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BOSCH MONOMOTRONIC MA1.7.3 S.P.I. INTEGRATED INJECTION/IGNITION SYSTEM

Introduction

The SPI BOSCH MONOMOTRONIC system is the integrated type, where one single electronic control unit regulates both the injection and the ignition.

It is an SPI system, in other words there is only one single injector which controls the moment and the duration of the injection of the petrol upstream of the butterfly and the moment that the spark strikes in the explosion chamber for each cylinder (advance angle).

The MONOMOTRONIC engine control system is based on information concerning the engine load conditions, the butterfly angle/number of revs (α/n) i.e. the quantity of petrol required and the advances, calculated according to the value of the butterfly opening angle and the engine speed.

This system is equipped with a heated type LAMBDA sensor and, on the basis of the signal coming from the sensor indicating whether the mixture is rich or lean, it correct the injection time. This produces a CLOSED LOOP system.

SYSTEM MANAGEMENT STRATEGIES

Inside the control unit memory there is a management programme (software) which comprises a series of strategies, each of which manages a precise control function for the system.

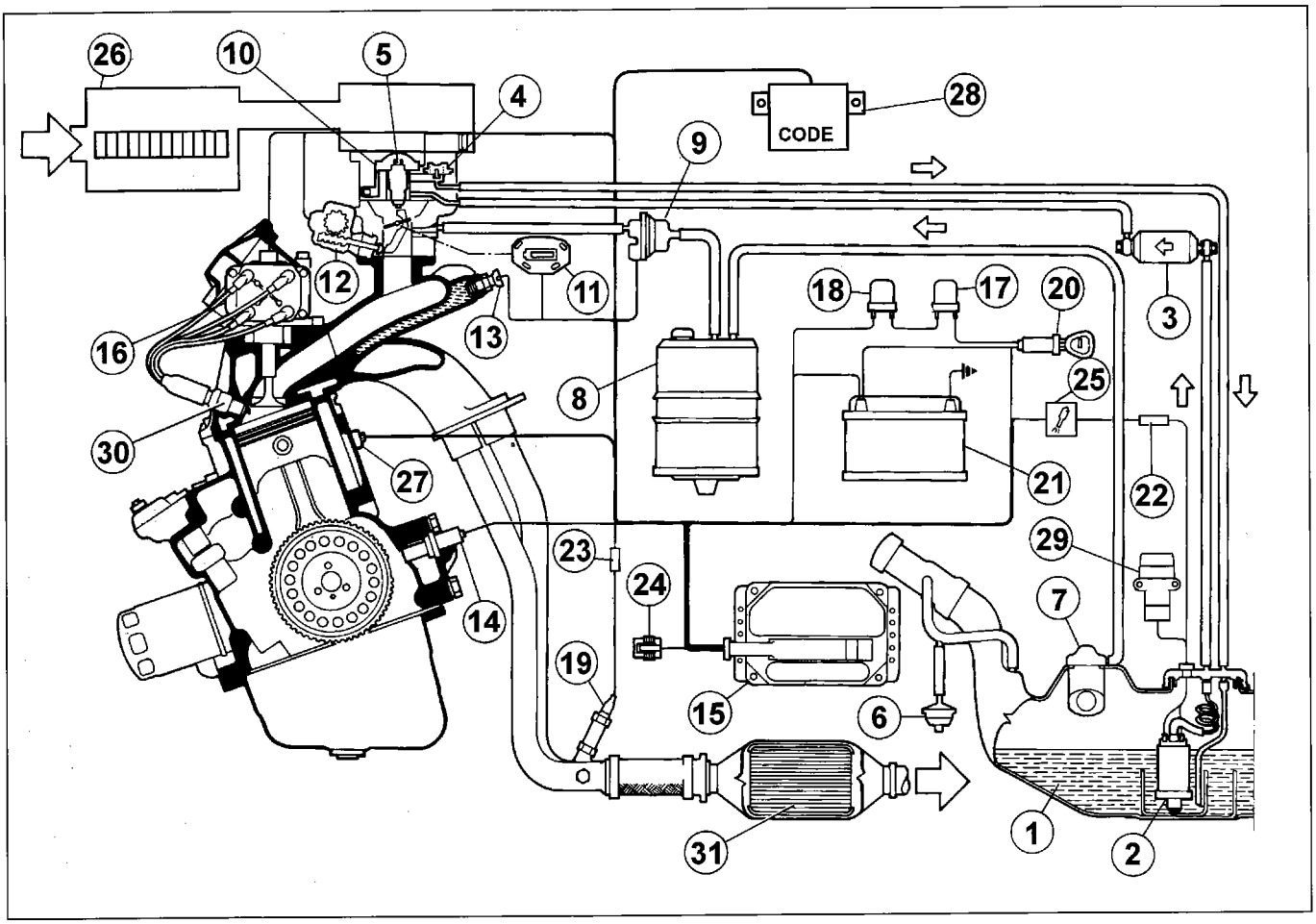
By using the information (input), each strategy processes a series of parameters, based on maps of data memorized in special areas of the control unit and then operates the system actuators (output) which are devices which allow the engine to operate.

In addition to controlling the moment of ignition and the temperature/pressure of the air drawn in at the various engine speeds, in order to allow the engine to run smoothly when the environmental parameters and the loads applied vary, the management strategies must control and manage the injection so that the stoichiometric ratio (air/fuel) is always within the optimum value.

The system management strategies are basically as follows:

1. management of the injection;
2. management of the ignition;
3. management of the engine idle control;
4. management of the fuel vapour recirculation;
5. control of the detonation;
6. management of the climate control system;
7. self-adjustment of the system;
8. management of the engine immobilizer function - Fiat CODE;
9. management of the fault diagnosis.

DIAGRAM SHOWING OPERATION OF INJECTION/IGNITION SYSTEM



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1. Fuel tank
2. Electric fuel pump
3. Fuel filter
4. Fuel pressure regulator integrated in the butterfly casing
5. Injector
6. Vapour breather safety valve (into atmosphere)
7. Breather, ventilation and overturn float valve
8. Active charcoal filter
9. Fuel vapour cut out solenoid valve
10. Air temperature sensor
11. Butterfly valve opening angle sensor (potentiometer)
12. Direct current motor for controlling the engine idle speed incorporaating the butterfly valve closure recognition micro-switch
13. Coolant temperature sensor
14. Engine rpm sensor
15. Electronic control unit
16. High tension coil
17. Main system relay feed
18. Electric fuel pump relay
19. Heated Lambda sensor
20. Ignition switch
21. Battery
22. Electric fuel pump fuse
23. System fuse
24. Diagnostic socket
25. System failure warning light
26. Thermostatic duct
27. Detonation sensor
28. Fiat CODE control unit
29. Inertia switch
30. Spark plugs
31. Catalytic silencer

MANAGEMENT OF THE INJECTION

Through the acquisition of information concerning the engine speed (n) and the butterfly valve opening (alfa), the control unit identifies the basic injection time (ti) in a special map.

Given the varying usage conditions of the engine, the injector opening values are optimized by correcting the times on the basis of the following variations: the coolant temperature (1), the air temperature (2) and the signal sent by the lambda sensor (3), always using a synchronous type injection, timed with the moment of ignition.

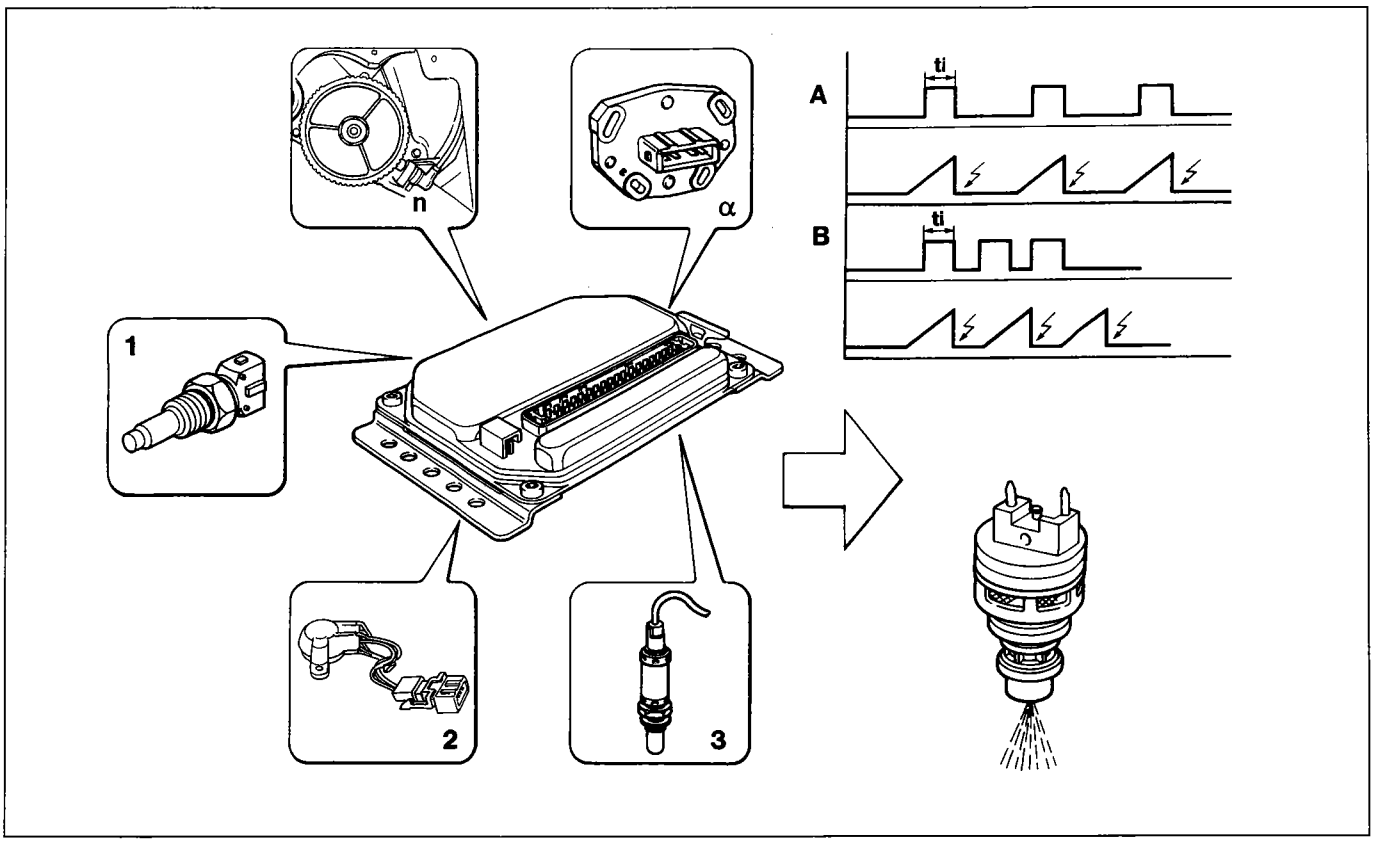
By means of special maps selected by interpolation, the control unit tries to always keep the metering values close to the stoichiometric value (14.7 parts of air and 1 part of petrol).

In order to keep this ratio constant, **the electronic control unit uses two different methods for controlling the opening of the injector.**

The first method is that of **synchronous operation, where the injector is opened each time a high tension impulse is sent to the spark plugs** (diagram A).

The second method involves **asynchronous operation, where the electronic control unit controls the opening of the injector irrespective of the number of high tension impulses sent to the spark plugs** (diagram B).

This takes place because in certain conditions (with basic injection times which are too short, ⩾ 1.4 milliseconds) the mechanical inertia characteristics (hystersis) of the injector do not allow suitable openings and closures; for this reason a particular strategy which comes within the mechanical characteristics of the injector must be adopted.



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Checking the electric fuel pump supply

The operation of the electric fuel pump (A) is entrusted to the electronic control unit which, by means of the relay (B), ensures that it is switched on when the engine is being started up and when it is running normally.

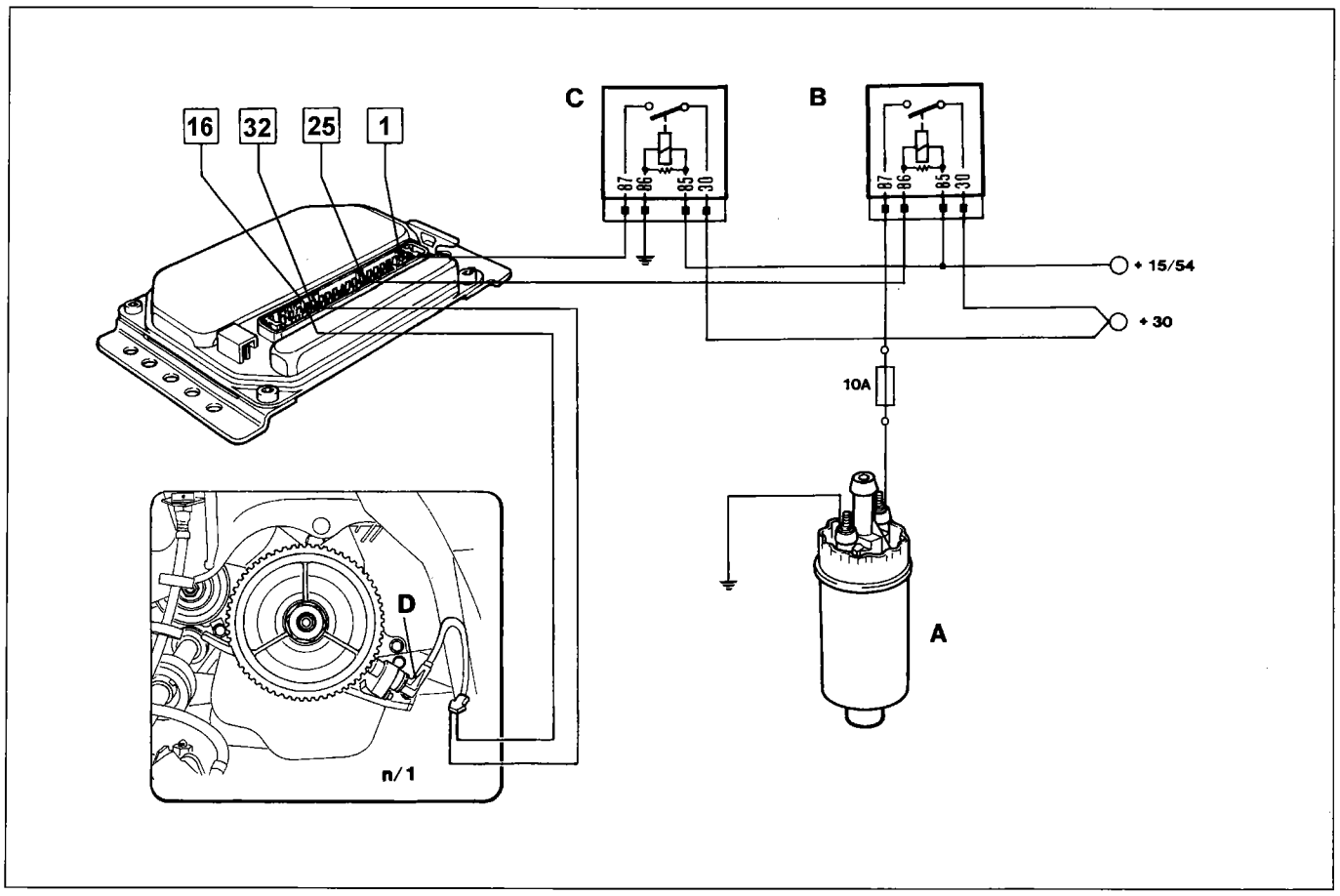
With the ignition switch in the ON position (15/54), the pump relay (B) and the main relay (C) are supplied simultaneously and the latter, on closing, supplies the control unit (terminal 1).

By means of a special circuit, the control unit closes the pump relay (B) to earth via terminal (25) and the pump relay supplies the fuel pump (A), via a 10 A fuse, pressurizing the fuel system for around 1 to 2 seconds.

When the engine is started up, as the engine rpm signal coming from the rpm and T.D.C. sensor (D) reaches terminals 16 and 32 of the control unit, after around 1 second the relay (B) is energized and consequently the fuel pump cuts out (for safety reasons) even with the ignition switch in the ON position.

If the batterry voltage goes below the nominal value (for example during cold starting), the fuel pump supply pressure tends to decrease.

In order to overcome this problem, the control unit increases the injection times proportionally in accordance with a correction factor in order to ensure the exact metering of the fuel.



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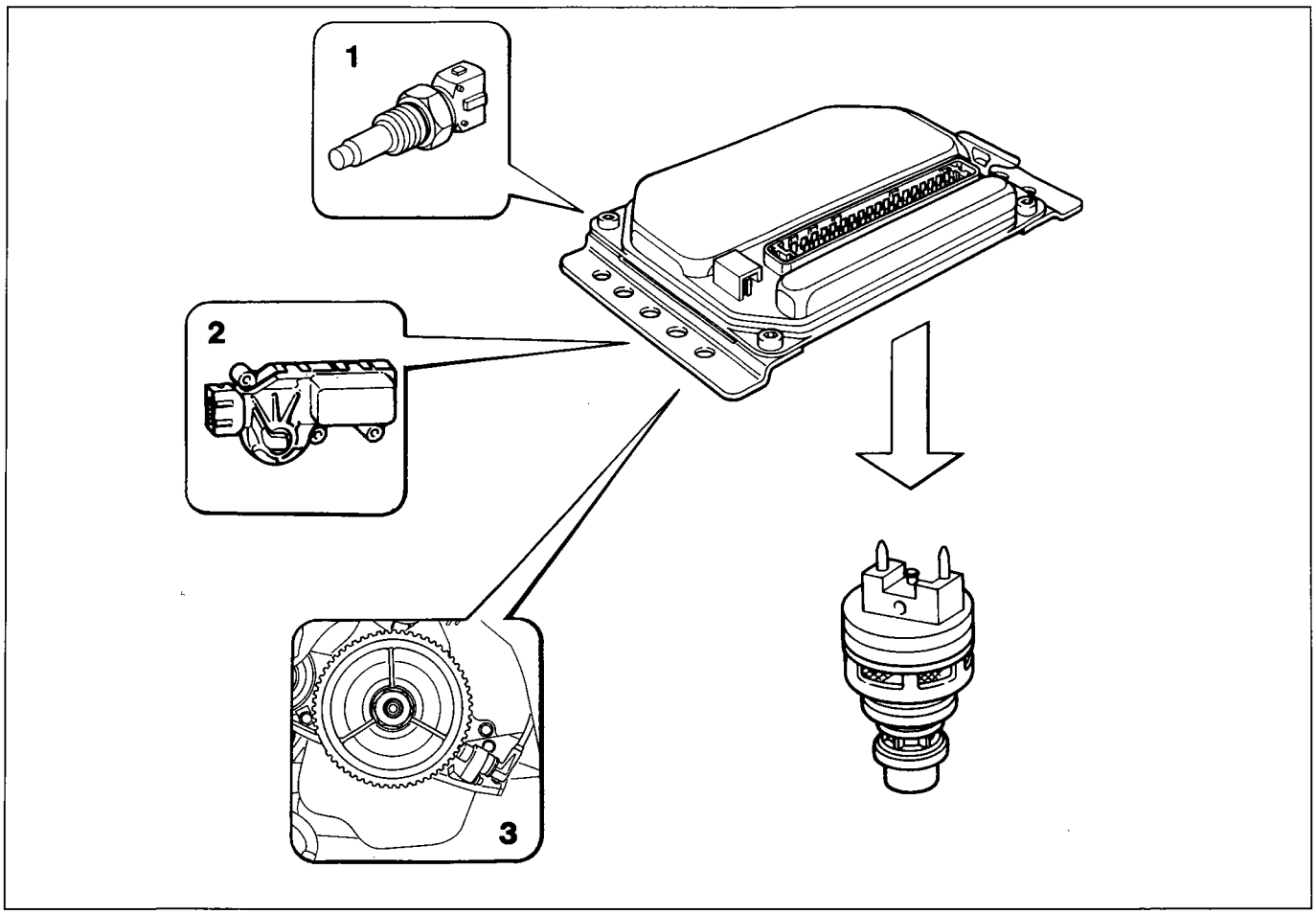
Starting

With the ignition key in the ON position, the electronic control unit supplies the electric pump for several moments and acquires the data from the various sensors.
According to the coolant temperature sensor (1) the control unit arranges the opening of the butterfly valve by means of the direct current motor (2). **The starting stage is recognized by the control unit when the value of the engine speed detected by the sensor (3) is above 30 rpm.**
At low engine temperatures, the injection times are increased: the injector remains open for longer, producing a richer mixture.
At high engine temperatures, the injection times are decreased with a consequent approaching of the stoichiometric ratio.
There is also an anti-flooding function in the control unit, controlled by an internal timer, which gradually reduces the enrichment of the mixture when the engine does not start up for any reason.
During the post-starting stage, the basic injection times, selected by the control unit, are enriched by a function which varies in relation to the temperature of the engine coolant which is cancelled according to the time.
The multiplication value is not maintained constant for the entire period of engagement, but is gradually reduced (by a timer in the control unit).
Whilst the engine is warmin up a further enrichment of the mixture takes place, dependent on the temperature of the engine coolant, which is not timed and which is added to the post-starting one.
This enrichment decreases gradually in a manner which is inverserly proportional to the engine temperature.



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10.

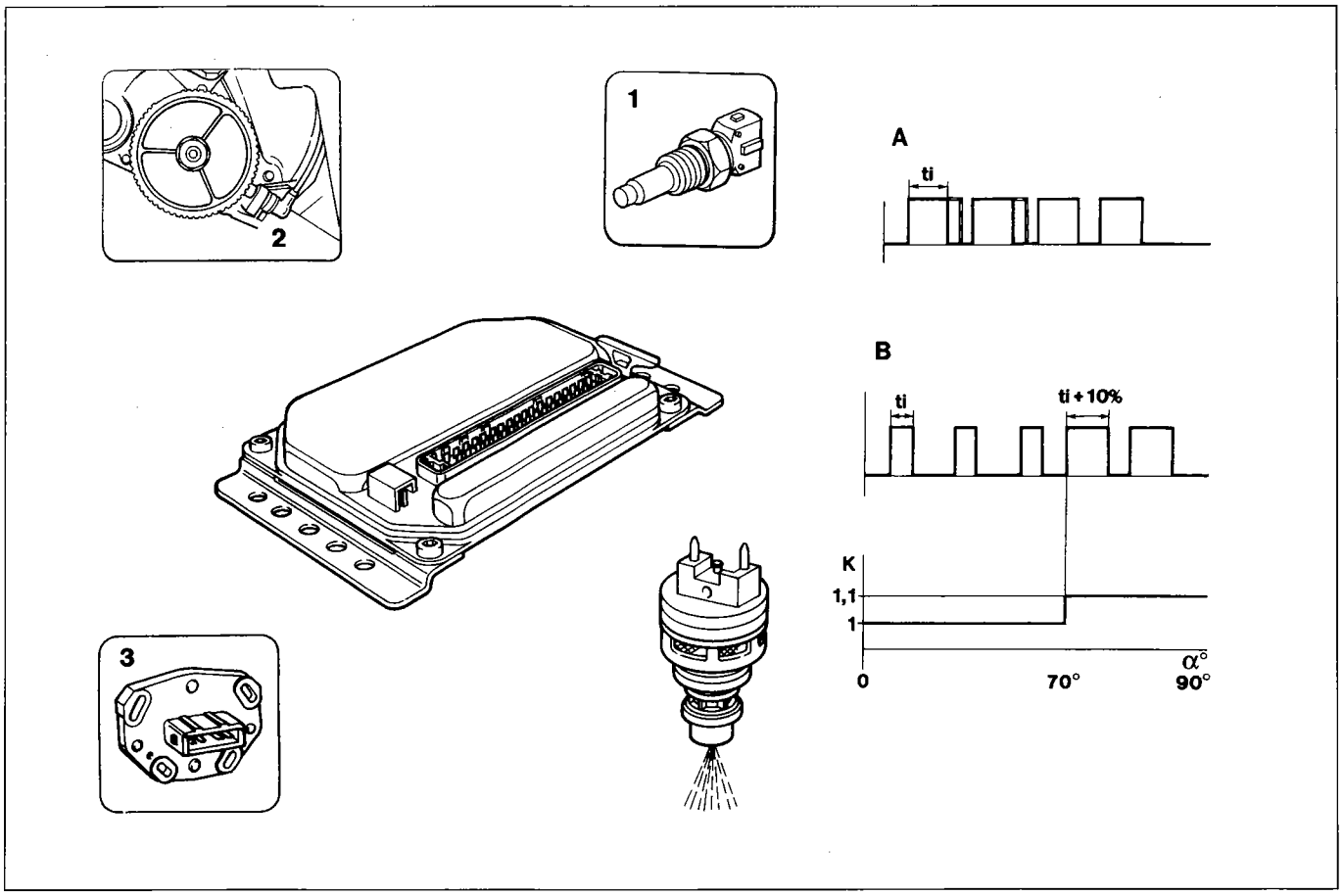
Acceleration and full power

During acceleration the electronic control unit always provides enrichment (diagram A) of the mixture strength according to the signals sent by the engine coolant temperature sensor (1), the rpm sensor (2) and the butterfly valve angular position sensor (3).

During the operation of the engine in full power conditions the basic injection times (ti) are increased (enrichment) by a factor (K) which depends on the butterfly valve (3) oening angle (α).

When the butterfly valve opening angle exceeds 70° (diagram B), the full power enrichment is operational and the basic injection times are increased by about 10%.

When 6000 rpm is exceeded, the system restricts the maximum number of revs through the electronic control unit (which suppresses the injection impulses cutting off the fuel supply).



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Deceleration and CUT-OFF

During deceleration it is necessary to make the mixture leaner to reduce fuel consumption and pollutant emissions (HC + CO).

In order to achieve this objective, there is a function in the control unit known as the fuel cut off which depends on the closure of the contact (1) in the idle control motor, the temperature of the coolant and the engine speed.

The first two conditions necessary for activating the CUT-OFF function are:

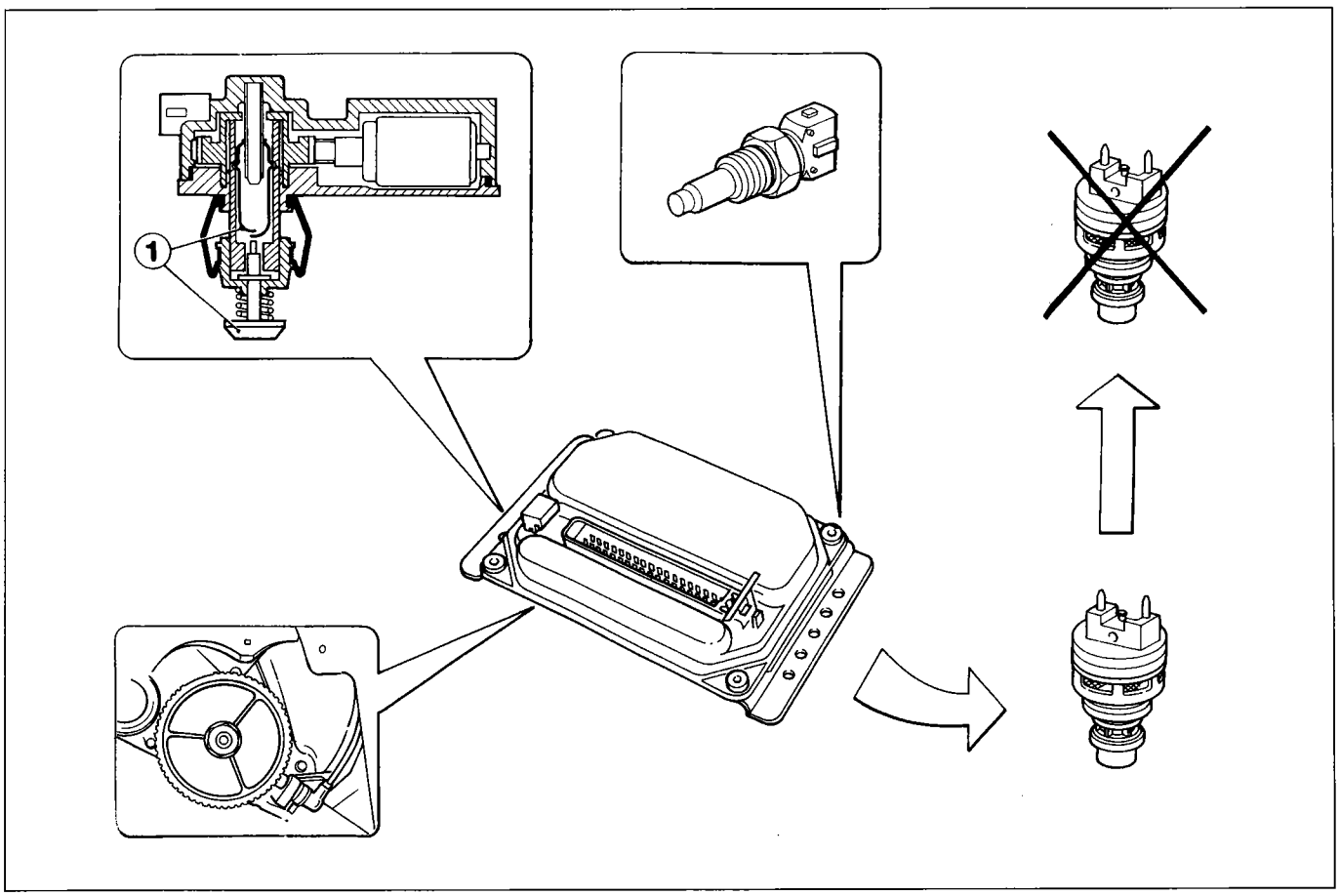
- coolant temperature above around 40° C,
- engine speed above around 1800 rpm

If the above mentioned conditions exist during deceleration, when the idle contact (1 - butterfly closed) closes terminal 3 for the control unit is placed to earth and the control unit, in turn, interrupts the injection of fuel via terminal 21.

In addition to cutting off the fuel, the control unit activates a special ignition curve with an advance known as "release".

The cutting off the injection of fuel and the specific advnance curve are opertional until the engine reaches a speed of around 1500 rpm, below which the injection impulses must be activated in order to prevent the engine from cutting out.

When the injection is restored, the control unit implements a fuel enrichment strategy in order to reform the film of petrol on the inlet manifold which improves the operation of the engine.



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10.

LAMBDA adjustment

The control of the mixture is ensured by the LAMBDA sensor which detects the residual oxygen content in the exhaust gases.

Since the ceramic material is not activated below 300° C, the LAMBDA sensor is electrically heated by a resistance (inside it) which always receives a positive supply controlled by the ignition and is protected by a 10 A fuse.

This heating is necessary during cold starting to preserve the efficiency of the sensor in case the engine is idling for a long period.

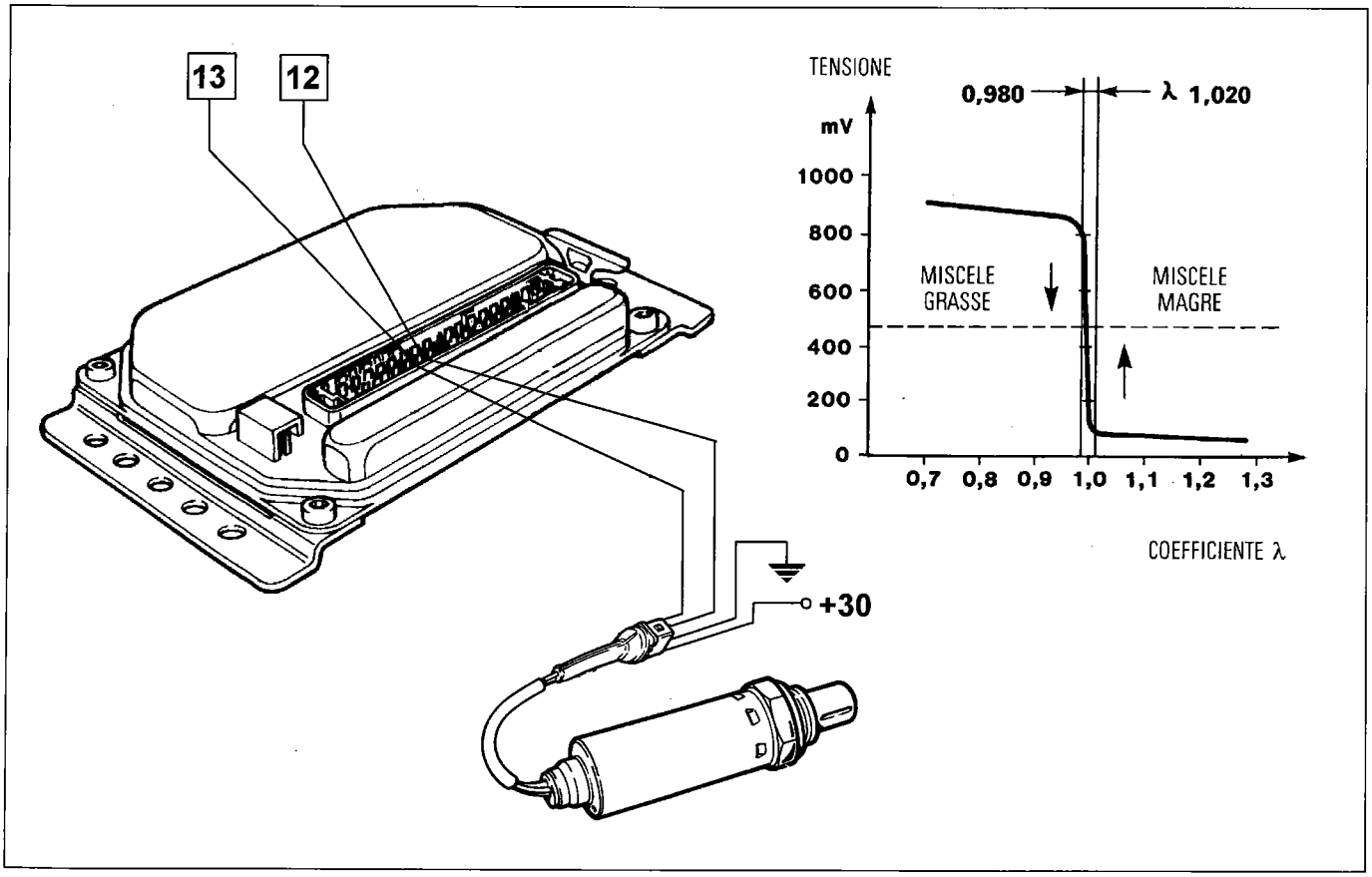
At temperatures above 300° C, the ceramic material becomes a conductor of oxygen ions, consequently if the quantity of oxygen present at the two sides of the sensor is in differing percentages a variation in voltage is created between the two poles.

The LAMBDA sensor causes the voltage variation signal to reach the control unit via terminals (12) and (13).

The LAMBDA sensor detections concerning the composition of the exhaust gases allow the electronic control unit to constantly correct the mixture strength in real time (making it leaner/richer) in order to keep it as close as possible to the stoichiometric strength. The efficiency of the operation of the catalyzer and the restriction of the toxicity of the exhaust gases depends on the exact composition of the mixture.

During the above mentioned stagtes, the variations in the injection time made by the control unit according to the LAMBDA sensor signal are excluded because they would be in opposition to the driving conditions set; consequently the engine operates in OPEN LOOP conditions.

With the LAMBDA sensor working properly and the control unit control circuit operating, the percentages of pollutant gases at the exhaust are automatically regulated by the system without the possibility of external adjustments.



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MANAGEMENT OF THE IGNITION

The ignition system used is the static advance type. The term static comes from the fact that as there is no high tension distributor (casing-brushes-cap) there are no moving parts.

The coil (B) has 4 high tension sockets which are connected directly to the spark plugs and whose operation is managed entirely by the control unit (A).

Inside the control unit (in addition to the various values for controlling the fuel metering) a map (C) containing an entire series of optimum advance angle values is stored which the engine uses according to the range in which it is operating: engine load (α) and number of revs (n).

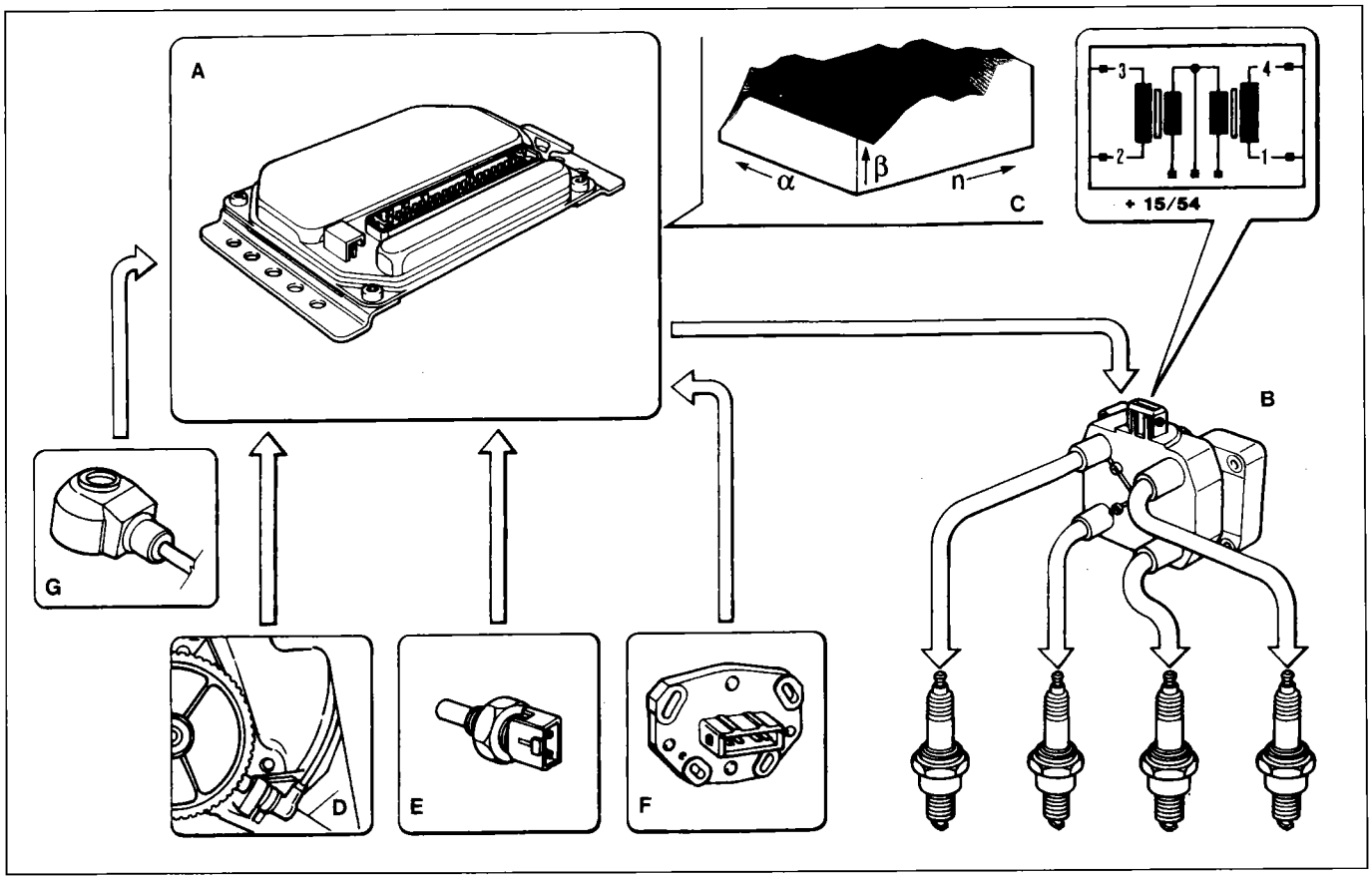
The values memorized are obtained experimentally, with the engine at the test bench, taking into account power, consumption and pollutant emissions.

On the basis of the maps memorized, the values for the number of revs (D), the temperature of the coolant (E), the engine load (F) and possible detonation (G), the control unit manages to select the correct advance value operating the ignition unit power module.

As the engine operating conditions vary there are 3 different basic maps for the advance angle:
- full load, where it depends on the engine speed and load conditions.
- partial load, where it still depends on the engine speed and load conditions.
- idling where it depends on the engine speed.

The advance angle in full load and partial load conditions may also have additional corrections according to the temperature of the engine and the temperature of the air; whilst the idle advance angle is only corrected on the basis of the engine temperature (its value is around 7° not constant).

There is an algorhythm in the control unit which calculates the advance according to the number of revs and battery voltage at which the current starts to flow through the ignition coil.



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The ignition is composed of two primary windings, connected to the control unit (A) via terminals 34 and 35, supplied by the battery voltage and two high tension secondary windings whose outlets are connected directly to the spark plugs for cylinders 1-4 and 3-2.

The high tension reaches the pair of spark plugs each time the circulation of the current in the primary winding is interrupted by the power module. The static distribution of the high tension takes advantage of the different pressure conditions which exist simultaneously in the pairs of cylinders 1-4 and 3-2.

In pratice, during the compression stroke for one cylinder, where there is a mixture of air/petrol, the other cylinder is in the exhaust stroke.

If, in these conditions, the voltages required to strike the spark between the spark plug electrodes is examined, it can be seen that during the compression stroke the voltage is very high (10 - 15 kV), whilst during the exhaust stroke the voltage is extremely low (in the order of 500 V).

The secondary circuit for each coil is therefore closed by two sparks; one of around 500 V also known as the lost spark because it occurs in the cylinder in the exhaust stroke and the other between 10 - 15 plus kV in the cylinder in the compression/explosin stroke capable of burning the air/petrol mixture in the actual cylinder.

MANAGEMENT OF THE ENGINE IDLE CONTROL

The general aim of the strategy is to keep the engine idle speed around the value memorized (engine warm: 850 ± 50 rpm): the position assumed by the idle speed control actuator depends on the following engine conditions:

Starting stage

When the ignition is switched on, the actuator assumes a position which depends on the temperature of the engine coolant and the battery voltage (open loop position).

Warming up stage

The number of revs is corrected, above all, according tothe temperature of the engine coolant.

With the engine at operating temperature the management of the idle depends on the signal coming from the engine rpm sensor; when external loads are applied, the control unit manages the idle sustained.

Deceleration stage

In deceleration conditions outside of idling, the control unit controls the position of the actuator by means of a special flow rate curve (dash-pot), slowing down the return of the push rod towards it housing, thereby reducing the braking effect of the engine.

MANAGEMENT OF THE FUEL VAPOUR RECIRCULATION

The fuel vapours (pollutant, according to 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 fuel entering by reducing the supply to the injectors.

CONTROL OF THE DETONATION

This function has the task of detecting the presence of the phenomenon of detonation (engine knock) by processing the signal coming from the appropriate sensor. The control unit constantly compares the signals coming from the sensor with a base value which is, in turn, constantly updated, in order to take into account the basic 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 until the phenomenon disappears. Later, 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 also has a self-adjustment function which memorizes the reductions in the advance which are constantly repeated in order to adjust the map to the different engine operating conditions.

MANAGEMENT OF THE CLIMATE CONTROL SYSTEM

When the climate control is switched on the compressor absorbs power from the engine which, when idling, tends to cut out. To avoid this problem the control unit adjusts the air flow rate to the new power requirements, operating the appropriate actuator (this adjustment also takes place in usage conditions to maintain optimum driveability). Another function of the system is that of momentarily interrupting the compressor supply in the case of high engine power requirements (strong acceleration).

SELF-ADJUSTMENT OF THE SYSTEM

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 the processes of bedding in over a period of time and the ageing of both the component and the actual engine.
These changes are memorized in the form of modifications to the basic map and have the aim of adapting the operation of the system to the gradual alterations of the engine and the components compared with when they are new.
This adjustment function also makes it possible to compensate for the inevitable differences (due to production tolerances) of components which may have been replaced. This makes it possible to have maximum results in all vehicles without special adjustment and control operations.
The self-adjustment parameters are lost if the control unit is disconnected.

MANAGEMENT OF THE ENGINE IMMOBILIZER FUNCTION (FIAT CODE)

The system is equipped with an engine immobilizer function. This function is achieved thanks to the presence of a special control unit (Fiat CODE), capable of dialogue with the injection/ignition control unit and an electronic key which has a special transmitter for sending a recognition code.

Each time the ignition is turned to the OFF position, the Fiat CODE system completely deactivates the injection/ignition control unit.
By turning the ignition to the ON position the following operations take place in the order given:

1. the engine control unit (whose memory contains a secret code) sends the Fiat CODE control unit a request to send the secret code to deactivate the immobilizing of the functions;
2. the Fiat CODE control unit responds by only sending the secret code after having, in turn, received the recognition code sent by the ignition key;
3. the recognition of the secret code allows the deactivating of the immobilizing of the injection/ignition electronic control unit and its normal operation.

NOTE *Given the presence of the Fiat CODE system, during the diagnosis and/or any operating checks* **DO NOT CARRY OUT** *testsusing another injection/ignition control unit. In effect, in such a case the Fiat CODE control unit would transfer the (unrecognized) recognition code to the test control unit which would therefore no longer be fit for use on other vehicles.*

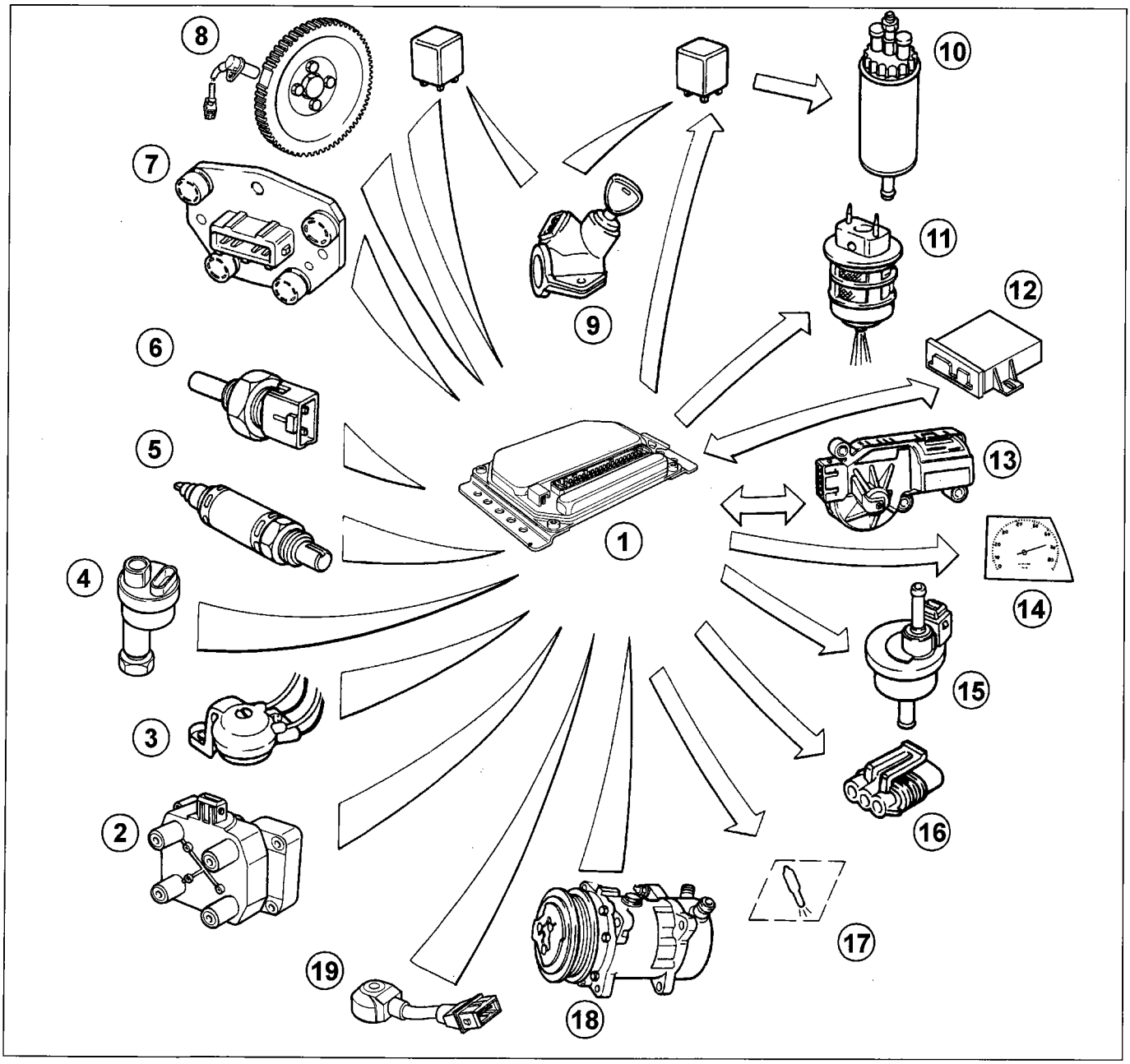
MANAGEMENT OF THE FAULT DIAGNOSIS

A complete electronic fault diagnosis of the injection/ignition system is obtained by connecting the FIAT LANCIA TESTER to the diagnostic socket.

The system is, however, also equipped with an auto-diagnostic function which recognizes, memorizes and signals any failures.

If a failure is detected at the sensors or actuators, the signal reconstruction (recovery) strategies are immediately activated in order to ensure the operation of the engine at an acceptable level without adversely affecting its performance. It is therefore possible to drive the vehicle to a service centre where the appropriate repairs can be carried out.

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



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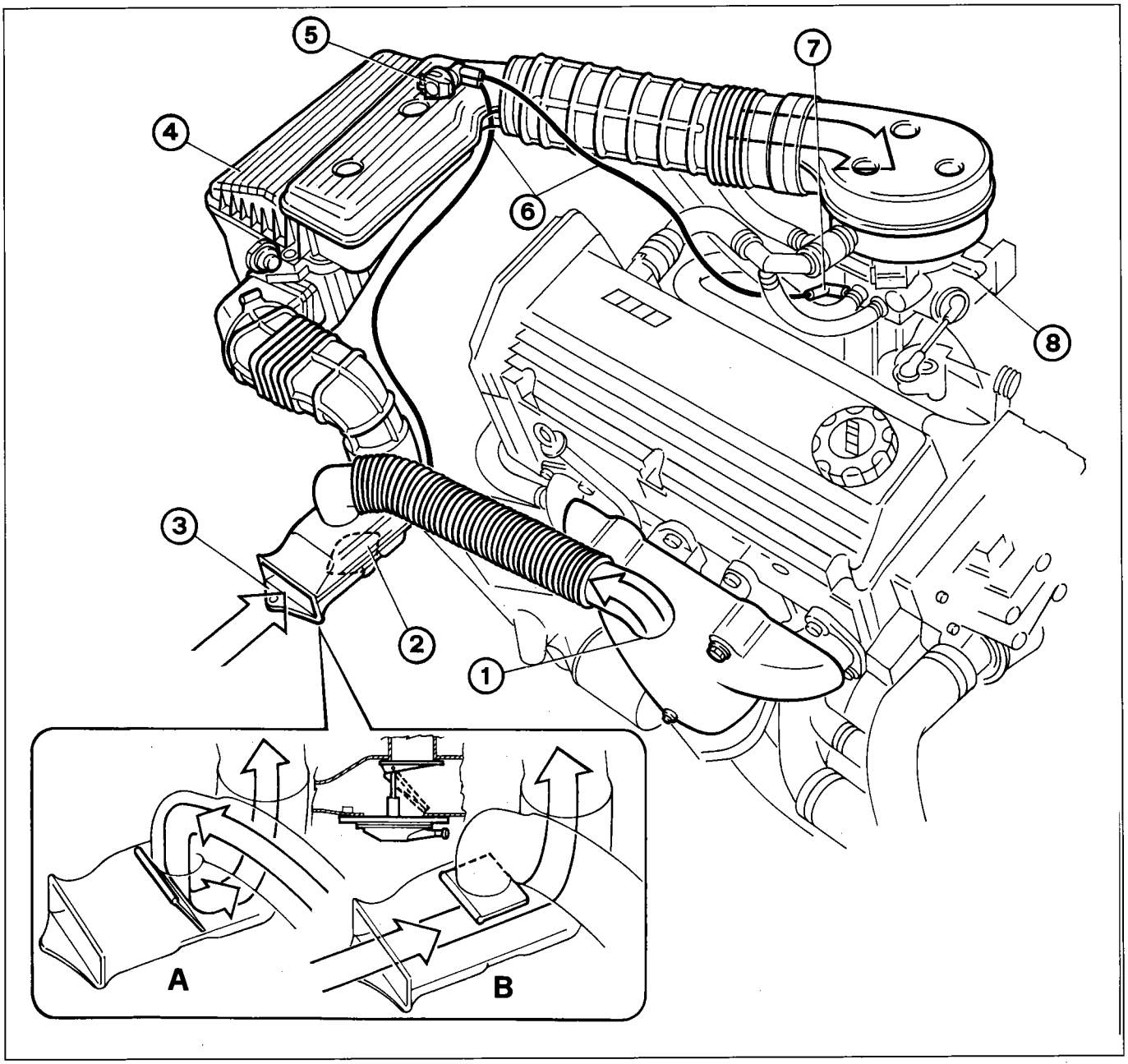
Components key

1. Electronic control unit
2. Coil
3. Air temperature sensor
4. Speedometer sensor
5. Lambda sensor
6. Engine coolant sensor
7. Butterfly position sensor
8. Rpm and TDC sensor
9. Ignition switch
10. Electric fuel pump
11. Injector
12. Fiat CODE control unit
13. Engine idle speed actuator
14. Rev counter
15. Fuel vapour cut out solenoid valve
16. Diagnostic socket
17. Injection failure warning light
18. Climate control compressor
19. Detonation sensor

DIAGRAM SHOWING AIR INTAKE CIRCUIT

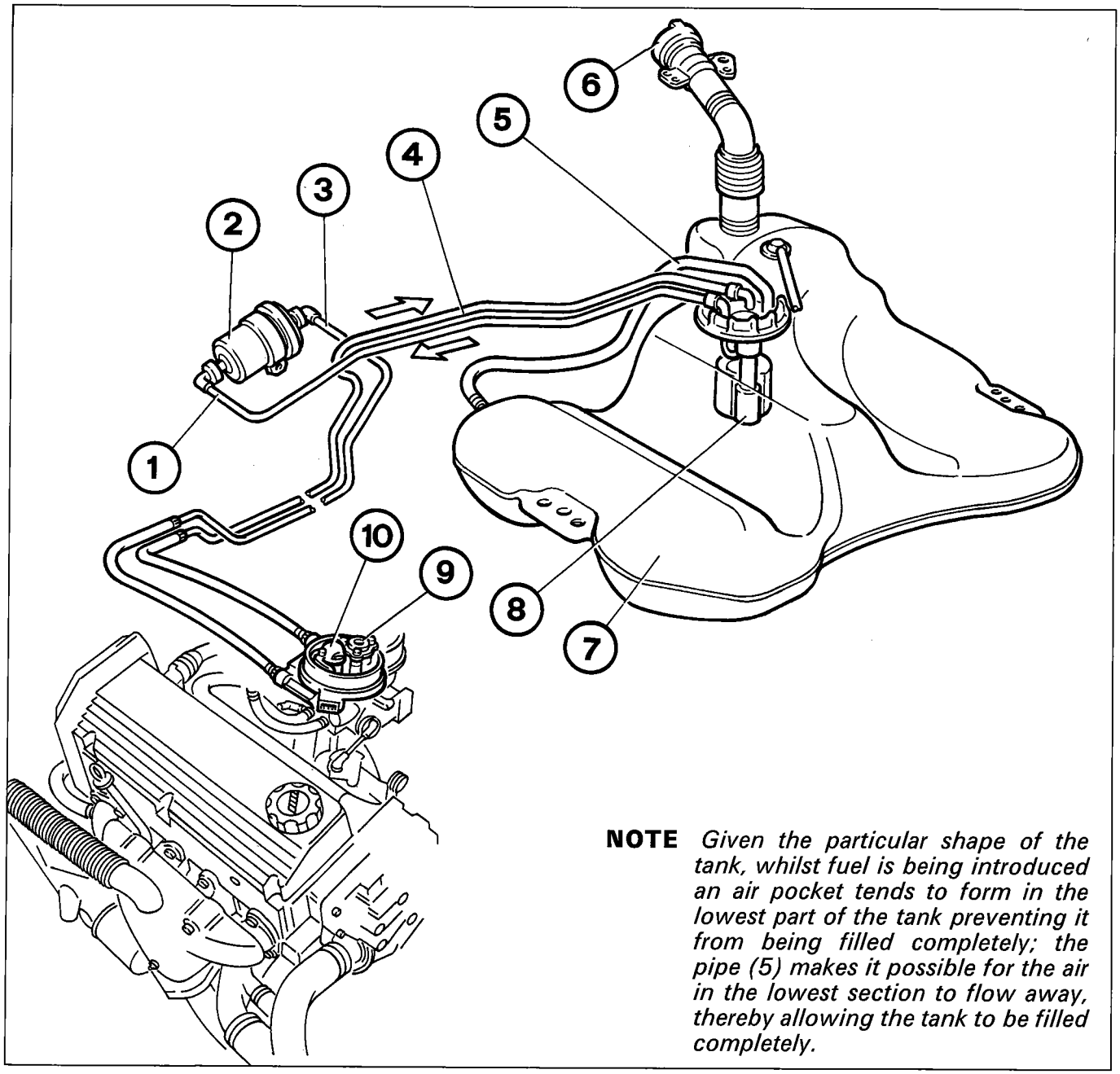


P4F13AJ01

1. "Hot" air intake on the exhaust manifold
2. Actuator for "hot/cold" air deflector
3. "Cold" air inlet vent
4. Air filter
5. Thermostatic valve
6. Vacuum ducts
7. Vacuum pick up
8. Butterfly casing

The air intake circuit is made up of various components which direct the air flow rate required by the engine in different operating conditions.
The intake of "hot" or "cold" air is dealt with by the deflector (2) which, according to the position of the thermostatic vale (5), may or may not be reached by the vacuum coming from the inlet manifold.
In particular, where the intake air temperature is above 9°C, the thermostatic valve (5) remains closed, not allowing the vacuum to reach the actuator (2) (position B).
Conversely, when the temperature of the intake air goes below 9°C, the thermostatic valve (5) opens, and the vacuum passing through it reaches the actuator (2) (position A).

DIAGRAM SHOWING FUEL SUPPLY CIRCUIT



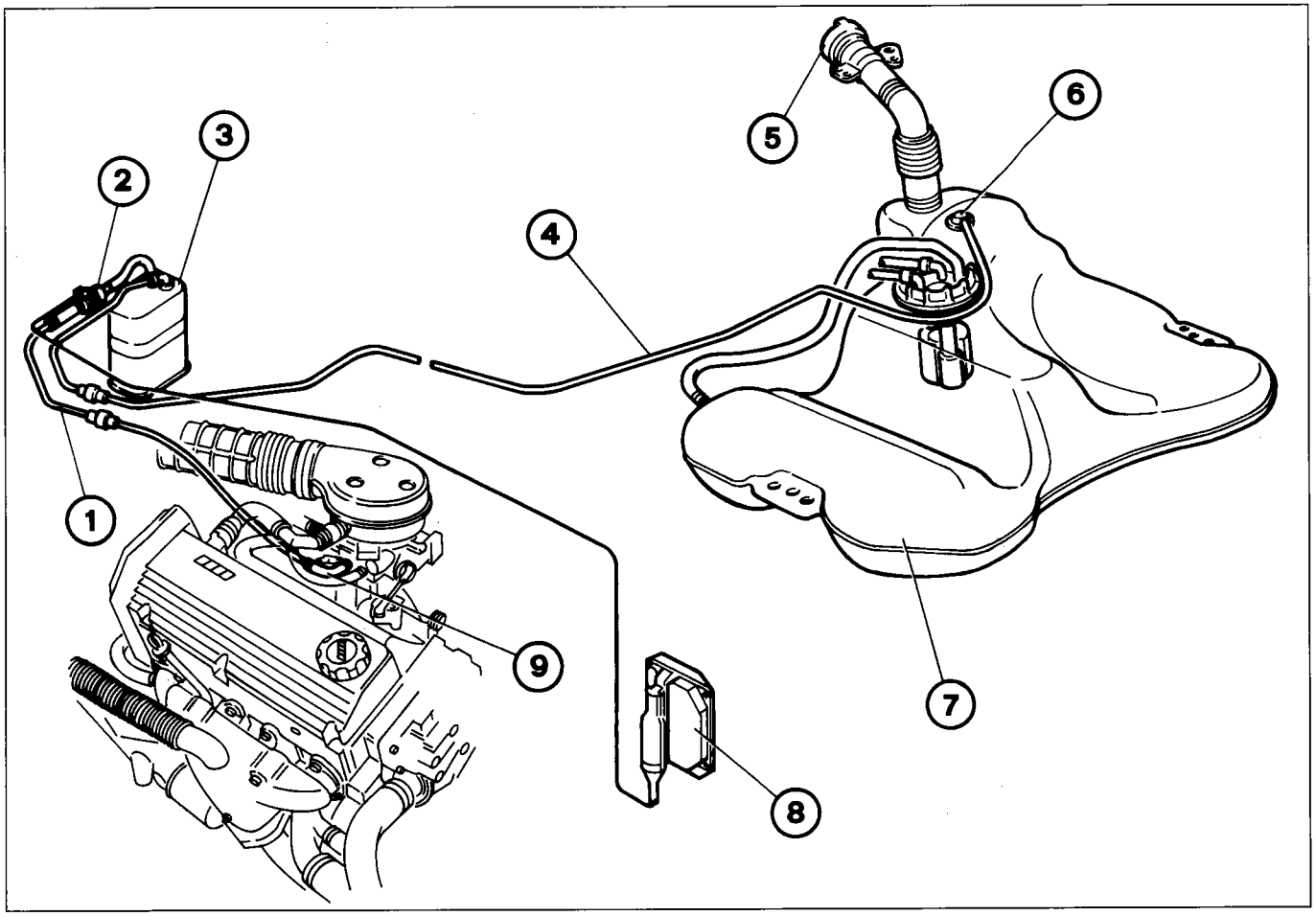
NOTE *Given the particular shape of the tank, whilst fuel is being introduced an air pocket tends to form in the lowest part of the tank preventing it from being filled completely; the pipe (5) makes it possible for the air in the lowest section to flow away, thereby allowing the tank to be filled completely.*

P4F14AJ01

1. Supply pipe from the tank to the filter
2. Fuel filter
3. Supply pipe from the filter to the injector
4. Return pipe
5. Breather pipe
6. Filler with ventilation and safety valve
7. Tank
8. Electric pump
9. Pressure regulator
10. Injector

The supply of fuel is ensured by means of an electric pump (8) immersed in the tank (7) which draws in the fuel and sends it to the filter (2) and then to the injector (10) passing through the pressure regulator (9) which has the task of keeping the fuel supply pressure to the injector constant. The excess fuel flows from the fuel regulator to the tank, not under pressure.

DIAGRAM SHOWING FUEL ANTI-EVAPORATION CIRCUIT



P4F15AJ01

1. Fuel vapour supply pipe to the butterfly casing
2. Fuel vapour cut out solenoid valve
3. Charcoal filter
4. Fuel vapour supply pipe from the tank to the charcoal filter
5. Safety and ventilation valve
6. Multi-purpose valve
7. Tank
8. Injection/ignition control unit
9. Fuel vapour inlet in the inlet manifold

The anti-evaporation system has the task of preventing the fuel vapours, composed of the lightest fractions of hydrocarbons, which basically 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 towards evaporation increases: in this situation the pressure inside the tank increases.

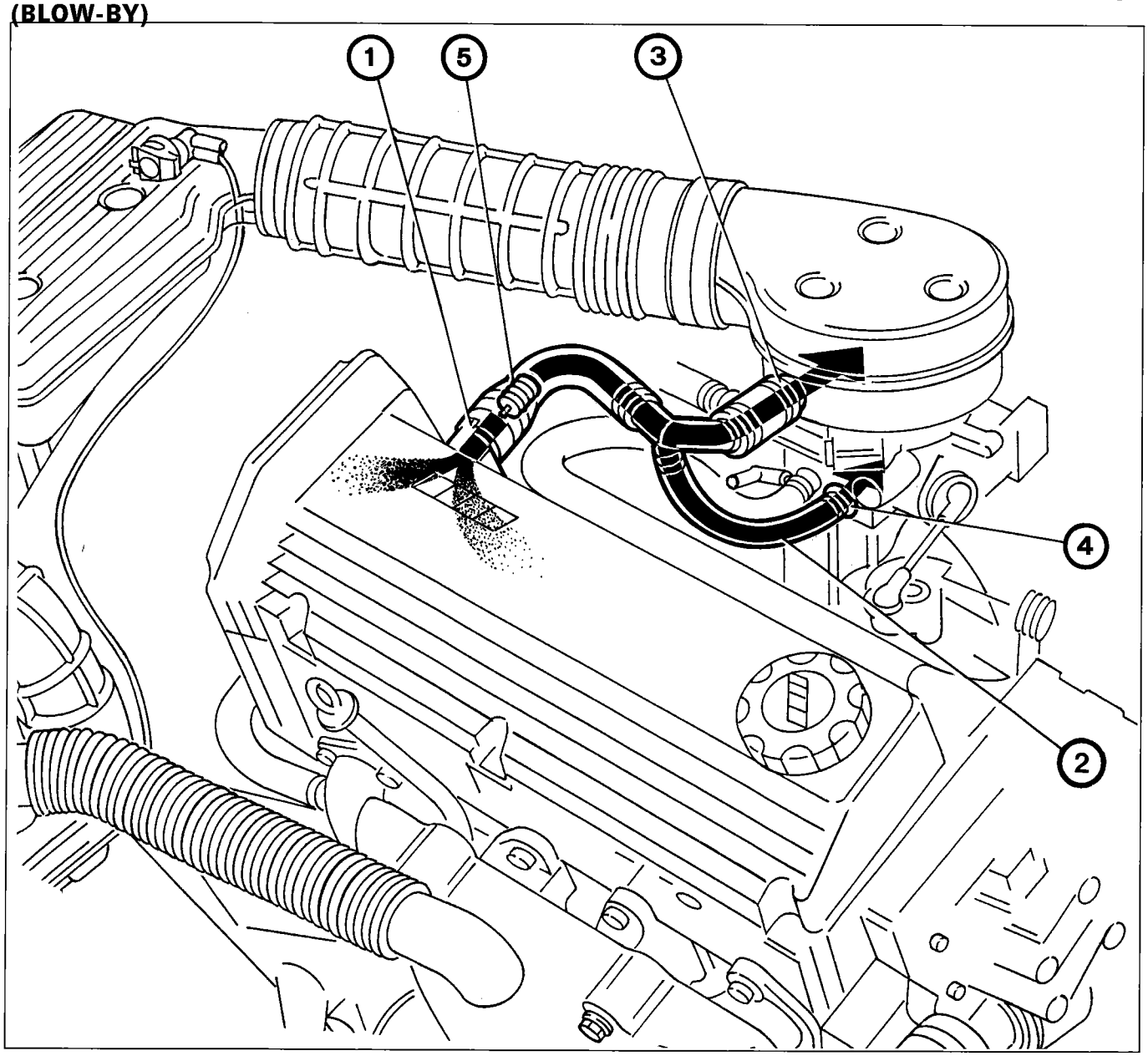
When the pressure inside the tank reaches around 30-40 mbar, the multi-purpose valve (6) opens and the fuel vapours reach the charcoal filter (3). The valve (6) also allows an air intake into the tank through the charcoal filter if it proves necessary following a decrease in the level of the fuel and the consequent vacuum which is formed inside the tank. On the other hand, if there is a great deal of splashing during driving or the vehicle overturns, the valve (6) closes preventing the fuel from escaping.

When the engine is running, the control unit (8) operates the solenoid valve for the charcoal filter (2), which allows the intake of vapours by the engine and the consequent scavenging of the charcoal filter.

If as a result of the malfunction of any of the components, the pressure inside the tank increases dangerously, the safety valve (5) located in 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 from reaching excessive values.

10.

DIAGRAM SHOWING RECIRCULATION OF GASES COMING FROM THE ENGINE CRANKCASE (BLOW-BY)



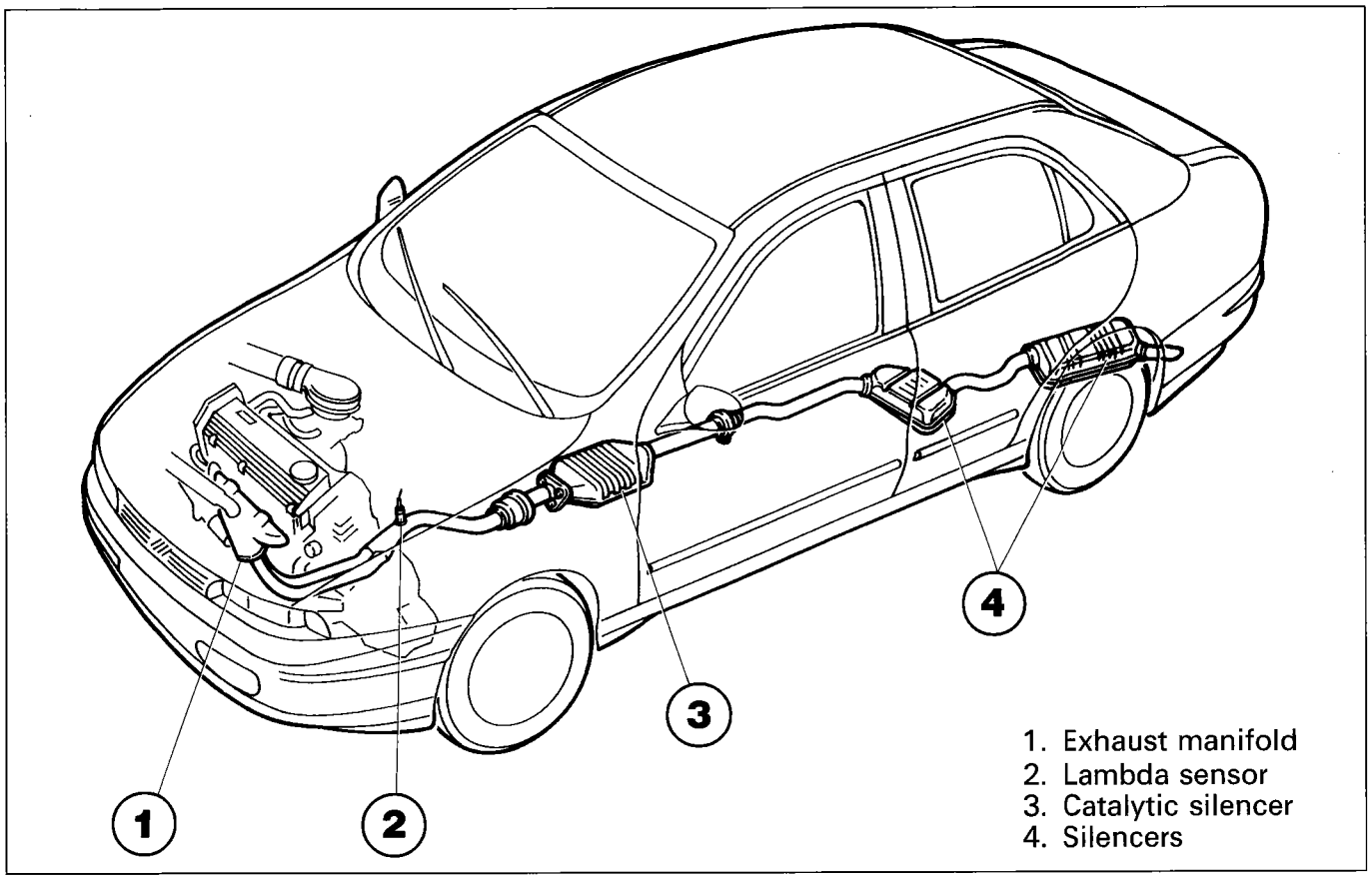
The system controls the emissions, from the engine crankcase, of breather gases made up of air/petrol mixtures and unburnt gases which come through the piston seals, as well as lubricant oil vapours, recirculating them to the inlet.

The gases come out of the inlet (1) which contains a spark-out (5) to prevent combustion due to flame returns from the butterfly casing.

With the accelerator butterfly open, the gases are drawn in upstream of the butterfly through the inlet (3) on the air duct to the butterfly casing.

With the accelerator butterfly closed, (engine idling), the pressure downstream of the butterfly, draws in the gases (in limited quantities) directly through the small pipe (2) and the calibrated port (4).

ENGINE EXHAUST ASSEMBLY DIAGRAM



P4F17AJ01

The system shown in the diagram allows the metering of the air/petrol mixture to be close to the stoichiometric value.

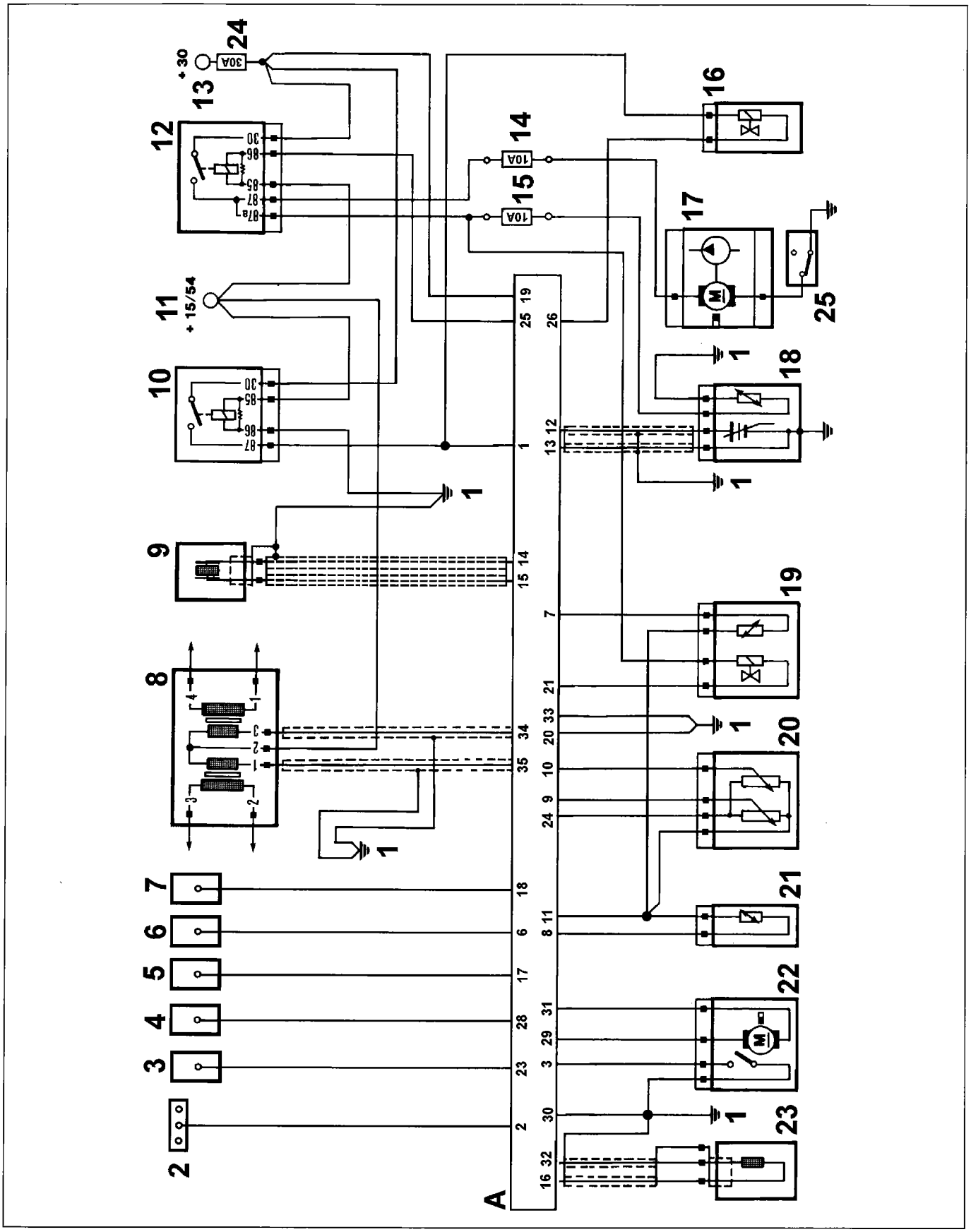
The control of the mixture strength, which is the closed loop type, is activated by the Lambda sensor which measures the oxygen content in the exhaust gases upstream of the catalytic silencer.
The Lambda sensor measurements allow the electronic control unit to constantly correct the quantity of petrol injected thereby keeping the air/fuel ratio constant.
The control of the harmful exhaust emissions is carried out in this way and is completed by the three way catalytic converter (catalytic silencer).
The efficient operation of the catalytic silencer and consequently the restriction of the toxicity of the exhaust gases depends on the air/fuel ratio with which the engine is supplied.
The three way catalytic converter makes it possible to simultaneously restrict the three pollutant gases present in the exhaust gases: unburnt hydrocarbons (HC), carbon monoxide (CO), nitrous oxides (NOx).
Two types of chemical reaction take place inside the converter:
- oxidation of the CO and the HC, converted into carbon dioxide (CO2) and water (H2O);
- reduction of the NOx, converted into nitrogen (N2).

The following will put the catalytic converter out of use very quickly and make it irreparable:
- the presence of lead in the petrol which lowers the degree of conversion to levels which make the presence of the catalytic converter in the system pointless;
- the presence of unburnt petrol in the converter: in effect, a flow of petrol lasting 30 secs in an ambient of 800 °C (temperature inside the silencer) is sufficient to cause the catalyzer to melt and break.

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

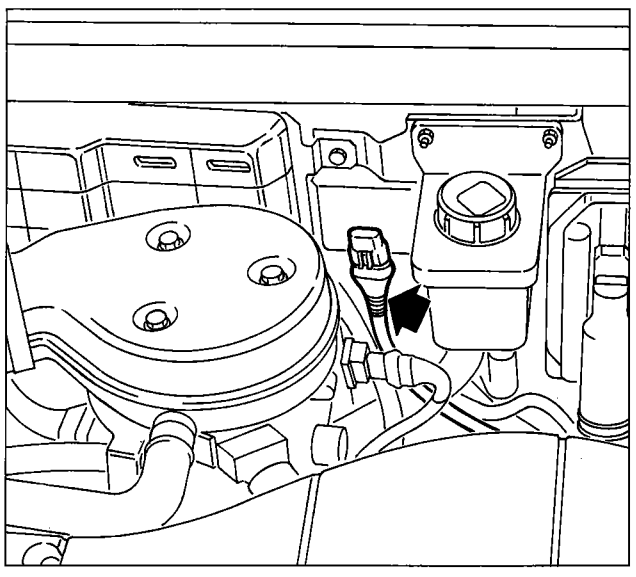
10.

INJECTION/IGNITION SYSTEM WIRING DIAGRAM



Injection/ignition system wiring diagram components key

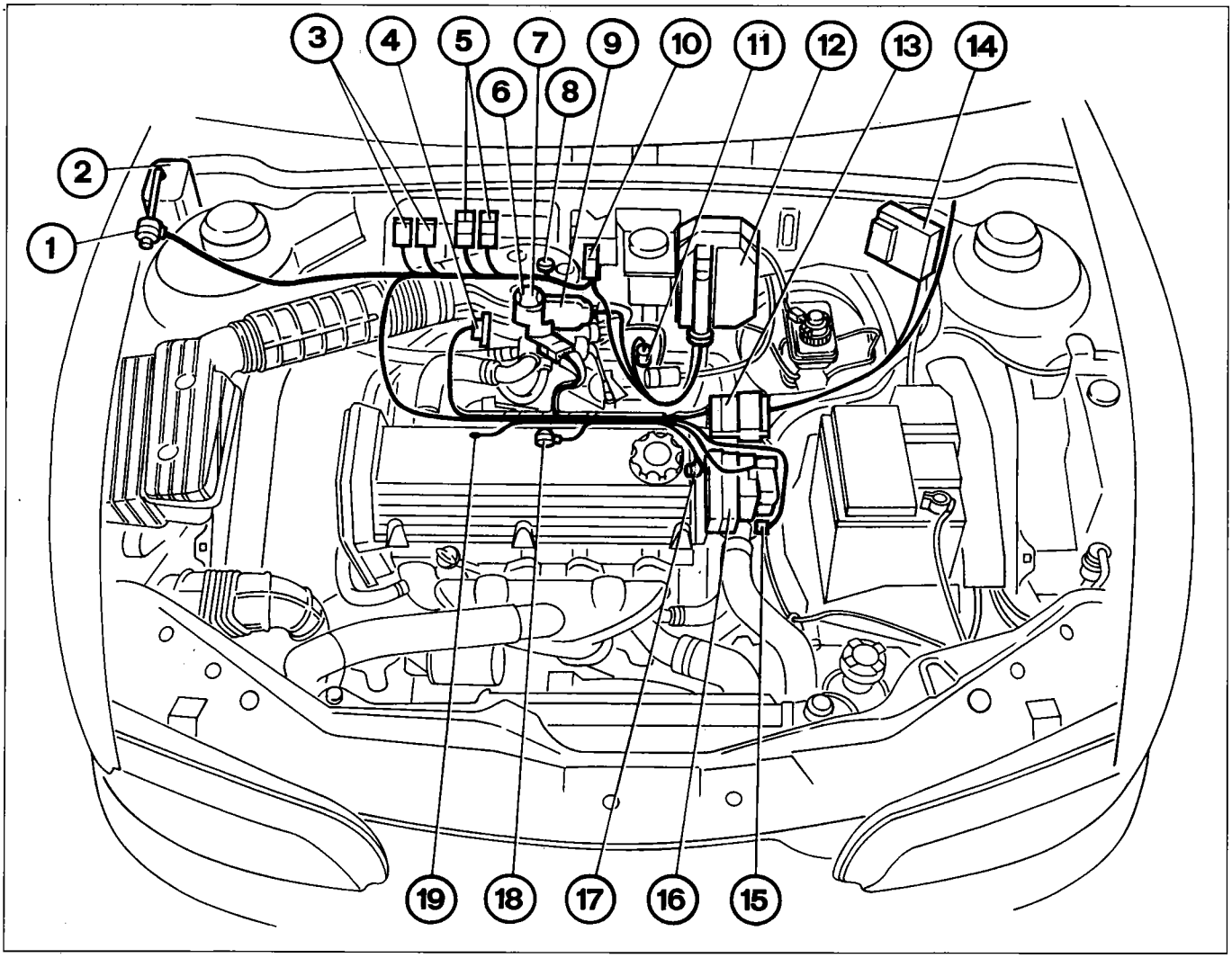
A. Injection/ignition electronic control unit
1. Earth
2. Diagnostic socket
3. Climate control system connection
4. Injection/ignition system failure warning light
5. Rev counter
6. Fiat CODE control unit
7. Speedometer signal
8. Ignition coil
9. Detonation sensor
10. Injection/ignition system relay feed
11. Ignition switch
12. Electric fuel pump and Lambda sensor relay feed
13. Battery positive (+30)
14. 10A protective fuse for electric fuel pump
15. 10A protective fuse for Lambda sensor heating resistance
16. Fuel vapour cut out solenoid valve
17. Electric fuel pump
18. Heated Lambda sensor
19. Injector and intake air temperature sensor
20. Butterfly valve position sensor
21. Coolant temperature sensor
22. Engine idle speed actuator
23. Rpm and TDC sensor
24. General 30 A protective fuse for the injection/ignition system
25. Inertia switch



P4F19AJ01

Location of diagnostic socket

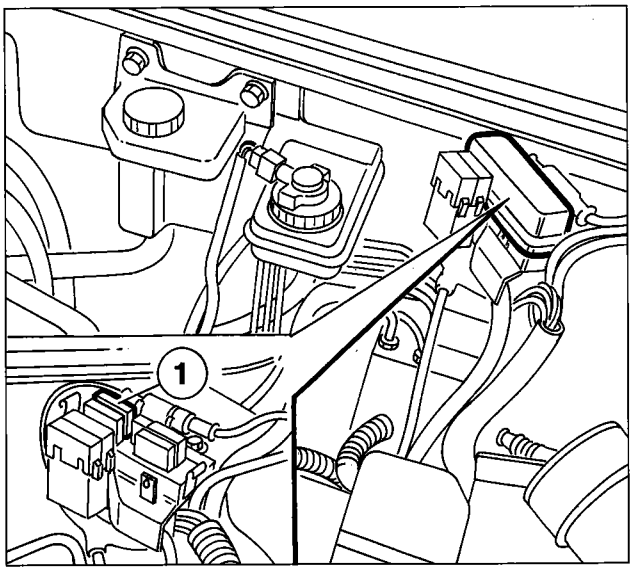
LOCATION OF INJECTION/IGNITION SYSTEM COMPONENTS



P4F20AJ01

Components key

1. Fuel vapour cut out solenoid valve
2. Charcoal filter
3. 10A protective fuse for electric pump and injection/ignition system
4. Butterfly valve position sensor
5. Electric pump and injection/ignition system relay feeds
6. Injector
7. Air temperature sensor
8. Fuel pressure regulator
9. Engine idle speed actuator
10. Diagnostic socket
11. Lambda sensor
12. Injection/ignition control unit
13. Join between injection cable and front cable
14. 30A general system protective fuse
15. Coolant temperature sensor
16. Ignition
17. Rpm and TDC sensor
18. Detonation sensor
19. Earth

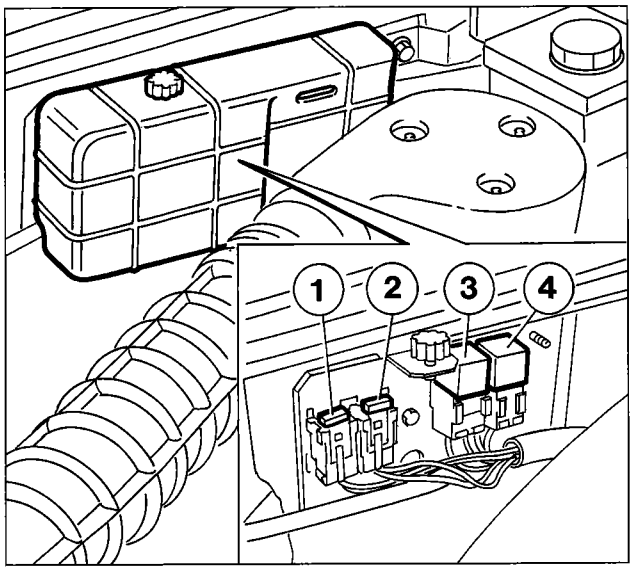


P4F21AJ01

INJECTION SYSTEM FUSES AND RELAYS

General system protective fuse

The general fuse (EFI-30A) protecting the injection/ignition system (1) is housed inside a container; to gain access, remove the cover undoing it from the side clips.



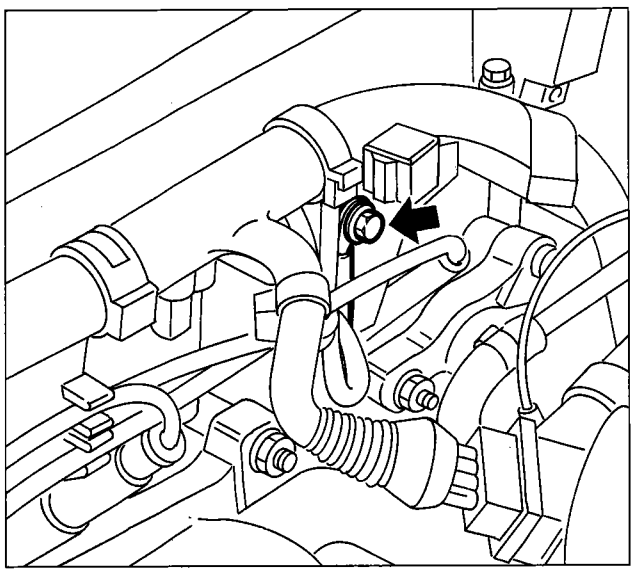
P4F21AJ02

Fuses and relays

The following components are housed on a bracket positioned against the rear partition of the engine compartment:

1. 10A protective fuse for electric fuel pump
2. 10A fuse protecting the Lambda sensor heated resistance
3. Injection/ignition control unit relay feed and fuel vapour cut out solenoid valve
4. Electric pump, injector and Lambda sensor relay feed.

To gain access to the components listed above, undo the ring nut and remove the cover.


P4F21AJ03

EARTH POINT

The earth for the injection/ignition system is fixed at the right rear of the engine, near the spark plug for the first cylinder.

INJECTION/IGNITION SYSTEM COMPONENTS

The injection/ignition system is basically made up of wiring, an electronic control unit (I.E. control u nit) and the following sensors/actuators:

Sensors

- Speedometer sensor
- Rpm and T.D.C. sensor
- Detonation sensor
- Coolant temperature sensor
- Butterfly valve position sensor
- Intake air temperature sensor
- Lambda sensor

Actuators

- Engine idle speed actuator
- Fuel vapour cut out solenoid valve
- Electric fuel pump
- Injector
- Ignition coil
- Spark plugs

INJECTION/IGNITION SYSTEM WIRING

The different system components are connected by means of one set of wiring fitted with various type connectors, grouped together in special ducts fitted on the engine (pre-wiring).

INJECTION/IGNITION ELECTRONIC CONTROL UNIT (0.261.203.868)

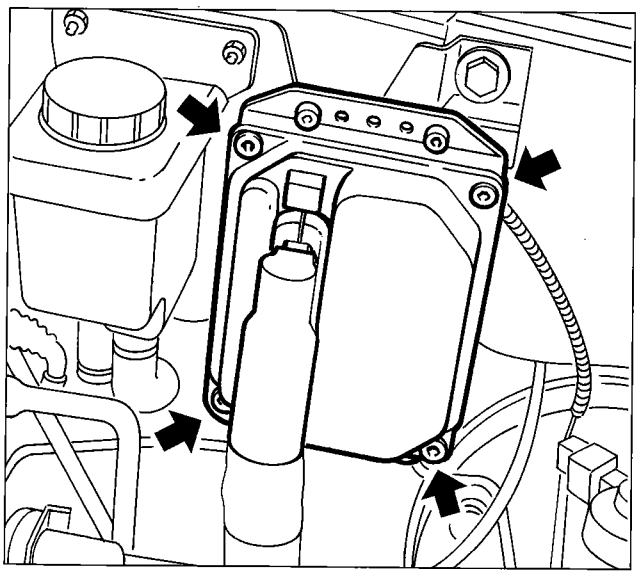
The electronic control unit analyzes the data concerning the engine operating conditions which is transmitted by the sensors; it processes the signals arriving from the peripheral sensors and, with the aid of programmed diagrams, controls the impulses for the injector and the moment of ignition.

It is connected to the system by means of a 35 pin connector and is protected from false polarity and short circuits.

The electronic control unit can detect the failed operation of the different sensors and replace the incorrect or unreceived data with values taken from appropriate areas of the memory capable of guaranteeing the operation of the engine even in emergency conditions; in addition, it is also equipped with an AUTODIAGNOSTIC strategy for both the input and output sensors with a special memory for detecting any problems which are then transmitted during the fault diagnosis.

Therefore, with the help of the Fiat/Lancia TESTER connected to the system, it is possible to automatically diagnose or display any errors present in the memory.

Another important feature of the control unit is the self-adjustment. This function makes it possible for the system to recognize and, by means of appropriate strategies, adapt to the various changes (ranging from atmospheric to those which stem from the wear of the components) which could cause irregular operation of the engine.



P4F22AJ01

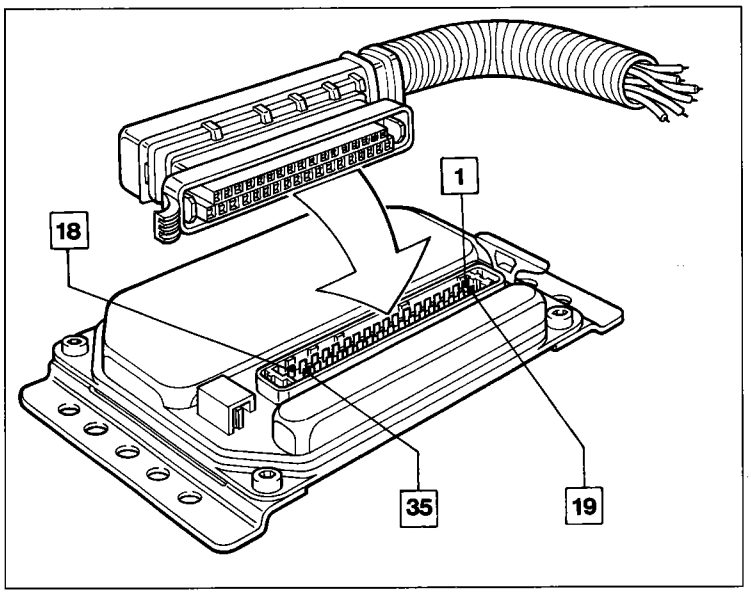
Removing-refitting control unit

Disconnect the electrical connector. Undo the fixing nuts and remove the control unit.

It is absolutely forbidden to exchange injection control units between different vehicles to check their efficiency.

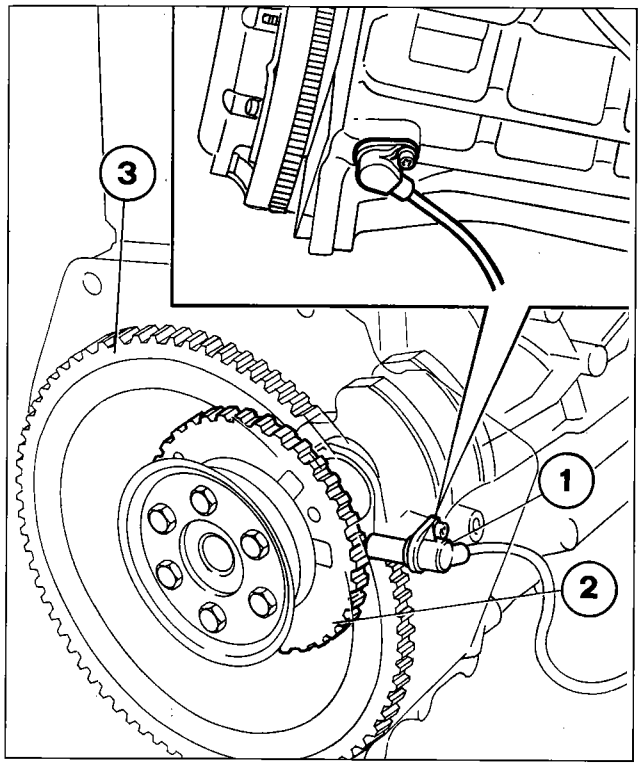
During fault diagnosis, before replacing the control unit, make sure that the component being examined really is not working properly because when a new control unit is supplied the secret code for the Fiat CODE system is memorized which makes it totally impossible to use it in other vehicles.

IDENTIFICATION OF CONTROL UNIT CONNECTIONS (PIN-OUT)



P4F23AJ01

1. I.E. system relay feed
2. Diagnostic socket
3. Engine idle speed actuator
4. Not connected
5. Not connected
6. Fiat CODE control unit
7. Intake air temperature sensor
8. Engine coolant temperature sensor
9. Butterfly valve position sensor
10. Butterfly valve position sensor
11. Coolant temperature sensor, butterfly valve position sensor and intake air temperature sensor supply
12. Lambda sensor
13. Lambda sensor
14. Detonation sensor
15. Detonation sensor
16. Rpm and TDC sensor
17. Rev counter signal
18. Speedometer sensor
19. Supply (+30)
20. Engine earth
21. Injector
22. Not connected
23. Climate control system connection
24. Butterfly valve position sensor
25. Electric fuel pump relay feed and Lambda sensor
26. Fuel vapour cut out solenoid valve
27. Not connected
28. Injection system failure warning light
29. Engine idle speed actuator
30. Engine earth
31. Engine idle speed actuator
32. Rpm and TDC sensor
33. Engine earth
34. Ignition coil
35. Ignition coil



P4F24AJ01

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

RPM AND TDC SENSOR (0.281.002.102)

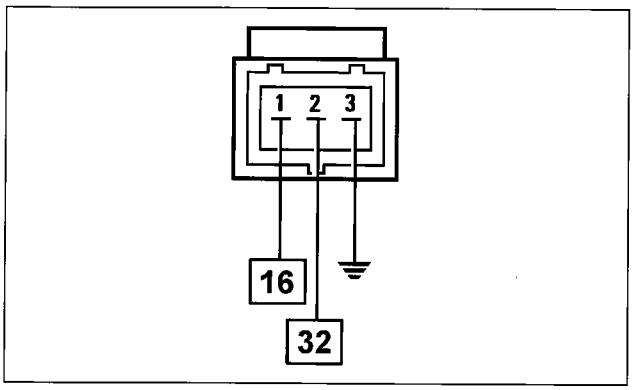
The sensor which detects the number of revs and the TDC is the inductive type, i.e. it operates by varying the magnetic field produced when the teeth pass in front of a toothed pulley (flywheel) inside the engine crankcase. In this waythe sensor is fixed to the crankcase and it is no longer necessary to check and adjust the gap and the angular position.

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 consequence, produces an alternating voltage whose range depends on the number of revs.

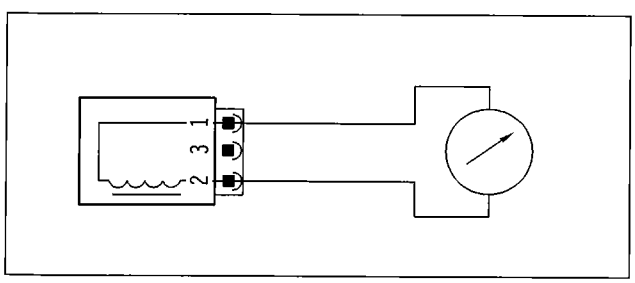
The flywheel is made up of 58 teeth plus a space equivalent to the two missing teeth.

The reference defined by the space of the two missing teeth makes up the basis for detecting the synchronims point (TDC).

For a more detailed description of the operating principle, refer to the Fuel System section for the 1581 16v engine.



P4F24AJ02



P4F24AJ03

Removing-refitting

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

- Disconnect the electrical connector;
- undo the bolt fixng the sensor and remove it from its housing.

Wiring connector

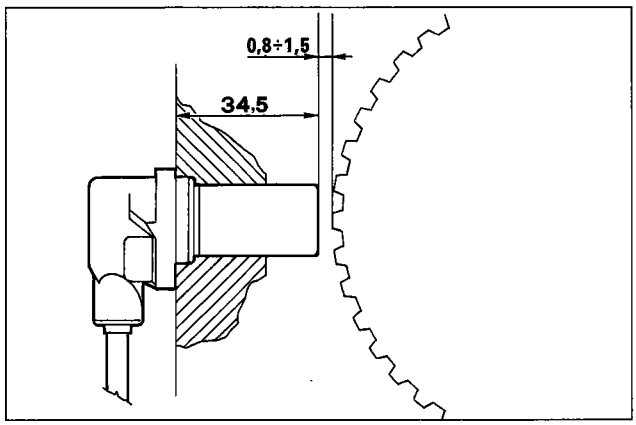
The sensor is connected to the electronic control unit (pins 16 and 32) by means of twisted cables with an outer casing to protect against interference connected to earth.

NOTE *The numbers indicate the corresponding control unit pins.*

Checking the resistance

The resistance of the sensor may be measured by disconnecting the connector and connecting an ohmmeter to the sensor.

Resistance: 774-946 ohm at 20°C



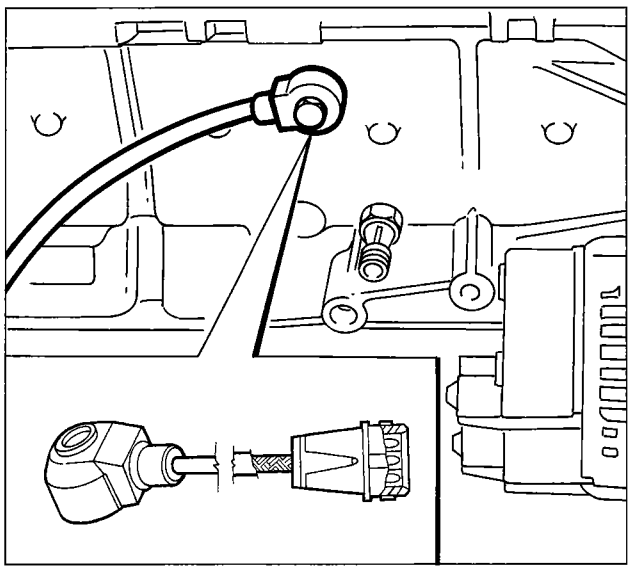
P4F25AJ01

When measuring the distance it is necessary to be sure 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 engine crankcase and the gap and the angular position do not therefore have to be adjusted. If an irregularity is suspected it is, however, possible to check the gap by 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) with the gap (0.8 - 1.5 mm).



P4F25AJ02

DETONATION SENSOR (0.261.203.007)

The detonation sensor is located at the rear of the monobloc, between cylinders 2 and 3.

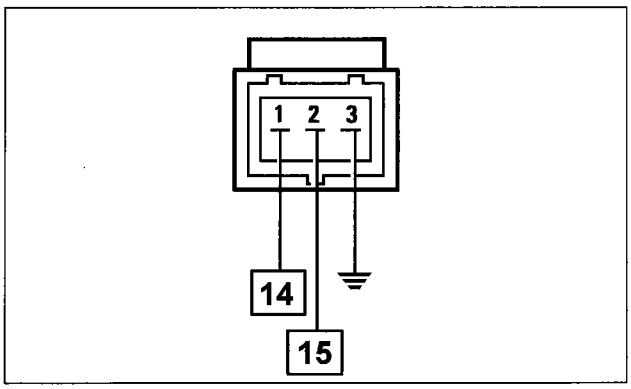
For a more detailed description of thel operating principle of the detonation sensor, refer to the fuel system section for the 1998 20v version.

Recovery

Delay of the ignition advance: 8° - 9° depending on the engine speed.

De-activation of the control of the detonation.

If the failure involves the interface circuit with the sensor, the control unit imposes a dealy in the ignition advance equal to 10°.



P4F25AJ03

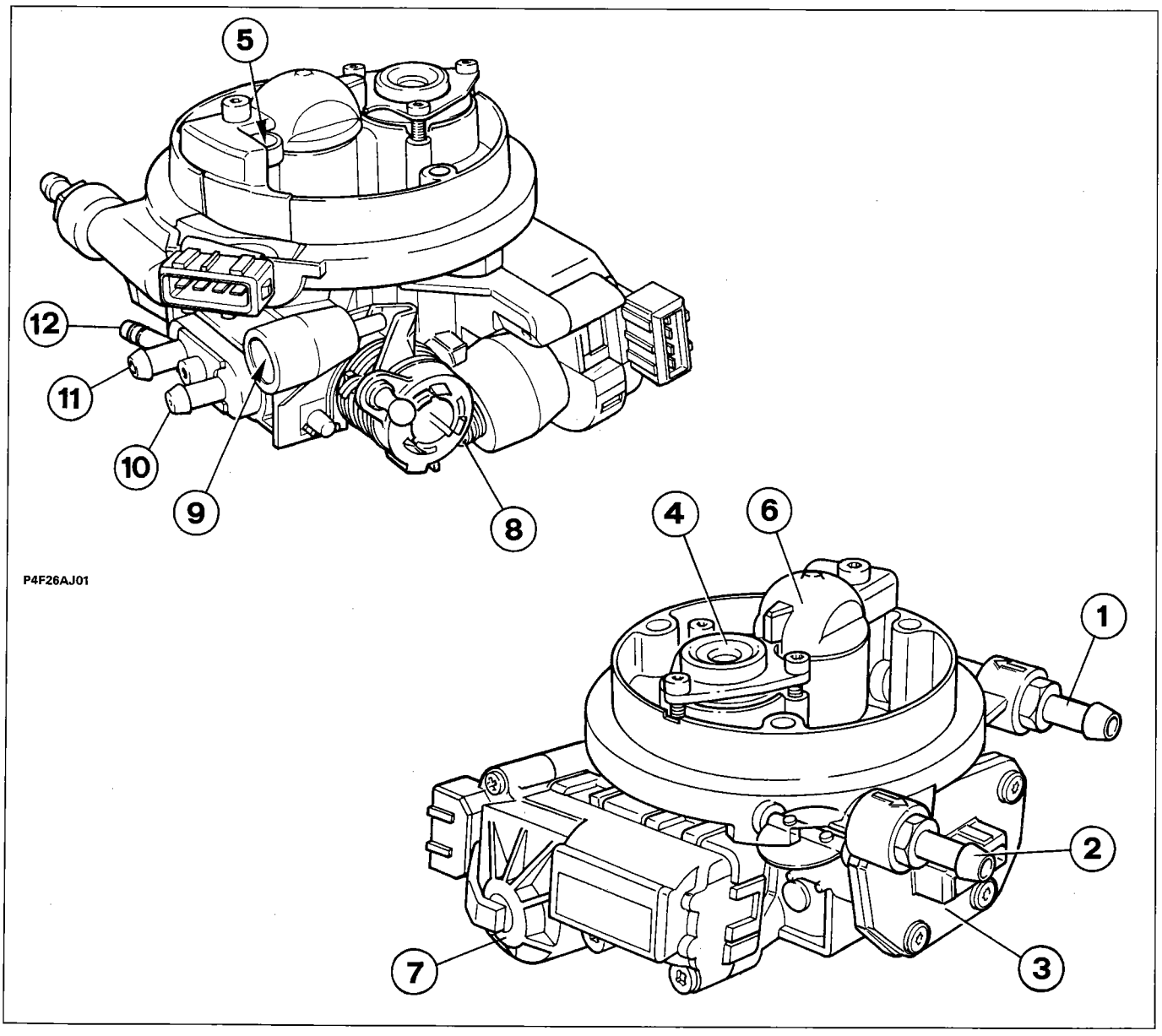
Wiring connector

The numbers indicate the corresponding control unit pins.

BUTTERFLY CASING (0.438.201.523)

The aluminium butterfly casing or injector holder turret has extremely tiny components and is very compact. Most of the system sensors and actuators are fitted on it:

1. Fuel inlet connector
2. Fuel return connector
3. Accelerator butterfly position sensor (potentiometer)
4. Fuel pressure regulator
5. Intake air temperature sensor
6. Injector
7. Direct current motor for controlling idle speed
8. Micro-switch regognizing closed butterfly valve position incorporated in the motor (7)
9. Butterfly position adjustment screw (not to be tampered with)
10. Oil vapour recirculation connector coming from engine crankcase (BLOW-BY)
11. Connector for inlet of fuel vapours coming from the charcoal filter through the fuel vapour cut out valve
12. Connector for thermal valve operating vacuum on the air filter



P4F26AJ02

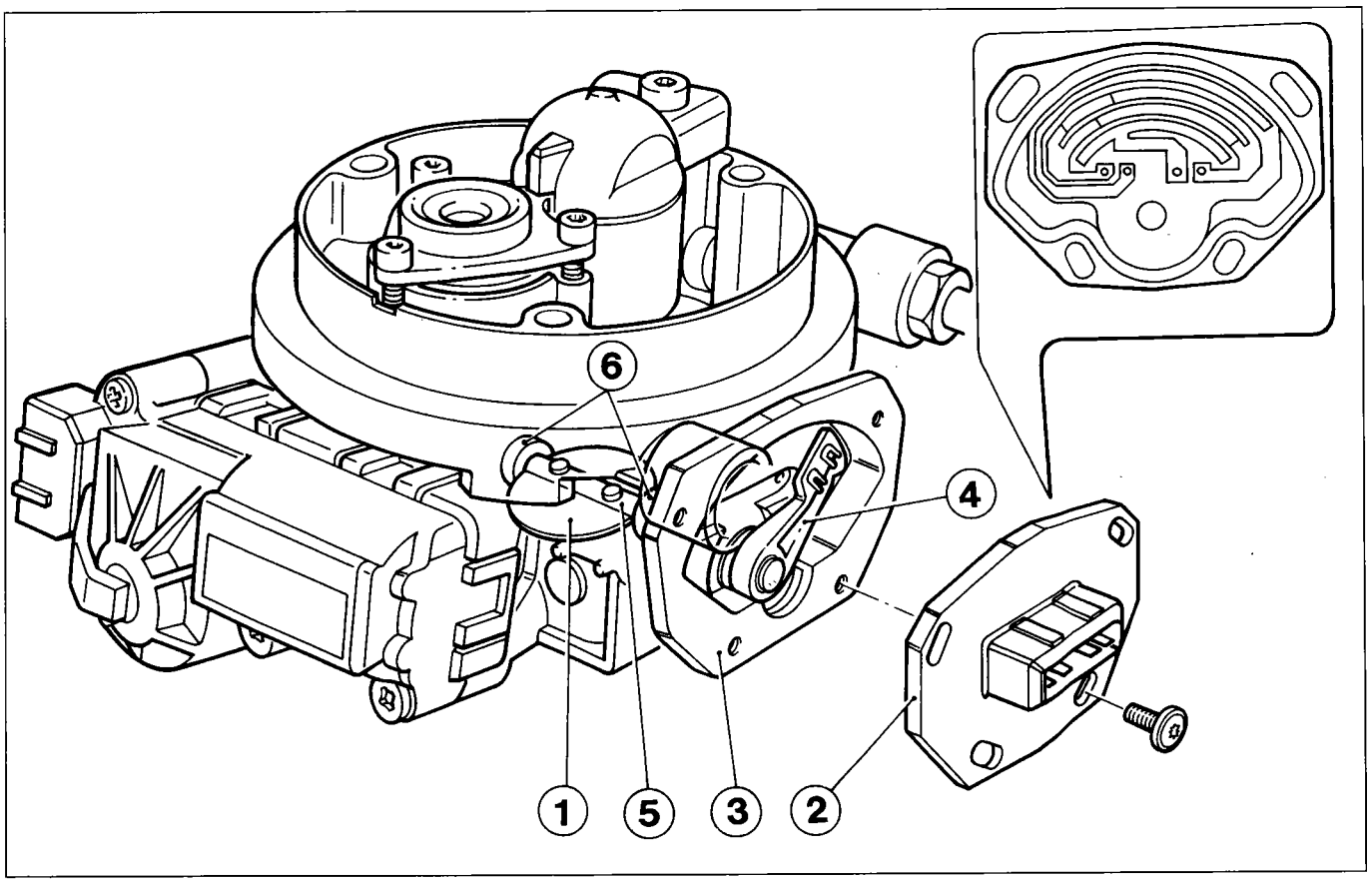
Butterfly valve opening angle sensor

The angular position signal (α) for the butterfly (1), plays a fundamental role in determining the basic injection times.

This signal is measured on a twin track potentiometer (2) fitted on the butterfly casing (3) by means of a brush with twin combs (4) fixed to the butterfly valve shaft (5).

In order to avoid sticking or errors when measuring the angle α, the butterfly shaft is fitted on two ball bearings (6).

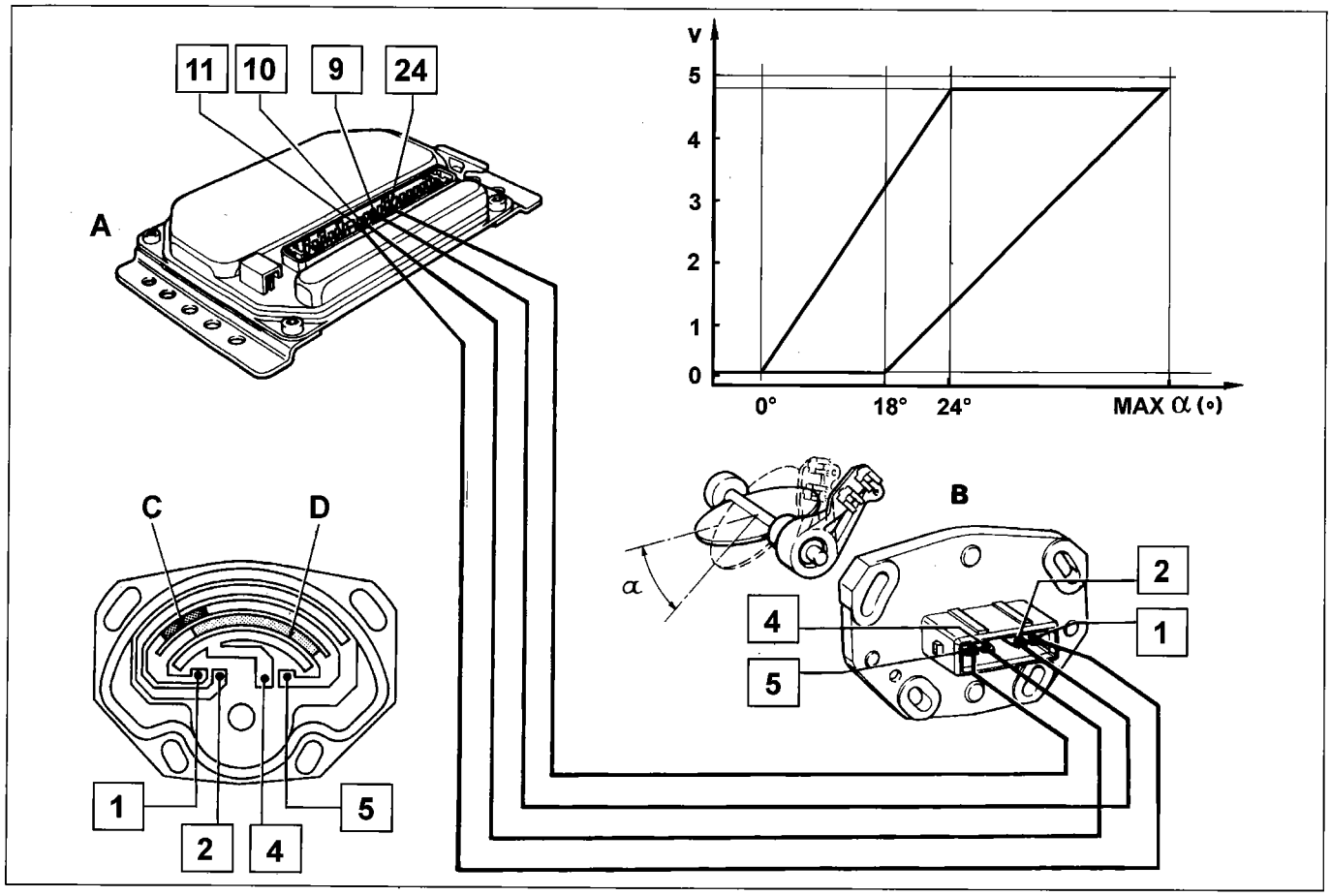
The potentiometer (2) is already adjusted in relation to the butterfly casing when it is fitted in the factory and should not be removed for any reason; in the case of a failure, the complete butterfly casing must be replaced.



P4F27AJ01

The control unit (A - see diagram overleaf), provides terminal 5 of the butterfly valve opening angle sensor (B) with a (constant) reference voltage of around 5 V via terminal 24.

A voltage signal measured at the first track (C) is sent from terminal 2 of the potentiometer to terminal 9 of the control unit; it is proportional to the positions assumed by the butterfly in the first 24° (0° ÷ 24°) of opening.



P4F28AJ01

Therefore, the value of the signal is close to 0 Volt when the butterfly is completely closed, and approximately 5 Volt for an opening of 24° in the rest position.

In the butterfly valve opening range between 0° - 24°, there are 10 corresponding reference points in the control unit map (α), which represent the same number of significant positions assumed by the butterfly valve. In this way, the electronic control unit can recognize small angular variations of around 2°25'.

This sensitivity allows the control unit to select the basic injection times in the specific map with greater precision during the most critical engine operating conditions, i.e, during idling and in partial load conditions.

Starting from an 18° opening of the butterfly valve, until it is completely open (about 90°), the signal supplied by terminal 4 of the potentiometer (B) intervenes, i.e. the one for the second track (D).

This signal, sent to terminal 10 of the control unit, relates to the average and full load engine operating conditions.

The range of the second track is divided in the control unit map α with less resolution compared with the one for the first track, i.e. in 5 points corresponding to angular variations of around 13° of the butterfly valve. Therefore, for the entire opening of the butterfly valve there are 15 significant points or openings in the control unit which are recognized by the electronic system by means of the two potentiometer tracks.

At butterfly valve opening angles of between 18° and 24°, the simultaneous presence of voltage signals at terminals 2 and 4, for the first and second tracks, respectively, should satisfy a given ratio.

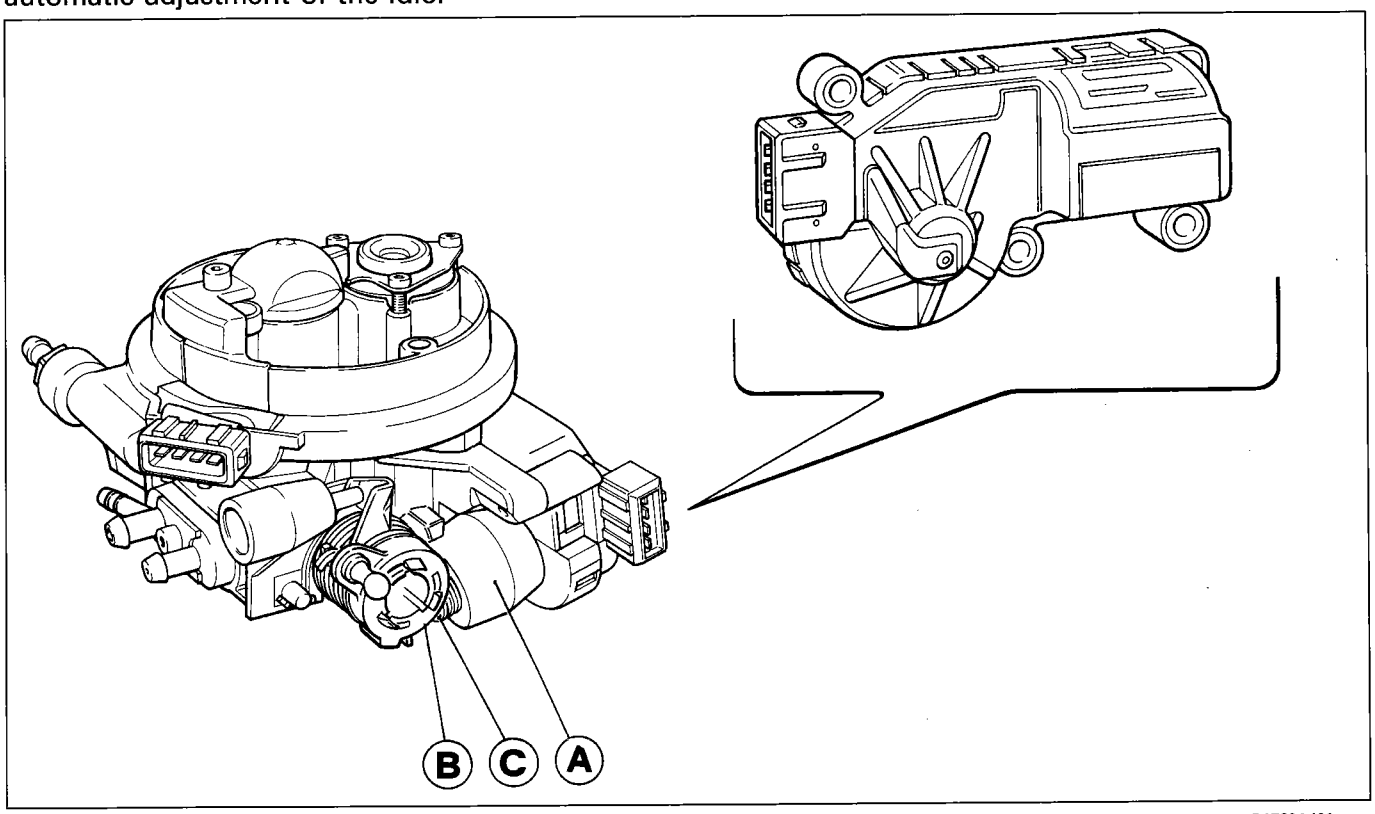
The electronic control unit carries out the plausibility test, in the above conditions, to check the exact synchronization between the signals for the first track (C - minimum/partial load) and those for the second track (D - average load/full load).

Terminal 1 of the potentiometer is placed to earth in the control unit by terminal 11.

Recovery
The emergency/safety function relating to the potentiometer becomes operational when irregularities do not allow the electronic control unit to detect the actual butterfly valve opening angle (α).
- with faults in track 1 of the potentiometer, a pre-defined safety injection time and ignition advance are set and an emergency position for the idle adjustment motor is adopted.
- with faults in track 2, only a safety injection time and ignition advance are set.
- with synchronization faults the value for the last piece of information memorized is set, offset between the two tracks.

Direct current motor for controlling engine idle speed

The adjustment of the engine idle speed is controlled automatically by the electronic control unit via 12 V direct current electric motor (A) which, by means of a suitable reduction system, acts directly on the butterfly valve control levers (B).
There is a micro-switch (C) incorporated in the butterfly opening motor which is closed with the accelerator pedal in the rest position (released).
The closing of the contact activates the dual CUT-OFF function during the deceleration stage and the automatic adjustment of the idle.



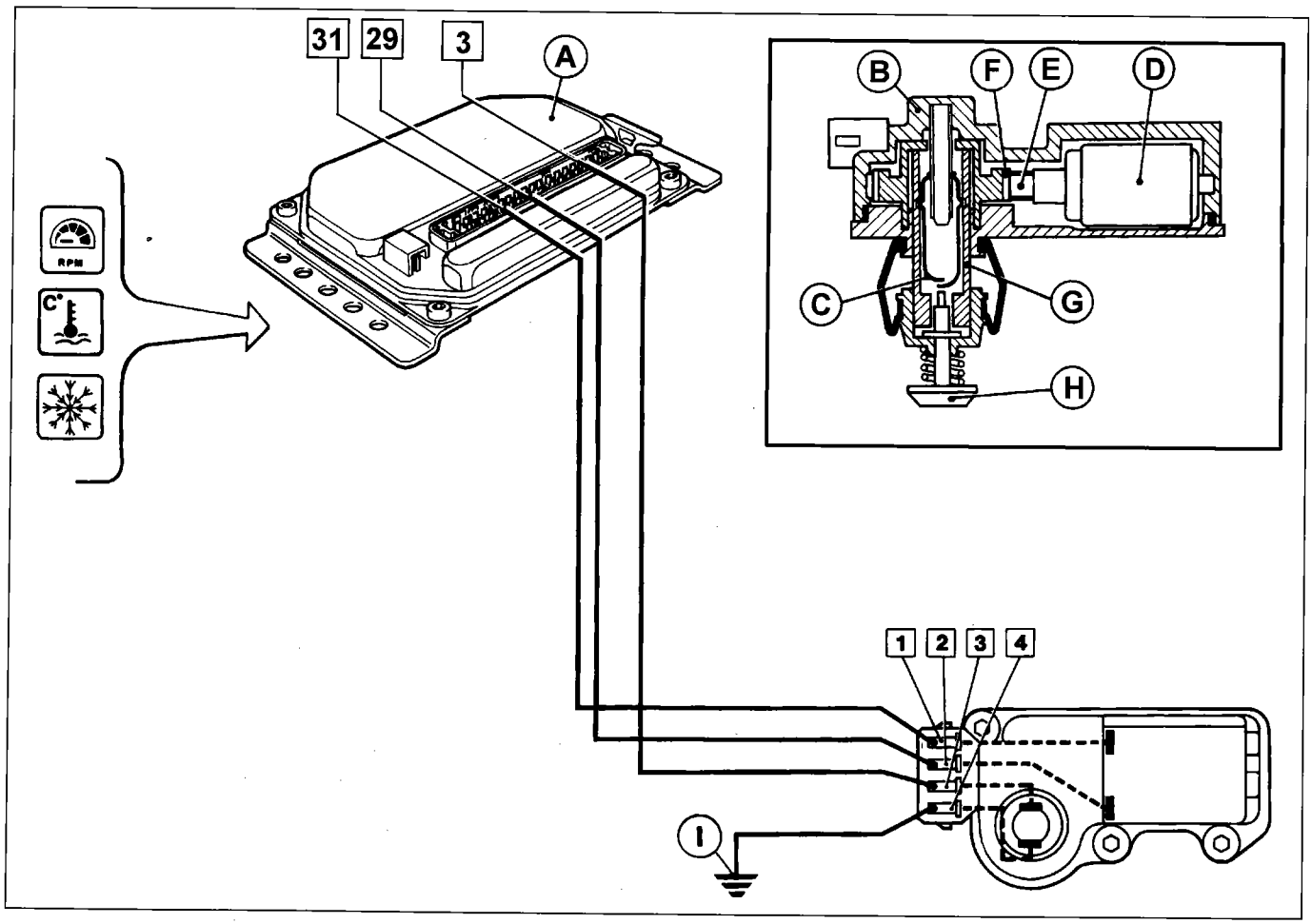
P4F29AJ01

The restoration of the injection impulses after a CUT-OFF stage and the activation of the engine idle adjustment function are managed by the control unit (A see diagram overleaf) in relation to the engine speed and the coolant temperature.
In addition, the electronics may also take other parameters into consideration, namely: the engine during starting or whilst it is warming up, whether the air conditioning is switched on.
The function of controlling the idle is activated by the closing of the contact (C in the diagram overleaf) which connects terminal 3 for the control unit to earth via terminals 3 and 4 for the motor (B) connector at point (I).
When necessary, the control unit supplies the adjustment motor (D), via terminals 31 and 29, so that the idle speed is corrected when the butterfly valve opens or closes.
An electronic switch inside the control unit reverses the polarity at the motor, as appropriate, in order to achieve the two directions of rotation (clockwise and anti-clockwise).

When the motor (D) is supplied it causes the rotation of the reduction unit which comprises a worm screw (E) and a helical wheel (F).

Inside the helical wheel there is a female screw on which the micro-switch (G) casing is tightened/loosend so that it can extend/retract according to the direction of rotation of the actual wheel.

The total travel of the push rod (H), acting on the butterfly valve lever, can produce a maximum opening of around 18°.



P4F30AJ01

Recovery

As a result of an error at the idle contact (short circuit or open circuit) the control unit implements two strategies according to the moment of recognition:

- recognition (open circuit) when the key is in the ON position with no recovery value (ignored);
- recognition (short circuit or open circuit) with key in ON position, the control unit will operate the direct current motor placing it in the safety position (butterfly idling).

On account of an error at the motor (motor stuck or defective, operating stage faulty or defective), detected by compaing the operating value withthe effective position in closed idle contact conditions, the control unit restricts the number of revs which varies between 1400 and 2000 rpm.

Injector

The injector has the task of atomizing the fuel required to form the fuel mixture. It is made from stainless so it is resistant to any impurities which may be present in the fuel; it is located centrally on the injector holder turret above the butterfly valve.

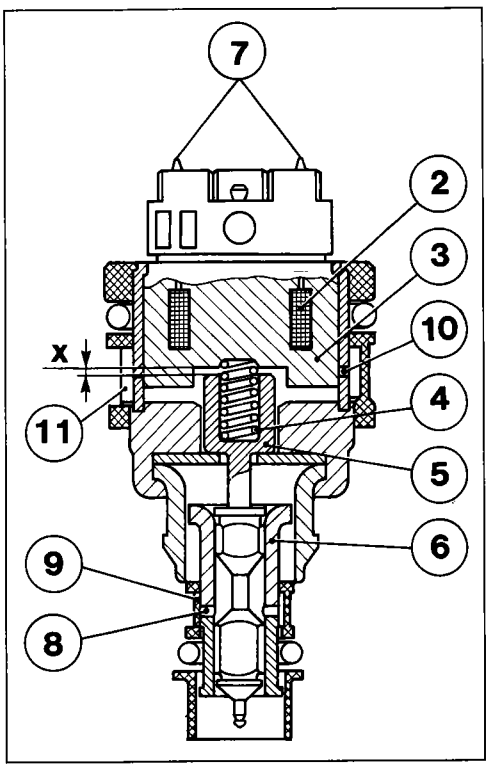
It is made up of an outer casing (1) which contains a winding (2) with a ferromagnetic core (3) and a spring (4) which has the task of keeping the shutter (5) in a closed position in the housing in the casing (6). The assembly is completed by the following components: the electrical contacts (7), the fuel inlet duct (8) and filter (9) and the fuel outlet duct (10) and filter (11).

The control impulses, coming from the electronic control unit, reache the injector by means of electrical contacts (7) creating a magnetic field at the core (3) through the winding (2), raising the shutter (5) from its seat, overcoming the opposing spring (4) loading and causing the opening of the injector.

The shutter lift is 0.06 mm (distance **x**); taking the physical characteristics of the fuel as constant, the quantity injected depends only on the opening time of the injector (injection time) which is established by the electronic control unit according to the engine usage conditions.

The jet of fuel, which comes out of the injector at a pressure of around 1 bar, is instantly atomized forming a cone of between 30° and 90° and is injected upstream of the accelerator butterfly. The operation of the injector is the synchronous type, i.e. one injection for each ignition.

There is a port (12) at the accelerator butterfly which has the function of optimizing the distribution of the mixture in the inlet manifold whilst the engine is warming up.



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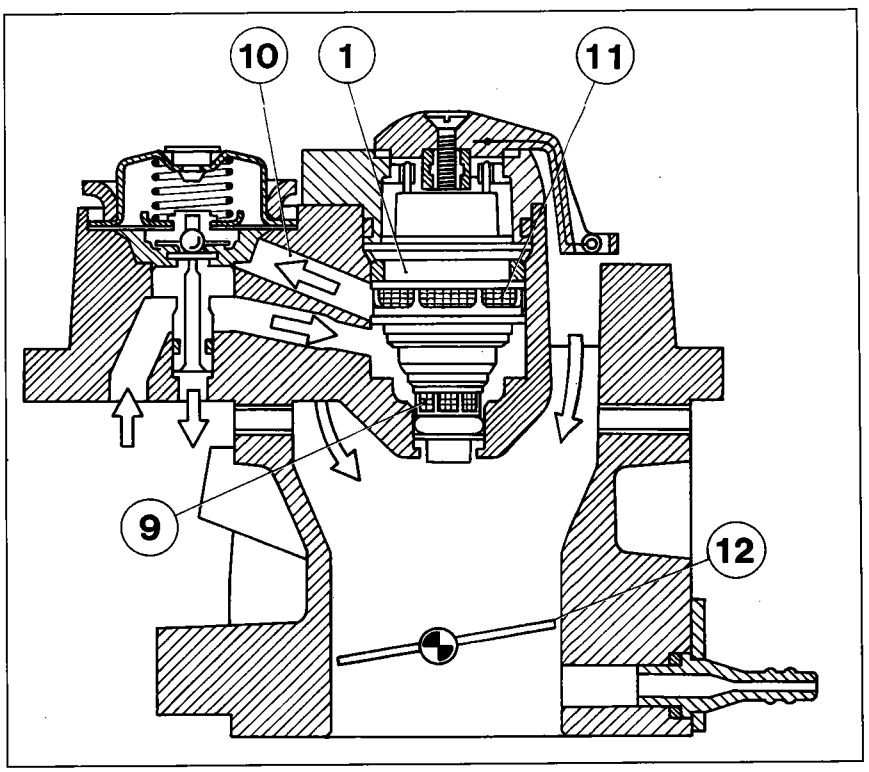
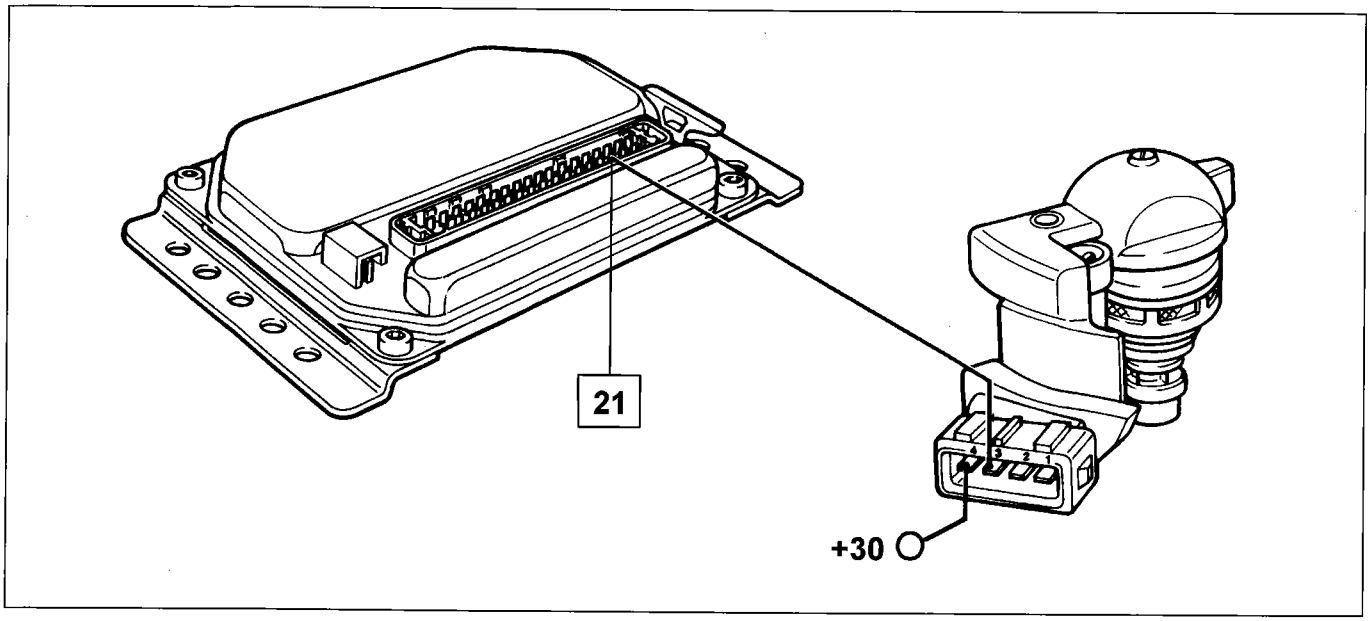


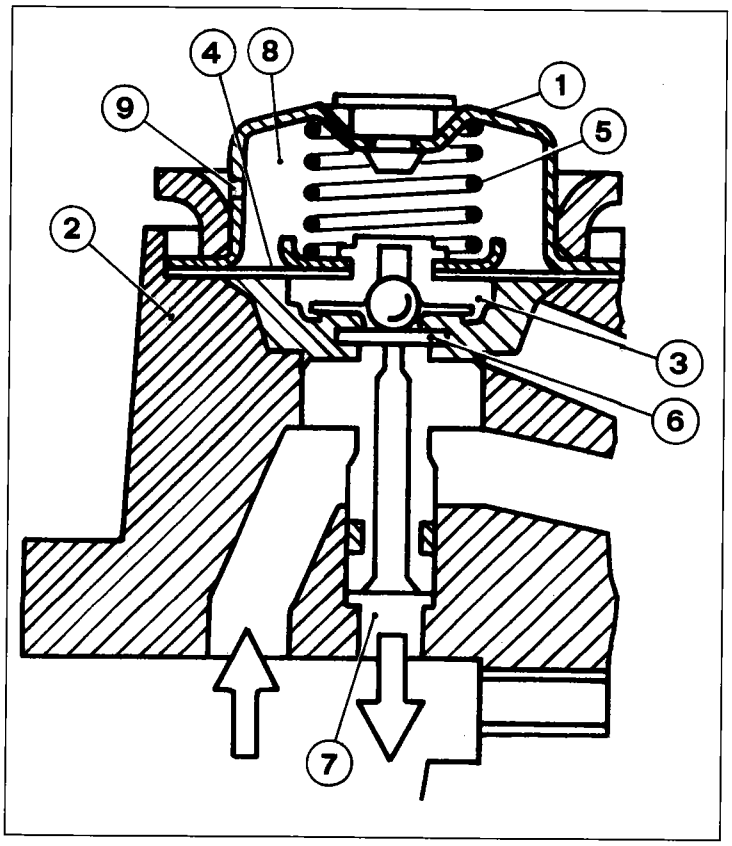
P4F31AJ02

The positive for the injector supply is supplied by the same terminal as the relay which supplies the fuel pump; the circuit closes to earth in the control unit by means of terminal 21.



P4F32AJ01

Fuel pressure regulator



P4F32AJ02

The mechanical diaphragm type regulator (1) is fitted on the injector holder turret (2).

The function of the pressure regulator is to keep the pressure at which the fuel is sent to the injector constant at around 1 bar.

The fuel under pressure coming from the electric pump reaches the hydraulic chamber (3) of the pressure regulator.

If the pressure at the diaphragm (4) exceeds a value of 1 bar, it overcomes the opposing spring (5) loading and moves the plate (6) allowing the fuel to flow through the duct (7) into the tank.

There is a port (9) in the upper chamber (8) of the regulator which places the chamber (8) in contact with the outside, so that a vacuum is not created in the actual chamber.

When the engine is switched off the supply of fuel also ends; the one-way valve for the electric pump and the injector close; in this way the supply pressure in the hydraulic section is maintained for a certain length of time.

This operation prevents the formation of vapour bubbles after the fuel has warmed up due to the heat given off by the engine thereby always guaranteeing that the engine can be started up without problems.

Intake air temperature sensor

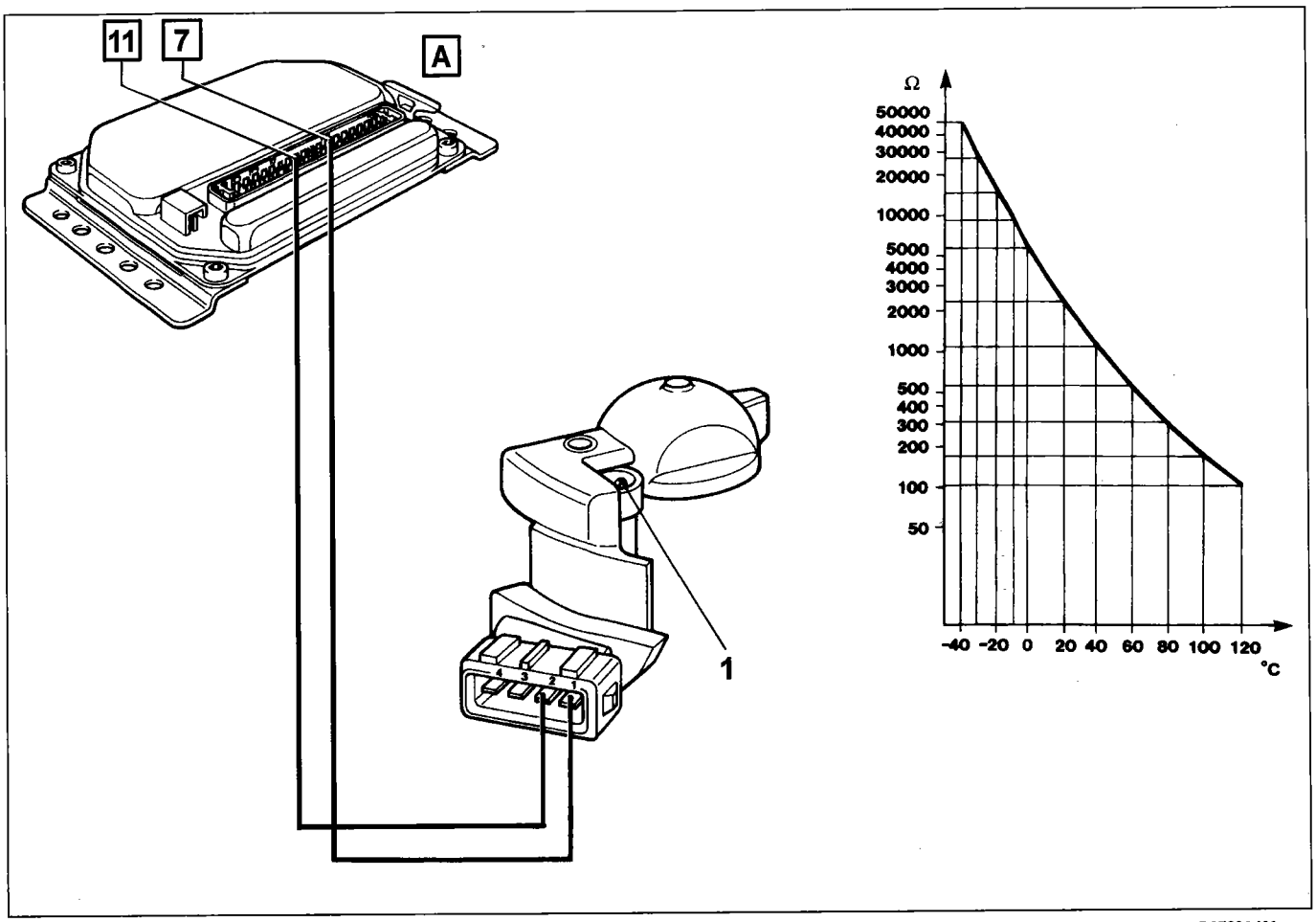
The temperature of the intake air is measured by the temperature sensor (B) on the butterfly casing.

This sensor is made up of a plastic casing on which the reaction element (1), made up of an N.T.C. resistance, which varies in a manner which is inversely proportional to the temperature, is fitted.

If the temperature is between 15° C and 30° C, the resistance is 3.3 - 1.5 kΩ whilst if the temperature is around 80°C, the resistance is 0.280 - 0.360 Ω.

The electronic control unit (A) supplies the sensor (B) through terminal 13; the circuit closes to earth from terminal 2 of the sensor to terminal 27 of the control unit.

With the sensor disconnected, the control unit supplies a voltag of 5 V . With the sensor connected, the supply voltage varies according to the temperature (sensor internal resistance).



P4F33AJ01

Recovery

With the air temperature sensor short circuited(c.c.) or with an open circuit (c.a.), the control unit receives signals which are not plausible, i.e.:

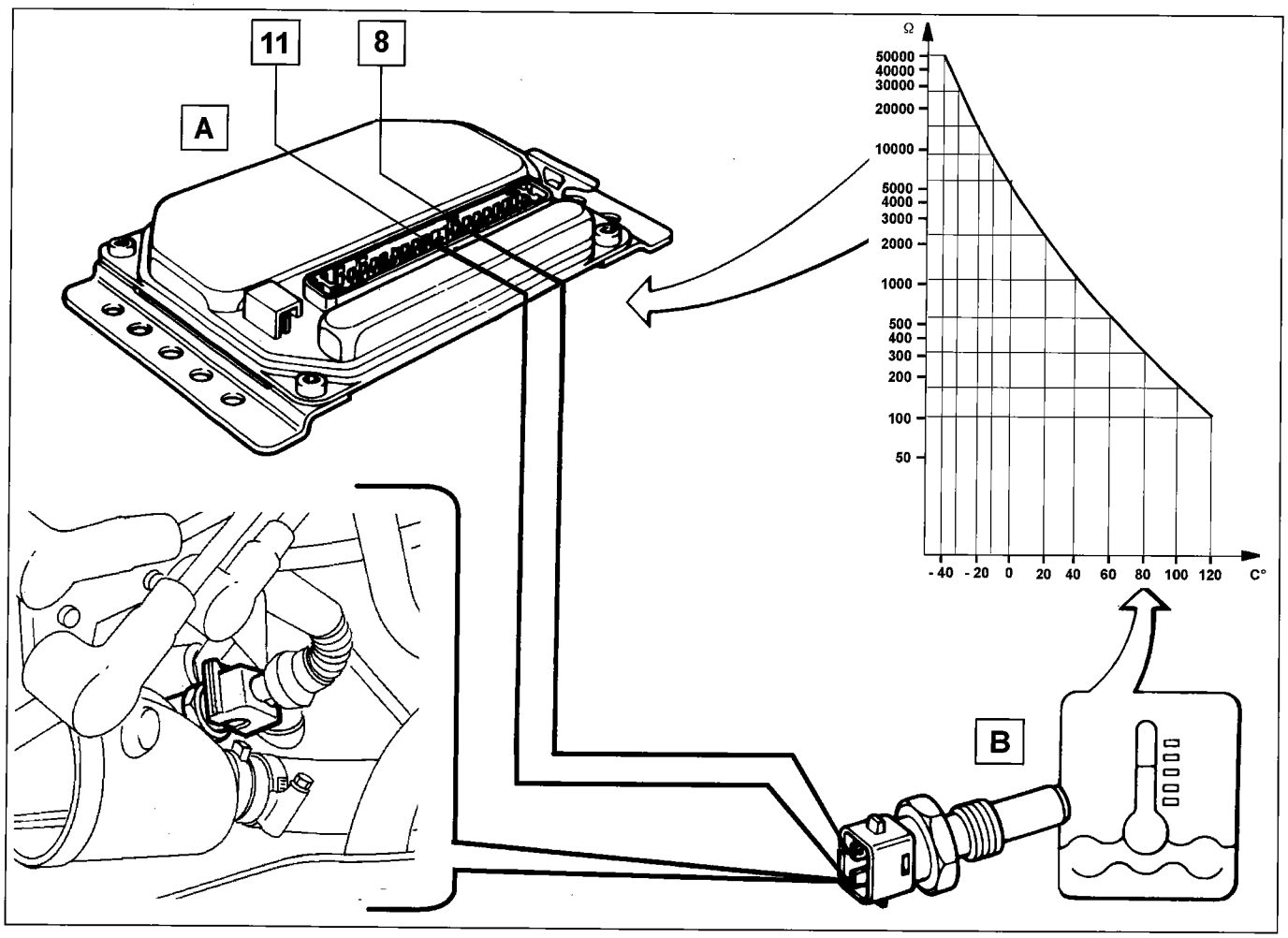
- sensor c.c.: air temperature > 128° C
- sensor c.a.: air temperature < -50° C

In these cases, the control unit implements the Recovery strategy which takes an air temperature equal to 20° C as a reference.

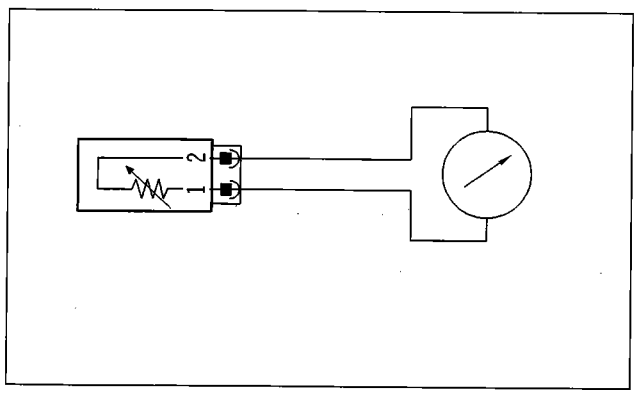
COOLANT TEMPERATURE SENSOR (0.280.130.026)

The coolant temperature sensor (B) is made up of an N.T.C. variable resistance; it is fitted on the thermostat casing and its operation is similar to the intake air temperature sensor.

The electronic control unit supplies the sensor (B), via terminal 8, the circuit closes to earth from the sensor terminal to terminal 11 of the control unit.



P4F34AJ01



P4F34AJ02

Checking the resistance

The graph shows the typical progress for the sensor which can be measured by disconnecting the connector and connecting an ohmmeter to the sensor.

Removing-refitting

Disconnect the electrical connection and remove the sensor.

Tightening torque 2.4 daNm.

Recovery

- with the coolant temperature sensor disconnected, short circuited (c.c.) or with an open circuit (c.a.), the signals arriving at the control unit are not plausible, i.e.:

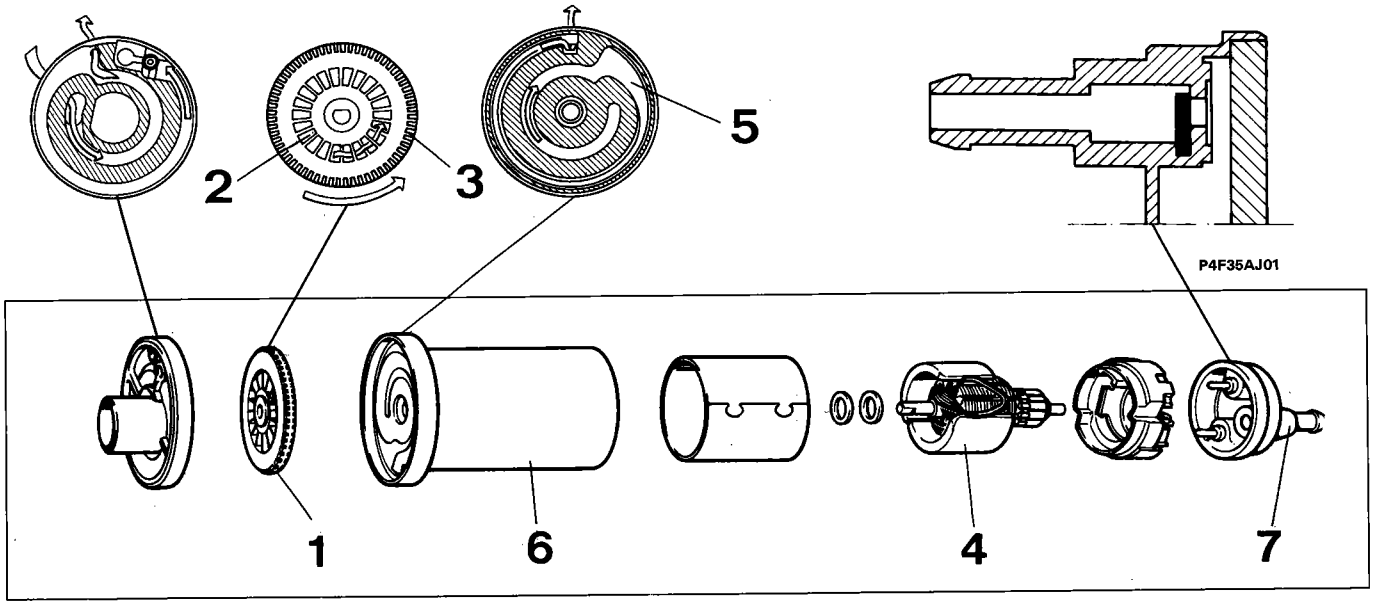
- c.c.: coolant temperature > 96.5 °C
- c.a.: coolant temperature < 96.5 °C
- false contact: when the difference between two consecutive temperature readings is large displaying a downwards trend.
- implausible signal: if the signal from the sensor does not vary with the coolant temperature < +60° C and the engine running.

If the control unit detects one or more of the above signals it implements the RECOVERY strategy:

- with the air temperature < 24° C, the control unit considers the coolant temperature to be the same as the air temperature for about 4 minutes, after which it assumes a coolant temperature equal to 100° C;
- with the air temperature ⩾ 24° C, the control unit considers the coolant temperature to be 100° C.

ELECTRIC FUEL PUMP (0.580.453.514)

The electric fuel pump, immersed in the tank, is the two stage turbo pump and is integrated with the fuel level gauge.
The pump is designed to operate, with a supply of 12 V, at a nominal pressure of 1.1 ± 0.1 bar providing a capacity of 100 litres/hour.
The advantages of low pressure turbo pumps compared with high pressure pressure pumps (2.5 bar) are that they are smaller, weigh less and are quieter.



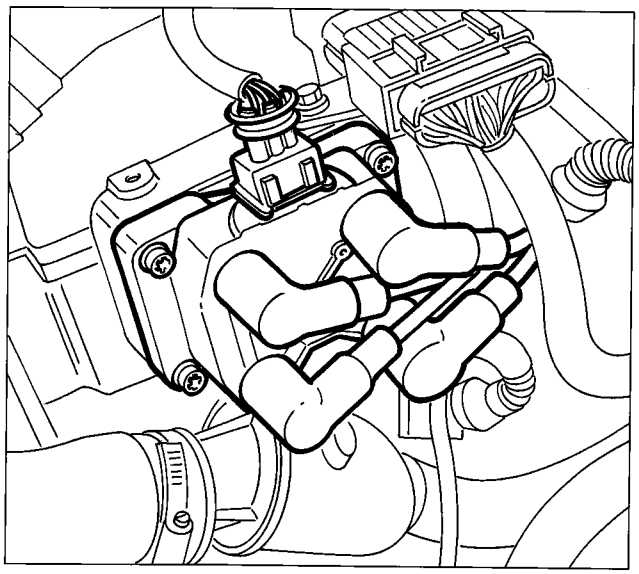
P4F35AJ02

The electric pump contains an impeller (1) which causes two sets of vanes to rotate: one internal (2) with a side profile and one external (3) with a peripheral profile.
With the rotation of the inductor in the rotor (4), the fuel is drawn intothe first side profile stage then, it flows into the second peripheral stage, by mteans of a duct in the inlet disc (5), where it acquires further speed and is sent, through the supply casing (6) and the anti-reflux valve (7), to the injector holder turret.
It is supplied by the control unit via the relay and 10 A fuse.

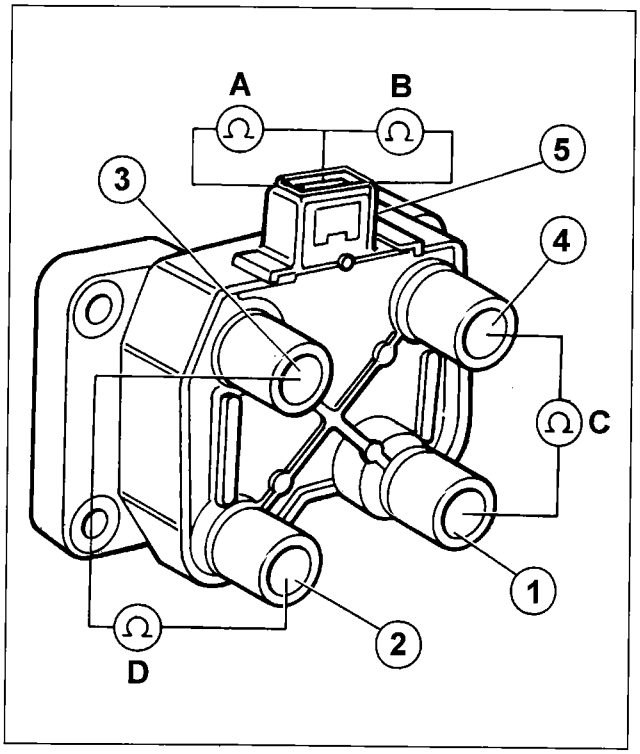
NOTE *For the positioning and the removing-refitting procedure, refer to the fuel supply section for the 1581 16V version.*

FUEL FILTER (A.450.024.262)

The fuel filter is fitted under the floor panel, on the fuel supply pipe. For the positioning and the removing-refitting procedure, refer to the fuel supply section for the 1581 16V version.



P4F36AJ01



P4F36AJ02

Connector wiring

NOTE *The numbers indicate the corresponding control unit pins.*

IGNITION COIL (0.221.503.407)

The coil, which is the closed magnetic circuit type, is fixed on the left hand side of the cylinder head cover.

1. H.T. socket for cylinder 1 spark plug
2. H.T. sockect for cylinder 2 spark plug
3. H.T. sockect for cylinder 3 spark plug
4. H.T. socket for cylinder 4 spark plug
5. Control unit connection L.T. socket

Checking winding resistance

Primary circuit (A cylinders 2-3, B cylinders 1-4)

Place the probes of an ohmmeter in contact with the positive terminal (centre pin) and the negative terminal (pin 1 for circuit A and pin 2 for circuit B).

The resistance value for the primary circuit read on the instrument should be between 0.45 and 0.55 ohm at 23 °C.

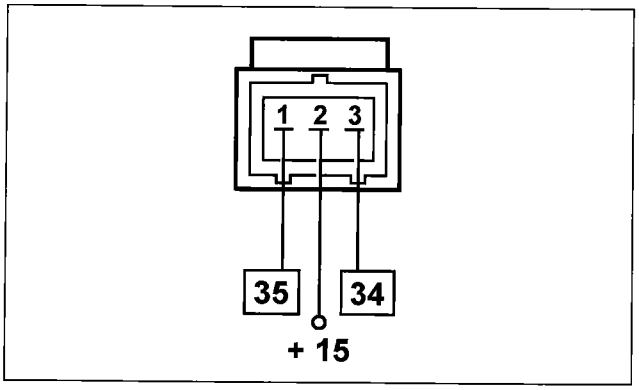
Secondary circuit (C cylinders 1-4, D cylinders 2-3)

Place the probes of an ohmmeter between the two high tension outlet terminals.

The resistance value for the secondary circuit read on the instrument should be between 12000 and 14600 ohm at 23 °C.

Removing-refitting

Disconnect the H.T. and L.T. connections, then undo the fixing bolts and remove the coil.



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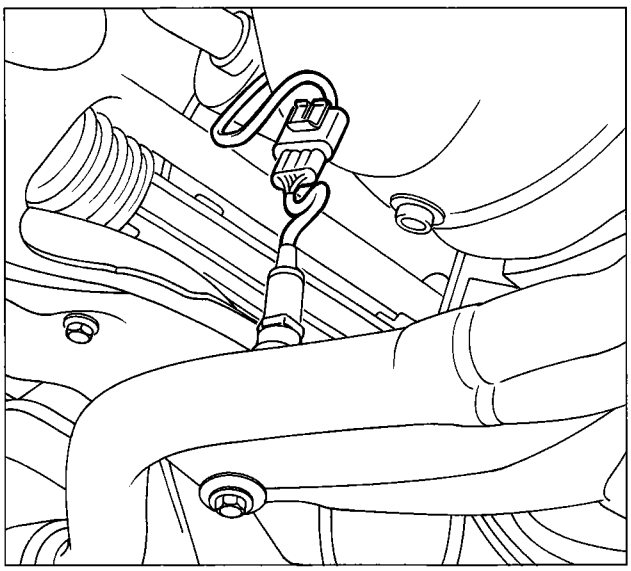


P4F37AJ01

LAMBDA SENSOR (0.258.003.805)

The vehicle is equiped with a heated Lambda sensor with four wires which measures the oxygen content of the exhaust gases. For a full description of the Lambda sensor, refer tothe Fuel System section forthe 1581 16V version.

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

Removing-refitting

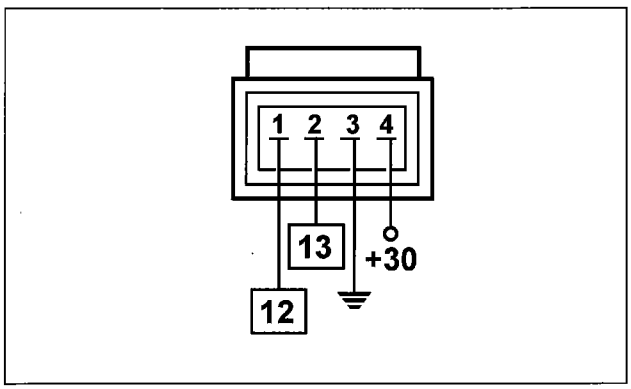
- Position the vehicle on a lift.
- Disconnect the neg. lead from the battery.
- Raise the vehicle
- Disconnect the electrical connection
- Remove the Lambda sensor from its housing.
- When tightening, do not exert force on the component or else it will be irreparably damaged.

If the Lambda sensor is being replaced, when refitting apply anti--seizing graphite grease to the threaded part (for example Bosch VS 14016- FT).

Tightening torque 5 - 6 daNm

Wiring connector

The numbers indicate the corresponding control unit pins.



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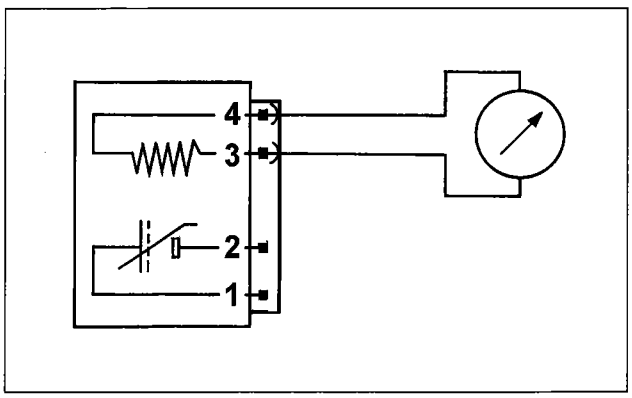
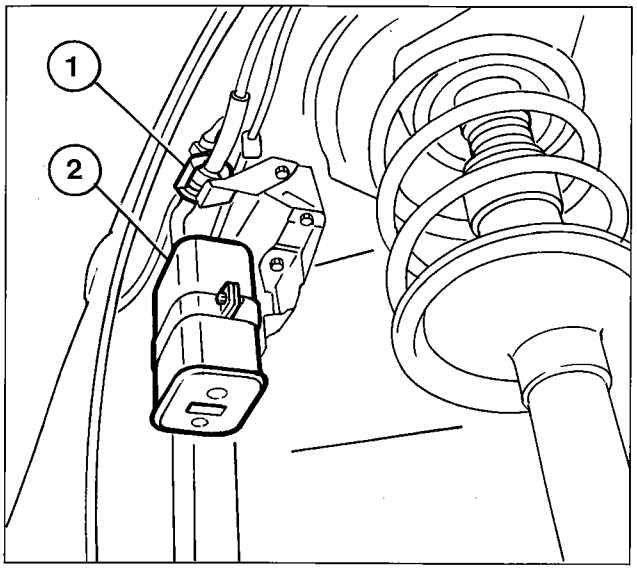


P4F37AJ03

Checking the resistance

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

Resistance: 4.5 ± 0.5 ohm at 20 °C



P4F38AJ01

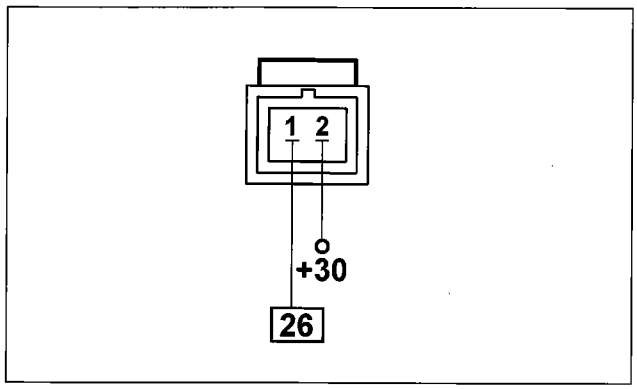
CHARCOAL FILTER AND FUEL VAPOUR CUT OUT SOLENOID VALVE

The charcoal filter and the solenoid valve are located inthe right wheel arch.

For the description of the charcoal filter, refer to the Fuel System section for the 1581 16V version.

For the description of the fuel vapour cut out solenoid valve and the removing-refitting procedures for both the filter and the cut out solenoid valve, refer to the Fuel System section forthe 1998 20V version.

1. Vapour cut out solenoid valve
2. Charcoal filter

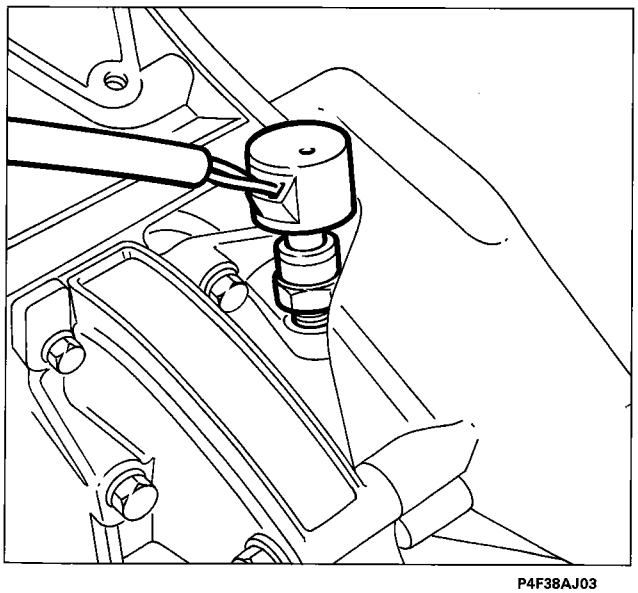


P4F38AJ02

Vapour cut out solenoid valve (0.280.142.300)

Wiring connector

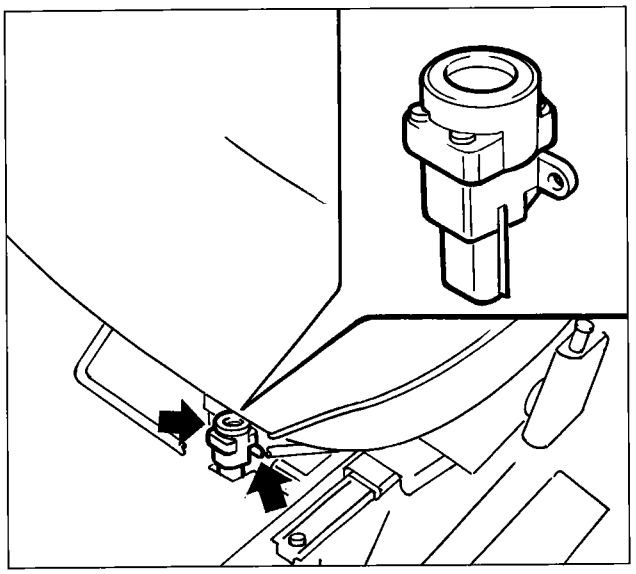
NOTE *The numbers indicate the corresponding control unit pins.*



P4F38AJ03

SPEEDOMETER SENSOR

The speedometer sensor (vehicle speed sensor) is made up of a Hall effect sensor which is located at the differential outlet.
The sensor sends the control unit a signal whose frequency varies according to the speed of the vehicle.
The control unit uses this information to improve the management of the engine idle adjustment actuator.



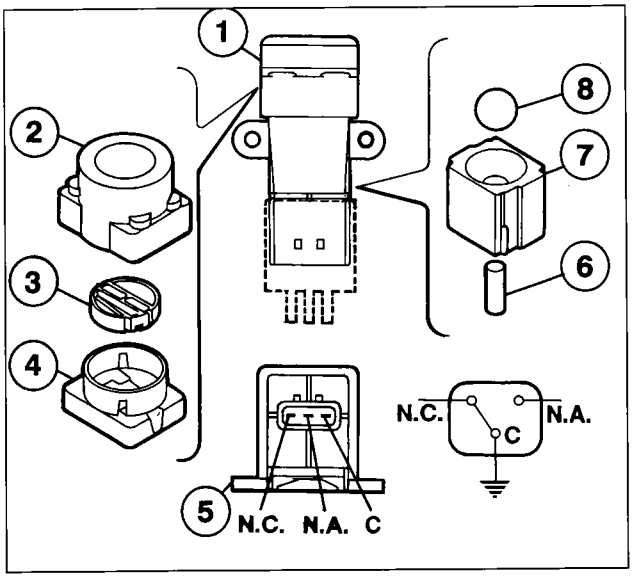
P4F39AJ01

INERTIA SWITCH

In order to increase the degree of safety for the occupants of the vehicle in the case of an impact, the vehicle is fitted with an interia switch located inside the passenger compartment, under the driver's seat.

This sensor reduces the risk of fire (as a result of fuel escaping from the injection system), de-activating the electric pump which supplies the injection circuit.

For the full description and the removing-refitting procedure, refer to the Fuel System section for the 1581 16V engine.



P4F39AJ02

Inertia switch components

1. Complete inertia switch
2. Outer casing
3. Push button
4. Upper side
5. Engagement side
6. Permanent magnet
7. Housing for permanent magnet
8. Steel ball

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

Even after an apparently slight impact, if there is a smell of fuel or leaks are noticed from the fuel system, do not turn the switch back on, but search for the fault and repair it in order to avoid the risk of fire.

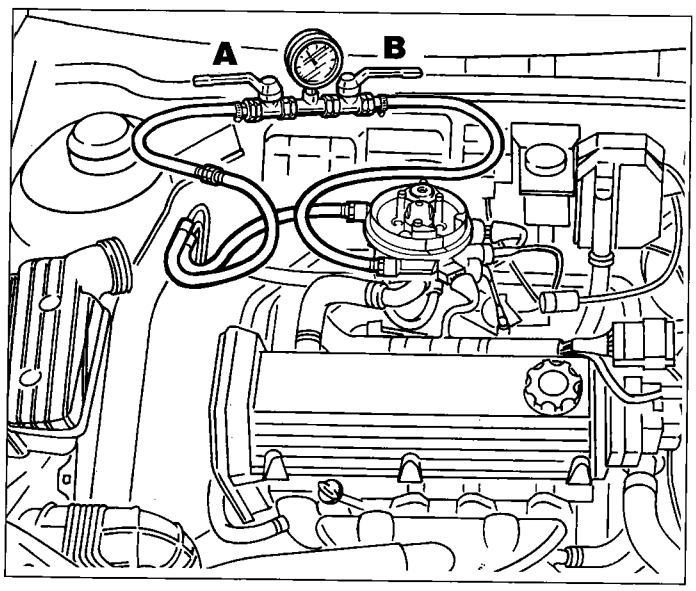
MULTI-PURPOSE VALVE AND SAFETY AND VENTILATION VALVE

These valves belong to the anti-evaporation and fuel vapour recirculation system. For a description of them, refer to the Fuel System section for the 1581 16V version.

CHECKS, ADJUSTMENTS AND REPAIR OPERATIONS FOR THE BOSCH MONOMOTRONIC SYSTEM

THE FOLLOWING PRECAUTIONS SHOULD BE OBSERVED WHEN WORKING ON A VEHICLE EQUIPPED WITH A MONOMOTRONIC INJECTION/IGNITION SYSTEM:

- *do not start up the engine with the electrical connector terminals not properly connected or slack at the battery poles;*
- *do not use a rapid battery charger to start up the engine;*
- *never disconnect the battery with the engine running;*
- *in order to charge the battery, disconnect it first from the electrical system;*
- *if the vehicle is going in a drying oven after painting, at temperatures above 80 °C, the electronic control unit should be remove first;*
- *do not attach or disconnect the multiple connector for the electronic control unit with the ignition switch in the ON position;*
- *always disconnect the battery negative before carrying out electrical welding on the vehicle.*
- *Remember that this system has a memory which is always supplied (stand-by memory) where the self-adjustment values are memorized. The operation of disconnecting the battery involves the loss of this information which can be obtained once again after a certain distance, therefore this operation should be limited as far as possible.*



P4F40AJ01

CHECKS FOR THE FUEL SUPPLY CIRCUIT

1st Test

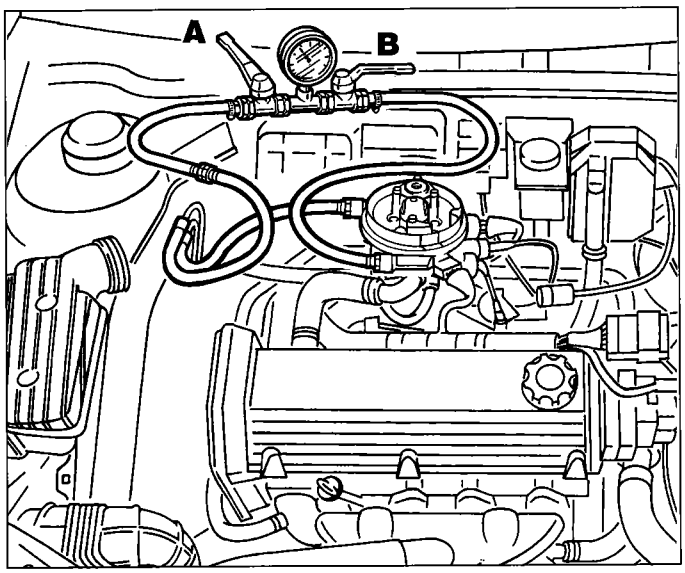
Check the **fuel supply pressure** in the following way:

- Disconnect the pipe arriving at the injector holder turret (coming from the fuel filter) from the inlet duct;
- Place pressure gauge 189589000, with both taps A and B in the open position, between the end of the disconnected pipeand the injector holder turret inlet duct;
- Operate the electric pump with the engine switched off;

This last operation is carried out with the help of the Fiat/Lancia Tester by activating the "fuel pump" test.

The pressure reading on the gauge should stabilize, in those test conditions, at 1.1 ± 0.1 bar.

If the pressure is too low, carry out the next test.



P4F41AJ01

2nd Test

Checking maximum fuel supply pressure (or electric pump efficiency)

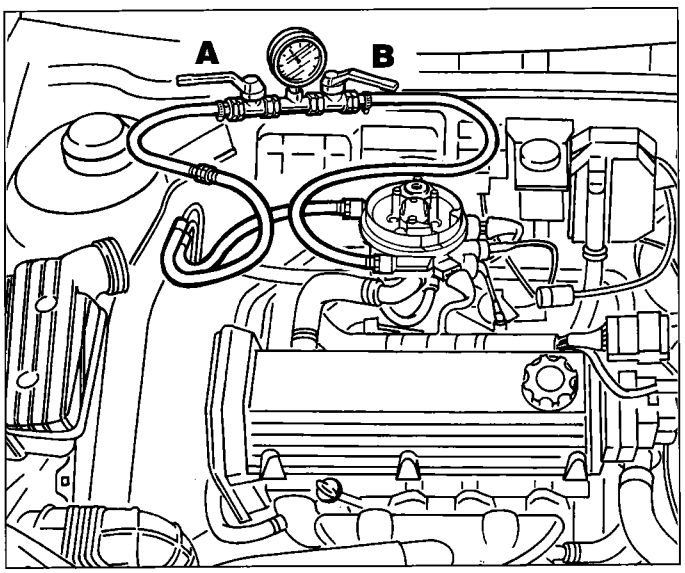
The same connections as for the previous test apply

- close the fuel tap control lever A;
- operate the electric pump with the engine switched off, as described on the previous page: the pressure should not exceed 5 bar (pump safety valve setting). If this is not the case, replace the electric pump because it is defective.

If the pressure reading in the 1st test (see previous page) was more than 1.1 ± 0.1 bar, it is necessary to:

- disconnect the fuel return pipe from the pressure regulator and replace it, temporarily, with a pipe going to a suitable container to collect the fuel
- operate the electric pump, with the engine idling, then read the pressure on the gauge:

a) if it reachess 1.1 ± 0.1 bar, the fuel return pipe to the tank should be replaced because it is obstructed or bent
b) if it exceeds 1.1 ± 0.1 bar, then the regulator is defective and the injector holder turret should be replaced



P4F41AJ02

3rd Test

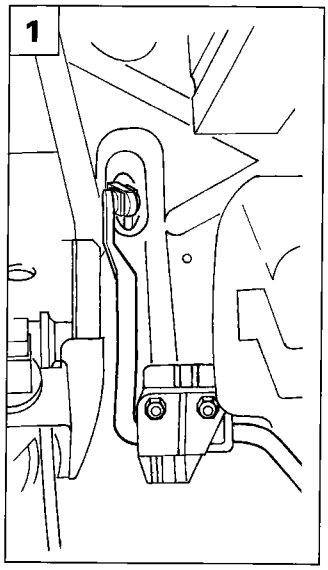
Injector leakage test

In order to check whether the injector is dripping, simply apply the connection for the 1st test (checking regulation pressure), then operate the electric pump with the engine switched off. When the regulation pressure is reached, close the fuel tap control lever B; in this way the pressure of the fuel and that in the injector is the same.

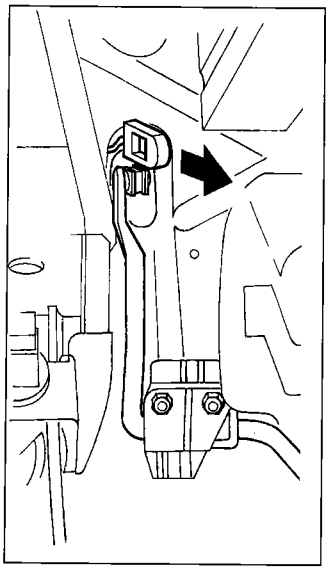
Then:

- switch off the electric pump
- observe whether as soon as the pressure stabilizes (i.e. decreases slightly) it remains constant for around 60 secs
- after having supplied the electric pump with the engine switched off visually inspect whether the injector or any connections are dripping.

Replace any injector which is dripping and/or renew the defective seal from where there is a leak.



P4F49CJ01



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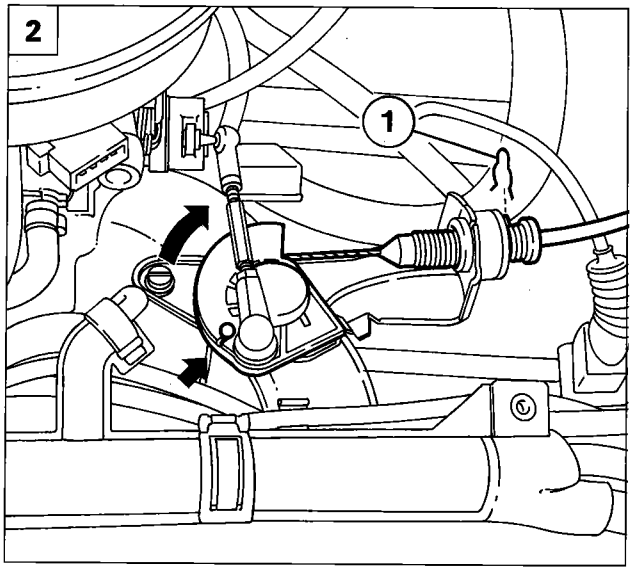
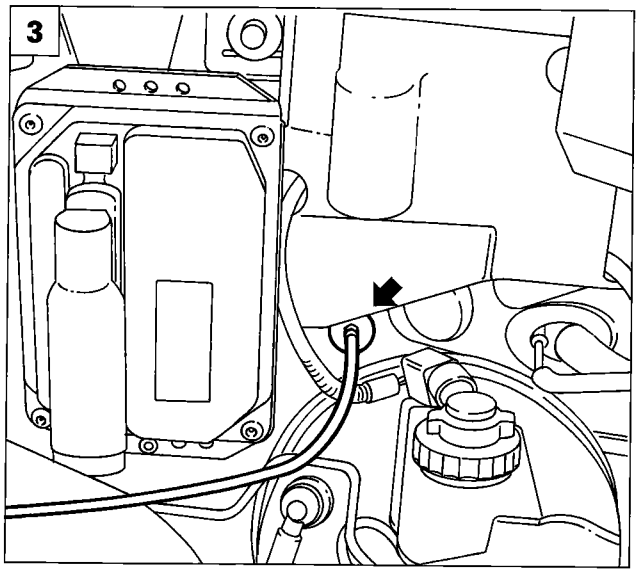


P4F42AJ03



P4F42AJ02

REMOVING-REFITTING ACCELERATOR CABLE

Disconnect the cable from the battery, then proceed as described below:

1. Working from inside the vehicle, disconnect the cable from the mounting on the accelerator pedal.
2. Rotate the butterfly valve control lever, in the engine compartment, and release the accelerator cable. Extract the spring (1), then removethe cable from the mounting bracket.
3. Remove the flexible buffer from the anchorage opening in the dashboard partition and extract the complete accelerator cable.

When refitting, adjust the accelerator cable as described in the paragraph "Adjusting the accelerator cable".

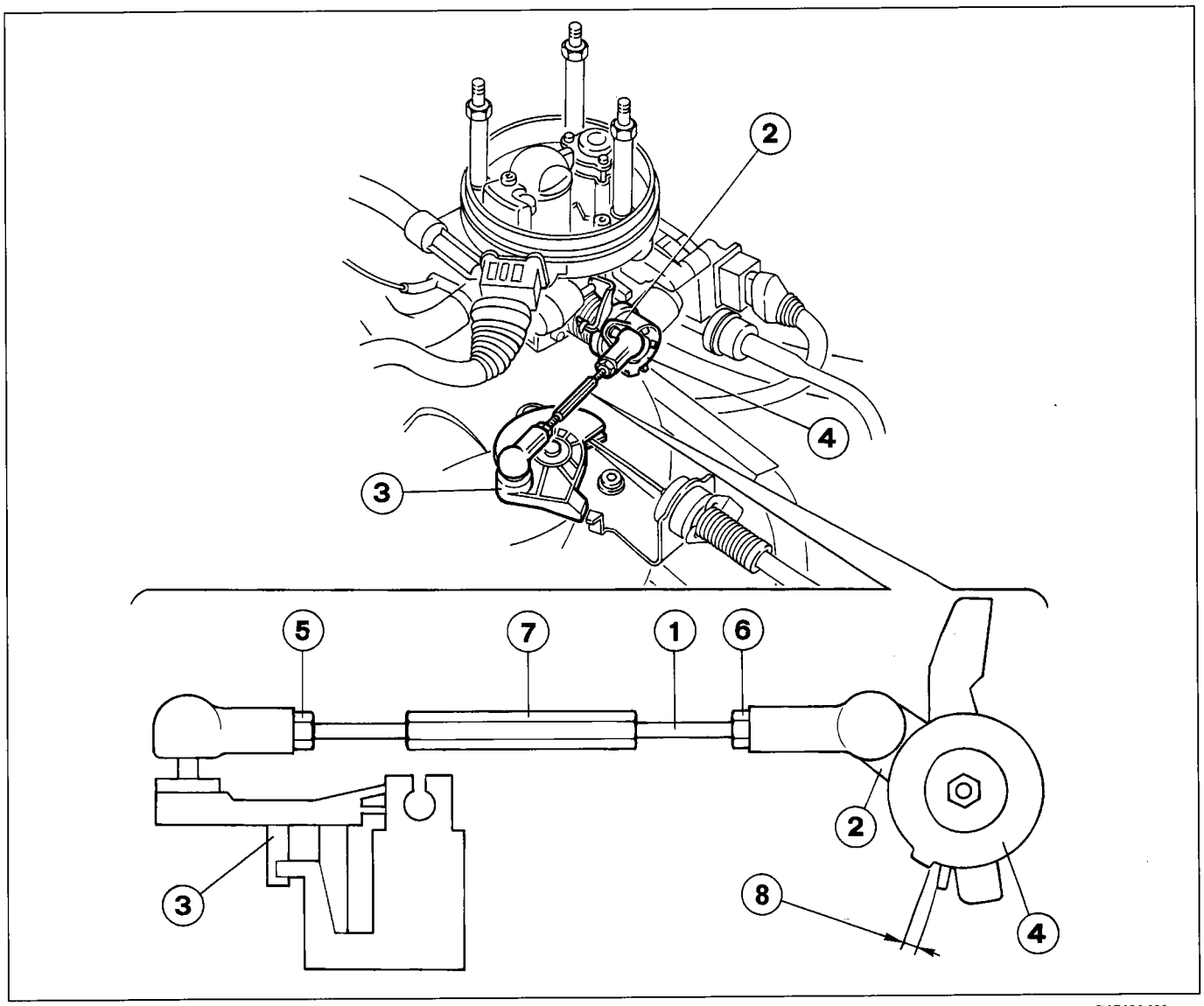
REMOVING-REFITTING ACCELERATOR PEDAL

For the procedure for removing-refitting the accelerator pedal, refer to the Fuel System section for the 1581 16V version.

REMOVING-REFITTING FUEL TANK

For the procedure for removing-refitting the fuel tank, refer to the Fuel System section for the 1581 16V version.

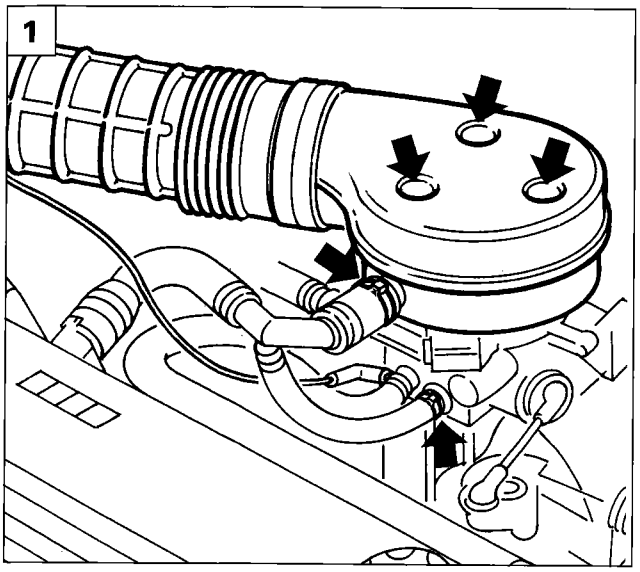
ADJUSTING BUTTERFLY VALVE OPENING



P4F43AJ01

For the smooth operation of the Monomotronic injection system it is vital for the butterfly opening linkage to be correctly adjusted.
Check that with the rod (1) disconnected from the lever, the pulley (3) is in the end of travel position. **In this condition the accelerator cable should be neither too taut nor too slack so that there is no free play for the accelerator pedal.** If this is not the case, act on the accelerator cable spring.
With the rod (1) disconnected from the lever (2), let the engine warm up (the radiator cooling fan should switch on and off).
Make sure that all the vehicle electrical consumers (including the two radiator and climate control cooling fans) are switched off and then switch off the engine.
Connect the rod (1) to the lever (2) and check that the clearance (8) between the two levers (2 and 4) is as follows:
- for new engines 1.6 - 1.8 mm
- for engines which have been run in 0.7 - 0.9 mm

If the above measurement does not correspond to the figure given, loosen the nuts (5 and 6) and tighten/loosen the rod (1) adjuster (7).
When the adjustment is complete make sure that with the accelerator pedal fully depressed, the butterfly is completely open.



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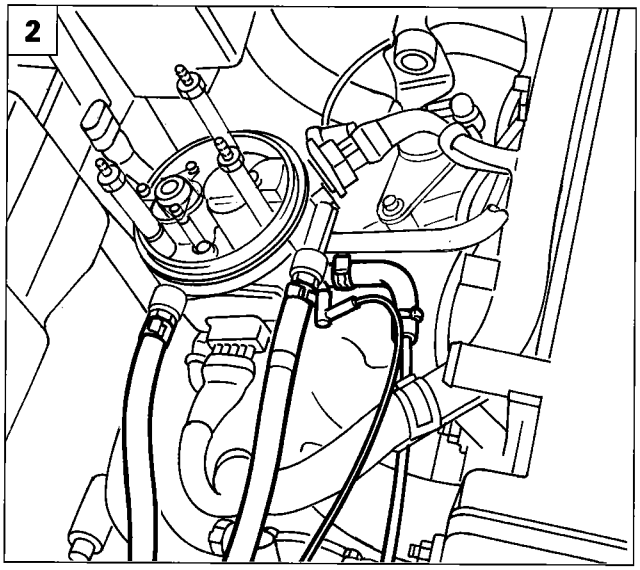

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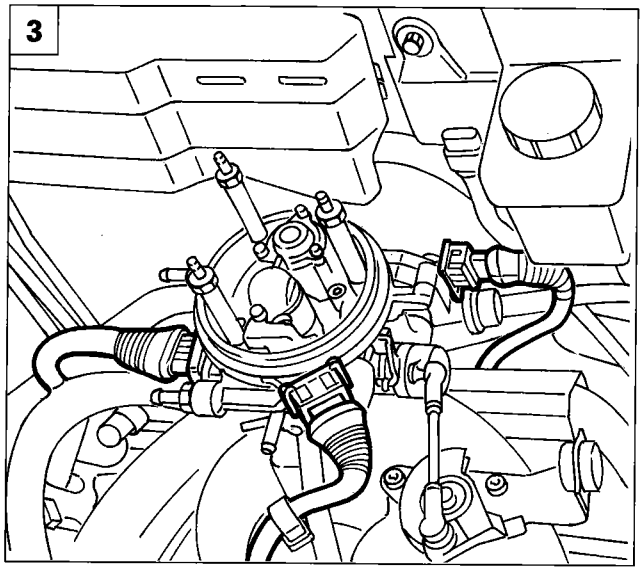
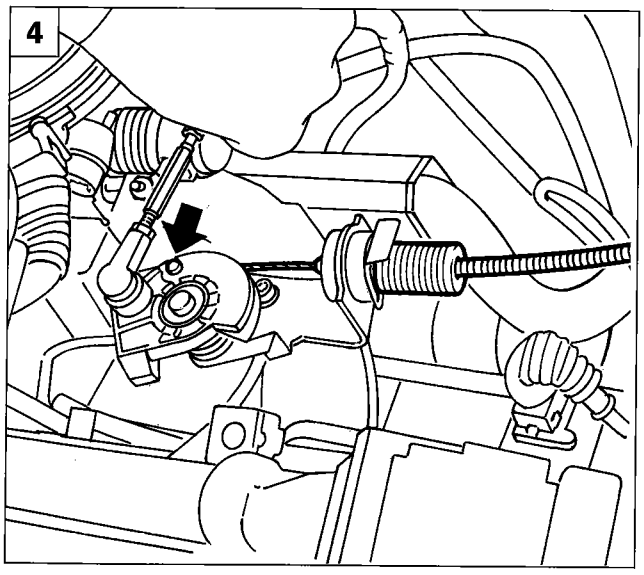


P4F44AJ03

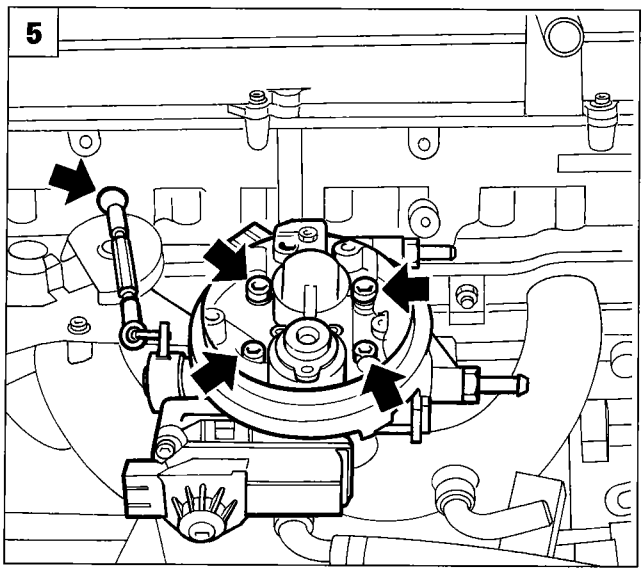
REMOVING-REFITTING BUTTERFLY CASING

1. Remove the air duct and the gas recirculation pipes coming from the engine crankcase (blow-by) by acting at the points shown.
2. Disconnect the fuel pipes, the anti-evaporation pipe and the vacuum duct.
3. Disconnect the electrical connections

4-5 Release the accelerator control rod, undo the bolts shown and remove the butterfly casing.



P4F44AJ04



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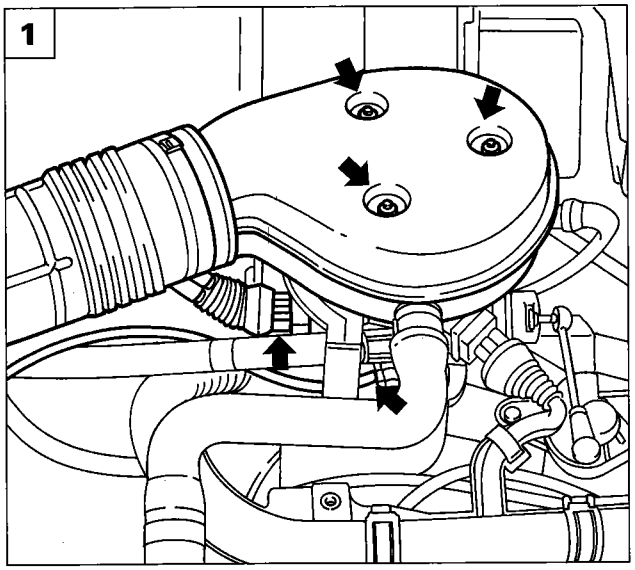

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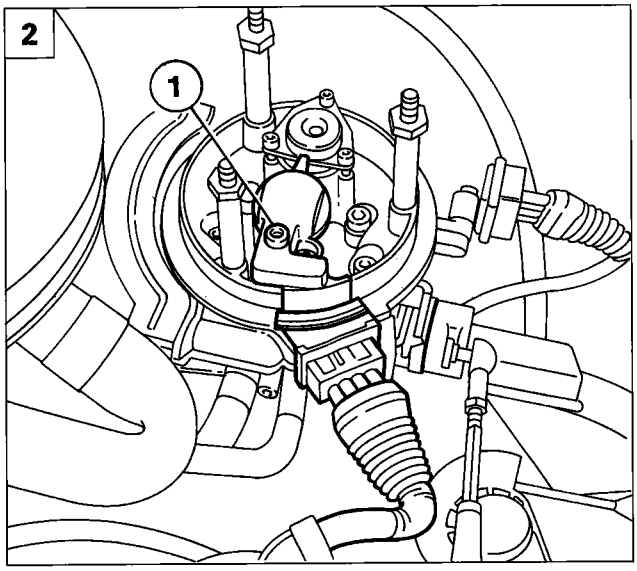

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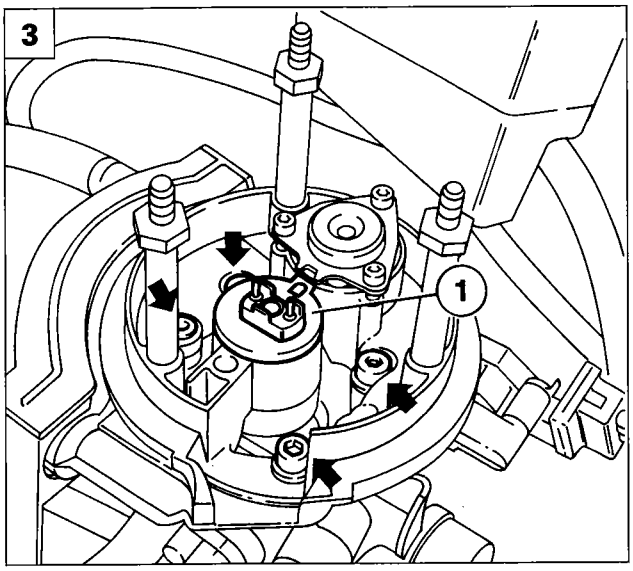

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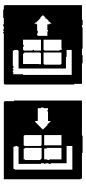
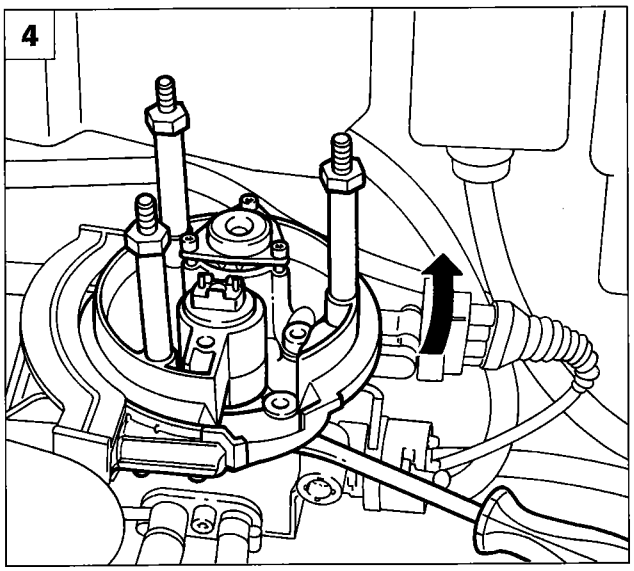


REMOVING-REFITTING AIR TEMPERATURE SENSOR AND INJECTOR

1. Remove the air duct, the electrical connection for the butterfly valve position sensor and the vacuum duct acting at the points shown.
2. Disconnect the electrical connection, undo the bolt (1) and remove the air temperature sensor.
3. Remove the seal (1) from the injector and undo the bolts shown.
4. Using a screwdriver for leverage, separate the upper section of the butterfly casing.
5. Using a spanner (or suitable equivalent tool), carefully push on the outside edge of the injector and extract it from its seat.



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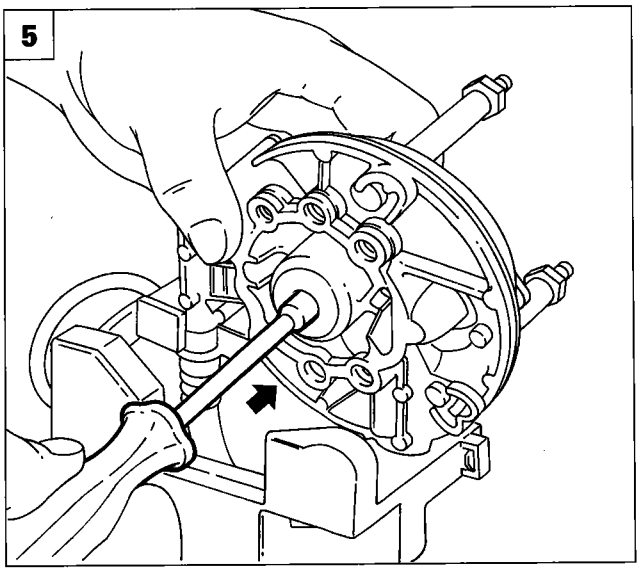

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CHECKING ENGINE IDLE SPEED

If the engine idle speed is not 850 ± 50 rpm and the injection/ignition control unit is the self-adjusting type, then it is not possible to adjust it and it is necessary to check that the accelerator control linkage is correctly adjust and the problem should be sought by carrying out a full fault diagnosis using the Fiat/Lancia Tester.

CHECKING CONCENTRATION OF POLLUTANT EMISSIONS

By automatically adjusting the system, the Monomotronic system ensures a constant check of the idle speed and the CO percentage thereby rendering any external adjustment operation superfluous (there are no 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

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

1. Undo the cap 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 to the tool.
3. Start up the engine and let it reach operating temperature.
4. Check that the idle speed corresponds to the figure recommended.
5. Check that the idle concentration of CO is within the recommended values given in the table overleaf; if this is not the case, it is necessary to check:
   - that the Lambda sensor is working properly, using the Fiat/Lancia Tester;
   - for the presence of air penetration in the area surrounding the Lambda sensor housing;
   - the injection and ignition system (**especially the wear of the spark plugs**).
6. In the same conditions, check that the HC concentrationis less than 600 p.p.m.
7. If these values are not found, check the engine, paying special attention to:
   - the ignition advance angle;
   - the valve clearances;
   - the valve gear timing;
   - the engine compression.

Checking concentration of CO and HC at the exhaust

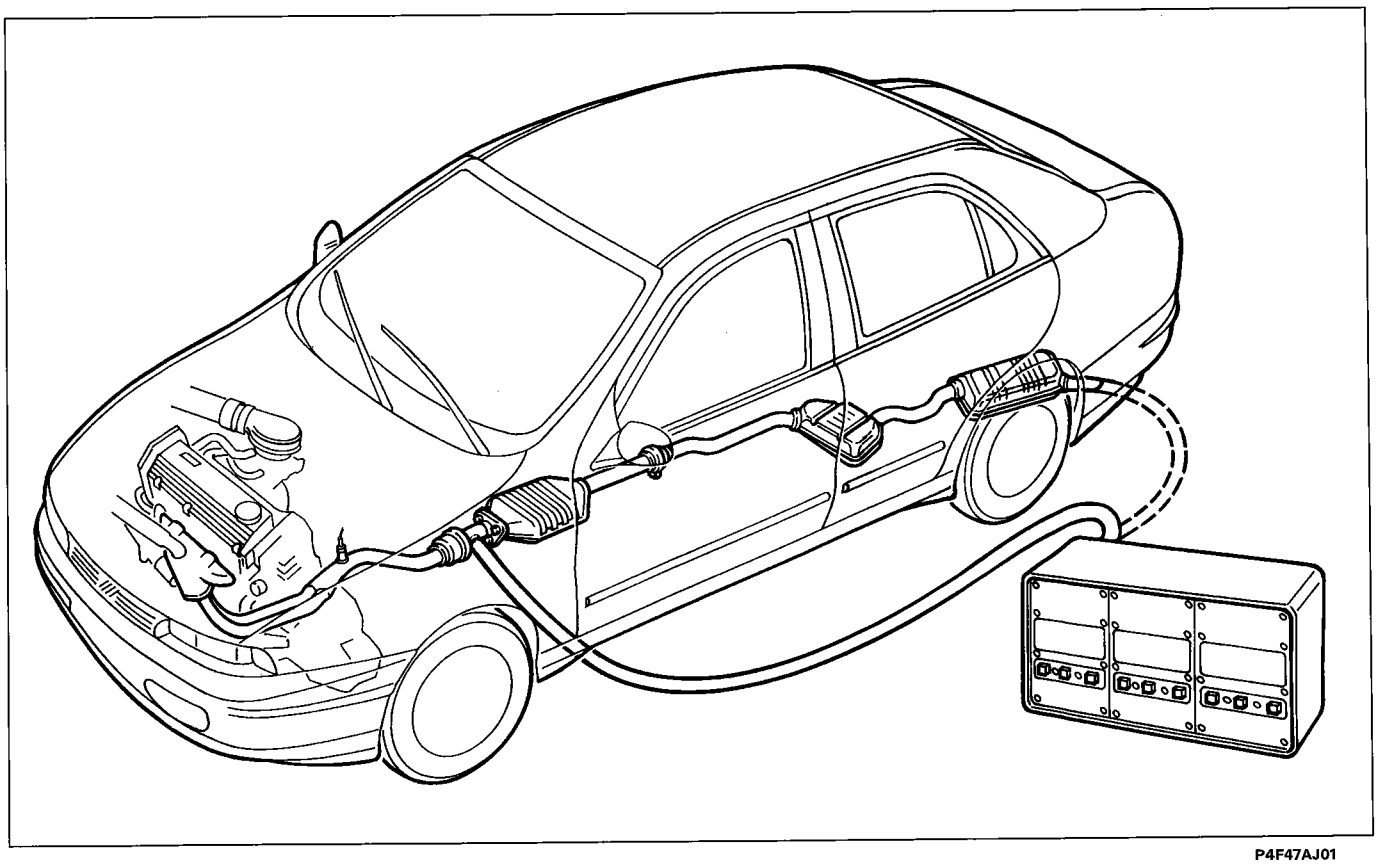
The concentration of carbon monoxide (CO) and unburnt hydrocarbons (HC) at the exhaust is measured by inserting a suitably calibrated CO tester at least 30 cm into the end of the exhaust pipe as shown in the diagram.

If the shape of the end section of the exhaust pipe is such that the sensor cannot be completely inserted, then a special extension pipe which guarantees the seal in the join area must be added.

1. Check that the idle CO and HC concentrations are those indicated in the table.
2. If the HC value differs from the figures given, whilst the value previously measured upstream of the catalyzer was okay, then the engine parameters are correct and the cause of the problem should be sought in the decreased efficiency of the catalyzer.

Table summarizing pollutant emission tolerance figures

	CO (%)	HC (p.p.m.)	CO_2 (%)
Upstream of the catalyzer	0,4 ÷ 1	600	⩾ 12
Downstream of the catalyzer	⩽ 0,35	⩽ 90	⩾ 13



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DIAGNOSIS

The complete diagnosis of the system is possible through an active dialogue with the Fiat/Lancia Tester
If a failure is detected at the sensors, then the electronic control unit replaces the information coming from the faulty sensor with one memorized (recovery) to allow the operation of the engine. The detection of a fault involves it being memorized permanently and the sensor excluded from the system until the signal is compatible once again.
The same procedure is applied if the fault involves an actuator. The detecting of the fault and its replacement with recovery data involves the failure being signalled by the special warning light in the instrument panel coming on.
The parameters which can, in the case of a fault, be managed by the control unit are: idle adjustment actuator, coolant temperature sensor, butterfly valve position sensor, air temperature sensor and detonation sensor. On request, the operator can read the faults in the control unit using the Fiat/Lancia Tester.

Detecting faults

This is carried out duringthe basic function through which the sensor/actuator is managed.

Memorizing the error and structure of the errors memory

The errors are memorized in the control unit in the order in which they arrive in the RAMs. The location of each of them is memorized and there is a frequency counter.

Classification of the defect

If a defect is recognized for the first time and the error state persists for the recognition time, then the defect is memorized as "permanent". If this defect later disappears, then it is memorized as "intermittent". If it then reappears, it becomes "permanent" once again.
The classification of a defect as "permanent" activates the recovery functions; when the fault disappears the normal reading or implementation function is restored.
Several types of fault are classified as "important", in terms of the pollution control regulations. The presence of these faults is signalled to the user by the failure warning light in the dashboard coming on.

Frequency counter

Each error is allocated a frequency counter which is used to determine the moement in which a fault no longer present was memorized. The first time the fault is detected, the counter is set at 10. If the fault disappears, it remains memorized as intermittent and the counter is decreased each time the engine is started up without the fault reappearing. If the counter reaches zero, the fault is automatically cancelled from the memory.

If after the counter has been decreased, the fault should reappear, the counter is set at 10 (if, however, it was already greater than 10, then it is not altered).

Signalling a failure

The failure warning light comes on when there is a defect memorized as "present" and "important".
The delay time between detecting the fault and the warning light coming on is 2.5 s.condi; the delay time between the fault disappearing from the memory and the warning light going out is 0 seconds.
The warning light comes on each time the ignition key is turned to the ON position. If there are no "important" faults already present then 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 in the following cases:

- through the "cancel errors memory" command sent by the tester;
- by interrupting the electronic control unit supply (disconnecting the battery or the control unit connector).

Fault diagnosis with the Fiat/Lancia TESTER

The diagnostic socket to which the Fiat/Lancia Tester is connected is located at the side of the electronic control unit.

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

The Tester can provide the following information:

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

List of errors

Rpm sensor	Signal not correct (open circuit) Loss of synchronism (implausible signal)
Butterfly potentiometer	Track 1 defective - Track 2 defective - Synchronism error between the tracks
Air temperature sensor	C.A.-C.C.
Coolant temperature sensor	C.A.-C.C.- False contact - Implausible signal
Lambda sensor	C.A.-C.C.- Limits reached for Lambda integrator and automatic adjustment factor
Idle speed actuator	C.A.-C.C.
Control unit	Control unit memory irregularities are signalled
Detonation sensor	C.A.-C.C.
Fiat CODE	Code not recognized or not received

Parameters displayed

Engine rpm
Injection time
Intake air temperature
Coolant temperature
Butterfly valve opening angle (angle track 1, angle track 2, normalized angle and ratio between the tracks)
Lambda sensor (state, value of integrator, auto-adjustment factor and sensor voltage signal)
Fiat CODE (state byte)

Active diagnosis

The following tests can be carried out using the Fiat/Lancia Tester:
- Injector
- Fuel vapour cut out solenoid valve
- Rev counter
- Idle speed actuator
- Cancelling errors.

Recovery

In the case of failures at the sensors, the control unit replaces the value transmitted by the sensor with a so-called Recovery value which, according to the different irregularities, is stored in the control unit memory or is specially constructed using other available information, in order to allow the vehicle to reach a service centre.

This value is also transmitted to the Fiat/Lancia Tester, therefore during the fault diagnosis it is a good idea to bear in mind that if there are problems, the Fiat/Lancia Tester signals the error for the sensor involved and the Recovery value appears on the display.

Permanent memory

The control unit is equipped with a «permanent» type memory, i.e. it keeps a record of the error even if the cause no longer exists and the ignition is turned to the OFF position; and a «volatile» type memory (RAM) where the information is lost as soon as the cause of the error disappears.

This also makes it possible to identify occasional errors more effectively.

Before ending the fault diagnosis, the contents of the «permanent» memory should be cancelled using the Fiat/Lancia Tester in Active diagnosis.

If this is not the case, when the Fiat/Lancia Tester is reconnected, the errors already examined will be signalled.

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