Chapter 5
Engine electrical systems

Contents

Degrees of difficulty

Easy, suitable for novice with little experience 

Fairly easy, suitable for beginner with some experience 

Fairly difficult, suitable for competent DIY mechanic 

Difficult, suitable for experienced DIY mechanic 

Very difficult, suitable for expert DIY or professional 

Specifications

General

Electrical system type	12 volt, negative earth
Ignition system type:	Breakerless, Hall effect, with electronic control of advance
Carburettor models	ESC II system
Fuel-injection models	EEC IV system
Firing order:	
OHC	1-3-4-2 (No 1 at pulley end)
V6	1-4-2-5-3-6 (No 1 at front of right-hand bank)

Alternator

Make and type	Bosch KI-55A, NI-70A or NI-90A
Rated output at 13.5 volts and 6000 engine rpm	55, 70 or 90 amps
Rotor winding resistance at 20°C (68°F):	
KI-55A	3.4 to 3.7 ohms
NI-70A and NI-90A	2.8 to 3.1 ohms
Brush wear limit	5 mm (0.2 in)
Regulated voltage at 4000 engine rpm and 3 to 7 amp load	13.7 to 14.6 volts
Voltage regulator type	Solid state, integral

Starter motor

Make and type	Bosch short frame, long frame or reduction gear
Rating:	
Short frame	0.85 or 0.95 kW
Long frame	1.1 kW
Reduction gear	1.4 kW
Brush wear limit:	
Short frame and reduction gear	8 mm (0.32 in)
Long frame	10 mm (0.39 in)
Commutator minimum diameter	32.8 mm (1.29 in)
Armature endfloat	0.3 mm (0.012 in)

Ignition coil

Make	Bosch, Femsa or Polmot
Primary resistance	0.72 to 0.86 ohm
Secondary resistance:	
All except DOHC fuel-injection	4.5 to 7.0 k ohms
DOHC fuel-injection	4.5 to 8.6 k ohms
Output voltage (open-circuit):	
All except DOHC fuel-injection	25 kV minimum
DOHC fuel-injection	30 kV minimum

HT leads

Maximum resistance per lead	30 k ohms

Distributor

Make	Bosch or Motorcraft
Rotation	Clockwise (viewed from above)
Automatic advance	Controlled by module
Dwell angle	Controlled by module

Ignition timing (see text)

SOHC and 2.8 litre V6 engines:	
Leaded fuel (97 octane):	
Carburettor models	10° BTDC
Fuel-injection models	12°BTDC
Unleaded fuel (95 octane):	
Carburettor models	6°BTDC
Fuel-injection models:	
2.0 litre	8°BTDC
2.8 litre	12°BTDC (no change)
2.4 & 2.9 litre V6 engines:	
Models with catalytic converter	15° BTDC
Models without catalytic converter	12° BTDC*

** Standard setting for 97 octane leaded fuel.*

Torque wrench settings

	Nm	lbf ft
Alternator adjusting strap:		
To steering pump bracket (OHC)	21 to 26	16 to 19
To front cover (V6)	41 to 51	30 to 38
Spark plugs:		
All models except 2.8 litre V6	20 to 28	15 to 21
2.8 litre V6	30 to 40	22 to 30
Air charge temperature sensor	20 to 25	15 to 18
Engine coolant temperature sensor	20 to 25	15 to 18
Fuel rail temperature sensor (DOHC)	8 to 11	6 to 8
Crankshaft speed/position sensor screw (DOHC)	3 to 5	2 to 4

1 General information and precautions

The ignition system is responsible for igniting the fuel/air charge in each cylinder at the correct moment. The components of the system are the spark plugs, ignition coil, distributor and connecting leads. Overall control of the system is one of the functions of the engine management module. Fuel-injection models have a subsidiary ignition module mounted on the distributor.

There are no contact breaker points in the distributor. A square wave signal is generated by the distributor electro-magnetically; this signal is used by the engine management module as a basis for switching the coil LT current. Speed-related (centrifugal) advance is also handled by the module. On carburettor models, ignition timing is also advanced under conditions of high inlet manifold vacuum.

The engine management models are “black boxes” which regulate both the fuel and the ignition systems to obtain the best power, economy and emission levels. The module fitted to carburettor models is known as the ESC II (Electronic Spark Control Mk II) module. On fuel-injection models the more powerful EEC IV (Electronic Engine Control Mk IV) module is used.

Both types of module receive inputs from sensors monitoring coolant temperature, distributor rotor position and (on some models) manifold vacuum. Outputs from the module control ignition timing, inlet manifold heating and (except on 1.8 litre models) idle speed. The EEC IV module also has overall control of the fuel-injection system, from which it receives information.

Provision is made for the ignition timing to be retarded to allow the use of low octane fuel if necessary. On all except 1.8 litre models there is also a facility for raising the idle speed.

The EEC IV module contains self-test circuitry which enables a technician with the appropriate test equipment to diagnose faults in a very short time. A Limited Operation Strategy (LOS) means that the car is still driveable, albeit at reduced power and efficiency, in the event of a failure in the module or its sensors.

Due to the complexity and expense of the test equipment dedicated to the engine management system, suspected faults should be investigated by a Ford dealer, or other competent specialist. This Chapter deals with component removal and refitting, and with some simple checks and adjustments.

On DOHC carburettor engines, the basic operating principles of the ignition system are as described above. A development of the ESC II (Electronic Spark Control II) system is used to control the operation of the engine. The ESC II module receives information from a crankshaft speed/position sensor and an

engine coolant temperature sensor. The crankshaft speed/position sensor is activated by a toothed disc on the rear of the crankshaft, inside the cylinder block. The disc has 35 equally spaced teeth (one every 10°), with a gap in the 36th position. The gap is used by the sensor to determine the crankshaft position relative to Top Dead Centre (TDC) of No 1 piston.

The ignition advance is a function of the ESC II module, and is controlled by vacuum. The module is connected to the carburettor by a vacuum pipe, and a transducer in the module translates the vacuum signal into an electrical voltage. From the vacuum signal, the module determines engine load; engine speed and temperature are determined from the crankshaft speed/position sensor and the engine coolant temperature sensor. The module has a range of spark advance settings stored in the memory, and a suitable setting is selected for the relevant engine speed, load and temperature. The degree of advance can thus be constantly varied to suit the prevailing engine speed and load conditions.

On DOHC fuel-injected engines, a development of the EEC IV (Electronic Engine Control IV) engine management system is used to control both the ignition and fuel-injection systems. The EEC IV module receives information from a crankshaft speed/position sensor (the same as that fitted to the carburettor models), a throttle position sensor, an engine coolant temperature sensor, a fuel temperature sensor, an air charge temperature sensor, a Manifold Absolute Pressure (MAP) sensor, and a vehicle speed sensor (mounted on the gearbox). Additionally, on models with a catalytic converter, an additional input is supplied to the EEC IV module from an exhaust gas oxygen (HEGO) sensor. On models with automatic transmission, additional sensors are fitted to the transmission to inform the EEC IV module when the transmission is in neutral, and when the downshift is being operated.

The module provides outputs to control the fuel pump, fuel-injectors, idle speed, ignition system and automatic transmission . Additionally, on models with air conditioning, the EEC IV module disengages the air conditioning compressor clutch when starting the engine or when the engine is suddenly accelerated. On models fitted with a catalytic converter, the EEC IV module also controls the carbon canister purge solenoid valve.

Using the inputs from the various sensors, the EEC IV module computes the optimum ignition advance, and fuel-injector pulse duration to suit the prevailing engine conditions.

On 2.4 & 2.9 litre V6 engines, the system operates in much the same way as that fitted to the DOHC fuel-injected engine, noting the following points.

a) *There is no crankshaft speed/position sensor.*
b) *The vehicle speed sensor is only fitted to models equipped with a catalytic converter.*

Precautions

ESC II module

Although it will tolerate all normal under-bonnet conditions, the ESC II module may be adversely affected by water entry during steam cleaning or pressure washing of the engine bay.

If cleaning the engine bay, therefore, take care not to direct jets of water or steam at the ESC II module. If this cannot be avoided, remove the module completely, and protect its multi-plug with a plastic bag.

Ignition system HT voltage

Take care to avoid receiving electric shocks from the HT side of the ignition system. Do not handle HT leads, or touch the distributor or coil, when the engine is running. When tracing faults in the HT system, use well insulated tools to manipulate live leads. **Electronic ignition HT voltage could prove fatal.**

Electronic ignition systems

Warning. The voltages produced by the electronic ignition system are considerably higher than those produced by conventional systems. Extreme care must be taken when working on the system with the ignition switched on. Persons with surgically-implanted cardiac pacemaker devices should keep well clear of the ignition circuits, components and test equipment.

General

Further details of the various systems are given in the relevant Sections of this Chapter. While some repair procedures are given, the usual course of action is to renew the component concerned. The owner whose interest extends beyond mere component renewal should obtain a copy of the *Automobile Electrical & Electronic Systems Manual*, available from the publishers of this manual.

It is necessary to take extra care when working on the electrical system, to avoid damage to semi-conductor devices (diodes and transistors), and to avoid the risk of personal injury. In addition to the precautions given in *Safety first!* at the beginning of this manual, observe the following when working on the system:

Always remove rings, watches, etc before working on the electrical system. Even with the battery disconnected, capacitive discharge could occur if a component's live terminal is earthed through a metal object. This could cause a shock or nasty burn.

Do not reverse the battery connections. Components such as the alternator, electronic control units, or any other components having semi-conductor circuitry, could be irreparably damaged.

If the engine is being started using jump leads and a slave battery, connect the batteries *positive-to-positive* and *negative-to-negative* (see *"Jump starting"*). This also applies when connecting a battery charger.

Never disconnect the battery terminals, the alternator, any electrical wiring, or any test instruments, when the engine is running.

Do not allow the engine to turn the alternator when the alternator is not connected.

Never test for alternator output by "flashing" the output lead to earth.

Never use an ohmmeter of the type incorporating a hand-cranked generator for circuit or continuity testing.

Always ensure that the battery negative lead is disconnected when working on the electrical system.

Before using electric-arc welding equipment on the car, disconnect the battery, alternator, and components such as the fuel-injection/ignition electronic control unit, to protect them from the risk of damage.

2 Electrical fault-finding - general information

Refer to Chapter 13

3 Battery - charging

1 In normal use the battery should not require charging from an external source, unless the vehicle is laid up for long periods, when it should be recharged every six weeks or so. If vehicle use consists entirely of short runs in darkness it is also possible for the battery to become discharged. Otherwise, a regular need for recharging points to a fault in the battery or elsewhere in the charging system.

2 There is no need to disconnect the battery from the vehicle wiring when using a battery charger, but switch off the ignition and leave the bonnet open.

3 Domestic battery chargers (up to about 6 amps output) may safely be used overnight without special precautions. Make sure that the charger is set to deliver 12 volts before connecting it. Connect the leads (red or positive to the positive terminal, black or negative to the negative terminal) **before** switching the charger on at the mains.

4 When charging is complete, switch off at the mains **before** disconnecting the charger from the battery. Remember that the battery will be giving off hydrogen gas, which is potentially explosive.

5 Charging at a higher rate should only be carried out under carefully controlled conditions. Very rapid or "boost" charging should be avoided if possible, as it is liable to cause permanent damage to the battery through overheating.

6 During any sort of charging, battery electrolyte temperature should never exceed 38°C (100°F). If the battery becomes hot, or the electrolyte is effervescing vigorously, charging should be stopped.

4 **Battery** - removal and refitting

1 Disconnect the battery negative (earth) lead.
2 Disconnect the battery positive leads. These may be protected by a plastic cover. Do not allow the spanner to bridge the positive and negative terminals.
3 Release the battery hold-down clamp. Lift out the battery. Keep it upright and be careful not to drop it - it is heavy.
4 Commence by placing the battery in its tray, making sure it is the right way round. Secure it with the hold-down clamp.
5 Clean the battery terminals if necessary then reconnect them. Connect the positive lead first, then the negative lead.

5 **Alternator** - testing on the vehicle

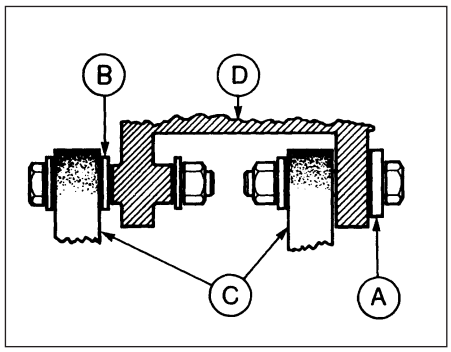
1 Should it appear that the alternator is not charging the battery, check first that the drivebelt is intact and in good condition and that its tension is correct. Also check the condition and security of the alternator electrical connections and the battery leads.
2 Accurate assessment of alternator output requires special equipment and a degree of skill. A rough idea of whether output is adequate can be gained by using a voltmeter (range 0 to 15 or 0 to 20 volts) as follows.
3 Connect the voltmeter across the battery terminals. Switch on the headlights and note the voltage reading: it should be between 12 and 13 volts.
4 Start the engine and run it at a fast idle (approx 1500 rpm). Read the voltmeter: it should indicate 13 to 14 volts.
5 With the engine still running at a fast idle, switch on as many electrical consumers as possible (heated rear window, heater blower etc). The voltage at the battery should be maintained at 13 to 14 volts. Increase the engine speed slightly if necessary to keep the voltage up.
6 If alternator output is low or zero, check the brushes. If the brushes are OK, seek expert advice.
7 Occasionally the condition may arise where the alternator output is excessive. Clues to this condition are constantly blowing bulbs; brightness of lights vary considerably with engine speed; overheating of alternator and battery, possible with steam or fumes coming from the battery. This condition is almost certainly due to a defective voltage regulator, but expert advice should be sought.
8 Note that the alternator voltage regulator can be renewed without removing the alternator from the vehicle. The procedure is part of brush renewal.

6 **Alternator** - removal and refitting

1 Disconnect the battery negative lead.
2 Disconnect the multi-plug from the rear of the alternator. It may be secured by a wire clip.
3 Slacken the alternator adjusting and pivot nut(s), bolt(s) and washer(s) **(see illustration).** Swing the alternator towards the engine and slip the drivebelt(s) off the pulley.
4 Support the alternator. Remove the adjusting and pivot nuts, bolts and washers, noting the fitted positions of the washers. Lift out the alternator. Do not drop it, it is fragile.
5 Refit by reversing the removal operations. Tension the drivebelt(s) then tighten the adjustment strap bolt followed by the pivot nut and bolt. If there are two pivot bolts, tighten the front one first.
6 Refit the multi-plug and reconnect the battery.

7 **Alternator** - brush renewal

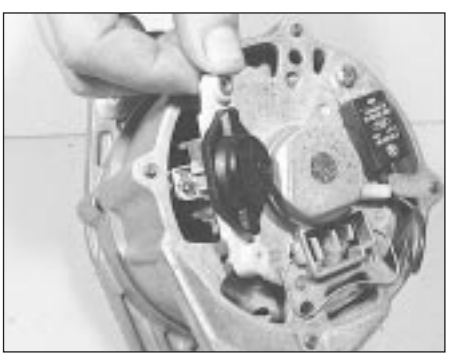
1 The alternator brushes can be inspected or renewed without removing the alternator from the vehicle, but disconnect the battery negative lead first.
2 From the rear of the alternator remove the two screws which secure the voltage regulator/brush carrier assembly. Withdraw the assembly **(see illustration).**
3 Measure the length of each brush protruding from the carrier **(see illustration)**. If they are worn down to, or below, the minimum specified, the old brushes will have to be unsoldered and new ones soldered into place. Some skill with a soldering iron will be required; excess heat from the soldering iron could damage the voltage regulator. When fitted, the new brushes must move freely in their holders.
4 Clean the slip rings with a cloth moistened with methylated spirit **(see illustration)**. If they are badly burnt or damaged, seek expert advice.
5 Refit the assembled brush carrier/voltage regulator and secure it with the two screws. If the alternator is on the vehicle, reconnect the battery negative lead.



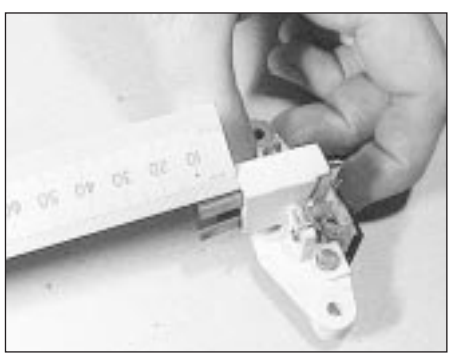
6.3 Alternator mounting details
A Large washer
B Small washer (not always fitted)
C Mounting bracket
D Alternator
Some models have a single pivot bolt

8 **Starter motor** - testing on the vehicle

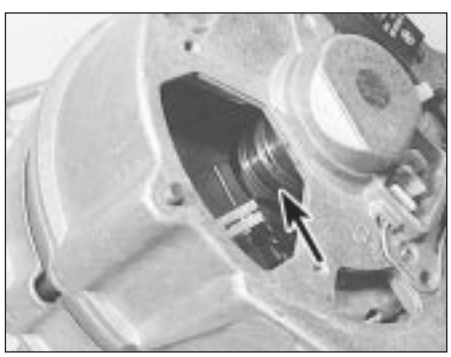
1 If the starter motor fails to operate, first check that the battery is charged by switching on the headlights. If the headlights do not come on, or rapidly become dim, the battery or its connections are at fault.
2 Check the security and condition of the battery and starter solenoid connections. Remember that the heavy lead to the solenoid is always “live” - disconnect the battery negative lead before using tools on the solenoid connections.



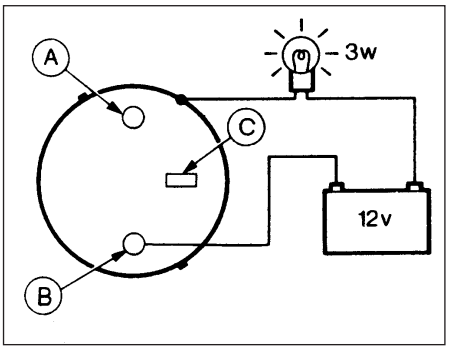
7.2 Removing the voltage regulator/brush carrier



7.3 Measuring brush protrusion

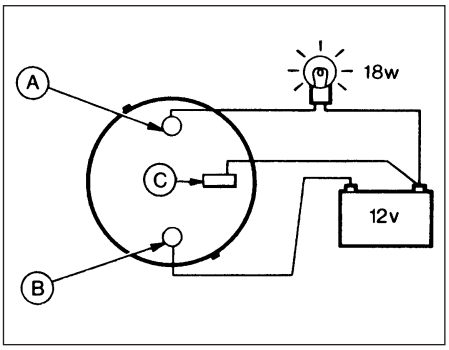


7.4 Clean the slip rings (arrowed)



8.4 Solenoid winding check

A Battery terminal C Spade terminal
B Motor terminal



8.5 Solenoid contact check

A Battery terminal C Spade terminal
B Motor terminal

Solenoid check

3 Disconnect the battery negative lead, and all leads from the solenoid.
4 Connect a battery and a 3 watt test lamp between the solenoid body and the solenoid motor terminal **(see illustration).** The test lamp should light: if not, the solenoid windings are open-circuit.
5 Connect a battery and an 18 to 21 watt test lamp across the solenoid motor and battery terminals. Connect a further lead from the battery positive terminal to the solenoid spade terminal **(see illustration).** The solenoid should be heard to operate and the test lamp should light: if not, the solenoid contacts are defective.

On load voltage check

6 Remake the original connections to the solenoid and reconnect the battery negative lead. Connect a voltmeter across the battery terminals, then disconnect the low tension lead from the coil positive terminal and operate the starter by turning the ignition switch. Note the reading on the voltmeter which should not be less than 10.5 volts.
7 Now connect the voltmeter between the starter motor terminal on the solenoid and the starter motor body. With the coil low tension lead still disconnected, operate the starter and check that the recorded voltage is not more than 1 volt lower than that previously noted. If the voltage drop is more than 1 volt a fault exists in the wiring from the battery to the starter.
8 Connect the voltmeter between the battery positive terminal and the terminal on the starter motor. With the coil low tension lead disconnected operate the starter for two or three seconds. Battery voltage should be indicated initially, then dropping to less than 1 volt. If the reading is more than 1 volt there is a high resistance in the wiring from the battery to the starter and the check in paragraph 9 should be made. If the reading is less than 1 volt proceed to paragraph 10.
9 Connect the voltmeter between the two main solenoid terminals and operate the starter for two or three seconds. Battery voltage should be indicated initially then dropping to less than 0.5 volt. If the reading is more than 0.5 volt, the solenoid and connections may be faulty.
10 Connect the voltmeter between the battery negative terminal and the starter motor body, and operate the starter for two or three seconds. A reading of less than 0.5 volt should be recorded; however, if the reading is more, the earth circuit is faulty and the earth connections to the battery and body should be checked.

9 **Starter motor** - removal and refitting

1 Disconnect the battery negative lead. Raise and support the front of the vehicle.
2 From underneath the vehicle, disconnect the feed (heavy) cable from the solenoid.
3 Disconnect the command lead from the solenoid spade terminal.
4 Undo the starter motor securing bolts and (where fitted) the support bracket fastenings. Withdraw the starter motor from the vehicle.
5 Refit by reversing the removal operations. Check for correct operation on completion.

10 **Starter motor** - brush renewal

1 Disconnect the motor lead from the solenoid terminal.
2 Remove the two screws which secure the armature end cap. Remove the cap, the C-washer and the plain washer(s).
3 Remove the two through-bolts or studs.

> **HAYNES HiNT** ***If the stud nuts are inaccessible, lock two nuts together on the stud and turn them to unscrew it .***

4 Remove the commutator end cover to expose the brushgear. Carefully withdraw the brushplate from the commutator. Be careful to avoid damage to the brushes as they are released.
5 Examine the brushes: they should not be excessively worn (see Specifications) and must slide freely in their holders. Brush renewal varies according to motor type as follows:

Short frame - the brush lead must be removed from the stand-off connector on the brushplate, and the clip on the new brush lead soldered to the connector.

Long frame - the old brush leads must be cut and the new leads attached by soldering

Reduction gear - the brushplate must be renewed complete with brushes, holders and springs

6 Reassembly is the reverse of dismantling whilst noting the following:
7 Clean the commutator with a rag moistened with methylated spirit, then refit the brushplate.
8 Either clip the brushes in place after fitting the plate, or use a tube of suitable diameter to keep the brushes retracted during fitting.
9 Make sure that the brushplate is correctly positioned to allow the passage of through-bolts or studs.

11 **Spark plugs** - removal, inspection and refitting

See Chapter 1, Section 20.

12 **HT leads, distributor cap and rotor arm** - removal, inspection and refitting

See Chapter 1, Section 39.

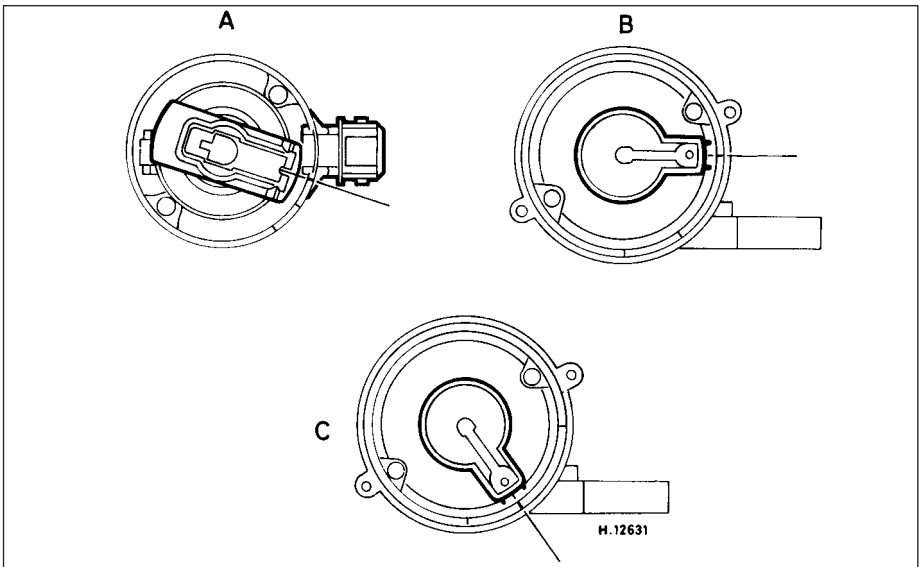
13 **Distributor** - removal and refitting

All engines except 2.4 & 2.9 litre V6

Note: *The distributor should not be removed without good cause, since the accuracy of ignition timing achieved in production is unlikely to be regained*
1 Disconnect the battery negative lead.
2 Remove the distributor cap as described in the previous Section. Depending on model, it may be possible to move the cap aside without disconnecting the HT leads.
3 Using a spanner on the crankshaft pulley bolt, turn the engine to bring No 1 cylinder to firing point. (If the distributor cap is secured by clips, make sure the clips stay clear of the distributor moving parts.) No 1 cylinder is at firing point when:

a) The timing marks are in alignment.
b) The tip of the rotor arm is pointing to the place occupied by the No 1 HT lead connector in the distributor cap ***(see illustration).***

4 With No 1 cylinder at firing point, the tip of the rotor arm should also be aligned with a notch in the distributor body. Mark the notch for reference when refitting.
5 Depress the locking tab on the distributor



13.3 Distributor rotor arm positions before removal - No 1 firing point

A Carburettor models B OHC fuel-injection models C V6 models

multi-plug. Disconnect the plug, pulling on the plug itself, not the wires **(see illustration)**.

6 Make alignment marks between the distributor body and the engine, then remove the distributor clamp bolt and clamp plate **(see illustration)**. On V6 models access is poor, and a crow's-foot spanner will be needed. The clamp bolt may be covered in sealant to discourage tampering - if so, scrape it off. Unbolt the support bracket, when fitted.

7 Lift out the distributor **(see illustration)**. Mark the position taken up by the rotor arm after removal.

8 If the distributor is mechanically or electrically defective, it must be renewed. The only spares available are the cap, rotor arm, module (when applicable) and the shaft O-ring **(see illustration)**.

9 Commence refitting by positioning the rotor arm to the point noted in paragraph 7. This will be approximately 20° clockwise from the No 1 firing point (paragraph 4) **(see illustration).**

10 Make sure that the engine is still positioned at the firing point for No1 cylinder.

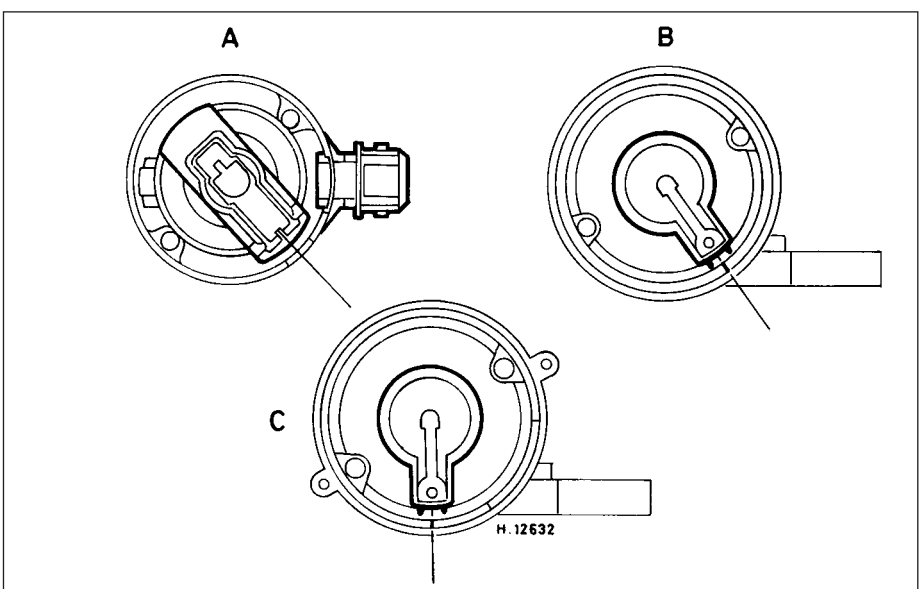
11 Offer the distributor to the engine, observing the distributor body-to-engine alignment marks. As the drivegear meshes, the distributor shaft will turn anti-clockwise. The rotor arm should end up in the correct position for No1 firing - if not, withdraw the distributor, re-position the shaft and try again.

13.5 Disconnecting a distributor multi-plug

13.6 Distributor clamp bolt (arrowed)

13.7 Removing the distributor

13.8 Distributor shaft O-ring



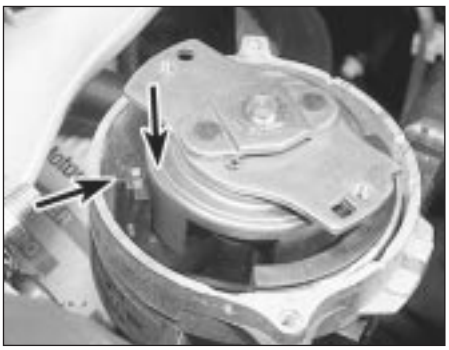
13.9 Distributor rotor arm positions ready for refitting

A Carburettor models B OHC fuel-injection models C V6 models

12 When the distributor is at the firing point, the leading edge of one of the vanes should be in line with the rib on the sensor **(see illustration)**. Turn the distributor body slightly if necessary to achieve this.
13 Refit the clamp plate and bolt. Just nip up the bolt for the time being. Tighten it finally after checking the timing. Also secure the support bracket, when fitted.
14 Refit the rotor arm, distributor cap and HT leads.
15 Reconnect the distributor multi-plug.
16 Reconnect the battery. Run the engine and check the ignition timing as described in the next Section.

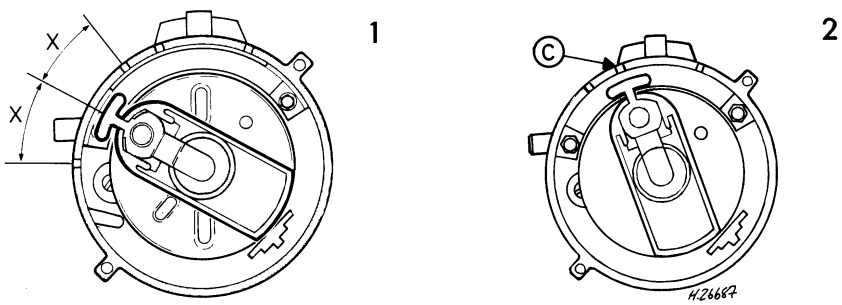
2.4 & 2.9 litre V6 engines

Note: *The distributor should not be removed or disturbed without good cause, since the accuracy of timing achieved in production is unlikely to be regained. If difficulty is experienced in setting the timing after refitting, or if a new distributor has been fitted, the timing should be set by a Ford dealer using a STAR (Self Test Automatic Readout) tester.*
17 Disconnect the battery negative lead.
18 Disconnect the HT leads from the spark plugs noting the correct fitted locations.
19 Release the distributor cap and place it to one side, complete with the HT leads.
20 Turn the engine by means of the vibration damper centre bolt until No 1 piston is at its firing point (12° BTDC) **(see illustration)**.
21 If there is no mark visible, mark the rim of the distributor body to indicate the point of alignment of the contact end of the rotor.
22 Mark the position of the distributor mounting plate in relation to the cylinder block.
23 Disconnect the distributor wiring connector.
24 Scrape the sealant from around the distributor clamp bolt then unscrew the bolt and withdraw the distributor.
25 Prior to refitting the distributor check that the crankshaft is still set in the 12° BTDC position for the No 1 piston.
26 Hold the distributor over the hole so that the mounting plinth and cylinder head marks are aligned then align the rotor arm contact end with the mark on the distributor rim **(see illustration).**
27 As the distributor is inserted, the rotor will turn due to the meshing of the drive gears. When the distributor is fully inserted, rotate the distributor body until the rotor arm aligns with mark C on the distributor rim.
28 Once the rotor arm, cylinder head and distributor alignment marks are all correctly aligned, fit the clamp bolt and tighten it securely.
29 Refit the distributor cap then connect the HT leads, reconnect the vacuum pipe and wiring plug.
30 Run the engine to normal operating temperature and check the ignition timing, bearing in mind the note made at the start of this sub-Section.



13.12 Vane leading edge and sensor rib (arrowed) are aligned at firing point

13.20 Crankshaft pulley notch set to the 12° BTDC position



13.26 Rotor arm position before (1) and after (2) refitting the distributor

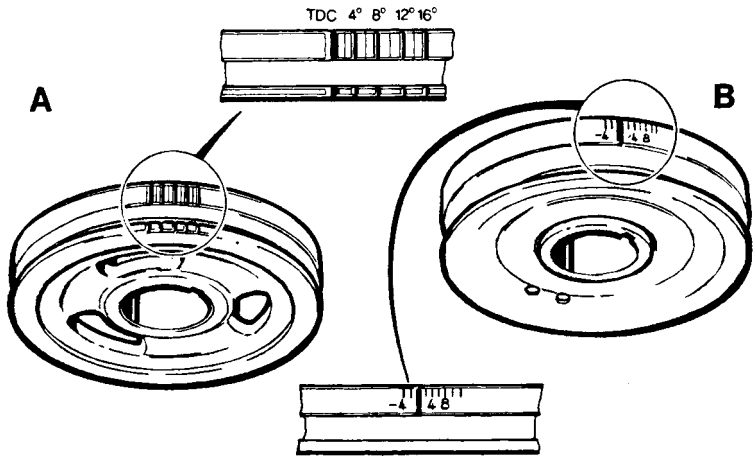
X = X *C Notch*

14 Ignition timing - checking

All engines except DOHC

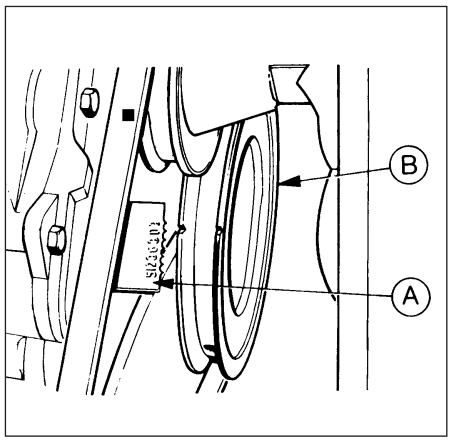
1 Ignition timing is set very accurately in production. It does not need to be checked or adjusted on a routine basis. Adjustment will only be necessary if the distributor, or an associated component such as the timing belt, has been disturbed.
2 Before checking the timing, the following conditions must be met:
a) The engine must be warmed up
b) On carburettor models, the vacuum pipe must be disconnected from the manifold and the manifold hole be plugged
c) Idle speed must be below 900 rpm
d) Any earthed "octane adjustment" wires must be temporarily isolated
3 Locate the timing marks. On SOHC engines the timing scale is on the crankshaft pulley, and a pointer on the timing cover must be aligned with the appropriate mark on the pulley **(see illustration)**. Note that two alternative types of pulley may be fitted **(see illustration).** On V6 engines there is a single notch on the pulley and the timing scale is on the timing cover **(see illustration).** The desired values are given in the Specifications. Highlight the appropriate marks with white paint.
4 Connect a timing light (strobe) to No 1 HT lead, following the maker's instructions. Some lights require additional power connections to be made, either to the mains or to the battery.
5 Run the engine at idle and shine the timing light onto the marks. Take care not to get the timing light leads, clothing etc tangled in the fan blades or other moving parts. The timing marks will appear stationary and (if the timing is correct) in alignment.

14.3a Timing marks and pointer
Cast pulley shown



14.3b Ignition timing marks - SOHC

A Cast pulley B Pressed steel pulley



14.3c Ignition timing marks - V6

A Timing scale B Pulley

6 If adjustment is necessary, stop the engine. Slacken the distributor clamp bolt and turn the distributor body slightly. To retard the ignition (move the mark nearer TDC) turn the distributor body clockwise, and *vice versa* to advance the ignition. Tighten the clamp bolt and re-check the timing.

7 When adjustment is correct, stop the engine and disconnect the timing light. Reconnect the vacuum pipe, when applicable, and reconnect any "octane adjustment" wires.

DOHC engine

8 The ignition timing for this engine is controlled by the ESC II or EEC IV module and no adjustment is possible.

15 Ignition module (fuel-injection models) - removal and refitting

SOHC and 2.8 litre V6 engines

1 Disconnect the battery negative lead.

2 Disconnect the distributor multi-plug.

3 On V6 models only, make alignment marks between the distributor body and the engine. Slacken the distributor clamp bolt and swivel the distributor to make the module securing screws accessible.

4 Remove the two screws which secure the module **(see illustration)**. These screws are deeply recessed. The screws seen here have Torx heads; ordinary hexagon heads have also been encountered, and to undo these a thin socket or box spanner will be required.

5 Pull the module downwards and remove it.

6 When refitting, coat the rear face of the module with heat sink compound to Ford spec 815F-12103-AA. This is extremely expensive, so it may be worthwhile trying to obtain a smear from a friendly dealer or auto electrician.

7 Plug the module into the distributor and secure it with the two screws.

8 On V6 models, return the distributor to its original position and nip up the clamp bolt.

9 Reconnect the distributor multi-plug.

10 Reconnect the battery and run the engine to check for correct function.

11 On V6 models, check the ignition timing and then finally tighten the distributor clamp bolt.

DOHC engine

12 The ignition module is located in the left-hand front corner of the engine compartment, beside the air cleaner housing.

13 To remove the module, first disconnect the battery negative lead.

14 To improve access remove the air cleaner housing.

15 Release the locking lug and disconnect the ignition module wiring plug **(see illustration)**. Pull on the plug, not on the wiring.

16 Remove the two securing screws, and remove the module from the engine compartment.

17 Refitting is a reversal of removal, ensuring that the underside of the module and the corresponding area of the body panel are clean.

2.4 & 2.9 litre V6 engines

Note: *Removal of the ignition module requires the distributor to be disturbed.*

18 The ignition module is mounted onto the side of the distributor.

19 To remove the module first disconnect the battery negative terminal.

20 Carefully disconnect the distributor wiring connector.

21 Make alignment marks between the distributor mounting and cylinder block then scrape the sealant from around the distributor clamp bolt and slacken but **do no**t remove the bolt.

22 Rotate the distributor to gain access to the ignition module retaining bolts.

23 Slacken and remove the two retaining bolts and carefully slide the module downwards to disengage it from the distributor, taking great care not to damage the module wiring pins.

24 Apply a coating of the special Ford heat-sink compound (Part number 815F-12103-AA, available from a Ford dealer This is extremely expensive, so it may be worthwhile trying to obtain a smear from a friendly dealer or auto electrician) to the rear of the ignition module and carefully slide the module into position on the distributor. **Note:** Do not force the module

15.4 Two screws (arrowed) which secure the ignition module

15.15 Ignition module (viewed with air cleaner removed)

16.1 Ignition coil location

into position or the wiring pins will be damaged.
25 Refit the module retaining bolts and tighten them securely.
26 Rotate the distributor until the marks made on removal are aligned then securely tighten the clamp bolt.
27 Reconnect the distributor wiring connector and the battery negative terminal.
28 Run the engine to normal operating temperature and check the ignition timing.

16 Ignition coil - testing, removal and refitting

All engines except DOHC fuel-injection

1 The ignition coil is mounted on the left-hand side of the engine compartment **(see illustration)**. If it fails, there will be no spark and the engine will stop.
2 To test the coil an ohmmeter will be required. Disconnect the LT and HT leads from the coil and measure the resistance between the two LT terminals (primary resistance), then between the HT terminal and either LT terminal (secondary resistance). Desired values are given in the Specifications. In fact most test gear will not be able to distinguish between a normal primary resistance (which is very low) and a short-circuit.
3 In the absence of an ohmmeter, test the coil by substitution of a known good unit.
4 To remove the coil, disconnect the LT and HT leads, then remove the two screws which secure the coil clamp. Lift out the coil.
5 Refit by reversing the removal operations.

2.0 litre DOHC fuel-injection engines

6 Refer to the above paragraphs but note that on some models the coil heat shield must be removed for access to the coil securing bolts. The heat shield is secured by two screws. An earthing lead and/or a suppressor may also be secured by one of the coil retaining screws **(see illustration)**.

17 Fuel trap (carburettor models) - removal and refitting

1 On carburettor models, a fuel trap is fitted in the vacuum pipe between the inlet manifold and the ESC II module.
2 Disconnect the battery negative lead.
3 Disconnect the vacuum pipes from the trap and remove it. Dispose of it carefully, it may contain fuel.
4 When refitting, note that the end of the trap marked CARB goes towards the manifold, and the end marked DIST towards the module.
5 Reconnect the battery.

18 Engine management control module - removal and refitting

ESC II module (carburettor models)

SOHC engines

1 Disconnect the battery negative lead.
2 Disconnect the vacuum pipe from the module **(see illustration)**.
3 Release the locking catch and disconnect the multi-plug from the module **(see illustration)**.
4 Remove the three securing screws and detach the module and bracket from the left-hand inner wing.
5 Refit by reversing the removal operations. Make sure that the multi-plug is securely fitted and the locking catch engaged.

16.6 Suppresser secured by one of the coil retaining screws

Note: *From January 1987, a new type of module was fitted to the 1.8 litre engine. The new module is smaller than the old unit and is in the engine compartment mounted onto the left-hand wing valance. The new module is known as the ESC Hybrid Module*. **(see illustration)**

DOHC engine

6 Removal and refitting is as above.
7 The module is located on the left-hand side of the engine compartment and is secured by two screws.

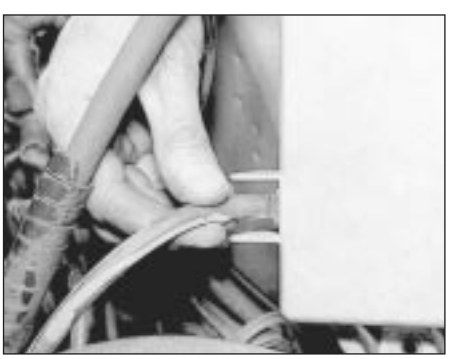
EEC IV module (fuel-injection models)

SOHC and 2.8 litre V6 engines

8 Disconnect the battery negative lead.
9 Remove the under-dash trim on the passenger side.
10 Unclip the module and lower it onto the vehicle floor.
11 Remove the control bolt from the multi-plug and disconnect the plug from the module.
12 Refit by reversing the removal operations.

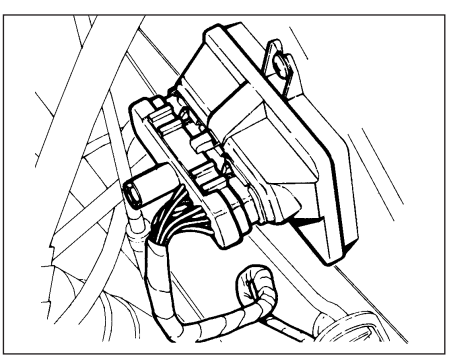
DOHC and 2.4 & 2.9 litre V6 engines

13 The module is situated behind the passenger side of the facia and is accessible from underneath the glovebox.
14 To remove the module first disconnect the battery negative terminal.
15 Reach up behind the glovebox and unclip the module from the mounting bracket **(see illustration)**.

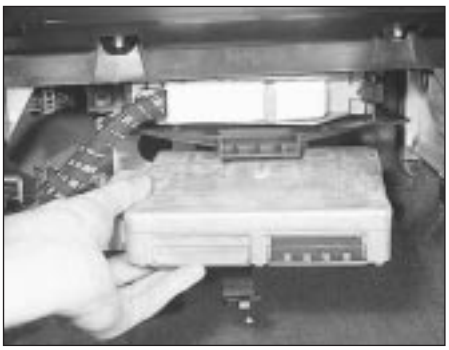


18.2 Disconnecting the ESC II module vacuum pipe

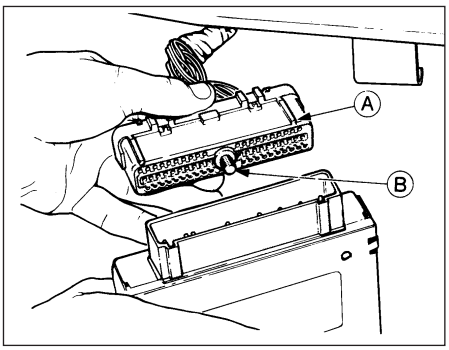
18.3 ESC II module multi-plug



18.5 Engine management module - 1.8 litre engine from January 1987

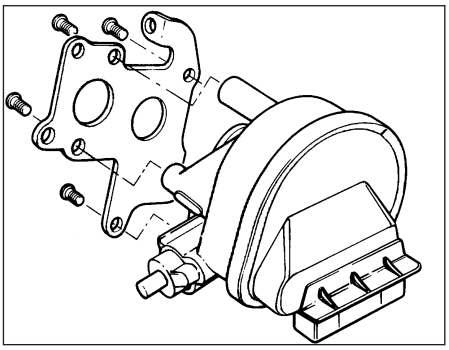


18.15 Removing the engine management modules (glovebox removed for clarity)



18.16 Disconnecting the EEC IV module

A Multi-plug *B Securing bolt*



19.4 Carburettor stepper motor and mounting bracket

16 Undo the wiring connector retaining bolt then carefully disconnect the wiring plug and remove the module from the car **(see illustration).**

17 Refitting is a reverse of the removal procedure ensuring that the wiring plug bolt is securely tightened. On completion start the engine and check that it runs correctly.

19 Carburettor stepper motor (2.0 litre models) - removal, refitting and adjustment

Note: *Irregular idle is not necessarily caused by a faulty or badly adjusted stepper motor. Good electrical contact between the stepper motor plunger and the adjusting screw is essential. Before attempting adjustment or renewal of the motor, try the effect of cleaning the plunger and adjusting screw contact faces with abrasive paper followed by switch cleaning fluid. Switch cleaning fluid is available from electronic component shops.*

1 Disconnect the battery negative lead.

2 Remove the air cleaner.

3 Disconnect the multi-plug from the stepper motor. Release the locking clip and pull on the plug, not on the wires.

4 Remove the four screws which secure the stepper motor bracket to the carburettor. Remove the motor and bracket and separate them **(see illustration).**

5 Refit the motor and bracket to the carburettor and secure with the four screws. Reconnect the multi-plug.

6 Make an initial adjustment to the throttle lever adjusting screw if necessary so that it protrudes from the lever by dimension X **(see illustration).**

7 Reconnect the air cleaner vacuum hose. Position the air cleaner to one side so that there is still access to the carburettor and stepper motor.

8 Connect a tachometer (rev. counter) to the engine as instructed by the manufacturers. Reconnect the battery.

9 Run the engine. Check the idle mixture (CO level) as described in Chapter 4 and adjust if necessary.

10 Switch off all electrical loads (headlights, heater blower etc). If the idle speed adjustment lead is earthed, temporarily isolate it. Make sure that the automatic transmission selector is in the N or P position (where applicable).

11 Accelerate the engine to a speed greater then 2500 rpm, allow it to return to idle, then repeat. Insert a feeler blade of thickness 1.0 mm (0.04 in) between the stepper motor plunger and the adjusting screw **(see illustration).** With the feeler blade in place, engine speed should be 875 ± 25 rpm.

12 If adjustment is necessary, remove the tamperproof cap from the adjusting screw locknut. Release the locknut, turn the adjusting screw to achieve the correct speed and tighten the locknut.

13 Repeat paragraph 11 and check that the speed is still correct. Readjust if necessary.

14 Remove the feeler blade. Stop and restart the engine, observing the stepper motor plunger. Immediately after switching off, the plunger should move to the "anti-dieseling" position; after a few seconds it should extend to the "vent manifold/start" position **(see illustration).**

15 Disconnect the test gear and refit the air cleaner.

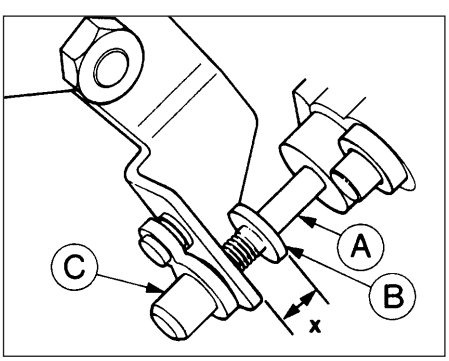
16 Recheck the idle mixture.

17 Fit new tamperproof plugs or caps if necessary - see Chapter 4,

18 Reconnect the idle speed adjustment lead if it was earthed.

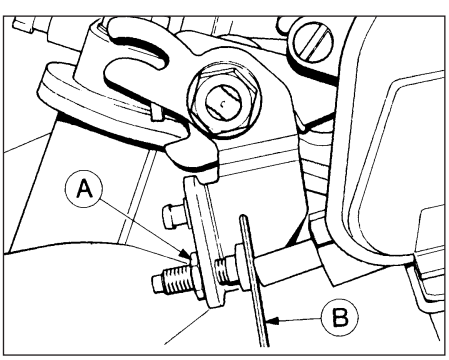
20 Coolant temperature sensor - removal and refitting

1 The engine management system temperature sensor is located on the underside of the inlet manifold (SOHC engines), the side of the manifold (DOHC engines) or on the front face of the cylinder block (V6 engines).



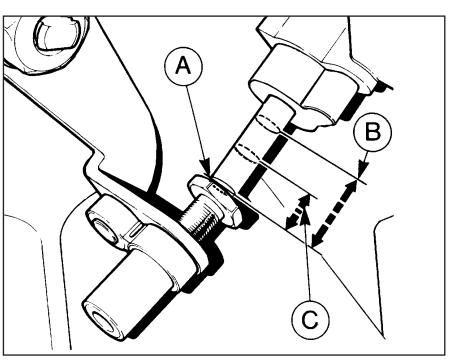
19.6 Throttle lever initial adjustment

A Plunger *X 7.5 ±1.0 mm (0.30 ± 0.04 in)*
B Adjusting screw
C Cap



19.11 Stepper motor adjustment

A Locknut *B Feeler blade*



19.14 Stepper motor plunger positions

A Vent manifold/start *C Idle*
B Anti-dieseling

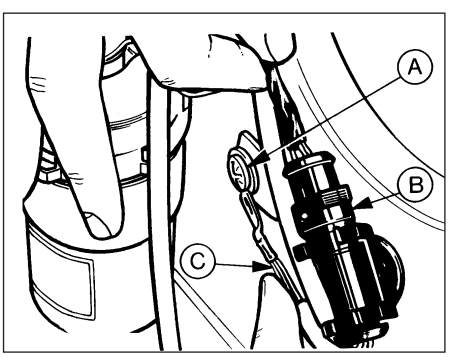
20.4 Coolant temperature sensor multi-plug

2 Disconnect the battery negative lead.
3 Drain the cooling system (Chapter 3). Save the coolant if it is fit for re-use.
4 Disconnect the multi-plug from the sensor. Pull on the plug, not on the wiring **(see illustration)**.
5 Unscrew the sensor and remove it.
6 Refit by reversing the removal operations. Refill the cooling system.

21 Manifold heater (carburettor models) - removal and refitting

Note: *The manifold heater must not be removed while it is hot.*
1 Disconnect the battery negative lead.

23.2a Octane adjustment lead multi-plug



23.2b Service adjustment lead for timing and idle adjustment

A Earthing point (coil screw)
B Multi-plug
C Cut wires not to be earthed

21.5 Removing the manifold heater

2 Remove the air cleaner to improve access.
3 Remove the three bolts which secure the heater to the underside of the manifold.
4 Disconnect the electrical feed from the heater.
5 Remove the heater. Recover the gasket and O-ring **(see illustration)**.
6 Use a new gasket and O-ring when refitting. Offer the heater to the manifold, insert the three bolts and tighten them evenly, making sure that the heater does not tip or jam.
7 Reconnect the electrical feed.
8 Refit the air cleaner and reconnect the battery.

22 Engine management system relays - testing

All relays are located behind the facia panel. Access is gained by removing the facia top **(see illustration).**

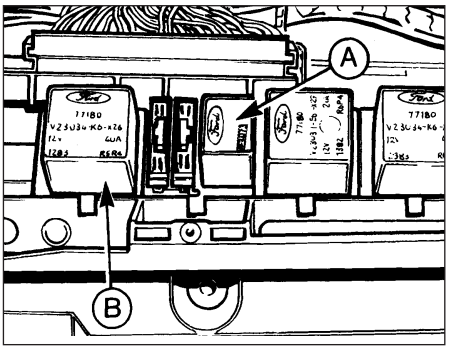
Testing of a suspect relay is by substitution of a known good unit.

23 Ignition timing and idle speed adjustments

1 All models have a facility for retarding the ignition timing by up to six degrees without physically disturbing the distributor. The adjustment is intended for use when the correct grade of fuel is not available.
2 Adjustment is made by earthing one or two leads (sometimes called "octane adjustment" leads) which terminate in a multi-plug next to the ignition coil **(see illustrations)**. Ideally a service adjustment lead, available from a Ford dealer, should be used. Cut and insulate the wires in the adjustment lead which are not to be earthed.
3 The amount of ignition retardation is as follows:

Wire(s) earthed	Degrees retard Carb.	injection	V6
Blue	*2*	*4*	*6*
Red	*4*	*2*	*3*
Blue and red	*6*	*6*	*Forbidden*

4 Performance and efficiency will suffer as a result of this adjustment. Normal timing should be restored (by isolating the adjustment leads) when the correct grade of fuel is available.
5 If the yellow adjustment lead is earthed, this



22.1 Engine management system relays

A Power hold *B Manifold heater*

will raise the idle speed by 75 rpm (OHC) or 50 rpm (V6). It may be found that the yellow lead has already been earthed in production, in which case disconnecting it will lower the idle speed by the same amount. This adjustment does not apply to 1.8 litre carburettor models.

1.8 models from January 1987

6 The effect of the "octane adjustment" leads on these models fitted with the ESC Hybrid Module is as follows.

Red lead earthed	*2° retarded*
Blue lead earthed	*4° retarded*
Red and blue leads earthed	*6° retarded*

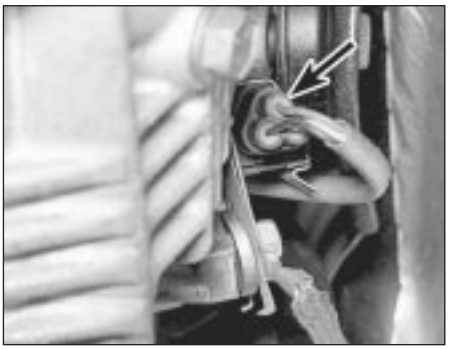
24 Crankshaft speed/position sensor - removal and refitting

1 Fitted to DOHC engines,the sensor is located at the right-hand rear of the cylinder block, behind the oil filter **(see illustration)**.
2 To remove the sensor, first disconnect the battery negative lead.
3 Access is most easily obtained from underneath the vehicle. To improve access, apply the handbrake, then jack up the front of the vehicle and support it securely on axle stands (see "*Jacking*").
4 Disconnect the wiring plug from the sensor.
5 Remove the securing screw and withdraw the sensor from the location in the cylinder block.
6 Refitting is a reversal of removal, using a new sensor O-ring and tightening the retaining screw to the specified torque setting.

24.1 Crankshaft speed/position sensor (viewed from underneath)

25.3 Disconnecting the air charge temperature sensor wiring plug

26.3 Disconnecting the fuel temperature sensor wiring plug



27.4 Vehicle speed sensor wiring plug (arrowed)

25 Air charge temperature sensor - removal and refitting

1 The sensor is located in the upper section of the inlet manifold (DOHC fuel-injection engines) or the side of the plenum chamber (V6 engines).
2 To remove the sensor, first disconnect the battery negative lead.
3 Disconnect the sensor wiring plug by pulling on the plug, not the wiring **(see illustration)**.
4 Unscrew the sensor from the inlet manifold and remove it.
5 Refitting is a reversal of removal, applying a smear of sealant to the threads of the sensor and tightening it to the specified torque.

26 Fuel temperature sensor - removal and refitting

1 Fitted to 2.0 litre DOHC fuel-injected engines,this sensor is located in the top of the fuel rail.
2 To remove the sensor, first disconnect the battery negative lead, and to improve access, disconnect the wiring plug from the air charge temperature sensor (in the inlet manifold). Disconnect the sensor wiring plug by pulling on the plug, not the wiring.
3 Disconnect the fuel temperature sensor wiring plug, again pulling on the plug **(see illustration)**.
4 Unscrew the sensor from the fuel rail and remove it.
5 Refitting is a reversal of removal, tightening the sensor to the specified torque.

27 Vehicle speed sensor - removal and refitting

1 Fitted to DOHC fuel-injected engines and to V6 engines with catalytic converters, this sensor is located in the left-hand side of the gearbox/transmission.
2 To remove the sensor first disconnect the battery negative lead.
3 Firmly apply the handbrake then jack up the vehicle and support it securely on axle stands (see "*Jacking*").
4 Detach the sensor wiring connector from the bracket, and separate the two halves of the connector **(see illustration)**.
5 Unscrew the securing bolt, and withdraw the wiring connector bracket, noting the orientation.
6 Withdraw the sensor from the gearbox/transmission casing.
7 Before refitting the sensor, examine the O-ring, and renew if damaged or worn.
8 Refitting is a reversal of removal, ensuring that the wiring connector bracket is correctly located.

28 Manifold absolute pressure (MAP) sensor - removal and refitting

1 On DOHC fuel-injected engines, this sensor is located on the right-hand side of the engine compartment where it is mounted either on the suspension turret or on the bulkhead **(see illustration)**. V6 engines have the sensor mounted on the centre of the engine compartment bulkhead.
2 To remove the sensor first disconnect the battery negative terminal.
3 Remove the two sensor retaining screws and carefully withdraw the sensor, taking care not to strain the wiring.
4 Disconnect the wiring plug from the sensor, pulling on the plug not the wiring, then disconnect the vacuum hose and remove the sensor.
5 Refitting is a reversal of removal.

28.1 Manifold Absolute Pressure (MAP) sensor location - models equipped with a catalytic converter