IGNITION CONTROL

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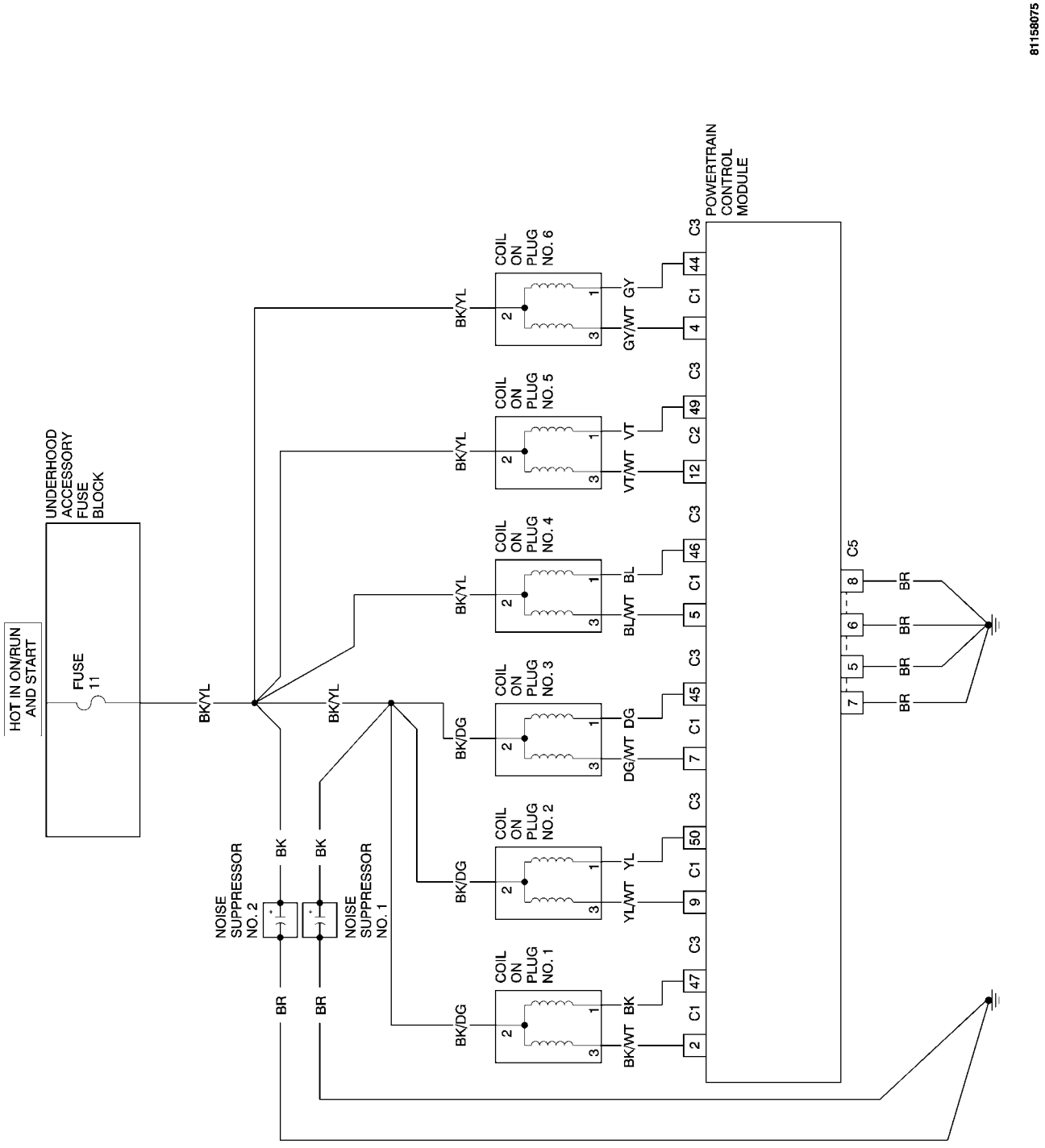

IGNITION SYSTEM CIRCUIT DIAGRAM

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IGNITION SYSTEM - SERVICE INFORMATION

DESCRIPTION

The High Energy Ignition (HEI) system uses one coil and two spark plugs per cylinder. Individual coils for each cylinder ensure consistent performance at high rpms and allow individual cylinder spark control. Dual spark plugs provide more complete combustion, particularly near the cylinder walls, thus decreasing emissions. Also, HEI enhances combustion efficiency when firing mixtures diluted by EGR (Exhaust Gas Recirculation), which in turn improves overall efficiency and lowers emissions.

OPERATION

The crankshaft position sensor and camshaft position sensor are hall effect devices. The camshaft position sensor and crankshaft position sensor generate pulses that are inputs to the PCM. The PCM determines engine position from these sensors. The PCM calculates injector sequence and ignition timing from crankshaft & camshaft position. For a description of both sensors Camshaft Position Sensor, **Refer to Page 8I-4**, and Crankshaft Position Sensor, **Refer to Page 14-30**.

The two spark plugs per cylinder are fired slightly out of phase to prevent the cylinder pressures from rising too quickly, which could cause knocking. To prevent one spark plug from eroding more quickly than the other, they alternately lead each other. Under normal conditions, the timing is the same for all cylinders, but the timing can be delayed in individual cylinders if knocking is present in one or more. Highly sensitive anti-knock sensors, **Refer to Page 8I-6**, can distinguish knocking conditions in individual cylinders and retard the ignition timing on the cylinders that are knocking. This anti-knock control prevents damage to the engine and allows operation on lower grade fuel, but only in emergencies. Premium grade fuel is required under normal operating conditions to ensure full power and economy, and because the anti-knock control system may not be able to prevent knocking on low grade fuels under all operating conditions.

SPECIFICATIONS

SPECIFICATIONS - SPARK PLUGS

DESCRIPTION	SPECIFICATION	
Bosch	F 8 DPER	
Champion	KC 11 PYP	
NGK	IFR5D 10	
Spark Plug Gap	.80 mm	0.040 in
Firing Order	1-4-3-6-2-5	

SPECIFICATIONS - TORQUE

DESCRIPTION	N·m	Ft. Lbs.	In. Lbs.
Camshaft Sensor Bolt	8	6	71
Coil Retaining Bolt	8	6	71
Knock Sensor Bolt	20	15	177
Spark Plugs	28	21	248

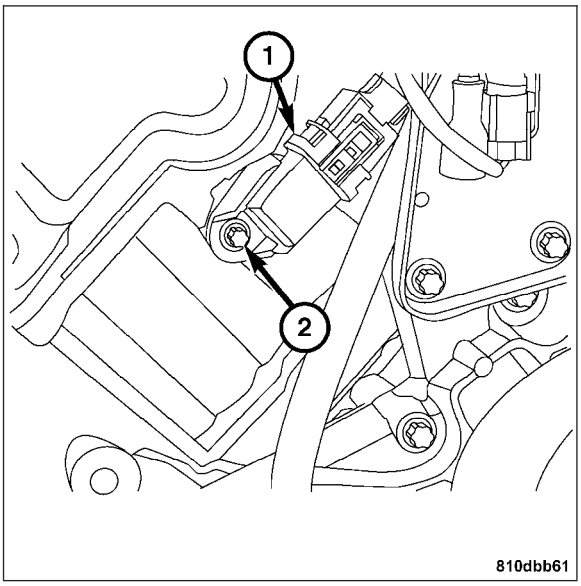
CAMSHAFT POSITION SENSOR

OPERATION

The camshaft position sensor provides cylinder identification to the Powertrain Control Module (PCM). The sensor generates pulses. The PCM determines engine position from the camshaft position sensor and crankshaft position sensor inputs. The PCM uses the input to determine fuel injection synchronization and to determine which ignition coil to energize.

REMOVAL

1. Disconnect the negative battery cable.
2. Disconnect the camshaft position sensor harness connector (1).
3. Remove the retaining bolt (2) and the camshaft position sensor.



INSTALLATION

Note: Lubricate the camshaft position sensor o-ring with engine oil.

1. Position the camshaft position sensor on the cylinder head.
2. Install the retaining bolt (2) and tighten to 8 N·m (71 in. lbs.).
3. Connect the camshaft position sensor harness connector.
4. Connect the negative battery cable.

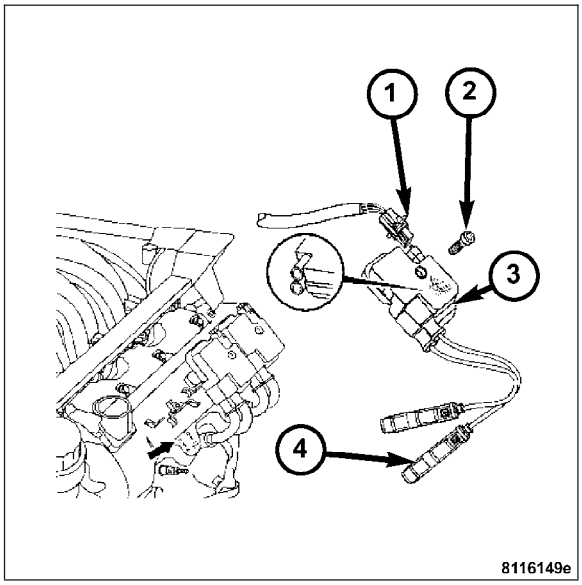
IGNITION COIL

DESCRIPTION

Coils are mounted on the cylinder head cover and are connected to the spark plugs via short cables. Platinum-tip spark plugs allow 100,000-mile (161,000-km) replacement intervals in normal service.

REMOVAL

1. Disconnect the negative battery.
2. Remove the air cleaner housing.
3. Disconnect the ignition coil wire harness connector (1).
4. Disconnect the spark plug cables (4) from the spark plug.
5. Remove the retaining bolt (2) and the ignition coil (3) from the cylinder head cover.



INSTALLATION

1. Position the ignition coil (3) on the cylinder head cover.
2. Install and tighten the retaining bolt (2) to 8 N·m (71 in. lbs.).

Note: 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.

Note: 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 spark plug.

3. Connect the spark plug cables (4) to the spark plug.
4. Connect the ignition coil wire harness connector (1).
5. Install the air cleaner housing.
6. Connect the negative battery cable.

KNOCK SENSOR

DESCRIPTION

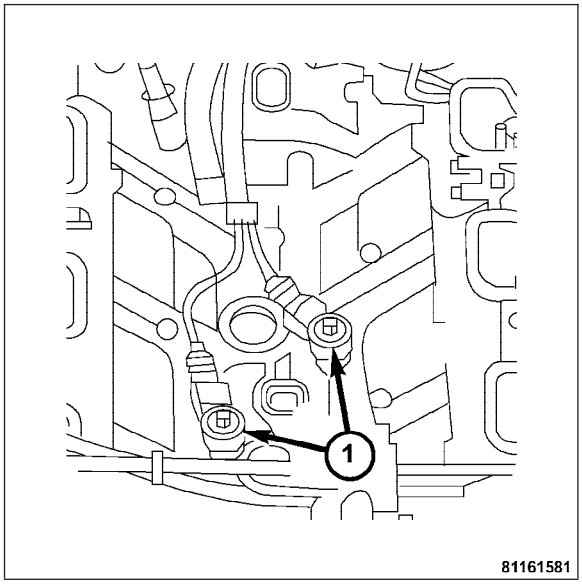
The knock sensors bolt onto the cylinder block below the intake manifold. They are designed to detect engine vibration that is caused by detonation.

OPERATION

Highly sensitive anti-knock sensors can distinguish knocking conditions in individual cylinders and retard the ignition timing on the cylinders that are knocking. This anti-knock control prevents damage to the engine and allows operation on lower grade fuel, but only in emergencies. Premium grade fuel is required under normal operating conditions to ensure full power and economy, and because the anti-knock control system may not be able to prevent knocking on low grade fuels under all operating conditions.

REMOVAL

1. Remove the intake manifold. **Refer to Page 9-678**.
2. Disconnect the wire harness connectors at the knock sensors (1) and remove the retaining bolts. Remove the knock sensors from the engine block.



INSTALLATION

1. Position the knock sensors (1) on the engine block.

Note: The knock sensor bolt torque is higher than other sensors. If the proper torque is not applied to the knock sensor, driveability can be affected.

2. Install the retaining bolts. Tighten the bolts to 20 N·m (15 ft. lbs.).
3. Connect the wire harness connectors.
4. Install the intake manifold. **Refer to Page 9-680**.

SPARK PLUG

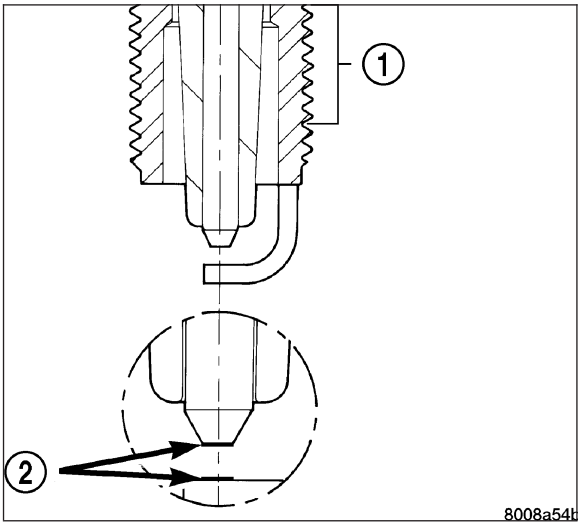
DESCRIPTION - PLATINUM PLUGS

The engine uses platinum tip resistor spark plugs. They have resistance values of 6,000 to 20,000 ohms when checked with at least a 1000 volt tester. For spark plug identification and specifications, **Refer to Page 8I-4**.

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

Spark plugs using either a single or double platinum tips have a recommended service life of 100,000 miles for normal driving conditions per schedule A in this manual. The spark plugs have a recommended service life of 75,000 miles for severe driving conditions. A thin platinum pad is welded to both or just the center electrode (2) end(s). Extreme care must be used to prevent spark plug cross threading, mis-gapping and ceramic insulator damage during plug removal and installation.

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



OPERATION

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

Spark plugs that have low mileage may be cleaned and reused if not otherwise defective. Adjust the gap between the electrodes to 1.00 mm (.039 in.).

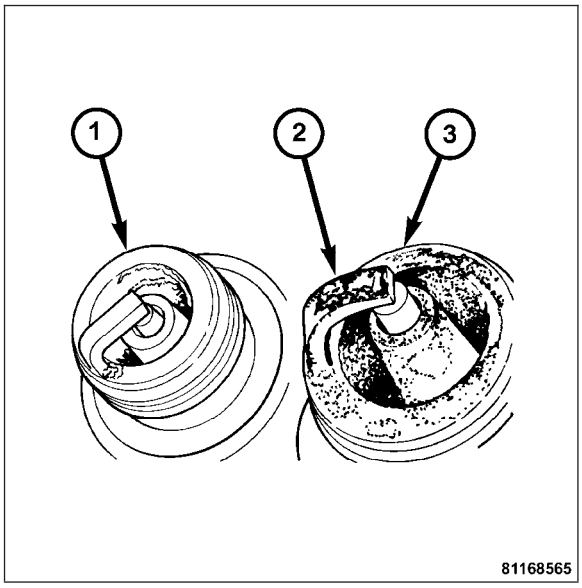
Always tighten spark plugs to the specified torque. Over tightening can cause distortion resulting in a change in the spark plug gap or damage to the cylinder head. Tighten the spark plugs to 28 N·m (21 ft. lbs.).

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. 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 (1) can usually be cleaned, have the gap set and then be installed.

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 (2). 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. 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

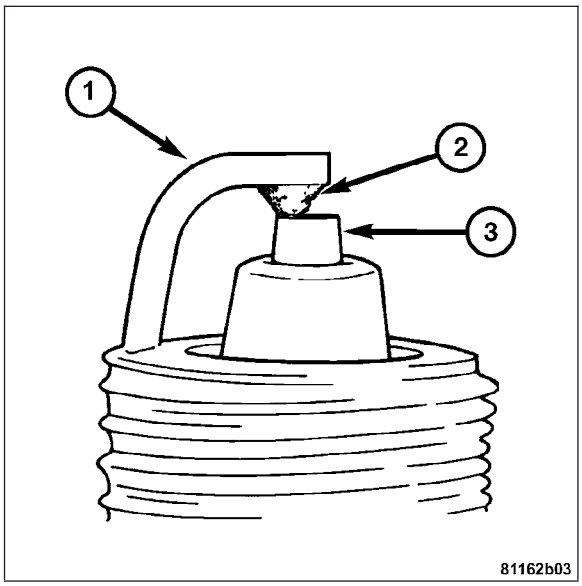
A spark plug coated with excessive wet fuel or oil is wet fouled. In older engines, worn piston rings, leaking valve guide seals or excessive cylinder wear can cause wet fouling. In new or recently overhauled engines, wet fouling may occur before break-in (normal oil control) is achieved. This condition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

OIL OR ASH ENCRUSTED

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

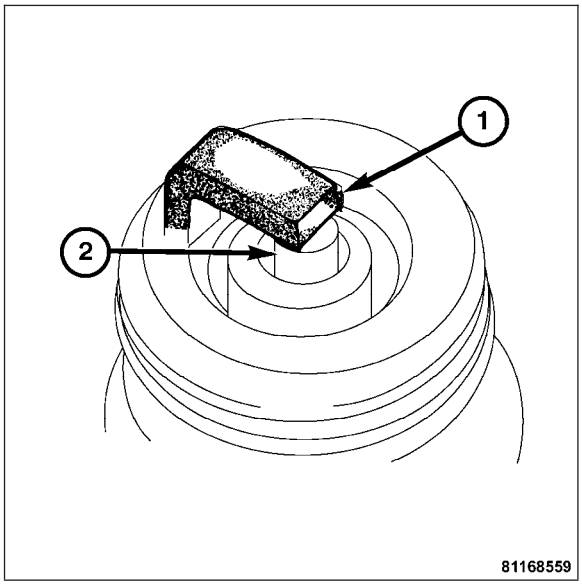
ELECTRODE GAP BRIDGING

Electrode gap bridging may be traced to loose deposits in the combustion chamber. These deposits (2) 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 (3). This short circuits the electrodes. Spark plugs with electrode gap bridging (1) should be replaced.



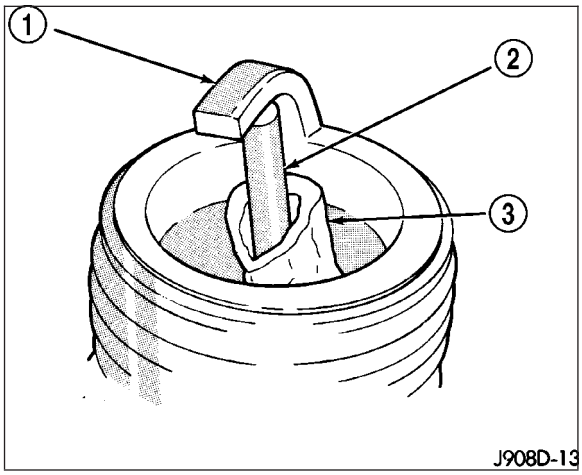
SCAVENGER DEPOSITS

Fuel scavenger deposits may be either white or yellow. 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 (1) 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 solvent.



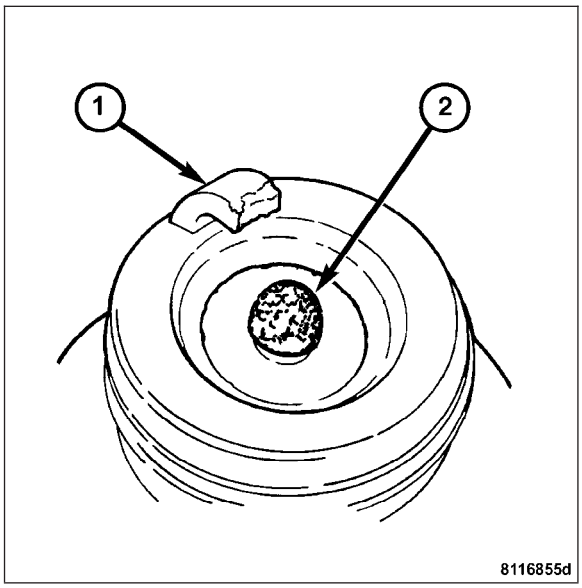
CHIPPED ELECTRODE INSULATOR

A chipped electrode insulator (3) usually results from bending the center electrode (2) while adjusting the spark plug electrode gap. Under certain conditions, severe detonation can also separate the insulator from the center electrode. Spark plugs with this condition must be replaced.



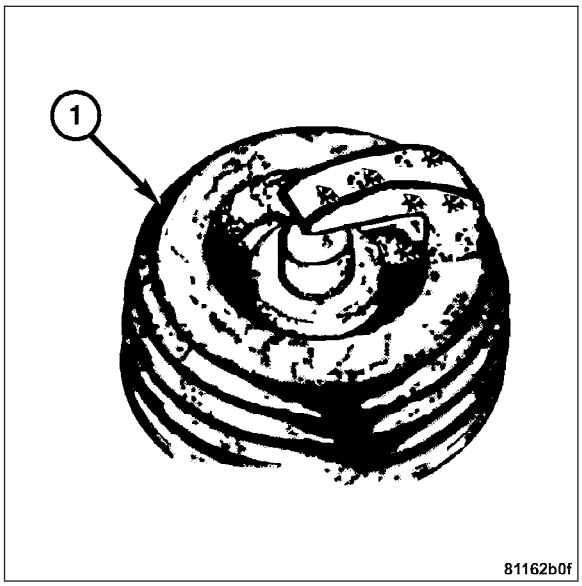
PREIGNITION DAMAGE

Preignition damage is usually caused by excessive combustion chamber temperature. The center electrode (2) dissolves first and the ground electrode (1) dissolves somewhat later. 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 electrode's porcelain insulator.)



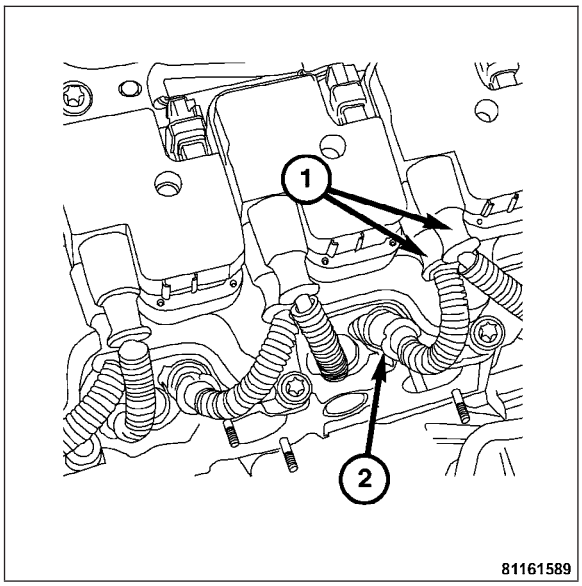
SPARK PLUG OVERHEATING

Overheating is indicated by a white or gray center electrode insulator that also appears blistered. The increase in electrode gap will be considerably in excess of the normal 0.025 mm (.001 in.) per 3200 km (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 (1).



REMOVAL

1. Pull and turn the metal clad spark plug cable boots (2) to remove them from the spark plugs.

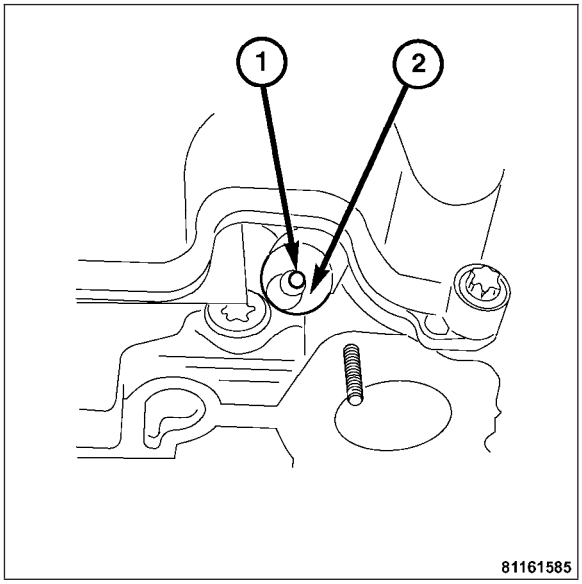


Note: Avoid allowing debris to fall into the spark holes during replacement.

2. Clean the cylinder head spark plug recesses (2) using low pressure compressed air.

CAUTION: Do not use power tools to replace spark plugs. Damage to the cylinder head can result.

3. Use a rubber insulated spark plug socket and a hand ratchet to remove the spark plugs (1).

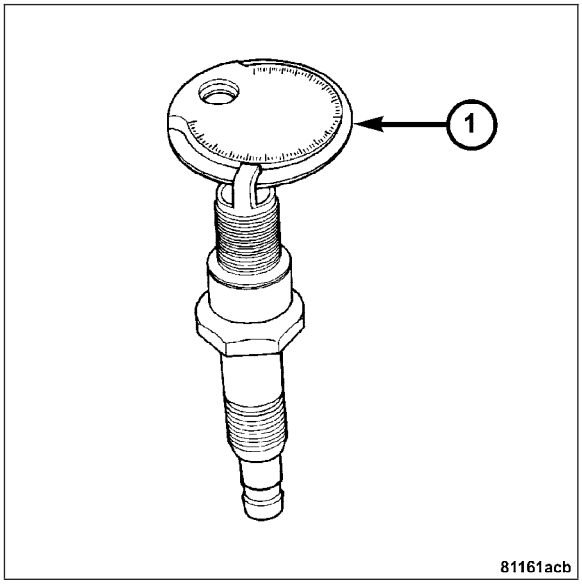


INSTALLATION

1. Using a gap gauge (1), gap the spark plugs to 1.00 mm (.039 in.) before installing them.
2. Tighten the spark plugs to 28 N·m (21 ft. lbs.).

Note: A snap should be felt when a good connection is made between the cable and the spark plug.

3. Install the spark plug cables.



SPARK PLUG CABLE

DESCRIPTION

Spark Plug cables are sometimes referred to as secondary ignition wires. The wires transfer electrical current from the electronic ignition coils to the individual spark plugs at each cylinder. The nonmetallic spark plug cables have built in resistance. The cables provide suppression of radio frequency emissions from the ignition system.

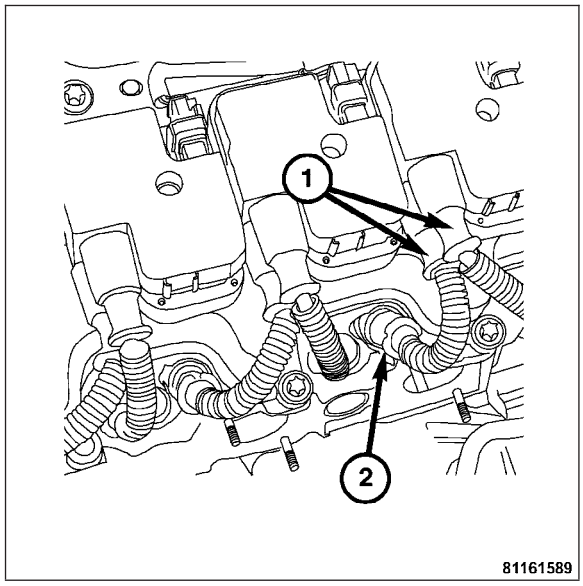
Check the spark plug cable connections for good contact at the coil and at the spark plugs. Terminals should be fully seated with audible click. The nipples and spark plug covers should be in good condition. Nipples should fit tightly on the coil and spark plug cover should fit tight around spark plug insulators. Loose cable connections can cause ignition malfunctions by permitting water to enter the towers, corroding, and increasing resistance. **To maintain proper sealing at the terminal connections, the connections should not be broken unless testing indicates high resistance, an open circuit or other damage.**

Clean high tension cables with a cloth moistened with a non-flammable solvent and wipe dry. Check for brittle or cracked insulation.

REMOVAL

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

1. Remove the spark plug cable boot from the ignition coil (1).
2. Turn and pull the spark plug cable metal clad boot (2) from the spark plug.



INSTALLATION

Note: When replacing the spark plug 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.

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

Install the spark plug cables in the proper engine cylinder firing order, **Refer to Page 8I-4**.