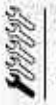
Chapter 4 Part B:
Fuel system - multi-point petrol injection models

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

System type	Weber-Marelli integrated multi-point fuel injection/ignition system
Fuel system data	
Fuel pump type	Electric, immersed in fuel tank
Fuel pump delivery rate:	
1242 cc (8-valve) engine	120 litres/hour minimum
1242 cc (16-valve) engine	110 litres/hour minimum
Regulated fuel pressure:	
1242 cc (8-valve) engine:	
Pre-1998 models	2.5 bars
1998 models onward	3.5 bars
1242 cc (16-valve) engine	3.0 bars
Crankshaft TDC sensor resistance at 20°C	650 to 720 ohms
Injector electrical resistance:	
Pre-1998 models	16.2 ohms
1998 models onward	13.8 to 15.2 ohms
Injector duration (at idle)	2.0 ms
Recommended fuel	
Minimum octane rating	95 RON unleaded

Torque wrench settings	**Nm**	**lbf ft**
Coolant temperature sensor	3	2
Idle control stepper motor	4	3
Inlet manifold brake servo union	35	26
Inlet manifold upper section-to-lower section (16-valve engines)	9	7
Inlet manifold-to-cylinder head (16-valve engines)	15	11
Inlet manifold-to-cylinder head (8-valve engines)	27	20
Throttle body to manifold	7	5
Throttle potentiometer	3	2

1 General information and precautions

General information

The IAW Weber-Marelli multi-point injection (MPI) system is a self-contained engine management system, which controls both the fuel injection and ignition **(see illustrations)**. This Chapter deals with the fuel injection system components only - refer to Chapter 5B for details of the ignition system components.

The fuel injection system comprises a fuel tank, an electric fuel pump, a fuel filter, fuel supply and return lines, a throttle body, a fuel rail with four electronic injectors, and an Electronic Control Unit (ECU) together with its associated sensors, actuators and wiring.

On pre-1998, 8-valve engines and all 16-valve engines, the fuel pump delivers a constant supply of fuel through a cartridge filter to the fuel rail, and the fuel pressure regulator (located on the fuel rail) maintains a constant fuel pressure at the fuel injectors and returns excess fuel to the tank via the return line. This constant flow system also helps to reduce fuel temperature and prevents vaporisation. On later 8-valve engines, a returnless fuel system is used. With this arrangement, the fuel filter and fuel pressure regulator are an integral part of the fuel pump assembly located in the fuel tank. The regulator maintains a constant fuel pressure in the supply line to the fuel rail and allows excess fuel to recirculate in the fuel tank, by means of a bypass channel, if the regulated fuel pressure is exceeded. As the fuel filter is an integral part of the pump assembly, fuel filter renewal is no longer necessary as part of the maintenance and servicing schedule.

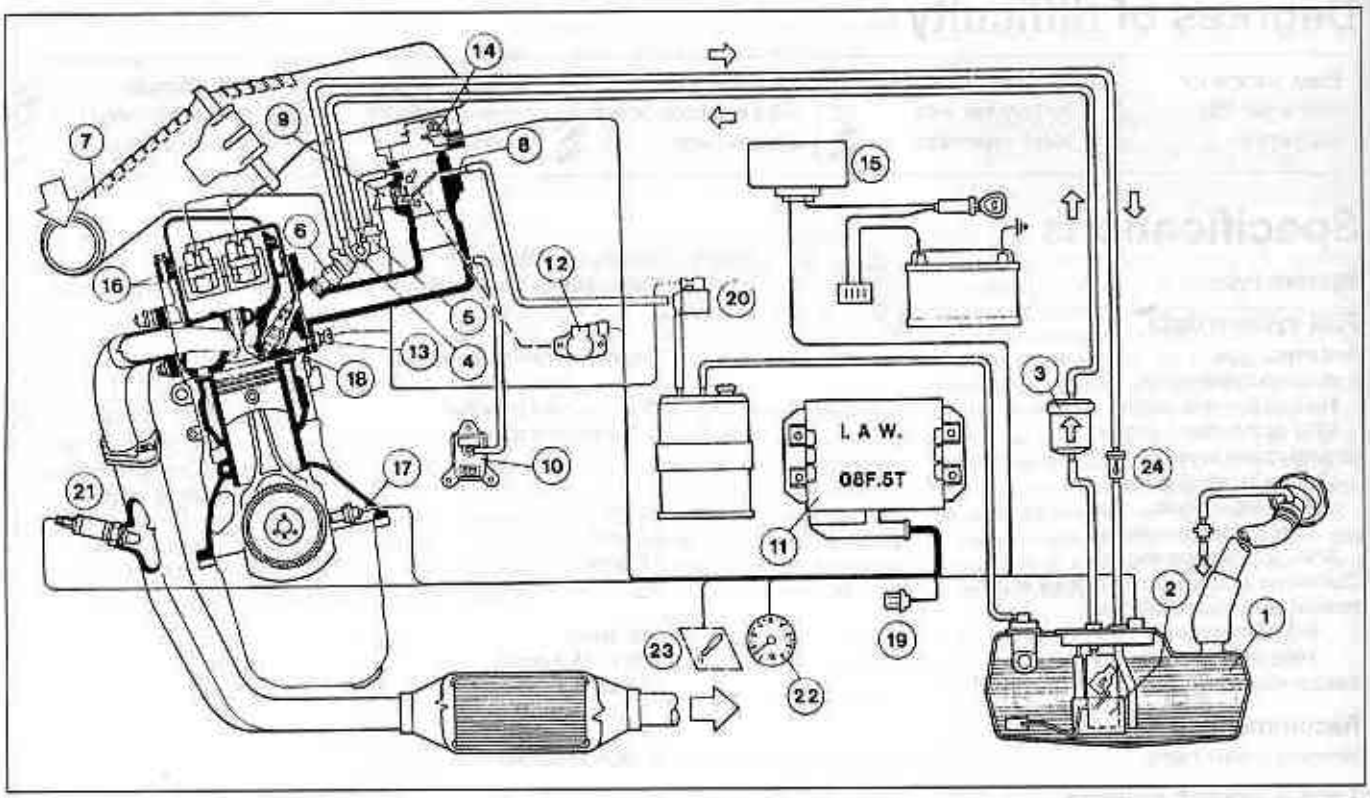
The fuel injectors are opened and closed by an Electronic Control Unit (ECU), which calculates the injection timing and duration according to engine speed, throttle position and rate of opening, inlet air temperature, coolant temperature and exhaust gas oxygen content information, received from sensors mounted on the engine. The injectors are operated simultaneously (ie not sequentially) and inject half of the quantity of fuel required on each turn of the crankshaft.

Inlet air is drawn into the engine through the air cleaner, which contains a renewable paper filter element. On 8-valve engines, the inlet air temperature is regulated by a vacuum operated valve mounted in the air ducting, which blends air at ambient temperature with hot air, drawn from over the exhaust manifold.

Idle speed is controlled by a stepper motor located on the side of the throttle body. Cold starting enrichment is controlled by the ECU using the coolant temperature and inlet air temperature parameters to increase the injector opening duration.

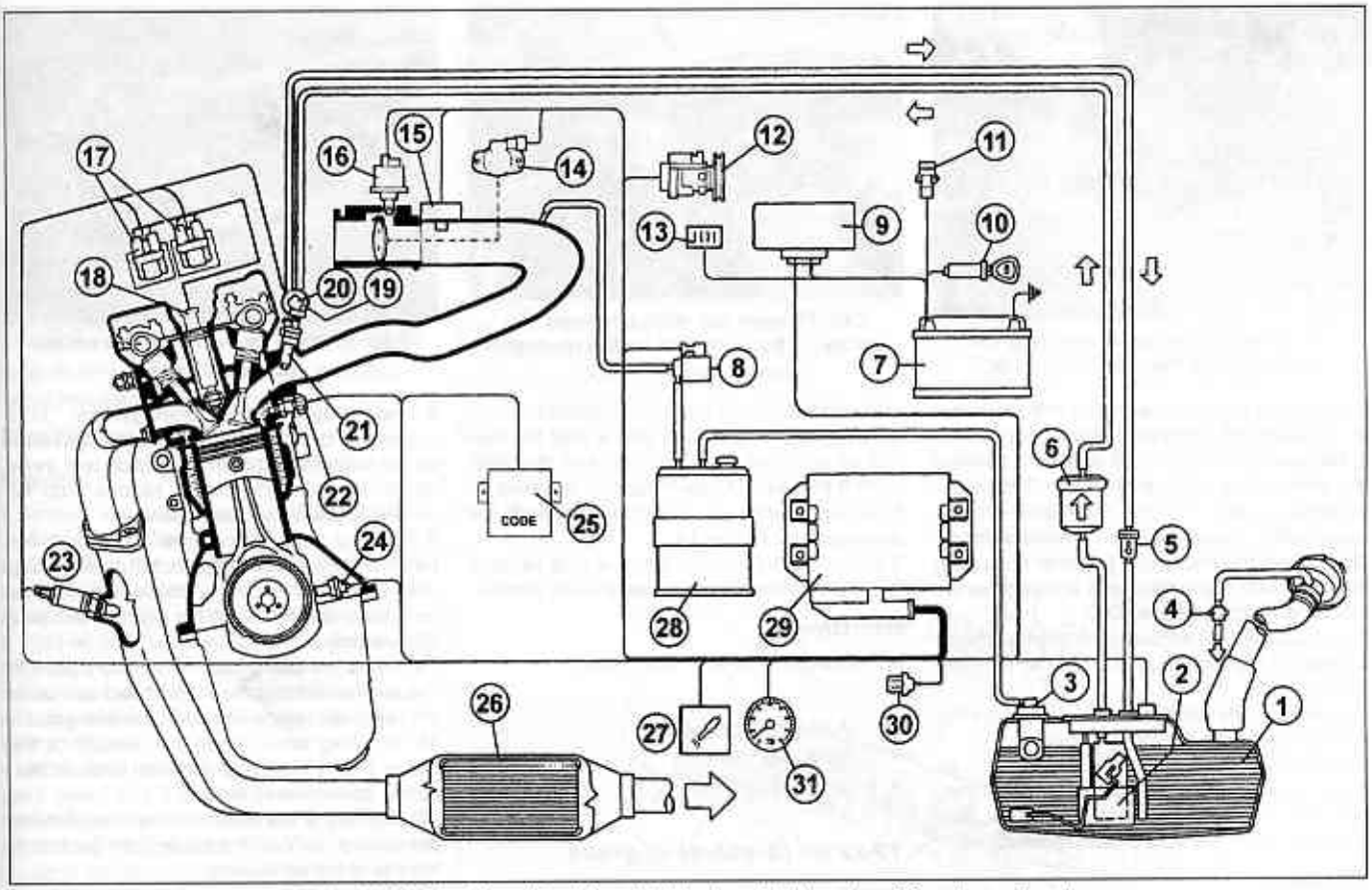
The exhaust gas oxygen content is constantly monitored by the ECU via the Lambda/oxygen sensor, which is mounted in the exhaust downpipe. The ECU then uses this information to modify the injection timing and duration to maintain the optimum air/fuel ratio. An exhaust catalyst is fitted to all models. The ECU also controls the operation of the activated charcoal filter evaporative loss system - refer to Chapter 4D for further details.

It should be noted that fault diagnosis of the IAW Weber-Marelli system is only possible with dedicated electronic test equipment.



1.1a IAW Weber-Marelli multi-point injection (MPI) system (8-valve engines)

1 *Fuel tank*
2 *Fuel pump*
3 *Filter (pre-1998 models)*
4 *Fuel rail*
5 *Pressure regulator (pre-1998 models)*
6 *Injectors*
7 *Air cleaner*
8 *Fuel vapour trap*
9 *Idle control stepper motor*
10 *Manifold absolute pressure sensor*
11 *ECU*
12 *Throttle position sensor*
13 *Coolant temperature sensor*
14 *Intake air temperature sensor*
15 *Dual relay*
16 *Ignition coils*
17 *Rpm and TDC sensor*
18 *Spark plugs*
19 *Diagnostic socket*
20 *EVAP solenoid*
21 *Lambda/oxygen sensor*
22 *Rev counter*
23 *IAW failure warning light*
24 *Anti-reflux valve*



1.1b IAW Weber-Marelli multi-point injection (MPI) system (16-valve engines)

1 *Fuel tank*
2 *Fuel pump*
3 *Multi-purpose valve*
4 *Safety valve*
5 *Anti-reflux valve*
6 *Filter*
7 *Battery*
8 *EVAP solenoid*
9 *Dual relay*
10 *Ignition switch*
11 *Inertia switch*
12 *Air conditioning compressor*
13 *Fuse*
14 *Throttle position sensor*
15 *Intake air temperature/pressure sensor*
16 *Idle control stepper motor*
17 *Ignition coils*
18 *Spark plugs*
19 *Fuel rail*
20 *Pressure regulator*
21 *Injectors*
22 *Coolant temperature sensor*
23 *Lambda/oxygen sensor*
24 *Rpm and TDC sensor*
25 *Engine immobiliser control unit*
26 *Catalytic converter*
27 *IAW failure warning light*
28 *EVAP canister*
29 *ECU*
30 *Diagnostic socket*
31 *Rev counter*

Problems with the system should therefore be referred to a Fiat dealer for assessment. Once the fault has been identified, the removal/refitting procedures detailed in the following Sections can then be followed.

Precautions

⚠ ***Warning: Many procedures in this Chapter require the removal of fuel lines and connections, which may result in fuel spillage. Before carrying out any operation on the fuel system, refer to the precautions given in Safety first! at the beginning of this manual, and follow them implicitly. Petrol is a highly dangerous and volatile liquid, and the precautions necessary when handling it cannot be overstressed. Note that residual pressure will remain in the fuel lines long after the vehicle was last used, When disconnecting any fuel line, first depressurise the fuel system (see Section 9).***

2 Air cleaner and inlet system - removal and refitting

Removal

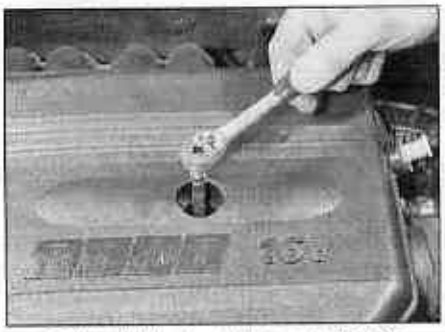
1242 cc (8-valve) engines

1 Remove the air cleaner element as described in Chapter 1A.
2 Disconnect the outer section from the hot air tube and the inlet air duct and remove it from the engine compartment.
3 If necessary remove the inlet air duct.
4 Disconnect the large and small breather hoses from the inner section of the air cleaner, then unscrew the retaining nuts and lift the section from the throttle body.
5 Recover the sealing ring. Check the ring for condition and renew it if necessary.
6 Wipe clean the inner surfaces of both the inner and outer sections of the air cleaner.

1242 cc (16-valve) engines

7 Release the hose clip and disconnect the inlet air duct from the resonator **(see illustration)**.

2.7 Release the hose clip and disconnect the inlet air duct from the resonator



2.8 Undo the two bolts securing the resonator to the camshaft cover

8 Undo the two bolts securing the resonator to the camshaft cover **(see illustration)**.
9 Release the wiring loom support clip from the slot on the side of the resonator lower extension, then lift the resonator off the camshaft cover **(see illustrations)**. Disconnect the crankcase breather hose from the underside of the resonator and remove the resonator from the engine.
10 Undo the nuts securing the sides of the air cleaner to the mounting brackets at the front of the engine.
11 Release the hose clip and disconnect the inlet air duct from the throttle body.
12 Release the crankcase ventilation hose from the pipe stub on the camshaft cover then remove the air cleaner and inlet air duct assembly from the engine **(see illustration)**.

Refitting

13 Refitting is a reversal of removal but renew the air cleaner element as described in Chapter 1A, if necessary.

3 Inlet air temperature regulator - removal and refitting

Removal

1 The thermostatically-controlled cold air flap opener, fitted to 8-valve engines, is located in the air cleaner outer casing section. To check the unit, disconnect the air inlet duct with the engine cold and use a mirror to check that the flap is positioned to admit only hot air from the shroud on the exhaust manifold. Next, warm up the engine and check that the flap moves to admit only cold air from the inlet duct. If the unit is faulty it must be renewed.
2 Remove the air cleaner element as described in Chapter 1A.
3 Unscrew the retaining screw and remove the regulator from the air cleaner outer section.

2.12 Removing the air cleaner and inlet air duct assembly

2.9a Release the wiring support clip (arrowed) from the slot on the resonator lower extension . . .

2.9b . . . then lift the resonator off the camshaft cover

Refitting

4 Refitting is a reversal of removal.

4 Accelerator cable - removal, refitting and adjustment

1242 cc (8-valve) engines

Removal

1 Remove the air cleaner as described in Section 2.
2 To release the cable from the throttle body, unscrew the outer cable locknuts, then disengage the inner cable from the throttle cam, and release the outer cable from its mounting bracket.
3 Working under the instrument panel inside the vehicle, unhook the cable from the fork at the top of the pedal arm.
4 Release the bulkhead grommet and withdraw the accelerator cable from inside the engine compartment.

Refitting and adjustment

5 Refitting is a reverse of the removal process, but adjust the cable (by means of the outer cable locknuts) so that there is only a very small amount of free play present at the throttle body end of the inner cable. Have an assistant depress the accelerator pedal, and check that the throttle cam opens fully and returns to the at-rest position, then securely tighten the cable locknuts.

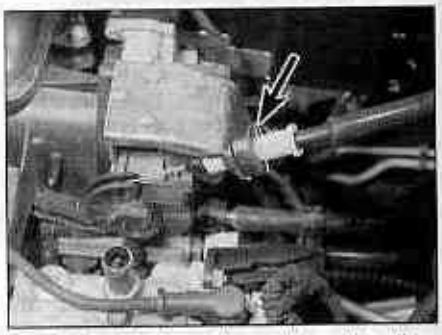
1242 cc (16-valve) engines

Removal

6 Disconnect the battery negative terminal (refer to *Disconnecting the battery* in the Reference Section of this manual).
7 Remove the resonator, air cleaner and inlet air duct as described in Section 2.
8 Undo the engine management ECU mounting bracket bolts, release the ECU wiring loom from the support clips and move the ECU and wiring loom to one side for access to the accelerator cable.
9 Free the accelerator inner cable from the throttle cam, remove the outer cable spring clip, then pull the outer cable out from its mounting bracket rubber grommet **(see illustration)**.
10 Trace the cable back to its entry point in the engine compartment bulkhead and undo the bulkhead support bracket mounting bolt.
11 Working back along the length of the cable, free it from any retaining clips or ties, noting its correct routing.
12 Working under the instrument panel inside the vehicle, unhook the cable from the fork at the top of the pedal arm.
13 Release the bulkhead support bracket and withdraw the accelerator cable from inside the engine compartment.

Refitting and adjustment

14 Refitting is a reverse of the removal process, but adjust the cable as follows before refitting the outer cable spring clip.
15 Ensuring that the throttle cam is fully against its stop, gently pull the cable out of its grommet until all free play is removed from the inner cable.
16 With the cable held in this position, fit the spring clip to the first outer cable groove visible in front of the mounting bracket rubber grommet. This should leave a small amount of freeplay in the inner cable which is necessary to ensure correct throttle operation.



4.9 Accelerator outer cable spring clip (arrowed)

17 Have an assistant depress the accelerator pedal and check that the throttle cam opens fully and returns smoothly to its stop. If necessary, reposition the spring clip in the next outer cable groove and recheck the throttle operation.
18 Refit the remainder of the disturbed components.

5 Engine management system components (1242 cc, 8-valve engines) - removal and refitting

Note: *Refer to the warning given in Section 1 before proceeding.*

Throttle body assembly

Removal

1 Remove the air cleaner and inlet air duct as described in Section 2.
2 Disconnect the wiring connectors from the throttle potentiometer, the idle control stepper motor and the inlet air temperature sensor.
3 Slacken the accelerator cable locknuts, then disengage the inner cable from the throttle cam and free the outer cable from its retaining bracket. Position the cable clear of the throttle body.
4 Unclip and disconnect the EVAP purge valve hose, and the MAP sensor hose from the rear of the throttle body then, where applicable, disconnect the fuel pressure regulator vacuum hose from the front of the throttle body.
5 Slacken and remove the four bolts securing the throttle body assembly to the inlet manifold, then remove the assembly along with its insulating spacer.

Refitting

6 Refitting is a reversal of the removal procedure, bearing in mind the following points:
a) Examine the insulating spacer for signs of damage, and renew if necessary.
b) Ensure the throttle body, inlet manifold and insulating spacer mating surfaces are clean and dry, then fit the throttle body and spacer, and securely tighten the retaining bolts.
c) Ensure all hoses are correctly reconnected and, where necessary, that their retaining clips are securely tightened.
d) Adjust the accelerator cable as described in Section 4.

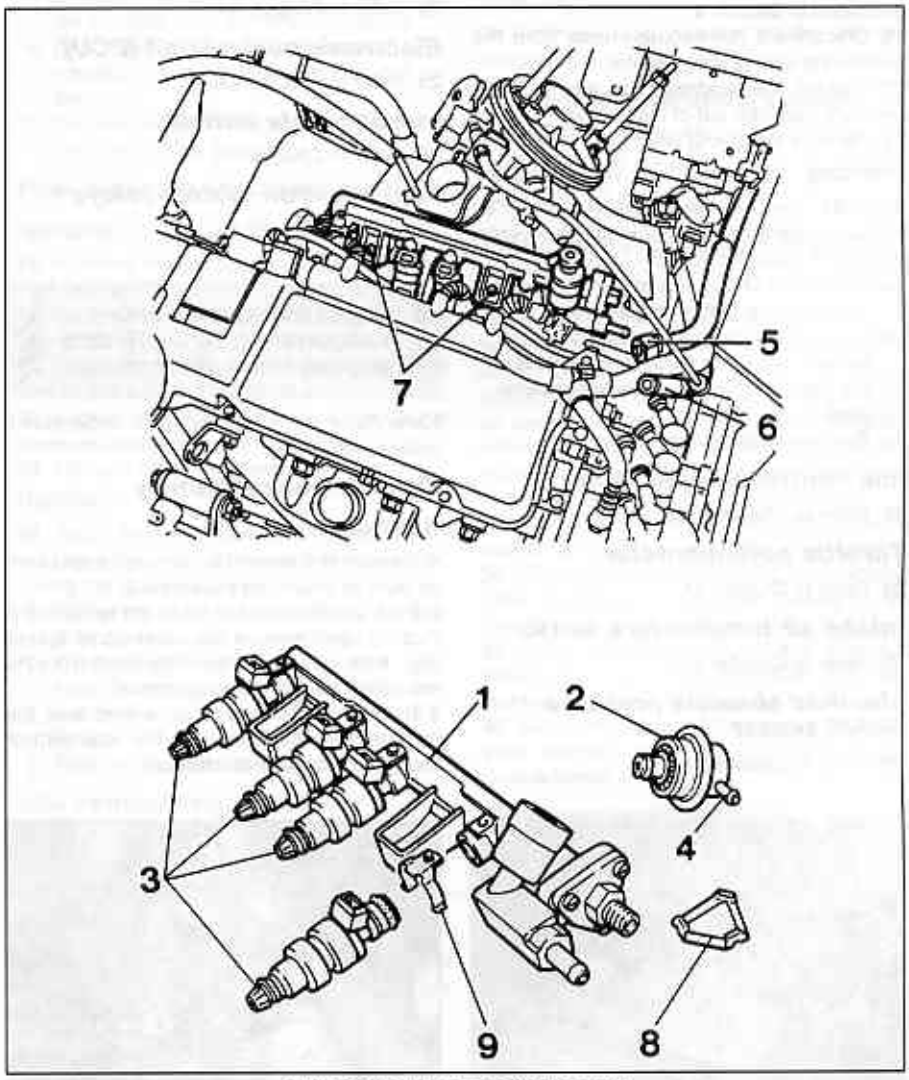
Fuel rail and injectors

Removal

7 Disconnect the battery negative terminal (refer to *Disconnecting the battery* in the Reference Section of this manual).
8 Remove the throttle body assembly as described earlier in this Section, however it is only necessary to move the unit to one side for access to the fuel rail and therefore it is unnecessary to disconnect the accelerator cable and hoses etc.
9 Depressurise the fuel system as described in Section 9.
10 Loosen the clips or release the quick-release couplings and disconnect the fuel inlet and, on pre-1998 models, outlet hoses from the fuel rail. Note the fitted positions of the hoses to aid refitting later.
11 Unplug the injector wiring harness connectors, labelling them to aid correct refitting later.
12 Unscrew the bolts securing the fuel rail assembly to the inlet manifold, then carefully pull the injectors from the inlet manifold. Remove the assembly from the engine and remove the injector lower O-ring seals.
13 The injectors can be removed individually from the fuel rail by extracting the relevant metal clip and easing the injector out of the rail. Remove the injector upper O-ring seals **(see illustration)**.
14 On pre-1998 models, if necessary remove the retaining clip and remove the fuel pressure regulator from the fuel rail.
15 Check the electrical resistance of the injector using a multimeter and compare it with the Specifications. **Note:** *If a faulty injector is suspected, before condemning the injector, it is worth trying the effect of one of the proprietary injector-cleaning treatments.*

Refitting

16 Refit the injectors and fuel rail by following the removal procedure, in reverse, noting the following points:
a) Renew the injector O-ring seals, and smear them with a little Vaseline before assembling. Take care when fitting the injectors to the fuel rail and do not press them in further than required to fit the retaining clip otherwise the O-ring seal may be damaged.



5.13 Fuel rail and injector removal

1 Fuel rail
2 Fuel pressure regulator
3 Injectors
4 Vacuum stub connection
5 Fuel inlet hose
6 Fuel return hose
7 Mounting bolts
8 Injector mounting clip
9 Injector mounting clip

b) Ensure that the injector retaining clips are securely seated.
c) Make sure the fuel supply and return hoses are correctly fitted as noted on removal.
d) Check that all vacuum and electrical connections are remade correctly and securely.
e) On completion check the fuel rail and injectors for fuel leaks.

Fuel pressure regulator

Note: *On 1998 models onward, the fuel pressure regulator is an integral part of the fuel pump and cannot be renewed separately. The following procedure applies to pre-1998 models only.*

Removal

17 Remove the air cleaner and inlet air ducts as described in Section 2.
18 Depressurise the fuel system as described in Section 9.
19 Disconnect the vacuum hose from the port on the side of the regulator.
20 Extract the retaining clip and pull the pressure regulator out of the fuel rail.
21 Remove the O-ring seal.

Refitting

22 Refit the fuel pressure regulator by following the removal procedure in reverse, noting the following points:
a) Renew the O-ring seal and smear it with a little Vaseline before assembling.
b) When fitting the retaining clip, use a suitable socket or metal tube to press in the three anchorage points at the same time.
c) Refit the vacuum hose securely.

Idle control stepper motor

23 Refer to Chapter 4A.

Throttle potentiometer

24 Refer to Chapter 4A.

Intake air temperature sensor

25 Refer to Chapter 4A.

Manifold absolute pressure (MAP) sensor

26 Refer to Chapter 4A.

6.3 Disconnect the wiring connectors from the throttle potentiometer and the idle control stepper motor

Coolant temperature sensor

27 Refer to Chapter 4A.

Crankshaft TDC sensor

28 Refer to Chapter 4A.

Electronic control unit (ECU)

29 Refer to Chapter 4A.

Inertia safety switch

30 Refer to Chapter 4A.

Fuel injection system relays

31 Refer to Chapter 4A.

6 Engine management system components (1242 cc, 16-valve engines) - removal and refitting

Note: *Refer to the warning given in Section 1 before proceeding.*

Throttle body assembly

Removal

1 Remove the resonator, air cleaner and inlet air duct as described in Section 2.
2 Free the accelerator inner cable from the throttle cam, remove the outer cable spring clip, then pull the outer cable out from its mounting bracket rubber grommet.
3 Disconnect the wiring connectors from the throttle potentiometer and the idle control stepper motor **(see illustration)**.
4 Slacken and remove the three bolts securing the throttle body assembly to the inlet manifold, then remove the assembly along with its insulating spacer. As the throttle body is withdrawn, disconnect the vacuum hose from the underside of the unit.

Refitting

5 Refitting is a reversal of the removal procedure, bearing in mind the following points:
a) Examine the insulating spacer for signs of damage, and renew if necessary.
b) Ensure the throttle body, inlet manifold and insulating spacer mating surfaces are clean and dry, then fit the throttle body and spacer, and securely tighten the retaining bolts.
c) Adjust the accelerator cable as described in Section 4.

Fuel rail and injectors

Removal

6 Disconnect the battery negative terminal (refer to *Disconnecting the battery* in the Reference Section of this manual).
7 Remove the resonator, air cleaner and inlet air duct as described in Section 2.
8 Free the accelerator inner cable from the throttle cam, remove the outer cable spring clip, then pull the outer cable out from its mounting bracket rubber grommet.
9 From the side of the throttle body, disconnect the wiring connectors from the throttle potentiometer and the idle control stepper motor.
10 Depressurise the fuel system as described in Section 9.
11 Loosen the clips or release the quick-release couplings and disconnect the fuel inlet and outlet hoses from the left-hand end of the fuel rail, below the throttle body. Note the fitted positions of the hoses to aid refitting later. Undo the support bracket retaining bolt and move the fuel hoses to one side.
12 Disconnect the wiring connectors for the fuel injector harness and the intake air temperature/pressure sensor **(see illustrations)**.
13 Disconnect the fuel pressure regulator vacuum hose and the EVAP purge valve hose **(see illustrations)**.

6.12a Disconnect the wiring connectors for the fuel injector harness . . .

6.12b . . . and intake air temperature/pressure sensor

6.13a Disconnect the fuel pressure regulator vacuum hose . . .

6.13b . . . and the EVAP purge valve hose

14 Undo the two bolts securing the plastic inlet manifold upper section to the lower section. Release the spark plug HT lead from the location groove in the manifold upper section, then lift the upper section, complete with throttle body, off the engine **(see illustrations)**. Recover the O-rings from the manifold ports.

15 Unscrew the two bolts securing the fuel rail assembly to the inlet manifold lower section, then carefully pull the injectors from the inlet manifold **(see illustration)**. Remove the assembly from the engine and remove the injector lower O-ring seals.

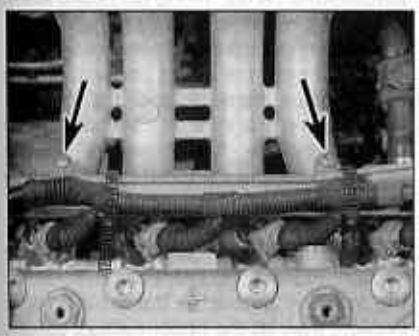
16 The injectors can be removed individually from the fuel rail by disconnecting the wiring connector, extracting the relevant metal clip and easing the injector out of the rail. Remove the injector upper O-ring seals.

17 Check the electrical resistance of the injector using a multimeter and compare it with the Specifications. **Note:** *If a faulty injector is suspected, before condemning the injector, it is worth trying the effect of one of the proprietary injector-cleaning treatments.*

Refitting

18 Refit the injectors and fuel rail by following the removal procedure, in reverse, noting the following points:

a) Renew the injector O-ring seals, and smear them with a little Vaseline before assembling. Take care when fitting the injectors to the fuel rail and do not press them in further than required to fit the retaining clip otherwise the O-ring seal may be damaged.



6.15 Fuel rail securing bolts (arrowed)

6.14a Undo the inlet manifold upper section retaining bolts . . .

b) Ensure that the injector retaining clips are securely seated.

c) Renew the sealing O-rings fitted between the manifold upper and lower sections if in any doubt about their condition.

d) Make sure the fuel supply and return hoses are correctly fitted as noted on removal.

e) Check that all vacuum and electrical connections are remade correctly and securely.

f) On completion check the fuel rail and injectors for fuel leaks.

Fuel pressure regulator

Removal

19 Remove the resonator, air cleaner and inlet air ducts as described in Section 2.

20 Depressurise the fuel system as described in Section 9.

21 Disconnect the vacuum hose from the port on the side of the regulator.

22 Extract the retaining clip and pull the pressure regulator out of the fuel rail.

23 Remove the O-ring seal.

Refitting

24 Refit the fuel pressure regulator by following the removal procedure in reverse, noting the following points:

a) Renew the O-ring seal and smear it with a little Vaseline before assembling.

b) When fitting the retaining clip, use a suitable socket or metal tube to press in the three anchorage points at the same time.

c) Refit the vacuum hose securely.

Idle control stepper motor

25 The idle control stepper motor is an integral part of the throttle body and cannot be individually renewed.

Throttle potentiometer

26 The throttle potentiometer is an integral part of the throttle body and cannot be individually renewed.

Intake air temperature/pressure sensor

Removal

27 Remove the resonator, air cleaner and inlet air duct as described in Section 2.

6.14b . . . and lift off the manifold upper section and throttle body

28 Disconnect the sensor wiring connector, located on the right-hand side of the inlet manifold upper section.

29 Undo the two screws and remove the sensor from the manifold.

Refitting

30 Refitting is a reversal of the removal procedure.

Coolant temperature sensor

31 Refer to Chapter 4A.

Crankshaft TDC sensor

32 Refer to Chapter 4A.

Electronic control unit (ECU)

Removal

Note: *The engine management system has a learning capability which allows the ECU to store details of the engine's running characteristics in its memory. This memory will be erased by the disconnection of the battery cables, with the result that the engine may idle roughly, or lack performance for a while, until the engine's characteristics are re-learnt.*

33 The ECU (electronic control unit) is located on the right-hand inner wing panel.

34 Disconnect the battery negative terminal (refer to *Disconnecting the battery* in the Reference Section of this manual).

35 Undo the mounting bracket nuts and withdraw the unit from the inner wing **(see illustration)**.

36 Disconnect the ECU wiring connector, then remove the unit from the engine compartment.

6.35 Undo the mounting bracket nuts and withdraw the ECU from the inner wing

Refitting

37 Refitting is a reversal of removal making sure that the wiring connector is securely reconnected.

Inertia safety switch

38 Refer to Chapter 4A.

Fuel injection system relays

Removal

39 The fuel injection system twin relay is located under a plastic cover on the engine compartment bulkhead.

40 The main purpose of the relay is to supply current to the fuel pump, ignition coils, oxygen sensor, injectors and EVAP solenoid. The relay is controlled by the ignition switch. A 15 amp fuse, protecting the fuel pump, oxygen sensor and EVAP solenoid is located adjacent to the relay.

41 Remove the cover and pull the relay directly from its socket.

Refitting

42 Refitting is a reversal of removal.

7 Fuel pump and fuel gauge sender unit - removal and refitting

Removal

Note: *Refer to the warning given in Section 1 before proceeding.*

1 Disconnect the battery negative terminal (refer to *Disconnecting the battery* in the Reference Section of this manual).

2 Depressurise the fuel system as described in Section 9.

3 Remove the rear seat as described in Chapter 11. Prise the fuel pump access cover out of the floor panel to gain access to the pump unit. On later models, undo the three retaining screws to release the cover.

4 Disconnect the wiring connector.

5 Bearing in mind the warning given in Section 1, disconnect the fuel supply and, where applicable, the return lines from the pump unit by pressing the tabs. Plug the ends of the lines or cover them with adhesive tape.

6 Using a suitable tool, unscrew the large ring nut and carefully withdraw the fuel pump/fuel tank sender unit assembly from the fuel tank, along with its sealing ring.

7 If necessary, the unit can be dismantled and the pump and sender unit separated. If this is the case, carefully note the correct fitted positions of all components while dismantling the unit, and use these notes on reassembly to ensure that all items are correctly fitted.

Refitting

8 Refitting is a reversal of the removal procedure using a new sealing ring. Prior to refitting the access cover, reconnect the battery, then start the engine and check the fuel line union(s) for signs of leakage.

8 Fuel tank - removal and refitting

Refer to Chapter 4A.

9 Fuel injection system - depressurisation

Note: *Refer to the warning given in Section 1 before proceeding.*

Warning: The following procedure will merely relieve the pressure in the fuel system - remember that fuel will still be present in the system components and take precautions accordingly before disconnecting any of them.

1 The fuel system referred to in this Section is defined as the tank-mounted fuel pump, the fuel filter, the fuel rail, the fuel injectors, and the metal pipes and flexible hoses of the fuel lines between these components. All these contain fuel which will be under pressure while the engine is running and/or while the ignition is switched on. The pressure will remain for some time after the ignition has been switched off, and must be relieved before any of these components are disturbed for servicing work.

2 Disconnect the battery negative terminal (refer to *Disconnecting the battery* in the Reference Section of this manual).

3 Have a large rag ready to cover the union to be disconnected and, if possible, place a container beneath the relevant connection/union.

4 Slowly loosen the connection or union nut (as applicable) to avoid a sudden release of pressure, and ensure that the rag is wrapped around the connection to catch any fuel spray which may be expelled. Once the pressure is released, disconnect the fuel line, and insert plugs to minimise fuel loss and prevent the entry of dirt into the fuel system. Note that on later models, quick-release fuel couplings are used on many of the fuel line connections. To release these couplings, depress the two clips on the side of the coupling while keeping the fuel line pushed in. With the clips depressed, slowly withdraw the fuel line from the coupling allowing the fuel pressure to release, then withdraw the fuel line fully.

10 Inlet manifold - removal and refitting

Note: *Refer to the warning given in Section 1 before proceeding.*

1242 cc (8-valve) engines

Removal

1 Remove the throttle body assembly as described in Section 5.

2 Remove the fuel rail and injectors as described in Section 5.

3 Drain the cooling system as described in Chapter 1A.

4 Disconnect the wiring connector from the coolant temperature sensor (situated on the left-hand side of the manifold).

5 Undo the bolt securing the accelerator cable mounting bracket to the manifold, and position it clear of the manifold.

6 Slacken the retaining clip and disconnect the coolant hose from the rear of the manifold.

7 Disconnect the brake vacuum hose.

8 Undo the seven manifold retaining nuts and bolts, and remove the manifold from the engine. Remove the gasket and discard it; a new one should be used on refitting.

Refitting

9 Refitting is a reverse of the removal procedure, noting the following points:

a) Ensure that the manifold and cylinder head mating surfaces are clean and dry, and fit a new manifold gasket. Refit the manifold and securely tighten its retaining nuts.

b) Ensure all relevant hoses are reconnected to their original positions and are securely held (where necessary) by the retaining clips.

c) Refit the fuel rail and injectors, and the throttle body assembly with reference to Section 5.

d) On completion, refill the cooling system as described in Chapter 1A.

1242 cc (16-valve) engines

Removal

10 Disconnect the battery negative terminal (refer to *Disconnecting the battery* in the Reference Section of this manual).

11 Remove the resonator, air cleaner and inlet air duct as described in Section 2.

12 Drain the cooling system as described in Chapter 1A.

13 Free the accelerator inner cable from the throttle cam, remove the outer cable spring clip, then pull the outer cable out from its mounting bracket rubber grommet.

14 From the side of the throttle body, disconnect the wiring connectors from the throttle potentiometer and the idle control stepper motor. Disconnect the coolant temperature sensor wiring connector located in the inlet manifold below the throttle body, and disconnect the brake servo vacuum hose.

15 Disconnect the wiring connectors for the fuel injector harness and the intake air temperature/pressure sensor, then disconnect the fuel pressure regulator vacuum hose and the EVAP purge valve hose **(see illustration)**.

16 Undo the two bolts securing the plastic inlet manifold upper section to the lower section. Release the spark plug HT lead from the location groove in the manifold upper section, then lift the upper section, complete with throttle body, off the engine. Recover the O-rings from the manifold ports.

17 Unscrew the two bolts securing the fuel rail assembly to the inlet manifold lower section, then carefully pull the injectors from the manifold. Lift the fuel rail and injector assembly, with fuel hoses still connected, and position it to one side **(see illustration)**.

18 Disconnect the heater hose from the manifold stub.

19 Undo the engine oil dipstick tube bracket retaining bolt and the two bolts securing the wiring harness support clips to the manifold.

20 Undo the ten manifold retaining nuts and remove the manifold from the cylinder head studs. Remove the gasket and discard it; a new one should be used on refitting.

Refitting

21 Refitting is a reverse of the removal procedure, noting the following points:

a) Ensure that the manifold and cylinder head mating surfaces are clean and dry, and fit a new manifold gasket. Refit the manifold and securely tighten its retaining nuts.

b) Renew the sealing O-rings fitted between the manifold upper and lower sections if in any doubt about their condition.

c) Ensure all relevant hoses are reconnected to their original positions and are securely held (where necessary) by the retaining clips.

d) Renew the injector O-ring seals, and smear them with a little Vaseline before assembling.

e) Adjust the accelerator cable as described in Section 4.

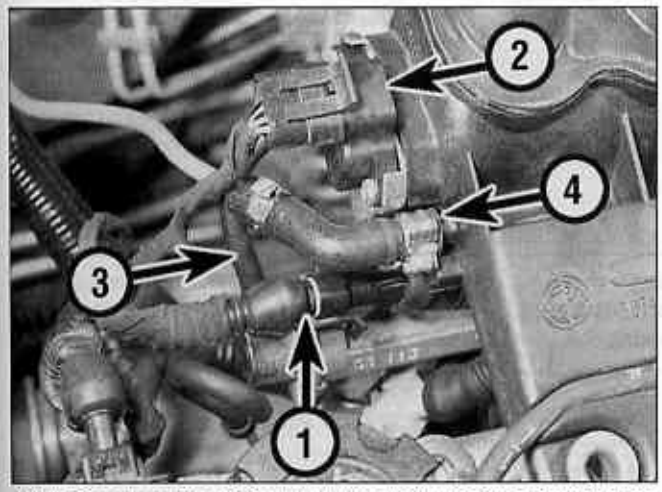
f) On completion, refill the cooling system as described in Chapter 1A.

11 Fuel injection system - testing and adjustment

Refer to Chapter 4A.

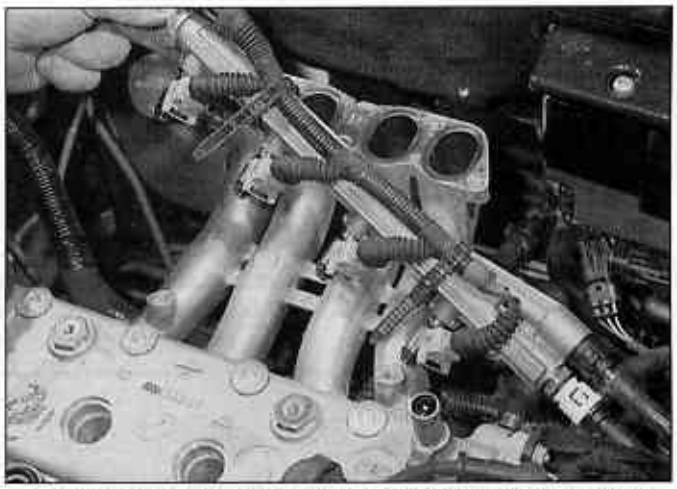
12 Unleaded petrol - general information and usage

Refer to Chapter 4A.



10.15 Disconnect the wiring connectors and hoses from the fuel rail and manifold

1 Fuel injector harness wiring connector
2 Intake air temperature/pressure sensor wiring connector
3 Fuel pressure regulator vacuum hose
4 EVAP purge valve hose



10.17 Lift off the fuel rail and injector assembly, with fuel hoses still connected, and position it to one side

Chapter 4 Part C:
Fuel system - diesel models

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

System type	Rear-mounted fuel tank, distributor fuel injection pump with integral transfer pump, indirect injection. Turbocharger on TDS, TD and TDSX models
Firing order	1-3-4-2 (No 1 at timing belt end of engine)

Injection pump (Bosch VE)

Direction of rotation	Clockwise, viewed from sprocket end
Static timing:	
Engine position	No 1 piston at TDC
Pump timing measurement	0.93 ± 0.05 mm
Maximum engine speed	5200 to 5300 rpm

Injection pump (Lucas/CAV FT08)

Direction of rotation	Clockwise, viewed from sprocket end
Static timing:	
Engine position	No 1 piston at TDC
Pump timing measurement	0° ± 1° TDC (**Note:** *Value shown on pump - see text*)
Maximum engine speed	5150 ± 50 rpm

Injectors

Type	Pintle
Opening pressure:	
Bosch	150 to 158 bar
Lucas:	
New	124 to 131 bar
After running in	116 to 123 bar

RPM sensor

Sensor-to-flywheel ring gear teeth gap	0.25 to 1.3 mm
Winding resistance	680 ± 100 ohms

Torque wrench settings	Nm	lbf ft
Fuel injection pump rear bracket	29	21
Fuel injection pump	25	18
Fuel injectors	55	41
Fuel pipe union nuts	30	22
Inlet manifold	24	18
Lower oil filter mounting and injection pump mounting nut	71	52
Turbocharger to exhaust manifold	40	30
Upper oil filter mounting and injection pump mounting nut	98	72

1 General information and precautions

General information

The fuel system consists of a rear-mounted fuel tank, a fuel filter with integral water separator, a fuel injection pump, injectors and associated components. A turbocharger is fitted to TDS, TD and TDSX models.

Fuel is drawn from the fuel tank to the fuel injection pump by a vane-type transfer pump incorporated in the fuel injection pump. Before reaching the pump, the fuel passes through a fuel filter, where foreign matter and water are removed. Excess fuel lubricates the moving components of the pump, and is then returned to the tank. On turbo models with the Bosch fuel injection system, an electrically operated heater is incorporated in the fuel filter housing.

The fuel injection pump is driven at half-crankshaft speed by the timing belt. The high pressure required to inject the fuel into the compressed air in the swirl chambers is achieved by a cam plate acting on a single piston on the Bosch pump, or by two opposed pistons forced together by rollers running in a cam ring on the Lucas (CAV) pump. The fuel passes through a central rotor with a single outlet drilling which aligns with ports leading to the injector pipes.

Fuel metering is controlled by a centrifugal governor, which reacts to accelerator pedal position and engine speed. The governor is linked to a metering valve, which increases or decreases the amount of fuel delivered at each pumping stroke. On turbocharged models, a separate device also increases fuel delivery with increasing boost pressure.

Basic injection timing is determined when the pump is fitted. When the engine is running, it is varied automatically to suit the prevailing engine speed by a mechanism which turns the cam plate or ring.

The four fuel injectors produce a homogeneous spray of fuel into the swirl chambers located in the cylinder head. The injectors are calibrated to open and close at critical pressures to provide efficient and even combustion. Each injector needle is lubricated by fuel, which accumulates in the spring chamber and is channelled to the injection pump return hose by leak-off pipes.

Bosch or Lucas fuel system components may be fitted, depending on the model. Components from the latter manufacturer are marked either CAV, Roto-diesel or Con-diesel, depending on their date and place of manufacture. With the exception of the fuel filter assembly, replacement components must be of the same make as those originally fitted.

Cold starting is assisted by preheater or glow plugs fitted to each swirl chamber. On the Bosch injection pump, an automatic cold injection advance device operated through a thermal switch, advances the injection timing by increasing the fuel pressure. The device operates at coolant temperatures below 55° C.

A stop solenoid cuts the fuel supply to the injection pump rotor when the ignition is switched off **(see illustration)**.

Provided that the specified maintenance is carried out, the fuel injection equipment will give long and trouble-free service. The injection pump itself may well outlast the engine. The main potential cause of damage to the injection pump and injectors is dirt or water in the fuel.

Servicing of the injection pump and injectors is very limited for the home mechanic, and any dismantling or adjustment other than that described in this Chapter must be entrusted to a Fiat dealer or fuel injection specialist.

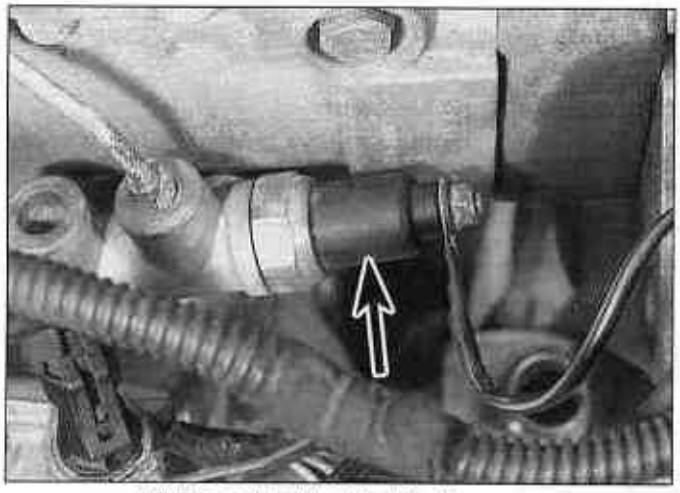
Precautions

Warning: It is necessary to take certain precautions when working on the fuel system components, particularly the fuel injectors. Before carrying out any operations on the fuel system, refer to the precautions given in Safety first! at the beginning of this manual, and to any additional warning notes at the start of the relevant Sections.

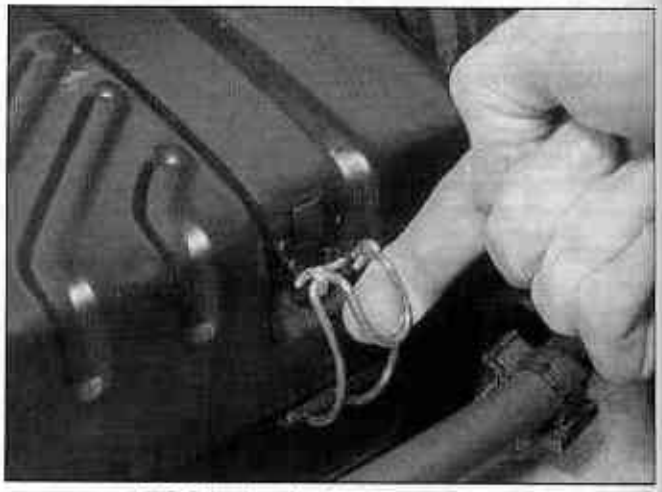
2 Air cleaner and inlet system - removal and refitting

Removal

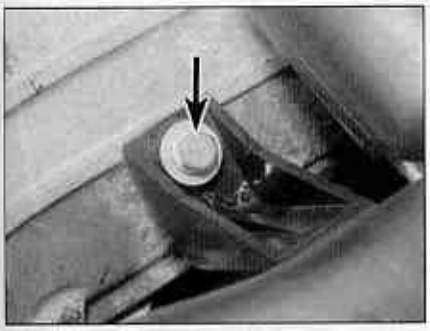
1 Remove the air cleaner element as described in Chapter 1B **(see illustration)**.



1.9 Stop solenoid on the injection pump



2.1 Releasing the air cleaner cover clips

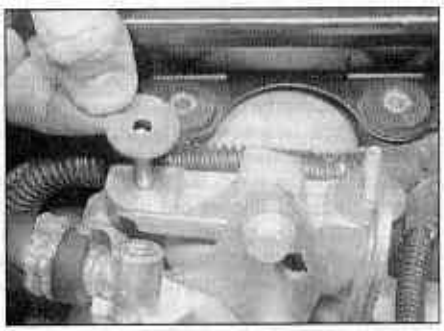


2.7a Unscrew the bolt . . .

2.7b . . . and remove the inlet air duct assembly

2.9a Unscrew the mounting nuts . . .

2.9b . . . remove the air cleaner body . . .



2.9c . . . and spacers

Non-turbo models

2 Disconnect the intermediate air duct from the air cleaner cover and the resonance box.
3 Disconnect the inlet duct from the resonance box and unbolt it from the front of the engine compartment.
4 Unscrew the mounting nuts and remove the resonance box. Note the location of the special spacers.
5 If necessary unbolt and remove the support brackets for the resonance box.

Turbo models

6 Disconnect the intermediate air duct from the air cleaner cover and front inlet air duct assembly.
7 Unbolt and remove the inlet air duct assembly **(see illustrations)**.
8 Disconnect the air ducts from between the air cleaner and turbocharger, and between the turbocharger and inlet manifold.
9 Unscrew the mounting nuts and remove the air cleaner body. Note the location of the special spacers **(see illustrations)**.

Refitting

10 Refitting is a reversal of the removal procedure.

3 Accelerator cable - removal, refitting and adjustment

Removal

1 Remove the air inlet ducting as described in Section 2.
2 Working in the engine compartment, remove the cylindrical spring clip, and release the inner cable from the lever **(see illustration)**.
3 Pull the outer cable from the grommet in the fuel injection pump bracket **(see illustration)**.
4 Release the cable from the remaining clips and brackets in the engine compartment, noting its routing.
5 Working under the instrument panel inside the vehicle, unhook the cable from the fork at the top of the pedal arm.
6 Release the bulkhead grommet and withdraw the accelerator cable from inside the engine compartment.

Refitting

7 Refitting is a reversal of removal, but ensure that the cable is routed as noted before removal, and on completion, adjust the cable as follows.

Adjustment

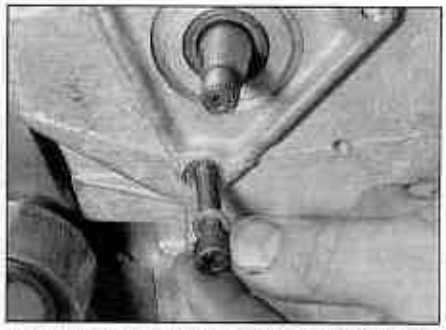
8 Remove the spring clip from the accelerator outer cable **(see illustration)**. Ensuring that the control lever is against its stop, gently pull the cable out of its grommet until all free play is removed from the inner cable.
9 With the cable held in this position, refit the spring clip to the last exposed outer cable groove in front of the rubber grommet and washer. When the clip is refitted and the outer cable is released, there should be only a small amount of free play in the inner cable.
10 Have an assistant depress the accelerator pedal, and check that the control lever opens fully and returns smoothly to its stop.

3.2 Remove the spring clip and release the inner cable

3.3 Removing the outer cable

3.8 Removing the spring clip from the accelerator outer cable

5.9 Unscrewing the rear support bracket bolt (Bosch)



5.10a Injection pump lower mounting bolt removal (Bosch)

5.10b Removing the special injection pump mounting bracket (Bosch)

4 Fuel system - priming and bleeding

The injection pump is self-priming and no special procedures are necessary to prime the fuel system. However where the fuel system has been completely drained it is helpful to loosen the injector union nuts while turning the engine on the starter motor in order to purge trapped air.

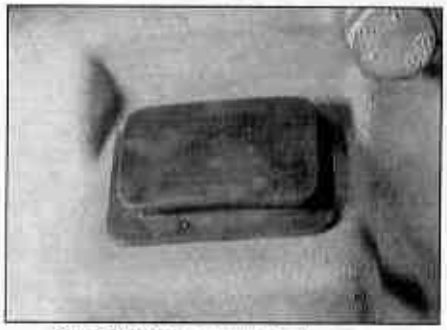
5 Fuel injection pump - removal and refitting

Removal

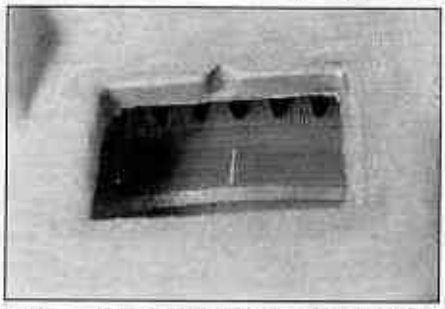
1 Disconnect the battery negative terminal (refer to *Disconnecting the battery* in the Reference Section of this manual).
2 Remove the timing belt and injection pump sprocket as described in Chapter 2C.
3 Disconnect the accelerator cable from the fuel injection pump, with reference to Section 3.
4 Loosen the clip, or undo the banjo union, and disconnect the fuel supply hose. Recover the sealing washers from the banjo union, where applicable. Cover the open end of the hose, and refit and cover the banjo bolt to keep dirt out.
5 Disconnect the main fuel return pipe and the injector leak-off return pipe banjo union. Recover the sealing washers from the banjo union. Again, cover the open end of the hose and the banjo bolt to keep dirt out.
6 Disconnect all relevant wiring from the pump.
7 Unscrew the union nuts securing the injector pipes to the fuel injection pump and injectors. Counterhold the unions on the pump, while unscrewing the pipe-to-pump union nuts. Remove the pipes as a set. Cover open unions to keep dirt out, using small plastic bags, or fingers cut from discarded (but clean!) rubber gloves.
8 Mark the fuel injection pump in relation to the mounting bracket, using a scriber or felt tip pen. This will ensure the correct pump timing is retained when refitting.
9 Unscrew the bolt(s) from the rear support bracket **(see illustration)**.
10 Unscrew the mounting nuts/bolt, remove the special bracket, then remove the injection pump from the mounting bracket/housing **(see illustrations)**.

Refitting

11 Locate the injection pump in the mounting bracket and align the marks made on the pump and bracket before removal. If a new pump is being fitted, transfer the mark from the old pump to give an approximate setting. Locate the special bracket and fit the nuts/bolt loosely.
12 Refit the rear support bracket and fit the bolts loosely.
13 Set up the injection timing, as described in Sections 7 and 8 (as applicable).
14 Refit and reconnect the injector fuel pipes.
15 Reconnect all relevant wiring to the pump.
16 Reconnect the fuel supply and return hoses, and tighten the unions, as applicable. Use new sealing washers on the banjo unions.
17 Reconnect and adjust the accelerator cable with reference to Section 3.
18 Refit the injection pump sprocket and timing belt as described in Chapter 2C.
19 Reconnect the battery negative terminal.
20 Start the engine, and check for any leakage at the fuel unions. To enable the engine to start it may be necessary to loosen the injector union nuts while turning the engine on the starter motor in order to purge trapped air.
21 Check and if necessary adjust the idle speed as described in Chapter 1B.



6.2a Remove the rubber bung . . .



6.2b . . . when checking the injection pump timing dynamically. Timing marks shown on flywheel and transmission casing

5.10c Removing the injection pump (Bosch)

6 Injection timing - checking methods

1 Checking the injection timing is not a routine operation. It is only necessary after the injection pump has been disturbed.
2 Dynamic timing equipment does exist, but it is unlikely to be available to the home mechanic. The equipment works by converting pressure pulses in an injector pipe into electrical signals. If such equipment is available, use it in accordance with its maker's instructions using the timing mark on the flywheel **(see illustrations)**.
3 Static timing as described in this Chapter gives good results if carried out carefully. A dial test indicator will be needed, with probes and adapters appropriate to the type of injection pump. Read through the procedures before starting work, to find out what is involved.

7 Injection timing (Bosch fuel injection pump) - checking and adjustment

Caution: Some of the injection pump settings and access plugs may be sealed by the manufacturers at the factory, using paint or locking wire and lead seals. Do not disturb the seals if the vehicle is still within the warranty period, otherwise the warranty will be invalidated. Also do not attempt the timing procedure unless accurate instrumentation is available.

Note: *To check the injection pump timing a special timing probe and mounting bracket is required. Without access to this piece of equipment, injection pump timing should be entrusted to a Fiat dealer or other suitably equipped specialist.*

1 If the injection timing is being checked with the pump in position on the engine, rather than as part of the pump refitting procedure, disconnect the battery negative terminal (refer to *Disconnecting the battery* in the Reference Section of this manual), and remove the air inlet ducting from the front of the engine.

2 Unscrew the union nuts and disconnect the injector pipes from the injection pump and injectors. Counterhold the unions on the pump, while unscrewing the pipe-to-pump union nuts. Remove the pipes as a set. Cover open unions to keep dirt out, using small plastic bags, or fingers cut from discarded (but clean!) rubber gloves.

3 Referring to Chapter 2C, set the engine at TDC on cylinder No 1.

4 Unscrew the access screw, situated in the centre of the four injector pipe unions, from the rear of the injection pump **(see illustration)**. As the screw is removed, position a suitable container beneath the pump to catch any escaping fuel. Mop up any spilt fuel with a clean cloth.

5 Screw the adapter into the rear of the pump and mount the dial gauge in the adapter **(see illustration)**. If access to the special Fiat adapter cannot be gained, they can be purchased from most good motor factors. Position the dial gauge so that its plunger is at the mid-point of its travel and securely tighten the adapter locknut.

6 Slowly rotate the crankshaft first back then forwards whilst observing the dial gauge, to determine when the injection pump piston is at the bottom of its travel (BDC). When the piston is correctly positioned, zero the dial gauge.

7 Rotate the crankshaft slowly in the correct direction until the TDC timing marks are aligned on both the crankshaft, camshaft and injection pump sprockets.

8 The reading obtained on the dial gauge should be equal to the specified pump timing measurement given in the Specifications at the start of this Chapter. If adjustment is necessary, slacken the front and rear pump mounting nuts/bolts and slowly rotate the pump body until the point is found where the specified reading is obtained. When the pump is correctly positioned, tighten both its front and rear mounting nuts and bolts securely.

7.4 Unscrew the access screw from the rear of the injection pump (Bosch)

9 Rotate the crankshaft through one and three quarter rotations in the normal direction of rotation. Find the injection pump piston BDC as described in paragraph 6 and zero the dial gauge.

10 Rotate the crankshaft slowly in the correct direction of rotation until the TDC marks are aligned. Recheck the timing measurement.

11 If adjustment is necessary, slacken the pump mounting nuts and bolts and repeat the operations in paragraphs 8 to 10.

12 When the pump timing is correctly set, unscrew the adapter and remove the dial gauge.

13 Refit the screw and sealing washer to the pump and tighten it securely.

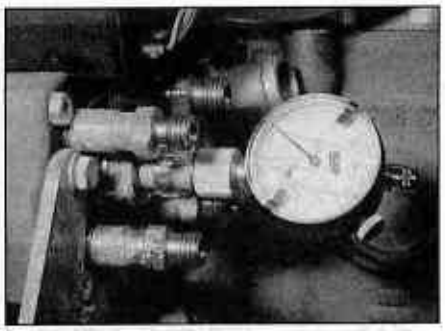
14 If the procedure is being carried out as part of the pump refitting sequence, proceed as described in Section 5.

15 If the procedure is being carried out with the pump fitted to the engine, refit the injector pipes tightening their union nuts to the specified torque setting. Reconnect the battery and refit the air inlet ducting.

16 Start the engine, and check for any leakage at the fuel unions. To enable the engine to start it may be necessary to loosen the injector union nuts while turning the engine on the starter motor in order to purge trapped air.

17 Check and if necessary adjust the idle speed as described in Chapter 1B.

8.4 Removing the injection pump timing inspection plug (Lucas)



7.5 Dial gauge and adapter (Bosch)

8 Injection timing (Lucas fuel injection pump) - checking and adjustment

Caution: Some of the injection pump settings and access plugs may be sealed by the manufacturers at the factory, using paint or locking wire and lead seals. Do not disturb the seals if the vehicle is still within the warranty period, otherwise the warranty will be invalidated. Also do not attempt the timing procedure unless accurate instrumentation is available.

Note: *To check the injection pump timing a special timing probe and mounting bracket is required. Without access to this piece of equipment, injection pump timing should be entrusted to a Fiat dealer or other suitably equipped specialist.*

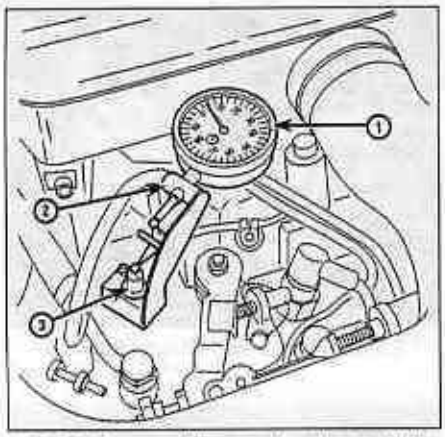
1 If the injection timing is being checked with the pump in position on the engine, rather than as part of the pump refitting procedure, disconnect the battery negative terminal (refer to *Disconnecting the battery* in the Reference Section of this manual), and remove the air inlet ducting from the front of the engine.

2 Unscrew the union nuts and disconnect the injector pipes from the injection pump and injectors. Counterhold the unions on the pump, while unscrewing the pipe-to-pump union nuts. Remove the pipes as a set. Cover open unions to keep dirt out, using small plastic bags, or fingers cut from discarded (but clean!) rubber gloves.

3 Referring to Chapter 2C, set the engine at TDC on cylinder No 1, then turn the crankshaft backwards (anti-clockwise) approximately a quarter of a turn.

4 Unscrew the access plug from the guide on the top of the pump body and recover the sealing washer **(see illustration)**. Insert the special timing probe into the guide, making sure it is correctly seated against the guide sealing washer surface. **Note:** *The timing probe must be seated against the guide sealing washer surface and not the upper lip of the guide for the measurement to be accurate.*

5 Mount the bracket on the pump guide (using adapter tool) and securely mount the dial gauge (dial test indicator) in the bracket



8.5 Dial gauge (1), mounting bracket (2) and setting rod (3) in position on the injection pump (Lucas)

so that its tip is in contact with the bracket linkage **(see illustration)**. Position the dial gauge so that its plunger is at the mid-point of its travel and zero the gauge.

6 Rotate the crankshaft slowly in the correct direction of rotation (clockwise) until the crankshaft is positioned at TDC on No 1 piston with all the sprocket timing marks aligned.

7 Check the reading on the dial gauge which should correspond to the value marked on the pump (there is a tolerance of ± 0.04 mm). The timing value may be marked on a plastic disc attached to the front of the pump, or alternatively on a tag attached to the pump control lever **(see illustrations)**.

8 If adjustment is necessary, slacken the front pump mounting nuts/bolt and the rear mounting bolt, then slowly rotate the pump body until the point is found where the specified reading is obtained on the dial gauge (access to the lower front bolt is gained through the hole in the injection pump sprocket). When the pump is correctly positioned, tighten both its front mounting nuts/bolt and the rear bolt to their specified torque settings.

9 Withdraw the timing probe slightly, so that it is positioned clear of the pump rotor dowel. Rotate the crankshaft through one and three quarter rotations in the normal direction of rotation.

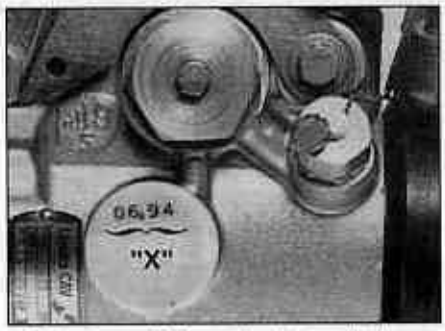
10 Slide the timing probe back into position ensuring that it is correctly seated against the guide sealing washer surface, not the upper lip, then zero the dial gauge.

11 Rotate the crankshaft slowly in the correct direction of rotation to the TDC position and recheck the timing measurement.

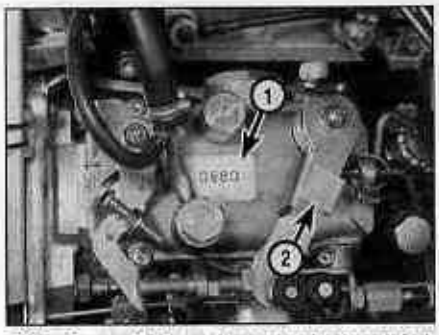
12 If adjustment is necessary, slacken the pump mounting nuts and bolt and repeat the operations in paragraphs 8 to 11.

13 When the pump timing is correctly set, remove the dial gauge and mounting bracket and withdraw the timing probe.

14 Refit the screw and sealing washer to the guide and tighten it securely.



8.7a Pump timing value (x) marked on plastic disc (Lucas)



8.7b Pump timing values marked on label (1) and tag (2) (Lucas)

15 If the procedure is being carried out as part of the pump refitting sequence, proceed as described in Section 5.

16 If the procedure is being carried out with the pump fitted to the engine, refit the injector pipes tightening their union nuts to the specified torque setting. Reconnect the battery and refit the air inlet ducting.

17 Start the engine, and check for any leakage at the fuel unions. To enable the engine to start it may be necessary to loosen the injector union nuts while turning the engine on the starter motor in order to purge trapped air.

18 Check and if necessary adjust the idle speed as described in Chapter 1B.

9 Fuel injectors - testing, removal and refitting

Warning: Exercise extreme caution when working on the fuel injectors. Never expose the hands or any part of the body to injector spray, as the high working pressure can cause the fuel to penetrate the skin, with possibly fatal results. You are strongly advised to have any work which involves testing the injectors under pressure carried out by a dealer or fuel injection specialist.

Testing

1 Injectors do deteriorate with prolonged use, and it is reasonable to expect them to need reconditioning or renewal after 60 000 miles (100 000 km) or so. Accurate testing, overhaul and calibration of the injectors must be left to a specialist. A defective injector which is causing knocking or smoking can be located without dismantling as follows.

2 Run the engine at a fast idle. Slacken each injector union in turn, placing rag around the union to catch spilt fuel, and being careful not to expose the skin to any spray. When the union on the defective injector is slackened, the knocking or smoking will stop.

Removal

3 Remove the air inlet ducting from the front part of the engine.

4 Carefully clean around the injectors and injector pipe union nuts.

5 Pull the leak-off pipes from the injectors **(see illustration)**.

6 Unscrew the union nuts securing the injector pipes to the fuel injection pump. Counterhold the unions on the pump when unscrewing the nuts. Cover open unions to keep dirt out, using small plastic bags, or fingers cut from discarded (but clean!) rubber gloves.

7 Unscrew the union nuts and disconnect the pipes from the injectors. If necessary, the injector pipes may be completely removed. Note carefully the locations of the pipe clamps, for use when refitting. Cover the ends of the injectors, to prevent dirt ingress.

8 Unscrew the injectors using a deep socket or box spanner, and remove them from the cylinder head **(see illustration)**.

9 Recover the fire seal washers from the cylinder head and discard them **(see illustration)**.

9.5 Disconnecting the injector leak-off pipes

9.8 Removing an injector

9.9 Removing the fire seal washer

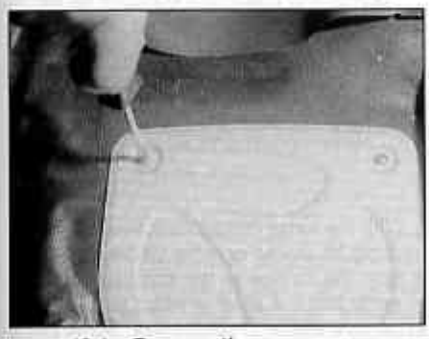
9.13 Tightening an injector with a torque wrench

Refitting

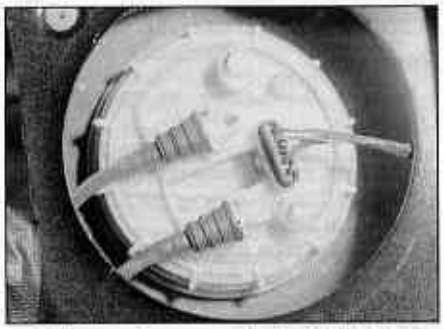
10 Obtain new fire seal washers.
11 Take care not to drop the injectors, or allow the needles at their tips to become damaged. The injectors are precision-made to fine limits, and must not be handled roughly. In particular, never mount them in a bench vice.
12 Commence refitting by inserting the fire seal washers (convex face uppermost).
13 Insert the injectors and tighten them to the specified torque **(see illustration)**.
14 Refit the injector pipes and tighten the union nuts. Make sure the pipe clamps are in their previously-noted positions. If the clamps are wrongly positioned or missing, problems may be experienced with pipes breaking or splitting.
15 Reconnect the leak-off pipes.
16 Refit the air ducting.
17 Start the engine, and check for any leakage at the fuel unions. To enable the engine to start it may be necessary to loosen the injector union nuts while turning the engine on the starter motor in order to purge trapped air.

10 Fuel gauge sender unit - removal and refitting

Refer to Chapter 4A, however note that the unit does not incorporate a pump **(see illustrations)**.



10.1a Remove the cover . . .



10.1b . . . for access to the fuel gauge sender unit

11 Fuel tank - removal and refitting

Refer to Chapter 4A, however note that in addition a safety valve with an anti-roll device is fitted in the top of the tank with a ventilation pipe to the front of the tank. The fuel gauge sender unit does not incorporate a pump as this unit is located in the injection pump.

12 Inlet manifold - removal and refitting

Note: *The inlet and exhaust manifolds are both located on the rear of the engine and share the same securing bolts and gasket. Although the following procedure describes removal of the inlet manifold separately it may be necessary to remove the exhaust manifold as well in order to renew the gasket.*

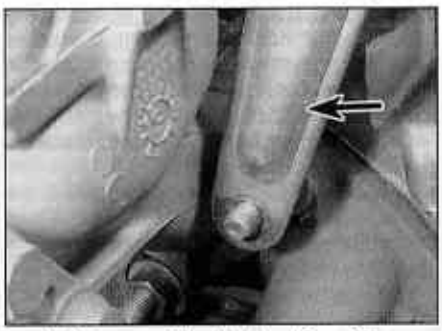
Removal

1 Remove the air cleaner and ducting as described in Section 2.
2 Unbolt and remove the relay guard and bracket from the left-hand side of the engine.
3 On turbo models disconnect the air duct from the inlet manifold elbow. If necessary the elbow can be unbolted from the manifold and the sealing ring removed.
4 Unscrew the nuts securing the inlet manifold to the cylinder head noting the position of the support bracket. Note that some of the nuts also secure the exhaust manifold. Withdraw the inlet manifold from the studs **(see illustrations)**.
5 Examine the gasket. If it is damaged it will be necessary to remove the exhaust manifold in order to renew it.

Refitting

6 Refitting is a reversal of removal, but tighten all nuts and bolts to the specified torque.

12.4a Unscrew the inlet manifold mounting nuts . . .



12.4b . . . noting the location of the support bracket

12.4c Removing the inlet manifold

14.6 Nuts securing the exhaust downpipe to the exhaust manifold

14.8 Disconnecting the oil return pipe from the turbocharger

13 Turbocharger - description and precautions

Description

A turbocharger is fitted to TDS, TD and SX models. It increases engine efficiency by raising the pressure in the inlet manifold above atmospheric pressure. Instead of the air simply being sucked into the cylinders, it is forced in. Additional fuel is supplied by the injection pump in proportion to the increased air inlet.

Energy for the operation of the turbocharger comes from the exhaust gas. The gas flows through a specially-shaped housing (the turbine housing) and in so doing, spins the turbine wheel. The turbine wheel is attached to a shaft, at the end of which is another vaned wheel known as the compressor wheel. The compressor wheel spins in its own housing, and compresses the inlet air on the way to the inlet manifold.

Boost pressure (the pressure in the inlet manifold) is limited by a wastegate, which diverts the exhaust gas away from the turbine wheel in response to a pressure-sensitive actuator. A pressure-operated switch operates a warning light on the instrument panel in the event of excessive boost pressure developing.

The turbo shaft is pressure-lubricated by an oil feed pipe from the main oil gallery. The shaft floats on a cushion of oil. A drain pipe returns the oil to the sump.

Precautions

The turbocharger operates at extremely high speeds and temperatures. Certain precautions must be observed, to avoid premature failure of the turbo, or injury to the operator.

Do not operate the turbo with any of its parts exposed, or with any of its hoses removed. Foreign objects falling onto the rotating vanes could cause excessive damage, and (if ejected) personal injury.

Do not race the engine immediately after start-up, especially if it is cold. Give the oil a few seconds to circulate.

Always allow the engine to return to idle speed before switching it off - do not blip the throttle and switch off, as this will leave the turbo spinning without lubrication.

Allow the engine to idle for several minutes before switching off after a high-speed run.

Observe the recommended intervals for oil and filter changing, and use a reputable oil of the specified quality. Neglect of oil changing, or use of inferior oil, can cause carbon formation on the turbo shaft, leading to subsequent failure.

14 Turbocharger - removal and refitting

Removal

1 Remove the battery as described in Chapter 5A.

2 Unbolt and remove the relay guard and bracket from the left-hand side of the engine.

3 Remove the air cleaner and ducting as described in Section 2.

4 Loosen the clips and remove the air outlet duct between the turbocharger and inlet manifold. Also disconnect the air inlet duct from the turbocharger.

5 Apply the handbrake, then jack up the front of the vehicle and support on axle stands (see *Jacking and vehicle support*).

6 Bend back the locking tabs (if fitted) and unscrew the nuts securing the exhaust downpipe to the exhaust manifold **(see illustration)**. Disconnect the downpipe from the exhaust system (refer to Part 4D) and remove it from under the vehicle. Recover the gasket.

7 Unscrew the union nut and disconnect the oil supply pipe from the turbocharger. Recover the copper ring and tape over the end of the pipe to prevent dust entry.

8 Disconnect the oil return pipe from the turbocharger **(see illustration)**.

9 Unscrew the bolt securing the mounting bracket to the cylinder block.

10 Unscrew the mounting nuts and withdraw the turbocharger from the studs in the exhaust manifold. Recover the gasket. If it is to be refitted, store the turbocharger carefully, and plug its openings to prevent dirt ingress.

Refitting

11 Refitting is a reversal of removal, bearing in mind the following points:

a) If a new turbocharger is being fitted, change the engine oil and filter.

b) Tighten all nuts and bolts to the specified torque.

c) Before starting the engine, prime the turbo lubrication circuit by disconnecting the stop solenoid lead at the injection pump, and cranking the engine on the starter for three ten-second bursts.

15 Turbocharger - examination and renovation

1 With the turbocharger removed, inspect the housing for cracks or other visible damage.

2 Spin the turbine or the compressor wheel, to verify that the shaft is intact and to feel for excessive shake or roughness. Some play is normal, since in use, the shaft is floating on a film of oil. Check that the wheel vanes are undamaged.

3 The wastegate and actuator are integral, and cannot be checked or renewed separately. Consult a Fiat dealer or other specialist if it is thought that testing or renewal is necessary.

4 If the exhaust or induction passages are oil-contaminated, the turbo shaft oil seals have probably failed.

5 No DIY repair of the turbo is possible. A new unit may be available on an exchange basis.

Chapter 4 Part D:
Exhaust and emission control 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

Torque wrench settings	Nm	lbf ft
Exhaust downpipe to manifold	24	18
Exhaust manifold	24	18
Exhaust system mounting	27	20
Exhaust to catalytic converter:		
M8	24	18
M10x1.25	40	30
Lambda oxygen sensor	53	39

1 General information

Emission control systems

All petrol engine models use unleaded petrol and are controlled by engine management systems that are 'tuned' to give the best compromise between driveability, fuel consumption and exhaust emission production. In addition, a number of systems are fitted that help to minimise other harmful emissions; a crankcase emission-control system (petrol models only) that reduces the release of pollutants from the crankcase, an evaporative loss emission control system (petrol models only) to reduce the release of hydrocarbons from the fuel tank, a catalytic converter (petrol and diesel models) to reduce exhaust gas pollutants, and an Exhaust Gas Recirculation (EGR) system (turbo diesel models only) to reduce exhaust emissions.

Crankcase emission control

To reduce the emission of unburned hydrocarbons from the crankcase into the atmosphere, the engine is sealed and the blow-by gases and oil vapour are drawn from inside the crankcase, through a flame trap, into the inlet tract to be burned by the engine during normal combustion.

Under conditions of high manifold depression (idling, deceleration) the gases will by sucked positively out of the crankcase. Under conditions of low manifold depression (acceleration, full-throttle running) the gases are forced out of the crankcase by the (relatively) higher crankcase pressure; if the engine is worn, the raised crankcase pressure (due to increased blow-by) will cause some of the flow to return under all manifold conditions.

Exhaust emission control - petrol models

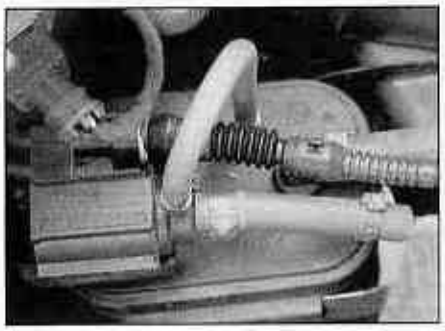
To minimise the amount of pollutants which escape into the atmosphere, a catalytic converter is fitted in the exhaust system. The fuel system is of the closed-loop type, in which a Lambda (or oxygen) sensor in the exhaust system provides the engine management system ECU with constant feedback, enabling the ECU to adjust the air/fuel mixture to optimise combustion.

The Lambda sensor has a heating element built-in that is controlled by the ECU through the Lambda sensor relay to quickly bring the sensor's tip to its optimum operating temperature. The sensor's tip is sensitive to oxygen and relays a voltage signal to the ECU that varies according on the amount of oxygen in the exhaust gas. If the inlet air/fuel mixture is too rich, the exhaust gases are low in oxygen so the sensor sends a low-voltage signal, the voltage rising as the mixture weakens and the amount of oxygen rises in the exhaust gases. Peak conversion efficiency of all major pollutants occurs if the inlet air/fuel mixture is maintained at the chemically-correct ratio for the complete combustion of petrol of 14.7 parts (by weight) of air to 1 part of fuel (the stoichiometric ratio). The sensor output voltage alters in a large step at this point, the ECU using the signal change as a reference point and correcting the inlet air/fuel mixture accordingly by altering the fuel injector pulse width.

Exhaust emission control - diesel models

An oxidation catalyst is fitted in the exhaust system of all diesel engine models. This has the effect of removing a large proportion of the gaseous hydrocarbons, carbon monoxide and particulates present in the exhaust gas.

An Exhaust Gas Recirculation (EGR) system is fitted to all turbo diesel engine models. This reduces the level of nitrogen oxides produced during combustion by introducing a proportion of the exhaust gas back into the inlet manifold, under certain engine operating



2.2 Charcoal canister location behind the right-hand headlight

conditions, via a plunger valve. The system is controlled electronically by means of an emissions system control unit.

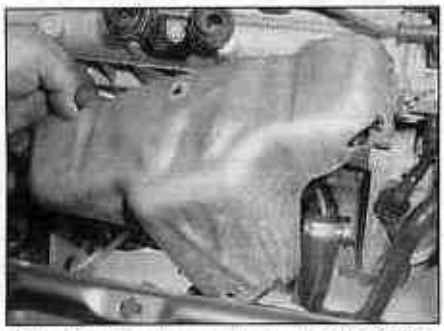
Evaporative emission control - petrol models

To minimise the escape of unburned hydrocarbons into the atmosphere, an evaporative loss emission control system is fitted to petrol models. The fuel tank filler cap is sealed and a charcoal canister is mounted underneath the right-hand headlamp to collect the petrol vapours released from the fuel contained in the fuel tank. It stores them until they can be drawn from the canister (under the control of the fuel injection/ignition system ECU) via the purge valve into the inlet tract, where they are then burned by the engine during normal combustion.

To ensure that the engine runs correctly when it is cold and/or idling and to protect the catalytic converter from the effects of an over-rich mixture, the purge control valve is not opened by the ECU until the engine has warmed up, and the engine is under load; the valve solenoid is then modulated on and off to allow the stored vapour to pass into the inlet tract.

Exhaust systems

The exhaust system comprises the exhaust manifold, an exhaust downpipe, a catalytic converter, an intermediate pipe with silencer, and a tailpipe with silencer. On turbo diesel models the turbocharger is fitted between the exhaust manifold and the downpipe.



5.5a On 16-valve engines, undo the bolts and remove the manifold heat shield . . .

5.5b . . . then remove the bracket

2 Evaporative loss emission control system - information and component renewal

Information

1 The evaporative loss emission control system consists of the control solenoid (or purge valve), the activated charcoal filter canister and a series of connecting vacuum hoses.

2 The control solenoid and charcoal canister are both mounted on the right-hand side of the engine compartment behind the headlight **(see illustration)**.

Component renewal

Control solenoid

3 With the bonnet open, disconnect the hoses from the control solenoid on the top of the charcoal canister.

4 Disconnect the wiring and remove the solenoid.

5 Refitting is a reversal of removal.

Charcoal canister

6 Remove the control solenoid as described previously.

7 Disconnect the fuel tank hose from the canister.

8 Detach the mounting and remove the canister.

9 Refitting is a reversal of removal.

Multifunction valve

10 The multifunction valve is mounted on top of the fuel tank. Removal and refitting is similar to that described for the tank sender gauge/pump (refer to Chapter 4A or 4B).

3 Crankcase emission system - general information

The crankcase emission control system consists of a hose from the camshaft cover to the air cleaner with a branch to the throttle body. The main hose incorporates a flame trap and the inlet to the throttle body incorporates a calibrated hole.

The system requires no attention other than to check at regular intervals that the hoses are free of blockages and undamaged.

4 Lambda oxygen sensor - removal and refitting

Note: *The Lambda oxygen sensor is delicate and will not work if it is dropped or knocked, if its power supply is disrupted, or if any cleaning materials are used on it.*

Removal

1 The sensor is threaded into the exhaust front downpipe. Access if best gained from underneath the vehicle. Apply the handbrake then jack up the front of the vehicle and support on axle stands (see *Jacking and vehicle support*).

2 Disconnect the sensor wiring connector located on the front of the engine.

3 Working beneath the vehicle, unscrew the sensor, taking care to avoid damaging the sensor probe as it is removed. **Note:** *As a flying lead remains connected to the sensor after it has been disconnected, if the correct spanner is not available, a slotted socket will be required to remove the sensor.*

Refitting

4 Apply a little anti-seize grease to the sensor threads - avoid contaminating the probe tip.

5 Refit the sensor to the downpipe, tightening it to the correct torque. Reconnect the wiring.

6 Lower the vehicle to the ground.

5 Exhaust manifold - removal and refitting

Petrol models

Removal

1 On 1242 cc (16-valve) engines, remove the air cleaner and inlet system components as described in Chapter 4B.

2 Firmly apply the handbrake, then jack up the front of the car and support it securely on axle stands (see *Jacking and vehicle support*).

3 Disconnect the oxygen sensor wiring or alternatively remove the sensor completely.

4 Unscrew the nuts and disconnect the exhaust downpipe from the exhaust manifold flange. Recover the gasket.

5 On 1242 cc (16-valve) engines, undo the bolts and remove the manifold heat shield, then remove the bracket at the timing belt end of the manifold **(see illustrations)**.

6 Unscrew the mounting nuts, remove the washers, and recover any additional brackets fitted over the studs, noting their locations. Withdraw the manifold from the studs on the cylinder head.

7 Recover the gaskets from the studs.

Refitting

8 Refitting is a reversal of the removal procedure but fit new gaskets. Tighten the nuts to the specified torque.

Diesel models

Note: *On diesel models the inlet and exhaust manifolds are located on the rear of the engine and share the same securing nuts and gasket.*

Removal

9 Remove the inlet manifold as described in Part C of this Chapter.

10 Firmly apply the handbrake, then jack up the front of the car and support it securely on axle stands (see *Jacking and vehicle support*).

11 Straighten the tab washers (where fitted), then unscrew and remove the exhaust downpipe retaining nuts. Detach the downpipe from the manifold/turbocharger. Suitably support the downpipe.

12 Undo the manifold-to-cylinder head securing nuts and withdraw the manifold **(see illustration).**

13 Separate the turbocharger from the manifold with reference to Chapter 4C.

14 Remove the gasket and clean the mating faces of the manifold, cylinder head and downpipe flange **(see illustration).** The gasket must be renewed when refitting the manifold.

Refitting

15 Refitting is a reversal of the removal procedure but fit a new gasket. Tighten the retaining nuts to the specified torque and where necessary lock them by bending over the locktabs.

6 Exhaust system - general information and component renewal

General information

1 A three section exhaust system is fitted consisting of a twin-branch front downpipe, a catalytic converter, and a tailpipe with two silencers. The downpipe-to-manifold and downpipe-to-catalytic converter joints are both of flange and gasket type, whereas the remaining joint is of the sleeve type secured with a clamp ring **(see illustration).**

2 The system is suspended throughout its entire length by rubber mountings.

Removal

3 Each exhaust section can be removed individually or, alternatively, the complete system can be removed as a unit. Where separation of the rear sleeve joint is necessary, it may be more practical to remove the entire system rather than try and separate the joint in position.

4 To remove the system or part of the system, first jack up the front of the vehicle and support on axle stands (*see Jacking and vehicle support*). Alternatively position the vehicle over an inspection pit or on car ramps.

5.12 Removing the exhaust manifold (diesel engine)

Downpipe

5 Support the catalytic converter using an axle stand or blocks of wood. Where applicable on petrol models, refer to Section 4 and remove the oxygen sensor from the exhaust downpipe.

6 Unscrew and remove the bolts securing the downpipe to the catalytic converter, then separate the joint and recover the gasket.

7 Bend back the locktabs (where fitted) then unscrew the nuts securing the downpipe to the exhaust manifold/turbocharger, and lower the downpipe. Recover the gasket.

Catalytic converter

8 Support the tailpipe section of the exhaust using an axle stand or blocks of wood.

9 Unscrew and remove the bolts securing the downpipe to the catalytic converter, then separate the joint and recover the gasket.

10 Unscrew the clamp bolt and separate the converter from the tailpipe section.

11 Release the mounting rubber and remove the converter from under the vehicle.

Tailpipe and silencers

12 Support the catalytic converter using an axle stand or blocks of wood.

13 Unscrew the clamp bolt and separate the catalytic converter from the tailpipe section.

14 Release the tailpipe section from its mounting rubbers and remove from under the vehicle.

Complete system

15 Disconnect the downpipe from the exhaust manifold as described in paragraph 7.

6.1 Exhaust clamp ring securing the tailpipe to the front exhaust system

5.14 Removing the exhaust manifold gasket (diesel engine)

16 With the aid of an assistant, free the system from all its mounting rubbers and manoeuvre it out from underneath the vehicle.

Heatshield

17 The heatshield is secured to the underbody by bolts and is easily removed once the exhaust system has been removed.

Refitting

18 Each section is refitted by a reverse of the removal sequence, noting the following points.

a) Ensure that all traces of corrosion have been removed from the flanges and renew all necessary gaskets.

b) Inspect the rubber mountings for signs of damage or deterioration and renew as necessary.

c) Before refitting the tailpipe joint, smear some exhaust system jointing paste to the joint mating surfaces to ensure an air-tight seal. Tighten the clamp bolt.

d) Prior to fully tightening the rear joint clamp, ensure that all rubber mountings are correctly located and that there is adequate clearance between the exhaust system and vehicle underbody.

7 Catalytic converter - general information and precautions

The catalytic converter is a reliable and simple device which needs no maintenance in itself, but there are some facts of which an owner should be aware if the converter is to function properly for its full service life.

Petrol models

a) DO NOT use leaded petrol in a car equipped with a catalytic converter - the lead will coat the precious metals, reducing their converting efficiency and will eventually destroy the converter.

b) Always keep the ignition and fuel systems well-maintained in accordance with the manufacturer's schedule.

c) If the engine develops a misfire, do not drive the car at all (or at least as little as possible) until the fault is cured.

d) DO NOT push- or tow-start the car - this will soak the catalytic converter in unburned fuel, causing it to overheat when the engine does start.

e) DO NOT switch off the ignition at high engine speeds.

f) DO NOT use fuel or engine oil additives - these may contain substances harmful to the catalytic converter.

g) DO NOT continue to use the car if the engine burns oil to the extent of leaving a visible trail of blue smoke.

h) Remember that the catalytic converter operates at very high temperatures. DO NOT, therefore, park the car in dry undergrowth, over long grass or piles of dead leaves after a long run.

i) Remember that the catalytic converter is FRAGILE - do not strike it with tools during servicing work.

j) In some cases a sulphurous smell (like that of rotten eggs) may be noticed from the exhaust. This is common to many catalytic converter-equipped cars and once the car has covered a few thousand miles the problem should disappear.

k) The catalytic converter, used on a well-maintained and well-driven car, should last for between 50 000 and 100 000 miles - if the converter is no longer effective it must be renewed.

Diesel models

Refer to the information given in parts f, g, h and i of the petrol models information given above.

Chapter 5 Part A:
Starting and charging 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

System type	12 volt, negative earth

Starter motor

Type:	
Petrol engines	Magneti-Marelli pre-engaged
Diesel engines	Bosch pre-engaged with reduction gear
Output:	
Petrol engines	0.8 kW (1108 cc) or 0.9 kW (1242 cc)
Diesel engines	1.7 kW

Battery

Capacity:	
Petrol engines	32 to 50 amp/hr
Diesel engines	60 amp/hr
Charge condition:	
Poor	12.5 volts
Normal	12.6 volts
Good	12.7 volts

Alternator

Type	Magneti-Marelli
Output	65 to 85 amp

Torque wrench settings

	Nm	lbf ft
Alternator	60	44
Battery tray	29	21
Oil pressure switch:		
Petrol engine	32	24
Diesel engine	37	27

1 General information and precautions

General information

The engine electrical system consists mainly of the charging and starting systems. Because of their engine-related functions, these components are covered separately from the body electrical devices such as the lights, instruments, etc (which are covered in Chapter 12). On petrol engine models refer to Part B for information on the ignition system, and on diesel models refer to Part C for information on the preheating system.

The electrical system is of 12-volt negative earth type.

The battery fitted as original equipment is of maintenance-free (sealed for life) type and is charged by the alternator, which is belt-driven from the crankshaft pulley. If a non-original battery is fitted it may be of standard or low maintenance type.

The starter motor is of the pre-engaged type incorporating an integral solenoid. On starting, the solenoid moves the drive pinion into engagement with the flywheel ring gear before the starter motor is energised. Once the engine has started, a one-way clutch prevents the motor armature being driven by the engine until the pinion disengages from the flywheel.

Precautions

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 but in this case both of the battery terminals should first be disconnected.

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.

Several systems fitted to the vehicle require battery power to be available at all times, either to ensure their continued operation (such as the clock) or to maintain control unit memories or security codes which would be wiped if the battery were to be disconnected. To ensure that there are no unforeseen consequences of this action, Refer to *Disconnecting the battery* in the Reference Section of this manual for further information.

2 Battery - testing and charging

Standard and low maintenance battery - testing

1 If the vehicle covers a small annual mileage, it is worthwhile checking the specific gravity of the electrolyte every three months to determine the state of charge of the battery. Use a hydrometer to make the check and compare the results with the following table. Note that the specific gravity readings assume an electrolyte temperature of 15°C (60°F); for every 10°C (18°F) below 15°C (60°F) subtract 0.007. For every 10°C (18°F) above 15°C (60°F) add 0.007.

	Ambient temperature	
	Above 25°C	Below 25°C
Charged	*1.210 to 1.230*	*1.270 to 1.290*
70% charged	*1.170 to 1.190*	*1.230 to 1.250*
Discharged	*1.050 to 1.070*	*1.110 to 1.130*

2 If the battery condition is suspect, first check the specific gravity of electrolyte in each cell. A variation of 0.040 or more between any cells indicates loss of electrolyte or deterioration of the internal plates.

3 If the specific gravity variation is 0.040 or more, the battery should be renewed. If the cell variation is satisfactory but the battery is discharged, it should be charged as described later in this Section.

Maintenance-free battery - testing

4 In cases where a sealed for life maintenance-free battery is fitted, topping-up and testing of the electrolyte in each cell is not possible. The condition of the battery can therefore only be tested using a battery condition indicator or a voltmeter.

5 Certain models may be fitted with a maintenance-free battery with a built-in charge condition indicator. The indicator is located in the top of the battery casing, and indicates the condition of the battery from its colour. If the indicator shows green, then the battery is in a good state of charge. If the indicator turns darker, eventually to black, then the battery requires charging, as described later in this Section. If the indicator shows clear/yellow, then the electrolyte level in the battery is too low to allow further use, and the battery should be renewed. **Do not** attempt to charge, load or jump start a battery when the indicator shows clear/yellow.

6 If testing the battery using a voltmeter, connect the voltmeter across the battery and compare the result with those given in the *Specifications* under 'charge condition'. The test is only accurate if the battery has not been subjected to any kind of charge for the previous six hours. If this is not the case, switch on the headlights for 30 seconds, then wait four to five minutes before testing the battery after switching off the headlights. All other electrical circuits must be switched off, so check that the doors and tailgate are fully shut when making the test.

7 If the voltage reading is less than 12.2 volts, then the battery is discharged, whilst a reading of 12.2 to 12.4 volts indicates a partially discharged condition.

8 If the battery is to be charged, remove it from the vehicle (Section 3) and charge it as described later in this Section.

Standard and low maintenance battery - charging

Note: *The following is intended as a guide only. Always refer to the manufacturer's recommendations (often printed on a label attached to the battery) before charging a battery.*

9 Charge the battery at a rate of 3.5 to 4 amps and continue to charge the battery at this rate until no further rise in specific gravity is noted over a four hour period.

10 Alternatively, a trickle charger charging at the rate of 1.5 amps can safely be used overnight.

11 Specially rapid boost charges which are claimed to restore the power of the battery in 1 to 2 hours are not recommended, as they can cause serious damage to the battery plates through overheating.

12 While charging the battery, note that the temperature of the electrolyte should never exceed 37.8°C (100°F).

Maintenance-free battery - charging

Note: *The following is intended as a guide only. Always refer to the manufacturer's recommendations (often printed on a label attached to the battery) before charging a battery.*

13 This battery type takes considerably longer to fully recharge than the standard type, the time taken being dependent on the extent of discharge, but it can take anything up to three days.

14 A constant voltage type charger is required, to be set, when connected, to 13.9 to 14.9 volts with a charger current below 25 amps. Using this method, the battery should be usable within three hours, giving a voltage reading of 12.5 volts, but this is for a partially discharged battery and, as mentioned, full charging can take considerably longer.

15 If the battery is to be charged from a fully discharged state (condition reading less than 12.2 volts), have it recharged by your FIAT dealer or local automotive electrician, as the charge rate is higher and constant supervision during charging is necessary.

3 Battery - removal and refitting

Note: *Refer to Disconnecting the battery in the Reference Section of this manual before proceeding.*

Removal

1 Slacken the clamp bolts and disconnect the clamp from the battery negative (earth) terminal.

2 Remove the insulation cover (where fitted) and disconnect the positive terminal lead(s) in the same way.

3 At the base of the battery, unscrew the bolt from the battery holding clamp plate and remove the clamp plate **(see illustration)**.

4 Remove the battery from the engine compartment.

5 If necessary the mounting tray may be removed by unscrewing the bolts. On diesel models it will be necessary to remove the relay guard bolts as well.

Refitting

6 Refitting is a reversal of removal but make sure that the positive terminal is connected first followed by the negative terminal.

4 Alternator/charging system - testing in vehicle

Note: *Refer to the warnings given in Safety first! and in Section 1 of this Chapter before starting work.*

1 If the ignition warning light fails to illuminate when the ignition is switched on, first check the alternator wiring connections for security. If satisfactory, check that the warning light bulb has not blown, and that the bulbholder is secure in its location in the instrument panel. If the light still fails to illuminate, check the continuity of the warning light feed wire from the alternator to the bulbholder. If all is satisfactory, the alternator is at fault and should be renewed or taken to an auto-electrician for testing and repair.

2 If the ignition warning light illuminates when the engine is running, stop the engine and check that the drivebelt is correctly tensioned (see Chapter 1A or 1B) and that the alternator connections are secure. If all is so far satisfactory, have the alternator checked by an auto-electrician.

3 If the alternator output is suspect even though the warning light functions correctly, the regulated voltage may be checked as follows.

4 Connect a voltmeter across the battery terminals and start the engine.

5 Increase the engine speed until the voltmeter reading remains steady; the reading should be approximately 12 to 13 volts, and no more than 14 volts.

6 Switch on as many electrical accessories (eg. the headlights, heated rear window and heater blower) as possible, and check that the alternator maintains the regulated voltage at around 13 to 14 volts.

7 If the regulated voltage is not as stated, the fault may be due to worn brushes, weak brush springs, a faulty voltage regulator, a faulty diode, a severed phase winding or worn or damaged slip rings. The alternator should be renewed or taken to an auto-electrician for testing and repair.

3.3 Removing the battery clamp plate

5 Alternator - removal and refitting

Removal

1 Disconnect the battery negative terminal (refer to *Disconnecting the battery* in the Reference Section of this manual).

2 Firmly apply the handbrake, then jack up the front of the car and support it securely on axle stands (see *Jacking and vehicle support*). Remove the right-hand front roadwheel.

3 Remove the inner cover from under the right-hand wheelarch for access to the right-hand side of the engine.

4 Disconnect the cables from the rear of the alternator **(see illustration)**.

Petrol models

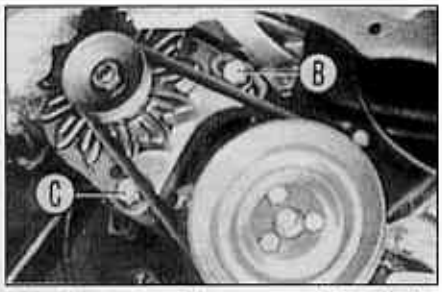
5 Loosen the pivot and adjustment bolts then swivel the alternator towards the engine and slip off the drivebelt. Note that the position of the rpm sensor will prevent complete removal of the drivebelt from the crankshaft pulley.

6 Unscrew and remove the pivot and adjustment bolts then unscrew the upper slot-mounted bolt. Withdraw the alternator from the engine **(see illustrations)**.

Diesel models

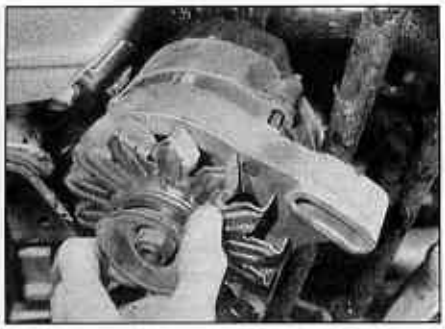
7 For additional working room, unclip and remove the upper timing belt cover then unbolt and remove the lower timing belt cover.

5.4 Cable connections on the rear of the alternator

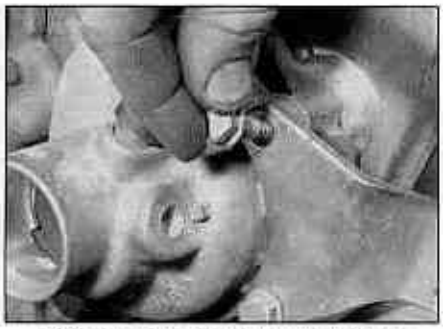


5.6a Alternator adjustment and pivot bolts (petrol engine)

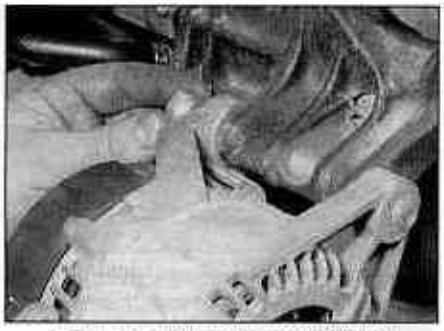
B Adjuster bolt *C Pivot bolt*



5.6b Removing the alternator (petrol engine)



5.9a Unbolting the alternator upper bracket from the rear of the coolant pump



5.9b Removing the pivot bolt and alternator from the engine

8 Loosen the pivot bolt and adjustment locknut then unscrew the adjustment bolt and swivel the alternator towards the engine so that the drivebelt may be slipped off the alternator pulley.

9 Unscrew and remove the pivot and adjustment bolts and withdraw the alternator from the engine compartment. If preferred the upper alternator bracket may be unbolted from the rear of the coolant pump **(see illustrations)**.

Refitting

10 Refitting is a reversal of removal. Refer to Chapter 1A or 1B as applicable for details of tensioning the auxiliary drivebelt. On completion tighten the pivot and adjustment bolts/nut to the specified torque.

6 Alternator - brush holder/regulator module renewal

1 Remove the alternator as described in Section 5.

2 Extract the two small bolts and withdraw the brush box. Note the small plastic grille on the Marelli alternator **(see illustrations)**.

3 Using a steel rule check the length of the brushes. If less than 5.0 mm the complete brush holder assembly should be renewed.

Note: *On Bosch alternators it may be possible to obtain the brushes separately, in which case the brush leads should be unsoldered from the terminals and the new brush leads soldered onto the terminals.*

4 Check the slip rings for excessive wear and clean them with a rag soaked in fuel.

5 Fit the new holder using a reversal of the removal procedure but make sure that each brush moves freely.

7 Starting system - testing

Note: *Refer to the precautions given in Safety first! and in Section 1 of this Chapter before starting work.*

1 If the starter motor fails to operate when the ignition key is turned to the appropriate position, the following possible causes may be to blame.

a) The battery is faulty.

b) The electrical connections between the switch, solenoid, battery and starter motor are somewhere failing to pass the necessary current from the battery through the starter to earth.

c) The solenoid is faulty.

d) The starter motor is mechanically or electrically defective.

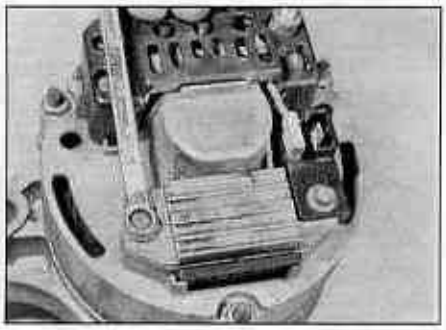
2 To check the battery, switch on the headlights. If they dim after a few seconds, this indicates that the battery is discharged - recharge (see Section 2) or renew the battery. If the headlights glow brightly, operate the ignition switch and observe the lights. If they dim, then this indicates that current is reaching the starter motor, therefore the fault must lie in the starter motor. If the lights continue to glow brightly (and no clicking sound can be heard from the starter motor solenoid), this indicates that there is a fault in the circuit or solenoid - see following paragraphs. If the starter motor turns slowly when operated, but the battery is in good condition, then this indicates that either the starter motor is faulty, or there is considerable resistance somewhere in the circuit.

3 If a fault in the circuit is suspected, disconnect the battery leads (including the earth connection to the body), the starter/solenoid wiring and the engine/transmission earth strap. Thoroughly clean the connections, and reconnect the leads and wiring, then use a voltmeter or test lamp to check that full battery voltage is available at the battery positive lead connection to the solenoid, and that the earth is sound. Smear petroleum jelly around the battery terminals to prevent corrosion - corroded connections are amongst the most frequent causes of electrical system faults.

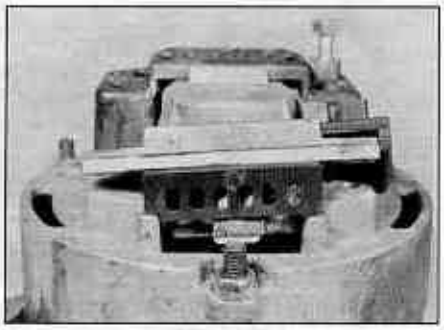
4 If the battery and all connections are in good condition, check the circuit by disconnecting the wire from the solenoid blade terminal. Connect a voltmeter or test lamp between the wire end and a good earth (such as the battery negative terminal), and check that the wire is live when the ignition switch is turned to the start position. If it is, then the circuit is sound - if not, the circuit wiring can be checked as described in Chapter 12, Section 2.

5 The solenoid contacts can be checked by connecting a voltmeter or test lamp across the solenoid. When the ignition switch is turned to the start position, there should be a reading or lighted bulb, as applicable. If there is no reading or lighted bulb, the solenoid is faulty and should be renewed.

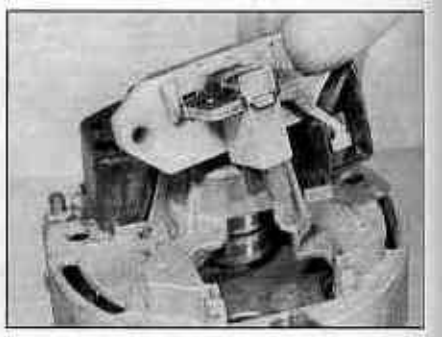
6 If the circuit and solenoid are proved sound, the fault must lie in the starter motor. In this event, it may be possible to have the starter motor overhauled by a specialist, but check on the cost of spares before proceeding, as it may prove more economical to obtain a new or exchange motor.



6.2a Remove the retaining bolts . . .



6.2b . . . noting the small plastic grille on the Marelli alternator . . .



6.2c . . . and withdraw the brush box