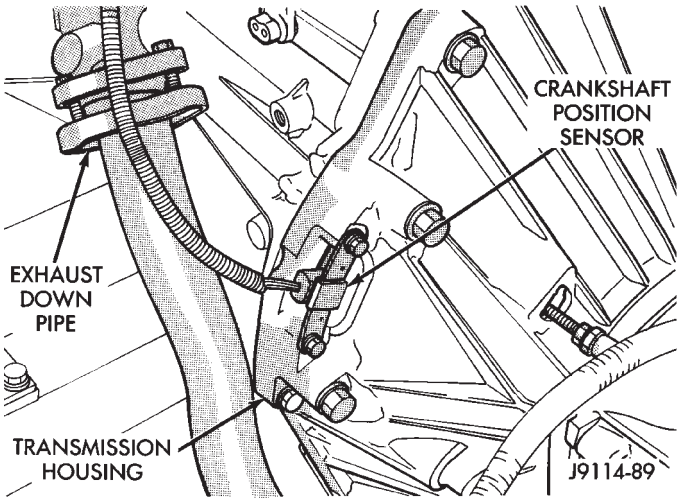


***Fig. 4 Crankshaft Position Sensor—2.5L 4-Cylinder Engine—Typical***

*REMOVAL—ALL ENGINES*

(1) Near the rear of the intake manifold, disconnect the pigtail harness (on the sensor) from the main electrical harness.

(2) Remove the nut holding sensor wire clip to fuel rail mounting stud.

(3) Depending upon application, remove either the sensor mounting bolt(s) or nuts.

(4) Remove the sensor.

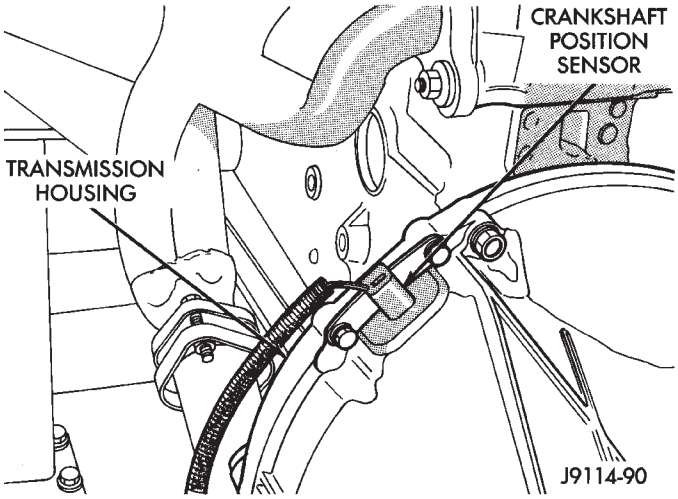


***Fig. 5 Crankshaft Position Sensor—4.0L 6-Cylinder Engine—All Except YJ models With Automatic Transmission***

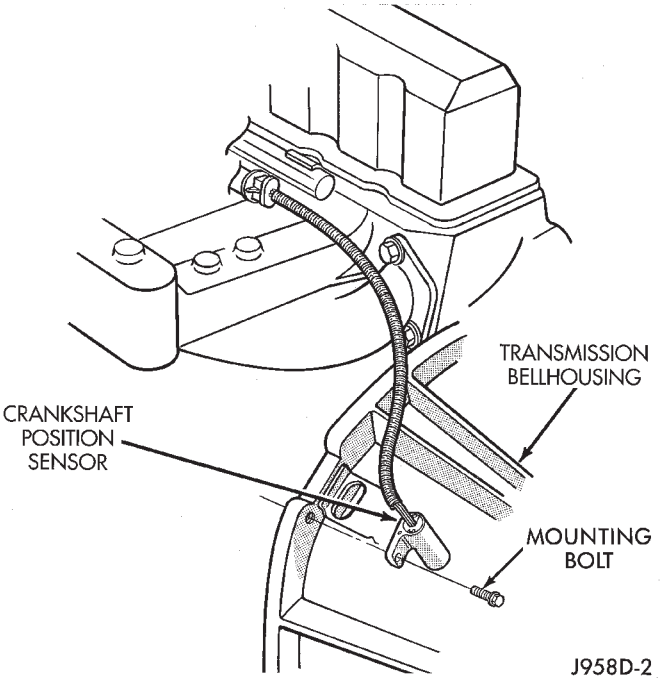


***Fig. 6 Crankshaft Position Sensor—4.0L 6-Cylinder Engine—YJ models With Automatic Transmission***

(5) Remove clip from sensor wire harness.

*INSTALLATION—ALL EXCEPT YJ MODELS WITH 4.0L 6-CYLINDER ENGINE AND AUTOMATIC TRANSMISSION*

(1) Install the sensor flush against the opening in the transmission housing.

(2) Install and tighten the two sensor mounting bolts (or nuts) to 19 N·m (14 ft. lbs.) torque.

**CAUTION: On some models, two bolts are used to secure the sensor to the transmission. These bolts are specially machined to correctly space the unit to the flywheel. Do not attempt to install any other bolts.**

(3) Connect the electrical connector to the sensor.
(4) Install clip on sensor wire harness.
(5) Install clip over fuel rail mounting stud. Install clip mounting nut.

*INSTALLATION—YJ MODELS WITH 4.0L 6-CYLINDER ENGINE AND AUTOMATIC TRANSMISSION*

(1) Install the sensor into the access hole on the transmission.
(2) Install sensor mounting bolt (Fig. 6).
(3) Tighten sensor mounting bolt to 6-to-8 N·m (50-to-70 in. lbs.) torque.
(4) Connect the electrical connector to sensor.
(5) Install the clip to sensor wire harness.
(6) Install clip over fuel rail mounting stud. Install clip mounting nut.

## ENGINE COOLANT TEMPERATURE SENSOR

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

## DISTRIBUTOR

*GENERAL INFORMATION*

All distributors contain an internal oil seal that prevents oil from entering the distributor housing. The seal is not serviceable.

Factory replacement distributors are equipped with a plastic alignment pin already installed. The pin is located in an access hole on the bottom of the distributor housing (Fig. 7). It is used to temporarily lock the rotor to the cylinder number 1 position during installation. The pin must be removed after installing the distributor.

The camshaft position sensor is located in the distributor on all engines (Fig. 8). For removal/installation procedures, refer to Camshaft Position Sensor. Distributor removal is not necessary for sensor removal.

Refer to figure 8 for an exploded view of the distributor.

A fork with a slot is supplied on the bottom of the distributor housing where the housing base seats against the engine block (Fig. 8). The centerline of the slot aligns with the distributor holddown bolt hole in the engine block. Because of the fork, the distributor cannot be rotated. Distributor rotation is not necessary as all ignition timing requirements are handled by the powertrain control module (PCM).

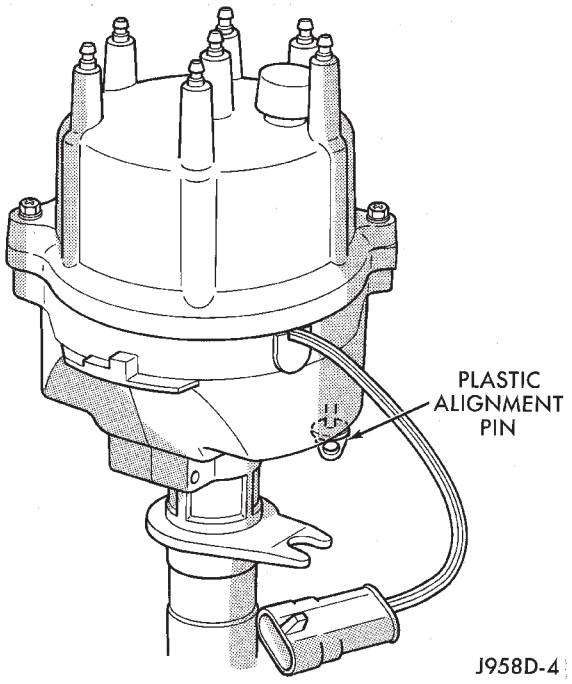


***Fig. 7 Plastic Alignment Pin***

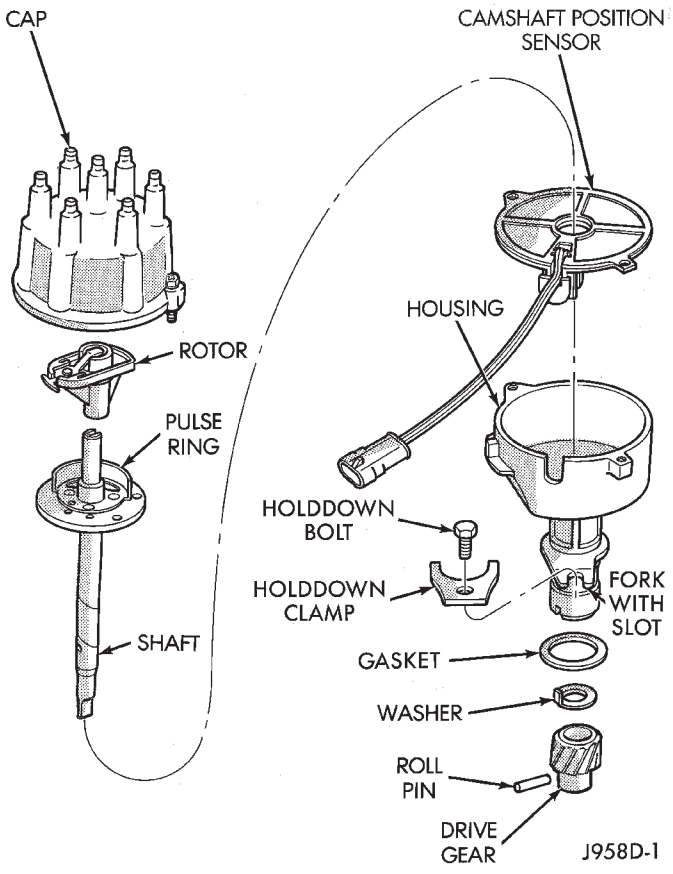


***Fig. 8 Distributor—2.5L Or 4.0L Engines—Typical***

The position of the distributor determines fuel synchronization only. It does not determine ignition timing.

**Do not attempt to modify this fork to attain ignition timing.**

*REMOVAL—2.5L OR 4.0L ENGINE*

(1) Disconnect the negative battery cable at the battery.

(2) Disconnect coil secondary cable at coil.

(3) Remove distributor cap from distributor (2 screws). Do not remove cables from cap. Do not remove rotor.

(4) Disconnect the distributor wiring harness from the main engine harness.

(5) Remove the cylinder number 1 spark plug.

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

Slowly continue to rotate the engine. Do this until the timing index mark on the vibration damper pulley aligns with the top dead center (TDC) mark (0 degree) on timing degree scale (Fig. 9). Always rotate the engine in direction of normal rotation. Do not rotate the engine backward to align the timing marks.

On XJ models equipped with A/C, remove the electrical cooling fan and shroud assembly from the radiator. Refer to Group 7, Cooling System for procedures.

This will provide room to turn the engine crankshaft with a socket and ratchet using the vibration damper bolt.

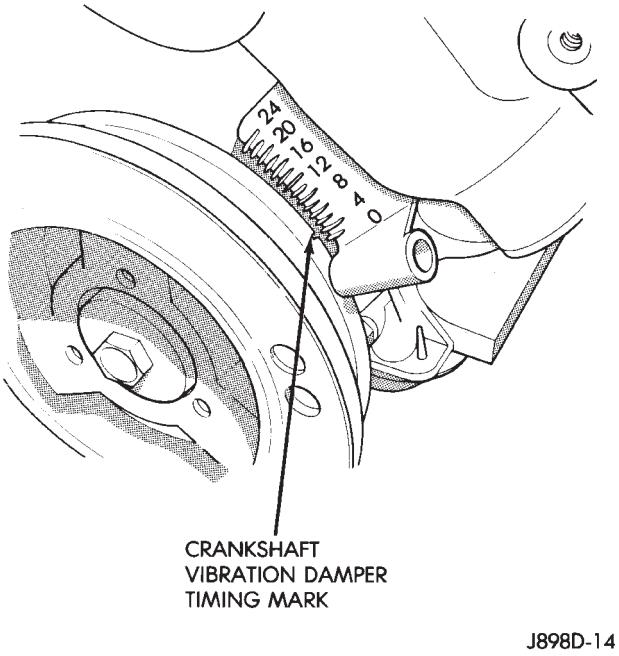


***Fig. 9 Align Timing Marks***

(7) Remove the distributor holddown bolt and clamp (Fig. 8).

(8) Remove the distributor from engine by slowly lifting straight up.

Note that the rotor will rotate slightly in a counterclockwise direction while lifting up the distributor. The oil pump gear will also rotate slightly in a counterclockwise direction while lifting up the distributor. This is due to the helical cut gears on the distributor and camshaft.

Note the removed position of the rotor during distributor removal. During installation, this will be referred to as the Pre-position.

**2.5L 4-Cylinder Engine:** Observe the slot in the oil pump gear through the hole on the side of the engine. It should be slightly before (counterclockwise of) the 10 o'clock position (Fig. 10).

**4.0L 6-Cylinder Engine:** Observe the slot in the oil pump gear through the hole on the side of the engine. It should be slightly before (counterclockwise of) the 11 o'clock position (Fig. 11).

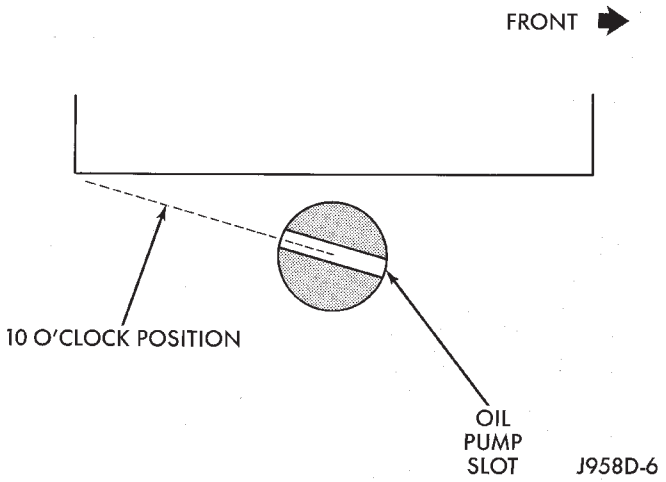


***Fig. 10 Slot At 10 O'clock Position—2.5L Engine***

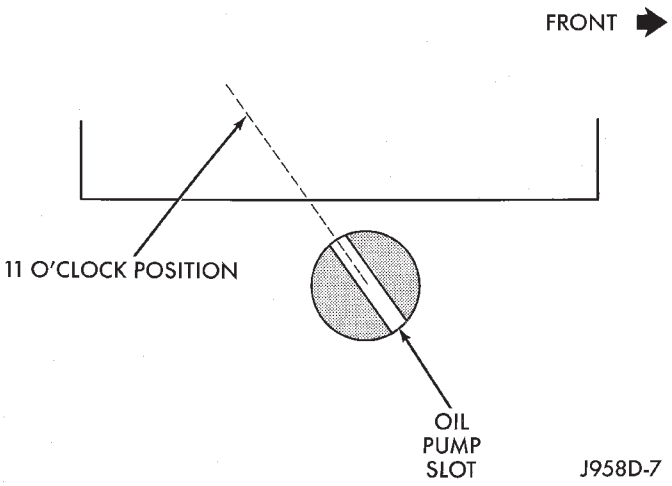


***Fig. 11 Slot At 11 O'clock Position—4.0L Engine***

(9) Remove and discard the old distributor-to-engine block gasket (Fig. 8).

*INSTALLATION*

(1) If the engine crankshaft has been rotated after distributor removal, cylinder number 1 must be returned to its proper firing stroke. Refer to the previous REMOVAL steps number 5 and 6. These steps must be done before installing distributor.

(2) Check the position of the slot on the oil pump gear. On the 2.5L engine, it should be just slightly before (counterclockwise of) the 10 o'clock position (Fig. 10). On the 4.0L engine, it should be just slightly before (counterclockwise of) the 11 o'clock position (Fig. 11). If not, place a flat blade screwdriver into the oil pump gear and rotate it into the proper position.

(3) Factory replacement distributors are equipped with a plastic alignment pin already installed (Fig. 7). This pin is used to temporarily hold the rotor to the cylinder number 1 firing position during distributor installation. If this pin is in place, proceed to step number 8. If not, proceed to step number 4.

(4) If the original distributor is to be reinstalled, such as during engine overhaul, the plastic pin will not be available. A 3/16 inch drift pin punch tool may be substituted for the plastic pin.

(5) Remove the camshaft position sensor from the distributor housing. Lift straight up.

(6) Four different alignment holes are provided on the plastic ring (Fig. 12). **Note that 2.5L and 4.0L engines have different alignment holes (Fig. 12).**

(7) Rotate the distributor shaft and install the pin punch tool through the proper alignment hole in the plastic ring (Fig. 12) and into the mating access hole in the distributor housing. This will prevent the distributor shaft and rotor from rotating.

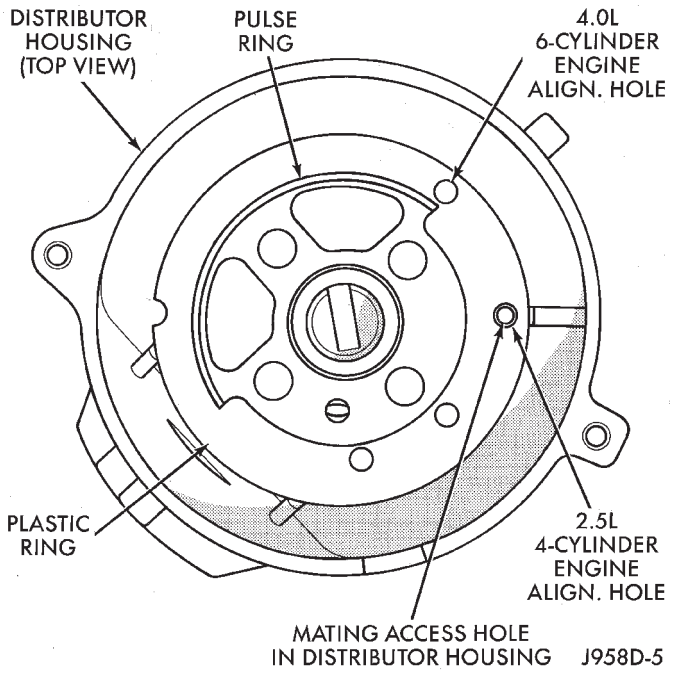


*Fig. 12 Pin Alignment Holes*

(8) Clean the distributor mounting hole area of the engine block.

(9) Install a new distributor-to-engine block gasket (Fig. 8).

(10) Install the rotor to the distributor shaft.

(11) **2.5L 4-Cylinder Engine:** Pre-position the distributor into the engine while holding the centerline of the base slot in the 1 o'clock position (Fig. 13). Continue to engage the distributor into the engine. The rotor and distributor will rotate clockwise during installation. This is due to the helical cut gears on the distributor and camshaft. When the distributor is fully seated to the engine block, the centerline of the base slot should be aligned to the clamp bolt mounting hole on the engine (Fig. 14). The rotor should also be pointed slightly past (clockwise of) the 3 o'clock position.

**4.0L 6-Cylinder Engine:** Pre-position the distributor into the engine while holding the centerline of the base slot in the 1 o'clock position (Fig. 13). Continue to engage the distributor into the engine. The rotor and distributor will rotate clockwise during installation. This is due to the helical cut gears on the distributor and camshaft. When the distributor is fully seated to the engine block, the centerline of the base slot should be aligned to the clamp bolt mounting hole on the engine (Fig. 15). The rotor should also be pointed at the 5 o'clock position.

It may be necessary to rotate the rotor and distributor shaft (very slightly) to engage the distributor shaft with the slot in the oil pump gear. The same may have to be done to engage the distributor gear with the camshaft gear.

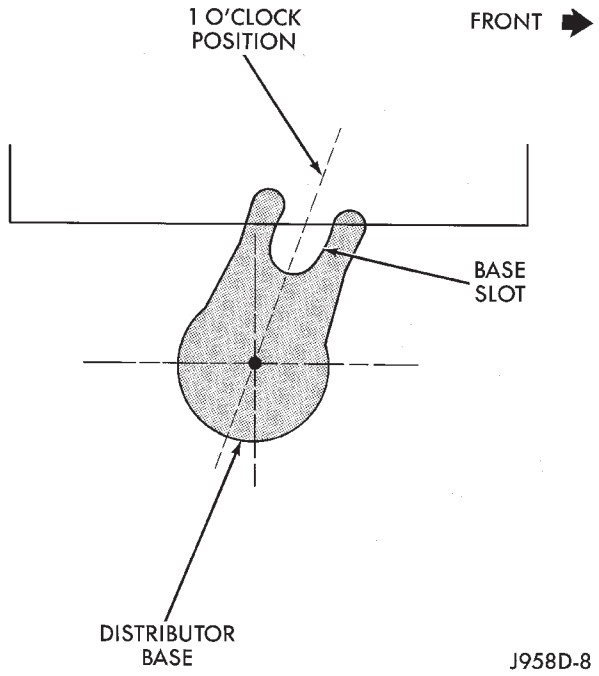


*Fig. 13 Distributor Pre-position—All Engines*

**The distributor is correctly installed when:**

- the rotor is pointed at the 3 o'clock position (2.5L engine), or at the 5 o'clock position (4.0L engine).
- the plastic alignment pin (or pin punch tool) is still installed to distributor.

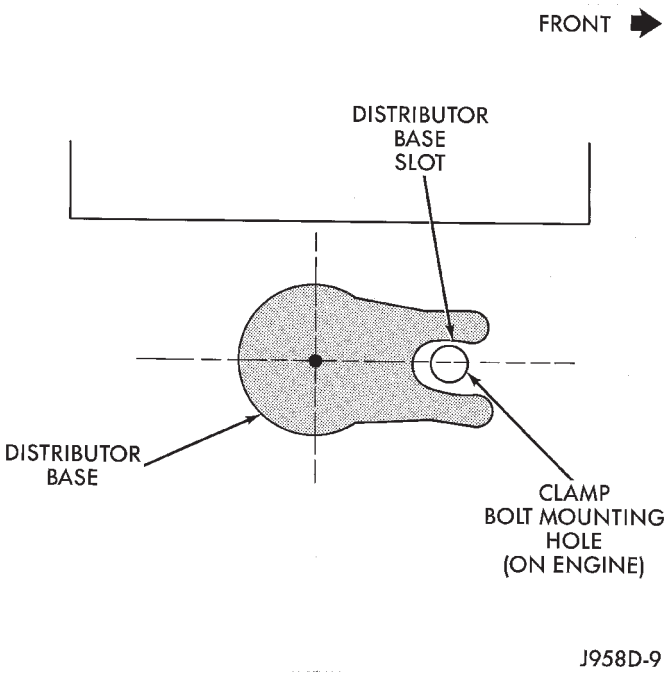


*Fig. 14 Distributor Engaged Position—2.5L 4-Cylinder Engine*

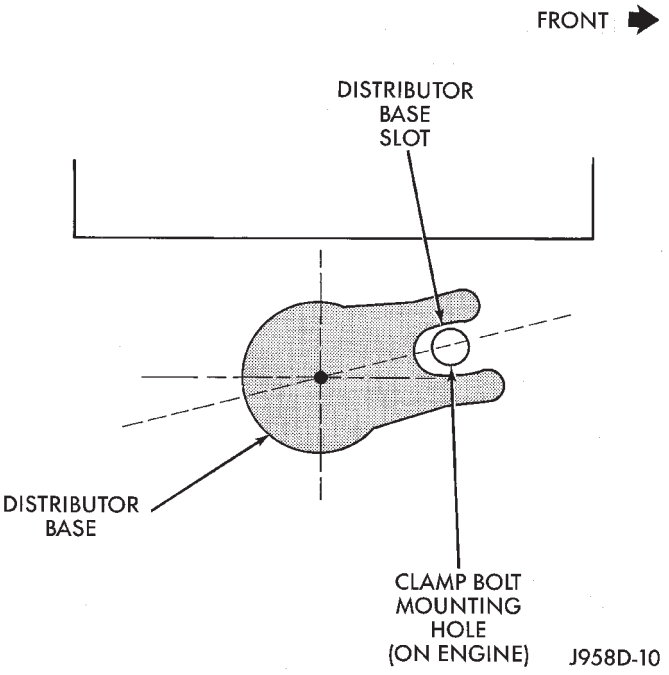


*Fig. 15 Distributor Engaged Position—4.0L 6-Cylinder Engine*

• the number 1 cylinder piston is set at top dead center (TDC) (compression stroke).
• the centerline of the slot at the base of the distributor is aligned to the centerline of the distributor holddown bolt hole on the engine. In this position, the holddown bolt should easily pass through the slot and into the engine.

No adjustments are necessary. Proceed to next step.

(12) Install the distributor holddown clamp and bolt. Tighten the bolt to 23 N·m (17 ft. lbs.) torque.

(13) Remove the pin punch tool from the distributor. Or, if the plastic alignment pin was used, remove it straight down from the bottom of the distributor. Discard plastic pin.

(14) If removed, install the camshaft position sensor to the distributor. Align the wiring harness grommet to the notch in the distributor housing.

(15) Install the rotor.

**CAUTION: If the distributor cap is incorrectly positioned on distributor housing, the cap or rotor may be damaged when engine is started.**

(16) Install the distributor cap. Tighten distributor cap holddown screws to 3 N·m (26 in. lbs.) torque.

(17) If removed, install the spark plug cables to the distributor cap. For proper firing order, refer to the Specifications section at the end of this group. See Engine Firing Order.

(18) Connect the distributor wiring harness to the main engine harness.

(19) Connect battery cable to battery.

## IGNITION COIL

The ignition coil is an epoxy filled type. If the coil is replaced, it must be replaced with the same type.

### *REMOVAL*

On the 2.5L 4-cylinder engine, the ignition coil is mounted to a bracket on the side of the engine (to the rear of the distributor).

On the 4.0L 6-cylinder engine, the ignition coil is mounted to a bracket on the side of the engine (to the front of the distributor) (Fig. 16).

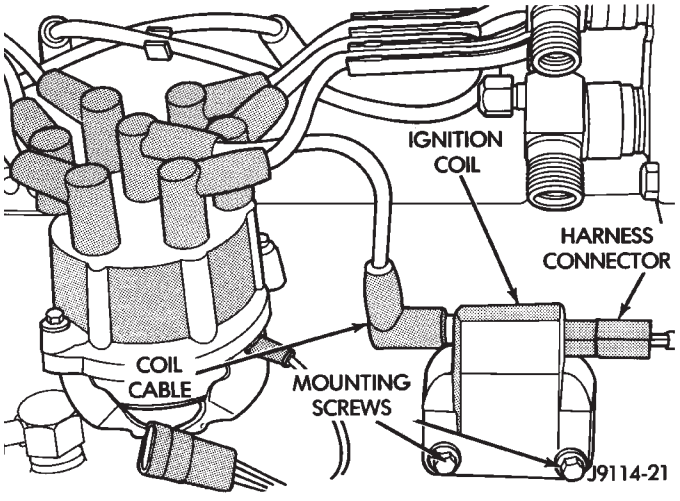


*Fig. 16 Ignition Coil—Typical (4.0L Shown)*

(1) Disconnect the ignition coil secondary cable from ignition coil (Fig. 16).

(2) Disconnect engine harness connector from ignition coil.

(3) Remove ignition coil mounting bolts (nuts are used on back side of bracket). Remove coil.

*INSTALLATION*

(1) Install ignition coil to bracket on cylinder block with mounting bolts and nuts.
(2) Connect engine harness connector to coil.
(3) Connect ignition coil cable to ignition coil.

## INTAKE MANIFOLD AIR TEMPERATURE SENSOR

For an operational description, diagnosis or removal/ installation procedures, refer to Group 14, Fuel Systems.

## MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

## OXYGEN (O2S) SENSOR

For an operational description, diagnosis or removal/ installation procedures, refer to Group 14, Fuel Systems.

## POWERTRAIN CONTROL MODULE (PCM)

The PCM was formerly referred to as the SBEC or engine controller.

*XJ MODELS*

On XJ models, the PCM is located in the engine compartment next to the air cleaner (Fig. 17).

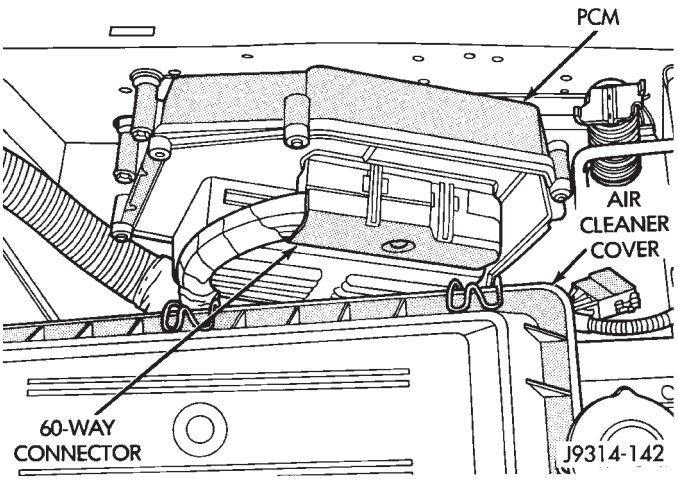


***Fig. 17 PCM Location—XJ Models***

**REMOVAL**

(1) Disconnect negative battery cable at battery.
(2) Loosen 60-way connector mounting screw until connector can be disengaged from PCM.
(3) Pull 60-way connector straight back from PCM.
(4) Remove PCM mounting bolts.
(5) Remove PCM from vehicle.

**INSTALLATION**

(1) Check the pins in the PCM 60-way electrical connector for damage. Repair as necessary.
(2) Install PCM. Tighten mounting bolts to 1 N·m (9 in. lbs.) torque.
(3) Engage 60-way connector into PCM. Tighten connector mounting screw to 4 N·m (35 in. lbs.) torque.
(4) Connect battery cable to battery.

*YJ MODELS*

On YJ models, the PCM is located in the engine compartment behind the windshield washer fluid reservoir (Fig. 18).

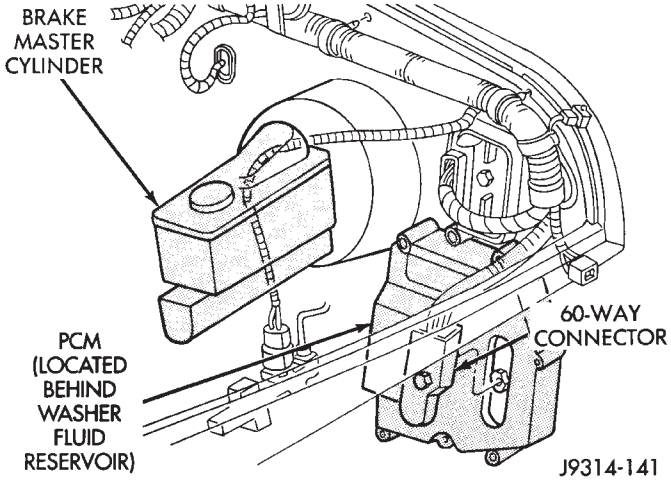


***Fig. 18 PCM Location—YJ Models***

**REMOVAL**

(1) Disconnect negative battery cable at battery.
(2) Remove windshield washer fluid reservoir.
(3) Loosen 60-way connector mounting screw until connector can be disengaged from PCM.
(4) Pull 60-way connector straight back from PCM.
(5) Remove PCM mounting bolts.
(6) Remove PCM from vehicle.

**INSTALLATION**

(1) Check the pins in the PCM 60-way electrical connector for damage. Repair as necessary.
(2) Install PCM. Tighten mounting bolts to 1 N·m (9 in. lbs.) torque.
(3) Engage 60-way connector into PCM. Tighten connector mounting screw to 4 N·m (35 in. lbs.) torque.
(4) Connect battery cable to battery.
(5) Install washer fluid reservoir.

## SPARK PLUGS

*PLUG REMOVAL*

(1) Always remove spark plug or ignition coil cables by grasping at the cable boot (Fig. 19). Turn the cable boot 1/2 turn and pull straight back in a steady

motion. Never pull directly on the cable. Internal damage to cable will result.

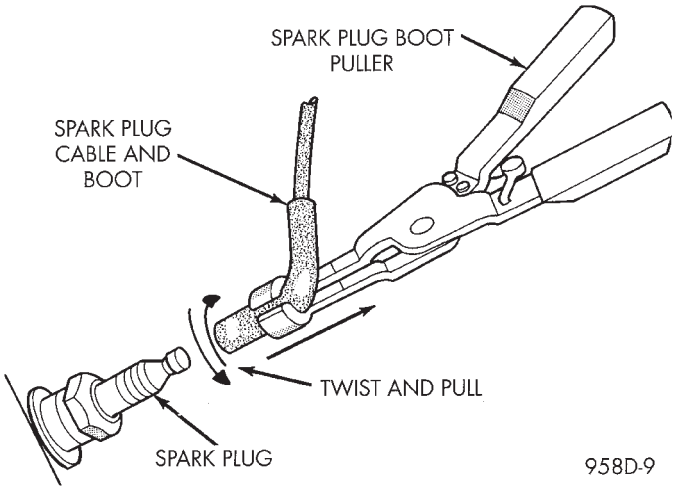


***Fig. 19 Cable Removal***

(2) Prior to removing the spark plug, spray compressed air around the spark plug hole and the area around the spark plug. This will help prevent foreign material from entering the combustion chamber.

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

(4) Inspect the spark plug condition. Refer to Spark Plugs in the Diagnostics/Service Procedures section of this group.

### PLUG CLEANING

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

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

### PLUG GAP ADJUSTMENT

Check the spark plug gap with a gap gauge tool. If the gap is not correct, adjust it by bending the ground electrode (Fig. 20). **Never attempt to adjust the gap by bending the center electrode.**

### SPARK PLUG GAP

- 2.5L 4-Cylinder Engine Spark Plug Gap: .89 mm (.035 in).
- 4.0L 6-Cylinder Engine Spark Plug Gap: .89 mm (.035 in).

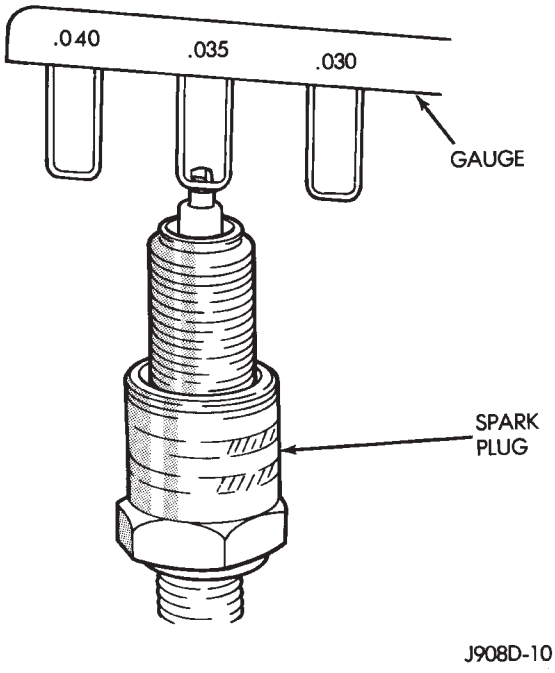


***Fig. 20 Setting Spark Plug Gap—Typical***

### PLUG INSTALLATION

Always tighten spark plugs to the specified torque. Over tightening can cause distortion. This may result in a change in the spark plug gap, or a cracked porcelain insulator.

When replacing the spark plug and ignition 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. It could cause cross ignition of the spark plugs, or short circuit the cables to ground.

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

(2) Tighten the spark plugs to 35-41 N·m (26-30 ft. lbs.) torque.

(3) Install spark plug cables over spark plugs.

## SPARK PLUG SECONDARY CABLES

**CAUTION: When disconnecting a high voltage cable from a spark plug or from the distributor cap, twist the rubber boot slightly (1/2 turn) to break it loose (Fig. 19). Grasp the boot (not the cable) and pull it off with a steady, even force.**

Install cables into the proper engine cylinder firing order (Figs. 21 or 22).

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

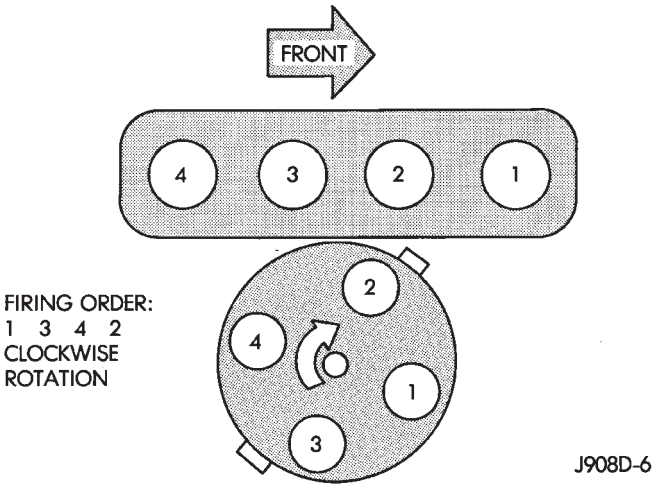


*Fig. 21 Engine Firing Order—2.5L 4-Cylinder Engine*

When installing new cables, make sure a positive connection is made. A snap should be felt when a good connection is made between the plug cable and the distributor cap tower.

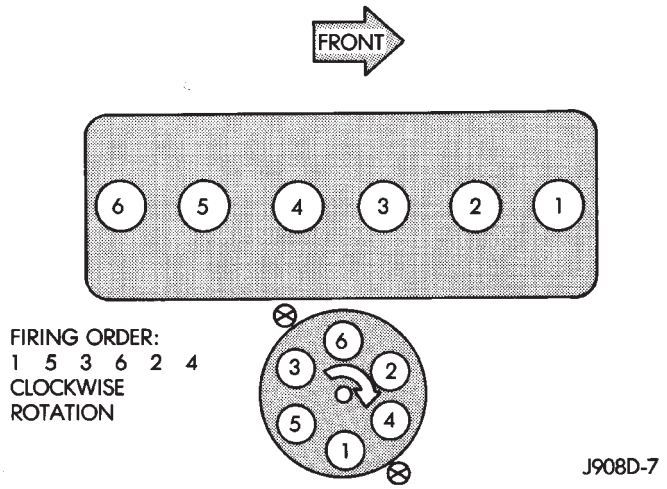


*Fig. 22 Engine Firing Order—4.0L 6-Cylinder Engine*

## THROTTLE POSITION SENSOR (TPS)

For an operational description, diagnosis and removal/installation procedures, refer to Group 14, Fuel System.

## IGNITION SWITCH—XJ MODELS

### IGNITION SWITCH AND KEY CYLINDER SERVICE

The ignition switch is located on the steering column. The Key-In-Switch and Halo Light are integral with the ignition switch. Refer to Group 8U for Key-In-Switch and Halo Light diagnosis for XJ models.

Refer to Group 8W, Wiring for ignition switch wiring circuits.

*REMOVAL*

(1) Disconnect negative battery cable from battery.

(2) If vehicle has a tilt column, remove tilt lever by turning it counterclockwise.

(3) Remove upper and lower covers from steering column (Fig. 1).

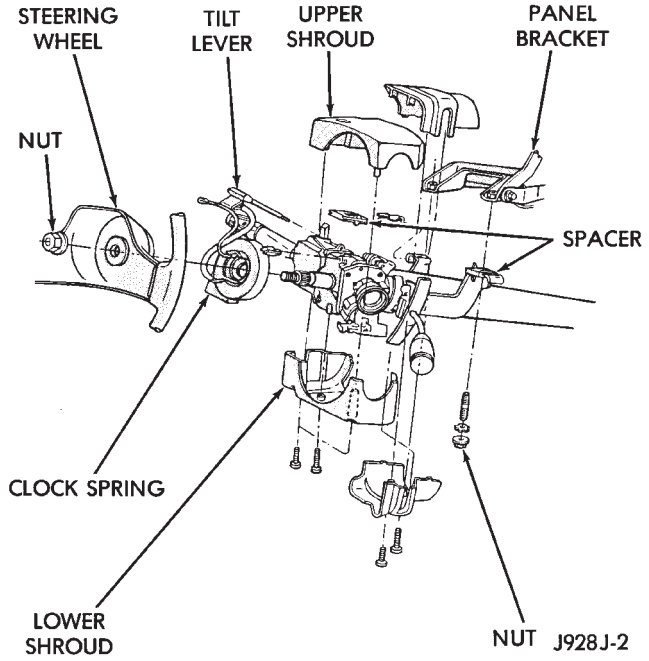


***Fig. 1 Shroud Removal/Installation—Typical***

(4) Remove ignition switch mounting screws. Use tamper proof torx bit Snap-on TTXR20A2 or equivalent to remove the screws (Fig. 2 or 3).

(5) Gently pull switch away from column. Release connector locks on 7-terminal wiring connector, then remove connector from ignition switch.

(6) Release connector lock on 4-terminal connector, then remove connector from ignition switch (Fig. 4).

(7) To remove key cylinder from ignition switch:

(a) Insert key in ignition switch. Turn key to LOCK position. Using a TTXR20A2 or equivalent torx bit, remove key cylinder retaining screw and bracket (Fig. 5 or 6).

(b) Rotate key clockwise to the OFF position. Key cylinder will unseat from ignition switch (Fig. 7). When key cylinder is unseated, it will be approximately 1/8 inch away from ignition switch halo light ring. **Do not attempt to remove key cylinder at this time.**

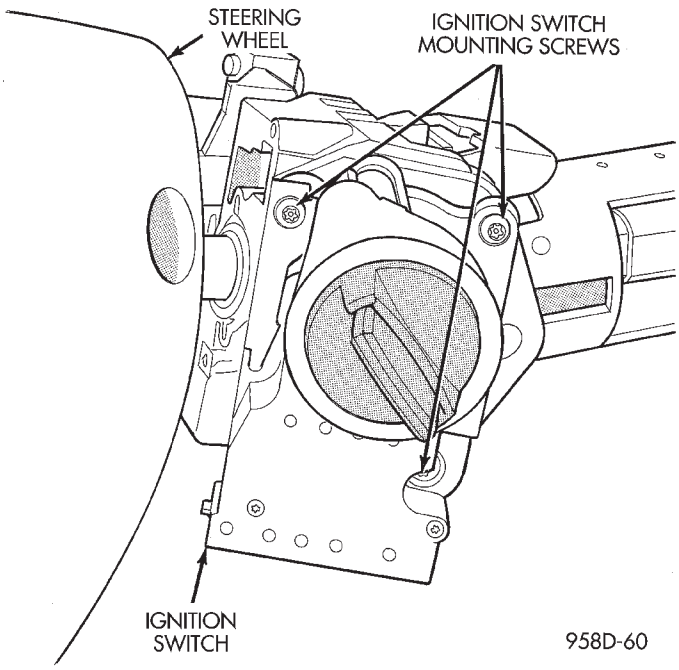


***Fig. 2 Ignition Switch Screw Removal***

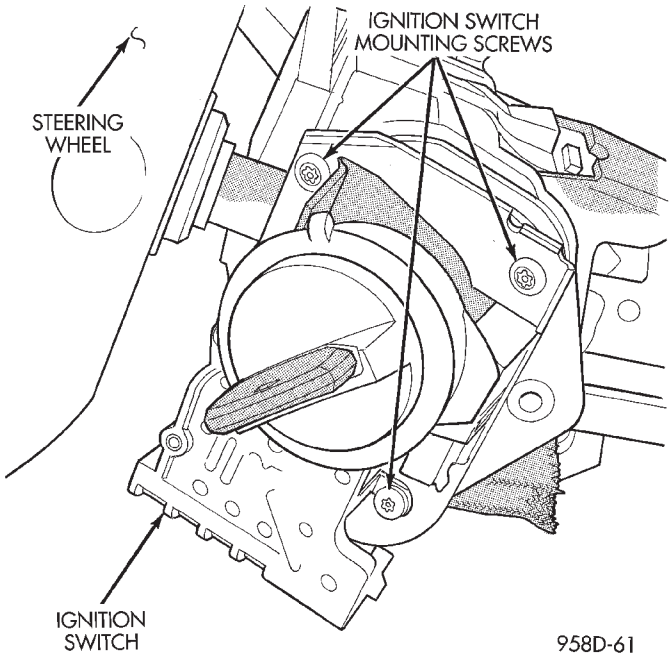


***Fig. 3 Ignition Switch Screw Removal***

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

(d) Remove key cylinder from ignition switch (Fig. 8).

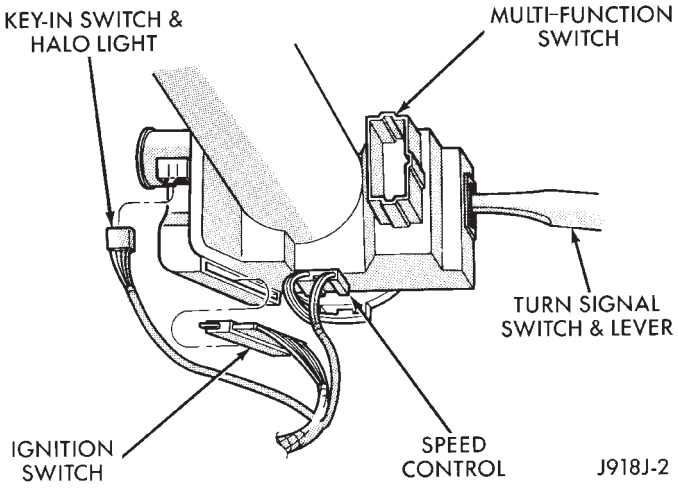


***Fig. 4 Key-In-Switch and Halo Lamp Connector***

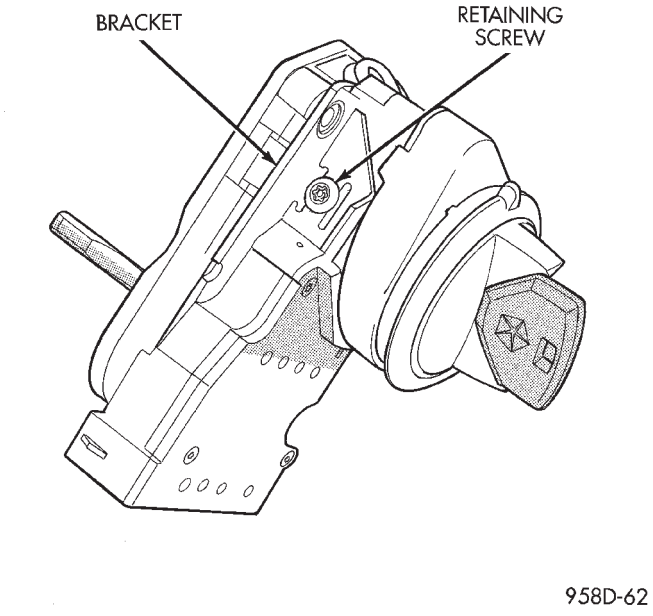


***Fig. 5 Key Cylinder Retaining Screw***

*INSTALLATION*

(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. The park lock dowel pin and column lock flag must also be properly indexed before installing switch (Fig. 9).

(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. 9).

(c) Position ignition switch park lock dowel pin so it will engage steering column park lock slider linkage (Fig. 10).

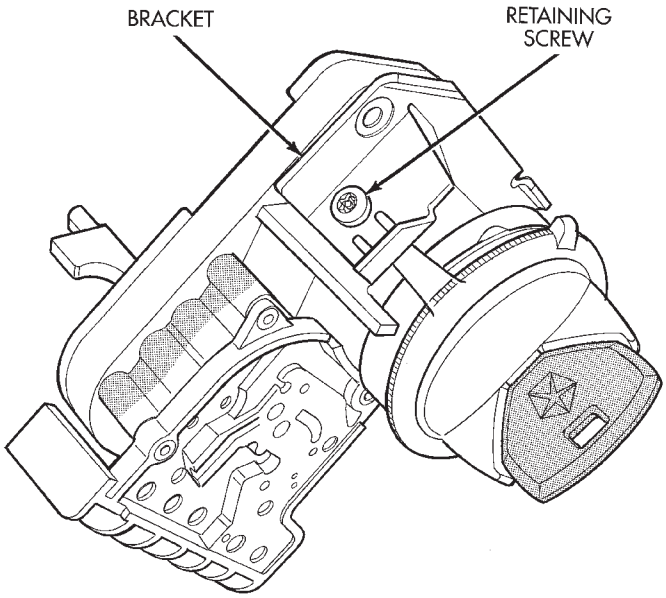


***Fig. 6 Key Cylinder Retaining Screw***

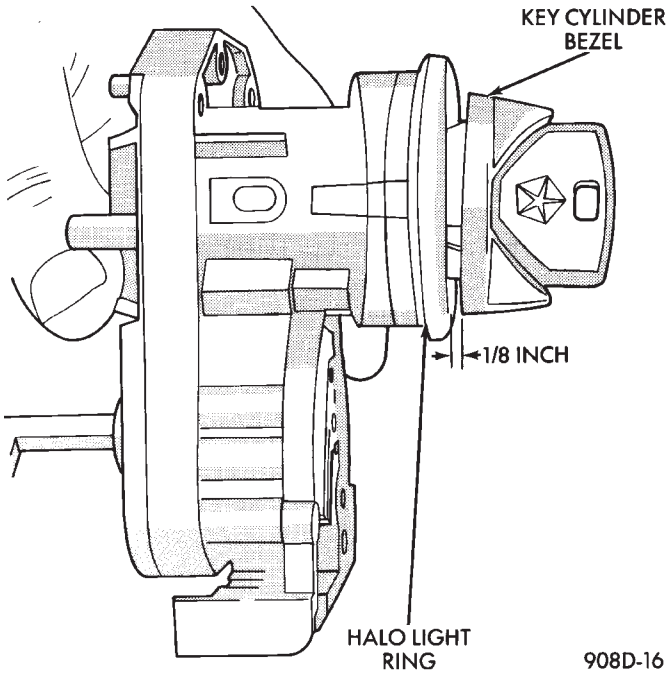


***Fig. 7 Unseated Key Cylinder***

(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:

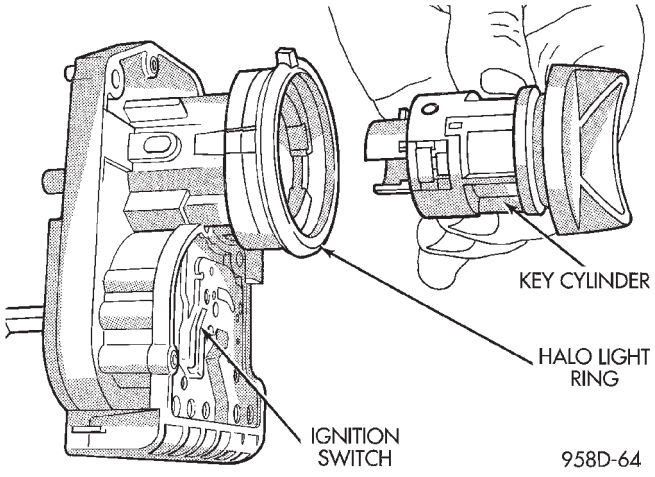


*Fig. 8 Key Cylinder Removal*

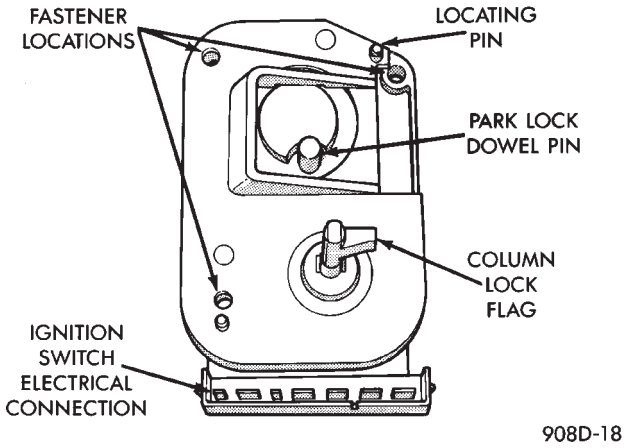


*Fig. 9 Ignition Switch View From Column*

(a) With lock cylinder and ignition switch in Lock position, insert lock cylinder into ignition switch until it bottoms.

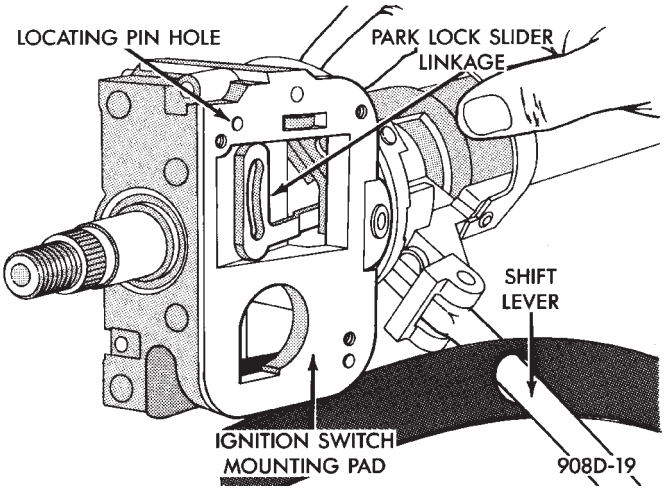


*Fig. 10 Ignition Switch Mounting Pad*

(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.

# IGNITION SWITCH—YJ MODELS

## GENERAL INFORMATION

**This section will cover the electrical portion of the ignition switch. To service the mechanical ignition key switch, refer to Group 19, Steering.**

Refer to Group 8W, Wiring for ignition switch wiring circuits.

The ignition switch is mounted under the instrument panel on the lower section of the steering column. The headlamp dimmer switch is mounted beside the ignition switch (Fig. 11). Both of these switches (ignition and dimmer) share the same mounting screws.

The switch is connected to the ignition key lock assembly by a remote actuator rod. This remote actuator rod fits into an access hole on the bottom of the ignition switch (Fig. 12).

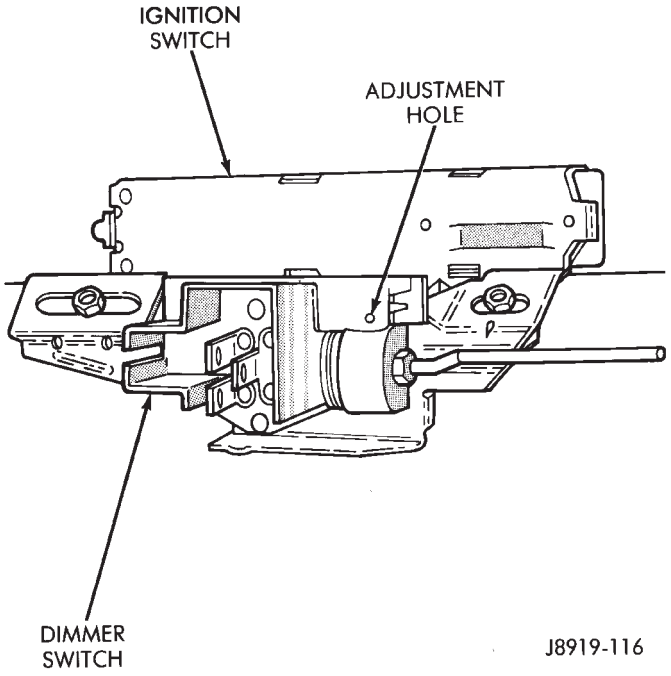


***Fig. 11 Ignition Switch/Headlamp Dimmer Switch—Typical***

### REMOVAL

(1) Disconnect the negative battery cable at the battery.

(2) Remove the windshield wiper intermittent control module and its bracket (if equipped).

(3) Place the ignition key lock in ACCESSORY position.

(4) Remove the two headlamp dimmer switch attaching nuts. Lift the switch from steering column while disengaging actuator rod.

**Before removing dimmer switch, tape the two remote control actuator rods (ignition switch and dimmer) to the steering column. This will prevent accidental disengagement from the upper part of the steering column.**

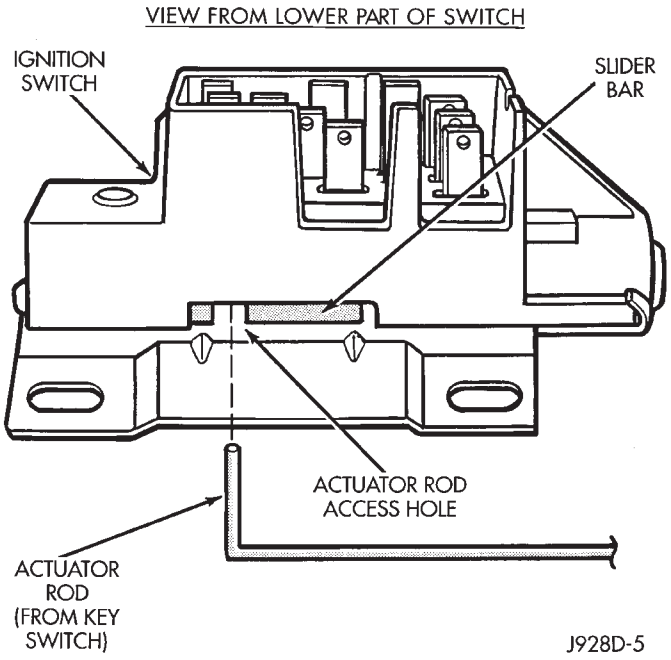


***Fig. 12 Ignition Switch/Remote Actuator Rod—Typical***

(5) Remove the ignition switch-to-steering column attaching screws.

(6) Disengage the ignition switch from the remote actuator rod by lifting straight up. Remove switch from steering column.

(7) Remove wiring from switch as follows:

Two electrical connectors are used to connect all wiring to the ignition switch. One of the connectors is installed (interlocked) over the top of the other connector. Remove wiring from switch by disconnecting the (black) harness connector first and then the other connector. Remove the switch from the vehicle.

### SWITCH TESTING

To test the ignition switch circuity and continuity, proceed as follows. Place the slide bar (on the ignition switch) (Fig. 12) into the detent position to be tested. An ohmmeter or continuity light may be used to check switch continuity. Refer to the Ignition Switch Continuity Tests chart for continuity tests. Refer to (Fig. 13) for the lettered/numbered terminal positions. **All wiring must be disconnected from the ignition switch before performing any continuity testing.**

There are five positions on the ignition switch. The switch positions (in order) are: ACCESSORY, OFF-LOCK, OFF, ON AND START (Figs. 14 or 15). Each position has a detent stop (except START), which is

spring loaded to release when the key is released.

The maximum voltage drop between any two connected terminals should not exceed 12.5 millivolts per amp. For example: If a 10 amp load is drawn through the switch, maximum voltage drop should be 10 x 0.0125 or 0.125 volt.

### IGNITION SWITCH CONTINUITY TESTS

| SWITCH DETENT POSITION | NORMAL CIRCUIT CONTINUITY |
|---|---|
| START | Between I-1, B-1 and S.<br>G-1 and G-2 to switch case (ground). |
| ON | Between I-1, A, I-3 to B-1, B-2 and B-3. |
| OFF | Between B-1, B-2 and B-3 only. |
| OFF-LOCK | Between B-1, B-2 and B-3 only. |
| ACCESS. | Between A and B-2. |
| Note: Circuits B-1, B-2 and B-3 are commonly connected and will show continuity at all times. | |

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### INSTALLATION/ADJUSTMENT

(1) Place the key lock switch in the ACCESSORY position.

(2) Place the slider bar (in the ignition switch) (Fig. 12) into the ACCESSORY detent position.

(3) Connect the wiring to the switch as follows: Install the non-black (colored) connector first and then the black (colored) connector to the ignition switch. One connector will interlock the other connector.

(4) Slip the remote actuator rod into the access hole on the switch (Fig. 12). Install the switch to the steering column. Be careful not to move the slider bar (on the switch) out of the ACCESSORY detent position. Remove the ignition switch actuator rod securing-tape from steering column.

(5) Install the two ignition switch-to-steering column screws finger tight. **Do not tighten screws at this time.**

(6) Adjust ignition switch as follows:

(a) Non-tilt steering column: While holding key lock switch in ACCESSORY position, gently slide ignition switch **up** (towards steering wheel). This will remove slack from switch. Tighten attaching screws. Do not allow the ignition switch to move from the ACCESSORY detent position.

(b) Tilt steering column: While holding the key lock switch in the ACCESSORY position, gently slide the ignition switch **down** (away from steering wheel) to remove slack from switch. Tighten attaching screws. Do not allow the ignition switch to move from the ACCESSORY detent position.

Because the ignition switch and the headlamp dimmer switch share the same two mounting screws, one of the screws must be removed from the ignition switch. This must be done **after** the ignition switch has been adjusted and **before** the dimmer switch has been installed. Remove one screw. **Do not** remove the stud/nut.

(7) Install the headlamp dimmer switch as follows: Slip switch into actuator rod and position over the ig-

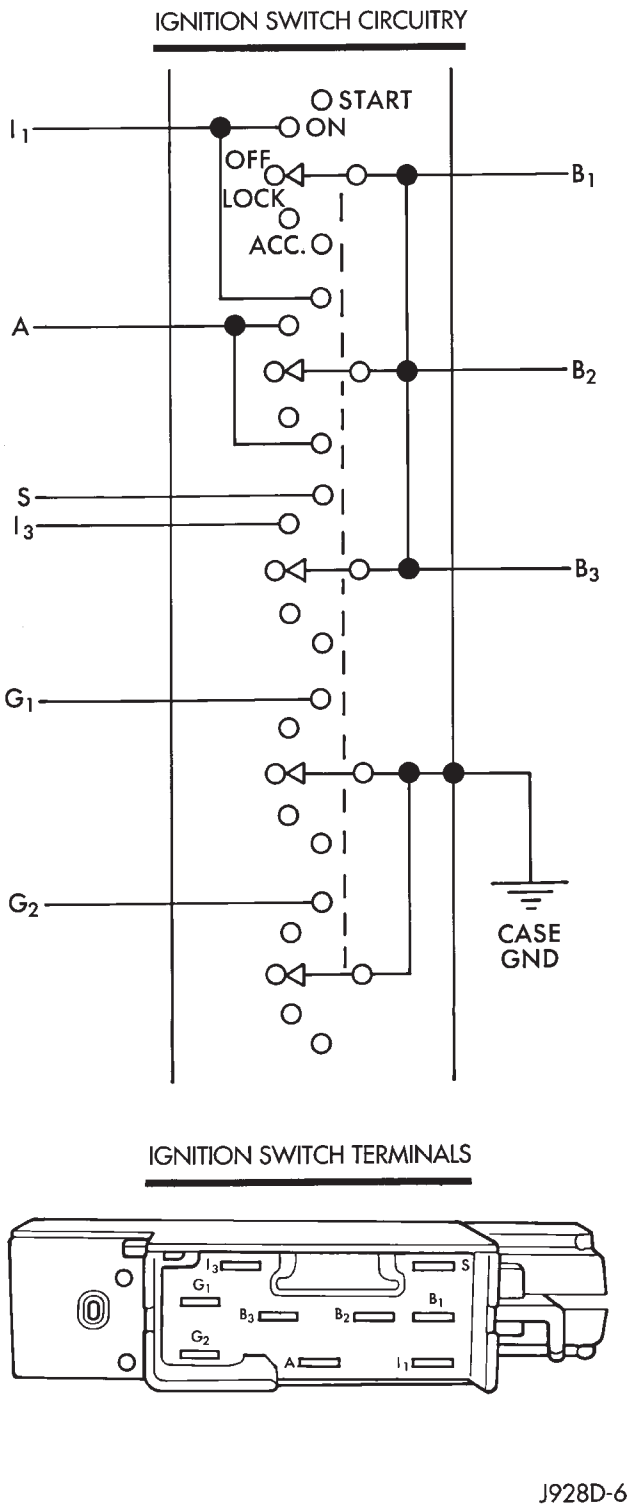


***Fig. 13 Ignition Switch Terminals/Circuits***

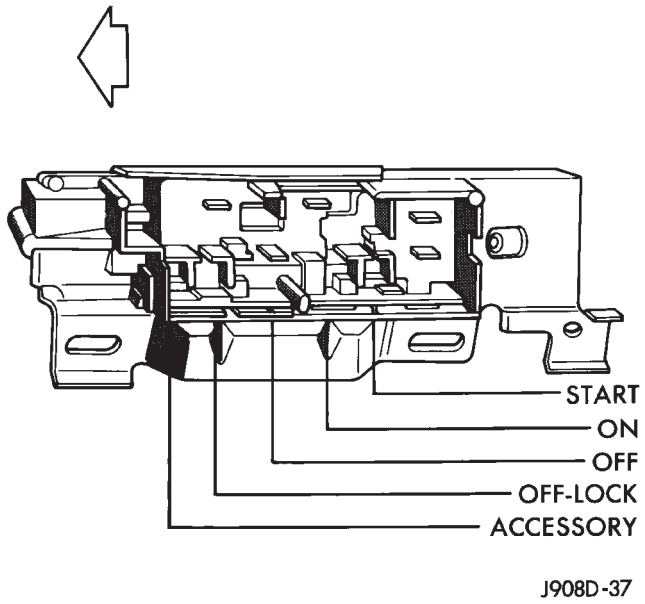


***Fig. 14 Detent Positions—Non-Tilt Steering Column***

nition switch. Install screws finger tight. Remove the dimmer switch actuator rod securing-tape from steering column.

(8) Adjust dimmer switch as follows: Depress the switch slightly and insert a 3/32-inch drill bit into the adjustment hole (Fig. 11). This is done to prevent horizontal switch movement.

(9) Move switch toward steering wheel to remove any lash from switch actuator rod. Tighten dimmer and ignition switch fasteners to 4 N·m (35 in. lbs.) torque.

(10) Install the windshield wiper intermittent control module and its bracket (if equipped).

(11) Install the negative battery cable.

Test dimmer switch. Test ignition switch operation in all switch positions. If equipped with a tilt steering column, test operation of dimmer switch and ignition switch in all tilt positions.

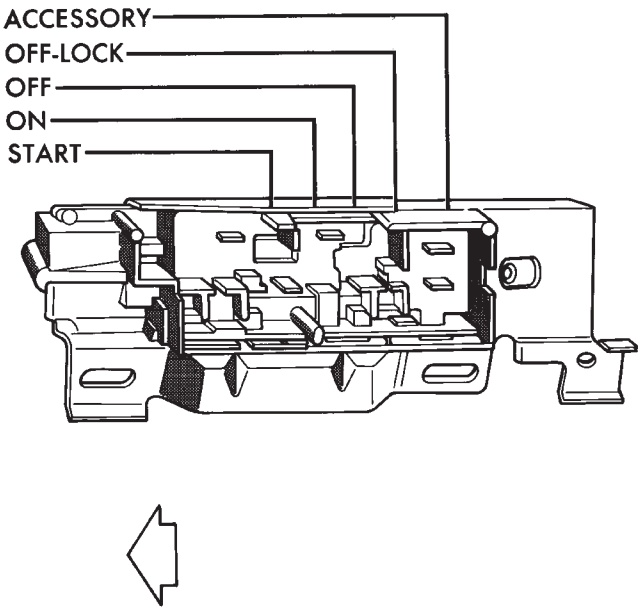


***Fig. 15 Detent Positions—Tilt Steering Column***

# SPECIFICATIONS

## GENERAL INFORMATION

The following specifications are published from the latest information available at the time of publication. **If anything differs between the specifications found on the Vehicle Emission Control Information (VECI) label and the following specifications, use specifications on VECI label.** The VECI label is located in the engine compartment.

### SPARK PLUGS

| ENGINE | PLUG TYPE | ELECTRODE GAP |
|---|---|---|
| 2.5L/4.0L | RC12LYC | 0.89 mm (0.035 in.) |

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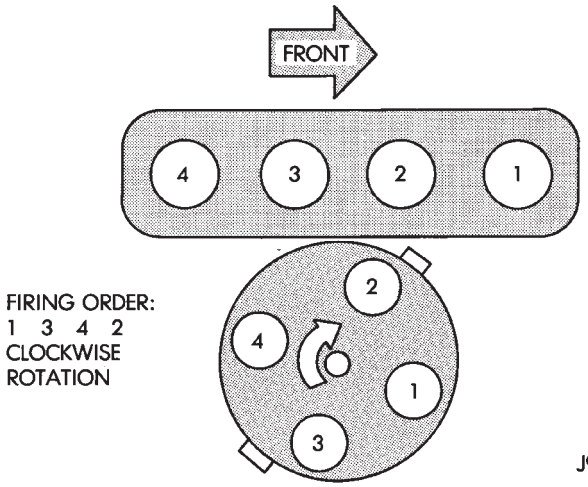
### ENGINE FIRING ORDER—2.5L 4-CYLINDER ENGINE

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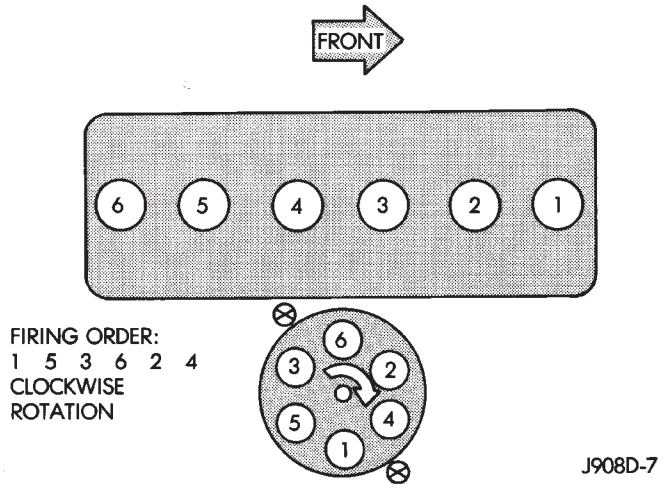
### ENGINE FIRING ORDER—4.0L 6-CYLINDER ENGINE

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### TORQUE

| DESCRIPTION | TORQUE |
|---|---|
| Coolant Temperature Sensor | 28 N·m (21 ft. lbs.) |
| Crankshaft Position Sensor | 19 N·m (15 ft. lbs.) |
| Distributor Hold Down Bolt | 23 N·m (17 ft. lbs.) |
| PCM Mounting Screws | 1 N·m (9 in. lbs.) |
| PCM 60-Way Electrical Connector | 4 N·m (35 in. lbs.) |
| Headlamp Dimmer Switch/Ignition Switch Mounting Screws/Nuts | 4 N·m (35 in. lbs.) |
| Intake Manifold Air Temperature Sensor | 28 N·m (20 ft. lbs.) |
| Oxygen Sensor | 30 N·m (22 ft. lbs.) |
| Spark Plugs-All Engines | 37 N·m (27 ft. lbs.) |

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