

IGNITION SYSTEM

CONTENTS

	page	page
GENERAL INFORMATION		
INTRODUCTION	1	
DESCRIPTION AND OPERATION		
AUTOMATIC SHUTDOWN (ASD) AND FUEL PUMP RELAYS	4	
CAMSHAFT POSITION SENSOR	5	
COIL ON PLUG	3	
CRANKSHAFT POSITION SENSOR	4	
ENGINE COOLANT TEMPERATURE SENSOR ...	6	
IGNITION INTERLOCK	7	
IGNITION SYSTEM	1	
INTAKE AIR TEMPERATURE SENSOR	6	
KNOCK SENSORS	7	
LOCK KEY CYLINDER	7	
MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR	7	
POWERTRAIN CONTROL MODULE (PCM)	2	
SPARK PLUGS	2	
THROTTLE POSITION SENSOR (TPS)	7	
DIAGNOSIS AND TESTING		
CAMSHAFT POSITION SENSOR AND CRANKSHAFT POSITION SENSOR	8	
ENGINE COOLANT TEMPERATURE SENSOR ...	8	
IGNITION TIMING PROCEDURE	8	
INTAKE AIR TEMPERATURE SENSOR	8	
MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR TEST	8	
SPARK PLUG CONDITION		8
THROTTLE POSITION SENSOR		8
REMOVAL AND INSTALLATION		
AUTOMATIC SHUTDOWN RELAY		12
CAMSHAFT POSITION SENSOR—2.7L		12
CAMSHAFT POSITION SENSOR—3.2/3.5L ...		12
CRANKSHAFT POSITION SENSOR		13
ENGINE COOLANT TEMPERATURE SENSOR ..		13
IGNITION COIL		11
IGNITION INTERLOCK		17
IGNITION SWITCH		15
INTAKE AIR TEMPERATURE SENSOR		14
KNOCK SENSOR		13
LOCK CYLINDER HOUSING		17
LOCK KEY CYLINDER		15
MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—2.7L		14
MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—3.2/3.5L		14
POWERTRAIN CONTROL MODULE (PCM) ...		10
SPARK PLUG		11
THROTTLE POSITION SENSOR		15
SPECIFICATIONS		
SPARK PLUGS		18
TORQUE		17
VECI LABEL		17

GENERAL INFORMATION

INTRODUCTION

This group describes the ignition systems for the 2.7, 3.2, and 3.5L engines.

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

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

DESCRIPTION AND OPERATION

IGNITION SYSTEM

NOTE: All engines use a fixed ignition timing system. Basic ignition timing is not adjustable. All spark advance is determined by the Powertrain Control Module (PCM).

The distributorless ignition system used on these engines is referred to as the Direct Ignition System (DIS). The system's three main components are the coils, crankshaft position sensor, and camshaft position sensor. The coil on plug ignition system utilizes an ignition coil for every cylinder, it is mounted directly over the each spark plug.

DESCRIPTION AND OPERATION (Continued)

The crankshaft position sensor and camshaft position sensor are hall effect devices. The camshaft position sensor and crankshaft position sensor generate pulses that are inputs to the PCM. The PCM determines crankshaft position from these sensors. The PCM calculates injector sequence and ignition timing from crankshaft position. For a description of both sensors, refer to Camshaft Position Sensor and Crankshaft Position Sensor in this section.

POWERTRAIN CONTROL MODULE (PCM)

The PCM regulates the ignition system (Fig. 1). The PCM supplies battery voltage to the ignition coil through the Automatic Shutdown (ASD) Relay. The PCM also controls the ground circuit for the ignition coil. By switching the ground path for the coil on and off, the PCM adjusts ignition timing to meet changing engine operating conditions.

During the crank-start period the PCM advances ignition timing a set amount. During engine operation the following inputs determine the amount of spark advance provided by the PCM. During the run mode the coils are turned on and off by inputs from the following:

- Intake air temperature
- Coolant temperature
- Engine RPM
- Available manifold vacuum
- Knock sensor

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

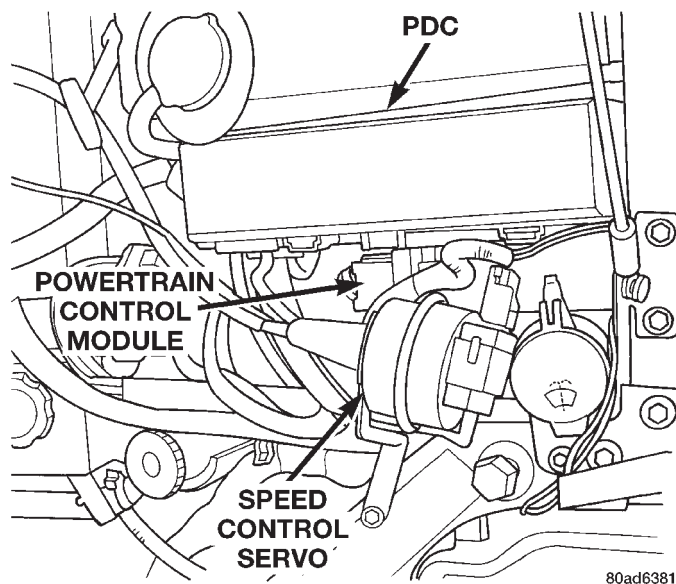


Fig. 1 Powertrain Control Module

SPARK PLUGS

The 2.7, 3.2, and 3.5L engines use platinum resistor spark plugs. They have resistance values of 6,000 to 20,000 ohms when checked with at least a 1000

volt tester. For spark plug identification and specifications, Refer to the Specifications section at the end of this group.

Do not use an ohm meter to check the resistance of the spark plugs. This will give an inaccurate reading.

Remove the spark plugs and examine them for burned electrodes and fouled, cracked or broken porcelain insulators. Keep plugs arranged in the order in which they were removed from the engine. An isolated plug displaying an abnormal condition indicates that a problem exists in the corresponding cylinder. Replace spark plugs at the intervals recommended in Group 0.

The spark plugs are double platinum and have a recommended service life of 100,000 miles for normal driving conditions per schedule A in this manual. The spark plugs have a recommended service life of 75,000 miles for severe driving conditions per schedule B in this manual. A thin platinum pad is welded to both electrode ends as shown in (Fig. 3). Extreme care must be used to prevent spark plug cross threading, mis-gapping and ceramic insulator damage during plug removal and installation.

CAUTION: Never attempt to file the electrodes or use a wire brush for cleaning platinum plugs. This would damage the platinum pads which would shorten spark plug life.

Adjust the gap between the electrodes (Fig. 2) to the dimensions specified in the chart at the end of this section.

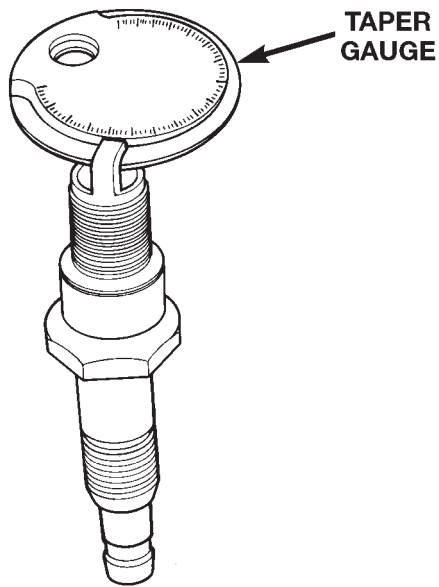
Apply a very small amount of anti-seize compound to the threads when reinstalling the vehicle's original spark plugs that have been determined good. **Do not apply anti-seize compound to new spark plugs.**

NOTE: Anti-seize compound is electrically conductive and can cause engine misfires if not applied correctly. It is extremely important that the anti-seize compound doesn't make contact with the spark plug electrodes or ceramic insulator.

Never force a gap gauge between the platinum electrodes or adjust the gap on platinum spark plugs without reading the Spark Plug Gap Measurement procedures in this section.

Always tighten spark plugs to the specified torque. Over tightening can cause distortion resulting in a change in the spark plug gap. Overtightening can also damage the cylinder head.

DESCRIPTION AND OPERATION (Continued)



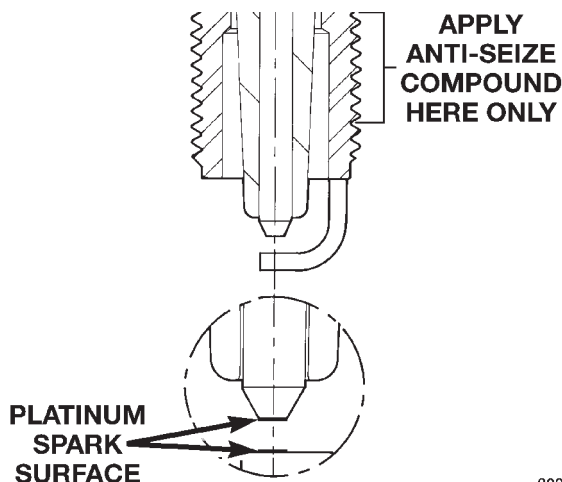
803f5851

Fig. 2 Setting Spark Plug Electrode Gap**SPARK PLUG GAP MEASUREMENT**

CAUTION: The Platinum pads can be damaged during the measurement of checking the gap if extreme care is not used.

- **USE ONLY A TAPER GAP GAUGE (Fig. 2).**
- Never force the gap gauge through the platinum pads. Only apply enough force until resistance is felt.
- Never use a wire brush or spark plug cleaner machine to clean platinum spark plugs.
- Use an OSHA approved air nozzle when drying gas fouled spark plugs.

If gap adjustment is required of platinum plug, bend only the ground electrode. **DO NOT TOUCH** the platinum pads. Use only a proper gapping tool and check with a taper gap gauge.

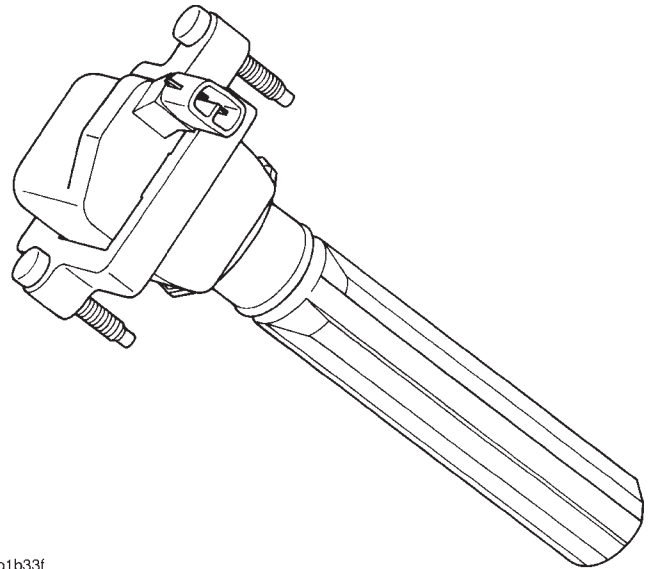
**Fig. 3 Platinum Pads**

8008a54b

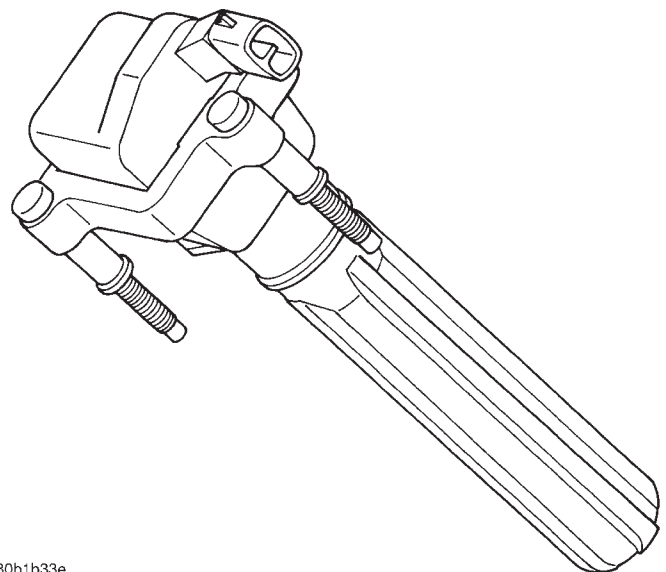
CAUTION: Cleaning of the platinum plug may damage the platinum tip.

COIL ON PLUG

The engines are equipped with a coil on plug ignition system. Each cylinder has a dedicated coil that sits atop each plug. No secondary wires are required and connection from the coil to plug is made with a boot that is attached to the coil. The Powertrain Control Module (PCM) determines which coil to charge and fire at the correct time.



80b1b33f

Fig. 4 2.7L Coil

80b1b33e

Fig. 5 3.2/3.5L Coil

The Auto Shutdown (ASD) relay provides battery voltage to the ignition coil. The PCM provides a ground contact (circuit) for energizing the coil. When the PCM breaks the contact, the energy in the coil primary transfers to the secondary causing the

DESCRIPTION AND OPERATION (Continued)

spark. The PCM will de-energize the ASD relay if it does not receive the crankshaft position sensor and camshaft position sensor inputs. Refer to Auto Shutdown (ASD) Relay—PCM Output, in this section for relay operation.

The coil's low primary resistance (0.4 - 0.6 ohm) allows the PCM to fully charge the coil for each firing. There are coil capacitors added to each bank of cylinders for radio noise suppression.

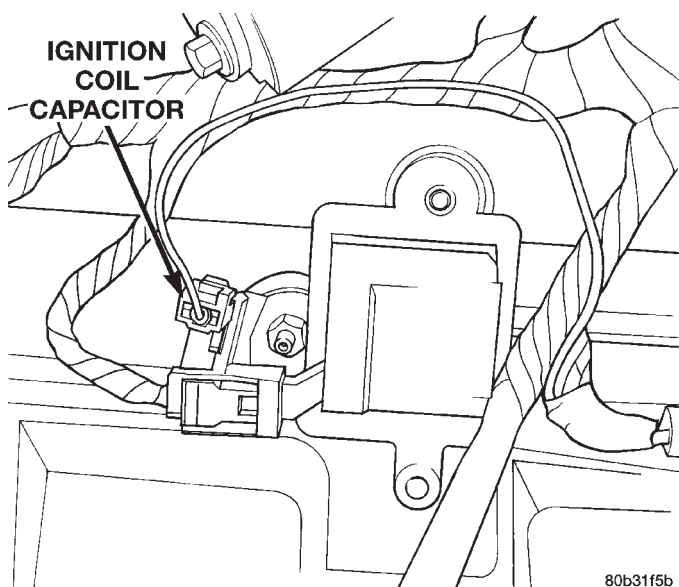


Fig. 6 Coil Capacitor

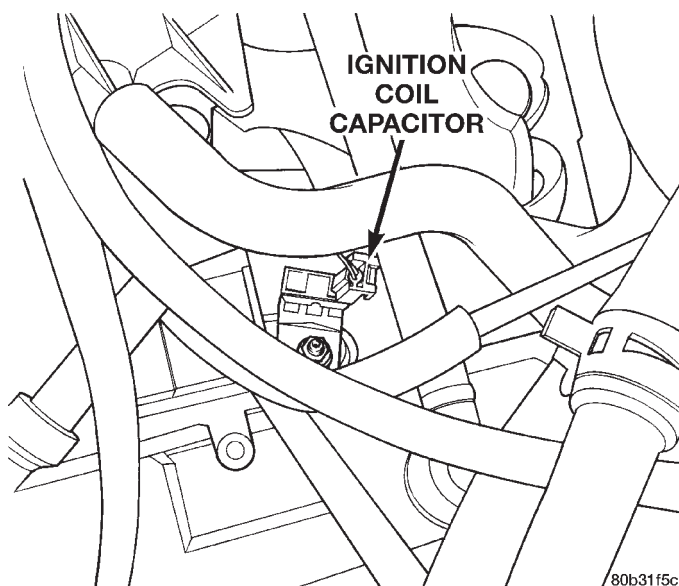


Fig. 7 Coil Capacitor

AUTOMATIC SHUTDOWN (ASD) AND FUEL PUMP RELAYS

The PCM operates the ASD relay and fuel pump relay through one ground path. The PCM operates them by switching on and off the ground path for the

solenoid side of the relays. Both relays turn on and off at the same time.

The ASD relay connects battery voltage to the fuel injectors and ignition coils. The fuel pump relay connects battery voltage to the fuel pump.

The PCM turns the ground path off when the ignition switch is in the Off position. Both relays are off. When the ignition switch is in the On or Crank position, the PCM monitors the crankshaft position sensor and camshaft position sensor signals to determine engine speed and ignition timing. If the PCM does not receive a crankshaft position sensor signal and camshaft position sensor signal when the ignition switch is in the Run position, it de-energizes both relays. When the relays de-energize, battery voltage is not supplied to the fuel injectors, ignition coil and fuel pump.

The ASD relay and fuel pump relay are located in the Power Distribution Center (PDC) near the battery (Fig. 8). A decal on the underside of the PDC cover shows the locations of each relay and fuse contained in the PDC.

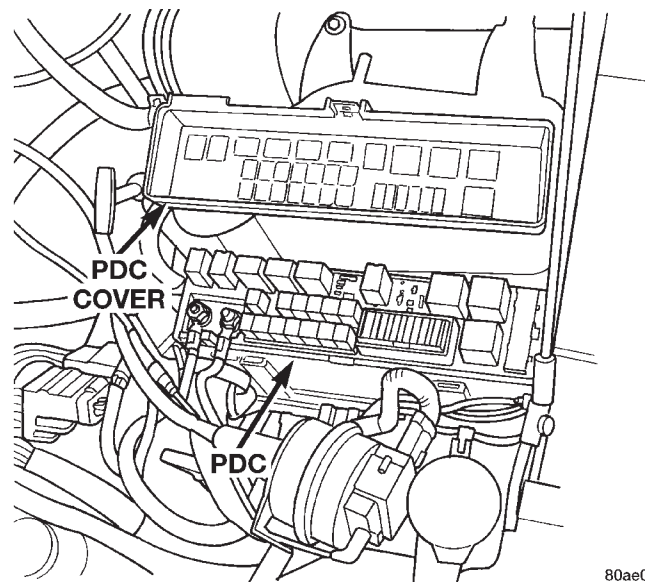


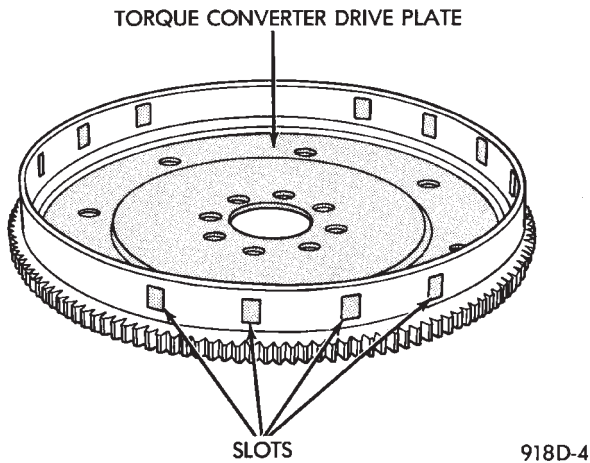
Fig. 8 Power Distribution Center

CRANKSHAFT POSITION SENSOR

The crankshaft position sensor detects slots cut into the transmission driveplate extension. There are 3 sets of slots. Two set contain 4 slots and one set contains 5 slots, for a total of 13 slots (Fig. 9). Basic timing is set by the position of the last slot in each group. Once the Powertrain Control Module (PCM) senses the last slot, it determines crankshaft position (which piston will next be at TDC) from the camshaft position sensor input. It may take the PCM one engine revolution to determine crankshaft position.

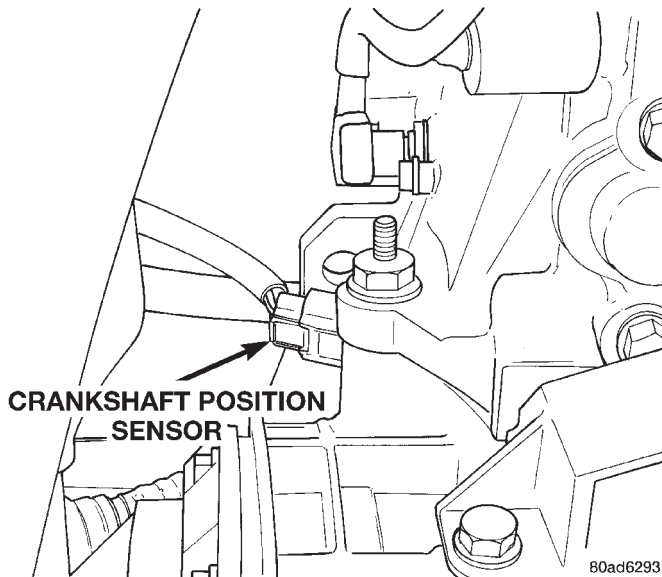
The PCM uses crankshaft position reference to determine injector sequence and ignition timing.

DESCRIPTION AND OPERATION (Continued)

**Fig. 9 Timing Slots**

Once the PCM determines crankshaft position, it begins energizing the injectors and coils in sequence.

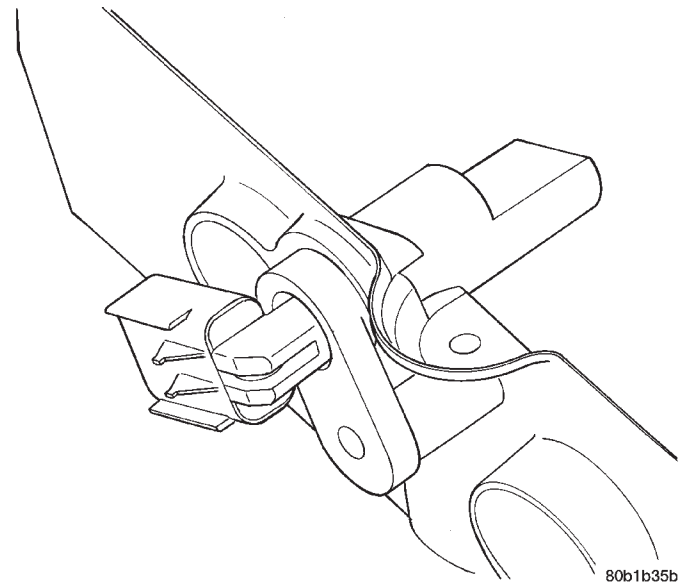
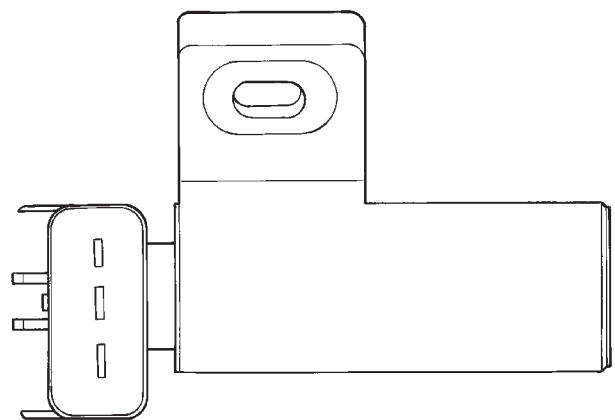
The crankshaft sensor is located on the passengers side of the transmission housing, above the differential housing (Fig. 10). The bottom of the sensor is positioned next to the drive plate.

**Fig. 10 Crankshaft Position Sensor Location****CAMSHAFT POSITION SENSOR**

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

When the PCM receives one camshaft pulse after the long flat spot on the sprocket, cylinder number two crankshaft timing marks are next. After 3 camshaft pulses, the PCM knows cylinder four crankshaft timing marks follow. The PCM can synchronize on cylinders 1 or 4.

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

**Fig. 11 Camshaft Position Sensor—2.7L Engine****Fig. 12 Camshaft Position Sensor—3.2/3.5L Engine**

DESCRIPTION AND OPERATION (Continued)

The camshaft position sensor is mounted in the front of the timing case cover (Fig. 13) or (Fig. 14).

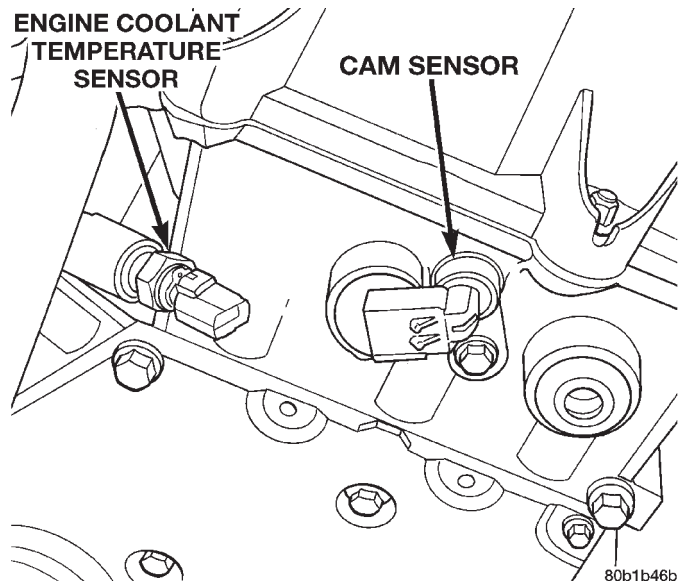


Fig. 13 Camshaft Position Sensor Location—2.7L Engine

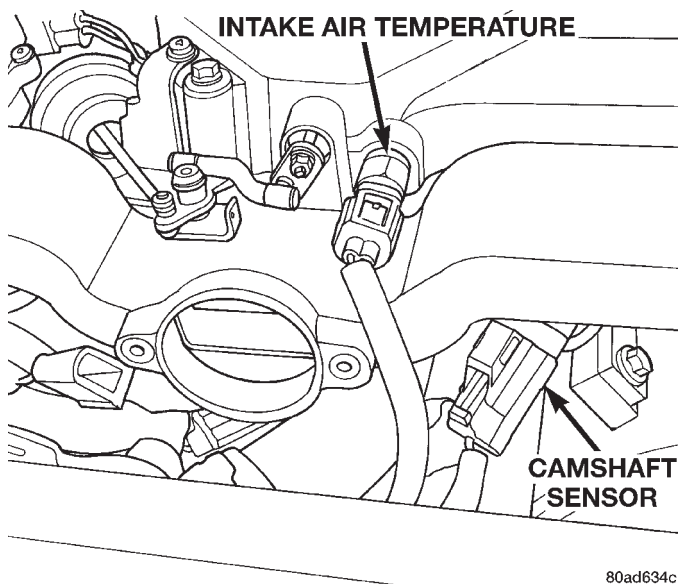


Fig. 14 Camshaft Position Sensor Location—3.2/3.5L Engine

ENGINE COOLANT TEMPERATURE SENSOR

The engine coolant temperature sensor threads into the water jacket next to thermostat housing (Fig. 15) or (Fig. 16). The sensor provides an input to the powertrain control module (PCM). As coolant temperature varies, the sensor resistance changes, resulting in a different input voltage to the PCM.

The PCM contains different spark advance schedules for cold and warm engine operation. The schedules reduce engine emission and improve driveability. When the engine is cold, the PCM will demand

slightly richer air-fuel mixtures and higher idle speeds until normal operating temperatures are reached.

The engine coolant sensor input also determines operation of the low and high speed cooling fans.

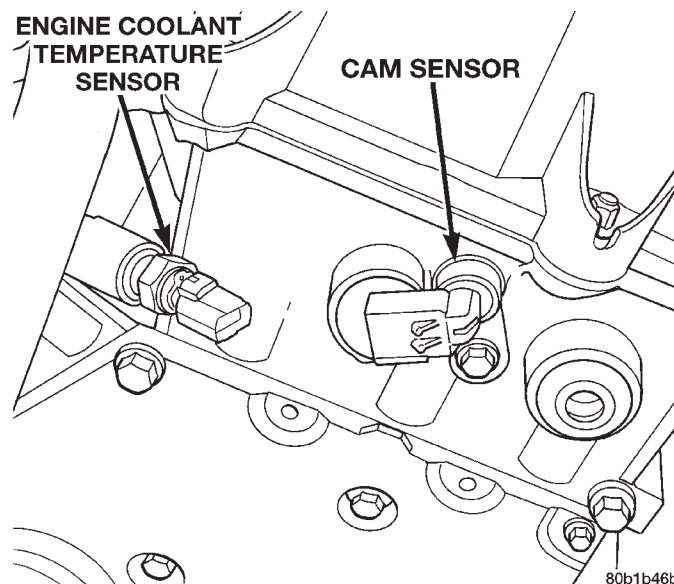


Fig. 15 Engine Coolant Temperature Sensor—2.7L

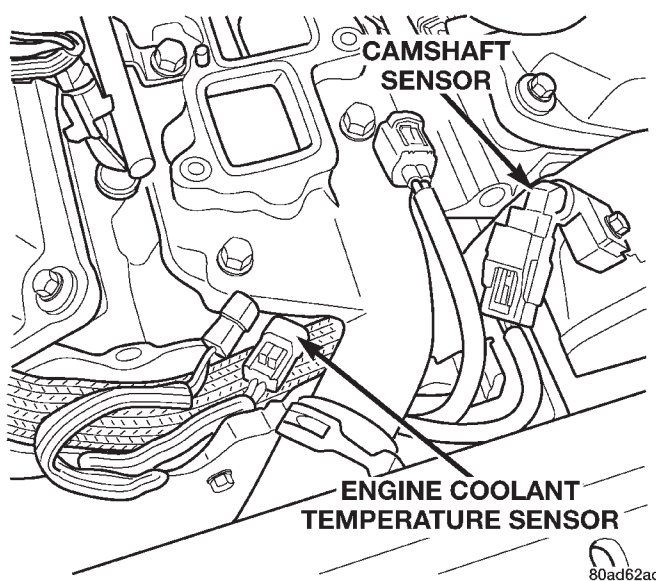


Fig. 16 Engine Coolant Temperature Sensor—3.2/3.5L

INTAKE AIR TEMPERATURE SENSOR

The Intake Air Temperature (IAT) sensor measures the temperature of the air as it enters the engine. The sensor supplies one of the inputs the PCM uses to determine injector pulse-width.

The IAT sensor threads into the intake manifold.

DESCRIPTION AND OPERATION (Continued)

KNOCK SENSORS

The engine has one knock sensor. The knock sensor bolts into the top of the cylinder block below the cylinder heads (Fig. 17). When the knock sensor detects a knock in one of the cylinders, it sends an input signal to the PCM. In response, the PCM retards ignition timing by a scheduled amount.

Knock sensor contain a piezoelectric material which constantly vibrates and sends an input voltage (signal) to the PCM while the engine operates. As the intensity of the crystal's vibration increase, the knock sensor output voltage also increases.

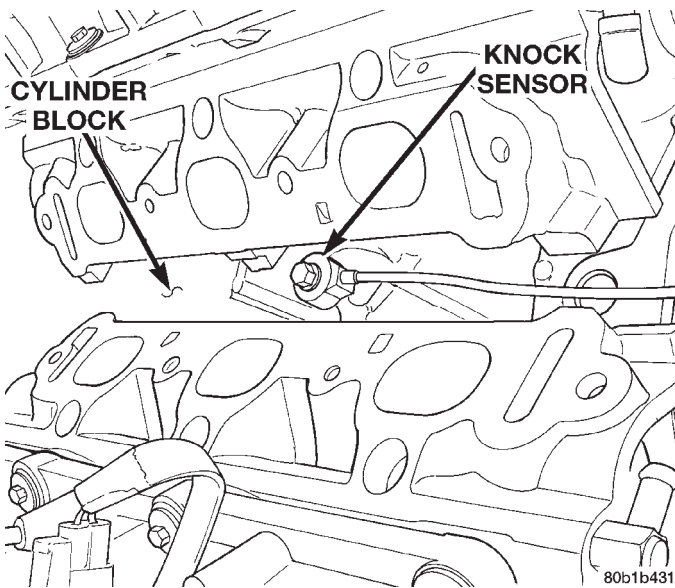


Fig. 17 Knock Sensor Location

NOTE: Over or under tightening effects knock sensor performance, possibly causing improper spark control.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

The Powertrain Control Module (PCM) supplies 5 volts to the Manifold Absolute Pressure (MAP) sensor. The MAP sensor converts intake manifold pressure into voltage. The PCM monitors the MAP sensor output voltage. As vacuum increases, MAP sensor voltage decreases proportionately. Also, as vacuum decreases, MAP sensor voltage increases proportionately.

Key on, before the engine starts running, the PCM determines atmospheric air pressure from the MAP sensor voltage. While the engine operates, the PCM determines intake manifold pressure from the MAP sensor voltage. Based on MAP sensor voltage and inputs from other sensors, the PCM adjusts spark advance and the air/fuel mixture.

The MAP sensor mounts to the intake manifold.

THROTTLE POSITION SENSOR (TPS)

The TPS mounts to the side of the throttle body. The TPS connects to the throttle blade shaft. The TPS is a variable resistor that provides the Powertrain Control Module (PCM) with an input signal (voltage). The signal represents throttle blade position. As the position of the throttle blade changes, the resistance of the TPS changes.

The PCM supplies approximately 5 volts to the TPS. The TPS output voltage (input signal to the powertrain control module) represents throttle blade position. The TPS output voltage to the PCM varies from approximately 0.38 volts to 1.2 volts at minimum throttle opening (idle) to a maximum of 3.1 volts to 4.4 volts at wide open throttle.

Along with inputs from other sensors, the PCM uses the TPS input to determine current engine operating conditions. The PCM also adjusts fuel injector pulse width and ignition timing based on these inputs.

LOCK KEY CYLINDER

The lock cylinder is inserted in the end of the housing opposite the ignition switch. The ignition key rotates the cylinder to 5 different detents (Fig. 18):

- Accessory
- Off (lock)
- Unlock
- On/Run
- Start

• UNLOCK

• ON/RUN

• START

• OFF

• ACCESSORY

938D-22

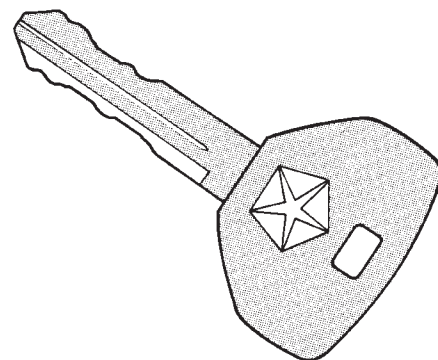


Fig. 18 Ignition Lock Cylinder Detents

IGNITION INTERLOCK

All vehicles equipped with automatic transaxles have an interlock system. The system prevents shifting the vehicle out of Park unless the ignition lock cylinder is in the Off, Run or Start position. In addition, the operator cannot rotate the key to the lock position unless the shifter is in the park position. On vehicles equipped with floor shift refer to Group 21 - Transaxle for Automatic Transmission Shifter/Ignition Interlock.

DIAGNOSIS AND TESTING

IGNITION TIMING PROCEDURE

The engines for this vehicle, use a fixed ignition system. The PCM regulates ignition timing. Basic ignition timing is not adjustable.

CAMSHAFT POSITION SENSOR AND CRANKSHAFT POSITION SENSOR

The output voltage of a properly operating camshaft position sensor or crankshaft position sensor switches from high (5.0 volts) to low (0.3 volts). By connecting an Mopar Diagnostic System (MDS) and engine analyzer to the vehicle, technicians can view the square wave pattern.

ENGINE COOLANT TEMPERATURE SENSOR

Refer to Group 14, Fuel System for Diagnosis and Testing.

INTAKE AIR TEMPERATURE SENSOR

Refer to Group 14, Fuel System, for Diagnosis and Testing.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR TEST

Refer to Group 14, Fuel System for Diagnosis and Testing.

THROTTLE POSITION SENSOR

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

The Throttle Position Sensor (TPS) can be tested with a digital voltmeter (DVM). The center terminal of the sensor is the output terminal. One of the other terminals is a 5 volt supply and the remaining terminal is ground.

Connect the DVM between the center and sensor ground terminal. Refer to Group 8W - Wiring Diagrams for correct pinout.

With the ignition switch in the ON position, check the output voltage at the center terminal wire of the connector. Check the output voltage at idle and at Wide-Open-Throttle (WOT). At idle, TPS output voltage should be approximately 0.38 volts to 1.2 volts. At wide open throttle, TPS output voltage should be approximately 3.1 volts to 4.4 volts. The output voltage should gradually increase as the throttle plate moves slowly from idle to WOT.

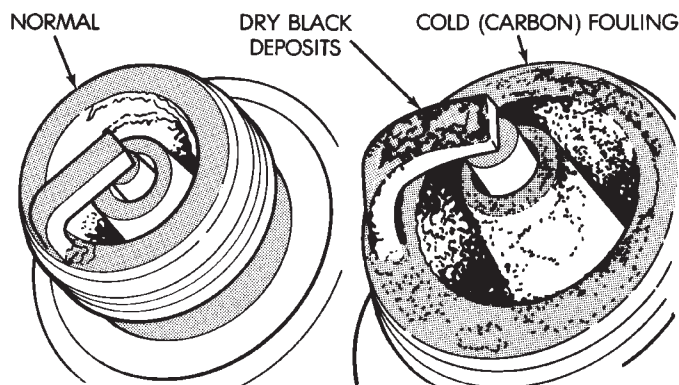
Check for spread terminals at the sensor and PCM connections before replacing the TPS.

SPARK PLUG CONDITION

NORMAL OPERATING CONDITIONS

The few deposits present will be probably light tan or slightly gray in color with most grades of commercial gasoline (Fig. 19). There will not be evidence of electrode burning. Gap growth will not average more than approximately 0.025 mm (.001 in) per 1600 km (1000 miles) of operation for non platinum spark plugs. Non-platinum spark plugs that have normal wear can usually be cleaned, have the electrodes filed and regapped, and then reinstalled.

CAUTION: Never attempt to file the electrodes or use a wire brush for cleaning platinum spark plugs. This would damage the platinum pads which would shorten spark plug life.



J908D-15

Fig. 19 Normal Operation and Cold (Carbon) Fouling

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

COLD FOULING (CARBON FOULING)

Cold fouling is sometimes referred to as carbon fouling because the deposits that cause cold fouling are basically carbon (Fig. 19). A dry, black deposit on one or two plugs in a set may be caused by sticking valves or misfire conditions. Cold (carbon) fouling of the entire set may be caused by a clogged air cleaner.

Cold fouling is normal after short operating periods. The spark plugs do not reach a high enough operating temperature during short operating periods. **Replace carbon fouled plugs with new spark plugs.**

DIAGNOSIS AND TESTING (Continued)

FUEL FOULING

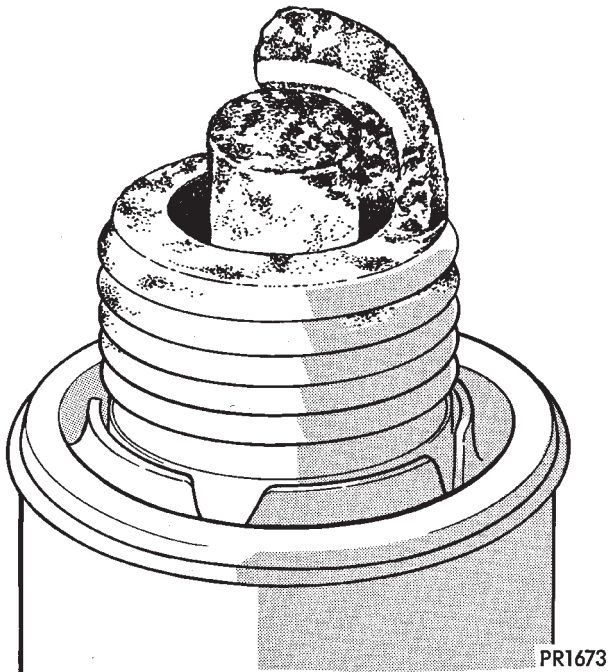
A spark plug that is coated with excessive wet fuel is called fuel fouled. This condition is normally observed during hard start periods. **Clean fuel fouled spark plugs with compressed air and reinstall them in the engine.**

OIL FOULING

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

OIL OR ASH ENCRUSTED

If one or more plugs are oil or ash encrusted, evaluate the engine for the cause of oil entering the combustion chambers (Fig. 20). Sometimes fuel additives can cause ash encrustation on an entire set of spark plugs. **Ash encrusted spark plugs can be cleaned and reused.**



PR1673

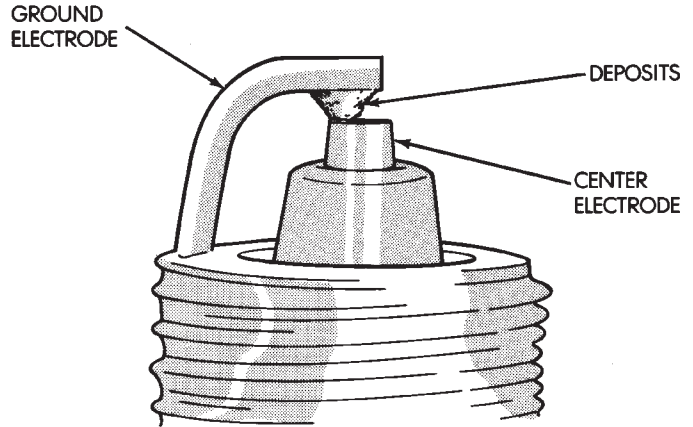
Fig. 20 Oil or Ash Encrusted

HIGH SPEED MISS

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

ELECTRODE GAP BRIDGING

Loose deposits in the combustion chamber can cause electrode gap bridging. The deposits accumulate on the spark plugs during continuous stop-and-go driving. When the engine is suddenly subjected to a high torque load, the deposits partially liquefy and bridge the gap between the electrodes (Fig. 21). This short circuits the electrodes. **Spark plugs with electrode gap bridging can be cleaned and reused.**

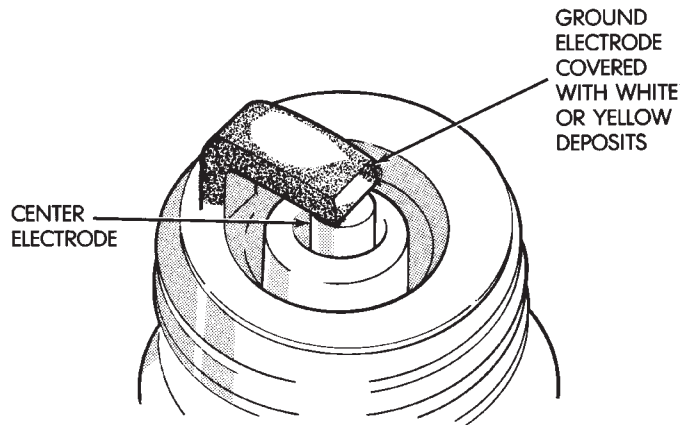


J908D-11

Fig. 21 Electrode Gap Bridging

SCAVENGER DEPOSITS

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



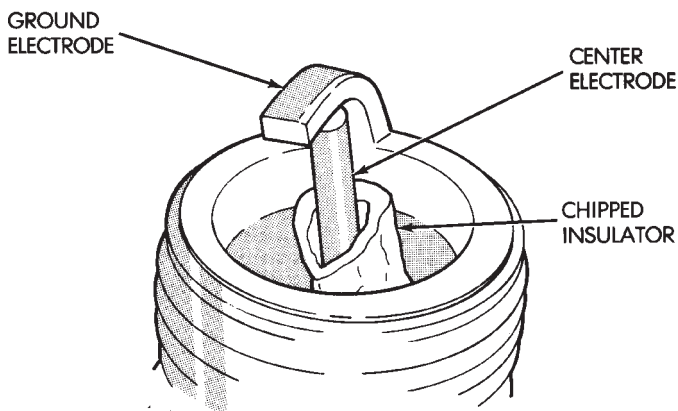
J908D-12

Fig. 22 Scavenger Deposits

DIAGNOSIS AND TESTING (Continued)

CHIPPED ELECTRODE INSULATOR

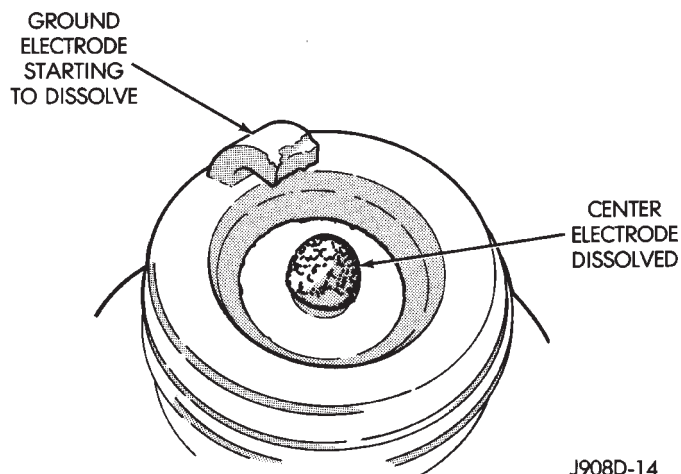
A chipped electrode insulator usually results from bending the center electrode while adjusting the spark plug electrode gap. Under certain conditions, severe detonation also can separate the insulator from the center electrode (Fig. 23). **Spark plugs with chipped electrode insulators must be replaced.**



J908D-13

Fig. 23 Chipped Electrode Insulator**PREIGNITION DAMAGE**

Excessive combustion chamber temperature can cause preignition damage. First, the center electrode dissolves and the ground electrode dissolves somewhat later (Fig. 24). Insulators appear relatively deposit free. Determine if the spark plugs are the correct type, as specified on the VECI label, or if other operating conditions are causing engine overheating.

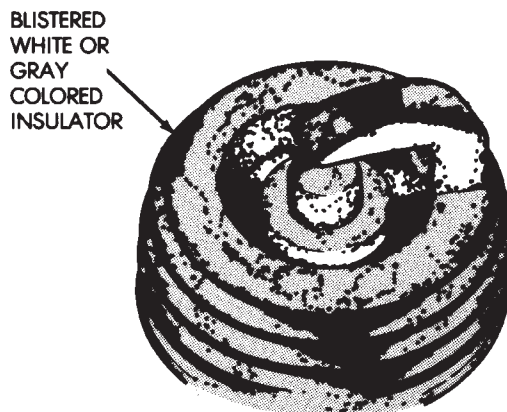


J908D-14

Fig. 24 Preignition Damage**SPARK PLUG OVERHEATING**

Overheating is indicated by a white or gray center electrode insulator that also appears blistered (Fig. 25). The increase in electrode gap will be consider-

ably in excess of 0.001 in per 1000 miles of operation. This suggests that a plug with a cooler heat range rating should be used. Over advanced ignition timing, detonation and cooling system malfunctions also can cause spark plug overheating.



J908D-16

Fig. 25 Spark Plug Overheating**REMOVAL AND INSTALLATION****POWERTRAIN CONTROL MODULE (PCM)**

The PCM engine control strategy prevents reduced idle speeds until after the engine operates for 320 km (200 miles). If the PCM is replaced after 320 km (200 miles) of usage, update the mileage and vehicle identification number (VIN) in the new PCM. Use the DRB scan tool to change the mileage and VIN in the PCM. If this step is not done a Diagnostic Trouble Code (DTC) may be set. Refer to the appropriate Powertrain Diagnostic Manual and the DRB scan tool.

REMOVAL

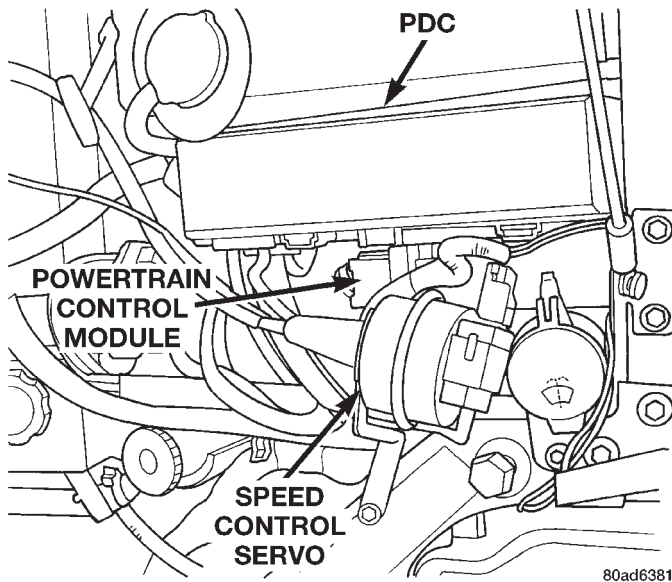
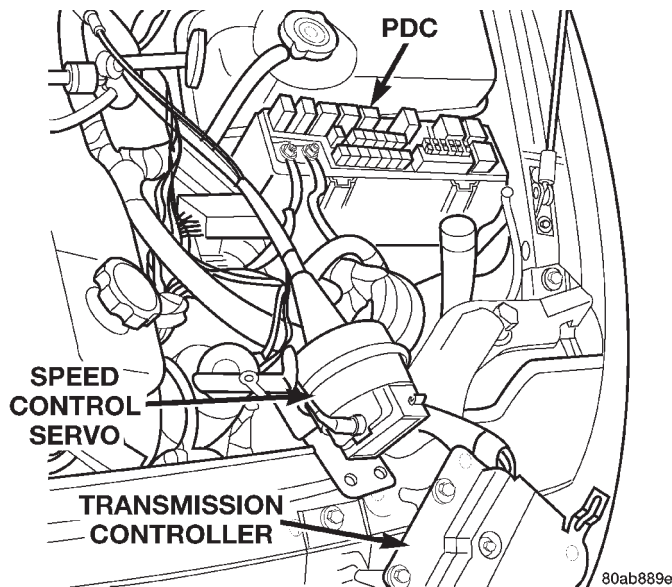
To avoid possible voltage spike damage to PCM, ignition key must be off, and the negative battery cable must be disconnected before unplugging the PCM connectors. Note radio programs.

- (1) Remove speed control servo and bracket and reposition out of the way (Fig. 26).
- (2) Reposition wiring harness out of the way.
- (3) Remove washer bottle filler neck.
- (4) Remove Transmission Control Module (TCM) reposition out of the way (Fig. 27).
- (5) Remove PCM
- (6) Disconnect PCM 2 40-way connector.

INSTALLATION

- (1) Attach 2 40-way connector to PCM.
- (2) Install PCM. Tighten bolt to 4 N·m (35 in. lbs.) torque.
- (3) Install TCM.
- (4) Install washer bottle filler neck.

REMOVAL AND INSTALLATION (Continued)

**Fig. 26 PCM Location****Fig. 27 TCM Location**

- (5) Reposition wiring harness.
- (6) Install speed control servo and bracket and tighten fasteners
- (7) Connect negative battery cable and reprogram radio and clock.
- (8) Using DRB scan tool, program mileage and vehicle identification number (VIN) into PCM. Refer to the DRB scan tool and the appropriate Powertrain Diagnostic Manual.

SPARK PLUG

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

REMOVAL

- (1) Prior to removing the spark plug, spray compressed air around the coil area and spark plug.
- (2) Remove electrical connector from ignition coil.
On 3.2/3.5L engines, it is necessary to loosen the screws by alternating back and forth. Do not lose the spacers under the coil when loosening the screws.
- (3) Remove 2 fasteners from ignition coil.
- (4) Remove ignition coil.
- (5) Remove rubber boot from spark plug.
- (6) Remove the spark plug using a quality socket with a rubber or foam insert.
- (7) Inspect the spark plug condition. Refer to Spark Plug Condition in this section.

INSTALLATION

- (1) To avoid cross threading, start the spark plug into the cylinder head by hand.
- (2) 3.2/3.5L engines tighten spark plugs to 28 N·m (20 ft. lbs.) torque, 2.7L engine tighten spark plugs to 17.6 N·m (13 ft. lbs.).
- (3) Install rubber boot onto ignition coil.
- (4) Install ignition coil and boot onto spark plug.
- (5) Install coil screws and tighten. 2.7L engine to 6.2 N·m (55 in. lbs.), 3.2/3.5L engines to 6.7 N·m (60 in. lbs.).
- (6) Connect the electrical connector.

IGNITION COIL**REMOVAL**

- (1) Prior to removing the ignition coils, spray compressed air around the coil area and spark plug.
- (2) Remove electrical connector from ignition coil.
On 3.2/3.5L engines, it is necessary to loosen the screws by alternating back and forth. Do not lose the spacers under the coil when loosening the screws.
- (3) Remove 2 fasteners from ignition coil.
- (4) Remove ignition coil.

INSTALLATION

- (1) Install ignition coil onto boot for spark plug.
- (2) Install coil screws and tighten. 2.7L engine to 6.2 N·m (55 in. lbs.), 3.2/3.5L engines to 6.7 N·m (60 in. lbs.).
- (3) Connect the electrical connector.

REMOVAL AND INSTALLATION (Continued)

AUTOMATIC SHUTDOWN RELAY

The relay is located in the Power Distribution Center (PDC) (Fig. 28). For the location of the relay within the PDC, refer to the PDC cover for location. Check electrical terminals for corrosion and repair as necessary.

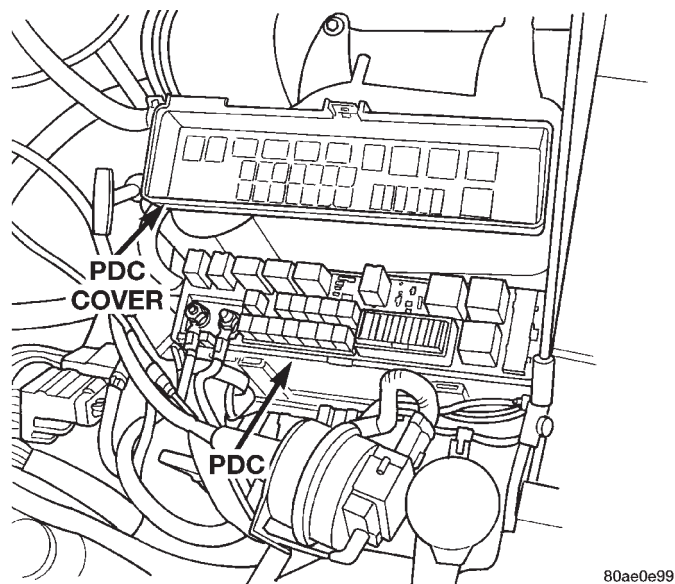


Fig. 28 Power Distribution Center (PDC)

CAMSHAFT POSITION SENSOR—2.7L

The camshaft position sensor is mounted in the front of the timing case cover (Fig. 29).

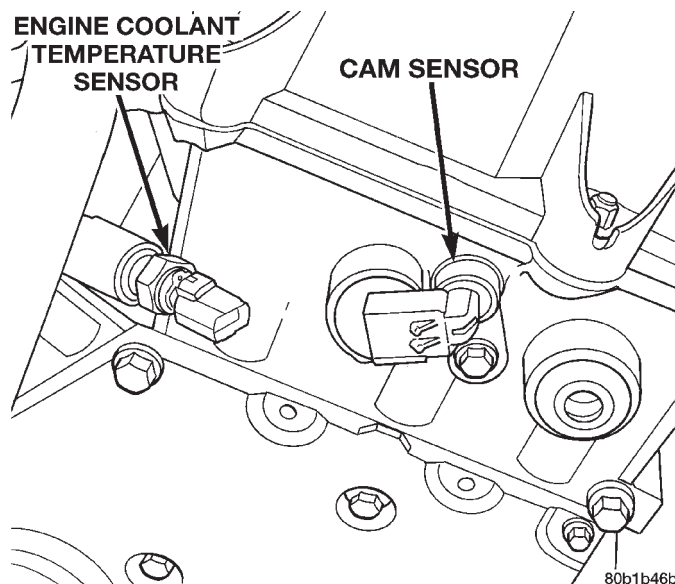


Fig. 29 Camshaft Position Sensor Location

REMOVAL

- (1) Disconnect electrical connector from sensor.
- (2) Loosen camshaft position sensor screw.
- (3) Without pulling on the connector wires, pull the sensor up out of the chain case cover.

INSTALLATION

- (1) Install sensor in the chain case cover and push sensor down until contact is made with the timing chain cover. While holding the sensor in this position, install and tighten the retaining bolt to 12 N·m (105 in. lbs.) torque.

- (2) Attach electrical connector to sensor.

CAMSHAFT POSITION SENSOR—3.2/3.5L

The camshaft position sensor is installed in the timing belt housing cover above the left camshaft sprocket (Fig. 30).

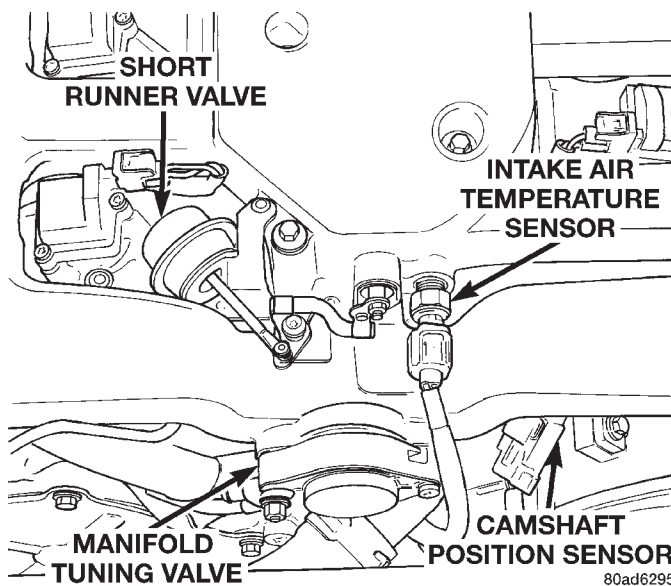


Fig. 30 Camshaft Position Sensor

REMOVAL

- (1) Disconnect the negative battery cable.
- (2) Remove the upper intake plenum, refer to Group 11, Intake and Exhaust System.
- (3) Disconnect electrical connector from sensor.
- (4) Remove camshaft position sensor screw.
- (5) Pull sensor up out of the timing belt housing cover.

INSTALLATION

If the removed sensor is reinstalled, clean off the old spacer on the sensor face. Attach a NEW SPACER to the face of the sensor before installation. If installing a new sensor, confirm that the paper spacer is attached to the face (Fig. 31).

- (1) Install sensor in the timing belt housing and push sensor down until contact is made with the camshaft sprocket. While holding the sensor in this position, install and tighten the retaining bolt to 12 N·m (105 in. lbs.) torque.
- (2) Attach electrical connector to sensor.
- (3) Install the upper intake plenum, refer to Group 11, Intake and Exhaust System.
- (4) Connect the negative battery cable.

REMOVAL AND INSTALLATION (Continued)

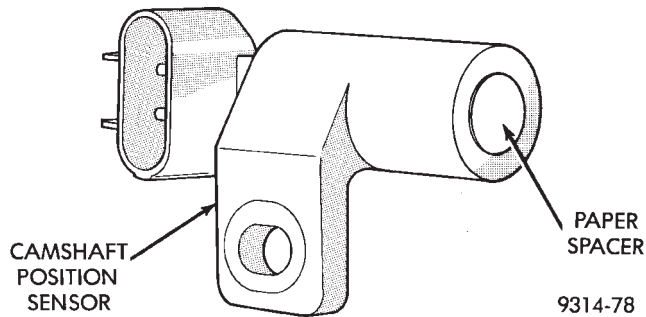


Fig. 31 Paper Spacer—3.2/3.5L Engine

CRANKSHAFT POSITION SENSOR

The crankshaft sensor is located on the passenger side of the transmission housing, above the differential housing (Fig. 32). The bottom of the sensor sits above the drive plate.

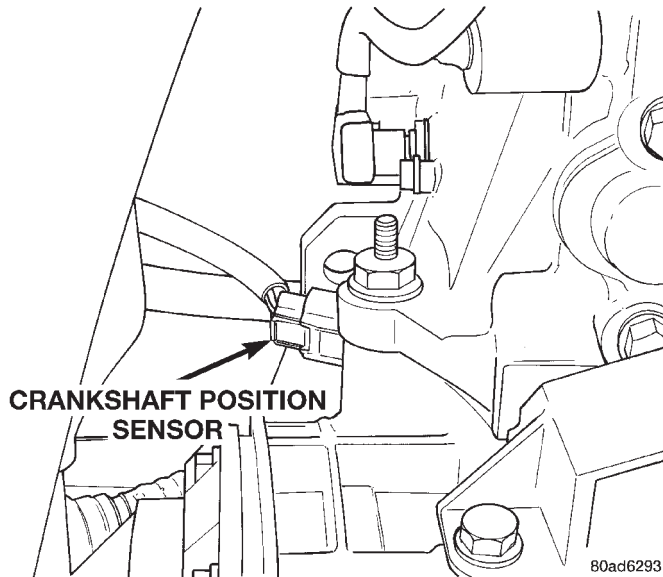


Fig. 32 Crankshaft Position Sensor

REMOVAL

- (1) Disconnect electrical connector from crankshaft position sensor.
- (2) Remove sensor mounting screw. Remove sensor.

INSTALLATION

- (1) Install sensor
- (2) Install sensor and push sensor down until contact is made with the transmission case. While holding the sensor in this position, install and tighten the retaining bolt to 12 N·m (105 in. lbs.) torque.

ENGINE COOLANT TEMPERATURE SENSOR

The engine coolant sensor is located next to the thermostat housing (Fig. 33) or (Fig. 34).

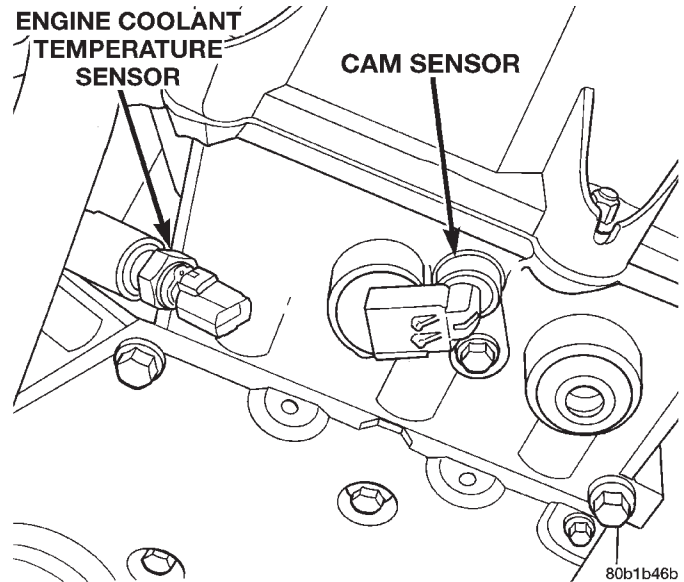


Fig. 33 Engine Coolant Temperature Sensor—2.7L

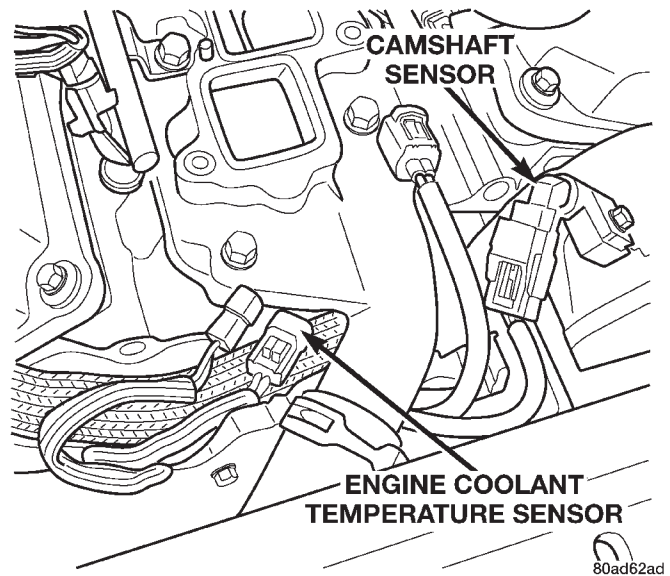


Fig. 34 Engine Coolant Temperature Sensor—3.2/3.5L

REMOVAL

- (1) With the engine cold, disconnect coolant sensor electrical connector.
- (2) Remove coolant sensor.

INSTALLATION

- (1) Install coolant sensor. Tighten sensor to 28 N·m (20 ft. lbs.) torque.
- (2) Attach electrical connector to sensor.

KNOCK SENSOR

The engine uses one knock sensors. The sensor is bolted into the cylinder block, directly below the intake manifold.

REMOVAL AND INSTALLATION (Continued)

REMOVAL

(1) Remove intake manifold plenum and intake manifold. Refer to Group 11, Exhaust and Intake System.

(2) Disconnect electrical connector from knock sensor(s) (Fig. 35).

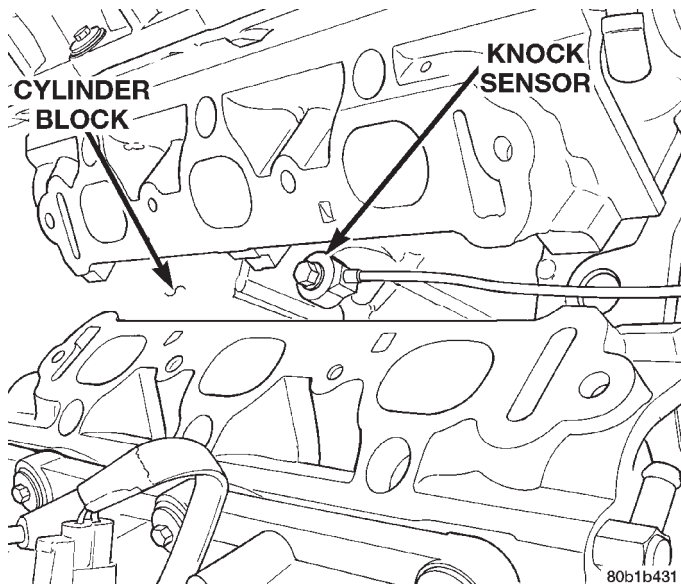


Fig. 35 Knock Sensor—3.5L Engine

(3) Use a crows foot socket to remove the knock sensor bolt.

INSTALLATION

(1) Install knock sensor. Tighten bolt to 10 N·m (7 ft. lbs.) torque. **Over or under tightening effects knock sensor performance, possibly causing improper spark control.**

(2) Attach electrical connector to knock sensor.

(3) Install intake manifold plenum and intake manifold. Refer to Group 11, Exhaust and Intake System.

INTAKE AIR TEMPERATURE SENSOR

For removal and installation of sensors refer to Group 14, Fuel Systems.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—2.7L

On 2.7L engine, the MAP sensor mounts onto the side of the intake manifold plenum (Fig. 36).

REMOVAL

(1) Disconnect the electrical connector from the MAP sensor.

(2) Remove sensor.

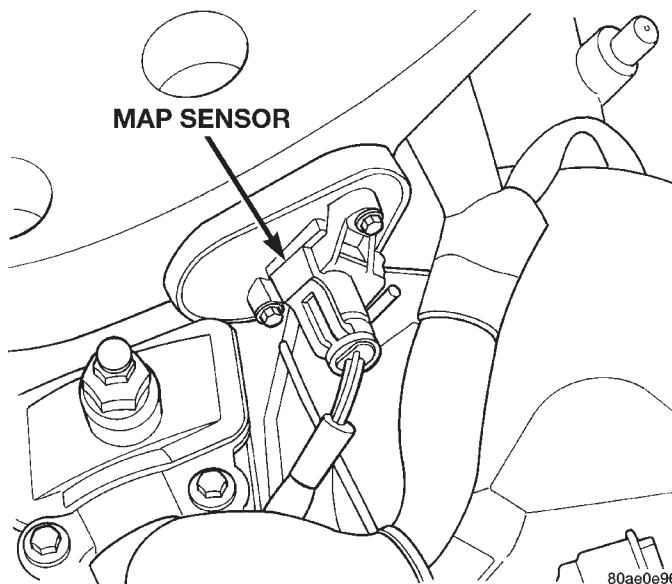


Fig. 36 MAP Sensor—2.7L Engine

INSTALLATION

(1) The sensor mounts onto intake manifold plenum. Tighten screws to 2 N·m (20 in. lbs.) torque.

(2) Attach electrical connector to sensor.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—3.2/3.5L

On 3.2/3.5L engines, the MAP sensor mounts into the left side of the intake manifold plenum (Fig. 37).

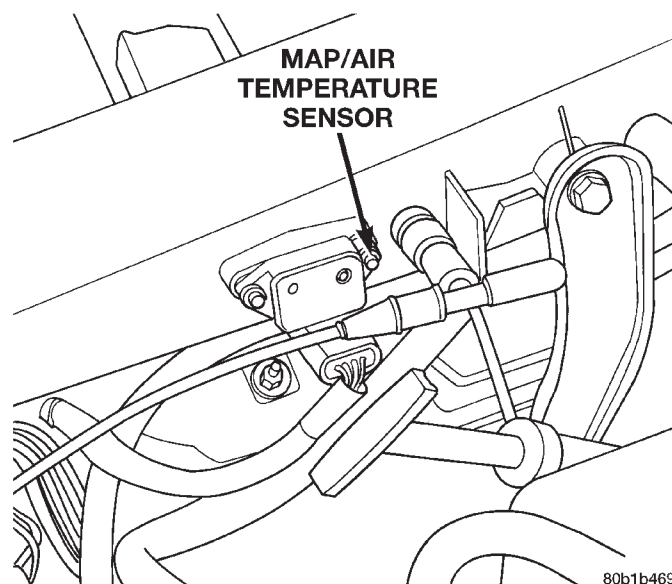


Fig. 37 MAP Sensor—3.2/3.5L Engine

REMOVAL AND INSTALLATION (Continued)

REMOVAL

- (1) Disconnect the electrical connector from the MAP sensor.
- (2) Remove sensor.

INSTALLATION

- (1) The sensor mounts onto intake manifold plenum. Tighten screws to 2 N·m (20 in. lbs.) torque.
- (2) Attach electrical connector to sensor.

THROTTLE POSITION SENSOR

Refer to Group 14, Fuel Injection Section, for Removal/Installation.

IGNITION SWITCH

The ignition switch attaches to the lock cylinder housing on the end opposite the lock cylinder (Fig. 38). For ignition switch terminal and circuit identification, refer to Group 8W, Wiring Diagrams.

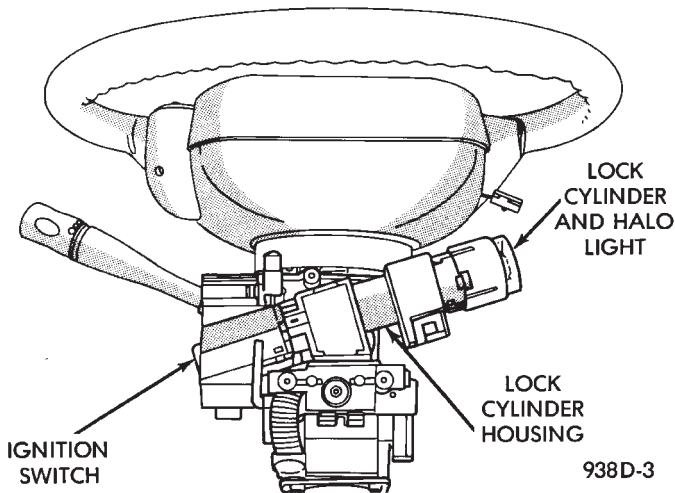


Fig. 38 Ignition Switch

REMOVAL

- (1) Disconnect negative cable from battery.
- (2) Remove tilt lever attaching screw. Remove lever.
- (3) Remove upper and lower cover from steering column.
- (4) Remove Sentry Key Immobilizer Module (SKIM) if equipped refer to Group 8Q Power Door Locks for removal.
- (5) Remove multi-function switch.
- (6) Disconnect electrical connector from ignition switch (Fig. 39).
- (7) Remove Ignition switch mounting screws. Remove switch.

INSTALLATION

- (1) A tab on the ignition switch indexes to a notch in the lock cylinder housing (Fig. 40). Also, a slot in the end of the ignition switch fits over the shaft in

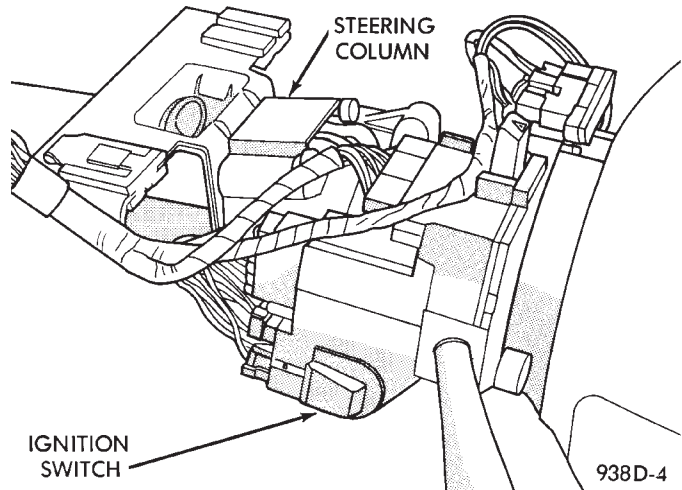


Fig. 39 Ignition Switch Removal/Installation

the end of the lock cylinder housing. Use the ignition key to rotate the lock cylinder to align the ignition switch with lock cylinder housing.

- (2) Install and tighten ignition switch mounting screws.
- (3) Attach electrical connector to ignition switch.
- (4) Install multi-function switch.
- (5) Install SKIM if equipped, refer to Group 8Q Power Door Locks for installation.
- (6) Install upper and lower cover on steering column.
- (7) Install tilt lever.
- (8) Connect negative cable to battery.

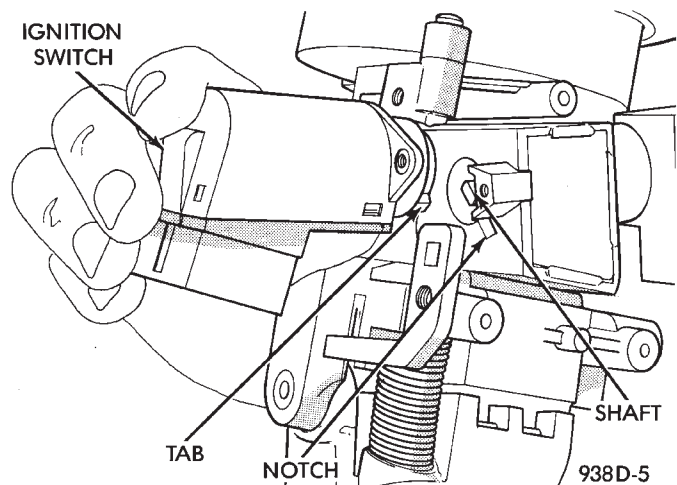


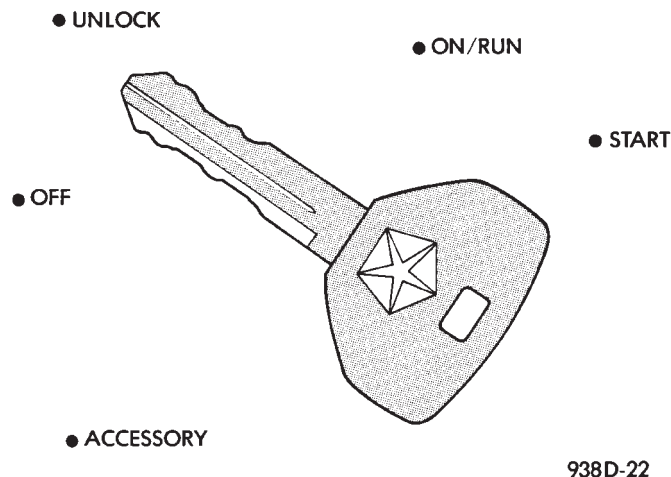
Fig. 40 Ignition Switch Alignment

LOCK KEY CYLINDER

The lock cylinder is inserted in the end of the housing opposite the ignition switch. The ignition key rotates the cylinder to 5 different detentes (Fig. 41):

- Accessory
- Off (lock)
- Unlock
- On/Run
- Start

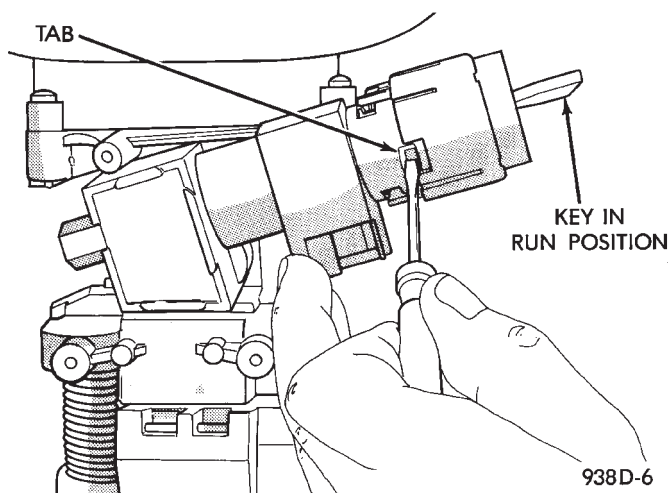
REMOVAL AND INSTALLATION (Continued)

**Fig. 41 Ignition Lock Cylinder Detentes**

When replacing the lock cylinder, if the vehicle has a column shifter, install a new interlock cassette. If the vehicle has a floor shift, adjust the interlock cable at the floor shifter when the lock cylinder is replaced. Refer to Floor Shift Interlock Adjustment in Group 21.

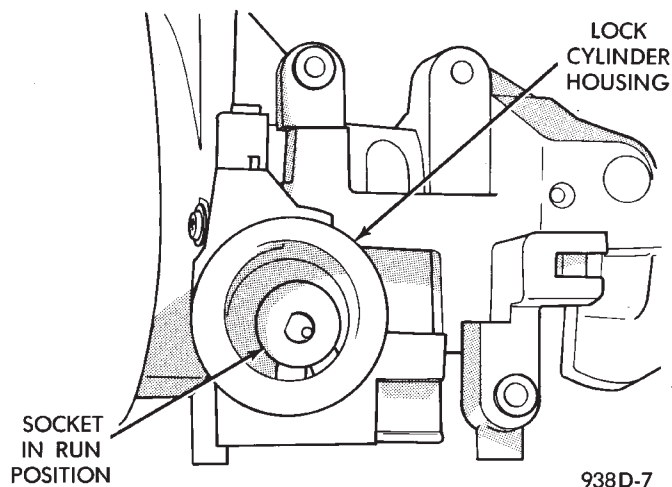
REMOVAL

- (1) Disconnect negative cable from battery.
- (2) Remove the tilt lever attaching screw. Remove lever.
- (3) Remove the upper and lower covers from the steering column.
- (4) Turn the ignition key to the run position. When ignition switch is in the run position, the lock cylinder retaining tab will depress.
- (5) Depress tab and slide lock cylinder out of housing (Fig. 42).

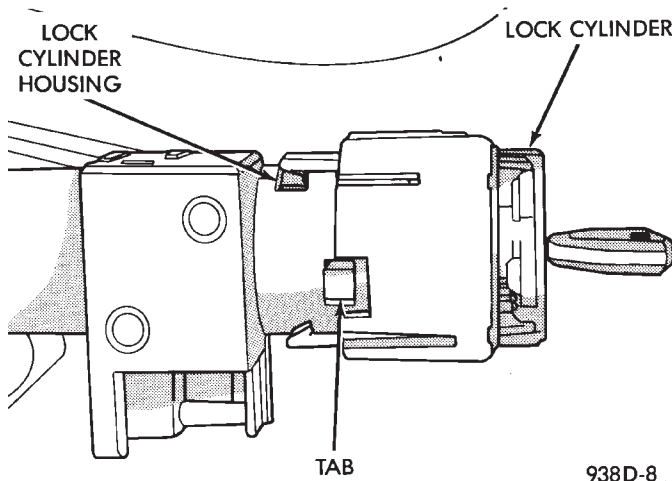
**Fig. 42 Lock Cylinder Removal****INSTALLATION**

(1) Install key in lock cylinder. Turn key to run position (retaining tab on lock cylinder can be depressed).

(2) The shaft at the end of the lock cylinder aligns with the socket in the end of the housing. To align the socket with the lock cylinder, ensure the socket is in the Run position (Fig. 43).

**Fig. 43 Socket in Lock Cylinder Housing**

(3) Align the lock cylinder with the grooves in the housing. Slide the lock cylinder into the housing until the tab sticks through the opening in the housing (Fig. 44).

**Fig. 44 Lock Cylinder Installation**

- (4) Turn key to Off position. Remove key.
- (5) If the vehicle has column shift and a new lock cylinder was used, install and adjust a new interlock cassette. Refer to Ignition Interlock in this section. If the vehicle has a floor shift, adjust the interlock cable when the lock cylinder is replaced. Refer to the Floor Shift Interlock Adjustment procedure in this section.

REMOVAL AND INSTALLATION (Continued)

- (6) Install upper and lower cover on steering column.
- (7) Install tilt lever.
- (8) Connect negative cable to battery.

IGNITION INTERLOCK

Refer to Group 21, Transaxle for Shifter/Ignition Interlock Service.

LOCK CYLINDER HOUSING

The lock cylinder housing attaches to the steering column with tamper-proof screws and hardened washers (Fig. 45) (Fig. 10).

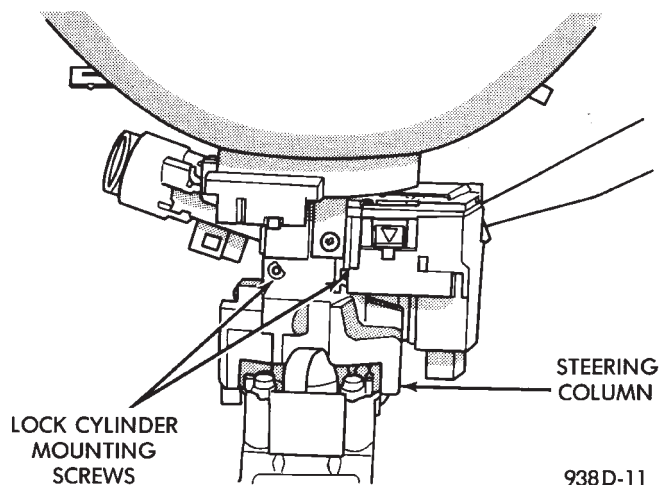


Fig. 45 Lock Cylinder Housing Mounting Screws

REMOVAL

- (1) Remove the tilt lever attaching screw. Remove lever.
- (2) Remove the upper and lower covers from the steering column.
- (3) If the vehicle has floor shift, remove the interlock cable. If the vehicle has column shift, remove and discard the column shift interlock cassette.
- (4) Remove the multi-function switch and ignition switch. Refer to Ignition Switch in this section.
- (5) Center punch the tamper-proof screws.
- (6) Using a 6 mm (1/4 inch) drill bit, drill out the screw heads. Drill until the bit contacts the hardened washer under the screw head.
- (7) Remove the lock cylinder housing from the steering column.
- (8) Use a pair of pliers to remove the bolts from the steering column lock.

INSTALLATION

The heads of the tamper-proof mounting screws shear off when tightened.

- (1) Position lock cylinder housing on steering column.
- (2) Tighten new mounting screws until the heads of the tamper-proof screws shear off.
- (3) Install ignition switch and multi-function switch.
- (4) If the vehicle has column shift, install a new column shift interlock cassette. If the vehicle has a floor shift, reconnect and adjust the shift cable.
- (5) Install upper and lower covers on steering column.
- (6) Install tilt lever

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.

TORQUE

Description	Torque
2.7L Camshaft Position Sensor Screw	12 N·m (105 in. lbs.)
3.2/3.5L Camshaft Position Sensor Screw	12 N·m (105 in. lbs.)
Engine Coolant Sensor	28 N·m (20 ft. lbs.)
2.7L Crankshaft Position Sensor Screw	12 N·m (105 in. lbs.)
3.2/3.5L Crankshaft Position Sensor Screw	12 N·m (105 in. lbs.)
2.7L Ignition Coil	6.2 N·m (55 in. lbs.)
3.2/3.5L Ignition Coil	6.7 N·m (60 in. lbs.)
Knock Sensor	10 N·m (7 ft. lbs.)
2.7L Map Sensor	2 N·m (20 in. lbs.)
3.2/3.5L Map Sensor	2 N·m (20 in. lbs.)
2.7L Spark Plugs	17.6 N·m (13 ft. lbs.)
3.2/3.5L Spark Plugs	28 N·m (20 ft. lbs.)

SPECIFICATIONS (Continued)

SPARK PLUGS

Engine	Spark Plug	Gap	Thread Size
2.7L	RE10PMC5	0,048 TO 0,058 in.	14mm (1 in.) reach
3.2L	RC12PEC5	0.048 TO 0.053 in.	14 mm (3/4 in.) reach
3.5L	RC12PEC5	0.048 TO 0.053 in.	14 mm (3/4 in.) reach