## HITACHI INTEGRATED INJECTION/IGNITION SYSTEM

### Introduction

The Hitachi system fitted on the Bravo-Brava with the 1747 i.e. 16v engine belongs to the category of static advance digital electronic ignition systems integrated with multiple phased type intermittent electronic fuel injection systems.
This system therefore has only one control unit, one set of wiring and one set of common sensors for both systems.
The integrated system can be summarized in the following syb systems:

ELECTRICAL/ELECTRONIC CIRCUIT
AIR INTAKE CIRCUIT
FUEL SUPPLY CIRCUIT
EMISSION CONTROL DEVICES

The system is capable of detecting the following parameters via special sensors:
1. the engine rotation speed;
2. the position of each pair of pistons in relation to TDC for cylinder 1;
3. the engine intake air flow rate;
4. the position and the speed of the variation of the position of the accelerator butterfly;
5. the temperature of the engine coolant;
6. the effective strength of the mixture (through the Lambda sensor signal);
7. the presence of detonation;
8. the speed of the vehicle;
9. the battery voltage;
10. whether the climate control compressor is switched on.

This information, usually of an analogue type, is converted into digital signals by analogue/digital (A/D) converters in order to be able to be used by the control unit.
In particular, any engine operating point is detected, moment by moment, by two parameters:

- the engine rotation speed, measured in revolutions per minute (rpm);
- the engine load, which is constituted by the quantity of air drawn in by each cylinder.
  This quantity is calculated on the basis of the flow rate of the air drawn in and is represented by the parameter TP, measured in milliseconds (ms).

Inside the control unit memory there is a managment programme (software) which comprises a series of strategies, each of which manages a precise system control function.
By using the (input) information listed previously, each strategy processes a series of parameters, based on the data maps stored in the control unit memories and then controls the system (output) actuators which are the devices which allow the engine to operate, namely:

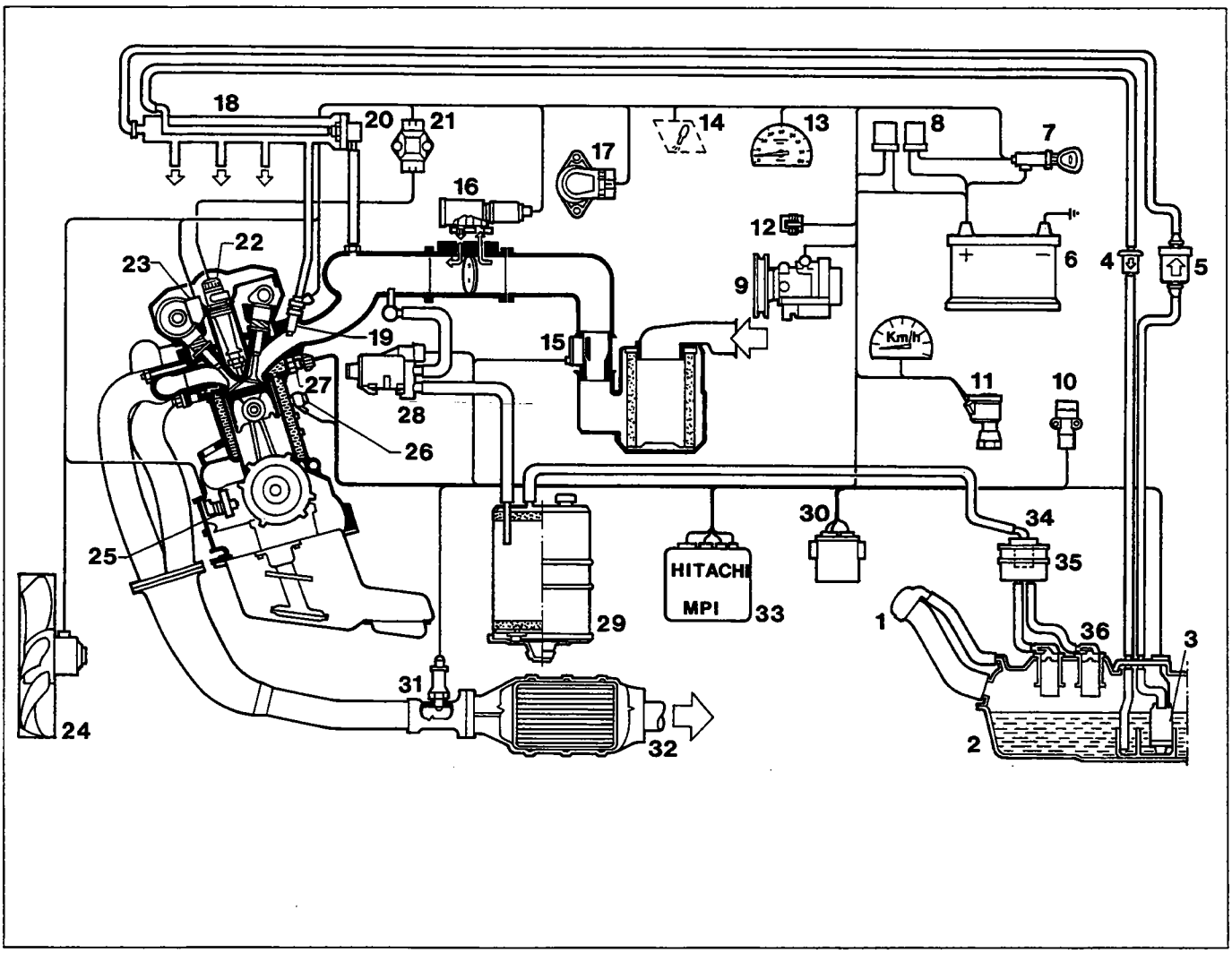
1. injectors;
2. ignition coils;
3. solenoid valves implementing various functions;
4. fuel pump;
5. control relays.

**NOTE** *The HITACHI injection/ignition system does not require any adjustment as it is self-regulating and self-adjusting.*

**NOTE** *In the diagrams, the numbers indicate the corresponding HITACHI engine control unit pins.*

**NOTE** *All the connectors are seen from the side opposite the cable input.*

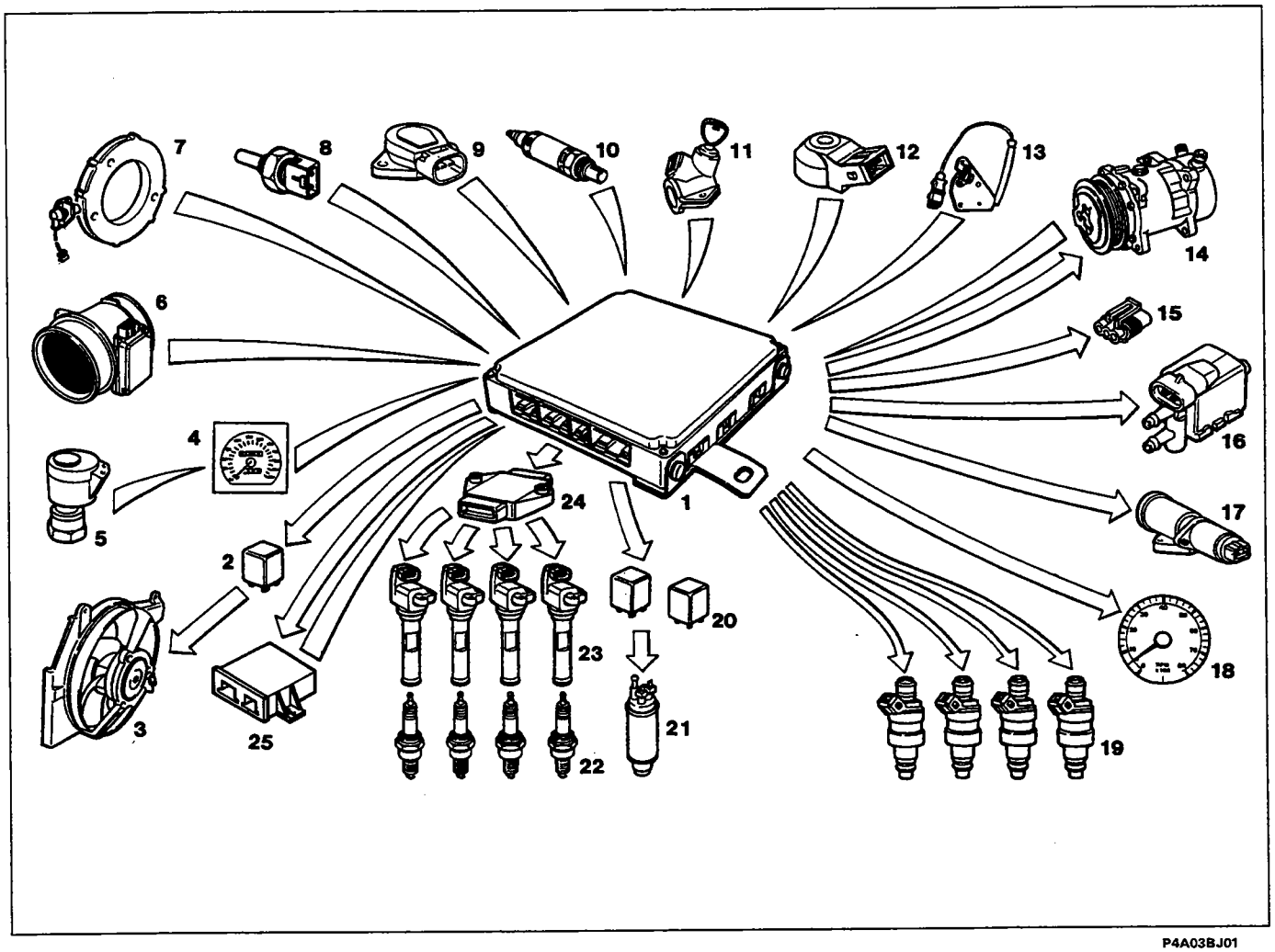
## DIAGRAM SHOWING OPERATION OF HITACHI INJECTION/IGNITION SYSTEM




P4A02BJ01

1. Cap with safety valve
2. Fuel tank
3. Electric fuel pump
4. Anti-flow valve
5. Fuel filter
6. Battery
7. Ignition switch
8. System relays
9. Climate control compressor
10. Inertia switch
11. Vehicle speed sensor
12. F/L Tester connector (diagnostic socket)
13. Rev counter
14. System failure light
15. Air flow meter
16. Engine idle adjustment solenoid valve
17. Butterfly position sensor
18. Fuel manifold with integrated pressure regulator
19. Injector
20. Fuel pressure regulator
21. Ignition power module
22. Ignition coil
23. Engine timing sensor
24. Radiator fan
25. Engine rpm sensor
26. Detonation sensor
27. Coolant temperature sensor
28. Charcoal filter solenoid valve
29. Charcoal filter
30. Fiat CODE control unit
31. Lambda sensor
32. Catalytic silencer
33. HITACHI engine control unit
34. Multi-purpose valve
35. Fuel vapour separator
36. Float valve

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

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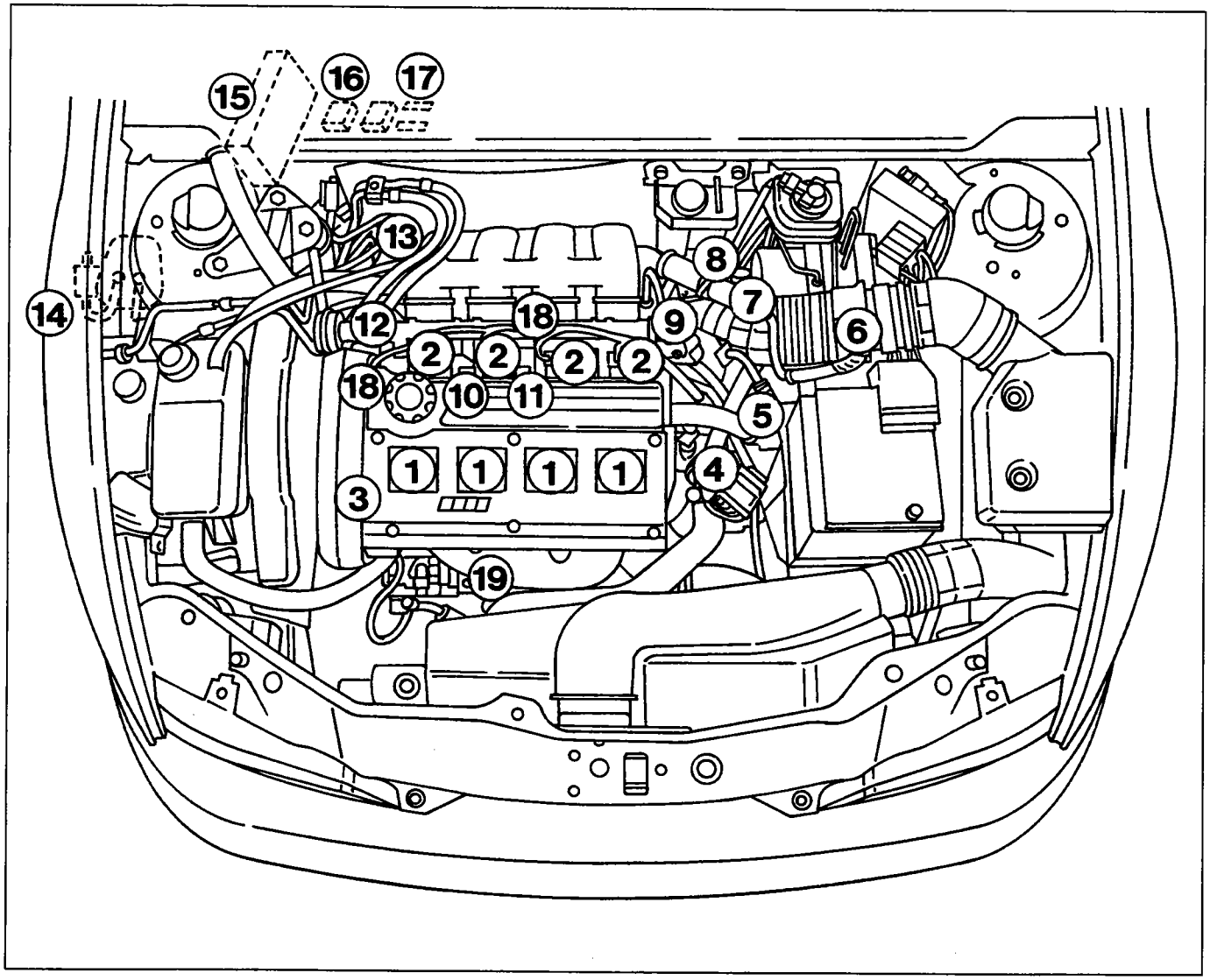
1. HITACHI engine control unit
2. Radiator fan solenoid valve
3. Radiator fan
4. Speedometer
5. Vehicle speed sensor
6. Air flow meter
7. Engine rpm sensor
8. Coolant temperature sensor
9. Butterfly position sensor
10. Lambda sensor
11. Ignition switch
12. Detonation sensor
13. Engine timing sensor
14. Climate control compressor
15. F/L Tester connector (diagnostic socket)
16. Charcoal filter solenoid valve
17. Engine idle adjustment solenoid valve
18. Rev counter
19. Injectors
20. System relays
21. Electric fuel pump
22. Spark plugs
23. Ignition coils
24. Ignition power module
25. Fiat CODE control unit

## LOCATION OF HITACHI INJECTION/IGNITION SYSTEM COMPONENTS IN ENGINE COMPARTMENT




P4A04BJ01

1. Ignition coils
2. Injectors
3. Engine timing sensor
4. Coolant temperature sensor
5. Vehicle speed sensor
6. Air flow meter
7. Engine idle speed adjustment solenoid valve
8. Butterfly position sensor
9. Fuel pressure regulator
10. Engine rpm sensor
11. Detonation sensor
12. Fuel manifold
13. Ignition power module
14. Charcoal filter solenoid valve
15. HITACHI engine control unit
16. Relays
17. Fuses
18. Injection/ignition system earths
19. Lambda sensor

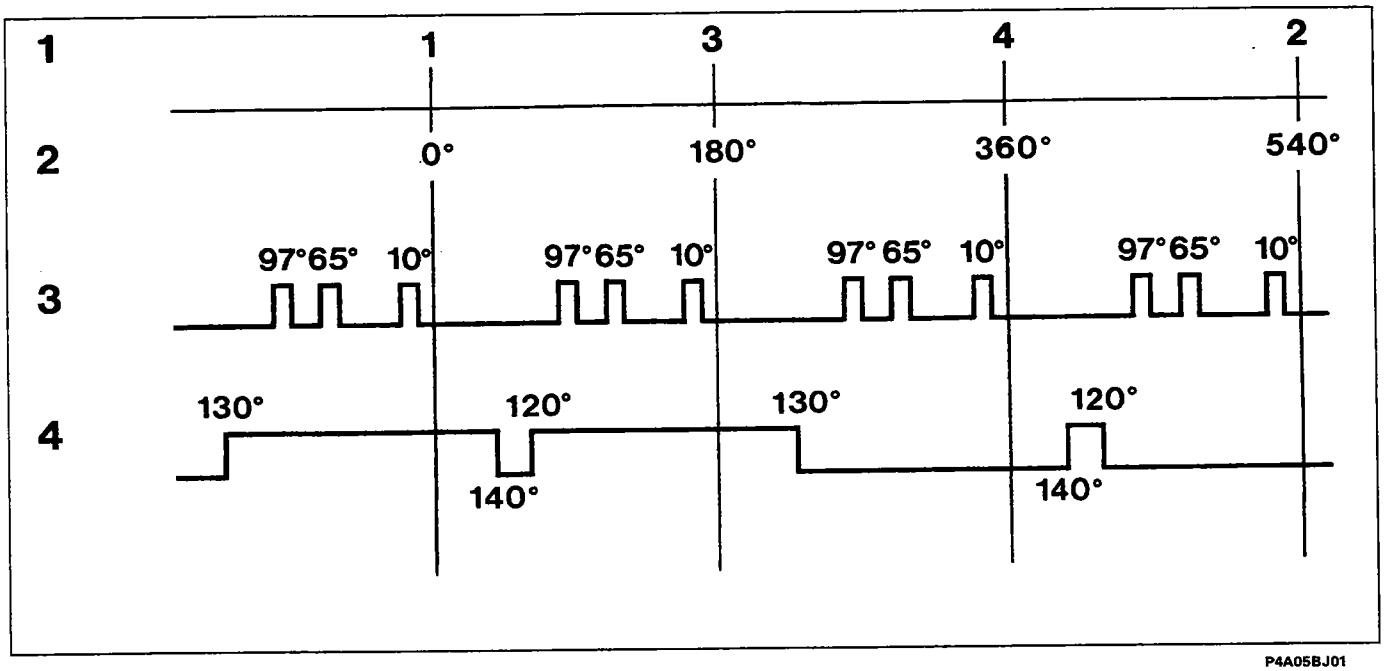
## SYSTEM MANAGEMENT STRATEGIES

### SIGNAL MANAGEMENT

During starting, the control unit recognizes the injection and ignition timing which are fundamental for the subsequent operation of all strategies.
This recognition is implemented on the basis of the interpretation of the succession of signals coming from the flywheel sensor on the crankshaft and from the engine timing sensor on the camshaft.

**NOTE** *The end of the signals refers to the collection of signans coming from the sensor on the crankshaft and the one on the camshaft which, featuring a precise reciprocal position, supply the control unit with a synchronized sequence of signals which the control unit is capable of recognizing.*

In particular, the signals are made up as follows:
- flywheel on the crankshaft: equipped with two symmetrical sets of teeth, located at 10°, 65° and 97°, respectively in advance of each TDC;
- flywheel on the camshaft: equipped with two long windows and a short one, wide enough and positioned in such a way as to supply the signal as shown in the diagram.




1. cylinder TDC
2. Crankshaft angles
3. Crankshaft flywheel signal (engine rpm sensor)
4. Camshaft flywheel (engine timing sensor)

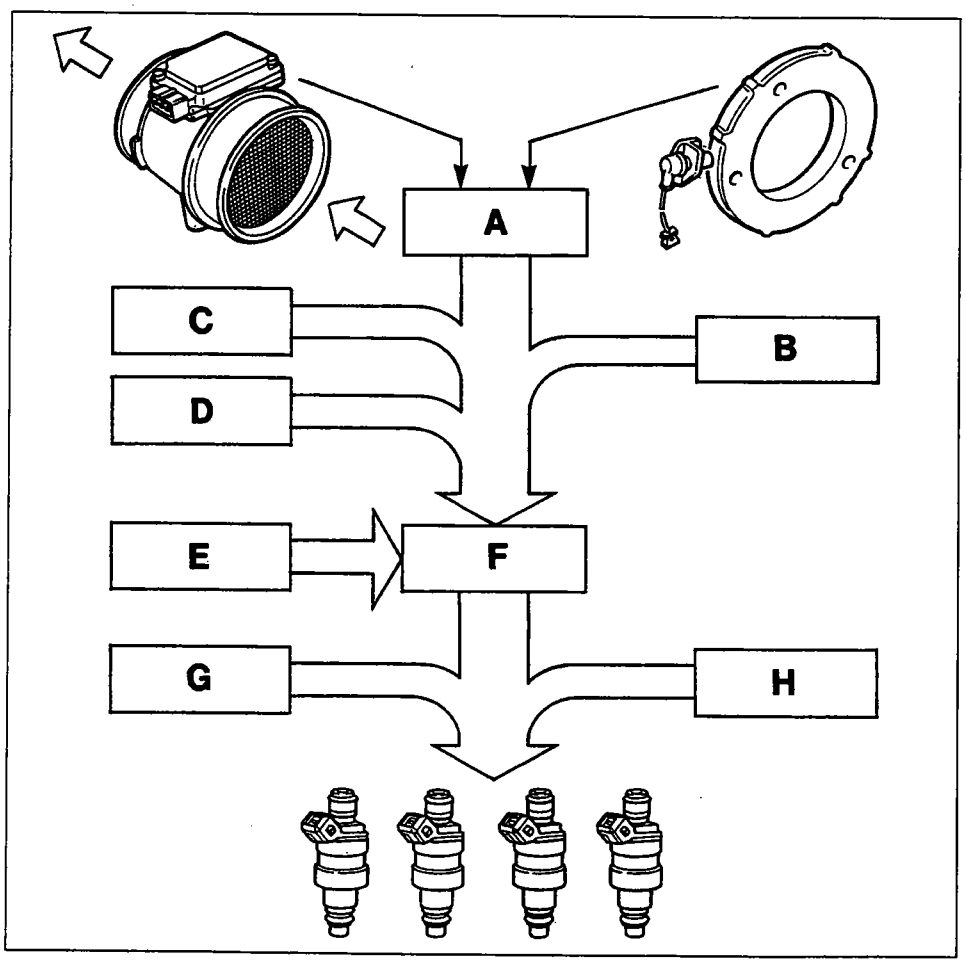
**NOTE** *The numerical values relating to the signals indicate the crankshaft angles in advance of TDC.*

## INJECTION MANAGEMENT

The injection management strategies have the aim of supplying the engine with the correct quantity of fuel at the desired moment according to the engine operating conditions.

**NOTE** *The presence of the air flow meter makes it possible to directly measure the mass of intake air, making the presence of the intake air temperature sensor superfluous.*

The management of the injection consists essentially in the calculation of the injection time, the determining of the injection timing and the subsequent implementation by operaating the injector.
The "basic" injection time depends on the characteristics of the injector and corresponds to the quantity of fuel to be injected into each cylinder. The latter, in turn, multiplies the quantity of air drawn in by each cylinder (calculated on the basis of the quantity of intake air and on the engine rotation speed) for the desired mixture strength in relation to the engine operating point.
The final injection time is determined through a calculation algorhythm in which the "basic" injection time is corrected by a series of coefficients which take into account the different engine operating conditions which are shown by the various sensors present in the system.

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A: "basic" injection time
B: corrective coefficients:
- low engine temperature
- high engine temperature
- starting and post-starting
- butterfly fully open
- deceleration
- acceleration

C: checking mixture strength
D: self-adjustment
E: cut-off
F: intermediate injection time
G: extra-pulse
H: management not timed by injection

### Checking mixture strength

**NOTE** *The following ratio is defined as the mixture ratio and is denoted by the Greek letterα (alfa):*

$$\frac{\textbf{quantity of air drawn in by the engine}}{\textbf{quantity of fuel injected}}$$

*The following ratio is defined as the stoichiometric mixture and is denoted by* $\alpha_{st}$*:*

$$\frac{\textbf{theoretical quantity of air to burn all the fuel injected}}{\textbf{quantity of fuel injected}}$$

*The following ratio is defined as the mixture strength andis denoted by the Greek letter* $\lambda$ *(lambda):*

$$\frac{\textbf{quantity of air drawn in by the engine}}{\textbf{theoretical quantity of air to burn all the fuel injected}}$$

It can easily be deduced that $\alpha / \alpha_{st} = \lambda$ .
The stoichiometric ratio depends on the type of fuel: for current unleaded petrols it is around 14.7 - 14.8 which corresponds to a Lambda strength of 1.
We talk of a mixture being *rich* when the quantity of air is lower than the stoichiometric ratio in which case the Lambda $<1$:
we talk of a mixture being *poor* (or *lean*) when the quantity of air is higher than the stoichiometric ratio in which case the Lambda $>1$,

The strategy has the function of correcting the "basic" injection times so that the mixture strength constantly oscillates at a high frequency between 0.98 and 1.02.
The oscillation frequency varies according to the engine load and speed: it is in the order of tens of Hertz.

**NOTE** *1 Hz = 1 oscillation per second*

In conditions of:
- cut-off,
- butterfly opening above 70°,
- engine temperature below 25°C,

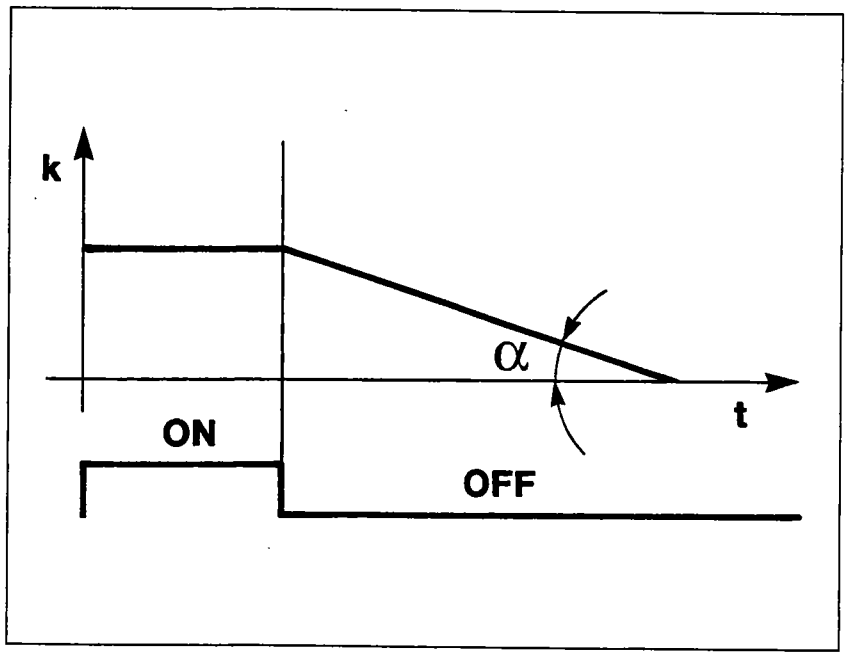
the strategy is disabled.

### Self-adjustment

The control unit is equipped with a self-adjustment function which has the task of memorizing any differences between the basic map and the corrections set by the Lambda sensor which may occur during operation. These differences (due to the ageing of the system and engine components) are memorized permanently, allowing the adaption of the operation of the system to gradual alterations of the engine and the components in relation to the characteristics when new.
The strategy is disabled when the charcoal filter solenoid valve is open.
If the control unit is replaced it is necessary to carry out a road test which allows the engine to reach operating temperature and the control unit (above all during idling stops) to operate in the self-adjustment mode.

### Starting and post-starting

During starting it is not possible to recognize the engine timing and consequently it is not possible to implement the timed injection.
During the first revolutions of the engine an initial simultaneous injection is carried out (also because the considerable fluctuations in the rotation speed do not allow the correct calculation of the injection timing) and subsenquently the injection is the timed type.
The "basic" injection time "is increased by a multiplication coefficient for the entire time the engine is driven by the starter motor.
After starting has taken place the coefficient is gradually reduced until is disappears within a given time which the lower the engine temperature the longer the time taken.

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k: enrichment coefficient
t: time
α: decrease depending on the engine temperature
ON : engine driven (crank)
OFF : engine started (run)

### Operation when cold

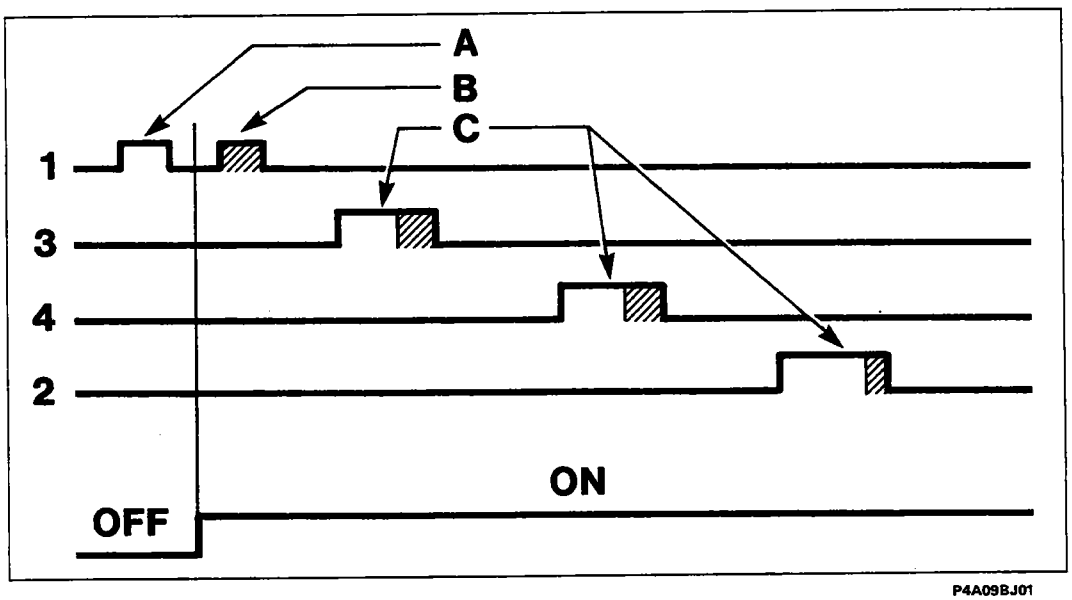
In these conditions there is a natural weakening of the mixture as a result of the reduced evaporation and the strong condensation of the fuel on the inner walls of the inlet manifold: in addition, the increased viscosity of the lubrication oil causes an increase in the passive resistance of the engine.
The "basic" injection time is corrected by a multiplication coefficient which depends on the temperature and the speed of the engine.

### Operation in full load conditions

The strategy is enabled when the butterfly opening exceeds 70°.
The "basic" injection time is multiplied by a coefficient (dependent on the engine speed) equal to around 1.1.

### Operation during acceleration

During this stage the control unit increases the quantity of fuel supplied.
The "basic" injection time is multiplied by a coefficient depending on the temperature of the engine and the speed of the opening of the accelerator butterfly (avearge value 1.2).
If the brisk variation in the injection time is calculated when the injector is already closed, the control unit reopens the injector (extra pulse), in order to compensate the mixture strength with increased speed; the subsequent injectors are, on the other hand, increase on the basis of the previously mentioned coefficients.




A: normal injection time
B: injector re-opening (extra-pulse)
C: injection time including enrichment
OFF: engine at stationary speed
ON: engine in transition

### Operation during deceleration

During this stage a negative transit strategy is implemented to decrease the quantity of fuel supplied: the "basic" injection time is multiplied by a coefficient which depends on the temperature of the engine, the speed and the load conditions at the moment immediately prior to the start of the deceleration.

### Operation during cut-off

The cuto-off strategy is implemented when the control unit recognizes the butterfly in the idle position (signal frombutterfly potentiometer) and the engine speed is above 1600 rpm (with the engine warm). The supply to the engine is re-enabled with the recognition of the butterfly in the not closed position orwhen the speed goesbelow 1200 rpm (with the engine warm).

### Rotation speed limiter

The strategy restricts the maximum speed which can be reached by the engine enabling the cut-off gradually, as shown in the table.
Maximum speed: 6550 rpm

| method \ cylinders | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| 1 cilindro | ● | | | |
| 2 cilindri | ● | | | ● |
| 3 cilindri | ● | | ● | ● |
| 4 cilindri | ● | ● | ● | ● |

### Electric fuel pump operation

The electric fuel pump is operated by the engine control unit via a relay.
The pump cut out takes place:

- if the engine speed goes below 50 rpm;
- after a certain time (about 5 seconds) with the ignition switch in the ON position without the engine being started up (timed inhibitor);
- if the inertia switch has intervened.

### Injector operation

The operation of the injectors is the sequential timed type. However, during starting the injectors are operated once in parallel.
The timing of the operation of the injectors is variable according to the engine speed.

## FIAT CODE ANTI-THEFT SYSTEM MANAGEMENT

The system is equipped with an anti-theft function. This function is achieved thanks to the presence of a special control unit (FIAT CODE), capable of dialogue with the engine control unit and an electronic key, equipped with a special transmitter for sending a recognition code.
Each time the key is turned to the OFF position, the Fiat CODE system completely deactivates the engine control unit.
If the key is turned to the ON position, the following operations take place in the order given:

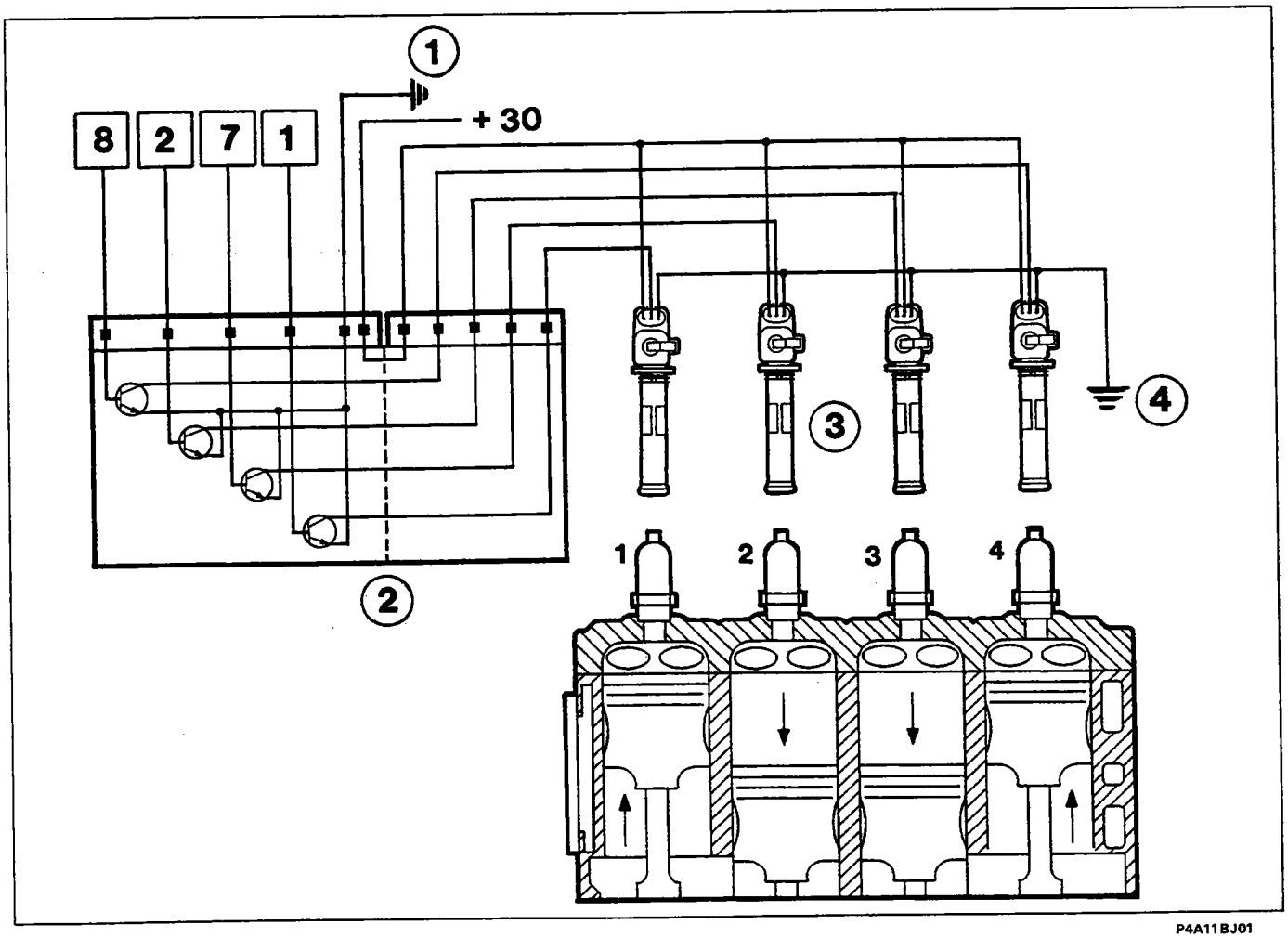
1. the engine control unit (whose memory contains a secret code) sends the FIAT CODE memory a request so that the latter sends the secret code to deactivate the locking of the functions;
2. the Fiat CODE control unit responds by only sending the secret code after having, in turn, received the recognition code transmitted by the ignition key;
3. the recognition of the secret code allows the de-activation of the locking of the engine control unit and its normal operation.

**NOTE** *The presence of the FIAT CODE anti-theft system makes it strongly inadvisable, during diagnosis, to proceed with the test using another engine 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 then make it unusable on other vehicles.*

## IGNITION MANAGEMENT

The ignition management strategies have the objective of striking the spark with the desired advance according to the engine operating conditions.

The management of the ignition basically consists of determining the ignition advance and its implementation by controlling the power module, connected externally to the control unit.
The value of the "basic" advance, calculated on the basis of the intake air flow rate and the engine speed, is then corrected depending on the different engine operating conditions.
The control unit determines the moment of the start of the conduction of the current in the coil primary winding on the basis of the engine rotation speed.
This moment obviously varies in relation to explosion TDC for each cylinder and the greater the engine rotation speed, the greater the advance because the time *(dwell)* required to saturate the current in the coil primary winding is more or less constant.
The moment of the start of conduction is corrected according to the battery voltage.

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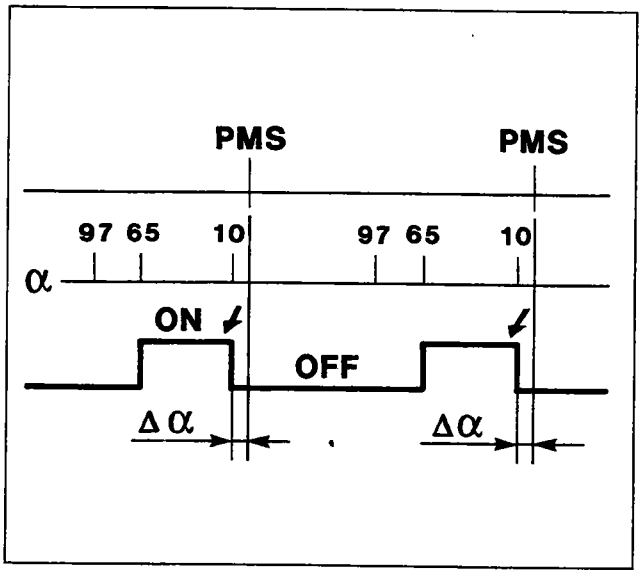
1. Ignition power module earth
2. Ignition power module
3. Single ignition coil (plug-top)
4. Secondary coil earth




P4A12BJ01

α: crankshaft flywheel signal
Δ α: fixed ignition advance (10° engine)
ON : activated coil conduction
OFF: de-activated coil conduction

**Starting**

During starting it is not possible to carry out the normal management of the advance because the considerable fluctuations in the rotation speed do not allow the correct calculation of the dwell and the advance.
The advance is therefore managed by taking the following as a reference:
- for the start of conduction, the tooth at 65°;
- for the ignition advance, the tooth at 10°.

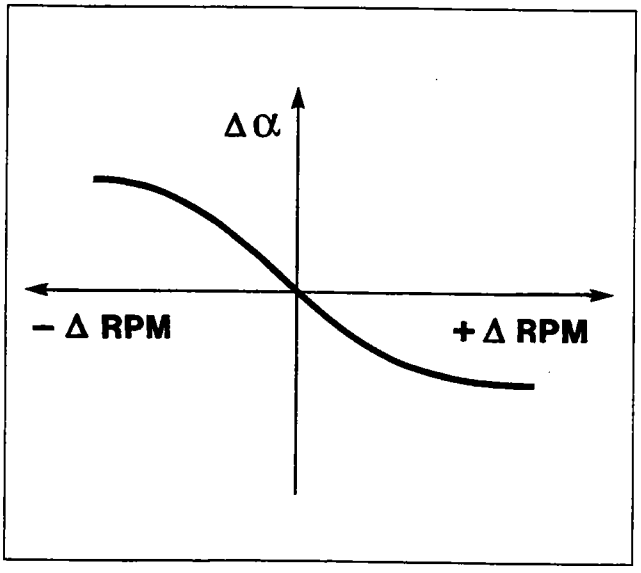
As a result there is a fixed advance at 10° for the entire time the engine is driven by the starter motor.

**Operation when cold**

During operation when cold an additional correction of the advance is implemented: the increase in the advance in relation to the one in the memory is inversely proportional to the temperature of the engine.

**Operation during cut-off**

The ignition advance is increased at the entry into cut-off: from the moment the supply of fuel is re-enabled the advance is gradually restored to the "base" value.

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Δ α: correection of ignition advance during idling
+Δ RPM: the idle speed exceeds the nominal value
-Δ RPM: the idle speed is lower than the nominal value

**Operation with engine idling**

When the engine is idling, the management of the advance is implemented independently of the "basic" advance.
The value of the advance during idling, which varies according to the temperature of the coolant (10° with the engine warm) is corrected in accordance with the variation of the speed in relation to the pre-set speed, which also depends on the temperature.
In particular, the advance is increased if the speed decreases and is reduced if the speed increases, in order to ensure the stability of the actual speed.

### Checking detonation

The strategy has the task of detecting the presence of the phenomenon of detonation, by processing the signal coming from the appropriate sensor. The strategy constantly compares the signal coming from the sensor with a level which, in turn, is constantly updated to take into account the background noise and the ageing of the engine.
If the system recognizes the presence of detonation, the strategy reduces the ignition advance, producing a step of 2° up to a maximum of 6°, until the phenomenon disappears. As a result, the advance is gradually restored until the basic value or until the phenomenon arises again. In particular, the advance increases are gradully implemented, whilst the reductions are introduced immediately.
During acceleration conditions, the strategy uses a higher level, to take into account the increased engine noise under these circumstances.
The strategy is also equipped with a self-adjustment function which permanently memorizes the advance reductions which must be continuously repeated in order to adapt the advance to the different conditions in which the engine finds itself (for example, the use of a low octane rating fuel). The strategy is capable of restoring the advance to the value in the memory if the conditions which have caused the reduction no longer exist.

## ENGINE IDLE CONTROL MANAGEMENT

The general objective of the strategy is to maintain the engine speed around the memorized value (engine warm: 850 rpm): the position assumed by the actuator depends on theengine speed and conditions and the speed of the vehicle.

### Starting stage

When the key is inserted the actuator assumes a position which depends on the temperature of the engine and the battery voltage (open-loop position).

### Engine started with accelerator pedal released

The engine speed varies according to the temperature of the engine and is constantly maintained close to this value modifying the position of the shutter to compensate for any oscillations in the speed.
This takes place in particular when external loads are applied (power assisted steering, heated rear windscreen, etc).
If the electric fans and the air conditioning are switched on, both of which are managed by the control unit, the strategy manages the advance actuator as appropriate.

### Normal opeartion

In these conditions the actuator is in the open-loop position.

### During deceleration

In deceleration conditions outisde of idling, the control unit operates the position of the actuator through a special curve *(dash-pot curve)*, or it slows down the return of the shutter towards its housing, achieving a reduction in the engine braking effect.

## CHARCOAL FILTER MANAGEMENT

The strategy controls the position of the charcoal filter solenoid valve as follows:
- during the starting stage the solenoid valve remains closed, preventing the fuel vapours from enriching the mixture; this condition persists until the engine coolant reaches 25°C;
- with the engine at operating temperature, the control unit causes the solenoid valve to operate in duty-cycle to control the quantity of fuel vapours sent to the inlet, according to the engine speed and load conditions.

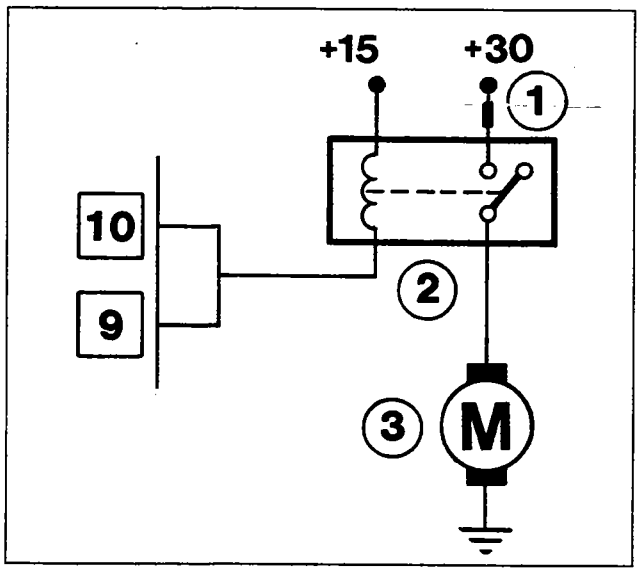
In the following operating conditions:
- butterfly in closed position,
- speed below 1250 rpm,
- engien load TP < 1 ms,

the operation of the solenoid valve is disabled, keeping it in the closed position.

## RADIATOR FAN MANAGEMENT

The control unit directly controls the operation of the radiator fan depending on the coolant temperature and whether or not there is a climate control system.

**NOTE** *Since the temperature of the engine is measured by the appropriate sensor there is no longer a thermal contact on the radiator.*

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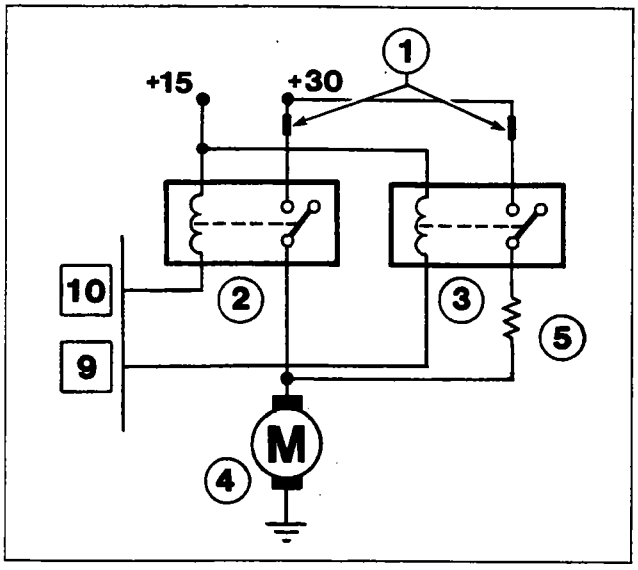
### Version without climate control

There is an electric fan which switches on when the temperature of the coolant exceeds 95°C.
It switches off with a hysteris of 2°C around the temperature level.

1. Fuse
2. Fan relay
3. Electric fan




P4A14BJ02

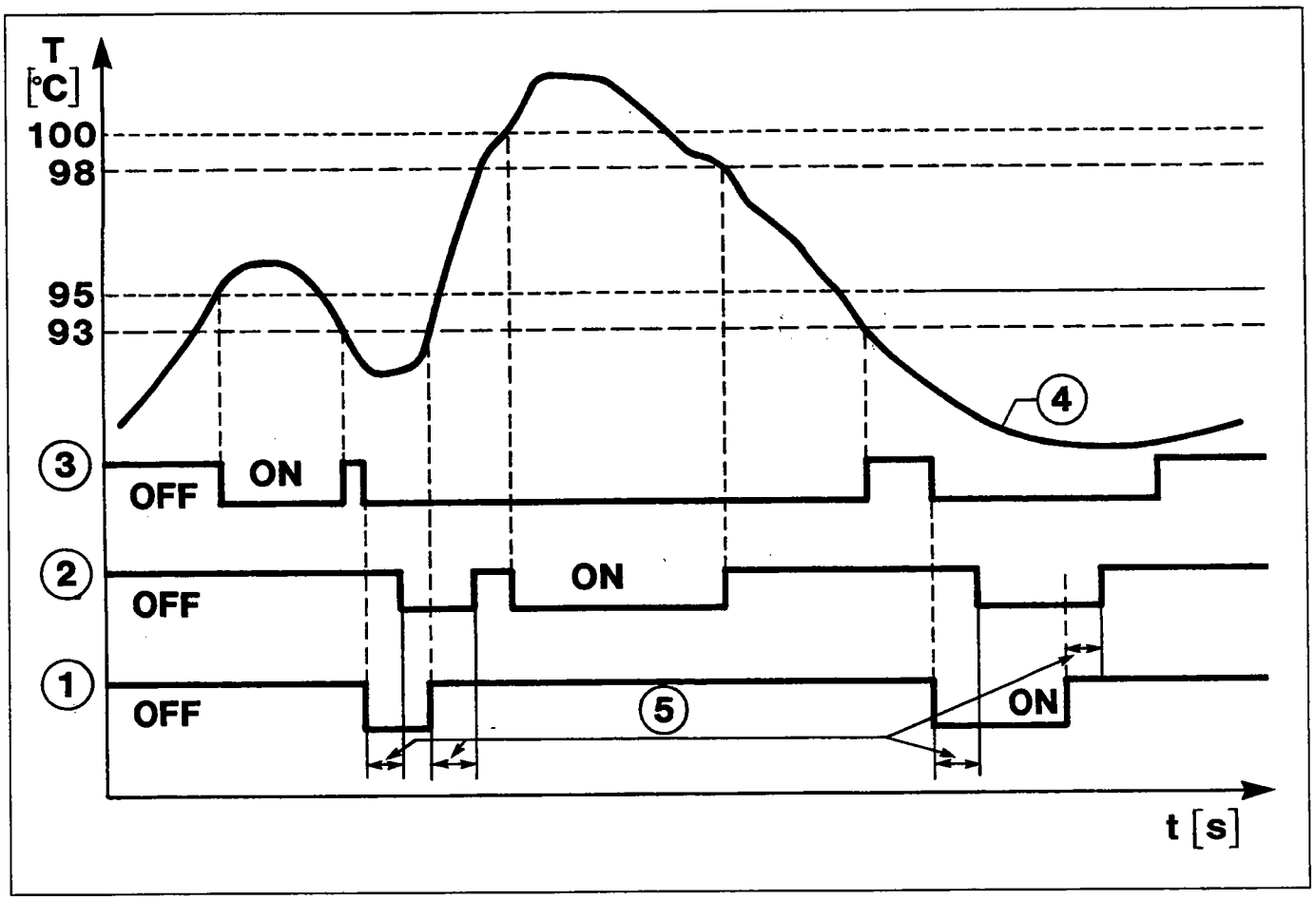
### Version with climate control

There is an electric fan with two operating modes:
- low speed,
- high speed.

1. Fuse
2. High speed relay
3. Low speed relay
4. Electric fan
5. Resistance

**Diagram showing operation of electric fan for version with air conditioning**

Low speed: it switches on when the temperature of the coolant reaches 95°C.
High speed: it switches on when the temperature of the coolant reaches 100°C.
The speed of the electric fan also depends on the state of the three stage pressure switch for the climate control system which determines the engagement of the first speed and, with a certain delay, that of the second and the subsequent switching off.




1. State of the three stage pressure switch
2. High speed operating condition
3. Low speed operating condition
4. Coolant temperature trend
5. Three stage pressure switch attachment/detachment delay

ON: speed/pressure switch activated
OFF: speed/pressure switch deactivated

## CLIMATE CONTROL SYSTEM MANAGEMENT

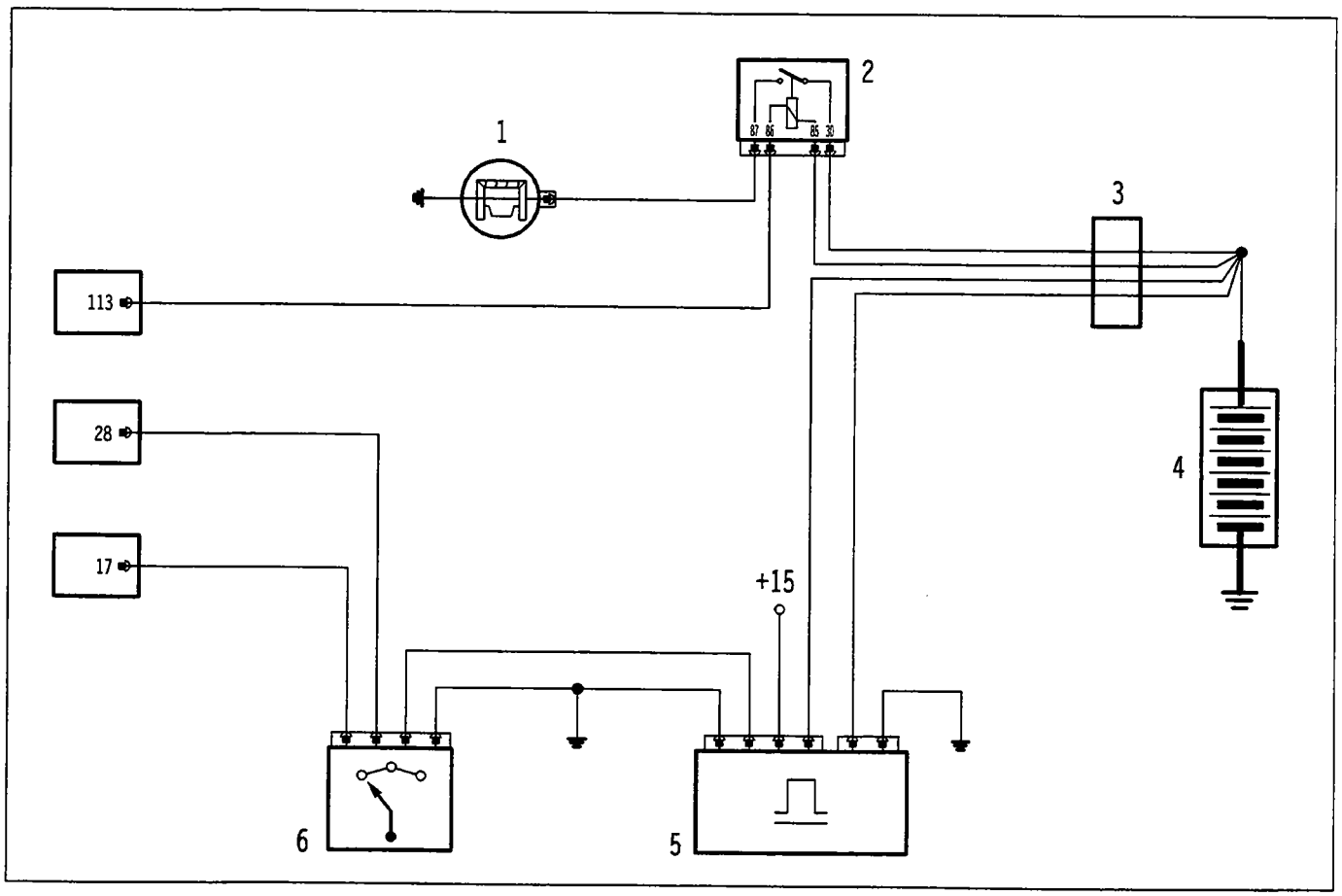
The Hitachi engine control unit is operationally connectedto the climate control system and:

1. receives the request to switch on the compressor from the climate control system control unit via pin 28 and operate the relevant functions (additional air);
2. gives the go ahead to switch on the compressor via pin 113 when the conditions laid down by the strategies are confirmed;
3. receives information concerning the state of the three stage pressure switch from pin 17 and operates the relevant functions (radiator fan operation).

As far as point 1 is concerned, if the engine is idling, the control unit increases the air flow rate which goes from the idle actuator in advance of the switching on of the compressor and viceversa places the actuator in the normal position in delay in relation to the switching off of the compressor.
On the other hand, as far as point 2 is concerned, the control unit automatically operates the switching off of the comrpessor:

a) for a time of 6 s (timed switching off):
   - in butterfly opening conditions of more than 70°,
   - when the vehicle is accelerating;

b) when the following critical conditions persist:
   - at coolant temperatures conditions above 114°C,
   - when the engine idle speed is below 750 rpm.

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1. Compressor
2. Compressor relay
3. Fuse box
4. Battery
5. Climate control unit
6. Three stage pressure switch

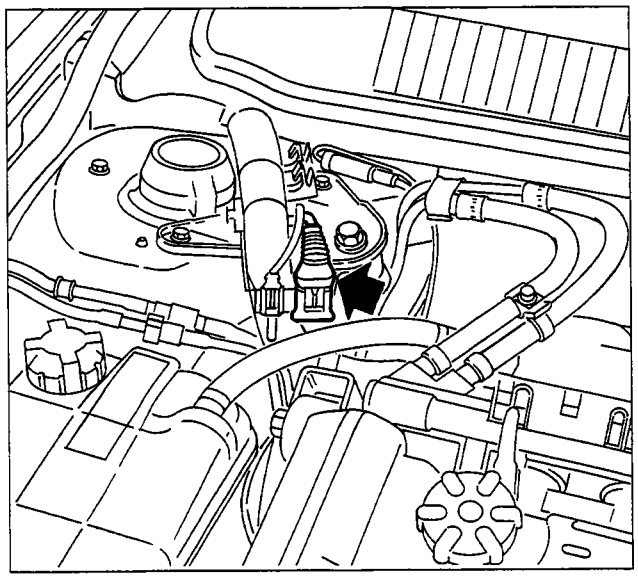
## DIAGNOSIS

The system is equipped with an autodiagnostic function which checks for any irregular state in the following components:

**Actuators**
injectors
coils
charcoal filter solenoid valve
engine idle adjustment solenoid valve
electric fuel pump relay
climate control compressor relay (if fitted)
electric fan low speed relay
electric fan high speed relay (if fitted)

**Sensors**
engine rpm sensor
engine timing sensor
air flow meter
Lambda sensor
coolant temperature sensor
butterfly position sensor
vehicle speed sensor
detonation sensor

**Location of F/L Tester connector**



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The detection of a fault, if confirmed, involves it being permanently memorized, as well as excluding the relevant sensor from the system until it is repaired.
The detection of a confirmed fault usually involves the warning light in the dashboard coming on: the warning light goes out when the fault is repaired.

Working with the Fiat Lancia Tester it is possible to carry out a complete fault diagnosis of the system which consists of three stages:
1. displaying a series of functional parameters (with the engine running);
2. displaying errors and cancelling them;
3. activating certain actuators (active diagnosis).

### 1. Parameters displayed

The following engine parameters are displayed:
- air flow rate,
- coolant temperature,
- butterfly sensor position,
- Lambda sensor voltage,
- battery voltage,
- Lambda sensor state,
- vehicle speed,
- engine rpm,
- air flow rate/maximum flow rate,
- ignition advance,
- charcoal filter solenoid valve duty cycle,
- injection time,
- engine load (TP),
- objective engine idle speed,
- engine idle speed adjustment solenoid valve duty cycle,
- FIAT CODE state,
- errors present.

### 2. Detecting and cancelling faults

*Detecting faults*
This is carried out during the basic functions through which the sensor/actuator is managed.

*Memorizing the error and the structure of the errors memory*
The errors are memorized in the control unit in the order in which they occur.
The following is memorized for each of them:
- the error code (component and type of error),
- the error counter,
- the time elapsed since the error was detected,
- two environmental conditions (specific for each type of fault) at the time the fault was detected.

*Classification of the fault*
If a fault is recognized for the first time and the error state persists for a certain length of time, the fault is memorized as "permanent". If this fault later disappears, then it is memorized as "not present". The classification of a fault as "permanent" activates the recovery functions: when the fault disappears, normal operation is restored.
The presence of a "permanent" fault also involves the system failure warning light in the dashboard coming on.

*Frequency counter*
The counter, which goes from 0 to 127 and which is activated in the case of a fault, is decreased each time the engine is started up without the fault reappearing: when the counter reaches zero, the fault is automatically cancelled from the memory.

*Failure warning light*
The failure warning light comes on when there is at least on "permanent" fault in the memory.

**NOTE** *During starting, the warning light is:*

- on for 4 seconds,
- off for 0.15 seconds,
- kept on/off according to whether or not there are "permanent" errors.

*Cancelling of the errors*
When the frequency counter reaches zero, the fault and the parameters associated with it are cancelled.
The immediate cancelling of the entire errors memory takes place in the following cases:

- through the "cancel errors memory" command sent by the F/L Tester;
- by interrupting the electrical supply for the control unit (disconnecting the battery or the control unit connectors) for at least 60 seconds.

### 3. Activating the actuators (active diagnosis)

The following actuators are activated with the engine switched off via a command from the F/L Tester:
- injectors (in the order cyls. 1, 2, 3 and 4),
- coils (in the order cyls. 1, 2, 3 and 4),
- electric fuel pump relay,
- charcoal filter solenoid valve,
- engine idle adjustment solenoid valve,
- system failure light,
- rev counter signal,
- climate control compressor relay (if fitted),
- electric fan low speed relay,
- electric fan high speed relay (if fitted).

## RECOVERY STRATEGIES

If a problem is detected with the sensors/ actuators the control unit, where possible, replaces the missing data, reconstructing it using software (recovery) to allow the operation of the engine.
For the sensors/actuators not mentioned in the list below, there is not type of recovery.

**Engine timing sensor**
*recovery:* the engine cannot be started up, however if the problem occurs with the engine started up, it stays operating.

**Air flow meter**
*recovery:* the air flow rate is calculated on the basis of the butterfly position and rotation speed values.
*additional provisions:* self-adjustment of the mixture strength and idle disabled; charcoal filter solenoid valve disabled.

**Coolant temperature sensor**
*recovery:* during starting T = 20°C; otherwise T = 20°C increased by 1°C every 6 seconds until reaching 80°C; during starting or with the key in the OFF position the radiator fan is off, otherwise it is activated.
*additional provisions:* self-adjustment of mixture strength and idle disabled.

**Butterfly position sensor**
*recovery:* fixed butterfly angle = 7°; if the engine load (TP) is below 1.75 ms and the speed is below 1000 rpm, then the engine is idling, otherwise it is outside of idling.
*additional provisions:* self-adjustment of idling disabled.

**Vehicle speed sensor**
*recovery:* speed = 0.
*additional provisions:* self-adjustment of idling disabled.

**Lambda sensor**
*recovery:* the reading of the sensor voltage is disabled (open-loop).

**Detonation sensor**
*recovery:* the "basic" advance is reduced by an average of 5° if the engine load TP is above 2.5 ms.

**Engine idle speed adjustment solenoid valve**
*recovery:* the valve is kept open at a pre-set value.

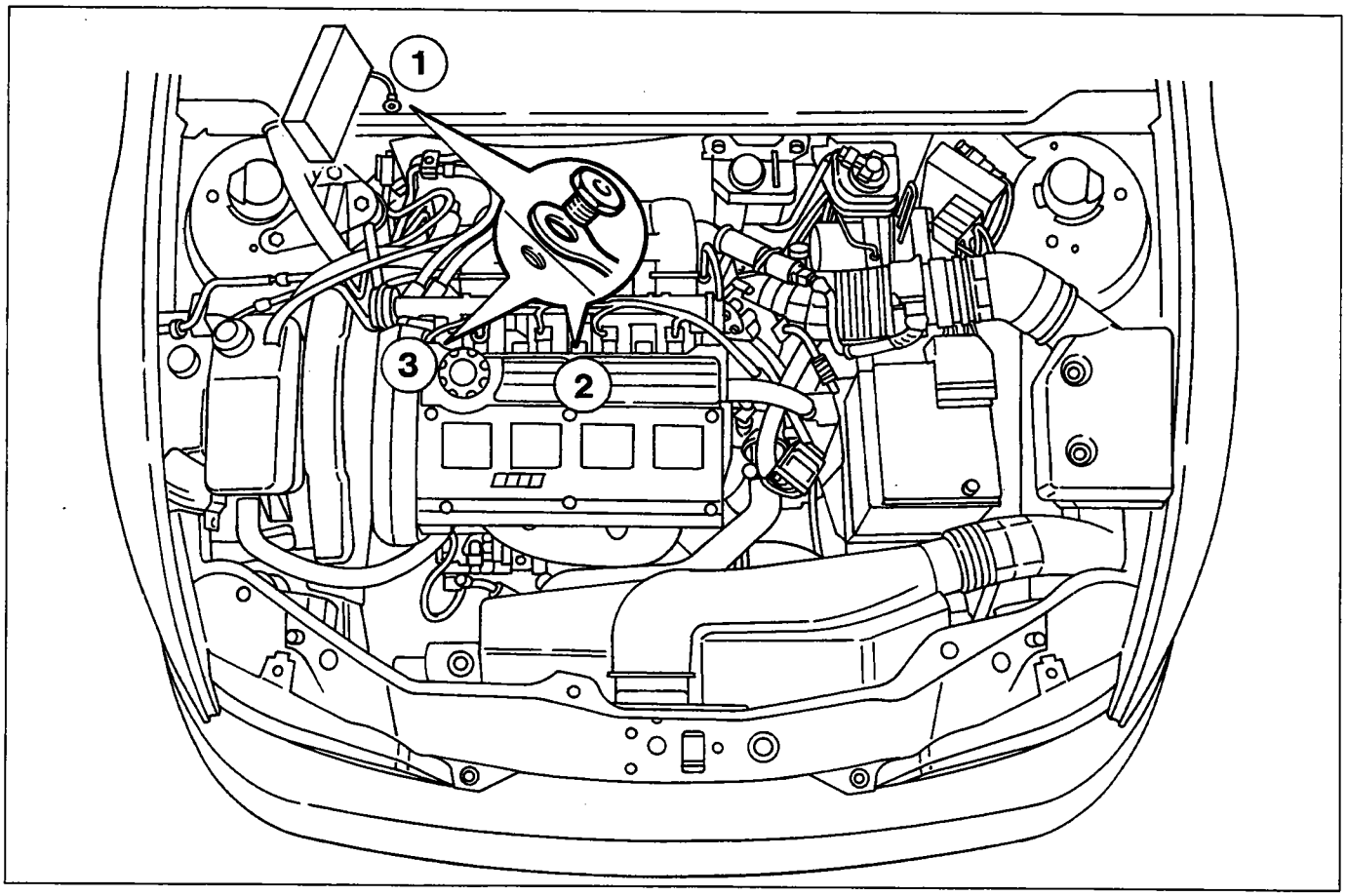
## ELECTRICAL/ELECTRONIC CIRCUIT

This circuit electrically connects all the components of the system and is made up of the following components:

- wiring with fuses;
- HITACHI engine control unit;
- system and pump relay;
- sensors:
  butterfly position sensor,
  coolant temperature sensor,
  air flow meter,
  engine rpm sensor,
  engine timing sensor,
  Lambda sensor,
  vehicle speed sensor,
  detonation sensor;
- actuators:
  electric fuel pump,
  injectors,
  engine idle speed adjustment solenoid valve,
  charcoal filter solenoid valve,
  electric pump cut out inertia switch,
  ignition power module,
  ignition coils;
- devices connected to the cotnrol unit:
  radiator fan relays,
  climate control compressor relay (if fitted),
  Fiat CODE control unit.

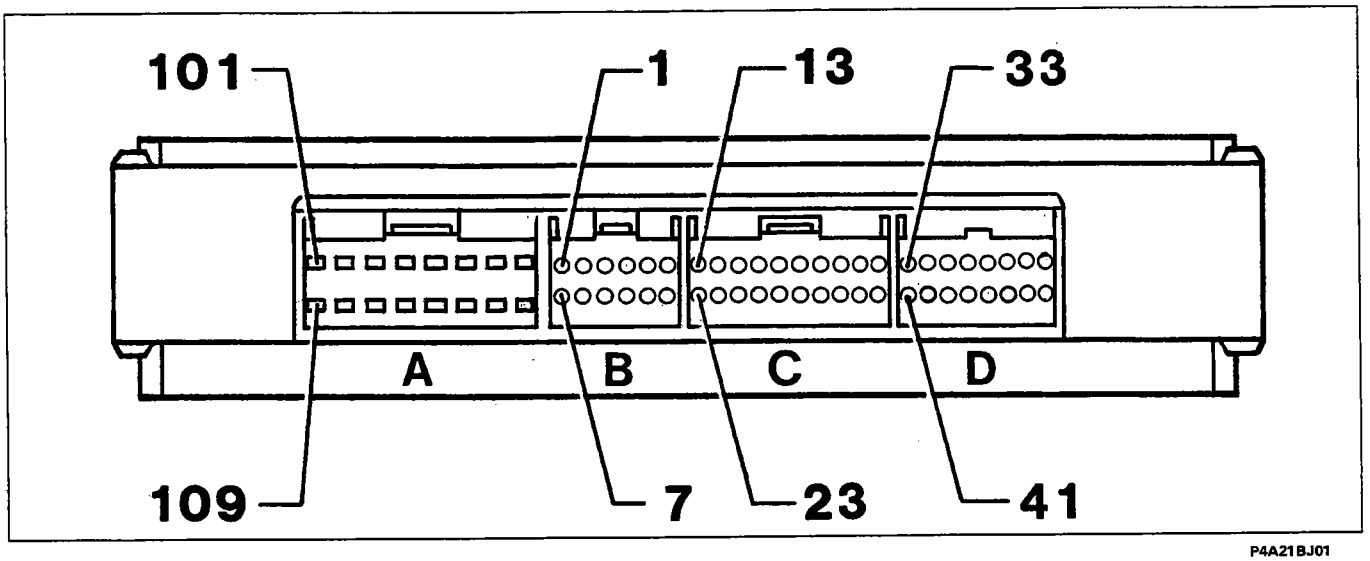
### Layout of system earth points

In order to increase the electro-magnetic compatibility and the operational reliability special care has been taken over the layout of the earth points, as shown in the diagram below:
1. control unit casing, connected to the vehicle bodyshell;
2. secondary coils connected under the cylinder head cover;
3. control unit internal earths (pins 6, 12, 107, 108, 116, 40, 48), Lambda sensor heater earth, relay earths, ignition power module earth connected to the engine cylinder block/crankcase.




P4A20BJ01

## HITACHI SYSTEM CONTROL UNIT PIN-OUT




P4A21BJ01

### Connector A

101. Operation of injector for cylinder 1
102. N.C.
103. Operation of injector for cylinder 2
104. Pump relay operation
105. Operation of injector for cylinder 3
106. Negative for charcoal filter solenoid valve
107. Earth
108. Earth
109. Negative for engine idle adjustment solenoid valve
110. Operation of injector for cylinder 4
111. Positive for engine idle adjustment solenoid valve
112. Control unit supply
113. Climate control compressor relay feed (if fitted)
114. N.C.
115. N.C.
116. Earth

### Connector B

1. Operation of coil for cylinder 1
2. Operation of coil for cylinder 3
3. Operation of rev counter
4. N.C.
5. N.C.
6. Earth
7. Operation of coil for cylinder 3
8. Operation of coil for cylinder 4
9. Operation of electric fan low speed relay
10. Operation of electric fan high speed relay *
11. Operation of system failure light
12. Earth

### Connector C

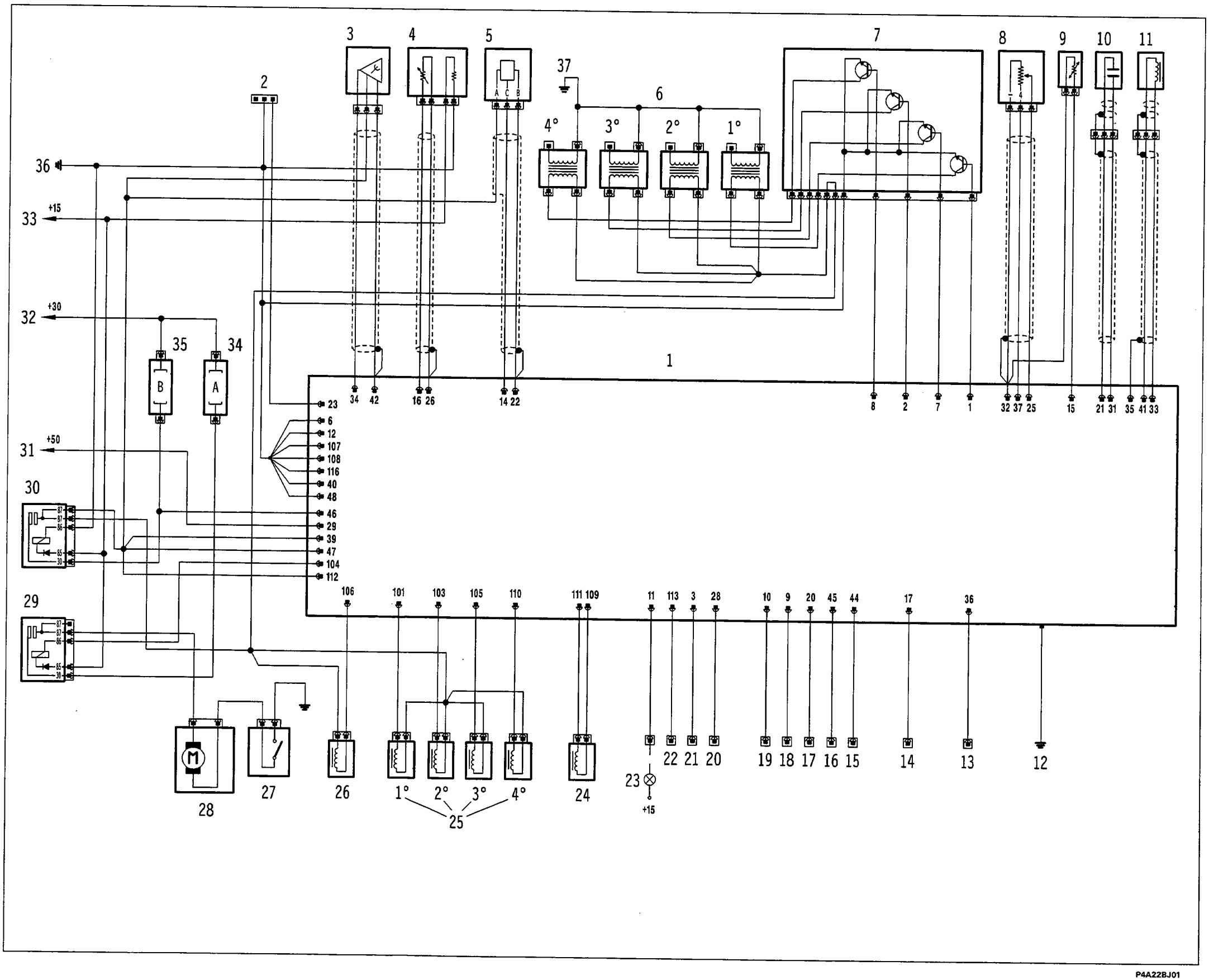
13. N.C.
14. Positive for air flow meter
15. Positive for coolant temperature sensor
16. Positive for Lambda sensor
17. Signal for three stage pressure switch (if fitted)
18. N.C.
19. N.C.
20. Connection with FIAT CODE
21. Positive for detonation sensor
22. Negative for air flow meter
23. Line K
24. N.C.
25. Signal for butterfly position sensor
26. Negative for lambda sensor
27. N.C.
28. Signal for engaging compressor (if fitted)
29. AVV signal from ignition switch (+50)
30. N.C.
31. Earth for detonation sensor
32. Negative for coolant temperature and butterfly position

### Connector D

33. Positive for engine rpm sensor
34. Positive for engine timing sensor
35. Earth for engine rpm sensor
36. Signal for vehicle speed sensor
37. Positive for butterfly position sensor
38. N.C.
39. Control unit supply
40. Earth
41. Negative for engine rpm sensor
42. Negative for engine timing sensor
43. N.C.
44. Calibration selection
45. Trim level selection (to earth for versions without climate control)
46. Control unit supply
47. Control unit supply
48. Earth

* Short circuited at pin 9 for versions without climate control

## HITACHI SYSTEM WIRING DIAGRAM




P4A22BJ01

### Hitachi system wiring diagram key

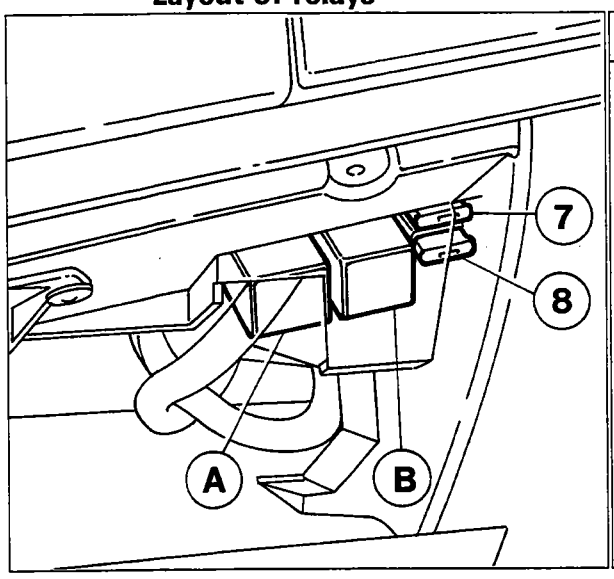
1. Engine control unit
2. F/L Tester (line K)
3. Engine timing sensor
4. Lambda sensor
5. Air flow meter
6. Ignition coils
7. Ignition power module
8. Butterfly position sensor
9. Coolant temperature sensor
10. Detonation sensor
11. Engine rpm sensor
12. Control unit casing earth on vehicle bodyshell
13. Vehicle speed inlet
14. Intake from three stage pressure switch (climate control if fitted)
15. Calibration selection
16. Trim level selection (to earth for versions without climate control)
17. Connection with Fiat CODE control unit
18. Operation of electric fan low speed relay
19. Operation of electric fan high speed relay (short circuited at pin 9 for versions without climate control)
20. Intake for request to engage climate control compressor (if fitted)
21. Operation of rev counter
22. Climate control compressor relay feed (if fitted)
23. Operation of system failure light
24. Engine idle speed adjustment sol. valve
25. Injectors
26. Charcoal filter solenoid valve
27. Inertia switch
28. Electric fuel pump
29. Electric fuel pump relay
30. System relay feed
31. AVV signal from ignition key (+50)
32. Supply from battery (+30)
33. Supply from ignition key (+15)
34. Pump fuse (30 A)
35. System fuse (15 A)
36. Earth (on engine block)
37. Earth (under cylinder head cover)

### SYSTEM RELAYS

With the ignition key in the ON position (+15) the energizing coils for both relays are supplied, which close the respective power contacts.
Relay (A) supplies the electric fuel pump, receiving voltage directly from the battery.
Relay (B) ensures the multiple supply of the control unit and the various system sensors and actuators, both directly and via the connectors.

**NOTE** *The layout of relays (A) and (B) and fuses (7) and (8) can vary through production requirements. They should be recognized on the basis of the electrical connections.*

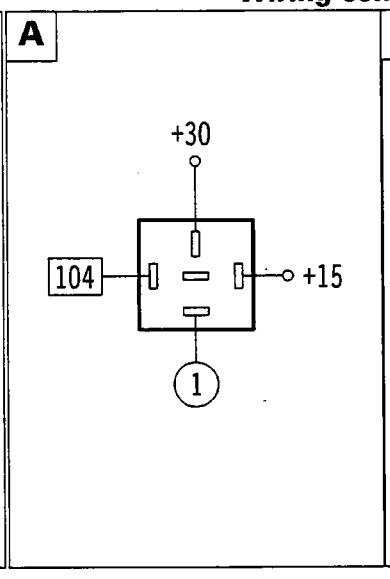
**Layout of relays**




P4A23BJ01

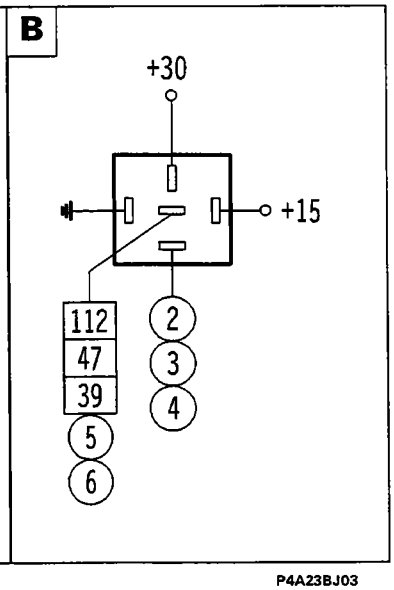
1. Electric fuel pump
2. Injectors
3. Charcoal filter solenoid valve
4. Ignition power module

**Wiring connectors**



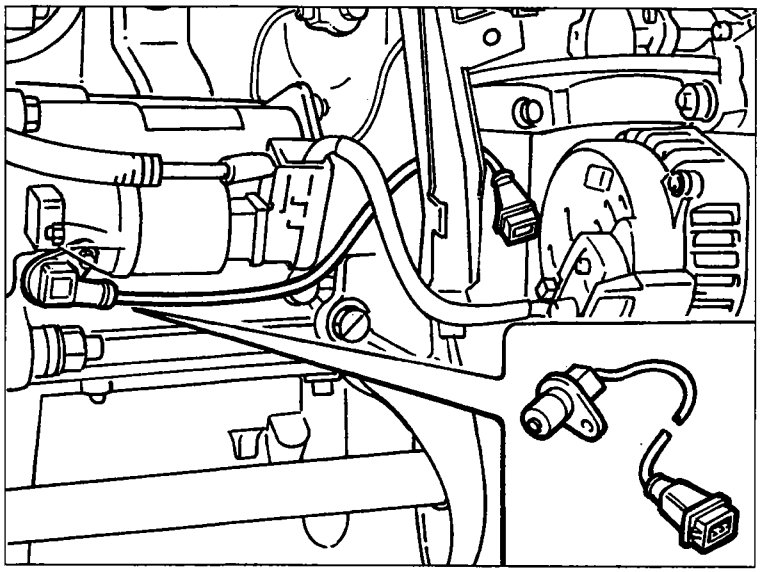

P4A23BJ02

5. Air flow meter
6. Butterfly position sensor
7. Fuse
8. Fuse




P4A23BJ03

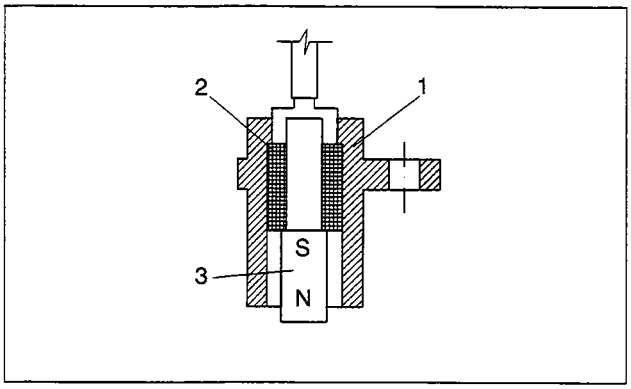
A. Electric fuel pump relay
B. System relay feed



P4A24BJ01

## ENGINE RPM SENSOR

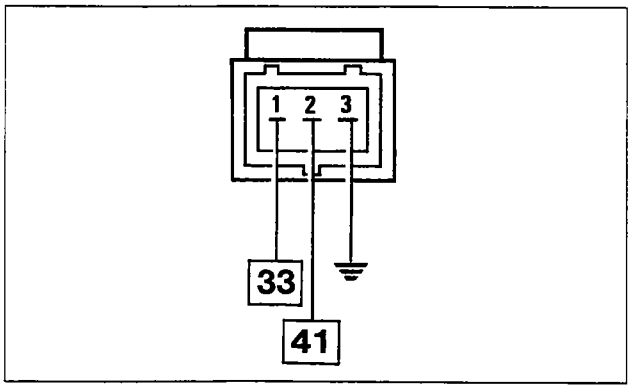
The sensor is fixed to the cylinder block-/crankcase: the flywheel is fixed with a crankshaft crank.




P4A24BJ02

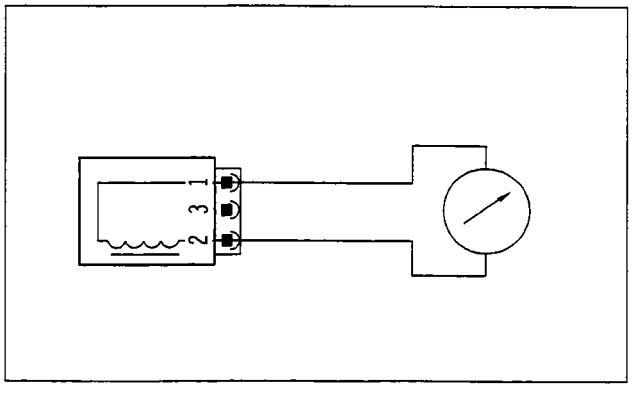
### Operating principle

The sensor is made up of a tubular casing (1) which houses a permanent magnet (3) and an electrical winding (2).
As a result of the flywheel teeth passing by, the magnetic flow produced by the magnet (3) undergoes oscillations resulting from the variation of the gap.
These oscillations create an electro-motive force in the winding (2) which produces a voltage which is alternatively positive (tooth facing the sensor) and negative (gap facing the sensor): see paragraph on "signal management". The peak sensor output voltage depends, with other factors being equal, on the distance between the sensor and the tooth (gap).




P4A24BJ03

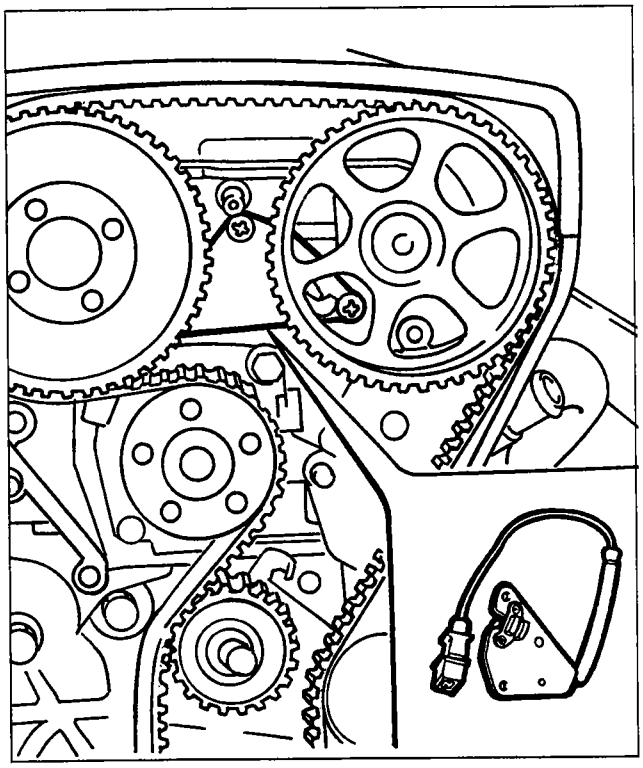
### Wiring connector




P4A24BJ04

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

**Resistance: 570 ± 57 ohm at 20°C**



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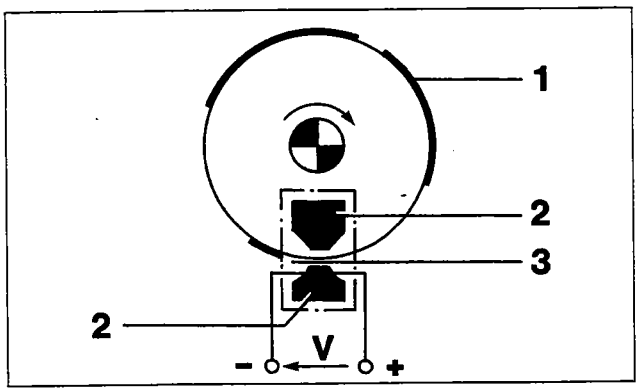
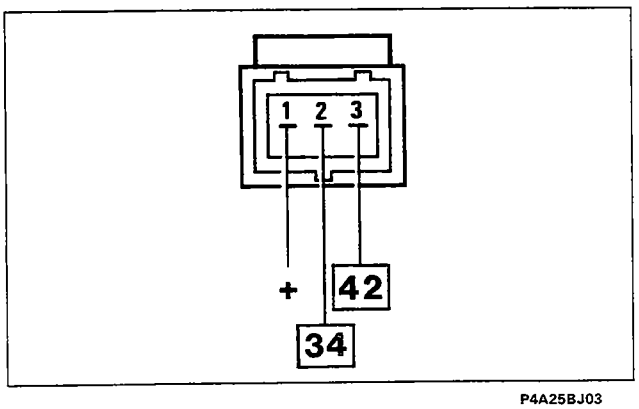



P4A25BJ02

1. Deflector
2. Magnetic material
3. Gap

### Wiring connector




P4A25BJ03

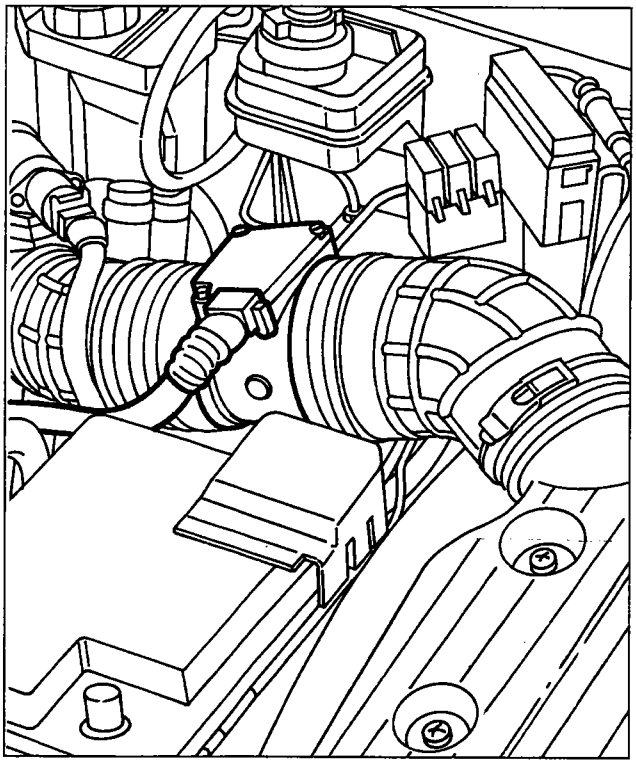
## ENGINE TIMING SENSOR

The engine timing signal, together with the engine rpm and TDC signal, allows the control unit to recognize the succession of cylinders to implement the injection timing.
This signal is generated by a Hall effect sensor, fitted by the exhaust camshaft drive pulley.

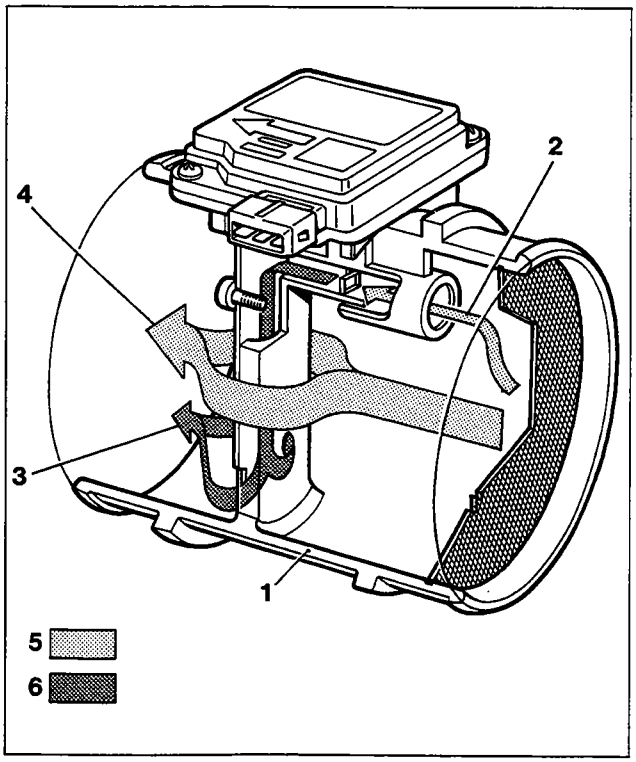
**NOTE** *It is not possible to carry out any adjustments to the angular position of the sensor.*

### Operating principle

A semi-conductor layer through which the current flows, immersed in a normal magnetic field (lines of force perpendicular to the direction of the current) generates a difference in power, known as Hall effect voltage.
If the intensity of the current remains constant, the voltage generated only depends on the intensity of the magnetic field. It is therefore sufficient if the intensity of the field varies periodically to obtain a modulated electrical signal.
In pratice, to obtain this change, the sensor has a metal ring passed through it (fixed to the inner part of the timing pulley) equipped with a series of openings: as it moves, when the ring covers the sensor, it blocks the magnetic field and the signal remains low, whilst as it passes the openings, the field closes and the signal becomes high.
The alternating of the signals therefore depends on the succession of the openings (see "signal management" chapter).



P4A26BJ01




P4A26BJ02

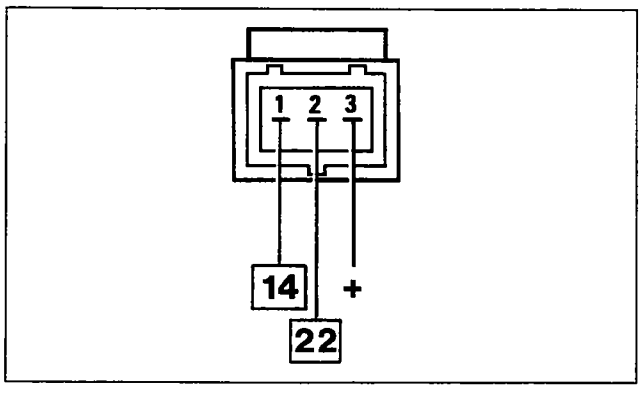
1. Flow meter casing
2. Air intake into the duct
3. Air outlet from the duct
4. Outlet air
5. Intake air
6. Air measured

## AIR FLOW METER

The air flow meter is the hot wire type where the flow rate is measured at source.
The upper part has a duct parallel to the main flow inside of which there is the heated wire.
One part of the intake air flow is introduced into the duct and, after having passed through it, it flows out of the opposite part, returning to the main flow.
Consequently, only part of the mass of air which passes through the flow meter is measured: this quantity is, however,proportional to the total mass in the flow meter.
The electrical voltage leaving the flow meter is therefore representative of the total flow rate which is calculated by applying suitable proportional parameters.
This type of flow meter has two advantages compared with the full flow type:

- considerable insensitivity to the phenomenon of air column pulses, particularly present at low speeds and heavy loads;
- less fouling of the wire, thanks to the reduced mass of air coming into contact with it; in effect the control unit does not have any wire cleaning strategy *(burn-in)*.

### Wiring connector

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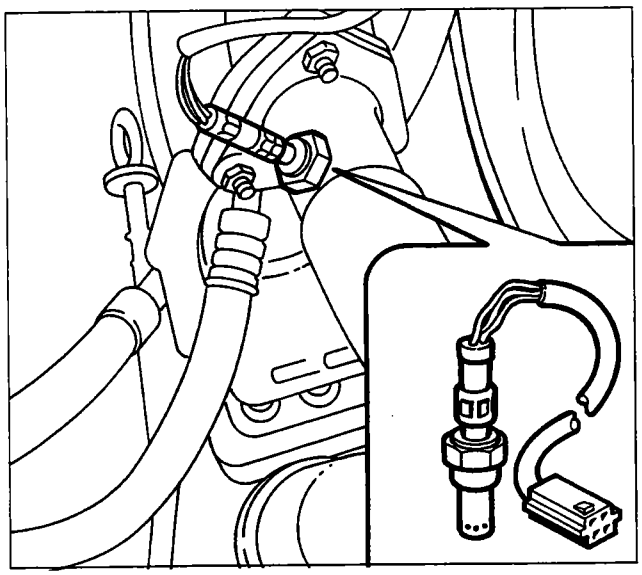

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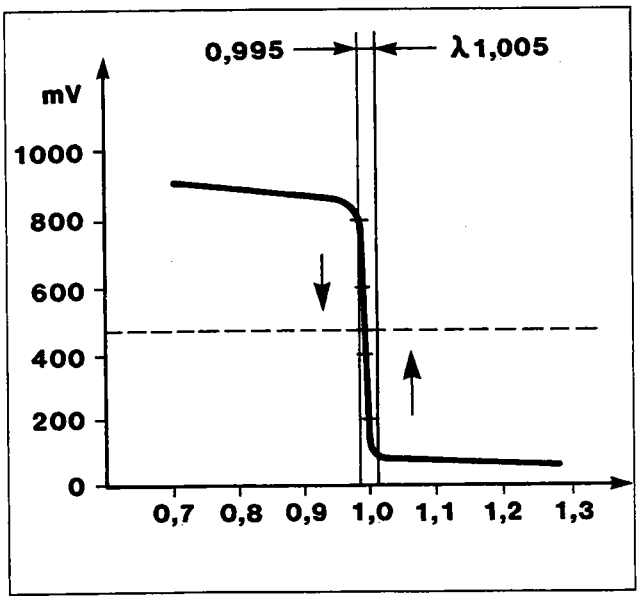
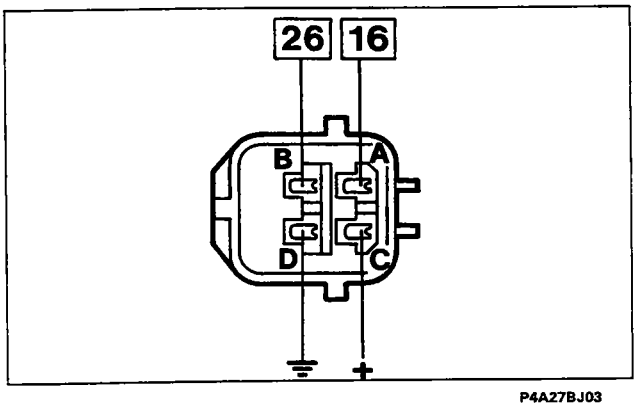



P4A27BJ02

lambda = 1: stoichiometric mixture
lambda < 1 : rich mixture, the CO values tend to be high
lambda > 1 : lean mixture, the CO values tend to be low

**Wiring connector**




P4A27BJ03

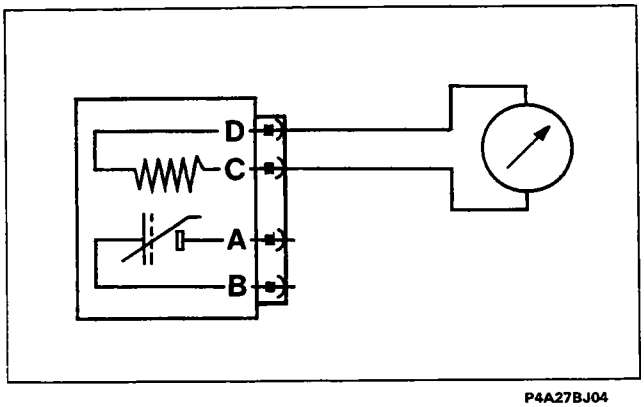
## LAMBDA SENSOR

The Lambda sensor measures the oxygen content in the exhaust gases: it is fitted on the exhaust pipe upstream of the catalytic silencer.
The sensor output signal is sent to the control unit to correct *(feed-back)* the mixture strength.
When the sensor supplies a low signal (voltage below 200 mV) the control unit recognizes a lean mixture and increases the injection time; subsequently, when the sensor signal is high (voltage above 800 mV), the control unit recognizes a rich mixture and decreases the injection time.
This sequence of operations is repeated with a frequency in the order of tens of Hertz, so that the engine operates with a mixture strength constantly oscillating around the stoichiometric value.
At temperatures below 300°C the ceramic material is not activated, therefore the sensor does not send reliable signals: to ensure rapid heating during starting and to maintain the temperature during idling, the sensor is equipped with a heater where the electrical resistance is always on.

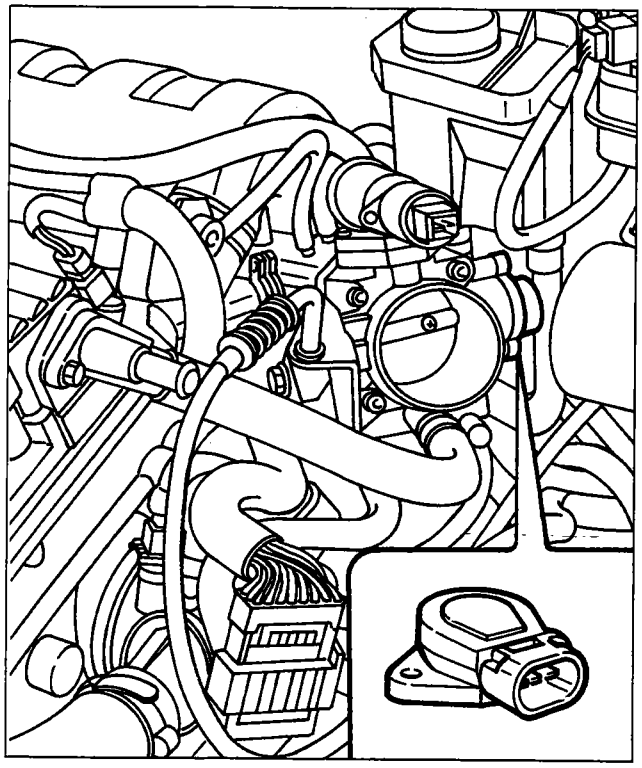
*The sensor can be rapidly put out of action by the presence of even the smallest amounts of lead in the fuel.*

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**




P4A27BJ04

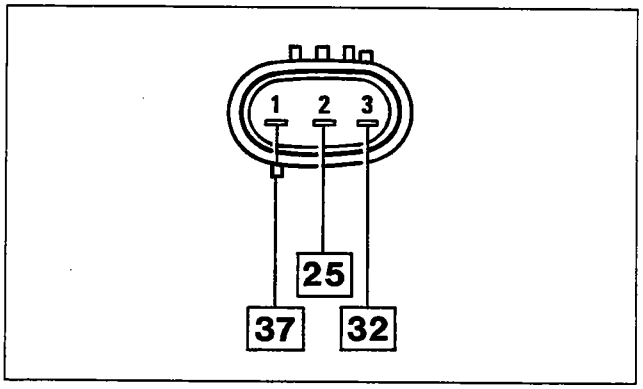


P4A28BJ01

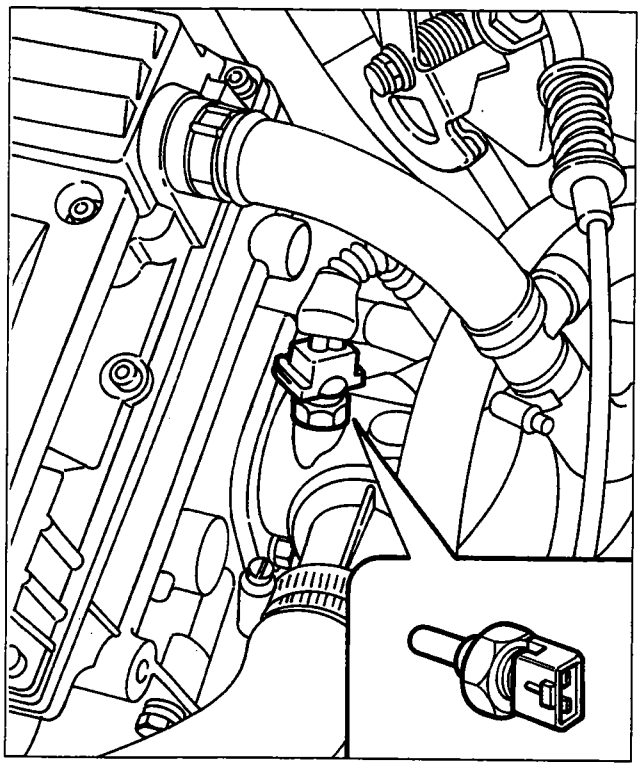
## BUTTERFLY POSITION SENSOR

It is made up of a single track potentiometer where the moving part is rotated by the accelerator butterfly shaft.

### Wiring connector



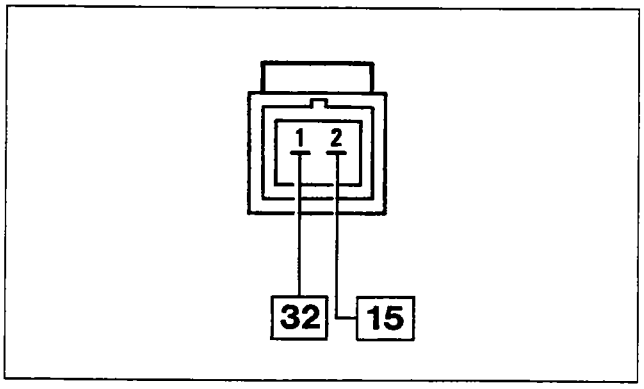

P4A28BJ02



P4A28BJ03

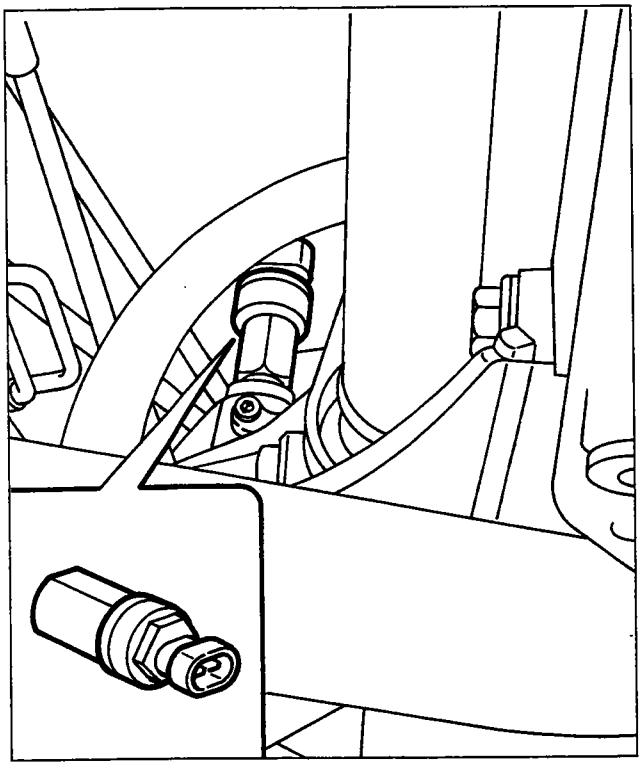
## COOLANT TEMPERATURE SENSOR

The sensor is fitted on the thermostat.
It is made up of a brass casing which protects the resistive element made up of an NTC (Negative Temperature Coefficient) thermistor where the electrical resistance decreases as the temperature increases.
The reference voltage is 5 Volt: since the control unit input circuit is designed as a voltage divider, the reference voltage is shared between a resistance in the control unit and the actual sensor.
As a result the control unit is capable of evaluating the variations in the sensor resistance through the changes in voltage.




P4A28BJ04

### Wiring connector

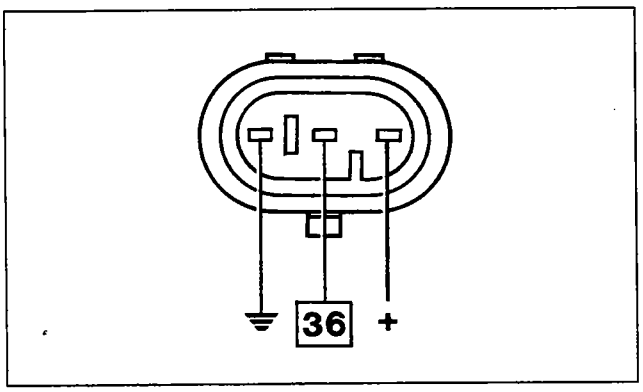


P4A29BJ03

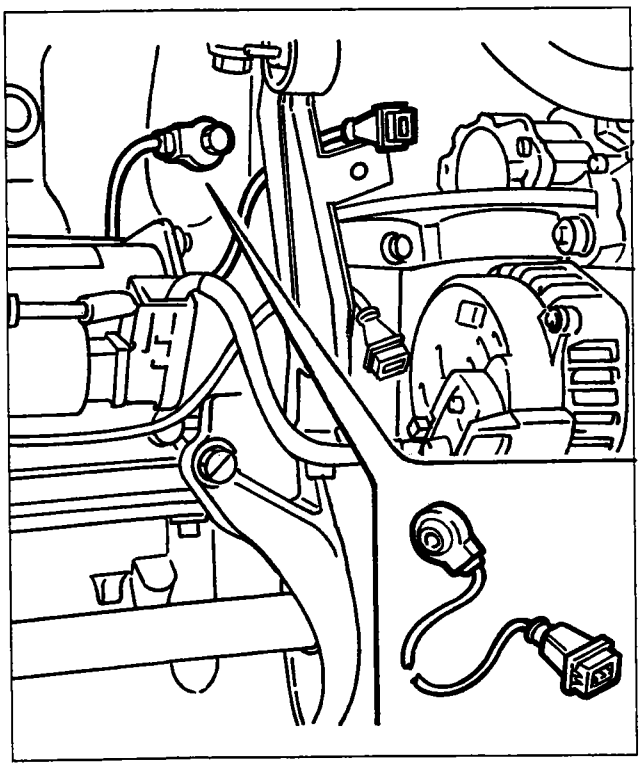
**Wiring connector**

## VEHICLE SPEED SENSOR

The sensor is positioned on the differential outlet, by the left drive shaft coupling and transmits the information relating to the vehicle speed to the control unit: the signal is also used for the operation of the speedometer.
The sensor is the Hall effect type (see "engine timing sensor" paragraph) and it is calibrated so that for each impulse there is a corresponding travel of one metre: on the basis of the frequency of the impulses it is therefore possible to know the speed of the vehicle.




P4A29BJ01

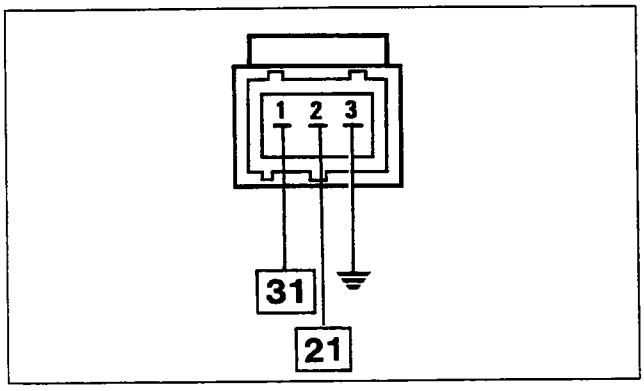


P4A29BJ04

**Wiring connector**

## DETONATION SENSOR

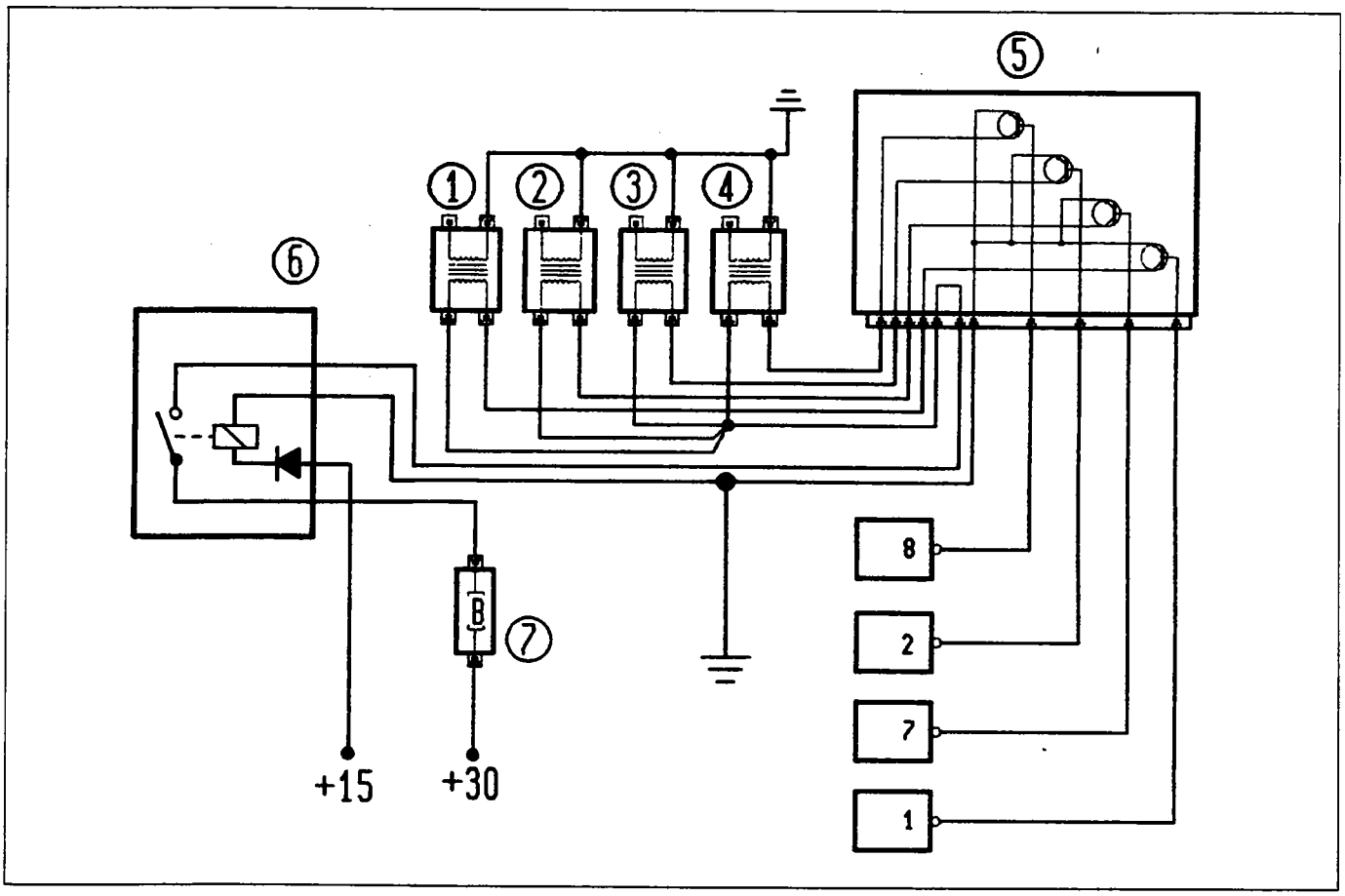
This sensor is the piezoelectric type and is fitted on the engine crankcase in a symmetrical position in relation to the pairs of cylinders 1-2 and 3-4.
This position is determined by the need to detect the start of detonation similarly for all cylinders.
When there is detonation, vibrations of a particular frequency are created in the crankcase which are transformed by the sensor into a signal whose voltage is proportional to their intensity.




P4A29BJ02

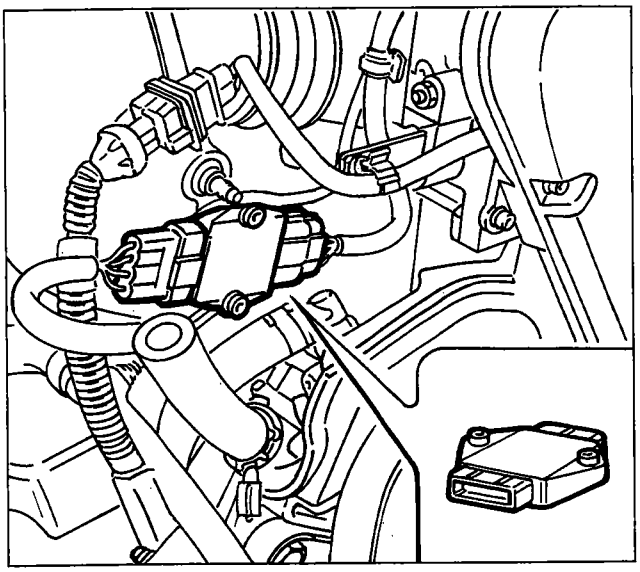
## IGNITION SYSTEM

The ignition circuit is the static advance inductive discharge type. The power module is outside of the control unit, whilst the high tension is supplied by four ignition coils fitted directly on the spark plugs (top-plug type coils).
The primary winding for each coil is supplied by the battery voltage via the system relay and is connected to the control module for connection to earth.
The optimum ignition advance is calculated by the control unit depending on the engine speed and load and is implemented in the form of the time between the moment in which the primary circuit supply is interrupted and the explosion stroke TDC.




P4A30BJ01

1. Coil for cylinder 1
2. Coil for cylinder 2
3. Coil for cylinder 3
4. Coil for cylinder 4
5. Ignition power module
6. System relay
7. Fuse



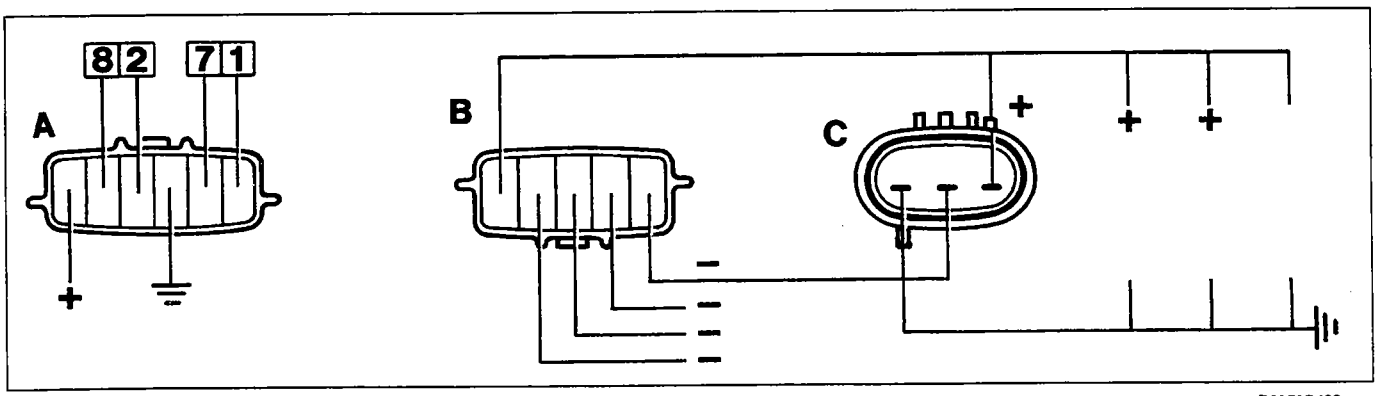
P4A31BJ01

## IGNITION POWER MODULE

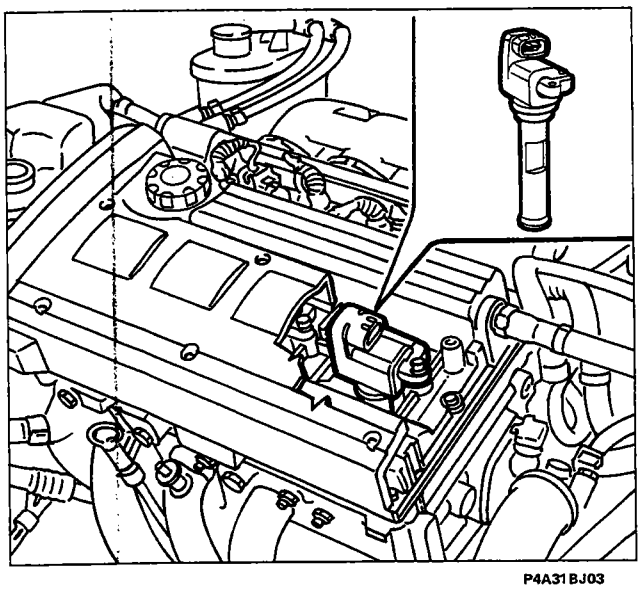
The power module, located on the side of the inlet manifold, is basically an electronic switch which, by means of the impulses coming from the control unit, controls the current in the ignition coil primary winding.
Through a particular circuit it limits the current which circulates in the coil primary winding when the maximum value is reached in order to reduce the heating of the actual module.
To prevent the overheating of the coil if the ignition takes place with the engine switched off, the module has a rest closing device when the ignition impulses cease arriving from the control unit.

**Wiring connector**

A: module input B: module output C: ignition coil




P4A31BJ02

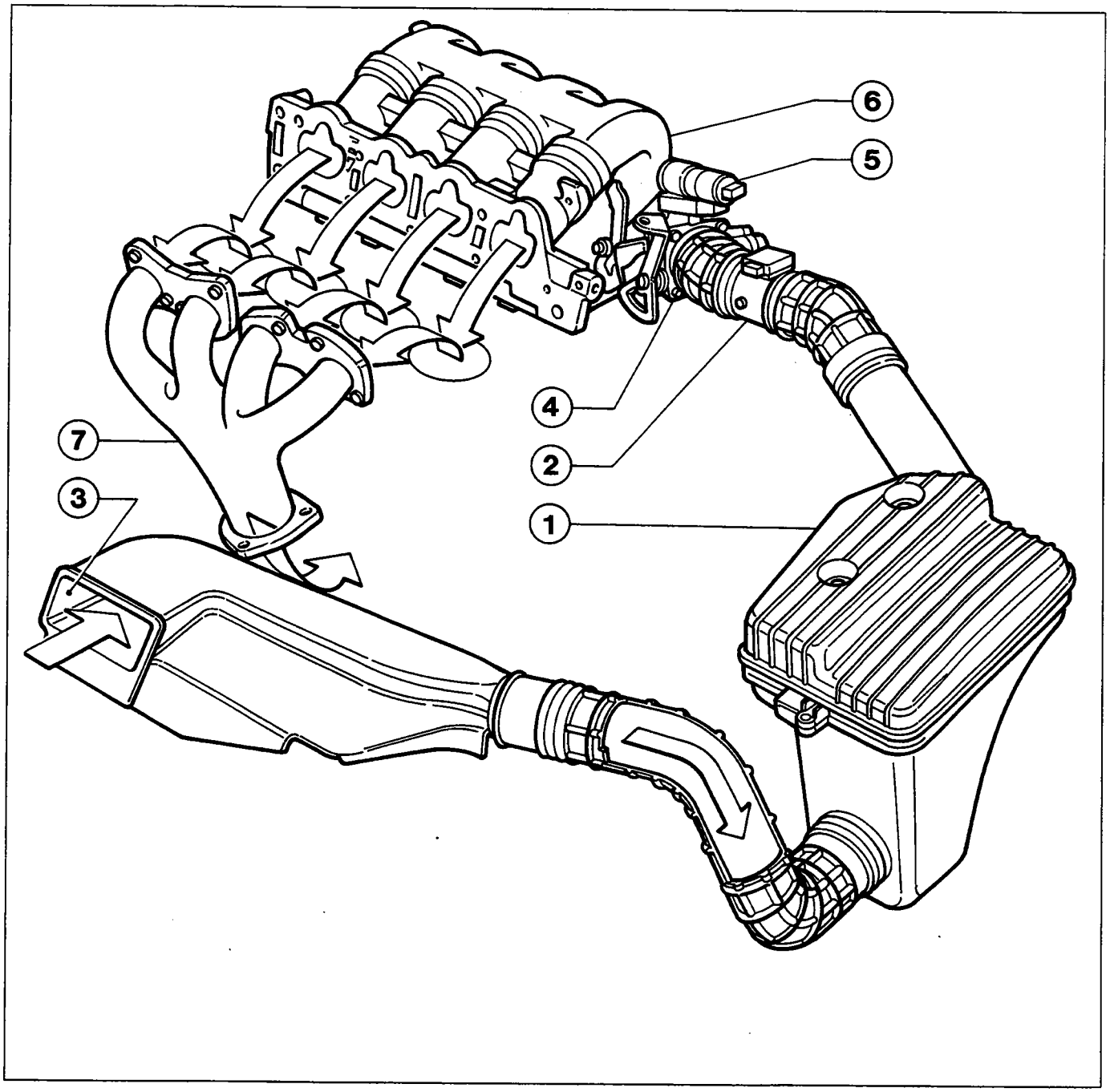


P4A31BJ03

## IGNITION COIL

The coil used is the closed magnetic circuit type with the windings in a plastic container immersed in epoxide resin.
The coil is connected directly to the spark plug by a silicon material extension which has high dielectric characteristics.
The earth for the secondary circuit is obtained with a special cable as the coil is insulated by the cylinder head.

## DIAGRAM SHOWING INTAKE CIRCUIT




P4A32BJ01

1. Air filter
2. Air flow meter
3. Inlet
4. Butterfly casing
5. Engine idle adjustment solenoid valve
6. Inlet manifold
7. Exhaust manifold

## INTAKE CIRCUIT

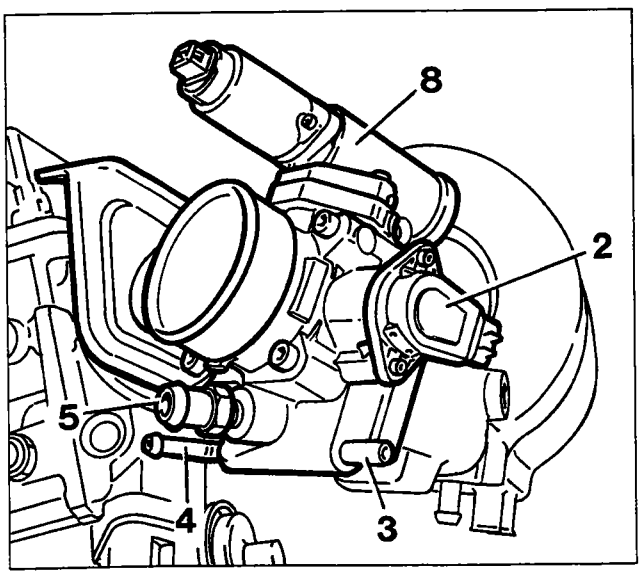
The intake circuit is made up of the following components:
- air filter with relevant sleeves;
- acoustic resonator fitted in parallel to the inlet sleeve;
- inlet manifold, on which the fuel manifold is fitted;
- butterfly casing, where the butterfly position sensor, the PCV valve *(Positive Crank Ventilation)* for the oil vapour recirculation circuit and tne engine idle adjustment solenoid valve are fitted.

## BUTTERFLY CASING

The butterfly casing has the task of metering the quantity of air supplied to the engine (and therefore the power developed) according to the driver's request via the accelerator control.
The butterfly casing is fixed to the inlet manifold by four bolts: the butterfly is opended by means of levers which create a small opening which, consistent with the pedal travel, produce small butterfly openings with the pedal gently pressed and viceversa large angle openings with the pedal strongly pressed.
With the pedal completely released (engine decelerating or idling) the additional air required is supplied by the engine idle adjustment solenoid valve: under these circumstances the butterfly opening lever is in contact with screw which prevents the butterfly from being locked in the closed position.

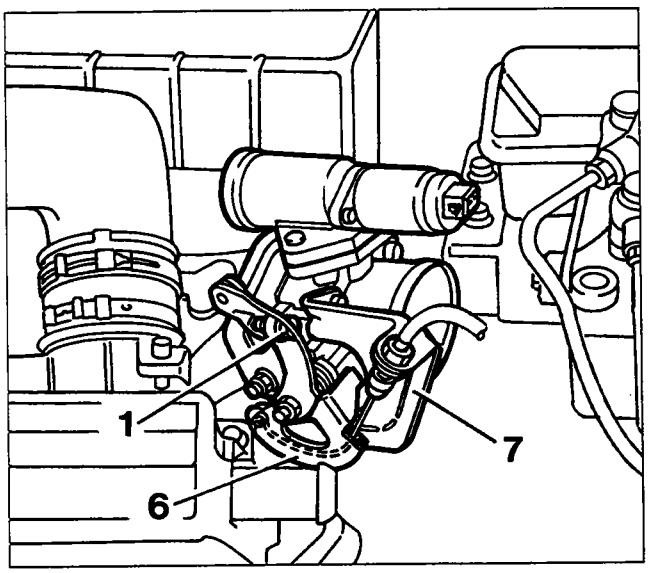
To prevent the formation of ice in the butterfly and the port connected to the PCV valve, the butterfly casing is heated with a small amount of coolant coming from the engine thermostat circulating in a chamber inside the actual casing.
The PCV valve for the oil vapour recirculation system and the butterfly position sensor are also fitted on the butterfly casing.

*The screw is adjusted during operation by fluxing in the factory and should never be tampered with.*



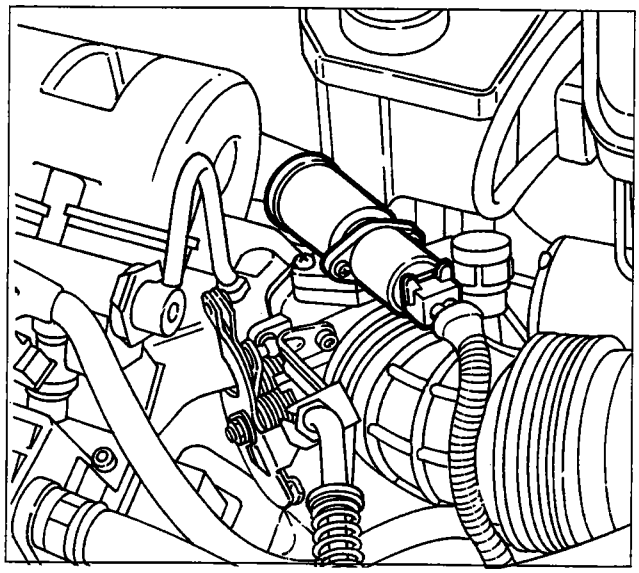
P4A33BJ01

1. Screw
2. Butterfly position sensor
3. Engine coolant inlet
4. Engine coolant outlet

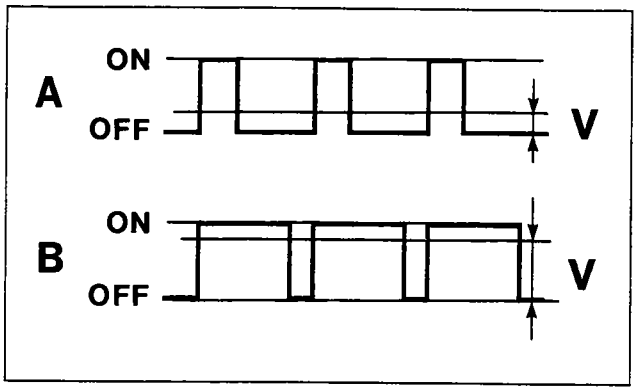


P4A33BJ02

5. PCV valve
6. Accelerator control lever
7. Accelerator cable adjustment bracket
8. Engine idle speed adjustment solenoid valve



P4A34BJ01



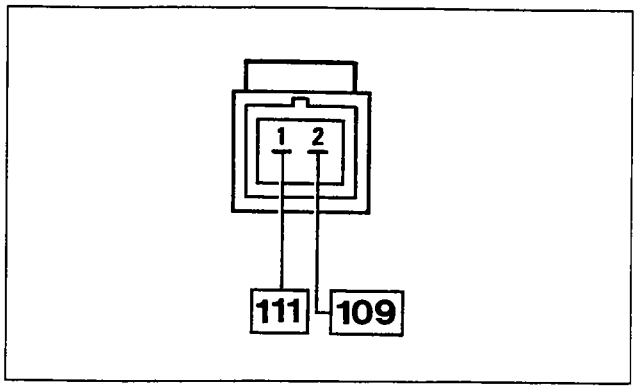

P4A34BJ02

**Operation in duty-cycle**

A: mainly OFF signal = low effective value
mainly ON signal = high effective value
B: effective value

V:

**Wiring connector**




P4A34BJ03

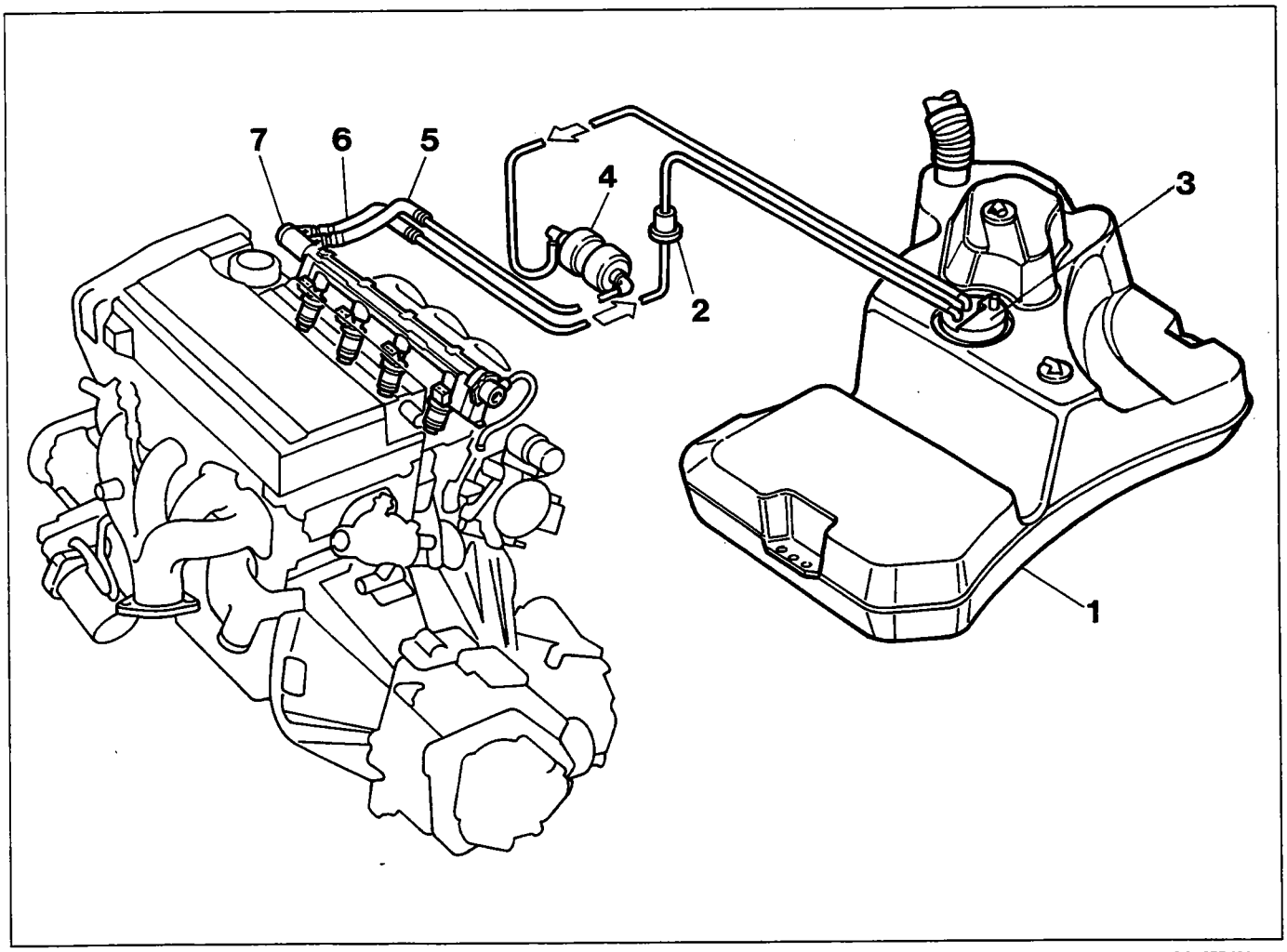
## ENGINE IDLE SPEED ADJUSTMENT SOLENOID VALVE

The solenoid valve, fitted on the butterfly casing, intercepts the flow of air which, coming from the air upstream of the butterfly, returns it downstream: it has the task of ensuring the additional air for the engine with the butterfly closed, in all conditions where it is required (idle, deceleration).
The valve is the proportional type where the shutter is fixed to a metal core surrounded by an electrical winding.

**Operating principle**

The position of the shutter depends on the intensity of the effective value of the current passing through the winding which creates a magnetic field which attracts the core.
The vairation in the effective value is obtained by modulating the winding electrical supply (operation in duty-cycle).
This operation consists of varying the battery voltage value (12 Volt nominal) until zero at a frequency where the shutter is not capable of moving following the instant voltage value, but reaches an intermediate position which depends on the proportion between the voltage presence time and the absence time.

## DIAGRAM SHOWING FUEL SUPPLY CIRCUIT




P4A35BJ01

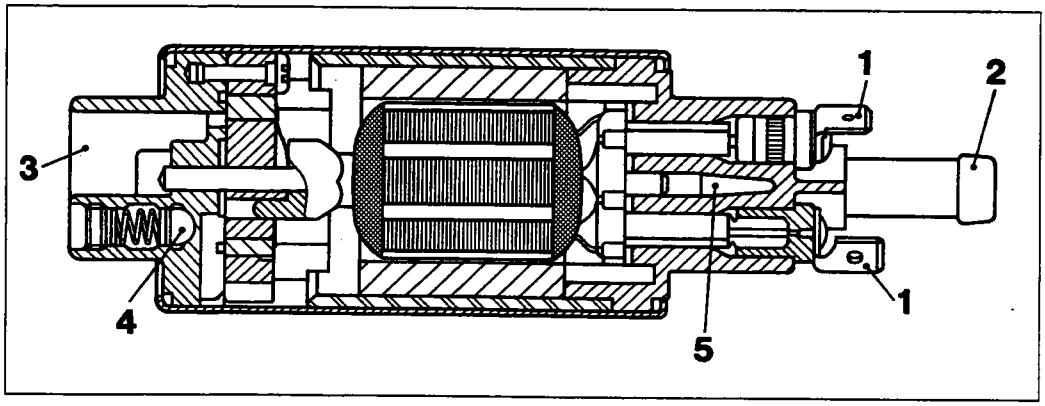
1. Fuel tank
2. Anti-flow valve
3. Electric fuel pump
4. Fuel filter
5. Fuel supply
6. Fuel return
7. Fuel manifold

## FUEL SUPPLY CIRCUIT

The fuel supply circuit is made up of the following components:
- fuel tank;
- electric pump immersed in the tank, equipped with gauze pre-filter;
- fuel filter;
- supply line;
- injectors;
- fuel pressure regulator;
- return line;
- anti-flow valve.

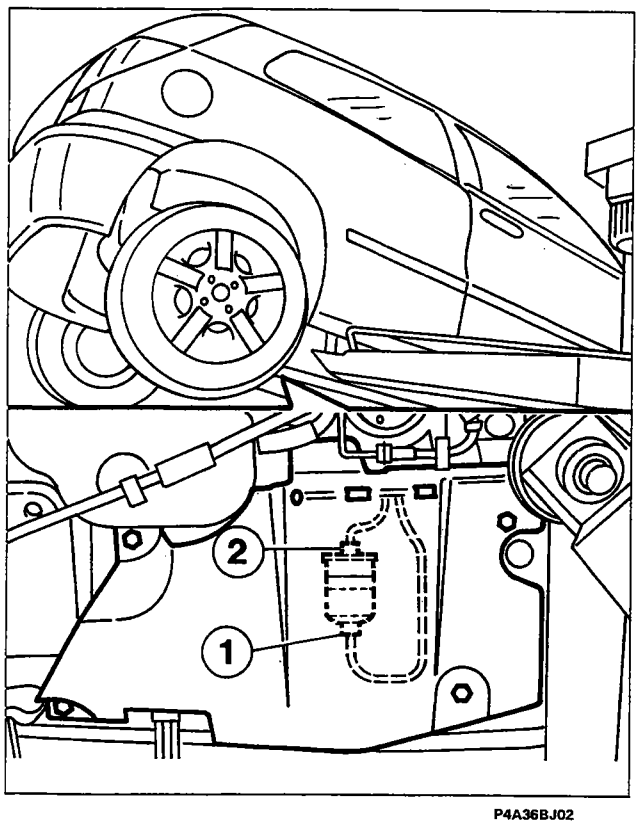
## ELECTRIC FUEL PUMP

The pump is housed inside the fuel tank on a special tray which also supports the fuel level gauge and is fitted with a gauze filter at the pump inlet.
The pump is the volumetric type (G-Rotor) and is designed to run on unleaded fuel.
The rotor is moved by a direct current motor supplied at the battery voltage directly by the appropriate relay operated by the control unit.
The motor is immersed in the fuel which has a detergent and cooling effect on the blades and the manifold.
The pump is equiped with an excess pressure valve, which short circuits the supply with the inlet if the pressure in the supply circuit exceeds 5 bar, to prevent the electric motor from overheating.
In addition, a one-way valve on the supply prevents the draining of the entire fuel circuit when the pump is not working.
The nominal capacity of the pump varies according to theangular speed of the rotor and therefore the supply voltage: with a voltage of 12 V it is around 140 l/h.




P4A36BJ01

1. electrical connectors
2. supply port
3. inlet port
4. excess pressure valve
5. one-way valve




P4A36BJ02

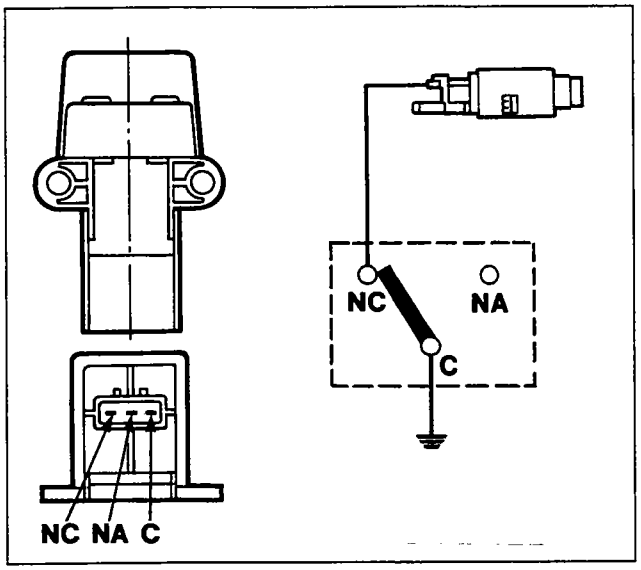
1. Fuel inlet
2. Fuel outlet

## FUEL FILTER

The filter, protected by a shield fixed under the bodyshell, is inserted along the fuel supply pipe. It is made up of a steel casing and a polyurethane internal support which has a high filtering capacity element.

**NOTE** *There is an arrow on the outer casing which indicates the direction of the flow of the fuel and the correct fitting position.*

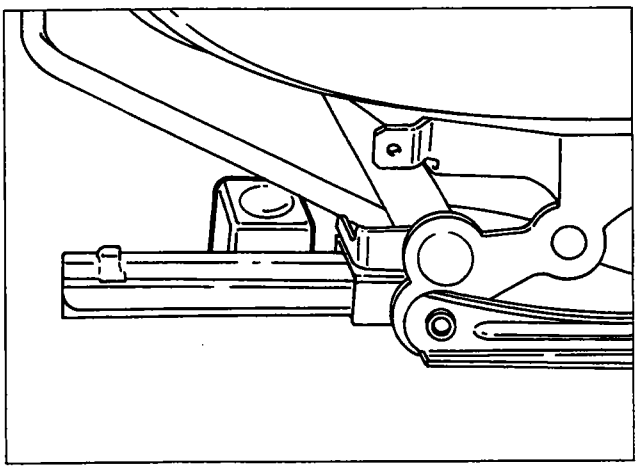
*The fuel filter should be changed at intervals of 30,000 Km.*




P4A37BJ01

## INERTIA SAFETY SWITCH

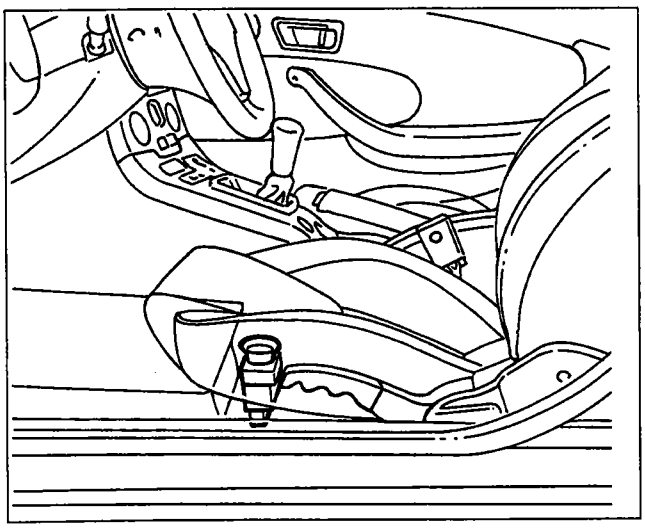
The inertia switch has the task of interrupting the electrical supply for the electric fuel pump if the vehicle undergoes violent deceleration (impact) to prevent fuel from escaping and creating a fire hazard if the fuel manifold or the supply pipe are damaged.
The switch is made up of a steel ball in a conical shaped housing kept in position by the attraction force of a permanent magnet.
Under the action of the acceleration due to the inertia force the ball can be released from the magnetic clip and gradually come out of the conical housing with an upwards movement depending on the angle of the cone.



P4A37BJ02

Above the ball there is a rapid attachement mechanism which forms a normally closed (NC) circuit. When struck by the ball, the mechanism changes position to the normallyopen (NA) circuit, thereby interrupting the electrical supply to the electric pump causing it to cut out.
The calibration of the switch causes its operation at acceleration above 1.2 g (about 11.7 $m/s^2$, corresponding to an impact at a speed of around 25 Km/h).
The switch can be restored by pushing the upper button protected by a flexible cover.

*After an apparently slight impact, if there is a smell of fuel or there are leaks from the fuel system, do not turn the switch back on, but search for the problem and eliminate it to prevent the risk of fire.*
*If this is not the case and there are no leaks and the vehicle can be driven again, press the button to reactivate the electric pump.*



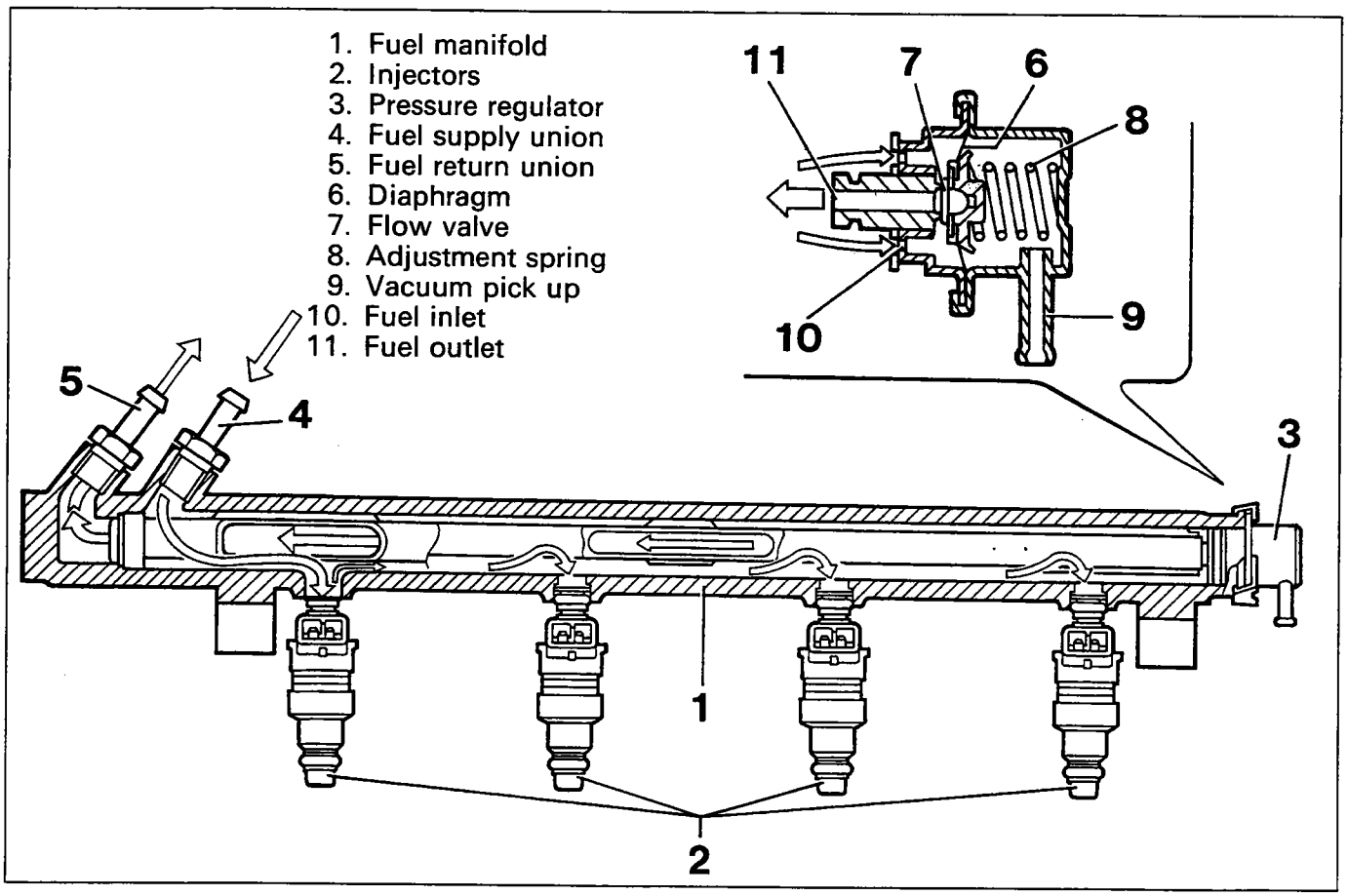
P4A37BJ03

## SINGLE-ACTING ANTI-FLOW VALVE

This is a safety valve fitted in the fuel return pipe near the tank.
The valve allows the return of fuel to the tank preventing it, however, from flowing out in the opposite direction if the pipe breaks.

## FUEL MANIFOLD

The fuel manifold, which has the function of distributing the fuel to the injectors, is made from die-cast aluminium and incorporates the housings for the injectors and for the pressure regulator.
The fuel inlet is achieved with a sealed fixing bolt.
The fuel recirculation is obtained by means of a pipe inside the manifold connected at one end to the regulator and at the other end to the outer fuel return pipe to the tank.

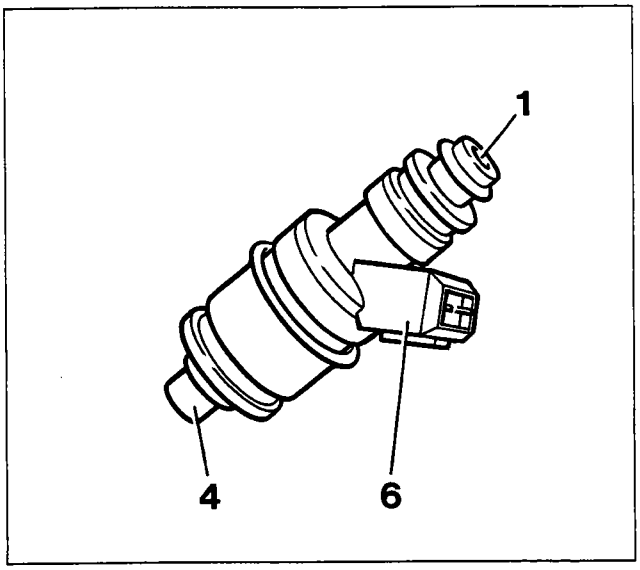



P4A38BJ01

## FUEL PRESSURE REGULATOR

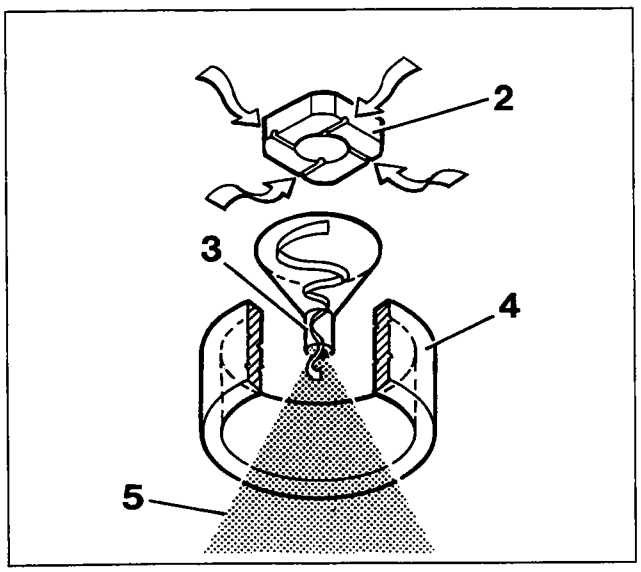
This is a differential diaphragm device, adjusted during manufacture to a pressure of 3.00 ± 0.05 bar.
The fuel under pressure, coming from the pump, exerts a force on the flow valve (7) opposed by the calibrated spring (8). When the calibration pressure is exceeded, the flow valve opens and the excess fuel returns to the tank, thereby stabilizing the pressure in the circuit.
In addition, via the pick up (9), the vacuum in the inlet manifold (at which the *nose* of the injector) also finds itself, acts on the regulator diaphragm, reducing the load exerted by the calibration spring.
In this way the differential in pressure between the fuel and the environment (inlet manifold) in which the injector finds itself in all engine operating conditions is kept constant.
Consequently, the injector flow rate (for a certain supply voltage) depends only on the injection time established by the control unit.

**NOTE** *The pressure is assumed by the control unit as a fixed parameter: as a result the regulator should never be tampered with so as not to alter the mixture strength for the engine.*



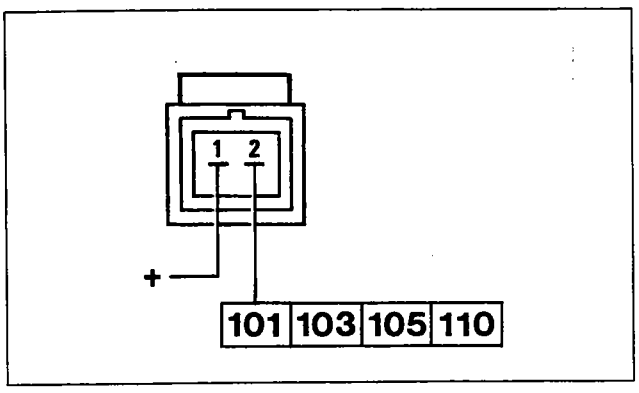

P4A39BJ01

1. Fuel inlet
2. Deflector
3. Jet
4. Nose
5. Jet of fuel
6. Electrical connector




P4A39BJ02

**Wiring connector**



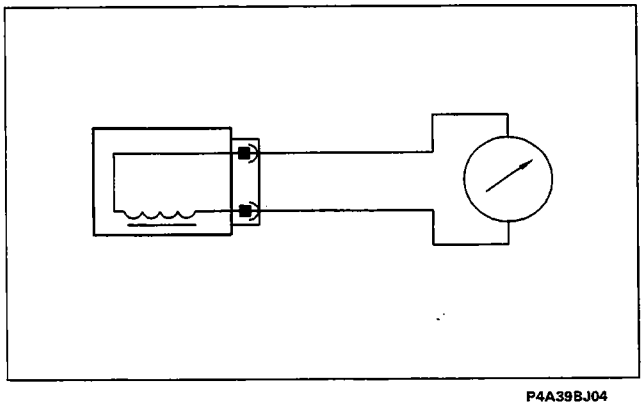

P4A39BJ03

## INJECTORS

The injectors have the task of supplying the quantity of fuel required for the operation of the engine: the fuel is injected into the inlet manifold, immediately upstream of the inlet valve.
The injector is the "top-feed" type, with the supply of the fuel from the rear of the casing, where the electrical winding connected to the connector (6) is also housed.
When the current passes through the winding, the magnetic field produced attracts the shutter causing the opening of the injector and the flow of fuel.
As the pressure differential between the inside and the outside of the injector is constant (thanks to the presence of the regulator), the quantity of fuel supplied, like the electrical voltage, only depends on the opening time, established by the control unit.
The end section of the injector or *nose* (4) is fitted with a jet (3) which gives the fuel a rotary motion, thanks to a deflector (2) fitted with four tangentially positioned flow ports.

The resistance of the injector can be measured by disconnecting the connector and connecting an ohmmeter as shown inthe diagram.

**Value of the resistance: 12 ± 1,2 ohm.**



P4A39BJ04

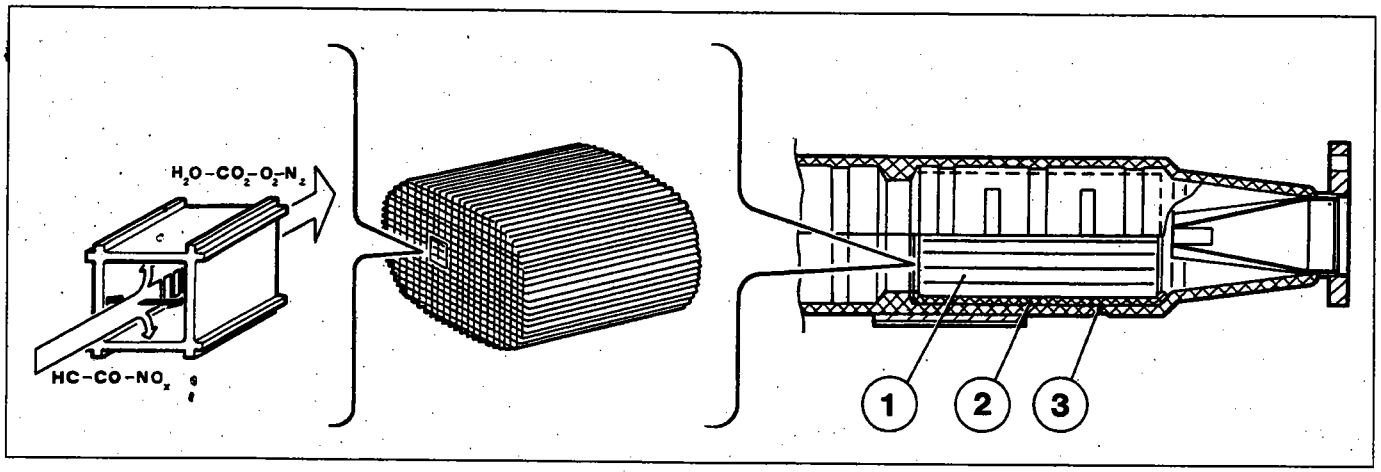
## EMISSION CONTROL DEVICES

The devices used have two objectives:
- to keep down the pollutant substances present in the exhaust, via the catalytic silencer;
- to eliminate the dispersion towards the outside of the unburnt hydrocarbons, via the (fuel) anti-evaporation system and the (lubrication) oil vapour recirculation system.

## CATALYTIC SILENCER

The catalytic silencer is a device which makes it possible to simultaneously keep down the three main pollutant compounds present in the exhaust: unburnt hydrocarbons (HC), carbon monoxide (CO) and nitrogen oxide (NOx).
Two types of chemical reaction take place inside the catalyzer:
- oxidation of the CO and the HC, converted into carbon dioxide ($CO_2$) and water ($H_2O$);
- reduction of the NOx, converted into Nitrogen ($N_2$).

These reactions can take place in extremely short periods of time thanks to the presence inside the catalyzer structure (ceramic support) of a layer of active substances (platinum and rhodium) which greatly accelerate the conversion speed of the harmful substances.
The effectiveness of this conversion process is conditioned by the fact that the mixture strength at which the engine operates is constantly oscillating around the stoichiometric value, which is achieved thanks to the feed-back control carried out by the control unit on the basis of the Lambda sensor signals.
Lastly, the conversion processes are activated at temperatures in excess of 300 - 350°C: it is therefore vital that the catalyzer reaches this temperature as soon as possible in order to work properly.



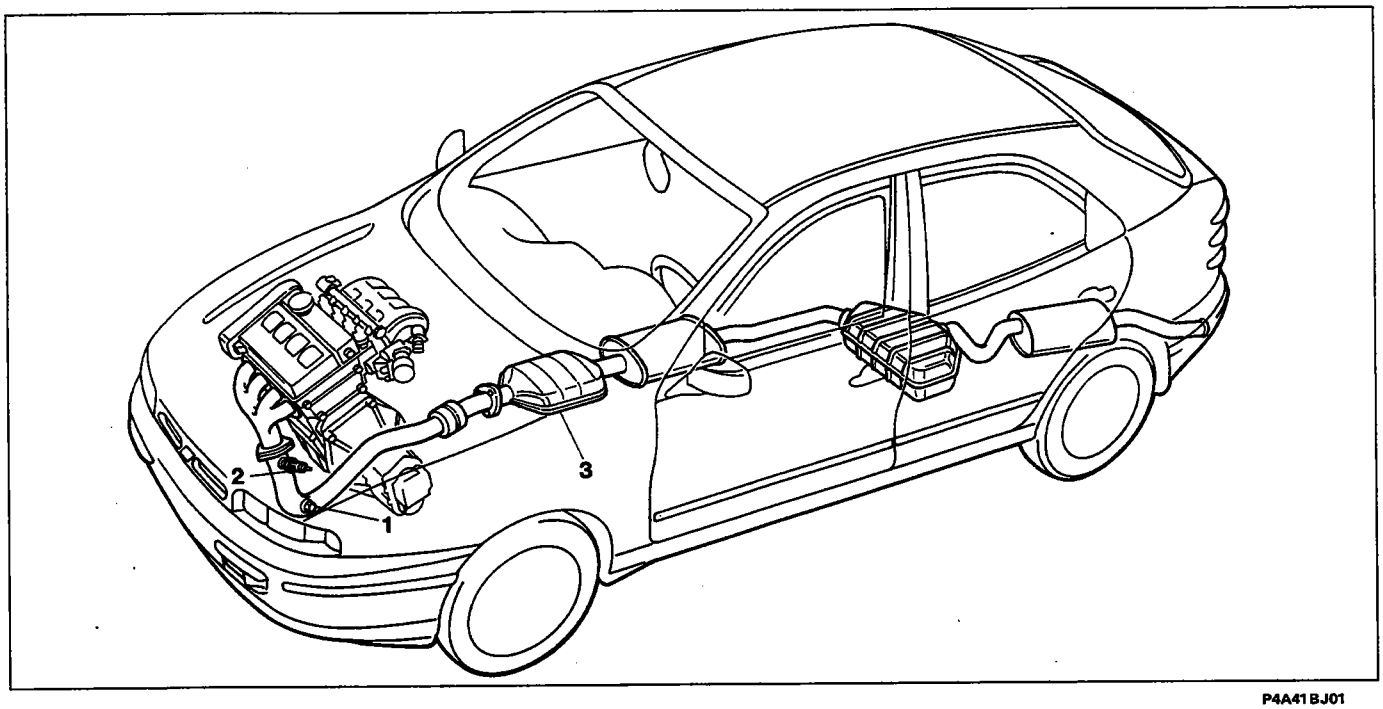

P4A40BJ01

1. Ceramic monolith
2. Metal support
3. Steel outer casing

*When it is necessary to operate near the catalytic silencer, it is necessary to leave the vehicle to rest for some time, since the (internal) operating temperature of the catalyzer is between 500 and 850°C.*

*There are basically two causes of the destruction of the inside of the catalyzer:*

- *the presence of lead in the fuel which lowers the degree of conversion at levels of practically nil ("lead poisoning") and which also irreparably damages the Lambda sensor;*
- *the presence of totally unburnt fuel in the exhaust gases, due to failed ignition, which causes an increase in the temperature which involves the fusion of the ceramic support. As a result, the connector for the coils should never be disconnected with the engine running: in the case of tests, the silencer should be replaced first with an equivalent section of pipe.*

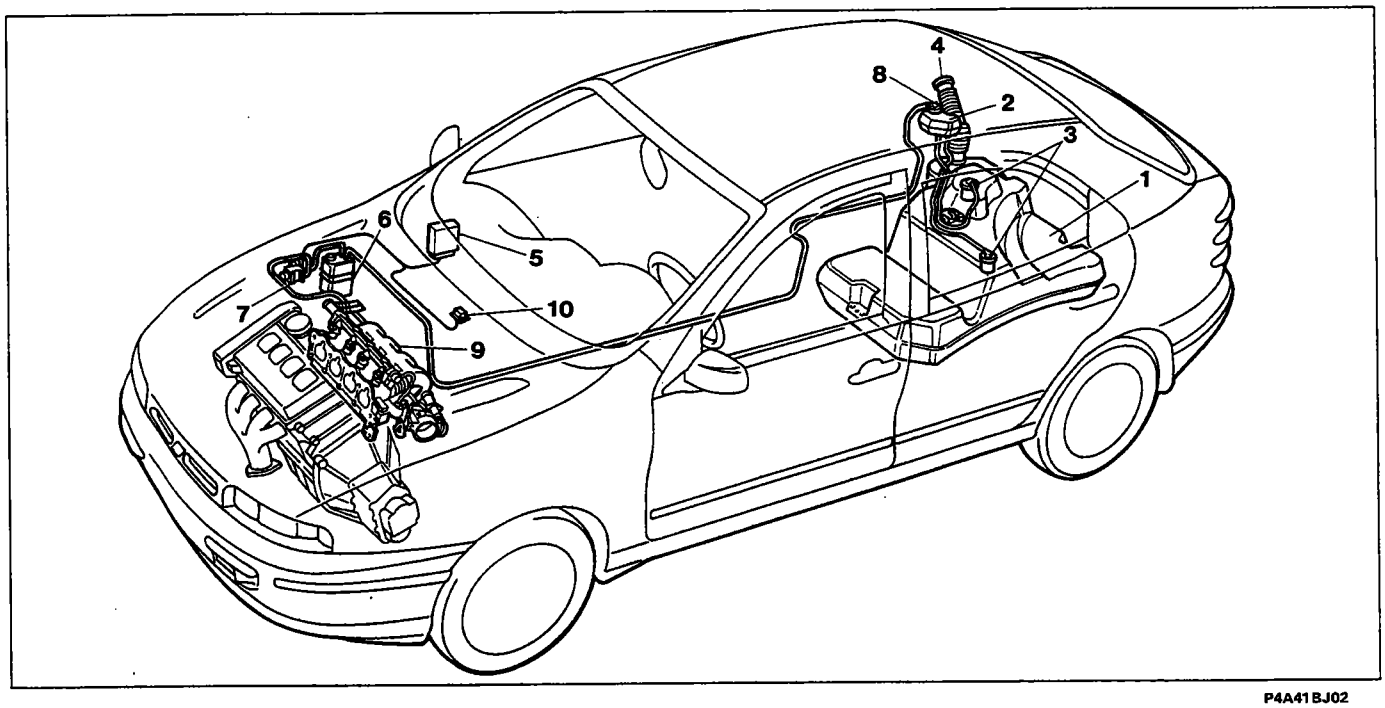



P4A41BJ01

**Exhaust system with catalytic converter**

1. CO socket
2. Lambda sensor
3. Catalytic silencer

## FUEL ANTI-EVAPORATION SYSTEM



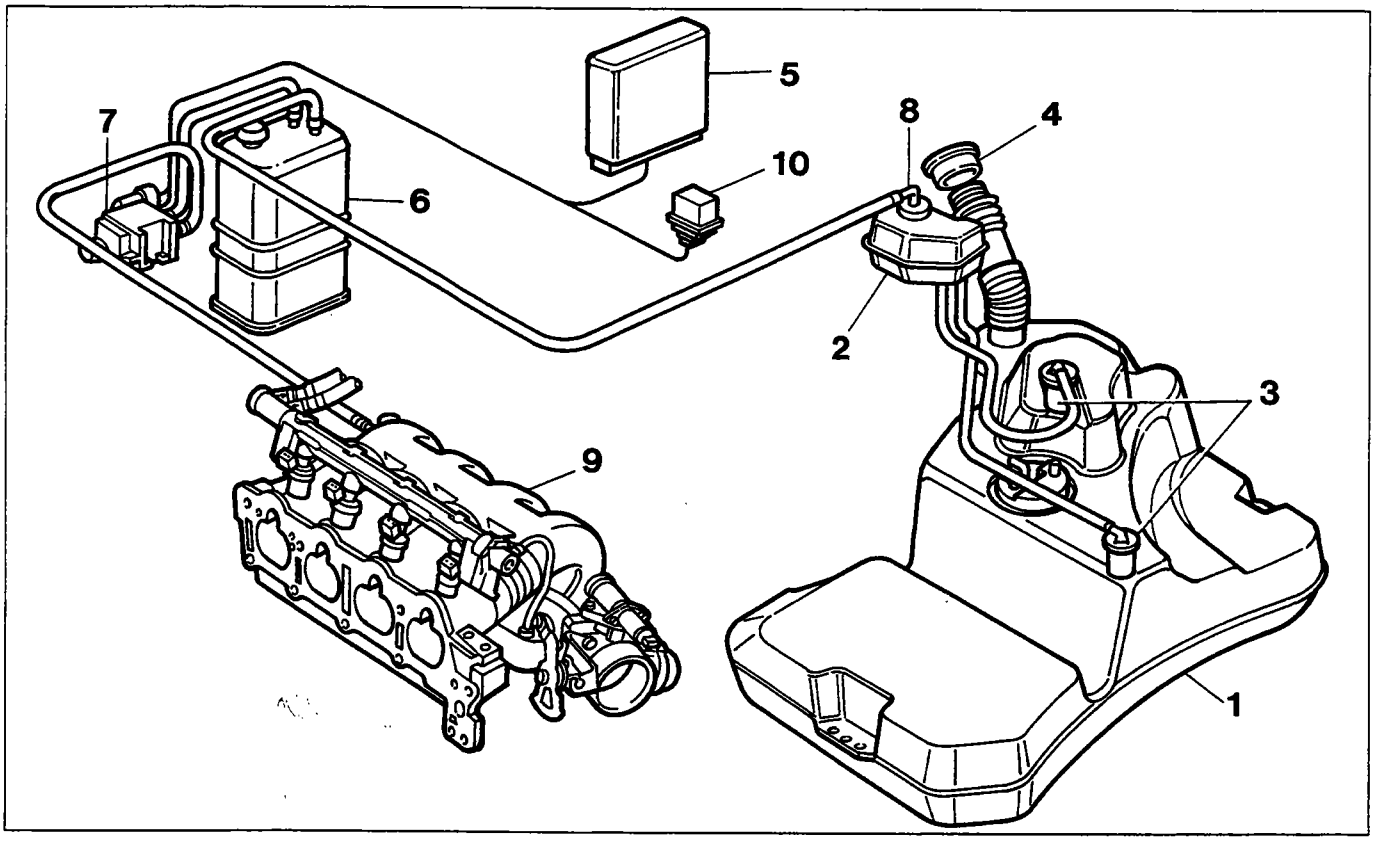

P4A41BJ02

**Location of anti-evaporation system components**

1. Fuel tank
2. Vapour separator
3. Float valve
4. Cap with safety valve
5. Engine control unit
6. Charcoal filter
7. Charcoal filter solenoid valve
8. Multi-purpose valve
9. Inlet manifold
10. Relay

### Operating principle

The anti-evaporation system has the aim of preventing the fuel vapours, made up of the lightest parts of the 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 increses and consequently the tendency towards evaporation increases: in this situation there is an increase in the pressure inside the tank.
In particular, even with the tank (1) full, with the vehicle stationary the two float valves (3) remain open as they are located higher than the breather pipe and therefore they allow the vapours to reach the separator (2) from where they mainly return to the tank as they condense.
If, on the other hand, there is strong splashing when the vehicle is driving or it overturns, the valves (3) close preventing fuel from escaping.
When the pressure inside the tank reaches about 30-40 mbar, the multi-purpose valve (8) opens and the fuel vapours reach the charcoal filter (6). The valve (8) also allows an intake of air into the tank through the charcoal filter if necessary following the lowering of the level of fuel and the consequent vacuum which is created inside the tank.
When the engine is running, the control unit operates the charcoal filter solenoid valve 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 one of the components, the pressure inside the tank increases to dangerous levels, the safety valve located in the cap (4) allows the pressure to be discharged outwards. If necessary, this valve can open in the opposite direction, to ventilate the tank and prevent the vacuum reaching excessive values.

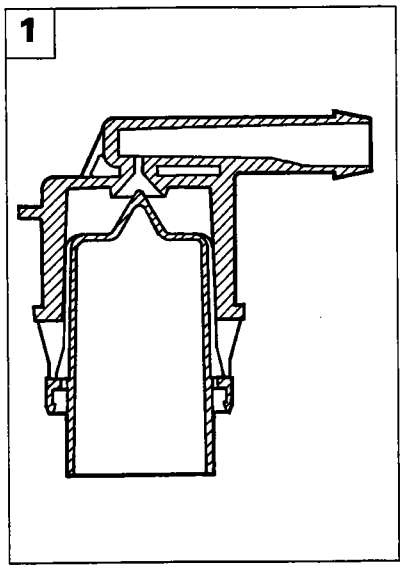



P4A42BJ01

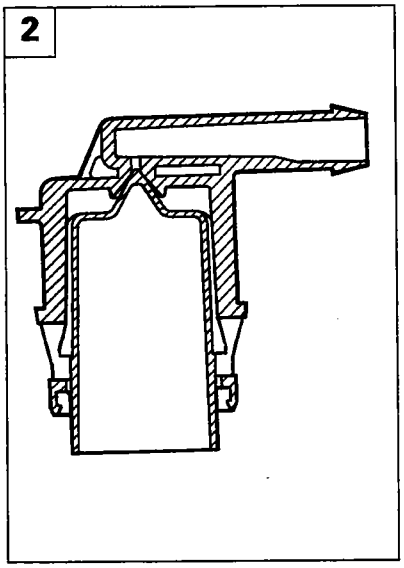
1. Fuel tank
2. Vapour separator
3. Float valve
4. Cap with safety valve
5. Engine control unit
6. Charcoal filter
7. Charcoal filter solenoid valve
8. Multi-purpose valve
9. Inlet manifold
10. Relay

### Float valve

The float valve has the task of allowing the flow of vapours towards the separator, without, however, allowing the escape of liquid fuel.
The valve contains a float, one end of which closes the valve outlet port in the following conditions:
- strong side acceleration (vehicle taking a bend) or longitudinal acceleration (vehicle braking) with the relevant movement of the mass of fuel as a result of the inertia force;
- overturning of the vehicle.



P4A43BJ01



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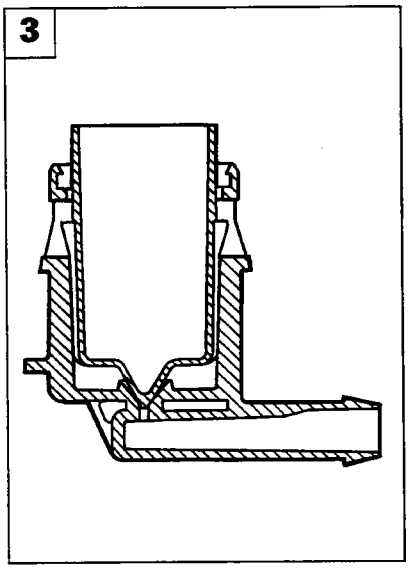
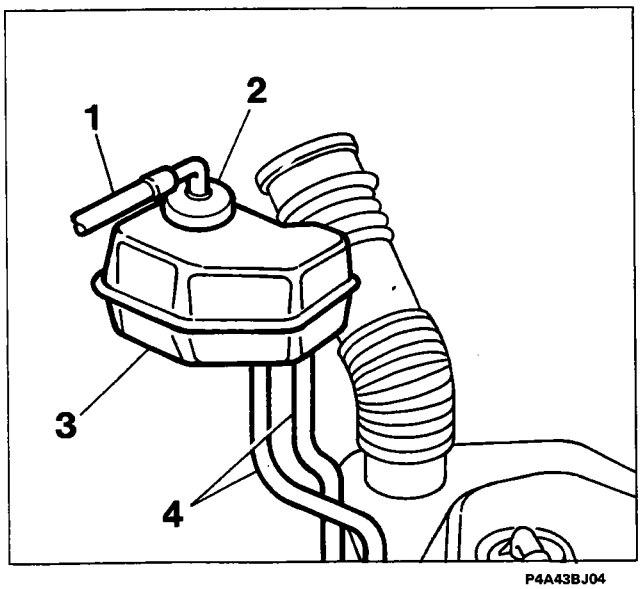


P4A43BJ03

1. Normal operating conditions: valve open
2. The fuel pushes the float upwards as a result of strong acceleration: valve closed
3. Vehicle overturned: valve closed



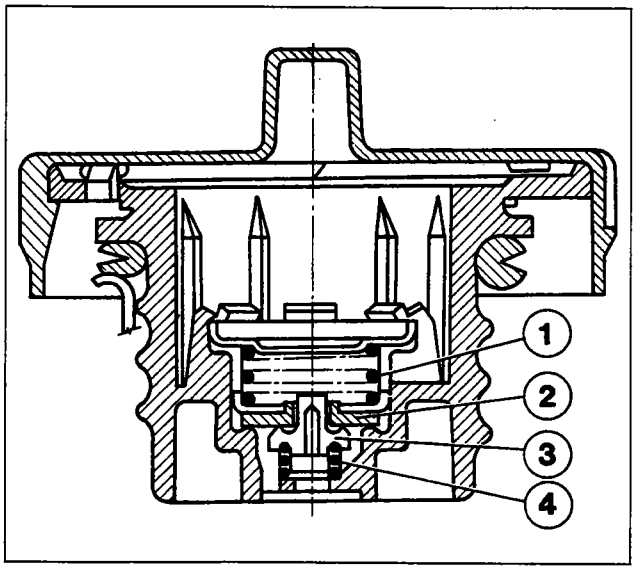
P4A43BJ04

1. Pipe connecting fuel vapour separator to the active charcoal filter
2. Multi-purpose valve

### Fuel vapour separator and multi-purpose valve

The fuel vapours coming from the tank reach the vapour separator (3), located at the side of the fuel filler, via the pipes (4).
Part of the vapours condense and return to the tank via the same pipes (4), whilst the remaining vapours escape from the separator through the multi-purpose valve (2) and are directed to the active charcoal filter via the pipe (1).

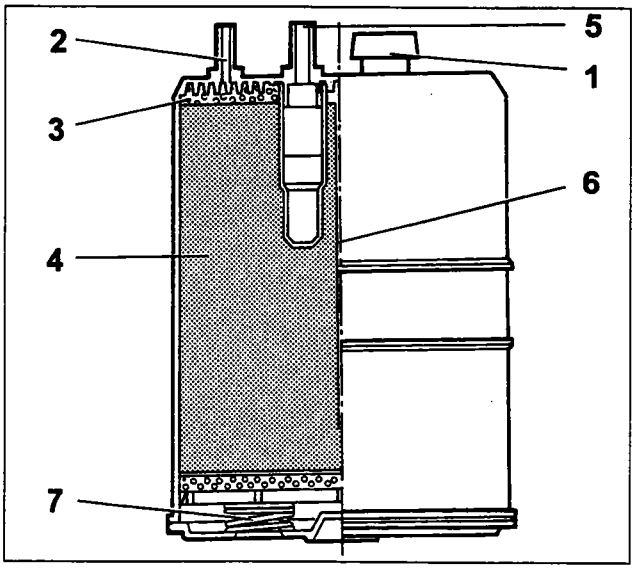
3. Fuel vapour separator
4. Pipes connecting vapour separator to the fuel tank




P4A44BJ01

### Safety and ventilation valve

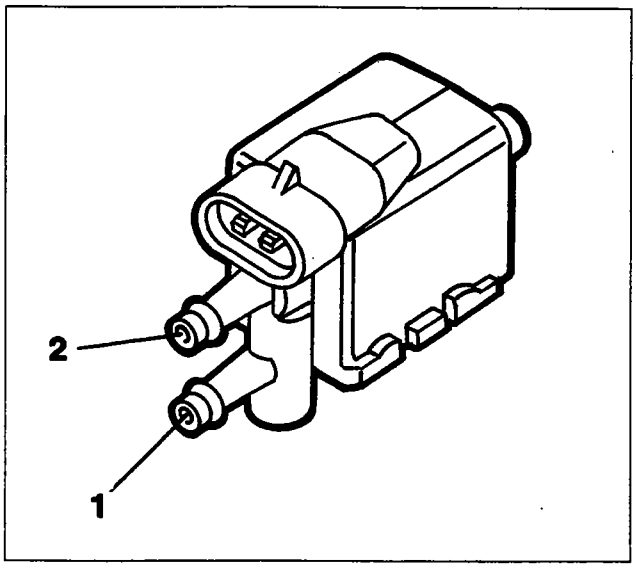
This valve is located in the fuel filler cap and carries out the following functions:
- discharging the excess pressure outwards which forms inside the tank (safety function); the pressure acts on the plate (2) and, overcoming the spring (1) loading, allows the excess vapours to be discharged outwards;
- allowing the flow of outside air in the tank when an excessive vacuum is formed inside the tank through the effect of the fuel consumption (ventilation function): when the vacuum exceeds the loading of the spring (4), it moves the valve (3), allowing the intake of air.




P4A44BJ02

### Active charcoal filter

This is made up of granules of charcoal (4) which trap the vapours entering through the inlet (5).
The scavenging air which enters through the inlet (1), passes through the paper filter (3), comes into contact with the charcoal granules removing the vapours and directs them towards the outlet (2) and from there towards the filter valve.
The air, having entered through the inlet (5) can also be sent by the vacuum into the tank for ventilation.
The partition (6) ensures that the warm scavenging air drawn in comes into contact with all the granules of charcoal.
There are also two springs (7) which allow the expansion of the mass of granules when the pressure increases.



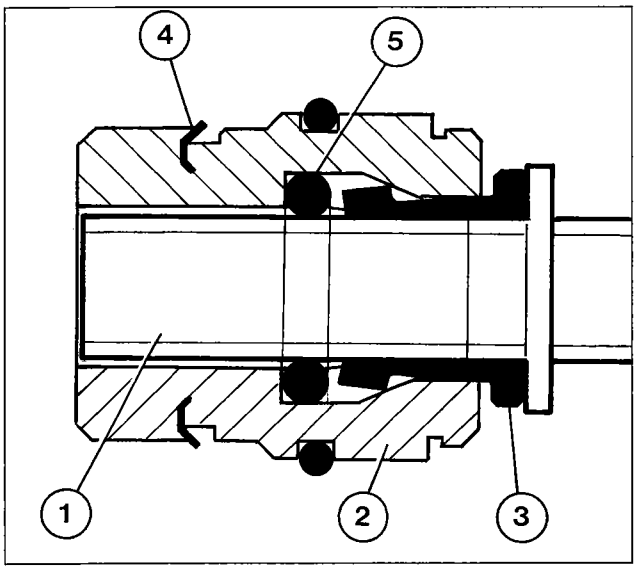

P4A44BJ03

### Charcoal filter solenoid valve

This valve, of the normally closed type, controls the flow of vapours reaching the inlet manifold and is operated by the control unit with duty-cycle operation.

**NOTE** *The inlet which has the word CAN (canister) written on it should be connected to the charcoal filter.*

1. From the charcoal filter
2. To the inlet manifold

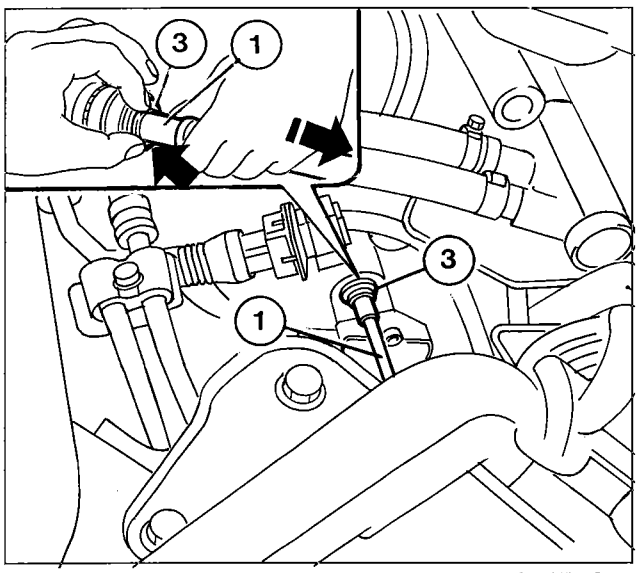



P4A44BJ04

## PROCEDURE FOR DISMANTLING THE RAPID ATTACHMENT PIPE FOR THE ANTI-EVAPORATION SYSTEM FROM THE INLET MANIFOLD

The pipe for the anti-evaporation system (1) is held in place on the inlet manifold cartridge (2) by the small clamp (3). A flexible washer (4) keeps the cartridge (2) in its housing preventing any fuel vapours from escaping by means of an O ring (5).

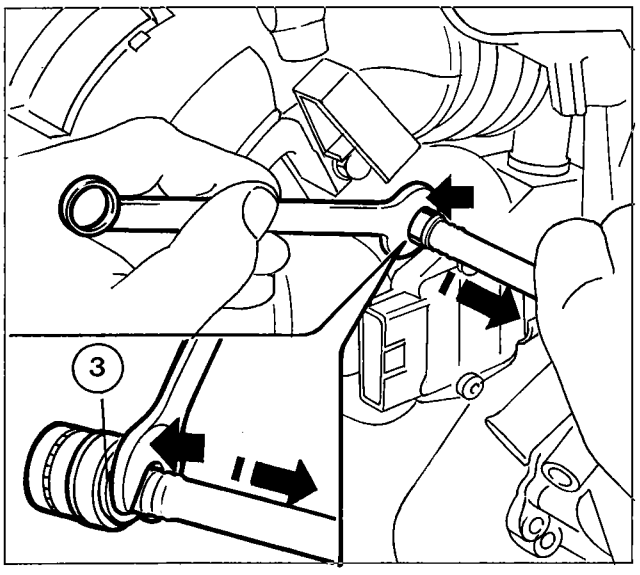
1. Anti-evaporation system rapid attachment pipe
2. Cartridge
3. Pipe retaining clamp
4. Flexible washer
5. O-ring



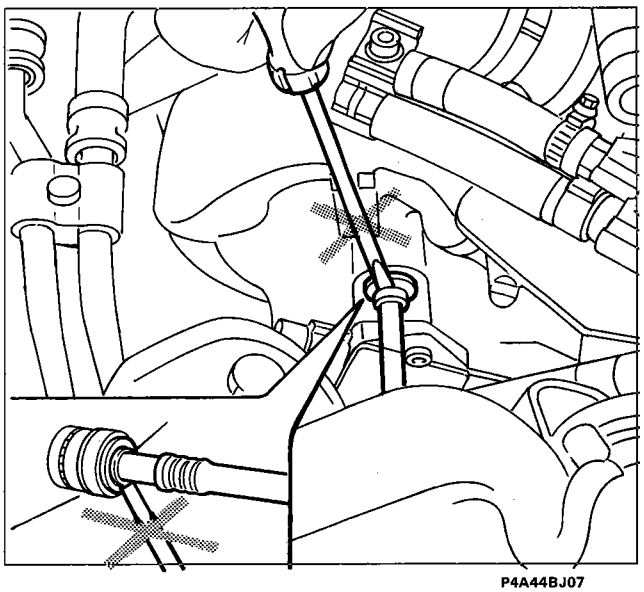

P4A44BJ05

In order to extract the pipe (1), push the clamp (3 with your fingers towards the manifold and, at the same time, extract the actual pipe. The operation can also be carried out with the help of an 11 mm spanner to facilitate the movement of the clamp (3) towards the manifold.

*Do not use tools to extract the pipe which could damage the system.*

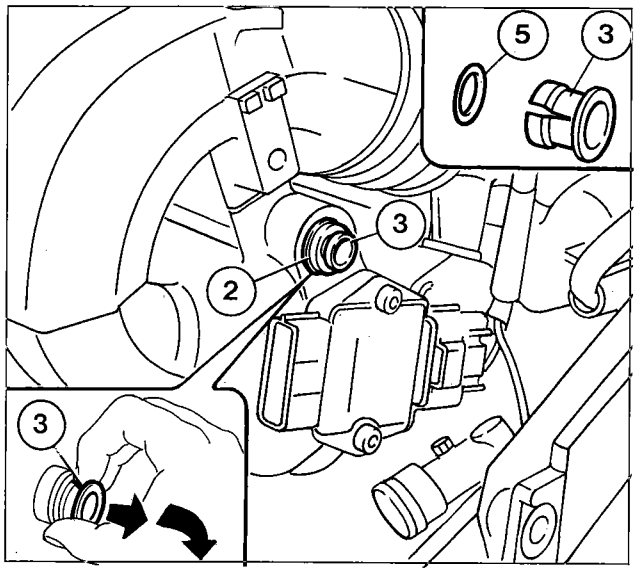



P4A44BJ06

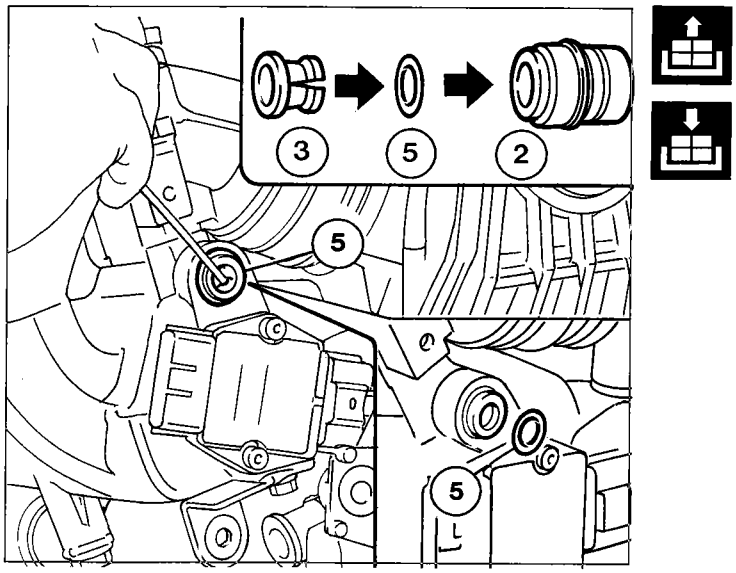


P4A44BJ07

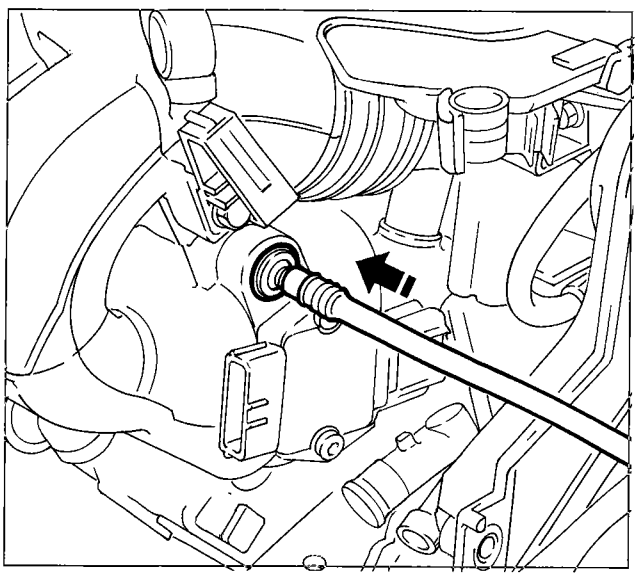
4A59BJ




P4A44BJ08




P4A44BJ09

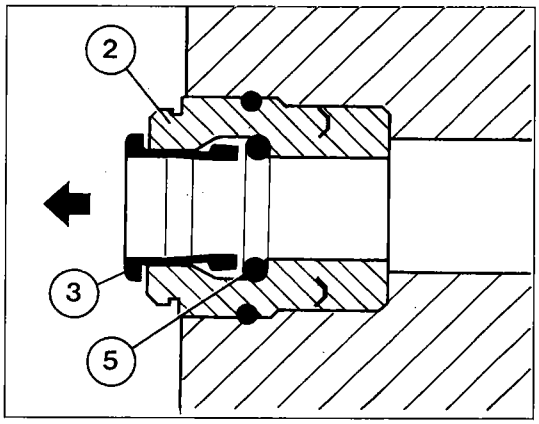


P4A44BJ10

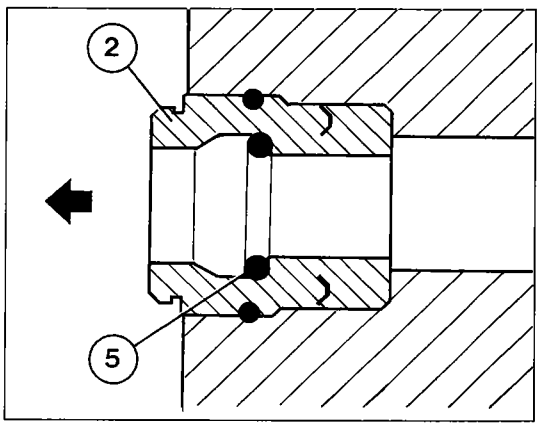
4A60BJ

### Replacing clamp

A kit is available for replacing the clamp which comprises an O-ring (5) and a clamp (3).
After having removed the pipe for the anti-evaporation system, insert your fingers between the clamp (3) and the cartridge casing (2) (to facilitate the operation, move the clamp aside using a screwdriver, working very carefully). Pull outwards and rotate the actual clamp.




P4A44BJ11



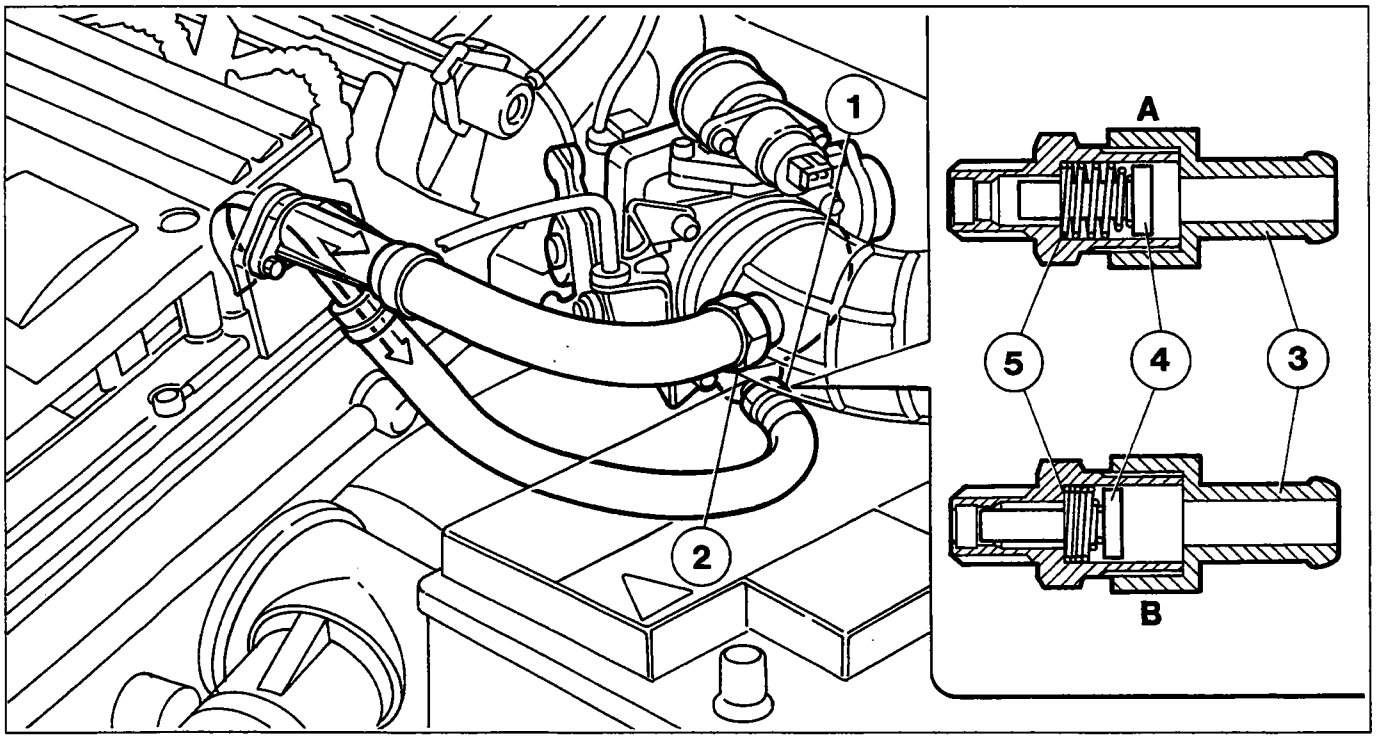

P4A44BJ12

Extract the O-ring (5) inside the cartridge. Clean the interior of the cartridge with an air jet and insert the new O-ring in its housing; then insert the new clamp.

Clean all impurities from the end section of the pipe before it is inserted inside the cartridge. Insert the pipe pushing it into the end of travel position.

## SYSTEM FOR RECIRCULATING GASES COMING FROM THE CRANKCASE (BLOW-BY)

This system controls the emissions from the crankcase of breather gases, made up of mixtures of air, fuel vapours and burnt gases which escape through the piston seals and of lubricant oil vapours, drawing them in again and burning them in the engine.
The breather gases coming from the crankcase reach the cylinder head and are directed into two different inlets (1) and (2).
With the butterfly open, the gases flow through the inlets (1) and (2) to be drawn into the manifold.
With the butterfly closed the vacuum in the inlet manifold draws in the gases through the intake (1) in which there is a PCV limiting valve (3) *(Positive Crank Ventilation)* which shutters the intake.
The PCV valve, in effect, can be modulated and the quantity of gases which pass through is proportional to the vacuum in the inlet manifold.
When the butterfly valve is completely open (condition A), the vacuum inside the inlet manifold is minimal, the spring (5) is completely extended and the PCV valve allows the maximum flow of breather gases.
Viceversa, with the butterfly completely closed (condition B), the vacuum inside the manifold is maximum, this causes the movement of the piston (4) which shutters the opening for the flow of breather gases inside the PCV valve and thereby restricts the intake into the manifold of the actual gases.

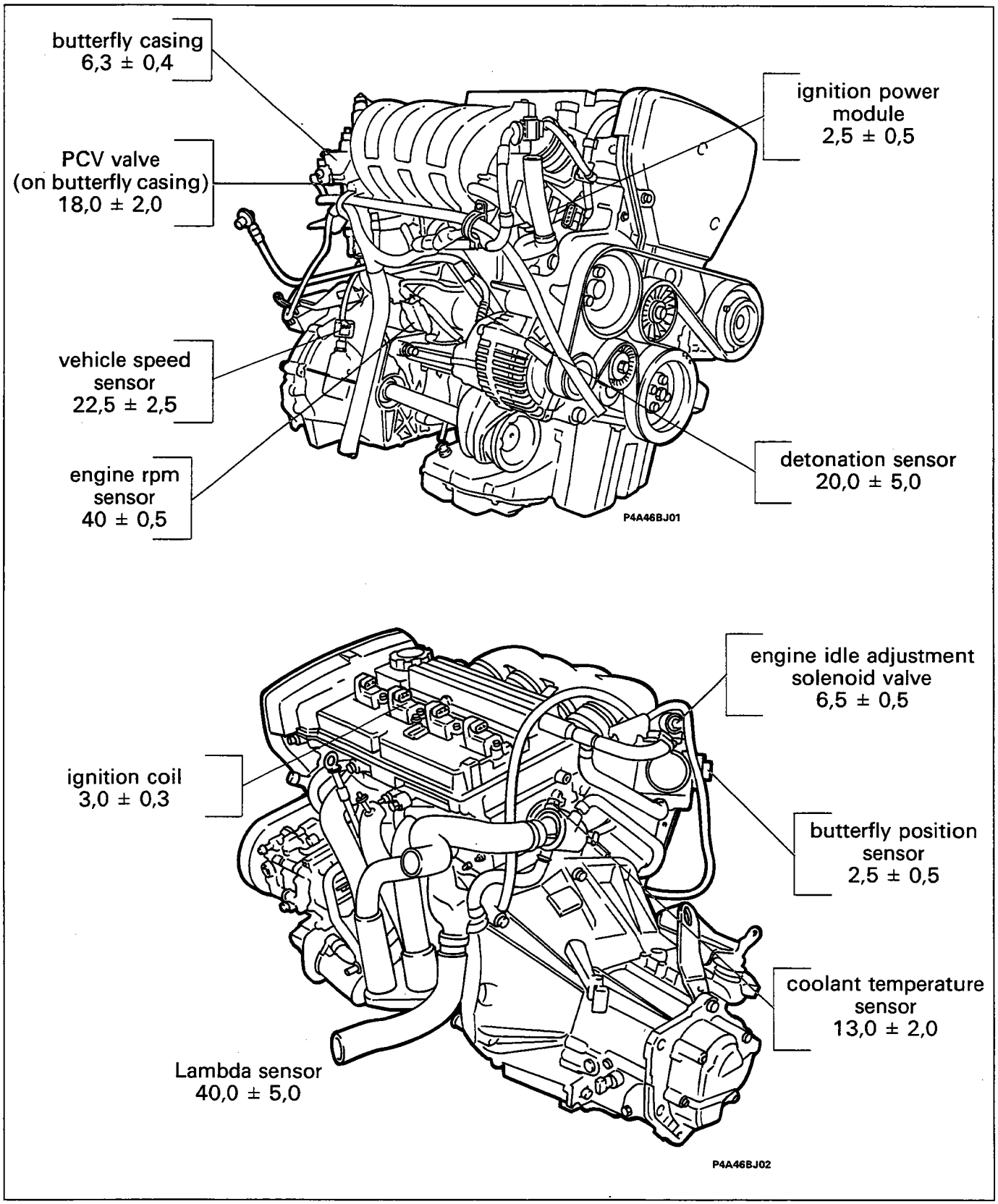



P4A45BJ01

1. Inlet on butterfly casing with PCV
2. Inlet on sleeve
3. PCV valve
4. Piston
5. Spring

## TIGHTENING TORQUES

The main tightening torques for the HITACHI injection/ignition system components are given below (values in Nm).



## CHECKS, ADJUSTMENTS AND REPAIR OPERATIONS ON HITACHI MPI SYSTEM

*When working on a vehicle equipped with a Hitachi MPI system, the following precautions should be observed:*

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

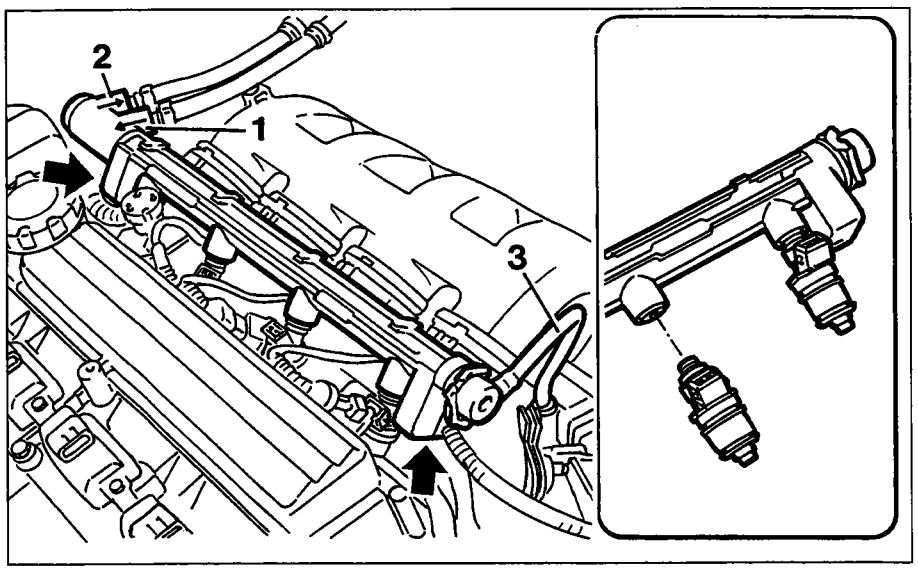
*The system has a memory which is directly supplied by the battery, even with the ignition switched off, where the values obtained during self-adjustment are stored. The operation of disconnecting the battery causes the loss of this data which can only be obtained again after a certain distance: therefore this operation should be restricted as far as possible.*

## FUEL SUPPLY CIRCUIT

**NOTE** *Before working on the supply circuit, it is advisable to drain the pressure for the circuit by disconnecting the vacuum pick up pipe between the pressure regulator and the inlet manifold and applying a slight vacuum.*

### Removing-refitting fuel manifold

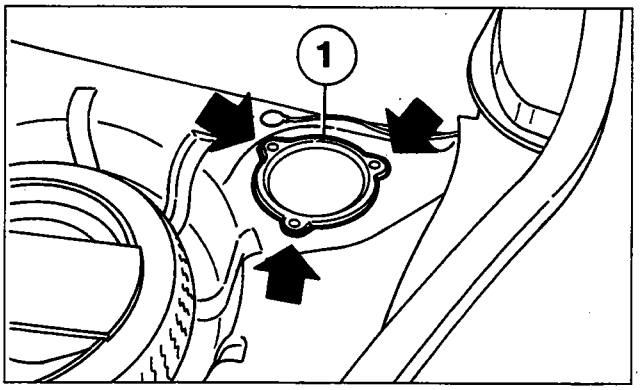
Remove the fuel manifold complete with injectors by carrying out the following operations:



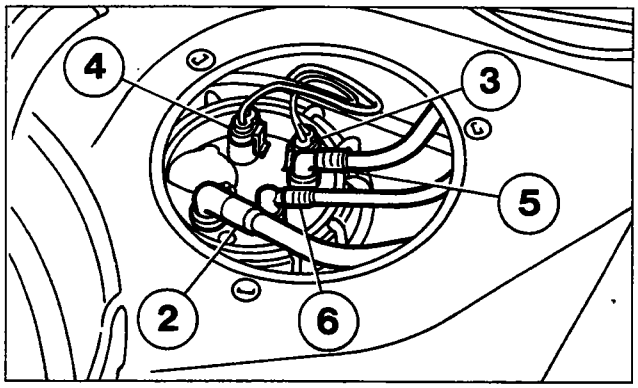

P4A47BJ01

- disconnect the fuel supply pipe (1) and the return pipe (2) from the respective unions at the fuel manifold;
- disconnect the vacuum pick up pipe (3) from the pressure regulator;
- disconnect the electrical connectors from the injectors;
- undo the two bolts fixing (arrow) the fuel manifold and remove it complete with injectors and pressure regulator.

The injectors do not have a clip: to remove them therefore simply release them from their housing (see detail).




P4A48BJ01



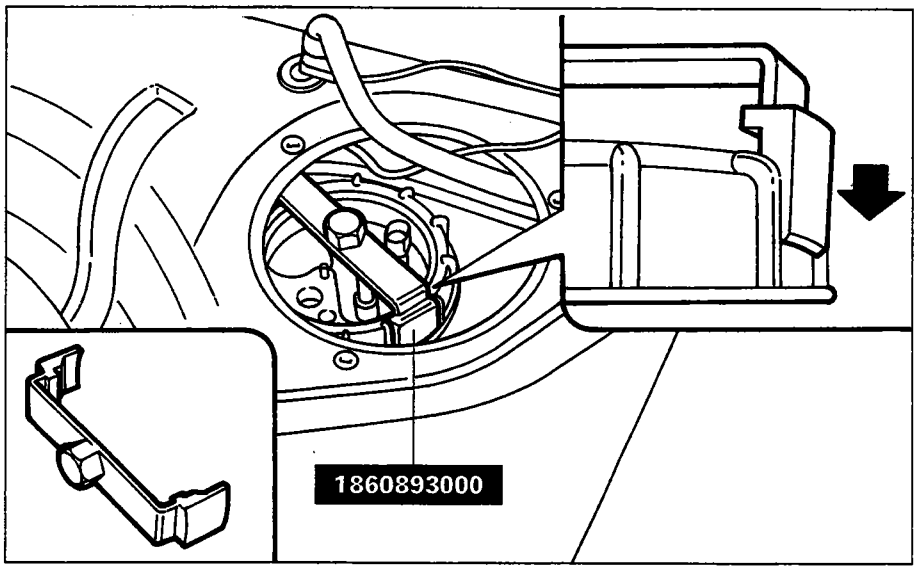

P4A48BJ02

### Removing-refitting electric fuel pump

Proceed with the removal of the pump as follows:

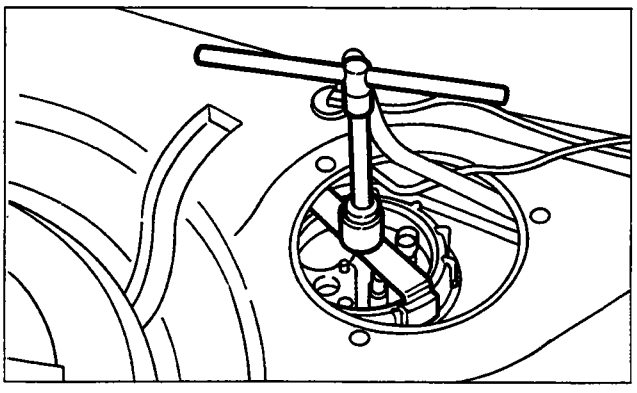
- working from the luggage compartment, remove the cover to gain access to the pump housing cover;
- undo the three fixing bolts (arrow) and remove the cover (1);
- undo the union (2) fixing the breather pipe and remove the pipe;
- disconnect the electrical connector for the fuel level gauge (3) and the one for the pump (4) supply;
- remove the rapid attachment fuel supply (5) and return (6) unions from the tray;

**NOTE** *When removing and refitting the rapid unions, refer to the procedures given in the service notes.*



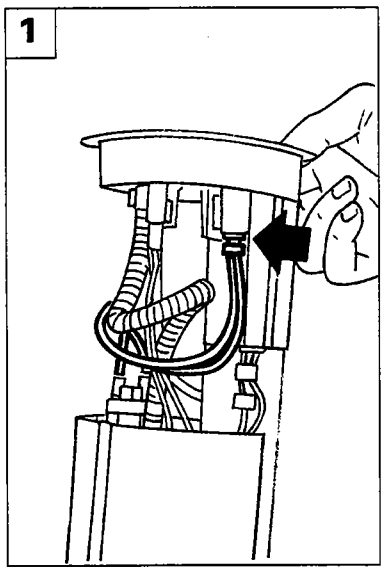

P4A48BJ03

- fit tool 1860893000 on the tray fixing flange, taking care to insert it correctly between the projections on the flange, as shown in the diagram;



P4A48BJ04

- undo the flange and remove it together with the tool, then carefully remove the tray complete with seal.



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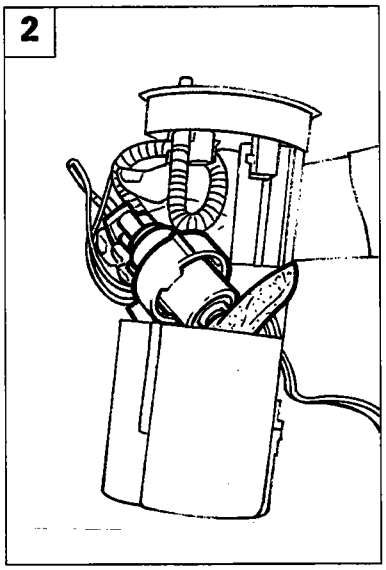
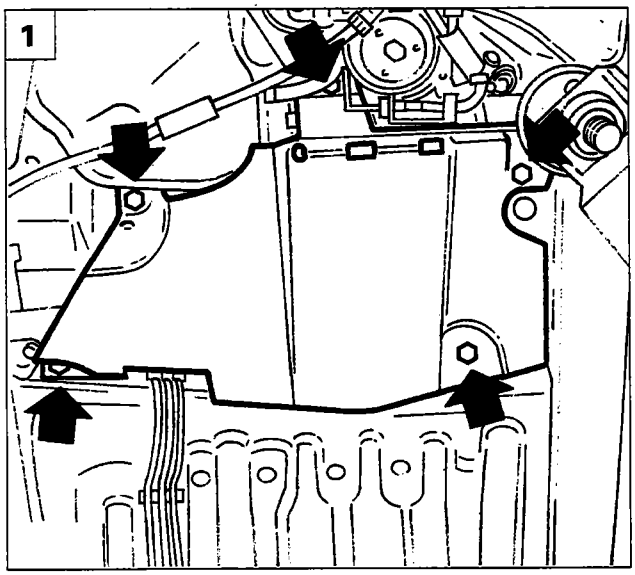


P4A49BJ01

With the drip tray removed, proceed as follows:

1. disconnect the pump supply connector from the drip tray;
2. lift up the pump and extract it by bending it sideways, as shown in the diagram.

Then open the band fixing the supply pipe and remove the pipe from the pump.
Lastly, remove the gauze filter from the pump.

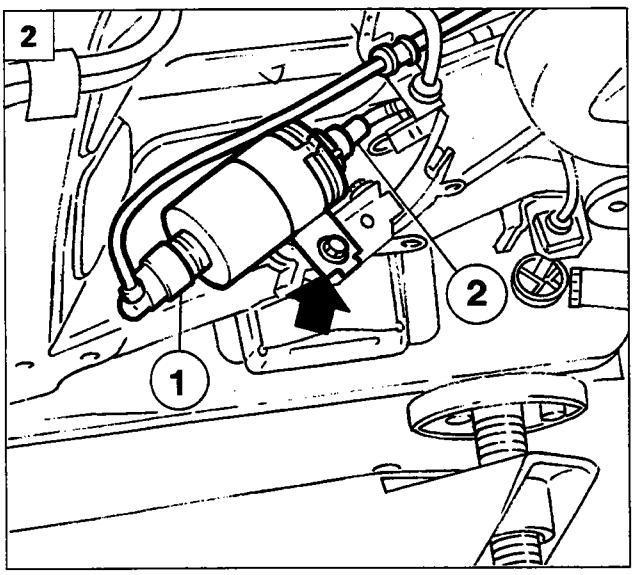


P4A49BJ04

**Removing-refitting fuel filter**

Raise the vehicle, then proceed as follows:

1. unto the four bolts and the nut (arrow) fixing the shield and remove the shield;
2. disconnect the fuel rapid inlet (1) and outlet (2) connectors from the filter and collect the fuel which comes out during the operation in a suitable container, then seal the connectors without either bending or twisting the pipes; lastly, undo the fixing bolt (arrow) and remove the filter.



P4A49BJ03

**NOTE** *When removing and refitting the rapid connectors, refer to the procedures described in the service notes.*

*The fuel filter should be replaced every 40,000 km.*
*After replacing the filter, start up the engine and check that no fuel is leaking from the connectors.*

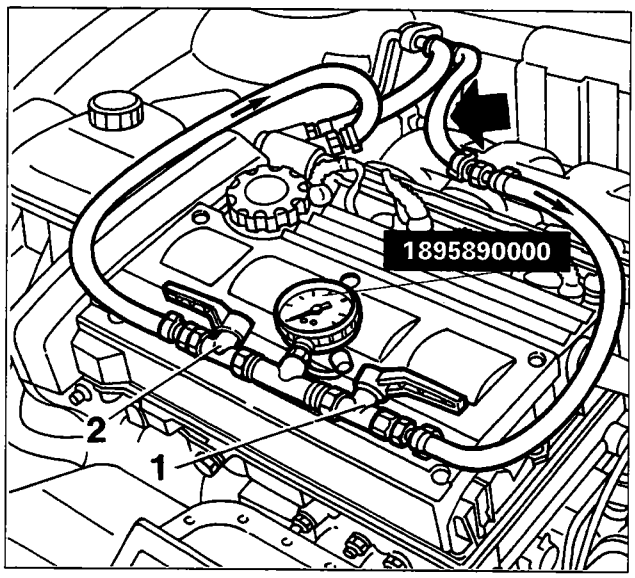
## FUEL CIRCUIT PRESSURE CHECKS

### Checking fuel regulation pressure

Disconnect the pipe coming from the filter (shown by the arrow) from the injector fuel manifold. Place pressure gauge 1895890000 and two taps (1) and (2) between the end of the disconnected pipe and the fuel manifold, as illustrated in the diagram.

Supply the electric pump with the engine switched off through the "active diagnosis" function of the F/L Tester.
Alternatively, proceed as follows:
- extract the pump relay from the socket
- make a connection as shown in the diagram using a suitable bridge for this purpose.

The pressure reading on the gauge should stabilize, in these conditions, at 3.0 bar ± 0.2 bar.
If the pressure is too low, carry out the next test.



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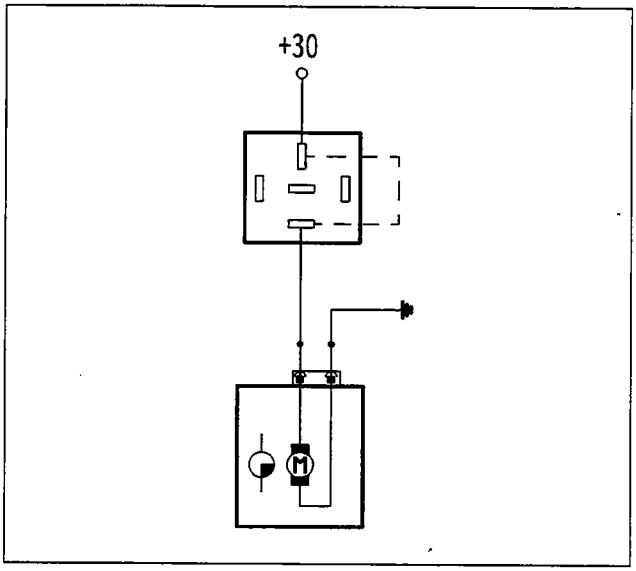

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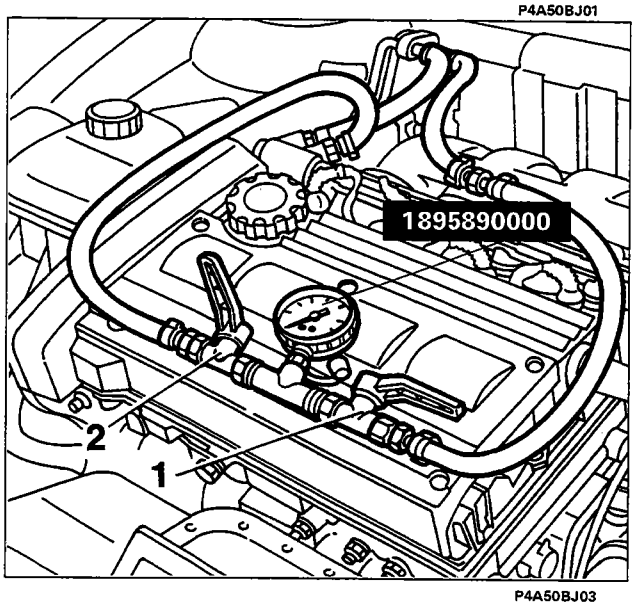


P4A50BJ03

### Checking maximum fuel supply pressure (or efficiency of electric pump)

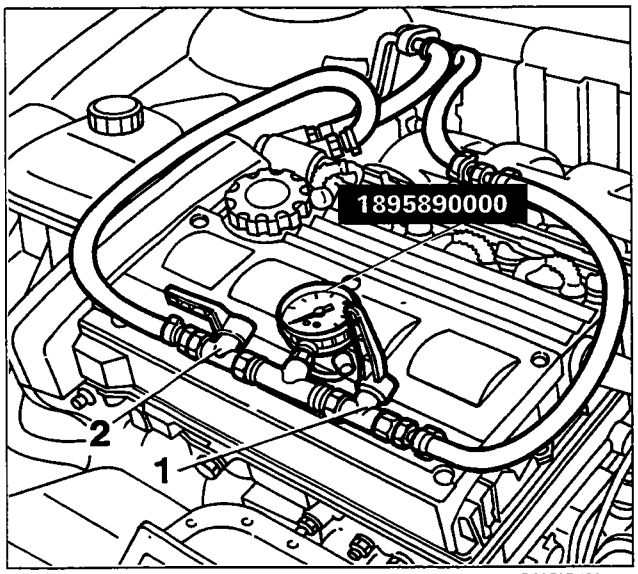
Keeping the same connections as for the previous test, close the tap (2) located downstream of the pressure gauge, operate the electric pump with the engine switched off, as described for the previous test: the pressure should reach 5 bar and not exceed 7 bar (pump safety valve setting). If this is not the case, replace the electric pump because it is defective.

If the pressure value in the previous test was higher than 3.0 bar it is necessary to:
- disconnect the fuel return pipe from the pressure regulator and replace it, temporarily, with a pipe which, inserted on the filler, allows the return of fuel to the tank.
- supply the electric pump with the engine switched off as described in the previous test, then read off the pressure value on the gauge:
  1. if it reaches 3.0 bar then the fuel return pipe to the tank must be replaced because it is obstructed or bent;
  2. if it exceeds 3.0 bar then the pressure regulator must be replaced because it is defective.

**NOTE** *At the end of the tests refit the pump relay in its housing if it has been removed.*

**Checking pneumatic part of pressure regulator**

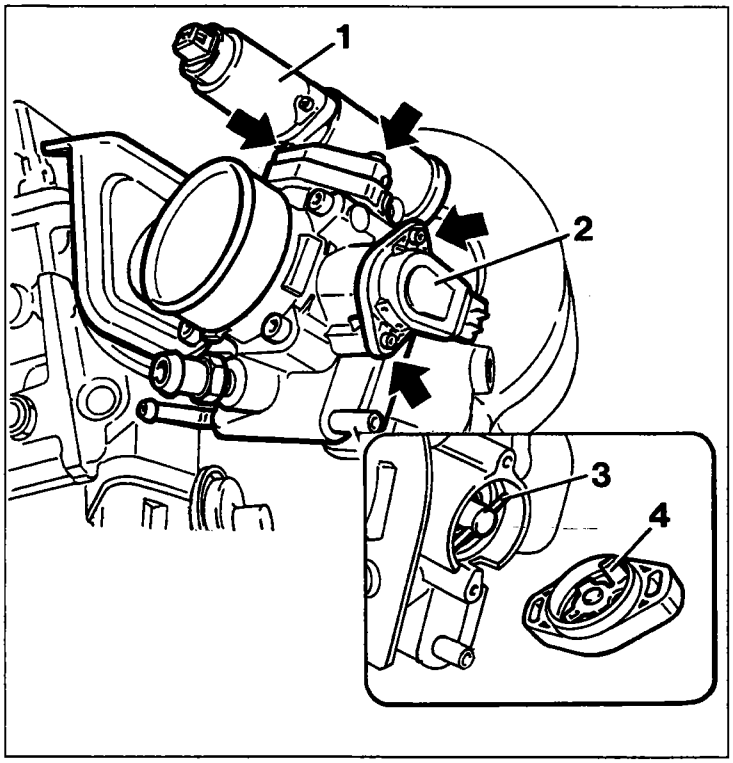
Start up the engine and let it idle.
The reading on the presure gauge should be around 2.5 bar.
If this is not the case, the air connecting pipe between the pressure regulator and the inlet manifold is damaged or the regulator itself is defective and should be replaced.




**Checking injector seal**

In order to check if the injectors are dripping, make the connection as described for the regulation pressure test. Then proceed as follows:
- supply the electric pump with the engine switched off;
- fully close the tap (1) Upstream of the pressure gauge once the regulation pressure has been reached: in this way the pressure in the fuel manifold and the injectors will be the same;
- switch off the electric pump and observe whether as soon as the pressure stabilizes (i.e. decreases slightly) it remains constant for around 60 secs; if this is not the case, there is a leak from one or more of the injectors or from a union.

In this case, remove the injectorsand the fuel manifold from the inlet manifold, keeping the connection with the pressure gauge.
Repeat the previous test leaving the tap (1) open.
When supplying the electric pump with the engine switched off, observe whether there is dripping from any connecting sections.
Replace any dripping injectors and/or renew any defective seals where there are leaks.




P4A52BJ01

## INTAKE CIRCUIT

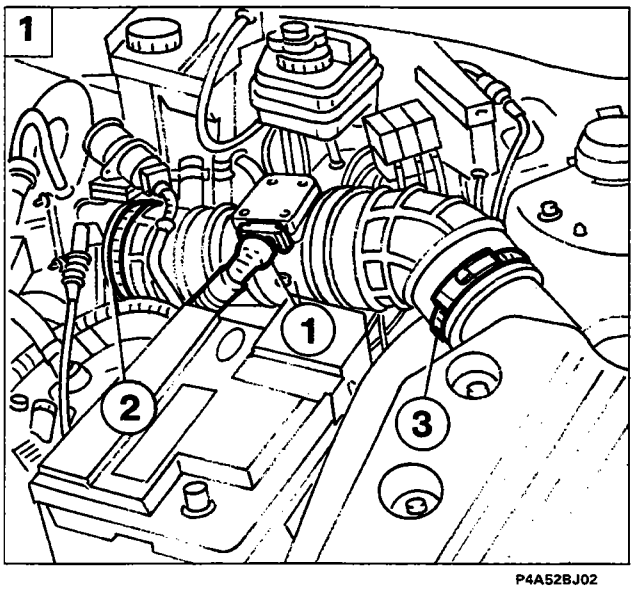
**Removing-refitting engine idle adjustment solenoid valve and butterfly position sensor**

- Undo the fixing bolts (arrow) to remove the engine idle adjustment solenoid valve (1);
- undo the fixing bolts (arrow) to remove the butterfly position sensor (2).

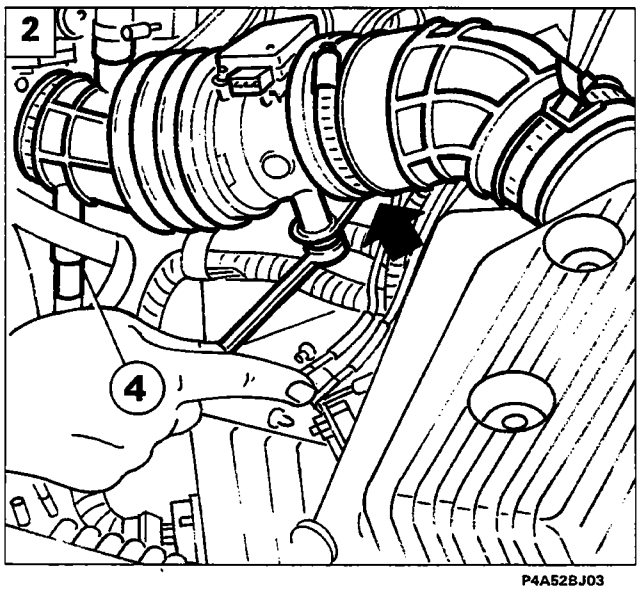
**NOTE** *When refitting the butterfly position sensor, take care that the operating lever fitted on the butterfly shaft (3) is above the sensor driving element (4), as shown in the diagram.*

**Removing-refitting air flow meter**

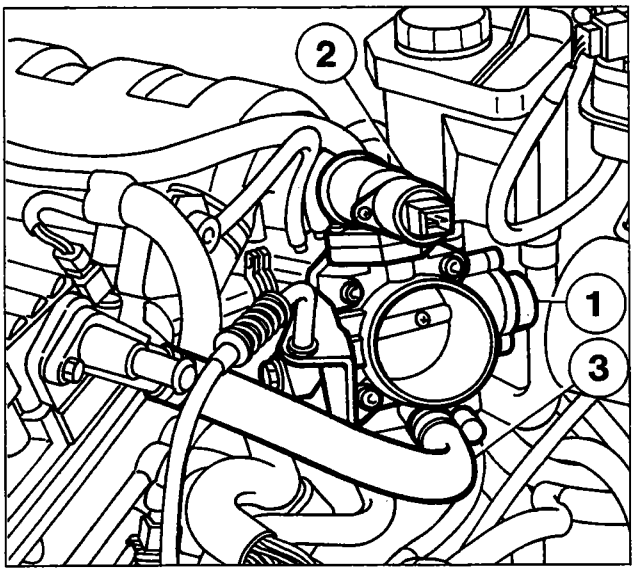
1. Remove the battery, disconnect the electrical connector (1) from the meter, loosen the bands (2) and (3) fixing the inlet sleeve;
2. disconnect the blow-by sleeve (4) from the inlet sleeve, undo the two bolts (arrow) fixing the flow meter mounting bracket and remove the assembly; then loosen the bands at the flow meter and remove the two sleeves.




P4A52BJ02



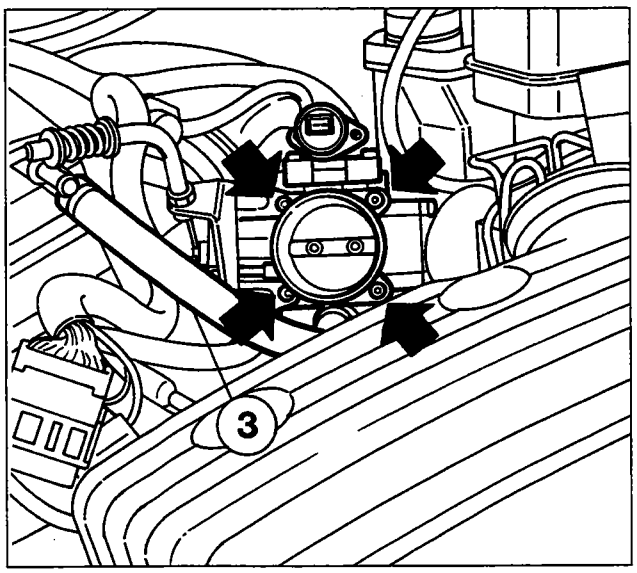

P4A52BJ03



P4A53BJ01

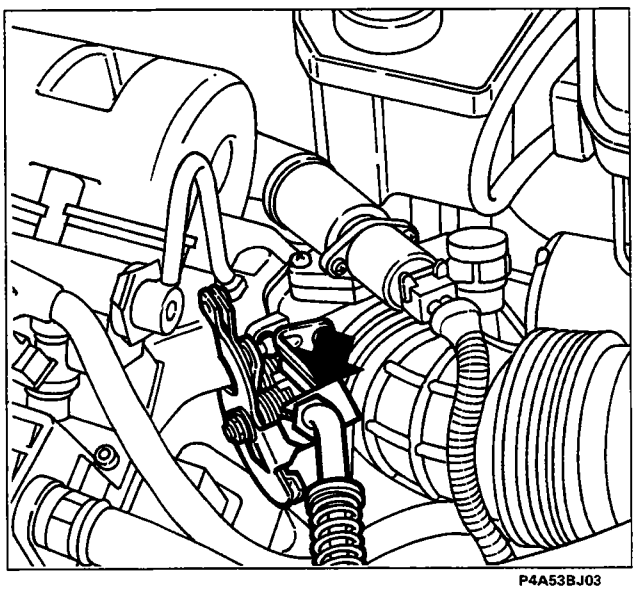
### Removing-refitting butterfly casing

Proceed as described for the removal of the air flow meter, removing the meter complete with the two sleeves.
Then, proceed as follows:
- disconnect the electrical connectors from the butterfly position sensor (1) and from the engine idle adjustment solenoid valve (2);
- remove the band fixing the blow-by pipe (3), cylinder head cover side and remove the pipe;



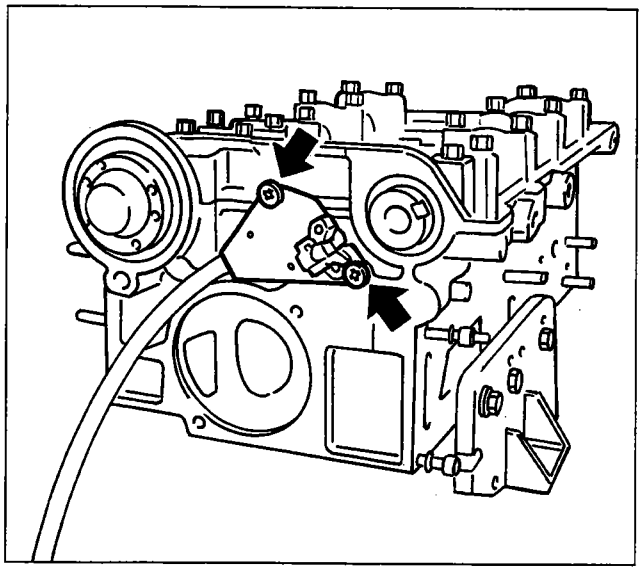
P4A53BJ02

- undo the four bolts fixing the butterfly casing (arrow) to the inlet manifold;
- release the end of the accelerator cable from the control lever;
- remove the coolant connecting pipes from the inlet and outlet pipes, sealing them as appropriate;
- lastly, remove the blow-by pipe (3) from the butterfly casing.

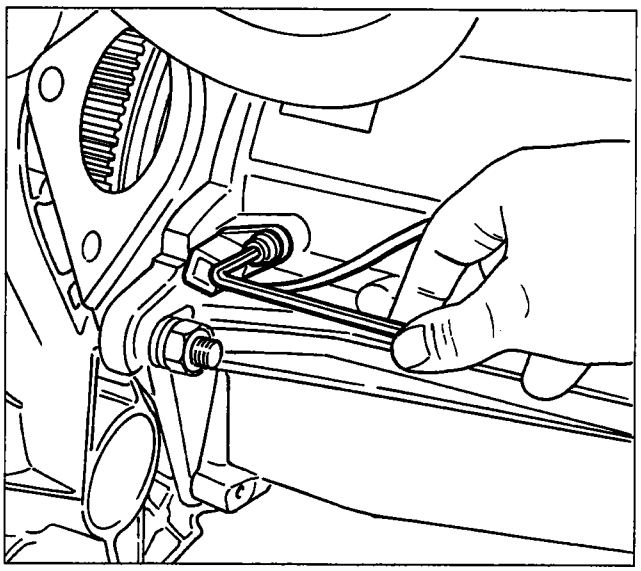

P4A53BJ03

### Adjusting accelerator control cable

Adjust the accelerator control cable by carrying out the following operations:
- loosen the lock nut at the bottom of the bracket;
- acting on the adjustment nut (arrow), adjust the accelerator cable clearance;
  **tighten** to **reducee** the clearance,
  **loosen** to **increase** the clearance;
- when the adjustment is complete, lock the lock nut.



P4A54BJ01



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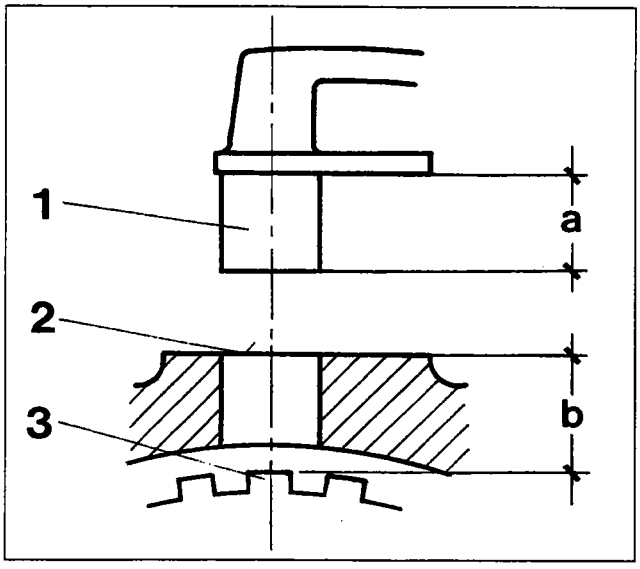



P4A54BJ03

## ELECTRICAL CIRCUIT

### Removing-refitting engine timing sensor

This operation involves removing the timing belt and the camshaft toothed pulley, exhaust side.
Having carried out these operations, it is necessary to:

- disconnect the electrical connector;
- undo the two fixing bolts (arrow) and remove the sensor.

When refitting carry out the procedure in the reverse order, following the instructions for fitting and tensioning the toothed belt.

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

### Removing-refitting engine rpm sensor

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

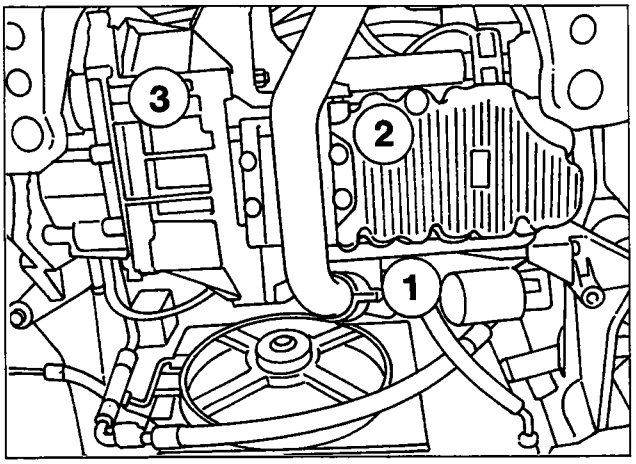
- disconnect the electrical connector;
- undo the bolt fixing the sensor and remove it from its housing.

**NOTE** *The sensor is fitted in production with tolerances which ensure a gap of 0.8 ± 0.4 mm without requiring further adjustments. This gap is also ensured if the sensor is replaced with a replacement one.*

If you wish to check the gap between the sensor and the flywheel, proceed as follows:

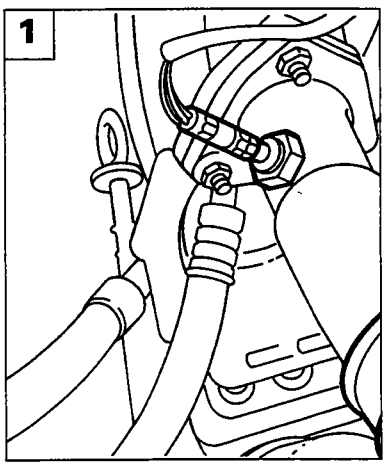
- measure the distance between the end of the sensor and the lower part of the sensor bracket (distance "a");
- measure the distance between the fitting element on the cylinder block/crankcase and the upper part of the tooth (distance "b"), repeating the measurement for at least two opposite teeth.
  The gap (t = b-a) should be between 0.4 and 1.2 mm.

1. Sensor
2. Fitting element
3. Flywheel tooth



P4A55BJ01

**Removing-refitting:**
1. **Lambda sensor**
2. **Detonation sensor**
3. **Vehicle speed sensor**



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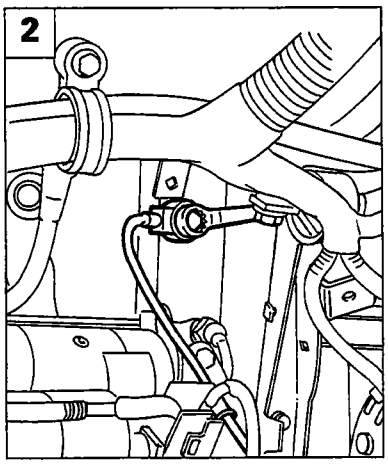

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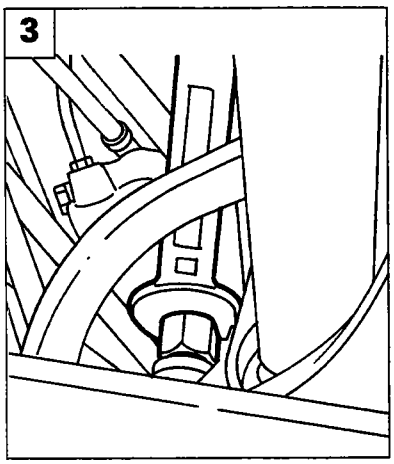
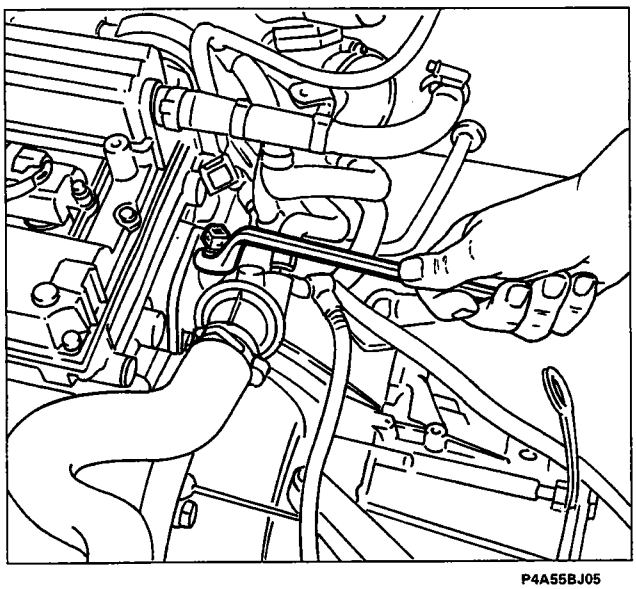


P4A55BJ04

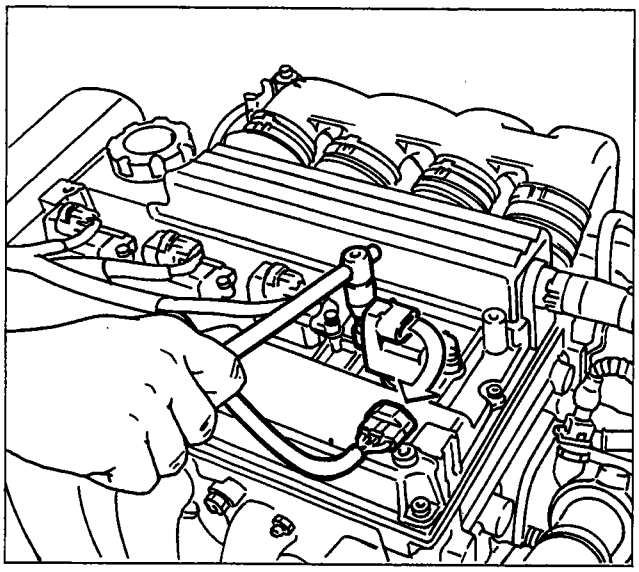
1. Disconnect the electrical connector, then undo the Lambda sensor and remove it from its housing.
2. Disconnect the electrical connector, undo the bolt fixing the detonation sensor and remove it.
3. Disconnect the electrical connector and undo the casing for the vehicle speed sensor, removing it from its housing.


P4A55BJ05

**Removing-refitting coolant temperature sensor**

- Disconnect the electrical connector from the sensor;
- undo the sensor removing it from its housing.

*Take great care that the sensor is correctly refitted and over the electrical connection, since the information sent by the sensor is also used by the control unit for operating the radiator fan.*

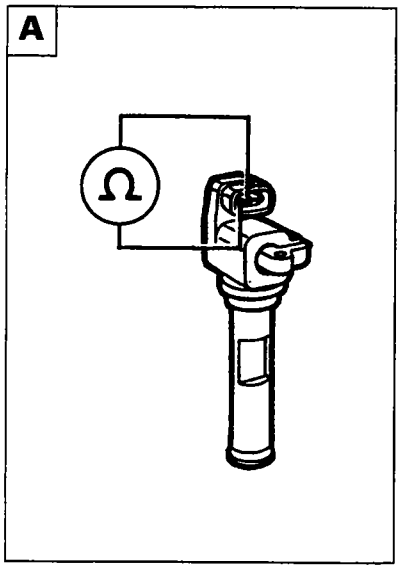


P4A56BJ01

### Removing-refitting ignition coils

Proceed with the removal of the ignition coils by carrying out the following operations:
- disconnect the electrical connector;
- undo the two fixing bolts and remove the coil, extracting it from the housing.

**NOTE** *The coil is fitted with an extension made from a silicon material with a high dielelectric power inside of which there is a pressure switch with a spring loading.*
*Do not dismantle the two components so as not to risk losing the internal contact or getting it dirty.*
*In the case of replacement, it is not necessary to separate the coil from the extension because the complete coil/extension assembly is available as spares.*

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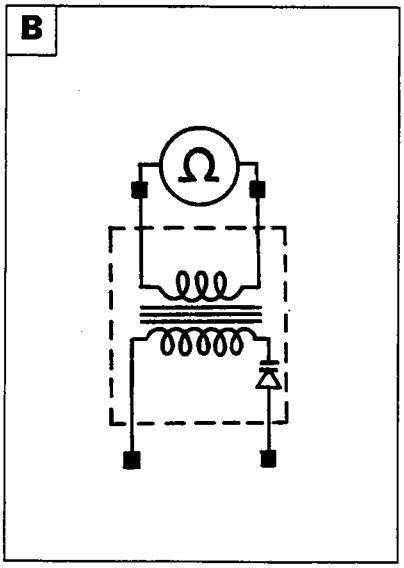
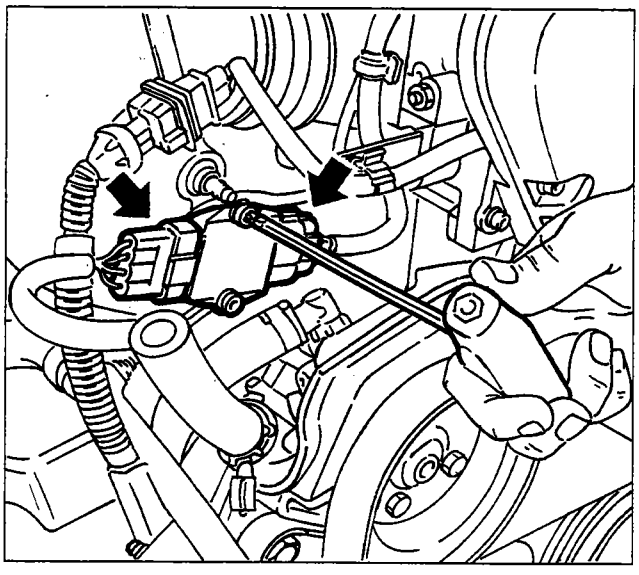



P4A56BJ03

### Checking primary circuit coil resistance

The resistance is checked by following the diagram.

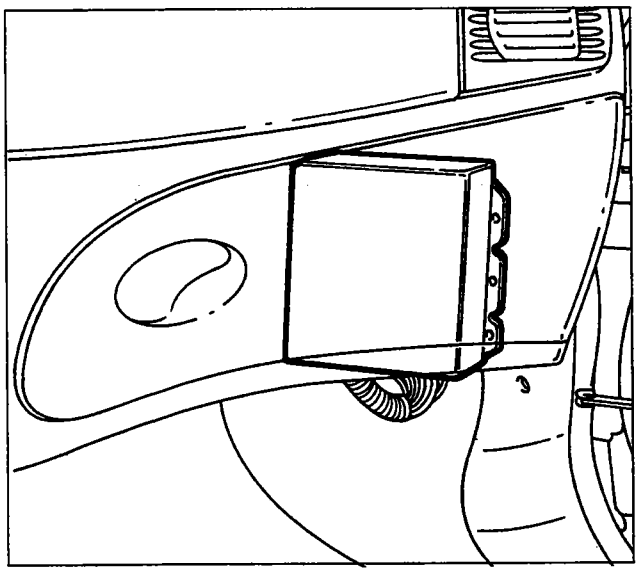
**Primary resistance: 0.6 ± 0.06 ohm**



P4A56BJ04

### Removing-refitting ignition power module

Remove the ignition power module carrying out the following operations:
- disconnect the electrical input and output connectors (arrow);
- undo the two fixing bolts and remove the module.


P4A57BJ01

**Removing-refitting engine control unit**

The control unit is located under the glove compartment.
Proceed with removing the control unit by carrying out the following operations:
- remove the glove compartment;
- undo the bolt fixing the mounting bracket and rest the control unit on the floor of the vehicle;
- undo the bolt fixing the earth cable to the bodyshell;
- disconnect the electrical connectors, one by one;
- remove the bracket from the control unit.

## CHECKING EMISSION CONCENTRATION

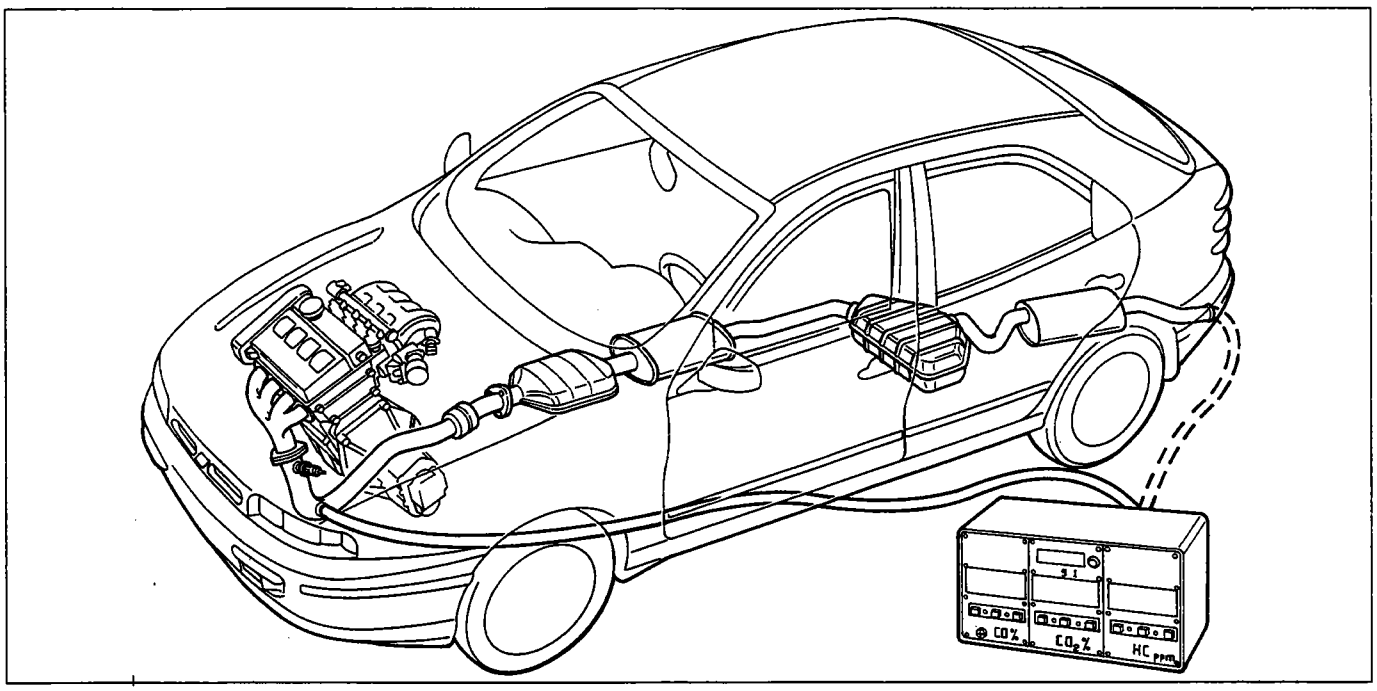
This system manages the content of carbon monoxide (CO) and the idle air flow rate which cannot, however, be manually adjusted.
However, checking the content of the exhaust gases upstream and downstream of the catalyzer can provide a useful indication of the injection/ignition system operating conditions, 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 located in the exhaust pipe, upstream of the catalyzer, and tighten the tool in its place.
2. Connect a suitably calibrated CO-tester sensor to the tool.
3. Start up the engine and let it reach operating temperature.
4. Check that the speed is correct.
5. Check that the idle concentration of CO is within the recommended limits (see table); if this is not the case, it is necessary to check:
   - that the Lambda sensor is working properly, using the F/L Tester;
   - for the presence of air penetration in the area surrounding the Lambda sensor housing;
   - the injection and ignition systme **(in particular the state of wear of the spark plugs).**
6. In the same conditions, check that the concentration of HC is less than 500 p.p.m.
7. If these values are not found, proceed with checking the engine, paying particular attention to:
   - the timing;
   - the engine compression.

**NOTE** *The engine is fitted with hydraulic tappets for the automatic recovery of the clearances.*




P4A58BJ01

**Table summarizing pollutant emission tolerance values**

| | CO(%) | HC (p.p.m.) | $CO_2$ (%) |
|---|---|---|---|
| Upstream of the catalyzer | 0,4 ÷ 1 | < 500 | > 12 |
| Downstream of the catalyzer | < 0,35 | < 90 | > 13 |

### Checking exhaust concentration of CO and HC

The concentration of carbon monoxide (CO) and unburnt hydrocarbons (HC) at the exhaust is measured by inserting a suitably calibrated sensor probe at least 30 cm into the end section of the exhaust pipe.

1. Check that the idle CO and HC concentration values are as recommended (see table).
2. If the HC value is outside of the recommended limits, whilst that previously measured upstream of the catalyzer was okay, then the engine parameters are taken to be correct and the cause of the problem should be sought in the decreased efficiency of the catalyzer.

## CHECKING ENGINE IDLE SPEED

If the engine idle speed is not correct as the system is the self-adjusting type it is not possible to carry out any adjustment: therefore it is necessary to check that the accelerator linkage is correctly adjusted and therefore the problem should be sought by means of a complete fault diagnosis using the F/L Tester.

## CHECKING IGNITION ADVANCE

In order to check the ignition advance values at different speeds it is necessary to use the F/L Tester diagnostic equipment.