IGNITION SYSTEM

CONTENTS

SPECIFICATIONS

GENERAL INFORMATION

INTRODUCTION

This group describes the ignition systems for 3.9L V-6, 5.2L/5.9L V-8, and 8.0L V-10 engines.

The 3.9L V-6 and 5.2L V-8 engines will be referred to in this Ignition Group as: Light Duty Cycle (LDC) engines. The 5.9L V-8 gas powered engine will be referred to as either: Light Duty Cycle (LDC) or Heavy Duty Cycle (HDC) engines. The 8.0L V-10 engine will be referred to as either: Medium Duty Cycle (MDC) or Heavy Duty Cycle (HDC) engines.

Either of the HDC gas powered engines can be easily identified by the use of an engine mounted air injection pump. The 3.9L V-6 engine, the 5.2/5.9L V-8 LDC or the 8.0L V-10 MDC gas engines will not use an air injection pump.

On Board Diagnostics is described in Group 25, Emission Control Systems.

Group 0, Lubrication and Maintenance, contains general maintenance information (in time or mileage intervals) for ignition related items. The Owner's Manual also contains maintenance information.

DESCRIPTION AND OPERATION

IGNITION SYSTEM—V-6/V–8 ENGINES

The ignition systems used on the 3.9L V-6, the 5.2L V-8 and the 5.9L V-8 are basically identical. Similarities and differences between the systems will be discussed.

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

The ignition system consists of:

- Spark Plugs
- Ignition Coil
- Secondary Ignition Cables
- Distributor (contains rotor and camshaft position sensor)
- Powertrain Control Module (PCM)
- Also to be considered part of the ignition system are certain inputs from the Crankshaft Position, Camshaft Position, Throttle Position and MAP Sensors

IGNITION SYSTEM—8.0L V-10 ENGINE

The ignition system used on the 8.0L V–10 engine does not use a conventional mechanical distributor. The system will be referred to as a distributor-less ignition system. The ignition coils are individually fired, but each coil is a dual output. Refer to Ignition Coil Pack for additional information.

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

The ignition system consists of:

- Spark Plugs
- Ignition Coil Packs containing individual coils
- Secondary Ignition Cables
- Powertrain Control Module (PCM)
- Also to be considered part of the ignition system are certain inputs from the Crankshaft Position, Camshaft Position, Throttle Position and MAP Sensors

POWERTRAIN CONTROL MODULE

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

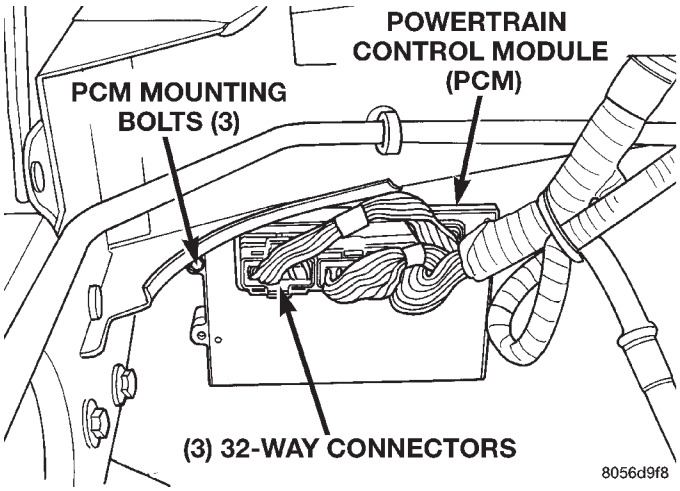

Fig. 1 Powertrain Control Module (PCM)

The ignition system is controlled by the PCM.

NOTE: On 3.9L/5.2L/5.9L engines, base ignition timing by rotation of distributor is not adjustable.

DESCRIPTION AND OPERATION (Continued)

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

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

DISTRIBUTOR

All 3.9L V-6 and 5.2L/5.9L V-8 engines are equipped with a conventional camshaft driven mechanical distributor containing a shaft driven distributor rotor. The distributor is equipped with the camshaft position (fuel sync) sensor (Fig. 2). This sensor provides fuel injection synchronization and cylinder identification.

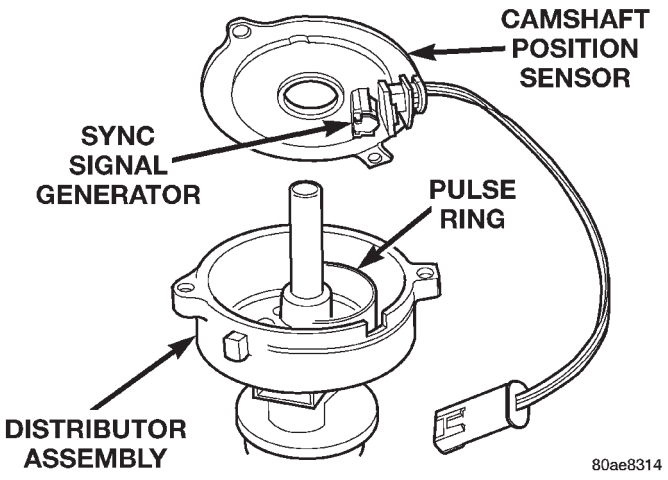

Fig. 2 Distributor and Camshaft Position Sensor-Typical

The distributor does 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.**

The distributor is held to the engine in the conventional method using a holddown clamp and bolt. **Although the distributor can be rotated, it 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.

SPARK PLUGS

The 3.9L V-6 and 5.2L/5.9L V-8 engines use resistor type spark plugs. The 8.0L V-10 engine uses inductive type spark plugs. Remove the spark plugs and examine them for burned electrodes and fouled, cracked or broken porcelain insulators. Keep plugs arranged in the order in which they were removed from the engine. A single plug displaying an abnormal condition indicates that a problem exists in the corresponding cylinder. Replace spark plugs at the intervals recommended in Group O, Lubrication and Maintenance

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

SPARK PLUG CABLES

Spark plug cables are sometimes referred to as secondary ignition wires. These cables transfer electrical current from the ignition coil(s) and/or distributor, to individual spark plugs at each cylinder. The resistive spark plug cables are of nonmetallic construction. The cables provide suppression of radio frequency emissions from the ignition system.

IGNITION COIL—3.9L/5.2L/5.9L ENGINES

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 on any engine. 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.

IGNITION COIL PACKS—8.0L ENGINE

The ignition system used on the 8.0L V-10 engine does not use a conventional mechanical distributor. It will be referred to as a distributor-less ignition system. **Ignition timing is not adjustable on any 8.0L V-10 engine.**

Two separate coil packs containing a total of five independent coils are attached to a common mounting bracket located above the right engine valve cover (Fig. 3). The coil packs are not oil filled. The front coil pack contains three independent epoxy filled coils. The rear coil pack contains two independent epoxy filled coils.

When one of the 5 independent coils discharges, it fires two paired cylinders at the same time (one cylinder on compression stroke and the other cylinder on exhaust stroke).

Coil firing is paired together on cylinders:

- Number 5 and 10

DESCRIPTION AND OPERATION (Continued)

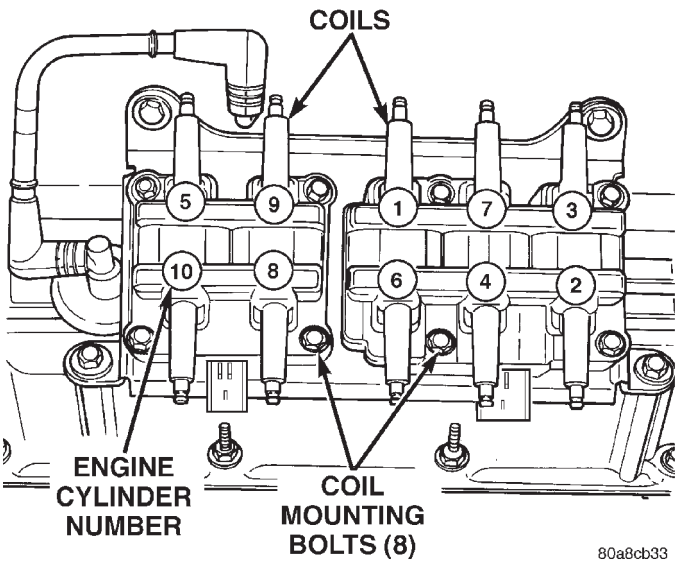

Fig. 3 Ignition Coil Packs—8.0L V-10 Engine

- Number 9 and 8
- Number 1 and 6
- Number 7 and 4
- Number 3 and 2

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 automatic shutdown (ASD) relay, after receiving signals from the crankshaft and camshaft position sensors, will supply battery voltage to all of the ignition coil positive terminals. If these signals are not received by the PCM after approximately one second of engine cranking (start-up), the ASD relay will shut off positive voltage to all of the coils. Coil operation (firing) is then controlled by switching ground circuits (off-and-on) through the PCM. The PCM will determine cylinder identification after receiving signals from the crankshaft and camshaft position sensors.

The PCM adjusts ignition timing based on inputs it receives from:

- The engine coolant temperature sensor
- The crankshaft position sensor (engine speed)
- The manifold absolute pressure (MAP) sensor
- The throttle position sensor
- Transmission gear selection

AUTOMATIC SHUTDOWN (ASD) RELAY—3.9L/ 5.2L/5.9L ENGINES

As one of its functions, the ASD relay 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.

AUTOMATIC SHUTDOWN (ASD) RELAY—8.0L V-10 ENGINE

As one of its functions, the ASD relay will supply battery voltage to each of the 5 independent ignition coils. 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.

CRANKSHAFT POSITION SENSOR—3.9L V-6 ENGINE

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.

The flywheel/drive plate has groups of notches at its outer edge. On 3.9L V-6 engines, there are three sets of double notches and three sets of single notches (Fig. 4).

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

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

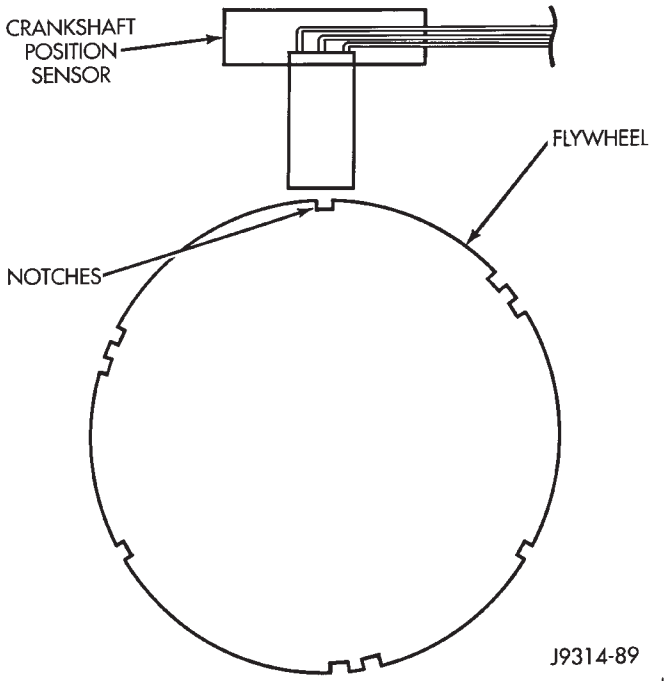

Fig. 4 Sensor Operation—3.9L Engine

DESCRIPTION AND OPERATION (Continued)

CRANKSHAFT POSITION SENSOR—5.2L/5.9L V-8 ENGINES

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

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

On 5.2L and 5.9L V-8 engines, the flywheel/drive plate has 8 single notches, spaced every 45 degrees, at its outer edge (Fig. 5).

The notches cause a pulse to be generated when they pass under the sensor. The pulses are the input to the PCM. For each engine revolution, there are 8 pulses generated on V-8 engines.

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

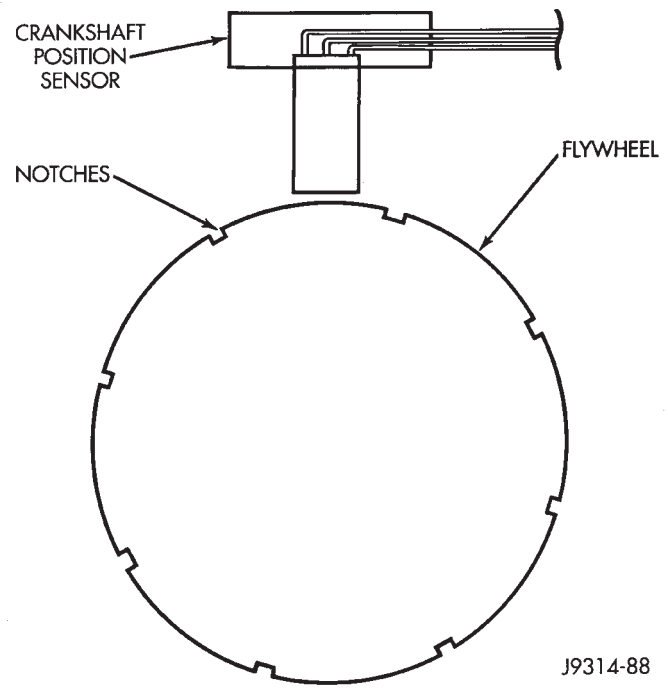

Fig. 5 Sensor Operation—5.2L/5.9L Engine

CRANKSHAFT POSITION SENSOR—8.0L V-10 ENGINE

The crankshaft position sensor is located on the right-lower side of the cylinder block, forward of the right engine mount, just above the oil pan rail (Fig. 6).

The crankshaft position sensor detects notches machined into the middle of the crankshaft (Fig. 7).

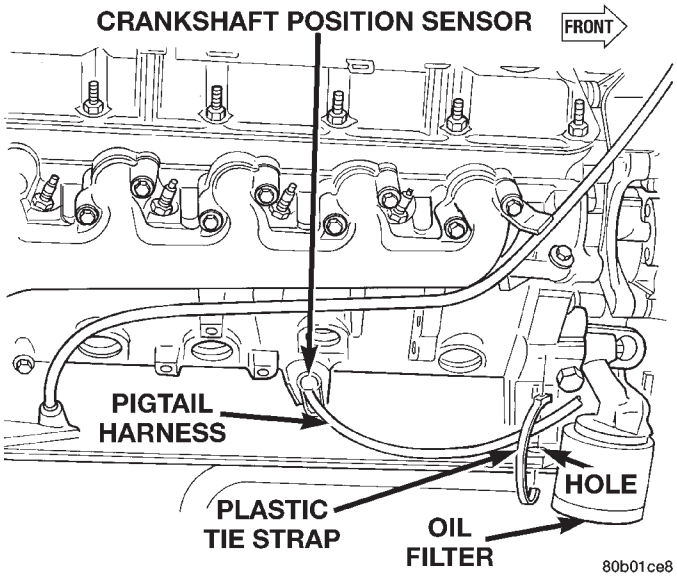

Fig. 6 Crankshaft Position Sensor Location—8.0L V-10 Engine

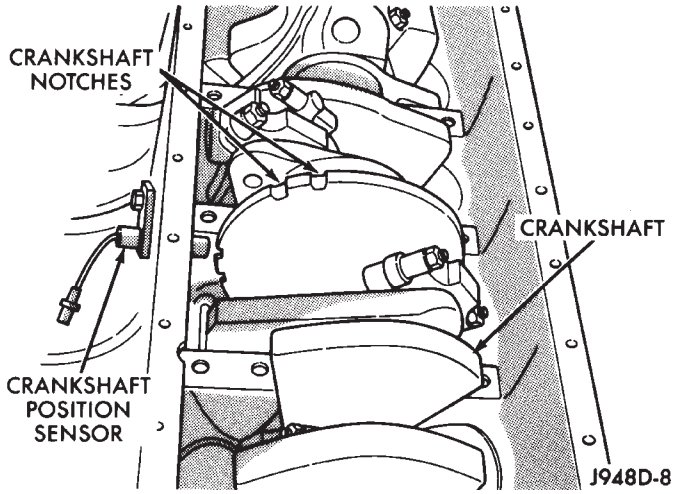

Fig. 7 Crankshaft Position Sensor Operation—8.0L V-10 Engine

There are five sets of notches. Each set contains two notches. Basic ignition timing is determined by the position of the last notch in each set of notches. Once the powertrain control module (PCM) senses the last notch, it will determine crankshaft position (which piston will next be at Top Dead Center). An input from the camshaft position sensor is also needed. It may take the module up to one complete engine revolution to determine crankshaft position during engine cranking.

The PCM uses the signal from the camshaft position sensor to determine fuel injector sequence. Once crankshaft position has been determined, the PCM begins energizing a ground circuit to each fuel injector to provide injector operation.

DESCRIPTION AND OPERATION (Continued)

CAMSHAFT POSITION SENSOR—3.9L/5.2L/5.9L ENGINES

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

The sensor contains a hall effect device called a sync signal generator to generate a fuel sync signal. This sync signal generator detects a rotating pulse ring (shutter) on the distributor shaft. 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.

CAMSHAFT POSITION SENSOR—8.0L V-10 ENGINE

The camshaft position sensor is located on the timing chain case/cover on the left-front side of the engine (Fig. 8).

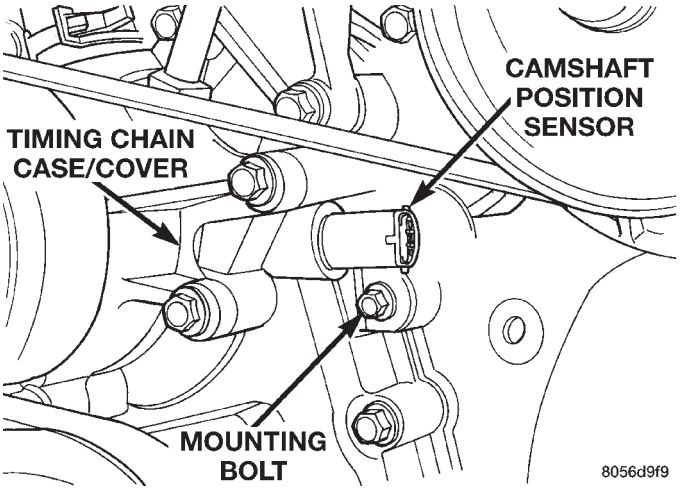

Fig. 8 Camshaft Position Sensor Location—8.0L V-10 Engine

The camshaft position sensor is used in conjunction with the crankshaft position sensor to differentiate between fuel injection and spark events. It is also used to synchronize the fuel injectors with their respective cylinders. The sensor generates electrical pulses. These pulses (signals) are sent to the powertrain control module (PCM). The PCM will then determine crankshaft position from both the camshaft position sensor and crankshaft position sensor.

A low and high area are machined into the camshaft drive gear (Fig. 9). The sensor is positioned in the timing gear cover so that a small air gap (Fig. 9) exists between the face of sensor and the high machined area of cam gear.

When the cam gear is rotating, the sensor will detect the machined low area. Input voltage from the sensor to the PCM will then switch from a low (approximately 0.3 volts) to a high (approximately 5 volts). When the sensor detects the high machined area, the input voltage switches back low to approximately 0.3 volts.

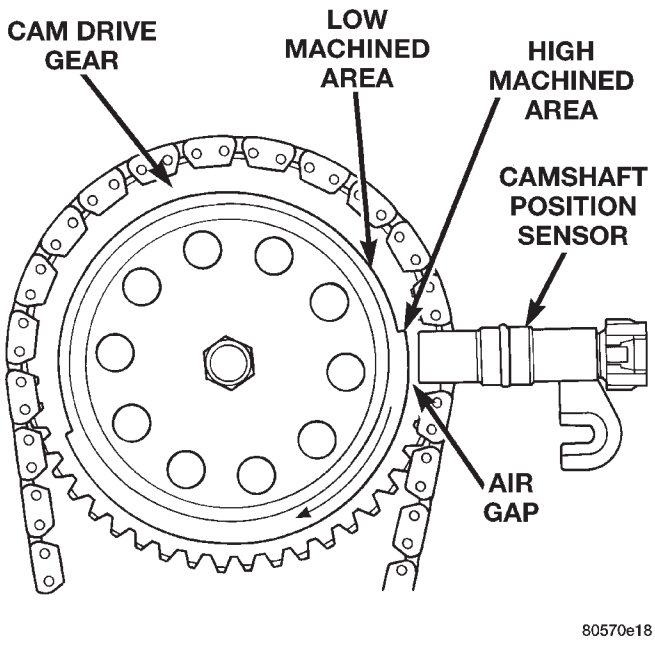

Fig. 9 Sensor Operation—8.0L V-10 Engine

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

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

ENGINE COOLANT TEMPERATURE SENSOR

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

THROTTLE POSITION SENSOR

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

INTAKE MANIFOLD AIR TEMPERATURE SENSOR

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

DESCRIPTION AND OPERATION (Continued)

IGNITION SWITCH AND KEY LOCK CYLINDER

The ignition switch is located on the steering column. The Key-In-Switch is located in the ignition switch module. For electrical diagnosis of the Key-In-Switch, refer to Group 8U, Chime/Buzzer Warning Systems. For removal/installation of either the key lock cylinder or ignition switch, refer to Ignition Switch and Key Cylinder Removal/Installation in this group.

On vehicles equipped with an automatic transmission, a cable connects an interlock device within the steering column assembly to the transmission floor shift lever. This interlock device is used to lock the transmission shifter in the PARK position when the key is in the LOCKED or ACCESSORY position. The interlock device is not serviceable. If repair is necessary, the steering column assembly must be replaced. Refer to Group 19, Steering for procedures. The shifter interlock cable can be adjusted or replaced. Refer to Group 21, Transmissions for procedures.

DIAGNOSIS AND TESTING

AUTOMATIC SHUTDOWN (ASD) RELAY TEST

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

TESTING FOR SPARK AT COIL—3.9L/5.2L/5.9L ENGINES

CAUTION: When disconnecting a high voltage cable from a spark plug or from the distributor cap, twist the rubber boot slightly (1/2 turn) to break it loose (Fig. 10). Grasp the boot (not the cable) and pull it off with a steady, even force.

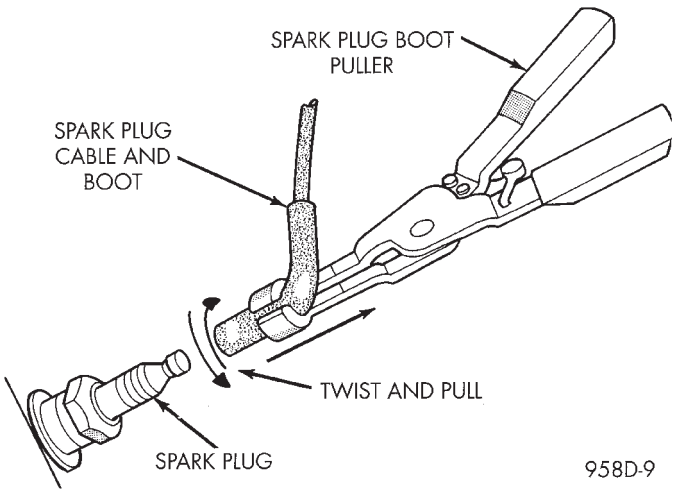

Fig. 10 Cable Removal

(1) Disconnect the ignition coil secondary cable from center tower of the distributor cap. Hold the cable terminal approximately 12 mm (1/2 in.) from a good engine ground (Fig. 11).

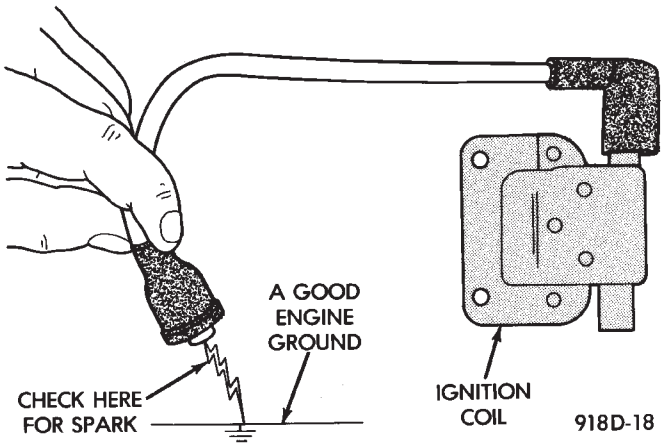

Fig. 11 Checking for Spark—Typical

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 the ignition coil cable is removed for this test, instead of a spark plug cable, the spark intensity will be much higher).** If steady arcing occurs at the spark plug cables, but the engine will not start, connect the DRB scan tool. Refer to the appropriate Powertrain Diagnostic Procedures service manual.

IGNITION COIL TEST—3.9L/5.2L/5.9L ENGINES

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. 12) is designed to operate without an external ballast resistor.

DIAGNOSIS AND TESTING (Continued)

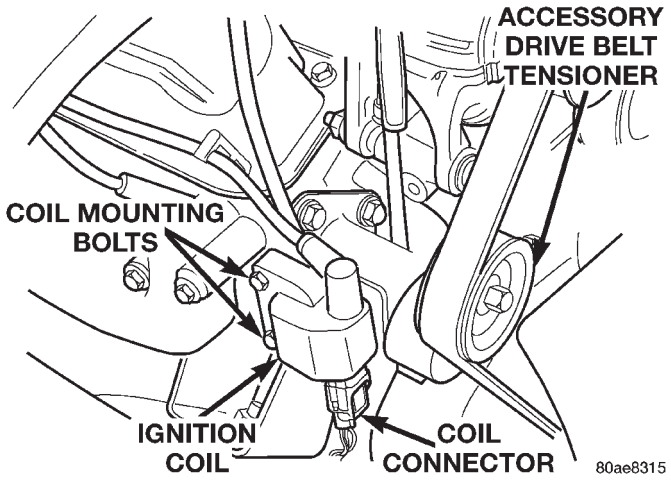

Fig. 12 Ignition Coil (5.2L Shown)

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

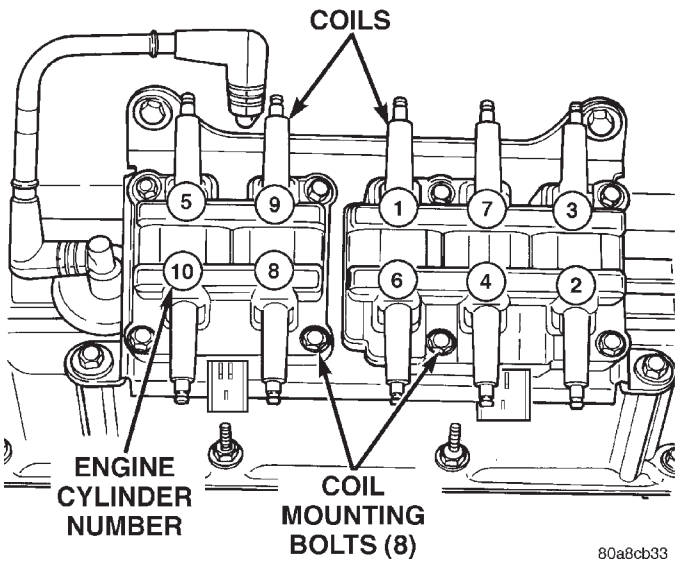

Fig. 13 Ignition Coil Packs—8.0L V-10 Engine

To test the secondary resistance of each individual paired coil, attach an ohmmeter across the coil towers (Fig. 14) or (Fig. 15). This must be done between corresponding cylinders number 3/2, 7/4, 1/6, 9/8 or 5/10 (Fig. 13). Refer to the IGNITION COIL RESISTANCE—8.0L V-10 ENGINE chart for specifications.

IGNITION COIL RESISTANCE—V-6/V-8

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

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 boot, 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 PACK TESTS—8.0L V-10 ENGINE

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

Two separate coil packs containing a total of five independent coils are attached to a common mounting bracket located above the right engine valve cover (Fig. 13). The coil packs are not oil filled. The front coil pack contains three independent epoxy filled coils that will fire six cylinders. The rear coil pack contains two independent epoxy filled coils that will fire four cylinders.

To test the primary resistance of the front coil pack, attach an ohmmeter between the B+ coil terminal and either the right (cylinders 3/2), center (cylinders 7/4) or left coil (cylinders 1/6) terminals (Fig. 16). Refer to the IGNITION COIL RESISTANCE—8.0L V-10 ENGINE chart for specifications.

To test the primary resistance of the rear coil pack, attach an ohmmeter between the B+ coil terminal and either the right (cylinders 9/8) or left (cylinders 5/10) coil terminals (Fig. 17). Refer to the IGNITION COIL RESISTANCE—8.0L V-10 ENGINE chart for specifications.

FAILURE TO START TEST—3.9L/5.2L/5.9L ENGINES

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

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

DIAGNOSIS AND TESTING (Continued)

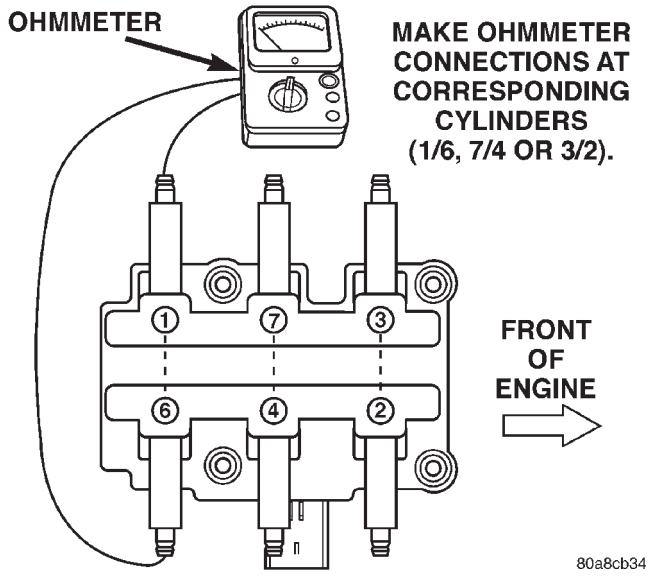

Fig. 14 Checking Coil Secondary Resistance—Front Coils—8.0L V-10 Engine

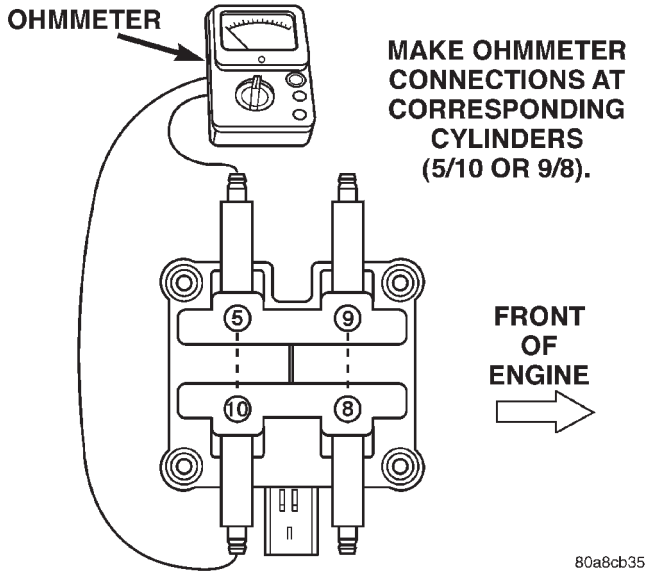

Fig. 15 Checking Coil Secondary Resistance—Rear Coils—8.0L V-10 Engine

(1) Unplug the ignition coil harness connector at the coil (Fig. 12).

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

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

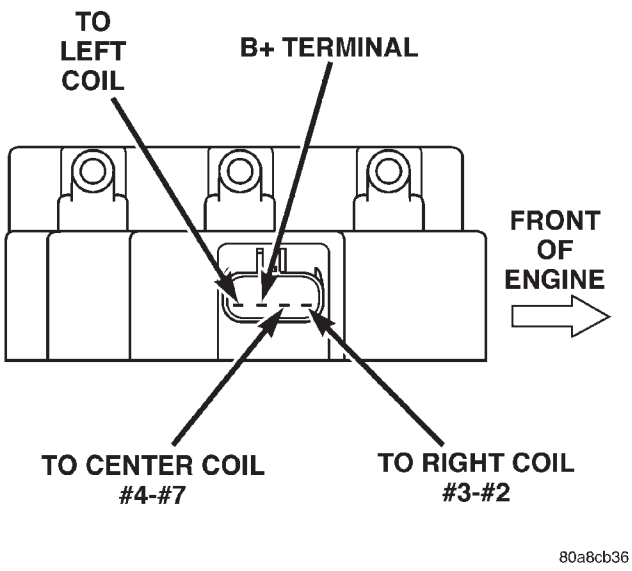

Fig. 16 Checking Coil Primary Resistance—Front Coils—8.0L V-10 Engine

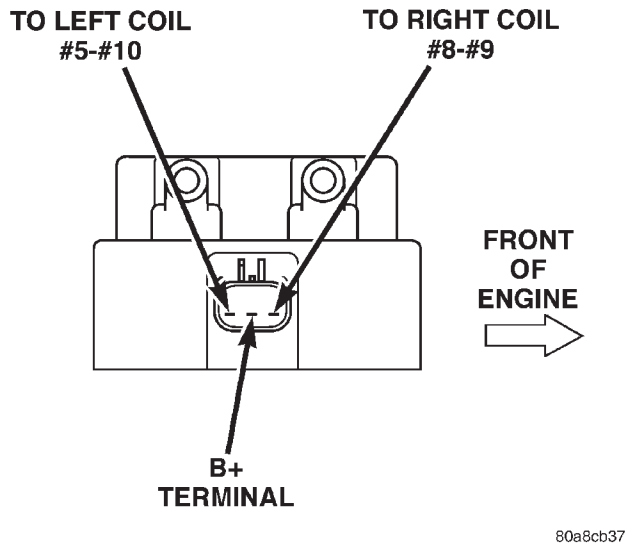

Fig. 17 Checking Coil Primary Resistance—Rear Coils—8.0L V-10 Engine

IGNITION COIL RESISTANCE—8.0L V-10 ENGINE

Primary Resistance: 0.53-0.65 Ohms. Test across the primary connector. Refer to text for test procedures.
Secondary Resistance: 10.9-14.7K Ohms. Test across the individual coil towers. Refer to text for test procedures.

DIAGNOSIS AND TESTING (Continued)

* Primary Resistance: 0.53 to 0.65 ohms ** Secondary Resistance: 10.9 to 14.7 K ohms	
* Test across the primary connector. Refer to text for test procedures. ** Test across the individual coil towers. Refer to text for test procedures.	

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Fig. 18 Ignition Coil Resistance—8.0L V-10 Engine

(4) Determine that sufficient battery voltage (12.4 volts) is present for the starting and ignition systems.

(5) Crank the engine for 5 seconds while monitoring the voltage at the coil positive terminal:

- If the voltage remains near zero during the entire period of cranking, refer to On-Board Diagnostics in Group 14, Fuel Systems. Check the Powertrain Control Module (PCM) and auto shutdown relay.
- If voltage is at or near battery voltage and drops to zero after 1-2 seconds of cranking, check the powertrain control module circuit. Refer to On-Board Diagnostics in Group 14, Fuel Systems.
- If voltage remains at or near battery voltage during the entire 5 seconds, turn the key off. Remove the three 32-way connectors (Fig. 19) from the PCM. Check 32-way connectors for any spread terminals or corrosion.

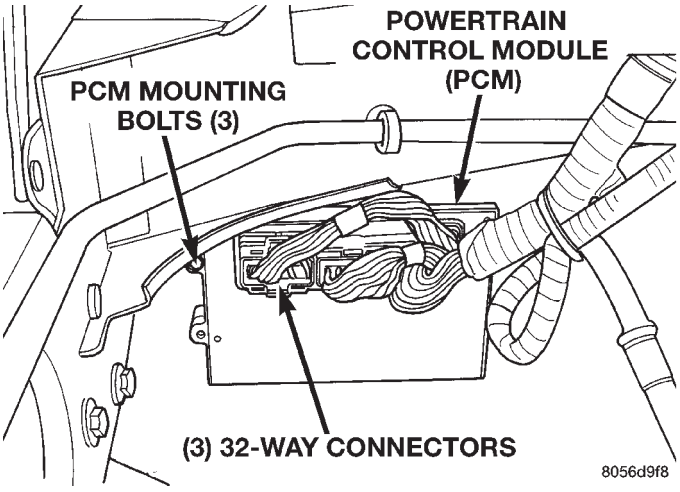


Fig. 19 PCM and Three 32–Way Connectors

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

(7) Make the special jumper shown in (Fig. 20). Using the jumper, **momentarily** ground the ignition coil driver circuit at the PCM connector (cavity A-7). For cavity/terminal location of this circuit, refer to Group 8W, Wiring. A spark should be generated at the coil cable when the ground is removed.

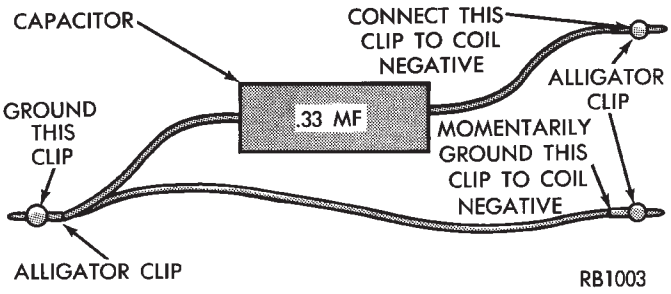


Fig. 20 Special Jumper Ground-to-Coil Negative Terminal

(8) If spark is generated, replace the PCM.

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

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

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

DISTRIBUTOR CAP—3.9L/5.2L/5.9L ENGINES

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 (Fig. 21) or (Fig. 22). 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.

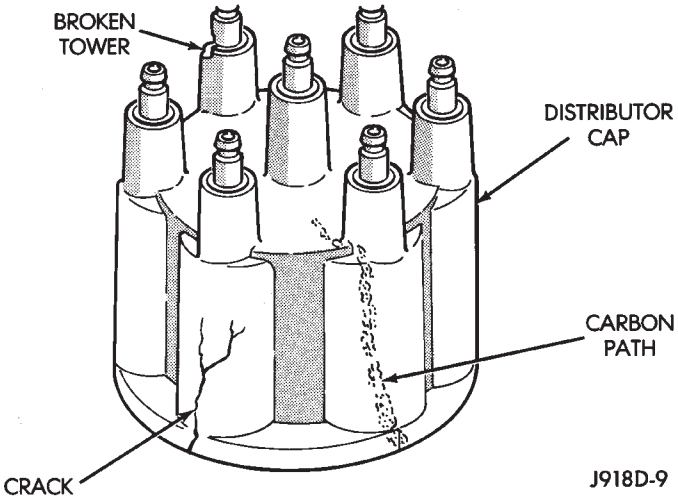


Fig. 21 Cap Inspection—External—Typical

DISTRIBUTOR ROTOR—3.9L/5.2L/5.9L ENGINES

Visually inspect the rotor (Fig. 23) for cracks, evidence of corrosion or the effects of arcing on the

DIAGNOSIS AND TESTING (Continued)

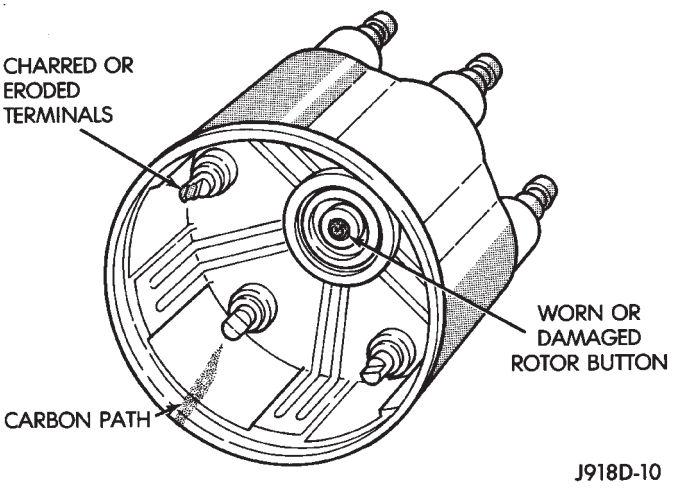


Fig. 22 Cap Inspection—Internal—Typical

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.

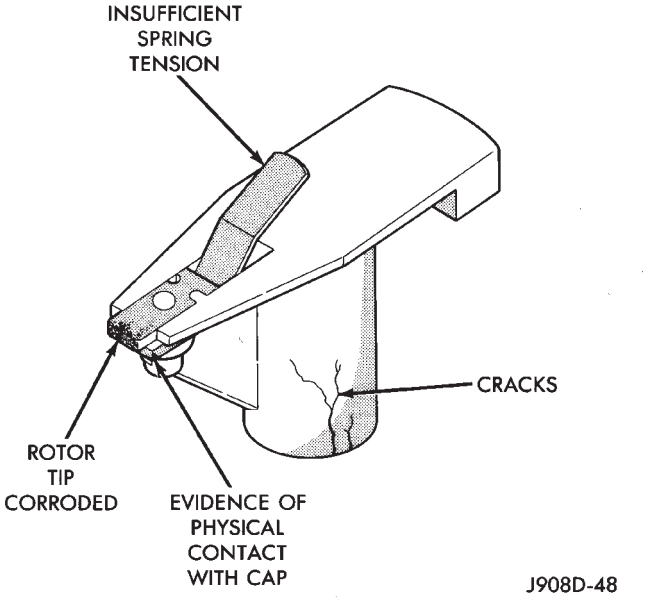


Fig. 23 Rotor Inspection—Typical

IGNITION TIMING

NOTE: Base (initial) ignition timing is NOT adjustable on any engine. On 3.9L/5.2L/5.9L engines, do not attempt to adjust ignition timing by rotating the distributor.

All ignition timing functions are controlled by the Powertrain Control Module (PCM). The DRB scan tool may be used to verify base timing and electronic timing advance. Refer to the appropriate Powertrain Diagnostics Procedures service manual for operation of the DRB Scan Tool.

Fuel synchronization can be verified and set by rotating the distributor. Refer to the Distributor Removal/Installation section of this group. See Checking Distributor Position. This operation can be performed on 3.9L/5.2L/5.9L engines only.

MAP SENSOR

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

CRANKSHAFT POSITION SENSOR

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.

CAMSHAFT POSITION SENSOR—3.9L/5.2L/5.9L ENGINES

The camshaft position sensor is located in the distributor (Fig. 24) on all engines.

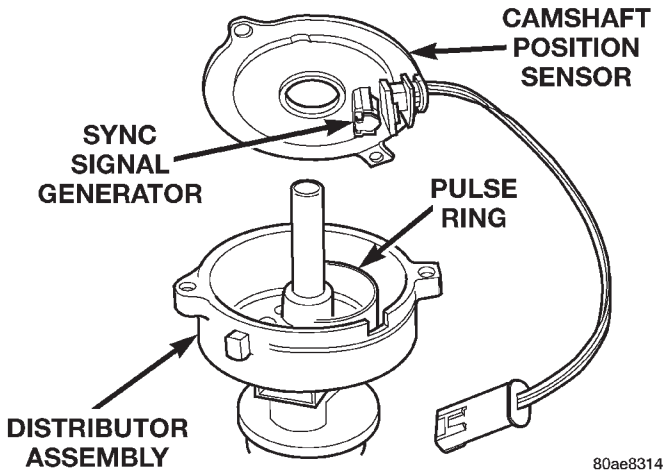


Fig. 24 Camshaft Position Sensor—3.9/5.2/5.9L Engines—Typical

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

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

DIAGNOSIS AND TESTING (Continued)

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 from distributor (two screws). Rotate (crank) the engine until the distributor rotor is pointed towards the rear of vehicle. The movable pulse ring should now be within the sensor pickup.

(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 5 volts is not present at supply wire, check for voltage at PCM 32-way connector (cavity A-17). Refer to Group 8W, Wiring for location of connector/terminal. 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 cavity A-17, but not at the supply wire:

(a) Check continuity between the supply wire. This is checked between the distributor connector and cavity A-17 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 cavity A-18 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

CAMSHAFT POSITION SENSOR TEST—8.0L V-10 ENGINE

The camshaft position sensor is located in the timing chain case/cover on the left-front side of the engine (Fig. 25).

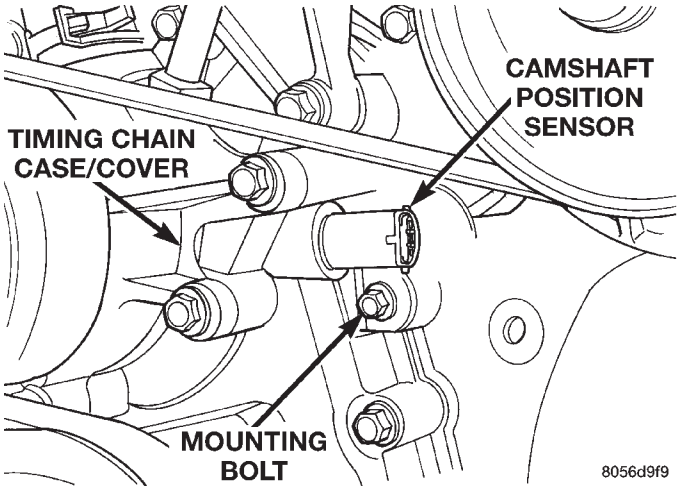


Fig. 25 Camshaft Position Sensor—8.0L V-10 Engine

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 sensor connector at sensor.

(2) Place an ohmmeter across terminals B and C (Fig. 26). **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.

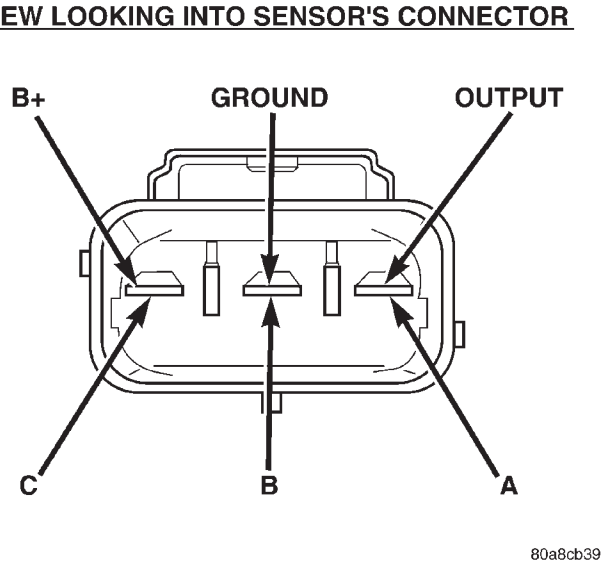


Fig. 26 Sensor Connector—8.0L Engine

DIAGNOSIS AND TESTING (Continued)

ENGINE COOLANT TEMPERATURE SENSOR

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

INTAKE MANIFOLD AIR TEMPERATURE SENSOR

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

SPARK PLUG CABLES

Check the spark plug cable connections for good contact at the coil(s), distributor cap towers, and spark plugs. Terminals should be fully seated. The insulators should be in good condition and should fit tightly on the coil, distributor and spark plugs. Spark plug cables with insulators that are cracked or torn must be replaced.

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

On 3.9L/5.2L/5.9L engines, spark plug cable heat shields are pressed into the cylinder head to surround each spark plug cable boot and spark plug (Fig. 27). These shields protect the spark plug boots from damage (due to intense engine heat generated by the exhaust manifolds) and should not be removed. After the spark plug cable has been installed, the lip of the cable boot should have a small air gap to the top of the heat shield (Fig. 27).

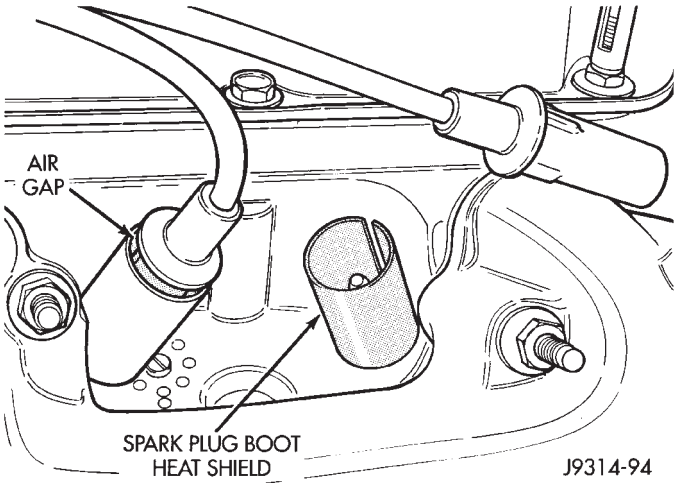


Fig. 27 Heat Shields—3.9L/5.2L/5.9L Engines

TESTING

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 running, remove spark plug cable from spark plug (one at a time) and hold next to a good engine ground. If the cable and spark plug are in good condition, the engine rpm should drop and the engine will run poorly. If engine rpm does not drop, the cable and/or spark plug may not be operating properly and should be replaced. Also check engine cylinder compression.

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. If equipped, 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

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.

DIAGNOSIS AND TESTING (Continued)

SPARK PLUG CONDITIONS

NORMAL OPERATING

The few deposits present on the spark plug will probably be light tan or slightly gray in color. This is evident with most grades of commercial gasoline (Fig. 28). 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.

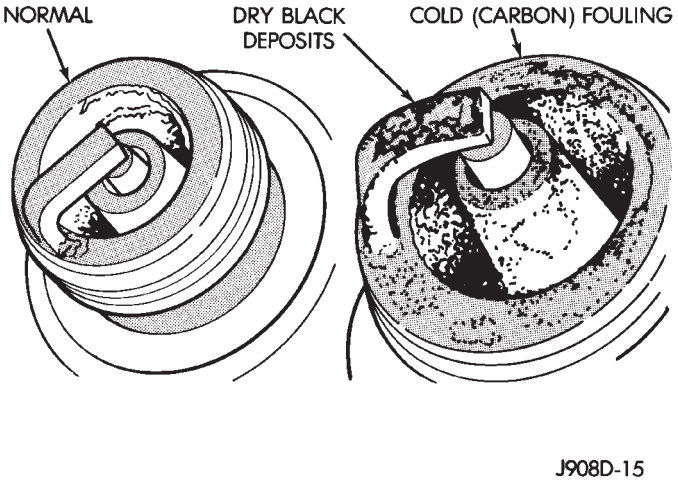


Fig. 28 Normal Operation and Cold (Carbon) Fouling

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. 28). A dry, black deposit on one or two plugs in a set may be caused by sticking valves or defective spark plug cables. Cold (carbon) fouling of the entire set of spark plugs may be caused by a clogged air cleaner element or repeated short operating times (short trips).

WET FOULING OR GAS FOULING

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

OIL OR ASH ENCRUSTED

If one or more spark plugs are oil or oil ash encrusted (Fig. 29), evaluate engine condition for the cause of oil entry into that particular combustion chamber.

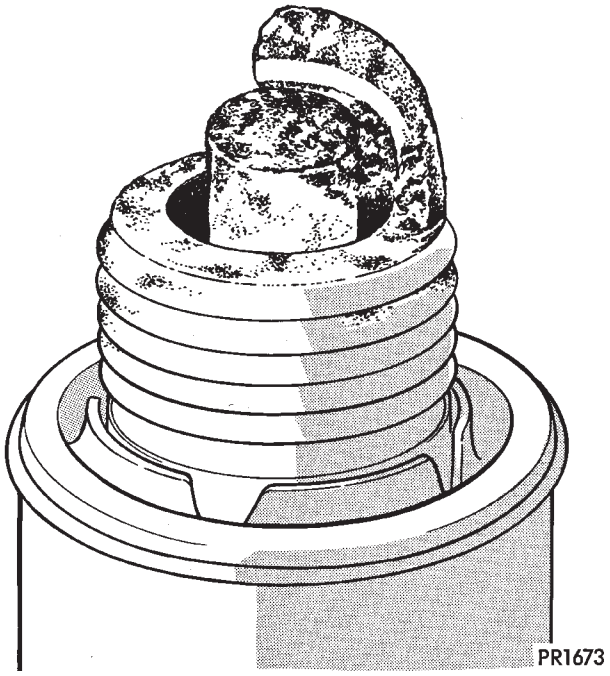


Fig. 29 Oil or Ash Encrusted

ELECTRODE GAP BRIDGING

Electrode gap bridging may be traced to loose deposits in the combustion chamber. These deposits accumulate on the spark plugs during continuous stop-and-go driving. When the engine is suddenly subjected to a high torque load, deposits partially liquefy and bridge the gap between electrodes (Fig. 30). This short circuits the electrodes. Spark plugs with electrode gap bridging can be cleaned using standard procedures.

SCAVENGER DEPOSITS

Fuel scavenger deposits may be either white or yellow (Fig. 31). 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.

DIAGNOSIS AND TESTING (Continued)

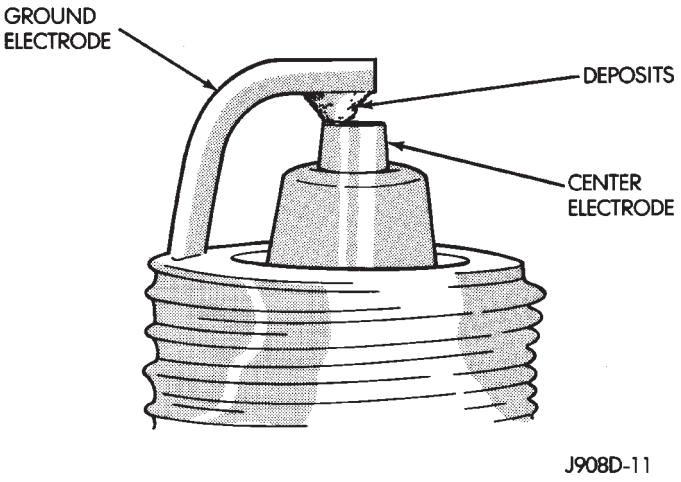


Fig. 30 Electrode Gap Bridging

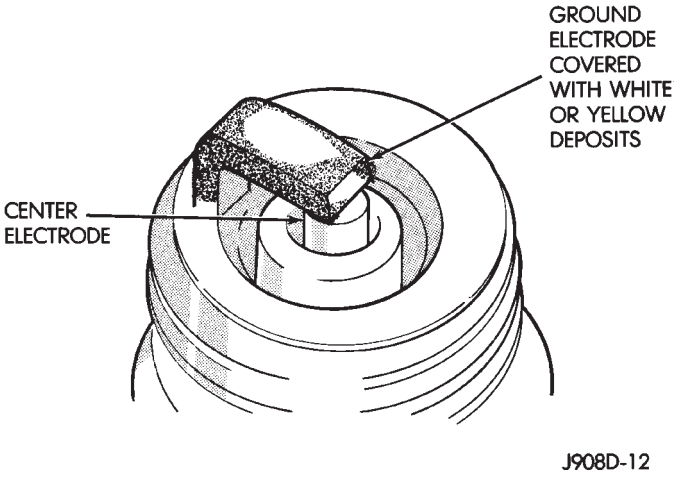


Fig. 31 Scavenger Deposits

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

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. 33). 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.)

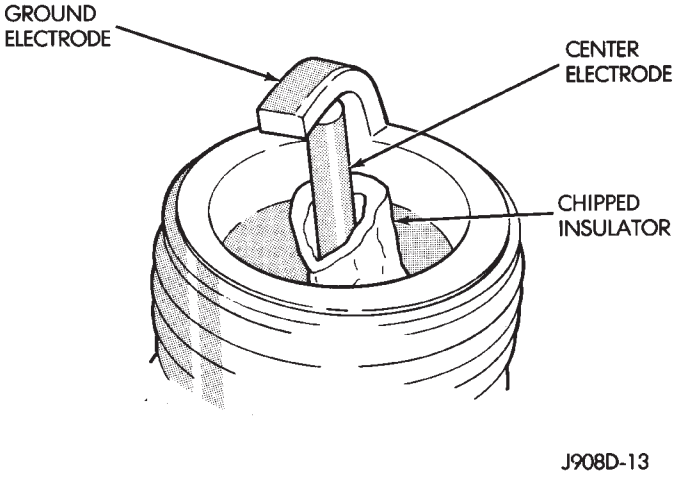


Fig. 32 Chipped Electrode Insulator

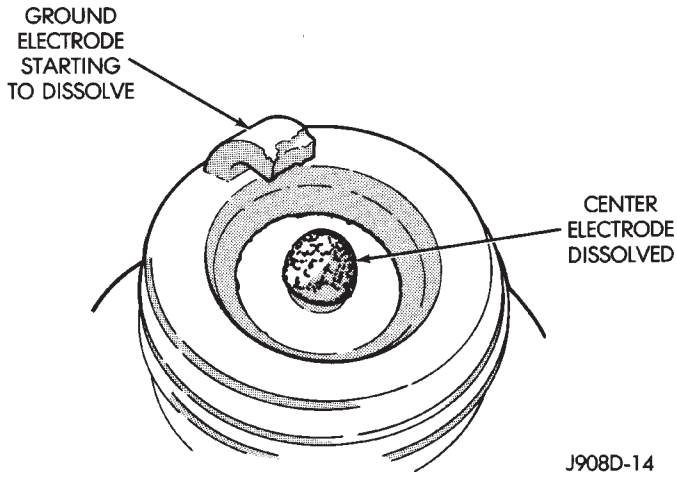


Fig. 33 Preignition Damage

SPARK PLUG OVERHEATING

Overheating is indicated by a white or gray center electrode insulator that also appears blistered (Fig. 34). 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.

REMOVAL AND INSTALLATION

SPARK PLUG CABLES

CAUTION: When disconnecting a high voltage cable from a spark plug or from the distributor cap, twist the rubber boot slightly (1/2 turn) to break it loose (Fig. 35). Grasp the boot (not the cable) and pull it off with a steady, even force.

REMOVAL AND INSTALLATION (Continued)

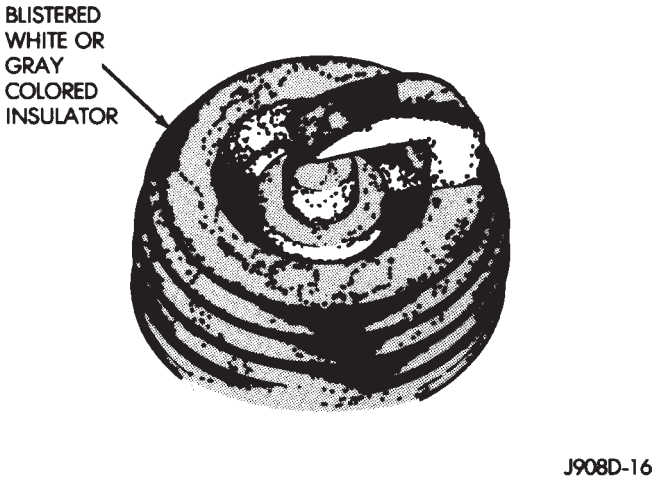


Fig. 34 Spark Plug Overheating

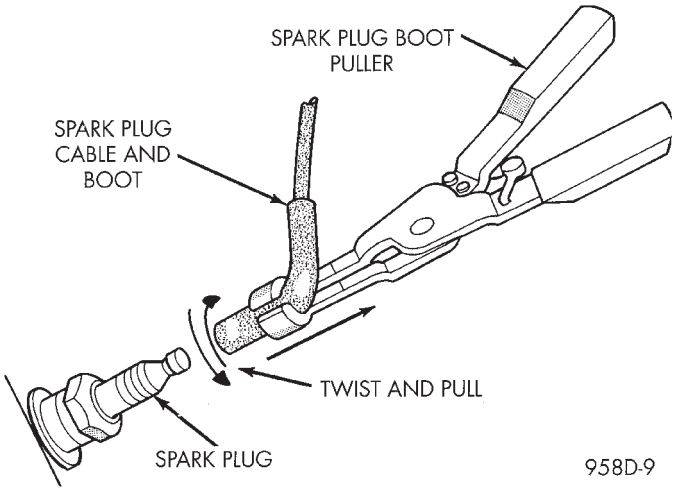


Fig. 35 Cable Removal

Install cables into the proper engine cylinder firing order (Fig. 36), (Fig. 37) or (Fig. 38).

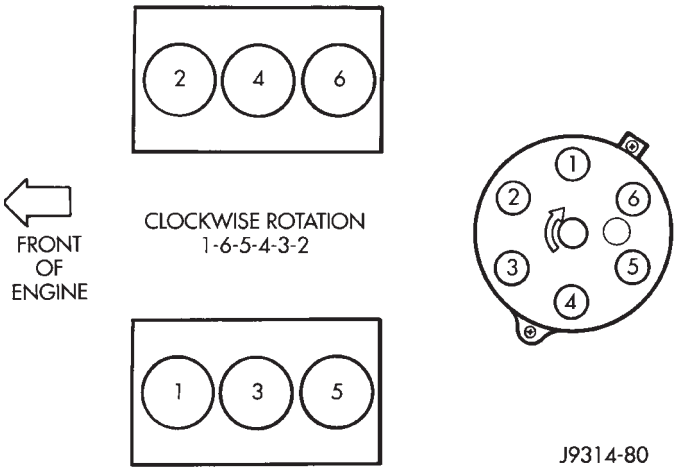


Fig. 36 Engine Firing Order—3.9L V-6 Engine

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.

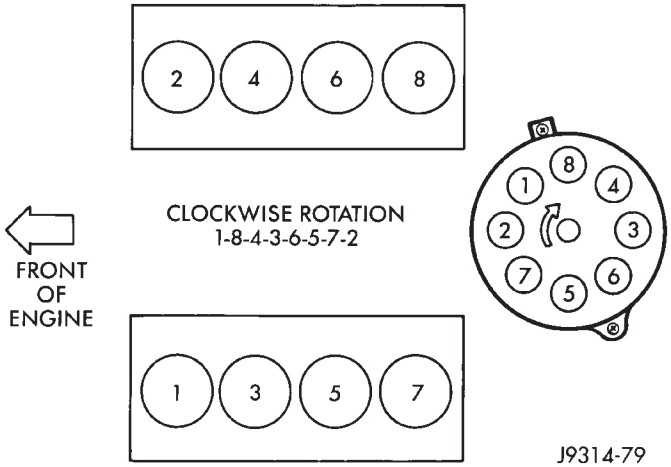


Fig. 37 Engine Firing Order—5.2L/5.9L V-8 Engines

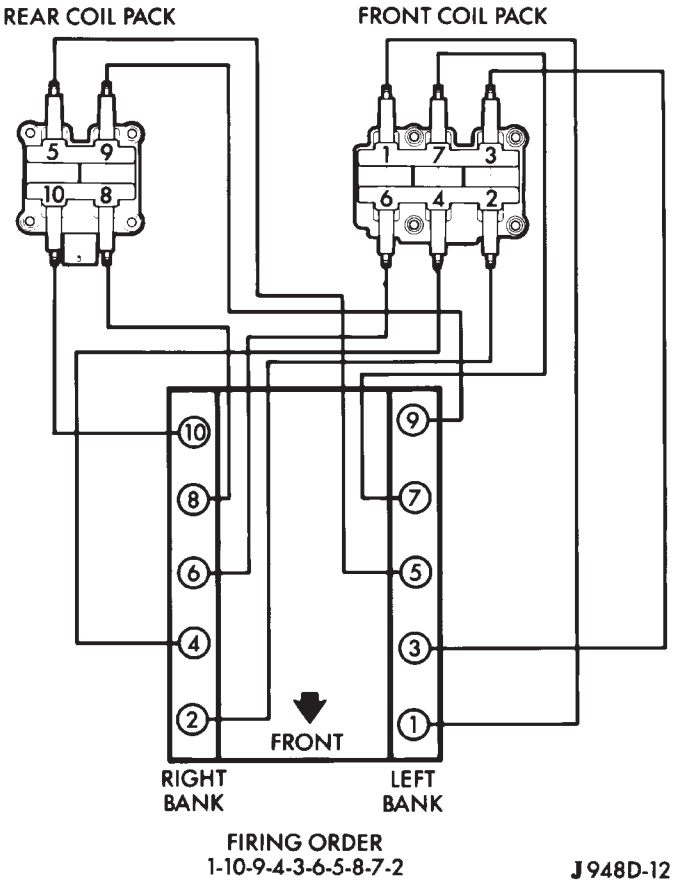


Fig. 38 Spark Plug Cable Order—8.0L V-10 Engine

REMOVAL AND INSTALLATION (Continued)

SPARK PLUGS

On 3.9L/5.2L/5.9L engines, spark plug cable heat shields are pressed into the cylinder head to surround each cable boot and spark plug (Fig. 39).

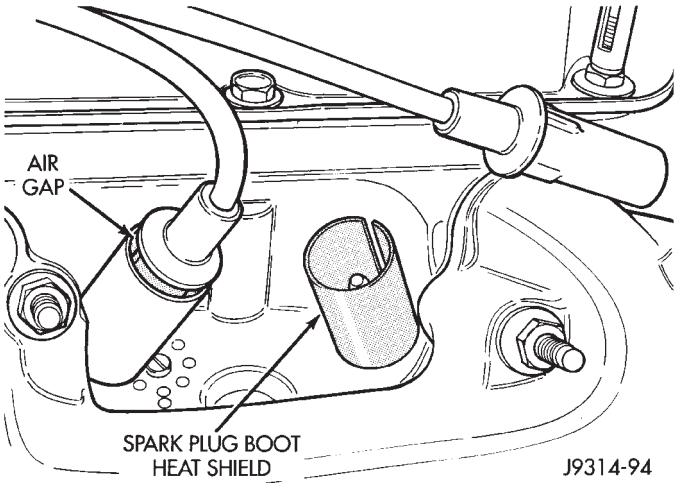


Fig. 39 Heat Shields—3.9L/5.2L/5.9L Engines

If removal of the heat shield(s) is necessary, remove the spark plug cable and compress the sides of shield for removal. Each shield is slotted to allow for compression and removal. To install the shields, align shield to machined opening in cylinder head and tap into place with a block of wood.

PLUG REMOVAL

(1) Always remove spark plug or ignition coil cables by grasping at the cable boot (Fig. 35). 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 Plug Condition in the Diagnostics and Testing section of this group.

PLUG CLEANING

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

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

PLUG GAP ADJUSTMENT

Check the spark plug gap with a gap gauge tool. If the gap is not correct, adjust it by bending the ground electrode (Fig. 40). **Never attempt to adjust the gap by bending the center electrode.**

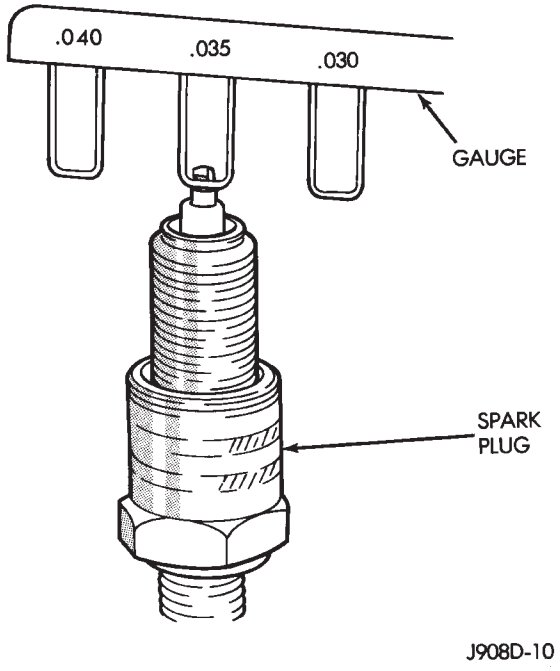


Fig. 40 Setting Spark Plug Gap—Typical

SPARK PLUG GAP

3.9L/5.2L/5.9L Engines: 1.01 mm (.040 in).
8.0L Engine: 1.14 mm (.045 in).

PLUG INSTALLATION

Special care should be taken when installing spark plugs into the cylinder head spark plug wells. Be sure the plugs do not drop into the plug wells as electrodes can be damaged.

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

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

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

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

(3) Install spark plug cables over spark plugs.

IGNITION COIL—3.9L/5.2L/5.9L ENGINES

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

REMOVAL AND INSTALLATION (Continued)

REMOVAL

3.9L V-6 or 5.2/5.9L V-8 LDC-Gas Engines: The coil is mounted to a bracket that is bolted to the front of the right engine cylinder head (Fig. 41). This bracket is mounted on top of the automatic belt tensioner bracket using common bolts.

5.9L V-8 HDC-Gas Engine: The coil is mounted to a bracket that is bolted to the air injection pump (AIR pump) mounting bracket (Fig. 42).

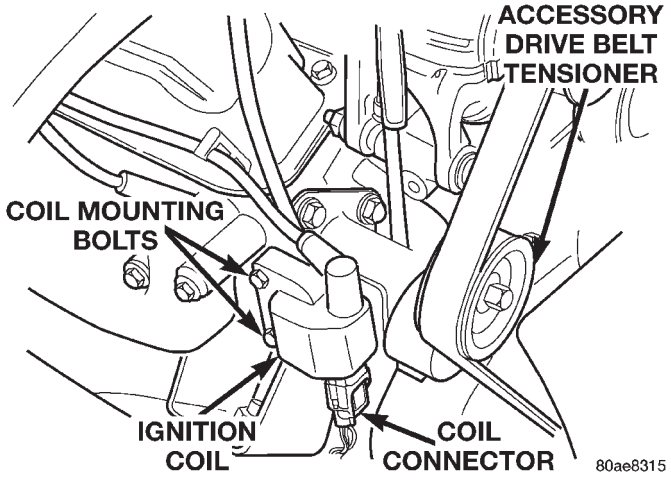


Fig. 41 Ignition Coil—3.9L V-6 or 5.2/5.9L V-8 LDC-Gas Engines

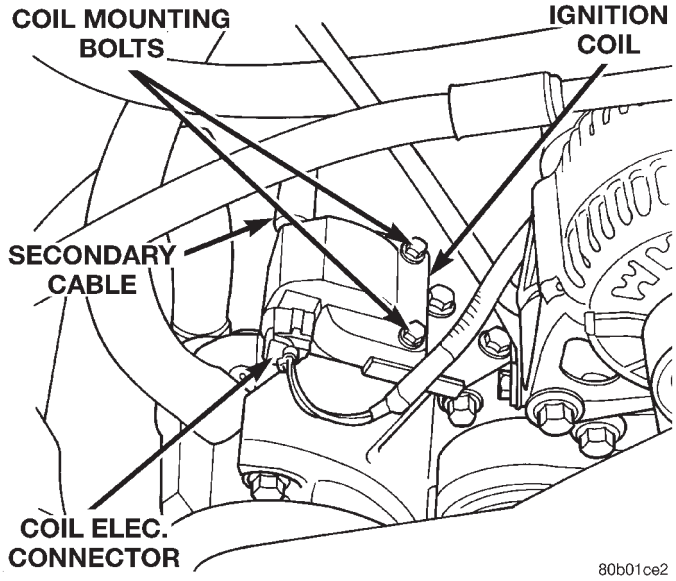


Fig. 42 Ignition Coil—5.9L V-8 HDC-Gas Engine

(1) Disconnect the primary wiring from the ignition coil.

(2) Disconnect the secondary spark plug cable from the ignition coil.

WARNING: 3.9L V-6 OR 5.2/5.9L V-8 LDC-GAS ENGINES: DO NOT REMOVE THE COIL MOUNTING BRACKET-TO-CYLINDER HEAD MOUNTING BOLTS. THE COIL MOUNTING BRACKET IS UNDER ACCESSORY DRIVE BELT TENSION. IF THIS BRACKET IS TO BE REMOVED FOR ANY REASON, ALL BELT TENSION MUST FIRST BE RELIEVED. REFER TO THE BELT SECTION OF GROUP 7, COOLING SYSTEM.

(3) Remove ignition coil from coil mounting bracket (two bolts).

INSTALLATION

(1) Install the ignition coil to coil bracket. If nuts and bolts are used to secure coil to coil bracket, tighten to 11 N·m (100 in. lbs.) torque. If the coil mounting bracket has been tapped for coil mounting bolts, tighten bolts to 5 N·m (50 in. lbs.) torque.

(2) Connect all wiring to ignition coil.

IGNITION COIL PACKS—8.0L V-10 ENGINE

REMOVAL

Two separate coil packs containing a total of five independent coils are attached to a common mounting bracket located above the right engine valve cover (Fig. 43). The front and rear coil packs can be serviced separately.

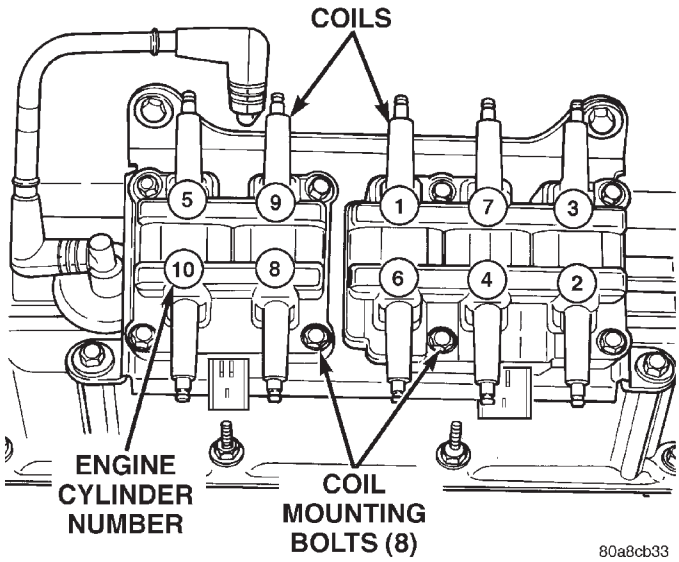


Fig. 43 Ignition Coil Packs—8.0L V-10 Engine

(1) Remove the secondary spark plug cables from the coil packs. Note position of cables before removal.

(2) Disconnect the primary wiring harness connectors at coil packs.

(3) Remove the four (4) coil pack-to-coil mounting bracket bolts for the coil pack being serviced (Fig. 43).

(4) Remove coil(s) from mounting bracket.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Position coil packs to mounting bracket (primary wiring connectors face downward).

(2) Install coil pack mounting bolts. Tighten bolts to 10 N·m (90 in. lbs.) torque.

(3) Install coil pack-to-engine mounting bracket (if necessary).

(4) Connect primary wiring connectors to coil packs (four wire connector to front coil pack and three wire connector to rear coil pack).

(5) Connect secondary spark plug cables to coil packs. Refer to (Fig. 44) for correct cable order.

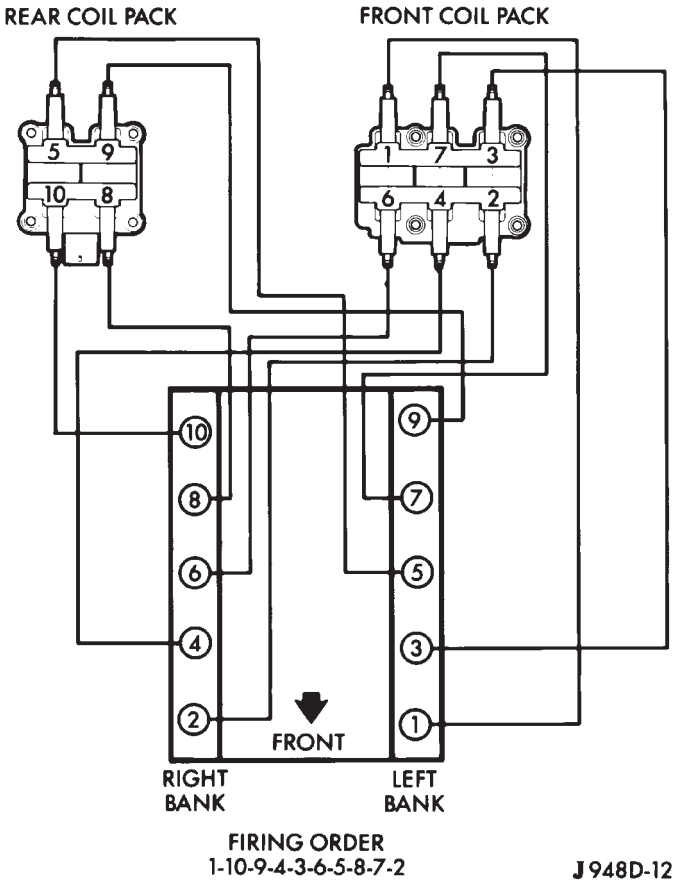


Fig. 44 Spark Plug Cable Order—8.0L V-10 Engine

AUTOMATIC SHUTDOWN (ASD) RELAY

The Automatic Shutdown (ASD) relay is located in the Power Distribution Center (PDC). The PDC is located in the engine compartment (Fig. 45). Refer to label on PDC cover for relay location.

REMOVAL

(1) Remove the PDC cover.

(2) Remove the relay by lifting straight up.

INSTALLATION

(1) Check condition of relay terminals at PDC for corrosion or damage. Also check the heights of relay terminal pins at PDC. Pin height should be same for all pins. Repair as necessary before installing relay.

(2) Push the relay into the connector.

(3) Install the relay cover.

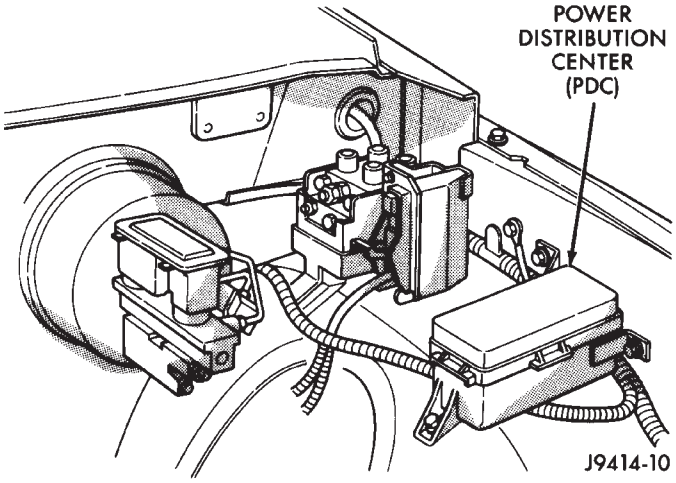


Fig. 45 Power Distribution Center

CRANKSHAFT POSITION SENSOR—3.9L/5.2L/5.9L ENGINES

REMOVAL

The sensor is bolted to the top of the cylinder block near the rear of right cylinder head (Fig. 46).

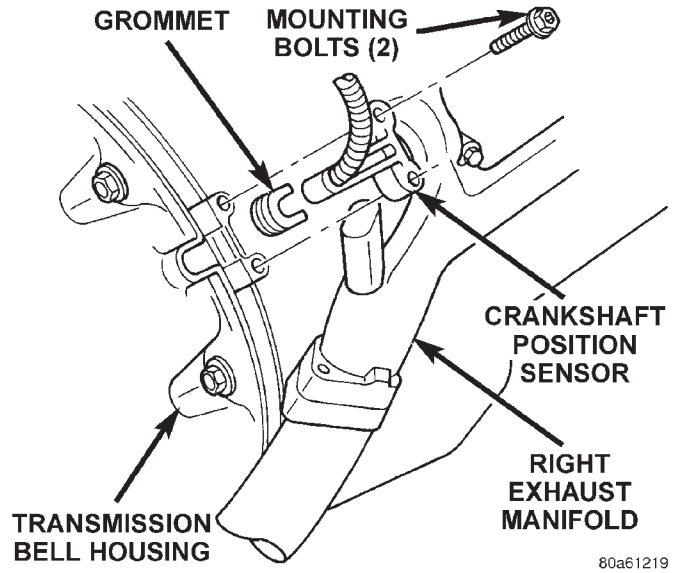


Fig. 46 Crankshaft Position Sensor

(1) Remove the air cleaner intake tube.

(2) Disconnect crankshaft position sensor pigtail harness from main wiring harness.

(3) Remove two sensor (recessed hex head) mounting bolts (Fig. 46).

(4) Remove sensor from engine.

REMOVAL AND INSTALLATION (Continued)

INSTALLATION

(1) Position crankshaft position sensor to engine.

(2) Install mounting bolts and tighten to 8 N·m (70 in. lbs.) torque.

(3) Connect main harness electrical connector to sensor.

(4) Install air cleaner tube.

CRANKSHAFT POSITION SENSOR—8.0L V-10 ENGINE

The crankshaft position sensor is located on the right-lower side of the cylinder block, forward of the right engine mount, just above the oil pan rail (Fig. 47).

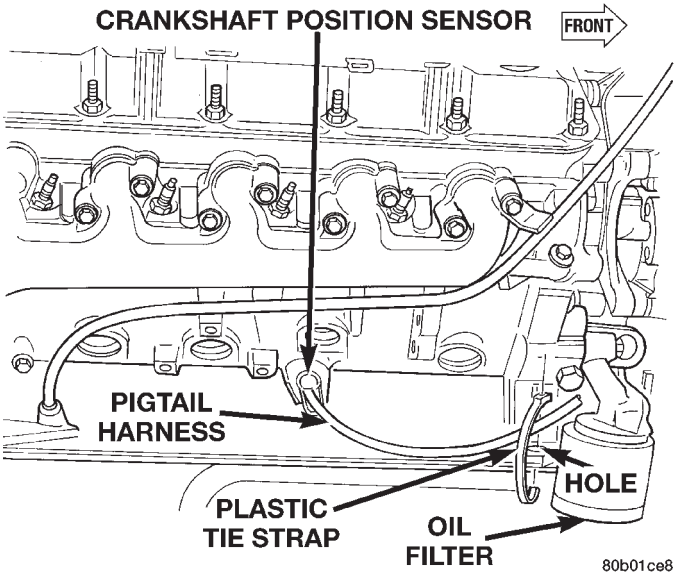


Fig. 47 Crankshaft Position Sensor Location—8.0L V-10 Engine

REMOVAL

(1) Raise and support vehicle.

(2) Disconnect sensor pigtail harness from main engine wiring harness.

(3) Remove sensor mounting bolt (Fig. 48).

(4) Cut plastic tie strap (Fig. 47) securing sensor pigtail harness to side of engine block.

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

(6) Remove sensor from vehicle.

(7) Check condition of sensor o-ring (Fig. 49).

INSTALLATION

(1) Apply a small amount of engine oil to sensor o-ring (Fig. 49).

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

CAUTION: Before tightening sensor mounting bolt, be sure sensor is completely flush to cylinder block (Fig. 48). If sensor is not flush, damage to sensor mounting tang may result.

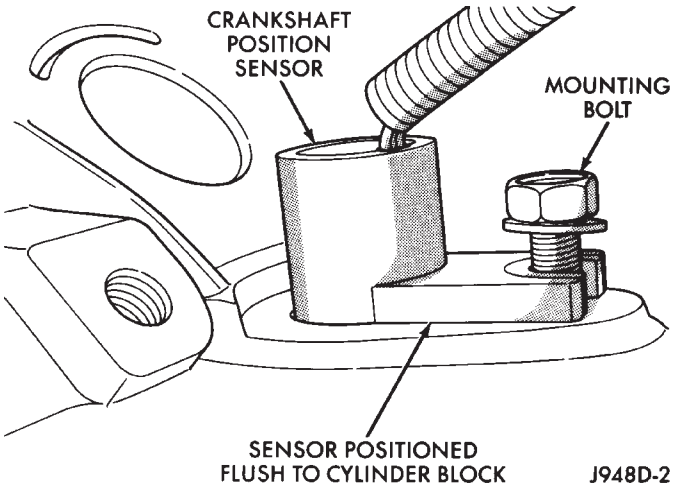


Fig. 48 Sensor Removal/Installation—8.0L V-10 Engine

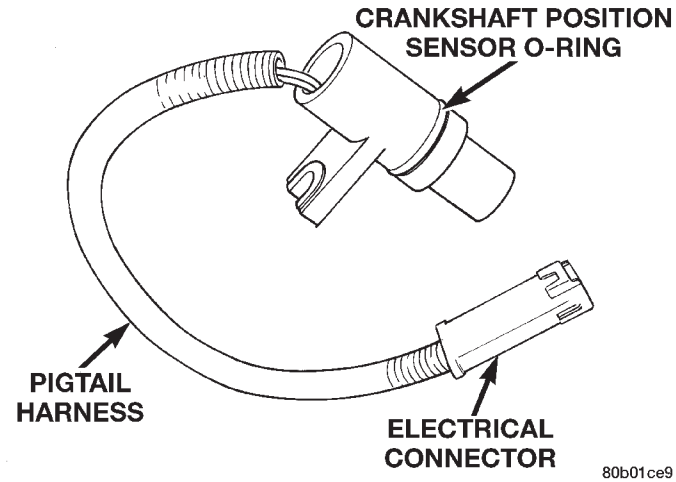


Fig. 49 Sensor O-Ring—8.0L V-10 Engine

(3) Install mounting bolt and tighten to 8 N·m (70 in. lbs.) torque.

(4) Connect sensor pigtail harness to main engine wiring harness

(5) Install new plastic tie strap (Fig. 47) to secure sensor pigtail harness to side of engine block. Thread tie strap through casting hole on cylinder block.

CAMSHAFT POSITION SENSOR—3.9L/5.2L/5.9L ENGINES

The camshaft position sensor is located in the distributor (Fig. 50).

REMOVAL

Distributor removal is not necessary to remove camshaft position sensor.

(1) Remove air cleaner assembly.

(2) Disconnect negative cable from battery.

REMOVAL AND INSTALLATION (Continued)

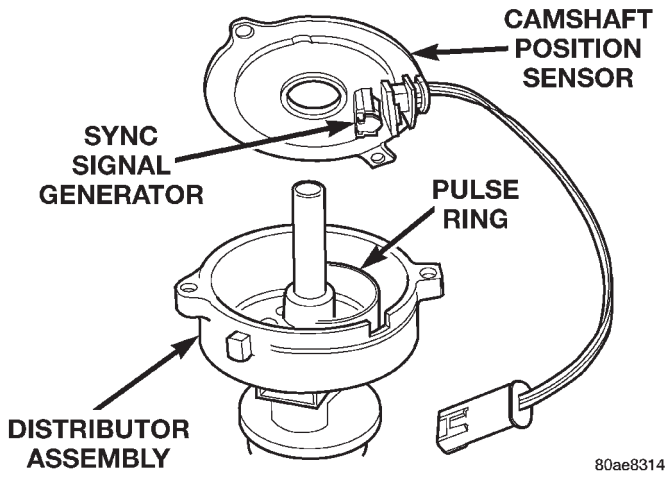


Fig. 50 Camshaft Position Sensor—Typical

(3) Remove distributor cap from distributor (two screws).

(4) Disconnect camshaft position sensor wiring harness from main engine wiring harness.

(5) Remove distributor rotor from distributor shaft.

(6) Lift the camshaft position sensor assembly from the distributor housing (Fig. 50).

INSTALLATION

(1) Install camshaft position sensor to distributor. Align sensor into notch on distributor housing.

(2) Connect wiring harness.

(3) Install rotor.

(4) Install distributor cap. Tighten mounting screws.

(5) Install air cleaner assembly.

CAMSHAFT POSITION SENSOR—8.0L V-10 ENGINE

The camshaft position sensor is located on the timing chain case/cover on the left-front side of the engine (Fig. 51).

A thin plastic rib is molded into the face of the sensor (Fig. 52) to position the depth of sensor to the upper cam gear (sprocket). This rib can be found on both the new replacement sensors and sensors that were originally installed to the engine. The first time the engine has been operated, part of this rib may be sheared (ground) off. Depending on parts tolerances, some of the rib material may still be observed after removal.

Refer to either of the following procedures, Sensor Removal—Replacing Old Sensor With Original, or Sensor Removal—Replacing With New Sensor:

SENSOR REMOVAL—REPLACING OLD SENSOR WITH ORIGINAL

If the original camshaft position sensor is to be removed and installed, such as when servicing the timing chain, timing gears or timing chain cover, use this procedure.

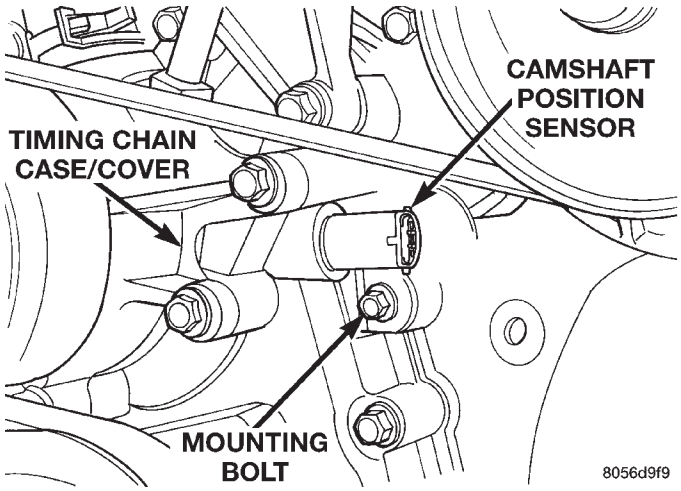


Fig. 51 Camshaft Position Sensor Location—8.0L V-10 Engine

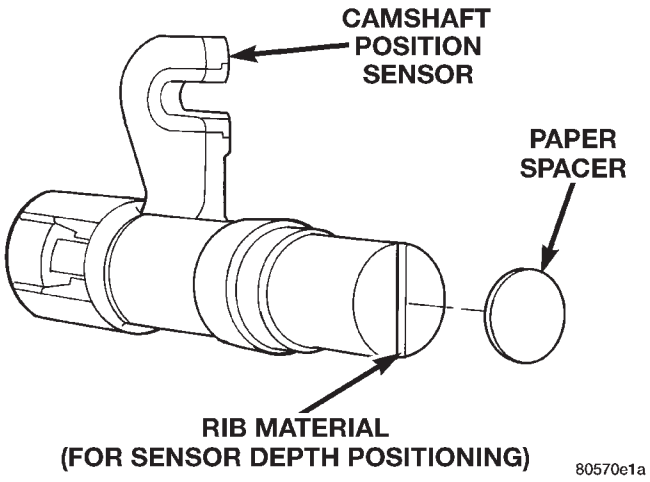


Fig. 52 Sensor Depth Positioning Rib—8.0L V-10 Engine

(1) Disconnect the sensor harness connector from the sensor.

(2) Remove the sensor mounting bolt (Fig. 51).

(3) Carefully pry the sensor from the timing chain case/cover in a rocking action with two small screwdrivers.

(4) Remove the sensor from vehicle.

(5) Check condition of sensor o-ring (Fig. 53).

INSTALLATION

When installing a used camshaft position sensor, the sensor depth must be adjusted to prevent contact with the camshaft gear (sprocket).

(1) Observe the face of the sensor. If any of the original rib material remains (Fig. 52), it must be cut down flush to the face of the sensor with a razor knife. Remove only enough of the rib material until the face of the sensor is flat. Do not remove more

REMOVAL AND INSTALLATION (Continued)

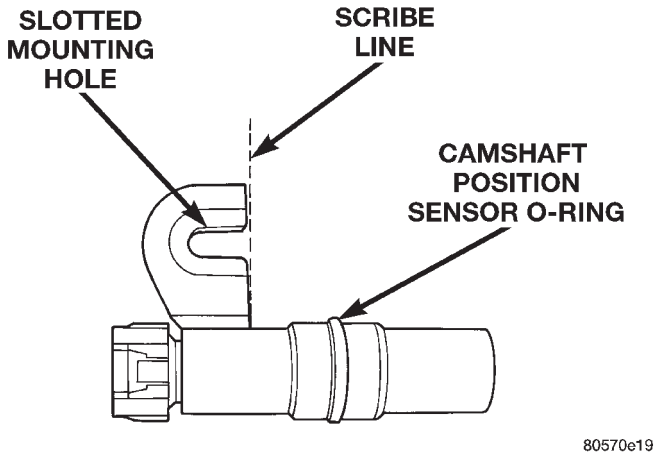


Fig. 53 Camshaft Sensor O-Ring—8.0L V-10 Engine

material than necessary as damage to sensor may result. Due to a high magnetic field and possible electrical damage to the sensor, never use an electric grinder to remove material from sensor.

(2) From the parts department, obtain a peel-and-stick paper spacer (Fig. 52). These special paper spacers are of a certain thickness and are to be used as a tool to set sensor depth.

(3) Clean the face of sensor and apply paper spacer (Fig. 52).

(4) Apply a small amount of engine oil to the sensor o-ring (Fig. 53).

A low and high area are machined into the camshaft drive gear (Fig. 54). The sensor is positioned in the timing gear cover so that a small air gap (Fig. 54) exists between the face of sensor and the high machined area of cam gear.

Before the sensor is installed, the cam gear may have to be rotated. This is to allow the high machined area on the gear to be directly in front of the sensor mounting hole opening on the timing gear cover.

Do not install sensor with gear positioned at low area (Fig. 55) or (Fig. 54). When the engine is started, the sensor will be broken.

(5) Using a 1/2 in. wide metal ruler, measure the distance from the cam gear to the face of the sensor mounting hole opening on the timing gear cover (Fig. 55).

(6) If the dimension is approximately 1.818 inches, it is OK to install sensor. Proceed to step Step 9.

(7) If the dimension is approximately 2.018 inches, the cam gear will have to be rotated.

(8) Attach a socket to the vibration damper mounting bolt and rotate engine until the 1.818 inch dimension is attained.

(9) Install the sensor into the timing case/cover with a slight rocking action until the paper spacer contacts the camshaft gear. Do not install the sensor

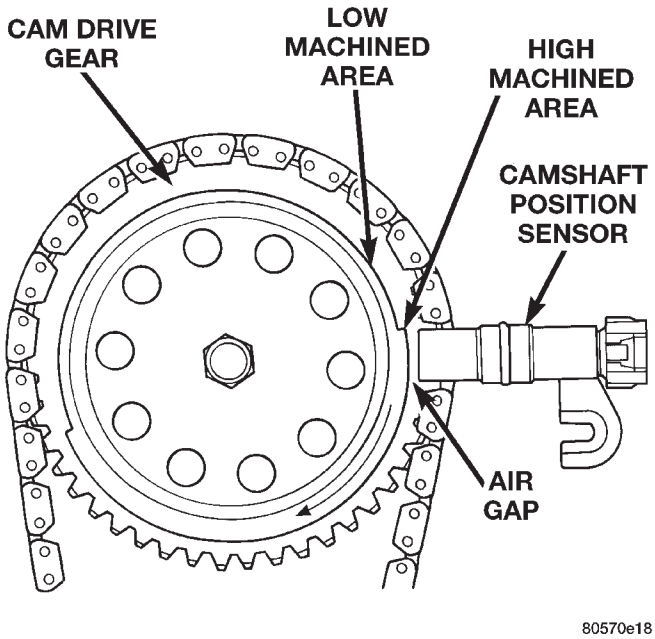


Fig. 54 Sensor Operation—8.0L V-10 Engine

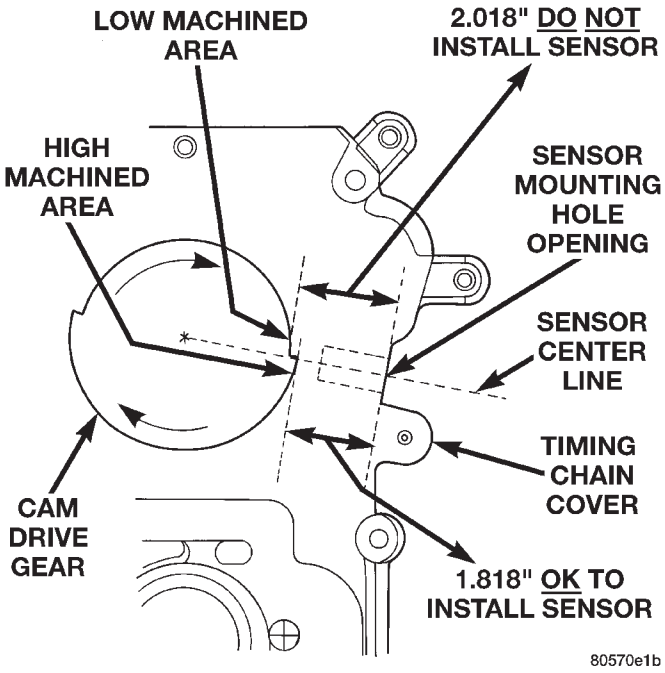


Fig. 55 Sensor Depth Dimensions

mounting bolt. Do not twist the sensor into position as damage to the o-ring or tearing of the paper spacer may result.

(10) Scratch a scribe line into the timing chain case/cover to indicate depth of sensor (Fig. 53).

(11) Remove the sensor from timing chain case/cover.

(12) Remove the paper spacer from the sensor. This step must be followed to prevent the paper

REMOVAL AND INSTALLATION (Continued)

spacer from getting into the engine lubrication system.

(13) Again, apply a small amount of engine oil to sensor o-ring.

(14) Again, install the sensor into the timing case/cover with a slight rocking action until the sensor is aligned to scribe line.

(15) Install sensor mounting bolt and tighten to 6 N·m (50 in. lbs.) torque.

(16) Connect engine wiring harness to sensor.

SENSOR REMOVAL—REPLACING WITH NEW SENSOR

If a new replacement camshaft position sensor is to be installed, use this procedure.

(1) Disconnect the sensor wiring harness connector from sensor.

(2) Remove the sensor mounting bolt (Fig. 51).

(3) Carefully pry the sensor from the timing chain case/cover in a rocking action with two small screwdrivers.

(4) Remove the sensor from vehicle.

INSTALLATION

(1) Apply a small amount of engine oil to the sensor o-ring (Fig. 53).

A low and high area are machined into the camshaft drive gear (Fig. 54). The sensor is positioned in the timing gear cover so that a small air gap (Fig. 54) exists between the face of sensor and the high machined area of cam gear.

Before the sensor is installed, the cam gear may have to be rotated. This is to allow the high machined area on the gear to be directly in front of the sensor mounting hole opening on the timing gear cover.

Do not install sensor with gear positioned at low area (Fig. 55) or (Fig. 54). When the engine is started, the sensor will be broken.

(2) Using a 1/2 in. wide metal ruler, measure the distance from the cam gear to the face of the sensor mounting hole opening on the timing gear cover (Fig. 55).

(3) If the dimension is approximately 1.818 inches, it is OK to install sensor. Proceed to step Step 9.

(4) If the dimension is approximately 2.018 inches, the cam gear will have to be rotated.

(5) Attach a socket to the vibration damper mounting bolt and rotate engine until the 1.818 inch dimension is attained.

(6) Install the sensor into the timing case/cover with a slight rocking action. Do not twist the sensor into position as damage to the o-ring may result. Push the sensor all the way into the cover until the rib material on the sensor (Fig. 52) contacts the camshaft gear.

(7) Install the mounting bolt and tighten to 6 N·m (50 in. lbs.) torque.

(8) Connect sensor wiring harness to engine harness.

When the engine is started, the rib material will be sheared off the face of sensor. This will automatically set sensor air gap.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

For removal and installation, refer to Manifold Absolute Pressure Sensor in group 14, Fuel Systems.

ENGINE COOLANT TEMPERATURE SENSOR

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

THROTTLE POSITION SENSOR

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

INTAKE MANIFOLD AIR TEMPERATURE SENSOR

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

DISTRIBUTORS

REMOVAL

CAUTION: Base ignition timing is not adjustable on any engine. Distributors do not have built in centrifugal or vacuum assisted advance. Base ignition timing and timing advance are controlled by the Powertrain Control Module (PCM). Because a conventional timing light can not be used to adjust distributor position after installation, note position of distributor before removal.

(1) Remove air cleaner assembly.

(2) Disconnect negative cable from battery.

(3) Remove distributor cap from distributor (two screws).

(4) Mark the position of distributor housing in relationship to engine or dash panel. This is done to aid in installation.

(5) Before distributor is removed, the number one cylinder must be brought to the Top Dead Center (TDC) firing position.

(6) Attach a socket to the Crankshaft Vibration Damper mounting bolt.

(7) Slowly rotate engine clockwise, as viewed from front, until indicating mark on crankshaft vibration damper is aligned to 0 degree (TDC) mark on timing chain cover (Fig. 56).

REMOVAL AND INSTALLATION (Continued)

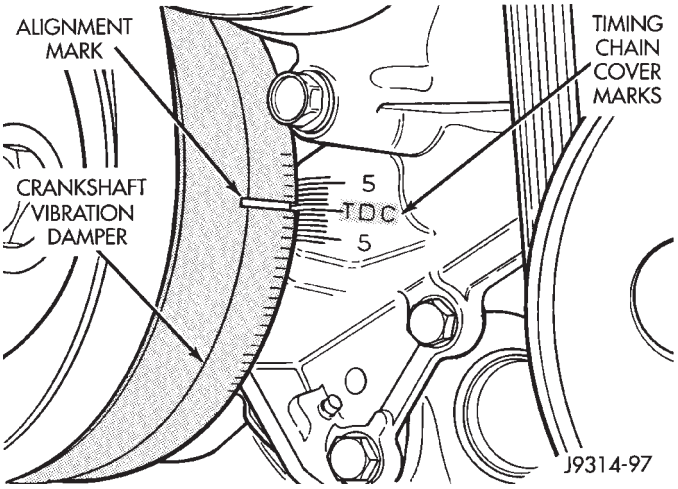


Fig. 56 Damper-To-Cover Alignment Marks—Typical

(8) The distributor rotor should now be aligned to the CYL. NO. 1 alignment mark (stamped) into the camshaft position sensor (Fig. 57). If not, rotate the crankshaft through another complete 360 degree turn. Note the position of the number one cylinder spark plug cable (on the cap) in relation to rotor. Rotor should now be aligned to this position.

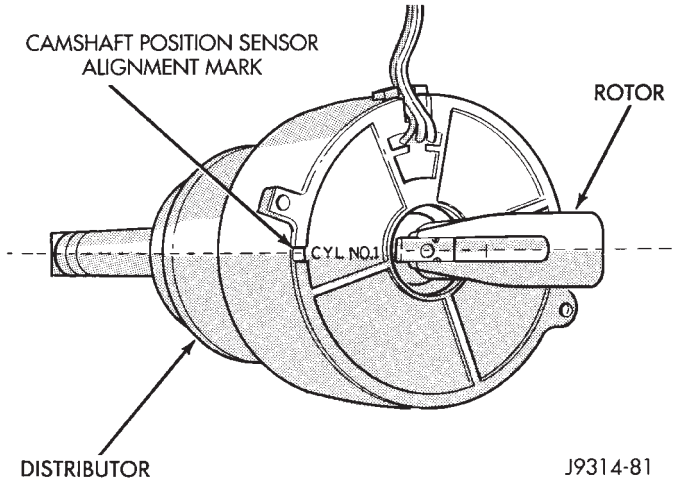


Fig. 57 Rotor Alignment Mark

(9) Disconnect camshaft position sensor wiring harness from main engine wiring harness.

(10) Remove distributor rotor from distributor shaft.

(11) Remove distributor holddown clamp bolt and clamp (Fig. 58). Remove distributor from vehicle.

CAUTION: Do not crank engine with distributor removed. Distributor/crankshaft relationship will be lost.

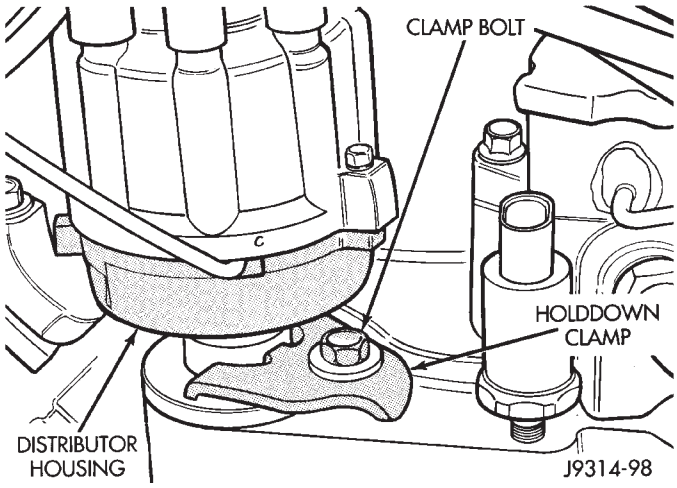


Fig. 58 Distributor Holddown Clamp

INSTALLATION

If engine has been cranked while distributor is removed, establish the relationship between distributor shaft and number one piston position as follows:

Rotate crankshaft in a clockwise direction, as viewed from front, until number one cylinder piston is at top of compression stroke (compression should be felt on finger with number one spark plug removed). Then continue to slowly rotate engine clockwise until indicating mark (Fig. 56) is aligned to 0 degree (TDC) mark on timing chain cover.

(1) Clean top of cylinder block for a good seal between distributor base and block.

(2) Lightly oil the rubber o-ring seal on the distributor housing.

(3) Install rotor to distributor shaft.

(4) Position distributor into engine to its original position. Engage tongue of distributor shaft with slot in distributor oil pump drive gear. Position rotor to the number one spark plug cable position.

(5) Install distributor holddown clamp and clamp bolt. Do not tighten bolt at this time.

(6) Rotate the distributor housing until rotor is aligned to CYL. NO. 1 alignment mark on the camshaft position sensor (Fig. 57).

(7) Tighten clamp holddown bolt (Fig. 58) to 22.5 N·m (200 in. lbs.) torque.

(8) Connect camshaft position sensor wiring harness to main engine harness.

(9) Install distributor cap. Tighten mounting screws.

(10) Refer to the following, Checking Distributor Position.

CHECKING DISTRIBUTOR POSITION

To verify correct distributor rotational position, the DRB scan tool must be used.

REMOVAL AND INSTALLATION (Continued)

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

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

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

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

(4) With engine running at **idle speed**, the words IN RANGE should appear on screen along with 0°. This indicates correct distributor position.

(5) If a plus (+) or a minus (-) is displayed next to degree number, and/or the degree displayed is not zero, loosen but do not remove distributor holddown clamp bolt. Rotate distributor until IN RANGE appears on screen. Continue to rotate distributor until achieving as close to 0° as possible. After adjustment, tighten clamp bolt to 22.5 N·m (200 in. lbs.) torque.

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

After testing, install air cleaner assembly.

POWERTRAIN CONTROL MODULE (PCM)

Refer to Group 14, Fuel System for procedures.

IGNITION SWITCH AND KEY CYLINDER

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

KEY CYLINDER REMOVAL

(1) Disconnect negative cable from battery.

(2) If equipped with tilt column, remove tilt lever by turning it counterclockwise.

(3) Remove upper and lower covers (shrouds) from steering column (Fig. 59).

(4) If equipped with automatic transmission, place shifter in PARK position.

(5) A retaining pin (Fig. 60) is located at side of key cylinder assembly.

(a) Rotate key to RUN position.

(b) Press in on retaining pin while pulling key cylinder from ignition switch.

IGNITION SWITCH REMOVAL

(1) Remove key lock cylinder. Refer to previous steps.

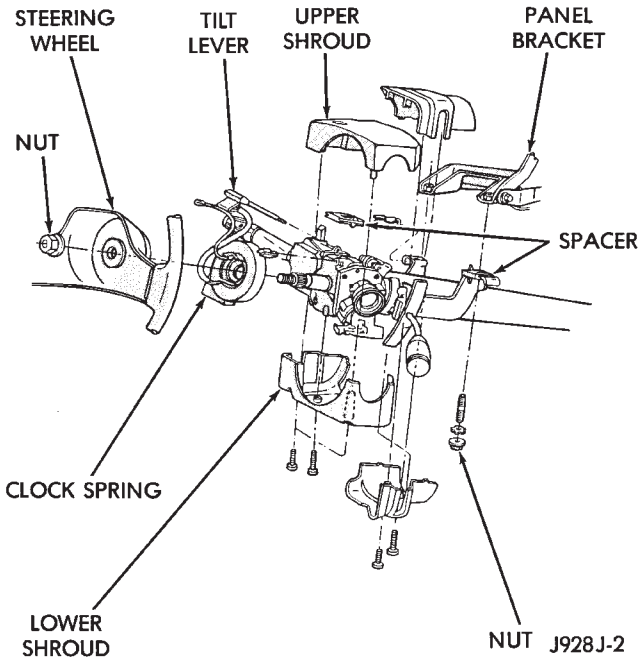


Fig. 59 Shroud Removal/Installation—Typical

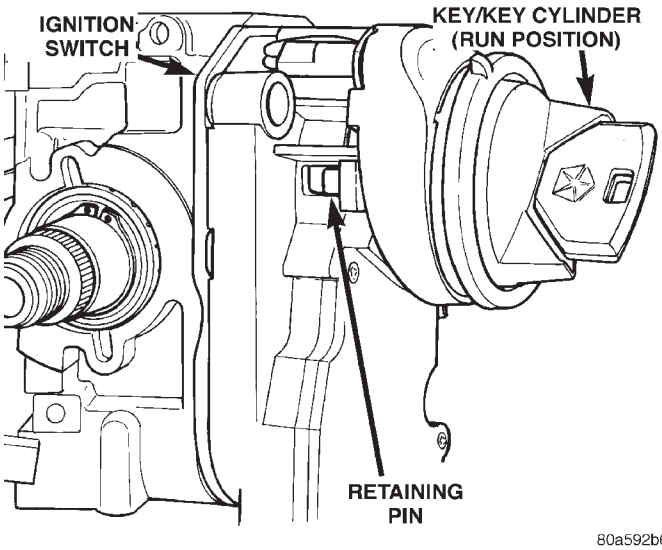


Fig. 60 Retaining Pin

(2) Remove 3 ignition switch mounting screws (Fig. 61). Use tamper proof torx bit (Snap-On® SDMTR10 or equivalent) to remove screws.

(3) Gently pull switch away from column. Release connector locks on 7-terminal wiring connector at ignition switch and remove connector (Fig. 62).

(4) Release connector lock on 4-terminal halo lamp wiring connector and remove connector (Fig. 62).

IGNITION SWITCH AND KEY CYLINDER INSTALLATION

If installing **ignition key lock cylinder only,** proceed to following steps 2, 3 and 4. Also refer to fol-

REMOVAL AND INSTALLATION (Continued)

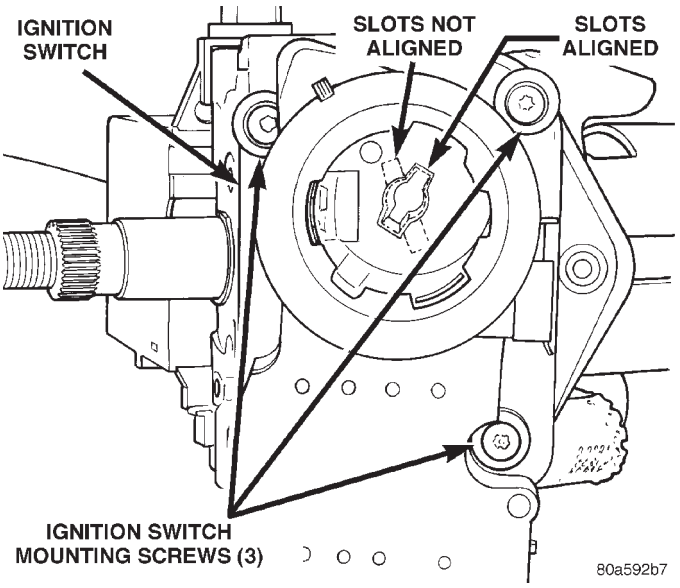


Fig. 61 Switch Mounting Screws

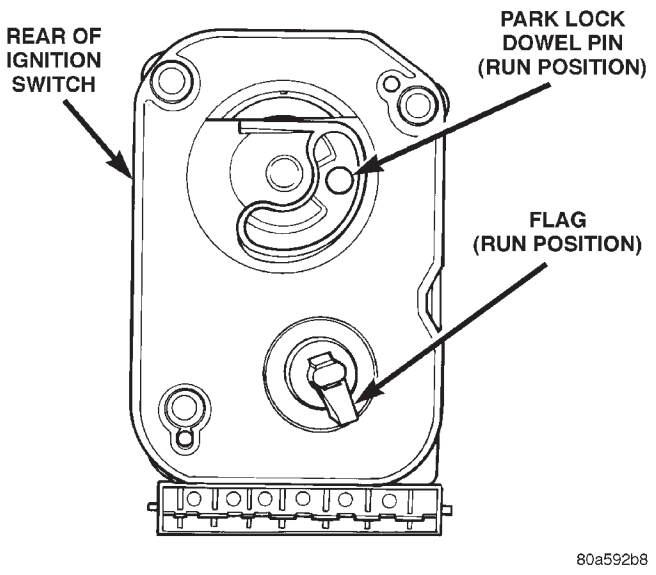


Fig. 63 Flag in RUN Position

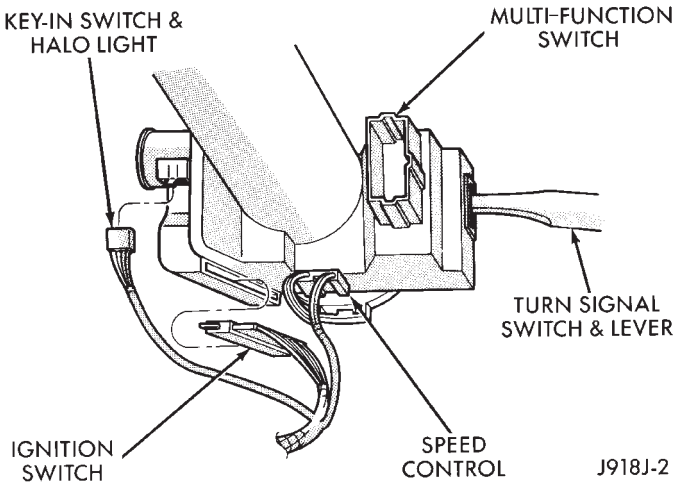


Fig. 62 Ignition Switch and Halo Lamp Connectors

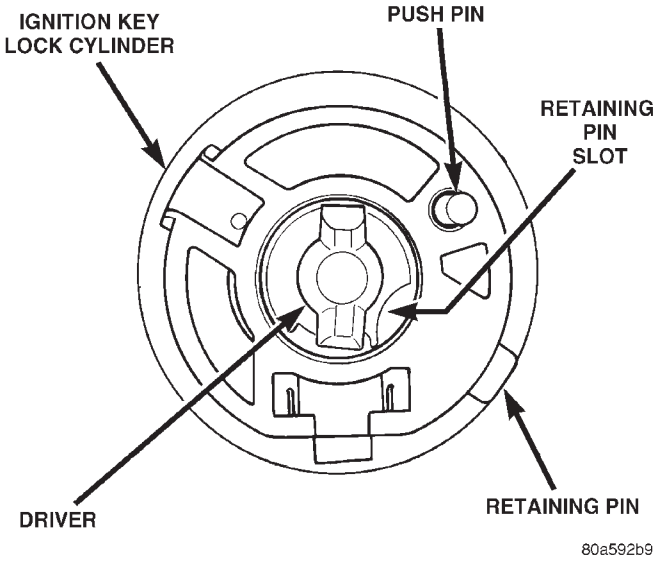


Fig. 64 Key Cylinder—Rear View

lowing steps 12 through 18. If installing both switch and key cylinder, refer to steps 1 through 18.

(1) Rotate flag (Fig. 63) on rear of ignition switch until in RUN position. This step must be done to allow tang (Fig. 64) on key cylinder to fit into slots (Fig. 61) within ignition switch.

(2) With key into ignition key cylinder, rotate key clockwise until retaining pin can be depressed (Fig. 64) or (Fig. 65).

(3) Install key cylinder into ignition switch by aligning retaining pin into retaining pin slot (Fig. 65). Push key cylinder into switch until retaining pin engages. After pin engages, rotate key to OFF or LOCK position.

(4) Check for proper retention of key cylinder by attempting to pull cylinder from switch.

(5) Automatic Transmission Only: Before attaching ignition switch to steering column, the transmission shifter must be in PARK position. The park lock dowel pin on rear of ignition switch (Fig. 66) must also be properly indexed into the park lock linkage (Fig. 67) before installing switch.

(6) The flag at rear of ignition switch (Fig. 66) must be properly indexed into steering column before installing switch. This flag is used to operate the steering wheel lock lever in steering column (Fig. 68). This lever allows steering wheel position to be locked when key switch is in LOCK position.

(7) Place ignition switch in LOCK position. The switch is in the LOCK position when column lock flag is parallel to ignition switch terminals (Fig. 66).

(8) Automatic Transmission Only: Apply a light coating of grease to park lock dowel pin and park lock slider linkage. Before installing switch, push the

REMOVAL AND INSTALLATION (Continued)

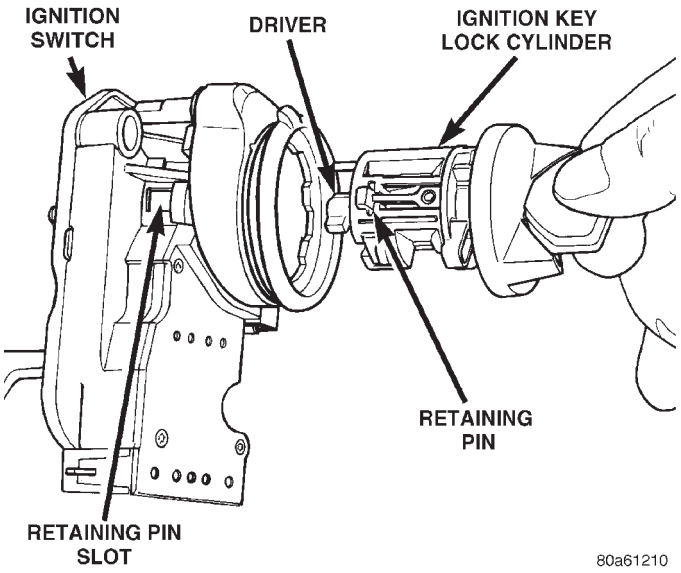


Fig. 65 Installing Key Cylinder Into Switch

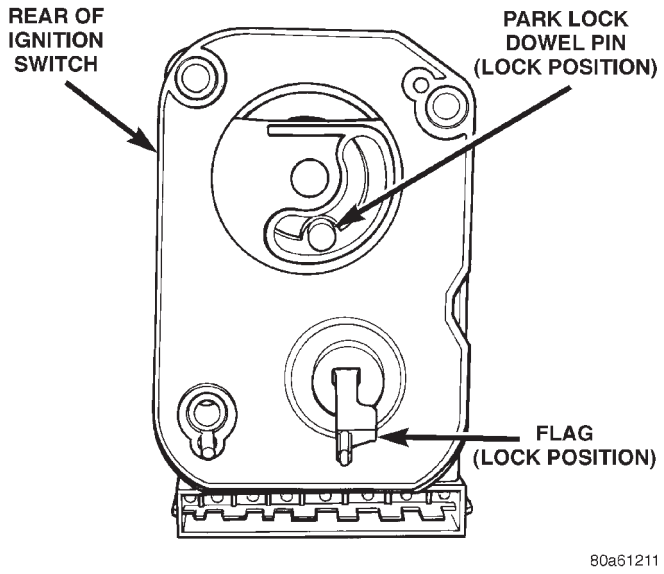


Fig. 66 Ignition Switch View From Column

park lock slider linkage (Fig. 67) forward until it bottoms. Do a final positioning by pulling it rearward about one-quarter inch.

(9) Apply a light coating of grease to both column lock flag and shaft at end of flag.

(10) Place ignition switch into openings on steering column.

(a) Automatic Transmission Only: Be sure park lock dowel pin on rear of ignition switch enters slot in park lock slider linkage (Fig. 67).

(b) Be sure flag on rear of switch is positioned above steering wheel lock lever (Fig. 68).

(c) Align dowel pins on rear of switch into holes on side of steering column.

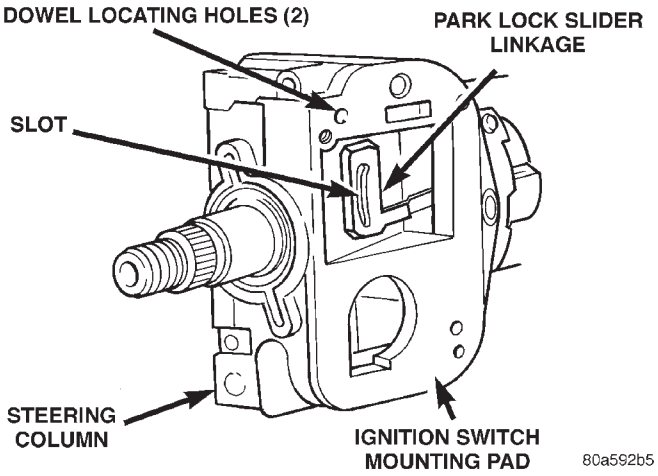


Fig. 67 Park Lock Linkage—Automatic Transmission—Typical

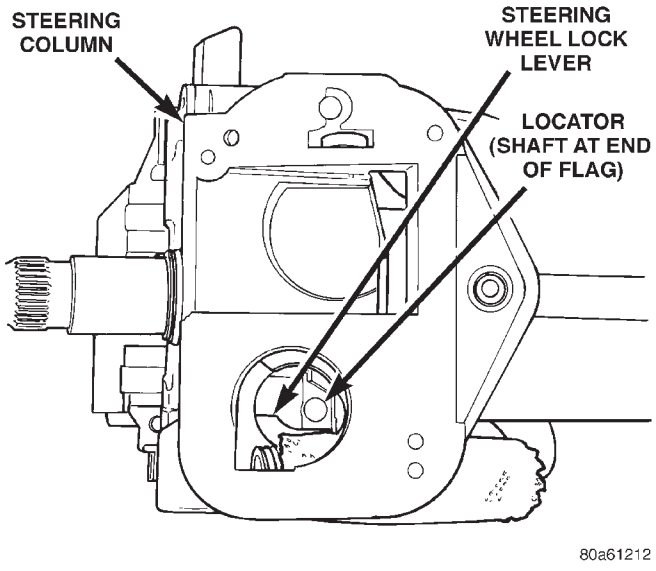


Fig. 68 Steering Wheel Lock Lever

(d) Install 3 ignition switch mounting screws. Tighten screws to 3 N·m ± .5 N·m (26 in. lbs. ± 4 in. lbs.) torque.

(11) Connect electrical connectors to ignition switch and halo lamp. Make sure that switch locking tabs are fully seated in wiring connectors.

(12) Install steering column covers (shrouds). Tighten screws to 2 N·m (17 in. lbs.) torque.

(13) Install tilt column lever (if equipped).

(14) Connect negative cable to battery.

(15) Check for proper operation of halo light.

(16) Automatic Transmission Only: Shifter should lock in PARK position when key is in LOCK position (if equipped with shift lock device). Shifter should unlock when key rotated to ON position.

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

REMOVAL AND INSTALLATION (Continued)

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

COLUMN SHIFT INTERLOCK

The column shift interlock is used to lock the transmission shifter in the Park position when the key is in the Off position. The interlock device is located within the steering column assembly and is not servicable. If repair is necessary, the steering column assembly must be replaced. Refer to Group 19, Steering for procedures.

SPECIFICATIONS

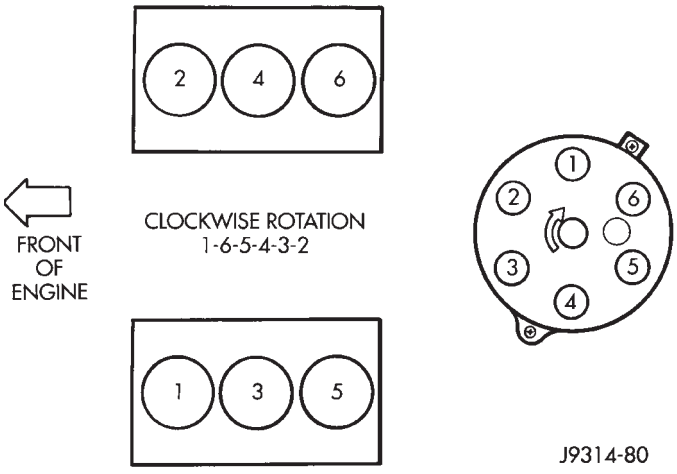
VECI LABEL

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.

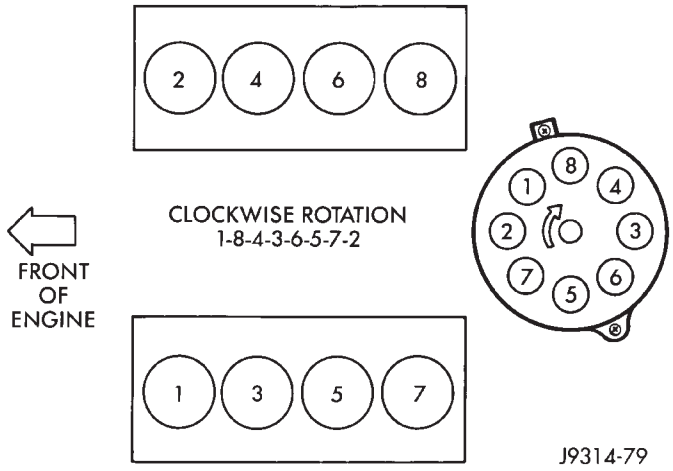
IGNITION TIMING

Ignition timing is not adjustable on any engine. Refer to Ignition Timing in the Diagnostics/Service Procedures section of this group for more information.

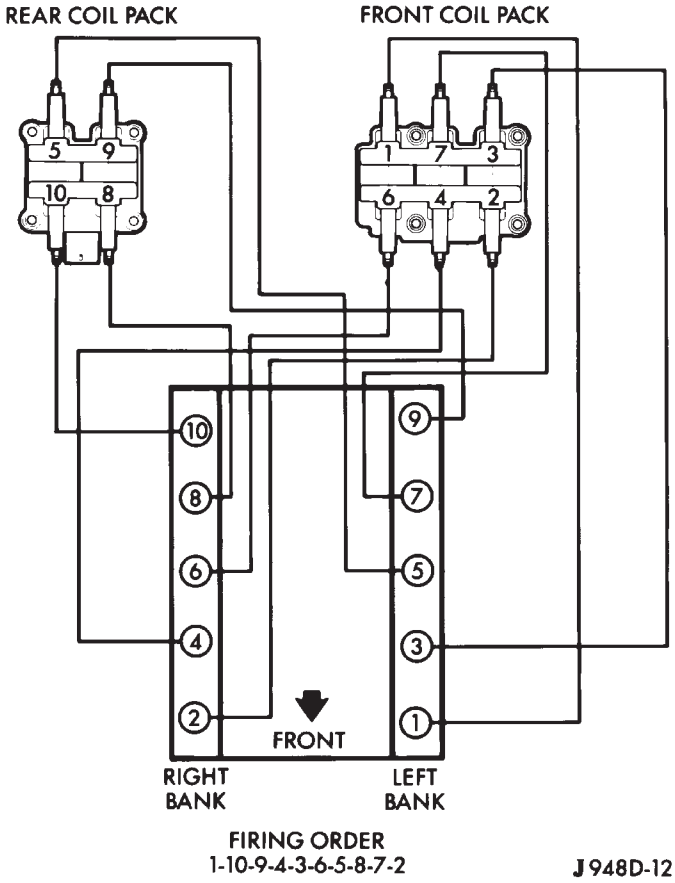
ENGINE FIRING ORDER—3.9L V-6 ENGINE



ENGINE FIRING ORDER—5.2L/5.9L V-8 ENGINES



SPARK PLUG CABLE ORDER—8.0L V-10 ENGINE



SPECIFICATIONS (Continued)

SPARK PLUGS

ENGINE	PLUG TYPE	ELECTRODE GAP
3.9L V-6	RC12LC4	1.01 mm (.040 in.)
5.2L/5.9L V-8	RC12LC4	1.01 mm (.040 in.)
8.0L V-10	QC9MC4	1.14 mm (.045 in.)

SPARK PLUG CABLE RESISTANCE

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

IGNITION COIL RESISTANCE—3.9L/5.2L/5.9L ENGINES

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

IGNITION COIL RESISTANCE—8.0L V-10 ENGINE

Primary Resistance: 0.53-0.65 Ohms. Test across the primary connector. Refer to text for test procedures.
Secondary Resistance: 10.9-14.7K Ohms. Test across the individual coil towers. Refer to text for test procedures.

TORQUE CHART

DESCRIPTION	TORQUE
Camshaft Position Sensor— 8.0L Engine	6 N·m (50 in. lbs.)
Crankshaft Position Sensor— All Engines	8 N·m (70 in. lbs.)
Distributor Hold Down Bolt	23 N·m (17 ft. lbs.)
Ignition Coil Mounting— 3.9L/5.2L/5.9L Engines— if tapped bolts are used	5 N·m (50 in. lbs.)
Ignition Coil Mounting— 3.9L/5.2L/5.9L Engines— if nuts/bolts are used	11 N·m (100 in. lbs.)
Ignition Coil Mounting— 8.0L Engine	10 N·m (90 in. lbs.)
Powertrain Control Module (PCM) Mounting Screws	1 N·m (9 in. lbs.)
Spark Plugs (all engines)	41 N·m (30 ft. lbs.)