BOSCH MOTRONIC ME 3.1 M.P.I. INTEGRATED INJECTION/IGNITION SYSTEM

Introduction

The Bosch Motronic system fitted on the 1998 5 cylinder 20 valve version belongs to the category of static advance, inductive discharge, digital electronic ignition systems integrated with phased, sequential type electronic injection systems.
This system has one electronic control unit, a single set of wiring and one set of joint sensors.
Its function is to inject the exact quantity of petrol, into the engine inlet manifold, upstream of the inlet valves, designed to mix with the air introduced into the cylinder in order to obtain the correct mixture strength.
The ME 3.1 Motronic system guarantees efficient operation giving optimum performance and consumption and a reduction in harmful emissions through a prompt response to the different engine operating conditions.

General description of the injection system

There are basically two essential conditions which must always be met for the smooth running of ignition systems when preparing the air/fuel mixture, namely:

1. the metering (air/fuel ratio) which must be kept as constant as possible and close to the stoichiometric value to ensure the necessary speed of combustion avoiding pointless fuel consumption;
2. the mixture must be composed of petrol vapours dispersed as finely and evenly as possible in the air.

As far as the optimum metering, on the other hand, is concerned, it is calculated by the control unit following these measurements:

- exact quantity of intake air via the flow meter;
- engine rotation speed via the rpm sensor;
- power requirement via the accelerator pedal potentiometer;
- engine coolant temperature via the sensor on the thermostat support;
- measurement of the exhaust gas oxygen content through the Lambda sensor.

This information is processed by a micro-calculator inside the injection/ignition electronic control unit which determines the basic injection time through experimentally obtained values which are stored in a special memory in the above mentioned control unit.

General description of the ignition system

The ignition system is the static advance inductive discharge type (i.e. there is no high tension distributor) with the power modules inside the electronic control unit.

The system has a single coil for each spark plug; the advantages of this solution are:

- less electrical overload
- guarantee of constant discharge at each spark plug

There is a map in the electronic control unit memory containing the entire series of optimum ignition advances for the engine operating range according to the engine speed and load conditions.
In the case of detonation it is possible to selectively delay the ignition for the individual cylinder, recognized by the combination of figures transmitted by the detonation sensors and the timing sensor.

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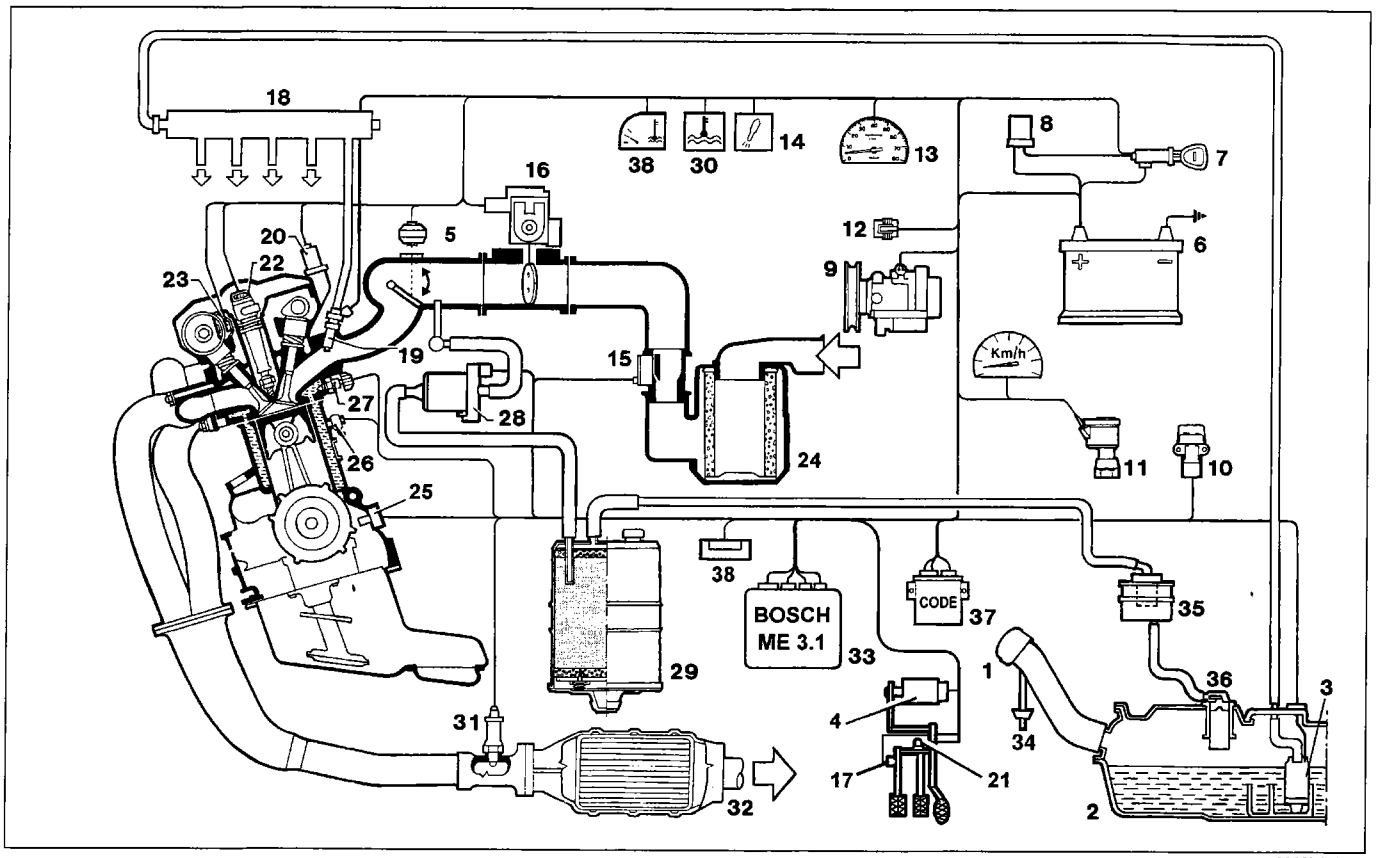
INJECTION/IGNITION SYSTEM FUNCTIONAL DIAGRAM



1. Fuel tank filler cap
2. Fuel tank
3. Electric fuel pump with filter and pressure regulator
4. Accelerator pedal potentiomer
5. Variable geometry manifold solenoid valve
6. Battery
7. Ignition switch
8. System relay feed
9. Climate control compressor
10. Inertia switch
11. Vehicle speed sensor
12. Diagnostic socket
13. Rev counter
14. System failure warning light
15. Air flow meter
16. Butterfly casing electronic actuator
17. Clutch pedal switch
18. Fuel manifold
19. Injectors
20. Phase transformer solenoid valve
21. Brake pedal switch
22. Ignition coils
23. Engine timing sensor
24. Air filter
25. Engine rpm sensor
26. Detonation sensors
27. Coolant temperature sensor
28. Fuel vapour solenoid valve
29. Charcoal filter
30. Coolant overheating warning light
31. Lambda sensor
32. Catalytic silencer
33. Injection/ignition control unit
34. Safety valve
35. Fuel vapour separator
36. Multi-purpose valve
37. Fiat CODE control unit
38. Coolant temperature gauge

These values are obtained experimentally by means of a long series of practical tests carried out on prototypes at the engine test bench to identify the advances which give the best possible compromise between the conflicting requirements of maximum power and minimum consumption and harmful exhaust emissions.
The optimum advances have then been stored in the systm control unit memory. Whilst the engine is running, the control unti is constantly informed of the (engine) speed and load conditions and, on this basis, it "selects" the optimum advance from its memory for striking the spark at the spark plug for the cylinder in the explosion stroke with the optimum advance.
In addition, the control unit corrects this value according to further factors such as the engine coolant temperature, the intake air temperature, detonation and the butterfly valve position so that the ignition point is always optimum.
The information required by the control unit for operating the single coils is transmitted by means of electrical signals from the following sensors:

a. **An rpm sensor** which produces an alternating, single phase signal whose frequency indicates the engine speed.

b. **An air flow meter** with a temperature sensor which, according to the quantity/temperature of the air drawn in by the engine, transforms these values into electrical signals, sending them to the electronic control unit.

c. **Two detonation sensors** which, located on the top part of the cylinder block/crankcase, one between cylinders 1 and 2 and the other between cylinders 4 and 5, allow the control unit to recognize the cylinder where there is detonation (or the onset of detonation) and only correct the ignition advance for the spark plug of the cylinder concerned.

d. **An accelerator pedal potentiometer** which transforms the angular value of the actual pedal into an electrical signal allowing the control unit to recognize minimum, partial and full load conditions.

Injection/ignition system functions

In addition to electronically controlling the moment of ignition and the air flow rate during idling, in order to allow the engine to run smoothly as the ambient parameters and loads applied vary, the control unit must control and manage the injection so that the stoichiometric (air/fuel) ratio is always within the optimum value.
The electronic control unit establishes the "time" for operating the injectors using a relatively simple rule which can be summarized as follows.
Taking the physical properties of the fuel (viscosity and density) and the difference in pressure between the pressure of the fuel and the pressure in the inlet manifolds as constant, the quantity of fuel injected only depends on the "opening time" of the injector.

The injection/ignition system basically performs the following functions:

- adjusting the injection times;
- adjusting the ignition advances;
- controlling cold starting;
- controlling enrichment during acceleration;
- fuel cut-off during overrun;
- controlling the engine idle speed;
- restricting the maximum number of revs;
- controlling combustion via the Lambda sensor;
- fuel vapour recovery;
- detonation control;
- phase transformer control;
- inlet manifold control;
- system self-adjustment;
- autodiagnosis;
- connection with engine immobilizer device (Fiat CODE);
- management of the climate control system;
- management of the radiator fans.

SYSTEM MANAGEMENT STRATEGIES

Adjustment of injection times

Digital technology has made it possible to ensure optimum consumption and performance using programmed maps, stored inside the control unit memory, according to the engine speed and load conditions.
The control unit operates the injectors with great speed and precision, calculating the opening time on the basis of the engine load (number of revs and air flow rate), also taking into account the battery voltage and the temperature of the engine coolant.
The injection is sequential and phased for each cylinder (the moment of injection is not simultaneous for all cylinders) and takes place at the optimum injection point.

Ignition advance adjustment

Thanks to a map stored in its memory, the control unit is capable of calculating the advance according to the engine load (minimum, partial, full - on the basis fo the engine speed and air flow rate), the temperature of the intake air and the temperature of the engine coolant.
The ignition can be selectively delayed at the cylinder as required, recognized by means of the combination of values recorded by the cam angle and detonation sensors.

Controlling cold starting

Under these circumstances there is a natural weakening of the mixture as a result of the poor turbulence of the particles of fuel at low temperature and reduced evaporation and condensation on the internal walls of the inlet manifold, all of which is exacerbated by the increased viscosity of the lubricant oil.
The electronic control unit recognizes this condition and corrects the injection time according to the signal for the coolant temperature, the intake air temperature, the battery voltage and the engine speed.
The ignition advance is only dependent on the number of revs and the temperature of the engine coolant.
During cold starting, the control unit carries out an initial simultaneous injection for all the injectors (full group) and, after recognizing the reference on on the flywheel, it switches to normal sequential, phased operation. Warm starting takes place immediately in a sequential, phased manner.

Controlling the enrichment of the mixture during acceleration

The control unit detects the request for acceleration from the signal from the accelerator pedal potentiometer and consequently increaes the injection times and modifies the opening of the butterfly valve to reach the number of revs required quickly.
If, following an acceleration request, the variation in the signal from the air flow meter exceeds a pre-set increase, the control unit, not only adapts the injection to the new requirement, but it also increases it further for several seconds to improve the responsiveness.

Fuel cut-off during overrun

When the accelerator pedal is released and beyond a pre-set engine rpm level, the injection control unit cuts off the supply to the injectors.
If there is no supply, the number of revs will start to decrease at a rate dependent on the vehicle driving conditions.
Before the idle speed is reached, the dynamics of the decreaes in the engine revs is verified.
If this is above a certain value, the fuel supply is partly restored according to a logic which involves the "soft accompaniment of the engine" during idling.

Having reached this condition, the normal functions for idling and cut-off during overrun are only reactivated when the fuel cut-off level is exceeded to ensure that the engine runs smoothly. The levels for restoring the supply and fuel cut-off vary according to the temperature of the engine.
Another fuel cut-off logic is developed in the control unit which intervenes in partial deceleration conditions, i.e. when the engine load conditions decrease.
This function is only activated if the new condition persists for a pre-set time and after the ignition advance angle has been adapted to the new situation.

Engine idle speed control

The control unit recognizes the "idle" condition (accelerator pedal released) from the signal supplied by the accelerator pedal potentiometer and according to the signals from the brake and clutch pedal switches and the electrical consumers switched on (climate control and radiator fan) and operates the butterfly valve motor to produce an idle speed of 700\26150 rpm.
The idle correction is also carried out through the variation of the ignition angle since it has a more prompt effect.
The correct self-learning of the minimum and maximum butterfly opening positions is essential for the effective control of the idle speed; it should therefore be carried out at least once in production and every time the engine control unit or the motorized butterfly casing is replaced.
The self-adjustment function makes it possible to adapt the idle adjustment to any variations in the idle management components.

Restricting the maximum number of revs (protection outside of revs)

When the engine speed exceeds 6,800 rpm, the electronic control unit reduces the operating times for the injectors to avoid overloading the engine also protecting it outside of revs.
If the engine speed exceeds 7,000 rpm, the control unit activates the "fuel cut-off" strategy, restoring the operation of the injectors when the speed goes below a certain level.

Controlling combustion via the Lambda sensor

The Lambda sensor informs the control unit of the quantity of oxygen present at the exhaust and therefore the correct air/fuel metering by means of a two stage voltage signal corresponding to a poor and rich mixture.
To produce the ideal mixture for the operation of the three-way catalyzer with minimal emissions, the petrol injected must correspond to a pre-set (stoichiometric ratio) with the intake air, measured by the unitary value of the Lambda parameter (=1); if the mixture is lean it is > 1, if it is rich is it < 1.
The Lambda sensor, in contact with the exhaust gases, produces an electrical signal whose voltage depends on the concentration of oxygen in the gases:

- if the mixture is lean (> 1), the sensor supplies a low voltage (< 200 mV) and the control unit slightly increases the quantity of petrol injected;
- if the mixture is rich (< 1), the sensor supplies a high voltage (> 800 mV) and the control unit reduces the quantity of petrol injected.

The closed-loop management of the Lambda sensor allows the control unit to keep the Lambda value very close to the theoretical unitary value, also aided by appropriate self-adjustment functions.
The control unit also manages the supply of the Lambda sensor heater. In effect, on the basis of the engine load and speed conditions, the control unit processes a forecast for the temperature of the exhaust gases and consequently controls the heater supply current, restricting it to the actual requirements dependent on the engine conditions.

10.

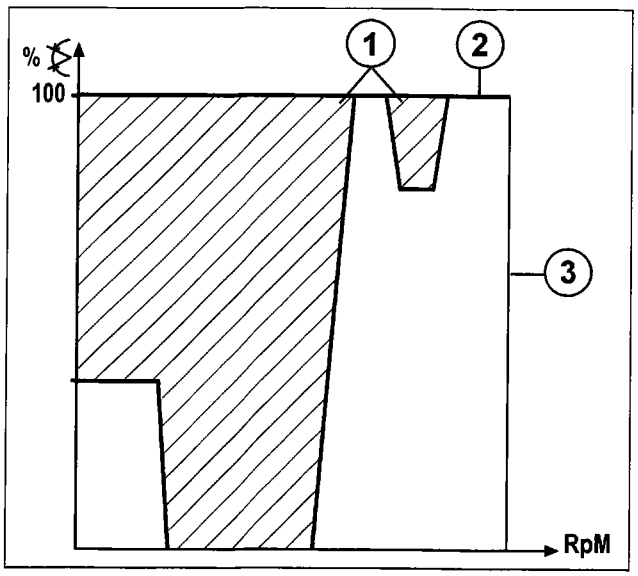
Fuel vapour recovery

The fuel vapours (pollutant according to the regulations) are sent to an active charcoal filter and from there to the engine where they are burnt; this takes place by means of a solenoid valve which is only operated by the control unit when the engine load conditions allow correct combustion without the operation of the engine being "disturbed": in effect, the control unit compensates for this quantity of petrol entering with a reduction in the injector supply.

Detonation control

This function has the task of detecting the presence of detonation (engine knock) by processing the signal coming from the sensors. The control unit continously compares the signals coming from the sensors with a set level which is, in turn constantly updated to take into account background noise and the ageing of the engine.
The control unit is therefore capable of detecting the presence of detonation (or the onset of detonation) and reduces the ignition advance (from 3° up to a maximum of about 9°) until the phenomenon disappears. Later on, the advance is gradually restored to the basic value.
In acceleration conditions, a higher level is used to take into account the increased noise of the engine in these circumstances. The detonation control strategy is also equipped with a self-adjustment function which memorizes the reductions in the advance which are continuously repeated to adapt the map to the various conditions in which the engine finds itself.

Phase transformer control



1. Transformer in ON position
2. Accelerator pedal fully depressed
3. Maximum speed restriction

The control unit controls the phase transformer hydraulic actuator solenoid valve (fitted on the inlet side camshaft) via a relay.
There are two operating positions for the transformer:

A. OFF position (power, reduced engine loads and idling), corresponding to the normal camshaft fitting value;

B. ON position (torque), corresponding to an 18\272 crankshaft advance of the camshaft.

The transformer, usually in the OFF position, is switched to the ON position depending on the engine load and speed conditions, as illustrated in the diagram.
In any case, the ON position is only enabled at coolant temperatures above 40°C.

Obviously the phase transformer control operates within a hysteresis range, i.e. the level for activating the solenoid valve is always higher than that for deactivating it; this is designed to prevent balanced conditions and too rapid a progression from one timing diagram to another with obvious operating problems.

Inlet manifold control

The control unit controls the geometry of the inlet manifolds to optimize the quantity of air drawn in by the engine.
The control unit selects short ducts for speeds above 4500 RPM and high engine loads.
In other engine operating conditions, the control unit selects the long duct configuration.

System self-adjustment

The control unit is equipped with a self-adjustment function which has the task of recognizing the changes which take place in the engine due to bedding in over time and the ageing of both the components and the actual engine.
These changes are memorized in the form of modifications to the basic map and are designed to adapt the operation of the system to the gradual alterations to the engine and components compared with when they were new.
This adjustment function also makes it possible to compensate for the inevitable differences (due to production tolerances) in components which are replaced. This allows optimum results in all vehicles without special regulation and control operations.

Autodiagnosis

The ME 3.1 injection/ignition system also has an "autodiagnostic" function which memorizes any irregularities with the sensors and actuators, facilitating their identification and correction. A fault is signalled by the special failure warning light in the instrument panel.

Connection with engine immobilizer device (Fiat CODE)

To improve protection against theft attempts, the vehicle is equipped with an engine immobilizer (Fiat CODE) which only allows the injection/ignition system to be activated by means of an electronic code.

Each time the key is turned to the OFF position, the Fiat CODE system completely deactivates the injection/ignition control unit.

When the ignition key is turned from OFF to ON, the following operations take place in the order given:

1. The injection/ignition control unit sends the Fiat CODE control unit a request for the secret code to deactivate the immobilizer 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 which contains a special transponder.
3. The recognition of the secret code allows the deactivation of the immobilizer function and the injection/ignition control unit can activate the normal system mangement programme.

A special two-way serial line allows the exchange of data between the injection/ignition control unit and the Fiat CODE control unit.
If there is a failure in the Fiat CODE system it is still possible to start up the vehicle using the emergency procedure.

Given the presence of the Fiat CODE system **DO NOT** *carry out tests using another injection/ignition control unit during the fault diagnosis and/or functional tests. Under these circumstances, the Fiat CODE control unit would transfer the (unrecognized) code to the test control unit which could then no longer be used on any other vehicles.*

10.

Management of the climate control system

The injection/ignition control unit is functionally connected to the climate control system as follows:

1. it receives the request to engage the compressor from the climate control unit via pin F6 and operates the various interventions (additional air);
2. it gives the go ahead to engage the compressor via pin F13 when the strategy conditions are verified;
3. it receives information on the four stage pressure switch status from pins F9 and F41 and operates the interventions (operation of radiator fan).

As far as point 1 is concerned, if the engine is idling, the control unit increases the flow rate of the air passing through the motorized butterfly casing before the compressor is switched on and, conversely, it returns the actual to the normal position after the compressor is switched off.

As far as point 2, on the other hand, is concerned, the control unit automatically switches off the compressor:

- for several seconds (timed disengagement):
  - in high engine power requirement conditions (fierce acceleration);
  - during engine take-off;
- as long as the following critical conditions persist:
  - at engine coolant temperatures above a certain level;
  - at engine speeds above or below a certain level.

Management of the radiator fan

The control unit directly controls the operation of the radiator fan according to the temperature of the engine coolant and the engagement of the climate control system.
The fan comes on when the temperature exceeds 98°C (1st speed) and 101°C (2nd speed). It is switched off with a hysteresis of 2°C below the temperature threshold.

AIR INTAKE CIRCUIT

The 1998 5 cylinder 20 valve version is equipped with a special air intake system. The manifold consists of two half shells and an internal rocker element (module) which, operated by a special pneumatic actuator, can assume two positions producing different inlet manifold lengths (variable geometry).

In this way it is possible to create five long (torque) ducts or five short (power) ducts.

The two different length ducts operate alternately allowing maximum volumetric efficiency at different speeds.

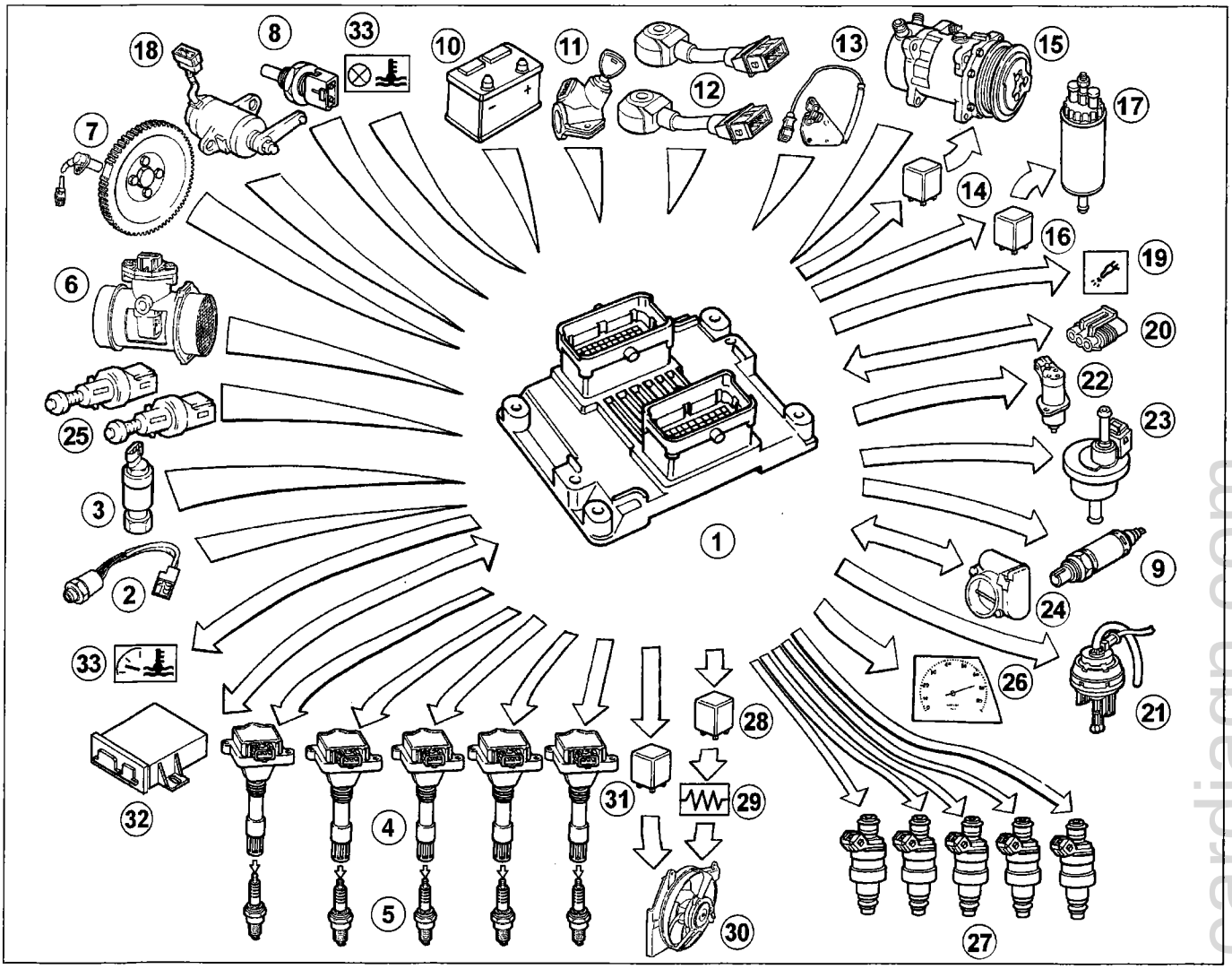
By selecting the appropriate length inlet manifold it is possible to ensure that the fluctuations in the column of gas entering are phased with the movement of the valve to increaes the inertia effect of the gaseous mass in the cylinder.

This makes it possible to achieve a better degree of filling than usual.

Obviously, the device works within a hysteresis range, i.e. the shifts from the "power" manifold and viceversa do not always take place at the same engine speed.

This is to avoid the possibility of balanced conditions being created and too rapid a succession of movements from one length to another with obvious operating problems.

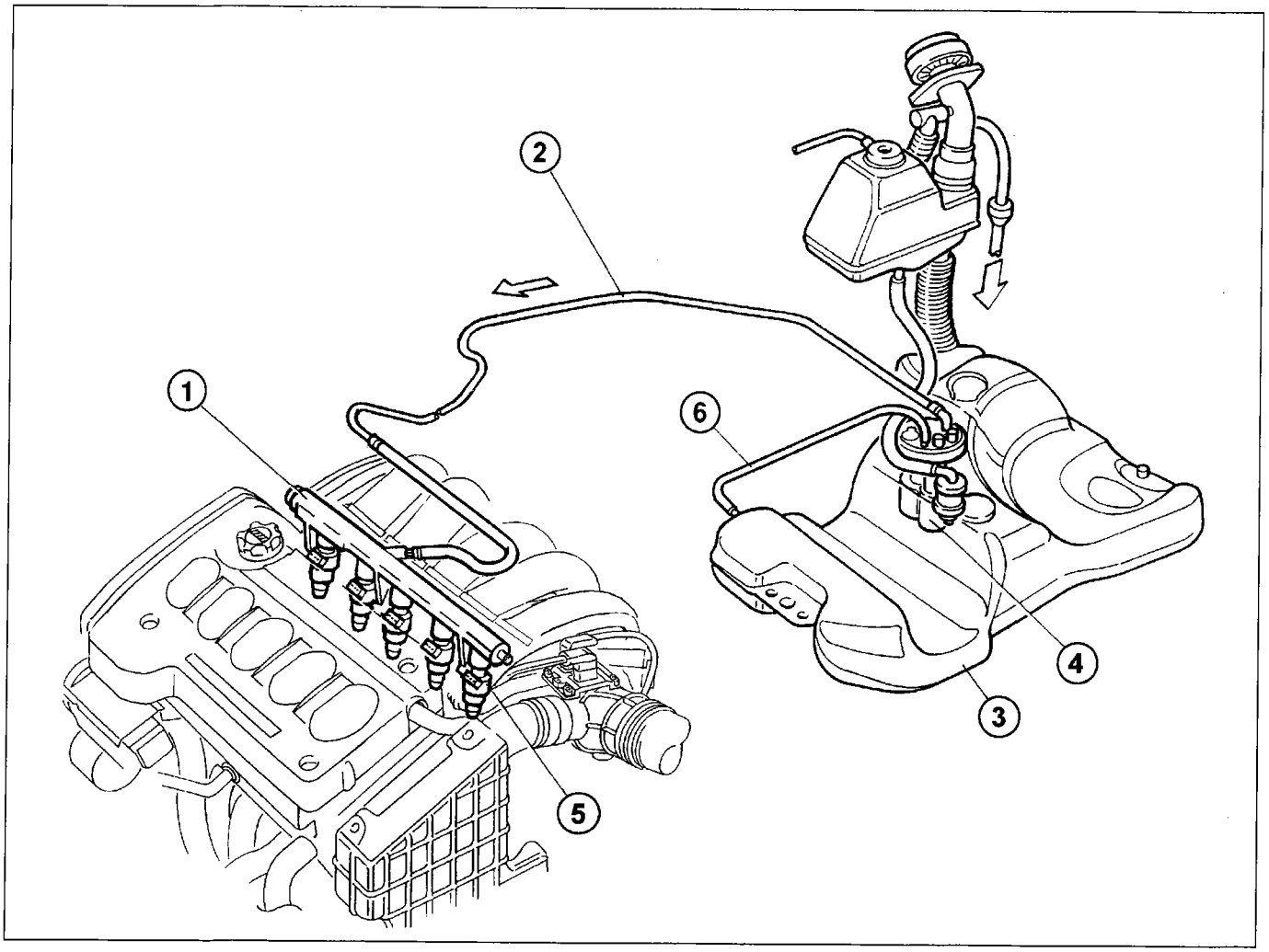
DIAGRAM SHOWING INFORMATION ENTERING/LEAVING THE INJECTION/IGNITION SYSTEM CONTROL UNIT AND SENSORS/ACTUATORS



1. Electronic control unit
2. Four stage pressure switch
3. Speedometer sensor
4. Coils
5. Spark plugs
6. Flow meter
7. Rpm sensor
8. Coolant temperature sensor
9. Lambda sensor
10. Battery
11. Ignition switch
12. Detonation sensors
13. Timing sensor
14. Air conditioning compressor relay
15. Climate control system
16. Electric fuel pump relay
17. Electric fuel pump
18. Accelerator pedal potentiometer
19. System failure warning light
20. Diagnostic socket
21. Variable geometry inlet manifold solenoid valve
22. Phase transformer solenoid valve
23. Fuel vapour solenoid valve
24. Butterfly casing actuator
25. Brake and clutch pedal switch
26. Rev counter signal
27. Injectors
28. Radiator fan 1st speed relay
29. Radiator fan 1st speed resistance
30. Radiator fan
31. Radiator fan 2nd speed relay
32. Fiat CODE control unit
33. Engine coolant temperature gauge

10.

FUEL SUPPLY CIRCUIT DIAGRAM



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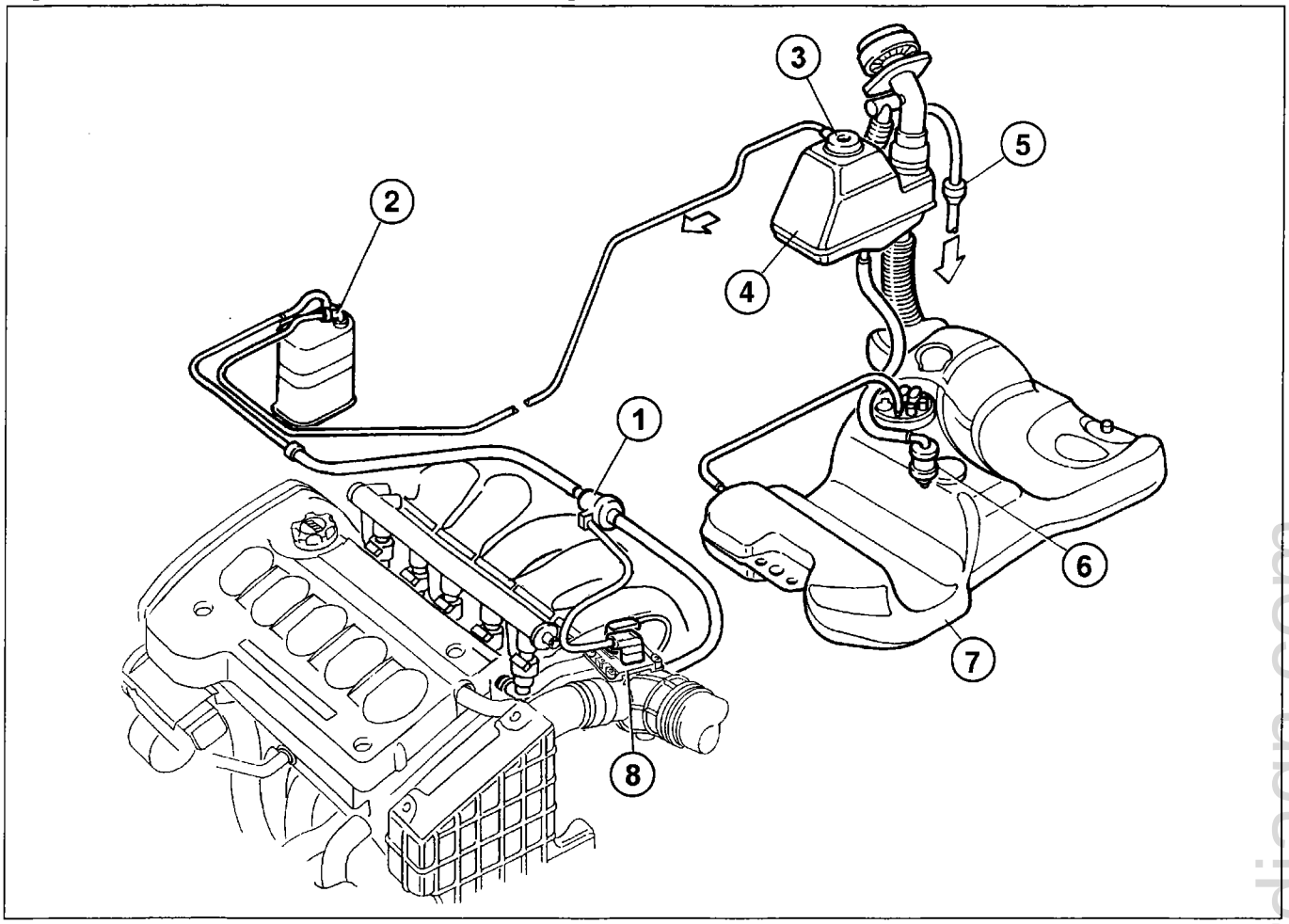
1. Fuel supply manifold
2. Fuel supply pipe to the injectors
3. Tank
4. Electric fuel pump with filter and pressure regulator
5. Injectors
6. Breather pipe

The fuel is supplied through an electric pump immersed in the tank which draws in the fuel and sends it to the filter and then to the injectors.
The fuel supply system is the returnless type, i.e. there is only one connecting pipe between the fuel tank and the engine.
This system makes it possible to:

- keep the risk of the vehicle catching fire in the case of an accident to a minimum;
- reduce the fuel vapour emissions into the atmosphere.

The electric fuel pump is enclosed by the drip tray which also incorporates the fuel pressure regulator, the fuel gauge and the fuel filter.
This system is also equipped with an inertia switch which interrupts the electric fuel pump supply if the vehicle is involved in an impact.

FUEL ANTI-EVAPORATION CIRCUIT DIAGRAM



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1. Fuel vapour cut out solenoid valve
2. Charcoal filter
3. Multi-purpose valve
4. Fuel vapour separator
5. Safety and ventilation valve
6. Float valve
7. Tank
8. Injection/ignition control unit

The anti-evaporation system is designed to prevent the fuel vapours, which are made up of the lightest fractions of hydrocarbons which form in the tank, from being discharged into the atmosphere.
The system operates above all at high outside temperatures when the temperature of the fuel increases and consequently the tendency for evaporation increases; in this situation there is an increase in pressure inside the tank (7).
In particular, even when the tank (7) is full, with the vehicle stationary the float valves (6) remain open as they are higher than the breather pipe and therefore allow the vapours to reach the separator (4), from where, on condensing, they mainly return to the tank (7).
If, on the other hand, the fuel splashes around whilst driving or the vehicle overturns, the float valves (6) close preventing the escape of fuel.
When the pressure inside the tank reaches about 30-40 mbar, the multi-purpose valve (3) opens and the fuel vapours reach the charcoal filter (2). The valve (3) also allows an intake of air into the tank through the charcoal filter, for example following the lowering of the fuel level with the consequent vacuum which is created inside the tank.
With the engine running, the control unit (8) operates the fuel vapour cut out solenoid valve (1), which allows the intake of vapours by the engine and the consequent scavenging of the charcoal filter (2).
If, as the result of the malfunction of one of the components, the pressure inside the tank increases dangerously, the safety valve (5), located near the cap, allows the pressure to be discharged outwards. If necessary, this valve can open in the opposite direction to ventilate the tank and prevent the vacuum reaching excessive levels.

10.

SYSTEM FOR RECIRCULATING GASES COMING FROM THE CYLINDER BLOCK/CRANKCASE (BLOW-BY)

This system controls the emission, from the cylinder block/crankcase, of breather gases consisting of air/petrol mixtures and burnt gases which escape from the piston seals in addition to lubricant oil vapours, recirculating them to the inlet.

The breather gases, directed by special partitions, rise by the engine oil filler and pass through the coils (7), under the tappet cover, where they lose part of the oil which they contain which returns to the camshafts, via the pipe (6), in the form of droplets.

The pipe (6) is a siphon shape to avoid the escape of breather gases
and only allow the recirculation of the oil droplets.

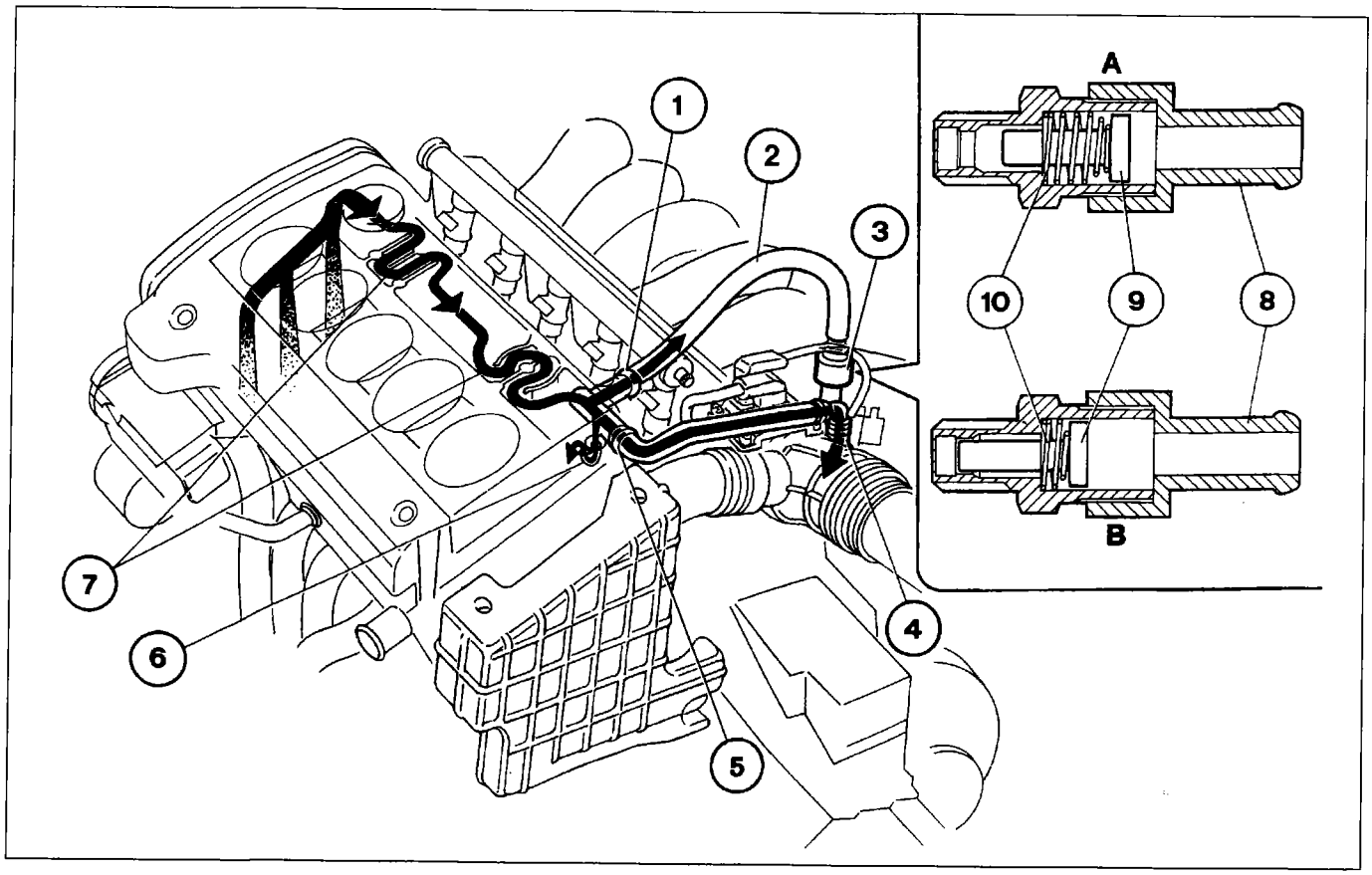
With the butterfly open, the gases escape through the outlet (5) and are sent, via the connector (4) on the air hose, upstream of the butterfly valve, to the manifold.

With the butterfly closed, the vacuum in the inlet manifold draws in the gases through the intake (1) and, via the pipe (2), they reach the connector (3) on the inlet manifold which contains a PCV valve (8) (Positive Crank Ventilation) which shutters the intake.

The PCV valve can be modulated and the quantity of gas which passes through is proportional to the vacuum in the inlet manifold.

When the butterfly valve is completely open (condition A), the vacuum inside the inlet manifold is minimal, the spring (10) is fully extendd and the PCV valve allows the maximum flow of breather gases.

Conversely, with the butterfly completed closed (condition B), the vacuum inside the manifold is maximum, which causes the movement of the piston (9) which shutters the flow of breather gaess inside the PCV valve thereby restricting the intake of gases into the manifold.



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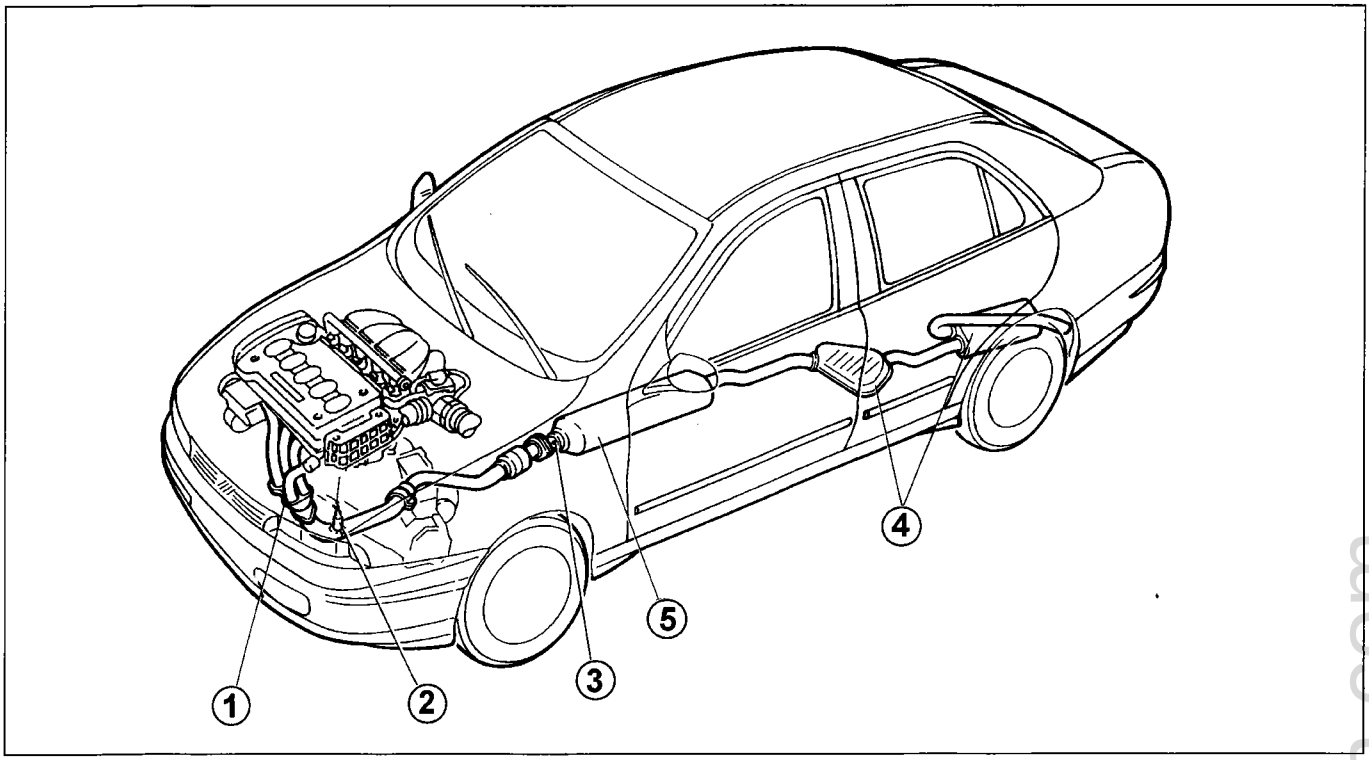
ENGINE EXHAUST ASSEMBLY DIAGRAM



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1. Exhaust manifold
2. Lambda sensor
3. Catalytic silencer
4. Silencers
5. CO intake

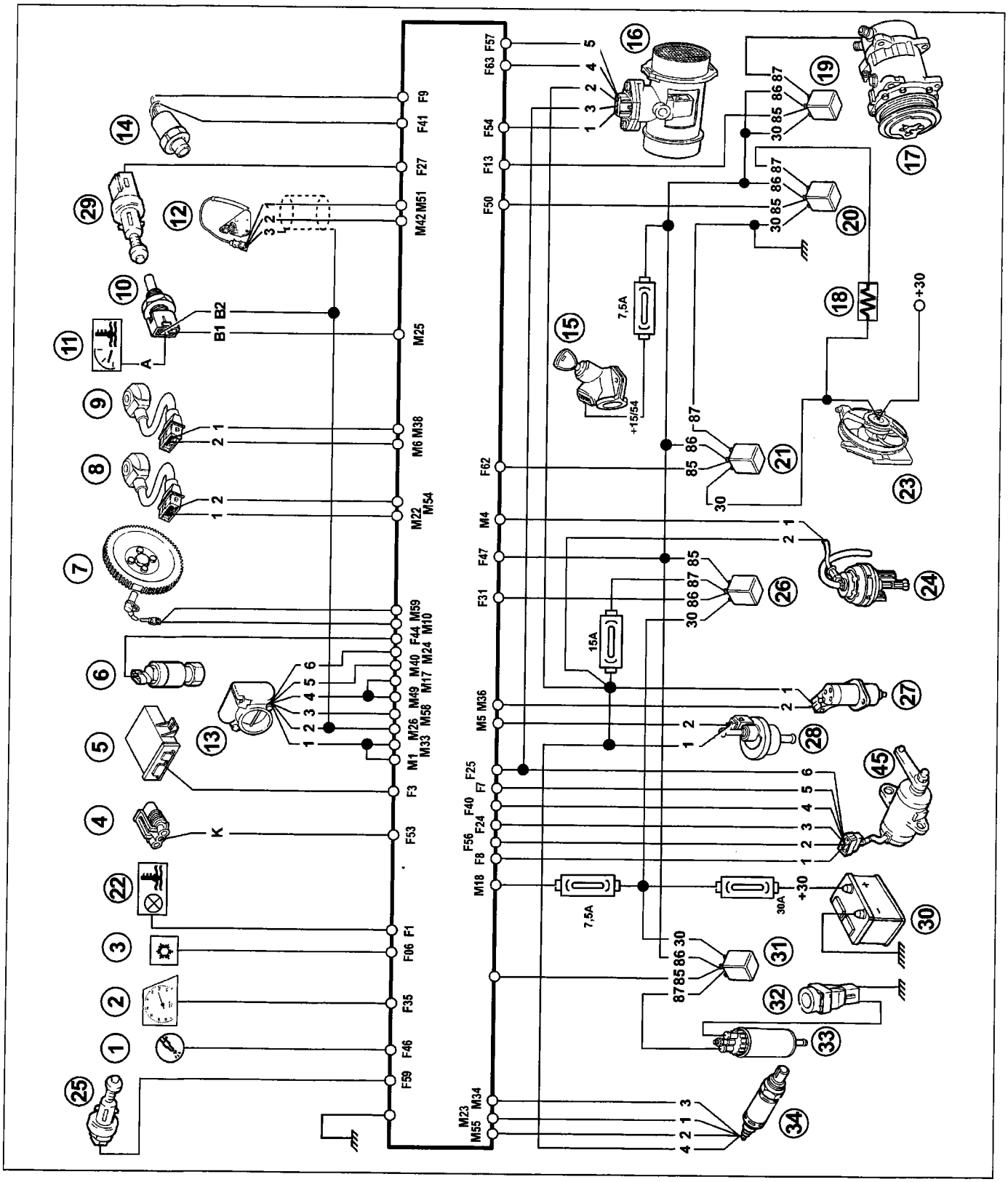
The closed-loop control of the mixture strength is activated by the Lambda senor which measures the oxygen content of the exhaust gases upstream of the catalytic silencer.
The Lambda sensor measurements allow the electronic control unit to continuously correct the quantity of petrol injected keeping the air/fuel ratio constant.
This means that the harmful exhaust emissions are controlled, a task completed by the three-way catalytic converter (silencer).
The efficient operation of the catalytic silencer and the consequent restriction of the toxic exhaust gases depends on the air/fuel ratio being received by the engine.
The three-way catalytic converter makes it possible to simultaneously keep down the levels of the three pollutant gases present in the exhaust gases: unburnt hydrocarbons (HC), carbon monoxide (CO) and nitrogen oxides (NOx).
Two types of chemical reaction take place inside the converter:
- oxidation of the CO and HC, converted into carbon dioxide (CO_2) and water (H_2O);
- reduction of the NOx, converted into nitrogen (N_2)

The following can put the catalytic converter out of action and damage it irreparably:
- the presence of lead in the petrol which lowers the degree of conversion to such an extent that the presence of the catalytic converter in the system is rendered superfluous;
- the presence of unburnt petrol in the converter: in effect a flow of petrol lasting 30s in an ambient of 800 °C (temperature inside the silencer) is sufficient to cause the catalyzer to melt and break.

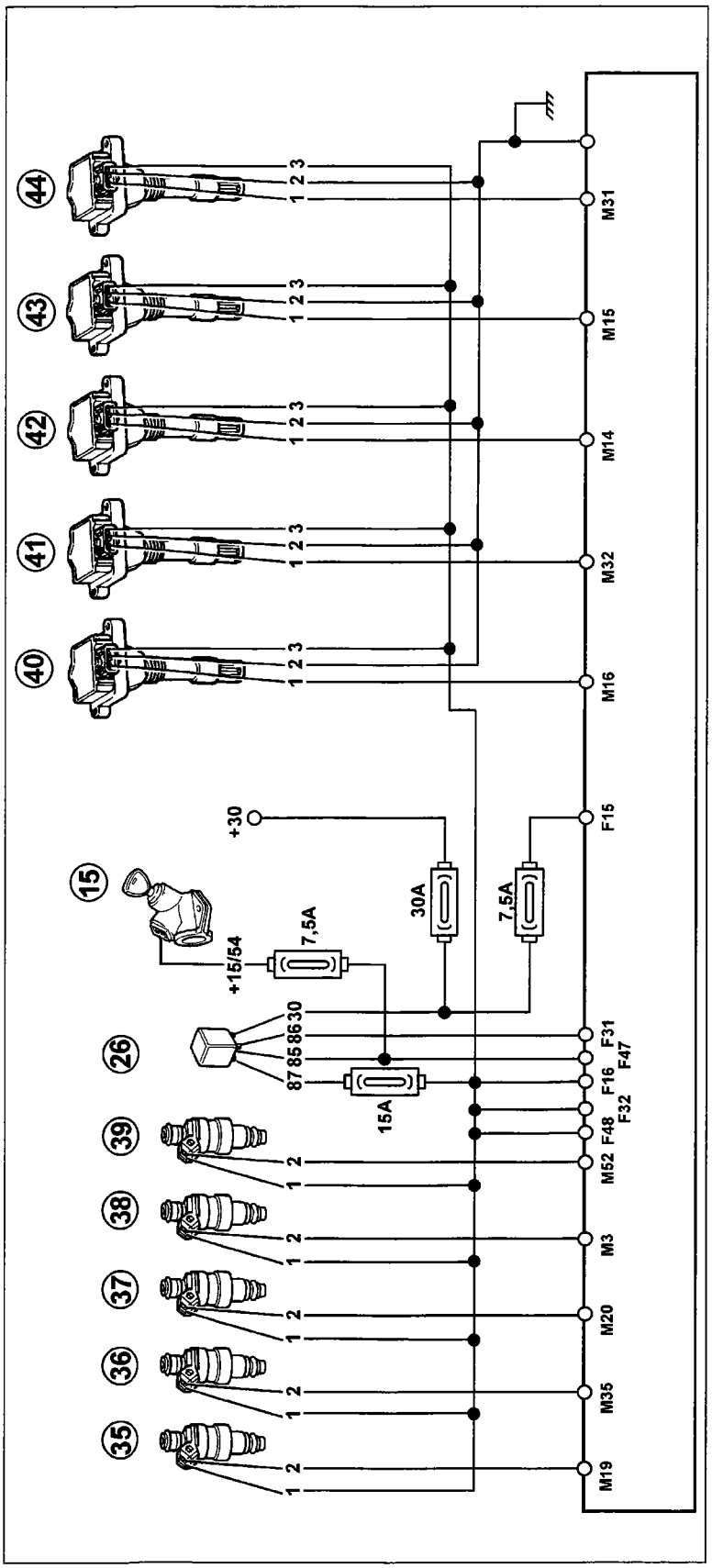
It is vital for the injection/ignition system to be working perfectly, therefore **the spark plug leads should not be disconnected, for any reason, with the engine running and the catalytic converter should be replaced with an equivalent length of pipe when carrying out tests.**

10.

INJECTION/IGNITION SYSTEM WIRING DIAGRAM



Control unit/ignition coil and injector connection



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Key:

1. Injection/ignition system failure warning light
2. Rev counter signal
3. Climate control engagement
4. Fiat CODE control unit
5. Vehicle speed senor
6. Engine rpm and TDC sensor
7. Detonation sensor 1
8. Detonation sensor 2
9. Engine coolant temperature sensor
10. Timing sensor
11. Butterfly casing actuator
12. Four stage pressure switch
13. Ignition switch
14. Flow meter
15. Air conditioning compressor
16. Flow meter
17. Air conditioning compressor
18. Radiator fan 1st speed resistance
19. Air conditioning compressor electro-magnet coupling relay
20. Radiator fan 1st speed relay
21. Radiator fan 2nd speed relay
22. Engine coolant temperature overheating warning light
23. Radiator fan
24. Variable geometry manifold fan
25. Clutch pedal switch
26. Injection/ignition system relay feed
27. Phase transformer solenoid valve
28. Fuel vapour solenoid valve
29. Brake pedal switch
30. Battery
31. Electric fuel pump and Lambda sensor relay
32. Inertia switch
33. Electric fuel pump
34. Lambda sensor

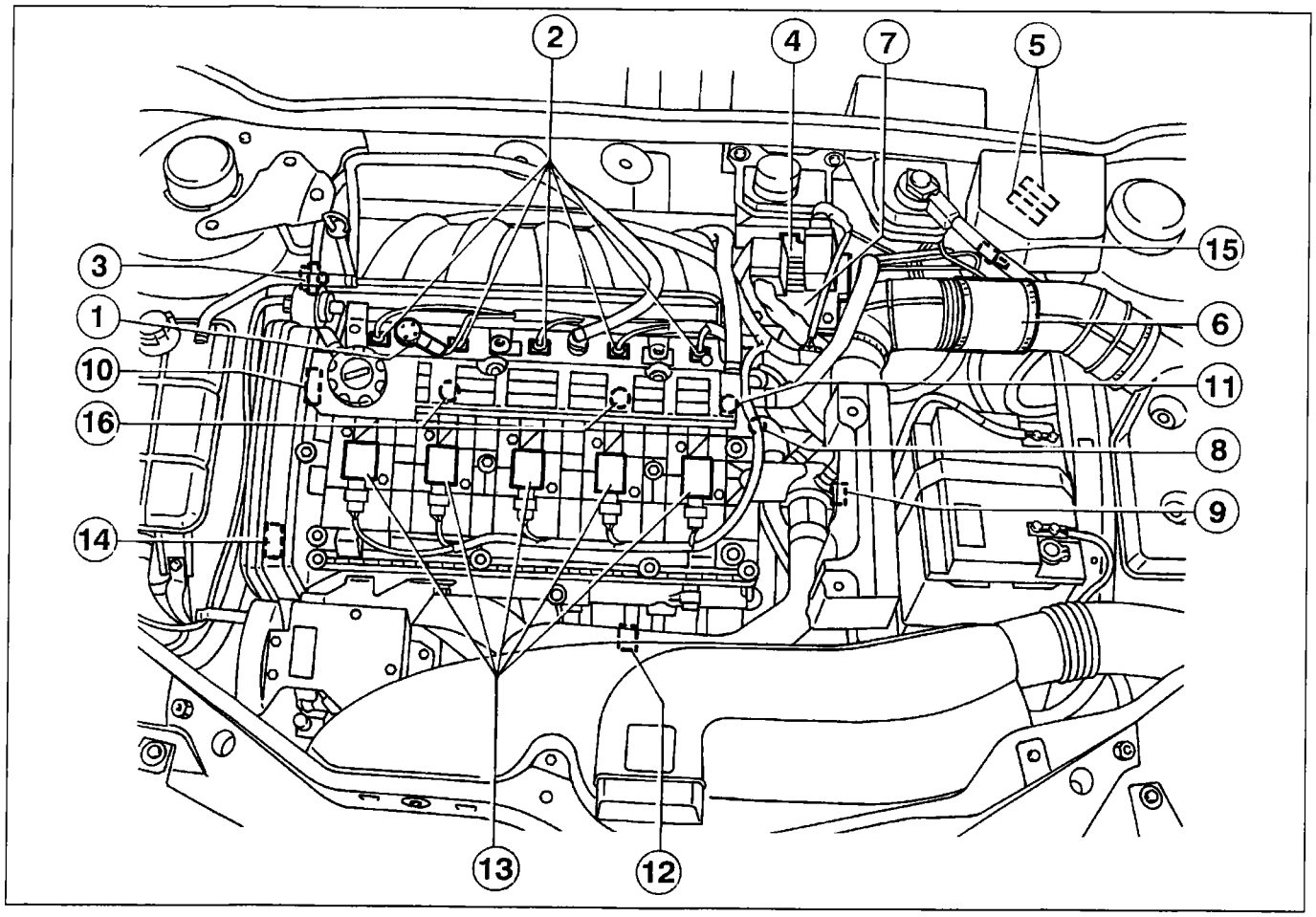
35-39. Inectors No. 1 to 5

40-44. Ignition coils for cylinders No. 1 to 5

45. Accelerator pedal potentiometer

10.

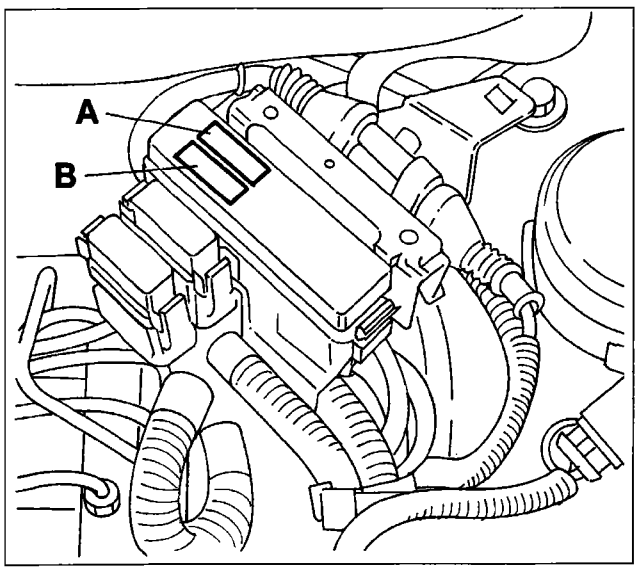
LOCATION OF INJECTION/IGNITION SYSTEM COMPONENTS



4A16LJ01

Key

1. Phase transformer solenoid valve
2. Injectors
3. Fuel vapour cut out solenoid valve
4. Injection/ignition control unit
5. General system protective fuse
6. Flow meter/air temperature sensor
7. Motorized butterfly casing
8. Engine coolant temperature sensor
9. Vehicle speed sensor
10. Variable geometry manifold actuator solenoid valve
11. Rpm sensor
12. Lambda sensor
13. Ignition coils
14. Timing senor
15. Diagnostic socket
16. Detonation sensors



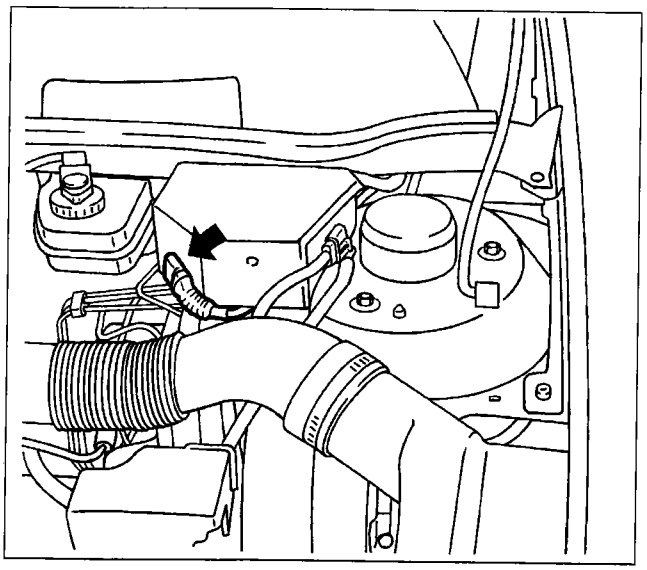
4A22JJ01

FUSES AND RELAYS

NOTE for further information, see Group 55 - Electrical equipment

Main fuses (maxi-fuse)

A. system fuse
B. fuse controlled by the ignition



4A15JJ01

DIAGNOSTIC SOCKET

The exchange of data between the injection/ignition control unit and the diagnostic equipment takes place via a two-way serial line (line K) using the standard Bosch communication protocol.

The positive logic transmission and the coding of the data is carried out through the NRZ methods (Non Return Zero) at a rate of 4.8 kbaud (208 µs/bit ± 5%)

Location of diagnostic socket

The arrow in the diagram shows the location of the diagnostic socket.

INJECTION/IGNITION SYSTEM COMPONENTS

The injection/ignition system mainly consists of wiring, an electronic control unit (I.E. control unit) and the following sensors/actuators:

Sensors

- Speedometer sensor
- Rpm and T.D.C. sensor
- Detonation sensors
- Engine coolant temperature sensor
- Timing sensor
- Butterfly valve position sensor (integrated in the butterfly casing actuator)
- Intake air temperature sensor
- Intake air temperature and flow rate sensor (flow meter)
- Lambda sensor
- Accelerator pedal potentiometer
- Brake pedal switch
- Clutch pedal switch
-

Actuators

- Butterfly casing actuator
- Phase transformer solenoid avlve
- Fuel vapour cut out solenoid valve
- Variable geometry manifold solenoid valve
- Electric fuel pump (including filter and pressure regulator)
- Injectors
- Ignition coils
- Spark plugs

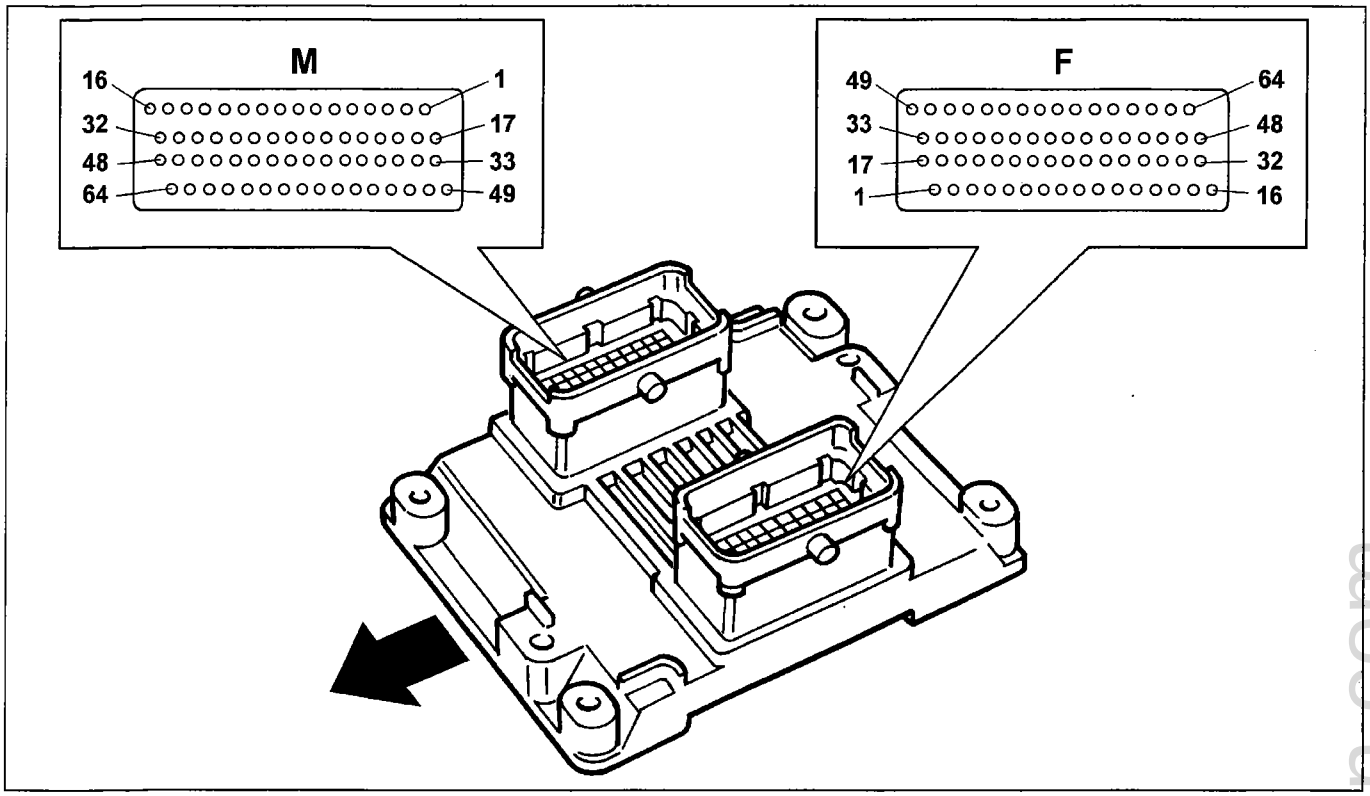
INJECTION/IGNITION SYSTEM WIRING

The different system components are connected by two distinct sets of wiring.
The engine side wiring (connector M) connects the components fitted on the engine to the injection control unit; the vehicle side wiring (connector F) connects the other components to the control unit and constitutes the interface with the other vehicle wiring.
The two connectors (M and F) are the same and both have 64 pins, but it is not possible to mix up the control unit connector wiring.

INJECTION/IGNITION ELECTRONIC CONTROL UNIT

The injection/ignition electronic control unit is located in the engine compartment, fixed to a bracket at the side of the inlet manifold.
The control unit processes the signals coming from the various sensors through the application of software algorhythms and operates the actuators (in particular, the injectors and the pressure regulator) in order to ensure the best possible operation of the engine.
The control unit is the flash E.P.R.O.M. type, i.e. it can be reprogrammed from the outside without having to adjust the hardware.

Identification of control unit connections (Pin out)



4A19LJ01

Connector F

1. Engine coolant overheating warning light
2. Not connected
3. Fiat CODE control unit
4. Not connected
5. Not connected
6. Reqeust to engage climate control system compressor
7. Accelerator pedal potentiometer 1 supply
8. Accelerator pedal potentiometer 1 signal
9. Request to engage radiator fan low speed
10. Not connected
11. Not connected
12. Not connected
13. Climate control system compressor engagement
14. Not connected
15. Supply from battery
16. Supply from relay
17. Not connected
18. Not connected
19. Not connected
20. Not connected
21. Not connected
22. Not connected
23. Not connected

Connector M

1. Butterfly casing motor (-)
2. Not connected
3. Injector for cylinder 4
4. Variable geometry manifold actuator
5. Fuel vapour cut out solenoid valve
6. Detonation sensor 2 reference earth
7. Not connected
8. Not connected
9. Not connected
10. Not connected
11. Not connected
12. Not connected
13. Not connected
14. Ignition coil for cylinder 3
15. Ignition coil for cylinder 4
16. Ignition coil for cylinder 1
17. Butterfly casing motor (+)
18. Not connected
19. Injector for cylinder 1
20. Injector for cylinder 3
21. Not connected
22. Detonation sensor 1 signal
23. Lambda sensor signal

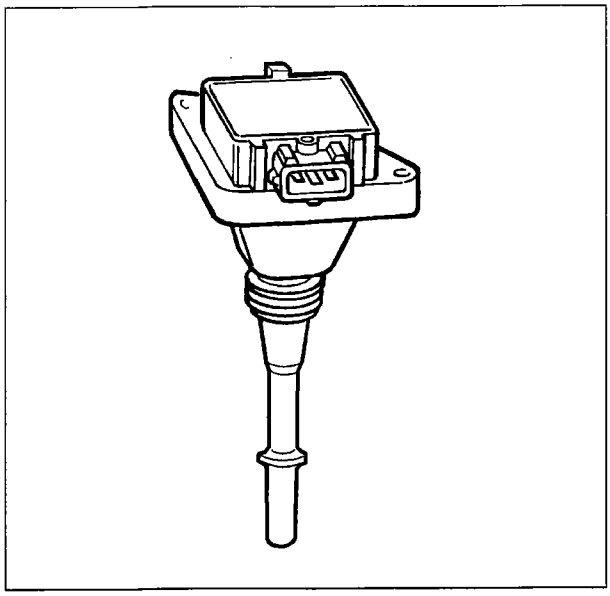
10.

Connector F

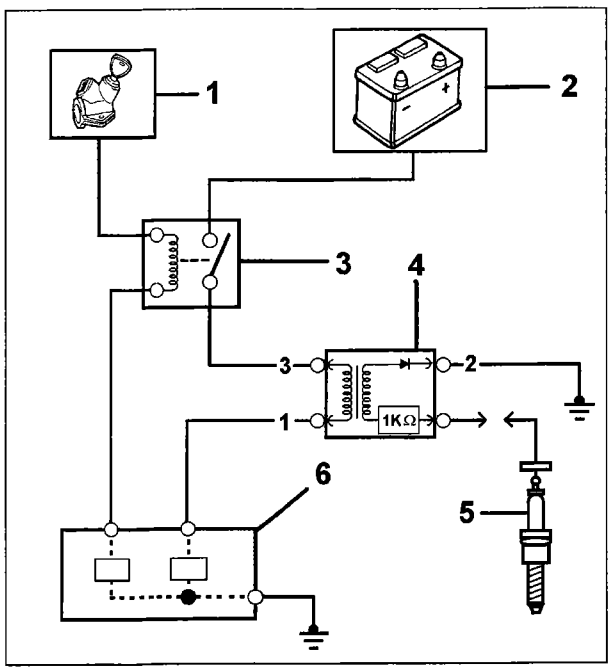
24. Accelerator pedal potentiometer 1 earth
25. Accelerator pedal potentiometer 2 earth and air flow meter
26. Not connected
27. Brake pedal switch
28. Not connected
29. Not connected
30. Electric fuel pump relay
31. Fuel system relay go ahead
32. Supply from relay
33. Not connected
34. Not connected
35. Rev counter signal
36. Not connected
37. Not connected
38. Not connected
39. Not connected
40. Accelerator pedal 2 potentiometer signal
41. Radiator fan high speed engagement request
42. Not connected
43. Not connected
44. Vehicle speed signal
45. Not connected
46. Injection system failure
47. Supply from ignition switch
48. Supply from relay
49. Not connected
50. Radiator fan low speed engagement go ahead
51. Not connected
52. Not connected
53. Diagnostic socket, line K
54. Intake air temperature signal
55. Not connected
56. Accelerator pedal 2 potentiometer supply
57. Intake air quantity signal
58. Not connected
59. Clutch pedal switch
60. Not connected
61. Not connected
62. Radiator fan high speed engagement go ahead
63. Flow meter reference voltage
64. Not connected

Connector M

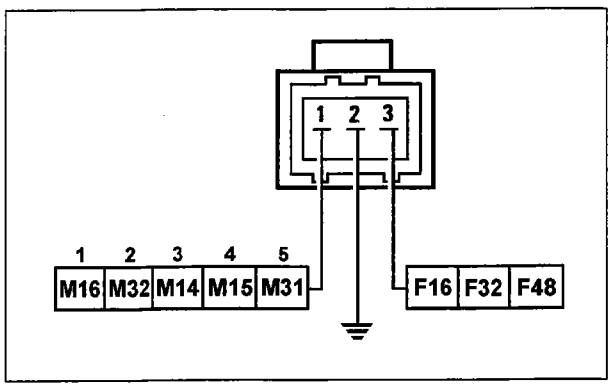
24. Butterfly casing potentiometer 1 signal
25. Engine coolant temperature
26. Temperature sensor, butterfly casing potentiometers 1 and 2 reference earth
27. Not connected
28. Not connected
29. Not connected
30. Not connected
31. Ignition coil for cylinder 5
32. Ignition coil for cylinder 2
33. Butterfly casing motor (-)
34. Lambda sensor heater earth
35. Injector for cylinder 2
36. Phase transformer solenoid valve
37. Not connected
38. Detonation sensor 2 signal
39. Not connected
40. Butterfly casing potentiometer 2 signal
41. Not connected
42. Timing sensor signal
43. Not connected
44. Not connected
45. Not connected
46. Not connected
47. Not connected
48. Not connected
49. Butterfly casing motor (+)
50. Not connected
51. Timing sensor reference voltage
52. Injector for cylinder 5
53. Not connected
54. Detonation sensor 1 reference earth
55. Lambda sensor reference earth
56. Not connected
57. Not connected
58. Buttefly casing potentiometer 1 and 2 supply
59. Engine rpm sensor
60. Not connected
61. Not connected
62. Not connected
63. Not connected
64. Not connected



4A21LJ01



4A21LJ02



4A21LJ03

IGNITION COILENS (0.221.504.014)

The ignition is the static advance electronic type with one single coil for each cylinder; this solution eliminates the high tension circuit, increasing reliability and safety and decreasing the risk of interference due to high tension leads and connectors.
It involves an ordinary coil which increases the voltage of the impulse sent to the spark plugs; each individual coil, located on the cylinder head, directly supplies a spark plug without intermediate leads.

Checking coil primary circuit resistance

The resistance is checked by connecting an ohmmeter to the connector outside pins (pins 1 and 3):

Primary resistance: 0.73 ohm

Electrical specifications

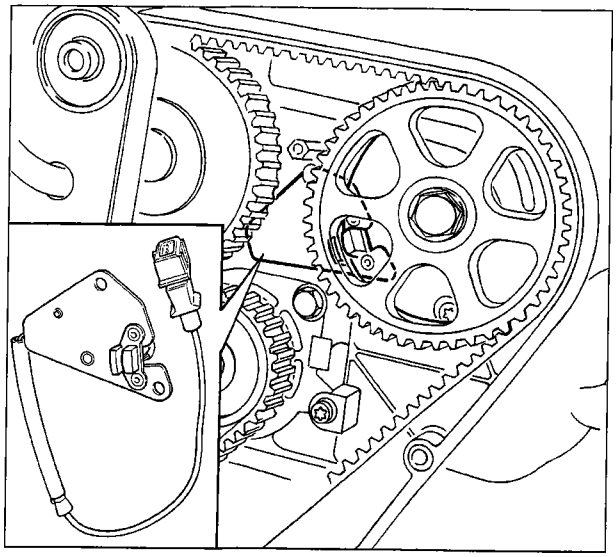
Primary winding inductace.....2.5 mH
Primary winding resistance.....0.73 Ω
Anti-interference resistance.....1 KΩ

Electrical connections wiring diagram

A. Operating signal
X. Primary winding
1. Ignition switch winding
2. Single coil
3. Electronic spark plug
4. Spark plug

Connector wiring

The numbers connector to pin 1 indicate the corresponding pins for the control unit arranged in the order of the cylinder numbers.

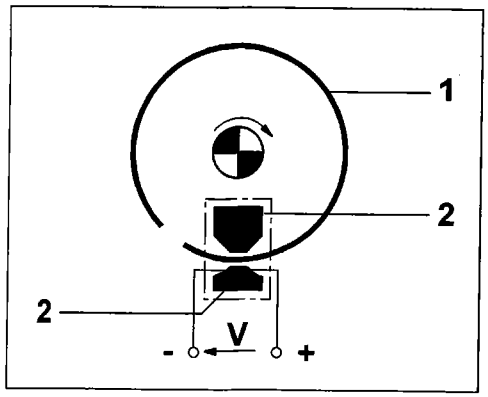


4A22LJ01

TIMING SENSOR (0.232.101.026)

The injection system in the Bosch Motronic ME 3.1 system is the phased, sequential type, i.e. the injection of the fuel takes place in sequence for each cylinder during the inlet stroke.
To achieve this, in addition to the rpm and TDC signal, the electronic control unit also uses a timing signal to determine the point of injection.
The signal sent to the control unit is produced by a Hall effect sensor fitted by the exhaut side camshaft drive pulley.

Operating principle



4A22LJ02

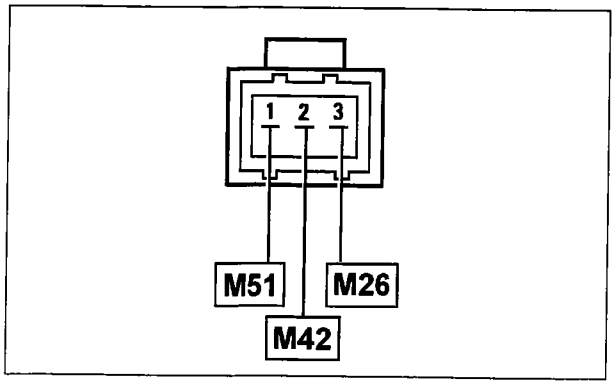
1. Deflector (pulley seal)
2. Magnetic material

A semi-conductor layer through which a current passes, immersed in a normal magnetic field (lines of force perpendicular to the direction of the current), produces a difference in power at its terminals known as HALL voltage.
If the intensity of the current remains constant, then the voltage produced only depends on the intensity of the magnetic field; the intensity of the magnetic field simply has to be periodically altered to produce a modulated electrical signal whose frequency is proportional to the speed at which the magnetic field changes.
To produce this change, a metal ring (inner part of the pulley) with an opening is passed through the sensor. As it moves, the metal part of the ring covers the sensor, stopping the magnetic field with a consequent low output signal; conversely, for the opening, where the magnetic field is present, the sensor produces a high signal.

As a result, a high signal alternates with a low signal once for every two revolutions of the engine, namely when cylinder N°1 is 78° before TDC. This signal, together with the rpm and TDC signal, allows the control unit to recognize the cylinders and determine the point of injection. For each engine revolution the control unit checks that there is a timing signal; if this signal is missing for two consecutive revolutions, the control unit signals the fault (warning light in the dashboard comes on) and does not allow the engine to be started up.

Connector wiring

The numbers indicate the corresponding control unit pins



4A22LJ03

Removing-refitting

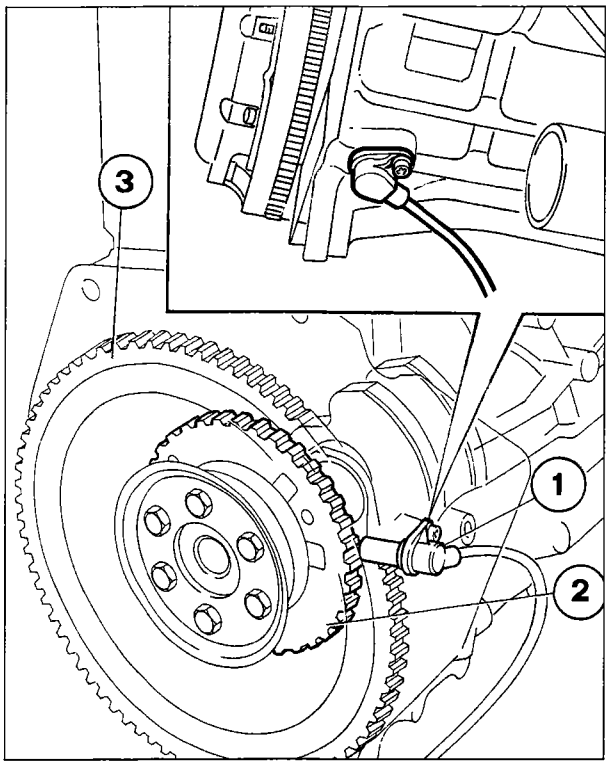
This operation involves the removal of the toothed belt from the timing system and from the exhaust side camshaft toothed pulley.

Having carried out these operations, it is necessary to:

- disconnect the electrical connector;
- undo the fixing bolts and remove the sensor.

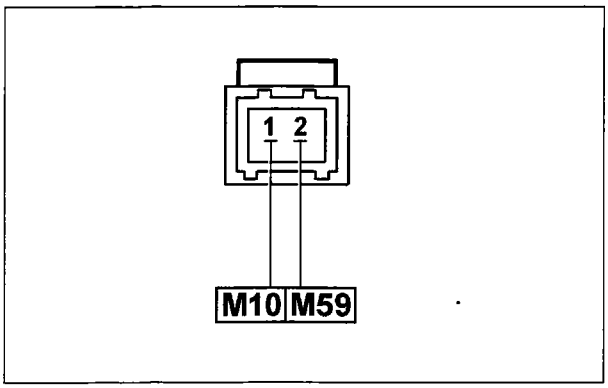
When refitting, reverse the order of the operations carried out for the removal, following the instructions for refitting and tensioning the toothed belt.

NOTE *The sensor does not require any type of adjustment*

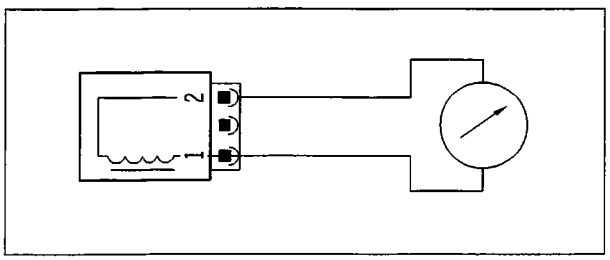


4A23LJ01

1. Rpm sensor
2. Toothed pulley
3. Engine flywheel



4A23LJ02



4A23LJ03

ENGINE RPM AND TDC SENSOR (0.261.210.160)

This sensor which measures the engine speed and TDC is the inductive type, i.e. it operates through the variation in the magnetic field produced by the passing of the teeth on a toothed pulley (flywheel) located inside the cylinder block/crankcase and fixed to the crankshaft rear counter-weight. In this way the sensor is fixed to the cylinder block/crankcase and the gap and the angular position no longer need to be checked or adjusted.

The teeth which pass in front of the sensor alter the gap between the pulley and the sensor; the dispersed flow, which varies as a result, produces an alternating voltage whose frequency depends on the number of revs.

The flywheel has 58 teeth plus a space equivalent to the missing two teeth.

The reference defined by the space for the missing two teeth constitutes the basis for detecting the point of synchronism (TDC).

Removing-refitting

Position the vehicle on a lift then, working from the underneath of the vehicle:

- disconnect the electrical connection;
- undo the bolt fixing the senor and remove it from its housing.

Connector wiring

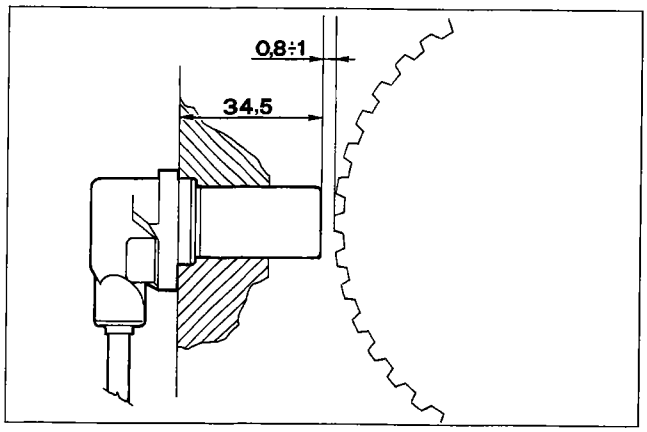
The sensor is connected to the electronic control unit (pins M10 and M59) by means of twisted cables covered by an outer casing.

The numbers indicate the corresponding control unit pins.

Checking the resistance

The sensor resistance can be measured by disconnecting the connector and connecting an ohmmeter to the sensor terminals.

Resistance: 774-946 ohm at 20°C



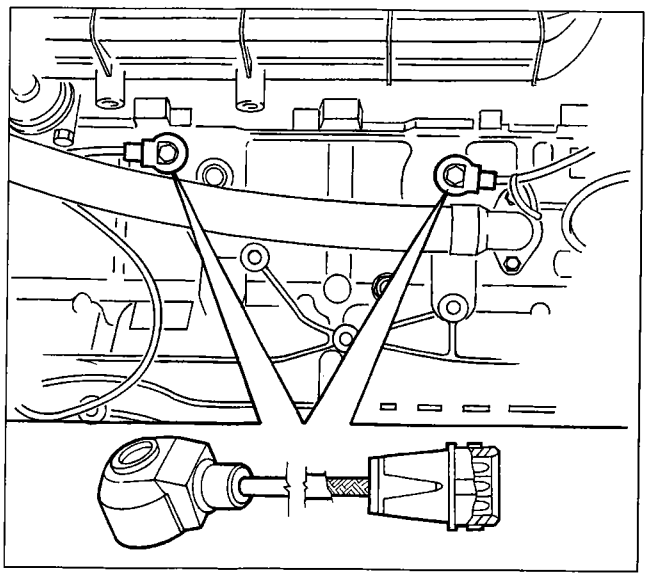
4A24LJ01

When measuring the distance it is imperative to be at right angles with the flywheel and corresponding to a tooth and not a gap.

Checking the gap

The rpm and TDC sensor is fixed directly to the cylinder block/crankcase and therefore the gap and the angular position no longer need to be adjusted. If a fault is suspected it is, however, possible to check the gap, proceeding as follows:

- remove the rpm and TDC sensor;
- check that the distance between the surface of the sensor and the flywheel tooth corresponds to the sum of the length of the sensor (34.5 mm) and the gap (0.8 - 1.5 mm).



4A24LJ02

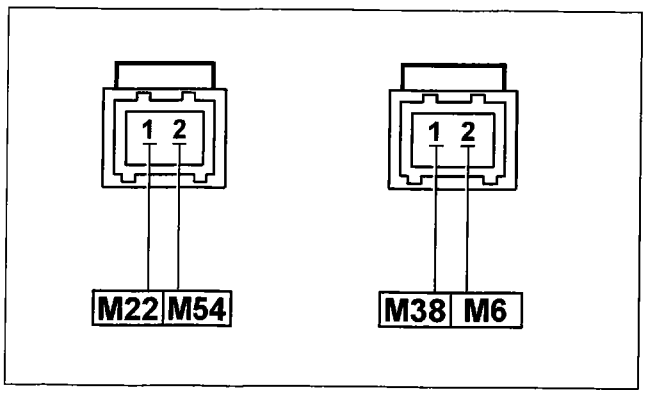
DETONATION SENSORS (0.261.231.131)

The detonation sensors are located on the monobloc under the inlet manifolds and between cylinders 1-2 and 4-5.

These sensors have a bush to prevent incorrect torque tightening.

In the case of replacement, do not place washers or shims between the cylinder block/crankcase and sensor contact surfaces.

When the engine is knocking (detonation), vibrations of a certain frequency are produced in the cylinder block/crankcase.
This phenomenon produces a mechanical repercussion on a piezoelectric crystal which sends a signal to the control unit; on the basis of this signal the control unit reduces the ignition advance (from 3° up to a maximum of 9.7°) until the phenomenon disappears. Later on, the advance is gradually restored to the basic value.

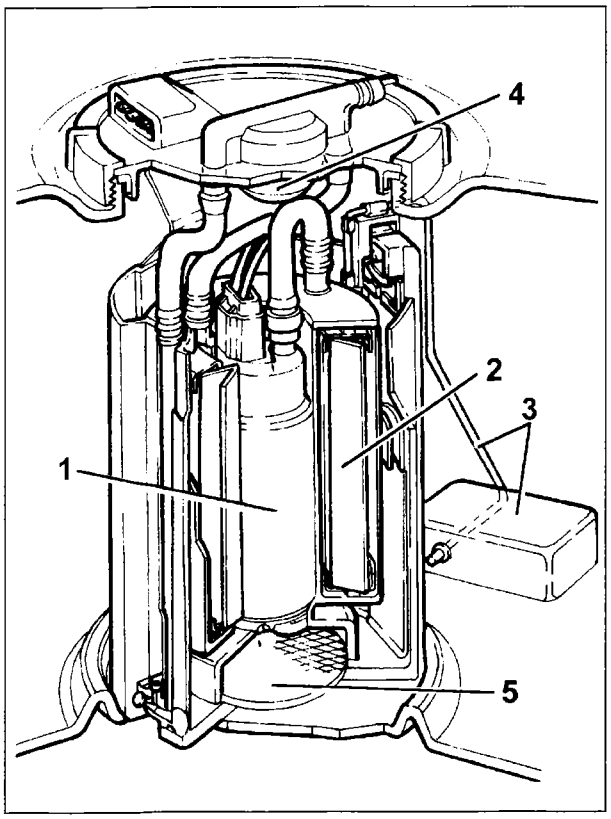


4A24LJ03

Connector wiring

The sensors are connected to the electronic control unit (Pins M22/M54 and M38/M6) by means of twisted cables with a protective outer casing.

The numbers indicate the corresponding control unit pins.



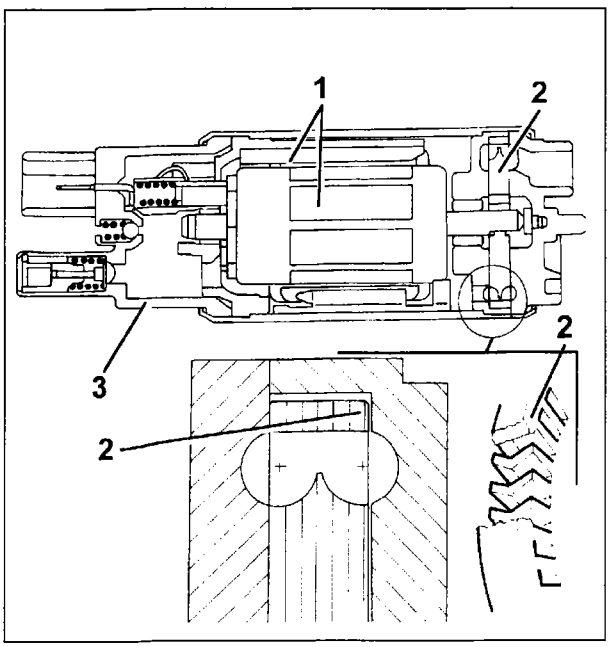
4A25LJ01

ELECTRIC FUEL PUMP (0.580.313.011)

The electric fuel pump is located inside the fuel tank, housed in a drip tray which also incorporates:

- the fuel pressure regulator;
- the fuel gauge;
- the fuel filter.

1. Electric fuel pump;
2. Fuel filter;
3. Fuel gauge with float;
4. Pressure regulator with diaphgram;
5. Gauze pre-filter;



4A25LJ02

The electric fuel pump has an electric motor with a permanent magnet (1) which operates the pump (2) impeller and a support cover (3) which contains the electrical and hydraulic connections.

The electric pump stage is the peripheral flow single type with high performance in low voltage and temperature conditions.

The advantages compared with electric pumps which operate on the volumetric principle are:

- lighter;
- smaller

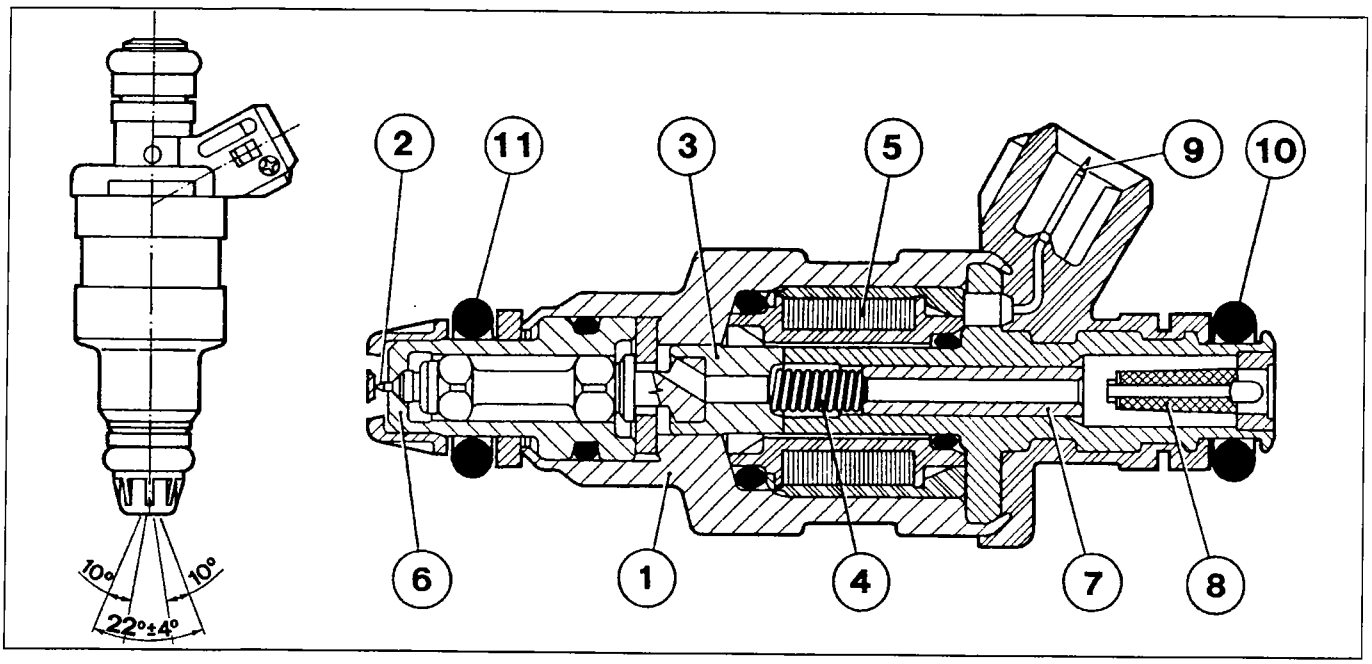
FUEL SUPPLY MANIFOLD

The fuel manifold is fixed to the inner part of the inlet manifold and its function is to send fuel to the injectors. The fuel manifold is made from die-cast aluminium and incorporates the injector seats. The fuel intake is achieved through a tapered fixing bolt.

10.

INJECTORS (0.280.155.770)

The twin jet type injectors are fitted on the inlet manifolds, immediately before the inlet valves.
These injectors are specific to engines with 4 valves per cylinder, in effect making it possible to direct the jets towards the two inlet valves.
The jets of fuel which come out of the injector at a pressure of 3 bar are instantly atomized forming two cones of about 10° each.
The operation of the injectors is the "phased, sequential" type, i.e. the five injectors are operated according to the inlet sequence of the engine cylinders, whilst the supply can already start for any cylinder during the expansion stroke until the inlet stroke has already commenced.
The injectors are fixed by the fuel manifold, which presses them into the seats in the inlet manifold. They are also secured to the fuel manifold by means of "safety clips". Two rubber seals (10) and (11) ensure the seal on the inlet manifold and the fuel manifold.

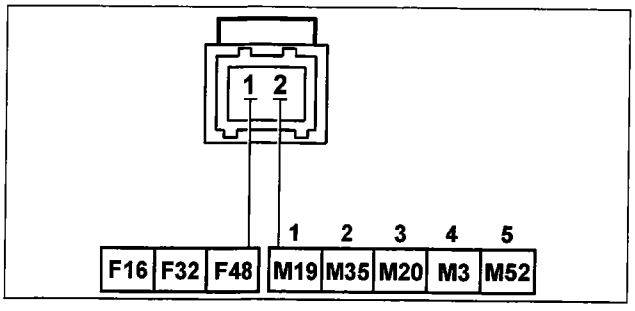


4A26LJ01

1. Injector body
2. Needle
3. Magnetic core
4. Coil spring
5. Winding
6. Injector nose
7. Adjustable spring
8. Fuel filter
9. Electrical connection socket
10. Fuel seal
11. Vacuum seal

Connector wiring

The numbers indicate the corresponding control unit pins arranged in the order of the cylinder numbers.

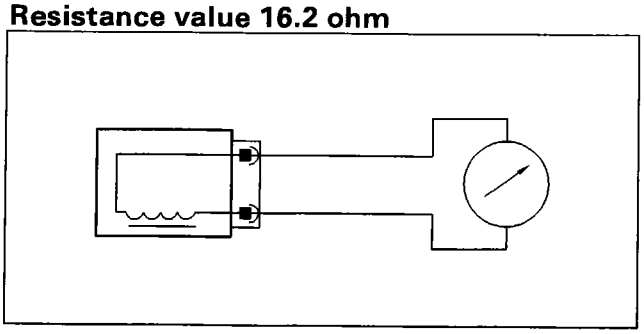


4A26LJ02

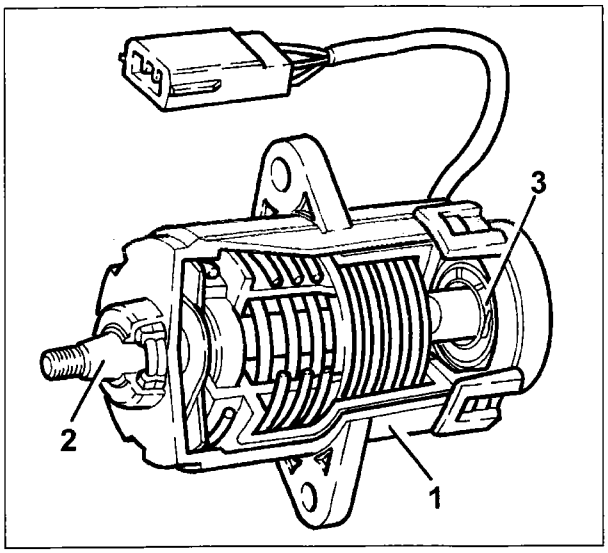
Checking the resistance

The injector resistance can be measured by disconnecting the connector and connecting an ohmmeter as illustrated in the diagram.

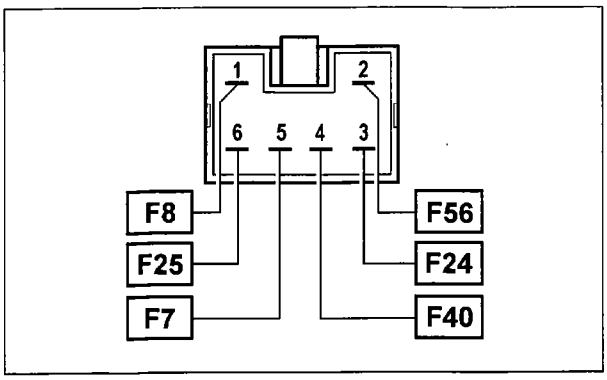
Resistance value 16.2 ohm



4A26LJ03



4A27LJ01



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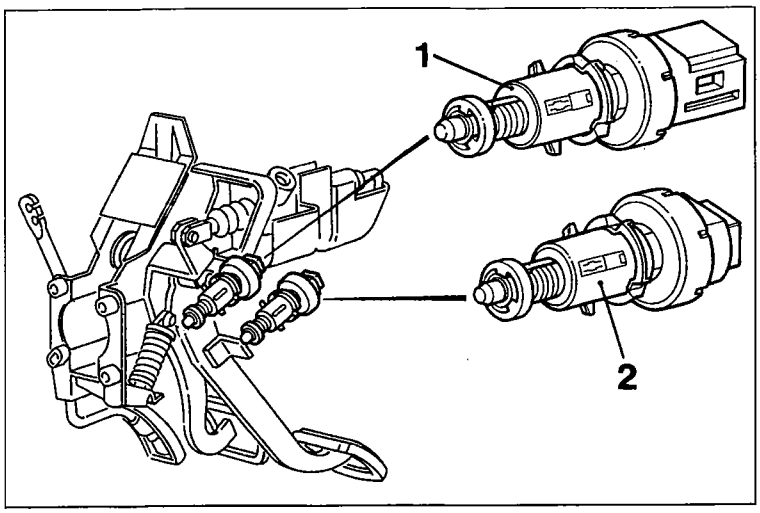


4A27LJ03

ACCELERATOR PEDAL POTENTIOMETER (0.281.002.203)

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

Connector wiring

The numbers indicte the corresponding control unit pins.

BRAKE PEDAL SWITCH

There is a switch (1) on the brake pedal which operates the brake lights; the same switch also sends a signal to pin F27 of the injection control unit.

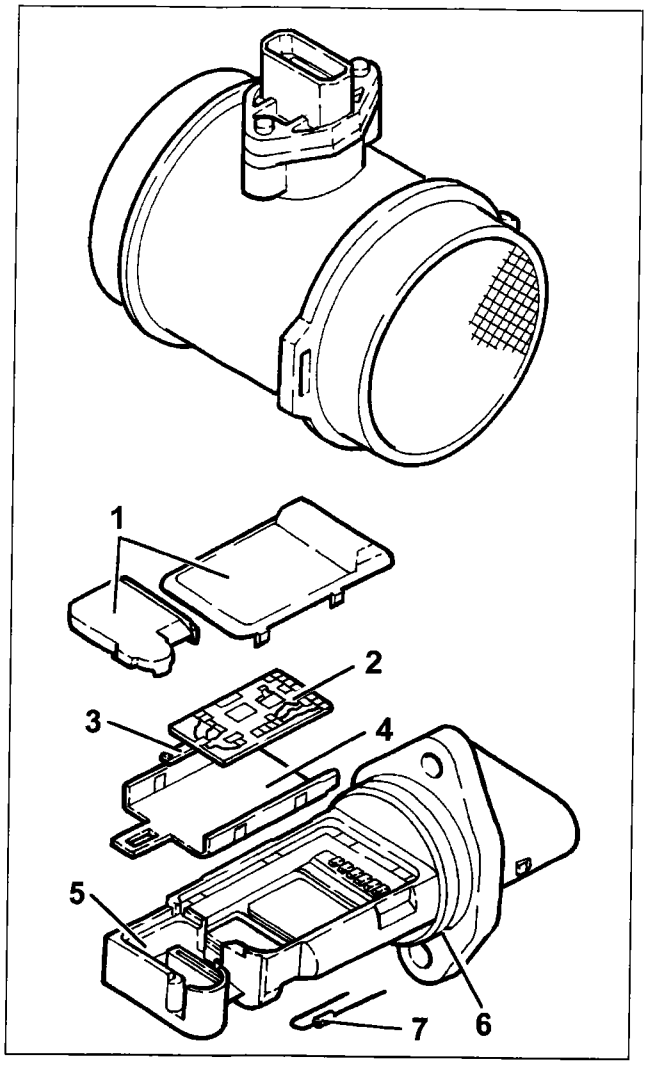
the "brake pedal pressed" signal is used by the control unit to:

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

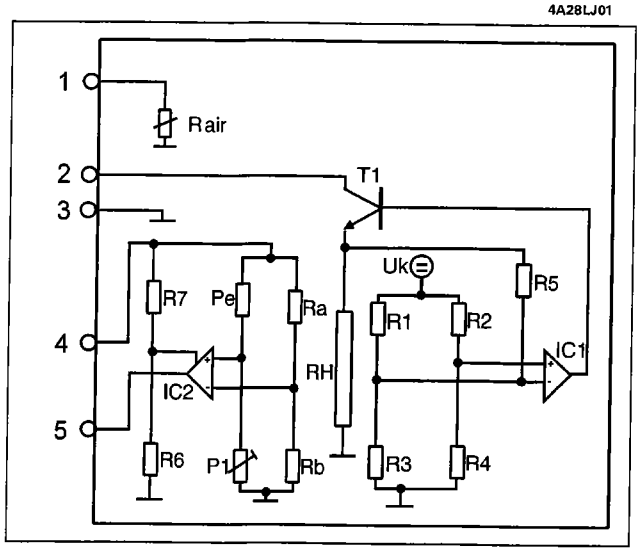
CLUTCH PEDAL SWITCH

There is a switch (2) on the clutch pedal connected to pin F59 of the injection control unit.

The "clutch pedal operated" signal is used by the injection control unit to distinguish the gear engaged and gear change conditions.



4A28LJ01



4A28LJ02

1. Air temperature signal
2. Battery voltage
3. Earth
4. Reference voltage (5V)
5. Air flow rate signal

AIR FLOW METER (0.281.002.199)

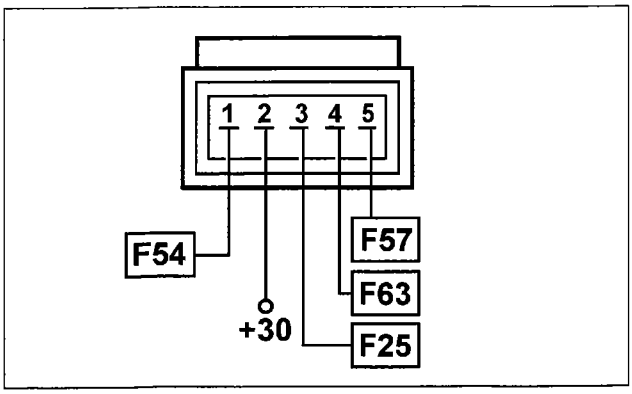
The flow meter is located on the air inlet hose and is the "heated film" type.
The intake air temperature sensor is inside the flow meter.
The operation is based on a heated diaphragm located in a measuring duct through which the intake air entering the engine flows.
The hot film diaphragm is kept at a constant temperature (about 120 °C higher than the temperature of the entering air) by the heating resistance.
The mass of air which passes 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 flow through the resistance.
This current, being proportional to the mass of air flowing to the engine, is measured by a 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

NOTE *This flow meter measures the mass of air (and not the volume) directly, thereby eliminating problems of temperature, altitude, pressure, etc.*

Description of the operation

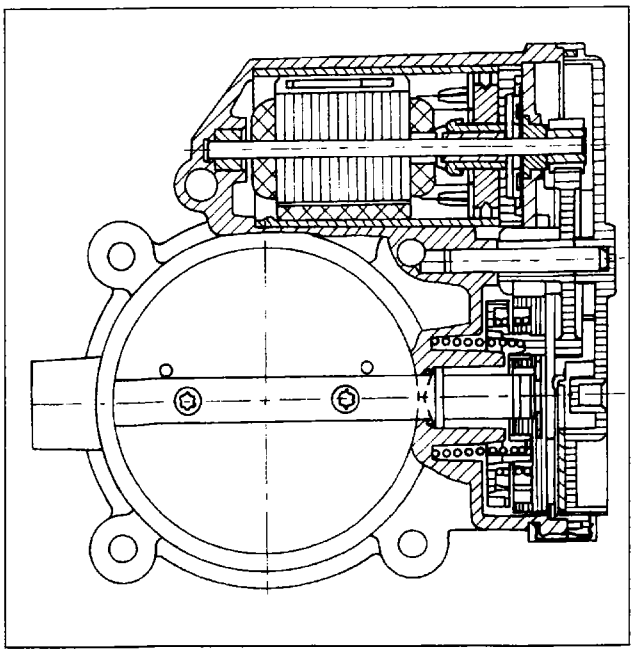
The Wheatstone bridge (made up of resistors R1,R2,R3,R4) is balanced when R3 is about 120 °C higher than the temperature of the air.
The air passing through the diaphragm removes heat from R3, therefore the bridge is unbalanced.
This situation is detected by the circuit at IC1 which operates transistor T1, in a manner which is proportional to the imbalance of the bridge, and as a result more current is directed through Rh to heat up R3 and restore the equilibrium of the bridge.
The circuit IC2 measures the current passing through Rh.
This current makes it possible to keep the bridge balanced and is consequently proportional to the mass of air passing through the air flow meter.



4A29LJ01

Connector wiring

The numbers indicate the corresponding control unit pins.

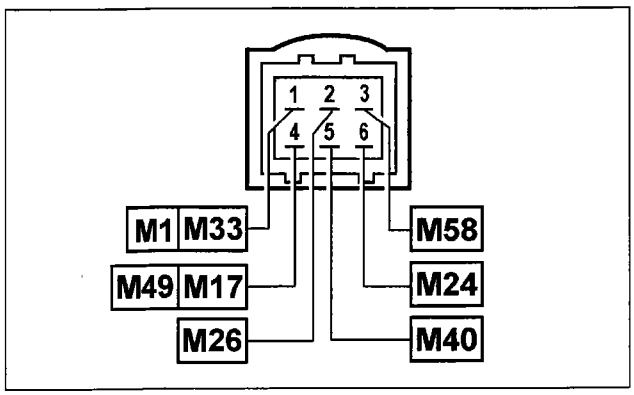


4A29LJ02

BUTTERFLY CASING ACTUATOR

The actuator is fixed to the inlet chamber and regulates the quantity of air drawn in by the engine.
According to the signal coming from the accelerator pedal potentiometer, the injection control unit controls the opening of the butterfly by means of a direct current motor incorporated in the butterfly casing actuator.
The butterfly casing actuator has two potentiometers, connected in parallel so that one controls the other and viceversa.
If the two potentiometers fail or if there is no supply, the control unit reduces the engine torque depending on the position of the accelerator pedal.
The replacement of the butterfly casing actuator or the injection control unit requires the "self-learning" procedure described below to be carried out.

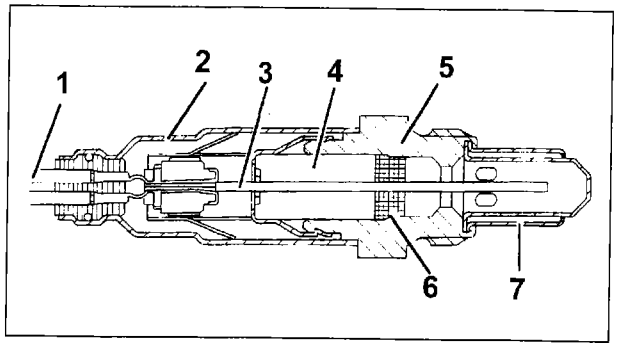
- Place the ignition key in the ON position and keep it there for 30 secs.
- Turn the ignition key to the OFF position for 5 secs.
- Turn the key to the ON position and start up the engine.



4A29LJ03

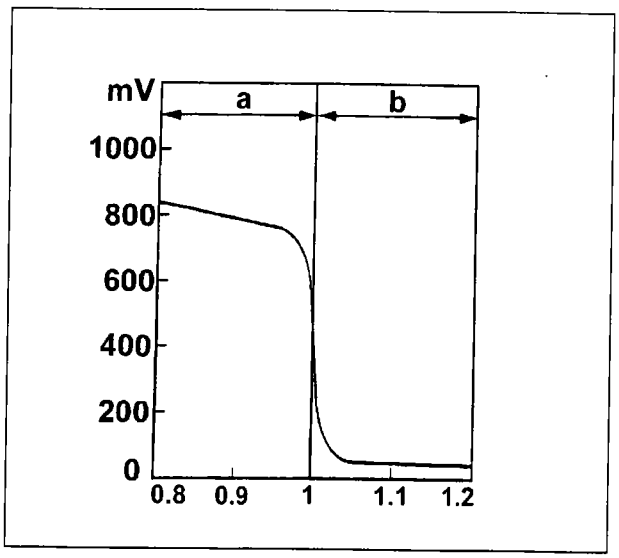
Connector wiring

The numbers indicate the corresponding control unit pins.



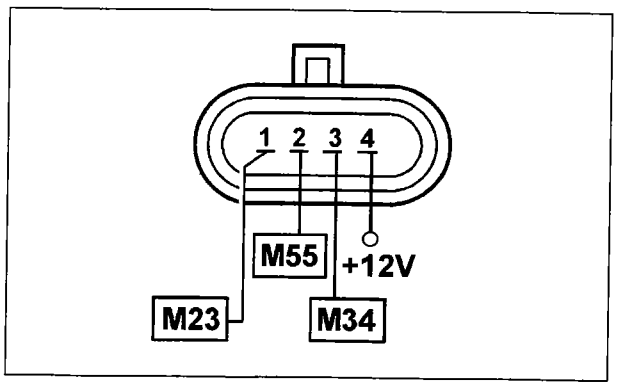
4A30LJ01

1. Connecting cable
2. Protective sleeve
3. Planar sensor element
4. Ceramic support pipe
5. Sensor housing
6. Ceramic seal
7. Protective tube



4A30LJ02

a. Rich mixture (lack of air)
b. Lean mixture (excess air)



4A30LJ03

LAMBDA SENSOR (B.258.040.092)

The Lambda sensor is the "planar" type, fitted on the front section of the exhaust pipe and informs the injection control unit of the progress of the combustion (stoichiometric ratio).
To obtain an ideal mixture the quantity of air drawn in by the engine must be equal to the theoretical amount required to burn all the fuel injected.
In this case the Lambda factor (λ) i.e. the ratio between the quantity of intake air and the theoretical quantity of air (which is required to burn all the fuel injected) is equal to 1.
Therefore:

$\lambda = 1$ ideal mixture

$\lambda > 1$ lean mixture

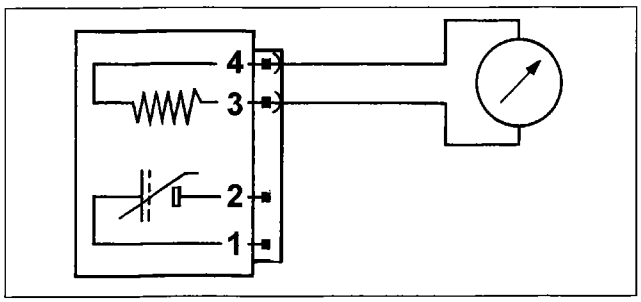
$\lambda < 1$ rich mixture

The Lambda sensor, in contact with the exhaust gases, produces an electrical signal, whose voltage value depends on the concentration of oxygen in the actual gases.
This voltage undergoes a sharp variation when the composition of the mixture shifts from the value $\lambda = 1$.
The heating of the Lambda sensor is managed by the injection control unit proportionally to the temperature of the exhaust gases.
This prevents thermal shocks to the ceramic casing due to contact with the condensed water present in the exhaust gases when the engine is cold.
The measuring cell and the heater are incorporated in the "planar" stratified ceramic element with the advantage of the rapid heating of the cell to allow the closed loop control (=1) within several seconds of the engine being started up.

Connector wiring

The numbers indict the corresponding control unit pins.

The sensor can be rapidly put out of action by the presence of even slight amounts of lead in the fuel.

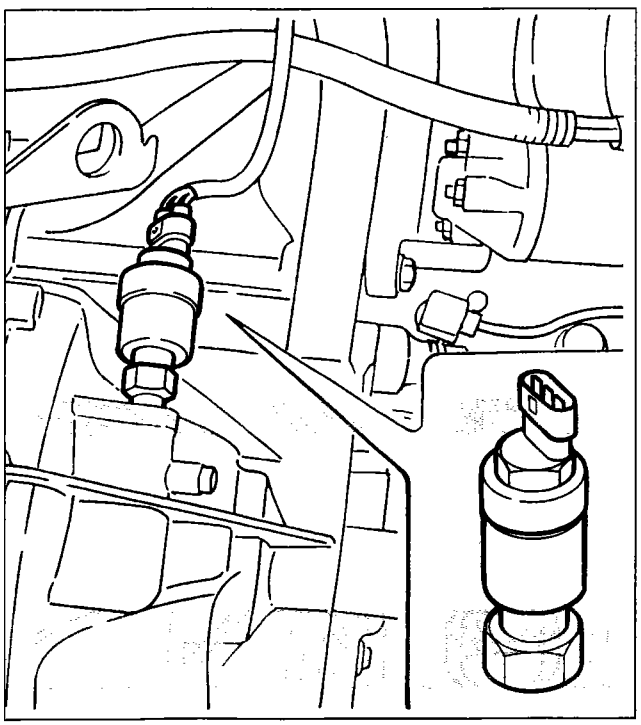


4A31LJ01

Checking the resistance

The resistance of the heater and the senor can be measured by disconnecting the connector and connecting an ohmmeter as illustrated in the diagram.

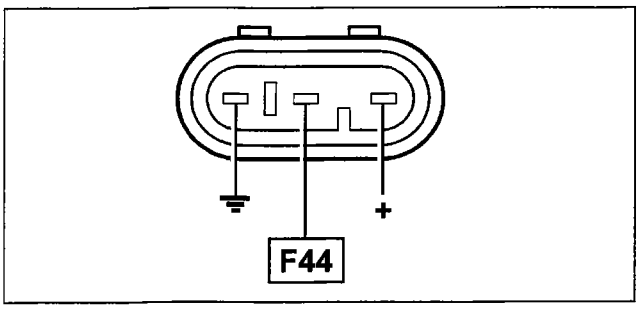
Resistance = 500-1000 ohm at 20°C



4A31LJ02

SPEEDOMETER SENSOR

The speedometer sensor (vehicle speed sensor) is located at the differential output, by the left driveshaft coupling and trasmits information concerning the vehicle speed to the control unit: the signal is also used for the operation of the speedometer.
The sensor is the Hall effect type (see "engine timing sensor" paragraph) and is calibrated so that a distance of one metre corresponds to each impulse; it is therefore possible to determine the speed of the vehicle from the frequency of the impulses.
The control unit uses this information to improve the management of the engine idle adjustment actuator and for the CUT-OFF strategy.



4A31LJ03

Connector wiring

The numbers indicate the corresponding control unit pins.

10.

PHASE TRANSFORMER

In order to ensure a good compromise between high performance in terms of power at high speeds and good torque at low speeds, this engine is fitted with an (electronically controlled, hydraulically operated) phase transformer for the inlet camshaft.

This device makes it possible to alter the timing diagram (inlet stroke) according to the engine load requirements; this parameter is processed by the MOTRONIC control unit according to the electrical signals received from the air flow meter and the rpm sensor and is sent as a command to the phase transformer electro-magnet.

The construction of the device consists of a main assembly on the inlet camshaft which is designed to alter the angular position of the shaft in relation to the drive pulley.

There is also a valve, operated by a solenoid, both of which are located on the inlet manifold and are hydraulically connected to the main assembly by means of ducts.

The operating principle is as follows:

- at coolant temperatures below 40 °C and when the engine is idling or the speed exceeds a certain level, the solenoid (1) is de-energized therefore the valve body (2), thrust by the opposing spring (3), remains raised not allowing the oil, which arrives from the duct (A), to reach the transformer.
  In this case the timing of the inlet valves remains unchanged.
  When the temperature of the coolant is above 40 °C and the engine speed is below a certain level, when the butterfly angle is greater than about 8°, the solenoid (1) is energized, pushing the valve chest (2) downwards. In this position the oil, coming from the duct (A), enters the piston chamber (B) and, from there, flows through a special port to the duct (C) inside the latter.
  The oil can only escape from the above chamber through the upper port (in contact with duct (D) supplying oil to the transformer) because as the valve body (2) is lowered, the lower port is not in contact with the drainage duct (E).
  Through ducts (D) and (F) the oil reaches the chamber (G) moving the piston (4) axially towards the engine; as a result of this axial movement the piston, which has helical teeth on the outside, is forced to rotate in a clockwise direction (as seen from the timing side).
  Its rotation is transmitted, by means of a straight-toothed splined profile, to the pinion (5) which, bolted onto the threaded end of the camshaft (6), transmits the rotation to the shaft, thereby altering the timing of the inlet valves with a 9° advance.

When the solenoid is de-energized, the valve body (2) returns to the original position, cutting off the fuel of oil under pressure to the chamber (G), but allowing the return of the oil to the exhaust, thanks to the force of the opposing spring (7).

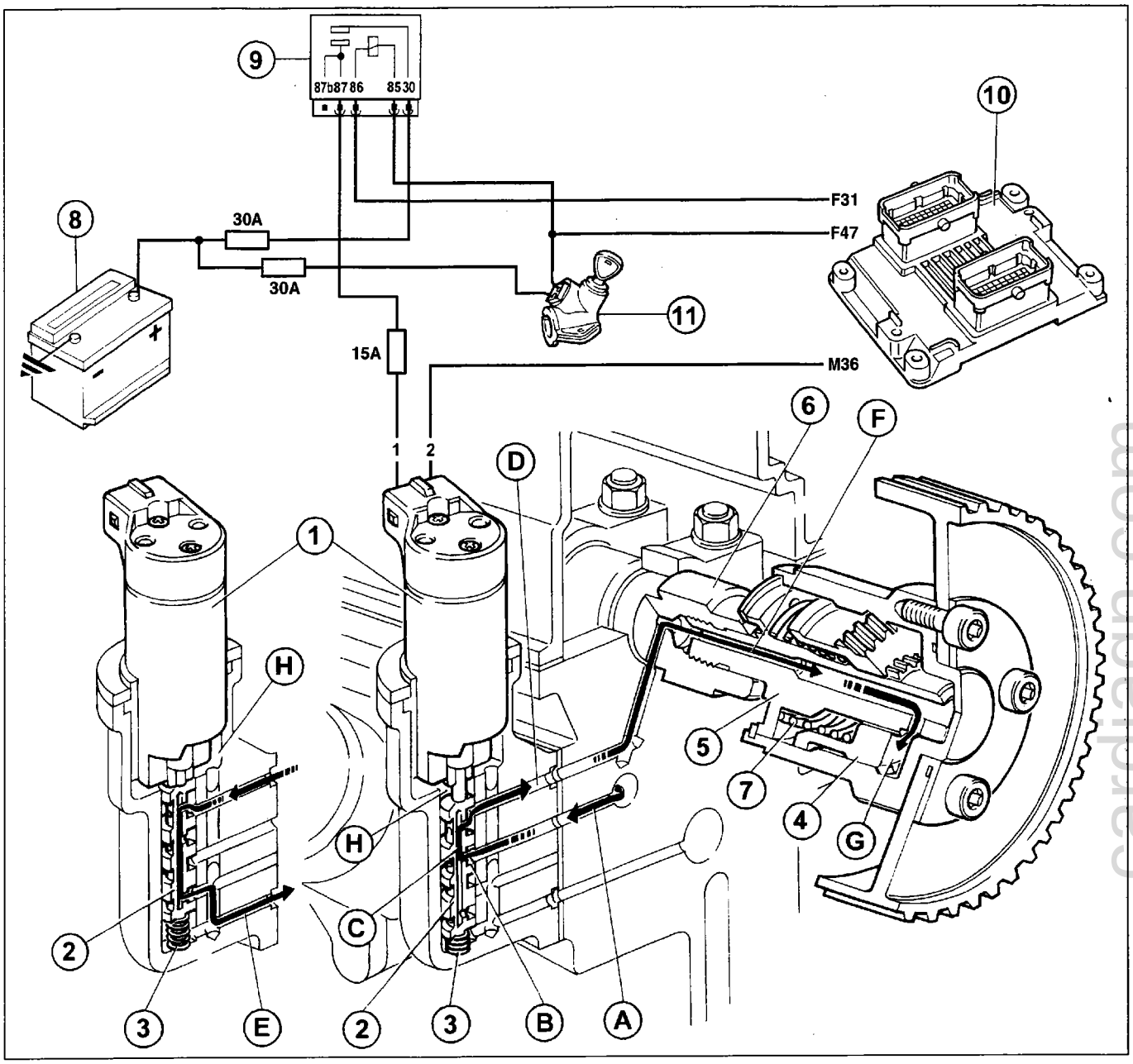
An additional duct ensures the lubrication of the camshaft bearing even when the device is not activated.

The oil which escapes and reaches the solenoid chamber (H) is drained through the drainage duct (E).

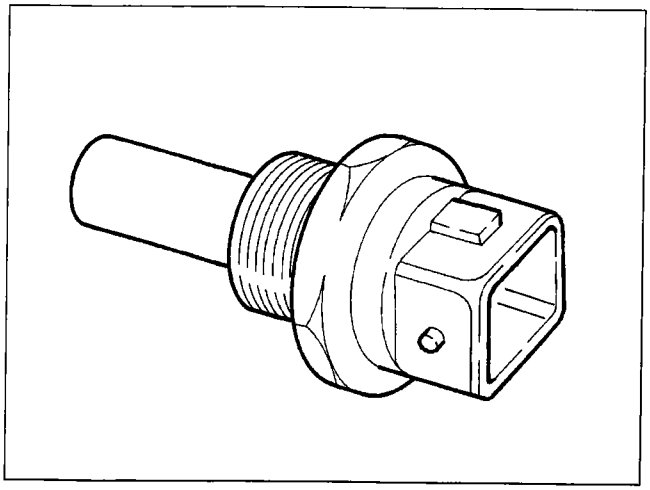
Recovery

If the solenoid valve fails, the control unit final stage (driver) is deactivated.

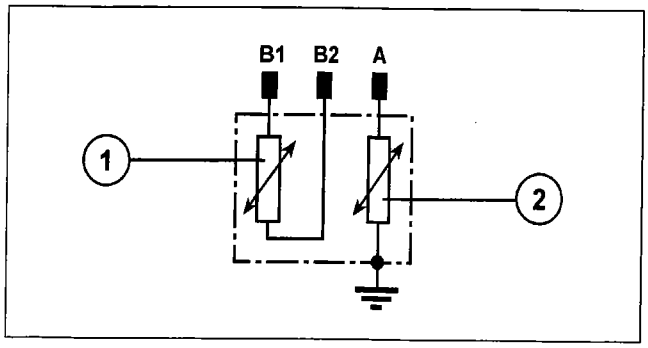
Diagram showing operation of phase transformer



1. Solenoid
2. Valve chest
3. Valve chest spring
4. Piston
5. Pinion
6. Camshaft element
7. Piston spring
8. Battery
9. Injection/ignition system relay
10. Injection/ignition control unit
11. Ignition switch



4A34LJ01



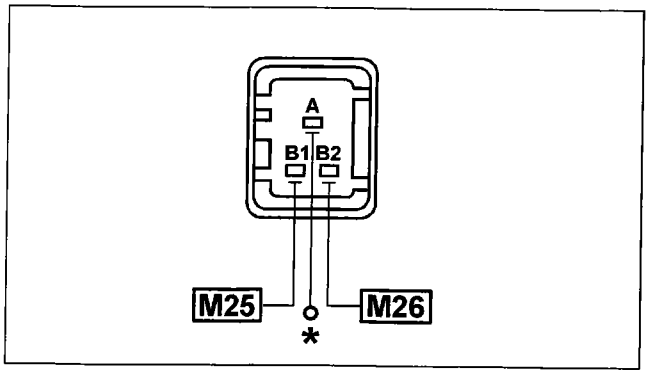
4A34LJ02

INJECTION NTC

	Ω	°C	Ω
-20	15970	40	1150
-10	9620	50	807
0	5975	60	576
10	3816	70	418
20	2500	80	309
25	2044	90	231
30	1679	100	176

INSTRUMENT NTC

°C	Ω
60	512-602
90	184-208
120	76-88



4A34LJ03

* Connection to the engine coolant temperature gauge in the instrument panel

ENGINE COOLANT TEMPERATURE SENSOR
(Jaeger 402.183.01)
(Elth 2690350)

This sensor is fitted on the thermostat casing; it comprises a brass casing which affords protection to the actual resistive elements consisting of two NTC (Negative Temperature Coefficient) type thermistors where the electrical resistance of the sensor decreases as the temperature increases. The two NTCs are distinct and provide information concerning the temperature to the specific gauge in the instrument panel and to the injection/ignition control unit. The reference voltage for the NTC element for the injection system is 5 Volt becuse the control unit intake circuit is designed as a voltage divider so this voltage is divided between a resistance in the control unit and the sensor NTC resistance. As a result the control unit is capable making evaluations through the changes in the voltage and thereby obtain information concerning the temperature.

1. Injection system NTC
2. Instrument panel gauge NTC

Recovery

The last value measured or a fixed value of 80 °C is used if the temperature of the intake air is above a certain level. The self-adjustment of the mixture strength is inhibited. The radiator fan is activated. The self-adjustment of the idle is inhibited.

Checking the resistance

The table at the side contains the resistance values for the NTC elements depending on the temperature. These values can be measured by disconnecting the connector and connecting an ohmmeter to the sensor pins.

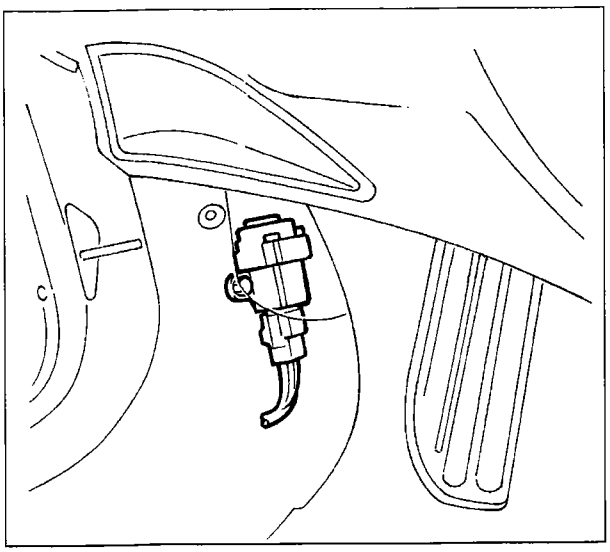
Removing-refitting

Disconnect the electrical connection and remove the sensor.

Tightening torque 2.2 daNm.

Connector wiring

The numbers indicate the control unit pins.

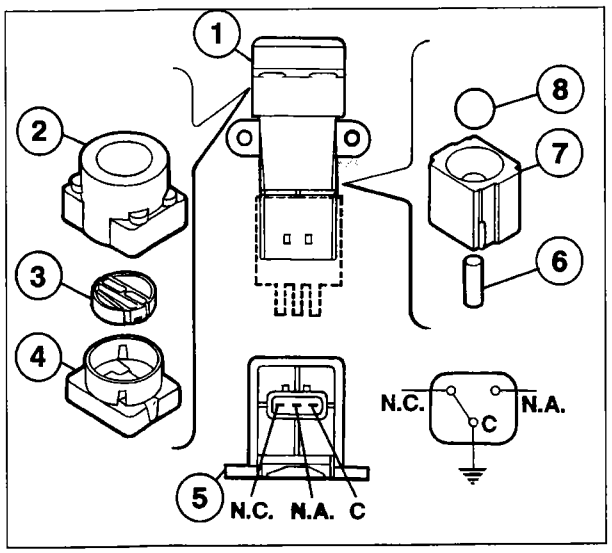


4A34JJ02

INERTIA SWITCH

In order to improve the safety of the occupants of the vehicle in the case of an impact, the vehicle is equipped with an inertia switched located inside the passenger compartment, on the left panel under the dashboard on the driver's side.
This sensor reduces the risk of fire (as a result of the escape of fuel) by de-activating the auxiliary electric pump which supplies the injection circuit.
The inertia switch consists of a steel ball fitted in a (conical shaped) housing and kept in position by the attraction force of a permanent magnet.
In the case of a violent impact, the ball is released by the magnetic clip and opens the normally closed (NC) electrical circuit interrupting the connection to earth of the electric pump and consequently the injection system supply.
To restore the connection to earth for the auxiliary pump, the seat has to be moved back and the switch pressed until a click is heard.

After even an apparently slight impact, if there is a smell of fuel or there are leaks from the fuel system, do not turn the inertia switch back on, but search first for the cause of the problem and remedy it to avoid the risk of fire.



4A35LJ02

Inertia switch components

1. Complete inertia sensor
2. Outer casing
3. Button
4. Upper side
5. Engagement side
6. Permanent magnet
7. Permanent magnet housing
8. Steel ball

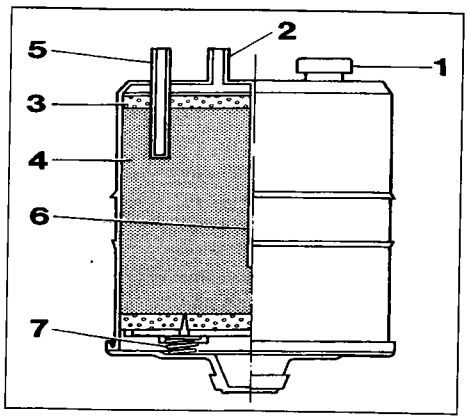
C. Common terminal
N.C. Normally closed contact
N.A. Normally open contact

10.

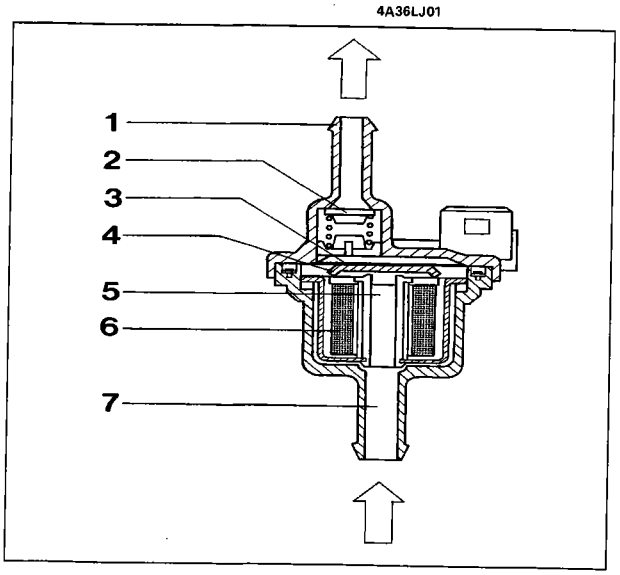
ANTI-EVAPORATION SYSTEM COMPONENTS

Charcoal filter and fuel vapour cut out solenoid valve

These components form part of the fuel vapour recovery and anti-evaporation system. The charcoal filter is located in the right wheel arch; to gain access to it the rear section of the right front wheel arch liner has to be removed.
The cut out solenoid valve is located in the engine compartment, under the inlet manifold.



4A36LJ01



4A36LJ02

1. Inlet connector
2. Single-acting valve
3. Spring
4. Shutter
5. Outlet port
6. Solenoid
7. Outlet connector

Charcoal filter

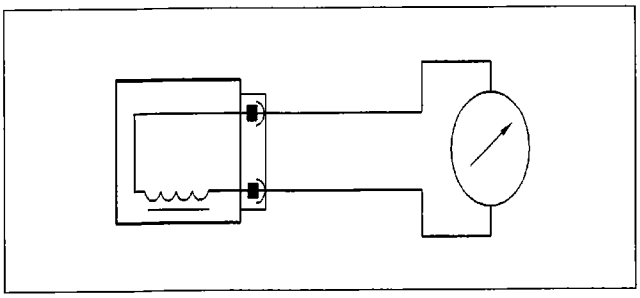
It consists of granules of charcoal (4) which trap the petrol vapours entering through the intake (5).
The scavenging air which enters through the intake (1), passes through the paper filter (3), comes into contact with the granules of charcoal and removes the petrol vapours and directs them towards the outlet (2) and from there to the cut out solenoid valve.
The air, entering through the intake (5), can also be recalled by the vacuum in the tank and used for ventilation purposes. The partition (6) ensures that the air introduced comes into contact with all the granules of charcoal facilitating the release of the petrol vapours to the inlet manifold.
There are also two springs (7) which allow the expansion of the mass of granules when the pressure increases.

Vapour cut out solenoid valve (0.280.142.340)

The function of this valve is to control the quantity of petrol vapours drawn in by the charcoal filter and directed to the inlet manifold which is achieved through the electronic control unit.
If this valve is not supplied it is in the open position; when the key is turned to the ON position, it closes and prepares for operation. In effect, if energized, the solenoid (6) attracts the shutter (4) which, overcoming the loading of the spring (3), closes the port (5), preventing the flow of petrol vapours.
The operation is controlled by the electronic control unit as follows:
- during starting, the solenoid valve remains closed, preventing the petrol vapours from excessively enriching the mixture;
- with the engine started up, the electronic control unit sends a signal to the solenoid valve which modulates the opening.

In this way the control unit controls the quantity of petrol vapours sent to the inlet, avoiding considerable variations (above all during idling) in the mixture strength.

NOTE *The solenoid valve must be fitted in the correct position: the arrow on the casing should be pointing towards the vacuum intake on the inlet manifold.*

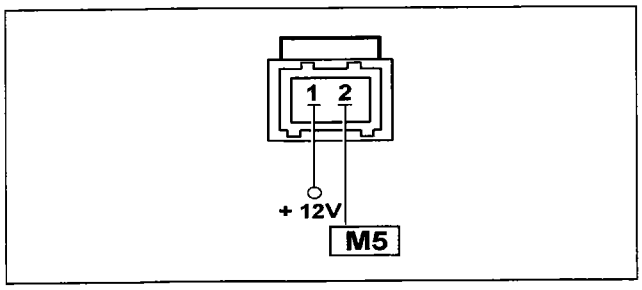


4A37LJ01

Checking the resistance

The resistance of the solenoid valve can be measured by disconnecting the connector and connecting an ohmmeter as illustrated in the diagram.

Resistance: 17.5-23.5 ohm at 20 °C



4A37LJ02

Connector wiring

The numbers indicate the corresponding control unit pins.

CHECKS, ADJUSTMENTS AND REPAIR OPERATIONS ON THE BOSCH MOTRONIC ME 3.1 INJECTION/IGNITION SYSTEM IN ADDITION TO THE FAULT DIAGNOSIS

WHEN WORKING ON VEHICLES EQUIPPED WITH MOTRONIC INJECTION/IGNITION SYSTEMS, FOLLOW THESE PRECAUTIONS:

- *do not start up the engine with the electrical connections not properly connected or the battery terminals slack;*
- *do not use a rapid battery charger to start the engine;*
- *never disconnect the battery from the system with the engine running;*
- *to carry out the rapid charging of the battery, disconnect it first from the system;*
- *if the vehicle is going into a drying oven after painting, at temperatures in excess of 80 °C, the injection/ignition electronic control unit must be removed first;*
- *do not connect or disconnect the electronic control unit multiple connector with the ignition switch in the ON position;*
- *always disconnect the negative battery lead before carrying out electrical welding on the vehicle.*

It should be remembered that this system has a memory which is always supplied (stand-by memory) which contains the self-adjustment values. Disconnecting the battery means that this information will be lost and can only be acquired again after a certain length of time therefore this operation should be carried out as infrequently as possible.

10.

ENGINE IDLE SPEED CONTROL

If the engine idle speed is not 750±50/min and the injection/ignition control unit is the self-adjusting type then it is not possible to carry out any adjustments so it is necessary to check that the accelerator linkage is correctly adjusted and the cause of the problem should be sought by carrying out a complete fault diagnosis using the diagnostic equipment.

CHECKING THE CONCENTRATION OF POLLUTANT EMISSIONS

Through the self-adjustment of the system, the Motronic ME 3.1 system guarantees a continuous check on the idle speed and the CO percentage making any other external adjustment operation superfluous (there are no longer any adjustment screws). However, a check on the content of the exhaust gases, downstream of the catalyzer, can provide precious information on the operating conditions of the injection/ignition system, the engine parameters and the catalyzer.

Checking idle concentration of CO and HC upstream of the catalytic silencer

To check the concentration of carbon monoxide (CO) and unburnt hydrocarbons (HC), upstream of the catalyzer, proceed as follows:

1. Undo the plug or the nut on the exhaust pipe, upstream of the catalyzer, and tighten the tool in its place.
2. Connect a suitably calibrated CO tester probe to the tool.
3. Start up the engine and let it reach operating temperature.
4. Check that the speed corresponds to the recommended figure.
5. Check that the CO idle concentration is within the recommended limits given in the table overleaf; if this is not the case, it is necessay to check:

   - that the Lambda sensor is working properly, using the diagnostic equipment;
   - for the presence of air penetration in the area surrounding the Lambda sensor housing;
   - the injection and ignition system (**in particular the wear of the spark plugs**).

6. Under the same circumstance, check that the concentration of HC is below 600 p.p.m.
7. If these values are not found, proceed with tuning the engine, in particular checking:
   the ignition advance angle - the valve clearances - the valve gear timing - the engine compression.

Checking exhaust concentration of CO and HC

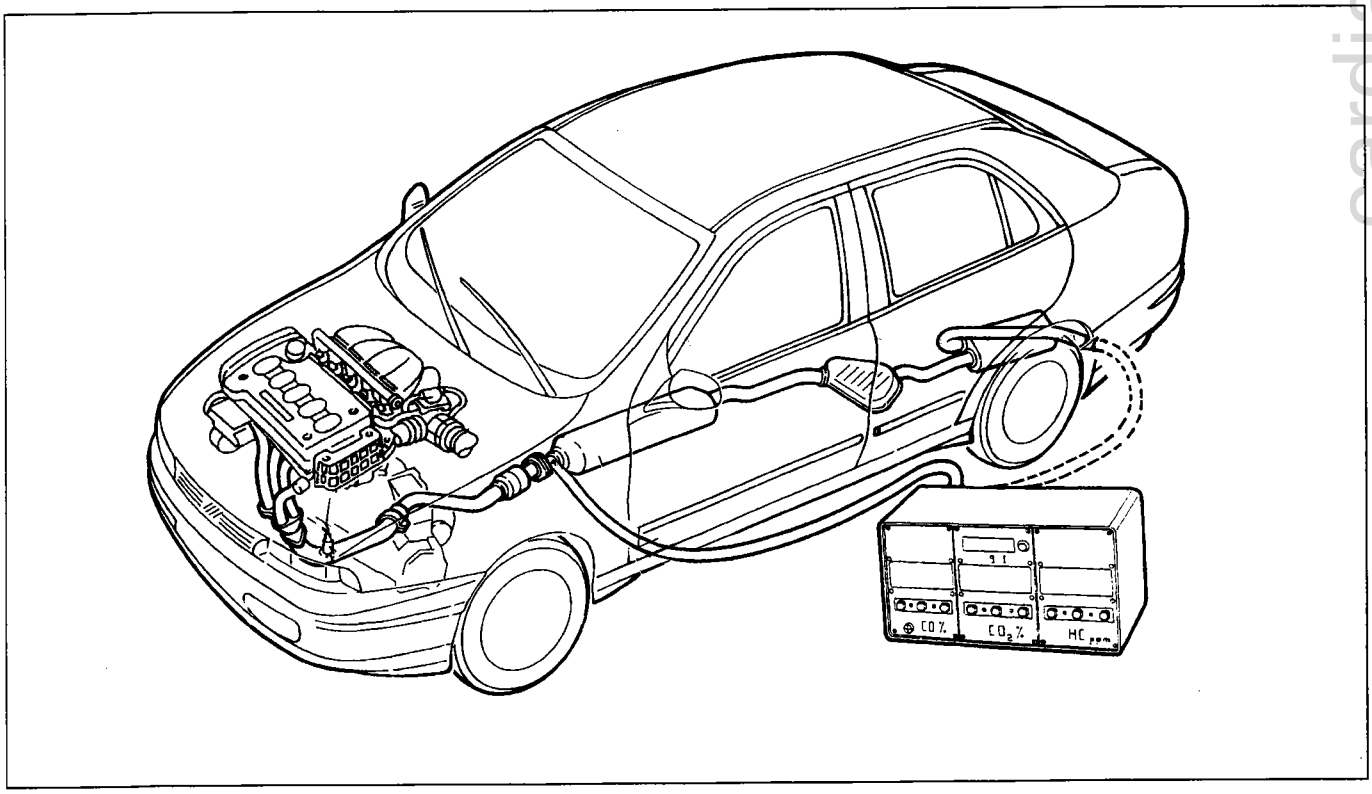
The exhaust concentration of carbon monoxide (CO) and unburnt hydrocarbons (HC) is meaured by inserting a suitably calibrated CO tester probe at leat 30 cm into the end of the exhaust pipe as illustrated in the diagram.

If the shape of the end section of the exhaust pipe does not allow the sensor to be fully inserted, a special extension pipe which ensure the seal in the join area must be added.

1. Check that the idle CO and HC concentration figures correspond to those in the table.
2. If the HC value is different from the recommended limit, whilst that measured previously upstream of the catalyzer was correct, the engine parameters are correct and therefore the cause of the problem should be sought in the decreased efficiency of the catalyzer.

Table summarizing pollutant emission tolerance values

	CO (%)	HC (p.p.m.)	CO_2 (%)
Upstream of the catalyzer	0.4 - 1	600	⩾ 12
Downstream of the catalyzer	⩽ 0,35	⩾ 90	⩾ 13



P4F39QJ01

10.

DIAGNOSTICS

The complete fault diagnosis of the system can be carried out through active dialogue with the diagnostic equipment.
If a failure at the sensors is detected, the electronic control unit replaces the information coming from the faulty sensor with pre-memorized (recovery) data to allow the operation of the engine. The detection of a fault involves it being permanently stored in the memory and the sensor excluded from the system until the signal is compatible again.
The same procedure is applied if the fault involves an actuator or control flap. The detection of a fault and its replacement with recovery data means that the fault will be signalled by the special warning light in the instrument panel coming on.
The following parameters can be managed by the control unit in the case of a breakdown: flow meter, engine coolant temperature sensor, butterfly casing actuator, Lambda sensor, air temperature sensor, battery voltage and detonation sensors. If there are problems with the control unit, the rpm sensor or the electric fuel pump, the system does not identify the fault and the vehicle comes to a halt. The faults can be read by the operator on the control unit using the diagnostic equipment.

Detecting faults

This is carried out during the basic function managing the sensor/actuator.

Memorizing the error and structure of the errors memory

The errors are stored in the control unit memory in the order in which they occur. For each of them the location, type of error and ambient conditions (specific for each type of fault) measured at the time the error was detected are memorized and there is a frequency counter.

Classification of the defect

If a defect is detected for the first time and the error state persists for a time t V 0.5s, then the defect is memorized as "permanent". If this defect later disappears, it is memorized as "intermittent" and "not present". If it then reappears, it remains memorized as "intermittent", but becomes "present".
The classification of a defect as "permanent" activates the recovery functions; when the fault disappears the normal reading or implementation function is restored.
Certain types of faults are classified as "important", i.e. in terms of pollution control regulations. The presence of these faults is signalled to the user by the failure warning light in the instrument panel coming on.

Frequency counter

Each error is allocated a frequency counter which is used to determine the moment in which a fault memorized is no longer present. The first time the fault is detected, the counter is set at 10. If the fault disappears, the counter remains at the current value. If it reappears, it is increaed by 1 (with an upper limit of 50).
The counter is decreased each time the engine is started up and the fault has not reappeared. If the counter reaches zero, the fault is automatically cancelled from the memory.
If after the counter has decreased, the fault reappears, the counter is returned to a value of 10 (if, on the other hand, it was already above 10, it is not altered).

Fault signalling

The failure warning light comes on when there is a defect memorized as "present" and "important".
There is a delay of 0.1 seconds between the detection of the fault and the warning light coming on; the delay between the fault disappearing from the memory and the warning light going out is 4 seconds.
The warning light comes on each time the ignition key is turned to the ON position. If there are "important" faults already present, the warning light goes out after 4 seconds.

Cancelling the error

When the frequency counter reaches 0, the fault and the parameters associated with it are cancelled.

The immediate cancellation of the entire errors memory takes place through the "cancelling errors memory" command sent by the diagnostic equipment.

Connection with the diagnostic equipment

The diagnostic socket to which the diagnostic equipment (Examiner or SDC) is connected is located at the front right of the engine compartment (see diagram on page 18).

The exchange of data between the control unit and the diagnostic equipment takes place via a two-way serial line (line K) using the standard Bosch communication protocol.

The diagnostic equipment can provide the following information:

- display of the engine parameters;
- display of the errors;
- active diagnosis.

List of errors

Description	Nature of the errors
Rpm sensor	Signal loss
Air temperature sensor	Implausible signal
Coolant temperature sensor	C.A-C.C.
Battery	Implausible voltage
Lambda sensor	C.C.
Injector	C.A.-C.C.
Butterfly casing actuator	Implausible potentiometer signal
Petrol vapour solenoid valve	C.C.
Actuator relays	C.A.-C.C.
Control unit	Operating problems with the microprocessor or the control unit memories are signalled.
Flow meter	Signal not plausible
Timing sensor	Signal not plausible
Detonation sensor	Signal not plausible
Speedometer sensor	Signal missing or not plausible
Phase transformer	C.C.
Electric fuel pump	C.C.
Fiat-CODE	Code not recognized or not received

10.

Parameters displayed

Engine rpm
Injection time
Advance
Intake air temperature
Engine coolant temperature
Butterfly valve opening angle
Battery voltage
Lambda sensor
Self-adjustment
Flow meter
Engine knock (detonation)
Vehicle speed
Petrol vapour cut out solenoid valve
Fiat-CODE
Atmospheric pressure

Active diagnosis

The following active tests can be carried out using the diagnostic equipment:
- Phase transformer
- Injector
- Failure warning light
- Petrol vapour solenoid valve
- Air conditioning
- Idle speed actuator
- Cancelling errors

Recovery

If there are failures at the senors, the control unit replace the value transmitted by the sensor which a so-called Recovery value which, depending on the different faults, is either stored in the control unit memory or specially reconstructed using other available information, to allow the vehicle to reach a service centre.

Permanent memory

The control unit is equippd with a "permanent" type memory (EEPROM), in other words the error is preserved even if the cause of the problem no longer exists and the ignition has been switched OFF and a "volatile" type memory (RAM) which loses the error information as soon as the cause of the problem disappears.
This also allows the more effective identification of errors of an occasional nature.
Before ending the fault diagnosis, the contents of the "permanent" memory must be cancelled using the diagnostic equipment in Active Diagnosis.
The contents of the "permanent" errors memory must be cancelled as follows:

1. Using the diagnostic equipment in active diagnosis.
If this is not the case, when the diagnostic equipment is reconnected, the errors already examined will be signalled.
2. If the cause of the error no longer exists and the engine has been started 5 times (letting it run for at least 20 minutes) with at least 2 minutes between each time the engine is started up.

Disconnecting the control unit from the system, even for very long periods, does not cancel the contents of the "permanent" memory.

OPERATIONS ON VEHICLE

Where the capacity is expressed, the validity of the operation only relates to the engine type specified.

The information contained in this publication is supplied as a guide and may no longer be up to date as a result of modifications made by the Manufacturer, at any time, for reasons of a technical or commercial nature in addition to meet legal requirements in different countries.

Fiat Auto S.p.A.

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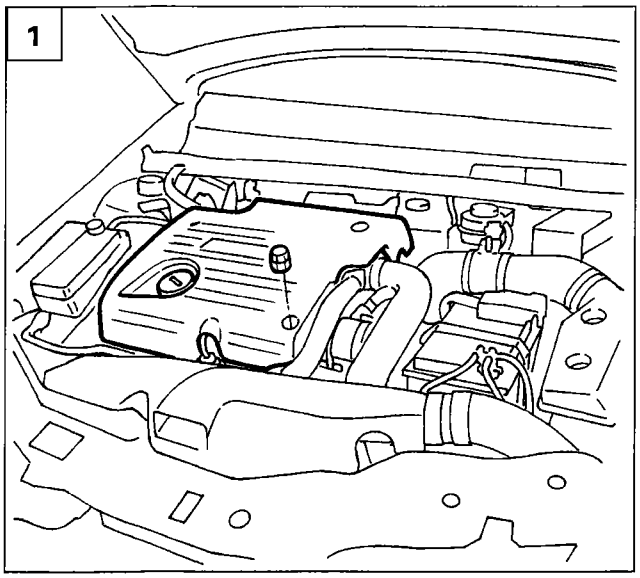
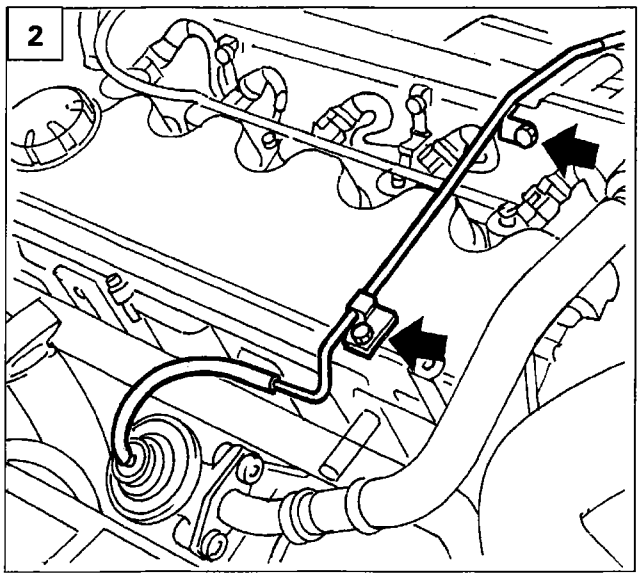


P4F27MJ02

REMOVING-REFITTING INJECTORS

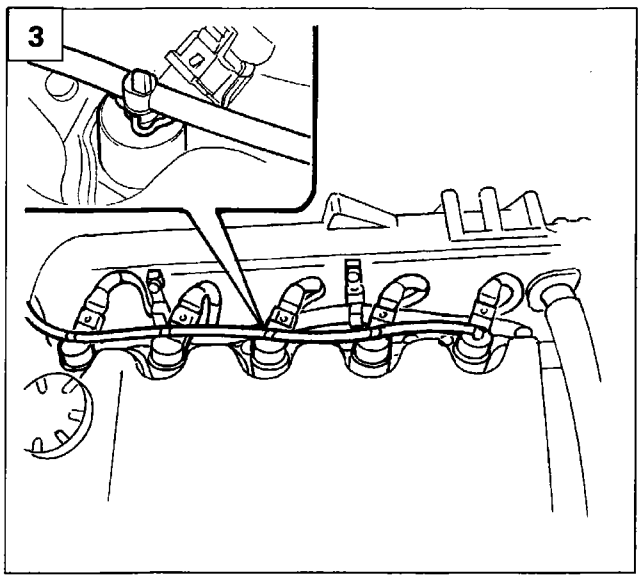
- Disable the alarm (if fitted), located in the luggage compartment on the right hand side and disconnect the negative battery terminal.

1. Remove the upper engine protective cover.



P4F27MJ03

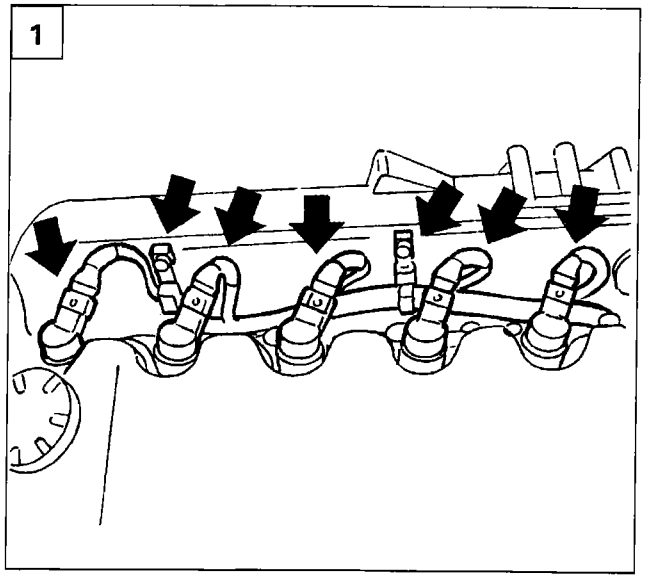
2. Undo the two bolts shown in the diagram and move the rigid pipe between the E.G.R. valve and the solenoid valve aside.



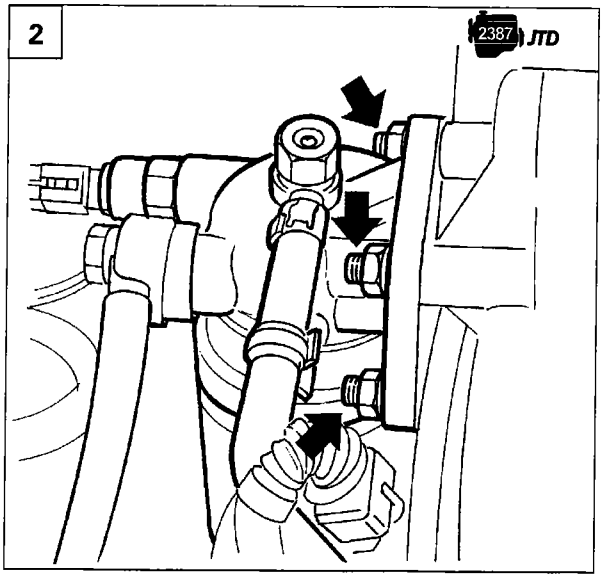
P4F27MJ04

3. Disconnect the fuel return pipe from the injectors, acting on the spring.

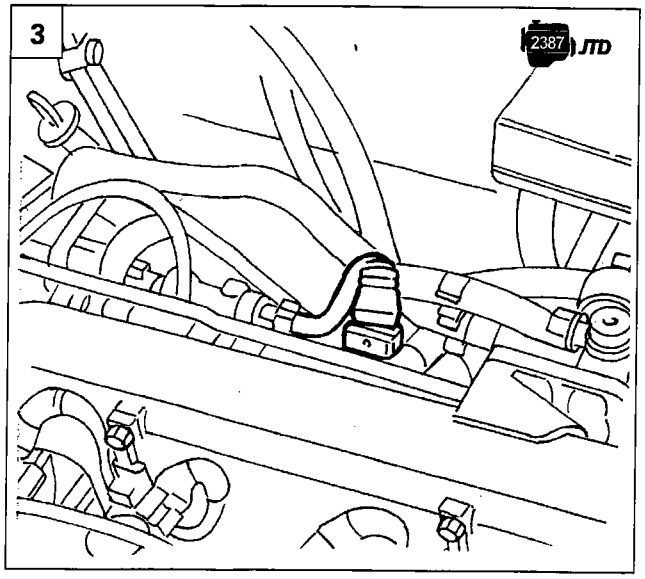
10



P4F28M J01

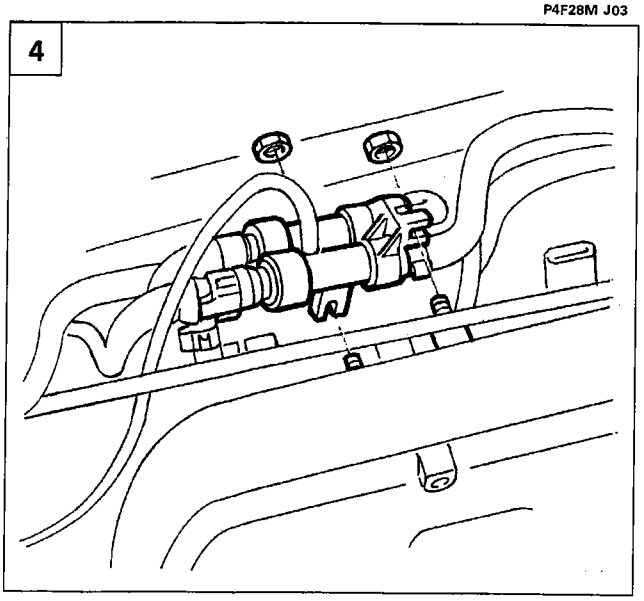


P4F28M J02

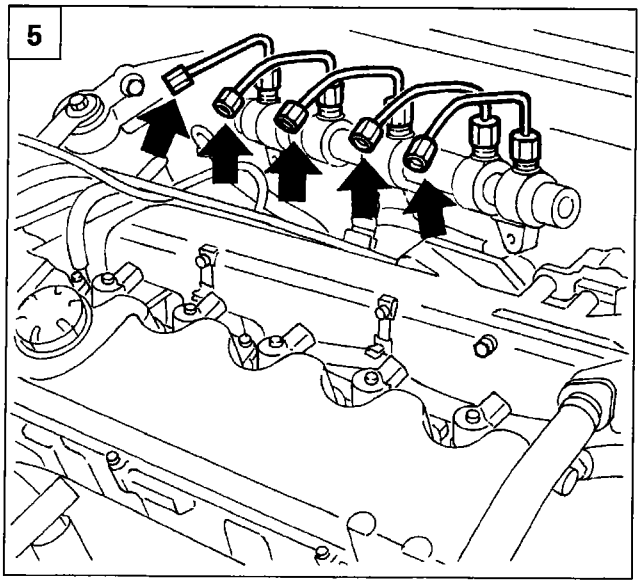


P4F28M J03

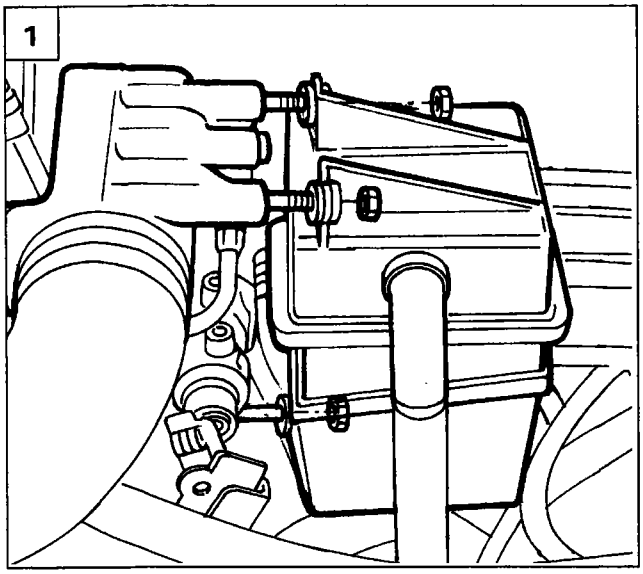
1. Disconnect the electrical connections from the injectors and move the wiring aside, undoing the two bolts as shown in the diagram.
2. Undo the fixing nuts and place the diesel filter to the side.
3. Disconnect the electrical connection from the excess pressure sensor.
4. Move the fuel return manifold aside.
5. Undo the injector side connectors for the pipes from the distribution manifold to the injectors.



P4F28M J04

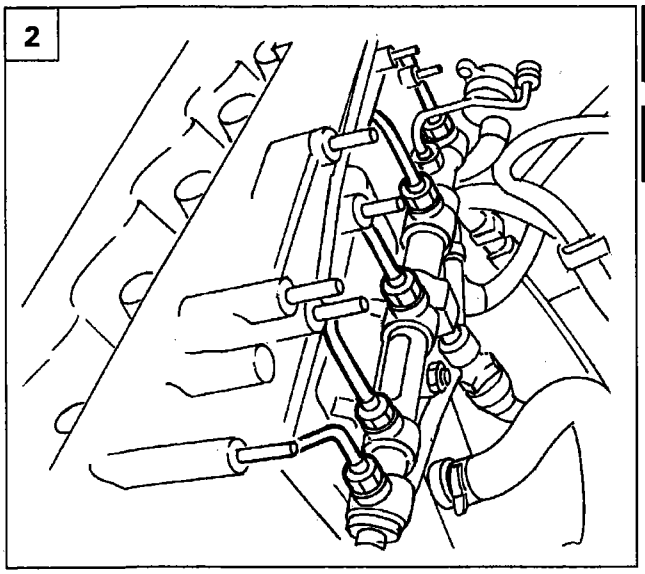


P4F28M J05



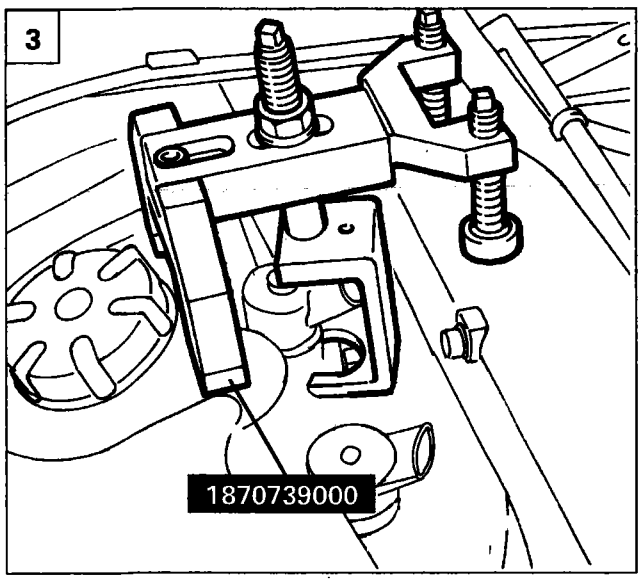
P4F29MJ01

1. Take off the oil vapour separator by undscrewing the three retaining nuts.



P4F29MJ02

2. Undo the manifold end pipe fittings from the rail leading to the injectors and remove them

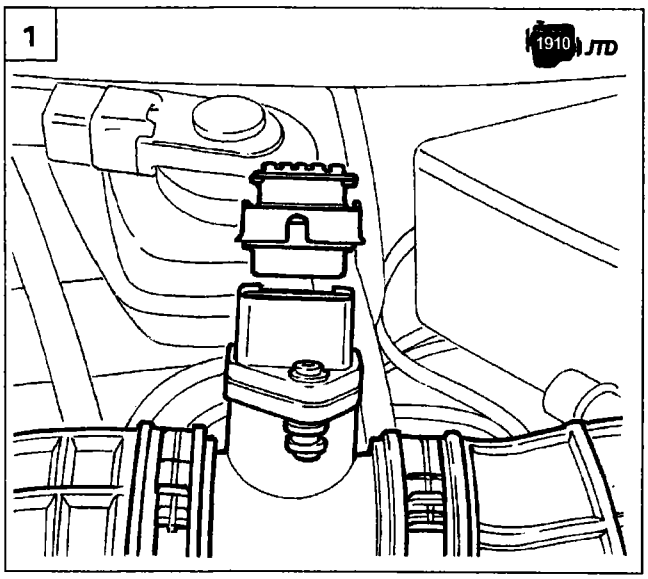


P4F29MJ03

3. Undo the retaining nuts and carefully remove the injector bracket. Use tool 1870739000 to remove the injectors.

NOTE *To refit, carry out the above operations in reverse order and replace the washers underneath the injectors and the pipes joining the manifold and injectors. Manifold side and injector side pipe fittings must be tightened to a torque of 2.2 daNm.*

10.

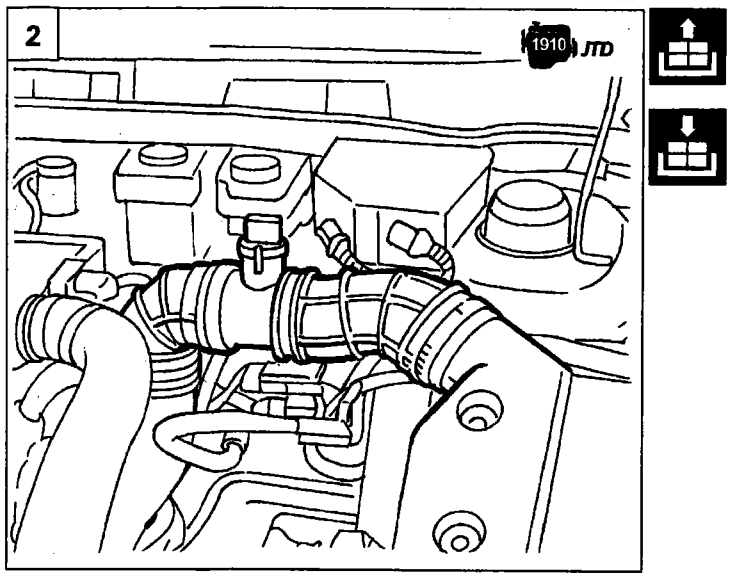


P4F30MJ03

REMOVING-REFITTING RAIL

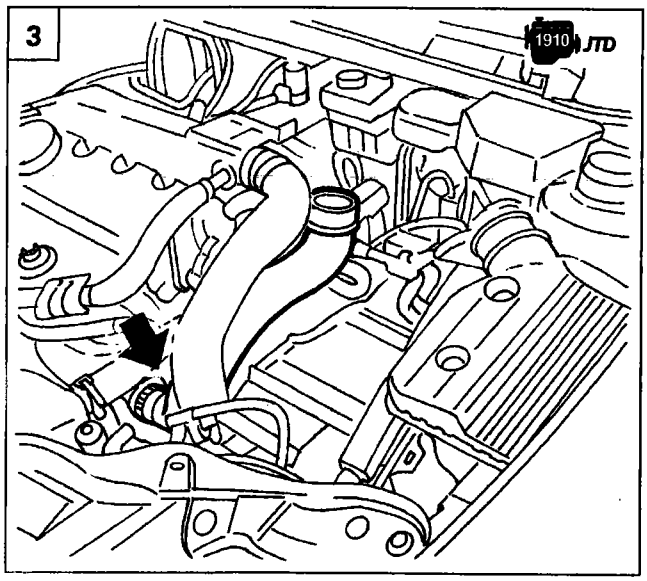
- Disable the alarm (if present) by means of the switch under the junction unit cover.
- Disconnect the terminals and remove the battery (1920 JTD).

1. Disconnect the electrical connection for the flow meter.



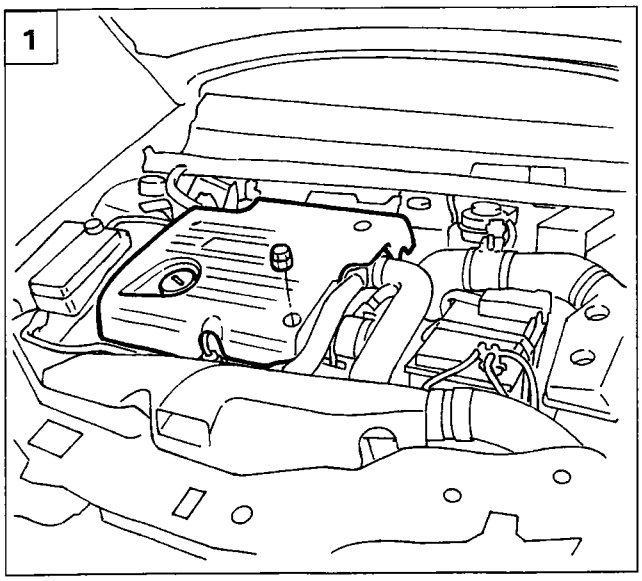
P4F30MJ04

2. Loosen the collars and remove the first pipe section between the air cleaner case and turbocharger.



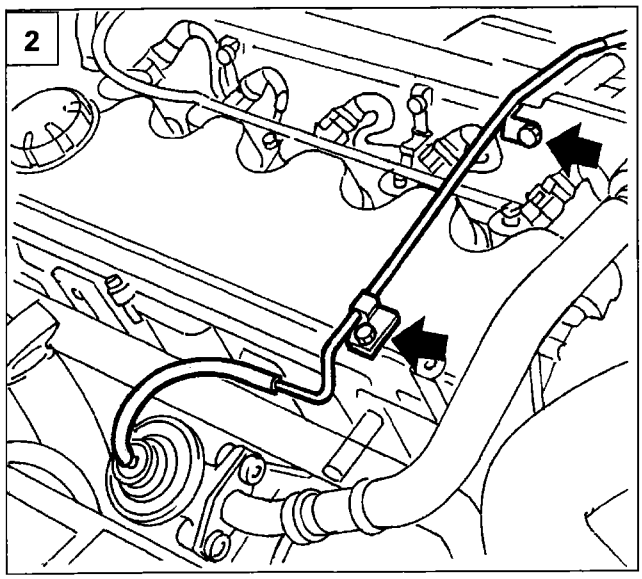
P4F30MJ05

3. Loosen the bands and remove the second pipe section between the air cleaner case and turbocharger.



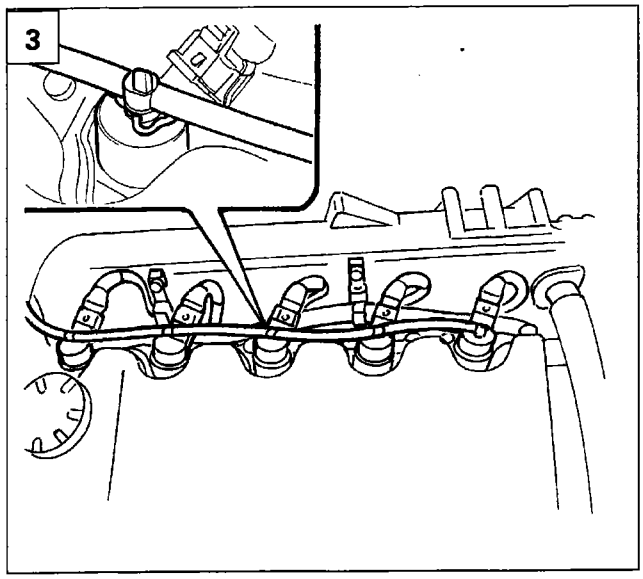
P4F27MJ02

1. Remove the upper engine protective cover.



P4F27MJ03

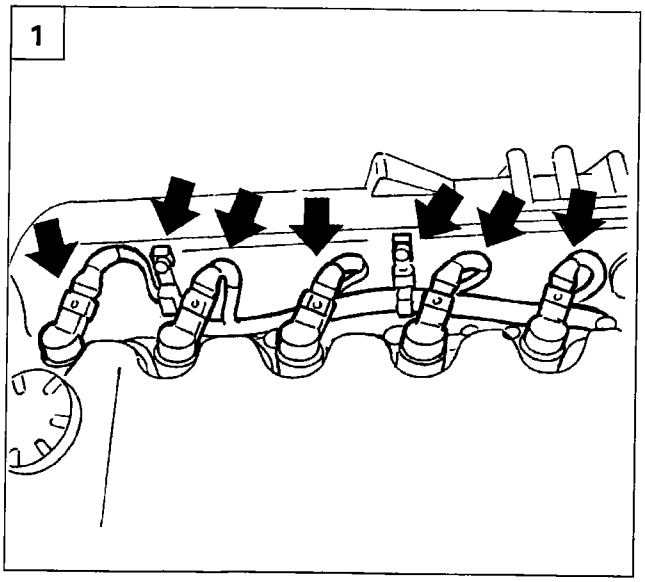
2. Undo the bolts and place the rigid pipe between the E.G.R. valve and the solenoid valve to the side.



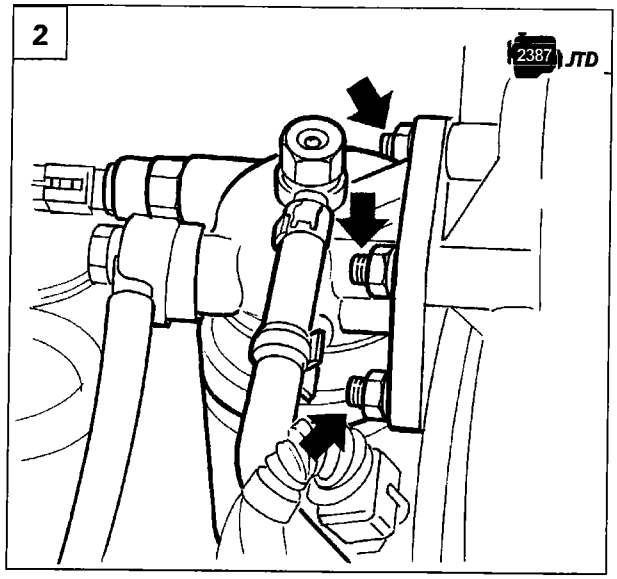
P4F27MJ04

3. Disconnect the fuel return pipe from the injectors.

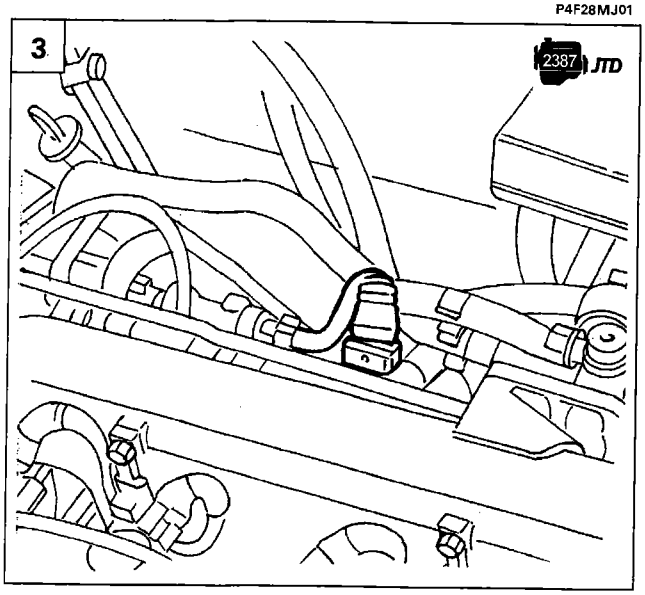
10



P4F28MJ01

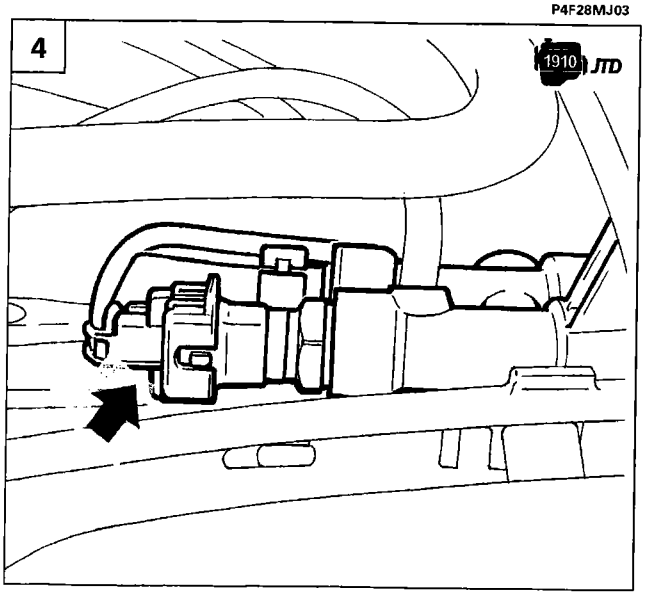


P4F28MJ02

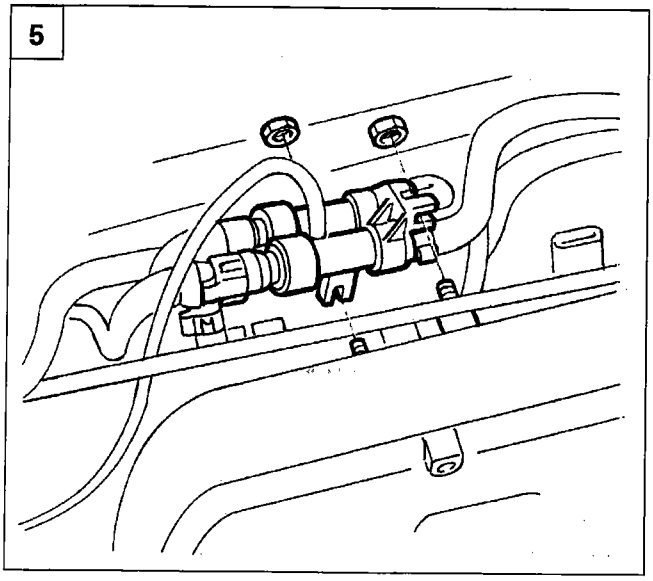


P4F28MJ03

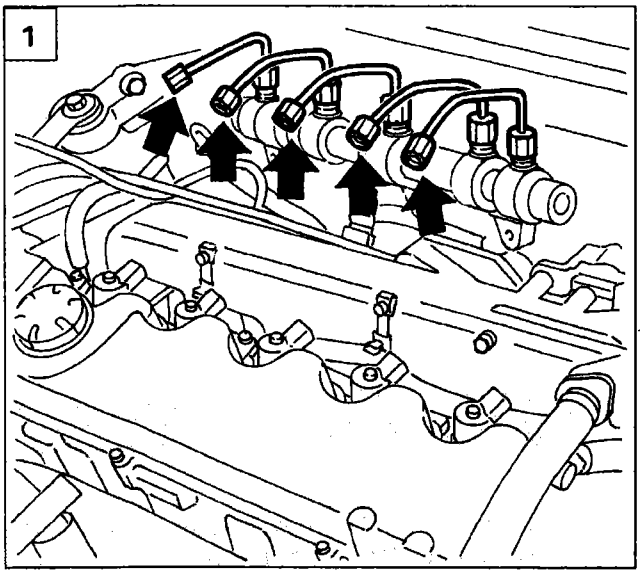
1. Disconnect the electrical connections from the injectors and undo the fixing bolts and place the wiring to the side.
2. Undo the fixing nuts and place the diesel filter aside.
3. Disconnect the electrical connection from the excess pressure sensor.
4. Disconnect the electrical connection from the fuel temperature sensor.
5. Move the fuel return manifold aside.



P4F32MJ01

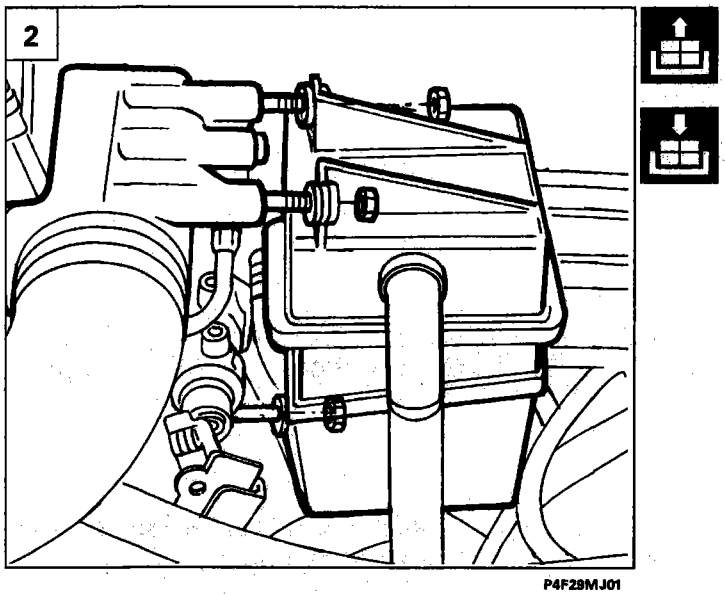


P4F28MJ04



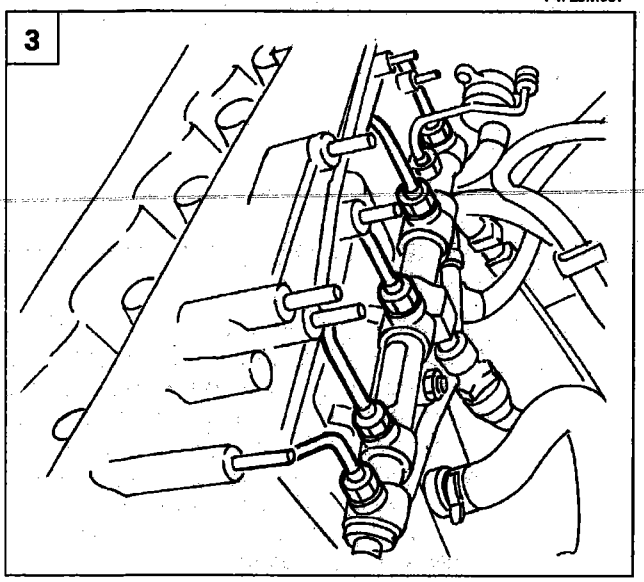
P4F28MJ05

1. Undo the injector end pipe fittings from the rail leading to the injectors.



P4F29MJ01

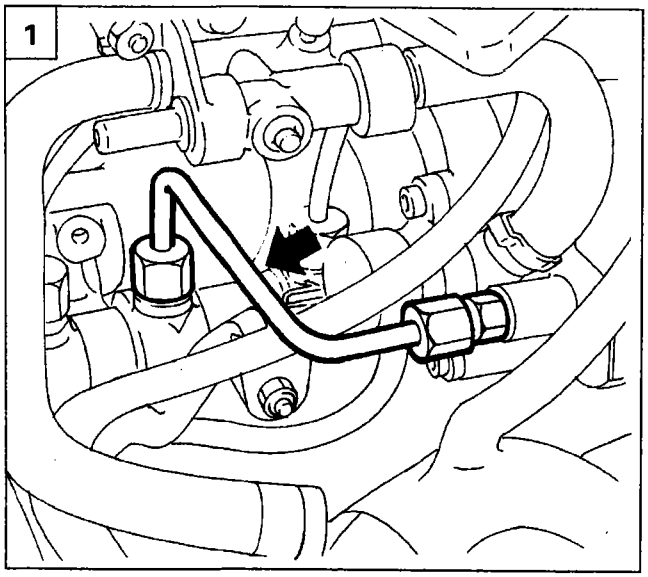
2. Remove the oil vapour separator by unscrewing the three retaining nuts.



P4F29MJ02

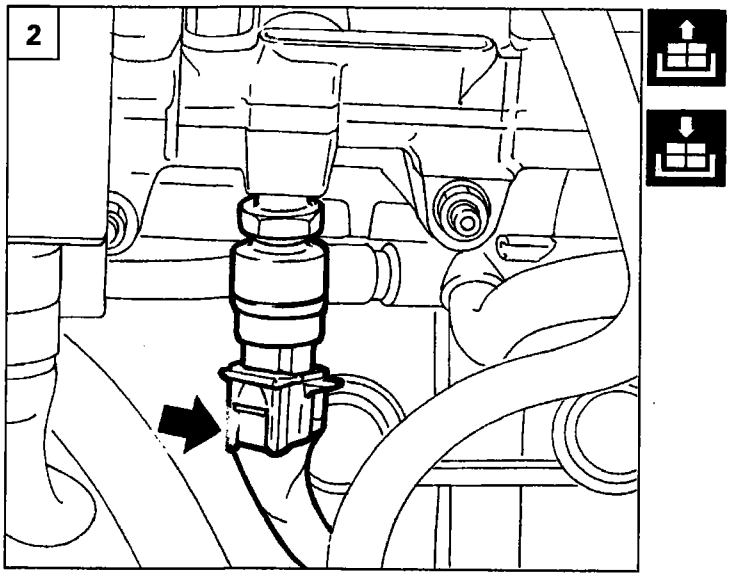
3. Undo the manifold end pipe fittings from the rail leading to the injectors and remove them

10.



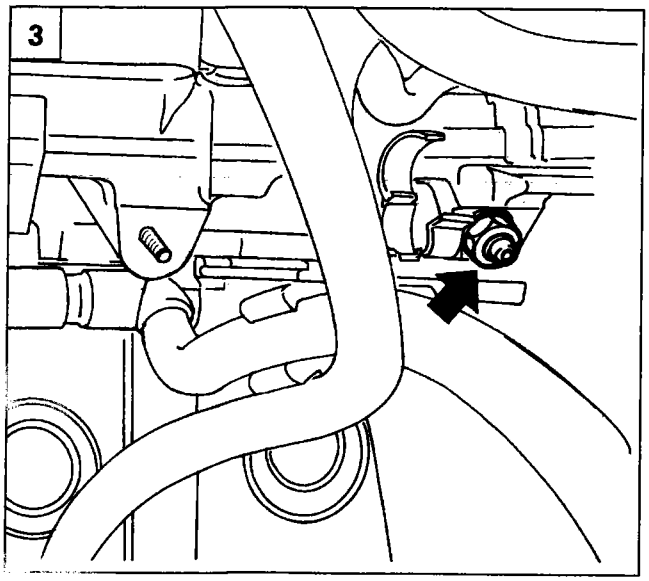
P4F34MJ01

1. Remove the fuel delivery pipe from the pressure pump to the rail pipe.



P4F34MJ02

2. Disconnect the electrical connection from the fuel pressure sensor

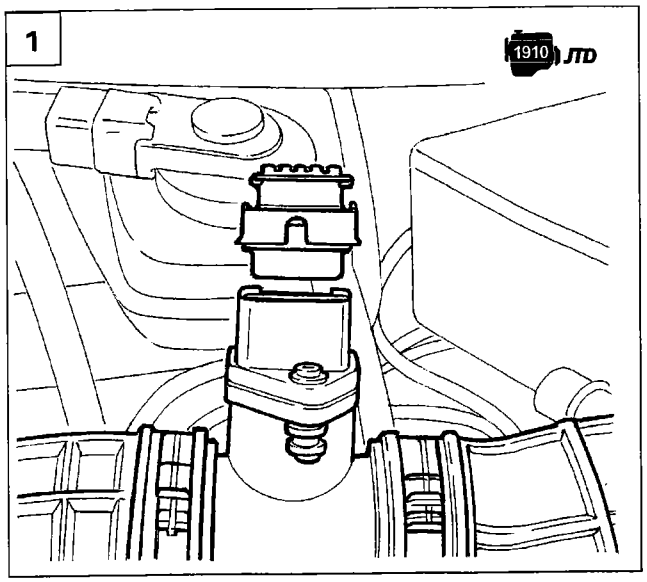


P4F34MJ03

3. Unscrew the remaining nut securing the rail and remove.

NOTE *To refit, carry out the above operations in reverse order and replace the washers underneath the injectors, the pipes joining the manifold and pressure pump and the pipes joining the manifold and injectors. The manifold side and injector/pressure pump side pipe fittings must be tightened to a torque of 2.2 daNm.*

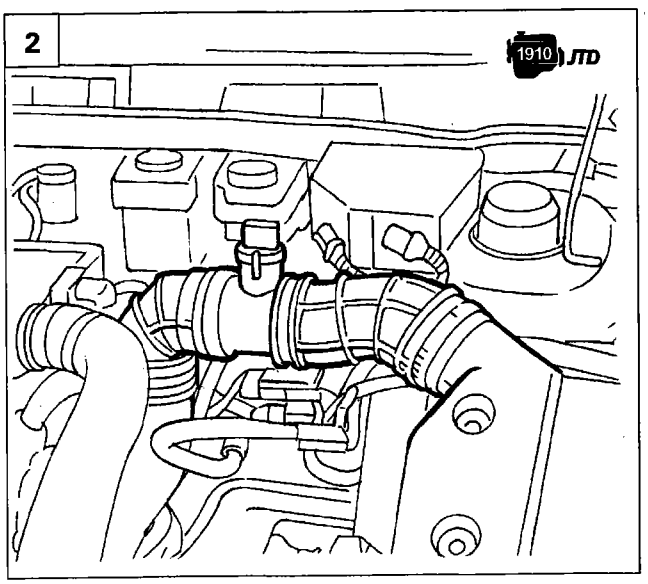
REMOVING-REFITTING HEATER PLUGS



P4F30MJ03

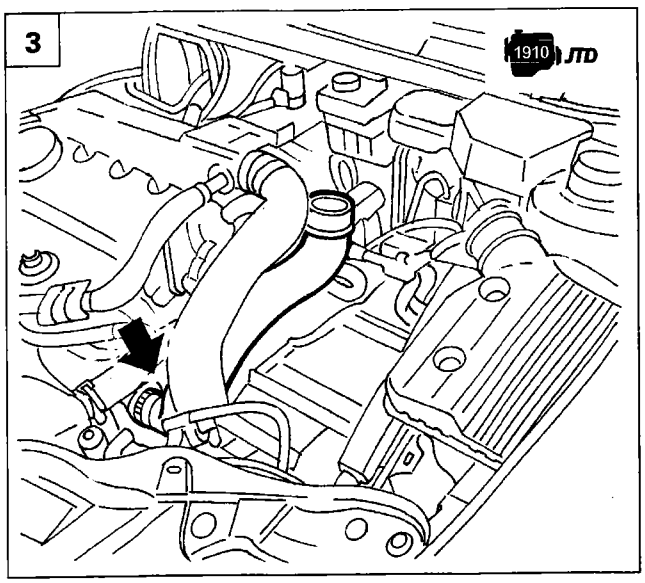
- Disable the alarm (if fitted) via the switch under the junction unit cover.
- Disconnect the terminals and remove the battery (1910 JTD).

1. Disconnect the electrical connection for the flow meter.



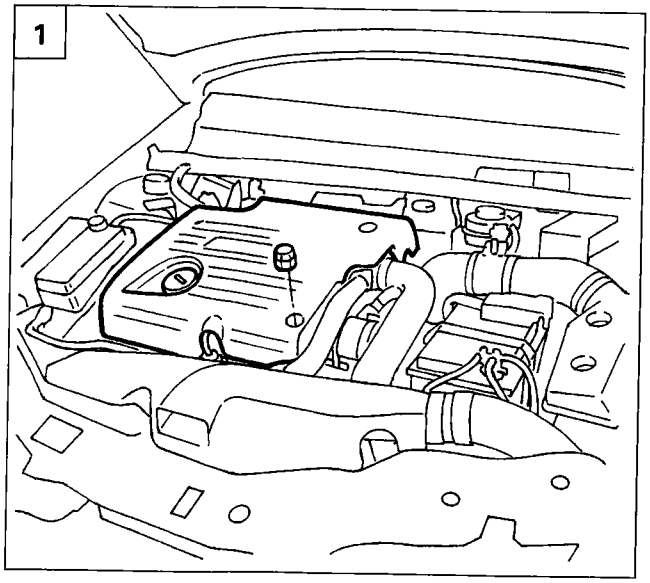
P4F30MJ04

2. Loosen the bands and remove the first section of the pipe between the air filter casing and the turbocharger.

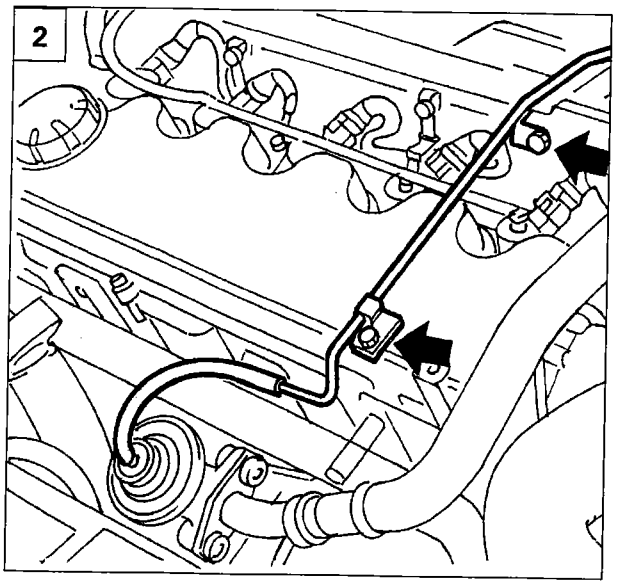


P4F30MJ05

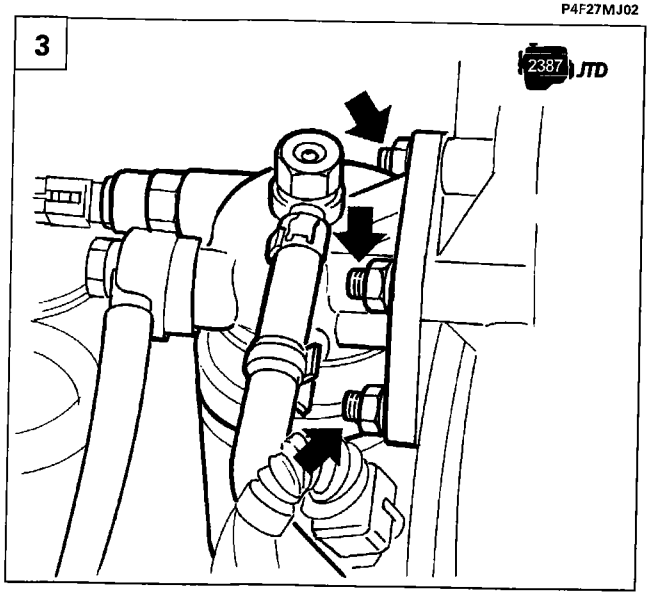
3. Loosen the bands and remove the second section of the pipe between the air filter casing and the turbocharger.



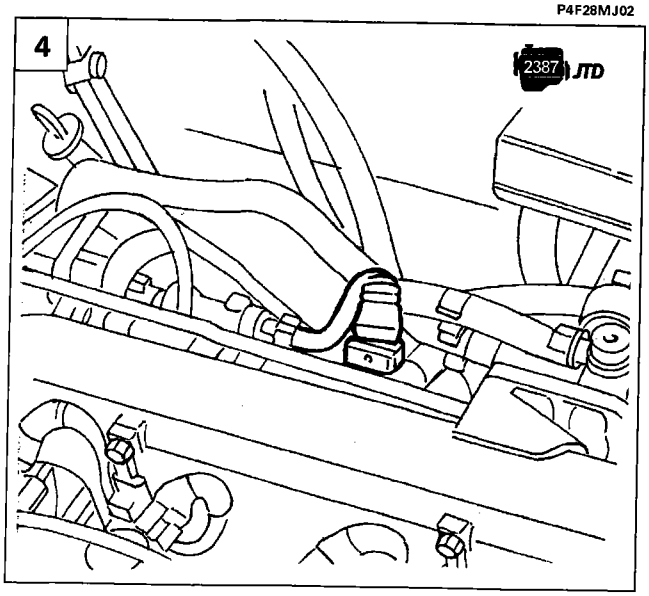
P4F27MJ02



P4F27MJ03



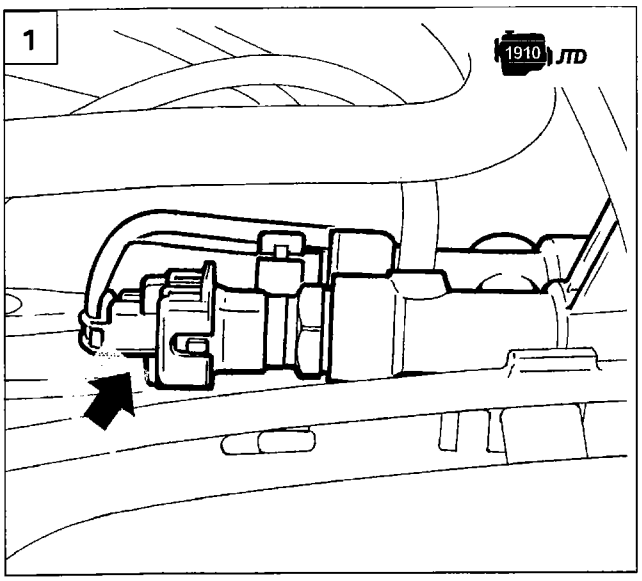
P4F28MJ02



P4F28MJ03

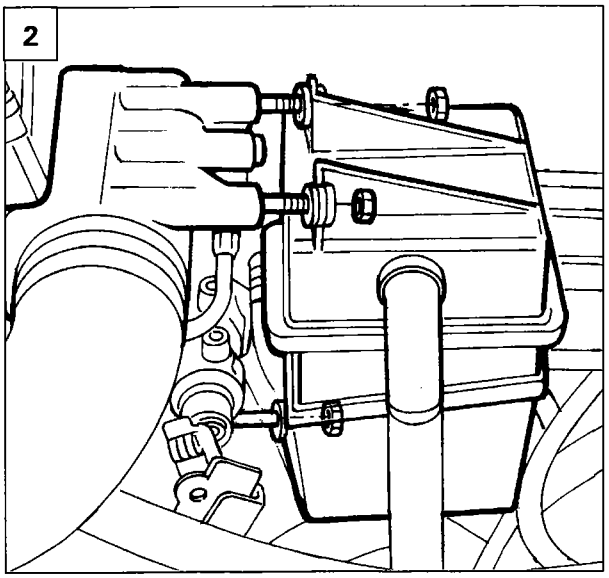
1. Remove the upper engine protective cover.
2. Undo the fixing bolts and place the rigid pipe between the E.G.R. valve and the solenoid valve to the side.
3. Undo the fixing nuts and place the diesel filter aside.
4. Disconnect the electrical connector from the excess pressure sensor.

1



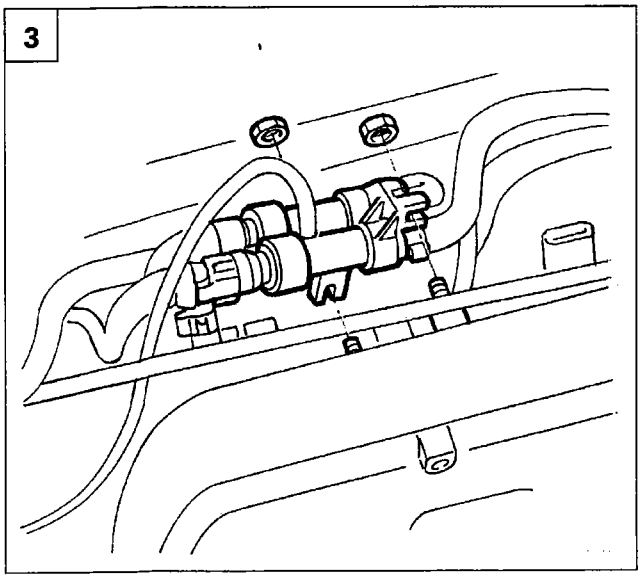
P4F302MJ01

2



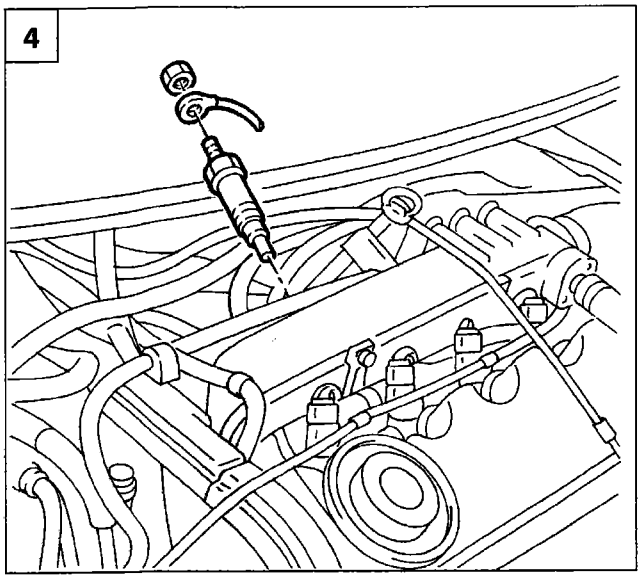
P4F29MJ01

3



P4F28MJ04

4



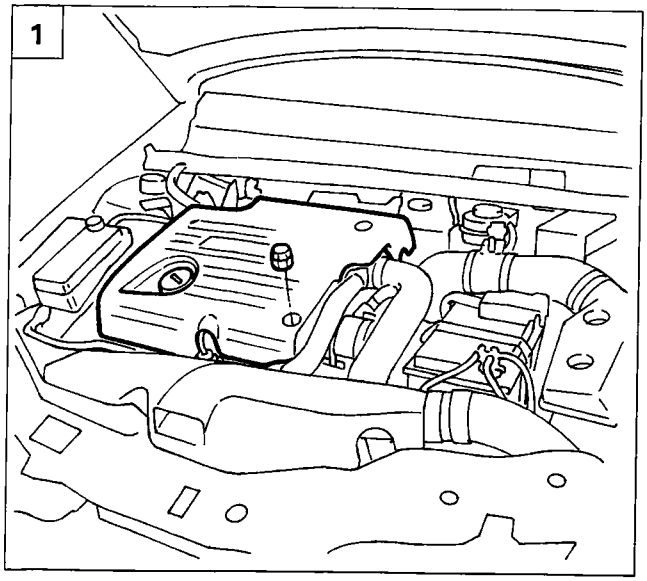
P4F37MJ05

1. Disconnect the electrical connection from the fuel temperature sensor.
2. Move the oil vapour separator aside undoing the three fixing nuts.
3. Move the fuel return manifold aside.

4. Disconnect the electrical connection undoing the fixing nut and remove the heater plugs using a suitable spanner.

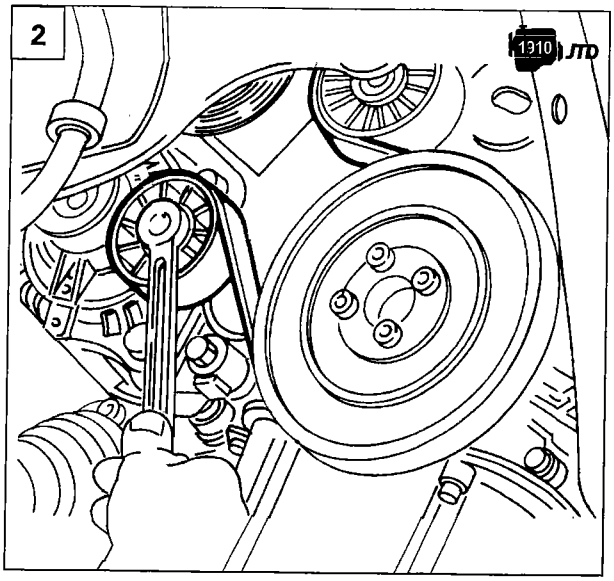
NOTE *When refitting, carry out the procedures described above in the reverse order.*

1



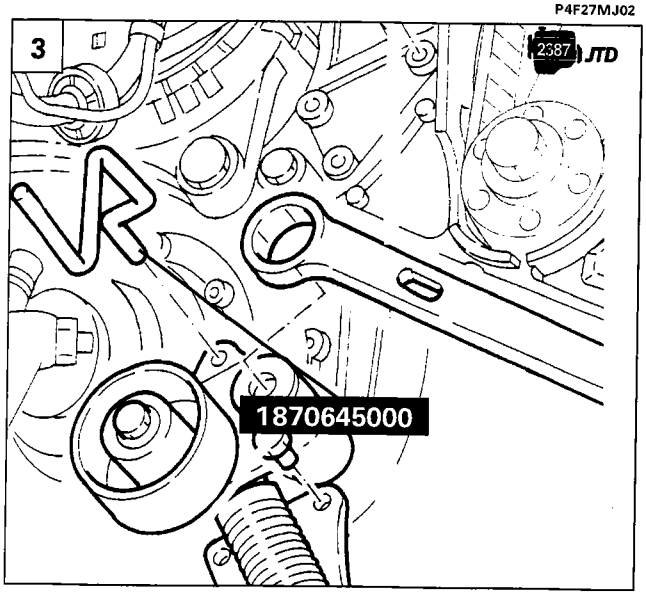
P4F27MJ02

2



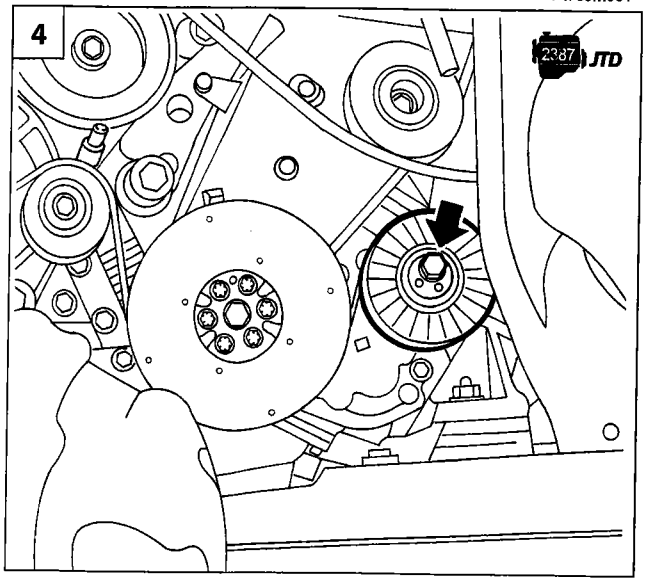
P4F38MJ05

3



P4F38MJ04

4



P4F38MJ05

REMOVING-REFITTING PRESSURE PUMP

Place the car on a lift.

- Disable the alarm (if fitted), located in the luggage compartment on the right hand side and disconnect the negative battery terminal.

1. Remove the upper engine protective cover.

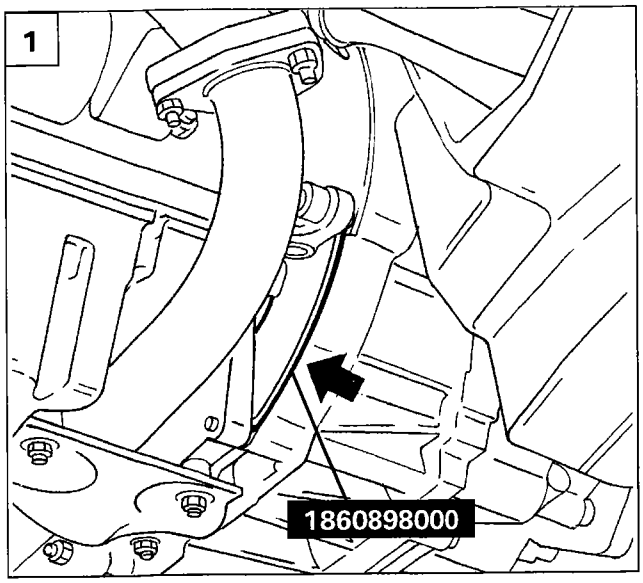
- Remove the right front wheel and the wheel arch liner.

2. Act on the tensioning device to loosen the auxiliary shaft belt tension.

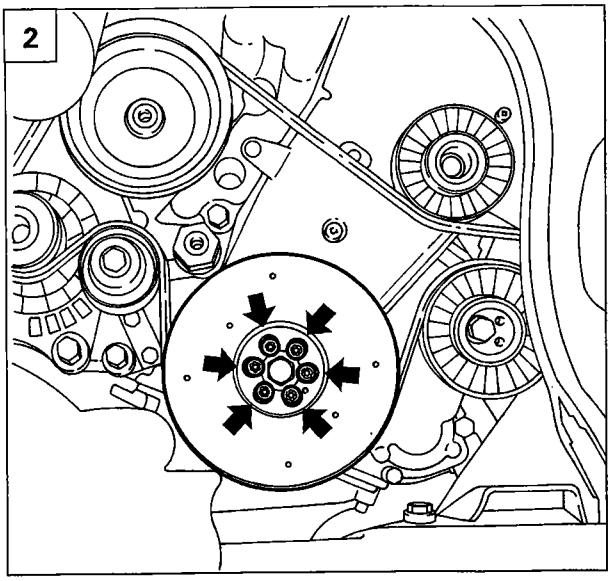
- Remove the auxiliary shaft belt (1910 JTD).

3. Rotate the tensioner until the reference opening in the actual tensioner coincides with the opening in the bracket; then insert tool 1870645000 in order to lock the tensioner in this position.

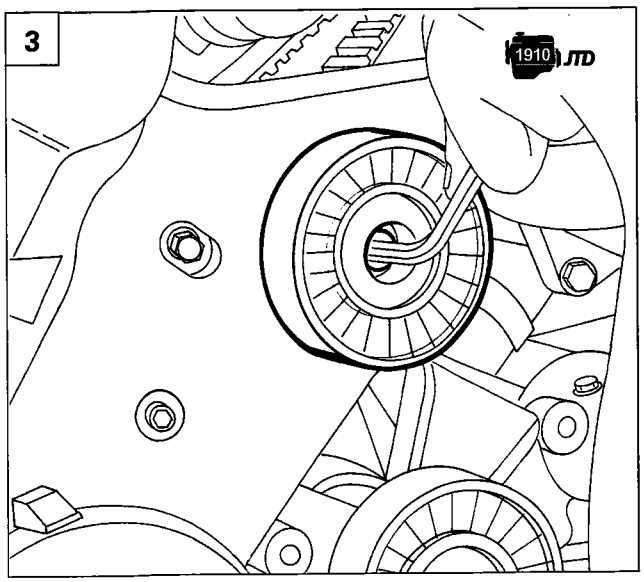
4. Loosen the tension of the moving pulley acting on the fixing bolt; then remove the auxiliary shaft drive belt.



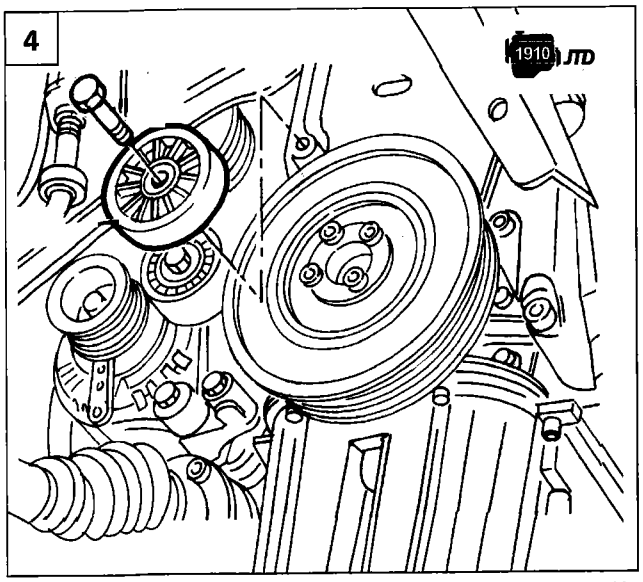
P4F39MJ01



P4F39MJ02

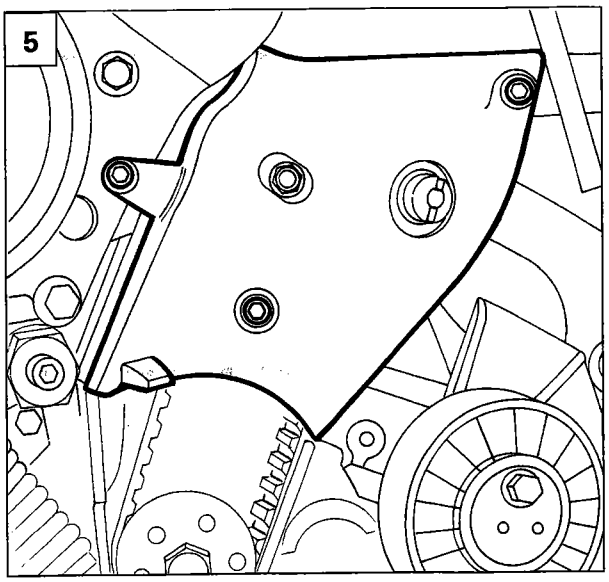


P4F39MJ03



P4F39MJ04

1. Remove the lower engine shield and lock the flywheel using tool 1860898000.
2. Remove the auxiliary shaft drive pulley on the crankshaft (the pulley on the 1910 JTD engine has four fixing bolts).
3. Remove the auxiliary shaft belt idler fixed pulley to allow the subsequent removal of the lower timing belt shield.
4. Undo the fixing bolt and remove the single drive belt fixed tensioner.
5. Remove the lower timing belt shield and remove the flywheel lock.



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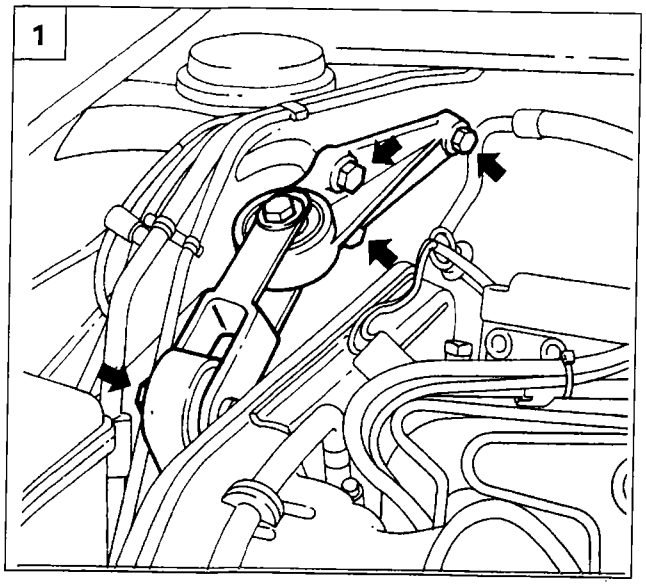
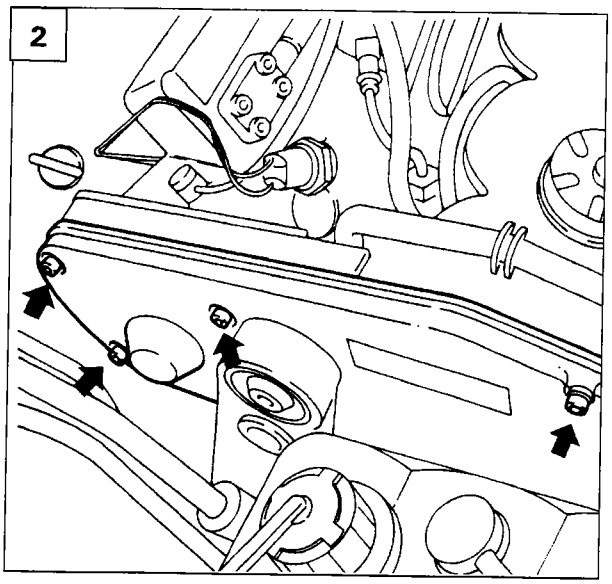
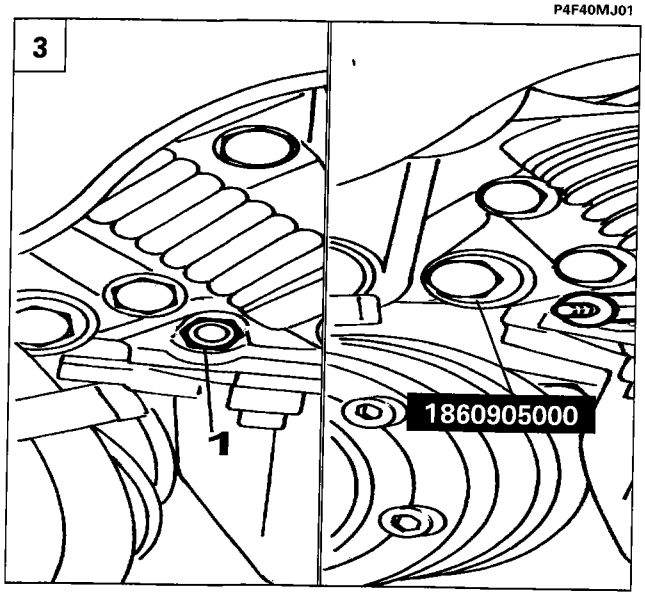


P4F40MJ01



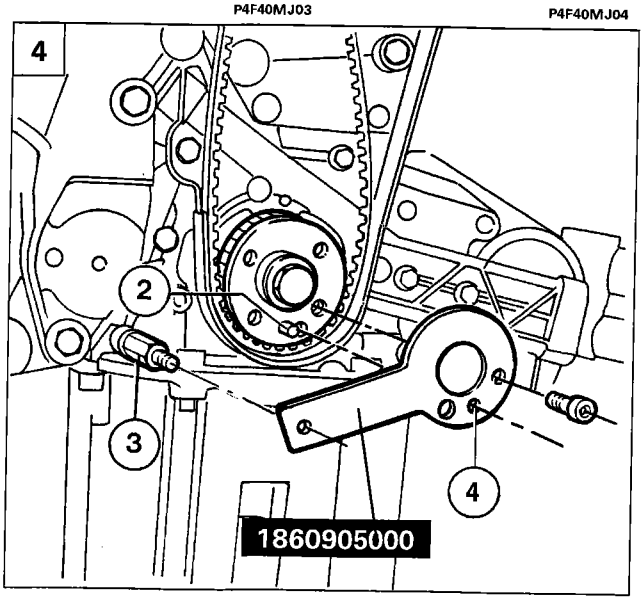
P4F40MJ02



P4F40MJ03

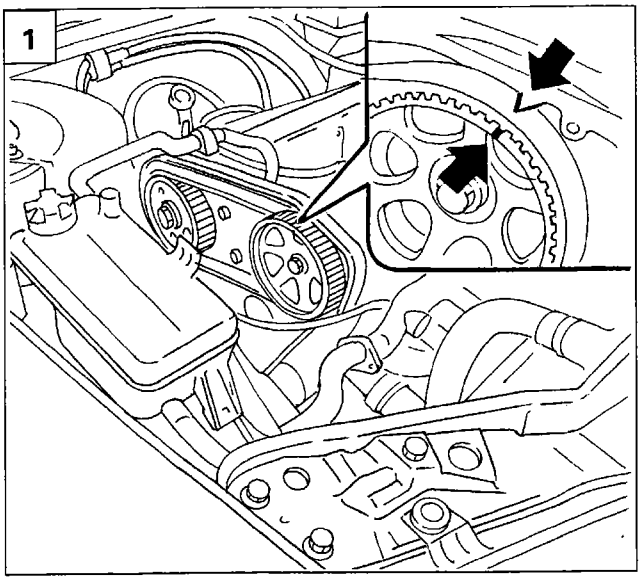
P4F40MJ04

1. Remove the reaction rod and support, acting on the fixings shown in the diagram, in order to allow the subsequent removal of the upper timing belt shield.
2. Remove the upper timing belt shield.
3. Remove the oil pump fixing bolt; in place of the bolt, position the pin for tool 1860905000 for determining T.D.C.

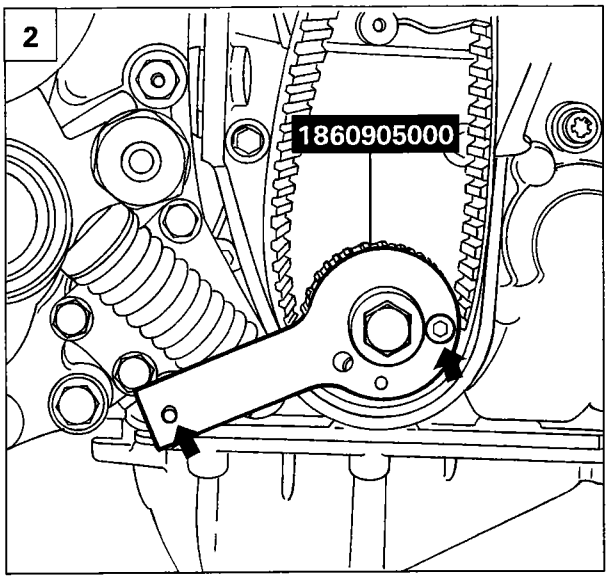


P4F40MJ05

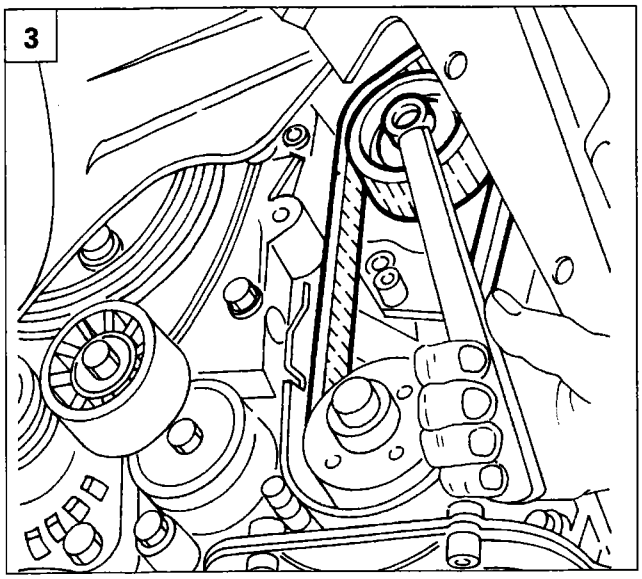
4. Position tool 1860905000 on the crankshaft drive gear and on the pin (3) fitted previously; rotate the crankshaft using small movements until the centering dowel (2) matches with the opening (4) in the tool. In this position cylinder no. 1 is exactly aligned at T.D.C.



P4F41MJ01

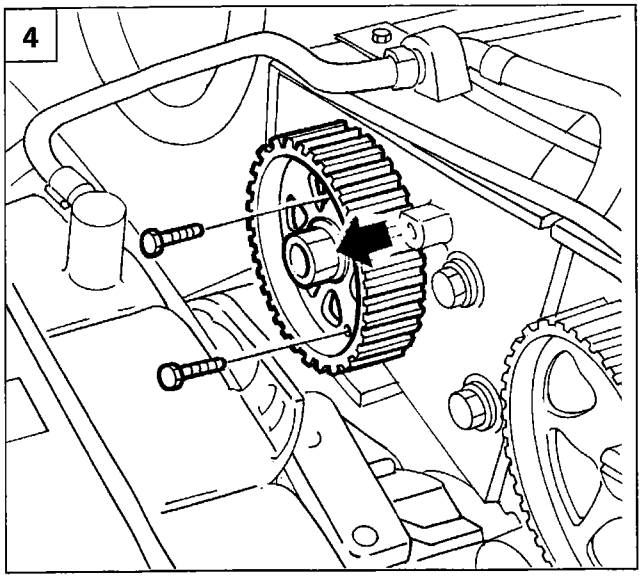


P4F41MJ02

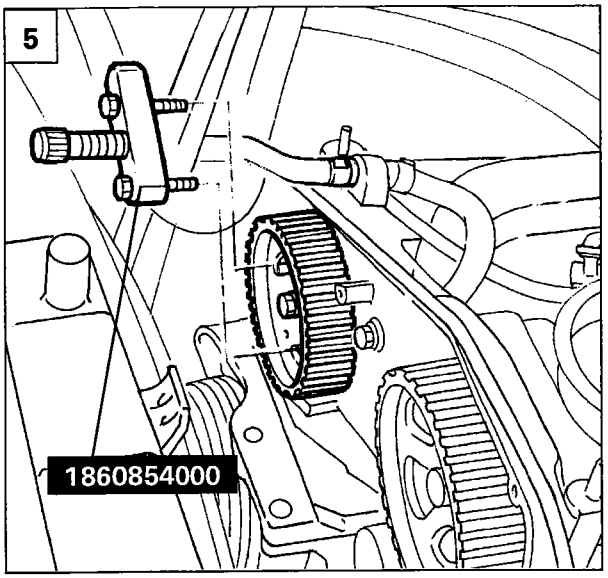


P4F41MJ03

1. Check that the reference on the timing toothed pulley is aligned with the reference mark for the timing of cylinder no. 1 at T.D.C.
2. Fix tool 1860905000 to the crankshaft drive gear using the bolt shown.
3. Loosen the timing drive belt moving tensioner nut and remove the timing belt."
4. Tighten the two adjustment screws in the special housings to lock the pressure pump drive pulley and undo the fixing nut.
5. Using tool 1860854000 shown in the diagram to remove the pulley.

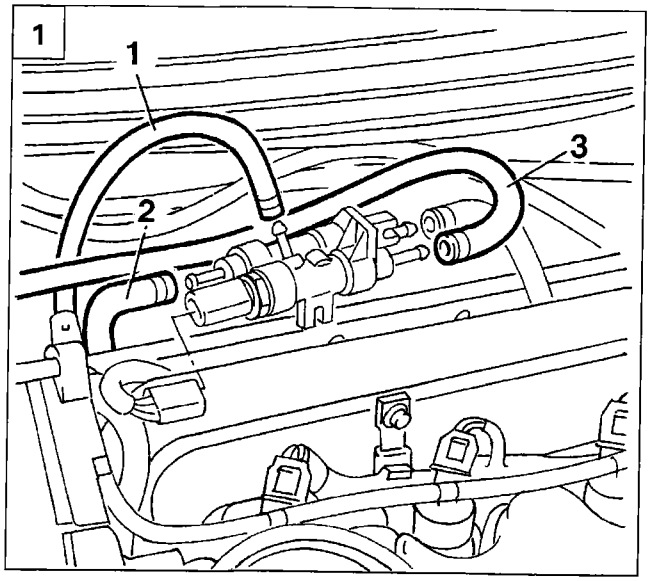


P4F41MJ04

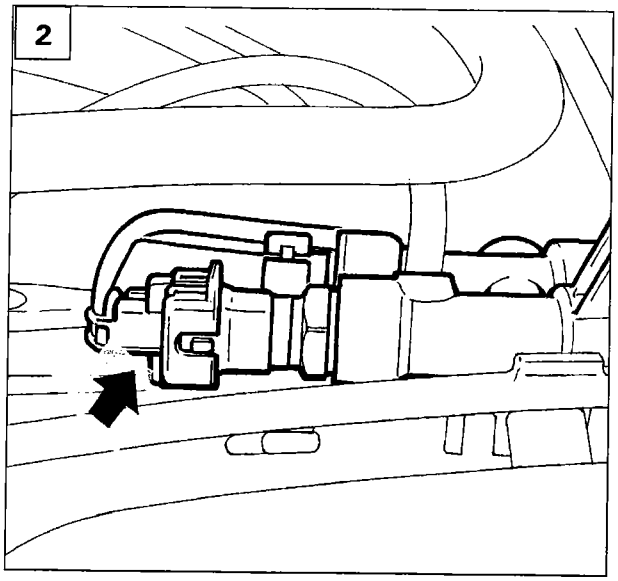


P4F41MJ05

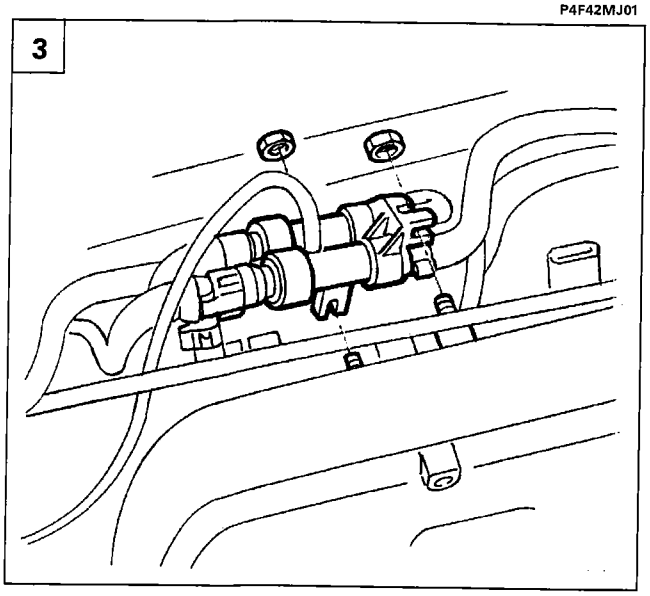
10



P4F42MJ01

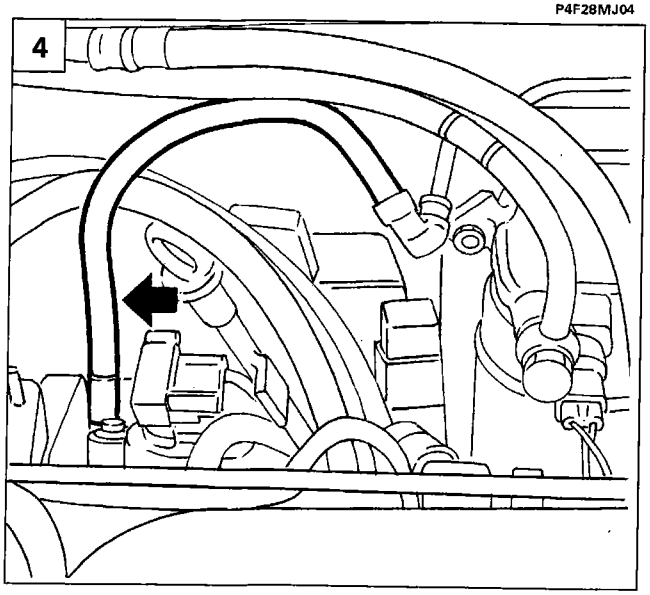


P4F32MJ01



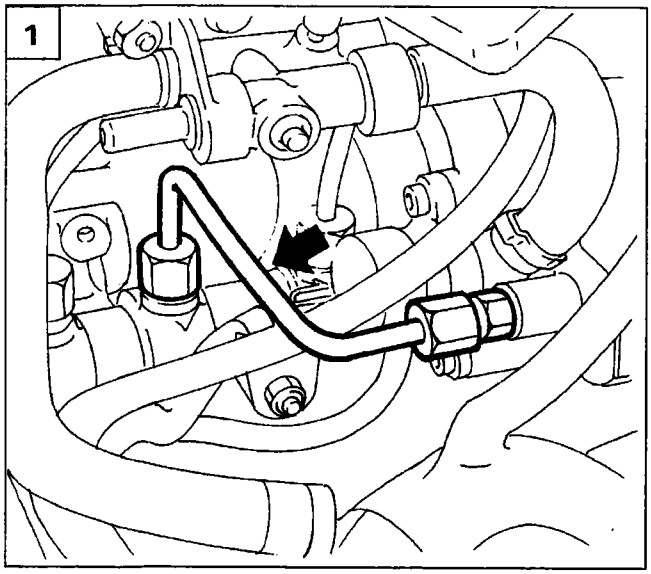
P4F28MJ04

1. Disconnect the following from the return manifold: the fuel return pipe from the injectors (1), the fuel return pipe from the pressure pump (2) and the fuel return pipe from the filter (3).
2. Disconnect the electrical connection from the fuel temperature sensor.
3. Acting on the fixing nuts, move the return manifold aside.



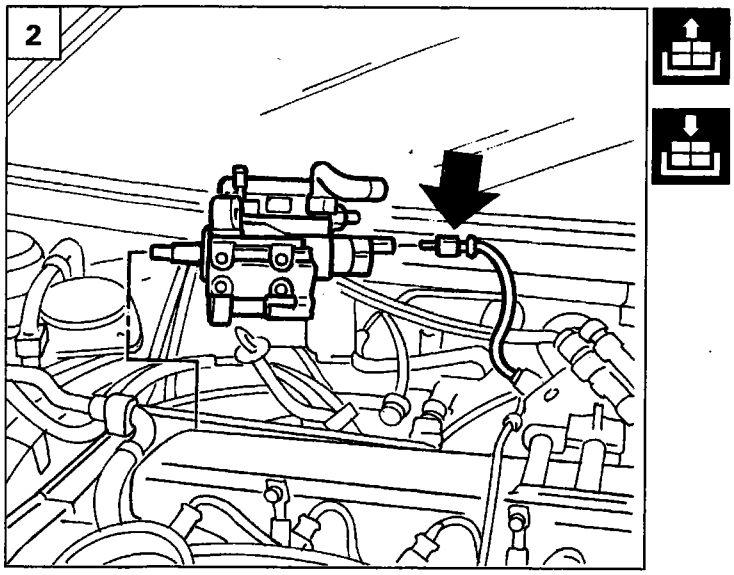
P4F42MJ02

4. Loosen the fixing band and disconnect the fuel inlet pipe.



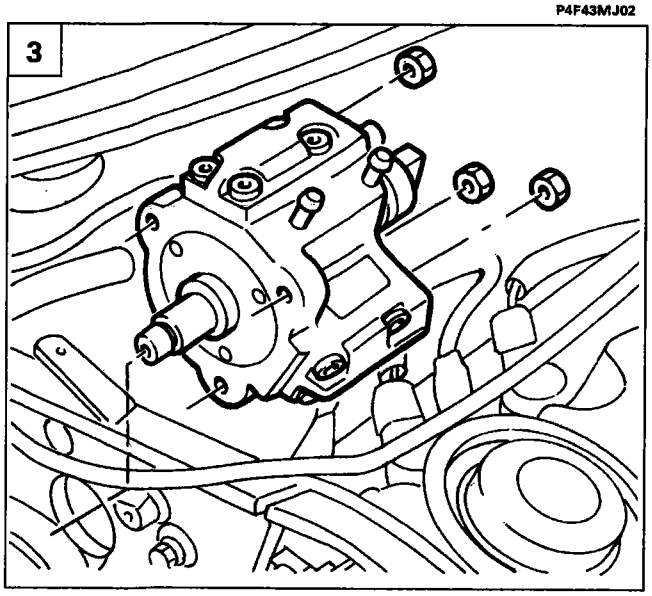
P4F34MJ01

1. Remove the fuel delivery pipe from the pressure pump to the rail pipe.



P4F43MJ02

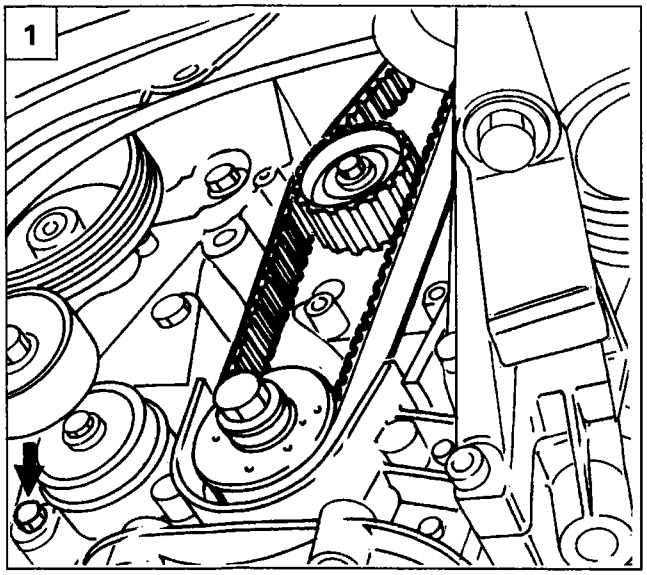
2. Disconnect the electrical connection from the pressure regulator on the pressure pump



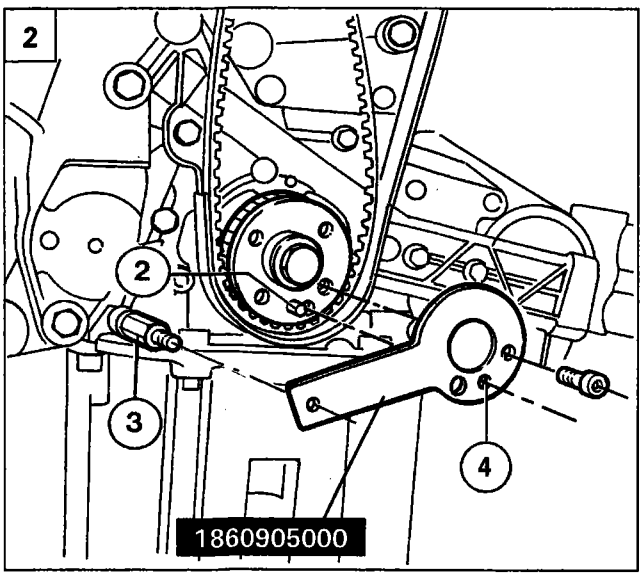
P4F43MJ03

3. Undo the retaining nuts and remove the pressure pump.

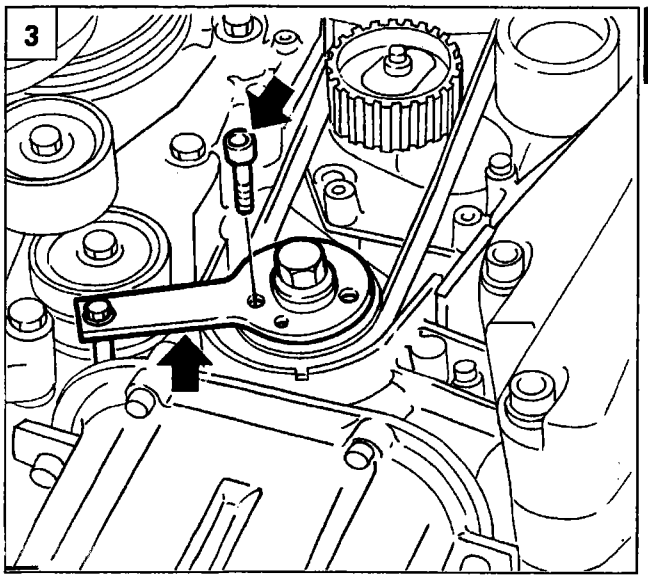
10.



P4F44MJ01



P4F44MJ02



P4F44MJ03

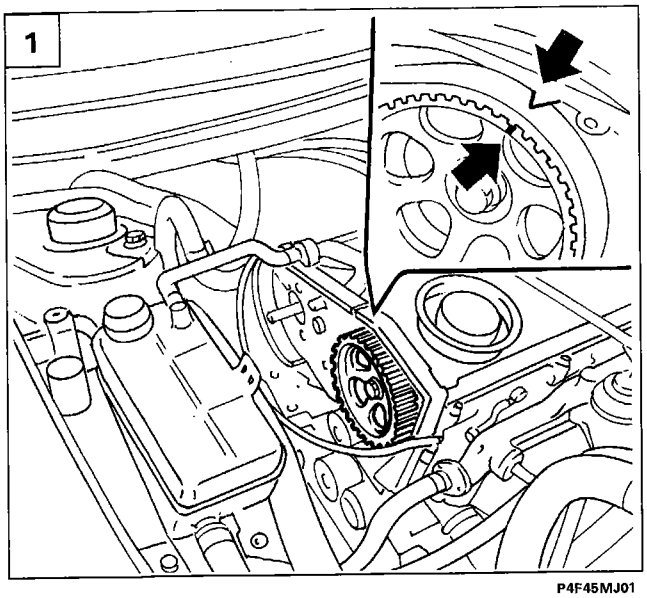
Refitting

Reverse procedure described for removal to the point where the pressure pump is refitted. Then refit and tension the timing belt and auxiliary drivebelt.

NOTE *The pipe leading from the pressure pump to the rail must be replace whenever it is disassembled and both pump side and manifold side fittings must be tightened to a torque of 2.2 daNm.*

Fitting and tensioning timing drive belt

1. Fit the timing belt to the crankshaft gear provisionally and remove the bolt indicated from the oil pump.
2. Position tool 1860905000 on crankshaft drive gear and pin (3); turn the crankshaft through small movements until locating dowel (2) fits into hole (4) on the tool. In this position, cylinder no. 1 is exactly aligned with TDC.
3. Secure the tool to the crankshaft drive gear using the bolt shown.

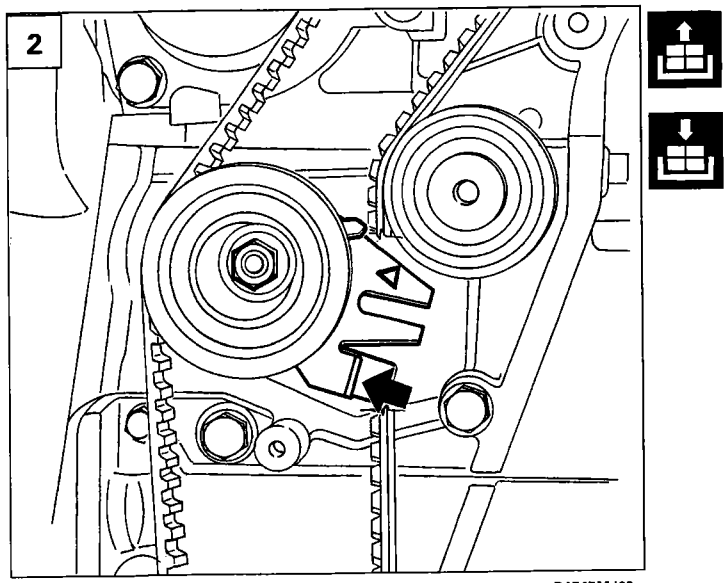


P4F45MJ01

Lower the lift.

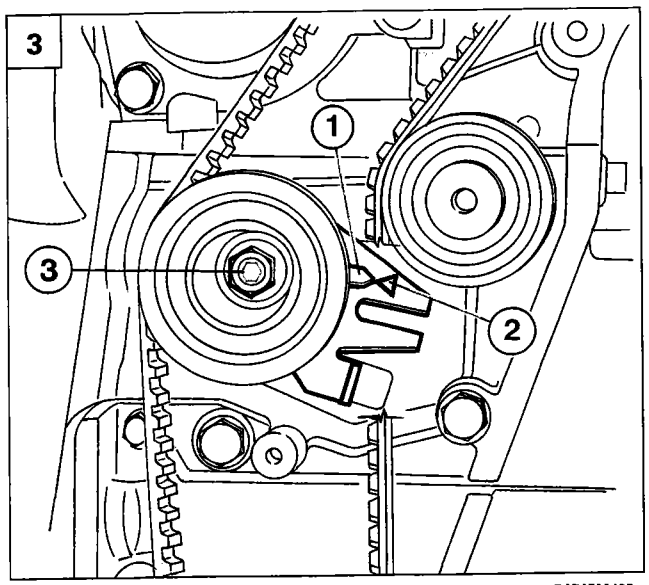
1. Rotate the driven pulley so that the timing references line up.

Raise the lift and complete the fitting of the timing belt, checking the timing.



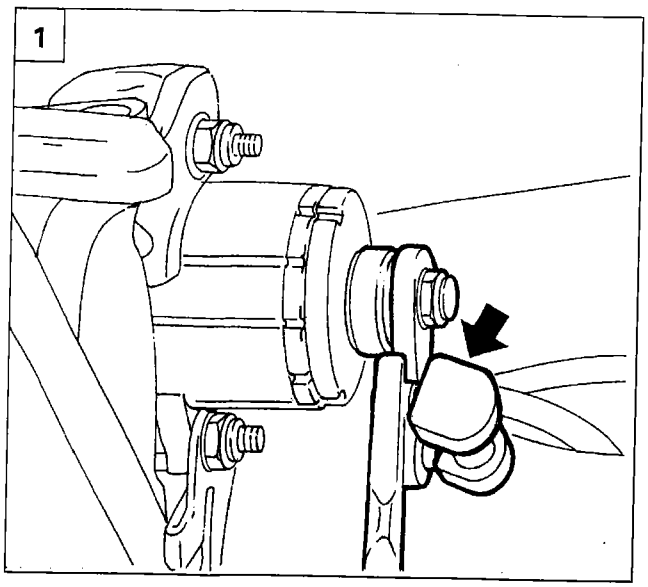
P4F45MJ02

2. Using a screwdriver, apply force to the automatic tensioner so that it is in the maximum tension position, then tighten the nut fixing the tensioner to the support. Remove tool 1860905000 and rotate the engine through two revolutions in its normal direction of rotation.

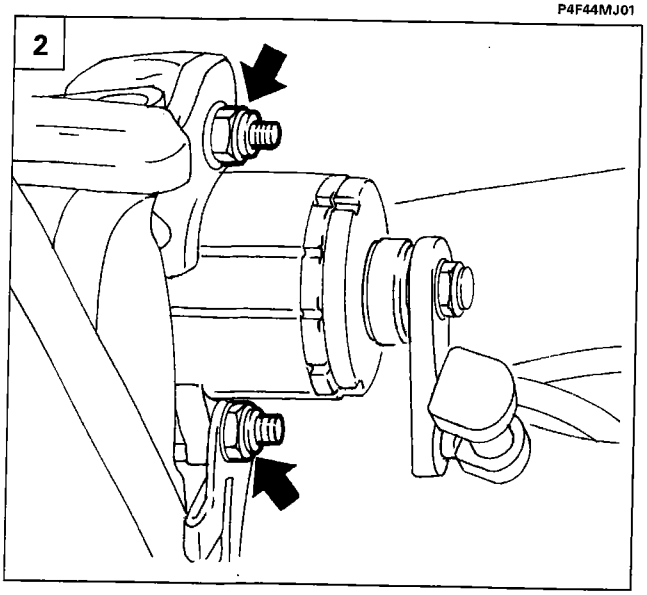


P4F45MJ03

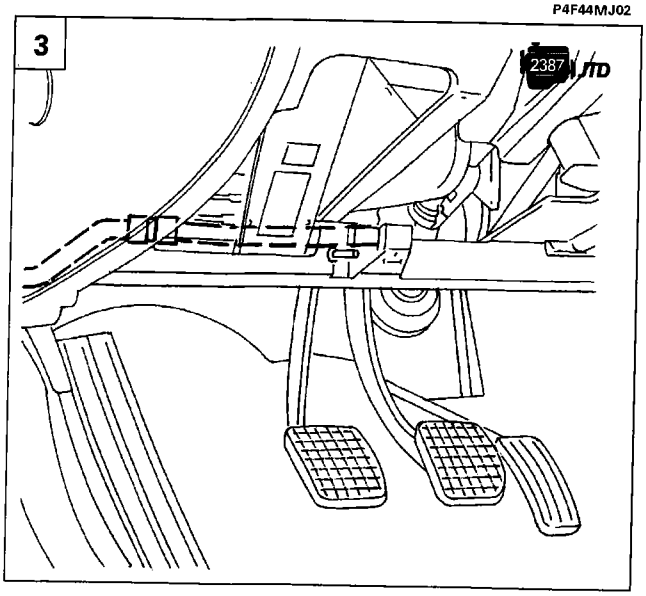
3. Loosen the nut fixing the tensioner (3) and, using a screwdriver for leverage in order not to completely discharge the tension, make sure that the moving reference (1) on the tensioner coincides with the fixed reference (2), then tighten the nut fixing the tensioner (3) to the recommended torque.



P4F44MJ01



P4F44MJ02



P4F44MJ03

REMOVING - REFITTING ACCELERATOR PEDAL POTENTIOMETER

- Disable the alarm (if fitted) via the switch under the junction unit cover and disconnect the negative battery terminal.
- Remove the shield under the pedals assembly.

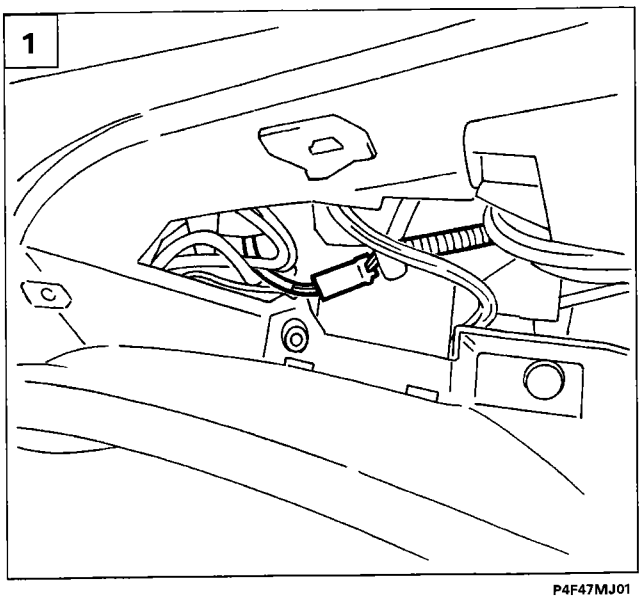
1. Remove the potentiometer idler rod from the accelerator pedal.

1910 JTD

2. Undo the nuts fixing the potentiometer to the bracket for the steering column and remove the potentiometer.

   Move the wiring as close as possible to the plastic casing retining it, taking care not to damage the surrounding cables and remove the shield for the fuses from the glove compartment.

3. Disconnect the electrical connector for the potentiometer.



P4F47MJ01

1. Disconnect the electrical connector for the potentiometer moving the wiring as close as possible to the plastic casing retaining it, taking care not to damage the surrounding cables.

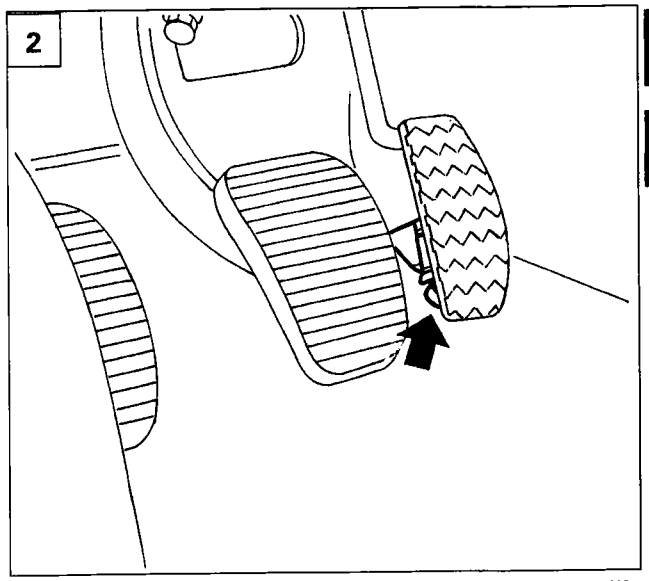
REFITTING

- Carry out the operations described above in the reverse order.

2387 JTD

- Positin the new potentiometer and restore the routing of the new bridge, fitting bands, as appropriate, under the tunnel so that the movement of the climate control components is not impeded and there is no noise/vibrations whilst the vehicle is moving.

2387 JTD

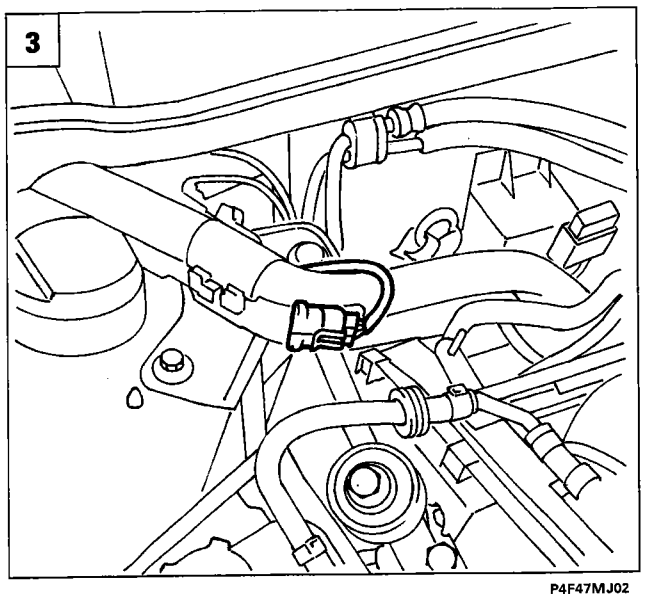


P4F47MJ03

ADJUSTING ACCELERATOR PEDAL END OF TRAVEL

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

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



P4F47MJ02

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