IGNITION SYSTEM

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GENERAL INFORMATION

INTRODUCTION

This group describes the ignition systems for the 2.4, 3.0, and 3.3/3.8L 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.

POWERTRAIN CONTROL MODULE

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

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

- available manifold vacuum

GENERAL INFORMATION (Continued)

- barometric pressure
- engine coolant temperature
- engine RPM
- intake air temperature (2.4L only)
- throttle position

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

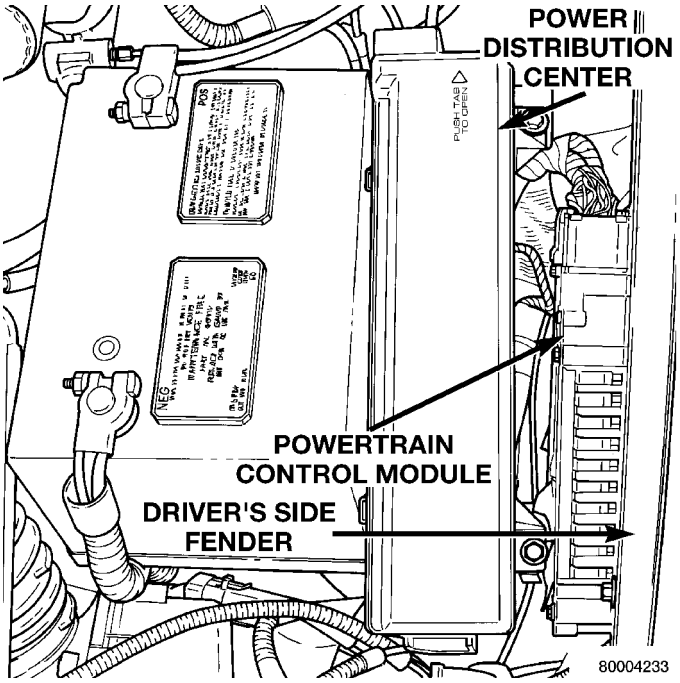


Fig. 1 PowertrainControl Module

IGNITION SYSTEM

NOTE: The 2.4, 3.0 and 3.3/3.8L engines use a fixed ignition timing system. Basic ignition timing is not adjustable. All spark advance is determined by the Powertrain Control Module (PCM).

The distributorless ignition system used on 2.4 and 3.3/3.8L engines is refered to as the Direct Ignition System (DIS). The system's three main components are the coil pack, crankshaft position sensor, and camshaft position sensor. The crankshaft position sensor and camshaft position sensor are hall effect devices.

The 3.0L engine uses a distributor, crankshaft sensor and ignition coil. The system's main components are the distributor, distributor pickup, camshaft signal, crankshaft signal and ignition coil.

SPARK PLUGS—2.4/3.0L

All engines use resistor spark plugs. They have resistance values ranging from 6,000 to 20,000 ohms when checked with at least a 1000 volt spark plug tester.

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 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. After cleaning, file the center electrode flat with a small flat point file or jewelers file. Adjust the gap between the electrodes (Fig. 2) to the dimensions specified in the chart at the end of this section.

Special care should be used when installing spark plugs in the 2.4L cylinder head spark plug wells. Be sure the plugs do not drop into the wells, damage to the electrodes can occur.

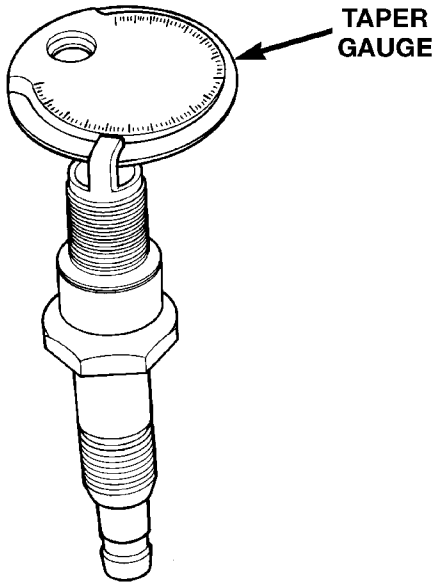


Fig. 2 Setting Spark Plug Electrode Gap

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

SPARK PLUGS—3.3/3.8L

The 3.3/3.8L engines utilize platinum spark plugs. Refer to the maintenance schedule in Group 0 of this service manual.

GENERAL INFORMATION (Continued)

All engines use resistor spark plugs. They have resistance values ranging from 6,000 to 20,000 ohms when checked with at least a 1000 volt spark plug tester.

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 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.

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 serve driving conditions per schedule B in this manual. A thin platinum pad is welded to both electrode ends as show in (Fig. 3). Extreme care must be used to prevent spark plug cross threading, mis-gaping 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.

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 3.3/3.8L 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. Tighten spark plugs to 28 N·m (20 ft. lbs.) torque.

Due to the engine packaging environment for the 3.3/3.8L engines, extreme care should be used when installing the spark plugs to avoid cross threading problems.

3.3/3.8L 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.

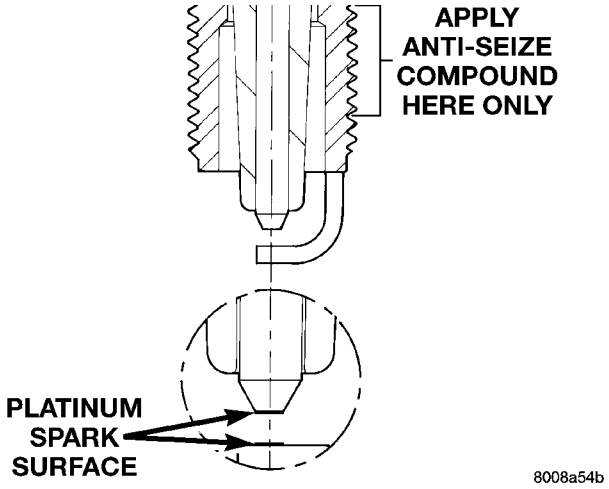


Fig. 3 Platinum Pads

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

SPARK PLUG CABLE

Spark Plug cables are sometimes referred to as secondary ignition wires. The wires transfer electrical current from the ignition coil pack, distributor (3.0L), 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.

Check the spark plug cable connections for good contact at the coil, distributor cap towers (3.0L), and spark plugs. Terminals should be fully seated. The insulators should be in good condition and should fit tightly on the coil, distributor (3.0L) and spark plugs. Spark plug cables with insulators that are cracked or torn must be replaced.

GENERAL INFORMATION (Continued)

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

SPARK PLUG CABLES—3.3/3.8L

The spark plug cables and spark plug boots are made from high temperature silicone materials. The spark plug boots utilize metal heat shields for thermal protection from the exhaust manifold. The heat shields slide over the spark plug boots. The notches on the heat shields ensure the spark plug boot and shield twist together during spark plug boot removal. They also identify proper heat shield installation on the boot for service. **Refer to 3.3/3.8L Spark Plug Cable removal and installation.** All spark plug cable leads are properly identified with cylinder numbers. The inside of the spark plug boot is coated with a special high temperature silicone grease for greater sealing and to minimize boot bonding to the spark plug insulator. The convoluted tubing on the rear plug cables are made of a high temperature plastic material. Under normal driving conditions, the spark plug cables have a recommended service life of a 100,000 miles. The spark plugs have a recommended service life of 75,000 miles for severe driving conditions per schedule B in this manual.

The spark plug heat shield can be reused if an ignition cable is replaced due to failure. Never reuse heat shield's that have heat shield anti-twist, side or spark plug attachment tabs bent or missing. Ensure that the heat shield is properly attached to the spark plug to avoid RFI problems. The bottom of the spark plug heat shield must make contact with the spark plug hex.

The front ignition cables must not make contact with the oil dip stick tube and #5 cable must not touch the coil mounting bolt to avoid abrasion/dielectric failures.

IGNITION COIL

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

The ignition coil assembly consists of 3 independent coils molded together (Fig. 4). The coil assembly is mounted on the intake manifold. Spark plug cables route to each cylinder from the coil. The coil fires two spark plugs every power stroke. One plug is the cylinder under compression, the other cylinder fires on the exhaust stroke. The Powertrain Control Module (PCM) determines which of the coils to charge and fire at the correct time.

Coil 1 fires cylinders 1 and 4, coil 2 fires cylinders 2 and 5, coil 3 fires cylinders 3 and 6.

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 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.

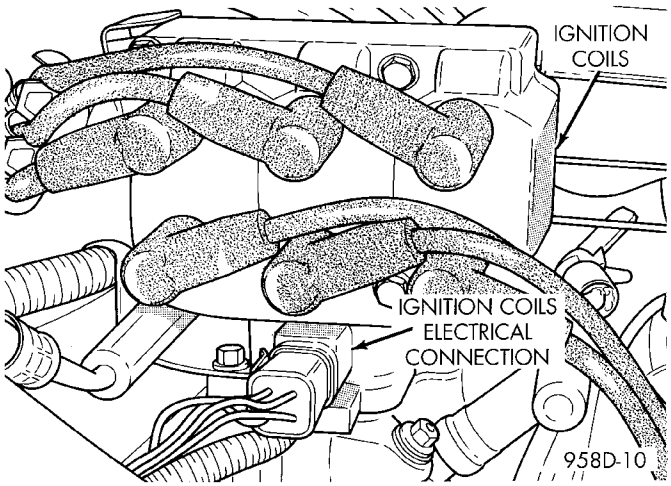


Fig. 4 IgnitionCoil Pack

AUTOMATIC SHUTDOWN (ASD) RELAY

The Powertrain Control Module (PCM) operates the Auto Shutdown (ASD) relay by switching the ground path on and off.

The ASD relay supplies battery voltage to the fuel injectors, electronic ignition coil and the heating elements in the oxygen sensors.

The PCM controls the relay by switching the ground path for the solenoid side of the relay on and off. The PCM turns the ground path off when the ignition switch is in the Off position unless the 02 Heater Monitor test is being run. Refer to Group 25, On-Board Diagnostics. 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 (coil dwell). If the PCM does not receive the crankshaft position sensor and camshaft position sensor signals when the ignition switch is in the Run position, it will de-energize the ASD relay.

The ASD relay is located in the Power Distribution Center (PDC). The PDC is located on the driver's side inner fender well (Fig. 5). A label on the underside of the PDC cover identifies the relays and fuses in the PDC.

GENERAL INFORMATION (Continued)

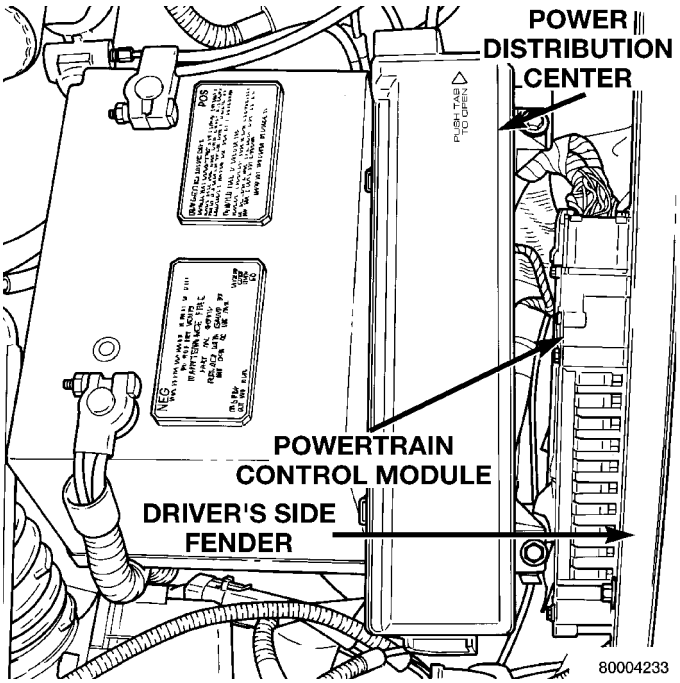


Fig. 5 Power DistributionCenter

CRANKSHAFT POSITION SENSOR

The crankshaft position sensor detects slots cut into the transmission driveplate extension (Fig. 6). There are 3 sets of slots. Each set contains 4 slots, for a total of 12 slots (Fig. 7). Basic timing is set by the position of the last slot in each group. Once the Powertrain Control Module (PCM) senses the last slot, it determines crankshaft position (which piston will next be at TDC) from the camshaft position sensor input. The 4 pulses generated by the crankshaft position sensor represent the 69°, 49°, 29°, and 9° BTDC marks. It may take the PCM one engine revolution to determine crankshaft position.

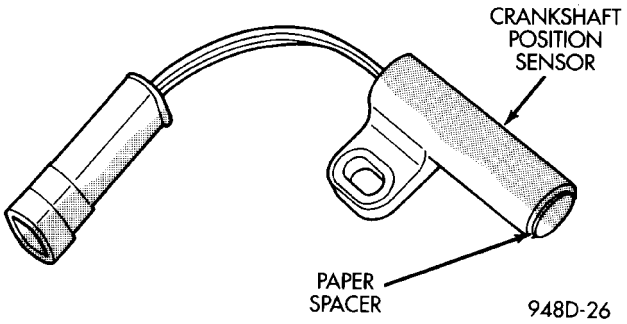


Fig. 6 CrankshaftPosition Sensor

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

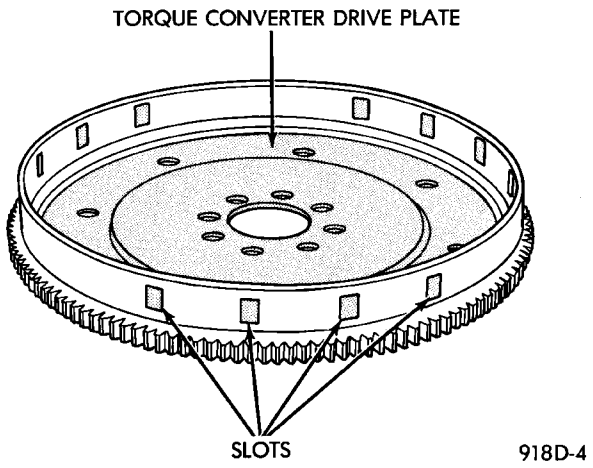


Fig. 7 Timing Slots

The crankshaft sensor is located on the passengers side of the transmission housing, above the differential housing (Fig. 8). The bottom of the sensor is positioned next to the drive plate.

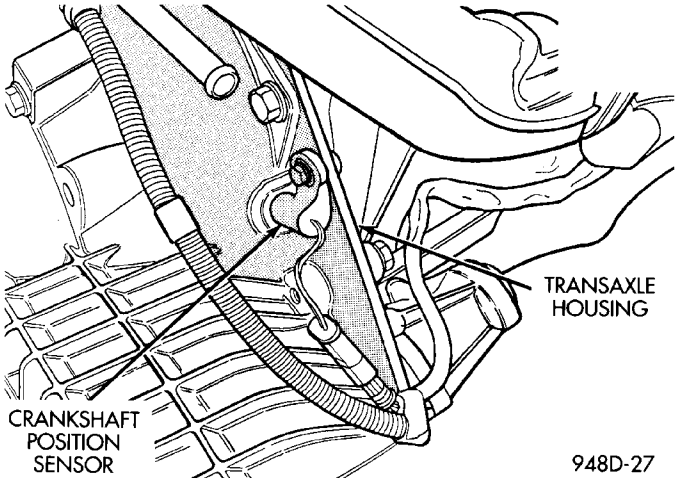


Fig. 8 CrankshaftPosition Sensor Location

CAMSHAFT POSITION SENSOR

The camshaft position sensor provides cylinder identification to the Powertrain Control Module (PCM) (Fig. 9). The sensor generates pulses as groups of notches on the camshaft sprocket pass underneath it (Fig. 10). The PCM keeps track of crankshaft rotation and identifies each cylinder by the pulses generated by the notches on the camshaft sprocket. Four crankshaft pulses follow each group of camshaft pulses.

When the PCM receives 2 cam pulses followed by the long flat spot on the camshaft sprocket, it knows that the crankshaft timing marks for cylinder 1 are next (on driveplate). When the PCM receives one camshaft pulse after the long flat spot on the sprocket, cylinder number 2 crankshaft timing marks are next. After 3 camshaft pulses, the PCM knows

GENERAL INFORMATION (Continued)

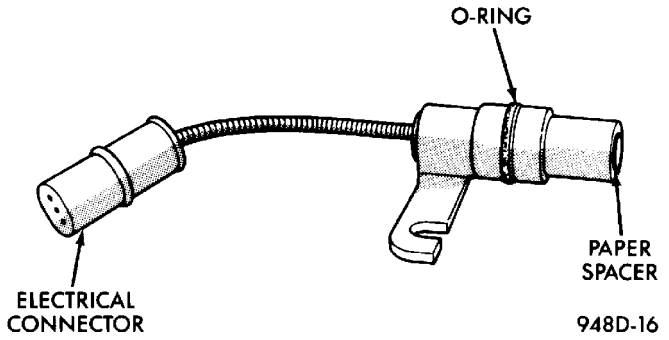


Fig. 9 CamshaftPosition Sensor

cylinder 4 crankshaft timing marks follow. One camshaft pulse after the 3 pulses indicates cylinder 5. The 2 camshaft pulses after cylinder 5 signals cylinder 6 (Fig. 10). 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 switches high (5.0 volts). As a group of notches pass under the sensor, the voltage switches from low (metal) to high (notch) then back to low. The number of notches determine the amount of pulses. If available, an oscilloscope can display the square wave patterns of each timing event.

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

The camshaft position sensor is mounted in the front of the timing case cover (Fig. 11).

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

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

The input voltage level supplies the PCM with information relating to ambient barometric pressure during engine start-up (cranking) and engine load while its operating. Based on MAP sensor voltage and inputs from other sensors, the PCM adjusts spark advance and the air-fuel mixture.

ENGINE COOLANT TEMPERATURE (ECT) SENSOR

The ECT sensor is located next to the thermostat housing (Fig. 12). The sensor provides an input voltage to the Powertrain Control Module (PCM). The

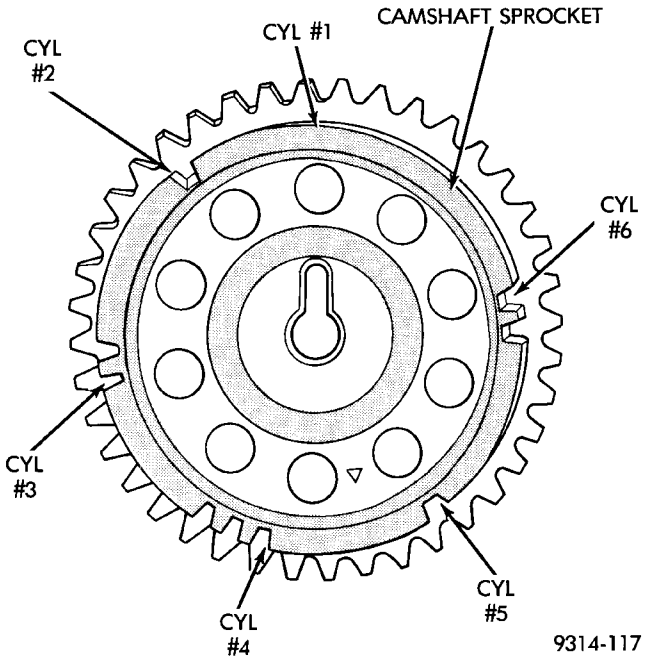


Fig. 10 CamshaftSprocket

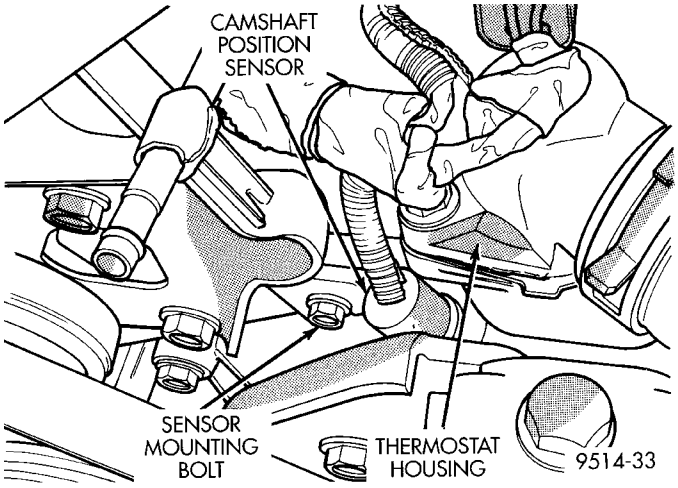


Fig. 11 CamshaftPosition Sensor Location

sensor is a variable resistance (thermistor) with a range of -40°F to 265°F. As coolant temperature varies, the sensors resistance changes, resulting in a different input voltage to the PCM.

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

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 ECT sensor input is also used for cooling fan control.

GENERAL INFORMATION (Continued)

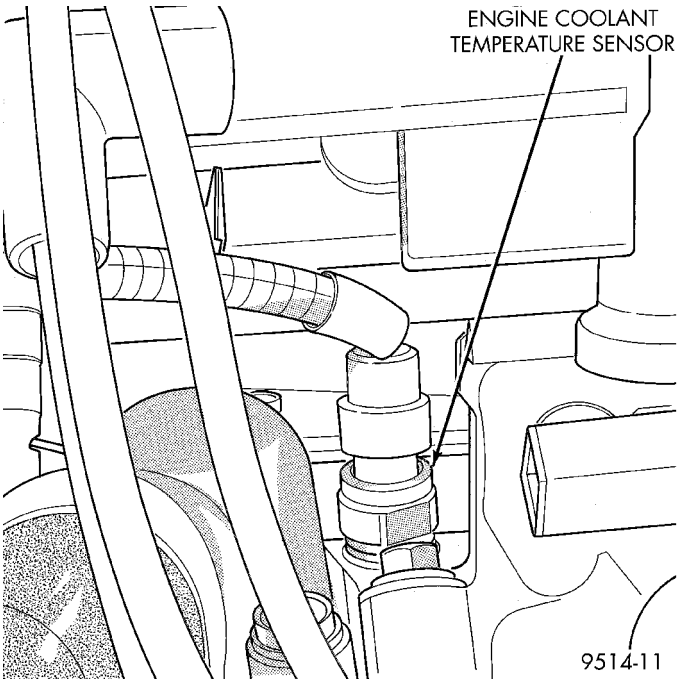


Fig. 12 Engine CoolantTemperature Sensor—3.3/ 3.8L

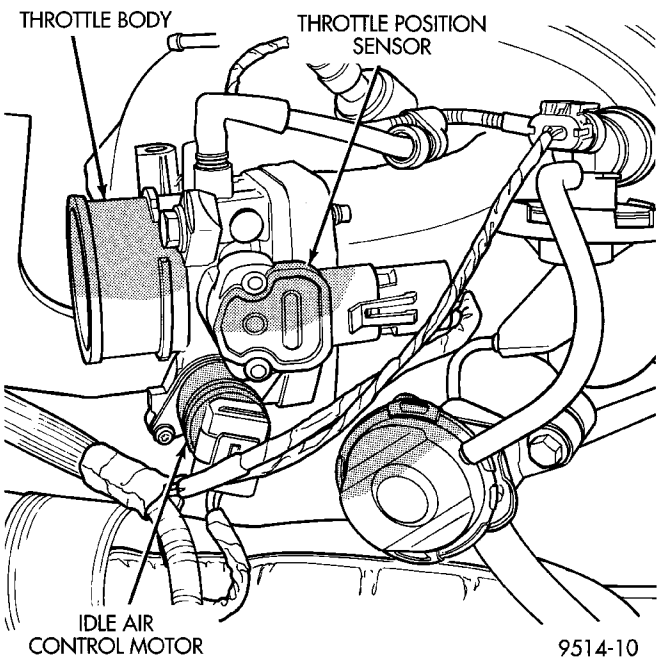


Fig. 13 Throttle Position Sensor and Idle Air Control Motor

THROTTLE POSITION SENSOR (TPS)

The TPS mounts to the side of the throttle body (Fig. 13).

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 0.40 volt at minimum throttle opening (idle) to a maximum of 3.80 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. 14):

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

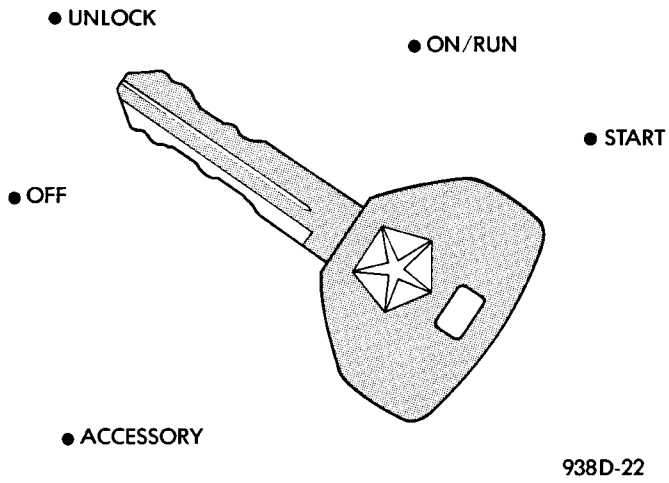


Fig. 14 IgnitionLock Cylinder Detents

KNOCK SENSOR

The knock sensor threads into the side of the cylinder block in front of the starter motor. 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 for all cylinders by a scheduled amount.

Knock sensors 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.

GENERAL INFORMATION (Continued)

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

DIAGNOSIS AND TESTING

TESTING FOR SPARK AT COIL—2.4/3.3/3.8L ENGINES

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

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

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

CAUTION: Do not leave any one spark plug cable disconnected any longer than 30 seconds or possible heat damage to catalytic converter will occur.

CAUTION: Test must be performed at idle and in park only with the parking brake on.

Use a new spark plug and spark plug cable for the following test.

(1) Insert a new spark plug into the new spark plug boot. Ground the plug to the engine (Fig. 15). Do not hold with your hand.

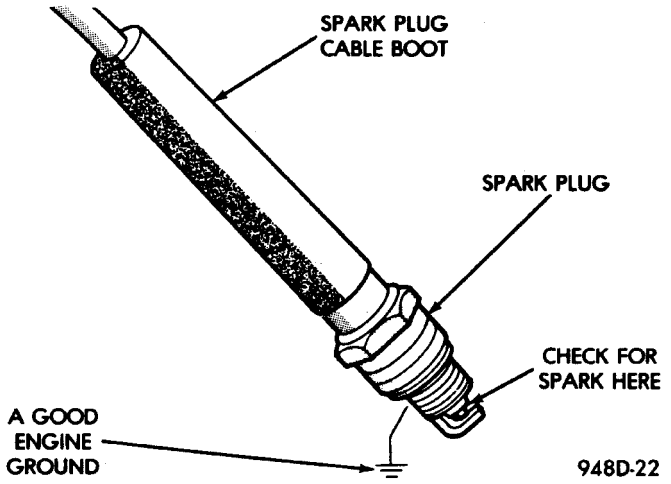


Fig. 15 TestingFor Spark

(2) Starting with coil insulator #1, remove it from the DIS coil.

(3) Plug the test spark plug cable onto #1 coil tower. Make sure a good connection is made; there should be a click sound.

(4) Crank the engine and look for spark across the electrodes of the spark plug.

CAUTION: Always install the cable back on the coil tower after testing to avoid damage to the coil and catalytic converter.

(5) Repeat the above test for the remaining coils. If there is no spark during all cylinder tests, proceed to the Failure To Start Test.

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

TESTING FOR SPARK AT COIL—3.0L

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

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

Remove the coil secondary cable from the distributor cap. Hold the end of cable about 6 mm (1/4-inch) away from a good engine ground using non-conductive ignition pliers (Fig. 16). Crank the engine and inspect for spark at the coil secondary cable.

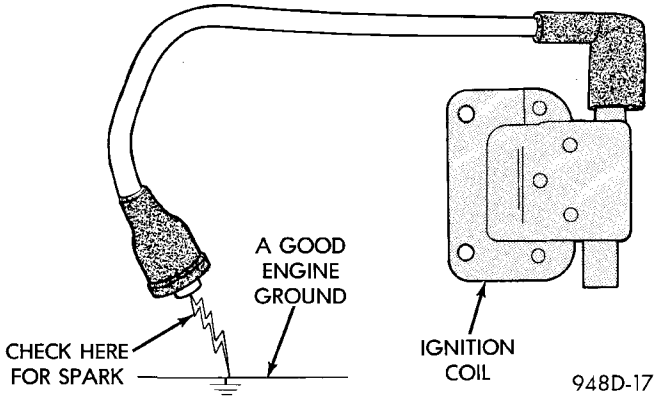


Fig. 16 Checkingfor Spark

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

If a constant spark is present and no arcing occurs at the coil tower, the ignition system is producing the necessary high secondary voltage. However, make

DIAGNOSIS AND TESTING (Continued)

sure that the spark plugs are firing. Inspect the distributor rotor, cap, spark plug cables, and spark plugs. If they are in proper working order, the ignition system is not the reason why the engine will not start. Inspect the fuel system and engine for proper operation.

CHECK COIL TEST—2.4L

Coil one fires cylinders 1 and 4, coil two fires cylinders 2 and 3. Each coil tower is labeled with the number of the corresponding cylinder.

(1) Remove ignition cables and measure the resistance of the cables. Resistance must be within the range shown in the Cable Resistance Chart in Specifications. Replace any cable not within tolerance.

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

(3) Measure the primary resistance of each coil. At the coil, connect an ohmmeter between the B+ pin and the pin corresponding to the cylinders in question (Fig. 17). Resistance on the primary side of each coil should be 0.45 - 0.65 ohm at (70° to 80° F). Replace the coil if resistance is not within tolerance.

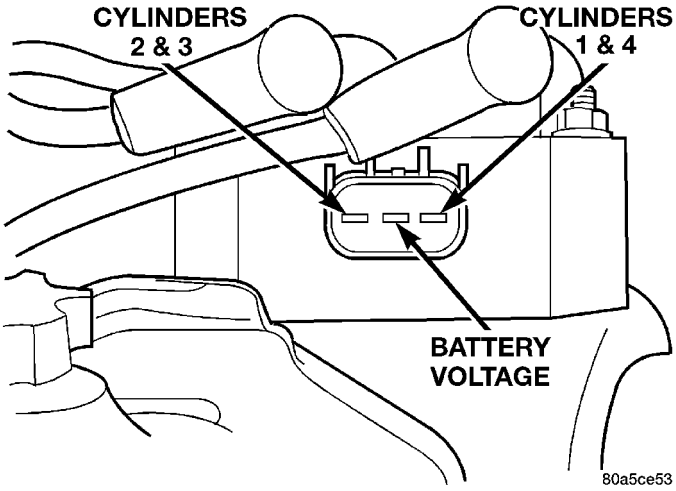


Fig. 17 Terminal Identification

(4) Remove ignition cables from the secondary towers of the coil. Measure the secondary resistance of the coil between the towers of each individual coil (Fig. 18). Secondary resistance should be 7,000 to 15,800 ohms. Replace the coil if resistance is not within tolerance.

CHECK COIL TEST—3.3/3.8L

Coil 1 fires cylinders 1 and 4, coil 2 fires cylinders 2 and 5, and coil 3 fires cylinders 3 and 6. Each coil tower is labeled with the number of the corresponding cylinder.

(1) Disconnect the electrical connector from the coil pack (Fig. 19).

(2) Measure the primary resistance of each coil. At the coil, connect an ohmmeter between the B+ pin

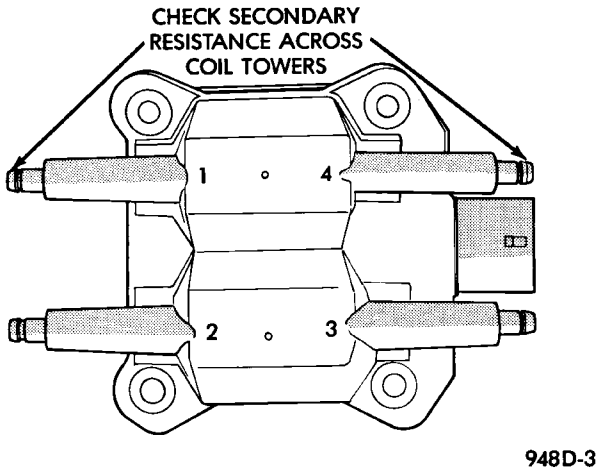


Fig. 18 Checking Ignition Coil SecondaryResistance

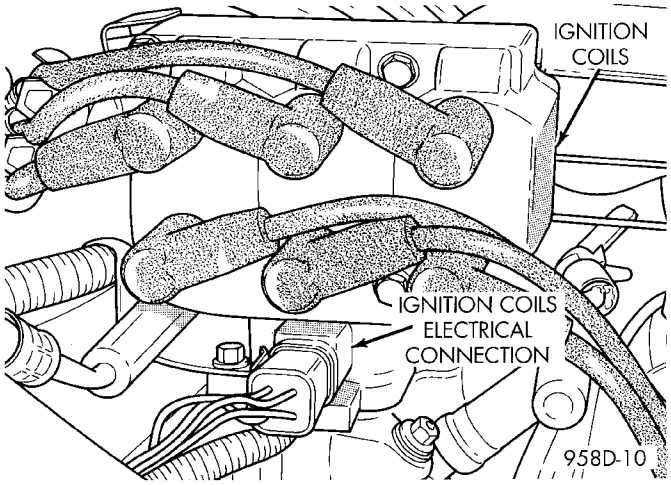


Fig. 19 IgnitionCoil Electrical Connector

and the pin corresponding to the cylinders in question (Fig. 20). Resistance on the primary side of each coil should be 0.45 - 0.65 ohm at 21° to 27°C (70° to 80°F). A coil that has not been allowed to cool off, would result in inaccurate measurement results. Replace the coil if resistance is not within tolerance.

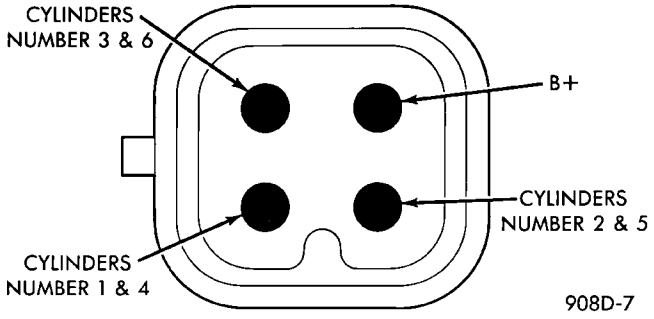


Fig. 20 IgnitionCoil Terminal Identification

DIAGNOSIS AND TESTING (Continued)

(3) Remove ignition cables from the secondary towers of the coil. Measure the secondary resistance of the coil between the towers of each individual coil (Fig. 21). Secondary resistance should be 7,000 to 15,800 ohms. Replace the coil if resistance is not within tolerance.

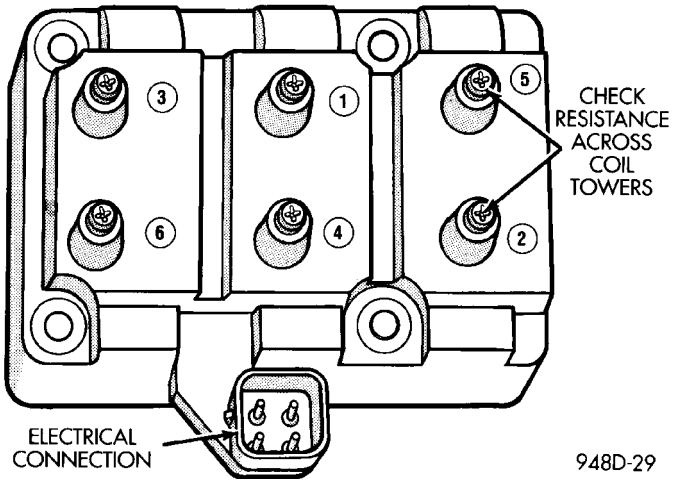


Fig. 21 CheckingIgnition Coil Secondary Resistance

FAILURE TO START TEST

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

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

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

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

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

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

(3) Connect a test light to the B+ (battery voltage) terminal of the coil electrical connector and ground as shown in (Fig. 22). The B+ wire for the DIS coil is dark green with an orange tracer. **Do not spread the terminal with the test light probe.**

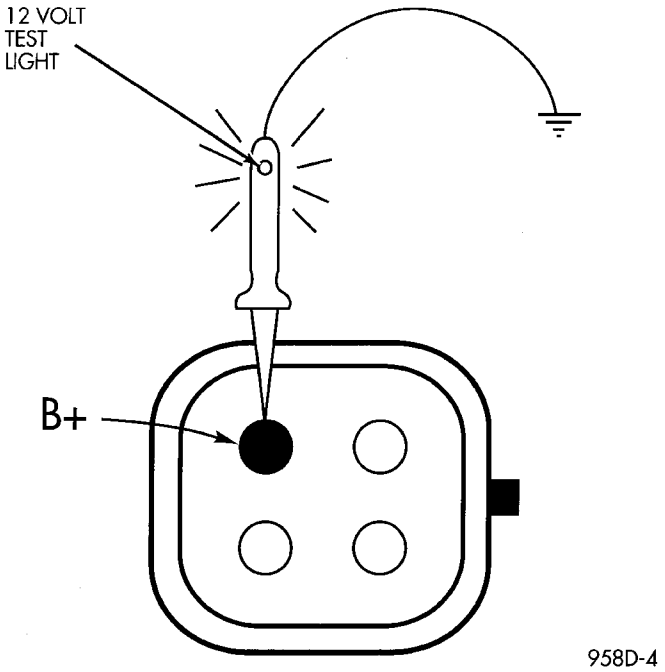


Fig. 22 Ignition Coil Engine Harness Connector

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

(a) If the test light flashes momentarily, the PCM grounded the Auto Shutdown (ASD) relay. Proceed to step 5.

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

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

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

(7) If the test light did not flash during cranking, unplug the crankshaft position sensor connector. Turn the ignition key to the off position. Turn the key to the On position, wait for the test light to momentarily flash once, then crank the engine. If the test light momentarily flashes, the crankshaft position sensor is shorted and must be replaced. If the light did not flash, the cause of the no-start is in

DIAGNOSIS AND TESTING (Continued)

either the crankshaft position sensor/camshaft position sensor 8 volt supply circuit, or the camshaft position sensor output or ground circuits. Use the DRB scan tool to test the camshaft position sensor and the sensor circuits. Refer to the appropriate Powertrain Diagnostics Procedure Manual. Refer to the wiring diagrams section for circuit information.

IGNITION TIMING PROCEDURE

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

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR TEST

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

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 Moper Diagonostic 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.

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. 23). 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-platnium 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.

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.

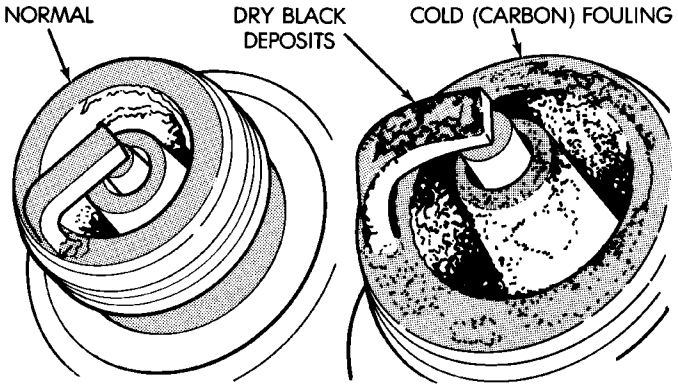


Fig. 23 Normal Operation and Cold (Carbon)Fouling

COLD FOULING (CARBON FOULING)

Cold fouling is sometimes referred to as carbon fouling because the deposits that cause cold fouling are basically carbon (Fig. 23). 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.**

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.**

DIAGNOSIS AND TESTING (Continued)

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. 24). Sometimes fuel additives can cause ash encrustation on an entire set of spark plugs. **Ash encrusted spark plugs can be cleaned and reused.**

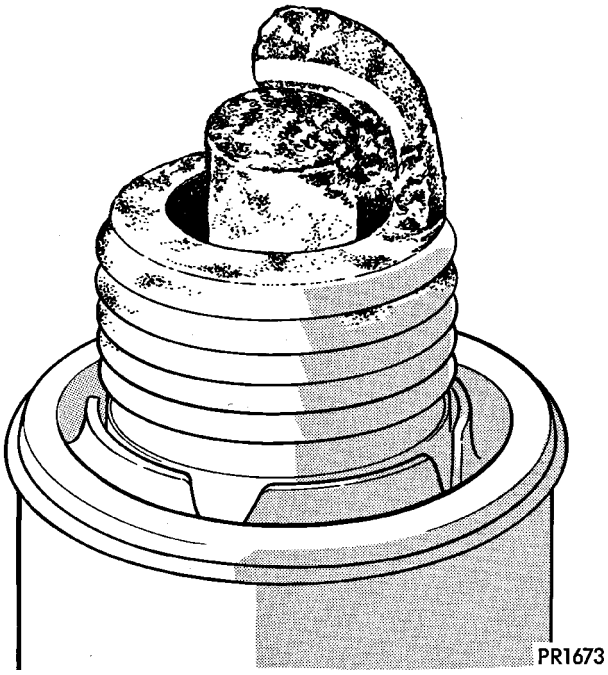


Fig. 24 Oil or Ash Encrusted

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. 25). This short circuits the electrodes. **Spark plugs with electrode gap bridging can be cleaned and reused.**

SCAVENGER DEPOSITS

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

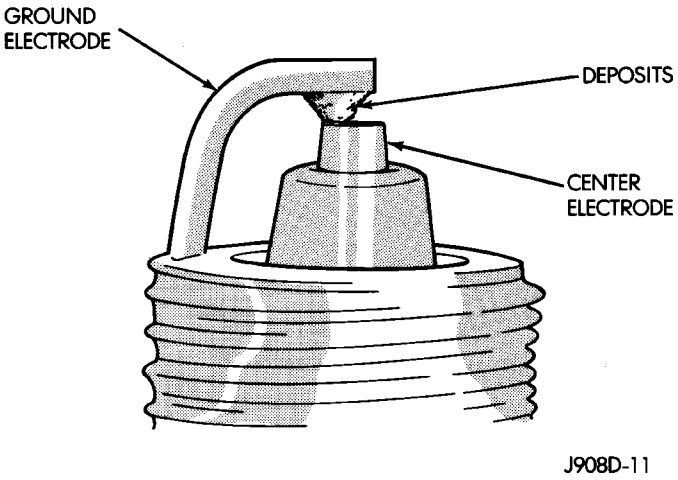
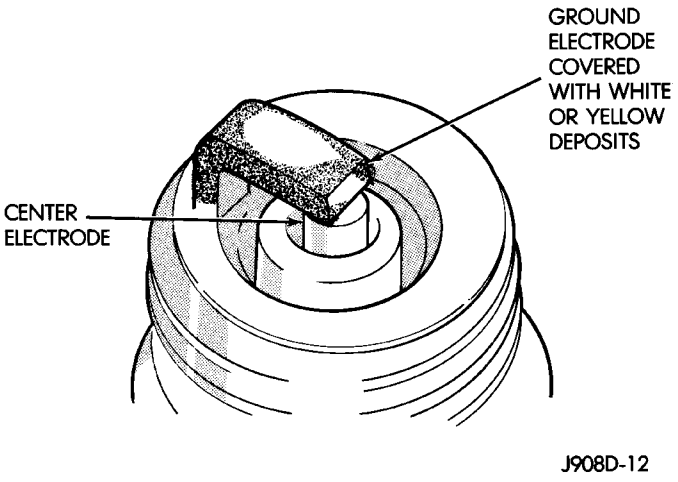


Fig. 25 Electrode Gap Bridging

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.**



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

Fig. 26 Scavenger Deposits

CHIPPED ELECTRODE INSULATOR

A chipped electrode insulator usually results from bending the center electrode while adjusting the spark plug electrode gap. Under certain conditions, severe detonation also can separate the insulator from the center electrode (Fig. 27). **Spark plugs with chipped electrode insulators must be replaced.**

DIAGNOSIS AND TESTING (Continued)

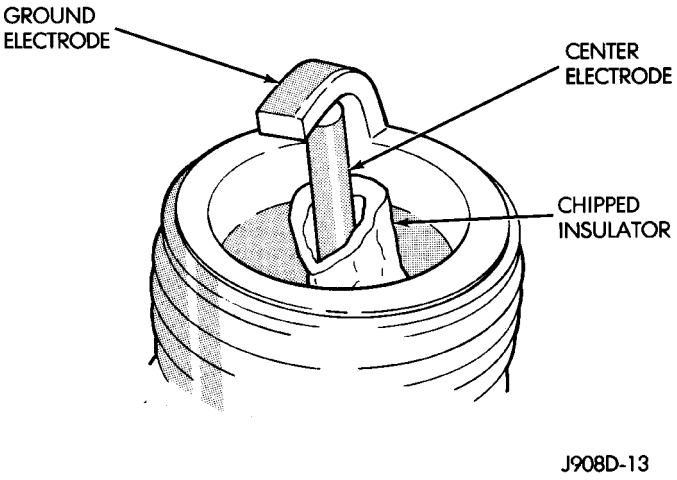


Fig. 27 Chipped Electrode Insulator

PREIGNITION DAMAGE

Excessive combustion chamber temperature can cause preignition damage. First, the center electrode dissolves and the ground electrode dissolves somewhat later (Fig. 28). 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.

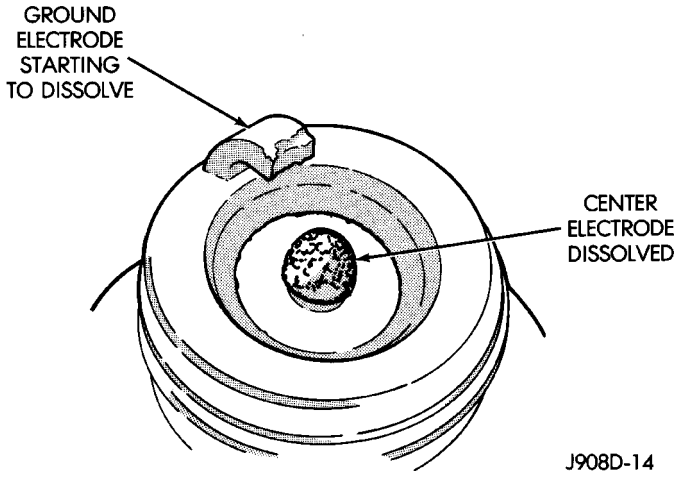


Fig. 28 Preignition Damage

SPARK PLUG OVERHEATING

Overheating is indicated by a white or gray center electrode insulator that also appears blistered (Fig. 29). The increase in electrode gap will be considerably in excess of 0.001 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.

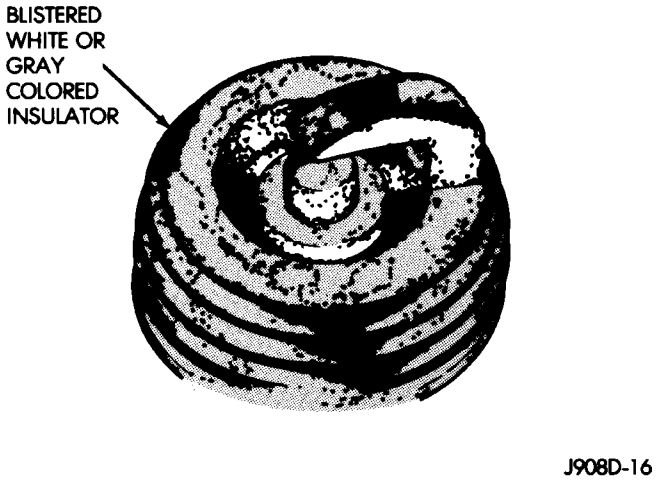


Fig. 29 Spark PlugOverheating

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.

SERVICE PROCEDURES

SPARK PLUG GAP ADJUSTMENT

Check the spark plug gap with a gap gauge. If the gap is not correct, adjust it by bending the ground electrode (Fig. 30).

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

Refer to 3.3/3.8L Spark Plug Gap Measurment in this section.

SERVICE PROCEDURES (Continued)

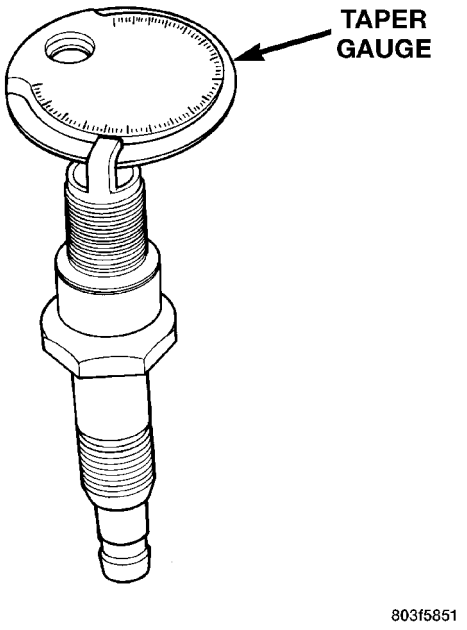


Fig. 30 Setting Spark Plug Electrode Gap—Typical

POWERTRAIN CONTROL MODULE

REMOVAL

(1) Disconnect both cables from battery, negative cable first.

(2) Remove 2 screws holding Power Distribution Center (PDC) to bracket (Fig. 31).

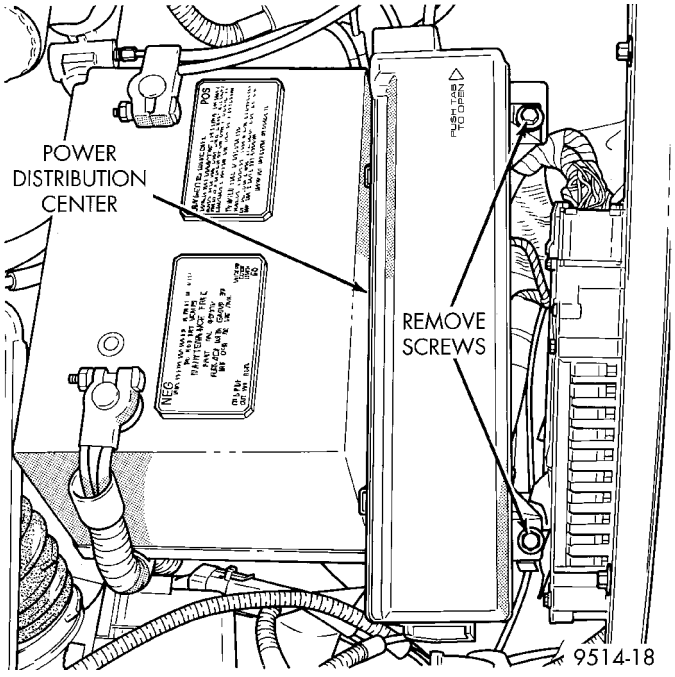


Fig. 31 Power Distribution Center RetainingScrews

(3) Remove heat shield from battery (Fig. 32).

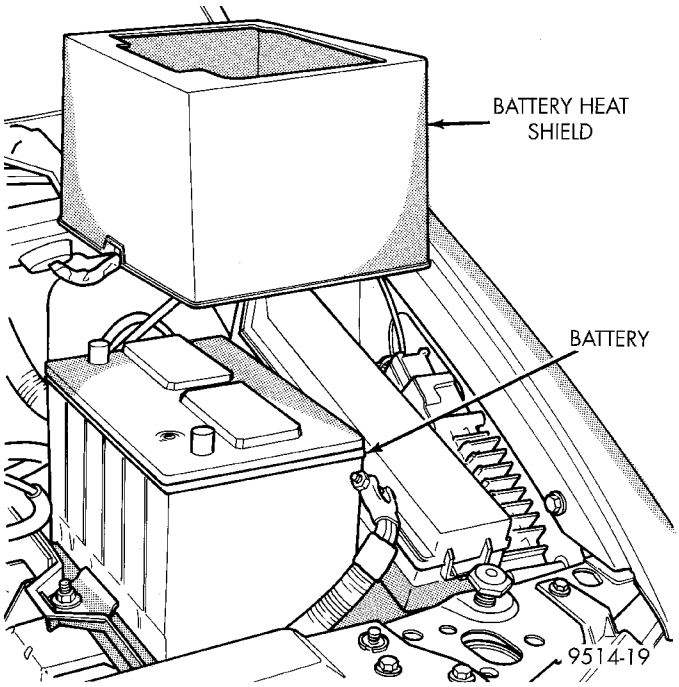


Fig. 32 Battery Heat Shield

(4) Remove nut and clamp holding battery to battery tray (Fig. 33).

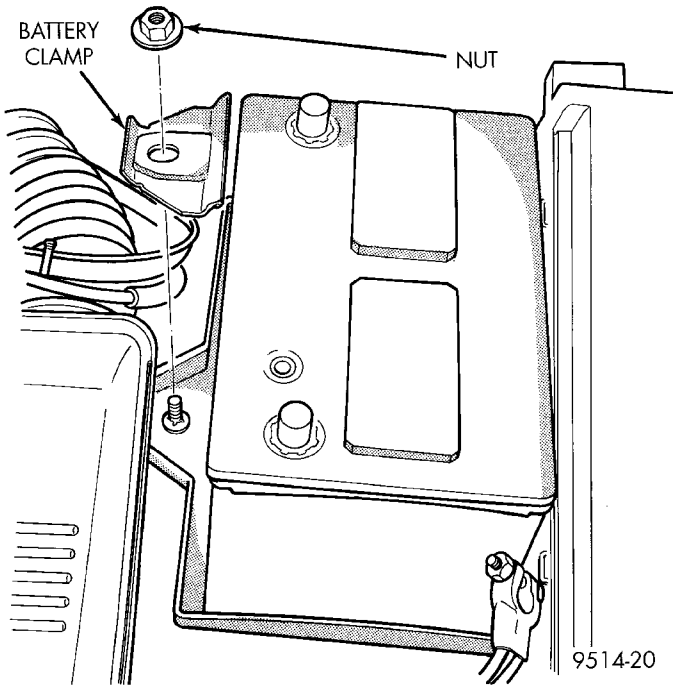


Fig. 33 Battery Clamp

(5) Remove battery from vehicle.

(6) Rotate PDC toward center of vehicle to remove from rear bracket (Fig. 34).

(7) Pull PDC rearward to remove from front bracket. Lay PDC aside to allow access to Powertrain Control Module (PCM).

SERVICE PROCEDURES (Continued)

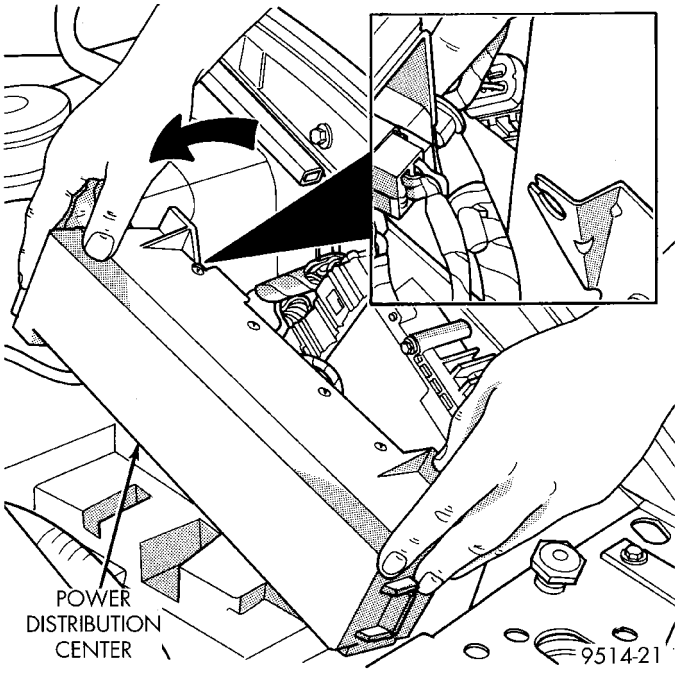


Fig. 34 PDC Rear Bracket

(8) Squeeze tabs on 40-way connector. Pull connector rearward to remove from PCM (Fig. 35). Remove both way connectors.

(9) Remove 3 screws holding PCM to fender (Fig. 36).

(10) Remove PCM from vehicle.

INSTALLATION

(1) Connect 2 40-Way electrical connectors to PCM (Fig. 35).

(2) Install PCM. Tighten mounting screws.

(3) Install PDC bracket.

(4) Install battery.

IGNITION TIMING PROCEDURE

The 2.4, 3.0, and 3.3/3.8L engines use a fixed ignition system. Basic ignition timing is not adjustable.

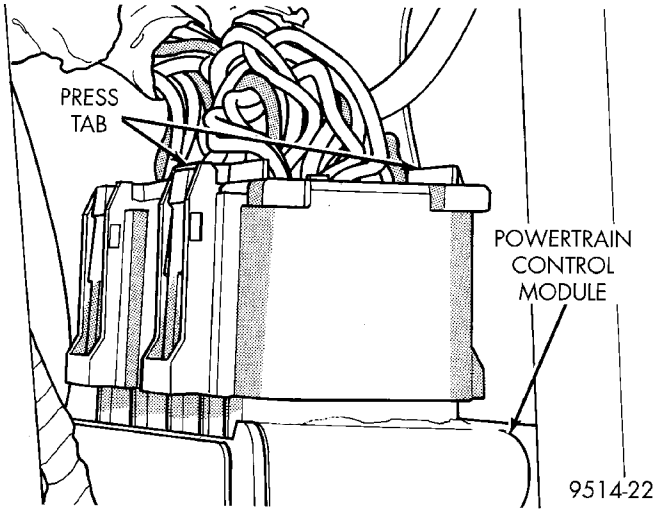


Fig. 35 PCM 40-Way Connectors

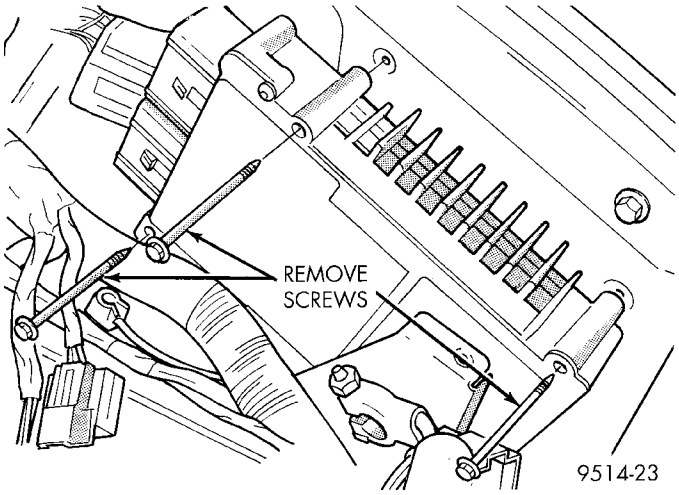


Fig. 36 PCM Removal/Installation

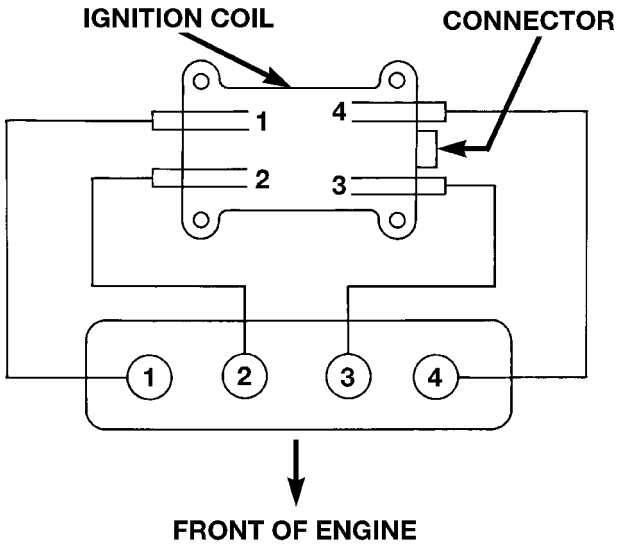
The Powertrain Control Module (PCM) regulates ignition timing.

2.4L ENGINE

INDEX

DESCRIPTION AND OPERATION

FIRING ORDER—2.4L



FIRING ORDER 1-3-4-2 8008a549

FIRING ORDER—2.4L

CRANKSHAFT POSITION SENSOR

The PCM determines what cylinder to fire from the crankshaft position sensor input and the camshaft position sensor input. The second crankshaft counterweight has machined into it two sets of four timing reference notches and a 60 degree signature notch (Fig. 1). From the crankshaft position sensor input the PCM determines engine speed and crankshaft angle (position).

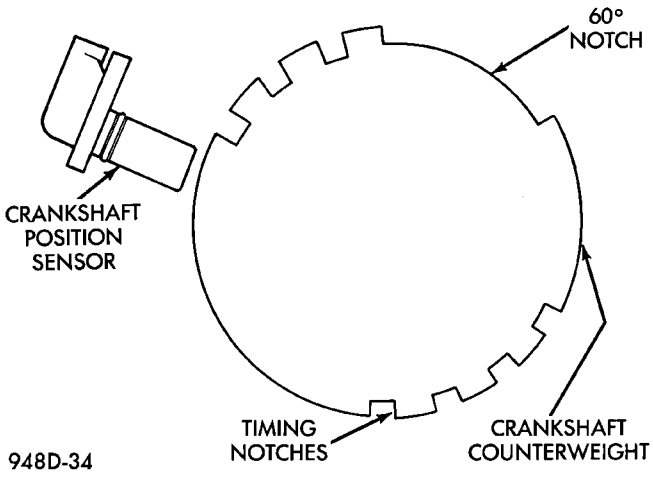


Fig. 1 Timing Reference Notches

The notches generate pulses from high to low in the crankshaft position sensor output voltage. When a metal portion of the counterweight aligns with the crankshaft position sensor, the sensor output voltage goes low (less than 0.3 volts). When a notch aligns with the sensor, voltage switches high (5.0 volts). As a group of notches pass under the sensor, the output voltage switches from low (metal) to high (notch) then back to low.

If available, an oscilloscope can display the square wave patterns of each voltage pulse. From the width of the output voltage pulses, the PCM calculates engine speed. The width of the pulses represent the amount of time the output voltage stays high before switching back to low. The period of time the sensor output voltage stays high before switching back to low is referred to as pulse width. The faster the

DESCRIPTION AND OPERATION (Continued)

engine is operating, the smaller the pulse width on the oscilloscope.

By counting the pulses and referencing the pulse from the 60 degree signature notch, the PCM calculates crankshaft angle (position). In each group of timing reference notches, the first notch represents 69 degrees before top dead center (BTDC). The second notch represents 49 degrees BTDC. The third notch represents 29 degrees. The last notch in each set represents 9 degrees before top dead center (TDC).

The timing reference notches are machined to a uniform width representing 13.6 degrees of crankshaft rotation. From the voltage pulse width the PCM tells the difference between the timing reference notches and the 60 degree signature notch. The 60 degree signature notch produces a longer pulse width than the smaller timing reference notches. If the camshaft position sensor input switches from high to low when the 60 degree signature notch passes under the crankshaft position sensor, the PCM knows cylinder number one is the next cylinder at TDC.

The crankshaft position sensor mounts to the engine block behind the generator, near the oil filter (Fig. 8).

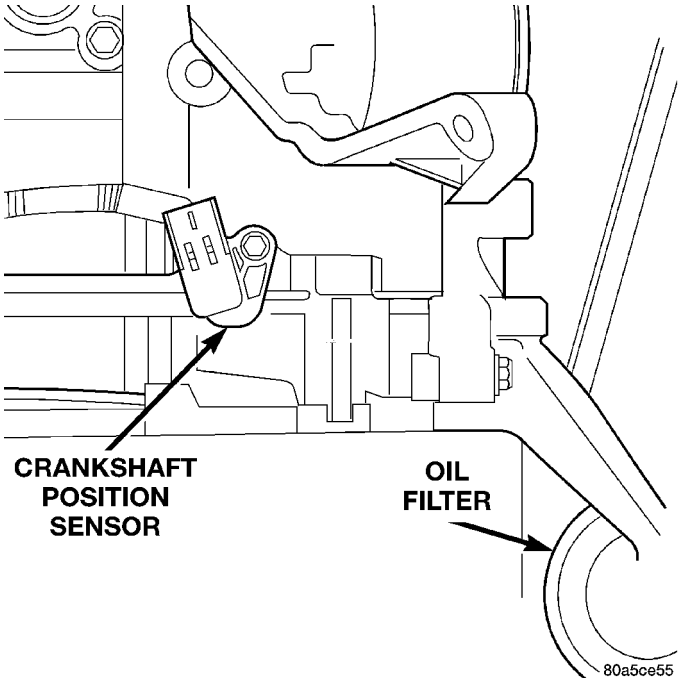


Fig. 2 Crankshaft Position Sensor

CAMSHAFT POSITION SENSOR

The PCM determines fuel injection synchronization and cylinder identification from inputs provided by the camshaft position sensor and crankshaft position sensor. From the two inputs, the PCM determines crankshaft position.

The camshaft position sensor attaches to the rear of the cylinder head (Fig. 2). A target magnet attaches to the rear of the camshaft and indexes to the correct position (Fig. 3). The target magnet has four different poles arranged in an asymmetrical pattern. As the target magnet rotates, the camshaft position sensor senses the change in polarity (Fig. 4). The sensor output switch switches from high (5.0 volts) to low (0.30 volts) as the target magnet rotates. When the north pole of the target magnet passes under the sensor, the output switches high. The sensor output switches low when the south pole of the target magnet passes underneath.

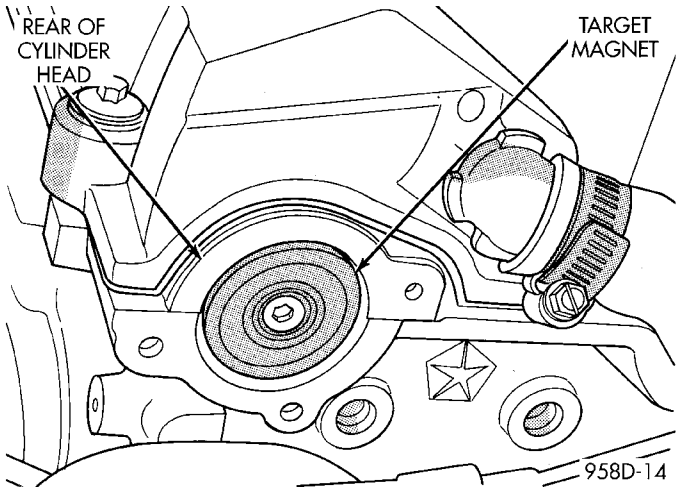


Fig. 3 Target Magnet

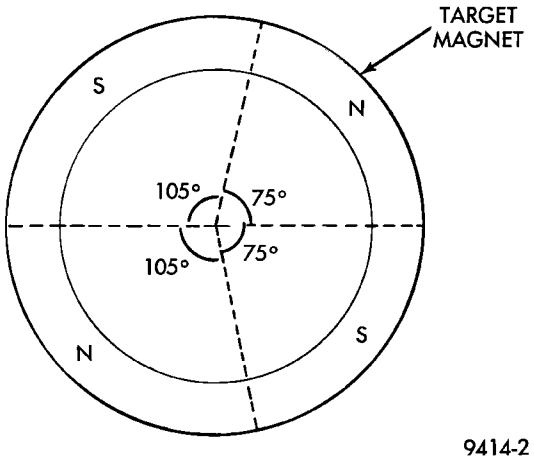


Fig. 4 Target MagnetPolarity

INTAKE AIR TEMPERATURE SENSOR—2.4L

The intake air temperature 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 and spark advance.

The intake air temperature sensor threads into the intake manifold (Fig. 5).

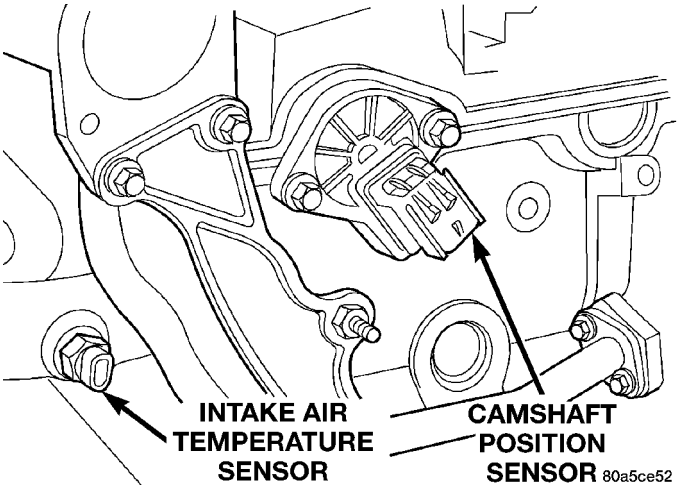


Fig. 5 Intake Air Temperature Sensor

REMOVAL AND INSTALLATION

SPARK PLUG CABLE SERVICE—2.4L

The cables insulate the spark plugs and covers the top of the spark plug tube (Fig. 6). To remove the cables, lightly grasp the top of the cable. Rotate the insulator 90° and pull straight up. To replace the cables, disconnect the cable from the ignition coil. **Ensure the #1 and #4 cables run under the #2 and #3 ignition coil towers. Keep #4 cable away from the oil fill cap.**

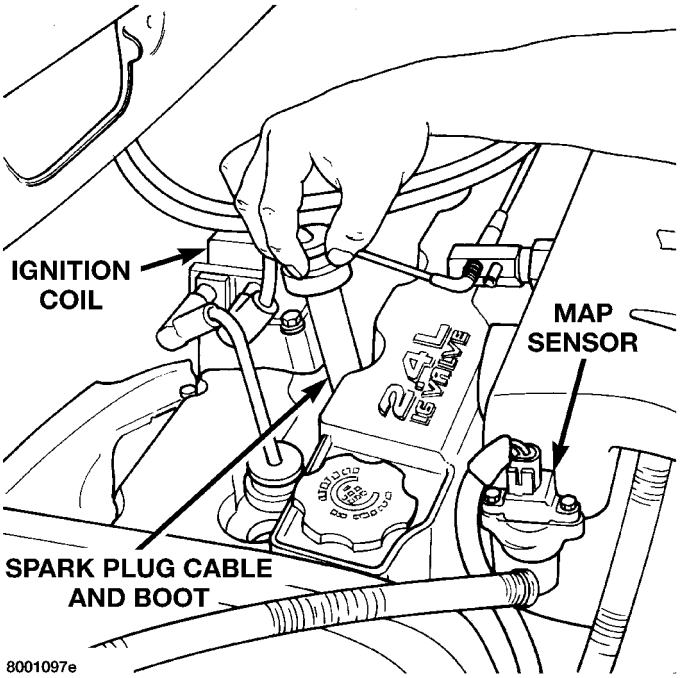


Fig. 6 Spark Plug Cables

SPARK PLUG SERVICE

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

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

REMOVAL

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

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

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

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

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

IGNITION COIL—2.4L

REMOVAL

REMOVAL

(1) Remove spark plug cables from coil (Fig. 7). Always twist the coil boots to break the seal with the coil and pull straight back on the boot.

(2) Remove ignition coil electrical connector.

(3) Remove ignition coil mounting bolts, throttle cable bracket or clip.

(4) Remove ignition coil.

INSTALLATION

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

(2) Transfer ignition cables to new coil pack. The coil pack towers and cables are numbered with cylinder identification.

REMOVAL AND INSTALLATION (Continued)

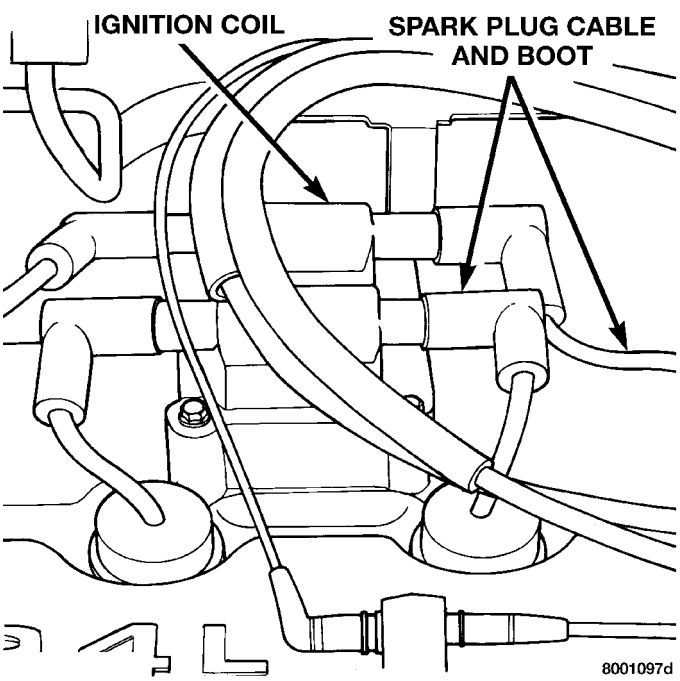


Fig. 7 IgnitionCoil Removal

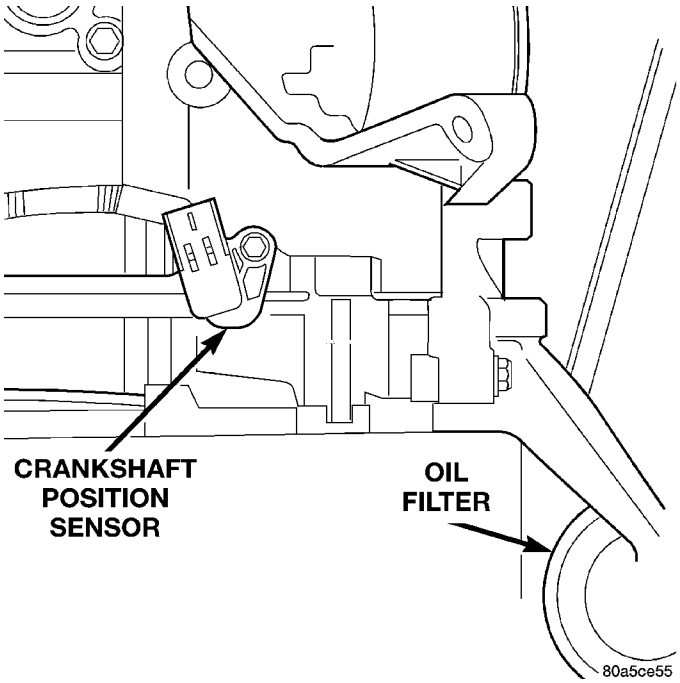


Fig. 8 Crankshaft Position Sensor

CRANKSHAFT POSITION SENSOR

The crankshaft position sensor mounts to the engine block behind the generator, just behind the oil filter (Fig. 8).

REMOVAL

(1) Raise and support vehicle.
(2) Disconnect electrical connector from crankshaft position sensor.
(3) Remove sensor mounting screw.
(4) Pull crankshaft position sensor straight out.

INSTALLATION

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

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

CAMSHAFT POSITION SENSOR

The camshaft position sensor is mounted to the rear of the cylinder head (Fig. 9).

REMOVAL

(1) Disconnect the filtered air tube from the throttle body and air cleaner housing. Disconnect the air tube from the oil separator hose. Remove filtered air tube.
(2) Remove the air cleaner inlet tube.
(3) Disconnect engine harness connector from camshaft position sensor.
(4) Remove camshaft position sensor mounting screws. Remove sensor.
(5) Loosen screw attaching target magnet to rear of camshaft (Fig. 10).

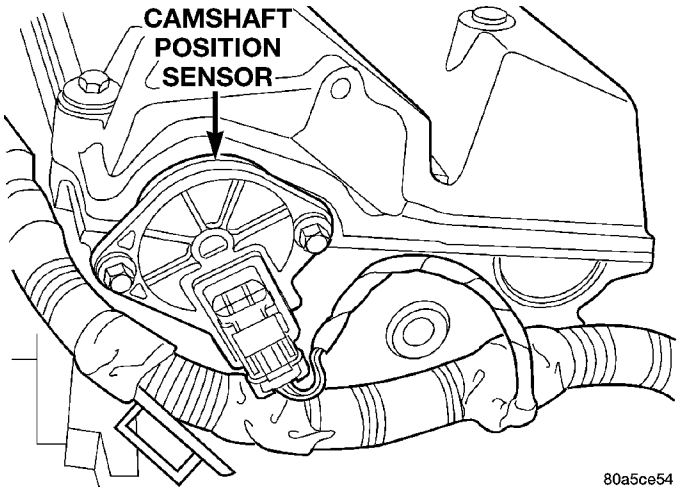


Fig. 9 Camshaft Position Sensor Location

INSTALLATION

The target magnet has locating dowels that fit into off-set machined locating holes in end of the camshaft (Fig. 11).

REMOVAL AND INSTALLATION (Continued)

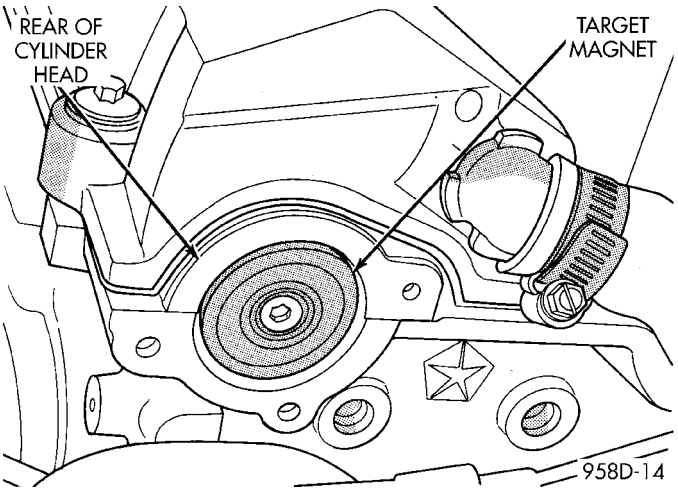


Fig. 10 Target Magnet

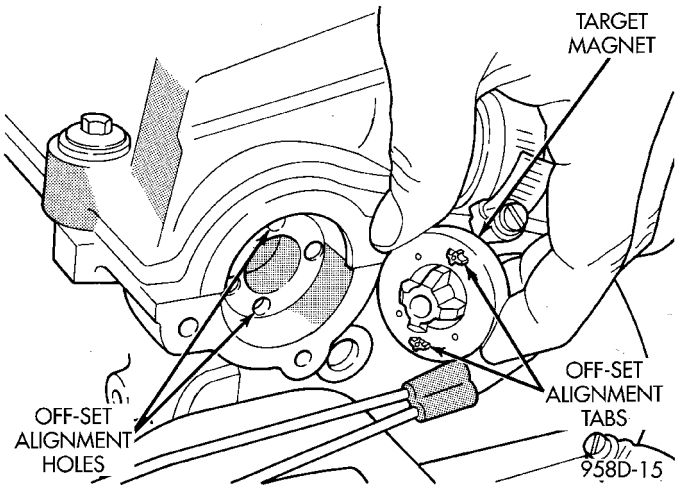


Fig. 11 Target Magnet Installation

(1) Install target magnet in end of camshaft. Tighten mounting screw to 5.65 N·m (50 in. lbs.) torque.

(2) Install a new O-ring on sensor.

(3) Install camshaft position sensor. Tighten sensor mounting screws to 9.6 N·m (85 in. lbs.) torque.

(4) Attach engine harness connector to camshaft position sensor.

(5) Install air cleaner inlet tube and filtered air tube.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—2.4/3.3/3.8L

REMOVAL

(1) Disconnect electrical connector from MAP sensor (Fig. 12).

(2) Remove two screws holding sensor to the intake manifold.

INSTALLATION

(1) Reverse the above procedure for installation.

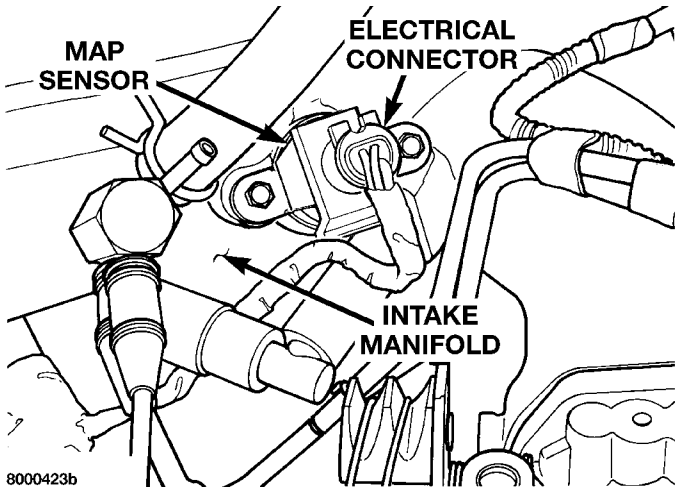


Fig. 12 Map AbsolutePressure Sensor

THROTTLE POSITION SENSOR

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

ENGINE COOLANT TEMPERATURE SENSOR—2.4L

The coolant sensor threads into the top of the thermostat housing (Fig. 13). New sensors have sealant applied to the threads.

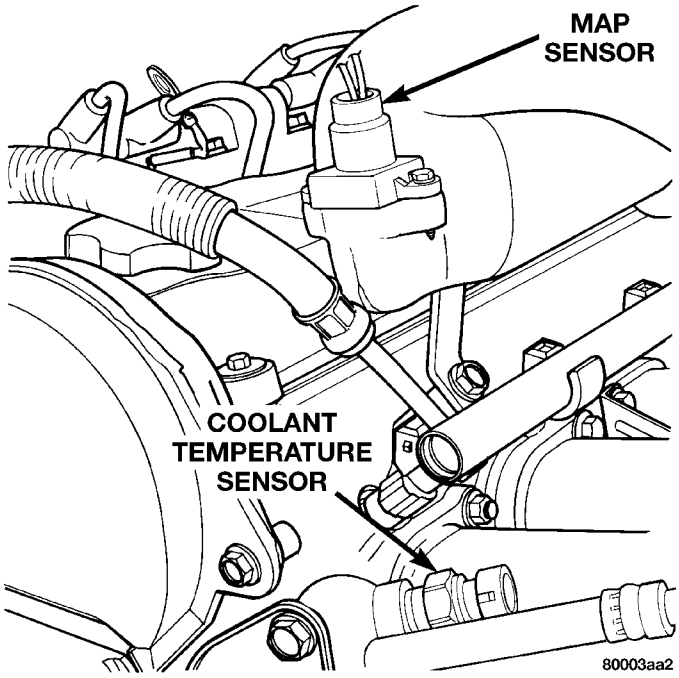


Fig. 13 Engine Coolant Temperature Sensor—2.4L

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

REMOVAL AND INSTALLATION (Continued)

REMOVAL

(1) With the engine cold, drain coolant until level drops below cylinder head. Refer to Group 7, Cooling System.

(2) Disconnect coolant sensor electrical connector.

(3) Remove coolant sensor.

INSTALLATION

(1) Install coolant sensor. Tighten sensor to 7 N·m (60 in. lbs.) torque.

(2) Attach electrical connector to sensor.

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

KNOCK SENSOR—2.4L

The knock sensor threads into the side of the cylinder block in front of the starter (Fig. 14).

REMOVAL

(1) Disconnect electrical connector from knock sensor.

(2) Use a crow foot socket to remove the knock sensors.

INSTALLATION

(1) Install knock sensor. Tighten knock sensor 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.

INTAKE AIR TEMPERATURE SENSOR—2.4L

The intake air temperature sensor threads into the intake manifold plenum (Fig. 15).

REMOVAL

(1) Remove electrical connector from sensor.

(2) Remove sensor.

INSTALLATION

(1) Install sensor. Tighten sensor to 28 N·m (20 ft. lbs.) torque.

(2) Attach electrical connector to sensor.

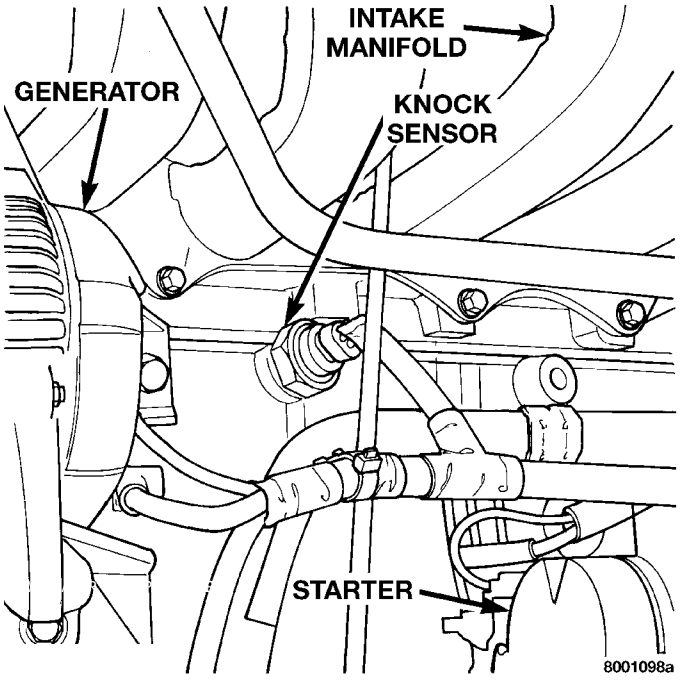


Fig. 14 Knock Sensor

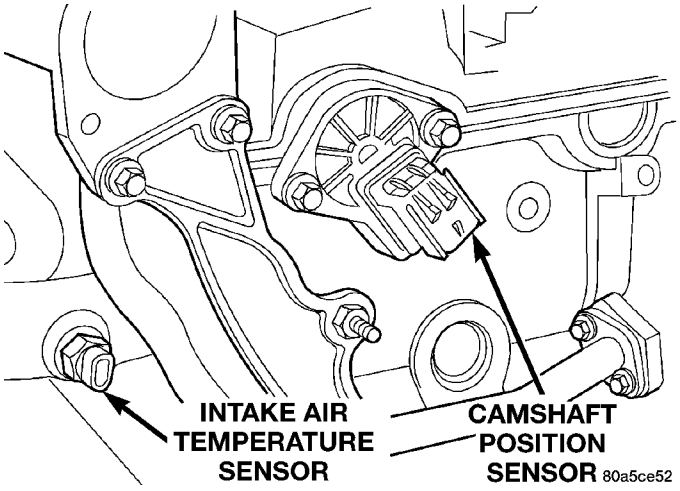
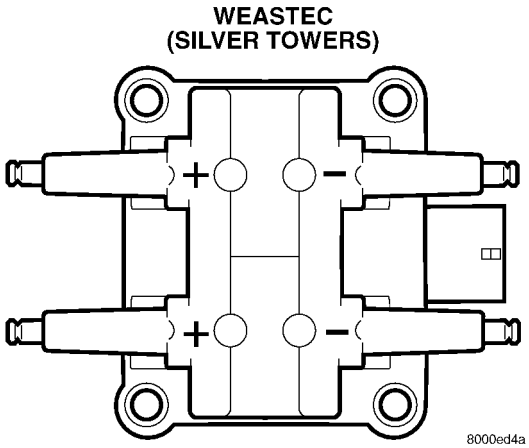


Fig. 15 Intake Air Temperature Sensor

SPECIFICATIONS

IGNITION COIL

Coil Manufacture	Primary Resistance at 21°C-27°C (70°F-80°F)	Secondary Resistance at 21°C-27°C (70°F-80°F)
Weastec (Steel Towers)	0.45 to 0.65 Ohms	7,000 to 15,800 Ohms



Coil Polarity

SPARK PLUG

Engine	Spark Plug	Gap	Thread Size
2.4L	RC12YC5	0.048 TO 0.053	14mm (3/4 in.) reach

TORQUE SPECIFICATION

DESCRIPTION	TORQUE
2.4L Target Magnet Screw	3 N·m (30 in. lbs.)
2.4L Camshaft Position Sensoe Screw	9 N·m (80 in. lbs.)
Ignition Switch	2 N·m (17 in. lbs.)
Spark Plugs	28 N·m (60 in. lbs.)

SPARK PLUG CABLE RESISTANCE—2.4L

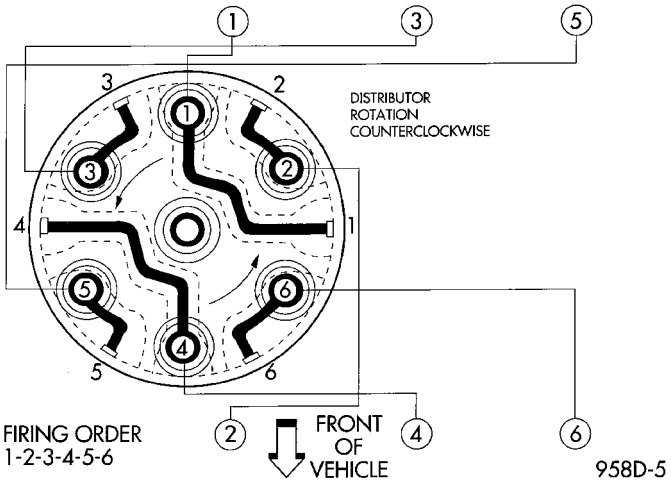
CABLE	Maximum Resistance
#1 & #4	4.2K ohms
#2 & #3	3.2K ohms

3.0L ENGINE

INDEX

DESCRIPTION AND OPERATION

FIRING ORDER—3.0L



SPARK PLUG WIRE ROUTING—3.0L ENGINE

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

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

The input voltage level supplies the PCM with information relating to ambient barometric pressure during engine start-up (cranking) and engine load while its operating. Based on MAP sensor voltage and inputs from other sensors, the PCM adjusts spark advance and the air-fuel mixture.

CAMSHAFT POSITION SENSOR

The PCM determines fuel injection synchronization and cylinder identification from inputs provided by the camshaft position sensor and crankshaft position sensor. From the two inputs, the PCM determines crankshaft position.

The 3.0L engine is equipped with a camshaft driven mechanical distributor, containing a shaft driven distributor rotor. The distributor is also equipped with an internal camshaft position (fuel sync) sensor (Fig. 1). This sensor provides fuel injection synchronization and cylinder identification to the PCM.

The camshaft position sensor contains a hall effect device callled a sync signal generator. This sync signal generator detects a rotating pulse ring (shutter) on the distributor shaft. The pulse ring rotates 180 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 shutter enters the sync signal generator, the interruption of magnetic field causes the voltage to switch high. This causes a sync signal of approximately 5 volts.

When the trailing edge of the shutter leaves the sync signal generator, the change of magnetic field causes the sync signal voltage to switch low to 0 volts.

Since the shutter rotates at half crankshaft speed, it may take 1 engine revolution during cranking for the PCM to determine the position of piston number 6.

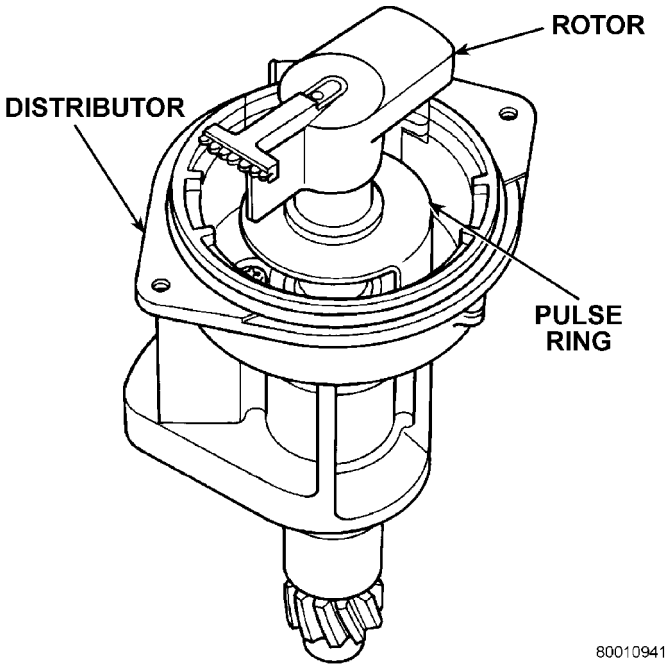


Fig. 1 CamshaftPosition Sensor—3.0L Engine

REMOVAL AND INSTALLATION

SPARK PLUG SERVICE

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

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

REMOVAL

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

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

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

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

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

IGNITION COIL—3.0L

The ignition coil is located at the back of the intake manifold (Fig. 2).

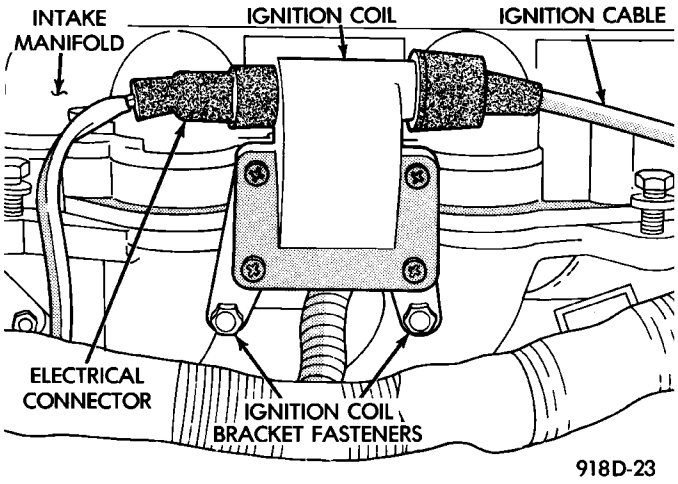


Fig. 2 IgnitionCoil—3.0L Engine

REMOVAL

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

INSTALLATION

(1) Loosely install ignition coil on intake manifold. Tighten the intake manifold fastener to 13 N·m (115 in. lbs.) torque. Tighten ignition coil bracket fasteners to 10 N·m (96 in. lbs.) torque.

(2) Connect the wiring harness connector.

(3) Connect the coil to distributor ignition cable.

(4) Install the air cleaner assembly. Tighten the air cleaner fasteners to 25 N·m (225 in. lbs.) torque.

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR—3.0L

REMOVAL

(1) Remove vacuum hose and mounting screws from manifold absolute pressure (MAP) sensor (Fig. 3).

(2) Disconnect electrical connector from sensor. Remove sensor.

INSTALLATION

(1) Reverse the above procedure for installation.

REMOVAL AND INSTALLATION (Continued)

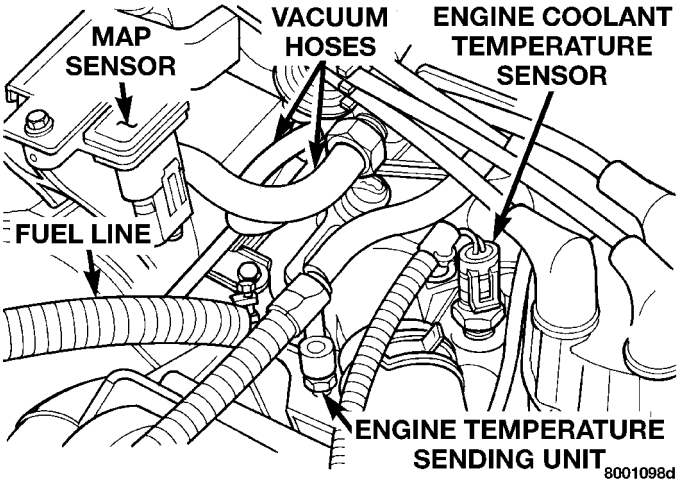


Fig. 3 ManifoldAbsolute Pressure Sensor

ENGINE COOLANT TEMPERATURE SENSOR—3.0L

The sensor is installed next to the thermostat housing (Fig. 3).

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

REMOVAL

(1) With the engine cold, drain coolant until level drops below cylinder head. Refer to Group 7, Cooling System.

(2) Disconnect coolant sensor electrical connector.

(3) Remove coolant sensor.

INSTALLATION

(1) Install coolant sensor. Tighten sensor to 7 N·m (60 in. lbs.) torque.

(2) Attach electrical connector to sensor.

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

CRANKSHAFT POSITION SENSOR

REMOVAL

(1) Raise and support vehicle.

(2) Disconnect crankshaft position sensor electrical connector from the wiring harness connector (Fig. 4).

(3) Remove crankshaft position sensor retaining bolt.

(4) Pull crankshaft position sensor straight up out of the transaxle housing.

INSTALLATION

NOTE: If the removed sensor is to be reinstalled, clean off the old spacer on the sensor face. A NEW SPACER must be attached to the sensor face before installation. If the sensor is being replaced, confirm that the paper spacer is attached to the face of the new sensor (Fig. 5).

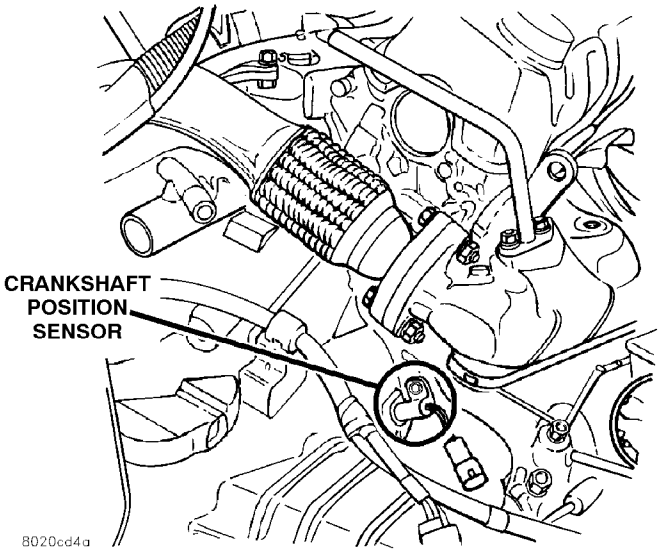


Fig. 4 CrankshaftPosition Sensor Connector

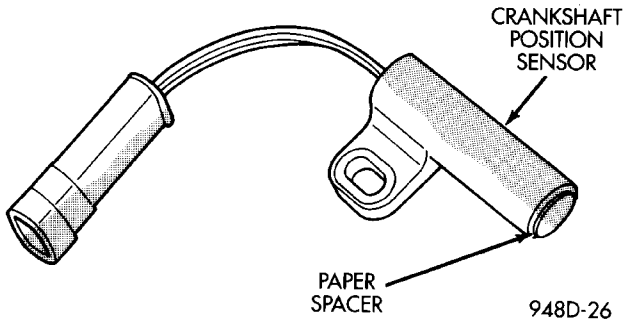


Fig. 5 CrankshaftPosition Sensor and Spacer

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

(2) Raise and support vehicle.

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

THROTTLE POSITION SENSOR

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

DISASSEMBLY AND ASSEMBLY

DISTRIBUTOR—3.0L

REMOVAL

(1) Disconnect distributor connector from distributor (Fig. 6).

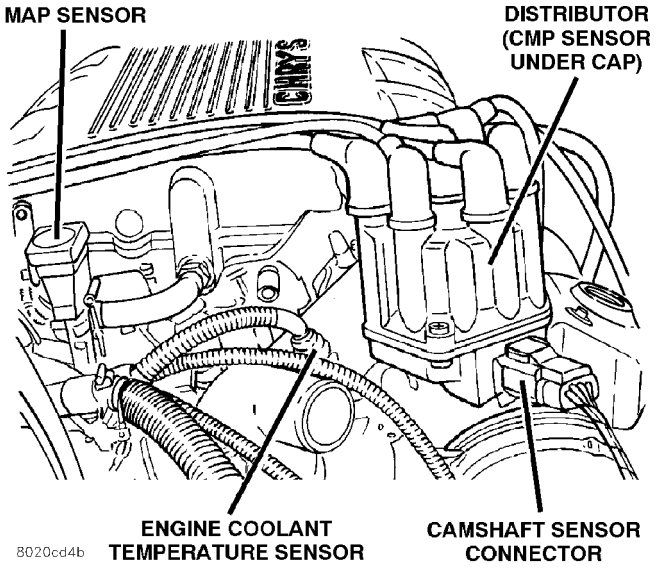


Fig. 6 Distributor Electrical Connector—3.0LEngine

(2) Loosen distributor cap retaining screws.

(3) Lift cap of off distributor.

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

(5) Remove distributor hold down nut (Fig. 7).

(6) Carefully lift the distributor from the engine.

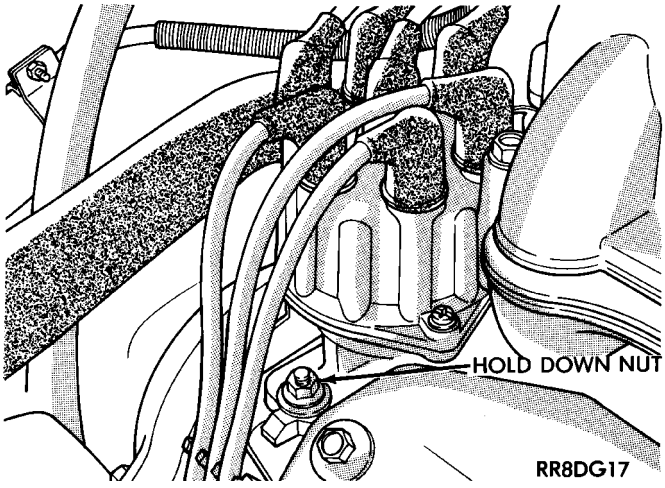


Fig. 7 Distributor Hold-Down

INSTALLATION

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

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

(a) Rotate the crankshaft until number one piston is at top of compression stroke.

(b) Rotate rotor to number one rotor terminal (Fig. 8).

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

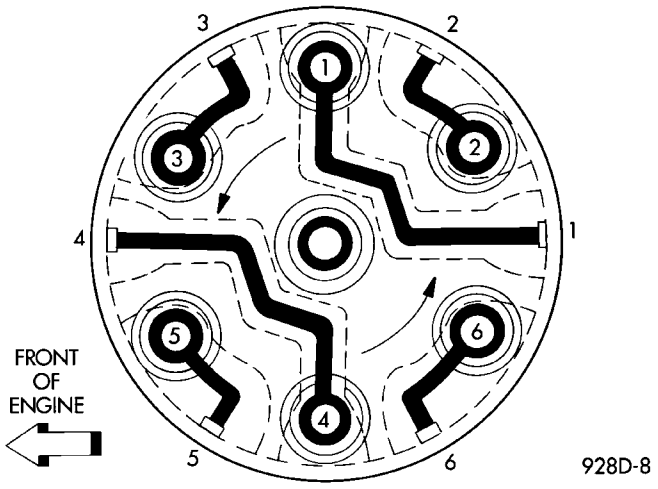


Fig. 8 Distributor Cap Terminal Routing,View from Top of Cap

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

(4) Install hold-down nut and tighten (Fig. 7).

(5) Connect distributor electrical connector to distributor (Fig. 6).

CLEANING AND INSPECTION

DISTRIBUTOR CAP

Remove the distributor cap and inspect the inside for flashover, cracking of carbon button, lack of spring tension on carbon button, cracking of cap, and burned, worn terminals (Fig. 9). Also check for broken distributor cap towers. If any of these conditions are present the distributor cap and/or cables should be replaced.

CLEANING AND INSPECTION (Continued)

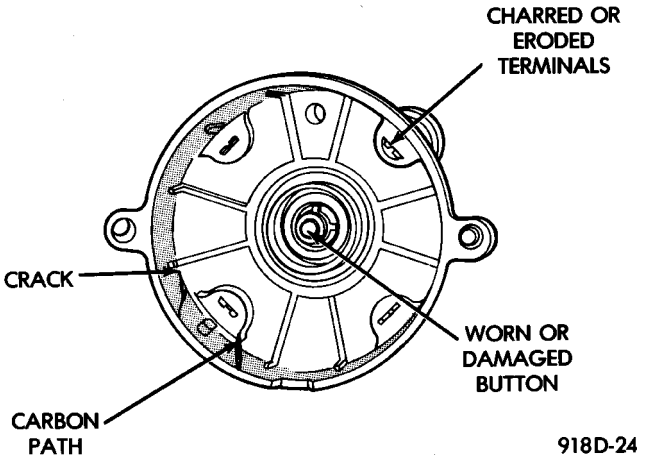


Fig. 9 DistributorCap Inspection—Typical

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

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

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

DISTRIBUTOR ROTOR—3.0L

Replace the rotor if it is cracked, the tip is excessively burned or heavily scaled (Fig. 10).

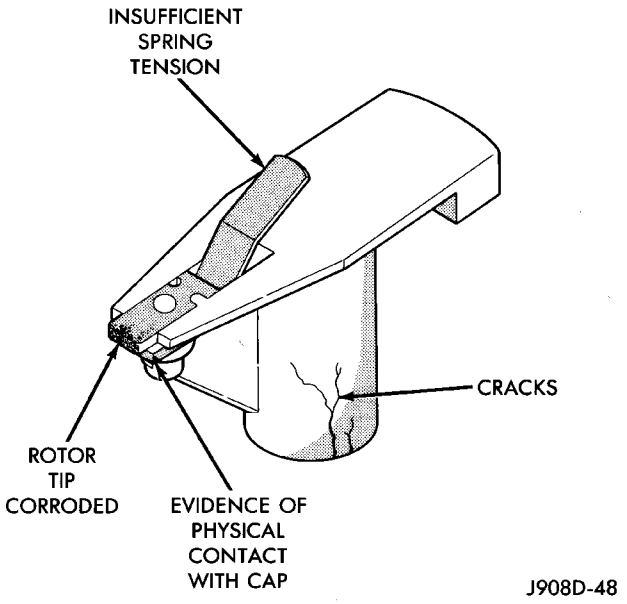


Fig. 10 Rotor Inspection—Typical

SPECIFICATIONS

SPARK PLUG

Engine	Spark Plug	Gap	Thread Size
3.0L	RN11YC4	0.039 TO 0.044	14mm (3/4 in.) reach

TORQUE SPECIFICATION

DESCRIPTION	TORQUE
Distributor Hold Down	14 N·m (124 in. lbs.)
Ignition Coil Bracket	10 N·m (96 in. lbs.)
Ignition Switch	2 N·m (17 in. lbs.)
Spark Plugs	28 N·m (60 in. lbs.)

SPARK PLUG CABLE RESISTANCE—3.0L

CABLE	Maximum Resistance
#1	14.0K ohms
#2	10.4K ohms
#3	14.9K ohms
#4	11.5K ohms
#5	17.5K ohms
#6	10.3K ohms
Coil Lead	11.1K ohms

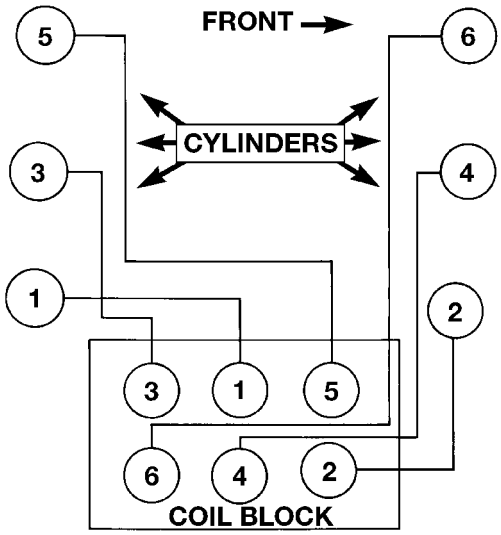
3.3/3.8L ENGINE

INDEX

DESCRIPTION AND OPERATION

FIRING ORDER—3.3/3.8L

The firing order for 3.3L and 3.8L engines is 1-2-3-4-5-6.



FIRING ORDER 1-2-3-4-5-6 8008a54a

Firing Order—3.3/3.8L

REMOVAL AND INSTALLATION

SPARK PLUG CABLE SERVICE—3.3/3.8L ENGINES

WARNING: The ignition cables should not be removed while the engine is hot. This could cause sever injury/burns and can cause damage to the ignition cables.

The spark plug boot heat shield needs to be installed correctly on the boot before being installed on the engine (Fig. 1). If it is not installed correctly engine misfire would occur.

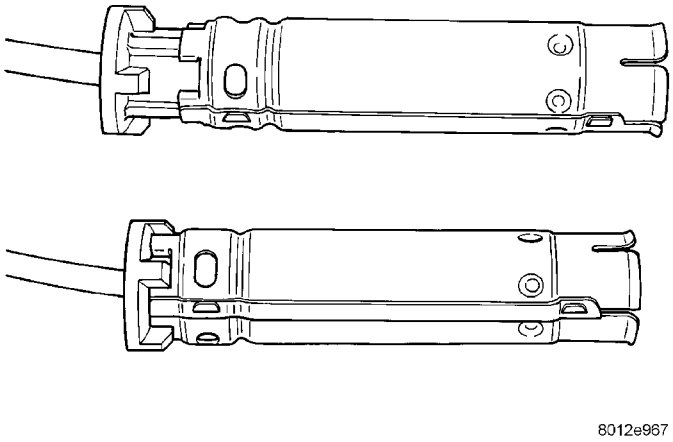


Fig. 1 Spark PlugBoot/Heat Shield Orientation

Do not use pliers to pull the boot/heat shield assembly from the spark plugs. This will damage the shield assembly.

Spark plug boot heat shields must be replaced if they are bent or damaged. It is extremely important the shield is reinstalled correctly as shown. The bottom of the spark plug heat shield must make contact with the spark plug socket hex.

REMOVAL AND INSTALLATION (Continued)

CAUTION: Never coat the inside of spark plug boots with silicone grease. Some types of silicone grease can damage the ignition cable conductor.

SPARK PLUG CABLES #3 AND #5

REMOVAL

(1) Remove the resonator.

(2) Grasp the spark plug boot/heat shield as close as possible to the spark plug. **Twist the boot slightly to break its seal with the plug and pull straight back. Do not use pliers, pull on the ignition cable, or pull the spark plug boot at an angle.** This could damage the spark plug insulator, terminal, or the cable insulation. Wipe spark plug insulator clean with a dry cloth before installation.

(3) Remove the cable from the retaining bracket. Make sure that they are also detached from the rear retaining clip mounted on the rear of the intake manifold.

INSTALLATION

(1) When installing the spark plug cables, make sure the coil and spark plug insulator and terminals are fully seated. A **click sound should be heard or terminal engagement is felt when the terminals are properly attached.**

(2) Install the cable into the retaining bracket. Make sure that they are also attached to the rear retaining clip mounted on the rear of the intake manifold.

(3) Install the resonator.

SPARK PLUG CABLE #1

REMOVAL

(1) Remove the accessory drive belt, refer to Group 7, Cooling.

(2) Remove the four bolts from the upper half of the generator bracket.

(3) Push the Generator rearward.

(4) Grasp the spark plug boot/shield assembly as close as possible to the spark plug. **Twist the boot slightly to break its seal with the plug and pull straight back. Do not use pliers, pull on the ignition cable, or pull the spark plug boot at an angle.** This could damage the spark plug insulator, terminal, or the cable insulation. Wipe spark plug insulator clean with a dry cloth before installation.

(5) Remove the cable from the retaining bracket.

INSTALLATION

(1) When installing the spark plug cables, make sure the coil and spark plug insulator and terminals are fully seated. A **click sound should be heard or terminal engagement is felt when the terminals are properly attached.**

(2) Rotate Generator back into place.

(3) Install upper Generator bracket with the four bolts.

(4) Install the accessory drive belt, refer to Group 7, Cooling.

SPARK PLUG SERVICE—3.3/3.8L ENGINES

WARNING: The ignition cables should not be removed while the engine is hot. This could cause server injury/burns and can cause damage to the ignition cables.

Use extreme care when removing and installing the spark plug cables.

The spark plug boot heat shield needs to be installed correctly on the boot before being installed on the engine (Fig. 1). If it is not installed correctly engine misfire would occur.

Do not use pliers to pull the boot/heat shield assembly from the spark plugs. This will damage the shield assembly.

SPARK PLUG #3 AND #5

REMOVAL

(1) Remove the resonator.

(2) Remove intake strut to cylinder head bolt at cylinder head.

(3) Loosen bolt for intake strut at intake.

(4) Swing strut away.

(5) Grasp the spark plug boot/shield assembly as close as possible to the spark plug. **Twist the boot/ shield assembly slightly to break the seal with the plug and pull straight out. Do not use pliers, pull on the ignition cable, or pull the spark plug boot at an angle.** This could damage the spark plug insulator, terminal, heat shield or the insulation. Wipe spark plug insulator clean with a dry cloth before installation.

(6) Remove spark plug

INSTALLATION

(1) Install spark plug and tighten to 28 N·m (20 ft. lbs.).

(2) When installing the spark plug cables, make sure spark plug insulator and terminals are fully seated. A **click sound should be heard or felt when the terminals are properly attached.**

(3) Install the cable into the retaining bracket. Make sure that they are also attached to the rear retaining clip mounted on the rear of the intake manifold.

(4) Swing strut back into place.

REMOVAL AND INSTALLATION (Continued)

(5) Install intake strut bolt to cylinder head at cylinder head.
(6) Tighten bolt to intake strut at intake.
(7) Tighten bolt at cylinder head.
(8) Install the resonator.

SPARK PLUG #1

REMOVAL

(1) Remove the accessory drive belt, refer to Group 7, Cooling.
(2) Remove the 4 bolts from the upper half of the generator bracket.
(3) Push the Generator rearward.
(4) Grasp the spark plug boot/shield assembly as close as possible to the spark plug. **Twist the boot/shield assembly slightly to break its seal with the plug and pull straight out. Do not use pliers, pull on the ignition cable, or pull the spark plug boot at an angle.** This could damage the spark plug insulator, terminal, or the insulation. Wipe spark plug insulator clean with a dry cloth before installation.
(5) Remove spark plug

INSTALLATION

(1) Install spark plug and tighten to 28 N·m (20 ft. lbs.).
(2) When installing the spark plug cables, make sure the coil or spark plug insulator and terminals are fully seated. A **click sound should be heard or felt when the terminals are properly attached.**
(3) Pull Generator back into place.
(4) Install upper Generator bracket with the 4 bolts.
(5) Install the accessory drive belt, refer to Group 7, Cooling.

IGNITION COIL

REMOVAL

(1) Remove spark plug cables from coil (Fig. 2). Always twist the spark plug boots to break the seal with the plug and pull straight back on the boot.
(2) Remove ignition coil electrical connector.
(3) Remove ignition coil mounting screws.
(4) Remove ignition coil.

INSTALLATION

(1) Reverse the above procedure for installation. Tighten mounting screws to 12 N·m (105 in. lbs.) torque.
(2) Transfer spark plug cables to new coil pack. The coil pack towers and cables are numbered with the cylinder identification.

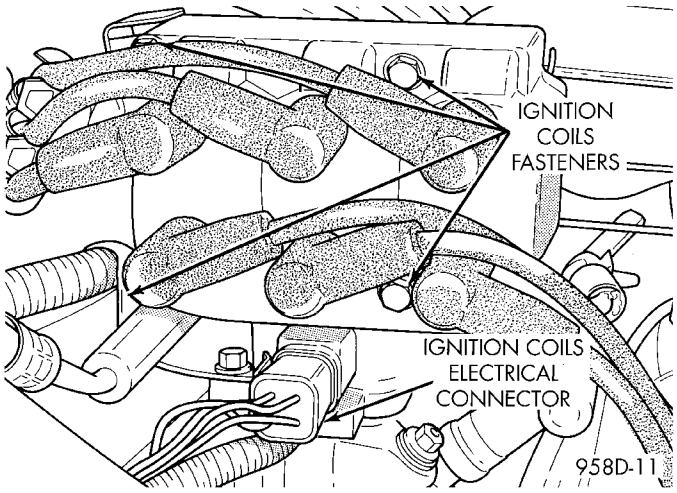


Fig. 2 IgnitionCoil Removal

CRANKSHAFT POSITION SENSOR

REMOVAL

(1) Raise and support vehicle.
(2) Disconnect crankshaft position sensor electrical connector from the wiring harness connector (Fig. 3).

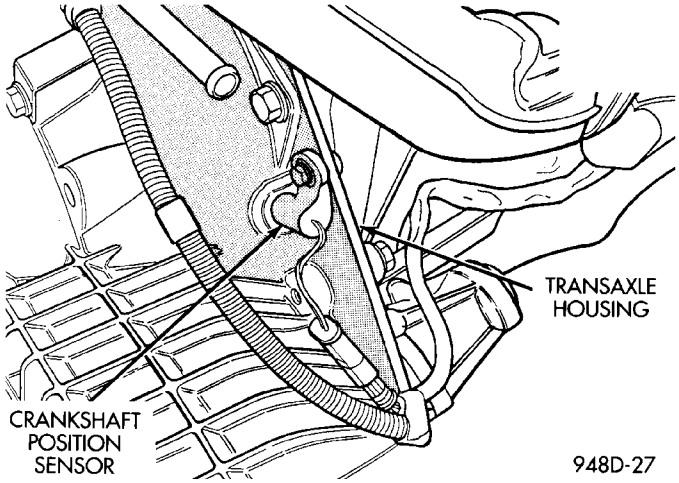


Fig. 3 Crankshaft Position Sensor Connector

(3) Remove crankshaft position sensor retaining bolt.
(4) Pull crankshaft position sensor straight up out of the transaxle housing.

INSTALLATION

NOTE: If the removed sensor is to be reinstalled, clean off the old spacer on the sensor face. A NEW SPACER must be attached to the sensor face before installation. If the sensor is being replaced, confirm that the paper spacer is attached to the face of the new sensor (Fig. 4).

(1) Install sensor in transaxle and push sensor down until contact is made with the drive plate.

REMOVAL AND INSTALLATION (Continued)

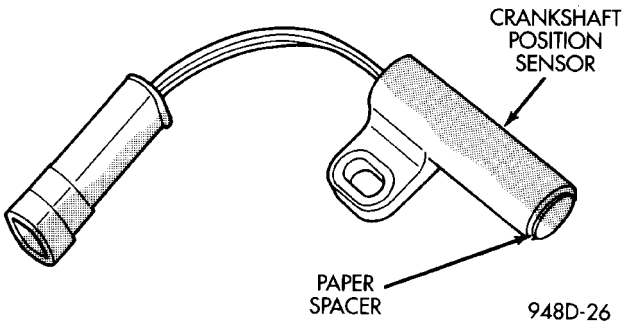


Fig. 4 CrankshaftPosition Sensor and Spacer

While holding the sensor in this position, and install and tighten the retaining bolt to 11.9 N·m (105 in. lbs.) torque.

(2) Raise and support vehicle.

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

CAMSHAFT POSITION SENSOR

REMOVAL

(1) Disconnect camshaft position sensor electrical connector from the wiring harness connector (Fig. 5).

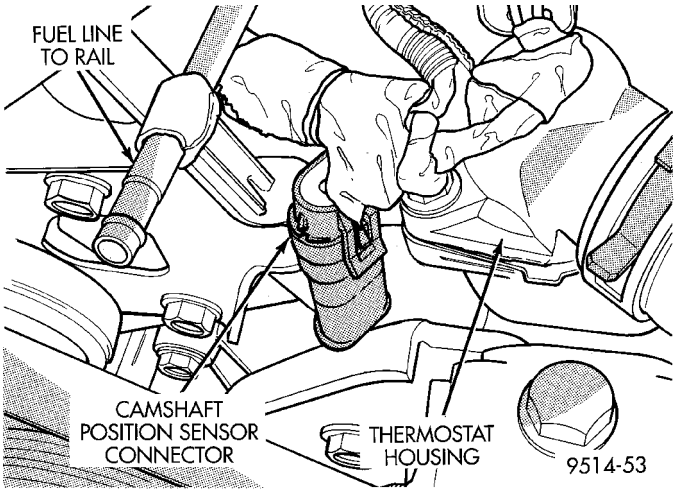


Fig. 5 CamshaftPosition Sensor

(2) Remove bolt holding sensor (Fig. 6). **There is a hole in the bracket for tool access to the sensor bolt.**

(3) Rotate sensor away from block (Fig. 7).

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

INSTALLATION

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

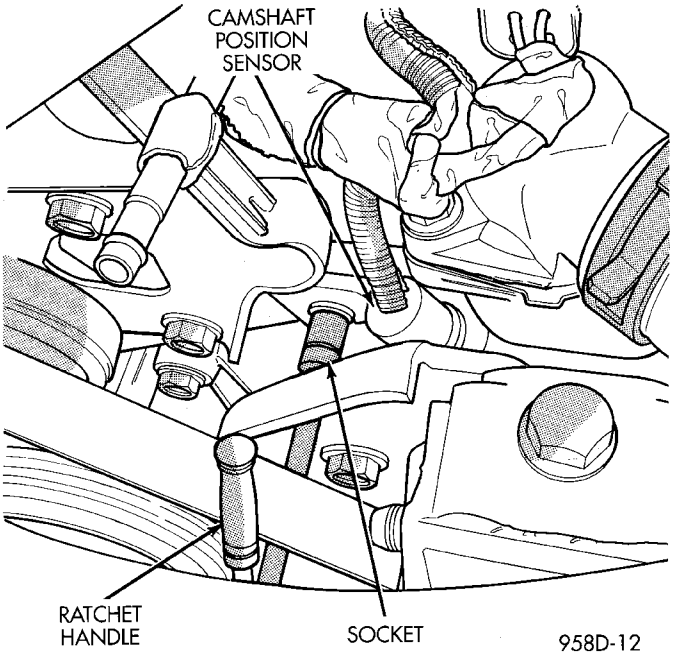


Fig. 6 CamshaftSensor Bolt Removal/Installation

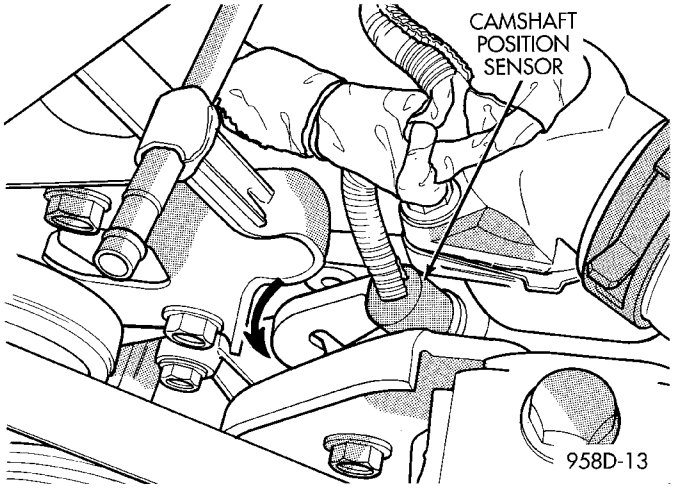


Fig. 7 CamshaftSensor Removal/Installation

(1) Apply a couple drops of clean engine oil to the O-ring prior to installation.

(2) Install sensor in the chain case cover and rotate into position.

(3) Push sensor down until contact is made with the camshaft gear. While holding the sensor in this position, install and tighten the retaining bolt 14 N·m (125 in. lbs.) torque.

(4) Connect camshaft position sensor electrical connector to harness connector.

REMOVAL AND INSTALLATION (Continued)

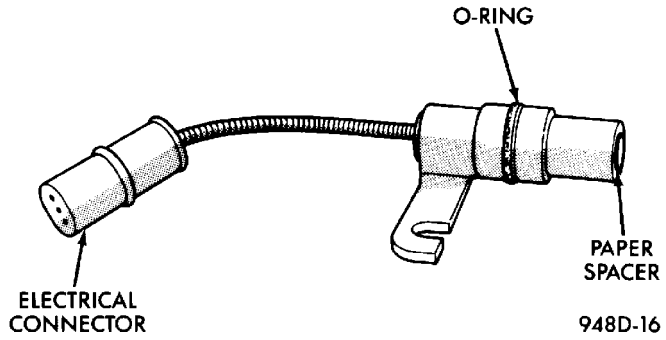


Fig. 8 CamshaftPosition Sensor and Spacer

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

REMOVAL

(1) Disconnect electrical connector from MAP sensor.

(2) Remove 2 screws holding sensor to intake manifold (Fig. 9).

(3) Remove sensor from manifold.

INSTALLATION

Reverse the above procedure for installation.

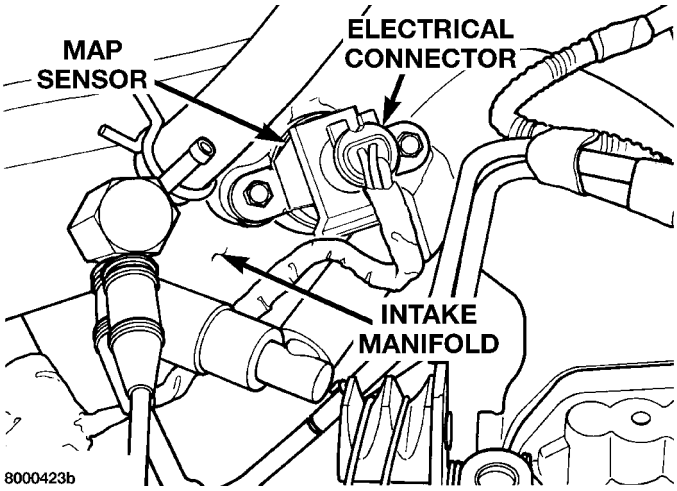


Fig. 9 Manifold Absolute Pressure Sensor

ENGINE COOLANT TEMPERATURE SENSOR

The Engine Coolant Temperature (ECT) sensor is located below the ignition coil (Fig. 10).

REMOVAL

(1) Drain cooling system until coolant level is below sensor. Refer to Group 7, Cooling System.

(2) Remove electrical connector from coil (Fig. 11).

(3) Remove coil mounting screws.

(4) Rotate coil away from engine coolant temperature sensor.

(5) Disconnect electrical connector from engine coolant temperature sensor.

(6) Remove sensor from engine.

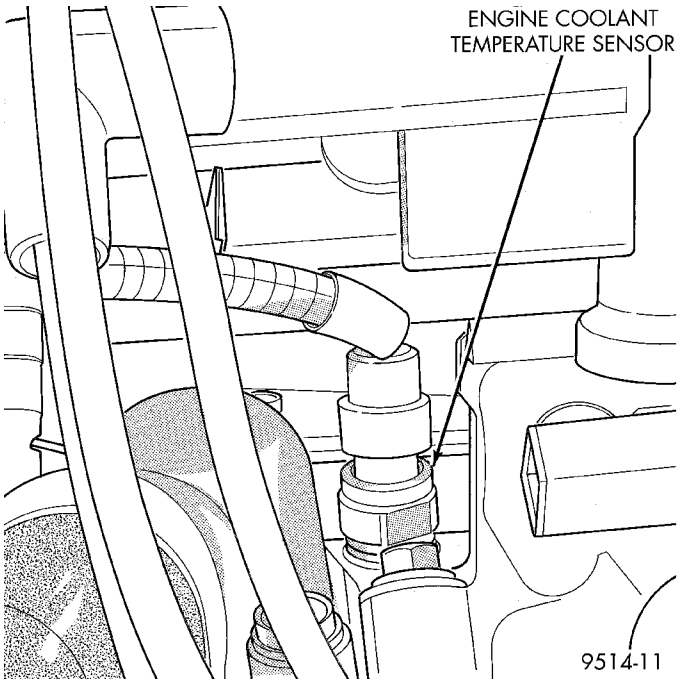


Fig. 10 Engine CoolantTemperature Sensor

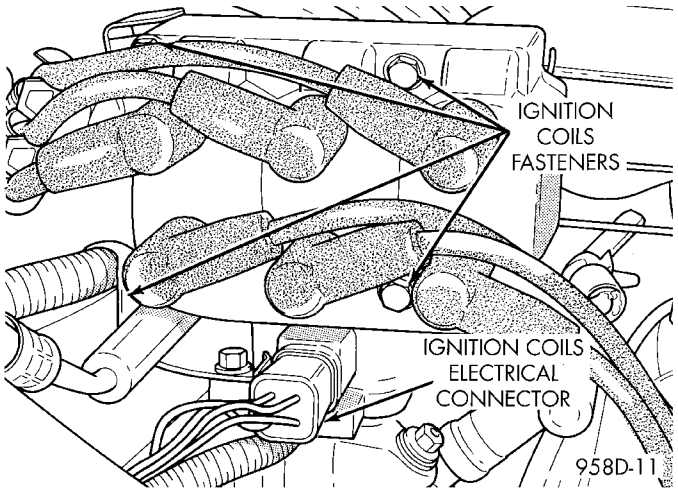


Fig. 11 IgnitionCoil Removal

INSTALLATION

(1) Tighten the sensor to 7 N·m (60 in. lbs.) torque.

(2) Connect electrical connector to sensor.

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

(4) Install coil. Tighten coil mounting screws to 12 N·m (105 in. lbs.) torque.

(5) Connect electrical connector to coil.

THROTTLE POSITION SENSOR

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

KNOCK SENSOR—3.3/3.8L

The knock sensor threads into the side of the cylinder block in front of the starter (Fig. 12).

REMOVAL AND INSTALLATION (Continued)

REMOVAL

(1) Disconnect electrical connector from knock sensor.

(2) Use a crow foot socket to remove the knock sensor.

INSTALLATION

(1) Install knock sensor. Tighten knock sensor 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.

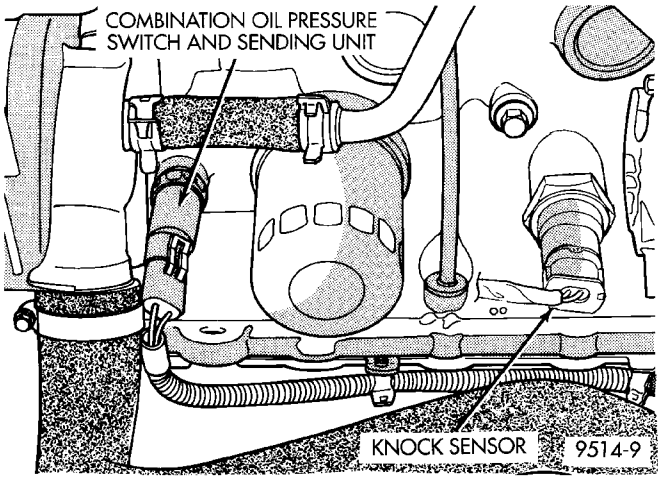


Fig. 12 Knock Sensor

SPECIFICATIONS

IGNITION COIL

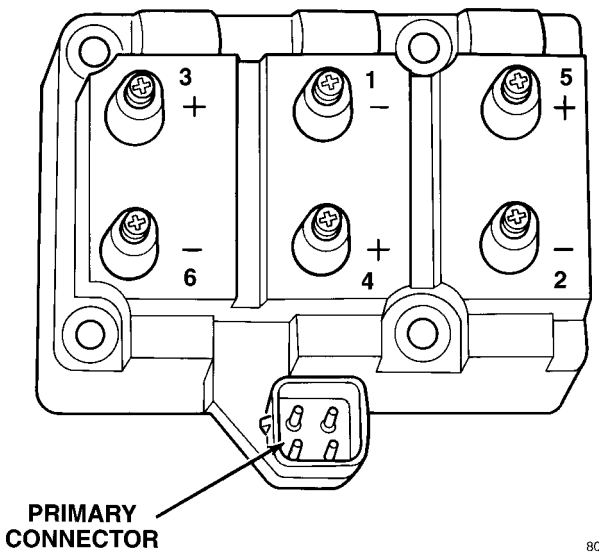
SPARK PLUG

Coil Manufacture	Primary Resistance at 21°C-27°C (70°F-80°F)	Secondary Resistance at 21°C-27°C (70°F-80°F)
Weastec (Aluminum Towers)	0.45 TO 0.65 Ohms	7,000 to 15,800 Ohms
Diamond Electric (Brass Towers)	0.45 TO 0.65 Ohms	7,000 to 15,800 Ohms

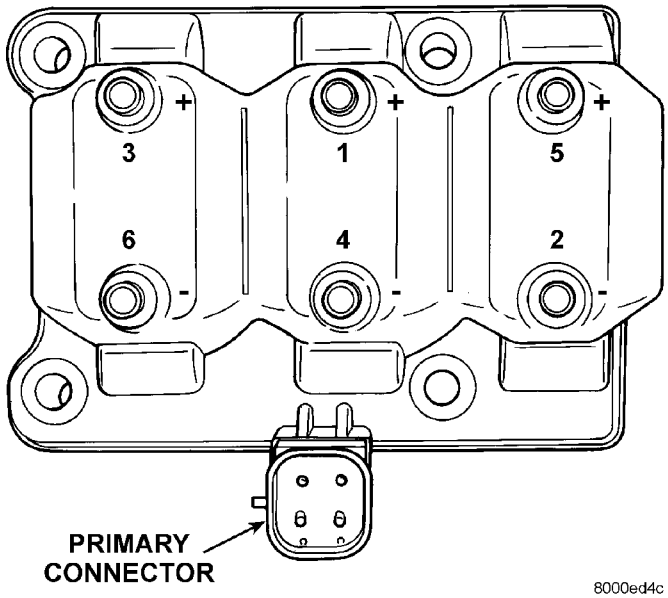
* New Spark Plug Gap

SPECIFICATIONS (Continued)

DIAMOND
(BRASS TOWERS)



WEASTEC
(SILVER TOWERS)



Coil Polarity

Coil Polarity

Engine	Spark Plug	Gap *	Thread Size
3.3L	RN14PMP5	0.048 TO 0.053	14mm (3/4 in.) reach
3.8L	RN14PMP5	0.048 TO 0.053	14mm (3/4 in.) reach

TORQUE SPECIFICATION

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

SPARK PLUG CABLE RESISTANCE—3.3/3.8L

CABLE	Maximum Resistance
#1	18.5K ohms
#2	15.5K ohms
#3	20.4K ohms
#4	21.2K ohms
#5	27.7K ohms
#6	26.7K ohms

IGNITION SWITCH AND LOCK CYLINDER

INDEX

DESCRIPTION AND OPERATION

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.

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. 14):

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

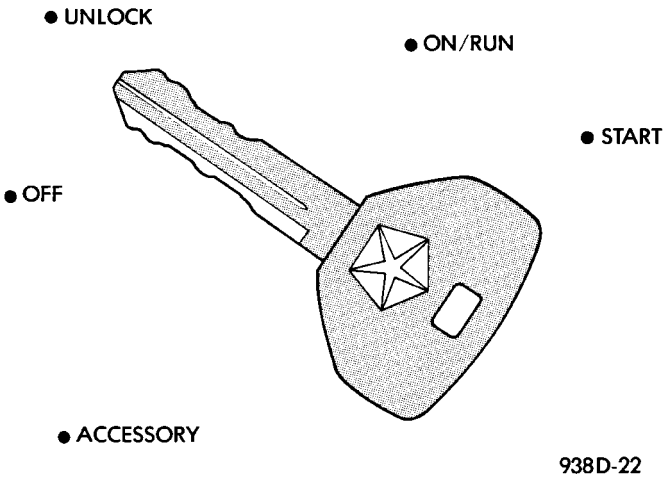


Fig. 1 IgnitionLock Cylinder Detents

REMOVAL AND INSTALLATION

IGNITION SWITCH

The ignition switch attaches to the lock cylinder housing on the end opposite the lock cylinder (Fig. 2). For ignition switch terminal and circuit identification, refer to Group 8W, Wiring Diagrams.

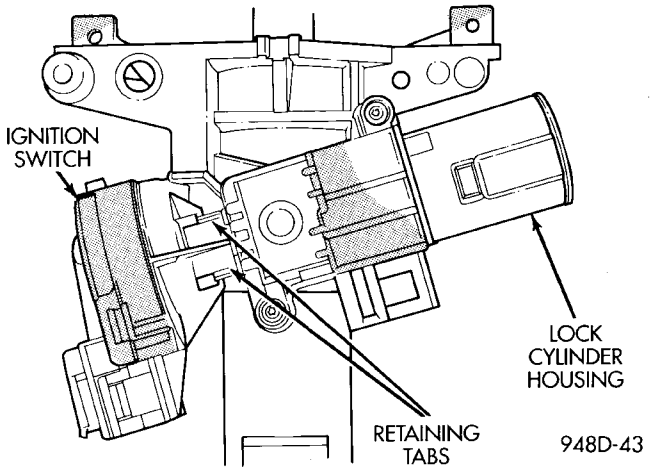


Fig. 2 IgnitionSwitch—Viewed From Below Column

REMOVAL

(1) Disconnect negative cable from battery.

(2) Remove steering column cover retaining screws (Fig. 3).

(3) Remove parking brake release cable from handle (Fig. 4).

(4) Remove screws holding steering column shrouds (Fig. 5) and remove lower shroud.

(5) Place key cylinder in RUN position. Depress lock cylinder retaining tab and remove key cylinder (Fig. 6).

(6) Remove ignition switch mounting screw (Fig. 7) with a #10 Torx® tamper proof bit.

(7) Depress retaining tab (Fig. 3) or (Fig. 8) and gently pry ignition switch from steering column (Fig. 9).

(8) Disconnect electrical connectors from ignition switch and remove switch (Fig. 10).

REMOVAL AND INSTALLATION (Continued)

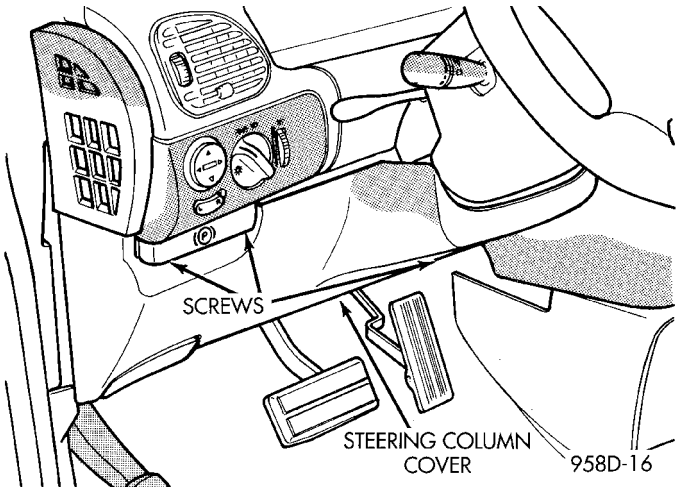


Fig. 3 SteeringColumn Cover

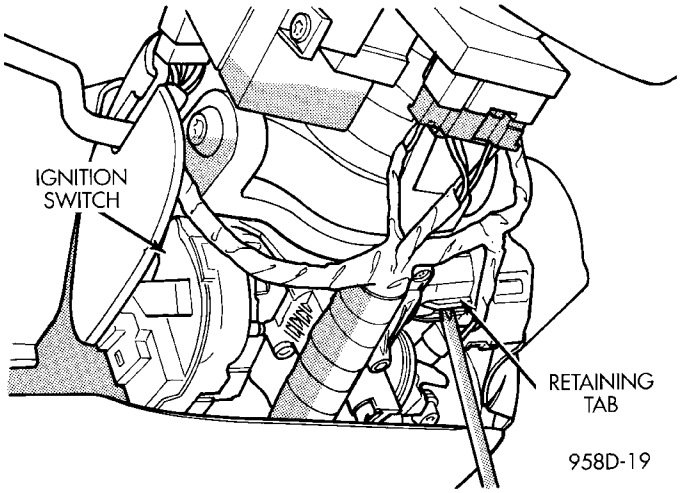


Fig. 6 Lock CylinderRetaining Tab

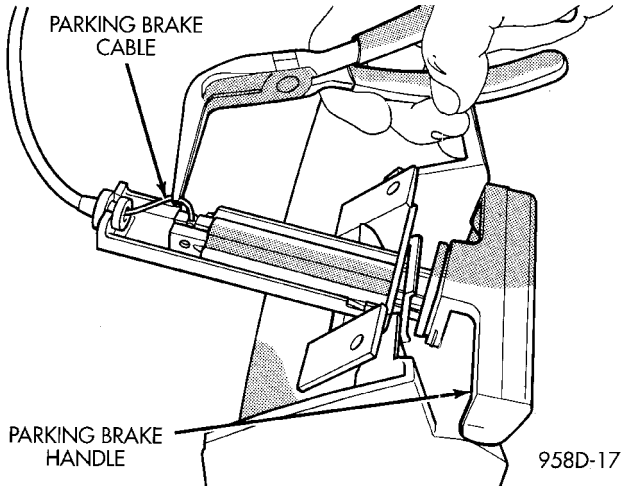


Fig. 4 Parking BrakeRelease Cable

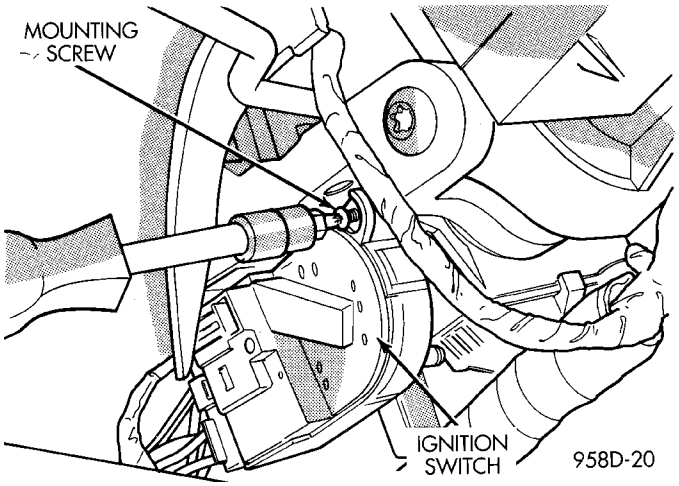


Fig. 7 IgnitionSwitch Mounting Screw

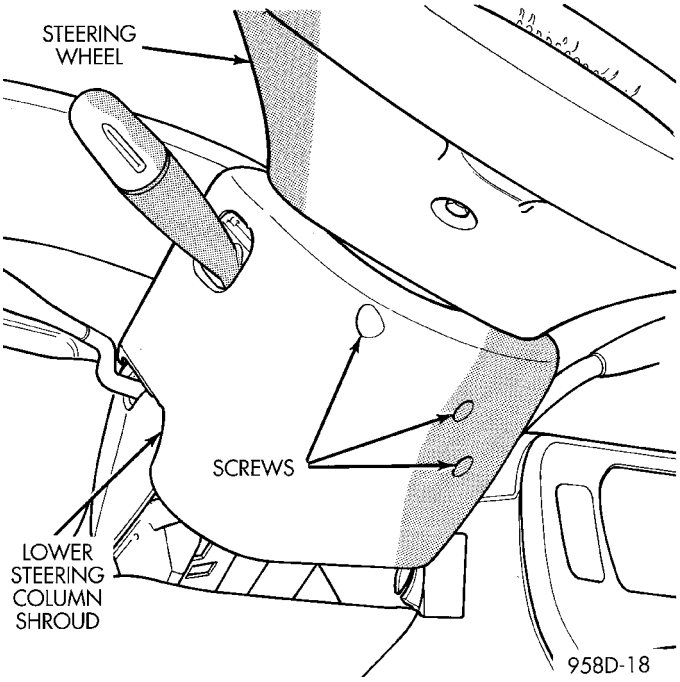


Fig. 5 SteeringColumn Shroud Screws

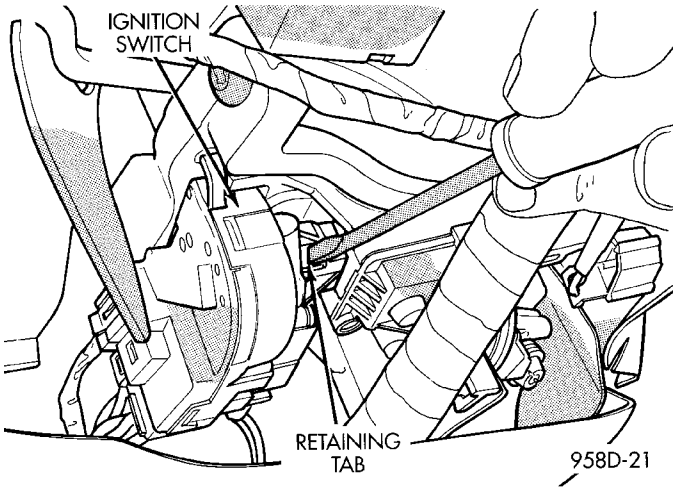


Fig. 8 IgnitionSwitch Retaining Tab

INSTALLATION

(1) Ensure the ignition switch is in the RUN position and the actuator shaft in the lock housing is in the RUN position.

REMOVAL AND INSTALLATION (Continued)

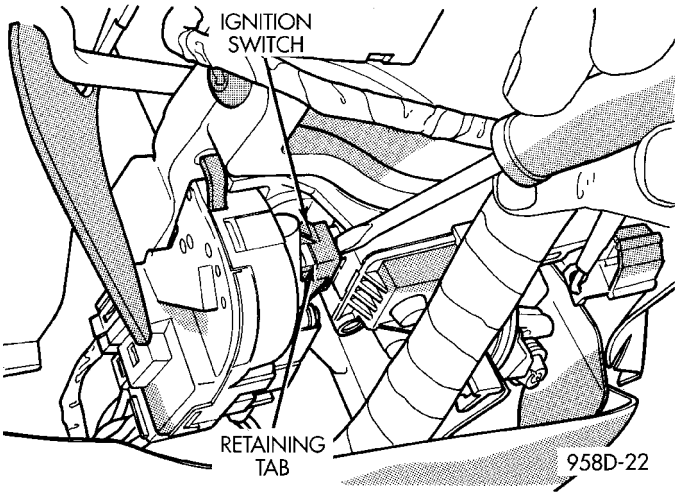


Fig. 9 RemovingIgnition Switch

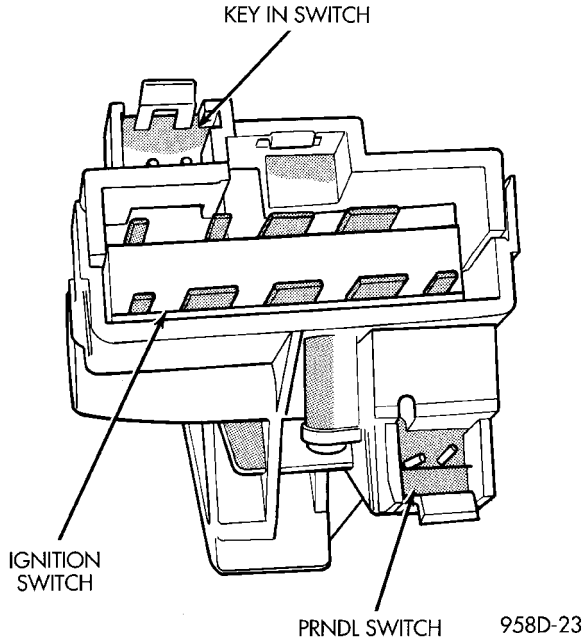


Fig. 10 IgnitionSwitch Connectors

(2) Install electrical connectors to ignition switch.

(3) Carefully install the ignition switch. The switch will snap over the retaining tabs (Fig. 11). Install mounting screw (Fig. 7).

(4) Install upper and lower shrouds.

(5) Install key cylinder (cylinder retaining tab will depress only in the RUN position).

(6) Connect negative cable to battery.

(7) Check for proper operation of ignition switch and key-in warning switch.

LOCK KEY CYLINDER

REMOVAL

(1) Disconnect negative cable from battery.

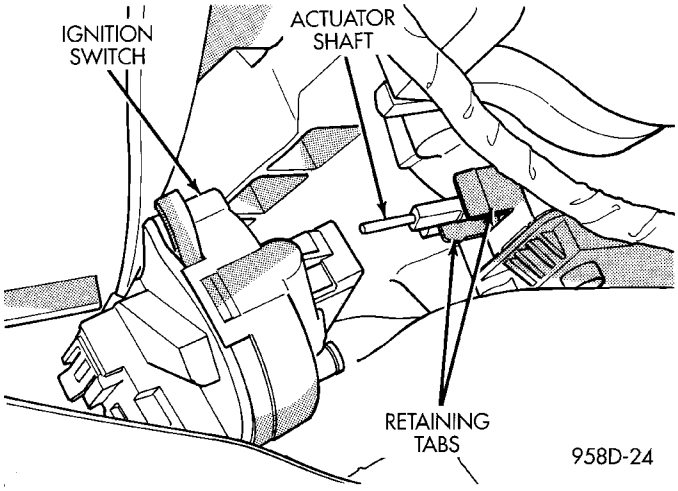


Fig. 11 IgnitionSwitch Installation

(2) Remove steering column cover retaining screws (Fig. 3).

(3) Remove screws holding steering column shrouds (Fig. 5) and remove lower shroud.

(4) Place key cylinder in RUN position. Depress lock cylinder retaining tab and remove key cylinder (Fig. 6).

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. 12).

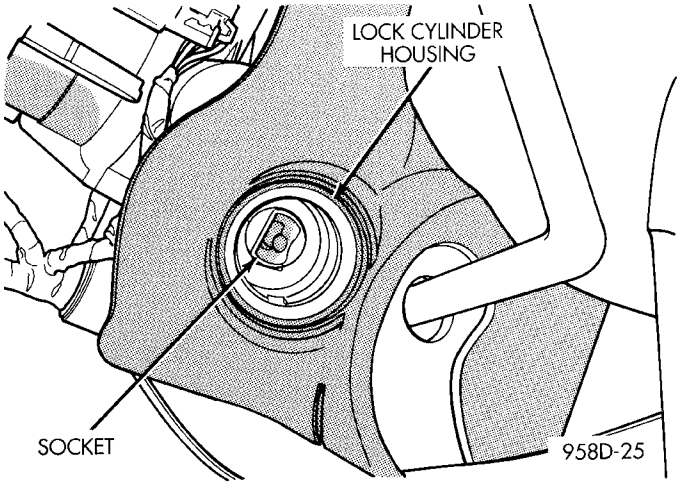


Fig. 12 Socket inLock Cylinder Housing

(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.

REMOVAL AND INSTALLATION (Continued)

(4) Turn the key to the Off position. Remove the key.
(5) Install lower steering column shroud.
(6) Install steering column cover.
(7) Connect negative cable to battery.

IGNITION INTERLOCK

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

LOCK CYLINDER HOUSING

Refer to Steering Column in Group 19, Steering, for Lock Cylinder Housing Service.

IGNITION SYSTEM

CONTENTS

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2.0L ENGINE

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page

DESCRIPTION AND OPERATION

IGNITION SYSTEM

The 2.0L engine use a fixed ignition timing system. The distributorless electronic ignition system is referred to as the Direct Ignition System (DIS).

Basic ignition timing is not adjustable. The Powertrain Control Module (PCM) determines spark advance. The system's three main components are the coil pack, crankshaft position sensor, and camshaft position sensor.

POWERTRAIN CONTROL MODULE

The Powertrain Control Module (PCM) regulates the ignition system (Fig. 1). The PCM supplies battery voltage to the ignition coil through the Auto 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 maintains spark advance at 9° BTDC. During engine operation

DESCRIPTION AND OPERATION (Continued)

the following inputs determine the amount of spark advance provided by the PCM.

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

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

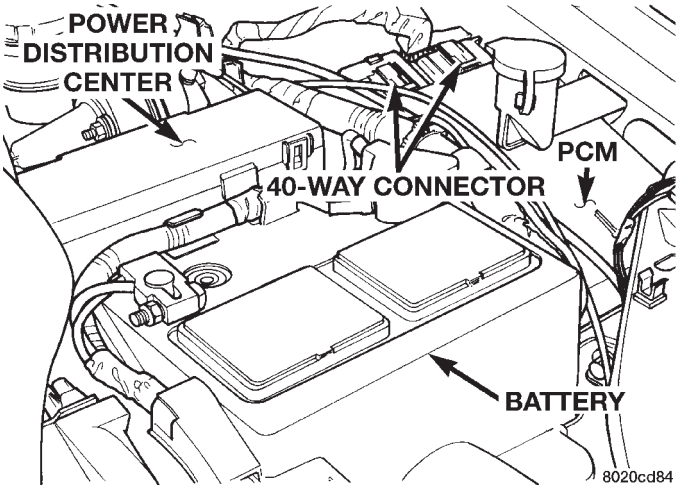


Fig. 1 Powertrain Control Module

SPARK PLUGS

The 2.0L engines uses resistor spark plugs. For spark plug identification and specifications, Refer to the Specifications section at the end of this group.

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.

Spark plugs that have low mileage may be cleaned and reused if not otherwise defective. Refer to the Spark Plug Condition section of this group. After cleaning, file the center electrode flat with a small point file or jewelers file. Adjust the gap between the electrodes (Fig. 2) to the dimensions specified in the chart at the end of this section.

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

SPARK PLUG CABLES

Spark plug cables are sometimes referred to as secondary ignition wires. The wires transfer electrical current from the coil pack to individual spark plugs at each cylinder. The resistor type, nonmetallic spark

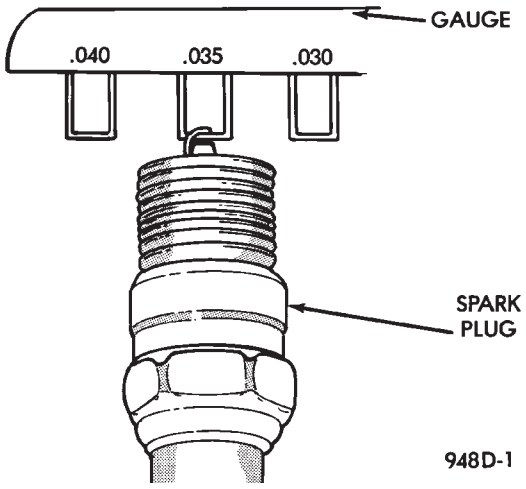


Fig. 2 Setting Spark Plug Electrode Gap

plug cables provide suppression of radio frequency emissions from the ignition system.

Check the spark plug cable connections for good contact at the coil and spark plugs. Terminals should be fully seated. The nipples and spark plug covers should be in good condition. Nipples should fit tightly on the coil. Spark plug boot should completely cover the spark plug hole in the cylinder head cover. Install the boot until the terminal snaps over the spark plug. A snap must be felt to ensure the spark plug cable terminal engaged the spark plug.

Loose cable connections will corrode, increase resistance and permit water to enter the coil towers. These conditions can cause ignition malfunction. Plastic clips in various locations protect the cables from damage. When the cables are replaced the clips must be used to prevent damage to the cables. The #1 cable must be routed under the PCV hose and clipped to the #2 cable.

ELECTRONIC IGNITION COILS

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

The coil pack consists of 2 coils molded together. The coil pack is mounted on the valve cover (Fig. 3). High tension leads route to each cylinder from the coil. The coil fires two spark plugs every power stroke. One plug is the cylinder under compression, the other cylinder fires on the exhaust stroke. Coil number one fires cylinders 1 and 4. Coil number two fires cylinders 2 and 3. The PCM determines which of the coils to charge and fire at the correct time.

The Auto Shutdown (ASD) relay provides battery voltage to the ignition coil. The PCM provides a ground contact (circuit) for energizing the coil. When

DESCRIPTION AND OPERATION (Continued)

the PCM breaks the contact, the energy in the coil primary transfers to the secondary causing the 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.

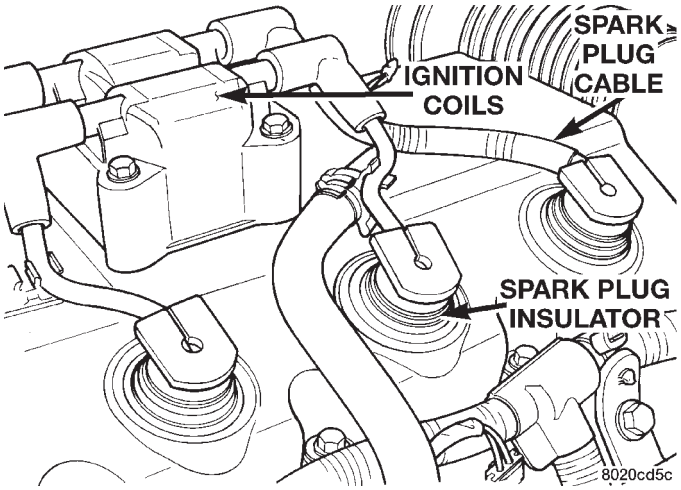


Fig. 3 Ignition Coil Pack—SOHC

AUTOMATIC SHUTDOWN RELAY

The Automatic Shutdown (ASD) relay supplies battery voltage to the fuel injectors, electronic ignition coil and the heating elements in the oxygen sensors.

A buss bar in the Power Distribution Center (PDC) supplies voltage to the solenoid side and contact side of the relay. The ASD relay power circuit contains a 20 amp fuse between the buss bar in the PDC and the relay. The fuse also protects the power circuit for the fuel pump relay and pump. The fuse is located in the PDC. Refer to Group 8W, Wiring Diagrams for circuit information.

The PCM controls the ASD relay by switching the ground path for the solenoid side of the relay on and off. The PCM turns the ground path off when the ignition switch is in the Off position. When the ignition switch is in On or Start, the PCM monitors the crankshaft and camshaft position sensor signals to determine engine speed and ignition timing (coil dwell). If the PCM does not receive crankshaft and camshaft position sensor signals when the ignition switch is in the Run position, it will de-energize the ASD relay.

The ASD relay is located in the PDC (Fig. 4). The inside top of the PDC cover has label showing relay and fuse identification.

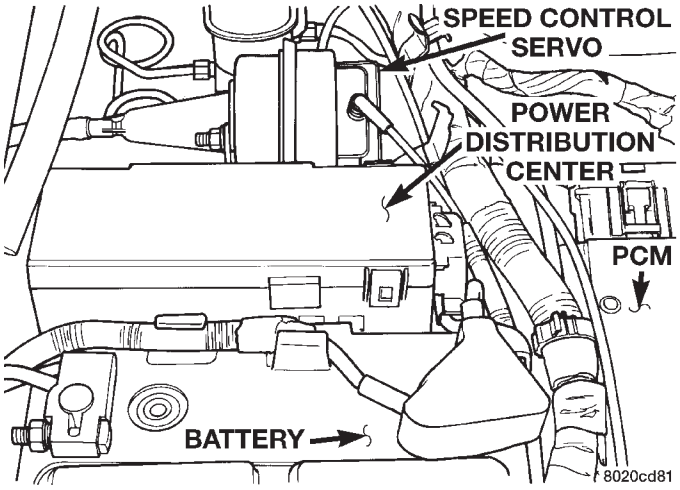


Fig. 4 Power Distribution Center (PDC)

DESCRIPTION AND OPERATION (Continued)

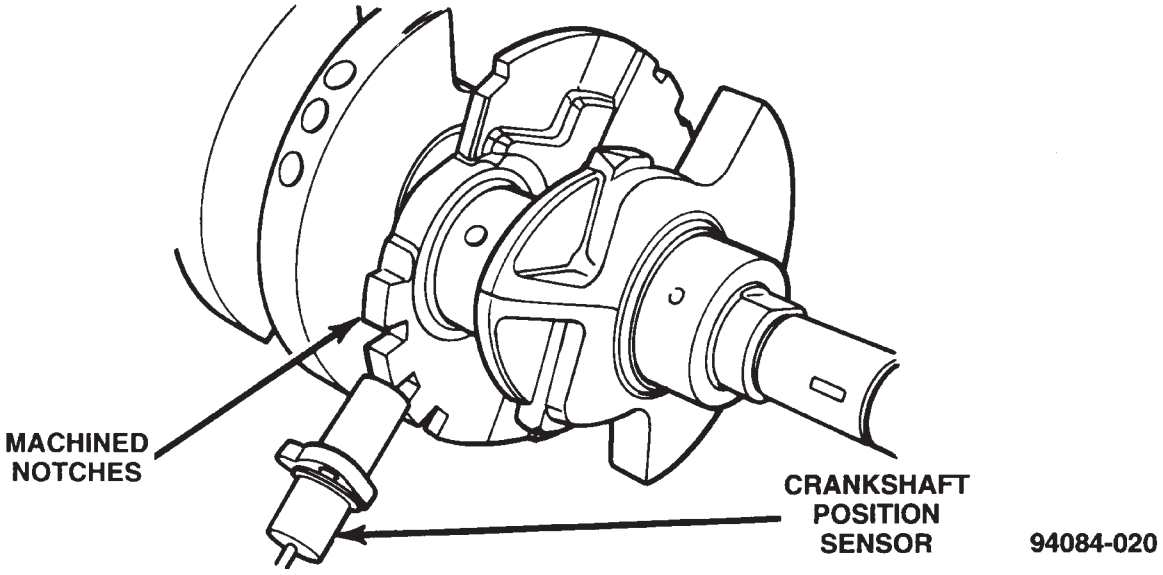


Fig. 5 Timing Reference Notches

CRANKSHAFT POSITION SENSOR

The PCM determines what cylinder to fire from the crankshaft position sensor input and the camshaft position sensor input. The second crankshaft counterweight has machined into it two sets of four timing reference notches including a 60 degree signature notch (Fig. 5). From the crankshaft position sensor input the PCM determines engine speed and crankshaft angle (position).

The notches generate pulses from high to low in the crankshaft position sensor output voltage. When a metal portion of the counterweight aligns with the crankshaft position sensor, the sensor output voltage goes low (less than 0.5 volts). When a notch aligns with the sensor, voltage goes high (5.0 volts). As a group of notches pass under the sensor, the output voltage switches from low (metal) to high (notch) then back to low.

If available, an oscilloscope can display the square wave patterns of each voltage pulse. From the frequency of the output voltage pulses, the PCM calculates engine speed. The width of the pulses represent the amount of time the output voltage stays high before switching back to low. The period of time the sensor output voltage stays high before switching back to low is referred to as pulse-width. The faster the engine is operating, the smaller the pulse-width on the oscilloscope.

By counting the pulses and referencing the pulse from the 60 degree signature notch, the PCM calculates crankshaft angle (position). In each group of timing reference notches, the first notch represents 69 degrees before top dead center (BTDC). The second notch represents 49 degrees BTDC. The third notch represents 29 degrees. The last notch in each set represents 9 degrees before top dead center BTDC.

The timing reference notches are machined at 20° increments. From the voltage pulse-width the PCM tells the difference between the timing reference notches and the 60 degree signature notch. The 60 degree signature notch produces a longer pulse-width than the smaller timing reference notches. If the camshaft position sensor input switches from high to low when the 60 degree signature notch passes under the crankshaft position sensor, the PCM knows cylinder number one is the next cylinder at TDC.

The crankshaft position sensor mounts to the engine block behind the generator, just above the oil filter (Fig. 6).

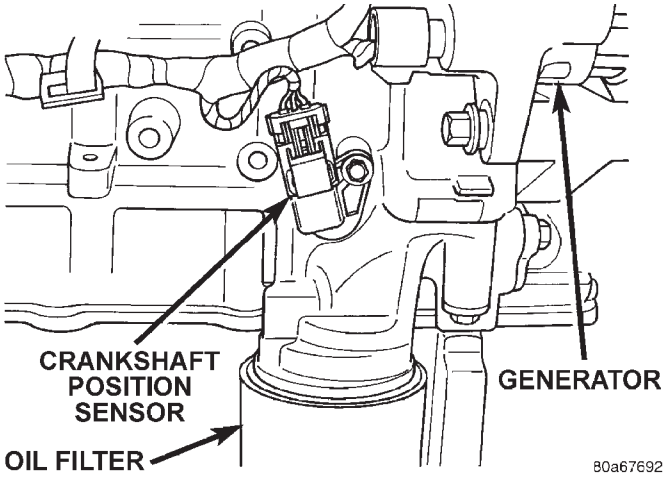


Fig. 6 Crankshaft Position Sensor

DESCRIPTION AND OPERATION (Continued)

CAMSHAFT POSITION SENSOR

The PCM determines fuel injection synchronization and cylinder identification from inputs provided by the camshaft position sensor (Fig. 7) or (Fig. 8) and crankshaft position sensor. From the two inputs, the PCM determines crankshaft position.

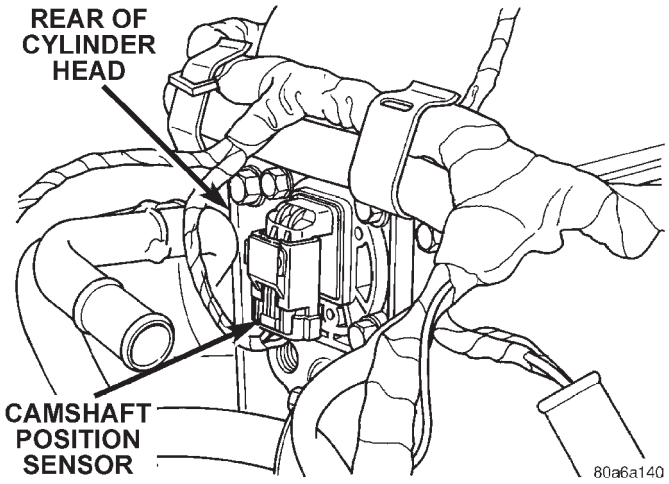


Fig. 7 Camshaft Position Sensor—SOHC

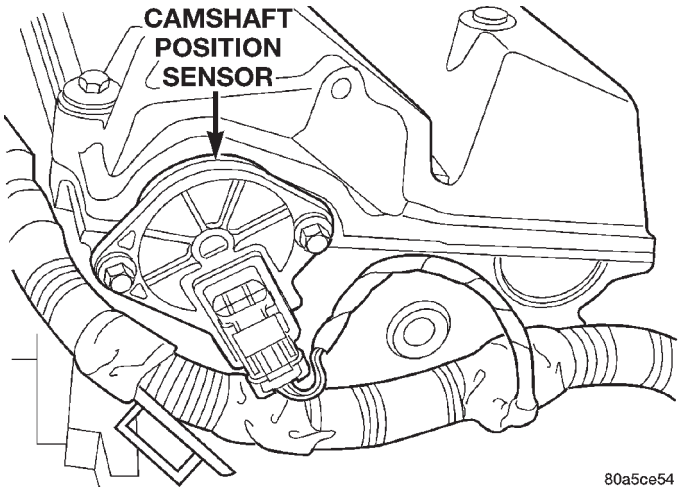


Fig. 8 Camshaft Position Sensor—DOHC

The camshaft position sensor attaches to the rear of the cylinder head (Fig. 9). A target magnet attaches to the rear of the camshaft and indexes to the correct position. The target magnet has four different poles arranged in an asymmetrical pattern. As the target magnet rotates, the camshaft position sensor senses the change in polarity (Fig. 10). The sensor input switches from high (5 volts) to low (0.30 volts) as the target magnet rotates. When the north pole of the target magnet passes under the sensor, the output switches high. The sensor output switches low when the south pole of the target magnet passes underneath.

The camshaft position sensor is mounted to the rear of the cylinder head. The sensor also acts as a thrust plate to control camshaft endplay on SOHC engines.

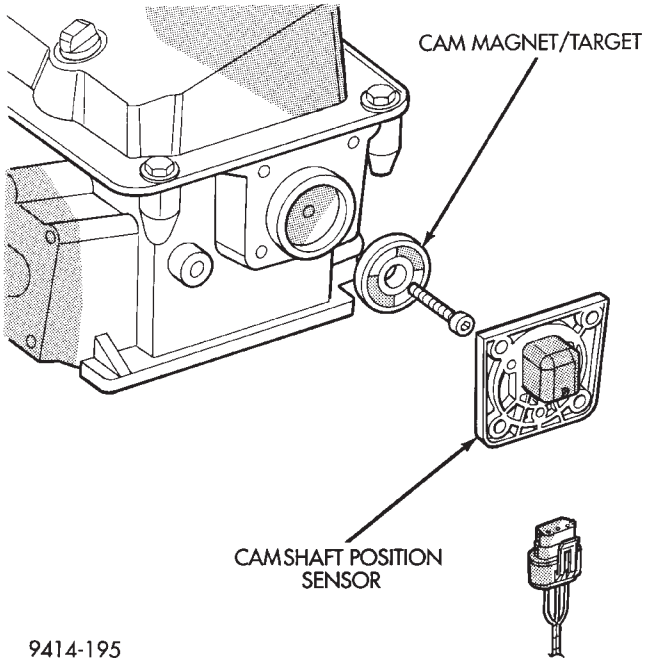


Fig. 9 Target Magnet —Typical

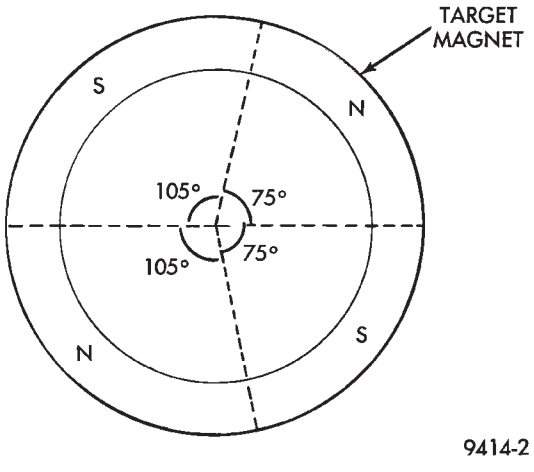


Fig. 10 Target Magnet Polarity

COMBINATION ENGINE COOLANT TEMPERATURE SENSOR

The coolant temperature sensor provides an input voltage to the PCM and a separate input voltage to the temperature gauge on the instrument panel. The PCM determines engine coolant temperature from the coolant temperature sensor. As coolant temperature varies, the coolant temperature sensor resistance changes resulting in a different input voltage to the PCM.

When the engine is cold, the PCM will demand slightly richer air-fuel mixtures and higher idle

DESCRIPTION AND OPERATION (Continued)

speeds until normal operating temperatures are reached.

SOHC

The coolant sensor threads into the end of the cylinder head, next to the camshaft position sensor (Fig. 11). New sensors have sealant applied to the threads.

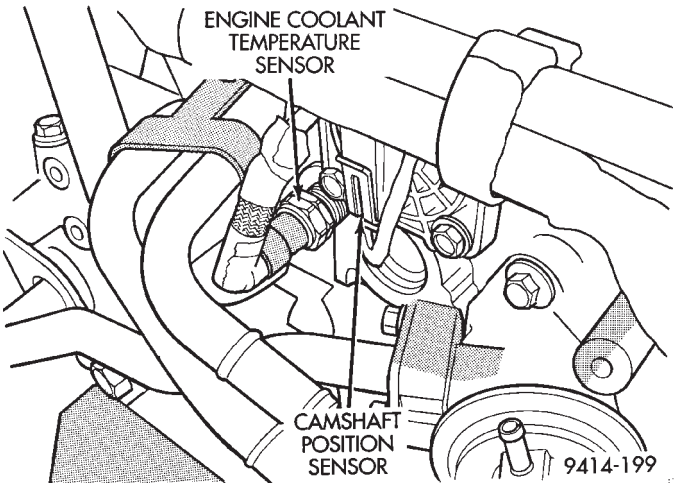


Fig. 11 Engine Coolant Temperature Sensor—SOHC

DOHC

The coolant sensor threads into the intake manifold next to the thermostat housing. New sensors have sealant applied to the threads.

INTAKE AIR TEMPERATURE SENSOR

The intake air temperature 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 MAP/Intake Air Temperature (IAT) sensor, located on the intake manifold, combines the MAP and Intake Air Temperature (IAT) functions into one sensor (Fig. 12).

KNOCK SENSOR

The knock sensor threads into the side of the cylinder block in front of the starter motor. 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 for all cylinders by a scheduled amount.

Knock sensors 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.

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

MANIFOLD ABSOLUTE PRESSURE SENSOR (MAP)

The PCM supplies 5 volts to the MAP sensor. The MAP sensor function 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.

During cranking, 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/IAT sensor mounts to the intake manifold (Fig. 12).

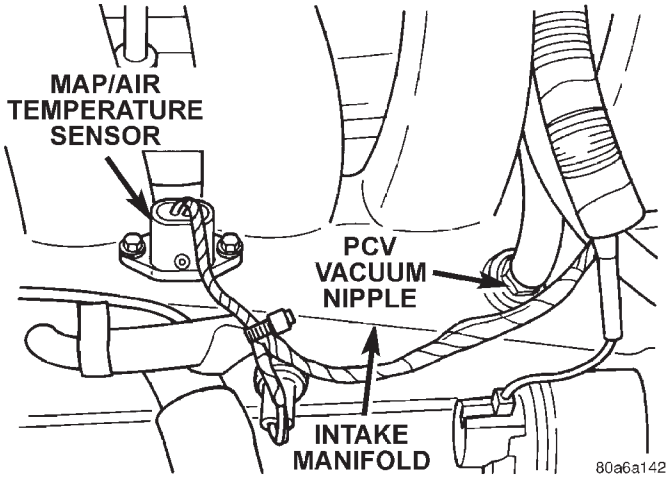


Fig. 12 MAP/IAT sensor—SOHC

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.

DESCRIPTION AND OPERATION (Continued)

IGNITION SWITCH

In the RUN position, the ignition switch connects power from the Power Distribution Center (PDC) to a 30 amp fuse in the fuse block, back to a bus bar in the PDC. The bus bar feeds circuits for the Powertrain Control Module (PCM), duty cycle purge solenoid, EGR solenoid, and ABS system. The bus bar in the PDC feeds the coil side of the radiator fan relay, A/C compressor clutch relay, and the fuel pump relay. It also feeds the Airbag Control Module (ACM)

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. 13):

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

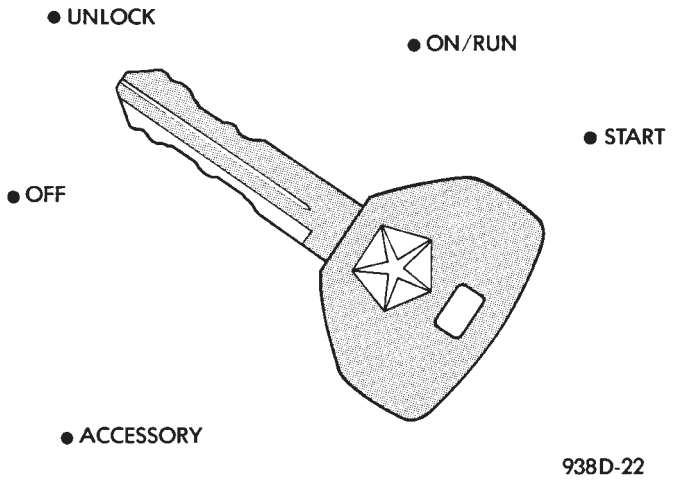


Fig. 13 Ignition Lock Cylinder Detents

DIAGNOSIS AND TESTING

TESTING FOR SPARK AT COIL—2.0L

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

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

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

CAUTION: Do not leave any one spark plug cable disconnected any longer than 30 seconds or possible heat damage to catalytic converter will occur.

CAUTION: Test must be performed at idle and in park only with the parking brake on.

NOTE: New isolated engine valve cover may not provide adequate ground. Use engine block as engine ground.

Use a new spark plug and spark plug cable for the following test.

(1) Insert a new spark plug into the new spark plug boot. Ground the plug to the engine (Fig. 14). Do not hold with your hand.

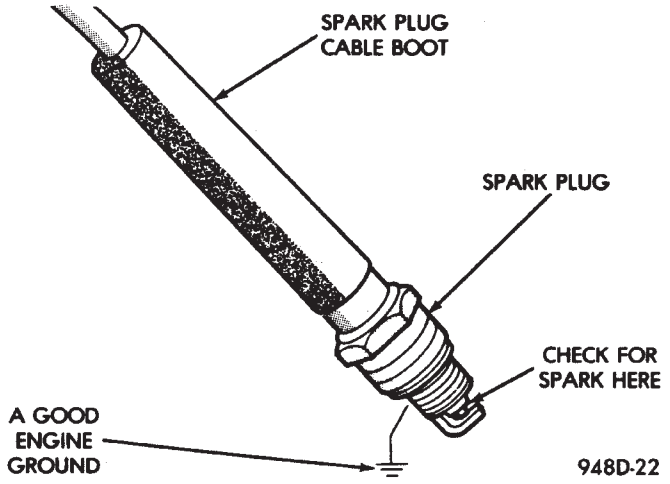


Fig. 14 Testing For Spark

(2) Starting with coil insulator #1, remove it from the DIS coil.

(3) Plug the test spark plug cable onto #1 coil tower. Make sure a good connection is made; there should be a click sound.

(4) Crank the engine and look for spark across the electrodes of the spark plug.

CAUTION: Always install the cable back on the coil tower after testing to avoid damage to the coil and catalytic converter.

(5) Repeat the above test for the remaining coils. If there is no spark during all cylinder tests, proceed to the Failure To Start Test.

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

DIAGNOSIS AND TESTING (Continued)

CHECK COIL TEST

NOTE: Coil one fires cylinders 1 and 4, coil two fires cylinders 2 and 3. Each coil tower is labeled with the number of the corresponding cylinder.

(1) Remove the ignition cables and measure the resistance of the cables. Resistance must be between ranges shown in chart in specifcation section in this group. Replace any cable not within tolerance.

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

(3) Measure the primary resistance of each coil. At the coil, connect an ohmmeter between the B+ pin and the pin corresponding to the cylinders in question (Fig. 15). Resistance on the primary side of each coil should be 0.45 - 0.65 ohm. Replace the coil if resistance is not within tolerance.

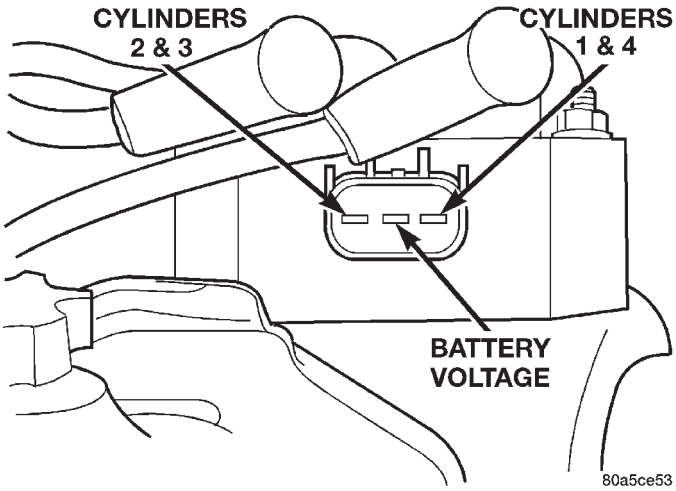


Fig. 15 Terminal Identification

(4) Remove ignition cables from the secondary towers of the coil. Measure the secondary resistance of the coil between the towers of each individual coil (Fig. 16). Secondary resistance should be 11,000 to 14,000 ohms. Replace the coil if resistance is not within tolerance.

FAILURE TO START TEST—2.0L

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

Use the DRB scan tool to test the camshaft position sensor and the sensor circuits. Refer to the appropriate Powertrain Diagnostics Procedure Manual. Refer to the wiring diagrams section for circuit information.

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

When the ignition key is turned and left in the On position, the PCM automatically energizes the Auto

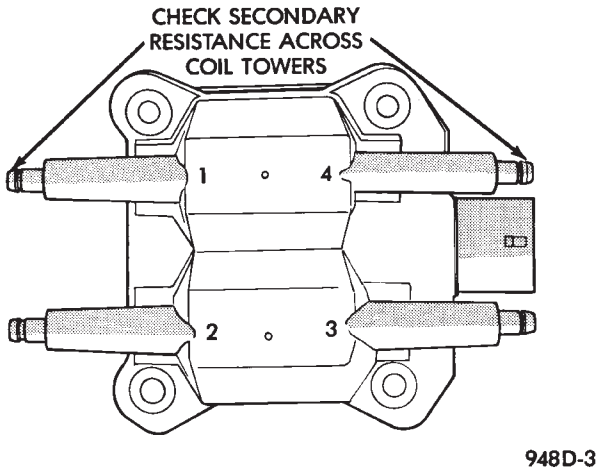


Fig. 16 Checking Ignition Coil Secondary Resistance

Shutdown (ASD) relay. However, the controller de-energizes the relay within one second because it has not received a camshaft position sensor signal indicating engine rotation.

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

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

(2) Disconnect the harness connector from the coil pack (Fig. 17).

(3) Connect a test light to the B+ (battery voltage) terminal of the coil electrical connector and ground. The B+ wire for the DIS coil is the center terminal. **Do not spread the terminal with the test light probe.**

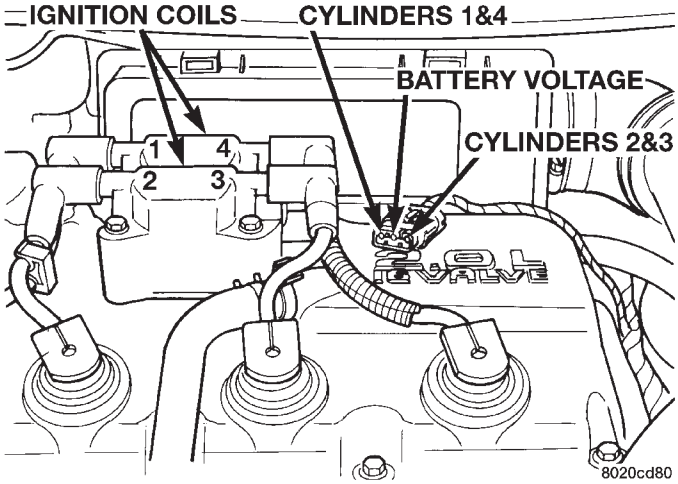


Fig. 17 Ignition Coil Engine Harness Connector

DIAGNOSIS AND TESTING (Continued)

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

(a) If the test light flashes momentarily, the PCM grounded the ASD relay. Proceed to step 5.

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

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

(6) If the test light momentarily flashes during cranking, the PCM is not receiving a crankshaft position sensor signal.

(7) If the test light did not flash during cranking, unplug the crankshaft position sensor connector. Turn the ignition key to the off position. Turn the key to the On position, wait for the test light to momentarily flash once, then crank the engine. If the test light momentarily flashes, the crankshaft position sensor is shorted and must be replaced. If the light did not flash, the cause of the no-start is in either the crankshaft position sensor/camshaft position sensor 8 volt supply circuit, or the camshaft position sensor output or ground circuits.

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 Moper Diagonostic 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.

DIAGNOSIS AND TESTING (Continued)

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. 18). 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-platnium 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.

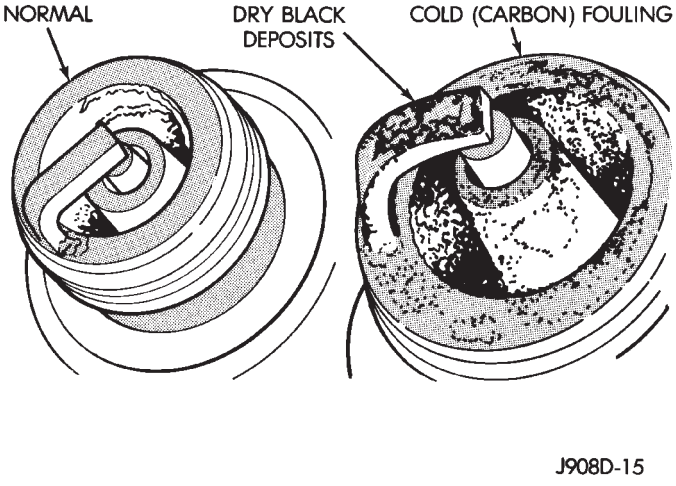


Fig. 18 Normal Operation and Cold (Carbon) Fouling

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. 18). 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.**

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. 19). Sometimes fuel additives can cause ash encrustation on an entire set of spark plugs. **Ash encrusted spark plugs can be cleaned and reused.**

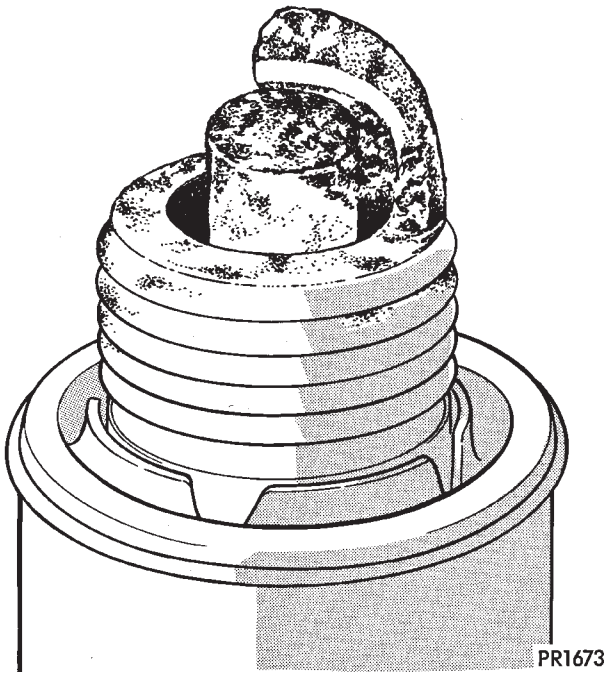


Fig. 19 Oil or Ash Encrusted

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.

DIAGNOSIS AND TESTING (Continued)

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. 20). This short circuits the electrodes. **Spark plugs with electrode gap bridging can be cleaned and reused.**

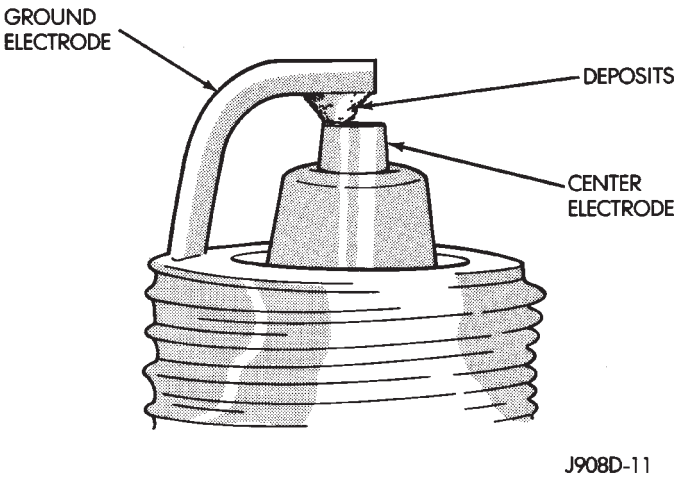


Fig. 20 Electrode Gap Bridging

SCAVENGER DEPOSITS

Fuel scavenger deposits may be either white or yellow (Fig. 21). They may appear to be harmful, but are a normal condition caused by chemical additives in certain fuels. These additives are designed to change the chemical nature of deposits and decrease spark plug misfire tendencies. Notice that accumulation on the ground electrode and shell area may be heavy but the deposits are easily removed. **Spark plugs with scavenger deposits can be considered normal in condition, cleaned and reused.**

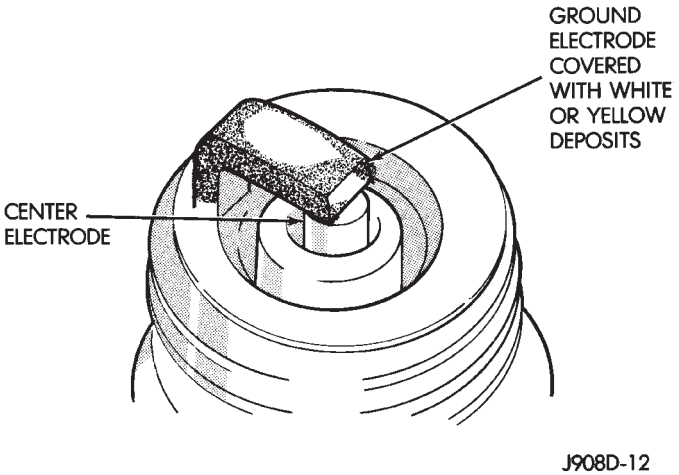


Fig. 21 Scavenger Deposits

CHIPPED ELECTRODE INSULATOR

A chipped electrode insulator usually results from bending the center electrode while adjusting the spark plug electrode gap. Under certain conditions, severe detonation also can separate the insulator from the center electrode (Fig. 22). **Spark plugs with chipped electrode insulators must be replaced.**

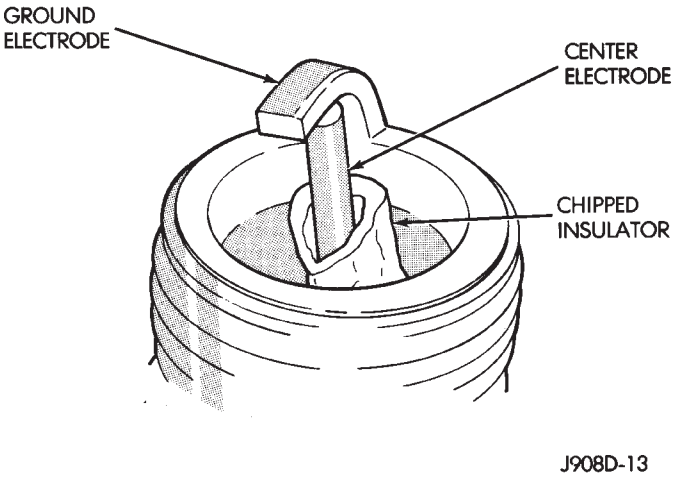


Fig. 22 Chipped Electrode Insulator

PREIGNITION DAMAGE

Excessive combustion chamber temperature can cause preignition damage. First, the center electrode dissolves and the ground electrode dissolves somewhat later (Fig. 23). 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.

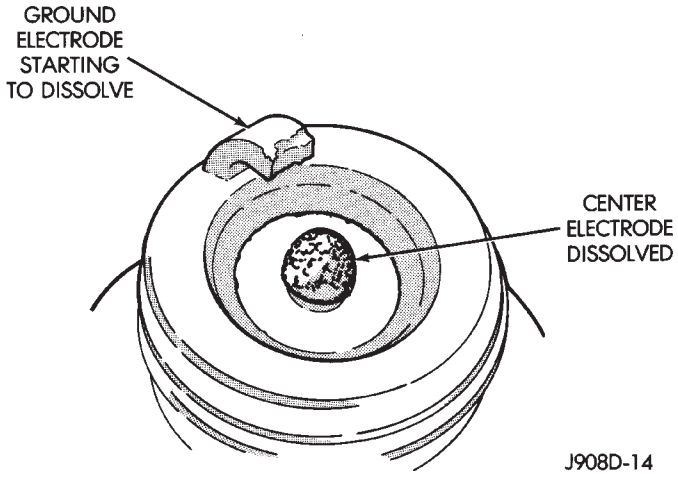


Fig. 23 Preignition Damage

SPARK PLUG OVERHEATING

Overheating is indicated by a white or gray center electrode insulator that also appears blistered (Fig. 24). The increase in electrode gap will be consider-

DIAGNOSIS AND TESTING (Continued)

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.

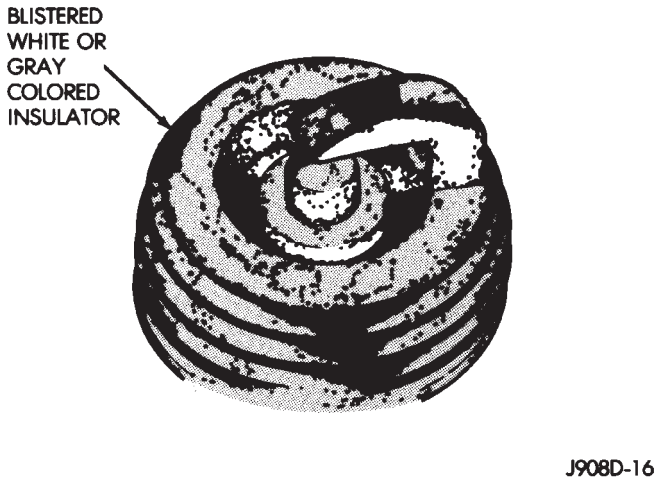


Fig. 24 Spark Plug Overheating

REMOVAL AND INSTALLATION

SPARK PLUG SERVICE

Failure to route the cables properly could cause the radio to reproduce ignition noise, cross ignition of the spark plugs or short circuit the cables to ground.

REMOVAL

REMOVE CABLES FROM COIL FIRST.

Always remove the spark plug cable by grasping the top of the spark plug insulator, turning the boot 1/2 turn and pulling straight up in a steady motion.

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

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

(3) Install spark plug insulators over spark plugs. Ensure the top of the spark plug insulator covers the upper end of the spark plug tube.

Reconnect to coil.

SPARK PLUG CABLE SERVICE

Failure to route the cables properly could cause the radio to reproduce ignition noise, cross ignition of the spark plugs or short circuit the cables to ground.

REMOVAL

Remove spark plug cable from coil frist.

Always remove the spark plug cable by grasping the top of the spark plug insulator, turning the boot 1/2 turn and pulling straight up in a steady motion.

INSTALLATION

Install spark plug insulators over spark plugs. Ensure the top of the spark plug insulator covers the upper end of the spark plug tube.The connect the other end to coil pack. On **SOHC** engines, be sure that dual plastic clip holds #1,#2 cables off of valve cover and that PCV hose plastic clip holds #3 cable away from metal PCV clamp and edge of air duct. On **DOHC** , be sure that the plastic clip on PCV hose is positioned so that cable clip is beneath hose, and that #1 cable is snapped into this clip to protect it from metal PCV clamp.

SPARK PLUG TUBES

The spark plugs tubes are pressed into the cylinder head. Sealant is applied to the end of the tube before installation. For engine information, refer to Group 9, Engines.

IGNITION COIL

SOHC/DOHC

The electronic ignition coil pack attaches directly to the valve cover (Fig. 25).

REMOVAL

(1) Disconnect electrical connector from coil pack.
(2) Remove coil pack mounting nuts.
(3) Remove coil pack.

INSTALLATION

(1) Install coil pack on valve cover.

(2) Transfer spark plug cables to new coil pack. The coil pack towers are numbered with the cylinder identification. Be sure the ignition cables snap onto the towers.

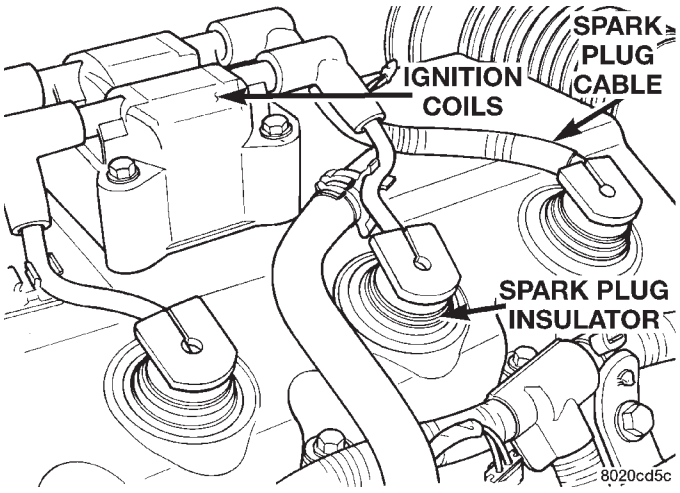


Fig. 25 Electronic Ignition Coil Pack—SOHC

REMOVAL AND INSTALLATION (Continued)

AUTOMATIC SHUTDOWN RELAY

The relay is located in the Power Distribution Center (PDC) (Fig. 26). The PDC is located next to the battery in the engine compartment. 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.

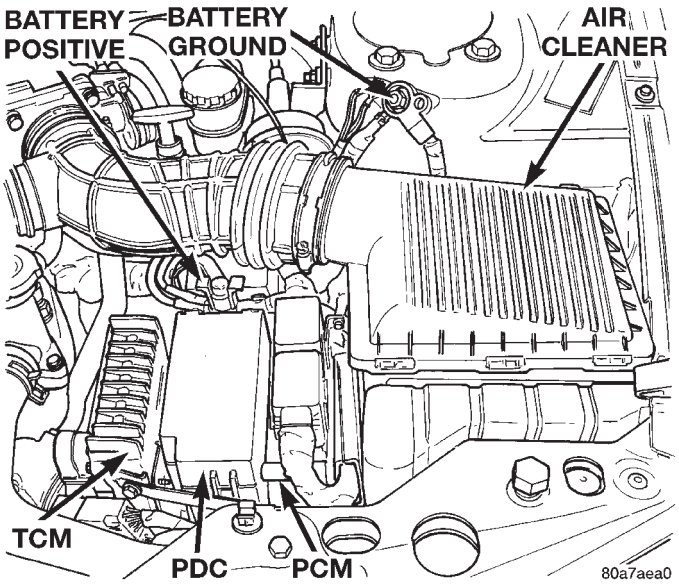


Fig. 26 Power Distribution Center (PDC)

CAMSHAFT POSITION SENSOR—SOHC

The camshaft position sensor is mounted to the rear of the cylinder head (Fig. 27).

REMOVAL

(1) Disconnect the filtered air tube from the throttle body and air cleaner housing. Remove filtered air tube.

(2) Remove the air cleaner inlet tube.

(3) Disconnect electrical connectors from engine coolant sensor and camshaft position sensor.

(4) Remove brake booster hose and electrical connector from holders on end of cylinder head cover.

(5) Remove camshaft position sensor mounting screws. Remove sensor.

(6) Loosen screw attaching target magnet to rear of camshaft (Fig. 28).

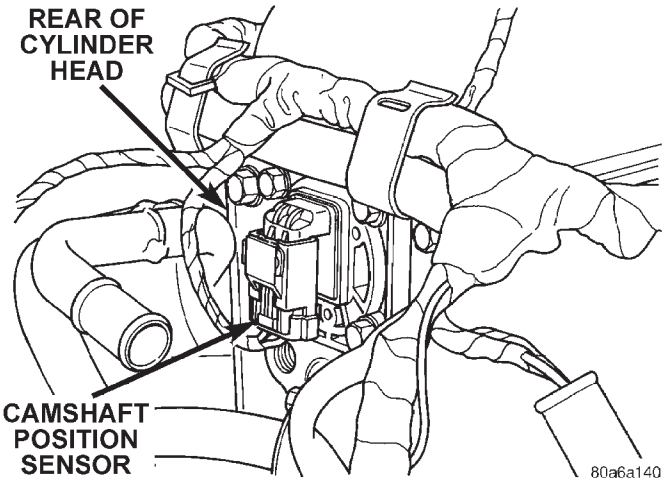


Fig. 27 Camshaft Position Sensor Location—SOHC

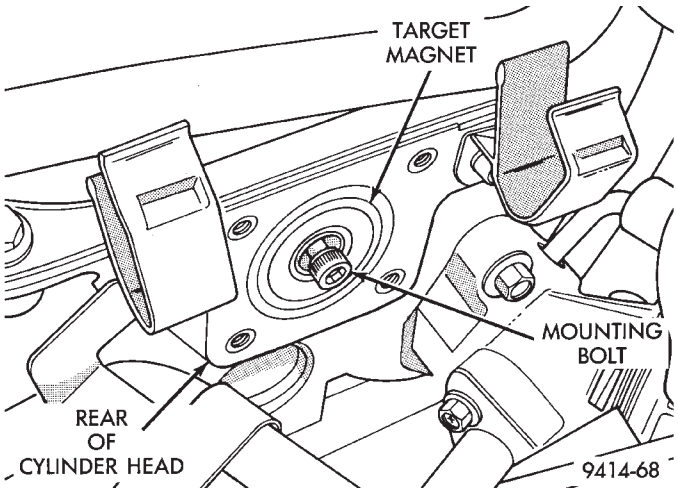


Fig. 28 Target Magnet Removal/Installation

INSTALLATION

The target magnet has two locating dowels that fit into machined locating holes in end of the camshaft.

(1) Install target magnet in end of camshaft. Tighten mounting screw to 3.4 N·m (30 in. lbs.) torque.

(2) Install camshaft position sensor. Tighten sensor mounting screws to 9 N·m (80 in. lbs.) torque.

(3) Place brake booster hose and electrical harness in holders on end of valve cover.

(4) Attach electrical connectors to coolant temperature sensor and camshaft position sensor.

(5) Install air cleaner inlet tube and filtered air tube.

REMOVAL AND INSTALLATION (Continued)

CRANKSHAFT POSITION SENSOR

The crankshaft position sensor mounts to the engine block behind the generator, just above the oil filter (Fig. 29).

REMOVAL

(1) Disconnect electrical connector from crankshaft position sensor.

(2) Remove sensor mounting screw. Remove sensor.

INSTALLATION

Reverse procedure for installation.

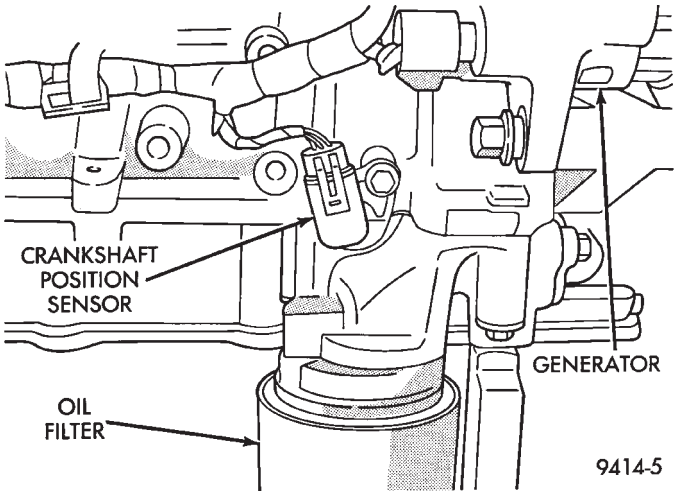


Fig. 29 Crankshaft Position Sensor

COMBINATION ENGINE COOLANT TEMPERATURE SENSOR—SOHC

The combination engine coolant sensor is located at the rear of the cylinder head next to the camshaft position sensor (Fig. 30). New sensors have sealant applied to the threads.

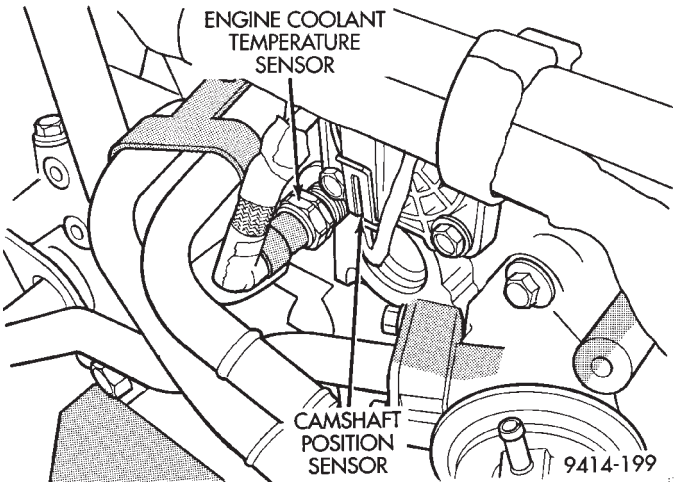


Fig. 30 Engine Coolant Temperature Sensor

REMOVAL

(1) With the engine cold, drain the cooling system until coolant level drops below sensor. Refer to Group 7, Cooling System.

(2) Disconnect coolant sensor electrical connector.

(3) Remove coolant sensor

INSTALLATION

(1) Install coolant sensor. Tighten sensor to 18.6 N·m (165 in. lbs.) torque.

(2) Attach electrical connector to sensor.

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

MAP/IAT SENSOR—SOHC

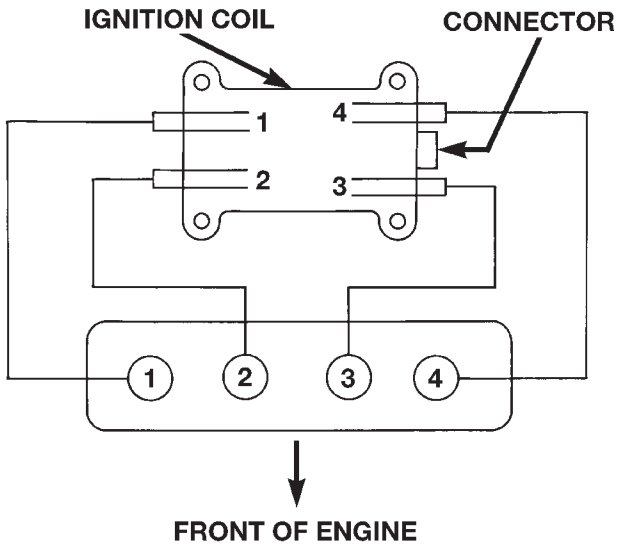
Refer to Group 14, Fuel Injection Section for Removal/Installation.

THROTTLE POSITION SENSOR

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

SPECIFICATIONS

FIRING ORDER—2.0L



FIRING ORDER 1-3-4-2

8008a549

SPECIFICATIONS (Continued)

TORQUE SPECIFICATION

DESCRIPTION	TORQUE
Camshaft Position Sensor Screw	9 N·m (80 in. lbs.)
SOHC Cam Magnet/Target	3.4 N·m (30 in. lbs.)
DOHC Cam Magnet/Target	3 N·m (30 in. lbs.)
Crankshaft Position Sensor Screw	9 N·m (80 in. lbs.)
Coolant Temp. Sensor	18.6 N·m (165 in. lbs.)
Ignition Coil to Cyl. Head	22 N·m (200 in. lbs.)
Ignition Coil Bracket Nuts	22 N·m (200 in. lbs.)
Knock Sensor	10 N·m (90 in. lbs.)
MAP/IAT Sensor Plastic Manifold	2 N·m (20 in. lbs.)
MAP/IAT Sensor Aluminum Manifold	3 N·m (30 in. lbs.)
Spark Plugs	28 N·m (20 ft. lbs.)

SPARK PLUG CABLE RESISTANCE—SOHC

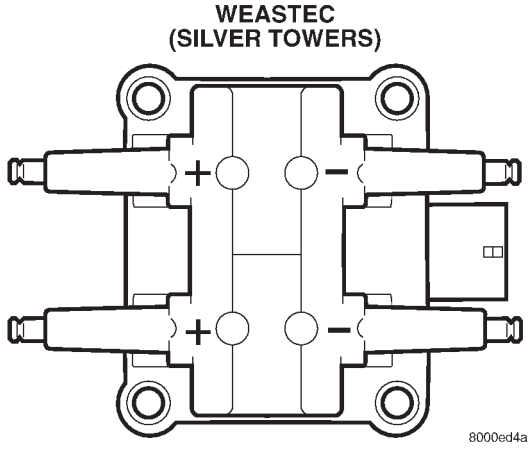
CABLE	RESISTANCE
#1,#4	3500 ohms— 4900 ohms
#2,#3	2950 ohms— 4100 ohms

SPARK PLUG

Engine	Spark Plug	Gap	Thread Size
2.0L	RC9YC	0.033 TO 0.038	14mm (3/4 in.) reach

IGNITION COIL

Coil Manufacture	Primary Resistance at 21°C-27°C (70°F-80°F)	Secondary Resistance at 21°C-27°C (70°F-80°F)
Weastec (Steel Towers)	0.45 to 0.65 Ohms	7,000 to 15,800 Ohms



Coil Polarity