page

FUEL SYSTEM

INTRODUCTION

The Marea and Marea Weekend 1.9 JTD and 2.4 JTD vehicles are equipped with a 4 cylinder in line 1910 cc turbodiesel engine for the former and a 5 cylinder lin line 2387 cc turbodiesel engine for the latter, both with two valves per cylinder, a counter-balance shaft, an overhead camshaft, supercharged by a turbocharger and intercooler and with electronic fuel injection.

The fuel system ensures the correct operation of the engine and can be summarized in the following circuits:

- fuel supply circuit with Common Rail type injection;
- air supply circuit;
- exhaust circuit;
- oil vapour recirculation circuit from the crankcase;
- exhaust gas recirculation circuit (EGR).

The optimum operation of the various "circuits" which make up the fuel system is achieved through an electronic control system managed by a specific control unit.
The main feature of the fuel system is the Common Rail type fuel injection. The Common Rail system involves electronic injection at high pressure for direct injection fast diesel engines.

The main features of the Common Rail system are:

- availability of high injection pressures (up to 1350 bar);
- possibility of modulating these pressures (from a minimum of 150 bar up to a maximum of 1350 bar) independently of the engine rotation speed and load.;
- capacity for operate at high engine speeds (up to 6000 rpm);
- precision injection control (advance and duration of injection);
- reduction in consumption;
- reduction in emissions.

FUEL SYSTEM MANAGEMENT STRATEGIES

The control unit memory contains the management programme (software) which consists of a series of strategies, each of which manages a precise system control function.

By using the information supplied by the various sensors (input), each strategy processes a series of parameters, based on data maps stored in special areas of the control unit memory and then controls the system actuators (output) which are the devices which allow the engine to run.

The main aim of the management strategies is to determine the exact quantity of fuel which should be injected into the cylinders with the timing (injection advance) and pressure so that the engine behaviour is optimum in terms of power, consumption, fumes, emissions and driveability.

The main system management strategies are basically the following:

- controlling the quantity of fuel injected;
- controlling the injection advance;
- controlling the injection pressure;
- controlling the auxiliary electric fuel pump;
- controlling the injection during deceleration (cut-off);
- controlling the idle speed;
- controlling the restriction of the maximum speed;
- controlling the restriction of the maximum torque;
- controlling the fuel temperature;
- controlling the temperature of the engine coolant;
- controlling the heater plugs;
- controlling the exhaust fumes;
- controlling the exhaust gas recirculation (EGR);
- controlling the engagement of the climate control system;
- controlling the engine immobilizer function (Fiat CODE);
- autodiagnosis.

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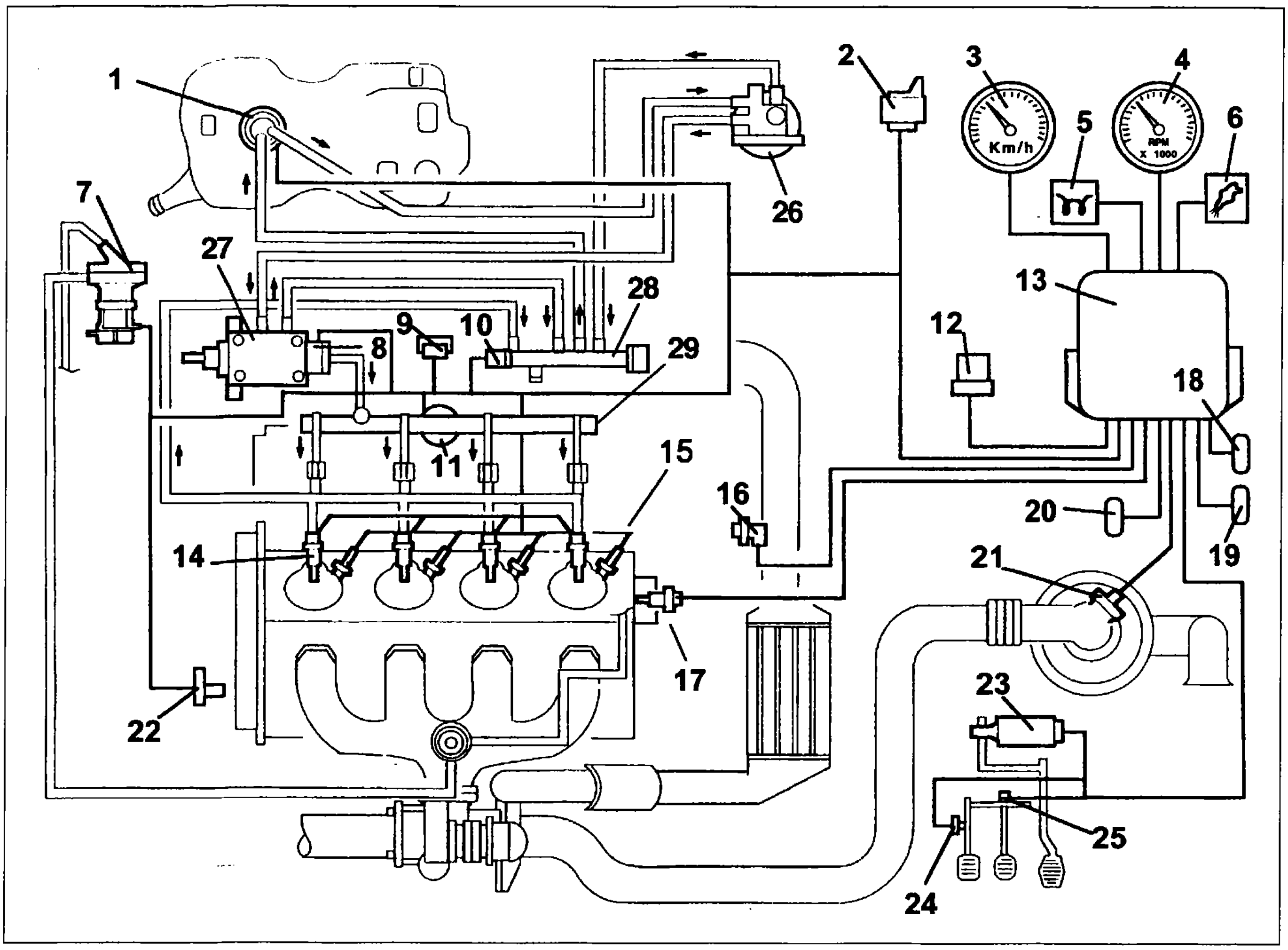
FUEL SYSTEM FUNCTIONAL DIAGRAM



NOTE *The 1910 JTD (4 cylinder) engine is illustrated; the diagram for the 2387 JTD version only differs through the presence of the 5th cylinder.*

1. Auxiliary electric fuel pump
2. Heater plugs control unit
3. Vehicle speed
4. Rev counter
5. Heater plugs warning light
6. Infocenter (system failure warning)
7. EGR valve
8. Pressure regulator
9. Excess pressure sensor
10. Fuel temperature sensor
11. Fuel pressure sensor
12. Injection system relay
13. Electronic control unit
14. Injectors
15. Heater plugs
16. Rpm sensor
17. Engine coolant temperature sensor
18. Climate control system connector
19. Diagnostic socket
20. Fiat CODE system connector
21. Flow meter
22. Timing sensor
23. Potentiometer on accelerator pedal
24. Switch on clutch pedal
25. Switch on brake pedal
26. Fuel filter
27. Pressure pump
28. Return manifold (low pressure)
29. Supply manifold (high pressure)

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Checking quantity of fuel injected

According to the signals coming from the accelerator pedal potentiometer, the flow meter and the rpm sensor, the control unit controls the fuel pressure regulator and the injectors.
The injection timing and phasing is determined by the starting of the engine using the signals coming from the rpm sensor and the timing sensor (synchronization phase); later, the injection timing is implemented using only the rpm signal and with the injection sequence 1-3-4-2 for the 1910 JTD version and 1-2-4-5-3 for the 2387 JTD version.

The control unit inhibits the injection in the following cases:

fuel pressure value above 1500 bar;
fuel pressure value below 120 bar;
engine speed above 6000 rpm.

At operating temperature the maximum duration of the injection (opening time of the injector) is 1500 ns, whilst during starting it can reach 3000 ns.

Injection advance check

The electronic control unit determines the injection advance mainly on the basis of the quantity of fuel to be injected.
Later on, the injection advance is corrected according to the temperature of the engine coolant and engine speed in order to compensate, during the warm up stage, for the increase in the ignition delay due to the "low" temperatures in the combustion chambers.

Injection pressure check

This check is particularly important because the injection pressure affects the following parameters:

the quantity of fuel introduced into the cylinders in relation to the duration of the injection;
the atomization of the fuel injected;
the penetration of the jet;
the delay betweenthe electrical operation of the injector and the effective start and end of the injection.

The above mentioned parameters have a considerable influence on the behaviour of the engine, especially as far as the power supplied, exhaust emissions, noise and driveability are concerned.
According to the engine load, the injection control unit operates the pressure regulator to always achieve an optimum line pressure.
With the engine cold, the injection pressure is corrected according to the engine speed and the temperature of the engine coolant in order to satisfy the engine requirements at different operating temperatures.

Check on auxiliary electric fuel pump

The auxiliary electric fuel pump, immersed in the tank, is supplied by the injection control unit by means of a relay when the ignition key is in the ON position.
The supply to the electric pump is inhibited when one of the following conditions is verified:
-after the ignition has been switched ON for a certain time and the engine is not started up;
-if the inertia switch has been operated.

Check on injection during deceleration (cut-off)

The fuel cut-off strategy is implemented when the injection control unit receives the information from the potentiometer that the accelerator pedal is released.
Under these circumstances the control unit cuts off the supply to the injectors and reactivates before the idle speed is reached.

10.

Control of idle speed

According to the signals coming from the rpm sensor and the engine coolant temperature sensor, the injection control unit operates the pressure regulator and alters the operating times for the injectors to keep the idle speed constantly stable.
In certain conditions, the control unit also takes into account the battery voltage when controlling the idle speed.

Maximum speed restriction control

According to the number of revs, the injection control unit limits the maximum speed through two types of intervention:

- as the maximum speed is approached, it decreases the quantity of fuel injected, reducing the line pressure;
- when 6000 rpm is exceeded it inhibits the operation fo the injectors.

Maximum torque restriction control

According to the engine speed, the injection control unit calculuates the torque limit and maximum permissible fumes parameters using pre-defined maps in its memory.
It therefore corrects the above parameters with data on the engine coolant temperature and vehicle speed and uses the figures obtained in this way to meter the quantity of fuel to be injected acting on the pressure regulator and the injectors.

Fuel temperature control

The injection control unit is constantly informed of the temperature of the fuel by the snsor on the return manifold.
If the temperature of the fuel exceeds a certain value (about 110 °C), the control unit reduces the line pressure acting on the pressure regulator and leaving the injection times unaltered.

Engine coolant temperature control

The injection control unit is constantly informed of the temperature of the engine coolant by the sensor on the thermostat.
If the temperature of the engine coolant exceeds certain values, the control unit implements the following strategies:

- it reduces the quantity of fuel injected, acting on the pressure regulator and the injectors (power reduction);
- it operates the engine radiator cooling ran.

Heater plugs control

The injection control unit controls the operation of the heater plugs control unit so that the temperature in the combustion chambers facilitates the self-ignition of the fuel and makes starting easier.
In effect, the injection control unit controls the operation of the heater plugs control unit for a given period of time both before (pre-heating) and after (post-heating) the engine is started and also controls the warning light in the instrument panel.
The pre-heating and post-heating times, plus how long the heater plugs warning light remains on, depend on the temperature of the engine coolant.

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Exhaust fumes control

Through this function the control unit limits any exhaut fumes which could occur during fierce acceleration.
To satisfy this requirement, the control unit processes the signals from the accelerator pedal potentiometer, the rpm sensor and the intake air quantity sensor (flow meter) and operates the fuel pressure regulator and the injectors to meter the quantity of fuel to be injected.

Exhaust gas recirculation control

According to the signals from the rpm sensors, the quantity of intake air, the temperature of the engine coolant and the position of the accelerator pedal, the injection control unit calculates the operating times for the EGR solenoid valve so that the exhaust gases are only partly recirculated in certain engine operating conditions.

Air conditioning system engagement control

The injection control unit manages the operation of the air conditioning system compressor electromagnet coupling following a logic aimed at avoiding operating conditions which would adversely affect engine performance.

When the compressor is switched on, the injection control unit increases the quantity of fuel at the idle speed to help the engine adjust to the greater power requirements and interrupts the supply to the compressor in the following conditions:

- high power requirements by the engine (fierce acceleration);
- excessive engine coolant temperature.

Engine immobilizer function control

The system is equipped with an engine immobilizer function. This function is achieved thanks to the presence of a special control unit (Fiat CODE) capable of conversing with the injection control unit and an electronic key with a special transmitter for sending a recognition code.
Each time the key is turned to the OFF position, the Fiat CODE system completely deactivates the injection control unit.

When the key is turned to the ON position, the following operations take place in order:

1. the injection control unit (whose memory contains a secret code) sends the Fiat CODE control unit a request for the latter to send the secret code to deactivate the immobilizing function;
2. the Fiat CODE control unit responds by only sending the secret code after having, in turn, received the recognition code transmitted by the ignition key;
3. the recognition of the secret code allows the deactivation of the immobilizer function on the injection control unit and normal operation can be resumed.

Autodiagnosis

The complete electronic fault diagnosis of the injection system can be achieved by connecting the special equipment (EXAMINER or SDC) to the diagnostic socket.

The system is also equipped with an autodiagnostic function which recognizes, memorizes and signals any possible failure.

If a fault is detected in the sensors or actuators, the signal reconstruction strategies are immediately activated (recovery) so that the operation of the engine at an acceptable level is guaranteed without adversely affecting the operation. \311 it is possible to drive the vehicle to a service centre for appropritate repairs.

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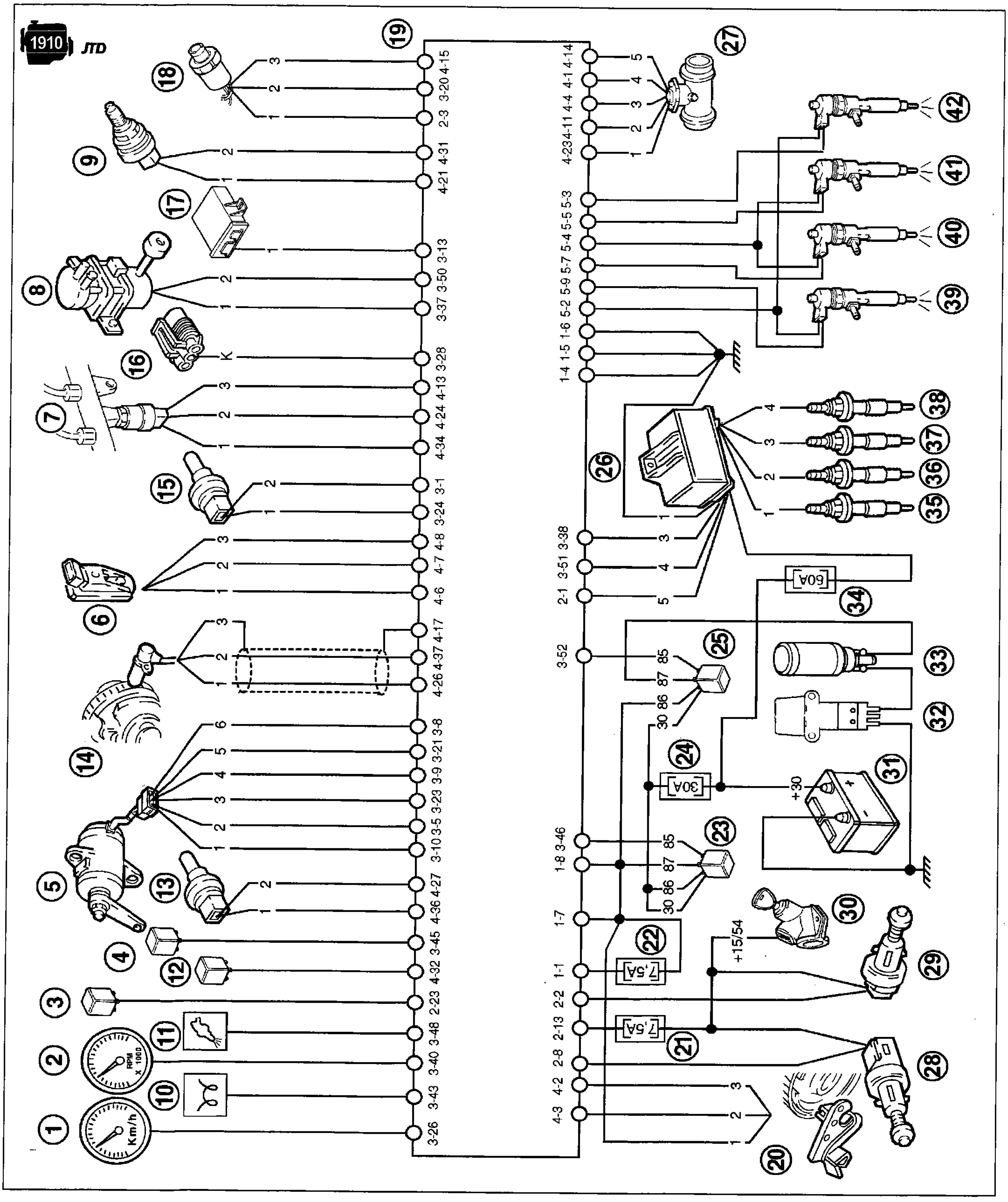
INJECTION SYSTEM WIRING DIAGRAM



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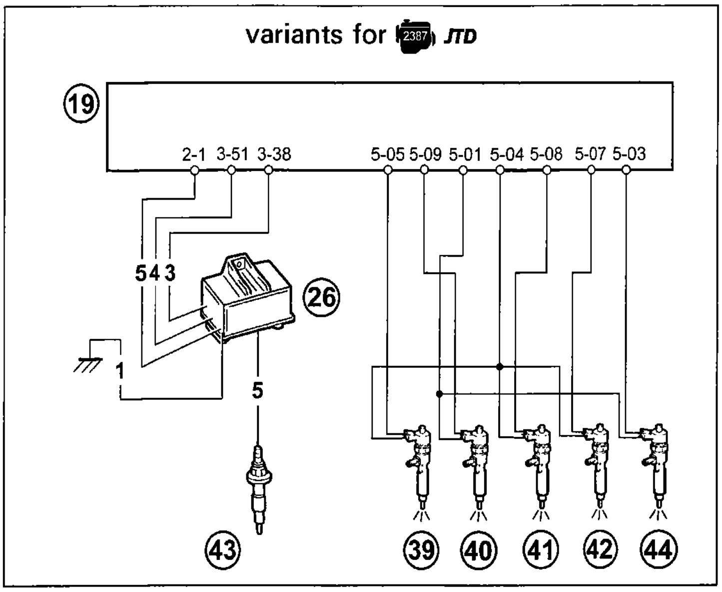
Injection system wiring diagram components



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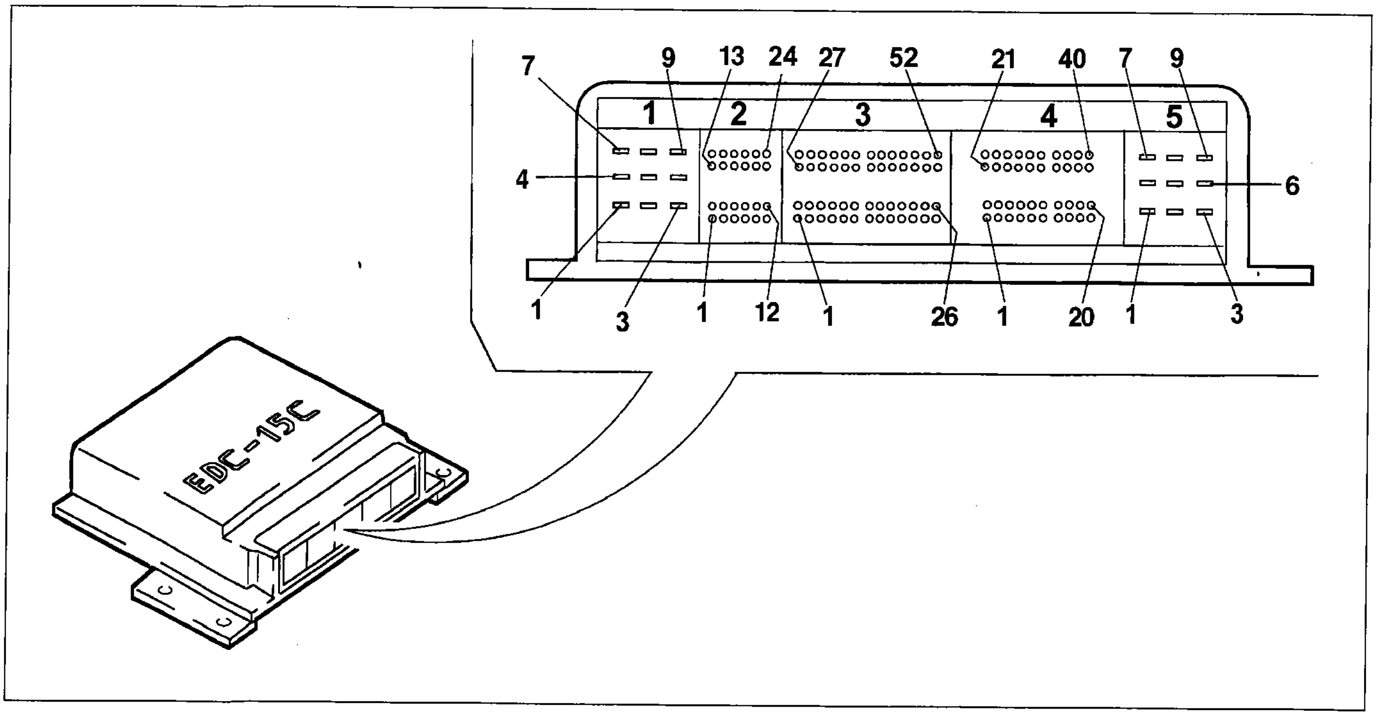
1. Vehicle speed
2. Rev counter
3. Engine radiator fan low speed relay feed
4. Engine radiator fan high speed relay feed
5. Accelerator pedal potentiometer
6. Timing sensor
7. Fuel pressure sensor
8. EGR solenoid valve
9. Fuel pressure regulator
10. Heater plugs warning light in instrument panel
11. Injection system failure warning light
12. Air conditioning system relay feed
13. Engine coolant temperature sensor
14. Rpm sensor
15. Fuel temperature sensor
16. Diagnostic socket
17. Fiat CODE control unit
18. Four stage pressure switch
19. Injection electronic control unit
20. Excess pressure sensor
21. Injection system protective fuse (7.5A) (+15 supply from ignition switch)
22. Injection control unit protective fuse (7.5A) (+30 supply from battery)
23. Injection system main relay
24. Injection system protective fuse (30A)
25. Auxiliary electric fuel pump relay feed
26. Heater plugs control unit
27. Intake air temperature and quantity sensor (flow meter)
28. Switch on brake pedal
29. Switch on clutch pedal
30. Ignition switch
31. Battery
32. Inertia switch
33. Auxiliary electric pump (immersed in tank)
34. Heater plugs control unit protective fuse (60A)
35. Heater plug for cylinder no.1
36. Heater plug for cylinder no.2
37. Heater plug for cylinder no. 3
38. Heater plug for cylinder no. 4
39. Injector for cylinder no. 1
40. Injector for cylinder no. 2
41. Injector for cylinder no. 3
42. Injector for cylinder no. 4
43. Heater plug for cylinder no. 5 (2387 JTD only)
44. Injector for cylinder no. 5 (2387 JTD only)

10.

INJECTION ELECTRONIC CONTROL UNIT

The injection electronic control unit processes the signals coming from the various sensors through the application of software algorhythms and controls the operation of the actuators (in particular the injectors and pressure regulator) to ensure the best possible operation of the engine.
The control unit is the flash E.P.R.O.M. type which can be reprogrammed from the outside without adjusting the hardware.
The injection control unit includes an absolute pressure sensor and is connected to the wiring by means of a 134 pin connector.

Identification of injection control unit connections (pin-out)



4F008NJ01

1-01 Battery positive (+30) from main relay
1-02 Not connected
1-03 Not connected
1-04 Earth
1-05 Earth
1-06 Earth
1-07 Battery positive (+30) from main relay
1-08 Battery positive (+30) from main relay
1-09 Not connected
2-01 Heater plugs timer signal
2-02 Switch on clutch pedal
2-03 Climate control engagement request
2-04 Not connected
2-05 Not connected
2-06 Not connected
2-07 Not connected
2-08 Switch on brake pedal
2-09 Not connected
2-10 Not connected
2-11 Not connected
2-12 Not connected
2-13 Positive (+15) from ignition switch
2-14 Not connected
2-15 Not connected
2-16 Not connected
2-17 Not connected
2-18 Not connected
2-19 Not connected
2-20 Not connected
2-21 Not connected
2-22 Not connected
2-23 Engine radiator fan low speed engagement request
2-24 Not connected
3-01 Fuel temperature sensor earth
3-02 Not connected
3-03 Not connected

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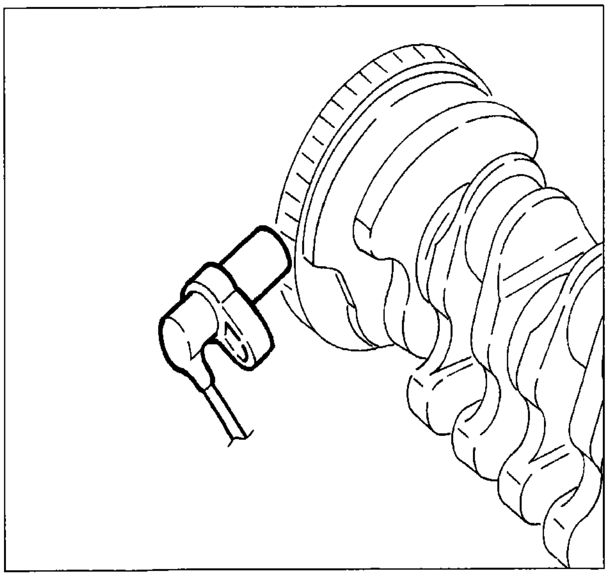
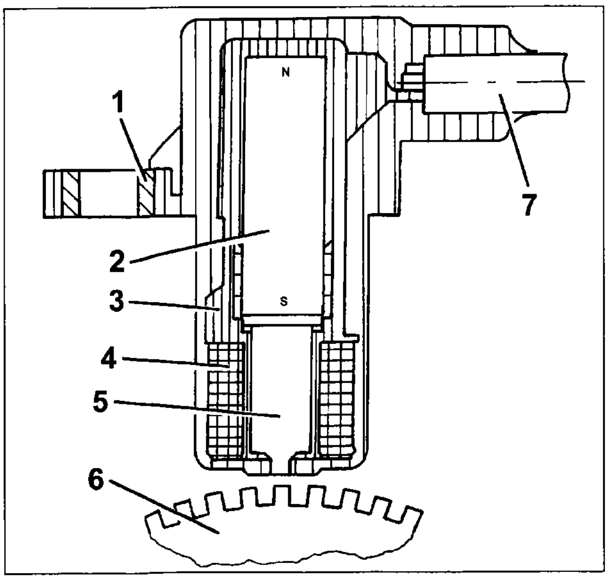
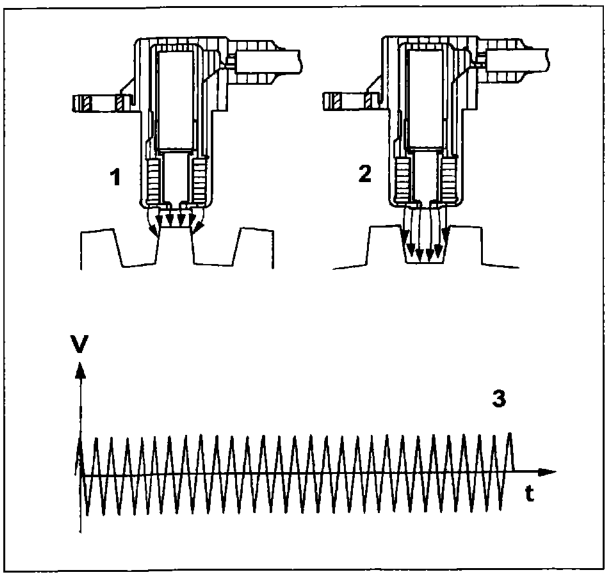


4F011NJ01



4F011NJ02



4F011NJ03

RPM SENSOR

The rpm sensor is fitted on the cylinder block/crankcase and is facing the flywheel on the crankshaft.

The sensor is the inductive type, i.e. it operates through the variation in the magnetic field produced by the passing of the flywheel teeth (60-2 teeth) in front of the sensor element.

The injection control unit uses the rpm sensor signal to determine the angular position of the crankshaft and the speed.

Operation

The passage from full to empty, due to whether or not there is a tooth, determines a variation in the magnetic flow sufficient to produce an alternating voltage from the counting of the teeth on the flywheel.

The peak output voltage value from the rpm sensor depends, all things being equal, on the distance between the sensor and the flywheel teeth.

1. Metal bushing
2. Permanent magnet
3. Sensor casing
4. Winding
5. Core
6. Flywheel
7. Electrical connection

To obtain correct signals, the distance between the flywheel and the sensor (gap) should be between 0.8 and 1.5 mm.
This distance cannot be adjusted therefore if the gap measured is outside of the tolerance, check the condition of the sensor and the flywheel.

Winding resistance: 860 Ohm ±110% at 20 °C

1. Maximum magnetic flow
2. Minimum mangetic flow
3. Alternating voltage

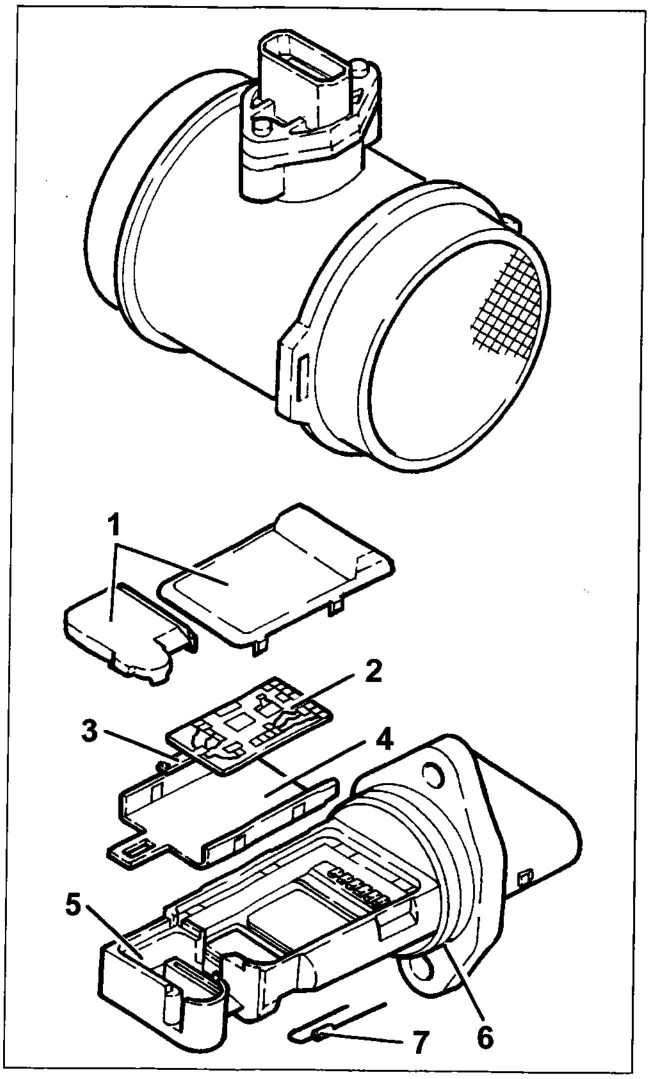
10.

TIMING SENSOR

This sensor is the Hall effect type and is fitted on the cylinder head facing the camshaft pulley (exhaust).
There is an opening in the pulley which allows the timing sensor to detect and signal the engine timing position to the injection control unit.
The injection control unit uses the timing senor signal to recognize TDC at the end of the compression stroke.

Operation

A semi-conductor layer, through which current flows, immersed in a normal magnetic field (lines of force perpendicular to the direction of the current) produces a difference in power known as Hall voltage.
If the intensity of the current remains constant, the voltage produced only depends on the intensity of the magnetic field; the intensity of the magnetic field simply needs to vary periodically to produce a modulated electrical signal whose frequency is proportional to the speed at which the magnetic field changes.
To obtain this change, the sensor passes through a metal ring (inner part of the pulley) with an opening.
As the metal part of the ring moves it covers the sensor blocking the magnetic field with a consequent low output signal; conversely, corresponding to the opening and the presence of the magnetic field, the sensor produces a high signal.
This signal, together with the rpm and TDC signals, allow the injection control unit to recognize the position of the pistons and determine the injection point.



4F012NJ01

AIR FLOW METER

The flow meter is on the air inlet hose and is the heated film type.
The intake air temperature sensor is inside the flow meter.

Operation

The operating principle is based on a heater diaphragm in a measuring duct through which the intake air entering the engine flows.
The hot film diaphragm is kept at a constant temperature (about 120 °C above the temperature of the intake air) by the heating resistance.
The mass of air passing through the measuring duct tends to remove heat from the diaphragm therefore, in order to keep the latter at a constant temperature, a certain current must pass through the resistance.
This current, being proportional to the mass of air flowing to the engine, is measured by a suitable Wheatstone bridge and the signal is sent to the injection control unit.

1. Covers
2. Electronic card
3. Sensor
4. Support plate
5. Support
6. Seal (O-Ring)
7. Temperature sensor

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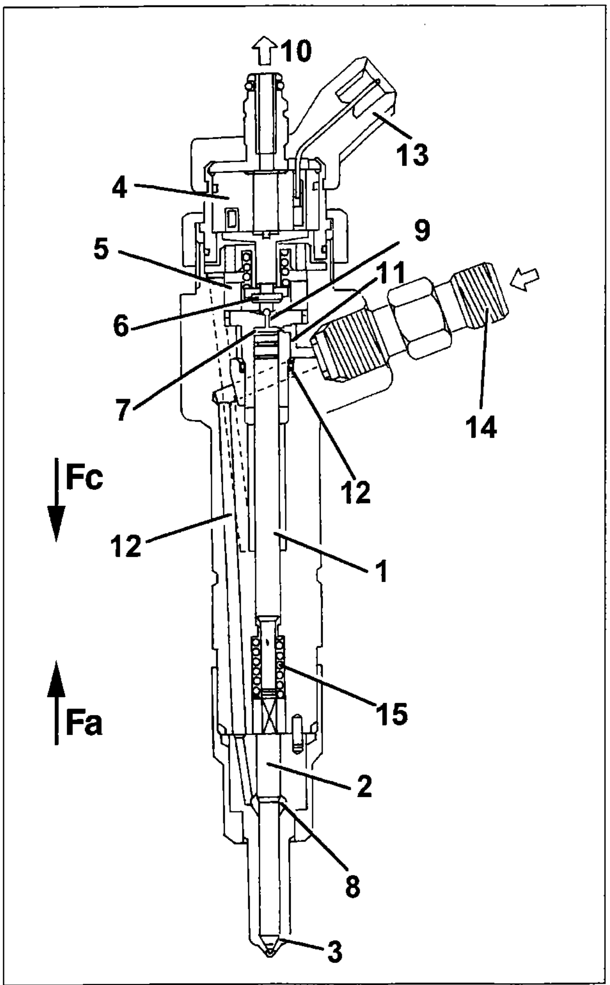


4F013NJ01

1. Pressure rod
2. Pin
3. Jet
4. Coil
5. Valve
6. Ball shutter
7. Control area
8. Supply volume
9. Control volume
10. Fuel outlet connector (low pressure)
11. Control duct
12. Supply duct
13. Electrical connection
14. Fuel inlet connector (high pressure)
15. Spring

INJECTORS

The injectors, fitted on the cylinder head, are the electro-magnetic type operated directly by the injection control unit.
The injector have a high pressure supply duct and a recirculation pipe at ambient pressure; the supply duct is connected to the supply manifold (rail) with pipes designed to withstand high operating pressures.

The injector can be divided into two sections:

- actuator/nozzle consisting of a pressure rod (1), pin (2) and jet (3);
- solenoid valve consisting of a coil (4) and valve (5).

Operation

The operation of the injector can be divided into three stages:

1. rest position

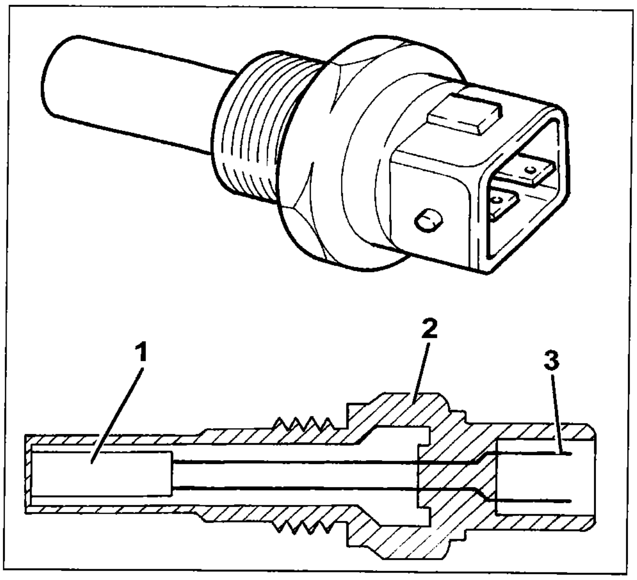
The coil (4) is de-energized and the shutter (6) is in the closed position and does not allow the introduction of fuel into the cylinder: Fc > Fa where Fc is the force produced by the pressure acting on the control area (7) of the pressure rod (1) and Fa is the force due to the pressure acting in the supply volume (8).

2. start of injection

The coil (4) is energized and causes the lifting of the shutter (6). The fuel flows from the control volume (9) to the return manifold causing a decrease in pressure at the control area (7). At the same time, the line pressure passes through the supply duct (12) exerting a force in the supply volume (8) Fa > Fc causing the lifting of the pin (2) with the consequent introduction of fuel into the cylinders.

3. end of injection

The coil (4) is de-energized and returns the shutter (6) to the closed position recreating an equilibrium which returns the pin (2) to a closed position and consequently ends the injection.



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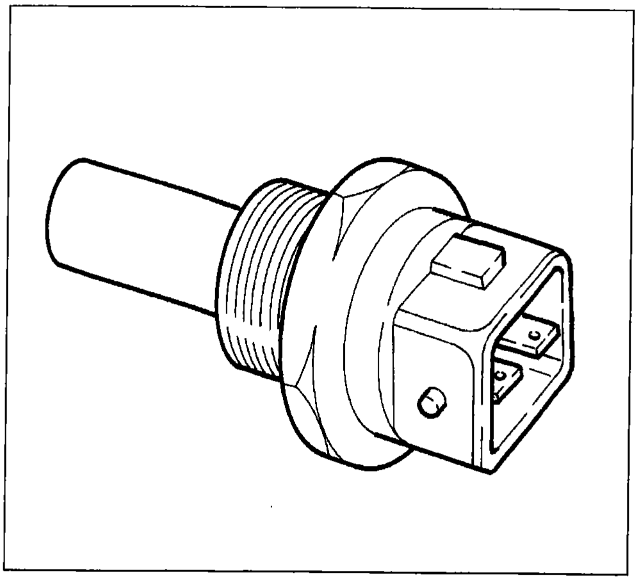
ENGINE COOLANT TEMPERATURE SENSOR

This sensor is fitted on the thermostat and measures the temperature of the engine coolant by means of an NTC thermistor with a negative resistance coefficient.
The sensor is produced using semiconductor technology, therefore if the temperature of the sensor element increases as the temperature of the coolant increases, the value of the resistance decreases.
As the resistance variation is not linear, a temperature increase is higher at lower temperatures than at higher ones.

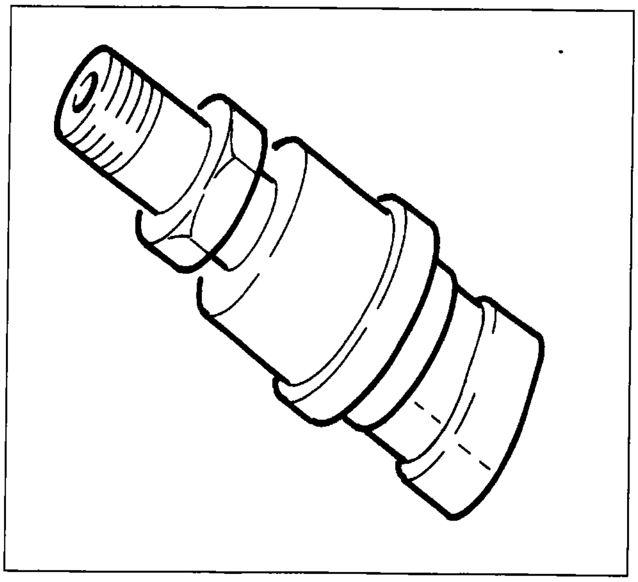
1. NTC resistance
2. Sensor body
3. Electrical connector


4F014NJ02

FUEL TEMPERATURE SENSOR

This sensor is fitted on the return manifold and measures the temperature of the fuel by means of an NTC thermistor with a negative resistance coefficient.

For the operation of the sensor, refer to the previous description of the coolant temperature sensor.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FUEL PRESSURE SENSOR

This sensor is fitted at the centre of the fuel supply manifold (rail) and has the task of providing the injection control unit with a feedback signal for:

- regulating the injection pressure;

- regulating the duration of the injection.

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3-04 Not connected
3-05 Accelerator pedal potentiometer 1 supply
3-06 Not connected
3-07 Not connected
3-08 Accelerator pedal potentiometer 2 earth
3-09 Accelerator pedal potentiometer 2 signal
3-10 Accelerator pedal potentiometer 1 signal
3-11 Not connected
3-12 Not connected
3-13 Fiat CODE control unit
3-14 Not connected
3-15 Not connected
3-16 Not connected
3-17 Not connected
3-18 Not connected
3-19 Not connected
3-20 Climate control engagement go ahead from four stage pressure switch
3-21 Accelerator pedal 2 potentiometer supply
3-22 Not connected
3-23 Accelerator pedal potentiometer 1 earth
3-24 Fuel temperature sensor signal
3-25 Not connected
3-26 Vehicle speed signal (from ABS)
3-27 Not connected
3-28 Diagnostic socket connection (line K)
3-29 Not connected
3-30 Auxiliary electric fuel pump supply (immersed in the tank)
3-31 Not connected
3-32 Not connected
3-33 Not connected
3-34 Not connected
3-35 Not connected
3-36 Not connected
3-37 EGR solenoid valve supply
3-38 Heater plugs timer operation
3-39 Not connected
3-40 Rpm signal to rev counter
3-41 Not connected
3-42 Not connected
3-43 Heater plugs warning light
3-44 Not connected
3-45 Request to engage engine radiator fan high speed
3-46 Main relay go ahead
3-47 Not connected
3-48 Injection system failure
3-49 Not connected
3-50 EGR soleniod valve earth
3-51 Heater plugs operation timer
3-52 Auxiliary electric fuel pump relay go ahead
4-01 Flow meter supply
4-02 Timing sensor earth
4-03 Timing sensor signal
4-04 Flow meter earth
4-05 Not connected
4-06 Excess pressure sensor signal
4-07 Excess pressure sensor earth
4-08 Excess pressure sensor supply
4-09 Not connected
4-10 Not connected
4-11 Flow meter supply
4-12 N.C.
4-13 Fuel pressure sensor supply
4-14 Flow meter signal
4-15 Four stage pressure switch
4-16 Not connected
4-17 Rpm sensor screening
4-18 Not connected
4-19 Not connected
4-20 Not connected
4-21 Fuel pressure regulator
4-22 Not connected
4-23 Air temperature sensor signal
4-24 Fuel pressure sensor signal
4-25 Not connected
4-26 Rpm sensor signal
4-27 Engine coolant temperature sensor earth
4-28 Not connected
4-29 Not connected
4-30 Not connected
4-31 Fuel pressure regulator
4-32 Climate control system relay
4-33 Not connected
4-34 Fuel pressure sensor earth
4-35 Not connected
4-36 Engine coolant temerature sensor signal
4-37 Rpm sensor earth
4-38 Not connected
4-39 Not connected
4-40 Not connected
5-01 (1910 JTD) N.C.
5-01 (2387 JTD) Injectors for cylinders 2 and 5 supply
5-02 (1910 JTD) Injectors for cylinders 1 and 4 supply
5-02 (2387 JTD) N.C.
5-03 (1910 JTD) Operation of injector for cylinder no. 4
5-03 (2387 JTD) Operation of injector for cylinder no. 5
5-04 (1910 JTD) Injectors for cylinders 2 and 3 supply
5-04 (2387 JTD) Injectors for cylinders 1, 3 and 4 supply
5-05 (1910 JTD) Operation of injector for cylinder no. 3
5-05 (2387 JTD) Operation of injector for cylinder no. 1
5-06 (1910 JTD) N.C.
5-06 (2387 JTD) N.C
5-07 (1910 JTD) Operation of injector for cylinder no. 2
5-07 (2387 JTD) Operation of injector for cylinder no. 4
5-08 (1910 JTD) N.C.
5-08 (2387 JTD) Operation of injector for cylinder no. 3
5-09 (1910 JTD) Operation of injector for cylinder no. 1
5-09 (2387 JTD) Operation of injector for cylinder no. 2

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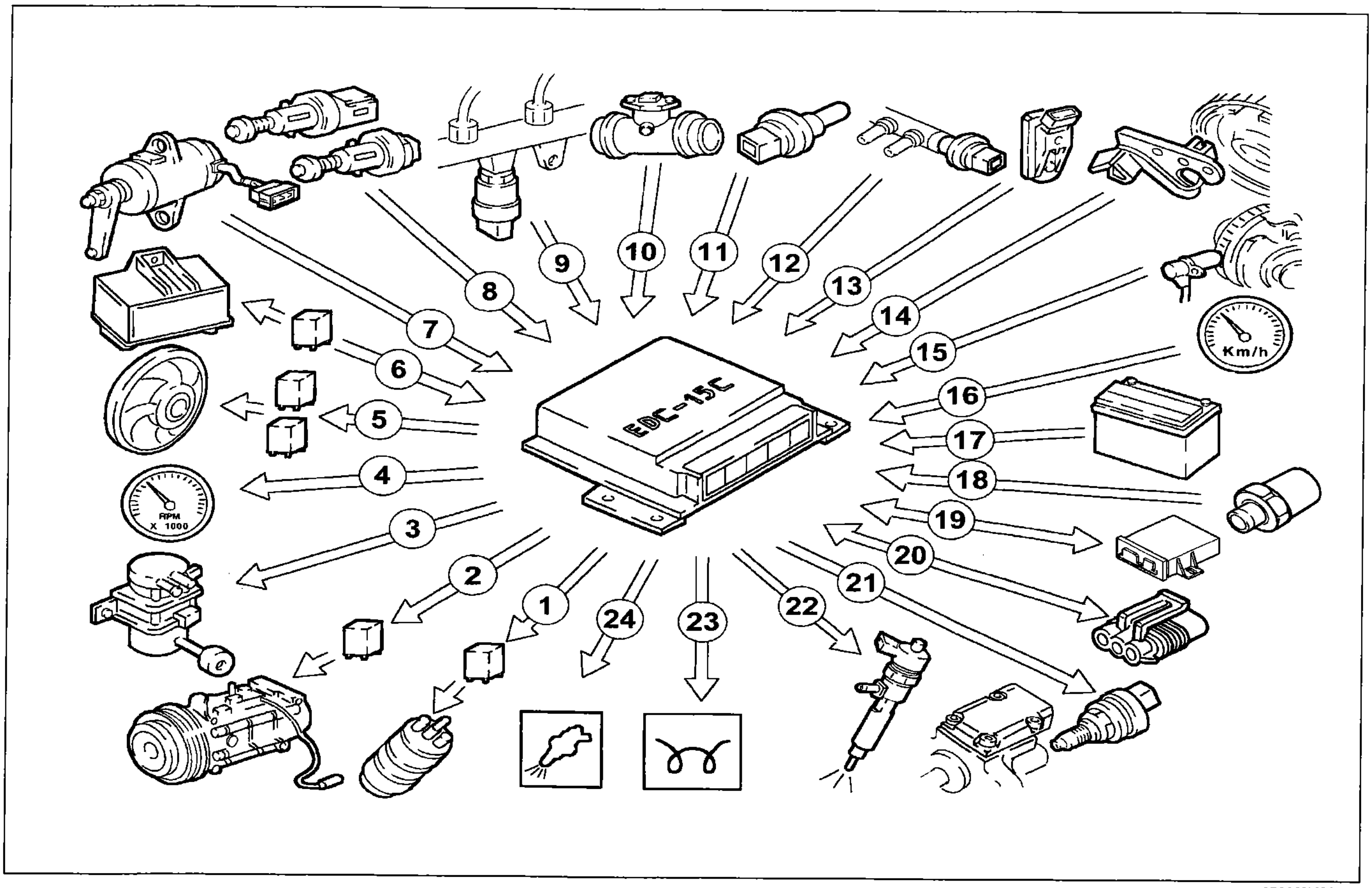
DIAGRAM SHOWING INFORMATION ENTERING/LEAVING THE INJECTION CONTROL UNIT AND SENSORS/ACTUATORS



1. Auxiliary electric fuel pump
2. Climate control compressor
3. EGR solenoid valve
4. Rev counter
5. Engine radiator fan
6. Heater plugs control unit
7. Accelerator pedal potentiometer
8. Brake and clutch pedal switches
9. Fuel pressure sensor
10. Intake air temperature and quantity sensor (flow meter)
11. Engine coolant temperature sensor
12. Fuel temperature sensor
13. Excess pressure sensor
14. Timing sensor
15. Rpm sensor
16. Vehicle speed
17. Battery
18. Four stage pressure switch
19. Fiat CODE control unit
20. Diagnostic socket
21. Fuel pressure regulator
22. Injectors
23. Heater plugs warning light
24. Injection system failure

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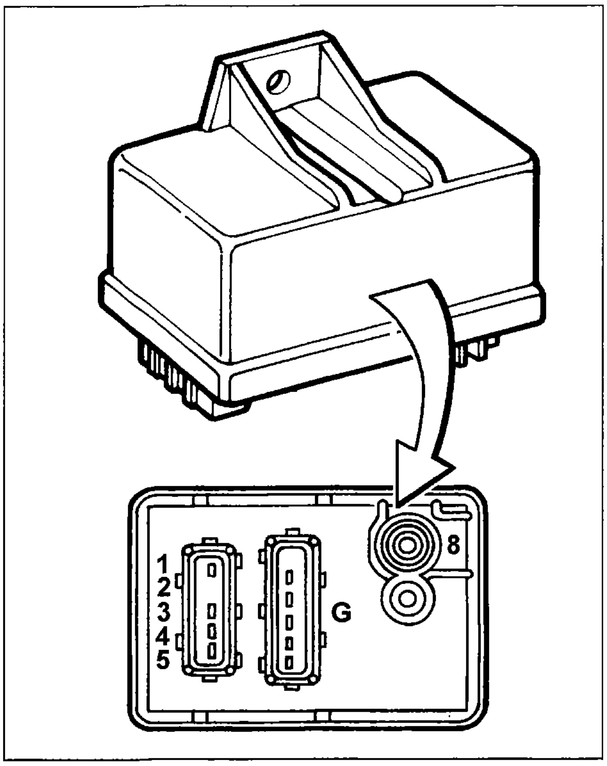


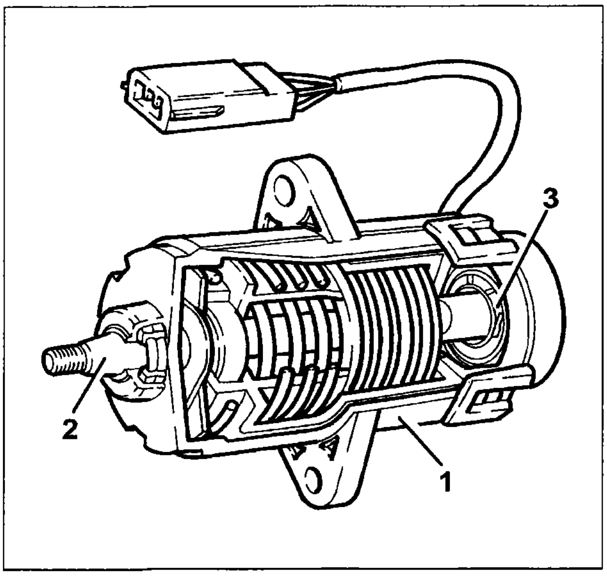
4F015NJ01

HEATER PLUGS CONTROL UNIT

The operation of the heater plugs takes place via the heater plugs control unit under the direct control of the injection control unit.
There is an intelligent relay inside the heater plugs control unit which sends a feeback signal to the injection control unit which is therefore informed of any failure in the heater plugs control unit or a short circuit to earth for the heater plugs.

The diagram shows the connectors at the base of the heater plugs control unit and the pin out:

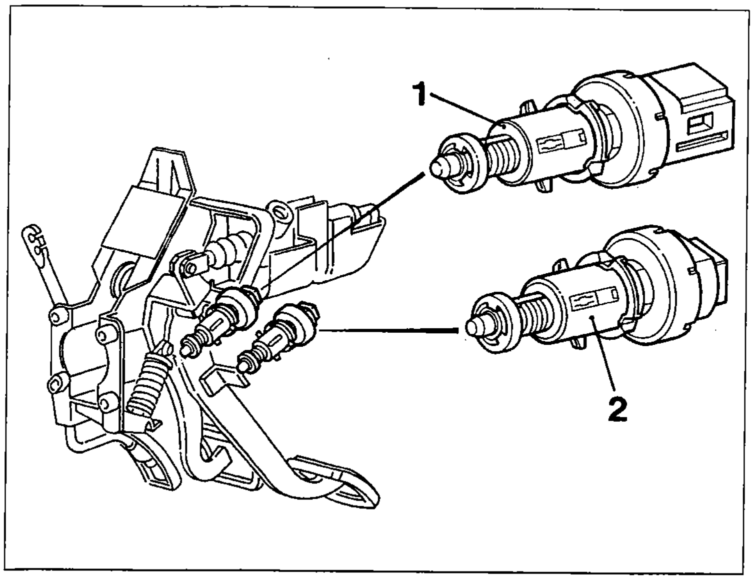
1. Earth
2. Connected to earth
3. Injection control unit (pins 3-38)
4. Injection control unit (pins 3-51)
5. Injection control unit (pins 2-1)
6. Battery positive (+30)
G. Heater plugs (only 4 outlets are used)



4F015NJ02

ACCELERATOR PEDAL POTENTIOMETER

The position of the accelerator pedal is transformed into an electrical voltage signal and sent to the injection control unit by the potentiomter connected to the pedal.
The accelerator pedal position signal is processed together with information concerning the engine speed to obtain the injection time and pressure.
The sensor consists of a casing (1), fixed to the pedals assembly by a flange, which contains a shaft (2), in an axial position, connected to the two potentiometers (3): one main one and one safety one.
A coil spring on the shaft ensures the correct resistance to pressure, whilst a second spring ensures the return on release.



4F016NJ01

BRAKE PEDAL SWITCH

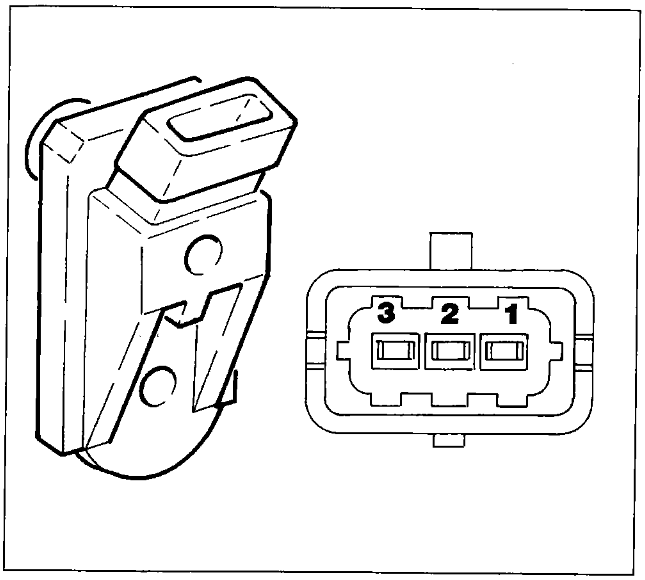
There is a switch (1) on the brake pedal which operates the brake lights; the same switch sends a signal to pins 2-8 of the injection control unit.

The "brake pedal pressed" signal is used by the control unit for:

- understanding that there is a deceleration situation;
- checking the plausibility of the signal coming from the accelerator potentiometer.

CLUTCH PEDAL SWITCH

There is a switch (2) on the clutch pedal connected to pins 2-2 of the injection control unit.
The "clutch pedal operated" signal is used by the injection control unit to distinguish between gear engaged and gear change conditions.



4F016NJ02

EXCESS PRESSURE SENSOR

This sensor is fitted on the inlet manifold and the signal transmitted to the injection control unit is used for:

- regulating the injection pressure;
- regulating the duration of the injection.

The diagram at the side illustrates the sensor and the electrical connector with the pin out:

1. Pressure signal
2. Earth
3. Supply

ATMOSPHERIC PRESSURE SENSOR

The atmospheric pressure sensor is contained inside the injection electronic control unit and has the task of measuring the atmospheric pressure in order to correct the air flow rate values measured and the reference values for controlling the EGR function.

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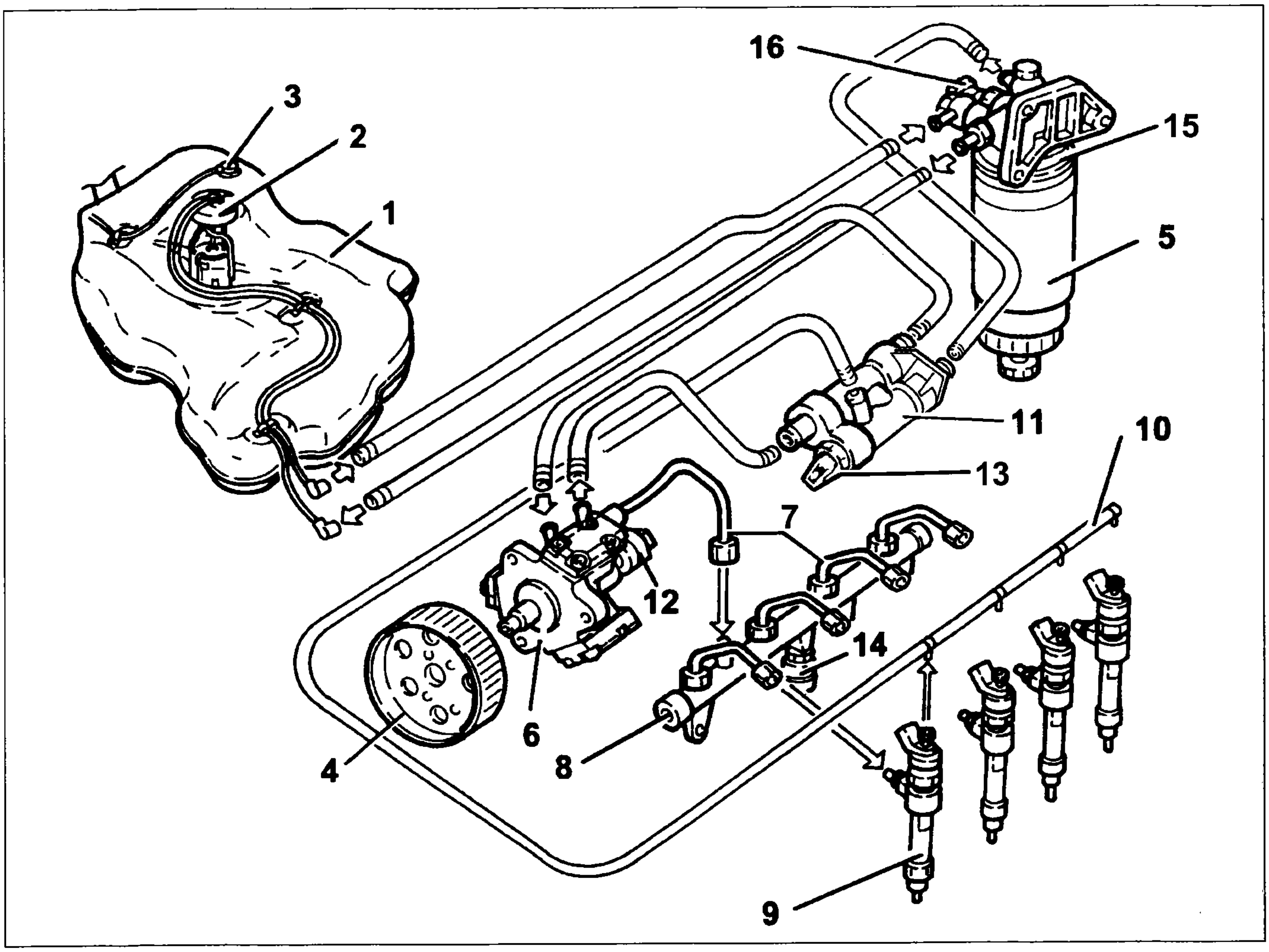
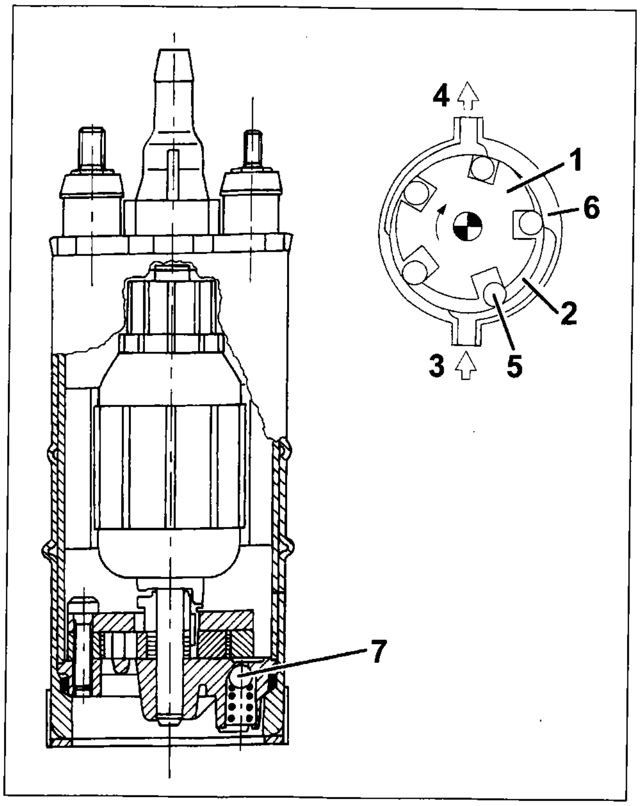
FUEL SUPPLY CIRCUIT

The fuel supply circuit is divided functionally into the low pressure circuit and the high pressure circuit.
The low pressure circuit consists of a tank, multi-purpose valve, auxiliary electric pump immersed in the tank and return manifold.
The high pressure circuit consists of a radialjet pressure pump, supply manifold and injector.



4F017NJ01

1. Fuel tank
2. Immersed (auxiliary) electric pump assembly complete with gauge
3. Multi-purpose valve
4. Pressure pump drive pulley
5. Diesel filter cartridge
6. Pressure pump
7. High pressure pipes
8. Supply manifold (rail)
9. Injectors
10. Fuel recirculation pipe (injectors return)
11. Return manifold
12. Pressure regulator
13. Fuel temperature sensor
14. Fuel pressure sensor
15. Diesel heater
16. Thermal switch



4F018NJ01

1. Impeller
2. Volumes
3. Inlet port
4. Supply port
5. Rollers
6. Outer seal
7. Excess pressure valve

IMMERSED (AUXILIARY) ELECTRIC FUEL PUMP ASSEMBLY AND GAUGE

The assembly basically consists of:

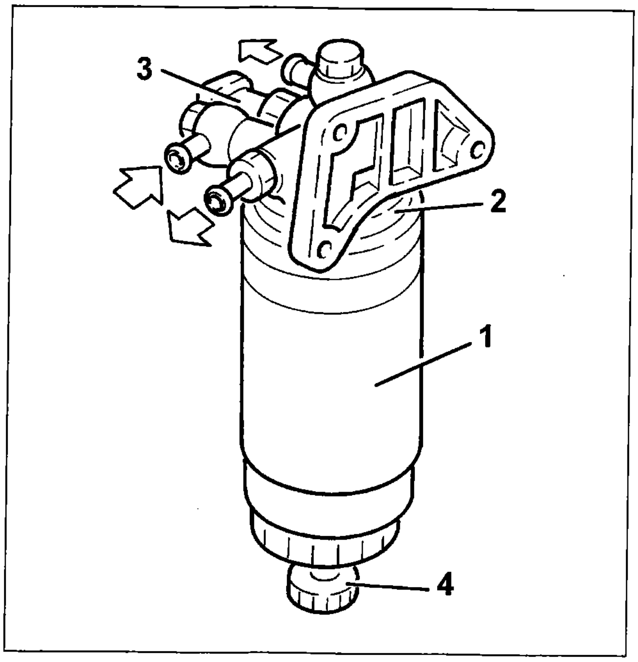
- a roller type electric pump;
- a fuel gauge;
- a fuel filter

The electric pump immersed in the fuel is the volumetric roller type with a motor with permanently energized magnets.

The impeller (1) rotates, driven by the electric motor, creating volumes (2) which move from the inlet port (3) to the supply port (4).

These volumes are defined by rollers (5) which adhere to the outer seal (6) during the rotation of the motor.

The electric pump has two valves: one single-acting valve to prevent the fuel circuit draining (when the pump is not working); the second excess pressure valve (7) which recirculates the supply with the inlet when pressures in excess of 5 bar are created.



4F018NJ02

FUEL FILTER

The fuel filter is located in the engine compartment, fixed to the inlet manifold.

The filter is the cartridge type with a filter element (1) consisting of a pack of paper discs with a filtering surface of about 5300 cm 2 and a filtering degree of 4 - 5 mm.

The filter is equipped with a fuel pre-heating device (2) operated by a thermal switch (3) fitted on the actual filter.
When the temperature of the diesel is below 6 °C, an electrical resistance heats it up to a maximum of 15 °C before sending it to the pressure pump.
A plug (4) for draining the water is bolted to the base of the fuel filter cartridge.

1. Filter cartridge
2. Diesel pre-heating device
3. Thermal switch
4. Water drain plug

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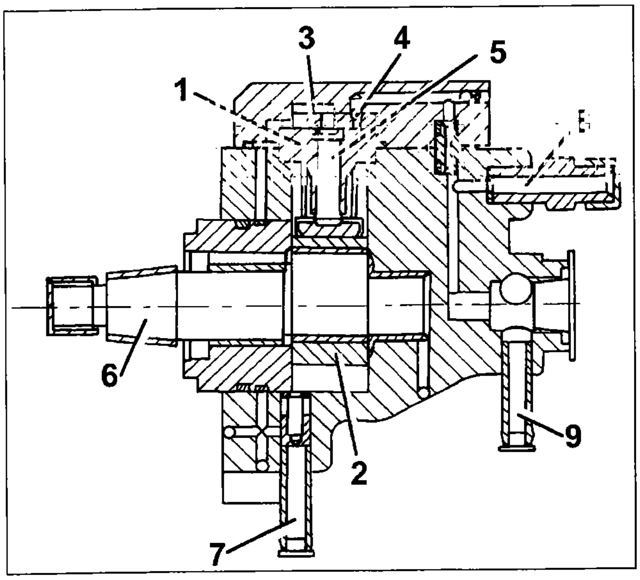
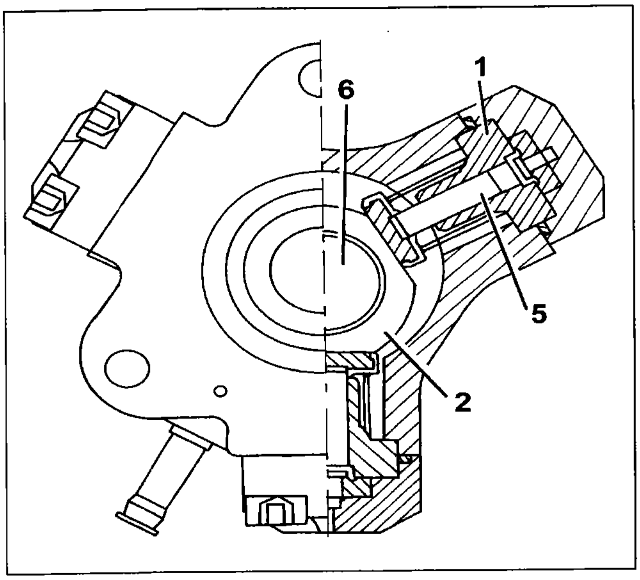
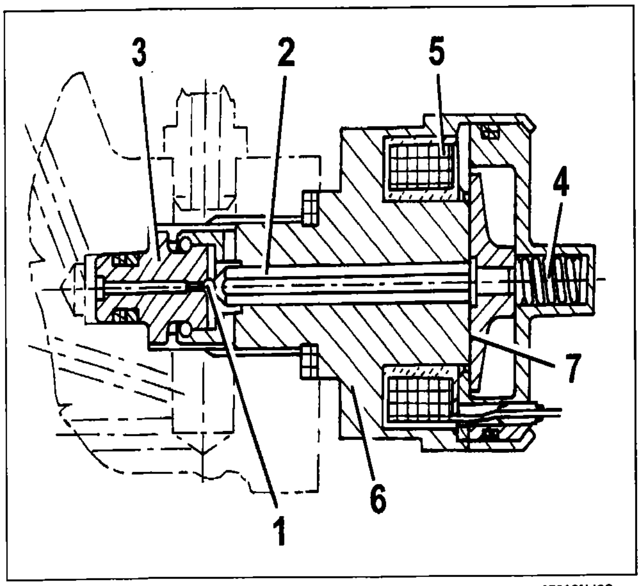


4F019NJ01



4F019NJ02



4F019NJ03

PRESSURE PUMP

The pressure pump is the radialjet type with three radial pistons (total capacity 0.657 cc) and is operated by the timing belt without timing restrictions.

Each pumping unit consists of:

a piston (5) operated by a cam (2) fixed to the pump shaft (6);

an inlet valve (3);

a supply ball valve (4).

The pressure pump should receive a supply of at least 0.5 bar; for this reason the fuel system is equipped with an auxiliary electric pump immersed in the tank.

The pressure pump is lubricated and cooled by the same diesel fuel by means of suitable ducts and is capable of supplying a maximum pressure of 1350 bar.

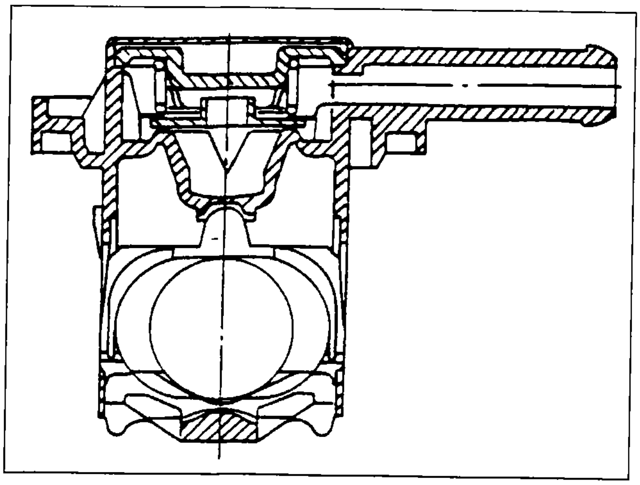
1. Cylinder
2. Cam
3. Inlet valve
4. Supply ball valve
5. Piston
6. Pump shaft
7. Diesel inlet connector - low pressure - from fuel filter
8. Diesel supply connector - high pressure - to manifold (rail)
9. Diesel supply connecotr - low pressure – recirculation

FUEL PRESSURE REGULATOR

The fuel pressure sensor is fitted on the pressure pump and operated directly by the injection control unit, regulating the fuel supply pressure to the injectors.

The pressure regulaor consists mainly of the following components:

1. Ball shutter
2. Pin
3. Valve
4. Pre-loading spring
5. Coil
6. Corpo
7. Keeper



4F020NJ01

MULTI-PURPOSE VALVE

The multi-purpose valve is lcoated on the fuel tank and carries out the following tasks:

- pressurizing the tank
- ventilation
- seal in case of overturning

Pressurizing the tank

The tank pressure is kept at between 55 and 75 mbar by means of a valve resting on a sealing edge.

The valve is supported by a steel plate and opposed by a spring.

When the pressure in the tank exceeds the recommended value, it overcomes the resistance of the spring allows the valve to lift, thereby allow the flow of vapours.

When the pressure returns to within the limits, the valve closes again.

Ventilation

In certain operating conditions, a vacuum may form in the tank through the effect of:

- heat variations;
- fuel consumption.

The function of the valve, under these circumstances, is to restore the pressure inside the tank through the intake of air.

Any problem with this function can cause irregular operation or the breakdown of the vehicle through problems with the electric pump supply.

Seal in the case of overturning

The roll-over function is to prevent the escape of fuel from the tank if the vehicle overturns or is at a very steep angle.
During the normal operation of the vehicle (bends, acceleration, braking, etc.) the fuel is shaken around in the tank and may spill out.
The high sensitivity of this valve to roll-over prevents these escape.

SUPPLY MANIFOLD (RAIL)

The supply manifold (rail) is fitted on the cylinder head, inlet side.

With its volume it dampens the pressure fluctuations of the fuel due mainly:

- to the operation of the pressure pump;
- to the opening of the injectors.

The fuel pressure sensor is fitted in the centre of the supply manifold.
The (high pressure) hydraulic connections are achieved through special steel pipes.

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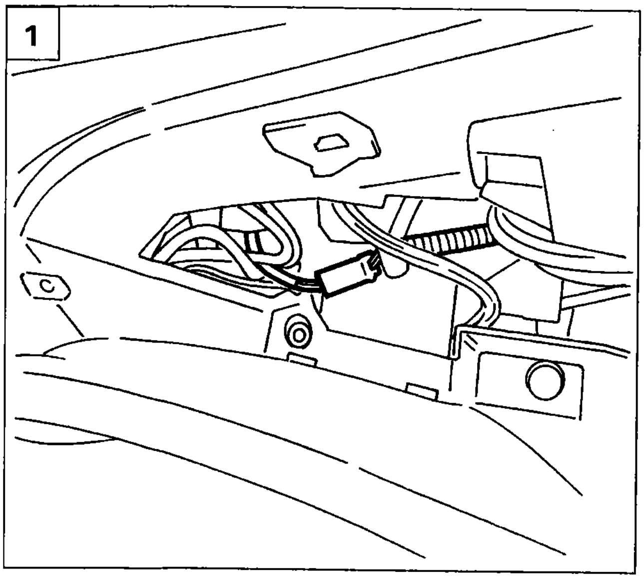
10.

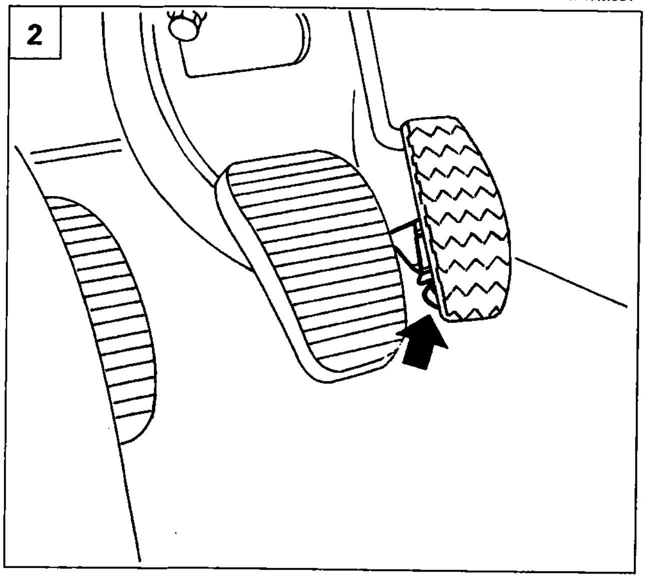


4F47MJ01

1. Disconnect the electrical connector for the potentiometer cutting off the wiring as close as possible to the plastic duct which retains it, taking care not to damage the surrounding cables.

REFITTING

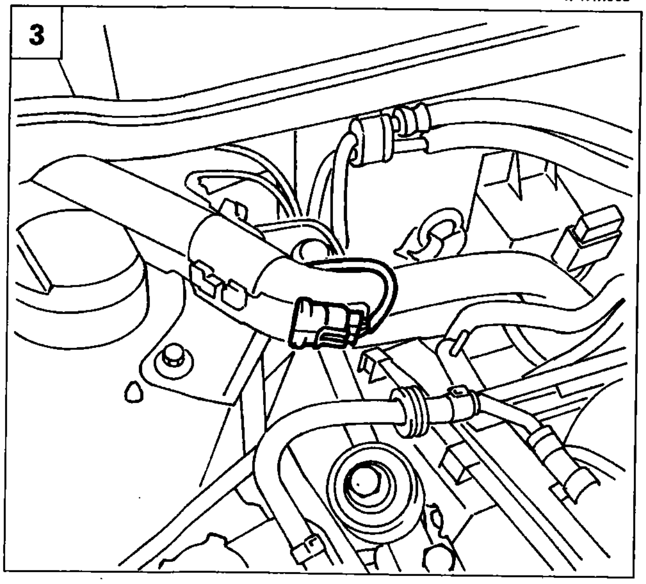
- Carry out the operations described above in the reverse order.
- Position the new potentiometer and restore the routing of the new bridge fastening it under the tunnel so that the latter does not impede the movement of the climate control unit and does not produce noise/vibrations whilst the vehicle is being driven.



4F47MJ03

2. Connect the diagnostic equipment to the socket in the engine compartment, on the right side of the vehicle, in the area of the pillar.

With the pedal in the end of travel position, check that the voltage reading on the instrument is 3.8V ± 1V.



4F47MJ02

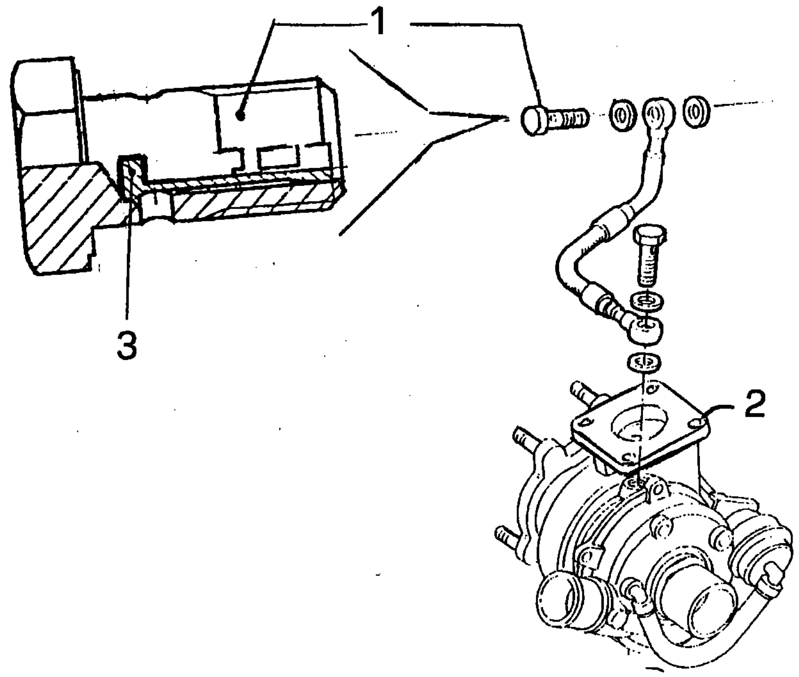
3. To correct the voltage readings with the accelerator in the maximum position, regulate the adjustment device and repeat the measuring procedure using the diagnostic equipment.

10.

SERVICING INSTRUCTIONS TO BE FOLLOWED WHEN DISMANTLING THE TURBOCHARGER

In the case of "major" repairs to the engine (e.g. overhauling) or when the turbocharger assembly (2-Fig.1) is dismantled **it is necessary to replace the filler (1) no. 4640121** for the connector for the flexible supply pipe to the turbo (cylinder block/crankcase side) when there is an oil filter (3) fitted as illustrated in figure 1.

Fig. 1



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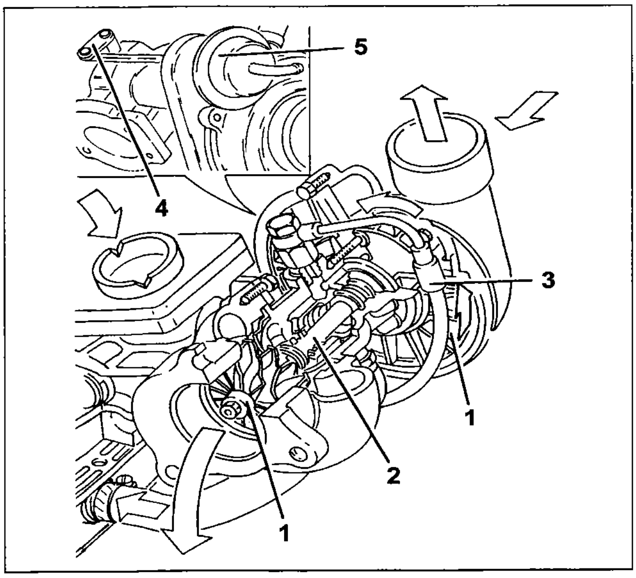
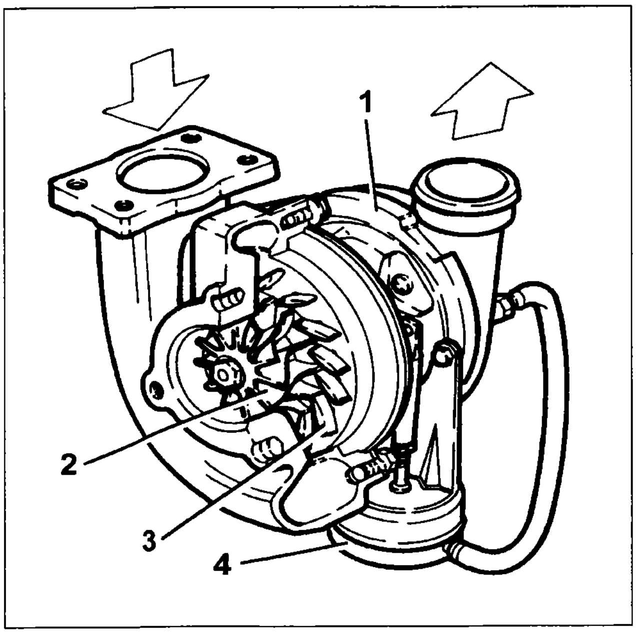


4F023NJ01

TURBOCHARGER 1910 JTD

It basically consists of two impellers (1) fitted on the same shaft (2) which rotates on floating bearings lubricated via a duct (3) in the engine lubrication circuit.
The oil used dissipates part of the large amount of heat given off by the exhaust gases.
There is a waste-gate valve (4) fitted on the turbocharger, operated by a pneumatic actuator (5), which makes it possible to shutter the flow of exhaust gases to the turbine according to the engine power/torque requirements.

1. Impellers
2. Shaft
3. Lubrication
4. Waste-gate
5. Actuator



4F023NJ02

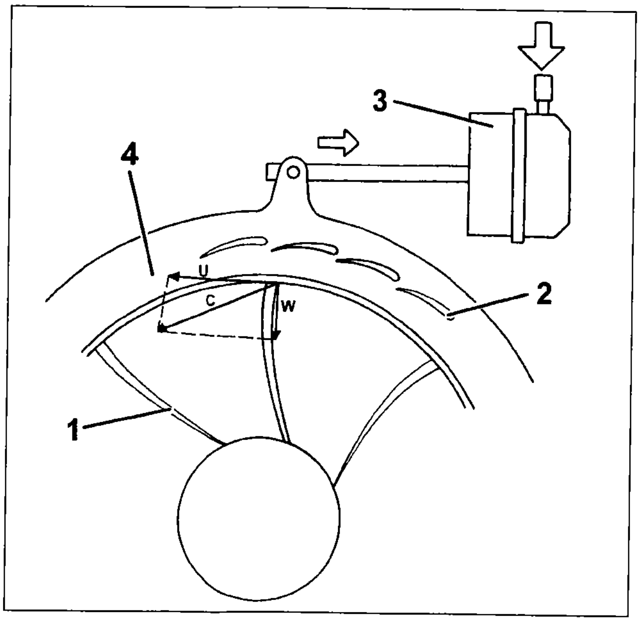
TURBOCHARGER 2387 JTD

This is a variable geometry turbocharger, connected to the exhaust manifold; it is designed to increase the engine thermal output.

The variable geometry turbocharger consists of:
- a centrifugal compressor (1)
- a turbine (2)
- a series of moving vanes (3)
- a pneumatic actuator (4) controlling the moving vanes.

The variable geometry turbocharger makes it possible to:
- increase the speed of the exhaust gases coming into contact with the turbine at low engine speeds
- slow down the speed of the exhaust gases coming into contact with the turbine at high speeds.

The control of the speed (kinetric energy) of the exhaust gases makes it possible to have greatre engine torque at low speeds and increased maximum power at high speeds.

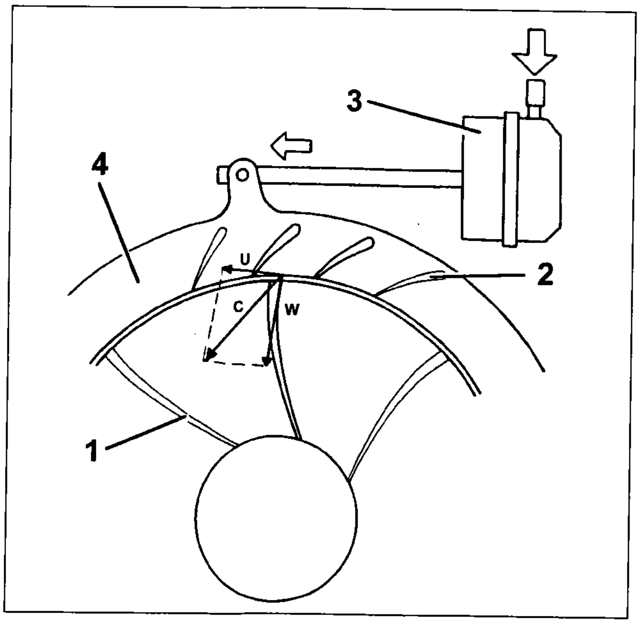


4F024NJ01

Operation at low rotation speeds

When the engine is rotating slowly, the exhaust gases possess a small amount of kinetic energy: under these circumstances a traditional turbine would rotate slowly, providing a limited supercharging pressure.
In the variable geometry turbine (1) on the other hand, the moving vanes (2) are in the fully closed position and the small sections between the vanes increase the speed (C) of the inlet gases.
Increased inlet speeds involve increased peripheral speeds (U) of the turbine and consequently the compressor.
The speed of the gases flowing inside the impeller is indicated by the vector (W).

1. Turbine
2. Moving vanes
3. Pneumatic actuator
4. Rotary seal



4F024NJ02

Operation at high rotation speeds

Increasing the engine rotation speed gradually increases the kinetic energy of the exhaust gases.
As a result, the speed of the turbine (1) increases and therefore the pressure of the supercharging, also acting on the actuator (3).
The actuator (3) opens the moving vanes (2), by means of a rod, according to the supercharging pressure, until the fully open position is reached.
The section therefore increases and there is a consequent slowing down in the flow of the exhaust gases passing through the turbine (1) with speeds equal to or less than the low speed condition.
The speed of the turbine (1) decreases and settles down at a suitable value for the correct operation of the engine at high speeds.

1. Turbine
2. Moving vanes
3. Pneumatic actuator
4. Rotary seal

EXHAUST GAS CIRCUIT

The engine exhaust gases flow through the manifold to the turbocharger and then, by means of a pipe, to the catalytic converter and the silencer.
Special protection limits the heat transmitted to the bodyshell.

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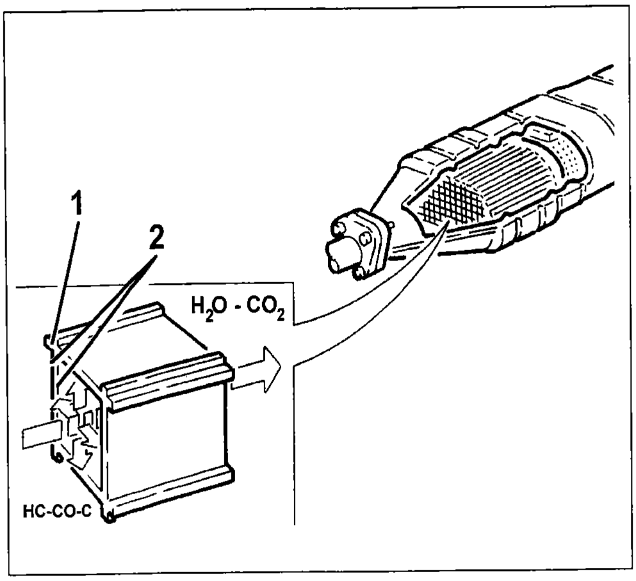
EMISSION CONTROL DEVICES

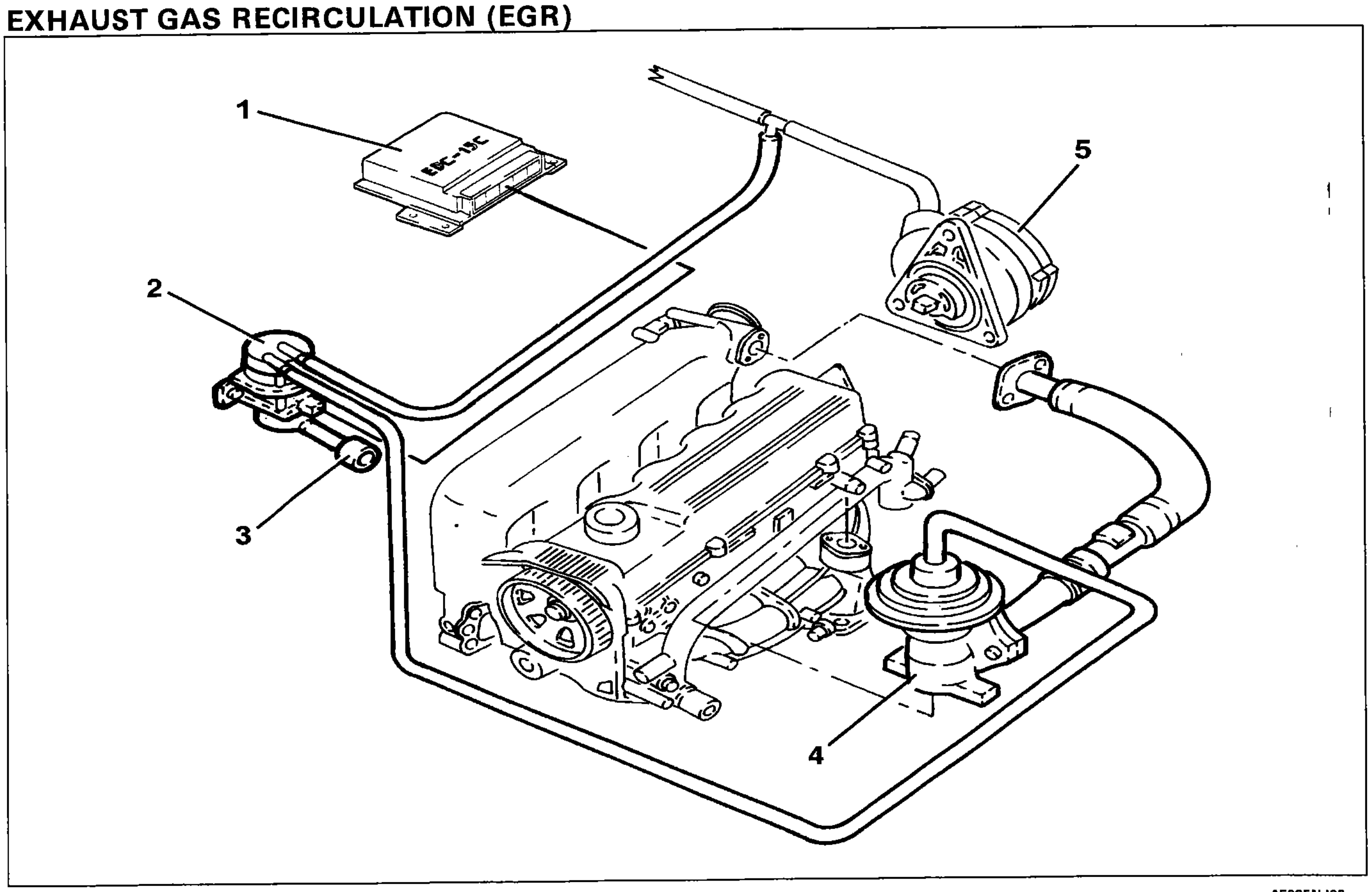


4F025NJ01

CATALYTIC CONVERTER

The catalytic converter is a post-treatment device for oxidizing the CO, the HC and the particulates, transforming them into carbon dioxide (CO 2) and water vapour (H2O).
The catalyzer consists of a ceramic honeycomb monolith (1), whose cells are impregnated with platinum (2) which acts as a catalyst for the oxidation reactions.
The exhaust gases passing through the cells heat the catalyzer, triggering off the conversion of the pollutants into inert compounds.
The chemical oxidation of the CO, HC and particulates, is effective at temperatures of between 200 °C and 350 °C.
Above 350 °C the sulphur contained in the diesel fuel starts to oxidize producing sulphur dioxide.

EXHAUST GAS RECIRCULATION (EGR)



4F025NJ02

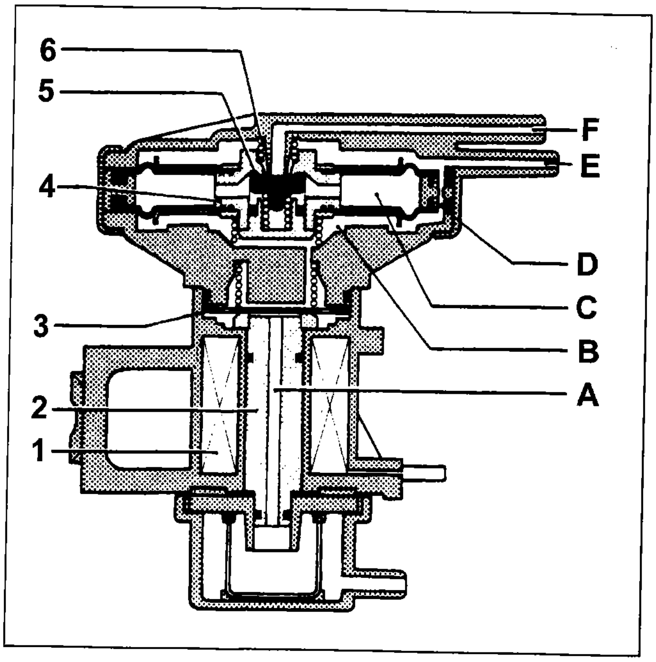
This system makes it possible to send some of the exhaust gases to the inlet in certain engine operating conditions.
This dilutes the fuel mixture with inert gases lowering the peak temperature in the combustion chamber; this contains the formation of nitrogen oxides (NOx) producing a 30-50% reduction at the exhaust.

10.

The recirculation of the exhaust gases is only permitted at medium-low loads, when the air/fuel ratio is very high and the operation of the engine is not adversely affected by the presence of inert gases in place of the air.
The recirculation is controlled by the injection control unit (1) which, mainly according to the signals from the accelerator pedal potentiometer, the rpm sensor and the engine coolant temperature senor, supplies an output signal for the modulating solenoid valve (2).
The latter, connected to the atmosphere by means of a filter (3), transmits a lesser or greater vacuum, according to the signal received, coming from the brake servo vacuum pump (5) to the EGR valve.
If the vacuum is sufficient, the valve (4) opens placing the exhaust manifold in contact with the inlet manifold.

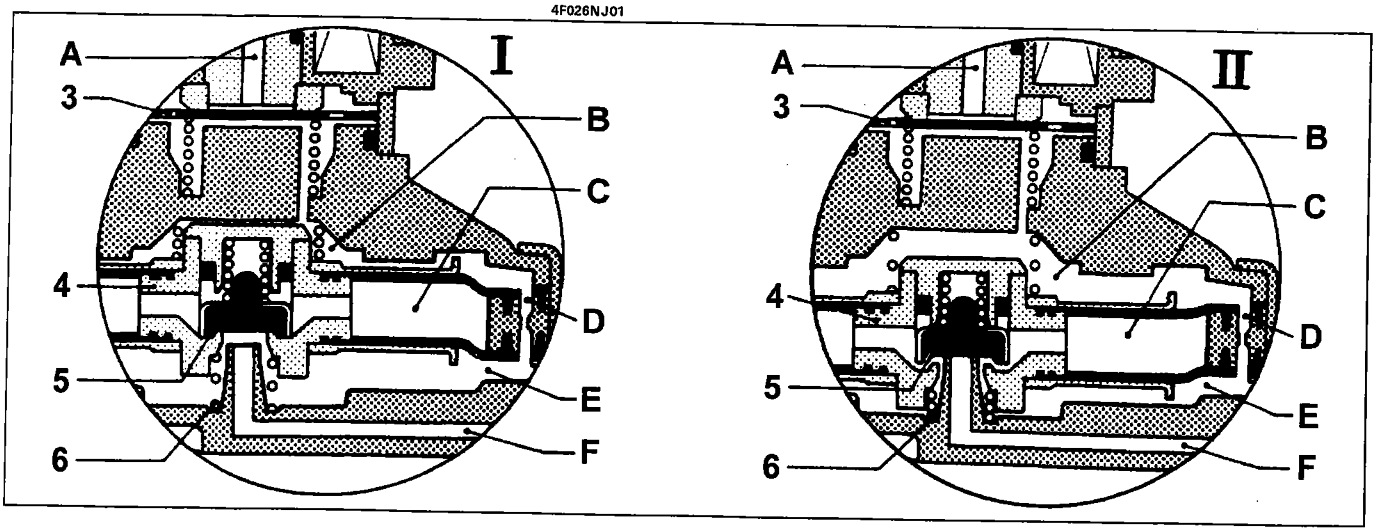
EGR MODULATING SOLENOID VALVE

The vacuum coming from the vacuum pump for the brake servo reaches the chamber (E) from the duct (F) (case I) because the force of the spring (6) acts on the moving element (4) and the valve (5) allows its flow.
The vacuum then enters the chamber (B), through the compensation port (D) and the surface of the disc shuter (3).
When the forces acting on the disc (3) are balanced, the atmospheric pressure in the duct (A) enters the chamber (B), moving the moving element downwards (case II), therefore the valve (5) shutter closes the duct (F) and places chamber (E) in contact with chamber (C) at atmospheric pressure, decreasing the vacuum in the duct (E).



4F026NJ01

The decreased vacuum value or the increased absolute pressure in the chamber (E) raises the moving element (4) (case I), closing the section (C) and placing the valve (5) in the ideal condition (E in contact with F) and the cycle is repeated.



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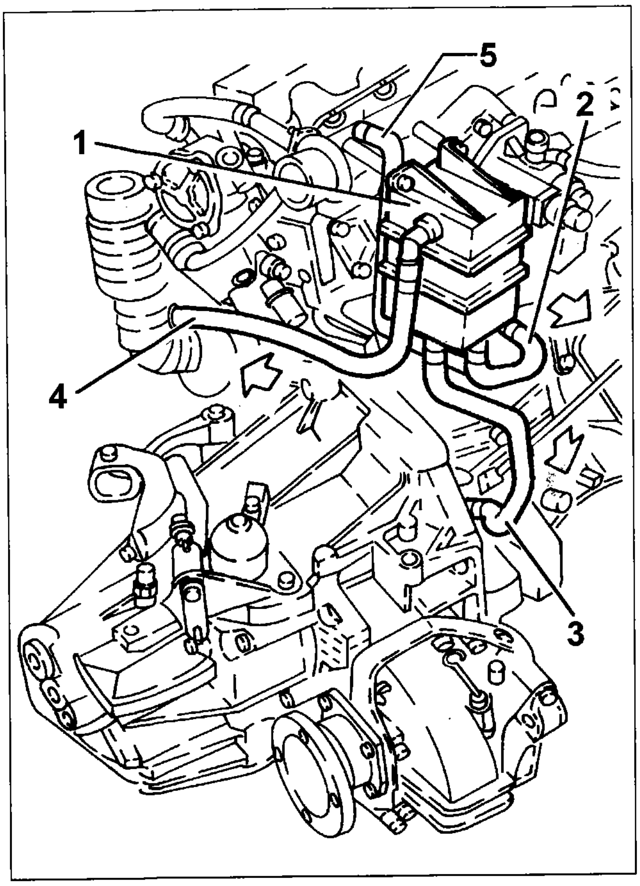

4F027NJ01

RECIRCULATION CIRCUIT FOR VAPOURS COMING FROM THE CRANKCASE (BLOW-BY)

The engine crankcase emissions consist of air/diesel mixtures and burnt gases which escape through the piston seals as well as lubricant oil vapours.

These are defined as blow-by or breather gases.

The breather gases coming from both the crankcase (2) and the cylinder head (5) reach the separator (1).

In the separator (1) the gases lose part of the oil dissolved in them which returns to the sump in the form of droplets via the pipe (3).

The remaining gases, on the other hand, are directed to the intake circuit via the pipe (4).