Electronic Distributorless Ignition System (EDIS)

PART 9-1

DESCRIPTION AND OPERATION

All engines use an Electronic Distributorless Ignition System (EDIS).

EDIS consists of the following parts:

1. Crankshaft Position Sensor (CKP sensor) and timing wheel: the sensor is a single pole inductive pickup; the toothed wheel has 35 teeth at 10° intervals, with the 36th tooth missing. The CKP sensor reads both the crankshaft speed and the crankshaft position.

2. Coil pack: the coil pack contains 3 or 4 separate coils with a common B + terminal. The other end of each coil is connected to the EEC module. Inside the EEC module, each coil is connected in series to a 100 mW resistor (for current sensing) and a transistor that connects the coil to ground.

   Each ignition coil fires two spark plugs simultaneously:
   - One spark plug on the compression stroke. This spark plug uses the majority of the ignition coil energy.
   - One spark plug on the exhaust stroke. This spark plug uses very little of the ignition coil stored energy.

   Since these two spark plugs are connected in series:
   - The firing voltage of one spark plug will be negative with respect to ground.
   - The voltage of the other will be positive with respect to ground.

3. EDIS CPU (built into the EEC module). The EDIS CPU processes the signals from the CKP sensor, and sends a synthesised PIP signal to the EEC CPU. It receives timing information from the EEC CPU and controls both the spark timing and the coil dwell.

When the crankshaft rotates, the CKP sensor produces a signal as shown in figure 1. This signal voltage Vp varies from 150 mV at 30 RPM to 200 V at 5500 RPM. The missing tooth produces a distortion of the sine curve, and the EDIS CPU uses this point to determine the position of TDC cylinder 1. After the missing tooth has passed the sensor for the first time, EEC starts to operate the coils and the injectors.

The sensor produces a sine wave; the failing edge of the sine wave crosses the 0 V line when the tooth centre is opposite the sensor.

The EDIS CPU uses the CKP signal to synthesize a PIP signal, as demonstrated in figure 2 for six cylinder engines.

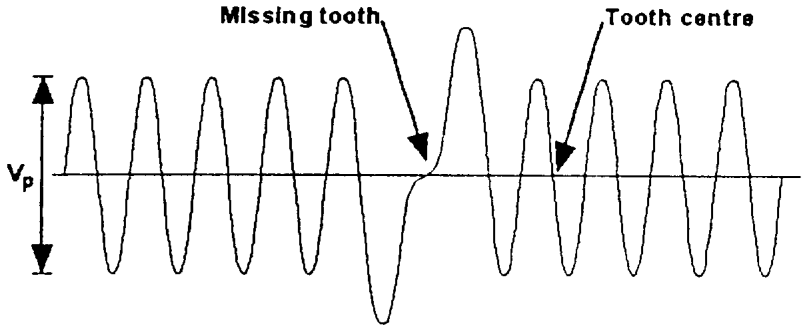


FIG. 1 — Crankshaft position sensor signal

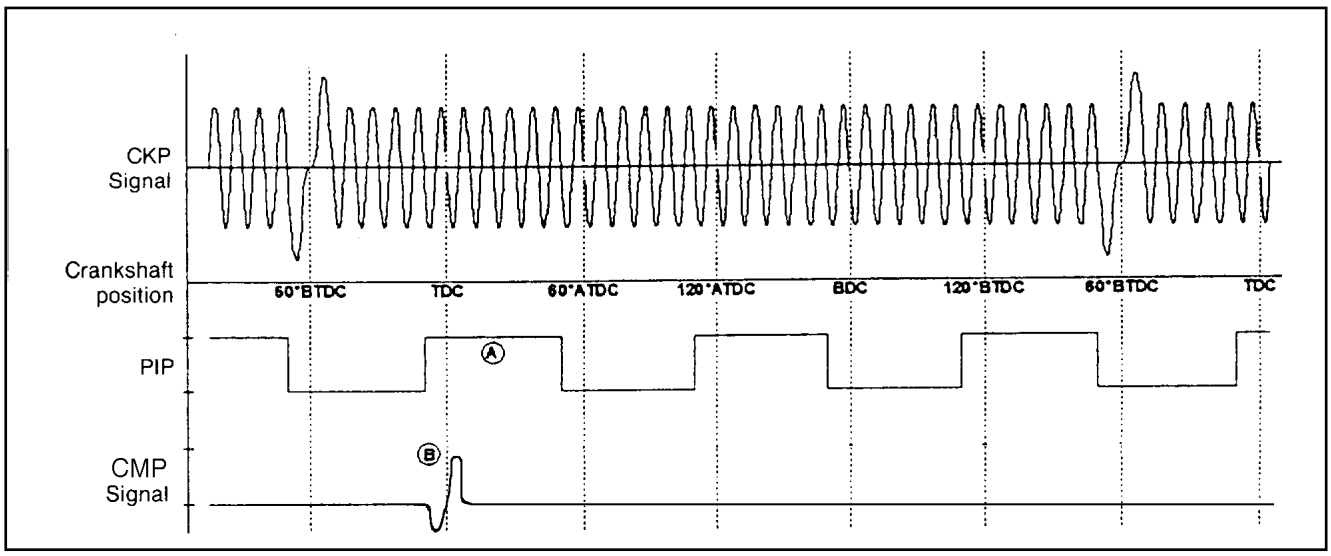


FIG. 2 — CKP signal in relation to crank position, PIP signal and CMP signal (6 Cylinder shown)

The PIP signal is not produced until the missing tooth has passed the sensor for the first time. After the missing tooth has passed the sensor, the EDIS CPU can calculate the position of TDC, and produces a PIP rising edge ('A' in the figure above) to start at 10° BTDC. Each PIP lasts for 60° of crank rotation for 6 cylinder and 45° for 8 cylinder.

For ignition to occur, only the PIP signal is needed. For full synchronisation of the fuel system, and for proper self test, the EEC CPU also needs to know which part of the engine cycle the crank is in. It uses the signal from the Camshaft Position (CMP) sensor for this. The CMP Variable Reluctance (VR) sensor consists of a sensor which produces a sine wave pulse at cylinder 1 TDC.

The CMP signal is also used by the EEC CPU if one of the coils fails to fire. This would normally result in two cylinders misfiring, and an accumulation of unburnt fuel in the catalytic convertor, which could lead to failure of the convertor. To prevent this type of failure, EEC checks the coil primary current each time a coil is energised. If one of the coils fails to charge (repeatedly), the EEC CPU turns off the two injectors associated with that coil.

KNOCK CONTROL SYSTEM - 6 Cylinder only

A knock sensor is fitted to the six cylinder engine to sense the onset of engine knock and return this information to the EEC V module. The EEC V module can then adjust the timing appropriately.

The knock sensor is fitted to the engine block, next to number 5 cylinder, under the inlet manifold.

If engine speed is below 4500 RPM and load is above 50%, EEC will 'listen' for knocking. When the sensor 'hears' detonation in the engine, EEC retards the timing at each PIP signal until the knocking stops. Each step is about 1-2°, depending on the current engine speed and load. When the knock stops, EEC will start ramping up the advance in steps of 1/4° at each PIP signal until the knock starts again. This allows the engine to operate with maximum advance, limited by the speed and load, the octane rating of the fuel and the engine condition, to give maximum engine performance. This is illustrated in figure 3.

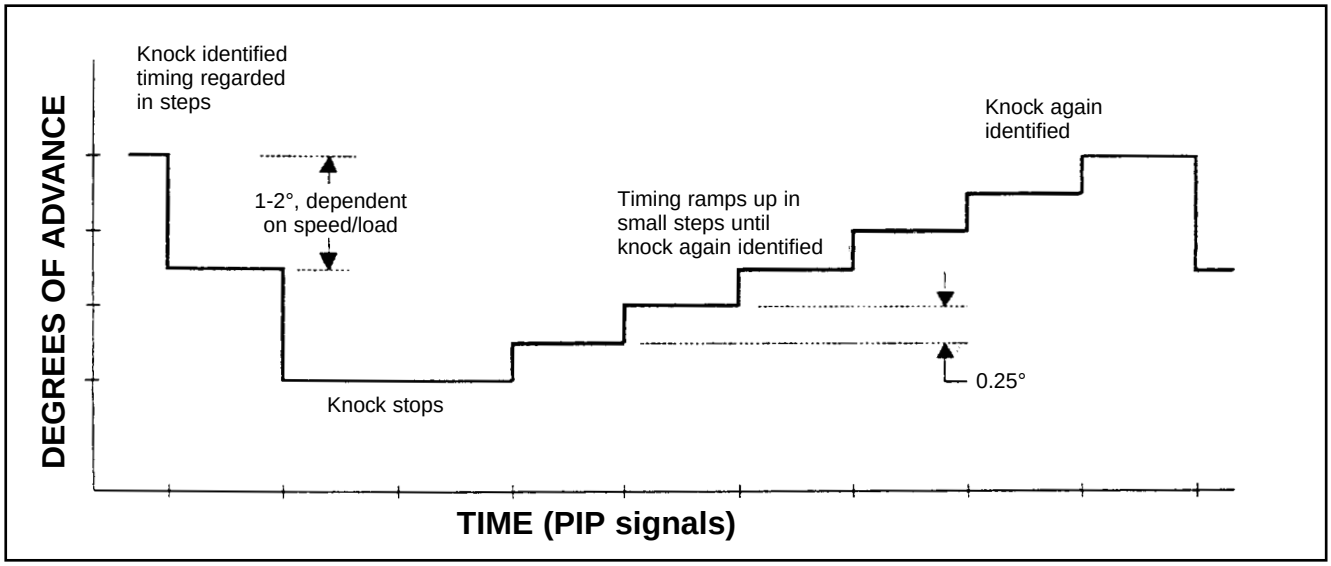


FIG. 3 — Knock control (6 cylinder)

DIAGNOSIS AND TESTING

The EEC V module provides diagnosis of ignition system failures (refer Group 10 for list of error codes and EEC V module pin identification).

EDIS faults generally exhibit the following symptoms:

- engine not starting
- engine runs rough
- engine lacks power.

However, these symptoms are not unique to the EDIS system.

To aid diagnosis, perform EEC self-test.

EDIS Related Error Codes	**Action to Take**
320	Carry out test A.
340	Carry out test C for six cylinder engine and D for V8 engine.
350/351/352/353/354	Carry out test E for six cylinder engine and F for V8 engine.
325/327	Carry out test B (six cylinder only)
1358	Change EEC V module. Retest.
No codes reported	Carry out test G.
Will not self-test	Check power and ground connections. Check BUSP, BUSN wiring. Retest. If not rectified, replace EEC V module.

TEST A:
Checking Crankshaft Position Sensor

TEST STEP	**RESULT ▶**	**ACTION TO TAKE**
A1 • Is the Sensor fitted correctly?	Yes ▶ No ▶	Go to A2 Rectify and Retest.
A2 • Check sensor continuity using ohmmeter • Is the reading between 300-400W	Yes ▶ No ▶	Go to A3 Check sensor and wiring. Rectify and Retest.
A3 • With the sensor disconnected measure the resistance across the connector for a possible short in EEC or wiring. Does a short exist?	Yes ▶ No ▶	Rectify and Retest. Go to A4.
A4 • Measure the resistance from CKP(+ve) to ground and CKP(-ve) to ground for a possible short. • Does a short exist?	Yes ▶ No ▶	Rectify and Retest. Go to A5
A5 • Check wiring for open circuit. • Does an open circuit exist?	Yes ▶ No ▶	Rectify and Retest. Check sensor and tone wheel for damage. Rectify and Retest.

TEST B:
Checking Knock Sensor - six cylinder engine only

TEST STEP	RESULT ▶	ACTION TO TAKE
B1		
• Is the sensor fitted correctly?	Yes ▶ No ▶	Go to B2 Rectify and Retest.
B2		
• Measure resistance across sensor. • Is the reading above 10,000 ohms?	Yes ▶ No ▶	Go to B3 Check sensor and wiring. Rectify and Retest.
B3		
• Disconnect knock sensor. • Check each wire from the EEC to the sensor connector for an open circuit. • Are the readings less than 5 ohms?	Yes ▶ No ▶	Go to B4 Check for open-circuit in wiring from the EEC V to the sensor connector. Rectify and Retest.
B4		
• Measure the resistance across the sensor connector for possible short in EEC V module. • Is the reading above 10,000 ohms?	Yes ▶ No ▶	Go to B5 Replace EEC V module. Retest.
B5		
• Using the NGS check for correct base timing • Is the base timing correct?	No ▶	Rectify and Retest.

NOTE: To log the fault code of 325 or 327 the NGS takes the vehicle to a point in the KOER test where knock should exist and verifies that existence.

TEST C:
Checking Camshaft Position Sensor (CMP) - six cylinder

TEST STEP	RESULT ▶	ACTION TO TAKE
C1		
• Is the sensor fitted correctly?	Yes ▶ No ▶	Go to C2 Rectify and Retest.
C2		
• Check sensor continuity using ohmmeter • Expected 800-900 ohms @ 20˚C • Is the reading within the expected ranges?	Yes ▶ No ▶	Go to C3 Check sensor and wiring. Rectify and Retest.
C3		
• Measure the resistance across the CMP connector on the EEC side for a possible short in the wiring or EEC. • Does a short exist?	Yes ▶ No ▶	Rectify and Retest. Go to C4
C4		
• Check for short to ground on CMP(+ve) or CMP(-ve). • Does a short exist?	Yes ▶ No ▶	Rectify and Retest. Go to C5
C5		
• Check the wiring for an open circuit. • Does an open circuit exist?	Yes ▶ No ▶	Rectify and Retest. Check the sensor and auxiliary drive sprocket for damage. Rectify and Retest.

TEST D:
Checking Camshaft Position Sensor (CMP) - eight cylinder

TEST STEP	RESULT ▶	ACTION TO TAKE
D1		
• Is the sensor fitted correctly?	Yes ▶ No ▶	Go to D2 Rectify and Retest.
D2		
• Check sensor continuity using ohmmeter • Expected 540-640 ohms @ 20˚C • Are the readings within the expected ranges?	Yes ▶ No ▶	Go to D3 Check sensor and wiring. Rectify and Retest.
D3		
• Measure the resistance from: CMP (+ve) (pin 85) to ground CMP (-ve) (pin 8) to ground • Does a short exist?	Yes ▶ No ▶	Check for short-circuit in wiring to GND or EEC module. Retest. Go to D4
D4		
• Check for an open circuit in the wiring or a short circuit across the EEC. • Is the wiring OK?	Yes ▶ No ▶	Go to D5 Check the wiring continuity. Rectify and Retest.
D5		
• Remove the sensor and check the synchroniser timing • Is the timing correct?	Yes ▶ No ▶	Go to D6 Rectify and check for damage. Retest.
D6		
• Remove the synchroniser and inspect for damage • Does the synchroniser look fine?	Yes ▶ No ▶	Go to D7 Replace and retest
D7		
• With ignition off, check across pins 85 and 8 in the EEC V for possible short. • Does a short exist?	Yes ▶	Replace module Retest

TEST E:
Checking Coil Pack - Six Cylinder

TEST STEP	RESULT ▶	ACTION TO TAKE
E1		
• Is the coil connector fitted correctly?	Yes ▶ No ▶	Go to E2 Rectify and Retest
E2		
• Check the power supply to the coil pack. • Is the supply at ignition voltage?	Yes ▶ No ▶	Go to E3 Check coil power circuit for open circuit. Rectify and Retest
E3		
• Measure resistance between: coil 1 pin 26 and coil 2 pin 52 coil 1 pin 26 and coil 3 pin 78 coil 2 pin 52 and coil 3 pin 78 • Are all three readings less than 3W ?	Yes ▶ No ▶	Go to E5 Go to E4
E4		
• Check the resistances of the three coil driver wires from EEC V module to coil pack. • Are the readings less than 1W ?	Yes ▶ No ▶	Go to E5 Check coil driver wires for open circuit. Rectify and Retest
E5		
• Check the resistance between coil pack pin 4 (VPWR) and each of the other 3 pins • Are the readings < 1W ?	Yes ▶ No ▶	Go to E6 Replace coil pack. Retest.
E6		
• With key ON, measure DC voltage from: coil 1 (EEC pin 26) to ground coil 2 (EEC pin 52) to ground coil 3 (EEC pin 78) to ground • Is the reading within 1 volt of VPWR?	Yes ▶ No ▶	Go to E7 Check for short/open circuits in wiring to coil pack.
E7		
• With engine running, measure AC voltages: (Backprobe) coil 1 to ground coil 2 to ground coil 3 to ground • Are the readings between 1-2V?	Yes ▶ No ▶	Go to E8 Replace EEC V module. Retest system.
E8		
• Check for regular sparking during crank (using dummy plug). • Does regular sparking occur (ie. one spark per plug each engine revolution)?	No ▶	Check plugs, high-tension leads and secondary coil impedance. Rectify and Retest.

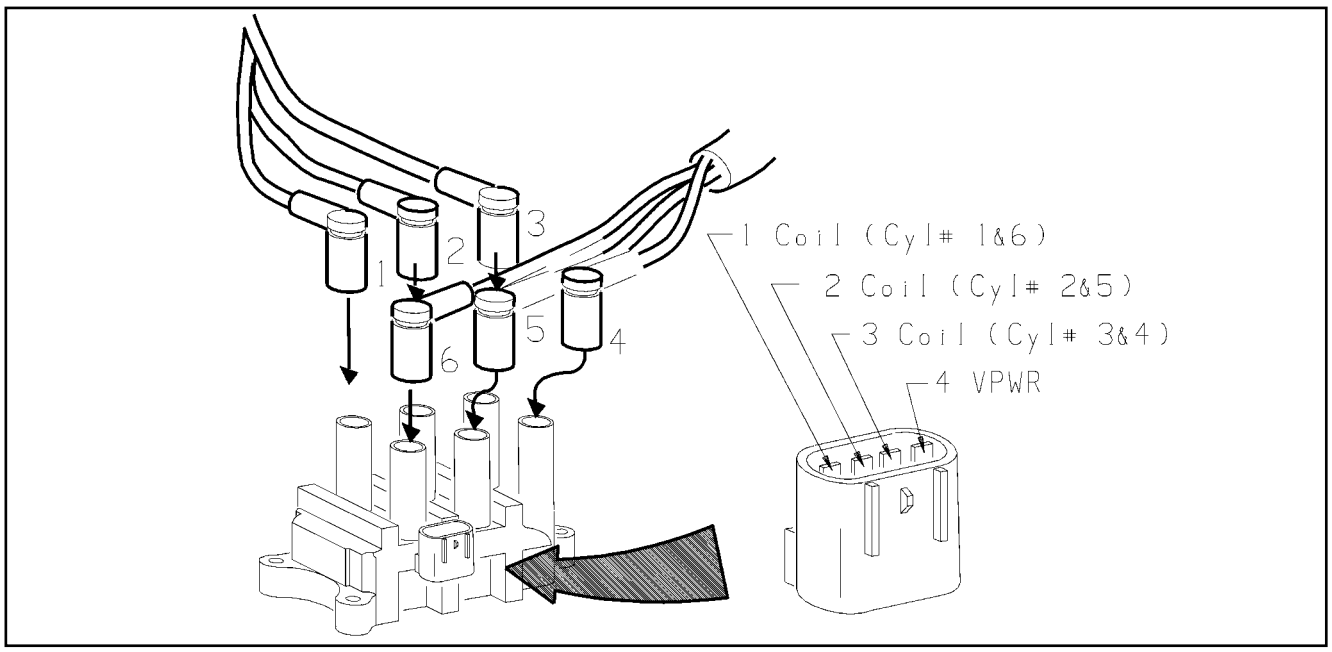


FIG. 4 — Ignition Coil Pack

TEST F:
Checking Coil Packs - eight cylinder

TEST STEP	RESULT ▶	ACTION TO TAKE
F1		
• Is the coil connector fitted correctly?	Yes ▶ No ▶	Go to F2 Rectify and Retest.
F2		
• Check the power supply to the coil packs. • Is the supply at ignition voltage?	Yes ▶ No ▶	Go to F3 Check coil power circuit for open circuit.
F3.		
• Measure resistance between: coil 1 pin 26 and coil 2 pin 52 coil 3 pin 78 and coil 4 pin 104 • Are both readings less than 3 ohms?	Yes ▶ No ▶	Go to F5 Go to F4
F4		
• Check the resistance of the four coil driver wires from the EEC to the coil packs. • Are the readings less than 1 ohm?	Yes ▶ No ▶	Go to F5 Check coil driver wires for open circuit. Rectify and Retest.
F5		
• Check the resistance between VPWR and coil pack pins (separate for each coil pack) on the coil pack • Are the readings less than 1 ohm?	Yes ▶ No ▶	Go to F6 Replace coil pack. Retest.
F6		
• With key ON, measure DC voltage from: coil 1 pin 26 to ground coil 2 pin 52 to ground coil 3 pin 78 to ground coil 4 pin 104 to ground • Are the readings within 1 volt of VPWR?	Yes ▶ No ▶	Go to F7 Check for short/open circuit in wiring to coil pack. Rectify and Retest.

TEST STEP	RESULT ▶	ACTION TO TAKE
F7		
• With engine running, measure AC voltages (Backprobe): coil 1 pin 26 to ground coil 2 pin 52 to ground coil 3 pin 78 to ground coil 4 pin 104 to ground • Are Readings between 1-2 volts?	Yes ▶ No ▶	Go to F8 Replace EEC V module Retest System.
F8		
• Check for regular sparking during crank (using dummy plug). • Does regular sparking occur (ie one spark per plug engine revolution)?	No ▶	Check plugs, high-tension leads and secondary coil impedance. Rectify and Retest.

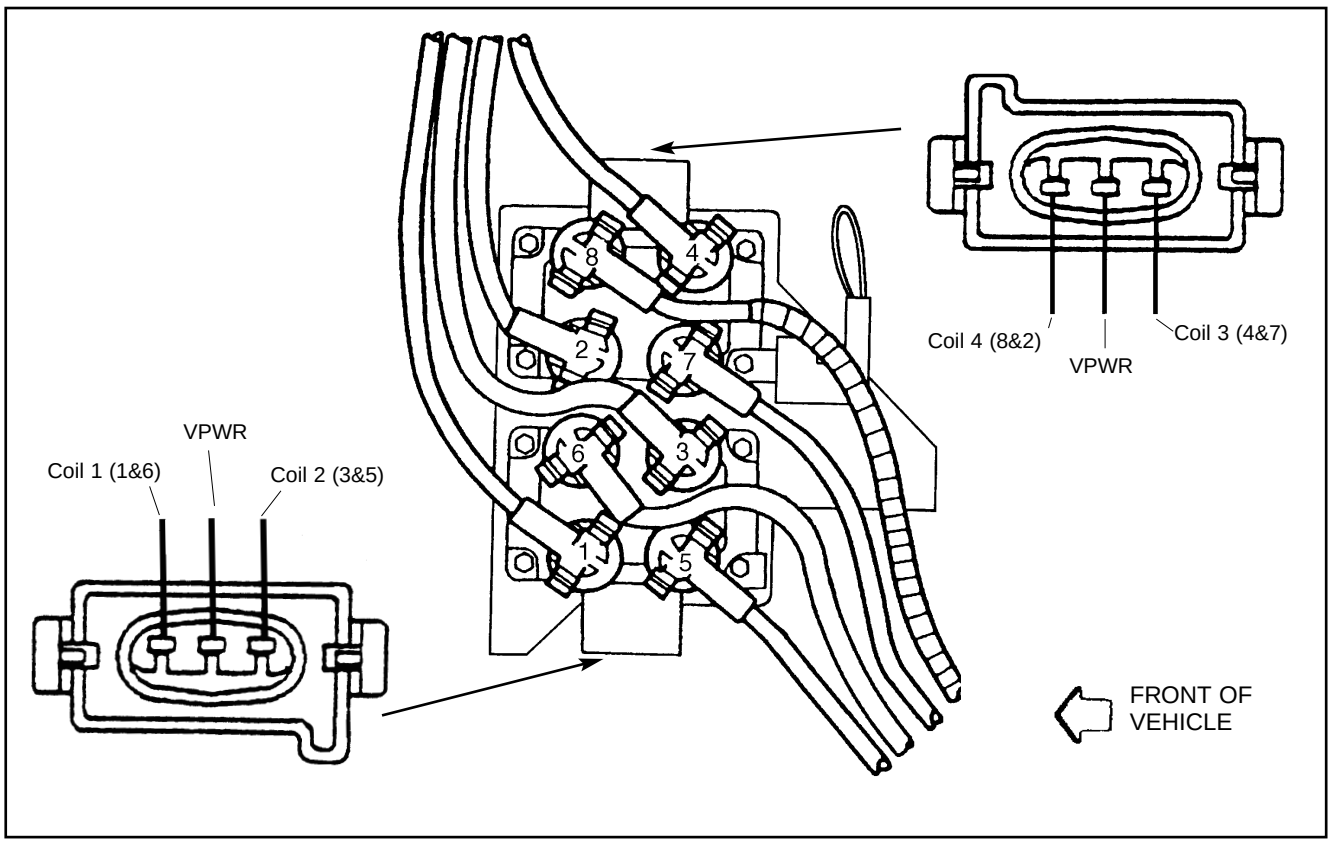


Fig. 5. Ignition Coil Pack and Connectors - V8

TEST G:
No Self-Test Error Codes Reported

TEST STEP	RESULT ▶	ACTION TO TAKE
G1		
• Check for regular sparking during crank (using dummy plug). • Does regular sparking occur (ie. one spark per plug each engine revolution)?	Yes ▶ No ▶	Go to G2 Perform tests A and D.
G2		
• Run an ignition timing test in ' function tests' of the NGS PCM diagnostics. • Is the timing set at 0° ± 2° BTDC for I6 or 10° ± 2° BTDC	No ▶	Replace crankshaft pulley and tone-wheel. Retest.

REMOVAL AND INSTALLATION

- SIX CYLINDER

CRANKSHAFT POSITION AND CAMSHAFT POSITION SENSOR (Fig. 6)

Removal

1. Disconnect battery ground cable.
2. Remove drive belt cover, front air intake duct, fan assembly and drive belt.
3. Disconnect crankshaft position and camshaft position sensors electrical connector.
4. Remove crankshaft position and camshaft position sensor protector.
5. Remove crankshaft position and camshaft position sensor retaining screws and both sensors.

Installation

1. Position crankshaft position and camshaft position sensors on engine front cover.
2. Install crankshaft position and camshaft position sensors. Tighten retaining screw to 2-4 Nm.
3. Route crankshaft position and camshaft position sensors wiring harnesses and connect wiring connectors.
4. Install drive belt, fan assembly, air intake duct and radiator cover.
5. Connect battery ground cable.

IGNITION COIL (Figs. 7 & 8)

Removal

1. Disconnect battery ground cable wiring.
2. Raise vehicle.
3. Disconnect wiring connector from ignition coil.
4. Remove ignition wires.
5. Remove ignition coil retaining screws and remove ignition coil and suppressor.

Installation

1. Install ignition coil and suppressor and insert retaining screws. Tighten retaining screws to 10-17 Nm.
2. Connect ignition wires to ignition coil. Connect wiring connector to ignition coil.
3. Connect battery ground cable.

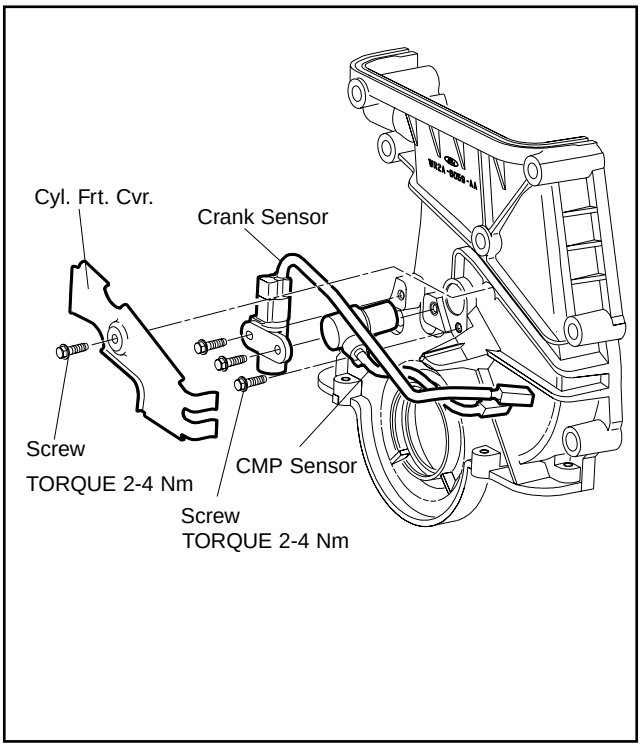


FIG. 6 — CKP and CMP Sensor Installation

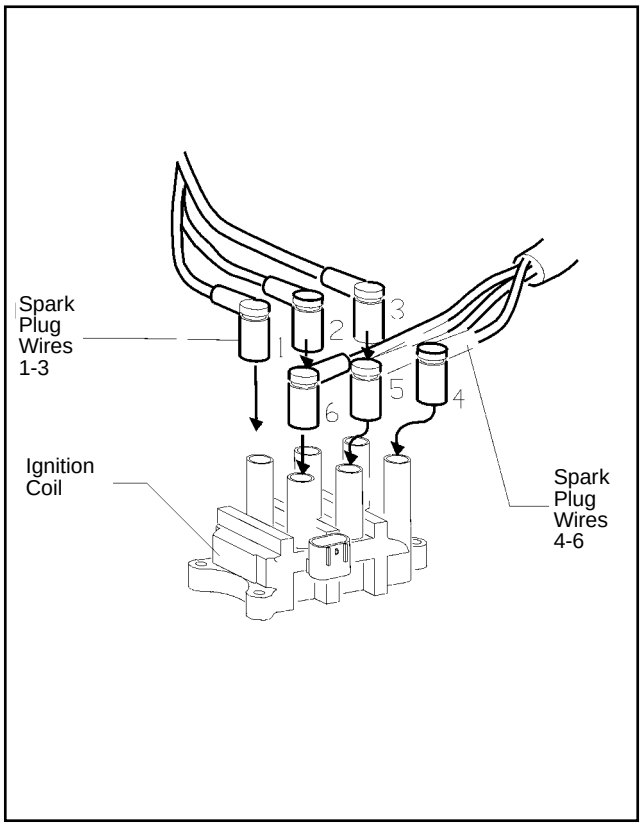


FIG. 7 — Ignition Wire Installation

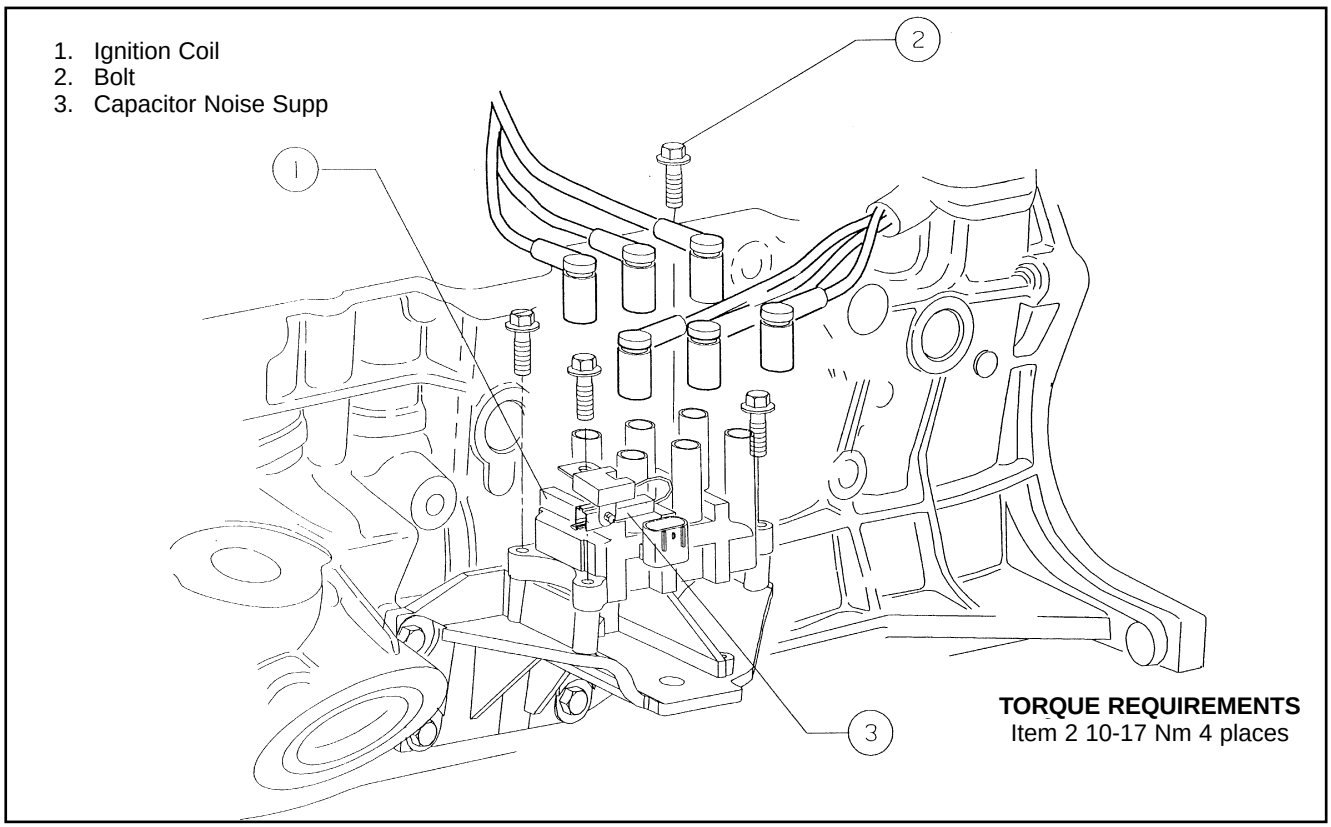


FIG. 8 — Coil Pack Installation

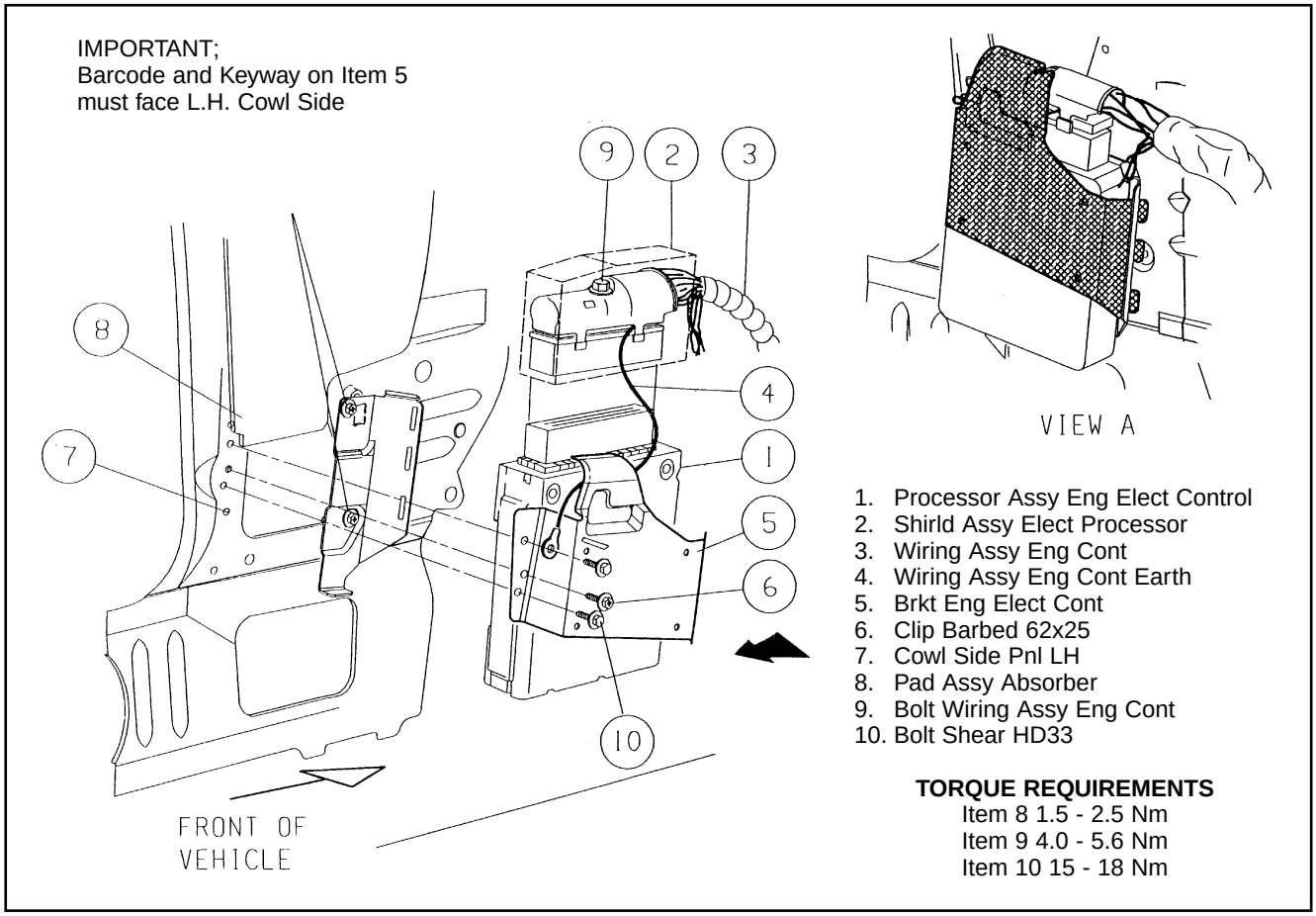


FIG. 9 — EEC V Module Installation

ELECTRONIC ENGINE CONTROL (EEC V) MODULE (Fig. 9.)

Removal

1. Remove LH side scuff plate.
2. Remove inner door liner rubber.
3. Pull carpet back gently releasing liner clips.
4. Remove left-hand retaining screw and earthing wire from module bracket.
5. Remove bracket and module.
6. Pull back electrical connector cover (item 2) and release connector retaining bolt and remove connector.

Installation

Reverse of the removal procedure.

KNOCK SENSOR (Fig. 10)

Removal

1. Raise the vehicle on a hoist.
2. Disconnect knock sensor wiring.
3. Remove nut and sensor from stud.

Installation

1. Place sensor over hole and screw bolt on, torque to 17-24 Nm.
2. Connect wiring to sensor.
3. Lower vehicle.

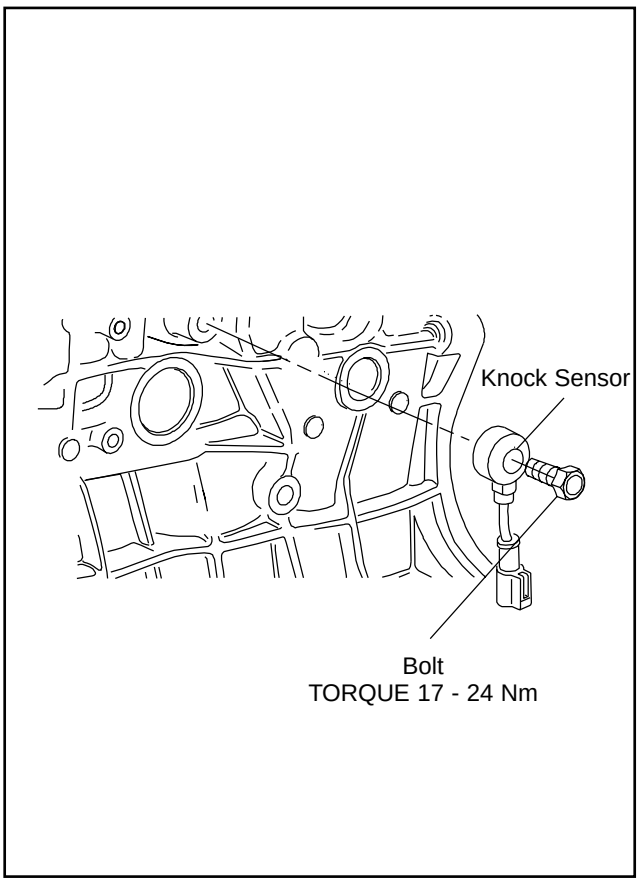


Fig. 10. - Knock Sensor Installation

REMOVAL AND INSTALLATION

- EIGHT CYLINDER

CRANKSHAFT POSITION SENSOR (Fig. 11)

Removal

1. Disconnect battery ground cable wiring.
2. Remove CKP electrical connector.
3. Remove retaining bolts.
4. Remove CKP sensor.

Installation

1. Position CKP sensor and install retaining bolts, tighten to 8-12 Nm.
2. Reconnect CKP electrical connector.
3. Reconnect battery ground cable wiring.

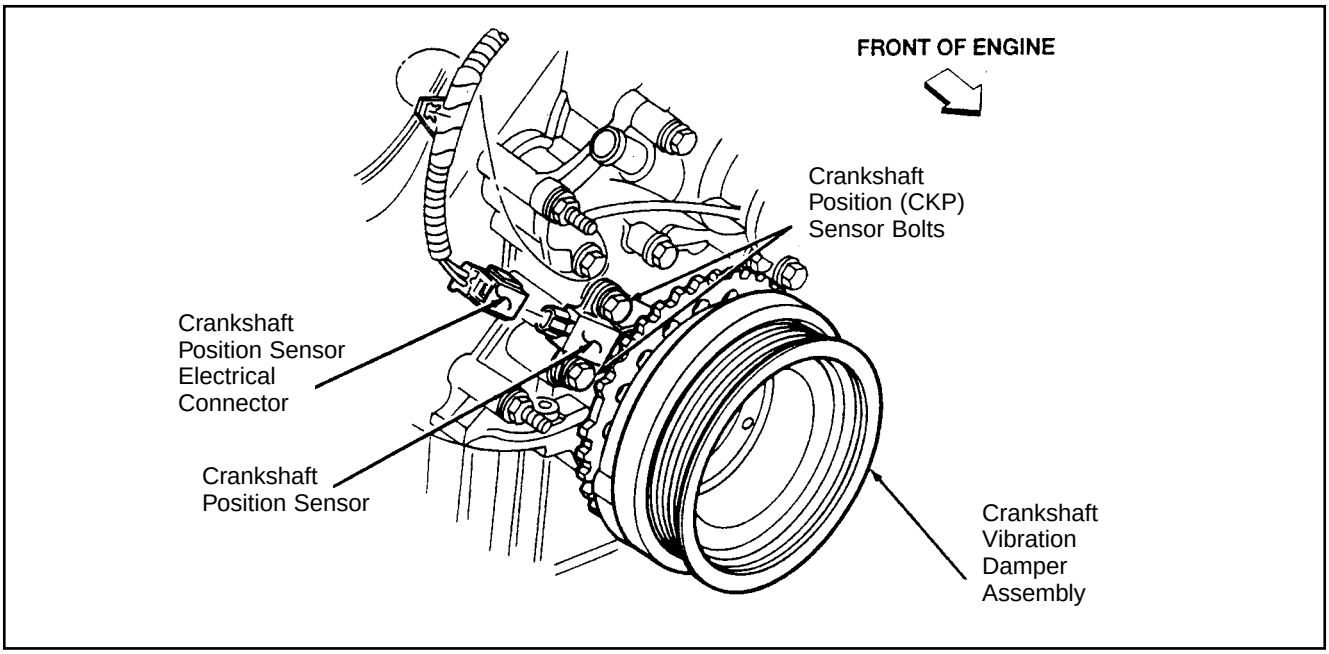


Fig. 11. - Crankshaft Position Sensor - Eight Cylinder

IGNITION COIL PACKS (Fig. 12.)

Removal

1. Disconnect battery ground cable wiring.
2. Remove wiring connectors from ignition coil.
3. Remove ignition wires.
4. Remove ignition retaining screws and remove ignition coil packs and suppressor.

Installation

1. Position ignition coils and suppressor, insert retaining screws and tighten to 5-7 Nm.
2. Connect ignition wires and ignition coil connectors. (Ignition wire configuration shown).
3. Reconnect battery ground cable wiring.

CAMSHAFT POSITION SENSOR AND SYNCHRONISER (Figs. 13, 14, & 15.)

CAUTION: Synchroniser positioning tool (No. 303-630) must be obtained prior to removal and replacement of Synchroniser assembly. Failure to follow this procedure will result in the fuel system being out of time with the engine, possible causing engine damage.

Prior to the removal of the CMP sensor, set cylinder 1 to TDC of compression stroke. Then note the position of the CMP electrical connector. The installation procedure requires that the electrical connector be located in the same position.

Removal

1. Disconnect battery ground cable wiring.
2. With cylinder 1 set at TDC of compression stroke, disconnect CMP electrical connector.
3. Remove the CMP sensor screws and CMP sensor from the synchroniser.

NOTE: Do not move camshaft until entire installation is complete.

4. Using the synchroniser positioning tool (303-630) to check for correct positioning of the synchroniser.

Only continue to step 5 if the synchroniser requires removal.

5. Remove hold-down clamp.
6. Remove synchroniser assembly from cylinder block.

Installation

1. Attach the synchroniser positioning tool (303-630).
2. Align the synchroniser vane with the radial slot of the Syncro Positioning Tool (303-630).
3. Rotate the tool on the synchroniser base until the tool's boss engages the base notch.
4. Dip gear end into oil to coat gear, thrust washer and lower bearing.
5. Install camshaft synchroniser into cylinder block making sure that the arrow is pointing forward parallel to the centre line of the camshaft.
6. Install hold-down clamp and tighten to 23-34 Nm.
7. Remove Synchroniser positioning tool.
8. Install CMP sensor and CMP sensor screws. Tighten to 2.5-3.5 Nm.
9. Reconnect CMP connector to CMP.
10. Reconnect Battery ground cable wiring.

ELECTRONIC ENGINE CONTROL (EEC-V) MODULE

For removal and installation information see the section for six cylinder.

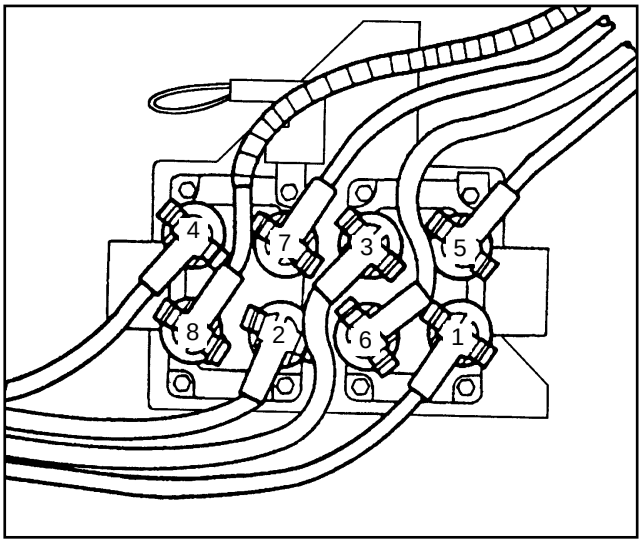


FIG. 12. - Ignition Coil Packs - Eight Cylinder

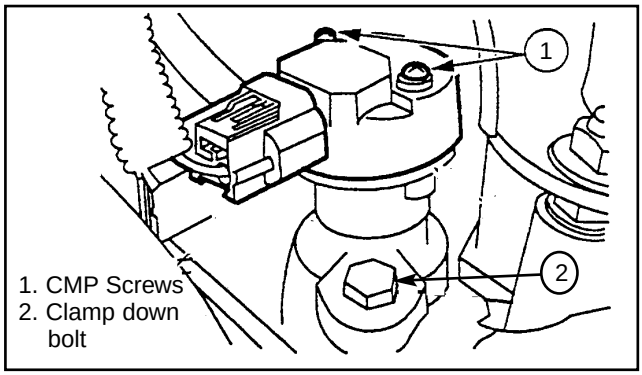


FIG. 13. - CMP and Synchroniser

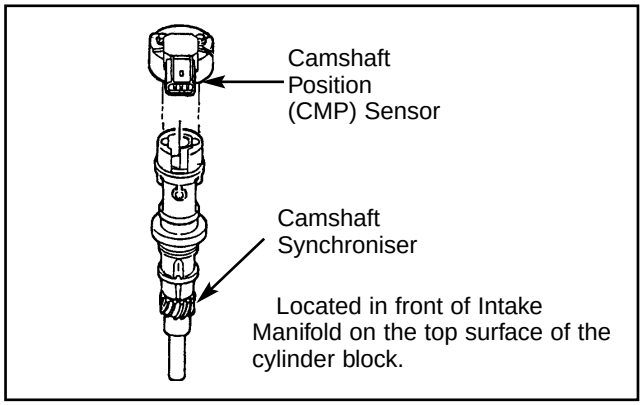


FIG. 14. - CMP and Synchroniser

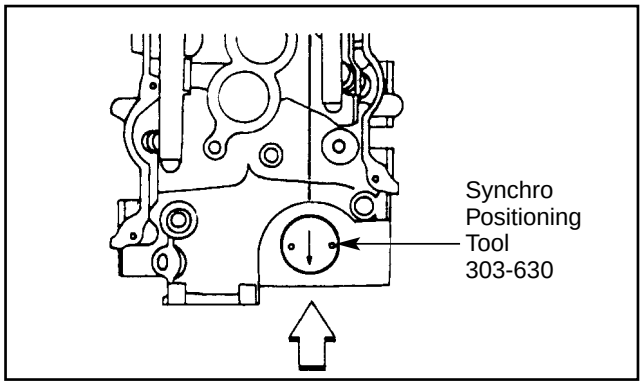


FIG. 15. - Correct Synchroniser Position

SPARK PLUGS AND LEADS

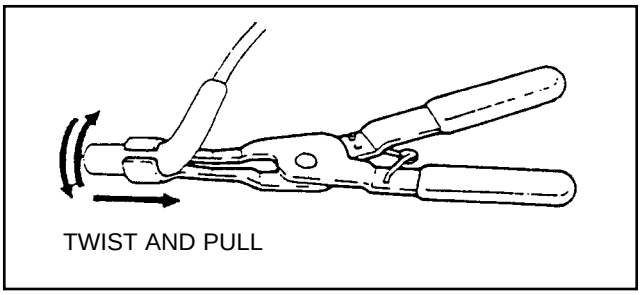


FIG. 16. - Spark Plug Wire Removal

REMOVAL AND INSTALLATION

Caution: When working on electronic ignition systems, please observe the following points:

1. Electronic ignition systems can produce HIGH TENSION VOLTAGES in the PRIMARY and SECONDARY circuits which are dangerous. Ensure that all work is carried out with the utmost care.
2. Semi-conductor devices cannot withstand high induction voltages. Before removing or refitting any connections ensure that the ignition system is switched off.
3. Do not open circuit high tension leads. The electronic control unit cannot withstand prolonged open circuits in the high tension lead.
4. It is most important that any connections made to the electronic control unit are correct polarity as reversal of polarity destroys the electronic control unit.

SPARK PLUG WIRES (Figs. 16, 17 and 18)

Removal

When removing wires from spark plugs, use a universal type tool. Grasp and twist the boot back and forth on the plug insulator to free boot. Use the tool to pull the boot from the plug. Do not pull on the wire directly, or it may become separated from the connector inside the boot.

When removing wires from the coil pack, grasp the boot by hand and remove with a twisting and pulling motion. Do not pull on the wire.

Carefully pull the wires from the clips on the valve rocker arm cover and remove the wires.

Cleaning, Inspection and Testing

Refer to the following pages in this section for cleaning and inspection procedures. Check the resistance of the spark plug and ignition coil high tension wires with an ohmmeter. Resistance of the wires should be within the tolerance shown in the specification section. If the wires are not to specification, install new wires.

Installation

1. Whenever a high tension wire is removed for any reason from a spark plug, or coil or a new high tension wire is installed, Dow Corning Heat Sink Compound 340 or equivalent must be applied to the boot before it is reconnected. Using a small clean tool, coat the entire interior surface of the boot with the compound.
2. Insert each wire on the proper terminal of the coil pack. Be sure the wires are all the way over their terminals. The terminals are identified on the packs.
3. Remove the wire retaining separators from the old high tension wire set and install them on the new set in the same relative position. Install the separators to the valve rocker arm cover studs.
4. Connect the wires to the proper spark plugs.

SPARK PLUGS

Removal

1. Remove spark plug wire from spark plug using the tool with a twisting-pulling motion. Do not pull directly on spark plug wire.
2. Inspect spark plug wires for physical damage. Replace as necessary.
3. Clean area around each spark plug port with compressed air.
4. Unscrew the spark plug.

Installation

1. Set spark plug gap to specification as shown on Vehicle Emission Decal.
2. Install spark plug and tighten to specification.
3. Coat the inside of the spark plug wire boot with Dow Corning Heat Sink Compound 340 and install on spark plug.

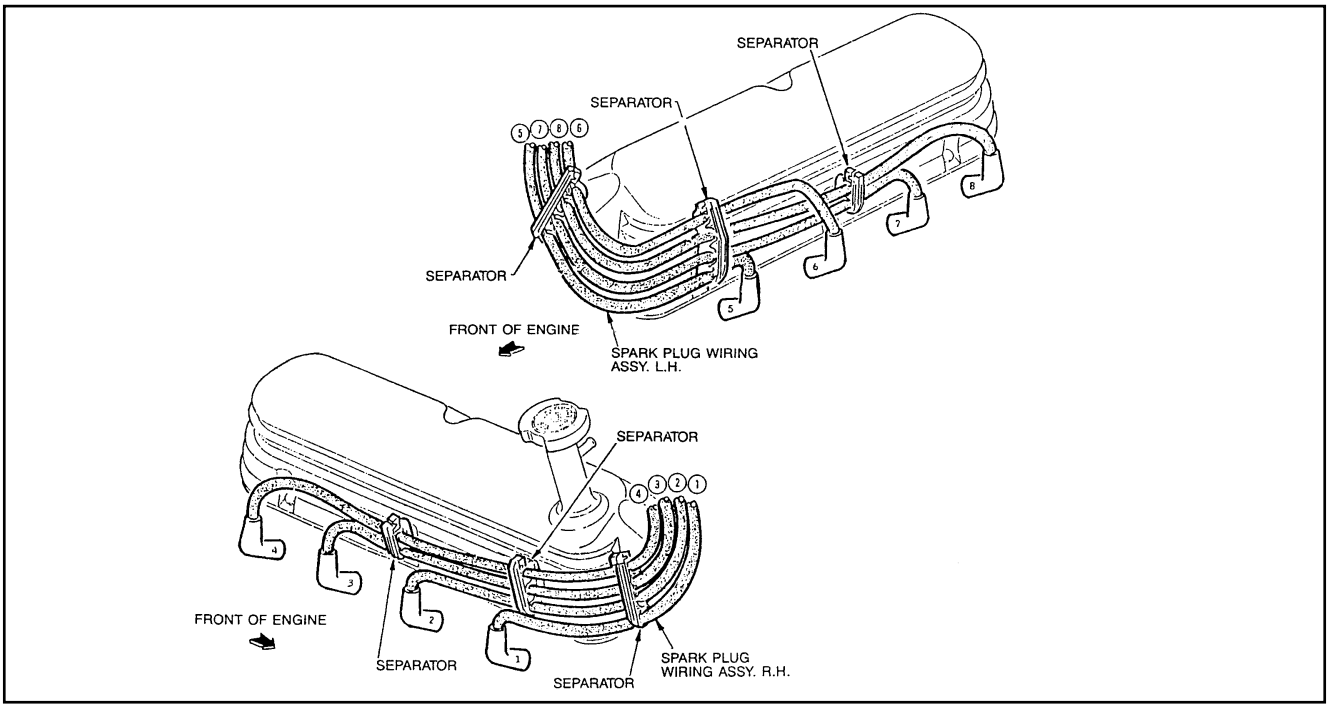


FIG. 17. - Spark Plug Lead Installation - 8 Cylinder

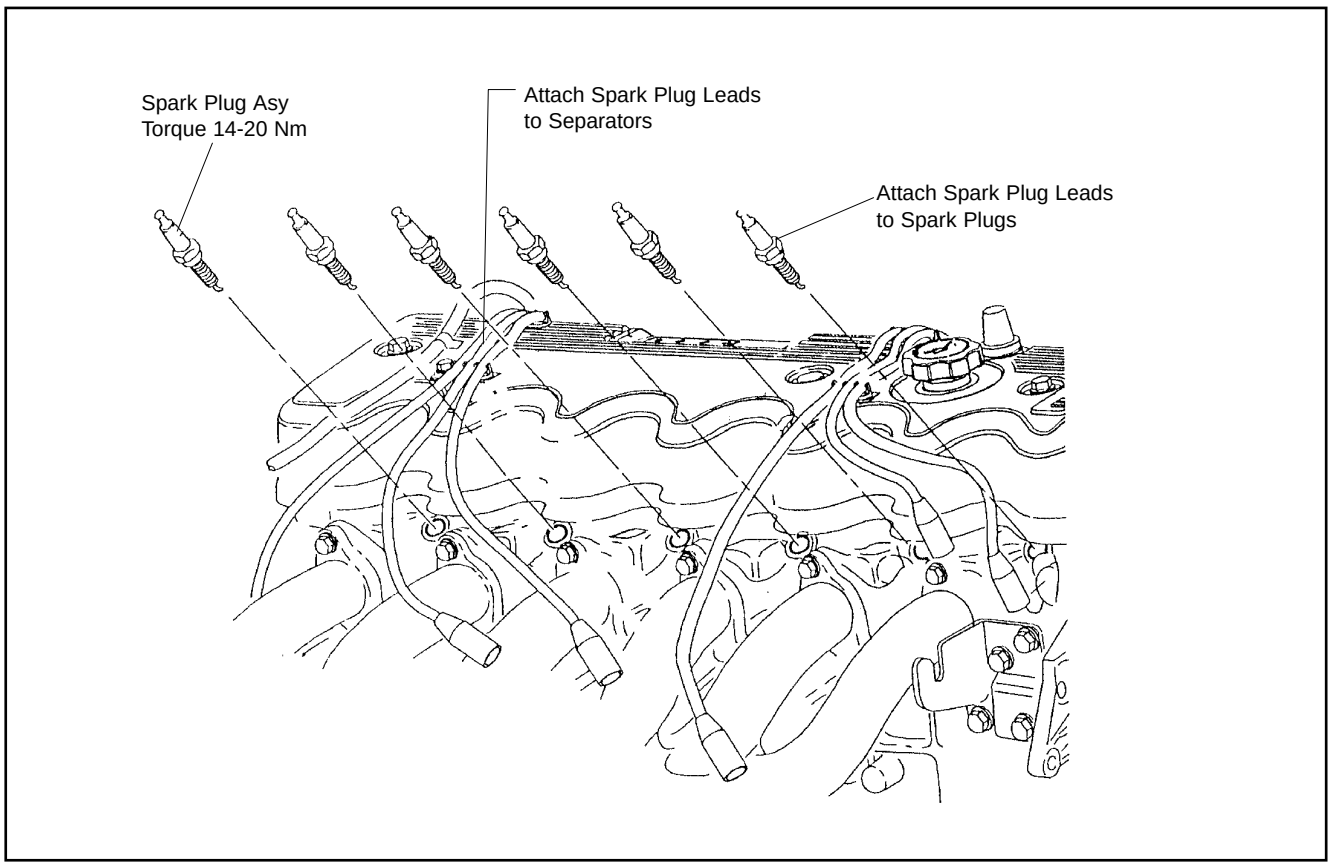


FIG. 18. - Spark Plug Lead Installation - 6 Cylinder

CLEANING AND INSPECTION

SPARK PLUGS (Figs. 19 and 20)

Examine the firing ends of the spark plugs noting the type of deposits and the degree of electrode erosion. Various types of spark plug fouling and their causes are shown.

Clean the plugs on a sand blast cleaner, following the manufacturer's instructions. **Do not prolong the use of the abrasive blast as it will erode the insulator and electrodes.** Clean the electrode surfaces with a small file. Dress the electrodes to obtain flat parallel surfaces on both the centre and side electrodes.

After cleaning, examine the plug carefully for cracked or broken insulators, badly pitted electrodes, and other signs of failure. Replace as required.

After the proper gap is obtained, check the plugs on a testing machine. Compare the sparking efficiency of the cleaned and gapped plug with a new plug. Replace the plug it if fails to meet 70% of the new plug performance.

Test the plugs for compression leakage at the insulator seal. Apply a coating of oil to the shoulder of the plug, where the insulator projects through the shell, and to the top of the plug, where the centre electrode and terminal project from the insulator. Place the spark plug under pressure with the tester's high tension wire removed from the spark plug.

Leakage is indicated by air bubbling through the oil. If the test indicates compression leakage, replace the plug. If the plug is satisfactory, wipe it clean.

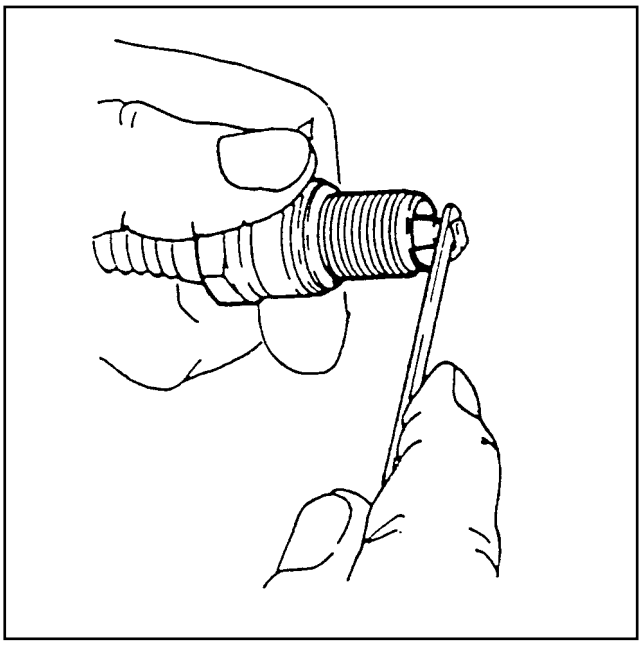


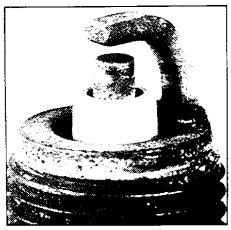
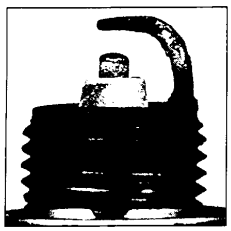
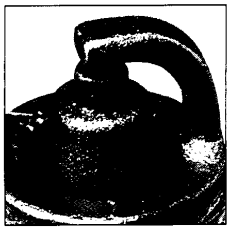
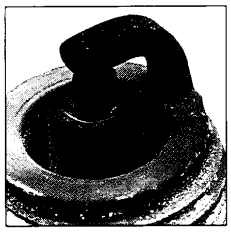
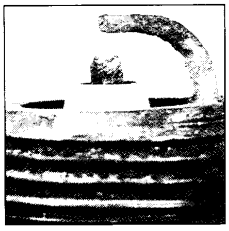
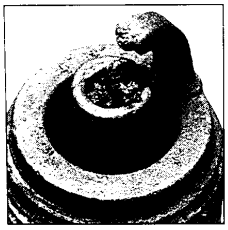
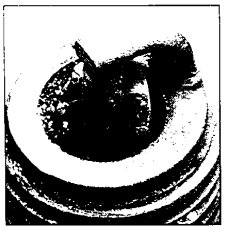
FIG. 19. Cleaning Spark Plug Electrode

SECONDARY WIRING

Wipe the wire with a damp cloth and check for fraying, breaks or cracked insulation. Inspect the terminals and weather seals for looseness or corrosion. Replace any wires that are not in good condition.

COIL PACK

Wipe the coil pack with a damp cloth and check for any cracks or other defects.

APPEARANCE-CONDITION	EFFECT CAUSE	CORRECTIVE ACTION
 **NORMAL** •Light grey-to-tan deposits, slight electrode wear.	•Normal operation •Correct heat range plug for engine /operating conditions.	•Renew at normal replacement intervals.
 **WORN OUT** •Excessive electrode wear.	•Misfiring, poor driveability and economy •These plugs have passed their efficient service life.	•Replace spark plugs, tune-up engine.
 **OIL FOULED** •Plug tip covered in oily deposits.	•Misfiring, poor driveability and economy - smoky exhaust •Excessive oil in combustion chamber - worn rings, valve seals, guides.	•Replace spark plugs. Check engine, as general overhaul may be required.
 **CARBON FOULED** •Dry, sooty carbon deposits.	•Misfiring, hard starting and poor economy •Over-rich mixture, late timing faulty ignition system, or spark plug too cold for operating conditions.	•Replace spark plugs. Check timing, ignition and fuel systems, and air filter.
 **OVERHEATED** •White insulator with small fused black spots and signs of electrode edges melting.	•Misfiring, pinging, power loss •Over-advanced timing, faulty ignition/fuel systems, mixture too lean, inefficient cooling system or plug too hot.	•Replace spark plugs. Check ignition, fuel and cooling systems.
 **PRE-IGNITION** •Melted electrode tip.	•Misfiring, pinging •May be one, or a combination of causes- combustion chamber hot spots, cross-firing, or as with “overheated” plugs.	•Replace spark plugs. Check fuel and ignition systems, H.T. wires and general engine condition.
 **DETONATION** •Plug insulator nose fractured.	•Misfiring, pinging •Over-advanced timing, lean mixture or low octane fuel.	•Replace spark plugs. Check fuel and ignition systems. Check engine for damage.

Caution: To assist correct seating of spark plugs, plug and cylinder head threads must be free from deposits. Incorrectly seated plugs may overheat/destruct.

FIG. 20. Spark Plug Inspection