IGNITION CONTROL

TABLE OF CONTENTS

IGNITION CONTROL

DESCRIPTION - 8.0L V-10

The ignition system used on the 8.0L V–10 engine does not use a conventional mechanical distributor. The system will be referred to as a distributor-less ignition system.

OPERATION

OPERATION - 8.0L V-10

The ignition coils are individually fired, but each coil is a dual output. Refer to Ignition Coil for additional information.

The ignition system is controlled by the Powertrain Control Module (PCM) on all engines.

The ignition system consists of:

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

OPERATION - V-8

The ignition system is controlled by the Powertrain Control Module (PCM) on all engines.

The ignition system consists of:

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

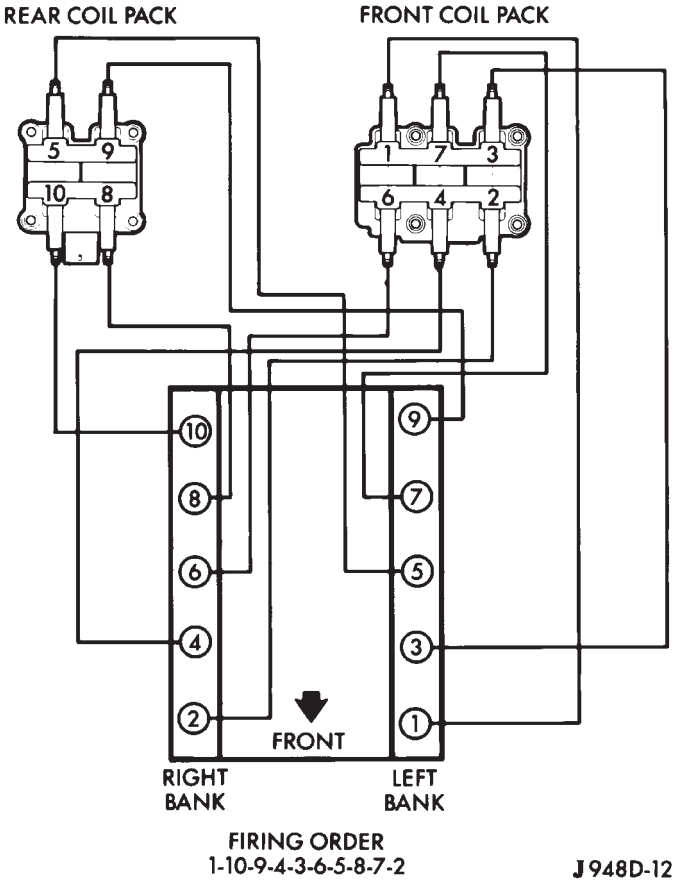
SPECIFICATIONS

SPECIFICATIONS - TORQUE - IGNITION

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Camshaft Position Sensor—8.0L Engine	6	-	50
Crankshaft Position Sensor—All Engines	8	-	70
Distributor Hold Down Bolt	23	17	-
Ignition Coil Mounting—5.9L Engines—if tapped bolts are used	5	-	50
Ignition Coil Mounting—5.9L Engines—if nuts/bolts are used	11	-	100
Ignition Coil Mounting—8.0L Engine	10	-	90
Spark Plugs (all engines)	41	-	30

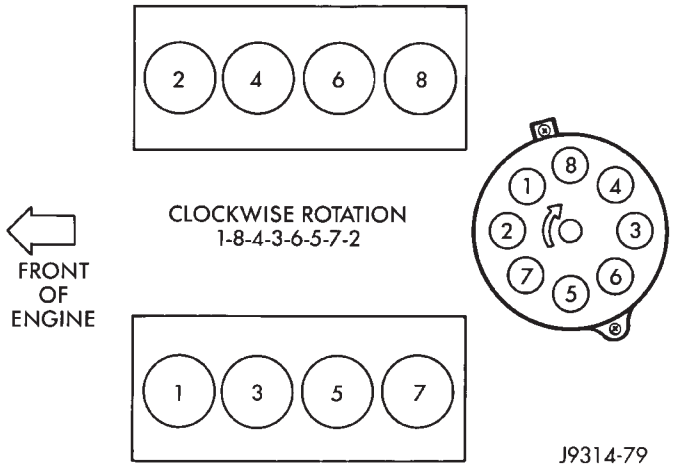
IGNITION CONTROL (Continued)

SPARK PLUG CABLE ORDER—8.0L V-10 ENGINE



Spark Plug Cable Order—8.0L V-10 Engine

ENGINE FIRING ORDER—5.9L V-8 ENGINES



SPARK PLUG CABLE RESISTANCE

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

SPARK PLUGS

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

IGNITION COIL RESISTANCE—5.9L ENGINES

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

IGNITION CONTROL (Continued)

IGNITION COIL RESISTANCE—8.0L V-10 ENGINE

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

IGNITION TIMING

Ignition timing is not adjustable on any engine.

AUTOMATIC SHUT DOWN RELAY

DESCRIPTION - PCM OUTPUT

The 5–pin, 12–volt, Automatic Shutdown (ASD) relay is located in the Power Distribution Center (PDC). Refer to label on PDC cover for relay location.

OPERATION

OPERATION - PCM OUTPUT

The ASD relay supplies battery voltage (12+ volts) to the fuel injectors and ignition coil(s). With certain emissions packages it also supplies 12–volts to the oxygen sensor heating elements.

The ground circuit for the coil within the ASD relay is controlled by the Powertrain Control Module (PCM). The PCM operates the ASD relay by switching its ground circuit on and off.

The ASD relay will be shut–down, meaning the 12–volt power supply to the ASD relay will be de-activated by the PCM if:

- the ignition key is left in the ON position. This is if the engine has not been running for approximately 1.8 seconds.
- there is a crankshaft position sensor signal to the PCM that is lower than pre-determined values.

OPERATION - ASD SENSE - PCM INPUT

A 12 volt signal at this input indicates to the PCM that the ASD has been activated. The relay is used to connect the oxygen sensor heater element, ignition coil and fuel injectors to 12 volt + power supply.

This input is used only to sense that the ASD relay is energized. If the Powertrain Control Module (PCM) does not see 12 volts at this input when the ASD should be activated, it will set a Diagnostic Trouble Code (DTC).

DIAGNOSIS AND TESTING - ASD AND FUEL PUMP RELAYS

The following description of operation and tests apply only to the Automatic Shutdown (ASD) and fuel pump relays. The terminals on the bottom of each relay are numbered. Two different types of relays may be used, (Fig. 1) or (Fig. 2).

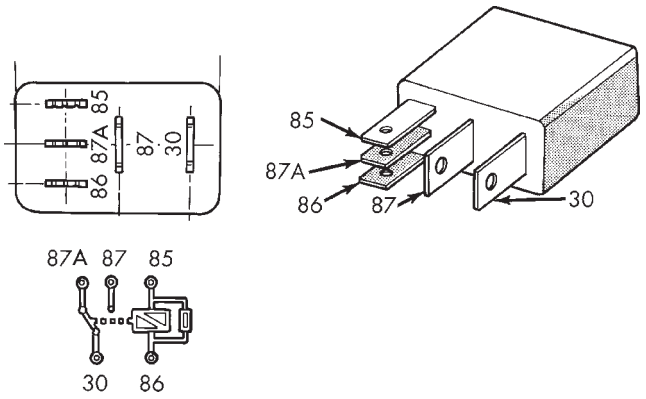


Fig. 1 ASD and Fuel Pump Relay Terminals—Type 1

TERMINAL LEGEND

NUMBER	IDENTIFICATION
30	COMMON FEED
85	COIL GROUND
86	COIL BATTERY
87	NORMALLY OPEN
87A	NORMALLY CLOSED

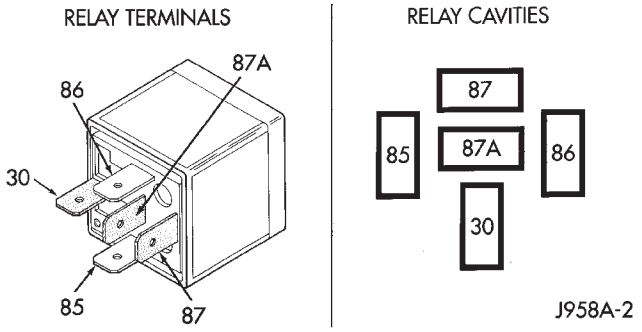


Fig. 2 ASD and Fuel Pump Relay Terminals—Type 2

TERMINAL LEGEND

NUMBER	IDENTIFICATION
30	COMMON FEED
85	COIL GROUND
86	COIL BATTERY
87	NORMALLY OPEN
87A	NORMALLY CLOSED

AUTOMATIC SHUT DOWN RELAY (Continued)

- Terminal number 30 is connected to battery voltage. For both the ASD and fuel pump relays, terminal 30 is connected to battery voltage at all times.
- The PCM grounds the coil side of the relay through terminal number 85.
- Terminal number 86 supplies voltage to the coil side of the relay.
- When the PCM de-energizes the ASD and fuel pump relays, terminal number 87A connects to terminal 30. This is the Off position. In the off position, voltage is not supplied to the rest of the circuit. Terminal 87A is the center terminal on the relay.
- When the PCM energizes the ASD and fuel pump relays, terminal 87 connects to terminal 30. This is the On position. Terminal 87 supplies voltage to the rest of the circuit.

The following procedure applies to the ASD and fuel pump relays.

(1) Remove relay from connector before testing.

(2) With the relay removed from the vehicle, use an ohmmeter to check the resistance between terminals 85 and 86. The resistance should be 75 ohms +/- 5 ohms.

(3) Connect the ohmmeter between terminals 30 and 87A. The ohmmeter should show continuity between terminals 30 and 87A.

(4) Connect the ohmmeter between terminals 87 and 30. The ohmmeter should not show continuity at this time.

(5) Connect one end of a jumper wire (16 gauge or smaller) to relay terminal 85. Connect the other end of the jumper wire to the ground side of a 12 volt power source.

(6) Connect one end of another jumper wire (16 gauge or smaller) to the power side of the 12 volt power source. **Do not attach the other end of the jumper wire to the relay at this time.**

WARNING: DO NOT ALLOW OHMMETER TO CONTACT TERMINALS 85 OR 86 DURING THIS TEST. DAMAGE TO OHMMETER MAY RESULT.

(7) Attach the other end of the jumper wire to relay terminal 86. This activates the relay. The ohmmeter should now show continuity between relay terminals 87 and 30. The ohmmeter should not show continuity between relay terminals 87A and 30.

(8) Disconnect jumper wires.

(9) Replace the relay if it did not pass the continuity and resistance tests. If the relay passed the tests, it operates properly. Check the remainder of the ASD and fuel pump relay circuits. Refer to 8, Wiring Diagrams.

REMOVAL

The ASD relay is located in the Power Distribution Center (PDC) (Fig. 3). Refer to label on PDC cover for relay location.

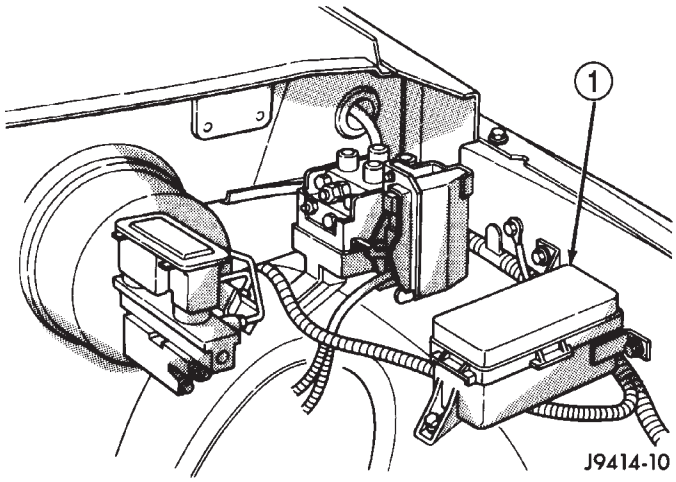


Fig. 3 Power Distribution Center (PDC)

1 - POWER DISTRIBUTION CENTER (PDC)

(1) Remove PDC cover.

(2) Remove relay from PDC.

(3) Check condition of relay terminals and PDC connector terminals for damage or corrosion. Repair if necessary before installing relay.

(4) Check for pin height (pin height should be the same for all terminals within the PDC connector). Repair if necessary before installing relay.

INSTALLATION

The ASD relay is located in the Power Distribution Center (PDC) (Fig. 3). Refer to label on PDC cover for relay location.

(1) Install relay to PDC.

(2) Install cover to PDC.

CAMSHAFT POSITION SENSOR

DESCRIPTION

DESCRIPTION - DIESEL

The three-wire Camshaft Position Sensor (CMP) is located below the fuel injection pump (Fig. 4). It is attached to the back of the timing gear cover housing.

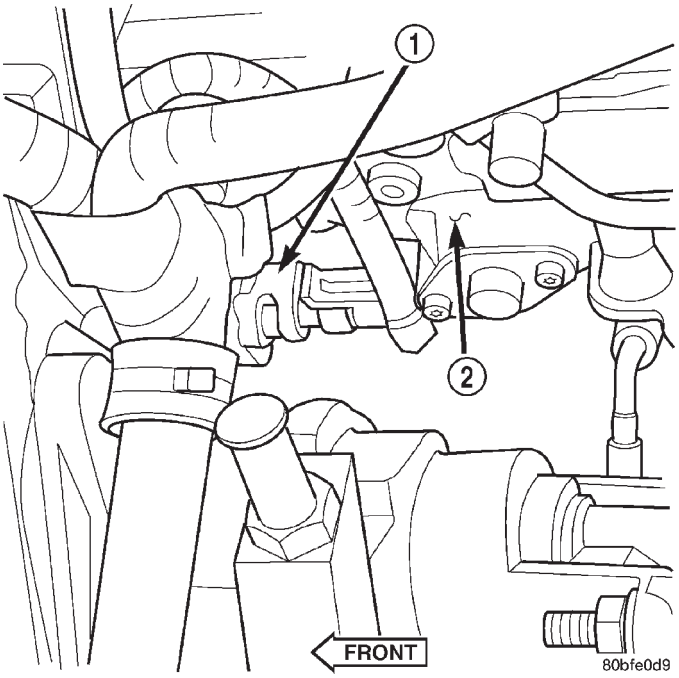


Fig. 4 Camshaft Position Sensor (CMP) Location

1 - CAMSHAFT POSITION SENSOR (CMP)
2 - BOTTOM OF FUEL INJECTION PUMP

DESCRIPTION - 5.9L

The Camshaft Position (CMP) sensor is located in the distributor.

DESCRIPTION - 8.0L

The Camshaft Position (CMP) sensor is located on the timing chain case/cover on the left-front side of the engine (Fig. 5).

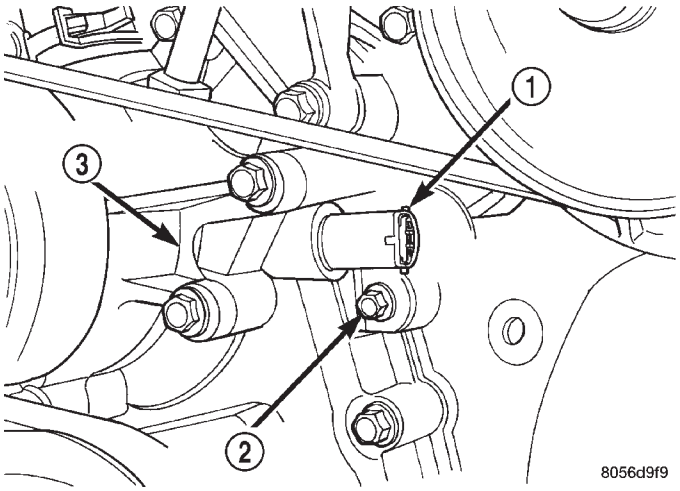


Fig. 5 CMP Sensor Location—8.0L V-10 Engine

1 - CAMSHAFT POSITION SENSOR
2 - MOUNTING BOLT
3 - TIMING CHAIN CASE/COVER

OPERATION

OPERATION - DIESEL

The Camshaft Position Sensor (CMP) performs multiple functions. One function is to detect engine speed (rpm). Another function is to relate crankshaft position and Top Dead Center (TDC) of the number 1 cylinder. Because the CMP is now used to relate crankshaft position, **the Crankshaft Position Sensor (CKP) is no longer used.**

The CMP (Fig. 6) contains a hall effect device called a sync signal generator to generate a sync signal.

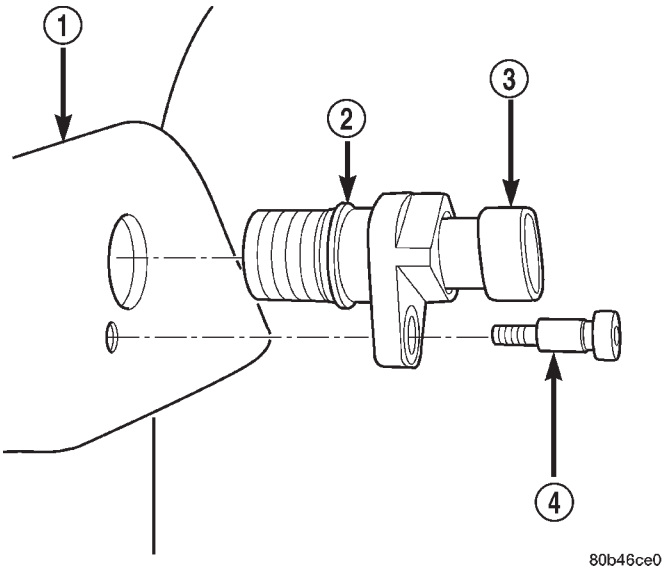


Fig. 6 Camshaft Position Sensor (CMP)

1 - GEAR HOUSING
2 - O-RING
3 - CMP SENSOR
4 - CMP HEX HEAD BOLT

The CMP uses three wires (circuits) for operation. One wire supplies a 5–volt signal from the Engine Control Module (ECM). Another wire supplies a sensor ground. The third wire supplies a signal back to

CAMSHAFT POSITION SENSOR (Continued)

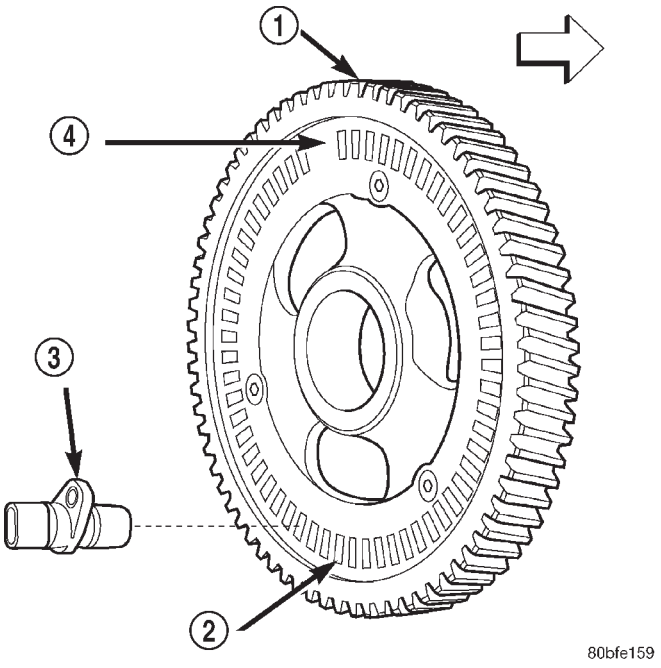


Fig. 7 Notches at Rear Of Camshaft Drive Gear

1 - CAMSHAFT DRIVE GEAR
2 - NOTCHES
3 - CAMSHAFT POSITION SENSOR (CKP)
4 - NO NOTCH

the ECM relating engine speed and crankshaft position.

The sensor detects machined notches on the rear face of the camshaft drive gear (Fig. 7) to sense engine speed.

The CMP also detects an area on the camshaft drive gear that has no notch (Fig. 7). When the sensor passes this area, it tells the Engine Control Module (ECM) that Top Dead Center (TDC) of the number 1 cylinder is occurring. The ECM will then adjust fuel timing accordingly.

As the tip of the sensor passes the notches, the interruption of magnetic field causes voltage changes from 5 volts to 0 volts.

OPERATION - 5.9L

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

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

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

OPERATION - 8.0L

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

A low and high area are machined into the camshaft drive gear (Fig. 8). The sensor is positioned in the timing gear cover so that a small air gap (Fig. 8) exists between the face of sensor and the high machined area of cam gear.

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

REMOVAL

REMOVAL - DIESEL

The camshaft position sensor (CMP) is located below the fuel injection pump (Fig. 9). It is attached to the back of the timing gear cover housing.

(1) Disconnect both negative cables from both batteries.
(2) Clean area around CMP.
(3) Disconnect electrical at CMP (Fig. 9).
(4) Remove CMP mounting bolt. Bolt head is female-hex (Fig. 10).
(5) Remove CMP from engine by twisting and pulling straight back.
(6) Discard CMP o-ring (Fig. 10).

REMOVAL - 5.9L

The camshaft position sensor is located in the distributor (Fig. 11).

Distributor removal is not necessary to remove camshaft position sensor.

(1) Remove air cleaner assembly.
(2) Disconnect negative cable from battery.
(3) Remove distributor cap from distributor (two screws).

CAMSHAFT POSITION SENSOR (Continued)

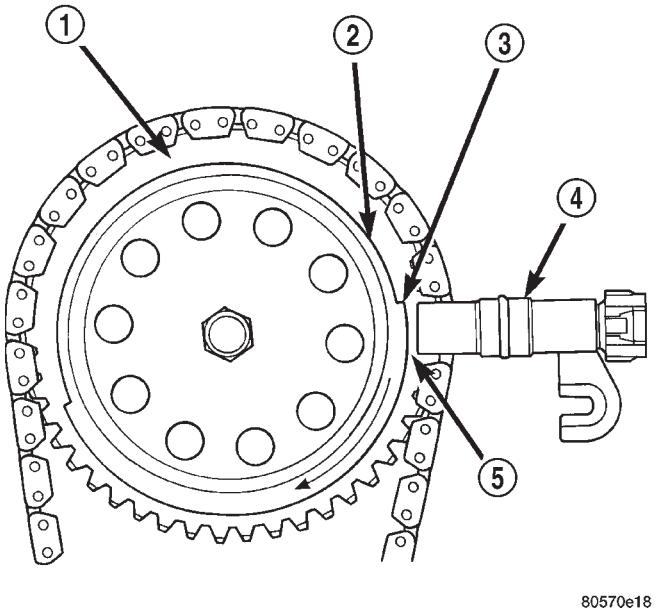


Fig. 8 CMP Sensor Operation—8.0L V-10 Engine

1 - CAM DRIVE GEAR
2 - LOW MACHINED AREA
3 - HIGH MACHINED AREA
4 - CAMSHAFT POSITION SENSOR
5 - AIR GAP

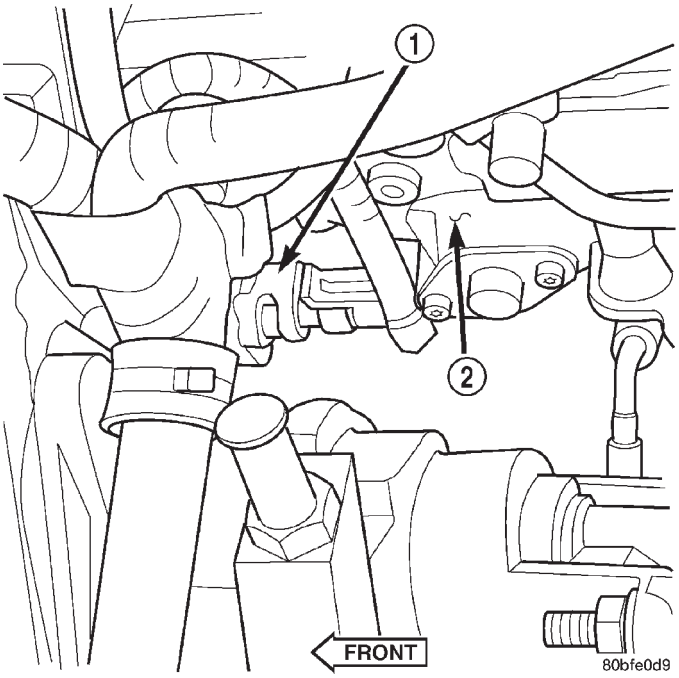


Fig. 9 CMP Location - Diesel

1 - CAMSHAFT POSITION SENSOR (CMP)
2 - BOTTOM OF FUEL INJECTION PUMP

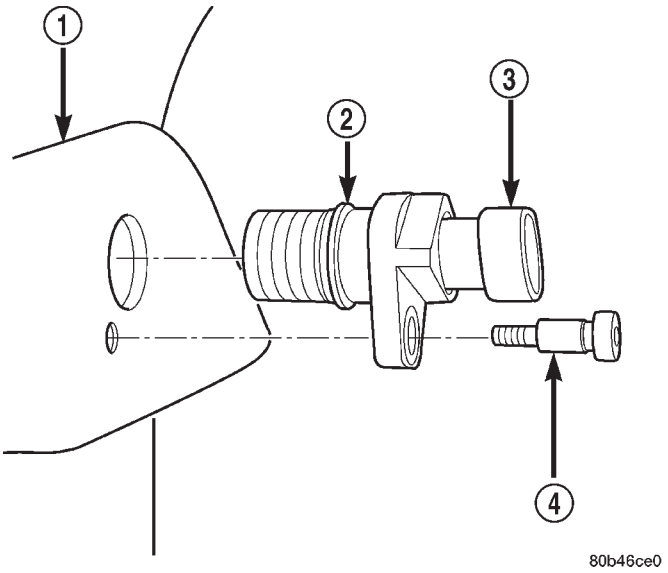


Fig. 10 CMP R/I - Diesel

1 - GEAR HOUSING
2 - O-RING
3 - CMP SENSOR
4 - CMP HEX HEAD BOLT

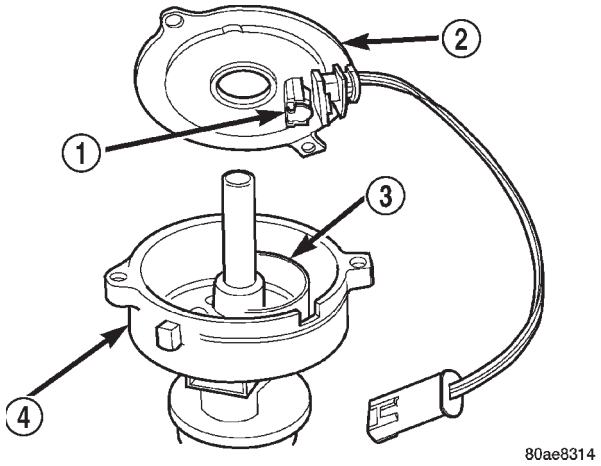


Fig. 11 Camshaft Position Sensor—Typical

1 - SYNC SIGNAL GENERATOR
2 - CAMSHAFT POSITION SENSOR
3 - PULSE RING
4 - DISTRIBUTOR ASSEMBLY

(4) Disconnect camshaft position sensor wiring harness from main engine wiring harness.
(5) Remove distributor rotor from distributor shaft.
(6) Lift the camshaft position sensor assembly from the distributor housing (Fig. 11).

REMOVAL - 8.0L

The camshaft position sensor is located on the timing chain case/cover on the left-front side of the engine (Fig. 12).

CAMSHAFT POSITION SENSOR (Continued)

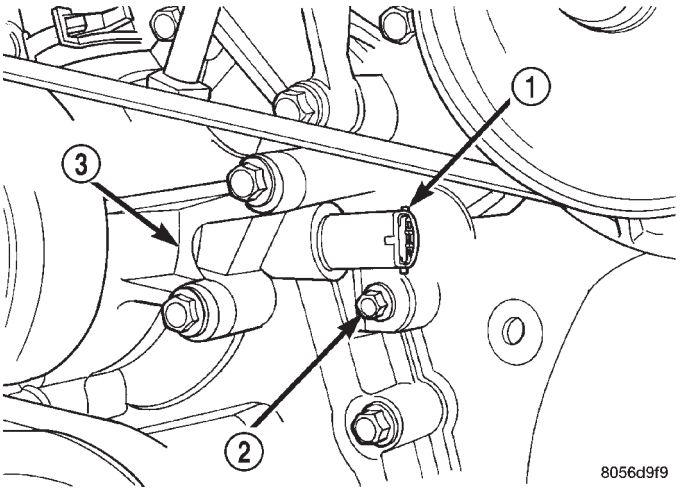


Fig. 12 CMP Location - 8.0L

1 - CAMSHAFT POSITION SENSOR
2 - MOUNTING BOLT
3 - TIMING CHAIN CASE/COVER

A thin plastic rib is molded into the face of the sensor (Fig. 13) to position the depth of sensor to the upper cam gear (sprocket). This rib can be found on both the new replacement sensors and sensors that were originally installed to the engine. The first time the engine has been operated, part of this rib may be sheared (ground) off. Depending on parts tolerances, some of the rib material may still be observed after removal.

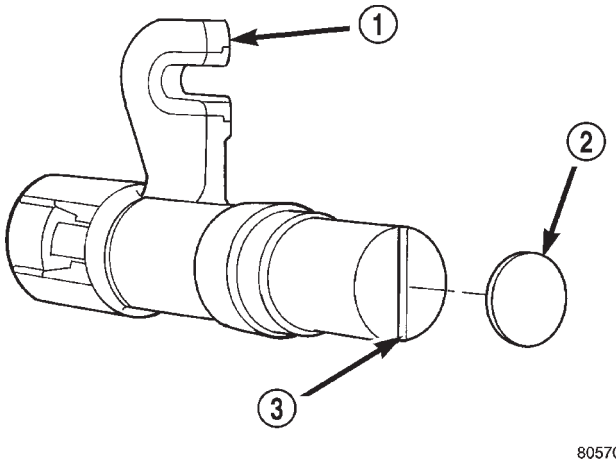


Fig. 13 Sensor Depth Positioning Rib—8.0L V-10 Engine

1 - CAMSHAFT POSITION SENSOR
2 - PAPER SPACER
3 - RIB MATERIAL (FOR SENSOR DEPTH POSITIONING)

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

REPLACING OLD SENSOR WITH ORIGINAL

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

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

(2) Remove the sensor mounting bolt (Fig. 12).

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

(4) Remove the sensor from vehicle.

(5) Check condition of sensor o-ring (Fig. 14).

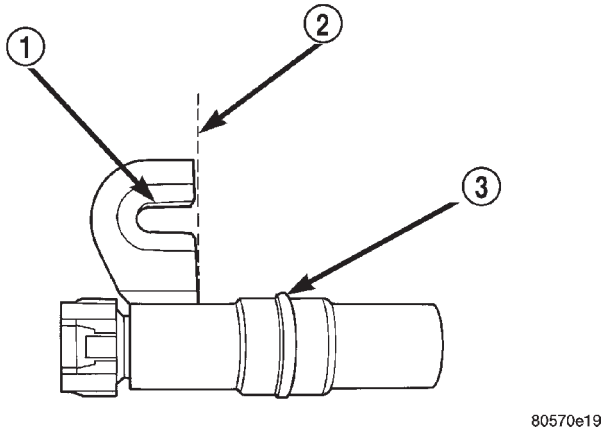


Fig. 14 Camshaft Sensor O-Ring—8.0L

1 - SLOTTED MOUNTING HOLE
2 - SCRIBE LINE
3 - CAMSHAFT POSITION SENSOR O-RING

REPLACING WITH NEW SENSOR

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

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

(2) Remove the sensor mounting bolt (Fig. 12).

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

(4) Remove the sensor from vehicle.

INSTALLATION

INSTALLATION - DIESEL

The camshaft position sensor (CMP) is located below the fuel injection pump (Fig. 9). It is attached to the back of the timing gear cover housing.

(1) Install new o-ring to CMP. Apply clean engine oil to o-ring.

(2) Clean area around CMP mounting hole.

(3) To prevent tearing o-ring, install CMP into gear housing using a twisting action.

CAMSHAFT POSITION SENSOR (Continued)

(4) Install mounting bolt and tighten to 20 Nm (15 ft. lbs.) torque.
(5) Install electrical connector to CMP.
(6) Connect both negative cables to both batteries.

INSTALLATION - 5.9L

The camshaft position sensor is located in the distributor (Fig. 11).
(1) Install camshaft position sensor to distributor. Align sensor into notch on distributor housing.
(2) Connect wiring harness.
(3) Install rotor.
(4) Install distributor cap. Tighten mounting screws.
(5) Install air cleaner assembly.

INSTALLATION - 8.0L

If Replacing Old Sensor With Original

The camshaft position sensor is located on the timing chain case/cover on the left-front side of the engine (Fig. 12).

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

(1) Observe the face of the sensor. If any of the original rib material remains (Fig. 13), it must be cut down flush to the face of the sensor with a razor knife. Remove only enough of the rib material until the face of the sensor is flat. Do not remove more material than necessary as damage to sensor may result. Due to a high magnetic field and possible electrical damage to the sensor, never use an electric grinder to remove material from sensor.

(2) From the parts department, obtain a peel-and-stick paper spacer (Fig. 13). These special paper spacers are of a certain thickness and are to be used as a tool to set sensor depth.

(3) Clean the face of sensor and apply paper spacer (Fig. 13).

(4) Apply a small amount of engine oil to the sensor o-ring (Fig. 14).

A low and high area are machined into the camshaft drive gear (Fig. 15). The sensor is positioned in the timing gear cover so that a small air gap (Fig. 15) exists between the face of sensor and the high machined area of cam gear.

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

Do not install sensor with gear positioned at low area (Fig. 16) or (Fig. 15). When the engine is started, the sensor will be broken.

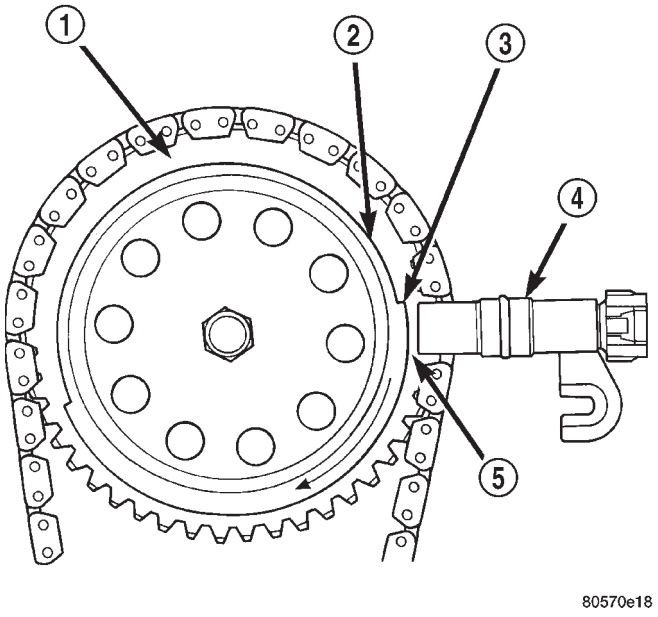


Fig. 15 Sensor Operation—8.0L V-10 Engine

1 - CAM DRIVE GEAR
2 - LOW MACHINED AREA
3 - HIGH MACHINED AREA
4 - CAMSHAFT POSITION SENSOR
5 - AIR GAP

(5) Using a 1/2 in. wide metal ruler, measure the distance from the cam gear to the face of the sensor mounting hole opening on the timing gear cover (Fig. 16).

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

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

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

(9) Install the sensor into the timing case/cover with a slight rocking action until the paper spacer contacts the camshaft gear. Do not install the sensor mounting bolt. Do not twist the sensor into position as damage to the o-ring or tearing of the paper spacer may result.

(10) Scratch a scribe line into the timing chain case/cover to indicate depth of sensor (Fig. 14).

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

(12) Remove the paper spacer from the sensor. This step must be followed to prevent the paper spacer from getting into the engine lubrication system.

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

CAMSHAFT POSITION SENSOR (Continued)

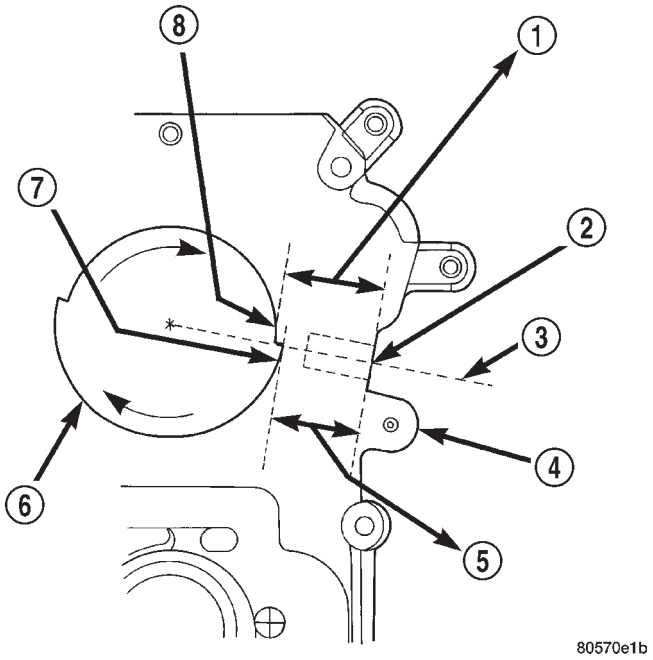


Fig. 16 Sensor Depth Dimensions

1 - 2.018" DO NOT INSTALL SENSOR
2 - SENSOR MOUNTING HOLE OPENING
3 - SENSOR CENTER LINE
4 - TIMING CHAIN COVER
5 - 1.818" OK TO INSTALL SENSOR
6 - CAM DRIVE GEAR
7 - HIGH MACHINED AREA
8 - LOW MACHINED AREA

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

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

(16) Connect engine wiring harness to sensor.

Replacing With a New Sensor

(1) Apply a small amount of engine oil to the sensor o-ring (Fig. 14).

A low and high area are machined into the camshaft drive gear (Fig. 15). The sensor is positioned in the timing gear cover so that a small air gap (Fig. 15) exists between the face of sensor and the high machined area of cam gear.

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

Do not install sensor with gear positioned at low area (Fig. 16) or (Fig. 15). When the engine is started, the sensor will be broken.

(2) Using a 1/2 in. wide metal ruler, measure the distance from the cam gear to the face of the sensor mounting hole opening on the timing gear cover (Fig. 16).

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

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

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

(6) Install the sensor into the timing case/cover with a slight rocking action. Do not twist the sensor into position as damage to the o-ring may result. Push the sensor all the way into the cover until the rib material on the sensor (Fig. 13) contacts the camshaft gear.

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

(8) Connect sensor wiring harness to engine harness.

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

DISTRIBUTOR

DESCRIPTION

All 5.9L engines are equipped with a camshaft driven mechanical distributor (Fig. 17) containing a shaft driven distributor rotor. All distributors are equipped with an internal camshaft position (fuel sync) sensor (Fig. 17).

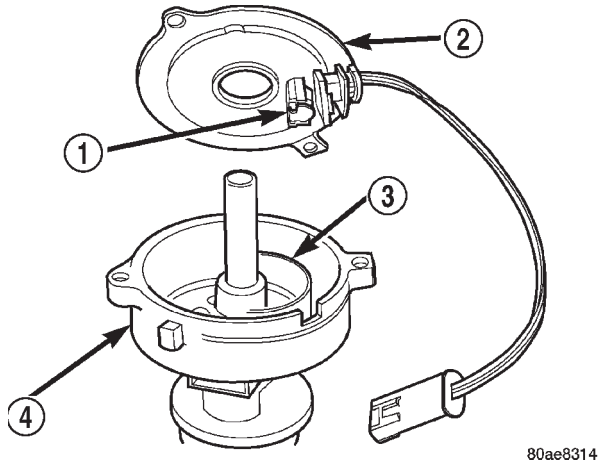


Fig. 17 Distributor and Camshaft Position Sensor

1 - SYNC SIGNAL GENERATOR
2 - CAMSHAFT POSITION SENSOR
3 - PULSE RING
4 - DISTRIBUTOR ASSEMBLY

DISTRIBUTOR (Continued)

OPERATION

The camshaft position sensor provides fuel injection synchronization and cylinder identification.

The distributor does not have built in centrifugal or vacuum assisted advance. Base ignition timing and all timing advance is controlled by the Powertrain Control Module (PCM). Because ignition timing is controlled by the PCM, **base ignition timing is not adjustable.**

The distributor is held to the engine in the conventional method using a holddown clamp and bolt. **Although the distributor can be rotated, it will have no effect on ignition timing.**

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

REMOVAL

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

(1) Remove air cleaner assembly.

(2) Disconnect negative cable from battery.

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

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

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

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

(7) Slowly rotate engine clockwise, as viewed from front, until indicating mark on crankshaft vibration damper is aligned to 0 degree (TDC) mark on timing chain cover (Fig. 18).

(8) The distributor rotor should now be aligned to the CYL. NO. 1 alignment mark (stamped) into the camshaft position sensor (Fig. 19). If not, rotate the crankshaft through another complete 360 degree turn. Note the position of the number one cylinder spark plug cable (on the cap) in relation to rotor. Rotor should now be aligned to this position.

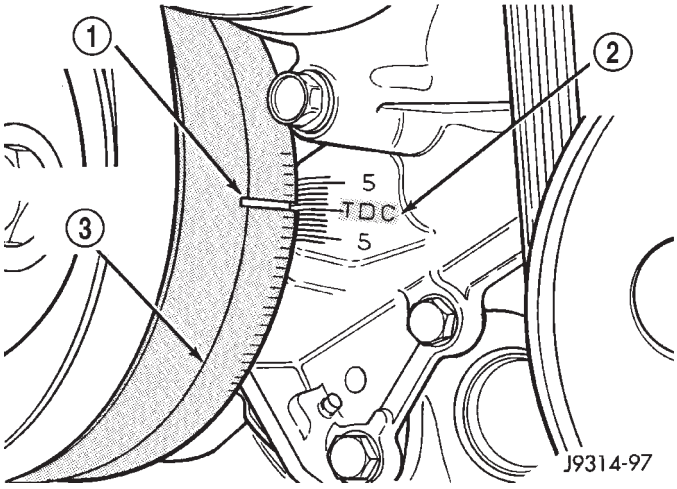


Fig. 18 Damper-To-Cover Alignment Marks—Typical

1 - ALIGNMENT MARK
2 - TIMING CHAIN COVER MARKS
3 - CRANKSHAFT VIBRATION DAMPER

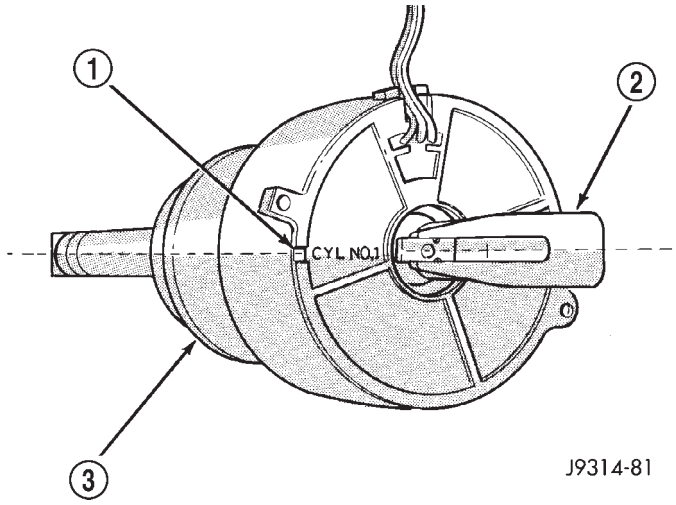


Fig. 19 Rotor Alignment Mark

1 - CAMSHAFT POSITION SENSOR ALIGNMENT MARK
2 - ROTOR
3 - DISTRIBUTOR

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

(10) Remove distributor rotor from distributor shaft.

(11) Remove distributor holddown clamp bolt and clamp (Fig. 20). Remove distributor from vehicle.

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

DISTRIBUTOR (Continued)

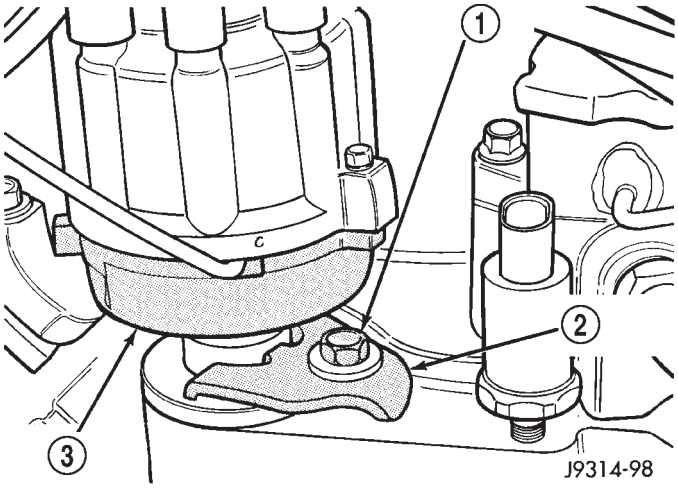


Fig. 20 Distributor Holddown Clamp

1 - CLAMP BOLT
2 - HOLDDOWN CLAMP
3 - DISTRIBUTOR HOUSING

INSTALLATION

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

Rotate crankshaft in a clockwise direction, as viewed from front, until number one cylinder piston is at top of compression stroke (compression should be felt on finger with number one spark plug removed). Then continue to slowly rotate engine clockwise until indicating mark (Fig. 18) is aligned to 0 degree (TDC) mark on timing chain cover.

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

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

(3) Install rotor to distributor shaft.

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

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

(6) Rotate the distributor housing until rotor is aligned to CYL. NO. 1 alignment mark on the camshaft position sensor (Fig. 19).

(7) Tighten clamp holddown bolt (Fig. 20) to 22.5 N·m (200 in. lbs.) torque.

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

(9) Install distributor cap. Tighten mounting screws.

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

Checking Distributor Position

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

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

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

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

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

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

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

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

After testing, install air cleaner assembly.

DISTRIBUTOR CAP

DIAGNOSIS AND TESTING - DISTRIBUTOR CAP

Remove the distributor cap and wipe it clean with a dry lint free cloth. Visually inspect the cap for cracks, carbon paths, broken towers or damaged rotor button (Fig. 21) or (Fig. 22). Also check for white deposits on the inside (caused by condensation entering the cap through cracks). Replace any cap that displays charred or eroded terminals. The machined surface of a terminal end (faces toward rotor) will indicate some evidence of erosion from normal operation. Examine the terminal ends for evidence of mechanical interference with the rotor tip.

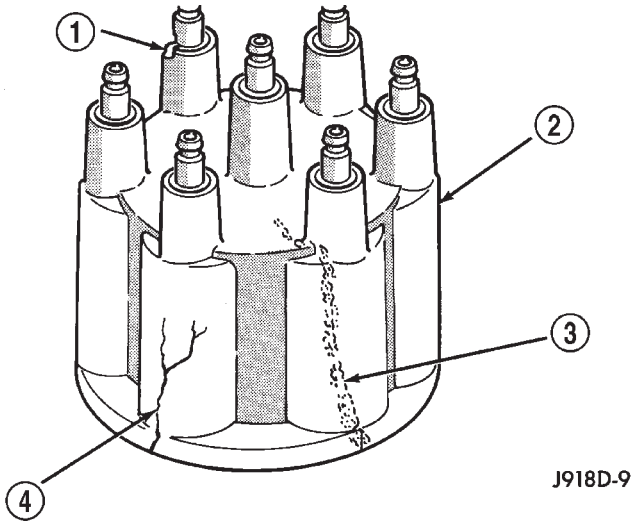


Fig. 21 Cap Inspection—External—Typical

1 - BROKEN TOWER
2 - DISTRIBUTOR CAP
3 - CARBON PATH
4 - CRACK

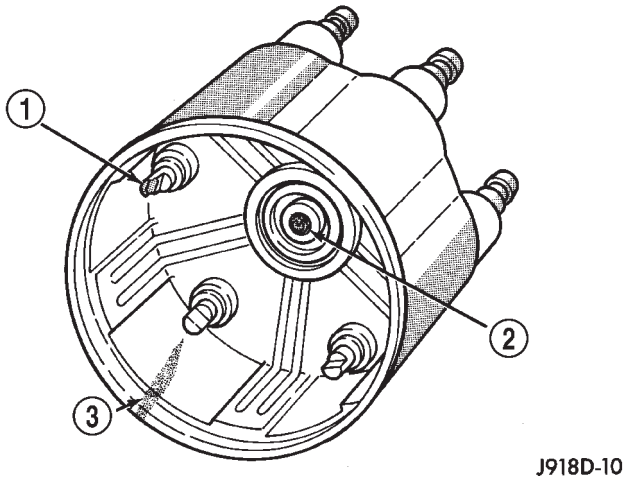


Fig. 22 Cap Inspection—Internal—Typical

1 - CHARRED OR ERODED TERMINALS
2 - WORN OR DAMAGED ROTOR BUTTON
3 - CARBON PATH

DISTRIBUTOR ROTOR

DIAGNOSIS AND TESTING - DISTRIBUTOR ROTOR

Visually inspect the rotor (Fig. 23) for cracks, evidence of corrosion or the effects of arcing on the metal tip. Also check for evidence of mechanical interference with the cap. Some charring is normal on the end of the metal tip. The silicone-dielectric-varnish-compound applied to the rotor tip for radio interference noise suppression, will appear charred. This is normal. **Do not remove the charred compound.** Test the spring for insufficient tension. Replace a rotor that displays any of these adverse conditions.

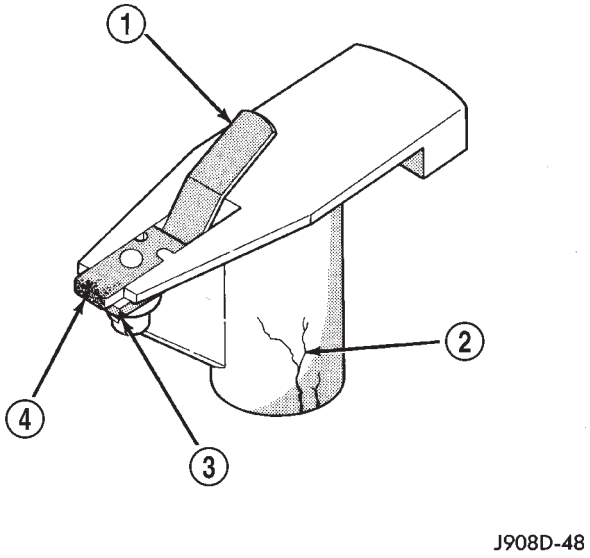


Fig. 23 Rotor Inspection—Typical

1 - INSUFFICIENT SPRING TENSION
2 - CRACKS
3 - EVIDENCE OF PHYSICAL CONTACT WITH CAP
4 - ROTOR TIP CORRODED

IGNITION COIL

DESCRIPTION

DESCRIPTION - 5.9L

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

DESCRIPTION - 8.0L

Two separate coil packs containing a total of five independent coils are attached to a common mounting bracket. They are located above the right engine valve cover (Fig. 24). The coil packs are not oil filled. The front coil pack contains three independent epoxy filled coils. The rear coil pack contains two independent epoxy filled coils.

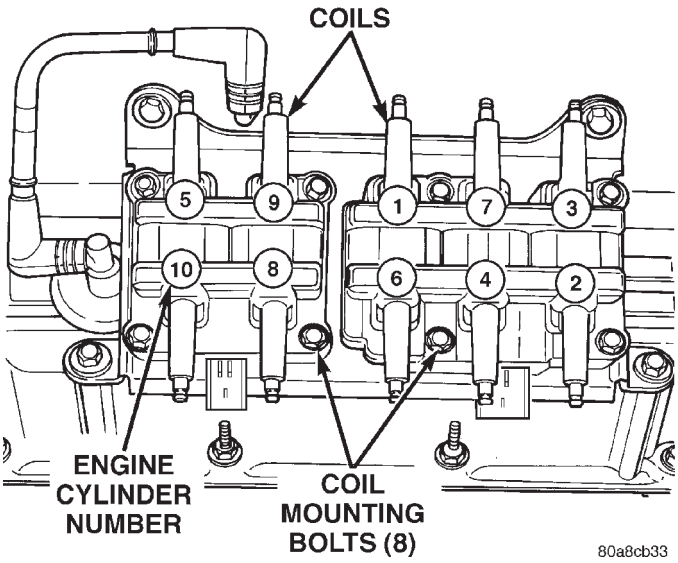


Fig. 24 Ignition Coil Packs—8.0L V-10 Engine

OPERATION

OPERATION - 5.9L

The Powertrain Control Module (PCM) opens and closes the ignition coil ground circuit for ignition coil operation.

Battery voltage is supplied to the ignition coil positive terminal from the ASD relay. If the PCM does not see a signal from the crankshaft and camshaft sensors (indicating the ignition key is ON but the engine is not running), it will shut down the ASD circuit.

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

OPERATION - 8.0L

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

Coil firing is paired together on cylinders:

- Number 5 and 10
- Number 9 and 8
- Number 1 and 6
- Number 7 and 4
- Number 3 and 2

The ignition system is controlled by the Powertrain Control Module (PCM) on all engines.

Battery voltage is supplied to all of the ignition coils positive terminals from the ASD relay. If the PCM does not see a signal from the crankshaft and camshaft sensors (indicating the ignition key is ON but the engine is not running), it will shut down the ASD circuit.

Base ignition timing is not adjustable on the 8.0L V-10 engine. By controlling the coil ground circuit, the PCM is able to set the base timing and adjust the ignition timing advance. This is done to meet changing engine operating conditions.

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

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

REMOVAL

REMOVAL - 5.9L

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

5.9L V-8 HDC-Gas Engine: The coil is mounted to a bracket that is bolted to the air injection pump (AIR pump) mounting bracket (Fig. 25).

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

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

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

IGNITION COIL (Continued)

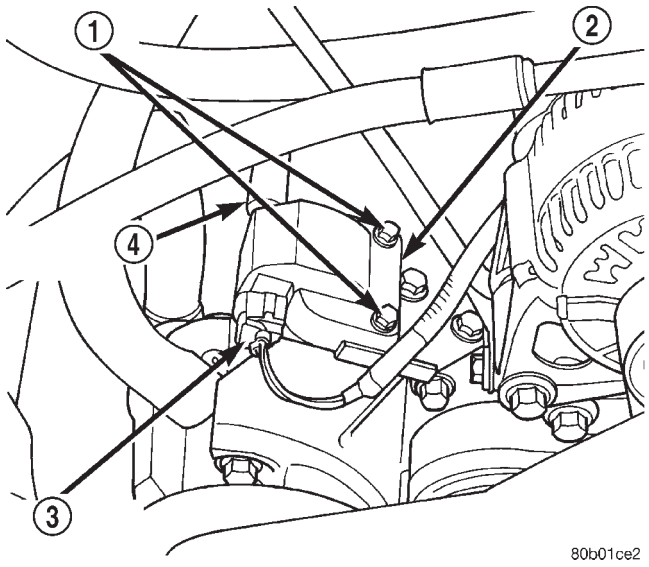


Fig. 25 Ignition Coil—5.9L V-8 HDC-Gas Engine

1 - COIL MOUNTING BOLTS
2 - IGNITION COIL
3 - COIL ELEC. CONNECTOR
4 - SECONDARY CABLE

REMOVAL - 8.0L

Two separate coil packs containing a total of five independent coils are attached to a common mounting bracket located above the right engine valve cover (Fig. 26). The front and rear coil packs can be serviced separately.

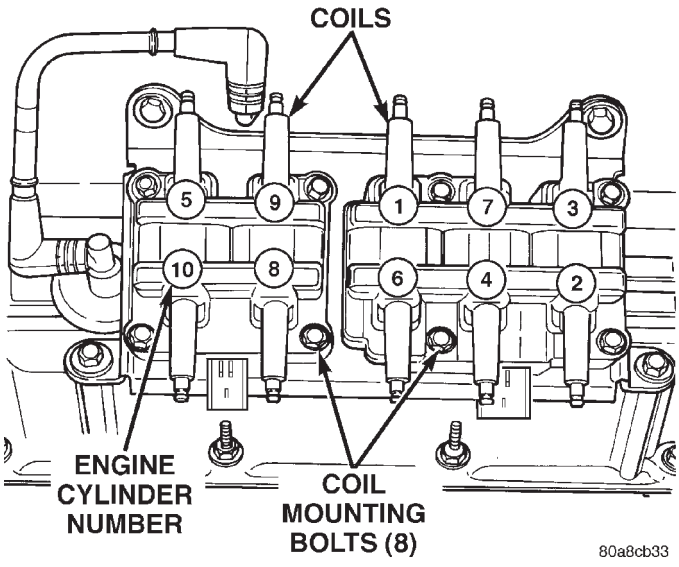


Fig. 26 Ignition Coil Packs—8.0L V-10 Engine

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

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

(3) Remove the four (4) coil pack-to-coil mounting bracket bolts for the coil pack being serviced (Fig. 26).

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

INSTALLATION

INSTALLATION - 5.9L

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

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

(2) Connect all wiring to ignition coil.

INSTALLATION - 8.0L

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

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

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

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

(5) Connect secondary spark plug cables to coil packs. Refer to (Fig. 27) for correct cable order.

SPARK PLUG

DESCRIPTION

The 5.9L V-8 engines use resistor type spark plugs. The 8.0L V-10 engine uses inductive type spark plugs.

Spark plug resistance values range from 6,000 to 20,000 ohms (when checked with at least a 1000 volt spark plug tester). **Do not use an ohmmeter to check the resistance values of the spark plugs. Inaccurate readings will result.**

OPERATION

To prevent possible pre-ignition and/or mechanical engine damage, the correct type/heat range/number spark plug must be used.

Always use the recommended torque when tightening spark plugs. Incorrect torque can distort the spark plug and change plug gap. It can also pull the plug threads and do possible damage to both the spark plug and the cylinder head.

Remove the spark plugs and examine them for burned electrodes and fouled, cracked or broken porcelain insulators. Keep plugs arranged in the order

SPARK PLUG (Continued)

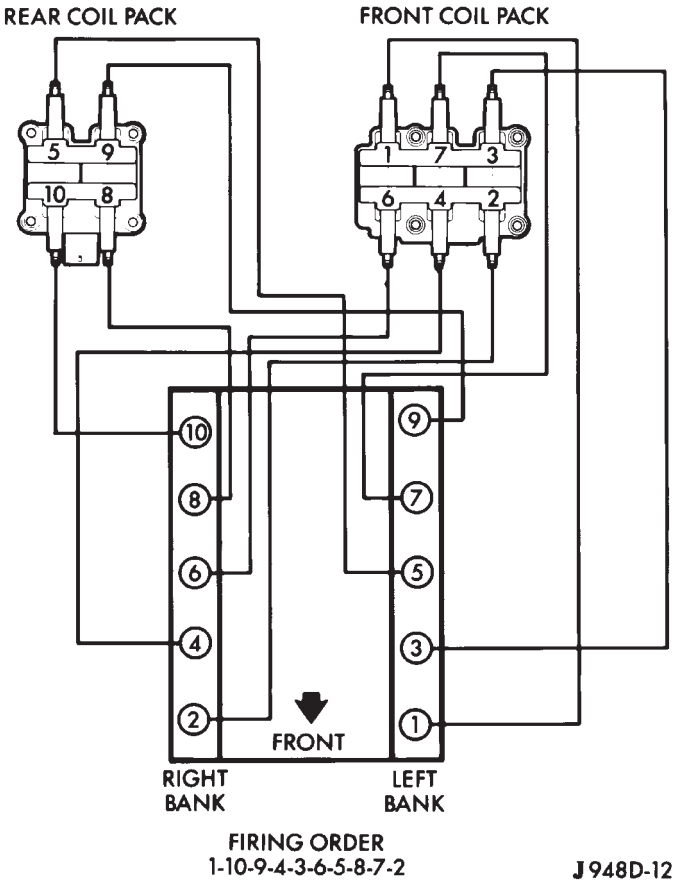


Fig. 27 Spark Plug Cable Order—8.0L V-10 Engine

in which they were removed from the engine. A single plug displaying an abnormal condition indicates that a problem exists in the corresponding cylinder. Replace spark plugs at the intervals recommended in Group O, Lubrication and Maintenance

Spark plugs that have low mileage may be cleaned and reused if not otherwise defective, carbon or oil fouled. Also refer to Spark Plug Conditions.

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

DIAGNOSIS AND TESTING - SPARK PLUG CONDITIONS

NORMAL OPERATING

The few deposits present on the spark plug will probably be light tan or slightly gray in color. This is evident with most grades of commercial gasoline (Fig. 28). There will not be evidence of electrode burning. Gap growth will not average more than approximately 0.025 mm (.001 in) per 3200 km (2000 miles) of operation. Spark plugs that have normal wear can usually be cleaned, have the electrodes filed, have the gap set and then be installed.

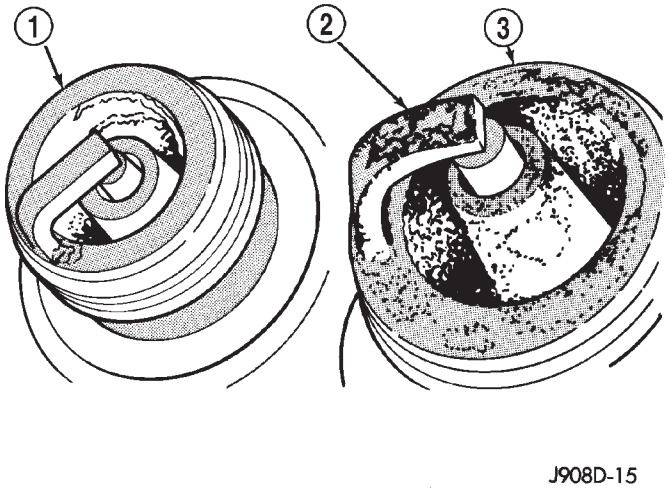


Fig. 28 Normal Operation and Cold (Carbon) Fouling

1 - NORMAL
2 - DRY BLACK DEPOSITS
3 - COLD (CARBON) FOULING

Some fuel refiners in several areas of the United States have introduced a manganese additive (MMT) for unleaded fuel. During combustion, fuel with MMT causes the entire tip of the spark plug to be coated with a rust colored deposit. This rust color can be misdiagnosed as being caused by coolant in the combustion chamber. Spark plug performance may be affected by MMT deposits.

COLD FOULING/CARBON FOULING

Cold fouling is sometimes referred to as carbon fouling. The deposits that cause cold fouling are basically carbon (Fig. 28). A dry, black deposit on one or two plugs in a set may be caused by sticking valves or defective spark plug cables. Cold (carbon) fouling of the entire set of spark plugs may be caused by a clogged air cleaner element or repeated short operating times (short trips).

WET FOULING OR GAS FOULING

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

OIL OR ASH ENCRUSTED

If one or more spark plugs are oil or oil ash encrusted (Fig. 29), evaluate engine condition for the

SPARK PLUG (Continued)

cause of oil entry into that particular combustion chamber.

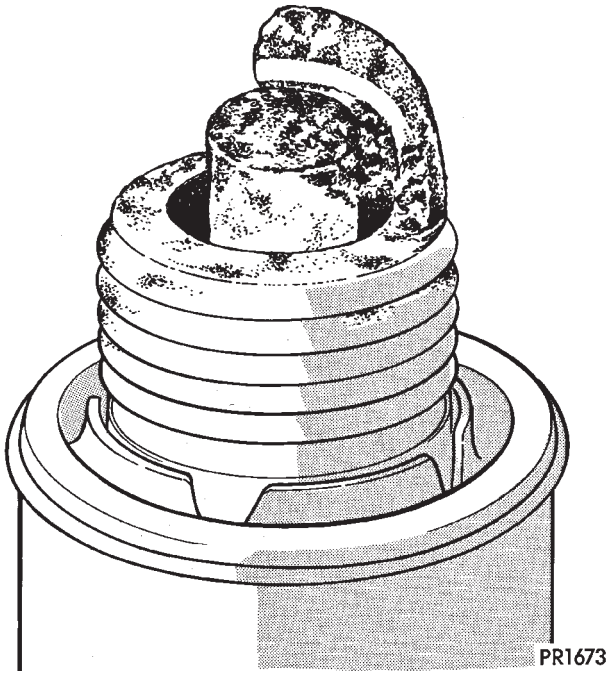


Fig. 29 Oil or Ash Encrusted

ELECTRODE GAP BRIDGING

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

SCAVENGER DEPOSITS

Fuel scavenger deposits may be either white or yellow (Fig. 31). They may appear to be harmful, but this is a normal condition caused by chemical additives in certain fuels. These additives are designed to change the chemical nature of deposits and decrease spark plug misfire tendencies. Notice that accumulation on the ground electrode and shell area may be heavy, but the deposits are easily removed. Spark plugs with scavenger deposits can be considered normal in condition and can be cleaned using standard procedures.

CHIPPED ELECTRODE INSULATOR

A chipped electrode insulator usually results from bending the center electrode while adjusting the spark plug electrode gap. Under certain conditions, severe detonation can also separate the insulator from the center electrode (Fig. 32). Spark plugs with this condition must be replaced.

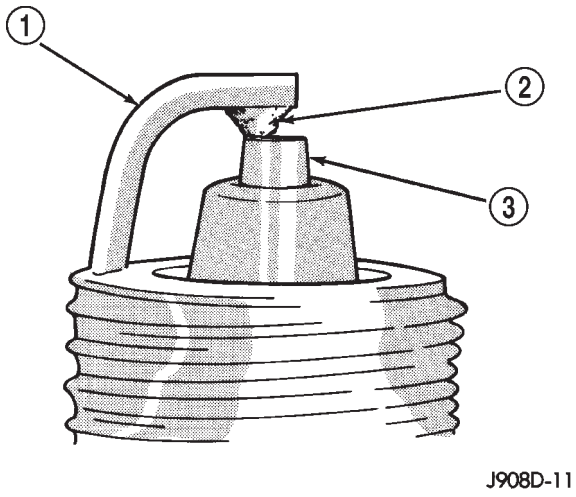


Fig. 30 Electrode Gap Bridging

1 - GROUND ELECTRODE
2 - DEPOSITS
3 - CENTER ELECTRODE

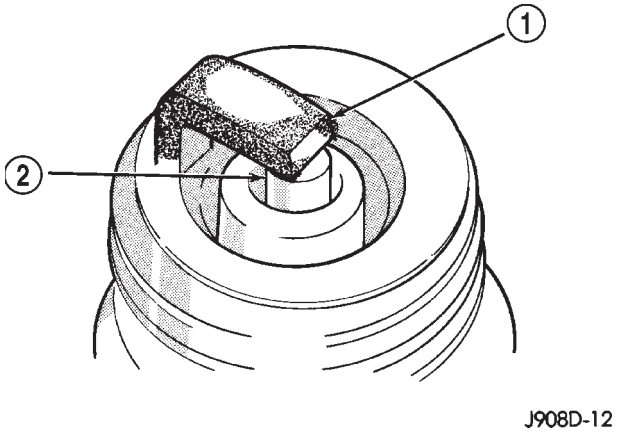


Fig. 31 Scavenger Deposits

1 - GROUND ELECTRODE COVERED WITH WHITE OR YELLOW DEPOSITS
2 - CENTER ELECTRODE

PREIGNITION DAMAGE

Preignition damage is usually caused by excessive combustion chamber temperature. The center electrode dissolves first and the ground electrode dissolves somewhat latter (Fig. 33). Insulators appear relatively deposit free. Determine if the spark plug has the correct heat range rating for the engine. Determine if ignition timing is over advanced or if other operating conditions are causing engine overheating. (The heat range rating refers to the operating temperature of a particular type spark plug. Spark plugs are designed to operate within specific temperature ranges. This depends upon the thickness and length of the center electrodes porcelain insulator.)

SPARK PLUG (Continued)

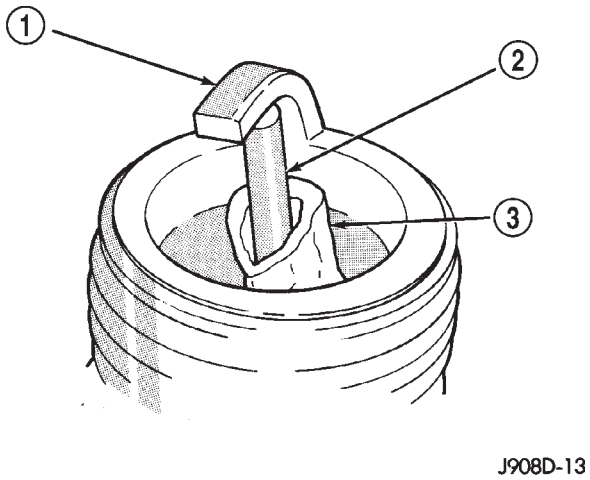


Fig. 32 Chipped Electrode Insulator

1 - GROUND ELECTRODE
2 - CENTER ELECTRODE
3 - CHIPPED INSULATOR

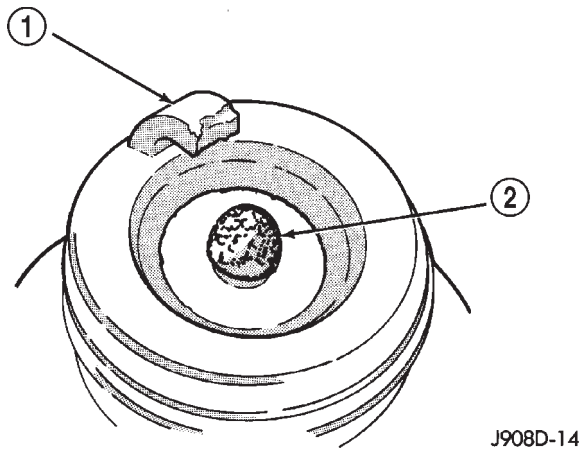


Fig. 33 Preignition Damage

1 - GROUND ELECTRODE STARTING TO DISSOLVE
2 - CENTER ELECTRODE DISSOLVED

SPARK PLUG OVERHEATING

Overheating is indicated by a white or gray center electrode insulator that also appears blistered (Fig. 34). The increase in electrode gap will be considerably in excess of 0.001 inch per 2000 miles of operation. This suggests that a plug with a cooler heat range rating should be used. Over advanced ignition timing, detonation and cooling system malfunctions can also cause spark plug overheating.

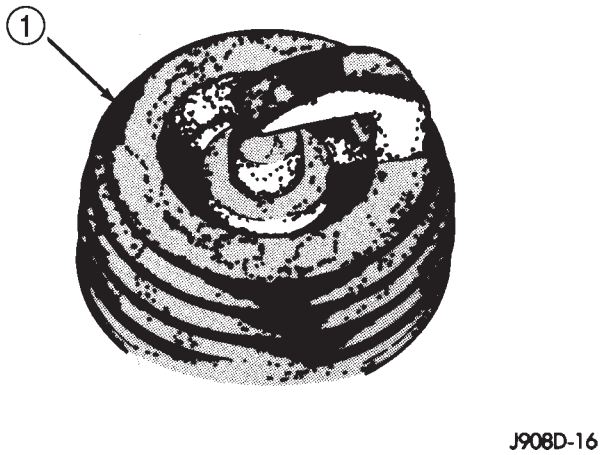


Fig. 34 Spark Plug Overheating

1 - BLISTERED WHITE OR GRAY COLORED INSULATOR

REMOVAL

On 5.9L engines, spark plug cable heat shields are pressed into the cylinder head to surround each cable boot and spark plug (Fig. 35).

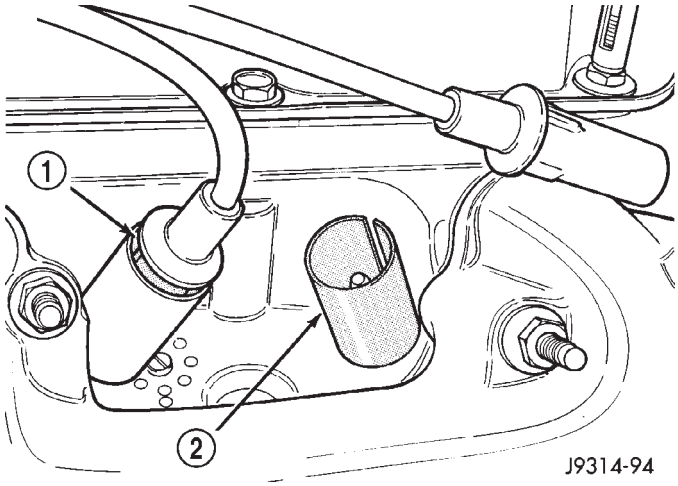


Fig. 35 Heat Shields—5.9L Engines

1 - AIR GAP
2 - SPARK PLUG BOOT HEAT SHIELD

(1) Always remove spark plug or ignition coil cables by grasping at the cable boot (Fig. 37). Turn the cable boot 1/2 turn and pull straight back in a steady motion. Never pull directly on the cable. Internal damage to cable will result.

SPARK PLUG (Continued)

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

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

(4) Inspect the spark plug condition. Refer to Spark Plug Condition in the Diagnostics and Testing section of this group.

CLEANING

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

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

INSTALLATION

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

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

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

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

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

(3) Install spark plug cables over spark plugs.

SPARK PLUG CABLE

DESCRIPTION

Spark plug cables are sometimes referred to as secondary ignition wires.

OPERATION

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

DIAGNOSIS AND TESTING - SPARK PLUG CABLES

Cable routing is important on certain engines. To prevent possible ignition crossfire, be sure the cables are clipped into the plastic routing looms. Try to prevent any one cable from contacting another. Before removing cables, note their original location and routing. Never allow one cable to be twisted around another.

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

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

On 5.9L engines, spark plug cable heat shields are pressed into the cylinder head to surround each spark plug cable boot and spark plug (Fig. 36). These shields protect the spark plug boots from damage (due to intense engine heat generated by the exhaust manifolds) and should not be removed. After the spark plug cable has been installed, the lip of the cable boot should have a small air gap to the top of the heat shield (Fig. 36).

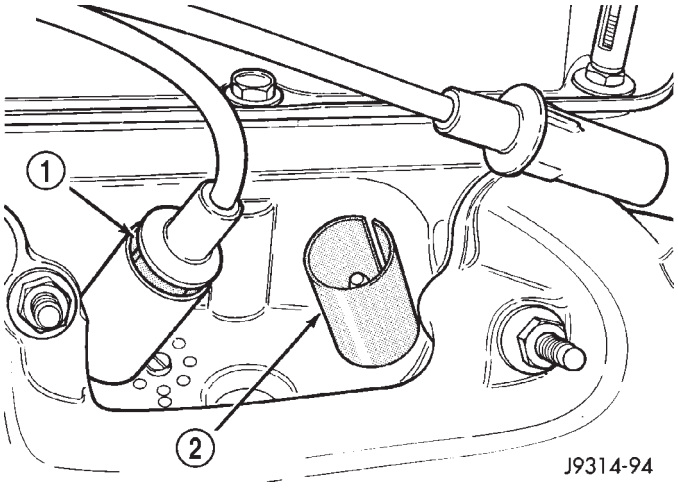


Fig. 36 Heat Shields—5.9L Engines

1 - AIR GAP
2 - SPARK PLUG BOOT HEAT SHIELD

TESTING

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

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

SPARK PLUG CABLE (Continued)

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

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

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

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

SPARK PLUG CABLE RESISTANCE

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

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

REMOVAL

CAUTION: When disconnecting a high voltage cable from a spark plug or from the distributor cap, twist the rubber boot slightly (1/2 turn) to break it loose (Fig. 37). Grasp the boot (not the cable) and pull it off with a steady, even force.

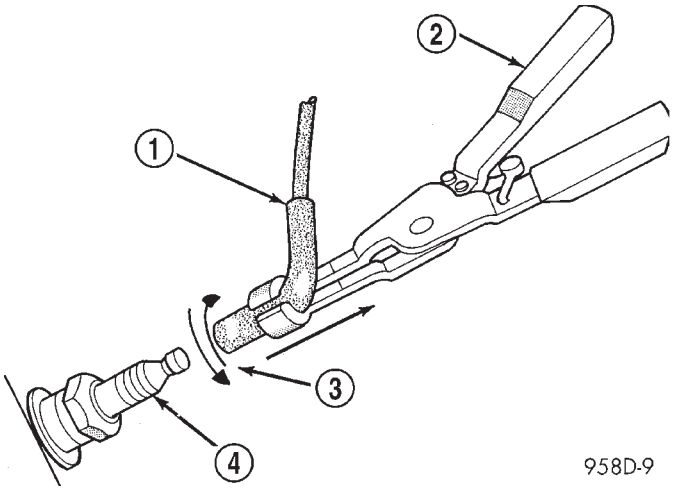


Fig. 37 Cable Removal

1 - SPARK PLUG CABLE AND BOOT
2 - SPARK PLUG BOOT PULLER
3 - TWIST AND PULL
4 - SPARK PLUG

INSTALLATION

Install cables into the proper engine cylinder firing order (Fig. 38) or (Fig. 39).

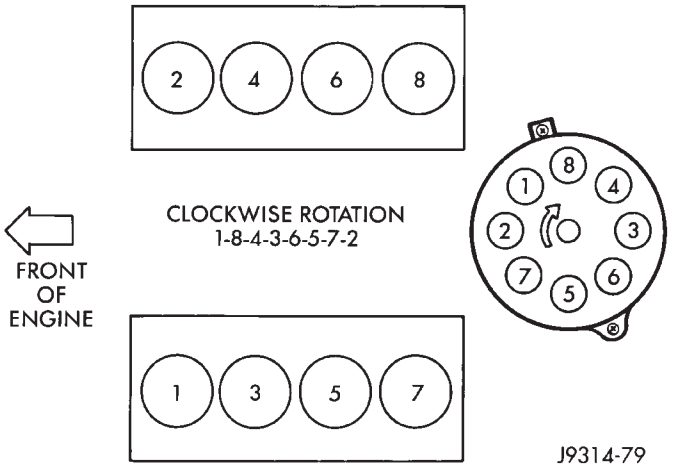


Fig. 38 Engine Firing Order—5.9L V-8 Engines

SPARK PLUG CABLE (Continued)

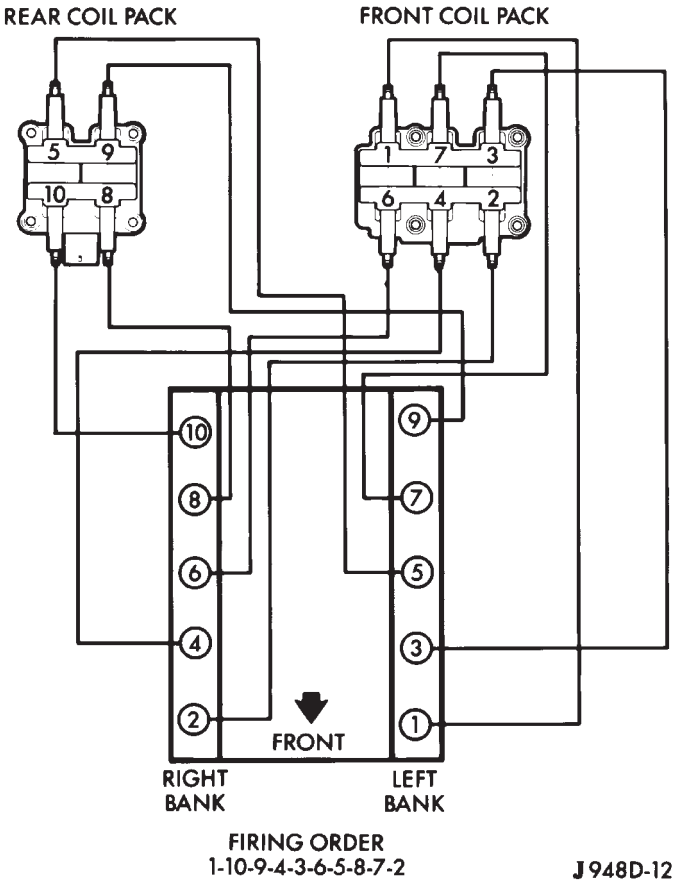


Fig. 39 Spark Plug Cable Order—8.0L V-10 Engine

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

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