WEBER-MARELLI 18FD M.P.I. INTEGRATED INJECTION/IGNITION SYSTEM

Foreword

The Weber-Marelli I.A.W. 18FD system fitted on the Fire 16v engine, belongs to the semi-sequential intermittent type electronic fuel injection systems integrated with static advance, digital, electronoic ignition systems, where the injectors are operated in pairs every T.D.C.

GENERAL DESCRIPTION OF THE SYSTEM

The smooth operation of a petrol engine requires the mixture strength (air/fuel weight ratio) to be kept constant for all operating speeds without being affected by the variations in the coolant temperature, intake air and absolute pressure according to the operating conditions.

The quantity of fuel to be injected is therefore directly proportional to the quantity of air drawn in by the engine and, in effect, it is this parameter that the system takes as a reference to implement the injector opening time.

The fuel is injected in FULL-GROUP during the initial stages, in other words for each revolution of the engine the injectors are operated simultaneously, then once the system is synchronized, the fuel is injected semi-sequentially, i.e. for each pair of cylinders at a time established similarly to the firing order.

In this system the stoichiometric metering (= air/petrol weight ratio = 14.7) is also kept constant by means of a Lambda sensor which, by continuously analyzing the quantity of oxygen in the exhaust gases, enables the electronic control unit for the system to constantly correct the quantity of fuel to be injected so that the stoichiometric metering is achieved in the desired operating range.

This injection system is known as the **"angular engine rotation speed - intake air density - mixture control" type, more commonly referred to as Speed-Density-Lambda.**

The inductive discharge ignition is completely static, in other words there is no distributor, with the power module transferred inside the injection/ignition control unit. The ignition system consists of two coils with high tension twin outlet terminals connected directly to the spark plugs (1-4 and 2-3).

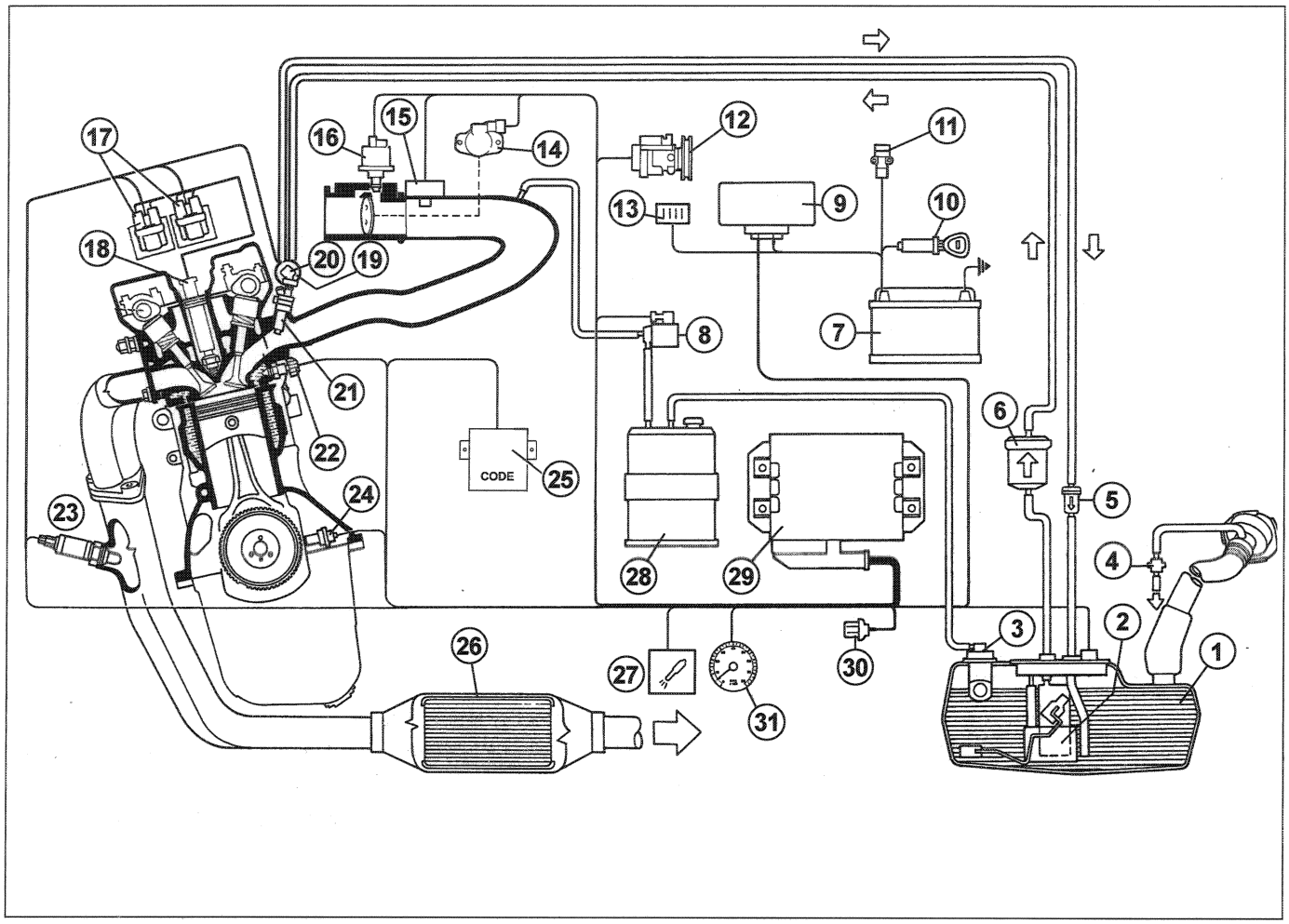
The primary winding for each coil is connected to both the power relay (therefore supplied by the battery voltage) and to terminals 1 and 19 (respectively) of the injection/ignition control unit. The latter controls the supply of the coils calculating the moment to establish internal earth contact for the time required to supply the coils by means of information from the sensors.

The optimum advance for the ignition system is calculated by the control unit on the basis of the engine operating speed and the value of the absolute pressure in the inlet manifold and is then implemented taking into account the time required for charging the ignition coil.

Given the closing characteristics of the secondary circuit (spark plugs in series), the high tension destined to supply the spark plugs will differ in intensity. This is due to the fact that one of the two spark plugs supplied is alternately in a high pressure ambient (compression stroke) whilst the other one is in a low pressure ambient (exhaust stroke).

The current, having to overcome a greater dielectric in the spark plug which is in the compression stroke, creates a more powerful spark, whilst in the other one it is insignificant.

DIAGRAM SHOWING OPERATION OF INJECTION/IGNITION SYSTEM



P3M02LJ01

1. Fuel tank
2. Electric fuel pump
3. Multi-purpose valve
4. Safety valve
5. Flow valve
6. Fuel filter
7. Battery
8. Fuel vapour cut out solenoid valve
9. Twin relay
10. Ignition switch
11. Inertia switch
12. Air conditioning system
13. Protective fuse
14. Butterfly valve position sensor
15. Air pressure and temperature sensor
16. Engine idle speed actuator
17. Ignition coils
18. Spark plugs
19. Fuel supply manifold
20. Fuel pressure regulator
21. Injectors
22. Coolant temperature sensor
23. Lambda sensor
24. Rpm and T.D.C. sensor
25. Fiat CODE control unit
26. Catalytic silencer
27. System failure warning light
28. Active charcoal filter
29. Injection/ignition electronic control unit
30. Diagnostic socket
31. Rev counter

FUNCTIONS OF THE SYSTEM

The management programme (software) is inside the control unit memory; it comprises a series of strategies, each of which manages a precise function of the system.

The main functions carried out by the injection/ignition system are:
- adjustment of the injection times;
- controlling the ignition advance;
- controlling and managing the idle speed;
- controlling cold starting;
- butterfly transition;
- deceleration control (cut-off);
- control of acceleration and full power;
- limiting the maximum number of revs;
- controlling combustion via the Lambda sensor;
- self-adjustment of the system;
- checking fuel vapour recirculation;
- connection with the climate control system;
- connection with the engine immobilizer device (CODE);
- autodiagnosis.

Adjustment of the injection times

In addition to electronically controlling the moment of ignition, in order to allow the smooth operation of the engine as the environment parameters and loads applied vary, the control unit must control and adjust the injection so that the stoichiometric (air/fuel) ratio is always within the optimum value.

Taking the physical characteristics of the fuel (viscosity and density) and the pressure of the fuel in the inlet manifold as constant, the quantity of fuel injected only depends on the "opening time" of the injectors.

This time is calculated by processing the different engine operating parameters which are listed below:

1. First of all a basic injection time is calculated using one and two dimension maps whose input parameters are the engine rotation angular speed and the pressure value in the inlet manifold.
2. The figure obtained in this way is corrected on the basis of the air intake temperature according to a table in the control unit and on the basis of the battery voltage.
3. The figure calculated in this way is finally corrected using the information from the Lambda sensor in order to keep the mixture strength at the correct stoichiometric value.

Controlling the ignition advance

The electronic control unit also processes the static advance electronic ignition operating strategy.

The optimum advance angle is calculated in this way:

1. A basic advance angle is calculated using a map stored in the memory whose input paraameters are the angular rotation speed of the engine and the absolute pressure measured in the inlet manifold. In idle and full load conditions, two distinct one dimension tables are used according to the engine speed.

2. The figures obtained in this way are added to the correction of the coolant temperature for the entire period that the engine is warming up after cold starting.
3. The idle figure in the table is further corrected if there is a sudden drop in the idle speed (for example after a consumer is switched on).
4. In the case of deceleration and the consequent cut-off action, a subtraction is made.
5. The advance angle figure is also subject to correction in the following conditions:
   - butterfly transition;
   - return from cut-off for butterfly transition;
   - return from cut-off from engine idle speed level.

Controlling and managing engine idle speed

The adjustment of the idle speed is carried out in all operating conditions by means of the idle actuator which acts on the butterfly by-pass.

In addition to controlling the actual idle speed it also carries out the functions of a supplementary air valve and idle regulator when the various consumers are switched on (e.g. the climate control compressor); with the butterfly in the end of travel position, in effect, the actuator regulates the by-pass port compensating for the power required by the consumers in order to ensure that the idle speed is as constant as possible around the value of 860 ± 50 rpm.

The actuator fitted on this version guarantees a high degree of responsiveness during the adjustment in that the opening and closing of the by-pass are both operated by magnetic windings.

The idle is correct by means of an electronic control unit through the use of error management algorhythms in relation to the speeds memorized.

The following operations are carried out:

- **During idling:** comparison of the actual rotation speed and the ideal speed stored in the memory depending on the value of the coolant temperature and intervention (control of by-pass port, injection time and advance angle) in order to obtain a shift value which is as close as possible to zero.
- **During starting:** controlling the quantity of air drawn in by the engine during starting through the position of the shutter (and consequently the useful section of the by-pass port) according to the coolant temperature and whether or not the climate control is switched on.
- **During release:** there are two strategies during this stage:

1. One negative strategy to decrease the quantity of fuel required by the engine (less consumption). This stage is recognized by the control unit when the butterfly potentiometer signal undergoes negative variations.
2. One dash-pot strategy to lessen the variation of the negative torque (less engine braking and less pollution). This strategy is implemented when the potentiometer signal indicates the butterfly is idling and the speed is high, conseuently the stepping motor gradually decreases the air flow rate passing through the by-pass.

Controlling cold starting

In these circumstances the mixture is naturally weakened as a result of the poor turbulence of the fuel particles at low temperatures and reduced evaporation and condensation on the internal walls of the inlet manifold, all of which is exacerbated by the increased viscosity of the lubrication oil.

The electronic control unit recognizes this condition and corrects the injection time on the basis of the following parameters:

- engine coolant temperature;
- intake air temperature;
- battery voltage (only for the starting stage).

Butterfly tranistion (i.e. butterfly opening speed)

The butterfly angle and the load variation requested by the engine are used in calculating the injection time with the usual corrections according to the engine coolant temperature and intake air.

Controlling deceleration (cut-off)

The cut-off strategy is implemented when the control unit recognizes the butterfly valve in a closed position (signal from the butterfly potentiometer).

The recognition of the butterfly valve in a non closed position re-enables the engine supply.

Controlling acceleration and full power (operation in full load conditions)

In full load conditions the basic injection time must be increased to obtain maximum engine power.

Full load conditions are detected by the control unit by means of the figures supplied by the butterfly position and absolute pressure sensors.

On the basis of this information, the injection/ignition electronic control unit implements the appropriate correction, increasing the basic injection time by 10% and disabling the control of the Lambda sensor if it is recognized as active.

Limiting the maximum number of revs (protection outside revs)

When the engine rotation speed exceeds the figure of 6900 rpm set by the manufacturer, the power unit finds itself in "critical" operating conditions.

When the electronic control unit recognizes that this limit has been exceeded, it implements a reduction in the injector operating times and a reduction in the ignition advance.

When the speed returns to a non critical value, normal management of the system is restored.

Controlling combustion - Lambda sensor

The Lambda sensor informs the control unit of the quantity of oxygen present in the exhaust and consequently the correct air/fuel metering.

The optimum mixture corresponds to a Lambda coefficient of1 (optimum stoichiometric mixture). The electric signal which the sensor sends to the control unit varies sharply precisely when the composition of the mixture changes from Lambda=1.
When the mixture is "poor" (Lambda »1), the control unit increases the quantity of fuel; when the mixture is "rich" (Lambda «1) it decreases it: in this way the engine operates as close as possible to the ideal Lambda value.

The engine carburation can therefore be regulated with precision through this sensor. This makes it possible, amongst other things, to operate within the limits concerning emissions.

Fuel pump relay management

The injectors, the fuel pump, the anti-evaporation solenoid valve and the Lambda sensor heater receive current from the fuel pump relay which is operated by the injection/ignition electronic control unit with the ignition switch in the ON position.

If there is no signal from the rpm sensor, the electronic control unit deactivates the control of the relay.

This operation is immediately reactivated as soon as, on starting up the engine, the signal arrives from the rpm sensor.

If, as a result of a fault, the fuel pump relay is not operated, the engine cannot be started up.

Connection with 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. In order to avoid this problem the control unit adjusts the air flow rate to the new power requirements, operating the appropriate actuator (the adjustment also takes place in usage conditions to maintain optimum driveability). Another function of the system is to momentarily interrupt the compressor supply if the engine power requirements are high (strong acceleration).

The compressor is switched off if the temperature of the engine coolant exceeds 120 °C and is only reactivated if the temperature returns below this figure.

Connection with the engine immobilizer device

In order to improve protection against theft attempts, the vehicle is equipped with an engine immobilizer device (CODE) which only allows the injection/ignition control unit to be activated via an electronic code.

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

A special two direction serial line allows the exchange of information between the injection/ignition control unit and the CODE control unit.

If there is a failure in the CODE system it is still possible to start up the vehicle using special emergency procedures.

It is absolutely forbidden to exchange injection control units between different vehicles in order to check whether they are working or not.

During the fault diagnosis, before replacing the control unit, make sure that the component being exmained is really not working properly, because when a new control unit is supplied the secret code is memorized making it impossible to use it on any other vehicles.

Fuel vapour inlet (anti-evaporation solenoid valve)

This function controls the opening of the fuel vapour inlet valve as follows:

- the solenoid valve remains closed during the starting stage, preventing the fuel vapours from excessively enriching the mixture; this condition persists until the engine coolant reaches a certain temperature.
- with the engine at operating temperature, the electronic control unit sends a square wave signal to the solenoid valve (duty-cycle operation) which modulates the opening.

The aim of this function is to wash the canister sufficiently without disturbing the operation of the engine (for example increase in harmful emissions, driving defects as the result of rapid variations in the mixture strength, decrease in the idle speed on account of an increase in the supplementary air flow rate or mixture strength etc.).

The control unit establishes the solenoid valve opening time taking the following parameters into account:

- the injection time cannot go below a minimum time;
- the quantity of air during idling should be compatible with the control of the engine revs.
- in open-loop conditions the quantity of fuel supplied via the canister cannot be managed with certainty so it should therefore be limited;
- the start of the scavenging should be slow and gradual.

The vapour inlet function (canister scavenging) communicates with other functions in the following way:
- it receives the average mixture strength to "learn" the hydrocarbons contained in the canister;
- it receives information from the fuel control that the injection time implemented is the minimum possible;
- it indicates the equivalents steps to the idle speed actuator to compensate for the quantity of vapours drawn in by the canister;
- it indicates the quantity of vapours supplied via the canister to the fuel control.

System connections to earth

The wiring for the injection/ignition system is connected to an earth point on the engine. The earth for the electronic control unit electronic circuits and the earths for the various system components are connected at this point. The electronic control unit, in turn, is connected to earth through the fixing bolts.

Corrosion at these earth points and poor connections to earth for the cables could cause operating defects.

Self-adjustment of the system

The control unit is equipped with a self-adjusting function which has the task of recognizing thechanges which take place in the engine due to bedding in over a period oftime and ageing of both the components and the engine itself.

These changes are memorized in the form of modifications tothe basic map and are designed to adapt the operation of the system to the gradual alterations to the engine and components compared with when they are new.

The self-adjustment parameters "learnt" by the control unit are used in all operating conditions because they correspond to derivations from the engine or the system.

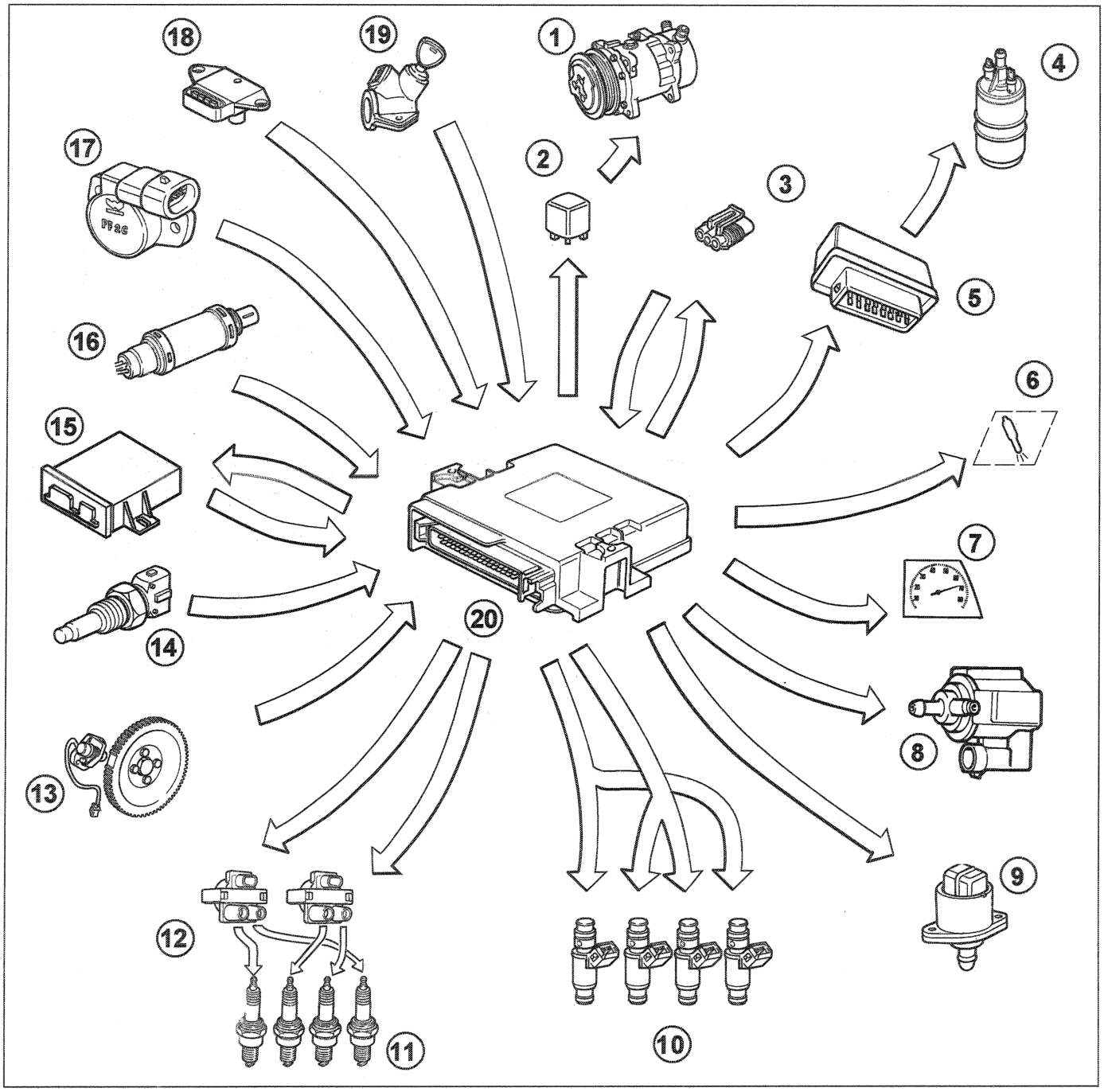
Updating, on the other hand, can only take place if a series of conditions exists: authorization of the calibrated strategies, engine at operating temperature, operating conditions established for a certain length of time, derivation from average value of mixture strength correction ...

Once the update conditions for a self-adjustment parameter have occurred, the difference between the average actual value for the mixture strength coefficient and the theoretical value (i.e. the centre band value in the case of a stoichiometric target figure) is evaluted.

A significant difference means that the open-loop calibration is not centered and therefore the self-adjustment parameter for the updating area identified should be increased or decreased by a step proportional to the dispersion.

The parameters "learnt" by the control unit should satisfy the continuity function: after a "gain or offset" update the difference between the self-adjustment paramters in 2 adjacent rpm bands should not be too great. If necssary, the adjacent parameter should also be updated.

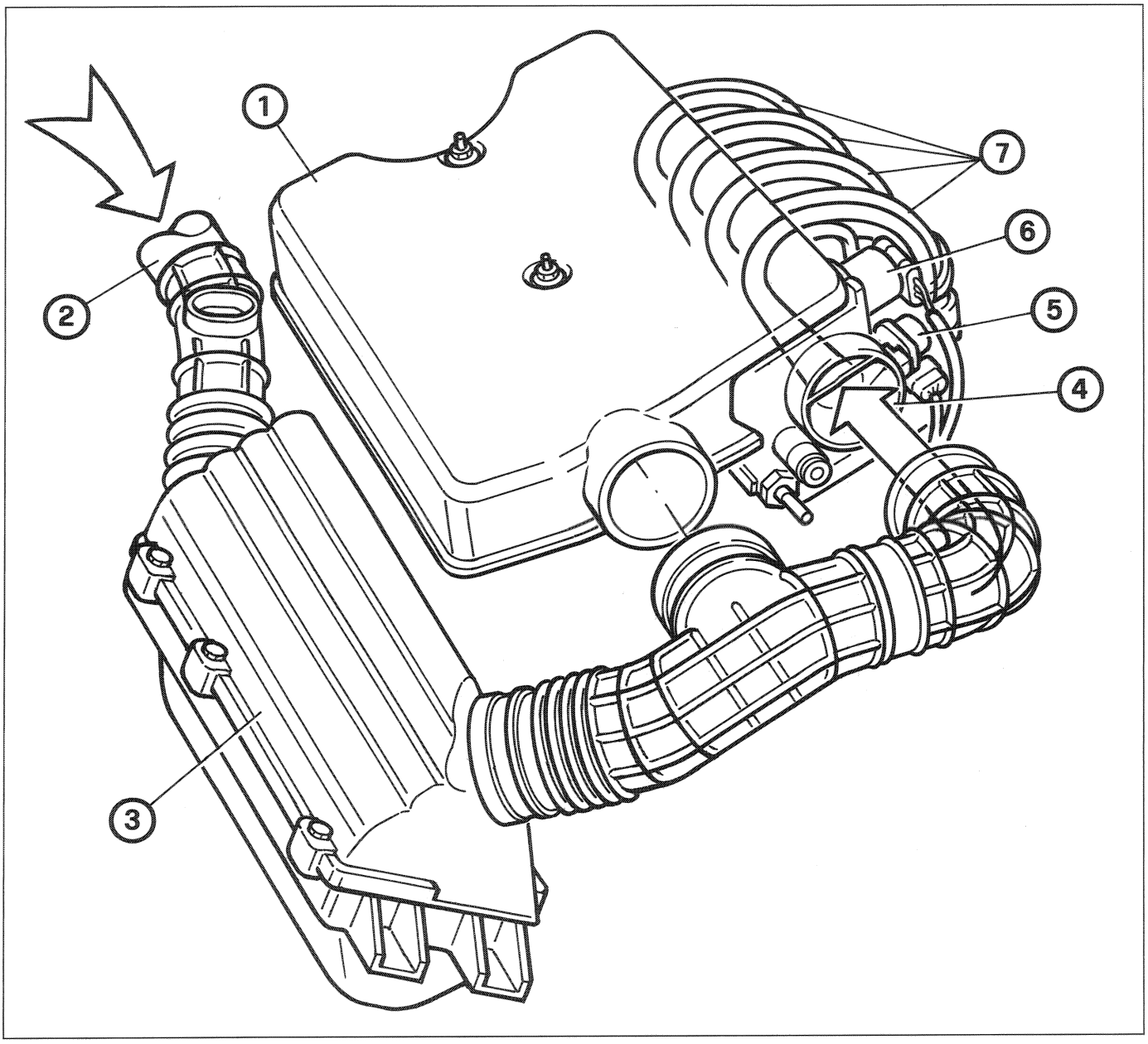
DIAGRAM SHOWING INFORMATION ARRIVING AT AND LEAVING THE INJECTION/IGNITION SYSTEM CONTROL UNIT AND SENSORS/ACTUATORS



P3M08LJ01

1. Climate control system
2. Climate control system relay
3. Diagnostic socket
4. Electric fuel pump
5. Twin relay
6. System failure warning light
7. Rev counter
8. Petrol vapour recirculation solenoid valve
9. Engine idle speed adjustment actuator
10. Injectors
11. Spark plugs
12. Ignition coils
13. Rpm and T.D.C. sensor
14. Coolant temperature sensor
15. Fiat CODE control unit
16. Lambda sensor
17. Butterfly valve position sensor
18. Intake air pressure and temperature sensor
19. Ignition switch
20. Injection/ignition electronic control unit

DIGRAM SHOWING AIR INTAKE CIRCUIT

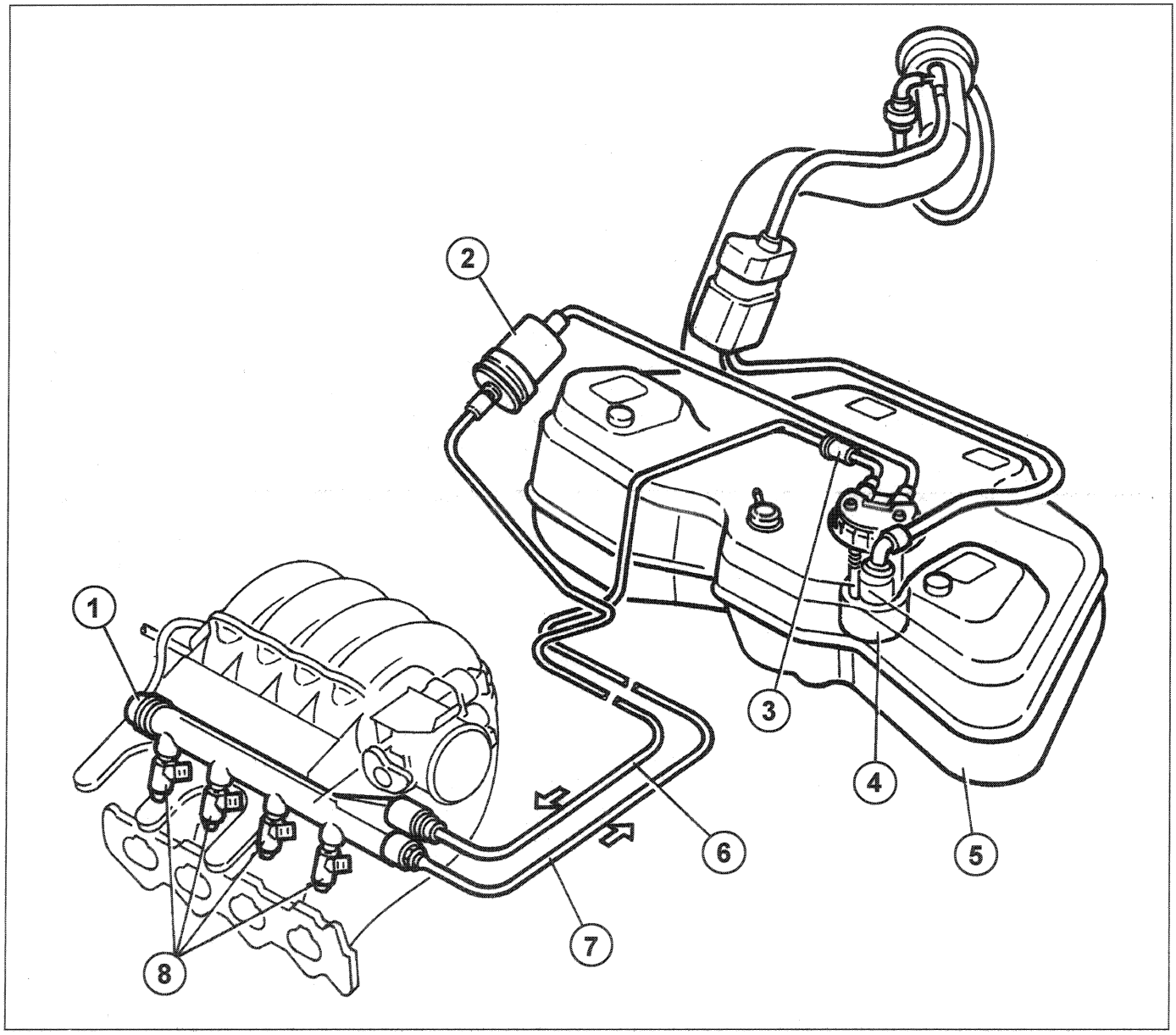


P3M09LJ01

This is made up of various components which ensure that the necessary air flow rate is directed to the engine in all operating conditions

1. Resonator
2. Inlet vent
3. Air filter
4. Butterfly valve
5. Butterfly valve position sensor
6. Engine idle speed adjustment actuator (stepping motor)
7. Inlet manifold

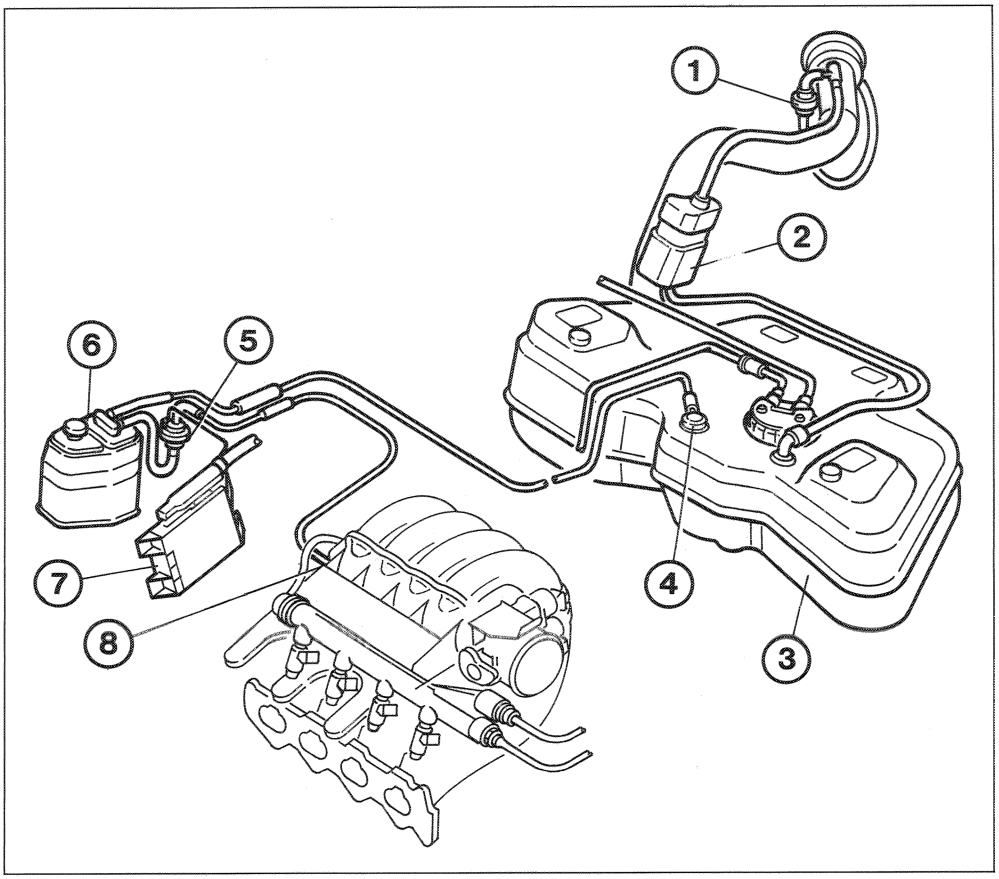
DIAGRAM SHOWING FUEL SUPPLY CIRCUIT



P3M10LJ01

1. Fuel pressure regulator
2. Main fuel filter on supply line
3. Single-acting valve
4. Electric pump immersed in the tank
5. Tank
6. Supply line
7. Return line
8. Injectors

DIAGRAM SHOWING ANTI-EVAPORATION CIRCUIT AND FUEL VAPOUR RECIRCULATION

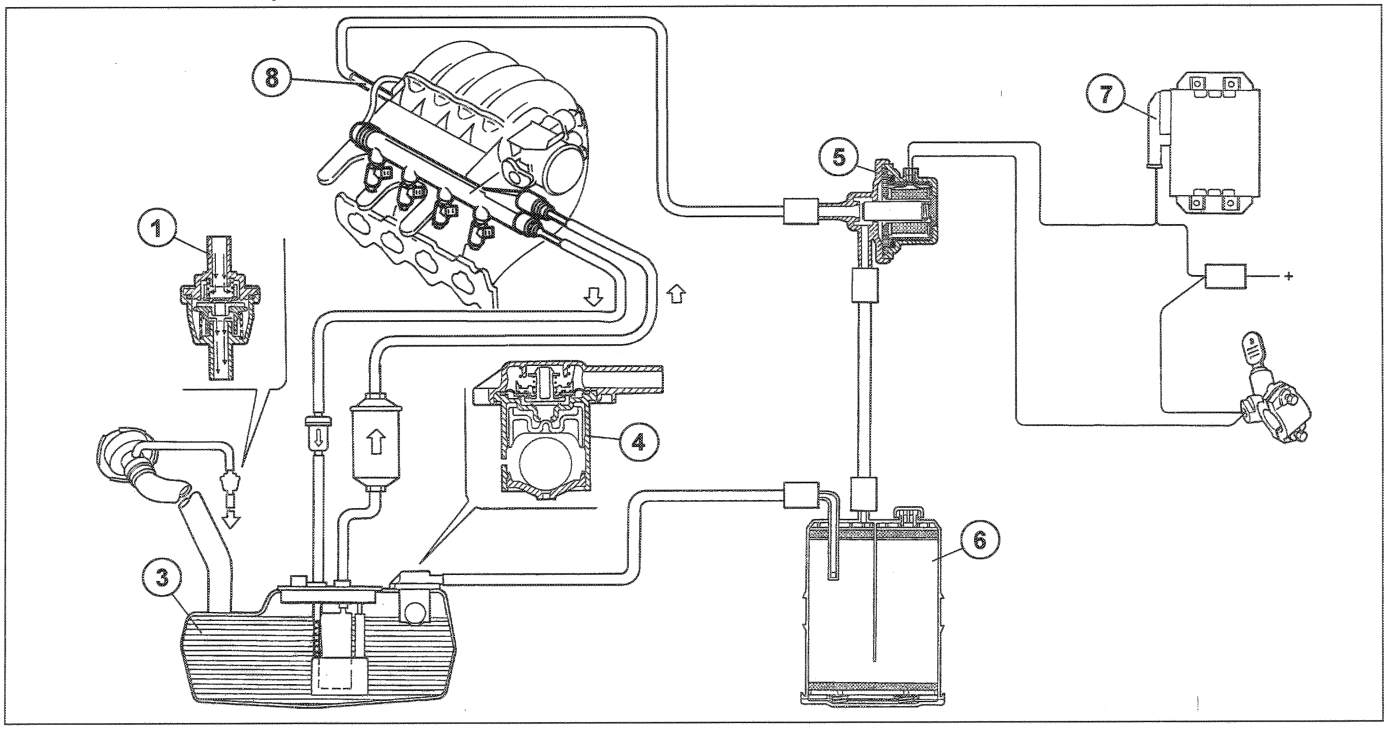


P3M11LJ01

1. Two way safety valve
2. Expansion tank
3. Fuel tank (with filler cap without aeration)
4. Multi-purpose valve
5. Fuel vapour cut out solenoid valve
6. Active charcoal filter
7. Injection/ignition control unit
8. Intake on inlet manifold

This system is designed to prevent the fuel vapours, composed of the lighest fractions of hydrocarbons which basically form in the tank, from being discharged into the atmosphere.

NOTE *The operation of system and its components is the same as the description in chapter 10 for the 1242 fuel system.*



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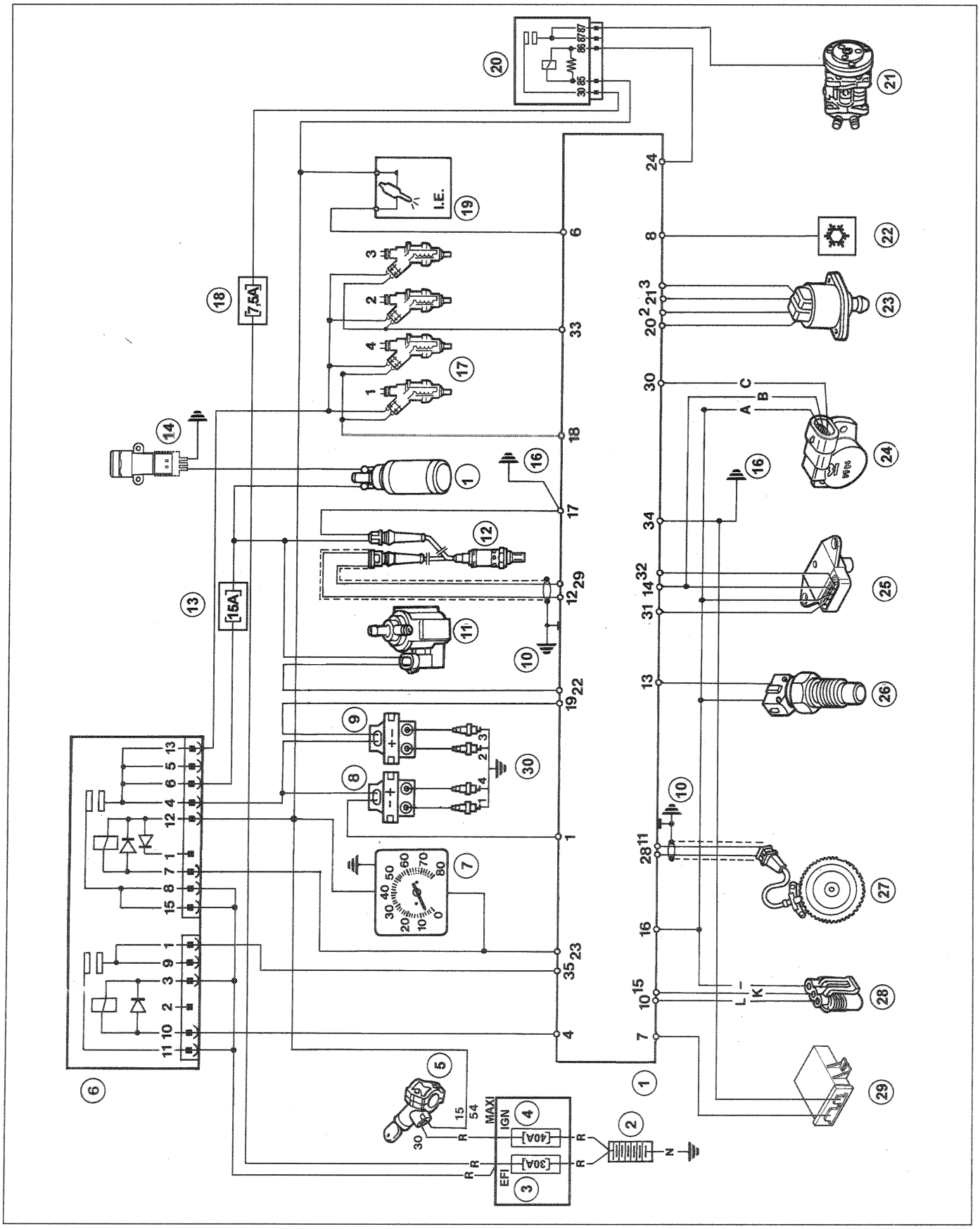
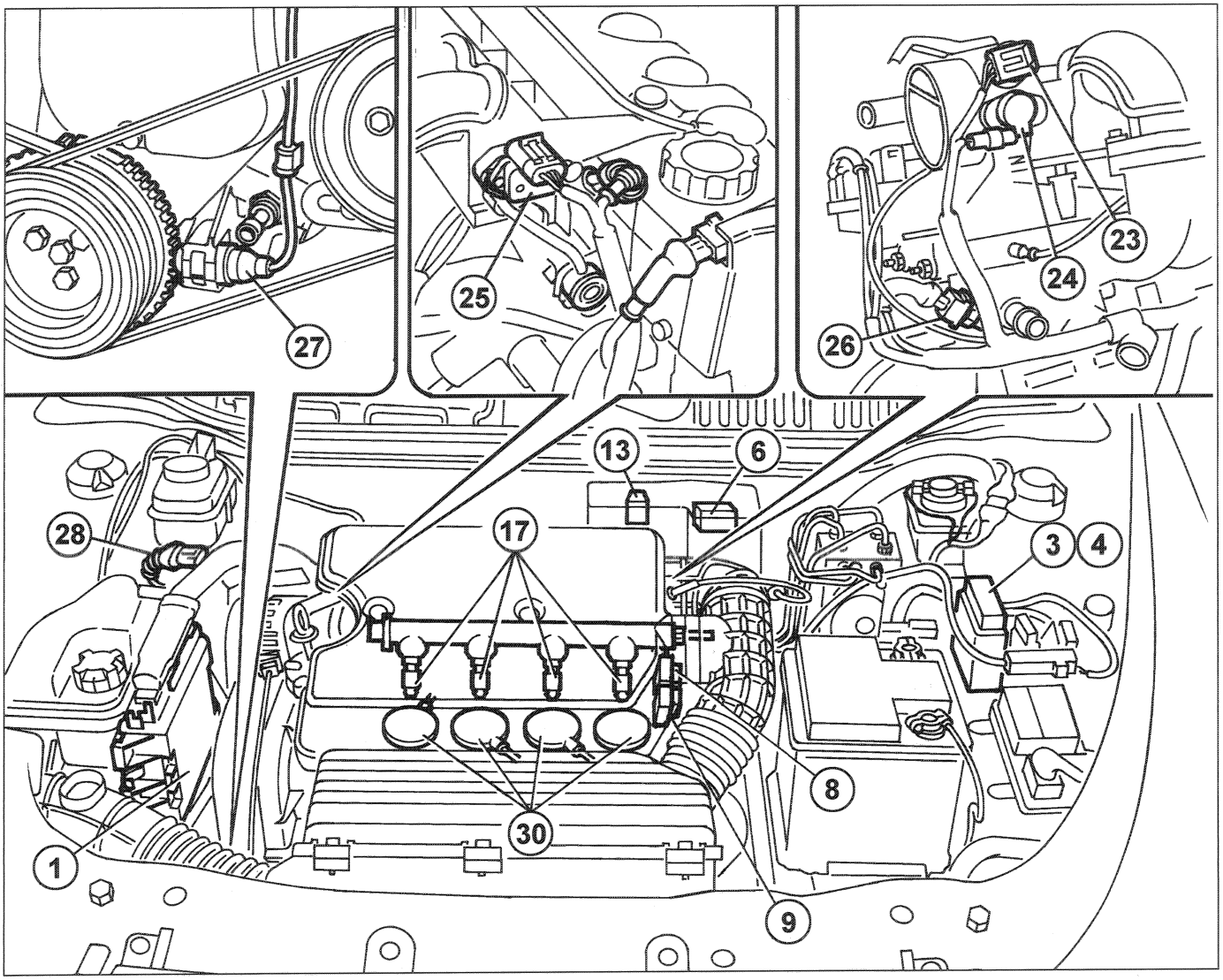
INJECTION/IGNITION SYSTEM WIRING DIAGRAM

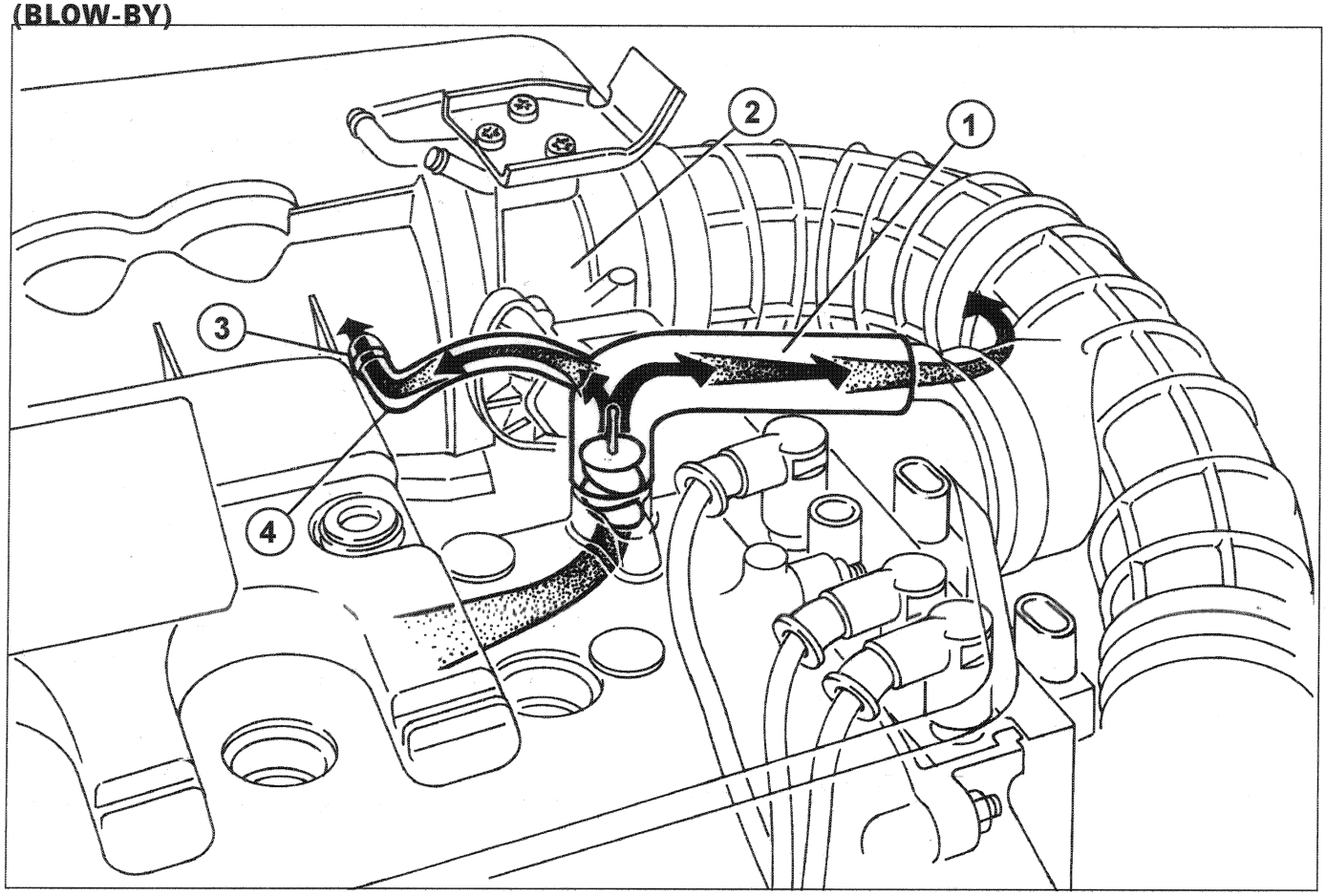


LOCATION OF COMPONENTS IN ENGINE COMPARTMENT



1. Injection/ignition control unit
2. Battery
3. Injection/ignition system 30A general protective fuse
4. 40A general fuse protecting consumers controlled by ignition
5. Ignition switch
6. Twin relay
7. Rev counter
8. Ignition coil for cylinders 1-4
9. Ignition coil for cylinders 2-3
10. Chassis earth
11. Anti-evaporation solenoid valve
12. Lambda sensor
13. 15A fuse protecting electric fuel pump, Lambda sensor and anti-evaporation solenoid valve
14. Inertia switch
15. Electric fuel pump
16. Earth on engine
17. Injectors
18. 7.5A fuse protecting compressor electro-magnet coupling
19. System failure warning light
20. Air conditioning compressor relay
21. Air conditioning compressor
22. Requested engagement of air conditioning system
23. Engine idle speed actuator
24. Butterfly valve position sensor
25. Intake air pressure and temperature sensor
26. Coolant temperature sensor
27. Rpm and T.D.C. sensor
28. Diagnostic socket
29. Fiat CODE control unit
30. Spark plugs

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



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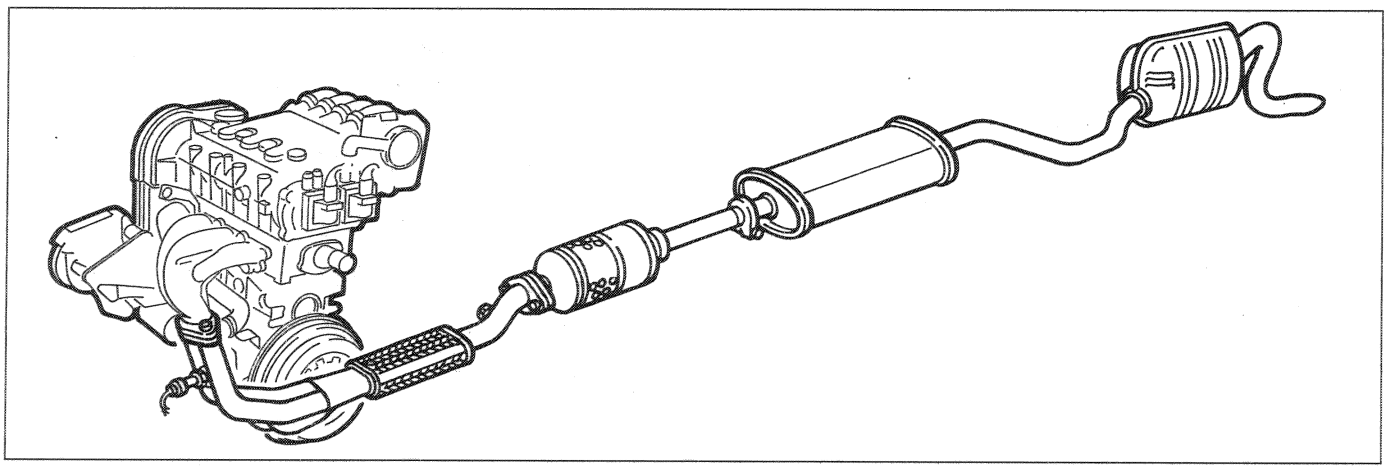
This system controls the emissions, from the engine crankcase, of breather gases made up of air/petrol mixtures and burnt gases which escape from the piston seals, in addition to lubricant oil vapours, recirculating them to the inlet.

With the accelerator butterfly open, the gases from the upper cover reach the main air inlet pipe through pipe (1) inside of which there is a spark out to prevent the phenomenon of combustion due to flame returns from the butterfly casing (2).

With the accelerator butterfly closed (engine idling), the vacuum in the inlet manifold draws in the gases (in limited quantities) directly through the small pipe (4) and the calibrated port (3).

ENGINE EXHAUST ASSEMBLY DIAGRAM



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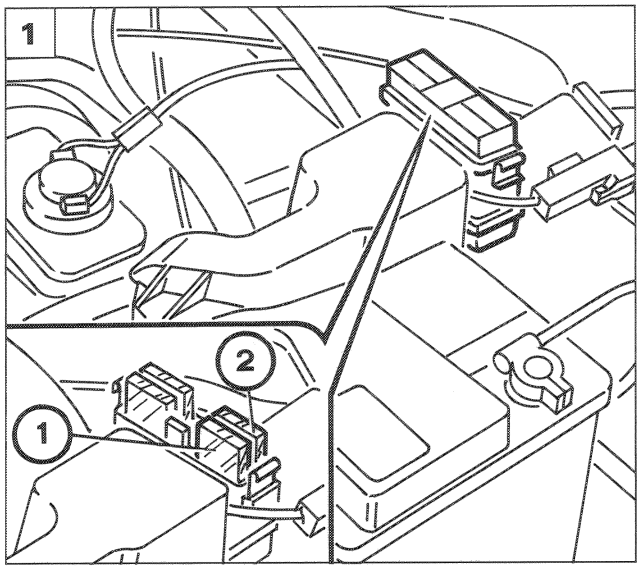
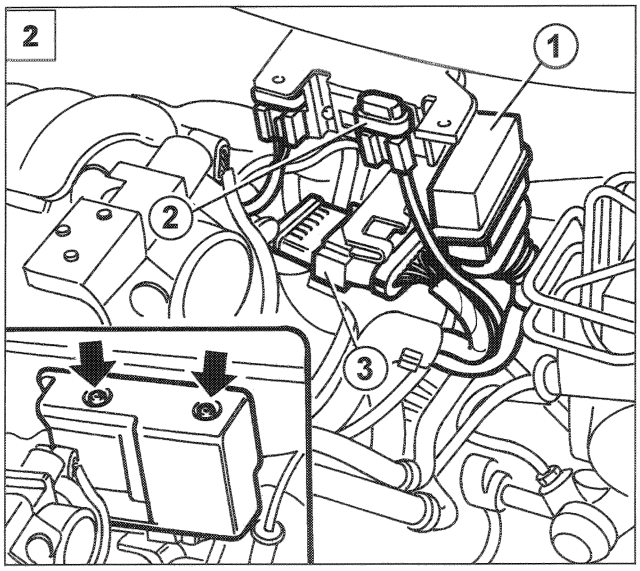


P3M15LJ01



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INJECTION/IGNITION SYSTEM FUSES AND RELAYS

1. General system protective fuses

The general injection/ignition system protective fuses are housed in the engine compartment in a container; to gain access to them, remove the cover releasing it from the side clips.

1) Injection/ignition system 30A protective fuse.
2) 40A fuse protecting consumers controlled by the ignition.

2. Fuses and relays

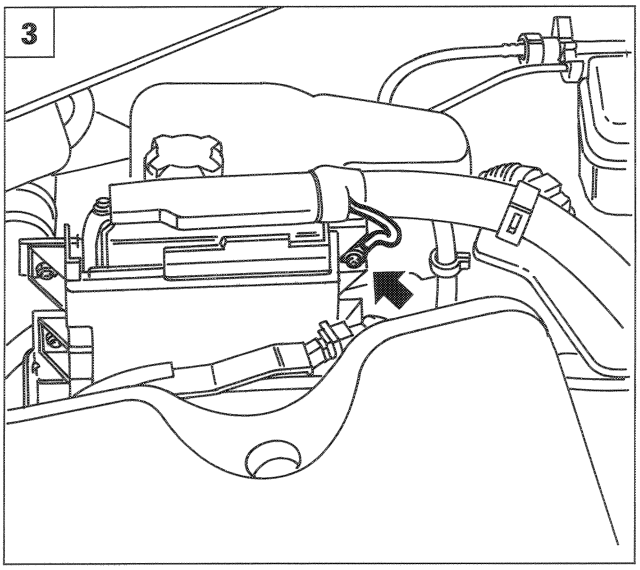
The following components are housed in the engine compartment on a bracket against the rear wall:

1) Twin relay.
2) 15A fuse protecting the electric fuel pump, Lambda sensor and anti-evaporation solenoid valve.
3) Front/injection cables coupling.

To gain access to the components listed above, undo the fixing bolts and remove the cover.

EARTH POINTS

3. Earth connection for rpm and T.D.C. sensor and Lambda sensor cable outer casings.
4. Power earth on engine crankcase below the starter motor.



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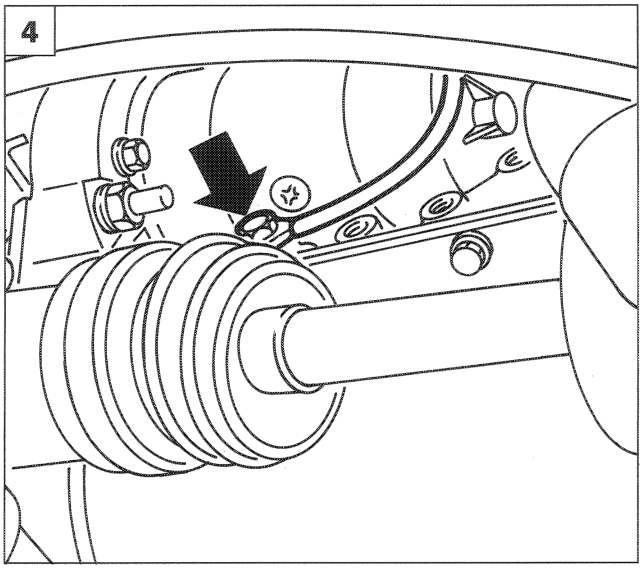

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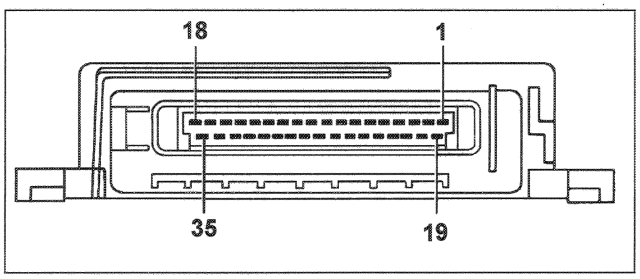
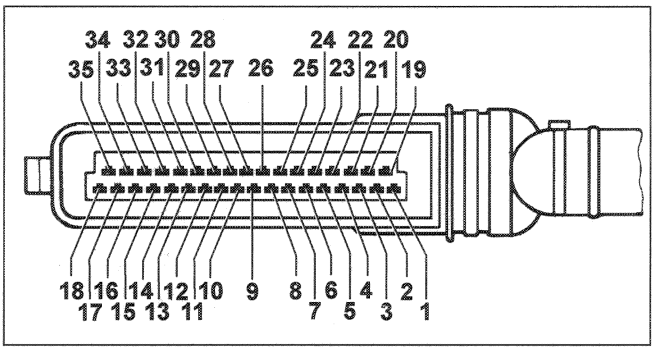
IDENTIFICATION OF CONNECTIONS AT THE CONTROL UNIT (PIN-OUT)

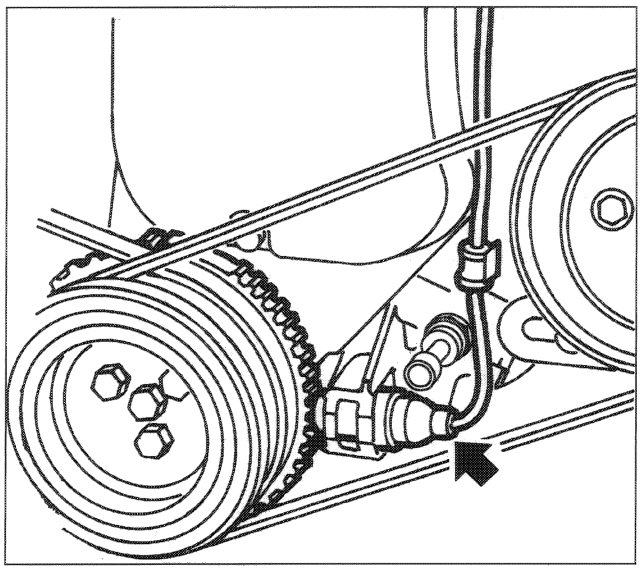


P3M16LJ01



P3M16LJ02

Terminal No.	Information received or transmitted	Terminal No.	Information received or transmitted
	Input signals		**Output signals**
7	CODE	1	Fuel system for primary ignition coil for cylinders 1-4
8	Air conditioning input signal		
10	Serial line L for diagnostic socket	2	Fuel system for stepping motor, phase B
11	Rpm and T.D.C. sensor		
12	Lambda sensor	3	Supply for stepping motor, phase D
13	Coolant temperature sensor	4	Internal earth with electronic safety device for operating twin relay
28	Rpm and T.D.C. sensor		
29	Lambda sensor		
30	Butterfly valve position sensor	6	System failure warning light
31	Intake air temperature signal	14	Supply (+5V) for air pressure and temperature and butterfly valve position sensors
32	Intake air pressure signal		
34	Power earth	15	Serial line K for diagnostic socket
35	12 Volt inlet supply: activating all control unit functions	16	Earth sensors: butterfly valve position, engine coolant, intake air pressure and temperature
		17	Power earth
		18	Operation of injectors 1-4
		19	Supply for primary ignition coil for cylinders 2-3
		20	Supply for stepping motor, phase A
		21	Supply for stepping motor, phase C
		22	Fuel vapour cut out solenoid valve
		23	Signal for electric fuel pump cut out and rev counter operation
		24	Air conditioning relay operation
		33	Operation of injectors 2-3



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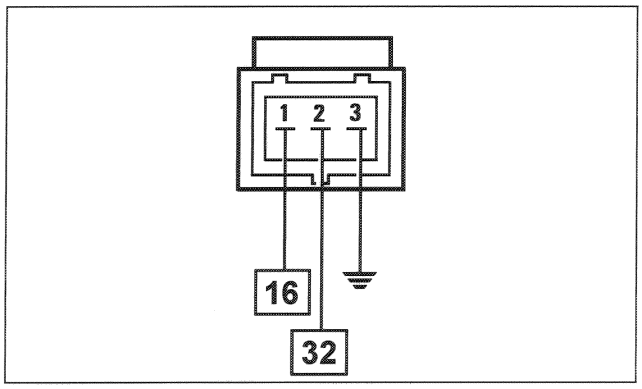
RPM AND T.D.C. SENSOR

This sensor is made up of a variable reluctance and is located in front of a flywheel with 60 teeth.



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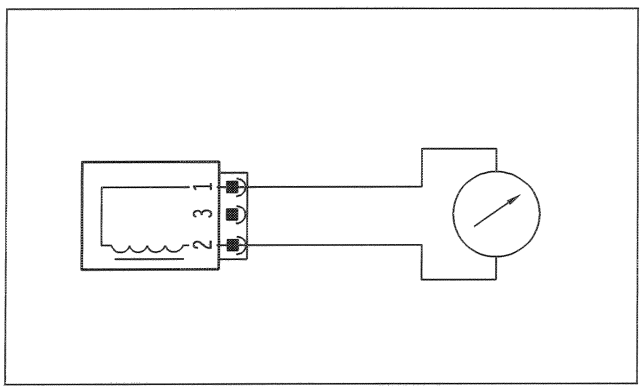
Connector and wiring

The sensor is connected to the control unit (pins 11 and 28) by means of twisted cables covered with an anti-interference outer casing connected to earth.

The numbers in the boxes indicate the corresponding control unit pins.



P3M17LJ03

Checking resistance and gap

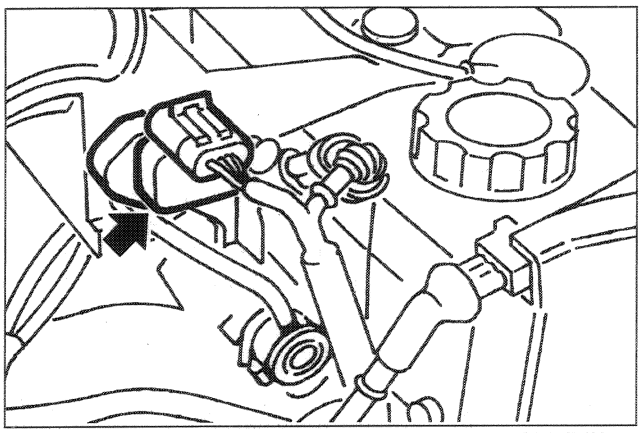
The sensor resistance can be measured by disconnecting the connector and connecting an ohmmeter to the sensor terminals.

Resistance 575 - 750 ohm at 20 °C

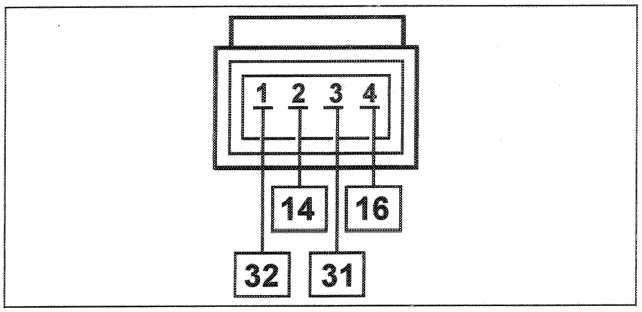
Gap: 0.5 - 1.5 mm

Recovery:

There is no recovery, if the sensor is not working, the vehicle cannot be started up.



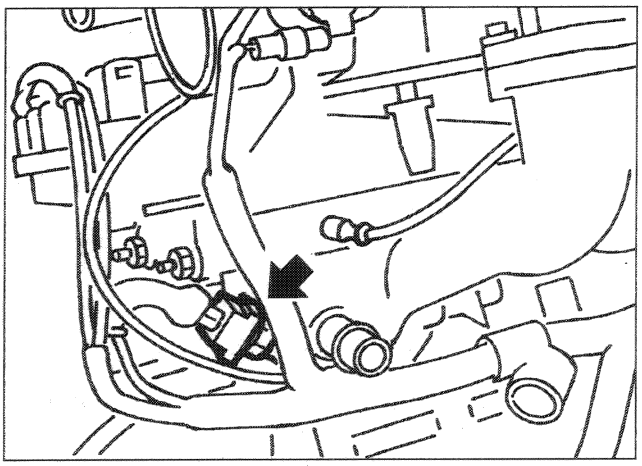
P3M18LJ01



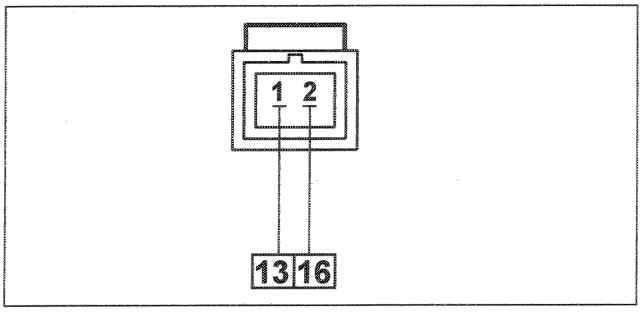
P3M18LJ02

Wiring connector

The numbers indicate the corresponding control unit pins.



P3M18LJ03



P3M18LJ04

Wiring connector

The numbers indicate the corresponding control unit pins.

AIR TEMPERATURE AND PRESSURE SENSOR

The air temperature and pressure sensor is an integrated component which has two functions: one of reading the pressure in the inlet manifold and the other of measuring the temperature of the air inside the inlet manifold. Both pieces on information are used by the injection control unit to define the quantity of air drawn in by the engine; this information is then used to calculate the injection time and the ignition point. The sensor is fitted on the inlet manifold.

Autodiagnosis and alternative function

When the pressure sensor signal starts to fail, the butterfly potentiometer and the rpm signals are used to calculate the injection time; when suitably processed by the M.P.I. control unit, these signals make it possible to reconstruct the missing signal (recovery function).
If the air temperature sensor is broken, the M.P.I. control unit uses a recovery temperature figure of 50 °C stored in its memory and the mixture strength self-adjustment is disabled.

The autodiagnostic function controls the two sensor output signals.
It recognizes the following for both signals:
- Short circuit to earth.
- Short circuit to the positive and reference voltage.
- Open circuit/break.

WATER TEMPERATURE SENSOR

This is an NTC type sensor, i.e. as the temperature increases, the resistance decreases; it is connected to the control unit via the connector shown below at the side.

Electrical features

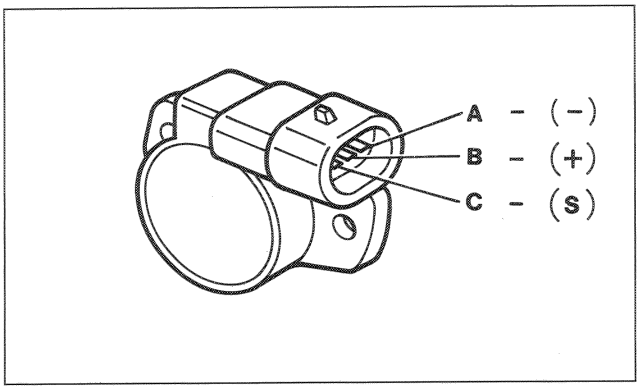
The dynamic characteristics of the sensor can be measured using an ohmmeter and are as follows:

20°C = 3541-3953 ohm
50°C = 1011-1149 ohm
90°C = 252-298 ohm

Recovery

In case of a sensor failure, the control unit activates the following strategies:
Air temperature below 20°C: water temperature = air temperature, with an increase of 10°C/min up to a maximum of 80°C
Air temperature above 20°C: water temperature = 80°C
If the air temperature is faulty: water temperature = 80°C

BUTTERFLY VALVE POSITION SENSOR



P3M19LJ01

A Negative (pin 16)

B Positive (pin 14)

C Signal (pin 30)

This sensor comprises a potentiometer with the moving part operated by the butterfly valve shaft.

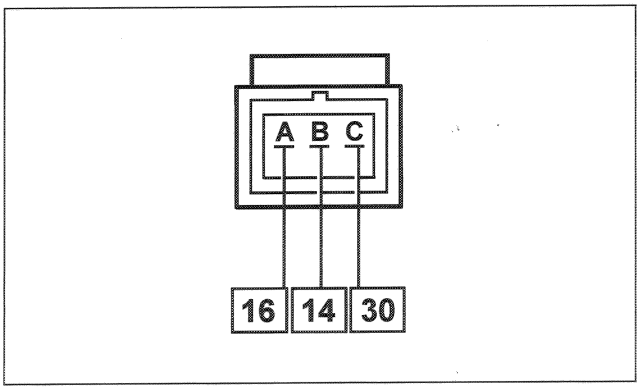
The potentiometer, is the single ramp type and has the following main features:

Useful electric angle 90° ± 2°

Mechanical angle 105° ± 4°

Total mechanical travel 110° ± 8°

Temperature operating range -30°C - +125°C.



P3M19LJ02

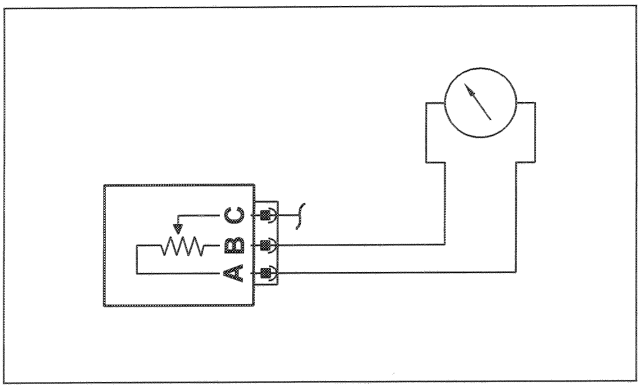
Wiring connector

The numbers indicate the corresponding control unit pins.

Checking the electrical resistance

The sensor resistance can be measured in the following way:

- connect an ohmmeter between pins A and B of the sensor and carry out the checked with a fixed resistance of 1440 ohm;
- then connect the ohmmeter between pins A and C and on opening/closing the butterfly valve, check that the resistance value varies between 960 and 1440 ohm.



P3M19LJ03

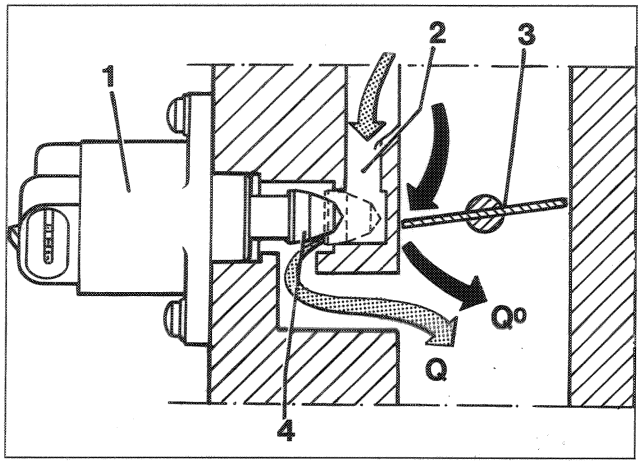
Recovery

An angular value is taken according to the engine speed and pressure relating to the nominal idle speed.

ENGINE IDLE SPEED CONTROL ACTUATOR (MARELLI B20)

In order to obtain this result the system uses a stepping motor (1) fixed to the butterfly casing assissted by the electronic control unit which, when operating, moves a stem with a shutter (4) which alters the section of the by-pass duct (2) and consequently varies the quantitye of air (Q + Qo) drawn in by the engine.

The electronic control unit uses the engine angular speed and coolant temperature parameters from the respective sensors to regulate this type of action.



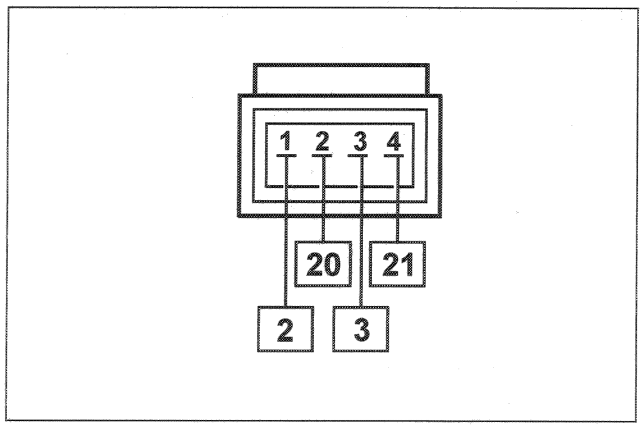
P3M20LJ01

Air flow rate from butterfly (constant) - **Qo**

Air flow rate adjusted by actuator (variable) - **Q**

Diagram showing supplementary air and idle adjustment actuator

1. Stepping motor
2. By-pass duct
3. Butterfly valve
4. Shutter



P3M20LJ02

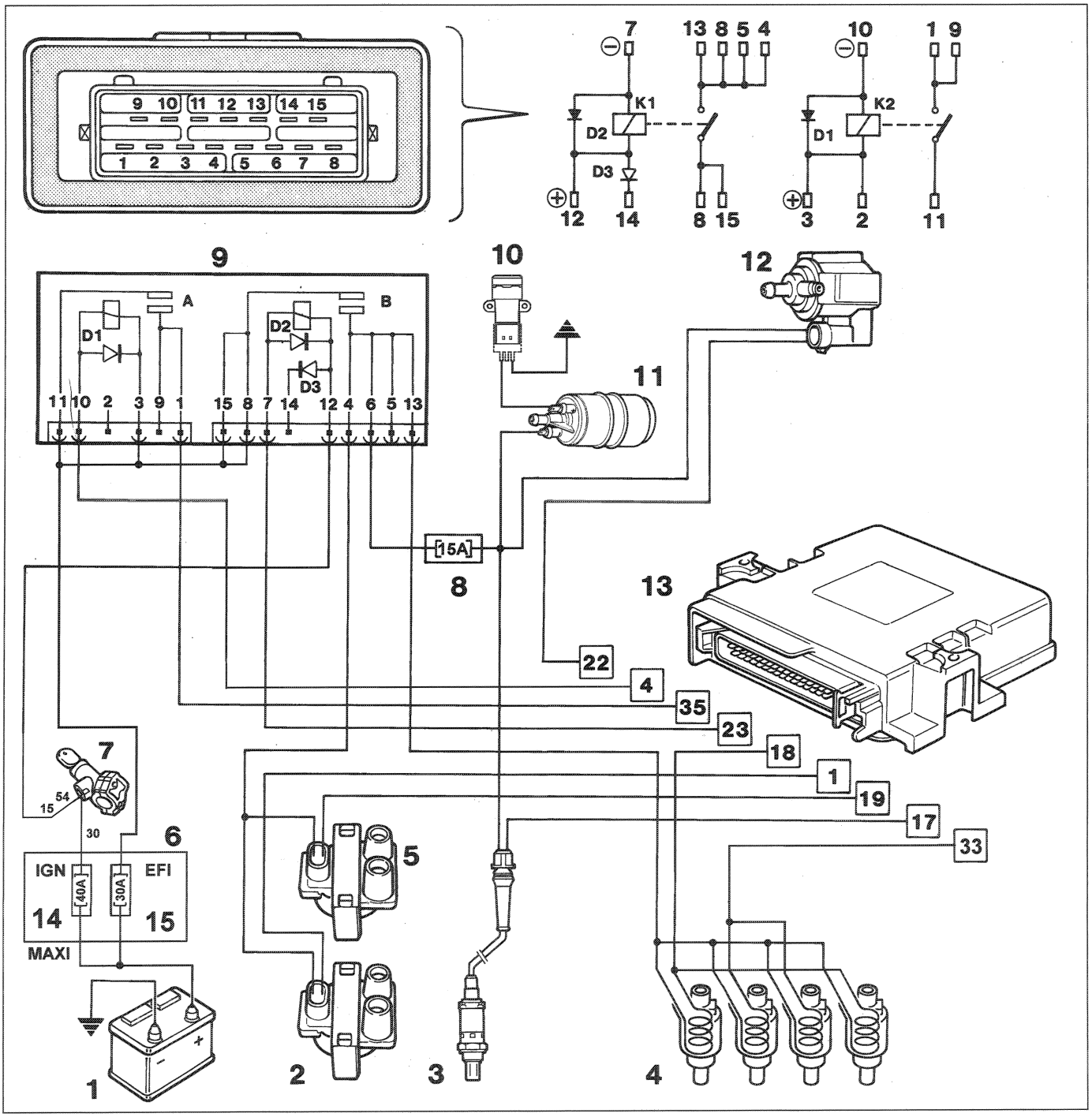
Wiring connector

The numbers indicate the corresponding control unit pins.

Recovery

When the control unit detects that the operating current for one or more motor phases increases beyond a certain value, an error is detected and the operation of the actuator is immediately disabled.

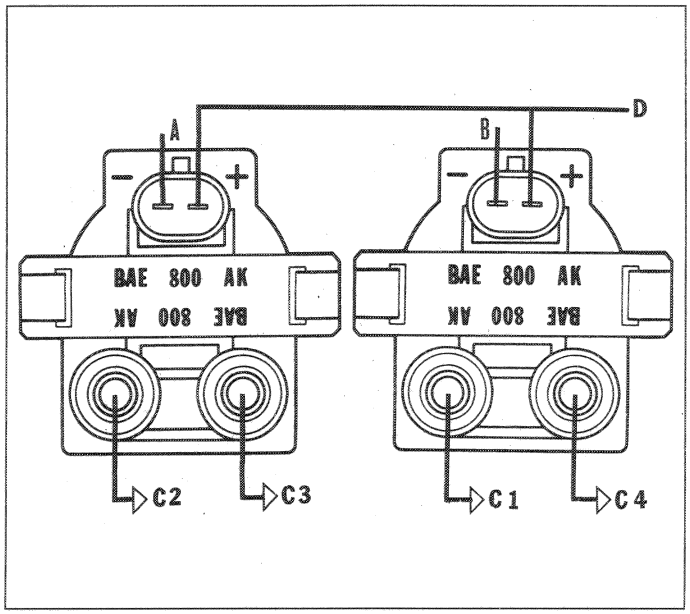
SYSTEM RELAY FEED (NDRS 240-113)



1. Battery
2. Ignition coil for cylinders 1-4
3. Lambda sensor
4. Injectors
5. Ignition coil for cylinders 2-3
6. MAXI-FUSE box
7. Ignition switch
8. 15A protective fuse
9. Twin relay
10. Inertia safety switch
11. Electric fuel pump
12. Anti-evaporation solenoid valve
13. Injection/ignition control unit
14. 40A general fuse protecting consumers controlled by the ignition
15. 30A general fuse protecting injection/ignition system

Recovery

There is no Recovery. If the vehicle will not go, replace the relay.



P3M22LJ01

IGNITION COILS (MARELLI BAE 800 AK)

The ignition system has two twin outlet coils connected directly to the spark plugs for cylinders 1-4 and 2-3.

These coils are operated by the power modules located in the control unit.

A - B Connection to terminals 19 and 1 of the control unit.

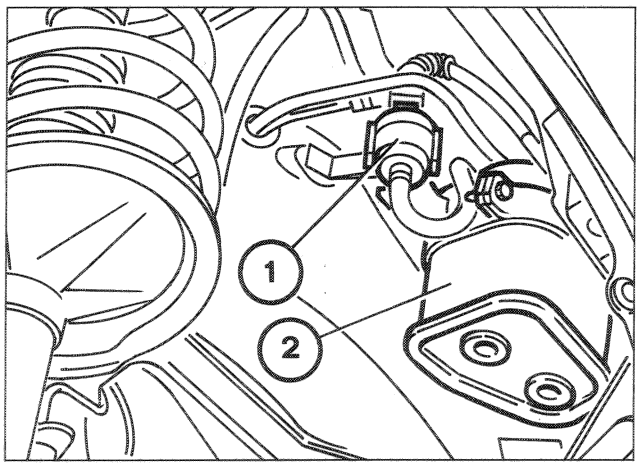
C1... C4 To the spark plugs (as indicated by the numbers on the ignition coil frame).

D Supply: from the power relay (with the ignition switch in the ON position).

Recovery

Short circuit to +Vb error: immediate disabling of the injector operation for the defective coil.

Short circuit to earth or open circuit error: the control unit applies the charging time from the coil in open-loop.



PETROL VAPOUR CUT OUT SOLENOID VALVE

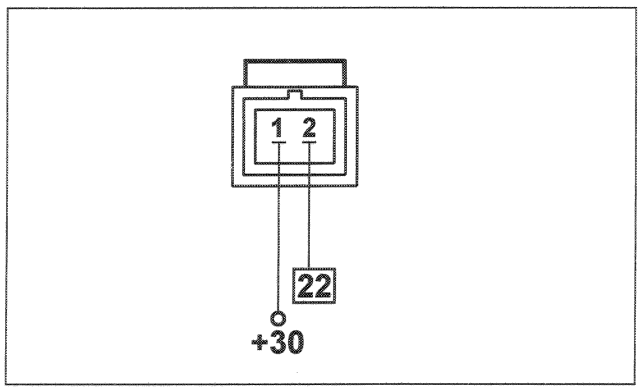
This is the normally closed closed type with a resistance of between 17.5 and 23.5 ohm at 20°C.

Depending on the duty-cycle supply, the capacity should be:

A) duty-cycle 100% = 58 - 75 l/min

B) duty-cycle 50% = 24 - 36 l/min

C) duty-cycle 20% = 5.5 - 13.5 l/min.



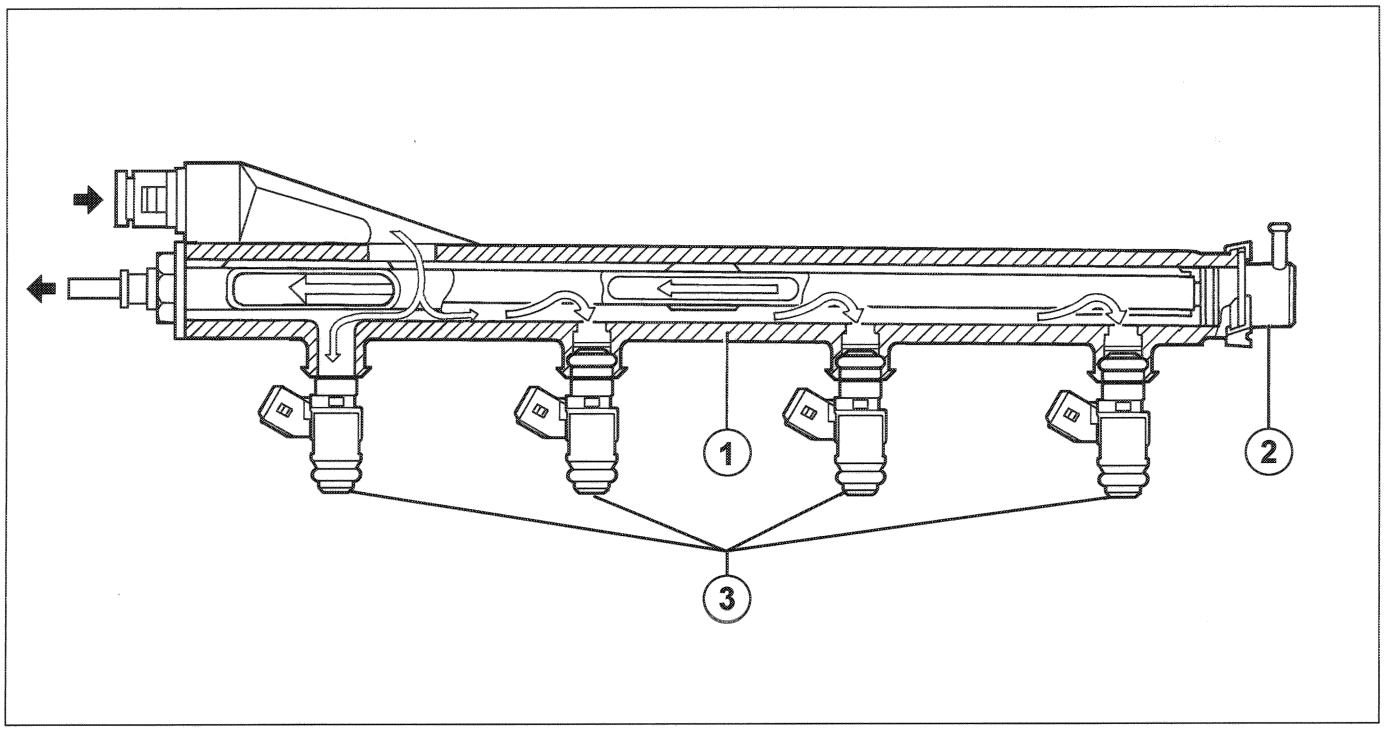
P3M22LJ03

Wiring connector

The numbers indicate the respective control unit pins.

Recovery: If there is a fault the operation of the solenoid valve is disabled.

FUEL MANIFOLD WITH INJECTORS AND PRESSURE REGULATOR



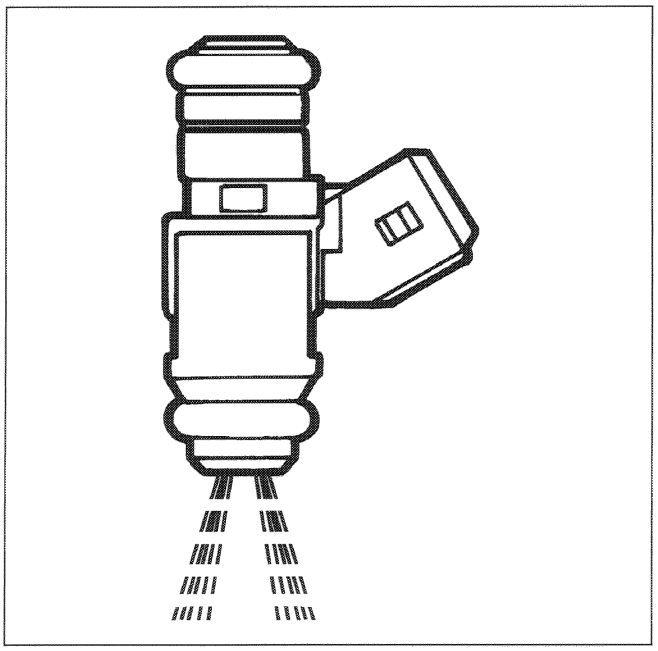
P3M23LJ01

The fuel manifold (1) is made from die-cast aluminium with the pressure regulator (2) on the right end.

It is fitted with rapid type fuel safety attachments.

The pressure regulator setting with the engine idling is 25 bar (operating pressure 3 bar ± 0.2).

The injectors (3) are a press fit with O-Rings and are held in place by a steel spring.



P3M23LJ02

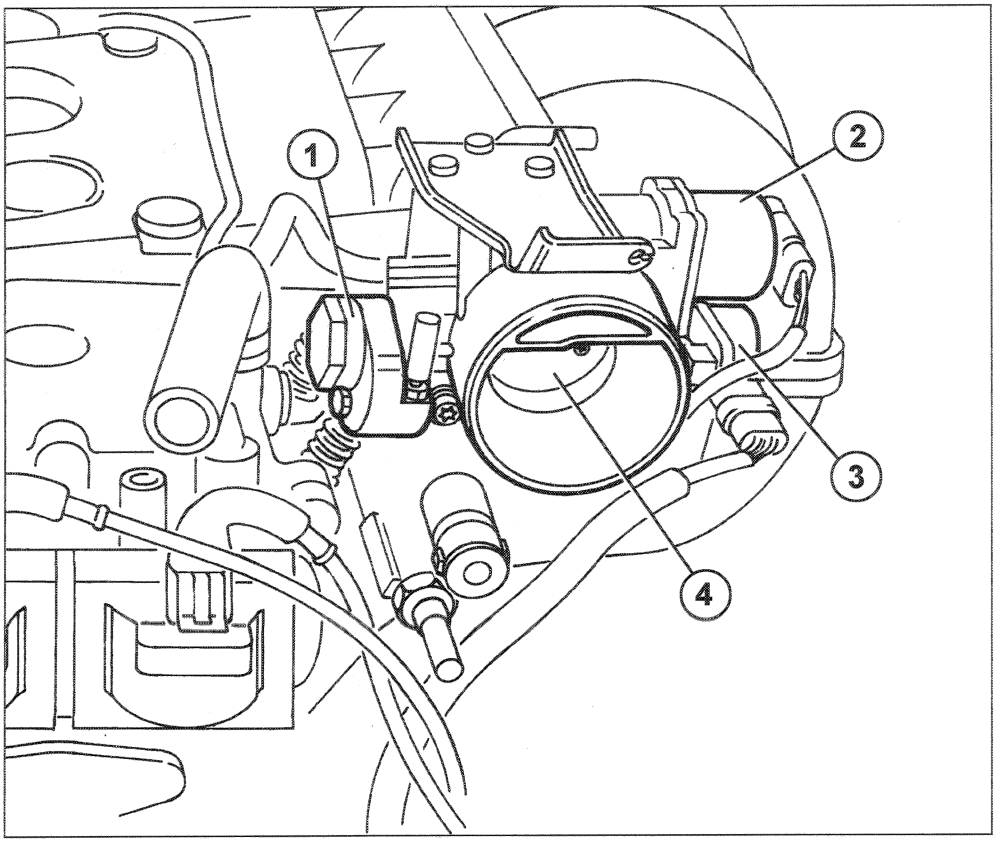
INJECTOR (IWP045)

The Weber injectors are the miniature type (Pi-co).

The plastic identification bush is green in colour.

They receive a 12V supply and have an internal resistance of 13.775-15.225 ohm.

BUTTERFLY CASING



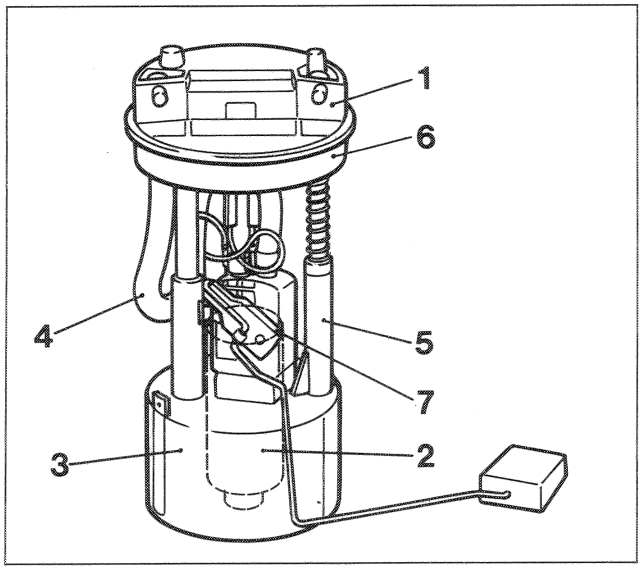
P3M24LJ01

The butterfly casing is composed of the following components:

1. Butterfly opening control levers
2. Engine idle speed actuator
3. Butterfly valve position sensor
4. Butterfly valve

ELECTRIC FUEL PUMP (Marwal MSS071)

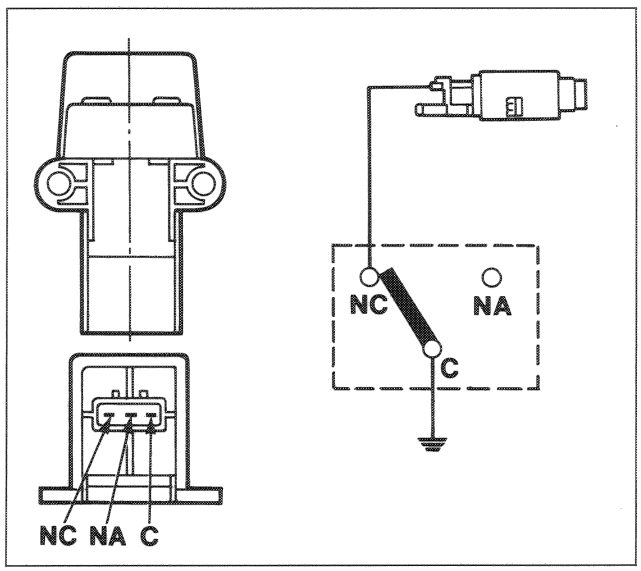
It is the immersed type and has a nominal capacity of 90 l/min.
It is operated by the control in order to ensure:
- the cut out of the pump if the engine goes below a minimum speed.
- the timed go ahead (lasting around 15 secs) of the pump each time the key is turned to the ON position without the engine being started up.
- the go ahead for operation during driving or with the engine started up.



P3M24LJ02

Electric fuel pump assembly components

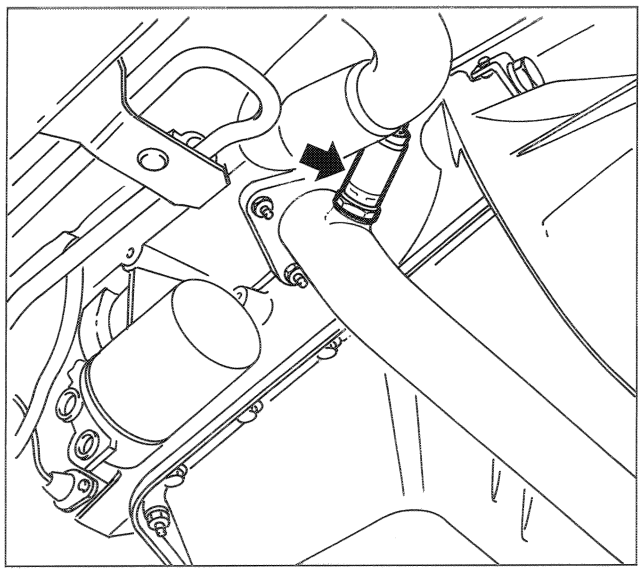
1- Fixing plate
2- Electric fuel pump
3- Gauze pre-filter
4- Supply pipe
5- Return pipe
6- Seal
7- Transmitter for fuel level gauge



P3M25LJ01

INERTIA SAFETY SWITCH

In order to improve the safety of the occupants of the vehicle in the case of an impact the vehicle is equipped with a switch located at the side of the driver's seat on the left hand side which comes into operation if the vehicle suffers a violent impact interrupting the connection to earth of the electric fuel pump and consequently cutting off the supply to the injection system.
To restore the connection to earth for the electric fuel pump, press the switch until it is heard enagaging.



P3M25LJ02

LAMBDA SENSOR

The Lambda sensor is the 4 wire heated type. It is located on the exhaust pipe and is connected to the control unit via the 4 pin connector shown in the diagram.

Recovery

The control unit activates the operating strategy in open-loop

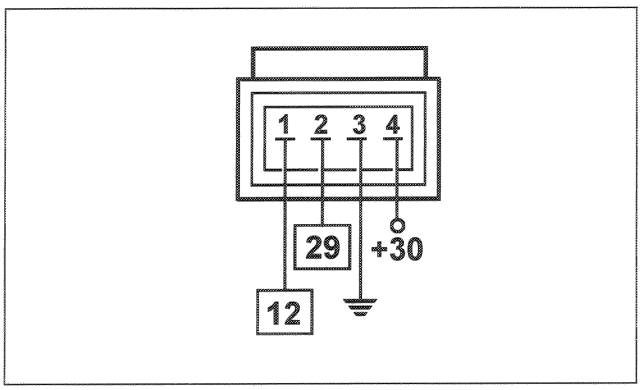
Checking the resistance

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

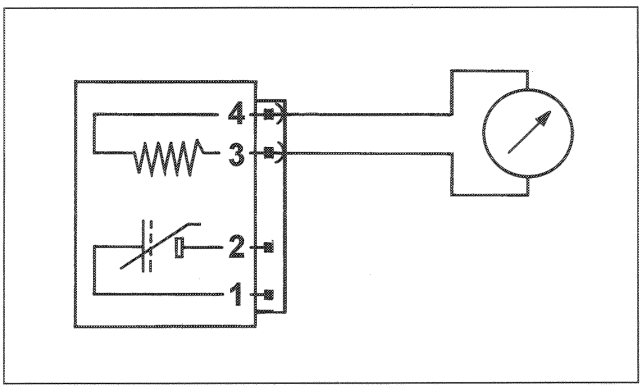
Resistance 4.5 ± 0.5 ohm at 20 °C

Wiring connector

The numbers indicate the corresponding control unit pins



P3M25LJ03



P3M25LJ04

FAULT DIAGNOSIS

Autodiagnosis

The injection/ignition system is equipped with an "**autodiangnostic**" function which memorizes any faults at the sensors and actuators, making it easier to identify and correct them.

If a fault is detected at the sensors, the electronoic control unit replaces the information coming from the faulty sensor with information stored in the memory (recovery) to allow the operation of the engine. The detection of a fault involves it being permanently memorized 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 or its controls. The detection of a fault and the replacement with recovery data involves the failure being signalled by means of the specific warning light in the instrument panel coming on.

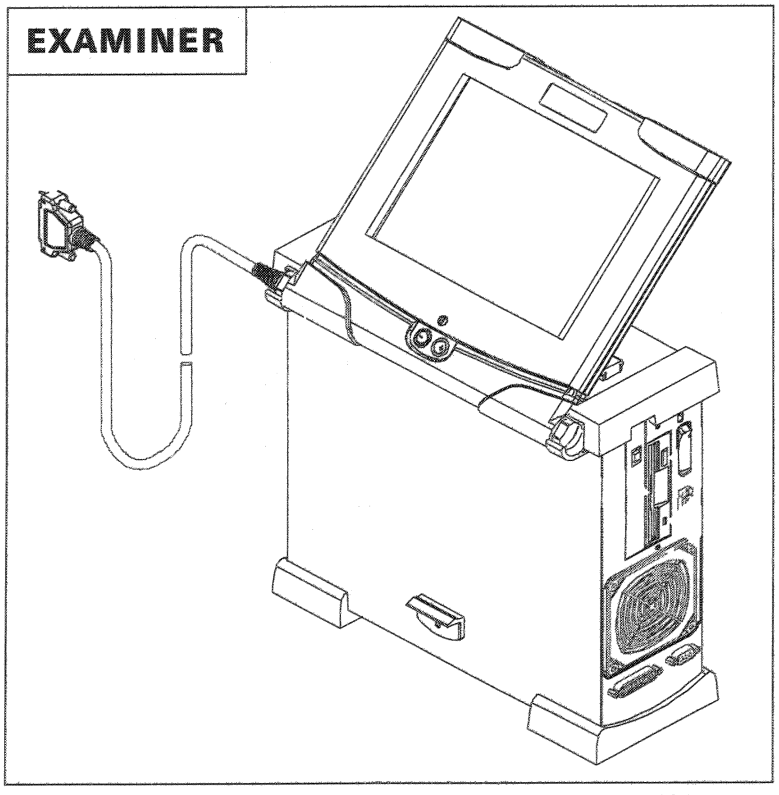
The warning light comes on each time the ignition key is turned to the ON position and, if there are no faults, the warning light goes out after 4 seconds.

Fault diagnosis using the SDC or Examiner

This system temporarily stores any faults which have taken place inside the control unit memory and, when the ignition is switched off, it transfers them to the permanent memory to allow them to be read with the diagnostic equipment (SDC or Examiner).

There is a diagnostic socket on the left hand side of the engine compartment for connection with the diagnostic equipment.

The exchange of data takes place by means of two diagnostic lines K and L; line Kis used for transferring data from the control unit to the diagnostic equipment and line L is used for transferring data from the diagnostic equipment to the electronic control unit.



P3M26LJ01

The exchange of data between the control unit and the diagnostic equipment takes place in accordance with standard ISO 4 communication protocol; the information is coded and transmitted NRZ (Non Return Zero), with a positive logic and at a speed of 7812. 5 Baud.

CHECKING ENGINE IDLE SPEED

If the engine idle speed is not 860±50 rpm and the injection/ignition control unit is the self-regulating type then it is not possible to carry out any adjustments. It is therefore necessary to check that the accelerator control linkage is correctly adjusted and to search for the problem by carrying out a complete fault diagnosis using the Fiat Lancia/Tester.

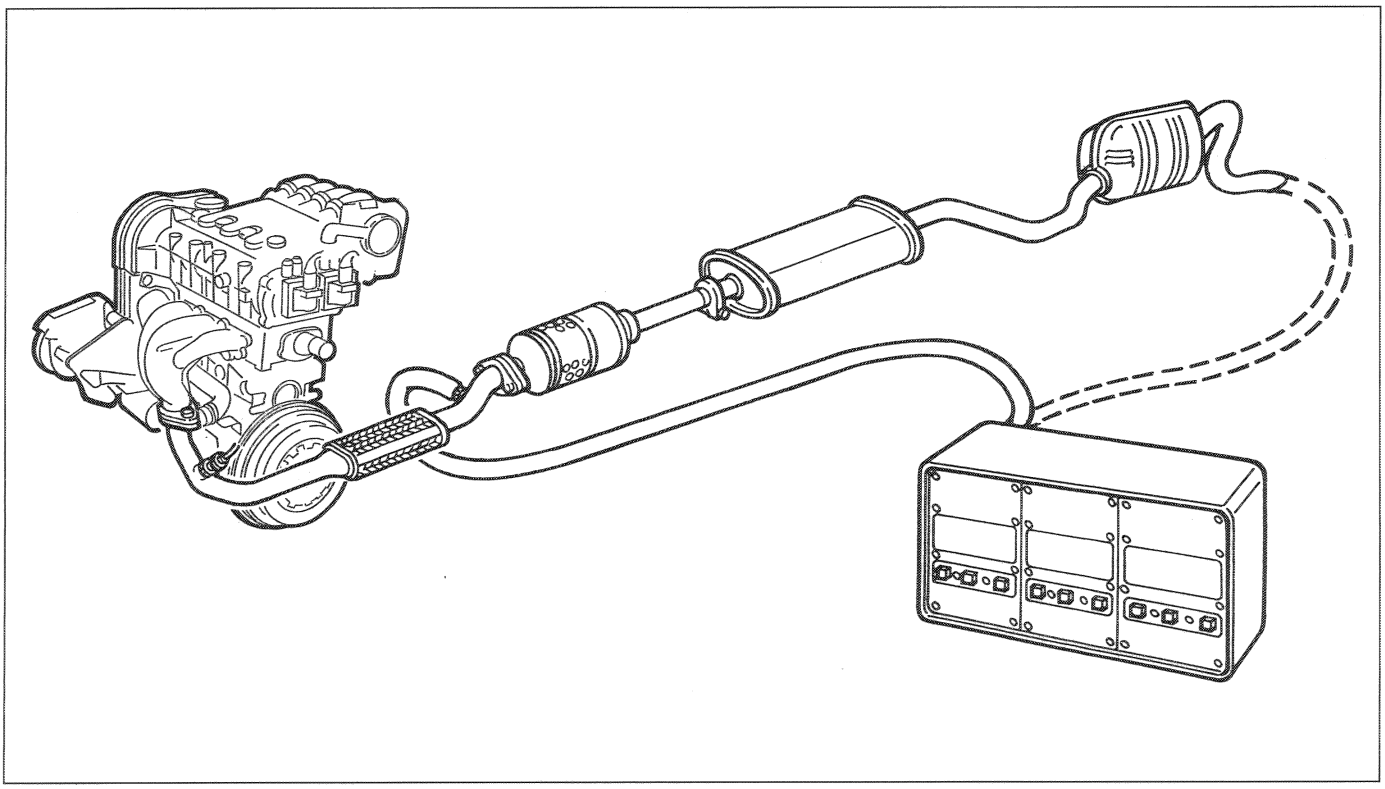
CHECKING CONCENTRATION OF POLLUTANT EMISSIONS

This electronic injection/ignition system is capable of automatically controlling the advance, the carbon monoxide (CO) content and the idle air flow rate, therefore no manual adjustment operations are required.

However, a check on the content of the exhaust gases, upstream and downstream of the catalyzer, can provide precious information on the injection/ignition system operation and the catalyzer and engine parameters.

Table summarizing pollutant emission tolerance figures

	CO (%)	HC (p.p.m.)	CO2 (%)
Upstream of the catalyzer	0.4÷1	⩽ 600	⩾ 12
Downstream of the catalyzer	⩽ 0.35	⩽ 90	⩾ 13



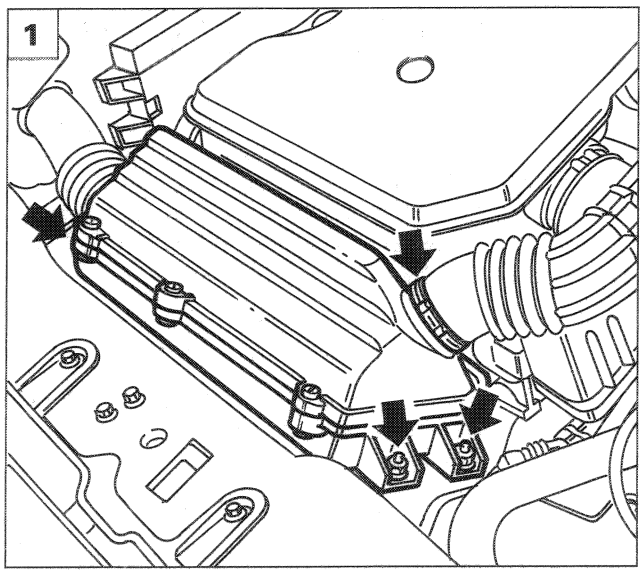
P3M27LJ01

10.

CHECKS - ADJUSTMENTS AND REPAIR OPERATIONS FOR INJECTION/IGNITION SYSTEM

WHEN WORKING ON A VEHICLE EQUIPPED WITH AN IAW INJECTION/IGNITION SYSTEM, OBSERVE THE FOLLOWING PRECAUTIONS:

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



P3M02AX05

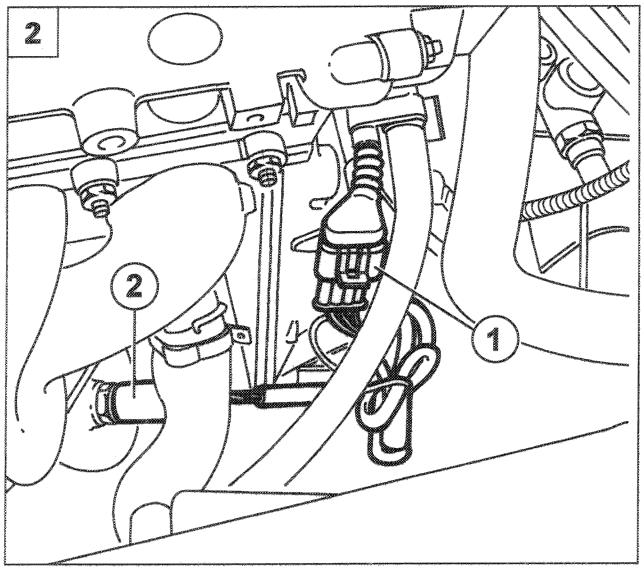
Remember that this system has a memory which is always supplied where the values acquired during auto-adjustment are stored. The operation of disconnecting the battery will result in this information being lost so this operation shoudl, as far as possible, be limited.

REMOVING-REFITTING LAMBDA SENSOR

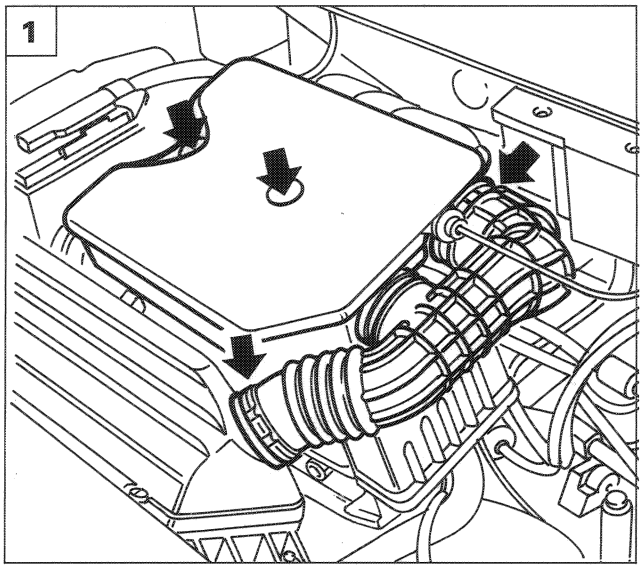
1. Remove the complete air filter casing acting on the fixing nuts and the band shown.
2. Disconnect the electrical connection (1), then remove the Lambda sensor (2) from its housing on the exhaust pipe.

If the Lambda sensor is being replaced, when refitting apply graphite grease which is resistant to high temperatures to the thread.

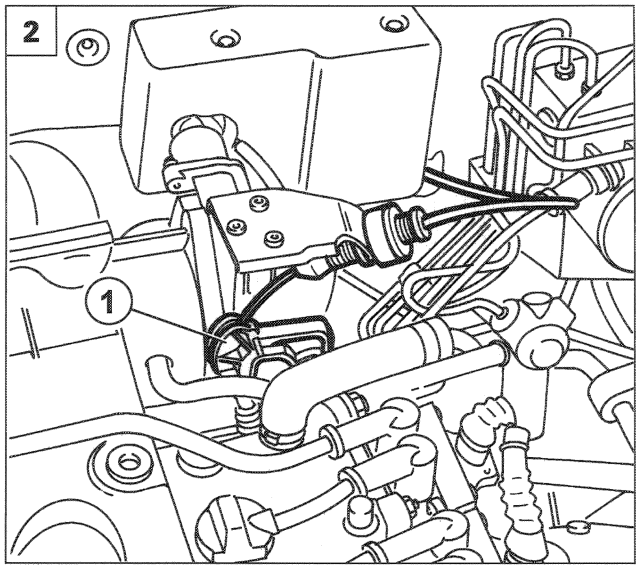
Tightening torque 5 - 6 daNm



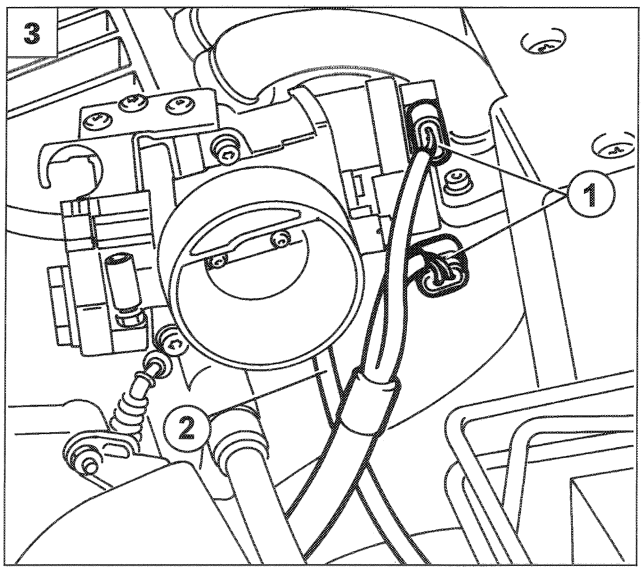
P3M28LJ01



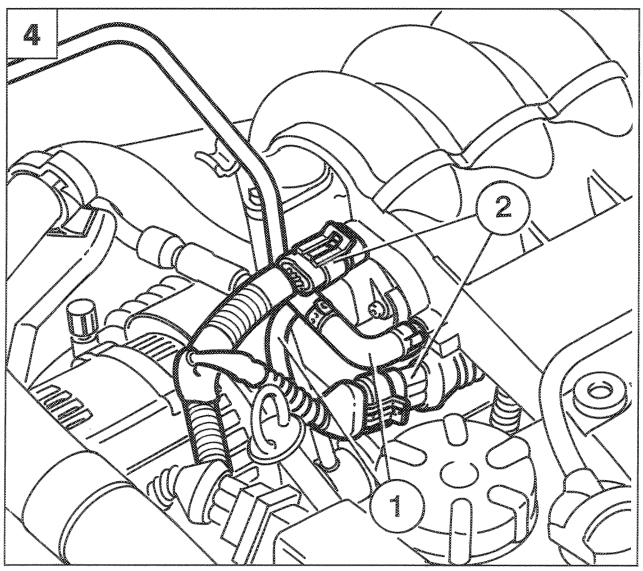
P3M26AX01



P3M29LJ01



P3M29LJ02

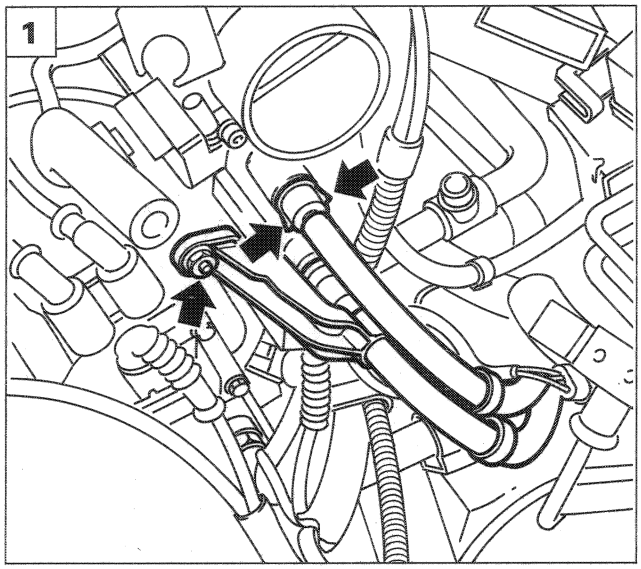


P3M16AX02

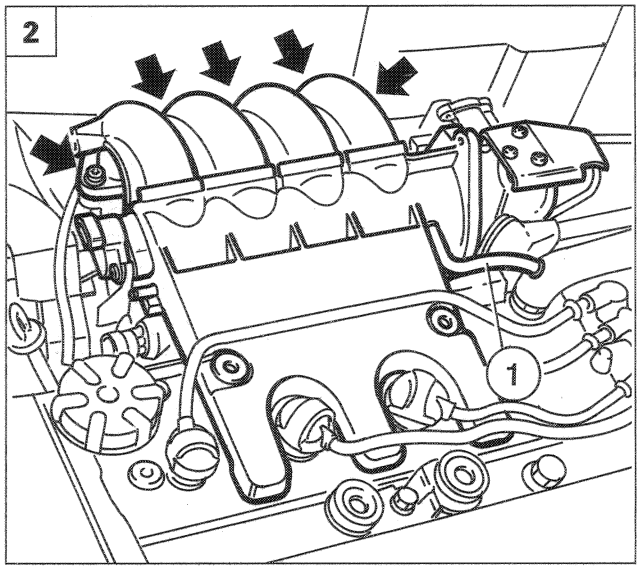
REMOVING-REFITTING FUEL MANIFOLD AND INJECTORS

1. Remove the resonator complete with air inlet hose disconnecting the band shown from the butterfly casing and undo the fixing bolts. Also disconnect the oil vapour recovery pipe from the lower part of the resonator.
2. Disconnect the accelerator cable from the butterfly valve control lever (1).
3. Disconnect the electrical connections (1) and the brake servo vacuum pipe (2) from the butterfly casing.
4. Disconnect the pipes (1) for the fuel pressure regulator and the fuel vapour recirculation system plus the electrical connections (2) for the intake air temperature and pressure sensor and the injector supply bridge from the upper part of the inlet manifold.

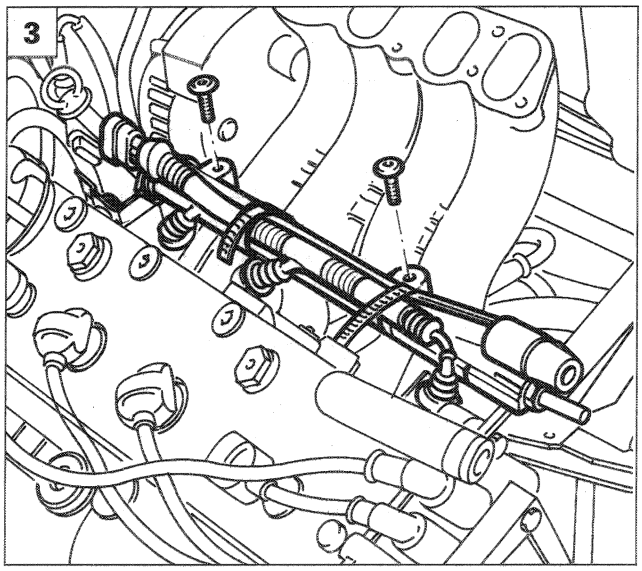
10.



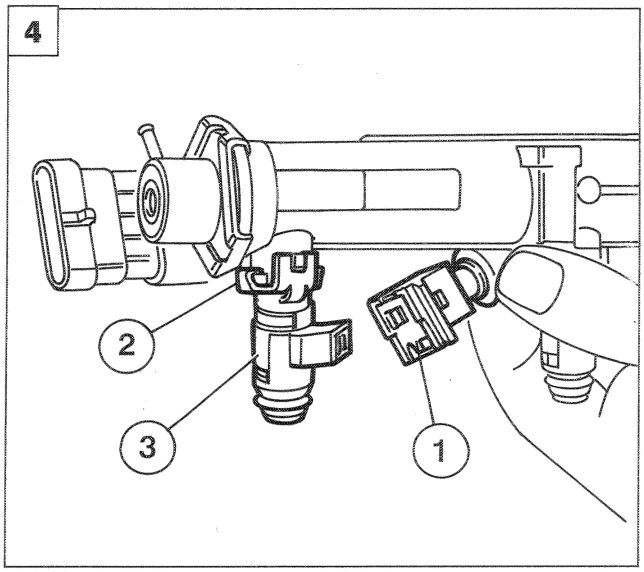
P3M04AX03



P3M16AX03



P3M30LJ01

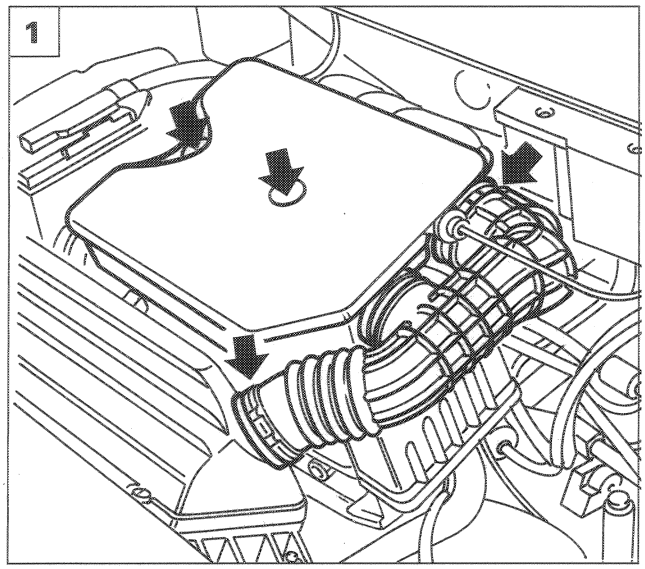


P3M30LJ02

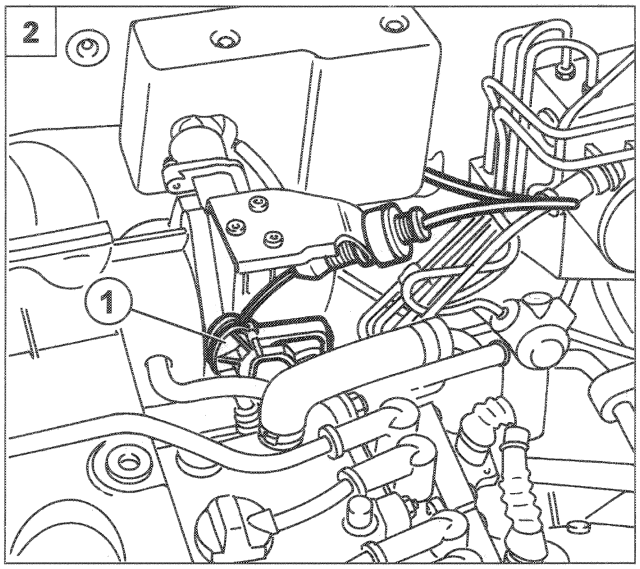
1. Disconnect the fuel supply pipes acting on the retaining tabs. Then remove the mounting bracket shown in the diagram.
2. Remove the fixing bolts for the upper part of the inlet manifold using spanner USAG TX 27 or similar, disconnect the oil vapour recovery pipe (1) and remove the manifold from the vehicle complete with the butterfly casing.
3. Undo the fixing bolts and remove the fuel manifold complete with injectors and pressure regulator.
4. To remove the injectors, proceed as follows:
   - Disconnect the electrical connection (1).
   - Remove the safety clip (2).
   - Remove the injector (3) which is a press fit.

Never act on the electrical connector to remove the injector.

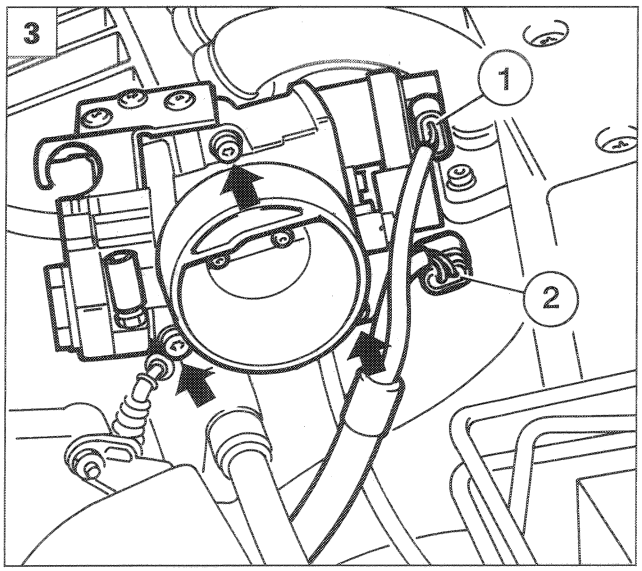
Before refitting, check the condition of the seals.



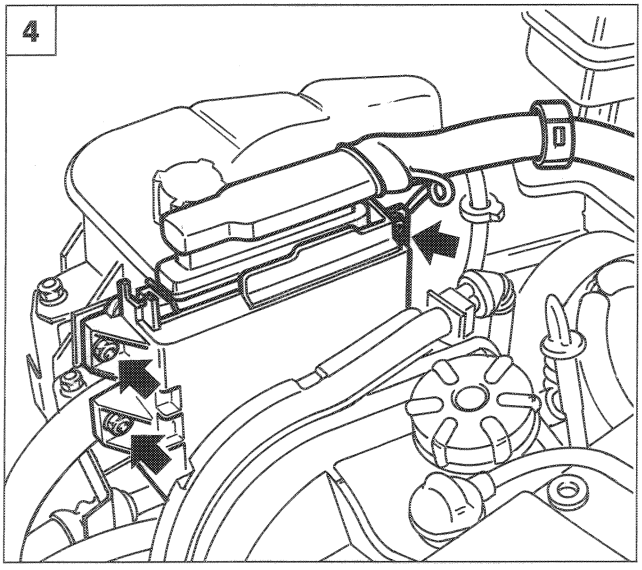
P3M26AX01



P3M29LJ01



P3M31LJ01



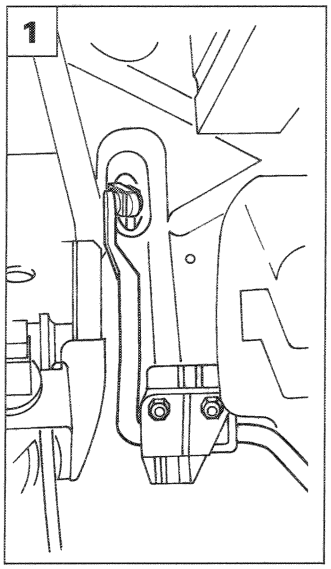
P3M05AX01

REMOVING-REFITTING BUTTERFLY CASING

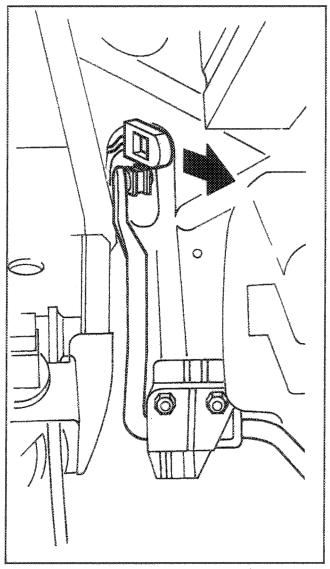
1. Remove the resonator complete with air inlet hose disconnecting the band shown from the butterfly casing and undo the fixing bolts. Also disconnect the oil vapour recovery pipe from the lower part of the resonator.
2. Disconnect the accelerator cable from the butterfly valve control lever (1).
3. Disconnect the electrical connections for the engine idle speed actuator (1) and the butterfly valve position sensor (2), then loosen the fixing bolts shown and remove the butterfly casing.

REMOVING-REFITTING INJECTION/IGNITION CONTROL UNIT

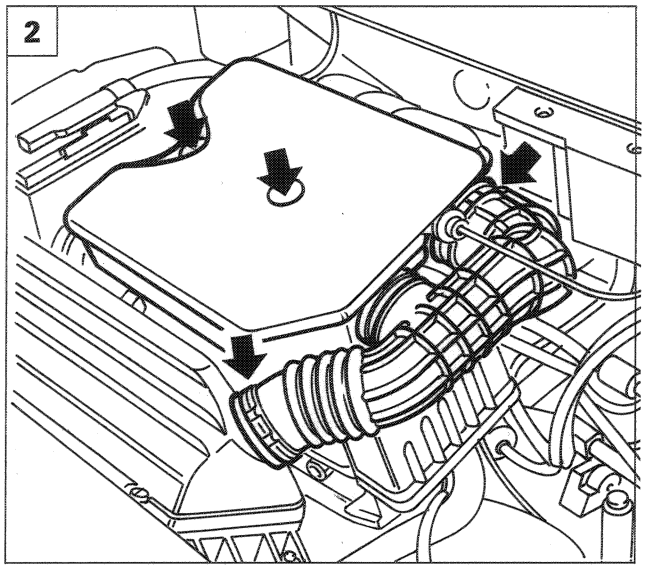
4. Disconnect the connector from the injection/ignition control unit, undo the fixing bolts, then remove the control unit from the mounting bracket.



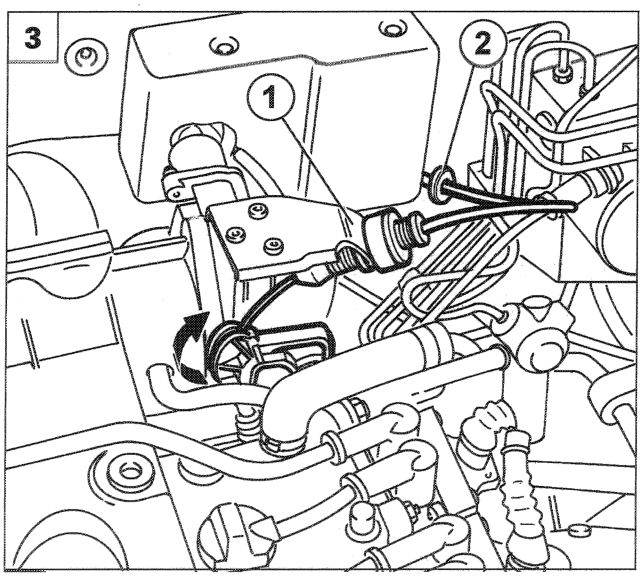
P3M32LJ01



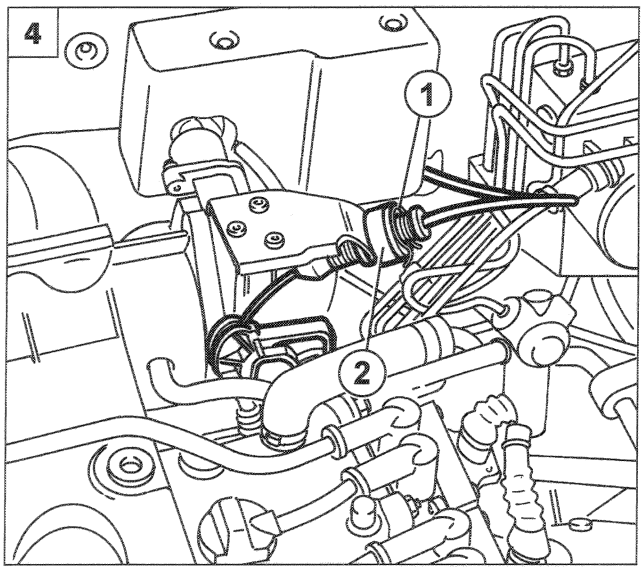
P3M32LJ02



P3M26AX01



P3M32LJ03



P3M32LJ04

REMOVING-REFITTING ACCELERATOR CABLE

1. Working from inside the vehicle, disconnect the control cable from the anchorage on the accelerator pedal.
2. In the engine compartment, remove the resonator complete with air inlet hose disconnecting the band shown from the butterfly casing and undo the fixing bolts. Also disconnect the oil vapour recovery pipe from the lower part of the resonator.
3. Rotate the butterfly valve control lever and disconnect the acclerator cable; then separate the cable from the support (1). Remove the flexible buffer (2) from the anchorage opening in the rear wall of the engine compartment and extract the complete accelerator cable.

When refitting, adjust the accelerator cable as described in the paragraph which follows.

ADJUSTING ACCELERATOR CABLE

4. The accelerator cable is adjusted by moving the clip (1) in the different bush (2) splines.

Make sure that with the accelerator pedal fully depressed the butterfly valve is completely open.

CHECKS ON THE FUEL SUPPLY CIRCUIT

Checking fuel supply pressure

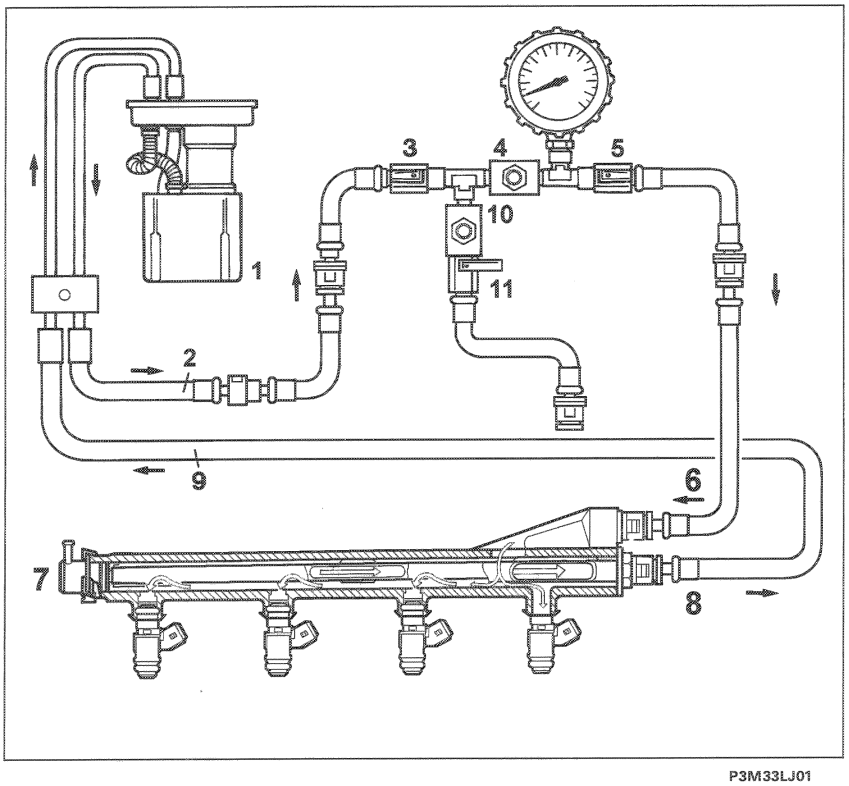
- Disconnect the fuel supply pipe (2) to the manifold from the appropriate connector (6);
- Position tool 1860955000 connecting it to the fuel supply pipe (2) and the connector (6) at the fuel manifold using the appropriate adaptor.

NOTE *Tool 1860955000 comes with adaptors for connection to various types of injection systems; before carrying out the connections, fit the appropriate adaptors to the equipment.*

- Position valve (11) in a closed position and valves (3) and (5) in an open position; make sure that the adjustment valve (4) is completely open.
- Operate the electric fuel pump (1) with the engine switched off using the Fiat/Lancia Tester activating the "fuel pump" test.
- The pressure reading on the gauge should stabilize at a pressure of 3 bar ± 0.2 bar.
- If the pressure measured is higher:
- disconnect the return pipe (9) from the fuel manifold and connect another pipe to collect the fuel which comes out in a suitable container;
- operate the electric pump once again, then check the pressure reading on the gauge:
  a. if it reaches 3 bar, then the fuel return pipe to the tank must be checked because it is obstructed or bent;
  b. if it exceeds 3 bar then the pressure regulator must be replaced because it is defective.

Checking maximum fuel supply pressure (or electric pump efficiency)

- Connect tool 1860955000 as described in the previous test.
- Close valve (5), keep valves (3 and 4) in a fully open position and valve (11) closed.
- Operate the electric pump (1) with the engine switched off as described in the previous test; the pressure should be exceed i 5 bar (electric pump safety valve setting). If this is not the case, replace the electric pump because it is defective.



P3M33LJ01

1. Electric fuel pump
2. Fuel supply pipe
3. Ball valve
4. Fuel pressure micrometric adjustment valve
5. Ball valve
6. Connector for supply pipe on fuel manifold (7)
7. Fuel manifold
8. Connector for return pipe on fuel manifold (7)
9. Fuel return pipe
10. Fuel pressure micrometric adjustment valve
11. Ball valve

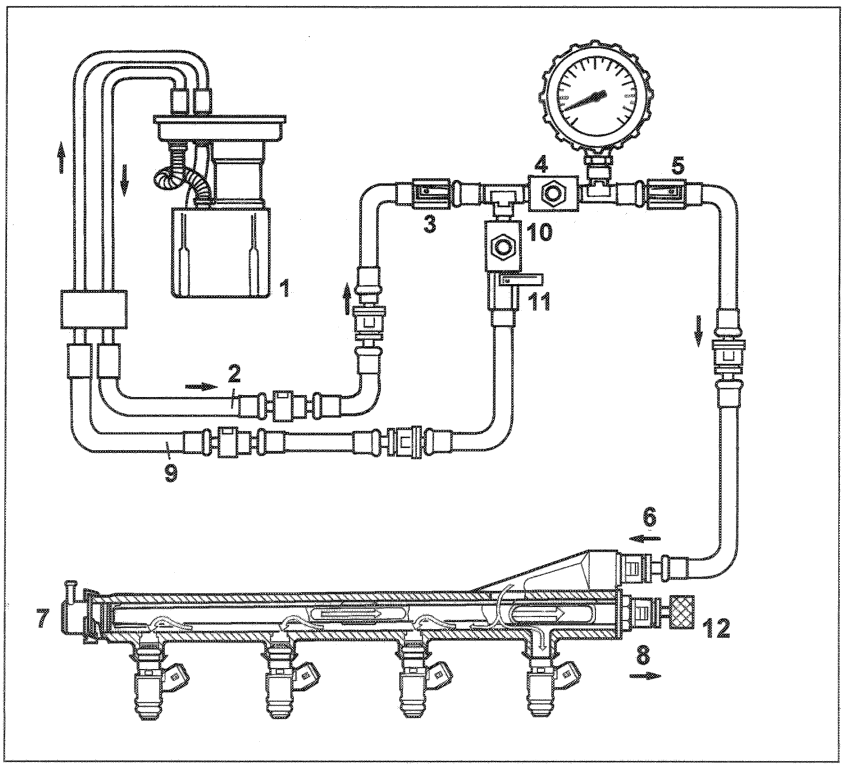
Injector leakage test

The injector leakage test is carried out as follows:

- Connect tool 1860955000 with the fuel supply circuit as described for the previous tests.
- Fit the special plug (12) in the return pipe (8) connector and connect the end of pipe (9) using the appropriate adaptors, then place the ball valve (11) in a closed position.

NOTE *Tool 1860955000 comes with adaptors for connection to various types of injection systems; before carrying out the connections, fit the appropriate adapators to the equipment.*

- Operate the electric fuel pump (1) with the engine switched off as described for the previous tests; wait until the nominal pressure (3 bar) is reached in the system, then close the valve (3) and switch off the electric pump (1).
- As soon as the pressure stabilizes (i.e. decreases slightly) whether it remains constant for around 60 seconds; if this is not the case, then one or more of the injectors or one of the connectors is leaking.



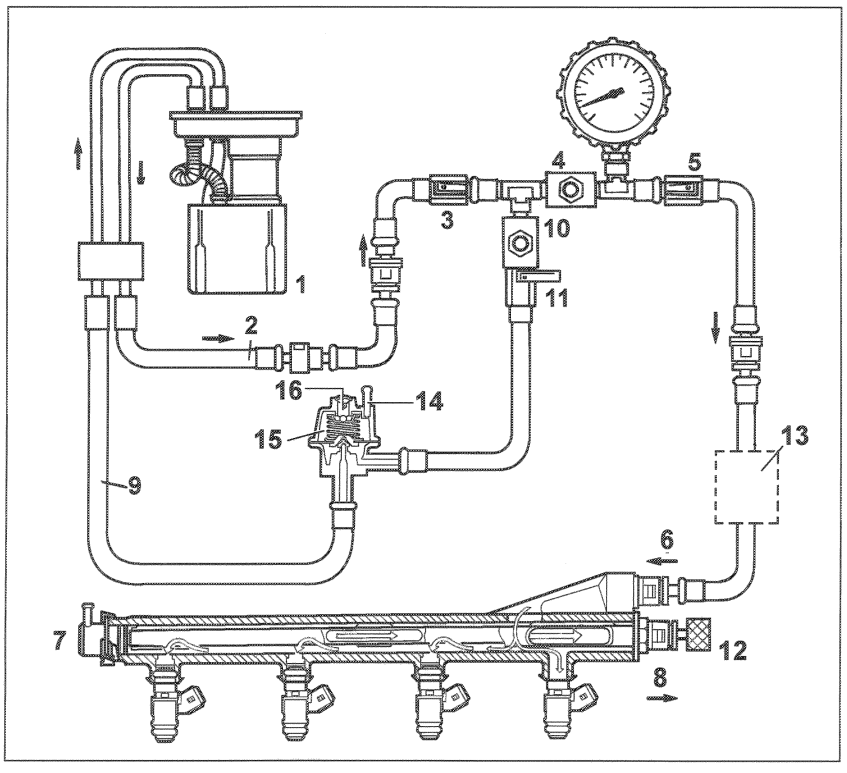
P3M34LJ01

1. Electric fuel pump
2. Fuel supply pipe
3. Ball valve
4. Fuel pressure micrometric adjustment valve
5. Ball valve
6. Connector for supply pipe on inlet manifold (7)
7. Fuel manifold
8. Connector for return pipe on inlet manifold (7)
9. Fuel return pipe
10. Fuel pressure micrometric adjustment valve
11. Ball valve
12. Adaptor fitted with plug

CHECKING FUEL CONSUMPTION USING FLOWTRONIC EQUIPMENT

Check the fuel consumption proceeding as follows:

- Connect tool 1860955000 to the fuel injection system as described in the previous paragraph dealing with the injector leakage test.
- Position the FLOWTRONIC equipment on the fuel supply pipe between tool 1860955000 and the manifold (7) after having fitted the rapid attachments on the inlet and outlet pipes.
- Place the valve (3, 4, 5, 10, and 11) in an open position.
- Position a pressure regulator (15) (order number 7780352) on the fuel return line carrying out the connections shown in the diagram;.
- Disconnect the inlet vacuum pipe from the fuel pressure regulator and connect it to the regulator (15) socket (14).
- Operate the electric fuel pump (1) as described for the previous tests; then, acting on the adjustment screw (16), set the supply pressure at the nominal value (3 bar).
- Connect the tester for the FLOWTRONIC equipment (n° 1806149001) and road test the vehicle as follows:
  a. The road test should be carried out a constant speeds of 90 and 120 km/h, on a flat road in wind free conditions.
  b. The tyre inflation pressure should be correct and the vehicle should not be equipped with accessories on the exterior which alter the aerodynamics.
  c. If air conditioning is fitted it should be swithced off.
  d. It is vital for a constant speed to be maintained throughout the entire duration of the test, avoiding altering the accelerator as far as possible.
- Check that figures measured correspond to those given in Section 00 "Technical data".



P3M35LJ01

1. Electric fuel pump
2. Fuel supply pipe
3. Ball valve
4. Fuel pressure micrometric adjustment valve
5. Ball valve
6. Connector for supply pipe on fuel manifold (7)
7. Fuel manifold
8. Connector for return pipe on fuel manifold (7)
9. Fuel return pipe
10. Fuel pressure micrometric adjustment valve
11. Ball valve
12. Plug
13. FLOWTRONIC equipment
14. Vacuum socket (to be connect to the inlet manifold)
15. Fuel pressure regulator (order n° 7780352)
16. Calibration screw