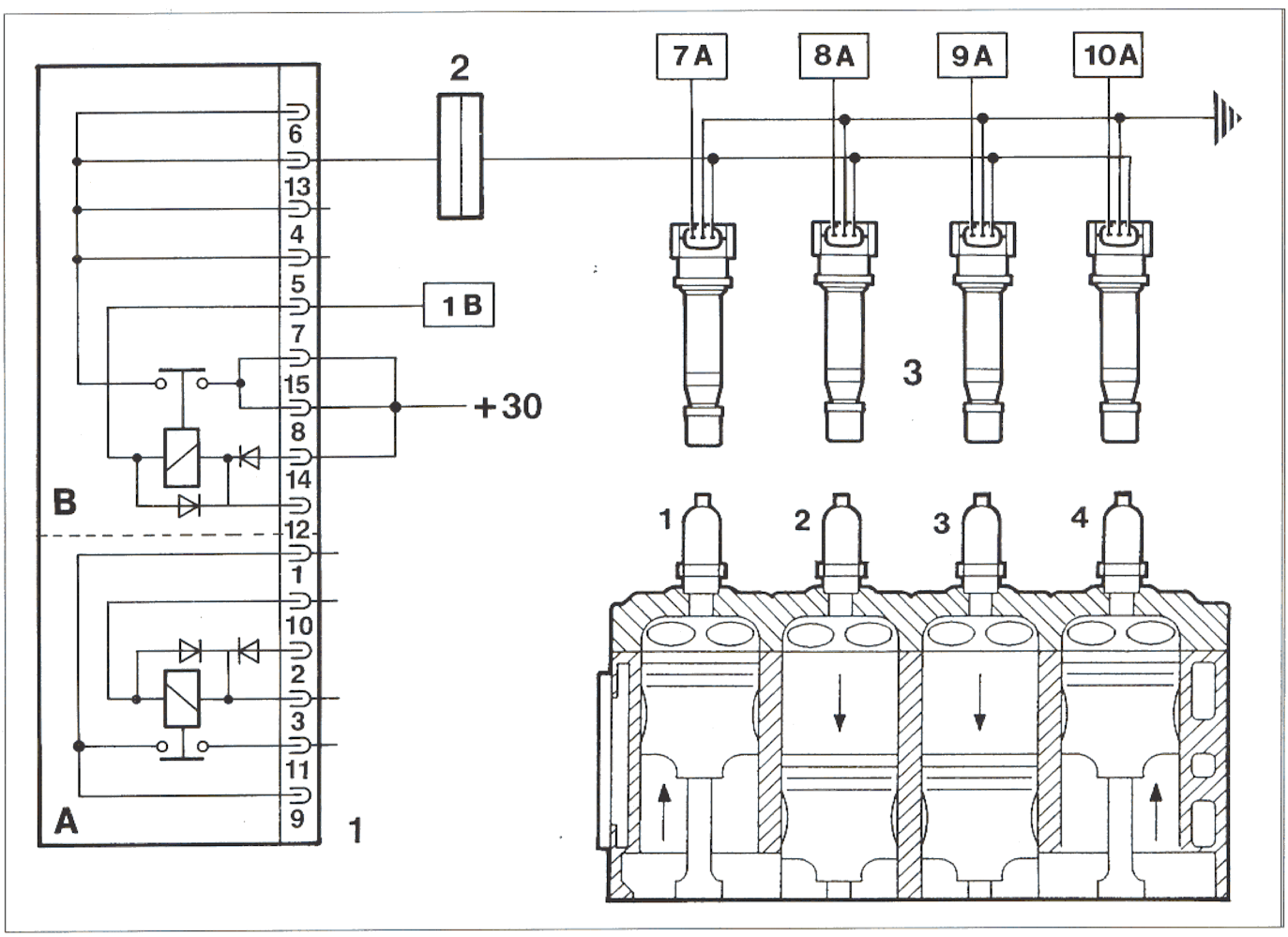
MANAGEMENT OF IGNITION

The purpose of the ignition management strategies is to make the spark occur with the required advance in accordance with the engine's operating conditions.

The management of ignition basically consists of determining the ignition advance and implementing it by driving the power transistor built into each coil.
The "basic" advance value, calculated in accordance with the intake air flow rate and engine speed, is then corrected in accordance with the engine's different operating conditions.
The control unit determines the instant for starting conduction of current in the coil primary winding in accordance with the engine speed.
This instant naturally varies in terms of angle in relation to the TDC power stroke of each cylinder, and is all the more advanced the higher the engine speed, as the time *(dwell)* required for saturating the current in the coil primary is roughly constant.
The start-of-conduction instant is corrected in accordance with the battery voltage.



P3W11BJ01

1. Double contactor
2. Interface connector
3. Single ignition coil (pencil-coil)

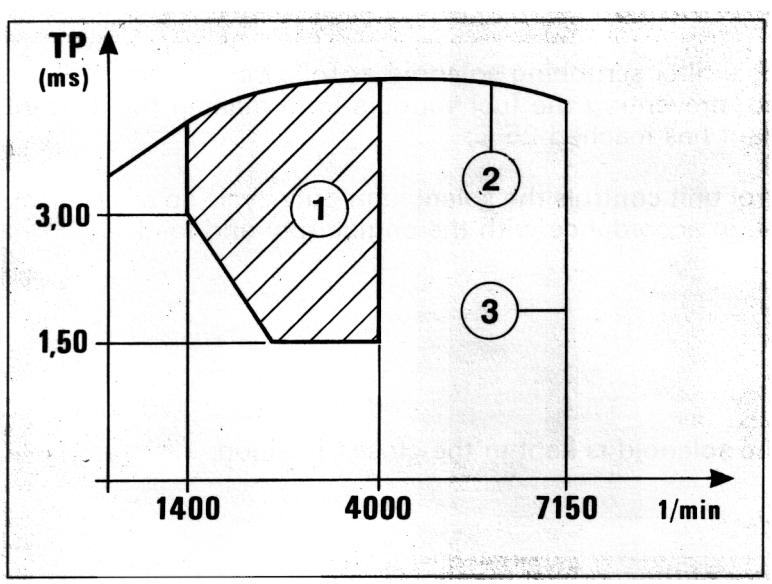
Knock control

The purpose of this strategy is to detect the presence of knocking, by processing the signal coming from the relevant sensor. The strategy continuously compares the signal from the sensor with a threshold, which is in turn continuously updated, to take into account the background noise and ageing of the engine.
If the system recognizes the presence of knocking, the strategy reduces the ignition advance in 2° steps up to a maximum of 7°, until the knocking disappears. The advance is then gradually restored to its basic value or until the knocking reoccurs. The increases in advance are made gradually, while the reductions are made immediately.

Under acceleration conditions, the strategy uses a higher threshold to take account of the increased noise of the engine under those conditions.
The strategy also has a self-adaptivity function, which memorizes in a non-permanent manner reductions in advance which are constantly repeated, so as to adapt the advance to the different conditions now affecting the engine (e.g. using a low octane number fuel). The strategy can restore the advance to the mapped value when the conditions which led to the reduction are no longer present.

Operation with active timing variator

As the timing variator is activated/deactivated, the "basic" advance is adjusted in accordance with the engine rpm and load.



1. Variator in ON position
2. TP power curve (engine load)
3. Maximum rpm limitation

MANAGEMENT OF TIMING VARIATOR

The control unit controls the hydraulic actuator of the timing variator (mounted on the camshaft on the inlet side) via a contactor.
The variator has two operating positions:

A. OFF position (power, reduced engine loads and idle speed), corresponds to the camshaft static timing;

B. ON position (torque), corresponds to a camshaft advance of 25° in relation to the crankshaft.

The variator, normally in the OFF position, is set to the ON position in accordance with the engine load and rpm, as shown in the figure.

At all events, the ON position is enabled only if the coolant temperature is over 40°C.

MANAGEMENT OF IDLE SPEED CONTROL

The general aim of the strategy is to keep the engine idle speed at around the mapped value (hot engine: 850 rpm): the position assumed by the actuator depends on the engine conditions and rpm and the vehicle speed.

Starting
When the ignition is switched on, the actuator assumes a position depending on the engine temperature and battery voltage (open loop position).

Engine started with accelerator pedal released
The engine speed varies in accordance with the engine temperature, and it is kept constantly close to the mapped value by the variations in position of the shutter which compensate for any fluctuations in the rpm.
This takes place in particular when external loads are swithed on (power steering, heated rear window, etc.): the fans and air conditioner come on, both managed by the control unit, the strategy manages the actuator before the fans and air conditioner come on.

Normal driving
In these conditions, the actuator is in the open loop position.

In deceleration
In conditions of overrunning outside idle speed, the control unit controls the actuator's position by means of a particular flow curve (dashpot curve), i.e. it slows down the return of the shutter to its seat, thus reducing the braking effect of the engine.

MANAGEMENT OF CHARCOAL FILTER SCRUBBING

The strategy checks the position of the charcoal filter scrubbing solenoid as follows:
- during starting, the solenoid remains closed, preventing the fuel vapours from making the mixture richer; this condition remains until the coolant has reached 25°C;

- with the engine up to temperature, the control unit controls the solenoid in duty cycle so as to check the amount of fuel vapours sent to the inlet, in accordance with the engine rpm and load.

In the following operating conditions:
- throttle in closed position
- rpm below 1250 rpm
- TP engine load < 1 ms

the control of the solenoid is disabled, and the solenoid is kept in the closed position.

MANAGEMENT OF MODULAR MANIFOLD

The control unit controls the pneumatic actuator of the modular manifold (mounted on the inlet manifold) by means of a solenoid.
The modular manifold has two operating positions:
A. intake from the long pipes (up to 5400 rpm): in this position, the solenoid is not supplied and the actuator is in the rest position, so the throttles are closed and the engine draws from the long pipes in order to obtain a high driving torque at medium engine speeds
B. intake from the short pipes (over 5400 rpm): in this position the solenoid is supplied and it places the actuator in communication with the vacuum, causing the throttles to open, so the engine draws from the short pipes, to obtain maximum power.

MANAGEMENT OF AIR CONDITIONING

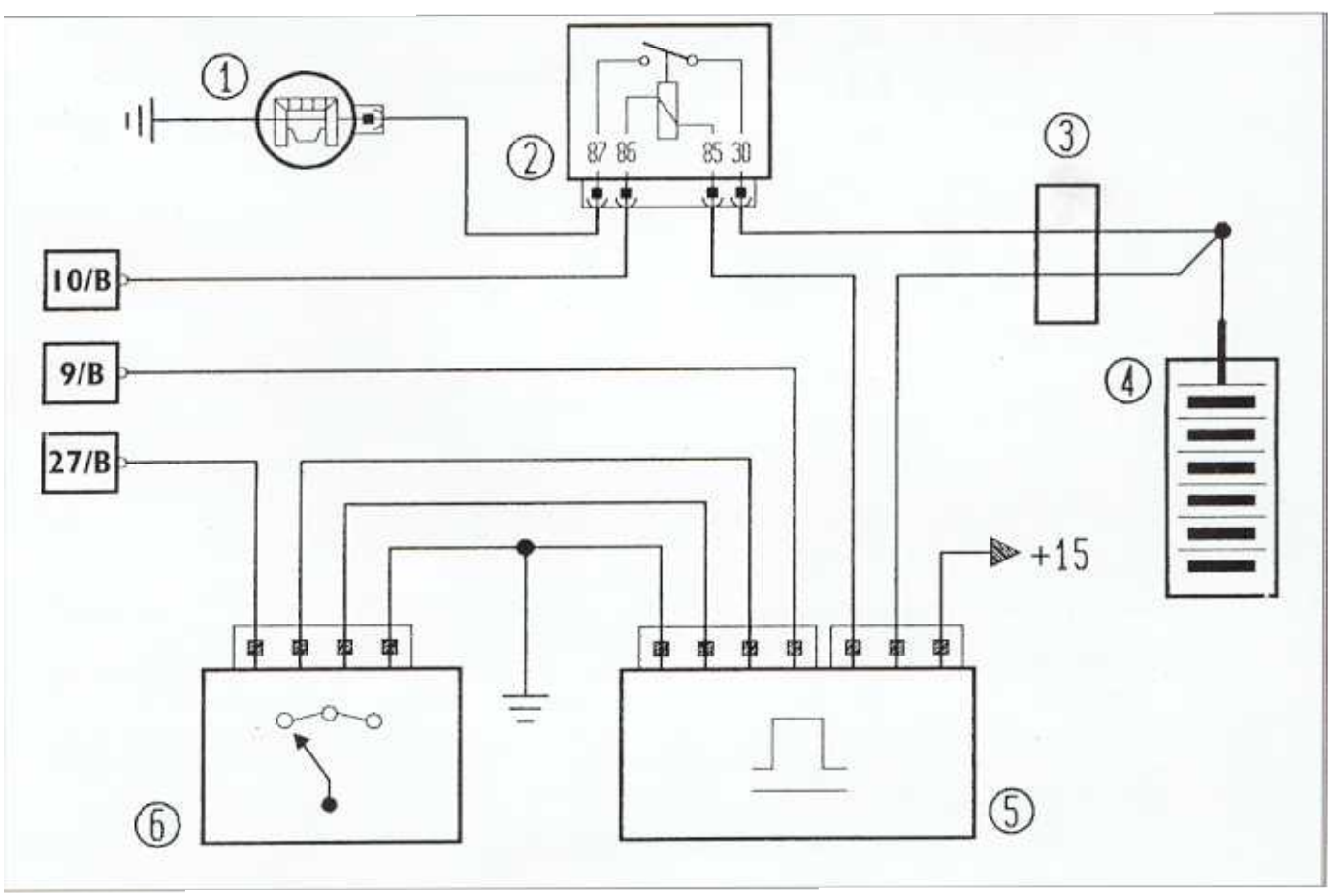
The Hitachi engine control unit is functionally connected to the air conditioning system, as:

1. it receives the request to switch on the compressor through pin 9/B, and makes the relevant interventions (additional air);
2. it gives enablement to the switching on of the compressor through pin 10/B, when the conditions covered by the strategies arise;
3. it receives information on the state of the three-stage pressure switch from pin 27/B and makes the relevant interventions (controls radiator fans).

As regards point 1, if the engine is idling, the control unit increases the air flow passing from the idle speed actuator before the compressor is switched on, and vice versa returns the actuator to the normal position after the compressor has been switched off.
As regards point 2, the control unit automatically controls the switching off of the compressor:

- for 6 s (time-lagged disconnection):
  - when the throttle is over 70° open
  - when the vehicle sets off;

  for as long as the critical conditions remain:
  - for coolant temperatures exceeding 114°C
  - for engine speeds of below 750 rpm.



P3W15BJ01

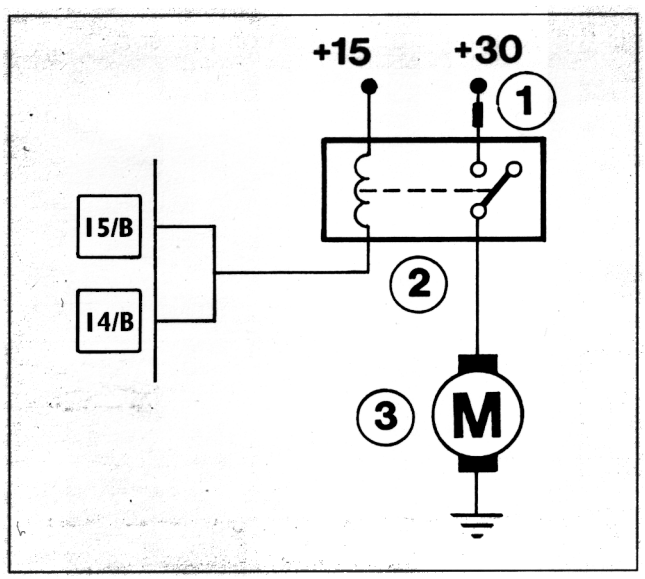
1. Compressor
2. Compressor control contactor
3. Fuse box
4. Battery
5. Air conditioner control unit
6. Three-stage pressure switch

10.

MANAGEMENT OF RADIATOR FANS

The control unit directly controls the operation of the radiator fans in accordance with the engine coolant temperature and whether or not there is air conditioning.

NOTE *As the engine temperature is measured by the relevant sensor, the thermal contact on the radiator is no longer prsent.*



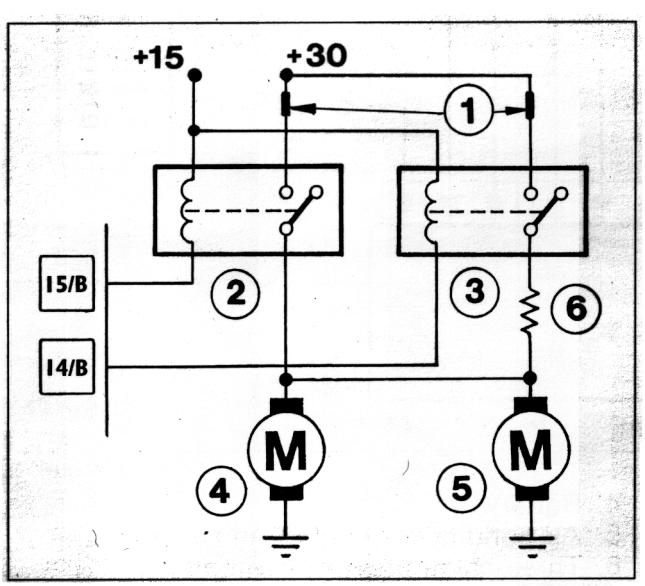
P3W16BJ01

Version without air conditioning

There is only one fan which comes on when the coolant temperature exceeds 95°C.

It is switched off with a lag of 2°C on the temperature threshold.

1. Fuse
2. Fan contactor
3. Electric fan



P3W16BJ02

Version with air conditioning

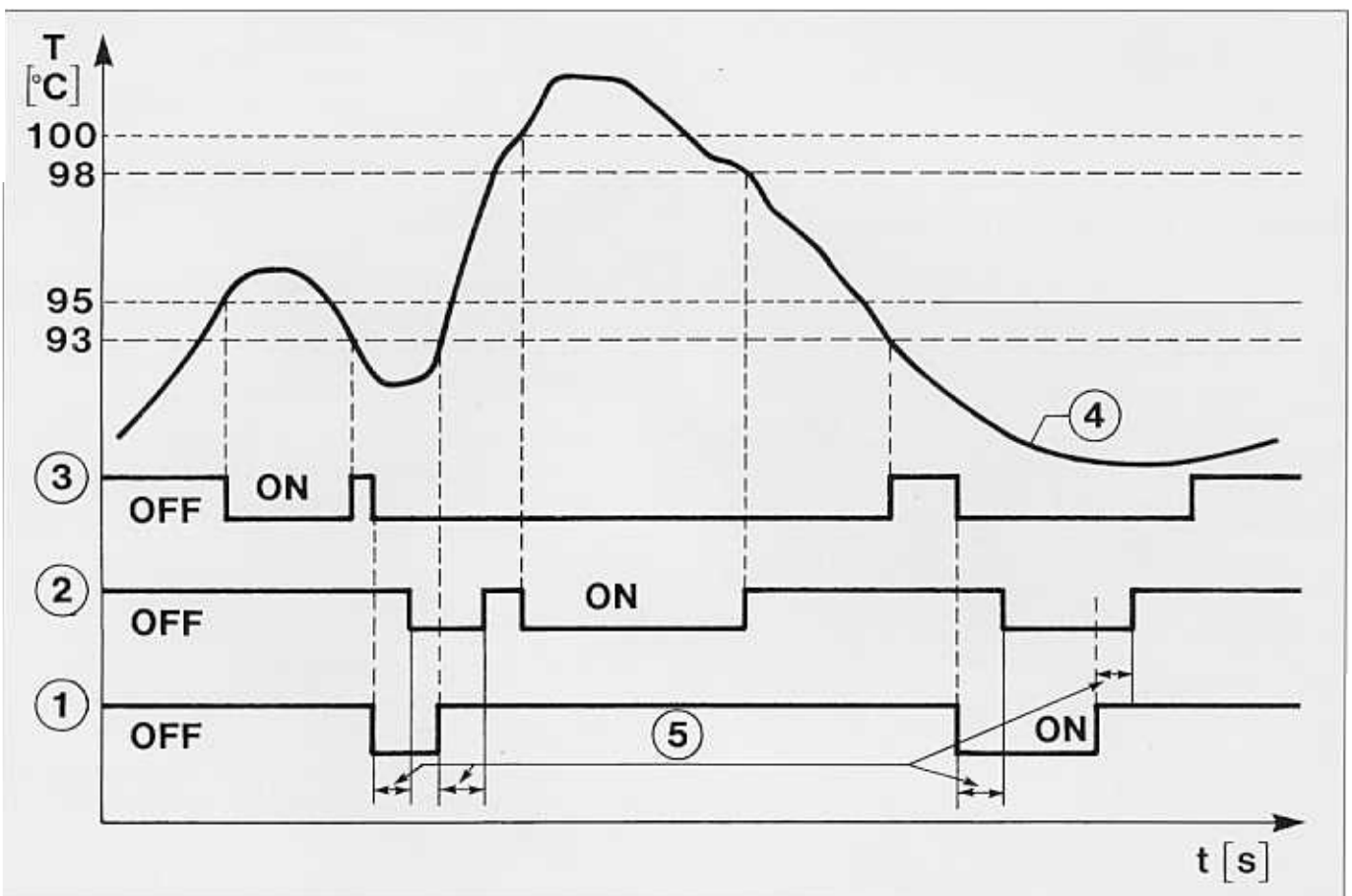
There are two electric fans: a low speed fan and a high speed fan.

NOTE *If the high speed fan is switched on, the low speed fan will operate simultaneously.*

1. Fuse
2. High speed fan contactor
3. Low speed fan contactor
4. High speed fan
5. Low speed fan
6. Load resistor

Functional diagram of the switching on of the fans for the version with air conditioning

Low speed fan: this comes on when the coolant temperature reaches 95°C.
High speed fan: this comes on when the coolant temperature reaches 100°C: the first fan is not switched off until the second one is switched off.
The switching on of the fans also depends on the status of the three-stage pressure switch of the air conditioning system, which determines when the first fan is switched on, and after a certain delay, the second fan, and when they are switched off.



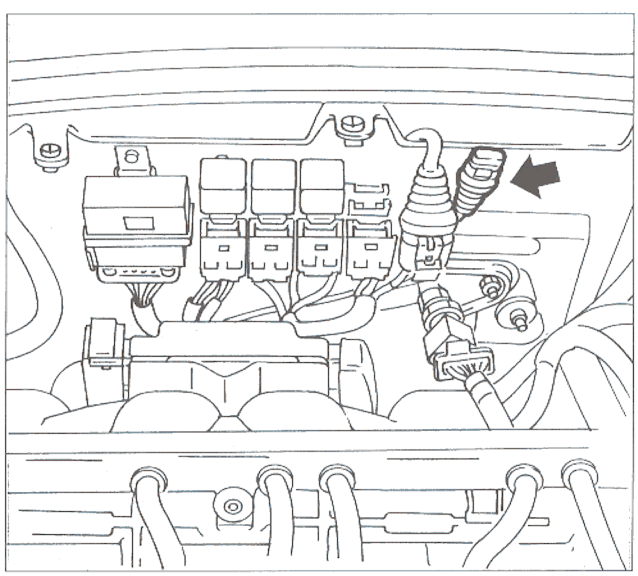
1. Condition of the three-stage pressure switch
2. Condition of the high speed fan
3. Condition of the low speed fan
4. Trend of the coolant temperature
5. Delay of connection/disconnection of the three-stage pressure switch

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

The system comprises fault diagnosis which checks any faults in the following components:

Actuators	Sensors
fuel injectors coils charcoal filter scrubbing solenoid idle speed adjustment stepper motor fuel pump contactor modular manifold solenoid timing variator solenoid contactor air conditioner compressor contactor (if present)	engine rpm sensor engine timing sensor air flow meter lambda probe coolant temperature sensor knock sensor throttle position sensor vehicle speed sensor

Location of fault diagnosis connector



P3W18BJ01

If the fault is confirmed, it is stored permanently in memory, and the relevant sensor is excluded from the system, until the fault is eliminated.

If a confirmed fault is detected, it usually causes the warning light on the dashboard to come on; this light goes out when the fault condition is eliminated.

NOTE

During starting, the light:

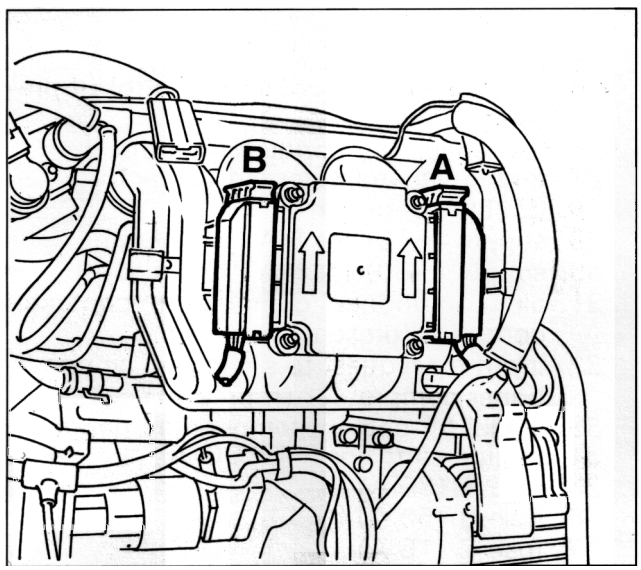
- comes on for 4 seconds
- goes out for 0.1 seconds
- stays on/off permanently depending on whether or not there are "permanent" errors.

Using a diagnostic instrument, a full diagnosis of the system can be carried out, which consists of three stages:

- display of a set of operating parameters (with engine off or running);
- display of the errors and their deletion;
- activation of certain actuators (active diagnosis).

Recovery strategy

If a fault is detected on the sensors/actuators, the control unit where possible replaces the missing data by reconstructing it via the software (recovery) in order to allow the engine to operate.



P3W19BJ01

engine side wiring (A)

throttle position sensor
coolant temperature sensor
air flowmeter
engine rpm sensor
engine timing sensor
knock sensor
fuel injectors
coils
idle speed stepper motor
module manifold actuator solenoid
charcoal filter scrubbing solenoid

ELECTRICAL/ELECTRONIC SYSTEM

Wiring

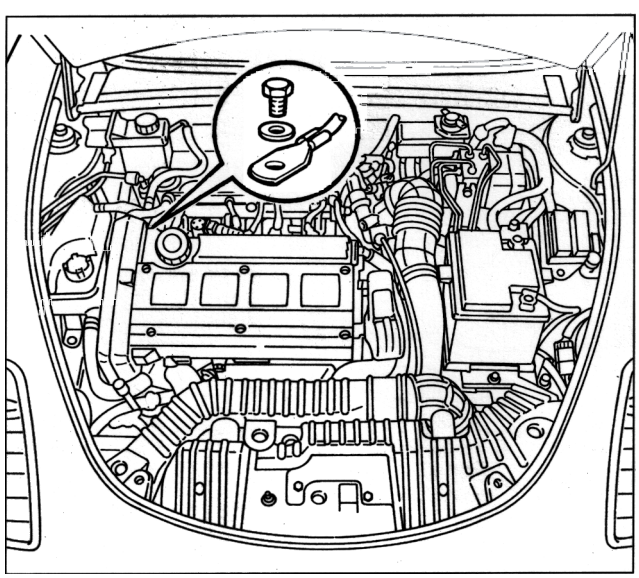
The system has two separate wiring systems. The wiring on the engine side (A) connects the components mounted on the engine to the engine control unit, while the wiring on the vehicle side (B) instead connects the other compnents to the control unit and forms the interface with the vehicle wiring.

NOTE

The two connectors are the same, so if the control unit is dismantled, the direction of assembly (arrow) must be respected to avoid inversions.

vehicle side wiring (B)

vehicle speed sensor
double contactor (pump, fuel injection)
radiator fans contactor
air conditioner compressor contactor (if present)
timing variator solenoid contactor
fuses
lambda probe
diagnostic instrument
FIAT CODE control unit
instrument panel connection
supply from battery
supply from ignition switch



P3W19BJ02

Location of system earth points

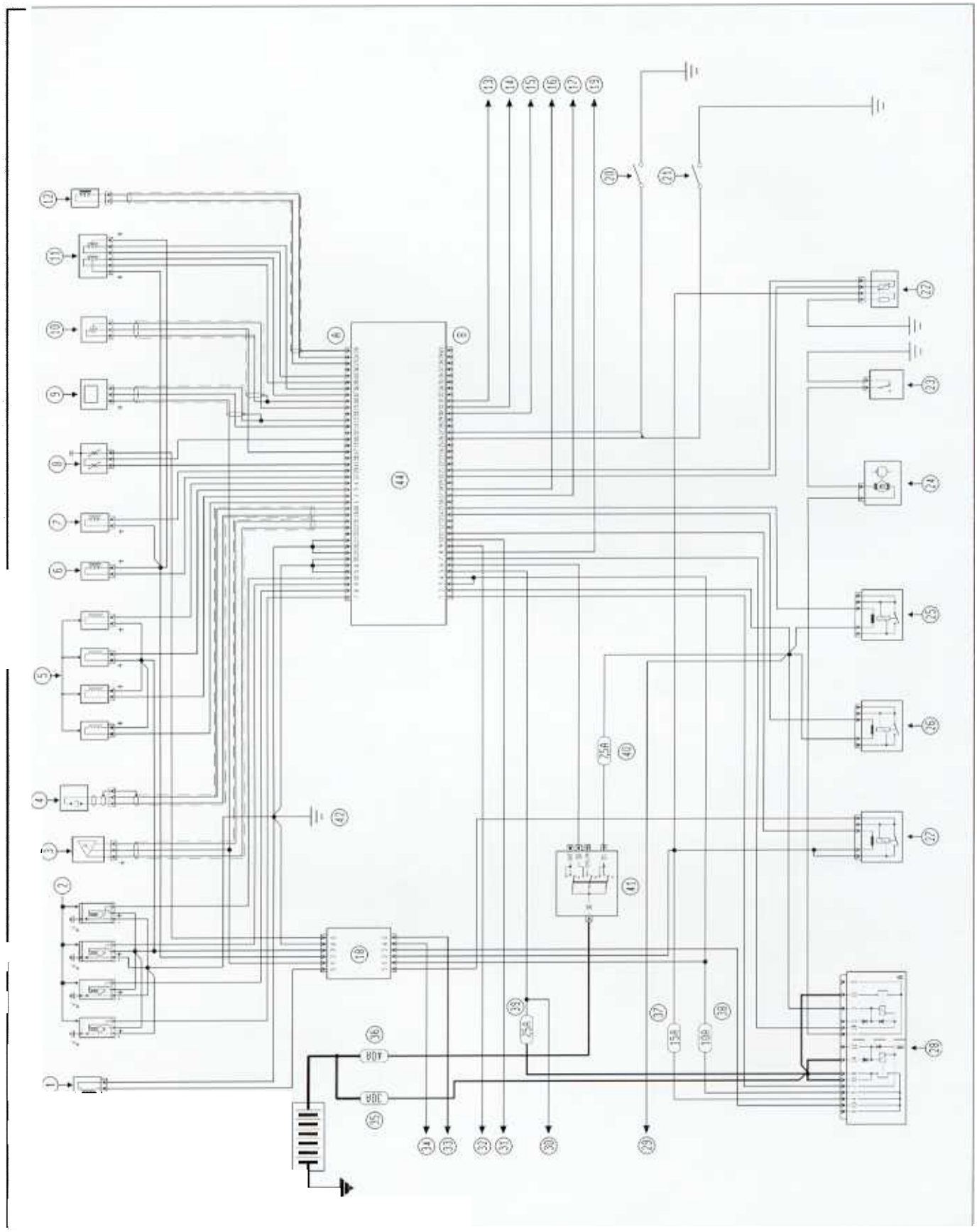
In order to increase the electromagnetic compatibility and operating reliability, the number and positions of the earth points have been carefully designed in accordance with the following layout:

- main earth directly on the battery negative;
- engine control system earth on engine block (area of power steering mounting)

10.

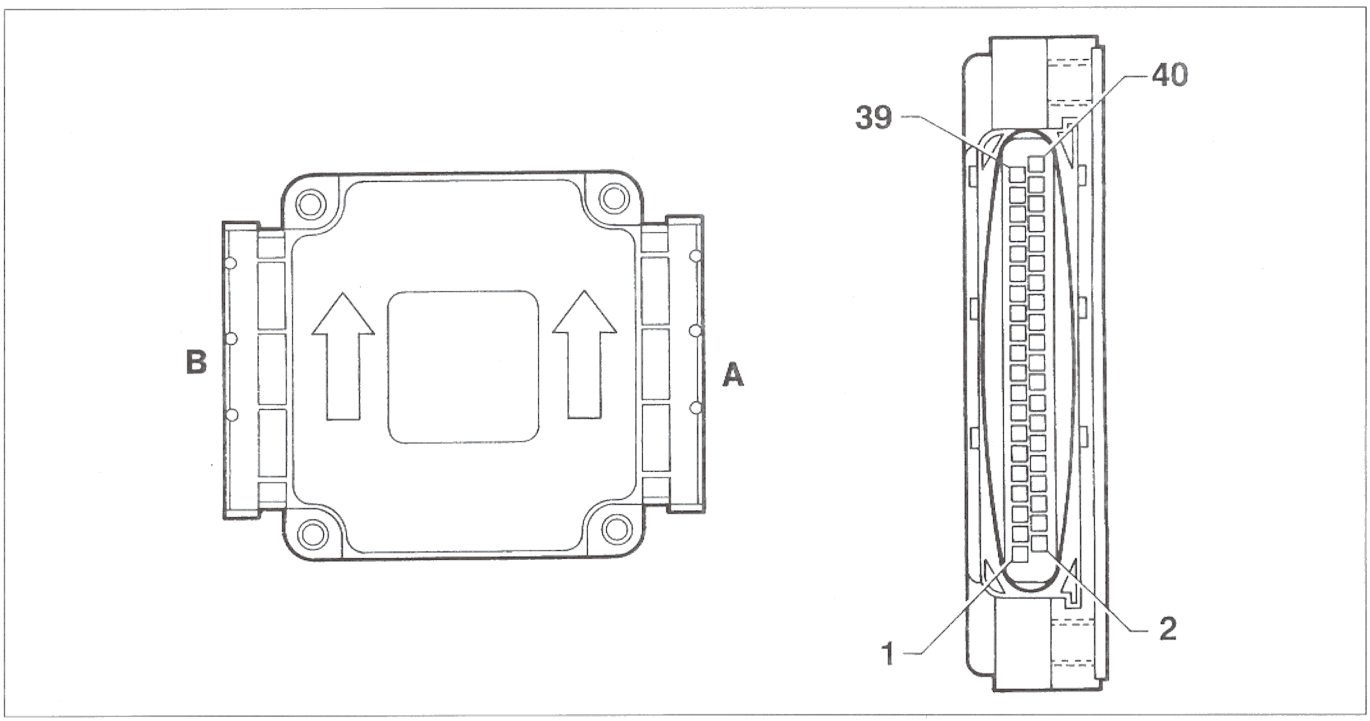
Key to wiring diagram of Hitachi system

1. timing variator solenoid
2. single coils
3. engine timing sensor
4. knock sensor
5. fuel injectors
6. charcoal filter scrubbing solenoid
7. module manifold control solenoid
8. coolant temperature sensor
9. air flowmeter
10. throttle position sensor
11. engine idle speed adjustment actuator
12. engine rpm sensor
13. line K
14. memory reprogramming
15. FIAT CODE control unit connection
16. vehicle speed input
17. rev counter control
18. interface connector
19. system fault warning light control
20. input from air conditioner three stage thermal switch (if present)
21. version selection (connected to earth only for versions without air conditioning)
22. lambda probe
23. inertial switch
24. fuel pump
25. high speed fan contactor control (if present)
26. low speed fan contactor control
27. timing variator solenoid contactor
28. double contactor
29. supply (+15) for FIAT CODE
30. supply (+30) for FIAT CODE
31. air conditioner compressor contactor control (if present)
32. input for request to switch on air conditioner compressor (if present)
33. signal for coolant temperature gauge
34. engine earth for FIAT CODE
35. fuse A (30 A)
36. fuse B (50 A)
37. fuse C (15 A)
38. fuse D (10 A)
39. fuse E (7.5 A)
40. fuse F (7.5 A)
41. ignition switch
42. engine earth
43. battery
44. engine control unit


25A
15A
10A
30A

10.

HITACHI CONTROL UNIT CONNECTOR PINS

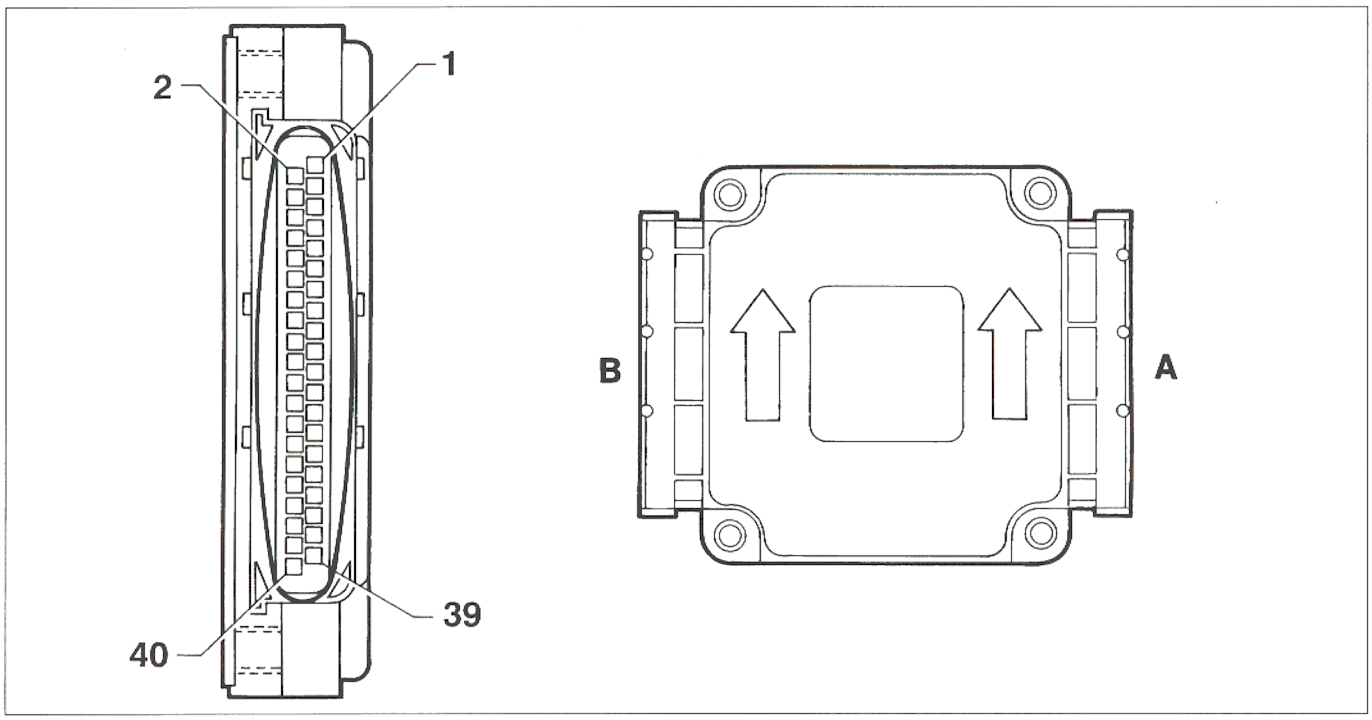


P3W22BJ01

Connector A

1. Cylinder 1 fuel injector control
2. Cylinder 2 fuel injector control
3. Cylinder 3 fuel injector control
4. Cylinder 4 fuel injector control
5. Ignition earth
6. Power earth (1)
7. Cylinder 1 coil control
8. Cylinder 2 coil control
9. Cylinder 3 coil control
10. Cylinder 4 coil control
11. Coolant temperature earth
12. Air flow meter earth
13. N.C.
14. Air flow meter signal
15. Throttle position sensor signal
16. Coolant temperature sensor signal
17. Supply to throttle position sensor (5 volt)
18. Throttle position signal earth
19. Knock sensor signal
20. Knock sensor earth
21. Casing earth
22. Engine timing sensor signal
23. Engine rpm sensor positive
24. Engine rpm sensor negative
25. A/D converters earth
26. Sensors earth
27. Charcoal filter scrubbing solenoid control
28. Engine rpm sensor shield
29. Modular manifold solenoid control
30. N.C.
31. Engine timing sensor earth
32. N.C.
33. N.C.
34. N.C.
35. Power earth (2)
36. N.C.
37. Idle speed actuator control stage 1
38. Idle speed actuator control stage 2
39. Idle speed actuator control stage 3
40. Idle speed actuator control stage 4

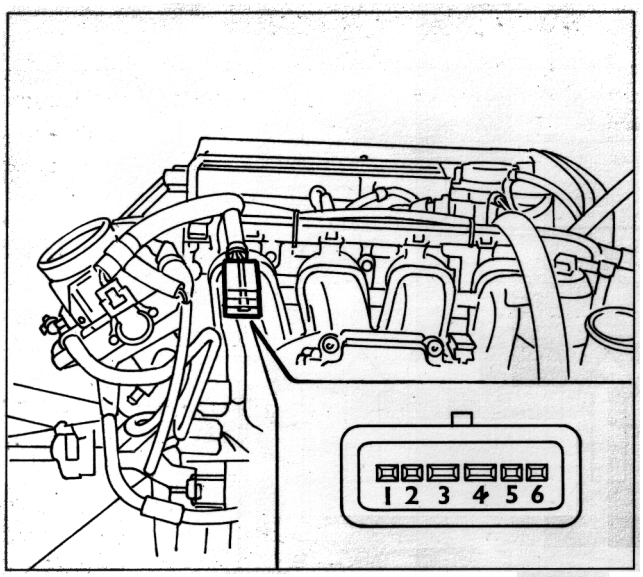
HITACHI CONTROL UNIT CONNECTOR PINS



P3W23BJ01

Connector B

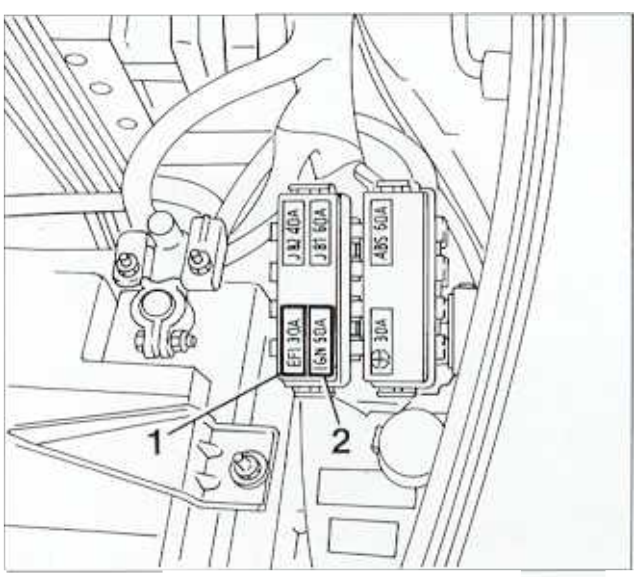
1. Control of double contactor sec. B
2. Control unit supply (+15)
3. Power supply 1
4. Power supply 2
5. Control unit supply (+30)
6. Engine started signal from ignition key +50
7. Control of double contactor sec. A (fuel pump)
8. Control of system fault warning light
9. Signal for switching on air conditioner compressor (if present)
10. Control for air conditioner compressor contactor (if present)
11. Control of timing variator fan contactor
12. N.C.
13. N.C.
14. Control of low speed fan contactor
15. Control of high speed fan contactor
16. N.C.
17. Control of rev counter
18. Vehicle speed sensor signal
19. N.C.
20. Lambda probe signal
21. Lambda probe negative
22. N.C.
23. N.C.
24. N.C.
25. N.C.
26. Version selection (to earth only for versions without air conditioning)
27. Three-stage thermal switch signal (only for versions with air conditioning)
28. N.C.
29. N.C.
30. Connection with FIAT CODE
31. Reprogramming
32. Line K
33. N.C.
34. N.C.
35. N.C.
36. N.C.
37. N.C.
38. N.C.
39. N.C.
40. N.C.



P3W24BJ01

Interface connector

1. Supply for sensors
2. Supply for actuators
3. Supply for injectors and coils
4. FIAT CODE earth
5. Timing variator control
6. Coolant temperature sensor (for instrument panel)



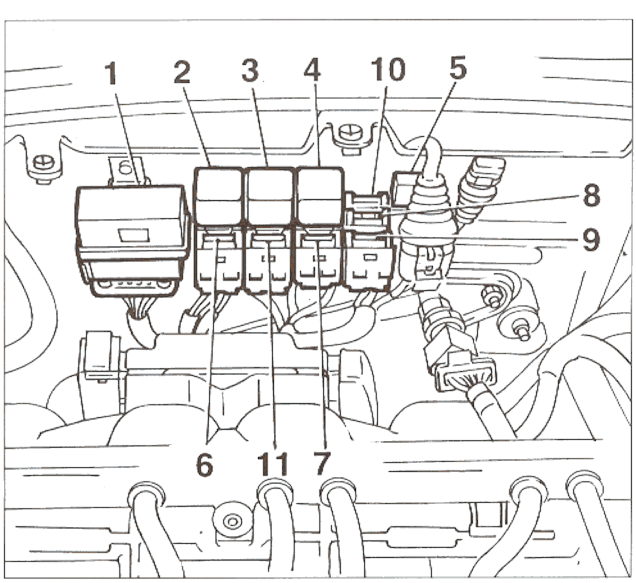
P3W24BJ02

Location of fuses and contactors of engine control system

NOTE *For more information, see Section 55-Electrical system*

Main fuses

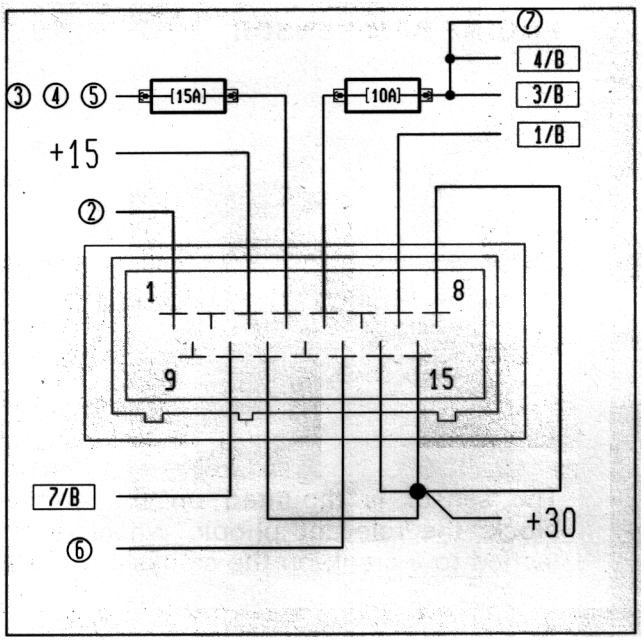
1. Fuse A (30 A)
2. Fuse B (50 A)



P3W24BJ03

Fuses and contactors

1. Double contactor
2. Timing variator contactor
3. 1st speed fan contactor
4. 2nd speed fan contactor (if present)
5. Contactor for switching on compressor (if present)
6. Fuse C (15 A)
7. Fuse D (10 A)
8. Fuse E (7.5 A)
9. Fuse F (7.5 A)
10. Compressor fuse (if present)
11. ABS fuse



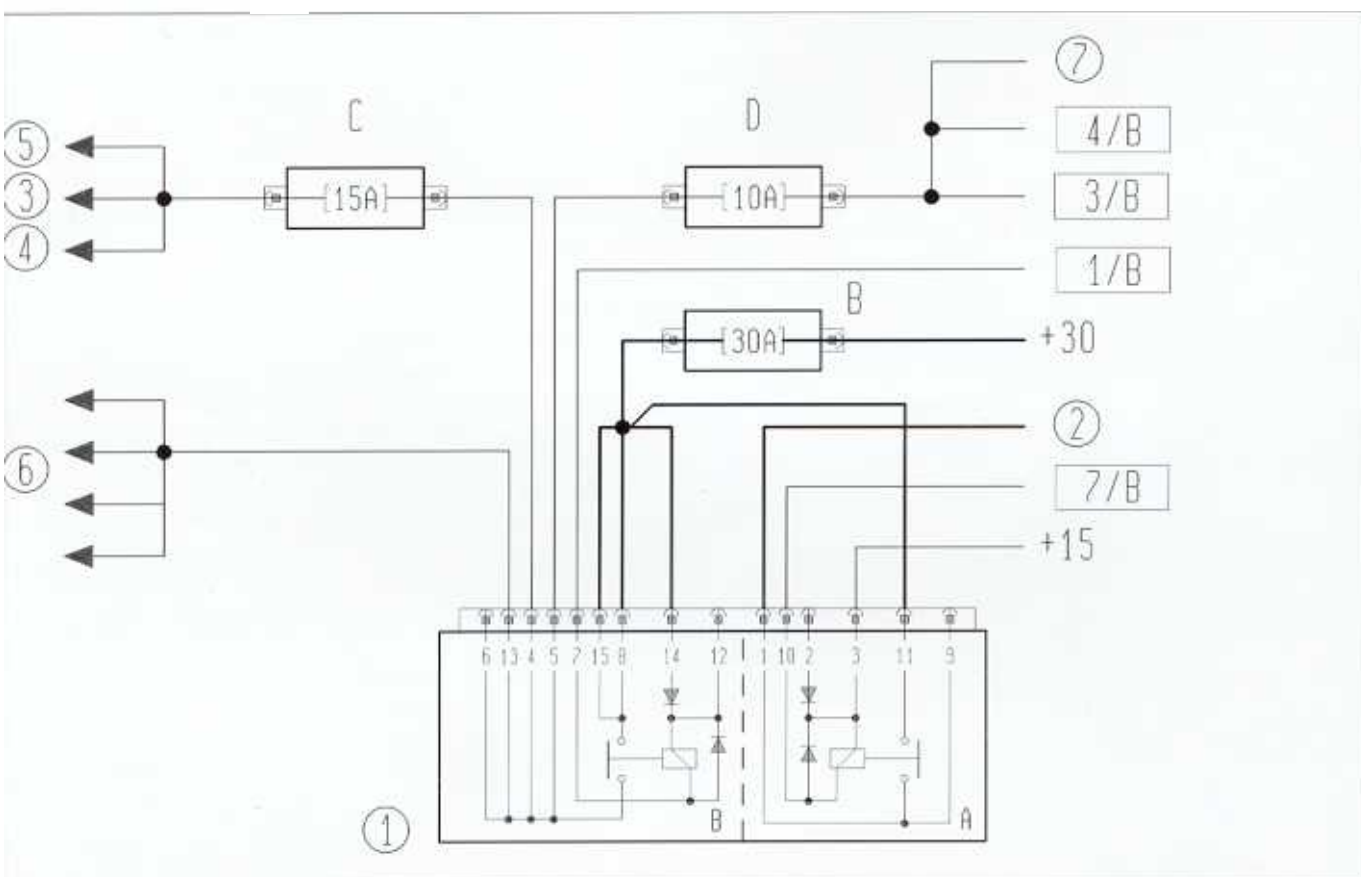
P3W25BJ01

DOUBLE CONTACTOR

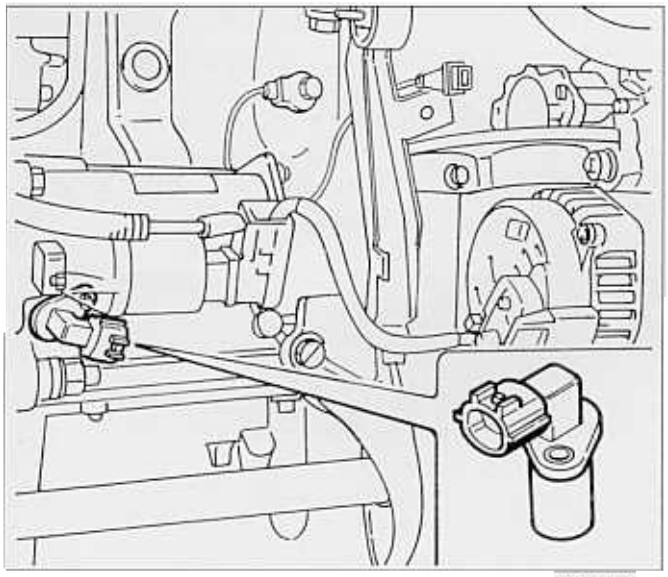
A double contactor is used to ensure the electrical supply to the system. This device comprises a single casing which contains two contactors of the normally open type, whose job is to supply the control unit and the system's components.

With the ignition on (MAR position) (+15), the excitation coils of both contactors are supplied (pins 2 and 14), which close the relevant power contacts.
The first contactor (sec.A) supplies (pin 11) the fuel pump, receiving voltage directly from the battery (pin 1).
The second contactor (sec.B) ensures (pins 3,4,5 and 7) the multiple supplies of the control unit and the various sensors and actuators of the system, both directly and through connector blocks.

Wiring connector



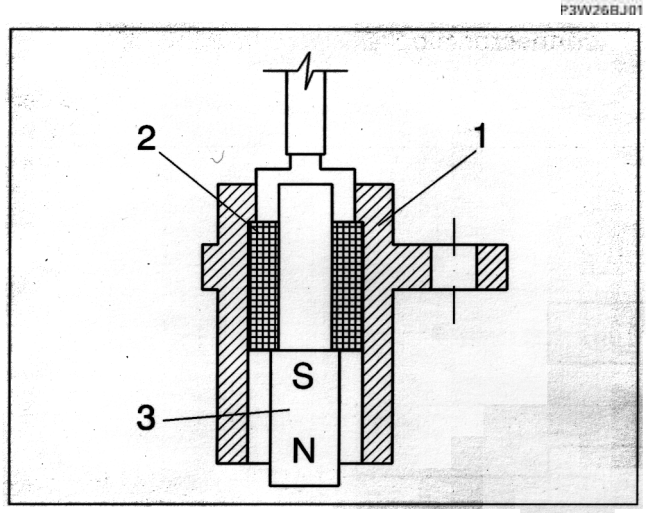
1. Double contactor
2. Electric fuel pump
3. Lambda probe heater
4. Timing variator fan contactor
5. Supply to actuators
6. Ignition coils
7. Supply to sensors



P3W26BJ01

ENGINE RPM SENSOR

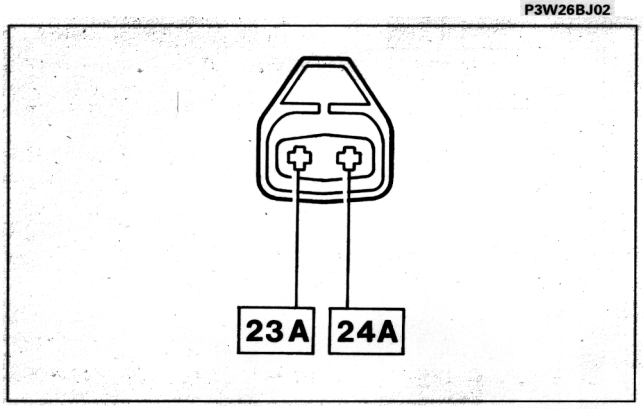
The sensor is mounted on the engine block: the relevant phonic wheel is attached to a crank on the crankshaft.



P3W26BJ02

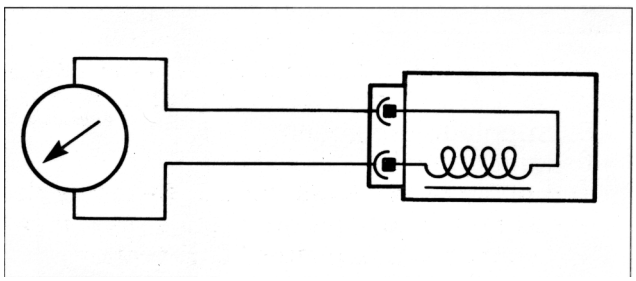
Principle of operation

The sensor consists of a tubular casing (1) in which there is a permanent magnet (3) and electrical winding (2).
Because of the passage of the teeth of the phonic wheel, the magnetic flow created by the magnet (3) undergoes fluctuations as a result of the change in gap.
These fluctuations induce an electromotive force in the winding (2), at the ends of which there is a voltage which is alternately positive (tooth opposite sensor) and negative (gap opposite sensor: see "management of signal picture" sub-section). The peak value of the output voltage from the sensor depends, provided all other factors remain the same, on the distance betwen the sensor and tooth (gap).



P3W26BJ03

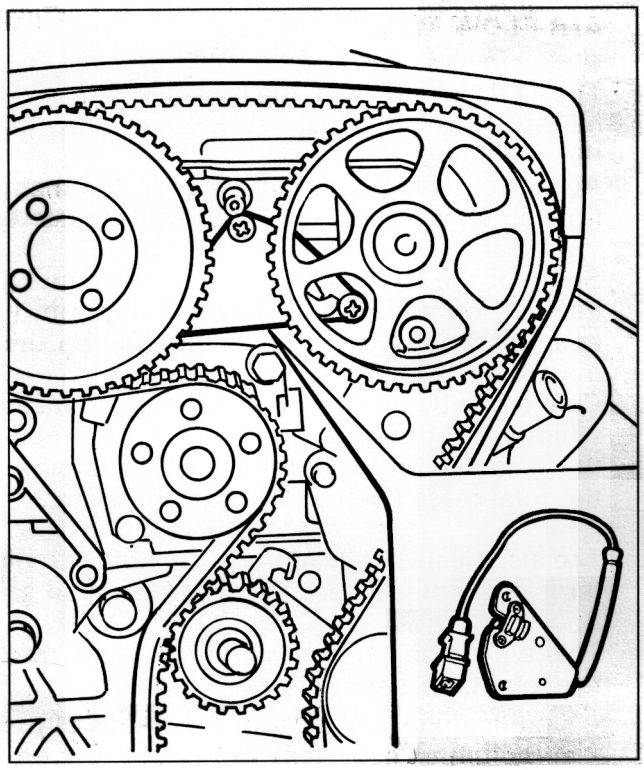
Wiring connector



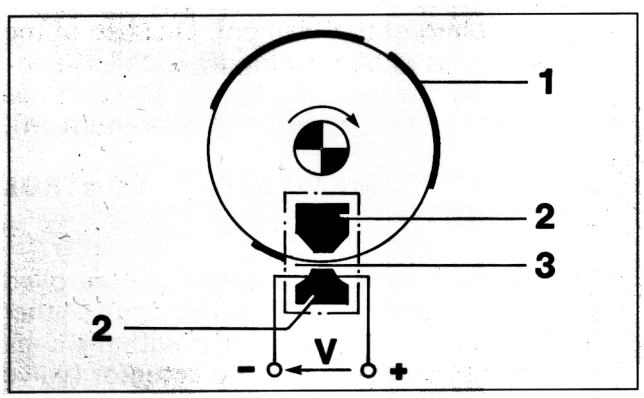
The sensor's resistance can be measured by disconnecting the connector and connecting an ohmmeter to the ends of the sensor.

Resistance: 570 ± 57 ohm at 20°C

ENGINE TIMING SENSOR



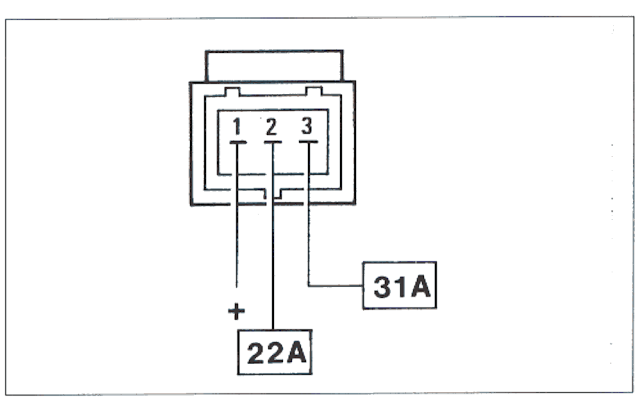
P3W27BJ01



P3W27BJ02

1. Deflector
2. Magnetic material
3. Gap

Wiring connector



P3W27BJ03

The engine timing signal, together with the engine rpm and TDC signal, enables the control unit to know the succession of cylinders in order to implement phased injection.
This signal is generated by a Hall-effect sensor, mounted near the exhaust camshaft drive sprocket.

NOTE *The angle of the sensor cannot be adjusted.*

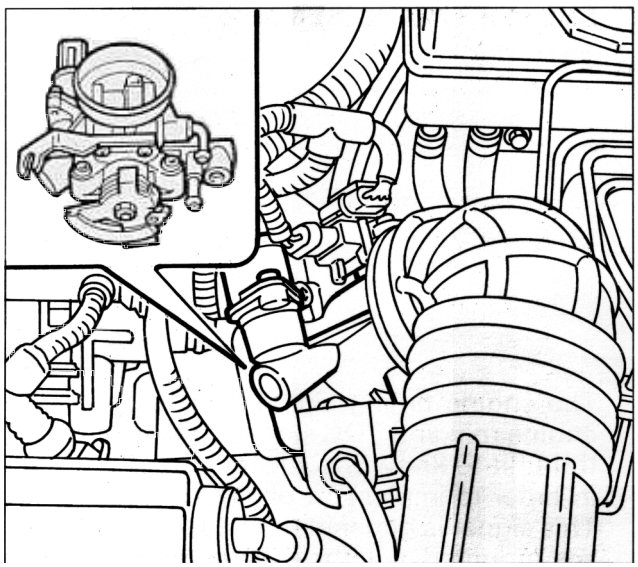
Principle of operation

A semiconducting layer through which current passes, immersed in a magnetic field perpendicular to it (force lines perpendicular to the current direction), generates at its ends a difference in potential known as Hall voltage.

If the current intensity remains constant, the voltage generated depends only on the intensity of the magnetic field. It is therefore sufficient for the field intensity to vary periodically to obtain a modulated electrical signal.

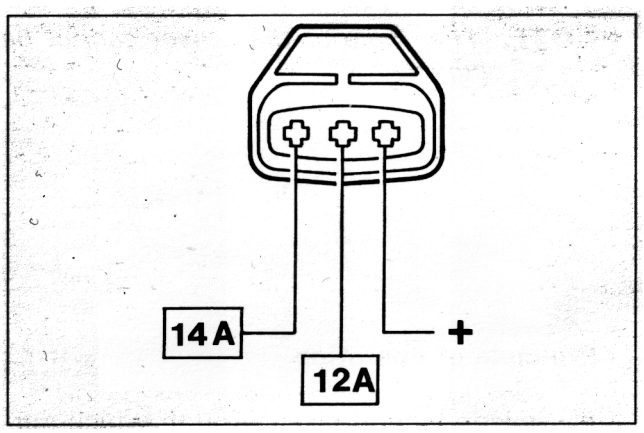
In practice, to obtain this change, a metal ring passes through this sensor (joined to the inside of the timing sprocket). This ring comprises a series of gaps; in its movement, when the ring covers the sensor, it blocks the magnetic field and the signal remains low, while when the gaps pass, the field closes and the signal becomes high.

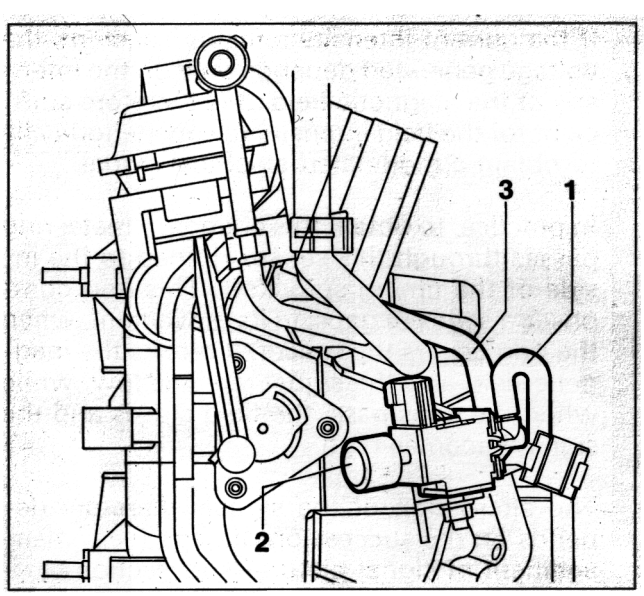
The alternation of the signals therefore depends on the succession of gaps (see "management of signal picture" sub-section).



P3W28BJ01

Wiring connector





P3W28BJ03

AIR FLOW METER

The air flow meter is of the hot-wire type with measurement of bypass flow, built into the throttle body.
At the top it has a duct parallel to the main flow, in which the heated filament is located.

Some of the flow of intake air is introduced into the duct and, after flowing through, it emerges on the opposite side, rejoining the main flow.
Consequently, only some of the air mass which passes through the meter is measured: this quantity is nevertheless proportional to the total mass passing through the meter.

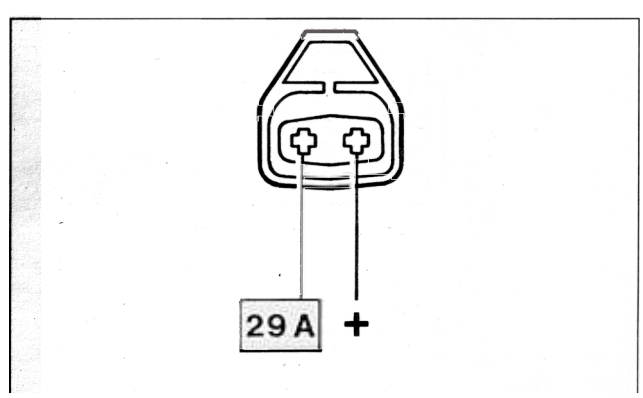
The electrical voltage at the output of the meter is therefore representative of the total air flow.
This type of meter has two advantages over the total flow type:

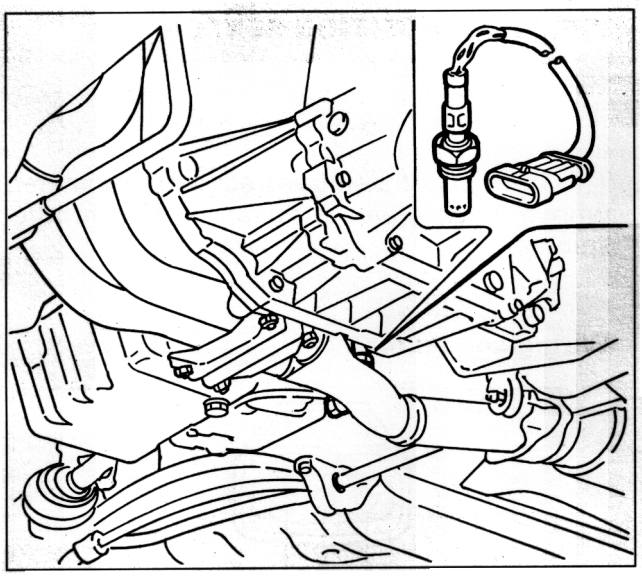
- significant insensitivity to pulsations of the air columns, especially present at low engine speeds and at high loads;
- less fouling of the filament, because of the lower mass of air enveloping it; this is confirmed by the fact that the control unit has no strategy for cleaning the wire (burn-in).

MODULAR MANIFOLD CONTROL SOLENOID

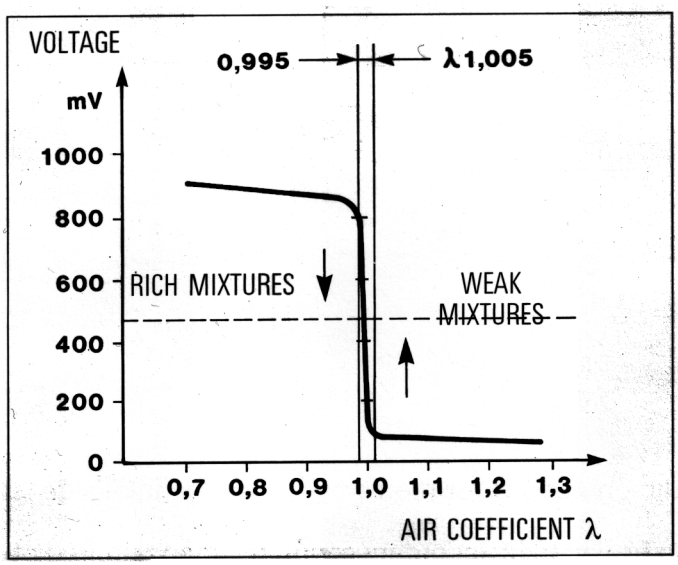
The modular manifold actuator is controlled by a three-way solenoid which puts either the filter (2) in communication with the connection (3) connected to the actuator (valve not supplied), or the connection (1) connected to the vacuum reservoir in communication with the connection (3) connected to the actuator (valve supplied).

Wiring connector



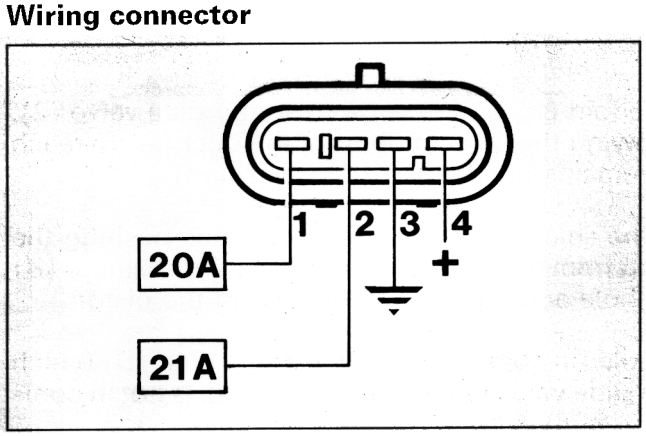


P3W29BJ01



λ= 1 Ideal mixture (stoichiometric)
λ> 1 Weak mixture
Excess air; the CO tends to be low
λ< 1 Rich mixture
Insufficient air; the CO tends to be high

Wiring connector



P3W29BJ04

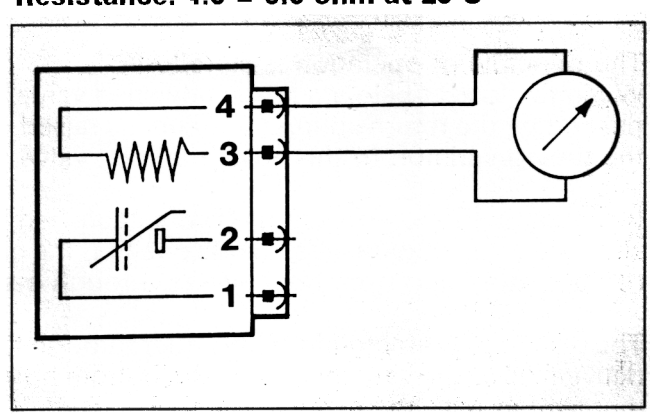
LAMBDA PROBE

The lambda probe measures the oxygen content in the exhaust gases: it is mounted on the exhaust pipe upstream of the catalytic converter.
The sensor's output signal is sent to the control unit for feedback correction of the mixture strength.
When the probe gives a low signal (voltage below 200 mV) the control unit recognizes a weak mixture and increases the fuel injection time; when the probe's signal is high (voltage higher than 800 mV), the control unit recognizes a rich mixture and decreases the fuel injection time.
This sequence of interventions is repeated at a frequency of a few dozen Hertz, so that the engine functions with a mixture strength which continuously fluctuates around the stoichiometric value.
At temperatures below 300°C, the ceramic material is not active, so the probe does not give reliable signals; to ensure quick heating on starting and keep the temperature to a minimum, the probe is fitted with an electrical heating resistor which is always on.

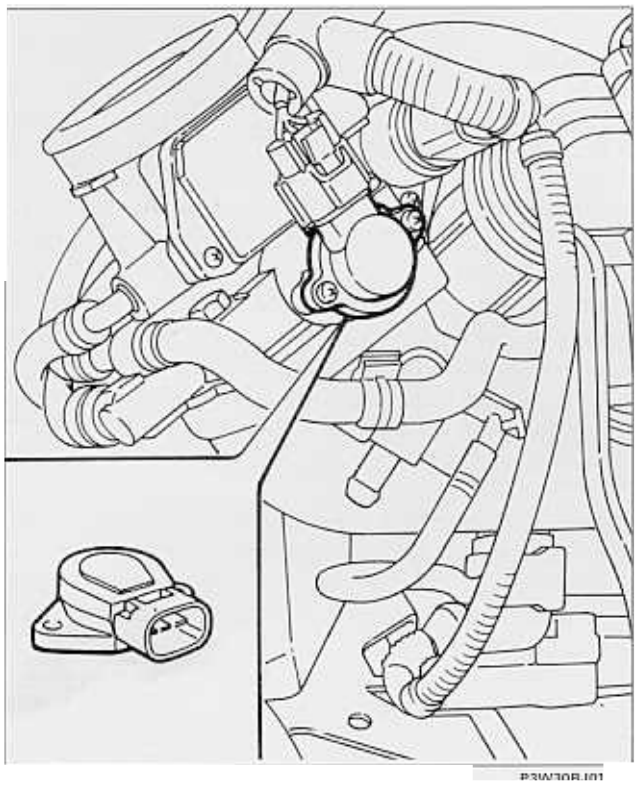
The probe can quickly be put out of service if even a small quantity of lead is present in the fuel.

The resistance of the probe's heater can be measured by disconnecting the connector and connecting an ohmmeter as shown in the figure.

Resistance: 4.5 ± 0.5 ohm at 20°C



P3W29BJ03

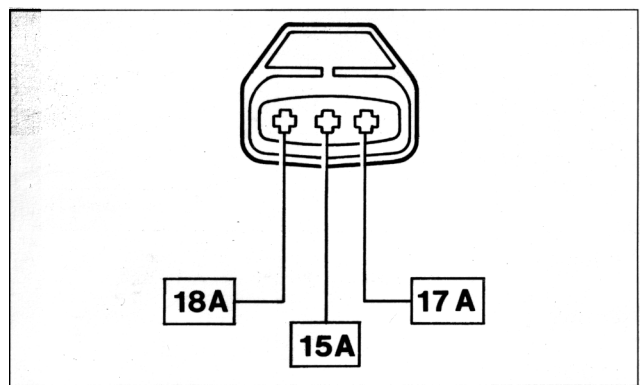


P3W30BJ01

THROTTLE POSITION SENSOR

This consists of a single-track potentiometer whose moving part is driven by the throttle spindle.

Wiring connector



P3W30BJ02

TIMING VARIATOR CONTROL SOLENOID

A timing variator (with electronic control and hydraulic operation) for the camshaft on the inlet side is been fitted to this engine.
The device allows the timing diagram (intake phase) to be varied in accordance with the load required of the engine; this parameter is processed by the HITACHI control unit on the basis of the electrical signals received by the air flow meter and the rpm sensor, and sent as a command to the solenoid controlling the timing variator.
In constructional terms, the device consists of a main unit fitted on the inlet side camshaft, which varies the angle position of the camshaft in relation to the drive sprocket.

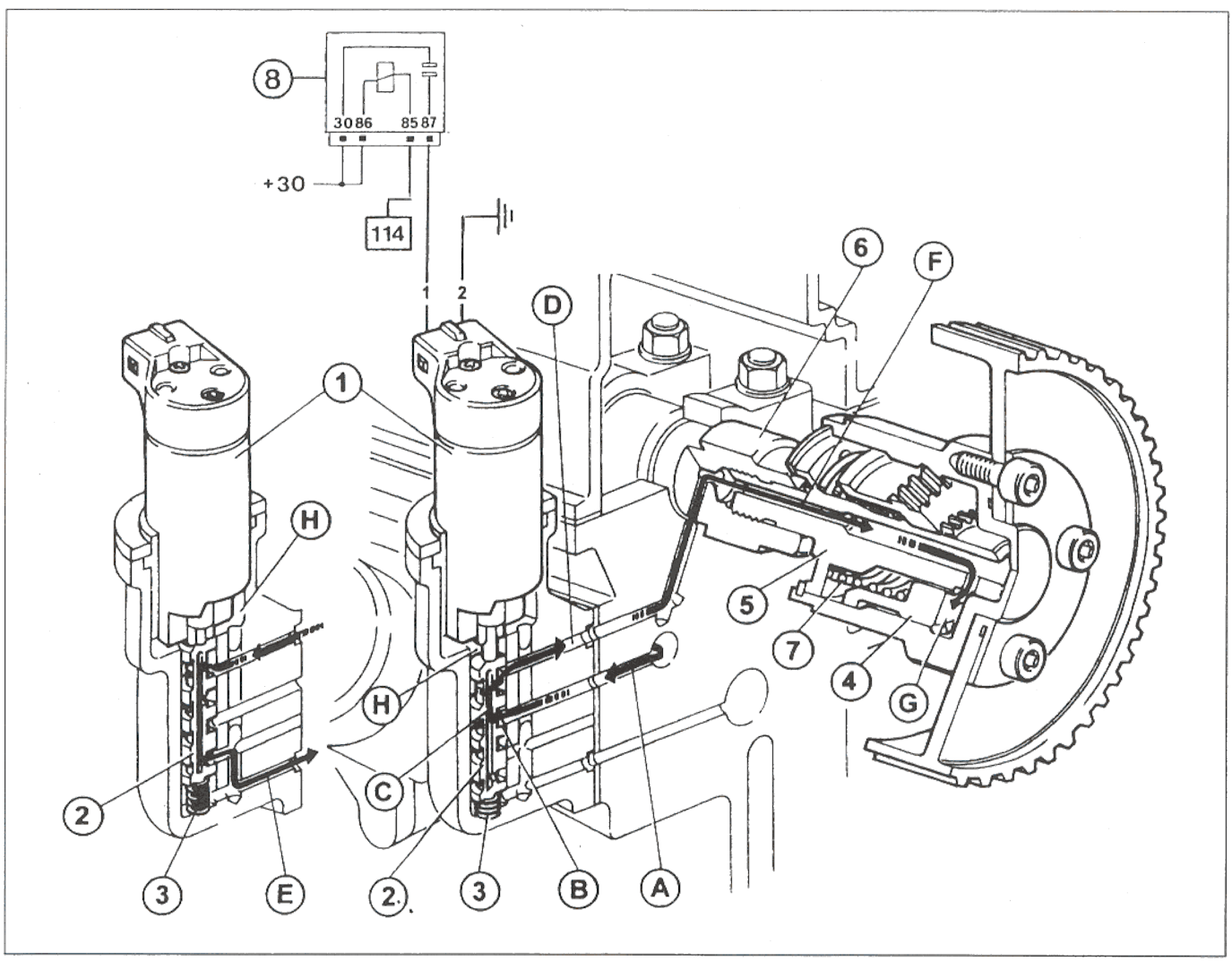
In addition there is an actuation valve driven by a solenoid, both located on the inlet manifold and connected hydraulically to the main unit by means of specific ducts.

The principle of operation is as follows.
When the load is below a pre-established value, the solenoid (1) is de-energized so the slide valve (2), pushed by the return spring (3), remains raised, not allowing the oil coming from the duct (A) to reach the timing variator. In this case, the inlet valve timing remains unchanged (OFF position).

If the engine load exceeds the pre-established value, the solenoid (1) is energized, thus pushing the slide valve (2) downwards. In this position the oil coming from the duct (A) enters into the chamber (B) of the piston, and from here passes through a specific hole and enters the duct (C) in the piston.

The oil can only emerge from this duct through the top hole (in communication with the duct (D) which delivers oil to the variator), since the bottom hole, as the slide valve (2) has been lowered, is not in communication with the exhaust duct (E).

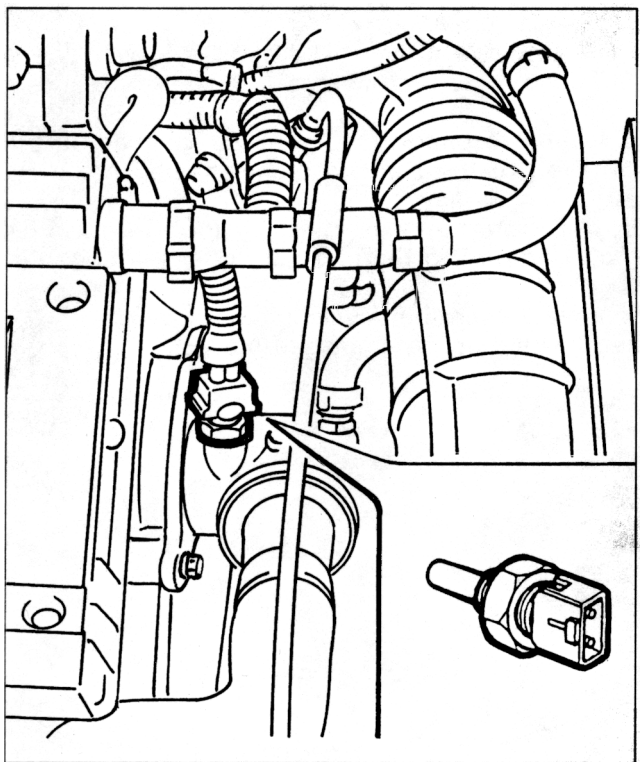
The oil flows thorugh ducts (D) and (F) into chamber (G) to move piston (4) sideways toward the engine. Because the piston is fitted with helical teeth, it is forced to turn clockwise (viewed from camshaft side) when it moves sideways.
Piston rotation is transmitted via a curb-toothed splined section to pinion (5), which is screwed onto the threaded shank of camshaft (6). The pinion transmits rotation to the shaft in order to alter intake shaft timing (ON position).
Wnen the electromagnetic is no longer excited, valve box (2) returns to its initial position to cut off the flow of oil under pressure to chamber (G) but allowing oil to return to the exhaust under the pressure of counter spring (7).
A supplementary duct ensures camshaft journal lubrication even when the device is not active.
The oil leaking through chamber (H) of the electromagnet drains thorugh drainage duct (E).



3W31AJ02

1. Variable valve timing control solenoid
2. Variable valve timing control valve
3. Valve counter spring
4. Piston
5. Pinion
6. Camshaft
7. Piston counter spring
8. Electromagnet control relay

A. Oil supply channel
B. Valve piston chamber
C. Valve piston inner channel
D. Channel delivering oil to VVT
E. Oil drain channel
F. VVT oil inlet channel
G. VVT internal chamber
H. Upper valve chamber

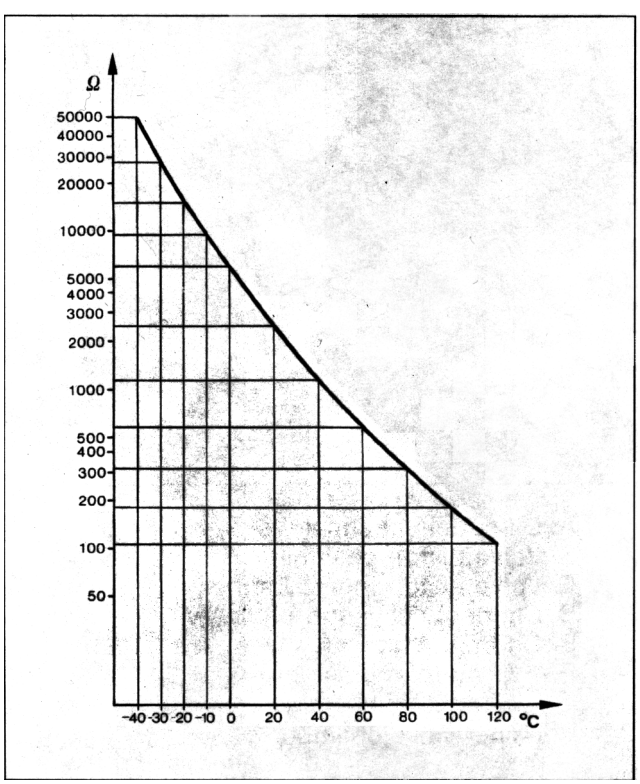


3W32AJ01

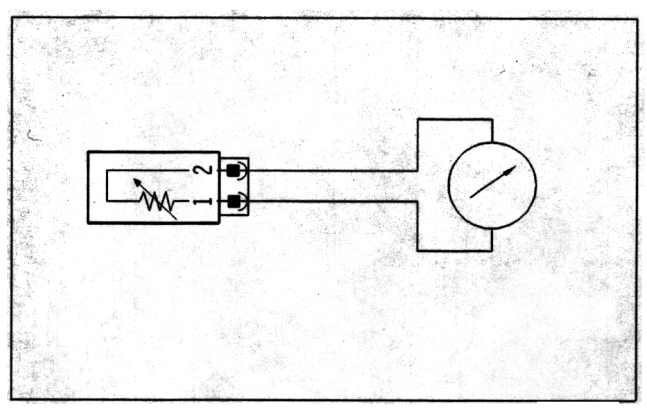
ENGINE COOLANT TEMPERATURE SENSOR

The sensor is fitted to the thermostat
It consists of a brass case that protects the actual resistance element. The element consists of an NTC (Negative Temperature Coefficient) thermistor: i.e. its electrical resistance falls as temperature rises.
The reference voltage is 5 Volts: because the control unit input circuit is designed as a voltage divider, the reference voltage is distributed between a resistance in the control unit and the sensor itself.
The control unit is therefore able to assess sensor resistance changes through voltage changes and thus obtain temperature information.

The following graph plots sensor output. The output may be measured by disconnecting the connector and connecting an ohmmeter as shown in the figure alongside.

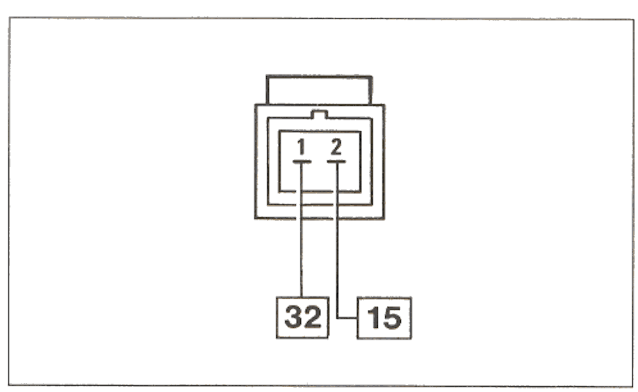


3W32AJ02

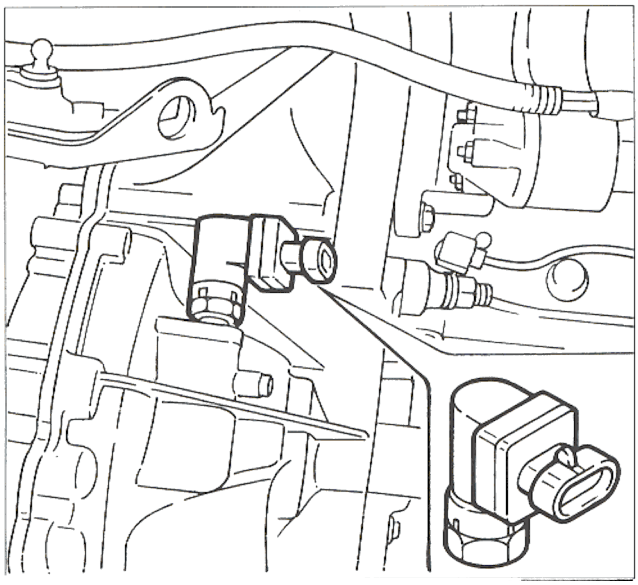


3W32AJ03

Wiring connector



3W32AJ04

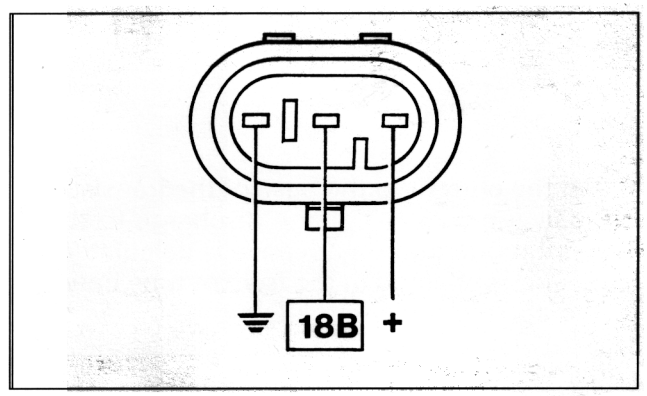


P3W33BJ03

Wiring connector

VEHICLE SPEED SENSOR

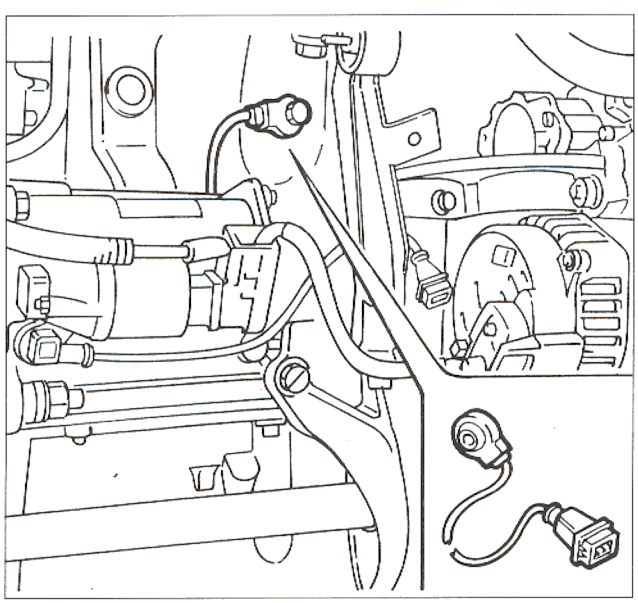
The sensor is located at the output of the differential, near the left drive shaft coupling, and it transmits to the control unit information relating to the vehicle speed. The signal is also used for the operation of the speedometer.
The sensor is of the Hall-effect type (see "engine timing sensor" subsection), and is calibrated so that each pulse corresponds to a travelled distance of one metre; it is therefore possible to find out the vehicle speed on the basis of the pulse frequency.



P3W33BJ01

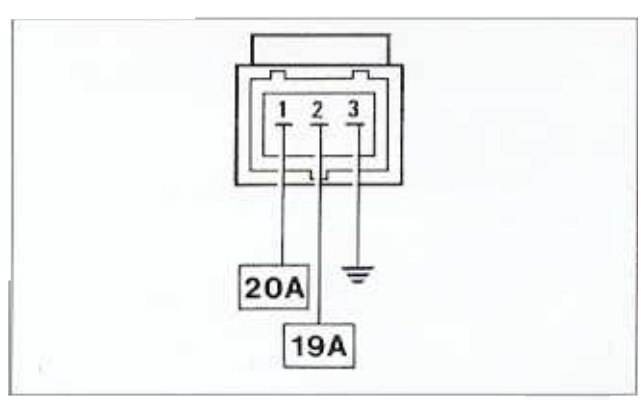
KNOCK SENSOR

This is a piezoelectric sensor mounted on the engine block 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 occurrence of knocking in the same way for all the cylinders.
When the engine knocks, vibrations of the engine block are generated at a particular frequency, which are transformed by the sensor into a voltage signal proportional to their intensity.

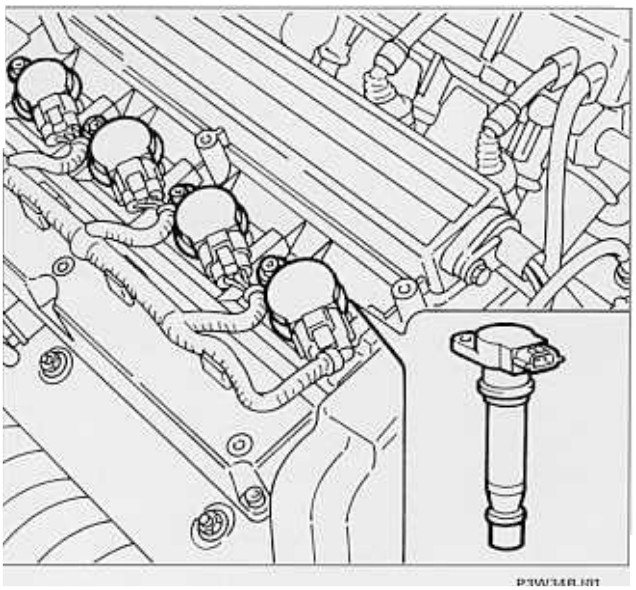


P3W33BJ04

Wiring connector



P3W33BJ02

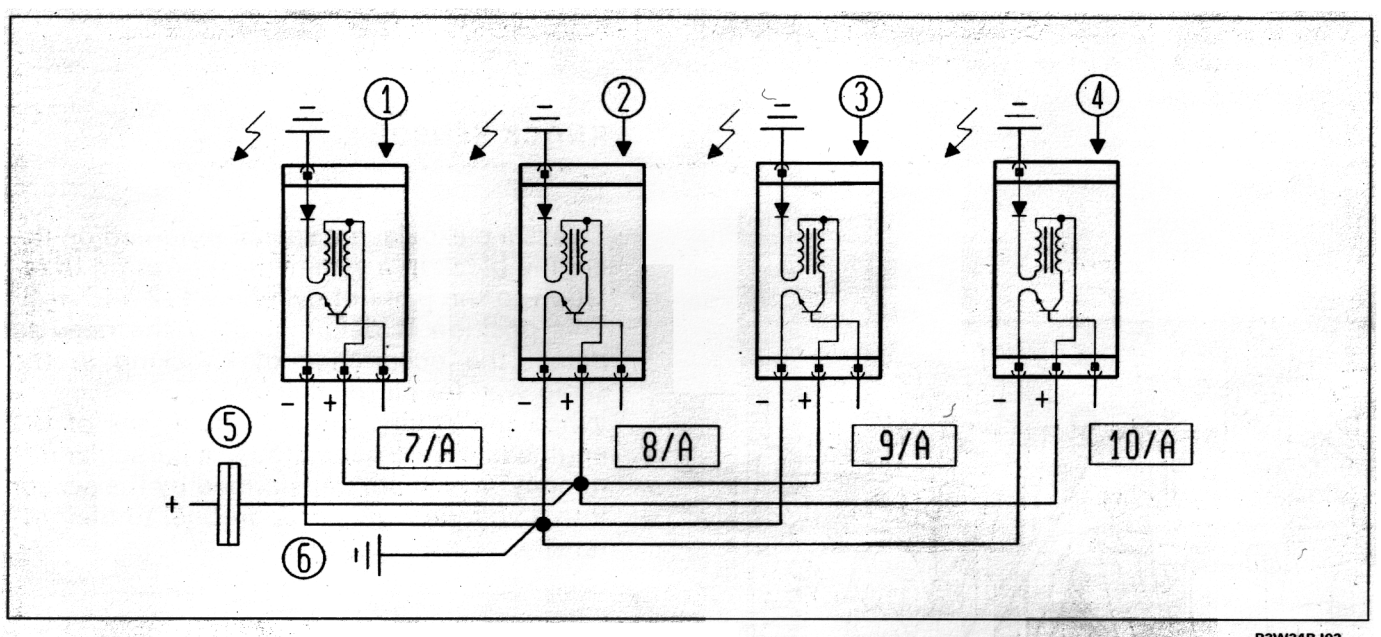


IGNITION COIL

The ignition system is of the static type with inductive discharge, whose high voltage is supplied by four coils mounted directly on the spark plugs (pencil coils).
The coil is of the closed magnetic circuit type, with the windings located in a plastic container and encapsulated in epoxy resin. The coil is connected directly to the plug by means of a silicon extension with high dielectric characteristics.

The coil includes a power transistor to cut off the primary circuit.
The primary of each coil is supplied by the battery voltage (+30) through the double contactor, and is connected to earth via the built-in power transistor whose base is connected to the relevant control unit pins.

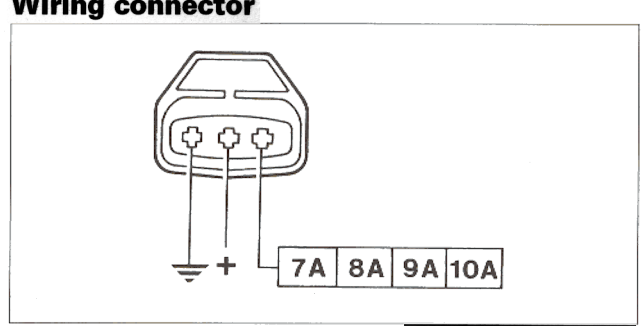
When the current to the base of the transistor is cut off, the connection to earth of the primary is also cut off, causing a high-voltage discharge to the secondary winding.
The optimum ignition advance is calculated by the control unit in accordance with the engine rpm and load, and is effected in the form of time between the power TDC and the instant of cutting off the supply to the coil's primary circuit.



P3W34BJ02

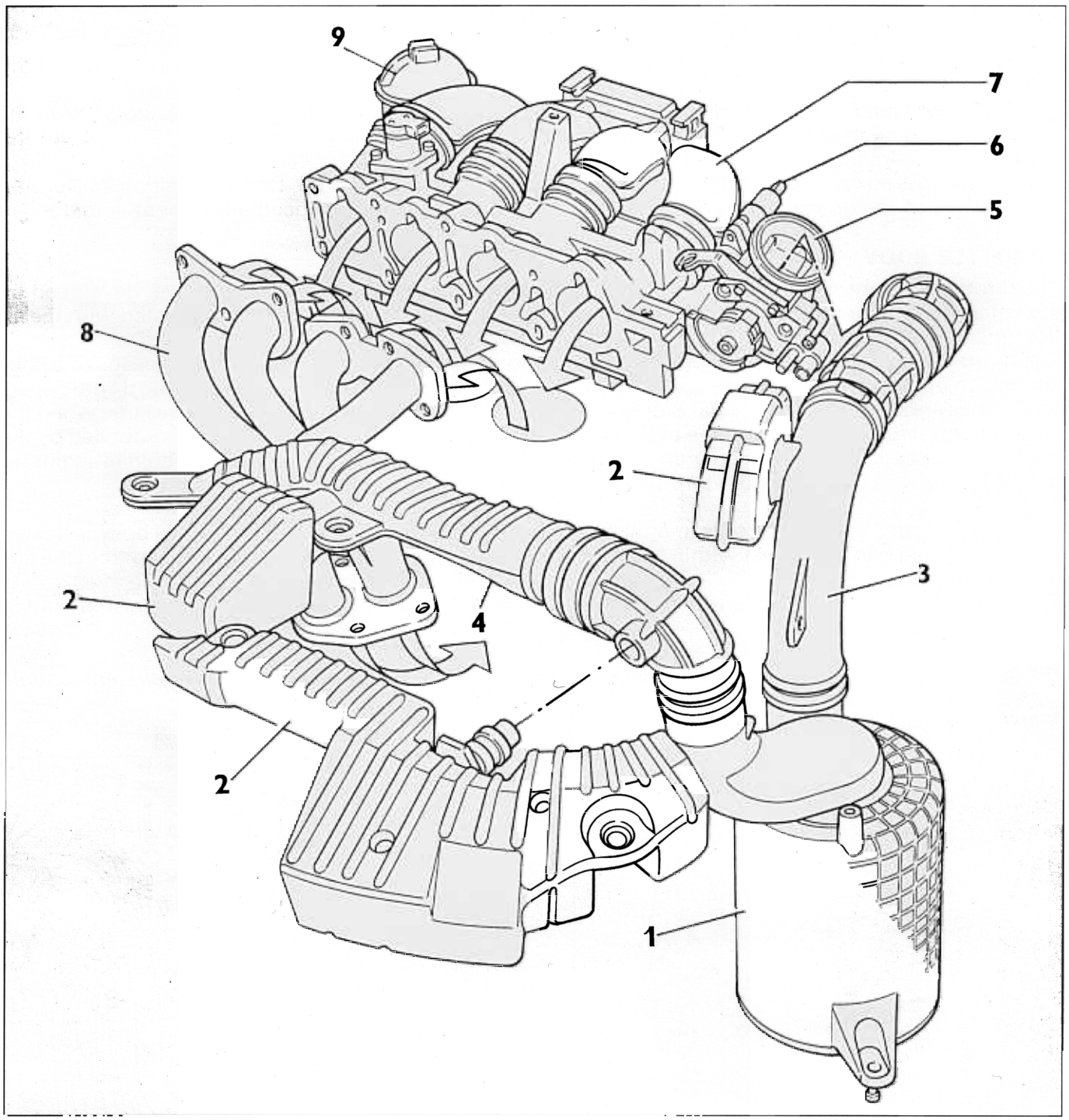
1. Cylinder 1 coil
2. Cylinder 2 coil
3. Cylinder 3 coil
4. Cylinder 4 coil
5. Interface connector
6. Engine earth

Wiring connector



P3W34BJ03

DIAGRAM OF INTAKE SYSTEM



P3W35BJ01

1. Air cleaner
2. Resonator
3. Inlet hose
4. Inlet pipe
5. Throttle body with flow meter
6. Idle speed adjustment actuator
7. Inlet manifold
8. Exhaust manifold
9. Modular manifold actuator

INTAKE SYSTEM

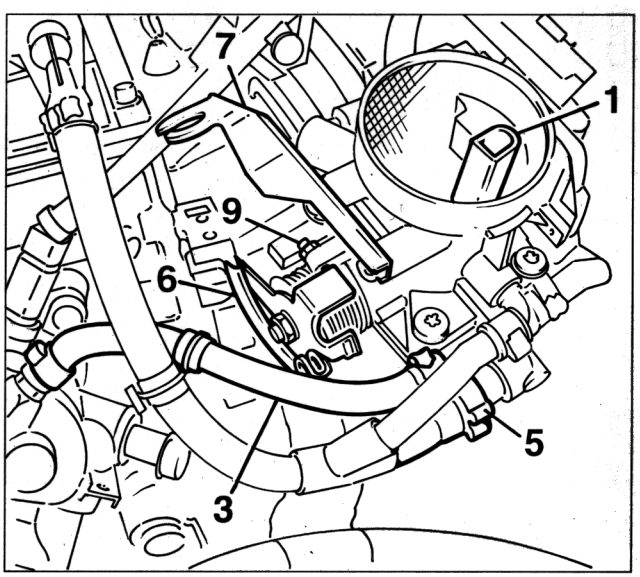
The intake system comprises the following components:
- air cleaner with its hoses;
- acoustic resonators mounted in parallel to the intake hose (two upstream and one downstream of the filter);
- modular inlet manifold on which are mounted the fuel manifold complete with fuel injectors, the modular manifold control actuator, the engine control unit, the charcoal filter scrubbing solenoid and the modular manifold actuator control solenoid;
- throttle body, integrated with the flow meter, on which are mounted the throttle position sensor, the PCV valve of the oil vapour recirculation system and the engine idle speed adjustment actuator.

THROTTLE BODY

The throttle body measures the quantity of air drawn in by the engine (and so the power developed by the latter) in accordance with the driver's demand via the accelerator pedal, and is integrated with the air flow meter.
The throttle body is secured to the inlet manifold by four bolts; the throttle is opened by means of a linkage which operates in accordance with a law whereby for the same travel of the pedal, the throttle aperture angles are small when the pedal is only slightly pressed, and vice versa the angles are large when the pedal is pressed fully. With the pedal released (engine overrunning or idling), the additional air required is supplied by the engine idle speed adjustment actuator; in these conditions, the throttle aperture lever homes agains an anti-stall screw, which stops the throttle jamming in the closed position.

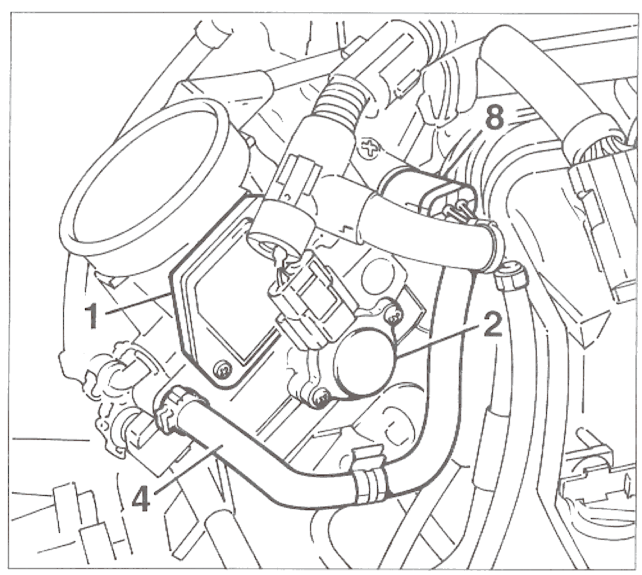
To avoid ice forming on the throttle and the hole connected to the PCV valve, the throttle body is heated by the circulation, in a chamber within the throttle body, of a small amount of water coming from the engine thermostat.
The PCV valve of the oil vapour recirculation system and the throttle position sensor are also mounted on the throttle body.

The anti-stall screw is adjusted during the through-flow operation in the factory, and should never be tampered with.



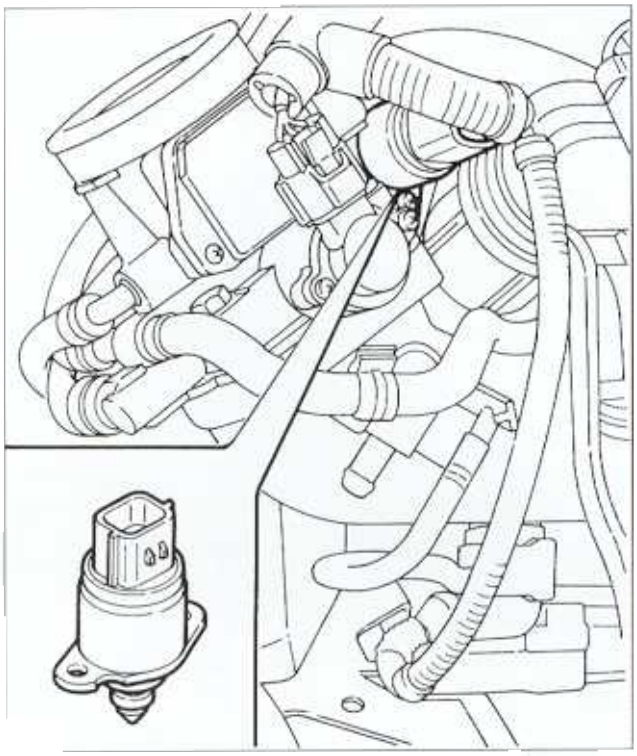
P3W36BJ01

1. Air flow meter
2. Throttle position sensor
3. Engine coolant inlet
4. Engine coolant outlet
5. PCV valve



P3W36BJ02

6. Throttle control lever
7. Throttle cable adjustment bracket
8. Engine idle speed adjustment actuator
9. Anti-stall screw


P3W37BJ0

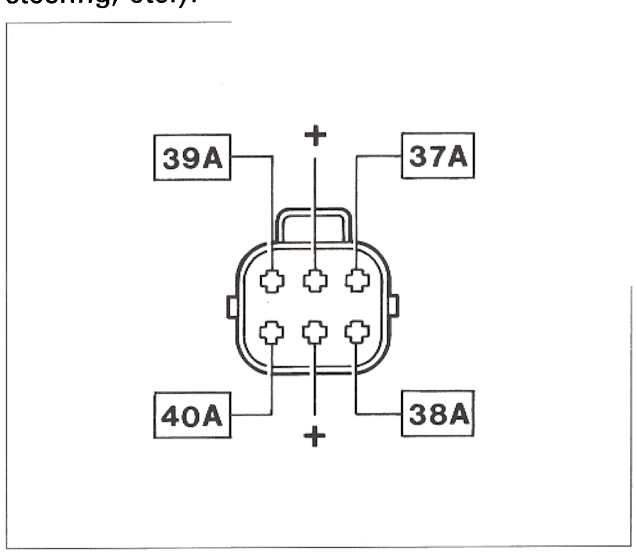
ENGINE IDLE SPEED ADJUSTMENT ACTUATOR

The actuator is mounted on the throttle body and it intercepts an air flow, drawing air upstream of the throttle and returning it downstream. Its purpose is to provide the engine with additional air when the throttle is closed, in all conditions when this is necessary (idling and overrunning).
To achieve this result, a stepper motor is used, mounted on the throttle body and controlled by a drive circuit in the engine control unit.

Principle of operation

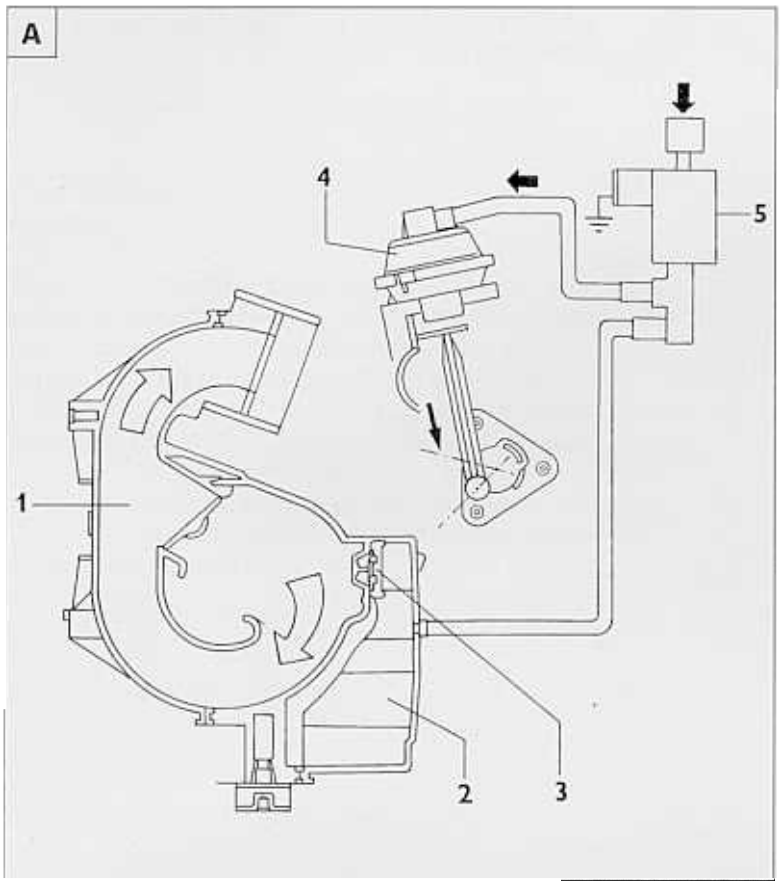
The actuator comprises:
- a stepper motor with two windings in the stator and a rotor which comprises a number of pairs of permanent magnetic poles;
- a screw-nutscrew reduction gear which converts the rotary motion into straight-line motion.

The stepper motor is driven directly by the engine control unit which, combining in an appropriate manner the phase displacement and direction of travel of the current in the windings, causes the rotor to rotate in both directions by a particular number of steps.
The screw-nutscrew assembly causes the movement of a stem with a conical shutter, which varies the cross-sectional area of the bypass pipe, and hence the quantity of air drawn in by the engine so as to obtain the desired engine speed even if external loads are applied (air conditioner, electric fans, power steering, etc.).

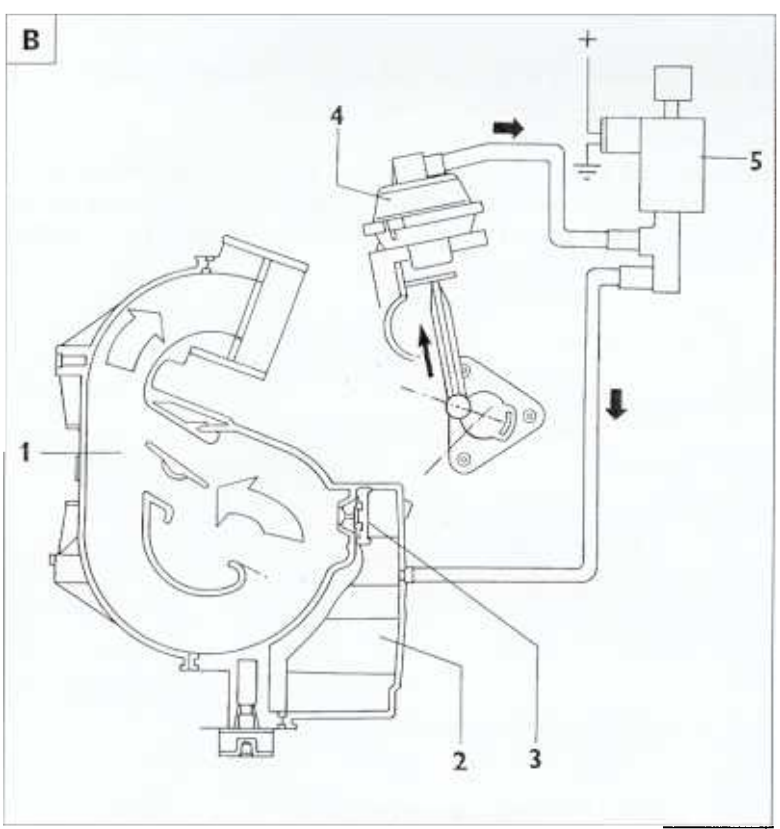


P3W37BJ02

Wiring connector



P3W38BJ01



P3W38BJ02

MODULAR MANIFOLD

The inlet manifold has two sets of branches, one long set and one much shorter set. A set of butterfly valves (1) controlled by a pneumatic neumatico (4) can cut off the short branches, forcing the air to pass through the long branches.
The pneumatic actuator controls the butterfly valves via specific linkages, and is in turn controlled via a solenoid (5) by the engine control unit depending on the engine rpm in accordance with the following table:

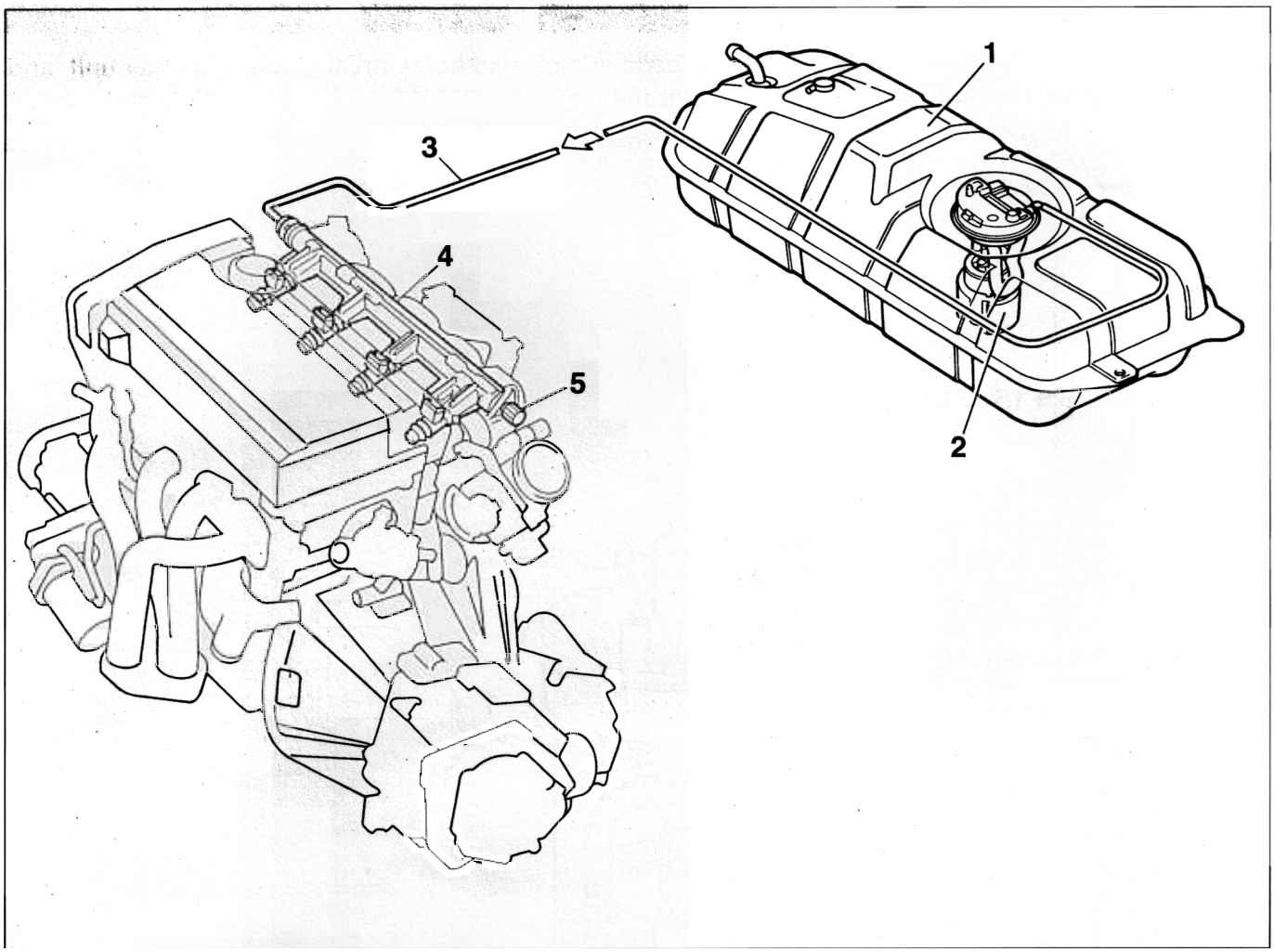
butterflies	inlet branches	engine rpm
A: closed	long	<5400
B: open	short	>5400

The vacuum required for the operation of the actuator is taken from a reservoir (2) connected to the manifold and kept under vacuum by means of a non-return valve (3).

Operation

A: butterflies closed
The solenoid (5) is not supplied and places the barometric capsule of the actuator (4) in communication with the outside; the butterflies (1) are in the closed position and the air is drawn in through the long branches.
B: butterflies open
The solenoid (5) is supplied and places the vacuum reservoir (2) in communication with the barometric capsule of the actuator (4), which causes the butterflies (1) to rotate open; the air is drawn in through the short branches, which match the high engine rpm.

DIAGRAM OF FUEL SYSTEM



P3W39BJ01

1. Fuel tank
2. Cage complete with pump, filter, pressure regulator and fuel gauge sender float
3. Delivery pipe
4. "Returnless" fuel manifold
5. Air bleed connection

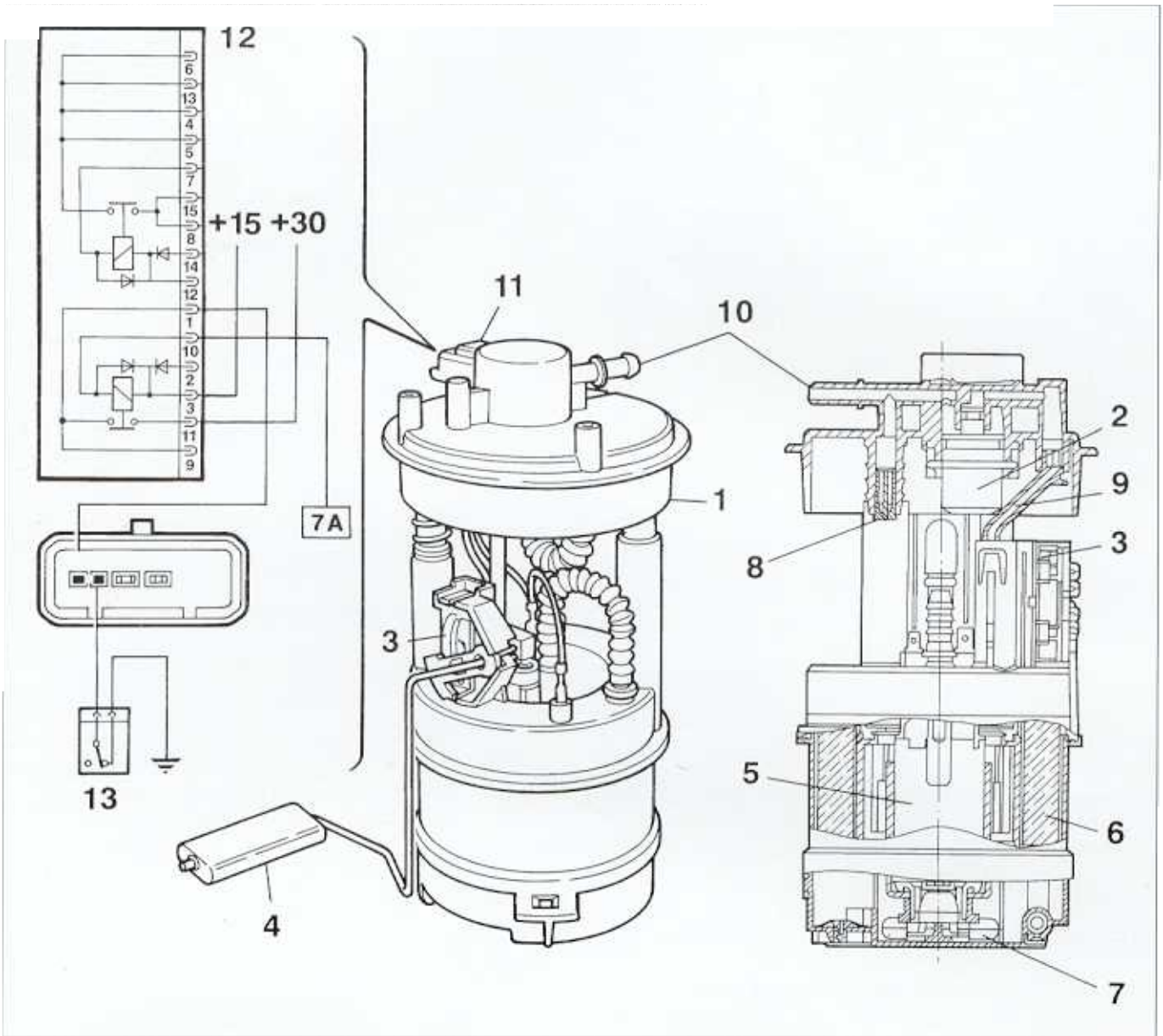
FUEL SUPPLY SYSTEM

The system comprises the following parts:

- Fuel tank
- Cage complete with pump, filter, pressure regulator and fuel gauge sender float
- Delivery pip
- "Returnless" fuel manifold complete with fuel injectors

FUEL CAGE ASSEMBLY

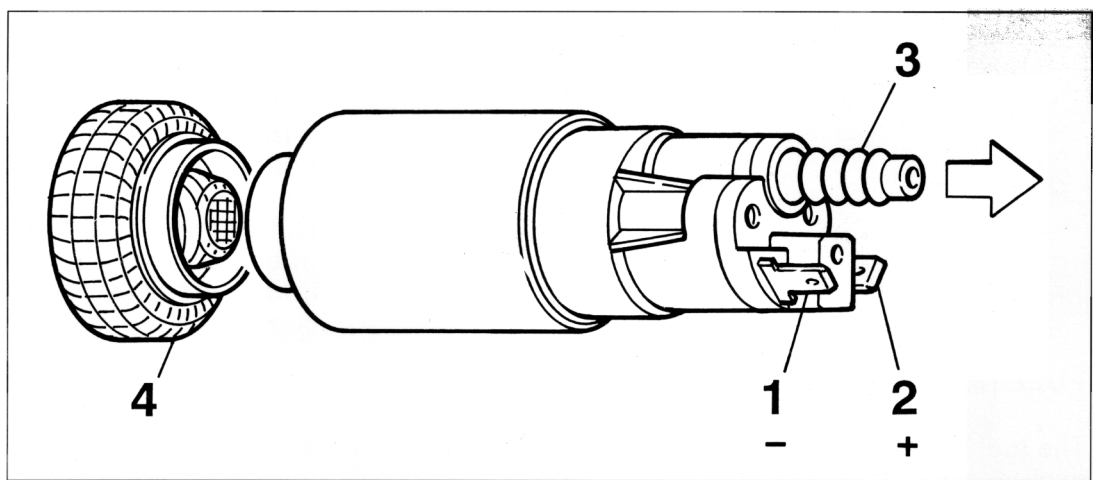
Fuel pump
The pump is housed in the fuel tank in a special cage, which also holds the fuel gauge sender unit, and has a mesh filter on the pump inlet. The pressure regulator is mounted on the pump delivery.



1. Complete cage
2. Pressure regulator
3. Fuel gauge sender unit
4. Float
5. Electric pump
6. Fuel filter
7. Prefilter
8. Non-return valve
9. Internal fuel return
10. Fuel delivery
11. Electrical connector
12. Double contactor
13. Inertial switch

The pump is of the positive-displacement type and is designed to function with unleaded fuel. The rotor is driven by a DC motor supplied at the battery voltage directly by the double contactor, controlled by the control unit, to ensure:

- that the pump stops if the engine rpm falls below a minimum threshold (about 450 rpm);
- time-lagged operation (about 15 seconds) whenever the ignition is switched on, even if the engine is not started;
- operation when the engine has started.



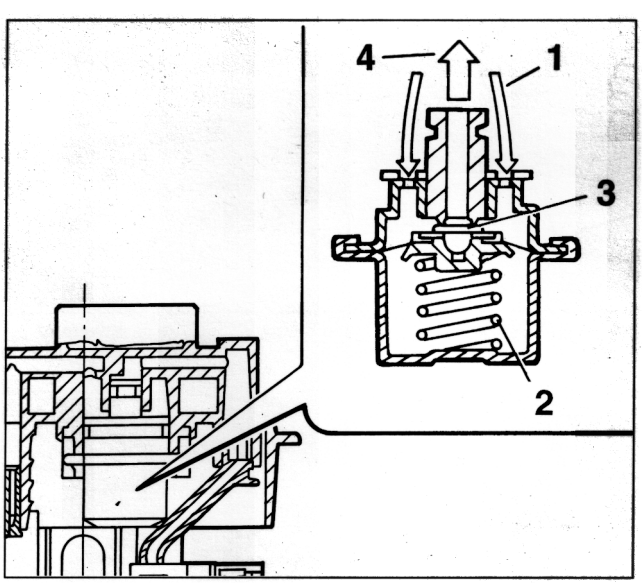
P3W41BJ01

1. Negative
2. Feed
3. Delivery
4. Prefilter

The pump has an overpressure valve, which bypasses the delivery with the inlet if the pressure in the delivery circuit exceeds 5 bar, thus preventing the electric motor from overheating.
In addition, a non-return valve fitted in the delivery prevents the entire fuel system from emptying when the pump is not in operation.
The pump's nominal flow rate varies depending on the speed of the rotor and so the supply voltage.

Fuel filter

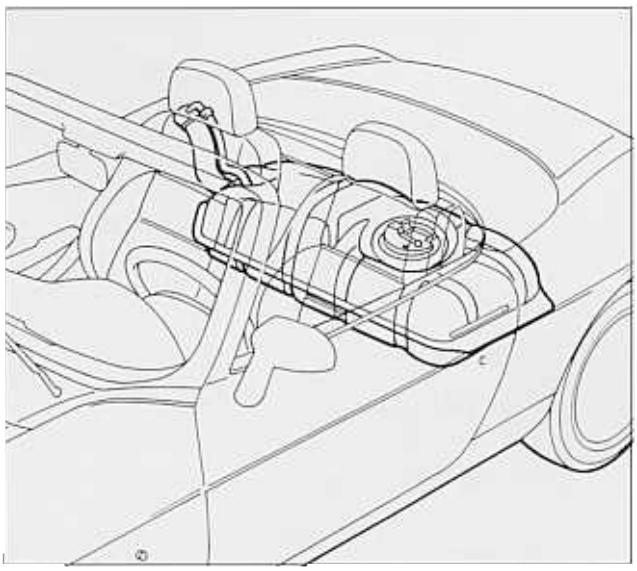
The fuel filter is contained in the casing which houses the pump, and does not require periodical replacement.



P3W41BJ02

Fuel pressure regulator

This is a differential device with diaphragm, factory set to a pressure of 3.50±0.05 bar and located at the top of the cage.
The pressurized fuel (1) coming from the pump exerts a thrust on the backflow valve (3) counteracted by the calibrated spring (2). When the calibrated pressure is exceeded, the backflow valve opens and the surplus fuel (4) returns to the tank, thus stabilizing the pressure in the system.



P3W42BJ01

FUEL TANK

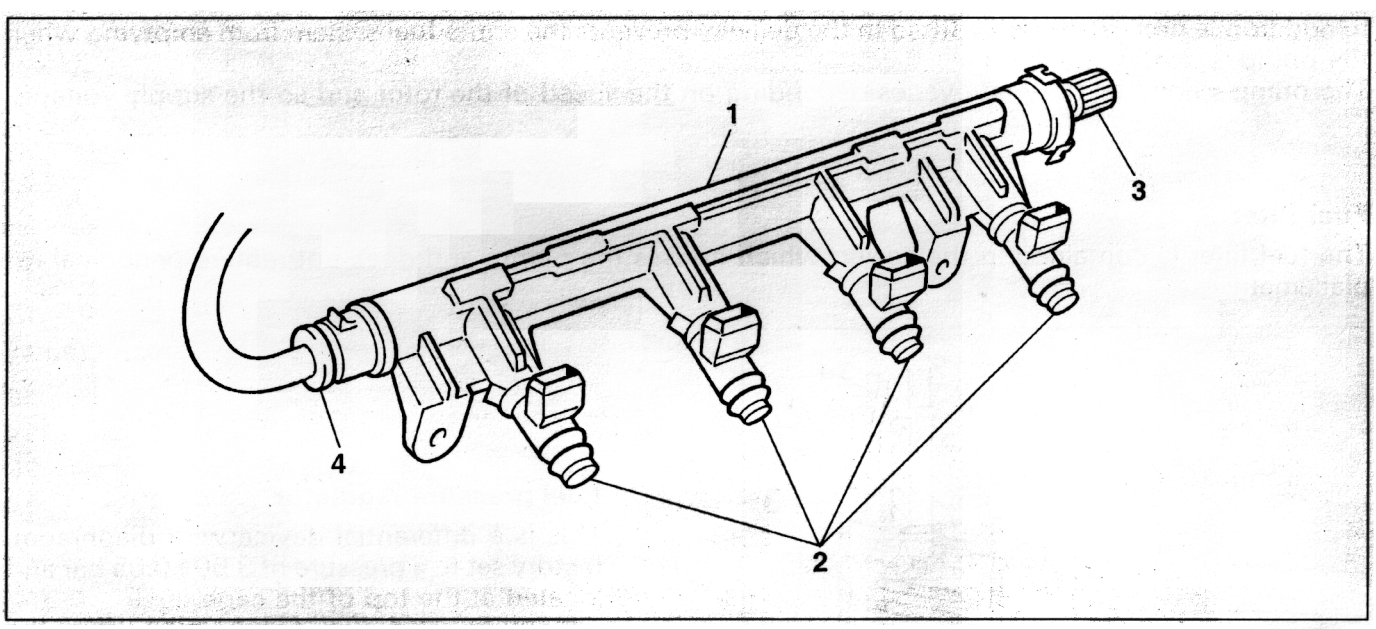
The fuel tank is located at the rear of the vehicle.
If access has to be gained to the fuel tank, proceed as follows:

- remove the seats;
- remove the panel behind the seats, which separates the car interior from the tank.

If the pump has to be removed, the tank need not be removed, simply lift the hood compartment cover and the part of the hood attached to the bodywork in order to access an opening covered by a flange, through which interventions can be carried out on the cage containing the pump.

FUEL MANIFOLD

The fuel manifold, whose function is to distribute the fuel to the fuel injectors, is made of die-cast aluminium and it comprises the seats for the fuel injectors and bleed valve.
The fuel inlet comprises a tapered sealing screw. As the system is of the "returnless" type, there is no recirculation pipe.

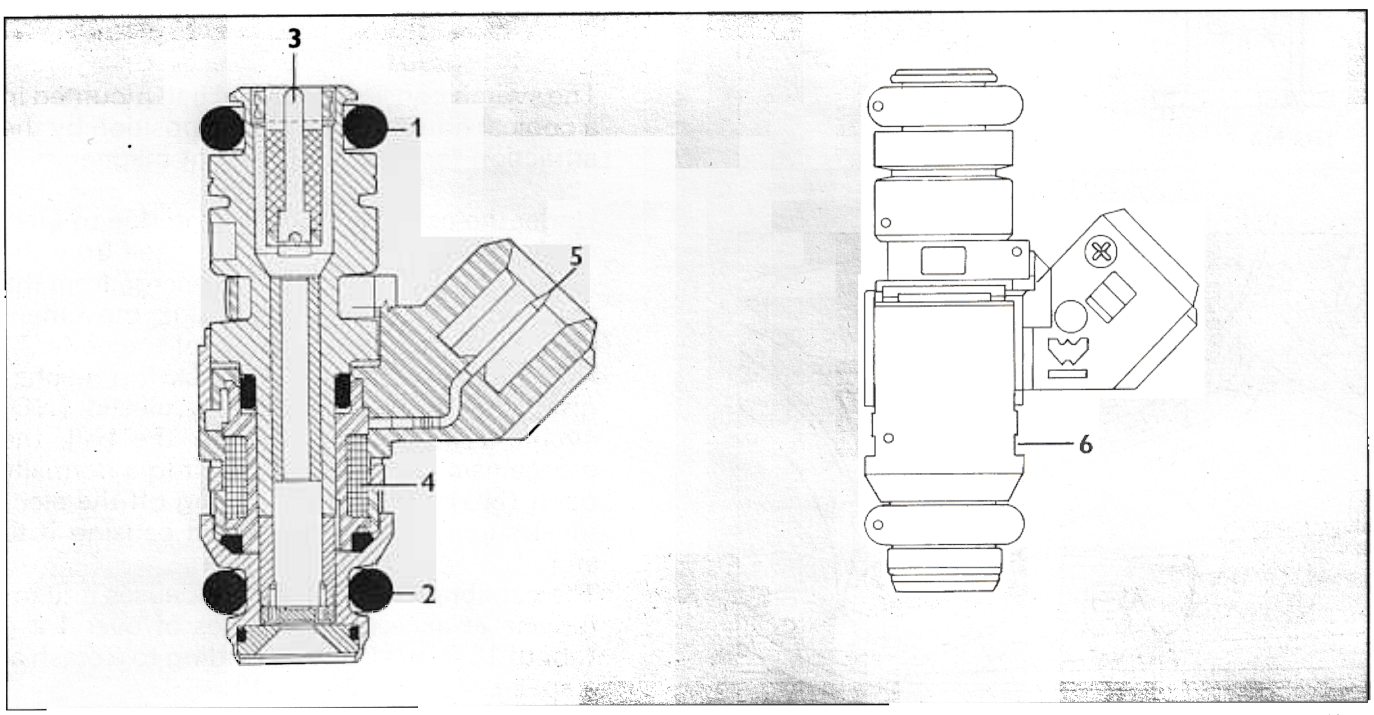


P3W42BJ02

1. Fuel manifold
2. Fuel injectors
3. Bleed valve
4. Fuel inlet connection

FUEL INJECTORS

The fuel injector has to deliver the necessary quantity of fuel for engine operation; the fuel is injected into the inlet pipe, immediately upstream of the inlet valves.
The injector is of the topefeed twin-jet type, with fuel feed (3) from the top of the body, which also houses the electrical winding (4) connected to the terminals (5) of the connector.
When current passes through the winding, the magnetic field which is created attracts the shutter, causing the fuel injector to open and fuel to pass.
Two rings ensure a seal on the fuel manifold side (1) and inlet manifold side (2). A notch (6) determines the angle position of the injector in relation to the inlet pipe to ensure the correct direction of the jets in relation to the inlet valves.

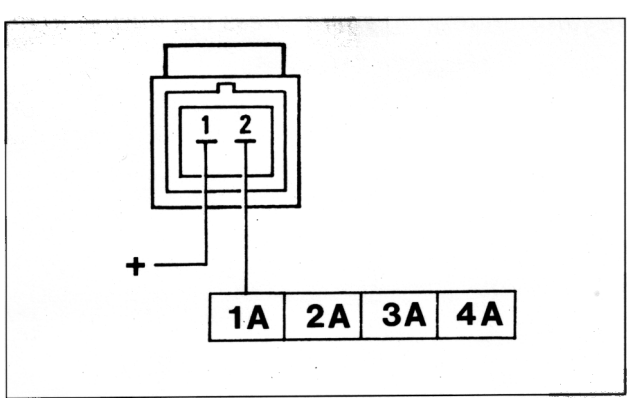


P3W43BJ01

The injector's resistance can be measured by disconnecting the connector and connecting an ohmmeter as shown in the figure.

Resistance: 14.5 ± 5% ohm.

Wiring connector



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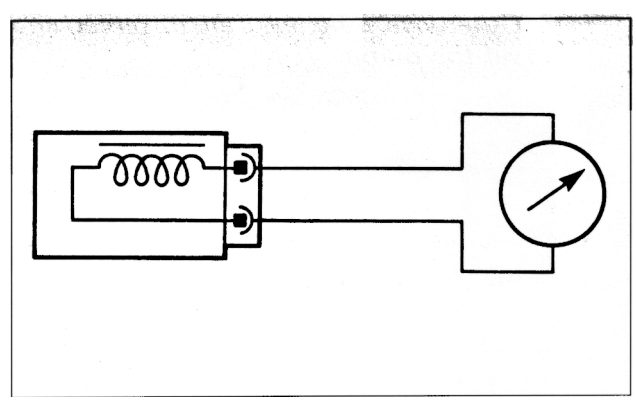

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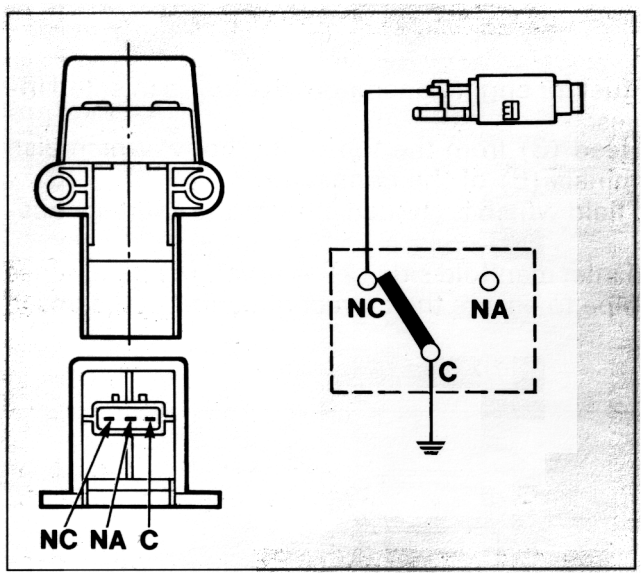
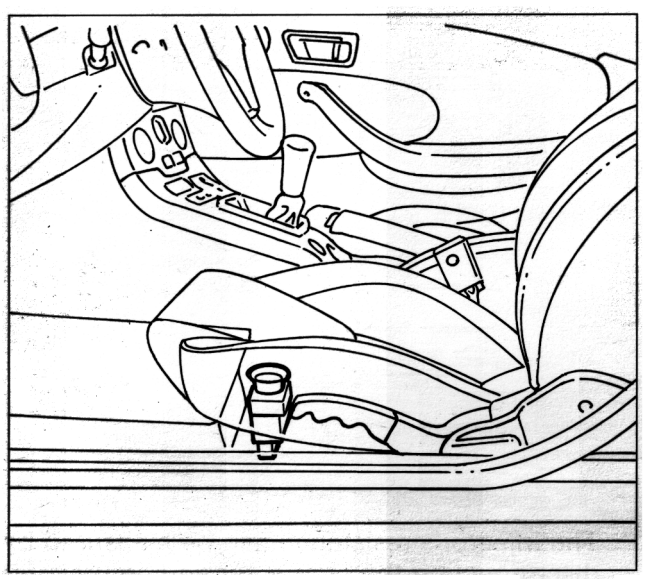


P3W44BJ01



P3W44BJ02

SAFETY INERTIAL SWITCH

The inertial switch cuts off the power supply to the electric fuel pump if the vehicle undergoes very abrupt deceleration (crash), to avoid the vehicle catching fire if the fuel manifold or delivery pipe are damaged.

The switch consists of a steel ball mounted in a conical housing and held in position by the attraction force of a permanent magnet.

Under the action of acceleration due to inertial forces, the ball can release itself from the magnetic lock and gradually emerge from the tapered seat with an upward movement which depends on the angle of the cone.
Above the ball, there is a quick-trip mechanism which forms a normally closed (NC) circuit. When it is struck by the ball, the mechanism changes position into a normally open (NO) circuit, thus cutting off the electrical supply to the pump and causing it to stop.
The cablibration of the switch causes it to intervene at acceleration values of over 1.2 g (about 11.7 m/s², corresponding to a crash at a speed of about 25 km/h).
The switch can be reset by pushing the top button protected by a rubber cover.

After an apparently minor crash, if the smell of fuel or fuel leaks are detected, do not reset the switch, but look for the fault and eliminate it, to avoid fire risks.
Otherwise, if no leaks are observed and the vehicle can start driving again, press the button to reset the pump.

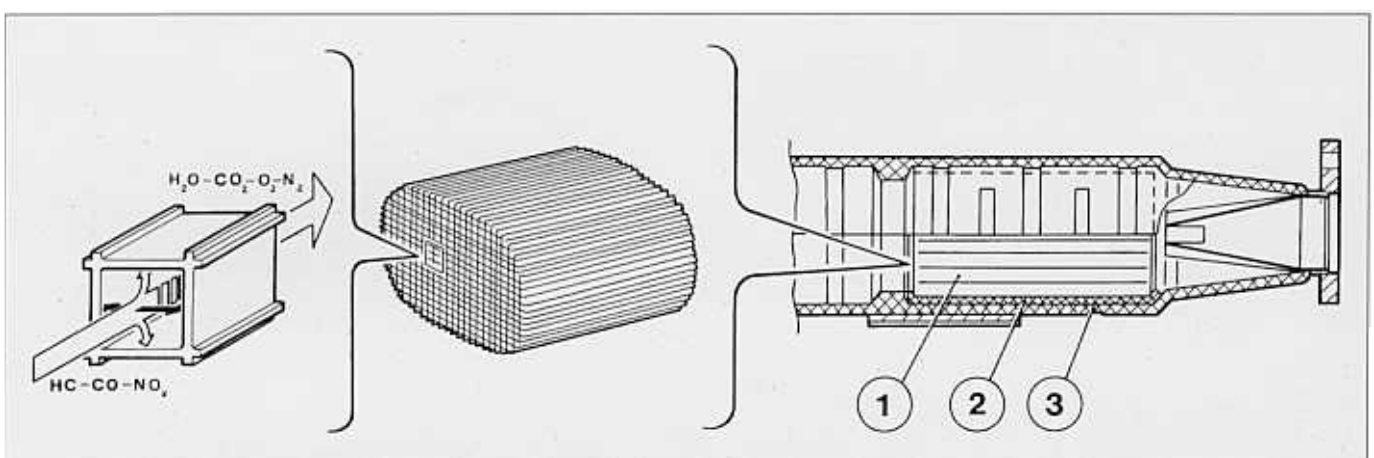
EMISSION CONTROL SYSTEMS

These devices have two purposes:
- to reduce polluting substances present in the exhaust, by means of the catalytic converter;
- to eliminate the dispersion towards the outside of unburnt hydrocarbons, by means of the anti-evaporation system (fuel) and oil vapour recirculation system (lubricant).

CATALYTIC CONVERTER

The catalytic converter is a device which allows the three main pollutants present in the exhaust to be reduced simultaneously: unburnt hydrocarbons (HC), carbon monoxide (CO) and nitrogen oxides (NOx).
Two types of chermical reaction take place in the catalytic converter:
- oxidation of the CO and HC, converted into carbon dioxide (CO_2) and water (H_2O);
- reduction of NOx, converted into nitrogen (N_2).

These reactions occur very quickly because of the presence, in the structure (ceramic mounting) of the catalytic converter, of a layer of active substances (platinum and rodium) which greatly accelerate the rate of conversion of the harmful substances.
The efficiency of this conversion process is influenced by the fact that the mixture strength with which the engine operates constantly fluctuates around the stoichiometric value, which is obtained thanks to the feedback control by the control unit on the basis of the Lambda probe's signals.
Finally, the conversion processes are active for temperatures of over 300 - 350°C: it is therefore essential for the catalytic converter to reach this temperature as quickly as possible in order to function correctly.



P3W45BJ01

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

When working near the catalytic converter, the vehicle must be left to stand at rest for some time, as the internal working temperature of the catalytic converter is between 500 and 850°C.

There are two causes which can destroy the inside of the catalytic converter:

- *presence of lead in the fuel, which lowers the conversion gradient to virtually zero ("lead poisoning") and also irreparably damages the Lambda probe;*
- *presence of totally unburnt fuel in the exhaust gases, due to lack of ignition, causing an increase in temperature which leads to the melting of the ceramic housing. Consequently, under no circumstances should the coil connector be disconnected with the engine running; during tests, the catalytic converter should first be replaced with an equivalent piece of piping.*

FUEL EVAPORATION CONTROL SYSTEM

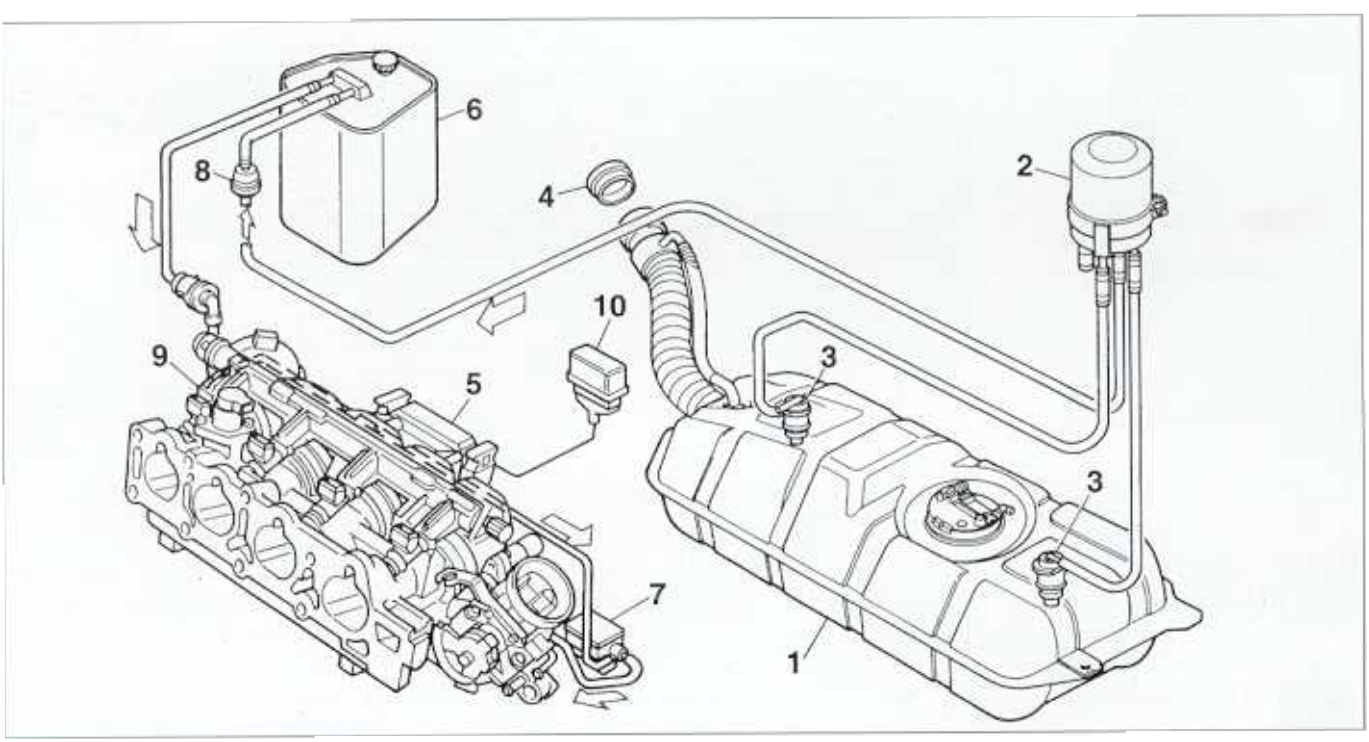
The purpose of the fuel evaporation control system is to prevent the fuel vapours, consisting of the lighter fractions of hydrocarbons, which form in the tank from discharging into the atmosphere.
The system consists of the tank, vapour separator, two float valves, a two-way ventilation valve, the charcoal filter and a charcoal filter scrubbing solenoid, controlled by the control unit. The cap is fitted with a two-way safety valve.

Principle of operation

The system mainly operates in high external temperatures, when the fuel temperature increases and so the tendency to evaporate also increases; in this situation, there is an increase in pressure inside the tank.

In particular, even when the tank (1) is full, the two float valves (3) remain open, as they are located in a higher position than the vent pipe, and so they always allow fuel vapours to reach the separator (2), thus preventing fuel leaks.
The fuel vapours reach the charcoal filter (6) when the pressure inside the tank causes the ventilation valve (8) to open. This valve also allows air to go into the tank through the charcoal filter, if this is necessary following a reduction in fuel level.

When the engine is running, the control unit drives the charcoal filter scrubbing solenoid, which allows vapours to be drawn in by the engine and so the charcoal filter to be scrubbed.
If the pressure in the tank increases dangerously because of the malfunction of a component, the safety valve located in the cap (4) allows the pressure to discharge to the outside. If necessary, this valve can open in the opposite direction, to ventilate the tank and prevent the vacuum reaching excessive values.

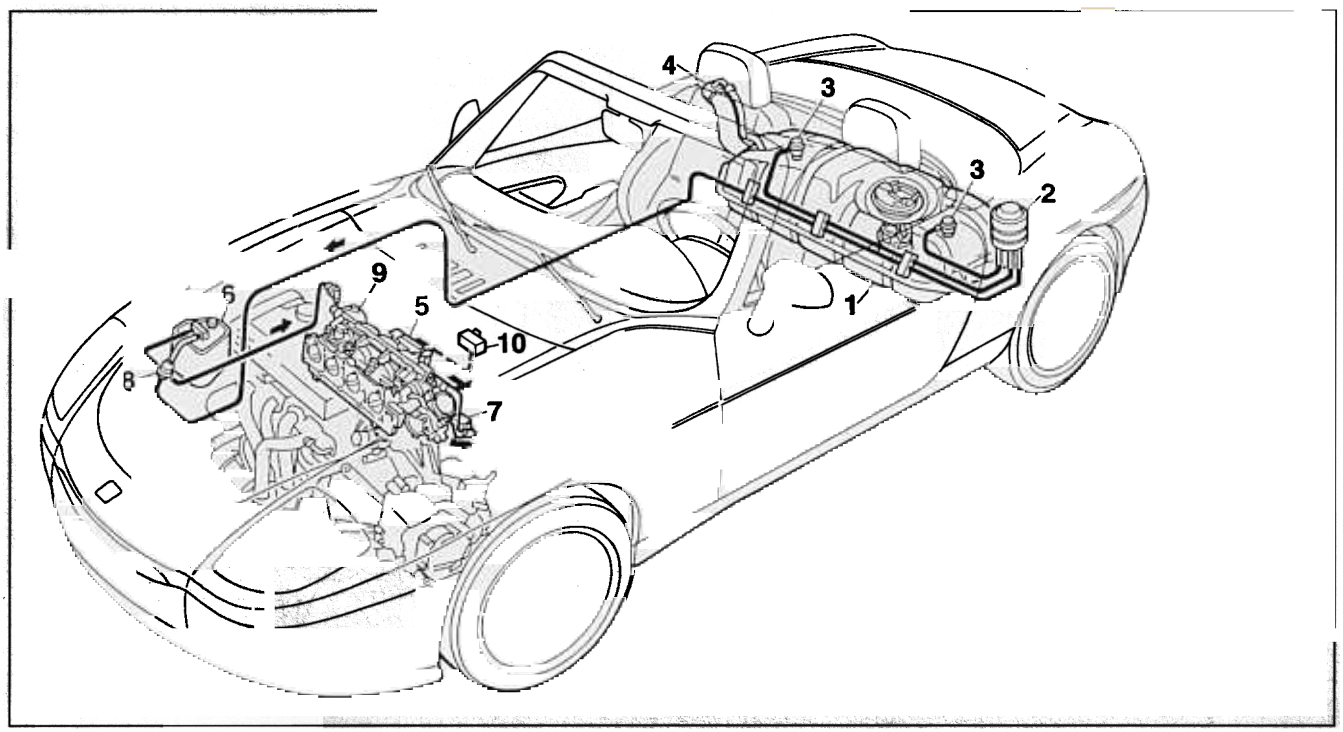


P3W46BJ01

1. Fuel tank
2. Vapour separator
3. Float valve
4. Cap with safety valve
5. Engine control unit
6. Charcoal filter
7. Charcoal filter scrubbing solenoid
8. Ventilation valve
9. Inlet manifold
10. Double contactor

Location of evaporation control components

1. Fuel tank
2. Vapour separator
3. Anti-roll valves
4. Cap with safety valve
5. Engine control unit
6. Charcoal filter
7. Charcoal filter scrubbing solenoid
8. Ventilation valve
9. Inlet manifold
10. Double contactor



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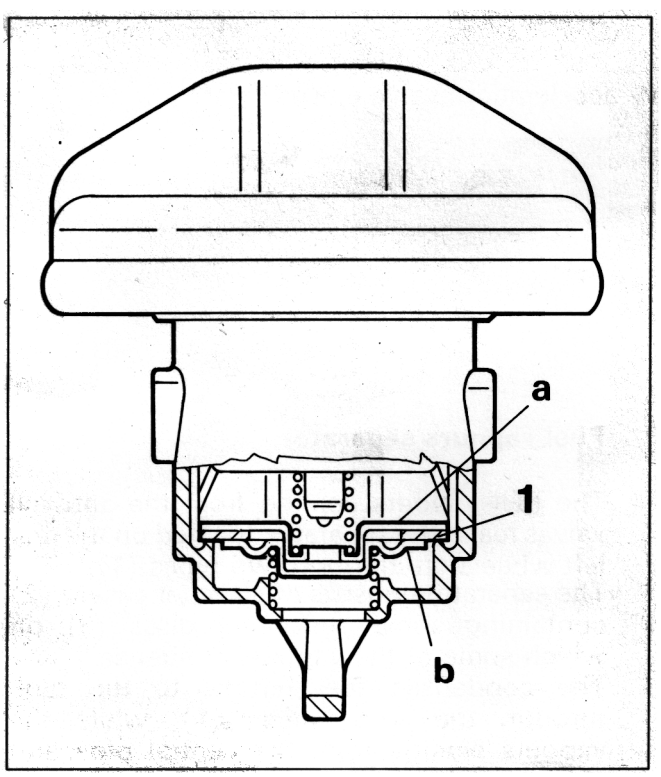


P3W47BJ02

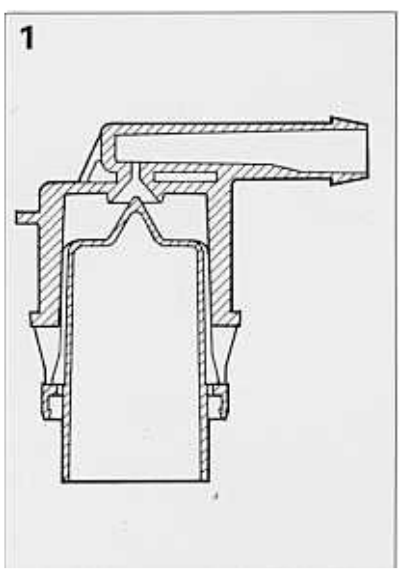
Safety and ventilation valve

This valve (1) is located in the fuel filler cap and, depending on the pressure in the tank, it carries out the following functions:

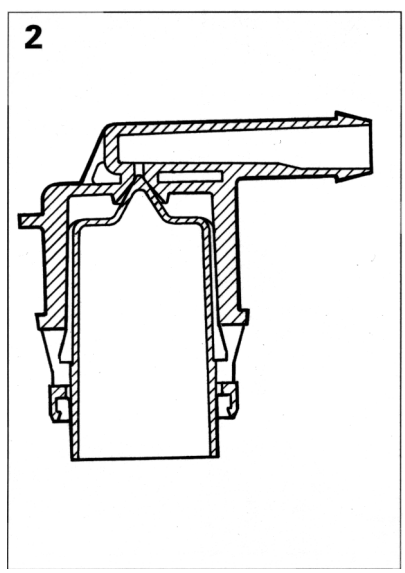
- when the pressure exceeds the calibration pressure of the outer spring, the plate (a) opens and allows the pressure to discharge to the outside (safety function);
- when instead a vacuum is created in the tank which is higher than the calibration threshold of the internal spring, the plate (b) opens and allows external air to enter (ventilation function).

Float valve

The float valve allows vapours to flow back to the separator, without however allowing liquid fuel to leak through.
The valve contains a float, the end of which is specially shaped and closes the outlet hole of the valve in the following conditions:
- strong lateral acceleration (vehicle on bend) or longitudinal acceleration (vehicle braking) with relevant shifting of the fuel mass because of the inertial force;
- rolling of the vehicle.



P3W48BJ01



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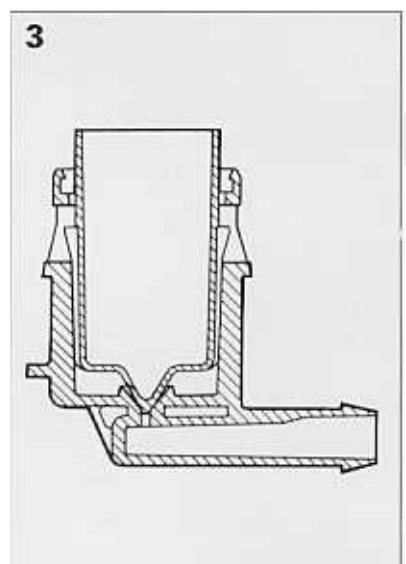
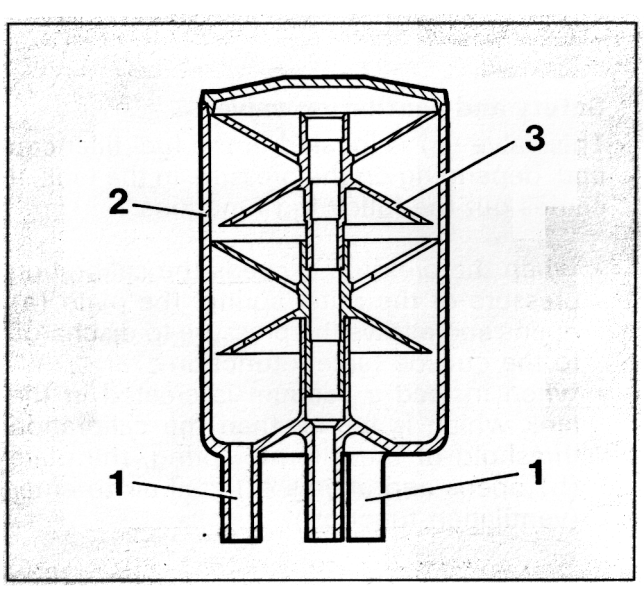


P3W48BJ03

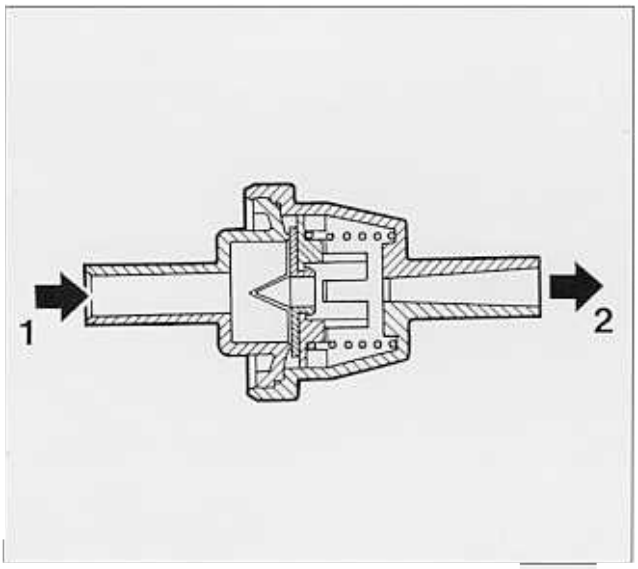
1. Normal operating conditions: valve open
2. The fuel pushes the float upwards because of heavy acceleration: valve closed;
3. Vehicle rolled: valve closed.



P3W48BJ04

Fuel vapours separator

The fuel vapours coming from the anti-roll valves reach the separator, located on the rear left wheelarch, through two pipes (1).
The separator consists of an outer casing (2) containing some perforated discs (3) on which some of the vapours condense.
The condensed fuel returns to the tank through the same pipes (1), while the vapours emerge from the central pipe and reach the charcoal filter.



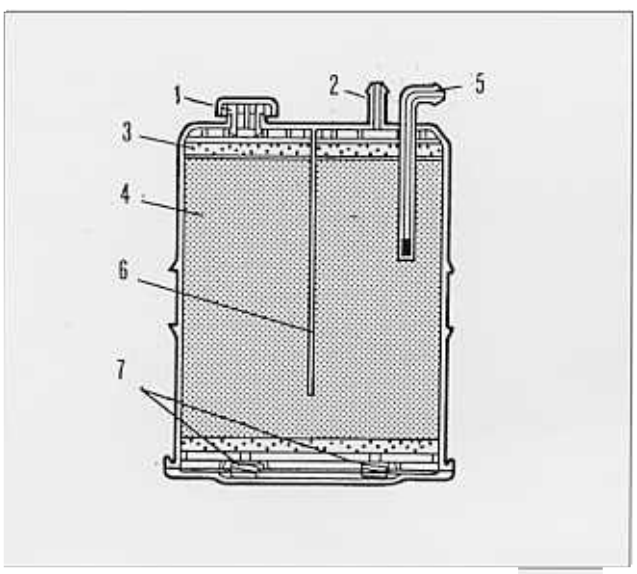
P3W49BJ0

Two-way ventilation valve

The ventilation valve allows vapours to flow back to the charcoal filter when the pressure in the tank causes it to open.

In addition, the valve allows ventilation air coming from the charcoal filter connection to pass to the tank, when the latter is in a slight vacuum.

1. From the fuel vapour separator
2. To the charcoal filter

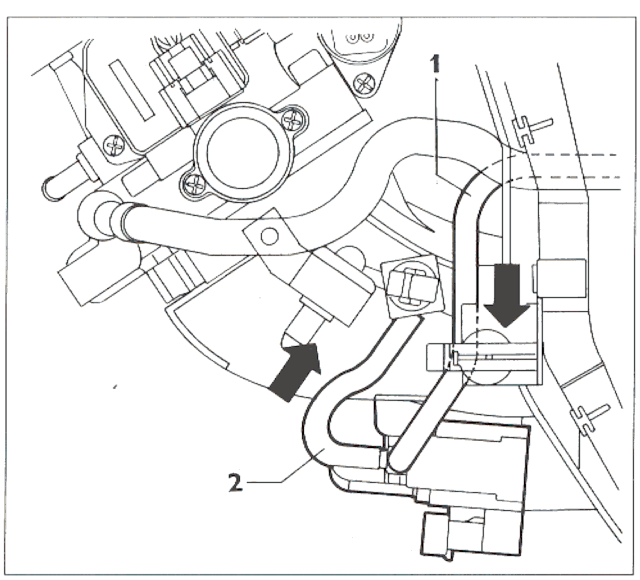


P3W49BJ02

Charcoal filter

This consists of a mass (4) of charcoal granules which retain the fuel vapours coming from the connection (5).

The scrubbing air enters from the connection (1), passes through the paper filter (3), envelops the granules, and removes the vapours, conveying them to the outlet connection (2), which is connected via the scrubbing solenoid to the inlet manifold.
The baffle (6) ensures that the charcoal mass is scrubbed evenly.
The air can also be recalled through the connection (1) by the vacuum in the tank.
The springs (7) compensate for the expansions of the charcoal mass.



P3W49BJ03

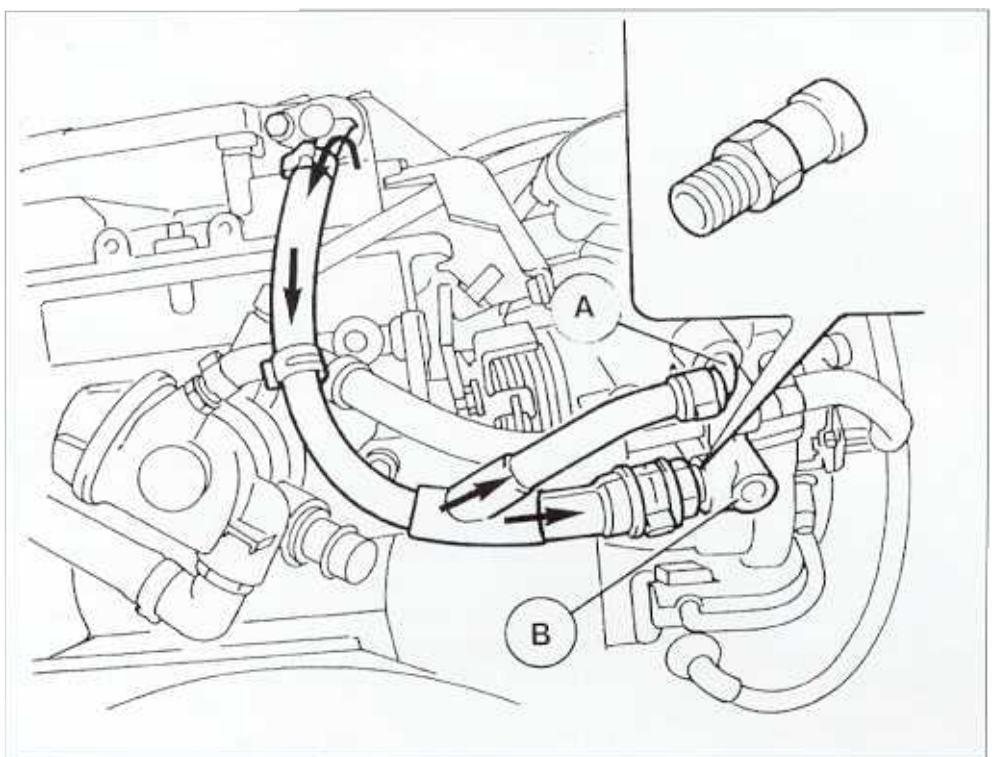
Charcoal filter scrubbing solenoid

This valve is of the normally closed type, and controls the flow of vapours reaching the inlet manifold; the valve itself is controlled by the control unit in a duty cycle.

1. From charcoal filter
2. To inlet manifold

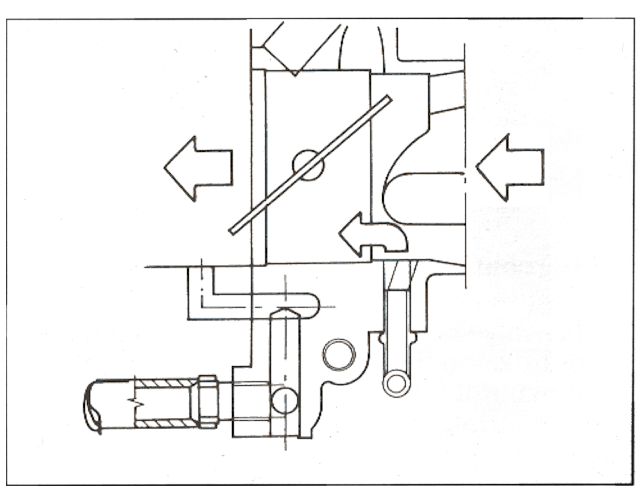
CRANKCASE GAS RECIRCULATION SYSTEM (BLOW-BY)

The system controls the emissions of vent gases from the crankcase, consisting of mixtures of air, fuel vapours and burnt gases which leak through the piston rings, and lubricating oil vapours, by having them drawn back in and burnt by the engine.
The vent gases coming from the crankcase rise up to the cylinder head, and are conveyed in two different inlet connections:
- at medium-large apertures of the throttle valve, the gases are drawn in by the pipe located immediately downstream of the flow meter (detail A);
- at small apertures of the throttle (especially if the engine is idling or overrunning) the gases are drawn in through the PCV (Positive Crank Ventilation) valve mounted on the throttle body downstream of the throttle (detail B).



P3W50BJ01

Detail A



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Detail B