IGNITION SYSTEMS

CONTENTS

COMPONENT IDENTIFICATION/SYSTEM OPERATION

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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
- Ignition distributor (contains rotor and camshaft position sensor)
- Powertrain Control Module (PCM)
- Crankshaft Position Sensor

AUTOMATIC SHUT DOWN (ASD) RELAY

The automatic shut down (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). The PCM regulates ASD relay operation by switching the ground circuit on-and-off.

CAMSHAFT POSITION SENSOR

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

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

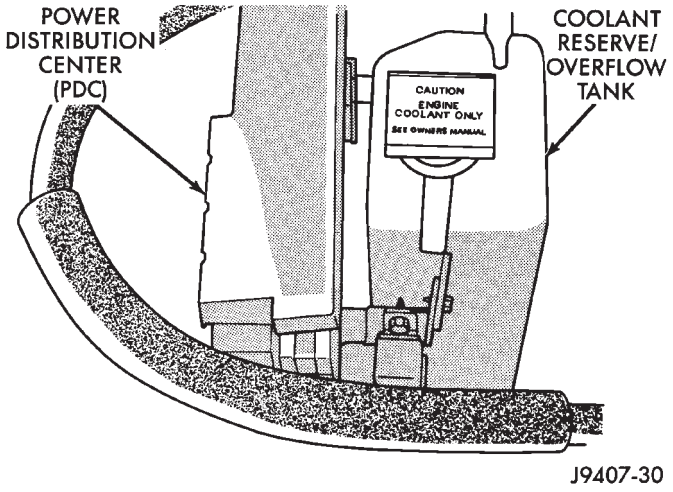

Fig. 1 PDC—XJ Models

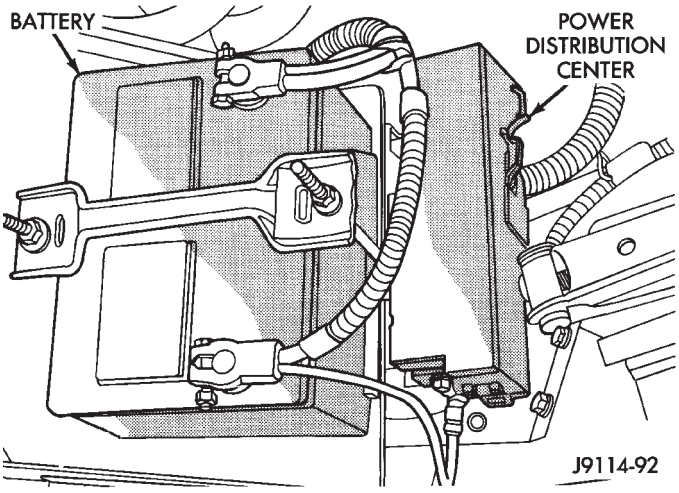

Fig. 2 PDC—YJ Models

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.

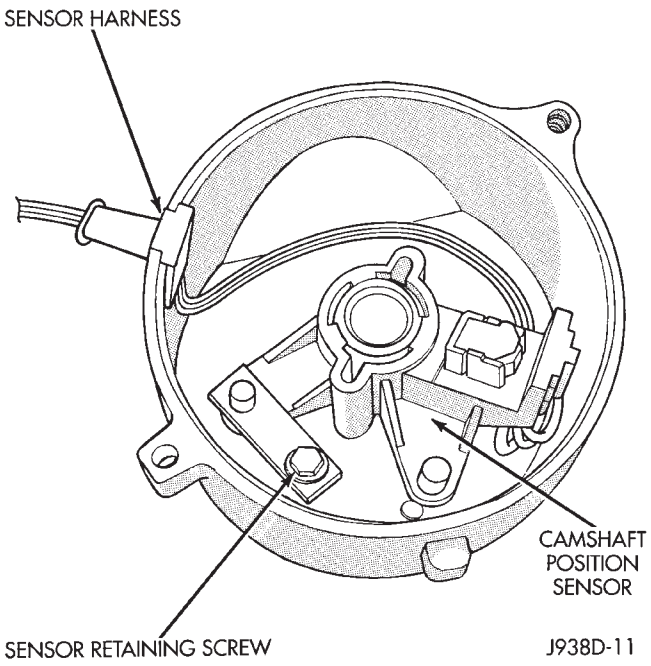

Fig. 3 Camshaft Position Sensor—Typical

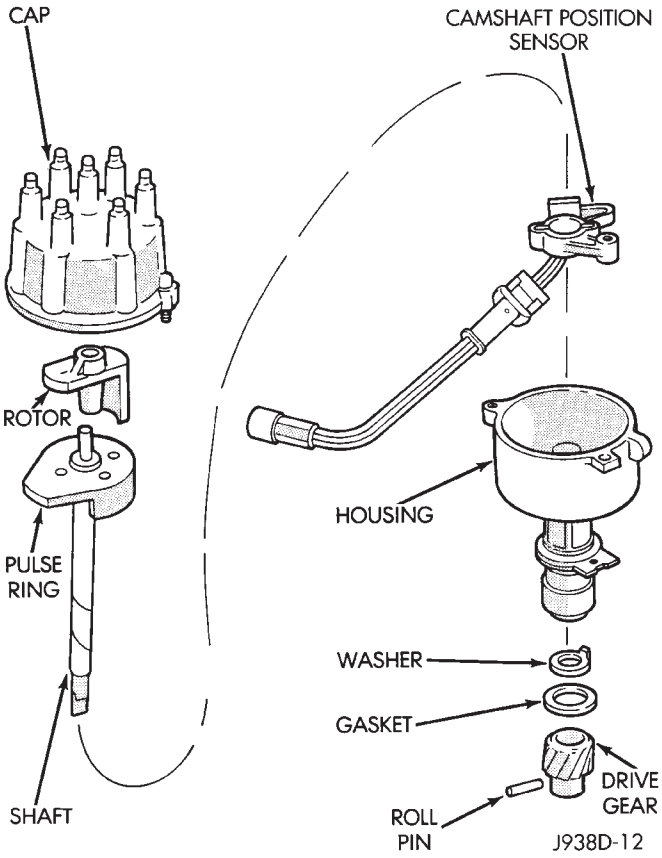

Fig. 4 Distributor—Typical

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).

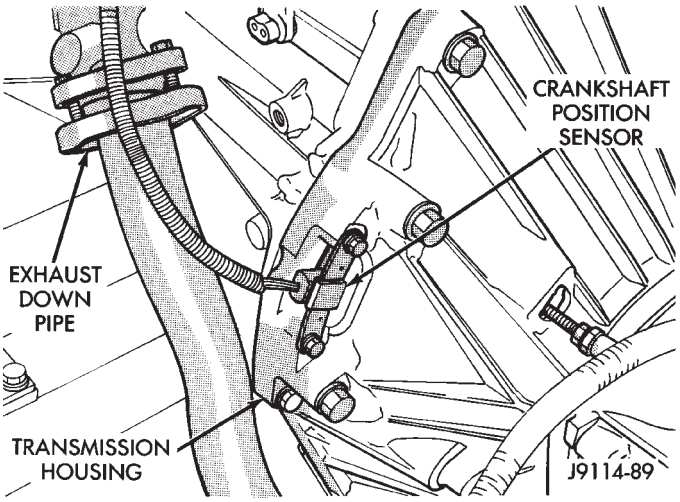

Fig. 5 Crankshaft Position Sensor—2.5L Engine—Typical

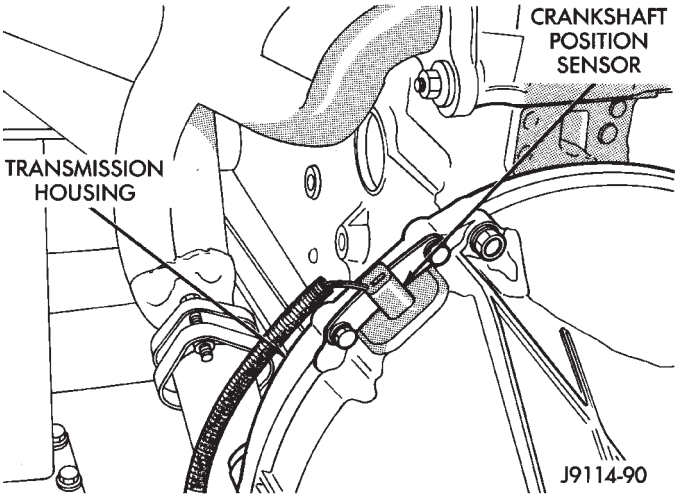

Fig. 6 Crankshaft Position Sensor—4.0L Engine—All Except YJ models With Automatic Transmission

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.

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).

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

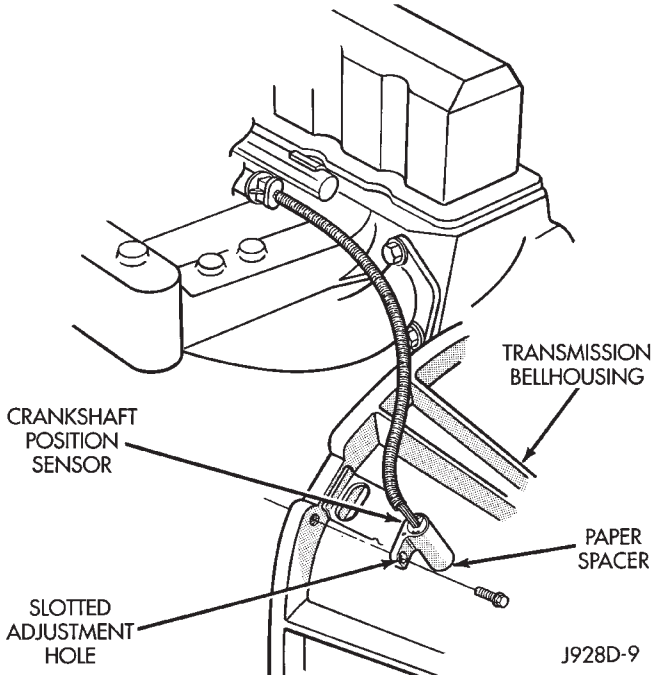

Fig. 7 Crankshaft Position Sensor—4.0L Engine—YJ models With Automatic Transmission

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.

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 the 2.5L and 4.0L 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 notch on the distributor housing. The distributor holddown clamp bolt passes through this notch when installed. Because the distributor position is locked when in-

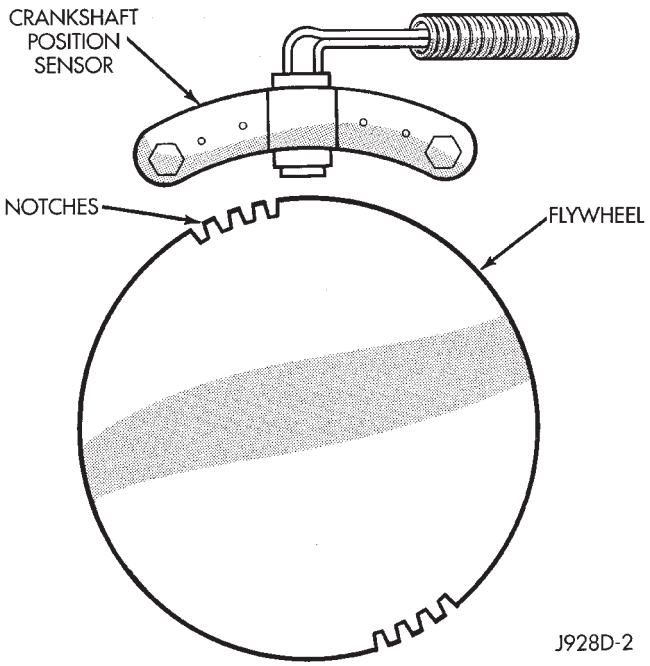

Fig. 8 Sensor Operation—2.5L Engine

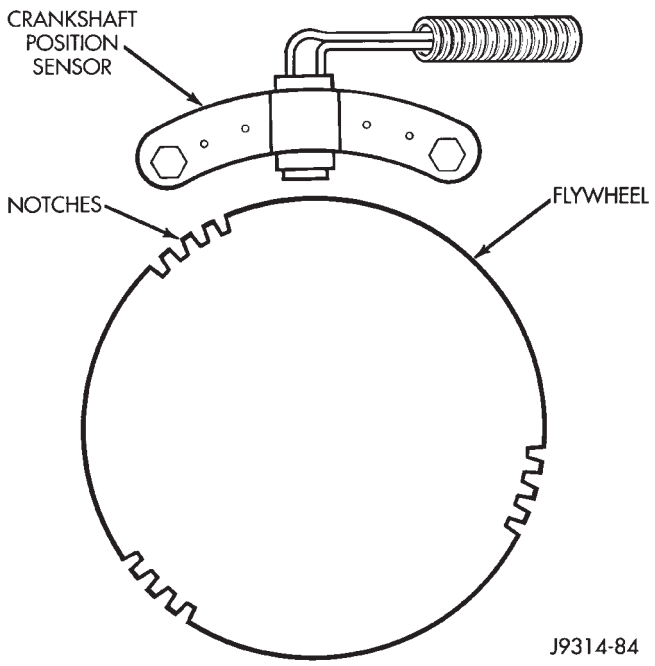

Fig. 9 Sensor Operation—4.0L Engine—All Except YJ Models With Automatic Transmission

stalled, 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.**

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

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

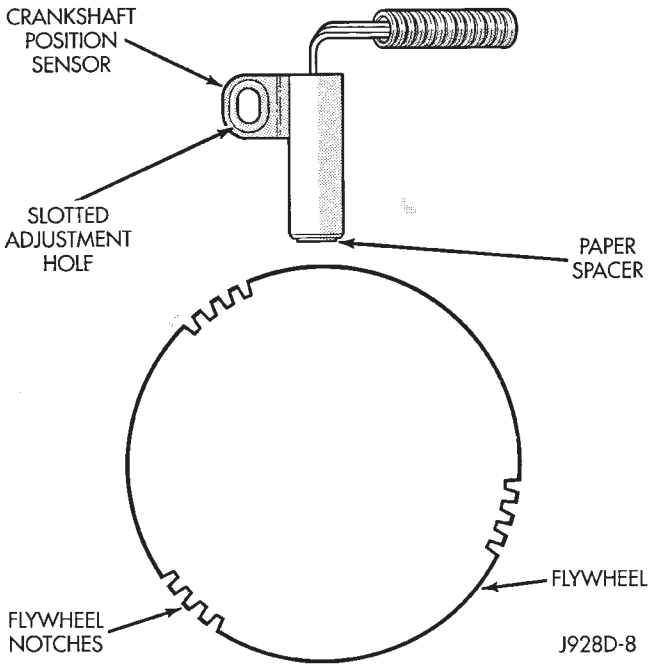

Fig. 10 Sensor Operation—4.0L Engine—YJ Models With Automatic Transmission

For removal and installation of this component, refer to 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.

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.

The ignition coil is mounted to a bracket on the side of the engine (Fig. 11).

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

The engine coolant temperature sensor provides an input voltage to the Powertrain Control Module (PCM) relating coolant temperature. The PCM uses this input, along with inputs from other sensors, to determine injector pulse width and ignition timing.

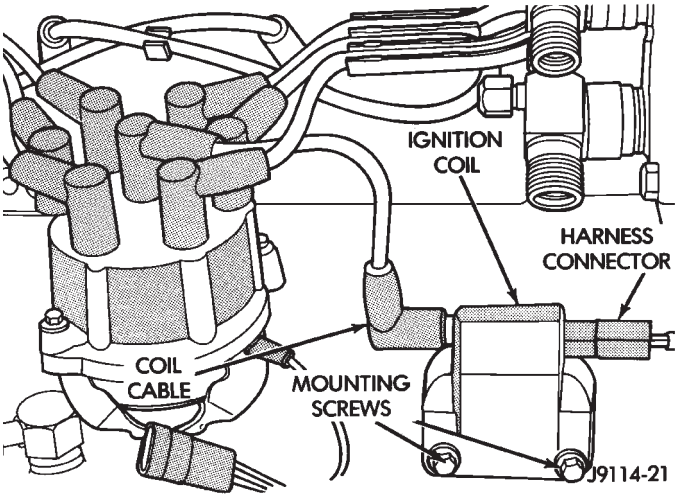

Fig. 11 Ignition Coil—Typical

As coolant temperature varies, the sensor resistance will change, resulting in a different input voltage to the PCM.

When the engine is cold, the PCM will operate in the Open Loop Cycle. It will demand slightly richer air-fuel mixtures and higher idle speeds, until normal operating temperatures are reached. Refer to Modes Of Operation in Group 14, Fuel System for a description of Open and Closed Loop operation.

This sensor is installed in the thermostat housing (Fig. 12).

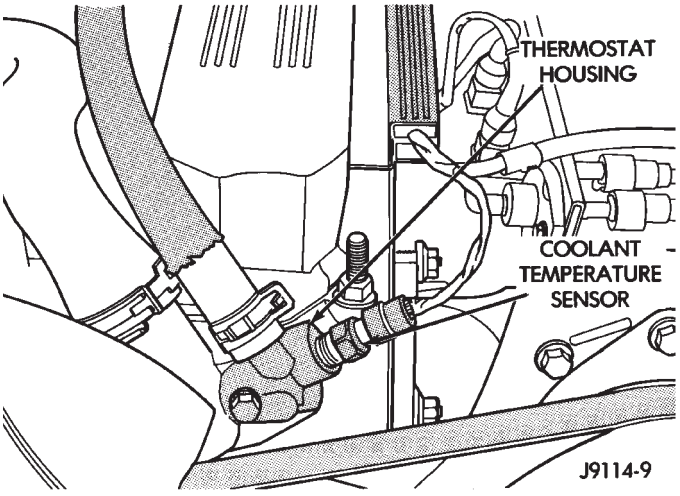

Fig. 12 Coolant Temperature Sensor—Typical

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.

INTAKE MANIFOLD AIR TEMPERATURE SENSOR

The sensor element extends into the intake manifold air stream. It provides an input voltage to the Powertrain Control Module (PCM) indicating intake manifold air temperature. The input from this sensor is used along with inputs from other sensors to determine injector pulse width. As the temperature of the air-fuel stream in the manifold varies, the sensor resistance will change. This will result in a different input voltage to the PCM. For more information, refer to Group 14, Fuel System.

This sensor is installed in the intake manifold (Fig. 13, 4.0L engine or Fig. 14, 2.5L engine).

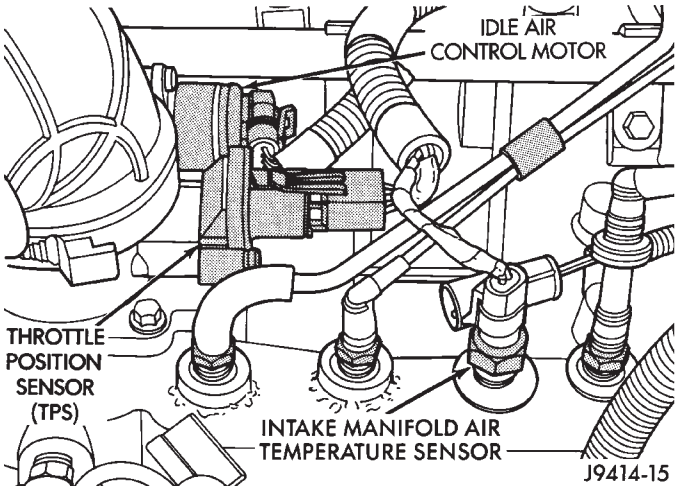

Fig. 13 Air Temperature Sensor Location—4.0L Engine

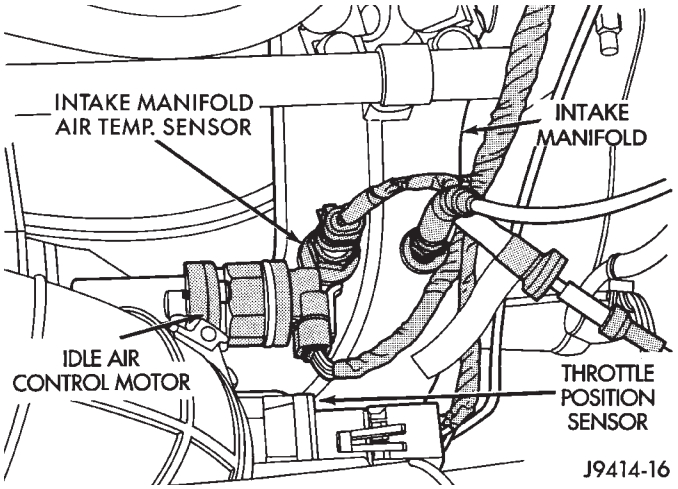

Fig. 14 Air Temperature Sensor Location—2.5L Engine

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.

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, causing the MAP

sensor voltage to change. This change results in a different input voltage to the PCM. The input voltage level supplies the PCM with information. This relates to ambient barometric pressure during engine start-up (cranking) and to engine load while the engine is running. The PCM uses this input, along with inputs from other sensors, to adjust air-fuel mixture.

For more information, refer to Group 14, Fuel System.

The MAP sensor is located in the engine compartment near the rear of engine cylinder head (valve) cover (Fig. 15). It is connected to the throttle body with a vacuum hose and to the PCM electrically.

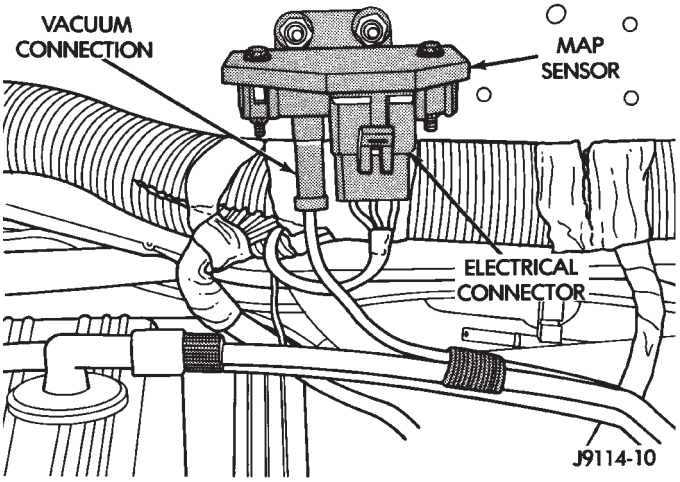

Fig. 15 MAP Sensor—Typical

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.

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. 16). On YJ models, the PCM is located in the engine compartment behind the windshield washer fluid reservoir (Fig. 17).

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.

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.

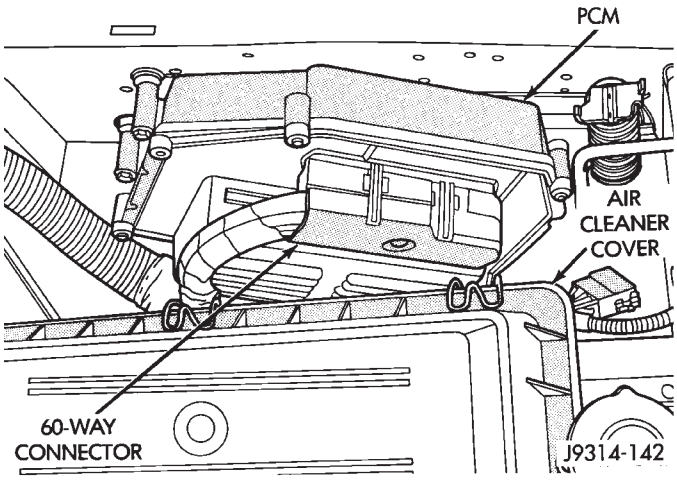

Fig. 16 PCM Location—XJ Models

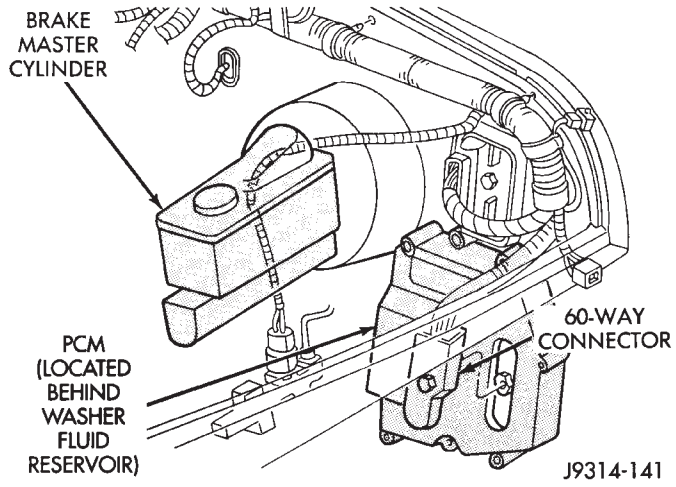

Fig. 17 PCM Location—YJ Models

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

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

THROTTLE POSITION SENSOR

The sensor is mounted on the throttle body (Figs. 18 or 19). It is connected to the throttle blade shaft. The sensor is a variable resistor. It provides the Powertrain Control Module (PCM) with an input signal (voltage) that represents throttle blade position. As the position of the throttle blade changes, the resistance of the sensor changes.

The PCM supplies approximately 5 volts to the sensor. The sensor output voltage (input signal to the PCM) represents the throttle blade position. The PCM receives an input signal voltage from the sensor. This will vary in an approximate range of from 1 volt at minimum throttle opening (idle), to 4 volts at wide open throttle. Along with inputs from other sensors, the PCM uses the sensor input to determine

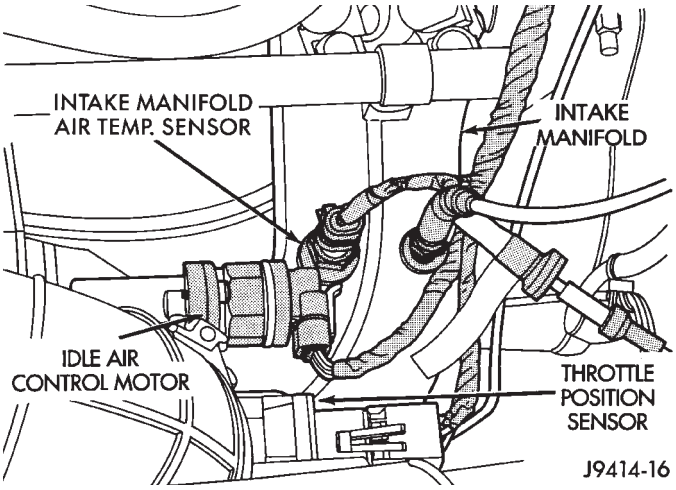

Fig. 18 Throttle Position Sensor—2.5L Engine

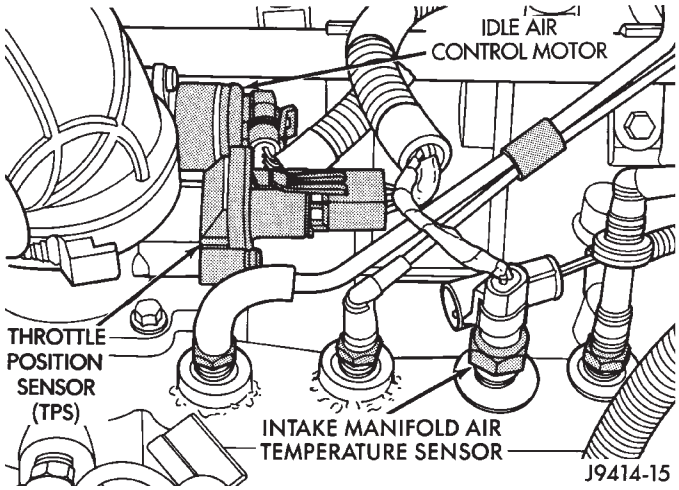

Fig. 19 Throttle Position Sensor—4.0L Engine

current engine operating conditions. It will also adjust fuel injector pulse width and ignition timing.

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.

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 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.

AUTOMATIC SHUT DOWN (ASD) RELAY

Refer to Relays—Operation/Testing in the Group 14, Fuel System section of this service manual.

CAMSHAFT POSITION SENSOR TEST

The camshaft position sensor is located in the distributor on all engines.

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:

2.5L OR 4.0L ENGINE

For this test, an analog 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.

(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. Rotate (crank) engine with starter until pulse ring (Fig. 1) enters the magnetic pickup on camshaft position sensor. Distributor rotor should be pointed in 9 o'clock position. The movable pulse ring should now be within the sensor pickup.

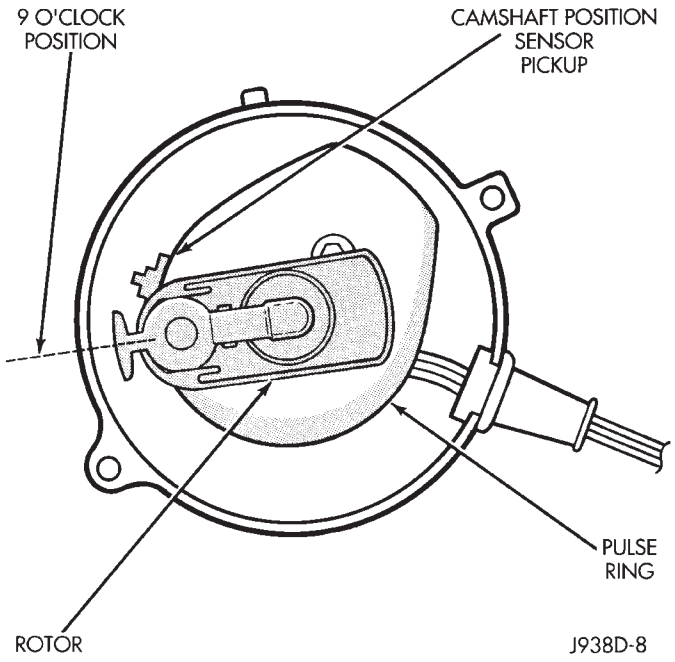

Fig. 1 Pulse Ring/Rotor Position—Typical

(5) Turn ignition key to ON position. 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 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.

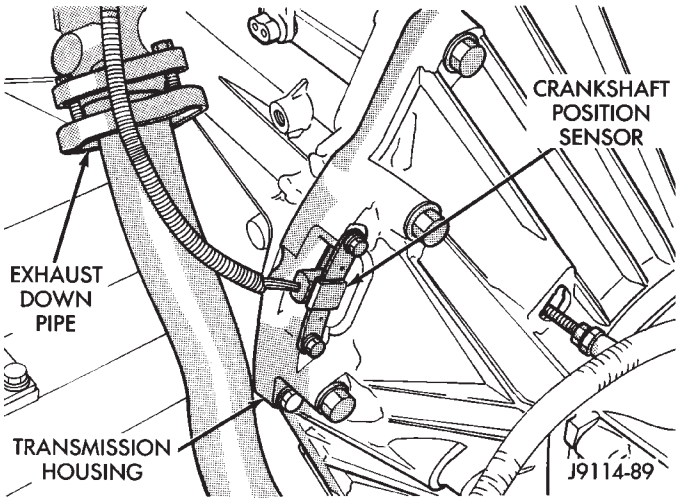

Fig. 2 Crankshaft Position Sensor—2.5L Engine—Typical

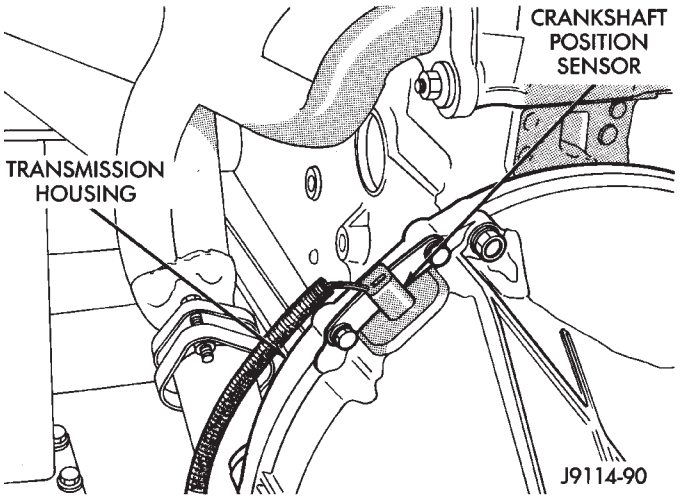

Fig. 3 Crankshaft Position Sensor—4.0L Engine—All Except YJ models With Auto. Trans.

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 machined 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 cap. Fully seat the cables onto the towers. If neces-

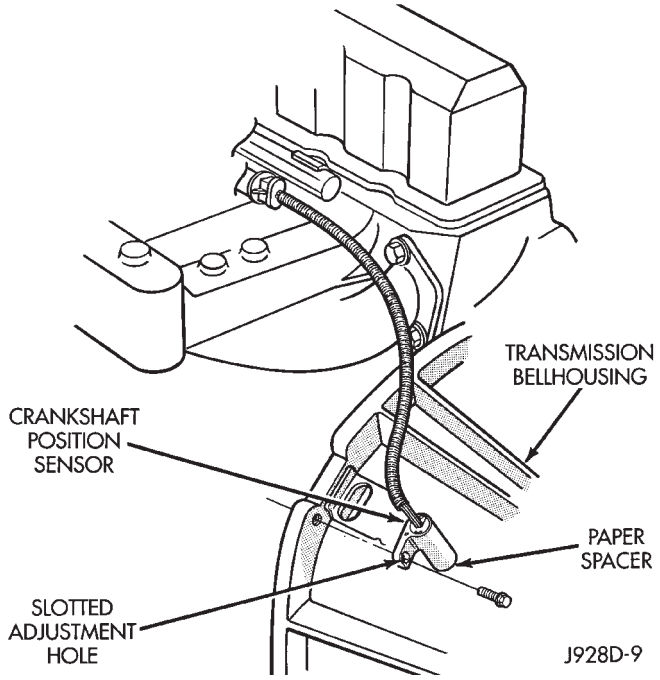

Fig. 4 Crankshaft Position Sensor—4.0L Engine—YJ models With Auto. Trans.

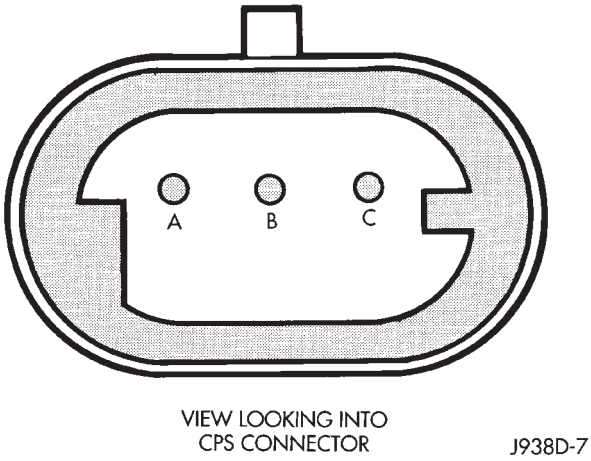

Fig. 5 Crankshaft Position Sensor Connector

sary, 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.

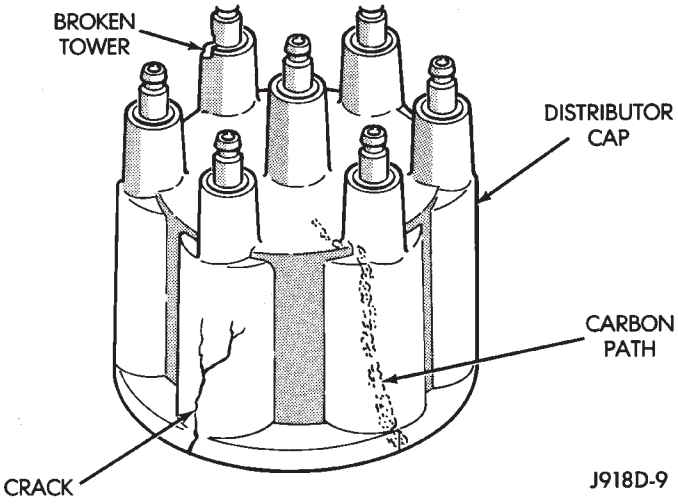

Fig. 6 Cap Inspection—External—Typical

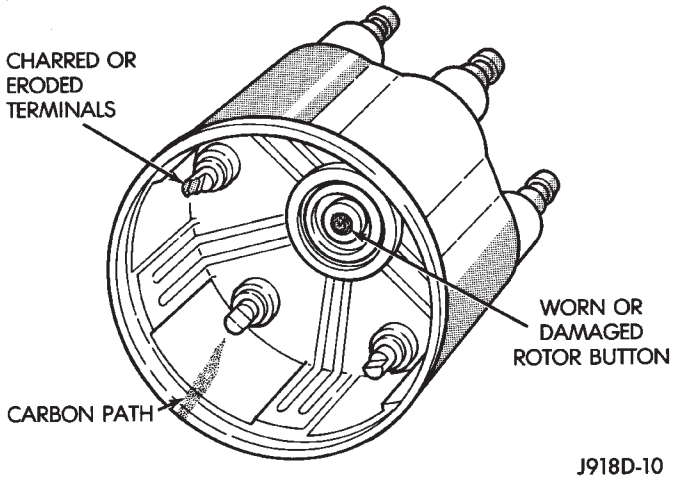

Fig. 7 Cap Inspection—Internal—Typical

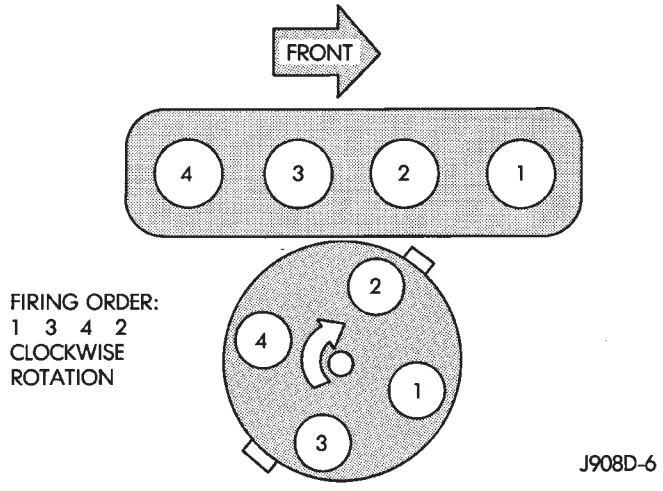

Fig. 8 Firing Order—2.5L 4 Cylinder Engine

DRB SCAN TOOL

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

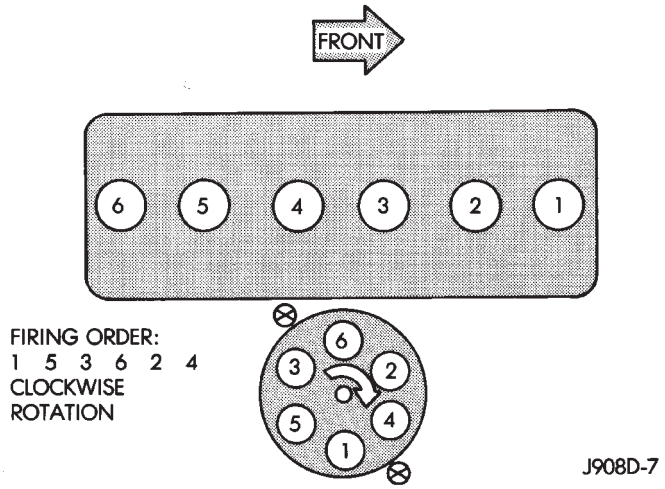

Fig. 9 Firing Order—4.0L 6 Cylinder Engine

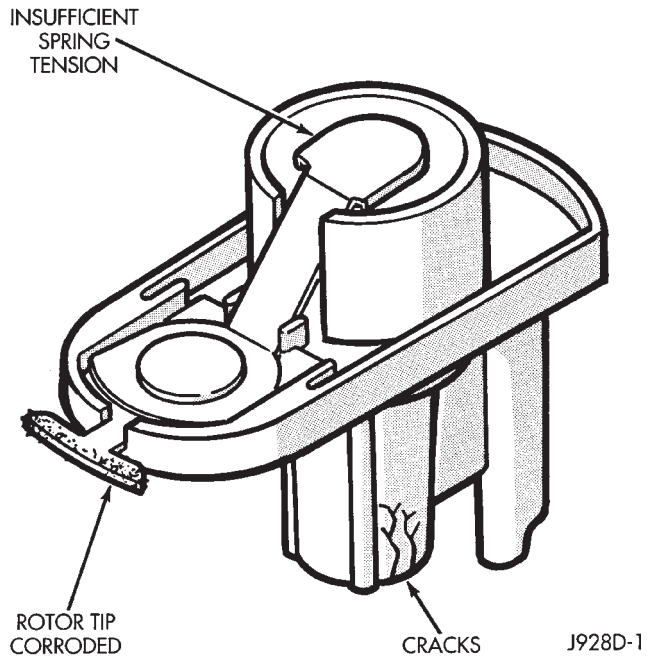

Fig. 10 Rotor Inspection—Typical

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.

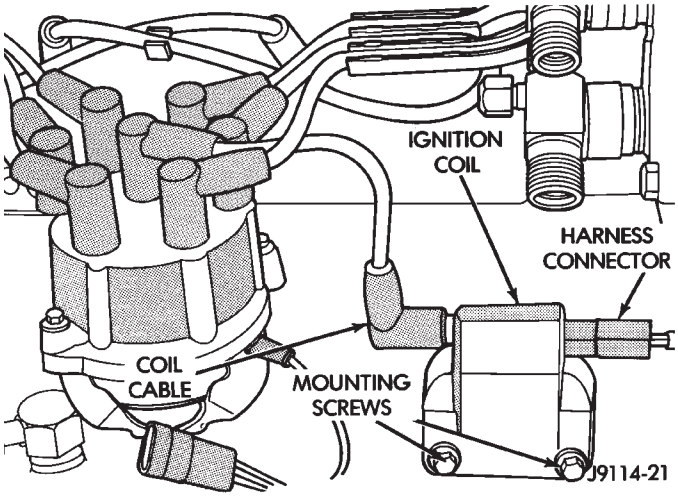

Fig. 11 Ignition Coil—Typical

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.

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

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ENGINE COOLANT TEMPERATURE 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 installed in the thermostat housing (Fig. 12).

(1) Disconnect wire harness connector from sensor (Fig. 12).

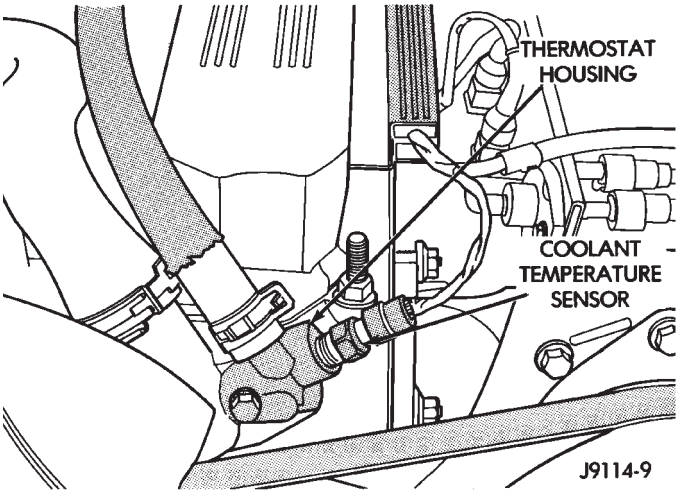

Fig. 12 Coolant Temperature Sensor—Typical

(2) Test the resistance of the sensor with a high input impedance (digital) volt-ohmmeter. The resistance should be less than 1340 ohms at normal engine operating idle temperature. For resistance values, refer to the Sensor Resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

(3) Test continuity of the wire harness. This is done between Powertrain Control Module (PCM) wire harness connector terminal-2 and the sensor connector terminal. Also check continuity between wire harness terminal-4 to the sensor connector terminal. Repair the wire harness if an open circuit is indicated.

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. Grasp the boot (not the cable) and pull it off with a steady, even force.

(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).

SENSOR RESISTANCE (OHMS)

TEMPERATURE		RESISTANCE (OHMS)	
C	F	MIN	MAX
−40	−40	291,490	381,710
−20	−4	85,850	108,390
−10	14	49,250	61,430
0	32	29,330	35,990
10	50	17,990	21,810
20	68	11,370	13,610
25	77	9,120	10,880
30	86	7,370	8,750
40	104	4,900	5,750
50	122	3,330	3,880
60	140	2,310	2,670
70	158	1,630	1,870
80	176	1,170	1,340
90	194	860	970
100	212	640	720
110	230	480	540
120	248	370	410

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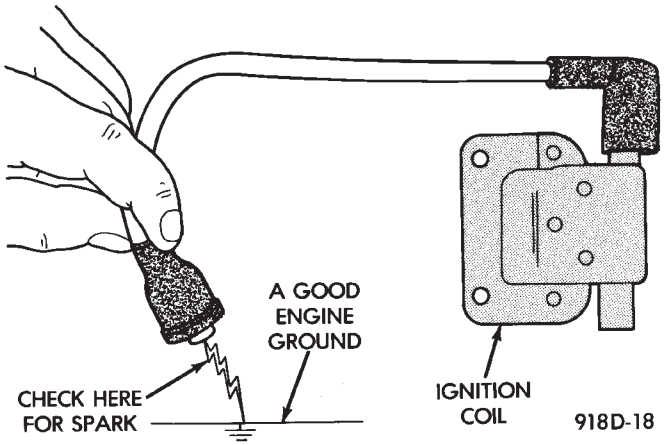

Fig. 13 Checking for Spark—Typical

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. 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 for DRB operation.

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).

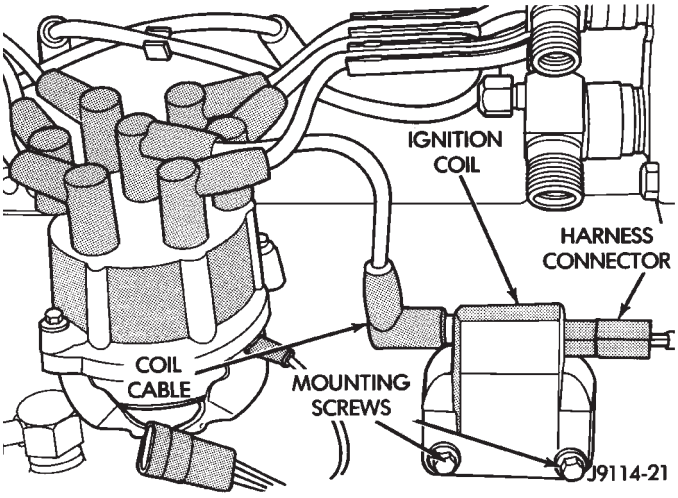

Fig. 14 Coil Harness Connector—Typical

(2) Connect a set of small jumper wires (18 gauge or smaller) between the ignition coil and coil electrical connector (Fig. 15).

(3) 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 shut down relay.
- If voltage is at 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 near battery voltage during the entire 5 seconds, turn the key off. Remove the

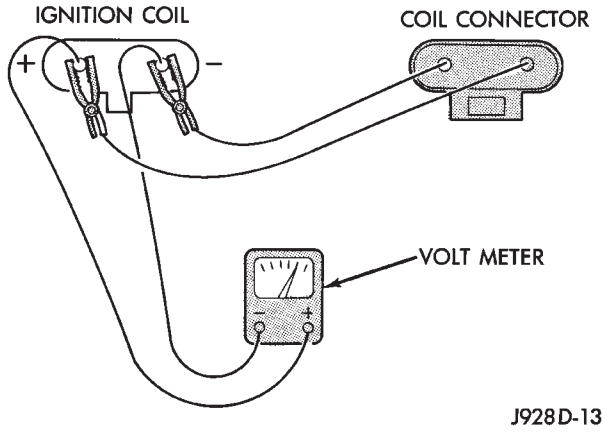

Fig. 15 Coil Terminals—Typical

60-way connector (Fig. 16) from the PCM. Check 60-way connector for any spread terminals.

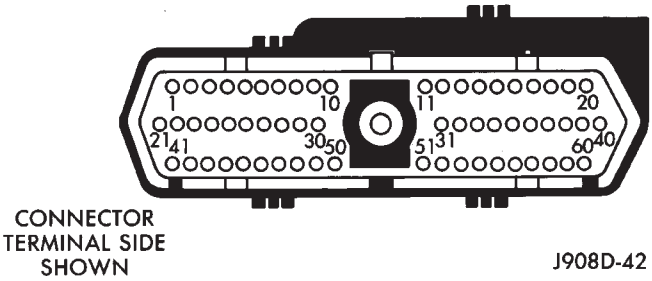

Fig. 16 PCM 60-Way Connector

(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 17. Using the jumper, **momentarily** ground terminal-19 of the 60-way connector. A spark should be generated at the coil cable when the ground is removed.

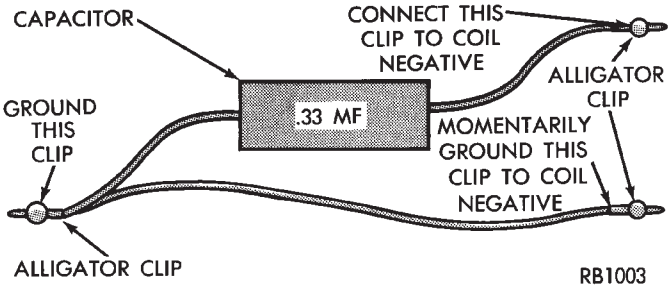

Fig. 17 Special Jumper Ground-to-Coil Negative Terminal

(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

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:

(1) Disconnect the wire harness connector from the sensor (Figs. 18 or 19).

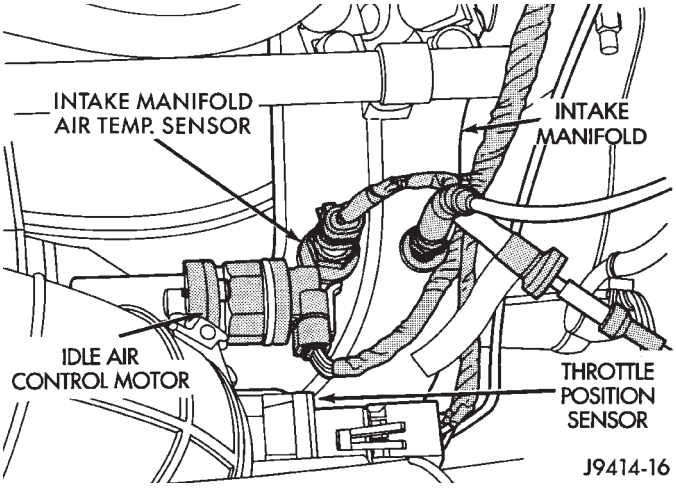

Fig. 18 Air Temperature Sensor—2.5L Engine

(2) Test the resistance of the sensor with a input impedance (digital) volt-ohmmeter. Do not remove the sensor from the engine for testing. For resistance values, refer to the Sensor Resistance chart. Replace the sensor if it is not within the range of resistance specified in the chart.

(3) Test the resistance of the wire harness. This is done between the Powertrain Control Module (PCM) wire harness connector terminal-21 and the sensor connector terminal. Also check continuity between terminal-4 to the sensor connector terminal. Repair the wire harness as necessary if the resistance is greater than 1 ohm.

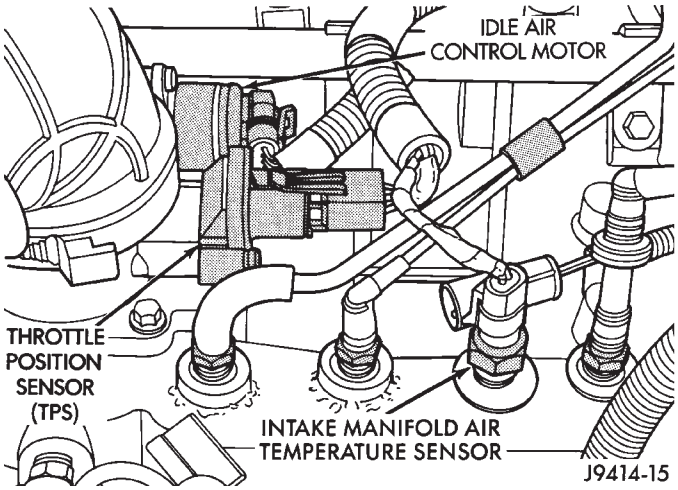

Fig. 19 Air Temperature Sensor—4.0L Engine

SENSOR RESISTANCE (OHMS)

TEMPERATURE		RESISTANCE (OHMS)	
C	F	MIN	MAX
−40	−40	291,490	381,710
−20	−4	85,850	108,390
−10	14	49,250	61,430
0	32	29,330	35,990
10	50	17,990	21,810
20	68	11,370	13,610
25	77	9,120	10,880
30	86	7,370	8,750
40	104	4,900	5,750
50	122	3,330	3,880
60	140	2,310	2,670
70	158	1,630	1,870
80	176	1,170	1,340
90	194	860	970
100	212	640	720
110	230	480	540
120	248	370	410

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MANIFOLD ABSOLUTE PRESSURE (MAP) 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 MAP sensor is located on the cowl panel near the rear of the engine cylinder head (valve) cover (Fig. 20).

(1) Inspect the sensor vacuum hose connections at the throttle body and sensor (Fig. 20). Repair as necessary.

CAUTION: When testing the sensor, be sure that the harness wires are not damaged by the test meter probes.

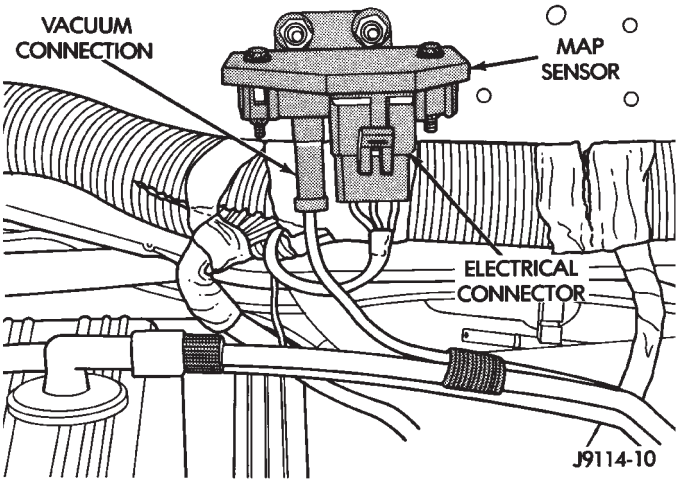

Fig. 20 MAP Sensor—Typical

(2) Test the sensor output voltage at the sensor connector between terminals A and B as marked on the sensor body (Fig. 21). This is done with the ignition switch ON and the engine OFF. Output voltage should be 4-to-5 volts. **The voltage should drop to 1.5-to-2.1 volts with a hot, neutral idle speed condition.**

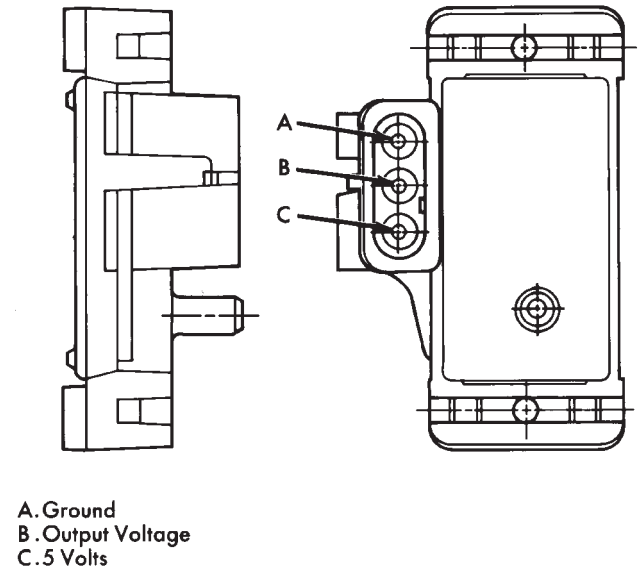

Fig. 21 MAP Sensor Test—Typical

(3) Test Powertrain Control Module (PCM) terminal-1 for the same voltage described above to verify the wire harness condition. Repair as necessary.

(4) Test sensor supply voltage at sensor connector between terminals A and C with the ignition ON. The voltage should be approximately 5 volts (±0.5V). Five volts (±0.5V) should also be at terminal-6 of the corresponding Powertrain Control Module (PCM) wire harness connector. Repair or replace the wire harness as necessary.

(5) Test the sensor ground circuit at sensor connector terminal-A and PCM connector terminal-4. Repair the wire harness if necessary.

(6) Test the sensor ground circuit at the PCM connector between terminal-4 and terminal-11 with an ohmmeter. If the ohmmeter indicates an open circuit, inspect for a defective sensor ground connection. Refer to Group 8W, Wiring for location of ground connection. If the ground connection is good, replace the PCM. If terminal-4 has a short circuit to 12 volts, correct this condition before replacing the PCM.

POWERTRAIN CONTROL MODULE (PCM)

The PCM (formerly called the SBEC or engine controller) is located in the engine compartment behind the windshield washer fluid tank on YJ models (Fig. 22). It is located in the engine compartment next to the air cleaner on XJ models (Fig. 23).

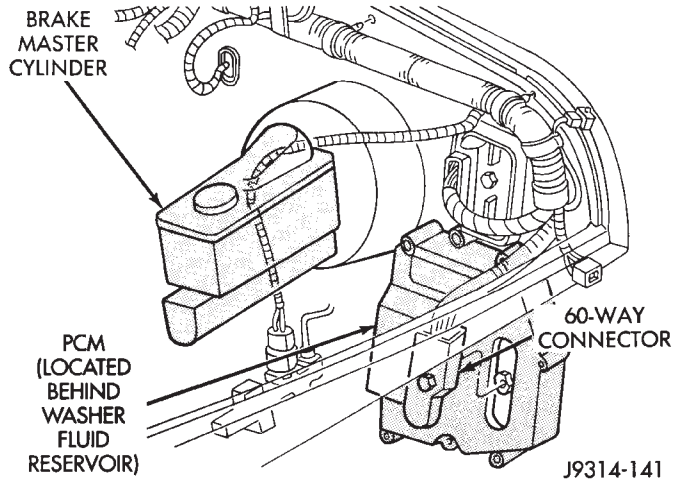

Fig. 22 PCM Location—YJ Models

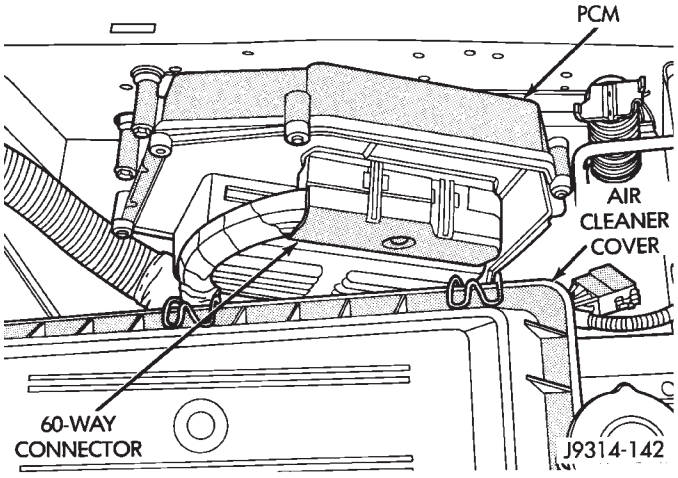

Fig. 23 PCM Location—XJ Models

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.

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. 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. 24). 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.

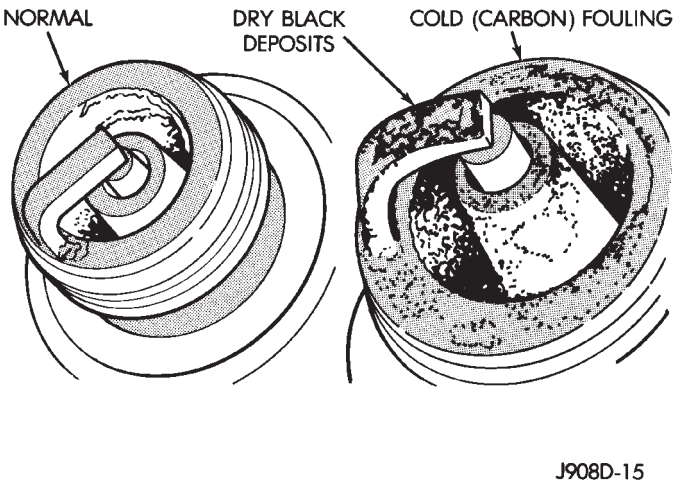

Fig. 24 Normal Operation and Cold (Carbon) Fouling

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. 24). 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 filter or repeated short operating times (short trips).

ELECTRODE GAP BRIDGING

Electrode gap bridging may be traced to loose deposits in the combustion chamber. These deposits accumulate on the spark plugs during continuous stop-and-go driving. When the engine is suddenly subjected to a high torque load, deposits partially liquefy and bridge the gap between electrodes (Fig. 25). This short circuits the electrodes. Spark plugs with electrode gap bridging can be cleaned using standard procedures.

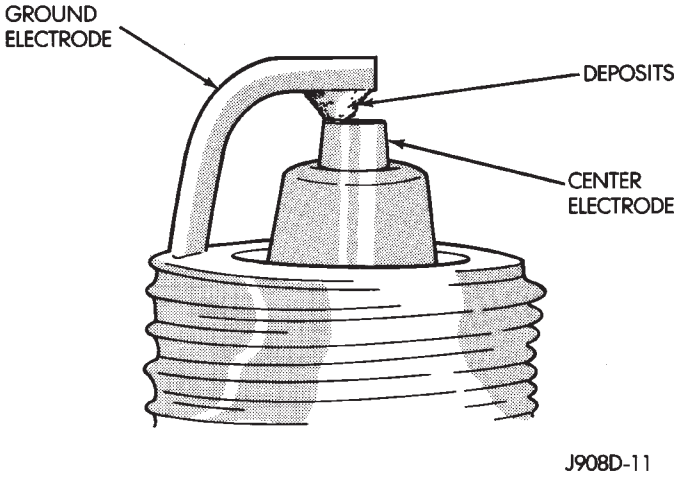

Fig. 25 Electrode Gap Bridging

SCAVENGER DEPOSITS

Fuel scavenger deposits may be either white or yellow (Fig. 26). 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.

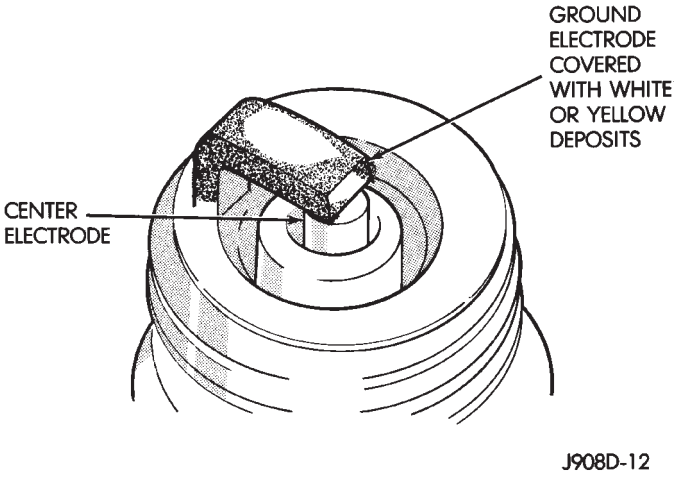

Fig. 26 Scavenger Deposits

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. 27). Spark plugs with this condition must be replaced.

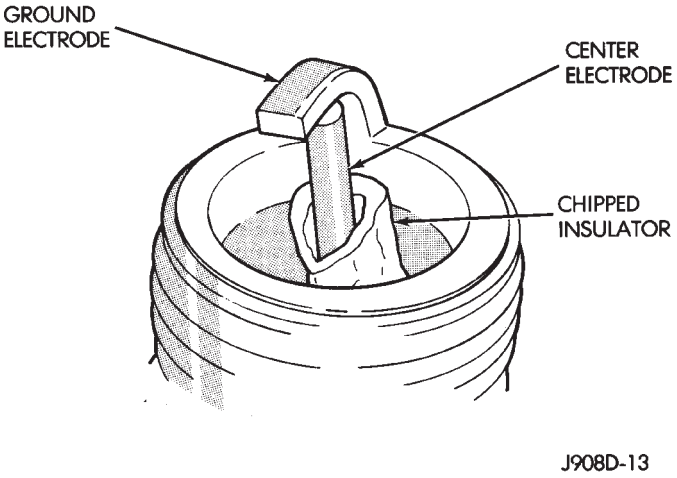

Fig. 27 Chipped Electrode Insulator

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. 28). 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.)

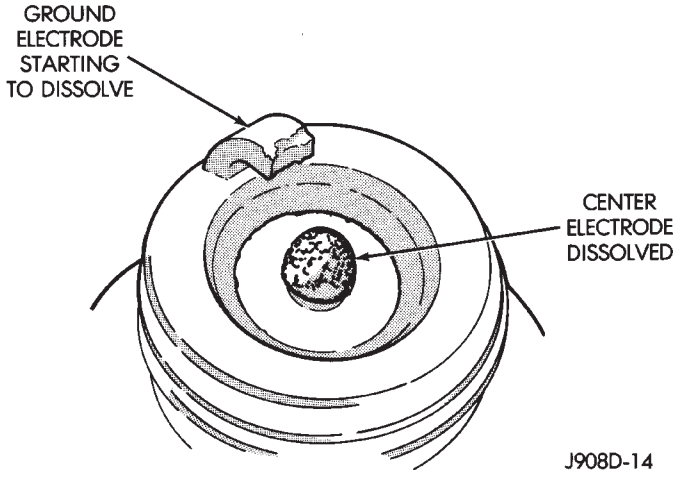

Fig. 28 Preignition Damage

SPARK PLUG OVERHEATING

Overheating is indicated by a white or gray center electrode insulator that also appears blistered (Fig. 29). 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.

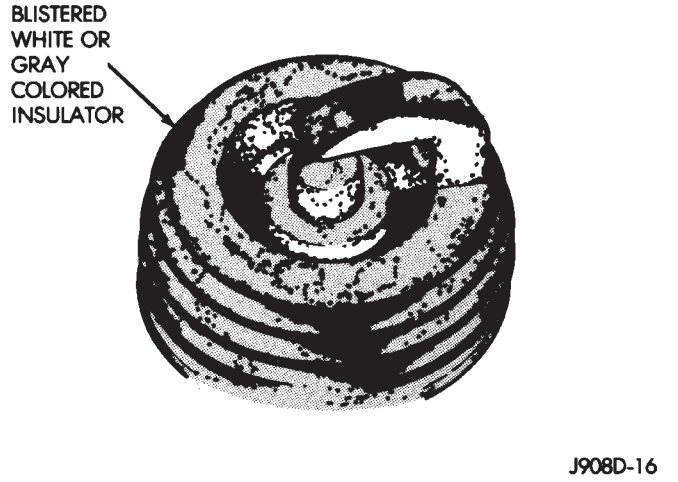

Fig. 29 Spark Plug Overheating

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

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 throttle position sensor can be tested with a digital voltmeter. The center terminal of the sensor connector is the output terminal (Figs. 30 or 31).

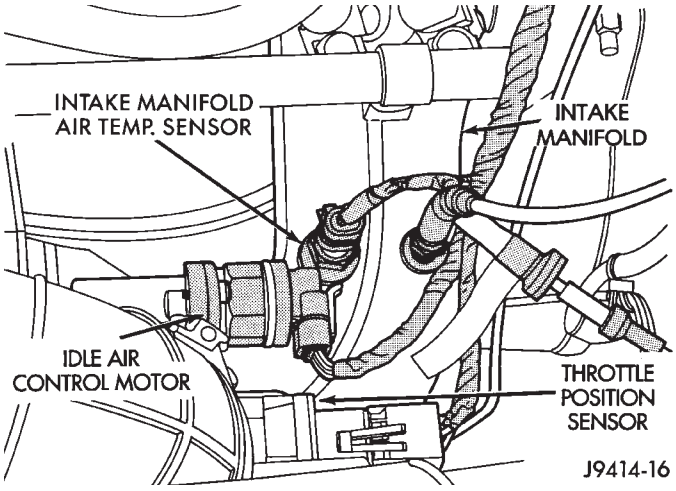

Fig. 30 Sensor—2.5L Engine

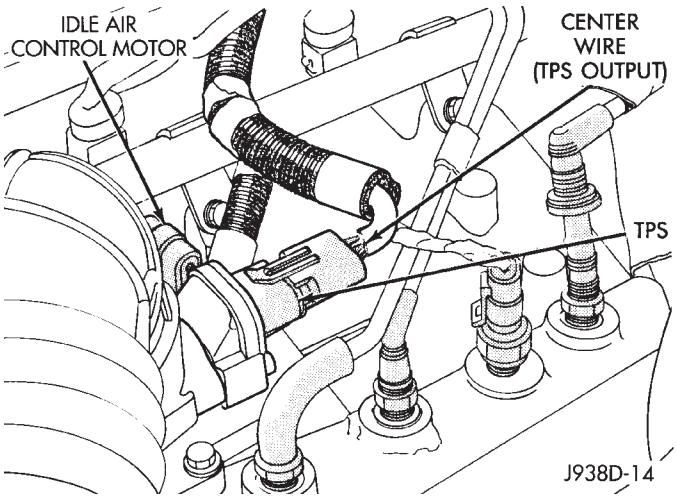

Fig. 31 Sensor—4.0L Engine

With the ignition key in the ON position and engine not running, check the sensor output voltage at the center terminal wire of the connector. Check this at idle (throttle plate closed) and at wide open throttle (WOT). At idle, sensor output voltage should be greater than 200 millivolts. At wide open throttle, sensor output voltage must be less than 4.8 volts. The output voltage should increase gradually as the throttle plate is slowly opened from idle to WOT.

OXYGEN SENSOR TESTS

For diagnosis, removal or installation, refer to Group 14, Fuel Systems in this manual.

ON-BOARD DIAGNOSTICS (OBD)

FOR IGNITION SYSTEM COMPONENTS

The powertrain control module (PCM) has been programmed to monitor certain ignition system circuits:

EXAMPLE:

If a reference signal is not being detected during engine cranking from the crankshaft position sensor, a Diagnostic Trouble Code (DTC) number 11 can be observed at the Check Engine Lamp.

If the problem is sensed in a monitored circuit often enough to indicate an actual problem, a DTC is stored. The DTC will be stored in the PCM memory for eventual display to the service technician. If the problem is repaired or ceases to exist, the PCM cancels the DTC after 51 engine starts.

Certain criteria must be met for a DTC to be entered into PCM memory. The criteria may be a specific range of engine rpm, engine temperature and/or input voltage to the PCM.

A DTC indicates that the PCM has recognized an abnormal signal in a circuit or the system. A DTC may indicate the result of a failure, but never identify the failed component directly.

It is possible that a DTC for a monitored circuit may not be entered into memory even though a malfunction has occurred. Refer to On-Board Diagnostics (OBD) in Group 14, Fuel Systems for additional information.

ACCESSING DIAGNOSTIC TROUBLE CODES

A stored Diagnostic Trouble Code (DTC) can be displayed by cycling the ignition key On-Off-On-Off-On within three seconds and observing the Malfunction Indicator Lamp. This lamp was formerly referred to as the Check Engine Lamp. The lamp is located on the instrument panel.

They can also be displayed through the use of the Diagnostic Readout Box (DRB) scan tool. The DRB connects to the data link connector in the engine compartment (Figs. 32 or 33). For operation of the DRB, refer to the appropriate Powertrain Diagnostic Procedures service manual.

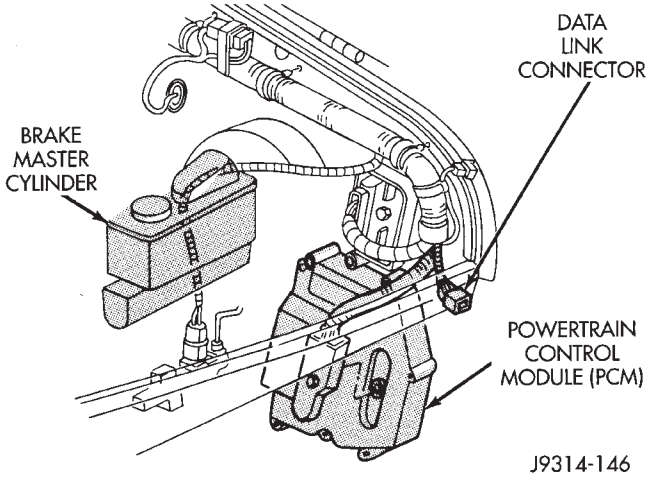

Fig. 32 Data Link Connector—YJ Models—Typical

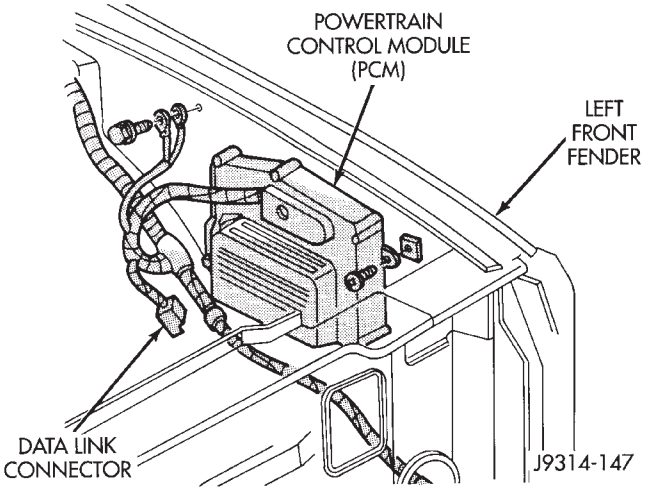

Fig. 33 Data Link Connector—XJ Models—Typical

EXAMPLES:

- If the lamp flashes 1 time, pauses and flashes 1 more time, a flashing Diagnostic Trouble Code (DTC) number 11 is indicated.
- If the lamp flashes 3 times, pauses and flashes 5 more times, a flashing Diagnostic Trouble Code (DTC) number 35 is indicated.

After any stored DTC information has been observed, the display will end with a flashing DTC number 55. This will indicate the end of all stored information.

ERASING TROUBLE CODES

After the problem has been repaired, the DRB scan tool must be used to erase a DTC. Refer to the appropriate Powertrain Diagnostic Procedures service manual for operation of the DRB scan tool.

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 SHUT DOWN (ASD) RELAY

The ASD relay is installed in the Power Distribution Center (PDC) (Fig. 1). Relay location is printed on the PDC cover.

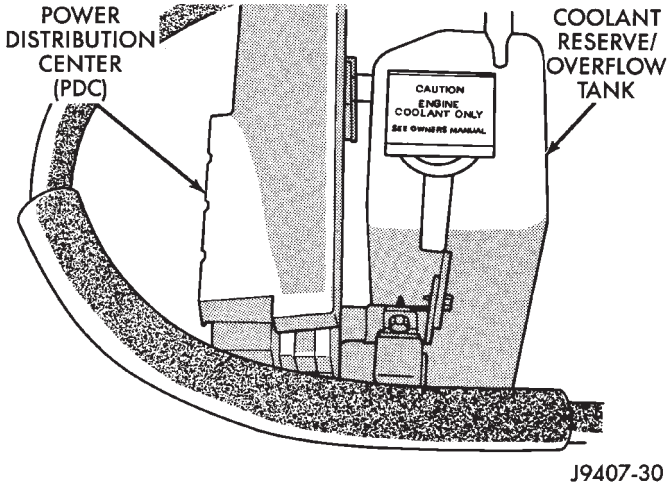

Fig. 1 PDC—XJ Models

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.

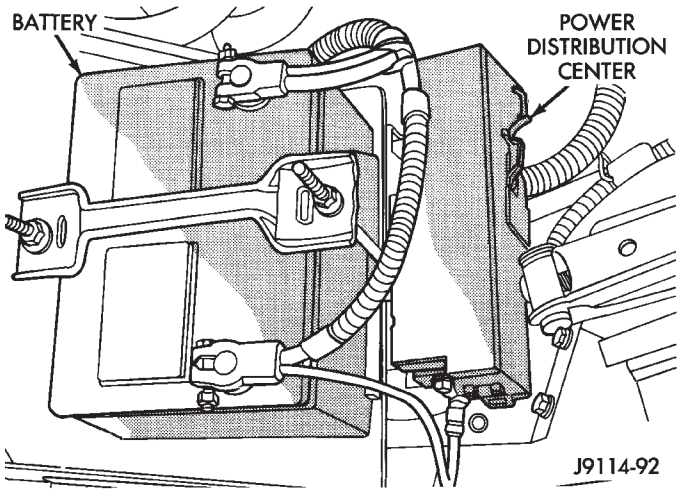

Fig. 2 PDC—YJ Models

CAMSHAFT POSITION SENSOR

The camshaft position sensor is located in the distributor.

REMOVAL

(1) Remove the distributor. Refer to Distributor Removal.

(2) Remove the distributor rotor.

CAUTION: Do not position the distributor in a vise when removing or installing the drive gear roll pin. Support the distributor with wooden blocks.

(3) Mark the position of the gear and the shaft in line with the roll pin. The gear **MUST** be installed back to its original position on the distributor shaft.

(4) Using a small pin punch and hammer, remove the distributor gear roll (spring) pin (Fig. 3).

(5) Lightly tap the end of the distributor shaft until distributor gear and thrust washer are removed.

(6) Slide the distributor shaft out of the distributor housing.

(7) Remove the camshaft position sensor mounting screw and positioning arm (Fig. 4).

(8) Slide the wire harness grommet out of the distributor housing. Remove the camshaft position sensor.

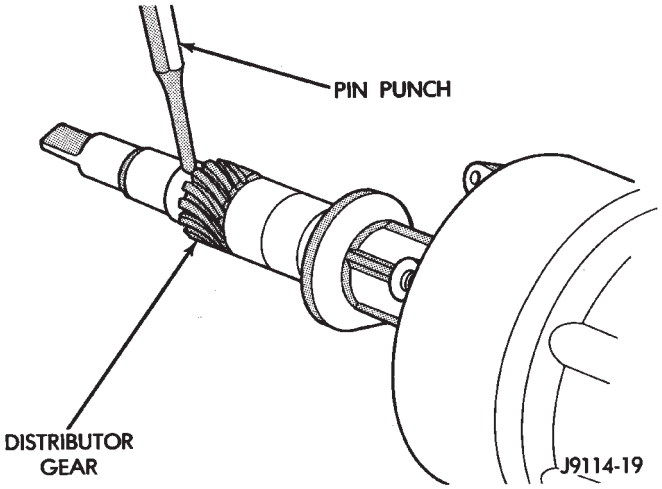

Fig. 3 Distributor Gear—Removal/Installation

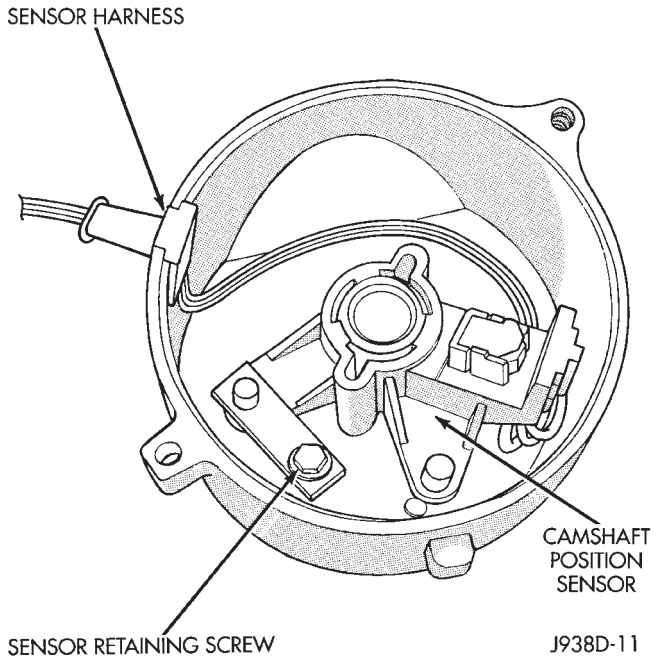

Fig. 4 Camshaft Position Sensor

INSTALLATION

(1) Position the camshaft position sensor in the distributor housing. Place the wire harness grommet into the opening in the distributor housing.

(2) Install retaining arm and retaining screw.

(3) Install distributor shaft into distributor housing. Make sure the upper thrust washer is installed on the shaft.

(4) Position thrust washer and drive gear on distributor shaft.

(5) Note the previous **CAUTION** and install distributor drive gear roll pin.

(6) Install rotor.

(7) Install distributor.

CRANKSHAFT POSITION SENSOR

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

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

On YJ models with a 4.0L engine and automatic transmission, the sensor uses a single slotted hole to adjust its depth. A paper/cardboard type spacer with self-adhesive (Fig. 7) is attached to the bottom of the sensor to set this depth. After the engine has been started (and after sensor installation), this temporary spacer will be sheared off. New factory replacement sensors are equipped with this spacer. If the original sensor is to be reinstalled, such as with transmission and/or flywheel removal, a new spacer **MUST** be installed.

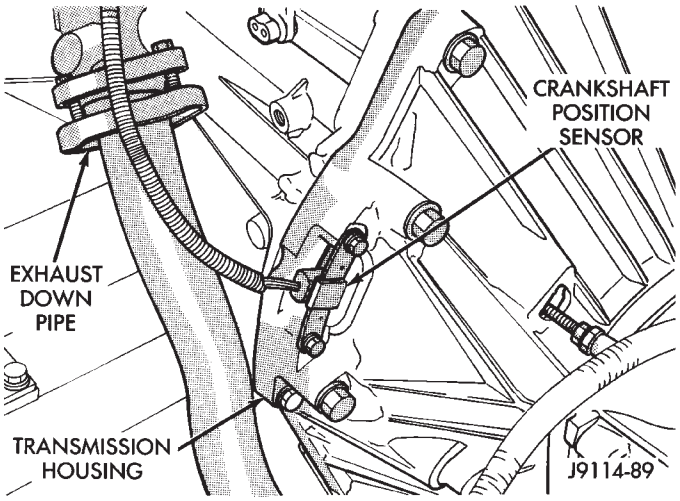

Fig. 5 Crankshaft Position Sensor—2.5L Engine—Typical

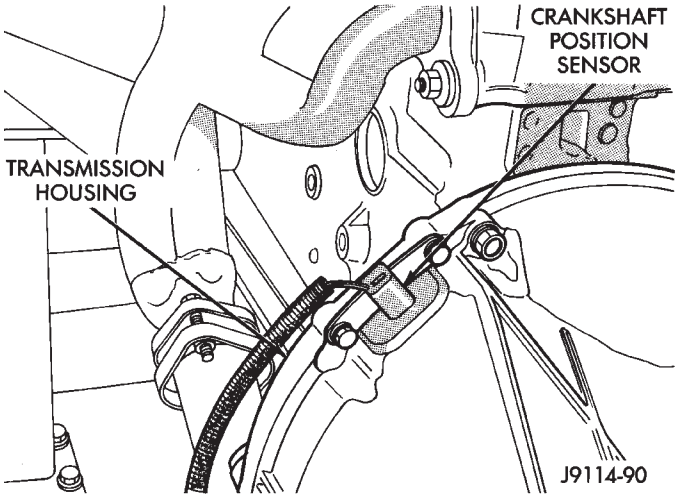

Fig. 6 Crankshaft Position Sensor—4.0L Engine—All Except YJ models With Automatic Transmission

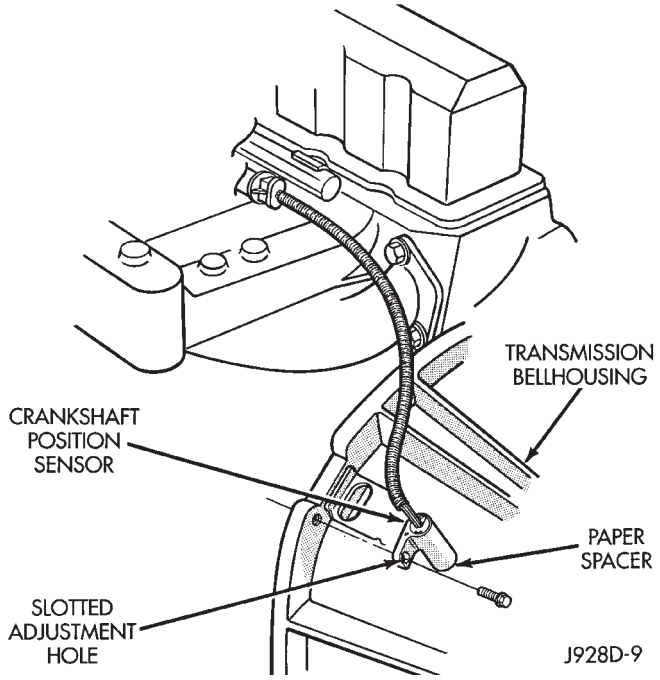

Fig. 7 Crankshaft Position Sensor—4.0L Engine—YJ models With Automatic Transmission

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.

(5) Remove clip from sensor wire harness.

INSTALLATION—ALL EXCEPT YJ MODELS WITH 4.0L 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 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 ENGINE AND AUTOMATIC TRANSMISSION

(1) Be sure the paper/cardboard spacer (Fig. 7) has been installed to the bottom of the new sensor.

If original sensor is being reinstalled (such as with transmission or flywheel removal), clean bottom of the sensor before installation. Obtain a new spacer and remove the paper backing. Install the self-adhesive side to bottom of sensor. This spacer **MUST** be installed. If spacer is not installed, sensor will be damaged when engine is started.

(2) Position sensor to transmission bellhousing and install mounting bolt finger tight.

(3) Gently seat (push down) the sensor until the paper spacer contacts the outer edge of the flywheel.

(4) Tighten sensor mounting bolt (Fig. 7) to 17-to-21 N·m (13-to-16 ft. lbs.) torque.

(5) Connect the electrical connector to sensor.

(6) Install the clip to sensor wire harness.

(7) Install clip over fuel rail mounting stud. Install clip mounting nut.

ENGINE COOLANT TEMPERATURE SENSOR

WARNING: HOT, PRESSURIZED COOLANT CAN CAUSE INJURY BY SCALDING. COOLING SYSTEM MUST BE PARTIALLY DRAINED BEFORE REMOVING THE COOLANT TEMPERATURE SENSOR. REFER TO GROUP 7, COOLING.

REMOVAL

The sensor is installed in the thermostat housing (Fig. 8).

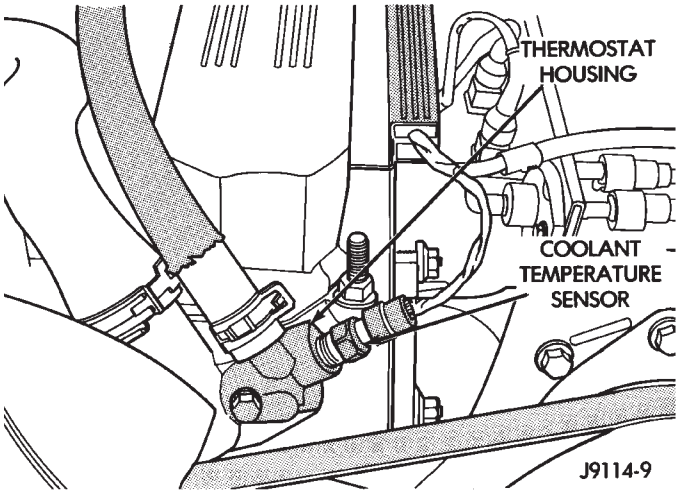

Fig. 8 Coolant Temperature Sensor—Typical

(1) Drain cooling system until the coolant level is below the cylinder head. For cooling system draining, refer to Group 7, Cooling.

(2) Disconnect the coolant temperature sensor wire connector.

(3) Remove the sensor from the thermostat housing (Fig. 8).

INSTALLATION

(1) Install coolant temperature sensor into the thermostat housing. Tighten to 28 N·m (21 ft. lbs.) torque.

(2) Connect the wire connector.

(3) Fill the cooling system. Refer to group 7, Cooling System.

DISTRIBUTOR

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

The camshaft position sensor is located in the distributor on all engines (Fig. 9).

Refer to Fig. 9 for an exploded view of the distributor.

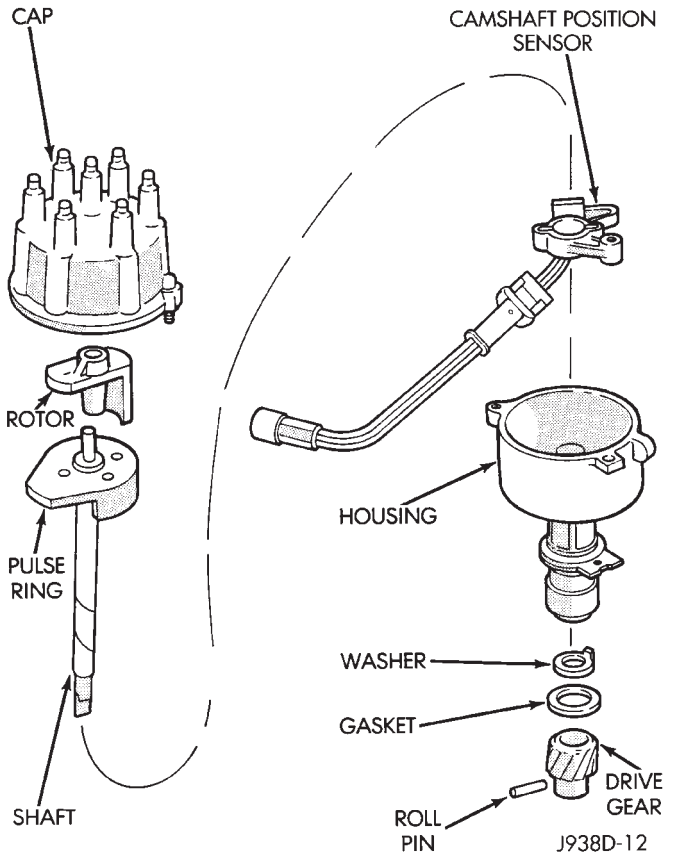

Fig. 9 Distributor—2.5L/4.0L Engines—Typical

REMOVAL—2.5L 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.

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

(5) Scribe a mark on the distributor housing in line with the tip of the rotor. Note the position of the rotor and distributor housing. This is in relation to the surrounding engine components as reference points for installing the distributor.

(6) Remove the distributor holddown bolt and clamp.

(7) Remove the distributor from engine by lifting straight up. Remove and discard old distributor-to-engine block gasket. Note that the rotor will rotate slightly in a counterclockwise direction while lifting up the distributor. Note this position after removal.

INSTALLATION—2.5L ENGINE

ENGINE NOT ROTATED AFTER REMOVAL

This procedure assumes that the engine was not rotated with distributor out of engine.

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

(2) Install a new distributor-to-engine block gasket.

There is a fork on the distributor housing where the housing seats against the engine block. The slot in the fork aligns with the distributor holddown bolt hole in the engine block. The distributor is correctly installed when the rotor is correctly positioned. This is with the slot in the fork aligned with the holddown bolt hole in the cylinder block. Because of the fork on the distributor housing, initial ignition timing is not adjustable (the distributor cannot be rotated).

(3) Position the distributor shaft in the cylinder block. If the engine was not rotated while the distributor was removed, perform the following:

- Align the rotor tip with the scribe mark on the distributor housing during removal. Turn the rotor approximately 1/8-turn counterclockwise past the scribe mark.

CAUTION: Be sure that the distributor shaft fully engages into the oil pump drive gear shaft. It may be necessary to slightly rotate (bump) the engine. This is done while applying downward hand force on the distributor body. It should fully engage the distributor shaft with the oil pump drive gear shaft.

- Slide the distributor shaft down into the engine.

It may be necessary to move the rotor and shaft (slightly) to engage the distributor shaft with the slot in the oil pump shaft. The same may have to be done to engage the distributor gear with the camshaft gear. However, the rotor should align with the scribe mark when the distributor shaft is down in place.

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

(4) Install the distributor cap (with the ignition cables) on the distributor housing (Fig. 10). Tighten distributor cap holddown screws to 3 N·m (26 in. lbs.) torque.

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

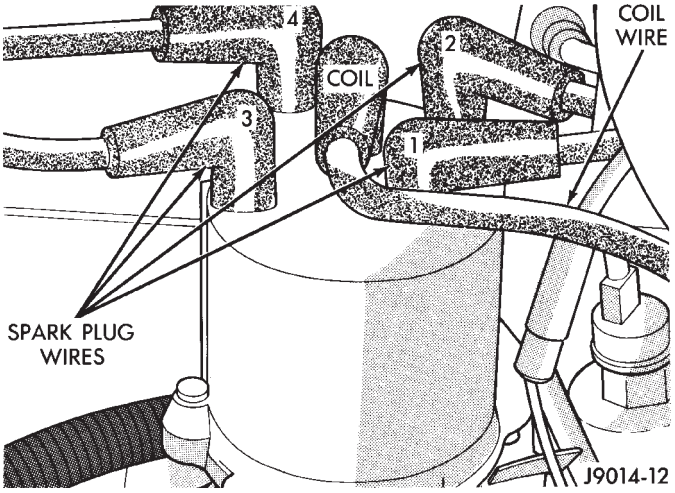

Fig. 10 Spark Plug Cable Positions—2.5L Engine

CAUTION: Do not puncture the spark plug cables or boots to make the connection. Use proper adapters.

(6) Connect battery cable to battery.

ENGINE ROTATED AFTER REMOVAL

There is a fork on the distributor housing where the housing seats against the engine block. The slot in the fork aligns with the hole for the distributor holddown bolt in the engine block. The distributor is correctly installed when the rotor is correctly positioned. This is when the slot in the fork is aligned with the hole for the distributor holddown bolt in the cylinder block. Because of the fork on the distributor housing, initial ignition timing is not adjustable (the distributor cannot be rotated).

(1) If the engine was rotated while the distributor was removed, it will be necessary to establish timing according to following procedure:

- Remove the No. 1 spark plug. Hold a finger over the spark plug hole and rotate the engine until compression pressure is felt. Slowly continue to rotate the engine. Do this until the timing index on vibration damper pulley aligns with top dead center (TDC) mark (0 degree) on timing degree scale. Always rotate the engine in direction of normal rotation. Do not turn the engine backward to align the timing marks.
- Using a flat blade screwdriver, rotate the oil pump gear. Do this to position the gear slot on the oil pump shaft slightly before the 11 o'clock position (Fig. 11).
- With the distributor cap removed, install the distributor with the rotor located just past the 2 o'clock position (Fig. 12).

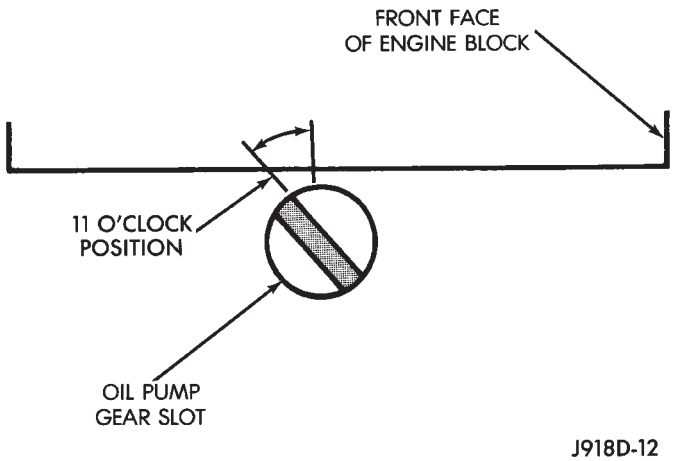

Fig. 11 Align Oil Pump Gear Slot—2.5L Engine

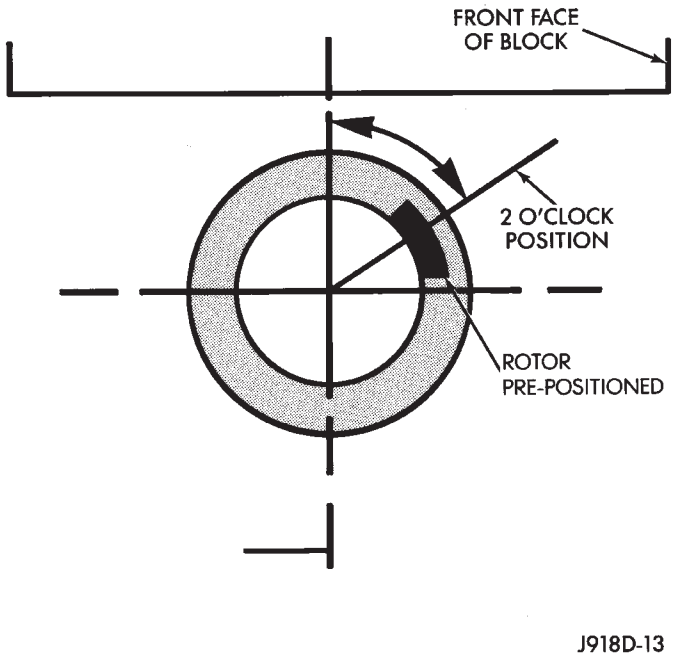

Fig. 12 Distributor Installation—2.5L Engine

- When distributor is fully engaged in its correct location, the rotor should be just past the 3 o'clock position (Fig. 13).
- Install the distributor holddown clamp and bolt. Tighten the holddown bolt to 23 N·m (17 ft. lbs.) torque.

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

(2) Install the distributor cap (with ignition cables) on the distributor housing. Be sure that the cap fits securely on rim of the distributor housing.

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

CAUTION: Do not puncture the spark plug cables or boots to make the connection. Use proper adapters.

REMOVAL—4.0L ENGINE

The distributor used in the 4.0L engine contains an internal oil seal that prevents oil from entering the distributor housing. The seal is not serviceable.

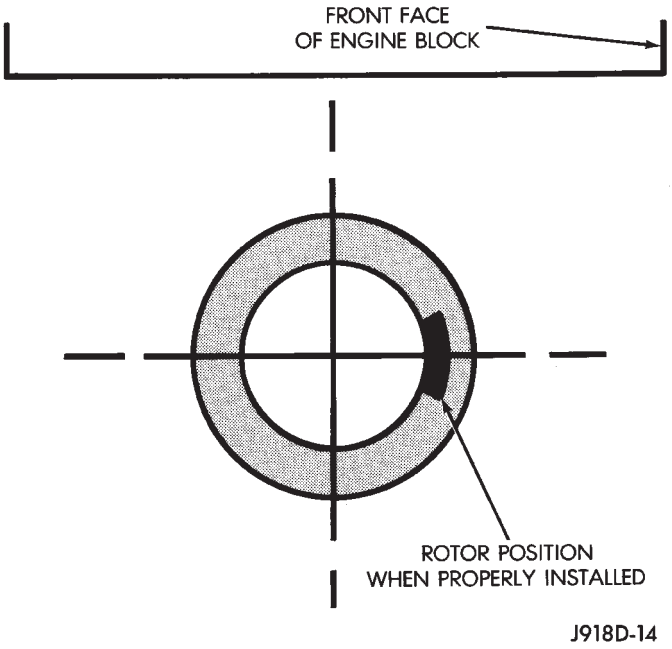

Fig. 13 Distributor Rotor Position—2.5L Engine

The camshaft position sensor is located in the distributor on all engines (Fig. 9).

Refer to figure 9 for an exploded view of the distributor.

(1) Disconnect the negative battery cable at battery.

(2) On XJ models equipped with A/C, remove the electrical cooling fan and shroud assembly from the radiator. This will provide room to turn the engine with a socket and ratchet using the vibration damper bolt.

(3) Scribe a mark on the distributor housing. Do this below the left side of (past) the number one spark plug cable post of the distributor cap. This will be used as a reference for #1 cylinder firing position (Fig. 14).

(4) Remove the distributor cap from distributor (2 screws).

(5) Turn the engine in a clockwise direction until the rotor is approaching the scribe mark on the distributor housing. Then slowly turn the engine until the timing mark on the crankshaft vibration damper lines up with zero on the front cover timing scale (Fig. 15).

The timing mark is on the edge of the vibration damper closest to the engine front cover.

(6) Align the trailing edge of the rotor blade with the scribe mark on the distributor housing (Fig. 16).

(7) Remove the distributor holddown bolt and clamp.

(8) Remove the distributor from the engine by lifting straight up. Remove and discard old distributor-to-engine block gasket. Note that the rotor will rotate slightly in a counterclockwise direction while lifting up the distributor. Note this position after removal.

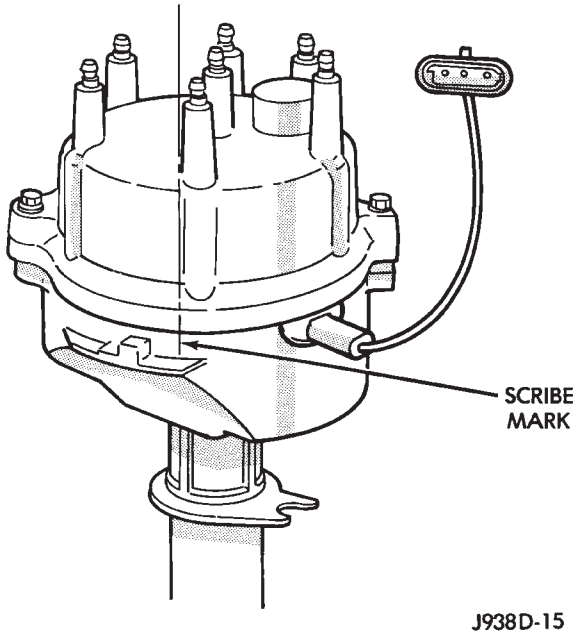

Fig. 14 Mark Distributor Housing

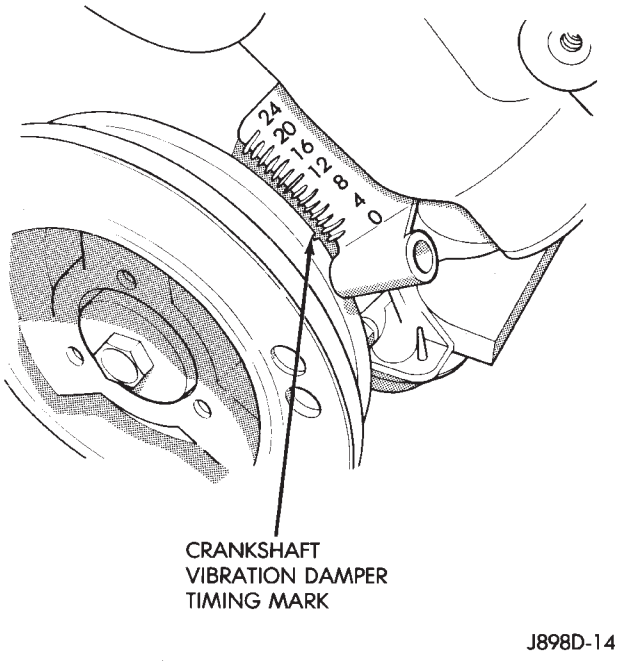

Fig. 15 Align Timing Marks

INSTALLATION—4.0L ENGINE

(1) Clean the distributor mounting area of the cylinder block.

(2) Install a replacement distributor-to-engine block gasket.

(3) Using a flat blade screwdriver, turn the oil pump gear shaft. Do this until the slot is slightly past the 11 o'clock position (Fig. 17).

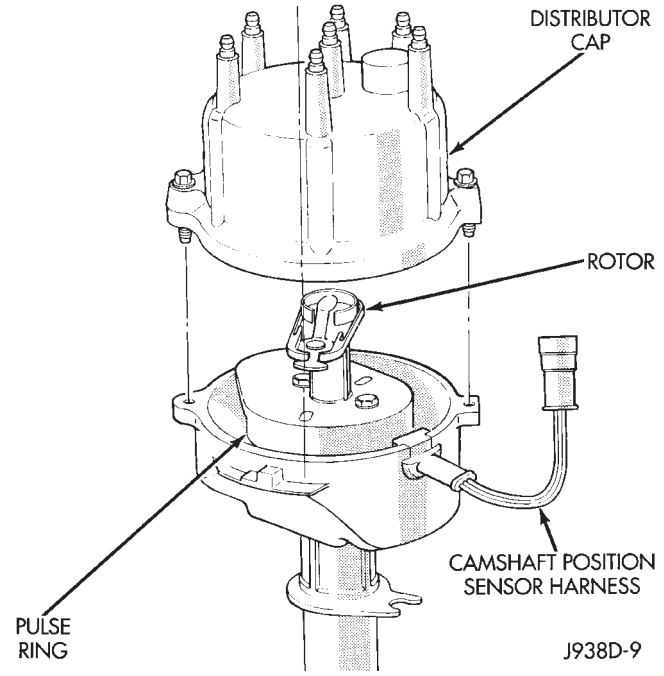

Fig. 16 Align Rotor Trailing Edge With Scribe Mark

The oil pump shaft is located down in the distributor hole.

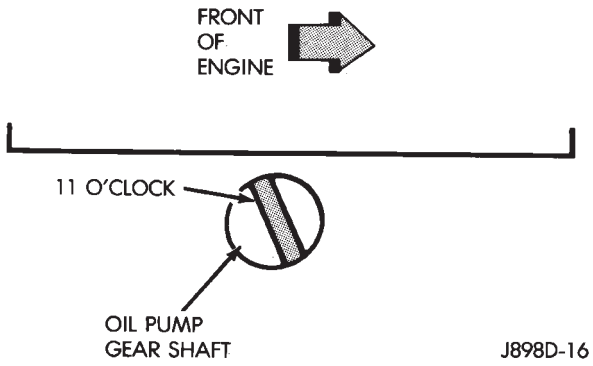

Fig. 17 Align Oil Pump Gear Shaft—4.0L Engine

(4) Install the rotor.

(5) Without engaging the distributor gear into the cam gear, position the distributor into the hole in the engine block. Be sure the distributor gasket is installed.

(6) Visually line up the holddown ear of the distributor housing with the holddown clamp hole (Fig. 18).

(7) Turn the rotor to the 4 o'clock position (Fig. 19).

(8) Slide the distributor down into the block until it seats. Keep the holddown ear aligned to the hole in the block.

(9) The rotor should be in the 5 o'clock position. This is with the trailing edge of rotor blade lined up with scribe mark on distributor housing (number one spark plug cable post location).

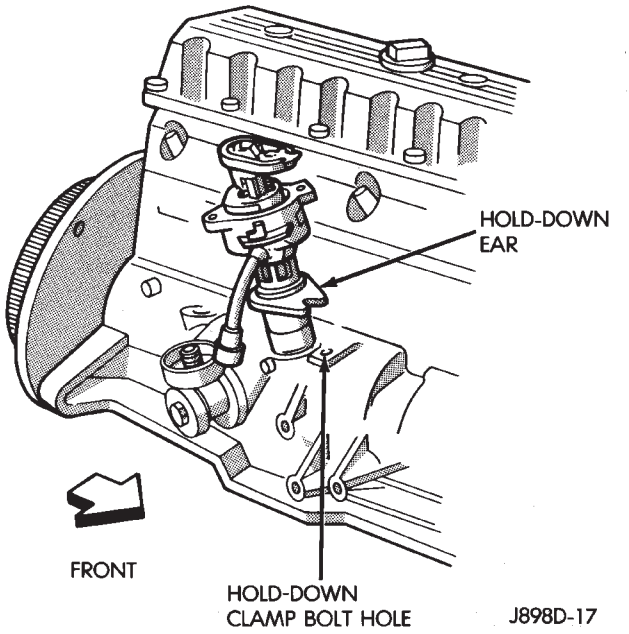

Fig. 18 Distributor Installation—Typical

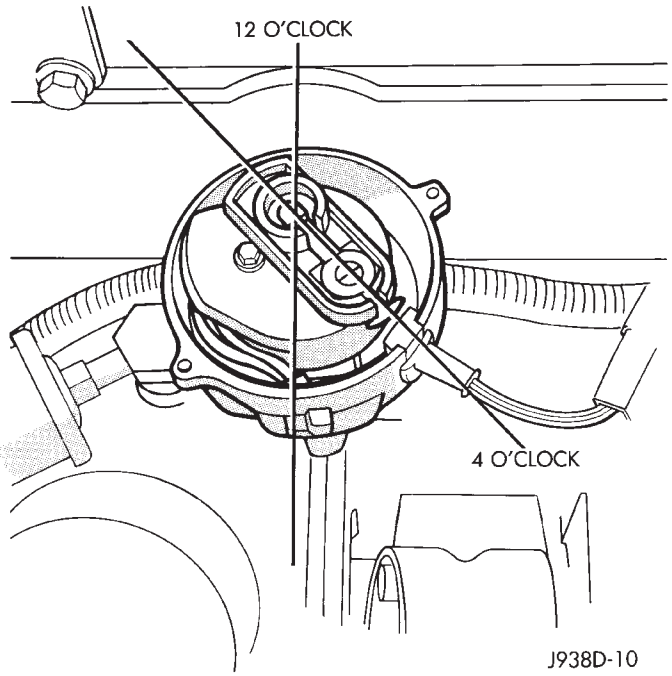

Fig. 19 Rotor Alignment

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

(11) Install the distributor cap and connect the distributor electrical connector.

(12) Install electrical cooling fan and shroud if applicable.

(13) 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

The ignition coil is mounted to the right side of the engine block next to the distributor (Fig. 20).

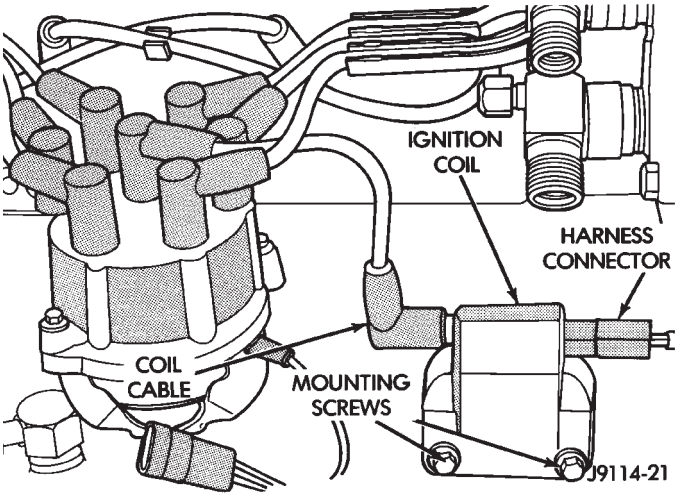

Fig. 20 Ignition Coil—Typical

(1) Disconnect the ignition coil secondary cable from ignition coil (Fig. 20).

(2) Disconnect engine harness connector from ignition coil.

(3) Remove ignition coil mounting bolts. Remove coil.

INSTALLATION

(1) Install ignition coil to bracket on cylinder block with mounting bolts.

(2) Connect engine harness connector to coil.

(3) Connect ignition coil cable to ignition coil.

INTAKE MANIFOLD AIR TEMPERATURE SENSOR

REMOVAL

The intake manifold air temperature sensor is installed into the intake manifold plenum (Figs. 21 or 22).

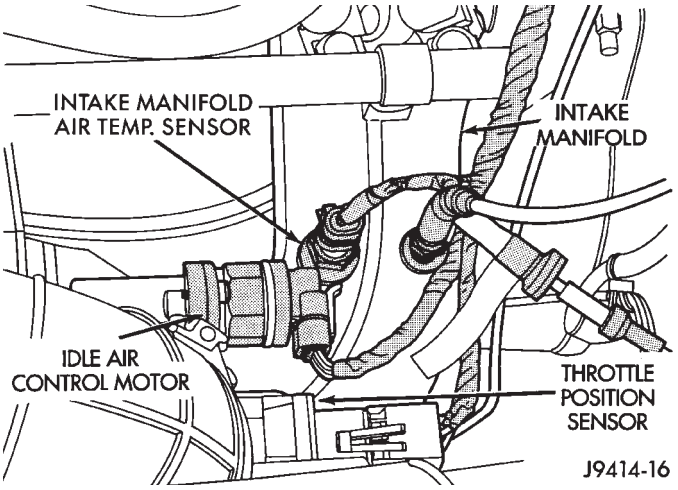

Fig. 21 Air Temperature Sensor—2.5L Engine

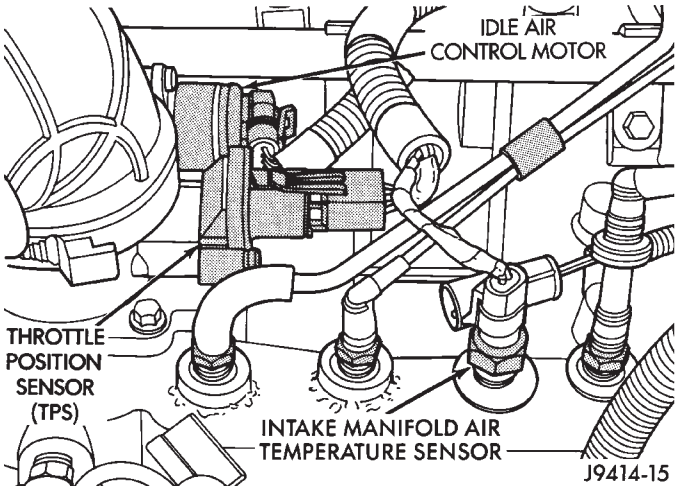

Fig. 22 Air Temperature Sensor—4.0L Engine

(1) Disconnect the electrical connector from the sensor.

(2) Remove the sensor from the intake manifold.

INSTALLATION

(1) Install the air temperature sensor into the intake manifold. Tighten the sensor to 13 N·m (10 ft. lbs.) torque.

(2) Connect the electrical connector to the sensor.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The MAP sensor is located on the dash panel near the rear of the engine cylinder head (valve) cover (Fig. 23).

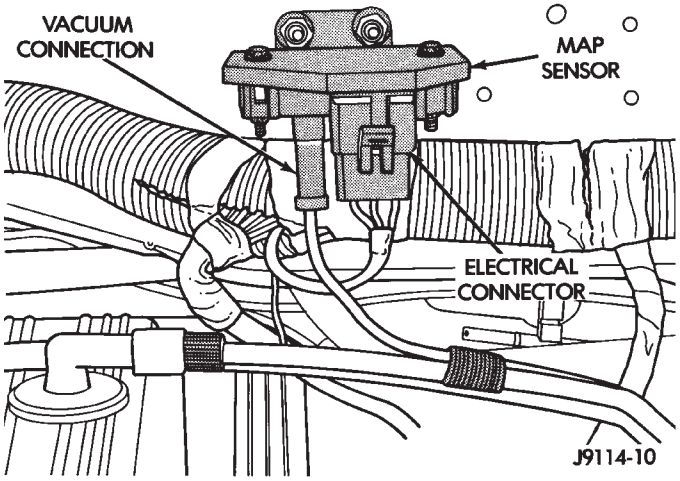

Fig. 23 MAP Sensor—Typical

REMOVAL

(1) Disconnect the MAP sensor electrical connector (Fig. 23).

(2) Disconnect the MAP sensor vacuum supply hose (Fig. 23).

(3) Remove the MAP sensor mounting nuts and remove MAP sensor.

INSTALLATION

(1) Install MAP sensor to dash panel and secure with mounting nuts.
(2) Install the MAP sensor vacuum supply hose.
(3) Connect the MAP sensor electrical connector.

OXYGEN (O2S) SENSOR

For diagnostics and removal/installation procedures, refer to Group 14, Fuel Systems, in this manual.

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. 24).

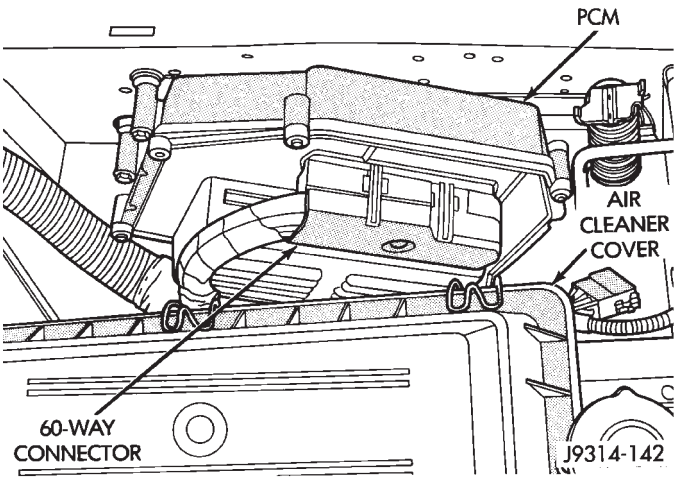

Fig. 24 PCM Location—XJ Models

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. 25).

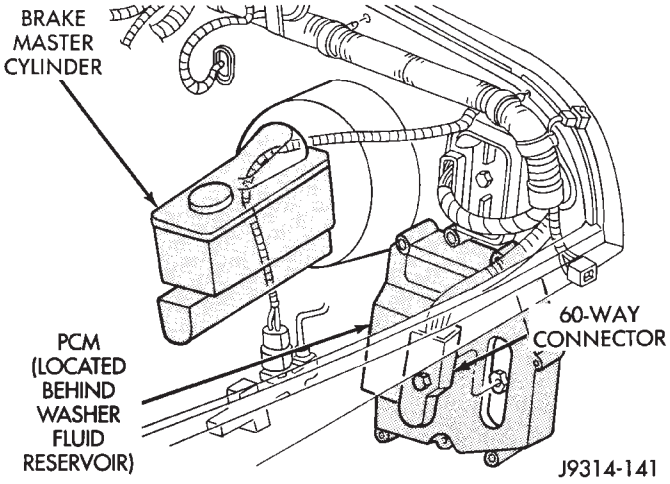

Fig. 25 PCM Location—YJ Models

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. 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.
(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.

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. 26). **Never attempt to adjust the gap by bending the center electrode.**

SPARK PLUG GAP

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

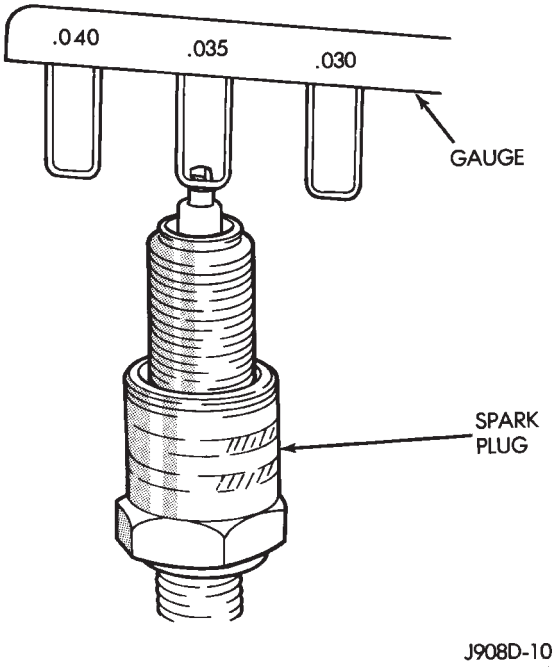

Fig. 26 Setting Spark Plug Gap—Typical

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.

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. 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. 27 or 28).

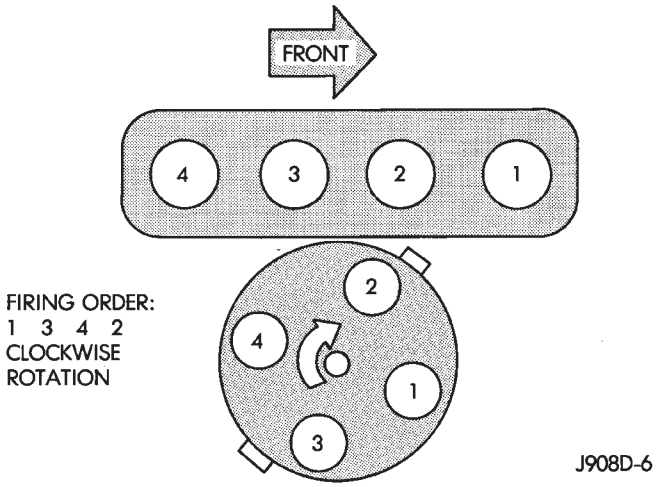

Fig. 27 Engine Firing Order—2.5L Engine

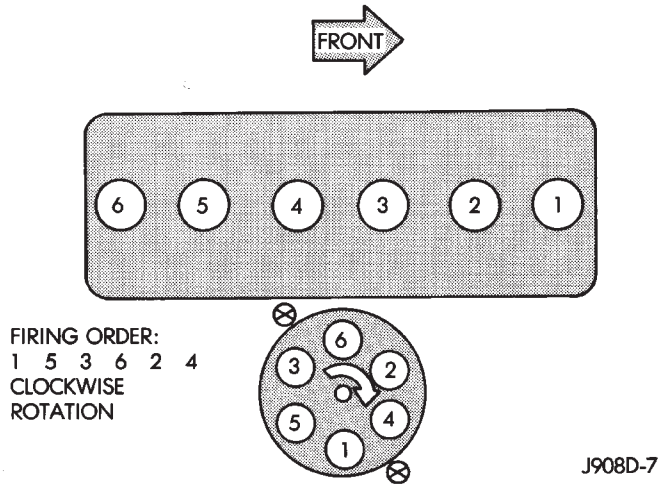

Fig. 28 Engine Firing Order—4.0L Engine

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.

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.

THROTTLE POSITION SENSOR (TPS)

For diagnostics and removal/installation procedures, refer to Group 14, Fuel Systems, in this manual.

IGNITION SWITCH

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GENERAL INFORMATION

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. 1). 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. 2).

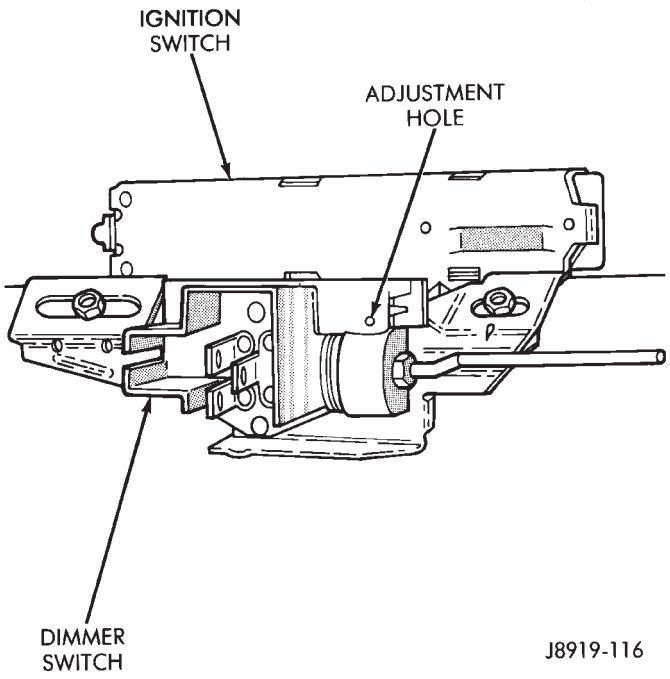

Fig. 1 Ignition Switch/Headlamp Dimmer Switch—Typical

IGNITION SWITCH REMOVAL

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

(2) XJ models: Remove the lower instrument panel trim assembly. YJ models: 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.

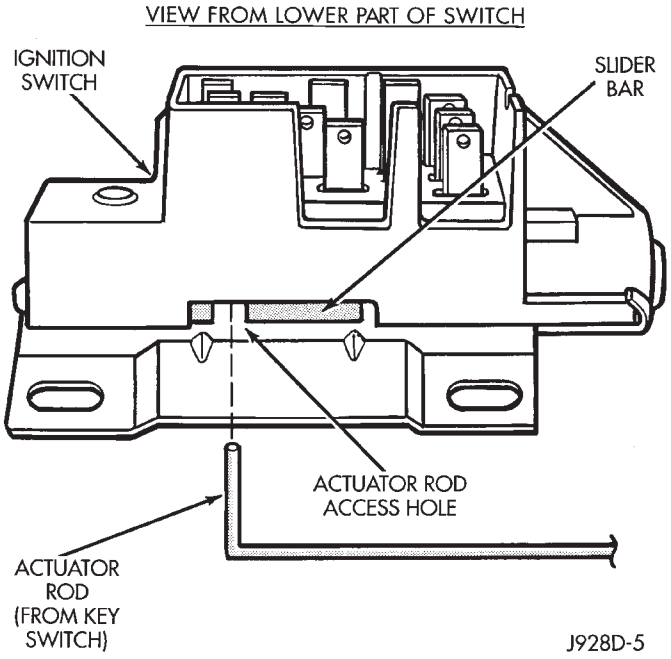

Fig. 2 Ignition Switch/Remote Actuator Rod—Typical

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.

(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.

IGNITION SWITCH TESTING

To test the ignition switch circuity and continuity, proceed as follows. Place the slide bar (on the ignition switch) (Fig. 2) 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. 3) 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. 4 or 5). 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. 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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IGNITION SWITCH INSTALLATION/ADJUSTMENT

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

(2) Place the slider bar (in the ignition switch) (Fig. 2) 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. 2). 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

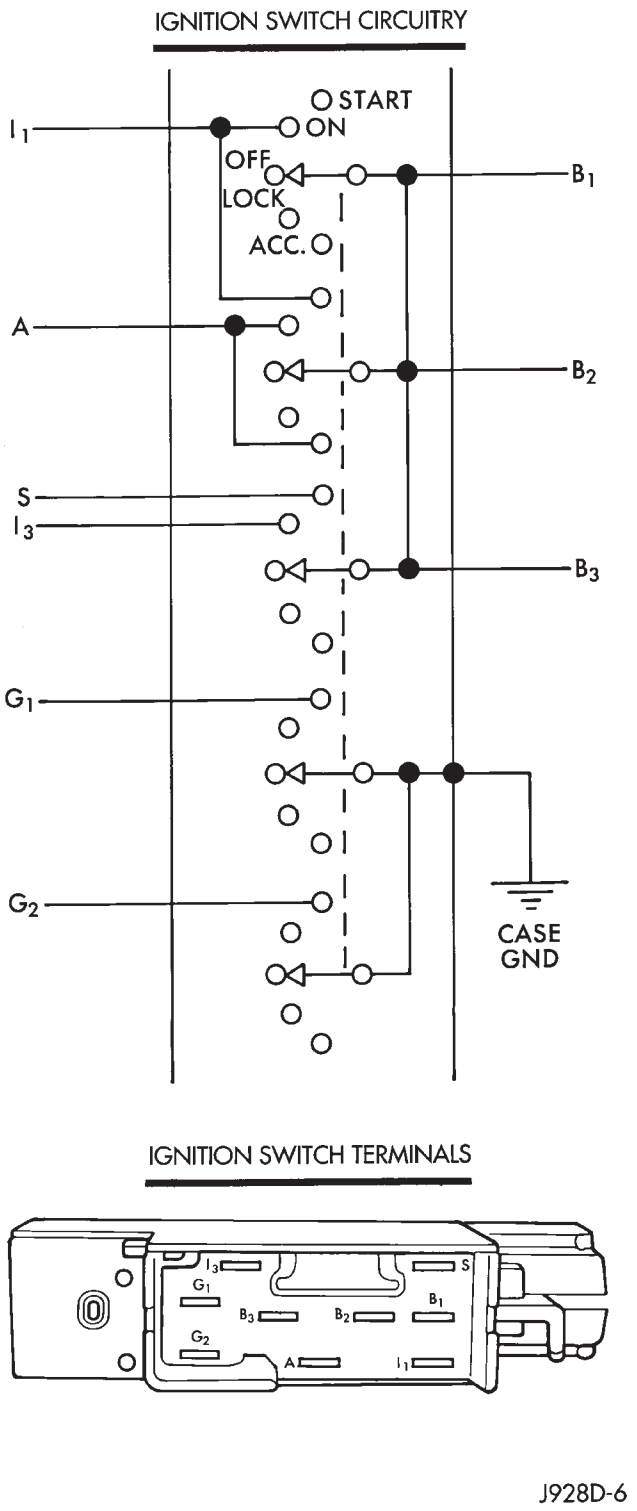

Fig. 3 Ignition Switch Terminals/Circuits

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 at-

taching 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 ignition 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. 1). 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) XJ models: Install the lower instrument panel trim assembly. YJ models: 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.

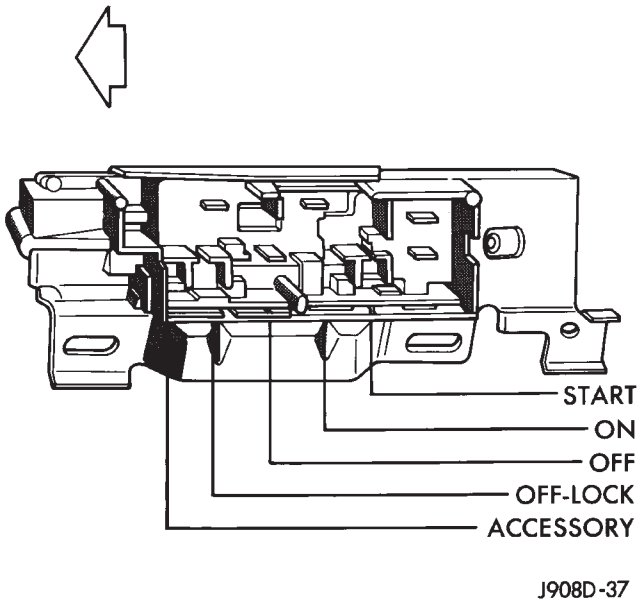

Fig. 4 Detent Positions—Non-Tilt Steering Column

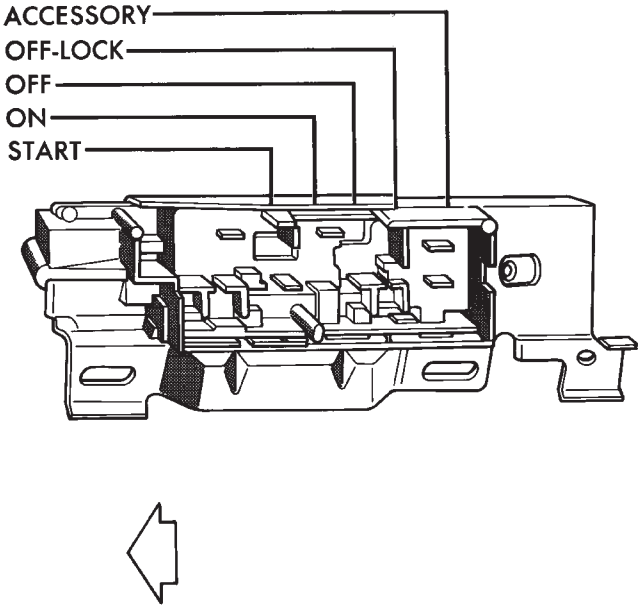

Fig. 5 Detent Positions—Tilt Steering Column

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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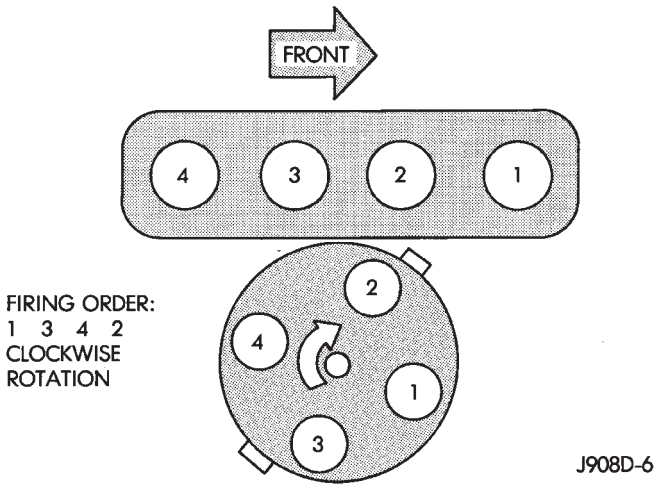
ENGINE FIRING ORDER—2.5L ENGINE



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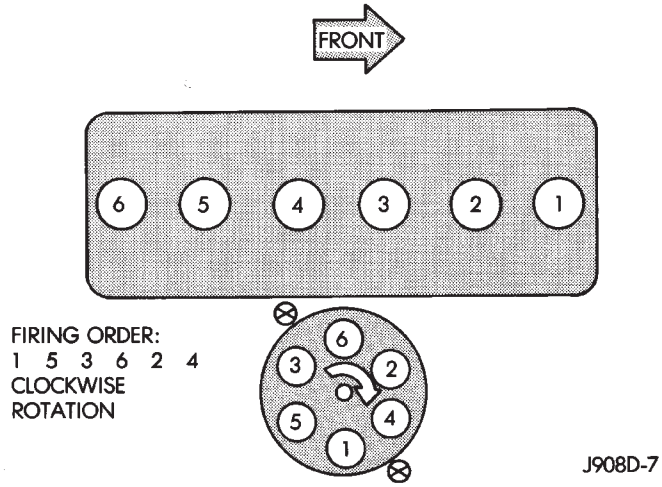
ENGINE FIRING ORDER—4.0L ENGINE



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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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